Digital Diagnosis and Repair

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Introduction

Dstl is a key provider of military operational analysis (OA) to support the UK MoD's procurement, policy and operational decisions. The Logistics Analysis Group within the Policy and Capability Studies Department in Dstl provides objective and independent advice, based on expert knowledge and analysis to support senior decision-makers in MoD.

The General Purpose Thermal Image Repair Facility (GPTIRF) and the Digital and Analogue Analyser (DIANA), collectively known as General Purpose Automatic Test Equipment (GPATE), are approaching their out of service date of 2012. Digital Diagnosis and Repair (DDR) is the name given to the capability solution for maintaining the availability of battlefield electronic and optronic equipment. As part of the DDR assessment phase, Workshop Support Services Integrated Project Team (WSS IPT) are required to conduct a Combined Operational Effectiveness and Investment Appraisal (COEIA) to assess how best to replace the capability provided by GPATE. Dstl has been tasked to assist in the production of the COEIA, in particular, to identify and assess alternative technologies, to identify alternative options that go beyond a direct replacement of the capability, and conduct OA to assess all the options considered within the COEIA.

The analysis will consider all the military systems which rely on GPATE, such as Challenger 2 (CR2), and so requires the involvement of many Stakeholders, including many IPTs, the Directorate of Equipment Capability (Expeditionary and Logistics Support) (DEC(ELS)), and representation from the users (the Army) under HQ Land.

The study is developing a system-level model, built in the simulation package Simul8. Customer and stakeholder involvement at all stages ensures that the model design is suitable and that relevant parameters are chosen for sensitivity analysis. Availability of the equipments is chosen as the measure of effectiveness as this has a direct effect on combat outcome.

Current Process Overview

The study will model the equipments that will require GPATE; namely CR2, AS90, SCRA(T), HVM and ADAD, in a concurrent operational environment. Failures are generated for each equipment by their usage. Based on reliability and failure data, each failure is attributed to either a Line Replaceable Unit (LRU) that requires GPATE or one that does not. For those that do require GPATE, the LRU is transported back to GPATE where the fault is diagnosed. Depending on the result of the diagnosis, the faulty LRU will either be repaired at GPATE, or sent back to industry in the UK for repair. The process overview is depicted in Figure 1.

GPATE is supporting multiple equipments concurrently. LRUs are repaired as and when a fault occurs. If there are more repairs needed than are possible at GPATE two priority schemes will decide the order in which LRUs are repaired, namely:

1. The LRUs that are running lowest in the Forward Repair Pool (FRP)
2. LRUs in the following order of equipments
   a. Air Defence
   b. CR2
   c. AS90
   d. SCRA(T)

Figure 1: Process overview

Aim of Study

Within the COEIA, five different options that require investigation have been identified:

- Option 1 – Do nothing; keep running GPATE until its out of service date;
- Option 2 – Do minimum; repair and maintain GPATE to extend its out-of-service date;
- Option 3 – Mid-life upgrade by design authority;
- Option 4 – Competitive procurement of a replacement facility;
- Option 5 – Alternative options, which go beyond replacement of facility.

This study aims to assess the impact of the DDR capability on equipment availability, and Dstl have been asked to assist in developing potential solutions within options 3, 4 and 5.

Outline Method

A technology trawl was conducted to identify any other equipment or technologies, currently available or to be developed in the future, that can provide solutions within Option 4. This investigated hardware and software for Test & Measurement (T&M), along with alternative solutions, such as increasing the amount of health & usage monitoring on equipment to reduce the need for T&M.

The possibilities included under option 5 are:

- The range of forms of the solution; such as a physical piece of equipment, or a software package;
- Any valid methods of utilising the procured capability such as a solution that could be used '1st to 4th line' or '1st to 2nd line';
- Solutions with different scope; be it a bespoke solution for each platform type or a 'one size fits all' solution;
- Different lifetime solutions, as the systems supported by DDR have differeing out-of-service dates.

It was identified that a simulation tool will be used to model the range of equipment support solutions identified in the COEIA options. The tool will be capable of assessing different types of equipments and different methods of repair, and will allow for the analysis of different sensitivities.

Customer and Stakeholder Involvement

Interaction with the customer and stakeholders is invariably a key ingredient to the success of an OA study in order to ensure that all the right questions are being answered to the desired fidelity. This has been prevalent at all times during the study, for example:

1. Each IPT has been involved in the development of the model to ensure their systems are properly represented.
2. Data has been sourced through both the Defence Logistics Organisation (DLO) and Arms and Services Directorates.
3. The technology trawl has involved a number of key industrial partners.

Model Design

No suitable models were in existence and it was recognised that a spreadsheet approach would not give the required level of granularity. A model was designed in conjunction with the customer and stakeholders and is being built in the modelling package SIMUL8, which will give a fast running model that can be developed in a short time period. The model design is outlined in Figure 2.

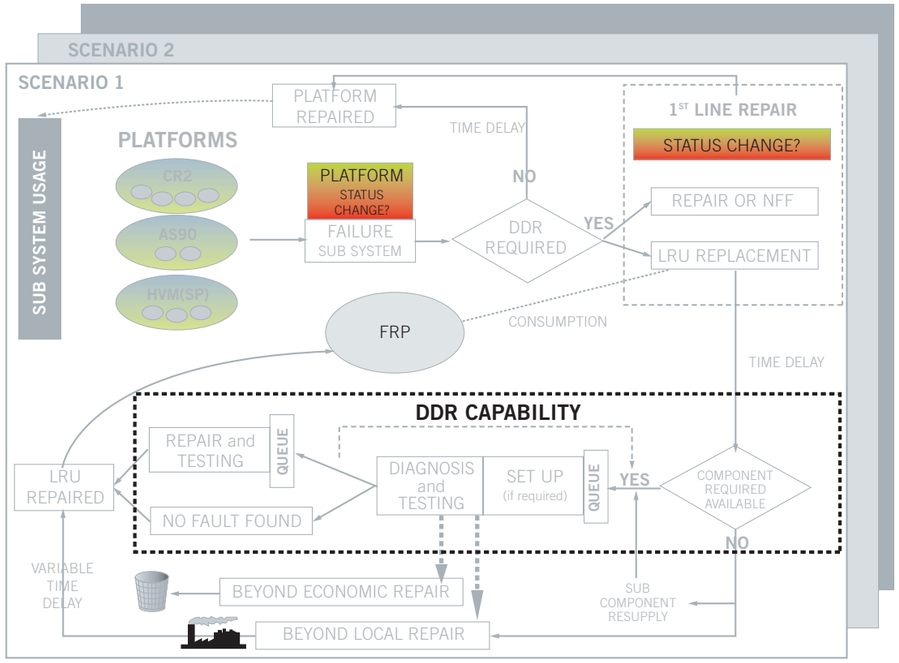

Figure 2: Model design

The model is stochastic in nature and will have the ability to perform multiple repetitions quickly. The model has been designed on the basis of the wide range of options that the DDR capability could take. For example, it will be capable of representing diagnosis and repair in theatre using DDR, a 1st to 4th line solution with repair by industry, or a combination of the two.

Results

The tool output will be an equipment availability profile over the course of each scenario. Figure 3 represents a generic vehicle and its availability over time. There will be an assessment of the impact of the different solutions, highlighting the areas that cause delays in the repair loop. The output from the tool will then be used to assess the balance of availabilities across multiple equipments.

The model will generate output of sufficient range and detail for both the current GPATE solution and future DDR options being analysed. All outputs will be represented over time, over multiple runs, and over a number of concurrent scenarios and equipments. Analysis will show the benefits and risks for each solution.

Figure 3: Illustrative results

Conclusions

Based on the analysis findings, Dstl will provide WSS IPT with recommendations on the form and utilisation of the replacement capability. The analysis will provide answers to the questions "is there a need for a replacement capability, and is there a need for one in theatre?"