An Introduction to Cyber Peacekeeping

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Abstract—Peacekeeping is a noble and essential activity, helping to bring peace to conflict torn areas and providing security to millions of people around the world. Peacekeepers operate in all domains of war: buffer zones on land, no fly zones in the air and ensuring free passage at sea. With the emergence of cyberspace as a domain of war, questions on the role of peacekeeping in this domain naturally arise. There is extensive research around the topic of cyber warfare, but surprisingly little on how to restore and maintain peace in its aftermath. This is a significant gap which needs addressing. We begin by providing an overview of peacekeeping, describing its overarching goals and principles, using the United Nations model as a reference. We then review existing literature on cyber peacekeeping. The paper progresses to discuss the question of whether cyber peacekeeping is needed, and if so, if it is a plausible concept. We explore some ideas on how cyber peacekeeping could be performed and the challenges cyber peacekeepers will face, before making suggestions on where future work should be focused.

Index Terms—Cyber Peacekeeping

I. INTRODUCTION

The topic of cyber warfare is one that continues to receive a great deal of coverage in the media and on the political stage in both the UK and the USA. The research community has responded to the rise of cyber warfare by taking on some of the most pressing and immediate challenges that the topic presents. The legality, ethics and doctrine of cyber warfare have all been debated in great detail. While research into cyber warfare is clearly extensive, there remains a significant unanswered question: how can we restore and maintain peace in the aftermath of cyber warfare? We address this question by considering the concept of cyber peacekeeping.

Section II sets out the background to the topic. We begin by discussing what is meant by the term peacekeeping and adopt the UN definition. A brief introduction to UN peacekeeping history, goals and principles is provided. We answer the question of whether cyber peacekeeping is necessary, looking at arguments both for and against its existence. Previous work on the topic is presented and analysed. Definitions of both cyber peacekeeping and cyber peacekeepers are then formulated. Each peacekeeping activity is examined in detail to consider its potential value and feasibility in a cyber warfare context. Sections XVII and XVIII conclude the paper, by describing future work and our conclusions.

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II. PEACEKEEPING

The term peacekeeping is defined by the Oxford English Dictionary as “The active maintenance of a truce between nations or communities, especially by an international military force”, but many definitions exist with little international agreement on which is correct. With no single definition, the term peacekeeping has often been used loosely, and at times as a label to legitimise questionable military activity. This lack of a single definition is an obstacle towards investigating the topic of cyber peacekeeping, since we cannot discuss cyber peacekeeping without first knowing the meaning of peacekeeping.

A legal and political debate on how peacekeeping should be defined is beyond the scope of this paper. Instead we adopt the definition used by one particular organisation: The United Nations (UN). Arguably the most high profile peacekeeping organisation of today, peacekeeping carried out by the UN receives extensive media coverage which exposes their work to the public. The UN definition of peacekeeping is as follows: “Action undertaken to preserve peace, however fragile, where fighting has been halted and to assist in implementing agreements achieved by the peacemakers”. While we have picked UN peacekeeping as our focus, it must be acknowledged that many other organisations perform peacekeeping. The Multinational Force and Observers (MFO) is one such example of a non-UN organisation whose stated aim is to undertake peacekeeping responsibilities in the Sinai.

Bellamy and Williams note the importance of considering our own political and theoretical preferences when discussing the concept of peacekeeping. Some nations have a Westphalian preference to peacekeeping theory. This is the view that the world consists of sovereign states who recognise no higher authority. Other states and organisations should not interfere with issues inside of that state unless invited. Others nations have a preference for a post-Westphalian order. This is the view that a state can enjoy sovereignty and non-interference in domestic affairs so long as they protect the welfare of their citizens. If this responsibility to protect fails, the international community can and should intervene. By examining peacekeeping from a UN perspective, it is acknowledged that our research will have a bias towards a post-Westphalian approach to cyber peacekeeping. Such a bias does not reduce the value of the work or impact the aim of the paper, which is to present discussion and analysis on how cyber peacekeeping could be performed in the context of UN peacekeeping.
B. A Brief History of UN Peacekeeping

The first United Nations peacekeeping operation was formed in 1948, in response to concern over hostilities in the Middle East. The United Nations Truce Supervision Organization (UNTSO) was dispatched as an unarmed monitoring mission to monitor the Armistice Agreement between Israel, Egypt, Lebanon, Jordan and Syria [13]. UNTSO remains in operation today, providing monitoring and facilitating diplomacy between the various parties in the Middle East. Despite the efforts of UNTSO to maintain peace in the region, the Armistice Agreement broke down in 1956 as the Suez Crisis erupted [13]. This crisis led to the formation of the UN’s first armed peacekeeping force, the UN Emergency Force (UNEF) [14]. Throughout the 1960s and 70s, the UN continued to dispatch small scale peacekeeping operations, helping to monitor ceasefires and uphold peace in post conflict environments.

In the late 1980s the scope and number of UN peacekeeping operations expanded, with 22 new peacekeeping operations being formed in just a six year period between 1988 and 1994 [15]. These new operations went beyond the traditional peacekeeping tasks seen in previous operations and expanded in scope to include more complex goals such as the supervision of elections, providing humanitarian support and building democratic institutions.

It was during this period that the UN encountered some high profile failures. The Bosnian War of 1992 and the UN Operation in Somalia II (UNOSOM II) in 1993 are both regarded as failings in UN peacekeeping [16]. In Somalia, UN peacekeeping troops were placed into a situation where there was no peace to keep, and peacekeepers were drawn into a violent guerilla conflict, effectively becoming a participant in the conflict rather than acting as peacekeepers. In Bosnia, UN peacekeepers failed to prevent ethnic cleansing and ensure the protection of civilians. The Dutch state was later found liable for 300 deaths, with The Hague district court ruling that Dutch peacekeepers did not do enough to ensure their protection [17]. Similarly in the high profile case of Rwanda (1994), UN peacekeepers failed to protect civilians, abandoning people who had sought refuge and UN protection at a school. These people and others were later massacred as part of a genocide [18].

In the following years, the UN was forced to re-evaluate its approach to peacekeeping [15]. Secretary-General Boutros-Boutros Ghali called for a return to strict adherence of the core principles of peacekeeping, and in 2003 a report by Lakhdar Brahimi [19] concluded that reforms were necessary. These reforms were wide ranging, but fundamentally set out that peacekeeping was not always the answer, and was only appropriate when there was a peace to keep.

Today, UN peacekeeping still faces multiple challenges. As an example, MONUSCO holds the title of the most expensive ongoing peacekeeping operation. Aimed at restoring peace in the DR Congo, it was established in 1999 and is still ongoing today (October 2017) with 22,000 uniformed personnel deployed in the region and a budget of just over $1b per year. Despite the long involvement of peacekeeping forces and some important successes such as the holding of free and fair elections in 2006, fighting between combatants and attacks on civilians continues and there is little sign of long term peace. Other problems facing UN peacekeeping include a constant struggle to secure troop and police contributions, weak support from the international community and the internal challenge of running such a huge organisation effectively.

C. UN Peacekeeping Goals

As the history of UN peacekeeping shows, ambitions have steadily grown from the relatively simple and successful goal of monitoring and observation to complex operations with mixed results. Today, the UN defines two type of peacekeeping operation that it can undertake: Traditional and Multi-Dimensional.

- **Traditional**: Operations which adhere strictly to the traditional goals of observation, monitoring and reporting.
- **Multi-Dimensional**: More complex operations which include peacekeeping but also extend into peace building e.g. reforming a state’s security sector and clearing mines.

D. Peacekeeping amongst other activities

Whilst our research is focused upon cyber peacekeeping, it is important to note that peacekeeping is an activity which overlaps with a wider set of peace activities. According to the UN, these other activities are:

- **Conflict Prevention**: Early intervention to prevent a dispute escalating.
- **Peacemaking**: Diplomatic measures aimed at bringing about a ceasefire.
- **Peace Enforcement**: Restoring peace without consent of the parties.
- **Peace Building**: Laying the foundation for long term peace and preventing relapse into conflict.

These activities and their relationship to peacekeeping are shown in figure 1.

![Figure 1: UN Peace Activities](image)

The overlap between each of the activities is clear; Peacekeeping operations cannot be viewed in isolation, and peacekeepers are often called upon to assist in peacemaking and peace building where necessary. With such overlap and linkage between these activities, any research that attempted to view one in isolation would be short sighted. Therefore, while section [4] focus on the activities related to peacekeeping as described by the UN, our section on future work discusses how cyber peacekeeping could impact conflict prevention, peacemaking and peace enforcement.
E. UN Peacekeeping Principles

UN Peacekeeping has always been guided by a number of core principles, further refined following the Brahimi report [19]. Today, these principles are generally defined as follows:

- **Consent of the parties**: Peacekeeping operations should only be deployed with the consent of the main conflicting parties. This gives the operation the legitimacy to act both physically and politically in the area. Without consent of all parties, the operation risks becoming involved in the conflict.
- **Impartiality**: Carrying out a mandate without favouring any of the involved parties. An operation must be seen as impartial to remain legitimate in the eyes of the consenting parties. Following the Brahimi report, it was clarified that impartiality does not excuse inaction to prevent threats to peace.
- **Non use of force, except in self defence and defence of the mandate**: Use of force should be a measure of last resort. Following the Brahimi report, it was made clear that force could be used in defence of the mandate. This highlighted that force could be used against those who were determined to undermine the peace process.

III. Existing Research

In comparison to works covering the topic of cyber warfare, there is relatively little literature regarding cyber peacekeeping. Cahill et al. [20] presented the concept in 2003. They examined the five original peacekeeping principles but chose to retain only one for cyber peacekeeping: voluntary contributions. They describe six activities which cyber peacekeeping should conduct:

- **Cyber Border Management**: Identifying network connections available to combatants. Having the capability to discover attacks passing over these connections and to seal off these boundaries to attacks.
- **Monitoring and Verification**: Monitoring internet traffic. The use of signature and anomaly detection to monitor incidents.
- **Cantonment**: A cantonment is a place of shelter for combatants during a ceasefire. Cahill et al. suggest two subtypes: virtual cyber cantonment, whereby profiling takes place to determine what each combatant does and whom they target and physical cyber cantonment, whereby combatants are given internet accounts that are segregated from their former enemies and heavily monitored.
- **Disarmament and Demobilization**: Disarming cyber warfare troops. They suggest that this will involve kinetic monitoring and inspections to locate cyber weapons.
- **Threat Awareness and Proactive Threat Removal**: The maintenance of cutting edge technology and knowledge, to ensure that cyber peacekeepers always have superior technical ability over those they are monitoring.
- **Peacekeeper Self-security**: Ensuring that cyber peacekeeping forces are invulnerable to the threats they are mandated to prevent. This includes defending from both cyber and kinetic attacks.

Cahill et al’s [20] work is valuable because it began the debate about performing peacekeeping in cyber space, but some of the suggested activities can be questioned. For example, there are significant technical questions regarding the idea of cyber border management. In particular it must be asked if there are such things as borders in cyber space, and whether it would be technically possible to monitor all connections to cyber space from a particular entity. From today’s perspective the idea of cantonment is also questionable, since peacekeeping doctrine places less of an emphasis upon this activity today than it did in 2003. Cahill et al. [20] performed a cyber peacekeeping experiment as part of their work. They used three servers: two for the hostile parties and one for the cyber peacekeeping force. A cyber peacekeeping toolkit was developed, which contained open source tools such as IPtables, SNORT and netSTAT. To simulate warfare, denial of service attacks were used between the hostile parties. They found that the cyber peacekeeping force was able to detect the attacks and assign them a level of severity. They conclude by suggesting that secure border gateway protocol (S-BGP) is a technology which may help cyber peacekeeping in the future.

Kleffner and Dinniss [21] contributed to the topic by examining the legal aspects of conducting cyber activities during peace operations. They conclude that most peacekeeping mandates will be broad enough to allow the monitoring of specific internet traffic, but that caution must be used not to monitor arbitrarily and to violate human rights and privacy laws. With regards to use of force, they conclude that uses of force by peacekeepers must abide by the principles of necessity and proportionality, and that this can be easily carried into the cyber domain. For example, if a cyber attack is threatening the safety of a dam and has real physical threats, force can be used to prevent this attack from occurring and to protect civilians. They argue that the need for cyber operations during peacekeeping will increase in the future, highlighting that the laws of armed conflict do not normally apply to peacekeeping operations. This means that cyber operations during peacekeeping will be guided by international humanitarian law. They conclude that Security Council mandates are seen as legal in the eyes of the international community, and therefore the type and scope of cyber operation that can be legally performed by UN peacekeepers will depend on the specific mandate of that operation.

The most recent substantial work regarding cyber peacekeeping was contributed by Akatyev and James [22] in 2015. They proposed that cyber peacekeeping will be needed in the future, and offer a definition: “cyber conflict prevention, mitigation, aftermath containment and rehabilitation with a focus on conflict de-escalation and civilian security.” [22] They argue that cyber peacekeeping should have six goals:

1) Protect Civilians.
2) Increase trust and security in cyberspace.
3) Prevention of cyber attacks and escalation of cyber conflicts.
4) Mitigating the damage of conflicts.
5) Aftermath containment.
6) Rehabilitation.

They propose that cyber peacekeeping has a role to perform during the stages of pre-conflict, conflict and post-conflict. In the pre-conflict stage, cyber peacekeepers conduct activities to maintain and enhance international peace. If and when conflict erupts, the roles change to protecting civilians from attack. They describe two practical implementations of cyber peacekeeping - a Rapid Response Division (RRD) and a Long Term Stability and Relief Division (LSRD). The focus of the RRD is primarily to protect what they term the “cyberspace safe layer”. This is defined as being a nation’s “pre-identified, minimally-required critical infrastructure necessary for civilian safety” [22]. In the case of cyber conflict, the RRD will therefore take immediate measures to protect and ensure the availability of this safe layer. The LSRD takes a more longer term approach, working to build capacity and defences to ensure a longer lasting peace. Akatyev and James [22] conclude their work by proposing that future efforts should focus upon establishing what a cyberspace safe layer should look like, and on gathering feedback from stakeholders on whether their proposals are viable.

IV. THE NEED FOR CYBER PEACEKEEPING

The use of the cyber domain is a relatively new aspect of war [6], and the world has yet to see a war in which cyber warfare has played a significant part. It is therefore reasonable to ask: is cyber peacekeeping necessary?

Research shows that there is a lack of understanding and international agreement in most aspects of cyber warfare [6]. Traditional kinetic warfare is guided by well established laws and regulations such as the Geneva Convention. Being in its infancy, cyber warfare is both untested and unregulated, and we propose that this lack of regulation will present threats to civilians. Just as the unregulated use of land mines led to indiscriminate and prolonged harm to civilians in previous wars [23], the unregulated use of cyber warfare has the potential to have similar effects. This in itself could be used to argue that cyber peacekeeping is necessary. As Bellamy and Williams note, outside observers and policy makers alike expect peace operations to protect civilians under their care [8].

An alternative view on the need for cyber peacekeeping is to study the UN Charter’s existing mandate. Chapter I of the UN Charter [24] defines the core objectives of the UN, one of which is to maintain international peace and security. This is often the basis from which existing peacekeeping operations are formed: if international peace and security is threatened, the Security Council can take a number of measures, including the establishment of a peacekeeping operation. From a cyber peacekeeping perspective, this raises an important question: can international peace and security be threatened by cyber warfare? The answer to this largely depends upon how the term “threats to international peace and security” is defined, and as with most aspects of peacekeeping, the answer is not straightforward. When the term was originally used in the UN Charter, it was envisioned that most cases arise out of state vs. state conflict [8]. Over the years however, the UN has widened the scope to include events such as state collapse, HIV/AIDS, nuclear proliferation, humanitarian suffering and massive human rights abuses [8]. In effect, the UN Security Council has a large degree of discretion on what constitutes a threat to international peace and security.

If events such as state collapse, humanitarian suffering and human rights abuses are a threat to international peace and security, then it can be argued that cyber attacks are also threats through their potential to initiate, compound or prolong such events. Using this rationale, cyber attacks used during cyber warfare could be deemed as a threat to international peace and security. As an example, cyber attacks could at least contribute towards the collapse of a state if they initiate or prolong the failure of critical national infrastructure. Nations are becoming reliant on the cyber domain to provide services that keep a nation running: power grids, water supplies, communications, transportation and finance are all increasingly becoming cyber dependant. Warfare which causes blackouts, cuts off supplies to safe drinking water, makes travelling dangerous or destabilises the national economy is clearly a threat to the stability of a nation and is therefore a threat to international peace and security.

Similar arguments can be made for other events such as human rights violations. At the most critical end of the spectrum, a national blackout or toxic water supply has the potential to threaten millions of civilian’s human right to life. Less grave but still important is the right of every person to seek, receive and impart information and ideas through any media and regardless of frontiers [25]. These are human rights that are clearly at risk during cyber warfare, and it should be noted that the UN has shown an active interest in tackling such violations. As an example, when the Cameroon government cut off internet access to predominantly English speaking parts of the country, the UN stated that it was “an appalling violation of their right to freedom of expression” [26]. This evidences the fact that the UN believes human rights can be threatened in the cyber domain and therefore adds weight to the argument that cyber warfare holds the potential to amount to a threat to international peace and security.

Although the world has yet to see solid evidence that cyber warfare has been used as part of a war, we must also consider other events such as election hacking as a justification for cyber peacekeeping. Free and fair elections are an essential ingredient towards peace in a nation [27], and any doubt over the legitimacy of the result can lead to a threat to international peace and security. Alleged targeting of elections by cyber means is becoming more common, with extensive media coverage over possible Russian influence on the 2016 US presidential election [28]. Similarly, a 2017 cyber attack on Emmanuel Macron’s party in France was described as a clear attempt to destabilise the election and democratic process [29]. If future elections are going to be destabilised by cyber attacks, it is further evidence that peacekeepers will need to begin operating in the cyber domain to fulfil their mandate.

The research community is divided on the topic however, and the arguments for and against cyber peacekeeping offered by others will now be analysed.

Kleffner and Dinniss [21] have suggested that cyber peace-
keeping will become a necessity, predicting that peacekeepers will find themselves having to operate inside of the cyber domain in order to maintain peace in future conflicts. Akatyev and James [22] agree, stating that cyber peacekeeping is needed to protect an increasingly-connected number of people, to help prevent escalation of cyber conflicts, to provide arbitration among states, and to help build and maintain trust in cyberspace. John Bumgarner, Chief Technology Officer at the U.S. Cyber Consequences adds weight to the argument for cyber peacekeeping by stating that: “The UN needs to figure out how they can deploy peace keepers in the digital borders of a nation, virtual peacekeepers that would protect the peace” [30].

On the opposing side of the debate, others have argued that cyber peacekeeping is not necessary since it is both premature and redundant [31]. The argument that it is premature is based upon the premise that there is currently no military doctrine or legal framework to define the kinds of cyber incident that amount to an act of war. In effect, the argument is that until cyber warfare is more understood and defined, there is no value in debating how peacekeeping organisations may combat it. The redundancy argument is made by proposing that other organisations such as inter-governmental, educational and non-profits are better placed to perform peacekeeping tasks in the cyber domain.

The argument that cyber peacekeeping is premature is effectively the opposite of the argument we have presented in favour of cyber peacekeeping. On one side, it is argued that the lack of understanding and experience with cyber warfare fuels the need for cyber peacekeeping. This is because unregulated and untested forms of cyber warfare have the potential to inflict indiscriminate, disproportionate and prolonged suffering to civilians, and present a threat to international peace and security through human rights violations and state collapse. The counter argument proposes that this lack of understanding and regulation is precisely the reason why cyber peacekeeping research should be delayed: if the rules and regulations of cyber warfare are not yet formed, cyber peacekeeping cannot be usefully designed.

It is proposed that both arguments hold a valid position. Cyber peacekeeping will become necessary, but is not necessary today. However, it is argued that to fully develop cyber peacekeeping it is prudent to begin the debate today. This provides time to make proposals, hold debate and prepare peacekeeping organisations such as the UN for their future role in the cyber domain.

The view that cyber peacekeepers are redundant due to other organisations being better placed must also be challenged. It is true that Internet Service Providers (ISPs), non-governmental organisations and charities are well placed to tackle cyber attacks and encourage the peaceful use of cyberspace. But in the context of cyber warfare, it must be questioned if the international community can expect these entities to shoulder the responsibility and cost of acting as peacekeepers. Furthermore if we apply the same redundancy argument to kinetic peacekeeping, all UN peacekeepers are redundant since private security companies and charities could do it. The answer is that such a large scale response that interferes with sovereign states requires a level of international legitimacy that a telecommunications firm or charity could not deliver. This is not to say that other organisations could not contribute; they already contribute in important ways with specialised skills and assets, but the peacekeeping operation as a whole will likely be orchestrated by the UN, or a regional organisation such as the EU, Arab League, OSCE or NATO.

The international commitment to the concept of ‘responsibility to protect’ (R2P) must also be considered as a justification for cyber peacekeeping. R2P is an agreement that all states have a responsibility to protect civilians from genocide, war crimes, ethnic cleansing and crimes against humanity, and was agreed upon unanimously by world leaders in 2005 [32]. Although R2P can be used as a justification for peacekeeping, its justification for cyber peacekeeping is questionable. While cyber warfare can target critical infrastructure and result in harm to civilians, it is questionable whether this activity would rise to the level of a war crime or genocide. However, in the case of attacks on civilian air traffic control, water supplies, or dams the potential for indiscriminate and mass civilian casualties is high. Therefore the potential for war crimes via cyber warfare and the relevance of R2P cannot be entirely dismissed.

In summary, while there are arguments both for and against the existence of cyber peacekeeping, there is strong evidence that cyber warfare has the potential to threaten international peace and security. Just as a mortar can cause injury and death, a cyber attack on a water treatment plant, a power plant or a nation’s financial networks has the capacity to cause disproportionate and indiscriminate physical, psychological and economic harm upon civilians. Without any plan for how these systems will be restored in the aftermath of warfare, this suffering has the potential to be long term as nations struggle to bring infrastructure back online safely. During this time, there is a risk of state collapse, humanitarian crises and human rights violations, all of which are already regarded as threats to international peace and security. It is acknowledged that cyber peacekeeping is not required today, but that it will be required in the near future. It is therefore concluded that starting the debate and laying the foundations of research into this area is justified, so that peacekeeping organisations can be best prepared for their future role in the cyber domain.

V. DEFINING CYBER PEACEKEEPING

With the need for cyber peacekeeping established, we must address one of the most significant questions: what is cyber peacekeeping? The UN definition of peacekeeping, which we adopt for this work, is as follows:

“Action undertaken to preserve peace, however fragile, where fighting has been halted and to assist in implementing agreements achieved by the peacemakers.” [33]

To make an initial proposal of cyber peacekeeping, this definition can be modified to make it relevant to cyber space:

“Action undertaken in cyberspace to preserve peace, however fragile, where fighting has been halted and
to assist in implementing agreements achieved by the peacemakers.”

The primary strength of this definition is that it is built upon wording that is already established in the international community. It takes the UN definition of peacekeeping, and adapts it to confine the ‘action’ to the cyber domain. A potential weakness in the definition is that requiring an action be performed in cyberspace to count as cyber peacekeeping means that activities which require cyber knowledge but are kinetic in nature (such as training or assisting with policy reforms) cannot be regarded as cyber peacekeeping. To counter this, an alternative definition can be offered.

**Cyber related** action undertaken to preserve peace, however fragile, where fighting has been halted and to assist in implementing agreements achieved by the peacemakers.

This definition removes the requirement that the action must be in cyber space, but to decide which definition is correct an important question must be answered: should the test for whether an action is cyber peacekeeping be the type of knowledge being used or the actual domain it is being performed in? For assistance in answering this question, we can refer to existing guidance for an already established domain. The UN Peacekeeping Missions Military Maritime Task Force Manual [4] provides guidance for those carrying out maritime peacekeeping. It states the following:

“The Maritime Task Force is not limited to maritime effects at sea. Its ships provide advanced platforms for military aviation, communications and medical support to the ground force. These maritime capabilities strengthen the Force Commander’s capability with enhanced deterrence, situational awareness, medical facilities and military transportation sustaining operations and the execution of mandated tasks on shore and afloat.” [4]

This suggests that a naval task force dispatched to conduct “maritime peacekeeping” is not confined to conducting tasks at sea. The reference to maritime capabilities being used to strengthen the operation suggests that naval peacekeeping is defined by the application of a *maritime capability*, rather than the action being confined to any specific domain. This proposal is supported further by the manual, which goes on to describe training in areas such as maritime law and policy as being a task of the maritime task force. It is therefore argued that if maritime peacekeeping is the application of maritime capability in any domain, it follows that cyber peacekeeping should be the application of cyber capability in any domain. The definition can therefore be refined as follows:

**Definition 1.** UN Cyber Peacekeeping. The application of cyber capability to preserve peace, however fragile, where fighting has been halted and to assist in implementing agreements achieved by the peacemakers.

For completeness, it is also necessary to define the term cyber peacekeeper. The term ‘peacekeepers’ has been defined as “individuals and groups who perform peacekeeping activities” [8]. This is a broad definition, and therefore includes civilians, armed forces, charities, governmental and non-governmental organisations. The UN does not provide a definition of a peacekeeper. Whether the term refers to uniformed blue helmets, or to all people involved in a UN peacekeeping operation such as civilian staff, volunteers and partner organisations remains unclear. We adapt the definition offered by Bellamy and Williams [8] as follows:

**Definition 2.** Cyber Peacekeeper. An individual performing cyber peacekeeping activities.

VI. CYBER PEACEKEEPING ACTIVITIES

When considering potential cyber peacekeeping activities, we identified two possible approaches. Firstly, cyber peacekeeping could be examined as a unique concept and a set of activities could be drawn up from scratch. Secondly, we could examine established UN peacekeeping activities and discuss their applicability to cyber peacekeeping. We conclude that the latter approach brings a number of benefits:

- **Adoption:** When cyber peacekeeping can be demonstrated to fit alongside the established framework, decision makers will be more likely to understand and adopt it.
- **Comprehensive:** By understanding and considering existing doctrine, it is more likely that the ideas presented in this paper will address the issues that are significant to peacekeeping operations.
- **Integration:** By sharing a common approach, cyber peacekeeping has the flexibility to either operate as a standalone event, or alongside kinetic peacekeeping as part of a wider operation.

With this approach in mind, the following sections will examine the existing tasks undertaken by kinetic UN peacekeeping operations and explore the potential value and feasibility of performing those tasks in a cyber warfare context. Figure 2 presents the activities that kinetic UN peacekeeping operations currently perform, as defined by the United Nations Department of Peacekeeping Operations (DPKO) [11].

VII. OBSERVATION, MONITORING AND REPORTING

Observation, Monitoring and Reporting (OMR) is one of the core activities performed during a UN peacekeeping operation. The activity brings value by providing impartial reporting on adherence to ceasefire agreements, violations of human rights and other information where trust in its correctness is critical towards maintaining peace. OMR can be a specific task, such as a foot patrol around a specific area or by the dispatch of unarmed UN Military Observers (UNMOs). It is also an incidental task, performed by peacekeeping staff who observe and report issues during the course of their other peacekeeping duties. UN Infantry Battalion Manuals Volumes One and Two [35, 36] specify three observational goals of OMR. UN personnel aim to observe, monitor and report upon:

1) Actions which violate peace agreements.
2) Human rights abuses.
3) Changes in terrain, dispositions and civilian activity.
When considering how OMR could apply to the cyber domain, an immediate point of note is that the concept of observation, monitoring and reporting in cyberspace is not new. Cyber attacks against businesses and governments have encouraged research into how observation, monitoring and reporting in cyberspace can be improved [37], [38]. Books by authors such as Bejtlich [39], [40] and Murdoch [41] provide advice on best practice regarding network monitoring and reporting, and certifications such as the Cisco cybersecurity specialist certification [42] are designed to give cyber security professionals the skills needed to effectively observe and monitor in the cyber domain. It is therefore true that many of the existing techniques of monitoring in cyberspace will likely be used by cyber peacekeepers. The focus of this section is therefore not to discuss how cyberspace can be monitored and observed, since this is an already established field of study. The focus is to explore how existing cyber observation methods could be used to fulfil the three OMR observational goals. To this end, the first goal is now examined.

A. Actions which violate peace agreements

It has been stated that wars of the future will contain elements of cyber warfare [6]. If this is true, it follows that future peace agreements will contain cyber warfare terms. It is therefore prudent to explore whether it would be technically feasible and valuable for cyber peacekeeping to observe for actions which violate peace agreements. From a value perspective, it is expected that monitoring for violations of cyber terms will bring high value. This is because it will bring confidence to the peace process and allows a neutral third party to provide independent monitoring. For example, if country A agrees not to attack country B’s power grid, cyber peacekeeper monitoring would be valuable in acting as a trusted third party to monitor for adherence to that agreement.

From a technical feasibility perspective, a basic monitoring capability is feasible to establish using existing knowledge, but there are significant challenges. Firstly, caution must be used when the cyber terms are agreed. Stating that country A will cease all cyber attacks upon country B is one that will be difficult to monitor. The reason for this is that asking any organisation to monitor every network in a nation is unrealistic: it would simply require an amount of resources (both human and hardware) that would be infeasible to provide in the context of a peacekeeping operation. It is therefore envisioned that peace agreements would list specific networks that should not be attacked. The idea of a cyberspace safe layer as described by Akatyev and James [22] would fit this requirement, whereby a minimal set of critical systems that should be observed are identified. Arguably the most significant technical obstacle is the attribution problem. While it will be possible to observe an attack on a network, it will be difficult to prove where that attack came. Research into the attribution problem is ongoing [43], [44], [6], but it likely will present an obstacle towards observing for actions which violate peace agreements.

Figure 3 shows how an attack might be routed through multiple countries and organisations, each with varying levels of cooperation and political relations in order to make tracing the attack difficult.

This is a potential obstacle towards feasibility, since there are significant implications in making a statement that a particular party has violated a peace agreement. If solid, evidenced attribution cannot support such a statement, the feasibility of reaching this particular OMR goal is reduced. The nature of cyber peacekeeping does present a potentially novel solution however. As Wheeler and Larsen [44] noted, prepositioning of trust is an essential part of solving the attribution problem. While it will be possible to observe an attack on a network, it will be difficult to prove where that attack came. Research into the attribution problem is ongoing [43], [44], [6], but it likely will present an obstacle towards observing for actions which violate peace agreements.

Figure 3 shows how an attack might be routed through multiple countries and organisations, each with varying levels of cooperation and political relations in order to make tracing the attack difficult.
as part of future work. At this stage, it is concluded that while the value of monitoring for actions which violate peace agreements would be high, the feasibility of doing so in the cyber domain is expected to be low, due to attribution problems.

B. Human rights abuses

Human rights is an issue that has always been at the core of peacekeeping, and monitoring for abuses of people’s human rights is therefore the second observational goal of OMR. Looking at human rights abuses from a cyber warfare perspective, the first question to consider is whether they can be violated in the cyber domain. Upon inspection of the rights laid out in the Universal Declaration of Human Rights (UDHR), it is proposed that three are vulnerable to threat in cyber space. These are shown in figure 4.

Observing for violations of privacy (Article 12) is expected to be of low technical feasibility, primarily due to detection being technically challenging. Snooping upon network traffic is fundamentally a passive activity which is difficult to detect technically. For example, a government may inspect all traffic passing through a government controlled ISP, or compel regional technology firms to provide access to customer data such as emails. These are rights violating activities that are difficult to detect with a technical solution. The political feasibility of observing for article 12 violations will also be low. Cyber peacekeepers will be operating with the consent of the host nation, and this consent may be jeopardised if the host suspects or detects that cyber peacekeepers are seeking to uncover privacy violations.

Monitoring for violations of freedom of expression and access to information (Article 19) is also challenging from a technical perspective. A scenario exists whereby a particular nation begins to block access to certain information or deny internet access to people with certain views. In 2016 UN special rapporteur David Kaye criticised Turkey’s “vast wave of internet shutdowns and content takedowns” in the wake of the attempted July coup [45]. If a cyber peacekeeping unit can secure access into a national internet service provider (ISP), there is potential to observe and report upon content blocking and other restrictions to access. However, political feasibility may again present an obstacle due to the principle of consent. Cyber peacekeepers must consider if consent for their operation would be maintained, if it is suspected that the cyber peacekeepers would be aiming to criticise the activities of the consenting government. Feasibility is therefore rated as medium, while the value is high. The high value is justified, since a lack of access to unbiased information from international sources has the potential to fuel unrest and allow propaganda to spread misinformation about the conflict.

Observing for threats towards life, liberty and security of person (Article 3) is feasible from a technical perspective and is highly valuable. Cyber attacks upon critical infrastructure such as the public water supply or air traffic control hold the potential to threaten civilian life and security, and these can be monitored for threats, providing consent to monitor them is given.

While the cyber domain presents obstacles towards observing for human rights abuses, it also presents potential opportunities. Social media has become an aid for monitoring human rights around the world [46], [47] giving victims of breaches a method of reporting that was previously unavailable. Considering this point, there is potential for cyber peacekeepers to observe social media and monitor not just violations occurring in the cyber domain, but also in the kinetic domain. Many charities and organisations such as Privacy International and
Human Rights Watch already perform such monitoring, and it is arguable that a cyber peacekeeping operation performing this activity would not bring any additional value on-top of what existing efforts contribute.

In addition to the rights set out in the UDHR, there are efforts to develop a set of cyberspace human rights which aim to secure a new set of rights such as a right to access. Should the world adopt such a set of rights, it is arguable that cyber peacekeepers would have a mandate to protect them. Until such rights are agreed upon, it is difficult to make predictions on their value and feasibility.

In summary, the value of monitoring for violations of human rights is either high or medium. Universal rights such as privacy, freedom of expression and of life and security can be threatened in the cyber domain and observing violations would contribute towards peace and security. The feasibility of doing so is varied however. Monitoring for privacy violations is expected to be difficult. Monitoring for violations of the right to seek and impart information and for threats to life and security are expected to be more feasible, providing the necessary consent from the host nation can be secured. Monitoring for threats to life is the most feasible of the three, and also arguably the most valuable.

C. Changes in terrain, dispositions and civilian activity

The final observational goal of OMR is to monitor and report upon changes in terrain, dispositions of forces and civilian activity. Reporting changes in terrain allows peacekeeping forces to keep local maps updated with key features of the terrain which can help to inform where patrols should take place and potential hot spots for conflict.

To consider how these observational goals might apply to a cyber context, some translation effort is necessary. For example, observing for changes in ‘terrain’ does not immediately make sense in the cyber domain, since it is a domain in which terrain does not exist. It is therefore proposed that rather than monitor for changes in terrain, cyber peacekeepers should monitor for changes in network structure. As examples, the sudden unavailability of servers or the addition of new devices would be valuable changes to look for. It must be noted however, that networks are naturally subject to change in normal conditions: routing tables can change depending on network conditions and servers can become unavailable for patching and maintenance. It will therefore be essential that cyber peacekeepers build up an understanding of what is normal and what is abnormal, effectively conducting anomaly detection upon the network. The ultimate aim is to improve situational awareness regarding the structure of the cyber domain in the region and use that awareness for some valuable purpose. To discover what this value may be, we can turn to existing literature. When considering situational awareness in air traffic control, Jeannot, Kelly and Thompson defined it simply as “knowing what is going on around you” [49]. A more detailed definition was given by Dominguez et al, who stated that situational awareness involved four specific steps: [50]

1) Extracting information from the environment;
2) Integrating this information with relevant internal knowledge to create a mental picture of the current situation;
3) Using this picture to direct further perceptual exploration in a continual perceptual cycle; and
4) Anticipating future events.

Observing for changes in network structure in cyber peacekeeping would fulfil these four steps. Cyber peacekeepers observe the cyber environment, create a picture of it, identify areas where further exploration is needed and then use that information to anticipate future events. Observing for changes in network structure can therefore bring value in the following ways:

1) Providing legitimate explanations for changes in traffic that would otherwise be alarming, e.g. Requests to a previously unknown DNS server, or an increase in traffic along a route due to a new file store.
2) Highlighting new potential attack targets or the removal of old ones.
3) Giving indications of a violation which has not yet been detected by other means.

Observing for changes in network structure is feasible, since extensive literature already exists on how this can be achieved. NIST provides one such example, presenting guidance regarding network discovery, port and service identification, vulnerability scanning and wireless scanning. By conducting activities such as these, cyber peacekeepers can gain a view of the cyber ‘terrain’ and observe for changes.

Observing for changes in dispositions allows peacekeepers to monitor the locations and make-up of military forces. A build up of troops outside a town, or the arrival of armoured vehicles to an area are both examples of changes in dispositions. When considering how this observational goal could apply to the cyber domain, difficulties are encountered. The first obstacle is that observing cyber weapons and cyber combatants is challenging. Cyber weapons are still not fully understood or defined and cyber combatants do not have to physically relocate or group up in order to launch effective attacks. An alternative approach is to consider the aims of monitoring dispositions and then to consider how these aims could be achieved in the cyber domain. It is proposed that the aims of disposition monitoring are as follows:

- Identifying potential flashpoints of conflict - a build up of opposing combatants in close proximity, or an unusual building of forces in a particular area.
- Identifying growth or decline in warfare capability - e.g. Addition of advanced weapons and C2 platforms.

If these are taken as the aims of disposition monitoring, it is possible to theorise about two methods of achieving them in the cyber domain. Firstly, potential flashpoints of conflict could be identified by observing for changes in cyber security dispositions. For example, a nation diverting cyber security resources towards protecting its power grid is arguably an unusual build up forces which may indicate power systems as a point of conflict in the near future. This is certainly something cyber peacekeepers would be interested in spotting, and achieves the same goals as kinetic dispositions monitoring. The feasibility of this monitoring is questionable however.
While the movement of kinetic troops and vehicles can be observed, cyber troops can perform their duties at a variety of sites without physically relocating. Spotting redeployments of cyber troops to different areas of the cyber infrastructure will therefore be a challenge to feasibility.

The second method is to identify a growth or decline in observed cyber warfare capability. Cyber peacekeepers operating in a network could monitor the sophistication of cyber security techniques employed by local staff at sites where they are deployed, and make conclusions regarding their level of cyber capability. For example, the arrival of new staff who are clearly more adept at cyber security or observing more advanced attacks upon the infrastructure they are monitoring. This would be feasible to perform, although the value is questionable. Even if an advanced attack was detected, the attribution problem would make any conclusion regarding the cyber warfare capability of any particular group difficult. However, if this activity was feasible it would be valuable to perform. Conclusions about the level of cyber warfare skill being employed could assist peacekeepers in making decisions on where to focus cyber peacekeeper protection.

Finally, the observation of civilian activity is an indicator of the level of peace and security felt by the local population. Any change in the usual patterns of civilian life may point towards a change in the local situation that is worth investigating further. It is proposed that in the cyber domain, this observational goal can be translated into changes in network traffic whereby cyber peacekeepers build a baseline for normal traffic and subsequently look for deviations from that baseline. This is a feasible observation goal, since anomaly detection in network monitoring is an established field of research \[52, 53\] with a number of products offering such a feature \[54\]. It would also bring value to the peacekeeping process, by alerting to potential malware infections, denial of service attacks, data exfiltration and unauthorised access to peacekeeper protected networks.

D. Obstacles

Some general obstacles towards performing cyber OMR must be noted at this stage. Firstly there is the issue of resistance at all levels (local, regional and national). While two opposing factions or nations may agree to peace at the highest level, this may not translate into automatic compliance with cyber peacekeepers at ground level. Cyber peacekeepers may find network owners are reluctant to open up their networks to cyber peacekeeper monitoring, even if it is one of the identified critical networks and access has been agreed by political leaders. This is especially true if the network is a private company such as an ISP. This is not a problem that is unique to cyber peacekeeping. Kinetic peacekeeping is also subject to local resistance \[55, 11\], and procedures are in place to help resolve such conflicts. It is proposed that cyber peacekeepers must be prepared to encounter resistance at all levels, and that it should be expected and planned for. Furthermore, it is foreseeable that resistance will occur even at the highest levels when considering highly sensitive networks such as critical national infrastructure (CNI). Nations may rightly be concerned about the national security implications of allowing cyber peacekeepers of multiple nationalities observe their CNI. In these cases, consent may be denied outright.

A second obstacle is the technical challenges CNI presents. Facilities such as power plants and water facilities have properties which make observation and monitoring more challenging than standard network monitoring techniques \[56\]. The use of proprietary protocols, air-gapping and a 24/7 availability requirement mean that performing OMR on these systems will require a specialised set of skills. Other potential obstacles include lone wolf attackers and the problem of spoilers \[57\]. These obstacles must be explored in future work.

VIII. CEASE-FIRE SUPERVISION AND SUPPORTING VERIFICATION MECHANISMS

Cease-fire agreements are the first step towards ending a conflict and restoring peace. They contain the terms agreed by each side, and can include any number of provisions. The 2015 Minsk agreements in Ukraine \[58\] set out twelve provisions that each side agreed to abide by. These included the withdrawal of heavy weapons from certain areas, prisoner releases and early local elections. While cease fire agreements are important, they do not automatically lead to peace. Forces at ground level may continue to fight, and an element of mistrust may exist between the conflicting parties. Peacekeepers help to maintain a ceasefire by acting as a trusted third party and verifying that each party is abiding by the agreed terms.

If future conflicts involve cyber warfare, it is foreseeable that ceasefire agreements will need to contain cyber related terms. Verifying compliance with these cyber terms will be just as important as with kinetic terms. There has not yet been an example of a ceasefire agreement which contains cyber terms, but it is possible to theorise on some examples:

- The cessation of all cyber attacks.
- Agreement to cooperate on cybercrime/spoiler attacks. E.g. Each nation will pursue and prosecute lone wolf/spoiler cyber attackers inside their borders.
- Declaration of information stolen during the conflict.
- Declaration of systems compromised and assistance with returning control to rightful owners.
- Declaration of known vulnerabilities in opposing party’s networks.
- Dismantlement of botnets.
- Remote disabling of malware (if possible) or assistance in locating and removing malware.

The value of these example agreements towards maintaining peace would be high. They would provide confidence building in the peace process and expedite each state’s ability to bring infrastructure back online and resume provision of essential services for civilians. This has the potential to avoid state collapse or human rights violations. The feasibility of verifying compliance with them is debatable however. Regarding the cessation of all cyber attacks for example, the attribution problem again makes it difficult to conclusively determine that a cyber attack came from a specific party. As concluded when discussing OMR, such terms should be avoided.

Regarding declarations of compromised systems and information stolen, cyber peacekeepers can work with both
sides to determine if such declarations appear to be true. This will involve an element of cyber forensics, in order to determine whether the declarations made align with the available forensic evidence on breached networks. This kind of activity highlights the supervision aspect: both sides may be reluctant to discuss and share information about cyber issues with each other, since this information may be used against them should the conflict restart. By disclosing the information to cyber peacekeepers, the information is kept with a secure and trusted third party for the purposes of restoring peace only. It must be noted however, that by declaring to cyber peacekeepers the attacks used and systems compromised, there is a risk that a party would be giving up an advantage held over their opponent since the cyber peacekeepers may subsequently close vulnerabilities and remove any unauthorised control of systems. In this regard there is a strong incentive to withhold information, in case the conflict reignites. This incentive to cheat is counter balanced against the potential for being revealed as a cheat by cyber peacekeepers. For example, if a nation does not declare that it has control of a nation’s water supply and such control is discovered later, the nation will be revealed as trying to cheat the peacekeeping process. The attribution problem provides additional incentive to cheat, since it may not be possible to provide unequivocal proof that a particular breach was conducted by a cease-fire signatory. In this regard, any ceasefire term which relies upon attribution has low feasibility in practice.

If attribution is an obstacle, terms which do not rely upon attribution are desirable. The dismantling of botnets which are geographically located inside the cease-fire signatories country is an example of this. This would be an activity that shows a commitment to reducing the potential for future cyber attacks originating from their region. It does not require attribution; regardless of who is using the botnet, the action of dismantling it removes it from use by anyone. This would be valuable towards peace and security, since it would reduce the opportunity for use in future conflict.

IX. INTERPOSITION AS A BUFFER ZONE

Interposition as a buffer zone (BZ) is the final activity of a traditional UN peacekeeping operation. The UN defines a buffer zone as “an area established between belligerents and civilians that is protected and monitored by battalion peacekeeping forces and where disputing or belligerent forces and attacks on each other and the civilian population have been excluded” [35]. This definition can be adapted for use in cyber peacekeeping, to define a cyber buffer zone (CBZ):

Definition 3. Cyber Buffer Zone. An area of cyber space that is protected and monitored by peacekeeping forces, where cyber attacks have been excluded.

The previous activity of OMR was a passive one: peacekeepers observe and report violations but do not interfere or become involved (except in the case of clear human rights violations, as highlighted by the Brahimi Report [19]). Interposition as a buffer zone places peacekeepers into a more active role, whereby they not only observe and report but also act to prevent and stop violations. This has the potential to disrupt attacks and keep the site functioning, which in the case of CNI has clear benefits for peace and security in the region.

To assist in proposing ways that a cyber buffer zone (CBZ) could be implemented, it is first necessary to understand the goals of a kinetic buffer zone (BZ). The stated goal of a UN peacekeeping buffer zone is to “maintain a visible presence and dominate the BZ with robust force projection to preserve the sanctity of the buffer zone by preventing any violation of ceasefire/peace agreement clauses” [36]. This goal can be split down into its two parts:

1) To create a visible and dominant presence: The creation of a visible presence acts as a first line of defence through deterrence. If an area is visibly well protected by peacekeeping forces, it acts as a deterrent to attackers since the risk of being observed and intercepted are high.

2) To prevent violations of a ceasefire agreement: When deterrence fails, belligerents may be tempted to commit a violation inside the buffer zone. Peacekeepers inside the zone are tasked with intercepting violators and stopping their actions with force if necessary.

When considering cyber peacekeeping, it must be asked whether a visible presence and the associated effect of deterrence can be replicated. This is important, since the deterrence effect of a BZ forms part of the value that it brings to maintaining peace and security. A significant point to note here, is that the issue of deterrence in cyber warfare is a well researched area [6], and there is ongoing debate regarding its effectiveness. It is beyond the scope of this paper to enter into this debate, but if it is accepted that deterrence is useful in cyber warfare, it is proposed that a CBZ could present a deterrent effect in the following ways:

1) Raising visibility through announcements that a particular site is now under cyber peacekeeping protection.

2) Threat of enhanced trace-back - Using the concept of cyber peacekeeper reservists based at backbone providers, there is an increased likelihood that an attacker will be identified and held accountable.

3) High risk of attack failure - A site protected by a CBZ will be regarded as a hard target for attack, this will have a deterrent effect since the risks outweigh the reward.

While not a visible presence in the traditional sense, these aspects would arguably produce the same effect: to influence the thought process of a potential attacker so that they decide not to launch an attack. An alternative view is that they also hold potential to have the opposite effect. For example, a hacking group may see a UN protected network as an enjoyable challenge. In this regard, a deterrent effect is something that the UN must fight for and win at an early stage. UN cyber peacekeeping must demonstrate that it can use the cyber reservist scheme to successfully trace back attacks and identify spoilers, regardless of their geographical location. Once this effectiveness is proven through high profile successes, a deterrent effect will be established for future operations. If the CBZ fails to do so, the potential for future deterrence is damaged.
With regards to preventing attacks, the cyber peacekeepers would work to secure the network both in the short and long term. The ultimate aim would be to strengthen security and local skills to a level where cyber peacekeepers could withdraw. A possible list of activities here are as follows:

- Dropping packets suspected of being cyber attacks.
- Blocking attacker IP ranges at network devices.
- Installing cyber peacekeeping defences (hardware and software).
- Performing host hardening (patching, removing unnecessary services).
- Providing additional capacity to reduce impact of DoS attacks.
- Providing training for local staff to enable eventual peacekeeper withdrawal.

It is concluded that a cyber buffer zone would bring value to the peacekeeping process, since the end result is the securing of networks that civilian populations rely upon for safety and security. It is also a feasible activity, since it utilises existing cyber security knowledge and tools to provide the buffer. There are obstacles however, since the change from a passive role to an active one increases the potential for local resistance. Care must be taken to avoid the appearance that external forces are coming into the network and taking over, potentially threatening the principle of consent. Additionally, the principle of impartiality is at risk if one party considers that cyber peacekeepers are overly protecting one side and not the other.

X. DISARMAMENT, DEMOBILISATION AND RE-INTEGRATION (DDR)

The UN defines DDR as an activity which “aims to deal with the post-conflict security problem that arises when combatants are left without livelihoods and support networks” [59]. It is a process which identifies ex-combatants and assists them in finding a path to a peaceful and sustainable civilian life. This is an important activity, since those who have known nothing but war for their adult lives may work against peace if they cannot sustain themselves in a peaceful environment. In the following sections, each of the three sub-activities - disarmament, demobilisation and reintegration will be examined to determine their potential feasibility and value in a cyber context.

1) Disarmament: Disarming ex-combatants during peacekeeping serves three purposes. Firstly it is a symbolic act, the giving up of weapons reinforcing the message to the ex-combatant that the conflict is over. Secondly, it serves to physically remove weapons from the region which reduces the likelihood of a relapse into armed conflict. The final purpose is to act as a confidence building measure. When civilians and ex-combatants from both sides witness weapons being surrendered, it provides reassurance that the peace process is real and that it is progressing. When considering the feasibility of disarmament in the cyber domain, three potential approaches can be identified, summarised in figure 5.

| Approach          | Description                                                                 | Analogy          |
|-------------------|-----------------------------------------------------------------------------|------------------|
| Software Disarmament | Taking away software that could be used as a cyber weapon                  | Removing ammunition |
| Hardware Disarmament | Surrendering computing devices which have the potential to launch cyber weapons | Removing weapons |
| Viability Disarmament | Making weapons unviable through closing vulnerabilities                      | Missile defence system |

Firstly, there is no widely accepted definition of a cyber weapon [60], [6]. Secondly, software can have both peaceful and warfare uses [6], which makes choosing which software to confiscate difficult. Thirdly, cyber weapons have characteristics which kinetic weapons do not; ease of replication allows cyber weapons to be acquired, passed on and proliferated at very little cost. If confiscated software can simply be downloaded, it is never truly removed. Software can also be easily hidden through the use of encryption and remote storage (e.g. to cloud service). These problems cause software disarmament to fail at the intended goals: it will not reduce the number of weapons, and subsequently not increase confidence because each party will be aware of its weaknesses. Whether it can act as a symbolic gesture is debatable. A cyber ex-combatant may find some psychological benefit from surrendering hacking tools to peacekeeping forces and is an aspect worth exploring in the future. Despite the problems with software disarmament, there are instances where it could be argued as having merit. For example, if a party developed a cyber weapon using zero-day exploits and kept strict controls over its replication, a software disarmament process could arguably destroy all copies and leave none behind. This argument has weaknesses however, since the vulnerability (and knowledge of it) would still exist, allowing the weapon to be recreated in the future.

The second approach is hardware disarmament, whereby computing devices such as laptops, PCs and tablets are surrendered. Without access to such devices, it is arguable that ex-combatants will not be able to resume launching cyber attacks. A significant problem with hardware disarmament is that the confiscated hardware, like software, is dual use. A laptop used for launching cyber attacks can also be used for social, economic and educational purposes. Taking this hardware away from an ex-combatant may actually harm the peace process by removing devices that are needed to flourish in a peaceful society. A further problem is that in wealthy nations, removing hardware is barely more than a temporary inconvenience. It must be concluded that this approach will not fulfil the goals of disarmament.

A third approach is viability disarmament. Here the focus is shifted away from the attacker and towards the target. By hardening targets and closing vulnerabilities, cyber weapons can be “disarmed” remotely. This is an appealing approach, since it avoids the problem of having to locate every copy of a cyber weapon.
weapon. This method exploits the fast life cycle characteristic of cyber weapons [6]. Considering the disarmament goals, this approach comes out favourably. It would not technically reduce the number of cyber weapons in a region, but it would reduce the effectiveness of those weapons on targets that are essential to peace and security. It would also be a confidence building measure, since both parties would understand that making cyber weapons ineffective is a technical solution that works. Regarding symbolism, viability disarmament requires no voluntary surrendering of weapons and therefore this goal is missed.

In summary, no single approach to cyber disarmament appears to fulfil all of the traditional goals. Viability disarmament provides confidence building and contributes towards reducing the number of effective weapons in the region. But this approach lacks the symbolism of an ex-combatant voluntarily surrendering their weapons. To achieve all of the goals of disarmament, a combined approach is necessary. Viability disarmament alongside an encouragement to voluntarily surrender software and tools is arguably the approach that would fulfil all of the disarmament goals. This would be a feasible approach, and also one that would bring value to the peacekeeping process.

2) **Demobilisation:** Demobilisation is both a physical and mental process of taking a combatant and supporting them in a transition back to civilian life. It is defined by the UN as “the formal and controlled discharge of active combatants from armed forces or other armed groups” [59]. There are two overall goals of demobilisation. The first is the physical goal of separating the combatant from their command and control structure. This is followed by the mental goal of changing their mindset from that of a combatant to that of a civilian. Demobilisation is attractive to ex-combatants due to the assistance they receive. In the short term, this assistance includes food, shelter, training, education and tools. This assistance ensures that a demobilised person can live comfortably in the period before reintegration begins. The value of performing kinetic demobilisation is that combatants are guided through a process which helps to ensure that they have peaceful ways of living and are not reliant on conflict to maintain a livelihood. When considering if this value could be mirrored in cyber peacekeeping, it is necessary to ask if demobilisation would be valuable. Cyber combatants will require demobilisation. This is not a simple question to answer, since there are generally two types of combatants recognised by the DDR process - those from armed forces (national militaries) and those from armed groups (informal factions).

For both category of cyber ex-combatant, it is proposed that demobilisation would be valuable. Cyber combatants will have a skillset which has the potential to damage the peace process. For example, without a demobilisation process they may turn to cyber crime in order to sustain themselves during peacetime. Demobilising them can provide education on legal opportunities that leverage their skills for a peaceful and sustainable purpose (e.g. cyber security roles).

In the case of cyber combatants from armed forces, this is feasible to perform, since the cyber combatants will be referred to the DDR process by their commander. Cyber combatants from armed groups present more of a feasibility challenge. Membership of armed groups may be informal, without any written documentation or proof of membership. This makes identifying members difficult. Additionally, armed groups may simply disband and mix in with civilian communities once hostilities have ended. The benefits that DDR offer are designed to solve this problem by encouraging self identification [59]. To ensure that DDR benefits are not being claimed fraudulently, self identifiers are tested for knowledge such as key battles and familiarity with weapons. Such tests could be adapted for cyber by testing for detailed knowledge of key cyber attacks: which vulnerabilities were used, which systems were breached and so on.

Another feasibility issue with armed groups is that the nature of cyber warfare allows for cyber combatants to be physically located outside the conflict region. This problem is unique to cyber peacekeeping, since kinetic combatants must generally be physically present in a region to conduct attacks. The closest guidance on this issue can be found in the UN DDR Framework Module 5.40 [61]. This module addresses the problem of foreign combatants crossing borders to conduct warfare in other nations. The suggested solution is to intern these combatants and return them to their country of origin without offering any DDR services. If this guidance is maintained into cyber peacekeeping, DDR should not be offered to foreign cyber combatants. Another potential avenue is to simply regard these people as outside spoilers. These have been defined as those not involved in the peace process, e.g. disgruntled groups, citizens and combatants [57]. If they are regarded as spoilers rather than ex combatants, demobilisation is not provided. A counter argument can be made however, in that providing DDR would bring value if it meant that the cyber attacks ceased and future cyber attacks from this person were avoided. Ultimately, the feasibility of tracking down such people and the pressures on funding are likely to result in this value being hard to realise.

In summary, demobilising cyber combatants would bring value to the peace process since it has the potential to guide cyber ex-combatants away from sustaining themselves with cyber crime during peacetime. It is also feasible to perform, since existing procedures can generally be followed with some adaptations. It is envisaged that demobilisation will largely take place in the kinetic domain, and is therefore an example of a cross-domain activity that cyber peacekeepers can provide to support a wider peacekeeping operation.

3) **Reintegration:** Demobilisation is a short term process, leading to reintegration which begins the long term process of helping an ex-combatant reintegrate into civilian life. It is formally defined as “the process by which ex-combatants acquire civilian status and gain sustainable employment and income” [59]. The value of reintegration as an activity is clear. It provides life skills, vocational training, education and on the job training to ex-combatants who have potentially little experience of living outside of conflict and war.

When considering if reintegration would bring value for cyber ex-combatants, a number of points must be considered. Firstly a cyber ex-combatant may already be integrated with society, and hold a job in civilian life that they can return to.
As an example, a cyber security professional may have been conscripted to fight for the government and can now return to their previous employment. In this regard, the reintegration process will either be not required or be very brief. Others may be on the opposite end of the scale and truly lack the knowledge on how their skills could be applied to civilian life. An example here is the teenage cyber combatant who has never held legal employment and would struggle to transfer their skills to peaceful means without some support. Reintegration would be valuable here.

Performing reintegration with cyber ex-combatants is feasible. Programmes can be developed that help ex-combatants capitalise on existing cyber skills and help to guide them into a sustainable livelihood. In particular, there are natural links that exist between the DDR process and the Security Sector Reform (SSR) process. As national police and security sectors are reformed, ex-cyber combatants are in a position to fill roles aimed at bolstering the cyber defence of the nation and to receive on the job training and development. A model such as the Estonian Defence League is a good example of what is possible: civilians with skills in cyber security can volunteer to join the country’s cyber defence unit, putting their skills towards the long term security of the nation and receiving on the job training. In a cyber peacekeeping context, such a unit presents an ideal destination for ex-cyber combatants who wish to reintegrate and find sustainable livelihoods. Private industry also has an incentive to actively take part in such reintegration efforts, since they will directly benefit from the recruitment of cyber skilled staff.

In conclusion, reintegration is expected to be both valuable and feasible. It is also an area where cross domain benefits can be realised: it not only makes a relapse into conflict less likely by reducing the likelihood of future cyber attacks, it also helps to fill a skills shortage in the global market and directs people with cyber skills into high quality positions that employers are struggling to fill.

XI. SECURITY SECTOR REFORM (SSR)

Security Sector Reform (SSR) is an activity which aims to leave a nation with a capable and suitable security sector. The UN gives SSR the following definition: “a process of assessment, review and implementation as well as monitoring and evaluation led by national authorities that has as its goal the enhancement of effective and accountable security for the State and its peoples without discrimination and with full respect for human rights and the rule of law”. UN SSR guidance states that any reform shall not include activities which compromise the sovereignty and territorial integrity of other states, human rights, or activities contributing to internal conflicts in the host nation. The UN therefore provides basic training only, and the programme is carefully designed to not provide any support that would enhance a country’s capability to wage war or violate human rights. The same approach must be taken towards developing a cyber capability. Training should be limited in scope to performing cyber defence, and policy reforms should bolster respect for human rights such as privacy and the right to seek and impart information.

When considering the specifics of cyber security sector reform, the UN could either develop its own model which provides a standardised level of capability, or adapt one of the many existing cyber defence frameworks. This is one area where the UN could seek external partnerships. Public and private organisations commonly contribute the resources, knowledge and skills needed to perform SSR. When considering cyber reform, NATO has expressed an interest in improving cyber security on a global scale and therefore would be a potential partner in reforming cyber security sectors, alongside other organisations. There are also clear links between the DDR and SSR processes. The DDR process aims to find legal, peaceful employment for ex-combatants, while the SSR process requires human resources with certain skills. Demobilised cyber ex-combatants are therefore an important resource for the SSR process. If the DDR process can harness their existing cyber abilities, there is potential to find long term employment in a reformed national cyber defence sector.

XII. ELECTORAL ASSISTANCE

The UN holds a belief that free and fair elections are an essential ingredient towards long term peace and security in a region, allowing citizens to exercise their human right to take part in periodic and genuine elections. Electoral assistance is
traditional kinetic approach requires voters to physically travel to a voting location and cast their ballot. This opens the area to violence and intimidation attempts, as well as the potential for interception of election materials by spoilers[27]. Electronic voting which allows voting via the internet is potentially a solution for this. On the other hand, allowing such remote voting makes providing physical security for voters more difficult than if they were gathered at one central location. The UN is aware that new voting technology has a potential to improve the holding of free and fair elections, but warns that it may lead to distrust in the election process if it is not transparent[27]. With confidence in the process being an essential ingredient, any decision to introduce electronic voting must be made with caution. Should the use of electronic voting become desired in electoral assistance, the value that cyber peacekeepers can bring will increase. In the second case, voter registration is one of the most complex, time consuming and expensive activities of electoral administration[27]. If electronic or internet voter registration is used to lessen this burden, cyber peacekeepers would bring value to the process by protecting the systems that register, transmit and store voter details. There is also potential for cyber peacekeepers to be on standby as technical support on election day, assisting with any technical issues regarding voting machines or the electronic voting process. This would be a feasible and valuable activity for cyber peacekeepers to perform.

In summary, cyber peacekeepers have potential to bring value in three ways. Firstly, they could assist during the run-up to an election. During this period, cyber peacekeepers could monitor and protect the systems of candidates and electronic voter registration systems. Secondly, value can be found by protecting cyber aspects of the election such as voter databases and electronic voting systems. Finally, they can support election day activities by providing technical support where necessary. All of these services would be valuable towards maintaining peace, since they help to ensure that the election remains credible and the outcome legitimate. It must be noted that the amount of value largely depends upon the cyber dependence of the election. If it is fully paper based and candidates use no digital technology, the value that cyber peacekeeping can bring will decline.

XIII. MINE ACTION

Mine action is an activity designed to reduce the threat and impact of mines and explosive remnants of war (ERW), including cluster munitions, on peace and security, humanitarian relief, human rights, and socio-economic development[74]. It has four overall goals. Firstly it aims to reduce risk to civilians through surveying, marking, fencing and clearance of affected areas. Education of civilians in an affected area and the coordination of emergency responses is also a part of reducing risk. Secondly mine action works to support victims of mines by working with a nation to secure access to rights and services. A third goal is to develop a national capacity whereby the nation can continue to perform mine action in the long term without external assistance. The fourth and final goal is to promote the issue of mine action at a national and international level.
The value that mine action brings to the peace process is clearly high. It allows civilians to resume working the land, opens up routes into areas which enables trade and prevents death and injuries. Translating mine action into the cyber domain is challenging, since mines are a problem that exist in the kinetic world. Although mine action cannot be directly translated, there are striking similarities between the kinetic problem of mines and the cyber problem of malware. Just as a field can be littered with mines during conflict, a computer system can be littered with malware. Both mines and malware remain hidden until activated or detected, and the harmful effects continue after a conflict has ended. These effects present threats to peace and security, especially if they are located in critical national infrastructure. It is therefore worth investigating whether “malware action” could be both a feasible and valuable activity.

A. Malware Action

To explore whether malware action could bring value to a peacekeeping operation, figure 6 presents the goals of mine action and suggests equivalent goals of malware action. As the figure shows, a cyber equivalent goal that closely matches can be found in all cases. This suggests that there may be value in performing malware action and that further investigation is justified. Malware action is also a feasible activity, since technical guidance on how to respond to a malware incident is well established in the literature. One such set of guidelines is provided by the National Institute of Standards and Technology (NIST) [75]. Using these guidelines for incident response as a template, it is possible to propose a tentative design of malware action. A seven phase approach towards malware action is proposed as follows:

**Phase one:** A request is made for malware action upon a set of devices or more generally at a particular site of importance. This is an essential first step, and highlights that malware action only takes place with consent and invitation of the network owner.

**Phase two:** Following a request for malware action, a plan will be developed. This will include a number of activities:
- Identification of devices and systems
- Prioritisation of systems
- Assignment of resources
- Identification of partners
- Stakeholder meetings to ensure ownership at all levels and understanding of the process.
- Identification of goals, risks and responsibilities.

**Phase three:** Surveying of target devices begins. Cyber peacekeepers examine systems for signs of malware infection.

**Phase four:** If a device is determined to be infected with malware, it is marked as such in documentation and cyber peacekeepers work to contain the malware to prevent it spreading and causing additional harm. This is equivalent to the fencing activity in mine action.

**Phase five:** Cyber peacekeepers work to remove the detected malware. This is equivalent to the clearance stage of mine action. Technical guidance on malware clearance is given in section 4.4 of NIST SP800-83 [75].

**Phase six:** Monitoring and evaluation. Cleaned devices are monitored over time to confirm that the malware has been fully removed. The clearance process is evaluated for future improvements.

These first six phases match the activities of surveying, marking, fencing and clearance. With regards to malware, a seventh phase is needed which is not included in existing mine action documentation.

**Phase seven:** Recovery of devices and systems to original state and removal of containment measures. This phase is analogous to removing barriers around a road once it is cleared and reopening it for traffic.

It must be noted that these phases will likely not occur in a linear fashion. In a network with many devices, phases may run in parallel or loop back to an earlier phase depending on the level of clearance success. Other goals of malware action such as providing malware education and coordinating emergency malware response teams are also feasible, but will occur in the kinetic domain.

XIV. PROTECTION AND PROMOTION OF HUMAN RIGHTS

Human rights are firmly established at the core of all peacekeeping operations, and are central to all other peacekeeping activities. For example, OMR has human rights abuses as one of its observational goals, mine action seeks to protect the right to life while electoral assistance protects people’s right to periodic and genuine elections. In addition to being placed at the core of peacekeeping activities, the protection and promotion of human rights is also an activity in itself and must therefore be examined for value and feasibility in cyber peacekeeping.

The activity of human rights protection and promotion manifests in two distinct ways. Firstly, human rights issues are highlighted and made explicit in training and planning documentation. Points at which a peacekeeping activity has
the potential to threaten human rights are made clear, and advice is given on how to proceed. This helps to avoid cases where the activities of peacekeepers themselves has the potential to violate human rights. Secondly the UN Office of the High Commissioner for Human Rights (OHCHR) supports all peacekeeping operations, providing expert advice regarding human rights on a day to day basis [76].

A. Protection

To consider the value of protecting human rights through cyber peacekeeping, it must be asked whether human rights have the potential to be violated both by cyber peacekeepers and by others in the cyber domain. This was briefly discussed when making a justification for cyber peacekeeping, where it was argued that human rights can be threatened by cyber attacks. In particular, the right to life and security of person was offered as a justification for the existence of cyber peacekeeping. In this section, a deeper exploration of the human rights issues that surround the concept of cyber peacekeeping is provided.

Research into human rights in cyberspace is extensive [77], [78], [79], [80], with authors highlighting sexual exploitation, freedom of speech, digital divides, censorship and privacy as areas where cyberspace presents human rights threats. The UN Human Rights Council [81] has emphasised the “unique and transformative nature of the Internet not only to enable individuals to exercise their right to freedom of opinion and expression, but also a range of other human rights, and to promote the progress of society as a whole” [81]. Other examples of the UN associating human rights violations and cyber are found in the expression of concern at the right to privacy being regularly violated in cyber space [82] and the passing of a resolution in 2016 condemning any nation which intentionally disrupted the internet access of its citizens [83].

Looking at the evidence, there is no doubt that the UN regards the cyber domain as a place where human rights can be threatened, and that online violations of human rights should be taken as seriously as offline violations.

From the perspective of avoiding breaches by cyber peacekeepers, arguably the biggest threat to avoid is a violation of privacy. Due to the nature of OMR and other activities such as malware action, there is potential that cyber peacekeepers will have access to personal information and communications. Kleffner and Dinnis [21] provide some insight here. They considered how cyber peacekeepers themselves might inadvertently threaten human rights, stating that “interference with cyber infrastructure or data must be carried out in compliance with the requirements of human rights law” [21]. However, they also note that rights such as privacy and freedom of expression are not absolute: international human rights law does allow certain interference where national security and public order issues are present [21]. In this regard, there is a balancing act to be made between allowing cyber peacekeepers to effectively maintain peace whilst also being careful not to breach human rights unnecessarily. This is therefore a risk that will need to be managed, and in line with existing procedures could be achieved via the following:

- Interweaving human rights considerations into cyber peacekeeping policy, training and evaluation. This would provide warnings of where extra caution must be taken and practical measures to minimise breaches.
- Daily support from the OHCHR regarding privacy issues as they arise. The OHCHR will require cyber-legal expertise to provide support to cyber peacekeepers in the field.

These are feasible activities to perform, since they already take place as part of the existing peacekeeping framework. As each cyber peacekeeping activity is developed, human rights must be considered and guidance provided on how to ensure their protection. This would clearly be a valuable activity, and one that should be performed.

B. Promotion

There are also opportunities for cyber peacekeeping to bring value by promoting human rights. At a local level, cyber peacekeepers are in a position to influence states to adopt policies and legislation that respects human rights in cyberspace. Arguably the best path to achieve this is through security sector reform (SSR). During SSR, a respect for privacy and other human rights can be promoted and included into policy and legislation reforms. This is a feasible activity to perform, since cyber peacekeepers are taking a leading role in the reform of national security institutions, a position which provides real opportunities for human rights promotion. It is also prudent to consider the value of promoting cyber related human rights on the international stage as a standalone activity. It is proposed that this activity would be more suited to other organisations and UN departments, and not to cyber peacekeeping. This is because cyber peacekeeping will be deployed in response to a specific situation, and with a specific mandate. Promoting cyber related human rights on a general level is unlikely to be part of this mandate, and more likely to fit better into work of other actors such as the UN Human Rights Council. It must be noted that the promotion of human rights will likely be one area where political obstacles will be encountered: not all nations will share the UN’s perspective on human rights, and will resist attempts to impose democratic values upon their nation.

In summary, cyber peacekeeping must protect against violations of human rights from two sources: external parties and from cyber peacekeeping itself. Protecting from external sources is largely covered in other activities such as OMR, electoral assistance and malware action. It therefore requires no separate action as part of this activity. To protect against violations from cyber peacekeeping itself, it has been proposed that the risk can be managed through an emphasis on human rights issues in cyber peacekeeping training and planning documentation. The Office of the High Commissioner for Human Rights can also provide further support, although this office will require the necessary cyber-legal expertise to do so.

XV. RESTORE AND EXTEND STATE AUTHORITY

Following a conflict, a nation’s control over its territory and borders may be weak or absent. Without the ability to operate
A government and provide basic services to the population, the stability of the nation and security of its population is under threat. The restoration and extension of state authority (RESA) is therefore one of the activities of a multi-dimensional peacekeeping operation. The UN Department of Civil Affairs lists the following tasks as part of RESA [84]:

- **Supporting development of transparency and accountability**: State authority relies on gaining the trust of citizens. Encouraging the government to be transparent and accountable in its actions is essential.
- **Assessment of capacity and support needs**: A review of the current situation and what assistance is required to improve it.
- **Performance Monitoring**: Identifying where weaknesses lie and how they could be improved.
- **Civic Education**: Citizen participation in areas such as voting is crucial, and this task aims to educate citizens on their role in the process.
- **Logistic and Administrative support**: Providing basic logistical and administrative assistance.
- **Small-scale capacity-building support**: E.g. training elected officials in local finance or budgeting.
- **Supporting policy, planning and decision-making processes**: State institutions may be starting from scratch and will require assistance in developing the basic processes undertaken by a state.
- **Support to resource mobilization**: Directing donor resources to areas of most need.

The UN makes it clear that its role in these tasks is always a supporting one, rather than as a substitute for the state. Terms such as enable and facilitate are used, to avoid creating a situation where the UN is seen to be providing services, rather than the state. By encouraging the state to be the provider, trust between citizens and government begins to develop. To explore whether cyber peacekeeping could bring value to the restoration and extension of state authority, it is necessary to ask whether a state’s ability to generate revenue and provide basic services can depend upon cyberspace. A problem here is that there is no definition of “basic service”, since it can vary depending upon the culture and expectations of the population. The UN Department of Civil Affairs [84] provides some guidance, proposing that water, sanitation, health and primary education are basic services common to all nations. Taking this list, it must be argued that the value of cyber peacekeeping towards providing these services is largely dependent upon a nation’s level of cyber dependence. Two scenarios highlight this point.

### A. Scenario A: Low Cyber Dependence

Nation ‘A’ has a low level of cyber dependence. The tax office works on standalone computers with local databases. The water supply is delivered from a central plant which has no external cyber connections. The value that cyber peacekeeping could bring in restoring state authority here is small. Restoring the functioning of the water plant or resuming operation of the tax office will likely be kinetic tasks with no need for cyber capability.

### B. Scenario B: High Cyber Dependence

Nation ‘B’ has a more cyber dependent infrastructure. Government departments are interconnected via an integrated IT system, which allows the sharing of information between departments and online access to government services for citizens. Power is supplied by a smart grid whilst driverless trains and smart traffic systems connect cities. Cyber peacekeeping will clearly bring greater value to the peace process here since restoring the functioning of these cyber dependent systems will be crucial in restoring government services.

In cases where cyber peacekeeping would prove valuable, it is also expected to be feasible. Evidence for this comes from the fact that it is possible to present examples of how existing activities could be applied to the cyber domain. Some examples to demonstrate this are provided in figure 7.

### XVI. Supporting Role Activities

The final two activities of a UN peacekeeping operation are socio-economic recovery and humanitarian assistance. These are marked as supporting roles, since the Department of Peacekeeping Operations aims to support the work of other organisations and UN departments in these areas, rather than become directly involved. For completeness, these final two activities will be examined for any value that they could bring in relation to cyber warfare.

### A. Socio-Economic Recovery

Long term social and economic recovery is important for long lasting peace and ultimately for the future prosperity of...
a nation. The DPKO is open about lacking the expertise and resources for this task, and peacekeeping operations are often not mandated to become involved. Despite this, peacekeeping operations are often able to support the process where necessary through facilitating efforts and acting as a conduit between multiple organisations.

From a cyber peacekeeping perspective, it is prudent to explore if any value can be found from offering cyber capability to economic recovery. It is proposed that there is one clear area where value could be found. Public trust in financial systems is an essential component of any economy, and should that trust be damaged by cyber warfare, there is potential for a threat to peace and security. In such a scenario, it is arguable that cyber peacekeepers could play a role in securing it, thereby increasing public confidence in the nation’s financial system. Despite this potential, the stated approach of this research is to respect existing peacekeeping doctrine. It is therefore arguable that such a task would be better suited to other organisations, rather than cyber peacekeepers, especially when considering the long term nature of economic recovery and the cost of a cyber peacekeeping operation. In line with existing practice, it is therefore concluded that the primary responsibility for socio-economic recovery remains with other organisations and departments, but that cyber peacekeeping can provide technical support where necessary.

B. Humanitarian Assistance

Humanitarian assistance is primarily a kinetic activity, aimed at providing food, shelter and other essential services to people in need. It is difficult to propose a role that cyber peacekeepers could play in this activity, and therefore its value towards bringing peace and security is low. It can be argued that enabling (and reducing the need for) humanitarian efforts via ensuring functioning public services e.g. power, clean water etc. is valuable, but this result is a by-product of other cyber peacekeeping tasks such as a buffer zone, malware action and restoration of state authority. It is therefore concluded that cyber peacekeeping has no direct value towards humanitarian assistance, only an indirect one through the performance of other activities.

XVII. FUTURE WORK

In this paper we have explored the concept of cyber peacekeeping. With peacekeeping being such an expansive topic, potential areas of future work are similarly expansive. We therefore provide some discussion of where future research themes may lie.

A. Conflict Prevention

The UN has indicated a desire to move towards a culture of conflict prevention. The case for making conflict prevention a priority rests upon three primary arguments. Firstly, there is a financial incentive: preventing conflict is regarded as being much cheaper than attempting to manage it once it has erupted. Evidence for this is cited in a study of the seven major peace operations in the 1990s, which concluded that a preventive approach to the conflicts would have saved the international community around $130b. Secondly it has been argued that the UN’s primary function should be to preventing violent conflict from starting, rather than attempting to restore peace in its aftermath. This view was repeatedly supported by secretary general Kofi Annan (1997-2006) who stated that conflict prevention was one of the UN’s primary obligations. The final argument for conflict prevention is a moral one. It has been proposed that the international community has a moral duty to prevent harm to civilians wherever possible, and not simply in the period following warfare.

Preventive peacekeeping deployments of the past have been regarded as successes. The preventive deployment in Macedonia in the 1990s has been credited with being directly responsible for the maintenance of peace in the region. The concept of a preventive cyber deployment is therefore identified as something which could be very valuable in the future. It would also be in line with a key finding of this project: that cyber peacekeeping will have a focus upon preventing cyber attacks, rather than attempting to attribute them. Research into preventive cyber peacekeeping would therefore be valuable in future work. Proposed questions in this area are:

- What would the aim of a preventive cyber deployment be?
- At a simple level the aim is to prevent cyber attacks, but looking deeper the aims and goals are not obvious. For example, is a preventive deployment looking to purely prevent CNI from being compromised or is it looking to prevent a wider conflict and avoid progression into physical violence?
- What kind of events should trigger a preventive deployment?
- An attack on CNI which threatens civilians is arguably too late, so there is potential to look at other events which can indicate that cyber warfare is imminent. Examples may include a sudden increase in denial of service attacks (e.g. Estonia 2007) or an attack on a nation’s economic stability.
- What kind of activities would take place during a preventive cyber deployment?
- Could such a deployment take place without violating UN principles?
- Would nations accept such a deployment?
- What are the legal implications?

B. Peace Enforcement

Peace enforcement occurs when the Security Council authorises a range of coercive measures in order to enforce peace. Authority to conduct peace enforcement is given by chapter VII of the UN charter, which states that the Security Council has the right to determine when a threat to, or breach of, international peace and security has occurred and to take peace enforcement measures in order to maintain it. An early example of UN peace enforcement occurred in 1950, when the Security Council authorised a US-led coalition to enforce peace between North and South Korea.

As with kinetic peace enforcement, cyber peace enforcement would occur when the UN Security Council considered
a situation to be a threat to, or a breach of, international peace and security. This raises an immediate issue, in that it is difficult to determine when this threshold has been reached. Research into cyber warfare [5] has shown that there is still no answer to questions such as what constitutes an armed attack or what the ethical boundaries of cyber warfare are. This problem is not unique to cyber peace enforcement - the five permanent members of the Security Council all hold a veto and unanimous consensus is difficult to achieve even in the kinetic domain. In the cyber domain, these problems are simply amplified to a point where it is difficult to foresee the Security Council agreeing to intervene based upon a cyber conflict.

Assuming that the Security Council did pass a resolution to take cyber peace enforcement measures, there are more obstacles to overcome. In the kinetic domain, overwhelming military force can overcome the problem of a lack of consent, such as it did in Korea. In the cyber domain, this show of force is more challenging. The first challenge is to determine how a peace enforcement group would get into the systems they are trying to bring peace to. Without consent of the owner, the peace enforcement forces would either have to break into the networks of the two parties, or leverage malware that is already inside a nation’s networks. It is arguable that the first method would only add to the conflict by causing more cyber attacks and disruption to peace. The second method is also undesirable. Even if a nation did have malware throughout another nation’s networks, it would be very unlikely for a nation to volunteer that it had this capability and offer to use it for peace enforcement.

An alternative approach would be to compel internet service providers (ISPs) to remove links between certain networks. ISPs control the routing of internet traffic around the globe, and are therefore in a position whereby they could halt a cyber conflict by leaving a particular network with no link to another network. This is not easy however. Routers are designed to cope with failure of a link, and will find new paths should one be removed. ISPs are also private organisations, and will not necessarily wish to comply. However, with enough coordination between the major backbone providers, it is feasible that a cyber conflict originating from a particular network could be halted or at least much reduced in effectiveness without their consent.

A third option is to perform cyber peace enforcement with the consent of one side only. While peacekeeping requires consent of both parties, enforcement could be performed with just the consent of one. By placing cyber experts into the networks of the consenting party, the UN can work to restore peace by setting up a cyber buffer zone as described in section IX.

C. Cyber Peacekeeping Reservists

One of the biggest obstacles towards the feasibility of performing valuable activities was the attribution problem. Research is ongoing in this area, but future work in the area of cyber peacekeeping reservists based at backbone providers would be beneficial to evaluate whether it would bring a solution quicker. The rationale behind the concept is based upon research by Wheeler and Larsen [44], who state that solving the attribution problem requires prepositioned trust between backbone providers, enabling them to work together and trace attacks when required. This was shown to be difficult, with Wheeler and Larsen [44] stating that “to be effective many attribution techniques require some sort of cooperation by networks along the path from the attacker to the victim. Gaining such trust, unfortunately, can be very difficult” [44]. A second identified problem is that of funding, with Wheeler and Larsen [44] noting that attribution technology will have a financial cost. Without a clear business case to invest in attribution, commercial network operators find no reason to purchase it.

It was proposed that the UN is an ideal organisation from which prepositioning of trust and funding of attribution technology could take place. The UN would approach network owners and request for one or two staff members to become cyber peacekeeping reservists. These people would not leave the organisation, but would be able to “activate” when required and cooperate with other reservists at other networks to perform attribution together. The UN would fund the required technology, since it is envisioned that this cost would be insignificant considering the value that reliable attribution of cyber attacks would bring to international peace and security. The following research questions for future work are therefore proposed:

- Would internet backbone organisations be willing to join the initiative? Potential incentives to join are compensation, free training for the reservists, and the technology being supplied for free.
- What would the cost of the scheme be (purchase of technology, maintenance, training etc.) and would the UN be willing to fund it?
- What attribution technology is available for use in the scheme?
- Who should be selected as a reservist and what issues may arise? (Leaving the organisation, unavailability etc.)
- How do reservists come together to coordinate a trace back and what is practically required to do so?
- Are there any existing models which it could build upon? (e.g. Estonian cyber defence unit)
- Is the final result effective? This could involve trials of the scheme.
- Could the scheme address more than just attribution? E.g. The ability to counter increasingly massive distributed denial of service attacks through the quick cooperation of multiple backbone organisations.

Answering these questions would provide a significant contribution towards the concept of cyber peacekeeping reservists, and would help to establish if the scheme was viable. This would have a significant impact on global peace and security, since it would improve the potential for cyber attacks to be properly attributed and potentially provide further benefits such as an internationally coordinated response to distributed denial of service attacks.
XVIII. CONCLUSION

Research into conducting and understanding cyber warfare is extensive and wide ranging [6], yet research into restoring peace after cyber warfare is sorely lacking. In this paper, we have begun to address this gap in research. We have argued that as cyber warfare becomes an increasing part of wider conflict, peacekeeping organisations such as the United Nations will find it necessary to perform cyber peacekeeping.

We offered a definition of cyber peacekeeping followed by an analysis of existing work on the topic. We opted to approach the topic in a manner that respects and builds upon existing UN peacekeeping doctrine. We justified this approach, showing that it would bring a number of benefits. We then examined specific UN peacekeeping activities and discussed the value of performing each one in cyberspace, how it could be done and the challenges it would encounter. We conclude that while cyber peacekeeping is not necessarily needed today, it will be required in the near future as cyber warfare becomes more commonplace. Organisations such as the UN will find it an increasing necessity to operate in cyberspace in order to maintain peace. They should therefore begin discussions today so that they are best prepared for this shift and to ensure that those of us who will rely upon them in the future have the best chance of enjoying the peace and security we deserve.

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