Program and Abstracts

Adelaide Convention Centre
Adelaide Australia
5 - 7 September 2016
Welcome to DST Group’s second Future Land Force Conference in Adelaide. Our aim this year is to focus on delivering world-leading innovation to our Land Forces.

The Chief of Army, LTGEN Angus Campbell, will set the stage for the conference as we seek to address the challenges the Australian Defence Force (ADF) now faces in a rapidly changing and unprecedented security environment. This conference brings together an impressive assembly of world-leading international and Australian Defence science experts who will discuss critical issues in the focus areas of human performance, land electronic warfare and autonomy.

This represents a great opportunity for us to gain an in-depth understanding of the challenges the ADF must meet by developing innovative concepts and effective solutions in order to remain at the leading edge of technological advancement.

Indeed many of the people here today – the Army officers, defence researchers, industry professionals and academics - will play important roles in transforming the military land force through science, technology and innovation.

I believe our focus should be on addressing the key question of how these emerging technologies and innovation can effectively modernise Australia’s land forces and give them the increased capability to succeed in strongly contested and hostile environments to defeat increasingly complex threats.

I would take this opportunity to thank our valuable partners in Army, industry, universities and research agencies who contribute to the conference program of stimulating plenary and technical presentations, panel discussions and networking events.

I encourage all of you to visit the various interesting trade exhibitions showcasing Australia’s industry capabilities for the ADF. I trust your participation will prove to be both productive and richly rewarding.

Dr Alex Zelinsky
Chief Defence Scientist
Introduction

This booklet provides information on the Future Land Force Conference (FLFC) plenary sessions, panel discussions, technical presentations, interactive sessions, associated networking and social functions and the international Land Forces 2016 industry exposition.

For further information, speak to the staff at the FLFC Registration Desk or visit www.landforces.com.au/future-land-force/program.asp
Registration desk and enquiries

The FLFC delegate registration desk is the on-site contact point for any information regarding the conference and associated activities. The desk will be operational during the following times:

- Sunday 4 September                               1400 - 1700
- Monday 5 September                                0730 - 1600
- Tuesday 6 September                               0800 - 1600
- Wednesday 7 September                             0800 - 1200

Name badges

FLFC delegates must wear their conference name badge at all times. Access to the FLFC conference room, Land Forces exhibition and all social functions will be monitored, and delegates without badges will not be permitted entry.

Plenary sessions and presentations

The Future Land Force Conference will be held in City Rooms 1-4, upper level of the Adelaide Convention Centre. Delegates are asked to arrive at the conference sessions and presentations on time. As a courtesy to all attendees and the presenters, delegates are requested to turn mobile phones to ‘mute mode’ prior to entering the conference room.
FLFC functions and social events

<table>
<thead>
<tr>
<th>Monday 5 September</th>
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<tbody>
<tr>
<td>1800 - 2200</td>
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<tr>
<td>Future Land Force Conference 2016 Dinner (Panorama Room)</td>
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<tr>
<td><em>Open to FLFC delegates and invited guests only</em></td>
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<tr>
<th>Tuesday 6 September</th>
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<tr>
<td>1700 - 1800</td>
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<tr>
<td>Land Forces 2016 - Industry Networking Function (Exhibition floor)</td>
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<tr>
<td><em>Open to FLFC delegates, trade visitors and exhibitors</em></td>
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<tr>
<td>0700 - 0830</td>
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<tr>
<td>CDS Breakfast (Panorama Room)</td>
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Land Forces 2016 Exposition

Land Forces 2016 is an international industry exposition to showcase equipment, technology and services for the armies of Australia, Asia and the Indo-Pacific.

All delegates have complimentary access to the Land Forces 2016 Exposition being held in Exhibition Halls 1-3. Delegates will need to display their FLFC delegate badge to gain entry to the trade show.

*Please note* that the exposition halls will not be open on Monday 5 September.
FUTURE LAND FORCE
Conference 2016

VENUE
Adelaide Convention Centre
Ground Level

Entry to Future Land Force Conference 2016

Escalator to Upper Level
Conference Rooms Level
City Rooms 1-4

LandForces
AUSTRALIA ASIA INDO-PACIFIC 2016
FUTURE LAND FORCE
Conference 2016

VENUE
Adelaide Convention Centre
Upper - City Level

- Registration and Speakers Prep Room
- * Interactive Presentations
- * Lunch, Morning Tea and Afternoon Tea
- Escalator to Lower Ground Level
- LAND FORCES 2016
  Exhibition Viewing
  Tuesday 6 - Thursday 8
  HALLS 1 - 3

FUTURE LAND FORCE CONFERENCE 2016
CITY ROOMS 1-4
Program
# Welcome and Opening

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Presenter</th>
<th>Organization</th>
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<tbody>
<tr>
<td>0900 - 0905</td>
<td>Welcome</td>
<td>Peter Shoubridge, CLD</td>
<td>DST Group, Australia</td>
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<tr>
<td>0905 - 0935</td>
<td>Chief of Army Address</td>
<td>Lieutenant General Angus Campbell, DSC, AM, Chief of Army</td>
<td>Australia</td>
</tr>
<tr>
<td>0935 - 1000</td>
<td>Conference Opening</td>
<td>Alex Zelinsky, CDS</td>
<td>DST Group, Australia</td>
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<tr>
<td>1000 - 1030</td>
<td>S&amp;T Innovation Pitches</td>
<td>Various Presenters</td>
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## Plenary Session

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<tbody>
<tr>
<td>1100 - 1120</td>
<td>Strength Together: International Partnerships for Defense Innovation</td>
<td>Ann Cataldo</td>
<td>Deputy Assistant Secretary of the Army for Defense Exports and Cooperation (USA)</td>
</tr>
<tr>
<td>1120 - 1150</td>
<td>Republic of Korea: Strategy for Future Warfare</td>
<td>Inho Kim</td>
<td>President of Agency for Defense Development (ROK)</td>
</tr>
<tr>
<td>1150 - 1220</td>
<td>Capability Advantage Engineering: The Hawkei Story</td>
<td>Chris Jenkins</td>
<td>CEO Thales Group Australia</td>
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<tr>
<td>1220 - 1230</td>
<td>Pitches for Interactive Sessions</td>
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<tr>
<td>1230 - 1330</td>
<td>Lunch</td>
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<tr>
<td>1330 - 1400</td>
<td>NZ Army 2020: Innovating for Enhanced Combat Capability</td>
<td>Brian Young</td>
<td>Director DTA (New Zealand)</td>
</tr>
<tr>
<td>1400 - 1430</td>
<td>How is Technology Development Shaping Future US Land Forces?</td>
<td>Jyuji Hewitt</td>
<td>Executive Deputy to the Commanding General, RDECOM (USA)</td>
</tr>
</tbody>
</table>
## FUTURE LAND FORCE
### CONFERENCE 2016

**Monday 5 September**  
City Rooms 1-4

### Autonomous Systems to Innovate the Land Force (Chair: Jason Scholz, DST Group)

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Speaker(s)</th>
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<tbody>
<tr>
<td>1430 - 1440</td>
<td>Autonomous Systems for the Land Force: Army’s Perspective</td>
<td>Australian Army Headquarters (Australia)</td>
</tr>
<tr>
<td>1440 - 1510</td>
<td>Envisioning and Enabling Future Army Robotics and Autonomous Systems Capability for the Warfighter</td>
<td>Bob Sadowksi (TARDEC, USA)</td>
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</table>
| 1510 - 1530| Formidable Foes for Advanced Live Fire Training: Autonomous Mobile and Static Targets and Effects | Andrew Lucas, Ian Mathieson and Matteo Pedrotti (AOS Group, Australia)  
Bruce Hughes (Department of Defence, Australia) |
| 1530 - 1540| Pitches for Interactive Sessions                                       |                                                       |
| 1540 - 1610| Afternoon Tea                                                           |                                                       |
| 1610 - 1640| Role of Human in the Future Land Force: From a Human-on-the-Loop Perspective | Saeid Nahavandi (Deakin University, Australia)       |
| 1640 - 1700| Autonomous Vehicles: Disengagements, Accidents and Reaction Times      | Vinayak V. Dixit, Sai Chand and Divya J. Nair (University of New South Wales, Australia) |
| 1700 - 1720| Beyond Robodogs: Applying Rational Frameworks for Selection and Prioritisation of Autonomous Systems | Ksenia Ivanova and Guy Gallasch (DST Group, Australia)  
Jon Jordans (Ground Effects for Army Logistics Consulting, Australia) |
| 1720 - 1740| Open System Architectural Principles for Land Vehicles: Introduction to LAVA | Jonathan Boan and Kate Foster (DST Group, Australia)  
Mathew Pink, James Forrest and Pelle Coscia (Consilium Technology Pty Ltd, Australia) |
| 1740 - 1800| Global Reach Military Sensor Network: Demonstrating the Internet of Military Things | David Krause (DST Group, Australia)  
David Haley and Alex Grant (Myriota Pty Ltd, Australia) |
| 1800 - 2200| Future Land Force Conference Dinner - Panorama Ball Room               |                                                       |

**Pre Dinner Speaker:** Neville Rowe, Chateau Tanunda  
**Dinner Speakers:** Air Chief Marshal Sir Angus Houston, AK, AFC (Retd)  
Taj Pabari, Fiftysix Creations
## Plenary Session

<table>
<thead>
<tr>
<th>Time</th>
<th>Topic</th>
<th>Presenter/Role</th>
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<tbody>
<tr>
<td>0900 - 0930</td>
<td>US Army S&amp;T: Meeting the Future Through Innovation and People</td>
<td>Thomas Russell, DASA R&amp;T [USA]</td>
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<tr>
<td>1000 - 1030</td>
<td>TBA</td>
<td>Quek Tong Boon, Chief Defence Scientist, Ministry of Defence (Singapore)</td>
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<tr>
<td>1030 - 1100</td>
<td>Morning Tea</td>
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<tr>
<td>1100 - 1110</td>
<td>Australia’s Land Domain S&amp;T Strategy</td>
<td>Ralph Gailis, SA-A [DST Group, Australia]</td>
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## Panel Discussion

<table>
<thead>
<tr>
<th>Time</th>
<th>Topic</th>
<th>Presenters/Role</th>
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| 1110 - 1220 | Future Joint Land Combat - What Should Be / Could Be Innovated? | Major General Fergus McLachlan, AM - Head of Modernisation and Strategic Planning - Army [Australia]  
Kate Louis - First Assistant Secretary Defence Industry Policy [Australia]  
Greg Zacharias - USAF Chief Scientist [USA]  
Peter Shoubridge - (CLD, DST Group, Australia)  
and others |
| 1220 - 1230 | Pitches for Interactive Sessions                                    |                                                                                |
| 1230 - 1330 | Lunch                                                               |                                                                                |
# Countering Cyber and Electronic Warfare in Future Joint Land Warfare

**Chair: Mark Pitt, DST Group**

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Speaker 1</th>
<th>Speaker 2</th>
<th>Institution/Location</th>
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<tr>
<td>1330 - 1340</td>
<td>Countering Cyber and EW - Army’s Perspective</td>
<td>Australian Army Headquarters</td>
<td>(Australia)</td>
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<tr>
<td>1340 - 1410</td>
<td>Army Electronic Warfare S&amp;T Strategy and the Benefits of US-Australian Collaboration</td>
<td>Henry Muller</td>
<td>(CERDEC, USA)</td>
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<tr>
<td>1410 - 1440</td>
<td>Integrated Survivability, Greater Than the Sum of the Parts</td>
<td>Heather Elsley</td>
<td>Programme Manager - Land Integrated Survivability (Dstl, UK)</td>
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<tr>
<td>1440 - 1500</td>
<td>Dynamic Cooperative Networked Arrays for Tactical Networks</td>
<td>Daniel Salmond and Stephen Leak</td>
<td>(DST Group, Australia)</td>
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<tr>
<td>1500 - 1520</td>
<td>MIRAGE: A Visible Signature Evaluation Tool</td>
<td>Joanne Culpepper and Vivienne Wheaton</td>
<td>(DST Group, Australia)</td>
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<td>1520 - 1530</td>
<td>Pitches for Interactive Sessions</td>
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<td>1530 - 1600</td>
<td>Afternoon Tea</td>
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<tr>
<td>1600 - 1620</td>
<td>Electronic Warfare Operations Support for Land and Maritime Environments: JP500 Phase 2A</td>
<td>Mark Pitt</td>
<td>(DST Group, Australia)</td>
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<tr>
<td>1620 - 1640</td>
<td>MIMO in UHF SATCOM for Land Vehicles</td>
<td>Balachander Ramamurthy and Gerald Bolding</td>
<td>(DST Group, Australia)</td>
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<tr>
<td>1640 - 1700</td>
<td>Augmented Capability Countermeasure Development for Land Platforms</td>
<td>Mark McKenzie</td>
<td>(DST Group, Australia)</td>
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<tr>
<td>1700 - 1720</td>
<td>Assured SATCOM On-The-Move Waveform for Land Vehicles</td>
<td>Luis Lorenzin</td>
<td>(DST Group, Australia)</td>
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<tr>
<td>1720 - 1740</td>
<td>Battlefield Situational Awareness System with Panoramic Imaging</td>
<td>Ivan Lee and Victor Stamatescu</td>
<td>(University of South Australia)</td>
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<tr>
<td>1740 - 1800</td>
<td>Electro-Optic Signatures for Counter-Surveillance</td>
<td>Raymond Oermann</td>
<td>(DST Group, Australia)</td>
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<td>Time</td>
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<td>Speaker/Institution</td>
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<tr>
<td>0700 - 0830</td>
<td>CDS Breakfast (by invitation only) - Venue: Panorama Rooms 1-2</td>
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<tr>
<td>0900 - 0910</td>
<td>Soldier and Technology Innovation - Army’s Perspective</td>
<td>Australian Army Headquarters (Australia)</td>
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<td>0910 - 0940</td>
<td>Human Performance: An Adaptive Systems Perspective</td>
<td>Laurel Allender (ARL, USA)</td>
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<td>0940 - 1000</td>
<td>Future Enhancements to Human Performance: Identifying their Emergence, Assessing their Development and Determining their Impacts on Defence</td>
<td>David Crone (DST Group, Australia)</td>
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<tr>
<td>1000 - 1020</td>
<td>Assessing Adaptability Using VR-Embedded Metrics</td>
<td>Simon Jackson and Sabina Kleitman (University of Sydney, Australia)</td>
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<td>1100 - 1120</td>
<td>Augmented and Mixed Reality Head Mounted Display Systems: Implications for Future Land Force Training</td>
<td>Susannah Whitney and Justin Fidock (DST Group, Australia)</td>
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<td>Sarah Hibbard (Consilium Technology Pty Ltd, Australia)</td>
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<tr>
<td>1120 - 1140</td>
<td>Digital Human Modelling for Vehicle Ergonomic Assessment</td>
<td>Philip Swadling and Carlo Perin (Thales Group, Australia)</td>
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<tr>
<td>1140 - 1200</td>
<td>Personalised Psychological Skills Training for Enhanced Human Performance</td>
<td>Philip Temby (DST Group, Australia)</td>
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<td>Mark Oostergo and Laura Sinclair (Australian Army)</td>
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<td>1200 - 1220</td>
<td>Combat Clothing with Improved Extremity Protection</td>
<td>Anthony Pierlot (CSIRO, Australia)</td>
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<tr>
<td>1220 - 1230</td>
<td>Best Paper Award and Closing Remarks</td>
<td>Peter Shoubridge, CLD (DST Group, Australia)</td>
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<td>Lunch</td>
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Plenary Sessions - Abstracts
Plenary session

Abstract: N/A

Autonomous Systems to Innovate the Land Force

(Chair: Jason Scholz, DST Group) – 5 September 2016

Autonomous Systems for the Land Force - Army's Perspective  [invited talk]
Australian Army Headquarters (Australia)
Abstract: N/A

Envisioning and Enabling Future Army Robotics and Autonomous Systems Capability for the Warfighter  [invited talk]
Author: Bob Sadowski (TARDEC, USA)
Abstract: N/A

Formidable Foes for Advanced Live Fire Training – Autonomous Mobile and Static Targets and Effects
Author: Andrew Lucas, Ian Mathieson and Matteo Pedrotti (AOS Group, Australia), Bruce Hughes (Department of Defence, Australia)
Abstract: Live fire training is an essential component of infantry and Special Forces training. Advances in target technology now permit sophisticated individual and team behaviours in a realistic and challenging manner, to confront trainees with formidable foes. This paper describes an ongoing, innovative project that augments mixtures of target types, so as to ensure trainees cannot predict opponent behaviour. These behaviours are developed and validated using the AOS Targetry Simulator in advance of deployment on the targets. The technological approach is summarised along with two illustrative scenarios. We conclude with a discussion of the lessons learnt and the way forward, including the development of autonomous target vehicles.

Role of Human in the Future Land Force – From a Human-on-the-Loop Perspective  [invited talk]
Author: Prof Saeid Nahavandi (Deakin University, Australia)
Abstract: Most existing robotic systems have human involvement in some way, shape or form. To achieve a robot assisted mission, human is often in the loop, performing a critical task to the mission that comes with its own weakness and disadvantage. This talk will highlight how robots play a major role the military. Major challenges are highlighted in the journey towards full autonomy and the shift from human in the loop to human on the loop.
**Autonomous Vehicles: Disengagements, Accidents and Reaction Times**

Author: Vinayak V. Dixit, Sai Chand and Divya J. Nair (University of New South Wales, Australia)

**Abstract:** Autonomous vehicles (AVs) are being viewed with skepticism in their ability to improve safety and the driving experience. Recent data released from the California trials provide interesting insights into the current factors influencing disengagements of autonomous mode. We find that the number of accidents observed has a significantly high correlation with the autonomous miles travelled. The reaction times to take control of the vehicle in the event of a disengagement was found to be stable across different companies at 0.83 seconds on average. Lack of trust caused by the exposure to automated disengagements was found to increase the likelihood to manually take control of the vehicle and lower reaction times.

**Beyond Robodogs: Applying Rational Frameworks for Selection and Prioritisation of Autonomous Systems for Army Logistics**

Author: Ksenia Ivanova and Guy Gallasch (DST Group, Australia), Jon Jordans (Ground Effects Consulting, Australia)

**Abstract:** In the emerging landscape of automated and autonomous technologies there are many applicable to Army logistics. How to select those worthy of investment in further research and capability development becomes a key question. This paper presents both the process and outcome of our recent effort to provide an answer, through the use of rational decision-making frameworks for technology identification, selection and prioritization. Ultimately, three technologies were identified for further research: Unmanned Aerial Systems (UAS) for last-mile distribution tasks in isolated and contested environments; portable networked health diagnostics; and predictive analytics. Context for technology use is provided through detailed use cases.

**Open System Architectural Principles for Land Vehicles: Introduction to LAVA**

Author: Jonathan Boan and Kate Foster (DST Group, Australia), Mathew Pink, James Forrest and Pelle Coscia (Consilium Technology Pty Ltd, Australia)

**Abstract:** This is an introduction to research undertaken in the software architecture for next generation vehicle systems with a particular focus on active protection systems. Open system architecture principles are applied in a Service Oriented Architecture consisting of a number of software services that collaborate in a distributed kill chain of incoming threats. This paper will introduce the software services of a kill chain for an active protection system and examine some of the architectural questions.

**Global Reach Military Sensor Network – Demonstrating the Internet of Military Things**

Author: David Krause (DST Group, Australia), David Haley and Alex Grant (Myriota Pty Ltd, Australia)

**Abstract:** Whilst the ‘internet of things’ (IoT) takes on a flourishing life of its own in the commercial world, its impact in the military context is less prevalent. In the spirit of current IoT
understanding, this paper presents a novel concept for integrating two innovative technological capabilities, to achieve a unique global-access military tactical sense and warn capability. The concept combines a prototype military chemical vapour sensor, worn by a soldier, with a state-of-the-art low cost commercial satellite transceiver and network. This has the potential to deliver crucial threat warnings directly from the battlefield to those who need to know, located anywhere in the world, significantly improving their situational understanding.

**Plenary session**

**0900 - 1220  [invited talks and panel discussion] - 6 September 2016**

**Abstract:** N/A

**Countering Cyber and Electronic Warfare in Future Joint Land Warfare**

*(Chair: Mark Pitt, DST Group) – 6 September 2016*

**Countering Cyber and EW - Army’s Perspective**  [invited talk]

*Australian Army Headquarters (Australia)*

**Abstract:** N/A

**Army Electronic Warfare S&T Strategy and the Benefits of US-Australian Collaboration**  [invited talk]

*Author: Henry Muller (CERDEC, USA)*

**Abstract:** N/A

**Integrated Survivability, Greater than the Sum of the Parts**  [invited talk]

*Author: Heather Elsley (Dstl, UK)*

**Abstract:** How do we meet the challenge of providing mobility, agility and protection whilst allowing our forces to obtain a position of advantage with respect to the enemy? Traditional protection methods can no longer overmatch the threat. The future requires open, modular, layered solutions that can be readily adapted as the threat changes. UK are approaching the challenge through Integrated Survivability, an approach which utilises all of the tools in the survivability toolbox

**Dynamic Cooperative Networked Arrays for Tactical Networks**

*Author: Daniel Salmond and Stephen Leak (DST Group, Australia)*

**Abstract:** Achieving communications at range is a continuing challenge for land tactical forces. High data rate communications can be achieved at short range within tactical units, however, the available capacity is likely to be underutilized. A novel dynamic cooperative networked array technology is proposed to exploit unused short-range capacity to achieve increased data rates at greater ranges.
MIRAGE: A Visible Signature Evaluation Tool
Author: Joanne Culpepper and Vivienne Wheaton [DST Group, Australia]

Abstract: Land forces are susceptible to visible detection, particularly larger elements like vehicles, artillery equipment and field installations. As one component of creating an effective land force, the ADF needs to understand susceptibility of its platforms and equipment to visible surveillance. Reliable tools for visible signature evaluation are required to support the delivery of advice and information to guide decision making on acquisitions and the development of new systems and tactics. The Defence Science and Technology (DST) Group is undertaking a research program to meet these needs, developing MIRAGE, a visible signature evaluation tool based on machine learning. MIRAGE will predict the detection range of land and maritime platforms from input images, either real (digital photographs) or synthetic (computer modelled).

Electronic Warfare Operations Support for Land and Maritime Environments: JP500 Phase 2A
Author: Mark Pitt [DST Group, Australia]

Abstract: Project JP 500 Phase 2A will provide Electronic Warfare Operations Support for land and maritime forces drawing on the airborne Countermeasure Development and Validation exemplar established between 2004-14. The elements of JP 500 Phase 2 are summarised. A key factor for success, especially early on, will be priority setting and establishing the governance. This must be done in a manner that recognizes the environment differences and a methodology has been proposed.

MIMO in UHF SATCOM for Land Vehicles
Author: Balachander Ramamurthy and Gerald Bolding [DST Group, Australia]

Abstract: Narrowband satellite communications (SATCOM) in the ultra high frequency (UHF) band is an attractive option within the military SATCOM (MILSATCOM) community. The UHF user terminals are typically low cost, easily deployable and have broad beamwidths so precise pointing to the satellite is not a requirement for mobile users. At the same time, some inherent disadvantages of UHF SATCOM are limited bandwidth and the inability to apply frequency reuse in the geostationary arc, hence low capacity. The multiple antenna technique, popularly referred to as MIMO (multiple input multiple output) is known to increase the channel capacity using spatial multiplexing. However, to achieve the required spatial orthogonality in the LOS dominated SATCOM channel, antenna separation on the order of several kilometers is required either in space or on the ground. In this paper, we consider using two satellites for a large antenna separation in space to enable closer antenna separation for users on the ground.

Augmented Capability Countermeasure Development for Land Platforms
Author: Mark McKenzie [DST Group, Australia]

Abstract: Current generation ADF Land platforms are deficient in Electronic Warfare capability, offering little to no Threat Warning and Situational Awareness to enable the crew or
commander to detect and avoid threat engagements. Additionally, Land platforms suffer from limitations to size weight and power in terms of adding new equipment. This paper illustrates current efforts to provide additional capability to the next generation of Land platforms, through research in Active Protective Systems with modular open vehicle architectures as an enabler. Previous successful application in the Air domain will also be shown.

**Assured SATCOM On-The-Move Waveform for Land Vehicles**

*Author: Luis Lorenzin (DST Group, Australia)*

**Abstract:** SATCOM On-The-Move (SOTM) for Wideband SATCOM is an emerging technology that is of interest to the Australian Defence Force. There are various challenges in providing assured and reliable communications in the Land SOTM environment, in particular at the higher frequency bands. This paper discusses the challenges and solutions to providing an assured SOTM capability. Defence Science and Technology Group have developed and successfully trialed a waveform for resilient and assured Wideband SOTM.

**Battlefield Situational Awareness System with Panoramic Imaging**

*Author: Ivan Lee and Victor Stamatescu (University of South Australia)*

**Abstract:** This paper presents a review of battlefield monitoring and reconnaissance using panoramic imaging devices. Design of the building-up components, including mobile imaging units, video transmission, scalable computing resources, and visualisation techniques, are described. This paper also investigates the research challenges in video analysis, including multi-object detection and tracking, and their potential benefits in improving human posture recognition.

**Electro-Optic Signatures for Counter-Surveillance**

*Author: Raymond Oermann (DST Group, Australia)*

**Abstract:** The term, “Infrared Signature”, is widely understood to describe how an object appears to an Electro-Optic (EO) detection system. If measures are taken to protect the asset against one particular threat, the process of determining the signature as perceived by that threat is relatively simple. As threats become more numerous and diverse in the aspects of the signature that they exploit, a more comprehensive signature assessment is required. This paper describes a two phased approach to the signature determination of military assets (with particular emphasis on Land assets) that could be applicable to both weapon and surveillance threats, but with emphasis on the latter. The first phase involves a relatively quick assessment using calibrated radiometric systems that closely resemble the threat system (or even the threat system itself). The second phase is more comprehensive and involves an in-depth study of the military asset. Each component of the asset that contributes to its signature must be modelled under each asset configuration and environmental condition. Following this, the background and conditions in which the asset is located when deployed must be modelled to the same level of finesse.
The Human Dimension of Innovating the Future Land Force

(Chair: Nick Beagley, DST Group) – 7 September 2016

**Soldier and Technology Innovation - Army’s Perspective**  [invited talk]
Australian Army Headquarters (Australia)

Abstract: N/A

**Human Performance: An Adaptive Systems Perspective**  [invited talk]
Author: Laurel Allender (ARL, USA)

Abstract: N/A

**Future Enhancements to Human Performance: Identifying their Emergence, Assessing their Development and Determining their Impacts on Defence**
Author: David Crone (DST Group, Australia)

Abstract: Delivering advice to Defence policy makers on future human enhancements is becoming common amongst scientists who do not necessarily have a background in the futures, forecasting, and foresight domain ("futures"). To aid these scientists this paper lists important futures concepts, discusses requirements for delivering that advice and lists the information required to form that advice.

**Assessing Adaptability Using VR-Embedded Metrics**
Author: Simon Jackson and Sabina Kleitman (University of Sydney, Australia)

Abstract: This paper describes a VR assessment of people’s adaptability when working in teams. The simulation is intended to provide the Australian Defence with a number of capabilities surrounding human cognitive performance. These immediately include the capacity to research and understand adaptability. Future capabilities will include the ability to select and prepare adaptive individuals to make effective decisions in challenging operational conditions, as well as the ability to augment the formation and preparation of effective teams. The combination of this simulation, and those that follow, with real-time performance analysis is discussed as an avenue by which Army’s human performance priorities may be realised more rapidly. A live demonstration of the simulation scenario will be available and preliminary validation results will be discussed.

**Augmented and Mixed Reality Head Mounted Display Systems: Implications for Future Land Force Training**
Author: Susannah Whitney and Justin Fidock (DST Group, Australia), Sarah Hibbard (Consilium Technology Pty Ltd, Australia)

Abstract: Army has recognized that augmented and virtual reality technologies can potentially be used to supplement existing training simulation technologies. This paper
discusses some of the affordances and constraints of the range of virtual and mixed reality technologies currently entering the market, identifies use cases for future force training, and suggests when these technologies may reach sufficient maturity to provide effective training.

**Digital Human Modelling for Vehicle Ergonomic Assessment**

*Author: Philip Swadling and Carlo Perin (Thales Group Australia)*

*Abstract:* This paper provides an overview of a series of activities that have been undertaken in a collaboration between Thales Australia and Defence Science and Technology (DST) group. The paper focuses on work carried out in 2015. The purpose of the project was to develop a military-specific Digital Human Modelling (DHM) and analysis methodology implementing ADF specific body size and ensemble data. The work culminated in the generation of a 3D Soldier Combat Ensemble (SCE) model for Driver and Dismounted Close Combat (DCC) ensemble. Models of a range of body shapes were also generated, for use with Digital Human Modelling techniques.

**Personalised Psychological Skills Training for Enhanced Human Performance**

*Author: Philip Temby (DST Group, Australia), Mark Oostergo and Laura Sinclair (Australian Army)*

*Abstract:* Performance psychology techniques, such as goal setting, arousal regulation, and visualisation, have been found to be effective for enhancing performance in various domains. Psychological skills training (PST) programs incorporating these techniques have been adopted by overseas military forces with positive outcomes. PST is also being applied within the Australian Army but is yet to reach its potential. The implementation of PST programs throughout Army training establishments could be a cost-effective and innovative approach to enhancing human performance and resilience. These programs would extend the ADF’s current psychoeducation delivery model and support the development of Army’s Human Performance Centres and FORCOMD Resilience Plan. Army’s capacity to cognitively prepare soldiers for future combat is likely to be enhanced by the implementation of PST programs.

**Combat Clothing with Improved Extremity Protection**

*Author: Anthony Pierlot (CSIRO, Australia)*

*Abstract:* High strength fabrics for combat clothing and garments have been developed to provide improved levels of fragmentation protection to the extremities of defence personnel compared to that offered by the current ADF uniform fabrics.
Interactive Sessions
<table>
<thead>
<tr>
<th>Interactive Session 1</th>
<th>Monday 5 September (1230 - 1330 Lunch Break)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tobias Baumart</td>
<td>Information Domination Determines the Success of the Mission</td>
</tr>
<tr>
<td>Paul Bennett and Charles Karl</td>
<td>Use of Probe Data by Future Land Forces</td>
</tr>
<tr>
<td>Stephen Cimpoeru and Paul Phillips</td>
<td>Full System Armoured Vehicle Survivability</td>
</tr>
<tr>
<td>Weimin Zhang, Stephen Leak and Darin Roberts</td>
<td>Practical Explorations of Airborne Radio Relay Supporting Tactical Communications</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Interactive Session 2</th>
<th>Monday 5 September (1540 - 1610 Afternoon Tea Break)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jie Ding, Lijin Wang and Rajkishore Nayak</td>
<td>Enhanced Stab Resistance of Soft Body Armour Fabric with Novel Shear Thickening Fluid</td>
</tr>
<tr>
<td>David Johnson, Graham Brooker, Alistair McEwan, Ralph Nanan and Guy Gallasch</td>
<td>Scoping the Application of Autonomy to Tactical Combat Casualty Care</td>
</tr>
<tr>
<td>Matthew Mckinna and Jason Mossman</td>
<td>Advanced Tactical Booster Technologies; Land-based Long-range Rocket System Applications</td>
</tr>
<tr>
<td>Vivienne Wheaton, Joanne Culpepper, Robert Hall, Mark Burridge and Brian Craig</td>
<td>Vehicle Signature Management Testbed</td>
</tr>
<tr>
<td>Jian Andrew Zhang, Y. Jay Guo and Xiaojing Huang</td>
<td>Framework of Joint Communications and Sensing Using Two Phased</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Interactive Session 3</th>
<th>Tuesday 6 September (1230 - 1330 Lunch Break)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Svetoslav Gaidow, Michael Burgess and Eyoel Teffera</td>
<td>CSS Implications Framework for Future Armoured Fighting Vehicles</td>
</tr>
<tr>
<td>James Groessler</td>
<td>Applications of Mission Data in the Land Environment</td>
</tr>
<tr>
<td>Benjamin Hoggan, Philip Temby and Justin Fidock</td>
<td>Team Adaptation: A Case Study of Mounted Combat Reconnaissance</td>
</tr>
<tr>
<td>David Mewett, Natalie Olsen, Andrew Wabnitz, Victor Fok and Leung Chim</td>
<td>A Small Satellite Approach to Big Space Applications</td>
</tr>
<tr>
<td>Matthias Seifert, Marc Leadstone and Delphine Mery</td>
<td>Laser Communication in an Active Electronic Warfare Environment</td>
</tr>
</tbody>
</table>

**Interactive Session 4** Tuesday 6 September (1530 - 1600 Afternoon Tea Break)

| Mathew Elliot and Robert Hunjet | Resilient Tactical Networking in Contested RF Environments |
| Madeleine Krastev, Luke Thiele and Jessica Vozzo | Immersive Simulation to Explore Responses to Future Threats |
| Ren Ping Liu, Jian Andrew Zhang and Y. Jay Guo | Resilient UAV Mesh Networks for Military Operations |
| Fabian Ochsner | A Toolbox of Capabilities to Conquer the Emerging Threat by Low, Slow and Small UAV's |
| Anthony Perry | Target Location Error improvement on an Armoured Vehicle Performance Estimation and Assessment of Enhancement Options |

**Interactive Session 5** Wednesday 7 September (1030 - 1100 Morning Tea Break)

| Thomas Debeneditis, Dominic Thewlis, Steven Milanese, Grant Tomkinson, Daniel Billing and Alistair Furnell | The Influence of Simulated Military Land Transit on Dismounted Combatant Physical Performance |
| Jonathan Jordans and Stephen Baker | Additive Manufacturing: Implications and Considerations for the ADF |
| Carolyn Mountford and Helen Cartledge | Biomarkers of Human Brain Deregulation: A Tool for Studying and Monitoring Brain Injury, Deregulation and Recovery |
| Robi Sen and Narelle Hoffman | MESMER Counter Drone |
| Kamil Zuber, Vivienne Wheaton and Peter Murphy | Adaptive Camouflage Devices |
Information Domination Determines the Success of the Mission

Author: Tobias Baumart (PSM GmbH, Germany)

Abstract: Information domination requires not only having knowledge, but receiving the relevant information at the right time, enabling strategic short and long term decisions quickly.

Commanding a complex high performance weapon system in a multi-threat combat situation requires a user friendly communication system to ensure that the right level of information is received by the respective and relevant recipients. Therefore, a reliable and well performing information management system is essential to achieve that mission critical requirement. The C4I suite is only one element of an effective information management system. The other element is the system-immanent technical Equipment such as training devices and simulators to enable Maximum effectiveness of the human potential on board or when dismounted.

The PUMA IFV’s key design criteria is survivability which incorporates Information management as one of its key aspects. This integrated modern IFV system is a fine example to demonstrate how and what benefits can be achieved if the Information management is seen as one aspect of survivability and defined as one major design criteria in the early development phase.

Use of Probe Data by Future Land Forces

Author: Paul Bennett and Charles Karl (Australian Road Research Board, Australia)

Abstract: Probe data is an emerging source of information on transport demand patterns and performance of the transport network. The growth in smartphones has sparked a phenomenal growth in the volume of probe data points. This paper examines the utility of probe data as an additional source of information on road network performance. It then considers the use of probe data as a source of information for planning and operations of future land forces in Australia.

Full System Armoured Vehicle Survivability

Author: Stephen Cimpoeru and Paul Phillips (DST Group, Australia)

Abstract: A full system approach to armoured vehicle survivability is presented where all potential protective layers are present to form a layered defence to enhance survivability and allow vehicles to keep ahead of and maintain protection relativities with emerging threats. All protective layers are required for robust protection schemes that maximise vehicle survivability against a wide range of potential threats.

Author: David Kitson (Drop Bear Technologies, Australia)

Abstract: Contemporary image intensifier night vision devices provide imaging capabilities over the 500nm to 900nm spectral band. Recent technology developments extending this range from approximately 300nm to 1000nm have resulted in significant out-of-band performance increases, leaving existing image intensifier based night vision, and digital/thermal based night vision blind to next-generation lasers, illuminators, pointers and beacons.

Practical Explorations of Airborne Radio Relay Supporting Tactical Communications

Author: Weimin Zhang, Stephen Leak and Darin Roberts (DST Group, Australia)

Abstract: In the past decade DST Group actively explored airborne radio relay in support of tactical communications. A range of developments and trials were conducted including collaboration with industry. These include: a latex balloon borne relay, UAV borne ad hoc radio nodes, combat-net radio relay AUTRY on different types of UAVs, and enhanced AUTRY, that is also ground deployable. The findings are briefly reported here.

Enhanced Stab Resistance of Soft Body Armour Fabric with Novel Shear Thickening Fluid

Author: Jie Ding (DST Group, Australia), Lijin Wang and Rajkishore Nayak (RMIT, Australia)

Abstract: Novel liquid body armour based on shear thickening fluids (STFs) has shown potential to provide soldiers with enhanced body protection and flexibility. An STF consists of rigid colloidal particles suspended in a carrier liquid. A commonly used STF consists of silica particles suspended in polyethylene glycol (PEG). A very small amount of graphene oxide (GO) in STF can greatly increase the STF viscosity, elastic and loss modulus. The stab resistance properties of Kevlar/STF (silica) composites show significant improvement over Kevlar fabric. In this paper we demonstrate the effect of GO as an active component of Kevlar/STF/GO composites on stab resistance and energy dissipation. We have found that Kevlar fabric treated with STF and additional GO shows improved stab resistance compared to conventional STF-treated Kevlar and untreated Kevlar fabrics of equivalent areal density.
Scoping the Application of Autonomy to Tactical Combat Casualty Care

Author: David Johnson and Graham Brooker (Australian Centre for Field Robotics, University of Sydney, Australia), Alistair McEwan and Ralph Nanan (University of Sydney, Australia), Guy Gallasch (DST Group, Australia)

Abstract: This paper describes an initial study into the application of autonomy to tactical combat casualty care, to bring medical capability ‘forward’ and improve upon the well-known 10-1-2 metric for aid delivery to the frontline. It includes methods for delivery of small and medium size packages for assistive care and a larger ‘smart stretcher’ concept for MedEvac purposes.

Advanced Tactical Booster Technologies: Land-Based Long-Range Rocket System Applications

Author: Matthew Mckinna (DST Group, Australia) and Jason Mossman (United States Air Force Research Laboratory, USA)

Abstract: This paper describes a number of technology advantages currently under development for tactical rocket motors which have direct application to land-based long-range rocket systems. Materials advances that enable superior inert mass fractions, along with innovative optimisation design techniques have the potential to allow for increased rocket payload capacity, improved rocket range or increased rocket loadout from the volumetrically constrained environment of a land-based launcher.

Vehicle Signature Management Testbed Standards

Author: Vivienne Wheaton, Joanne Culpepper, Robert Hall, Mark Burridge and Brian Craig (DST Group, Australia)

Abstract: The Defence Science and Technology Group (DST Group) is investing in programs developing new materials, coatings and systems to be applied to future signature management for land vehicles. Test and evaluation of new technology prototypes on sample systems can be done in the lab or on sample systems in the field, but testing at full vehicle scale can currently only be done on real military vehicles, with associated classification issues and burden on military resources. The ‘STANDCAM’ is a physical vehicle signature model designed to simulate realistic armoured fighting vehicle signatures in visible, thermal infrared and radar wavebands. This paper describes initial assessment of the STANDCAM capability for use as a testbed for signature management systems, which was conducted in a field trial at Cultana Training Area, South Australia. It outlines the proposed applications to current and future land vehicle signature management programs.
Framework of Joint Communications and Sensing Using Two Phased Antenna Arrays

Author: Jian Andrew Zhang, Y. Jay Guo and Xiaojing Huang (University of Technology Sydney, Australia)

Abstract: Joint communications and sensing (JCAS) is receiving strong interest from the defense research community and industry. It is one of the promising technologies to reduce system cost by sharing hardware and to improve performance by exchanging information. In this paper, we propose a system architecture which allows seamless operation of JCAS and flexible configurations of transceivers and antennas, based on the use of two phased antenna arrays. The signal processing required by JCAS for the proposed system is briefly discussed. Its application for UAV formation flying is exemplified.

Interactive Session 3 Tuesday 6 September (1230 - 1330 Lunch Break)

CSS Implications Framework for Future Armoured Fighting Vehicles

Author: Svetoslav Gaidow and Eyoel Teffera (DST Group, Australia), Michael Burgess (Ambrose Logistics Consulting, Australia)

Abstract: A framework is proposed for the identification of implications to the provision of combat service support (CSS) from acquiring future armoured fighting vehicles (AFVs) for the Land Force. The framework helps to elucidate the necessary capability and capacity of integral and close support assets needed within a combat brigade to support the AFVs on future deployments. The framework comprises questions aimed at determining the likely impacts caused by the AFV systems to the CSS functions of supply support, transport support and maintenance support. The practical applicability of the framework has been validated using data from current in-service armoured vehicles, which has also led to the creation of an assessment baseline. The framework is a decision support making tool that can be used throughout the life cycle of the AFVs to inform capability managers of the CSS implications – a major challenge to the Australian Army’s ongoing modernisation.

Applications of Mission Data in the Land Environment

Author: James Groessler (SRC Australia)

Abstract: Systems that operate in the land combat environment are not generally considered as extensive consumers of mission data (MD). This paper will examine current applications of MD in the land combat environment by examining three candidate systems. This paper will confirm that MD is required for all warfighting domains.
Team Adaptation: A Case Study of Mounted Combat Reconnaissance

Author: Benjamin Hoggan (Monash University Accident Research Centre, Australia), Philip Temby and Justin Fidock (DST Group, Australia)

Abstract: With the operational environment anticipated to become increasingly complex and dynamic, the Australian Army has identified adaptation to change as a key capability for the Land Force. However, little practical guidance is currently available on how and when adaptation should or does occur in small tactical teams, with the majority of research in this area being controlled and abstracted laboratory studies. A recent simulation-based study conducted at DST Group, titled 'VITAL UNION', aimed to explore team adaptation processes in a realistic (i.e. LAND 400) military context using a more naturalistic research approach. This paper describes the research approach employed, our initial findings from the study, and potential implications for training future land forces.

A Small Satellite Approach to Big Space Applications

Author: David Mewett, Natalie Olsen, Andrew Wabnitz, Victor Fok and Leung Chim (DST Group, Australia)

Abstract: The emerging field of small satellites and associated launch technologies could provide the future land force with an affordable and dedicated space-based platform. This capability can complement existing systems, and has considerable responsiveness and adaptability for contributing to the Army’s intelligence, surveillance, reconnaissance and communication needs in the future operating environment.

Laser Communication in an Active Electronic Warfare Environment

Author: Matthias Seifert (Airbus Defence and Space, Australia), Marc Leadstone and Delphine Mery (Airbus Defence and Space, Germany)

Abstract: Future Land Forces are likely to be part of joint operations abroad, working with Air Force and Navy to project force globally to areas of conflict and embedded with allied partners. This will require the ability to deploy troops fast, operate with light logistical footprint and exchange ever increasing amounts of data and information in a fast, secure and reliable manner. The need for an information-enabled war-fighting capability, based on networking capability of troops and their military equipment is expected to multiply and will require higher bandwidth, secure and resilient communication infrastructure. The use of laser communications, with its inherent low probability of intercept / detection and robustness to jamming and spoofing can provide a crucial backbone to Defence networks and encompassed in the SpaceDataHighway infrastructure, it will allow near-real time ISR data transmission, detailed analysis back home and timely dissemination to a commander in the field, thus resulting in true information superiority and a capability edge.
Resilient Tactical Networking in Contested RF Environments

Author: Mathew Elliot and Robert Hunjet (DST Group, Australia)

Abstract: Communications in a tactical environment enables the warfighter to act based on up to date information. However, challenges such as large distances and the presence of jamming can quickly bring down a communications network. In this paper we present two approaches, HARLEQUIN Mk II and SCADS, to facilitate information exchange in varying levels of RF contention.

Immersive Simulation to Explore Responses to Future Threats

Author: Madeleine Krastev and Jessica Vozzo (DST Group, Australia), Luke Thiele (RSA, Australia)

Abstract: In 2016 the study VITAL UNION created a simulation environment recreating key features of a future operating environment (in the 2025 timeframe) as envisaged by the Australian Army’s Future Land Warfare report. The aim of this study was to better understand individual and small-team decision-making under uncertain, time-pressured and complex conditions. In order to bring out these key factors, VITAL UNION represented a future adversary force utilizing unmanned and autonomous systems. The outcomes of this study have identified potential areas for enhancing the Australian Land Force response to uncertain environments and explored ways in which these unmanned and autonomous systems may be used tactically against conventional land forces.

Resilient UAV Mesh Networks for Military Operations

Author: Ren Ping Liu, Jian Andrew Zhang and Y. Jay Guo (University of Technology Sydney, Australia)

Abstract: Military operations are highly mobile and often carried out in hostile and tough environments. Commercial products and systems are unable to maintain reliable communications in military environment. We propose a two-tier UAV mesh network to provide resilient and reliable communications for military use. A number of key innovations are proposed to achieve fast initialization, high data rate, resilient, and reliable communications.
A Toolbox of Capabilities to Conquer the Emerging Threat by Low, Slow and Small UAV’s

Author: Fabian Ochsner (Rheinmetall Air Defence, Switzerland)

Abstract: Rapid technological advances in the field of unmanned aerial vehicles are triggering serious safety concerns. NATO has conducted multiple studies on the subject, concluding that there are no easy solutions to the problem. This paper provides a segmentation of the stakeholders and their missions and analyzes possible solutions which could serve as a tailored toolbox to address the issue.

Target Location Error Improvement on an Armoured Vehicle Performance Estimation and Assessment of Enhancement Options

Author: Anthony Perry (DST Group, Australia)

Abstract: The target locating error (TLE) performance of an armoured fighting vehicle was assessed in order to make decisions about potential sub-system upgrade options. Comparing likely performance improvements with system cost and complexity, the IVNS augmentation and GPS replacement were the highest priority, and a navigation system replacement was a lower priority.

Interactive Session 5 Wednesday 7 September (1030 - 1100 Morning Tea Break)

The Influence of Simulated Military Land Transit on Dismounted Combatant Physical Performance

Author: Thomas Debenedictis, Dominic Thewlis, Steven Milanese and Grant Tomkinson (University of South Australia, Australia), Daniel Billing and Alistair Furnell (DST Group, Australia)

Abstract: The purpose of this study was to investigate the impact of military land transit on dismounted combatant physical performance. Participants completed a battery of physical performance tests designed to test the physical attributes that underpin critical tasks regularly completed by Australian Defence Force (ADF) infantry personnel. Upon completion participants were exposed to two hours of simulated vehicle transit motion constructed using acceleration data collected from real world conditions and guided by the operational context collected during a questionnaire and focus group with soldiers. Participants then repeated the same physical performance protocol. The physical performance data presented in this abstract is a preliminary analysis only as the study is currently on going.
Additive Manufacturing: Implications and Considerations for the ADF

Author: Jonathan Jordans (Ground Effects Consulting, Australia) and Stephen Baker (DST Group, Australia)

Abstract: Additive Manufacturing (AM) promises the ultimate in forward adaptive provisioning. It potentially allows manufacturing at the point of use, decreases the logistic lines of support and delivers unique items, designed collaboratively with end users, directly to warfighters to increase their effectiveness. The technology does however, exhibit capability and capacity limitations, and introduces some difficult issues that will need to be overcome in bringing the technology to bear on the modern battlefield. This paper outlines these limitations and issues, and discusses their impact on the ADF’s ability to capitalise on AM as a value-add technology over time.

Biomarkers of Human Brain Deregulation: A Tool for Studying and Monitoring Brain Injury, Deregulation and Recovery

Author: Carolyn Mountford (Translational Research Institute, Australia) and Helen Cartledge (DST Group, Australia)

Abstract: There is now a way to objectively evaluate the human brain of front line defenders exposed to traumatic stress, blast injury, head injury and chronic pain. The new technology developed by an Australian team is being evaluated in Australia. The multidisciplinary team, led by the Australian Translational Research Institute, is documenting chemical deregulation in the human brain showing significant difference in the pathways affected when comparing healthy non exposed brains with those affected by PTSD, mild Traumatic Brain Injury. The broken pathways once established can be used for diagnostic purposes as well as to look for treatments.

The future use of this technology in the Armed Forces is to manage the health of enlisted men and women. The earlier such deregulation is identified the better the opportunity is for a full recovery. This also includes managing the effectiveness of ADF personnel training programs on the healthy brain. From this we may be able to predict, prevent and mitigate soldiers’ brain injuries and enhance their cognition and mental performance.

MESMER Counter Drone

Author: Robi Sen (Department 13 International Ltd) and Narelle Hoffman (EPE, Australia)

Abstract: Drones or UAVs are becoming ever more prevalent with ~12 million estimated to be in circulation by 2020. With the application and payload options developing exponentially, limited only by user’s imagination, this presents a very clear and present
vulnerability in current mitigation strategies. Recent, high profile incidents incorporating the use of drones either maliciously, intentionally or inadvertently have been well publicised ranging from threats to infrastructure, air transportation and personnel.

Department 13 International Ltd (D13) is launching its MESMER platform at Australian Land Forces 2016. This platform is a novel approach to enable the detection and disruption of radio controlled devices (e.g. drones or unmanned vehicles). In contrast to other systems, MESMER is not based on kinetic attacks, jamming solutions, or cyber-attacks. MESMER is a software platform that operates as a stand-alone system or alternately on top of, or can augment, existing hardware solutions. MESMER provides automated detection and high granularity mitigation strategies that can be selected to function autonomously or with a man in the loop. MESMER's detection stage occurs using cognitive techniques for blind signal detection and characterization to determine the existence of threats. MESMER's response stage is based on a technique that we call, “protocol manipulation”. Protocol manipulation uses signal features and metadata to select and apply strategies in order to curtail threats. These mitigation strategies include “taking control” of the drone, flying it, and landing it safely at a position of choice.

Adaptive Camouflage Devices

Author: Kamil Zuber and Peter Murphy (University of South Australia, Australia), Vivienne Wheaton (DST Group, Australia)

Abstract: Military camouflage as we know it today has been developed driven by the need to improve safety on the field by reducing visible signature. No matter how well such camouflage is matched with a chosen environment, it only works in the environment it was designed for. This paper presents the next generation of camouflage based on modular panels that can change colour adapting to the environment.
S&T Innovation Pitches

Monday 5 September 2016, 1000 to 1030 Session

LASAGNE, The Future of Combat and Mission Systems
Michael Mathers

Survival Aid for Encumbered (SAFE)
David Drohan

PyroFilm
Ken Smit

Superfast 3D Tracking, Next Generation High Speed Video in 3-D
Paul Phillips/Tania Holmes

HARLEQUIN, Tactical Network Planning Tool
Mathew Elliot

The ORBAT Builder
Kyran Lange

SAKI Geo and the SAKI Data Platform
David Watts

Microwave Assisted Thermal Sterilisation (MATS)
Theresa Hay

Visualisation Aid for Military Planning (VAMP)
Slava Shekh

Advanced Tactical Booster Technologies (ATBT)
Matthew McKinna