Approaching Transformational Coalition Operations along the Standardization, Interoperability and Integration (SI2) Continuum.

CCRTS Paper 024

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* The views expressed in this paper are solely those of the authors and do not necessarily represent the views of the Canadian Forces, the Canadian Department of National Defence or any Agency of the Government of Canada.

Abstract

This paper explores how an integrated approach to Coalition operations must be grounded in Standardization. Specifically, it posits the notion of the "SI2 continuum" whereby Standardization leads to Interoperability enabling Integration of efforts among Coalition partners. By formally recognizing and following the phased processes along the SI2 continuum, national defence practitioners will ensure the rational and coherent generation of forces capable of effective integration into Multinational Effects Based Operations.

Main Text

Standardization, Interoperability and Integration are terms that are employed synonymously, an error in usage that confuses their contextual understanding, development of appropriate applications and corresponding metric. The three terms, although explicitly linked, represent vastly different aspects of our ability to work cohesively as a Service, Joint Force, Coalition partner or Whole of Government. Emerging Transformational concepts such as Effects Based Operations and Network Centric Operations are built upon varying applications of standardization, interoperability and integration that necessitate a cogent understanding of the divisions, overlaps, sequential order of these terms, in order to facilitate an understanding of the

interrelationships and associated synergies. The operational aim is to position the right information in the right place at the right time in order enable disparate decision makers to synchronize the right effectors to facilitate the desired effect. This paper sees the relationship of Standardization, Interoperability and Integration (SI2) as a continuum, where Standardization leads to Interoperability to enable Integration. The SI2 continuum provides a model to more effectively and efficiently explore the linkages associated with the traditional military to military, service to service multinational coalition efforts together with other governmental organizations and multinational non-military structures for the examination of the underlying theory supporting the examination of Transformation.

The most widely accepted definitions of Standardization and Interoperability, certainly from a military perspective, are those developed within NATO. The most recent refinements of the definitions are:

Standardization – "The development and implementation of concepts, doctrines, procedures and designs in order to achieve and maintain the compatibility, interchangeability or commonality which are necessary to attain the required level of interoperability or to optimize the use of resources, in the fields of operations, material and administration,"[1] and,

Interoperability – "The ability to operate in synergy in the execution of assigned tasks."[2]

[1] NATO Committee for Standardization (NCS) approved, currently being incorporated into AAP-6
[2] Ibid

Note that the NATO definitions suggest a hierarchical relationship with standardization leading to interoperability, Figure 1.

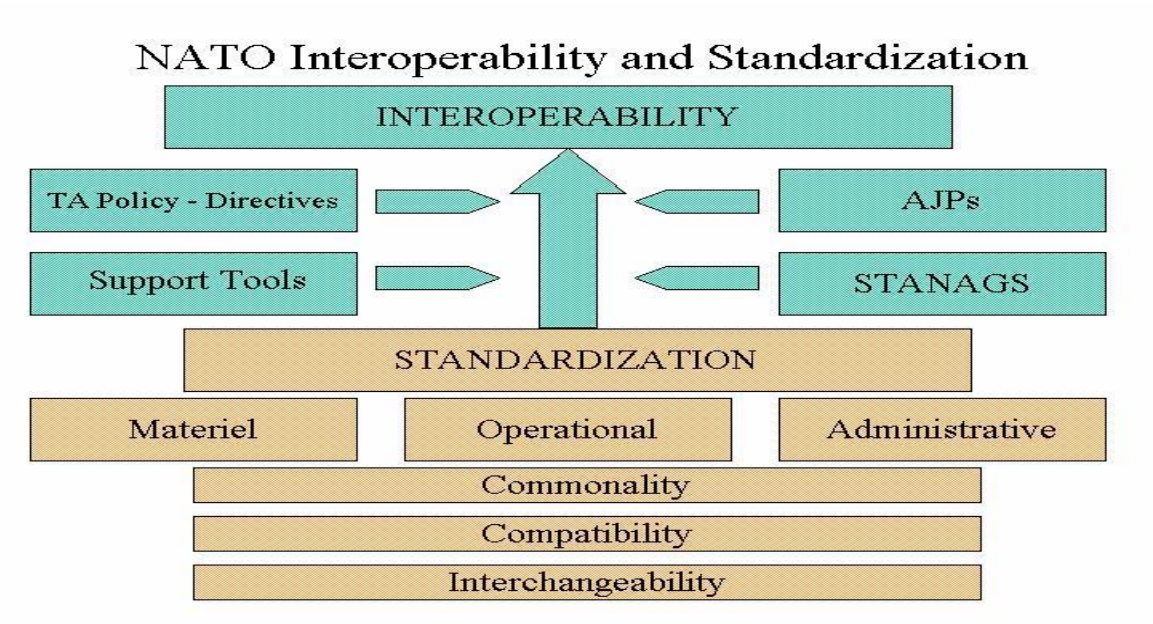


Figure 1 NATO - Standardization to Interoperability

It is interesting that the NATO Terminology database does not include a definition for Integration, which the Concise Oxford English Dictionary defines as to "combine or be combined to form a whole, to bring or come into equal participation in an institution or body." From this perspective, integration is therefore a level of unity in purpose and arguably a desirable outcome of standardization and interoperability where dissimilar components attempt to achieve a desired singular end state and combine to promote the goals of a larger institution or body. Each component integrates their separate functions to achieve a desired outcome without surrendering the identity or functionality of their own systems' characteristics. An analogy is found in the classic story over which body part should ascend to the top of the hierarchical heap when it comes to running the integrated body:

Who Runs the Human Body?

All the organs of the body were having a meeting, trying to decide who was in charge.
The brain said: "I should be in charge, because I run all the body's systems, so without me nothing would happen."
"I should be in charge," said the heart, "because I pump the blood and circulate oxygen all over the body, so without me you'd all waste away."
"I should be in charge," said the stomach, "because I process food and give all of you energy."
"I should be in charge," said the rectum, "because I'm responsible for waste removal."
All the other body parts laughed at the rectum and insulted him, so in a huff, he shut down tight. Within a few days, the brain had a terrible headache, the stomach was bloated, and the blood was toxic. Eventually the other organs gave in. They all agreed that the rectum should be the boss.
The moral of the story?
You don't have to be smart or important to be in charge...

Or that each component of the body must function in synchronise harmony for the body to survive.

The NATO definition of Standardization incorporates the view that the concepts of compatibility, interchangeability or commonality are critical enablers to achieving interoperability. The standardization policy of NATO, the Canadian Forces and many of the other National Defence Forces stresses the military aspects of interoperability achieved through standardization, within the traditional military to military, or service to service relationships to an extent that both constituents are thought of as one. Such policies do not address the achievement of "coherent effects based interoperability" delineated within the ACO/ACT Strategic Vision. The Strategic Vision statements delineates an effects based construct that seeks to integrate political, military, civil and economic processes needed to bring all instruments of power of the Alliance or of a Nation into focus in achieving a single overarching aim or goal. In a multilateral environment, this requires multinational interagency collaboration and civil-military co-operation achieved through standardization objectives, leading to degrees of enhanced

interoperability and integration amongst security partners. The SI2 Continuum should encompass not only activities of two or more services operating jointly, but should also incorporate national military interactions with any partner nations (multinational) and organizations (inter-agency) involved in security activities that influence the conduct and results of military operations. In short, Interoperability builds upon Standardization efforts to enable Integration of dissimilar components in the achievement of a singular, achievable and unifying outcome or effect.

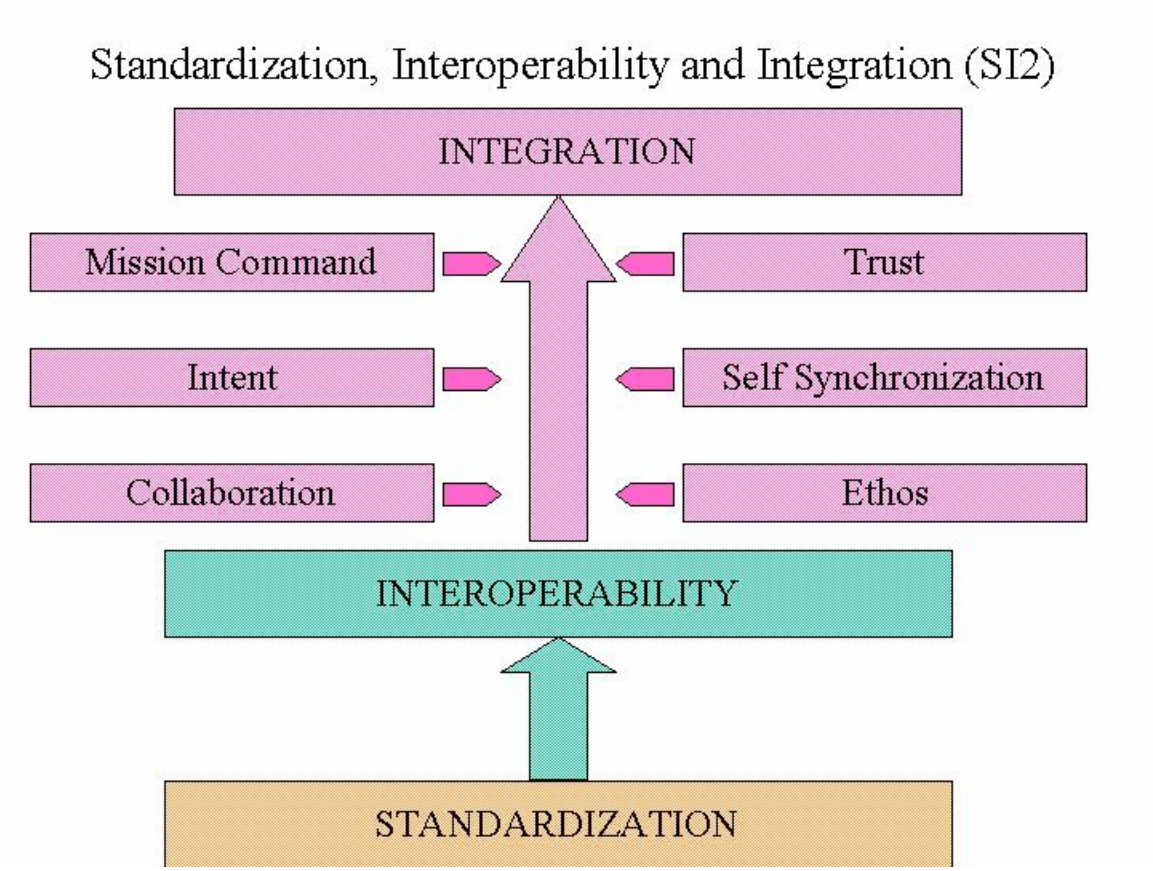


Figure 2 – Standardization leading to Interoperability enabling Integration

Standardization and Interoperability can therefore be thought of occurring in 4 broad domains: "physical" (the ability of tangible or concrete systems and their

components, including people and equipment, to connect and be compatible); "information" (the ability to share information including technological and procedural aspects); "cognitive" (the ability of non-tangible processes, including perception and thinking, to be sufficiently similar to be compatible); "social/cultural" (the ability to engage in co-operative activities with partners outside the normal social and cultural boundaries). These four domains lead to an ultimate fifth objective of "behavioral integration" (the ability of distinctly separate entities or capabilities to carry out a variety of interdependent courses of action in an integrated and ideally synergistic manner to achieve the desired effect).[3] Clearly there cannot be uniform levels of standardization and interoperability (SI) across the entire spectrum of organizations and boundaries due to varying technological/legislative provisions, government policies, and regulations and orders (placing a premium on the standardization components of compatibility, interchangeability or commonality). Different organizations and different nations accommodate different levels of SI within the four domains ranging from complete independence at the lower end, through de-confliction and coordination, to complete integration among partners at the upper end. The objective should be to maximize the opportunity for SI required to support multidimensional relationships to integrate the levers of power being applied to optimize cohesive execution or attainment of singular intent by dissimilar bodies. Indeed much of NATO's efforts, as well as those of other Multinational Fora, such as ABCA, AUSCANNZUKUS, MIC, etc, seek to delineate architectures, testing and validation frameworks, support tools, doctrines and tactics, techniques and procedures (TTP) within the SI domains of physical, information,

[3] The 5 Domains are taken from, "Effects Based Approach to Coalition Operations: A Canadian Perspective" written by LCOL J.D. Graham and Dr B.A. Smith-Windsor for CCRP 2004.

cognitive and social/structural as a means to influence the behavior of those that may or will participate in yet to be identified joint coalition efforts across the span of security actions.

Although SI2 attributes can be thought of as being implemented within each of the five domains, it is conceptually easier to compartmentalize each domain within the SI2 continuum where their application is most dominant. When this step is taken it can be seen that the Physical and Informational Domains dominate within the Standardization segment of the continuum; Cognitive and Social/Cultural Domains are emphasized within the Interoperability Segment; and the Behavioral Domain is most prevalent in the Integration portion of the SI2 continuum.

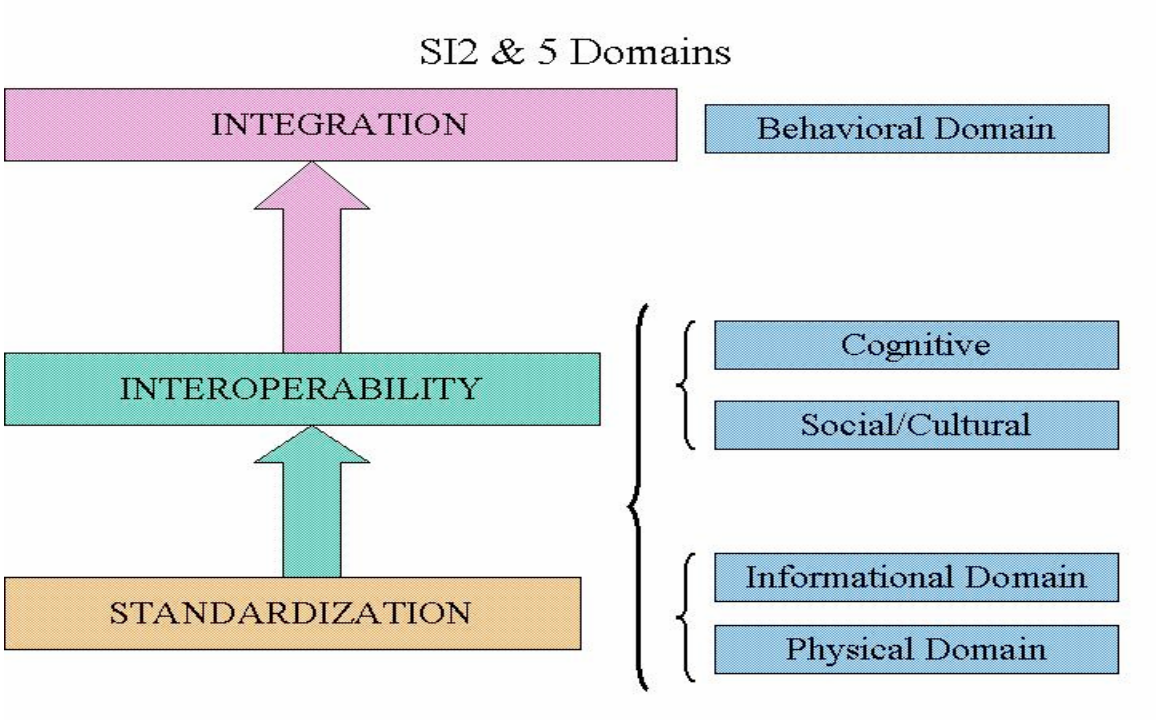


Figure 3 – SI2 and Domain Overlap

The vast majority of Military efforts have been expanded within the Standardization and Interoperability components of the SI2 Continuum seeking to unconsciously affect the behavioral domain as a means to achieving a desired effect. Be it Standardization by NATO STANAG or ABCA QSTAGS or the MIP Data Model, or the development of cognitive or social domain Interoperability Tactic Techniques and Procedures (TTP) or Doctrinal Publications, all ultimately sought to promote a single cohesive response from disparate organizations each seeking to achieve a single desired outcome. The truly transformational aspect of this construct is not that there is now an emphasis upon the higher behavioral domain but that this domain is now being realized, often without a second thought to the degrees of standardization and levels of interoperability that permit its attainment. Thea Clark and Terry Moon in their paper *Interoperability for Joint and Coalition Operations*,[4] illustrate this relationship in their examination of the US DOD LISI Model and Organizational Interoperability Model (OIM), which suggests a definable relationship between the technological standards emphasis of LISI and the human organizational interoperability emphasis of the OIM. The LISI model develops a measurement matrix of four primary attributes, PAID:

Procedures – What policies and procedures enable systems to exchange information, capabilities and services;

Applications – What set of applications enable information exchange, processing or manipulation;

[4] Thea Clark & Terry Moon, Systems of Systems Joint Systems Branch, *Interoperability for Joint and Coalition Operations*, Australian Defence Force Journal, No. 151, November/December 2001, pp. 23-36.

Infrastructure – What environment (hardware, communications and networks etc) enables system interoperability and integration; and,

Data – What information formats, data protocols, or databases enable the exchange of data and information?

The OIM model examines organizational interoperability within a matrix of four enabling attributes:

Preparedness – What doctrine, experience and training enables the organizations to work together;

Understanding – What level of information and knowledge sharing exists and how is the information used;

Command Style – How are roles and responsibilities delegated and shared; and,

Ethos – What level of trust, culture and values and goals are shared?

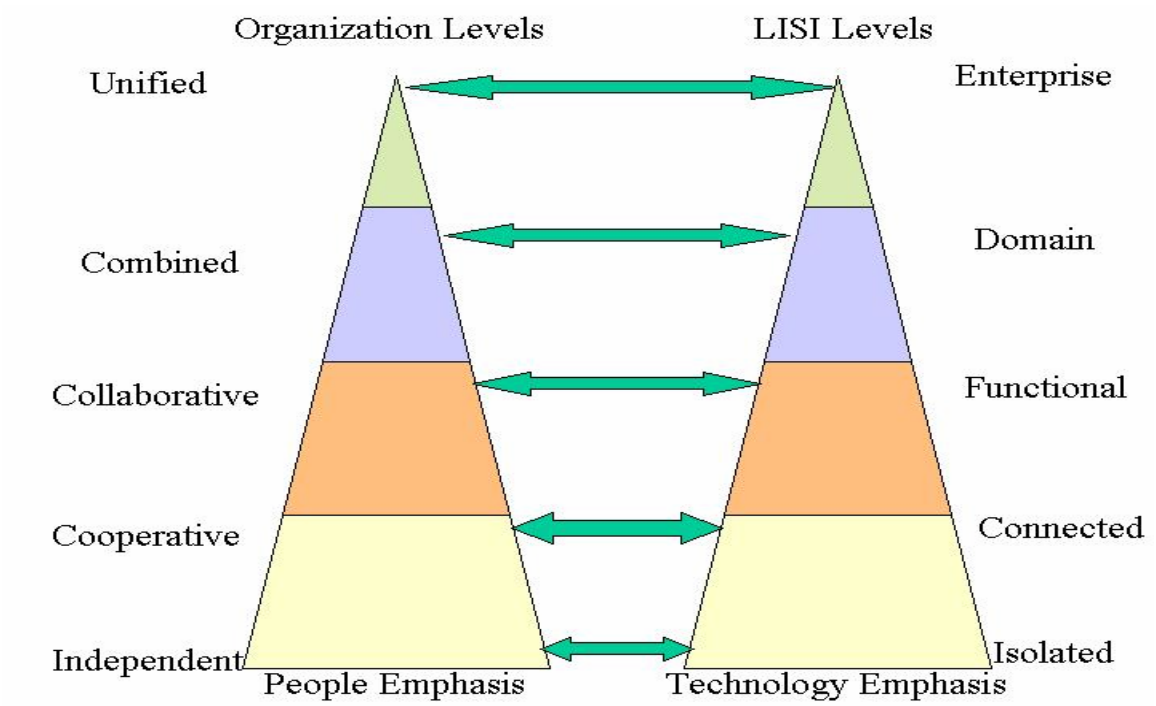


Figure - 4
OIM (People Emphasis) – LISI Comparison (Techno Emphasis)

The LISI and OIM models essentially overlap the SI2 Continuum as two separate components, Technology and People, and in so doing unintentionally obscure critical integrative outcome of behavior of emerging concepts. The "PAID" attributes and the OIM attributes of Preparedness and Understanding address standardization and interoperability characteristics consistent with measures associated with the physical, information, cognitive and social/structural domains. The OIM attributes of Command Style and Ethos initiate a crossover of investigation and understanding into the integrative fifth domain of behavior.

Command Style[5] attribute describes the management and leadership style of the organization, it's decision making, orders development, execution and monitor efforts. When collaboratively coordinating the efforts of multiple entities the command style employed becomes of particular interest to all participants. This is particularly true for an organization that employs mission command philosophy that is moving more and more to decentralized planning and highly decentralized execution where all participant actions are guided by Commanders intent.

Ethos[6] attribute is concerned with the culture and value system of the organization as represented through its constituent parts and is a direct reflection of trust.

In order to better understand this relationship and more specifically the theory of Transformation, the Office of Force Transformation in the United States developed a

[5] Stated as an attribute of the OIM model, with an emphasis within the interoperability cognitive domain. Re-stated in this paper as a transitional attribute as a potential means to measure the behaviour domain of the Integration portion of the SI2 Continuum.
[6] Ibid

Transformation Model. Developed from first principles, without the influence of models already addressing standardization and interoperability concerns, the transformation model effectively delineates many of the LISI and OMI attributes into a single all encompassing framework. The model postulates the 4 primary domains of SI, physical, information, cognitive and social, as critical to the transformational process. The model has been applied to a number of studies as a means to verify the correctness and truthfulness of the developing transformation theory.[7]

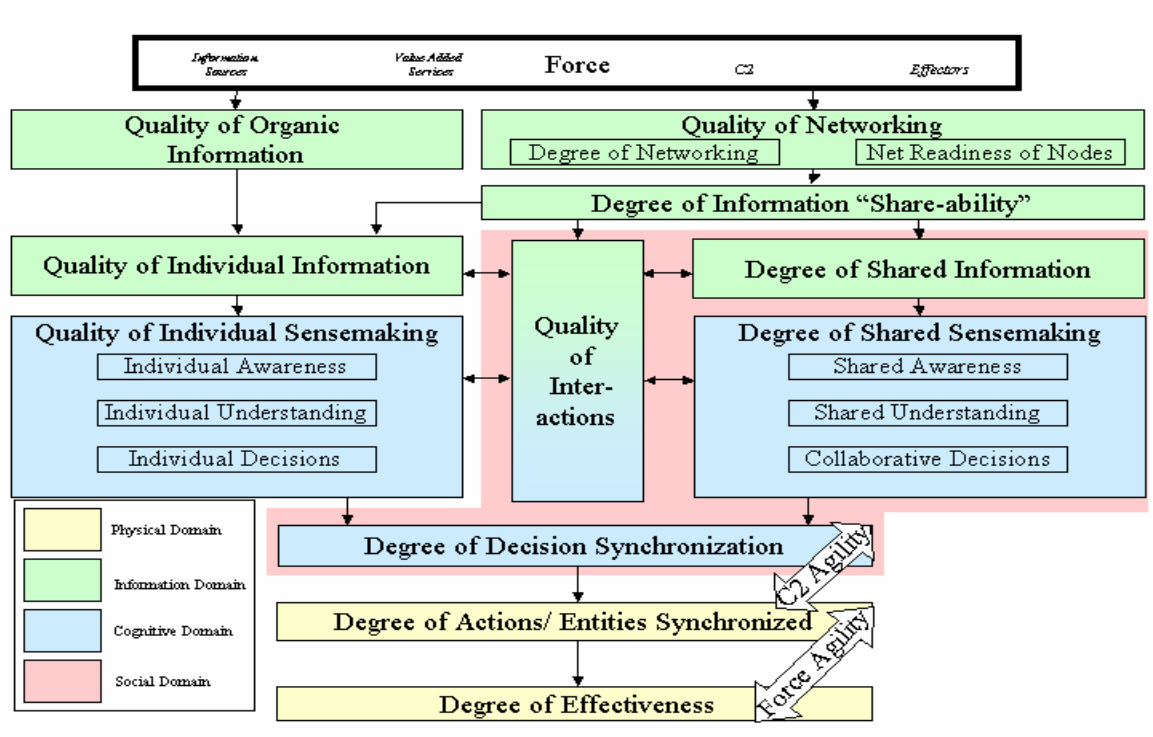


Figure 5 - Transformation Model
Office of Force Transformation

[7] The Office of Force Transformation – Transformation Model and Case Study Data is taken from a briefing given by Richard E. (Dick) Hayes, Ph.D., President, Evidence Based Research, Inc. (EBR) during the Network Enabled Operations DND/CF Responding to the New Security Environment, Symposium, November 30, 2004 Ottawa, Ontario, Canada, Titled - "Network Centric Operations (NCO) The Evidence Emerging from Case Studies"

The case studies conducted and published at the time of writing have successfully illustrated that the standardization and interoperability domains are critical to enabling transformation. The studies also go on to illustrate the existence and importance of the fifth behavioral domain within the Integration portion of SI2 Continuum. The case studies reviewed illustrated attributes where the individual decision making processes of disparate individuals, units or formations were unified in outcome while maintaining their uniqueness in function, as do the body parts in the everyday maintenance of the human body.

Office of Transformation Case Studies Findings that Elude to a Fifth Behavioural Domain	
Case Study	**Finding Relating to Fifth Behavioural Domain**
Commander Task Force-50	- More than 50 coalition ships were able to coordinate decision making and actions
Navy Special Warfare Group One in Afghanistan and Iraq	*- Improved mission effectiveness – situational awareness of SOF elements~*
Air to Ground Operations: OEF and OIF	- *Increased Shared Situational Awareness potentially increase mission effectiveness – requires verification*~*
NATO Networking in Peace Operations	- Collaboration and Trust across multinational participants increased
Joint US/ UK Combat Operations in Operation Iraqi Freedom	- Enabled U.S. forces to do "command on the move" at unprecedented speed of manoeuvre - U.S. forces attributed significantly higher confidence to FBCB2/BFT-provided information

* Not explicitly stated as a study finding but deduced from the defined outcomes
~ Emphasis of findings is within the Standardization and Interoperability components of the continuum.

Table 1 – Office of Force Transformation Study Outcomes

Standardization and Interoperability concerns have been a cornerstone of military business, industrial and information operations throughout their histories and reinforced by the majority of Study Findings. All five of the case studies listed within Table 1 illustrate that for Network Enabled Operations standardization and interoperability promotes increased situational awareness. But, promoting situational awareness itself is not transformational in and of itself. After all, military theorists and practitioners have

been seeking the ways and means to reduce “Friction” and eliminate the “Fog of War” throughout the conduct of warfare, a fundamental justification for standardization and interoperability. If we apply the SI2 continuum construct, it is the integrative behavioral attribute that stands out as potentially measurable to validate the conceptualization of transformation. Of the studies illustrated in Table 1, three case studies stand out as best illustrating behavioral integration aspects of the SI2 fifth domain; Commander Task Force 50; NATO Networking in Peace Operations; and, Joint US/UK Combat Operations in Operation Iraqi Freedom. The findings of these three case studies suggest that network attributes, facilitated by degrees of standardization leading to levels of interoperability, enable integration of disparate organizational behavioural processes to a unifying singular intent or desired effect and that modern SI constructs are enabling this manifestation to be facilitated with breadth and depth. A more detailed examination of the studies supporting documentation would be required to validate the perception, but the findings, as presented in Table 1, allude to the validity of this hypothesis. These three case studies are particularly germane since the force compositions were that of multiple national entities processing distinctive degrees of standardization and levels of interoperability within the primary physical, informational, cognitive and social domains, enabling scalable integration while maintaining the individual intrinsic values of the national components themselves. A shortfall of the model is that it presents the physical domain as an outcome rather then being an integral piece of the foundation of the other domains.

It is suggested that it is the introduction of the Fifth Domain to the Transformation Model, Figure 5, which demonstrates whether transformation is actually taking place.

Additionally it is consider critical to illustrate the foundational aspect of the physical domain in the model. Figure 6 is an attempt to modify the Transformation Model to illustrate the placement of the intrinsic linkages of the SI2 Continuum in the process. The Modified Transformation Model illustrates the SI2 Continuum as keystone enablers to quantifying and qualifying measures of domain (physical, information, cognitive, social and behavioural) application or importance.

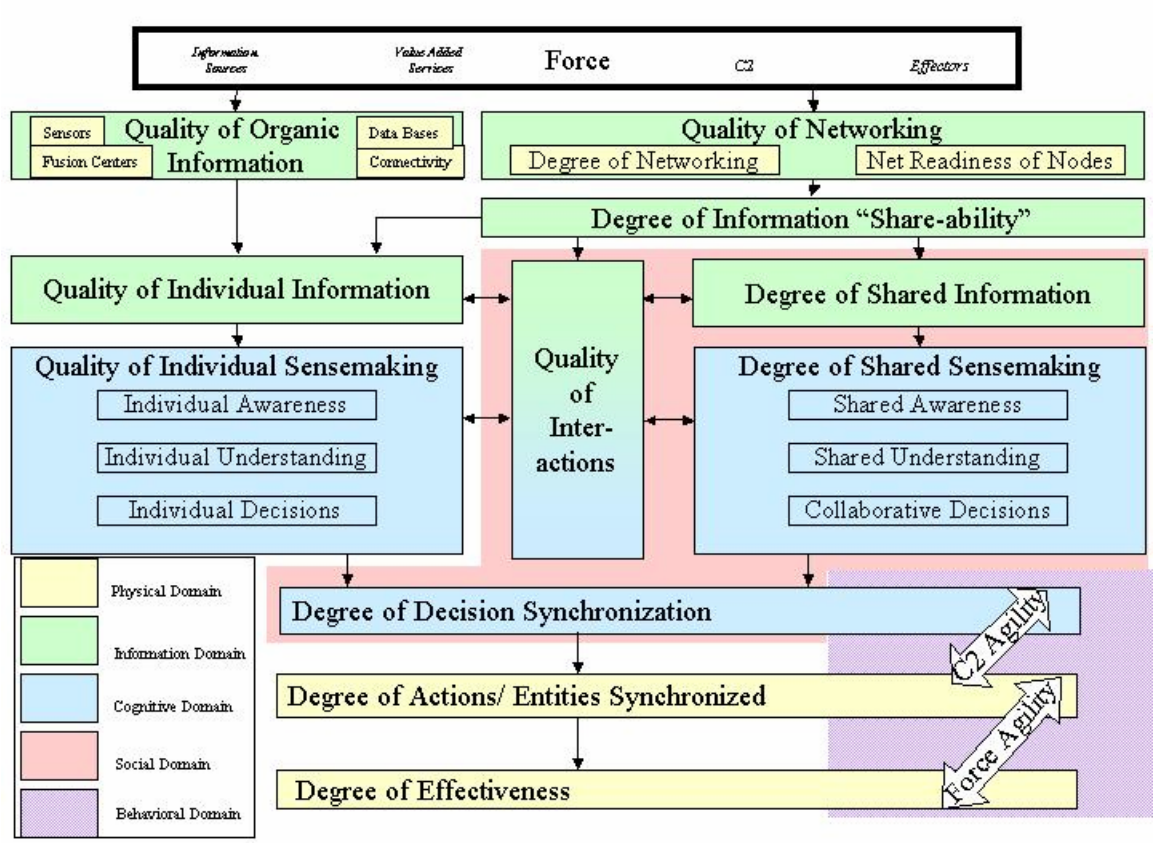


Figure 5 – Modified Transformation Model

All interactions involve some aspects of standardization or interoperability, with degrees of standardization and levels of interoperability now so pervasive in both civilian and military physical, informational, cognitive and social/structural domains that they have become invisible practitioners. Network Centric Operations, based upon

standardization and interoperability principles, are reducing the time required to develop actionable information through the promotion of situational awareness. This construct has further enabled the development of Effects Based Operations concepts where the application of force is tailored to the desired outcomes. Network Centric Operations and Effects Based Operations are further scaled to encompass the development of Joint Coalitions premised on Multinational and Multi-agency operations attempting to coordinate the efforts of multiple levers of power simultaneously in the achievement of a desired outcome. It is the behavior component of Integration that identifies how successful we are at facilitating this transformational objective. It is when disparate organizations that may not have previously trained, operated or functioned together, work as a cohesive team to achieve a desired outcome while maintaining dissimilar internalized procedures and processes that we realize we are witnessing a transformational event or activity. Such an activity requires degrees of standards and levels of interoperability that facilitate an environment which promotes cognitive understanding of intent, and a willingness and ability of entities with dissimilar interoperability levels to act upon stimuli in a cohesive manner in the achievement of a single desired outcome.

We have all experienced the disadvantages of a lack of standardization, interoperability and integration; the "wrong" plug point in a hotel, walking a wireless system around a "Hotpoint" searching for the elusive wireless connection, attempting to decipher the nuances of another language when trying to find one's way to a hotel after a long flight, or even driving on the "wrong" side of the road. Due to human and cultural differences, standardization and interoperability are not natural and thus have limitations.

Clearly the perception of integration or full standardization leading to uniformity has caused more than one author to warn against aspirants supporting the advancement of a single society. In our modern age, some uniformity would certainly lessen stress and frustration and is considered vital to the administration of the informational age, and critical to just-in-time delivery concepts, as well as the efficient management of resources in a business, bureaucracy or military structure. On one side of the coin, even in the information age we guard against the monopolization of a sole standard, witness the Microsoft court challenges. On the other side of the coin, standardization can be a tremendous force multiplier. In other words, if the level of standardization is sufficiently high then overall interoperability of forces will be greater than the sum of the individual components; they will all seemingly be able to "pull" in the same direction. In the "Information Age", the most fundamental requirement of standardization and interoperability is information. We must "know" what is required and how the others within the total system are carrying out their business, and preferably in a timely way to allow preparations of systems and operators and the self-synchronization of disparate efforts. As a North American or European, consider the consequences if you didn't know that you had to drive on the non-standardized side of the road when you arrived in the UK or Australia. Acquiring the proper knowledge enables behavioral conditioning and integrates multiple components of dissimilar standardized and interoperability rule sets to conform to a single underlying matrix. In this case the underlying matrix is the process of driving a car with the standardization and interoperability rule sets building upon this fundamental action. Critical to this conformity is the interrelationship of SI2 with physical, information, social/cultural, cognitive and behavioral domains.

The conceptualization of the SI2 Continuum as Standardization leading to Interoperability, with theories and metrics based in physical, information, social/cultural and cognitive domains, to enable Integration, supported by theories and metrics within the behavioral domain, provides a means to advance the theory of Transformation and the associated concepts of Effects Based and Network Centric Operations. The continuum suggests that transformation is grounded in standardization and interoperability principles to permit disparate organizations to function together in the achievement of an overriding goal or objective that is known and comprehended by all involved parties. The application of the continuum construct to the Transformation model illustrates the need quantify and qualify the levels and degrees of standardization and interoperability supporting behavioral or integration outcomes. The SI2 continuum provides a model to, effectively and efficiently, explore the linkages associated with the traditional military to military, service to service and multinational coalition efforts together with other governmental organizations and multinational non-military structures for the examination of the underlying theory supporting the examination of Transformation.

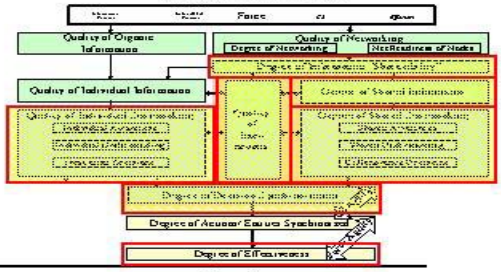
Case Study Summations

Commander Task Force-50

Scenario

- U.S. Navy's Commander Task Force 50 (CTF-50) aboard the USS Carl Vinson (CVN 70) during Operation Enduring Freedom, July 2001 – January 2002
- Exploration of the use of the Knowledge Web

Area of Focus



Hypotheses

Application of NCO capabilities improves:

- Information sharing
- Shared Situational Awareness
- Self-synchronization
- Speed of command
- Mission effectiveness

Findings

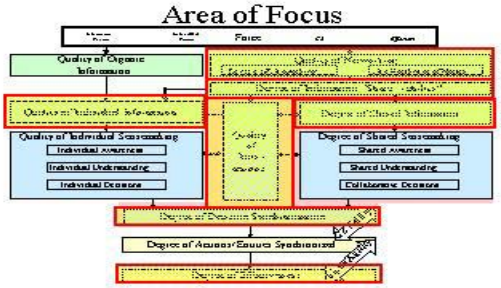
- More than 50 coalition ships were able to coordinate decisionmaking and actions
- Knowledge Web facilitated extensive shared situational awareness
- Dramatic changes to the standard operating procedures (no briefings, info was available on the network)
- Increased confidence and trust throughout
- Leadership and training were central for success

Navy Special Warfare Group One in Afghanistan and Iraq

Scenario

- NSWG1 mission support center's application of new technologies (e.g., MSC, A3, WEBBE, GBS) in OIF and OEF added greater capability to the planning and execution of special operations
- Missions: Cave Clearing Ops., Khairullah Capture, Al Faw Oil Field, GOPLAT Operations, Maritime Interdictions, etc.

Area of Focus



Hypotheses

- The application of NCO capabilities in the NSWG1 Mission Support Center improves:
  - Mission planning (timeliness and quality of plans)
  - Mission execution (more successful missions supported)

Findings

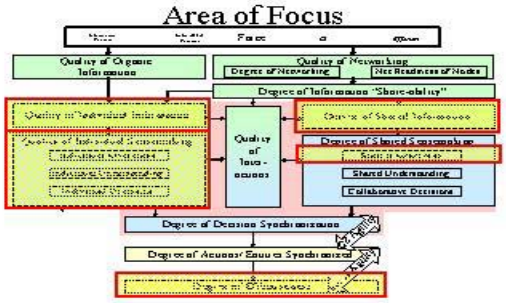
- Increased number of operations possible
- 70% reduction in forward footprint
- Dramatically improved mission planning process: more timely mission planning, better quality plans
- Improved mission effectiveness – situational awareness of SOF elements

Air to Ground Operations: OEF and OIF

Scenario

- Air-Ground Interaction (focusing on Close Air Support) using operations in OEF and OIF
- Involved USAF, USA, SOF, and/or USMC
- Technology used included: SADL, GBU-12, and AGM-65D equipped F-16s/ A/OA-10, pioneer video system, etc.

Area of Focus



Hypotheses

- Networked systems (voice plus data links) improves:
  - shared situational awareness
  - trust between air and ground elements
  - mission execution

Findings

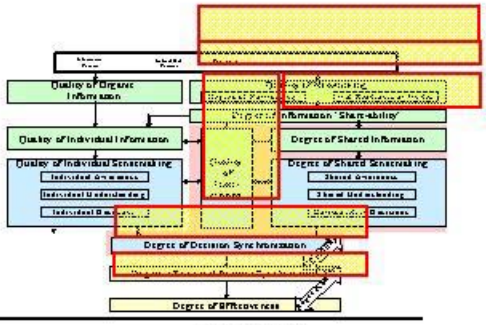
- Shared digital display technologies between air and ground (both seeing same picture in real time)
- Other digitalization systems facilitated CAS, especially western Iraq
- ***Increased Shared Situational Awareness potentially increase mission effectiveness – requires verification***

NATO Networking in Peace Operations

Scenario

- C2 experiment (IRTF (L)) and Operation Amber Fox in Macedonia (NATO)
- Involved: ACE Mobile Force (Land) (AMF (L)), and Task Force Fox (TFF)
- Use of ISIS (an Information Management tool) in IRTF (L) and TFF

Area of Focus



Hypotheses

- NCO capabilities applied during multinational operations increases:
  - information sharing
  - shared situational awareness
  - mission effectiveness

… relative to previous missions/exercises with traditional approaches

Findings

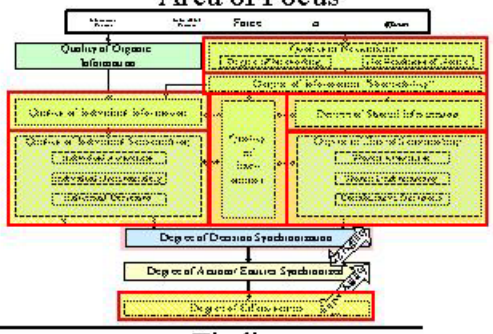
- Information sharing improved dramatically (CROP provided by ISIS)
- **Collaboration and Trust across multinational participants increased**
- Leadership essential for adoption and effective use of NCO technologies and practices
- **Cultural and organizational differences still remain obstacles to NCO**

Joint US/ UK Combat Operations in Operation Iraqi Freedom

Scenario

- Initial Combat Ops in Operation Iraqi Freedom
  - U.K. 1 Armored Division
  - U.S. 3 Infantry Division
  - USMC Units
- Augmentation to friendly force information and information sharing

Area of Focus



Hypotheses

- During Operation TELIC/IRAQI FREEDOM, the direct accessibility to FBCB2/BFT by U.K. and U.S. units provided:
  - Improved individual sensemaking
  - Enhanced the quality of interactions
  - Improved shared sensemaking
  - Increased mission effectiveness

… relative to previous operations and training without FBCB2/BFT.

Findings

- FBCB2/BFT provided nearly 60% of U.S. forces tactical SA compared to 10% in U.K.
- **Enabled U.S. forces to do "command on the move" at unprecedented speed of maneuver**
- U.K. forces could not fully exploit the capabilities of BFT because of gaps in deployment and training
- **U.S. forces attributed significantly higher confidence to FBCB2/BFT-provided information**