UK ISTAR Architectures and Capability Management

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ABSTRACT

The paper describes the development of a UK ISTAR architecture, compliant with the US Department of Defense Architecture Framework (and the UK MOD AF), and its application to ISTAR capability management. The need for an architecture to underpin descriptions of capability is established, followed by a description of the process and tool used to generate the architecture. The formal relationship between capability and equipments is discussed, and practical means to represent and manage this relationship are developed. The paper concludes with a description of the application of this methodology to the development of a UK ISTAR capability.

1.0 INTRODUCTION

UK MOD has adopted a capability-based procurement process. Capability is expressed principally in the form of Equipment. However, MOD also recognises 5 other "Lines of Development" (LODs): personnel, training, doctrine, sustainability and structures and estates that also contribute to Capability.

Directors of Equipment Capability (DECs) manage equipment procurement. DEC(ISTAR) (Intelligence , Surveillance, Target Acquisition and Reconnaissance) is responsible for provision of equipment to support the ISTAR function. DEC(ISTAR) also has a "core-DEC" role; this means that there are some ISTAR-related equipment programmes that he does not have direct control over; these programmes are managed by other DECs.

The challenge facing DEC(ISTAR) is to ensure that UK has an appropriate ISTAR Capability, recognising that this will be achieved not only by purchase of ever-more technologically-advanced equipment, but also by understanding how to use this equipment effectively, which may be achieved by changes in other LODs.

The capability delivered by equipments is also strongly influenced by the architecture in which they are employed. Trivially, for example, without adequate communications, equipments will not be able to deliver their data to the user. At a higher level, the architecture also captures how equipments interact at both the technical and operational levels to provide capability. This formal relationship is examined further in section 0.

Given the importance of an architecture to support management of (ISTAR) capability, DEC(ISTAR) has commissioned the production of a UK ISTAR architecture that describes the ISTAR System of Systems at

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Operational, System and Technical levels. Section 2.0 describes the UK architecture framework, and the use of a particular tool (ISSE) as a means to manage production of the architecture. The application of this framework and tools to the production of the UK ISTAR architecture is described in section 3.0. The integration of the ISTAR architecture into a Capability Architecture is discussed in section 4.0, where the requirements for a Capability Management tool are developed, and a design for such a tool are presented. Section 0 shows the application of the Architecture and Capability Architecture to the development of a future UK ISTAR Capability.

2.0 ARCHITECTURE FRAMEWORK AND TOOLS

2.1 The Ministry of Defence Architecture Framework

Architectural Frameworks provide us with a mechanism for producing and exchanging architecture products in a consistent fashion. They enable teams of architects to exchange specific views of an architecture by labelling them so that both parties know what to produce and what to expect. The Department of Defence Architectural Framework (DoDAF) is one such mechanism that has been widely adopted over the past couple of years. The UK MOD has recognised the utility of DoDAF, whilst at the same time noting some enhancements that will be necessary to fulfil all the needs of UK SMART (capability-based) procurement. This has led to the development of a UK Architectural Framework named, unsurprisingly, the Ministry of Defence Architecture Framework (MoDAF).

MoDAF has a number of key additions to DoDAF. Firstly the introduction of some new architectural views, namely Capability Views and Acquisition Views. Both of these are targeted at supporting the Equipment Capability community providing them with a graphical representation of how capability requirements are being met, will be met or when such capability will be withdrawn.

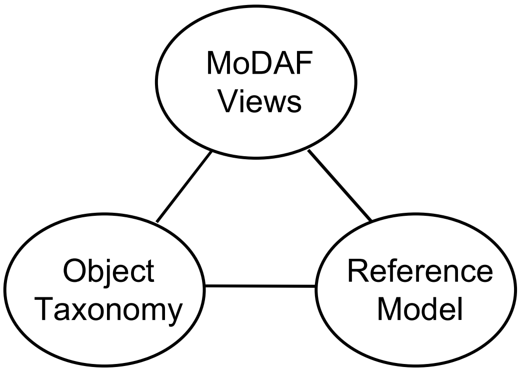

Figure 1 Three aspects to MoDAF

Equally important are the additional modelling constraints that MoDAF provides to aid consistency. The first of these is a Reference Model that constrains the way in which we describe an architecture, essentially through nodes and links. Only relationships that appear in the reference model are permitted. The second is the Object Taxonomy that provides a dictionary of terms that can be used in the architecture. This ensures that modellers use consistent terminology. Together these tools provide us with a powerful way to describe the MOD system of systems leading to an understanding that will enable informed decision making and fewer integration incidents.

2.2 Architecture Tools and the Need for a Government Repository

There are many tools available in the market for producing architectural views. Some of these now purport to being MoDAF compliant. The MOD recognised the need for a single validated model of the UK system of systems. As a result the Integration Services Support Environment (ISSE) was developed. ISSE is a bespoke application built by LogicaCMG and Vega for the Integration Authority (IA). ISSE is also MoDAF compliant. ISSE enables the IA to produce five types of models all inter-linked and stored in an Oracle database. Utilising a relational database enables the IA to perform structured queries on the data pulling out for example, time-based views on the phased introduction of a platform's capability.

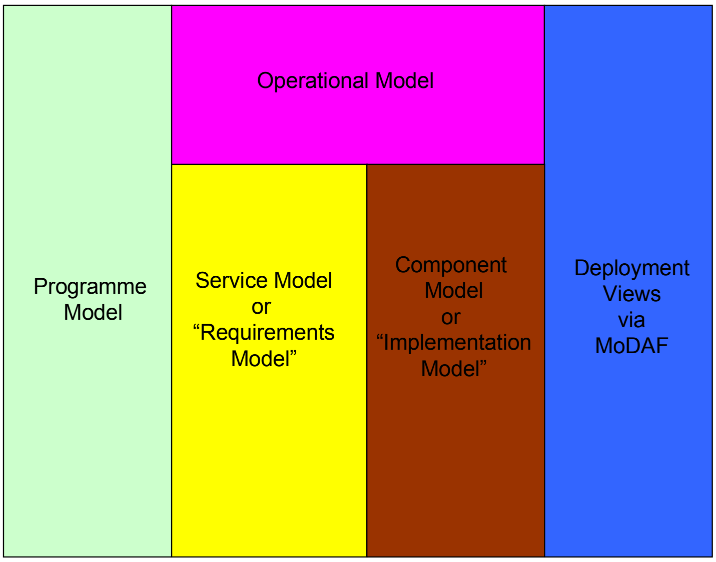

Figure 2 Five Dimensions to ISSE Models

The **Operational Model** describes the needs of the business in military terms. This model is system independent and justifies the need for equipment to support it. The operational model shows what information is required by which military roles and at which facilities/platforms.

The **Service Model** is used to describe in a logical manner the requirement for equipment to support operations. The MOD is moving towards complimenting existing requirements documentation, or even replacing it, with UML models that tends to lead to a more unambiguous statement of the requirement.

The **Component Model** is where industry can respond to the requirement in the Service Model. The linking between the Component Model and the Service Model shows how requirements are being met.

The **Programme Model** provides the time-based view of which programmes are responsible for delivering which aspects of the System of Systems. It is linked into the Service Model and the Component Model thus enabling a view on the 'as-is' architecture and to view planned future architectures.

All of the above Models feature in the **Deployment View** where we bring together real architectures built from the underlying validated models using the viewpoint that MoDAF provides. All of these models have been populated for the purposes of developing the ISTAR Architecture.

3.0 THE BASELINE UK ISTAR ARCHITECTURE

The UK Baseline ISTAR Architecture was commissioned by the Director of Equipment Capability (DEC) for ISTAR (Intelligence, Surveillance, Target Acquisition and Reconnaissance) in March 2004 with delivery in June 2004. DEC(ISTAR)'s requirement can be summarised by the single statement "Show me how my systems of interest will be used in the year 2010". The systems used within the architecture were ISTAR systems currently in service which will still be in service in the year 2010 (fielded systems), and ISTAR systems which, although still in procurement, will be in-service in the year 2010 (funded systems). An additional part of the DEC's requirement was that the modelling was to be undertaken using ISSE and that the architectural views would be compliant with the UK MoDAF.

The work was undertaken by a QinetiQ-led team in partnership with the IA and Dstl.

3.1 Aim and Scope of the UK Baseline Architecture

3.1.1 Aim

The UK Baseline ISTAR Architecture project was designed to provide DEC(ISTAR) with an initial view of his current/near-term ISTAR Architecture. The architecture needs to show how ISTAR assets are deployed throughout the command hierarchy, who can directly access those assets, what they are used for (where possible) and how they are used. The UK Baseline Architecture is to encompass the Operational, System and Technical views as defined by MoDAF.

The aim of the work can be expanded to cover the following questions:

- Show me who is using my systems?
- Show me why they are using my systems?
- Show me how my systems are organised?
- Show me what these systems are doing?
- Show me what support my systems require?

These statements expand the scope of the work to include a study of the requirements for ISTAR support to UK military forces as well as a presentation of the Command and Information Systems (CIS) required to deliver a UK ISTAR Capability.

Additionally, it is envisaged that the creation of the UK Baseline ISTAR Architecture will enable DEC(ISTAR), and his staff, to explore the uses of architectures and the potential power of having an ISTAR architecture. The UK Baseline ISTAR Architecture will also be used as a starting point to bring coherence to the Integrated Project Teams (within the Defence Procurement Agency) in how they use architectures, and bring coherence to the DECs and Customer 2 on how CONEMP, CONUSE and CONOPS may be developed in the future.

3.1.2 Scenarios

Given the drive to deliver a view of how the systems are used and integrated into a military command hierarchy it is necessary to set the UK Baseline Architecture within a scenario context. Although the UK has a number of standardised military scenarios which are used for operational analysis studies it was deemed that for this work a more generic scenario could be used which would then be applicable to more than one specific scenario with relatively few modifications. The generic scenario is based around a force-on-force quasi-symmetric warfighting operation

The Strategic context for this type of scenario is the next decade or so, where the 'western world' is opposed by national state opponents. UK forces are engaged on expeditionary operations against the Army of a nation state adversary, operating as a multinational coalition.

'Quasi-symmetric' Fighting Operations occur where this opposition leads to expeditionary warfare in which the UK moves into a region and uses formed forces to engage in combat with the adversary, who defends himself using formed forces. Both sides make use of broadly similar types of fighting capability, but the UK has a significant superiority, especially in the key capabilities of firepower (Weapons) and intelligence-gathering (ISTAR). Accordingly, the adversary adapts his Operational and Tactical Ways, in order to win the campaign politically, accepting defeat or stalemate on the battlefield.

The UK's military ends tend to be concerned with the Adversary's occupancy of ground, and with the state or activity of the adversary's forces. UK forces will seek a successful conclusion to the campaign quickly and with minimum casualties, whilst maintaining the integrity of its Coalition and the consent of the international community. The adversary will generally use a sequence of military and non-military parries to the UK's forceful intervention in the region. These will be targeted at the UK's Operational vulnerabilities (public opinion, coalition cohesion, need for speed, aversion to casualties), minimising tactical exposure to the UK's ISTAR and depth firepower and, on occasion, seeking to inflict loss in contact battles fought on the adversary's initiative. Thus, the adversary aims to keep or get UK forces out, while the UK forces may have similar aims, or may be seeking to neutralise the adversary force.

3.1.3 Military Commands

Another key factor for the scope of the architecture is the military command hierarchy and the headquarters which are likely to be represented within that hierarchy. For the UK Baseline Architecture a scope which included all deployed headquarters and the Permanent Joint Headquarters was chosen however, in order to reduce the scope slightly the Special Forces and Logistics Components were not considered. These components will be added to later stages of the Architecture.

3.1.4 Military Processes

In addition, since this was to be an *ISTAR* Architecture the scope of the ISTAR functions represented needed to be considered. The UK Doctrine uses the terminology Direction, Collection, Processing and Dissemination to represent the Intelligence cycle. The UK Baseline Architecture covers all of these stages but stops at looking at the processes and systems used to generate the intelligence requests, and at the use to which the intelligence is put once it is passed back to the consumer.

3.1.5 ISTAR and CIS Assets

Finally, it has already been stated that UK Baseline Architecture is limited in scope to the ISTAR Assets that are fielded and funded. However, the need to represent CIS is driven by the other elements of the architectural scope. In total some sixty or so CIS systems needed to be represented in order to complete the UK Baseline Architecture. These systems were represented at a very high level of abstraction and it is hoped that future development of these models will be undertaken by the DECs responsible for these systems (mostly the DEC responsible for Command and Control and Information Infrastructure – CCII).

3.2 Architectural Design Principles

It should be obvious by now that the UK Baseline Architecture is an instantiated architecture based on the architectural design principles and the systems/architectural components available to the chief architect. It is therefore necessary to identify the architectural design principles used.

The only authoritative documents available to the design team were current military joint and single-service doctrine. These documents describe a very conservative view of the use of ISTAR assets to support operations and sadly do not yet reflect some of the emerging concepts for the use and management of UK ISTAR assets. However, since this was the authoritative document set, and since this is a baseline architecture, these were the design principles used.

In some places the doctrine was either not of sufficient detail, or incomplete, to explain some aspects of the architecture. Where this was the case, expert technical and military judgement was used to 'fill the gaps'.

3.3 Modelling the Components

The components of the architecture were modelled using the Integrated Services Support Environment (ISSE) toolset.

In ISSE the operational layer describes military functions, role, resources and information products. These were populated for each of the three main services (Army, Navy and Royal Air Force) and for the Joint level of command. Where possible this data was validated with appropriate service lead. From this data an operational deployment diagram was created.

The system level is populated using logical service models and physical component models. Given the broad scope of the UK Baseline Architecture project, and the concentration on 'who does what functions with what systems?' it was only possible to create the complete baseline architecture using logical service models of the ISTAR and CIS assets. It was largely only possible to model the systems from their requirements, rather than actual system designs. The reason for this is that system design documentation largely resides within the hands of those companies which manufacture the systems and that these documents are often company proprietary. In time, the work of the ISTAR Architectures community will need to encompass the modelling of systems 'as they are' rather than 'as they were intended to be' but for this to happen there will need to be greater openness about system design within the defence industry.

The systems are modelled according to the services that they provide, the functions which they support and the information products which they exchange (either internally or externally).

For the first release of the UK Baseline ISTAR Architecture there has been no technical architecture provided.

3.4 Building the Architecture

Once the component models and architectural design principles are understood architectural instantiation can be created. In ISSE terms deploying the components according to the architectural design principles creates the architectural instantiation. This is the role of the chief architect. Physically, within ISSE, this is done by creating UML sequence diagrams that can then be used to create UML collaboration diagrams. From these collaboration diagrams various of the matrix views of information exchange products, etc. can then be generated.

3.5 Architectural Views

Two sets of architectural views were generated from the UK Baseline Architecture dataset. The first was the broad, but shallow UK Baseline Architecture while the second was a more detailed case study that looked at specific cueing interactions within a limited subset of the UK ISTAR Inventory. For each of these circumstances, a difference set of MoDAF views was generated.

For the broad UK Baseline Architecture the views generated were: AV-1, AV-2, OV-1, OV-2, OV-3, OV-5, SV-1, SV-2, SV-3, SV-5. For the more limited cross-cueing case study the views generated were: AV-1, AV-2, OV-1, OV-2, OV-3, OV-5, OV-6c, SV-1, SV-2, SV-3, SV-4, SV-5. These views can be directly read-across to the corresponding DoDAF views.

3.6 Completeness of the UK Baseline Architecture

The UK Baseline Architecture is by no means a complete ISTAR Architectural description and there are a number of significant steps that still need to be achieved before realising a complete ISTAR Architectural description.

The UK Baseline Architecture (or more specifically the ISSE repository that underpins the architecture) contains logical service models for all ISTAR Assets that are fielded and funded in 2010. However, many of these models are at a relatively high level of abstraction (layer 5 in ISSE-speak). There is clearly a significant amount of work that needs to be done in order to model all the assets to the same level of abstraction.

3.7 Next Steps for UK Architectural Studies

The UK Baseline Architecture is essentially an instantiated architecture representing the architectural design principles appropriate for 2004 but with a set of components which are suitable for the 2010 timeframe. Given the step-change in the UK ISTAR Capability which will occur in this timeframe there clearly need to be more thought given to the architectural design principles. There is planned follow-on work to determine the appropriate UK ISTAR Architectural Design Principles which support DEC(ISTAR)'s vision of how ISTAR will be managed in the year 2020. The design principles are key to achieving a UK ISTAR Capability which fully realises the potential of the new generation of ISTAR assets.

In addition to the key work on architectural design principles, the current UK Baseline Architecture will be used to prototype the use of ISTAR Architectures in supporting both the UK Capability Audit process as well as the UK Capability Architecture work described in this paper. It is vital to obtain a good understanding of how the ISTAR Architectural Design Principles enable the assets to fulfil their capability goals, and where the ISTAR Architectural Design Principles limit the utility of the assets being procured by the UK Ministry of Defence.

In order to achieve both of these visions the UK must form both an authoritative ISTAR Concepts forum and have detailed systems models available in order to be able to model architectural instantiations.

In the short-term the UK Baseline Architecture will be rolled out across the DEC and the IPTs to make them more architecturally aware and to help create dialogue and understand the true DEC(ISTAR) requirement for architectures. DEC(ISTAR) is also keen to engage with the defence industry to support the development of the architecture especially in the area of open standards and formats to enable a more enhanced ISTAR capability.

4.0 THE CAPABILITY ARCHITECTURE

4.1 The Purpose of the Capability Architecture

The aim of the capability architecture is to assist DEC(ISTAR) in the management of his equipment programme (EP), by enabling him to understand:

- The need for new ISTAR equipment

- The context within which the equipment must sit
- How ISTAR equipment relates to other equipments

4.2 The Formal Relationship between Capability and Architecture

The aim of this section is to derive the formal relationship between architectures and capability management. This will be used in later sections to assess existing approaches to capability modelling and as the basis for a proposal for a capability architecture.

Capability is defined to be

> "The set of equipment (systems), *men and procedures* that deliver a capability need or component of military force"

Therefore a capability model must represent

- The capability requirements, expressed as capability need or a component of military effect, in combination with
- Solutions, which includes equipment (captured in the EP portfolio), men and procedures, which, as discussed above implies a need for a representation of architecture in its most complete sense.

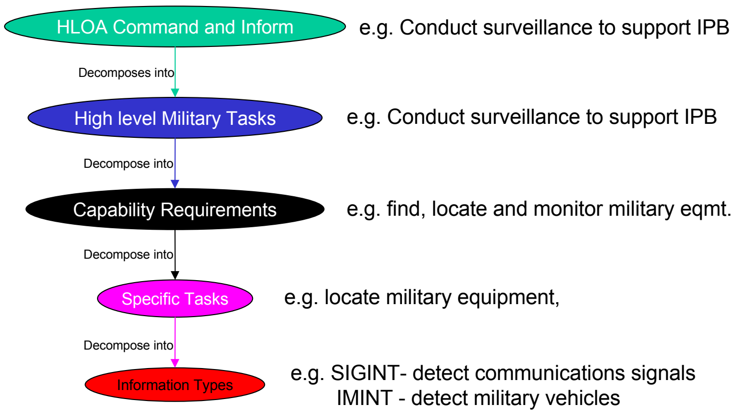

Figure 3 Capability Requirement Decomposition

High level [ISTAR] capability requirements can be decomposed (through a number of stages) into particular information types, which can then be associated with ISTAR equipments, as shown in Figure 3.

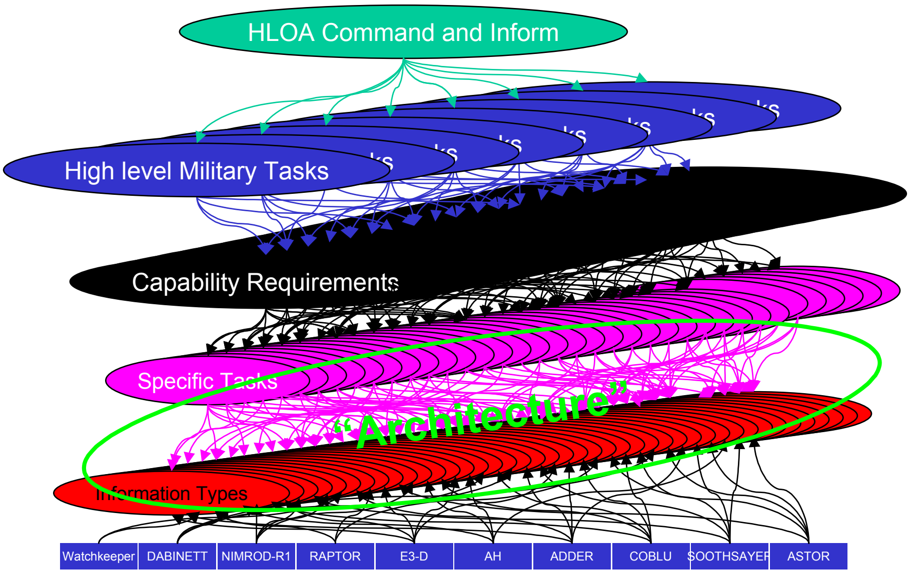

Figure 4 Equipment provides capability through architecture

In reality, all levels of this decomposition are one to many, and, as noted above, equipments can only be used to meet capability requirements when they are embedded in an architecture, as shown in Figure 4. This illustrates the complexity of the capability management problem, but it is possible to visualise (in Figure 5) two simple "queries" that must be supported by the capability model.

The query illustrated on the left is "Show me which equipments provide capability X" and the query on the right is "Show me which capabilities equipment Y contributes to". In both cases, the query is supplemented by the condition "subject to the architecture".

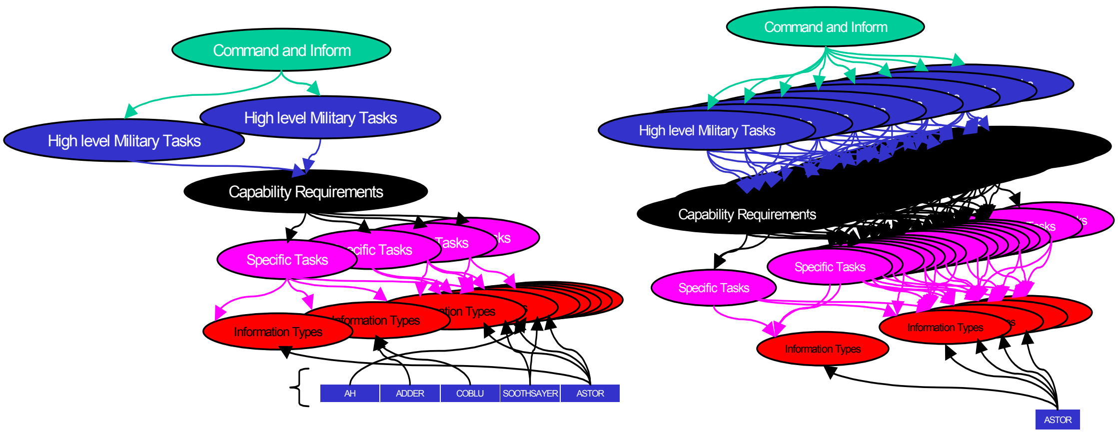

Figure 5 Capability Queries

Figure 3 describes one way in which a capability taxonomy may be derived, based on military tasks. There are alternatives, such as:

- A taxonomy based on commander's information requirements. These tend to be strongly related to scenarios, but this approach does provide a strong linkage to operational need for ISTAR capability
- A decomposition based on environment (Land, Sea, Air…), further decomposed into Deep, Close Rear… . This is the approach adopted by DEC(ISTAR) in his capability audit, and matches well to the organisational structure used to manage the EP
- ATP-61 "Reconnaissance and Surveillance Support to Allied Joint Operations" can be used to derive a taxonomy based on level of command (Strategic, Operational, Tactical) followed by tasks (Intelligence Preparation of the Battlespace, Identify enemy ORBAT…). This is operationally grounded, but lacks the scenario context.

From this, we can conclude that different users have different needs for a capability taxonomy, and therefore the capability architecture must be able to support different taxonomies.

4.2.1 Summary of Requirement

The Capability Architecture will capture how equipments provide capability, supported by the ISTAR architectures, and taking into account other Lines Of Development. This must be achieved in a "tool" that is useable by both DEC staff and the technical community. It must be capable of capturing the architecture in the link between equipment and capability, and the capability taxonomy is itself fluid.

4.3 A Pragmatic Approach

The relation between capability and equipment is captured succinctly in Figure 6.

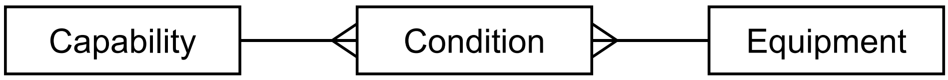

Figure 6 Relation between Capability and Equipment

In this diagram, the "crows foot" represents a "many to one" relationship. "Condition" captures the issues described in the preceding section. The kinds of relationships covered by Condition include:

- Scenario: the scenario setting within which an equipment is providing a capability
- Equipment: the other equipment that is required for the equipment under consideration to be able to provide the capability. (For example, Equipment A may need to be cued by Equipment B before it can perform certain tasks)
- Means of Use (CONEMP): A reference to documents describing how an equipment is expected to be used.
- Connectivity in Logical, Technical and Physical terms. Essentially, this is a link into (a fragment of) the ISTAR architecture, that gives assurance that the equipment will be able to provide the capability described.
- Architecture Metrics: This describes assumptions or conditions on the architecture that must be met to provide the capability. For example, it may be predicated on a certain bandwidth or timeliness of communications.

4.4 Implementation Considerations

Figure 6 shows how capability (captured in a suitable taxonomy) can be related to equipment that contributes to that capability, subject to certain conditions. This structure is able to support the kinds of queries described in section 0 (what equipment provides capability X, and how is capability Y provided?). And, if the "Conditions" data is suitably structured, it will also be able to

- Qualify the results of these queries. For example "Eqpt A provides the capability to identify targets, provided it is cued by Eqpt B, and that cross-cueing procedures are in place, and that suitable communications links are in place between Eqpt B and Eqpt A". The whole of the "provided" clause would be captured in Conditions
- Track the effect of any change in the Conditions. For example, if the provision of communications between Eqpt A and B is no longer assured (because of changes in a project providing communications infrastructure, perhaps), then the capability of Eqpt A to identify targets should be reassessed.

However, these kinds of queries will only be possible if the Conditions data is well structured. If this is not the case – for example, if all the Conditions are captured in a free format text document (or documents), it will be hard, if not impossible, to track changes automatically. On the other hand, trying to design a formal database structure in which all possible Conditions are rigidly parameterised is probably not practicable, as not all Conditions will apply in all cases, and even when there is a common set of Conditions, they may be parameterised in different ways.

Therefore, there is a need for a flexible tool that allows users to capture what is appropriate, but not so flexible that different users use different ways to model capability. Table 1summarises the benefits and shortcomings of different types of tool that could be used to support the capability architecture.

Table 1 Comparison of tool features to support capability architecture

Tool Type	Comments
Relational Database (e.g. Access)	Highly structured data. Large upfront investment to design and agree the relationships and attributes for Conditions. Strong rules to ensure valid data entry – may over-constrain users. Queries need to be designed by experienced user.
Spreadsheet (e.g. Excel)	Relatively flexible with respect to changing attributes. Hard to capture complex relationships, especially if these evolve. Easy to query and visualise data, provided it is reasonably well formatted.
Free text (e.g. Word)	Very easy data entry. Hard to enforce commonality of data entry. Templates can help, but reliant on user to obey template rules. Very hard to query.
Semantic Web	Supports flexible data structures. Data structure is "self-describing". Queries can be constructed based on this.

A strong driver for the development of Semantic web technology is a desire for improved interoperability and information exploitation across communities. This is achieved through the use of eXtensible Markupo Language (XML), the Resource Description Framework (RDF) and the Web Ontology Language (OWL). This removes the need for a "hard-coded" data model, in that the definitions of, and relations between, data entities are described in the data itself. In the author's assessment, Semantic Web technology will not, in the foreseeable future at least, provide information interoperability across all domains (ultimately, the "root" definitions and relationships must be hard-coded into applications). However, within defined communities, these basic definitions can be agreed, and then Semantic Web technology can be exploited. It is suggested that Capability Architecture forms such a community, and that Semantic Web is, therefore an appropriate enabler. It is expected that Semantic Web technology will allow users to express facts about capability (including "Conditions") in a way that can be queried automatically, without having to be dogmatic about the way in which users choose to represent Capability.

In summary, given the overall requirements, and the complications implied by the many potential Conditions linking equipment to Capability, Semantic Web appears to be the most promising technology to capture the Capability Architecture. An initial implementation of the capability architecture will be undertaken by December 2004, which will test this assertion.

4.5 Application

DEC(ISTAR) is currently formulating plans for a new capability. At the unclassified level, certain features of this capability are listed below:

- There is a requirement for concurrency in 3 theatres.
- The collection area covers close, deep and wide area: up to a maximum of X km x X km.
- Able to carry out surveillance of collection area 24/7 in all weathers for 30 days.
- The collection area cannot be overtly entered during peacetime.
- Within the collection area, the system will be capable of detecting groups of moving and stationary objects
- The system will be able to carry out persistent watch or tracking of a certain number of 'focused' areas within xx minutes for up to xx hours.
- Within the focused areas, the system will be capable of detecting and tracking small vehicles in all weathers.

The capability architecture can be used to support the analysis required to scope potential solutions:

Figure 7 shows existing equipment solutions in a "technical ability" space. The dimensions of this space include spatial and spectral resolution, phenomenology (SIGINT, HUMINT etc.), area covered etc. From this it can be seen that there are certain shortfalls in technical ability (the areas coloured pink in the figure.)

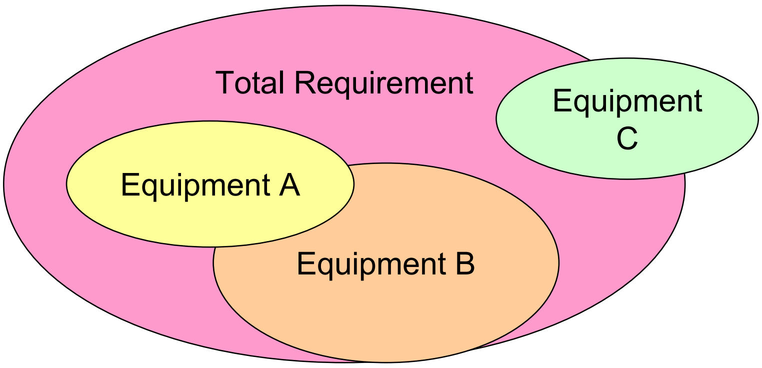

Figure 7 Equipment Technical Capability

However, the technical ability analysis is only a part of the process. For example:

- As shown, it effectively only considers each equipment in isolation. It may be that two sensors can be used to meet a particular technical requirement (e.g. area scan by one sensor, used to cue another sensor with a smaller field of view)
- It does not consider the tasking of the sensors, nor processing or dissemination of the data that is received.

We thus need a further "architectural" analysis that takes these factors into account. This is shown conceptually in Figure 8. In this diagram, green lines represent linkages which can be instantiated, while those in red represent architectural gaps. This diagram can be viewed from a number of different architectural perspectives. For example, if we take an "operational" view, then the red lines represent a lack of doctrine; for example it may that procedures for cross-tasking of sensors do not exist. An alternative is a technical view, where the red links represent areas where, for example, incompatible technical standards are in use, which would mean that the link could not be instantiated.

Therefore, the process of developing a new capability is multi-faceted: it is not sufficient to capture pure technical ability of sensors; all aspects (operational through to technical) of the capability must be considered. The capability architecture provides a framework for this analysis.

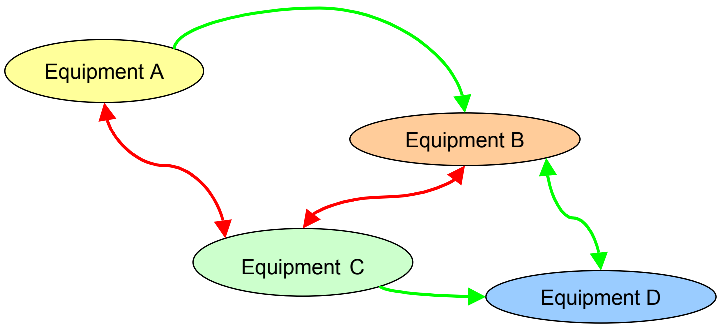

Figure 8 Architecture Considerations

5.0 CONCLUSIONS

Management of Capability lies at the heart of DEC(ISTAR)'s business, but it is a complex problem, and much more than simply managing equipment procurement. There are initiatives ongoing that attempt to address Capability Management, but there is currently no single definitive model.

The UK ISTAR Architecture is an integral part of the Capability Architecture, as it relates Equipment to Capability. This technical relationship is complex, and the paper has identified a pragmatic approach to resolving this complexity. The proposed supporting technology (Semantic Web) will enable an incremental approach to development of the Capability Architecture to be undertaken.