Developing a Trusted Human-AI Network for Humanitarian Benefit

Authors: S. Kate Devitt[1,2], Jason Scholz[1,3], Timo Schless[4], Larry Lewis[5]

[1]Trusted Autonomous Systems, Australia

[2] University of Queensland, Australia

[3] RMIT, Australia

[4] Whiteflag Foundation, Netherlands

[5] Center for Naval Analysis, Arlington, Virginia, USA

Corresponding Author: Dr Kate Devitt is Social and Ethical Robotics Researcher at Defence Science and Technology Group Australia, Chief Scientist of the Trusted Autonomous Systems Cooperative Research Centre in Australia and Adjunct Research Fellow at the University of Queensland. Email: k.devitt@uq.edu.au   https://orcid.org/0000-0002-6075-4969

Co-Authors:

Dr Jason Scholz is an Innovation Professor at the RMIT University and Chief Executive Officer for the Trusted Autonomous Systems Defence Cooperative Research Centre in Australia. Email: jason.scholz@rmit.edu.au   https://orcid.org/0000-0002-3656-046X

Mr Timo Schless MSc is one of the developers of the Whiteflag Protocol, and Advisor and Developer for the Whiteflag Foundation. Email: tschless@acm.org https://orcid.org/0000-0003-2501-6300

Dr Larry Lewis is the Director of the Center for Autonomy and Artificial Intelligence at CNA, a research organization in Arlington, VA. Email: LEWISL@cna.org https://orcid.org/0000-0002-2264-980X

Abstract: Humans and artificial intelligences (AI) will increasingly participate digitally and physically in conflicts yet there is a lack of trusted communications across agents and platforms. For example, humans in disasters and conflict already use messaging and social media to share information, however, international humanitarian relief organisations treat this information as unverifiable and untrustworthy. AI may reduce the 'fog-of-war' and improve outcomes, however current AI implementations are often brittle, have a narrow scope of application and wide ethical risks. Meanwhile, human error causes significant civilian harms even by combatants committed to complying with international humanitarian law. AI offers an opportunity to help reduce the tragedy of war and better deliver humanitarian aid to those who need it. However, to be successful, these systems must be trusted by humans and their information systems, overcoming flawed information flows in conflict and disaster zones that continue to be marked by intermittent communications, poor situation awareness, mistrust and human errors. In this paper, we consider the integration of a communications protocol (the 'Whiteflag protocol'), distributed ledger technology, and information fusion with artificial intelligence (AI), to improve conflict communications called "Protected Assurance Understanding Situation & Entities" PAUSE. Such a trusted human-AI communication network could provide accountable information exchange regarding protected entities, critical infrastructure; humanitarian signals and status updates for humans and machines in conflicts. Trust-based information fusion provides resource-efficient use of diverse data sources to increase the reliability of reports. AI can be used to catch human mistakes and complement human decision making, while human judgment can direct and override AI recommendations. We examine several case studies for the integration of these technologies into a trusted human-AI network for humanitarian benefit including mapping a conflict zone with civilians and combatants in real time, preparation to avoid incidents and using the network to manage misinformation.

Keywords: network, information fusion, conflict, blockchain, artificial intelligence, trust, communication

Highlights

- Managing the fog of war requires a trusted human-AI network for humanitarian benefit
- Human error causes significant civilian harms even by combatants committed to complying with international humanitarian law
- Humans in disasters and conflict use messaging and social media to share information, but international humanitarian relief organisations treat this information as unverifiable and untrustworthy
- Trust in humans and machines is composed of multiple factors but can be improved through information fusion that incorporates diverse information sources, a communications protocol and use of distributed ledger technologies such as Blockchain
- Protective AI used within a trusted network, can identify protected objects and persons and assist human decision-making in conflicts to reduce civilian harms.

1 Introduction

Artificial Intelligence (AI) is widely seen by States as imperative to national security. As a result, AI-enabled systems will increasingly make their way onto the battlefield, both by militaries and by humanitarian groups working to provide assistance to civilians. While stated rationales for the use of AI tends to focus on improved military effectiveness and cost saving measures, AI also brings an opportunity to help reduce the tragedy of war and better deliver humanitarian aid to those who need it. However, to be successful, these systems must be trusted by humans and their information systems, overcoming flawed information flows in conflict and disaster zones that continue to be marked by intermittent communications, poor situation awareness, mistrust and human errors.

This paper discusses practical steps to reduce the human costs of conflict and better protect providers of humanitarian assistance. We argue that this is achieved through the creation of a conflict communication standard for non-military and militaries within conflicts and indisputable record of communication transactions during conflicts. Shared information must be evaluated, justified and utilised to the satisfaction of individual parties in the conflict. A distributed ledger model of communication enables human-human, human-machine agent systems and machine agent-machine agent systems to build reputation and relay trusted

information within a multi-tiered network of checks and balances. The result is a safety net: technology does not take away from human decisions, but offers additional information that can help avert human mistakes that invariably happen.

This paper is the first step; conceptualising and laying the groundwork of a human-AI network for humanitarian benefit. Next steps include value-sensitive design with stakeholders to civil-military communication in a conflict, implementation trials, and building TRL capability of the network in line with responsible innovation (van den Hoven, 2013).

2 The Trust Challenge

2.1 The Fog of War

In Bomber Command at the start of WWII, British airmen experienced the fog of war[1], including the cloud cover that hid the world from their understanding (Clausewitz, Howard, & Paret, 1976, Book ii, Ch.2.). Instead of modern global positioning, navigators relied on establishing pinpoints from the ground described as "groping" (Ch.3, Hastings, 1979). Wireless operators could pick up a loop bearing (Mason, 1992) from England, but a misjudged signal could turn the aircraft on a 180-degree reciprocal course and the Germans often jammed the wavelengths. Weather reports were inaccurate, blowing aircraft off course and speed. Visual confirmation of targets required flying so low that there was a high risk to crews from flak or enemy fighters. Lacking radar, communications between planes in formation was by Aldis lamps[2] that required visual line of sight (Duffie Jr, 2017). Thus, even though explicit instructions from Command in 1940 were not to drop bombs indiscriminately, random results were the outcome[3].

---

[1] The term "fog of war" refers to the state of ignorance in conflict due to ambiguity. Carl von Clausewitz is credited with the first examination of the concept, though he did not use that precise phrase—attributed to Lonsdale Hale (e.g., Hale, 1897).

[2] An Aldis lamp is a signal lamp that allows light to deliver messages via morse code.

[3] The locations of bombs was in fact, so random, that Germany was genuinely unaware that Bomber Command was intending to attack a specific target or region. Still, missions were still flown, as it was deemed important that Britain was doing "something" (Hastings, 1979)

War creates unique conditions for uncertainty via intentional and inadvertent causes. Much of the error of war could be reduced if decision makers knew more had access to improved accuracy and analysis of information (Lewis, 2019b)[4]. Increasing the precision of weapons also increases the expectations of the civilian population that weapons will better avoid civilian causalities (Beier, 2003; Brown, 2007; Enemark, 2013; Walsh, 2015) Modern intelligence, surveillance and reconnaissance (ISR) technologies combined with precision effects have greatly increased the quality of justifications expected of decision-makers for their actions. For example, the information that guides a strike team into a compound after days or weeks of an ISR soak of the area can often justify (though not always) their actions in accordance with Commander's intent[5]. But protecting non-combatants and identifying combatants remains difficult in conventional warfare in high tempo environments where combatants operate in the same area with civilians (Lawfare, 2020).

2.2 Decision-making

The ambition of humanitarian organisations in conflict is to increase adherence to International Humanitarian Law (IHL) and the Laws of Armed Conflict (LOAC). There are three action components required to achieve this: Awareness, Intent (underpinned by "will") and Capability (Lambert & Scholz, 2005). If decision-makers inside conflict zones, have awareness regarding what and where protected objects are, have the intent to abide by IHL and have the capability to follow-through, then better humanitarian outcomes are predicted. This paper focuses primarily on the challenge of awareness, acknowledging that awareness absent humanitarian intent or capability is ineffective and leads to a lack of trust.

Awareness can be broken down into multiple concepts, include knowledge and understanding, but also awareness of degrees of ignorance. Knowledge has traditionally been defined as "justified true belief" and represents the highest epistemic goal (Moser, 2005; Sosa, 2011). Understanding may include causal mechanisms, reasons, explanations and the meaning of what is observed (Miller, 2019). However, given the uncertainties of conflict, a

---

[4] More data by itself won't necessarily solve the problem if the structure or method of analysis cannot give you the insight you need (private communication with Dr. Beth Cardier).

[5] Noting that knowledge of one's target does not ensure abidance with requirements of *jus in bello* and *jus ad bellum* obligations.

sound goal to maintain trust might not be knowledge, but something short of knowledge, such as rationally-justified belief, or evidence-based decision-making. The awareness demanded by alternate epistemic frameworks such as Bayesian epistemology (Bovens & Hartmann, 2004) and evidentialism (Conee & Feldman, 2004) is that an agent is justified in making a decision if they act responsibly and proportionately given the (often uncertain and incomplete) evidence. Bayesian epistemology also provides a normative framework to guide evidence selection, valuing both the independence and diversity of information sources.

Traditionally military information and communications technologies (ICT) have depended upon fairly narrow sets of vetted information regarded with high degrees of confidence. Future military and non-military ICT will likely draw on an internet of things including drone sensor feeds, high altitude platforms, satellites, social media, text messages and so forth plus social media messages and AI classification and recommendations to inform awareness and actions. If actors within a conflict broaden the data sources they draw on, it both increases their uncertainty and increases the potential of their awareness. In order to trust diverse information sources, their evidential value must be appraised and integrated appropriately within a larger operational picture.

Awareness of one's own uncertainty is a virtue associated with intellectual humility. We argue that decision-makers who acknowledge gaps in their knowledge and understanding are less likely to make foolhardy mistakes. So, whilst decision-makers might strive for knowledge, they are justified in the fog of war to make decisions when a certain threshold for evidence is met and the perceived risk of inaction is greater than the risk of action. The higher the humanitarian risk, the greater the evidential expectations in accordance with just war principles of discrimination and proportionality (Coates, 2016). As ISR technologies have improved, so has the expectation for militaries to hold fire under uncertainty (Ekelhof, 2018).

Perhaps surprisingly, militaries that embraced Internet technologies for decision-making through network-centric warfare (Cebrowski & Garstka, 1998; Eisenberg, Alderson, Kitsak, Ganin, & Linkov, 2018) have not necessarily invested in smarter methods to improve humanitarian protections. Despite the recent rise of digital, artificial intelligence (AI) and autonomous technologies, precision targeting and layered legal review processes, systemic situational incomprehension continues to result in unintentional harms and loss of life—and civilians bear the brunt of harm in conflict.

2.3 Human Error

The majority of casualties in conflict are civilians, with this harm compounded by reverberating effects of attacks (Nohle & Robinson, 2017; Roberts, 2010). Some of this harm is due to combatants that disregard requirements of international humanitarian law (IHL). For example, recent evidence uncovered by the New York Times reveal the intentionality of attacks by Russia and Syria on protected medical facilities (Triebert, Hill, Browne, Hurst, & Khavin, 2019). But significant harm to civilians can still occur with combatants committed to complying with IHL, such as contributors to the Counter-ISIS Coalition regarding operations in Iraq and Syria, or international forces operating in Afghanistan (Lewis, 2018). While those militaries conducted legal and policy reviews for every single strike, significant numbers of civilians were still harmed. Analysis of over 1000 incidents of civilian casualties revealed how this occurs in practice: while some cases were due to deliberate decisions that the military utility outweighed the cost to civilians, the vast majority of cases were due to human error. In these cases of human errors, either decision-makers missed indicators that civilians were present, or civilians were mistaken as combatants and attacked in that belief. Misidentifications were often a result of humans making judgments that a threat existed, either mis-associating intelligence with a specific location/individual or incorrectly ascribing hostile intent to observed behaviour. Such attacks often included a loss of situational awareness that could have helped inform a better engagement decision.

These human errors are also seen in attacks on medical facilities, as observed both in the US attack on a Médecins Sans Frontières (MSF) hospital in Afghanistan in 2015 and in multiple attacks on hospitals in Yemen by the Saudi-led coalition. Despite both reporting their location to military forces and displaying a red crescent sign, these hospitals were still attacked by military forces in the mistaken belief that they were military targets. Analysis of these inadvertent attacks reveals patterns of human errors both in deconfliction (since these structures were on the No Strike List) and in identification (since attacks failed to identify either the nature of medical facilities or the red crescent symbol marking the structure) of medical facilities (Lewis, 2019b).

Real world operations show that the deconfliction process is particularly challenging in cases of self-defence and dynamic targeting. For example, in Yemen, the majority of attacks on hospitals occurred due to dynamic targeting. Likewise, the US strike on an MSF hospital in 2015 was a dynamic targeting operation in defence of forces on the ground. Traditional

planning and intelligence preparation of the battlefield, including consultation of the No Strike List, may not be optimised for short-notice operations in dynamic environments.

Likewise, the identification of medical facilities and other protected entities can be challenging in practice. Such structures may not be within established hospitals, instead being located in other facilities or even in tents. The practical identification measure of a red cross or crescent, originally from the Geneva Conventions of 1949, is not always sufficient for identification to stop attacks. Not only can the time of day or night and the presence of obscurants (e.g. dusty or cloudy conditions) affect observation of these symbols, but the type of sensor can also play a role. For example, a coloured marking will not necessarily be a discriminating feature for a pilot conducting an air strike using an infrared sensor, a type of sensor used by many modern militaries.

In summary, while the law is clear regarding the protected status of civilians and of medical facilities in armed conflict, humans make mistakes, and the limited tools and procedures available on today's battlefield for protection leave much room for such mistakes, with tragic results. The number of tragic attacks on medical facilities over the past few years point out the benefit of developing additional practical measures that can reduce the chances of such mistakes.

2.4 A Human-AI network

A tool that might be able to assist IHL abidance is the autonomous and rapid identification and classification of protected objects and civilians using AI and machine learning. However, unpredictability, challange of explainability and bias of AI algorithms might also increase risk to civilians (International Committee of the Red Cross, 2019). Additionally, the usefulness of AI may be undermined by both deliberate tricking or "spoofing" and the challenges of keeping algorithms up-to-date in a changing environment (Brundage et al., 2018). Further challenges include the facts that telecommunications within conflicts remains volatile and intermittent; and that it is in militaries' interests to exploit the fog of war for strategic advantage by obfuscating operations and intentions while striving to better understand their operational environment.

Given then, that humans and AI systems have both strengths and weaknesses, we advocate that human strengths be applied to offset AI weaknesses, and AI strengths be applied to offset

human fallibilities. Such a human-AI network would also automatically record available information for potential legal review.

3 Trusted Networks

3.1 Diverse Information

The rise of digital technologies in all aspects of life has changed information availability in conflicts and disasters, driving a new requirement to share among disparate groups and in new applications. Those experiencing disasters and seeking information about the disasters use messaging and social media, yet international humanitarian relief organisations treat bystander information as unverifiable and untrustworthy and these data sources do not impact organisational decision-making (Tapia, Bajpai, Jansen, Yen, & Giles, 2011).

This situation appears to be unchanged today (Hiltz et al., 2020) with agencies "reluctant to use social media, especially to gather unverified crowdsourced data". Compounding this, military signaling has traditionally been secretive and bespoke to meet the needs of each Nation and to keep operations unknown to opposing forces. Likewise, historically humanitarian organisations have avoided sharing communication technologies with militaries to ensure their neutrality and hence immunity from harm. Yet, smart phones and social media are readily used for many purposes by: State and non-State actors to incite and engage in warfare (Singer & Brooking, 2018); by humanitarian groups to communicate regarding humanitarian needs and provision of aid; and by local populations to inform the world of the impacts of military actions. There is an opportunity for these groups to exchange these new sources of information to better meet humanitarian goals, but such exchanges must satisfy several conditions including how to manage diverse information sources and accountability for messages sent.

3.2 Information Fusion

Trust is a multi-faceted relationship that may be asymmetric between human-humans, humans-AI and AI-AI involving dimensions such as competence (including reliability, skills and experience) and integrity (including honesty, motivation and character) (Devitt, 2018). Trust can be measured as a factor of disposition, situation and learning (Hoff & Bashir, 2015). In some situations, a source may be trusted and in others not. Sources are also

distributed, so information must be fused to improve trust. A predominantly autonomous fusion scheme is needed that makes best use of an information network characterised by:

- duplication (a diversity issue);

- reporting errors and error propagation (a competency issue);

- intentional errors (an integrity issue); and

- cost in terms of access to sources and risk to validate (efficiency and risk issues).

A scheme that observes all of these characteristics is hard to find in practice (Azzedin & Ghaleb, 2019). Most rely on high-trust protected sources (to avoid deception), or large-scale diversity to provide statistical evidence. Fewer still attempt to use as few sources as possible to maximise trust. A system that comprehensively attempts to tackle all of these issues called TIDY (Etuk, Norman, Şensoy, Bisdikian, & Srivatsa, 2013) is illustrated in Figure 1.
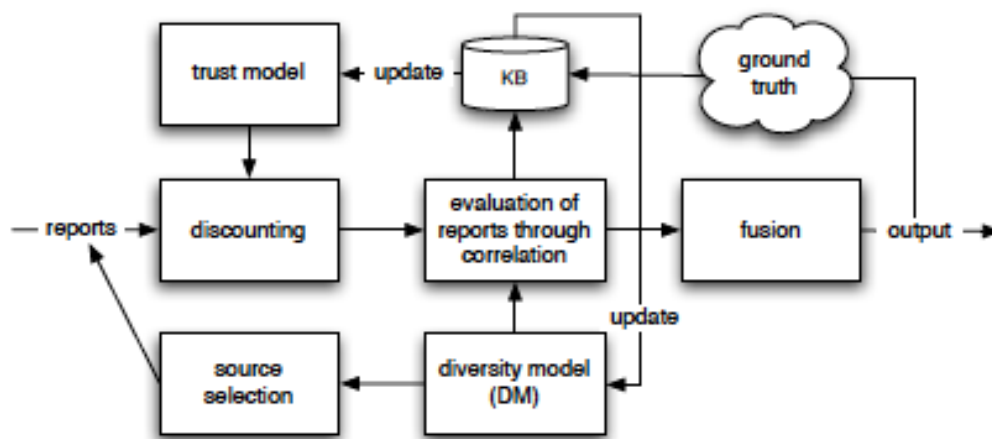

Figure 1. The framework for Trusted-based Information fusion through Diversity (TIDY).

In TIDY the trust model is based on subjective logic and enables discounting of reports to reflect the assessed reliability of the source of each report (noting all past reports are also used in this computation). The diversity model uses similarity metrics to structure the source population, so that similar sources are grouped together. Information sources with similar features are assumed likely to provide similar reports in a situation. Example features may include: organisational affiliation, known alliances, nationality, location for this report, time of this report, expertise, etc coded as numeric values. The source-selection module, uses knowledge of source diversity to sample the population of sources for evidence according to the assigned budget. Correlations of reports exploit knowledge provided in the diversity model. The knowledge base stores feedback on the fusion estimate with reference to later

observed ground truth. The knowledge base also holds behavioural evidence for sources in different groups with regard to report similarity. Based on the evidence gathered, both the trust and diversity models are updated to reflect new knowledge. In the case of the diversity model, a learning process may be initiated to maintain model consistency.

The fusion approach minimises the adverse effect of large groups of unreliable sources that might collude to undermine the trustworthiness of the fusion output. Civilian-military information exchange needs to incorporate diverse information sources and fused. But this is not enough to create a trusted communications network. In addition, information must be neutral, secure and provide undeniable proof of receipt. Neutral means the network is not owned or controlled by any of its users, and its use will not compromise the impartiality of their missions. Secure means the information exchanged between military and civilian parties is authenticated, confidential and has a level of integrity commensurate with the authority from which it was sourced. For example, the integrity of information from trusted sources may be high, and from an unknown casual observer low. Proof of receipt ensures ongoing support for the course of justice, ensuring information receipt cannot be repudiated as a valid record.

3.3 Distributed Ledger Technology

A distributed ledger via Blockchain technology provides a mechanism for recording transactions between parties efficiently and verifiably, without the use of a centralised register (Crosby, Nachiappan, Pattanayak, Verma, & Kalyanaraman, 2016). Although theoretically not completely immune to being altered, it is practically extremely difficult with diverse and independent sources to compromise as any retrospective alteration would need to be made consistent with alteration in all down-stream blocks, and so requires a high degree of consensus[6]. Blockchain technology is provides automated, highly secure records for tracking data, transactions, contracts and even algorithm provenance across the public and private sectors allowing collaboration and integration across organisations without the need for a trusted third party, a network operator or a system owner (Efanov & Roschin, 2018; Peck, 2017). Thus blockchain is 'trust-enhancing', providing some additional trustworthiness to information exchange through reliability, but note it does not resolve other features relevant

---

[6] (Efanov & Roschin, 2018; Peck, 2017).

to concepts of trust such as goodwill, encapsulated interest or integrity (Devitt, 2018; Jacobs, 2020).

Blockchain lends itself to public and open networks – even if intermittent[7]. Shared information, consensus, independent validation and information security are characteristics that make blockchain of particular interest to the humanitarian sector, in order to address all sorts of practical problems related to transparency, efficiency, scale and sustainability (Coppi & Fast, 2019). Messages on a blockchain cannot disappear or be manipulated, and the origin of the information cannot be disputed. Additionally, opposing forces and neutral organisations can quickly and directly communicate to one or more other parties involved in the conflict.

3.4 Communications Protocol

Organisations and individuals protected under humanitarian law in conflict and disaster zones need to identify themselves in order to prevent or minimise collateral damage. A communications protocol using blockchain might contribute to a trusted civilian-military communication network, allowing combatant and neutral parties in armed conflicts to digitally communicate (see Box 1. The Whiteflag Protocol). We argue that such a protocol in combination with an information fusion scheme could be used to assess the trustworthiness of information by instant verification of the originator, authentication of reliable sources, cross-checking facts with persistent information on the blockchain to evaluate reliability of sources, confirmation by multiple sources, duress functionality, and implementation-specific measures such as filtering, blacklisting, other sources[8].

Box 1: The Whiteflag Protocol

The Whiteflag protocol is a free and open standard for a digital communications protocol based on blockchain technology (Kolenbrander & Schless, 2019; "The Whiteflag Protocol," 2020). See Appendix A for the current, extensible, Whiteflag message set including protective signs,

---

[7] If telecommunications are intermittent, the distributed ledgers each record what information was available, where and when, to justify information available for decision retrospectively at the time, and then re-synchronises the ledger automatically when telecommunications are re-established.

[8] Integration with other information resources, such as Truepic, a photo and video verification platform fighting disinformation (see https://truepic.com) has been demonstrated.

emergency signals and status signals etc... Whiteflag can be implemented for new and existing systems, (e.g. geographical information systems, command & control systems, mobile devices, beacons, transponders in cars, autonomic systems, etc.) and a variety of blockchain networks (e.g. Bitcoin and Ethereum).

Whiteflag messages may be disclosed only to trusted parties, and be hidden to others, by using encryption; they can be made available to entities with limited visibility, e.g. beyond visible range, to smart weapons, etc.; their source can be verified to establish their authenticity; they cannot be manipulated by others, and their existence is recorded permanently with undeniable proof to create transparency and help the course of justice. For example, in an extremely hostile environment, humanitarian organisations may use Whiteflag encryption to prevent information becoming available to potential hostile parties.

Whiteflag makes use of the Advanced Encryption Standard (AES) that can be set-up in multiple ways. One way is to use automatically negotiated keys for secure one-on-one communication, eliminating the need for any prior coordination. In addition, more advanced implementations are possible, where multiple sets of encryption keys are shared between participants to create different trusted subgroups. Since Whiteflag does not reveal any information on the intended recipient of the information, and the originator may choose an authentication method that only reveals its identity to trusted parties, not only the information content itself is secured, but information about the communicating parties can also be concealed.

Whiteflag has been verified and validated at Technology Readiness Level (TRL) 5 out of 9 (Jamier, Irvine, & Aucher, 2018), which means that Whiteflag technically works and the overall functionality is considered useful (Capgemini, 2018), but further operational test & evaluation activities are required to work out specific use cases, to identify and mitigate risks, and to integrate it effectively, safely and securely in new and existing systems. The Whiteflag software used for testing is open sourced and available on GitHub (Timo [ts5746]) and all test data is on the Ethereum Rinkeby Test Network (between blocks 3350000 and 6350000).

3.5 Protective AI

So far in the paper we have discussed the needs of decision-makers in a conflict to incorporate diverse information sources on a trusted network. It is at this juncture that we

would now like to consider how AI might contribute to building a more trusted network for humanitarian benefit. A recent study of software requirements related to social media for humanitarian and emergency management applications suggested AI in half their features for priority development (see Table 5. Hiltz et al., 2020). For example, AI has been recommended for dynamically extracting information and identifying damage and severity of harms in social media images including injured, trapped or displaced people. Understandably, there are moral concerns for the potential range of uses of AI in critical roles in conflicts. While AI is likely to be incapable of a level of reasoned action sufficient to attribute moral responsibility in the near term, we argue it might today autonomously execute human value-laden decisions embedded in its design and in code. By doing so AI can perform actions to meet enhanced ethical and legal standards (Scholz & Galliott, 2018). We consider two conceptual possibilities with regards to embedded ethics within machines: MaxAI and MinAI

A maximally-just ethical machine or "MaxAI" guided by both acceptable and non-acceptable actions has the benefit of ensuring that ethically obligatory lethal action is taken, regardless of engineering foresight. That is, MaxAI is a machine that could potentially make "life and death" decisions. However, a maximally-just ethical AI requires extensive ethical engineering and may not meet the human-based judgements required under IHL. Additionally reasoning about the full scope of what is ethically permissible, including notions of proportionality and rules of engagement is a hard problem. Arguably, such an advance for machines to comprehend the human condition seems remote.

A minimally-just ethical machine or "MinAI" at the other end of the spectrum, could deal only with what is ethically impermissible. That is, MinAI could make "life" decisions. In conflict zones, these constraints are based around the need to identify and avoid "protected" objects and behaviours including lawfully-protected symbols, protected locations, basic signs of surrender (including beacons), and potentially those that are *hors de combat*. These AI problems range from easy to difficult, but not impossible, and technologies will likely continue to improve. A simple example is the ability for standard machine learning algorithms to identify symbols of protection, such as a Red Cross, in order to avert attacks.

Figure 2 illustrates application of the "Faster RCNN" algorithm[9], to a mobile military hospital facility, with markings clearly and automatically identified on tents and on trucks.
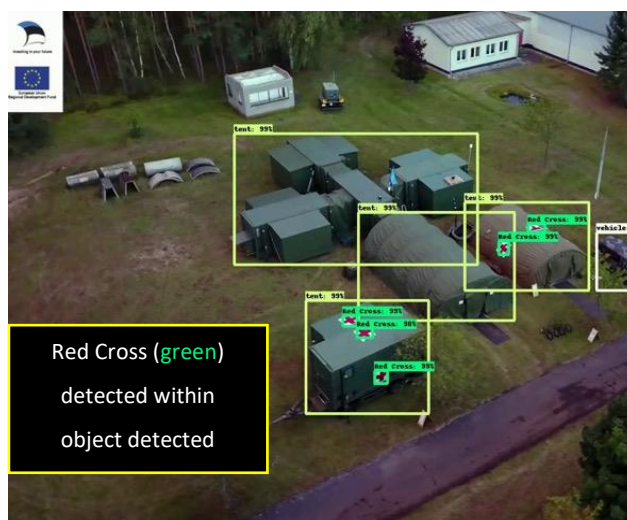

Figure 2. Example of open-source AI for detecting and classifying objects in a video stream including tents and vehicles, and within those object detections, the presence of protected symbols of the Red Cross.

This technology, if implemented, could potentially have saved the lives of medical workers and averted damage to medical facilities in recent Yemen security operations (Lewis, 2019a).

---

[9] Shaoqing Ren, Kaiming He, Ross Girshick, and Jian Sun, "Faster R-CNN: Towards Real-Time Object Detection with Region Proposal Networks", Cornell University ArXiv.org, 6 Jan 2016, available at https://arxiv.org/abs/1506.01497

Figure 3 illustrates examples from our own trials examining the potential for AI identification of surrender[10].

Figure 3. Highly-magnified examples of classifier detecting and classification as part of a video stream: (i) a person without uniform with a white flag, (ii) non-uniformed person with hands behind their head, and (iii) two persons each with hands in the air, which are separated from an AK47 gun.

Noting that Faster RCNN combines detection, signified by a coloured box, with classification, signified by a label. When multiple detections and classifications are made, it is possible to perform rudimentary automated reasoning. For example, in Figure 2, the yellow boxes indicate a tent, and within some of these boxes, there are other boxes indicating a symbol of the Red Cross, which implies the "Red Cross is on the tent". Protective AI also holds promise to track actions and change of state of significance, i.e. consider from the elements in Figure 3, the potential to detect surrender behaviour as a transition from a state where a person is holding a gun, then discards it, and puts their "hands in the air" separated from the "gun" on the ground.

Design of systems to achieve Protective AI based on a starting point of MinAI, must consider its own weaknesses and errors (see Appendix B. possible decision states for MinAI-enabled weapon systems). The humanitarian value added by Protective AI is when the machine correctly perceives protected objects and the human does not. From the humanitarian perspective this is essentially the addition of a safety net: it doesn't detract from anything that a human would do, and if a human makes a mistake, this is a chance for a machine-enabled capability to catch and correct that mistake. From the military perspective this is balanced

---

[10] Work undertaken by Cyborg Dynamics Engineering and Skyborne Technologies as part of a project for the Trusted Autonomous Systems Defence Cooperative Research Centre, see https://tasdcrc.com.au/

against when the Protective AI incorrectly perceives an object as protected when it is legally afforded no protection, and a strike is inappropriately called off. The latter may occur as a matter of natural error and should be infrequent, however, if deliberately-caused through adversarial action this should be a matter for the creation of new legal restrictions related to perfidy.

Any Protective AI needs an appropriate legal and policy framework to inform development and use. Some policies specific to AI and data protection might include:

- Data used for machine learning object recognition, including object labelling shall be protected from tampering;
- It shall not be permitted to train neural networks starting with weights derived from unverified data sources (due to the potential to have embedded adversarial examples);
- Any delivered machine-learning system shall include not only the algorithm, but all data used in training (to ensure the executable code can be reconstructed);
- Any delivered machine-learning system shall be reproducible and repeatable entirely from its algorithm and all its training data. Etc.

4 A Trusted Human-AI Network

Taking now the elements of human decision-makers, a communications network and AI, we propose a trusted human-AI network that adopts a civil-military communications protocol with diverse information fusion on a distributed ledger as illustrated in Figure 4. We call this network: Protected Assurance Understanding Situation and Entities (PAUSE). The PAUSE architecture mirrors trust relationships between military and civil authorities to increase efficiency and timeliness of information processing and exchange. PAUSE also makes use of AI and automation to extract, clarify, identify, categorize, locate, assess and most importantly fuse information from eye-witness sources (with variable trustworthiness) to improve the accuracy and accountability of decision-makers.
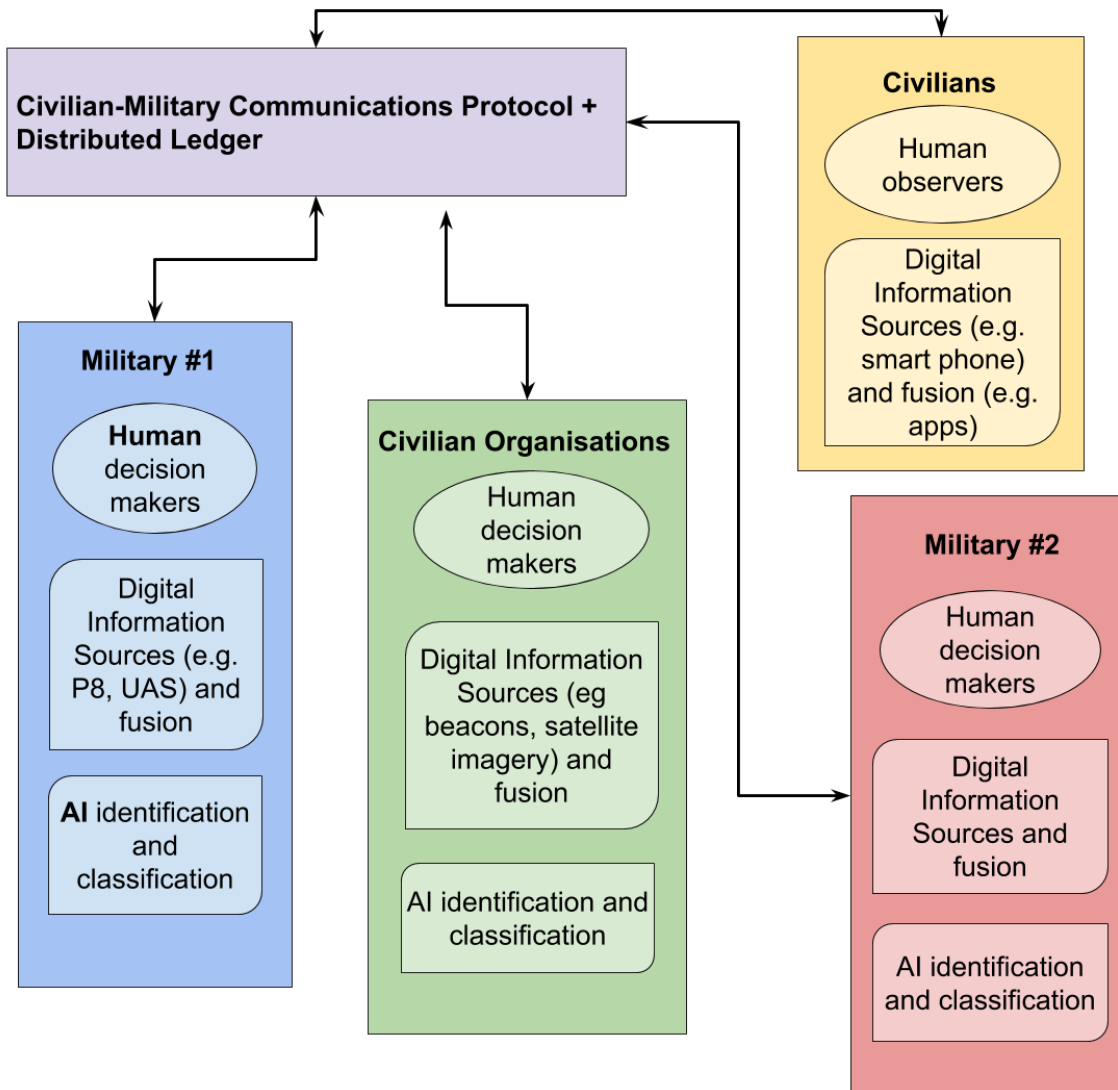
Figure 4. The PAUSE network relies on military and civilian organisations to bear responsibility for communication to the ledger including any human, digital and AI based information generated or used by these organisations. Civilians can broadcast including signs of surrender, proof of life and so forth. Civilian and military organisations could form their own judgments with regards to how to represent and respond to communications. In particular, civilian safety considerations must be managed if their messages put themselves at risk of harm by parties to a conflict. It might be agreed that an anonymity layer is required for civilian reports such as differential privacy (Dwork & Roth, 2014).

The PAUSE network recognizes that the locus of moral responsibility for any decision rests with humans, individually or within an organisation. Digital or AI assets support human decision-making. Humans must design AI and autonomous features within the context of human values using a human-centred approach (van den Hoven, 2013).

An AI classifier used by the military belongs to a State and the State must take end-to-end responsibility for their AI, noting that Protective AI and digital resources might be open-sourced. Many organisations, governments and militaries are actively progressing ethical frameworks to assist decision-makers in creating procedures and protocols for the development, testing, deployment, evaluation and adaptation of AI (International Committee of the Red Cross, 2019; Lopez, 2020). However, how to operationalize these frameworks within technologies is less advanced. In the first instance organisations must understand an AI's training data, inputs, functions, outputs, and boundaries (Robbins, 2019). Then organisations must situate the AI within a network of information where its limits and affordances are appropriately harnessed and restrained.

Protective AI and a civil-military communications protocol need to be "surfaced" in software applications in order for each organisation to use in accordance with their objectives and values. Technologies may be integrated within existing military and civilian software systems, or through new applications. For example, militaries seeking to abide by IHL are likely to want to layer data emerging from compliant communications with command and control data including military objectives and (ISR) data (Paul, Clarke, Triezenberg, Manheim, & Wilson, 2018). To better understand applications, we examine several case studies.

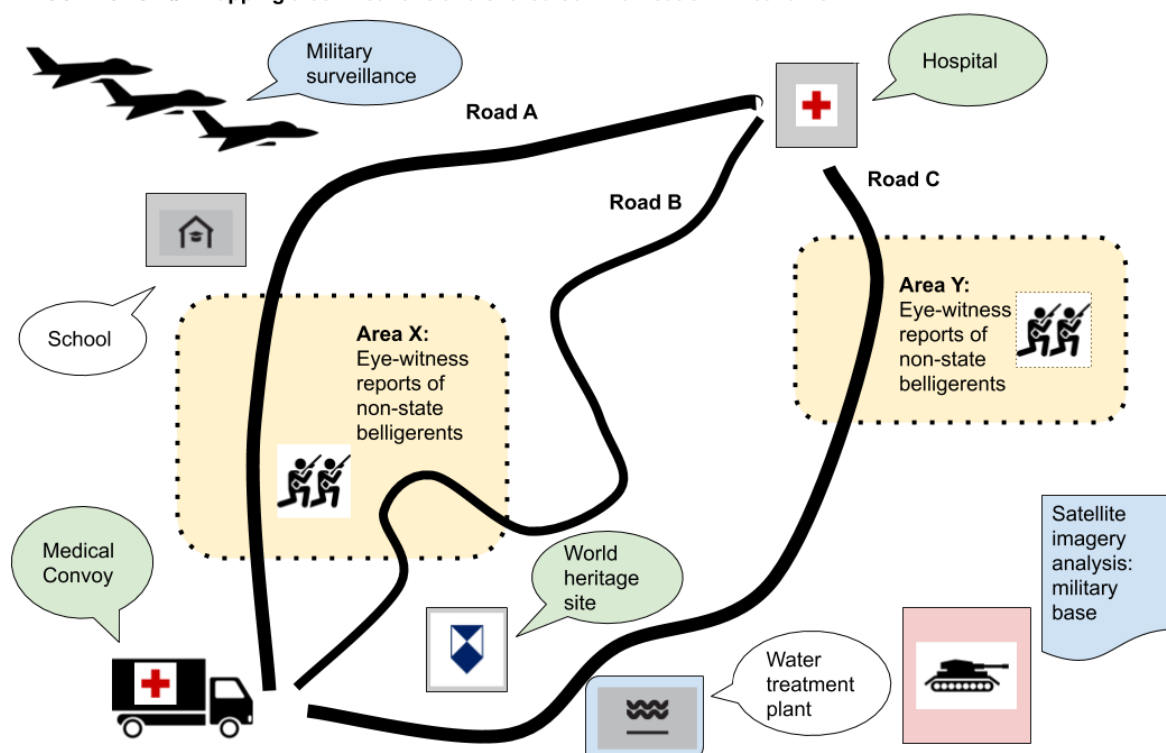## 4.1 Case 1: Mapping a conflict zone in real time

Figure 5. Example mapping of a conflict zone from a military perspective showing some protected objects and critical infrastructure, Whiteflag-compliant communications received from objects (white and green speech bubbles) and anonymised human observation reports (dotted boxes), combined with military analyses (blue reports)

The PAUSE system case in Figure 5, aims to "map" the location of protected sites and critical infrastructure in a conflict zone with real-time fully-traceable updates to reduce uncertainty, ambiguity and error. In a conflict zone there will be transmitters and receivers of information. Transmitters include protected object beacons, protected object detection sources (from AI), computer logs, video footage, satellite imagery, audio recordings. Humans in the zone may be both transmitters and receivers identifying people in need of assistance and/or surrendering (see Box 2: Digital and Trusted Surrender). Civilian communications may need special protections such as being anonymised using techniques such as differential privacy(Dwork & Roth, 2014). Assets that are responsibility of local government, NGOs, ICRC, UN etc. may also be transmitters and receivers. Using PAUSE each organisation decides what kinds of information to incorporate. Each nation or organisation would also

create validation procedures for receivers, giving weight to information in relation to values, priorities and trust metrics. Transmitted data from some entities (e.g. ICRC) would be considered a trusted source.
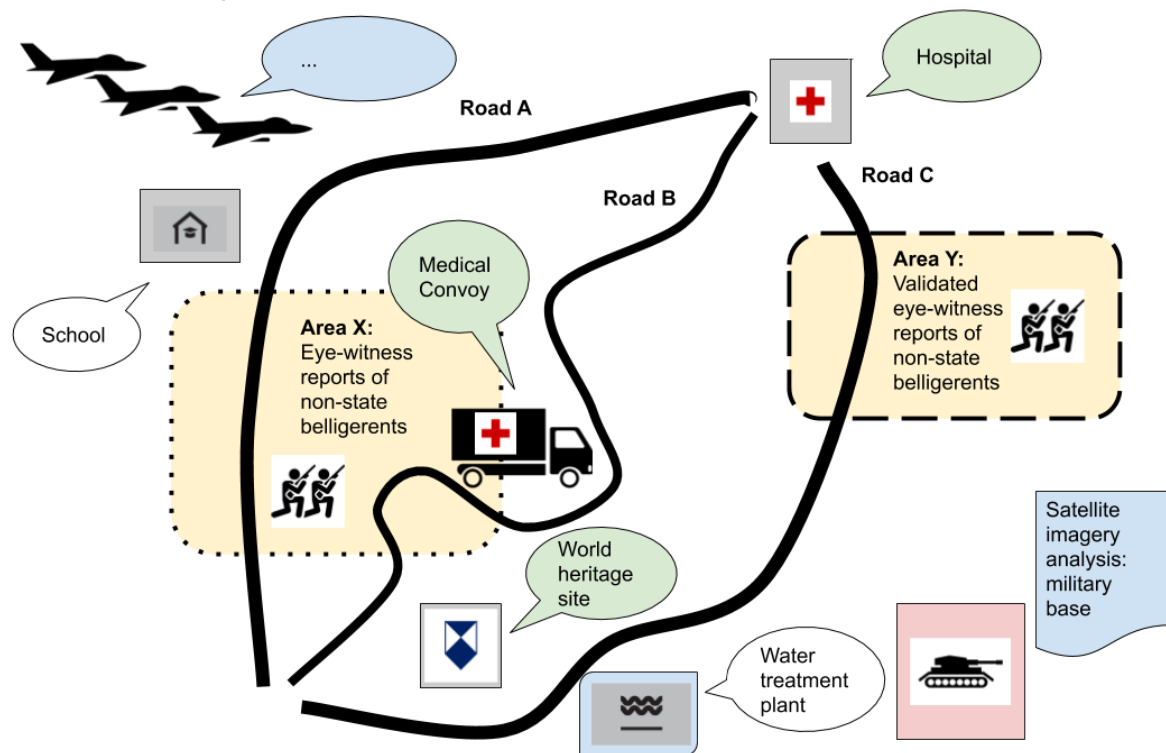

Box 2: Digital and Trusted Surrender

Humans could use the PAUSE system to register and better facilitate surrender and there is the potential for radio or other beacons to signal surrender. These signals would be visible to Combat systems and may require new laws to prevent unwanted exploitation. To illustrate, if the PAUSE system were available to US troops in the Persian Gulf War, (United States, 1992), Iraqi combatant lives may have been saved as information of surrender could be transmitted via a neutral communications channel like Whiteflag from beacons and/or text messages.

4.2 Case 2: Preparation to avoid incidents

PAUSE - CASE #2 Preparation to avoid incidents

Figure 6. A humanitarian organisation using PAUSE to evaluate the risks to a resupply mission for humanitarian aid to a hospital via Road A, B or C. Road B could be chosen to minimise the likelihood of contact with: military activities such as the aircraft and non-state belligerents in Area X near Roads A and B, or a military base and non-state belligerents in Area Y near Road C. Analysis of anonymised human observations may lend more credibility to the hypothesis that non-state belligerents are near road C and less likely on Road A.

Best practice would be for States and organisations to incorporate PAUSE into their decision-making to avoid violations of IHL. Actors are expected to act in good faith to avoid an accident. Not using information provided via PAUSE may need justification if it becomes the de facto "standard". Figure 6 illustrates humanitarian organisations use of PAUSE to de-risk plans. In this scenario, PAUSE helps track the changing locations of protected objects such as the movement of medical supplies along Road B. Each organisation in a conflict should reassess any actions in light of this updated information.

A particular challenge for civilian and military organisations is to come to terms with how to respond to different information sources. This is why we consider models of information fusion. Once a normative model for decision-making by organisations is adopted, then agreement from diverse sources might be trusted more than the aggregation of views from a set of more homogeneous individuals (e.g. highly connected within social networks) (Schmidt et al., 2017). Information from trusted allies is likely to be weighted more highly than unfamiliar sources. Highly uncertain or contentious information might trigger ISR actions depending on the perceived risk of inaction. Thresholds for actions under different densities of evidence and under various levels of uncertainty would be decided within each State depending on their risk appetite and political will. Thus, the PAUSE network can be used to undertake a risk assessment of actions by both civilian and military groups.

4.3 Case 3: Dealing with Misinformation

The PAUSE network would enable organisations to establish appropriate levels of trust in sources and fusion of information with varying levels of trust and changing trust over time. This means that mistaken information or deliberate disinformation campaigns are anticipated and more readily identified and managed. Figure 7 illustrates a case where PAUSE uncovers military attempts to manipulate information and progress misinformation or disinformation campaigns.
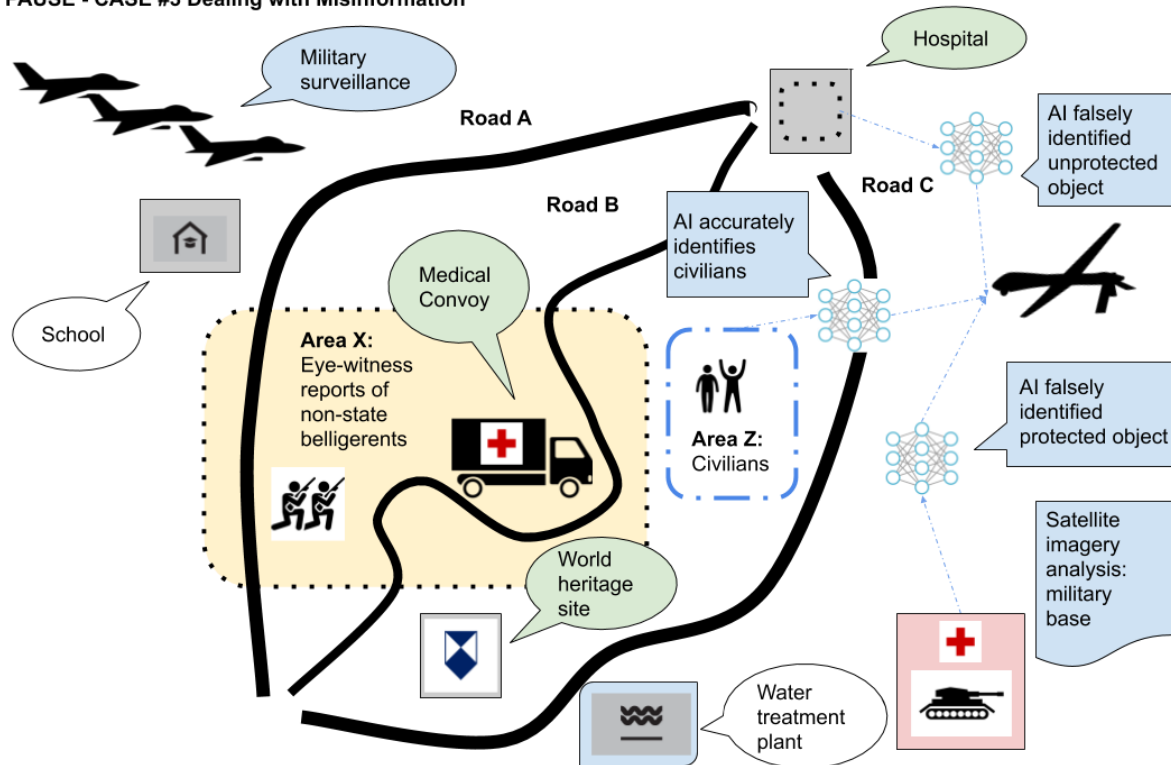
Figure 7. Belligerents try to unlawfully spoof ISR-equipped drones into believing military targets are protected (see red square) or that protected objects such as hospitals are neutral or military targets. The PAUSE system provides countervailing evidence so that disinformation campaigns can be questioned and mistaken information corrected. In this way, AI is part of the information system with many checks and balances.

Take for example a deliberate campaign to make protected symbols on protected objects unreadable to an AI visual feed or infrared sensor. If a military depended upon the AI processed inputs via drone feed to make decisions, then it could be fooled into believing a hospital was a legitimate military target. However, an AI within the PAUSE network would be augmented with counter veiling evidence that a hospital is at the stated location, moving decision-makers from fast intuitive Type I decisions to a more deliberate and reflective Type II thought-process (Kahneman, 2011) when appropriate.

An alternate scenario is that military objects would attempt to spoof AI classifiers into believing they were protected targets by painting protected icons on their sides, such as a tank painting a red cross. In the first instance, a smart AI would not just rely on identifying a red cross, but also the silhouette of a tank so that it would be cognisant of conflicting classifications. Additionally, if the AI-generated results were within the PAUSE network, alternate evidence would suggest both a) the absence of a known humanitarian vehicle in that area, e.g. the vehicle lacks an official ICRC beacon or similar and b) the known presence of

military forces in that location, e.g. Satellite imagery reveals the massing of military hardware where vehicle is located. Militaries are likely to invest heavily in AI-design and complimentary ISR capabilities to autonomously sort through conflicted data to provide operators with timely advice on how to proceed.

In sum, there are three responses to the disinformation risk, 1) a range of AI techniques exist to deal with these situations with a high degree of confidence and 2) the PAUSE system, by allowing organisations and nations to set their own information fusion methods, would provide data-driven techniques to address adversarial uses of AI technically. The distributed ledger of objects and behaviours within conflict zones offer a reliable means to capture evidence to support new laws to make spoofing AI illegal. 3) a civilian-military protocol over a distributed ledger allows cross-checking with other trusted non-AI sources

5 Conclusion

Although the "fog of war" limiting situation awareness may never entirely clear, it should not be held as the standard to explain away civilian targets, justify collateral damage, or give up on the pursuit of better technologies. In a world increasingly plagued by extreme events yet brimming with information, more proactive responses are needed. We have outlined our suggestion that a trusted human-AI network requires diverse information sources to be appropriately fused and a communications protocol based on blockchains for civilian-military information adopted. We have illustrated the potential for AI to process humanitarian and critical infrastructure information, but acknowledge the risks of dis- and misinformation that must be managed through individual, organisational and inter-organisational information optimisation. A trusted network based on these technologies holds the potential to improve the efficiency and timeliness of humanitarian actions in conflict and disaster settings. In this way, States, non-state actors, humanitarian organisations and NGOs might change the technical means by which they communicate in conflict without threatening their neutrality or security, while making reliable use of eye-witness materials and social media.

Developing a Trusted Human-AI Network for Humanitarian Benefit

6 References

Azzedin, F., & Ghaleb, M. (2019). Internet-of-Things and information fusion: Trust perspective survey. *Sensors, 19*(8), 1929.

Beier, J. M. (2003). Discriminating Tastes: 'Smart' Bombs, Non-Combatants, and Notions of Legitimacy in Warfare. *Security Dialogue, 34*(4), 411-425. doi:10.1177/0967010603344003

Bovens, L., & Hartmann, S. (2004). *Bayesian epistemology*. Oxford: Oxford University Press.

Brown, J. M. (2007). To Bomb or Not to Bomb? Counterinsurgency, Airpower, and Dynamic Targeting. *Air & Space Power Journal, 21*(4), 75-85,127.

Brundage, M., Avin, S., Clark, J., Toner, H., Eckersley, P., Garfinkel, B., . . . Filar, B. (2018). *The Malicious Use of Artificial Intelligence: Forecasting, Prevention, and Mitigation*. Retrieved from Future of Humanity Institute, University of Oxford, Centre for the Study of Existential Risk, University of Cambridge, Center for a New American Society, Electronic Frontier Foundation, OpenAI: https://arxiv.org/pdf/1802.07228.pdf

Capgemini. (2018). *Whiteflag Protocol Simulation Test Report, The Netherlands, Utrecht, December 2018*.

Cebrowski, A., & Garstka, J. (1998). Network-centric warfare: Its origin and future. *United States Naval Institute. Proceedings, 124*(1), 28-35.

Clausewitz, C. v., Howard, M., & Paret, P. (1976). *On war*. Princeton, N.J.: Princeton University Press.

Coates, A. J. (2016). *The ethics of war* (2nd ed.). Manchester: Manchester University Press.

Conee, E., & Feldman, R. (2004). *Evidentialism: Essays in epistemology*: Oxford Scholarship Online.

Coppi, G., & Fast, L. (2019). *Blockchain and distributed ledger technologies in the humanitarian sector*. Retrieved from Overseas Development Institute: https://www.odi.org/publications/11284-blockchain-and-distributed-ledger-technologies-humanitarian-sector

Crosby, M., Nachiappan, Pattanayak, P., Verma, S., & Kalyanaraman, V. (2016). Blockchain Technology: Beyond Bitcoin. *Applied Innovation Review, 2*. Retrieved from http://scet.berkeley.edu/wp-content/uploads/AIR-2016-Blockchain.pdf

Devitt, S. K. (2018). Trustworthiness of autonomous systems. In H. A. Abbass, J. Scholz, & D. J. Reid (Eds.), *Foundations of Trusted Autonomy* (pp. 161-184). Cham: Springer International Publishing.

Duffie Jr, W. (2017, 17 July). Text Tech: Can Navy vessels use shipboard signal lamps for text messaging? *Office of Naval Research*. Retrieved from https://www.onr.navy.mil/en/Media-Center/Press-Releases/2017/Tech-Solutions-FLTC-Converter

Dwork, C., & Roth, A. (2014). The algorithmic foundations of differential privacy. *Foundations and Trends in Theoretical Computer Science, 9*(3-4), 211-407.

Efanov, D., & Roschin, P. (2018). The All-Pervasiveness of the Blockchain Technology. *Procedia Computer Science, 123*, 116-121. doi:https://doi.org/10.1016/j.procs.2018.01.019

Eisenberg, D. A., Alderson, D. L., Kitsak, M., Ganin, A., & Linkov, I. (2018). Network Foundation for Command and Control (C2) Systems: Literature Review. *IEEE Access, 6*, 68782-68794.

Ekelhof, M. A. (2018). Lifting the fog of targeting. *Naval War College Review, 71*(3), 61-95.

Enemark, C. (2013). *Armed Drones and the Ethics of War: Military Virtue in a Post-heroic age*: Routledge.

Etuk, A., Norman, T. J., Şensoy, M., Bisdikian, C., & Srivatsa, M. (2013). *TIDY: A trust-based approach to information fusion through diversity*. Paper presented at the Proceedings of the 16th International Conference on Information Fusion, IEEE, July

Hale, L. (1897). The Professional Study of Military History. *Royal United Services Institution. Journal, 41*(232), 690-721. doi:10.1080/03071849709416036

Hastings, M. (1979). *Bomber Command*: Pan Books.

Hiltz, S. R., Hughes, A. L., Imran, M., Plotnick, L., Power, R., & Turoff, M. (2020). Exploring the usefulness and feasibility of software requirements for social media use in emergency management. *International journal of disaster risk reduction, 42*, 101367.

Hoff, K. A., & Bashir, M. (2015). Trust in automation: Integrating empirical evidence on factors that influence trust. *Human Factors, 57*(3), 407-434.

International Committee of the Red Cross. (2019). *Artificial intelligence and machine learning in armed conflict: A human-centred approach*. Retrieved from https://www.icrc.org/en/document/artificial-intelligence-and-machine-learning-armed-conflict-human-centred-approach

Jacobs, M. (2020). How Implicit Assumptions on the Nature of Trust Shape the Understanding of the Blockchain Technology. *Philosophy & Technology*, 1-15.

Jamier, V., Irvine, B., & Aucher, C. (2018). Demystifying TRLs for Complex Technologies. *Leitat*. Retrieved from https://projects.leitat.org/demystifying-trls-for-complex-technologies/

Kahneman, D. (2011). *Thinking, fast and slow*. New York: Farrar, Straus and Giroux.

Kolenbrander, M., & Schless, T. (2019). Specification of the Whiteflag Protocol Version 1, Draft 6 (Standard). Retrieved from https://github.com/whiteflagprotocol/whiteflag-standard. from Github https://github.com/whiteflagprotocol/whiteflag-standard

Lambert, D. A., & Scholz, J. (2005). *A Dialectic for Network Centric Warfare*. Paper presented at the 11th International Command Control Research Technology Symposium (ICCRTS), McLean, Virginia 13-17 June. http://www.dodccrp.org/events/10th_ICCRTS/CD/papers/016.pdf

Lawfare. (2020). Civilian Casualiities & Collateral Damage. Retrieved from https://www.lawfareblog.com/civilian-casualties-collateral-damage

Lewis, L. (2018). *Redefining Human Control: Lessons from the Battlefield for Autonomous Weapons*. Retrieved from Arlington Virginia: https://www.cna.org/CNA_files/PDF/DOP-2018-U-017258-Final.pdf

Lewis, L. (2019a). *Promoting Civilian Protection during Security Assistance: Learning from Yemen*. Retrieved from CNA: https://www.cna.org/research/Yemen

Lewis, L. (2019b). *Protecting Medical Care in Conflict: A Solvable Problem*. Retrieved from CNA, Arlington Virginia: ttps://humanrightscommission.house.gov/sites/humanrightscommission.house.gov/files/documents/Protecting%20Medical%20Care%20in%20Conflict%20-%20Lewis.pdf

Lopez, C. T. (2020). DOD Adopts 5 Principles of Artificial Intelligence Ethics. *DOD News*. Retrieved from https://www.defense.gov/Explore/News/Article/Article/2094085/dod-adopts-5-principles-of-artificial-intelligence-ethics/

Mason, G. B. (1992). HF/DF or Huff Duff — High Frequency radio direction finding in Royal Navy Warships. *Naval-History.Net*. Retrieved from https://www.naval-history.net/xGM-Tech-HFDF.htm

Miller, T. (2019). Explanation in artificial intelligence: Insights from the social sciences. *Artificial Intelligence, 267*, 1-38.

Moser, P. K. (2005). *The Oxford Handbook of Epistemology*. New York: Oxford University Press, Incorporated.

Nohle, E., & Robinson, I. (2017). War in cities: The 'reverberating effects' of explosive weapons. *ICRC Blog*. Retrieved from https://blogs.icrc.org/law-and-policy/2017/03/02/war-in-cities-the-reverberating-effects-of-explosive-weapons/

Paul, C., Clarke, C. P., Triezenberg, B. L., Manheim, D., & Wilson, B. (2018). *Improving C2 and Situational Awareness for Operations in and Through the Information Environment*. Retrieved from RAND: https://www.rand.org/pubs/research_reports/RR2489.html

Peck, M. E. (2017). Blockchains: How They Work and Why They'll Change the World. *IEEE Spectrum, 54*(10), 26-35. Retrieved from https://spectrum.ieee.org/computing/networks/blockchains-how-they-work-and-why-theyll-change-the-world

Robbins, S. (2019). AI and the path to envelopment: knowledge as a first step towards the responsible regulation and use of AI-powered machines. *AI & Society*. doi:10.1007/s00146-019-00891-1

Roberts, A. (2010). Lives and statistics: Are 90% of war victims civilians? *Survival, 52*(3), 115-136. Retrieved from https://weblearn.ox.ac.uk/access/content/user/1044/Survival_Jun-Jul_2010_-_AR_on_lives___statistics_-_non-printable.pdf;

Schmidt, A. L., Zollo, F., Del Vicario, M., Bessi, A., Scala, A., Caldarelli, G., . . . Quattrociocchi, W. (2017). Anatomy of news consumption on Facebook. *Proceedings of the National Academy of Sciences, 114*(12), 3035-3039. doi:10.1073/pnas.1617052114

Scholz, J., & Galliott, J. (2018). *AI in Weapons: the moral imperative for minimally-just autonomy*. Paper presented at the International Conference on Science and Innovation for Land Power, Adelaide. https://www.dst.defence.gov.au/sites/default/files/basic_pages/documents/ICSILP18Wed1600_Scholz_et_al-AI_in_Weapons.pdf

Singer, P. W., & Brooking, E. T. (2018). *LikeWar: The weaponization of social media*. New York: Houghton Mifflin Harcourt.

Sosa, E. (2011). *Knowing Full Well*. Princeton, NJ: Princeton University Press.

Tapia, A. H., Bajpai, K., Jansen, B. J., Yen, J., & Giles, L. (2011). *Seeking the trustworthy tweet: Can microblogged data fit the information needs of disaster response and humanitarian relief organizations*. Paper presented at the Proceedings of the 8th International ISCRAM Conference, Portugal, May 2011.

Timo [ts5746]. The Whiteflag Application Programming Interface (API) GitHub. Retrieved from https://github.com/WhiteflagProtocol/whiteflag-api

Triebert, C., Hill, E., Browne, M., Hurst, W., & Khavin, D. (2019, 13 October). How Times Reporters Proved Russia Bombed Syrian Hospitals. *New York Times*. Retrieved from https://www.nytimes.com/2019/10/13/reader-center/russia-syria-hospitals-investigation.html

United States. (1992). Appendix O on the Role of the Law of War. In *United States: Defense Department Report to Congress on the Conduct of the Persian Gulf War* (pp. 612, 641-644). Retrieved from International Committee of the Red Cross: Case Book

'United States, surrendering in the Persian Gulf War' https://casebook.icrc.org/case-study/united-states-surrendering-persian-gulf-war

van den Hoven, J. (2013). Value sensitive design and responsible innovation. In R. Owen, J. Bessant, & M. Heintz (Eds.), *Responsible Innovation* (pp. 75-83). Chichester, UK: John Wiley & Sons, Ltd.

Walsh, J. I. (2015). Precision Weapons, Civilian Casualties, and Support for the Use of Force. *Political Psychology, 36*(5), 507-523. Retrieved from www.jstor.org/stable/43783881

The Whiteflag Protocol. (2020). Retrieved from https://www.whiteflagprotocol.net/

7 Appendices

7.1 Appendix A. Whiteflag protocol functional message categories and examples

FUNCTION	DESCRIPTION	EXAMPLES
PROTECTIVE SIGNS	Signs to mark objects under the protection of international law	Hospitals, Safety Zones, White Flag, Humanitarian Convoys, Cultural Property, Medical Units
EMERGENCY SIGNALS	Signals to send an emergency signal when in need of assistance	Emergency Beacon, Distress Signal
DANGER SIGNS	Signs to mark a location or area of imminent danger	Mark danger such as an area under attack, land mines, disasters, etc.
STATUS SIGNALS	Signals to provide the status of an object, or specifically for persons: give a proof of life	Personal beacon on individuals or confirmation of persons for assistance, status of critical infrastructure.
INFRASTRUCTURE SIGNS	Signs to mark critical infrastructure	Roads, schools, utilities, water treatment, hospitals, power plants etc.
MISSION SIGNALS	Signals to provide information on activities undertaken during a mission	Intentions of objects such as convoys as they progress and adapt through a mission, deconfliction with military operations
REQUEST SIGNALS	Signals to perform requests to other parties	Requests for area access, cease fire, etc.
RESOURCE MESSAGES	Messages to point to an internet resource with additional information	Additional information from official websites on cultural property, minefields, news feeds, authenticated photographs, etc.
FREE TEXT MESSAGES	Messages to send a free text string to clarify and provide context to other messages	Supplementary commentary to enable further clarification of ambiguous events

Whiteflag messages sent on a blockchain are pre-defined and based on international rules and standards for armed conflicts and disasters. This ensures interoperability between any Whiteflag-capable system and a common understanding between the communicating parties. The messages should be seen as digital equivalents

of physical signs and communication signals marking entities protected under international humanitarian law, critical infrastructures, emergencies, and danger zones such as minefields etc. These messages enable entities protected under humanitarian law to make themselves known in real-time to parties they trust for deconfliction; disclose real-time critical information to trusted parties to improve overall shared situational awareness; and allow organisations to notify others of their planned and ongoing activities. For natural disasters on the other hand, close collaboration between aid workers, affected people and the general public is important. In those circumstances, Whiteflag may be used openly with information made available by anybody to everyone to quickly create and disseminate near real-time information about imminent dangers, available aid, etc. to create shared situational awareness. ("The Whiteflag Protocol," 2020).

7.2 Appendix B: Decision error considerations for MinAI-enabled weapon systems

Truth	Operator Perceived	Machine Perceived	State	Consequences
Protected	Protected	Protected	Correct protection	Protection achieved
Protected	Protected	Not Protected	Correct protection	Protection achieved as human prohibits machine to engage.
Protected	Not protected	Protected	Correct protection	Protection achieved as machine prohibits engagement
Protected	Not protected	Not protected	Protection fail	Protection failure
Not protected	Protected	Protected	False protection	Military objective not achieved
Not protected	Protected	Not protected	False protection	Military objective not achieved as human prohibits machine to engage
Not protected	Not protected	Protected	False protection	Military objective not achieved as machine prohibits engagement
Not protected	Not protected	Not protected	Unprotected	Military objective achieved within IHL/ILAC-boundaries

.