University of South Australia

School of ITMS

IT Projects

DECLARATION OF CONTRIBUTION

Project No: 2017-SP5-1

The following is a declaration of your individual contributions towards this group assessment. If any contribution does not meet the assessment requirements, the course coordinator may adjust individual marks up or down, depending on the level of contribution made.

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I contributed entirely towards this assessment.

I worked on all sections/questions.

Blue-Force Tracking using Commodity Smart Phone Technology

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# BUSINESS REQUIREMENTS

## EXECUTIVE SUMMARY

Blue Force Tracking is a system that provides military commanders and troops with information in regards to the location of friendly and hostile forces (Smithsonian 2017). The system provides timely and accurate real-time visualisation of a combat zone, which enhances situational awareness and lowers the risk of friendly fire (Smithsonian National Air and Space Museum 2012). Blue Force Tracking systems comprise of the following:

* A computer to show location information
* A satellite terminal and antenna to send location and other data
* A global positioning satellite (GPS) receiver to ascertain its own bearings
* Command-and-control software to give and receive orders, along with other support functions
* Mapping software that displays the Blue Force Tracking device, along with the locations of other friendly and enemy forces (Wikipedia 2017)

This project will be looking at making use of commodity hardware to simulate Blue Force Tracking systems, which are otherwise unavailable for use in Defence Science and Technology Group (DST Group) trials. GPS locations from Android devices are to be sent to a server, which in turn will generate a situational awareness display and pass a stream of collated GPS positions to a data diode. This will allow for the emulation of Blue Force Tracking systems in future trials, enhancing situational awareness and permitting near real time analysis of trial events as they unfold.

## PROJECT PURPOSE/JUSTIFICATION

The purpose of this project is to construct a simulated Blue Force Tracking system that can be utilised during science and technology trials. Trial events need to emulate real military operations as much as possible and providing a system to emulate that of Blue Force Tracking systems will increase trial realism.

### Business Need/Case

A major undertaking of the project sponsor group (Information Architectures) within the National Security and Intelligence, Surveillance and Reconnaissance Division (NSID) of DST Group is to explore and develop Integrated Intelligence, Surveillance and Reconnaissance (ISR) software to support Defence and its coalition partners (DST Group 2017). In order to validate and test the exemplar software produced, experimental trials are conducted. These trials are typically conducted with Defence service personnel alongside DST Group personnel and must imitate real Defence operations as much as possible.

In Australia, Defence utilise specialised Blue Force GPS Tracking systems for operations. As a customer of the project sponsor group, Defence have requested the capabilities provided by a Blue Force Tracking system during trials to assist in providing a realistic military setting by establishing ground truth, which is the actual outlook of a tactical situation.

Unfortunately, the Blue Force Tracking system and respective devices used by Defence are not readily available for use in science and technology experimental trials. As such, the project sponsor group are lacking the functionality that these GPS tracking systems provide. Therefore, there is a need to emulate the capability of Blue Force GPS Tracking systems, which would be used to enhance near real-time situational awareness of troops during trials and allow near real-time analysis of the trial events as they unfold. The emulated system would also enrich the genuineness of experimental trials, which may in turn lead to improved ISR software as it would allow for the testing of exemplar applications in a more realistic setting.

### Business Objectives

This project supports not only the DST Group strategic plan, but also the NSID strategic plan in several ways. The business objectives for the project which relate to the strategic plans are outlined in Table 1.

Table 1 – Business objectives supporting DST Group and NSID strategic plans

|  |  |  |
| --- | --- | --- |
| **Strategic Plan** | **Component** | **Business Objectives for Project** |
| DST Group | Vision   * Support and transform Australia’s defence and national security | Support defence and national security of Australia by allowing personnel to conduct trials in a more realistic environment and review their actions in near real-time. Near real-time analysis could lead to more informed operational decisions |
| Values   * Innovation – actively looking for better ways of doing business | Improve how business is done by providing a means in which personnel can conduct trials in a more realistic environment |
| Strategic Initiatives   * Strategic engagement with client focus | Client focus is the primary driver for this project as it has been derived through the request of Defence, who are a major client of DST Group |
| NSID | Mission   * To enhance Australia’s capability to produce accurate, relevant, timely and actionable information to enable decision-making superiority for Defence and to support whole-of-Government national security science and technology coordination and delivery | Increase the volume of accurate, relevant, timely and actionable information by providing ground truth capabilities during trials. Improve decision-making by enhancing the near real-time situational awareness of troops during trials and allowing near real-time analysis of the trial events as they unfold |
| Values   * Openness – within security constraints, encouraging free information exchange and research collaboration across organisational boundaries enabling new capabilities for the benefit of Australian Defence and national security | Encourage free information exchange and research collaboration across organisations by utilising free and open source software, working with external organisations for the development of the project and allowing the University of South Australia to further modify and use the software solution without restriction |
| Core Roles   * Sustainment – supports sustainment, improvement and operational effectiveness of Defence ISR systems | Boost operational effectiveness of ISR systems by allowing for the testing of exemplar applications in a more realistic setting, which can lead to improved software |
| Science and Technology Capabilities Goals   * Integrated ISR Enterprise Analysis and Experimentation * Integrated ISR Architecture Development and Demonstration | By improving the realism of science and technology experimental trials. Provides test data that can be fed into exemplar software to shape possible system integration with Blue Force Tracking systems. |
| Science and Technology Capabilities Goals   * Multi Source Data Analysis and Information Fusion | By enhancing the near real-time situational awareness of troops during trials and allowing near real-time analysis of the trial events as they unfold |

## PROJECT DESCRIPTION

There are two major components to this project. Firstly, Android devices with an application capable of capturing and forwarding periodic GPS updates and other pertinent data to an internet connected server will simulate the functionality of a Blue Force Tracking system being able to receive information relating to friendly and enemy forces; the Android devices will represent friend or foe systems. The second component will consist of a server, which will generate a web-based situational awareness display of the Android devices, as well as pass a stream of the collated GPS positions and relevant data of devices to a data diode. While traditional Blue Force Tracking systems are able to determine and send their own location, the simulated server will not have this functionality. In addition, the server will not feature command-and-control software and will therefore not be capable of giving or receiving orders to actor devices.

Figure 1 – Commodity Blue-Force Situation Awareness



The tracking devices along with the server and situational awareness visualisation will emulate the functionality of Blue Force Tracking systems for use in future trials.

Figure 1 illustrates how the system will operate during a trial. From the left of the diagram, Android devices are carried by actor vehicles and people as they move around the exercise area. These devices, loaded with the afore mentioned application, will send periodic position update reports to an internet connected server. On the right-hand side, the server will parser the messages from the devices, generate a situational awareness display and pass a stream of the collated device data to a cross-domain diode. In the top right of the diagram, an actor with an internet connected device will be able to access the situational awareness display produced by the server using a web browser.

In order to reduce the software development efforts, both the Android application and the internet connected server application may be derived from existing open source software.

### Project Objectives and Success Criteria

Develop a simulated commodity-based Blue Force Tracking system for the purpose of science and technology trials within 13 weeks.

### Requirements

Input from the project sponsor has emphasised a number of high-level project requirements which act as guidelines within which the project must conform:

* The system must emulate the functionality of Blue Force Tracking systems
  + In Blue Force Tracking systems, the system knows its own location, as well as the location of other devices. For the project, the backend server does not need to know its own location
  + Android devices do not need to know the location of other Android devices
* The server shall support up to 20 Android devices at a time, but an extensible solution that supports a greater number of devices is desirable
* Android devices must have the following configurable attributes:
  + Location upload intervals, with a minimum upload time of 1 second
  + Server IP address and port
* Location data sent to the server must be collaborated and output as a UDP stream
  + Collaborated data should handle the data of multiple Android units simultaneously
  + Data output as a UDP stream needs to be of a format specified by the client
* Location data must be sent from an Android device, reach the server and be output as a UDP stream within 5 seconds
* The situational awareness display should be web-based so it is accessible from all internet connected devices using a web browser
* Access to the situational awareness display should require authorisation and authentication credentials
* The situational awareness display should be configurable and allow the user to stop tracking certain Android devices and change the displayed icons of devices to represent friendly or hostile units
* The situational awareness display should feature a configurable time zone, but if this is not possible, UTC time should be used
* Extant open standards for serving and visualising information should be used to enable the reuse of what is developed
* The situational analysis visualisation should make use of internet connected foundation imagery services
* The data stream going to the cross-domain diode should be a UDP stream
  + The diode should be treated as a system boundary.
  + The diode will expose a UDP server socket.
  + Do not worry about what happens to the data past this point.
* The server shall implement a REST service to allow for the request of track data for a given period of time
* The server should log the received messages
* The user must be able to turn on and off the GPS location upload functionality on Android devices
* User experience needs to be simple so that personnel with minimal experience can operate both the Android devices and web-based situational awareness display with little instruction
* The backend software should be packaged in such a way to allow installation on standalone networks
* It is proposed that a free AWS compute server or similar is used to host the server backend software
* Stretch goal: there should be functionality to allow for the replay of recorded messages

### Constraints

A number of limitations in regards to people, time and equipment available for the project have been identified and are detailed below:

* As the project is to be undertaken by just one person, the skill set and technical knowledge required will be confined to that individual. The lack of a cross-functional team will mean that the full potential of deliverables may not be met – for example, as the individual has minimal networking expertise, the networking portion of the project may consist of only basic, simplified functionality. The lack of team also means the number of man-hours available to the project will be far fewer than that of a team-based project.
* Another constraint on time is the fact that the project is to span approximately 13 weeks, a period that is non-negotiable. This is due to the fact that the project is undertaken as part of a University assessment, and is confined to a semester of work. Therefore, there is no room for extension.
* Testing multiple devices concurrently may also prove to be problematic due to the lack of team – it will not be possible to gather simultaneous, differing test data using the Android devices with just one person. The devices will either have to capture track data with different timestamps, or capture stationary track data with identical timestamps. Ideally, you would have several devices capturing active, moving GPS tracks at the same time to test that the system functions as expected.
* As the number of Android devices supplied is limited and largely unvarying, this will reflect in the test GPS data supplied to the server. Limited test data will mean that GPS data sent from other commodity devices will be untested and unaccounted for on the server side. Should the project expand to use different commodity devices, their capabilities will be unknown and may produce unpredicted results. The small number of similar devices provided mean it will not be possible to develop ‘generalised’ software – the software will only be guaranteed to work with the devices provided.
* The Android devices provided for use during trials will be of low processing power and will feature low resolution displays, with the likely vertical resolution being 480 pixels. Therefore, the application chosen will need to be computationally lean, as well as offer support for low resolution devices.

### Assumptions

The following assumptions highlight expected conditions of the project, without it having been specifically stated:

* The choice of development tools used to build the software will be at the discretion of the project team
* If the developed software is based on open source software, the licencing agreements for the derived software will remain unchanged
* The commodity Android devices and related hardware will be in functioning condition and have access to mobile networks, Wi-Fi and an application market so that client side software can be installed and managed
* If the server is hosted on a cloud-based, virtual machine, the machine will be available for the duration of the project and resizable as required

### Preliminary Scope Statement

The scope of this project is to include the following:

* Delivery of a commodity-based, mock Blue Force Tracking system as outlined in the requirements section, for use by personnel in experimental science and technology trials.
* Delivery of relevant documentation.
* Delivery of a test data stream.

Completion of the project will be established when software and test data to be delivered is tested and stable, and documentation fulfils its purpose. Stretch goals, where stated, do not need to be achieved for the project to be characterised as complete.

## RISKS

The following high-level risks have been found to apply to this project:

* There is a risk that due to the strict deadline of the project, it may not be completed to a satisfactory level in time. This risk can be mitigated by clearly defining the requirements before commencing the project and holding discussions with the project sponsor if it is believed that some requirements may be too difficult for one person to accomplish in the timeframe given.
* Another risk is that the delivered software will not be suitable for the purpose of science and technology trials as intended. This may be due to low quality software, or the fact that the software cannot be readily tested for ‘heavy load’ situations, in which there are a large number of devices reporting their location data simultaneously. The risk of producing low quality software can be minimised by clearly defining the requirements and ensuring a suitable number of use cases have been explored. Ensuring the project sponsor and academic supervisor are kept notified of major milestones in development should assist in ensuring the project is advancing as intended. Reducing the risk associated with the software not running as intended under ‘heavy load’ post-completion may not be possible due to the constraints listed earlier – a lack of team members and devices means the ability to ‘stress test’ is not readily available.
* The availability and suitability of a free cloud compute server for hosting backend and web interface services could also pose a risk to the project. Free server instances are likely to offer limited infrastructure or software capabilities, which may prove inadequate for the purposes of the project. To alleviate the risk of using an ill-equipped compute server, research should be conducted into the offerings and limitations of cloud providers. The project sponsor has also offered to assist in establishing a more suitable solution if a free server proves inadequate.

## PROJECT DELIVERABLES

* Android devices loaded with software capable of capturing and forwarding periodic GPS updates and other pertinent data
* Backend server
* PCAP file of captured UDP stream
* Documentation
  + Information with regards to design and architecture decisions
  + User guides
  + Instructions on standing up the server
  + WADL definition for REST interface

## SUMMARY MILESTONE SCHEDULE

An estimated schedule of all high-level project milestones is described below. The schedule is an estimate and is likely to change over the course of the project period.

|  |  |
| --- | --- |
| **Milestone Name and Description** | **Expected Completion Date** |
| Delivery of System Requirements Document | 13 August 2017 |
| Delivery of Project Proposal Presentation Slides | 13 August 2017 |
| Project Proposal Presentation | 15 August 2017 |
| DST Group Trial   * This trial can be used for testing of the system, if needed * Trials run for three weeks, commencing at the given date | 16 October 2017 |
| Delivery of Final Project Presentation Slides | 29 October 2017 |
| Delivery of Fair Day Poster | 29 October 2017 |
| Delivery of System Design Document | 5 November 2017 |
| Delivery of Final Deliverables | 5 November 2017 |
| Delivery of Fair Day Presentation Slides | 5 November 2017 |
| Project Presentation | 5 November 2017 |
| Project Fair Day | TBA |
| DST Group Trial   * The trial for which the system is intended to support * Trials run for three weeks, commending at the given date | 13 November 2017 |

## SUMMARY BUDGET

The following cost components necessary to the project have been identified:

|  |  |
| --- | --- |
| **Component** | **Cost** |
| Android smartphones | On loan from sponsor |
| Pre-paid mobile sim cards | On loan from sponsor |
| Pre-paid recharge vouchers | Provided by sponsor |
| Cloud compute server | Free – if a free server is not suitable, a more suitable solution is to be established in consultation with the project sponsor |
| Open source software | Free |
| Development hardware | The project team has the choice to use personally owned, University-based, or hardware provided by the sponsor. With the exception of personally owned hardware, the other choices will bear no cost on the project team |
| Development software | The project team has the choice to use personally owned, University-based or sponsor-based development software. With the exception of personally owned software, the other choices will bear no cost on the project team |
| Networking and internet connectivity | The project team has the choice to use personally owned, University-based or sponsor-based network facilities and internet provision. With the exception of personally owned network and internet functionality, the other choices will bear no cost on the project team |
| Travel | Meetings with the client and academic supervisor are to be held at either the University of South Australia Mawson lakes campus or on-site at DST Group Edinburgh. These costs are expected to be minimal and will be borne by the project team |

## PROJECT APPROVAL REQUIREMENTS

The requirements which must be met to gain project approval include:

* The project is to emulate the capability of Blue Force Tracking systems
* The project must include a configurable application loaded on Android devices, used to report location data to a server
* The server must be packaged in such a way to allow for it to be installed on a different host machine
* The server is to receive and log data from the Android devices, visualise the devices on a configurable web-based display, and stream received data to a specified UDP port
* The server must feature a REST service endpoint and allow for the request of logged data
* The project must be extensible
* All high-level project requirements outlined in section 1.3.2 have been met

## PROJECT MANAGEMENT

As this project is being undertaken solely by Danielle Heinrich, that person will also act as the project manager.

### Project Manager Responsibilities

The project manager will be responsible for all client communication, management and development obligations.

### Project Management Plan

To ensure optimal client communication, the project manager will initially liaise with the sponsor at least once a week, or as often as reasonably necessary. Once the project requirements and scope have been defined and authorisation to move ahead with the project has been sought from the sponsor, it is expected that client communication will occur less frequently.

Meetings with the academic supervisor will also be held on a weekly basis to start, with the rate of communication expected to fall as the project matures.

Whenever meetings with the client or academic supervisor are sought, the project manager will prepare required documentation, such as meeting minutes and clarification questions, ahead of time. Following a meeting, a summarisation of meeting discussions will be sent to the respective persons – this will assist in reiterating the understanding of project specifications between parties, as well as acting as a log of evidence.

The project manager will also generate the project schedule, referring to it weekly to track the progress of project milestones. If milestones are at risk of running over their allotted period of time, the project manager will investigate the cause of delay and either reallocate project resources or update the schedule accordingly. Conversely, if milestones are completed ahead of time, the schedule can be updated to reflect this, and additional time can be instead allocated to other elements of the project.

## AUTHORISATION

Approved by the Project Sponsor:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: / /

Project Sponsor Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

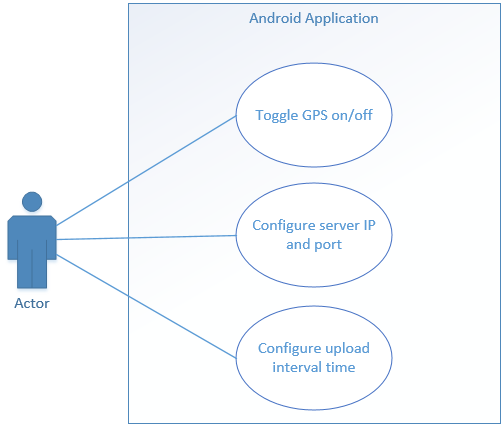
Project Sponsor Title: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

# 2. SYSTEM REQUIREMENTS



## USE CASE ANALYSIS

### Actor operating mobile Android device



The actor is carrying the mobile Android device during a trial exercise.

The actor has been instructed to start or stop sending their GPS location, so they toggle this functionality on or off as required.

The actor needs to configure the IP address and port of the server to which the location data must be sent.

The actor needs to configure the upload interval time for the data sent to the server.

### Actor operating situational awareness display



The actor needs to login to the web-based situational awareness application.

The actor decides to stop displaying a single device on the situational awareness display, though the situational awareness display is still receiving the location data of the device. Conversely, the actor decides to start displaying a single device that is already being tracked by the situational awareness display.

The actor decides to stop tracking a device, so the situational awareness display is no longer receiving the location data of the device. This device can no longer be selected or displayed.

The actor decides to add a device to start receiving and tracking its location data.

The actor decides to assign an icon to a device to represent whether the actor carrying the device is a friendly, hostile or unknown force.

The actor wants to display only friendly, hostile or unknown force icons, or any combination of those groupings.

The actor wants to configure the time zone, and if this is not possible, UTC should be assigned as the default time zone.

The actor wants to replay previously recorded location data. They must select a date and time period for which they want the previously recorded data to occur in.

### Developer operating backend server



The developer wants to install the server on a host machine.

The developer wants to conduct a REST service request to get previously logged data. They must select a date and time period for which they want the previously recorded data to occur in.

The developer needs to configure the IP address and port of the UDP socket to which the streaming location data must be sent.

## FUNCTIONAL REQUIREMENTS

### Android device application

The system shall:

FR1: Present an interface in which an actor can configure if their device transmits location data, where the device transmits location data to and how often the device transmits location data.

FR2: Allow the actor to toggle whether location data is sent or not

FR3: Allow the actor to configure the IP address and port of the server to which the location data must be sent

FR4: Allow the actor to configure the upload interval time for the data sent to the server

### Situational awareness display application

The system shall:

FR5: Present an interface in which an actor can view the representative positions of Android devices on a map

FR6: Allow the actor to toggle the display of individual devices on a map on or off

FR7: Allow the actor to stop tracking a device, so the application no longer receives data pertaining to that device

FR8: Allow the actor to start tracking a device, so the application receives data pertaining to that device

FR8.1: By default, the device should have an ‘unknown’ icon

FR8.2: By default, the device should be displayed on the map

FR9: Allow the actor to assign a friendly, hostile or unknown icon to a device

FR9.1: By default, devices should have an ‘unknown’ icon

FR10: Allow the actor to display only friendly, hostile or unknown icons (or any combination of these groupings) on the map

FR10.1: By default, all groupings are displayed at the same time

FR11: Allow the actor to configure the time zone

FR11.1: By default, the time zone should be UTC

FR12: Allow the actor to replay previously recorded location data

FR12.1: The actor must select a date and time period

### Backend server

The system shall:

FR13: Allow the developer to install the backend server on a host machine

FR14: Allow the developer to conduct a REST service request to get previously logged data

FR14.1: The developer must select a date and time period

FR15: Allow the developer to configure the IP address and port of the UDP socket to which the streaming location data is sent

FR16: Collaborate received location data and output as a stream

FR17: Log received messages

## NON-FUNCTIONAL REQUIREMENTS

### Usability

The system shall:

NFR1: Allow the user to zoom in and pan around the situational awareness display map

NFR2: User interfaces must be simple and intuitive to use, with little instruction necessary

### Performance

The system shall:

NFR3: Ensure the server can support up to 20 mobile devices at a time

NFR4: Ensure the server is extensible to support a greater number of mobile devices in the future

NFR5: Ensure the mobile application can configure the upload interval time to a minimum of 1 second

NFR6: Location data must be sent from a mobile device, reach the server and be output as a stream within 5 seconds

### Security

NFR7: Ensure access to the web-based situational awareness display is protected by authorisation and authentication controls

### Design

NFR8: Mobile phone application must run on an Android operating system

NFR9: Mobile phone application must operate on low performance CPUs (approximately 1.3GHz)

NFR10: Mobile phone application must operate on low screen resolution (approximate vertical resolution of 480 pixels)

NFR11: Ensure the collaborated output stream from the server is formatted according to client specifications

NFR12: Ensure the situational awareness display application is web-based and accessible from Internet connected devices using a web browser

NFR13: Ensure the backend software is packaged to allow for the installation on standalone networks

### Supportability

NFR14: Ensure the installation process of the backend server is configured in such a way to require minimal user input

NFR14.1: Installation documentation should be provided separately

### Implementation

NFR15: Ensure the collaborated output stream from the server is sent over UDP

NFR16: Ensure the system uses open standards for serving and visualising information

NFR17: Ensure the situational awareness display makes use of internet connected foundation imagery services

NFR18: A free Amazon Web Services compute server should be used to host the backend software

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