Australian Government

Department of Defence
Science and Technology

Conducting Information Superiority Research in an Unclassified Surrogate Defence Environment

Andrew Walters, Russell Anderson, Jonathan Boan, Angela Consoli, Mark Coombs, Adam Iannos, Drew Knight, Mathew Pink[1], Jayson Priest, Tim Priest, Andrew Smith, Brad Tobin, Sonya Williamson[2] and Ben Laurenson[2]

Weapons and Combat Systems Division

Defence Science and Technology Group

DST-Group-TR-3529

ABSTRACT

Defence experimentation brings significant value, but also significant overheads. Therefore to achieve rapid development it is important to strike a balance between working on real systems and surrogate systems (when there is a straightforward translation to Defence systems and/or scenario). The emergency services domain is one such non-Defence surrogate system offering significant potential to mitigate many of these overheads. In November 2017 an information exchange experiment was conducted under the Real-Time Information Superiority Experimentation (RISE) initiative with Surf Life Saving South Australia to gauge the applicability of this domain to Defence research. The outcome was a success, leveraging extended resources and expertise at no cost, producing a varied set of applicable data products and a rich pool of information capable of supporting ongoing research into information superiority. We recommend to continue this line of experimentation while increasing its complexity and exploiting its dynamic nature.

RELEASE LIMITATION

Approved for Public Release

[1] Consilium Technology Pty. Ltd.
[2] Surf Life Saving South Australia

Produced by
Weapons and Combat Systems Division
DST Group Edinburgh
PO Box 1500
Edinburgh SA 5111
Telephone: 1300 333 362

September 2018
AR-017-280

APPROVED FOR PUBLIC RELEASE

Conducting Information Superiority Research in an Unclassified Surrogate Defence Environment

Executive Summary

As always, mission success at the 'tactical edge' will be enabled by information superiority over adversaries. The nature, extent and seamless availability of the information needed to achieve this superiority in the future battle-space will continue to grow over time. The Defence Science and Technology (DST) Group is conducting research on the development and application of advanced information-network and software technologies; seeking seamless integration of heterogeneous military tactical information systems by addressing the challenges of operating at the tactical edge.

This work is supported by various stages of research: from generating hypotheses, to modelling and simulation, laboratory tests and operationally relevant experimentation with Defence systems. Despite the value derived from experimentation involving Defence systems and operators, such experimentation can bring significant overheads and impediments to timely progress. In the majority of cases, many of the vexing integration and interoperability science and technology (S&T) risks and issues can be investigated and solved more quickly, and at much lower cost, in a completely unclassified surrogate environment.

A potential surrogate domain that operates in a tactical edge-like environment is the emergency services domain (ESD). This domain seeks to develop many of the same information exchange and management concepts and capabilities that Defence is pursuing, but in an unclassified environment that is adaptable, agile and highly configurable. Under the Real-Time Information Superiority Experimentation (RISE) initiative, an experiment was conducted on 25 November 2017 by DST, Consilium Technology and Surf Life Saving South Australia (SLSSA). That experiment investigated the utility of conducting Defence-relevant experimentation within the ESD to support ongoing information superiority research. The experiment used a simulated search and rescue scenario to identify the quality and quantity of suitable data/information that could be produced in a surf life saving environment to assess its suitability for informing Defence research.

It was determined that this ESD scenario contained similar characteristics, challenges and technologies as the Defence tactical edge. The environment was found to be dynamic and produced multiple complimentary data products that involved diverse and rapid information exchanges between participants. Post-experimental analysis further confirmed Defence relevance by identifying challenges in sharing, processing and interpreting information. The Tactical-Systems-Integration Experimentation Architecture Support (TEXAS) framework was also found to be a solid foundation for experimentation, supporting multiple aspects of the future research. Working in the ESD allowed abstracted information, technologies and scientific concepts to be studied quickly and at low cost whilst providing tangible benefits to Defence. From this initial study we recommend moving to the next phase of experimentation, where the focus will be on trusted reference data, interoperability, decision aids and fully adaptable software architectures.

This page is intentionally blank.

Contents

Glossary

AMQP	Advanced Message Queuing Protocol
ATV	All-Terrain Vehicle
BSLSC	Brighton Surf Life Saving Club
CFS	Country Fire Service
COP	Common Operating Picture
DST	Defence Science and Technology
ESD	Emergency Services Domain
GPS	Global Positioning System
HQ	Headquarters
IRB	Inflatable Rescue Boat
ITAR	International Traffic in Arms Regulations
JRB	Jet Rescue Boat
JSON	Javascript Object Notation
LASAGNE	Layered Approach to Service Architecture for Global Networked Environment
MFS	Metropolitan Fire Service
QoI	Quality of Information
RCC	Rescue Coordination Centre
RISE	Real-Time Information Superiority Experimentation
RWC	Rescue Water Craft
SA	Situational Awareness
SAR	Search and Rescue
SES	State Emergency Service
SLSA	Surf Life Saving Australia
SLSC	Surf Life Saving Club
SLSSA	Surf Life Saving South Australia
SOA	Service Orientated Architecture
TEXAS	TSI Experimentation Architecture Support
TSI	Tactical Systems Integration
URL	Uniform Resource Locator

This page is intentionally blank

1. Introduction

In the future battle space, establishing and maintaining a common shared situational understanding at the tactical edge will require knowledge of what is happening, why it is happening and foresight about what may happen next. Information Superiority is defined as 'the operational advantage derived from the ability to collect, process, and disseminate an uninterrupted flow of information while exploiting or denying an adversary's ability to do the same' [1]. To achieve information superiority within a tactical environment a joint task force must:

- be interoperable (share and understand machine-readable information when needed)
- be able to integrate diverse information to form an holistic picture of the environment.

The implementation of technologies that can support information superiority [2] at the tactical edge (where the war fighter and first incident responders operate) presents a significant challenge. Heterogeneous systems, varying information requirements, ad hoc wireless networks, limited on-board storage, processing-power limitations, power supply limitations, unstable links with limited bandwidth, variable latency and interference from non-military systems demand capabilities that are seldom fully realised. Operating at the tactical edge requires rapid access to relevant, accurate and timely information along with the ability to create and share knowledge so as to support superior decision-making in an assured environment in the presence of unprecedented quantities of data [3]. To address this seemingly insurmountable gap, innovative solutions in software, hardware and operational doctrine are required.

The Defence Science and Technology (DST) Group is conducting research on adaptive information management, networking, and architectures that address the challenges of operating heterogeneous systems at the tactical edge. This includes technologies and concepts such as Internet Protocol (IP)-based communication networks, service-orientated open software architectures (SOA), unstructured data extraction and information fusion and quality of information (QoI).

Investigating the use, application and integration of these advanced technologies into a tactical environment requires various degrees of experimentation. This experimentation can be facilitated through a range of means such as simulation, tightly controlled laboratory-based experiments, and trials within an operational or operationally representative environment. These steps are summarised in Figure 1, which illustrates an indicative research process mapped to the established Technology Readiness Levels (TRL) [4].

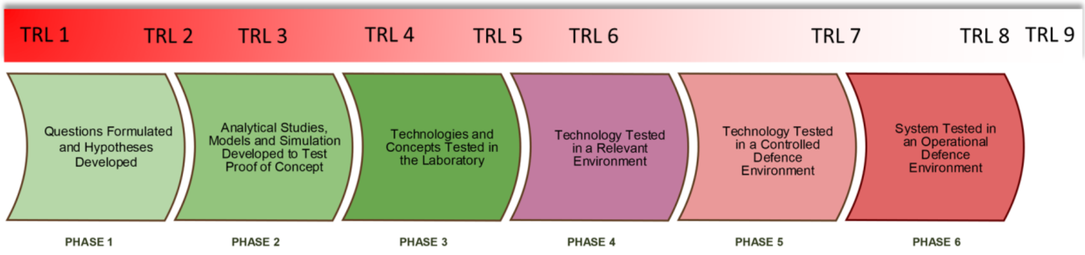

Figure 1. Research Phases

Juxtaposed to the value that experimentation involving Defence systems and operators brings, such experimentation also carries significant overheads. Notable among these are: security; managing ITAR (International Traffic in Arms Regulations) proprietary information; direct costs; and the availability of assets and operators. These overheads often require the experimental tests to be rigidly defined well in advance of the testing. It is therefore important to strike a balance between the experimentation conducted using real systems and the use of surrogate systems. An ideal surrogate experimentation environment should be representative, low-cost and allow for rapid changes to the experiments in situ.

An exemplar non-Defence domain that operates in a tactical edge-like environment is the emergency services domain (ESD) [5]. The ESD offers potential to significantly reduce the overheads associated with going directly from simulation to operational exercises while providing strong parallels to the Defence tactical edge. Potentially relevant ESD forces include Surf Life Saving Australia (SLSA), the Police Force, the Metropolitan Fire Service (MFS), the Country Fire Service (CFS), the State Emergency Service (SES) and Ambulance services. Surf Life Saving is a useful first option as it offers a complex environment with a mix of land, sea and air assets operating within a coordinated framework.

The utility of the ESD environment for ongoing information superiority research can be assessed against key criteria; specifically:

- Is the environment sufficiently dynamic to support the generation of datasets large enough to demonstrate quantifiable trends in information flow?
- Can multiple data types be collected to provide cross validation?
- Can the environment facilitate the sharing of different information types to support information integration research?
- Does the environment provide adequate stimulation to experiment with service-orientated open software architectures (SOA)?
- Does the environment exhibit Defence-relevant challenges in information sharing, processing and interpretation?
- Can an experimentation framework be developed to facilitate the desired investigations?

This report details a collaborative experiment conducted using the 'Real-time Information Superiority Experimentation' (RISE) experimental framework, conducted on the 25th of November 2017 by the Defence Science and Technology Group, Consilium Technology and Surf Life Saving South Australia to address the above questions. It details the infrastructure developed, data/information collected, lessons learnt and the proposed way forward.

2. Surf Life Saving South Australia

Surf Life Saving South Australia (SLSSA) reflects aspects of the ADF in miniature. Operations typically involve: water assets (e.g. jet boats and/or jet skis); land assets (e.g. patrol vehicles); land forces (e.g. surf life savers); and a centralised coordinator (e.g. SURFCOM), with incidents coordinated over a range of information pipelines (from voice on digital radios and smart phones through to IP chat). Tactical engagements are also driven at a similar tempo to those of Defence and with similar challenges. SLSSA assets regularly face problems in communications connectivity, limited bandwidth, information quality issues, difficulty in the interpretation of information and the requirement to make quick decisions in an ever-changing environment.

An example of a local beach setup is shown in Figure 2 along with some typical incidents.

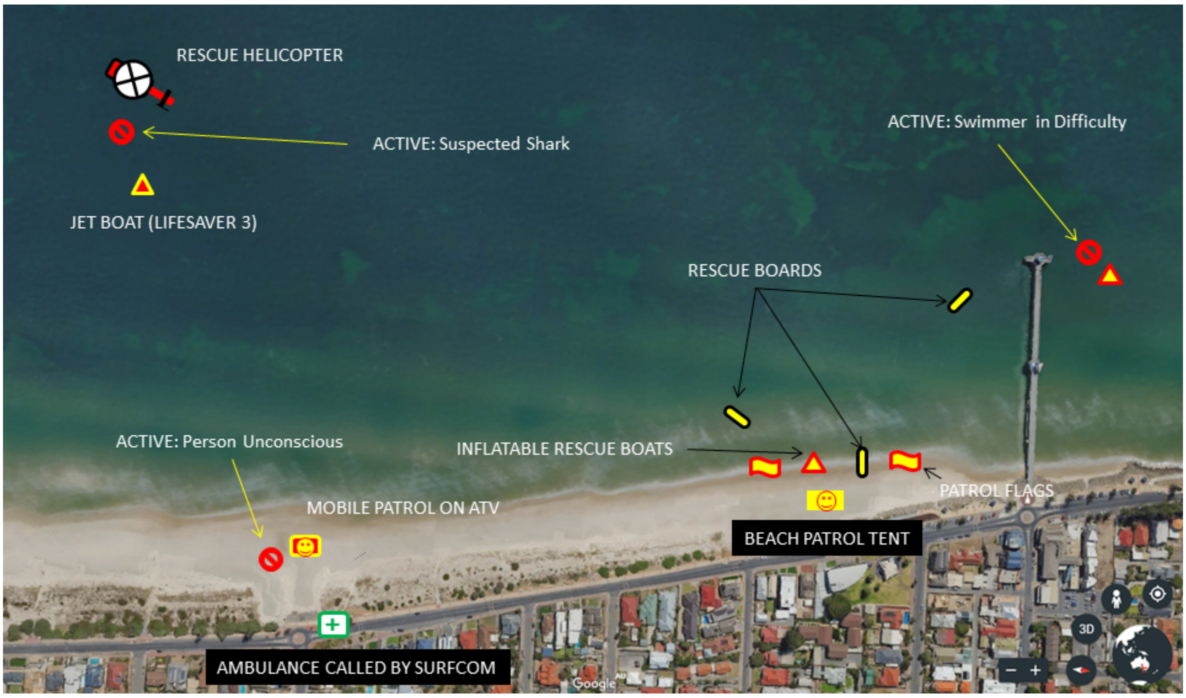

Figure 2. Pictorial representation of some typical surf rescue scenarios at a local beach

The SLSSA main assets operated by SLSSA are described in further detail in the following sections.

2.1. SLSSA HQ & SURFCOM

SLSSA headquarters (HQ) is located at West Beach, South Australia. All surf life saving operations within South Australia are managed from this facility (see Figure 3). This includes emergency services coordination, training and education and surf sports competitions. Their mission and vision statements are [6]:

> **Mission**
> To save lives and build healthier and safer communities.
>
> **Vision**
> A unique and celebrated water safety organisation building vibrant and inclusive community hubs that inspire people through the delivery of excellence in emergency service, training, education and sport.

Figure 3. Surf Life Saving South Australia Headquarters at West Beach SA

Co-located with SLSSA HQ is the operations building, SURFCOM. Housing the main radio room (see Figure 4), it is from here that all operations are coordinated. SURFCOM also houses a platform preparations area, from which some water assets are launched (Jet Skis and two Jet Boats).

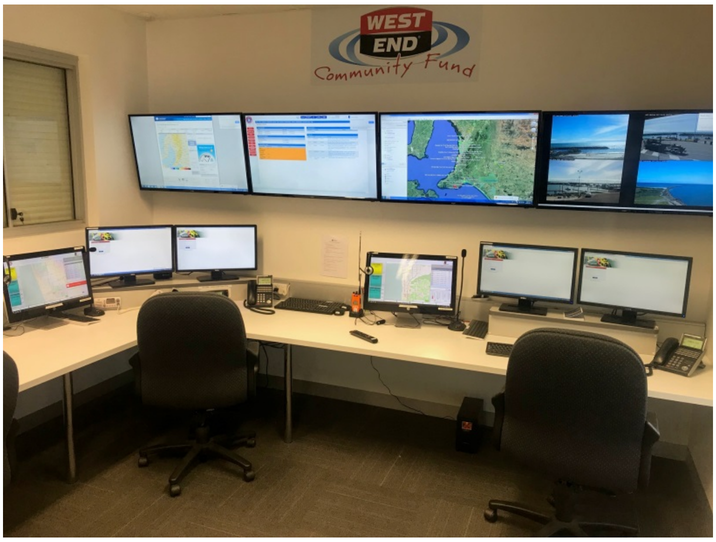

Figure 4. Surf Life Saving SA Radio Room

2.2. Rescue Helicopter

The rescue helicopter, Figure 5, operates along the extended Adelaide coastline to provide aerial surveillance support and a search/find/track capability. The call sign for the helicopter is 'WESTPAC1'.

Figure 5. Surf Rescue Helicopter - Westpac 1

2.3. Jet Rescue Boat

Jet rescue boats (JRBs), Figure 6, are used for rapid response from the water, with the ability to rescue numerous people in one sortie. The boats conduct surveillance and rescue operations along the coastline in the metropolitan, mid-South and far South regions of the state. They are constructed to allow close shore approach. The call signs for these craft are LIFESAVER 2 and 3 respectively. These craft are crewed by at least two qualified surf life savers.

Figure 6. SLSSA jet rescue boat (JRB)

2.4. Jet Skis

Jet skis provide a rapid first respondent capability that is agile, able to rescue small numbers of people and can access confined spaces and difficult to access areas. These craft are given the designations 'Rescue Water Craft' or RWC. The craft is shown in Figure 7.

Figure 7. Surf Rescue jet ski

2.5. Inflatable Rescue Boats (IRBs)

IRBs offer short range, rapid water response and are able to rescue multiple people (see Figure 8). IRBs are launched from the local surf life saving clubs and generally stay within the confines of that club's patrol area unless engaged in special support requests, such as event surveillance. These craft are generally crewed by two surf life savers, a driver and a crewperson.

Figure 8. Inflatable Rescue Boat (IRB)

2.6. All-Terrain Vehicle (ATV)

All-terrain vehicles (ATV), Figure 9, provide fast response on the sand and the ability to transport people in need to a first-aid room or an ambulance. ATVs have some equipment-carrying capacity and provide a towing capability for assets, including trailers. The vehicle can accommodate two surf life savers in the cabin area.

Figure 9. All-terrain vehicle (ATV)

2.7. Beach Patrol

Each major beach along the South Australian metropolitan coast is patrolled by a group of surf life savers from a nearby surf life saving club (SLSC) (e.g. Brighton Surf Life Saving Club, BSLSC). The patrol is under the control of a patrol captain and is usually staffed by five to ten surf life savers. A patrol tent is used as a temporary base and contains required equipment including oxygen bottles, first-aid kits, radios, a spinal board, rescue boards, rescue tubes and various signal flags (see Figure 10). The beach patrol also manages the 'Safe to Swim' patrol flags that are placed on the shore to signify an area that is under constant surveillance; and therefore considered a low risk swimming area.

Figure 10. Typical beach patrol setup.

3. TEXAS Framework

As SLSSA do not presently use the equivalent of combat or mission system on their assets or within the control/coordination area, a framework was required to host technologies for experimentation within the SAR environment. The goal was to make an unclassified framework that is adaptable, extensible, fully configurable and runnable on a range of hardware platforms. Developed services and components were designed to support the research program, allowing the investigation of particular methodologies and/or technologies.

To facilitate the above-stated requirements the Tactical-Systems-Integration Experimentation Architecture Support (TEXAS) framework was developed. The TEXAS framework was – and continues to be – developed as a research tool in collaboration with Defence–industry partner Consilium Technology.

TEXAS has two major components: the user interface and the technologies running in the background. TEXAS allows for the positions of multiple 'blue' assets to be presented as tracks on a digital map user interface, leveraging SOA technologies such as the LASAGNE[3] [7] middleware framework developed by DST Group in response to a growing need within defence for tactically-directed SOA. Using LASAGNE gives the system a significant level of fluidity and adaptability, providing a near ideal environment in which to develop prototypes for experimentation within a Defence exercise; in essence reducing the risks around complex experimentation with high value Defence assets.

[3] Layered Approach to Service Architecture for Global Networked Environment.

3.1. Functionality

The presentation layer of the TEXAS framework was developed using web technologies, permitting deployment on Android, iPhone and any device that can run a modern browser (such as Google Chrome). TEXAS can utilise the available sensors on the platform, including the Global Positioning System (GPS), video camera and magnetic compass. For Experiment 1 TEXAS was deployed on a set of Android devices (see Figure 11) as well as desktop machines via the browser (see Figure 12). As well as providing a blue force tracking capability, TEXAS was used to monitor and record key performance and information metrics during the experiment. The aim in experiment 1 was to collect this data and analyse it post experiment in support of the evaluations discussed in Section 1. All data was logged in JavaScript Object Notation (JSON) format. A full list of data items monitored by TEXAS in this experiment is shown in Table 1.

Figure 11. TEXAS application on the issued smart-phone

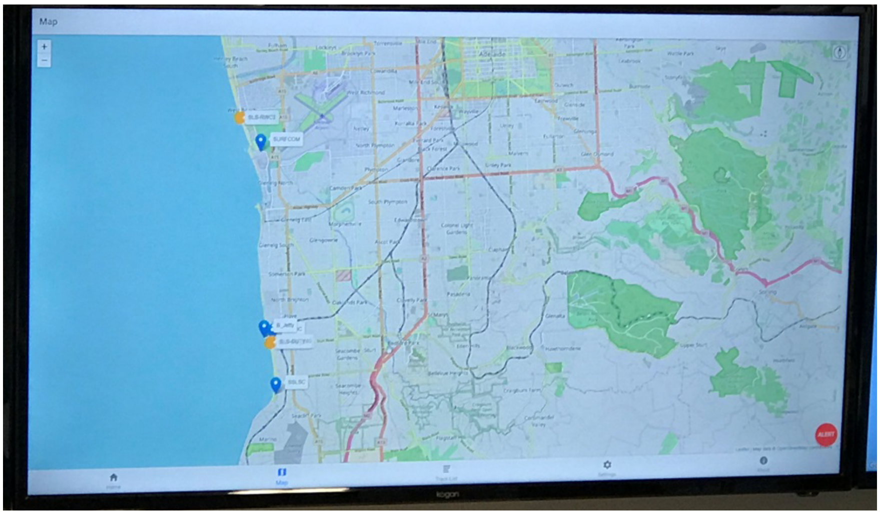

Figure 12. TEXAS application computer display

Table 1. TEXAS application recorded data items.

Data Item	Description
Asset ID	The ID given to the asset (TEXAS smart phone) as it appears on the user interface.
Asset Location	Latitude and Longitude of each asset as a function of time.
Status	Reporting or not reporting location bound by a time threshold i.e. not reported for 10 secs therefore appears as offline.
Heading	Direction facing in relation to the underlying map.
Time	All data are time stamped.
Battery Level	The smart phone battery level is recorded as a percentage. There is also an indication of charging state (plugged in or not).
Signal Strength	Mobile receiver strength (dBm).
Application Settings	Device name, GPS enabled, Compass enabled, track prefix, LASAGNE enabled, LASAGNE backend Uniform Resource Locator (URL), message queue (mq) enabled, mq server address, mq user, mq password.

3.1.1. Situational Awareness

Situational Awareness (SA) is the main responsibility of the TEXAS user interface. Using a geographical map that occupies most of screen, the user is able to see their current location as well as those of other assets. The map can be panned and zoomed dynamically to alter the level of detail to suit the user and their immediate needs. Figure 13 shows an illustration of the TEXAS map.

Figure 13. TEXAS Map

3.1.2. Alert Status

Another capability of TEXAS in experiment 1 was to permit the sending and receiving of alerts. When an alert is sent from one asset it is received by all other assets within the network. The alert is sent by one user clicking the Alert button as illustrated in Figure 14. Figure 14 also illustrates what the alerts look like for the receiving assets.

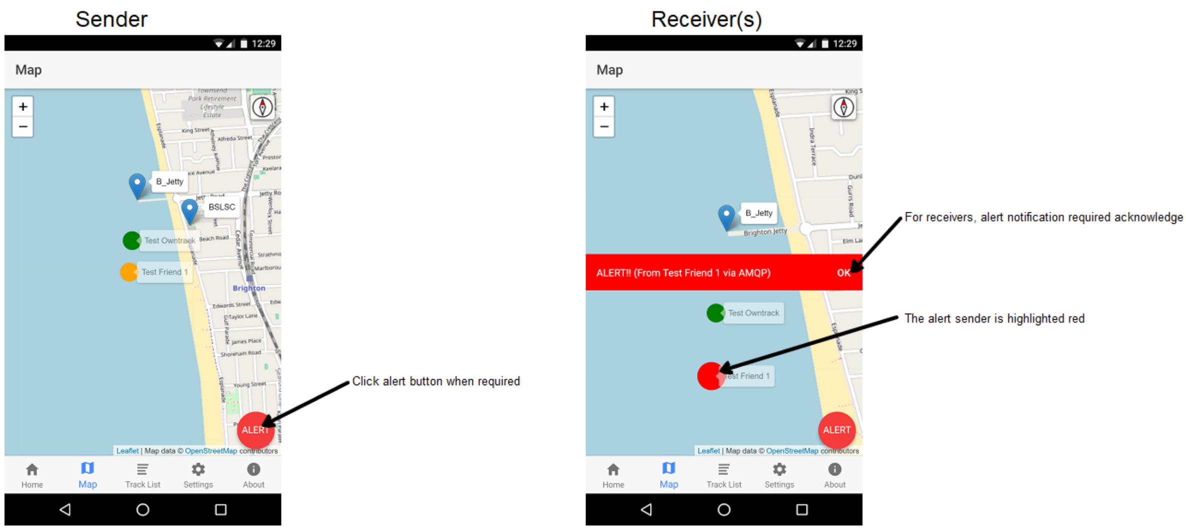

Figure 14. TEXAS Alerts

3.1.3. TEXAS Data Flow

The TEXAS framework stores data locally as well as communicating data to and from a designated server. The diagram in Figure 15 gives an overview of this data flow during a typical passage of activity during experiment 1.

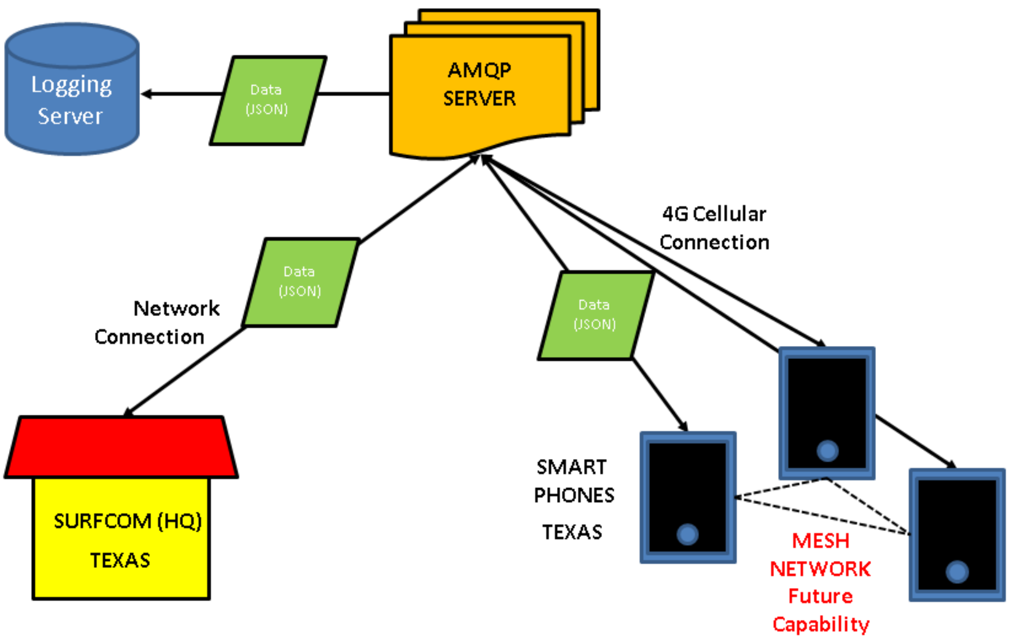

Figure 15. High level data flow diagram for the TEXAS application

The mesh network between the smart phones shown in Figure 15, required for a fully functional implementation of LASAGNE, is a planned future upgrade of the system. For experiment 1 this capability was not required as the services deemed to be adequately supported by using an AMQP (Advanced Message Queuing Protocol) server accessible through the terrestrial and cellular networks. The intent for experiment 2 is to have a full LASAGNE implementation across a point-to point-network utilising a bearer such as Wi-Fi direct. Further planned TEXAS services/component capabilities are listed in Section 7, Table 4.

4. Procedure for Experiment 1

As mentioned in Section 1, the overarching aim of this experiment was to test the applicability of the SLSSA environment for conducting Defence-relevant research related to information superiority. Below this was a domain specific aim in the context of the search and rescue (SAR) training exercise that supported the information research. The SAR aim was to investigate the functionality of TEXAS to SLSSA participants as a blue force tracking tool to support enhanced situational awareness. SLSSA standard operating procedures facilitate common SA through radio communications between assets and SURFCOM. The introduction of a digital map with task force asset locations in real-time is a step change in the way SLSSA monitors and reacts to the environment.

With the above in mind, it was decided that the experimental procedure would be to conduct three runs of a common scenario: two with TEXAS as an SA tool and one using SLSSA radio communications only, while collecting statistics on both the quality and quantity of the exchanged information.

It should be noted that this study was not intended to explicitly assess the impact of introducing a tool like TEXAS into the SLSSA environment; rather the overall aim was to assess the applicability of SLSSA as a suitable unclassified surrogate environment. It is acknowledged that the experiment did not contain an adequate number of runs to produce or make an assessment on the impact of TEXAS on SA. In addition there was an unavoidable 'learned behaviour' by participants across the three runs, resulting in a potential bias in the SAR activity. All attempts were made to minimise this effect within the constraints of the resources available.

4.1. The Scenarios

The SAR scenarios used for this experiment were based around a typical training exercise conducted by SLSSA. The primary storyline was:

> SURFCOM receives a report from Sea Rescue that a small boat has been reported as overdue, not returning to its departure point by the expected time. The boat contains six passengers, is red/orange in colour and was last seen 1 to 2 km off of the Seacliff coastline.

For this experiment SLSSA provided the following assets (with required personnel):

- 1 x jet boat (LIFESAVER 3)
- 2 x jet skis
- 2 x inflatable rescue boats (IRBs)
- 1 x inflatable rescue boat (Boat in Distress)
- Beach Patrol at Brighton Surf Life Saving Club
- 1 x all-terrain vehicle (ATV)
- Coordination through SURFCOM
- Local incident commander, designated 'DUTY 10'.

The designations of the craft and assets, along with the designation used within the TEXAS framework, are listed in Table 2.

Table 2. Rescue Craft Assets in Experiment 1

Rescue Craft	Origin at Start of Run	Designation in TEXAS
Jet Boat (Lifesaver 3)	West Beach	SLS-LS3
Jet Ski 2	West Beach	SLS-RWC1
Jet Ski 4	West Beach	SLS-RWC2
Inflatable Rescue Boat	Brighton Beach	SLS-IRB_B1
Inflatable Rescue Boat	Brighton Beach	SLS-IRB_B2
All-Terrain Vehicle	Brighton Beach	SLS-ATV_B1
Inflatable Rescue Boat	Seacliff Beach	RED-BID

This search and rescue scenario, controlled and coordinated by SLSSA, was conducted in an area at sea 1 - 2 km offshore (see Figure 16). In addition to the SLSSA assets and personnel, DST and Consilium Technology staff were involved in conducting the measurement element of the experiment. The location and numbers of the assets and personnel involved are shown in detail in Figure 16.

Figure 16. Map of the experiment environment

As shown in Figure 16, the experiment utilised three main sites:

- SLSSA HQ & SURFCOM at West Beach
- Brighton Beach, shown in Figure 17
- The offshore region between Brighton and Seacliff.

The teams from SLSSA and the DST Group observers involved in the exercise were split between SURFCOM and Brighton Beach. The Brighton Beach site is located 8.5 km South of SURFCOM, an approximately 16 minute drive. The Brighton Surf Lifesaving Club (BSLSC) is located at Brighton beach and was fully equipped to conduct the required weekend beach patrols. The surf life savers from BSLSC who participated in the trial conducted their operations from the club rooms where the vehicles, boats and lifesaving equipment were stored.

Figure 17. Brighton Beach SA

For the SAR scenarios, six simulated patients (plastic tubs with patient information adhered to them) were placed in a SLSSA rescue boat designated 'RED-BID'. Together they formed the 'boat in distress' target for the SAR scenarios (see Figure 18 and Figure 19).

The experiment was broken into three runs:

1. Run number one was to conduct the SAR scenario using standard practices enhanced by the Common Operating Picture (COP) provided by TEXAS running on Defence owned smart phones. During this run, TEXAS was used to support the radio centric SAR co-ordination
2. The second run was to repeat the SAR scenario using standard practices co-ordinated over radio communications only; the TEXAS application was used in record-mode during this run to assist with post activity analysis
3. The third and final run was a repeat of the first with the TEXAS application being used to support SAR coordination by the SLSSA personnel

Figure 18. Boat in distress with simulated patients, 'RED-BID'

Figure 19. Simulated patients (blue tubs) showing the A4 sheets detailing the medical conditions, attached to the outside of the containers. These are listed in Appendix A.

Each run commenced with the call of 'EXERCISE, EXERCISE, EXERCISE' followed by a simulated report of an overdue boat, containing six passengers, to SURFCOM. Assets were scrambled to locate the position of the boat using standard SLSSA operating instructions when conducting a search. In experiment Runs 1 and 3 the first respondent to the boat in distress raised the alert on TEXAS (Figure 14) and other assets converged to the position and coordinated transport of patients from the water to BSLSC where patients were assessed and the next level of first-aid was determined. To stimulate information flow, and therefore enrich the scenarios, the simulated patients were given prior and current (incident induced) medical conditions for the surf life savers to address and treat. Prior medical conditions are listed in Appendix A, Table 5, while the 'current' medical conditions used across the three experimental runs are shown in Appendix A, Table 6. This was done to add variety for those participating in the experiments and reduce the impact of the learning effect from previous experimental runs.

To further reduce the learning effect, in addition to changing the medical conditions, the initial location of the boat-in-distress was also changed. The goal was to have the boat located such that it could not easily be seen at the start of the experimental run, would require some effort to search for and stimulate information flow between all assets (see Figure 20).

Figure 20. Locations of the boat in distress for the three runs.

4.2. Data Types Collected

During the experimental runs, data/information was collected from various sources for post experimental analysis. The data aggregated into three main categories:

- observations made by researchers
- digital data collected by TEXAS
- digital data recorded using equipment and systems not attached to, or integrated with, TEXAS

A brief description of these data products are provided in the following sections.

4.2.1. Observations

DST staff were located at several key positions in order to record their observations during the course of each experimental run. The number and location of observers is shown in Figure 16 by the 'green' person icons. The largest concentration of observers was within SURFCOM where the DST staff served several roles (Figure 21 and Figure 22). One role was as observers in the radio room to document events as they unfolded, taking note of the information flow between the radio operators and the information transmitted and received from those out in the field. Another was as experimental coordinators – from a

DST perspective – ensuring all the required information products were being collected, and making observations in regard to the evolution of the experiment. DST staff also worked alongside Consilium Technology staff members to monitor the performance of TEXAS and to address issues as required.

DST staff were also located on Brighton Jetty (Figure 23) to record video of the experiment from afar and to make additional observations of events. Observers were also placed near the Brighton beach patrol tent and at BSLSC (Figure 24). Again, this was to observe and record the evolution of the experimental runs, to ensure all data products were captured and to provide any real-time maintenance to DST equipment, as required. The DST teams and the SLSSA personnel are shown in Figure 25 and Figure 26. A benefit of having researchers observe the experiments in real-time was the ability to modify and change aspects of the study in response to unexpected outcomes. This resulted in a more agile framework of investigation and optimised use of resources with a focused research outcome.

Figure 21. DST Coordination and TEXAS team at SURFCOM

Figure 22. DST observers in SURFCOM

Figure 23. Brighton Jetty observation point

Figure 24. BSLSC Observation Point

Figure 25. The SURFCOM Team

Figure 26. Brighton Beach and Jetty teams

4.2.2. Audio Recordings

The audio recordings from the SURFCOM software system represent one of the key data products from this experiment. The recordings captured the radio communications made between SLSSA personnel that occurred on the SLSSA digital radio network during the experiment. The Tait handheld radio used is shown in Figure 27. The digital audio files were captured within the SURFCOM RediTalk™ system located on a computer within the radio room at West Beach (see Figure 28). The audio files were organised into conversations, with recordings stopped after a predefined period of silence. These files were in the waveform audio file (WAV) format.

Figure 27. The Tait TP9300 handheld digital radio used by SLSSA

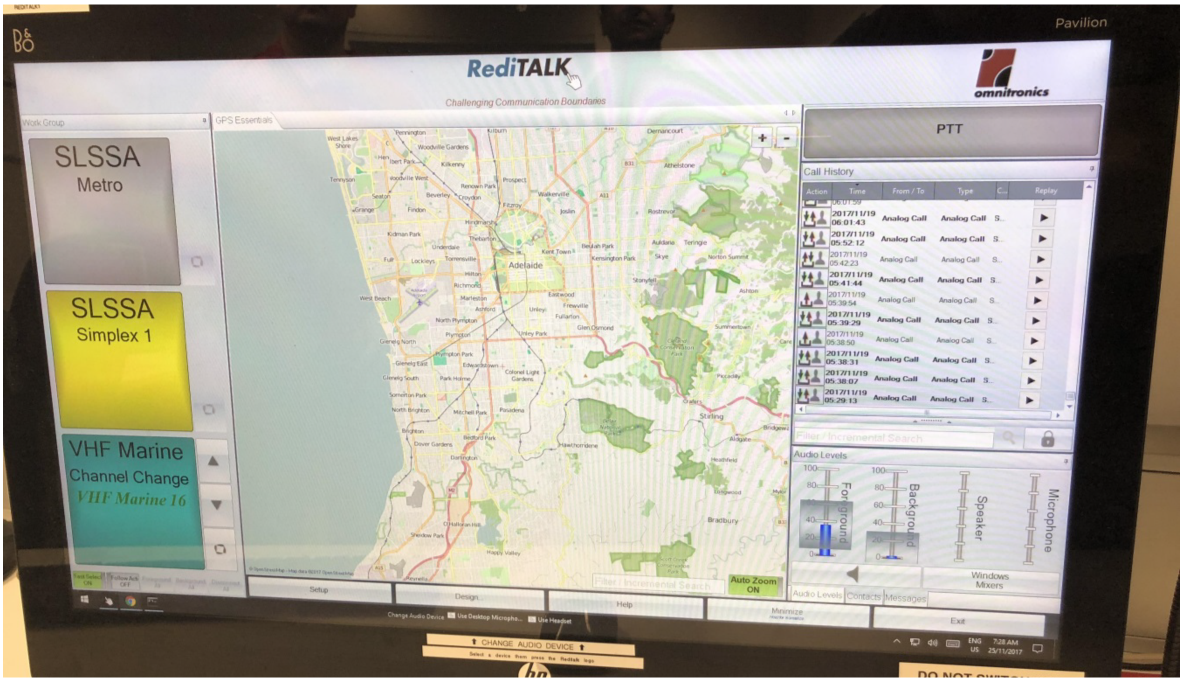

Figure 28. RediTalk™ user interface

4.2.3. TEXAS Logs / Recordings

All data logged by the TEXAS application was saved in JSON format, with the data products listed in Table 1. These recordings were time stamped, facilitating analysis of the experimental runs. Details of the TEXAS log schema are shown in Appendix B.

4.2.4. Recorded Video

In order to capture the context of the information flows/exchanges during the experimental runs, video was recorded from multiple vantage points. The video had the benefit of providing multiple layers of data: imagery, audio track and GPS position. These separate artefacts could either be used as data in their own right or as cross-validation for data from other sources. GoPro HERO 6 units were attached to the jet skis, jet boat (Figure 29) and crew within the IRBs (Figure 30). Video was also recorded from within the SURFCOM radio room and from the end of Brighton Jetty. These video streams were not transmitted across the network during the experiment. All video was recorded on 128 GB micro SD cards within the devices and then collected for post-experimental analysis.

Figure 29. GoPro installed on the jet boat

Figure 30. GoPro attached to IRB driver

4.2.5. Photographs

During setup periods, and during experimental runs, still imagery was taken from various locations. This imagery was used to confirm the evolution of the experiment, the setup of all the equipment and assets, and as a backup where there were gaps in the data from primary data sources.

4.2.6. Backup GPS Data

As mentioned, TEXAS logged the location of the smart-phones as a function of time, represented as movement of icons on the TEXAS display. As GPS position information was a key data product during the experiment, independent measurements were logged using a separate GPS tracking system. The GPS system chosen utilised TK20GSE 4G GPS trackers integrated with a commercial tracking server for near real-time GPS location and asset information. The units chosen were water resistant (IPX7)[4], had a magnetic base for ease of deployment (using steel mount points), Secure Digital[5] (SD) storage capability for data redundancy when live tracking was unavailable, had a large battery for extended use and incorporated active power management to extend the available tracking time.

Two units were installed for this experiment: the first on the Jet Boat (SLS-LS3) and the second on Jet Ski 1 (SLS-RWC1). Each unit was configured to update location to the tracking server every second (1 Hz) and was monitored via the web based user interface of the GPS tracking server. Figure 31 shows the installed unit on the Jet Boat for the experiment.

[4] https://en.wikipedia.org/wiki/IP_Code
[5] Secure Digital is a non-volatile memory card format developed by the SD Card Association for use in portable devices.

Figure 31. GPS Tracker mounted behind Jet Boat Driver seat.

5. Results

As noted earlier, the intent of experiment 1 was to assess whether the unclassified SLSSA environment was suitable as a Defence surrogate for supporting tactical information research; in particular from the three vectors of Information Architectures, Information Integration and Interoperability and Decision Support. This section describes the data types, quantity and quality of data collected during the experiment and the diversity in its utility to support various information superiority research threads. The major categories of data/information collected were: written logs by DST observers or SLSSA staff; electronically recorded data, such as video and audio recordings; and TEXAS performance metrics.

5.1. Evolution of the Experiment

In general, the experimental runs proceeded to plan. However, some issues were identified as to be expected in experimentation. For example, in the tracking of assets through the TEXAS application, some phone signals were temporarily lost or a smart-phone battery was drained to the extent that the phone was unable to transmit a signal. It was also found that some particular aspects of the scenarios developed for the experiment required more detail than was captured in scenario development. This included the source of the overdue boat report. Incident commanders asked whether the reports were from a trusted source, such as another emergency service, or from a potentially less trustworthy source such as the general public. More information was also required around the timed release of a description of the boat in distress, including information such as: colour, partial registration numbers and size.

The entire experiment, after setup, was conducted from approximately 8:30 am until just after 11:10 am on 25 November, 2017. The Sun was in the eastern sky (see Figure 32) and illuminated the facing side of objects at sea, maximising their visibility to observers on the shore. Each run took approximately 30 to 40 min with the last run slightly longer than runs one and two. This difference was attributed to changes in the complexity of the scenario.

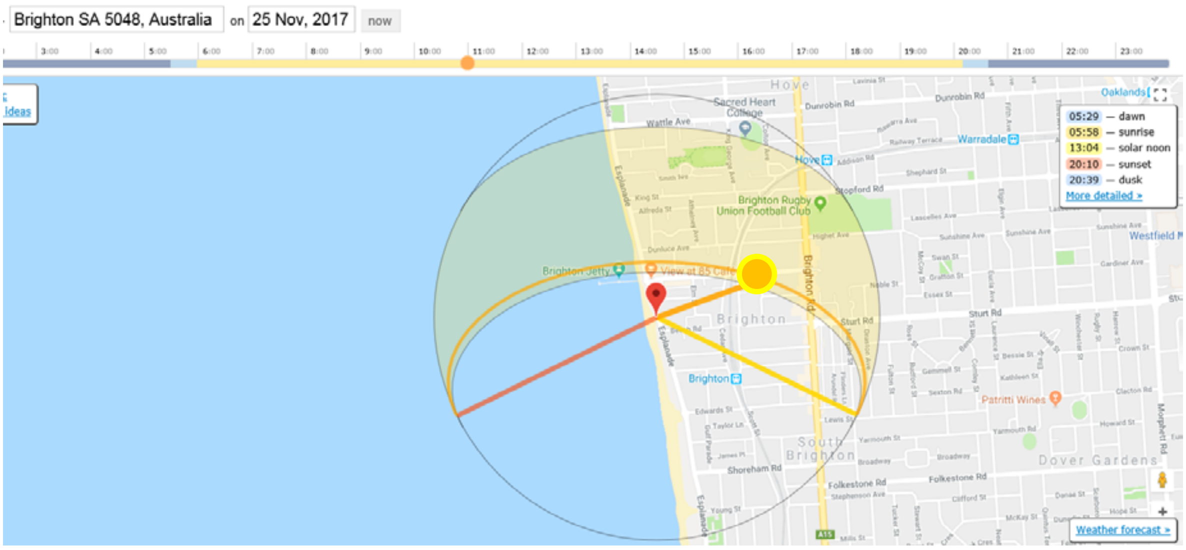

Figure 32. Location of the Sun in relation to Brighton is relation to visibility. Image taken from the SunCalc website [8].

5.1.1. Weather Conditions

The weather conditions for the day were near ideal for search and rescue operations, with very little wind, clear skies and near flat sea. This meant visibility was high and audio communications over the radio network were clear. The average weather conditions for the day are shown in Table 3. Weather details were sourced from the South Glenelg weather station on Weather Underground [9].

Table 3. Average weather conditions over the course of the experiment.

Quantity	Average Value Over Experiment
Temperature (deg C)	23
Pressure (hPa)	1011
Wind Speed (kph)	4.5
Humidity (%)	68

5.1.2. SLSSA Asset Availability

The SLSSA assets on the day were fully functional and available for the experiment, apart from the helicopter, WESTPAC 1, which was also included in the scenarios during initial planning. However, more immediate operational factors meant that the helicopter was unavailable for the experiment on the day. There was also a personnel shortage at the BSLSC location with one person covering both the beach patrol and the operation of the ATV. Although these factors presented some challenges, it was felt that they did not impact the successful operation, or larger goals of the experiment or the realistic execution of a SAR activity. Both the helicopter and staff shortage provided minimal impact since SLSSA had policies and procedures in place to handle such eventualities as a routine part of their real patrol activities.

To minimise the impact on the patrolling service SLSSA provides to the general public, the experiment was run outside of normal patrol hours, utilised a training/special event radio channel, and had SLSSA staff monitoring standard rescue channels at all times. The South Australian Police department was also notified of the training exercise.

5.1.3. Measurement Equipment Performance

As mentioned in Section 4.2 the various data products collected during the course of the experiment relied on a variety of measurement equipment, including: GoPro video cameras; Samsung Galaxy S9 smart phones; GPS trackers; access to the cellular network; and the RediTalk™ system in SURFCOM. In general, the equipment performed as required over the three hour duration of the experiment. However, close analysis of the data collected did identify some limitations.

Battery life of the smart-phones was reduced by having all power saving mechanisms on the devices disabled to allow for continuous position reporting. While this had only a limited impact on this experiment it would prove problematic for longer experimental tests and for realistic utilisation of the devices. This limitation will be remediated in future experiments through more active power management and the use of auxiliary battery packs where necessary.

The GoPro cameras also suffered from limited battery life, with many battery changes required during the morning. As a result there were some gaps in the captured video. This was mitigated to a large extent by the redundancy in video recording achieved using multiple assets recording the same event. The GPS trackers placed on a jet ski and the jet boat performed without issue and validates the need for additional units during future experiments to provide information redundancy.

As the cellular network was the only network connecting the mobile assets, there was no network redundancy in place. Regardless, signal strength for the mobile SLSSA assets was not reported as a problem during the experiment by the users. This result does not provide a deep insight into the system performance however, as the participants still relied heavily on the digital radio network to exchange information and may not have noticed temporary gaps in phone connectivity. The connectivity between the smart phones running TEXAS and the cellular network for a few of the SLSSA assets during Run 1 is shown in Figure 33.

While there were no apparent network dropouts, there were dropouts in position reports during the course of the experiment, with the cause yet to be identified and is the subject of ongoing investigation. This is discussed in more detail in Section 5.2.4. Another issue was a loss of connection to a phone placed in one of the patient tubs that was thrown overboard to simulate a drifting body. As the orientation of the phone in the tub was not fixed and the tub sat partially under the water line, connection between the phone and a transmission tower was lost. This can be easily mitigated in the future with some minor modifications to the phone's placement in the tub.

Finally, there was an issue experienced in relation to SLSSA's RediTalk™ system, namely the system rebooted during the experiment as the result of an automatic software update. This resulted in the need to use the backup radio control for that period of time. Unfortunately, this had the impact that the Run 1 audio recording data was lost.

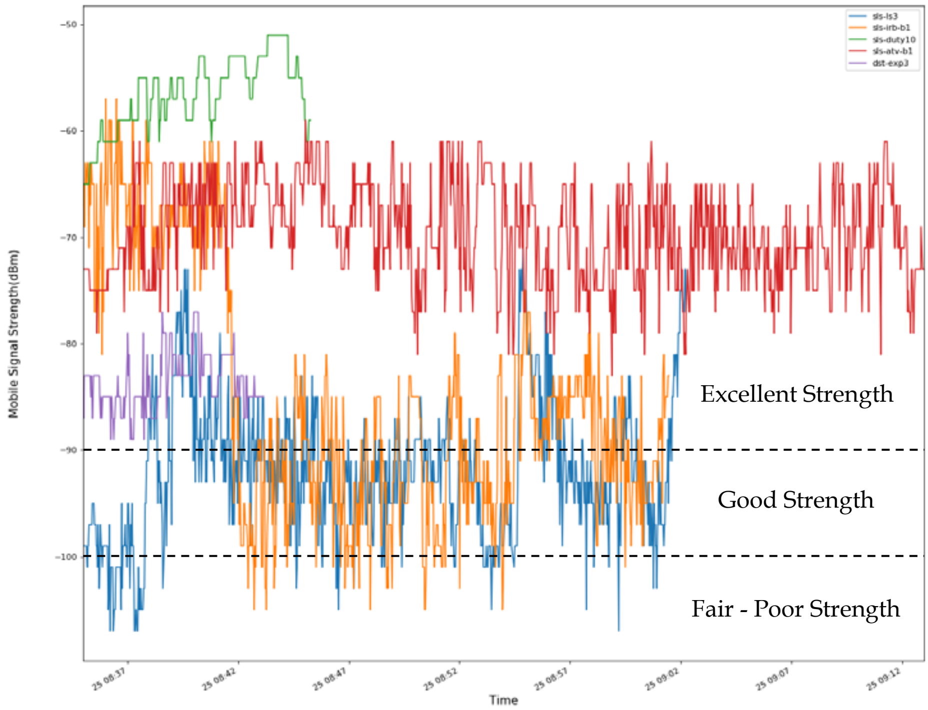

Figure 33. Smart Phone cellular network signal strength recorded during Run 1 for some of the assets within the environment.

Overall, the experimental runs were a rich collection of information exchanged between the participants in performing the tasks. There were many examples of real-time problem solving requiring high levels of coordination between assets and to both local and central command and control areas. The scenario details and variability stimulated a range of information flows across the three runs, with SLSSA procedures being executed as per training, knowledge and experience. Superficially at least, the SLSSA environment presented as being representative of various aspects of operating at the Defence tactical edge.

5.2. Data Collected

The following section details the characteristics of the data collected during the experiment, with some example research presented to demonstrate the ongoing utility.

5.2.1. Video Recordings

In total there were 316 video clips recorded during the experiment (290 GB). The volume of the video data associated with each asset is shown in Figure 34.

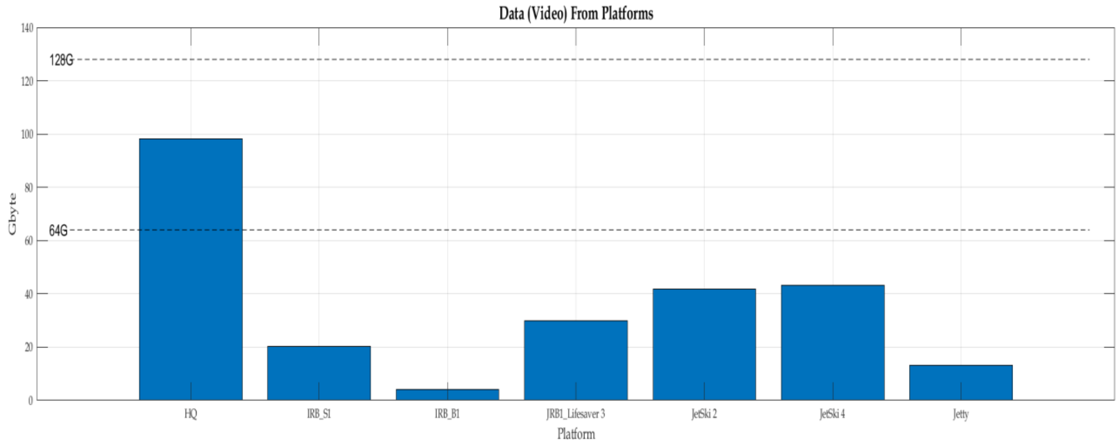

Figure 34. Video data quantity per asset.

As can be seen in Figure 34, the largest volume (by Gigabyte) of video recorded was at SURFCOM (HQ). One reason for this was that the video camera at this location was on mains power and therefore did not need to be turned off during the course of the experiment. As the video cameras on the mobile assets ran on battery power, the battery level was manually managed by switching the cameras off between runs.

The coverage of all collected video data in relation to the experimental runs is shown in Figure 35. In the figure, the purple, green and blue lines represent the time duration of runs 1, 2 and 3. The data in Figure 35 shows that across the board there is complete video coverage of the experiment.

On an asset-to-asset case there is also good coverage of video data except for 'Brighton IRB'. Considerable video is missing due to an unknown cause. However, since the operators of the cameras were asked to manually manage power usage, it is possible that the cameras were unintentionally not turned on when required on this asset. There is also some data missing from 'Seacliff IRB'. This appears to be a battery issue as it occurs mainly towards the end of the experiment (Run 3). All video recorded was HD 1080p quality, with clear audio and GPS metadata. A frame from the Seacliff IRB is shown in Figure 36, while

Figure 37 shows a frame captured from the jetty and Figure 38 shows an example SURFCOM recording.

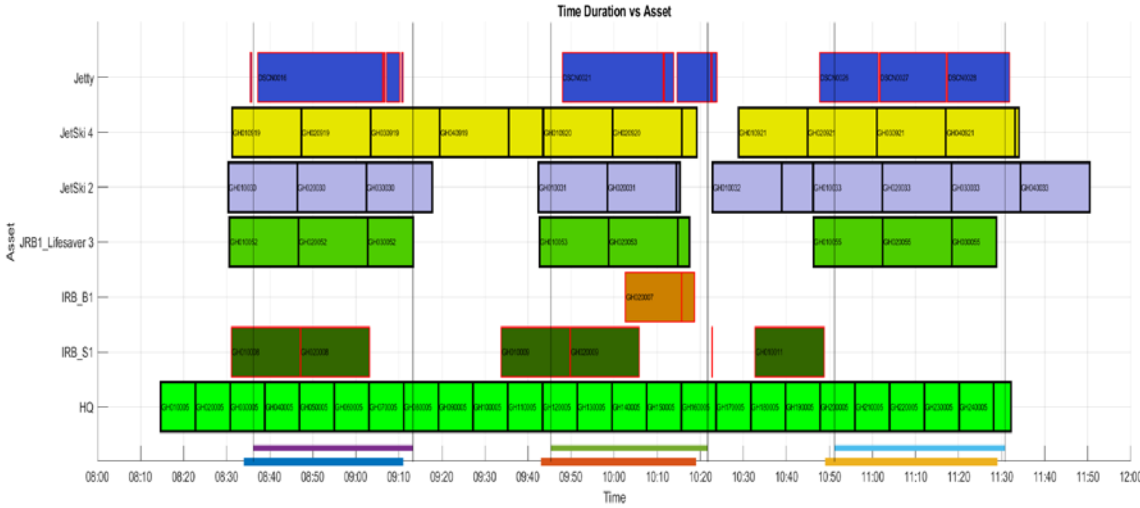

Figure 35. Time coverage of the video captured for each asset.

Figure 36. Still image capture from Seacliff IRB video footage.

Figure 37. Still image captured from the Brighton Jetty footage of the boat in distress. This shows the quality of the video zoom with the boat at a distance of over 2 km from the jetty.

Figure 38. Still image captured from the SURFCOM video recording.

The overall assessment of the video quality and quantity captured during the experiment is as follows:

- Video is clear and of 4K resolution, potentially supporting machine learning research for automatic identification
- The audio track from the video is clear and ideal for unstructured data mining research

- GPS positioning tags can be extracted and used for analysis. This supports information integration research for assessing the utility of imagery with and without metadata
- Extensive video coverage over each of the approximately 30 minute runs supports deeper analysis of information flow, information exchange and the use of reference data to support mission execution.

5.2.2. Audio Recordings

A total of 84 audio files were recorded on the SLSSA RediTalk™ system over the three hour period. (This included not only the audio during the SAR activity, but also the initialisation process preceding each run.) The files were saved as WAVs with a total storage size of 125 MB. The coverage of the audio files across the three runs is shown in Figure 39. As noted in section 5.1.3 there were no audio files received for Run 1. In Figure 39 files are given alternating colours in the plot to differentiate the incidence at which information was exchanged between participants over radio. It is important to recognise that each coloured interval in Figure 39 represents a complete conversation, rather than a single two-way exchange. As the files for Run 1 could not be retrieved, the audio track from the SURFCOM video recording may suffice as a substitute. However, this is left as future work as it will require time to translate/extract the recording.

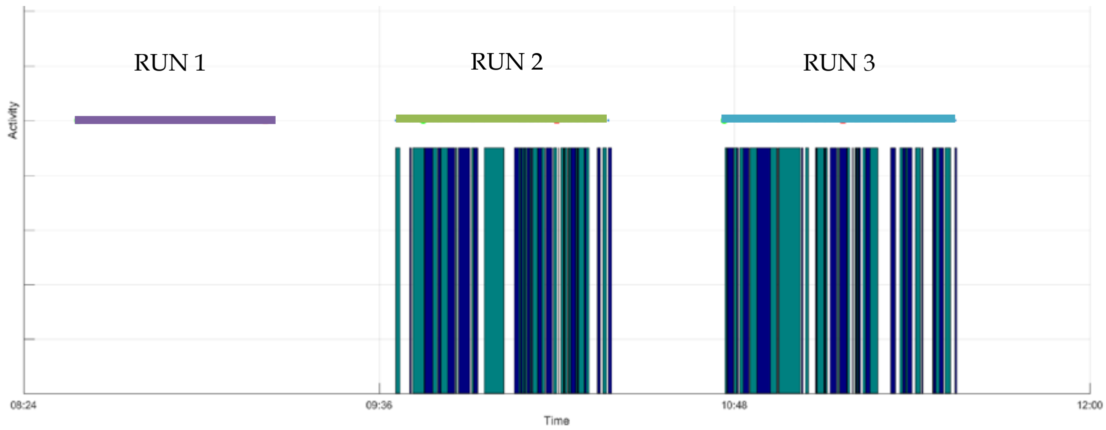

Figure 39. Individual audio files plotted as a function of time with respect to the run times (shown by the coloured horizontal lines).

The verbal exchanges over the radio network shown in Figure 39 imply a rapid information exchange during the experiment. This volume of information flow, and the nature of the subsequent decisions, has the potential to support multiple aspects of the planned information superiority research. This includes the study of unstructured data mining techniques, the integration of unstructured and structured information and the production of machine-readable, and ultimately actionable, information. This further demonstrates the diverse applicability of the captured data products.

5.2.3. GPS Track Data

The GPS data recorded by the two independent trackers was monitored and captured in near real-time to provide some redundancy to the data captured by TEXAS; proving valuable in situations where position reporting from TEXAS was temporarily lost. An example of the data produced by the GPS trackers is shown in Figure 40. The tracks are smooth and continuous, partially resulting from the 2 s update rate.

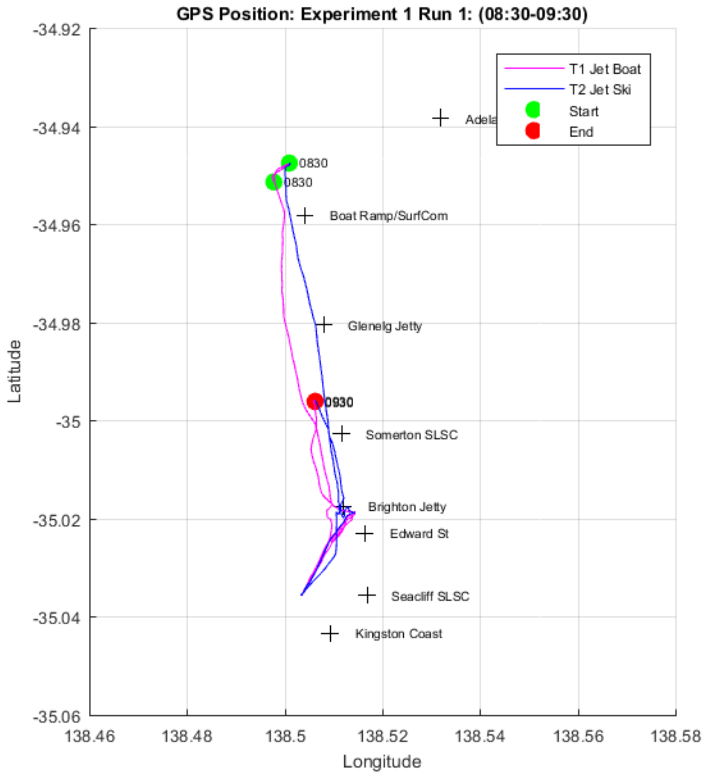

Figure 40. GPS tracks from the trackers for the Jet Boat and one of the jet skis during Run 1

The benefits of continuous position data are that it helps provide context to the information flow in regard to the environment while providing information in its own right in establishing situational awareness. In the context of Defence, a possible extension to this would be to combine data from a multiple sensors and test automatic identification technologies. This would support reference data and decision aiding research. Software development plans for future experiments are investigating these components/services.

5.2.4. Research Question Preliminary Analysis

Data was also captured from the TEXAS framework described in Section 4.2.3 over the three experimental runs. To demonstrate its utility for one of its intended uses, some preliminary analysis is outlined below in relation to the TEXAS framework performance. Following that, an example analysis of the researchers' observations is presented to demonstrate some of the diverse applications of the data.

5.2.4.1. Observations from the TEXAS data set

One of the research hypotheses was that the introduction of the TEXAS application would improve information correctness and temporal currency (major contributors to situational awareness), thereby potentially improving information superiority (see Section 4).

Every smart-phone and mobile device in the experiment recorded information regarding track generation and reception, and local device characteristics such as battery usage, signal strength and network usage. The most reliable information for track information was collected at the centralised message logging server, shown in Figure 15.

Each device sent its position to the message queue every 2 seconds (0.5 Hz). The currency of track information can be partially inferred by examining the interval between position reception times for messages from each device. Figure 41 captures the periods, over the course of the entire experiment, when a device reported to the message queue within a threshold of 3 seconds[6]. As the system is designed to report every 2 seconds, the threshold was defined in order to capture delays in reporting that exceed this 2 second requirement.

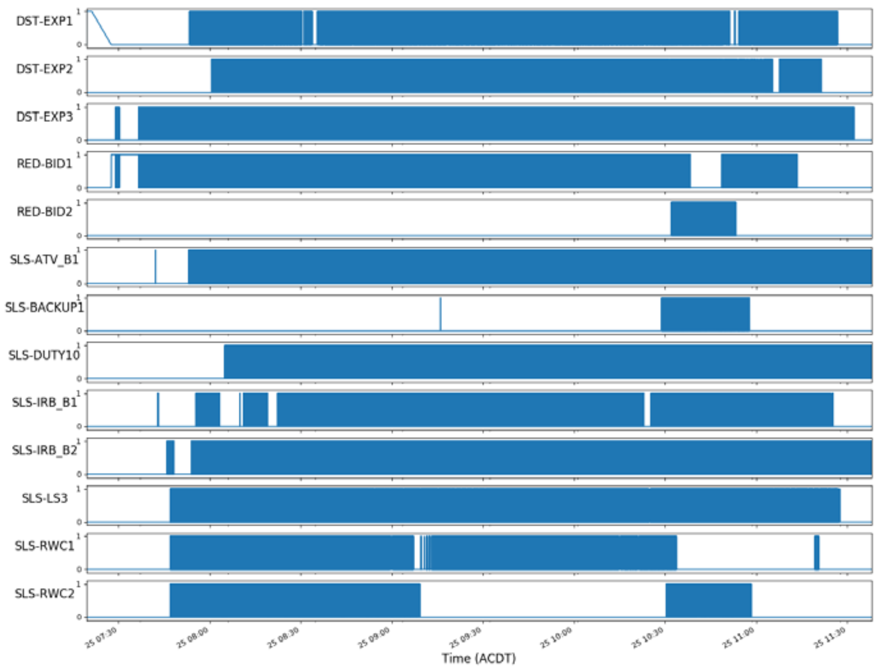

Figure 41. Whole of experiment showing 3 second update threshold

Looking at the entire experimental timeline we can clearly see when the devices came online and started reporting. Interestingly, position information was not received consistently for the full duration of the experiment – indicated by breaks in the lines for

[6] The threshold is an analysis construct, setting the maximum interval allowable between position reports. Outside this interval a report is considered a nil report. The 3 second threshold allows for 1 second latency on the 2 s reporting interval. This approach allows investigation into the timeliness of the position reports. The threshold level is arbitrary and was set to three seconds as an initial look into the reporting data.

each device. What follows is a closer inspection of the currency of information for each run.

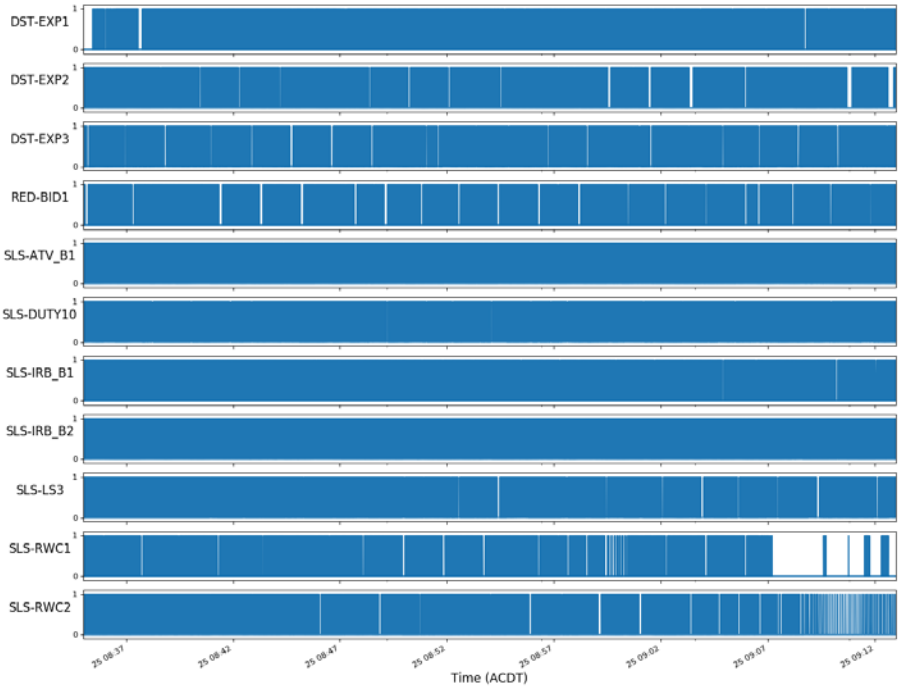

Figure 42. Run 1 showing 10 second update threshold

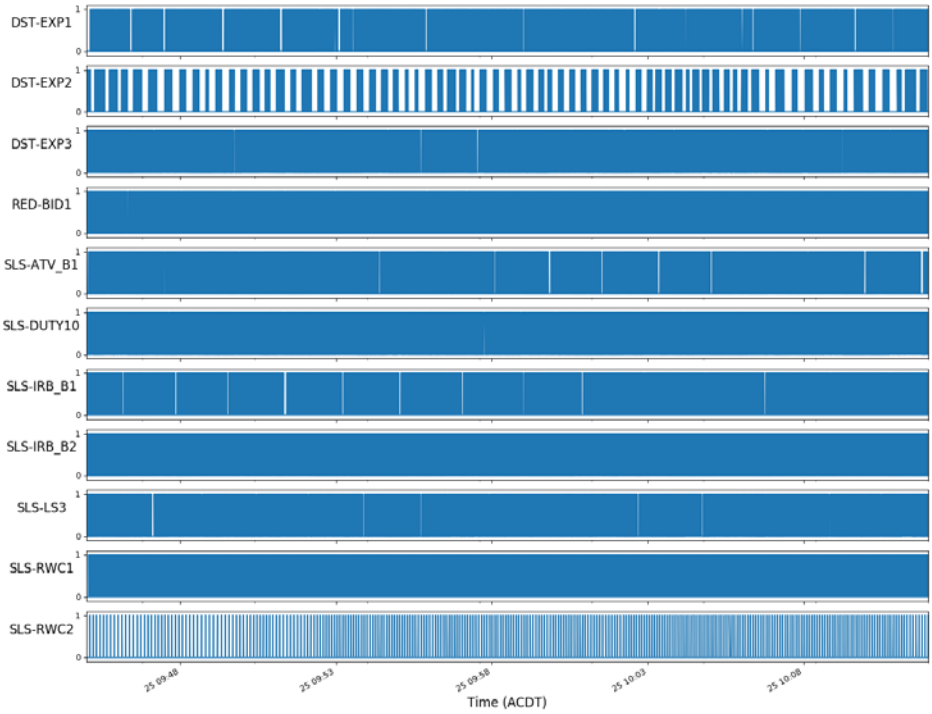

Figure 43. Run 2 showing a 10 second update threshold

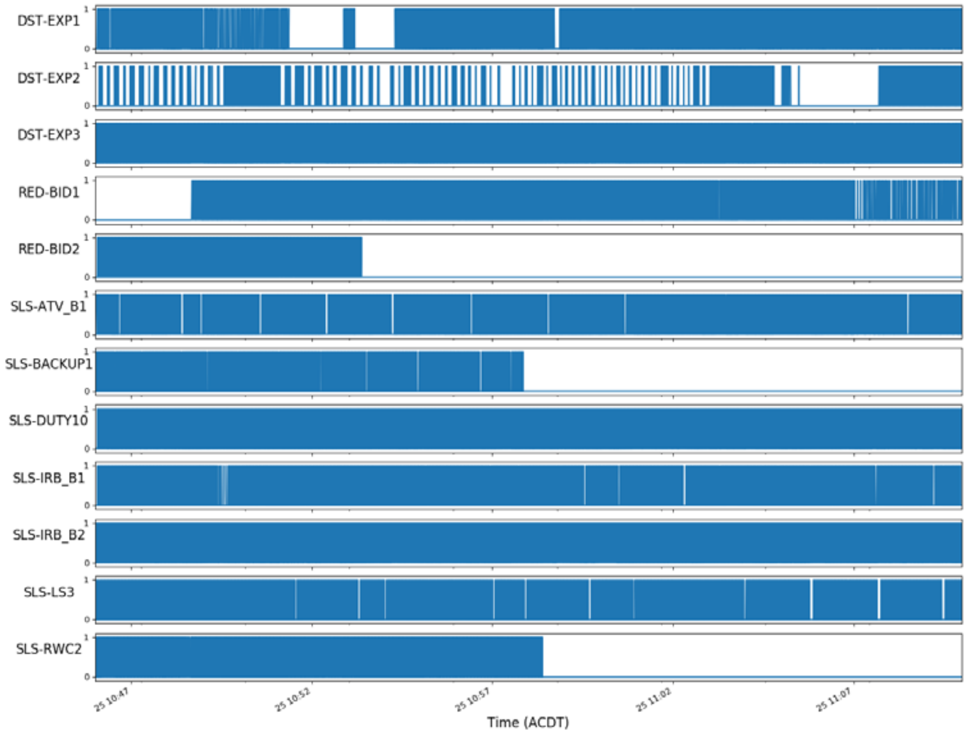

Figure 44. Run 3 showing a 10 second update threshold.

For Run 1 the jet ski assets, SLS-RWC1 and SLS-RWC2, had periods where the position was not reported, as can be seen in Figure 42. On the other hand, for Run 2 (Figure 43) the SLS-RWC2 device was not reporting position information in a consistent manner. The cause(s) of this sporadic reporting are not known but could be related to communication and propagation issues with the mobile channel for those devices. Although not impacting the human participants during the experiment, this non-reporting issue could pose an issue as the TEXAS system becomes more automated into the future. For Run 3 (Figure 44), the loss of positional information from Jet Skis SLS-RWC2 and SLS-BACKUP1[7] (swapped with SLS-RWC1 for Run 3) was a result of device operating-system enforced power conservation and subsequent battery failure.

Another aspect of the exchanged information is the correctness of the information pushed to the server. For Run 2, SLS-LS3 was observed to be not updating its position on the TEXAS display. Figure 43 indicates that the server was receiving information from SLS-LS3, but Figure 45 and Figure 46 show that the positional information reported by TEXAS departed significantly from the information reported by the independent GPS tracker during Run 2. For Run 2 there was no situational assistance from the TEXAS software, so this error did not impact the evolution of the SAR activity.

[7] This was a backup phone used during the experiment.

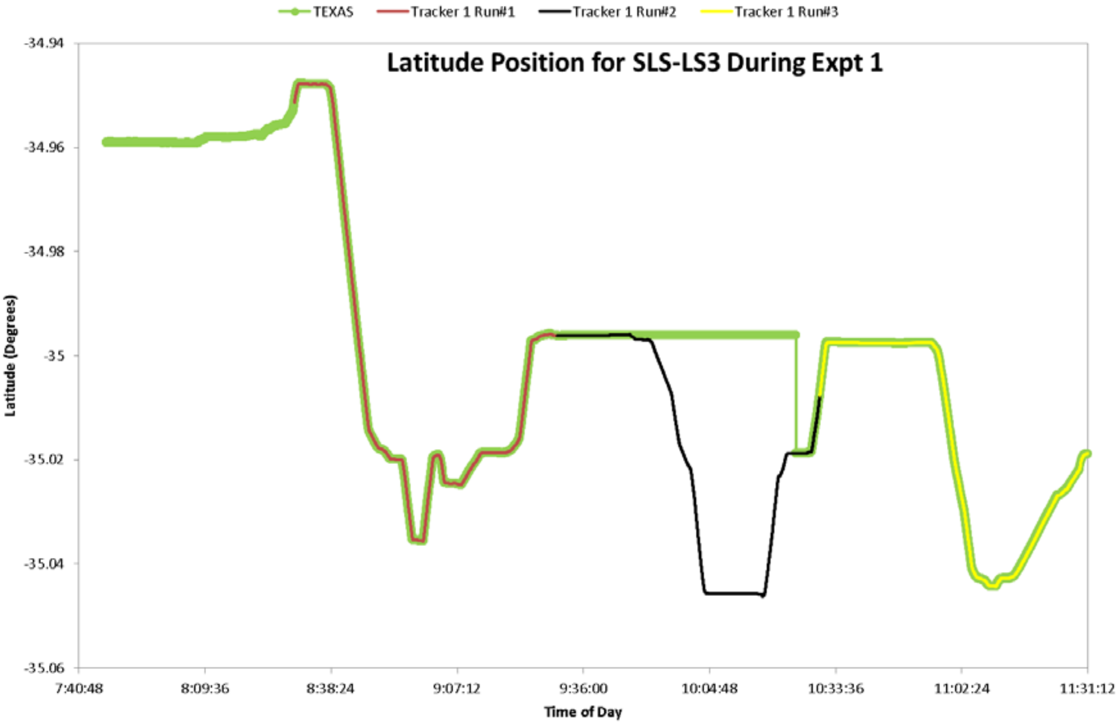

Figure 45. LS3 latitude comparison.

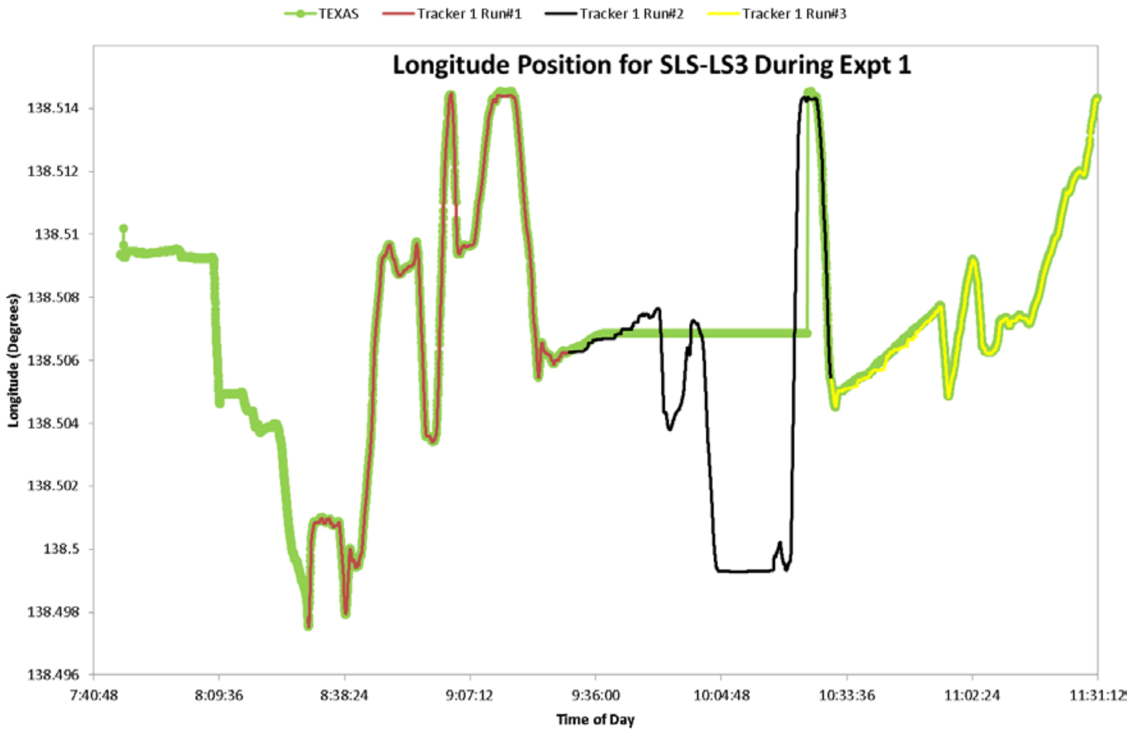

Figure 46. LS3 longitude comparison.

This result demonstrates the importance of information integration as a mechanism for establishing information resilience to support situational understanding. As an example of how such resilience could be achieved without the need for multiple GPS redundancy and cross-checking, the GPS position from a system like TEXAS could be fused with other sources, such as unstructured data [10].

Lastly, one device performance metric for the experiment was the battery charge level, as shown in Figure 47. The plot shows the consistent battery drain of the smart phones primarily caused by the TEXAS framework requesting constant GPS location and network access over the course of the experiment.

Devices SLS-RWC2 and DST-EXP2 demonstrate a higher discharge rate compared to the other devices. This higher rate of discharge could be the result of multiple factors, including: different characteristics for those particular devices; increased power usage as a result of automatic gain control in the devices; and individual demands during the experiment in terms of user operation. Regardless, the discharge rate for all devices demonstrates a need to manage power consumption dynamically; either by the user, a central coordinator or autonomously as a result of stimuli from the environment. This has been noted as a future development thread for the TEXAS framework.

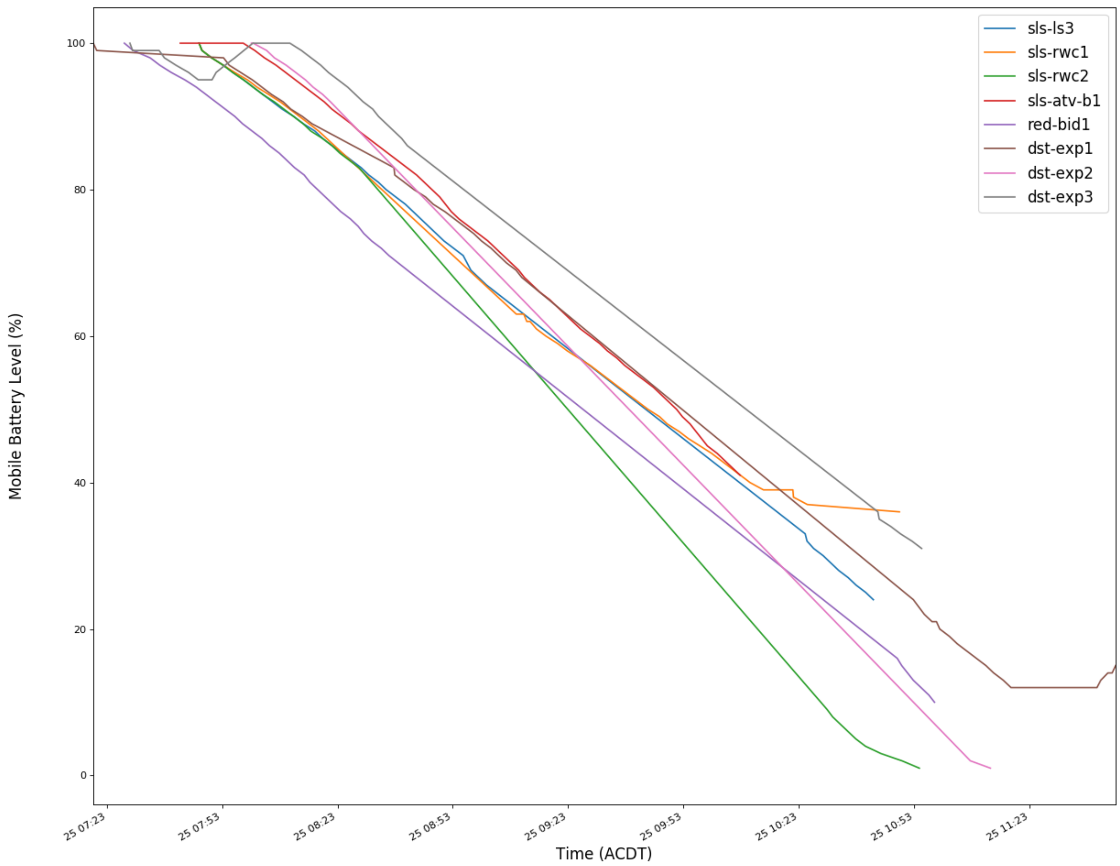

Figure 47. Whole experiment – Battery charge levels

This analysis example data demonstrates that the quantity and quality of the information collected can provide detailed insights into the architecture that underpins the information superiority challenge.

5.2.4.2. Observations at SURFCOM

As described in Section 4.2.1, two DST researchers captured their observations of the evolution of the experiment from information exchange and decision making perspectives. The following section details some preliminary analysis regarding how this data might be utilised to support information superiority research.

5.2.4.2.1 Crewing and Roles

Observations at SURFCOM were made by monitoring the activities from immediately behind two SLSSA personnel who were crewing the radio system. A photo of the arrangement is shown in Figure 48.

The two operators' broad roles were as follows. The operator on the left used a voice radio system to send and receive messages from the various outstations at other SLSSA locations to provide broad, high-level coordination of operations, and made notes on paper summarising the message traffic that they dealt with. As necessary, this operator would hand these notes to the operator on the right for manual entry into an event logging system. The screens used by the left and right operators are shown in Figure 49 and Figure 50, and one of the notes sheets used for manual keyboard entry is shown in Figure 51.

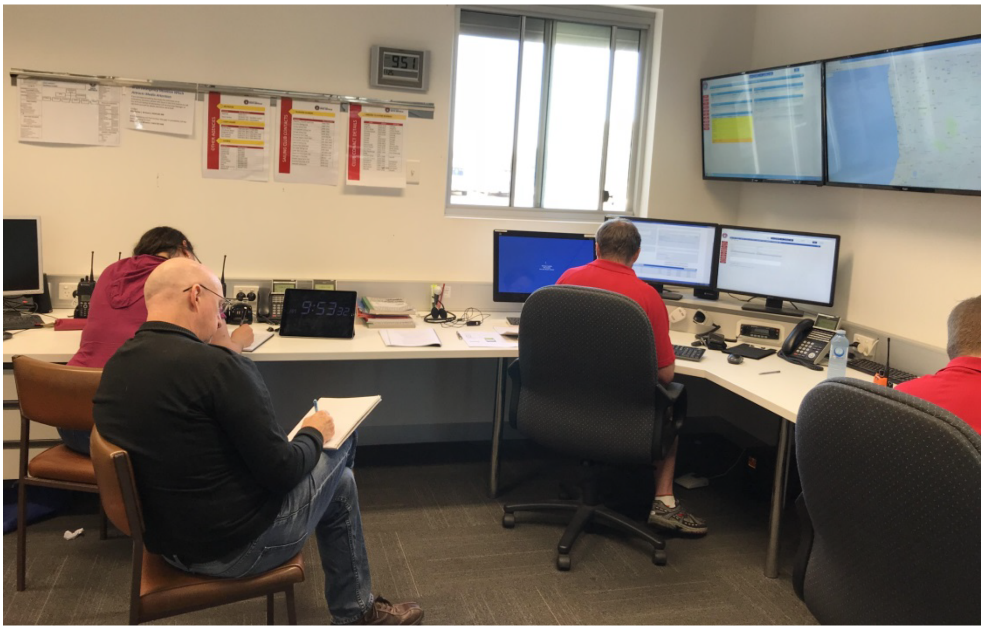

Figure 48. SURFCOM observations setup

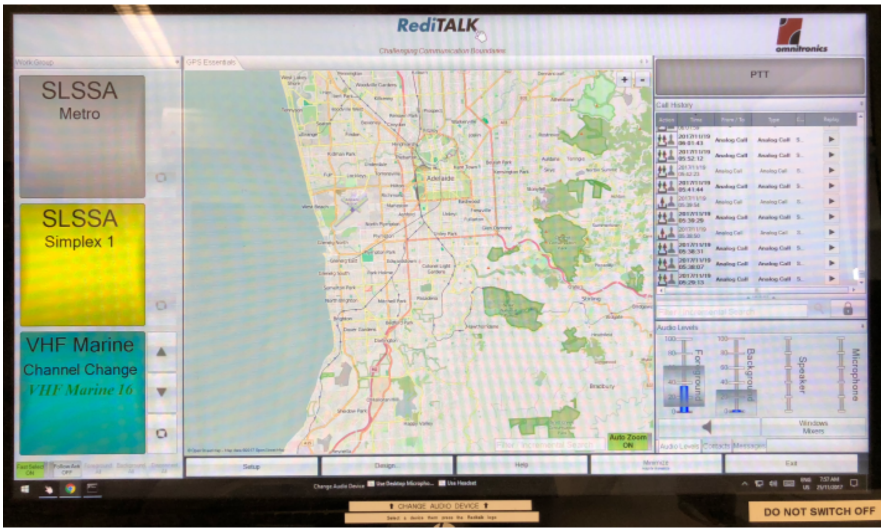

Figure 49. Voice Radio Screen

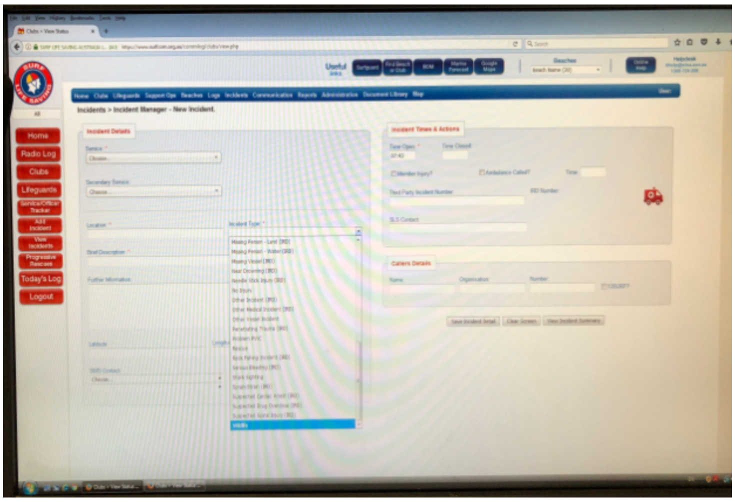

Figure 50. Event Logger

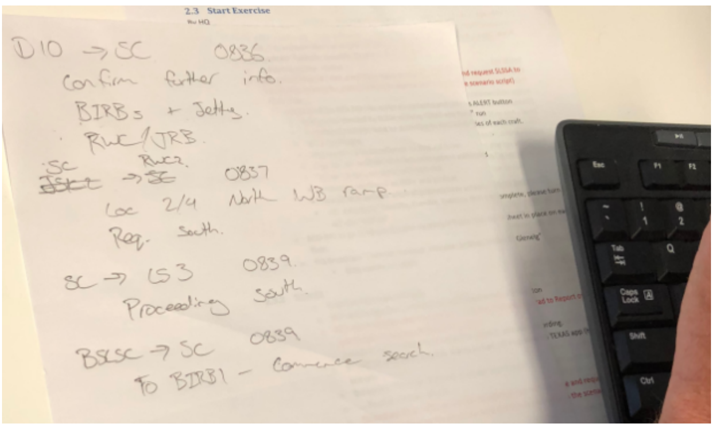

Figure 51. Notes Page

The logging operator (right operator) was fully occupied by the logging task and performed no role in the communication or coordination with external actors. DST observer logs of the event sequence during the three runs are given in Appendix C. The following section summarises these records to provide a characterisation of the communications at SURFCOM during the experiment.

5.2.4.3. SURFCOM Communications Summary

The following list categorises the communications handled by SURFCOM.

- Logging radio voice communications in the logging database
- Relaying information from outside agencies (including SA Police and Sea Rescue)
  - e.g. an initial report of an overdue boat
    - Expected time of return of boat
    - Number of people on board
    - Identification details of the boat
- Coordinating requests from local assets to communicate with each other
- Checking that incoming reports matched the information received from outside agencies
  - e.g. making sure that the number of people retrieved during a rescue matched the number reported missing by the outside agency
- Receiving requests for extra assistance
  - e.g. assistance was requested by a local asset dealing with a patient with a blue-ringed octopus bite.

There were some instances where these tasks interfered with each other. For example, when an asset spent time getting permission from SURFCOM before alerting local command that they had a sighting of the boat in distress.

5.2.4.4. Event Timing Analysis

Is it possible to use observer notes of SURFCOM event timings to compare the times taken to perform particular similar tasks with and without the new technology? An example is shown in Figure 52.

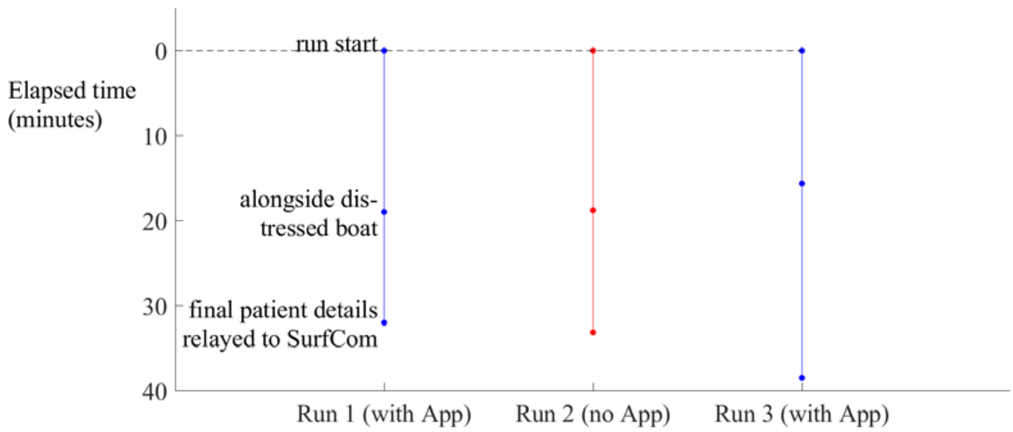

Figure 52. Timing Analysis

This plot shows the relative timing of two key events during the three runs. (Runs 1 and 3 used the TEXAS application to support situational awareness and Run 2 used standard procedures.) Time proceeds from top to bottom on this plot, with the start of the run at the top. The key events are:

1. the surf asset declares itself to be alongside the vessel in distress
2. all patient details are successfully relayed to SURFCOM.

From this plot it is difficult to make any firm statements about whether the technology affected mission timings, given such a low number of runs and differences between the locations of the distressed vessel. However, it points to a type of analysis that may be of interest in future experiments. Clearly, real-time note taking is important to capture the context and intent of the information, and facilitates the generation of information flow models, decision trees, information requirements and information categorisation, to name a few domains, post experiment.

5.2.4.5. Observations at Brighton Beach

This section provides further examples of the types of observations made during the experiment, this time from Brighton beach.

Observations at Brighton beach were recorded by three DST Group observers: one located at BSLSC; one located at the Brighton beach patrol; and one located at the end of Brighton Jetty with the SLSSA co-ordinator for the training exercise. Located with the DST Group observer at BSLSC were two SLSSA personnel, including the duty manager for the search and rescue activity (Duty 10), who had overall command and control of the search and rescue activity. Located with the DST Group observer at Brighton beach patrol was one SLSSA member who was subordinate to the duty manager for co-ordinating the search and rescue.

Located with the DST Group observer at Brighton Jetty was another member of SLSSA, who was positioned at the jetty to observe the conduct of SLSSA personnel during the search and rescue activity and to liaise with the boat in distress (RED-BID) for each run.

5.2.4.6. Duty Manager Communications Summary

The following list summarises the categories of communications handled by the duty manager, Duty 10:

- Receiving the initial search and rescue request
- Requesting additional information from SURFCOM to assist the search and rescue (including information received from outside agencies)
- Receiving situational information from local beach patrol and other SLSSA assets
- Requesting participation from additional assets geographically separated from the search and rescue location
- Directing asset locations, movements, search patterns and rescue activities
- Handing-off co-ordination and control of the search and rescue to the local beach patrol
- Requesting SURFCOM to relay status updates to, and to seek assistance from, outside agencies.

5.2.4.7. Beach Patrol Communications Summary

The following list summarises the categories of communications handled by the beach patrol:

- Receiving the initial search and rescue request
- Requesting permission from SURFCOM to communicate with other SLSSA assets
- Receiving direction from the duty manager to assist with the search and rescue activity
- If required, receiving temporary co-ordination and control duties from the duty manager for the search and rescue
- Establishing communication with other surf life saving clubs in relation to the search and rescue
- Providing situational information to the duty manager, including any visual identifications
- Receiving status information from SLSSA assets transporting patients to their beach patrol location
- Providing status information to SURFCOM for rescued patients under care at the beach patrol location.

A detailed account of the Brighton observations is given in Appendix C.2. These observations again reinforce both the dynamic nature of the experiment and the richness and diversity of the information exchanged.

6. Conclusion

Information superiority is a key concept and enabler with relevance to many domains, including the commercial sector, emergency services and Defence. In the Defence tactical domain, information superiority underpins both mission effectiveness and survivability. The challenge within the Defence domain is that operations are largely carried out at what is known as the 'tactical edge'[8]. In this region there are many factors that work against the components required for information superiority. This includes the volatile nature of the environment at the tactical edge, which results in unstable communication links with limited bandwidth, variable latency, limited on-board storage, processing power limitations, electrical power limitations and interference from non-military systems. Environmental factors at the tactical edge may also adversely affect information exchange and understanding.

Similar limitations are also experienced within the emergency services domain with the requirement to act quickly and precisely to address incidents and, in many cases, save lives. The emergency services domain provides several advantages for Defence in conducting fast-turn, low-cost and low-risk integration and interoperability research.

This report outlined an experiment conducted as a 'test of concept' to test the ability to transfer or translate research outcomes conducted in the Surf Life Saving South Australia (SLSSA) environment along the South Australian metropolitan coastal region.

In particular, this report discussed whether the SLSSA environment demonstrates characteristics of operating at the tactical edge such that concepts and technologies can be studied. The following questions were asked in this context:

- *Is the environment sufficiently dynamic to support the generation of datasets large enough to demonstrate quantifiable trends in information flow?*
  The data collected has shown that indeed the environment is dynamic, with preliminary analysis demonstrating that valuable insight can be gained from studying the trends in the data.

- *Can multiple data types be collected to provide cross validation?*
  It was also shown that the data types collected exhibit redundancy, allowing cross validation, with a prime example being GPS (Section 5.2.4.1). There is also the potential for investigating the benefits of information integration producing machine readable content.

[8] The tactical edge shares many similarities to the commercial 'network edge'.

- *Can the environment facilitate the sharing of different information types to support information integration research?*
  Post-experimental analysis indicates that this is resounding yes, with all of the data types collected having both the quantity and quality required to support further research in line with the information integration and interoperability research being conducted by DST Group. For example, the study of computer processed video and audio feeds to resolve ambiguities between GPS positional information feeds.

- *Does the environment provide adequate stimulation to experiment with service-orientated open software architectures?*
  The preliminary analysis conducted in Section 5.2.2, although not detailed architecture assessments, provides promising indicators for what could be possible in future experimentation. The preliminary analysis touched on the performance of interactions between software components across the network and how the influence of the environment impacts that performance.

- *Does the environment exhibit Defence-relevant challenges in information sharing, processing and interpretation?*
  Although their ultimate goals can be different, and the specific types of equipment used are different, the need to share vast amounts of relevant, accurate information to key stakeholders is the same for both SLSSA and Defence. This point was reinforced within the results from experimentation with SLSSA. An example was establishing a common operating picture for all participants. System limitations, environmental factors, network limitations, various user skill levels and interpretation of information was seen across all aspects of the three runs conducted. These challenges are consistent with operational challenges faced at the tactical edge by Defence.

- *Can an experimentation framework be developed to facilitate the desired investigations?*
  The TEXAS application used for this experimentation was an initial implementation of an experimentation framework. It was able to present a basic 'blue force tracking' capability to the users during the experiment. There is no doubt that the interface would benefit from a human-factors assessment to enhance the user experience and move away from a 'one size fits all' implementation. This is an ongoing action that will be addressed as resources become available. During the experiment TEXAS was used to record numerous data products that show interesting trends in the data associated with architectural performance. The LASAGNE framework upon which TEXAS was based promises adaptability and a fully configurable implementation. These benefits were only partially realised in this first experiment. Subsequent experiments will test these aspects with greater rigor. The initial assessment is that TEXAS provided a capability that met the needs of the first experiment. Follow-on development that emerged from the observations of the first experiment in preparation for future experiments have shown great progress, demonstrating the speed ease with which the TEXAS framework can be modified and extended.

Ultimately the question is whether the results of the Real-Time Information Superiority Experimentation (RISE) initiative warrant pursuing the concept further with the various emergency services operators. The answer to that appear to be an unqualified 'yes'.

Favourable outcomes associated with data product quantity and quality supports this assessment, as does the experience and lessons learned by the staff in conducting research trials and the resource leverage provided by the volunteers from the ESD. We acknowledge that the ESD assets lack the diversity and complexity of computer systems and sensors seen within the Defence domain. However, working in the ESD has undeniable benefits that outweigh this limitation.

Abstracted information science technologies and concepts can be studied with return benefits for Defence. The ESD environment in this first experiment was: unclassified; readily accessible for quick turnaround experimentation at varying levels of complexity; extensible, providing the potential for the addition of other services (e.g. SA Police and ambulance); configurable; low on implementation overhead to trial new concepts and technologies; conducive to facilitated strong engagements with partners where normally interactions are limited due to information release policies.

The finding from this initial study is to move onto the next phase of experimentation where the focus will be on Defence relevant concepts such as trusted reference data, interoperability, decision aiding and fully adaptable software architectures.

7. Ongoing Work

Following the outcomes of experiment 1, some ideas for immediate enhancements to the TEXAS framework has emerged to support research to be conducted in future experiments. These are listed in Table 4.

Table 4 TEXAS Future Enhancements.

Enhancement	Description
LASAGNE integration	LASAGNE integration would permit real-time, peer to peer sharing of phone/asset data without the need for a centralised server.
Better Situational Awareness	Improvements to the existing TEXAS user interface could be made to improve usability and enhance situational awareness.
Wearable integration	Wearable technology including smart watches, smart glasses and headphones could be incorporated to convey the situation to different SLS.
Cloud Based Configuration	This would allow for near real-time changes to the configuration of nodes on the network during an experiment.
Manual Tracks	Users would be able to add IDs for items seen within the environment

	on the TEXAS interface and share them with all network nodes.
Triangulation	Users would be able to broadcast a bearing for an item of interest by aiming their smart phone and pressing the direction button. Triangulation allows the location of the item to be estimated when multiple users within the network do the same from different vantage points.
Video Streaming	Video could be taken from the GoPro cameras and broadcast across the network to those users who wish to use it. This may be used to support users and computer vision constructs. The dynamic Pre-processing of the video at network nodes will also allow Quality of Information (QoI) constructs to be investigated.

Further enhancements are also planned for the longer term to facilitate some of the more complex research requirements. These will require more development and scoping. The enhancements listed above demonstrate the potential for the TEXAS framework to be utilised as an adaptive, fully configurable experimentation framework. Its strength lies in its ability to support advanced technology concept studies, facilitating rapid turn-around investigations. TEXAS will allow for these concepts to be refined and fortified before being designed into an optimised, risk-reduced Defence experiment, where bug-riddled studies have a sizable impact on resources and trial outcomes.

Figure 53 shows experiment 1 in the context of the research threads planned for experimentation over the next couple of years. Each experiment builds from the previous one in complexity and scale. The concepts and technology prototypes will be primed for inclusion into a future Defence exercise, such as Talisman Sabre.

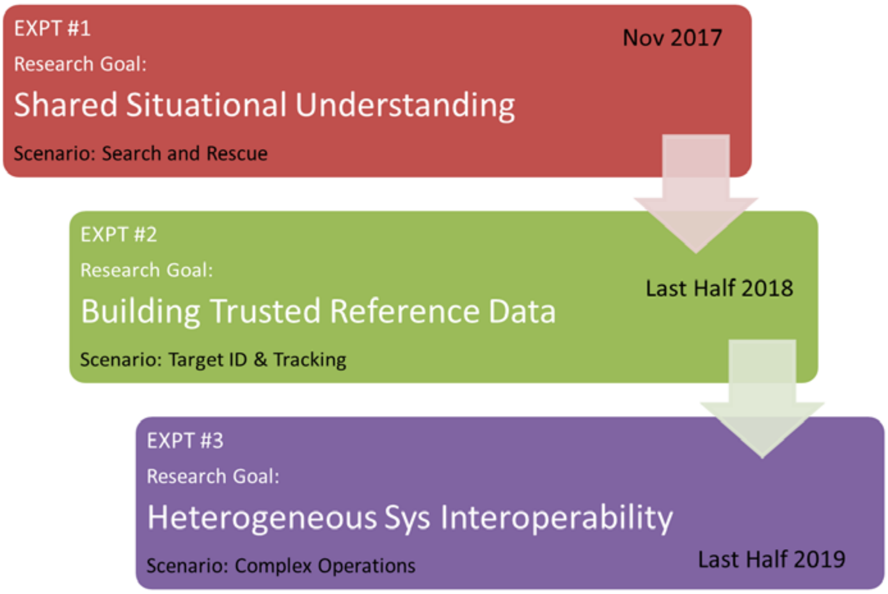

Figure 53. Experimentation plan.

References

[1] DJFD, *Department of Defence Dictionary of Military and Associated Terms, JP 1-02,* US Director of Joint Force Development, 2010.

[2] D. Fatma, "Tactical Edge Characterization Framework, Volume 1: Common Vocabulary for Tactical Environments," *MITRE Technical Report MTR070331,* p. 39, 2007.

[3] R. Kissel, "Glossary of Key Information Security Terms NISTIR 7298 Rev 2," NISTIR, 2013.

[4] J. Zhao, Y. Jia, L. Shi and L. Kong, "Research on Technical Readiness Evaluation Method in Model Development," in *8th International Symposium on Computational Intelligence and Design (ISCID)*, 2015.

[5] SAGOV, "About Emergency Services," South Australian Government, 2017. [Online]. Available: https://www.sa.gov.au/topics/emergencies-and-safety/emergency-services.

[6] SLSSA, "What We Do," 2018. [Online]. Available: http://www.surflifesavingsa.com.au/what-we-do-1/.

[7] D. Dominish and M. Mathers, "Service Oriented Integration," in *15th Australian International Aerospace Congress (AIAC15)*, 2015.

[8] SunCalc, "SunCalc," 2018. [Online]. Available: http://suncalc.net/#/-35.0189,138.5151,15/2017.11.25/11:00.

[9] WU, "Weather Underground," 2018. [Online]. Available: https://www.wunderground.com/.

[10] A. N. Bishop and B. Ristic, "Fusion of spatially referring natural language statements with random set theoretic likelihoods," *IEEE Transactions on Aerospace and Electronic Systems,* pp. 932 - 944, 2013.

[11] H. Seppanen, J. Makela, P. Luokkala and K. Virrantaus, "Developing Shared Situational Awareness for Emergency Management," *Safety Science,* pp. 1-9, 2013.

[12] A. M. S. A. AMSA, "National Search and Rescue Manual, February 2018 Edition," AMSA, 2018.

[13] *Letter of Agreement - Real-Time Information Superiority Experimentation (RISE) Program,* 2017.

Appendix A Patient Conditions

Table 5. 'Boat in Distress' Passenger Profiles

Name	Age	Place in Family Group	Weight (kg)	Height	Ongoing medical conditions
Robert Smith	45	Father	90	185	Lower back pain
Helen Smith	43	Mother	70	175	None
Amy Smith	15	Daughter	50	165	None
Thomas Smith	13	Son	55	170	Severe allergy to nuts
Barbara Smith	71	Grandmother	60	160	High blood pressure and onset of glaucoma
John Smith	69	Grandfather	80	177	High blood pressure and cholesterol

Table 6. Current medical conditions given to the six passengers.

Name	Condition Run 1	Condition Run 2	Condition Run 3
Robert Smith	Severe lower back pain	Death	Electric Shock – unconscious
Helen Smith	Impaled by metal object – suffering shock	Severed Hand	Unconscious – rescued from water
Amy Smith	Anxiety	Shock	Anxiety – hyperventilating
Thomas Smith	Unconscious – blocked airway	Suspected blue ringed octopus bite	Shock
Barbara Smith	Suspected hypothermia	Anxiety	Broken Arm
John Smith	Suspected heart attack – Chest pain	Heat Exhaustion	Suspected spinal injury (neck)

Appendix B Texas Log Schemas

B.1. TEXAS Tracks

All track/asset data that passed through the centralised server used the schema shown in Figure 54:

```
{
  "id":":"The unique ID of the record",
  "key":"The unique key of the record (same as ID)",
  "value":{
    "rev":"The CouchDB revision ID"
  },
  "doc":{
    "_id":"The unique ID of the record",
    "_rev":"The CouchDB revision ID",
    "source":"ID of the source",
    "deviceName":"The name of the issuing device",
    "deviceId":"The ID of the issuing device",
    "position":{
      "lat":”The latitude of the track/asset”
      "lon":”The longitude of the track/asset”
    },
    "heading":”The heading of the track/asset”
    "active":"True if the track/asset is enabled",
    "timestamp":"The time that the track/asset update was sent"
  }
}
```

Figure 54 Track/asset server schema

Figure 55 is a track/asset update example:


```
{
  "id":"4c7cda5a7e9143e7f2e38e79b09d1366",
  "key":"4c7cda5a7e9143e7f2e38e79b09d1366",
  "value":{
    "rev":"1-c5126cac0c4202b2ed60876c9b15da85"
  },
  "doc":{
    "_id":"4c7cda5a7e9143e7f2e38e79b09d1366",
    "_rev":"1-c5126cac0c4202b2ed60876c9b15da85",
    "source":2,
    "deviceId":"7888977e94e992c1",
    "deviceName":"DST-EXP2",
    "position":{
      "lat":-35.018827500000000441,
      "lon":138.51526749999999311
    },
    "heading":241.44903564453125,
    "active":true,
    "timestamp":"2017-11-24T22:21:50.218Z"
  }
}
```


Figure 55 Track/asset server report example

B.2. TEXAS Alerts

All alert data that passed through the centralised server used the schema shown in Figure 56:

```
{
  "id":"The unique ID of the record",
  "key":"The unique key of the record (same as ID)",
  "value":{
    "rev":"The CouchDB revision ID"
  },
  "doc":{
    "_id":"The unique ID of the record",
    "_rev":"The CouchDB revision ID",
    "deviceName":"The name of the issuing device",
    "deviceId":"The ID of the issuing device",
    "active":"True if the alert is enabled",
    "message":"Any specific alert message",
    "source":"ID of the source",
    "timestamp":"The time that the alert was sent"
  }
}
```

Figure 56 Alert server schema

Figure 57 is an alert data example:


```
{
  "id":"4c7cda5a7e9143e7f2e38e79b0d0f48e",
  "key":"4c7cda5a7e9143e7f2e38e79b0d0f48e",
  "value":{
    "rev":"1-a43e3ccad05048c0e4ece7067ff4efa5"
  },
  "doc":{
    "_id":"4c7cda5a7e9143e7f2e38e79b0d0f48e",
    "_rev":"1-a43e3ccad05048c0e4ece7067ff4efa5",
    "deviceName":"SLS-LS3",
    "deviceId":"dcf64e5192da52a9",
    "active":true,
    "message":"ALERT!!",
    "source":2,
    "timestamp":"2017-11-24T22:27:12.099Z"
  }
}
```


Figure 57 Alert server schema example

B.3. Phone / asset Log Structure

As well as server logging, each phone/asset logged the following (if available):

- when another phone update was received
- battery strength
- signal strength
- network changes.

All data that was logged locally on each phone/asset used the schema shown in Figure 58:

```
{
  "id":"The unique ID of the record",
  "key":"The unique key of the record (same as ID)",
  "value":{
    "rev":"The PouchDB revision ID"
  },
  "doc":{
    "_id":"The unique ID of the record",
    "_rev":"The PouchDB revision ID",
    "data":"data object"
  }
}
```

Figure 58 Local logging schema

Figure 59 is a sample of the log for the phone battery:

```
{
  "id":"9c4f2e3379ba77c/battery/2017-11-24T00:58:14.252Z",
  "key":"9c4f2e3379ba77c/battery/2017-11-24T00:58:14.252Z",
  "value":{
    "rev":"1-43e3b933575a4c609e358e9525005cee"
  },
  "doc":{
    "_id":"9c4f2e3379ba77c/battery/2017-11-24T00:58:14.252Z",
    "_rev":"1-43e3b933575a4c609e358e9525005cee",
    "data":{
      "isTrusted":false,
      "level":100,
      "isPlugged":true
    }
  }
}
```

Figure 59 Local logging schema example

Appendix C Observations

C.1. SURFCOM Observations

C.1.1. Run 1

Time	Message direction	Note	Post-event comment
			Run 1 is using the new technology
7:50	internal	Questioning whether to create a new incident for each run	
7:50	internal	Performing radio checks	
8:17	outgoing	Coordinating proceedings, coms channels, assets via radio	
8:17	internal	2 people at consoles + 1 standing behind	
8:21	incoming	status report from LS3: "3 people on board"	
8:21	incoming	coms check from jetskis	
8:21	incoming	JS2 & 4 are on patrol, 1 person on board each jetski	
8:24	observation	left operator doing voice coms over radio, right operator silent and interacting with screens (logging incoming radio information?)	
8:26	incoming	Brighton patrol status	
8:26	incoming	Brighton IRB1 on patrol	
8:26	outgoing	?Confirm number of persons on board	delays introduced by incomplete status reports from assets
8:26	incoming	confirm 2 persons on board	
8:28	incoming	IRB2 signing on patrol	
8:28	outgoing	?Confirm number of persons on board	
8:28	incoming	Confirm […]	
8:29	internal	Left to Right operator: adjust […]	
8:29	observation	Jayson: 2-step GoPro process	
8:29	outgoing	All stations: 2-step GoPro process: exercise about to commence	I think this was getting asset crew to switch on their GoPros.

Time	Message direction	Note	Post-event comment
8:29	outgoing	?Confirm equipment operational	I think this was in relation to the GoPros, wrist phones, etc.
8:29	incoming	… JS2: "all good"	
8:29	incoming	JS4: "all good:	
8:29	outgoing	?Brighton IRB1	Brighton IRB1 needed prompting to give readiness status
8:29	incoming	"all good"	
8:33	outgoing	?Brighton confirm ATV operational	
8:33	incoming	all good	
8:34	internal	Left to Right operator: ready Brian?	
	internal	Right to Left operator: almost	delay introduced by logging?
8:36	outgoing	Run 1 is go	Run 1 was using the new technology
	outgoing	Vessel overdue reported, with 6 persons on board	beginning of simulated search and rescue scenario
	incoming	?further info - location of asset?	requesting more information
	outgoing	no further info available	
	incoming	?description of craft, how reported when available	requesting more information
	incoming	from Duty10: ?location of surf life saving assets	requesting more information
8:39	outgoing	Jetski2 go to jetty	asset relocation command
	incoming	Brighton […]	delayed response due to radio operator scribing notes
8:41	incoming	?Are we looking for overturned vessel?	requesting more information (possible misheard info)
	outgoing	"No overdue"	repeating previous info
8:42		more discussion takes place of overdue versus overturned	discussion to clarify target info
	incoming	?Permission for Brighton to speak to IRB2?	permission was granted

Time	Message direction	Note	Post-event comment
	incoming	request for visual screen	Brighton locally directing assets to form a search pattern
8:46	incoming	?How was call initiated?	repeat previous request for more information
8:47	incoming	13 craft visible. Need more details - lots of white craft	requesting more information about the target to distinguish it from general traffic
	outgoing	small inflatable, red-orange in colour	giving more detail about the target
8:48	incoming	?registration number?	
		?when were they due back?	
	outgoing	to Duty10: 06:30 hours, about 2 hours ago	
	internal	L to R: passing paper, scribed notes to be input to logging page	logging fully occupied the right hand operator
8:51	incoming	from Brighton: ?Permission to contact …	
	outgoing	Granted	
8:52		not able to contact other clubs	?
8:53	incoming	arrange search about 50 metres between vessels, speed […] knots	this is overhearing local command issuing orders for a search pattern (see row 41
	incoming	I have a visual on blow-up vessel, five to six hundred metres off Seacliff	initial sighting of boat in distress
	outgoing	?visual	?
8:54	incoming	All assets head that way	local command issuing order to all assets
	outgoing	reminder for first asset to see the vessel to raise the alert in the app	not sure whether operator meant first asset to go alongside the vessel
	outgoing	info on registration number	
8:55	incoming	we have vessel and have pressed alert	location of vessel in distress promulgated to all assets with app display
	outgoing	give me more info	

Time	Message direction	Note	Post-event comment
	incoming	LS3: we have unconscious person on board	
8:57		contacting ambulance	
8:58	incoming	taking person unconscious, another	
	outgoing	?Age/gender?	
	incoming	13 … another left in boat	
8:59	outgoing	accounts for three, what about the report of six persons on board?	
	incoming	?confirm handling of spinal injury	
	outgoing	don't know, and don't have info re 3 outstanding persons	
	outgoing	standby	
9:03	internal	Left operator comment: alert raised here but no assets are there	
9:05	incoming	from Brighton: I have details of 6 patients	Left operator scribing incoming info as well as communicating over radio
	outgoing	go ahead	
	incoming	1. John Smith age 69 heart attack	
	outgoing	1. John Smith age 69 heart attack, roger	
	incoming	2. unconscious blocked airway	
	outgoing	2. unconscious blocked airway, roger	
	incoming	3. Helen Smith 43 impaled on metal object	
9:07	outgoing	roger	
	incoming	4. Barbara Smith 71 suspected hypothermia	
	incoming	5. Robert Smith 45 lower back pain	
9:08	incoming	6. […]	
	outgoing	message scrambled, say again	
	incoming	6. Amy Smith 15 anxiety	
9:10	internal	connection error on app screen. Fixed by Concilium	
9:11	incoming	from Duty10: all assets are at Brighton Beach. Call endex?	
	outgoing	roger. Standby	
9:13	outgoing	Run 1 complete. Switch off GoPros.	

C.1.2. Run 2

Time	Message direction	Note	Post-event comment
		Run 2 is without the new app	Run 3 is NOT using the new technology
		Left and Right operators swapped positions due to RediTalk™ computer doing a software update.	
9:40:00 AM	incoming	from Duty10: ready to go	
		?query location of jetskis and of patients during triage	
9:42:22 AM	outgoing	exercise is about to start	
		time spent confirming apps on home screen and GoPros recording	
9:45:22 AM	outgoing	Run 2 is go	
	outgoing	report of 1 boat overdue in vicinity of Brighton jetty	
	incoming	from Duty10: ?where did report come from?	
	outgoing	from Sea Rescue. Seeking more info.	
9:46:40 AM	incoming	?Can you do a quick visual scan	overhearing traffic from local command to local assets
	incoming	about 18 vessels	
	incoming	look for signs of distress, flares, smoke, etc.	
9:48:56 AM	incoming	Jetski standing by	
	outgoing	[…]	
		LS4 to JS 2/4: perform search	
9:49:30 AM		20 knots, 100 metre separation	
		log any boats seen along the way	?why
9:50:30 AM	incoming	report any unusual	

Time	Message direction	Note	Post-event comment
		activity	
		no unusual activity at the moment	
	incoming	?what assets do you have?	
	outgoing	to Duty10 description of vessel and last known position	
9:53:10 AM	incoming	will extend search south of Brighton jetty	
9:54:15 AM	incoming	look for red boat to the south	
9:55:00 AM	incoming	Duty10: permission to speak to LS3	
	outgoing	granted	
	incoming	?current location?	
9:55:30 AM	incoming	increase pace to 25 knots	
9:57:30 AM	incoming	from Duty10: […]	
	outgoing	Westpac 1 non-operational	?
9:58:20 AM	incoming	Brighton ATV to Surfcom?	
		Permission to speak to Duty10	presumably granted
9:58:55 AM		ATV to Duty10: I have visual on red boat off Hallet Cove	Asset spent time getting permission from Surfcom before alerting local command of sighting the boat in distress
9:59:30 AM	incoming	from Brighton IRB: confirmed	
	incoming	confirm colour - not marker buoy	
		100 metres North from Seacliff tower	Using local landmarks to geo-locate
10:00:00 AM		Start search for that location	Why a search and not an order to go to that location?
10:03:00 AM	incoming	Duty10 to Surfcom: ?permission to speak to	

Time	Message direction	Note	Post-event comment
		Brighton?	
10:04:10 AM	LS3 to Duty10	We are at distressed vessel	
10:04:40 AM	LS3 to Surfcom		
	incoming	?current location?	
		1 km off Marino Rocks	
	outgoing	?detail re number of person on craft	
10:05:27 AM	incoming	Jetski2 returning to Brighton with suspected blue ring bite	
	outgoing	Confirm, and ?how many persons on craft?	second question regarding number of people on target craft
10:06:10 AM	incoming	IRB2 returning with shock/heatstroke	
		IRB1 returning with severed hand and anxiety	
	outgoing	roger	
10:07:19 AM		Pink floats - any chance of recovery/survival? No. Please take photo.	?what's this about?
10:08:48 AM		All returning to Brighton	
10:09:26 AM		Brighton ATV: ?Permission to speak to Duty10?	
		Yes	
		Surfcom ATV returning to Brighton beach to help with patients	
10:10:10 AM		Jetski2 request permission to speak to Duty10?	
10:10:39 AM	incoming	Currently on scene request assistance with blue ring bite	
10:11:00 AM	outgoing	On your own. Give resuscitation	
		Surfcom to LS3: ? Confirm number of patients going where?	

Time	Message direction	Note	Post-event comment
10:11:50 AM		2 on IRB plus 2 on IRB plus 1 with us	
10:13:06 AM		Duty10 to Surfcom: ?permission?	
10:13:19 AM		Return all assets to Brighton	
10:14:00 AM		Brighton Patrol to Surfcom: Have 5 patients. Are you ready to receive details?	
		Yes	
10:14:50 AM		Patient 1 Helen Smith 43 severed hand	
		Patient 2 Charles[?] Smith 13 blue ring octopus bite	
		name is Thomas [?] Smith	
		(fend off other calls)	
10:17:13 AM		Surfcom to Brighton patrol: continue details	
10:17:30 AM		Patient 3 Amy Smith 15 shock	
		Patient 4 John Smith 69 heat exhaustion	
10:18:07 AM		Patient 5 Barbara Smith 71 Anxiety	
		Confirm all patients	
10:18:30 AM		Yes	
10:20:00 AM		App needs resetting. Not tracking.	
		(5 patients on beach plus 1 deceased)	
10:21:00 AM		End run 2	

C.1.3. Run 3

Time	Message direction	Note	Post-event comment
			Run 3 is using the new technology
10:46:30 AM	outgoing	Surfcom to all: exercise about to start	
10:47:30 AM	incoming	jetski2: I can't read my screen. Very dark. Low batter?	
	internal	Trial Director: continue as best you can	
		[…]	traffic relating to setting up GoPros and phones
10:51:15 AM		Startex	
		Report of overdue boat	
10:51:50 AM		Brighton patrol to Duty 10	
	incoming	?more info on source of report	
10:52:50 AM	outgoing	Possible small vessel, orange	
10:53:24 AM	incoming	?perform visual scan	
	outgoing	will do	
10:53:50 AM	incoming	Please request surf rescue for further details of missing vessel	
10:54:00 AM		Perform search spaced 100 metres apart, inshore mark 800 metres offshore	
10:55:20 AM		We'll set the pace	
		Brighton patrol permission to speak to Duty10	
		Approx. 16 vessels from Seacliff to Somerton	
10:56:00 AM		Any matching description?	
		No - all white	
10:57:00 AM		Commencing line search 100 metres apart	
10:57:19 AM		Vessel last reported drifting south	
		Small inflatable. Partial rego SL2	
		Possible 1 person overboard plus 5 persons on board	
		Coordinate with SAPOL water ops	
10:59:00 AM		Duty10 to Brighton Patrol	

Time	Message direction	Note	Post-event comment
10:59:20 AM		Brighton patrol: have possible visual	
		to Brighton patrol: perform search	
11:00:00 AM		Contact Somerton	
		Permission to speak to LS3	
11:00:50 AM		Duty10 to LS3: look for boat and missing […]	
11:01:50 AM		Be aware of small pleasure craft and fishing vessels	
11:02:30 AM			
11:02:56 AM		LS3: possible sighting	
11:04:34 AM		be aware of 2 kayakers	
		LS3 to Duty10: confirm visual, will deploy assets	
11:05:20 AM		Be aware of person in water. Perform search.	
		JS2: have submerged object	
		BIRB1 to BIRB2: come to our location	
11:06:53 AM		Alert dropped on app	
11:07:50 AM		Retrieved 43 year old person unconscious on jetski	
11:08:30 AM		Ambulance contacted	
		BIRB	
11:09:30 AM		JS4 to Surfcom: JS2 just received […]	
		on route to Brighton SLS	
		Confirm 1 patient on board	
		IRB2 have towed boat from rocks with 5 persons with injuries	
11:10:39 AM		Please provide patient details when able	
11:11:11 AM		We'll take control of the boat. You come around to the port side	
11:12:00 AM		Commencing triage	
		Duty10 to Brighton Patrol: Patient with electric shock	
11:12:48 AM		Duty10 to Brighton Patrol: Patient with broken arm	
11:13:00 AM		final patient hyperventilating	
		vessel with suspect spinal on board	
11:14:11 AM		Surfcom to LS3: We have 5 patients. Is there one outstanding?	
11:14:40 AM		LS3: Total of 5	

Time	Message direction	Note	Post-event comment
	outgoing	report was total of 6	
11:15:15 AM		Correction total of 6. JS had 1 patient.	
		Brighton IRB2 to 2:	Confirming number and location of people
		LS3	
		?Where to transfer to ambulance?	
11:16:20 AM		at Brighton	
		Currently passing Seacliff. Will need assistance at Brighton	
11:17:00 AM		Patrol has taken unconscious patients for further treatment	
11:20:00 AM	incoming	Brighton patrol to Surfcom: Permission to speak to LS3	
		?Confirm you have 1 patient on board?	
11:20:30 AM		Yes suffering anxiety	
11:21:50 AM	incoming	Brighton patrol to Surfcom: Ready for patient details	
11:22:10 AM		Patient 1 […] Smith 43 unconscious, breathing	
11:22:40 AM		Patient 2 Robert Smith 45 suspected electric shock, unconscious, breathing	
11:22:55 AM		Patient 3 Barbara Smith 71 Suspected broken arm	
11:23:13 AM		Patient 4 Thomas Smith 13 Shock	

C.2. Brighton Beach Observations

C.2.1. Run 1

Time	From	To	Run	Description
8:26 AM	DST Observers			Camera mounted 3/4 of the way down Brighton Jetty
8:28 AM				Confirmed the location of RED-BID1 using binoculars
8:31 AM				Relocated camera to the end of the jetty to ensure we are able to view assets approaching
8:34 AM				Brighton Jetty setup complete
8:36 AM	SURFCOM	ALL	Run#1	Exercise start
8:37 AM	DUTY10	SURFCOM		Acknowledge and request for additional information
8:38 AM				All assets on water
8:38 AM				Jet Ski locations
	Jet Ski (JS) 2			Heading south to Brighton Jetty and commencing search
8:39 AM	Life Saver (LS) 3			On route to Brighton area
8:40 AM	Inflatable Rescue Boat (IRB) 1			Commencing search
8:40 AM	SURFCOM	DUTY10		Confirmation provided that it is an overdue vessel
8:42 AM	Brighton Patrol (BP)			Seeking permission to communicate with Brighton IRB2
8:43 AM	BP	IRB2		Brighton IRB2 tasked to get more details. Search commenced.
8:45 AM				One jet ski does not appear to be tracking in the TEXAS App.
8:45 AM				LS3 and Jet skis now visible to observers on jetty.
8:46 AM	DUTY10	SURFCOM		Still seeking additional details on the overdue boat.
8:47 AM	SURFCOM	DUTY10		Original call regarding the boat received from the public.
8:48 AM	SURFCOM	DUTY10		Overdue boat stated to be a small inflatable craft, red in colour.
8:49 AM	SURFCOM	DUTY10		Boat was due back at West Beach boat ramp.
8:49 AM	DUTY10	BP		Tasking regarding the search for an inflatable craft.
8:49 AM	BP	DUTY10		No visual at this stage.

Time	From	To	Run	Description
8:50 AM	BP	DUTY10		Seeking permission to contact other surf clubs to monitor for return to West Beach.
8:52 AM	BP	DUTY10		No communication back from other clubs.
8:53 AM	DUTY10	ALL		Directed to conduct a light search, 50 metres between assets. LS3 the furthest out to ocean.
8:54 AM	BP	DUTY10		Visual on red inflatable craft. 500 to 600 metres off Seacliff Beach.
8:55 AM	SURFCOM	ALL		Instructed to use Alert on the TEXAS App to identify the position.
8:57 AM	LS3			Alert generated through the TEXAS App. Jetty observer confirmed receipt of alert in local TEXAS App instance. Alert acknowledged.
8:58 AM	LS3			One patient on board - Unconscious, blocked airway. Returning to shore.
8:58 AM	DUTY10			Confirm contact ambulance.
8:58 AM	DUTY10			Confirm contact police.
8:59 AM				1x patient in IRB - suspected heart attack.
9:00 AM				Require patient age and gender.
9:00 AM				1x asset left with spinal victim.
9:01 AM	SURFCOM			Observed multiple people transmitting on top of each other.
9:03 AM	LS3			Returning to RED-BID for spinal patient.
9:04 AM				TEXAS App observation - alert stayed with LS3 as it was traversing back and forth between Brighton beach and Seacliff RED-BID.
9:05 AM				Voice message garbled.
9:05 AM	BP	SURFCOM		Details on patients provided. Patient #1 - John Smith, 69, Suspected Heart Attack. Patient #2 - Tom Smith, 13, Blocked Airway. Patient #3 - Helen Smith, 43, Impaled. Patient #4 - Barbara Smith, 71, Hypothermia.
9:08 AM	BP	SURFCOM		Patient #5 - Rob Smith, 45, Lower Back Pain. Patient #6 - Amy Smith, 15, Anxiety.
9:08 AM	BP	SURFCOM		Voice message garbled. Required to repeat Patient #6 details.
9:10 AM				IRB RED-BID and LS3 returning to shore.
9:12 AM				Run Complete.
9:13 AM			Run#1	End of Run#1.

C.2.2. Run 2

Time	From	To	Run	Description
9:40 AM				RED-BID confirmed in place at Marino Rocks.
9:42 AM	SURFCOM	ALL		Instructed to start GoPro cameras.
9:45 AM	SURFCOM	ALL	Run#2	Exercise start.
9:45 AM	SURFCOM	DUTY10		Overdue boat last seen in the vicinity of Brighton Jetty.
9:46 AM	DUTY10	BP		Following up from discussions with SURFCOM.
9:47 AM	BP			Confirming number of boats in the vicinity looking for a sign of the overdue boat.
9:47 AM	LS3	DUTY10		On way to Brighton Jetty.
9:47 AM	DUTY10	LS3		Instructed LS3 to remain in position at Somerton Park initially.
9:48 AM	DUTY10	SURFCOM		Asking if there are any Jet Skis in the area.
9:48 AM	SURFCOM	DUTY10		Communication with Jet Ski 2 and 4.
9:49 AM	DUTY10			Able to communicate with LS3, JS2 and JS4. Commence linear search with LS3 as lead.
9:50 AM	D10	BP		Advising heading to Brighton, 20 minutes ETA.
9:50 AM	BP			Nothing suspicious on water. No unusual activity.
9:51 AM	DUTY10	BP		Confirmed assets at Brighton.
9:51 AM	LS3			Confirming now on search.
9:52 AM	SURFCOM	DUTY10		Vessel identified as red vessel, last seen south of Seacliff.
9:53 AM	DUTY10			Extending search further south.
9:53 AM	DUTY10	BP		IRBs to conduct line search. 20 to 30 knots with 25 to 30 metres between the IRBs.
9:54 AM	DUTY10	BP		Brighton ATV to do beach search for visual identification.
9:54 AM	DUTY10	SURFCOM		Requested permission to speak to LS3.
9:55 AM	DUTY10	LS3		Requested to confirm position
9:55 AM	LS3	DUTY10		Informed that LS3 heading towards Brighton Jetty.
9:55 AM	DUTY10	LS3		Instructed to increase speed to 25 knots and keep jet skis at pace.
9:57 AM	DUTY10	SURFCOM		Advising to contact Westpac 1.
9:58 AM	Brighton All Terrain Vehicle (B-ATV)	DUTY10		Communication garbled/mixed with jet skis.

Time	From	To	Run	Description
9:58 AM	JSs			Commencing communication. Garbled/mixed with Brighton ATV.
9:58 AM	B-ATV	DUTY10		Visual identification of orange craft around the Hallett cove region.
9:59 AM	DUTY10	LS3		Seeking confirmation that LS3 is also able to detect the orange craft based on visual information from Brighton ATV.
9:59 AM	IRB2			Confirmed sighting of orange craft.
9:59 AM	DUTY10	IRB2		Had to confirm call sign (obviously wasn't expecting response from IRB2 at this stage - had addressed LS3).
10:00 AM	IRB2	DUTY10		Providing location referenced to land (Seacliff marker).
10:00 AM	DUTY10	LS3		Commence further search. Half throttle.
10:01 AM	LS3	DUTY10		Possible confirmation of vessel Going to investigate.
10:01 AM	DUTY10	LS3		Keep Jet Ski 2 and 4 in contact.
10:03 AM	DUTY10	BP		Confirm position. Heading down to patrol for a conversation.
10:04 AM				Confirming location of vessel as 1km off Marino rocks.
10:05 AM	JS			Returning with Blue Ring Octopus victim.
10:06 AM	IRB2			Returning with heat stroke (this had to be reconfirmed over radio).
10:07 AM				Pink float communicated (code for deceased). Notify SAPOL.
10:09 AM	SURFCOM	B-ATV		Resend last message. Wished to speak with DUTY10.
10:09 AM	B-ATV	DUTY10		No response.
10:10 AM	B-ATV	SURFCOM		Returning to Brighton Headquarters.
10:10 AM	JS2	SURFCOM		Request permission to speak with DUTY10.
10:10 AM	JS2	DUTY10		Beached at Brighton. Request control for Blue Ring Octopus patient.
10:11 AM	LS3			Confirmed 2 patients in each IRB. 1 pink float with them at the RED-BID datum. 1 patient with Jet Ski.
10:13 AM	DUTY10	LS3		Permission for all to return to Brighton Headquarters. Jet Ski 4.
10:13 AM	BP	SURFCOM		Patient details being relayed. 1. Helen, 43, Severed Hand (Had to repeat). 2. Thomas, 13, Blue Ring Octopus (Had to repeat name).

Time	From	To	Run	Description
				…..
10:15 AM	DUTY10	SURFCOM		Interjected to request permission to communicate with LS3.
10:15 AM	DUTY10	LS3		Hand patient to RED-BID to then reset with Jet Ski (Message to LS3 was unreadable on first transmission).
10:17 AM	BP	SURFCOM		Completed relaying patient details.
10:19 AM	DST Observer			Observed RWC1 still located at Marino Rocks in TEXAS App, but it had already returned to Brighton.
10:20 AM	DST Observer			RWC1 location error cleared.
10:21 AM			Run#2	End of Run#2.

C.2.3. Run 3

Time	From	To	Run	Description
10:23 AM				Issue observed with location information from LS3. TEXAS App reset on scenario reset. Backup also in operation.
10:44 AM				Battery on RED-BID1 at 18%. Reverting to using RED-BID2 for location (stored in canister of patient).
10:45 AM				RED-BID in position.
10:46 AM				Check location and TEXAS App is running with each asset.
10:47 AM				Jet Ski 2 can't read screen. Confirmed TEXAS App in map mode but screen is dark. Continuing in this state.
10:51 AM	SURFCOM	ALL	Run#3	Exercise start.
10:51 AM	SURFCOM	BP		Boat overdue in vicinity of BP.
10:52 AM	BP	DUTY10		Liaising, seeking additional information.
10:52 AM	SURFCOM	BP		Additional information received from Sea Rescue. Small vessel, orange in colour. No location provided.
10:53 AM	DUTY10	BP		Visual on a number of craft.
10:53 AM	DUTY10	SURFCOM		Looking for additional details on the boat.
10:54 AM	DUTY10	LS3, JS2, JS4		Possible overdue boat. Requested to commence line search from present location to Brighton Jetty; 800m offshore at 25 knots. Initial quick search approximately 100m apart.
10:55 AM	BP	SURFCOM		Requested permission to communicate with DUTY10.
10:55 AM	BP	DUTY10		16 vessels have been observed between Seacliff and Somerton.
10:56 AM	DUTY10	BP		Prepare asset at Brighton.
10:57 AM				Experiment team lost battery on phone at Brighton SLSC.
10:57 AM	SURFCOM	DUTY10		Additional information provided. License plate SL2, possibly one overboard, located south of Seacliff.
10:58 AM	DUTY10	SURFCOM		Ensure others are aware of the situation - Sea Rescue, SAPOL.
10:59 AM	BP	DUTY10		2 orange vessels spotted 300m offshore at Seacliff. Close to the rocks.
11:00 AM	DUTY10	BP		On way down to Brighton now. Approximately 15 minutes away.

Time	From	To	Run	Description
11:02 AM				Be aware of small craft and fishing boats in the area.
11:02 AM	SURFCOM	DUTY10		Contacted Somerton. Deploy in 3 minutes.
11:02 AM	LS3	DUTY10		Possible sighting.
11:04 AM				2 kayakers.
11:04 AM	LS3	DUTY10		Confirmation that craft has been located.
11:05 AM	DUTY10	LS3		Possible overboard. Request to search for this as well.
11:05 AM	LS3	JS2, JS4		Instructed to search for overboard.
11:05 AM	JS2			Submerged object confirmed. Instructed IRBs to come to location.
11:06 AM				Alert raised on TEXAS App by SLS-IRB-B1.
11:08 AM	JS2			Retrieved 43 year old person. JS4 with them. Patient is unconscious.
11:08 AM	DUTY10	SURFCOM		Make sure ambulance is on its way to Brighton.
11:08 AM	IRB			Check status of patients.
11:09 AM	JS4	SURFCOM		JS2 has unconscious patient. Heading back to Brighton Headquarters with JS4.
11:10 AM	IRB2	SURFCOM		Towed/secured boat with 5 patients on board.
11:12 AM	IRB2	BP/DUTY10		Bringing in patient suffering electric shock (actually 2 patients).
11:12 AM	IRB1	BP/DUTY10		Bringing in 2 patients, one with a broken arm, the other with shock.
11:12 AM	DUTY10			Confirm if ambulances are required.
11:12 AM	LS3	BP		Towing boat. Spinal injury remaining in the boat along with other patients on board.
11:12 AM	LS3			Count of 5 patients. Question marks over whether there is one patient outstanding.
11:14 AM	SURFCOM			Reports were for a total of 6 people.
11:15 AM	LS3	SURFCOM		Actually 6 patients. The JS has 1. Additional reconfirmation of numbers conducted. SURFCOM missed IRB2 having 2 patients).
11:16 AM	LS3	DUTY10		Where to drop spinal injury patient for ambulance?
11:17 AM	JS	DUTY10		Onshore at Brighton.
11:19 AM	DST Observer			In TEXAS App, observed the following locations for RED-BID: BID1 = Last Update 11:13:36 BID2 = Last Update 10:53:22

Time	From	To	Run	Description
11:19 AM	DST Observer			Wind has picked up noticeably for Run#3.
11:21 AM	BP	SURFCOM		Patient details being relayed. 1. Helen Smith, 43, Unconscious but breathing (recovered from water). 2. Robert Smith, 45, Suspected electric shock (breathing). 3. Barbara Smith, , Suspected Broken Arm. 4. Thomas Smith, 13, Shock.
11:23 AM	BP	SURFCOM		Patients 5 and 6 currently with LS3.
11:23 AM	DUTY10	ALL		All assets can stand down from exercise.
11:24 AM	DUTY10			Changing back to Channel 3.
11:24 AM	SURFCOM	DUTY10		Advised not to end exercise or change radio channel at this stage.
11:25 AM	DUTY10	LS3		LS3 head back to Brighton.
11:26 AM	LS3	DUTY10		Returned patients to RED-BID to return to Brighton.
11:28 AM	LS3	DUTY10		Location for drop-off. Coming into Brighton.
11:28 AM	BP	SURFCOM		Completed patient details. 5. John Smith, 69, Spinal injury (neck). 6. Amy Smith, 15, Anxiety and hyperventilating.
11:30 AM	BP	SURFCOM		Had to repeat transmission of details for Patient 6.
11:30 AM			Run#3	End of Run#3.
11:32 AM	DST Observer			EXP3 Phone battery at 11%.

DEFENCE SCIENCE AND TECHNOLOGY GROUP **DOCUMENT CONTROL DATA**	1. DLM/CAVEAT (OF DOCUMENT)

2. TITLE	3. SECURITY CLASSIFICATION (FOR UNCLASSIFIED LIMITED RELEASE USE (U/L) NEXT TO DOCUMENT CLASSIFICATION)
Conducting Information Superiority Research in an Unclassified Surrogate Defence Environment	Document (U) Title (U) Abstract (U)
4. AUTHOR(S)	5. CORPORATE AUTHOR
Andrew Walters, Russell Anderson, Jonathan Boan, Angela Consoli, Mark Coombs, Adam Iannos, Drew Knight, Mathew Pink, Jayson Priest, Tim Priest, Andrew Smith, Brad Tobin and Sonya Williamson	Defence Science and Technology Group DST Group Edinburgh PO Box 1500 Edinburgh SA 5111

6a. DST GROUP NUMBER	6b. AR NUMBER	6c. TYPE OF REPORT	7. DOCUMENT DATE
DST-Group-TR-3529	AR-017-280	Technical Report	September 2018

8.TASK NUMBER	9.TASK SPONSOR	10. RESEARCH DIVISION
JNT 17/471	Joint Capability Group	Weapons and Combat Systems Division

11. MSTC	12. STC
Tactical Systems Integration	Tactical Information Integration and Interoperability

13. SECONDARY RELEASE STATEMENT OF THIS DOCUMENT

Approved for public release.

OVERSEAS ENQUIRIES OUTSIDE STATED LIMITATIONS SHOULD BE REFERRED THROUGH DOCUMENT EXCHANGE, PO BOX 1500, EDINBURGH, SA 5111

14. DELIBERATE ANNOUNCEMENT

No limitations

15. CITATION IN OTHER DOCUMENTS

Yes

16. RESEARCH LIBRARY THESAURUS

Information, Research, Data, Situational Awareness, Experimentation

17. ABSTRACT

Defence experimentation brings significant value, but also significant overheads. It is therefore important to strike a balance between working on real systems and the use of surrogate systems, where there is a straightforward translation to defence systems and/or scenarios, to facilitate rapid development. A non-Defence surrogate system offering significant potential to mitigate many of these overheads is the emergency services domain. In November 2017 an information exchange experiment was conducted under the Real-Time Information Superiority Experimentation (RISE) initiative with Surf Life Saving South Australia to gauge the applicability of this domain to Defence research. The outcome was a success, leveraging extended resources and expertise at no cost, producing a varied set of applicable data products and a rich pool of information capable of supporting ongoing research into information superiority. The recommendation is to continue this line of experimentation while increasing its complexity and exploiting its dynamic nature.