Lessons from the UK Land Tactical HQ Research Exercise FIRST BASE

Andrew H Smith[1]
Defence Evaluation & Research Agency
Fort Halstead,
Sevenoaks,
Kent, TN14 7BP.
England.
(44) 1959 514416
ahsmith@dera.gov.uk

Abstract

This paper describes the findings from Exercise FIRST BASE, which is the first in a planned series of research exercises under the UK Land Tactical HQ Research Project. The exercises involve regular Army end users taking part in **unit level**[2] virtual (laboratory based) command post exercises under controlled simulated battlefield conditions (i.e. Synthetic Environments). The purpose of the research is to explore and evaluate potential options (hypotheses) for improvement in future Command, Control, Communications, Computing and Information (C4I) systems. These improvement hypotheses include possible changes in organisations, processes, staffing and in particular through the provision of new digitization technologies. The exercise is considered to have been very successful, despite minor difficulties with integration of the research prototype systems employed. A considerable body of valuable data was collected which is the first involving a real UK Battlegroup HQ equipped with a basic Command Information System (CIS) broadly representative of Stage 2 of the UK Digitization of the Battlespace Land (DBL) programme. The research is intended to support the UK BOWMAN, ComBAT and Battlefield Infrastructure equipment capability projects.

1. **Introduction**

1.1 ***UK Digitization Programme***

In common with other NATO nations, the UK has begun the process of "digitizing" its forces. In the land domain this will be accomplished by a three-phase approach that will successively deliver:

- **Digitization Stage 1 –** a basic capability which provides limited support to current C2 functions at formation level (brigade HQ and above);

[2] UK Unit or Battlegroup (BG) equates to US Battalion or Battalion Task Force and sub-unit equates to Company or Squadron.

- **Digitization Stage 2 –** a more comprehensive approach which provides an integrated set of tools designed to provide support tailored to user roles at any echelon in the land hierarchy, but still largely based upon current business processes;
- **Digitization Stage 3 –** which applies business process re-engineering to change the methods of working within the organisation and hence allow the maximum exploitation of the benefits that digitization can offer.

To deliver this programme the MoD has a complex set of linked projects that deliver individual components of the enterprise. These include:

- A new tactical Combat Net Radio (CNR) system (BOWMAN) to provide a secure voice and digital data communications capability;
- A Battlefield Infrastructure to provide the underlying computing services needed to support user applications;
- Common Battlefield Applications Toolset (ComBAT) to provide a set of user Command and Control (C2) tools that are common across the military functional areas from division down to sub-unit level;
- Battlefield Information Systems Applications (BISAs) to provide user tools specifically designed to support individual roles at every echelon.

To aid this process, the UK has created a Land Digitization Test and Prototyping Rig (the Rig) which allows early investigation of some of the most pressing development and integration issues.

1.2 ***Digitization Test and Prototyping Rig***

The Rig is described in a paper presented at CCRTS 2000 [Baker, 2000]. In summary, the Rig's primary purpose is to conduct experiments to investigate **future concepts** for systems to support the UK's Digitization initiative. This research covers the following areas:

- performance and effectiveness of individual applications;
- performance and effectiveness of the components of the underlying infrastructure;
- interactions between applications and infrastructure;
- performance of overall system of systems that comprises the complete set of applications and infrastructure components;
- investigations into alternative concepts of use, procedures and organisations structures.

Where possible, this research draws upon prototype applications and infrastructure components developed under the MoD's Applied Research Programme. This allows important deductions to be drawn about the performance and behaviour of these prototypes. Ultimately this leads to an enhanced understanding of the true user requirement and the quality of service characteristics that can be expected from technology when it is delivered to the user. Although prototype systems can be unreliable, their limitations can be generally determined in advance and useful experiments can be designed to make best use of their capabilities.

1.3 *Land Tactical HQ Research Project*

The Land Tactical Headquarters (LTHQ) research project was established to “determine the extent to which the operation of deployed units will benefit from digitization and which functions will benefit most, in order to support requirements capture and business case development” - for future unit level battle management systems. The project is being undertaken for the BOWMAN, ComBAT and Battlefield Infrastructure equipment capability projects. The research is expected to provide support to Stages 2 and 3 of the DBL programme. Exercise FIRST BASE was the first in a planned series of exploratory and experimental exercises under the project. The aim being ‘to obtain representative unit level C4I systems performance data under controlled laboratory conditions in order to address the initial LTHQ experimental questions and thus inform the procurement process for an evolving unit-level CIS and subsequent stages of the LTHQ project’.

The agreed initial LTHQ experimental questions were:

a. What are the unit level C2 capability gaps and limitations in the baseline case ?
b. What are the residual capability gaps, given a basic CIS ?
c. What is the impact of a limited deployment of a basic system compared to a comprehensive deployment ?

2. **Research Approach**

2.1 *Overall Project Strategy*

A “classical” research method is being employed for the LTHQ project, based upon observation and testing of improvement hypotheses. Figure 1 illustrates the structured 'model-test-model' approach that links the ‘real’ world, laboratory and modelling environments.

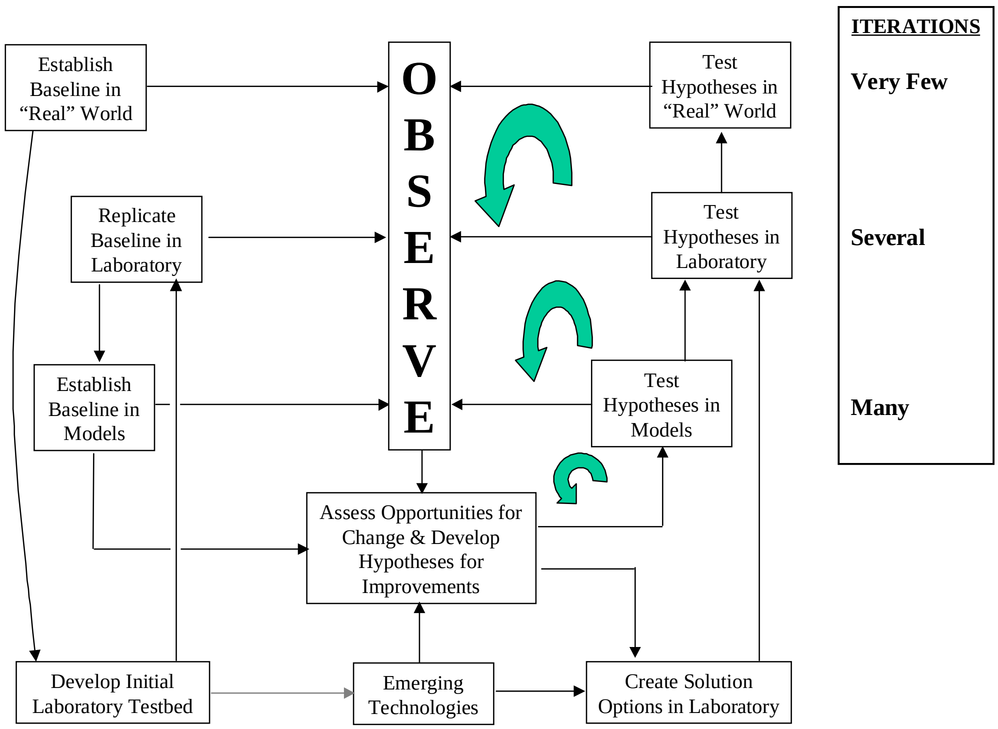


Figure 1. A Structured 'Model-Test-Model' Type Approach

The key to this approach is the establishment of a sound baseline in each environment and achieving coherence across the environments. Observation of the baseline will identify frequently encountered capability gaps and permit initial questions and improvement hypotheses to be developed. Continuing observation of the effects of the postulated improvements will permit the hypotheses to be refined iteratively.

The research approach therefore requires the following components:

- Analysis of a baseline [Woolford and Rooney, 2000] and enhanced case in a 'real' world environment (using the British Army Training Unit Suffield (BATUS));
- Analysis of a virtual (laboratory based) baseline and a number of enhanced cases in a laboratory environment (The LTHQ Testbed with the Rig) [Smith et al, 2000];
- Analysis of a baseline and a large number of potential enhanced cases in modelling environments (as these become available).

2.2 ***Experimental Design***

Given the 'exploratory' nature of this first exercise, the experimental design was straightforward. A 'within subjects' design was employed with two conditions, the first representing the current systems as a baseline and the second with a basic CIS provided. As an exploratory study, the purpose was to obtain a better understanding of the main variables of the 'system' in a loosely controlled manner rather than to evaluate them rigorously in a tightly controlled manner. The two conditions and corresponding CIS variables and controls are shown in Figure 2 below:

Current Systems Baseline	Basic CIS Deployed
CIS Variables	
• No IS (personal Laptops allowed)	• Basic IS facilities: • Electronic Maps & Overlays • Situation Awareness Support (inc APLNR) • Planning Support • Order Preparation & Dissemination
• No Data Comms	• Digital Data Comms
• Paper Maps & Talcs	• Electronic Map Displays
• Manual Procedures	• Modified Procedures for Basic CIS
Controls	
• Physical Environment:	
• Scenario (Military Context):	
• Command Processes:	
• Voice Comms (Secure CNR & Telephone):	
• Armoured Fighting Vehicles with Global Positioning System & Laser Range Finder:	
• Learning:	

Figure 2: Experimental Conditions, Variables and Controls

The level of experimental control achieved, as ever, was a practical compromise between the need for military realism and inter-action (free-play) in the exercise environment and the need to collect data in a sound scientific manner.

A number of important simplifications were included in the experimental design. Although these impacted upon the results from the exercise, it was judged that the exercise findings were not unduly influenced.

2.3 ***LTHQ Testbed Configuration***

The exercise was based upon an Armoured Infantry BG virtual Command-Post Exercise with selected BG missions from a recent BATUS exercise. The exercise was conducted using the Rig comprising components obtained from across DERA:

a. Modular Semi-Automated Forces (ModSAF) - an entity level simulated battlefield in which the selected scenarios can be played out;
b. Combined Low-cost Advanced Warfighting Simulation (CLAWS) – fighting vehicle simulators enabling drivers and commanders to be immersed in the simulated battlefield (as shown in Figures 3a and 3b below);

Figure 3a. CLAWS Vehicle Simulator Driver (left) and Commander (right)

Figure 3b. CLAWS Vehicle Drivers Screen

c. Automatic Position Location Navigation and Reporting (APLNR) – a representation of a possible future application providing regular updates of own force locations;

d. Secure voice communications - representations of Ptarmigan telephone and future CNR for communications to Bde and the BG net respectively;
e. Data communications – a simple emulation of future Very High Frequency (VHF) and High Capacity Data Radio (HCDR) data nets;
f. Advanced Land Platform Systems HQ version (ALPS HQ C4I) – an application providing the majority of the representative basic CIS (shown as a workstation in Figure 4a and an electronic birdtable in Figure 4b below);

Figure 4a. ALPS HQ C4I at a Workstation

Figure 4b. ALPS HQ C4I on a Birdtable

g. Command Decision Making Aids (CDMA) – an application providing additional planning aids to the BG HQ in conjunction with ALPS HQ C4I.

The focus of the exercise was on the Command, Control, Communications, Computing and Information (C4I) processes and procedures in the BG MAIN and TAC HQs, as these relate to the lower command levels of ComBAT. The testbed was configured to provide a physical exercise environment for the players that was representative of normal working practice within the constraints applied by the experiment, as shown in Figure 5 below.

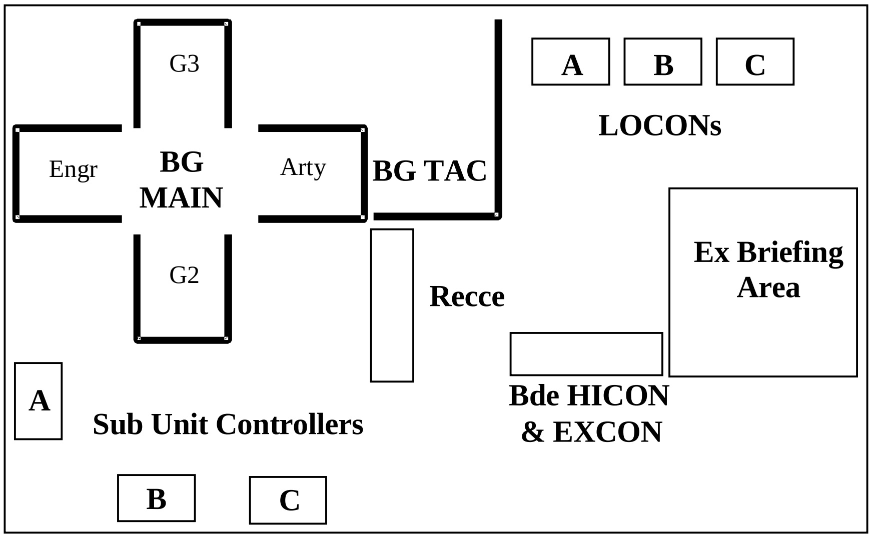


Figure 5. Testbed Configuration

A static four-cell layout was established in BG MAIN HQ, covering G3 (Ops Officer), G2, (Intelligence Officer), an Arty cell simulating the FPC (Battery Commander (BC)) and Engr cell (Battlegroup Engineer Officer (BGEO)). The Battlegroup Second-in-Command (BG 2IC) worked centrally in a co-ordinating role as the BG Chief of Staff together with the Commanding Officer (CO), if present. When BG TAC HQ was activated, the CO and BC moved to a separate cell with a driver to simulate the physical movement of the vehicles.

In addition to the player HQs a three-level EXCON was established:

- HICON simulating Bde HQ and the flank BGs;
- Three sub-unit controllers (Sqn/Coy Commanders) and the Recce Platoon with Forward Observation Officer (FOO) and engineer support;
- Three Tp/Pl LOCONs.

This arrangement was adopted to introduce the need to aggregate information and reduce over-accurate reporting of ‘ground truth’.

3. **Summary of Findings**

The most important findings are highlighted and described in modest detail. The other main findings are presented briefly in a summary format.

3.1 ***The Most Important Findings***

3.1.1 ***Situational Awareness***

Situational awareness[3] is an across-the-board capability that underpins every other C2 process and activity and was considerably enhanced by APLNR. This was identified as a key issue by the BG CO in his post exercise report "The overall situational awareness within BG HQ was much better than in the baseline case, it was one of the key areas of improvement, allowing more time to consider options, wargame them and task assets in time".

3.1.2 ***A Basic CIS Provides Clear User Benefits***

A basic CIS provides clear user benefits such as faster decision making and improved tempo. Figure 6 shows an analysis of key stages in the planning process. In the basic CIS case Warning Orders (WngOs) were issued by BG HQ approximately 70 minutes earlier and Decision Points were reached 90 minutes earlier than in the baseline case. Even when data 'outliers' were removed WngOs were issued at least 30 minutes earlier than in the baseline case. The overall CIS process from receipt of WngO to issue of Orders took only 60 % of the total time taken in the baseline case. This compares well with data obtained from Ex BIG PICTURE 1 [Morris et al, 1997] where the digitized case took only 58% of the time taken by the baseline case.

[3] The term Situational Awareness is used here to describe an attribute of the CIS rather than as a human state of comprehension as many others would define it. This is to be consistent with use of the term in a number of related UK MoD documents such as the ComBAT User Requirements Document.

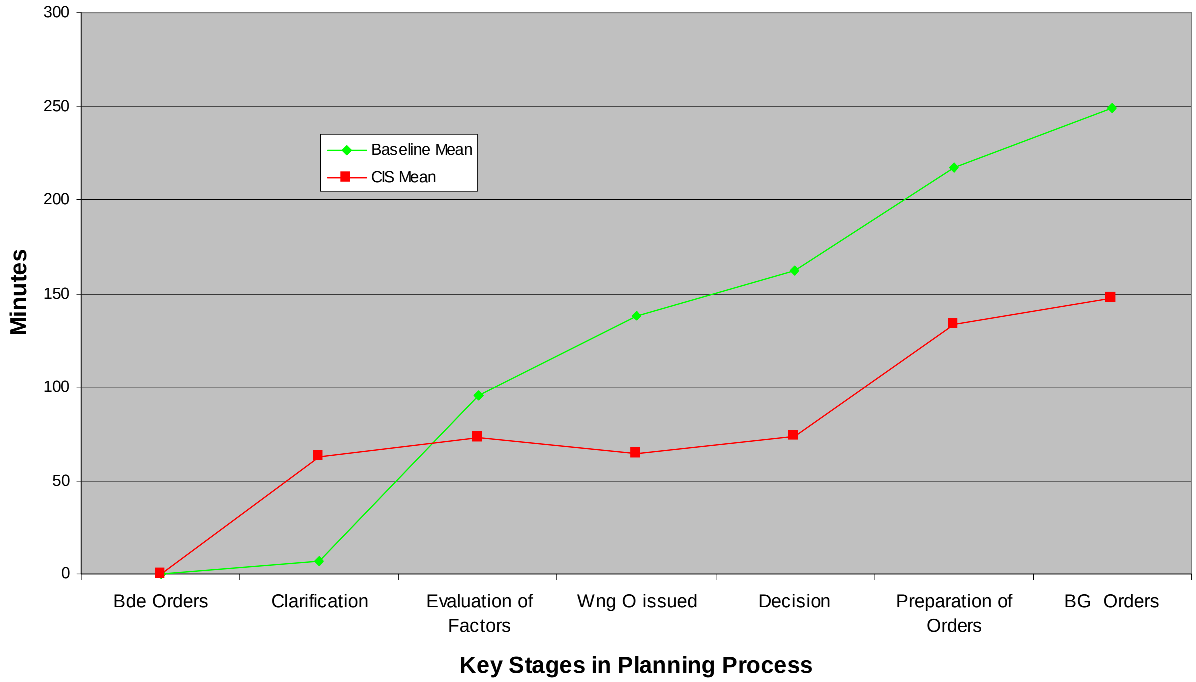


Figure 6. Mean Lapse Times for the Planning Processes

Battle procedure appears to be slower in the baseline compared to the basic CIS case prior to the decision point. The BG also appear to issue digital orders in the basic CIS case 100 minutes earlier than verbal Orders in the baseline case. Even when data 'outliers' were removed the time elapse between earliest receipt of formation orders and the issue of BG orders is faster in the basic CIS case by at least 10 minutes. This is commendable if one considers that with data 'outliers' removed, the baseline data refers to one deliberate operation and a quick attack, whilst the basic CIS data refers to 2 deliberate operations which included formal face-to-face Orders Groups.

This is an important finding. The tempo of operations at lower levels of command increased in the basic CIS case as did the overall rate of battle procedure of the BG HQ, due to faster decision making.

3.1.3 *Electronic Maps and Digital Overlays*

Electronic maps and digital overlays were used extensively during all stages of the exercise. Figure 7 shows the numbers and types of digital overlays sent on the BG net per mission.

Mission	OpO	PIS	DSO	ENG	SITREP	FRAGO	Misc
1 - Attack 1 (21st)	6	20	5	2	8	1	4
2 - Attack 2 (22nd)	10	29	2	5	0	2	8
3 - Defence (23rd)	2	14	2	4	3	1	4
Total	**18**	**63**	**9**	**11**	**11**	**4**	**16**

Figure 7. Digital Overlays Sent per Mission by Type

In comparison, the numbers in the baseline case were very low i.e. limited to those exchanged during the BG Orders Groups where subordinates were required to copy the BG trace. Provision of electronic maps and digital overlays must be core components of future battlefield CIS.

3.1.4 **BG Net Voice Traffic Levels**

Considerable reductions were observed in the voice traffic levels on the BG Net when a basic CIS was provided. Figure 8a shows a breakdown of the average voice traffic utilisation of the BG net by message type between the baseline and CIS cases. In particular it shows an overall reduction in voice traffic levels between the two cases. This is also seen in the overall average levels which are shown for each mission and the baseline and CIS cases in Figure 8b.

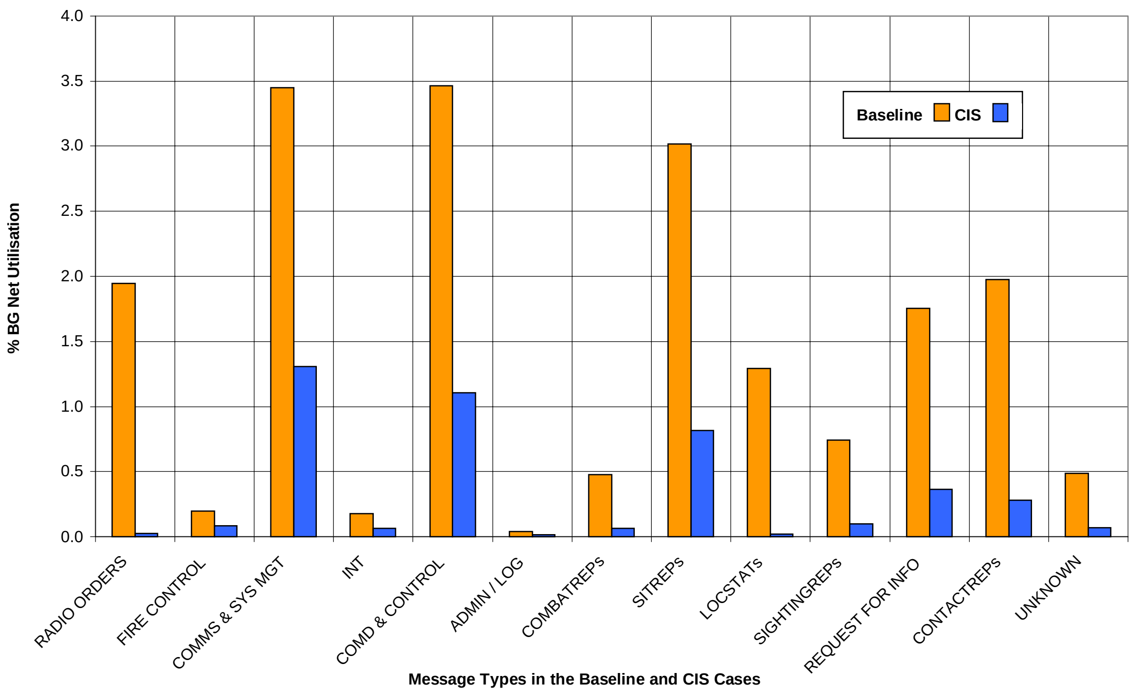


Figure 8a. Breakdown of Voice traffic by Message Type

Mission	Baseline 1 (Adv)	Baseline 2 (Wdr)	Baseline 3 (Attk)	Mean Baseline	Basic CIS 1 (Attk)	Basic CIS 2 (Attk)	Basic CIS 3 (Def)	Mean Basic CIS
Average Utilisation	23.0%	17.5%	16.5%	**19%**	10.4%	6.4%	11.6%	**9.5%**

Figure 8b. Average Voice Utilisation of the BG Net per Mission

These considerable reductions indicate users were content to convey most of the routine and a good deal of the key information by digital messages and overlays. Less time spent sending information by voice leaves more time for other tasks and makes more efficient use of the BG radio net.

3.1.5 *Future BG VHF Net Capacity*

Future BG VHF net capacity may be sufficient for voice and data traffic on the basis of the experimental simplifications and assumptions made for the exercise:

- Figure 9 shown an example of overall (voice and data) utilization of the BG net. It includes a number of important assumptions about the characteristics of a future CNR.

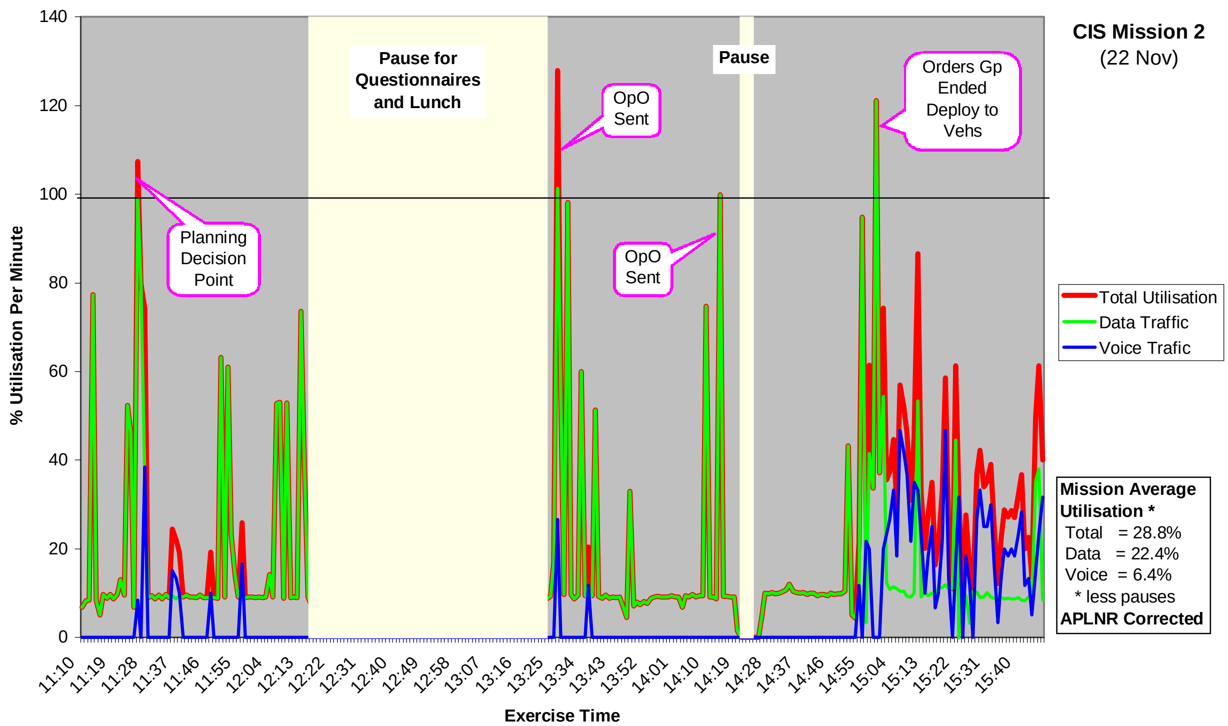


Figure 9. Overall Utilisation of the BG Net for Basic CIS Mission 2 (Attack)

On a modest number of occasions, during both missions, the overall BG Net utilisation exceeded 100%. These all correspond to Orders and Overlays being sent at important times in the command processes. This would have resulted in increased delays in the transmission of Orders and Overlays, but only by a matter of minutes. The average and peak utilisation values observed suggest that, with careful management of net usage, the BG Net should have sufficient capacity for both voice and data traffic;

- Taking into account the precedence of voice over data and the peak traffic levels observed, the likely delays in data transmission times would be no more than a matter of seconds or minutes;
- The update frequency and aggregation strategies for APLNR were the largest factors affecting BG VHF radio data traffic levels and require further investigation;
- The need for careful management of net usage to contain any excessive growth in traffic on these nets must be actively addressed.

3.1.6 *Data Entry*

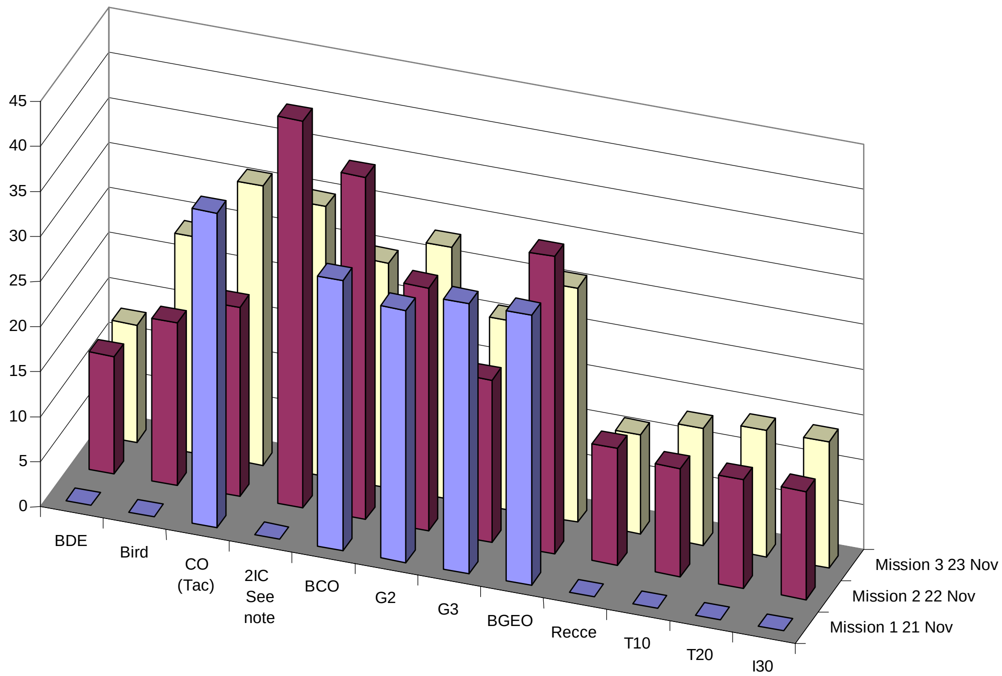
Data entry was again revealed as a fundamentally important and complex issue:

- There is a conflict between the ideal of data entry at source and the need for such sources to focus on their primary warfighting tasks;
- The continuing importance of secure voice communications must not be undermined by the benefits available from a digital data communications capability;
- Caution is necessary to avoid the potential pitfalls associated with users receiving information via an uncoordinated and inappropriate mix of media types.

The alternative methods available require further investigation at both unit and particularly sub-unit levels.

3.1.7 *Information Management*

Information management issues must be resolved to avoid user confusion and mistakes that waste time and could lead to a breakdown in effective working. Figure 10 shows the numbers of digital documents accumulated in BG HQ.



Note: The 2IC terminal was not established on 21st . Data assumed to be CO (TAC)

Figure 10. Numbers of Digital Documents Accumulated by Each User per Mission

Over the course of the three basic CIS case missions, BG HQ dealt with 132 overlays (50 of which it generated itself) and 35 orders. The precise method of information management will naturally depend upon the design and level of complexity of the CIS and must be compatible with the CIS concept of use and corresponding SOIs.

3.2 *Other Main Findings*

3.2.1 *A Modest Electronic Birdtable*

A modest electronic birdtable was found to provide an important aid to BG collaborative planning and needs further investigation.

3.2.2 *One Size Doesn't Fit All*

Some of the functional and non-functional aspects of the formation level research prototype tools provided were just not suitable for the operational processes at the BG level.

3.2.3 *Equipment Scaling*

Equipment scaling must be sufficient to reap the benefits of concurrent working in the BG MAIN and TAC HQs to avoid a loss of tempo.

3.2.4 ***Planning Tools***

Planning tools beyond basic digital overlays were not explored in detail during the exercise. Some features of the tools provided to BG MAIN HQ were considered to be of value. However tools that involved a relatively time consuming levels of formality were considered to be inappropriate for the needs and timescales at BG level. A modest family of BG planning tools for use as time permits, requires further investigation.

3.2.5 ***Intelligence Collation, Analysis and Picture Dissemination Tools***

Intelligence collation, analysis and picture dissemination tools are considered to be an important additional BG capability. This will be increasingly so if the IO receives information in a mixture of voice and data messages and is to provide timely and accurate intelligence products. A modest family of BG intelligence support tools needs further investigation, especially given the number of new ISTAR assets expected to enter service in the next five plus years.

3.2.6 ***A Concept of Use***

A concept of use and corresponding new culture, mindset and training, must be established at a very early stage if a CIS is to be procured and exploited effectively. It should continue to be developed in conjunction with research into the opportunities presented by existing and emerging CIS technologies.

3.2.7 ***Communicating Command Intent***

Communicating command intent was said to be improved with the basic CIS, however, analysis of the questionnaires did not support this. This is an important issue and requires further investigation.

3.2.8 ***Reversionary Operating Modes***

Reversionary operating modes in the event of full or partial system failure are an essential part of any new CIS SOIs and require further investigation.

3.2.9 ***CIS HCI 'Style'***

CIS HCI 'style' has a considerable impact on usability, training and thus the overall effectiveness of digitization systems. It is essential to establish a flexible but common standard and enforce it for future CIS procurements.

4. **Conclusions**

One of the main thrusts of the UK DBL programme is to improve collaborative working, both within and between national force components, which fits neatly with the symposium theme of **collaboration in the information age**. This is by no means a simple and straightforward undertaking and the UK has created a Land Digitization Test and Prototyping Rig to enable early investigation of some of the most pressing development and integration issues. The accumulated experience and expertise in conducting laboratory exercises enables 'best practice' to be identified within a valuable and productive C2 research and technology capability.

The overall "classical" research approach adopted on the LTHQ project has worked well to-date with a pleasing level of agreement between observations from the real world (BATUS and other field exercises) and the laboratory. The analysis of C2 capability gaps (problems) in the baseline case provided a good basis for testing the initial improvement hypotheses in this first 'exploratory' research exercise. This has helped considerably to identify the most important topics that impact upon both the functional and non-functional requirements for future systems. Many of these topics require further investigation and the combination of systems analysis with practical research exercises is considered to be a very suitable way to proceed.

The positive and co-operative approach of the participating Army team was fundamental to the success of the exercise. Participation by real end users in research exercises, especially at the early stages in equipment capability projects, is vital to ensure that the demands placed on prototype system components and the views and feedback obtained, truly represent those of the military end users. Without such participation the facilities specified and benefits predicted may not be realised by those who need them in the battlefield.

5. **References**

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