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Delivering Network Enabled Capability A Capability Architecture for 2020

> **Topic:** Policy /Edge Organisations

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ABSTRACT Delivering Network Enabled Capability A Capability Architecture for 2020

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Network Enabled Capability (NEC) is the 'enabling process' whose purpose is the enhancement of operational effectiveness by enabling an effects based approach to operations. To do this requires a considered view of how the components of military capability need to interact in a given time frame, here taken to be Transitional NEC in 2015, and based on the aspirations of future concepts and doctrine. This view is called a Capability Architecture and it is important for the delivery of NEC in providing coherence for all Lines of Development (LODs)¹

In developing a Capability Architecture for 2020, this paper takes a conservative, operational view of Transitional NEC. It is concerned with structures in the form of deployed operational groups (DOGs) and higher command organisations, and the relationship between these structures in terms of both their command relationships and the integration of common functions as described by the components of the Defence Capability Framework (DCF). Together these describe how Effects Based Operations, the doctrinal requirement, will be supported by agile mission grouping, the NEC enabler, in the Transitional NEC era.

The integration of functions, such as Operate, Inform, Protect, across these DOGs is pursued in order that a number of benefits can be achieved:

- Functions can be provided, shared, reinforced or substituted across DOGs.
- It provides the DOG with access to a wider range of resources, thereby increasing their capability to undertake diverse and demanding missions.

Functional integration is achieved through 'capability networking' and can be valued in terms of responsiveness and availability. However, networking is not always the best approach and the analysis shows that there are conditions when sharing diminishes this value and hence diminishes operational effectiveness.

The other aspect to be reflected in the Capability Architecture for 2020 is how command will be exercised and how a force wide expression of Command Intent is to be achieved. This view of Transitional NEC retains a hierarchical structure as it provides clear lines of authority and accountability. While a principal driver for NEC is that it is a force multiplier, the doctrinal driver is the need to empower commanders so that they can deal with rapidly changing situations using opportunistic, innovative and creative solutions. However, the command freedom of the DOG commander to create such novel actions is meaningless unless he can access the wider range of capabilities offered by functional integration. One purpose of the Capability Architecture, therefore, is to resolve any conflicts that might arise between these two drivers.

To deal with complexity, commanders must be given the freedom to form the relationships they understand will allow them to deal with the situation and its inherent unpredictability; that is, to

¹ Defence Lines of Development; *Training, Equipment, Personnel, Information, Doctrine and Concepts, Organisation, Infrastructure, Logistics.* (JDCC proposed framework as at Oct 04).

exercise choice over the appropriate degree of mission command and the associated C2 arrangements. Their ability to do this is expressed in the form of a 'command space' within which the commander can move and act, and this ability to vary command freedom as appropriate to the nature of the operational setting must be considered as a value in its own right.

The Capability Architecture addresses the relationship between the DOGs and the higher command organisations: in this relationship, the higher organisation's primary purpose is planning, and the DOGs are focussed on execution. Deliberate planning, achieved largely through collaborative working, is needed to develop and disseminate Command Intent and generate the task orientated organisations to carry it through. Dynamic planning, achieved largely through the functional integration already described, allows the formation of ad hoc groupings very quickly in response to complex and rapidly changing situations.

The architecture can be used to inform the transformation process by guiding coherent development across all lines of development and the values and cost system derived allows potential contributors to transformation process to be accessed.

INTRODUCTION

1. The UK is evolving the current British approach to military operations² to address new and complex security issues by adopting an Effects-based approach to operations. By focusing on effects, this approach is outcome rather than activity focused and 'allows the widest possible consideration of the way in which issues can be addressed'³. It emphasises the need for cross-government collaborative working in order to enable the military to identify how it may best support, and be supported by, the other Instruments of Power⁴ when dealing with issues of strategic change⁵. It concludes that 'adopting an approach based on Effects requires development of both our way of thinking and enabling processes, activities and structures'.

2. Network Enabled Capability (NEC) is the 'enabling process' whose purpose is the enhancement of operational effectiveness by enabling an effects based approach to operations. To do this requires a considered view of how the components of military capability need to interact in a given time frame, here taken to be NEC in 2020, and based on the aspirations of future concepts and doctrine. This view is called a Capability Architecture and it is important for the delivery of NEC in providing coherence for all Lines of Development (LODs)⁶.

PURPOSE

3. The purpose of this paper is to describe a Capability Architecture for NEC in 2020 in order to provide a common view towards which all Lines of Development can migrate. Such an architecture is necessary to avoid transformation becoming ad hoc interoperability interventions which, while trying to improve military capability in the short to medium-term, will increasingly erodes the

² British Defence Doctrine (BDD), Chapter 3.

³ UK Military Effects-Based Operations – An Analytical Concept. JDCB 3* Circulation D/JDCC/7/2/12 dated 29 Nov 04.

⁴ UK Instruments of Power; Diplomatic, Economic and Military, each underpinned by Information.

⁵ The identification of pertinent issues relating to strategic change (changes within all dimensions of the Strategic Environment) is a cross-government activity that is usually foreign policy driven.

⁶ Defence Lines of Development; *Training, Equipment, Personnel, Information, Doctrine and Concepts, Organisation, Infrastructure, Logistics.* (JDCC proposed framework as at Oct 04).

capacity to deal with complex situations. The architecture provides the rules⁷ for how structures, such as mission groups, are assembled from the building blocks provided and, because there are rules, the associated costs and values (or benefits) of alternative structures can be gauged and without which no meaningful value can be assigned to a proposed intervention. It follows, therefore that the architecture allows practical boundaries to be drawn in terms of capability from which systems design can proceed.

NATURE AND INFLUENCE OF NEC

4. The July 2004 UK Defence White Paper 'Delivering Security in a Changing World - Future Capabilities' emphasises the importance of Network Enabled Capability (NEC) as the means which 'will enable us to operate more effectively in the future strategic environment through the more efficient sharing and exploitation of information within the UK Armed Forces and with our coalition partners'. It continues that 'this will lead to better situational awareness across the board, facilitating improved decision-making, and bringing to bear the right military capabilities at the right time to achieve the desired military effect. The ability to respond more quickly and precisely will act as a force multiplier enabling our forces to achieve the desired effect through a smaller number of more capable linked assets'.

5. From this we understand that NEC is not about building a network or, indeed, simply about improving situational awareness and decision making, but that it should enhance military capability through the appropriateness, timeliness and precision of the application of effects, and that it can be seen in terms of cost (smaller number of assets) and value. In this analysis, all elements of cost relate ultimately to monetary expenditure, for example, the level of training needed or the ownership costs of a platform. All elements of value relate to military effectiveness; hence, the ability to deliver synchronised actions has a positive value, and anything which renders a capability unavailable has a negative value. Annex D introduces a more a detailed discussion of cost and value.

CAPABILITY ARCHITECTURE AND THE DELIVERY OF MILITARY CAPABILITY

6. This view of NEC taken here is not concerned purely with the technical integration of systems; it extends into the informatic, cognitive and social domains and becomes an issue for all LODs. It also relies on a high degree of strategic integration within the UK MOD, between the MOD and other Government Departments (OGDs) and, where necessary, with Non-Governmental Organisations (NGOs). If there is to be coherence within and between LODs, then some vision or reference model is needed to which they can cohere, which NEC, as an enabler, cannot provide but which it can strongly influence. We have called this model a Capability Architecture because it describes a structure, the relationship of the elements within that structure and the rules which govern the way in which they can combine. In this case, the structure is military capability as it is exercised in the context of an operation, the elements are the components of that capability and rules are developed here to describe how this can be done in the context of current doctrinal concepts. In showing how integration is achieved, the Capability Architecture is able to guide all LODs in the delivery of military capability, and in particular, it shows how a system can be valued in terms of its contribution to military capability, from which decisions can be made as to whether or not it is worth having.

⁷ Strictly speaking, the architecture provides the rules for the mechanistic framework *within which* the commander exercises his judgement about the shape of the military endeavour to address the operational situation. This paper does not describe the 'architecture of the art of command', which needs to proceed from an appreciation both of the history of military command and a view of the nature of future operations.

7. In developing a Capability Architecture for NEC in 2020 this paper takes a conservative, operational view of NEC based on the nature of the concepts described in the Joint High Level Operating Concept (HLOC

- 8. To meet the principal aspirations of HLOC, the key requirements for NEC are that it should:
 - a. Allow the creation of forces:

(1) With the agility to operate in complex situations where unpredictability and uncertainty prevail.

(2) That can be both pre-configured and dynamic cross-component mission groups which take account of the human and moral dimension.

b. Provide an adaptive command and control system that:

(1) Allows commanders to be innovative and creative.

(2) Supports the relationships between commanders, superior, subordinate and peer-to-peer in accordance with the philosophy of mission command.

9. The architecture, therefore, is concerned with *structures* in the form of Deployed Operational Groups (DOGs) and the higher command organisation, the relationship between these structures in terms of both their *command relationships* and *the integration of common functions* described by the components of the Defence Capability Framework (DCF)⁸ and the rules that allow this to happen in manner that that accords with doctrinal concepts. Together these describe how Effects Based Operations, the doctrinal requirement, and the aspirations of HLOC will be supported by agile mission grouping, the NEC enabler.

ARCHITECTURAL DRIVERS

STRUCTURES

10. In this timeframe, it is argued that forces will continue to be provided in environmentally based context-specific groups since the organisations which currently exist, such as brigades and task groups, already fill many needs across all LODs, particularly in terms of human issues and, as a result, provide an organisation that is utilitarian and stable. These groups result from a deliberate planning process that task-organises resources to create specific effects and are described as 'built organisations'.

FUNCTIONAL INTEGRATION

11. DOGs are already multi-functional in that they contain (and can integrate the effects of) functional elements such as Operate, Inform, Protect, described in HLOC. However, the ability of a DOG to access a wider range of resources will increase its capability to undertake diverse and demanding missions.

12. Functional integration is achieved through 'capability networking' and can be valued in terms of responsiveness and availability. However, reliance on assets and resources owned by others, that is, shared working, is not always the best approach and, as the analysis reported elsewhere in this symposium⁹ shows, there are conditions when sharing can diminish this value and hence diminish

⁸ UK Joint Vision, 15 Jun 01. The Defence Capability Framework comprises 7 components of capability: Command, Inform, Protect, Operate, Sustain, Project and Prepare.

⁹ Functional impacts of network-centric operations on Future C2. Lorraine Dodd et al.

operational effectiveness. This is reflected in the Capability Architecture where the provision, sharing, reinforcement or substitution of functional capability across DOGs is a key part of functional integration, but the dynamic networking of capability has to be placed in a sound context of command and organisation.

COMMAND RELATIONSHIPS

13. The other aspect to be reflected in the Capability Architecture, therefore, is how command will be exercised; how, for example, is a force wide expression of Command Intent to be achieved. This view of NEC retains a hierarchical command structure as it provides clear lines of authority and accountability. While a principal driver for NEC is that it is a force multiplier achieving greater operational effectiveness with fewer forces, the doctrinal driver is the need to empower commanders so that they can deal with rapidly changing situations using opportunistic, innovative and creative solutions. However, the freedom of command given a DOG commander to create such novel actions is meaningless unless he can access the wider range of capabilities offered by functional integration. One purpose of the Capability Architecture, therefore, is to resolve any conflicts that might arise between these two drivers.

14. To deal with complexity, commanders must be given the freedom to form the relationships they understand will allow them to deal with the situation and its inherent unpredictability; that is, to exercise choice over the appropriate degree of mission command and the associated command and control arrangements. Their ability to do this is expressed in the form of a 'command space' within which the commander can move and act, and this ability to vary command freedom as appropriate to the nature of the operational setting must be considered as a value in its own right.

15. The commander's location within the command space constrains the options available to him, each option being characterised by its utility value (usually expressed in terms of cost-benefit) and entropy (a measure of disorder, uncertainty and confusion). It is important to acknowledge the importance of uncertainty in this context as it relates to the predictability of systems and of outcomes. The complex nature of current and future operations means that they are inherently unpredictable, as any consideration of effects based planning amply demonstrates, and outcomes are uncertain. Lack of certainty and predictability is an inherent feature of complex non-linear systems, and is augmented in this context by insufficient evidence and cultural misinterpretation. Concepts which rely on certainty and predictability, such as notions of 'just in time' or 'predicted delivery' cannot apply when dealing with complex and unpredictable circumstances. Equally, the applicability to conflict situations of information age economics¹⁰, which relies on perfect knowledge of the value of information, has yet to be established. Thus a critical effect of functional integration for the commander is to allow him to create a 'buffer' for himself in resources (including information) that increases his command space 'options' and further emphasises the importance of the 'built organisation' in providing a set of certainties from which he can develop options, and of functional integration as one of the mechanisms which the commander can exploit.

16. The analysis⁹ shows that, in any of these domains, the values of responsiveness and availability, of authority and accountability and of command space mobility and agility, will not always align. In particular, when resources are scarce, freedoms are generally undermined (though scarcity of resources can sometimes promote innovative thinking!) and the conflicts of interest that arise can lead to loss of operational effectiveness.

¹⁰ As espoused in, for example, Power to the Edge, DS Alberts and RE Hayes, CCRP, Washington, June 2003.

DELIBERATE AND DYNAMIC PLANNING – THE BUSINESS PROCESS

17. NEC can help manage these complexities by an approach which exploits the virtues of both deliberate planning, which results in task organisation, and dynamic planning, which exploits the possibilities created by functional integration. The significance of deliberate planning is that it provides a baseline operational organisation that is stable and well understood in terms of command relationships, which can then be modified by dynamic planning to meet the most rapid changes in the situation, and periodically re-baselined as the operation unfolds. This organisational mobility describes the UK notion of agile mission grouping.

18. The Capability Architecture addresses the relationship between the higher command organisation, whose principle purpose is direction and coordination based on a deliberate planning process, and the DOGs, whose principal purpose is fighting based on a dynamic planning process. Deliberate planning, achieved largely through collaborative working, is needed to develop and disseminate Command Intent and generate the task orientated organisations to carry it through. Federation of the dynamic planning processes inherent in all DOGs enables the functional integration already described, and allows the configuration of ad hoc groupings very quickly in response to rapidly changing and complex situations (Figure 1).



Figure 1. The planning processes.

19. The deliberate and dynamic planning processes, and the products generated by these processes, are shown in expanded form in Figure 2.



Figure 2: Characterisation of deliberate and dynamic planning processes.

20. The need for a managed interplay between the deliberate and the dynamic is highlighted vividly by the requirements of Air /Land integration which involve the management of scarce air assets in support of the land component, as recently raised by the UK Director General Doctrine and Development (DG D&D)¹¹. He concluded that 'the key to making this work is a proactive C2 system (ie deliberate) which also has the flexibility to be reactive (ie dynamic) when circumstances change rapidly and unexpectedly. Past experience shows that whilst this sounds easy in theory it is hard to put into practice. Crucial to improving the situation will be the development of common understanding between elements of different components; achieving this will, in turn, lead to the proliferation of mutual trust. Issues such as a soldier's misgivings about the flexibility of the Air Tasking Order will be allayed, and an airman's doubts about the ability to integrate him into the land battle will disappear'.

21. The Command Intent expressed to the DOGs is elaborated within the DOGs to the benefit of subordinates, working to progressively tighter time horizons at lower levels of command which suggests that 'deliberate' and 'dynamic' are purely relative terms. In the execution domain, however, dynamic may have an absolute meaning associated with near-real-time operations. We need to retain the idea that there are near-real-time decisions which could be needed at the higher organisational levels for tactical purposes. This implies that we need to think about 'strategic', 'operational' and 'tactical' as domains¹², not labels for organizations or commanders.

22. This discussion enables us to clarify a number of distinctions about command relationships which have become blurred in the NATO command states and in much discussion of command and

¹¹ Future Manoeuvre Development Cell 10/04 Air/Land Integration – Key Insights: Insight 10/04.3: Management Of Air Assets. Enclosure 1 To D/DGDD/2/127/6/1.A dated 15 Dec 04. ¹² I.e. 'spheres of activity' or 'realms of cognition': domains are in this context a construct to help us characterise

particular aspects of the military endeavour, not the product of organizational or geographical boundaries.

control. Such clarification is essential if issues of authority and responsibility are going to be translate into the networking age.

THE CAPABILITY ARCHITECTURE

23. In this Capability Architecture for 2020, the DOGs are the basis for networked capability, and the organisational mobility required for agile mission grouping is achieved through the deliberate and dynamic planning processes. The dynamic planning process allows this to happen by integrating like functions, such as Strike and Protect, across DOGs.

24. However, for a DOG commander to be able to participate, he must have the necessary command freedom to do so. The architecture therefore expresses command status in terms of the freedom given a commander to participate in dynamic planning with other DOGs. The DOG commander provides a critical interface between the deliberate planning process of the higher command organisation and the dynamic of the DOGs themselves. By being able to participate in both processes, the DOG commander is able to inform and be informed by the Command Intent, thus reducing the risk of asynchronicity between the two domains. This is shown diagrammatically in Figure 3.



Figure 3. Outline Capability Architecture.

25. Functional integration across DOGs requires that each function in the set is managed to avoid conflicts and assign priorities. This is done within the higher command organisation which also

participates in the deliberate planning processes and, therefore, is well placed to do so in the context of the Command Intent.

26. Functional integration also takes place within DOGs and integration across functions (multifunctional integration) provides each commander with a local commander's tactical picture¹³. Common functional components within and between DOGs are connected by dedicated information buses, shown in Figure 4, and can be used to extend functional integration, and deliberate and dynamic planning, across the operating space. Its provision can usefully be considered as a form of 'managed' service with all the organisational and technical connotations that implies.



Figure 4. Representation of Information Buses.

MEETING THE NEED

27. The Capability Architecture described here has shown how the principal aspirations of HLOC can be met, in that:

a. It provides a process that allows the creation of forces:

(1) With the agility to operate in complex situations where unpredictability and uncertainty prevail.

(2) That can be both pre-configured and dynamic cross-component mission groups which take account of the human and moral dimension.

¹³ A very rich picture can be developed that is not merely a geographical view of locations, but includes status, opinions, interpretations, projections, in addition to all or parts of any superior commander's picture necessary to convey the Command Intent. See Annex F.

b. It provides an adaptive command and control system through the concepts of command space and command freedom that:

- c. Allows commanders to be innovative and creative.
- d. Supports the relationships between commanders, superior, subordinate and peer-to-peer in accordance with the philosophy of mission command.

28. In addition this architecture meets the criteria used to describe the mature NEC state; one typified by the dynamic creation of mission groups enabled by collaborative working.

IMPLICATIONS FOR THE NEC THEMES

29. The Capability Architecture can be used to refine the NEC themes and provide greater meaning as described in Annex A. Table 1 in Annex A views these refinements across the LODs using the matrix shown in Figure 5 (the Implications Matrix), and provides detail against which the characteristics of in-service or intended systems can be mapped to see the extent to which they meet future need as described by the Capability Architecture.

NEC Theme	Inclusive	Resilient	Full	Shared	Dynamic	Agile Mission	Effects
	Flexible	Information	Information	Understanding	Collaborative	Grouping	Synchronisation
	Acquisition	Infrastructure	Accessibility	_	Working		
Theme							
Description							
CA 2020							
Refinement							
Concepts and							
Doctrine							
Organisation							
Equipment							
Information							
Logistics							
Training							
Personnel							

Figure 5. Implications Matrix.

30. This work offers the opportunity to develop hard NEC requirements. Expanding the analysis from Level 1 as shown to Level 3 will provide detail against which the characteristics of in-service or intended systems can be mapped to see the extent to which they meet future need as described by the Capability Architecture. It also provides a logical framework for the capture of Lessons Identified and other benefits analysis.

31. Consideration of the analysis shows the lack of a coherent high-level operational lifecycle spanning all LODs. Currently each LOD has its own lifecycle and these are brought together by the commander in preparation for and during deployment. In order to bring coherence across the LODs in terms of issues such as crisis management, training, equipment integration, configuration control and service management, CA 2020 must be supplemented by such a high-level lifecycle. The drive for financial economies reduces the services' ability to provide buffers in terms of skill-sets, asset flexibility and organisational agility which leads increasingly to specialisation. In these circumstances, the importance of having such a lifecycle lies in preserving the ability of command to shape the military endeavour, otherwise, increasingly, the parts begin to dictate the shape of the whole.

CONCLUSIONS

32. The view of NEC taken in this analysis is based on the requirements of HLOC and is a conservative view that acknowledges the importance of the UK relationship with the US. The functional integration described in this analysis and incorporated into the Capability Architecture means, however, that, unlike the proponents of NCW, the UK is not subscribing to a universalist view of NEC where all entities in the battlespace are inter-connected and have access to all information. Instead, it commits to a 'communities' view in which entities work together in a basic structure to carry out a task¹⁴ and gain or lose degrees of functionality according to the need to adapt to the task. Within the architecture, military capability is provided by environmentally based stable utilitarian operational groupings, termed DOGs, such as the current brigade or task group, able to share functionality between groupings to adapt their capability according to circumstance. Integrating like functions across the components of military capability, as expressed by these stable, utilitarian operational groupings, results in a defined set of functional integrations through which resources can be shared and variety found.

33. Identification of the optimal set of stable utilitarian operational groupings (DOGs) is a task for JDCC, starting from an appreciation of the types of operation in which UK forces will be involved and an understanding of the 'art of command': this is the exercise of judgement by the commander in relation to the shape of the military endeavour to address the operational situation, within the mechanistic framework provided by this paper.

34. The provision, sharing, reinforcement or substitution of functional capability across DOGs is a key part of functional integration, but the dynamic networking of capability has to be placed in a sound context of command and organisation. The effectiveness of pools of capability assets / resources in providing services to other groupings will always be dependent on having an abundance of capability. If, as is likely always to be the case for the UK, assets and resources are scarce, then allocation of these assets and resources becomes a command decision of prime importance. It is, moreover, of such profound significance to his subordinates that some commitment, at least, has to be made in the context of deliberate planning - it cannot be purely dynamic.

35. The integrated processes of deliberate and dynamic planning underpin the ability to form DOGs and allow them to share resources through functional integration and a full understanding and implementation of these processes is crucial agile mission grouping in the face of complex and rapidly changing situations. These processes are also key to the development and dissemination of Command Intent, without an understanding of which agile mission grouping cannot take place. The architecture supports functional integration through a set of information buses that provides for their delivery through a set of managed services.

36. Further development of the architecture offers the opportunity to develop hard NEC requirements by refining the NEC themes in terms of the Capability Architecture and expressing these across the LODs (the Implications Matrix). This provides a method to gauge the extent to which in-service or intended systems meet future needs while also providing a logical framework for the capture of Lessons Identified and other benefits analysis.

37. This analysis also shows the lack of a high-level operational lifecycle spanning all LODs capable of bringing coherence in issues such as crisis management, training, equipment integration, configuration control and service management. The importance of having such a lifecycle lies in

¹⁴ As they would need to do anyway, even in the Universalist view!

preserving the ability of command to shape the military endeavour, when otherwise the parts begin to dictate the shape of the whole.

38. The Capability Architecture for 2020 provides a common view towards which all Lines of Development can migrate. It demonstrates that there are requirements for adaptability, agility and re-configurability which will affect all Lines of Development. These requirements can be catalogued now, but formal analysis is required in order that options for realisation can be valued.

39. It has become clear, during the preparation of this paper, that there is an entire discipline concerning complex, adaptive systems in the military environment (stretching back over nearly a century of military history) which has become disconnected from most government defence departments' current appreciation of capability and architecture. Since this paper has demonstrated that the exploitation of Information Age possibilities takes us straight back to the commander's ability to build effective organizations, there is an urgent need to re-invigorate this discipline, rather than abandoning it as a historical irrelevance.

40. Finally, it is clear to us that if these requirements for adaptability, agility and re-configurability are not addressed, and the role of the commander re-asserted, military forces effectively never get beyond an 'interoperability' epoch and, paradoxically, may become increasingly *incapable* of dealing with complex, non-linear situations.

ANNEX A

REFINING THE NEC THEMES

NETWORK ENABLED CAPABILITY (NEC) THEMES

1. The NEC Themes¹⁵ define the essence of NEC and drive future development. Early analysis utilised the knowledge gained from previous UK initiatives to implement enterprise wide CIS in support of operations, such as the Joint Battlespace Digitization programme and DOCIS¹⁶, and from an understanding gained through involvement with the US Network Centric Warfare (NCW) programme¹⁷ and the Force Transformation process that it inspired. The UK view derived from this analysis is one of a capability enabled by networking rather than the network centric doctrine espoused by US. Importantly, therefore, in UK terms NEC is an 'enabler' for the conduct of operations.

2. This analysis recognised from the outset that any discussion of NEC could not be done solely in technical terms as there was a very strong human and social component that had to be included. This led to the view currently held of NEC as being a complex socio-technical capability that must be considered holistically across all LODs. The NEC Themes derive from this holistic view and define the essence of NEC. They are shown in *italics* Table 1.

3. By defining a Capability Architecture the NEC themes can be extended to provide a more detailed description of how they are achieved, as shown below.

Theme	Description, refined by CA 2020				
Inclusive Flexible	Co-ordinating processes across MOD, OGDs and industry that promote				
Acquisition	the rapid insertion of new technologies, facilitates coherence between				
	acquisition programmes and provides an incremental approach to				
	delivering and maintaining 'net-ready platforms'.				
	Uses CA 2020 to provide a coherent view for technological systems				
	integration and technology insertion.				
Resilient	Ensuring information is managed coherently across the battlespace and				
Information	that the potential for secure and assured connectivity is provided to all				
Infrastructure <i>battlespace users</i> .					
	Supports a range of managed services to levels agreed through SLAs.				
	These reflect the bounds of IM set by Command Intent in the context of				
	organisational structure and the socio-technical capabilities of the network				

¹⁵ Dstl/IMD/SOS/500(FY03)/2.1: Refined NEC Concept: Part 2 – Revised NEC Core Themes and Conceptual Framework.

¹⁶ L2 report JPW /GF

¹⁷ See, for example, Power to the Edge, DS Alberts and RE Hayes, CCRP, Washington, June 2003.

Full	Enabling users to search, manipulate and exchange relevant information of
Information	different classifications (respecting security constraints) captured by, or
Accessibility	available in, sources internal and external to the battlespace.
	Provided by managed services that enable users to disseminate and /or access
	information. Services include the generation, compilation and dissemination
	of rich pictures (functional and multifunctional) and directed (eg peer-to-peer)
	task-orientated exchanges.
Shared	Enabling each user to generate an understanding of the battlespace that is
Understanding	appropriate and adequate to their task and consistent with the understanding
	of other users. This understanding covers the interpretation of the situation
	(current situation, its history, and potential developments of all battlespace
	participants) and of Command Intent (the effects and outcomes higher
	command wants to achieve).
	Facilitated by membership of, and subscription to information services offered
	by communities which are based on DOGs, the functions through which they
	are integrated and the dynamic 'virtual' groupings created on top of them to
	execute particular co-operative tasks.
Dynamic	Enabling agile command and control within and between mission groups
Collaborative	through the ability to concurrently plan and execute operations in a way that
Interworking	is dynamic, continuous and synchronized. Thus, it allows all entities
	(including non-frontline MOD bodies, Other Government Departments,
	industry, academia and public service as well as military) to work together
	dynamically to meet changing mission needs.
	Brought about by the federation of dynamic planning processes within and
	between DOGs, superimposed on the planning capabilities (deliberate and
	dynamic) of the higher command organisation. Achieved through dynamic
	'virtual' groupings characterised by co-operative behaviour (e.g. service
	provision, supporting/supported relationships) and IM policies tuned to
	command intent.
Agile Mission	Enabling the dynamic creation and configuration of task orientated mission
Grouping	groups that share understanding and that employ and co-ordinate available
	assets to deliver the desired effect.
	Organisational agility achieved on two timescales: TASKORG creates
	groupings whose composition reflects deliberate planning; their characteristics
	then enable the construction of dynamic 'virtual' groups through functional
	integration, potentially across the TASKORG, in response to tasking as a
	result of dynamic planning. There are also cognitive and procedural
	dimensions to agility.
Effects	Achieving the desired effects through the synchronization of activities within
Synchroniz-	and between mission groups.
ation	Achieved through a spectrum of methods, ranging from the network wide
	expression of command intent and explicitly choreographed co-operative
	activity.

REFINING THE NEC THEMES: IMPLICATIONS FOR LINES OF DEVELOPMENT.

NEC Theme	Inclusive	Resilient	Full Information	Shared	Dynamic	Agile Mission	Effects
	Flexible	Information	Accessibility	Understanding	Collaborative	Grouping	Synchronisation
	Acquisition	Infrastructure			Working		
Theme Description	Co-ordinating processes across MOD, OGDs and industry that promote the rapid insertion of new technologies, facilitates coherence between acquisition programmes and provides an incremental approach to delivering and maintaining 'net- ready platforms'.	Ensuring information is managed coherently across the battlespace and that the potential for secure and assured connectivity is provided to all battlespace users.	Enabling users to search, manipulate and exchange relevant information of different classifications (respecting security constraints) captured by, or available in, sources internal and external to the battlespace	Enabling each user to generate an understanding of the battlespace that is appropriate and adequate to their task and consistent with the understanding of other users. This understanding covers the interpretation of the situation and of Command Intent.	Enabling agile command and control within and between mission groups through the ability to concurrently plan and execute operations in a way that is dynamic, continuous and synchronized. Thus, it allows all entities to work together dynamically to meet changing mission needs.	Enabling the dynamic creation and configuration of task orientated mission groups that share understanding and that employ and co-ordinate available assets to deliver the desired effect.	Achieving the desired effects through the synchronization of activities within and between mission groups.
CA 2020 Refinement	Uses CA 2020 to provide a coherent view for system integration and technology insertion.	Supports a range of managed services to levels agreed through SLAs. These reflect the bounds of IM set by Command Intent in the context of organisational structure and the socio-technical capabilities of the network	Provided by managed services that enable users to disseminate and /or access information. Services include the generation, compilation and dissemination of rich pictures (functional, and multifunctional) and directed (eg peer-to- peer) task-orientated exchanges.	Facilitated by membership of, and subscription to information services offered by communities which are based on DOGs, the functions through which they are integrated and the dynamic 'virtual' groupings created on top of them to execute particular co-operative tasks	Brought about by the federation of dynamic planning processes within and between DOGs, superimposed on the planning capabilities (deliberate and dynamic) of the higher command organisation. Achieved through dynamic 'virtual' groupings characterised by co-operative behaviour(eg service provision, supporting/supported relationships).	Organisational agility achieved on two timescales: TASKORG creates groupings whose composition reflects deliberate planning; their characteristics then enable the construction of dynamic 'virtual' groups through functional integration, potentially across the TASKORG, in response to tasking as a result of dynamic planning.	Achieved through a spectrum of methods, ranging from the network wide expression of command intent and explicitly choreographed co- operative activity.
Concepts and Doctrine	CA 2020 provides a route for concepts to drive the acquisition process	Doctrine must expand on the need for direction and give context to infrastructure issues.	Develop the organisation to support the use of managed services (building on existing examples, e.g. Arty) and interoperability requirements	The commander's direction to IM will be cognisant of 'command space' considerations.	Doctrine must define the extent to which DCW is needed.	The commander must be cognisant of equipment dependencies and limitations, and human capabilities	The commander's decision on how to synchronise effects will be based on 'command space' considerations.

4. An expansion of this work analyses these refinements across the Lines of Development, as shown in the Implications Matrix below (Table 1).

NEC Theme	Inclusive	Resilient	Full Information	Shared	Dynamic	Agile Mission	Effects
	Flexible	Information	Accessibility	Understanding	Collaborative	Grouping	Synchronisation
Organisation	Acquisition Organisational	Non-technological	Based on requirements	The value of common	DCW must be able to work	Need for common training and procedures underpins the importance of Operational Groups (pre- and post-deployment) as stable, utilitarian structures from which the force can be composed.	
	continuity based on a cohering operational lifecycle is essential.	dimensions of the Information Infrastructure are closely coupled to organisational structure, both formal and informal.	of LODs, specify the network and equipment needs to support managed services. Support flexible grouping	experience, procedures and training underpins the importance of Operational Groups (pre- and post- deployment) as stable, utilitarian structures.	across organisational boundaries.		
Equipment	Equipment should be evolving towards the acquisition of modular and re- useable technological components. Must support re- configuration and composition of modular components on theatre, together with connection to allies, OGDs and NGOs	Networks are formed by integrating equipment and services which have been acquired separately but which are standards compliant. The configuration of services (e.g. picture- sharing services) is driven by IM. Must maximise the potential for interoperability between systems.	Based on requirements of LODs, specify the network and equipment needs to support managed services. Support flexible grouping through inter- operability, filters/ translators and IM mechanisms, at the behest of the commander.		DCW needs tools to supports its use which will include true collaborative working technology.	Components must be capable of being composed into larger 'virtual systems' through functional integration in responses to unfolding operational needs (ie systems integration on the deliberate planning timescale)	and reconfigured to meet the most dynamic processes underpinning Effects Synchronisation
Information		Information is not data: the value of information lies in its utility which is necessarily subjective and context dependent.	Depends on common data-models / meta- models permitting access across different domains based on an IM policy	Understanding is based in part on common experience, procedures and training	Requires a variety of information sharing paradigms over and above picture sharing.	Focussed on the purpose and roles of communities which reflect TASKORG, plus the task-orientated communities established as 'virtual;' groupings.	Focussed on task- orientated exchanges (which may be peer-to- peer)underpinned by the selective sharing of rich picture elements.
Logistics			Support and maintenance of managed services.			Must have the flexibility to track changes in TASKORG.	
Training	Equipment based training of useres, operators, managers and maintainers must cover complete CONUSE of the equipment in the military setting.	The training burden can be mitigated by using automated facilities for data capture and interpretation	Training users, operators, mangers and maintainers must make them sufficiently militarily-literate to appreciate the value of information to the commander.			The ability to AMG is bounded by training which must include the human aspects of affiliation to communities formed by TASKORG (relatively stable) and tasking (potentially fleeting).	Ability to achieve Effects Synchronisation paradigms will depend on training - highly structured protocols will be needed unless the participants have undergone collective training together.

NEC Theme	Inclusive	Resilient	Full Information	Shared	Dynamic	Agile Mission	Effects
	Flexible	Information	Accessibility	Understanding	Collaborative	Grouping	Synchronisation
	Acquisition	Infrastructure			Working		
Personnel			Critical information handling roles, such as Liaison Officers, need particular skills in order to value information of the commander's behalf and to provide continuity that helps overcome friction		Places significant requiremen people	ts on the criteria for recruiti	ng and selecting suitable
			and/or effects controlled information sharing without inducing unwanted coupling				
Infrastructure	Consider the non-functional infrastructure needs - estates etc						

Table 1. Implications Matrix. Level 1 analysis.

5. This work offers the opportunity to develop hard NEC requirements. Expanding the analysis from Level 1 as shown to Level 3 will provide detail against which the characteristics of in-service or intended systems can be mapped to see the extent to which they meet future need as described by the Capability Architecture. It also provides a logical framework for the capture of Lessons Identified and other benefits analysis.

6. Consideration of the analysis shows the lack of a coherent high-level operational lifecycle spanning all LODs. Currently each LOD has its own lifecycle and these are brought together by the commander in preparation for and during deployment. In order to bring coherence across the LODs in terms of issues such as crisis management, training, equipment integration, configuration control and service management, CA 2020 must be supplemented by such a high-level lifecycle. The drive for financial economies reduces the services ability to provide buffers in terms of skill-sets, asset flexibility and organisational agility which leads increasingly to specialisation. In these circumstances, the importance of having such a lifecycle lies in preserving the ability of command to shape the military endeavour, otherwise the parts increasingly begin to dictate the shape of the whole.