



INNOVATION THROUGH PARTNERSHIP

# **NECTISE**

*Network Enabled Capability Through Innovative Systems Engineering*

INTEGRATED PROGRAMME  
IN SYSTEMS ENGINEERING

# NECTISE

*Network Enabled Capability Through Innovative Systems Engineering*

A jointly sponsored, academic-industry collaborative research programme into the delivery and through-life support of network enabled military capability in the changing UK defence environment.

*Academic Partners*

Loughborough University

University of Bath

University of Cambridge

Cranfield University

University of Leicester

University of Leeds

University of Manchester

Queen's University of Belfast

University of Strathclyde

University of York

**EPSRC**

Engineering and Physical Sciences  
Research Council

**BAE SYSTEMS**

“The achievement of NEC is the highest priority for the Advice to Capability Management research output, as well as being a strategic research priority for MOD, requiring a coherent programme of studies together with consistent assumptions on the capability offered by enablers and the potential of NEC.”

*Network Enabled Capability – An Introduction (MoD, version 1.1, April 2004)*

“We have now reached a crossroads. We are seeing a shift away from platform oriented programmes towards a capability-based approach, with corresponding implications for the demand required of the traditional defence industrial base.”

*Defence Industrial Strategy, 2005 (Paragraph A1.4)*

In the UK, the respective roles of government and industry in support of military capability are undergoing major changes at the same time as progress is made towards Network Enabled Capability aspirations. It is clear that provision of NEC must consider not only the networking of sensors, decision makers, implementers and weapon systems, but how such a capability can be deployed, supported through-life and used in a new defence acquisition paradigm in which activities previously undertaken by MoD are increasingly assumed by industry.

## THE RESEARCH PROGRAMME

### What it is

NECTISE is a joint academic-industry research programme that investigates some of the many implications of moving to a capability-based acquisition environment in which the delivered capability is network enabled.

The challenges addressed are centred on:

- Through-life provision of military capability: acquisition, service and support
- Decision support within a capability-based acquisition environment: decision support tools and collaborative environments
- Architectures for network enabled capability: service oriented, evolvable architectures for military capability and support organisations
- Control and monitoring for systems of systems: health monitoring, reconfiguration and prognosis

The first two of these are associated with the systems engineering needed for industry to deliver into the NEC environment. The second two apply to frameworks and technologies to support operational effectiveness in that environment.

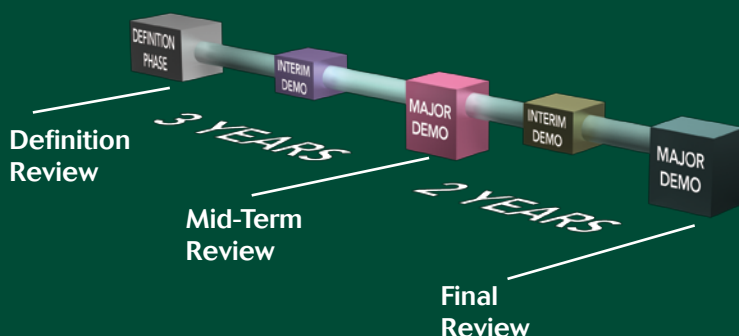
### What it offers

The successful programme will create new Systems Engineering approaches, knowledge, processes and tools that will be exploited to improve BAE Systems' ability to deliver through-life, network enabled capability to the military.

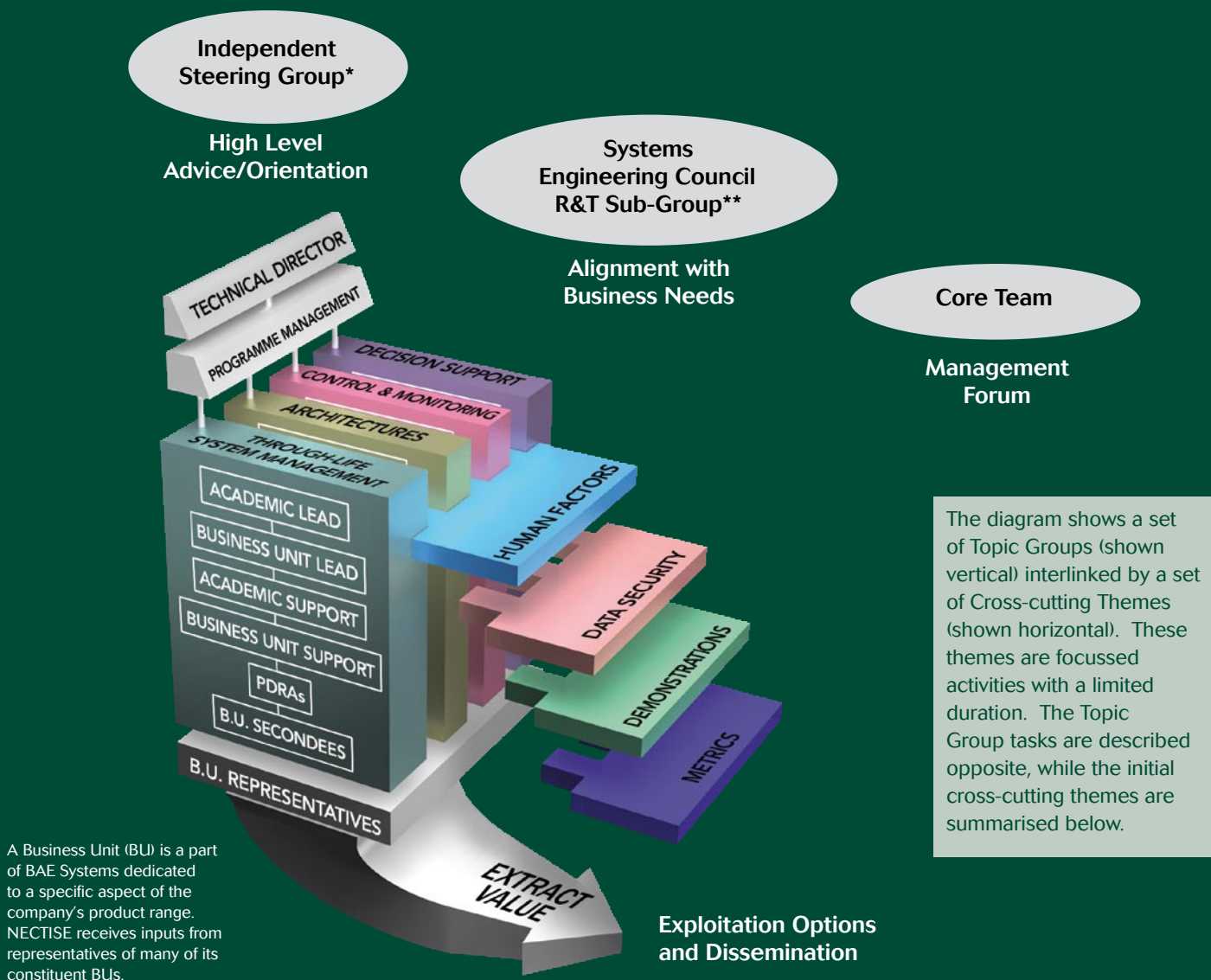
The research will lead to:

- The articulation, and detailed understanding, of what through-life systems management means for defence capability
- Systems engineering tools and processes to support through-life management of defence capability, effectively transferred into BAE Systems and the defence supply chain
- NEC-applicable architectures and supply chain structures to support cost-effective incremental acquisition/delivery of defence capability
- Clear elucidation of the metrics appropriate to through-life management of defence capability and the means through which they can be measured
- An understanding of how to deliver NEC-readiness of products and services
- Convincing demonstrations of the advances in applied Systems Engineering achieved by the programme
- Dissemination of knowledge in Systems Engineering for through-life management of NEC, particularly through the development of training suitable for both supplier and customer organisations
- Knowledge of the implications of interoperability for standards and guidelines to address the integration challenges associated with NEC

## NECTISE Lifecycle



# NECTISE Programme Structure



A Business Unit (BU) is a part of BAE Systems dedicated to a specific aspect of the company's product range. NECTISE receives inputs from representatives of many of its constituent BUs.

\* Jointly appointed by EPSRC & BAE Systems  
 \*\* A BAE Systems themed management group

## Cross-cutting Themes

### Human factors

Soft issues are important to all aspects of the programme and both the organisational and operational domain will be considered. Initial work has prioritised three main themes that will be explored in a cross-cutting sense. These are:

**Shared information** - with particular reference to problems of information overload and cultural concerns regarding the willingness of actors to share information.

**Shared sense making** - with a need to provide reliable means of making comparisons between the sense making activities/approaches.

**Collaboration and decision making** - investigating how to prevent collaboration slowing the decision-making process, and learning how to apply good practice from high-reliability organisations.

### Data security

For the NEC concept to be effective, data exchange must be carried out in a way which respects and maintains any restrictions on that data. An analysis will be carried out of threats, security infrastructure, data separation concepts and options, identity, management of assets and an evaluation of security realised. The outputs will have a bearing on each of the TG's programmes.

### Demonstrations

During the project there are periods in which the results will be demonstrated and assessed. Each demonstration will test the research questions and will lead into the following phase with a more refined (or expanded) set of questions. The initial demonstration will use a generic scenario (shown opposite) and each aspect of the project will investigate how its outcomes can be applied to and enhance appropriate aspects. Later demonstrations will have a more integrated approach, with a wider range of scenarios.

### Metrics

A knowledge of the readiness for NEC requires measures. It is fundamental to the demonstration assessments, evaluations within specific research strands, and delivery of processes, tools, and technologies as NEC enablers, that intelligent measures of value can be made. However, the metrics and measurement techniques are not necessarily available or even defined. All topics will construct metrics as various research strands develop; the task of the cross-cutting theme team will be to collect the metrics emerging from the topics and document them carefully so that their generality may be tested across the programme, with their usefulness, appropriateness, and validity subjected to critical review.

# NECTISE Topic Groups

## Through-Life System Management

Network Enabled Capability calls for operational effectiveness to be achieved in a highly adaptable way, with many systems working together in dynamic and flexible Systems of Systems. Through-Life System Management (TLSM) for the overall capability, and for each contributing system, is very different from the lifecycle management of conventional single systems, and the TLSM research is investigating how the desired capability and the contributory systems should be developed, sustained and evolved. This includes aspects such as the adaptable operational effectiveness itself and also the affordability, safety, certification and achievability of proposed system elements. Also encompassed are the contractual and resource management decisions, within and between elements, and which are necessary to develop and manage these elements throughout their separate lifecycles.

**Universities:** Cranfield (lead), Manchester, Leeds, Queen's (Belfast) and York.

## Decision Support

The aim is to develop an Integrated Decision Support Environment (IDSE) that will provide through-life support within a networked organisation for capability-based acquisition. Different types of decision-making will be considered (eg systematic, naturalistic) and mapped to the differing requirements of the life-phases being considered.

The main challenges for the provision of decision support within the NECTISE project are:

- a more rigorous definition of resources in terms of their decision making and task performance capabilities
- the relationship with other resources, and their hierarchical status
- mapping decision support technologies to the differing demands of the life phases considered and capturing the design rationale
- predicting the impact of potential change to provide the decision maker with a more detailed description of the decision alternative space
- enabling multiple decision makers to collaborate within the decision making process
- integrating these elements into a complete decision support solution within the context of an IDSE.

**Universities:** Strathclyde (lead), Bath, Cambridge and Loughborough.

## Architectures

Practical evidence shows that system architectures are the most important factor that affects both a system's functionality as well as its non-functional aspects, such as scalability, flexibility and dependability. Architectural models and styles will be developed that describe components, interactions between components and properties that regulate the composition of components. Patterns and design guides will be produced, focusing on Service Oriented Architecture, to support dynamic composition and evolution of components. Systemic approaches will be explored to design for change (including dynamic evolution and unanticipated changes in use and environment). Architectural frameworks will be extended to express capability stakeholders' viewpoints for planning through-life capability, component selection and runtime monitoring and reconfiguration. The research will investigate methods of evaluation of systems architectures based on quality of service metrics, while the architectural concepts will be evaluated using contextual examples of system integration for dynamic composition of NEC. The result is a capability that can be evaluated before use, together with a set of metrics to be used to ensure dependable continuous delivery.

**Universities:** Leeds (lead) and Cranfield.

## Control & Monitoring

Techniques to control and monitor a complex system are not straightforward, especially if the system, or system of systems, has the reconfigurability needed for effective NEC. Three streams are being investigated, as follows:

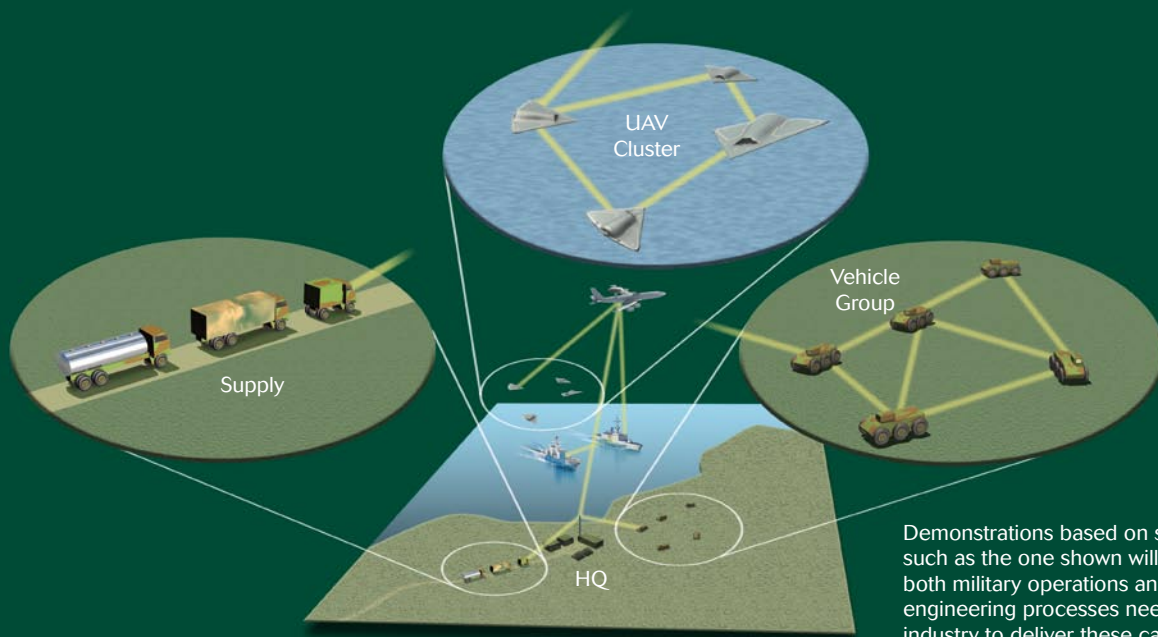
**Health Management** - methods for the reliable detection of failing network elements.

**Prognostics** - methods for inferring the impact of a failing element upon the network.

**Reconfiguration** - techniques for minimising the detrimental effects of failing network elements.

The integration of the developments resulting from these three streams will allow a Control & Monitoring toolkit to be produced for managing uncertainty in an NEC environment, based on the components of detection (health management), assessment (prognostics), and response (reconfiguration).

**Universities:** Leicester (lead) and Loughborough.



Demonstrations based on scenarios such as the one shown will consider both military operations and the systems engineering processes needed by industry to deliver these capabilities through-life

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## BAE SYSTEMS UNIVERSITY PARTNERSHIPS PROGRAMME

BAE Systems is a global company engaged in the development, delivery and support of advanced defence and aerospace systems in the air, on land, at sea and in space. The company designs, manufactures and supports military aircraft, surface ships, submarines, fighting vehicles, radar, avionics, communications, electronics and guided weapon systems. It is at the forefront of innovation, working to develop the next generation of intelligent defence systems.

BAE Systems has many synergistic requirements to be addressed in the university sector to prepare a range of competitive products, processes and capabilities for future markets. The university partnership programme provides a framework to align stakeholder interests with the best academic groups, our Primary Partners. Within this framework our businesses identify multi-disciplinary Strategic Requirements Domains to capture priorities for research and education and to develop relevant recruitment pools. The requirements in each domain are addressed by a network of primary partners, coordinated by a Strategic Partner with knowledge across the domain. In partnership with EPSRC, large-scale integrated research programmes are established to underpin each domain. The overall approach of stakeholder consultation, alignment and integration of requirements, skills and funding brings benefit and leverage to all stakeholders.

In the domain of Systems Engineering, Loughborough University is the Strategic Partner engaged in the delivery of research and training, and in supporting recruitment.

## SYSTEMS ENGINEERING

Systems Engineering is the core competency underpinning profitability and growth in today's industry and commerce. It complements and integrates traditional engineering fields with people, processes and tools, to improve the management of risk, configuration and technology insertion throughout the life of products and services.

The International Council on Systems Engineering (INCOSE) has the following summary. 'Systems Engineering integrates all the disciplines and speciality groups into a team effort forming a structured development process that proceeds from concept to production to operation. It considers both the business and the technical needs of all customers, with the goal of providing a quality product that meets the user's needs.'

The significance of Systems Engineering for the MoD is summarised thus (in the Defence Industrial Strategy, 2005):

'.....maintaining a UK systems engineering capability in defence sectors has a broader political and strategic impact: it signifies the UK's status as a major defence nation ...'

The BAE Systems business is very dependent on a strong systems engineering capability. As the prime integrator on major defence contracts, BAE Systems relies on highly skilled systems engineers operating across the land, sea, air and communications defence sectors. The activities include not only the design and delivery of complex systems products, but support of these for life cycles of considerable duration. Systems Engineering is, therefore, an important strategic domain for BAE Systems, reflected in the University Partnership programme in Systems Engineering led by Loughborough University, and in the setting up of the Systems Engineering Innovation Centre close to the Loughborough University campus. The strength of the university's contribution in this field has been increased through the setting up in 2006 of the Systems Engineering Doctoral Training Centre based at Loughborough, and partly funded by BAE Systems.

## THE SYSTEMS ENGINEERING INNOVATION CENTRE

The SEIC was established at Loughborough in 2002 and is a jointly funded endeavour by the University, BAE Systems, and the East Midlands Development Agency (EMDA) to create a national centre for systems engineering. The centre has engineers from BAE Systems and dstl working alongside academics in a unique venture to transform fundamental research into commercial or defence benefit in as rapid a way as possible. In its broader role, the SEIC will engage businesses across many industry sectors to develop systems engineering and to spread its good practice. The SEIC is an important environment through which the research outputs from NECTISE will be exploited.



## OPPORTUNITIES TO ENGAGE WITH NECTISE

Consistent with the BAE Systems open innovation approach throughout its University Partnership Programme, and the desire to get sufficient scale of effort behind substantial business and research challenges, the NECTISE partners welcome discussions with other potential collaborators from university and industrial sectors, to explore mutually beneficial ways of working together. Involvement of SMEs and the supply chain is particularly welcome to engage key stakeholder communities.

The challenges of capability-based acquisition and support which NECTISE addresses confront the whole of the defence supply chain and have many parallels in other sectors. Examples of areas relevant to the NECTISE programme are given below.

Systems architectures	Health monitoring and management for systems
Communications networks	Decision support
Cost modelling	Design for maintainability
Dependable computing	Life cycle modelling
Dependable systems	Enterprise modelling
Autonomous systems	Architectures frameworks and visualisation
Control technologies	Requirements management

Engagement can be through collaborative research projects, support to demonstrations and simulation of research, and specialist workshops and knowledge transfer activities.

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## CONTACTS

For more information see: [www.seic-loughborough.com/nectise](http://www.seic-loughborough.com/nectise)  
or contact:

Prof. Michael Henshaw (Technical Director)  
Loughborough University  
[m.j.d.henshaw@lboro.ac.uk](mailto:m.j.d.henshaw@lboro.ac.uk) Tel: 01509 227214

Dr. David Gunton (Programme Manager)  
BAE Systems Advanced Technology Centre  
[david.gunton@baesystems.com](mailto:david.gunton@baesystems.com) Tel: 01245 242002

Mr. Steve Hinsley (Project Manager)  
Loughborough University  
[s.w.hinsley@lboro.ac.uk](mailto:s.w.hinsley@lboro.ac.uk) Tel: 01509 635219

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