

Valuing Agility: A Demand-Led Approach to Capability Management

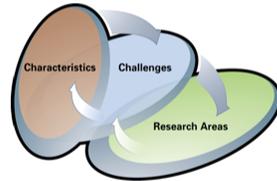
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1 Introduction

1.1 SEI Work on Ultra-Large-Scale Systems

Some Characteristics of ULS systems:

- Decentralization
- Continuous evolution and deployment
- Heterogeneous, inconsistent, and changing elements
- Erosion of the people/system boundary
- New paradigms for acquisition and policy



ULS Challenges:

- We need to think 'socio-technical ecosystems' -
includes people, organizations, and technologies at all scales with significant and competing interdependencies.

SEI Research :

- Computational Mechanism Design
- Architecture in ULS system context
- Assurance in ULS systems
- *Distributed governance in dynamic contexts*

SEI is a Federally Funded Research and Development Center based at Carnegie Mellon University. My work is with the Ultra-Large-Scale systems which are the context within which systems of systems operate. We have to think of these ULS systems as 'socio-technical' because of their hybrid social and technical natures, and as 'ecosystems' because they are made up of large numbers of managerially and operationally independent constituents. This leads to distributed governance operating in dynamic and turbulent environments.

1.2 Thinking 'socio-technical ecosystems'

'Large-scale' Analysis

'multi-sided' analysis of the deployed force relationship to demand

Establishing alternative economics of delivering force cohesion 'at the edge' (e.g. through the use of Tactical UAVs)

'Medium-scale' Analysis

fitting together multiple stakeholders' perspectives on how particular systems of systems support demand

Identifying the interoperability risks across multiple parts of the SoS (e.g. AWACS modernisation)

'Small-scale' Analysis

establishing operational performance of software-reliant systems and sensors

Analyzing end-to-end sensor and data fusion processes (e.g. Multi-Sensor Integration)

The challenge is alignment across the different scales

The challenge of working with ULS systems is to work across different scales, relating the performance of equipment at the small scale through to its impact on agility at the large scale.

My focus for this presentation is on this challenge as it is faced by Through-Life Capability Management.

2 Agility means always being able to meet campaign tempo

2.1 Through-Life Capability Management: the example of Tactical UAV

Phoenix and Watchkeeper UAVs were conceived as extensions to existing concepts of operation:

- Phoenix provided better target acquisition (TUAV I)
- Watchkeeper provided better servicing of a Commander's Critical Information Requirements (TUAV II)

For TUAVs I & II, the focus was on the capabilities of the **system** itself.

The close coupling of Hermes 450 UAS capability to fighters on the ground reflected an increased campaign tempo, and

- The need for much greater tactical agility (TUAV III)

For TUAV III, the focus shifted to the **variety of demands** on the way the system can be used.

An illustration of TLMCM can be found in considering the through-life costs of the use of UAVs in the tactical domain.

The Phoenix UAV came into service in 1999 to extend the range of the gunner's eyeballs. That is, it was closely coupled to MLRS and operated by 32 Royal Artillery. Its ability to see more than the gunner needed to see gave rise to the idea of airborne surveillance in the land tactical domain and what became the Watchkeeper programme was launched.

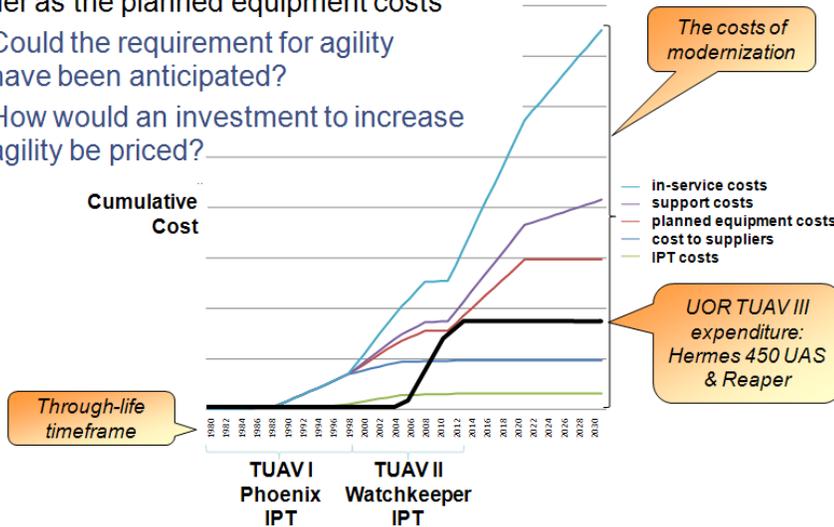
Watchkeeper will also be operated by 32 RA, but its contribution as an ISTAR asset serving *inter alia* the Land Component Commander gives it a wider user community than the earlier Phoenix. Indeed, its ability to carry a wide range of payloads offers a flexibility of participation in the land tactical, operational and strategic domains. Watchkeeper will enter service in 2010.

Watchkeeper will replace and deliver much greater capability than the Hermes 450 UAS delivered to both Iraq and Afghanistan under a UOR. Although equipped with a single payload, the Hermes 450 UAS has had a major impact on the conduct of land tactical missions in that it has been so closely coupled to the fighters on the ground that some missions cannot be undertaken without the participation of these assets.

Phoenix and Watchkeeper were conceived as extensions to existing concepts of operation: better target acquisition and better servicing of the Commander's Intelligence Requests. But the close coupling of this capability to fighters on the ground reflects the increased campaign tempo and the need for much greater tactical agility.

2.2 Tactical UAV: through-life costs of the capability

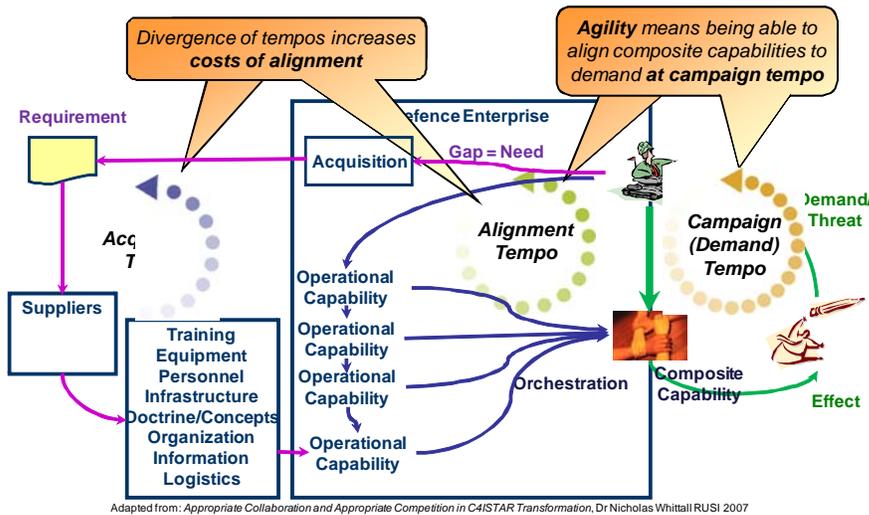
- The TUAV III UOR costs were of the same order as the planned equipment costs
 - Could the requirement for agility have been anticipated?
 - How would an investment to increase agility be priced?



This graph shows the through-life costs of the capability on the basis of TUAV II expectations. In fact, the TUAV III UOR expenditures associated with Hermes 450 UAS and Reaper were of the same order of magnitude as the planned equipment costs. Could this requirement to support a wider variety of operational uses, i.e. to support greater agility, have been anticipated? And had it been, how would such an investment have been priced?

2.3 The three tempos

To answer these questions, we need to consider three tempos affecting this capability space:



The *campaign tempo* is the rate at which *demand* arises within the operational theatre – the context of use within which the defence enterprise operates. The rate of change in the tempo of this demand may be driven *inter alia* by changes in technology (e.g., incorporating a new capability, say TUAVs), or by changes in doctrine (the opposition's or our own) – e.g. their use of improvised explosive devices (IEDs).

This idea is not limited to Defence, but to any enterprise, particularly those active in rapidly changing contexts, such as the providers of mobile technology or of fashion. Marks & Spencer's buyers, for example,

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face many different campaign tempos as they face the different fashion tempos across the range of contexts – middle age through teenage to child – fashion. Indeed, it may be their inability to respond at the demand tempo of teenage fashion that sees this segment barely addressed.

This inability to meet campaign tempo arises firstly from the alignment tempo the enterprise can achieve.

The *alignment tempo* is the rate at which the military commander can orchestrate the individual military capabilities available to him to form those composite capabilities that will deliver the effect that meets the demand arising at the campaign tempo. This alignment tempo is governed largely by the ability to orchestrate force elements to form composite capabilities. A gap arising in the range and flexibility of individual capabilities needing to be orchestrated may manifest itself as a user *need* that is registered with the procurement agency.

The *acquisition tempo* is then the rate at which the MoD meets this need, which it does through a process of publishing a *requirement* – usually for equipment, where Industry is concerned, although this may be across any combination of DLoDs – and delivering to the military commander whatever is required to close the gap in the orchestration process.

The separation of these tempos is neither unique to Defence – it applies to all enterprises – nor unique to this age. However, their separation leads to the conclusion that meeting the campaign tempo at the lowest cost in blood and treasure is the defining characteristic of Value for Defence.

Meeting the campaign tempo then depends on the alignment tempo possible, which in turn depends on the acquisition tempo at which gaps in capability can be filled. Any slowness in acquisition tempo leads to increased bricolage and process short cuts (UORs) to enable the alignment tempo to keep up with the campaign tempo. Again, this is a feature of all enterprises. A company organised as largely independent business units close to their markets will align their capabilities around customer demand more efficiently and more effectively than a centralised corporation demanding multiple layers of approval.

Thus, “agility” finds its richest expression in the ability of the alignment tempo to meet the required campaign tempo at the lowest cost – i.e. to maximise the Value for Defence.

3 VfD is maximised when this agility is delivered at minimum cost

3.1 The Engineering 'V' and the Alignment 'A'

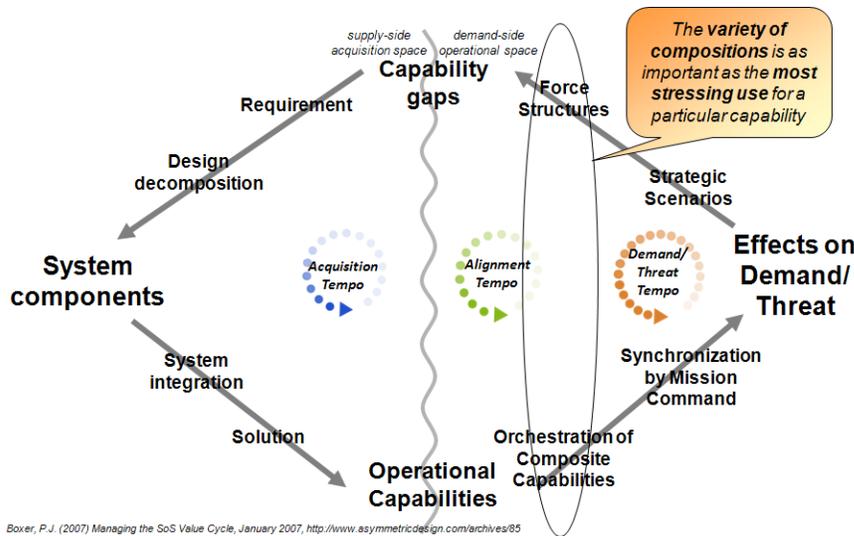
This demand-side approach represents a change in perspective from that currently dominant. Whilst significant and important work is undertaken at the enterprise level in terms of strategic planning and operational analysis, the dominant perspective is from the equipment side, whether in terms of combat aircraft or bayonets. This is hardly surprising.

The focus on securing economies of scale and scope encourage functional specialisation and decomposition of enterprises into their contributing systems. Thus the dominant paradigm within which today's systems engineers operate is one of working an engineering “V” from a requirement through functional analysis and decomposition processes towards components that can be integrated to deliver a system that meets the requirement. That is, we decompose things into manageable pieces, then compose the pieces and connect them according to interface control documents and demonstrate that the resulting system delivers against the requirement set.

Design decisions taken through this process seek the lowest project cost, with little regard to the ways in which systems are used with other systems in a range of contexts. This supply side perspective may reach towards these contexts of use through contracts for the availability of fielded equipment – as in SKIOS, which refers to the platform alone – or aspire towards TLM where the capability is identified with particular equipment or platforms. But these are far from the contexts in which the military commander faces demands with a palette of operational capabilities at his disposal. This process needs a feedback loop – an inverted V or “alignment A” – to engineer how the resultant systems will be, or could be, used with other systems in varying contexts-of- use.

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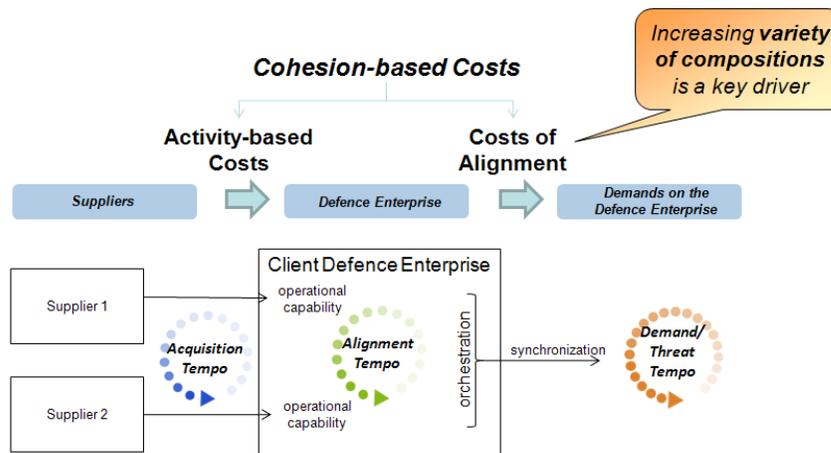
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Orchestrating composite capabilities involves composing systems of systems that can be operationally synchronized to deliver effect. Equally, within the context of strategic scenarios, the way these force structures can and cannot be orchestrated defines the capability gaps that the engineering 'V' must address.

3.2 Supply-side activities and Demand-side Cohesion

This introduces a tension between the constraints of design decisions taken in order to acquire equipment or platforms to a *requirement*, and the degrees of freedom envisaged as desirable in enabling them to be orchestrated in response to changes in *demand*. Discontinuity between the demand and the requirement has created the divergence of tempos that has incurred unanticipated costs in UORs beyond the contingency budgets. Indeed, as the range of demands becomes wider and the rate of change of demand increases – these things fuelled by technology and doctrine – then the greater the pressure on contingency budgets which fall outside the supply side view of procurement.



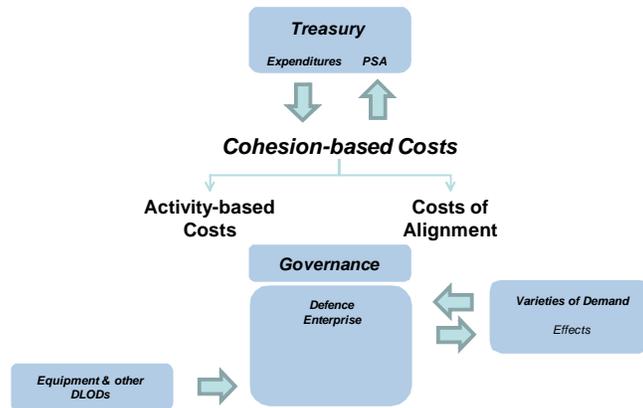
If we ignore for a moment the demand side contexts of use, then we can readily cost this enterprise from an activity based perspective. That is, we know the costs of maintaining fleets and regiments and real estate etc and this is part of the cost of Defence. However, a further and important element is the cost of aligning these activities and assets to meet the accelerating tempo of demand in the operational contexts of use. These two elements – the cost of activities and the costs of alignment – tell us the true cost of Defence. This we call *cohesion cost*.

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Of course, Defence budgets may not be able to afford to do everything. And whilst making available a capability for an infinite variety of compositions of capability may be viewed as ideal, this is costly if even possible, and unlikely to offer the best Value for Defence. Locating a balance is therefore required between UOR overuse and wasteful flexibility through examining the costs of meeting varieties of demand.

3.3 The relationship between Agility and Value for Defence



- Value for Defence is maximised when agility is delivered at minimum cohesion cost

This idea of examining the costs of meeting varieties of demand is not a new concept. Every department of state has a Public Service Agreement with the Treasury that governs the value the department is required to deliver against the money the Treasury commits. Thus, there is already a notion of Value for Defence wrapped up in this PSA, even if it is not connected through the Enterprise from the contexts of use to the supply side procurement activity.

Once we know cohesion costs, then we can evaluate the price we are prepared to pay for that level of agility. That is, we have a relationship between agility – which we may define as doing right things right at the right time – and Value for Defence, and thus a new basis on which to set and evaluate the PSA.

How can we do this?

4 Cohesion-based costing is key to maximising Vfd

4.1 Projective Analysis: understanding the alignment processes

4.1.1 Phoenix (TUAV I): each line represents a relationship that generates cost

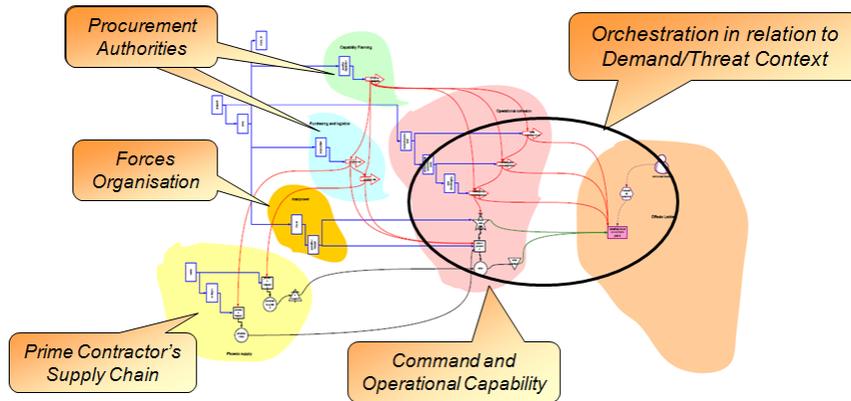
Consider first Phoenix, TUAV 1. This diagram shows all the relationships between the various entities involved in bringing Phoenix to its context of use. This includes the prime contractor and its supply chain, the procurement authorities, the command and support organisations, etc. Each line represents a relationship that incurs a cost.

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Providing better target acquisition (TUAV I)

– Each line represents a relationship that generates cost

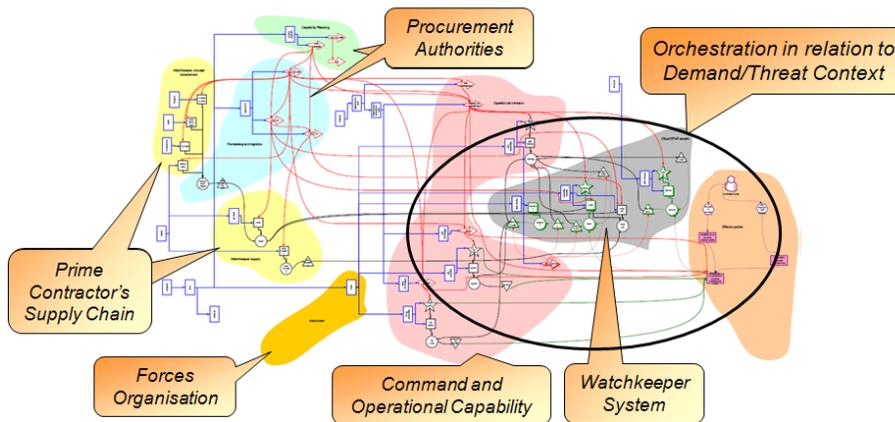


These relationships form a set of matrices that link the equipment through the capability to the context of use and thus to the cohesion costs incurred in Phoenix's participation in some decisive point or other within a campaign. Since Phoenix was closely coupled to MLRS, this analysis is fairly straightforward.

4.1.2 Watchkeeper (TUAV II): more complex set of relationships, but the same approach

Providing better servicing of CCIRs (TUAV II)

– A more complex system focused on its wider integration



If we do the same for Watchkeeper, then we see a more complex set of relationships which, nonetheless, may be analysed in the same way and the cohesion costs uncovered.

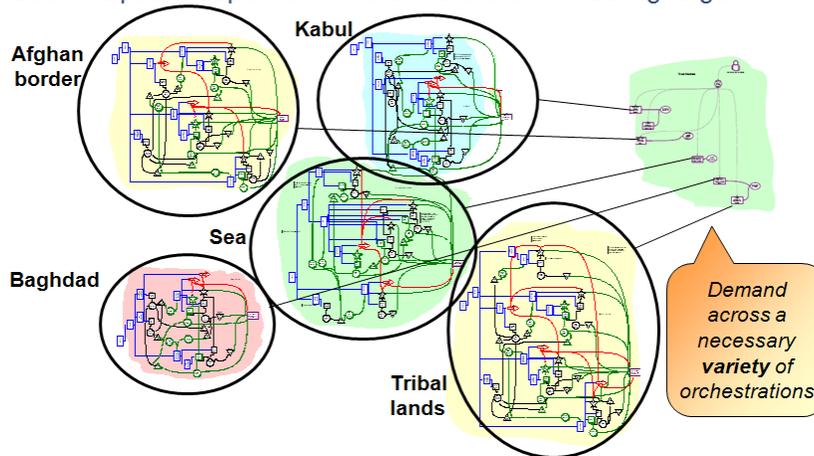
4.1.3 Modeling across the different scales (TUAV III): analysing the variety of orchestrations becomes crucial

For the Hermes 450 UAS and Reaper, while the analytical approach holds good, the picture becomes even more complex because consideration has to be given to the variety of composite capabilities in which TUAV III must participate.

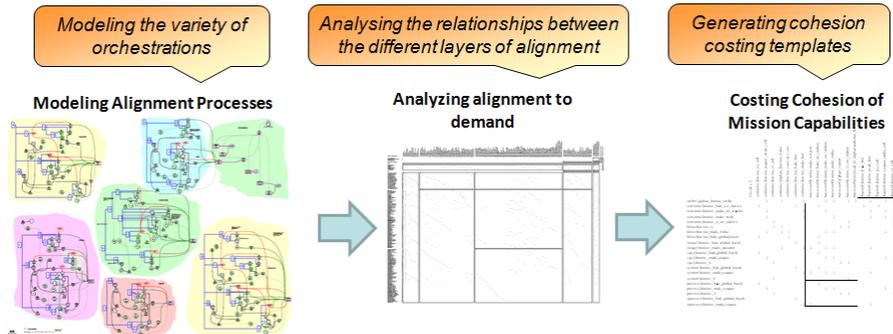
In this example a range of mission types were considered, involving the interdiction of fleeting targets, the range chosen to represent the variety of possible orchestrations.

Much greater tactical agility across a variety of orchestrations (TUAV III)

- Decisive points dependent on the interdiction of fleeting targets



4.2 Analysis across the different scales: cohesion-based costing



The ability to analyse across different scales offers two useful outputs:

- The cohesion costs of any particular decisive point in a campaign
- The range of possible costs across a variety of decisive points across a range of campaigns

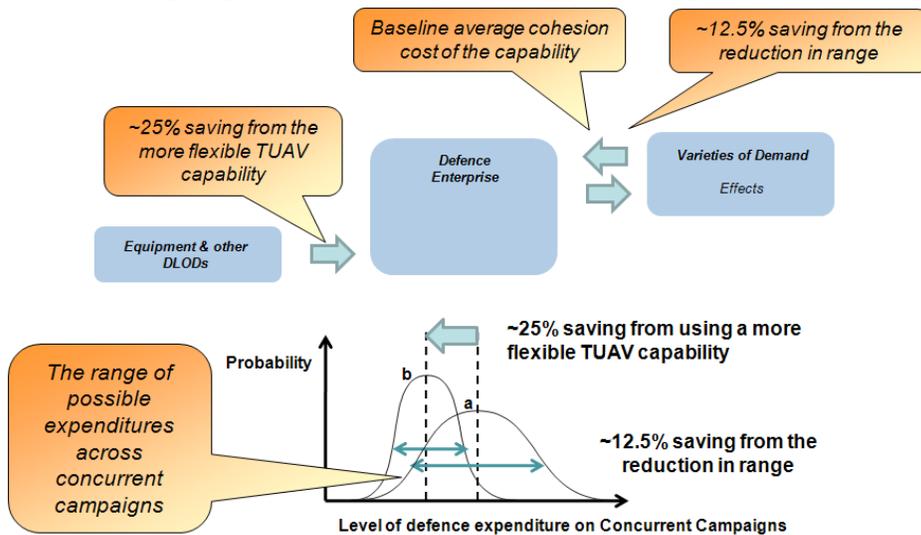
The analysis of these models allows us to extract the different layers of alignment process between the underlying equipment and the ultimate demand contexts, producing templates for the analysis of cohesion costs.

This analysis offers at least two useful outputs:

- the cohesion costs of any particular decisive point in a campaign
- the range of costs across a variety of decisive points across a range of campaigns.

It is this latter point that is of more interest, because this offers a means of assessing the impact of particular flexibilities built into systems on the costs of alignment of the systems of systems or composite capabilities available to the commander. In our case, how does the introduction of particular flexibilities into the TUAV capability impact on the costs of alignment for the variety of composite capabilities used in the range of mission types.

4.3 Pricing Agility: valuing the impact of greater TUAV flexibility



The probabilities can be estimated of different kinds of campaign arising concurrently, and of the incidence of different mission types within these campaigns. Given the cohesion costs of each mission type, we can use monte carlo methods to get this probability distribution of defence expenditure relating to these mission types. The NPV of these expenditures average £3.85bn

Introducing flexibilities into the TUAV change the costs of alignment for these mission types, which has two effects:

- the average expenditure is reduced by £1.05bn, and
- the saving arising from the reduction in variation of expenditures is £0.5bn

The first of these savings is the impact on expenditure that is equivalent to making a capability trade. The second saving, however, arises directly from an increase in agility: a greater variation in timely effect able to be generated from a simplified underlying set of operational capabilities.

4.4 What should the supplier be paid? Determining the maximum price

The analysis of cohesion costs delivers:

- A baseline range of costs of delivering this variety of decisive points
- A lower average cost and a narrower range of costs of delivering this same variety with more flexible TUAV capability

The price should reflect the impact on both the average and the range

