Network Based Defence logic

- From an innovation point of view -

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Abstract

The focus on a network based defence (NBD) is one of the most fundamental changes in the Swedish armed forces since the days of Carolus XII in the early eighteenth century. The transformation will affect not only the military structure but also defence industry, research agencies as well as the work of the Ministry of Defence as a whole.

With a network centric approach it will in future be possible to act in new environments and places with new partners and with new behaviours. The reasoning supporting NBD is built on flexibility and increased degrees of freedom. One goal is to use current and future resources and technologies in new ways and combinations in order to gain greater operational effects and advantages at a lower total cost than before. The ability to *innovate* will be the key success factor in the introduction of network based defence. As there will always be scarce resources available for defence, it is more important than ever to optimise the outcomes and effects. The prerequisite for the new logic is *multi finality*, i.e. there are several opportunities and possible paths to achieve goals, which is also forms the basis for flexibility.

A fruitful way to study the change of military structure is to use a theoretical framework based on innovation and multi finality. The questions to be addressed are: *what is really new with NBD in relation to earlier concepts* and *what would a method built on network centric logic look like?*

This paper first discusses the relationship between innovation and the network centric logic and then goes on to discuss an analytical approach built on *combinatorial methods* with *value chain*s which is used to explain the idea of multi finality. In conclusion, different aspects of the combinatorial method are discussed. The overall purpose of using such an approach is to transfer knowledge and experience from the research arena into the military arena in order to exploit the full potential of future defence systems.

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Introduction

The development of the Network Based Defence (NBD) can be seen as the biggest change in Swedish military defence since the days of Carolus XII. This may be a somewhat controversial statement, but the focus on building a system around network based defence is without doubt revolutionary and will affect military development for many years hence. These changes will have an impact on the Swedish Armed Forces, the various defence agencies and the industry which develop systems, platforms, products and services for defence. One of the reasons behind the NBF development is to increase Swedish options for engaging in future conflicts in new environments and new places with new partners and capabilities. The theory and tactics underlying NBF are influenced not only by the US NCW[1] and the British NEC[2] but also by socio-technical system theory[3] and modern leadership and organisational theories.[4]

The reasoning behind future defence is built on flexibility and increased freedom of action. The aim is to use existing and future resources and technologies in a new way and in new combinations to carry out operations and reach given goals with a lower total cost than previously. Innovation will be decisive in the creation of new defence reasoning. The capability for optimising military operations will become more important as future resources are likely to be more limited in terms of both time and scope than those of today. The prerequisite for the new reasoning is *multifinality,* i.e. the insight that there are many different ways of achieving a goal, which is itself a prerequisite for flexible military operations.

NBD can be studied from the perspectives of both "innovation" and multifinality. In this context innovation means *the new features in NBD relative to earlier warfare concepts and what a method built around NBD reasoning might look like?* This article begins with a description of the innovation concept and its relationship to the new defence reasoning before going on to describe a possible method built on *combinatorial methods* and *value chains* which explains the new reasoning behind multifinality. Finally the article discusses some of the different aspects of the combinatorial method connected to NBD and innovation. The aim is to show how previous experiences from innovative research can act as a motor for the development of future defence.

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[1] Network Centric Warfare
[2] Network Enabled Capabilities
[3] W.A, Pasmore, *Designing Effective Organizations: The Socio-technical perspective.* New York. John Wiley & Sons Ltd., 1988. Trist, Higgin, Murray, Pollock, *Organizational choice*. London. Tavistock Publications, 1963.
[4] B. Hedberg, G. Dahlgren, J. Hansson, and N-G. Olve, *Virtual organizations and beyond: discovering imaginary system*. Chichester, England. John Wiley & Sons Ltd., 1994

Innovation and future defence reasoning

There are different kinds of innovation, some are *radical and revolutionary,* and others are *incremental and evolutionary.* By the first named we mean innovations which fundamentally change the face of the world and what we mean by normal. In the context of defence and security the development of the atom bomb can be regarded as radical and revolutionary. After the first atom bombs were dropped the focus of defence and security policy changed from one centred on the balance of forces between competing powers to one based on deterrence, where the ability to retaliate in kind was an important factor. The later development of automatic weapons can be seen as more incremental, where new products and tactics have been introduced. Both examples show how product and process innovations have produced new battlefield functionality which has in turn affected defence reasoning.

NBD has been held up as a consequence of the so called Revolution in Military Affairs (RMA)[5] which is in turn built on the concept of a paradigm shift.[6] It is said that such a revolutionary change occurs every forty to fifty years and that it is driven primarily by technical development. In military terms there have been a number of RMAs throughout history, ranging from the introduction of the longbow, the development of railways, tanks, submarines, aircraft, gunpowder and the atom bomb. All of these innovations had an impact on warfare in their time and what was then seen as rational. At present we are again in a phase which includes both radical changes and incremental developments. NBD reasoning is primarily built on modern information and communications technology coupled to the development of new weapons and sensors.

The reasoning is built up of four parts: changes in *personnel, methods (doctrine), technology* and *organisation.* To this may be added the introduction of new *processes.* The changes consist of a range of events at different levels where the technical and social systems integrate with each other and with their surroundings. A developing reasoning stands in contrast to existing doctrines and thought processes, i.e. the existing views and ideologies. There is therefore a conflict between the accepted world order and the future. Its takes time and often a major war before the new reasoning is fixed and becomes the primary structure. The older structure has then been replaced through an evolutionary process. An example of this is when the tank replaced horse cavalry during the Second World War.

A new doctrine

A change in reasoning both drives and is driven by changes in doctrine. In Sweden defence is moving from one based around a relatively static defence against an invasion to one based on mobile operations. Previous threats based on the Cold War have been toned down at the same time as others have been identified as potentially dangerous, e.g. terrorism, local hot spots, environmental destruction etc. It is becoming ever more important to develop defences against diverse technical threats which may have serious implications for both civilians and the military, e.g.

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[5] Rekkedal, N.M. Vad är militärteori idag. Krigsvetenskaplig årsbok. 2002. Stockholm. Försvarshögskolan, 2003.

[6] In this context a paradigm shift is like that described in T.S. Kuhn, *The structure of Scientific revolution*. Chicago. University Press of Chicago, 1970.

information warfare including computer operations[7] and electronic warfare. The changes in threat since the Cold War have consequences for the way in which defence develops its overarching strategies and tactics, i.e. the relationship between the new reasoning and doctrinal changes.

The starting point for Swedish military doctrine is manoeuvre warfare and mission-oriented command (auftragstaktik) which define how military units and formations should act in a given conflict. The aim is to find and neutralise the enemies' decisive points and command structures. Doctrinal changes therefore require new capabilities and behaviours at all levels. Today the battle could be fought in different arenas in both Swedish and foreign environments. In these context arenas means the sea, air, ground, space and information spheres of action.[8] This final sphere could be different kinds of psychological and information operations such as the distribution of leaflets, TV transmissions or even the destruction of an opponent's digital infrastructure.

Changes in doctrine create requirements for interoperability between nations, systems, weapons and equipment. To make interoperability work the various functions, weapons, platforms etc. must be connected to from a coherent whole using well defined and agreed international agreements and standards. This capability is also affected by the presence (or absence) of successful cultural and verbal interactions. There is also a requirement for methods and terminology which can be understood by all those involved with the aim of creating common rules of action and tactical/operational directions for battle. The key to winning the battle, the war and the ensuing peace is thought to be information superiority.[9] By this it is meant that the combatant which has an advantage in terms of volume and quality of information will also have greater possibilities for steering the character of the conflict in a direction which suits them rather than their opponents.

Technological changes

The technical changes in current reasoning are, as has been previously mentioned, largely driven by the development of information and telecommunications technology such as the internet and wireless communications. To create and maintain information superiority one must have systems to support this. The aim is to create a network of networks with nodes which enable the fusion of different kinds of telecommunications and computer related information. At an architectural level this includes the development of small scale fixed and mobile networks which can be interconnected to form larger networks.

The Swedish Armed Forces are focussing on the development of automatic and semi-automatic systems and sensors such as unmanned air vehicles and aerostats. These are systems which can survey, evaluate and attack different targets within a defined area. Nanotechnology has brought with it new materials and structures with completely new characteristics in areas such as strength, durability and elasticity. To this can be added stealth technology coupled to heat and cooling capabilities. These

[7] An example of this is Computer Networks Operation (CNO) i.e. hacking and computer piracy.

[8] Although several western nations include space in their doctrine, Swedish military doctrine (2002) does not. Although Sweden does not have its own space program space is of such importance that it should be included in future doctrine.

[9] The term information superiority has in this paper been used as a common term for what is referred to internationally as Dominant Battlefield Awareness (DBA) without further detail.

have become important aids to increase the survivability of ships and aircraft in conflict zones. For individual soldiers developments include new battlefield equipment.[10]

Organisational changes

The new reasoning requires organisational changes owing to factors such as the development of modern command and control systems, collaboration and cooperation between units and levels and changes in the way tasks are organised in time and space. In future organisations it is predicted that a traditional command structure where more senior officers decide and subordinates act will be replaced by more democratic systems. The aim is to create trust between parties where a "networking" capability becomes more important. This new order will in turn require lead to requirements for cultural competence and personal knowledge.[11]

The development of network organisations is due partly to a general increase in educational level amongst individuals and partly to the fact that technological developments in turn require greater higher qualifications and changes in management style compared to previous systems. It is not clear that the more senior officers will have the greatest experience of organising and leading an operation at every given opportunity. Most importantly, a rigid and hierarchical organisation is neither effective nor optimal in a changing world.[12] It is necessary to take account of the individual's competence, willpower and capability (mission-oriented command). There will still be a requirement for some sort of hierarchy even in a network based system, as decisive factors in battlefield success are clear rules and relationships which everyone in the organisation understands.

Mission-oriented command in conjunction with information fusion makes it possible for those units and formations nearest the area of conflict to take part in deciding what is to be done, when and by whom with the intention of reaching the operational goals. This requires access to, and sharing of, information held by all those units and formations involved in the operation. The aim is to give all those involved, irrespective of their level in the organisation, a common operational picture and a shared situational awareness. The way in which the picture is to be interpreted and adapted to the situation depends on two things, the role (i.e. whether it is a soldier or an officer) and the way in which the information is presented. Transmission of the operational picture may take place using computer screens, verbal communications, digital maps etc., or by some combination of these. The accessibility and distribution of the information has a direct impact on the possibilities for cooperation and collaboration between different actors and formations. One of the consequences of distributing information to many units and formations is to change the power structure in the organisation. In summary the ability of the individual to steer and influence events in a given situation is thought to be much greater in an NBD environment than in a hierarchical structure.

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[10] An example of equipment development for individual soldiers is the Swedish Markus concept.

[11] Gardner, H., Csikzentmihalyi, M., Damon, W. *Good Work: When Excellence and Ethics meet.* New York. Basic Books, 2002. This discusses individual competence (EQ) and defines it as the individual's ability to adapt to new environments and people according to situation, which is seen as a prerequisite for managing dynamic situations.

[12] Burns, T., Stalker, G.M. *The management of Innovation*. London. Tavistock Publications, 1966.

Process changes

As noted previously future defence is not just about changes in personnel, methods, technology and/or organisation, it is also about changes in processes. Previously, in the shadow of the Cold War, the Swedish Armed Forces focussed on the notion that quantity produced strength. A number of formations, flotillas or divisions were set up, each with individually good firepower. These were built up using a variety of weapons and platforms, each with varying characteristics. Cooperation within and between formations and units was of varying quality. What is new now is that in these times of restricted resources the Swedish Armed Forces have focussed on *function and effect,* i.e. where, how and in which environment each system can be used to optimal effect and in what ways they can be connected to give the greatest possible effect for a given cost. The term *service*[13] has been introduced as a means to achieve this.

One of the aims of NBD is that it should be *service based*. There should be teamwork between the service producer on one side and the service user, i.e. consumer, on the other. The focus on services ensures that the traditional platform based structures and processes are broken up and replaced by new value chains.

Network based logic built on combinatorial methods and value chains

In the introduction it was asked whether there was a method for studying NBF reasoning which could take account of the concepts described above.

One way to structure and develop a model from the perspectives of innovation, domain and areas is to use a combinatorial method as shown in Figure 1. The reasoning behind this is based on the ability to combine different parts of the system to form new entities which can then be coupled to the mission, point of effect and the degree to which mission aims are achieved.[14] The basis for the combinatorial approach is the creation of *value chains*, i.e. the ability to create combinations of components, functions, platforms and subsystems which in terms of both time and resources are sufficient to meet a range of possible events. Using value chains it is possible to conduct the missions and reach the required goals.

Value chains can also be seen in terms of automation, costs and "frictions". This means that certain value chains will be logical and self evident. They can be automated to a high degree at low cost and become parts or extensions of the "same" system. Other value chains may be difficult to build for various reasons and will require manual intervention at relatively high cost. It could be said that there is some kind of friction between the component parts. The third category is those value chains which are desirable but which cannot today be built without radical changes to the whole system.

The overall value chain can itself be broken down into sub-chains for each domain and arena touched by the value chain. The aim is to show at a lower level which functions and components are involved in the process.

[13] The term is more fully developed in FMV report 09100:54985/02.
[14] In this context aim means the mission overall operational goal.

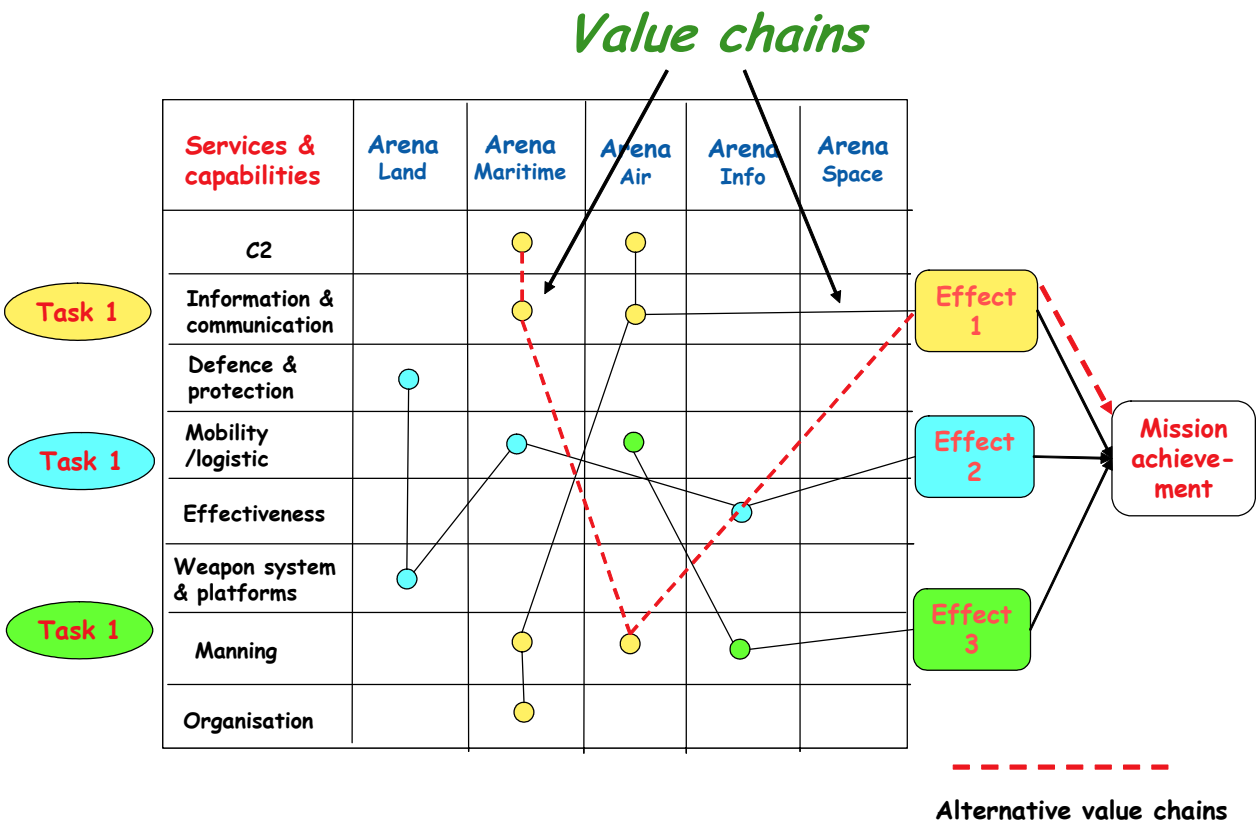

Figure 1 – Combinatorial method with value chains for assessing effect and mission achievement for different options

The connection between value chains and achievement factors

To develop the potential in the combinatorial method the formation of value chains must be related to achievement factors. Four such factors have been identified as important: *changeability, usability, security* and *degree of interoperability.*[15]

Changeability *(flexibility and adaptability)*

The ability to change, i.e. flexibility and adaptability, includes the possibilities for combining different functions, platforms etc. in a value chain to solve a given mission. In certain cases this may be difficult to do. This may depend on things such as lack of system compatibility, lack of common interfaces, disturbances of various sorts etc. In these cases the value chain will be "one dimensional" where the component parts have interactions with other nodes. The value chains flexibility, including any underlying functional chains or "sub-chains", is therefore dependant on

[15] Heickerö, R. *Utvecklingen av metod för mätning och värdering av potential i DEMO 05/06.* FOI-Memo, 2002.

the number of possible combinations which can be achieved. The number of relationships, i.e. the degree of freedom a node can have, will in turn affect the chains adaptability in the face of changes in given circumstances. This means that certain platforms, formations or units can be used in many different situations whilst others are strictly linked to one or a few different types of mission. For example, amphibious units and their equipment have a relatively great ability to act in different environments in conjunction with external parties. Mine clearance units on the other hand are more specialised and can only be used for a small number of mission types. This will result in a choice between specialisation and generalisation. By adding new functionality, interfaces etc it is possible to increase the degree of freedom even for specialised units.

Usability (simplicity and usefulness to the user)

The usability of chain to the user in terms of simplicity and usefulness depends partly on the cost of creating the chain and partly on how accessible the chain is in a given situation and circumstances. The cost may be real or perceived. The real cost hangs on the degree of automation and friction which arise when some combinations are self evident but others require new management and methods. The latter case implies that the number of possible combinations is restricted by the views and experiences of those building the chains. Lack of experience of new combinations means that those involved are often locked in an older structure with older ways of thinking.[16]

Security (secrecy, accessibility, robustness)

The usefulness of a value chain is also depends partly on how robust the chain is to disturbances of various kinds. To create redundancy and guarantee quality it is important to understand and evaluate which parts of the chain are most sensitive to strain, which types of disturbances could occur and when these could occur. An evaluation of possible risks in the chosen chain compared to those in alternative chains is therefore important and will repay attention.

Interoperability and cooperation

A value chain does not stand alone but must be related to other external value chains which continually change in both time and space. Transparency between ones own and others value chains creates requirements for interoperability. This includes a range of factors such as standardised interfaces between products and platforms, backward compatibility with previous systems (the legacy) and also requirements for common terminology, management methods and Rules of Engagement. Achieving good cooperation is especially important in international missions.

[16] An example of new types of value chain which combine both high technology and old technology comes from the war in Afghanistan. During this conflict small specialist teams used mules to ride through the Tora Bora Mountains. The teams were in direct radio contact with the strategic bomber aircraft. When they identified potential targets they could direct the B-52 aircraft to these in real time. In previous conflicts there would have been more communications links with more hierarchical management. The freedom to act would probably also have been lower.

Conclusions

The focus on network based defence requires new reasoning and changes in doctrine, technology, organisations and processes. The new world affects the Swedish Armed Forces ability to manage conflicts and achieve peace keeping missions. One way to both understand and use the new reasoning effectively is to use methods based on combinatorial methods and value chains.

Combinatorial methods have several positive features such as multifinality. The method gives an overall picture of the relationships between different units and sub-systems and shows which parts of the chain are used most. This makes it possible to redirect resources between functions and in this way achieve optimal performance for an overall lower cost.

In theory one could also take a bottom up approach, i.e. define a value chain including services and then assess which missions this chain could achieve. Such an "alternative" process may be regarded as somewhat radical. This approach has not yet been studied but could be an area for future research. Irrespective of approach, it may be concluded that combinatorial methods in conjunction with multifinality gives new freedoms to develop the inherent potential in the Swedish Armed Forces.

References

Burns, T., Stalker, G.M. *The management of Innovation*. London. Tavistock Publications, 1966.

Gardner, M., Csikzentmihalyi, Damon. W. *Good Work: When Excellence and Ethics meet.* New York. Basic Books, 2002.

Hedberg, B., Dahlgren, G., Hansson, J., Olve, N-G. *Virtual organizations and beyond: discovering imaginary system*. Chichester, England. John Wiley & Sons Ltd., 1994.

Heickerö, R. *Utvecklingen av metod för mätning och värdering av potential i DEMO 05/06.* FOI-Memo, 2003.

Heickerö, R. 2003. *3G. Strategier och drivkrafter*. Studentlitteratur. Malmö 2003.

Kaiser, M., Larsson, P., Hörnsten, L. (2004). *Krishantering med en vidgad syn på nätverksorganisering.* Vetenskaplig rapport. FOI – R – 1248 – SE

Kuhn, T.S. *The structure of Scientific revolution*. Chicago. University Press of Chicago, 1970.

Pasmore, B. *Designing Effective Organizations: The Socio-technical perspective.* New York. John Wiley & Sons Ltd., 1988. Publications, 1966.

Rekkedal, N.M. Vad är militärteori idag. Krigsvetenskaplig årsbok. 2002. Stockholm. Försvarshögskolan, 2003.

Wik., M. 2002. *Revolution in information affairs. Tactical and strategic implications of information warfare and information operations.* Defence Material Administration. Report.