

Niteworks White Paper, October 2014

Styles of Architecting

A smarter approach to architecting the Defence Enterprise

David Evans, Niteworks Chief Architect

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Styles of Architecting – A smarter approach to architecting the Defence Enterprise

David Evans

Comments pertaining to this report are invited and should be forwarded to the author at david.evans@niteworks.net.

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The concept of architectural styles within this white paper draws heavily on previous work which was developed and presented jointly by Mike Wilkinson and the author at the NATO STO-MP-SCI-254 Symposium on Architecture Assessment for NEC, Tallin, Estonia, 2013, in a paper entitled "UK MOD's 'perfect storm' and the need for Architectural Styles". To avoid unnecessary referencing, this source is acknowledged here and cited again only where signification replication occurs.

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1. Introduction and Summary

1.1 Overview

This White Paper draws on best practice from a variety of Niteworks' projects to describe a practical approach to classifying and developing system architectures¹ across UK Defence. The proposed approach – Styles of Architecting² – is particularly relevant to achieving agile delivery and assured coherence in the post Levene operating model³.

It is clear that MOD is facing a range of transformation challenges and Niteworks believes that appropriate use of architecture is a fundamental success factor for both change and 'business as usual' activities across the whole Defence Enterprise⁴. However, whilst there is some understanding of 'what' things must be done there is very little understanding of 'how' they should be done in practice. Despite the foundational work done by a number of MOD initiatives, this situation is compounded by the lack of a standardised terminology and approach to architectures across Defence.

There are many opinions on the value, definition and use of architecture but this paper has taken a broad view of the discipline. This considers architecture primarily as a structured approach to help the decision maker to understand, decide upon and implement change.

Architecting is complex but in skilled hands it can be an effective method for enabling coherent decision making and implementing change. In unskilled hands, however, it can increase the perceived degree of complexity and become a blocker to success. The focus must be on 'just enough' architecting with an approach that is adaptable to changing needs and tailored to the organisation's architectural maturity; importantly the approach must have strong leadership if it is deliver real value. Architecting Styles provide a set of proven approaches for those who commission, use and evaluate architecture products, as well as those who create them.

The proposed four styles of architecting are: Authoritative, Directive, Coordinative and Supportive.

1.2 Key benefits

By understanding and using these styles, key decision makers, as the 'customers' of architecture, can be better informed on the use and limitations of architecture. This enables them to act as 'intelligent' customers, quickly and confidently agreeing the purpose or value of architecting work and the approach required to ensure success, before commissioning any work.

1 See the definition in ISO/IEC/IEEE 42010:2011.

2 D. Evans and M. Wilkinson, "UK MOD's 'perfect storm' and the need for Architectural Styles", NATO STO-MP-SCI-254 Symposium on Architecture Assessment for NEC, Tallin, Estonia, 2013.

3 Lord Levene. Defence Reform -An independent report into the structure and management of the Ministry of Defence. June 2011. ISBN: 9780108510663.

4 The term Defence Enterprise or Defence includes government, the industry supply base and academia.

Further, by understanding the use of different Architecting Styles across the Defence Operating Model⁵ a pragmatic and coherent Defence-wide approach can be reached; this enables limited resources to be focused on areas that offer the biggest return and in turn prevents nugatory or detrimental activities occurring. The use of Architecting Styles also provides a practical approach to enabling common practices across Defence; this fosters a better understanding of how different initiatives relate and the level of interaction that is needed, each of which promotes Defence-wide coherence.

1.3 The Aim

The purpose of this White Paper is to transfer the practical experience gained by Niteworks on a wide range of projects supporting MOD, into strategic guidance (policy) on the different Architecting Styles that are required to support the Defence Operating Model.

1.4 Key Recommendations

Niteworks recommends that MOD adopts the use of Authoritative, Directive, Coordinative and Supportive Architecting Styles and ensures that its range of architecting initiatives consistently delivers value, through:

- MOD Chief Technology Officer (CTO), as the head of Head of Discipline for Enterprise Architects within the IT Profession, becoming the champion of Architecting Styles for general adoption within Defence;
- Developing practical guidance for both the ‘customer’ and ‘architect’ that is focused on meeting the gaps in expertise across Defence.

It is further recommended that to improve the effectiveness of architecting across the Defence Operating Model that the key enablers (as highlighted in this paper) are established. These include:

- A coherent set of Defence Reference Architectures, with senior ownership, that support the Defence Operating Model;
- A policy of encouraging industry to invest in common Reference Architectures, alongside MOD, to ensure coherency through the Defence Enterprise;
- An Architecting community of practice, which covers all domains and acts as a focus for the development, sharing, reuse and co-ordination of best practice;
- A means to publish, configure and consult on Reference Architectures with the Defence Enterprise that is open to MOD, industry and academia;
- The secondment of suitably qualified and experienced Architects from wider government and industry, who can act as a catalyst to transform the approach to architecture across MOD;
- Guidance within the Acquisition Operating Framework, to ensure the architecture approach is embedded, managed and assured as part of existing programme or project documentation, for example within the SEMP⁶ or PMP⁷;

5 The New Operating Model - How Defence Works. Version 3.0: December 2012.

6 System Engineering Management Plan

7 Programme Management Plan

- Ongoing training and development of MOD's Architects (as opposed to modellers⁸) that draws on wider industry practices and experiences, that includes a proven value case for architecture to support engagement with senior decision maker.

2. Facing the perfect storm - the challenges for UK MOD

It has been observed that MOD is facing a “perfect storm”, brought about by three linked factors^{9,10} : unprecedented levels of organisational change; the ever increasing complexity of platforms and systems used by MOD in coalition operations, and; the on-going effects of the global economic crisis, manifested as strict financial constraints. Change is nothing new in MOD – rather there has been a multitude of change activities over recent years, to the extent that change is piled upon change, often before the earlier changes have had time to take hold. Neither are financial constraints new in MOD – but the ongoing demand for austerity bought on by the (current) economic crisis has triggered further changes that attempt, perhaps for the first time in a generation, to bring MOD spending under control and keep it under control.

The complexity of systems and platforms has been increasing for a number of years; networks are now ubiquitous, with the concept that everything should be connected. The challenges of achieving integration between long-lived systems and platforms that were not purchased with the intention of working together are significant and too often only fixed in the field rather than being integrated by design. This problem is further compounded with the rapid introduction of new capabilities through Urgent Operational Requirements (UORs) and the issues of interoperability and compatibility they bring with established systems and platforms.

Against this backdrop of constant change, increasing complexity and financial constraints, one of the solutions that offers the promise of cutting to the root of the problem and providing a way ahead is Architecture¹¹. However the use of architecture within MOD and wider Defence has a chequered history: some good work has been conducted in some areas but other areas have invested significantly in creating architectures that registered a poor return.

While Defence has its own unique challenges, many are common across wider government and the commercial sector. Like Defence other users of architecture have experienced mixed results. For example the US federal government has adopted Enterprise Architecture through Federal law and policy¹² and has developed a Common Approach¹³, which requires US Federal Agencies to develop and maintain an architecture that integrates strategic drivers, business requirements, and technology solutions.

8 A modeller wants to describe the world, whereas an architect wants to change it.

9 Sir Richard Dannat, *Leading from the Front*, 2011, ISBN: 9780552162616.

10 HM Government. *The Strategic Defence and Security Review*. 2010. Cm 7948.

11 For the purposes of this paper the term Architecture is used broadly and implies the inclusion of System, System of Systems Architecture and Enterprise Architecture.

12 The Clinger-Cohen Act of 1996 (P.L. 104-106) and E-Government Act of 2002 (P.L. 107-347)

13 Common Approach to Federal Enterprise Architecture, May 2 2012

However it has been observed that much of the billion dollars spent on an Enterprise Architecture by the US federal government was wasted¹⁴.

A number of issues are believed to have contributed to this, ranging from a lack of shared and common understanding of the discipline, to confusion of where architecture belongs, as well as issues in compliance and reporting of the work. In addition, there is an emerging belief that 'traditional' Enterprise Architecture approaches do not work effectively in practical contexts¹⁵.

The following section examines in greater detail some of the reasons why architecture in Defence has consistently failed to deliver on its promises, before describing how Architecting Styles can be used to address these issues.

¹⁴ Why Doesn't the Federal Enterprise Architecture Work?, Stanley B. Gaver, © 2010.

¹⁵ *ibid.*

3. Architecture and the failure to deliver on previous promises

The concept of architecture is not new to UK Defence (as illustrated in Figure 1), with over a decade of experience since adopting the concept from the US and the development of a dedicated MOD Architecture Framework (MODAF¹⁶). However, the continued use¹⁷ and wider adoption¹⁸ of MODAF should not be mistaken as an indication of success, in contrast there is little tangible evidence that the range of MODAF initiatives over the years has realised proportional improvements to UK Defence capabilities - which should be the only real measure. In practice, it is not uncommon for projects to have seen MODAF and architecture as a superfluous overheads that were left to the enthusiastic amateur. This is in part due to a lack of understanding of the value of Architecture and also not knowing what good looks like; which is reflected in a general lack of willingness by senior decision makers to fully support architecture initiatives.

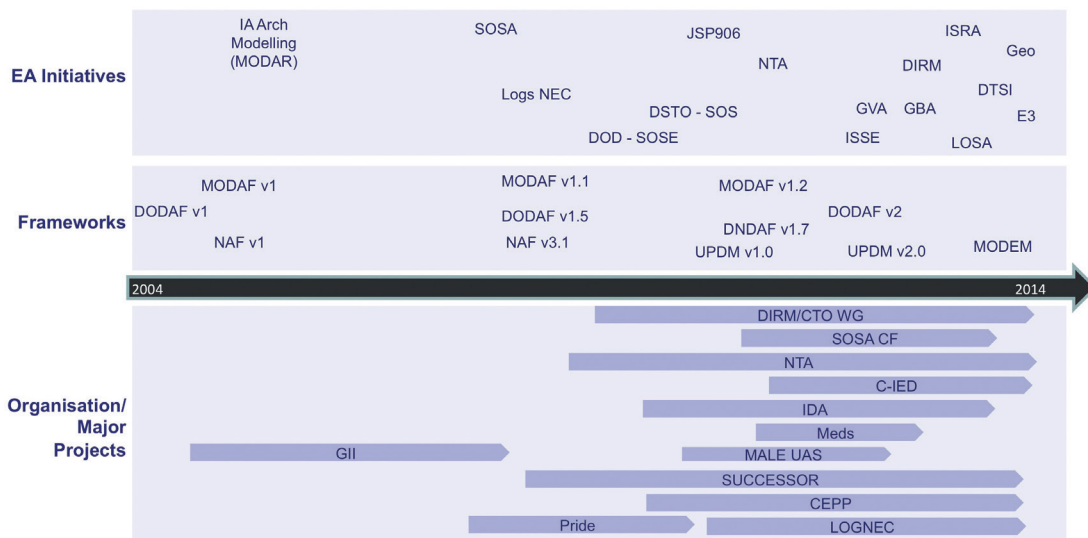


Figure 1: The Defence architecture journey over the past decade, showing: the range of Enterprise Architecture initiatives undertaken by MOD to support the use of architectures; the associated development of the key architecture frameworks; and, an example range of major projects or organisations that have been using architecture.

Despite this attitude, Defence continues to produce a wide range of architectures: some are high-level reference frameworks; others are the definitive description of a solution; yet others record the conduct of an experiment or describe the nature of a threat. There have been numerous dedicated activities to help develop, coordinate and align these architectures, which were promoted as the answer to delivering Network Enabled Capability

16 <https://www.gov.uk/mod-architecture-framework>

17 For example JSP906 Design Principles for Coherent Capability and the on-going initiative of MODEM (MODAF Ontological Data Exchange Model) continues to show a commitment for the use of MODAF.

18 The NATO Architecture Framework (NAF) and TRAK (originally commissioned by London Underground Limited) have their roots in MODAF.

(NEC), but they failed to meet initial promises for a number of key reasons¹⁹, namely:

- **Poor Value Proposition.** Senior decision makers or non-architects have not understood the value of Architecture, which is due to a combination of the practitioners not being able to clearly communicate this value nor being able to clearly demonstrate it – perhaps due to the typical lag between investment in architecture and when it delivers benefit in the lifecycle.
- **Architecture for architecture's sake.** The architecture activity was often focused on producing dedicated views to meet requirements for project Gate Submissions and this ended up being too little, too late to add real value and was therefore never maintained.
- **Products not owned or valued.** The conduct of the architecture activity was often detached from those who should have had a legitimate interest in it, so the outputs were commonly ignored by the real decision makers - architecture was 'done to them not with them'.
- **Poor understanding of architectural outputs.** Policy²⁰ was produced at the time, which stated the architecture views that were to be produced, rather than the questions to be addressed by architecture. This led to an industry of modellers that revelled in producing complex and detailed architectural products with no practical application.
- **Focus on modelling rather than architecting.** The focus of the activity was on the development of models (often of the 'as-is' system) rather than focusing on architecting as a creative decision making process, focussing on what needed to be improved and how that could be achieved.
- **Limited grasp of architectural concepts and use.** There were very few 'capable' practitioners, which led to a poor understanding of what architecture was there to do and how it should be done. This, along with little or no co-ordination across projects and domains, led to multiple approaches of varying maturity that often competed with each other.

In summary, the practical problem is that architecture is as much an art as a science; there are many types of architecture, many ways of describing them and it is easy to become lost in the detail and distracted by the resulting complexity. Useful principles, such as: 'architect for purpose', 'do just enough', and 'engage with the stakeholders early', are widely understood²¹ but unfortunately also widely ignored. Along with this lack of focus, the development of architectural models is often burdensome, with no immediate connection to 'value' as seen by senior decision makers. Not only is value difficult to articulate but for every good example of the use of architecture, there is at least one bad example where architecture has failed to deliver on its promises. While "architecture" is no longer a dirty word in Defence there is still considerable scepticism about its true value.

¹⁹ Architectures for Decision Makers, D Camm and D Evans, Integrated-EA 2012.

²⁰ For example JSP 602: 1012 - Information Interchange and The Enterprise Architecture Strategy – A sub-set of the MOD Information Strategy.

²¹ By the architecting community at large within Defence.

4. A smarter approach to architecting

4.1 Building on practical experiences and successes

Over the past decade Niteworks has been actively involved in helping MOD address a broad range of challenges, and has brought together the experiences of the partnership in a non-competitive environment including architectural practices. This experience (see Annex A for selected examples) has led to the development of a pragmatic architectural approach as a problem-solving tool, within a broader systems approach, across a wide range of projects. This experience and approach has been captured in a set of **principles** (see section 4.2) that underpins Niteworks' architecture work.

With these principles in mind, it is Niteworks' belief that any successful architecture effort starts with a meaningful dialogue between the customer of the architecture output and the architect. Each will bring a vital contribution to the debate, for example the customer as the problem owner will generally define the purpose and identify the level of change or impact required. The architect will propose an outline method or approach for tackling the problem by understanding what resources (enablers) are required and what elements of a solution already exist. There are several well-recognised methods and Niteworks draws on them all appropriately to define a set of broad **components** (see section 4.3) required for a successful architecting approach.

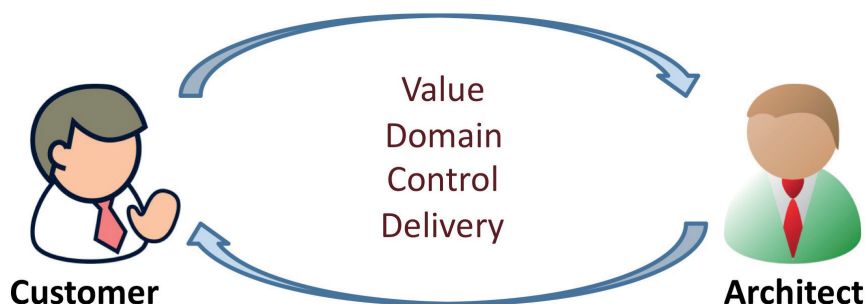


Figure 2: A meaningful dialogue between the customer and architect is vital to initiate any successful architecture.

However, these principles and components of an architecting approach do not necessarily lead to success; they need to be combined appropriately to suit particular situations. Neither do principles and components when considered alone help to coordinate or optimise the effort across the variety of architectures that are developed for an organisation. Through analysis of a wide variety of architecting approaches, used within Niteworks projects and beyond, Niteworks has observed that architecting approaches tend to fall into a range of categories. It is asserted that if the architect and, equally importantly, the customer are able to understand the category of architecting required for a particular problem then this gives strong guidance on how the architecture should be developed and governed. These categories of architecting are called *Architecting Styles*²².

22 D. Evans and M. Wilkinson, "UK MOD's 'perfect storm' and the need for Architectural Styles", NATO STO-MP-SCI-254 Symposium on Architecture Assessment for NEC, Tallin, Estonia, 2013.

4.2 Architecting Principles

The important insight from Niteworks' experience is that there is no 'one size fits all' for an architecture solution because each problem is described by a different fundamental structure – so that different architectural approaches are needed. Over the years Niteworks has embraced the many forms of architecture to underpin its delivery of a range of projects from: Operational Support; Capability Planning & Delivery; Visualising Complex Scenarios; Option Analysis; Solution Support; Integration & Coherency; and, Experimentation Management. This experience has helped identify a number of principles that focus on the value, means of control, problem scope and delivery methods of the architecting activity.

Principles for Successful Architecting

VALUE focused

- ▼ **PURPOSE.** Identify the purpose of the architecture through understanding what decisions or activities it will support.
- ▼ **OUTPUTS.** Develop outputs that can be owned and incorporated into the customer's decision-making process in order that real benefits can be realised.

CONTROL focused

- ▼ **GOVERNANCE.** Agree and regularly review a governance mechanism for changes and ownership of architectural "artefacts".
- ▼ **SCOPE and DETAIL.** Identify the scope and level of detail required to support the decisions, and only model what is needed.

SCOPE focused

- ▼ **USER INPUT.** Ensure stakeholder validation throughout and develop mechanisms to allow users to provide feedback both during development and post handover.
- ▼ **REFERENCE and REUSE.** Identify, gather and understand provenance of reference material early for reuse.

DELIVERY focused

- ▼ **PRESENTATION AND NAVIGATION.** Develop a means of presentation that provides a logical and navigable structure for the knowledge captured for the stakeholders.
- ▼ **VIEWS.** Develop ways of looking at the knowledge that allow users to be informed in their decision-making.

4.3 Making architecture work – key components of a successful approach

There are many views of what constitutes an architecting approach; foremost in many people’s mind is a framework for architecture descriptions (such as Zachman²³ or MODAF²⁴). However, with the growth of the discipline there is now a common recognition that a broader set of elements is required to make an approach usable and sustainable, such as that found in The Open Group Architecture Framework (TOGAF)²⁵. These frameworks are very much for the architect; there is very little guidance for the customer on how to commission the work or to understand what ‘good’ looks like. To support the application of TOGAF-like ideas by non-specialists in the Defence environment, a tailored set of approach components has been defined to aid the initial dialogue between the customer and architect. The components are broken down into those that help the customer articulate the problem context, and those that are brought together by the architect to develop an approach to resolve the problem. These components are illustrated below, along with example considerations for each.

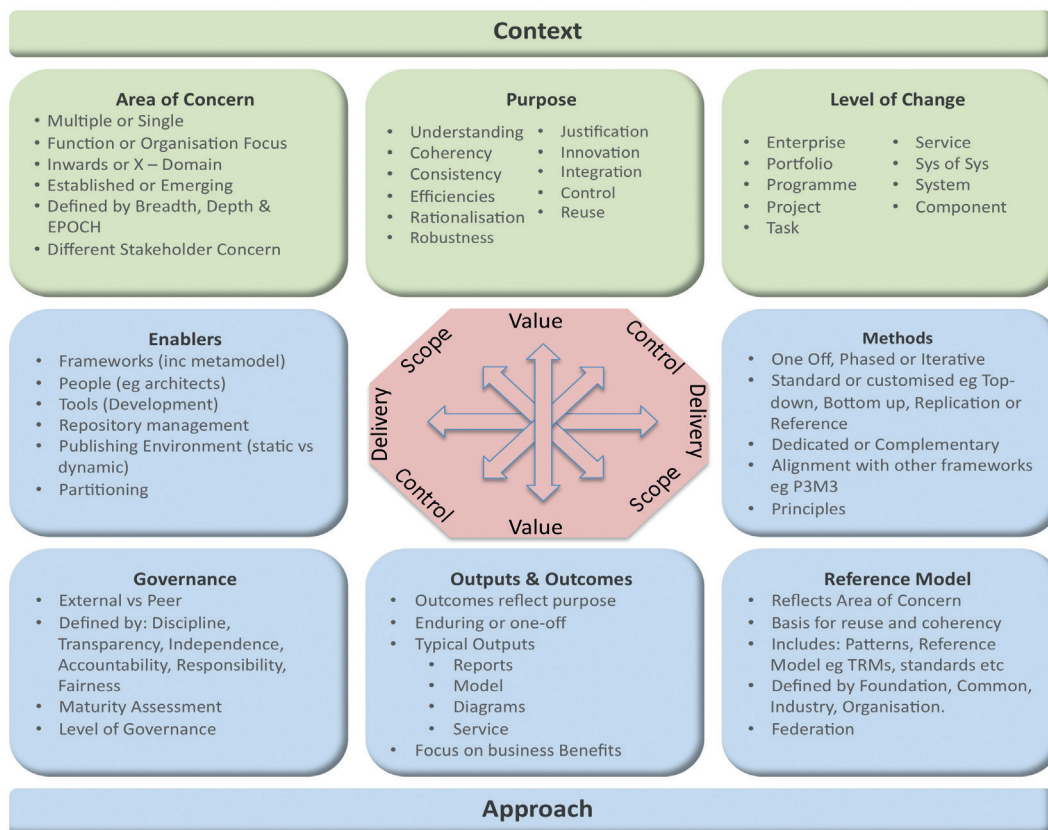


Figure 3: Components of a successful architecture approach and example considerations that build on wider best practice and the practical experiences of Niteworks.

23 John Zachman’s Concise Definition of the The Zachman Framework. 2008. Zachman International.

24 See <https://www.gov.uk/mod-architecture-framework>

25 The Open Group. TOGAF Version 9.1. G116. ISBN: 9789087536794. <http://www.opengroup.org/togaf/>

The most important thing is to determine the ‘purpose’ of the architecture, as this will dictate the content of the approach and delivery elements. This is an obvious statement to make, but is normally the cause for the majority of failed initiatives, in that they failed to fully understand the customer’s need or they did not clearly articulate that purpose to the wider enterprise. The context of the problem will drive the approach and there are a number of key relationships that should always be considered:

- **Value.** The *purpose* of the architecture will directly drive the shape and form of the *outputs and outcomes*²⁶;
- **Scope.** The *area of concern* will dictate what *Reference Models* or standards need to be considered and (re)used;
- **Control.** The *change mechanism* will identify the type of *governance* that needs to be applied and by whom;
- **Delivery.** There is a strong synergy between the selected *development method* and the *enablers*. This relationship will be influenced by each of the other components in turn as reflects the constraints of the approach, eg use of a corporate tool or framework.

These components are not discussed further as they are close to the ones well known in the architecting community but are summarised in the below table.

²⁶ The draft ISO/IEC 42030, Architecture Evaluation, deals with this relationship and how an architecture is evaluated against the stakeholder concerns.

Table 1: Summary of the components of an architectural approach and the key linking relationships of Value, Scope, Control and Delivery between them.

Context	Approach
The enterprise context is the environment within which the architecting approach must be effective.	There are many views of what constitutes an architecture approach. The following are the proposed key elements of an architecture approach, the corresponding TOGAF term is indicated where appropriate.
Purpose	Value Outputs & Outcomes
The problem space context for the architecture expressed as the problem the architecture is intended to solve. The architecture purpose must align with the overall objectives of the enterprise and stakeholder concerns. This is a key tenet of ISO 42010. Standards or Policy for single or multiple domain.	The approach will produce a number of outputs, which can take multiple forms, ranging from formal architecture views, reports, customised graphics to simple briefings. To ensure consistency, reuse and repeatability of these outputs a structural model for architectural content is needed which defines a set of views and the underlying data structure through a metamodel. Considerable time and effort can be consumed in the production of architecture outputs but if the desired outcome and benefit is considered first, the outputs can be suitably focused (cf TOGAF Architecture Content Framework).
Area of Concern	Scope Reference Models
The context for the architecture expressed as the stakeholder areas of concern. These aspects of context can be described in terms of System, Capability and Task/Function etc. The relationships between these elements, their levels of abstraction and the temporal state for each are key determinants of the architectural approach.	A Reference Model is a base on which the approach builds to ensure consistency and alignment with broader enterprise goals. In Defence this is normally in the form of Policy or Standards but a growing number of specific Reference Models exist, such as the DIRM ²⁷ and GVA ²⁸ . Consistency and alignment is achieved through reuse of language, taxonomies or common architecture building blocks; in essence this provides the provenance of the architecture work and in turn should be built upon for future work (cf TOGAF Reference Models).
Area of Concern	Control Governance
The change ‘wrapper’ for the architecture that is responsible for delivering its value. Examples include P3M (Project, Programme, Portfolio Management) using MSP ²⁹ , PRINCE ³⁰ or similar.	Architecture governance is how architectures are managed and controlled at an enterprise or domain level. No matter at what level within the enterprise or at what scale the architecture, it must come under a governance regime to ensure that its outputs can be held to account. By its nature, architecture does not occur in isolation and ensuring it fits within the broader enterprise (including temporally) is a key responsibility of the governance regime (cf TOGAF Architecture Capability Framework).
Development Methods	Delivery Enablers
This is the method for developing and managing the lifecycle of an architecture to meet the needs of the Defence Enterprise. (cf Architecture Development Method).	The required organisation structures, processes, roles and tools to successfully deliver value from the architecture approach. This may be instantiated as a one off activity for a fixed time period or as a sustainable organisational function (cf TOGAF Enterprise Continuum & Tools).

27 Defence Information Reference Model.

28 Generic Vehicle Architecture as part of the Land Open Systems Architecture.

29 <http://www.msp-officialsite.com>

30 <http://www.prince-officialsite.com>

4.4 Being smart about architectures – Architecting Styles

It is widely recognised that the development of an architecture approach is not straightforward and typically the development of an approach is limited by the expertise and experience of an individual architect. This results in varying degrees of success and a continual need to reinvent. To help architects and the customers who commission the use, and ultimately control, the funding for architecture outputs, a small number of standardised architecting styles have been proposed. These styles help to understand the approach that should be taken; set expectations on what can be achieved; clarify what is involved (eg in terms of costs, skills and governance); and, help to understand how value is delivered to the enterprise. The styles are driven by the purpose or reason for the architecture and reflect currently observed best practice. The four proposed styles of architecting³¹ (as illustrated in Figure 4) are:

- **Authoritative.** This style provides direction/policy to one or more domains to drive coherency, consistency, reuse and alignment with corporate objectives. The resultant architecture is an enduring reference source for other architecture activities and supports all phases of the enterprise life cycle. It requires constant management and strong governance to ensure it remains relevant and valid. A specialist team commonly enables this style with a wide remit for coherence or interoperability across the enterprise.
- **Directive.** This style plays a key role in the development, definition, design and implementation of new capabilities, areas of responsibilities, processes or systems within existing engineering practices and governance. It is applicable to all domains but is normally focused on a single domain or sub-domain that is planning for, or going through change. Depending on the domain this style will use relevant reference models, policies or standards along with a range of dedicated/specialist tooling.
- **Coordinative.** This style supports the co-ordination of change activities within a single domain or sub-domains by aggregation across lower levels; it is normally used at the Programme or Enterprise level. Governance is needed to ensure that the supplied Management Information (MI) is of suitable quality to support required decisions. The approach draws heavily on broader P3M practices and may be part of a Programme Support Office (PSO). Tooling is specialised with aggregated data being presented through dashboards or composite graphics to meet different decision makers' needs.
- **Supportive.** This is a focused style that supports key interventions or decision points across all levels of change and it can also be used as an initial activity to identify the need for change or explore an area of interest. It can function with limited governance (eg peer review) but must be held to account when supporting key decisions. This style is normally undertaken by a small team (or individual) of dedicated architects working as part of a wider multi discipline team; using best available tooling including standard office products.

31 D. Evans and M. Wilkinson, "UK MOD's 'perfect storm' and the need for Architectural Styles", NATO STO-MP-SCI-254 Symposium on Architecture Assessment for NEC, Tallin, Estonia, 2013.

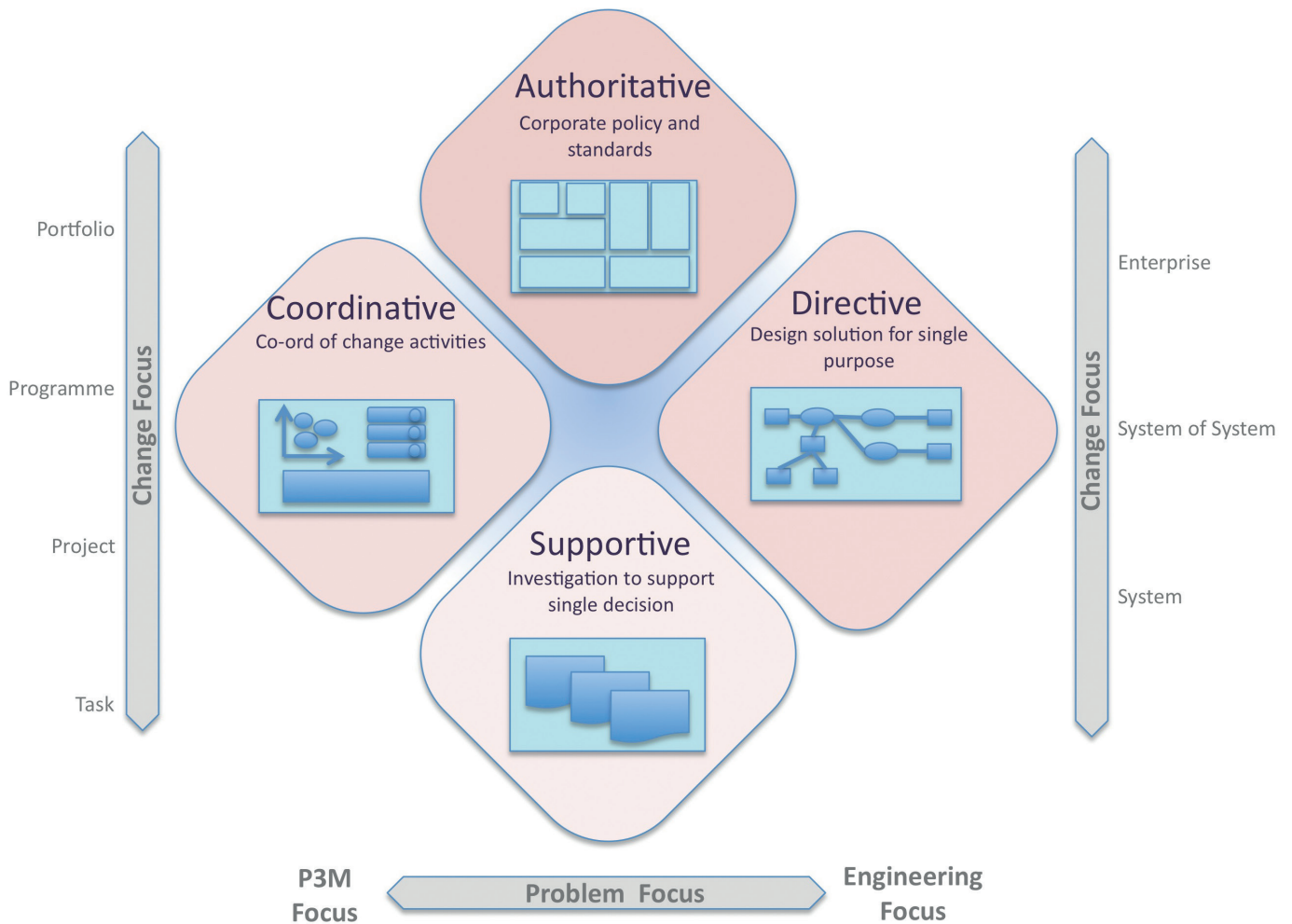


Figure 4: Architecting Styles help to understand the approach that should be taken; set expectations on what can be achieved; clarify what is involved; and, help to understand how value is delivered.

Looking at each component of an architecture approach separately provides a range of things to consider that will then need to be aligned to the other components to create an effective and achievable approach. The style helps to situate the context of the problem being faced and then identifies the typical elements of an approach that could be used to address that type of issue. Simply choosing a style first helps to develop an approach by drawing on the experiences of previous work and communicate what the enterprise is trying to achieve and how. Typical considerations per component of the approach are included in Annex B for each style; it is suggested that these crib-sheets can be used to reinforce the type of architecture that is being developed and to ensure that the approach is both appropriate and complete. Additionally a number of Frequently Asked Questions on Architecting Styles is included in Annex C, to provide further clarity.

4.5 A pragmatic approach to applying styles

There are no hard and fast rules for the application of architectures and it falls to the experience of the architect to develop the most appropriate approach. The trouble is that architecture by its nature is complex and at first glance is indecipherable by the uninitiated; unfortunately these are often the same people who sponsor or support the work. Even for those immersed in the subject, opinions will regularly differ on the best approach and, importantly, where to start. An agreement on which style is being applied is a starting point but anybody that has practical experience will soon point out that there are complex dependencies between each of the components and some of these dependencies will not become apparent until well into the work. This is where the experience of the architect becomes invaluable – nevertheless a structure that is easily understood by the customer is needed to ensure the approach is justified and supported.

Along with the experience of the architect, strong leadership is essential if any architecture initiative is going to succeed. A clear connection between effort and value is often missing, as significant time is normally required to see the eventual benefits of good architecture, which has normally been done ‘up-front’. Thus, leadership also requires resilience to adapt the approach if the first or subsequent iterations fail to deliver the desired outcome.

There is no simple mapping of a single style to a single role or problem; in fact it is more realistic that an approach will need to adopt elements from a number of styles through the life of the architecture to meet different concerns. For example at the start of a programme a supportive style might be adopted to help shape a programme and establish boundaries. Once established, a directive style might be adopted by the component projects as they look to deliver specific solutions, while the programme office looks to adopt an authoritative style to ensure basic coherence of these solutions. Once the programme is in full delivery the programme office could also adopt a coordinative style to harmonize a complex range of delivery activities. Throughout the life of the programme a supportive style could be repeatedly called on, to deal with specific decision points or risks. In all cases the architecture approach must be ‘just enough’ as well being adaptable to changing needs and the organisation’s architectural maturity.

Each of these styles has its own characteristics, which helps to understand what is trying to be achieved and what the style is useful for and what is involved in using it; so helping to set the expectations and understanding of both the customer and architect. Looking at a number of examples of architecture initiatives across Defence³² there are noticeable differences, for example: the formality or rigour of the approach; the depth of analysis required, and; the currency of the outputs. From Niteworks’ experience the following characteristics of an architectural approach have been identified to further help distinguish the styles and help the customer and architect in developing the approach³³:

32 Chief Information Office Architecture Landscape QuickLook. Mulvey and Tomlinson. Niteworks. November 2012.

33 D. Evans and M. Wilkinson, “UK MOD’s ‘perfect storm’ and the need for Architectural Styles”, NATO STO-MP-SCI-254 Symposium on Architecture Assessment for NEC, Tallin, Estonia, 2013.

- **Formality**, the degree of rigour or ceremony with which an architecture is verified, validated and endorsed. Authoritative and Directive architectures have a high level of formality associated with them.
- **Persistence**, the extent to which the architecture is needed to endure over time.
- **Granularity**, the level of detail that the architecture needs to achieve its stated purpose.
- **Utility**, the breadth of use, the number of different ways the architecture will be used or the number of projects it is relevant to.
- **Effort**, this tends to be a function of Persistence, Granularity and Utility, it is an index of how much effort should be put into developing an architecture.

The following table is a comparison of the styles and reinforces the notion that ‘one size doesn’t fit all’ when it comes to architecture.

Table 2: Characteristics of the four Architecting Styles, showing the different considerations when developing an architecture approach.

Style	Formality	Persistence	Granularity (detail)	Utility	Effort
Authoritative	Strong governance - aligned to enterprise objectives	Enduring - similar to enterprise development	Either high level (breadth) or focused detail (depth) but unlikely to be both	Single purpose	Reasonable Effort needed to develop, maintain and communicate
Directive	Strong governance - aligned with established SE practices	Similar to life of Programme or project	Level of detail similar breadth or depth of programme or project	Limited purposes	Considerable effort to develop and maintain
Coordinative	Selective governance - focus on validity of source MI	Valid for duration of source MI	Aggregated information from projects	Multiple purpose	Reasonable effort to support decision makers
Supportive	Review to ensure validity of recommendations	Focused on specific intervention points with limited reuse	Limited detail focused on single decision	Limited or single purposes	Focused effort to support a defined decision point

4.6 Implications of Styles

So far the discussion has only considered a single dialogue between a customer and an architect, however across Defence there are numerous discussions at all levels of the enterprise and on a range of subjects. Simply applying a structure to these conversations should help to deliver more worthwhile architecture initiatives but it is not necessarily optimal. As each dialogue and resulting architecture is about the Defence Enterprise, in theory there should be some degree of coherency across each of them and in turn the potential for reuse.

In this simple concept of federation, however, it is inevitable that there will be multiple (and often conflicting) purposes often resulting in a variety of styles of architecture that could be joined together. Such a federated architecture is problematic because the artefacts will be developed with differing levels of governance, granularity, persistence, etc, making it impossible to assure the architecture as a whole. By considering what style of architecting is being applied, Defence can start to understand how different initiatives should relate (if at all) through providing a common reference point between different architects or architecture teams.

Importantly for Defence, by understanding the styles of architecting that are needed and where they apply, it can start to understand where federation is worthwhile and what common components of an approach are needed (and so which are missing) in order to enable a smarter tailored set of approaches. For example this consideration should help to:

- Identify the most appropriate Governance mechanism by aligning with existing constructs through the Defence Operating Model. Importantly, understanding what needs strong governance and what can operate more freely.
- Identify what are the required Key Reference Architectures across Defence and how they are controlled, maintained and (physically or logically) federated.
- Engage with industry to better articulate the requirement for architectural support.
- Tailor different approaches and supporting tools to meet specific problems that are relevant for architectures to address and in doing so share common practices.
- Set retention policies for architecture models to support reuse and manage the maintenance overhead.

5. Architecting styles across the Defence Operating Model

5.1 Defence Operating Model

There is a range of architectures produced in the Defence Enterprise³⁴ for a wide range of reasons. For example, the figure below is a representation of the Defence Operating model³⁵ overlaid with typical problems that architectures should be able to address, along with the type of style, which is the most appropriate.

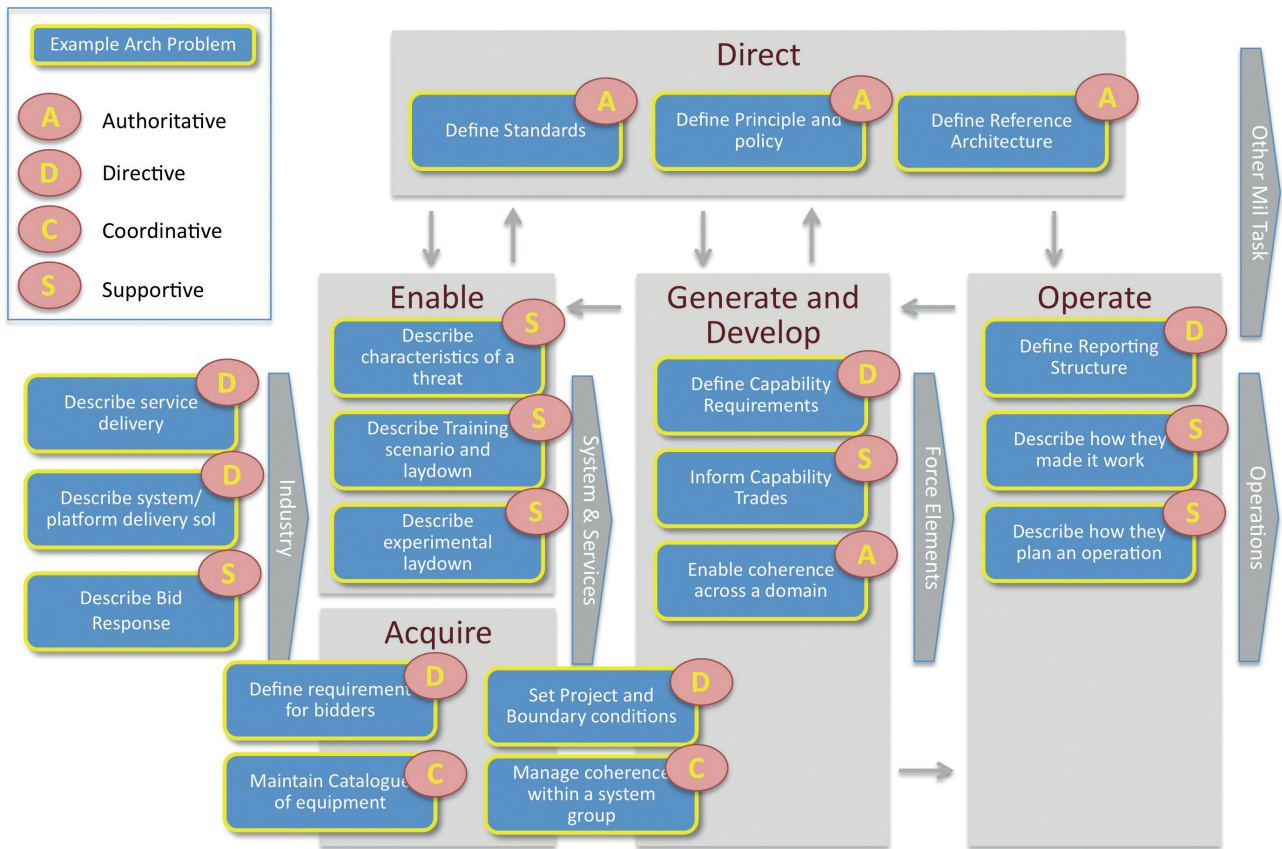


Figure 5: Example architecture problems across the Defence Operating Model and the type of architecting style that could be used to resolve them.

This is not an exhaustive list of problems but shows that firstly architecture has a place across the whole of Defence and secondly a mix of styles is needed. By considering each style across the Defence Operating Model: common practices and enablers can be established; a tighter focussing of limited resources onto problems that cross cut Defence can be achieved; and, a better understanding can be gained of how different architecture initiatives relate and the level of interaction that is needed.

³⁴ Chief Information Office Architecture Landscape QuickLook. Mulvey and Tomlinson. Niteworks. November 2012.

³⁵ The New Operating Model - How Defence Works. Version 3.0: December 2012.

The above understates the number of supportive architectures, which are believed to be the most prolific type. In practice there are many architecture initiatives across Defence from well-recognised and established teams to ad hoc one-offs with little or no governance/formality. All are valid uses of architecture and if conducted appropriately will deliver value. However with this range of initiatives, it becomes difficult to unpick what the holistic values of such initiatives are and conversely to know when to stop. For example, in Niteworks the term ‘disposable’ architecture is often used to indicate that once the work is complete and the architecture has met its purpose it is then archived and not maintained. It is not unusual that architecture initiatives misunderstand their place in the Enterprise and either fail to understand when to stop or if they should be maintained (and by whom).

Consideration of the type of style of the architecture initiative will help situate all these activities and in doing so enable the correct ‘wrapper’ of control, domain and delivery to ensure they maximise their value to the Defence Enterprise (and conversely minimise distribution and resource). The following considers each style and how this is applicable to Defence.

5.2 Implication of Architecting Styles for Defence

5.2.1 Authoritative Architectures in Defence

The number of reference architectures developed by an Authoritative Style should be limited across Defence to ease development, co-ordination and usage. In turn they should be well publicised, controlled, maintained and used as a reference for all other architecture initiatives. (The development of these reference architectures could be developed jointly between MOD and industry using a common approach.) They should also have a clear understanding of how they relate (federate) with similar authoritative architectures. Thus they should have a clear role (mandated) in the Defence Operating Model with well-established boundaries. Importantly they should have senior ownership and established governance.

Examples:

- Defence Information Reference Model (DIRM);
- Land Open System Architecture (LOSA).

Key Enablers:

- Clear senior responsibility for ownership, maintenance and usage of a closely aligned set of Defence Reference Architectures that support the Defence Operating Model;
- An Architecting community of practice, which covers all domains and acts as a focus for the development, sharing, reuse and co-ordination of best practice;
- A mechanism to ‘open’ Reference Architectures to industry so encouraging co-development while protecting commercial interests;
- A means to publish, configure and consult on Reference Architectures with the Defence Enterprise at large, ie across MOD, industry and academia.

5.2.2 Directive Architectures in Defence

This style will be aligned with established Programmes, Projects and Change Initiatives to help define and align (capability) needs and solutions. Typically this will be in a supporting role to the established requirements management (or Systems Engineering) process³⁶; to drive coherency of Capability Requirements to User Requirements, System Requirements³⁷ and Solution Components. For certain domains, such as Information and Communications Technology (ICT), the architecture may take a more prominent role and be a key enabler to drive agility through a Continuous Capability Evolution³⁸ approach. For larger initiatives it would be expected that the role of architecture would be defined within the System Engineering Management Plan (SEMP). The approach should reuse and align with the established Defence Reference Architectures but fall under the established governance of the related Programme, Project or Change Initiative. Typically the approach should call on established methods and tools, which should be standardised across Defence, and be developed by an integrated team.

Examples:

- Defence Core Network Services Architecture Reference Model;
- Le TAC CIS Programme Architecture;
- Fixed and Deployed Technical Architecture issued by the Network Technical Authority.

Key Enablers:

- Suitably qualified and experienced Architects who are drawn from both government and industry, who can act as a catalyst to support a more robust approach to architecture across Defence;
- A set of methods that focus on typical Directive architecture purposes to drive consistency and capture existing best practice, for example methods to support requirements development and solution architectures;
- An agreed architecture approach embedded as part of the programme or project documentation, eg within the SEMF;
- Continued usage and investment into MODAF³⁹;
- A set of well bounded Defence Reference Architectures that drive commonality and reuse, and which industry is encouraged to invest in alongside the MOD;
- An architecture library or catalogue that enables the identification of previous work to increase reuse and drive coherence;
- Ongoing training and development of MOD's Architects (as opposed to modellers) that draws on wider industry practices and experiences.

5.2.3 Coordinative Architectures in Defence

Coordinative architectures are typified by the need to draw on 'real' data to present the progress or state of an initiative or organisation's architecture. For example an output

³⁶ These processes are through life from conception to disposal.

³⁷ Including Information Exchange Requirements (IERS).

³⁸ Continuous Capability Evolution – A Practical Approach to the Acquisition of Modern Defence Capabilities, Mike Wilkinson, Niteworks White Paper, February 2014.

³⁹ Including support for the Unified Profile for DoDAF/MODAF (UPDM).

of this type of work could be a Dash Board reporting on established Key Performance Indicators (KPIs) or a Technology Roadmap. In Defence this type of approach has value across the whole operating model but would normally report at the management layer. The feed of 'real' data can be live or manually incorporated, but it must be done regularly for as long as the reporting is needed. For example, this approach can be used to report on the current state of Capability, Operational Effectiveness, Service Levels, etc, and would be required to enable monitoring of delivered capability/operational effectiveness to drive a Continuous Capability Evolution⁴⁰ approach. Key to this approach is ensuring strong Information Management and the need for specialist tooling and developers.

Examples:

- Counter Improvised Explosive Devices (C-IED) Knowledge Base;
- High-level ISTAR Architecture (HIRA) for Capability Planning;
- Enterprise Technology Roadmaps.

Key Enablers:

- Continued development of Data models and definitions⁴¹;
- Ability to leverage emerging tools and techniques from wider industry onto the Defence Network to take advantage of emerging technologies and practices;
- The interfaces to MOD's corporate databases to be 'opened up' to enable easier access to generate specific Dashboards that are driven by bespoke needs across the whole business;
- A set of methods that focus on typical Coordinative architecture purposes that will drive consistency and capture existing best practice, for example road-mapping.

5.2.4 Supportive Architectures in Defence

Supportive architectures are developed throughout Defence to support specific decisions and can take many forms, from formal large-scale MODAF architectures to one-off PowerPoint views. However, all are about supporting a single decision point. After this decision is made the work can be archived and there is no need to maintain it. In some cases, when the decision needs to be re-addressed, eg annually, the architect may look to maintain the architecture in the interim to enable a more rapid response next time. Importantly the control and review of the architecture is local or peer-reviewed so from a corporate perspective these initiatives can be self-governing. However guidance on commonly used techniques would be valuable and a means to share best practice is needed.

Examples:

- Capability Audits or Investigation;
- Interoperability Investigations.

40 Continuous Capability Evolution – A Practical Approach to the Acquisition of Modern Defence Capabilities, Mike Wilkinson, Niteworks White Paper, June 2014.

41 For example the Defence Reference Data Architecture as part of Box 6 of the DIRM.

Key Enablers:

- An architecture library or catalogue that enables the identification of previous work to increase reuse and drive coherence;
- Raised awareness of architecting styles to ensure it is understood that a Supportive Approach can be used in a 'light-touch' manner and does not necessarily need the overheads of the other styles, so encouraging uptake.

5.3 MOD Chief Technology Officer (CTO) Architecture Approach

In developing this White Paper, the concepts have been shared with MOD CTO who is responsible for the development of the DIRM, which aims to drive coherency and ensure alignment of the Defence C4ISR ICT estate. However there is a wider need to understand, co-ordinate and assure the range of architecture activities that fall within his remit. To date this has been difficult due to the variety of initiatives with diverse purposes. Overlaying the concepts of styles has helped to categorise different activities to understand how they relate and what 'wrappers' need to be applied or provided by the CTO. Table 3 is a summary of this discussion and outlines how each element of an architecture approach can be tailored by considering each style to support ICT for C4ISR.

5.4 Wider Application: INCOSE UK Architecture Working Group

In addition to the CTO, the concept of architecting styles has been shared with the International Council on Systems Engineering (INCOSE) UK Chapter Architecture Working Group and work is in hand to include the idea of styles in emerging industry wide guidance - The Practice of System Architecture: A UK Perspective. The concepts have also been taken forward into INCOSE's international architecture forum.

Table 3: Example application of architecture styles to support the development of the CTO Architecture Approach for ICT within the C4ISR domain.

		CTO Architecture Approach (proposed)			
		Style			
		Authoritative	Directive	Coordinative	Supportive
Value	Purpose	To develop, maintain, operate and govern the single Defence Information Reference Model to enable cohere ICT in Defence.	To evolve, operate and govern the defence ICT architecture estate through the development of compliant ICT Solutions or Propositions.	To monitor and report on the defence ICT architecture estate to drive ICT Alignment.	Ad hoc or repeatable activities that are use to investigate specific or potential issues within the defence ICT architecture estate
	Output/ Outcome	Output: • DIRM • Patterns (assured) Outcomes: • Info Coherence	Output: • Solution High-level Design/Arch • Proposition High-level Design/Arch • URD/SRD • (Arch Models) Outcomes: • Solution Compliance	Output: • Capability Assessment (management) • Roadmaps (tech and product) Outcomes: • ICT Alignment	Output: • Capability Audits (one off) • Proposition HL Design/ Arch • Patterns (un-assured) • Report • (Arch Models) Outcomes: • Info Coherence
Scope	Area of Concern	• ICT for C4ISR	• Defined by Programme or Project • Within or Cross cutting ICT for C4ISR	• Programme or Project (C4ISR)	• Adhoc • Includes ICT for C4ISR
	Reference Model	• Defence Policy (MODIS etc) • X Government Stan/Policy • NATO Stan/Policy	• DIRM (inc Policy and Standards) • Domain Specific (non ICT) • Arch Library (reuse)	• DIRM (inc language, DAR) • Arch Library (reuse) • X Gov or Ind Tech Ref Models	• As applicable (by scope) • DIRM (inc language) • Arch Library (reuse)
Control	Level of Change	• C4ISR	• Programme or Project • Front Line Commands	• C4ISR (through CTO/NTA)	• As appropriate (inc Programme, Projects, TLB's, FLCs, R&D)
	Governance	• DAfC4ISR • CIO (accountable) • CTO (responsible)	• DAfC4ISR (strategy) • CIO/CTO (URD) • NCA (SRD) • NTA (Solution & Proposition HL Design/ Arch) • NOA (Operation) • Scrutiny	• DAfC4ISR (Capability) • CTO • NTA	• Local or peer review of output • Outputs feed established process • NTA Front Door
Delivery	Methods	• DIRM Development Method	• CTO Arch Approach • Methods • Solution Architectures • Proposition Arch • Baseline Arch • Model Driven Req	• CTO Arch Approach • Methods • Road Mapping • Capability Assessment Strategy	• CTO Arch Approach • Methods or ad hoc • Capability Audits Assessment
	Enablers	• DIRM (language, metamodel) • MODEM • MOOD and MS Share Point • Arch Community of Practice	• MODAF • DART • Tools (as appropriate) • Notation (eg IDEF, SysML, RIVA) • Skills Matrix • Advice and Support • Arch Library(reuse) • Hosting/Collaboration Environment • Arch Community of Practice	• Tools (as appropriate) • Skills Matrix • Advice and Support • Arch Community of Practice • Industry Community of Practice (eg NTA Industry Advisory Group)	• As appropriate but can include; • MODAF or bespoke • Various Tools (inc MS Office and specialist tools)

6. Conclusions and Recommendations

6.1 Conclusions

It is clear that the MOD is facing a range of transformation challenges and Niteworks believes architecture is a fundamental success factor for both change and ‘business as usual’ activities across the whole defence enterprise. Drawing on best practice from a variety of Niteworks projects, a practical approach to classifying and developing architectures – Architecting Styles – has been proposed and the following conclusions have been made:

- **The value of architecture.** The use of architecture within MOD and Defence at large has a chequered history, with some notable success but many initiatives registering a poor return on investment.
- **Leadership Commitment.** The level of commitment by senior decision makers in the use of the discipline is patchy, which is due to the poorly understood connection of effort and value in the life cycle.
- **Architecting is Complex.** In skilled hands architecting can be effective and valuable, but unfortunately in unskilled hands it can increase the perceived degrees of complexity and become a blocker to change.
- **Recognition of the architect.** The success of an approach is limited by the expertise and experience of the architect, which results in varying degrees of success and a continual need to reinvent.
- **Many types of architecture.** There is a need to conduct a variety of architecting activities across the whole Defence Operating Model. All are valid uses of architecture and, if conducted appropriately, will deliver value.
- **Lack of Guidance.** There is very little guidance for commissioners and practitioners but importantly there is no ‘one size fits all’ so that different approaches are needed.
- **Ability to Change.** There is often a lack of collective experience sufficient to adapt the approach if: the first or subsequent iterations fail to deliver the desired outcome; or, the circumstances or architectural context changes.
- **Use of Architecting Styles in Defence.** A standardised set of architectural styles, distilled from best practice and employing consistent terminology, can be used as the mechanisms of choice to address specific problems in capability management and acquisition. The four styles of architecting are: Authoritative, Directive, Coordinative and Supportive.
- **Smarter about architecture.** By considering the use of each style across the Defence Operating Model then common practices and enablers can be established which will help focus limited resources to areas of biggest return.

6.2 Recommendations

Niteworks recommends that MOD adopts the use of Authoritative, Directive, Coordinative and Supportive Architecting Styles to ensure the range of architecting initiatives consistently delivers value, through:

- MOD Chief Technology Officer (CTO), as the head of Head of Discipline for Enterprise Architects within the IT Profession, becoming the champion of Architecting Styles for general adoption within Defence;
- Developing practical guidance for both the ‘customer’ and ‘architect’ that is focused on meeting the gaps in expertise across Defence.

It is further recommended that to improve the effectiveness of architecting across the Defence Operating Model that the key enablers (as highlighted in this paper) are established. These include:

- A coherent set of Defence Reference Architectures, with senior ownership, that support the Defence Operating Model;
- The need for industry to be encouraged to invest in common Reference Architectures alongside the MOD, to ensure coherency through the Defence Enterprise;
- An Architecting community of practice, which covers all domains and acts as a focus for the development, sharing, reuse and co-ordination of best practice;
- A means to publish, configure and consult on Reference Architectures with the Defence Enterprise that is open to MOD, industry and academia;
- The secondment of suitably qualified and experienced Architects from wider government and industry, who can act as a catalyst to transform the approach to architecture across MOD;
- Guidance within the Acquisition Operating Framework, to ensure the architecture approach is embedded, managed and assured as part of existing programme or project documentation, for example within the SEMP or PMP;
- Ongoing training and development of MOD’s Architects (as opposed to modellers) that draws on wider industry practices and experiences, and includes a proven value case for architecture to support engagement with senior decision maker.

Annex A

Examples of Successful Architecting by Niteworks

Training Transformation (Authoritative)

MOD has a training vision of a modern and affordable 21st century training capability exploiting legacy and emerging technology to deliver individual, team and collective training in a joint and coalition environment for current and contingent operations

To help demonstrate how this vision could be achieved, a Training Transformation (TT) Programme consisting of three systems projects and a Core Capability Concept Demonstrator (CCD) project were undertaken. The Core CCD project was established to provide a common Core Reference Architecture for the system projects to follow, together with guidance on the technical direction and standards for the overall programme moving forward. A key element was to demonstrate that off-the-shelf products (including gaming technology) can deliver cost effective training through:

- Establishing user confidence in relevant software and devices;
- The use of modular systems with open interfaces as part of an underpinning architecture approach to simulation and training.

The chosen architectural approach for the Core Reference Architecture was Service Orientated Architecture (SOA) that was developed through engagement with a range of stakeholders by the core project. Then the system projects were tasked with implementing a SOA in order to uncover limitations and constraints when applying the Core Reference Architecture in a specific domain.

The reference architecture was developed using a common set of principles to enable the architecture requirements to be achieved and ultimately the business objectives of the enterprise to be realised. This approach enables traceability from architecture product through to requirement and upwards to business objectives.

Command, Staff and Tactical Training Exercises Operation HERRICK (Directive)

Since Operation (Op) HERRICK 14 (H14) Niteworks has conducted a series of Training Capability Concept Demonstrators (CCDs) to help deliver collective training involving the new Command, Control, Communications, Computers, and Intelligence (C4I) and Surveillance and Target Acquisition (STA) systems introduced under Urgent Operational Requirements (UOR). In preparation for Op HERRICK 18 Niteworks conducted a Command, Staff and Tactical Training Group (CSTTG) Training exercise for 1 Mechanised Brigade (1 Mech Bde).

This used a synthetic environment, which built on knowledge and experience from

previous work and was based upon the VBS2 product but also looked to integrate other software to meet the overall requirements of the exercise. As part of the planning phase a design for the exercise was developed that was driven by an architectural approach to produce: a conceptual design; deployment plans; logical interactions (interfaces); and, physical laydown. This involved a number of domain and technology experts along with a range of specialist architecture tools. These designs were then used in the delivery of an infrastructure and the ultimately the delivery of training to 1 Mech Bde before their deployment to Afghanistan.

High-level ISTAR Reference Architecture (Coordinative)

The UK's Intelligence, Surveillance, Target Acquisition and Reconnaissance (ISTAR) and Information Operations (IO) capabilities are delivered by a complex collection of systems, platforms, processes, organisations and people, operating together across Defence, Other Government Departments (OGDs) and Allies. The ISTAR Design Architect (IDA) team had the task of assisting the staff involved in capability planning, delivery and generation of the ISTAR & IO capability. The IDA sought to identify gaps, overlaps, shortfalls, redundancy and project inter-dependencies in the portfolio in order to support the development of a coherent, affordable and viable Capability Management Plan. The IDA recognised the need to adopt a robust engineering discipline (ie underpinned by architecture and process) that would instil efficiency and effectiveness in order to support the design, production and operation of ISTAR & IO capabilities; hence, an architectural approach was adopted.

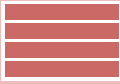




This was developed in a phased approach to produce guidance and tools offering a 'bureau service' to support key stakeholder decision-making across ISTAR & IO capability planning, delivery and generation. This was achieved by developing a common language and a set of building blocks from which decision makers could develop specific models that met their questions/concerns. A component of the solution was the development of semi-automated project summary sheets that enabled side-by-side comparison of projects by drawing together capability, risk, interdependencies and milestones through the use of the established common language and building blocks.

Through this approach savings of the order of £83⁴² Million were identified through service rationalisation with negligible impact on capability.

42 Embedding Architecture in the Enterprise, Wg Cdr Alex Hicks – Cap ISTAR DPD Lead Planner, Luke Tucker Niteworks, Integrated-EA 2012.

Annex B
Architecting Styles Crib Sheets

Authoritative Style of Architecting Crib-sheet	
This style provides direction/policy to one or more domains to drive coherency, consistency, reuse and alignment with corporate objectives. The resultant architecture is an enduring reference source for other architecture activities and supports all phases of the enterprise life cycle. It requires constant management and strong governance to ensure it remains relevant and valid. A specialist team commonly enables this style with a wide remit for coherence or interoperability across the enterprise.	
Context	Approach
Purpose	Outputs & Outcomes
<ul style="list-style-type: none"> Define/support standards or policies for a single or multiple domains to ensure coherency, consistency, 'best-for the enterprise approaches are adopted Provide a common language for the Enterprise A means to assure the compliance to standards or polices Typically wanting to reflect existing best practice, relate wider concepts, develop common structures and contain patterns for reuse An enduring need that supports both change and business as usual 	<ul style="list-style-type: none"> Standards or polices (or contribution to) Reference Architectures that are accessible by other initiatives Patterns, taxonomies, definitions Outcome - coherency, consistency, reuse, assurance and/or alignment of chosen Area of Concern Outputs are well structured and easily accessible Forms part of the corporate language and hence enduring Normally published on corporate intranet or more widely on the internet
Area of Concern	Reference Model
<ul style="list-style-type: none"> Normally applicable to an established domain, environment, or organisation to reflect best/common practice, eg SOSA Domains or by single DLOD Need to address multiple stakeholder concerns Can cover strategic, business, systems, information and technology perspectives Breadth is normally priority over depth Primary focus is inwards once established 	<ul style="list-style-type: none"> Will have connections to wider best practice/sources outside of the enterprise eg OMG, OGDs, NATO etc Can be recursive, ie a reference architecture can contain other reference architectures Initial development draws on existing artefacts to reflect best practice
Level of Change	Governance
<ul style="list-style-type: none"> Typically at the enterprise level to drive a coherent SoS approach Reflects established business practices rather than acting as a starting point for change Requires senior management ownership to succeed Leadership (architectural) key to gaining buy-in in disparate groups Aligns, or in turn drives, corporate governance 	<ul style="list-style-type: none"> Requires strong governance to ensure it remains relevant and valid to the enterprise Softer skills needed to communicate value and utility to achieve traction/use Aligns to corporate structures Ongoing assessment of applicability and value
Development Methods	Environment & Enablers
<ul style="list-style-type: none"> Continuous activity to refine and maintain artefacts Published on a regular basis, eg www or company intranet Draws heavily on existing best practices Draw on techniques in developing patterns and taxonomies (ontologies) Underpinned by corporate principles Development is transparent with strong emphasis on communication (selling) of concepts Key to success is ensuring stakeholder are bought into the concept through strong communications 	<ul style="list-style-type: none"> Supported by a team with a wide remit for coherence or interoperability across the enterprise Requires corporate hosting/sharing environment Uses endorsed/recommended frameworks ie MODAF Requires experience architects to ensure usability across multiple domain Varied tools can be used depending on scope and hosting environment Commonly utilise 'community of practice' to support development

Authoritative Style of Architecting Crib-sheet			
Characteristics:			
Formality: 	Typified by strong formality in the way it's applied and controlled to ensure the outputs are fit for purpose.	Utility: 	Normally has a single or limited purpose but is critical to drive coherence/ alignment.
Persistence: 	Outputs are enduring in nature and so is team/effort to maintain/ upkeep (but may flex).	Effort: 	Initial development effort limited as draws on existing best practice but will require considerable co-ordination.
Granularity: 	Breadth is the norm to provide common language across domain(s). Depth is added through application in given domains.		Enduring effort is required but can be limited to maintain and evolve outputs through coordination with users/ business.

Example Use case:

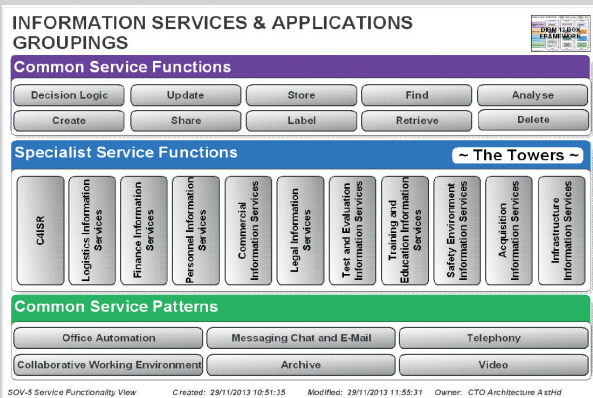
A CIO of a global organization wishes to drive reuse of core solutions across a number of disparate Business Units without overly constraining local operations and innovation. The initial issue is being able to understand and compare existing solutions across the different Business Units to enable the identification of common solutions and best practice. A reference architecture is chosen to provide the basis for a common language to enable solutions to be recognized at the corporate level and to enable the starting point for comparison. The CIO uses an experienced architect, familiar with the business and wider industry, to develop a simple taxonomy of solutions by engaging with each business unit to both reflect current and future solutions. A large part of the initial activity is to sell the vision of the CIO and the need to drive reuse. Once complete the reference architecture is published on the CIO website and is owned and maintained by the corporate IS board chaired by the CIO.

Examples in Defence:

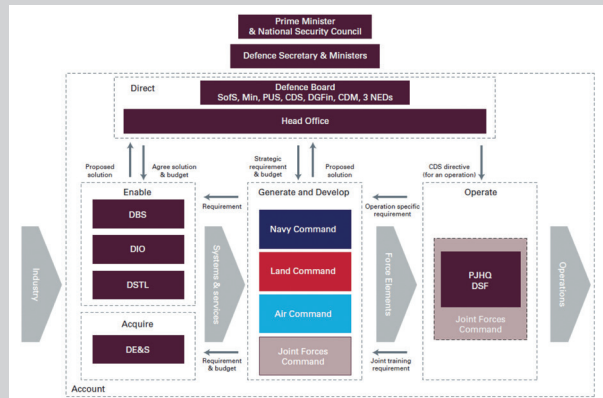
Defence Information Reference Model (DIRM), Land Open Systems Architecture (LOSA) including Generic Vehicle Architecture (GVA) and Generic Base Architecture (GBA).

Example Visualisation:

Note all views and viewpoints are valid for each style and those below are purely illustrative of the type that could be expected to be produced.








Source: DIRM Box 8, CTO.



Source: The New Operating Model, How Defence Works, Version 3.0: December 2012.

Directive Style of Architecting Crib-sheet	
This style plays a key role in the development, definition, design and implementation of new capabilities, areas of responsibilities, processes or systems within existing engineering practices and governance. It is applicable to all domains but is normally focused on a single domain or sub-domain that is planning for, or going through change. Depending on the domain this style will use relevant reference models, policies or standards along with a range of dedicated/specialist tooling.	
Context	Approach
Purpose	Outputs & Outcomes
<ul style="list-style-type: none"> • Development, design or implementation of a new (or changes to an existing) capability, process or system • Includes understanding of the baseline (to support planning for change) • Focus is on delivering change to the enterprise (or element of) • Ensuring that the system solution is justified by the Business Need • Identification, development and justification of options for change 	<ul style="list-style-type: none"> • Configured artefacts that reflect the engineering process/need of the project • For example outputs could include: ‘as is’ and ‘target’ architecture; high-level design, transition plan; design schematics; user/sys requirements; solution options etc. • Ensure solutions are compliant with the System of Systems solution (as defined in reference arch.) • Needs a clear handover between customer and supplier • Basis of acceptance into service
Area of Concern	Reference Model
<ul style="list-style-type: none"> • Focus on a single domain or x-domain • Typically focused on supporting a phase(or phases) of the programme/solution life cycle • Aligns with established or emerging business/commercial boundaries • Cognisant of legacy solutions and need to integrate with or replace them 	<ul style="list-style-type: none"> • Depending on domain, will use relevant reference models or standards • Strong reuse of organisation’s and industry best practice • Customer needs to avoid risk of preventing innovation by supplier • Outputs may in turn be feed back into existing reference models
Change	Governance
<ul style="list-style-type: none"> • Predominately at the programme, project or task level • Needs to part of established programme, project structure with a Single Responsible Owner (SRO) • Business change normally driven by relevant operating group eg FLC or by appropriate DLOD owner 	<ul style="list-style-type: none"> • Strong governance that aligns with existing engineering practice and design authority(s) • Clear ownership and sign off of artefacts required (customer vs Supplier) • Acts a co-ordination tool between multiple organizations (customer and supplier) • Design authorities ensure proposed solutions are compliant with required corporate/enterprise requirements
Development Methods	Environment & Enablers
<ul style="list-style-type: none"> • Follows prescribed ‘enterprise’ process as part of delivery or service provision, eg standards methods for high level design, requirement development, option development, solution architecture. • Strong collaboration with stakeholders (including supplier base) to ensure validity • Key to success is applying a pre-considered and robust architecture method from the outset (eg TOGAF) • Must be integrated with recognised change process, eg Programme Management Plan (PMP) or the System Engineering Management Plan (SEMP) 	<ul style="list-style-type: none"> • Supported by a recognized EA or SE tool set, • Established framework (eg MODAF) and notation (eg UML, Archimate etc) • A federated tooling approach is normally need • Enabled by a dedicated multidisciplinary team responsible for key artefacts • SQEP architects for given purpose and area of concern • Typically led by a Chief Engineer • Artefacts distributed to key stakeholders • Architecture library to identify reuse of existing material • Community of practice to share best Practice (inc practice lead)

Directive Style of Architecting Crib-sheet			
Characteristics:			
Formality: 	Strong degrees of formality to ensure outputs are robust. Level will depend on specific area of concern and purpose	Utility: 	Utility is normal limited to area of concern but may be used to support a range of activities.
Persistence: 	Outputs and efforts are limited to life of Programme of Project, after which they are not maintained and archived in accordance with cooperate policy.	Effort: 	Initial development is relatively intensive requiring specialist skills and experience along with a need to maintain outputs for the required duration.
Granularity: 	Depth is typical – as purpose is driving towards a solution.		

Example Use Case:

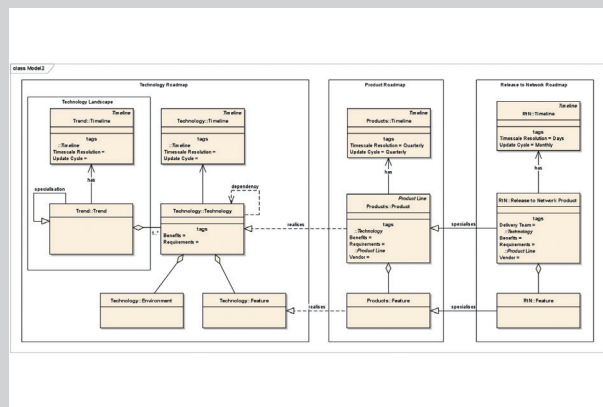
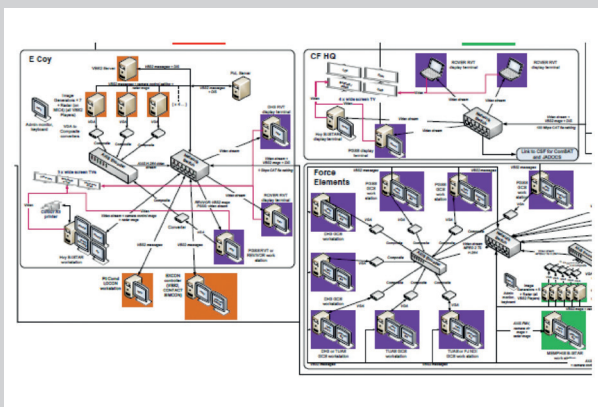
A Senior Manager has been tasked with updating a company’s IT systems as part of expansion plans and the need to replace legacy technologies which are becoming increasingly costly to maintain. The manager’s team sets about developing an architecture by engaging with a range of stakeholders to understand the business drivers, existing processes and legacy infrastructure to develop a number of To Be architectures. After consultation with the commercial team it is decided to go to a competition for the delivery of the new IT Systems. The To Be architectures form part of the Statement of Work and selection process and once a supplier has been selected they are handed over and used as the basis for detailed design, delivery and acceptance.

Examples in Defence:

Defence Core Network Services Architecture Reference Model; Le TAC CIS Programme architecture; Fixed and Deployed Technical Architecture, Network Technical Authority.

Example Visualisation:






Note all views and viewpoints are valid for each style and those below are purely illustrative of the type that could be expected to be produced.



Coordinative Style of Architecting Crib-sheet	
This style supports the co-ordination of change activities within a single domain or sub-domains by aggregation across lower levels; it is normally used at the Programme or Enterprise level. Governance is needed to ensure that the supplied Management Information (MI) is of suitable quality to support required decisions. The approach draws heavily on broader P3M practices and may be part of a Programme Support Office (PSO). Tooling is specialised with aggregated data being presented through dashboards or composite graphics to meet different decision makers' needs.	
Context	Approach
Purpose	Outputs & Outcomes
<ul style="list-style-type: none"> • Support co-ordination of change activities (ie projects and programmes) through understanding complex dependencies of: milestone, risks, capability, process, interfaces etc • Includes understanding of internal and external activates to Area of Concern (eg through a roadmap) • Typically an enduring requirement that requires regular (eg monthly/quarterly) reporting • Architecture provides more robustness/efficiencies to existing processes/practices 	<ul style="list-style-type: none"> • Example outputs include roadmaps, dashboards, heat maps to support <ul style="list-style-type: none"> o Programme board MI o Capability assessment o Technology/product roadmaps • Typically outputs can take form of dynamic dashboards tailored to meet different (senior) decision makers needs • Outcomes is regular reporting to managers on state of project, programme, capability etc • Is used to make decisions on or report on, the direction of the programme or Project or current capability
Area of Concern	Reference Model
<ul style="list-style-type: none"> • Typically monitors business as usual and business change to drive decisions for change • Typically about the aggregation of concepts/issues of a given stakeholder/role eg SRO or design authority 	<ul style="list-style-type: none"> • No specific reference models but may need to comply with enterprise reporting requirements or information models/control value repository • Where applicable 'common language' drawn from ref. model is used to ensure consistent reporting
Change	Governance
<ul style="list-style-type: none"> • Enterprise, programme, project • Used as enduring resource to report on change and make decisions on change 	<ul style="list-style-type: none"> • Assurance of supplied information (MI) is suitable quality to support decisions • Needs to be of value of the stakeholder and in turn is supported by the stakeholder to drive information quality • Process of aggregation (compilation) is normally peered reviewed
Development Methods	Environment & Enablers
<ul style="list-style-type: none"> • Strong IM that draws on broader P3M and PSO practices • After initial setup has periodic maintenance and update by a specialist team • Key to Success; <ul style="list-style-type: none"> o Quality of source data o Identifying the required KPI of the business o A tool strategy to the integration of corporate data o Ease of use • Method is a process (normally supported by a tool) that enables the repeatable combining of business information to support decision makers 	<ul style="list-style-type: none"> • Initially developed by a small development team • Team skills should include info/data Management, visualisation and tool development/configuration • Access to corporate data (preferably directly) • Used as part of business as usual so needs to be integrated into corporate infrastructure • Uses specialist MI tools that interfaces with other IM databases in the business

Coordinative Style of Architecting Crib-sheet

Characteristics:

Formality: 	Limited degree of formality which is concerned more with ensuring the quality of the source data rather than the architecture process.	Utility: 	Supports multiple purposes in context of area of concern - ie record once, use many times.
Persistence: 	Specific outputs eg dashboard/roadmap are limited to the currency of the source data.	Effort: 	Initial development draws on specialist team (domain, process and tools) so is not trivial. Once established limited effort required to maintain/manipulate data and specialist effort to support tool updates/changes.
Granularity: 	Mixed granularity depending on need to drill through source data but typically presented at a high-level of abstraction.		

Example Use Case:

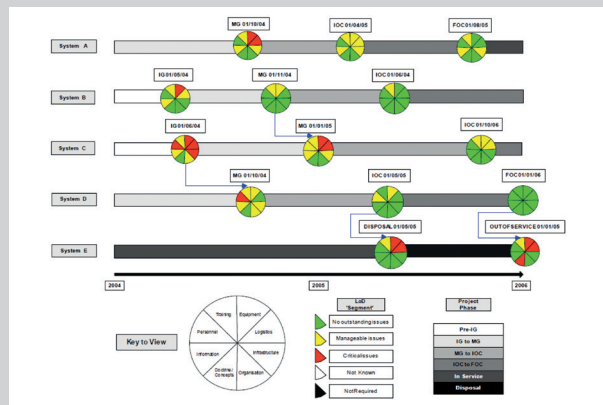
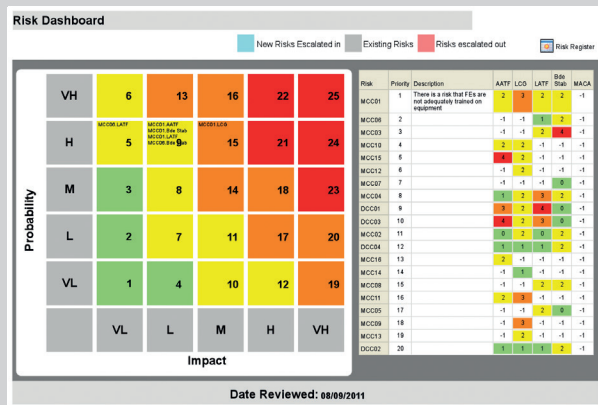
A programme manager has inherited a number of legacy projects due to a reorganization of the business. The programme manager believes there is some overlap in these projects both from the technology and business perspectives. These projects are in themselves complex with a plan for delivery over the next five years. The Programme Manager wants a method to be able understand these overlaps and be able to manage these going forward as it is intended that more projects will be added to his portfolio. A team is brought in that sets about analysing the projects by applying a number of architectural perspectives and develops a model to help understand and resolve the overlaps. This model then becomes an enduring tool that is handed over to the Programme Office to understand and plan the introduction of new projects to the portfolio and changes to the existing projects.

Examples in Defence:

Defence Application Register; Enterprise Technology Roadmaps.

Example Visualisation:

Note all views and viewpoints are valid for each style and those below are purely illustrative of the type that could be expected to be produced.



Source: www.gov.uk/mod-architecture-framework/

Supportive Style of Architecting Crib-sheet	
This is a focused style that supports key interventions or decision points across all levels of change and it can also be used as an initial activity to identify the need for change or explore an area of interest. It can function with limited governance (eg peer review) but must be held to account when supporting key decisions. This style is normally undertaken by a small team of dedicated architects working as part of a wider team using best available tooling including standard office IT products.	
Context	Approach
Purpose	Outputs & Outcomes
<ul style="list-style-type: none"> • Typical aim is to understanding a complex space or issue • Emphasis is on bounding the problem rather than solving it • May be the initiation activity to further work leading to different architecture styles/approaches • Normally a one off but annual review may occur of issue but should not be confused with enduring ref architecture 	<ul style="list-style-type: none"> • Architecture views form part of a final report/briefing, a body of evidence or is a coordinating tool within the team • Output contains visualizations that provide insight that are tailored to the business and NOT the architect • Key output is next steps/recommendation to resolve issue, if found to exist
Area of Concern	Reference Model
<ul style="list-style-type: none"> • Support to key intervention points in the life of the programme or project. • Looks at emerging features of a SoS or capturing legacy SoS design 	<ul style="list-style-type: none"> • Depending on domain, will draw on relevant Reference models or standards as needed • Also draws on broader concepts that help understand the problem space
Change	Governance
<ul style="list-style-type: none"> • Is in response to a customer needs and can be at any level 	<ul style="list-style-type: none"> • Can function with limited governance (eg peer review) but must be held to account when supporting key decisions • Mainly focuses on either breadth or depth but not both to support decision
Development Methods	Environment & Enablers
<ul style="list-style-type: none"> • Premeditated approach is tailored to support specific purpose eg interoperability, process improvement, capability planning • May reuse existing approaches from previous engagements but needs to be flexible • In certain circumstances architect may maintain model to support response to future requests/questions • Typically a short duration task • Key to success is experience of team rather than a robust architecture 	<ul style="list-style-type: none"> • Small team or individual architects working as part of a wider multiple-discipline team to support key business decision or intervention point • Range of dedicated tooling or standard office IT products can be used • Emphasis is on visualisation rather than robustness of model • Artefacts are typically used once and quickly become redundant once task complete

Supportive Style of Architecting Crib-sheet			
Characteristics:			
Formality: 	Little or no formality that reflects the ad hoc or one-off nature of the work. However may need to feed a more formal decision process eg Capability Assessment.	Utility: 	Normally limited to single purpose or single decision.
Persistence: 	Once complete is normally redundant with little potential for reuse. Note – in some case material may be maintained to support repeat questions/issues.	Effort: 	Development is part of wider team addressing issue. No effort is required to maintain once complete
Granularity: 	Normally limited due to time constraints and is focused on single issue.		

Example Use Case:

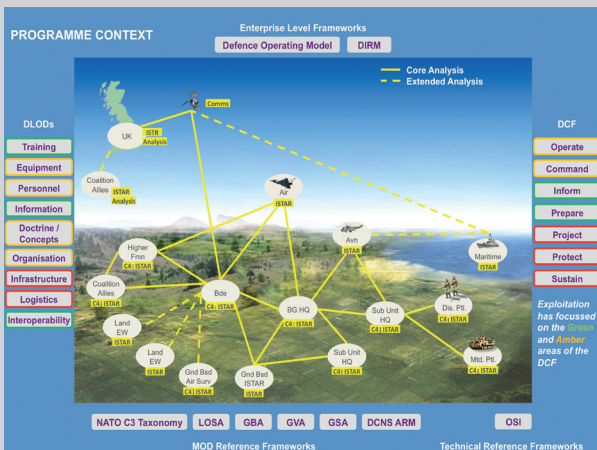
A project manager needs help to understand the issue of implementing a new global training solution. A small team is brought in to investigate the problem and report back to the project manager. The multi discipline team includes an architect, who draws on the team’s training specialists to develop a target architecture at a number of transition points. These views, tailored to the business, are used to engage further with Key Stakeholders to drive out the issues. Some of these views are then incorporated into the final report to the project manager.

Examples in Defence:

Capability Audits or Investigation; Interoperability Investigations.

Example Visualisation:

Note all views and viewpoints are valid for each style and those below are purely illustrative of the type that could be expected to be produced.



Annex C

Frequently Asked Questions on Architecting Styles

Q What if an architecture fits more than one style?

A The best way to resolve this is to go back to the purpose of the architecture. If the purpose of the architecture spans more than one style perhaps the purpose needs to be revisited with the sponsor. It is conceivable that a Directive or Coordinative architecture could also be used to answer tactical questions in a Supportive manner, but the main reason for the architecture will be to direct or coordinate and the architecture should be governed in that way. The supportive output should be treated as a beneficial by-product.

Q Is it possible to have multiple styles of architecture in one repository?

A This is more a question of tooling rather than style, it is possible for multiple architectures of different styles to exist within the same physical repository but this may be poor practice. It would certainly require MODeller to be cognisant of the potential conflicts of governance required to ensure the individual architecture remained fit for purpose.

Q What if an architecture does not fit any of the styles described – are there special cases?

A Possibly, but Niteworks has not encountered any. The styles are there to provide guidance. If an architecture falls outside the four styles identified then the architect is advised to go back to the purpose of the architecture and determine:

- How will it be used?
- Will it need to be maintained?
- What level of detail is required?
- How will it be signed off or scrutinised?
- What are the relevant reference models and standards?

By answering these questions the architect can then develop an architecture plan that defines the level of Formality, Persistence, Granularity, Utility and Effort required. However it is believed that in doing this work the architect will detect a natural affiliation to one of the styles already identified.

Q Can an architecture's style change during its life?

A This would mean that the purpose of the architecture must have fundamentally changed. If this were the case, then an analysis of the work done to date would need to be conducted to ensure that it was fit for the new purpose.

Q Are Directive and Coordinative fundamentally different styles or are these opposite ends of a continuum. Is there a grey bit in the middle?

A They are similar but distinct. The Directive style is very much focussed on the design of a system of interest, its context and its detail, whereas Coordinative architectures are focused on the timing, dependencies and coordination issues of two or more systems.

Q How do architecture styles relate to the different types of System of Systems?

A There are four commonly recognised types of SoS (Maier 1998; Dahmann and Baldwin 2008); Directed, Collaborative, Acknowledged and Virtual. These characterisations offer a framework for understanding SoS based on the origin of the SoS capability objectives and the relationships among the stakeholders for both the SoS and the systems. These are viewed very much as a characterisation of the architecture itself rather than the way it is produced, which is what the styles focus on, ie architecting. There may be a tendency for there to be a correlation, for example Directed SoS could be architected by the Directive style, but further work would be needed to understand this.

Q There are several emerging Reference Models in Defence but not all initiatives appear to fall under the Authoritative Style?

A Within Defence there is no clear definition of what is a Reference Architecture or Reference Model. From a styles perspective only any Authoritative Style of architecting can produce a Reference Architecture, as it is proposed that it should be applicable to the Enterprise and is enduring. Architectures developed by projects or programmes may become Reference Architectures but would have to be adopted by the appropriate enterprise Authority and managed as such.

About the author

David Evans is the Chief Architect for the Niteworks partnership and has experience of working in central government, defence and wider industry. From an early career working in the Defence Procurement Agency, he became involved in the disciplines of Systems Engineering and Enterprise Architecture which coincided with the infancy of MODAF. Since then he has worked on a range of projects both within and outside of Defence promoting the use of architecture in a pragmatic and value-focused manner.

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