9-Liner-MedEvac Request Chat Between Military and Civil Units

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ABSTRACT

In severe disasters such as the storm in Valencia, Catalonia, Spain in 2024, which resulted in torrential flooding, the fastest possible evacuation of people and especially the wounded is the highest priority (Staff members of CNN, 2024). A disaster on this level needs urgent support from both civil and military emergency services. With this paper, a chat tool is presented to exchange location data of a person with their related 9-Liner-patient protocol with their extension of up to 12 lines with full vital signs and an example from Germany between military and civil geoinformation system (GIS) users via chat for quickest medical evacuation (MedEvac) management (Staff members of US Army, 2015).

Keywords

9-Liner-MedEvac, patient protocol, chat message attachment, cooperation, military GIS, civil GIS

INTRODUCTION

One of the most time-critical tasks in disasters is the search and rescue of humans and sometimes livestock, so how to accelerate this seamlessly? In the case of people buried in buildings, trapped in floods, fires or shootings, wounded or seriously injured, every minute counts. The first 5 minutes for injured persons are known as the „Platinum 5 Minutes“, the first 60 minutes as the „Golden Hour“. During this period, the chances of saving lives or at least reducing damage to human health are highest in major emergencies. Although these terms originate from the military context of the “Tactical Combat Casualty Care (TCCC)”, it has been shown that the military emergency world is more advanced in casualty evacuation (CasEvac) and medical evacuation (MedEvac) than the civil one. Since the Korean War in the 1950s and the first matured TCCC-concept in the Somalia conflict in 1993, TCCC has steadily grown to a professional lifesaving standard in the (Western) world, especially in the North Atlantic Treaty Organization (NATO) (Butler, 2017; Savage et al., 2011; Staff members of Bundeswehr, 2022b). Moreover, the NATO and European Free Trade Association (EFTA) member states, as well as Australia, New Zealand and many other countries, use the same military GIS, which already contains the full range of disaster management software tools for civil units (Staff members of Systematic, 2022a). The next step can only be to make these uniform 9-liner and GIS solutions available to the civilian world by offering communication interfaces to manage a crisis with casualties with the quickest possible civil-military cooperation. This is done with this publication. For better understanding, a full 9-liner patient protocol is explained in the paragraph.

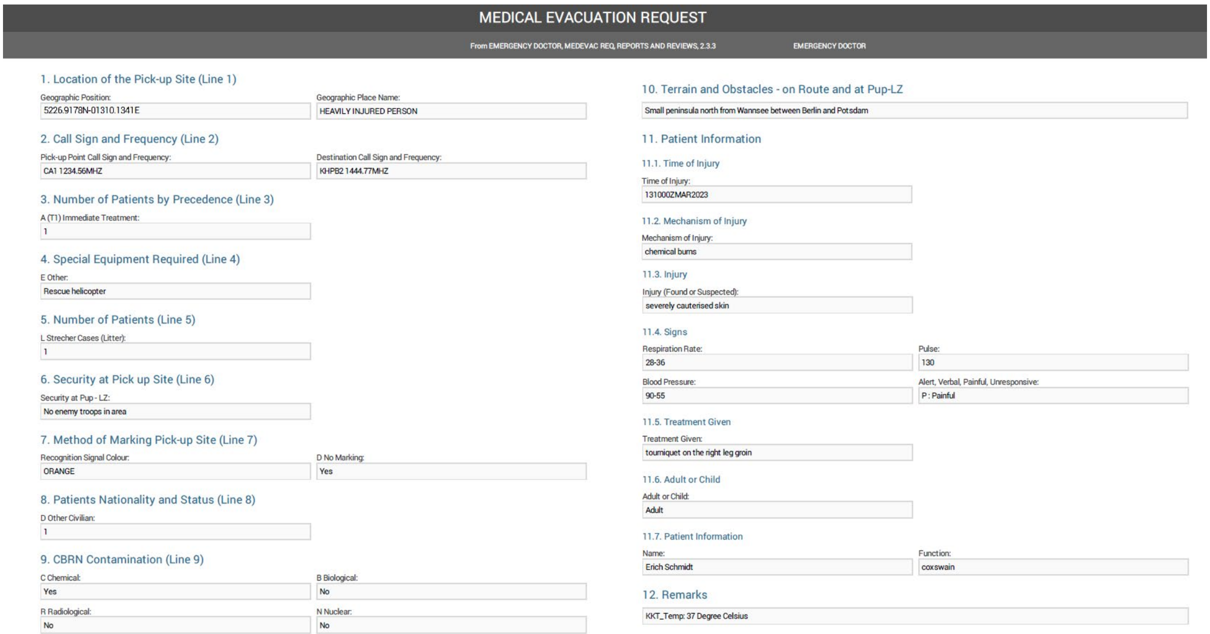
9-Liner Composition and Extension

The „9-Liner Medical Evacuation Request“ patient emergency protocol, or 9-Liner MedEvac for short, takes its name from its nine lines of notes, whereas there is a “zero”-line as message identifier on top: „1 – Location of the pick-up site (of the casualties)“, „2 – Call sign and frequency (for communication)“, „3 – Number of patients by precedence“, „4 – Special equipment required“, „5 – Number of patients (with specific needs, either lying down or able to walk)“, „6 – Security at pick up site“, „7 – Method for marking pick-up site (for arriving rescue personnel)“, „8 – Patient nationality and status“, „9 – (Chemical/Biological/Radiological/Nuclear) CBRN contamination“. As of today, the protocols have been expanded to 12 lines. These are in addition „10 – Terrain and obstacles – on route and at (pick-up landing zone) PuP-LZ“, „11 – Patient information (Time of injury, Mechanism of injury, Injury, Signs, Treatment given, Adult or child, ZIP-code (possible military identification), Patient information (name and possible profession)“ and „12 – Remarks“.

In particular, the vital signs (respiration rate, pulse, blood pressure and patient behaviour) of a patient have been added. A further core vital sign, the body temperature with the variable name “KKT_Temp”, has been added into the category “Remarks” of this paper for completeness. Depending on national or international standards, “KKT” is the German “Körperkerntemperatur” or the English “Temperature”. The range of vital sign variables and units is standardised after ISO 22077-1 in the tables 5 and 10 (Staff members of ISO, 2022). The selection of the relevant vital parameter units in line 11 for signs is based on the ISO 22077-1 standard, whereby respiratory rate, blood pressure and core body temperature in particular still exhibit a high degree of variability between individual countries in terms of unit variable representation, although this does not affect the numerical values themselves (Staff members of ISO, 2022). In detail, patient behaviour is described via AVPU-scheme, the patient level of consciousness “A: Alert & fully awake - V: Verbal response - P: Pain - U: Unresponsive”.

Each note line corresponds to a line in a text file (txt), is terminated by a double slash and is therefore clearly machine-readable (Staff members of Systematic, 2023). Compared to civilian patient emergency protocols, the 9-liner has the advantage that it can be filled out for all civil defence scenarios, whether civilian, military or civil-military.

This can be shown with a fictional example, where a military emergency doctor treats and reports a flooding victim who was washed ashore with his boat on a little peninsula near Berlin. The boat sprang a leakage with oil and the victim himself jammed his leg under the boat keel. The respective 9-Liner was filled out as follows:



MEDICAL EVACUATION REQUEST

From EMERGENCY DOCTOR, MEDEVAC REQ, REPORTS AND REVIEWS, 2.3.3 EMERGENCY DOCTOR

1. Location of the Pick-up Site (Line 1)
Geographic Position: 5226.9178N-01310.1341E
Geographic Place Name: HEAVILY INJURED PERSON

2. Call Sign and Frequency (Line 2)
Pick-up Point Call Sign and Frequency: CA1 1234.56MHZ
Destination Call Sign and Frequency: KHPB2 1444.77MHZ

3. Number of Patients by Precedence (Line 3)
A (T1) Immediate Treatment: 1

4. Special Equipment Required (Line 4)
E Other: Rescue helicopter

5. Number of Patients (Line 5)
L Strecher Cases (Litter): 1

6. Security at Pick up Site (Line 6)
Security at Pup - LZ: No enemy troops in area

7. Method of Marking Pick-up Site (Line 7)
Recognition Signal Colour: ORANGE
D No Marking: Yes

8. Patients Nationality and Status (Line 8)
D Other Civilian: 1

9. CBRN Contamination (Line 9)
C Chemical: Yes
B Biological: No
R Radiological: No
N Nuclear: No

10. Terrain and Obstacles - on Route and at Pup-LZ
Small peninsula north from Wannsee between Berlin and Potsdam

11. Patient Information

11.1. Time of Injury
Time of Injury: 131000ZMAR2023

11.2. Mechanism of Injury
Mechanism of Injury: chemical burns

11.3. Injury
Injury (Found or Suspected): severely cauterised skin

11.4. Signs
Respiration Rate: 28-36
Pulse: 130
Blood Pressure: 90-55
Alert, Verbal, Painful, Unresponsive: P : Painful

11.5. Treatment Given
Treatment Given: tourniquet on the right leg groin

11.6. Adult or Child
Adult or Child: Adult

11.7. Patient Information
Name: Erich Schmidt
Function: coxswain

12. Remarks
KKT_Temp: 37 Degree Celsius

Figure 1. The 9-Liner MedEvac request completion form with error-free input technology and example content of a fictional boat accident in Germany (Staff members of Systematic, 2024)

As sending direction from a military chat towards a civil addressee, a geographic position with latitude (LAT) and longitude (LON) is mandatory because a civil emergency unit with their GIS does not use a Military Grid Reference System (MGRS) and may confuse them. Moreover, the geographic place can be selected freely. This must not contain the geographic location itself but the medical situation. That is why (para) medics often use buzzwords for location where emergencies occur. For this example, the geographic place name contains the buzzword “HEAVILY INJURED PERSON”. The actual terrain description with possible obstacles takes place in line 10. This 9-Liner example was used for procedure verification of method no. 1, which is shown in the chapter “METHODOLOGICAL BACKGROUND” as a separate subchapter. The 9-liner form has typing error protection and is validated before being saved in the applied software Sitaware. Including its standard heading in an IRIS FORMS (text) file (“.irs” or “.txt” readable), the 9-liner in this detailed example, including all its content variants for a single reported accident victim, consists compactly of the following 20 lines:

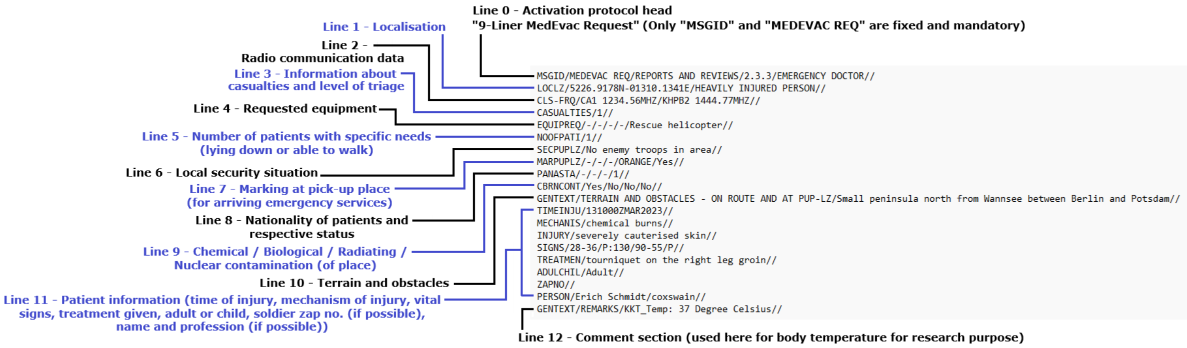


Figure 2 – Same 9-liner shown as a text file. Can be read by trained personnel without technical assistance.

The 9-Liner can exist either in ".irs"- or ".txt"-file type. ".irs"-file types are related to Iris Web Forms, standardised formatted military messaging and interoperability approximately since the 1990s and is being used in most of the Western world around the globe (IEEE Computer Society, 2003):

Figure 3. Use of IRIS FORMS military messaging standard marked in light blue (Staff members of Systematic, 2023)

STATE OF THE ART

In this chapter, the state of the art is determined about how casualty data can be exchanged as quickly as possible in natural, civil or military disasters regarding disaster location, patient vital signs and other necessary information. Before developing this specific messaging service with patient data and geolocation as attachment, it was necessary to carry out a literature search, which was done through general internet search, patent search (Staff members of DPMA, 2023) and deeper investigation in Scopus with university licence (Staff members of Elsevier, 1788) and the ISCRAM database (Staff members of ISCRAM, 2004).

Used key words for scientific search were for instance: Search and Rescue (SAR), communication, chat, patient protocol, causualty, wounded, ill(ness), pandemic, catastrophe, war, defense, (natural) disaster, mass incident, evacuation, short message service (sms), app, vital signs, tracking, monitoring, civil / military cooperation, internet, intranet, radio, television, (social) media, message / messaging, (tele) call, stream(ing), HL7, emergency (services), GIS, interface, Representational State Transfer Application Programming Interface (= REST API) and many more.

As an introduction, a larger knowledge source is the book "***Information Systems for Emergency Management***" by Van de Walle, B., Turoff, M. and Hiltz, S.R., which comprises the important constraints this research paper uses (van de Walle et al., 2010):

- Integrated message broadcasting as one of the key functions for emergency operations (p.13),
- Building information technology systems (p.194),
- Defining the Three Dimensions of Information Sharing: Operational, Organizational, Governance (p.197),
- Common Technologies Used in Emergency Management Systems (EMS) - The time-critical information services (TCIS) (p.200, Table 9.1),
- Automation for Emergency Responders (p.209),
- Incident Visualization (p.210),
- The Mayday system (p.216) and
- Challenges for emergency response system development (p.221).

In the field of patents, the European Patent EP 2 561 656 B1 "*SERVLET API AND METHOD FOR XMPP*

PROTOCOL" from 2011 describes an XMPP-related server architecture on how chat messages are being processed without going deeper into purpose. XMPP stands for "Extensible Messaging and Presence Protocol". Moreover, important disaster management subsystems for geo-tracking, geodata parsing and forwarding, as well as patient protocol attachments in messages, are not described at all (Chen et al., 2011).

Main Relevant Papers

For this scientific paper, the found main relevant papers are displayed in a chronological order as follows:

In 2007, Arunachalan, Light and Watson published a "*Mobile Agent Based Messaging Mechanism AMMA) for Emergency Medical Data Transmission Over Cellular Networks*" with the internationally standardised "Health Level Seven (HL7)"-Format, whereas AMMA stands for "Agent-Based Mobile Middleware Architecture". HL7, with current Version 3, relates to the ISO reference model for communication (ISO/IEC 7498, 1994). Although this digital service architecture has not yet worked out with this paper, a globally standardised medical messaging will gain acceptance in future, the researchers wrote (Arunachalan et al., 2007). As comparison, a 9-Liner MedEvac request ca be integrated into a HL7 architecture as well (North Atlantic Treaty Organization [NATO], 2018).

Oosterveer, de Visser and Heringhaus did research in 2018, published in 2022/2023, about how a text message (TM) alert system improved the rates of return of spontaneous circulation (ROSC) and survival in out-of-hospital cardiac arrest (OHCA) patients in a region with above-average survival rates in the Mid-West of the Netherlands. The results are that TM alert system responders reached 15.9% of OHCA patients, 42 in total, earlier than the first responders or ambulance. 73,8%, which is 31 of these 42 OHCA patients, were connected to an automated external defibrillator (AED) before the ambulance arrived. Between 2012 and 2018, more AEDs were steadily deployed. ROSC was reached successfully more often in the text messaging-group with 61.0% in comparison to 29.4% of a group without TM alert system. Three-month and 1-year survival did not differ significantly between the two groups. In conclusion, a TM alert system improves the rescue chain just because it is faster in every aspect, such as AED-attachment time and ROSC rate of OHCA patients (Oosterveer et al., 2023).

Andersson and Hedman published about "*Issues in the Development of a Mobile-based Communication Platform for the Swedish Police Force and Appointed Security Guards*" in 2006. The focus of this paper is on the early phases of development, in particular on the specific technical issues such as interoperability and standards used in the development of mobile-based systems. The results were that global and national standards, such as the "multi-media message standard 7 (MMS 7)" as an Extensible Markup Language file (XML) for sending multi-media messages, are not always standardised. On the one hand, it seems that operators and mobile phone manufacturers make minor alterations and interpretations of the standard, and thereby, some of the benefits found in standards disappear. On the other hand, mobile-based communication platforms have a large potential for contributing to the field of emergency management information systems since they can be based on open and nationally accepted standards. For example, the continuing connections with "https" work (Andersson & Hedman, 2006).

Flizikowski, Przybyszewski, Stachowicz, Olejniczak and Renk developed and published an open-source Text Analysis Tool "*TWeet lOcator – TAT2*" in 2015, which derives Information from short messages (Tweets) in Twitter, known as X today. This tool deduces sentences as well as (buzz) words and interprets them, getting the geolocation if given in the context of crisis events. For this tool, a validation process, complementing experimentation and test results, including the involvement of end-users, Public Protection and Disaster Relief (PPDR) services and citizens during a realistic crisis exercise showcase were done. In addition, the integration of TAT2 with external tools has also been validated. The software architecture contains Tweets text importing, a preparation and disambiguation subsystem as "Accurate Online Disambiguation of Named Entities in Text and Tables (AIDA)" for English and French, an algorithm named "Artificial Intelligence for Disaster Response (AIDR)", Wikipedia database as knowledge base, although Wikipedia cannot seen as a verified source, Google Geocoding with API, a time zone filter and an area filter (Staff members of AIDR, 2015; Staff members of Google, 2024). The showcase included a real exercise of crisis operation to demonstrate, validate and use the functionalities of the named "iSAR+ solutions", which are already shut down online. The TAT2 application was used during the showcase by OsintLab analysts to complement OsintLab itself for geo-tagging optimisation and language translation other than French or English (Staff members of OsintLab, 2023). Overall results are promising since TAT2 is able to find the location of around 2-4% of tweets, while available sources say that only 1-3% of tweets are geo-tagged. TAT2 led to a more comprehensive analysis of social media content for PPDRs during a crisis. In future, better and more serious sources than Wikipedia are necessary (Flizikowski et al., 2015). Overall, this publication had the most overlaps with our research paper.

In 2015, Tapia, Giacobe, LaLone and Soule published about "*Scaling 911 Messaging for Emergency Operation Centers During Large Scale Events*" with a developed system, which provides data in real-time directly to emergency managers during a large-scale crisis. The software name is “TAMEE - Text Analytics for Monitoring Extreme Events” and comes with a “mySQL”-database (Staff members of Oracle, 1995). The system is designed to accept, sort, triage and deliver hundreds of direct text messages from the public safety answering point (PSAP) and provides them directly to emergency management staff, who can leverage their content. The deduced data can be used to inform resource allocation decisions, enhance operational situational awareness, and potentially improve response to crises. An Emergency Operations Centre (EOC) is a facility that manages communications capabilities and leading emergency service staff that support the response to a disaster. The mobile version is called Incident Command Vehicle (ICV). The system can display short messages from Twitter, known as X today (Tweet feed), including raw message backend content, a related word cloud and word frequency chart, as well as multiple (buzz) word and hashtag tops lists. For testing, four American Football games were analysed live. With this tool, it was also possible to text the US American 911 emergency number directly. As a result and conclusion, it was said that during a mass crisis event, the inability to connect with emergency services could cause additional panic and frustration and put lives at further risk. To address this problem, next generation 911-services like this tool would come online. Sending a text uses a fraction of the bandwidth required to place a phone call. Voice calls are supplemented or replaced by texts during mass events. An EOC or ICV will play a future role in analysing disaster data as well as being an overflow capacity in mass crises for the successive 911 centre. (Tapia et al., 2015)

Moreno, Garrison and Bhat published the 2017 conference paper “*WhatsApp for Monitoring and Response during Critical Events: Aggie in the Ghana 2016 Election*”, whereas Aggie was the developed software. The attempt was to integrate WhatsApp into Aggie, a social media aggregating and monitoring platform, which also analysed Facebook, Twitter respective X as well as Rich Site Summary (RSS) for website feeds. Only textual content was retrieved without two-way communication. The WhatsApp messages collected by Aggie during the election improved the effectiveness of the monitoring efforts. Regarding these messages, more incidents were found and escalated to the electoral commission and security forces. Mobile Instant Messaging (MIM) systems are now being used by emergency teams to coordinate action response and to receive reports of emergencies. Aggie is an open-source web application for aggregating social media and other digital resources to track incidents around real-time events such as elections or natural disasters. As emergency user groups, there were the “Tracking Team”, the “Veracity Team”, the “Escalation Team” and “The Embedded Team”. Unlike Facebook and Twitter, WhatsApp had no space for public messages and WhatsApp did not provide an open interface for logging in and accessing messages in 2016, which is different today. The alternative WhatsApp API was a so-called “jugaad implementation”, a self-coded API, which is not in service today anymore as WhatsApp is offering its own official API nowadays. Moreover, a Mozilla Firefox browser plugin named GNotifier7 was used for incoming WhatsApp messages, which is not in service anymore. As a command line tool and client-side program library to transfer online data via Uniform Resource Locator (URL), client-side program library to transfer online data via Uniform Resource Locator (cURL) was used (Stenberg, 1998). The Aggie server parses the content and author of the message to create reports. The WhatsApp data was displayed in different categories, namely “statistically”, “actionable”, “as a follow-up to actionable reports”, “relevant but not actionable”, “conversational”, “internal emergency communications”, “election results”, “other election-related”, “not related to the election”, “non-text content” and “not understandable”. In total, the emergency and political services, as well as other social media platforms, benefited from this WhatsApp analysing service (Moreno et al., 2017).

Caputo, Muschietti, Burkhart, et al. published about SMS-based system notifications compared to a smartphone application (app) service for earlier cardio-pulmonary resuscitation initiation in Ticino, Switzerland 2017 (Caputo et al., 2017).

Pijls, Nelemans, Rahel and Gorgels published in 2017 that an implemented text message (TM)-alert system in the Netherlands in the province of Limburg increases the survival of sudden out-of-hospital cardiac arrest (OHCA) (Pijls et al., 2018).

Nagayo, Al Ajmi, Guduri, et al. published a paper in 2021 where a flying drone started from an ambulance vehicle in Oman for GPS-related accident location exploring, transporting multi-purpose first aid kits for a possibly critically ill patient, including patient video streaming to the connected ambulance, a microcontroller-based physiological data monitoring system (PDMS) with early warning scoring (EWS) function and health risk assessment (Nagayo et al., 2021).

Between the years 2022, 2023 and 2024, there were not noteworthy publications with the same explicit purpose. By the year 2025, Qiu and Sun published about the standardised digital architecture design for offshore-related search & rescue operations in Chinese maritime matters via the main Chinese satellite system “Beidou”, comparable to GPS. This software supports hardware products such as personal portable beacons, ship-borne beacons and positioning navigation tracking terminals via seamless communication and tracking at the same time. The software comprises five packages, a user layer for alerting, communicating and tracking, an application layer, a platform layer and two digital packages namely “security and assurance”, which includes a blockchain among others and “governance and configuration”, which includes digitally connected Governance services and management. Although, this software represents an holistic maritime approach for search and rescue, it does not work out in emergency cases on land (Qiu & Sun, 2025).

Meyer has developed and published a comprehensive casualty depiction system in October 2025 with a “NATO A16-casualty card”, similar to a 9-Liner, which can be used in a so-called large-scale mass casualty (MASCAL), which are linked to time-based illness scripts within a Health Level 7-standard (Meyer, 2025; Staff members of HL7, 1987). This was tested in a large-scale, multiday, immersive simulation called “Bushmaster”. Three hundred casualty cards linked to 49 illness scripts were created, evaluated and processed at Bushmaster. 170 military members utilised the new casualty depiction system. 96% of interviewed clinical faculty members were satisfied with this solution (Meyer, 2025). Although this principle comes close to what is presented in this paper, the referred A16-casualty card is only used in the armed forces of the USA and is not compatible with civil emergency service communication. In contrast, a 9-Liner MedEvac request protocol, vital signs and locations in particular, can be integrated into this A16-casualty card, therefore processed in Bushmaster and exchanged with civil units through primitive “.txt-files”. Both a A16-casualty card and a 9-Liner are compatible according to NATO patient data document AMedP-5.1 (NATO, 2018).

METHODOLOGICAL BACKGROUND

In a first methodological step, the suitable patient protocol and GIS were identified to cover a wide range of countries for holistic national and cross-border disaster management with the primary focus on live-saving, casualty evacuation (CasEvac) up to medical evacuation (MedEvac). Derived from the military side, these are the mentioned 9-Liner-MedEvac request forms and the GIS Sitaware as sender in the chapters above (Staff members of Systematic, 1985; Staff members of US Army, 2015). As GIS message & 9-Liner receiver, ArcGIS, one of the most used GIS worldwide has been chosen as the civil side in disaster management (Staff members of ESRI, 1999).

As a second step, it was necessary to identify the whole communication process with more profound analysis of the specific communication subsystems. The Sitaware chat is realised by a free software called Openfire by Ignite Realtime, which is based on an XMPP-server, whereupon XMPP stands for “Extensible Messaging and Presence Protocol”. XMPP is an open communication protocol written in Java (Staff members of Jive Software, 2002). Sitaware uses the same coding language. Sitaware itself is a cost-intensive GIS and can be procured by states, military, official emergency services, related and certified suppliers, healthcare facilities, critical infrastructure organisations and universities only (Staff members of Systematic, 2022b). For this paper, it was possible to get a Sitaware licence for further research for seamless civil-military communication in patient data exchange.

ArcGIS uses an own chat system in the ArcGIS Mission chat surrounding and respective API with Python as coding language (Staff members of ESRI, 2020). The ArcGIS Mission Server is an ArcGIS Enterprise server role and is cost-intensive as well. Although an ArcGIS Pro licence could be used via a university licence to set up an application programming interface (API) towards Sitaware, including necessary overlayer services, it was not possible to get an ArcGIS Mission Messenger service for a reasonable price.

Therefore, the focus of this paper is on the unidirectional messaging of patient data from military units towards civil emergency services only. A bidirectional messaging must be investigated in further research in a successor paper. Those two described methodological steps can be displayed as follows:

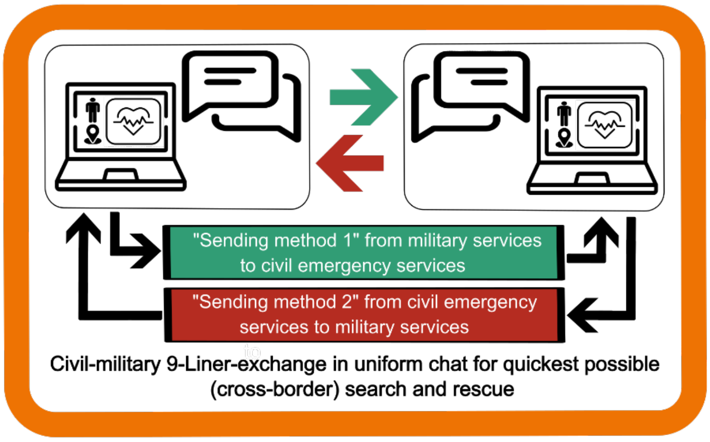


Figure 4. Civil-Military 9-Liner-exchange in uniform chat for quickest possible (cross-border) search and rescue

Sending Method No. 1

In a third step, the chat message listening method is described on a deeper technical level. During a larger disaster, a military GIS employee gets a report of a wounded or ill person at a specific location, which is named a "Point of Injury (POI)", which comes with the same abbreviation as the superior "Point of Interest". The employee either has received a 9-Liner protocol or is writing it themself. The generated or written 9-Liner ".txt"-files can be read and used on every smartphone, laptop or computer on every operating system from Microsoft, Apple, Google, Linux et cetera.

Then, the employee shares the 9-Liner protocol as an attachment within a chat message in a chatroom, which also addresses external civil GIS. At this moment, the developed XMMP client reacts. It listens to the chat and triggers every time a 9-Liner protocol has been attached to a chat message, because the XMMP client code contains allowable login credentials of the military chat for paired civil-military cooperation. Now, the code separates the 9-Liner attachment from the chat message and reads out every line of the 9-Liner step by step. A modern 9-Liner contains up to 12 content lines plus header line "zero", as the number 9 in the name has historic roots. The 9-Liner is explained in the Introduction-chapter above of this paper. The readout of the 9-Liner is done by a second code in parallel as this is necessary to send the 9-Liner-related components towards a "Representational State Transfer Application Programming Interface (REST API)" of a civil GIS to be compounded and displayed on a specific 9-Liner-overlayer on a map. The REST API works with a civil API key, which must be requested by the military GIS side. This enables neat civil-military cooperation as the civil side can change the API key whenever they want to quit cooperation with the military side, which is legally essential in disaster management.

With this 9-Liner-overlayer, injured or ill persons are displayed directly on a public and civil map. Once a civil person, an emergency employee, for example, clicks on the POI on the map, the 9-Liner protocol appears to be read. The displayed 9-Liner can be directly downloaded as well. This 9-Liner specific XMMP-listening method from the military GIS chatroom to an overlayer for a map of a civil GIS, for quickest "Search and Rescue (SAR)" operations in civil-military cooperation, can be displayed as follows:

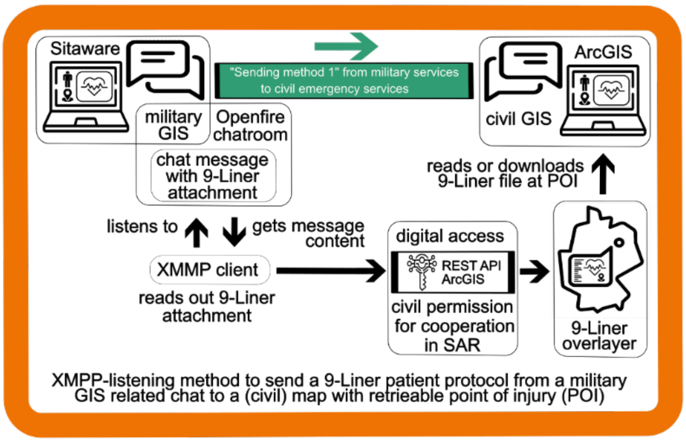


Figure 5. XMMP-listening technique to enable sending messages from military chat to civil overlayer map

The use of 9-liners in the file style of IRIS Forms and ".txt" makes this tool the most generic of its kind. It is possible to rescue casualties on an international level without converting or changing chat software or means of communication in a broader civil-military cooperation. It can be used without any additional software installation or further change of software, but just standard military GIS software in the beginning and browser-related civil GIS software at the end, where even laypersons can download text-files from open maps in a browser.

SOFTWARE PACKAGES

It took two major attempts to develop this software-based method. In the first attempt, only recommended versions for assisted software systems were used aligned to the military GIS Sitaware and its related software development kit (SDK) version. Assisted software were Gradle, Java Development Kit (JDK) and Java Runtime Environment (JRE) (Staff members of Gradle, 2008; Staff members of Oracle, 2014). Furthermore, the coding was done in Visual Studio Code (VS Code or VSC) and the counterpart civil GIS with API key was processed through ArcGIS Pro (Staff members of ESRI, 2015; Staff members of Microsoft, 2015; Staff members of TUM, 2003). With the first try, having Sitaware Headquarters (SW HQ)-aligned version settings, sent 9-Liner attachments could only be found and utilised in tabular form in ArcGIS, which would not have been a benefit in quick SAR in civil-military cooperation as it is necessary to display casualties via an overlayer on a map directly for every user. Based on the findings in the second try, Openfire and its XMPP-server were the centre of an independent messenger listening and “9-Liner”-data processing. With this independent XMPP-trick, higher versions for Gradle, JDK and JRE could be used, which also affected most of the mentioned software applications in return as they now run faster and stablest. With this XMPP-trick related improvement, it is now possible to display 9-Liner attachments of military emergency messages on a civil overlayer.

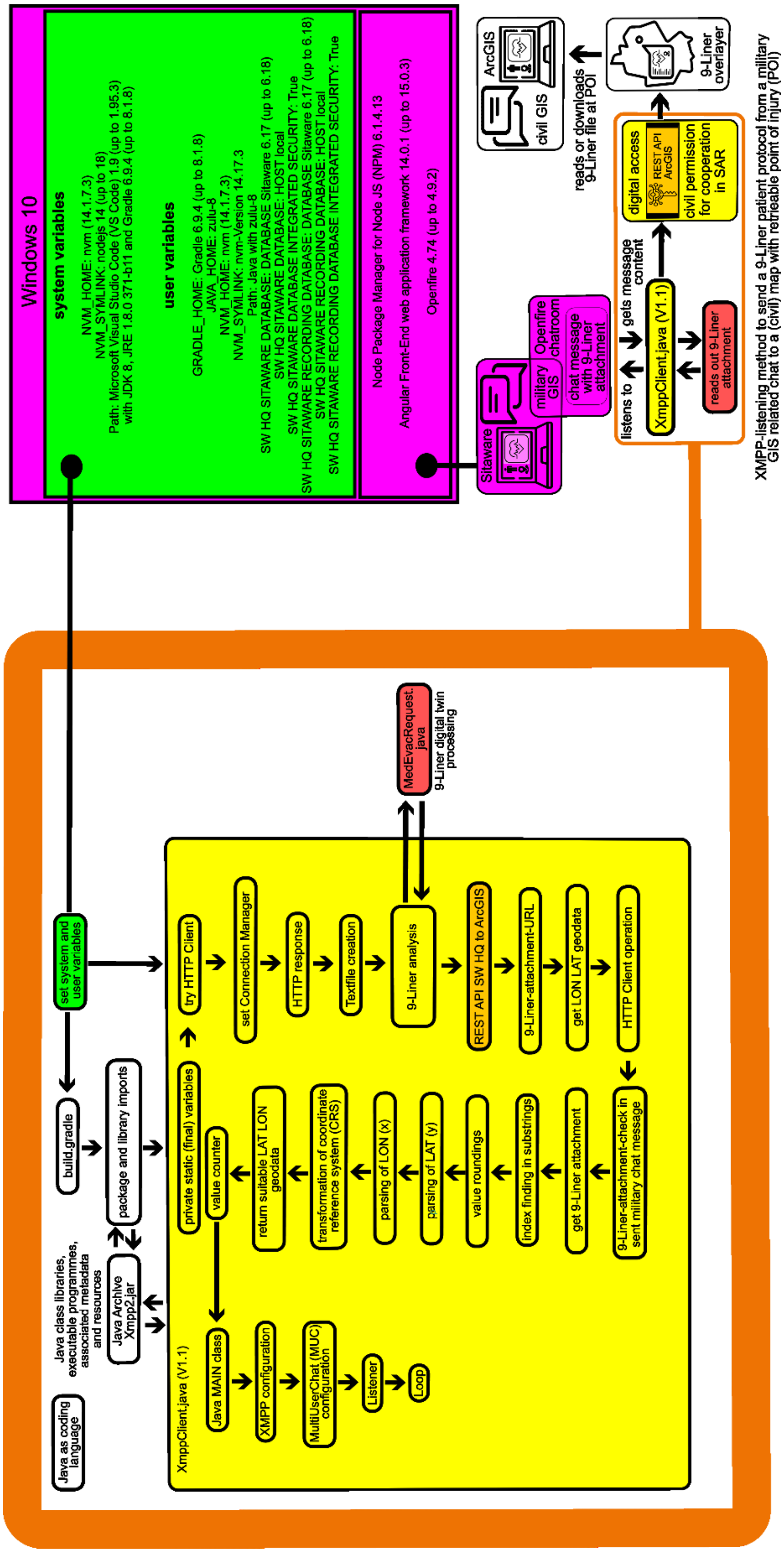


Figure 6. Software architecture with respective packages to send a 9-Liner MedEvac request patient protocol with internationally standard usable LAT-LON geodata from a military chat to a free overlayer of a civil GIS map

Before writing those main codes, it was necessary to do prework with the military GIS and respected SDK, where the assisted software systems were still bound to their prior used versions. In parallel, the user and system variables under the Windows 10 operating system were set up. The whole setting and installation process contained the software systems Sitaware HQ, ArcGIS Pro, Angular by Google, NodeJS, Openfire, Node Package Manager (NPM), Node Version Manager (NVM) but also the already mentioned set Gradle and Java variables for JDK and JRE as well as the VSC path (Staff members of ESRI, 2015; Staff members of Google, 2016; Staff members of Jive Software, 2002; Staff members of OpenJS, 2009; Staff members of Systematic, 2024). Then, sample artefacts were finally built, such as “angular-backwards-compatibility-samples”, “angular-samples” and “white listener-sample”.

From the lessons learned with the mentioned samples as well as the main subsystems and packages of the finally developed and tested codes, which resulted in two main consecutive versions, the current code architecture ”Xmpp2.jar” as Java Archive-file (jar), with comprised XmppClient.java and MedEvacRequest.java as a digital twin for a 9-Liner, both as subsystem versions 1.1, are shown in Figure 6.

This method only contains standard “World Geodetic System 1984 (WGS84)” geodata processing with latitude (LAT) and longitude (LON), as the addressee is civil and cannot use the military grid for geolocation or positioning at all. Nevertheless, 9-Liners can be filled with a Military Grid Reference System (MGRS) based on Universal Transverse Mercator (UTM), which is a flattening tile principle (MGRS-UTM), which is necessary for a future medical chat service method no. 2 from civil emergency units towards military ones.

For this method no. 1 from military users towards civil users, an MGRS-UTM would not reach the addressee on purpose as it cannot and should not be interpreted by civil emergency units or laypersons (Staff members of gs-soft, 2024). Moreover, the shown separated MedEvacRequest.java as digital twin in the figure above converts every 9-Liner attachment into a text file, independent from if it was a “.irs”- or “.txt”-file before. So, a civil addressed ArcGIS or any other GIS system can interpret this sent primitive text-attachment without file type errors on every operating system and every device.

The transformation of the coordinate reference systems (CRS), as shown in the software process blocks above, converts an European Petroleum Survey Group Code 4326 (EPSG 4326), known as World Geodetic System 1984 (WGS84) coordination system, with LON-LAT in Sitaware to a metric EPSG Code 3857, which is a WGS84 specific web mercator. Then, this is used for an overlayer projection in an ArcGIS Online browser tabulator. However, this does not change the 9-Liner geodata content itself. The civil addressee works with LON-LAT data for search and rescue (SAR) with regard to consistent civil-military cooperation as the 9-Liner content must remain machine-readable in addition (Staff members of Bundeswehr, 2022a; Staff members of MapTiler, 2020, 2022).

Procedure Verification and Validation of Method No. 1

In the beginning, the presented 9-Liner example from above was sent by an admin of a command and control post (C2 post). In disaster management, a C2 post could be a well-assembled team of civil and military emergency service leaders or deputies to handle major incidents who are sitting in a fixed emergency operation centre (EOC) or an Incident Command Vehicle (ICV) (Azzouni, 2023; Tapia et al., 2015). In this example, the admin got a 9-Liner from an emergency doctor of the armed forces who had been at the POI. In this situation, the admin passed on the 9-Liner from a heavily injured patient via a joint emergency chat, in German “Notfall”-chat, towards civil paramedic units, who were watching updates on a 9-Liner specific, self-updating overlayer in their civil GIS on their devices. With this information in this scenario, the paramedics activated a civil rescue helicopter as MedEvac. The procedure is displayed in the showns sequence of figures as follows:

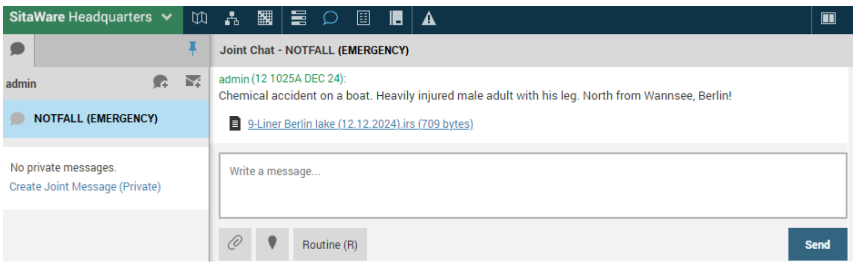


Figure 7. Joint Chat “NOTFALL (= EMERGENCY)”, sending a 9-Liner MedEvac request to all participants, including civil emergency service units, which can supervise casualties on their civil GIS map via “ArcGIS Online” during a civil-military cooperation (Staff members of ESRI, 1999; Staff members of Systematic, 2024)

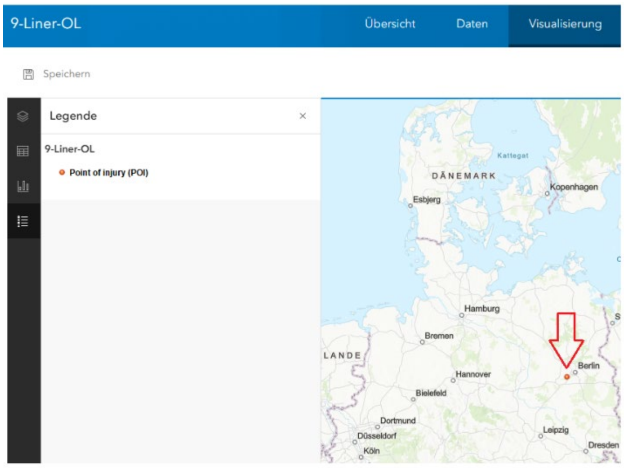


Figure 8. Self-updating overlayer "9-Liner-OL", which can be used as a map overlayer by any user in civil ArcGIS Online (Staff members of ESRI, 1999)

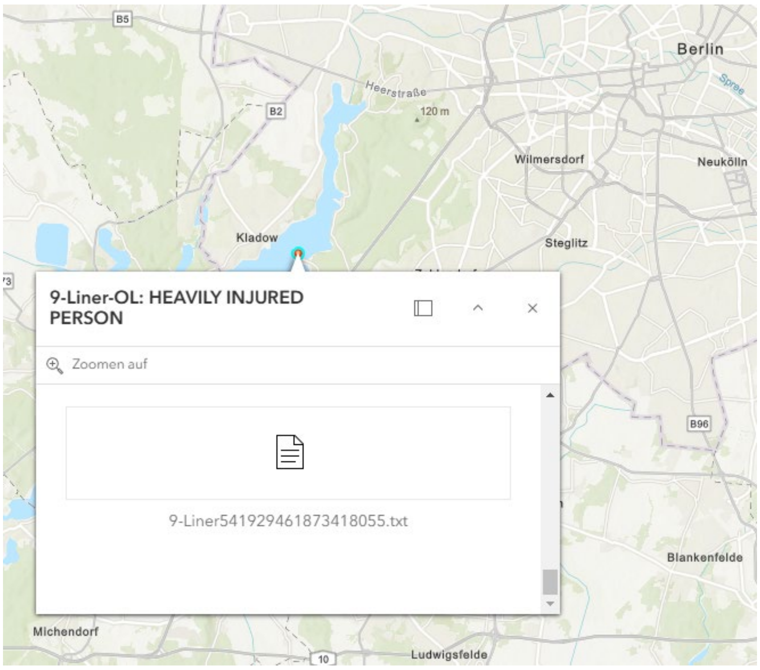
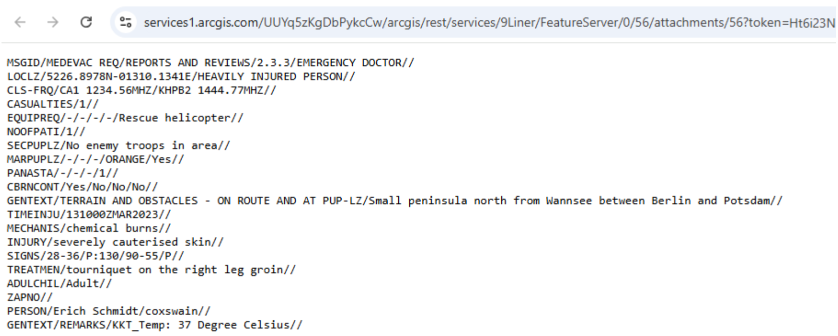


Figure 9. Clicking on POI "Heavily injured person" in civil GIS: Pop-up window with 9-Liner MedEvac attachment in ArcGIS Online (Staff members of ESRI, 1999)


services1.arcgis.com/UUYq5zKgDbPykcCw/arcgis/rest/services/9Liner/FeatureServer/0/56/attachments/56?token=Ht6i23N

```
MSGID/MEDEVAC REQ/REPORTS AND REVIEWS/2.3.3/EMERGENCY DOCTOR//
LOCLZ/5226.8978N-01310.1341E/HEAVILY INJURED PERSON//
CLS-FRQ/CA1 1234.56MHZ/KHPB2 1444.77MHZ//
CASUALTIES/1//
EQUIPREQ/-/-/-/-/Rescue helicopter//
NOOFPATI/1//
SECPUPLZ/No enemy troops in area//
MARPUPLZ/-/-/-/ORANGE/Yes//
PANASTA/-/-/-/1//
CBRNCONT/Yes/No/No/No//
GENTEXT/TERRAIN AND OBSTACLES - ON ROUTE AND AT PUP-LZ/Small peninsula north from Wannsee between Berlin and Potsdam//
TIMEINJU/131000ZMAR2023//
MECHANIS/chemical burns//
INJURY/severely cauterised skin//
SIGNS/28-36/P:130/90-55/P//
TREATMEN/tourniquet on the right leg groin//
ADULCHIL/Adult//
ZAPNO//
PERSON/Erich Schmidt/coxswain//
GENTEXT/REMARKS/KKT_Temp: 37 Degree Celsius//
```

Figure 10. Displayed 9-Liner-txt-file, opened in a new browser tab, which is compatible on every device. The file can also be downloaded regularly by emergency services, first responders and laypersons.

As the displayed 9-Liner-format style is invariable to remain machine-readable for Sitaware and related data exchange processes, it is important to read the given coordinates correctly in a manual way for first responders, laypersons and (para-)medics. In a 9-Liner file, the shown coordinates are multiplied by a factor of 100. For this example, the coordinates of “LOCLZ” are 5226,8978 => 52,268978 degrees North (deg N) and 1310,1341 => 13,101341 degrees East (deg E). The ISO-standardised vital data “SIGNS” show a 28 - 36 respiration rate per minute (“Resp.” in [1/min]), a pulse P of 130 beats per minute (“BPM” in [1/min]), blood pressure values between 90 - 55 mmHG with upper (“RR_systolic” = 90 mmHg) and lower (“RR_diastolic” = 55 mmHg) value, a painful reaction “P” and a body temperature of 37 degrees Celsius (“Temp.” in [°C]), whereas the body temperature is displayed in the “REMARKS” line additionally (Staff members of ISO, 2022). Concerning this medical hypotension, a possibly heavily wounded leg with blood loss and tourniquet treatment as written in the 9-Liner, this heavily injured casualty needs urgent transport to a suitable hospital.

To test error-free transmission verification, all 9-Liner variants had to be sent. As Sitaware can detect error-free input typing, the highest number of 9-Liner protocols results from either the sum of ticking and filling out single fields or the highest amount of their combinations. The total sum of single ticking or filling out fields are mathematically identified with 57, whereas the combination use of protocol line zero to twelve results in 720. Therefore 720 different 9-Liners were sent via this second fully developed software version. As result, all 9-liner combinations were successfully transmitted on the civil map overlayer without any error return feedback.

CONCLUSION

The development of this software has shown that legal tapping of specific SAR information, such as vital signs and geolocation, in the shape of a 9-Liner MedEvac request, in a military chat to be subsequently shown on a civil GIS overlayer for cooperating emergency units and laypersons, works out very well. The main thing that made it work was to tap information from the independent Openfire chat with XMPP protocol as pivotal point. Moreover, using text-files makes the information exchange independent from operating system or device. Finally, Sitaware and ArcGIS are well established GIS solutions on both sides the military and civil one for wide-spread seamless cooperation. Precise geo-tracking of patients is one of the fastest variants to identify casualties while simultaneously checking vital signs.

In addition as advantage, civil units can always cut off the cooperation with military units by changing or deactivating the API key for a lean handling in disaster management, so responsibilities and power are clearly distributed. The consistent usage of the civil geo data style, which is also familiar to military units, enables uniform civil-military cooperation for fast SAR. Nevertheless, in future, the MGRS must also be usable for emergency messages towards the opposite direction.

As an outlook, the sending method no. 2 from civil emergency services towards military services via 9-Liner MedEvac requests in SAR must be developed to complete a bidirectional communication platform for identifying casualties on maps with their vital signs attached. As a further improvement, a geo data converter from civil geo data to MGRS will be implemented in a constructive second paper with software version number three.

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