Chapter 4 – THE INFORMATION DOMAIN

APPROACH

The top level view of the Conceptual Model is shown in Figure 4-1. This chapter discusses the information domain portion of the conceptual model as highlighted in the white boxes in the figure below.

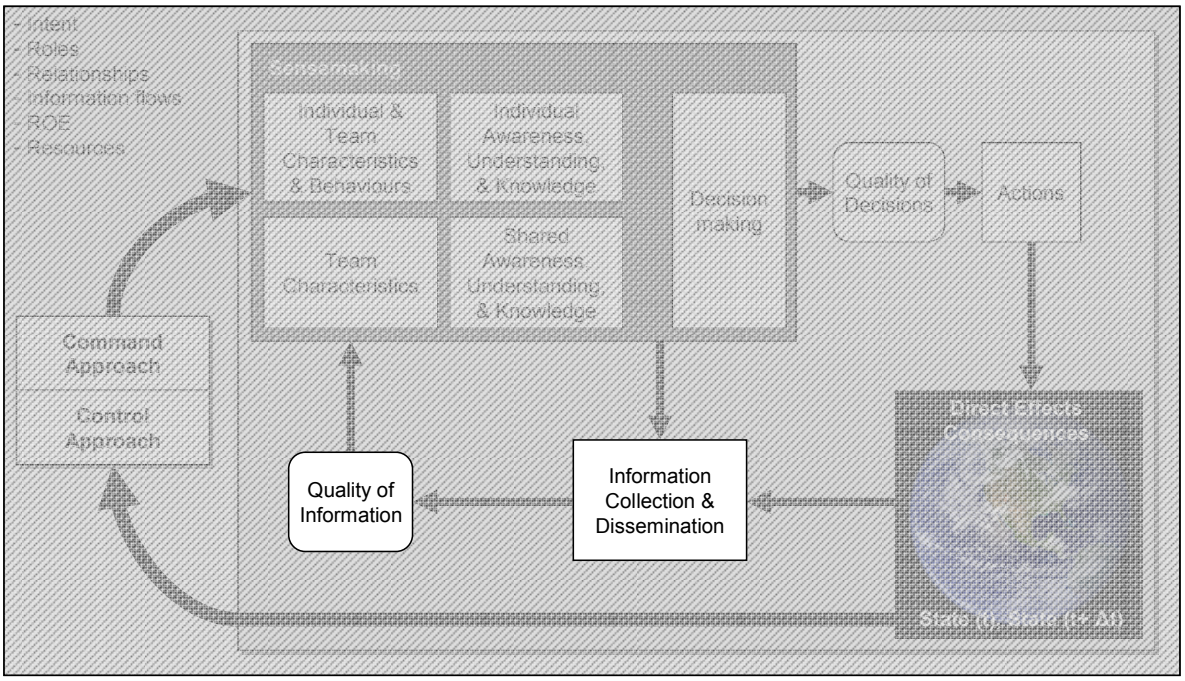

Figure 4-1: Information Domain Aspects in the Top Level View of C2 Conceptual Model.

The working group's aim was to ensure that the model adequately reflected a complete and robust set of information-related variables (sufficient to cover all the likely applications of the C2 Conceptual Model) and to suggest links between the variables (as supported by evidence where possible).

Figure 4-2 centres on the Quality of Information, a measure of merit of the product of the Information Domain. Also depicted in Figure 4-2, within dotted lines, are the C2 Approach and the Sensemaking Process. The C2 Approach establishes many of the conditions that affect Information Domain resources and processes, while the Sensemaking Process relies heavily on Information Domain products. The Distribution of Information, a key dimension of the C2 Approach, is a major determinant of the Quality of Information. The Distribution of Information is influenced by the characteristics of the Network, as well as the other dimensions of C2. The characteristics of the Network also influence Collaboration, which in turn influences the Quality of Information. Collaboration is affected by the Situational Characteristics, which also affect the nature of the information sources that are needed and/or available. Information Sources also directly affect the Quality of Information.

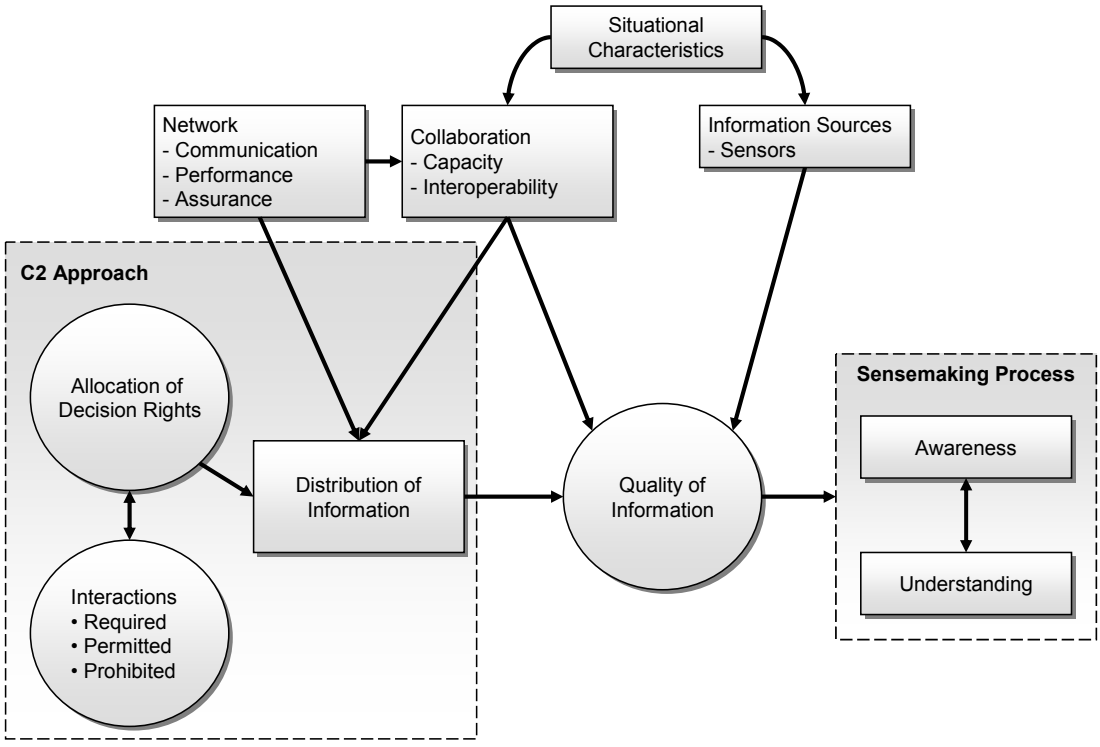

Figure 4-2: Variables that Contribute to Quality of Information.

The nature and characteristics of Information Sources are subdivided in the C2 Conceptual Reference Model into databases, direct sensing, indirect sensing, information source characteristics, open sources, and task currency/latency.

- *Databases* are collections of information organized in a structured fashion.
- *Direct sensing* takes place when humans experience an object or event in the physical domain with one of their senses (such as seeing, hearing, or smelling), and the sensing registers directly in the cognitive domain.
- *Indirect sensing* is to become aware of and perceive by involving intermediate or intervening parts or pathways.
- *Information source characteristics* are the traits of tools used to develop facts, data, or instructions in any form or medium.
- *Open sources* refers to the willingness and ability of an individual to change their understanding of a situation when confronted with new or contradictory information.
- *Task currency/latency* is the time lag of information.

Sensors, direct or indirect, are often employed to gather information about the situation. The composite variable, Sensors, consists of the attributes of mobility, resolution, sensor coverage (spatial), sensor coverage (medium), sensor coverage (spectrum), and sensor persistence.

- *Mobility* is the *e*xtent to which a sensor is able to move from place to place while retaining its ability to fulfil its primary mission.

- *Resolution* is the measurement of the smallest detail that can be distinguished by a sensor system under specific conditions.
- *Sensor coverage (spatial*) is the sequence or range of values (e.g., frequency, optical, infrared) that a sensor exhibits in order to observe, analyze, and report targets of interest.
- *Sensor coverage (medium)* is the sequence or range of values (e.g., frequency, optical, infrared) that a sensor exhibits in order to observe, analyze and report targets of interest.
- *Sensor coverage (spectrum)* is the sequence or range of values (e.g., frequency, optical, infrared) that a sensor exhibits in order to observe, analyze and report targets of interest.
- *Sensor persistence* is a compound attribute that addresses the percentage of time an area is covered along different dimensions of the spectrum.

There are a number of uncertainties that can and do affect the characteristics of the situation that, in turn, influence the nature and availability of information. S*ituational characteristics* are subdivided into ambiguity of situation, complexity of situation, equivocality of situation, uncertainty of situation, situational familiarity, and temporal focus.

- *Ambiguity of situation* is the inability to make sense out of a situation, regardless of available information.
- *Complexity of situation* is being faced with a situation made up of an interrelated set of variables, solutions, and stakeholders, each individually understood but which together exceed the processing capacity of the individual, the team, or organisation to synthesize.
- *Equivocality of situation* is having multiple interpretations of the same information.
- *Uncertainty of situation* is not having sufficient information to describe a current state or to forecast future states, preferred outcomes, or the actions needed to achieve them.
- *Situational familiarity* is the characteristic of having encountered or seen, or having knowledge of a situation.
- *Temporal focus* is the time into the future of an understanding or plan.

Available information, to be useful, must be distributed. The Distribution of Information depends, in part, on the characteristics of the network that is subdivided into: communication systems characteristics, information richness, information transfer approach, network reach, network richness, and quality of visualization.

- *Communication systems characteristics* have the following distinguishing traits: reach, reliability, robustness, richness of a communication system.
- *Information richness* measures the quality of the information content used by actors.
- *Information transfer approach* is the movement and distribution of information.
- *Network reach* is the number and variety of people, work stations, or organisations that can share information.
- *Network richness* is the quality and breadth of the information found in the network.
- *Quality of visualization* is the ability to capture the full richness of the insights, particularly risk and uncertainty (e.g., depicts the distribution rather than just the statistical) that are derived in assessments.

Verification of the information is necessary to generate trust and confidence in the information. The variables found within *information assurance* are authentication, confidentiality, information pedigree, integrity, network assurance, network availability, network reliability, network redundancy, network sustainability, non-repudiation, and privacy.

- *Authentication* is a security measure designed to protect a communications system against acceptance of a fraudulent transmission or simulation by establishing the validity of a transmission, message, or originator.
- *Confidentiality* is information or material that requires protection from unauthorized disclosure that could reasonably be expected to cause damage to national security.
- *Integrity* is that quality or condition of being whole or undivided, complete.
- *Non-repudiation* is the inability to avoid responsibility for inserting data, information, or knowledge into the information domain.
- *Information pedigree* is the extent to which you know where information came from.
- *Privacy* is a system in which no one except authorized users has access and each user's access is appropriate for their roles and responsibilities.
- *Network assurance* is the degree of confidence in the ability of force entities to have good connectivity. This includes the security, privacy, and integrity of the network and its contents.
- *Network availability* is the percentage of time that all authorized users have access to the network. This is necessary if current information is to be shared and if the user community is to develop trust and confidence in using the information in the system.
- *Network redundancy* is multiple ways to get at the same information or to get from point A to point B in a network. This helps in the availability of the system, where if part of the network goes down, then there are other means of accessing or getting to a certain part of the network.
- *Network reliability* is an attribute of any network that consistently produces the same results, preferably meeting or exceeding its specifications.
- *Network sustainability* is the ability to maintain the necessary level and duration of operational activity to achieve military objectives. In a network context, sustainability is a function of the ability to manage, maintain, and restore the network and network components.

The processing of information also relies on the *performance of information equipment*, which is subdivided into quality of communications equipment, quality of computing equipment, quantity of communications equipment, and quantity of computing equipment.

- *Quality of communications equipment* is the subjective assessment of the quality of available tangible forces, materiel, and other assets.
- *Quality of computing equipment* is the subjective assessment of the quality of computing hardware and associated equipment.
- *Quantity of communications equipment* is the number of available tangible forces, materiel, and other assets.
- *Quantity of computing equipment* is the number of computing hardware and associated equipment.

Information-related processing and analysis involves collaboration among individuals and organisations. Collaboration is dependant upon the collaboration environment that is available. This in turn depends on the capabilities and reliability of the network. Collaboration involves actors sharing data, information, knowledge, perceptions, or concepts when they are working together toward a common purpose.[1] *Collaboration* is subdivided into collaboration capacity, collaboration completeness, collaboration mechanism, collaboration participants, continuity of interactions, frequency of interactions, and interaction quality.

- *Collaboration capacity* is the team members' ability to work together towards a common purpose.
- *Collaboration completeness* includes collaboration about capabilities, environment, forces, intentions, and mission.
- *Collaboration mechanism* is a system that enables collaboration.
- *Collaboration participants* is the ability of team members to work together towards a common purpose.
- *Continuity of interactions* is an uninterrupted succession or flow of mutual or reciprocal actions or influences.
- *Frequency of interactions* is the rate of interactions over time. It should be noted that time scale depends on level of modelling, e.g. tactical seconds/minutes/ hours... enterprise months/years.
- *Interaction quality* is the usefulness of actively sharing information, developing awareness, and understanding and/or making decisions (developing plans) in a collaborative environment.

Collaboration and interoperability go hand-in-hand and affect the ability of mission participants and the systems that support them to work together. This needs to occur at a number of levels or layers to enable entities to communicate, share information, and collaborate with one another.[2] *Interoperability* is subdivided into system semantic interoperability, data interoperability, human semantic interoperability, communications interoperability, and quality of interactions.

- *System semantic interoperability* is consistency of meaning across systems.
- *Data interoperability* represents a level of interoperability in which data from one system can be used directly as data in another system, without translation or transformation.
- *Human semantic interoperability* is consistency of meaning across individuals.
- *Communications interoperability* is the condition achieved among communications-electronic systems or items of communications-electronic equipment when information or services can be exchanged directly and satisfactorily between them and/or their users.
- *Quality of interactions* is the usefulness of actively sharing information, developing awareness, and understanding and/or making decisions (developing plans) in a collaborative fashion.

Information quality consists of nine attributes or variables including information accuracy, information completeness, information consistency, information correctness, information currency, information precision, information relevance, information timeliness, information uncertainty, information service characteristics, information sharability, and information source characteristics.

[1] Alberts, Garstka, Hayes and Signori, *Understanding Information Age Warfare*. p. 185.

[2] Alberts and Hayes, *Power to the Edge*. pp. 107-108.

- *Information accuracy* is the degree to which information quality matches what is needed.
- *Information completeness* is the extent to which information relevant to ground truth is collected.
- *Information consistency* is the extent to which information is consistent with prior information and consistent across sources.
- *Information correctness* is the extent to which information is consistent with ground truth.
- *Information currency* is the difference between the current point in time and the time the information was made available.
- *Information precision* is the level of measurement detail of information item.
- *Information relevance* is the extent to which information quality is relevant to the task at hand.
- *Information timeliness* is the extent to which currency of information is suitable to its use; the relationship between availability of the information and when it is needed.
- *Information uncertainty* is a fundamental attribute of war and pervades the battlefield in the form of unknowns about the enemy, the surroundings, and our own forces.
- *Information service characteristics* describe a range of processing services support than might be provided to the force for continuance of operations where each alternative builds on the previous one.
- *Information sharability* is the extent to which an element of information is in a form or format understandable by all nodes in a network.
- *Information source characteristics* are the traits of tools used to develop facts, data, or instructions in any form or medium and all information sources are reporters.

If the information is shared among individuals, it takes on new qualities. *Shared information quality* is subdivided into shared information accuracy, shared information completeness, shared information consistency, shared information correctness, shared information currency, shared information precision, shared information relevance, shared information timeliness, and shared information uncertainty.

- *Shared information accuracy* is the appropriateness of precision of shared information for a particular use.
- *Shared information completeness* is the extent to which relevant shared information is obtained.
- *Shared information consistency* is the extent to which shared information is consistent within and across communities of interest.
- *Shared information correctness* is the extent to which shared information is consistent with ground truth.
- *Shared information currency* is the time lag of shared information.
- *Shared information precision* is the level of granularity of shared information.
- *Shared information relevance* is the proportion of shared information that is related to task at hand.
- *Shared information timeliness* is the extent to which currency of shared information is suitable to its use.
- *Shared information uncertainty* is the subjective assessment of confidence in shared information.