US/UK Sensor -To-Shooter Coalition C4 Interoperability Study
Timeline Analysis

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Abstract

This paper describes the work carried out by the Defence Evaluation and Research Agency (DERA) during the US/UK Sensor to Shooter (STS) Study. It focuses on the timeline analysis carried out by the UK team and some broad conclusions drawn from this. Some lessons learnt regarding the conduct of such studies are also presented.

1 Introduction

The US initiated four studies in the STS series during the period 1994-1997. They all recommended changes to the US procurement program. In 1997 the UK Director General, Information and Communications Services, initiated UK involvement in a bilateral study, the US/UK STS study, to examine interoperability issues between UK and US sensors and weapons platforms. UK involvement commenced in September 1998 with the US leading.

The overall objective of the US/UK study was to develop a multinational US/UK system and operational architecture that applies to fixed-wing air, call for fire, precision engagements and manoeuvre operations. The UK objective was to 'examine the interoperability issues associated with cueing weapon platforms in US/UK coalition warfare' and to 'enhance the relationship between the US and UK analytical and military communities in the area of STS with a view to co-operating in further bilateral studies.'

The work carried out by the US during this project examined the effect of varying levels of US/UK communications interoperability on combat outcome. The UK team, with less experience and smaller resources, carried out complementary analysis which investigated the potential for improvements to engagement timelines at a single, basic, level of interoperability. Considerable effort was also expended in providing the US team with data on UK systems and procedures. The work was carried out in two phases. This paper concentrates on the timeline analysis carried out by the UK team during Phase 2.

2 Timeline Analysis

2.1 *Methodology*

The approach used was, in principle, simple. A series of situations involving various combinations of sensor, target and shooter was selected and the processes between detection and engagement traced. The total elapsed time for all processes to be carried out was then calculated.

The insight into the processes involved gained during the preparation of the initial timelines was then used to assist in the generation of a number of options for timeline reduction. Modified timelines were generated for the most promising of these and the results used to inform the next stage of analysis.

The final stage of analysis examined the benefits to be gained from selected costed combinations of options for timeline reduction. Military judgement was used to asses the overall reduction in engagement timeline against three criteria:

a. Impact on the number of engagements possible in a given period.
b. The influence of each engagement on the battle.
c. The impact on the survivability of the shooter.

Wherever possible the UK analysis used US data and assumptions in order to remain compatible with the US work. Alternative sources of data were used where this was inappropriate. Some data had, however, to be estimated. Table 1 shows the sensor and shooter pairings chosen for analysis.

The timelines covered the period from initial detection to the impact of the final round on the target.

Serial	Sensor			
	JSTARS	**ASTOR**	**US Artillery FOO**	**UK BG Close Recce**
1	US MLRS (Rkt)			
2	UK MLRS (Rkt)			
3	US MLRS (ATACMS)			
4		US MLRS (Rkt)		
5		UK MLRS (Rkt)		
6		US MLRS (ATACMS)		
7	Retasked OAS A/c			
8		Retasked OAS A/c		
9			UK AS90	
10				US CAS A/c

Table 1. Sensor and Shooter Pairings

2.2 *Assumptions*

The analysis drew on work carried out by the US in previous phases of their STS study for the US portions of the timelines. UK timelines were based on current practice, modified to take account of the coalition setting.

The following assumptions concerning the engagements were made:

a. The targets were targets of opportunity and did not feature in any previous attack plans.
b. The targets were ‘new’; their identity could not be inferred from pre-existing intelligence.
c. There was no direct support link in place between sensor and shooter.
d. The targets would be engaged as soon as possible; an attack would not be delayed until they become stationary.
e. Systems loaded, or carrying, the correct ammunition type were available to carry out the attack. In the case of air attacks there were suitable aircraft in flight available for tasking or re-tasking against the target in question
f. The Rules of Engagement in force did not impose extra checks or other restrictions that would extend the engagement timelines.

The aim of these assumptions was to place the greatest possible strain on the sensor to shooter system. They also excluded issues outside the scope of the analysis, such as ammunition supply.

It was assumed that US/UK trunk communications interoperability in the 2010 timeframe would exist for at least ADatP-3 (or similar) data messages and that Artillery C2 applications (Fire Support BISA and AFATDS) would be capable of interoperation.

The baseline assumption was that UK ASTOR Ground Stations would be integrated into the US C3I system by means of an ‘exchange’ of remote workstations with appropriate manpower. The US was assumed to deploy an All Sources Analysis System (ASAS) terminal into the ASTOR Ground Station and the UK to deploy an ASTOR analysis terminal into the appropriate Analysis and Control Element[1].

Planning of an engagement based on data from an airborne sensor was assumed to begin following confirmation of the target’s location and identity.

The US/UK analysis used a common background setting. Based on a scenario used in the US STS IV study the scenario featured a multinational force involving the US and UK defending against an invasion in the 2010 timeframe. As the build up was not yet complete the forces involved were relatively small (‘early entry’ units only). UK Land forces comprised a single Brigade, plus supporting assets, operating under command of a US Army division. In practice the overall scenario had little impact on the timeline analysis, the primary influence being to define the timeframe and the command and control relationships.

2.3 *Improvement Options*

2.3.1 *Overview*

Following the generation of the baseline timelines a number of improvement options were generated. The options chosen were:

- A Early planning.
- B Concentration of decision making
- C Improved fire planning.
- D Improvement to UK MLRS launcher.
- E Improved MLRS firing procedure.
- F Increased use of data messages in air operations.
- G Increased use of data messages in land operations (CAS tasks).
- H Alternative deployment of UK ASTOR Ground Station.
- I Greater integration of ASTOR GS with US systems.

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[1] The intelligence collation, analysis and planning cell within a US HQ

2.3.2 *Early Planning (Variation A)*

This variation investigated the possible benefits of planning on a contingency basis based on MTI data rather than awaiting confirmation of the target's identity.

This approach has the potential to generate large amounts of unnecessary staff work due to errors in identifying potential targets. The approach was, however, deemed worth investigation on the basis that if a target is identified with sufficient reliability to justify the tasking of SAR or other sensors then it is likely to be worthwhile starting the planning process.

2.3.3 *Concentration of Decision Making (Variation B)*

This investigated the possible benefits of potential changes to the C3I process made possible by the introduction of digitization. With the increased capability to move information around the battlefield this brings there is the potential to concentrate decisions at a single location.

Many decisions are currently made by a succession of commanders or their staffs. For example, in the case of a US MLRS launcher firing in support of the division the process is:

a. The MLRS Battalion to be used is decided within the Division HQ.
b. The Battery to be used is decided within the MLRS Battalion.
c. The launcher to be used is decided within the MLRS Battery.

This process is largely driven by the availability of information at each level of command. With the advent of digitization the potential exists to provide sufficient information at the Divisional HQ to enable the entire allocation decision to be made at this level.

The modelling took account of the need to retain a reversionary capability and to provide sufficient information to local commanders to enable them to veto or modify an erroneous decision.

2.3.4 *Improved fire planning (Variation C)*

This investigated the benefits of carrying out portions of the fire planning task whilst the Gun or launcher was moving from its hide to the firing point.

2.3.5 *Improvement to UK MLRS launcher (Variation D)*

The effect of the UK adopting the US ILMS or a similar modification in order to reduce the time taken to slew and elevate the launcher was examined.

2.3.6 *Improved MLRS firing procedure (Variation E)*

The introduction of new technology creates the possibility of shortening the MLRS firing procedure.

2.3.7 *Increased use of data messages in air operations. (Variation F)*

This variation considered the scope for improving attack aircraft response times by making increased use of data, rather than voice, messages. This would involve the introduction of new equipment.

2.3.8 *Increased use of data messages in land operations (CAS tasks). (Variation G)*

This investigated the effect of making greater use of the data messaging capability of BOWMAN for land tactical communications.

2.3.9 *Alternative deployment of UK ASTOR Ground Station. (Variation H)*

This investigated the benefits of deploying an ASTOR Ground Station with the US Divisional HQ to supplement those at higher level HQs.

2.3.10 *Greater integration of ASTOR GS with US systems. (Variation I)*

This assumed that integration of the ASTOR Ground Stations was achieved through connection of the ASTOR analysis terminals to the US ASAS system rather than via the use of remote terminals. The means by which this might be achieved was left open, but a likely candidate is the use of the US "Rosetta" technology.

2.3.11 *Combinations of Improvements*

The effect of introducing combinations of the most promising improvements listed above was also examined. This analysis was limited in scope, examining the effect on the MLRS and AS90 timelines (serials 1-6 and 9) of two combinations, one containing 'procedural' improvements only and a second adding a variety of hardware-related improvements.

2.4 *Operational Impact*

Military judgement was used to asses the operational impact of the most promising individual improvements and the two combinations mentioned in section 2.3.11. Improvements in the following areas were considered:

a. **Rate of engagement.** The improvement in the number of engagements that can be carried out in a given time.

b. **Value of each engagement.** The increase in the influence of each engagement on the battle. Due consideration was given to such factors as the likely urgency of the situation.

c. **Shooter survivability.** Any improvements in shooter survivability arising from the shortened timeline.

The level of improvement was categorised as being either:

a. **Negligible.** Not introducing any disadvantage but providing no clearly identifiable improvement.
b. **Moderate.** Providing identifiable improvements, the value of which is uncertain.
c. **Significant.** Providing a definite improvement.

3 Conclusions

3.1 *Timelines*

Whilst the numerical results were necessary and valuable, much of the value of this work lay in the insights gained during the process of carrying out the analysis.

It became clear that, given the level of digitization and interoperability assumed, the principle influences on the engagement timelines were:

a. The time to analyse the target data; this is a 'man in the loop' process.
b. The time taken to position and prepare the shooter. There are only limited opportunities to reduce this.

There were thus limited opportunities to reduce the timelines by technical rather than procedural means. Fortunately the ability to move information rapidly and securely around the digitized battlefield creates opportunities for changes to current procedures.

There were several opportunities for timeline reduction though the increased use of data messaging to replace voice transmissions. The reasons (in the cases studied) for the continued use of voice in a digitized environment were:

a. Historical; planned procedures had not been changed to allow for the availability of data messaging.
b. Due to a lack of planned or actual equipment (although it was subsequently found in one case that the deficiency was in the process of being corrected).

There are many situations where the immediacy and personal contact provided by voice is essential or to be preferred. This was not the case, however, in the processes studied.

It was noted that, with the exception of option F (the use of data messages in air operations) the options studied could be introduced at relatively little cost. Procedural changes would, of course, not be free due to the required software changes and retraining.

3.2 *Military Impact*

The conclusion was that the options whose military impact were considered all provided moderate improvements to the effectiveness of each engagement. It was noted that the sensitivity to changes in engagement timeline of the military value of each engagement was strongly dependent on the nature of the target being engaged.

The improvements considered could improve engagement rates for some systems in the short term. In the long term, however, rates of engagement were primarily limited by ammunition supply and/or sortie rates. It was also concluded that the timeline improvements seen were insufficient to improve shooter survivability.

3.3 *National Procedures*

It was noted that, whilst both nations complied with NATO standards, a number of differences existed between the UK and US in terms of procedures and internal unit organisation. These often arise from the requirements imposed by differences in equipment (for example, JSTARS and ASTOR). This reduces the potential for harmonisation and increases the difficulties involved in achieving interoperability through the use of common C2 applications.

4 Commentary

4.1 *Limitations*

A single level of UK/US interoperability was considered. The work did not investigate alternative levels of interoperability, the UK work was aimed identifying means of increasing the efficiency of the engagement process at this level.

The analysis was based on a single warfighting scenario. This influenced the C2 relationships involved. As a consequence the detailed conclusions may or may not be applicable in other situations.

The battlefield impact of the timeline reductions was assessed by means of military judgement rather than quantitative methods. They should therefore be treated with caution.

4.2 *Future Work*

There were a number of potential timeline improvements that were not investigated due to resource and time limitations. These are candidates for consideration in any further work.

It was felt that future work should pay greater attention to factors other than the sensor to shooter link. In particular the reaction times required to engage particular target units or equipments should be considered.

4.3 *US-UK Analytical Co-operation*

Good working relationships between the two teams were established from the outset and maintained throughout the study. However classified communications were limited to the secure mail system and occasional personal meetings. Much time was wasted due to simple misunderstandings that could have been avoided if had more frequent communication unrestricted by security issues been available. These misunderstandings usually arose from different interpretations regarding terminology and a lack of knowledge of subtle differences in national doctrine and procedures. The most valuable time for dealing with these issues was when UK and US analysts were physically together.

It was recommended that future work should give early consideration to secure communications between the teams (due to the associated long lead times) and/or an exchange of staff.

4.4 *Impact of this work*

The US Joint Staff has been briefed on the findings of the study and has noted its conclusions. A classified report on the UK work has been published and passed to interested parties in both the UK and US. This report will inform UK policy on Joint Battlefield Digitization.

4.5 *Disclaimer*

The work reported in this paper was advisory in nature. Nothing in this paper should be taken as necessarily reflecting the views or policy of the UK MOD or any of its constituent parts and agencies.

Abbreviations

A/c	Aircraft
ADatP-3	Allied Data Publication 3 (NATO). Defines a standard (STANAG 5500) for the format of text messages.
AFATDS	Advanced Field Artillery Tactical Data System
Analysis and Control Element. (ACE)	The intelligence collation, analysis and planning cell within a US HQ
AS90	UK 155mm Self Propelled Gun
ASAS	All-Source Analysis System. US Army Command Information System (CIS) for intelligence data
ASTOR	Airborne STand-Off Radar, UK manned airborne ground surveillance radar system.
ATACMS	Army Tactical Missile System
BG	BattleGroup
BISA	Battlefield Information Systems Application. UK Command Information System (CIS) application hosted on BOWMAN (q.v.)
C3	Command, Control and Communications
C3I	Command, Control, Communications and Intelligence

CAS	Close Air Support
DERA	Defence Evaluation and Research Agency
FOO	Forward Observation Officer
ILMS	Improved Launcher Mechanical System
JSTARS	Joint Surveillance Target Acquisition and Reconnaissance System.
MLRS	Multiple Launch Rocket System
MOD	Ministry of Defence
MTI	Moving Target Indication
OAS	Offensive Air Support
Recce	Reconnaissance
Rkt	Rocket
Rosetta	US personal computer based advanced translation technology.
SAR	Synthetic Aperture Radar
STS	Sensor To Shooter