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# Army Warfighting Experiment 2018 - Autonomous Warrior: Summary Report

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# Executive Summary

Autonomous Warrior - Land (AW-L) was a Combined, Joint and Multinational experiment and demonstration event, held on Salisbury Plain Training Area across four weeks in November and December of 2018. AW-L was the main experiment within Army Warfighting Experiment 2018 (AWE18), which assessed various industry supplied Robotic and Autonomous Systems (RAS) utilised within tactical scenarios by Light Role, Armoured and Mechanised Infantry, plus attachments, operating alone and within a combined arms Battlegroup (BG). This report is a high level summary report, of evidenced observations and insights into the effectiveness delivered (both positive and negative) by the AWE18 capabilities against the seven AWE18 Hypotheses, listed below.

- Hypothesis 1: RAS will enable effective break into or defence of an urban environment, reducing risk and increasing operational advantage against a complex and challenging threat;
- Hypothesis 2: RAS will support better & faster wide area surveillance and targeting & application of precision effects;
- Hypothesis 3: RAS will enable dispersed forces;
- Hypothesis 4: RAS can reduce own force vulnerability to Unmanned Air System targeting (of long range fires) and swarming systems;
- Hypothesis 5: RAS will improve tempo by enhancing mobility and counter mobility;
- Hypothesis 6: RAS enables agile Command and Control (C2) of dispersed forces in a contested environment;
- Hypothesis 7: RAS improves the effectiveness of Combat Service Support (CSS) and enables self-sustainable CSS.

The RAS capabilities assessed at AW-L are each categorised within one (or more) of the following main themes:

- Unmanned Air System (UAS) Capabilities
- Unmanned Ground Vehicle (UGV) Capabilities
- Enhanced Dismounted Situational Awareness, Battlespace Management Systems and Communications (EDSA, BMS & comms) Capabilities
- Counter UAS (CUAS) Capabilities

This report summarises against each hypothesis the effectiveness changes observed from the utilisation of the RAS capabilities. In addition, against each theme the wider effectiveness impacts are discussed, including the constraints and future considerations for further experimentation and use.

AW-L was a successful experiment that met its objectives. The evidence provided though experimentation supported all seven of the AWE18 Hypotheses, although this evidence is limited for hypotheses 3, 4 and 6. There was no significant evidence to show the hypotheses were false. Limitations included the capability provided (free of charge) by industry, which did not necessarily align with the Hypotheses, constraints on the experiment (e.g. real-estate limitations and safety considerations for flying) and restricted comms integration.

**[REDACTED: 9 PARAS]**

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# 1 Introduction

## 1.1 Background

1.1.1 The Army established the RAS Capability Spotlight [1] to focus on the opportunities offered by rapid adoption of Robotic and Autonomous Systems (RAS), with an aim to:

> "Identify how the Army can exploit developments in RAS technology through focused analysis, capability integration and experimentation to deliver affordable operational capability in the short-medium term".

1.1.2 A core component of this spotlight was the Army Warfighting Experiment 2018 (AWE18), the main element of which was Autonomous Warrior – Land (AW-L). This was a Combined, Joint and Multinational, experiment and demonstration event, held on Salisbury Plain Training Area (SPTA), across four weeks in November and December of 2018.

## 1.2 Experiment Design

**[REDACTED: 1 PARA AND DIAGRAM]**

## 1.3 This Report

1.3.1 This report is a high level summary report, of evidenced observations and insights into the effectiveness delivered (both positive and negative) by the AWE18 capabilities; these are reported against each of the seven AWE18 Hypotheses (section 3 on page 10), as well as by each RAS capability theme (section 4 on page 11).

1.3.2 This construct enables a reader who is not interested in all AWE18 Hypotheses or all capability themes to focus their attention at that level without the need to analyse and extract from the report. However, it also means there is a level of duplication for those reading the whole report, as the same capability delivers to more than one hypothesis and effectiveness is also summarised by capability theme.

1.3.3 The Technology Readiness Level (TRL) of the AWE18 equipment varied considerably, with many systems concept demonstrators and prototypes. This meant there were equipment challenges during the experiment when compared to what would normally be experienced for a user experiment. In particular, there were challenges with the robustness and reliability of systems, as well as immaturity in design for elements such as the Human Machine Interface (HMI) and integration. This report focusses on the capabilities delivered (when fully functioning), and their potential effectiveness. However, each equipment down-selected for assessment through AWE18 is also the subject of an individual capability / system report, which goes into the detail of each system, including pan DLOD impacts and their HMI. These reports are authored by the most appropriate Army Trial and Development Unit (TDU) for that capability and should be referred to for more detailed assessment of each system.

1.3.4 There are a large number of abbreviation used in this document, these are listed within the List of Abbreviations at section 9 on page 17

# 2 AWE18 Experimentation

## 2.1 The Experiment

2.1.1 The observations described herein are framed within the context and constraints of the experiment conducted, which incorporated:

- Tactical use of AWE18 capabilities down-selected for AW-L;
- Employed by the following deployed elements:
  - A Light Role Infantry Platoon (LR Inf Pl), formed predominantly by US Inf and including Royal Marine section;
  - A Mechanised (Mech) Inf Pl with MASTIFF (MAS) vehicles;
  - An Armoured (Armd) Inf Pl, with WARRIOR (WR);
  - With supporting attachments and detachments (Att/Det), including: Fire Support Team (FST); Javelin (JAV); Engineer Troop (Engr Tp) and Unmanned Air Vehicle Troop (UAV Tp);
  - Plus a Battlegroup (BG) Headquarters (HQ).
- Employed at various levels, from section and Att/Det team use, up to utilisation within a combined arms BG;
- Utilised in combination with manned platforms within a Manned-Unmanned Teaming (MUMT) context;
- Within representative force-on-force tactical vignettes;
- In offensive and defensive postures (AW-L incorporated an offensive force opposed by a smaller defensive force, both of which were equipped with AWE capabilities);
- Within rural (including small urban, e.g. compounds), the urban of Copehill Down Village (CDV) and the rural-urban fringe terrains;
- Within the temperate climate of SPTA in November and December.
- Data captured, based upon the categorisations from ‘Land Handbook - Force Development Analysis and Experiment’ [4], is primarily Level 3 evidence[1].

2.1.2 The experimentation was preceded, supported and informed by standalone equipment assessments (level B assessments) conducted on each equipment by the TDUs.

## 2.2 Capability Themes

2.2.1 The equipment experimented with during AWE18 has been grouped within the following broad capability themes:

- Unmanned Ground Vehicle (UGV) Capabilities;
- Unmanned Air System (UAS) Capabilities;
- Enhanced Dismounted Situational Awareness, Battlespace Management Systems and Communications (EDSA, BMS & comms) Capabilities;

---

[1] Insights based on individuals’ expert judgement of issues examined in single events / activities (e.g. a Military Judgement Panel (MJP) or one-off exercise)

- Counter UAS (CUAS) Capabilities;
- Other Capabilities.

2.2.2 For a description of each individual system utilised with AW-L, the capability themes they sit within and lead TDU for the individual equipment reports, please refer to Table A-1 of Appendix A. The following summarises the capabilities delivered within each capability theme.

2.2.3 In grouping by theme there is some consequential overlap in the capabilities described. This illustrates to a degree the power delivered by combinations and the challenge of easily delineating the capability being delivered to a singular theme. Where a capability sits in multiple themes it is listed against each.

### 2.2.4 UGV Capabilities

2.2.4.1 AW-L featured eleven different UGV systems, covering nano (*n*), mini (m), small (s), medium (M) and heavy (H) platforms (further details of these categories is included at Table A-3 on page 23), delivering the following capabilities

- Appliqué control, converting manned and unmanned vehicles, into UGVs with a common remote control (RC) and/or tele-operated control systems at mUGV, MUGV and HUGV (WR in-service Armd Inf Fighting Vehicle);
- Intelligence, Surveillance, Target Acquisition and Reconnaissance (ISTAR) at Section (Sect), Platoon (Pl), Company (Coy) and Battlegroup (BG) levels, incorporating Electro-Optic and Infra-red (EO/IR) sensors, mounted directly on the UGV, on telescopic masts, and/or on a tethered UAS;
- Load carriage and casualty evacuation (CASEVAC) / Lightweight Tactical Mobility Platform (LTMP);
- Weapons platforms: Distraction Device and a Remote Weapon Station (RWS);
- Mobile shield[2];
- Surface laid & ground sign Explosive Ordnance search, utilising EO/IR camera;
- Engineering plant (HUGVs).

### 2.2.5 UAS Capabilities

2.2.5.1 Thirteen different UASs were utilised within AW-L, covering Nano (*n*), Micro (µ), Mini (m) and small (s) air platforms (further details of these categories in included at Table A-2 on page 23), delivering the following capabilities

- Aerial ISTAR at Sect-Pl (*n*UAS), Pl-Coy (µUAS) and BG (m-sUAS) with EO/IR sensor payloads and tethered capabilities for extended endurance;
- Generation of CAT1 targeting from UAS payload feeds;
- Integration of *n*UAS feeds within DSA;
- Elevated communications (comms) node;
- Extended endurance elevated sensors (EO/IR) and comms node through tethered mUAS;

[2] This was an emulated capability with wooden panels providing cover from fire. A more detailed assessment of the options for panels and their impact on the platforms load carriage capability is recommended.

- Explosive ordnance search (e.g. Minefield and sub-surface IED) utilising µUAS and mUAS mounted Metallic Mine Detector (MMD) and Ground Penetrating Radar (GPR) systems.

### 2.2.6 EDSA, BMS & comms Capabilities

2.2.6.1 Four different DSA systems were deployed on AW-L, as well as a multitude on comms bearers (including four separate Mobile Ad-hoc Network (MANET) networks) linking to Command and Control (C2) devices and BMS', delivering the following capabilities:

- Enhanced DSA through the augmentation of a basic DSA capability with:
  - Helmet mounted display to enable head-up use, within the Pl;
  - Fused II/TI NVG with Augmented Reality (AR) injections from DSA for commanders (Cmdrs) within the Pl;
  - DSA Integration with nUAS, providing downlink to Cmdrs within the Pl;
- MANET radio systems, delivering voice and data connectivity;
- MANET with UAS, UGV and ground (sensor, vehicle and person mounted) communication nodes
- Multiple comms integration (e.g. LTE, MANET, WiFi and BCIP);
- Battlespace Management and Geographical Information Systems.

### 2.2.7 CUAS Capabilities

2.2.7.1 There were three CUAS systems deployed on AW-L, it should be noted that this only included their Detect, Recognise, Identify (DRI) Warn and Track capabilities. UAS counter measures were not deployed**, [REDACTED: 1 SENTENCE].**

- UAS DRI, warn and track capabilities;
- UAS defeat capabilities (only evaluated at BRISTOW).

### 2.2.8 Other Capabilities

2.2.8.1 In addition to the RAS Capabilities above, there were two additional capabilities deployed on AW-L

- Image recognition software[3];
- On-board vehicle electrical power management and monitoring.

3 This was not deployed within any tactical vignettes, instead it was briefly demonstrated by the supplier during the experiment.

# 3 Effectiveness against Hypotheses

3.1 The following sections summarise the data gathered during AWE18 to provide evidence against each of the seven AWE18 Hypotheses. Furthermore, it states by capability theme and in general whether this evidence supports or undermines each hypothesis. It should be noted that there is a degree of overlap between the Hypotheses, with the same capability delivered effectiveness impact, affecting more than one hypothesis. A lack of comment on a capability theme against any hypothesis does not indicate no effectiveness change could be delivered, only that it was not observed within the confines of AW(L).

**3.2 Hypothesis 1: RAS will enable effective break into or defence or an urban environment, reducing risk and increasing operational against a complex and challenging threat**

**[REDACTED: 15 PARAS]**

**3.3 Hypothesis 2: RAS will support better & faster wide area surveillance and targeting & application of precision effects**

**[REDACTED: 4 PARAS]**

**3.4 Hypothesis 3: RAS will enable dispersed forces**

**[REDACTED: 8 PARAS]**

**3.5 Hypothesis 4: RAS can reduce own force vulnerability to UAS targeting (of long range fires) and swarming systems**

**[REDACTED: 3 PARAS]**

**3.6 Hypothesis 5: RAS will improve tempo by enhancing mobility and counter mobility**

**[REDACTED: 11 PARAS]**

**3.7 Hypothesis 6: RAS enables agile C2 of dispersed forces in a contested environment**

**[REDACTED: 4 PARAS]**

**3.8 Hypothesis 7: RAS improves the effectiveness of Combat Service Support (CSS) and enables self-sustainable CSS**

**[REDACTED: 6 PARAS]**

# 4 Effectiveness by Capability Theme

## 4.1 Measures of Effectiveness

4.1.1 Changes to effectiveness were gauged against Mission Measures of Effectiveness (MMOEs) taken from [6]; these were a subjective comparison between the baseline and enhanced configurations, as further detailed within [2] and [3]. Within Table 4-1 on page 25, Table 4-2 on page 30, Table 4-3 on page 36, and Table 4-4 on page 41, the impact on effectiveness is rated against a Red, Amber, Green (RAG) scale where generally positive (green), negative (red) or negligible (amber) are indicated, those MMOEs not exercised for that capability within AW-L are excluded from the tables.

## 4.2 UGV Capabilities

**[REDACTED: 10 PARAS AND ONE TABLE]**

## 4.3 UAS Capabilities

**[REDACTED: 11 PARAS AND ONE TABLE]**

## 4.4 Comms Capabilities, BMS & EDSA

**[REDACTED: 19 PARAS AND ONE TABLE]**

## 4.5 CUAS Capabilities

**[REDACTED: 6 PARAS AND ONE TABLE]**

## 4.6 Other Capabilities

**[REDACTED: 3 PARAS]**

# 5 Discussion

## 5.1 Combinations

5.1.1 What was clearly apparent during AW-L was that although individual capabilities might increase effectiveness, the significant gains came from their use in combination, both through MUMT approaches and through RAS capabilities used together.

5.1.2 An example, based upon a RAS equipped Mech Inf Pl and pulled together from activities and combinations observed during AW-L, is included at Appendix B on page 24. This illustrates how µUAS, *n*UAS, CUAS, sUGV, EOD Search mUAS, EDSA, and MANET comms, when used in combination with and by the Pl delivered significant enhancements to their overall effectiveness.

5.1.3 To fully enable these combinations and the benefits they deliver across the BG requires a suitably integrated SA, C2 and comms network at this level.

## 5.2 Autonomy Levels

5.2.1 The majority of RAS on AWE18 had relatively low levels of autonomy requiring significant human operation and control, as opposed to tasking/programming and the RAS executing through its own decisions making cycle. For example:

**[REDACTED: 2 BULLET POINTS]**

5.2.2 Low levels of autonomy also act as a barrier to fully effective and efficient employment of the MUMT concept. The greater the level of autonomy the less of a burden the unmanned element is on the manned element of the team, therefore increased autonomy is a fundamental enabler for MUMT.

5.2.3 **[REDACTED: 1 SENTENCE]** However, the majority of the development in these areas is being driven by the civilian market and aligns with their requirement. **[REDACTED: 1 SENTENCE]**

## 5.3 Cognitive capacity

5.3.1 The relatively low levels of autonomy meant that most AWE18 systems required permanent manning whilst operating, and this task was typically all consuming on that individual's attention. However, from the observations and reports captured on AWE18, there appeared sufficient cognitive capacity within the troops to effectively utilise RAS enhancements at the Pl level, even if this burden prevented the operator from concurrently conducting other activates, and this additional burden was considered by the users as a worthwhile trade. For example, on a number of occasions Cmdrs highlighted the burden on the Pl of operating the ISTAR RAS was less than that of operating in an 'information vacuum' and trying to fill that void by conventional means, or accommodating multiple contingencies.

5.3.2 The general familiarity with modern technologies and willingness to experiment was high with the troops. Nevertheless, to maximise effectiveness, multi-roling, re-roling and upskilling, to accommodate the optimum employment of RAS capabilities within the systems physical limitation, may need to be considered.

Increased technical knowhow and engineering sympathy, blended with tactical acumen will be required to make the most of the capability provided and deliver the necessary warfighting edge.

5.3.3. At the BG HQ (which was significantly undermanned compared to a conventional construct) there were multiple data feeds delivered from many (but not all) of the AWE18 systems. **[REDACTED: 3 SENTENCES]**

5.3.4 **[REDACTED: 1 PARA]**

5.3.5 As the quantity and complexity of deployed systems increases, the cognitive burden is likely to increase, although greater autonomy could mitigate some of these challenges.

## 5.4 Concept of Employment

5.4.1 During AWE18 current doctrine was not observed as a barrier to RAS employment. However, at the lower levels, the CONEMP with respect to some capabilities (e.g. UGVs operating with Infantry) is still in its infancy and requires significant development.

5.4.2 **[REDACTED: 1 PARA]**

5.4.3 The CONEMP and CONUSE needs to consider the combination of assets, cognitive burden and impact of levels of Autonomy on these, as discussed in the above paragraphs. The development also needs to be informed by the 'art of the possible' within the realities of military operations and likely combinations of capabilities, an area to which AW-L has helped to deliver understanding.

## 5.5 Experiments

5.5.1 AW-L was a successful experiment that met its objectives, however (and not unexpected) there are limitations in what it could and did deliver, as discussed below.

5.5.2 Human-in-the-loop (HITL) simulations are normally divided into Live, Virtual and Constructive (LVC), with strengths and weaknesses identifiable within each (as indicated in Table 5-1 below from Ref [7]), and a full picture only available through a combination.

*Table 5-1: Strengths and Weakness on LVC Simulations [7]*

| Live (HITL) Simulation | Virtual (HITL) Simulation | Constructive Simulation (including analytic war-game) |
|---|---|---|
| Future scenarios representation | Future scenarios representation | Future scenarios representation |
| Kinetic effect representation | Kinetic effect representation | Kinetic effect representation |
| C2 and SSA representation | C2 and SSA representation | C2 and SSA representation |
| Operational friction representation | Operational friction representation | Operational friction representation |

| Live (HITL) Simulation | Virtual (HITL) Simulation | Constructive Simulation (including analytic war-game) |
|---|---|---|
| Integration assessment (esp. human factors issues) | Integration assessment (esp. human factors issues) | Integration assessment (esp. human factors issues) |
| Interoperability assessment | Interoperability assessment | Interoperability assessment |
| CP representation | CP representation | CP representation |
| Experimental control | Experimental control | Experimental control |
| Ability to represent ODE DLODs | Ability to represent ODE DLODs | Ability to represent ODE DLODs (via war-games) |
| Multiple runs / replication | Multiple runs / replication | Multiple runs / replication |
| Relative cost and resource requirements | Relative cost and resource requirements | Relative cost and resource requirements |
| Relative speed of options development | Relative speed of options development | Relative speed of options development |

5.5.3 AW-L was a live simulation whose strengths were around:

- The integration and teaming of actual capabilities (the AWE18 equipment supplied by industry) with personnel (the SETT), as opposed to extensive simulation of conceptual systems;
- The majority of AWE18 equipment directly delivered information, SA or load carriage,. The few items delivering kinetic effects (e.g. the UGV with RWS) were areas they could adequately be simulated within a live experiment;
- The command, control and operation of these within tactical scenarios;
- The effectiveness these could deliver, alongside the frictions occurring.

5.5.4 The majority of the benefits realised, came at the lower levels (e.g. Sect-Pl) where the equipment was deployed, however these also deliver an increase in overall effectiveness at the higher levels.

5.5.5 Benefits delivered directly to the BG and then cascade down were significantly constrained, this was through a mixture of:

**[REDACTED: 3 BULLET POINTS]**

5.5.6 For future RAS experiments, the most appropriate mix of LVC Simulations needs to be carefully considered to optimise the evidence gatherable in the most cost effective and efficient manner. At the sub-unit level and below, and with human centric concepts, especially involving infantry operating dismounted (whether they are LR, Mech or Armd), and where these concepts physically exist and can be used (or effectively simulated) within a live construct, then this is likely to continue as the optimum tool for experimentation. Moving to to larger constructs (sub-unit and above) and to more conceptual capabilities and or ones that are more difficult to physically simulate or generate sufficient credible data to exercise them effectively, then Virtual or Constructive become stronger candidates. However, often these can be enhanced through low level Live Experiments to inform the art of the possible. Constructive simulations can deliver low cost and rapid initial assessments to inform initial thinking and de-risk subsequent more expensive Live or Virtual activities.

# 6 Conclusions

## 6.1 AWE Hypotheses

6.1.1 AW-L has provided evidence that supports all seven of the AWE18 Hypotheses, although this was very limited for hypotheses three, four and six. **[REDACTED: 1 SENTENCE]** but also to constraints on the experiment (e.g. Live Simulation restrictions including real-estate limitations and safety considerations for flying) and **[REDACTED: REMAINDER OF SENTENCE]**

6.1.2 It should also be noted that no prominent counter evidence against any of the hypotheses emerged from AW-L.

6.1.3 The evidence gathered indicates that although improvements in effectiveness came from single capabilities, the more notable gains were from combinations. This includes from both working with personnel in MUMT constructs and from combinations of RAS capabilities.

## 6.2 Capability Themes

**[REDACTED: 8 PARAS]**

# 7 Recommendations

## 7.1 Thematic

7.1.1 The main conclusion from AW-L is that RAS does deliver against the AWE18 Hypotheses. However, there were limitations in both the capabilities available and what could be achieved within the constraints of this experiment. Therefore it is recommended the MOD continues to invest in:

**[REDACTED: 2 BULLET POINTS]**

7.1.2 The most significant gains came from the uses of combinations of capabilities. However, this is enabled by the individual capabilities; the following paragraphs are capability specific recommendation drawn from this experiment.

## 7.2 Capability Specific

**[REDACTED: 9 PARAS]**

# 8 References


1. ECAB, *Robotics and Autonomous Systems Capability Spotlight*, ECAB, ECAB/P(17)015, 8 May 2017.
2. [REDACTED]
3. [REDACTED]
4. DG Capability, *Land Handbook – Force Development Analysis and Experimentation,* Army HQ, July 2014.
5. [REDACTED]
6. NATO Army Armaments Group (NAAG), *NATO Dismounted Soldier Systems Measurements for Analysis – a framework for trials, modelling and simulations, ATO Measurements for Analysis*, NAAG Land Capability Group 1, AC/225(LCG/1)WP(2011)0003 (PFP), 2011.
7. DSTL, *URBAN WARRIOR 5: Question 1 (Live, Virtual and Constructive) Final Report*, DSTL, DSTL/CR74747/v2.0, 29 November 2013.

# 9 List of Abbreviations

| | |
|---|---|
| µUAS | Micro Unmanned Air System |
| µUGV | Micro Unmanned Ground Vehicle |
| AAR | After Action Review |
| AI | Artificial Intelligence |
| AR | Augmented Reality |
| Armd | Armoured |
| Att | Attachment |
| AWE18 | Army Warfighting Experiment 2018 |
| AW-L | Autonomous Warrior - Land |
| BG | Battlegroup |
| BLOS | Beyond Line of Sight |
| CASEVAC | Casualty Evacuation |
| CDV | Copehill Down Village |
| Cmdr | Commander |
| CONEMP | Concept of Employment |
| CONOP | Concept of Operation |
| CONUSE | Concept of Use |
| COP | Common Operating Picture |
| Coy | Company |
| CSS | Combat Service Support |
| CSup | Combat Supplies |
| CTR | Close Target Recce |
| CUAS | Counter Unmanned Air System |
| CXP | Casualty Exchange Point |
| DCE | Digital Concepts Engineering |
| DET | Detachment |
| DMC | Digital Magnetic Compasses |
| DRI | Detect Recognise Identify |
| DSA | Dismounted Situational Awareness |
| EDSA | Enhanced DSA |
| Engr | Engineer |
| EO/IR | Electro-Optic / Infra-red |
| EOD | Explosive Ordnance Device |
| EUD | End User Device |
| EW | Electronic Warfare |
| FoM | Freedom of Manoeuvre |
| FST | Fire Support Team |
| GPR | Ground Penetrating Radar |
| HAPU | Hybrid Auxiliary Power Unit |
| HITL | Human In the Loop |
| HMI | Human Machine Interface |
| HQ | Headquarters |
| HUGV | Heavy Unmanned Ground Vehicle |
| IM | Information Management |
| Inf | Infantry |
| ISTAR | Intelligence Surveillance Target Acquisition and Reconnaissance |
| IX | Information Exploitation |
| JAV | Javelin |
| LARES | Land Airborne Reconnaissance Enrichment Services |
| LMUK IS | Lockheed Martin UK Integrated Systems |
| LR | Light Role |
| LTMP | Lightweight Tactical Mobility Platform |

| | |
|---|---|
| LVC | Live, Virtual and Constructive |
| MANET | Mobile Ad-hoc Network |
| MAS | Mastiff |
| Mech | Mechanised |
| MIST | Mechanism Injury Symptom Treatment |
| MMD | Metallic Mine Detector |
| MMOE | Mission Measures of Effectiveness |
| mUAS | Medium Unmanned Air System |
| mUAS | Mini Unmanned Air System |
| MUGV | Medium Unmanned Ground Vehicle |
| mUGV | Mini Unmanned Ground Vehicle |
| MUMT | Manned-Unmanned Teaming |
| nUAS | Nano Unmanned Air System |
| nUGV | Nano Unmanned Ground Vehicle |
| OCU | Operator Control Unit |
| ODOA | Obstacle Detection and Obstacle Avoidance |
| OODA | Observe Orientate Decide Act |
| PEL | Pearson Engineering Limited |
| PID | Positive Identification |
| Pl | Platoon |
| PLI | Position Location Information |
| PRS | Personal Reconnaissance System |
| RAG | Red Amber Green |
| RAS | Robotic and Autonomous Systems |
| RC | Remote Control |
| RCS | Radar Cross Section |
| RM | Royal Marine |
| RoE | Rules of Engagement |
| RWS | Remote Weapon Station |
| RX | Receive |
| S&R | Surveillance and Reconnaissance |
| SA | Situational Awareness |
| Sect | Section |
| SPTA | Salisbury Plain Training Area |
| SRCC | Simple Remote Command and Control System |
| sUAS | Small Unmanned Air System |
| sUGV | Small Unmanned Ground Vehicle |
| SWaP | Size Weight and Power |
| SWPD | Soldier Worn Power and Data |
| TDU | Trial and Development Unit |
| Tp | Troop |
| TRL | Technology Readiness Level |
| TUAS | Tactical Unmanned Air System |
| UAS | Unmanned Air System |
| UAV | Unmanned Air Vehicle |
| UGV | Unmanned Ground Vehicle |
| VP/A | Vulnerable Point / Area |
| VRS | Vehicle Reconnaissance System |
| WR | Warrior |

# A AW-L Equipment

A.1 The following capability themes have been used for AW-L:

1. Unmanned Ground Vehicles (UGV);
2. Unmanned Air Systems (UAS);
3. Enhanced Dismounted Situational Awareness, Battlespace Management Systems and Communications (EDSA, BMS & comms);
4. Counter UAS (CUAS);
5. Other;

Table A-1 below details the industry supplied equipment that participated within the AW-L Experiment and the main Capability Themes in which they sit. For the UAS and UGVs details on the categorisation used are included at Table A-2 on page 23 (UAS) and Table A-3 on page 23 (UGV[4]).

*Table A-1: AW-L Equipment*

**[REDACTED: DESCRIPTION COLUMN FROM TABLE]**

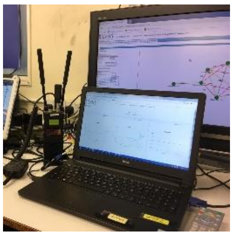
| # | **Product Name**<br>***Supplier*** | **Image** | **Capability Theme(s)** | **Lead TDU** |
|---|---|---|---|---|
| 100 | THeMIS + X-4 LE "Titan"<br>*Milrem AS* |  | UGV; UAS | ATDU |
| 101 | Simple Remote Command and Control System (SRCC)<br>*Thales UK* |  | EDSA, BMS & Comms | ITDU |
| 108 | Black Hornet 3 Vehicle Reconnaissance System (VRS)<br>*FLIR Unmanned Aerial Systems AS* |  | UAS | ATDU |

[4] With no common or widely accepted categorisation available for UGVs a bespoke categorisation based around man-portability and DVLA categories has been used.

| # | Product Name<br>***Supplier*** | Image | Capability Theme(s) | Lead TDU |
|---|---|---|---|---|
| 109 | Black Hornet 3 Personal Reconnaissance System (PRS)<br>*FLIR Unmanned Aerial Systems AS* |  | UAS; EDSA, BMS & Comms | ITDU |
| 129 | FLIR Ranger R20SS RADAR<br>*Beechwood Equipment Ltd* |  | CUAS | RATDU |
| 136 | Harris Integrated Soldier System (ISS)<br>*Harris Corporation* |  | EDSA, BMS & Comms | ITDU |
| 139 | TITAN SENTRY<br>*QinetiQ* |  | UGV | ATDU |
| 141 | ArcGIS Online<br>*Esri UK* |  | EDSA, BMS & Comms | CISTDU |
| 143 | OPTOnav Targeting<br>*Forsberg Services Ltd* |  | UAS | RATDU |
| 150 | Hybrid GENAIRCON<br>*Intracom Defense Electronics* |  | Other | ATDU |

| # | **Product Name**<br>***Supplier*** | **Image** | **Capability Theme(s)** | **Lead TDU** |
|---|---|---|---|---|
| 153 | ReconRobotics Throwbot 2<br>*Beechwood Equipment* |  | UGV | ITDU |
| 159 | Semi-Autonomous Tactical Logistic Support Communications<br>*Domo Tactical Communications Limited* |  | EDSA, BMS & Comms; UAS | CISTDU |
| 160 | Amulet UAS<br>*Cobham Antenna Systems* |  | UAS (EOD Search) | RETDU |
| 161 | AR3  Net-ray<br>*Tekever Ltd* |  | UAS | RATDU |
| 163 | HAWK Tactical Hotspot<br>*General Dynamics Mission Systems UK* |  | EDSA, BMS & Comms | CISTDU |
| 167 | GPR Drone<br>*DroneOps Ltd* |  | UAS (EOD Search) | RETDU |
| 201 | THeMIS CSS platform<br>*Milrem AS* |  | UGV | ATDU |
| 202 | HIPPO-X Modular UGS<br>*Pearson Engineering Limited (PEL)* |  | UGV | CSSTDU |

| # | Product Name<br>*Supplier* | Image | Capability Theme(s) | Lead TDU |
|---|---|---|---|---|
| 204 | Polaris MRZR X<br>*Polaris Britain Ltd* |  | UGV | CSSTDU |
| 211 | Marionette Remote Control System<br>*Digital Concepts Engineering (DCE) Ltd* |  | UGV | ATDU |
| 300 | Land Airborne Reconnaissance Enrichment Services (LARES)<br>*Lockheed Martin UK - Integrated Systems (LMUK IS)* |  | UAS | RATDU |
| 305 | TITAN STRIKE<br>*QinetiQ* |  | UGV | ATDU |
| 400 | AUDS CMIC, SA + C-UAV<br>*Chess Dynamics Ltd* |  | CUAS | RATDU |
| 402 | DIGITAL CREW<br>*Thales UK Ltd* |  | Other | |
| 410 | Drone Sentry<br>*Beechwood Equipment Ltd* |  | CUAS | RATDU |
| 500 | MIRA UGV Platform, MACE 3 on JCB 205T<br>*HORIBA MIRA Ltd* |  | UGV | RETDU |

| # | Product Name<br>*Supplier* | Image | Capability Theme(s) | Lead TDU |
|---|---|---|---|---|
| 502 | RAKKA 3000<br>*Rakkatec Ltd* |  | UGV | RETDU |
| 600 | StreamCaster Radio<br>*C3IA Solutions Ltd* |  | EDSA, BMS & Comms | CISTDU |

In addition the Royal Navy's 700X Naval Air Squadron had five different μUAS, four quad-copters and one fixed wing, available to them for demonstration and utilisation within the experiment,. Specifically, a Parrot Disco (fixed wing), a DJI Mavic Pro, Two InstantEye UAS (a Mk2 and a Mk3), and a GoPro Karma; with the InstantEyes and the GoPro being the most prolifically used.

*Table A-2: UAS Categories*

| UAS Common Taxonomy | MTOW | | NATO Class | Starting MAA Category |
|---|---|---|---|---|
| | Min | Max | | |
| Nano<br>(*n*UAS) | | <200 g | Class I | Class I(a) |
| Micro<br>(μUAS) | 200 g | <2 kg | | Class I(b) |
| Mini<br>(mUAS) | 2 kg | <20 kg | | Class I(c) |
| Small<br>(sUAS) | 20kg | <150 kg | | Class I(d) |
| Medium / Tactical<br>(TUAS) | 150 kg | <600 kg | Class II | Class II |
| Large / Heavy<br>e.g. MALE, HALE, Strike, Combat | >600 kg | | Class II | Class II |

*Table A-3: UGV Categories*

| UGV Taxonomy | Description |
|---|---|
| Nano<br>(*n*UGV) | Compact and light enough to be carried in a pouch by a soldier alongside their normal CSups and without adding significant burden |
| Micro<br>(μUGV) | Man-portable by a single soldier such as using a bespoke back-pack (e.g. Dragon Runner) |
| Mini<br>(mUGV) | Man-cartable over short distances by or across multiple persons (e.g. e.g. Talon / Wheelbarrow) |
| Small / Light<br>(sUGV) | Too large / heavy to be carried, but smaller than a typical car (e.g. DVLA Cat A and B1 vehicles) |
| Medium<br>(MUGV) | Size and weight of a typical medium-large car (e.g. DVLA Cat B vehicle) |
| Heavy<br>(HUGV) | Size and weight of a large vehicle (e.g. DVLA Cat C vehicle) |

# B Example RAS Vignette

B.1 This appendix describes a simple Vignette drawn together from activities and combinations observed during AWE18. It demonstrates how the systems were rarely used in isolation and how the significant benefit came from their use in combinations and teamed with the troops.

## B.2 The Mission

B.2.1 A RAS equipped Mech Inf Pl is tasked with identifying and clearing a route to an objective compound for the BG to occupy later in the day. The Pl is equipped with:

- DSA System;
- AR display for DSA;
- DSA display of *n*UAS feed;
- Man Portable µUAS;
- A vehicle mounted telescopic mast CUAS system
- A vehicle mounted *n*UAS with up to eight airframes (on the CUAS vehicle);
- Man portable *n*UAS with two airframes (one EO one IR), using same airframe as vehcle *n*UAS system, but with man portable controller;
- an EOD Search mUAS with GPR;
- a towable CSS sUGV;
- MANET comms for all of the above.

## B.3 Activities

**[REDACTED: 15 PARAS]**

# Initial Distribution List

**[REDACTED: NAMES AND CONTACT DETAILS]**

# DRRS Report Documentation Page

* Denotes a mandatory field

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| | | | |
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