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Topic: C2 Concepts and Organisation		
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REVISED ABSTRACT

In the context of the deployment of military forces, command is the director and integrator of other capabilities, i.e. the structures, processes and assets associated with Inform, Prepare, Project, Operate, Protect and Sustain[1]. Command is the 'builder' or 'composer' of the military organization (and its extra-military affiliations) in response to current operational needs.

The commander may wish to adopt any of a variety of organizational configurations, yet is constrained to build his organization out of the existing military fabric (e.g. procedures, staff, equipment, HQ facilities). This is the architectural thesis of composition (the whole being constructed from known building blocks through the satisfaction of an architectural ruleset), being applied in the context of the command of a specific operation. Re-composition (re-build) continues in theatre in the form of Task Organization, and the 'run-time' behaviour of the organization are then excitations of features of the 'built' structure under the conditions of executing operational activities.

This paper describes the CBM (Command and Battlespace Management) Model currently being developed for UK MOD, which takes as its starting point "What is to be commanded?", and goes on to develop a representation which eschews the internal detail of the building blocks (regarded as 'functional businesses') in favour of a model

[1] These are the categories of capability defined by UK MOD's Defence Capability Framework.

of the organization as a network of services whose configuration is defined by the commander.

The result is a model which is far more compact than previous representations, that can integrate with appropriately-modularised sub-models rather than needing to subsume them, and which can be aligned with the service-orientated architecture (SOA) paradigm with a view to the provision of reconfigurable information systems support to the military business.

Introduction

This paper describes the CBM (Command and Battlespace Management) Business Model currently being developed for UK MOD. The CBM Business Model is being constructed primarily with a view to supporting capability acquisition. Specifically, the Model is intended to inform:

- How specific projects' requirements can be related to the broader CBM business, with a view to:
    - Bounding and scoping projects.
    - Defining interfaces between systems.
    - Providing context to User Requirements Documents.
- How programmes can be scheduled and what influence this has on Business Cases.
- How context can be maintained throughout the equipment capability life-cycle (CADMID) to inform decisions on trade-offs, benefits management, migration, technology insertion and decommissioning.

More generally, the model is designed to support communication and mutual understanding between the different stakeholders involved in addressing doctrinal matters and capability management, integration and acquisition, across both MOD and the industrial supplier base.

The focus of this paper is on our engagement with the nature of the command business[2] and the implications of this for the way in which it can be modelled, given the needs of different stakeholders. It is <u>not</u> about the application of established business modelling technology (standards and tools) to command and control. Clearly the paper <u>is</u> of relevance to architectural frameworks (e.g. MODAF [1]) and notational issues, but the paper is primarily concerned with the required content of models (*what form* of expression, and of *what* aspects of the command business) rather than *how* it should be articulated.

Hence our starting points are an inspection of the command business and an appreciation of the model-user's perspective, and this leads us in the first place to the fundamental nature of command and its impact on the military organization as a whole. The need for users to appreciate the adaptation of command structures to meet different operational circumstances, and the dynamic configuration of these structures during an operation, leads to a number of innovative positions or slants on representational issues in relation to the conventional application of business modelling approaches in the military context. The result is a model whose nature engages with emerging paradigms in the provision of CIS support (notably Service-Orientated Architecture), whilst looking forward to an era of military operational practice in which flexibility, adaptability and re-configurability are recognised as key determinants of military capability.

[2] Although the use of the word 'business' sits unhappily in the context of military affairs, we use the word persistently to emphasise that we are not building a model of (technical) systems.

In summary, the paper should be of interest to:

- commissioners or developers of business models in the command domain (particularly those who aim to give end-user access to their models),
- others with an interest in the usability and integration issues for business models in the domain of military operations
- other stakeholders in the evolution of the CBM business.

The vision for a CBM business model

This work has been driven by a vision of a model which aims to provide a description of the CBM Business which:

- Accommodates full spectrum of conflict
- Accommodates National, Coalition and Alliance operations
- Accommodates OGDs, NGOs and HN involvement
- Describes interactions between commanders (and between staff) at different levels of command (spanning strategic, operational and tactical domains)[3].

We also want the model to be enduring, which means that it is valid at least as far as 'transitional' NEC epochs. On this timescale, it is our understanding that, whilst specific configurations and procedures may vary (e.g. as MOD explores possibilities for increased use of reachback from theatre), there are principles of structure and organization which are enduring, i.e. they are reflected in current practice and will be retained.

We are interested in organizations, processes, roles, information and decision-making, rather than applications, infrastructure, communications systems and data. However, it should be possible to overlay perspectives on system models (e.g. showing system boundaries) on top of a business model and draw conclusions, which could be that there are gaps, overlaps or relationships between projects.

In addressing these aims, we have sought to transcend the limitations of earlier models in this area:

- Limitations in scope, addressing particular military capabilities rather than the command of the deployed force capabilities as a whole.

- Reliance on direct elicitation of process descriptions from military SMEs, with attendant difficulties in gaining widespread agreement[4].

- Expression of either generic forms of the business (e.g. [2]) or specific contexts or situations, but not both.

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[3] Our focus to date has been the operational level and its interactions with higher tactical C2.

[4] In contrast, the CBM Business Model is grounded initially in doctrine and its interpretation by military subject matter experts. The need to distinguish between 'theory' and 'practice' is acknowledged, and is discussed later in relation to the distinctio between architecture and instances.

In particular, we have sought to avoid the pitfalls of IER (Information Exchange Requirement) modelling, which tends to produce models which are:

- Voluminous.
- Insensitive to deployment / operation.
- Hard to relate to concepts of operation.

The nature of the CBM business

Articulating the relationship between Command and the other elements of the Defence Capability Framework [3] (Inform, Prepare, Project, Operate, Protect, Sustain) has proved a challenge in earlier business modelling endeavours. The problem is, 'everybody does command and control'. From a process-modelling perspective, this means that C2-related processes turn up everywhere, and to get complete coverage of C2 processes appears to require 'a model of everything'. The alternative is to leave out the C2 processes which are specific to functional specialisms (STAR, Indirect Fire, Logistics, etc.) and focus on 'core' command processes.

Whilst the nature of these 'core' command processes is well defined in doctrine, descriptions of Command in the context of C4I, and CIS support in particular, have tended to emphasise the management (including control) of military activities. In particular, a preoccupation with Manoeuvre activities[5] may stem from the apparent preoccupation of J3/G3 with Manoeuvre elements (i.e. Combat, as opposed to Combat Support or Combat Service Support to use land-centric terms). A facet of the Command business which is easily lost in this is the commander's pre-eminent role as the 'builder' of the organization from the deployed elements at his disposal. Thus existing process models tend to reflect the end-product of this 'build' and remain silent about the means by which (and from which) it has been generated.

The perspective adopted by the CBM Business Model is that Command is the 'director' and 'integrator' of all other capabilities. In order to understand what the Commander (or "builder") is doing, we need to take a step back to ask, what is it that has to be commanded?

What has to be commanded?

The development of the model starts by defining a generic pattern for what has to be commanded. This has not been without its problems in that different stakeholder groups within the UK MOD tend to use subtly different terminology[6]; nevertheless, having a pattern has proved useful as a way of organising things and as a basis for explanation.

The right-hand side of Figure 1 shows a military operation broken down into missions and thence into tasks. An operation has a defined objective; missions are types of

[5] And hence, in our view, an over-emphasis on the significance of blue force positional information.

[6] In the senses of both using different words for the same concept, and of assigning particular (and often differing) meanings to the same words.

military activity (e.g. Air Manoeuvre), through whose prosecution the objective can be achieved.

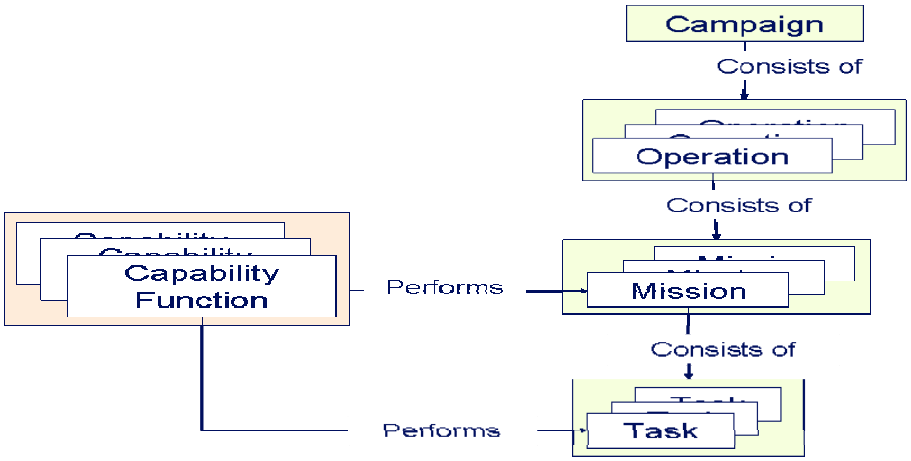

Figure 1: Breaking down operations into missions

Each mission in Figure 1 is achieved through the use of multiple capability functions. These capability functions are almost invariably associated with specialised assets, but are strictly defined in terms of the capability to prosecute particular military tasks. Capability functions are a refinement of MOD's primary classification of capability in the Defence Capability Framework [3].

Capability functions can themselves be categorised as:

- Effecting, e.g. Strike, Close Combat, ECM.
- Supporting, e.g. STAR, C4IS, NBC, MCM, Media, OGD.
- Sustaining, e.g. Transport, Equipment Support, Medical.

There are also a set of Command Supporting functions, addressing:

- Status – e.g. Blue, Red, White, Environment, Operational Context.
- Policy, Advice, Guidance – e.g. ROE, Legal, Targeting.
- Management – e.g. Battlespace, Information, Emission.

In contributing to a mission, each individual capability function performs one or more tasks; the corollary of this definition is that tasks may exhibit significant dependencies on each other, and hence task integration (implying collaboration in planning and synchronisation in execution) is a significant requirement for command.

There may be multiple operations being enacted simultaneously, and for completeness, operations are shown as deriving from an overarching campaign. At the operational level of command, the campaign is driven from the strategic level of command. However, the scheme shown in Figure 1 can be applied at any level of command: as it moves into the tactical, the missions become more specialised and the number of capability functions involved becomes fewer.

Generics and instances

Given that the CBM business can adopt many different forms (for different operations, different stages within those operations, different levels of command and capability areas), there is a need to understand not just the generic pattern but the particular forms which may be taken. The needs of specific situations are met by composition of generic structures (schemes and patterns) into specific configurations to respond to the influences of the current operational context.

Note that it is the arrangement or topology of this composition which reflects the specificity of the situation. The generic structures themselves remain essentially unaltered, which is consistent with a view of capability as a set of re-usable building blocks [4]. These building blocks are the basis for equipment capability acquisition. Blocks will be defined in a number of dimensions: structural, procedural, role-based, etc.. Of course, generic building blocks should also be scalable and support variations in their use in specific configurations[7].

For the CBM business, the most important building block is the structural definition of a generic HQ, whose shape is a direct response to the generic pattern for what has to be commanded (Figure 1). This is called the "HQ palette", and it is a recipe for an 'organizational chart' which in turn reflects the decompositional nature of HQ activities (high-level command activities giving direction to, and integrating the outcomes of, lower-level more specialised activities).

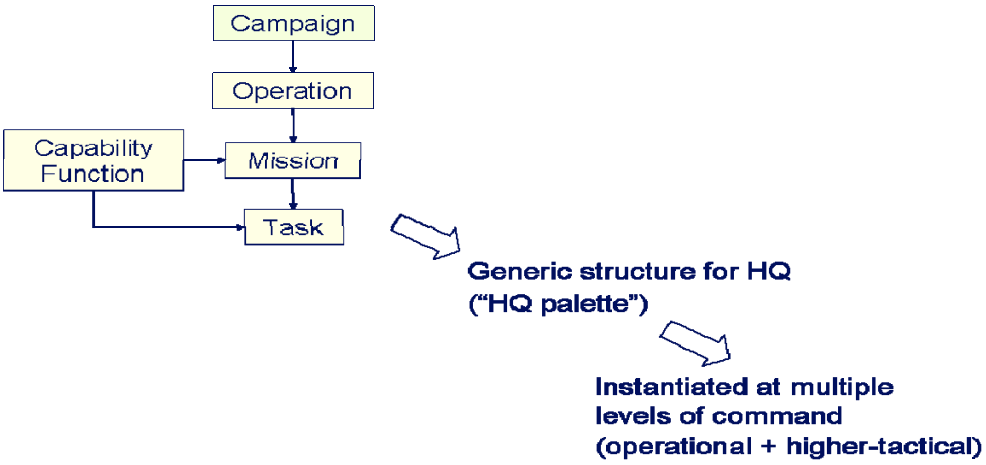

Figure 2: From generics to multiple instantiations (structural view)

The CBM Business Model contains both generic and specific configurational forms. From the modelling perspective, by developing specific configurations which reflect different operational contexts (for historical, current and future operations), we can demonstrate the appropriateness and usefulness of the architecture and the building

[7] In each of the dimensions in which building blocks are defined, there will be a defined range or repertoire of forms which can be selected or enacted, and a range of scales. These ranges or repertoires are pre-determined; the selections from them in operational circumstances lie with Command.

blocks of capability which we have defined. Hence, vignettes (episodes of activity arising within a broader scenario) represent 'use cases' for architecture[8].

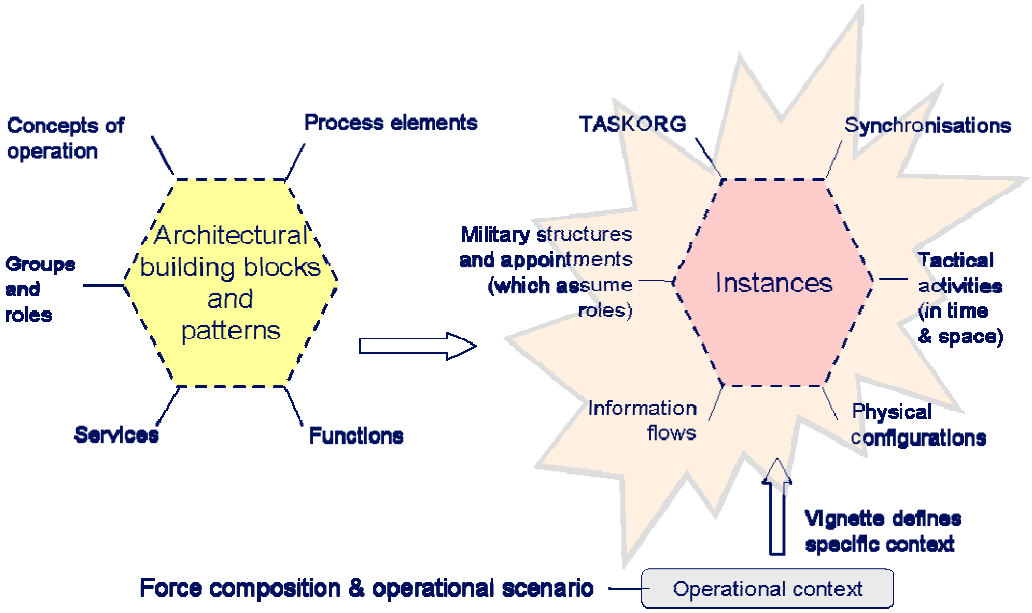

Figure 3: Architectural building blocks and vignette-based instances

As an operation unfolds, reconfiguration will occur (reflecting, in the first instance, Task Organization). These 'before' and 'after' configurations may appear as separate instances, but there is a need to demonstrate the persistence of force elements, appointments, etc., through the reconfiguration.

In summary, the specific configurations of the CBM Business are always driven by the operational context currently under consideration. However, the complexity of capability management can only be managed if we can find the generic and re-usable building blocks out of which specific instances can be built. Thus the Model reflects the principle of 'one architecture, many configurations'.

Deliberate and dynamic planning

In terms of command as the 'director' and 'integrator' of all other capabilities, direction is achieved through deliberate and dynamic planning and the formulation and dissemination of directives and orders [4]. Integration is achieved through the establishment of a framework of interconnections between the constituent functional capabilities' C2 elements; these interconnections are manifested by group activities involving two ore more roles in HQs.

'Deliberate' and 'dynamic' are terms used to imply changes in the pattern of command and staff relationships on two timescales:

[8] The elements of architecture have been designed to reflect fundamentals (underpinned by the 'theory' of doctrine); instances reflect possible configurational 'practice' in the context of vignettes. Hence the elicitation of practice directly from military practitioners is valuable (even if practitioners suggest different variations), provided that the results are interpreted as configurations of more fundamental objects.

a) On the *deliberate planning* timescale, the commander constructs his Task Organization to reflect his vision of the operation he wishes to pursue to address his mission.

b) As the planned operation unfolds, events give rise to perturbations in this command structure, at the instigation of *dynamic re-planning* and tasking. These perturbations are applied 'on top of' the Task Organization, rather than being changes to it per se. It does not alter command states, but may result in assets and resources allocated to one subordinate commander being provided as a service to another commander (peer or subordinate).

'Deliberate' and 'dynamic' timescales are not absolute but are relative to the level of command. Hence, at the operational level of command, 'deliberate' includes planning conducted prior to deployment; at Brigade level it could be one day ahead of execution. Moreover, assigning Task Organization to the deliberate phase is not a contingent observation: it is actually how we have defined *deliberate*. Changes in TASKORG may need to occur with rapidity, and even unexpectedly; we are characterising this as a reversion to deliberate planning.

In the dynamic phase, there is by definition no change in TASKORG, but what can change is the affiliation of supporting services, which are governed by tasking rather than TASKORG, are finite in terms of duration and geography and are constrained by resources (e.g. ammunition). For example, Artillery gun groups may fire in support of a variety of Combat elements while always remaining under command, as per TASKORG, of the Artillery Commander, and similarly for Close Air Support, Attack Helicopter Support, STAR support, and Air Transport[9]. Deliberate planning specifies Subordinations (and Groupings) in terms of command states (OPCOM, OPCON, TACOM, TACON). There is, however, no command state of 'In Support'.

On the whole, support 'affiliations' are communicated as tasks, and clearly both ends of the supporting / supported relationship have to be informed. This relationship varies with the military task in question and the implicit constraints and freedoms are frequently not clear (e.g. questions of whether a land commander can tell an air-commanded aircraft to follow a different path).

[9] In contrast, Support Helicopter assets would probably remain as allocated in TASKORG to avoid peer to peer conflict.

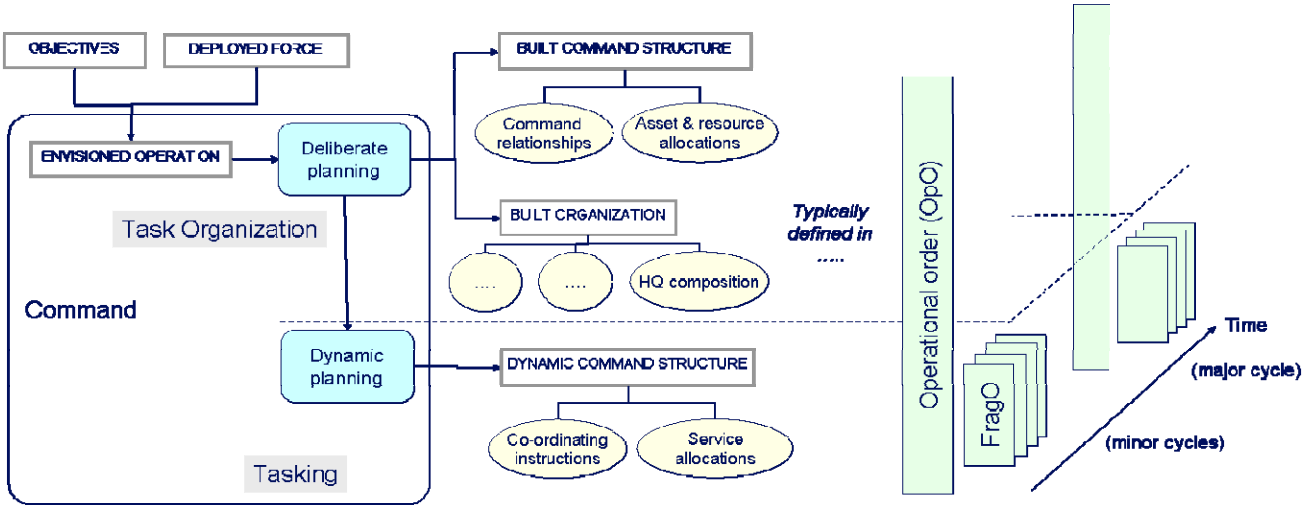

Figure 4: Products of deliberate and dynamic planning

As Figure 4 shows, deliberate and dynamic planning give rise to a number of different views of 'organizational structure' (the Deployed Force, the Task-Organized Force, the dynamic structures overlaid on these). The complex relationships and interdependencies between these views need to be respected when operations are modelled (as vignettes / instances). This is highlighted by the fact that an instance of the same modelling object (e.g. a structure or an appointment) may appear in multiple views (and different versions of the same view over time), as shown in Figure 5.

The achievement of persistence in the identity of the object (e.g. showing that the views at different times t_1 and t_2 are referring to the same object) requires some subtlety at the meta-model level, resulting in the distinct definition of:

- Schema Objects and Views (e.g. military structure, command topology, information repository), which lie, for the most part, within the DoDAF and MODAF [1] meta-models.

- Architectural Objects and Views (e.g. Built Command Structure, Dynamic Command Structure), which provide context to schema objects and whose modalities are outside the MODAF meta-model.

This is summarised in Figure 5; the items next to the Schema Object are the different classes of property which the object may have. The rules governing the relationships between property values in the different architectural views are dependent on the class.

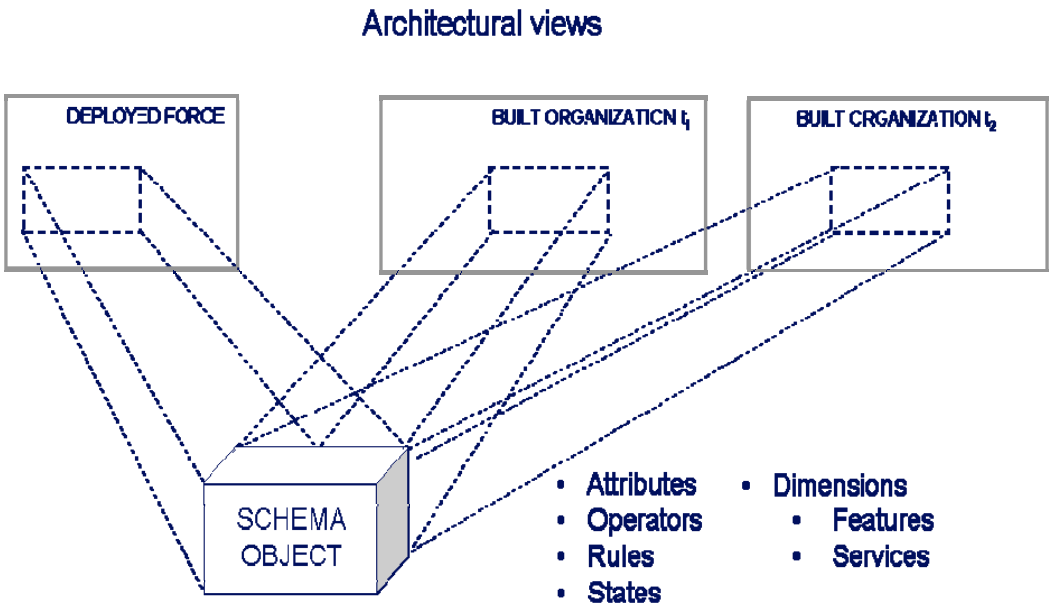

Figure 5: Schema objects and architectural views

Network of services

In the CBM Business Model, the establishment of interconnections is a process which is applied to *services* which are offered or demanded by the constituent elements. In other words, the 'hooks' and 'slots' on the architectural building blocks, reflecting the capacity to integrate with other blocks, are characterised as services. Hence the organization built by the commander can be characterised as a network of services.

This also means that the Model need not reproduce the internals of military specialisms, since it need only describe them in terms of the services provided to and received from others, including subordinate entities.

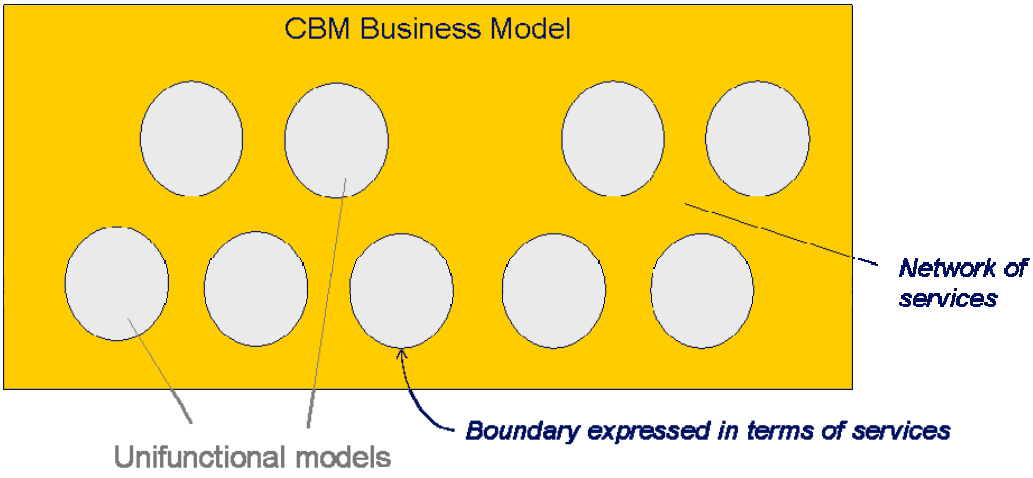

Figure 6: The CBM Business as a network of services connecting individual functions

Note that this use of the term *service* is much broader than is common; in particular, services in the CBM Business Model are not restricted to information services. Services are used in the CBM Business Model to describe all of the means by which Model components integrate with others. Hence, business services express:

- Parenthood - both structural (a military structure is 'part of' a larger military structure) and functional (that a functional task is subordinate to (and contributing to) a larger functional task).
- Command – formal command states.
- Ability to affiliate to, and accept affiliates to, communities [5].
- Information services – including information product exchange.

Moreover, when specific configurations are built, there is a need to represent other forms of coupling which amount to:

- Synchronisation – dependency or degree of inter-activity.
- Physical and geographical – cell or HQ participation, geographical proximity.

To accommodate this, the generic forms of the model have to express the capacity of components to be located and/or synchronised using yet further forms of service.

With these service definitions, we can assert that business 'process' is the result of service orchestration. This highlights another difference between the CBM Business Model and more conventional business modelling approaches, which start from an elicitation and analysis of business processes as the fundamental object of study. Given that the CBM business can (and must) flex and adopt different forms in different operational circumstances, process can appear to be unstable, whereas the underlying services are stable. Moreover, conventional process modelling may gravitate towards the 'immediate purpose' (e.g. 'the kill chain') but may ignore all the other things that sustain the organization in a fit state, such as information management and process management[10].

The CBM Business Model approach is not immune to sins of omission, but its grounding in a coherent view of function (out of which services and thence processes emerge) encourages a more systemic analysis. Specifically, the analysis of services required for each capability function is driven by an activity template. This prompts a rounded consideration of functions, highighting aspects which otherwise might have been missed. It also induces a normalisation of service descriptions: whilst subsequent refinement allows the recovery of function-specific variations (including terminological variations, in order to assist in stakeholder comprehension), grounding in a common template exposes the potential for standardisation and exploitation of commonality.

[10] This again leads to the concealment of many aspects of command and a view of C2 being developed which is 'control-centric' opposed to a 'command-centric'.

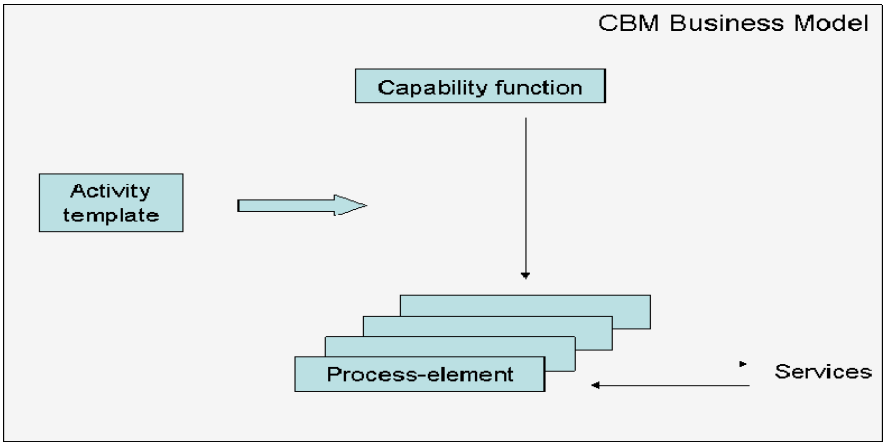

Figure 7: Analysis approach applied to capability functions

Information systems support to the business of command

One of the aspirations for the CBM Business Model is that it should be possible to overlay CIS systems on the Model, to show coverage and coherence.

The traditional expectation has been that it is the 'application layer' of CIS tools which can be seen as providing support to the business, and hence application coherence studies are viewed as providing an indication of business coverage. However, within UK MOD, DG Info's Information Exploitation (IX) initiative and the discussion of the 'Information Layer' (viewed as sitting between applications and basic infrastructure services) both point to the significance of the 'information map' and its need to reflect properly the shape of the military business. If, indeed, information management is 'the next bottleneck' to be encountered when MOD has a coherent application suite running on a sound infrastructural network, it is just as important to have 'IM / IX' overlays onto the business as it is to have system overlays.

Historically this would have been approached by mapping the 'arcs' in business process flow diagrams on to information flows (hence recovering the 'Information Exchange Requirement' (IER) views which have frequently stood as proxies for a true model of the military business). However, the construction of the CBM Business Model, in which business services are used as the means of expressing interactions between Business Model components, opens up a much better way of establishing this connection, and one which aligns with Service-Orientated Architecture (SOA), a paradigm which forms a key component of the UK MOD's current Information Exploitation initiative.

Services, in SOA-speak, fall into three broad categories:

- So-called 'core services' that enable the SOA middleware to function as an IT entity.
- Services that directly represent real-world business functions and when chained together (service orchestration) represents a real-world business process.
- Services that expose information/data sources.

There are also ‘macro-services’ that are typically legacy systems which have been wrapped so that they can be interrogated in some defined way by other services within the SOA infrastructure.

One of the ideas we wish to pursue is the use of SOA principles to show how the business services in the CBM Business Model map on to (i.e. are supported by) information services and other IM / IX structures (e.g. major information repositories). There are four issues which will need to be negotiated here:

- Firstly, the term *service* is used in the CBM Business Model to describe the means by which a Model component may integrate with others, whereas services in SOA are black-box functions with inputs and outputs, so *service* $_{CBM}$ equates roughly to *service* $_{SOA}$ *I/O*. However, the results of service orchestration are essentially the same in both cases: a connection (perhaps dynamic) between *functions* $_{CBM}$ or between *services* $_{SOA}$.

- Secondly, *services* $_{CBM}$ are used to describe <u>all</u> of the means by which Business Model components integrate with others, whereas alignment with SOA only requires us to consider ‘information services’.

- Alignment of the CBM Business Model with SOA is only concerned with *services* $_{SOA}$ that directly represent real-world business functions or services that expose information/data sources, not core middleware services.

- The CBM Business Model and SOA have their own criteria for the granularity at which services are sensibly defined. There is a level (or range of levels) of service encapsulation in SOA (to achieve effective re-use), and the service delineation achieved in the CBM Business Model is in general finer than that useful for SOA. Hence SOA induces the recognition of a higher level of service grouping in the CBM Business Model (which we may term an ‘activity type’), as shown in Figure 8. (The double-headed arrow on the right represents the approximate range of granularities for *services* $_{SOA}$ in relation to *services* $_{CBM}$.)

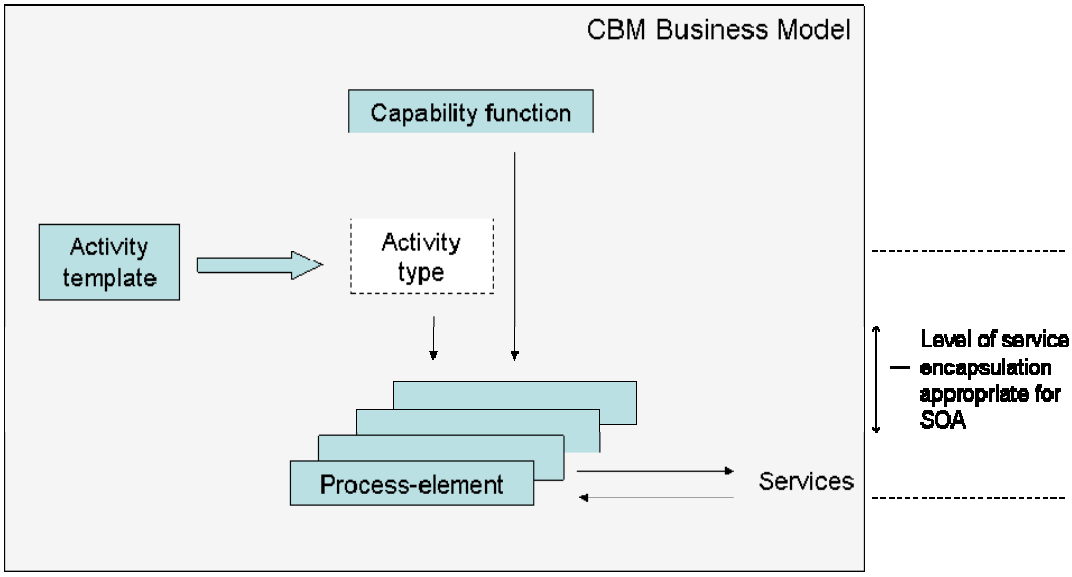

Figure 8: Relating business services (in the CBM Business Model) to services in SOA

Using the model

We are clearly talking about a very rich model with many different views. The customer needs to be able to pose queries (of different kinds) and get back responses, i.e. appropriate information presented in a relevant fashion.

Our current intention is to achieve this through the implementation of a model of user activity. Termed the supra-model, it is a model of the user's business, in this case the UK MOD's processes for capability analysis, management and acquisition. By navigating through this model, the user is implicitly defining a standpoint from which a selective view of the Model can be offered. In implementational terms, this is straightforward and is made manifest to the user as a set of introductory pages via which user selection brings him or her to a particular entry point into the Model. Some more interesting issues arise when the user wants to shift position in the supra-model (i.e. pose a different question) without totally losing orientation in the CBM Business Model itself.

Anatomy of the model

The anatomy of the model (Figure 9) reflects the various strands of discussion above.

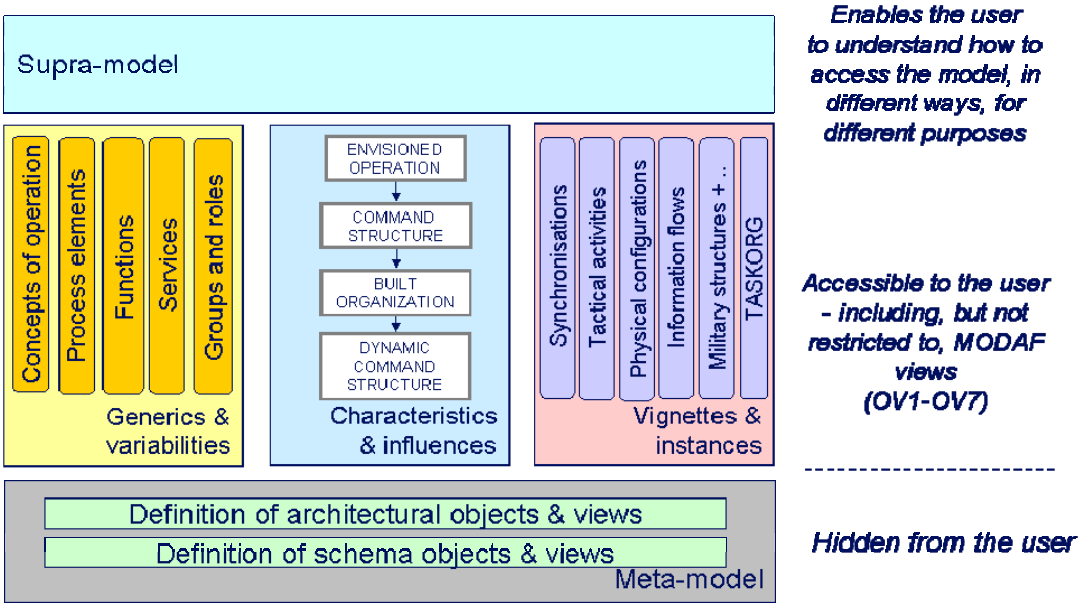

Figure 9: Anatomy of the CBM Business Model

Progress

In the first stage of the work, we have developed a prototype model which is focussed on the deployed force at the Operational / Tactical Level. The prototype model establishes the modelling method, provides the building blocks necessary to create Service Orientated Architectures and is ready for mapping current and planned systems.

We are currently engaged in the second phase of development, which is:

- Taking the model through into a pilot usage stage by a target group of DEC CCII Desk Officers.
- Integrating pre-existing material on command concepts.
- Demonstrating its practical application to specific projects and initiatives.
- Establishing a viable approach in terms of hosting and maintenance of a production version (including reference material).
- Considering integration and harmonisation with other architectural models (including models in the systems domain).

Summary

We are engaged in building a model with the following properties:

- It is a model of the CBM business, rather than a business perspective on the systems which support that business. The Model has been derived from the perspective of the operation and constituent missions and tasks to be commanded.

- It is far more compact than previous representations. Moreover, it links to unifunctional models rather than needing to subsume them.

- Our approach leads to a model of CBM as a reconfigurable network of services. Because it identifies process as the result of service orchestration, and information flows as the consequence of initiation / stimulus of services, it expresses underlying stable features of the business rather than attempting to elicit process or informatic descriptions (which are notoriously unstable). Hence the Model can be aligned with the service-orientated architecture (SOA) paradigm.

- It distinguishes between generics (which are the basis for capability acquisition) and configurational instances (which are the exercise of generic capabilities in the context of specific operational situations (vignettes)).

- It describes interactions between commanders (and between staff) at different levels of command, with the current focus on the operational level of command and its interactions with higher tactical C2.

- Through the design of its meta-model, the Model is capable of tracking a specific force structure / element through Task Organization changes.

- The Model is extensible in that its architectural principles accommodate integration with coalition and alliance forces, and OGDs and NGOs.

- It is enduring, at least as far as the transitional NEC Epoch (2015), because it is founded on organizational principles which are likely to change the most slowly, and it accommodates the full range of doctrinal aspirations (e.g. increased use of reachback, smaller-footprint Forward HQs).

References

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