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Ceasefire Monitoring and Verification and the Use of Technology: Insights from Ukraine 2014–2022

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Cover image: "OSCE monitor launching UAV during patrol near Schastia, Luhansk region," August 2017, OSCE/ Evgeniy Maloletka

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Foreword by Ambassador Simon Geissbühler

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Content

List of Acronyms

2D	Two Dimensional
3D	Three Dimensional
ACV	Armored Combat Vehicle
AGS	Automatic Grenade Launcher
AI	Artificial Intelligence
APC	Armored Personnel Carrier
CCTV	Closed-Circuit Television
COVID-19	Disease caused by the SARS-CoV-2 virus
D-Day	The marking of the Normandy (France) landings in the Second World War on 6 June 1944
ETHZ	Swiss Federal Institute of Technology in Zurich
EU	European Union
EUR	Euro (currency)
EGIS	Enterprise Geographic Information System
GCS	Ground Control Station
GIS	Geographic Information System
GPS	Global Positioning System
ICRC	International Committee of the Red Cross
IED	Improvised Explosive Device
IMC	Information Management Cell
IT	Information Technology
ITAR	International Traffic in Arms Regulation
JCCC	Joint Center for Control and Coordination
MANPADS	Man-Portable Air Defense Systems
MH17	Malaysia Airlines Flight 17
OSCE	Organization for Security and Cooperation in Europe
OSCE SMM	OSCE Special Monitoring Mission to Ukraine
RFI	Request for Information
RPG	Rocket Propelled Grenade
RPU	Reporting and Political Analysis Unit
SAM	Surface to Air Missile
SAR	Synthetic Aperture Radar
SPG	Antitank Grenade Launcher
SR	Special Representative of the OSCE Chairperson in Office
T-72	Soviet type Main Battle Tank
TCG	Trilateral Contact Group
TMC	Technical Monitoring Center
UAV	Unmanned Aerial Vehicles
UN	United Nations
UN OCHA	United Nations Office for the Coordination of Humanitarian Affairs
UXO	Unexploded Ordnance
USD	United States Dollar
VTOL	Vertical Take Off and Landing

Summary

The aim of this book is to review the use of technology in monitoring and verifying ceasefires, drawing on the Ukraine experience between 2014 and 24 February 2022. It explores the question of how technology can be used to improve the monitoring of conflicts and the verification of whether parties are adhering to their agreements.

The Organization for Security and Cooperation in Europe's Special Monitoring Mission to Ukraine (OSCE SMM) was, upon the invitation of the Government of Ukraine, deployed at the end of March 2014 by a decision of the OSCE Permanent Council following the annexation of Ukrainian Crimea by the Russian Federation. The OSCE SMM was mandated to reduce tensions and foster peace, stability, and security, and to monitor and support the implementation of all OSCE principles and commitments. Soon after its deployment, the OSCE SMM witnessed the continuation of Russia's war against Ukraine, first visible in the eastern part of Ukraine. Luhansk and Donetsk, two eastern regions of Ukraine directly affected by the first part of the war between 2014 and 2020, encompass an area larger than Switzerland, with a frontline that measured nearly 500 kilometers.

The OSCE SMM had an active role in Ukraine until 24 February 2022 when the Russian Federation launched a full-scale invasion of Ukraine engulfing large parts of the country. While the OSCE decided to temporarily withdraw its Mission from Ukraine following the 2022 invasion, it was the Russian Federation's refusal to join a consensus decision necessary to extend the Mission's mandate at the end of March 2022 which ended the Mission.

This report is historical in that it draws on a distinct period in time before the Russian Federation's full-scale invasion of Ukraine in February 2022. Yet the insights on the use of technology in ceasefire monitoring gained in Ukraine are maybe of relevance for future efforts to monitor and verify ceasefires in other conflicts around the world.

What was the context in 2014? In a separate and later development than the deployment of the OSCE SMM, in September 2014, the first two of at least eight substantive agreements were signed in the Belarusian capital, Minsk. Now known as the Minsk agreements, they outlined a broadly formulated set of measures to be put in place to end the war at the time. Central to the agreements was a ceasefire, which over time was followed by so-called

recommitments to the ceasefire. The number of such recommitments stood at least at 17. The ceasefire was never fully adhered to, preventing it from becoming irreversible. The agreements were met with controversy from the start and continued to be a source of dispute until they were rendered irrelevant by Russia's full-scale invasion.

Though at the time neither designed to operate in an active armed conflict nor staffed and equipped accordingly, the OSCE SMM was nevertheless asked in late 2014 to support the implementation of these agreements, particularly the security-related aspects of the ceasefire. The most critical new task was the monitoring and verification of the agreed security measures. This encompassed, but was not limited to, the recording of ceasefire violations, monitoring and verifying the withdrawal and storage of weapons, and overseeing the disengagement of forces and hardware. In addition, the Mission started to document the humanitarian impact of the armed conflict. Itself not a humanitarian aid organization, the OSCE SMM thus began to facilitate access to the conflict-affected areas for those able to provide assistance.

Since 2014, the OSCE SMM grew more than tenfold, in 2021 employing around 1,400 Mission members. Had it initially relied solely on human ground patrols for its monitoring and verification program, the OSCE SMM soon decided to complement these efforts by deploying technology. To cover the vast conflict theater, mitigate unnecessary and unacceptable security risks (e.g., operating during nighttime), and overcome restrictions on the freedom of movement imposed by the sides, the Mission started to use imagery from unmanned aerial vehicles, cameras, and satellites and resorted to acoustic sensors.

The deployment of technology in Ukraine as in other conflict contexts, however, was not without challenges. When looking at the challenges and benefits of technology in ceasefire monitoring and verification two broad categories of reflections[1] need to be made:

1. The **pre-conditions for a ceasefire** to be negotiated and upheld need to be in place. In part, these conditions lie outside the scope of the actual technical quality of the ceasefire agreement and how it is monitored or verified. Such conditions are defined by factors which include the parties' perception of a mutually hurting stalemate, their view of how far political

1 The twofold categorization is based on a lecture by Julian Th. Hottinger (Swiss FDFA) in the Oslo UN Ceasefire Mediation Course, 10 March 2015.

negotiations are a viable option to reach their political objectives and to end the conflict, and the coherence and clarity of their representation in negotiations.[2] To become sustainable, a ceasefire also needs to be linked to progress in political negotiations, else it is likely to collapse (Ukraine) or lead to a frozen conflict situation (Korean Peninsula). With the benefit of hindsight after 24 February 2022, these pre-conditions were not given or changed over time as the decision to launch a full-scale invasion of Ukraine by President Vladimir Putin clearly indicated.

2. The actual **technical quality** of a ceasefire agreement and its modalities of monitoring and verification are also key to an effectively implementable ceasefire. For *even* if the pre-conditions above are given, ceasefires can fail due to misunderstandings between conflict parties. Such misunderstandings can be minimized by a technically sound agreement, with clearly defined terms, clarity of modalities of force disengagement, and well defined monitoring and verification mechanism. Furthermore, an even more complex situation exists when it is unclear if the pre-conditions above are given, *and* the technical quality of the ceasefire agreement is being questioned. This book focuses on this situation. Here the question arises of how far the use of technology in ceasefire monitoring can or cannot compensate for the lack of clarity of a ceasefire agreement.

Ultimately, technology cannot compensate for a lack of will, ambition or clarity in the drafting of agreements. Technology can never offset the negative effects of one-sided compromises, political shortcuts, poorly constructed provisions concerning the monitoring and verification of a ceasefire, or the absence of an accountability mechanism. Moreover, much of the technology available to monitor and verify is expensive to procure and difficult to install, operate, and maintain in an active conflict area. Also, technology produces large volumes of data, which require additional resources for storage, collation, curation, analysis, and use. Furthermore, sufficient political will must be present to implement what has been agreed on, promote compliance, and reduce the rate and gravity of violations. There are also physical limitations to technology use that must be taken into account. As seen by this Mission in Ukraine, civilian technology is vulnerable to interference, damage, or destruction by the parties. While mitigation measures employed by the Mission saw some success

2 See for example: I William Zartman, *Ripe for Resolution* (New York: Oxford, 1985/1989).

in countering interference attempts, they were ultimately no match for the weapons and technology used to undermine the OSCE SMM's mandate. Adding to the equation constraints linked with inconsistent mandate interpretation, operational posture focused on risk aversion, weather conditions and the sensitive nature of some of the technology, the limitations of using technology in monitoring and verifying a ceasefire become all too obvious.

Despite these challenges, technology enabled the Mission to maintain its presence in the conflict area and permitted the OSCE SMM to produce a large and detailed account of the developments in eastern Ukraine until 24 February 2022. It recorded ceasefire violations, listed weapon systems in places where they should not have been, registered minefields, and documented the impact of the war on the local population. Most of the Mission's reports were public and used to contain and mitigate the conflict within certain parameters. They were also used by other organizations, including agencies of the United Nations, to deliver aid and relief where the OSCE SMM identified a need. Through this detailed record keeping, we know that, except for a few days between August and October 2020, the ceasefire was broken every single day for almost eight years.

Given both the mixed achievements of this innovative approach to monitoring and verifying and the serious challenges that go with it, this book will make the point that there is much to learn from the OSCE SMM's experience with technology. Monitoring and verification efforts in other conflict settings may draw on and benefit from the lessons learned by the OSCE in Ukraine. Some of the key lessons relevant beyond Ukraine include:

- *Pre-conditions for a ceasefire:* The pre-conditions for a ceasefire to be negotiated and held, e.g., the parties' willingness to try and use political negotiations to resolve differences, need to be given. Without these pre-conditions, the most carefully drafted ceasefire agreement and sophisticated monitoring mechanisms will fail. Human monitors and the use of technology cannot compensate for the shortcomings of imperfect agreements or the lack of political will.

- *Benefits:* Technology can reduce the costs of both monitoring and (to a lesser extent) verification missions, especially when compared to a mission exclusively relying on human patrols. Technology may increase the ability to attribute violations to a violator. One of the main benefits is that it

increases coverage, thus making up for some of the restrictions on the movement and access of human monitors. Information gathered through technology tends to be of high quality and is likely to be less disputed by conflict actors. Security risks and allegations of bias or inaccuracy that human monitors are confronted with can be mitigated through the careful use of technology.

- *Risks:* Some of the risks of using technology relate to the framing, management, and processes used when employing it. Thus, unless all parties agree to and are comfortable with these aspects of technology use, it may fuel mistrust, lead to a 'blame game' between actors, and even escalate the conflict.

- *Complementary to humans:* Technology can deliver facts more accurately, faster and in greater numbers. Hence, technology can enhance the effectiveness of human monitors and, to some degree, verification officers; but it will never replace them.

- *Amplifier function:* Technology provides negotiators and mediators with a solid basis to address deficiencies in implementing a ceasefire. It can also support joint fact-finding by the conflict parties, enhance dialogue between them and create an incentive and opportunity to collaborate and embark on a political process. Furthermore, technology can assist in facilitating the accurate and timely delivery of humanitarian aid.

- *Deterrent:* The introduction of technology as an additional tool for the monitoring and verification operation is a means of deterrence, as there will be more 'eyes on the ground'. In combination with an effective political settlement and an accountability mechanism, technology can prove an effective deterrent by increasing the detection rate of violations.

- *Preparation:* Preparation is pivotal in ensuring the effective use of technology. Several factors should be assessed in the preparatory phase: 1) political processes and context; 2) needs from the field; 3) analysis of the technical capabilities of the parties; 4) market analysis of available technology; 5) existing experiences; 6) security and risks; 7) administrative requirements; 8) operational environment; and 9) internal processes, data management included.

- *Criteria for success:* The following elements must be in place for technology to effectively contribute to ceasefire monitoring and verification efforts: 1) a politically supported and detailed *agreement* to cease fire, including an accountability mechanism; 2) agreed terms for the *freedom of movement* of ground-based monitoring and verification teams, extending to the use of technology to complement these teams; 3) sufficient long-term *funding* and *political support;* 4) the *ability to integrate* such technology into the monitoring and verification operation; 5) the will to mitigate rather than avoid risks when deploying ground teams and technology; and 6) unambiguous criteria for a *minimal threshold of compliance* from the parties, and a clear contingency plan by the monitoring mission if this threshold is not met.

Foreword

Switzerland has a longstanding tradition of good offices and peacebuilding. Our federal constitution provides the mandate for our role in fostering peace, human rights, and democracy worldwide. Our foreign policy strategy for 2024–2027 concretizes this commitment and spells out the need to further deepen Switzerland's engagement for peace bilaterally as well as multilaterally.

The harnessing of concrete and practical experiences from the field stands among the most crucial elements in the pursuit of our objective to build peace. By collecting and analyzing hands-on field experience, we contribute to establishing best practices and to better understanding the potential for innovation. We are looking for innovation in areas where we feel our responses to challenges in mitigating and resolving conflict could be more effective. Innovation is prompted by the specific needs in a given context, by the availability of new technology, and by the creation of structures and institutions to fulfill a specific mandate, e.g., the monitoring of a ceasefire. It is usually the conjunction of all these factors that allows us to move beyond the well-established frameworks we have grown accustomed to and to test new ideas creatively.

The present book, *Ceasefire Monitoring and Verification and the Use of Technology: Insights from Ukraine 2014–2022* by Alexander Hug, the former Principal Deputy Chief Monitor of the Special Monitoring Mission of the OSCE in Ukraine (2014–2018), is a case in point. It introduces the interested reader to an exciting world of practice by looking into the use of technology in ceasefire monitoring and by discussing its potential and pitfalls. These are the insights – directly from the field – that are needed not only by experts and the parties they work with but also by diplomats and policymakers to make our efforts to bring about peace more effective.

Whereas I remain convinced that technology will not replace human ceasefire monitors on the ground, I am equally persuaded that the use of technology – for example, satellite imagery, drones, cameras, sound detectors, social media, and others – will become more commonplace in ceasefire monitoring missions. Such instruments will provide a positive contribution as support elements to the work of the ceasefire monitors. Machines and technology cannot, however, build trust in a ceasefire monitoring mission. Humans do that. And building trust through monitoring is probably the most

important and most valuable element in a ceasefire – as it gives the warring sides and the civilian populations most affected by the conflict a perspective that the violence might stop, that the conflict might end, and that life can get back to normal.

I would like to thank Alexander Hug for sharing his invaluable experiences in a field of practice that will benefit from his insights and recommendations. We will put them to good use in our own work in building ceasefires and peace worldwide. We encourage conflict parties that are negotiating a ceasefire or that are about to enter such negotiations as well as experts in international organizations supporting such negotiations to read this publication and to integrate its findings – where possible and useful – into their work.

Ambassador Simon Geissbühler, Head Peace and Human Rights Division, Swiss Federal Department of Foreign Affairs until July 2024

Preface

This book tells the story of how civilian monitors, only armed with observation technology, pen and paper, were able to improve the protection of civilians and civilian infrastructure in Ukraine between 2014 and February 2022. The way the OSCE Special Monitoring Mission to Ukraine (OSCE SMM) monitored and reported on compliance with the Minsk agreements, including with technology, offers invaluable lessons learned for future efforts in other theatres aimed at easing tensions during armed conflict.

As Russia's invasion of Ukraine persists, it is worthwhile to reflect on previous attempts to end violence through diplomatic means, both successful and failed. The agreements reached in Minsk aimed at easing tensions, yet they ultimately failed to prevent a devastating war. While these agreements were far from perfect, a full-scale conflict could have been prevented had the outlined steps been taken and Ukraine's territorial integrity and sovereignty restored at the time.

From March 2014 to March 2022, the 57 participating States of the Organization for Security and Cooperation in Europe (OSCE), deployed a Special Monitoring Mission to Ukraine. After Russia's occupation and annexation of Crimea in 2014 and its subsequent support of violence in eastern Ukraine, it was clear that observers were needed to monitor the ceasefire which was eventually agreed upon in Minsk and signed by two OSCE participating States: the Russian Federation and Ukraine.

For various reasons, it fell to the OSCE to provide a monitoring and verification capacity, utilizing the already deployed OSCE SMM by repurposing it. And the OSCE delivered: The organization provided an increased budget, boosted its personnel, added more and new equipment, and, most importantly, established a permanent OSCE presence on both sides of the frontline by modifying the operational structure of its already deployed OSCE operation in Ukraine. France and Germany had been the driving forces behind the implementation of the Minsk agreements, and the OSCE SMM was a particularly important instrument in these efforts.

During its tenure, the OSCE SMM fulfilled an important function, and it did so well considering the difficult and often dangerous environment it was operating in. Widely underreported, the OSCE SMM's presence along the frontline and often between the parties to the war had a certain deterrence effect to the benefit of those most affected by the war. Using tech-

nology and persistent dialogue with all parties involved, the OSCE SMM managed to negotiate temporary pauses in the fighting, to enable the evacuation of civilians caught in the middle of the war, recovery of dead and wounded combatants and civilians, and repair of critical civilian infrastructure.

The reports of the OSCE SMM were a critical basis for all relevant talks. Further, the information contained in these reports on ceasefire violations, the movement of troops, and the observation of the withdrawal requirements for heavy weapons were key for the assessment of the situation on the ground. Until the end of its mandate, the monitors of the OSCE SMM remained the eyes and ears of the international community in eastern Ukraine. And we want, on this occasion, to pay tribute to the thousands of courageous women and men who had committed themselves to this mission.

The use of technology by the OSCE SMM, in particular, the combination of various sensors and the integration of the resulting information in its reporting increased the credibility and reliability of the facts presented by the mission. These facts were an important basis for measuring compliance by the warring parties and were part of the foundation for the continued negotiations led by Berlin and Paris. Using satellite images, cameras and drones allowed the OSCE SMM to establish at least a partial permanent presence around the clock at key areas along the frontline. The technology used by this mission enabled it to continue to report and overcome some of the obstacles created by the warring parties. More often than not, however, its reports illustrated violations rather than compliance with the agreements.

The OSCE SMM was a monitoring mission, not a political mission. It was of the highest importance for the mission not to be drawn into political controversies. Therefore, its reports had to contain only verified facts rather than draw on speculation or hearsay or provide comments and conclusions. It was after all up to the parties to the war, the Russian Federation and Ukraine as well as OSCE's other 55 participating States to draw conclusions and to use the information provided by the OSCE SMM, to address violations of the agreements, and ultimately to end the violence and further bloodshed. Unlike now, the international community had a representation on both sides of the frontline. OSCE SMM's reports will undoubtedly be part of how history books will describe this war between 2014 and 2022 as a treasure trove of objective and verified facts.

The violation of commitments and constant interference with the OSCE SMM's mandate, predominantly by Russian troops and affiliated armed group troops in eastern Ukraine, was the visible expression of the lack of will by the parties to the war to undermine the efforts to ease tensions.

While the OSCE's field operation in Ukraine could not prevent Russia's aggression against Ukraine, it helped to contain violence during the phase it was active.

This publication by Alexander Hug, whom we both got to know well while he led the OSCE SMM at the coalface in eastern Ukraine during its first five years of operation, provides an in-depth and objective review of OSCE's field operation in Ukraine. It may also serve as an inspiration for other leaders in peacekeeping confronted with similar challenges.

Ambassador Philippe Étienne
Ambassador of France

and

Ambassador Dr. Christoph Heusgen
Chairman of the Munich Security Conference

Introduction

Facts matter. In conflict resolution, a key fact one must establish is whether the parties are adhering to what they have agreed. If this question remains unanswered, it will lead the parties, mediators, and negotiators down a very narrow lane, if not a *cul-de-sac*. There is little leverage and influence if there is confusion or uncertainty over what is happening on the ground and trust building lacks an important basis. Any factual ambiguity will give the conflict parties ample opportunities to stall or derail the negotiation process; this could be simply due to a lack of information or incomplete monitoring and verification mandates. That said, parties may also fabricate or manipulate facts to undermine the reports and positions of their opponents.

A plethora of actors have an interest in establishing, factually, whether parties to an agreement adhere to it: negotiators and mediators, the parties themselves, multilateral organizations, state actors with a stake in the conflict or those determined to support its peaceful resolution, the media, and, above all, individuals directly affected by the hostilities. For the media in particular, the facts surrounding adherence to the ceasefire are essential. The media is often subject to interference and pressure from the parties to the conflict, barred from accessing the areas affected by the conflict, and mediating between and sometimes aligning with competing narratives. Without accurate information, the news cycle can quickly devolve into recrimination and misinformation, further exacerbating polarization.

Effective monitoring and verification can contribute to answering the question of compliance. Applied in a ceasefire (see Annex A for definition) context, these activities have the potential to furnish objective facts by mirroring the reality (monitoring) and adding an assessment that determines empirically whether ceasefire measures are implemented as agreed (verifying). This book seeks to shed light on how monitoring and verification efforts can benefit from integrating the use of technology, as it draws upon the OSCE experience in Ukraine and reflects on insights relevant to other contexts.

On the one hand, embracing technology can indeed be effective in managing and resolving a conflict situation. On the other hand, technology alone is not enough to stop the fighting and is certainly not a panacea for peacemaking. In a world in which technology increasingly assumes traditional functions previously carried out exclusively by humans, and consider-

ing the growing role of technology in warfare, it would be shortsighted for negotiators, ceasefire monitors and verification officers to ignore the progress in the field of technology. Upon examining old and new wars across the globe, it is evident that armies and armed groups are rapidly developing and acquiring new and technologically sophisticated weapons and tools. While the end of these technical developments is hard to predict, it is almost certain that these technologies will be a determining factor of future wars and must be taken into account when planning and executing ceasefire support operations.[3]

Russia's aggression against Ukraine and international efforts to manage and terminate the resulting war began to take shape in 2014. The OSCE SMM had been engaged before armed violence broke out in eastern Ukraine, but eventually became responsible for determining whether the ceasefire was adhered to and supporting measures were being followed. As they had been mandated and deployed in a different context than the one they later operated in, the OSCE SMM's civilian monitors had to rapidly adapt as they found themselves in the midst of an armed conflict developing at galloping speed. A partial remedy to overcome the difficulties associated with this transformation process was the early use of technology.

Without a mandate specifically designed to monitor a ceasefire, let alone to verify measures supporting the ceasefire, and with ceasefire agreements that had been defined only vaguely, the OSCE SMM was initially confronted with the question of how to ensure operational security and coverage of the vast areas engulfed by armed conflict.

Early on, the OSCE SMM decided to deploy technology to complement the work of its ground patrols. Unmanned aerial vehicles, cameras, acoustic sensors, and satellite images became an integral part of one of the most extensive and expensive field operations the OSCE had ever deployed. The OSCE SMM can serve as one of the first examples of a civilian monitoring and verification mission integrating various technologies into its operations in an active conflict setting to complement its human resources on the ground.

This book, based on first-hand experience in Ukraine that dates back to the period before first shots were fired, reflects on the use of technology for the purpose of monitoring and verifying a ceasefire between 2014 and 24

3 For an overview on mediating ceasefires, see for instance: United Nations Department of Political and Peacebuilding Affairs, *Guidance on the Mediation of Ceasefires*, September 2022.

February 2022. It is aimed at operational staff of missions with a comparable task; decision-makers of multilateral organizations and field operations; political echelons involved in supporting ceasefire agreements; parties to a conflict; and the mediators and negotiators of ceasefire agreements. If this book not only contributes to a better understanding of the roles of monitors and verification officers, but also succeeds in initiating a debate on how to improve their work through the use of technology, so much the better.

This book tries to answer the following seven questions:

- First, what needs to be in place to make the deployment of technology effective as well as worth the costs and efforts involved?
- Second, what are the broad categories of currently available options to monitor and verify a ceasefire through technology?
- Third, is information generated by technology more legitimate and trustworthy (and therefore reliable) than that by humans? Following this, should the use of technology seek to replace or merely complement the work of human ground patrols in monitoring and verifying?
- Fourth, how much monitoring and verification is required to support the implementation of a sustainable ceasefire and how is this related to the quality of the ceasefire agreement and the political pre-conditions for the ceasefire agreement to be held?
- Fifth, while technology certainly helps with early warning – is it also helpful in early action?
- Sixth, can technology assist in strengthening confidence-building measures and dialogue initiatives? Does it change the way in which parties to a conflict communicate?
- And finally, seventh: what effect does the deployment of technology have in the pursuit of a ceasefire where there is limited political will to end violence and address the underlying conflict issues?

Holding a magnifying glass to the OSCE SMM, eastern Ukraine, and the Minsk agreements (for an overview, see Annex A), this publication will strive to shed light on these important facets of peacemaking from the experiences between 2014 and 2022.

At the outset, in Chapter One, by examining Russia's war against Ukraine between 2014 and 2022, this book attempts to outline the evolution of the war up to February 2022, the regulatory framework of the ceasefire, and the OSCE SMM build-up with corresponding monitoring and verifi-

cation capabilities. This sets the scene and parameters for the decisions taken on whether and how to use technology while monitoring and verifying the agreed ceasefire.

In what follows, in Chapter Two, the case is made for the use of technology by exploring the obstacles the OSCE SMM faced when carrying out its monitoring and verification role. This discussion will focus on the restrictions placed on the Mission's access to the battleground. It is important to understand the active, passive, and self-imposed restrictions to access different conflict areas as this directly affected the Mission's ability to monitor and verify the ceasefire. There were multiple reasons for the use of technology (e.g., cost reduction, minimizing risks to human patrols, and a vast area to be covered), but one of the main reasons was the necessity to overcome access restrictions faced by human patrols.

In Chapter Three, the Mission's broad spectrum of different technologies to compensate for limitations in its coverage and restrictions on on-the-ground access will be examined. Specifically, this chapter will explore the use of unmanned aerial vehicles (UAVs), cameras, satellite imagery and acoustic sensors.

In Chapter Four, the challenges of how to organize the mass of information collected are going to be highlighted. We garner insights related to the Mission's experiences in gathering, analyzing, and communicating information from the deployed technology.

In Chapter Five, the challenges of relying on technology in the Ukrainian context and incorporating it into the monitoring and verification mechanisms of the Mission will be studied from technical, financial, operational, and political points of view. Special attention will be devoted to the responses of the Mission to these challenges, providing key areas to reflect on also in other contexts.

Finally, in Chapter Six, the book analyzes more generally how the specific Ukraine experience may be of relevance for other ceasefire monitoring and verification operations and will discuss ways how technology may evolve and be used in the future, beyond the context of the OSCE Mission in Ukraine.

This book does not intend to offer comprehensive answers to the above questions. Rather, it is meant to inform debates among those in pursuit of peace about how (and how not) to complement traditional approaches to monitoring and verifying ceasefires with the use of technology. Each

conflict is different, and the lessons drawn from Ukraine between 2014 and 2022 are not a blueprint for other operations.

This publication does not have the ambition to provide a comprehensive conflict analysis, an in-depth examination of the Minsk agreements, nor an exhaustive review of the war's history or an encompassing assessment of the OSCE SMM's mandate, deployment and findings. Considering the rapid changes and advancements made in this field, it cannot give a full and up-to-date catalogue of all technologies available to monitor and verify ceasefires, either.

Nevertheless, one thing is certain. In efforts to achieve a sustainable ceasefire, facts matter. They do so, regardless of whether they have been obtained through technology or by other means. To some extent, the fate of people affected by the fighting indirectly depends on these facts, as accurate assessments are undoubtedly part of the groundwork upon which a solution for the restoration of peace can be built. Identifying both violations and violators, highlighting shortcomings of existing arrangements as well as documenting and alleviating the people's suffering hinge on objective and verified information. In short, facts matter because people matter.

1. Framework

This framework section provides background information on the OSCE SMM's mandate that defined the monitoring mission between 2014 and 24 February 2022, as well as a brief overview of Russia's war against Ukraine and a broad examination of the ceasefire arrangements. The purpose is to set the scene for a more detailed exploration of the use of technologies in ceasefire monitoring and verification in Ukraine in the following sections.

Mandate of the OSCE Special Monitoring Mission to Ukraine

The Maidan or, as it is referred to in Ukraine, the 'revolution of dignity', started as a peaceful protest against the Government of President Yanukovych in the last months of 2013. It had been triggered by the Government's failure to follow through with the signature of the Association Agreement negotiated with the European Union. Demonstrations gradually led to unrest and violence, which culminated when the protesters were confronted by law enforcement units in the second half of February 2014, leading to deaths on both sides. Following the subsequent flight of then-President Yanukovych from the country, a temporary Government was appointed, and early presidential elections were organized. Then, 'anti-Maidan' protests erupted, mainly in the eastern part of the country, in part supported by the Russian Federation. In February and March 2014, armed forces of the Russian Federation occupied the Crimean peninsula, and later illegally annexed this Ukrainian territory.[4]

Faced with a political and security crisis, the OSCE considered possible ways to ease tensions and to generally address what was then referred to diplomatically as the 'crisis in and around Ukraine'. The OSCE, upon the invitation of the Government of Ukraine, decided to deploy a small field operation to the country as a conflict prevention and resolution instrument. Negotiations began in Vienna under the political leadership of the Swiss Chairmanship, accompanied by diplomatic brokering and the drafting of a

4 For an overview over these developments see for instance: Serhii Plokhy, *The Russo-Ukrainian War* (Penguin, 2023).

mandate for the operation. The idea for a Special Monitoring Mission to Ukraine thus started to take shape.

On 21 March 2014, all 57 OSCE participating States, including the Russian Federation and Ukraine, agreed upon the mandate of the OSCE SMM in OSCE Permanent Council Decision 1117 (hereinafter: 'mandate'). The mandate is a short and broadly formulated document of two pages.[5] When drafting the mandate and at the time of deployment, there was no armed conflict in eastern Ukraine.

The OSCE SMM was mandated to document adherence to the OSCE's politically binding principles and commitments and to reduce tension, aimed at fostering peace, stability, and security (Art. 2). The OSCE SMM was to be deployed to 10 cities across Ukraine, including Donetsk and Luhansk in eastern Ukraine.[6] The Mission initially deployed 100 civilian monitors and was mandated to operate around the clock, as necessary. The mandate did allow flexibility to increase the Mission strength "as necessary" (Art. 6).

The mandate provided for safe and secure access throughout Ukraine (Art. 7) and committed the Mission to report on any restrictions of its freedom of movement (Art. 3/6). The initial deployment was set for six months, with a possibility for extension (Art. 5).[7]

Seven explicit tasks which the Mission was to execute, under the principles of impartiality and transparency, were broadly outlined in the mandate. In a nutshell, its three main pillars are monitoring, reporting, and facilitating dialogue (Art. 3, see Figure 1).

Monitoring

The OSCE SMM's mandate twice referred to monitoring explicitly. At the outset, the mandate referred to "monitoring […] the implementation of all OSCE principles and commitments" (Art. 2). This referred to the political commitments which are legally non-binding stipulations in the OSCE's three dimensions: politico-military, economic and environmental, and human. In a second instance, the mandate tasked the OSCE SMM to "monitor […] respect for human rights and fundamental freedoms" (Art. 3/3).

5 OSCE, *Permanent Council Decision No. 1117*, 2014.

6 Other cities the OSCE SMM deployed to were: Kherson, Odesa, Lviv, Ivano-Frankivsk, Kharkiv, Dnipro, Chernivtsi and Kyiv.

7 Any extension required a consensus decision by all 57 OSCE participating States.

The OSCE SMM was also mandated to monitor the security environment in Ukraine, by being required to "gather information and report on the security situation in the area of operation" (Art. 3/1). The mandate went further by making an indirect reference to verification when it stated that the OSCE SMM should "establish and report facts in response to specific incidents and reports of incidents" (Art. 3/2).

Drafted prior to the eruption of war in eastern Ukraine, the mandate made no reference to a ceasefire and thus contained no explicit provision for verifying or monitoring a ceasefire agreement, let alone the use of technology for these purposes. With the benefit of hindsight, there may have been an opportunity to re-negotiate the mandate six months later once the Minsk agreements had been agreed and the OSCE subsequently was asked to monitor and verify the agreed ceasefire. That said, reopening the mandate for debate may well have led to lengthy debates at OSCE's Permanent Council, potentially risking the mandate altogether, considering the diverse interests of OSCE's 57 participating States.

Reporting

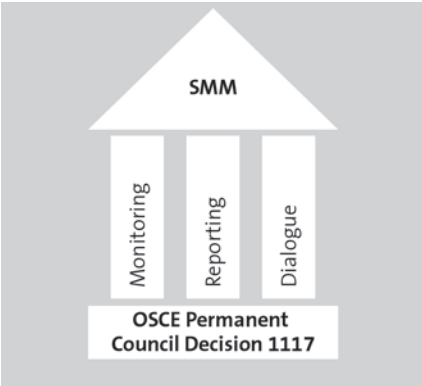
The mandate stated that the findings of the Mission should be reported "regularly" by the Head of Mission to the OSCE Permanent Council through the Chairperson-in-Office (Art. 8). Reporting as a mandated task was further mentioned with regard to information pertaining to the security situation (Art. 3/1), as well as to facts established in response to specific incidents and reports of incidents (Art. 3/2), and restrictions on the Mission's freedom of movement and other impediments to the implementation of its mandate (Art. 3/6).

Dialogue facilitation

The OSCE SMM was to engage with authorities, civil society, and members of the local population (Art. 3/4) as well as facilitate dialogue "to reduce tensions and promote the normalization of the situation" (Art. 3/5). Also, the Mission was mandated to cooperate with other relevant actors of the international community (Art. 3/7).

In summary, the OSCE Mission received a broad mandate to monitor and, arguably, also to verify the security situation in Ukraine. As this mandate was agreed upon before the armed conflict and before the Minsk agreements had been signed, it lacked specificity in relation to ceasefire monitoring and

Figure 1: The three main pillars of OSCE SMM's mandate



Source: A. Hug

verification. While no other monitoring or verification mandate was agreed upon later, the broad terms of its original mandate provided the OSCE with enough flexibility to repurpose the OSCE SMM to the evolving new reality.

Overview of Russia's war against Ukraine

Russia's war against Ukraine had different phases, starting in early 2014 but then massively escalating with Russia's full-scale invasion in February 2022. Up to this date, there was no agreement on when exactly the Russian Federation started the war, manifesting itself in eastern Ukraine soon after the OSCE SMM's deployment. Some argue that it all started at the end of February 2014 when the armed forces of the Russian Federation occupied the Crimean Peninsula, sovereign Ukrainian territory. Others suggest it was the deadly crackdown on the Maidan protesters that caused the escalation. Others again claim that the violence began with the occupation of administrative buildings in Donetsk and Luhansk or with the first battle fatalities in Kramatorsk and Sloviansk during the first two weeks of April of the same year.[8]

8 For a good overview over key events of the first year for this war, see Jakob Hauter, *Russia's Overlooked Invasion, The Causes of the 2014 Outbreak of War in Ukraine's Donbas* (Stuttgart: Ibidem-Verlag, 2023).

Ukraine has consistently made the case that Russia is a party to the war, insisting that the armed formations occupying large parts of eastern Ukraine were supported, trained, and controlled by Moscow; and that soldiers and hardware of the armed forces of the Russian Federation had been engaged in combat operations inside Ukraine, most notably so in the summer of 2014. However, the Russian Federation, which had signed the Minsk agreements, argued prior to its full-scale invasion of Ukraine in February 2022 that it was not a party to the war. Still, the Russian Federation admitted that Russian citizens fought against Ukrainian Government forces[9] and maintained that it was "forced to defend"[10] the Russian-speaking population in eastern Ukraine.

While these allegations remained unsubstantiated and despite the claims by the Russian Federation not being a party to the war, the international community recorded many incidents that indicated direct Russian involvement in the war in the years between 2014 and 2022. There were numerous reports, including reports issued by the OSCE SMM[11], of military-type convoys traversing sections of the border between Ukraine and Russia over which the Ukrainian Government has no control. There have been multiple verified sightings of weaponry not in the arsenal of the armed forces of Ukraine but used by the armed forces of the Russian Federation, including upgraded weapon systems, in areas outside the control of the Ukrainian Government.[12] Additionally, verified accounts put Russian-made military hardware (e.g., electronic warfare systems) in these same areas[13], and several combatants, captured by the armed forces of Ukraine, have also admitted to having been on active service with Russian military units at the

9 See for instance: Guardian News on Youtube, *Putin admits military presence of Russian military in Ukraine,* https://www.youtube.com/watch?v=mD4YrK0irQk, 2015.

10 See for instance: Kremlin, *Russia Calling! Investment Forum,* http://en.kremlin.ru/events/president/news/53077, 2016. and indicating the same line of argument earlier: Kremlin, *Vladimir Putin answered journalists' questions on the situation in Ukraine,* http://en.kremlin.ru/events/president/news/20366, 2014.

11 See for instance the report of a monitored military type convoy near the settlement of Manych: OSCE, *Latest from the OSCE Special Monitoring Mission to Ukraine (SMM) based on information received as of 19:30 11 October 2018*, 2018.

12 For instance, a 9M133 Kornet anti-tank weapon system as observed by the OSCE SMM: OSCE, *Latest from the OSCE Special Monitoring Mission to Ukraine (SMM) based on information received as of 19:30 18 June 2018*, 2018.

13 For instance, the electronic warfare systems: Repellent-1, Krasukha-2, and Bylina as observed by the OSCE SMM: OSCE, *Latest from the OSCE Special Monitoring Mission to Ukraine (SMM) based on information received as of 19:30 10 August 2018*, 2018.

time of their capture in Ukraine.[14] Notably, some of the first leaders of the armed formations were Russian citizens.[15] Moreover, as the Russian Federation unilaterally controlled parts of the Ukrainian-Russian state border, it had sole control over anyone or anything that crossed the international border from and to Ukraine. However, notwithstanding these facts, the Russian backed armed formations have consistently maintained that they have an organizational structure of their own, operating independently from Moscow. Already before the full-scale invasion of Ukraine by the Russian Federation in February 2022, the war had been defined as an international conflict with the Russian Federation as a party.[16]

Russia's war against Ukraine evolved with remarkable speed. At first, demonstrations were organized in response to events unfolding in Kyiv and other cities in Ukraine. Sticks and petrol bombs quickly gave way to pistols, and ultimately to Kalashnikovs, mortars, tanks, and multiple launch rocket systems. Initially holding large swathes of Donetsk and Luhansk regions, the elements that would become the armed formations directed and equipped by the Russian Federation were pushed back by Ukrainian Government forces in the spring and early summer of 2014, in what they then called an 'anti-terrorist operation'. The tide turned rather abruptly against Ukrainian troops, with a series of defeats, notably near Ilovaisk, with the direct involvement of regular Russian combat forces. While the majority of victims were combatants of one sort or another, civilians caught in the middle were hit particularly hard, and have indeed continued suffering to the present day.

Between 2014 and 2022, the two regions of Ukraine most directly affected by the fighting, Donetsk and Luhansk, encompassed an area larger than Switzerland: 52,000 square kilometers. The area in eastern Ukraine beyond the control of the Ukrainian Government covered roughly 17,000 square kilometers. Moreover, the Russian Government retained unilateral control of a 400-kilometer stretch of its 2,000-kilometer border with

14 As reported by the OSCE SMM: OSCE, *Latest from the OSCE Special Monitoring Mission to Ukraine (SMM) based on information received as of 19:30 20 May 2015*, 2015.

15 For instance: Igor Girkin or Aleksandr Borodai.

16 See for instance transcript of the MH17 judgment hearing: De Rechtspraak, *Summary of the day in court: 17 November 2022 Judgement*, 2022. See also paragraph 94 of the report by International Criminal Court (ICC), *Office of the Prosecutor: Report on Preliminary Examination Activities*, 2017.

Ukraine, leaving the Ukrainian Government unable to prevent cross-border movement of people, troops, weapons, or funds.[17]

In September 2014, when the first agreements were signed in the Belarusian capital of Minsk, an attempt was made to map a line separating Ukrainian Government from Russian backed forces. The Minsk agreements referred to it as the 'contact line' (see Annex A for details). This line was approximately 500 kilometers long and ran through the Donetsk and Luhansk regions of Ukraine, separating them into areas under and areas beyond Government control. The latter also encompassed about 70 kilometers of Azov Sea shore to the east of the Government controlled Black Sea harbor city of Mariupol in the southern part of the Donetsk region (see Figure 2).

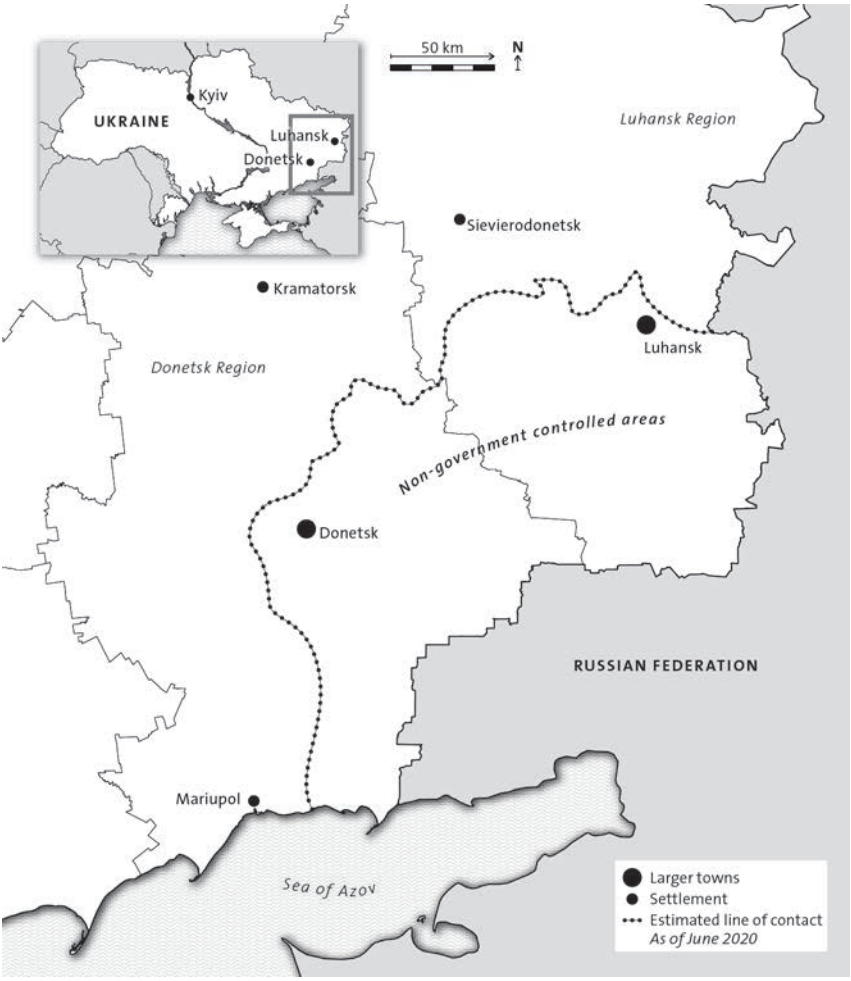
No matter what the term 'contact line' may have actually implied, the neat line drawn on maps was neither fully defined nor far from neat on the ground, as it cut through Ukrainian farmland, cities, and villages with no respect or allowance for either infrastructure or human bonds. It certainly was not a line along existing ethnic, religious or cultural divisions. Roads and railway tracks, as well as gas, water, and electricity pipelines zigzagged across the line while neighbors, friends, and relatives – often just hundreds of meters apart – were obliged to travel hundreds of kilometers to meet. At the very eastern end of the contact line in the Luhansk region and the southern part of the Donetsk region, the Siverskyi Donets and Kalmius rivers, respectively, represented natural obstacles between the sides. For most of the time when the OSCE SMM was present in eastern Ukraine, crossing the contact line was only allowed in five locations.[18]

While fighting had initially been fluid, it had become relatively static over time. Since the sides attempted to define the contact line, there were frequent verified reports of localized forward moves by both sides towards and across that line. In many places, Ukrainian forces and the Russian formations were dug in on both sides of the front line. The complex trench network in places where the sides had come dangerously close to one another resembled the layout of the battlefields of World War I; trench warfare was and remains a specific feature of this war.

17 OSCE participating States' framework for co-operation in this area is set out in the Ministerial Council's "Border Security and Management Concept": OSCE, *Border Security and Management Project*, 2005.

18 In spring 2020, three out of the five crossings were temporarily closed, with the remaining two locations only allowing limited crossing of the contact line.

Figure 2: Map of eastern Ukraine 2014–2022



Source: Simplified figure based on OSCE, Special Mission to Ukraine, Daily Report 141/2020, 15.06.2020, p. 4.

A wide spectrum of weapons was being used. Apart from infantry armaments, including small-caliber mortars, the sides had at their disposal an unspecified number of main battle tanks (e.g., T-64/72), as well as large-caliber, indirect-fire systems, most of which are highly mobile (e.g., the BM-21 'Grad' multiple rocket launcher, the D-20 towed 152 mm artillery

gun or the 2S1 'Gvozdika' self-propelled 122 mm artillery system). Apart from small arms, the most frequently used weapons included heavy machine guns, 82mm and 120mm mortars, automatic grenade launchers (e.g., AGS-17), grenade launchers (e.g., RPG-7), anti-tank grenade launchers (e.g., SPG-9), under-barrel grenade launchers (e.g., GP-25), anti-aircraft machine guns (e.g., ZU-23-2), and anti-tank guided missile systems. Anti-aircraft and electronic warfare equipment had also been in use. In addition, both off-the-shelf and makeshift models of unmanned aerial vehicles (UAVs) were used for reconnaissance and artillery target guidance (enemy battery identification and fire adjustment). At the time there were also repeated reports of UAVs used to attack and deliver explosive devices on enemy positions, a tactic now commonly practiced by both parties[19]. Since Russia's full-scale invasion of Ukraine, both armies increasingly rely on UAVs as inexpensive, readily available, and easily deployable weapons and surveillance tools. At the same time, the armed forces of Ukraine, Russia, and other countries along with the private industry are investing heavily in the development of advanced UAVs. Meanwhile, there are also efforts to develop sophisticated countermeasures to be used against enemy UAVs.

From the moment the sides had first agreed to the non-use of weapons until August 2020, the OSCE SMM did not report a single day during which no fire had been recorded. The rate of ceasefire violations observed by the OSCE SMM fluctuated. For instance, in all of 2019, the OSCE reported nearly 300,000 ceasefire violations (see Annex A for definitions).[20] Approximately 313,000 violations were recorded in 2018, and 401,000 in 2017.[21] In 2019, over 3,300 of the total incidents were attributable to the use of heavy weapons (see Annex A for definitions), including multiple launch rocket systems, other artillery, mortars, and tanks. In the same year, the OSCE SMM documented over 3,600 weapon systems observed in violation of the agreed withdrawal lines.[22] After a renewed recommitment to the ceasefire in the summer of 2020, the number of violations dropped signifi-

19 See for instance: Adam Lowther / Mahbube K. Siddiki, "Combat Drones in Ukraine", in: *AIR & SPACE OPERATIONS REVIEW* 1:4 (2022).

20 OSCE, *2019 Trends and observations from the Special Monitoring Mission to Ukraine*, 2020.

21 OSCE, *2018 Trends and observations from the Special Monitoring Mission to Ukraine*, 2019.

22 For more details on agreed security measures contained in the Minsk agreements, including those relevant to the ceasefire, see the following sections.

cantly; the OSCE SMM reported a 75% decrease for the period of July to September 2020, compared to the previous quarter.[23]

The area along the front line was critically contaminated with mines and unexploded ordnance. Anti-tank mines represented the vast majority of mines used. However, there were verified reports on the use of anti-personnel mines[24] and improvised explosive devices. The areas near the line, up to 15 kilometers on each side, were probably the most dangerous areas in the conflict zone at the time.

The United Nations reported that between 14,200 and 14,400 people had died in the conflict by 31 December 2021, a number that includes more than 3,400 civilians.[25] According to the United Nations Refugee Agency (UNHCR), over 854,000 Ukrainians were internally displaced while almost 50,000 had left the country by December 2021.[26] At the same time, Ukraine's ministry of reintegration of the temporarily occupied territories of Ukraine put the number of IDP's prior to Russia's full scale invasion to 1.5 million[27] and other reports suggest that over 660,000 Ukrainians have left Ukraine in 2021[28] and did not return.

Minsk agreements and overview of ceasefire arrangements

On 6 June 2014, the leaders of Germany, France, Ukraine, and the Russian Federation met at the margins of an event commemorating the 70th anniversary of D-Day in the French region of Normandy.[29] The leaders agreed that a Trilateral Contact Group (TCG) should be formed to tackle the continuing violence and the ensuing impact on the lives of people in eastern Ukraine. The TCG was to be composed of representatives of the Russian

23 OSCE, *Trends and observations July – September 2020*, 2020.

24 While Ukraine ratified the Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-Personnel Mines and on their Destruction (also known as the 'Ottawa Treaty) in 2005, the Russian Federation is no State Party to this treaty.

25 OHCHR, *Report on the human rights situation in Ukraine*, 2020.

26 UNCHR, *Ukraine Emergency*, 2023.

27 "4.8 million Ukrainians became internal Migrants in 2022 – Ministry of Reintegration," *Fokus,* 16.02.2023.

28 "Over 11 years, almost 3.3 million citizens have left Ukraine and never returned," Opendatabot, 17.12.2021.

29 Claire Phipps, "D-day landings 70th anniversary – live blog", *The Guardian,* 06.06.2014.

Federation, Ukraine, and the OSCE and was an entity separate from the OSCE SMM. Two days later, in Kyiv, the TCG met for the first time.[30] In May 2015, four working groups were established, mandated to support the work of the TCG in the areas of security, political arrangements, economic measures, and humanitarian relief (for an overview, see Figure 3). A Special Representative (SR) of the OSCE Chairperson-in-Office was appointed to chair the TCG, and experienced experts from OSCE-participating States were invited to coordinate the working groups. Had the meetings initially been held on the premises of the OSCE SMM in Kyiv, they were later organized in the Belarusian capital of Minsk. In June 2014, the TCG held consultations with the Russian backed armed formations in Donetsk who later also joined the TCG meetings in Minsk.[31] Due to the outbreak of the COVID-19 pandemic in 2020, the meetings of the TCG and its working groups were held online. On average, they met every second week.

The TCG became the platform for trying to reach agreements to end the violence and address its consequences, even if ineffectively, as the events of 24 February 2022 showed. At least eight substantive agreements were reached, encompassing a mixture of security, political, humanitarian, and economic measures (see Table 1 for a chronological overview of the Minsk agreements). However, the agreements were never fully implemented, with both sides blaming the other for the lack of implementation. The agreements defined the ceasefire only vaguely. With a few exceptions, they instead referred to the "cessation of the use of weapons", "ban on firing" or a "comprehensive ceasefire" without defining it more explicitly. Therefore, any use of a weapon arguably constituted a ceasefire violation. The early documents listed the ceasefire provision as the first and initial measure.[32] The agreements did not contain detailed maps and lacked baseline information (e.g., agreed lines of control (i.e. the 'contact line'), assembly points, or designated cantonment areas for weapons or troops (see Annex A) as well as a detailed schedule of the different phases of the ceasefire.[33]

30 Heidi Tagliavini, "Mediation während der Krise in der Ostukraine bis zum 23. Juni 2015", In: IFSH (eds.), *OSZE-Jahrbuch 2015* (Baden-Baden, 2016), pp. 239–251.

31 Tagliavini, "Mediation während der Krise in der Ostukraine bis zum 23. Juni 2015", pp. 239–251.

32 See for instance Article 1 of the 'Protocol' of 5 September 2014, Article 1 of the 'Memorandum' of 19 September 2014, or Article 1 of the 'Package of measures' of 12 February 2015.

33 See for instance: Nicholas Haysom / Julian Hottinger, "Do's and Don'ts of sustainable ceasefire agreements", *United Nations Peacemaker.*

Additionally, there was no consensus among the signatories about the sequencing of the measures foreseen in the Minsk agreements. While the Russian Federation consistently asserted that the political measures (e.g., constitutional changes, special status laws, elections) were to be complied with first, Ukraine maintained that a sustainable ceasefire and control over the state border with the Russian Federation was the precondition for the implementation of any other measures contained in the agreements. Hence, the motivation of the sides for agreeing to the ceasefire remained opaque and the sides repeatedly accused each other of exploiting ceasefires for strategic reasons to win time and regroup troops and equipment near the line of contact. Again, others claim that the ceasefire agreement was misused to increase the leverage to drive home political wins first.

The TCG made it standard practice to proclaim so-called 'recommitments' to the (already agreed) ceasefire. These agreements were announced around special occasions or dates (e.g., the beginning of the academic school year, Christmas, Easter, or the harvest season) and applied to the entire conflict zone. At least 17 such recommitments had been announced.[34]

On the ground, the OSCE SMM and other organizations facilitated local ceasefires on a regular basis. These arrangements, often referred to as 'windows of silence', were used for various purposes, including the repair of critical infrastructure located at the contact line or to facilitate access for humanitarian action. These breaks in fighting are best characterized as humanitarian pauses and often involved de-confliction arrangements between the sides.

To strengthen the ceasefire, the signatories agreed to undertake certain technical measures which included: the creation of a 30 kilometer-wide safety zone along the contact line; the prohibition of attacking moves; mandating a stop to forward deployment; the withdrawal of larger caliber weapons;[35] the disengagement of forces and hardware; the prohibition of live-fire exercises in areas near the contact line; the withdrawal of illegal military formations,

34 The additional measures agreed in July 2020 stipulated a 'ban on firing' (Paragraph 2) – there is disagreement whether this represents an additional recommitment to the existing ceasefire or an agreement of a new ceasefire. The number 17 includes this latest measure.

35 The Memorandum regulates the withdrawal of weapons with a caliber greater than 100mm. The Addendum regulated the withdrawal of tanks and artillery pieces up to 100mm and mortars with caliber up to 120mm. The OSCE SMM daily reports refer to 'Permanent Storage Sites' when referring to the sites where weapons regulated by the Addendum should be stored. When addressing the sites where weapons regulated by the Memorandum and Package of Measures are to be stored, the Mission's reports refer to these as 'Heavy Weapons Holding Areas' and 'Heavy Weapons Permanent Storage Sites'. For the purpose of this paper, the term 'designated storage areas' will be used.

hardware, militants and mercenaries from Ukraine; and the establishment of a safety zone in the border regions of Ukraine and the Russian Federation.

Table 1: Chronological overview of the Minsk agreements[36]

1	"Protocol (hereinafter **'Protocol'**) on the results of joint consultation of the trilateral contact group with respect to the joint steps directed towards the implementation of the peace plan of the President of Ukraine, P. Poroshenko, and the initiatives of the President of Russia, V. Putin."[37] *Purpose:* Contained 12 steps to end the violence, including an immediate ceasefire and the monitoring and verification of it by the OSCE.[38]	5 September 2014
2	Memorandum (hereinafter **'Memorandum'**) on implementation of the provisions of the protocol.[39] *Purpose:* Introduced steps to implement to agreed ceasefire and other security measures outlined in the Protocol. Introduced the use of technology for the purpose of monitoring by the OSCE.	19 September 2014
3[40]	Package of measures for the implementation of the Minsk agreements (hereinafter **'Package of measures'**).[41] *Purpose:* Reaffirmed an immediate and comprehensive ceasefire and further details the withdrawal of large caliber weapons. Referred to monitoring and verification by the OSCE, including the use of technology. Also contained political, economic, and humanitarian measures. Was endorsed by the United Nations Security Council.	12 February 2015
4	"Addendum (hereinafter **'Addendum'**) to the package of measures for the implementation of the Minsk agreements from 12 February 2015, including the withdrawal of tanks and artillery pieces with caliber up to 100mm and mortars with caliber up to 120mm (inclusive)."[42] *Purpose:* Added further weapons to list of weapons to be withdrawn and provided outlines of a mechanism to monitor and verify the withdrawal by the OSCE.	29 September 2015

36 There were other peace initiatives prior to the Minsk agreements. This included the so-called 15 points peace plan by the former Ukrainian President of June 2014 'On the peaceful settlement of the situation in eastern Regions of Ukraine' with a reference to ceasing the use of force (see UN Digital Library, Letter dated 20 June 2014 from the Permanent Representative of Ukraine to the United Nations addressed to the President of the Security Council, 2014.) and before that the 4-party meetings in Geneva (Ukraine, Russian Federation, United States of America and the European Union) and a corresponding 'roadmap' aimed at de-escalation.

37 United Nations Peacemaker, *Protocol Minsk Ceasefire Agreement*.

38 Note: guarantees to ensure the freedom of movement of the OSCE SMM is referenced in several of the agreements.

39 OSCE, *Memorandum of the 19 September outlining the parameters for the implementation of commitments of the Minsk Protocol of 5 September 2014*, 2014.

40 The Memorandum and Protocol are often referred to as 'Minsk I' whereas the Package of measures is often labeled as 'Minsk II'.

41 United Nations Peacemaker, *Minsk Agreement*, 2015.

42 OSCE, *Chief Monitor of the OSCE Special Monitoring Mission to Ukraine welcomes agreement on withdrawal of heavy weapons and military equipment*, 2015.

5	"Decision of the trilateral contact group on **mine action**."[43] *Purpose:* Identified 12 priority areas for demining to be monitored by the OSCE, also by remote means.	3 March 2016
6	"Decision of the trilateral contact group on full **cessation of live-fire exercises**."[44] *Purpose:* Prohibited live-fire training near the contact line to avoid misunderstandings, such as retaliatory fire in response to live-fire training perceived as an attack.	3 March 2016
7	"Framework decision (hereinafter **'Disengagement decision'**) of the trilateral contact group relating to disengagement of forces and hardware."[45] *Purpose:* Outlined the removing of troops and hardware where they stand too close. Identified three pilot areas with limited size for disengagement. Reference to monitoring and verifying by the OSCE, including through remote means. Outlined measure to address interference with technology deployed by the OSCE.	21 September 2016
8	"Measures to strengthen the ceasefire (hereinafter **'additional measures'**)."[46] *Purpose:* Reiteration of the ceasefire ('ban on firing'). Proposed that a coordination mechanism for responding to ceasefire violations was to be created.[47]	22 July 2020

The Package of measures was endorsed by United Nations Security Council Resolution 2202 (2015)[48]. Furthermore, each of the agreements and decisions were signed by a representative of the Russian Federation, Ukraine, and the OSCE. Additionally, individual members of the Russian backed armed formations of certain areas of Donetsk and Luhansk regions of Ukraine also subscribed to these documents, albeit regularly only with their names and without any title, function, or reference to their affiliation with the Russian backed armed formations. There is disagreement about the legal status of these agreements.

While the Protocol, Memorandum, and Package of Measures referred to the OSCE only and not to the OSCE SMM specifically, the subsequent

43 OSCE, Chief Monitor of OSCE Mission to Ukraine welcomes decisions on mine action and prohibition of live-fire exercises by Trilateral Contact Group, 2016.

44 OSCE, Chief Monitor of OSCE Mission to Ukraine welcomes decisions on mine action and prohibition of live-fire exercises by Trilateral Contact Group, 2016.

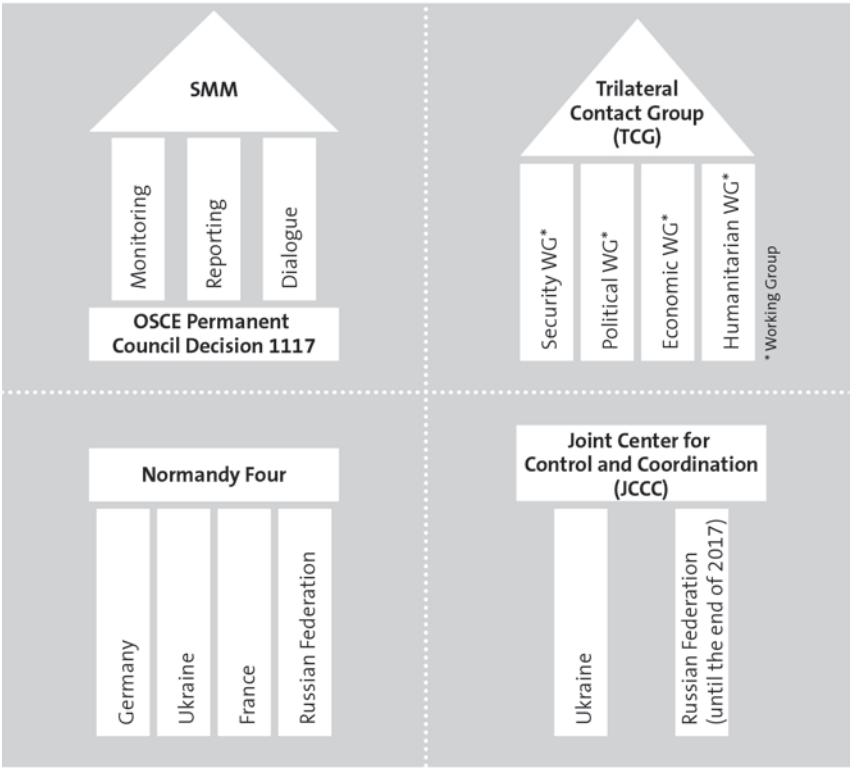
45 OSCE, *Framework decision of the Trilateral Contact Group on the disengagement of forces and equipment*, 2016.

46 OSCE, *Press Statement of Special Representative Grau after the regular Meeting of Trilateral Contact Group on 22 July 2020*, 2020.

47 Although it was agreed to create a mechanism for responding to ceasefire violations, relevant procedures and processes were not formalized. It is also noteworthy to mention the provision (paragraph 6) that created the right to retaliatory fire under certain conditions.

48 Resolution 2202 (2015) / adopted by the Security Council at its 7384th meeting, on 17 February 2015: https://digitallibrary.un.org/record/787968?ln=zh_EN.

Figure 3: Overview: The OSCE SMM, the TCG, the JCCC and the Normandy Four



Source: A. Hug

four agreements made explicit reference to the Mission. However, it is worthwhile to underline that the OSCE SMM was not a product of the Minsk negotiations, but continued to operate on the basis of a mandate which predated the war and these agreements (see Figure 3). The Mission supported the implementation of the agreements on the basis and within the framework of this mandate.

On 22 February 2022, shortly before ordering the full-scale invasion of Ukraine, the President of the Russian Federation declared that the Minsk agreements are "non-existent".[49] Two days later the armed forces of the Russian Federation started their attempt to fully invade Ukraine.

49 "Minsk Agreement cease to exist – Putin," *TASS*, 2022.

Figure 4: An OSCE SMM armored vehicle patrol on the frontline in the Donetsk region

Source: The OSCE SMM on patrol near the Donetsk Filtration Station, Donetsk region, March 2018, OSCE/ Evgeniy Maloletka.

Monitoring and Verification

Each of the agreements had their own monitoring or verification provisions. The agreements inconsistently referred to these terms and provided no definitions. For instance, the Protocol referred to the need to "ensure monitoring and verification by the OSCE of the regime of non-use of weapons" (Art. 2) and the more comprehensive Package of Measures stipulated that there should be "effective monitoring and verification of the ceasefire regime and the withdrawal of weapons by the OSCE" (Art. 3). The agreements – specifically the Addendum (Art. 6) – also obliged the sides to ensure "effective monitoring and verification by the OSCE SMM" (see Figure 4).

The reference to effective monitoring and verification suggested that there had been some acceptance among the signatories that the OSCE SMM should have operated, as a minimum, independently. This formulation further implied that the OSCE SMM should have enjoyed the full cooperation of the signatories, have unhindered access to the entire conflict area and that the sides would follow up on violations monitored by the Mission.

Joint Center for Control and Coordination (JCCC)

Except for an annex to the Addendum, no separate monitoring and verification mechanism or procedure was formally agreed. The Addendum made reference (Art. 5) to the Joint Center for Control and Coordination (hereinafter 'JCCC' see Annex A for details). The JCCC was established at the end of September 2014 after the Memorandum had been agreed and was meant to stabilize and coordinate the ceasefire (see, for instance, Disengagement decision Art. 10 lit a) and other agreed measures. It was an informal and bilateral set-up agreed to by Ukraine and the Russian Federation, and it was composed of officers of the General Staffs of the Russian and Ukrainian armed forces. The JCCC was originally headquartered in Debaltseve (Donetsk region). Following the assault on the town by Russian led forces in early 2015, the JCCC relocated roughly 50 km north northwest to the city of Soledar (Donetsk region). In the initial phases, members of the Russian led armed formations accompanied the representatives of the Russian Federation.[50] Still, no formal document on how the JCCC should be established and function was ever agreed to.

Soon after the arrival of the contingent of Russian JCCC officers in Ukraine, the OSCE SMM formed a team to interact with the JCCC. Importantly, the JCCC was tasked by the signatories of the Minsk agreements to ensure rapid response to any impediments to the OSCE SMM's monitoring and verification activities (see Disengagement decision Art. 10 lit b). Despite these obligations, the JCCC struggled to deliver on its tasks. The refusal of the Russian Federation to acknowledge that Russia was a party to the war and not merely a 'mediator' between the armed formation it commanded, equipped and financed and the armed forces of Ukraine, disabled the JCCC, rendering it, to a certain extent, ineffective.

In December 2017, Russian JCCC officers withdrew from the JCCC physically and never returned, even though the Russian Federation never left the JCCC formally. Moscow claimed that there were unresolved "complicating conditions" for its officers[51] which the Ukrainian side disputed, stating that the Russian officers "lived in the same conditions as officers of the Ukrainian Armed Forces" and expressed hope that Moscow would return its

50 See for instance: OSCE, *Latest from OSCE Special Monitoring Mission (SMM) to Ukraine based on information received as of 18:00 (Kyiv time), 9 December 2014*, 2014. In the later stages, the armed formations were not present in the locations where the Ukrainian and Russian officers worked jointly.

51 "Putin explains to Merkel reasons for withdrawal of Russian officers from JCCC", *TASS,* 2017.

officers to continue the work of the JCCC.[52] From then onwards, members of the Russian-backed armed formations pretended to be part of the JCCC. The JCCC, however, stopped functioning as a Russian-Ukrainian mechanism.

Technology

While the mandate of the OSCE SMM did not refer to the use of technology, there were such references in the Minsk agreements. Initially, the Memorandum (Art. 7) prohibited flights by military aircraft and "foreign unmanned aerial vehicles." The same article explicitly excluded the OSCE's UAVs from this prohibition. The additional measures agreed in the summer of 2020 (Art. 1) further clarified this provision by banning the use of any unmanned aerial vehicles by the sides. The Package of Measures (Art. 3) provided additional clarity as to the use of technology. It contained an open-ended list of possible technology to be used by the OSCE, and mandated that, for the purpose of ensuring monitoring and verification, the OSCE may use "all technical equipment necessary, including satellites, drones, radar equipment, etc."

The Disengagement decision (Art. 11) referred to monitoring and verification by means of "remote observation." Elsewhere, the agreements stated that the OSCE was to "record" violations of the agreed terms, such as in the Disengagement decision (Art. 6). Importantly, in the same decision, the sides consented to rapidly respond to "interference aimed at impeding the use of technical equipment necessary for monitoring and verification of disengagement" (Art. 9 lit. e). Finally, the Addendum referred to videoconferencing as a means of holding emergency meetings to address systematic intensive fire as recorded by the OSCE SMM (Art. 4). For an overview of relevant provisions in the Minsk agreements and mandate of the OSCE SMM, see Table 2.

52 "This is what Russia withdrawal from the joint ceasefire coordination center means," *Hromadske,* 2017.

Table 2: Overview of monitoring, verification, and technology provisions in the Minsk arrangements and mandate of the OSCE SMM

	Monitoring	Verification	Monitoring and Verification	Other
OSCE SMM mandate	'Gather information' on security situation – (Art. 3/1) Respect for human rights and fundamental freedoms – (Art. 3/3)	'Establish facts' in response to specific incidents and reports of incidents – (Art. 3/2)	–	Report restrictions of freedom of movement – (Art. 3/6)
Protocol	Safety zone in border regions Ukraine-Russian Federation – (Art. 4)	Safety zone in border regions Ukraine-Russian Federation – (Art. 4)	Ceasefire (non-use of weapons) – (Art. 2)	–
Memorandum	Specific area void of military hardware – (Art. 5) Exit of foreign fighters – (Art. 9)	–	–	OSCE may operate UAVs – (Art. 7)
Package of measures	Exit of foreign fighters and equipment – (Art. 10)	–	Ceasefire and withdrawal of heavy weapons – (Art. 3)	OSCE may use any technology to monitor and verify – (Art. 3)
Addendum	Monitoring results may trigger TCG meeting – (Art. 4)	–	Sides to ensure effective monitoring and verification – (Art. 6)	Video conferencing as tool for emergency TCG meetings – (Art. 4) Unhindered access to storage sites – (Art. 5)
Mine Action Decision	Defined areas for demining – (Art. 4)	–	–	Use of remote observation tools – (Art. 4)
Cessation of life fire exercises	Violations of cessation agreement (Point 2)	–	–	–
Disengagement	Monitoring results may trigger TCG meeting – (Art. 5) Ceasefire violations – (Art. 6)	A ceasefire holding 7 days – (Art. 2)	Disengagement process – (Art. 11)	Use of remote observation tools – (Art. 11) Safe and secure access for OSCE – (Art. 9d; 10 b/c) Rapid response to violations registered by OSCE and to interference with OSCE technology – (Art. 9e)
Additional measures	–	–	–	Ban on operation of aerial vehicles of the sides – (Art. 1) Commitment to create a coordination mechanism to respond to ceasefire violations – (Art. 5)

Mission build-up and its closure

As foreseen in its mandate, the OSCE SMM was deployed within 24 hours after the OSCE Permanent Council had adopted the Mission's mandate on 21 March 2014 by a consensus decision of all 57 OSCE participating States, including Ukraine and the Russian Federation. The OSCE SMM assigned monitoring teams to 10 cities across Ukraine, including the eastern cities of Donetsk and Luhansk. The monitoring teams of up to 10 monitors were led by a team leader. As stipulated by the mandate, Mission members were civilians, many with a background in the third dimension of the OSCE's comprehensive approach to security (human dimension).[53]

In March and early April 2014, the Mission was monitoring the Ukrainian Government's response to the Maidan events and strove to facilitate dialogue between segments of Ukraine's diverse society, including those factions that still occupied buildings in the capital and elsewhere in the country. This included additional monitoring tasks under an early and short-lived attempt by the United States, the European Union, Ukraine, and the Russian Federation in Geneva on April 17 to de-escalate tension.[54]

Before long, the two monitoring teams deployed to the two most eastern regions of Ukraine started to report street protests in Donetsk and Luhansk.[55] As described earlier, although initially of a peaceful nature, these protests soon turned violent. Within weeks, the Mission found itself in a situation that had changed completely and was confronted with an unpredictable security environment. In addition, they had become witnesses of Ukrainian Government structures that were gradually losing control over various parts of the two regions. However, as mandated, the OSCE SMM maintained its presence and continued to monitor and report about the security situation in those areas.

Fighting between armed groups, who were taking directions from Moscow[56], and Ukrainian Government forces represented highly challeng-

53 For more information relating to OSCE's comprehensive approach to security see: OSCE, *What we do*.

54 On April 17, 2014, it was agreed that "the OSCE Special Monitoring Mission should play a leading role in assisting Ukrainian authorities and local communities in the immediate implementation of these de-escalation measures wherever they are needed most, beginning in the coming days. The U.S., E.U. and Russia commit to support this mission, including by providing monitors." See https://geneva.usmission.gov/2014/04/18/text-of-the-geneva-statement-on-ukraine-released-by-the-us-eu-ukraine-and-russia.

55 OSCE, *OSCE Secretary General calls for calm in eastern Ukraine*, 08.04.2014.

56 De Rechtspraak, *Summary of the day in court: 17 November 2022 – Judgement*, 2022.

ing and ever-changing security issues.[57] The OSCE SMM's freedom of movement, guaranteed by its mandate (and therefore by OSCE's 57 participating States, including by the Russian Federation and Ukraine), though curtailed by both sides was predominantly interfered with by Russian led forces. Monitoring teams were held up and threatened at improvised checkpoints and the monitoring task became more difficult by the day. In the latter half of May 2014, two groups of four monitors were taken hostage by these armed groups and held captive for a month. After lengthy and complex negotiations, the eight Mission members were eventually released, physically unharmed. During this month-long episode, the Mission's operational activities contracted significantly under self-imposed risk mitigation measures. As a result, the OSCE SMM was no longer able to properly monitor and document the early stages of the war, in particular, the security development in areas the armed groups had taken control of; especially those in close proximity to the international border with the Russian Federation.

At that juncture, it became evident that the Mission was not adequately staffed and equipped to meet the new challenges. The OSCE Chairpersonship, the OSCE Secretariat, and individual OSCE participating States engaged immediately. They all acted quickly to enhance the resources available, first in an *ad hoc* manner, shifting and reallocating resources from elsewhere and in-kind; then more systematically by increasing staffing and budget.

In July 2014, the OSCE SMM, now with increased strength and better equipment, facilitated access to the crash site of the civilian airliner MH17 for various recovery missions. The plane had been shot down by a Russian BUK-type anti-aircraft missile, supplied by Russia and fired from an area held by the armed groups directed by the Russian Federation.[58] The OSCE SMM, deployed on both sides of the front line, engaged in dialogue both between the sides and the Dutch-led Joint Investigation Team. This work enabled the recovery of the dead and the collection and subsequent removal and transportation of the aircraft's debris. This was the first successful stress test of whether the Mission would be capable of implementing its mandate, and it did prove the mandate's adaptability in as far as it demonstrated how the Mission could operate within entirely unforeseen parameters without changing as much as a comma in its mandate.

57 Wikipedia, *East Ukraine conflict dynamics*, 2014.

58 De Rechtspraak, *Summary of the day in court: 17 November 2022 – Judgement*, 2022.

Six months into the Mission's deployment approximately, in September 2014, the first two Minsk agreements were signed, and with them came new roles for the OSCE SMM, among them were the tasks to monitor and verify the agreed ceasefire (e.g., Protocol, Art. 2). While these tasks were not explicitly mentioned in the Mission's mandate, it was formulated broadly enough to accommodate them. Mandated to "gather information and report on the security situation", the Mission began to focus its ground patrol activities on where the fighting was concentrated, which was mainly along the almost 500-kilometer contact line.

Interpreting its mandate broadly, the OSCE SMM set up permanent patrol hubs[59] and forward patrol bases[60] on both sides of this line (see Figure 5). These smaller forward patrol bases, in particular, permitted closer monitoring of the security situation, since the Mission had its human resources much nearer to the fighting areas. This arrangement also enabled the Mission to conduct limited nighttime observation activities in these areas.[61] Meanwhile, the OSCE SMM maintained its presence in the eight other Ukrainian towns in the remainder of the country it had originally been assigned to. As of 22 March 2021, the OSCE SMM had deployed 1,329 Mission members, including 456 national Mission members and 730 monitors. The monitors, only 139 of whom were females, were from 44 of the 57 OSCE participating States. 550 of the monitors were deployed to the 2 monitoring teams located in the Donetsk and Luhansk regions.[62]

On 24 February 2022, the same day as the full-scale invasion of Ukraine by the Russian Federation began, the OSCE Secretariat informed that the international staff members of the OSCE SMM would be temporarily evacuated due to security concerns.[63] On 7 March 2022, the Mission issued its last daily report, announcing that the temporary evacuation of its international staff has been completed.[64] On 31 March 2022, OSCE's Permanent Council failed to reach a consensus decision to extend the mandate

59 See for instance: OSCE, *OSCE Special Monitoring Mission to Ukraine opens forward patrol base in Shchastia*, 25.05.2016.

60 OSCE, *Forward patrol bases: two years on the contact line*, 26.09.2017.

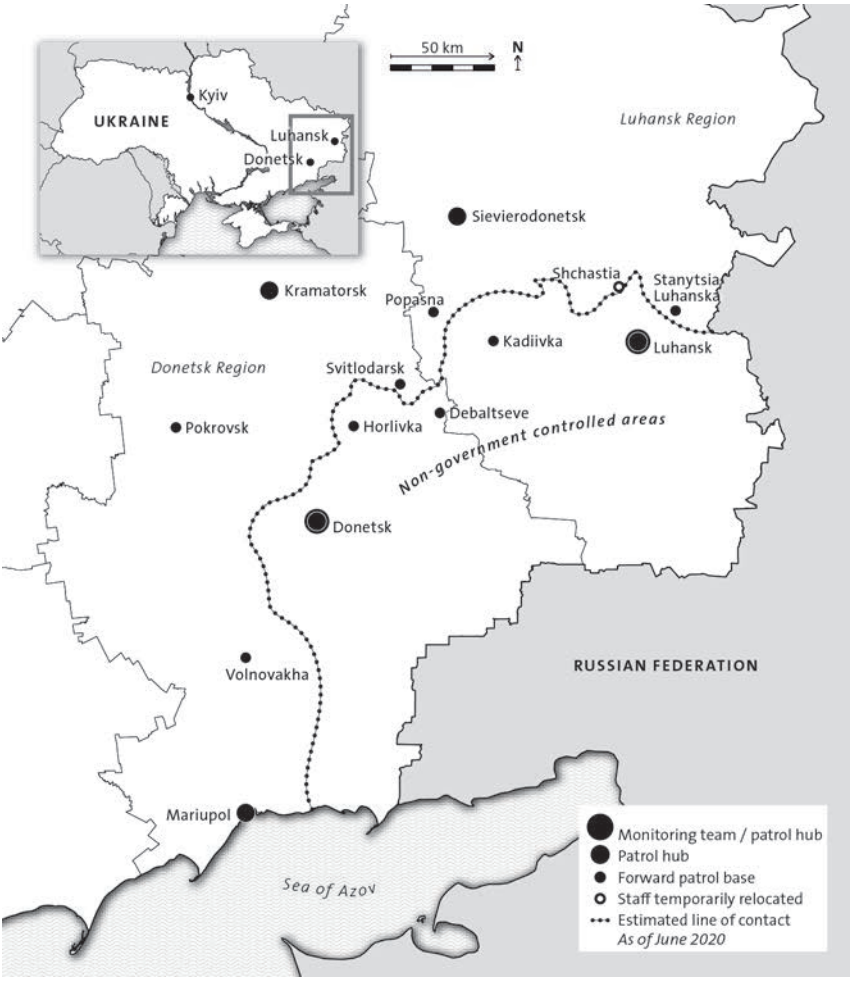
61 In eastern Ukraine there were two monitoring teams (Donetsk and Luhansk). These monitoring teams were organized in patrol hubs and the smaller forward patrol bases. There were up to ten such forward patrol bases combined on both sides of the contact line.

62 OSCE Special Monitoring Mission to Ukraine (SMM), *Status Report*, 2021.

63 OSCE, *Statement of the Secretary General on the temporary evacuation of the OSCE staff of Ukraine*, 2022.

64 OSCE, *OSCE Special Monitoring Mission to Ukraine (SMM) Daily Report 54/22 issued on 7 March 2022*, 2022.

Figure 5: OSCE SMM presence along the contact line



Source: OSCE, Special Monitoring Mission to Ukraine, Daily Report 08.09.2021, p. 9.

of the OSCE SMM due to the position of the Russian Federation.[65] On 28 April 2022, the OSCE announced the closure of the OSCE SMM.[66] At the

65 OSCE, *Chairman-in-Office and Secretary General expressed regret that no consensus reached on Mandate of Special Monitoring Mission to Ukraine*, 2022.

66 OSCE, *Chairman-in-Office and Secretary General announce upcoming closure of Special Monitoring Mission to Ukraine*, 2022.

time of writing this publication (summer 2024), three Ukrainian OSCE staff members remain deprived of their liberty in areas controlled by the Russian Federation.

Discussion: Promises and pitfalls of a broad mandate

The chapter above has outlined the mandate, buildup and closure of the OSCE SMM, highlighting the parameters and framework within which ceasefire monitoring and verification tasks were to be implemented. What stands out is that, from its very inception, the Mission's mandate was formulated in broad terms. This had the advantage of allowing for the adaptation of the Mission's monitoring and verification tasks as the conflict evolved. However, the broadness of the mandate also led to a degree of ambiguity and differing interpretations of the breadth and depth of the role and tasks of the Mission.

A major challenge was also the lack of clarity regarding a jointly owned compliance mechanism to make use of information gathered in the monitoring and verification of the ceasefire. Indeed, there never was a fully-fledged compliance mechanism. The creation of the JCCC was arguably an initial attempt towards achieving this objective. However, the informal nature of the JCCC, the lack of agreement on who should have participated in it and in what role, and, subsequently, the departure of Russian officers from the center all stood in the way of the formal creation of this much-needed mechanism.

The information that resulted from the monitoring and verification activities of the OSCE SMM – which was enhanced through technology, as we will see below – seemed to have an indirect effect on conflict behavior. As the information was openly accessible, the local population and the international community could see what was happening. This nudged the parties to minimize the use of violence, at least to the degree they were concerned about public opinion. Nevertheless, the potential of information to shape the reduction of violence could have been far greater. For instance, this would be the case if the two sides had collaborated in a joint compliance mechanism and if they had worked towards a mutually agreed political goal to resolve the armed conflict.

2. Making the Case for Technology

A grasp of the challenges the Mission faced in its ceasefire monitoring efforts is essential to understanding why technology was used. Specifically, the OSCE SMM's ability to monitor was undermined by: 1) restrictions on its movement, 2) the scope of its tasks, and 3) the complexities involved in accurate monitoring and reporting. These challenges prompted the OSCE to explore, like never before, the use of technology to lift its performance in the field.

Restrictions on access, safety and security

The OSCE SMM's ability to gather information and report on the security situation, inclusive of violations of the agreed ceasefire, largely depended on its freedom of movement. This concept referred to the Mission's authorization to move freely based on safe and secure access to and within its entire area of operation without impediments to implement its mandate. Any interference with the mandated freedom of movement inevitably led to reduced ground patrols, fewer observations, and reports that covered its area of operation only partially. Such deficiencies were bound to distort the picture and, eventually, undermined the reliability and relevance of the Mission's results. Operating in an evolving conflict, the OSCE SMM faced obstructions in mounting patrols, because of active and passive restrictions, as well as self-imposed constraints.

The drafters of the Mission's mandate had most certainly anticipated that the Mission's freedom of movement would be curtailed, as they explicitly mandated the OSCE SMM to report on such interferences. Accordingly, the Mission listed these violations of its mandate at the end of each of its daily reports. Throughout 2020 for instance, the OSCE SMM reported active interference with its freedom of movement in almost 850 instances, 96% of which had occurred in areas controlled by the Russian Federation. The Mission typically distinguished between access delays (9%, reported after a certain threshold/waiting time); conditional access (4%, e.g., when access was granted only after the Mission accepted certain conditions like being escorted or having its vehicles searched); or full denial of access (74%).[67]

67 OSCE Special Monitoring Mission to Ukraine (SMM), *2020 Trends and Observations*, 2020. By comparison, in 2019, there were over 1'000 active restrictions registered by the OSCE SMM, *2019 Trends and Observations*, 2019.

Limitations on the SMM's freedom of movement were also violations of the Minsk agreements, which obliged the signatories to "ensure effective monitoring and verification"[68] and bound the sides to "ensure safety and secure access for the OSCE SMM monitors."[69] Part of a civilian and unarmed Mission, OSCE SMM patrols did not enforce their access and were dependent on the sides' respect for its mandate and compliance with the Minsk agreements completely.

Active restrictions

Active restrictions were intentional actions taken by the sides aimed at impeding the Mission's freedom of movement. Such restrictions came in the form of actions by members of the Russian backed armed formations or Ukrainian armed forces personnel, preventing an OSCE SMM ground patrol from completing its patrol route. In such cases, patrols were often told, at times at gunpoint, that they were not entitled to move further or that instructions to let the patrols pass were not available or pending.

Such restrictions were frequently registered at permanent or *ad hoc* checkpoints maintained by the sides, and predominantly occurred near the contact line or in areas of military hardware concentration (e.g., storage facilities for withdrawn weapons). Active restrictions were also registered at the rear of the contact line, or near the Ukrainian – Russian Federation border area not controlled by the Ukrainian Government. At times they were conditional, i.e., patrols were told that they could only proceed on their route once certain conditions (e.g., sharing patrolling routes in advance of the patrol) were met.

Active restrictions also involved incidents in which patrols were impaired by security risks in connection with active hostilities such as when patrols came under indirect or direct fire. For instance, the Mission reported various instances when mortar and artillery fire impacted in close proximity to its patrols, sniper or small-arms fire targeted its teams, and ricochets jeoparded patrol members.

In several strategic areas along the contact line, the sides were positioned fewer than 50 meters from each other – a breeding ground for constant tensions which could erupt in an exchange of fire with little or no notice. This was particularly true in areas where the sides had moved forward,

68 E.g., Package of measures, Art. 3.

69 E.g., Disengagement decision, Art. 9 lit. d.

in defiance of their commitments not to do so under the measures agreed in Minsk. The capacity of the OSCE SMM ground patrols to monitor these hotspots was limited considering heightened security risks, the more so that additional resources were devoted to mitigating security risks through self-imposed restrictions (see below).

Indirect fire posed a major threat (e.g., injury/death by fragmentation airburst munition) for the Mission's members and, consequently, represented a major limiting factor. Harassing, interdicting, (counter) preparation, counterbattery or suppression fire were some of the most common uses of larger caliber weapons on both sides of the contact line. These weapon systems, in most cases produced during the time of the Cold War[70], are notoriously imprecise and typically aim at an area rather than a specific individual target. Regulated by the Minsk agreements, most of these weapon systems (namely multiple launch rocket systems, other artillery, mortars, and tanks) should have been withdrawn behind agreed lines and locked up in designated storage areas. Notwithstanding these provisions, in 2019 for instance, the OSCE SMM reported over 3,600 such weapons in violation of agreed withdrawal lines, 75% of them in areas not controlled by the Ukrainian Government.[71] For an overview of where and how freedom of movement restrictions occurred in the first half of 2021 (see Figure 6).

Passive restrictions

Restrictions were also of a passive nature. These refer to activities by the sides that did not necessarily target the Mission as such but nonetheless resulted in a restriction of its freedom of movement. Mines and unexploded ordnance on patrol routes, which prevented OSCE SMM patrols from advancing, are examples of passive restrictions in the Ukrainian context. In 2019, the United Nations Office for Humanitarian Affairs (UN OCHA) designated eastern Ukraine as one of the most landmine-contaminated areas in the world.[72] This proved fatal when, in April 2017, an OSCE SMM patrol member died in a mine incident.[73]

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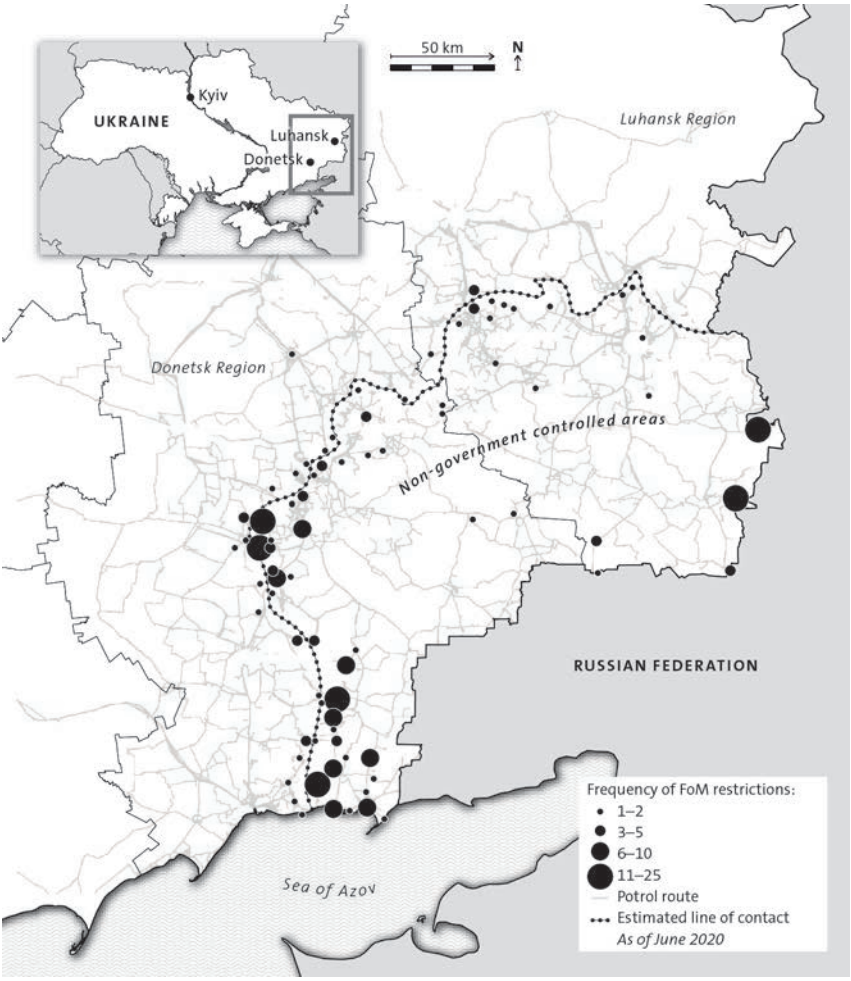
70 Modern large caliber artillery systems with smart ammunition, like the PhZ 2000 or the M142 High Mobility Artillery Rocket system, have significantly improved precision strike capabilities.

71 OSCE, *2019 Trends and Observations from the OSCE Special Monitoring Mission to Ukraine*, 2020.

72 OCHA, *Eastern Ukraine one of the areas most contaminated by landmines in the world*, 2019.

73 OSCE, *Spot Report: One SMM patrol member dead, two taken to hospital after vehicle hits possible mine near Pryshyb* https://www.osce.org/special-monitoring-mission-to-ukraine/312971, 2017.

Figure 6: Patrolling routes and freedom of movement restrictions



Source: OSCE, Special Monitoring Mission to Ukraine, Thematic Report, Restrictions of SMM's freedom of movement and other impediments to fulfilment of its mandate, December 2021, p. 29; OSCE, Special Monitoring Mission to Ukraine, Thematic Report, Restrictions of SMM's freedom of movement and other impediments to fulfilment of its mandate, December 2021, p. 31.

In addition, passive restrictions also involved the blockade of patrolling routes by deliberately destroyed road infrastructure (e.g., bridges), barbed wire, Czech hedgehogs, or trench work extending into patrolling routes. In some locations along the contact line, hazardous chemicals stored

in conflict-affected industrial areas (e.g., chlorine gas in water filtration stations located at the contact line) presented another deterring barrier to OSCE SMM patrols.

Self-imposed restrictions

Restrictions had also been self-imposed and were themselves often the Mission's response to passive or active inference with its mandate as the OSCE SMM invariably reassessed the security situation so as to determine the degree to which its patrols could operate. A major self-imposed restriction was the Mission's decision to suspend conducting mobile night patrols while still maintaining some static observation and listening posts at a safe distance to the contact line. Ongoing clashes, or a sudden outbreak of close proximity fighting resulted in the patrol moving to a different, safer location temporarily, or in abandoning the patrol and returning to base. As a result of the incident that claimed the life of a Mission member, the OSCE SMM introduced a general rule that permits monitoring patrols on asphalt and concrete roads exclusively.[74] This measure, however, prevented the Mission from accessing certain large parts of its operational area, including designated storage areas for larger caliber weapons, which were often located in forests and only accessible via dirt roads. In the face of the COVID-19 pandemic, the OSCE SMM introduced additional restrictions on its ground patrol activities.[75] One of the biggest challenges for the Mission's leadership was to find ways to continue mitigating rather than to avoid risks. In essence, the option of avoiding risk (e.g., patrols back to base) would have amounted to an end to the mandate implementation, whereas risk mitigation (e.g., monitoring at a safe distance) at least allowed a continued operation on a less risk-prone basis.

74 OSCE, Restriction of SMM's freedom of movement *and other impediments to fulfilment of its mandate*, 2018.

75 "In response to the COVID-19 pandemic, the Mission continued implementing stringent mitigation measures, adapting its operational posture to minimise contamination or transmission of COVID-19 to its personnel and the local communities. In line with its strict measures, the SMM limited its in-person presence on patrols and at its office premises throughout Ukraine." See: OSCE, *Thematic Report: Restriction of SMM's freedom of movement and other impediments to fulfilment of its mandate*, 2021.

The scope of endeavor

The Mission's task of monitoring the agreed ceasefire was daunting with regard to the dimensions of the area it had to serve, and, above all, the fact that its mandate extended far beyond ceasefire monitoring. Tasked to cover an area of approximately double the size of Rwanda,[76] roughly 600 civilian monitors (including those on leave or assigned to other duties) were deployed in total in 2020. In eastern Ukraine, the Mission operated from five patrol hubs[77] and 10 smaller forward patrol bases[78]. In 2017, from these locations, the OSCE SMM deployed over 25,000 patrols.[79]

With the signing of the Minsk agreements in September 2014, a 30-kilometer-wide security zone ('zone of the cessation of the use of weapons' (see Annex A)) was agreed.[80] The Mission dedicated most of its human resources to patrolling the said security zone in order to monitor and report violations of the ceasefire and the other measures adopted in Minsk. Yet, to cover an area of roughly 15,000 square kilometers around the clock would have required significantly more monitors than the 600 deployed at the time. Moreover, the contact line could only be crossed in five locations, which was yet another obstacle which created challenges for the Mission in deploying patrols effectively. In areas of active fighting or where the sides were positioned closely to one another, the Mission regularly deployed mirror patrols on both sides of the contact line in an effort to ensure better situational awareness as well as to allow indirect dialogue between the sides, the ultimate goal of which was to make sure ceasefire violations did not put the patrols at risk. Despite them being labor-intensive, mirrored patrols were also brought into play to facilitate humanitarian operations. To name but a few, such operations did involve the repair of critical civilian infrastructure or the recovery of the injured or dead.[81]

The breadth of the Mission's tasks becomes particularly evident when one takes into consideration how the withdrawal of weapons, as agreed to in Minsk, added to the burden of monitoring and verification. The withdrawal

76 When including the rear of the contact line where many of the heavy weapons withdrawal storage sites are located.

77 OSCE, *Table of ceasefire violations*, 2016.

78 OSCE, *Forward Patrol Bases: Two Years on the Contact Line*, 2017.

79 OSCE, *2017 SMM Activities in figures*, 2018.

80 See Memorandum, Article 4.

81 OSCE, *Mirror Patrols: Windows of hope in Eastern Ukraine*, 2017.

lines ran in parallel to the contact line at various distances (the larger the diameter of the barrel, the further away), adding huge swathes of land and lines to be monitored. Under the Minsk agreements, larger caliber weapons were to be stored beyond these lines. There were up to 200 designated storage areas, which were not permanently monitored by OSCE SMM staff but merely patrolled in an *ad hoc* manner, which made verification in particular a difficult undertaking. The task was additionally complicated by the long distances that monitors were required to travel to reach these areas, as OSCE SMM bases were located closer to the contact line. In fact, the designated storage areas for certain types of weapon systems were sometimes more than 70 kilometers in the rear of the contact line.

In September 2016, a disengagement decision was signed in an effort to further ease tensions, particularly near the contact line where forces and hardware were in close proximity. That decision stated, as a general rule, that disengagement areas of at least two by two kilometers would be established. Prior to the disengagement process, the OSCE SMM was to verify a seven-day ceasefire in these areas, which, if confirmed, would trigger the disengagement. The Mission was also called on to monitor the disengagement process itself. These provisions were meant to build trust between the sides and come with continued verification so that disengaged forces and hardware would not be returned to the area. The scope of these provisions, though, would have necessitated the Mission's permanent presence in these areas. Despite the promising nature of the 2016 decision, the OSCE ultimately determined it could not provide the level of support required with ground patrols alone, particularly not during night-time. Up to 2021, there were three such disengagement areas along the contact line, each of which was smaller than eight square kilometers.

Mandated to monitor respect for human rights and fundamental freedoms, the OSCE SMM was likewise tasked with reporting on the humanitarian crisis created by the ongoing conflict. A major component of this task was the documentation of the impact on the civilian population caused by ceasefire violations; this involved recording casualties among civilians as well as the destruction of and damage to civilian housing, but also transport infrastructure, and critical civilian infrastructure like gas and water pipelines, water purification installations, or the electrical grid. These essential utilities crossed the contact line in many areas and, thus, were often damaged by shelling, but generally needed to be maintained and repaired.[82]

82 OSCE, *SMM facilitation and monitoring of infrastructure repair in Eastern Ukraine*, 2019.

Figure 7: An OSCE SMM patrol at the contact line

Source: Near Avdiivka, Donetsk region, March 2016, OSCE/Evgeniy Maloletka.

The contact line, security zones, designated storage areas, and disengagement areas all belonged to the area the Mission was required to monitor and verify. It was easily understandable that the Mission would have needed significantly more personnel, were it to effectively monitor an area as vast as this with ground patrols (see Figure 7). On the whole, these settings showed one thing clearly: the OSCE SMM was, especially in its initial phases, vulnerable to obstruction, under-resourced and over-extended, preventing it from developing its full potential in support of the implementation of the Minsk agreements. For an overview of relevant monitoring and verification tasks for the SMM, see Table 3.

Table 3: Areas, incidents, and items of interest for monitoring and/or verification

Monitoring tasks *(day and night)*	**Description**
Hotspots	*Areas of regular and intensive fighting in the security zone as identified by the OSCE SMM. Strategic areas along the contact line, prone to tension. Though the number varies, there were regularly 6–15 hotspots as identified by the OSCE SMM, between 2 and 10 square kilometers in size. These areas included:* • Contact line: +/- 480 kilometers long (for most of the time this was a *de facto* frontline). No consensus on a formal definition of the contact line as referred to in the Minsk agreement; • Security zone: Defined by the Minsk agreements. 15 kilometers on each side of the contact line; • At strategic points and where the positions were in close proximity; • Disengagement areas and entry-exit checkpoints as well as certain key infrastructure.
Ceasefire violations	*Any 'use of weapons' as defined by the Minsk agreements:* • Could occur anywhere in the conflict area (not clearly defined, likely up to 50,000 square kilometers); • Included firing ranges, training, assembly, or staging areas.
Determining of firing positions and weapon systems	*Geographic location of static and mobile firing positions (in use and abandoned). Reports were to include the location, type, and number of weapon systems deployed.*
Weapons in violation of agreed withdrawal lines	*Large caliber weapons (as defined by the Minsk agreements) found in violation of agreed withdrawal lines:* • The Memorandum regulated the withdrawal of weapons of caliber greater than 100mm. The Addendum included the withdrawal of tanks and artillery pieces up to 100mm and mortars with caliber up to 120mm; • Lines ran on both sides and parallel to the contact line. The distance from the contact line was caliber-dependent: the larger the caliber, the further away from the line (e.g., for tanks: 15 kilometers from the contact line); • Reports were to identify type of weapon, caliber, and personnel.
Designated storage areas	*Generalized term for locations where the sides had agreed to store their large caliber weapons:* • Partially regulated by Minsk agreements (referred to as: Heavy Weapons Holding Areas; Heavy Weapons Permanent Storage Sites; Permanent Storage Sites); • No agreement on layout; • Number: +/- 180 in total on both sides of the contact line.
Impact sites	*Areas of visible impact traces following the use of weapons of all types. Basis for impact site assessment to determine weapon type and direction of fire. Included both crater and other impact types.*
Disengagement areas	*Areas where the sides had agreed to withdraw personnel, weapons and other hardware from:* • Ultimately, the entire contact line was to be disengaged; • Sides agreed on pilot areas, for most of the time there were only three such areas agreed; • Pilot areas measured 3.5–8 square kilometers.

Presence of troops and forward moves	*Areas with troop, weapon, and other military-type hardware concentration anywhere in the conflict area. Movement of personnel and hardware:* • Convoys, military-type transports (road, rail, water); • Troop rotation/amassing; • Trench work; • Occupied and/or repurposed infrastructure to support combat action by the two sides; • Hardware/ammunition storage facilities; • Training facilities.
Damage to critical infrastructure and environment	*Sensitive infrastructure which civilians depended on or which contained hazardous material in close proximity to the front line/hotspots:* • Gas, water, and electricity infrastructure near the front line; • Locations where damage to infrastructure might have led to environmental concerns (e.g., chemical or waste storage sites); • Road, rail, and other transport infrastructure along the contact line.
Damage to civilian housing and other property	*General damage assessment in and outside settlements. Basis for humanitarian damage assessment:* • Housing (villages and towns) and agricultural property; • Included: schools, hospitals, administrative buildings.
Entry-exit checkpoints and corresponding checkpoints on the non-Government-controlled side leading across the contact line	*Freedom of movement of civilians across the front line:* • Included the five crossing points across the front line; • Recorded the number of persons, cars, and conditions at these checkpoints; • Presence of troops, weapons, and other military-type hardware in these areas; • Identification of risks (e.g., mines).
Amassing of persons	*Identification of civilians on the move/fleeing:* • With or without connection to the ongoing fighting; • Build-up and development of protests (organized or spontaneous); • Build-up of persons due to restrictions of freedom of movement.
Mines, IEDs, UXOs	*Identification of mine fields and other areas polluted by unexploded ordnance (UXO) and improvised explosive devices (IED):* • Identification of mine fields; • Type, number identification; • Identification of mine action steps undertaken by the sides.
State border: Ukraine – Russian Federation	*Security situation in the border area (on Ukrainian territory, not controlled by Ukraine):* • There were 408 kilometers of land state border between Ukraine and the Russian Federation not controlled by the Ukrainian Government. Additionally, there was a stretch of open seashore (sea of Azov) beyond Ukrainian Government control (+/- 70 kilometers); • Removal of "unlawful military formations and military hardware, as well as militants and mercenaries, from the territory of Ukraine." (Art. 10 of the Protocol); • Monitoring the Ukrainian-Russian state border and verification of the corresponding security area as defined by the Minsk agreements.

The importance and challenges of accurate and reliable reporting

Integrity of the information is important

The quality and reliability of the information collected by the Mission was important. Its findings were influential and instructive to OSCE participating States, decision makers, and the general public. The OSCE SMM's findings had an impact on the implementation of the Minsk agreements and the humanitarian situation. To safeguard the integrity of the Mission and the information it generated, a sophisticated reporting mechanism was developed.

Conflict undermines the quality of information

In the face of security concerns, the vast area to cover and the extent of the task involved, the OSCE SMM could not be expected to be close enough to observe all violations of the agreed ceasefire. Even though the Mission regularly reported an average of up to 1,000 ceasefire violations every day until summer 2020[83], the actual number was most likely several times higher.

The question of attributing ceasefire and other violations of the agreements

Even in a limited geographical area, documenting exchanges of fire is not an exact science. The sounds of incoming and outgoing large-caliber weapon explosions are difficult for the human ear to differentiate. Small-arms exchanges hidden from sight are even more problematic to document accurately. Determining the location of firing positions is tricky, too, with wind and humidity potentially interfering distortions. If the belligerents attack both from their front infantry positions and their rear artillery sites, it is a near impossibility to capture every detail in a cacophony of small-arms, rocket-propelled grenade fire, incoming and outgoing artillery and mortar fire, ricochets, and tank fire. This was especially true at night when the Mission's listening posts were usually at some distance from the fighting.

It was similarly challenging to monitor the use of large caliber weapons, tanks, mortars, artillery, and multiple launch rocket systems – these being highly mobile systems. Even if a firing location were identified by monitors, the weapon systems would most likely have been removed by the time

83 On days with heavy fighting the OSCE SMM reported daily numbers exciding 10,000 daily ceasefire violations. See for instance: OSCE, *Latest on OSCE Special Monitoring Mission to Ukraine (SMM)*, 2017.

a patrol arrived at the location. Moreover, approaching firing positions, in particular with the weapon systems *in situ,* represented a security risk as these positions were by default targets for enemy fire.

In spring 2021, more than six years after the Minsk agreements had been approved of, there was still abundant evidence that the sides continued to ignore the ceasefire. Besides a daily catalogue of SMM reports of heavy weapons being used and positioned in violation of agreed withdrawal lines, there was also partial compliance only with commitments to provide inventories and access to designated weapons storage areas. Inevitably, all this rendered the Mission's task of verifying the withdrawal of weapons difficult if not impossible.

The Mission's efforts to maintain the integrity of the information

The cornerstone of the Mission's efforts in this regard was the individual monitoring officer's ability to identify key facts such as weapon type, direction of fire, and ammunition used. To refresh these skills and to acquire new ones, the OSCE obliged new Mission members to undergo an induction course run by the Austrian armed forces near Vienna.[84]

While the monitoring teams largely operated independently, guidance and coordination were provided through relevant structures at the OSCE SMM's head office. In particular, the reporting cycle was managed centrally from the Mission's offices there. The OSCE SMM reported its findings on a daily basis with the exception of Sunday (monitoring results were covered in the Monday edition). Additionally, significant incidents were reported in Spot Reports.[85] These publications were made publicly available in Ukrainian, Russian, and English. The Mission also issued thematic reports on, for example, its freedom of movement[86] or on mine action[87] and summarized its findings regularly on its website, as well as in its bi-weekly Status Reports.[88]

The daily reports, in particular, offered a detailed overview of the progress achieved by the sides in implementing the agreed measures. While these reports were primarily intended for the OSCE's 57 participating

84 OSCE, *SMM for Ukraine: Ready for Anything*, 2015.

85 OSCE, *Daily and Spots Reports from the Special Monitoring Mission to Ukraine*.

86 OSCE, *Restriction of SMM's movements and other impediments to fulfilment of its mandate*, 2019.

87 OSCE, *The impact of mines, unexploded ordnance and other explosive objects on civilians in the Donetsk and Luhansk regions of eastern Ukraine*, 2019.

88 OSCE, *Status Report as of 10 August 2020*, 2020.

Figure 8: An OSCE SMM foot patrol at the contact line

Source: Two monitors assessing the situation in the Donetsk region, August 2016, OSCE/Evgeny Maloletka.

States, making this information publicly available also enabled the belligerents to take remedial action, at least in theory, where agreed measures were violated. Furthermore, these reports also shared vital information on damage done to critical infrastructure and on other humanitarian needs which, in turn, allowed others with a relevant mandate (e.g., United Nations agencies, the ICRC) to provide effective relief. At last, the facts contained in these reports informed the general public about the realities on the ground and, as such, somewhat offset misinformation campaigns.

The most fundamental part of this around-the-clock reporting process was the patrol reports (Figure 8). Each OSCE SMM patrol reported on its observations. The Donetsk and Luhansk monitoring teams collected these reports and forwarded them, in the form of a monitoring team report, to the Mission's head office in Kyiv, where they were compiled into an OSCE SMM daily report. Where the reported information was documented insufficiently, the patrols were tasked to follow up on initial information, which was a time-consuming process. To avoid allegations of patrol reports to be colored by a specific OSCE participating State's agenda, the Mission only

dispatched patrols composed of staff members from different participating States. The OSCE SMM also pledged its monitors to high ethical and professional standards and all staff members were asked to sign the Mission's code of conduct before their deployment.

In light of the non-permissive security environment, combined with the extensive geographical area to cover, and the sheer scale and volume of violations, it gradually became apparent that such a resource-intensive system of monitoring, verification and reporting was untenable. As challenges mounted and results were seen to be less than optimal, particularly regarding ceasefire verification, the Mission looked for alternatives.

Discussion: Is technology the answer?

At times, the deterrence effect of monitoring patrols became evident as regularly fewer ceasefire violations occurred when they were present. However, there was also growing concern that more boots on the ground would not necessarily adequately help the patrols meet the formidable challenges they were facing. If anything, more monitors would most certainly have resulted in more movement restrictions, and as long as human error was in the frame, hardly generate more, and least of all more reliable and accurate, information. Furthermore, more information does not automatically lead to greater compliance without an agreed attribution and follow-up mechanism.

At the heart of the problem was the sides' persistent lack of political will to adhere to their commitments. The less likely the stalemate appeared to change, and the more its impacts on the Mission's ability to monitor and verify the sides' actions were felt on the ground, the clearer it became that something more was required.

Drawing on the limited experience of other civilian monitoring missions, and consulting OSCE participating States, the United Nations, other organizations with related expertise (including in the fields of law enforcement and military), and individual experts, the OSCE began to consider using technology to complement its ground patrols.

The OSCE SMM saw in technology a potentially effective means to overcome passive restrictions, in particular mines and other obstacles to patrolling. Technology also seemed a promising tool in helping to fill gaps in coverage areas created by active restrictions; the use of technology could mitigate security risks, enable night-time observations, and improve the accura-

cy and reliability of its monitoring. The aspiration was that it would even allow the SMM to establish additional permanent presences. Technology was also assessed as a tool to improve verification efforts. From the outset, the OSCE SMM had clarified that its ground patrols would remain the most valuable and first-tier source of information and that technology would only complement, not replace, ground patrols.

The enhancement of the OSCE SMM's monitoring and verification capabilities with technology was made possible with the signing of the Memorandum in mid-September 2014. It was already clear at that moment in time that the Mission would need readily available, easily-deployable technologies as soon as possible; and it began, along with the OSCE Chairmanship and the OSCE Secretariat, to explore options in this regard.

3. Technology for Monitoring and Verifying the Ceasefire

Each of the Mission's monitoring and verification tasks required a different technical solution that would overcome not only the freedom of movement limitations imposed by the sides but would also work in Ukraine's specific geographical and meteorological conditions. The technology had to be rapidly deployable, be able to assist in implementing the Mission's mandate (the monitoring/verifying of the ceasefire and weapons withdrawal included), and should not generate additional security risks for the Mission's staff. Experts who could operate and maintain the technology were to be taken on board quickly, as no in-house expertise was available; last but not least, it also warranted political support and financial viability.

The sudden eruption of violence and, as an immediate consequence thereof, the expectation to enhance the Mission's capacity, reach, and accuracy did neither allow for a thorough needs assessment nor a comparative study of the few civilian operations that had already deployed some technology for the monitoring and verifying of ceasefire agreements.

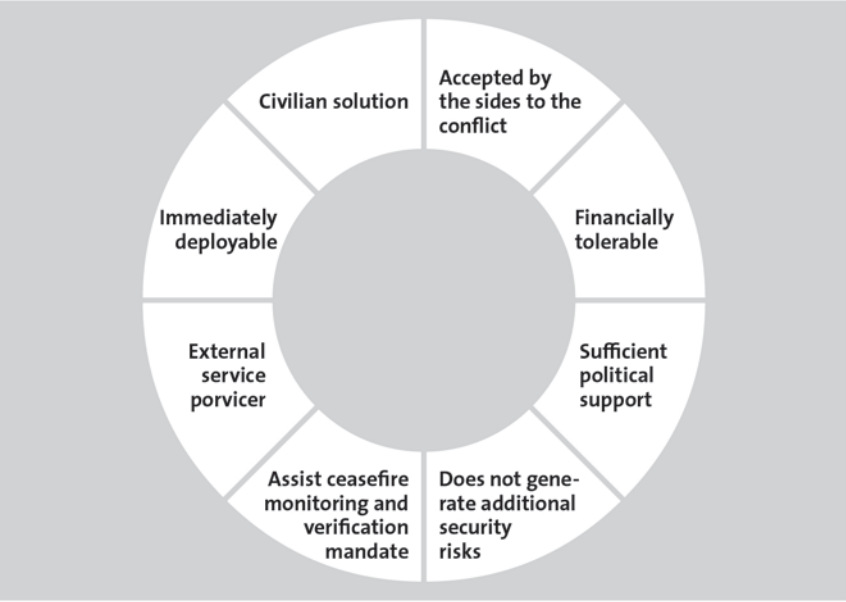
The following section will examine the deployment of unmanned aerial vehicles, cameras, and acoustic sensors as well as the use of satellite imagery by the OSCE SMM. It will also look into the criteria used to select the technology and provide an outline of the technical specifications and limitations of these technologies (see Figure 9). Furthermore, the section will lay out the operational requirements and give an overview on how the OSCE SMM integrated the data generated by the technology into its reporting architecture.

Unmanned aerial vehicles (UAV)[89]

With the assistance of external experts, the OSCE reviewed possible technological solutions (including static camera posts, acoustic sensors,

89 For a more detailed overview of current UAV developments, please see for instance: Syed Agha Hassnain Mohsan / Nawaf Qasem Hamood Othman, et al., "Unmanned aerial vehicles (UAVs): practical aspects, applications, open challenges, security issues, and future trends." *Intel Serv Robotics* 16 (2023), pp. 109–137.

Figure 9: Selection criteria for monitoring and verification



Source: A. Hug

balloon-mounted observation cameras, and unmanned aerial vehicles). Once this process was completed, the OSCE decided to first prioritize acquiring a suitable UAV system that could be deployed with relatively short preparation time and which operated remotely, i.e., at some distance from the non-permissive environment. The decision was in keeping with political reality, as within a month of the signing of the Protocol and Memorandum in Minsk, the leaders of the Normandy Four (Ukraine, Russia, France, and Germany) and Italy had agreed to consider offering UAVs and military personnel to be used to monitor adherence to the ceasefire and other provisions agreed in Minsk.[90]

While military technologies and support personnel provided by OSCE participating States were potentially an option,[91] they were eventually rejected

90 On the margins of the 10th Asia-Europe Meeting (ASEM) in Milan, Italy 16 – 17 October 2014. Giovanni Legorano, "Drones, Military Personal to be sent to monitor Ukraine Border with Russia," *The Wall Street Journal,* 17.10.2014.

91 OSCE, *Acknowledging further offers to enhance the OSCE's UAV capacities, CiO announces immediate consultations on respective modalities*, 2014.

as each deployment (operated by military personnel) was likely to require an additional force protection element. Arguably, an armed contingent as part of the OSCE SMM would have been incompatible with the civilian nature of the Mission (mandate; Art. 6). Itself a non-military Mission, the OSCE SMM needed a non-military solution, and solid political will to back it.

Fixed versus rotary wing UAVs

The OSCE had to find a UAV solution that would best fit its immediate operational needs. The market for UAVs offers a wide range of models of varying capabilities depending on the task at hand. There are rotary-wing based UAVs, such as quadcopters, hexacopters, and other helicopter-types able to land or take off vertically (VTOL systems: Vertical Take Off and Landing systems). Other UAV options include airplane-like fixed-wing types that may land with a parachute or on their belly. There are also electric or kerosene engine UAVs, and so forth. UAVs may carry sensors of different types and sizes (e.g., cameras), some have quite a short range while others are capable of flying at high altitude and over hundreds of kilometers. Some UAVs can be purchased by the public, while again others are regulated or restricted, particularly if they have a dual military/civilian use. There is no generally agreed upon and used categorization of UAVs, though. Consequently, the OSCE SMM created its own categorization consisting of mini-, mid-range, and long-range UAVs. This terminology will be frequently used and explained more profoundly throughout this publication, but it generally refers to the size and range of the UAV.

The two main differences between fixed- and rotary-wing UAVs are the way in which the aircraft are launched and landed, and the method in which they are flown. Fixed-wing UAVs generally require either a launching area (a runway, also needed for hand-launched UAVs) or a catapult for take-off and landing. Thus, a secure area of sufficient size is needed in order to operate this type of aircraft. VTOL systems only require a relatively small area from which they can operate. Fixed-wing UAVs are generally meant to survey large areas, and so the aircraft moves constantly and is capable of flying long distances. Rotary-wing UAVs are more suitable for tasks that require loitering, which means hovering above a specific area for an extended period of time.[92] At this point, it is worthwhile mentioning that the UAV

92 Fixed-wing UAVs have functions which enables these UAVs to circle over a point of interest via ground control station software.

market is evolving rapidly and also started producing hybrid VTOL/fixed-wing UAVs in order to remedy the take-off and landing constraints of traditional fixed-wing systems.[93]

Surveillance and technology sensor requirements

Unlike most of the smaller UAVs, long-range UAVs need to be equipped accordingly to carry the necessary payload. In most cases, this would be a type of sensor, most likely a camera. The Mission needed a camera capable of identifying weapon systems, moving objects, infrastructure (at greatest possible resolution), and persons (from a great height); during daytime and night-time, and preferably in any weather condition. All these requirements combined, the UAV would basically have to carry two cameras: a high-definition color camera for daytime use and an infrared thermal imager that can be used during either night-time or day-time. These instruments are produced and distributed by a few providers only. The Mission eventually decided to introduce an electro-optical and infrared single-axis camera as the sensor for its long-range UAV.

Additionally, such UAVs could be equipped with an additional Synthetic Aperture Radar (SAR).[94] This device is capable of penetrating cloud cover and of delivering generic information about vehicle or troop movements based on changes to the ground surface. SAR cannot always be mounted alongside the camera. In these cases, the SAR must be interchanged should clouds threaten to prevent the camera from capturing the necessary information. To purchase this high-tech equipment, the supplier of the SAR technology was obliged to obtain an export license, because both the camera and its components are subject to export controls as defined by international agreements such as the International Traffic in Arms Regulation (ITAR) or the multilateral Wassenaar Arrangement on Export Controls for Conventional Arms and Dual-use Goods and Technologies.[95]

93 See for instance: by Adnan S. Saeeda / Ahmad Bani Younesb et al., "A Survey of Hybrid Unmanned Aerial Vehicles," 2018.

94 For more background about the SAR technology, please see for instance: *What is Synthetic Aperture Radar* NASA.

95 *The Wassenaar Arrangement*, Wassenaar.

Long-range UAVs

Owing to the urgency of the situation and the scope of the task at hand, the OSCE decided to acquire a rotary-wing, long-range UAV first. The features of these VTOL systems met many of the Mission's requirements, in particular their property to be operated at a safe distance as well as the UAV's reach. However, there was immediate understanding too that such large aircraft would have to be operated by a third party; the technological and operational processes were too complex for the OSCE resources and expertise available. Thus, the OSCE sought out a service contract that would combine the hardware with a flight operating service provider which it procured after a formal tendering process. Naturally, the acquisition of a long-range UAV along with a suitable sensor required additional financial resources to which OSCE participating States needed to agree.

Once the contract had been finalized, suitable sites for launches, landings, and ground control station (GCS) facilities had to be found. Properties were rented, and accommodation for the contractor arranged. With the UAV's range of up to 200 kilometers, the GCS had to be placed at a location which allowed for the greatest possible coverage of the almost 500-kilometer-long contact line, while, at the same time, it was important to make sure the GCS and its personnel were not within firing range of the weapon systems commonly used by the sides. An overview of monitoring and verification tasks that can be supported by long-range UAVs can be found in Table 4. For security, practical, political, and legal purposes, a GCS location on the non-Government-controlled side of the contact line was not considered. Following negotiations with the Ukrainian government as well as security and operational assessments, a suitable site was identified in the Ukrainian Government-controlled areas of the Donetsk region.[96]

Eventually, there was political agreement among OSCE participating States and the signatories of the Minsk agreements on the use of UAVs by the OSCE SMM. Nonetheless, permission to operate these aircraft needed to be obtained from the host country's relevant authorities. The airspace over eastern Ukraine has been restricted since the beginning of the war.[97] Multiple reports confirmed that both sides had successfully (and to devastating

96 The OSCE GCS was initially near the village of Stepanivka (Donetsk region). See for instance here: OSCE, *Spot report by the OSCE Special Monitoring Mission to Ukraine (SMM)*, 27.10.2018.

97 Up to flight level 320. See more here: Dutch Safety Board, *Crash MH17, 17 July 2014,* https://www.onderzoeksraad.nl/en/page/3546/crash-mh17-17-july-2014, 2015.

effect) deployed various types of anti-aircraft weapons.[98] Military aircraft (fixed and rotary-wing) of the armed forces of Ukraine had been shot down starting May 2014[99], and the fact that the airspace over the conflict zone was a non-permissive environment for any aircraft was perceived world-wide when the civilian airliner MH17 was downed over eastern Ukraine[100].

On 23 October 2014, the OSCE SMM, at last, announced its first operational long-range UAV flight.[101]

Table 4: Monitoring, verification and other operational tasks benefiting from the deployment of long-range UAV[102]

Monitoring and/or verification task	Long-range UAV utility
Ceasefire (violations)	• Deployment at short notice to developing incident sites; • Monitoring of exchanges of fire; • Identification of firing position (thus, establishing the side responsible for the ceasefire violation) and the weapon system used; • Identifying changes in the battlefield (forward moves, new/strengthened positions et al); • Real-time imagery and nighttime deployment.
Weapons in violation of agreed withdrawal lines	• Monitoring and/or verifying weapons (static or mobile) in violation of agreed withdrawal lines; • Monitoring of a specifically defined area which should be void of heavy armaments and military equipment (Memorandum; Art. 5); • Real-time imagery and night-time deployment.
Designated storage areas	• Monitoring and/or verifying numbers and types of withdrawn weapons in designated storage areas on an *ad hoc* basis;[103] • Possible identification of movement of weapons through visible tracks on the ground; • Real-time imagery and night-time deployment.

98 This includes anti-aircraft guns (e.g., ZU-23), MANPADS (e.g., Strela, Igla), and SAM systems (e.g., Osa, Strela, Pantsir, Buk, Tor).

99 See for instance: Kevin Rawlinson, Paul Lewis, *Ukraine rebels shoot down military plane,* Guardian 14 June 2014, https://www.theguardian.com/world/2014/jun/14/russian-tanks-enter-ukraine.

100 "Malaysia jet crashes in east Ukraine conflict zone," BBC, 17.07.2014.

101 OSCE, *OSCE Special Monitoring Mission to Ukraine successfully completes the first flight of its unarmed/unmanned aerial vehicles,* 2014.

102 For examples, please see annex B.

103 Verification in this context: verification by the long-range UAV only relates to the number and possibly type of weapon systems in these designated storage areas. It was, however, not possible to verify whether previously declared weapons were present using a UAV observation as serial numbers on the weapons were only verifiable through ground patrols (unless the weapon systems were electronically tagged which would allow for remote detection/verification – this measure, suggested by the OSCE SMM, was rejected by both Ukraine and the Russian Federation).

Disengagement areas	• Monitoring the disengagement process; • Monitoring disengagement areas at short notice (e.g., establishing new positions and weapons, advancement of fortifications and trenches, the presence of personnel and other equipment, and new mine fields); • Real-time imagery and night-time deployment.
Human Dimension	• Assessing damage to critical infrastructure (e.g., water, gas, electricity), transport infrastructure (e.g., roads, railways), and housing; • Real-time imagery and night-time deployment.
OSCE SMM	• Situational awareness for ground patrols (road infrastructure, mines etc.); • Possible deterrence effect when deployed concurrently with ground patrols; • Operated at safe distance; • Real-time imagery and night-time deployment.

Operating long-range UAVs

Having long-range UAV capacity at its disposal instantly proved useful in the Mission's efforts, and the OSCE SMM quickly integrated it into its existing operations. Yet, operating a long-range UAV is a highly complex affair and the Mission needed a third party to step in. Thus, apart from acquiring the devices, the service provider chosen had to be able to provide trained and experienced UAV pilots and technicians. At a minimum, a team of three was required for a flight: a pilot, a sensor operator, and an engineer. The contractor was expected to build and equip the GCS and to ensure the necessary logistics, including fuel supply, were in place. The contract was designed to make the deployment of the UAV as simple and easy as possible for the Mission, and included contingencies to help manage the financial risks in case of aircraft losses.

The OSCE SMM dedicated a team of monitors, where available, with relevant aeronautic and/or UAV handling backgrounds to coordinate flight activities and support the service provider. This team was part of the Mission's operations unit and reported directly to the OSCE SMM's head office in Kyiv. It ensured secure communication of the UAV data to the head office and, together with the service provider, was assigned to the planning of long-range UAV patrols. The team was also responsible for supervising the contractor's work, and cooperated with the Mission's head office, relevant authorities, and armed formations in an effort to coordinate adequate responses to incidents (e.g., a recovery operation in case of a loss of a UAV).

The Mission created standard operating procedures for the operation of the long-range UAV, based on a general strategy that encompassed all of

the Mission's monitoring activities. To engage the long-range UAV, the Mission, both at field and head office level, identified areas of interest for possible long-range UAV surveillance and formulated a request for information (RFI). Such requests were made for a) standing tasks (e.g., monitoring a disengagement area or designated storage area for large caliber weapons), and b) for *ad hoc* needs (e.g., providing situational awareness for a ground patrol, verifying reported damage to critical infrastructure, monitoring of military-type ground movements). An RFI could also be used to redirect a long-range UAV at short notice to monitor, for example, a spike in ceasefire violations in a certain area.[104] The approved request was then transmitted from the Mission's head office to the long-range UAV team, which would subsequently see that the service provider executed the task in a timely manner and in accordance with the parameters set by the OSCE SMM.

Launching the long-range UAV at some distance from the front line in a Ukrainian Government-controlled area warranted some coordination with the Ukrainian Air Force so as to avoid collisions with military aircraft (helicopters, in particular) operating in the same area. This liaison work was the responsibility of the Mission's team assigned to the long-range UAV service provider. Since the formations led by the Russian Federation and the armed forces of Ukraine used all types of UAVs, albeit in violation of the Minsk agreements, a minimum level of coordination had to be established to avoid misidentification of an OSCE SMM UAV. These coordination efforts were made to maintain the Mission's independence and still not impair effective monitoring by making its patrols predictable; as such, the actual patrol routes of the UAV were not shared. Instead, the Mission only disclosed the coordinates of a large sector within which a long-range UAV patrol route would take place. Such a sector could be as large as half of the conflict area (see Figure 10).

The long-range UAVs of the OSCE SMM (see Figure 11) were clearly marked with the blue OSCE logo on a white aircraft body; this unique visual signature was communicated to the sides. The long-range UAVs also operated a transponder with a unique signature that any civilian or military radar was capable of reading and identifying as OSCE property. To avoid misidentification and accidental targeting of the Mission's long-range UAV, a de-confliction mechanism was developed. In short, this mechanism enabled the sides to contact a Mission 'hotline' whenever an unknown

104 OSCE, *OSCE SMM Spot Report 1/2020: Spike of ceasefire violations near the contact line in Luhansk region*, 2020.

Figure 10: Schematic example of long-range UAV flight sector and patrol path

Source: A. Hug

UAV had been identified. The Mission would then confirm whether or not the OSCE aircraft was operating in the area at the time of the incident, thereby reducing the risk of incidents while maintaining its independence. For as long as Russian and Ukrainian officers were both present at the JCCC, the de-confliction mechanism was channeled through the JCCC (see Fig-

Figure 11: OSCE SMM long range UAV launch

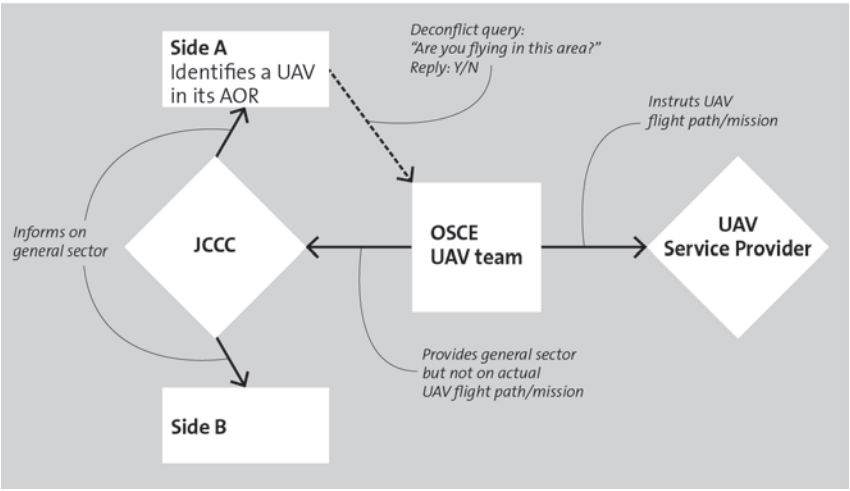
Source: The OSCE SMM launching the long-range unmanned aerial vehicle near Kostiantynivka, Donetsk region, March 2018, OSCE/ Evgeniy Maloletka.

ure 12). Once the Russian Federation had departed the JCCC in December 2017, the OSCE SMM dealt with hotline requests directly. Additionally, to avoid unintentional targeting, the Mission regularly reminded the sides of the location of its long-range UAV ground control station.

Smaller size UAVs (mini- and mid-range UAVs)

Deploying the Mission's long-range UAV capability was an expensive, complex, and rigid process. As only one long-range UAV aircraft at the time was in operation to cover the entire area of operation, the Mission lacked sufficient means to remedy the constant freedom of movement restrictions. Other options were needed to help the Mission maintain its reach, improve its situational awareness, and enhance its security. Consequently, the OSCE SMM decided to acquire smaller and less expensive UAVs, which it could operate and deploy quickly and easily to support and extend the reach of its ground patrols.

Figure 12: OSCE SMM UAV flight deconfliction mechanism



Source: A. Hug

In the category of smaller sized UAVs, the Mission differentiated between mini- and mid-range UAVs, depending on the size and range of the UAV. Both types could be deployed alongside ground patrols and did not require professional pilots or maintenance. Their easy handling made them particularly effective in overcoming mainly passive, but, at times, also active freedom of movement restrictions and in providing insight into areas the ground patrol could not access or was denied access to. The ability to detect possible risks or obstacles in the immediate vicinity of the patrol, including the patrolling route as such, improved the patrol's situational awareness and its security enormously. Furthermore, the cost of these types of UAVs was much lower than in the case of a long-range UAV and its sensor.

Whereas, due to their limited capacity, mini-UAVs are suitable for monitoring a single specific area of interest only, a mid-range UAV can cover a much larger area. This type of UAV is especially useful in mapping large areas that can then be transformed into 3D or 2D imagery. The mini-UAVs are deployable without extensive flight preparations. Mid-range UAVs, however, provide a broader overview, scan larger areas, and are most effective when their flight route is carefully planned ahead of the flight. Both are valuable in rural and urban areas and are easy to handle.

Operating smaller size UAVs

The Mission intended to equip as many patrols as possible with mini- and mid-range UAVs, and to train as many monitors as possible in their use. Unless otherwise specified by the Mission's head office, this equipment was operated by ground patrols autonomously. In fact, the mini-UAVs were piloted by any ground patrol. As their handling procedures are more complex, mid-range UAVs were operated by specially trained staff embedded in the ground patrols.[105] These smaller size UAVs were packed in the trunks of armored patrol vehicles, and the patrol assessed when it was safe and most efficient to deploy the devices. The storage, maintenance, and small repairs of these UAVs was undertaken directly by the field teams, with contracted external maintenance teams to assist them with more complex technical issues. The OSCE SMM head office was in charge of the recruitment of technical staff, training, providing operational guidance, substantial repair work, and the contracting and acquisition of mini and mid-range UAVs.

In 2019, the OSCE SMM operated at least 50 mini- and mid-range UAVs.[106] The main type of mini-UAVs among these were quadcopters, and the mid-range UAVs it operated were fixed-wing types. An overview of monitoring and verification tasks that can make use of mini and mid-range UAVs is listed in Table 5.

As with the operation of long-range UAVs, the OSCE SMM established standard operating procedures for the use of the smaller UAVs. The coordination of smaller UAV flights with the sides was slightly different from what has been described in the case of the long-range UAV. A ground patrol that deployed a smaller UAV (Figure 13 and 14) notified the sides of the wider area in which the patrol planned to operate it (though not the flight paths themselves) at least 30 minutes in advance of its flight. Up until the Russian officers left the JCCC, the Mission had liaised with the sides through the JCCC. Since then up to the closure of the OSCE SMM, the Mission communicated with the sides directly. These efforts were aimed at reducing the risk of misidentification of the Mission's UAVs. As with the long-range UAVs, the smaller UAVs were white or grey in color and carried the blue OSCE logo.

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105 Initially, staff with previous UAV piloting experience were selected and trained to operate mid-range UAVs. Later, the Mission recruited Technical Monitoring Officers to act as mid-range UAV operators.

106 OSCE, OSCE SMM technical monitoring, 2019.

Table 5: Monitoring and verification tasks and mid-range and mini-UAVs[107]

Monitoring and/or Verification task	Mini/mid-range UAV utility
Ceasefire (violations)	• Situational awareness: identifying changes in the battlefield (e.g., forward moves, new/strengthened positions); • Crater analysis, establishing firing direction and, where possible, identifying weapon systems; • Confidence building; • Real-time imagery.
Withdrawal of heavy weapons	• Monitor and/or verify weapons (static) in violation of agreed withdrawal lines; • Real-time imagery.
Designated storage areas	• Monitor/verify numbers and types of withdrawn weapons in designated storage areas on an *ad hoc* basis by ground patrols;[108] • Possible identification of the movement of weapons through visible tracks on the ground; • Real-time imagery.
Disengagement areas	• Monitor disengagement process (e.g., establish new positions and weapons, advancement of fortifications and trenches, the presence of personnel and other equipment, and new mine fields); • Real-time imagery.
Human Dimension	• Assessment of damage to critical infrastructure (e.g., water, gas, electricity), transport infrastructure (e.g., roads, railways), and housing.
OSCE SMM internal	• Situational awareness for ground patrols (e.g., road infrastructure, mines) through real-time imagery; • Tactical use. Operated by patrols autonomously.

Use of UAV imagery in publications, planning and internal briefings

During long-range UAV missions, the designated OSCE SMM UAV team analyzed the imagery at the GCS. The data were further analyzed at head-office level (so-called 'second level analysis') to guarantee accuracy. The Mission's head office then translated the images into a format suitable for inclusion in its reports, and ensured the information was shared internally. Besides reporting, the information was also used in patrol planning and tasking. For instance, if a long-range UAV mission had identified a burning house in a

107 For examples, please see annex B.

108 Verification by the UAV only relates to the number and possibly type of weapon systems in these designated storage areas. It was, however, not possible to verify whether previously declared weapons were present using a UAV observation as serial numbers on the weapons were only verifiable through ground patrols (unless the weapon systems were electronically tagged which would allow for remote detection/verification – this measure, suggested by the OSCE SMM, was rejected by both Ukraine and the Russian Federation).

Figure 13: OSCE SMM monitor launches mid-range UAV

Source: SMM monitoring officers preparing to launch a UAV near Hnutove, Donetsk region, OSCE/Germain Groll.

Figure 14: An OSCE SMM patrol launching a mini-UAV

Source: SMM monitors launching a UAV in Kruta Balka, Donetsk region, July 2017, OSCE/Mariia Aleksevych.

village, the Mission could task a ground patrol to follow up by talking to residents or by analyzing a possible impact site.

The data from the mini- and mid-range UAVs were transmitted to the patrol in the form of a live-feed, a swift procedure that allowed the patrol to draw conclusions at once on how to continue its mission. To prevent misuse, both the transmission and the on-board data storage was encrypted. The findings of the UAV flights, along with relevant imagery, were eventually included in the patrol's report. As was the case with other technology used by the OSCE SMM, the deployment of UAVs complemented human patrols and expanded the reach of the Mission (see Figure 15).

Additionally, the Mission used the imagery collected by UAVs to raise awareness of violations of agreed measures to sustain the ceasefire. For that reason, the OSCE SMM regularly published still and video imagery from its UAV operations in its reporting products, plus on its Twitter account[109] and Facebook page[110]. Together with its daily reports, these images and videos were intended to prompt the conflict actors to 'toe the line' and conduct themselves in the manner agreed to in Minsk. These publications also served to inform the public about the impact of the ongoing fighting, and they highlighted possible areas of risk, such as agricultural land contaminated by UXO/mines.[111] Sharing the information with the general public was also a useful tool to tackle inaccuracies or misinformation.

The Mission's reports and published images also assisted other parties (such as the United Nations agencies, the ICRC, Ukrainian Government offices, and non-governmental organizations etc.) in so far as they were supplied with better information, which, in turn, made the process of delivery of their activities, assistance, and humanitarian operations more efficient. Reports that pointed out minefields, destroyed and damaged homes, or critical infrastructure were indeed useful for these actors. What is more, the OSCE SMM frequently used these images to illustrate its public thematic reports[112] and to inform the OSCE participating States in regular internal briefings.

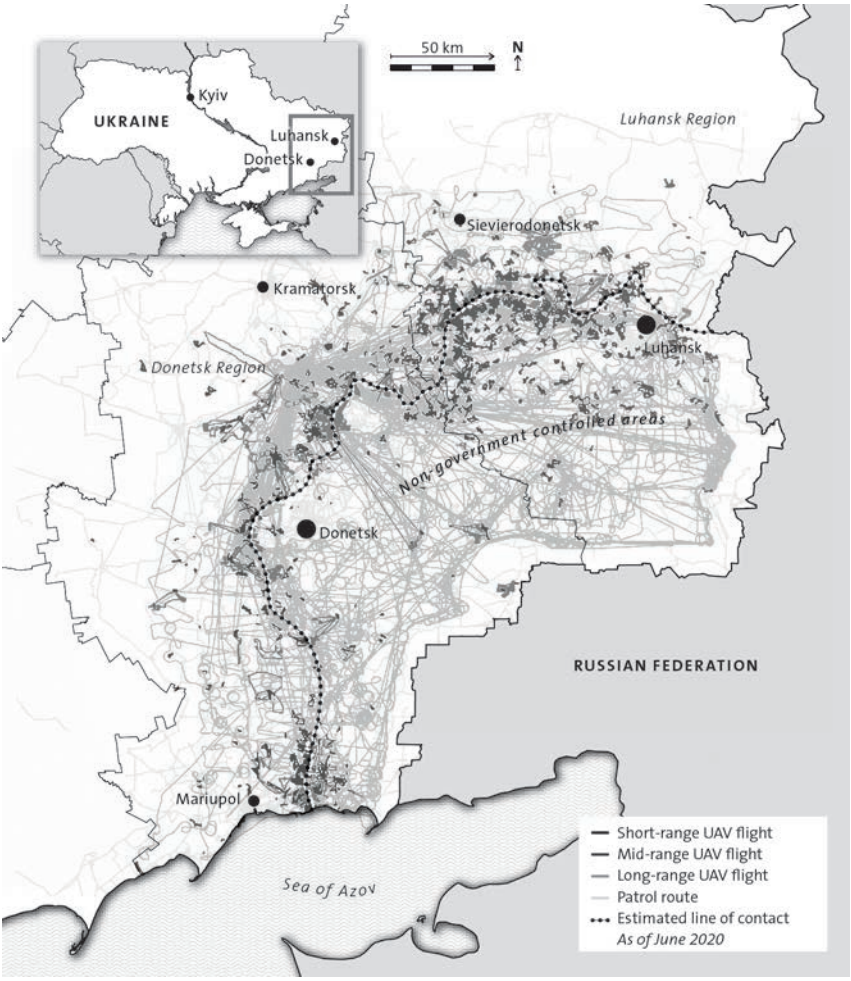
109 OSCE, *UAV operations*.

110 OSCE, *UAV operations*.

111 See for instance page 17: OSCE, *The impact of mines, unexploded ordnance and other explosive objects on civilians in the Donetsk and Luhansk regions of eastern Ukraine*, 2019.

112 OSCE, *Thematic Reports from the Special Monitoring Mission to Ukraine*.

Figure 15: OSCE SMM ground patrol routes and UAV flight paths



Source: OSCE, Thematic Report, Restrictions of SMM's freedom of movement and other impediments to fulfilment of its mandate, September 2019, p. 25.

Use of UAVs in trust and confidence building

The mini and mid-range UAVs were often used to bolster confidence-building measures, for example, by supporting localized humanitarian pauses. Ground patrols were then present on both sides of the front line and

deployed these UAVs in order to monitor any movement within a given area in which the sides had agreed they would not be active during a certain period of time. The Mission, thanks to its monitoring and reporting and applying a strict impartiality principle, managed to build – helped by its presence and technology – a thin layer of trust between the sides, upon which measures to ease localized tensions could be implemented.

Once introduced, technology became a means of facilitating dialogue. But it did not stop at helping coordinate the repair of infrastructure. The Mission also used technology to remind the sides not to succumb to the delusion that a localized cessation of hostility to the benefit of a (declared) infrastructure repair activity may be used as a pretense to advance troops and weapons. Furthermore, technology was used to identify mined areas and in return assist in mine action, monitor and facilitate the exchange of prisoners/hostages across the contact line, and oversee the transfer of cash for unpaid utility bills[113] from non-Ukrainian Government-controlled areas into Ukrainian Government-controlled areas. The strategic benefit of UAVs also became evident in the recovery of the dead from the battlefield in so far as they were helpful in identifying the location of the casualty and in the subsequent monitoring and support of an agreed pause in the fighting. The same approach was used to assist the recovery of civilians who were injured or had died in inaccessible areas.[114]

Cameras

Making the case for cameras

With its diverse UAV fleet, the OSCE SMM was able to cover inaccessible areas at short notice. They extended the reach of ground patrols and, to a certain degree, provided a remedy to restrictions on the Mission's freedom of movement. However, in areas where monitoring around the clock was warranted, the non-permissive security environment combined with the Mission's internal regulatory framework rendered a permanent physical presence of monitors impossible.

113 See for instance page 5: OSCE SMM, *Thematic Report: SMM facilitation and monitoring infrastructure repair in eastern Ukraine*, 2018.

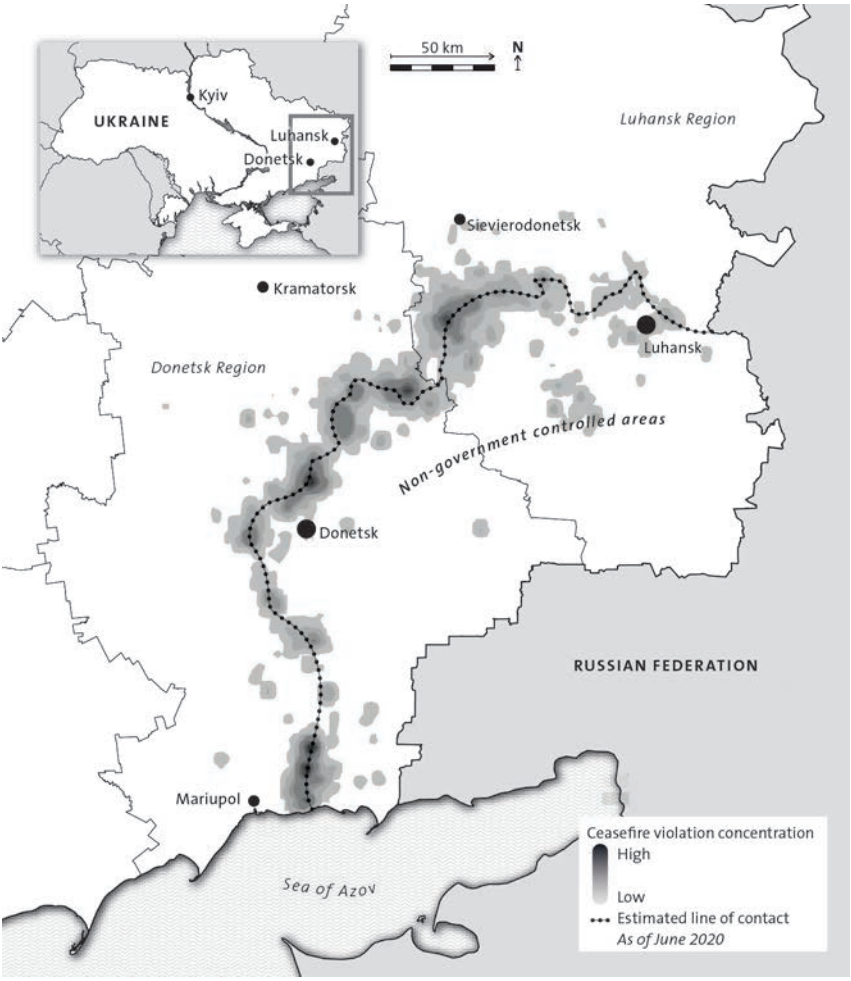
114 OSCE, *Latest from the OSCE Special Monitoring Mission to Ukraine (SMM), based on information received as of 19:30, 23 October 2018*, 2018.

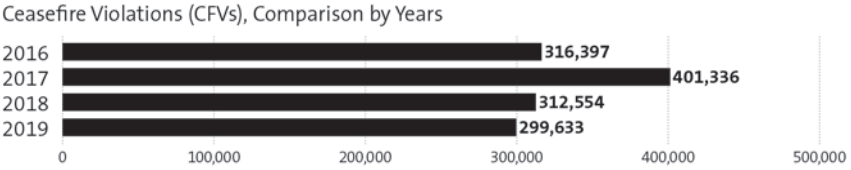
The mandate of the Mission formally provided the framework for around-the-clock operations, and the Minsk agreements called for a permanent presence of the OSCE SMM in certain areas of the conflict zone. Arguably, the verification tasks for certain commitments implied a permanent presence of the Mission (e.g., the uninterrupted adherence to the ceasefire for seven days prior to the disengagement of forces, or the adherence to the agreement to store heavy weapons in designated storage areas). Hence, there was a need to extend the Mission's presence and its monitoring capabilities. In particular, the following areas were considered of high priority for the development of a more permanent OSCE presence:

- **Hotspots:** While ceasefire violations could erupt at any location along the contact line, there were certain areas where fighting was almost constant. These hotspots were identified by the Mission and, with a few exceptions, had remained the same up to February 2022. They included areas where the sides were positioned in too close a distance; in some cases, merely across a road. Other hotspots were located in strategic areas such as along key transport arteries. Often, essential infrastructure or Ukrainian Government-controlled entry-exit checkpoints and the corresponding checkpoints in non-Government-controlled areas were located within a hotspot (see Figure 16).

  The hotspots represented the upper tier in the list of non-permissive locations along the contact line and were, due to their volatile nature, of key interest in monitoring and verifying efforts. As security concerns prevented the Mission from monitoring up close, OSCE SMM patrols would choose observation points in the general vicinity. These locations were typically elevated and close enough to the hotspot to ensure proper monitoring. In the predominantly flat terrain of eastern Ukraine, suitable vantage points are rare. When such points were identified, they were often at such a distance that monitoring was no longer possible as the battlegrounds were out of sight and monitors were seldom able to count individual explosions and shots reliably if solely based on what they could hear. The topography along the front line was mostly flat with tree lines, forests, or buildings/settlements that impaired the line of sight.

Figure 16: Heatmap and hotspots: Intensity of fighting along the contact line





Source: OSCE, Special Monitoring Mission to Ukraine, Trends and observations, 2019.

- **Disengagement areas:** In a number of places where the sides were positioned too close to one another, they defined areas at the contact line from which they agreed to move their hardware and troops at least one kilometer to the rear of the contact line. In September 2016, the Mission was then tasked with monitoring and verifying three pilot disengagement areas outlined in the Disengagement Decision on a permanent basis[115]. In 2020, TCG unsuccessfully undertook attempts to agree on additional disengagement areas.[116] These areas were at minimum four square kilometers in size, as stipulated in the Disengagement Decision[117], and although they were often quite kinetic, some limited daytime ground monitoring was possible.

- **Designated storage areas:** Designed to hold tanks, mortars, and artillery (including multiple launch rocket systems), designated storage areas in the rear of the contact line were established. These were created in accordance with the Minsk agreements or, if not stipulated there, at the behest of the OSCE SMM. The Mission has long reported that it had not received relevant information about these storage sites and that the established sites did not conform to the specific criteria set out for permanent storage sites.[118] Nonetheless, the OSCE SMM began to monitor sites known to contain weapons. These sites were often staging areas rather than "safe and secure storages", regularly inaccessible, and not clearly defined. To properly monitor these areas, or even be able to verify the adherence to the withdrawal commitments, the OSCE SMM would have needed a permanent presence in each of the nearly 200 designated storage areas.

115 Located at Stanytsia Luhanska, Zolote and Petrivske.

116 See for instance OSCE, *thematic report: restrictions to the SMM's freedom of movement and other impediments to the fulfilment of its mandate*, 2020 and President of Ukraine, *ceasefire regime continues: 20 demining sites and 4 new disengagement sites have been agreed at the TCG meeting*, 20.08.2020.

117 Example of a disengagement area: GoogleMyMaps, *Stanytsia Luhanska Disengagement Area,* https://www.google.com/maps/d/u/0/viewer?ll=48.630810381812644%2C39.492796999999996&z=15&mid=10rTx3TxhJQEwXxIayzducJ8DVwo_SSJU, 2019.

118 See for instance (section on withdrawal of heavy weapons): OSCE, *Latest from OSCE Special Monitoring Mission (SMM) to Ukraine, based on information received as of 19:30, 31 May 2016*, 2016.

- **Crossing the contact line:** There were five routes on which civilians (including OSCE SMM personnel) could cross the contact line.[119] These entry-exit checkpoints – and the corresponding checkpoints of the armed formations – were only open during daytime and consisted of a road that connected the sides in the form of a stretch of area not held or controlled by any of the sides. The shoulders of these roads, as well as adjacent areas, were contaminated with mines, and the crossing routes were heavily militarized at each end by either Ukrainian Government forces or the Russian Federation's armed formations. Civilians often queued for hours at these checkpoints before they were allowed to cross. The restricted pathways through this dangerous territory proved a critical challenge for monitors and verifiers too whenever they attempted to access vantage points and/or gather information they needed.

- **Essential civilian infrastructure:** This category included areas close to the contact line, or between the sides' positions, which contained critical infrastructure such as water filtration stations, electrical power transformer stations, or water, gas and electricity lines. A good example was the Donetsk water filtration station, which was located in between the forces' positions north of Donetsk city. This infrastructure was crucial for the safe supply of drinking water both in Ukrainian Government and non-Government-controlled areas. Its location made its facilities and staff vulnerable to the ongoing fighting in this area.[120]

In these key areas, monitoring by ground patrols required technological support beyond UAVs; the Mission needed to overcome security and access issues, while striving for permanent presence and a 24/7 coverage which the Mission's UAV capability could not provide. To meet these monitoring requirements, cameras were installed, allowing personnel to monitor a certain area from a safe distance. Some of the cameras installed could operate at night, making them the OSCE SMM's only tool that allows for constant 24/7 monitoring in a defined area (see Figure 17 and 18).

Ceasefire violations in disengagement areas were of special interest. According to the Disengagement Decision, the absence of an exchange of

119 In spring 2020, three out of the five crossings were temporarily closed, the remaining two locations only allowed limited crossing of the contact line.

120 OSCE, *Security situation around the Donetsk Filtration Station in eastern Ukraine remains critical, says OSCE Chief Monitor Apakan*, 2018.

Figure 17: Day and nighttime camera near Stanytsia Luhanska, near a disengagement area at the frontline

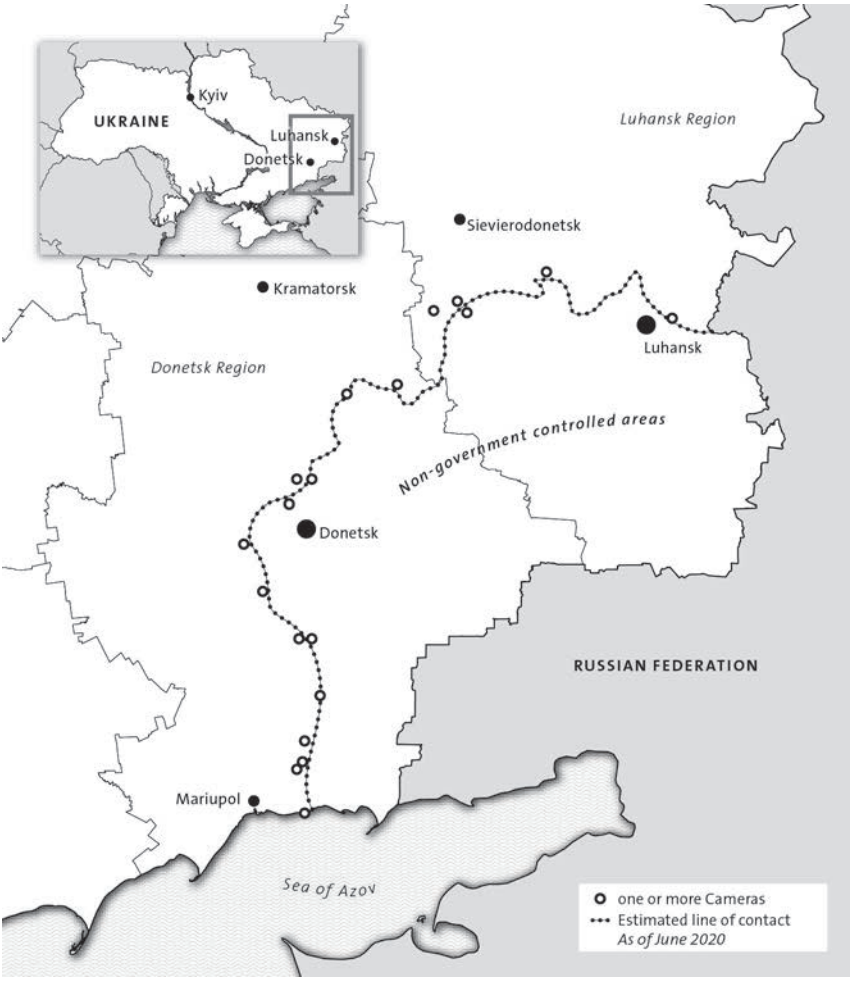
Source: OSCE SMM camera in Stanytsia Luhanska, Luhansk region, December 2016, OSCE/Evgeniy Maloletka.

fire for seven days as observed by the OSCE SMM was the pre-condition for effectively starting disengagement. Any ceasefire violation within the prescribed period would stop the process, at least temporarily.[121] Hence, cameras in disengagement areas made important contributions to confidence-building efforts as an additional layer of certainty was added to confirm that both sides were adhering to their commitments.

Located in hotspots and other points of interest, cameras, first and foremost, provided a factual record of whether ceasefire violations had occurred. Cameras could detect explosions, muzzle fire, tracer bullets, or projectiles in the air, and so made it possible to draw general conclusions with regard to the direction of fire. They could also record the movement and presence of persons (the personnel of the OSCE SMM included), weapons, and vehicles during an exchange of fire. Throughout 2020 for instance, the

121 For examples, please see annex B.

Figure 18: Location of OSCE SMM cameras along the front line



Source: OSCE, Special Monitoring Mission to Ukraine, Thematic Report, Restrictions of SMM's freedom of movement and other impediments to fulfilment of its mandate, December 2021, p. 23.

OSCE SMM reported 33% of all ceasefire violations as registered through its cameras deployed to hotspots.[122]

122 OSCE SMM, *2020 Trends and Observations*, 2020. In 2019, 39% of the roughly 300,000 ceasefire violations reported by the OSCE SMM were recorded by its cameras: OSCE, *2019 Trends and Observations*, 2019.

That way, the deployed cameras undoubtedly provisioned an additional layer of information, which permitted a better understanding of conflict dynamics in hotspots and backed the Mission's planning, in particular in relation to the deployment of patrols and UAVs. For instance, cameras deployed near the water filtration station to the north of Donetsk, a fiercely fought over area, helped the Mission ascertain if weapon systems were being used, and, if needed, send a long-range UAV to pinpoint the location of the firing position. The cameras also contributed to risk assessment in that they assisted to determine the hazards at locations where ground patrols were going to be deployed to.

In summary, cameras proved of use to establish facts that enabled the OSCE SMM to increase its situational awareness. The application of cameras produced a variety of the benefits seen with UAVs and other technologies. In particular, OSCE SMM reporting improved with the addition of camera data, and, in turn, contributed to more effective operational planning and tasking. Like UAVs, cameras provided footage which was immediately available. In conjunction with its back-end infrastructure, cameras kept a reliable record of monitored violations, which could be reviewed and analyzed at a later stage, and be stored electronically too. Finally, as with the deployment of UAVs, monitoring through cameras in hotspots had the potential to act as a deterrent for the actors knew their actions were constantly being recorded.

Types of cameras

To meet its needs, the OSCE SMM procured both closed-circuit television daylight-only camera (CCTV) systems and electro-optical/infrared cameras.[123] A combination of both types of cameras allowed for day and night monitoring. The cameras had to be mounted at a sufficiently elevated position so that they could survey the entire area and evade possible obstacles that could otherwise obstruct their view. Where possible, the OSCE SMM used existing structures or buildings – in one case a mineshaft elevator tower

123 See for instance: InfraTec: "Civilian observers of the Organization for Security and Cooperation in Europe (OSCE) use three high-resolution infrared thermal imaging systems of theVarioCAM® HD head security series to monitor compliance with the ceasefire in eastern Ukraine. The cameras are used to solve security and surveillance tasks with high range requirements. Similar systems have already proven themselves on comparable missions in Europe and North Africa." https://www.infratec.eu/company/history/.

Figure 19: A trailer-mounted camera system to the west of Shyrokyne, a village on the frontline inaccessible to the OSCE SMM

Source: The OSCE SMM observation camera in Shyrokyne, Donetsk region, January 2016, OSCE/Evgeniy Maloletka.

– as camera mounts.[124] Where this was not possible, the OSCE SMM erected towers for its cameras[125] or used trailer-mounted systems.[126] Trailer systems (see Figure 19), in particular, offered the flexibility the Mission needed in order to deploy these devices in emerging hotspots or at other points of interest where constant monitoring was required.

The OSCE SMM had about 30 camera systems in operation.[127] Political and operational requirements meant that cameras were deployed in areas prone to ceasefire violations, but none in or near designated storage areas in the rear of the contact line, leaving these areas without a permanent presence.

124 See for instance: OSCE, *Spot report by the Special Monitoring Mission to Ukraine (SMM): Man threatens SMM at camera site at Oktiabr mine*, 08.10.2016.

125 OSCE, *photos*, 2016.

126 See page 15: OSCE, *Restrictions of SMM's freedom of movement and other impediments to fulfilment of its mandate*, 2019.

127 OSCE, *OSCE SMM technical monitoring*, 2019.

Most of the camera systems used by the OSCE SMM could be panned and tilted via remote-control function. Cameras required a power supply and needed to be maintained regularly for which support from the sides was necessary. To avoid unintentional damage to the Mission's cameras or the personnel maintaining and installing the equipment on site, the Mission communicated the exact locations of its cameras to the conflict parties.

The OSCE SMM tested camera systems with data either stored on the system itself and/or transmitted to a remote server. Imagery storage on site, though, raised concerns over data security. Furthermore, such systems did not permit real-time monitoring as the stored images needed to be reviewed after being downloaded at the camera site. Even the act of going to the camera site located at a hotspot to download the data exposed Mission staff to additional security risks.

Data transmission from the camera to a remote server at the Mission's head office necessitated either mobile phone connectivity, an internet or microwave repeater connection, or a satellite link. The Mission initially established the connection between cameras and server via microwave-based repeater systems. Depending on the terrain and the distances involved, several repeaters were needed, each one required its own power supply and maintenance, a set-up which made the system vulnerable to interruption. The malfunctioning of a repeater meant that the entire data transmission was interrupted. This issue was even more pronounced in areas where access was restricted due to security concerns. To lessen the transmission interruptions, the Mission began transmitting some data via satellite connections which were more reliable.

To review the footage transmitted to the Mission's head office in real time and then include it in reporting in time, the OSCE SMM established a Technical Monitoring Center (henceforth referred to as 'TMC') at its head office in Kyiv. The TMC was incorporated into the Mission's operations unit[128] and equipped with multiple working stations and wide screens. These were operated in shifts around the clock by about 40 members of staff. The Mission's 'technical monitors' logged and tagged the findings from the camera feeds, for use in the Mission's reports.

128 See for instance: OSCE, *Chief of Technical monitoring center vacancy*, 2019.

Satellite imagery

The OSCE SMM enhanced its reach markedly through its use of cameras and UAVs. Yet, these additions still proved insufficient in covering the vast area to be monitored, and they were all potentially subject to outside interference. From restrictions on patrol movements, anti-aircraft fire, and electronic warfare, the Mission's monitoring and verification processes, by and large, remained vulnerable. Moreover, most of these tools recorded mere snapshots of a specific situation (like the presence of weaponry, a trench, or damage to a civilian dwelling in a village). Unless previous snapshots had been taken in exactly the same locations or a camera was installed to monitor a certain area around the clock, the Mission had difficulties in documenting changes over time.

To fill some of these information gaps, satellite imagery was assessed as an additional tool to back the efforts of patrols, UAVs, and cameras. Though not explicitly referred to in the mandate of the OSCE SMM, the Package of Measures unequivocally mentioned the use of satellites by the OSCE to ensure "effective monitoring and verification of the ceasefire regime." Since the Package of Measures was adopted in 2015, the OSCE SMM had access to satellite imagery provided by the European Union Satellite Center[129] in Madrid, funded by the European Union.[130] For instance, in 2015, the European Union allocated EUR 6 million to the OSCE SMM for satellite imagery and analysis. Additionally, the Mission was granted access to satellite imagery provided by France and Germany.[131]

It was this access to satellite imagery that allowed the Mission to track events that had already happened. In principle, this technology made it possible for the Mission to look back in time. Satellites run around the earth on a steady path and are, therefore, capable of photographing the same stretch of land every time they pass over. Thus, analysts who compared these pictures were likely to detect any actions taken on the battlefield, notably in relation to the positions of the forces, damage to critical infrastructure, the presence of weapon systems and other military-type installations, designated

129 European Union Satellite Center, Our Mission, https://www.satcen.europa.eu/Search/our-mission.

130 European Union External Action, *EU increases support for OSCE Special Monitoring Mission to Ukraine,* https://eeas.europa.eu/headquarters/headquarters-homepage/6351/eu-increases-support-osce-special-monitoring-mission-ukraine_en, 2015.

131 Book: *Kampf um die Ukraine: Ringen um Selbstbestimmung und geopolitische Interessen* (Studien Zur Friedensethik); Band 61; March 2018; p. 175.

storage and disengagement areas, and, in certain circumstances, the firing direction through crater analysis. These facilities, of course, also comprised the monitoring of the security situation beyond the contact line, up to the border with the Russian Federation. Overcast conditions were not a serious challenge to data collection, as satellites do have cloud penetrating SAR capabilities. That being said, the analysis of SAR-produced data is a far more time-consuming and resource-intensive endeavor than that of satellite images taken without cloud cover.

Based on the reports from the monitoring teams, as well as on UAV and camera image analysis, the OSCE SMM head office defined areas of interest and the Mission requested satellite imagery within parameters predefined by the European Union Satellite Center.

In agreement with the satellite image provider, a suitable format for the imagery requested was decided upon, as were details with regard to the secure transfer and storage of the data. In the majority of cases, the imagery provided indicated specific objects of interest to the Mission (e.g., weapon systems, destroyed housing, vehicle tracks). In 2017, the OSCE SMM received 510 information files of this kind from the European Union Satellite Center.[132]

In its reports, the Mission generally referred to 'aerial imagery' when drawing upon information contained in satellite imagery. For instance, in its report issued on 13 August 2019, the Mission reported: "Aerial imagery available to the SMM revealed the presence of 18 tanks and four surface-to-air missile systems (types undetermined) in a training area near Buhaivka (37 km south-west of Luhansk) (in the same area, aerial imagery revealed also the presence of 63 armored combat vehicles (ACV)."[133] While the OSCE SMM did not publish the satellite imagery it received, it did highlight important observations made from satellite imagery. This information was then shared via its social media channels, with links to the relevant reports.[134]

Satellite imagery also revealed visible developments not detectable by ground patrols. To give but one example, a slow-paced and gradual forward move of positions may have not necessarily been detected by ground patrols,

132 European Commission, *Good Administration,* https://ec.europa.eu/transparency/regdoc/rep/3/2018/EN/C-2018-3108-F1-EN-ANNEX-1-PART-1.PDF.

133 OSCE, *Latest from the OSCE Special Monitoring Mission to Ukraine (SMM), based on information received as of 19:30, 13 August 2019*, 2019.

134 OSCE, *OSCE SMM Report,* https://twitter.com/OSCE/status/913056068607135744, 2017.

especially where security concerns restricted access. A comparison of satellite imagery taken over time in areas of reported tensions (e.g., civilians complained about an increase in shelling to ground patrols) could establish facts should forward moves have taken place.

Furthermore, satellite imagery proved to be extremely useful when screening border areas. The location of the Mission's permanent presences near the contact line, but at a considerable distance from the international border between Ukraine and the Russian Federation, had regularly muddled comprehensive identification of cross-border activity. Satellite imagery was then successfully used by the OSCE SMM, for instance, to determine locations of frequent, unofficial crossings between Ukraine and the Russian Federation in non-Government-controlled areas. Traces on the ground left by heavy equipment were identified on satellite images and followed-up UAV patrols were sent to these locations. Consequently, the OSCE SMM managed to regularly obtain real-time footage of military-type convoys crossing the green border from the Russian Federation into Ukraine in areas of Ukraine controlled by Russia and back during nighttime[135]. That said, the flight path of most satellites is easy to predict and actions on the ground can be calibrated accordingly.

As the OSCE SMM was, in some way, able to 'look back in time', satellite imagery brought forth strong indications of where the Mission should dispatch its patrols, because it supplied the monitoring teams with an additional level of situational awareness, potentially useful for their patrol planning. An example of information relevant to security represented intelligence on the location of mine fields or destroyed transport infrastructure. If satellite imagery revealed newly placed anti-tank mines on a patrolling route, the Mission first deployed a UAV in the area to verify the facts and could, if the mines were still in place, re-route the patrol.

Acoustic sensors

Ground patrols monitoring ceasefire violations usually noted the number of explosions or shots they *heard*. However, audio-based evidence was often inconclusive as it was almost impossible to determine the firing direction,

135 See for instance: OSCE SMM spotted convoys of trucks entering Ukraine in the Donetsk region, https://youtu.be/Ani2YWDLXl0?feature=shared, 2019.

position, and weapon type while attempting to distinguish the sound of overlapping gunfire and explosions. The OSCE SMM's cameras, UAVs, and satellite imagery were only visual sensors and sources, respectively. In order to augment its monitoring capabilities, the OSCE SMM sought for additional sensors designed to capture and analyze the specific acoustic signature of a fired weapon system (e.g., gunfire, muzzle blasts, incoming artillery/mortar explosions).

Acoustic sensors consist of microphones pointed in different directions that are capable of registering battle sounds, triangulating the origin and direction of fire, and determining the type of weapon used. Acoustic sensors can either be installed permanently or mounted on vehicles for mobile deployment. They can be adjusted to point in the direction of an incident and can release a co-installed camera to point in the same direction.[136] A driving concept behind the Mission's decision to acquire sensors was the acknowledgment it needed to add another 24/7 monitoring tool to its kit.

For testing purposes, the OSCE SMM installed an acoustic sensor at its forward patrol bases in Popasna and Svitlodarsk, locations close to the contact line from where monitors had regularly recorded battle noise. The Mission initially encountered a range of difficulties in relation to the sensors. While audio devices were suitable for detecting and identifying single shots or shells fired, their applicability for the monitoring of intensive, overlapping and multi-weapon-layered battles was questionable. As a result, the OSCE SMM opted for a passive audio-detection sensor and decided against other related technology, such as counter-battery radars. The radar signature of the latter could be picked up and potentially led conflict actors to mistake the devices for enemy equipment, and so put the operators at risk. The Mission used the data provided by its acoustic sensors in its daily reports.[137]

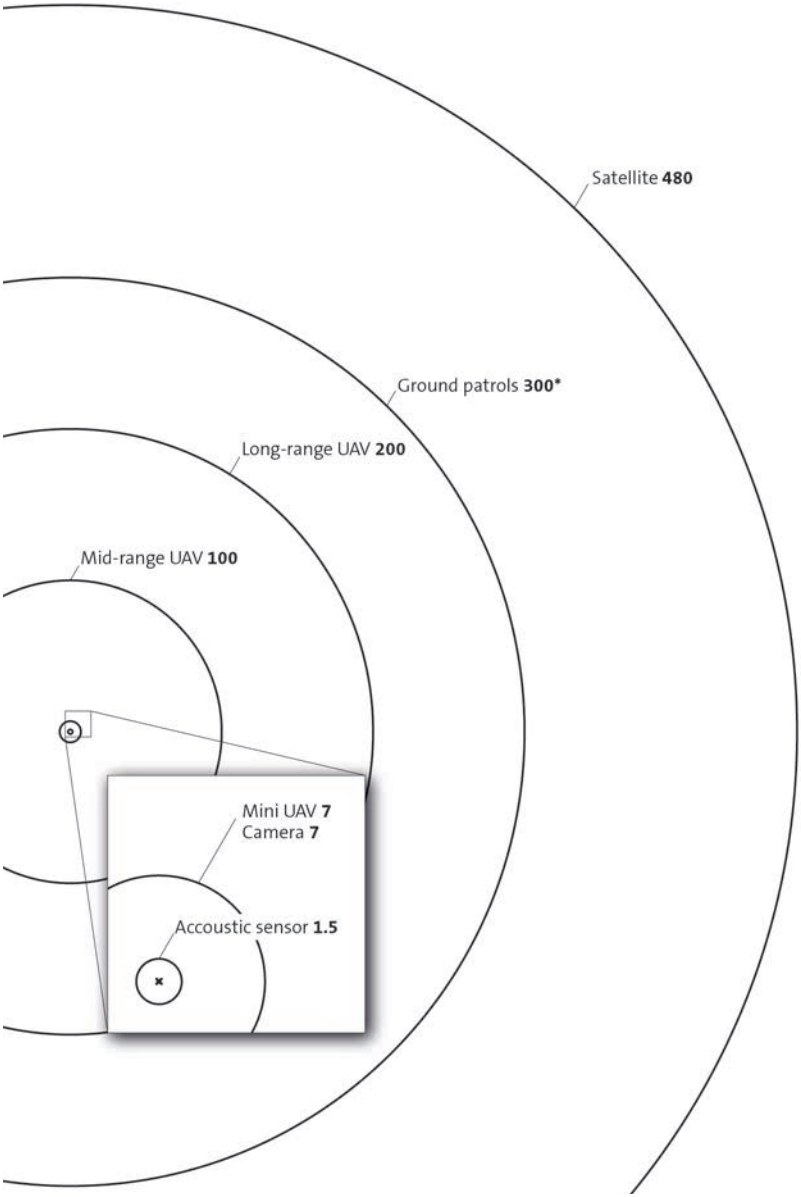
Discussion: Combining different technologies

The above discussion suggests that one single type of technology is likely insufficient to cover large and diverse geographical areas and to capture the various aspects of a ceasefire arrangement. The best results are achieved by a

136 See for instance A. Walter Dorn, "Smart Peacekeeping: Toward Tech-Enabled UN Operations," New York: *International Peace Institute* (July 2016), pp. 7–9.

137 See for instance page 3 at: OSCE, *OSCE Special Monitoring Mission to Ukraine (SMM): Table of ceasefire violations as of 19 April 2018*, 2018.

Figure 20: Range of monitoring Tools



Source: A. Hug
* Maximum daily reach of a patrol.

carefully tailored combination of different types of technology, complementing human patrols. When selecting such a combination, the factors to consider include the range of monitoring tools – summarized in a comparative manner in Figure 20. Other factors to consider are costs; the ease of deployment by human patrols; the quality, quantity, and timing of the information required; perceptions of the local population and the sides to the conflict; and the adaptability of the technology to conflict dynamics.

4. Organizing the Information: A Multi-layered, Multi-sensor Operation

Equipped with various sensors to complement ground patrols, the OSCE SMM was better equipped to support the implementation of the Minsk agreements despite incessant restrictions on its freedom of movement. Yet, the task of organizing all the data remained challenging; up to 90 patrols kept on producing detailed reports, nearly 30 cameras were running 24/7, plus there were multiple UAV missions per day, acoustic sensors, and satellite imagery. The Mission needed a robust system to compile, transfer, analyze, report, and store all the disparate information.

As a consequence, the OSCE SMM established a comprehensive set-up that involved three key units. Schematically, the Operations Unit coordinated the on-the-ground activities, the Reporting and Political Analysis Unit was responsible for the bulk of the reporting activity, and the Information Management Cell was tasked with processing the additional data generated through technical means (see Figure 21).

Operations Unit

The Operations Unit was the key controller and manager of the data collection in the field. It planed and deployed patrols to collect information, and installed and maintained technology; furthermore, it ensured the patrols' avail of the most appropriate technology. At field level, the unit coordinated the initial analysis of collected data, such as UAV imagery gathered by patrols. The Operations Unit was also responsible for the coordination of the transfer of information from the field to the Mission's head office. In this context, the unit flagged interference with its dispatched patrols and technology, and it notified the Mission's head office of projected interruption to the reporting schedule.

Information Management Cell

In a next step, the Mission needed to find ways to process the substantial load of images, video, and audio footage that came in every day. For this purpose, it established an Information Management Cell (IMC), which employed various experts, amongst whom there were imagery analysts,[138] information management officers,[139] and geographical information system officers.[140] The IMC was tasked with analyzing, compiling, disseminating, and storing data collected by the various sensors. As described earlier, the initial analysis of UAV outputs, acoustic sensor data, camera footage, and satellite imagery was conducted by either the ground patrols themselves, in kind contribution provided by OSCE participating States, or the TMC. If called upon, the IMC proceeded to analyze, compare, and consolidate these data sets. Being able to compare different data sources also helped eliminate 'double counting'. As a matter of fact, the centralized management of the data stemmed from the understanding and acknowledgement of the fact that a ceasefire violation captured by a camera may also have been registered by an acoustic sensor, a ground patrol and/or a second camera in the same area, and was a central factor in the Mission's effort to minimize the risk of reporting inflated, i.e., inaccurate, numbers of ceasefire violations.

The IMC compiled the different types of information to put together multi-layered visual products (e.g., a recent UAV image of a newly-identified fortification layered on top of satellite imagery in which the contact line is shown) as well as analytical products such as charts and tables. The TMC also produced annotated maps that permitted more in-depth analysis by the Reporting and Political Analysis Unit. The Mission frequently published visual products, maps, charts and tables produced by the IMC as part of its regular reporting and via the Mission's social media platforms.

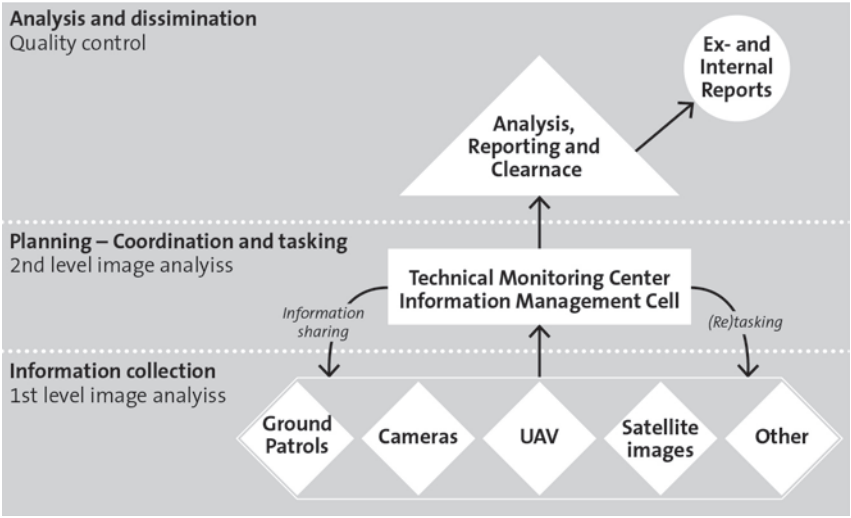
The IMC was also responsible for the secure storage of the information. Multiple years of video footage and a growing number of images require sophisticated archiving tools and large storage space. The Mission expanded its storage capacity by procuring secure servers. The Mission also

138 OSCE, *Imagery Analyst Office Vacancy,* https://jobs.osce.org/vacancies/imagery-analyst-officer-vnsmus00923, 2019.

139 OSCE, *Information Management Officer Vacancy,* https://jobs.osce.org/vacancies/request-information-management-officer-vnsmus00501, 2017.

140 OSCE, *Geographical Information System Officer Vacancy,* https://jobs.osce.org/vacancies/geographical-information-system-officer-vnsmus01033, 2020.

Figure 21: The multilayered process in collecting, analyzing and publishing information gathered by ground patrols and technology.



Source: A. Hug

sought to preserve the data for future reference beyond the timeframe required for immediate analysis and inclusion in the next Mission report. Therefore, it set about developing a searchable database, which raised the Mission's ability to identify trends and 'look into the past' whenever a current situation (e.g., location of new positions or damage to infrastructure) needed to be compared with an earlier period. All the information verified and collected by the OSCE SMM may also be of assistance to those who will look at Russia's war against Ukraine from a historical and arguably judicial point of view.

Reporting and Political Analysis Unit

The staff responsible for producing the Mission reports constituted another key unit of the OSCE SMM in its endeavor to implement the explicit monitoring and reporting tasks enshrined in the Mission's mandate. Not unlike the Operations Unit, the Mission's Reporting and Political Analysis

Unit (RPU) was established when the Mission first deployed. It was responsible for the compilation of reports and for drafting the Mission's reporting products. Operating with one reporting officer when the Mission was deployed in spring 2014, the RPU employed as of the end of 2019 around 25 staff members.[141] The RPU also advised the Mission's Operations Unit to follow up where reported information was evidently inconsistent or incomplete, or when required by incidents or new developments. RPU outputs arrived in the form of translations, interpretations and compilations of everything the Mission produced. Thus, the RPU basically served as an assessment tool both for the Mission's management and the OSCE participating States through the daily reports and regular updates provided by the Mission's management to OSCE's Permanent Council. Arguably, the work of the RPU also had the potential to inform sides of their shortcomings and, hence, the political process too. At last, the RPU's output provided a necessary baseline for humanitarian efforts directed at providing relief to civilians on both sides of the contact line.

Discussion

The Mission's experience highlights that the deployment of technology is only as good as the systems and people put into place to collect, store, analyze, and communicate the vast quantity of information generated. This can be human resource intensive – an issue we turn to in the following chapter. The interaction between human patrols and technology was key to success. Information collected by technology needed to be made available to human patrols, and such patrols indicated where complementary action through technology was required. Thus, the way human-technology interaction was structured had a direct bearing on the quality of the information generated.

141 See for instance: OSCE, *Head of Reporting and Political Analysis Unit Vacancy,* https://jobs.osce.org/vacancies/head-reporting-and-political-analysis-unit-vnsmus00945, 2019.

5. Incorporating Technology: Major Challenges and Responses

As described in Chapter 3, there were many obstacles the OSCE SMM had to overcome in order to fulfil its tasks. Technology helped the Mission to exploit the potential of its mandate more fully in so far as it effectively supported the implementation of the Minsk agreements despite all the restrictions it was exposed to. But technology is not a panacea, and there are still a number of critical considerations to be made by those exploring whether or not to incorporate technology into their own monitoring and verification efforts.

Sufficient resources

As demonstrated, the deployment of technology required hiring additional qualified staff members and did not result in a reduction in the mission's footprint.[142] The OSCE needed to source out a variety of experts to help live up to their technological monitoring and verification ambitions. However, largely due to budget constraints, the politics involved and the policies and procedures of the organization, this proved a difficult task.

The majority of the OSCE SMM's international staff were seconded.[143] The OSCE's 57 participating States were invited to nominate suitable candidates for a certain position. From this pool of candidates, the OSCE SMM selected its staff members. The organization was dependent on personnel provided by participating States and could not recruit in the open market for most of the required positions. Consequently, the OSCE SMM had difficulties in finding sufficient numbers of suitably qualified technical experts to procure, install and maintain its technology as well as analyze the data resulting from its operation. The resulting lack of expertise was a signif-

142 Armies around the world also recognized that automation does not lead to less staff: See for instance: Jack Watling, "Automation does not lead to learner land forces," *War on the Rocks,* 07.02.2014.

143 For general information related to OSCE's recruitment process: OSCE, *How to apply,* https://jobs.osce.org/how-to-apply.

icant problem, as it could have led to reduced capacity and, even worse, unreliable outputs. Mistakes made in its analysis, for instance, could have hurt the Mission's reputation and credibility, which would have seriously undercut the Mission's ability to assist the sides in implementing their agreements.

Often, these experts were in high demand in their home countries too, a fact that limited the pool available to the Mission even more. The majority of these experts were already employed as police officers, border guards, and members of the armed forces (for example, as long-range UAV operators). Sometimes, participating States offered to deploy such experts directly, but these short-term deployments did not help build the necessary institutional capacity and were, consequently, often of limited value to the OSCE SMM. Other experts in niche areas (e.g., software developers for GIS applications) were also in high demand in the private sector, which was in a position to offer more attractive compensation packages than a secondment arrangement to the OSCE.

A particular challenge was finding experts in imagery analysis. As described earlier, the huge volume of still images and video footage required significant human resources to analyze properly, and, in many cases, technical expertise too. Long-range UAVs with SAR capability are a particularly illustrative example. SAR enables the sensor to 'see through cloud cover' and is able to produce radar imagery no matter what the weather conditions are like. Interpretation of the outputs warrants specific training, as it is difficult for an untrained eye to recognize, for example, a tank in these images. The Mission's reduced attractiveness for reasons both structural as well as in terms of compensation and career options represented the kind of challenge the Mission faced with regard to the acquisition of specialists. As far as human resources were concerned, the Mission simply could not keep up with the private sector, the less so if they jockeyed for specialists such as SAR analysts, whose niche skillset was and remains in great demand globally. To stand but a small chance in recruiting enough of these specialists, dedicated and full-time headhunting would be required.[144]

Information-Technology (IT) experts were of similar importance to the Mission's work but proved similarly difficult to recruit and retain. Fun-

144 For more background on the complexities of analyzing Synthetic Aperture Radar (SAR) images, see for instance: New space economy, *Why using synthetic aperture radar imagery is hard,* https://newspaceeconomy.ca/2023/07/21/why-using-synthetic-aperture-radar-sar-imagery-is-hard-really-hard/.

damentally, the OSCE SMM needed experts and service providers able to install and maintain its technology. In contrast to other civilian contexts, however, these IT experts had to be willing and able to work near or at the frontline, a setting that was likely to put them at risk of being involved in security incidents. No wonder, the Mission – more often than not – found the task of ferreting out companies willing to dispatch staff to such a high-risk environment nearly impossible. Certainly, it is less problematic to find a company to install and maintain an infrared camera at the state border between France and Switzerland than a camera system along an active frontline. Where no service partner could be found, the Mission had to rely on the pool of seconded experts from OSCE participating States.

Technical expertise was indispensable both in the field and at the operational level (head office level). Using technology in the field was not a one-way street; analyzed information needed to be funneled back to the monitoring teams for a variety of reasons, often with feedback and new in-time instructions. Such processes were essential to improve output at field level (e.g., the quality of submitted mid-range UAV imagery and first-level analysis), and increase situational awareness of the patrols (e.g., by having access to analyzed UAV or satellite imagery). This information flow also involved the provision of feedback on the quality of the patrols' gathering of information, and of additional tasking on in-field monitoring or verification.

Behind the scenes, there was a large administrative and technological support system that made certain that the Mission's technological operations ran smoothly and efficiently. Incorporated in this were also planning and procurement processes, for instance, when new technology was introduced, or old equipment was replaced. The availability of subject-matter experts was also crucial in the early stages of the deployment, for example, to define the specification of the technology required for mobile cameras with night vision capability, to conduct market reviews, or develop the tender and respective evaluation criteria and, ultimately, to issue the invitation to tender. Business-minded staff was needed in the procurement process, not least to assist in striking the balance between the risks associated with price, quality, and delivery time of the technology. The selection of a company to provide high complex and expensive equipment (e.g., long-range UAV or SAR) was an intricate and time-consuming process. Finding the right staff for these important tasks was a major challenge.

Data management and coordination

The more technology the Mission deployed, the more information it collected and, as time passed, the amount of data vastly increased. In consequence, the Mission needed to find ways to cope with the magnitude of information and make it accessible to internal analysis. The OSCE SMM undertook structural changes, as outlined above, including the establishment of specialized units such as the Technical Monitoring Centre or the Information Management Cell. In addition, specific expert positions were created to boost information processing, which became part of a large apparatus within the Mission. Major challenges remained, some of which centered on the integration of the information generated by the technology in place into a single data management system.

The principal challenge for the Mission had three aspects: firstly, to make the information captured by the various technology tools more accessible; secondly, to bring about a more efficient analysis of this data; and, lastly, to improve the flow of information within the Mission. At the outset, data collected by the OSCE SMM was stored in different formats on individual tablets, phones, desktop computers and different servers. Acknowledging the fact that the individual handling of information was neither efficient nor sustainable, the Mission in its later years commenced to streamline its data, and its geographic data in particular, from its monitoring technology into a Mission-wide geographic information system, also known as Enterprise Geographic Information System (EGIS).[145] The creation of a Mission EGIS, enabled the OSCE SMM to introduce data standards, which improved the collection, processing, evaluation and sharing of geographic data within the organization.

Data security

While great efforts were made to secure the transmission of data from the Mission's UAVs and cameras, technology is not immune to unauthorized interception. This fact was especially critical in cases where the Mission's footage contained sensitive information, which it often did. Firstly, the

145 OSCE, *Statement by the Delegation of Ukraine in response to the update by Ambassador Martin Sajdik and to the report by Ambassador Yaşar Halit Çevik*, 2019.

OSCE SMM encrypted most of its transmitted data. If encrypted transmission was not possible or the technology proved incapable of transmitting, the devices stored the information in ciphered form on the system itself. Yet, even though ground patrols downloaded the information regularly, on-site storage had frequently been found to be problematic, because access to these sites was not always possible due to security concerns. Another issue was the fact that on-site data storage was susceptible to theft or destruction.

The transmission of larger data files represented a further challenge. In many cases, UAV imagery was too large to be transferred in full to the Mission's head office via a standard internet connection and was even more problematic with the instable and unreliable internet connection near the contact line. Therefore, a more selective transfer of smaller files was provided for by making the patrols or the operator teams do a first analysis. Initially, the full-length raw data were transferred physically via mobile hard drives. Later, to secure the transfer, the data were submitted through the medium of a specially designed secure network.

The raw data collected by the Mission's technology also needed to be stored safely so that it could not be interfered with or misused. The Mission expanded its server capacity and stored the data in an encrypted form. To share footage and data within the Mission for reporting and operational planning purposes, the OSCE SMM adopted a need-to-know approach. IT experts were brought in to maintain a 24/7-security surveillance of the Mission's IT infrastructure. There were several attempts[146] to hack the Mission's information technology infrastructure, which in turn stressed the importance of the OSCE SMM's efforts in improving data security.[147]

The reports of the OSCE SMM did not reveal sensitive information such as coordinates or other details that could potentially bestow a military advantage on either side. Information was detailed only to the extent necessary for violations to be remedied. It was unlikely, though, that such caution was necessary given that the conflict actors conducted round-the-clock reconnaissance on their part too. Still, upon request, the Mission would provide further details to the violator to enable remedial action.

146 OSCE, *OSCE Special Monitoring Mission to Ukraine's statement to media allegations*, 2018.

147 See for instance: "OSCE security monitors targeted by hackers," BBC, 28.12.2016.

Environmental factors

The weather could be a mighty challenge to the sensitive technology deployed by the OSCE SMM (see Table 6). Adverse weather conditions, such as dense cloud cover, strong winds, rain, snow, and extreme temperatures impaired the operability of all technology used by the Mission.

Even satellites work best in clear-sky conditions as cloud-penetrating radar images are far more labor-intensive to interpret. Consequently, cloud cover often encouraged movements on the ground despite possible satellite coverage of the area.

Though limited in range, mini-UAVs used by the OSCE SMM were capable of operating in difficult weather conditions. These UAVs can operate up to a wind speed of approximately 15 meters per second, but excessive wind, resulting in the batteries draining more quickly, limits their range. These small UAVs are rain-proof, albeit with limited camera performance in the rain owing to reduced visibility. Sub-zero temperatures also drain the battery quickly, though the UAVs still perform relatively well in temperatures as low as approximately minus 15 degrees Celsius.

In comparison, mid-range UAVs deployed by the Mission were more sensitive to adverse weather, which is down to the manner in which they are deployed; their range covers an area so big that weather conditions and influences may be hard to predict. Low temperatures and headwind cause the battery of a mid-range UAV to empty exceedingly fast, which either limits its range or, in the worst case, keeps the UAV from returning to the launch site. Moreover, a mid-range UAV operates at a higher altitude than mini-UAVs. Since it flies through cloud layers there is the danger that its wings ice over, potentially prompting temporary loss of control and, worse still, suffering loss of the UAV altogether should attempts to regain control fail.

The long-range UAV deployed by the OSCE SMM arguably performed best of the three in adverse weather conditions. Still, dense cloud cover, rain, or snowfall limited its visibility. Flying a long-range UAV through the clouds may expose it to icing too, which could equally result in the loss of control over the vehicle.

In contrast, the camera systems used by the Mission were less vulnerable to extreme weather conditions, though strong winds may interfere with the ability to pan or tilt the camera. Additionally, reduced visibility due to heavy snowfall, fog, or rain limits their ability to capture images with clarity. Snow cover on solar panels can also compromise the operation of solar-pow-

ered cameras. Furthermore, exposed cameras (e.g., when deployed on a mast) need to be protected from lightning strikes, by, for instance, surge protectors. In any case, each camera had to be earthed properly.

Table 6: Weather phenomena and level of interference[148] on technology deployed by the OSCE SMM

	Strong winds (loss of control)	Snow (impaired visibility)	Heavy rain (impaired visibility)	Negative temperatures (icing on wings loss of control)	Overcast (impaired visibility)	Lightning strike (loss of control)
Mini-UAV	medium[149]	low	low	low[150]	low	low
Mid-range UAV	medium[151]	low	medium	medium	medium	medium
Long-range UAV	low	low	low	medium	medium	medium
Camera	low	low	low	none	none[152]	medium
Satellite	none	medium	medium	none	medium	none

Source: A. Hug

The vegetation in an active fighting area needed to be taken into consideration as well. Near the contact line, bushes and trees grew untrammeled for months and years, and increasingly obstructed a camera's line of sight. Pruning vegetation was almost impossible and would have required a local ceasefire and, most likely, the demining of a large area. Dense vegetation could be used as additional cover by the combatants, and it was hardly surprising that the OSCE SMM had observed reluctance to remove vegetation that impaired the line of sight of its cameras.

148 The categories 'medium' and 'low' are not numerically defined and are based on experience. In the table these categories represent the interference potential of a certain weather condition with the different technology tools used by the OSCE SMM.

149 Up to 15 m/s.

150 Up to minus 15 degree Celsius.

151 Up to 15 m/s.

152 Fog would increase the risk to medium.

Balancing trade-offs

Speed vs. accuracy

As stated above, technology can prove an important tool for monitoring and verification, but also requires sophisticated data and imagery analysis. Both data collection methods described, and the analysis that stems from them, supplemented the Mission's already lengthy reporting process. The factor of time needed to analyze the volumes of data for reporting was a crucial aspect from the beginning, the more so in an environment as fluid and exposed to rapid and sudden changes of the battle dynamic as the OSCE Mission had to operate in. Time indeed mattered in an environment driven by social media that catalyzed raw information and imagery from diverse sources at – practically – lightning speed.

Facts matter, but to establish them was time-consuming; unverified hearsay, rumors, and speculation had to be prevented from seeping into the Mission's reports. For example, if a civilian had informed the OSCE SMM on the telephone that a local hospital in their town had been damaged by shelling, the Mission would have first decided how to verify this claim, and then – possibly – performed a UAV flight over the hospital. Only once the facts had been verified would the Mission have integrated the incident in its report. Afterwards, more time was taken up by the internal clearance of the report, to translate it into Ukrainian and Russian, and, in the end, to publish it online. With only a 24-hour turn-around period, this represented a significant effort that entailed considerable analytical and drafting work outside regular working hours.

At the same time, virtually every soldier, armed person or civilian with a mobile phone could become a 'monitor'. This had indeed led to situations where events monitored by the SMM were publicly broadcast on social media channels ahead of the publication of the Mission's report. Resultantly, the media, the general public, and even the combatants often for ulterior political motives began to speculate why the Mission had been keeping 'silent'– ignoring the stringent reporting processes of the Mission. This led to allegations that the OSCE SMM turned a blind eye and willfully refused to report key incidents, particularly in cases where SMM monitors had been seen to have witnessed the events. Thus, the Mission's commitment to accuracy ended up being used by others to undermine its reputation, sometimes with political and security implications.

The following example may serve to illustrate the Mission's delicate position in this regard: On 1 February 2017, an OSCE SMM patrol observed tanks in the town of Avdiivka, located close to the contact line. Clearly, their presence represented a violation of agreed withdrawal lines.[153] Since the Mission operated a camera that covered the same area 24/7, photographs were taken of OSCE SMM patrol cars and some monitors standing near the tanks, and, subsequently, journalists (and residents) published these pictures on social media.[154] As neither the information gathered by the patrol nor the photographs produced by the camera would feature in a Mission report until the following day, social media and the general public – now filled in on the incident prematurely and superficially (i.e., both ignorant of the context and standardized OSCE SMM procedures in such cases) – began to confer about why the Mission had not reported on the presence of the tanks, suggesting or even alleging that the Mission was deliberately withholding information because of political bias.[155] Little attention[156] was paid to the fact that on the following days the presence of the tanks was duly reported as a violation in the Mission's daily report.[157] Thus, long-term damage was inflicted on the Mission's reputation as the unfounded allegations kept on gaining traction.

So as to prevent such situations from happening, the Mission highlighted its working methodology at every opportunity, with a distinct focus on the time-consuming diligence it exerted when attempting to verify facts. Also, the OSCE participating States and the general public were regularly briefed by the Mission on the necessity and benefits of such an approach. At one point, the Mission even ran a TV campaign entitled 'Facts Matter'.[158] Where incidents were particularly serious or sensitive politically, the Mission – usually on the very same day – also released flash ('spot') reports.

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153 The industrial town of Avdiivka is located to the north of Donetsk city. The location in Avdiivka where the tanks were observed is roughly 4,5 kilometers away from the contact line. According to the Addendum (Art. 1), thanks should have been withdrawn at least 15 kilometers from the contact line.

154 For instance: Tom Soufi Burridge, *ceasefire violation*, https://twitter.com/TomBurridgebbc/status/826812407225909249, 01.02.2017.

155 Alexander Kots, *OSCE in Avdiivka monitors the implementation of the Minsk agreements. Tanks? What tanks?* https://twitter.com/sashakots/status/827038690094546945. 02.02.2017.

156 For instance: Bellingcat, *Ukrainian Tanks in Avdiivka Residential Area*, https://www.bellingcat.com/news/uk-and-europe/2017/02/03/ukrainian-tanks-avdiivka-residential-area/, 2017.

157 OSCE, *Latest from the OSCE Special Monitoring Mission to Ukraine (SMM), based on information received as of 19:30, 1 February 2017, 2017.*

158 See for instance: Youtube, *Facts Matter – OSCE SMM*, https://youtu.be/5505nDYFT8M, 2017.

Furthermore, the Mission occasionally used its social media channels to highlight situations whose evolving nature demanded immediate remedial action. For instance, in the case of the tanks in Avdiivka mentioned above, the Mission issued a clarifying statement.[159] Such interventions often relied on raw imagery generated by its technology. The same channels also issued 'fact checks' whenever the Mission's actions or a specific situation appeared to be or have been misrepresented. For instance, on 14 June 2017, the Mission's Facebook page published the following text:

> "FACT CHECK: Regarding incorrect news reports that the OSCE SMM did not record civilian casualties in Trudovskyi. The #OSCE SMM – contrary to some media reports – has in fact reported on the deaths of two civilians in the Trudovskyi area of Petrovskyi district in #Donetsk city. Not only has the OSCE reported the facts, it has done so despite restrictions on its access to the area […]."[160]

Intrusiveness of technology – monitoring vs. intelligence gathering

The line between monitoring and gathering intelligence can – to a point – be blurred as the two activities tend to overlap in several areas. Mistrust between the sides and limited understanding on the part of the general public with regard to the nature of the Mission's activities were ideal conditions for the emergence of allegations that the Mission was spying or employing spies. These often came with significant consequences for the OSCE SMM. In one particular incident, a SMM patrol was stopped at gunpoint at a checkpoint run by the Russian backed armed formations. In violation of international conventions governing diplomatic vehicles, an armed member of the formations searched the patrol vehicle and questioned the patrol members about the deployment of "equipment used for spying" and about "video footage".[161] Another time, armed men in the vicinity of a position of the armed forces of Ukraine surrounded OSCE SMM patrol members and "enquired about a camera that they said they had observed in the OSCE vehicle, filming positions of the armed forces of Ukraine and alleged that the SMM was

159 OSCE, *OSCE SMM statement,* https://www.facebook.com/oscesmm/posts/762137037271337.

160 OSCE, *OSCE SMM Fact Check,* https://www.facebook.com/oscesmm/posts/fact-check-regarding-incorrect-news-reports-that-the-osce-smm-did-not-record-civ/835037659981274/.

161 OSCE, *Spot Report by OSCE Special Monitoring Mission to Ukraine (SMM): SMM held at gunpoint at checkpoint in Lukove*, 2016.

'spying' for the 'Donetsk People's Republic' ('DPR') [Russian backed armed formations] by giving grid co-ordinates for artillery strikes".[162]

The level of perceived or real intrusiveness of the technology deployed could nurture mistrust in its use. This mistrust may have even exacerbated the challenges faced by the Mission. Regarding such mistrust, the UAVs deployed by the OSCE and the satellite imagery available to the SMM had the potential to capture more information than what was relevant for monitoring and verifying the ceasefire. Therefore, the Mission had strict guidelines on what data to gather and how to analyze and disseminate it (e.g., see below on the use of satellite imagery).

More critical still were rumors that the Mission was infiltrated by foreign secret service agents who operated the technology for the political gain of a particular country. For instance, Moscow claimed that OSCE staff was passing on sensitive information to the armed forces of Ukraine.[163] Right after Russia's full-scale invasion in February 2022, the deputy representative of the Russian Federation to the United Nations alleged that the OSCE as an organization was engaged in spying against his country.[164] Tragically, the Russian Federation detained OSCE SMM staff members based on these allegations, many of whom are still being held by Russia at the time of writing this publication (summer 2024).[165] There were persistent claims that all Russian monitors of the Mission were, in fact, Russian intelligence officers[166], and that OSCE staff members were engaged in propaganda work on behalf of one of the sides[167]. Others again asserted that the OSCE SMM provided cover for and harbored Ukrainian intelligence service members.[168]

Unfortunately, the deployment of sophisticated technology fueled some of these rumors even more. Likewise, the ensuing mistrust was exacerbated by the sides' attempts to deny or distract from violations reported by

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162 OSCE, *Latest from OSCE Special Monitoring Mission (SMM) to Ukraine based on information received as of 26 August 2015*, 2015.

163 "Russia says catches OSCE employee spying for Ukraine," *Reuters*, 18.10.2016.

164 "Russia's deputy UN envoy confirms facts about espionage by OSCE staff in Donbass," *Tass,* 19.04.2022.

165 OSCE, *OSCE Chairman-in-Office and Secretary General condemn sentencing of OSCE Mission members Petrov and Shabanov in Luhansk, demand their immediate release,* https://www.osce.org/chairmanship/526251, 19.09.2022.

166 For instance: Oksana Kovalenko, "Major General Kremenetsky: I am sure that any Russian officers in the OSCE mission are staff members of either the GRU or the FSB," *Pravda*, 11.01.2017.

167 "OSCE SMM observer in Luhansk region found to be Russian intelligence officer – media," *Interfax*, 28.10.2015.

168 "Russia's FSB arrests Ukrainian spy operating as an OSCE interpreter," *Tass,* 18.10.2016.

the Mission – and by their desire to shoot the messenger, sometimes literally. For instance, a leading member of the Russian-led armed formations, misleadingly stated publicly: "The OSCE cameras only point at us with reinforced ones, but they don't have a single camera on the other side. We don't have access to these cameras, and the Ukrainian servicemen sit behind these cameras and watch how we move."[169] While it was hard to prove that such statements had actually led to more aggressive behavior towards the Mission, the fact that several of its cameras were subsequently destroyed by small-arms fire proved that such allegations did not fail to take effect.[170]

Understandably, civilians felt uncomfortable and 'watched' when, say, a highly sophisticated night vision camera was installed in their neighborhood. Often, uneasiness derived from unfounded assumptions about the capacity of the technology. It is not by chance that human monitors were often perceived as less invasive. Artificial intelligence (AI) aside, it would be wrong to ignore the fact that technology is always operated in one way or another by humans who inevitably add elements of subjectivity to the process and whose decision-making is not immune to human error, even if they act on instruction. The intrusiveness of technology could be reduced through technical fine-tuning (e.g., aiming the camera at a specific object as opposed to observing an entire area). However, it remained a difficult task to explain the various devices' capabilities and their integration into the Mission's work, both to the sides and the local population. The persistent belief that the technology 'can see everything' was the seedbed of rumors and allegations that the Mission was secretly gathering information.

To counter these allegations, and by doing so, lessen the public's fear of intrusive technology, the OSCE SMM openly communicated the technical base-data and the purpose each deployment of its technology served. Similarly, the OSCE SMM had decided early on to make its reports public, which was a rather unusual step for an OSCE field operation. Traditionally, regular reports of an OSCE field operation would not be disclosed but only issued to the organization's participating States as diplomatic cables.

Following the same intention of abridging widespread suspicions about its monitoring work, the Mission's patrol cars were painted white with OSCE's blue emblem on all sides (including on the roofs) and thus clearly

169 "The head of the DPR accused the OSCE mission of bias," *Ria Novosti,* 17.01.2017.

170 See for instance: OSCE, *OSCE SMM camera at Donetsk,* https://www.facebook.com/oscesmm/posts/osce-smm-camera-at-donetsk-filtration-station-operational-only-1-day-already-sho/868071463344560/.

visible, camera locations were disclosed to the sides and marked distinctly, and the UAVs operated by the Mission had unmistakable markings and some even carried an individual transponder signature as noted earlier.

The particulars of operating in a conflict zone

Security risks associated with installing, maintaining and operating technology in a kinetic environment

The setting up and operation of technology in an active fighting area inevitably increases the security risks for the personnel involved. The risk of being caught in crossfire or even being willfully targeted is, naturally, significant when maintaining a camera system in the middle of a battleground, with positions of the warring parties in close proximity. Mounting a camera at a sufficient height additionally exposes technicians to sniper fire. And essential work at camera sites needs to be done on a regular basis and is not limited to the sensor only; the camera also needs wiring and has to be connected to a reliable power source. Electricity from the grid is not reliable in these areas, if it is available at all. Thus, generators are brought in, and these must be refueled. Solar panels need regular cleaning, direct exposure to sunlight and cannot be relied upon in winter due to snowfall. To ensure the safety and security of its personnel, prior to installing and maintaining the technology, lengthy negotiations and complicated coordination work were necessary to reassert agreements on local ceasefires and mine-clearance. Often, these agreements, too, were not complied with.

The operation of mini-UAVs by ground patrols was an additional risk prone activity. As the sides used similar UAVs for reconnaissance or even attack purposes, a Mission UAV was often mistaken for an enemy UAV. If they were not targeted intentionally, that is. Small-arms fire frequently targeted OSCE SMM's assets as well. Since the Mission's ground patrol UAV operator was relatively close to the smaller UAVs with their limited range, fire aimed at the UAV was a potential risk to the patrol that piloted it. The OSCE SMM reported that the sides took advantage of the deployment of the Mission's UAVs by using it as a cover to launch their own UAVs hoping that the other side would be more reluctant to open fire knowing that the Mission's UAV was active in the same area. Thus, unwittingly, the Mission offered a shield for the operation of the sides' UAVs.[171]

171 The Minsk agreements banned the use of UAVs and other aircraft by the sides.

To lose a UAV during an operational flight was a significant incident and created a host of problems for the OSCE SMM. For example, a single large long-range UAV weighed about 110 kilograms and could carry up to 60 liters of easily flammable kerosene, and could, should it crash, cause severe injuries and damage to persons and infrastructure, respectively. Thus, maneuvering long-range UAVs above constructed or inhabited areas required careful planning and enhanced operational skills. This was also true of mini- and mid-range UAVs despite the risks being less significant.

The recovery of a downed UAV (large or small) could also prove a formidable task. While it was possible to identify the position of a downed aircraft with the help of on-board GPS tracking, the crash sites themselves were often inaccessible and required mine clearance first. The OSCE SMM did not have its own mine-clearance capability, and so the sides had to approve of cooperation with the Mission for the recovery work to go ahead. Had the UAV come down near the contact line, a pause in the fighting had to be negotiated and coordinated between the sides to ensure the safe recovery of the UAV.

Targeting the Mission's technology

In a crowded conflict theater where opposing sides deployed some of the same technology as the monitors and verifiers, an accurate identification of technology as friend or foe was virtually impossible. The sides developed measures (see Figure 22) to detect or neutralize enemy technology, which – consciously or not – could also be directed against the OSCE SMM.

For example, from 1 January until the end of June 2021, the OSCE SMM reported a total of 2,197 mid- and mini-UAV flights. During this period, the Mission observed that GPS signal interference, possibly by jamming, had occurred at least during 734 flights (33% of all flights). In these six months, the OSCE SMM lost spatial control of ten such UAVs, none of which were recovered (Figure 23 a, b, c). The Mission also recorded 65 occasions on which the sides had opened fire (44 of those incidents were registered in non-government-controlled areas) and targeted its mini and mid-range UAVs – as assessed by the Mission. As a result, two such UAVs were downed in the first half of that year. During the same period, the Mission conducted 89 long-range UAV flights. During these flights, the Mission recorded GPS signal interference (Figure 23) in at least 226 cases resulting in the loss of two aircraft and one damaged beyond repair following an emer-

Figure 22: Example of electronic warfare equipment identified by a OSCE SMM UAV

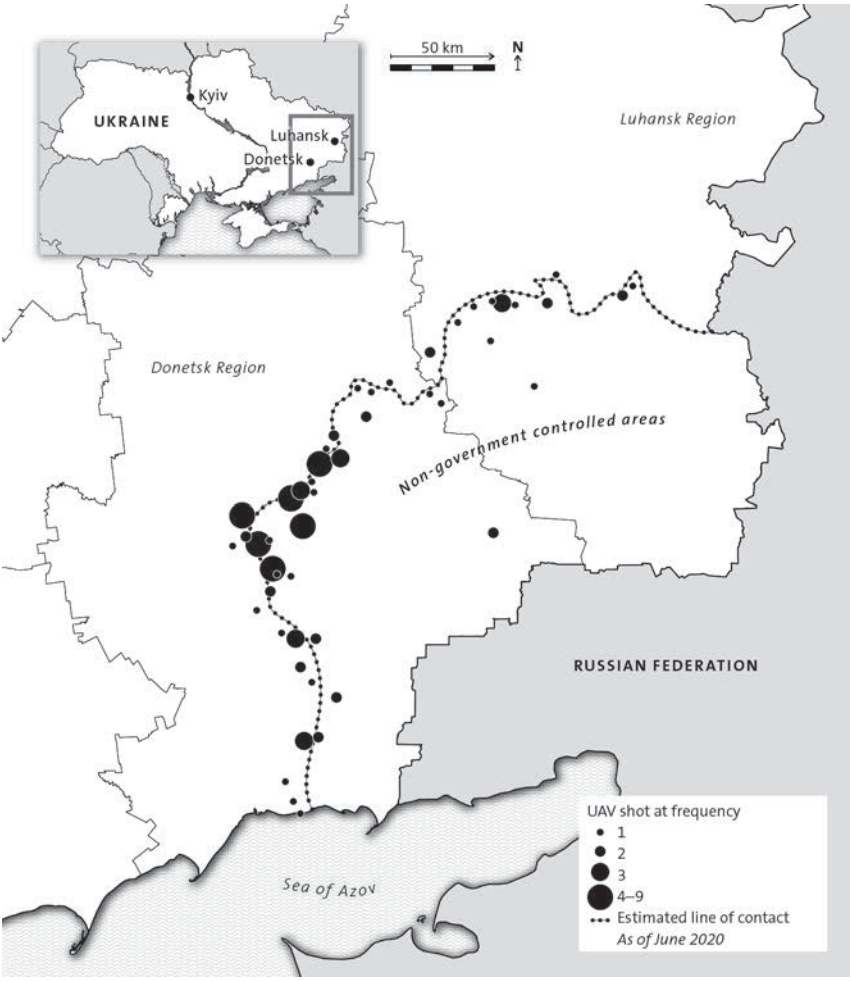
Source: InformNapalm, Exclusive Data: More Russian electronic warfare systems spotted in Donbas.

gency landing procedure.[172] The surveillance cameras deployed by the OSCE SMM were also frequently targeted. For instance, in June 2020 alone, four camera systems were rendered inoperable due to suspected small arms fire – losing more than 10% of its deployed camera capacity within a single month.[173]

172 OSCE, *Thematic Report: Restrictions to the SMM's freedom of movement and other impediments of its mandate*, 2021.

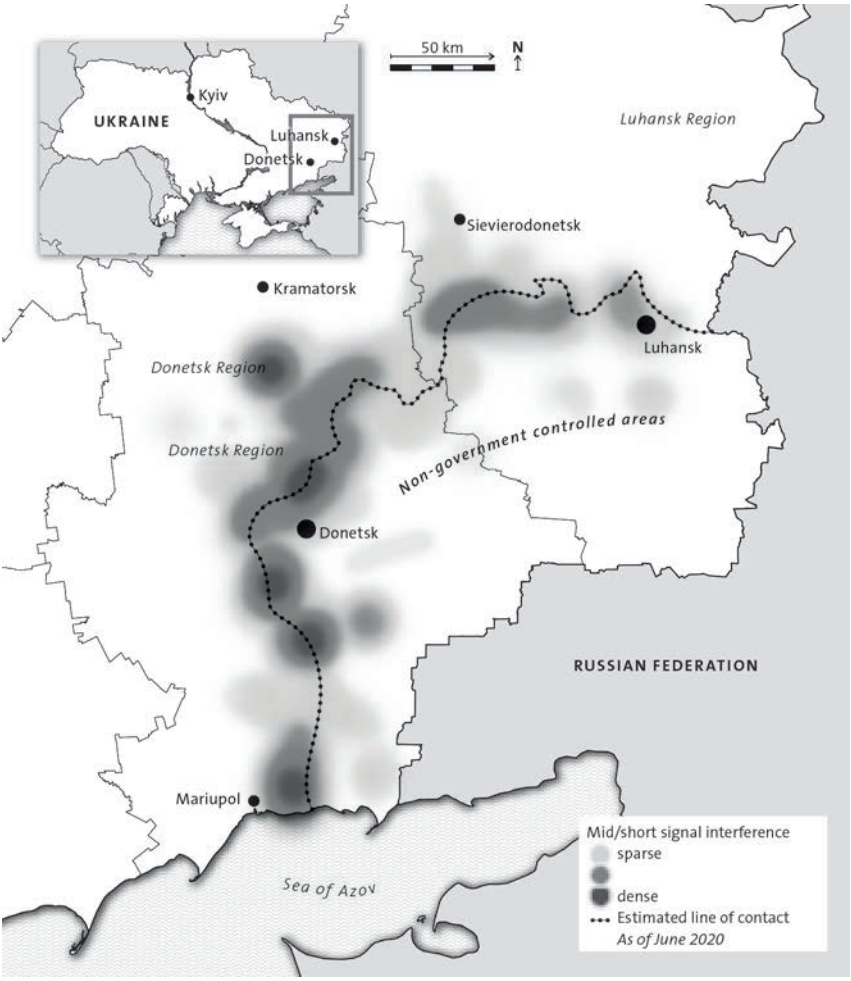
173 OSCE, *Thematic Report: Restrictions to the SMM's freedom of movement and other impediments of its mandate*, 2020.

Figure 23 a: Long-range UAV signal interference in the first six months of 2019



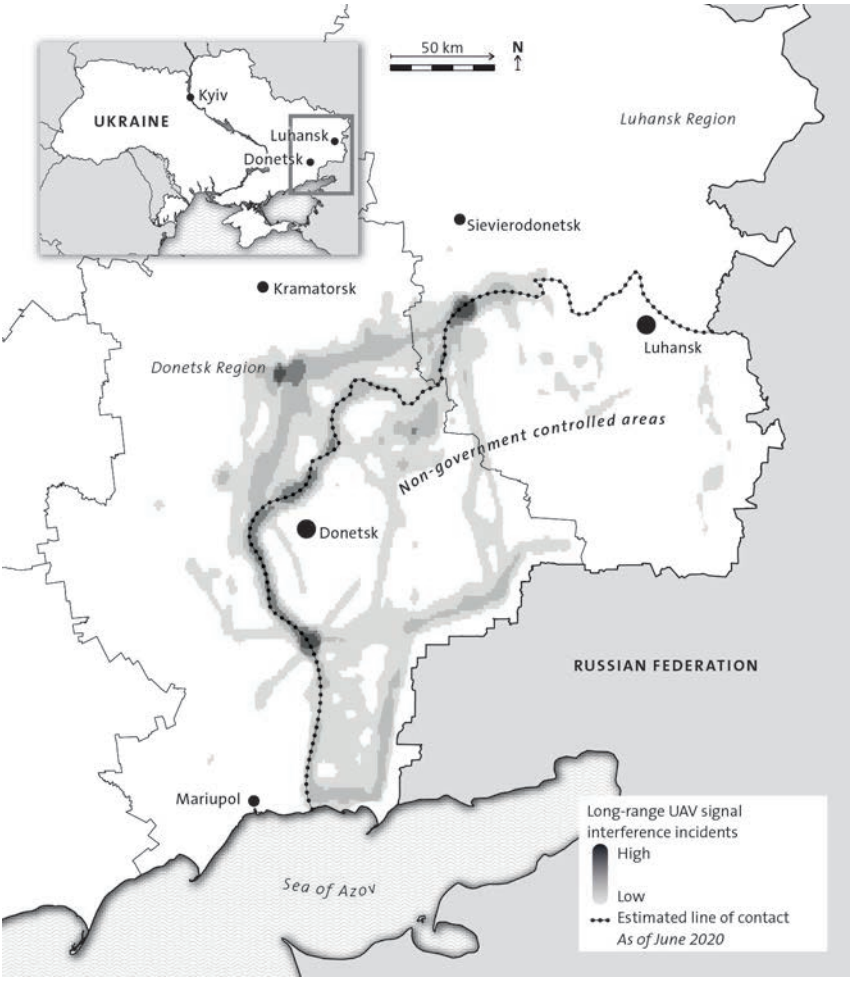
Source: OSCE, Special Monitoring Mission to Ukraine, Thematic Report, Restrictions of the SMM's Freedom of Movement and other Impediments to the fulfilment of its Mandate, December 2021, p. 33.

Figure 23 b: Long-range UAV signal interference in the first six months of 2019



Source: OSCE, Special Monitoring Mission to Ukraine, Thematic Report, Restrictions of the SMM's Freedom of Movement and other Impediments to the fulfilment of its Mandate, December 2021, p. 34.

Figure 23 c: Long-range UAV signal interference in the first six months of 2019



Source: OSCE, Special Monitoring Mission to Ukraine, Thematic Report, Restrictions of the SMM's Freedom of Movement and other Impediments to the fulfilment of its Mandate, December 2021, p. 34.

The sides used anti-aircraft fire against UAVs, surface-to-air missiles to target UAVs operating at higher altitudes (see Table 7), electronic interference with the data transmission and GPS of UAVs (spoofing or jamming with permanently installed or mobile jamming systems) (see Table 8), as well as radar detection and interference with information technology infrastructure as they sought to manipulate or destroy data collected (overview in Table 9).

Table 7: Examples of anti-aircraft weapon systems likely used against OSCE SMM UAVs

	Type	**Range (altitude)**[174]
MANPADS[175] **(e.g., 9K32, 9K38)**	Man-portable air defense systems	Up to 5 km
ZU-23[176]	Anti-aircraft gun (2 barrels)	Max. 2 km
OSA [9K33][177]	Short-range surface-to-air missile (SAM)	Up to 5 km
Strela-10[178]	Short-range SAM	3.5 km
Pantsir-1[179]	Medium-range SAM	Missile: max. 8 km (firing range: 20 km)
Machine gun (e.g., PK type)[180]	Multi-purpose machine gun – (7.62mm)	Effective range: 1.5 km

174 The numbers indicated are estimates. The actual range of these weapon systems depends on various factors, including on weather conditions.

175 OSCE, *Spot report by the OSCE Special Monitoring Mission to Ukraine (SMM), 2 November 2014: Anti-Aircraft Rounds Fired at SMM UAV*, 2014.

176 OSCE, *Latest from the OSCE Special Monitoring Mission to Ukraine (SMM), based on information received as of 19:30, 3 January 2019*, 2019.

177 OSCE, *Latest from OSCE Special Monitoring Mission (SMM) to Ukraine, based on information received as of 19:30, 11 September 2016*, 2016.

178 OSCE, *Spot Report by OSCE Special Monitoring Mission to Ukraine (SMM): SMM unmanned aerial vehicle downed near Horlivka*, 2016.

179 Bellingcat, *Russia's Pantsir S1S geolocated in Ukraine*, https://www.bellingcat.com/resources/case-studies/2015/05/28/russias-pantsir-s1s-geolocated-in-ukraine/, 2015.

180 OSCE, *Latest from the OSCE Special Monitoring Mission to Ukraine (SMM), based on information received as of 19:30, 19 July 2018*, 2018.

Table 8: Examples of electronic interference equipment used against OSCE SMM UAVs

	UAV/GPS interference	Communication interference	System range[181]
Zhitel [R-330Zh][182]	X	X	20–30 km
Leer-3 [RB-341][183] **and Orlan-10 UAV**	X	X	6 km (UAV reach: 140 km)
Bylina [RB109-A][184]	Likely	Likely	Unknown
Krasukha-2[185]	X		250 km
Repellent-1[186]	X		30 km
Other systems:	**R-330T**[187]**; TORN**[188]**; Tirada-2**[189]**; R-934B Sinitsa**[190]**; RB-636 Svet-KU**[191]		

At times, the sides also opted for low-intensity measures aimed at the Mission's surveillance equipment, for instance, when sniper fire targeted surveillance cameras, a ground control station or the camera operator directly, or when camera sensors were blinded by lasers, and the power supply or data wiring of a camera were intercepted. In addition, standard operating procedures of the sides often followed a 'fire-before-identifying' rule when, for instance, they attacked any UAV without bothering with prior identification, which made OSCE SMM UAVs likely targets.

181 The numbers indicated are estimates. The actual range of these weapon systems depends on various factors, including on weather conditions.

182 OSCE, *Latest from the OSCE Special Monitoring Mission to Ukraine (SMM), based on information received as of 19:30*, 18 March 2019, 2019.

183 OSCE, *Latest from the OSCE Special Monitoring Mission to Ukraine (SMM), based on information received as of 19:30*, 10 August 2018, 2018.

184 OSCE, *Latest from the OSCE Special Monitoring Mission to Ukraine (SMM), based on information received as of 19:30*, 10 August 2018, 2018.

185 OSCE, *Latest from the OSCE Special Monitoring Mission to Ukraine (SMM), based on information received as of 19:30*, 10 August 2018, 2018.

186 OSCE, *Latest from the OSCE Special Monitoring Mission to Ukraine (SMM), based on information received as of 19:30, 10 August 2018*, 2018.

187 OSCE, Latest from the OSCE Special Monitoring Mission to Ukraine (SMM), based on information received as of 19:30, 28 February 2019, 2019.

188 OSCE, *Latest from the OSCE Special Monitoring Mission to Ukraine (SMM), based on information received as of 19:30, 3 March 2019*, 2019.

189 OSCE, *Latest from the OSCE Special Monitoring Mission to Ukraine (SMM), based on information received as of 19:30, 18 March 2019*, 2019.

190 OSCE, *OSCE Special Monitoring Mission to Ukraine (SMM) Daily Report 60/2020 issued on 12 March 2020*, 2020.

191 OSCE, *OSCE Special Monitoring Mission to Ukraine (SMM) Daily Report 60/2020 issued on 12 March 2020*, 2020.

Table 9: Risk levels of intentional interference[192] with technology deployed by OSCE SMM[193]

	Small arms fire	Anti-aircraft fire	Surface to air missile	Electronic warfare (e.g., GPS jamming)	Hacking	Physical interference with assets	Attack on UAV GCS and/or UAV pilot
Mini-UAV	Medium	Low	None	**High**	Low	Medium	**High**
Mid-range UAV	Low	Low	None	**High**	Low	Medium	**High**
Long-range UAV	Low	Medium	**High**	**High**	Low	Low	Medium
Camera	**High**	Low	None	Low	Medium	**High**	None
Satellite	None	None	None	Low	Low	None	None

Source: A. Hug

The Mission employed a number of mitigation measures to prevent accidental targeting (Table 10). However, even though such precautions encompassed clear visual signatures for all devices deployed, transponders on long-range UAVs, de-confliction mechanisms for UAV flights, and the disclosure of camera positions to the conflict actors, destruction of the Mission assets continued.

192 The categories 'high, medium, low' are not numerically defined and are based on experience. In the table these categories represent the potential of a certain weapon system category to interfere with the different technology tools used by the OSCE SMM.

193 For examples see annex C.

Table 10: Possible mitigation measures to prevent and address interference with monitoring and verification technology

General mitigation measures	• Incident notification to the sides; • Involvement of the Joint Center for Control and Coordination; • Public reporting of incidents; • Referral to Trilateral Contact Group (body which concluded the ceasefire agreement and which oversaw the implementation of the Minsk agreements); • Visual signature of OSCE assets/sides notified of deployment; • Security assessment prior to deployment; • Request for compensation from the sides in case of loss/damage, and incident follow-up measures;[194] • Standard operational procedures; • Adequate cyber hygiene.
Small arms fire	• Cameras: Location notification to the sides; • Long-range UAV: Deconfliction mechanism.

Anti-aircraft gun fire	• Long-range UAV:
	  • Deconfliction mechanism
	  • Transponder

Surface-to-air missile	• Long-range UAV:
	  • Deconfliction mechanism
	  • Transponder

Electronic warfare (e.g., GPS jamming)	• Long-range UAV:
	  • Anti-jamming equipment on board
	  • Deconfliction mechanism
	  • Transponder

Hacking	• Adequate encryption levels (on-board / at location); • Secure connections for the transfer of data.

Physical interference with assets	• Cameras:
	  • Location notification and requesting protective measures by sides
	  • Adequate site protection (including for wiring and power supply)

Attack on UAV GCS and/or UAV pilot	• Small-, mid-range UAV: Training and adequate personal protection equipment for staff; • UAV GCS: Adequate site protection (e.g., shelter as necessary); • UAV GCS: Location notification and requesting protective measures by sides.

The sophistication and intensity of the sides' interference with the Mission's ground patrols and technology suggested a strong motivation to undermine SMM's operations carried out to document violations of the Minsk agreement. As frustrating as it may have been, this could, at the same time, have been interpreted as an encouraging testimony to the Mission's effectiveness in monitoring compliance with the Minsk agreements.

194 For example, the coordination with the sides of the recovery of a UAV that crash landed after the SMM patrol lost control over due to jamming.

Regardless of whether the targeting of the Mission's technology was intentional or not, such actions constituted double non-compliance, namely interference with the Mission's mandate (which the Russian Federation and Ukraine – along with the 55 other OSCE participating States – had agreed to), plus violation of the provisions of various Minsk agreements, meant to provide for effective monitoring and verification.

Adapting to the legal framework and administrative challenges

The Mission's mandate and the Minsk agreements, one of which has been endorsed by the United Nations Security Council[195], reflected political consensus on the use of technology for monitoring and verification of a ceasefire eventually agreed on. However, the Minsk agreements did not establish or elaborate the operational aspects of implementation. Hence, the establishment of a legal basis within the legal framework of Ukraine for the Mission to operate in (and deploy its technology) was a challenge. As was to ensure compliance with the applicable law while protecting the Organization, the Mission and its staff against legal claims. For this to be accomplished, numerous administrative steps had to be taken and countless agreements reached.

The initial situation that saw parts of the Mission's area of operation controlled by the Russian Federation and its armed formations rather than by the Government of Ukraine created considerable legal uncertainty. The fact that some members of these armed formations were subject to sanctions imposed by several OSCE participating States, including the United States of America, Canada and the European Union, only added to the complexity of the Mission.[196] These sanction regimes called for careful scrutiny in areas not under Ukrainian governmental control with regard to, for instance, banking, currency used and financial transactions for day-to-day operations.

Legal arrangements with the Mission's host country were only negotiated after the rapid deployment of the OSCE SMM to Ukraine on 21 March

195 UNO, *Resolution 2202*, 2015.

196 On EU Sanctions see: EUR Lex, *Council Decisions,* https://eur-lex.europa.eu/eli/dec/2014/145(1)/. For sanctions by the United States of America see for instance: The White House, *Executive Order – Blocking Property of certain persons contributing to the situation in Ukraine,* https://obamawhitehouse.archives.gov/the-press-office/2014/03/06/executive-order-blocking-property-certain-persons-contributing-situation, 2014.

2014. The Memorandum of Understanding, concluded on 14 April 2014, was the first document to establish any sort of legal framework, some provisions of which were agreed to be provisionally applied pending approval by the Ukrainian parliament. Its ratification by the Ukrainian parliament a month later[197] helped regulate, among other matters, the privileges and immunities of the Mission's international personnel and the inviolability of its premises and communication while it was implementing its mandate in Ukraine. These, however, only became enforceable upon signature by the President in June 2014.[198] In other words, for two full months the Mission and its members neither enjoyed any legal status nor legal capacity in Ukraine, and on account of this the Mission could not yet be considered a legal entity in Ukraine, which meant that contracts could not be concluded for the lease of office premises, the employment of local personnel, or to open bank accounts or import necessary equipment and supplies, the absence or lack of which brought about operational difficulties. Furthermore, the Mission and its members neither enjoyed diplomatic protection nor immunity from local jurisdiction, which posed a relevant legal risk and was only resolved once the privileges and immunities became enforceable two months later.

The operation of the Mission's technology, of the long-range UAVs in particular, needed to be in compliance with the host country's regulatory framework. Radio frequencies used by the Mission (e.g., for UAVs, communication, and data transmission) also needed to be formally requested and subsequently allocated through a regulated process. Once the laws, regulations, decrees and policies were in place, further steps towards compliance were found to be similarly demanding. The main challenge in this process was to find subject matter experts with sufficient knowledge of both the Ukrainian legal framework and the technology to be registered. This turned out to be both resource- and time-consuming, and at times delayed the deployment of technology.

A further major issue presented itself in trying to find suitable insurance against damage, injury, or death caused by a UAV operated by the Mission. Such provisions were of significance for the long-range UAVs in particular, because in the event of a crash or uncontrolled landing, their size, rotary wings, and explosive kerosene tanks were likely to cause substantial

197 29 May 2014.

198 The Memorandum of Understanding was received by the Verkhovna Rada (Ukrainian Parliament) on 19 May 2014 and was returned on 2 June 2014 with the President's signature.

damage or injury, or death. The OSCE had to launch lengthy procurement processes to acquire expensive third-party liability insurance coverage for these eventualities.[199] Most insurance companies do not insure against damage caused by events related to an active conflict, and there are no standardized international norms regulating the requirement for liability insurance for UAV operators, either.[200]

Furthermore, there needed to be coverage for losses caused by third parties such as was the case with the downing of a Mission-owned long-range UAV. While there were calls by some OSCE participating States for the Mission to send the bill for destroyed technology to the side responsible for the damage, for all practical purposes, this was not a feasible option. The absence of a general accountability mechanism for violations of the Minsk agreements rendered attempts to hold those responsible for damage or loss to account for it impossible. However, the elaborate technical and operational mitigation measures explained in sections above did significantly reduce the risk of financial loss. Repeatedly though, the contracts concluded with commercial providers of UAVs and personnel required amendment and renegotiation. A creative solution was also wanted to attain an extension of the grant of immunity to the UAV operators who were commercial service providers, not OSCE staff members, and thus faced liability for damages caused by UAVs.

Lastly, the use of UAVs and satellites near the section of the state border between Ukraine and the Russian Federation not controlled by the Ukrainian Government represented a legal concern. As the OSCE SMM's mandate comprised the territory of Ukraine exclusively, it was of great importance to avoid any sightings (e.g., of patrols collecting information) on the territory the Russian Federation or any other neighboring state. The fact that a long-range UAV flying at an altitude of 3–5 kilometers, even when operated over Ukrainian territory, was capable of capturing imagery beyond the state border and that, evidently, state borders presented no barriers for satellites only added to the delicacy of this undertaking.

For these reasons, the OSCE SMM established standard operating procedures for its UAV operations that made sure their long-range UAVs would only fly at such a scope that allowed the monitoring of territory up to

199 OSCE, Provision of Third Party Liability Insurance for OSCE Special Monitoring Mission to Ukraine's (SMM) Unmanned/Unarmed Aerial Vehicle (UAV) Fleet, 2019.

200 Steer Davies Gleave, Study on the third party liability *and insurance requirements of remotely piloted aircraft systems*, 2014.

the border, but not beyond. The Mission's mandate being defined by the state borders of Ukraine, requests for satellite images were only to be submitted for areas within those borders.

The OSCE had to be careful not to accept offers of in-kind donations of technology by OSCE participating States[201], as such would bear the potential to jeopardize its independence. These could include offers of satellite imagery or UAVs that would then be operated by the armed forces of a donating State.[202] Without doubt, if unsolicited satellite images from an OSCE participating State had been accepted, it would have given rise to suspicions that this respective state only provided imagery that served its specific political interests, and, consequently, affect the OSCE SMM itself. However, as outlined previously, the Mission had accepted satellite images from participating States but only on condition that the Mission itself could define the area and timeline of interest, rather than allowing the participating State to dictate which areas and timeframe it would provide the images for.

Political roadblocks

Many of the challenges discussed so far have had several different dimensions, primarily with political ramifications. For an effective and successful implementation of the Mission's mandate, an essential piece of the puzzle was the political will of the sides and, above all, the support of OSCE's 57 participating States. The necessary political will, however, could be easily undercut. The following section lists some of the key challenges that, if left unchecked, could have whittled away States' political will and undermined the Mission.

Costs and impact

Mounting financial costs were an obvious, and highly influential, point of contention for the political partners of the Mission. With all its UAVs, cameras, and other technology, questions increasingly arose on whether the impacts of the investments made were meaningful enough to justify the expenses. After all, OSCE participating States were investing their taxpayers' money and

201 See for instance: OSCE, *Acknowledging further offers to enhance the OSCE's UAV capacities, CiO announces immediate consultations on respective modalities*, 17.10.2014.

202 A description of legal and security obstacles for OSCE participating States who were willing to provide technology, see for instance: Anton Trojanovski / Nick Shchetko, "German-French Plan to send drones to Ukraine faces problems," *The Wall Street Journal*, 10.10.2014.

wanted to see a return for their contributions. It is therefore relevant to examine both the costs and the impact of technology used in a monitoring mission.

Firstly, despite the admittedly high financial costs of sourcing, operating, and maintaining technology, it was conceivably less expensive to make use of technology than to collect this information through monitors on the ground. If the Mission wanted to cover the same areas with ground patrols as it did with technology, and even if we assumed that security and access-related issues did not exist, the budget of the Mission would have had to increase significantly to compensate for the additional staff and equipment required.[203] For example, the mere exchange of a single camera by ground monitors within a hotspot would have commanded the Mission's permanent presence in that location, and necessitated the addition of at least 25 staff members.[204] Furthermore, the operation would have had to be equipped with proper communication tools such as night vision aids, shelter, power supply, and transportation means. In parallel, with more staff on the ground, the Mission would have had to raise the number of administrative support personnel.

Secondly, the extent of the Mission's activities becomes obvious when looking at the raw numbers: In 2020, the Mission employed nearly 1,400 personnel and, together with its technology, ran on an annual budget of just over EUR 100 million.[205] In 2019, the OSCE SMM conducted 28,500 patrols, 5,454 UAV sorties, operated 28 cameras in 23 locations, and issued over 300 daily reports.[206] In the same year, the OSCE SMM reported on almost 300,000 ceasefire violations, 3,661 weapons in violation of agreed withdrawal lines, and documented almost 150 civilian casualties.[207] Since the fighting erupted, the OSCE SMM thus documented the failures of the sides to implement the agreed ceasefire and other measures. The Mission further catalogued the impact of these violations on the civilian population and the

203 The overall percentage of the budget the OSCE SMM spent on technology amounted to roughly 10–15%.

204 This is a theoretical calculation. Minimum personnel required per standard observation post: six staff members per shift (with three shifts per 24-hour period) = 18 staff members. To compensate for holidays, sickness, and related absences, a cushion of approximately 33% of staff should be sufficient, taking the total to roughly 25 staff members. Accordingly, to replace the approximately 30 cameras that the OSCE SMM had in operation, the Mission would have had to add at least another 750 monitors to its staffing table, doubling its numbers of monitors. This does not factor in additional support staff.

205 Government of Poland, *Decision on the extension of the Special Monitoring Mission to Ukraine adopted,* https://www.gov.pl/web/osce/decision-on-the-extension-of-the-special-monitoring-mission-to-ukraine-smm-mandate-adopted2, 2020.

206 See page 73: OSCE, *OSCE Annual Report 2019*, 2019.

207 OSCE, *2019 Trends and Observations from the Special Monitoring Mission to Ukraine (SMM),* 2020.

infrastructure they depended on. The Mission did so factually and publicly, without blaming anyone for or speculating about incidents they reported on. Yet, despite these extensive operations, the fighting continued, unsurprisingly begging questions about the Mission's actual impact and value for money.

The OSCE SMM was often referred to, in particular during the first couple of years of its existence, as the 'eyes and ears' of the international community in eastern Ukraine, and up to the full-scale invasion of Ukraine by the Russian Federation in February 2022, the Mission has never abandoned its presence in the conflict area. It is indeed noteworthy that it had continued to operate in such a hostile environment uninterruptedly in spite of abduction, injury and death of its staff. What is more, it had even managed to gradually increase its footprint in the area, an accomplishment mainly owed to the additional technology the Mission had deployed, which had extended the geographic as well as the temporal range of monitoring. Though it cannot be proven, it seems likely that the Mission's presence, assisted by its technology, had a certain deterrence effect, which contributed to the containment of the violence. In fact, up to 24 February 2022, the dimension of the frontlines remained, seen from a bird eye's view, more or less unchanged.

The sides' failure to cease fire completely cannot be interpreted as a failure on the Mission's part. Ultimately, the ceasefire was a commitment made by the sides, not the Mission. Thus, to evaluate the OSCE SMM's success (or failure, respectively) by the level of violence it could not influence, or control would have meant to ignore its mandate, and would have led to unrealistic expectations on the Mission. This misconception, in the end, resulted in some actors blaming the Mission for the continuation of the fighting, thus shifting the responsibility for the implementation of the Minsk agreements from the combatants to the OSCE SMM.

In contrast, there is an abundance of measurable examples of the impact the Mission's use of technology had made, even if the Mission's overall efficacy was somewhat undermined by undue restrictions and limitations. One only needs to examine its contribution to confidence-building initiatives to appreciate the impact of technology on facilitating humanitarian assistance. Whenever, for instance, the Mission documented significant successes in facilitating the repair of critical infrastructure, the involvement of technology proved essential. Facilitating the repair of civilian infrastructure was a visible and positive example of the impact the use of technology can have as it allowed the Mission to overcome security obstacles that had previously been insurmountable. Consequently, hundreds of thousands of peo-

ple on both sides of the contact line benefited from these actions; they depended on such infrastructure, for example, for water and heating.

Replacing human patrols?

Related to saving costs and minimizing risks to human monitors, the question arises to what degree human patrols can be replaced by technology, but also what gets lost if this is done to an extreme degree. The following example highlights this problem and its political implications.

For example, whereas the findings of a patrol of monitors, recorded in a patrol report, may have been equally accurate, recordings made by the Mission's technology, such as UAV or satellite images, tended to be accepted as indisputable facts. That being said, pictures or videos, even when accompanied with profound analysis, may well be presented in the wrong context or in a misleading manner. Not without reason, the first paragraph of a publicly available OSCE SMM report referring to UAV imagery, read as follows:

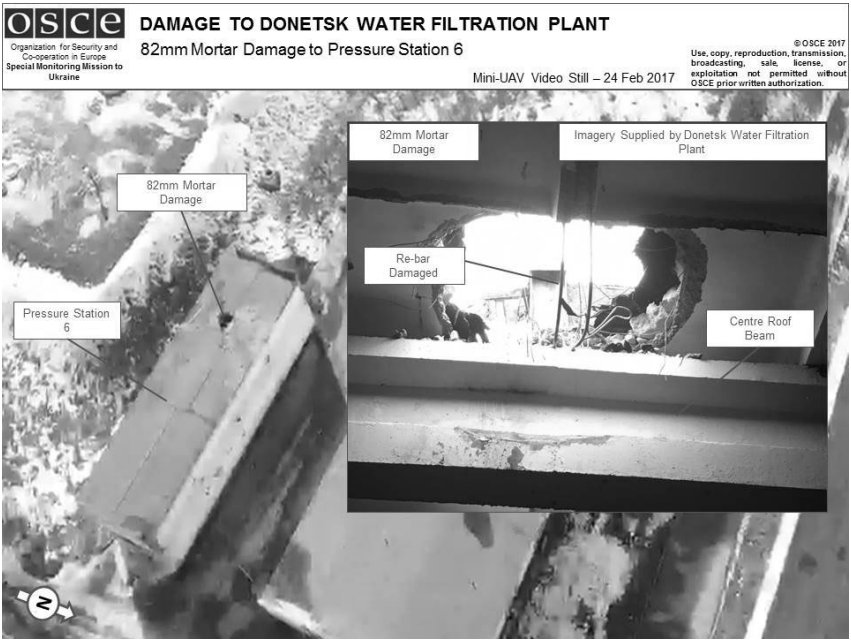
> "The SMM followed up on reports of damage to the Donetsk Water Filtration Station caused by shelling the previous night. The SMM conducted flights of its mini unmanned aerial vehicle (UAV) in the area, as the SMM patrol was unable to access the station due to a lack of security guarantees and the possible presence of mines. The UAV spotted four impact sites – three inside and one outside the station, all of which the SMM assessed as having been caused by 82mm mortar rounds (the SMM was not able to determine whether they were fresh). The aerial imagery showed damage to the southern edge of the roof of the Chlorine Storage building, and marks of broken building material stretching from north to south on the roof, and the SMM assessed it as having been caused by an 82mm mortar round fired from a northerly direction."[208]

To further draw attention to the damage done to this facility, and in particular to the damaged and highly poisonous chlorine storage unit, the OSCE SMM also published relevant imagery on its Twitter account (see Figure 24).[209]

208 OSCE, *Latest from the OSCE Special Monitoring Mission to Ukraine (SMM), based on information received as of 19:30, 24 February 2017,* https://www.osce.org/ukraine-smm/301841, 2017.

209 OSCE, SMM twitter status, https://twitter.com/OSCE_SMM/status/837625377669406720.

Figure 24: Monitoring of essential infrastructure. Impact site assessment at the Donetsk Water Filtration Station



Source: OSCE, Twitter Status Special Monitoring Mission to Ukraine, retrievable from Bellingcat, Water filtration plants and risks of a chlorine mass-casualty event in Donetsk, 10.03.2017.

At first sight, the picture and the report suggest that essential infrastructure (in this case, a water filtration plant) had been targeted with large caliber weapons. This would have constituted a clear violation of the Minsk agreements (e.g., ceasefire, non-withdrawn heavy weapons) and probably also a violation of internationally accepted standards that protect infrastructure the civilian population depends on.[210] Moreover, the damaged building contained poisonous substance (chlorine gas), which could have put the workers at the plant as well as civilians living nearby at risk. The reported direction of fire clearly pointed towards the culprit too. Read as a standalone, the presenter can paint a black-and-white picture, pointing to the UAV imagery.

210 See for instance: ICRC, *International Humanitarian Law Databases: Rule 54,* https://ihl-databases.icrc.org/en/customary-ihl/v2/rule54.

While these facts are true, the image and the report do not provide the necessary background. One would need to study other reports so as to learn that positions of the sides were located around the plant and that these positions had, over time, moved forward until, ultimately, they reached the close proximity of the plant. These forward moves were Minsk violations themselves, the use of weapons equally so and endangering the water filtration plant by the sides was most certainly unlawful. Even if the relevant paragraphs that document both the forward moves and the weapon systems were publicly accessible, the picture of the damaged plant still provided enough fuel for one side to accuse the other one of damaging a protected building, particularly if these accusations were made in the public arena. And once again, such dynamics were accentuated in the absence of an effective accountability process.

Lack of accountability

However, information alone cannot compel an actor to behave in a certain way, and the OSCE SMM's experience in eastern Ukraine is testament to this. Its public reporting was widely read and trusted by a range of relevant actors, and any interested side could access information concerning developments in eastern Ukraine. There was as good as no independent media in the conflict area, which effected that the Mission had inadvertently taken on the role of providing reliable information about conflict dynamics.

The attribution of violations for the vast part of actions incompliant with the Minsk agreements was directly extractable from the Mission's public reporting. For instance: Weapon systems located in areas in violation of the agreements, forward moves by one or the other sides in disregard of the agreements or movement restrictions of the OSCE SMM were clearly attributable to one or the other side from the daily reporting by the Mission. The attribution of ceasefire violations was less evident in the Mission's report, yet attentive readers of the Mission's daily reports were able to learn where ceasefire violations occurred, and, in some cases, even determine who was responsible for specific violations.[211]

Then again, as its daily reports contained bare facts rather than analytical or interpretative statements, drawing conclusions was up to the reader. The carefully worded reporting style, often using diplomatically agreed

211 See for instance: Konrad Schuller, "Wer bricht den Waffenstillstand?," *Frankfurter Allgemeine*, 14.08.2016.

wording and codes, made straight forward interpretation not an easy task. The Mission also issued weekly reports, which were more analytical, but these reports were shared with OSCE'57 participating States only and were not made public.

Likewise, high-tech equipment that allowed the Mission to compile detailed information had enabled the Mission to communicate data, statistics, imagery, graphs, and heat maps in easily-digestible formats to a broad audience. The Mission's detailed daily catalogue of violations offered the sides ample opportunity to adjust their operations and demonstrate increased compliance. The reports also pointed out quite explicitly how the conflict would intensify if the ceasefire and supporting measures continued to be largely ignored. That said, the sides still made hardly any attempts at minimizing the number of violations resulting from their activities and tended to refer to the reports merely to play down their significance, deny their responsibility or point to the other side.

The fundamental flaw in the entire process had always been in terms of enforcement. It had never been determined what the response should be like in the event of violations of the agreements. No one was positioned to enforce compliance; the Minsk agreements did not stipulate provisions to address violations and as a result, the international community could use neither carrot nor stick. Specifically, the lack of an accountability mechanism, for instance in the form of a joint military commission as used in other ceasefire agreements[212], hampered remedial action but did not preclude it. The apparent impunity that the sides enjoyed was an open invitation to more violence.

There had been a few attempts made to manage the implementation of the agreements, notably through the JCCC. Established at the outset of the conflict, officers of Ukraine and the Russian Federation were supposed to determine accountability and jointly address violations but never managed to do so mostly because its functioning and ultimate existence were plagued by issues of a broader political nature. As with the wider political settlement process, the sides were unable to make the JCCC function because they appeared to be unable (or unwilling) to even agree on what constituted a side

212 e.g., Joint Military Commission (JMC) as outlined in article VII in the Nuba Mountains Ceasefire Agreement of January 2002, between the Government of the Republic of Sudan and the Sudan Peoples' Liberation Movement / Nuba. See for instance: Peace Agreements, *Nuba Mountains Cease-Fire Agreement*, 2001.

to the conflict; with the Russian Federation denying it being a party to the conflict and its officers eventually walking away.

The additional measures agreed in July 2020 arguably constituted one more attempt towards creating a mechanism that would regulate the implementation of the agreements, albeit in limited form in so far as they only responded to ceasefire violations. However, as long as the question as to who is party to this war remained unanswered, the sides were prone to preclude any genuine engagement against impunity and would in all probability have used this latest agreement to score political points instead.

The OSCE SMM demonstrated that to have information of highest quality about violations was not enough if no tangible consequences could be administered. No matter how many monitors were deployed, how many violations were counted, and no matter how much money was spent on sophisticated technology, if there was insufficient political will and no defined process or mechanism to hold actors to account, the effect of such an operation could always be limited and fall short of its potential. As Antonia Potter aptly put it, "a handful of monitors can help maintain a ceasefire where the parties are truly willing. Legions of monitors and troops may fail where parties are not committed."[213]

More data, with higher accuracy and credibility thanks to technology, could help make the case for the introduction of such mechanisms. The experience of the OSCE in eastern Ukraine demonstrated that, in the absence of accountability mechanisms and processes, the only reliable record of listing agreement violations and corresponding responsibilities was produced through the use of technology complementing ground monitoring. This catalogue of facts provided the foundation for any future cooperation or joint work related to addressing ceasefire violations and preventing new infractions from occurring.

Fueling tensions?

Given the near-constant manipulation of the Mission's findings for political ends, it was natural to wonder whether this ostensibly impartial reporting was in fact further enflaming the war. The main addressees of the reports produced by the Mission – the OSCE's participating States, not least the Russian Federation and Ukraine, both signatories to the Minsk agreements

213 Antonia Potter. "Ceasefire Monitoring and Verification – Identifying Best Practice". *Centre for Humanitarian Dialogue*. 2004.

– more often than not used the Mission's reporting not to debate possible avenues out of the war but rather to 'cherry-pick' information to further blame each other. A quick browse through their statements and those of the other 55 participating States after OSCE Permanent Council meetings reveals how the Mission's reporting often underpinned talking points that accused each other of non-compliance. Rarely were the Mission's outputs being used as the basis for a constructive debate to find a sustainable solution to end the violence.

To ensure that its work was not misinterpreted, the Mission informed OSCE participating States about developments of the war through regular briefings, including those on its technology. Representing a major item in the OSCE SMM's budget, the participating States had a justified interest in understanding how the Mission deployed the sensors they funded. For those interested in building a robust peace, the main challenge had become shifting the conversation beyond the question of 'who was shooting first' to 'what can be done to prevent the shooting from happening again'. Unfortunately, the Mission had experienced significant trouble in shifting the conversation towards a more productive end, and discussions were often mired with facts presented in bad faith.

The media, too, often used the Mission's reports to support their view as to who was to blame for the ongoing violence. There was equally little public debate on how to break the stalemate, and any debates that did arise merely focused on trying to identify a culprit. The divisive and sometimes vicious debate in the public arena, often referring to OSCE SMM's reporting out of context, served to further entrench the general public in their ideas, distracted from the true task of peacemaking, and ultimately threatened to annihilate any hope for peace.

While the manipulation of OSCE SMM data for political purposes had obvious and serious ramifications, even the monitoring activities themselves could sometimes cement tensions. For instance, the camera systems deployed on both sides of the contact line effected the permanent presence of the OSCE. As such, the Mission risked contributing to formalizing wartime contingencies, which created previously non-existent divisions that could, over the years, harden and become permanent. In fact, the infrastructure at the few crossing routes over the frontline resembled border installations, rather than temporary arrangements at the front line within Ukraine.

6. Discussion: Key Insights and Looking Forward

This final chapter concludes in two sections. The first discusses key insights from the Ukraine experience and what is applicable to other contexts. The second looks at what lies ahead and outlines the potential future use of technology in ceasefire monitoring and verification.

Key Insights

The following seven key insights summarize the main findings of this book.

First Key Insight – Complementarity of Technology
Technology is a complement to human monitoring rather than a replacement of it. It can help to save lives, minimize costs, and lead to more objective data. However, technology cannot replace the human interaction needed for compelling stories, effective compliance mechanisms, and confidence building.

The political process leading to the use of technology in monitoring and verification in Ukraine was specific to that context, as was the amount of resources made available to the mission. The role that technology can play in complementing human monitoring, rather than replacing it appears to be applicable elsewhere. At the outset in Ukraine, technology was the only way that ensured continued monitoring and verification, and, above all, allowed for an expansion of the presence and reach of the Mission as conflict dynamics shifted. The use of technology was also less expensive than deploying human monitors and arguably reduced the OSCE SMM's staff exposure to unacceptable levels of security risk.[214]

Had there been full, safe, and unhindered access to the necessary areas, the Mission would have been less dependent on technology. However, the higher the likelihood and the greater the intensity of interference, the

214 Considering the risks involved, the OSCE SMM has reported only a few serious work-related incidents involving its staff. The Mission has thus far incurred one fatality among its staff, see: OSCE, *Spot Report: One SMM patrol member dead, two taken to hospital after vehicle hits possible mine near Pryshyb*, 2017.

more extensive the coverage by technology needed to be. The tempting possibility of only deploying technology instead of human monitors, if it had been realized, could have made access for ground patrols a largely theoretical issue. Yet, following this risk-aversion logic to its extreme, the Mission could theoretically have found itself involved in studying satellite imagery alone.

The Mission's reliance on technology increased steadily. Deviating from their unofficial stance of not welcoming around the clock surveillance, the sides increasingly demanded comprehensive and continual monitoring in areas they deemed to be of strategic importance. Such areas were possibly those where they wanted to keep an eye on the other side even though they had less of a covert military interest in them. At the crossing points, for instance, just as these places were becoming more dangerous – the scenes of regular artillery strikes and mine incidents – the demand for information increased from the sides, the OSCE participating States, and the general public. As thousands of people crossed every day – often waiting for hours if not days in dangerous conditions – the situation at the crossing points became more than just an unfolding humanitarian crisis in itself; it was also a barometer of wider conditions. It demonstrated how the conflict was slowing but inexorably taking its toll on the civilian population, forcing them to struggle for mere survival, even if that meant risking their lives. To avoid exposing its patrols to these risks too, the Mission had installed cameras and used its UAV fleet to monitor these areas. This made it possible for the OSCE SMM to determine the number of ceasefire violations and document the length of the queues at these sensitive points.

Data of this kind could, however, never capture the whole picture. The mandated interaction with people not only constituted the basis of outreach and human-interest stories but also gave context, a holistic whole and additional information on top of the data provided by technology. An authentic and tangible reflection of the reality was best attained only if technology complemented ground patrols, or at a minimum, when human monitors complemented technology. The impact on civilians, who were forced to expose themselves to harm when moving from one side to another across the contact line, only became tangible once the facts of the queues and ceasefire violations were complemented with their own words, outlining their fears, hopes and views. Numbers alone did not make for a full, let alone a compelling story. To that end – especially as the Mission's daily reports largely focused on listing ceasefire violations and other facts – the Mission started to

issue thematic reports[215], such as on the impact of the conflict on educational facilities and children's access to education[216] or about the reasons why civilians cross the contact line and what challenges they face[217].

Second Key Insight – The Role of Technology in Violence Prevention, Relief, Resolution, or Containment

If there is no political will to move towards conflict resolution, conflict parties may use facts obtained through technology in support of their 'blame game', thereby risking an increase in tensions. Yet, technology may also help international actors, civil society, media, and the local population see and hear what is going on, thereby contributing to the prevention or containment of violence. Further, where possible, it may also enable relief from the impacts of the violence.

The question whether the technology deployed has helped to reduce the extent of violence or not in Ukraine prior to Russia's full-scale invasion of Ukraine in February 2022, is not straightforward.

The use of technology for monitoring and verification purposes alone was not likely to produce a sustainable ceasefire. With the increased availability and affordability of monitoring and verification technology and the weariness of governments to deploy personnel to high-risk areas, combined with the fact that monitoring and verification organizations attempted to avoid rather than mitigate risks, it is tempting to see technology as a silver bullet. Yet technology is not a panacea for political disagreements. If technology is deployed to overcome political unwillingness to accept a monitoring and verification mechanism, any such attempt is bound to fail. Parties will reject the proposed technology, or restrict and hinder its use, just as they will refuse to accept ground patrols.

The availability and reliability of the facts acquired through technology might even add to increased polarization at the negotiation table. In the Ukraine case, the fact that the warring parties increasingly demanded direct access to the footage obtained by the technology operated by the OSCE SMM appeared to have been made in an effort to obtain 'hard facts' that could be used as valuable currency at the negotiation table, and even to ques-

215 OSCE, *Thematic Reports from the Special Monitoring Mission to Ukraine*.

216 For example: OSCE SMM, *Thematic Report: impact of the conflict on the educational facilities and children's access to education in eastern Ukraine*, 2020.

217 For example: OSCE SMM, *Thematic Report: Checkpoints along the contact line: reasons why civilians cross and the challenges they face*, 2019.

tion the reliability of the Mission's findings itself. This stage in monitoring mission-conflict party relations can cause ripple effects, as, typically, these missions are not normally used as pawns to such a degree by the parties to the conflict. It remains to be seen if this marks the start of a trend that will be observed in other areas of the world, or if it was simply an unfortunate reality specific to the Ukrainian situation only.

Moving on from the critical reflections, it is also key to highlight the potential of the use of technology in preventing or at least containing violence, even when political will is lacking. One can argue that even in the most hostile security environment and the most toxic political situations, technology can assist efforts to monitor and, in certain circumstances, to verify. In such situations, the use of technology strengthens the presence of the monitoring and verification organization and will deliver the data needed to help establish facts. Generally, enabling access to reliable information for international and local actors has a positive impact on containment. This is not least because the parties to a conflict generally do not want to be perceived as being the ones responsible for violations of a ceasefire agreement.

In summary, the less political will to achieve a sustainable ceasefire there is, the more inefficient monitoring and, particularly, verification processes will be, regardless of whether technology is used or not. Ultimately, ceasefire agreements are not only technical arrangements. Ceasefire agreements are political instruments too, having been negotiated in a specific political context. This fact must be kept in mind when planning any monitoring and verification operation. Delinking a ceasefire arrangement and related monitoring and verification procedures from the political process entails the risk that the conflict transforms itself into a long-lasting stalemate. This situation will lead to further instability and bears the risk of the conflict erupting again with little to no notice. Given these complicated and nuanced factors, it cannot be determined whether the use of technology reduced the level of violence in Ukraine, although the author would argue that the OSCE SMM, supported by technology, had as a minimum contributed to the containment of the conflict, at least up to February 2022 when the President of the Russian Federation declared that the ceasefire arrangements contained in the Minsk agreements ceased to exist. Admittedly, containment is not peace and "[p]eace is not the absence of conflict, but the ability to cope with conflict by peaceful means" to quote Ronald Regan.[218]

218 *Address at Commencement Exercises at Eureka College*, Eureka, Illinois, May 9, 1982.

Third Key Insight – Linking the Ceasefire Agreement, Monitoring, and Verification and Compliance

Technology may enhance effective monitoring and verification, yet it cannot replace the political support required for compliance mechanisms. Ceasefire agreements should specify which of the agreed measures require monitoring and verifying and through which processes – ideally collaborative in nature – compliance by the parties can be enhanced.

Monitoring and verification – general reflections

In ceasefire agreements, monitoring, derived from the Latin word for 'warning', usually refers to the process of collecting data, either by the parties to a conflict themselves or, more commonly, by an independent third party.[219] Monitors are tasked to report what they see, which includes information generated by technical means. Monitoring not only aims at documenting violations, but also provides the basis for observing and documenting possible shifts and trends in violations through the tabulation, comparison and classification of the facts. Monitoring reports typically contain information that is free of judgement, and they do not appropriate blame. Debatably, the reference to ceasefire *violations* in monitoring reports contains a degree of judgement as the firing of a weapon is beyond doubt a violation of the agreement on the use of weapons. Standalone monitoring operations might be sufficient for situations where ceasefire violations are a rare occurrence and where there is sufficient response capacity and political will by the parties to follow up on reported violations.

However, in complex and volatile environments, where there is little trust between the sides and where political will is largely absent, monitoring alone is not sufficient to ensure compliance with the ceasefire. In these circumstances, verification may be the next necessary step required to enable the parties to work towards compliance. Verification is habitually defined as the determination of parties' compliance or non-compliance with their commitments, by the parties themselves or a third party, through an agreed process. Verification aims at building confidence and trust through an assurance that agreed activities are actually being implemented.[220] Verification uncovers and may deter violations. It is a deeper and more involved task than mon-

219 On the role of third parties, see also: Jeremy Brickhill, Mediating Security Arrangements in Peace Processes: Critical Perspectives from the Field. (Zürich: CSS/ ETH,2018).

220 See also: UNIDIR, Coming to Terms with Security: A Handbook on Verification and Compliance, 2003.

itoring. In most cases, verification relies on a monitoring mechanism to provide the facts that make a judgement possible. Verification works best with agreed on and subsequently declared activities as well as with benchmarks which the verifiers can check against the behavior of the declaring party. As such, verification presupposes a verification process to which the participating parties agree to be subjected to (ideally specified in the ceasefire agreement or its annexes). Hence, a verification process is normally part of a wider political arrangement, and the resulting verification judgements have political ramifications. Apart from being a judgement on compliance, verification may also serve as the baseline for sanctions to be imposed for non-compliance through an accountability mechanism.

Monitoring and verification in the context of Ukraine

Unlike in the context of international arms control and disarmament, there are no blueprints that would define the process of monitoring and verifying ceasefires. In ceasefire agreements, what monitoring and verification entail is context-specific. As outlined above, the Minsk agreements used the terms 'monitoring and verification' without defining them, although monitoring and verification roles had been assigned. The agreement that regulated the withdrawal of larger caliber weapons exempted, no specific and formal verification process had been agreed. While the technology had augmented the monitoring activity of the SMM, the absence of a verification process and the corresponding political will had limited the potential impact technology could have had in verifying the implementation of the Minsk agreements.

In the case of the OSCE SMM, monitoring was an explicitly mandated activity that provided for the establishment of facts on the ground, especially as they related to the security situation and other aspects covered by the Mission's mandate. The facts generated through monitoring were subsequently made public in an apolitical and neutral manner. Monitoring was seen as the OSCE SMM's core task, enshrined in its mandate and in its Mission title. OSCE SMM monitoring did not call for additional cooperation or information from the sides, apart from the indispensability of safe and unfettered freedom of movement, which involved the unhindered use of technology. Monitors, assisted by technology, produced snapshots and descriptions of what had happened, focusing on facts rather than providing analysis. These snapshots contained long lists of recorded ceasefire violations, weapon systems observed in the conflict area, as well as destroyed property, mine fields, and civilian casualties.

Verification – vaguely referred to in the Minsk agreements – was less straightforward. Given that the OSCE SMM's mandate predated the Minsk agreements, it did not refer explicitly to ceasefire verification tasks. Furthermore, the Minsk agreements did not provide the necessary requirements for effective verification, and no comprehensive verification mechanism had been agreed, resulting in the lack of accountability outlined above. The benefits offered by verification could generally only have been achieved with a sustained political commitment and broad compliance from the conflict parties. This commitment included the declaration of objectively verifiable information, against which the OSCE SMM could have measured the sides' actions. The absence of sufficient cooperation, in particular, made the verification of the withdrawal and storage of large caliber weapons difficult, if not impossible, even with the technology at hand. Not only was the Mission unable to access weaponry so as to verify their serial numbers, but it also had difficulties in obtaining the full inventories needed from the sides.

The sides failed to provide the conditions for effective verification in other ways too. For instance, unhindered access to areas subject to verification, following the principle of transparency, was a never adhered to requirement. Moreover, the Mission was tasked with covering almost 200 designated storage areas, most of which were inaccessible due to security concerns. Many were not clearly defined (e.g., no identifiable physical boundary, no fencing, multiple entry/exit paths), which made effective verification impossible. In many cases, these areas were in reality often staging or training areas rather than safe and secure storage sites. Had the designated storage areas been designed in a way that would have facilitated verification, the Mission would have been able to install relevant technology (e.g., cameras at the entrance) to permit at least a minimum level of verification of the weapons withdrawal process. These deficiencies were a central factor in making the decision to deploy technology primarily at the contact line. There, technology could be operated with greatest effect and thus enhanced the implementation of the Mission's mandate as monitoring asked for less cooperation with the sides than the verification of weapons in designated storage areas.

The difficulties with regard to verifying compliance with these requirements unmet, as well as those related to the distinction between verification and monitoring, is best illustrated with the following scenario: a Mission UAV detects a T-72 tank in village A near the contact line. The UAV team reports the presence of the T-72, including the location and time. If a day later the UAV observes a T-72 tank in nearby village B, the Mission would

have reported two T-72 tanks observed in violation of the agreed withdrawal lines. Thus far, this is monitoring. It could well have been that the two spotted tanks were the same tank, just seen at different locations on different days. It could not be assumed that, in the meantime, the side concerned in this case had moved the detected tank near village A to a designated holding area. To verify whether the first tank had been and remained withdrawn, the Mission would have needed additional information and, above all, been given access to village A and the serial number of the tank seen near the village, and also been granted admittance to the designated storage area where the tank should have been withdrawn to. In the absence of such verification, the sides were left with monitoring reports which contained facts but did not contain information that would have assured them of verified compliance.

The lack of a verification mechanism through which the observations made by the OSCE SMM could have been processed threatened to widen the gap between ceasefire management and the wider political context, and consequently fostered a prolonged hot but frozen conflict cut from any political process. In fact, OSCE SMM reports suggested that the situation in eastern Ukraine was not far from this stalemate. Political will by all sides and an effective compliance mechanism – possibly some adapted form of the eventually defunct JCCC – would have been needed to secure a comprehensive and sustainable ceasefire.

Indeed, technology can provide the bedrock for initial direct or indirect collaborative monitoring and verification processes, especially in situations where political considerations stand in the way of visible direct cooperation between the parties to a conflict. The sides to the conflict could for instance either jointly or separately analyze imagery of violations of agreed terms. This potentially low-key review could assist to establish the responsibility for violations and determine steps to prevent future breaches. This approach could complement or be a precursor to the best practice model of 'three in a jeep'[221] – a tested verification and ceasefire mechanism that merges parties to conflict into a single joint operation.

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221 See Jeremy Brickhill, *Mediating Security Arrangements in Peace Processes: Critical Perspectives from the Field*. (Zürich: CSS/ETH, 2018), pp. 51/52: "Within the ceasefire organization, the verification and monitoring function is essential, and will usually require its own organizational capability. The most important element of verification is that the parties must be responsible for their own compliance. When a third party is involved, we use the "three-in-a-jeep concept" – Party A, Party B and the neutral third party. In Somalia it might be the "26-in-a-jeep" principle, because there are so many factions! The basic idea is that all forces participating in the ceasefire have to be represented in the verification and monitoring organization and operations. This approach ensures that you are taking an important step towards helping the parties take responsibility for their own ceasefire."

Lessons from Ukraine are likely also relevant in other contexts: While there are many factors – not least the political will of the conflict sides – that influence the level of compliance, verification and monitoring may be influential factors in this regard too. This requires clarity in the ceasefire agreement, which is negotiated ideally before any monitoring or verification operation is deployed. Lack of clarity in the ceasefire agreement will have ripple effects as regards what and how it can be monitored as well as how monitoring and verification should lead to greater compliance. Poor, insufficient or biased monitoring/verification – or perceptions thereof – may serve to undermine one or all sides' faith in the process, resulting in, or at least providing an excuse for, non-compliance. If the experience of the OSCE SMM is anything to go by though, the blame for allowing the sides to evade their commitments did not rest with the technology used. Any failure in monitoring or verification emerged despite and not because of the technology employed. Without it, the failure would likely have been much worse.

Fourth Key Insight – Pros and Cons of a Broad Mandate

The pros of a broad monitoring and verification mandate in the initial phase of a conflict are the flexibility and ability to adapt to a changing context. The cons are lack of precision as to who, what, and how to monitor and verify.

The Ukraine case illustrates both the pros and cons of a broad mandate. In contrast to most cases, the monitoring mandate was agreed on before the 'hot' phase of the conflict. Although originally designed to address a very different sort of crisis, the broad mandate enabled the OSCE and the Mission's management to adjust the OSCE SMM's activities to suit an armed conflict situation with relative ease. The wording of the mandate (e.g., "gather information and report on the security situation", "establish and report facts", or the "safe and secure access" provision) allowed enough latitude to accommodate ceasefire monitoring and verification tasks as well as the use of technology to complement the work of civilian monitors as they had originally been intended. The fact that the mandate pre-dated the war, and the Minsk agreements, strengthened the Mission's independence from the implementation process, and arguably helped to maintain its impartial role in proceedings. For example, its mandate covered the entirety of Ukraine, including areas that had eventually fallen beyond the control of the Ukrainian Government. Thus, the Mission was not limited to monitoring at the contact line exclusively.

The security measures stipulated in the Minsk agreements were similar to those applied in other conflicts (e.g., the disengagement of forces and hardware, withdrawal of weapons or mine action). Albeit lacking necessary details, the Minsk agreements provided the basis for the OSCE's supporting task in monitoring and verifying the implementation of what was agreed on. The agreement on the use of technology, defined in the Minsk agreements, certainly paved the way for the use of complementary tools. The reference to technology was an open-ended list of possible sensors, which granted the OSCE SMM enough leeway to deploy said sensors within its mandate. Explicit support from the heads of State of the 'Normandy Four' (France, Germany, Russia, and Ukraine) further strengthened the independent use of technology by the OSCE SMM. As a cost and life saving measure, clauses supporting the deployment of technology for the purpose of verifying and monitoring ceasefires are likely to be included in future ceasefire agreements.

However, there are also challenges when implementing a broad mandate. Constant and deliberate high-level non-compliance with agreed measures, a lack of political will, an absence of clarity on agreed terms, and vaguely defined roles and responsibilities in monitoring and verification were symptomatic of the attempts to end Russia's war against Ukraine. The challenge of lack of compliance not only applied to the measures designed to achieve a sustainable ceasefire, but it was also equally applicable to the respect shown to the mandate of the OSCE SMM. The latter was expressed through persistent interference with the Mission's freedom of movement and its prerogative to deploy technology in support of the implementation of the ceasefire. The resulting unpredictable security situation created a hostile environment in many areas, something which can prove dangerous for both humans and technology. The absence of a mechanism that would have enabled the parties to take responsibility (and credit) for remedying violations and increasing compliance was likely key.[222] The agreements, however, did not explicitly establish such an accountability process. Violations of the agreed measures were committed without incurring any directly related cost, political or otherwise.

222 Nicholas Haysom / Julian Hottinger, *"Do's and Don'ts of sustainable ceasefire agreements"*, United Nations Peacemaker.; Part B: "In addition to providing generally for monitoring the ceasefire a ceasefire agreement should enable complaints of a breach of the agreement to be investigated and a finding to be made. In this regard, the agency responsible for investigating complaints has an active investigatory role and will be required to make a finding in respect of the alleged breach."

In summary, and looking beyond Ukraine, a more detailed ceasefire agreement, which still contains mechanisms that allow for adaptability as a conflict evolves, seems ideal. Joint monitoring and verification mechanisms which involve all relevant parties can potentially enhance compliance and confidence. They can also serve as platforms to discuss the need for mandate adaptation. The actual adaptation, however, will always be politically led, hence the need to link such monitoring and verification mechanisms to the political process.

Fifth Key Insight – Clarity of Third Party Roles

The third party role of monitoring and verification needs to be carefully accommodated in the political process and differentiated from the role of working towards a political settlement.

A challenge related to those arising from a broad mandate is the lack of clarity about the roles of third parties. The necessity to clearly differentiate between roles also applies to a ceasefire's monitoring and verification officers and the mediators of a political settlement. If the organization tasked with monitoring and verifying a ceasefire is also mandated to mediate political negotiations at the same time, the efficiency of these processes may be limited. The fear of upsetting negotiations and stalling the process may make the monitoring and verification operation hesitant to call out ceasefire violations. This would be the case regardless of whether or not technology was used to monitor and verify.

The entity mandated to monitor and verify a ceasefire should be shielded from undue political pressure and interference. Its tasks need to be clearly defined and differentiated, and its independence must be unmistakably articulated.[223] Doing so will help to avoid misunderstandings, unrealistic expectations, and the politicization of the operation. It will also eventually enhance the entity's impartiality, transparency, and confidence-building power. Apart from this observation, but closely related to it, is the question on how to resolve the tension between conflict management and conflict settlement or resolution.

223 See also: "better agreements go into considerable detail on the obligations of both sides to the mission and to the ceasefire in general, explicitly stating that the primary responsibility for maintaining it lies with them and not the monitors, and specifying sanctions for violations. Ideally, such a clause could be made a standard feature of future ceasefire agreements." Antonia Potter. "Ceasefire Monitoring and Verification – Identifying Best Practice". *Centre for Humanitarian Dialogue.* 2004.

It is particularly important to do so, because technology has the potential to improve the quality and quantity of monitoring and verifying, and subsequently increase the attention of and interference by external actors. In Ukraine, where there was no accountability mechanism, and where the monitoring and verification tasks were not defined consistently, the OSCE SMM had been struggling to assume some vaguely defined verification tasks, with problematic results. Blurring the task of monitoring and verifying risked shifting the responsibility to maintain the ceasefire from the conflict parties to the monitors. An independent accountability mechanism, as outlined above, is often best suited to avoid uncertainties about roles and responsibilities.

Sixth Key Insight – Conditions for the Effective Use of Technology in Monitoring and Verification

The necessary conditions for the effective use of technology in monitoring and verification include an unambiguous ceasefire agreement, freedom of movement of monitors, a (joint) accountability mechanism, sustainable funding and political support, organizational capacity, and the will to minimize rather than avoid risks.

For the use of technology to make a tangible difference in monitoring and verifying a ceasefire and its measures, at least five elements must be in place: (a) a settlement on a clear and comprehensive ceasefire agreement, including an accountability mechanism for violations of the agreement; (b) agreed freedom of movement of ground-based monitoring and verification teams, and an understanding that technology will complement these teams; (c) sufficient long-term funding and political support of the organization tasked to monitor and verify, especially when deployed in a high-risk area; (d) the ability (institutional and managerial) of this organization to integrate technology: and (e) a willingness to mitigate rather than avoid risk when deploying ground teams and technology.

The more detailed and comprehensively these elements are worked out, the greater the amplifying effect of the use of technology. As discussed earlier, technology should be designed to complement ground-based monitors, not to replace them.

A definition of a minimum bar for these elements is essential as it prompts further discussion over how the operation should respond if certain levels of compliance with agreed terms are not reached. What if, for instance, one or more parties do not guarantee access to the area to be monitored or

an existing accountability mechanism is dismantled? How long should the monitoring and verification operation accept such restrictions and play along with the repeat violators? Should it bring its operations to a halt if compliance drops below a pre-determined level? These questions – and their answers – will be different for each context, but, as the example of the OSCE SMM showed, defining a minimum acceptable standard is undoubtedly vital to a mission's effective operations.

The more reliable the data that a mission has at its disposal, the higher its obligation to prove its reliability as an organization and to protect the integrity of its role, and, by extension, the peace process. To achieve this, the mission needs to make sure that minimum acceptable standards are regulated, agreed on, communicated, and respected. Failing to do so will not only result in the operation to squander its impact and relevance, but also involves the risk it ultimately aids and abets violations committed by the parties to a conflict.

Verification tasks, where a certain cooperation between the conflict parties and the verification mission is required, are a case in point. For instance, continuous reporting on verification activities in relation to withdrawn weapons, even though it is in fact impossible to verify much as it has little or no access to designated storage areas for withdrawn weapons or has not been provided with the Order of Battle (ORBAT)/inventories to check the equipment in designated storage areas against the declared weaponry, does not build confidence. In the end, results such as these offer only limited assurance on whether what has been agreed on has actually been implemented.

If the operation does not flag the access issues, the lack of cooperation exercised by the parties, and the resulting inability to verify to the parties themselves, at political level, the operation will inevitably present as verified a – *de facto* – unverified reality that might well be in violation of agreed terms. If unaddressed, this problem could see the parties pointing to the operation's monitoring and verification reports, saying they constitute evidence of their compliance. If a mission wishes to avoid such a situation, it can make further monitoring and verification activities dependent on certain measurable actions by the sides (e.g., follow-up to address violations, full and unhindered access). In fact, monitoring and verification missions deploying technology may consider limiting the use of these tools in reaction to an unacceptable level of violations until compliance is restored. This approach would be less risk prone operationally and, arguably, politically than the withdrawal of ground monitors.

In the case of the OSCE SMM in Ukraine, this 'nuclear' option was never required, with the Mission instead, with some success, undertaking a range of measures that involved constant review of the level of implementation of the Mission's mandate, as well as widespread contingency planning, which was based on pre-defined compliance thresholds. Besides maintaining political and diplomatic support, the Mission retained a stubborn – albeit cordial – stance in part by maintaining dialogue with all sides and insisting on the inviolability of the Mission's mandate and core principles at every opportunity and at every level.

Seventh Key Insight – Assessments for the Use of Technology

For operational effectiveness, an assessment preparing for the use of technology should consider political will, the needs technology should fulfill, the technology available on the market, lessons from past experiences, and risks and mitigation measures. Finally, it is key to assess the administrative, organizational, procedural, and equipment requirements to gather, process, and communicate the data.

Early planning is essential. Prior to any acquisition and deployment of a technology, a thorough assessment needs to be conducted. Due to the political requirement for the Mission to adapt promptly to the evolving conflict, the technology experience in Ukraine was marked by decisions taken within limited timeframes which needed to gauge implications for the existing OSCE SMM operation and the peace process as a whole. This is not to suggest that future missions should engage in lengthy planning exercises (which in the case of the OSCE SMM may well have reduced operational and political flexibility). However, to ensure operational effectiveness and political relevance, a broad spectrum analysis should take place. Such an assessment should encompass the following, at a minimum.

c. Political evaluation: What is the purpose of the ceasefire (humanitarian, provide space for political negotiations, manage or contain violence, dismantle the status of war etc.) and how does it link to the political negotiation process? Where can the use of technology be anchored within the political settlement process? What is the motivation of political entities to support/reject the deployment of technology? How will this fit within an existing mandate or are amendments required? Exit strategy? Avoiding or mitigating risks? How can the human monitor component be maintained and/or strengthened?

d. Needs assessment: What purpose is technology required for? Where is technology needed and why in these locations?
e. Security and technical capability assessment: In what environment will technology be deployed to? What are the technical abilities of the conflict parties to interfere with monitoring and verification technology?
f. Market analysis: What systems are currently available to cover the needs identified?
g. Evaluation of existing experience: Do other organizations or state authorities have experience in the use of technology? What can be learnt from these experiences?
h. Review of security and risk mitigation measures: What are the risks (political and operational) that may be encountered when installing, operating, and maintaining the technology? What needs to be in place (politically and operationally) to mitigate identified risks in deploying technology?
i. Assessment of required administrative processes: Are flexible and efficient administrative mechanisms for acquiring technology and related services and support staff in place? How can they be most effectively developed? Tender processes are in most cases highly bureaucratic, time- and resource-consuming, and do not necessarily guarantee a satisfying outcome (i.e., consider testing smaller batches of equipment within a limited time frame, rather than acquiring highly sophisticated equipment with long-term service arrangements not knowing whether the chosen technology actually is efficient; should services be outsourced?);
j. Internal review: Examine ways of integrating technology within the organization. Who will manage the technology and how? What new internal responsibilities, processes, and procedures need to be developed? What internal expertise/knowledge is needed (and what can be outsourced)?
k. Estimate of the supporting equipment and processes required: What is needed to process and store all the expected data (e.g., expertise, hardware and software, staff) and shape this information into a format that benefits the efforts to achieve a sustainable ceasefire? What is the plan on how to synchronize the back-end infrastructure[224], information processing, and operational side of the technology deployment?

224 This includes but is not limited to facilities, technical infrastructure, software, and the know-how necessary for transferring, storing, and interpreting collected data. For instance, for the long-range UAV, a mission might require: workstations at the UAV GCS, secure network infrastructure for data transfer, and GIS/mapping software. For cameras: workstations and office space to view the video feed 24/7, and secure servers to store the raw video footage.

Looking Forward

Every conflict needs to be addressed differently. Yet it seems likely that the carefully managed and efficient use of technology may very well prompt a small revolution in ceasefire monitoring and verification. Some of the different dimensions of this are explored below.

Exploring the future potential of the use of technology in ceasefire monitoring

Technology allows for more stringent and effective monitoring and verification with regard to an array of measures; in turn, monitoring missions may be able to considerably exceed what is currently expected of them. For instance, the verification of withdrawn weapons could be improved and refined through the use of movement sensor-based cameras in cantonment areas for weapons. Not only could larger caliber weapons be detected by satellite-based tracking systems but – by means of electronic anti-tampering devices – the safeguarding of sealed weapon storages would be an additional benefit. Furthermore, entry and exit paths to such storage sites could be monitored through infra-red beam barriers. The deployment of balloon-based camera systems in areas where troops and hardware have been or will be disengaged – along a frontline or border, for instance – is a further possibility to ensure comprehensive 'around-the-clock' monitoring and verification coverage in a specific area. The same would apply to taut-wire fences and ground surveillance radar in disengagement areas.

Furthermore, environmental hazards could be identified, contained, or even prevented more easily if technology were used on a larger scale. In a heavily industrialized and conflict-laden areas, technology can help manage environmental risks, such as related to chemical storage centers or the flooding of closed mines contaminating the water table.[225] Biological, chemical, or nuclear sensors may indeed prove invaluable to the early identification of such conflict-related risks to a monitoring operation, many of which are hardly identifiable without specialized equipment.

There are also ample opportunities to expedite many monitoring and verification tasks, to improve a mission's efficacy without sacrificing accuracy. Hazardous, hands-on analysis of impact craters in order to determine the

225 See for instance: Dr Yevhenii Yakovliev and Dr Sergiy Chumachenko, "Ecological Threats in Donbas, Ukraine," *Centre for Humanitarian Dialogue,* October 2017.

firing direction and weapon type by ground patrols could be replaced by a three-dimensional analysis that comprises handheld devices, satellite or UAV imagery. These options could also be combined, and their effect be further increased by additional collecting of information, as well as analytical and archiving capacities. Ground patrols, to name but one example, could be equipped with tools enabling the monitors to report 'live' and GPS-tag the information they gather (e.g., pictures).

Moreover, progress made in remote and environmental sensing have significantly decreased costs and other constraints. The quality of cost-effective 'high enough' resolution satellite imagery, or the deployment of replaceable consumer-grade environmental sensors to a conflict zone also add to objective visibility into events on the ground as they happen. The benefits of utilizing such features in conflict and ceasefire monitoring are obvious. Not only can rapidly deployable – and affordable – devices support credible monitoring anywhere in the world, but the monitoring itself can be conducted with increased transparency since said tools empower the entire world to witness events in real-time, thus, effectively neutralizing misinformation and disinformation.

The increasing investment, rapid development, and widespread use UAVs as weapons in conflicts around the world, including Ukraine,[226] necessitates the use of corresponding tools for detecting, tracking, monitoring, and verifying the use of such weapons during future ceasefire verification and monitoring operations. These tools will not differ much from those described in this book. The baseline for such tools will be the manuals containing the counter UAV methods used by armed forces that combat weaponized UAVs, which include specialized radar systems, special cameras, radio frequency analyzers, or acoustic sensors. AI-supported detection systems will likely play a central role in this regard (see below). The same will apply to UAVs used as reconnaissance and surveillance tools by adversaries. These specialized UAVs are regularly used in conjunction with weaponized UAV systems for target acquisition, observation, and adjustment, and thus represent a significant threat. At the same time, armies around the world are developing new technology as countermeasures to intercept and stop enemy UAV usage, which will significantly impact any future monitoring and verification mission requiring the use of this technology.

226 For an introduction of this topic, see for instance: Valentina Bartulović / Zvonko Trzun), "Use of Unmanned Aerial Vehicles in Support of Artillery Operations" Strategos 7 (2023).

Exploring the future potential of the use of AI to process information:
AI could also be used to collect, analyze, and share data more efficiently. For instance, it could automatically identify weapon systems, direct the UAV fleet to emerging hotspots, or predict forward moves in disengagement areas. This is particularly attractive given the labor-intensive process of analyzing imagery and also with regard to the lack of experts in the labor market. AI may also be used to identify and tackle misinformation levied against a monitoring or verification operation, and could be engaged to automate fact checking. In the same manner, AI may also be deployed to comb through the abundance of online data usually available and may facilitate early warnings, conflict development predictions or gauge averse sentiments vis-à-vis a ceasefire arrangement or a monitoring and verification mission on the parts of both the sides to a conflict and the general population. Yet, caution is imperative as far as exploring the potential of AI is concerned; unless used transparently and within a clear regulatory framework, it entails the potential to increase rather than mitigate distrust and fears of manipulative intelligence-gathering.

Exploring the use of technology for humanitarian missions:
The OSCE SMM has demonstrated how technology could be used to facilitate humanitarian relief and assistance.[227] Autonomously-flying UAVs are already being developed that can identify mines[228] and even neutralize them.[229] Other systems provide for the identification of unexploded ordnance.[230] While not directly related to ceasefire monitoring and verification processes, such relief missions are a form of establishing a dialogue, as parties need to agree on the aim and use of technology for relief purposes. They are beneficial in so far that they help build trust between the parties to a conflict,

227 See for instance: Ambassador Ertuğrul Apakan and Cono Giardullo, "UAVs for the Benefit of People: The use of Unmanned Aerial Vehicles Within the OSCE Special Monitoring Mission", Human Rights Quarterly, Volume 42, Number 2, May 2020, pp. 479–487.

228 See for instance: Carolina Castiblanco, Jose Rodriguez, Ivan Mondragon, Constanza Parra, Julian Colorado, "Air Drones for Explosive Landmines Detection". In: Manuel Armada, Alberto Sanfeliu, Manuel Ferre (eds) *ROBOT2013: First Iberian Robotics Conference. Advances in Intelligent Systems and Computing*, vol 253. (Cham: Springer, 2014).

229 See for instance: Timothy deSmet, Alex Nikulin, William Frazer, Jasper Baur, Jacob Abramowitz, Daniel Finan, Sean Denara, Nicholas Aglietti, and Gabriel Campos, "Drones and "Butterflies": A Low-Cost UAV System for Rapid Detection and Identification of Unconventional Minefields," *The Journal of Conventional Weapons Destruction (2018),* vol. 22 : Iss. 3, Article 10.

230 See for instance: Milan Bajic / Bozidar Potocnik, "UAV Thermal Imaging for Unexploded Ordnance Detection by Using Deep Learning," Single and Multi-UAS-based remote sensing and data fusion 15:4 (2023).

which in itself will heighten the sustainability of a ceasefire and keep minimal communication channels open.

Exploring the potential of communication tools and 'verified imagery'

Communication tools, including social media, may further enhance the dissemination of findings as necessary. For instance, the live feed of cameras in hotspots can be made accessible to the public – at least if sufficient precautions are made regarding problems related to a lack of confirmation and contextualization with respect to live feeds. Technology-based approaches, and social media-based applications in particular, may also support monitoring mechanisms where civilians themselves contribute to monitoring and verification through the use of technology. This has the dual benefit of enhancing the breadth of sources while also creating ownership and buy-in within the population affected by the conflict. Yet, it may also put civilians at risk, a phenomenon already experienced in other contexts where civilian monitors have been used.[231]

Recent technological advancements have laid the foundation for solutions that may soon provide real-time access to verified and immutable information from the ground to anyone. The provenance of information sourced from conflict environments has long stymied the credibility of crowd- or open-sourced reporting. This is especially true for conflicts that feature a highly contested information space and that are additionally complicated by competing agendas of powerful third parties. The use of so-called 'verified imagery' serves as one example of commercially available technology at little cost that can provide a strongly encrypted place- and time-stamped visual record of events that can be secured on a public ledger. The usefulness of this technology is two-fold. On the one hand, ensuring a strongly encrypted record on a public ledger renders the record effectively immutable. On the other hand, it increases the resource costs of generating and spreading false or spoofed information from the start. These advantages combined provide both a rapid source of highly trustworthy reporting of events as well as a long-term record of potential evidence for accountability and justice efforts.[232]

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231 Margaux Pinaud. *Home-Grown Peace: Civil Society Roles in Ceasefire Monitoring*, 2020.

232 Hala Systems is one for-profit social enterprise focused on bringing technological solutions to conflict monitoring and civilian protection. Noted for their work to bring early warning of airstrikes to civilians in Syria during the civil war there, Hala is working with international mechanisms to hasten the end of conflict and support accountability and security efforts using technology innovation.

7. Conclusions

It remains to be seen if technology, taken to this level as explored above, will be better positioned to mitigate some of the challenges at hand or will resolve any of the dilemmas described. Technology will always add a level of accuracy, better coverage, and reliability to human monitoring, and therefore will make a useful contribution; that is, if its use is planned and managed carefully. Any automation of monitoring and verification operations, however, will always require humans at the center of the process. Conflicts are, in essence, struggles of people about influence and power. At the negotiation table, technology may help to outline more objective solutions to this struggle, but it will require humans, not technology, to understand both the objective facts and their subjective interpretation. For both tangible objective facts and less tangible subjective interpretations motivate the opposing sides to fight *and* end the fighting.

It is perhaps safe to assume that, as the world relies on technology to an ever-increasing degree, the marriage of technology and peacemaking has always been inevitable. As demonstrated, the role of technology in a crisis situation is complex but can be highly effective. In a nutshell, technology can: (1) provide facts in support of an accountability mechanism; (2) increase the incentives for dialogue through the provision of more objective, less contestable, and readily reviewable facts; (3) give a reason for conflict parties to meet and talk and thus facilitate the installation and possible joint management of technology; (4) increase trust between the opposing sides, as monitoring or verification technology increases the ability to document the adherence to agreed terms without suspicions of bias regularly attributed to human monitors; (5) enhance the effect of any agreements through the flexible and rapid deployment of technology to monitor, verify, or otherwise support implementation; (6) enable the creation of virtual fact-finding and negotiation tables at short notice along with easy access to data for all parties; and (7) win the trust and cooperation of the wider population.

The OSCE SMM experience in Ukraine shows the potential in the use of technology for monitoring and verifying ceasefires. Technology, if used wisely, can be a force multiplier, not as replacement of human patrols, but rather in a complementary function. As a side effect, OSCE's experience in Ukraine illuminates the usefulness of technology in facilitating security conditions, even if temporary, for humanitarian access. This case study fur-

ther demonstrates that even with advanced technology deployed, a monitoring and verification operation remains largely ineffective when facing inadequately crafted agreements and even more so when encountering a lack of political will to adhere to agreed ceasefires. Still, the experience in Ukraine points out a compelling path forward on how to enhance the monitoring and verifications of ceasefires: Striking the right balance between human patrols and technology and its strategic integration into comprehensive agreements through diplomacy to optimize its impact.

Annex A: Terminology

The way the Minsk agreements outlined key measures pertaining to the ceasefire does not necessarily reflect commonly used definitions of the monitoring and verification of ceasefires found in literature. There was also considerable context-specific language, unique to the situation in Ukraine. While further background is provided throughout the text, below a selection of key terms as well as a short description of how these expressions are used in this book is listed.

Minsk agreements:
The media often refers to the 'Minsk I' and 'Minsk II' agreements. In fact, at least eight agreements were signed since 2014. 'Minsk I' typically refers to the Protocol and Memorandum (both signed in September 2014), while 'Minsk II' is used when the Package of Measures of February 2015 (the third agreement to have been signed) is referred to.[233] Each of these initial three agreements contains security, political, humanitarian and economic aspects with each new agreement expanding on and referring to the measures of the previous ones.

There was disagreement about the sequencing of these steps, in particular, whether the security or the political steps should be implemented first. The subsequent five agreements (e.g., on the withdrawal of large caliber weapons, demining, and disengagement) contained security-related measures exclusively, measures that were intended to strengthen the ceasefire as stipulated in the first three agreements. Arguably, the eight agreements were all part of one process of managing and resolving the conflict and are, therefore, not to be analyzed in isolation.

Not all of the eight agreements are publicly available. The signatories to these agreements were: The OSCE Special Representative of the OSCE Chairperson in Office, Ukraine, and the Russian Federation, as the members of the Trilateral Contact Group. The autographs (names only) of individual members of the Russian led and supported armed formations from certain areas of the Donetsk and Luhansk regions of Ukraine (non-Government controlled areas) are also visible on these documents. There was no uniform view about the legal status of these agreements. Some argue that these doc-

233 For details of all eight agreements see Table 1.

uments were not legally binding agreements but rather political commitments.[234] One of the agreements, the Package of Measures of February 2015, has been incorporated into a resolution of the United Nations Security Council.[235]

Although the facts established by the OSCE and meanwhile courts have determined that the Russian Federation and Ukraine are the parties to the war, there had never been a formal agreement as to who is party to the conflict within the process of the Minsk agreement. Hence, the term 'sides' is used in this publication. This refers to the main protagonists and signatories to the Minsk agreements, namely the Russian Federation and Ukraine. This term also includes members of the Russian backed armed formations from certain areas of the Donetsk and Luhansk regions of Ukraine.

Ceasefire:

The Minsk agreements defined the ceasefire broadly as the prohibition of the use of weapons. Hence, any use of a weapon represented a violation of this agreement. Subsequent agreements reiterated the ceasefire and multiple recommitments to the declared ceasefire were made. There was no common understanding on whether there was one agreed ceasefire, as promulgated in the first Minsk agreement (September 2014), or whether several subsequent independent ceasefires had been agreed to.

The sides to the conflict also regularly agreed to cease fighting for a specific purpose, during a limited time period, and in a defined area (e.g., to allow the delivery of humanitarian aid). Such arrangements were referred to as "windows of silence" by the OSCE SMM. These agreements to temporarily end the fighting fit into the general characterization of common types of ceasefires and related arrangements[236].

The ceasefires agreed in the Ukraine context are probably best described as a mixture between an agreement to cease hostilities (with no or limited monitoring and verification) and a preliminary ceasefire (with some form of monitoring and verification). The Minsk agreements stipulated a catalogue of measures to be introduced in order to make the ceasefire more sustainable

234 See for instance: Tim B. Peters /Anastasiia Shapkina, "The Grand Stalemate of the Minsk Agreements," *Konrad Adenauer Stiftung*, February 2019.

235 UN, *Unanimously Adopting Resolution 2202 (2015), Security Council Calls on Parties to Implement Accords Aimed at Peaceful Settlement in Eastern Ukraine*, https://www.un.org/press/en/2015/sc11785.doc.htm, 2015.

236 For example, see: *Jeremy Brickhill, Mediating Security Arrangements in Peace Processes: Critical Perspectives from the Field.* (Zurich: CSS/ETH, 2018).

(e.g., weapons withdrawal, disengagement of troops and hardware, etc.). No formally agreed ceasefire monitoring and verification process existed.

Ceasefire violation:
The Minsk agreements do not explicitly define what a ceasefire violation constitutes. The OSCE SMM interpreted the Minsk agreements to the extent that every shot fired is the result of the use of weapons which the Minsk agreements prohibited. Therefore, the Mission counted every shot fired as a violation.[237] The parties have often counted and reported their alleged registration of ceasefire violations using other definitions, leading to incomparable numbers.

Contact line:
The contact line was used to describe what was, in essence, the front line, which separated the Ukrainian Government and non-Government-controlled areas. The terminology was introduced by the Memorandum of September 2014. There was disagreement about whether the exact line had ever been agreed on. In fact, no coordinates, map or signed agreement of this line has ever been officially published. In fact, the line separating the respective forces changed continually, as it did even during the negotiation of the agreements.

The Package of Measures of February 2015 introduced the term of the '*de facto* contact line', which presumably described the real position of the line at the signature of this agreement. This line, though, had never been defined formally, agreed on or published either, nor had a de facto line based on the realities on the ground ever been formally defined by any third party. Despite the vagueness of what it represented, the contact line as used in the Minsk agreements was referred to as a baseline for many of the security pro-

237 The OSCE SMM annexed a 'Table of ceasefire violations' to each of its daily reports. This table contained the location of the monitoring position and that of the presumed violation, the means by which it was monitored, the number of violations, the type of event observed, a description of the event and the presumed weapon used to commit the violation and the date and time of the monitored event. The mission added the following caveat to its table: "The table only includes ceasefire violations directly observed by SMM patrols or recorded by the SMM cameras, and it may include those also assessed to be live-fire exercises, controlled detonations, etc. Details provided – in terms of distance, direction, weapons-type, etc. – are based on assessments provided by monitors on the ground and technical monitoring officers, and are not always necessarily precise. When information is not known (indicated with an "N/K"), the SMM was unable to ascertain such information due to distance, weather conditions, technical limitations and/or other considerations. Ceasefire violations recorded by more than one patrol/camera and assessed to be the same are entered only once." See for instance: OSCE SMM, table of ceasefire violations as of 20 February 2022, p. 13.

visions of the agreements, including, but not limited to, the withdrawal of weapons, the prohibition of forward moves and the definition of disengagement areas. The OSCE SMM at times referred to an 'estimated line of contact' in its public reporting.[238]

The contact line did not follow any administrative boundaries nor was it based on any existing line of division that pre-dates the armed conflict. Depending on how it was measured, the contact line was approximately 500 kilometers long. It was not a border, though. The international border between Ukraine and the Russian Federation in non-Government-controlled areas, was roughly 400 kilometers long (out of a total of 2,000 kilometers of international land borders between the two countries).

There were five locations along the contact line where the sides to the conflict had reached an understanding to open passages to let civilians cross this line.[239] There was no formal agreement on the number or location of these crossing points. Many main roads, railway lines and bridges remained closed. Crossing the contact line had become an administrative burden as well as a dangerous undertaking for civilians. The locations on the Ukrainian Government-controlled side at these crossings were referred to as 'entry-exit checkpoints' whereas those locations on the opposite side were named 'corresponding checkpoints in non-Government-controlled areas' (see Table 11 and Figure 25).

Table 11: List of crossing points at the contact line as of 2019

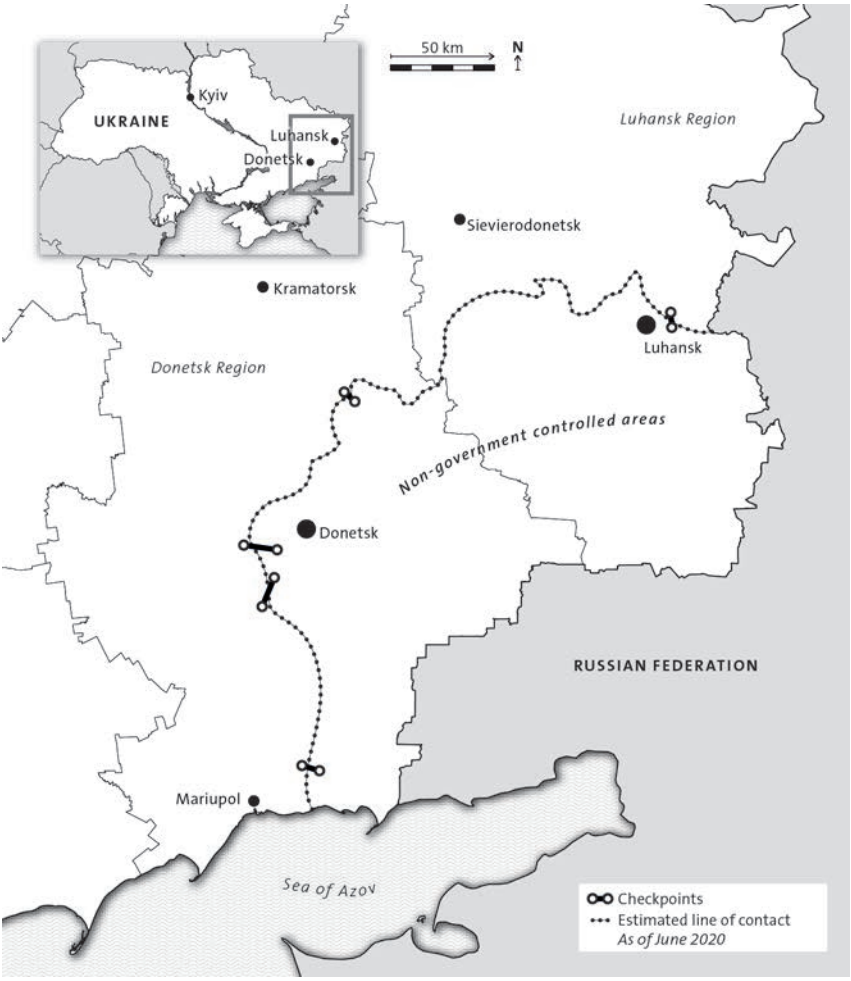
Entry-Exit Checkpoints in Ukrainian Government-controlled areas[240]	Corresponding checkpoints in non-Government-controlled areas
Hnutove	Verkhnoshyrokivske
Novotroitske	Olenivka
Marinka	Kreminets/Oleksandrivka
Maiorsk	Horlivka
Stanytsia Luhanska (pedestrian only)	Stanytsia Luhanska Bridge (pedestrian only)

238 See for instance: OSCE SMM, *2020 Trends and Observations*, 2020.

239 As of January 2020, three out of the five crossings were temporarily closed, with the remaining two locations only allowing limited crossing of the contact line. See the press statement of the OSCE Special Representative Grau: OSCE, *Press Statement of Special Representative Grau after the regular Meeting of Trilateral Contact Group on 8 July 2020*, 2020.

240 For a map of eastern Ukraine indicating these locations, see for instance page 6 at: OSCE, *Thematic Report: checkpoints along the contact line: challenges civilians face when crossing*, 2020.

Figure 25: Map with crossing points at the contact line



Source: OSCE, Thematic Report, The impact of mines, unexploded ordnance and other explosive objects on civilians in the conflict – affected regions of eastern Ukraine, May 2021, p. 13.

Heavy weapons:

The Package of Measures of February 2015 introduced the term of 'heavy weapons' and defined it as artillery systems of a caliber of 100 millimeters and above. There had been disagreement among the signatories as to what

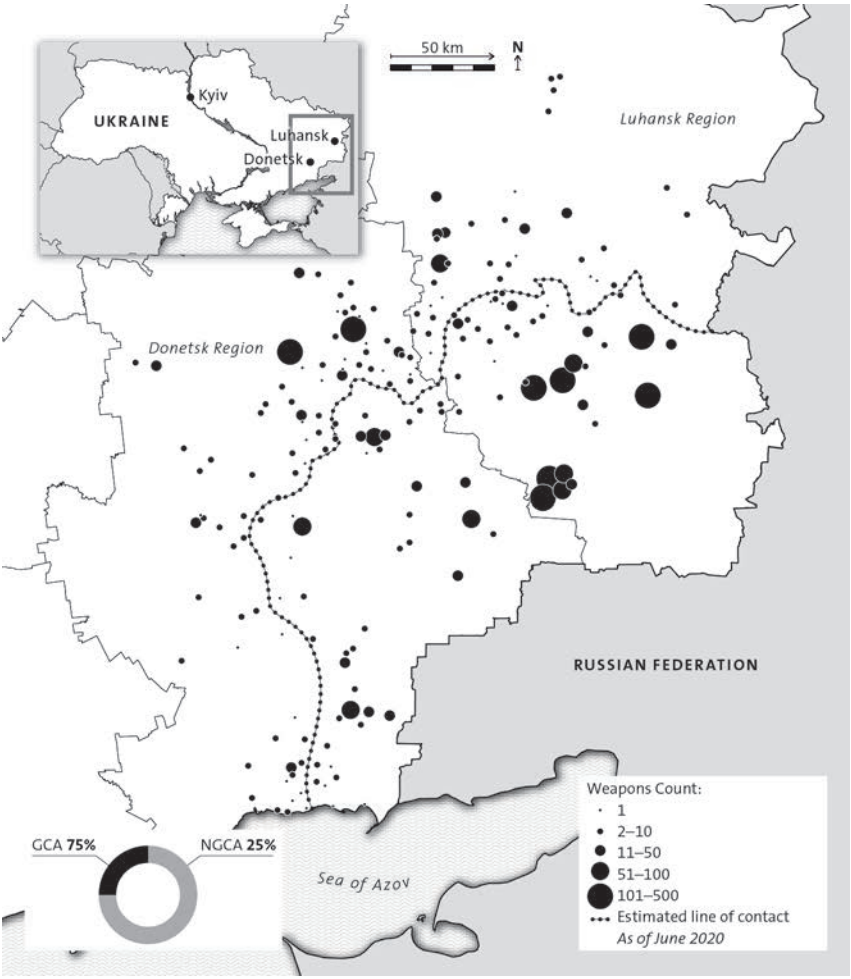
constituted an 'artillery system' or whether or not the caliber size alone defined a weapon as belonging to the category of heavy weapons. The Addendum to the Package of Measures, signed in September 2015, further regulated the withdrawal of large caliber weapons and included artillery pieces with a caliber of up to 100 millimeters and mortars with a caliber of up to 120 millimeters. This publication uses the term 'heavy weapons' to describe any large-caliber weapons that the Minsk agreements had identified as weaponry to be withdrawn (Figure 26).

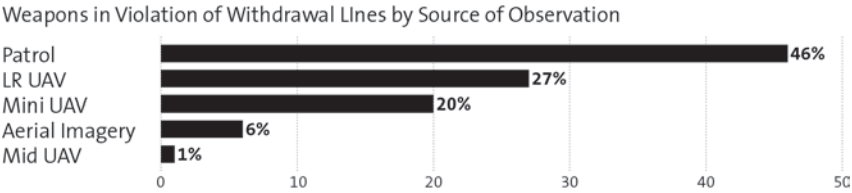
Designated storage areas:
The OSCE SMM's daily reports used the term 'Permanent Storage Sites' when referring to the sites where weapons regulated by the Addendum should have been stored. When addressing the sites where weapons regulated by the Memorandum and Package of Measures were to be stored, the Mission's reports referred to these as 'Heavy Weapons Holding Areas' and 'Heavy Weapons Permanent Storage Sites', respectively. For the purpose of this book, the term 'designated storage areas' will be used.

Security zone:
The Minsk agreements defined the areas to be void of heavy weapons as security zones. The sides had agreed to at least four such zones. The Memorandum (Art. 4) mandated a 30 kilometers wide security zone, the package of measures created an additional three security zones (50, 70, and 140 kilometers wide). These security zones were not the same as disengagement areas where the sides had agreed to withdraw troops, equipment and weapons of any sort to a distance of at least one kilometer from and along the contact line.

Joint Center for Control and Coordination (JCCC):
The JCCC was established at the end of September 2014 and was meant to stabilize and coordinate the implementation of the ceasefire. It was an informal and bilateral set-up agreed to by Ukraine and the Russian Federation, and composed of officers of the General Staffs of the armed forces of Ukraine and the Russian Federation. No formal document on how the JCCC was to be established and function was ever agreed to. In December 2017, Russian JCCC officers withdrew from the JCCC and never returned, although the Russian Federation never formally left the JCCC.

Figure 26: Monitoring of weapons in violation of withdrawal line: Technology complementing ground patrols





SSource: OSCE, Trends and Observations, 2019.

Annex B: Examples of technology in action

This annex lists selected examples of what information the technology deployed by the OSCE SMM was capable of delivering. These are excerpts of publicly available reports, and where possible are complemented by imagery published by the OSCE SMM on its website or social media feeds. The interested reader may consult the Mission's reports available on its website.[241]

Ceasefire violations

> "On the night between 22 and 23 April, the SMM camera in Zolote recorded about 30 projectiles in flight and two undetermined explosions, all at an assessed range of 2–6km east (all assessed as outside the disengagement area near Zolote but within 5km of its periphery)."[242]

> "On the night between 22 and 23 April, the SMM camera in Petrivske recorded 22 projectiles in flight at an assessed range of 1–3km west-south-west (assessed as inside the disengagement area near Petrivske), as well as five projectiles at an assessed range of 1–4km west-south-west (unable to be assessed as inside or outside the area)."[243]

SMM reports list observations obtained from cameras located at known hotspots. An example from the Mission's daily report issued on 30 March 2020 (see Table 12)[244]:

241 OSCE, *Daily and spot reports from the Special Monitoring Mission to Ukraine*.

242 OSCE, *OSCE Special Monitoring Mission to Ukraine (SMM) Daily Report 97/2020 issued on 24 April 2020*, 2020.

243 OSCE, *OSCE Special Monitoring Mission to Ukraine (SMM) Daily Report 97/2020 issued on 24 April 2020*, 2020.

244 OSCE, *OSCE Special Monitoring Mission to Ukraine (SMM) Daily Report 75/2020 issued on 30 March 2020*, 2020.

Table 12: Example of a ceasefire violations table as used in OSCE SMM daily reports

SMM position	Event location	No.	Observation	Description	Date, time
SMM camera in Avdiivka (governmentcontrolled, 17km N of Donetsk)	2–4km ESE	1	Projectile	NNW to SSE	27-Mar, 23:21
	2–4km ESE	2	Explosion	Undetermined	27-Mar, 23:22
	2–4km ESE	2	Explosion	Undetermined	28-Mar, 01:18
SMM camera in Berezove (governmentcontrolled, 31km SW of Donetsk)	1–3km ESE	9	Projectile	WSW to ENE	27-Mar, 21:32
	2–4km SE	1	Muzzle flash		28-Mar, 02:20
	2–4km SE	2	Projectile	SW to NE	28-Mar, 02:20
SMM camera in Chermalyk (governmentcontrolled, 77km S of Donetsk)	2–4km SSE	2	Projectile	NNE to SSW	28-Mar, 04:01
SMM camera at Donetsk Filtration Station (15km N of Donetsk)	1–2km SSW	6	Projectile	In vertical flight (also recorded by the SMM cameras in Avdiivka and at Oktiabr mine)	28-Mar, 03:35
SMM camera at entry-exit checkpoint in Hnutove (governmentcontrolled, 84km S of Donetsk)	1–3km ENE	1	Projectile	N to S	27-Mar, 23:02
	1–3km ENE	3	Projectile	N to S	28-Mar, 00:03
	1–3km ENE	1	Projectile	N to S	28-Mar, 01:08

Source: OSCE, Special Monitoring Mission to Ukraine, Daily Report 75/2020, p. 10.

"On the evening and night of 8–9 August, the SMM camera in Zolote recorded two bursts, two illumination flares, two muzzle flashes and 20 projectiles in flight (mostly from north to east), all at an assessed range of 1.5–4km south-east and south-south-east (all assessed as inside the disengagement area)."[245]

245 OSCE, *Latest from the OSCE Special Monitoring Mission to Ukraine (SMM), based on information received as of 19:30, 9 August 2019*, 2019. The Mission published relevant footage captured by its cameras online to raise awareness and further explain the Mission's mandate. For example: Youtube, *OSCE SMM thermal camera observations in Shyrokyne, Donetsk region,* https://youtu.be/SLLvCU-UQ19g, 2016.

The OSCE SMM daily reports listed captured ceasefire violations in a table. An example of the report by the Mission issued on 7 April 2020 (see Table 13)[246]:

Table 13: Example of a ceasefire violations table as used in OSCE SMM daily reports

SMM position	Event location	No.	Observation	Description	Date, time
SMM camera in Avdiivka (governmentcontrolled, 17km N of Donetsk)	2–4km ESE	1	Explosion	Undetermined	5-Apr, 20:55
	2–4km ESE	5	Projectile	NNE to SSW	5-Apr, 21:10
	2–4km ESE	10	Projectile	NNE to SSW	5-Apr, 22:34
	2–4km SE	6	Projectile	SW to NE	5-Apr, 22:35
SMM camera in Berezove (governmentcontrolled, 31km SW of Donetsk)	2–4km ESE	2	Projectile	SSW to NNE	5-Apr, 22:43
	2–4km ESE	14	Projectile	SSW to NNE	5-Apr, 22:45
	2–4km ESE	2	Projectile	SSW to NNE	5-Apr, 22:47
	2–4km ESE	11	Projectile	SSW to NNE	5-Apr, 22:49
	2–4km ESE	2	Projectile	SSW to NNE	5-Apr, 23:27
SMM camera 2km E of Bohdanivka (governmentcontrolled, 41km SW of Donetsk)	4–6km SE	1	Explosion	Undetermined (assessed as outside the Petrivske disengagement area)	5-Apr, 23:04

Source: OSCE, Special Monitoring Mission to Ukraine, Daily Report 82/2020, p. 9.

"On the night of 29 May, an SMM long-range unmanned aerial vehicle (UAV) spotted in "DPR"-controlled Mineralne (10km north-east of Donetsk) two self-propelled howitzers (2S3 Akatsiya, 152mm) firing four rounds in a north-western direction – in the general area of government-controlled Avdiivka (17km north of Donetsk)."[247]

246 OSCE, OSCE *Special Monitoring Mission to Ukraine (SMM) Daily Report 82/2020 issued on 7 April 2020*, 2020.

247 OSCE, *Latest from OSCE Special Monitoring Mission (SMM) to Ukraine, based on information received as of 19:30, 30 May 2016*, 2016. The Mission subsequently released the relevant imagery of this specific observation.

Determining firing positions and weapon systems

"Beyond withdrawal lines but outside designated storage sites in non-government-controlled areas, on 19 August, aerial imagery available to the SMM revealed the presence of 21 tanks (probable T-72), four surface-to-air missile systems (probable 9K35 Strela-10) and 75 armoured combat vehicles (ACV)."[248]

Weapons in violation of agreed withdrawal lines

"In violation of withdrawal lines in non-government-controlled areas, on 30 July, an SMM long-range unmanned aerial vehicle (UAV) spotted six multiple launch rocket systems (MLRS) (BM-21 Grad, 122m) at a compound in the centre of Khrustalnyi (formerly Krasnyi Luch, 56km south-west of Luhansk) and an additional six MLRS (BM-21) north of the city."[249]

"Beyond the respective withdrawal lines but outside designated storage sites, in non-government-controlled Myrne (28km south-west of Luhansk) on 22 September, an SMM mini unmanned aerial vehicle (UAV) spotted a large number of weapons and other hardware, which appeared to be well-maintained, refurbished and loaded with ammunition. The UAV spotted 30 tanks (28 T-64 and two T-72), seven self-propelled howitzers (2S1 Gvozdika, 122mm), six towed howitzers (D-30 Lyagushka, 122mm), nine mortars (120mm) and six anti-tank guns (MT-12 Rapira, 100mm), as well as 56 infantry fighting vehicles (IFV), six trucks each mounted with an anti-aircraft gun (ZU-23, 23mm), 14 APCs (13 MT-LB-variant and one BRDM), three armoured recovery vehicles (VT-55) and three mine-clearance vehicles (two UR-07 and one UR-77)."[250]

"In violation of withdrawal lines, in a non-government-controlled area, aerial imagery on 26 May revealed the presence of six towed howitzers (or mortars) (type undetermined) 1km east of Novoselivka (37km north-east of Donetsk)."[251]

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248 OSCE, *Latest from the OSCE Special Monitoring Mission to Ukraine (SMM), based on information received as of 19:30, 21 August 2018*, 2018.

249 OSCE, *Latest from the OSCE Special Monitoring Mission to Ukraine (SMM), based on information received as of 19:30, 31 July 2018*, 2018.

250 OSCE, *Latest from the OSCE Special Monitoring Mission to Ukraine (SMM), based on information received as of 19:30, 22 September 2017*, 2017.

251 OSCE, *Latest from the OSCE Special Monitoring Mission to Ukraine (SMM), based on information received as of 19:30, 30 May 2018*, 2018.

OSCE SMM daily reports listed weapons, military-type equipment, and personnel observed in violation of the Minsk agreements in a table format in an annex to its daily reports.[252] Below is an example from the daily report issued on 14 April 2020 (see Table 14)[253]:

Table 14: Example of a table of weapons in violation of agreed withdrawal lines used in OSCE SMM daily reports

Date	No. of weapons	Type of weapon	Location	Source of observation
Non-government-controlled areas				
11/04/2020	2	Self-propelled howitzer (one 2S1 *Gvozdika,* 122mm and one 2S3 *Akatsiya,* 152mm)	On the runway of an airfield in Peremozhne (19km south of Luhansk)	Long-range UAV
	3	Towed howitzer (one 2A65 *Msta-B,* 152mm, one D-30A *Lyagushka,* 122mm and one D20, 152mm)		
	1	Multiple launch rocket system (BM-21 *Grad,* 122mm)		
	1	Towed anti-tank gun (MT-12 *Rapira,* 100mm)		
12/04/2020	1	Surface-to-air missile system (9K35 *Strela-10*)	Near Sarabash (formerly Komunarivka, 26km south of Donetsk)	

Source: OSCE, Special Monitoring Mission to Ukraine, Daily Report 88/2020, p. 8.

Impact site assessment

"On 24 June, an SMM mid-range UAV spotted 13 fresh craters assessed as impacts of 122mm artillery rounds fired from a south-easterly direction, as well as 17 fresh craters assessed as impacts of 82mm mortar rounds (direction unable to be assessed) about 1.5km east of Vodiane, near previously observed forward positions of the Ukrainian Armed Forces."[254]

252 See for instance at page 9: OSCE, *OSCE Special Monitoring Mission to Ukraine (SMM) Daily Report 85/2020 issued on 10 April 2020,* 2020.

253 OSCE, *OSCE Special Monitoring Mission to Ukraine (SMM) Daily Report 88/2020 issued on 14 April 2020,* 2020.

254 OSCE, *Latest from the OSCE Special Monitoring Mission to Ukraine (SMM), based on information received as of 19:30, 25 June 2019*, 2019.

"On 21 April, an SMM mid-range UAV spotted about five craters, assessed as caused by artillery rounds fired from a westerly direction, in a field north of Sosnivske (non- government-controlled, 78km south of Donetsk)."[255]

"On 26 May, imagery from an SMM long-range unmanned aerial vehicle (UAV) revealed an impact on the eastern end of the roof of the Psychological Hospital, which the SMM assessed was caused by a 122mm artillery round. Damage to the southern-facing wall of the building and windows was also visible, along with debris on the ground. Imagery also revealed an impact 100m east of the hospital, which was assessed as caused by a 122mm artillery round fired from a south-easterly direction."[256]

"On 22 July, aerial imagery available to the SMM revealed the presence of about 30 recent craters inside the disengagement area near Zolote (government-controlled, 60km west of Luhansk): about five located about 1.2km north of its southern edge and 1.2km west of its eastern edge, about 15 located 800m north of its southern edge and 1.7km east of its western edge, and about ten located near its southern edge and about 2km west of its eastern edge."[257]

Disengagement areas

"On the evening and night of 8–9 October, the SMM camera at the Prince Ihor Monument south of the Stanytsia Luhanska bridge recorded six explosions, assessed as outgoing rounds 3km north (assessed as outside the disengagement area)."[258]

255 OSCE, *OSCE Special Monitoring Mission to Ukraine (SMM) Daily Report 97/2020 issued on 24 April 2020,* 2020.

256 OSCE, *Latest from the OSCE Special Monitoring Mission to Ukraine (SMM), based on information received as of 19:30, 27 May 2018*, 2018.

257 OSCE, *Latest from the OSCE Special Monitoring Mission to Ukraine (SMM), based on information received as of 19:30, 24 July 2019,* 2019.

258 OSCE, *Latest from the OSCE Special Monitoring Mission to Ukraine (SMM), based on information received as of 19:30, 9 October 2017,* 2017.

"On 8 April, inside the disengagement area near Zolote, an SMM mini-UAV spotted a person in a trench about 150m south of the its northern edge and about 500m west of its eastern edge. The UAV again spotted 55 anti-tank mines (probable TM-62) laid in fields south of the railway tracks east and west of road T-1316, assessed as belonging to the armed formations."[259]

"Aerial imagery of 5 September available to the SMM revealed that trenches assessed as belonging to the Ukrainian Armed Forces within the Petrivske disengagement area had been extended by approximately 65m in southerly directions, and firing positions in the trenches had been upgraded with sandbags, compared with imagery taken on 23 August."[260]

Presence of troops and forward moves

"On 24 January, about 2km north-east of Zolote-4/Rodina (government-controlled, 59km west of Luhansk), an SMM long-range UAV spotted two men digging a position, including a 10m-long trench (for previous observations in the area, see SMM Daily Report 18 January 2020)."[261]

"Aerial imagery taken on 4 July revealed the presence of new trenchesand positionsin a south-eastern part of Zaitseve (49km north-east of Donetsk) (not visible in imagery from 16November 2017), new defensive positions and four fresh impact sites near Bezimenne (30km east of Mariupol) (not visible in imagery from 1 June 2018), and numerousfresh impact sites between Bezimenne and Samsonove (101km south of Donetsk) (not visible in imagery from 1 June 2018)."[262]

259 OSCE, *OSCE Special Monitoring Mission to Ukraine (SMM) Daily Report 85/2020 issued on 10 April 2020,* 2020.

260 OSCE, *Latest from the OSCE Special Monitoring Mission to Ukraine (SMM), based on information received as of 19:30, 10 September 2018*, 2018.

261 OSCE, *OSCE Special Monitoring Mission to Ukraine (SMM) Daily Report 21/2020 issued on 27 January 2020,* 2020.

262 OSCE, *Latest from the OSCE Special Monitoring Mission to Ukraine (SMM), based on information received as of 19:30, 5 July 2018*, 2018.

"Aerial imagery from 1 February revealed that the forward lines of the Ukrainian Armed Forces and armed formations on the western outskirts of the town were approximately 800m closer compared with their positions in imagery from 10 December 2017. At one point, according to the latest imagery, they are about 180m from each other."[263]

"On 6 July, inside the Zolote disengagement area, an SMM mid-range unmanned aerial vehicle (UAV) spotted a recently dug 20m-long trench (assessed as a firing position) emerging from a tree line on the southern side of the railway line, 1.3km from the northern edge of the disengagement area and 1.2km from its western edge (not visible in imagery from 7 June 2018)."[264]

Damage to critical infrastructure and environment

"On the evening of 16 November, the SMM camera at the Donetsk Filtration Station (15km north of Donetsk) recorded, in sequence, an undetermined explosion, two projectiles in flight from east to west, three undetermined explosions, a projectile from east to west, a projectile from west to east, an undetermined explosion, eight projectiles from east to west, an undetermined explosion, four projectiles from east to west, an undetermined explosion, 15 projectiles from east to west, a projectile from west to east, four undetermined explosions, seven projectiles from east to west, two undetermined explosions, a projectile from south to north, and two undetermined explosions, all 0.5–1.5km south."[265]

Critical civilian infrastructure near the contact line, such as water filtration or pumping stations, often extended over large areas and sometimes across the contact line. This made them particularly vulnerable to shelling. Key private and state-owned utility providers benefited from the use of Mission's UAVs as the infrastructure they needed to repair was often inaccessible for damage assessment and repair crews. The same applied to the assessment of

263 OSCE, *Latest from the OSCE Special Monitoring Mission to Ukraine (SMM), based on information received as of 19:30, 23 April 2018*, 2018.

264 OSCE, *Latest from the OSCE Special Monitoring Mission to Ukraine (SMM), based on information received as of 19:30, 8 July 2018*, 2018.

265 OSCE, *Latest from the OSCE Special Monitoring Mission to Ukraine (SMM), based on information received as of 19:30, 17 November 2017*, 2017. The Mission also published sequences of the recorded footage from the fighting on its YouTube channel. Youtube, *Camera at the DFS recorded hundreds CFV, https://youtu.be/Wys2lpFRN68,* 2017.

damage to water, gas, and electricity lines in or near hotspots along the contact line. The mini- or mid-range UAV operations of the OSCE SMM also proved useful in conducting repairs at these locations. As they provided near-live imagery, repairs undertaken benefited from better situational awareness to improve their security and to direct the repair efforts where it was most needed.[266]

"The SMM followed up on reports of damage to the Donetsk Water Filtration Station caused by shelling the previous night. The SMM conducted flights of its mini unmanned aerial vehicle (UAV) in the area, as the SMM patrol was unable to access the station due to a lack of security guarantees and the possible presence of mines. The UAV spotted four impact sites – three inside and one outside the station, all of which the SMM assessed as having been caused by 82mm mortar rounds (the SMM was not able to determine whether they were fresh). The aerial imagery showed damage to the southern edge of the roof of the Chlorine Storage building, and marks of broken building material stretching from north to south on the roof, and the SMM assessed it as having been caused by an 82mm mortar round fired from a northerly direction."[267]

Damage to civilian housing and other property

"On 14 June, an SMM mini-unmanned aerial vehicle (UAV) spotted an impact to the roof of an agricultural building south-west of Dokuchaievsk (non-government-controlled, 30km south-west of Donetsk) (not visible in imagery from 21 April 2019).On 15 June, in a residential area on the northern edge of Prymorske (non-government-controlled, 76km south of Donetsk), an SMM mini-UAV spotted 11 fresh craters in the garden of a house, including three within 10m of the property, assessed as caused by 82mm mortar rounds fired from a westerly direction."[268]

266 For more information, please see: Ambassador Ertuğrul Apakan and Cono Giardullo, "UAVs for the Benefit of People: The use of Unmanned Aerial Vehicles Within the OSCE Special Monitoring Mission"; *Human Rights Quarterly* (May 2020), vol. 42, Number 2, pp. 479–487.

267 OSCE, *Latest from the OSCE Special Monitoring Mission to Ukraine (SMM), based on information received as of 19:30, 24 February 2017*, 2017.

268 OSCE, *Latest from the OSCE Special Monitoring Mission to Ukraine (SMM), based on information received as of 19:30, 17 June 2019*, 2019.

"On 24 May, aerial imagery revealed ten buildings damaged by probable shelling (including six without roofs) near Lopaskyne (government-controlled, 23km north-west of Luhansk) (not seen in imagery from 13 November 2017)."[269]

Entry-exit checkpoints at the contact line

The Mission used camera systems to monitor some of the entry and exit checkpoints where civilians could cross the contact line. The results from the camera observations helped to clarify allegations of non-compliance and highlighted human rights concerns, such as any violations of the ceasefire, military activities, or delays in processing the civilians. With only five possible locations to cross the almost 500 kilometer-long contact line, these entry-exit checkpoints were vital for the movement of civilians (including the staff of the OSCE SMM).

"On the morning of 3 March, the SMM camera at the entry-exit checkpoint in Marinka (government-controlled, 23km south-west of Donetsk) recorded two armoured utility vehicles (Kozak), one of which headed north-east and one of which headed south-east."[270]

Amassing of persons

Cameras or UAVs were useful to verify claims that checkpoints across the contact line were closed or opened by one side.

"During the same afternoon, the SMM cameras at the entry-exit checkpoints in Maiorsk (45km north-east of Donetsk), Marinka (23km south-west of Donetsk) and Pyshchevyk – across the contact line from Horlivka, Oleksandrivka and Verkhnoshyrokivske, respectively – recorded pedestrians and vehicles travelling in both directions. Later in the day, an SMM long-range UAV spotted civilian vehicles passing through the entry-exit checkpoints near Maiorsk and Berezove (31km south-west of Donetsk, across the contact line from Olenivka) as well as the checkpoint near Horlivka."[271]

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269 OSCE, *Latest from the OSCE Special Monitoring Mission to Ukraine (SMM), based on information received as of 19:30, 1 June 2018*, 2018.

270 OSCE, *OSCE Special Monitoring Mission to Ukraine (SMM) Daily Report 53/2020 issued on 4 March 2020*, 2020.

271 OSCE, *Latest from the OSCE Special Monitoring Mission to Ukraine (SMM), based on information received as of 19:30, 2 September 2018*, 2018.

Mine action

"On 21 April, about 1.5–2km north of Petrivske, an SMM mini-UAV again spotted four mine hazard signs and four rows of about 50 holes, assessed as caused by demining activities, all in a field east of the road between Petrivske and Styla (non-government-controlled, 34km south of Donetsk). (For previous observations in the area, see SMM Daily Report of 5 February 2020.) About 200m north-east, the same UAV spotted three small craters where five anti-personnel mines (PMN-2) were previously observed, assessed as caused by demining activities, and for the first time a clear sack containing about 20 anti-personnel mines (PMN-2) lying on the ground, assessed as belonging to the armed formations. An assessment was not able to be made as to whether demining or mine laying activities had been conducted based on observations."[272]

Similar to the mini-UAVs, the mid-range UAVs were capable of providing the Mission's ground patrols with valuable situational awareness, including the presence of mines and unexploded ordnance. Such information was especially valuable if it concerned potential patrolling routes.

"On 28 June, an SMM mid-range UAV spotted for the first time 15 anti-tank mines laid out in two rows across road M-03 near previously observed anti-tank mines (TM-62) about 5km south-east of Luhanske (government-controlled, 59km north-east of Donetsk)."[273]

"On 19 April, an SMM mid-range UAV again spotted more than 400 anti-tank mines and about 25 anti-tank mines laid in fields and across road T-0519, respectively, all north of Vodiane (government-controlled, 94km south of Donetsk). It also spotted about 75 anti- tank mines laid in fields further south-east. All these mines were assessed as belonging to the Ukrainian Armed Forces (for previous observations in the area, see SMM Daily Reports of 14 March 2020 and 10 April 2020).

272 OSCE, *OSCE Special Monitoring Mission to Ukraine (SMM) Daily Report 97/2020 issued on 24 April 2020,* 2020.

273 OSCE, *Latest from the OSCE Special Monitoring Mission to Ukraine (SMM), based on information received as of 19:30, 1 July 2019*, 2019.

The same UAV again spotted about 700 anti-tank mines in fields near the northern and western edges of Pikuzy (formerly Kominternove, non-government-controlled, 92km south of Donetsk), including four anti-tank mines attached to a board laid across a road leading from Pikuzy to Talakivka (government-controlled, 90km south of Donetsk). The UAV also spotted about 40 anti-tank mines (part of a larger minefield) in a field south of Pikuzy. All these mines were assessed as belonging to the armed formations (for previous observations, see SMM Daily Report 14 March 2020)."[274]

State border between Ukraine and the Russian Federation

The Mission's long-range UAV capacity, which enabled the Mission to undertake long distance aerial patrols, could establish facts about the security situation along a roughly 400 kilometer stretch of the international border between Ukraine and the Russian Federation, despite this area being outside Ukrainian control. According to the Mission's mandate, monitoring activities were limited to the borders of Ukraine. There were allegations that the border with the Russian Federation, which was not controlled by Ukraine, was used to resupply armed formations fighting in the area. The Mission's UAV observations were able to document the facts, especially as they almost exclusively occurred during night time when the OSCE SMM did not dispatch ground patrols (see Figure 27).

"In Sukhodilsk (non-government controlled, 38km south-east of Luhansk), about 10km west of the border, between 01:01 and 02:42 on the morning of 14 June, an SMM long-range UAV spotted several military trucks travelling back and forth for two and a half hour between the main railway station, from which the tracks extend westwards towards Molodohvardiisk (non-government-controlled, 35km south-east of Luhansk) and eastwards to the border with the Russian Federation south-east of Izvaryne (non-government-controlled, 52km south-east of Luhansk), and a warehouse south-west of the station."[275]

274 OSCE, *OSCE Special Monitoring Mission to Ukraine (SMM) Daily Report 95/2020 issued on 22 April 2020,* 2020.

275 OSCE, *Latest from the OSCE Special Monitoring Mission to Ukraine (SMM), based on information received as of 19:30, 14 June 2019*, 2019.

"Near the border with the Russian Federation in non-government-controlled areas south-east of Luhansk, where there are no border crossing facilities, an SMM long-range UAV spotted trucks travelling west on two occasions.

On the first occasion, on the night of 30–31 May, an SMM long-range UAV spotted three stationary military-type trucks facing west on an unpaved road near Cheremshyne (non-government-controlled, 59km south-east of Luhansk), about 2km west of the border. The UAV then spotted another military-type truck and a car proceeding from the north-east on a dirt track that is parallel to this unpaved road. The truck and the car then joined the other trucks in a convoy, which then proceeded to a compound of the armed formations on the south-eastern outskirts of Luhansk city (non-government-controlled) where four persons were seen unloading materials from the trucks. At least 35 military-type trucks and an APC (BTR-80) were also seen at the compound."[276]

Figure 27: Long-range UAV images of military-type convey crossing Ukrainian-Russian Federation state border

Source: InformNapalm, OSCE spotted Russian military convoys in the occupied territory of Donbas, 01.11.2020.

276 OSCE, *Latest from the OSCE Special Monitoring Mission to Ukraine (SMM), based on information received as of 19:30, 3 June 2019*, 2019.

"On 18 July, aerial imagery available to the SMM revealed [...] the presence of recent vehicle tracks, likely from non-agricultural vehicles, on a dirt road that leads to the border with the Russian Federation (in an area where there are no official border crossing points and no roads) about 1km east of Korolivka (58km south-east of Luhansk) and about 700m west of the border."[277]

"On 5 July, aerial imagery available to the SMM revealed the presence of at least five trucks facing west along a tree line along the border with the Russian Federation, about 2km south-east of Stepne (non-government-controlled, 72km south-east of Donetsk), in an area where there are no official border crossing points and no roads. About 2km west of the trucks, the same aerial imagery revealed the presence of five fresh vehicle tracks leading to the border. About 1.6km further south, it also revealed three fresh vehicle tracks leading towards the border."[278]

Situational awareness

Acoustic sensors deployed at a permanent presence of the OSCE SMM made contributions to the Mission's situational awareness. Table 15 below is an example of a published table of ceasefire violations collected by acoustic sensors as of 19 April 2018.[279]

Table 15: Reference to ceasefire violations registered by an acoustic sensor: Ceasefire violation table as used in OSCE SMM daily reports

SMM position	Distance	Direction	No.	Observation	Description	Date	Time
SMM acoustic sensor* in Svitlodarsk (government-controlled, 57km NE of Donetsk)	3–5km	SSW	1	Explosion	Undetermined	18-Apr	23:36
	3–5km	SSW	1	Explosion	Undetermined		23:37
	3–5km	SSW	1	Explosion	Undetermined		23:37
	3–5km	SSW	1	Explosion	Undetermined		23:39
1km SW from Luhanske (governmentcontrolled, 59km NE of	3–5km	NE	1	Explosion	Undetermined	19-Apr	10:11

* An SMM acoustic sensor continues to be tested until the end of April 2018.

Source: OSCE, Special Monitoring Mission to Ukraine, Table of ceasefire violations as of 19 April 2018, p. 3.

277 OSCE, *Latest from the OSCE Special Monitoring Mission to Ukraine (SMM), based on information received as of 19:30, 23 July 2019*, 2019.

278 OSCE, *Latest from the OSCE Special Monitoring Mission to Ukraine (SMM), based on information received as of 19:30, 12 July 2019*, 2019.

279 OSCE, *OSCE Special Monitoring Mission to Ukraine (SMM): Table of ceasefire violations as of 19 April 2018*, 2018.

"About 650m west of Verkhnoshyrokivske (formerly Oktiabr, non-government-controlled, 85km south of Donetsk), the same UAV again observed about 300 anti-tank mines laid in three rows from north to south for about 700m, assessed as belonging to the armed formations (for previous observations in the area, see SMM Daily Report of 3 February 2020). The same UAV spotted for the first time three anti-tank mines at a checkpoint of the armed formations west of Verkhnoshyrokivske, attached to a board and laid across a road leading fromVerkhnoshyrokivske toPyshchevyk."[280]

"On 5 April, an SMM long-range UAV again spotted at least 37 anti-tank mines, assessed as belonging to the armed formations, laid across road T-1303, about 350m east from the intersection with road T-1317 and about 2km north of Sentianivka."[281]

"On 10 May, while conducting a mini-unmanned aerial vehicle (UAV) flight over a training area near Shymshynivka (non-government-controlled, 27km southwest of Luhansk), the SMM heard seven shots of small-arms fire at an assessed distance of about 400m west-north- west, assessed as targeting its UAV, which was flying about 430m west-north-west. The SMM safely landed its UAV and left the area."[282]

280 OSCE, *OSCE Special Monitoring Mission to Ukraine (SMM) Daily Report 99/2020 issued on 27 April 2020*, 2020.

281 OSCE, *OSCE Special Monitoring Mission to Ukraine (SMM) Daily Report 82/2020 issued on 7 April 2020*, 2020.

282 OSCE, *OSCE Special Monitoring Mission to Ukraine (SMM) Daily Report 111/2020 issued on 11 May 2020*, 2020.

Annex C: Examples of interference with the OSCE SMM's technology

This annex highlights the ways in which the sides attempted to interfere with the technology operated by the OSCE SMM. This is a catalogue of examples, each of which represents a violation of the mandate of the Mission and at the same time a violation of the Minsk agreements. As such, these interferences are part of the Mission's public reporting and available on its website, and were at times referred to on its social media feeds.[283]

Small arms fire against UAVs

"On the evening of 18 July, an SMM long-range UAV spotted a PK machine gun (7.62mm) with one person behind it and three people around in the yard of a factory in Khrustalnyi (formerly Krasnyi Luch, non-government-controlled, 56km south-west of Luhansk) and recorded the machine gun opening fire towards the UAV. The UAV was not damaged."[284]

"An SMM mini-UAV spotted [...] a member of the armed formations firing a rifle at an SMM mini-UAV flying in Zernove (70km south of Donetsk)."[285]

"While conducting a mini-UAV flight on the northern edge of Obozne (non-government-controlled, 18km north of Luhansk), the SMM heard three bursts of small-arms fire about 3km north, assessed as aimed at the UAV, which was flying about 3km north of its position. The SMM lost control of the UAV and was unable to recover it."[286]

283 OSCE SMM, *Daily and spot reports from the Special Monitoring Mission to Ukraine*.

284 OSCE, *Latest from the OSCE Special Monitoring Mission to Ukraine (SMM), based on information received as of 19:30, 19 July 2018*, 2018.

285 OSCE, *Latest from the OSCE Special Monitoring Mission to Ukraine (SMM), based on information received as of 19:30, 3 July 2019*, 2019.

286 OSCE, *Latest from the OSCE Special Monitoring Mission to Ukraine (SMM), based on information received as of 19:30, 13 August* 2019.

"On 19 May, positioned in Kruta Balka (non-government-controlled, 16km north of Donetsk) while the SMM was conducting a long-range UAV flight near the DFS [Donetsk Water Filtration Station], the SMM heard uncountable shots of small-arms fire 200–800m south-west of its position assessed as directed at the UAV; the SMM completed the UAV flight and landed it safely."[287]

Anti-aircraft fire against UAVs

"About three minutes later, the UAV recorded a probable anti-aircraft gun (ZU-23, 23mm) located near the surface-to-air missile system also firing several rounds in the direction of the UAV. The SMM assessed the fire as directed at the UAV which was returned to base safely."[288]

"The SMM assessed that the anti-aircraft cannon fire was targeting an unmanned aerial vehicle (UAV) it observed flying in the area."[289]

Surface-to-air missile systems used against UAVs

"At 05:06 on 15 June, an SMM long-range unmanned aerial vehicle (UAV) that was flying over Betmanove (non-government-controlled, formerly Krasnyi Partyzan, 23km north-east of Donetsk) recorded a condensation trail of a missile following a ballistic trajectory at a significantly lower altitude than the UAV from the north-east."[290]

287 OSCE, *Latest from the OSCE Special Monitoring Mission to Ukraine (SMM), based on information received as of 19:30, 20 May 2018*, 2018.

288 OSCE, *Spot report by the OSCE Special Monitoring Mission to Ukraine (SMM): Surface-to-air missiles and rounds fired in direction of SMM long-range UAV*, 2018.

289 OSCE, *Latest from the OSCE Special Monitoring Mission to Ukraine (SMM), based on information received as of 19:30, 2 August 2017*, 2017.

290 OSCE, *Spot report by the OSCE Special Monitoring Mission to Ukraine (SMM): Surface-to-air missiles and rounds fired in direction of SMM long-range UAV* 2018. The Mission subsequently published the relevant video footage on its YouTube channel. Youtube, *OSCE SMM UAV targeted near Betmanove,* https://www.youtube.com/watch?v=sirVhEQ9b8c, 2018.

Electronic interference with GPS systems on UAVs

"An SMM mini-UAV experienced signal interference while flying over areas near Hnutove (government-controlled, 20km NE of Mariupol), assessed as caused by probable jamming."[291]

"At 2045 hrs, 18 April, the SMM launched a long-range unmanned aerial vehicle (UAV) flight over government- and non-government-controlled areas of Donetsk region. At 0126 hrs, 19 April, while near Vuhledar (government-controlled, 48km south-west of Donetsk), the UAV encountered dual GPS signal interference, assessed as due to jamming. This interference continued until 0235 hrs, when, while attempting to navigate the UAV to its ground control station near Stepanivka (government-controlled, 54km north of Donetsk), the SMM lost control of the UAV. SMM assesses that it crashed at 0236 hrs, in an area west of Horlivka (non-government-controlled, 39km north-east of Donetsk) and north-east of Novhorodske (government-controlled, 35km north of Donetsk)."[292]

Mission UAV operators under fire

"On 20 August at 16:44, as the SMM was landing an unmanned aerial vehicle (UAV) in Novooleksandrivka (65km west of Luhansk) it heard at least five bursts of small-arms fire (possibly AK), from a wooded area approximately 50m to the west."[293]

"On 4 July, an SMM patrol consisting of four members and two armoured vehicles was positioned at the checkpoint of the armed formations on the southern edge of the Zolote disengagement area (60km west of Luhansk) preparing to conduct a mini-unmanned aerial vehicle flight. [...] The SMM members heard bullets flying 10–15m above their heads and also heard and saw bullets impacting electricity poles 10–15m south-west of their position."[294]

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291 OSCE, *Latest from the OSCE Special Monitoring Mission to Ukraine (SMM), based on information received as of 19:30, 13 August 2019*, 2019.

292 OSCE, *Spot Report by OSCE Special Monitoring Mission to Ukraine (SMM): SMM long-range unmanned aerial vehicle crashes near contact line in Donetsk region* 2019.

293 OSCE, *Special Monitoring Mission (SMM) comes under small-arms fire in Novooleksandrivka*, 2016.

294 OSCE, *Spot Report by OSCE Special Monitoring Mission to Ukraine (SMM): Gunfire in close vicinity of SMM patrol members at Zolote disengagement area*, 2019.

Sniper fire against camera systems

"On 9 August, an SMM patrol inspected the cameras at the DFS and found out that the thermal camera had been damaged by small-arms fire. The SMM observed ten bullet impacts (five of calibre 7.62mm, two of calibre 5.45mm and three either calibre 7.62mm or 5.45mm) to the thermal camera and four bullet impacts (calibre 7.62mm or 5.45mm) to the camera mast."[295]

Blinding a camera with laser pointer

"For almost five hours on the evening of 4 October, the SMM camera in a non-government-controlled area south of Stanytsia Luhanska near the Prince Ihor monument was disabled by a laser that the SMM assessed as emanating from a concrete "LPR" position 70m north of the camera."[296]

Obstructing the installation or maintenance of technology assets

"Due to the presence of mines, including a road between Bohdanivka and Petrivske, the SMM's access to its camera in Petrivske remains limited, and thus the SMM has not been able to access observations from the camera since 22 June 2018."[297]

"At 17:45 on 7 October, an SMM patrol visited the Oktiabr mine ("DPR"-controlled, 8km north-west of Donetsk city centre) to inspect the SMM camera located at the site. While on the first floor of the mineshaft tower where the camera is installed, [...] the SMM heard the sound of a rifle being cocked and the man threatening in Russian: "OSCE get out, or I will shoot!"."[298]

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295 OSCE, *Spot Report by the Special Monitoring Mission to Ukraine (SMM): Small-arms fire destroys SMM camera at Donetsk Filtration Station*, 2017.

296 OSCE, *Latest from the OSCE Special Monitoring Mission to Ukraine (SMM), based on information received as of 19:30, 5 October 2017*, 2017. The Mission subsequently released relevant video footage on its YouTube channel. Youtube, *OSCE SMM camera at Stanytsia Luhanska blinded by* "LPR", https://youtu.be/jKFDEKgfm1o, 2017.

297 OSCE, *Latest from the OSCE Special Monitoring Mission to Ukraine (SMM), based on information received as of 19:30, 16 December 2018*, 2018.

298 OSCE, *Spot Report by OSCE Special Monitoring Mission to Ukraine (SMM): Man threatens SMM at camera site at Oktiabr mine*, 2016.

"The patrol was part of two patrols [...] facilitate and monitor adherence to the ceasefire for repairs of a powerline by Voda Donbassa and maintenance to an SMM camera at the entry-exit checkpoint in Maiorsk. [...] At 09:14, the three patrol members outside the vehicles heard an undetermined explosion approximately 500m north and another undetermined explosion about 500m south-south-east, followed by about ten shots of small-arms fire 100–150m north and north-west, two of which were assessed as flying over the heads of the three patrol members who were outside the vehicles."[299]

299 OSCE, *Spot report by the OSCE Special Monitoring Mission to Ukraine (SMM): Explosions and small-arms fire close to SMM patrol near Holmivskyi*, 2018.

Artistic impression of the complementary functions of human patrols and technology in ceasefire monitoring, by Anna Shulga.

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