VALIDATING THE NEC BENEFITS CHAIN

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INTRODUCTION

A UK Defence White Paper[1], states that "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 assets". A hypothesis of how this could be achieved was created by taking the NCW benefits map as proposed in the NCW Conceptual Framework and mapping it on to the UK Command and Battlespace Management building blocks. This hypothesis was then tested using the UK's collection of quantified evidence of the benefits and risks of NEC. This process has led to a modified benefits chain which is more fully supported by the evidence.

This paper presents the hypothesis of how NEC can lead to improved operational effectiveness, its testing using the evidence available and the resulting modifications.

NEC QUANTITATIVE EVIDENCE

NEC is about the coherent integration of sensors, decision-makers and weapon systems along with support capabilities[1]. It is not just about equipment; it is also about exploiting the benefits to be obtained from transformed doctrine and training, and optimised command and control structures[1]. NEC as a coherent concept is new, but many of its elements (equipment, processes, structures, and training) have been under analysis for many years. This existing knowledge has been brought together to provide a compendium of quantitative evidence of the benefits and risks of NEC. It is this evidence which has been used to assess the validity of the hypothesis presented in the NEC benefits chain.

THE HYPOTHESIS

The diagram in Figure 1 shows the NEC benefits chain. It was created by taking the benefits map proposed in the US NCW Conceptual Framework and mapping it onto the UK command and battlespace management building blocks (Appropriate connectivity, information and intelligence, shared understanding and agile groupings).

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[1] Delivering Security in a Changing World: Future Capabilities, July 2004
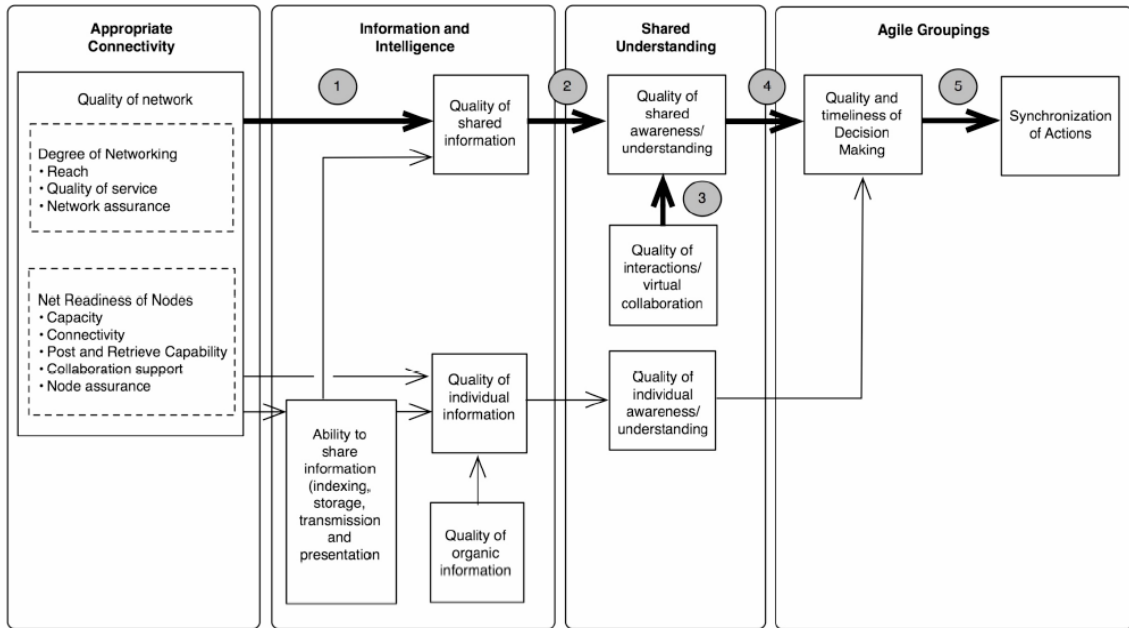
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Figure 1: NEC Benefits Chain

The benefits chain contains a series of linked arguments (indicated by bold arrows and numbered links in Figure 1 as follows: (1) that a robustly networked force should improve the quality of shared information; (2) that this should lead to an increase in Shared Situational Awareness and mutual understanding through (3) enhanced quality of interactions and collaborative planning processes. This, in turn, should enable improvements to (4) the quality and timeliness of decision-making, leading to (5) synchronised/agile actions, resulting in more timely and appropriate effects.

TESTING THE HYPOTHESIS

This section presents a summary and specific examples of the evidence related to the benefits chain arguments and draws conclusions about the validity of them. Modifications to the arguments are proposed as appropriate.

IMPROVING QUALITY OF SHARED INFORMATION

The original argument was that a robustly networked force should improve the quality of shared information.

The following Evidence was found from studies, experiments and operations:

a. There are many examples of when having insufficient quality of network is detrimental to the quality of shared information. This includes several warfighting experiments which found that when information infrastructure was poorly integrated and had low reliability, user confidence was easily lost and difficult to regain. Users quickly discontinued use of the new systems and did not use the information that these provided [1], [2], [3].

b. A collaborative working tool giving the ability to share information with ease has been shown to provide greater improvements in the quality of shared information than improvements to the network infrastructure alone. For example, an experiment found that an enterprise-wide collaborative working

tool increased the rate at which requests for information could be processed [4].

    c.   Sharing poor quality individual information has resulted in poor quality shared information. An example from Operation Iraqi Freedom: a Forward Air Controller (FAC) attempted to talk two aircraft on to a target using voice communications. The FAC had incorrectly correlated his map with imagery available and eventually the mission was aborted as the FAC was not confident that the pilots had correctly identified the target [5].

Therefore, a high quality of network is necessary but not sufficient for a high quality of shared information. The same is true of high quality information and intelligence. The ability to share information and intelligence is the key driver in achieving a high quality of shared information. A modified argument is therefore suggested: a robustly networked force along with the ability to easily share good quality information should improve the quality of shared information.

<div align="center">INCREASING SHARED SITUATIONAL UNDERSTANDING</div>

The original argument was that improved quality of shared information should lead to an increase in shared situational awareness and mutual understanding through enhanced quality of interactions and collaborative planning processes. The evidence collected is as follows:

    a.   There are cases where improvements to the quality of shared information combined with changes in working practices to take advantage of them have led to improvements in the quality of shared awareness. For example, integrated UK/US working[2] at Brigade HQ level compared with the current use of liaison officers to manually exchange information generated a 70% improvement in the completeness of shared situational awareness [6].

    b.   Where procedures are not in place for the processing of shared information or staff not appropriately trained in using the information, a high quality of information does not result in better shared awareness. For example, an experiment found that a new asset providing high quality information to a Battlegroup did not improve shared understanding because they did not appreciate its potential value and the quantity of reports stretched their processing capability [7].

    c.   There are examples of cases where increasing the quality of shared information has resulted in poorer overall situational awareness because users have become too focused on one area of information. For example, an experiment found that the provision of a tactical picture in a HQ led to greater situational awareness for individual engagements but loss of overall situational awareness and the relationship to the campaign objectives [8].

There is evidence that a poor quality interactions can lead to poor shared awareness:

    a.   Research suggests that teams that communicate virtually can find it hard to develop trust. A review of the operation of an air base during Op Iraqi Freedom shows that a lack of trust in a reachback facility led to information

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[2] Assumed LISI 2 interoperability: separate national applications and data with common functionality and formats; group collaboration via products such as annotated imagery; fully automated connections between national communication systems.

from that facility not being used and therefore not contributing to shared awareness [5].

b.   Research on human interaction with automated information systems shows that there is a tendency for users to become over-reliant on automated system output [9]. This also represents a poor quality of interaction. There is evidence from operations and experiments that show that over-reliance has resulted in poor shared awareness [10], [11], [12].

These findings indicate that all UK Defence Lines of Development[3]/ US DOTMLP[4] must be considered if this part of the benefits chain is to be realised. People must be appropriately trained to ensure that they are able to use shared information appropriately to improve their shared awareness.

Therefore the modified argument is as follows: improved quality of shared information accompanied by appropriate training and process adjustments to take advantage of this improvement should lead to an increase in shared situational awareness and mutual understanding through enhanced quality of interactions and collaborative planning processes.

IMPROVING QUALITY AND TIMELINESS OF DECISION MAKING

The original argument was that an increase in shared situational awareness and mutual understanding should enable improvements to the quality and timeliness of decision-making.

The available evidence was:

a.   There are many examples where greater shared understanding has led to improved quality of decisions-making (measured in terms of operational outcome resulting from the decision). For example, a number of studies and experiments considering land force digitization (sub-unit to battlegroup), found BLUE losses to be significantly reduced. Another example is found in air defence where experimentation in both the UK and US has shown substantial increases in loss exchange ratio with the ability to share information via Link 16 compared to voice only [13], [14].

b.   An experiment illustrated that a complete common operating picture (COP) in a joint HQ reduced decision-making time by up to 65% compared to the baseline with no COP. The mean time it took staff to become aware of incidents that required them to re-plan was reduced by 49%, compared to the baseline [15].

c.   There are also examples of where poor decisions have been taken despite good quality shared awareness. If the quality of shared awareness is over-estimated, then poorer decisions will often be made, even if shared awareness is good. For example, an experiment found that a complete common operating picture (COP) in a joint HQ reduced decision-making time whereas an incomplete and unfiltered COP actually increased decision-making time over the baseline with no COP [15].

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[3] Training, Equipment, Personnel, Information, Doctrine, Organisation, Infrastructure, Logistics
[4] Doctrine, Organizational, Training, Materiel, Leadership, and Personnel

d. A known risk to better decision making when a high level of shared understanding exists comes from a mode of thinking that can exist in cohesive groups, when the members' strivings for unanimity override their motivation to realistically appraise alternative courses of action as evidenced in the Space Shuttle Challenger disaster [16].

There is evidence that improvements in shared awareness will only result in improvements to decision making up to a certain point, beyond which improvements to shared awareness will not affect decision-making [17]. Evidence from civilian experiments of decision making in action indicates that the decision-maker attempts to match the currently observed situation to previous situations experienced and then apply procedures based on this understanding [18], [19], [20]. Therefore, once a level of situational awareness is reached which is sufficient for pattern matching to take place, no additional information will affect decision-making.

The evidence shows that human factors are particularly important in this part of the benefits chain. The evidence highlights that good quality personnel are essential to convert good quality shared understanding into good decision-making. An ability to estimate the quality of one's shared understanding is critical to making a good decision making.

A modified argument is suggested: high calibre decision makers assisted by an increase in shared situational awareness should enable improvements to the quality and timeliness of decision-making.

ENABLING SYNCHRONISATION OF ACTIONS

The original argument was that improvements to the quality and timeliness of decision-making should lead to synchronisation of actions. The evidence collected is as follows:

a. There is no evidence that better quality of decision-making alone leads to synchronisation of actions or the ability to do so.

b. There is evidence that adaptive C2 processes are a key factor in the ability to synchronise effects. For example, a study found that changing information-sharing principles without changing C2 processes had a limited positive effect on mission effectiveness. However, combining more agile C2 with greater information-sharing enabled significantly greater operational tempo [21]. A different study considering maritime interception operations found that there are only modest gains to be made from better information unless more agile CONOPS are adopted to allow the dynamic redeployment of intercept vessels [22].

c. Successful synchronisation of actions also requires quality of decision-making to ensure that local synchronisation is not detrimental to campaign level effects. For instance, the faster but unsynchronized movement of orders and intelligence can lead to poorer campaign outcomes compared to a slower but synchronized capability [23].

Therefore, adaptive C2 processes appear to be a key enabler in enabling synchronisation of actions. This leads to a modified argument that improvements to the quality and timeliness of decision-making along with ability to adapt C2 processes should enable synchronisation of actions.

ACHIEVING TIMELY AND APPROPRIATE EFFECTS

The original argument was that synchronisation of actions should lead to timely and appropriate effects. There is evidence that synchronisation of actions (the ability to control the order and timing of actions) can result in better delivery of effects.

    a. Research has shown that controlling the sequence and tempo of an operation is crucial to ensuring that the physical effects of BLUE's actions are given time to impact on RED's decision-making. This maximises the probability of BLUE being able to achieve the desired cognitive effect [24].

    b. Analysis of 160 past land and air campaigns indicates that if an attacker can keep a defender continually off balance by getting inside his decision cycle time, then the chances of success are greatly enhanced [25].

    c. The UK MoD has identified that the military instrument of power alone could not deal with complex modern crises involving communities and populations; all levers of power (diplomatic, military and economic) are required to work in an integrated manner. Experience from Sierra Leone, Afghanistan and Iraq showed that coherence requires strategic processes, planning and objectives to be harmonised across all instruments and agencies [26]. This is confirmed by historical analysis which has shown that having an integrated C2 chain to co-ordinate different security force elements (internal/external, police/paramilitary/military etc.) to achieve *common* strategic objectives and policy goals is significantly associated with both military success of the campaign and the political success[5] in counter-terrorism or counter-insurgency campaigns [27].

Therefore, this link is supported by the evidence and no change is suggested.

THE MODIFIED NEC BENEFITS CHAIN

The modified arguments derived from the evidence lead to a modified NEC benefits chain as shown in Figure 2. Areas in which the original has changed are denoted by dashed lines.

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[5] In terms of the extent to which each player's reported initial strategic political/military objectives were met at the end of the campaign.
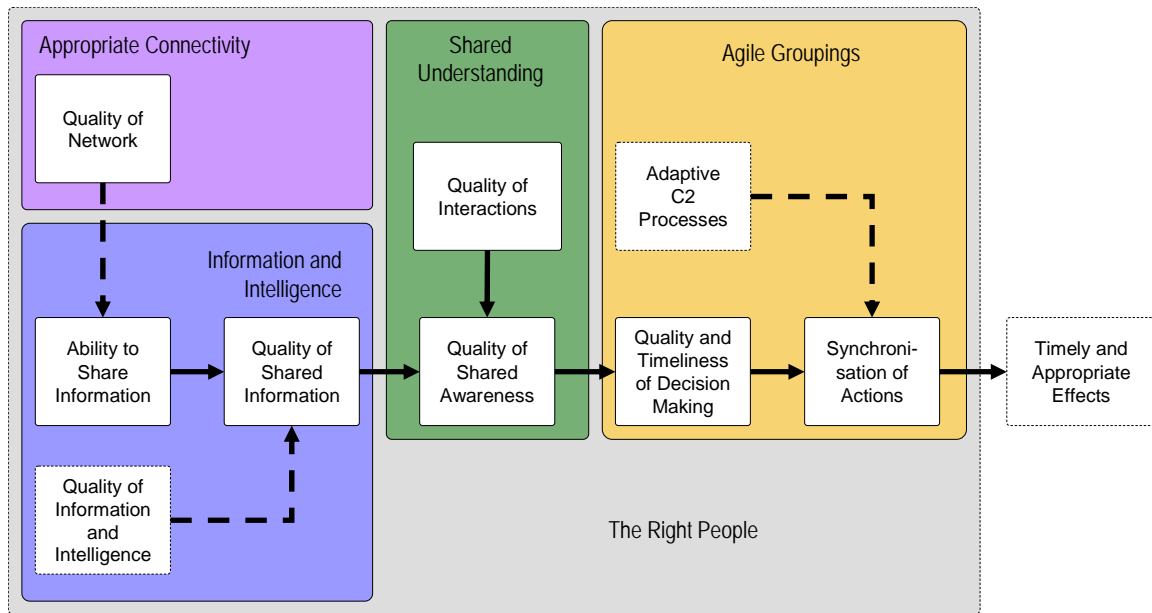
Figure 2: Modified NEC Benefits Chain

In summary, the changes are:

    a.   Quality of network does not directly result in quality of shared information, it must be accompanied by ability to share information.

    b.   Quality of information and intelligence is an additional factor in the quality of shared information.

    c.   The ability to adapt C2 processes is an additional factor in achieving synchronisation of actions.

    d.   The Right People building block is pervasive throughout the chain in the following ways:

        (1) Training in how to share information is necessary.

        (2) Training in how to take advantage of shared information is necessary.

        (3) Working practices need to be adapted to take advantage of high quality shared information where it is available.

        (4) Training is necessary to ensure that new information assets are fully exploited.

        (5) Training on how to overcome information overload and focus on the information required to improve shared awareness is necessary.

        (6) High calibre decision-makers are needed in order to take advantage of improvements in shared awareness.

        (7) An appreciation of the quality of shared awareness is key to making a good decision based on it.

It should be noted that the benefits chain does not now move in the linear sequence through Appropriate Connectivity to Information and Intelligence to Shared Understanding and Agile Groupings, as originally suggested. For example providing appropriate connectivity will not lead to improved quality of shared information

unless ability to share information is addressed simultaneously; also, good quality shared information improves quality of shared awareness but only if it is accompanied by high quality interactions and the necessary training to use the information.

The ultimate aim of the chain is to achieve timely and appropriate effects and so this should be included in the benefits chain.

CONCLUSION

The NEC benefits chain hypothesis can, with a few modifications, be supported by quantitative evidence. This means that the modified chain can now be used as the basis for analysis of NEC with confidence. As more evidence regarding NEC is produced, the benefits chain should be assessed again.

The work presented shows how scientific evidence can be drawn together from a variety of sources to validate the arguments presented by a benefits chain. This strengthens the arguments where they are supported and offers alternative arguments where they are not.

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