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Niteworks White Paper, June 2014

Continuous Capability Evolution – A Practical Approach to the Acquisition of Modern Defence Capabilities

Mike Wilkinson

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Niteworks is a partnership between MOD[1] and industry, whose purpose is to address those complex operational, capability management and acquisition problems in Defence that can be best addressed through a combination of MOD and industry expertise. A key principle of the Niteworks Way of doing business is to focus on 'exploitation', including the capturing of ideas and know-how created within Niteworks projects for subsequent re-use by MOD and industry. Some of this 'intellectual capital' has the potential to be synthesised across projects and then exploited by the Defence enterprise to achieve strategic and systemic change – in such cases the key ideas are communicated by Niteworks White Papers. Although the Niteworks White Papers draw on contributions to Niteworks projects from across the partnership, they do not purport to represent the consensus view of all partnership members.

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1 Including Dstl.

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Approved for release on behalf of Niteworks by Simon Jewell,
Niteworks Managing Director.

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Introduction and Summary

This White Paper draws on best practice from a variety of Niteworks' projects to describe a practical approach to the evolution of capability through small scale, low risk, increments. The proposed approach – called Continuous Capability Evolution (CCE) – is particularly but not exclusively relevant to the agile acquisition of systems that are primarily composed of fast-spin[2] off-the-shelf (OTS) technologies, such as information and telecommunications technologies (ICT). Key benefits of the approach are:

- the radical compression of acquisition timescales;
- exploitation of technologies at their optimum maturity point, and;
- the ability to incorporate operational lessons with minimal delay.

The approach brings together activities that are traditionally situated at opposite ends of the acquisition lifecycle through combined Capability Concept Demonstration (CCD)[3] and System (or Service) Integration (SI). Variants of the approach have been tested and refined in a wide range of Niteworks' projects, which, taken together, give reasonably high confidence in its effectiveness across a range of measures.

Aim

The aim of this White Paper is to outline the CCE approach and its benefits for consideration by senior decision makers involved in Capability Management and Acquisition. A programme of related exploitation activities is also underway to ensure maximum benefit is derived from MOD's investment in Niteworks.

Key Recommendations

Niteworks recommends that the CCE approach is adopted as a standard acquisition model within the Defence enterprise for 'ICT-rich' capabilities[4]. It is further recommended that the applicability of the model to other kinds of systems is investigated in more detail. The key steps required to achieve the adoption of CCE are, in outline:

- **Sponsorship/Governance:** The CCE approach needs to be championed and appropriately governed by the 2* Joint Forces Command (JFC) community, with aspects of embedding and transformation requiring sponsorship at the 3*/4* level, and with support from a range of other stakeholders, including scrutiny, engineering, commercial, and information system directorates[5];

2 Fast spin technologies are defined here as those that develop and mature at a faster rate than the typical system lifetime or acquisition timescale.

3 In this paper we adopt the definition of CCD developed in DG Fin's approvals guidance document, Sec(EC)/1/7 - Approvals Guidance v10.9 May 2013, as follows: "Capability Concept Demonstrators (CCDs) are intended to aid understanding of overall military utility, or how that utility may best be realised, using mature technologies. CCDs will therefore tend to focus on other lines of development. CCDs will nevertheless contribute to risk reduction in the EP by avoiding inappropriate equipment procurement choices and identifying and validating lower technical risk solutions to capability needs."

4 This phrase includes digital systems of many kinds, including communications systems, portable and desktop IT, other programmable systems and "software intensive systems".

5 D Scrutiny, DE&S D Tech, D Commercial and D ISS.

- **High Level Guidance:** High level guidance on the approach needs to be inserted into the Acquisition Operating Framework (AOF) (including Commercial Toolkit) and Capability Management guidance (the Generic Capability Model (GCM) and Capability Management Practitioners Guide (CMPG));
- **Detailed Guidance:** Detailed guidance on the approach needs to be developed as practical deskbook guidance for stakeholders who need to use the approach;
- **Change Management:** Validation, awareness and adoption of the approach need to be facilitated through a change programme, including a number[6] of CCE 'pilots', with associated training for personnel involved in the pilots.

6 The number and choice of pilots is yet to be determined.

1. Problems with traditional defence acquisition and technology development

Those with long memories and an interest in the defence sector might observe that Defence Acquisition seems to be in a state of never-ending reform. Some reforms[7], like Smart Procurement, the Defence Acquisition Change Programme (DACP), the Defence Acquisition Reform Programme (DARP) and the Materiel Strategy (Mat Strat), have been fairly fundamental. Others, like the System of Systems Approach (SOSA), service-based acquisition and evolutionary acquisition have been more about honing best practice. There is a similar story in the research domain, which feeds the 'front-end' of acquisition, with the sell-off of large parts of the Defence Research and Evaluation Agency (DERA) to form QinetiQ and Dstl at the grand scale, and other initiatives like the Centre for Defence Enterprise (CDE), Defence Technology Centres (DTCs), Towers of Excellence, and so on, at the smaller scale.

Despite this long history of reform a number of underlying problems in Defence Acquisition remain stubbornly intractable. This section aims to outline some of the most important issues, as a precursor to describing some specific issues in section 2, and then moving on to explain how they can be addressed in section 3.

To make the discussion concrete, imagine a (grossly oversimplified) 'traditional' system lifecycle (Figure 1-1), which is a sequence of activities, starting with a perceived need for a military capability that does not yet exist, which feeds a strategic research activity, then an applied research activity, followed by formulation of potential capability concepts and architectures, which are then verified by appropriate analyses and demonstrations, which then trigger an acquisition contract placed on industry, usually through competition and selection of the cheapest compliant bidder. At this point the solution is in theory fixed (including concept, performance, cost and schedule), yet industry still has the hard graft of developing, manufacturing and then integrating the solution. Once the (equipment) solution is delivered to the customer the process of making the solution usable begins, through careful integration of several other strands that have been developing in parallel, such as appropriate manpower, training, support, etc, – the so-called Defence Lines of Development (DLODs)). Only once this whole process is complete can this be called a 'capability', ready for operational use.

7 Although the initiatives mentioned have all occurred during the 21st century, there were many others going back much further.

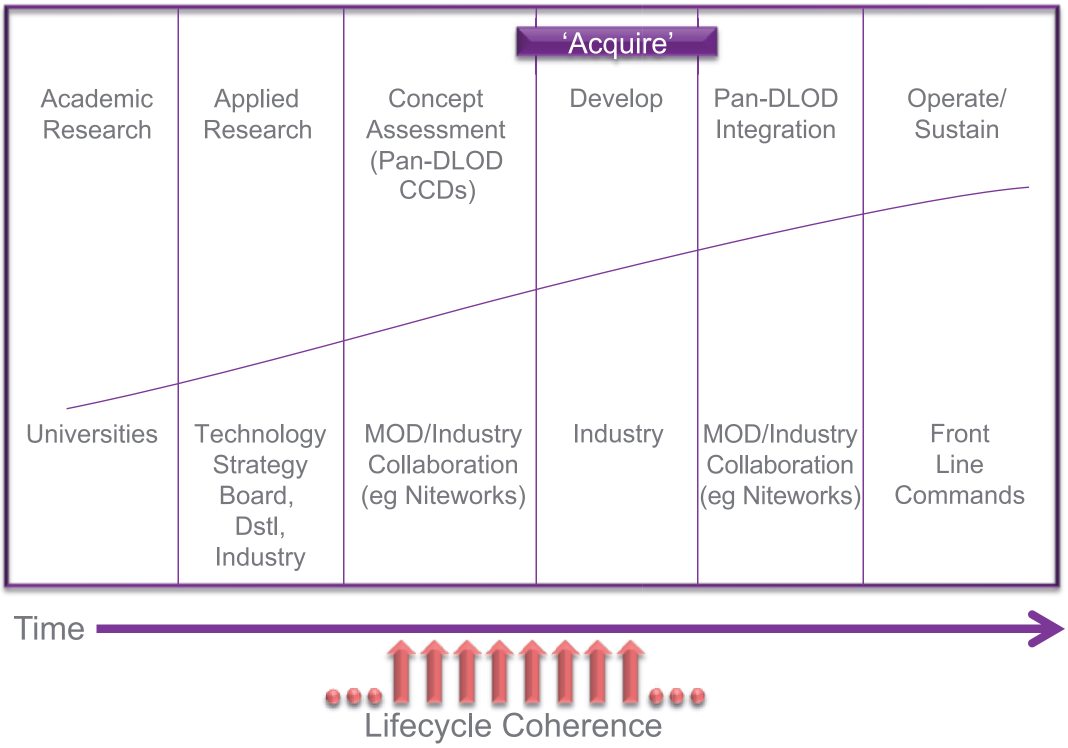

Figure 1-1: Simplified 'standard' acquisition lifecycle

The standard lifecycle[8] is clearly a long drawn-out process, with many stages and many opportunities for things to go wrong – not least the near certainty that something will have changed in the environment, capability need or technology space to render the carefully crafted solution obsolete, or at best sub-optimal. If this situation pertains, it often leads, inevitably, to troublesome consequential changes to commercial arrangements and the non-equipment DLODs. The first fundamental issue is therefore summarised as ***fragility to changed circumstances***.

The next issue concerns the need to align the research activities with the other stages of the process. The first problem is to funnel appropriate research outcomes into the conceptual stages of the lifecycle. This is clearly a 'hit-or-miss' affair, not dissimilar to the problem of aiming a spacecraft into the very narrow re-entry window of the Earth's atmosphere – just a little error either way spells disaster. Even if the basic research is promising, a component has to be developed to the right Technology/System Readiness Level (T/SRL) to be considered for the project. In one scenario, if the readiness level is too low, the project waits for the technology to mature; in another scenario the project proceeds without it. In the former case, a source of funding and development mechanism must be found to bring the technology to the appropriate readiness level. Even then, a suitable technology at a suitable readiness level may not be welcomed by the industry supplier, particularly if the supplier was not responsible for developing

8 Based on MOD's well-known Concept, Assessment, Development, Manufacture, In-Service and Disposal (CADMID) model.

the technology or perceives that adopting it transfers risk to him. Finally, the process can be so long that the technology is obsolete by the time it is fielded; the 'directed' nature of the process also means that it does not work well with disruptive technologies. As a shorthand, this second set of interlinked issues can be labelled the ***technology exploitation challenge***.

The next issue relates to requirements. The Defence acquisition process thrives on requirements: user requirements, system requirements, test requirements, and so on. They are an intrinsic part of the acquisition process and form the basis of contractual agreements. The idea of top-down requirements-driven capability acquisition is so familiar and has become so entrenched it almost slips by without remark. However, it is not the only way of thinking and it carries its own risks. It is obviously a good idea to avoid military requirements owners being 'polluted' by excessive knowledge of existing solutions and to encourage them to think a little more abstractly about the 'real requirement' – but this abstraction can be taken too far, leading to vague and unfocussed requirements. At the opposite extreme, requirements can be produced in great profusion and (apparent) precision, leading to over-specification. At either extreme, the standard process does not readily or sufficiently early take account of the 'art of the possible' which would set expectations and avoid the unknowing 'baking in' of requirements that are unachievable, or at best are cost drivers. Nor does the standard process have ready mechanisms for accommodating technology opportunities in a 'bottom-up' fashion. These issues are compounded by a general over-reliance on the written word to express requirements and insufficient use of visualisations and models; this typically results in poor clarity and incoherence. A final point, as a special case of the first issue above, is that the standard process does not handle changed requirements well. This set of issues is codified as ***susceptibility to poor requirements***.

At the core of the acquisition process is the commercial arrangement between industry supplier and MOD customer. The government's stated preference is for competitive contracting in the international marketplace. This sort of approach works very well for simple commoditised items available from a well-functioning market – but is much less successful when it comes to acquiring a complex capability from a monopsonistic[9]/ oligopolistic[10] market, as persists in the UK Defence market. In the latter situation, the "conspiracy of optimism" obtains: MOD aims high, industry bids low (for what might be the only opportunity in a generation for some domains); the cheapest compliant bidder is awarded the contract – and then the trouble starts. Cost escalation, schedule overruns, re-profiling and disappointment are typical consequences, particularly when there is reluctance to trade requirements if things start to go wrong. Nor is this the only problem. Big contracts tend to be 'attractors' for related capabilities, making them harder to manage, even making them "too big to fail". Prime contracting tends to squeeze out the smaller players, often closing the market to small and medium sized enterprises (SMEs) and inhibiting potential innovation pathways. It can also lead to 'contractor lock-in', where MOD's courses of action are severely curtailed. Finally, commercially taut contracts tend also to be very inflexible, making it costly and difficult to accommodate meaningful change. This set of issues is the ***commercial strait-jacket***.

9 A monopsony is a market with only one customer.

10 An oligopoly is a market with a small number of suppliers, who control the market.

Another unstated premise that goes without remark is the idea that acquisition problems must be broken down into manageable parts, such as discrete projects. Projects are intended to cohere into programmes and they come together through the DLODs to provide military capability. Considerable work has been invested in MOD to transform this aspect of the problem, starting some years ago with Through-Life Capability Management (TLCM) and progressing through a series of further transformations in response to Levene's operating model[11], which clearly identifies the Military Commands as having pre-eminent responsibility for pan-DLOD capability. Whatever model is adopted for end-to-end capability management, the standard acquisition model typically results in loose-coupling between users, equipment suppliers and adjacent systems. Although intentions are invariably good, there is in practice too little attention given to involving real users in the acquisition process, or to providing any form of meaningful capability/pan-DLOD/system-of-systems level coherence. This is the issue of ***capability incoherence***.

These five issues, inherent to the standard acquisition process as practised in the UK, are identified here as the fundamental barriers to effective capability acquisition. It should be noted that the standard process is by no means the only one; there is also a very important Urgent Operational Requirement (UOR) process, widely used in recent years, that trades away many desirable acquisition outcomes in favour of speed. The UOR process in its 'raw' form is not a serious contender for complex capability acquisition – but it has many attractive features and the approach proposed here draws heavily on Niteworks' practical experience of UOR integration, over several years, in support of recent operations.

11 See "How Defence Works", Version 4.0, 1 April 2014, available from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/302419/20140409-how-defence-works.pdf

2. Additional problems for modern systems

As if the challenges relating to traditional acquisition were not enough, the situation is immeasurably worse when we try to apply the standard model to *modern digitally based* systems. Such systems are astonishingly rich in 'fast-spin' digital technologies, and often stretch across multiple lines in the DLODs, resulting in such complexity that failure is all too frequent. Outside of Defence the situation is no different: the latest Range Rover reportedly has over 100M lines of code; the Airbus A380 has over 80M lines of code; on average 70% of project costs occur in operations and maintenance, and; 50% of outsourced projects fail to meet their objectives. This section describes a range of issues that are peculiar to modern systems and which represent the true challenge that Defence must address.

It is clear that many of today's military systems are actually digital systems – these days even weapons-bearing 'platforms', such as aircraft carriers and armoured vehicles, need to be thought of as mobile information systems. It is well known that digital technologies evolve at breakneck speeds and that many such technologies have a 'disruptive' effect on the way businesses operate. Yet, even while the rate of digital technology development accelerates, the development rate of the 'heavy metal' aspects of systems remains largely unchanged. A single lifecycle for acquisition, with gates and decision points fixed in time for all aspects of the system, is incapable of accommodating fast and slow spin technologies at one and the same time. One could go further and observe that the traditional engineering approach itself is incapable of dealing with such hybrid systems. This is the ***hybrid fast-spin/slow-spin system lifecycle incompatibility problem***.

As digital technologies increasingly infiltrate all aspects of life, the ability of the Defence enterprise to influence or shape these technologies significantly, let alone lead in their development, becomes ever more fanciful. Defence R&D budgets are dwarfed by those outside of Defence and it is no surprise therefore that Defence must increasingly rely on re-use of generic technologies packaged into Off-The-Shelf (OTS) products and system elements. Whilst it has always been the case that OTS components have been used in Defence systems, the 'granularity' of such re-usable elements is coarsening. Furthermore, the intrinsic complexity of digital technologies demands high levels of re-use, again driving system design towards integration of already existing elements. The traditional acquisition lifecycle is poorly matched to problems where the majority of the system elements are of necessity OTS. In particular, the top-down requirements and design driven process does not adequately reflect the practical constraints imposed by the need to use OTS and re-use existing solutions more generally. This is the ***presumption of requirements and design freedom***, which does not reflect reality.

Another consequence of the unstoppable rise of digital technologies, such as the internet and social media, is the democratisation of innovation[12], particularly in information systems. No longer is technology innovation the sole preserve of large companies or government departments with impressive research budgets; it is just as

12 See for example "Democratizing Innovation", Eric Von Hippel, MIT Press, London, 2005.

likely that tomorrow's technology innovations will come from new entrants that may not even exist today or that may currently be small companies. Although Prime Contractors have always fostered innovation through the supply chain, there is an historic power shift taking place away from the Primes and towards SMEs, specialists and even users. The traditional acquisition model, based on Prime Contracting, is out of kilter with this new situation[13]. Government policy has recognised this by stating that it is aiming for 25% of contracts (by number) to be passed out to SMEs but this, of itself, does not address the fundamental issue of the ***changing locus of innovation***.

The prevalence of 'fast-spin' technologies in today's systems is also a problem for broader pan-DLOD coherence. The traditional approach to achieving coherence separates the equipment DLOD acquisition from the other DLODs and relies on capability managers to provide appropriate training programmes, doctrine and so on. This is difficult enough to manage when systems develop on 'heavy metal' timescales, but is very challenging when application upgrades may be desired on a timescale of weeks, if not days. Equally, the traditional model has no real mechanism for operational lessons to influence an in-flight acquisition, nor to provide regular influence to in-service upgrades. Furthermore, in many cases, poor pan-DLOD coherence inhibits the ability of end users to play their part in stimulating innovation. This set of issues results in the problem of ***operational decoupling***.

All of these issues must be addressed head-on if Defence is to have the best chance of optimising its acquisitions and consequential operational effectiveness. Many organisations face similar problems – those that address them well gain competitive advantage. The next section describes, on the basis of lessons from of a broad range of Niteworks projects, how this might be done.

13 The Centre for Defence Enterprise (CDE) has a role to play here but does not yet form part of a robust innovation lifecycle.

3. Continuous Capability Evolution

This section proposes an approach to the acquisition of modern systems that is pragmatic, ie based on what is known to work, yet explicitly accommodates the need for agility and innovation. Although this approach preserves much of the standard acquisition best practice and could be regarded just as a particular way of accelerating CADMID acquisition, at its heart, the approach embodies more than this; it reflects a different conception of complex systems engineering and of the capability management lifecycle. The approach is called **Continuous Capability Evolution**, or **CCE**.

The first idea underpinning CCE is ***continuous change***. A direct consequence of having to accommodate 'fast spin' technologies is a necessary shift towards a temporal perspective that is much more compressed, and much more 'fine-grained', such that each small developmental increment comes hard on the heels of the previous one and there is a blurring of the boundaries between increments, which creates an impression of continuous change. One way of visualising this shift of perspective (Figure 3-1) is to redraw the traditional lifecycle such that time goes up the vertical axis and a single end-to-end lifecycle is then a rising line across the 'swimlanes' of each lifecycle stage. Focussing attention on each swimlane then allows them to be seen as (pseudo-) continuous activities – continuous research, continuous concept demonstration, continuous development, continuous integration and continuous operations.

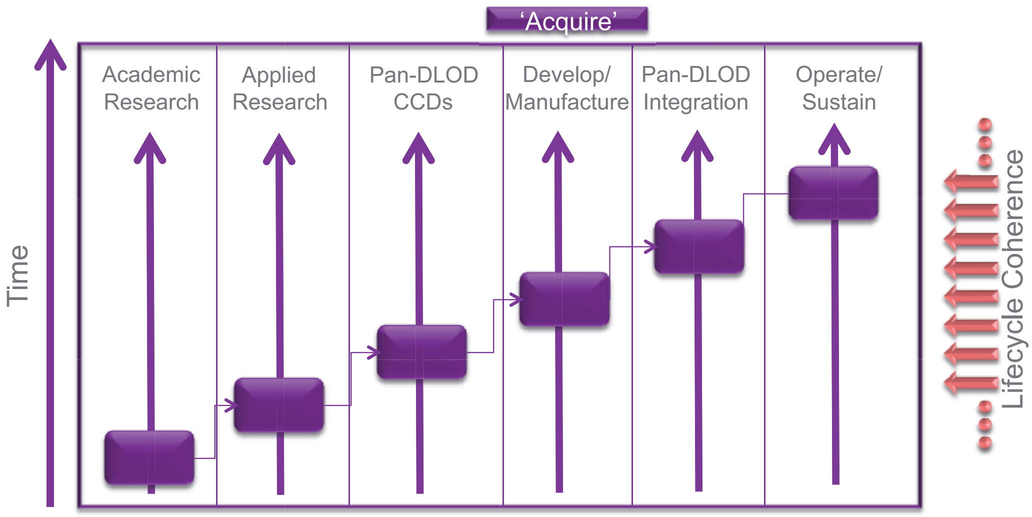

Figure 3-1: Continuous acquisition lifecycle

This idea of continuous stages has been mooted many times before in Defence – for example the Acquisition Operating Framework (AOF) already explicitly allows for an Evolutionary Acquisition (EA) approach, consistent with CADMID, although it provides very little guidance on how it could be implemented. Of course, CCE is broader than EA, covering all phases of the lifecycle but it is not inconsistent with the evolutionary approach.

The second idea underpinning CCE is the availability in some areas of ***external research and existing OTS 'plug and play' capabilities*** (products, system elements or services). In a world where a large amount of commercially developed Intellectual Property (IP) already exists, the need for MOD-funded research to support a capability need is much reduced; early work should survey what is 'on-the-shelf' and available for exploitation. Similarly, it is likely to be productive to approach the existing IP from an opportunity perspective, to see exactly what might be done with the available technologies and whether that might be useful operationally. This reduces the need for MOD in-house research to support fast-spin OTS technologies, shortens the front end of the lifecycle, and allows precious S&T funds to be spent elsewhere. As modern technologies 'spin' very quickly, the OTS survey/opportunity investigations must take place frequently, and this supports the notion of (pseudo-) continuous activity[14].

The opportunity-driven approach also ensures that technology is exploited at the most appropriate stage in its own maturity lifecycle, when it is still fresh and far from obsolete. In principle, OTS technologies are, by definition, high TRL and 'ready to use'. In practice, this is always subject to appropriate configuration and integration – which is where the real risk of opting to use OTS elements resides. The challenge of integrating OTS fast-spin technologies should not be underestimated – it must be undertaken by those with appropriate integration expertise and with a willingness to be flexible and accept compromises when necessary. Nevertheless, such integration is feasible and is achieved routinely in all manner of businesses; importantly, the benefits of using OTS elements outweigh these challenges. Although the CCE approach is focussed on OTS elements, a degree of 'horizon scanning' for emerging but high TRL technologies can inform the continuous evolution process on appropriate near-/medium-term timescales. In some cases, it may also be possible for MOD to influence the OTS pipeline to better address defence-specific needs.

Although the integration challenge should not be underestimated, it is in some respects greatly simplified because OTS technologies are typically designed in accordance with international standards, and an implicit (or explicit) modular integration architecture. This property can be used to manage coherence of system elements, overall systems, and systems of systems across the continuous change lifecycle. In fact, one of the primary disadvantages of using OTS elements, namely that changes are not controlled by the acquirer but by the market, is also mitigated by the existence of an integration architecture – market driven innovations will often be designed to work within the existing architecture, or provide backwards compatibility. Hence the existence of such an architecture is likely to be a critical success factor in the use of OTS.

Finally, the predominant use of existing OTS elements means that development and manufacturing timescales are greatly reduced, if not removed altogether, further compressing the whole lifecycle timescale. Even if some development is required, it should be incremental, building on what already exists and thereby controlling risks.

14 Of course, adoption of this perspective does not remove the need to justify in 'business' terms the benefits that would be provided by use of any particular existing product, system or service.

The third idea underpinning CCE is the ***coalescing of CCD and pan-DLOD integration activities*** into single investigative ‘events’, which are then organised into a series of such events, iterated through time. In the situation where little or no development is being undertaken and OTS elements are being used on an opportunity basis, concepts can be developed and refined through tangible demonstration activities which, inter alia, address a variety of technical integration, training, security accreditation and operational process issues, thus focussing on key requirements (and massively de-risking solutions). If the real users are involved in this activity, then feedback from the operational perspective is immediate and there is a very strong synergistic coupling between concept and use. This sequence of combined ‘events’ then constitutes an open innovation process, including feedback and optimisation, and the events define the drumbeats for planned capability increments. The sequence of drumbeats allows momentum to be preserved in the development of the capability and helps to avoid ‘gapping’. The events themselves focus on integration and configuration rather than development or manufacture, although they also take account of expected near-term developments in OTS that will be available for future events. The outputs from the CCE events feed an appropriate and specific acquisition activity, driven by operational imperatives, thus improving the understanding of and rationale for particular requirements. The high-quality, low-risk and high-specificity user and system requirements emerging from this process[15] lead to straightforward and immediate acquisition options, supported by coherent pan-DLOD actions.

The three ideas described above define a process for undertaking CCE for fast spin technologies. The ideas are shown visually in a process form in Figure 3-2 below. In the situation where fast and slow spin considerations are both present, the CCE model below should be applied for the fast spin elements and this should overlay a separate traditional process for the slow spin elements.

15 The requirements are documented in standard acquisition documents such as User Requirements Documents (URDs) and System/Service Requirements Documents (SRDs) - but the form of these documents is concise and focussed, specifically to support the acquisition of fine-grained capability increments through the integration of COTS elements.

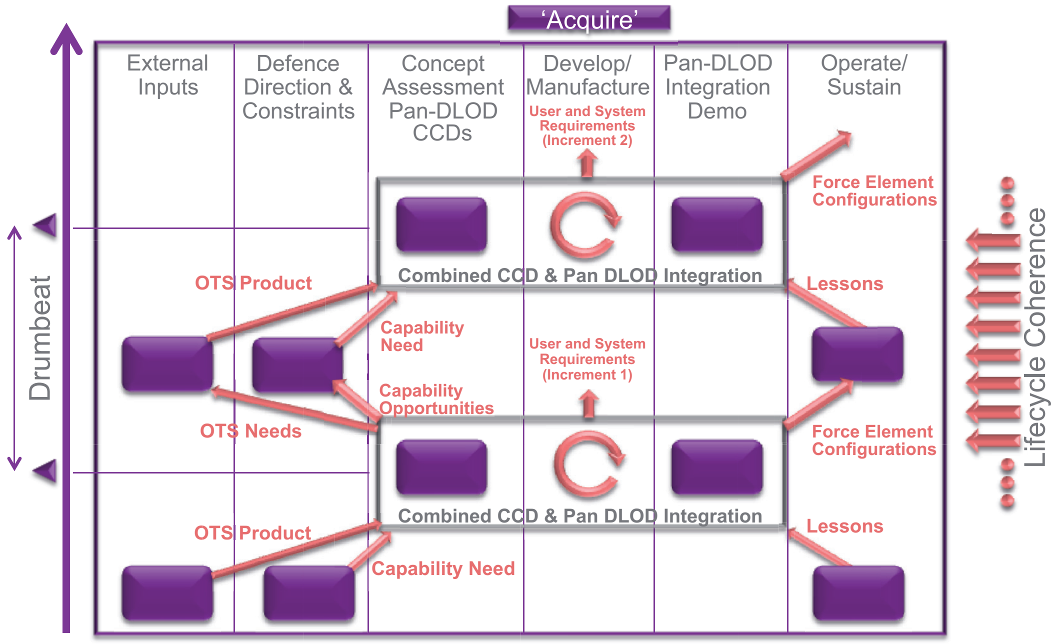

Figure 3-2: CCE lifecycle

The final idea in CCE is a structural one: namely, there is a need within CCE for a ***specific structure to support innovation*** – but with very close coupling to operations and acquisition. Structurally, three roles are important for implementing CCE:

- **Operations:** the operational role is supported by current or recent operational personnel[16] with experience of the kind of capability being developed. It provides experience to support decision making related to capability priorities, an assessment of the likely benefits of particular technology opportunities and support to the development of appropriate operational doctrine and processes for the capability. In so doing, it allows realistic intervention opportunities to be identified and understood. The operational role brings into service each capability increment provided by the acquisition function.

- **Acquisition:** the acquisition role is supported by MOD's acquisition professionals, along with their commercial and financial functions. This role provides the mechanism for turning user and system requirements developed through the CCE events into delivered capability through the usual mechanisms. The CCE process, however, simplifies the acquisition function and associated approvals by delivering optimised requirements that are realistic, clear and 'market tested'. In this model, the traditional 'prime contractor' role becomes a 'system integrator' role, with responsibility for delivering integrated systems. This system integrator role needs to be kept separate from the Innovation Hub role (see below) to avoid conflicts of interest arising. The Commands must take on the 'capability integrator' role with responsibility for

16 In the event that there are no operations and no such experience to call on, the experiences of individuals gained in exercises and similar will substitute for this.

delivering integrated pan-DLOD capability. As in standard capability management practice, this requires alignment of all DLODs associated with each capability increment but in this case such alignment is strongly supported through the CCE events. Although the acquisition role in CCE is essentially the same as in the standard acquisition process (including the use of competition), some degree of cultural transformation may be required, such as in the approvals and scrutiny functions, to ensure the successful embedding of CCE. This transformation may require senior (3*/4*) sponsorship and endorsement.

- **Innovation Hub:** this role is responsible for providing the core capability for constructing and managing the conduct of the CCE events, including bringing together the required range of stakeholders, such as technology suppliers, specialist suppliers, system integrators and military professionals ('intelligent users'), into the events. The role then produces draft requirements for endorsement by the operational role and subsequent action by the acquisition role (or appropriate DLOD owner). The activities performed by this role are in some respects similar to Applied Research and Concept/Assessment Phase activities in CADMID but they differ in that there is very tight coupling to the Operational and Acquisition roles and they operate in a much more agile way. In other respects the activities are similar to those undertaken by the System Integrator role in some acquisitions but differ because they operate in an impartial 'sandboxed' environment, deliberately kept isolated from 'live' operational systems. Critically, the Innovation Hub role is underpinned by the use of architectural methods and tools to ensure that there is lifecycle traceability, coherence and integrity – ultimately MOD must take ownership and 'design authority' responsibility for these architectures and reflect them in the operational system[17].

There is only one new organisational role in this model: namely the Innovation Hub. It is envisaged that this role would need to be fulfilled by an impartial combination of suppliers, acting in close concert with MOD, via the mechanisms of open innovation. The Innovation Hubs might have to be domain specific (eg ISTAR or OSINT) for optimum effect – although they should not be drawn too narrowly as this will create unnecessary tensions across boundaries. In any event, the Innovation Hubs should be responsible to the appropriate Command – Joint Forces Command (JFC) in the case of most ICT capabilities – which allows full harmonisation with the capability management practices now being implemented across the Commands. To be clear, the need for a comprehensive architectural underpinning to support evolution and the need to ensure coherence across different areas of capability requires appropriate governance mechanisms to be implemented within and across the Commands.

17 The companion Niteworks White Paper on *Styles of Architecting* provides more detail on the variety of different styles of architecting required to support Defence.

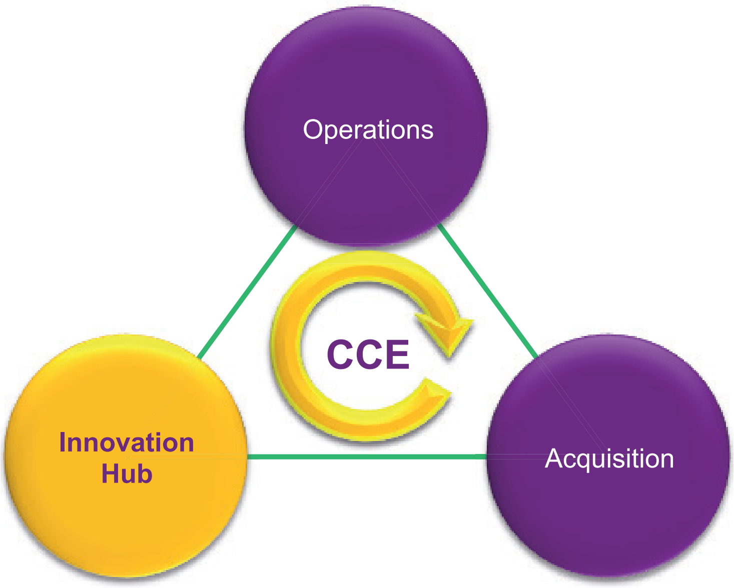

Figure 3-3: CCE organisational construct

Taken together, the four elements of the CCE concept outlined above (1. continuous change, 2. use of external research and existing OTS capabilities, 3. coalescing of CCD and pan-DLOD integration activities and, 4. the Innovation Hub structure) address the generic and modern system acquisition issues described in earlier sections. Several Niteworks project examples that have guided the development of the CCE approach are described in the Annex to this paper. In these examples, Niteworks has fulfilled the role of Innovation Hub, engaging MOD and industry within an agile, flexible, "safe to fail" innovation environment and spinning out requirements documents, training and other outputs/outcomes across iterations – without impacting the viability of subsequent competition. These example projects provide considerable comfort that the proposed approach is realistic and viable, although further validation is needed to confirm that the approach will 'scale' to very large projects. This does not, of course, mean that Niteworks is the only or the best construct that could potentially fulfil the Innovation Hub role, but it does highlight that any suitable construct would require similarly clear funding, commercial and legal arrangements[18] to ensure that collaboration could take place without compromising competition. The emerging Defence Growth Partnership (DGP) might provide a suitable vehicle for implementation of an Innovation Hub to address some of the larger scale acquisition challenges facing MOD.

Although the CCE approach has been synthesised primarily from recurring concepts used in a variety of Niteworks projects, it has many precursors in Defence and beyond. It aligns with the latest thinking in agile commercial ICT development[19] and is consistent with the agile approach proposed to address similar problems in the US DoD[20].

18 Including background IP protection and foreground IP sharing.

19 See, for example, IBM's "DevOps" approach, available from www-01.ibm.com/software/rational/innovate.

20 US DoD's "CIO 10 Point Plan for IT Modernization", available from http://dodcio.defense.gov.

From a MOD perspective, the approach builds on MOD's SOSA principles[21], the Technology Enterprise Model for Defence (TEM)[22] and in the avionics domain the Rapid Affordable Capability Evolution (RACE)[23] project. Finally, the approach resonates strongly with several key themes in the recently issued Defence ICT Strategy[24], for example:

"A limiting factor to date in our deployment of ICT has been the manner in which we express the requirement and the benefits we seek, which can exacerbate our occasionally weak understanding of the information needs and flows to be enabled. Users get the most from ICT when they have had an opportunity to explore its potential and this greater understanding shapes the way in which they choose to work. It is rare for a detailed upfront specification to match this more iterative approach either in user satisfaction or in the realisation of benefits. In a complex, adaptive system, a series of 'safe-to-fail' experiments in applications' design and deployment are more likely to yield positive results, and introduce innovation, than adherence to the meticulous, up-front specification of ICT solutions."

The CCE approach takes these ideas and initiatives further by showing how such an approach can be made to work in practice in the Defence context for a range of typical fast-spin problems. This has been achieved through the use of MOD's well-established Niteworks construct, drawing on its resolutely pragmatic focus ("learning by doing") and its emphasis on exploitation.

In summary, the CCE approach, as implemented via the operations/innovation/acquisition structure, is proposed as a practical means to deliver the following significant benefits for a range of fast-spin problems and potentially beyond:

- Timescale compression/cost saving (or avoidance) by use of OTS technologies and simultaneous DLOD development;
- Ability to exploit technologies at the optimum maturity point;
- Continuous lifecycle phases matched to fast-spin technologies;
- Early requirements challenge and shaping;
- Informed decision making through tangible demonstration;
- Ready absorption of operational lessons;
- Low risk acquisition of well-defined incremental capabilities;
- Open innovation encouraging SME participation;
- Coherence through architectural integrity;
- Capability agility and flexibility;
- Decreased development and in-service costs giving more affordable solutions.

21 "Design Principles for Coherent Capability", JSP906, Issue 1, Nov 2011

22 The TEM was proposed by D S&T Ops in 2009 but never implemented by MOD.

23 RACE was an initiative begun by Dstl.

24 Defence Information and Communications Technology Strategy, October 2013.

Conclusions and recommendations

The problems of MOD's traditional approach to acquisition are endemic and stubbornly intractable. These problems are multiplied in the case of complex modern systems based on rapidly evolving digital technologies. A new model of acquisition that is rooted in existing best practice is required to address these problems: the term coined for the approach proposed by Niteworks is Continuous Capability Evolution. The key features of CCE have been tested and honed in a variety of Niteworks projects, thus bolstering confidence in its viability and applicability more widely across Defence.

Niteworks recommends that the CCE approach is adopted as a standard acquisition model within the Defence enterprise for 'ICT-rich' capabilities. It is further recommended that the applicability of the model for other kinds of systems is investigated in more detail. The key steps required to achieve the adoption of CCE are, in outline:

- **Sponsorship/Governance:** The CCE approach needs to be championed and appropriately governed by the 2* JFC community, with aspects of embedding and transformation requiring sponsorship at the 3*/4* level, and with support from a range of other stakeholders, including scrutiny, engineering, commercial, and information system directorates[25];
- **High Level Guidance:** High level guidance on the approach needs to be inserted into the AOF (including Commercial Toolkit) and Capability Management guidance (the Generic Capability Model (GCM) and Capability Management Practitioners Guide (CMPG));
- **Detailed Guidance:** Detailed guidance on the approach needs to be developed as practical deskbook guidance for stakeholders who need to use the approach;
- **Change Management:** Validation, awareness and adoption of the approach need to be facilitated through a change programme, including a number of CCE 'pilots', with associated training for personnel involved in the pilots.

25 D Scrutiny, DE&S D Tech, D Commercial and D ISS.

Annex A: Examples of continuous capability evolution in action

Open Source Intelligence (OSINT)

Case Study contributed by Steven Harland, Niteworks Intelligence Programme Lead

Context

In 2013 MOD articulated its vision for the development of an enhanced Open Source Information (OSINF) gathering and Open Source Intelligence (OSINT) analysis capability. The vision recognised several significant elements of change, including far reaching changes in intelligence processes, burgeoning data and information technologies and the impact of austerity measures on resources.

Based on this vision the MOD defined a requirement for a Capability Concept Demonstrator (CCD) which examines the means of delivering an Open Systems information and data analysis capability. The CCD is now nearing the end of Phase 2 of the evaluation cycle and a working model has been established. A key aspect of the next phase will be to establish an acquisition approach that delivers the unique demands of OSINF collection and OSINT analysis.

Approach

The CCD established a multi-disciplinary industry team of current information specialists, with experience in infrastructure, data, security and intelligence. Emphasis was placed on a process of Action Based Research as an enabler for innovation building on a physical infrastructure trialled for security during the 2012 Olympics. A key focus was on establishing close collaboration with stakeholders within MOD and outreach to OGDs and agencies, and more broadly to partners in industry, academia and research.

The approach has used a programme of experimental sprints[26] based on intelligence Requests for Information (RFIs) (from the MOD Customer) covering a broad range of issues from strategic intelligence concerns through to specific Counter Terrorism and Counter Proliferation. Analysts were trained using a new curriculum for use of the CCD active system and the execution of the ‘sprints’ with the analysts allowed continuous and iterative development of a candidate OSINT solution approach as part of a process of feedback and continuous change. The evolving solution pack iterated versions of the physical infrastructure, functional architecture, security and risk management and OSINT operating processes, and these were captured in a MODAF model for traceability.

To address capability development across all DLODs, an OSINF Services Framework was developed that defined a set of information services to be provided to analysts in order to respond to commanders’ requirements.

26 The idea of sprints is borrowed from agile software development – each sprint is a focussed, intensive and time-bounded activity.

An innovation hub was established (outside of the operational sites) to provide a sand-pit for testing core capabilities, co-ordinating the experimental sprints and engaging technology suppliers and integrators. Continuous interaction with industry was central to the learning cycle, which was based on a model of “contribute, collaborate and challenge”. This activity facilitated consideration of existing OTS capabilities (products, system elements or services). In addition, close involvement of, and collaboration with, MOD accreditation and legal specialists enhanced and accelerated the understanding and viability of potential OSINT solutions. These processes ensured that the CCD was aligned with pan-DLOD integration activities into a series of investigations addressing technological, people and process issues.

The CCD has further developed the innovation environment by exploring acquisition approaches for the agile on-boarding of OSINF services. OSINF gathering and OSINT analysis places great demand on acquiring techniques and capabilities which can be applied and developed at tempo. In order to achieve this, the CCD evolved a robust evidence-based requirement, aligned to the new ICT Strategy (draft) and worked with the supplier base to align their commercial models.

Insights

The CCD has provided the following insights:

- An Open Innovation environment involving industry and MOD provides a robust and effective framework for rapid de-risking of capability development associated with the Concepts, Assessment and Demonstration phases of CADMID;
- An innovation hub provides a focus for enabling activities, including technology watch with rapid, applied, research and development to test and evaluate the best techniques, but needs to have conceptual and physical distance from operational sites;
- A multi-disciplinary team (technical and functional) working in highly collaborative manner over a series of experimental sprints and technology scrums facilitates DLOD integration;
- Industry participation significantly contributes to CCD evolution, but needs to be mediated through an Open Innovation process;
- Service-based frameworks suggest an outcome- (or acceptance-) based approach to requirements. Engagement with the acquisition community provides the mechanism for translating service specifications into viable commercial frameworks. CCD activity is fundamental to the maturation of service needs matched to service candidates in catalogues.

Brockworks

Case Study contributed by Steve Rawsthorn, Niteworks Brockworks Project Manager

The Major Projects Authority tasked the Head of ISS Programmes with “proving the viability of delivering a commodity IT service within the intent of the rules and to demonstrate achievability of service transition”[27]. Niteworks was tasked to run a demonstration programme, subsequently named Brockworks, which developed and executed an investigation to assess the viability of, and examine the barriers to, providing rapid acquisition of services within the Defence Communications Network Services (DCNS) portfolio, and to begin to explore the service portfolio transition path.

A small team of subject matter experts was selected to design and build a demonstration environment in less than three months. Rules, particularly on commercial constraints, were adapted where necessary but these derogations were captured, and the result was a working demonstrator of a secure (but non-accredited) cloud-based collaborative environment.

The project was conducted in an agile fashion using ‘scrum’ techniques. It consisted of an initial phase of problem analysis followed by high level design work using the team’s industry experts. The high level design was ratified via an industry workshop and was then turned into a logical and physical design, which was implemented in hardware and software in just over three weeks. Throughout, lessons and insights were captured to inform the original customer requirement and the design was iterated accordingly. In parallel, a commercial investigation was conducted; this was wide-ranging, and examined the procedural and cultural issues and blockers surrounding the rapid acquisition of complex commoditised services.

It was intended that the project should consist of a number of design phases and physical build implementations in a series of short ‘sprints’ or ‘drumbeats’ similar to an agile software development methodology. The candidate design was planned to last six weeks, followed by a series of security and integration sprints over individual one-month periods. The process is summarised in the diagram below:

27 “service transition” refers to the MOD’s stated intent to transition to a new portfolio of DCNS services, acquired through service acquisition rather than system acquisition.

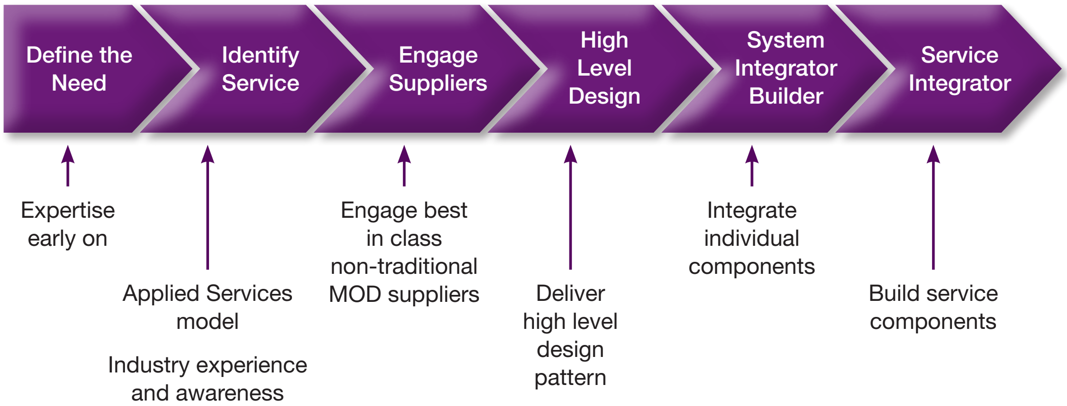

Figure A-1: The Brockworks process

Brockworks Project Approach

The candidate design phase was split into stages to ensure that the Customer need was fully met and that the overall focus of agile acquisition was maintained at all times. The solution was built using a set of commercially available off the shelf products that were integrated to provide a solution to address the stated needs.

The project's findings were varied; some were technical and related to the current mandated security accreditation and architectural processes within ISS, others were more cultural, for example in the commercial domain.

High level findings included:

- The project approach was successful and has wider utility. Key features included the use of a group of experts who were given a high degree of autonomy and who, whilst cognisant of security and commercial rules, and existing process, were not necessarily bound by them. The concept of "fast but safe failure" was also important.
- There is a need for an enduring Brockworks-like demonstration and integration capability embedded within the ISS way of doing business;
- The buying of preconfigured services, rather than building them from scratch, and maximising the use of COTS rather than bespoke functionality, resulted in notably faster delivery of capability and reduced costs compared to a 'traditional' approach;
- The use of Cloud services proved to be more flexible, scalable and agile, with significantly more elastic charging mechanisms, compared to the purchase of dedicated physical hardware;
- The longevity and functionality benefits of buying at the correct point on the "technology hype cycle"[28] are significant, compared with the practice of introducing technology that is already obsolete;
- There is a wide range of technical, commercial and security limitations on procuring complex commoditised IT services;

28 As defined by Gartner, see http://www.gartner.com/technology/research/methodologies/hype-cycle.jsp

- There is an enduring need for high levels of technical competence from the earliest stages in a Brockworks style project;
- There is enduring need for trusted system and services integration functions to achieve agile service acquisition.

The project achieved a number of concrete results that generalise to 'fast-spin' technology acquisition in the wider MOD:

- The demonstrator approach allowed the 'doing' process to tease out insights that could not have been achieved by purely intellectual or workshop techniques.
- The use of cloud-based services would offer a viable transition path to agile service acquisition for MOD ICT. The many benefits of 'cloud', such as elasticity of service and pay-per-use charging models, together with lower capital expenditure, could result in quick wins if the move to such services were managed appropriately.
- The project showed that fine-grained agile service acquisition, building end-to-end services from pre-defined commercial offerings, is a viable approach given a supportive demonstration, integration and commercial environment. However, this environment must be staffed with appropriate experts who have the knowledge and experience to specify and deliver capability at the required level, and in comparatively short timeframes.
- To realise the benefits of moving to agile service acquisition, changes would be required to some of the ways of working within MOD. Some of these are already in train (such as the emerging use of architectural and security 'patterns') but others, such as the cultural change required to move to the use of less rigid commercial constructs, would be potentially more problematic.

C4ISR for the Front Line

Case Study contributed by Al Campbell, Niteworks Tactical C4ISR Programme Lead

In mid-2011, Niteworks was tasked to support Mission Specific Training for operations in Afghanistan over three six-month brigade roulements. The aim was to enhance C4ISTAR capability achieved by (not simply provided to) brigades on operation, since many Urgent Operational Requirements (UORs) historically lay unused due to poor integration and training. The task was to ensure that the raft of latest C4ISTAR UORs was made available to the training audience and that the training adequately prepared personnel to use them. Since these new systems were frequently still in manufacture or acceptance when pre-deployment training was being undertaken, adequate fidelity emulations had to be designed and incorporated into the training at a few weeks' notice. Moreover, since this was fast-paced pre-deployment preparation, poor outcomes and delays were unacceptable. A novel training Capability Concept Demonstrator (CCD) approach presented emulations that were iterated with different users over several weekly cycles to develop operational ways of working and refine the emulations or even real equipment. A genuinely pan-DLoD solution was defined and, although not initially planned, adopted by Army HQ and the Permanent Joint Headquarters in directing changes in the operational C4ISTAR laydown in Afghanistan. Perhaps most importantly for the longer term, the real requirements were developed and understood by both the users and the industry developers as the two communities worked together day-to-day on the training events. The outline of this approach is shown in Figure A-2 below.

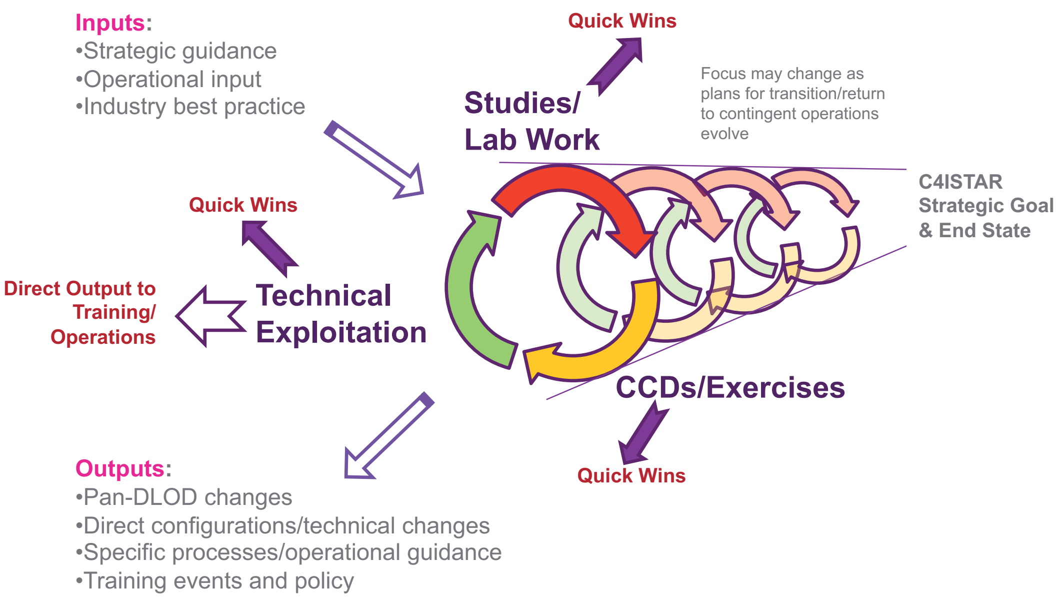

Figure A-2: The TacC4ISTAR process

The outcome of greatest potential benefit to MOD was to demonstrate that a programme of CCDs is highly cost- and time-effective for acquisition of coherent C4ISTAR capability, which in turn is perhaps the most effective short term means of delivering better operational performance. Moreover, the CCD approach could cost significantly less than the conventional equivalent. The Niteworks activity saved the MoD some £25m (of £30m planned) in one project and demonstrated cost savings of about 30% across a number of others. In summary, the process used involved:

- Model-test-model with real users involved, making best use of CCDs;
- Embed industry in problem/solution space before competition;
- Achieve best balance across people, processes, organisation and technology;
- Compete for equipment solution as late as possible, retaining a collaboration regime until one or more feasible pan-Defence Line of Development solutions is identified;
- Specify equipment in only enough detail to define desired outcome, leaving industry space to innovate, support and update in line with best commercial practice.

The programme of CCDs demonstrated:

- An improved requirements model, similar to ‘cardinal points’ but in outcome terms;
- A template for trading requirements and de-risking solutions based on user and industry involvement in practical test and evaluation;
- Delivery of integrated (people-process-organisation-technology) capabilities;
- Involvement of innovative and agile SME companies;
- Influencing of ‘big Prime’ behaviours to the benefit of MOD.

About the author

Mike Wilkinson is the Technical Director of Niteworks, where he is on secondment from Atkins. He has a first degree in physics and a PhD in theoretical physics from King's College London. He is a past president of the UK branch of the International Council on Systems Engineering (INCOSE) and is currently their Academic Director. He is Co-Chair of both INCOSE's UK and International Architecture Working Groups. Within Atkins he is a Technical Director in the Defence Business Unit and was the first Chair of the Atkins Systems Technical Network. He is a visiting professor at the University of Loughborough, where he is associated with the Engineering System of Systems (ESoS) group.

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