AN ANALYSIS OF INFORMATION ASSET VALUTION (IAV)

QUANTIFICATION METHODOLOGY FOR APPLICATION WITH

CYBER INFORMATION MISSION IMPACT ASSESSMENT (CIMIA)

THESIS

Denzil L. Hellesen, Master Sergeant, USAF

AFIT/GIR/ENV/08-M11

DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY

AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

The views expressed in this thesis are those of the author and do not reflect the official policy or position of the United States Air Force, Department of Defense, or the United States Government.

AFIT/GIR/ENV/08-M11

AN ANALYSIS OF INFORMATION ASSET VALUTION (IAV) QUANTIFICATION METHODOLOGY FOR APPLICATION WITH CYBER INFORMATION MISSION IMPACT ASSESSMENT (CIMIA)

THESIS

Presented to the Faculty

Department of Systems and Engineering Management

Graduate School of Engineering and Management

Air Force Institute of Technology

Air University

Air Education and Training Command

In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Information Resource Management

Denzil L. Hellesen, BS

Master Sergeant, USAF

March 2008

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

AFIT/GIR/ENV/08-M11

AN ANALYSIS OF INFORMATION ASSET VALUTION (IAV)

QUANTIFICATION METHODOLOGY FOR APPLICATION WITH

CYBER INFORMATION MISSION IMPACT ASSESSMENT (CIMIA)

Denzil L. Hellesen, BS
Master Sergeant, USAF

Approved:

/signed/	18 Mar 08
Michael R. Grimaila, PhD (Chairman)	Date
/signed/	17 Mar 08
Robert F. Mills, PhD (Member)	Date
/signed/	17 Mar 08
Dennis D. Strouble, PhD (Member)	Date
/signed/	12 Mar 08
Larry W. Fortson, Jr., Capt, USAF (Sponsor)	Date

AFIT/GIR/ENV/08-M11

Abstract

The purpose of this research is to develop a standardized Information Asset Valuation (IAV) methodology. The IAV methodology proposes that accurate valuation for an Information Asset (InfoA) is the convergence of information tangible, intangible, and flow attributes to form a functional entity that enhances mission capability. The IAV model attempts to quantify an InfoA to a single value through the summation of weighted criteria. Standardizing the InfoA value criteria will enable decision makers to compare-atively analyze dissimilar InfoAs across the tactical, operational, and strategic domains. This research develops the IAV methodology through a review of existing military and non-military valuation methodologies. IAV provides the Air Force (AF) and Department of Defense (DoD) with a standardized methodology that may be utilized enterprise wide when conducting risk and damage assessment and risk management. The IAV methodology is one of the key functions necessary for the Cyber Incident Mission Impact Assessment (CIMIA) program to operationalize a scalable, semi-automated Decision Support System (DSS) tool. The CIMIA DSS intends to provide decision makers with near real-time cyber awareness prior to, during, and post cyber incident situations through documentation of relationships, interdependencies, and criticalities among information assets, the communications infrastructure, and the operations mission impact.

Acknowledgments

I would like to express sincere appreciation to my thesis advisor, Dr. Michael R. Grimaila, for his tutelage; my AFRL sponsor, Capt. Larry Fortson, for sharing a common vision; my knowledgeable committee members, Dr. Robert F. Mills and Dr. Dennis D. Strouble, for their significant contributions; my follow students for helpful teamwork; my many dedicated professors for providing an invaluable education; and my wife and sons for their countless sacrifices while I attended AFIT.

MSgt Denzil L. Hellesen, BS

.

Table of Contents

Page

Page

Page

Page

Page

List of Figures

Page

Page

List of Tables

Page

AN ANALYSIS OF INFORMATION ASSET VALUTION (IAV) QUANTIFICATION METHODOLOGY FOR APPLICATION WITH CYBER INFORMATION MISSION IMPACT ASSESSMENT (CIMIA)

I. Introduction

If you know the enemy and know yourself, you need not fear the result of a hundred battles. If you know yourself but not the enemy, for every victory gained you will also suffer a defeat. If you know neither the enemy nor yourself, you will succumb in every battle," as interpreted by David E. Hawkins and Shan Rajagopal (Hawkins and Rajagopal 2005:134).

- Sun Tzu

Background

In a very real human way, we deal with valuation daily. In the morning a person makes a decision on whether to have coffee or cola. Internally, the person places a value on each of the drinks and then compares the values before making a decision. The valuation process may include tangible items such as cost or caloric content. The valuation process may also include intangible items such as a personal desire for one drink over the other. In the end, a small valuation process takes place to value which drink to choose before heading off for work. Value is currently playing a role in the information asset (InfoA) prioritization, however the details, characteristics, and arrangement of this role is uncertain due to the lack of research into this topic area. As Sun Tzu wisely suggests, information asset valuation may become a vital component of the Air Force (AF) ability at proactively understanding *yourself* as a service, before, during, and after battle.

Understanding value is not as easy as a math equation and requires broader acceptance of intrinsic-based qualities such as intangibility. In the accounting discipline, intangible assets are "non-physical such as franchises, trademarks, patents, copyrights, goodwill, equities, mineral rights, securities and contracts (as distinguished from physical assets) that grant rights and privileges, and have value for the owner,"(IGBV 2007), and "assets (not including financial assets) that lack physical substance," (FASB141 2001:105). Ultimately, intangible assets are difficult to accurately value due to the subjective nature of the assessor.

Importance of Information and System of Systems

There is little doubt about the utility of information and the system of systems connecting the military and society as a whole. From a historical military standpoint, war is possibly the most powerful demonstration of the system, and information importance, as they are considered priceless between battling nations from the Roman courier scalp tattoo to the World War II French Resistance radio broadcast (Miller 2005:58). Information is separate from the systems that collect, manipulate, distribute, and aggregate that information, with information being a valuable asset; moreover, the very age we live in, *the information age*, underscores the value of information (Nichols, Ryan et al. 2000:544).

Current Information Asset Valuation Methods

The current activity of information asset valuation used in the military is founded in the valuation of tangible computer system infrastructure as a whole entity, and information components, such as routers, servers, radios and other such physical devices

(Wong-Jiru 2006:26) that are used to manipulate, store, and transfer information. The valuation for these tangible items is through procurement or replacement cost. In terms of degradation, or failure, the valuation process includes costs for recovery, lost productivity, or lost revenue (Horony 1999:39). This method is predominant because people may more easily understand and work within this method; moreover, people may easily access source documents to define these costs such as purchase orders or personnel pay checks.

Importance of Information Asset Valuation (IAV)

This research intends to illustrate the benefit of the information asset valuation (IAV) methodology by providing foundational research toward potential and viable solutions to the problems of a lack of effective bonding between infrastructure to mission, lack of effective bonding between the competing functions of communications and operations, and the lack of immediate and effective cyber battlespace awareness for decision makers. Decision makers would benefit from having a single, recognizable, reference value for each information asset. The single recognizable reference value for each information asset should enable decision makers to quickly and easily understand the importance of the information asset's relationship to the mission.

Current State of Communications and Operations

In the Air Force, the two functionalized organizations of Communications and Operations are responsible for valuation of information assets in the cyber environment when incidents occur. The basis for an information asset valuation, both current and future, is knowledge of the mission and knowledge of the information infrastructure supporting the mission. Figure 1 illustrates the frequent problem with the functional separation of the Communications and the Operations communities: statement from Communicator to Operator “Circuit 7JA is down”; Operator replies “What does that mean to me?” and, “What is the impact?” The Communications area of concern is maintaining the devices to successfully pass bits and bytes. This action does not include management of the content, such as information, passing through the devices, therefore Communications cannot adequately respond to Operations on the issue of mission impact. In Figure 1, the resulting problem is illustrated, but from the opposite perspective: statement from Operator to Communicator “Our ATO terminal is down”; Communicator replies “All circuits and systems are in good working order.” This example demonstrates a typical disconnect between the Communication community’s emphasis on cyber activity and the Operation community’s emphasis on mission capability. The potential answer to this problem can be met with one of two approaches: 1) developing personnel with experiences in both Communications and Operations to build a bridge of common understanding for mission impact, or 2) embedding the experience and knowledge into a Decision Support Software (DSS) tool that presents to personnel the common understanding for mission impact. Each day Communications and Operations personnel filling these positions gain experience to bridge this problem gap. However, a well known issue in the Air Force is that personnel move from assignment to assignment undermining the aspect of mission continuity. The gains achieved by personnel in knowledge and experience move with personnel, and this initiates a new training cycle for the new personnel. Embedding knowledge and experience into the software of a DSS tool will enable new personnel to quickly increase on-the-job experience and knowledge for accuracy of the decision-making process.

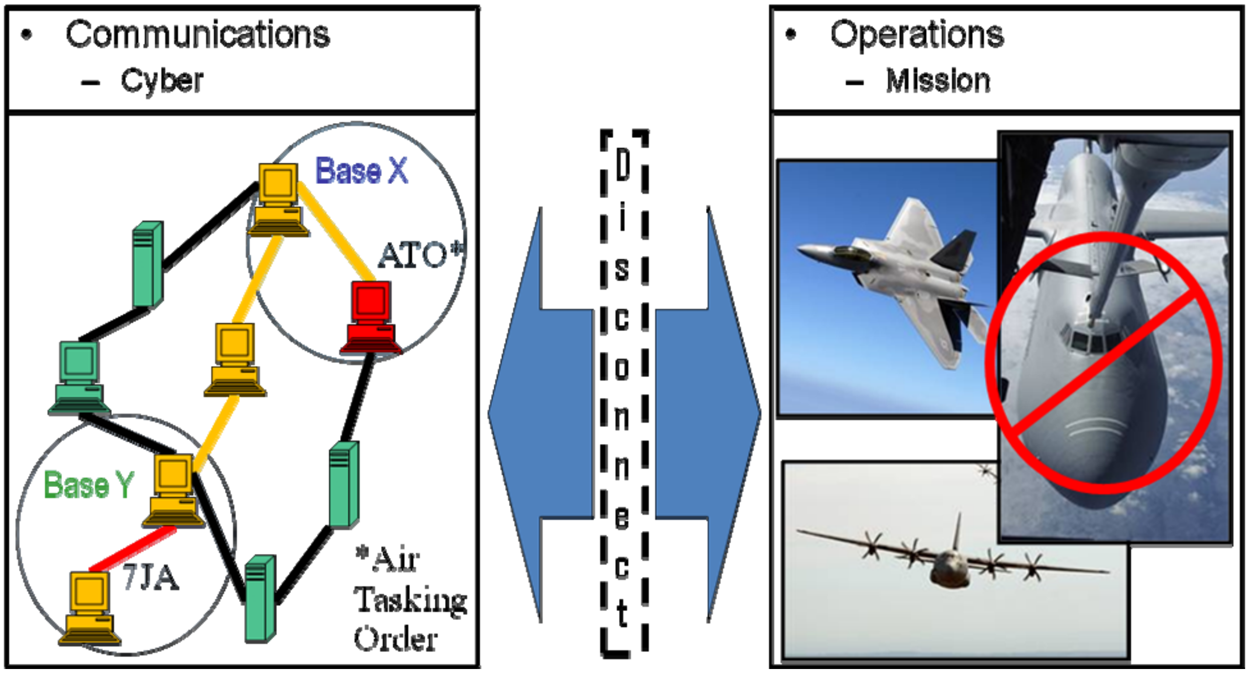

Figure 1. Communications and Operations Disconnect

The IAV methodology is important in order to provide cyber situational awareness for military commanders in achieving timely and effective decision making. The ultimate goal of this research is to develop foundational methodologies for the creation of a semi-automated Cyber Incident Mission Impact Assessment (CIMIA) DSS tool. CIMIA intends to provide a single integrated presentation of near real-time cyber environmental awareness to the competing functions of mission capability (operations) and the supporting computer infrastructure (communications) prior to, during, and post cyber incident. In essence, CIMIA will facilitate a bridge of mission capability to the infrastructure for on-demand damage and mission impact assessment. Readily available information asset identification, mission mapping, and valuation will enable decision makers to quickly and accurately understand the impact of a cyber incident without expending extraordinary time and effort to gather the information manually.

Cyber Incident Mission Impact Assessment (CIMIA) Project

CIMIA intends to connect the segmented information systems, which currently respond in a reactive manual method, with near real-time visual technologies. Previous research was conducted by Fortson, who identified five sequential, and potentially simultaneous, components phases for creating a CIMIA tool, as illustrated in Figure 2: 1) Information Asset Identification (IAI) is the realization that an information asset exists and needs to be documented; 2) Information Asset-to-Mission Mapping (IAMM) is the process of documenting the internal and external connections of the information asset; 3) Information Asset Valuation (IAV) is the process of establishing a standardized and comparable information asset criticality value; 4) Damage Assessment (DA) is the presentation of cyber battlespace awareness with near real-time information asset status for decision makers to act upon, and 5) Damage-to-Mission Assessment/Impact Reporting (DMAIR) is the information asset historical archive for trend analysis and *what-if* scenario forecasting (Fortson 2007). Shaw contributed significant foundational research toward the IAI and IAMM methodologies in relation to specific Air Operation Center (AOC) processes (Shaw 2007). The IAV methodology has the potential to play a significant role in providing military organizations with cyber battlespace awareness through establishment of a standard for valuing information assets. IAV, and value itself, is a human behavior-driven exercise that requires subjective qualitative measurement to quantify the human behavior. Providing a defensible methodology is the solution that will allow users of the IAV methodology to have faith in the results; moreover, an IAV methodology may be the key component binding the other CIMIA functions to together.

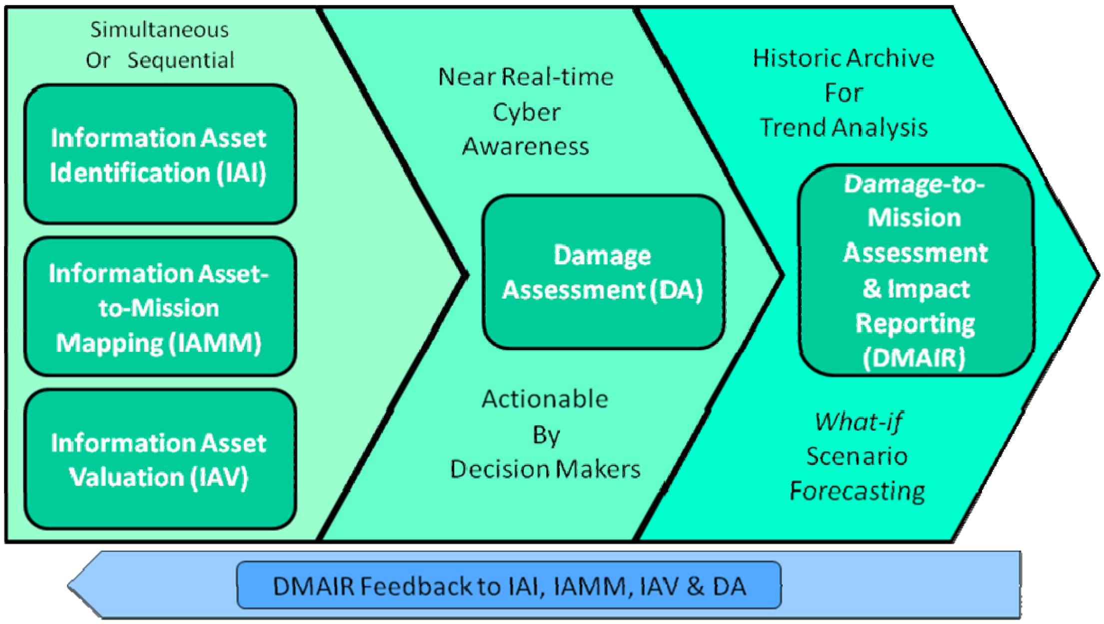

Figure 2. CIMIA Five Component Phases

Value is important to providing decision makers with cyber environment awareness. Just the level of assisting to describe the cyber environment in terms of value should organize the chaos of information overload to a useable and actionable information state. At precisely the moment when an incident occurs is when personnel time is at its most critically precious. It is at this moment when personnel need to concentrate on solutions for maintaining the network integrity, availability, confidentiality, or mission capability instead of reactively using this time to gather information on the system of systems infrastructure that could have been analyzed long before the incident occurred. When the adversary is attempting simple surveillance, or full-scale attack of the infrastructure, is precisely when personnel resources are more useful at analyzing the situation with positive cyber awareness for accurate and effective decision making. The following passage further highlights the desperate need for information and system of system awareness:

> *The morning of 9/11 showed, the hijacking of airplanes, the time it took authorities to understand that a serious problem existed, and the absence of procedures for handling this situation generated a particularly strong sense of surprise. During several minutes the U.S. Military and civilian air authorities found themselves in a state of uncertainty and, at best in an inadequate defensive posture. Just a momentary loss of air superiority proved enough to cause terrible losses, (Larribau 2007:28).*

Little discussion is necessary to further highlight the importance of information and the system of systems in context of cyber environmental awareness as these now pervade everyday society; moreover, the awareness has been instilled that the cyber domain posses at least as many threats as the cyber domain provides solutions.

Problem Statement and Investigative Questions

This research endeavors to answer the research and investigative questions that are critical to the creation of a useable and trustworthy IAV methodology:

R. What is the process for attributing value to an information asset?

1. *What is an information asset (InfoA)?*
2. *Can qualitative factors establish value?*
3. *Can a single value be established for an information asset?*
4. *Can one information asset have different values?*
5. *Are academic discipline models adaptable to information asset valuation?*

Thesis Construction

The research into the IAV methodology relies heavily on quantification of human behavior and development of a new research topic area. These two situations compel the research to deviate from commonly accepted research methodologies. The most appropriate methodology is an exploratory methodological strategy and approach hybrid by taking the most beneficial portions from other methodologies with a qualitative approach. This research has been conducted in the multi-phase of a qualitative case study approach examining public sector, including accounting and law, and military sector discipline methodologies for adaptation to the IAV methodology.

The accounting discipline is well known for valuing tangible business assets, such buildings, but this discipline also provides valuation for intangible assets, such as trademarks, Fair Market Value (FMV), brand and trademark, receivables for bad debt and subjective analysis will be examined from the accounting discipline.

Intangible asset valuation is also a concern in the legal discipline in the two main areas of intellectual property infringement and natural resource damage. The area of law lending itself to intangible asset valuation may be found in the documents covering litigation damage assessment such as the United States Codes (USC) and Comprehensive Environmental Response Compensation and Liability Act of 1980 (CERCLA).

Military processes concern themselves with the quantification of intangibles through the use of defensible qualitative methodologies. Some of the processes examined in this research include the Classified National Security Information (CNSI), Operational Security (OPSEC), and Operational Risk Management (ORM).

Foundational Terminology

For the purposes of this research, it is important to establish a common understanding of the terms *Information Asset Valuation* methodology and *information asset*. Information Asset Valuation, referred to as ***IAV***, signifies the methodology or model under construction in this research. Information asset, referred to ***InfoA***, is the descriptor to identify the entity being attributed a value. The term information asset is very ambiguous, and mostly undefined as a term, but is commonly found in the management disciplines. This ambiguity for *information* and *asset* stems from the separate and independent use of the words which does not necessitate a precise definition for *information asset* as a complete term. Prominent information and knowledge management leaders, including Thomas Davenport, Laurence Prusak, and Peter Drucker, defined data as objective facts that takes shape when context forms information; and, the addition of personal values, experiences, and insight forms knowledge (Drucker 1993; Davenport and Prusak 2000). The recognition of information as an entity within the business mainstream, whether originating with an accountant or a master business administrator, has led to the close attachment of the term information to the term asset. However, information asset is not defined and the reader is left to assume the meaning of information asset. Information, as Davenport, Prusak, and Drucker identified, is a compilation of data within a context and an asset is something having value to an entity.

Information asset, as a term, creates many avenues of definition possibilities. The following scenario is based on the following: Corporation Alpha is a widget maker; Alpha has a selling staff that utilizes a sales contact listing (SCL) composed of prospective and existing clients that need widgets; and, the SCL is maintained on the SCL1000 database server. The first view of information asset may be the information itself in the form of the SCL with which Alpha generates revenue. A second view of an information asset may be the sales staff that initiate and maintain close relationships with the SCL clients that provide the revenue. A third view is that the information asset may be the SCL1000 database server on the internal network for sales staff to access or the flow of the SCL back and forth from the SCL1000 through the network to the sales staff's computer terminals. A fourth view may be that the SCL has intrinsic qualities because it provides a revenue generating capability that Alpha's competitors do not own. This example demonstrates that an information asset may be the information itself, the flow of information, or intangible characteristics.

An information asset is more than just information tangibles such as static information, physical servers, or digital documents. Information does have value unto itself, as do the systems that process that information. The system of systems creates a situation where a single functional quantity of information may span across a labyrinth of computers, circuits, routers, geo-locations and provide an intrinsic advantage to the individual or organization. The failure of any one of these smaller components will result in the degradation or failure of that information process. For the purposes of this research an information asset (InfoA) is the combination of tangible assets (servers, circuits, data) and intangible assets (synergy, information, knowledge) that span internal and external organizational boundaries to create an interdependent system without form, substance, or physical presence. An InfoA is the convergence of information tangibles, information intangibles, and information flow to materialize as a functional entity that enhances the mission capability, as illustrated in Figure 3.

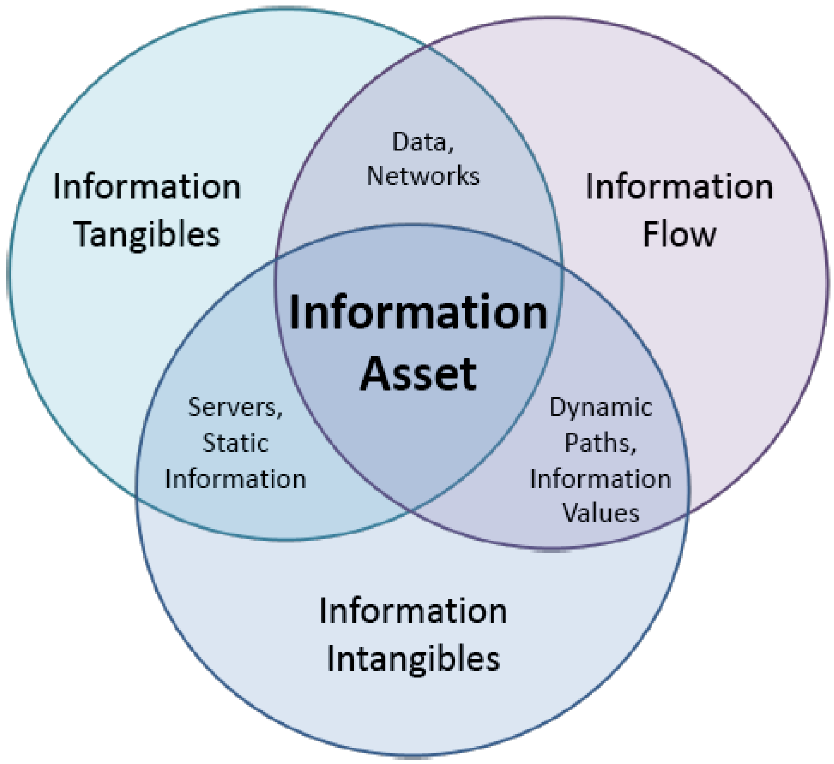

Figure 3. Conceptual InfoA

Research Scope

The scope of developing quantification of an InfoA to a useable value as a research topic can be a limitless endeavor. However, the ability to model InfoA valuation may prove to be severely important in achieving the desperately needed capability of cyber battlespace awareness and therefore must be addressed, discussed, and researched. As a concept, the IAV methodology is applicable to modern society on the whole through the many network-connected and driven-businesses, the banking industry, and the U.S.

Government; moreover, an examination of all these could lead to a situation of never ending analysis. Refinement of a manageable research topic area and research question was provided with the focus of the CIMIA project on the DoD, specifically on the AF. Embedding knowledge and experience into DSS tools, such as CIMIA, will enable planners and commanders in tactical, operational, and strategic levels of command to interact with the cyber environment; resulting in the application of another level of refinement. The valuation of InfoAs will provide the capability to interact with the cyber environment in the past through historical event analysis, in the present with near real-time alerts, as well as in the future through *what-if* driven scenario development. Achieving this level of cyber awareness calls for a multi-step methodology including: developing factors, scaling factors, aggregating factor values, aggregating across InfoA values, and binding InfoA values to mission impact. The true scope and focus of the IAV methodology is on, and for, the personnel who perform against the natural order of the existing system to establish the communications and operations InfoA valuations every day with archaic, manual, and cumbersome practices.

Chapter Summary

In this chapter, the need for an Information Asset Valuation (IAV) methodology was presented to motivate the research. Value is currently playing a role in the information asset (InfoA) prioritization, however the details, characteristics, and arrangement of this role is uncertain. The IAV methodology proposes the InfoA term definition as the convergence of information tangibles, information intangibles, and information flow to materialize as a functional entity that enhances the mission capability through physical and intrinsic contribution. Existing non-military and military valuation models are examined for adaptability to the IAV methodology. The IAV methodology is an attempt to assist the AF by providing an understanding of friendly InfoAs actively being utilized in the cyber domain and the association InfoAs have to mission impact via an automated DSS tool, CIMIA. Furthermore, this research will provide insight to future research efforts at understanding the criticality of adversarial information dependencies.

II. Literature Review

Chapter Overview

In this chapter, a literature review is conducted of various public and government sector discipline models for adaptation to valuing an InfoA: accounting models, legal models, and military models. In this chapter is the foundation of research contributing to analysis discussed in later chapters, as illustrated in Figure 4.

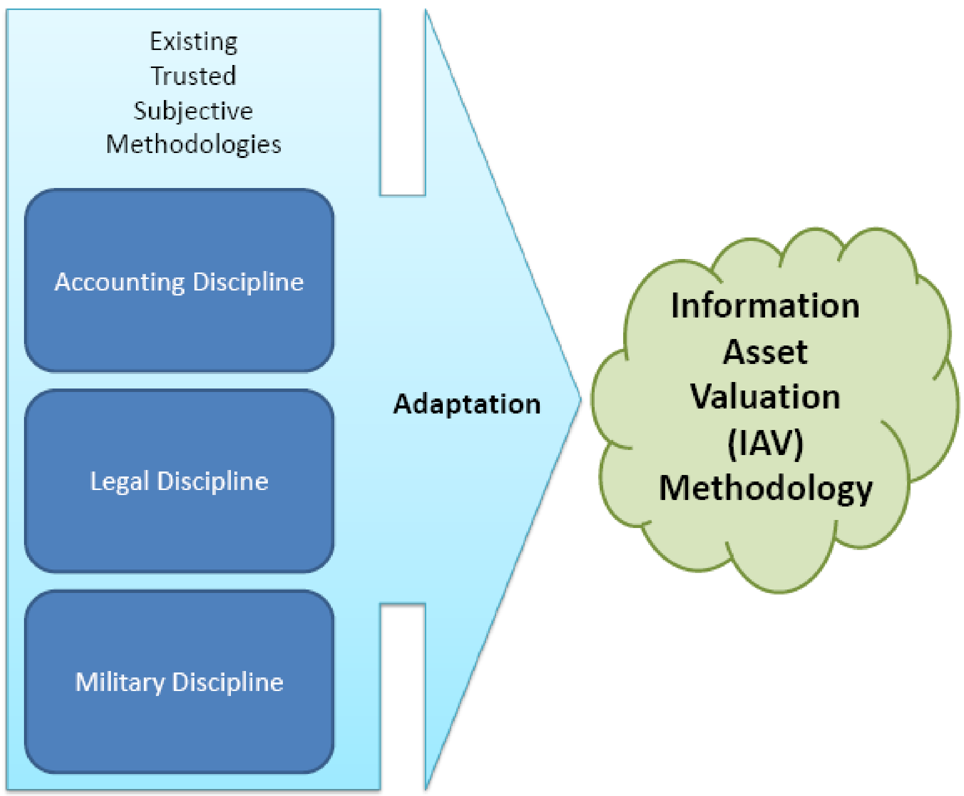

Figure 4. Literature Research Graphic

Accounting Discipline Models

The accounting discipline is well known for tracking and valuing tangible business assets, such as equipment, and this discipline also provides tracking and valuing for intangible assets. The very definition of InfoA includes both tangible and intangible characteristics to formula valuation. Financial, or business valuation, is the umbrella term for the accounting area dealing with many intangible asset valuation approaches that may apply to InfoA valuation. Two additional accounting areas that may apply to InfoA valuation are receivables for bad debt and subjective analysis. The accounting discipline values intangibles through market value, equivalent item comparisons, categorization, statistical calculations, and subjectivity.

Intangible Asset

Intangible assets are "non-physical assets such as franchises, trademarks, patents, copyrights, goodwill, equities, mineral rights, securities and contracts (as distinguished from physical assets) that grant rights and privileges, and have value for the owner," (IGBV 2007), and "assets (not including financial assets) that lack physical substance," (FASB142 2001:105). The accounting discipline's governing body identifies twenty-nine intangible assets classes (see Appendix A) ranging from patents representing ideas to ownership of the oxygen we breathe (Bossaerts 2001:28).

Financial Accounting Approaches

Financial accounting addresses the valuation of intangible assets like InfoAs and is divided into three approaches: 1) market or market comparable approach, where the costs of similar assets being sold are compared; 2) cost or asset approach, where the cost is determined by what a willing buyer would pay for the asset; and 3) income approach, where the value is determined by how much revenue may be created from intangibles such as patents (King 2002:75; Hitchner 2003:7). Although each approach may be available for valuation, the income approach most directly deals with intangible asset valuation. The income approach is further divided into the sub-approaches of valuation: Fair Market Value (FMV), Brand/Trade Names/Trademarks Value, Goodwill/Residual Value (King 2002; Hitchner 2003; Roche 2005), Investment/Intrinsic Value (Hitchner 2003; Roche 2005), Software Value (Hitchner 2003; King 2006), Research and Development Value (R&DV) (Roche 2005; King 2006).

Fair Market Value (FMV)

Fair Market Value (FMV) is "the price at which the property would change hands between a willing buyer having reasonable knowledge of relevant facts," (TR 2007). FMV is also commonly known as the Fair Value (FV). FV is "the amount at which an asset could be bought or sold in a current transaction between willing parties, that is other than in a forced or liquidation sale," (Bossaerts 2001:106). The FMV valuation process requires a market with a willing buyer and seller who conduct an economic transaction to establish value; moreover, comparing similar items is the foundation of this valuation approach. A very good example of an intangible asset that utilizes the FMV approach is found in the area of intellectual property valuation. Intangible assets, such as intellectual property "are most generally valued through the fair market value (FMV) approach which is the result of what others in the market place have judged the value to be", and "where the public market does not exist, the application of FMV becomes progressively more judgmental and less reliable," (Roche 2005:128). FMV utilizes a comparative analysis to determine intangible asset value.

Goodwill/Residual

Goodwill is the amount of *residual value* left when every other business component has been removed from the whole value and may "sometimes be used to describe the aggregate of all intangible assets of a business," (Hitchner 2003:813). Residual value takes the value of the whole company, subtracts all tangible and intangible assets from the business sell price, then the leftover value is attributed the intangible asset of goodwill (Roche 2005:125; King 2006:10). For example, if a company has a purchase price of $1,000 with tangible assets worth $800 and intangible assets worth $100, then goodwill is $100 ($1000 – $800 - $100 = $100). In the aggregate group approach, $200 ($100 + $100) worth of intangible assets and goodwill are divided among the total number of intangible assets.

Investment/Intrinsic

Investment value is "the value to a particular investor, which reflects the particular and specific attributes of that investor," (Hitchner 2003:5). Intrinsic value, "the value that an investor considers, on the basis of an evaluation or available facts, to be the true or real value that will become the market value when other investors reach the same conclusion," (IGBV 2007), and investment value, are similar approaches. The key for both of these approaches is the development of a personally internal, subjective factor for establishing value. For example, one person may determine that color is the most important factor when purchasing a vehicle where another person may determine that the sound of a vehicle's engine is the most important factor.

Research and Development (R&D)

Research and Development (R&D) utilizes the two valuation approaches for in-process R&D and new technologies: 1) Capital Asset Pricing Model (CAPM) or the alternate CAPM, and 2) estimation. The CAPM utilizes a beta measurement taken over at least 60 increments such as daily, weekly, or monthly, to provided a statistical average value, and the alternative CAPM requires "at least three separate CAPM calculations (low, medium, and high) with an assigned probability of occurrence," (Roche 2005:63). Even with statistical support, estimation of an intangible asset is an "educated guess that is often the only solution, recognizing that the margin for error may be significant," (Roche 2005:129).

Software

Coding rate is the driver behind software valuation and follows a three step approach: 1) determine the number of lines of code a programmer creates within a time window like a single hour to establish the code rate, 2) divide the total number of code lines within the software by the coding rate, and 3) multiply the number of hours by the lines of code required (Hitchner 2003:789). For example, in a situation with 10,000 lines of code, a programmer with a coding rate of 2 lines per hour, and a programmer with a pay rate of $30 an hour would have a software value of $150,000 (10,000/2 = 5,000 hours; 5,000 hours * $30 = $150,000).

Trademark, Brand Name/Trade Name

Brand or trade names and trademarks generally utilize two approaches for valuation: 1) direct cash flow analysis, and 2) relief from royalty. Direct cash flow utilizes Weighted Average Cost of Capital (WACC) where a 5-year projection is multiplied by a weighted debt-to-equity ratio (King 2006:129). Relief from royalty is determined by answering the question, "how much would the owner of the trade name pay to keep the use of the name or if the owner lost the right to utilize the name for a 5-year period," (Hitchner 2003:80). For example, a large company like Disney would determine how much it would pay to retain the use of the Disney brand name if Disney were to lose the Disney brand name. This valuation is an "estimate of what the brand name itself does from the perspective of the customer," and "it should be recognized that the estimate of the price…is still just that—an estimate," (King 2002:15).

Receivables for Bad Debt Approach

Receivables for bad debt is a statistical approach to determining intangible asset value because "we know a certain percentage of our customers will not pay, but we do not know in advance which they will be," *(King 2006:278)*. The receivable for bad debt approach establishes value through creation of a statistical percentage representing the number of accounts that will potentially default during the year. A second sub-approach "is to look at what a factoring company would pay because factoring companies actually buy receivables for cash" and this transaction for the purchase of receivable for bad debt establishes a value (King 2006:280).

Subjective Analysis Approach

In many instances, valuation for intangible assets is a subjective assumption supported by a defensible methodology. Some valuation experts see the assumption approaches as "the appraiser makes the assumption, or the client makes the assumption," (King 2002:143), and some negotiation occurs to establish the value. Alfred M. King, appraiser, and financial valuation expert states: "Determining values for intangible assets requires judgment and a lot of assumptions go into any valuation. These assumptions deal with the future and it is common for appraiser to state that *valuation is an art, not a science,*" (King 2002:143). To further the point of subjective valuation "the Federal Accounting Standards Board (FASB) has specified that appraisers should determine the amount that market participants would pay for the intangible asset. In effect it is up to the appraiser to estimate what the intangible asset(s) would be worth to other than the actual buyer," (King 2002:xv, 18; King 2006:176). Taken in combination, professional judgments based on personnel having gained experience and knowledge of the subject is at the forefront of appropriateness in the valuation process. Intangible assets have a similarity with tangible assets "like tangible property, intellectual property can be bought, sold, and rented. Also like tangible property, it can be lost or destroyed through carelessness or neglect" and "this value is often overlooked, underestimated, and underreported," (Poltorak and Lerner 2002:xiii). When dissecting the value or valuation, "value is the degree of usefulness or desirability of something, especially in comparison with other things where valuation is an assessment or measurement of something with respect to its embodiment of a certain value," (Andreissen 2004:18). Intellectual property is generally recognized as trademarks/service marks, patents, and copyrights.

Accounting Discipline Models Summary

Valuation of information is an intangible asset that FASB 141 defines and FASB 142 defines the specific monetary and non-monetary assessment method. Valuation of intangibles, such as InfoAs, within the accounting discipline has been developed and proven over time to be trusted assessment methodologies such as monetary market values, equivalent item comparisons, categorization, statistical calculations, and subjectivity. Specifically, the accounting discipline utilizes both tangible and intangible methods for valuing assets such as FMV, goodwill, investment, intrinsic, research and development, software, trademark, receivables for bad debt, and subjective analysis.

Legal Discipline Models

This literature review will examine the intangible asset valuation process through the legal discipline in the two main areas such as intellectual property infringement, and natural resource damages. Attorneys may be present during the initial valuation of intangible assets, such as registering patents, but attorneys are most prevalent during situations where intangible assets have come to some injury such as infringement or damages assessment. An examination of the Uniform Commercial Code (UCC), United States Codes (USC), and Comprehensive Environmental Response Compensation and Liability Act of 1980 (CERCLA) will provide a better understanding of how the legal objective and subjective methods for valuation may be adapted to the IAV model.

Uniform Commercial Code (UCC)

The UCC is the foundational guidance standardizing commerce issues across state boundaries. The definition for intangible asset is viewed by the UCC as "General Intangible" and found in Article 9, Secured Transactions, subpart 9-102(a)(42) Index of definitions, as "any personal property, including things in action, other than accounts, chattel paper, commercial tort claims, deposit accounts, documents, goods, instruments, investment property, letter-of-credit rights, letters of credit, money, and oil, gas, or other minerals before extraction," (UCC 2004).

The UCC definition for intangible asset is more effective at describing what an intangible is not than what an intangible is, such as intellectual property. Intellectual Property (IP) is simply a broad category for intangible items lacking the standard physical, distinguishable substance where valuation is through a residual or second-hand method. IP includes patents, copyrights, and trademarks, also known as servicemarks, are documented in many laws and statues such as the Copyright Act of 1976, the Digital Millennium Act of 1998, and the Family Entertainment and Copyright Act of 2005 and the United States Patent and Trademark Office (USPTO), (CA1976 1976; DMCA 1998; FECA 2005; USPTO 2005).

U. S. C. Title 18, Sections 1831-9 Trade Secret Protection

Trade secrets are a form of intellectual property patents, copyrights, and trademarks. Although trade secrets have long been in use the government provide significant statutory protection until the Economic Espionage Act of 1996, and inclusion to USC 18 Crime and Criminal Procedures (USC18§1831-9 1996). A trade secret is defined by USC 18 as:

> *the term "trade secret" means all forms and types of financial, business, scientific, technical, economic, or engineering information, including patterns, plans, compilations, program devices, formulas, designs, prototypes, methods, techniques, processes, procedures, programs, or codes, whether tangible or intangible, and whether or how stored, compiled, or memorialized physically, electronically, graphically, photographically, or in writing if (A) the owner thereof has taken reasonable measures to keep such information secret; and (B) the information derives independent economic value, (USC18§1831-9 1996).*

Trade secrets infringement entering the legal system and when offenders are found guilty, are assessed and sentenced based on the judgment of the court with penalties ranging from forfeiture of illegal gains to criminal penalties with fines and confinement (USC18§1831-9 1996).

Patents

Patents are the method for protecting the ideas of individuals found in commonly utilized products and services. The USPTO definition of a patent is “the granting of a property rights to the inventor,” and the USPTO further describes the patent right as “excluding others from making, using, offering for sale, or selling, or importing the invention into the United States,” (USPTO 2005). The USPTO identifies three types of patents: 1) Utility patent, approved for people who “ invent or discover any new and useful process, machine, article of manufacture, or composition of matter” or create an improvement for another invention; 2) Design patent, approved for people who “invent a new, original, and ornamental design for an article of manufacture”; and 3) Plant patent, approved for people who "invent or discover and asexually reproduction of any distinct and new variety of plant"(USPTO 2005).

Copyrights

Copyrights are the method for protecting the ideas of people seen and heard in writings and recordings. A copyright is the protection of an author's "original works of authorship including literary, dramatic, musical, artistic, and certain other intellectual works, both published and unpublished," (USPTO 2005). The copyright owner has the exclusive right "to reproduce the copyrighted work, to prepare derivative work, to distribute copies or phonorecords of the copyrighted work, to perform the copyrighted work publicly, or to display the copyrighted work publicly," (USPTO 2005).

Trademarks/Servicemarks

Trademarks are those monikers associated with given products or services. Trademark, or servicemark, is a "word, name, symbol, or device that is used in trade with goods to indicate the source of the goods and to distinguish them from the goods of others with a servicemark identifying a service rather than a product;" furthermore, the owner receives exclusive right "to prevent others from using a confusingly similar mark, but not to prevent others from making the same goods or from selling the same goods or services under a clearly different mark," (USPTO 2005).

Infringement

The legal environment does not usually engage with the initial valuation of an intangible asset but does engage with valuation in the form of infringement, damage and award. The foundation of an attorney's involvement with intangible asset valuation relies on some occurrence of wrong or injury with the intangible asset, such as infringement. The infringement is just the beginning as negotiation between parties may occur, but, over time, litigation may allow for assessment of damage and award. The USPTO utilizes *patent infringement* found in the United States Codes (USC) as a broad infringement definition for all intellectual property and intangible assets (USPTO 2005).

U. S. C. Title 35, Section 271 Patent Infringement

Infringement occurs when someone other than the intangible asset owner attempts to gain from the intangible asset or someone other than the owner prevents a gain by the owner from the intangible asset. The intangible asset owner is frequently referred to as the *claimant* because the owner lodges a lawsuit against the *infringer*. An infringer is the person, corporation, or entity who infringes upon the intangible asset owner. The USC utilizes the patent infringement statute to define all cases of infringement against the broad category of intangible assets as "whoever without authority makes, uses, offers to sell, or sells any patented [copyrighted, trademarked, or intellectual property] invention, within the United States or imports into the United States any patented invention during the term of the patent therefore, infringes the patent," (USC35§271 2000). A contributory infringer may be liable for knowingly offering to sell the "component of a patented machine, manufacture, combination or composition, or a material or apparatus for use in practicing a patented process" which constitutes a material part of the invention; moreover, the contributory infringing applies when the infringer knowing adapts the invention as "suitable for substantial non-infringing use" or circumvents infringement (Cooper, Watson et al. 2000:1).

Recovery by the claimant from the infringer is accomplished by one or both of the possible methods: injunction relief and damage. Injunction relief from infringement is "granted against an infringer to prevent the commercial manufacture, use, offer to sell, or sale within the United States or importation into the United States". The second form of relief, "damages or other monetary relief may be awarded against an infringer only if there has been commercial manufacture, use, offer to sell, or sale," (Cooper, Watson et al. 2000:2). Specific methods for making a determination on damages is covered separate section of USC, under Title 35 Section 284, but "the court will award to a successful patent infringement plaintiff damages sufficient to place the plaintiff in the position that the plaintiff would have occupied had the infringement not occurred," (Poltorak and Lerner 2002:125)

U. S. C. Title 35, Section 284 Patent Damages

Patent damage provides a method for valuing an intangible asset through assessment of a monetary device. In many cases the damage for infringement is pre-defined prior to any occurrence of infringement. There are three key characteristics of this methodology for valuation of intangible assets: 1) a pre-determination of the valuation standard, 2) a requirement to actively think ahead in developing the standard, and 3) a documentation of the standard enables all potential parties to review and interpret the valuation process prior to an actionable occurrence. One method for assessing damage is through "the court awarding damage adequate to compensate for the infringement, but in no event less than a reasonable royalty for the use made of the invention by the infringer," (Berry 2004:35). Reasonably royalty is calculated utilizing the previous year's "not to exceed 6 years for profits that would have been earned by the [claimant] if the infringer had not infringed, or is established by the prevailing royalty standard for the industry," (Rockman 2004:315). Assessing damage may be the responsibility of the jury or the court and "in either event the court may increase the damage up to three times the amount found or assessed," (USC35§284 2000). This method enables a creation of value for intangible assets from nothing. For example, should a corporation begin selling the same recipe of soda as a existing brand, the jury or the court may access the damage of $1 million; resulting in establishment of a base value for the intangible at $1 million. Furthering the example, the judge, or court, has the authority to subjectively determine an amount for triple the original assessment value, or $3 million.

U. S. C. Title 17, Section 504 Copyrights

More than under patent infringement, the copyright infringement damage is very specific. A copyright infringer is "liable for either: 1) the copyright owner's actual damage and any additional profits of the infringer, or 2) statutory damage, as actual damages and profits," (USC17 2000). Damages for copyright include "only of the infringer's gross revenue, and the infringer is required to prove his or her deductible expenses and the elements of profit attributable to factors other than the copyrighted work," (USC17 2000). The claimant my elect statutory damage at any time prior to final judgment, applying to every individual instance of infringement, or "a sum of not less than $750, or more than $30,000, as the court considers just," (USC17 2000). In the case of copyright infringement the court has the authority to consider what is *just* and for a willfully committed infringement the court may increase the award to “a sum of not more than $150,000,” (USC17 2000). Damage is a method of compensation to the claimant and hopefully prevents the infringer from “unfairly benefiting from a wrongful act,” (USC17 2000). Similar to patent infringement, the copyright valuation method establishes a value from nothing by providing a valuation standard prior to an occurrence of infringement.

U. S. C. Title 15, Section 1117 Trademarks/Servicemarks

Comparable to copyright infringement, the damage process for trademark and servicemark is specific. Claimants may recover the profits the infringer gained from the wrongful act and any damage sustained by the claimant as a result of the infringement offense. Assessment of damage is accomplished by the court “may enter judgment, according to the circumstances of the case, for any sum above the amount found as actual damage, not exceeding three times such amount,” (USC15 2000). The subjective nature of the court’s assessment is highlighted by the statement, “if the court shall find that the amount of the recovery based on profits is either inadequate or excessive the court may in its discretion enter judgment for such sum as the court shall find to be just, according to the circumstances of the case,” (USC15 2000). The specific statutory damages are an amount of “not less than $500 or more than $100,000” per separate instance of infringement, or in cases of willful and wrongful infringement, “not more than $1,000,000” per instance of infringement (USC15 2000). The claimant has some leeway to determine at any time, prior to final judgment, a replacement of actual damage with an assessment of "not less than $1,000 and not more than $100,000" per instances of infringement as the "the court considers just," (USC15 2000).

Damages for Natural Assets

A natural asset, or the *environment,* is another area of law where damage of an intangible asset may provide a valuation model and the statutory foundation for natural asset damage is the Comprehensive Environmental Response Compensation and Liability Act of 1980 (CERCLA). CERCLA provides intangible asset valuation through assessment model as "appropriate remedial strategy that is selected after consideration of a range of alternatives for restoration, rehabilitation, replacement, and/or acquisition of equivalent resources," (Lee and Bridgen 2002:219). Natural assets are frequently termed as invaluable but "those practicing this legal discipline argue that even the priceless must be valued in a market-based society; for without valuation there will not be appropriate protection and conservation of resource for future generations," (Lee and Bridgen 2002:281). CERCLA recognizes several methods for natural asset valuation: direct method, scaling, economic loss.

Economic loss is the "loss of business revenue occasioned by a products' failure to perform as expected or the inability to conduct business profitably for a period of time," (Madden 1992:48). For example, a polluted lake would impact the camping revenue for the period that campers cannot camp near the lake. The direct method, very similar to economic loss, is defined as "the sum of losses in use and nonuse values resulting from injury to the quantity of quality of service floes of the natural resource," (Kopp and Smith 1993:204). To continue the camping example, the direct method accounts for not only the economic loss in camping revenue but also the potential for camping that would have been abundant during the same period. The direct method accounts, over the same time period, for both the projection of resource use, such as the current season's worth of camping, and the projection potential of resource use, such as the current season's maximum camping occupancy. Scaling, or indirect method, encompasses several methods to determine value: comparison, adjusting costs from a similar project to meet the existing asset; probability, using expected value estimates to determine the *average*; factor, summing the product of several income items or activities; and, standard time data, estimating the standard time required for restoration of the natural resource, (Lee and Bridgen 2002:294).

Legal Discipline Models Summary

The legal discipline, driven by the man years of developing legal judgments, has shown an in-depth methodology for valuing intangible assets in both a tangible, quantity aspects, and intangible, qualitative aspects. Developing legal approaches over time through statute provide a subjective but trusted valuation methodology for information assets. An examination of intangible valuation process through legal instruments such as UCC infringement statutes, USC patent, copyright, trademark/servicemark and trade secret statues, and CERCLA damage assessment method will provide a overall better understanding of how the legal objective and subjective methods for valuation may be adapted to the IAV model.

Military Models

The military processes are being reviewed for qualitative measures with defensible subjective methodologies in the areas of Base Civil Engineering Work Order Management (BCE-WOM), Communications Helpdesk Trouble Ticket Management (HTTM), Enlisted Evaluation System (EES), Classified National Security Information (CNSI), Operational Security (OPSEC), Operational Risk Management (ORM), and Universal Joint Task List (UJTL).

Base Civil Engineering Work Order Management (BCE-WOM)

Base Civil Engineering work order management (BCE-WOM) has the responsibility to "manage, control, plan, schedule, and program work requirements by the most efficient means" in terms of work orders as defined by the "scope and complexity of the requirement," (AFI32-1001 2005:4-6). From this guidance two categories have been defined: 1) Planned Work, "to includes minor construction where the planner determines the scope, method, and type of resources"; and 2) Direct Scheduled Work, "to include work that generally does not require detailed planning," (AFI32-1001 2005:4-6).

Planned work orders are provided with four priority categories: "Priority 1–Mission, work in direct support of the overall base mission that, if not done, would reduce operational effectiveness; Priority 2–Safeguard Life and Property, work needed to give adequate security to areas subject to compromise, or to protect valuable property or equipment; Priority 3–Support, work that supports the mission or prevents a breakdown of essential operating or housekeeping functions; and Priority 4–Necessary, not qualifying for higher priority," (AFI32-1001 2005:4-6).

Direct schedule work orders are also provided with four priority categories: "Emergency, work required to eliminate an emergency condition within 24 hours of notification that is detrimental to the mission or reduces operational effectiveness; Urgent, work that is not an emergency, but must be responded to; and Routine, work that does not qualify as emergency or urgent work," (AFI32-1001 2005:4-6).

Communications Helpdesk Trouble Ticket Management (HTTM)

The Communications Helpdesk trouble ticket management (HTTM) process is the focal point for customers needing action on, and response to, communication's process issues. The Helpdesk is assigned the task of providing "network assistance, trouble resolution and will be based on a fully integrated trouble ticketing system. The trouble ticketing system should be able to automatically assign priorities and set response times and escalation timelines based on the criticality of the system being reported on," (Lee and Bridgen 2002:48; AFI33-115V1 2006:20-35). In no less than three hierarchical levels of Communications Management, Air Force Network Operations and Security Center (AFNOSC), Network Operations and Security Center (NOSC), and Network Control Center (NCC), are assigned responsibly to "analyze customer impact of all network incidents, problems and alerts, and develop corrective actions," (AFI33-115V1 2006:20-35). At the same time the customer is directed that "during a trouble call, the end users will: (3) Provide service provider with a description of problem, its priority, and potential mission impact," (AFI33-115V1 2006:74). Trouble ticket priorities are assigned according to work centers for jobs under their control utilizing mission impacts to determine the priority," (AFI33-115V1 2006:41). The methodology being employed for helpdesk trouble ticket processes relies on local development of qualitative measures.

Enlisted Evaluation System (EES)

The Enlisted Evaluation System (EES) process tracks personnel behavior against qualitative measures with the two steps of performance feedback and performance reporting. The purpose of the EES is three-fold: 1) establish individual expectations, achievement of expectation, and improvement at achieving expectations; 2) establish a long-term history of performance; and 3) provide comparable records for promotion boards (AFI21-116 2005:6). Performance is the key evaluation standard reflecting how well "the individual does his or her job, and the qualities the individual brings to the job" and is "most important for successful mission accomplishment," (AFI36-2406 2005:6). EES represents the epitome of human behavior quantification because EES looks to categories the spectrum of standards from worst performance to best performance through supervisory judgment.

The first step in EES is accomplishment of the performance feedback worksheet (PFW) which is utilized to establish communication and roles between the rater and ratee. The two versions of the PFW, one for lower and one for higher enlisted ranks, share the assessment areas of: 1) Primary Duties, with the supervisor considering adapting, learning, quality, quantity, timeless, technical knowledge, leading, professional growth, communication skills, and managing and supervising; 2) Standards Enforcement and Personal Adherence, Conduct, Character, Military Bearing, Customs and Courtesies with the supervisor considering enforcement and personal adherence, dress and appearance, and personal and professional conduct on and off duty; 3) Resource Management and Decision Making, with the supervisor considering efficiency, judgment, setting and meeting goals; 4) Training, Education, Off-duty Education, Professional Military Education (PME), Professional Enhancement and Communication, with the supervisor considering ancillary, on-the-job, readiness, providing, supporting and personal growth; and 5) Leadership, Team Building, Follwership, and Mentorship, with the supervisor considering team accomplishments, leveraging personal experience and community support, and recognition and reward for others (AFForm931 2007; AFForm932 2007). These five subjective PFW categories on performance rating are then measured with the threshold standards of: “does not meet,” “meets,” “above average,” and, “clearly exceeds,” (AFForm931 2007; AFForm932 2007).

The second step of the EES is documentation of performance with the Enlisted Performance Report (EPR). The PFW and the EPR are nearly identical to provide a strong bond between the two tools; however the EPR differs significantly with a category for overall performance assessment. The overall subjective assessment threshold standard categories are: “poor,” “needs improvement,” “average,” “above average,” and, “truly among the best,” (AFForm910 2007; AFForm911 2007).

Classified National Security Information (CNSI)

The Classified National Security Information (CNSI), or Executive Order (EO) 13292, process establishes a standardized system for “classifying, safeguarding, and declassifying national security information,” (EO13292 2003:15315-9). The EO defines who may classify information, and the qualitative measures for information classifying.

Who may classify information rests in the two parts of: classification guide and classification authority. The classification guide establishes the rules for dealing with specific information of an agency to "facilitate the proper and uniform derivative classification of information," (EO13292 2003:15315-9). The classification guide development is a requirement of the classification authority or the "senior agency official," (EO13292 2003:15315-9).

Three qualitative measurements with definitions are utilized to categorize information. The three levels are: 1) Top Secret "shall be applied to information, the unauthorized disclosure of which reasonably could be expected to cause exceptionally grave damage to the national security," 2) Secret "shall be applied to information, the unauthorized disclosure of which reasonably could be expected to cause serious damage to the national security," and 3) Confidential "shall be applied to information, the unauthorized disclosure of which reasonably could be expected to cause damage to the national security," (EO13292 2003:15315-9).

Operational Security (OPSEC)

The purpose of Operational Security (OPSEC) process, from an AF perspective, is to "reduce the vulnerability of AF missions from successful adversary collection and exploitation of critical information", and an important function of the OPSEC process is the "identification of critical information for each operation, activity, and exercise planned, conducted or supported," (AFI10-701 2007:4). The OPSEC requirement for the Critical Information Listing (CIL), also known as Commander's Critical Information Requirement (CCIR) or Critical Information Program (CIP), positions the commander to judge and ensure “CILs are developed and procedures are in place to control critical information and their indicators,” (AFI10-701 2007:9). The CIL defines categories of “critical information as specific facts about friendly intentions, capabilities, and activities vitally needed by adversaries for them to plan and act effectively, so as to guarantee failure or unacceptable consequences for friendly mission accomplishment; best identified by the individuals responsible for the planning and execution of the unit’s mission” such as an “OWG [Operations Working Group] or staff planning team,” (AFI10-701 2007:12). After the CIL has been developed, and vetted, the “commander must approve the list and then ensure their critical information is protected and/or controlled,” (AFI10-701 2007:12).

Operational Risk Management (ORM)

The Air Force Operational Risk Management (ORM) process is a “decision-making process to systematically evaluate possible courses of action, identify risks and benefits, and determine the best course of action for any given situation,” (AFI90-901 2001:1-3). ORM allows commanders and individuals to limit risk through assessment of an activity’s steps such as flying, a joint exercise, loading a truck, or driving home at the end of the day, “with quantitative or qualitative measures to determine the potential of ill effects in such activities,” (AFI90-901 2001:1-3). ORM utilizes a six step process highlighting qualitative measures of risk assessment.

ORM functions through the utilization of six fundamental steps, as illustrated in Figure 5, Operational Risk Management Process, (AFPAM90-902 2000:7). ORM Step 2, Assess the Risks, utilizes qualitative measures to associate hazards with risks through an "estimation of probability, severity, and exposure" for standardizing the comparison of differing risks (AFPAM90-902 2000:17). The development of risks utilizes the three components of: 1) Probability as the estimate of the likelihood that a hazard will cause a loss, 2) Severity as the estimate of the extent of loss that is likely, and 3) Exposure as the number of personnel or resources affected by a given event or over time (AFPAM90-902 2000:17). The qualitative measure of severity categories "provide guidance to a wide variety of missions and systems: 1) Catastrophic, complete mission failure, death, or loss of system; 2) Critical, major mission degradation, severe injury, occupational illness or major system damage; 3) Moderate, minor mission degradation, injury, minor occupational illness, or minor system damage; and, 4) Negligible, less than minor mission degradation, injury, occupational illness, or minor system damage," (AFPAM90-902 2000:17).

Figure 5. Operational Risk Management Process (AFPAM90-902 2000:7)

Universal Joint Task List (UJTL)

The Universal Joint Task List (UJTL) process is the overall guiding joint document with military service specific guidance through documents such as the Air Force Master Capabilities List (AFMCL), Army Universal Task List (AUTL), and Universal Naval Task List (UNTL). UJTL consists of "tasks, conditions, and measures" enabling tasks to be "mapped to capabilities to meet operational mission requirements," (CJCSM3500.04D 2005:A1). Categories of measurement of performance rely upon the "commander's approved measures and criteria [to] establish task standards based on mission requirements," (CJCSM3500.04D 2005:A3). Infrastructure Maintenance provides three representative qualitative measures: Low, excess infrastructure capacity or low economic needs required to sustain economy; Moderate, economy capable of withstanding some loss of infrastructure; and High, full infrastructure required to sustain basic economy," (CJCSM3500.04D 2005:C80).

Military Models Summary

Valuation of intangible such as information asset is possible with the time tested and developed processes utilized in the military. This section has presented a review of military processes for qualitative measures with defensible subjective methodologies in the areas of BCE-WOM, Communications HTTM, EES, CNSI, OPSEC, ORM, and UJTL. InfoA valuation requires the utilization of subjective qualitative measures similar to what may be found in existing military sector processes. Qualitative measure for human behavior is subjective and a defensible methodology model is necessary to establish user faith in the InfoA valuation process.

Chapter Summary

Existing models of subjective qualitative models for valuation of InfoAs from the public and military sectors have been examined for adaptability to the IAV methodology. The accounting, legal, and military models from this chapter are the foundation of research contributing to analysis discussed in later chapters. Valuation of intangibles, such as InfoAs, is accomplished in the accounting discipline with proven and trusted methodologies of monetary market values, equivalent item comparisons, categorization, statistically calculations, and subjectivity such as FMV, goodwill, investment, intrinsic, research and development, software, trademark, receivables for bad debt, and subjective analysis. An examination of intangible valuation process with legal instruments is accomplished with proven and trusted methodologies such as UCC, USC, and CERCLA statutes. InfoA valuation, with or without the IAV methodology, requires the utilization of subjective qualitative measures similar to what may be found in existing military sector models such as BCE-WOM, Communications HTTM, EES, CNSI, OPSEC, ORM, and UJTL.. Qualitative measure for human behavior is subjective and a defensible methodology model is necessary to establish user faith in the InfoA valuation process.

III. Methodology

Chapter Overview

Conducting research can have many paths, each of which will be, and should be, critically analyzed for accuracy, legitimacy, and validity. Finding the balance within a methodology for what may be the most well planned design versus the inherent failings within a methodology is an appropriate tactic to ensure new information comes to light as well as preserve the integrity of the information. This initial research is a social science driven study for application of human behavior in the valuation of InfoAs and requires an exploratory qualitative methodology. This chapter will discuss the methodological strategy, approach, and application of this research.

Methodology Strategy

Choosing the most effective methodological strategy for the specific research is important to achieve acceptance, credibility, and reliability. Many methodologies exist to conduct research such as archival analysis, case study, or phenomenological study (Patton 1990:109; Yin 2003:5; Leedy and Ormrod 2005:68), but it is the most appropriate methodology that will yield the best contribution to the body of literature. The research question being asked can identify which of the methodological strategies will be the most effective and fruitful.

Yin, noted research design and methods author, identified the research possibilities as experiment, survey, archival analysis, history, or case study; moreover, determining the most appropriate research method may be accomplished through analysis of three conditions, as illustrated in Table 1: 1) the type of research question posed, 2) the extent of control an investigator has over actual behavior events, and 3) the degree of focus on contemporary as posed to historical events (Yin 2003:5).

Table 1. Relevant Situations for Different Research Strategies (Yin 2003:5)

Strategy	Form of Research Question	Requires Control of Behavioral Events?	Focuses on Contemporary Events?
Experiment	How, why?	Yes	Yes
Survey	Who, what, where, how many, how much?	No	Yes
Archival analysis	Who, what, where, how many, how much?	No	Yes/No
History	How, why?	No	No
Case Study	How, why?	No	Yes

The form of the research question such as *who, what, what, how*, and *why* may be used to distinguish among the research methods (Yin 2003:5). Valuation of is a relatively new research area with little or no current body of research, process, framework, or methodology; therefore, research into this area is initial research. This initial research looks to answer questions of "how does this work," and "why does this work," and for both the experiment and the survey an existing level of research is needed in order to prepare valid instruments for analysis. Archival analysis questions such as "how many," or "how much," deal with the quantitative measurements which are not as compatible with social sciences. History and case study most closely match the nature of the IAV methodology by asking the “how,” and “why,” questions.

The level of behavior control that may be exercised in the research highlights two key initial investigative research elements. These elements are flexibility for looking at all forms of source information and the planning of an unfettered research approach. The case study provides for the broad range of investigative sources and has the “unique strength…to deal with a full variety of evidence—documents, artifacts, interviews, and observations—beyond what may be available for a historic study,” (Yin 2003:8). Historic and case study, as illustrated in Table 1, match the little or no exertion of control by researcher an individual’s internal process of valuation.

The effect of contemporary events on investigative research into valuation of an InfoA is a vital issue in developing a research design. An InfoA by definition is a new idea only existing in the contemporary environment; thus precluding historic analysis as a research method. Additionally, the case study has the advantage over historic research in the ability of “direct observation of the events being studied and interviews of the person involved in the events,” (Yin 2003:8).

The case study, on the surface, appears to satisfy the requirements of the IAV exploratory research; however, the case study has a unit of analysis issue. An integral part of the case study methodology is the unit of analysis which defines “what the case is,” (Yin 2003:22). The unit of analysis defines “what is actually measured or studied to test the hypothesis and it is not the variable being studied,” (Sirkin 2006:25). The IAV exploratory research looks to uncover the unit of analysis attribute and therefore no unit of analysis has yet been established. The resulting lack of a unit of analysis precludes a case study as the methodology. The importance of selecting the correct methodological strategy to establish fruitful research can be identified by the research question that needs to be answered.

Methodology Approach

Selecting the correct methodological approach for researching the IAV methodology requires a look at measurement. A measurable scale "assigns numbers to some characteristic of an observation according to a set of rules," (Porter and Hamm 1986:5). Measurement can be defined as a numerical representation of length, or width, "but also other simpler actions such as assignment of a person to particular category of a variable, to include somewhat different things-assignment by category," (Sirkin 2006:34). IAV relies on the quantification of the complex and unpredictable behavior of human beings. Quantitative consists of a measurable quantity, such as height or weight or temperature, and complex human behaviors are not well captured by quantitative techniques (Moore 1969:26; Stevens 2007). Qualitative research "assigns [data] to categories that do not imply quantities" much like for unpredictable behavior such as an "opinion," (Moore 1969:5). Understanding the measurement characteristics of a qualitative approach over a quantitative approach is appropriate to determine the most effective methodological approach.

The research goal has the characteristics of exploration, description, explanation, and development of categorization theory for the IAV model. These identified characteristics are perhaps the antithesis of the quantitative approach, as illustrated in

Table 2; however, these same characteristics lend themselves very well to the qualitative research approach. The Leedy and Ormrod expressed qualitative description addresses many of the criteria necessary for the IAV methodology.

Table 2. Characteristics of Approaches (Leedy and Ormrod 2005:96)

Question	Quantitative	Qualitative
What is the purpose of the research	To explain and predict To confirm and validate To test theory	To describe and explain To explore and interpret To build theory
What is the nature of the research process?	Focused Known variables Established guidelines Predetermined methods Somewhat context-free Detached view	Holistic Unknown variables Flexible guidelines Emergent methods Context-bound Personal view
What are the data like, and how are they collected?	Numeric data Representative, large sample Standardized instruments	Textual and/or image-based data Informative, small sample Loosely structure or non-standardized observations and interviews
How are data analyzed to determine their meaning?	Statistical analysis Stress on objectivity Deductive reasoning	Search for themes and categories Acknowledge that analysis is subjective and potentially biased Inductive reasoning
How are the findings communicated?	Numbers Statistics, aggregated data Formal voice, scientific style	Words Narratives, individual quotes Personal voice, literary style

Of the five reasons identified for performing qualitative research, the ones with the most relevance to researching the IAV methodology are “to understand a new or little understood problem,” “the nature of the research problem,” and “to provide understanding of the details in complex phenomena that cannot be easily conveyed with quantitative methodology," (Strauss and Corbin 1990). These first two reasons for qualitative research are related to the previously addressed issue with the IAV methodology being a new research area with little or no current research body of knowledge. The last reason for qualitative research is directly related to the quantification of human behavior where "reality is not easily divided into discrete, measurable [quantitative] variables," (Leedy and Ormrod 2005:96). The exploratory nature of explaining the IAV methodology lends itself to an approach utilizing "measurement instruments (e.g. interviews), categories (variables) emerging from the data, leading to "context-bound" information, patterns, and/or theories that help to explain the phenomena under study," (Leedy and Ormrod 2005:95). Understanding the measurement characteristic of a qualitative approach over quantitative approach is most appropriate "when little information exists on a topic, when variables are unknown, when a relevant theory base is inadequate or missing, [and] a qualitative study can help define what is important—that is, what need s to be studied," (Leedy and Ormrod 2005:95).

Methodology Application

Research into the IAV process relies heavily on quantification of human behavior and development of a new research area. These two situations compel the research to deviate from commonly accepted and overly structured research methodologies. The most appropriate methodology is an exploratory methodological strategy and a hybrid approach by taking the most beneficial portions from other methodologies with a qualitative approach. As illustrated in Figure 6, this research has been conducted in the multi-phase of a qualitative case study approach: Focus and Design, Prepare and Collect Data, and Analysis and Findings (Patton 1990:139; Leedy and Ormrod 2005:68).

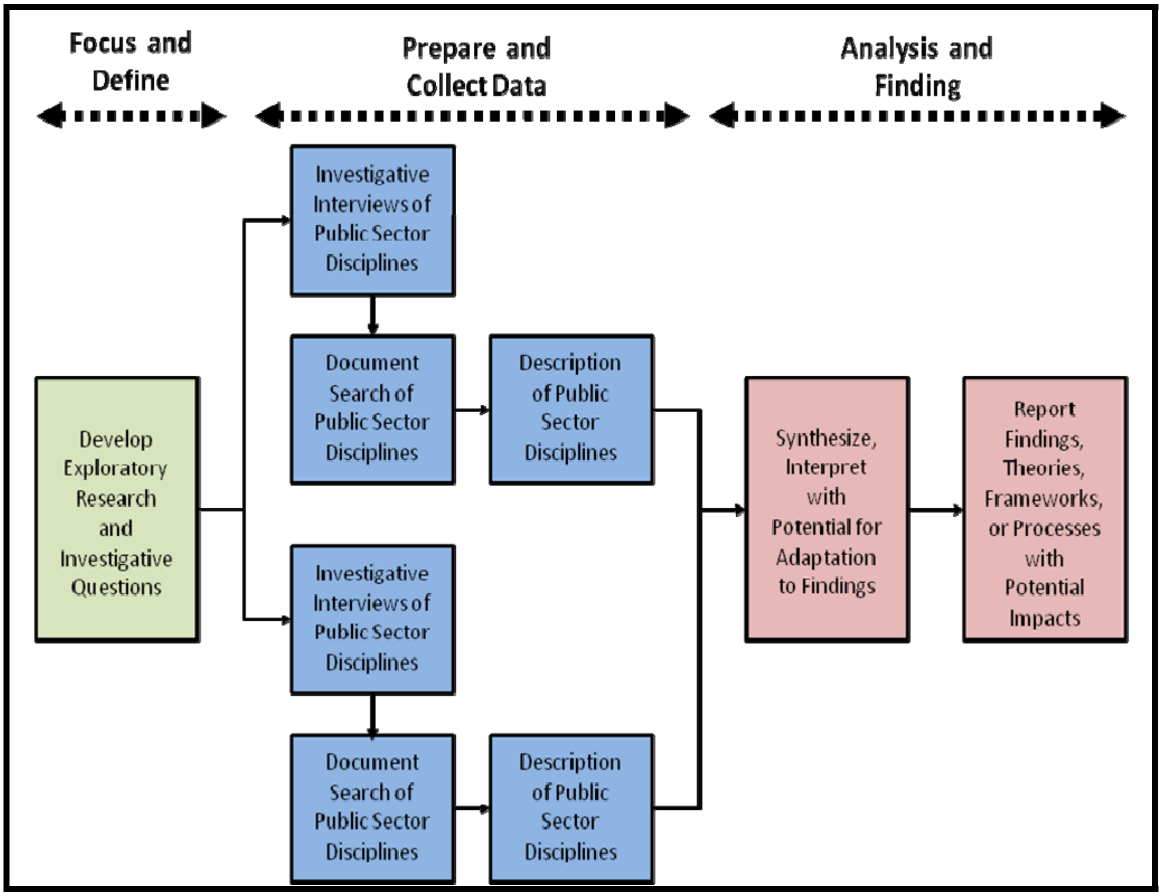

Figure 6. Methodological Application

Focus and Design

The focus and design stage is predominantly concerned with defining the purpose of, establishing a design for, and development of investigative questions for, the topic area of research.

This thesis engages with the research question, "What is the process for attributing value to an InfoA?" The goal of this research is to provide a better understanding of how the process of valuation occurs and the results utilized for application against the valuation of InfoAs. An understanding of the valuation process will help to identify factors, or qualitative measures, and enable a standard comparison scale for different InfoAs. The underlying general question is "how is this asset valuation important?" Understanding the valuation process and being able to apply measures of importance to InfoAs will provide powerful leverage for planning-to-execution decision makers. Additionally, the quantifiable value, or criticality, of InfoAs will provide decision makers with the ability to determine what assets to protect, conserve, enhance, and even disregard.

As previously discussed, the IAV methodology research has been performed as a hybrid of the most beneficial parts of other methodologies that emphasize a qualitative approach. The methodological approach may best be described as a qualitative phenomenological study where the study "attempts to understand people's perspectives, and understanding of a particular situation," (Patton 1990:139; Leedy and Ormrod 2005:68), such as in understanding an individual's perspective on valuation of an InfoA.

Development of a potential solution for the IAV methodology has been accomplished through the following research and investigative questions:

R. What is the process for attributing value to an information asset?

1. *What is an information asset (InfoA)?*
2. *Can qualitative factors establish value?*
3. *Can a single value be established for an information asset?*
4. *Can one information asset have different values?*
5. *Are academic discipline models adaptable to information asset valuation?*

Prepare and Collect Data

In this stage the three potential qualitative approaches to preparation and collection of data are "in-depth open-ended interviews, direct observations, and written documents," (Patton 1990:10). The research began with investigative subject matter expert interviews from both the private and military sectors to outline potential written documentation sources. Important at this stage, was seeking out multiple and varying areas of research, such as the accounting, legal, and military disciplines. The processes examined needed to have subjective but defensible qualitative methodologies for potential adaptation to the IAV methodology. Documentary research was conducted of contemporary statutory, policy, procedural and guidance material with the focus for uncovering potential IAV model categories, factors, and patterns.

Analysis and Findings

The final stage allowed synthesizing of patterns through "inductive reasoning, sorting and categorizing [data, until] gradually boiling it down to a small set of abstract factors" that influence the quantification of value (Leedy and Ormrod 2005:150). Utilizing the "interpretive procedures of coding categories are used to arrive at findings," theories, or frameworks for IAV (Strauss and Corbin 1990:20).

Chapter Summary

The methodological strategy, approach, application, of the research were discussed in this chapter. The research methodology accounts for the need to quantify subjective human behavior through qualitative measures and the need for an exploratory, investigative approach to uncover aspects of InfoA valuation. A hybrid methodological strategy and approach have been utilized to balance the positives and negatives of other methodologies. The exploratory IAV methodology research focuses on a qualitative hybrid methodology for quantification of human valuation behavior.

IV. Results and Analysis

Chapter Overview

This chapter focuses on the analysis of the research body to elicit an answer to the research question. Specifically, this analysis looks at the process for attributing value to an information asset and the underlying investigative questions. This chapter covers the analysis of the potential IAV methodology and the contributing subjective qualitative measures utilized in existing methodological approaches that may be adaptable to the IAV methodology, as illustrated in Figure 7.

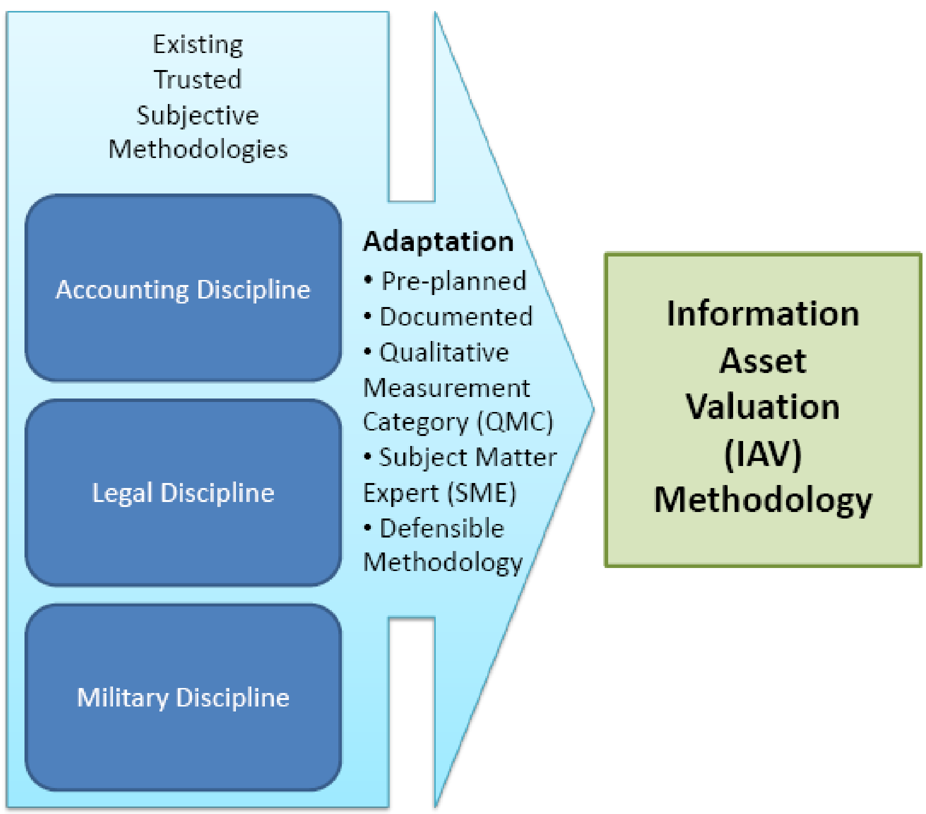

Figure 7. Existing Methodology Adaptation Model

Analysis of Value Subjectivity

Value analysis requires the qualitative measurement of human behavior and is therefore subjective. The current physical and quantitative method of valuation does not take into account information and is therefore not capable of fully capturing the value of InfoAs. These InfoAs are growing throughout the cyber environment and their very existence enables the mission to be accomplished. This subjectivity naturally requires the establishment of a valuation methodology that will ensure credibility in the InfoAs. The trust must be seated in the subjective category estimations which will build the InfoA value construct. Ultimately, the decision makers whom need this critical InfoA value input must rely on the underlying defensible methodology; moreover, this methodology must be as near a fact-based methodology of value estimation as may be developed. Without a defensible methodology, decision makers will not have trust in the valuation process and would surely be inclined to simply make their own estimations based upon their own beliefs and not the established, documented valuation estimations.

Adaptation of Other Methodologies

An examination of the three disciplines, accounting, legal, and military, revealed methodological commonalities of pre-planning, documentation, qualitative measure categories (QMC), and subject matter expert (SME) to provide a defensible methodology for adaptation to the IAV methodology. Pre-planning may be characterized as a deliberate forethought about how the process will provide for the needs of the users for that process. Pre-planning is also the development of qualitative measures that will be necessary in execution of the process and development of a plan prior to a need for the process. Documentation is an extension of the pre-planning step through personnel writing down the plan, communicating the plan to others, and providing a source and resource for users of the process in decision making capacity. The qualitative measure definition is both the qualitative measure category with associated definition and the subjectivity of the category with associated definition. An example of the qualitative measure categories with definitions may be seen in the CNSI categories. CNSI utilizes the three levels of Top Secret, Secret, and Confidential with associated definitions such as "shall be applied to information, the unauthorized disclosure of which reasonably could be expected to cause exceptionally grave, serious, or cause damage to the national security," (EO13292 2003:15315-9). The second part of qualitative measure definition is the subjectivity of the measure and definition. The qualitative measures of the BCE planned work order management methodology highlights subjective category definitions needing human estimation such as "the planner determines," (AFI32-1001 2005:5). Also found in the CNSI methodology are the subjective qualitative measure definitions with vague phrases which lend themselves to individual interpretation, such as "reasonably could be," or "cause serious damage," (EO13292 2003:15315-9). In the context of the reviewed processes, the SME is the individual, or group, that has gained enough experience from the pre-planning, documentation, and use of the qualitative measurement categories as to provide comprehensive and competent estimation or judgment. In example with the CNSI, the SME classification authority is expected to judge the definition of "cause serious damage" based on experience and knowledge of the subject. A defensible methodology is a requirement to establish trust in the results of the model and for users of the model to have faith in the model. In example, the EES process represents the application of subjective qualitative measures on human behavior through development of comparable standards on personnel behaviors. The defensibility of a methodology is underscored to users of the methodology through a culmination of pre-planning, documentation, subjective qualitative measure categories, and SME.

Methodology Commonalities

An analysis of the disciplines, all of which have developed over time, demonstrated similar characteristics in establishing credibility. The credibility of the methodology is exemplified by the discipline accepting or recognizing the results of the discipline process. These characteristics form the adaptation criteria that may be utilized to form a solid foundation of credibility in the IAV methodology. Methodological commonalities derived from the reviewed discipline processes, such as pre-planning, documentation, qualitative measure categories (QMC), subject matter expert (SME) and defensible methodology are illustrated in Table 3.

Table 3. Methodology Commonalities

(Accounting) Private Sector Processes	**Pre-Planning**	**Document-ation**	**(QMC) Qualitative Measurement Categories**	**(SME) Subject Matter Expert**	**Defensible Methodology**
Bad Debt	X	X	X	X	X
FMV	X	X		X	X
Goodwill	X	X		X	X
Investment	X	X		X	X
R&D	X	X		X	X
SA	X	X		X	X
Software	X	X		X	X
Trademarks	X	X	X	X	X

(Legal) Private Sector	**Pre-Planning**	**Document-ation**	**QMC**	**SME**	**Defensible Methodology**
Damages	X	X	X	X	X
Infringement	X	X	X	X	X
Trade Secrets	X	X		X	X

Military Sector Processes	**Pre-Planning**	**Document-ation**	**QMC**	**SME**	**Defensible Methodology**
BCE	X	X	X	X	X
Comm	X			X	X
EES	X	X	X	X	X
InfoClas	X	X	X	X	X
OPSEC	X	X	X	X	X
ORM	X	X	X	X	X
UJTL	X	X		X	X

Pre-planning

Pre-planning may be characterized as investing forethought into the possible needs of the process users, development of *what-if* situations likely to be handled by the process, and documentation creation supporting the process. Moreover, preplanning allows for the creation of qualitative measures, development of subject matter experts, and most importantly, the realization that a defensible methodology has been established to provide faith in the process. The pre-planning allows for planners to have a situational awareness prior to any need for the process, such as with trouble tickets and work order management, where pre-planning enables personnel to prioritize the jobs.

Pre-planning is vital to both the accounting and legal disciplines as much because these have developed over time as to the need for practical answers when the situations undoubtedly arise. Accounting has the advantage of history, but taken on the whole, accounting demonstrates a methodical approach to pre-planning as seen in each of the reviewed disciplines. The accounting history has allowed the development of a body of pre-planners, with organizations such as the American Institute of Certified Public Accountants (AICPA), (AICPA 2007), Financial Accounting Standards Board (FASB), (FASB141 2001), and Governmental Accounting Standards Board (GASB), (GASB 2007). Similar to accounting, the legal discipline has the advantage of historic pre-planning refinement as seen in the each of the reviewed areas. The law also has the advantage of many pre-planning support organizations such as the American Bar Association (ABA), (ABA 2007), American Bar Association Judicial Division (ABAJD), (ABAJD 2007), and Federal Bar Association (FBA), (FBA 2007).

Within the military discipline, each example utilized in pre-planning is achieved by defining the qualitative categories with threshold measures prior to their use by SME in the respective process. The principle of pre-planning is best captured by ORM as a "deliberate process of thorough hazard identification and risk assessment" requiring forethought and planning to achieve (AFPAM90-902 2000:12).

Documentation

Documentation, as a natural following step or extension of the pre-planning step, provides users of the process with a source and resource when developing decisions from a given process. Moreover, documentation provides the ability to determine if a valuation method remains high-quality over time and allows institutional learning and refinement of the assessment process. A benefit of documentation resources is the establishment of accountability by personnel, organizations, and entities within the process. The accounting discipline has many forms of documentation originating both from government agencies and governing bodies such as the IRS or FASB. Additionally, the previously discussed accounting associations such as AICPA or GAAP provide guidance for the accounting discipline. Similarly, in the legal discipline, documents such as the UCC and USC provide governance but the legal associations, such as ABA and FBA, provide governance. Each of the military methodologies evaluated had associated documentation guidance from the DoD, Joint, or AF communities.

Qualitative Measure Categories (QMC)

The qualitative measure definition is both the qualitative measure category with associated definition and the subjectivity of the category with associated definition. Two examples of qualitative measures in the accounting discipline come from receivables for bad debt and trademark, both of which utilize statistical calculation to establish value over time. In these two accounting instances the subjective measure definition is defined by buyers and sellers whom may or may not have the knowledge and experience to create effective estimations. The legal discipline utilizes qualitative categories that appear quantitative on the surface but in practice establish a subjective value within a spectrum, such as with the USC statement, "not less than $750 or more than $30,000," (USC17 2000). The military exhibits qualitative measure categories with definitions as seen in the CNSI categories of Top Secret, Secret, and Confidential with associated definitions, such as "shall be applied to information, the unauthorized disclosure of which reasonably could be expected to cause exceptionally grave [serious, or cause] damage to the national security," (EO13292 2003:15315-9). Each methodology reviewed contained qualitative measure categories with or without documented definitions.

The second part of qualitative measure definition is the subjectivity of the measure and definition. In accounting, the trademark provides substantial subjectivity in the definition as "how much the owner of the trade name [would] pay to keep the name," (Hitchner 2003:80). The subjectivity in legal terms is demonstrated with trademarks, where the "judge at court discretion, enters a sum as the court shall find to be just," (USC15 2000:1). The military qualitative measures of BCE planned work order management highlights subjective category definitions needing human estimation such as "reduces operational effectiveness", "give adequate security", "breakdown of essential operating", or "qualifying for higher priority"; additionally, the direct schedule work emergency category demonstrates the subjective nature of the measurement with "reduces operational effectiveness," (AFI32-1001 2005:5). The HTTM qualitative measures are driven by the user impact related to an outage or degradation of the service that calls for estimation by the commander, work center, and customer. The EES system illustrates qualitative measurement categories with subjectivity such as "consider adapting," "consider dress and appearance," "above average," or "clearly exceeds," (AFForm910 2007; AFForm911 2007; AFForm931 2007; AFForm932 2007). In the CNSI methodology, qualitative measures can easily be seen as subjective with vague phrases such as "reasonably could be," or "cause serious damage" which lend themselves to individual interpretation (EO13292 2003:15315-9). The qualitative measurement categories definitions of ORM demonstrate subjectivity with phrases such as "major or minor mission degradation," or "negligible loss," (AFPAM90-902 2000:17). HTTM and OPSEC are similar in that each has qualitative measure categories but both rely on the commander and work center or staff planning team (AFI10-701 2007:12) to set priorities, assignments, and response times (AFI33-115V1 2006:48) of the category definitions. Lastly, UJTL has qualitative measure categories with associated definitions and measures of performance, such as "excess" and "capable" relying on the commander's determination of that performance (CJCSM3500.04D 2005:C80).

Subject Matter Expert (SME)

In the context of the reviewed processes, the Subject Matter Expert (SME) is the individual, or group, whom has gained enough experience from the pre-planning, documentation, and use of the qualitative measurement categories to provide comprehensive and competent estimation or judgment. Accountants are the SME where "valuation is an art, not a science" and this is embraced by the FASB. Relief from royalty and investment value each rely upon the knowledge of a SME to establish value, such as the SME 5-year benefit projection for relief from royalty or the SME investor estimation of open market (Hitchner 2003). In each of these valuation instances, a reliance on the experience and knowledge SME is used to establish a legitimate value. The SME estimation of an intangible asset appears in the R&D value "as an educated guess," (Roche 2005). The receivable for bad debt approach presents the most quantitative model by refining a value with statistical estimation becoming more accurate as time elapses (King 2006). This same methodology could be adapted to IAV model with the SME estimating the initial value, and then statistically updating over time to increase the value accuracy. The idea of an SME is not new as in financial accounting "the appraiser makes the assumption" and "determining value for intangible assets requires judgment of professional," (King 2002). To further the point, in financial accounting the Federal Accounting Standards Board (FASB) has specified that appraisers should determine the intangible asset by having the appraiser estimate the intangible asset's actual worth (King 2002). Many SMEs exist in the legal discipline where it may be the judge or jury whom make estimations. The AF EES relies heavily upon the supervisor as the SME to pass judgment on the personnel under his or her supervision. The commander or staff brings the experience and skill to make estimations in BCE-WOM, HTTM, OPSEC, or UJTL processes. In the CNSI model, the classification authority as the SME applies experience and judgment on information to establish information classification guidelines. The cornerstone of ORM risk assessment is the use of “estimation” and “intuition” to establish a standard of risk for hazards, such as “consider expert opinion and intuition,” “my experienced NCOs feel that there is a real danger of the machine falling,” and “my gut feeling is that there is a real possibility we could lose control of this machine and topple it,” (AFPAM90-902 2000:87, A83).

Defensible Methodology

A defensible methodology is a requirement to establish credibility in the results of the discipline process. The reviewed disciplines of accounting, legal and military have developed their assessment methodologies over time to establish a defensible methodology as accepted by the discipline. As demonstrated by the reviewed discipline methodologies, a defensible methodology may be viewed as the recognition or acceptance of the processes’ results by the discipline. Business buyers and sellers accept the discipline’s subjective accounting method of valuation as attested with the multitude of transactions occurring daily. Within the legal discipline, litigation is settled every day, demonstrating a measure of the acceptance by the discipline and users of the process. The EES process best represents the application of subjective qualitative measures on human behavior through development of comparable standards for application against personnel behaviors; moreover, the supervisor has subjective measures that attribute confidence in the appropriate application of those qualitative measures on human behavior. The military discipline’s acceptance of the EES as a subjective, but trusted, methodology is seen in the daily use by Airman of all ranks. Each of the disciplines reviewed has developed their subjective valuation methodologies over a period of time and the culmination of pre-planning, documentation, subjective qualitative measure categories, and SME establishes within the discipline a processes' defensible methodology.

Proposed Information Asset Valuation (IAV) Methodology

This section will cover the IAV methodology proposal resulting from the research analysis. The quantification of InfoAs is a multi-step methodology including: the information asset (InfoA), developing factors, scaling factors, aggregating factor values, aggregating across InfoA values, and binding InfoA value to mission impact. The IAV conceptual model overview is illustrated in Figures 8 and 9, which demonstrates the pre-cursor, qualitative factor, and assignment of InfoA value processes. The pre-cursor functions of InfoA recognition and mapping are defined in the CIMIA program. As illustrated in Figure 8, the IAV model accounts for the recognition of an unknown, but presumably large, number of InfoAs. Each of the InfoAs will output the InfoA factor value mixture with a single Tactical InfoA value that is comparable to other differing InfoAs. Likewise, Figure 9 illustrates that many InfoA values will output from the Tactical level to the Operational level where the IAV model is applied to compare differing InfoAs. As the Operational values output to the Strategic level, again the IAV model is applied to compare the many differing InfoAs. The Figure 9 illustration indicates a single flow direction, however, if the IAV model perspectives discussed later are introduced this graphic become bi-directional. A pre-defined organizational InfoA value may be applied at the strategic level and flow back to operational and then tactical for a single InfoA value across the domains.

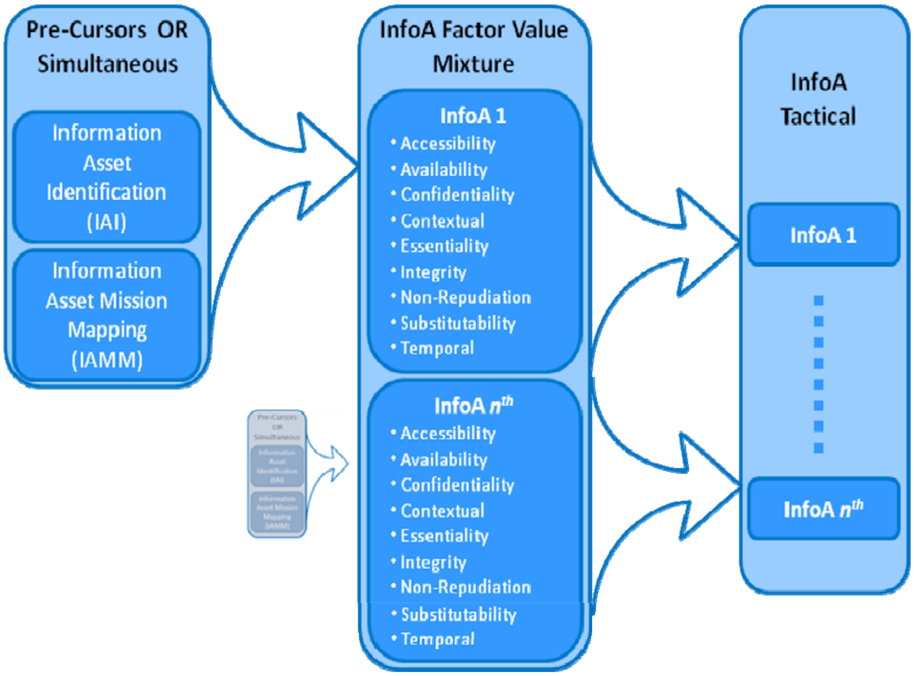

Figure 8. IAV Model of InfoA Factor Mixture

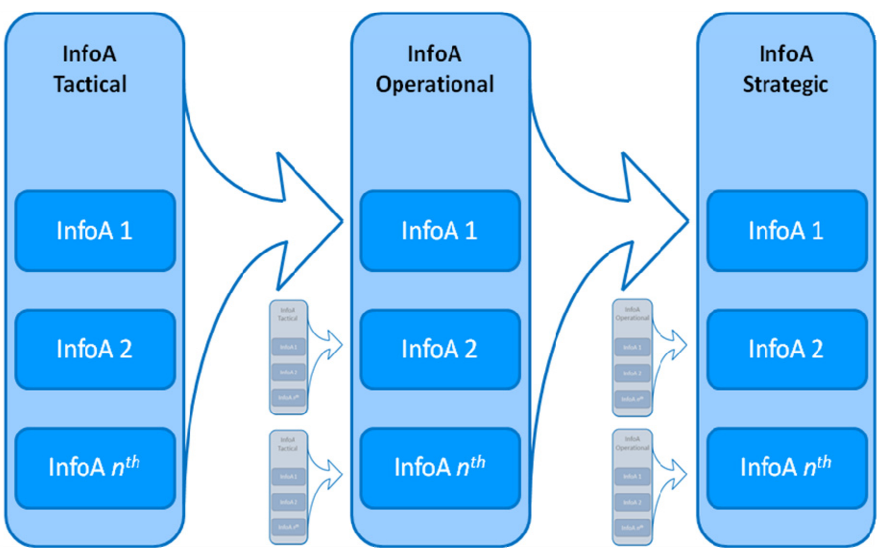

Figure 9. IAV Methodology

IAV Model Qualitative Factors

The quantification of an InfoA is a multi-step methodology. The method steps are: developing factors, scaling factors, aggregating factor values, and aggregating across InfoA values. After the pre-cursor steps of InfoA identification and mapping, the first step of the IAV model is determining the qualitative factors needed to quantify an InfoA value. Accessibility, availability, confidentiality, contextual, essentiality, integrity, non-repudiation, substitution, and temporal all appear to be factors for establishing the value of an InfoA, specifically InfoA 1, as illustrated in Figure 10. Field survey and testing will be necessary to validate the usefulness of the factors under realistic circumstances.

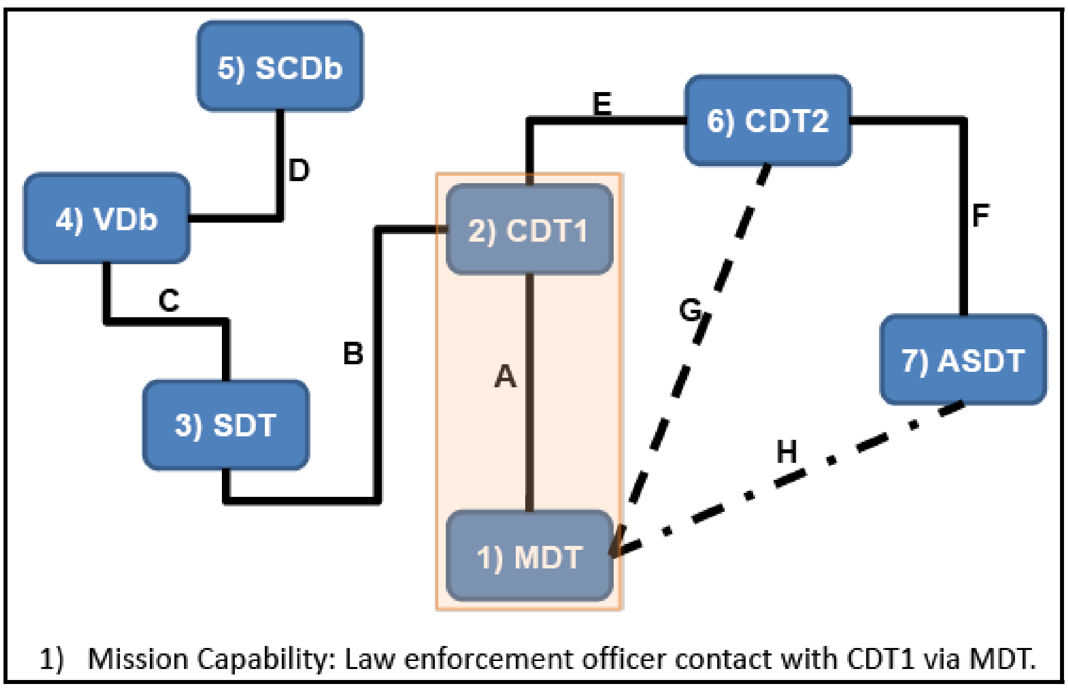

Figure 10. Example of an Information Asset, InfoA 1

Accessibility

The accessibility factor is characterized by the question, *how easily can I get use of this asset?* In the Figure 10 illustration of InfoA 1, the law enforcement officer may be dispatched to an area with intermittent *dead zone* coverage resulting in the sporadic MDT accessibility of the network (link A).

Availability

The availability factor is characterized by the question, *how often can I get use of this asset?* In the Figure 10 illustration of InfoA 1, the law enforcement officer may occasionally experience network saturation resulting in a sporadic ability to communicate with dispatch (CDT1).

Confidentiality

The confidentiality factor is characterized by the questions, *would exposure be detrimental?* In the Figure 10 illustration of InfoA 1, the law enforcement officer may have some reason that the information communicated using the MDT should be kept secret from exposure to others.

Contextual

The contextual factor is characterized by the question, *who and how is the asset used?* The contextual nature of an InfoA is an elusive factor. In the Figure 10 InfoA 1 illustration, one contextual requirement for a law enforcement officer is to communicate vitally important information using the MDT such as when conducting a traffic stop on a murder suspect vehicle. In this case it is vital for the officer to have access to the vehicle and criminal databases (VDb, and SCDb) for inquiry and determination that the vehicle they have stopped is considered armed and dangerous. In a low criticality context, the law enforcement officer may notify dispatch (CDT1) of a lunch break. A staggering number of context situations may exist, and context assists in prioritization of the InfoA value.

Essentiality

The essentiality factor is characterized by the question, *can I function without it?* In the Figure 10 illustration of InfoA 1, the nature of a law enforcement officer's duties requires the ability to communicate with the dispatch (CDT1) on-demand.

Integrity

The integrity factor is characterized by the question; *can the communicated information be corrupted?* In the Figure 10 InfoA 1 illustration, corrupted dispatch (CDT1) communication to the MDT may prevent the law enforcement officer from responding to an emergency or correct location.

Non-repudiation

The non-repudiation factor is characterized by the questions, *is this really the originator?* In the Figure 10 illustration of InfoA 1, dispatch (CDT1) needs to know that the information being communicated is actually from an authorized law enforcement MDT. Questionable communication, real or perceived, may prevent the appropriate response to an emergency.

Substitutability

The substitutability factor is characterized by the questions, *is there an alternative source?* In the Figure 10 illustration of InfoA 1, the law enforcement officer may have a personal cell phone or may be able to locate a nearby house or business with a phone that provides an alternate means to contact dispatch (CDT1).

Temporal

The temporal factor is characterized by the questions, *how does the importance of the information change as a function of time?* The temporal nature of the InfoA changes and represents the most elusive of the factors. As illustrated by InfoA 1 of Figure 10, the requirement for a law enforcement officer to communicate with the dispatch (CDT1) can change from moment to moment. One moment, the officer may be monitoring the flow of traffic through a busy intersection. The next instant, the officer may observe a major accident and need to immediately request fire and medical rescue units be dispatched to the scene.

IAV Model Factor Scale

The next step after identification of the factors is to apply quantification scale that relates the factors' importance to the mission impact. One requirement of the scale is that it must be easy to understand and utilize. Simplicity of the scale is necessary because human interaction, such as manual input, will be part of the process with or without automation. For example, computer antivirus software has become increasingly automatic but for the antivirus software to work effectively human interaction is still required during the configuration and input processes. The commonly utilized Likert scale may be the most effective for ease of use and understanding in IAV scaling levels as illustrated in Figure 11. An effective Likert scale may have these levels: 1 – Non-Critical Impact, 2 – Low Impact, 3 – Moderate Impact, 4 – High Impact, 5 – Critical

Impact. Factor field testing will be necessary to validate the most effective factor scaling model as *Critical Impact* may not work as effectively with the *Accessibility* as it does with the *Substitutability* factor.

0	1	2	3	4	5
Non-Critical Impact	Low Impact	Moderate Impact	Significant Impact	High Impact	Critical Impact

Figure 11. Example IAV Model Factor Scale

IAV Model Aggregation

The goal of IAV is to derive a single comprehensive value for the InfoA. Since there is more than one factor, the factors themselves need to be aggregated into a single InfoA value. Additionally, as multiple single value InfoAs filter from the tactical to the operational and finally the strategic domain, the InfoA aggregation allows for equivalency comparisons during prioritization efforts by decision makers.

InfoA Aggregation Without Weight

The straight forward derivation may be achieved through an averaging of factors method. This basic averaging method establishes a situation where all the factors are an equal weighted value at all times and in all situations. The simple averaging method does not work in a situation where the SME determines that one or more of the factor values should be ranked higher than all other factors for a given mission. A small example of a temporal factor may be seen in catching a plane at the terminal where the time a plane departs is more important than the other factors because these other factors are assumed to be previously satisfied. From previous discussion, the potentially higher than average significance of the temporal and contextual factors may require a weighting method which will better reflect the organization's canonical InfoA criticality value. In the case for an InfoA, the separate factor values calculated to a single InfoA value with simple averaging methods is demonstrated in Table 4. The simple averaging methodology of the factor value mixture for InfoA calculates to an overall InfoA value of *3* for a *Moderate Impact* to the mission.

Table 4. InfoA Aggregation Within Factor Values Without Weight

	Factor	Accessibility	Availability	Confidentiality	Contextual	Essentiality	Integrity	Non-Repudiation	Substitutability	Temporal	**Total**
InfoA 1		1	4	1	5	2	4	1	4	5	3

InfoA Aggregation With Weight

Similar to a project management screening matrix (Gray and Larson 2003:41) the weighted calculation takes into account a higher importance for the *contextual* and *temporal* factors as illustrated in Table 5.

Table 5. InfoA Aggregation Within Factor Values With Weight

	Factor	Accessibility	Availability	Confidentiality	Contextual	Essentiality	Integrity	Non-Repudiation	Substitutability	Temporal	**Total**
Weight		1	1	1	5	1	1	1	1	5	
InfoA 1*		1	4	1	5	2	4	1	4	5	3
InfoA 1		1	4	1	15	2	4	1	4	15	4

* Weights not included in calculation;
for visual comparison

A formula calculation such as illustrated in Table 6 (Meredith and Mantel 2006:385), may provide the necessary accuracy of value without overly complex mathematics. The essence of this weighted formula is to add the non-weighted individual factor values to the weighted individual factor values and then divide by the total number of factor instances. This formula maintains the 0-5 scale while taking into account the higher weight of certain individual factors and in this way maintains the single comparable value concept of the IAV model. In concept, Table 5 demonstrates, forgoing the underlying mathematics, the overall InfoA value with weights resulting in a *4 – High Impact* to the mission instead of a less accurate *3 – Significant Impact.* In the scope of this scenario, and in the broader context of real application, the weighted value may more accurately represent the mission impact for the users of this IAV model.

Table 6. InfoA Aggregation Weighted Formula (Meredith and Mantel 2006:385)

$\mathbf{V} = \dfrac{\boldsymbol{f + FW}}{\boldsymbol{T}}$	V = InfoA Value *f* = Factor Sum *F* = Weighted Factor Sum *W* = Weight *T* = Total Factor Instances

Aggregation Across InfoA Values

The goal of IAV is to provide the ability to establish the value, as a single expression, for an InfoA for comparison. InfoAs will exist in the tactical, operational, and strategic domains. Tactical being the lowest level will establish an initial InfoA value from either an organization or individual perspective. Each of these levels will have multiple InfoAs to value, compare, and prioritize. After the tactical level prioritizes the differing InfoAs, the values will pass up to the operational level. The operational level, like the tactical, will have multiple InfoAs to value, compare, and prioritize before passing the values up to the strategic level. Finally, the strategic level will also have multiple InfoAs to value, compare, and prioritize. At each level a factor valuation will aggregate to derive a single InfoA value that is passed up to the next level. The end result is that a low level InfoA will bubble up to the strategic level for decision making. Table 7 illustrates a tactical, operational, or strategic level InfoA prioritized listing with InfoA 1 having the lowest value of *1 – Non-Critical* Impact, and InfoA 5, or InfoA 6 with weights, having the highest value of *5 – Critical Impact*.

Table 7. Aggregation Across Multiple InfoAs

	Factor	Accessibility	Availability	Confidentiality	Contextual	Essentiality	Integrity	Non-Repudiation	Substitutability	Temporal	**Total**
		1	1	1	5	1	1	1	1	5	
InfoA 1*		1	1	1	1	1	1	1	1	1	1
InfoA 2*		1	1	1	1	3	4	1	1	5	2
InfoA 3*		1	1	2	2	2	4	5	5	5	3
InfoA 4*		3	3	4	4	4	4	4	5	5	4
InfoA 5*		5	5	5	5	5	5	5	5	5	5
InfoA 6*		2	4	1	5	2	4	3	4	5	4
InfoA 6		2	4	1	25	2	4	3	4	25	5
* Weights not included in calculation; for visual comparison											

The example of Table 7 will immediately identify for planners and decision makers the need to manage, protect, or exploit InfoA 5 in execution of the mission. Assuming that weights have been utilized in the initial InfoA valuation, a weight system may not be necessary at the level where aggregation across multiple InfoA takes place. However, an important key to this methodology is providing an adjustment mechanism along the hierarchal path. From the tactical to strategic level, personnel will need to modify what they judge to be an inaccurate value because personnel may not have enough knowledge about a specific InfoA for accurate judgments, personnel may not have enough time to comprehensively deal with the InfoA value, or personnel may need to simply rectify a system anomaly. The action taken could be a simple plus up or down of the factor values or the overall value.

IAV Model Binding to CIMIA

Binding the IAV model to the CIMIA program equates to linking the InfoA value to the mission impact alerts and linking the temporal aspects of mission executing. The preceding steps of the IAV model have established a value for the InfoA in an abstract. The "mission binding construct reflects the criticality of the InfoA to the organization's mission," (Fortson 2007:192) through a user friendly visual and effect on the mission of a period of time. This final step of the IAV model binds for IAV model presentation and time-cycles to the CIMIA program.

Binding Presentation

The importance of InfoA value becomes more apparent for planners and decision makers with the incorporation of other attributes in a visual presentation. In example, the InfoA value of *5 – Critical Impact* takes on more meaning when the InfoA is bound to other attributes such as the problem of "circuit 7JA is down," the mission description of "ATO generation capability for theater-wide refueling," the InfoA status of "technicians are troubleshooting," and that an alternative "dial-up circuit 9D72 at degraded speed" exists. Specifying the problem, mission description, status, alternatives, and a visual display as illustrated in Figure 12, represents a rudimentary culmination of these additional attributes supporting the InfoA value represented by the alert banner.

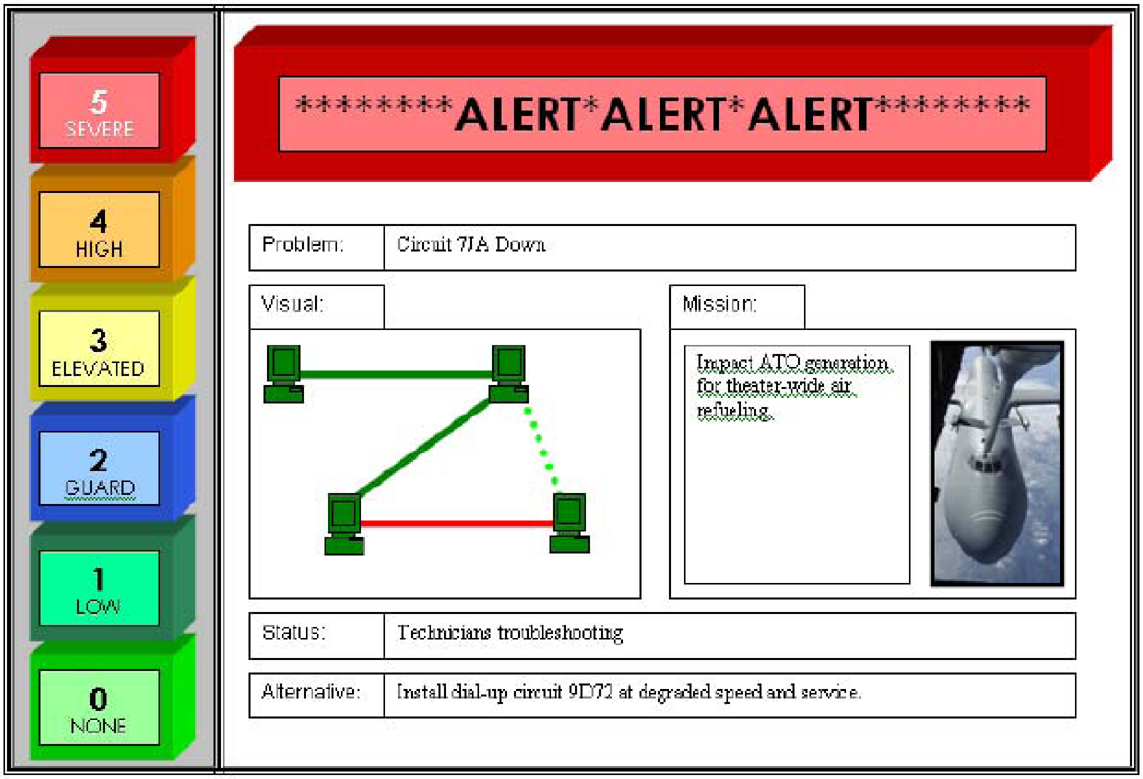

Figure 12. Conceptual CIMIA Visual

In step with the CIMIA goal to provide a DSS that is naturally intuitive for personnel to understand and utilize, the Department of Homeland Security (DHS) development of the Homeland Security Advisory System (HSAS) (DHS 2008) has presentation characteristics similar to the CIMIA presentation requirements. From frequent public exposure, the HSAS should have a broad range of familiarity to the personnel utilizing the CIMIA DSS tool which will ease utilization and foster acceptance. Borrowing from the HSAS scheme as an overlay for Figure 11, a new IAV model factor scale presentation binding is created as illustrated in Figure 13.

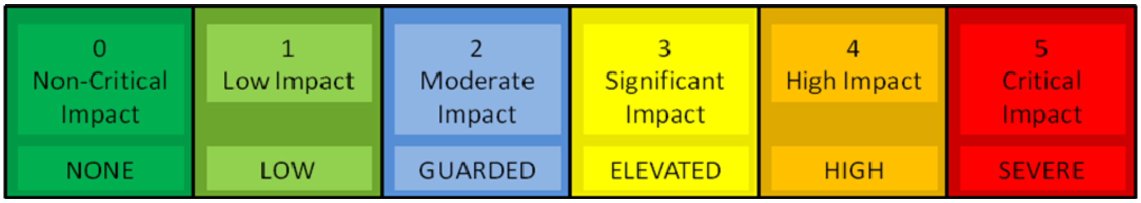

Figure 13. IAV Example Value Scale with Criticality

Binding Time Cycles

The main CIMIA presentation window will provide a concise level of information for planners and decision makers, however lower *drill-down* levels will be necessary to add more detail information. One level of drill-down will be the graphic time cycle relationship of an InfoA to mission criticality over a specified time period for mission planning projections. Figures 14, 15, and 16 illustrate the InfoA-to-mission-impact of a 30-day cycle, or an average month.

The first criticality example, Figure 14, is straight forward with a low InfoA value, or criticality. The criticality is low and flat, rapidly increases during an eight day peak, and then returns to low and flat criticality. This InfoA is, from a decision maker's perspective, is *valuable* for only a short period of the month, but has significant temporal importance when the InfoA is being utilized.

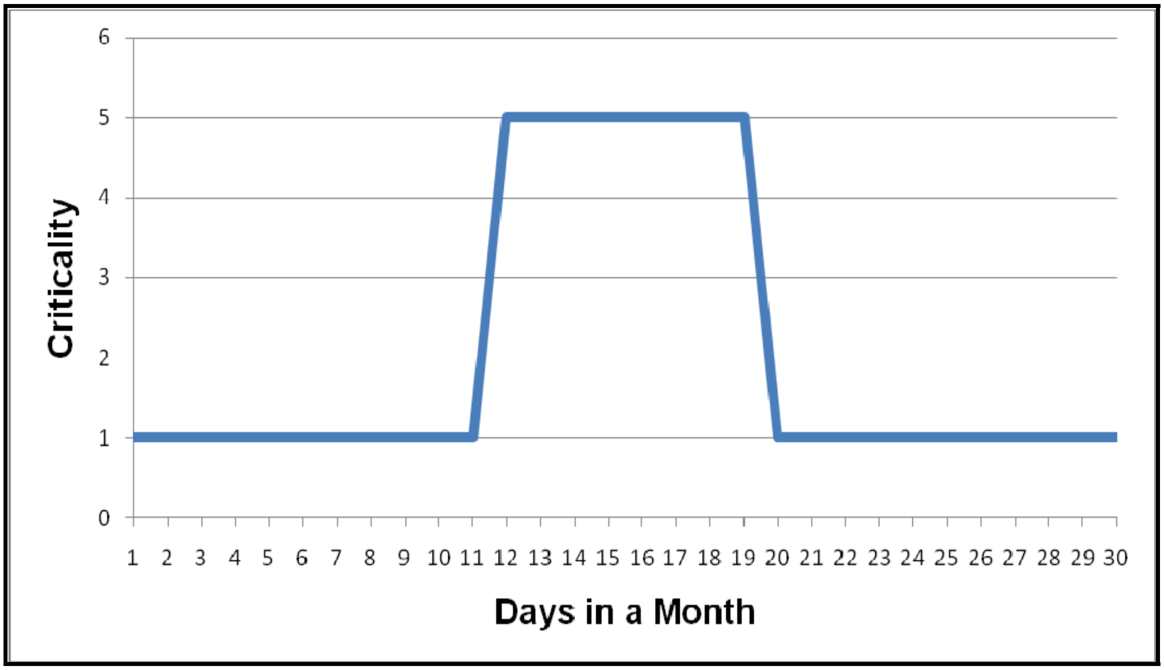

Figure 14. IAV Example Criticality Cycle 1

The second criticality example, Figure 15, demonstrates a gradual growth in the InfoA criticality until a single day peak and then a gradual return to a low criticality. From a decision maker perspective, this InfoA is *valuable* for the entire month cycle. This situation would indicate to decision makers that constant vigilance in protecting the resource may be necessary over the time cycle.

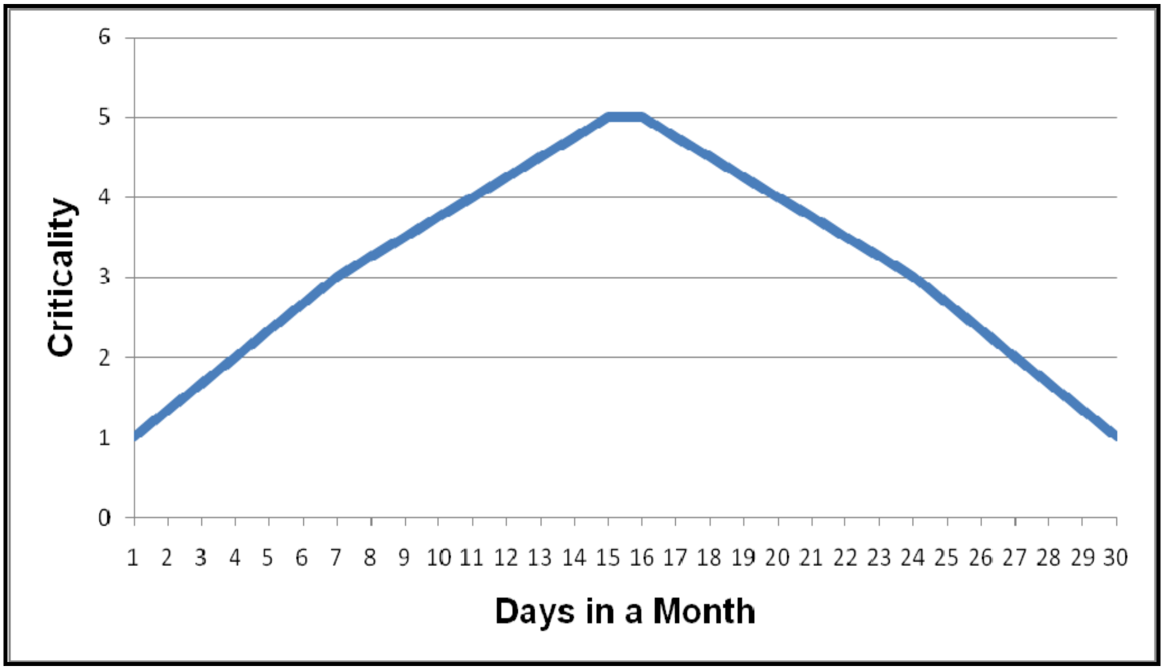

Figure 15. IAV Example Criticality Cycle 2

The third criticality example, Figure 16, is actually a criticality error. The criticality error illustrated if Figure 16 is the mirror opposite of Figure 14 and demonstrates the importance of this InfoA. During the tactical, operational, or strategic planning phase of a mission, the critical error graphic identifies periods when the InfoA is vulnerable. This critical error graphic would indicate to planners the vital nature of this InfoA to the mission impact at hand, over the time cycle, and failure of the InfoA during the time cycle may potentially cause failure of the mission.

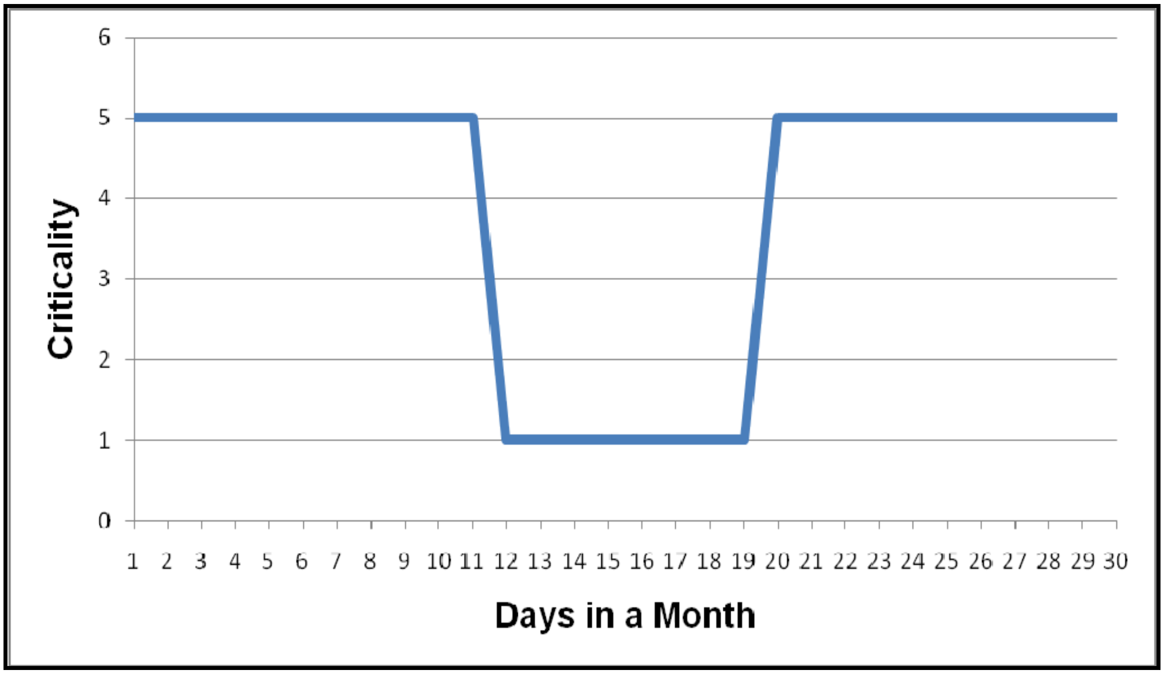

Figure 16. IAV Example Criticality Error Cycle

IAV Model Comprehensive Example

The core benefit of the IAV model is the association of mission capability to the InfoA, which strengthens the importance of the InfoA to the organization. In this section a comprehensive example will be utilized to demonstrate concepts of the IAV model. Refer to Figure 17, as well as following the discussion, for detail on the example scenario utilized throughout this section to demonstrate key IAV model concepts.

The following comprehensive IAV model scenario example utilizes the following entities: 1) a law enforcement agency as the organizational owner of the entire system of systems, 2) a law enforcement agency system of systems, 3) a law enforcement officer (LEO), and 4) various day to day missions being conducted by the LEO.

The law enforcement agency system of system, as illustrated in Figure 17, is composed of the: 1) Mobile Datalink Terminal (MDT), the lowest level interface system for accessing the wider system of systems through the Central Dispatch Terminal and the primary means for the LEO to interface with the law enforcement agency system of systems; 2) Central Dispatch Terminal (CDT), or CDT1, a city, municipality, or county level system that is able to interface with other systems within the law enforcement agency's system of systems and the primary interface system for the MDT; 3) State Dispatch Terminal (SDT), the next higher level system above the CDT that is able to interface with other systems within the law enforcement agency's system of systems; 4) Vehicle Database (VDb), the state database with vehicle and vehicle owner information; 5) State Criminal Database (SCDb), the database with criminal personal information; 6) Central Dispatch Terminal Two (CDT2), the CDT in the adjacent city, municipality, or county to CDT1, 7) Air Support Datalink Terminal (ASDT), the air support link to the law enforcement agency's system of systems, and 8) Links A-H, the various wired and wireless network connections within the law enforcement agency's system of systems.

The day to day missions of the LEO must be accomplished through the law enforcement agency's system of systems and these mission capabilities, as illustrated in Table 8, are: 1) contact with the CDT, 2) vehicle license plate inquiry, 3) criminal inquiry, 4) request for air surveillance support, and 5) directing air surveillance support.

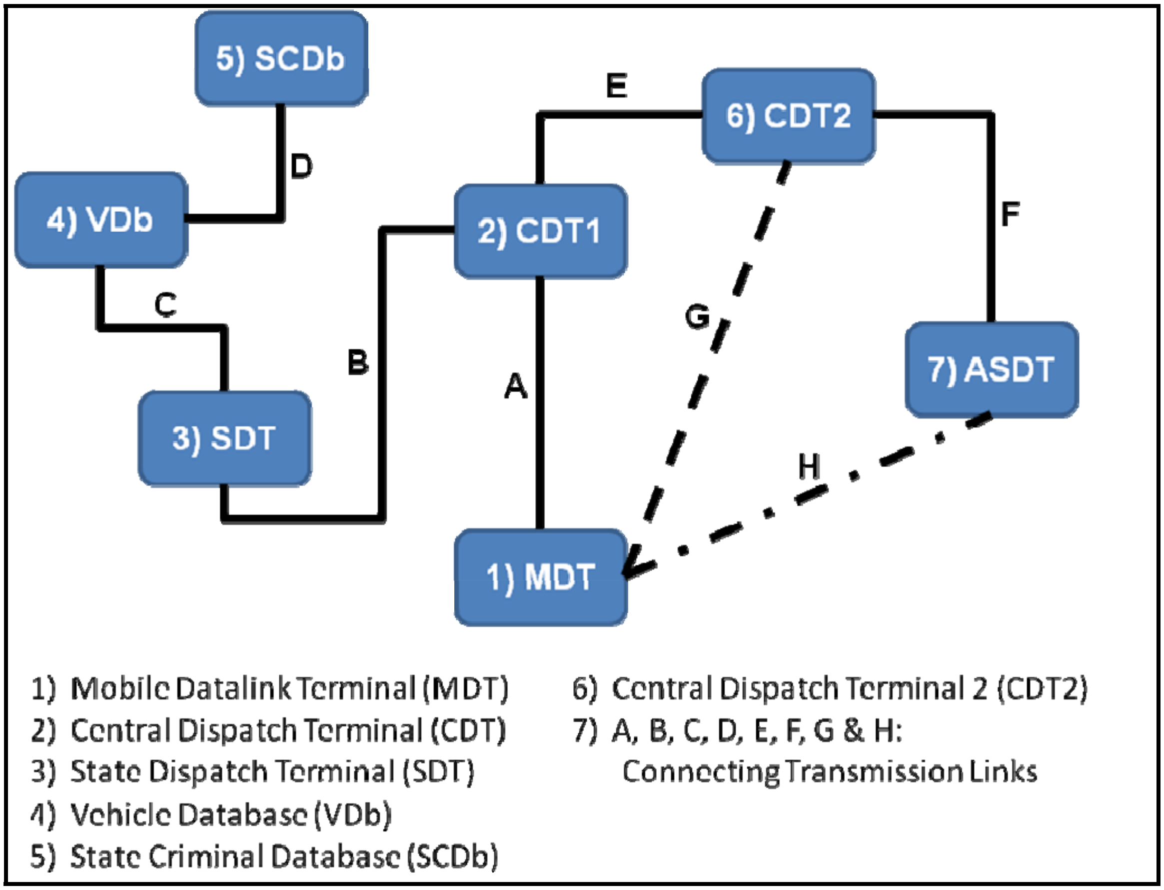

Figure 17. Example Scenario Detail

Table 8. Example Scenario Detail Mission Capability

Mission Capability 1	Contact with CDT via MDT
Mission Capability 2	Vehicle license plate inquiry
Mission Capability 3	Criminal inquiry
Mission Capability 4	Request for air surveillance support
Mission Capability 5	Directing air surveillance support

Simple InfoA Scenario Example

Utilizing a simple point-to-point InfoA, as illustrated in Figure 18, the three components of InfoA 1 (MDT, CDT1, and transmission link A) comprise the entire InfoA 1 and enable the *mission capability 1* to be accomplished. Figure 18, utilized in the following IAV model concept explanations, is provide for reader convenience, but is identical to previously utilized Figure 10. The LEO has a mission requirement to contact CDT1 via the MDT and this could be for an unremarkable reason such as a break or a more important reason such as a traffic stop; moreover, the overall InfoA 1 value, as illustrated in Table 7, is *1* for a *Low Impact*. Failure or degradation of the MDT, CDT1, or link A will prevent the law enforcement officer from successfully communicating with CDT1 as expressed in *mission capability 1.*

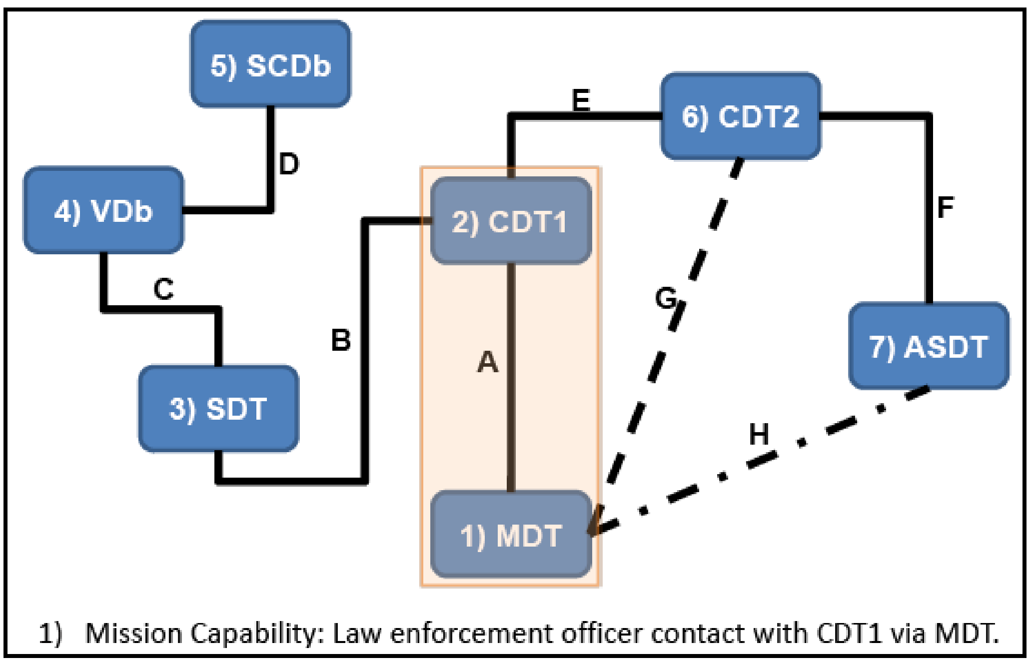

Figure 18. Example of an Information Asset, InfoA 1

IAV Model Perspectives

The IAV model is frame of reference dependent. In our example, the law enforcement officer has one perspective of value, but the mobile data terminal used by a combat soldier may have a very different perspective and value. Another example is that the law enforcement officer may have a value and the law enforcement officer's organization may have another value for the same InfoA. These two examples demonstrate the separate prospective of organization and individual. In example, using CDT1 as the organizational representative of the law enforcement agency, CDT1's organizational value of InfoA 1, as illustrated in Figure 18, may be established as *5* for *Critical Mission Impact* and applied to all like InfoAs regardless of the situation. Moreover, the LEO as the individual, where there is a lack of an organizationally mandated InfoA value, may establish InfoA 1, as illustrated in Figure 18, as *3* for a *Significant Mission Impact*. An organizational perspective is a policy-based mixture of factor values to arrive at a single InfoA value. An organizational policy would most likely be developed from a team of personnel knowledge about the InfoA with management concurrence. The organization as a whole may have a defined perspective with the InfoA having a standard factor value mix with a standard overall value. Table 7 demonstrates for InfoA 1 an example standard factor mix and value that an organization may place on all such similar InfoAs utilized within that organization. The policy may apply to a specific InfoA, or group of similar InfoAs, but ultimately provides guidance to all personnel interacting with the InfoA. The organizational perspective is a prime driver for the CIMIA project, but as the IAV methodology matures, the individual value will become more practical and necessary.

Complex InfoA Scenario Example 1

Figure 19 illustrates a more complex example of an InfoA. The four components of InfoA 2 (MDT, CDT1, SDT, VDb, and transmission links A, B, C) enable the *mission capability 2* to be accomplished. The LEO has made a traffic stop and has a requirement to determine who owns the vehicle; moreover, the overall InfoA value, as illustrated in Table 7, is *2* for a *Moderate Impact*. Should a system, server, or link be in degraded or failure status, the LEO will be unable to conduct a license plate inquiry as expressed in *mission capability 2*.

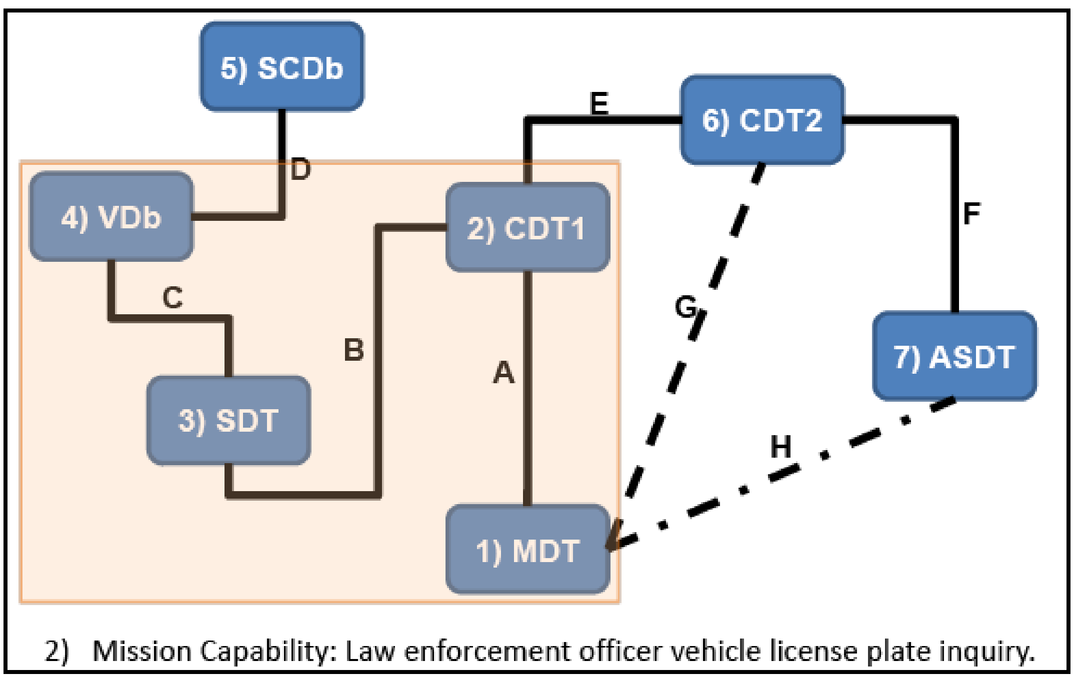

Figure 19. Example of an Information Asset, InfoA 2

Complex InfoA Scenario Example 2

Figure 20 illustrates an increasingly higher level example of a complex InfoA. The five components of InfoA 3 (MDT, CDT1, SDT, VDb, SCDb and transmission links A, B, C, D) enable the *mission capability 3* to be accomplished. During the traffic stop the LOE has determined the vehicle owner and has a requirement to determine if the owner is a criminal; moreover, the overall InfoA value, as illustrated in Table 8, is *3* for a *Significant Impact*. Should a system, server, or link be in degraded or failure status then, the LEO will be unable to conduct a license plate inquiry and subsequent criminal inquiry as expressed in *mission capability 3*.

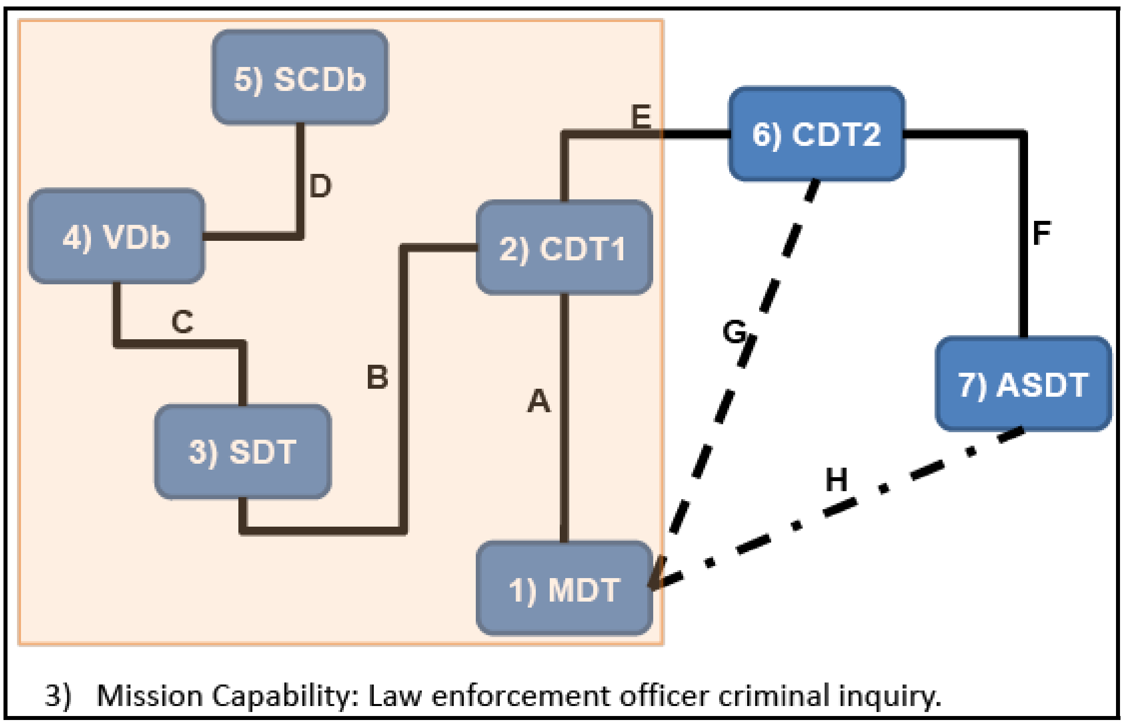

Figure 20. Example of an Information Asset, InfoA 3

Static vs. Dynamic InfoAs

It is important in the comprehensive example scenario to discuss the, at least two possible and distinct states of InfoAs: static and dynamic. InfoAs are composed of the connecting components from among the system of systems and this system of system is part of the real changing world in which it resides. Therefore the system of system changes frequently and without warning, however there are situations where the system remains fixed for a period of time, such as a month, year, or decade. These periods of time when the system of system experiences little change over time will be referred to as static. The static state is much more easily dealt with when the existence of the InfoA is constant. The static state of an InfoA is characterized by infrequent change, and when change does occur the change is telegraphed through the system in a way that the system of system is able to adapt to the change. In example, InfoA 3 (MDT, CDT1, SDT, VDb, SCDb and transmission links A, B, C, D), as illustrated in Figure 20, is likely to stay in a constant component configuration and InfoA 3 is less likely to change significantly or frequently. The stability of these InfoA components enables a static, steady state to emerge that fosters InfoA identification, mapping, and valuation. The dynamic nature of an InfoA emerges in InfoA 4, as illustrated in Figure 12, components (MDT, CDT1, CDT2, ASDT, and links A, E, F, G, H), that change significantly and with great frequency. The frequent change of components will necessitate more effort to track and understand the changes. As previously discussed, this dynamic nature highlights the elusiveness of the temporal and contextual InfoA factors.

Complex InfoA Scenario Example 3

This next comprehensive scenario example demonstrates the dynamic requirement to satisfy the *mission capability 4*, the LEO needs to request air surveillance support. The LEO requires air surveillance support because the traffic stop vehicle owner is a criminal and has fled the scene on foot. The LEO would normally make the air surveillance support request via CDT1 from within the InfoA 4 (MDT, CDT1, CDT2, ASDT, and links A, E, F, G, H), as illustrated in Figure 21; moreover, the overall InfoA value, as illustrated in Table 8, is *4* for a *High Impact*. A degradation or failure of transmission link A from within InfoA 4 necessitates the LEO to utilize CDT2 as a substitute. This substitution necessitates a change from InfoA 4 to InfoA 5.

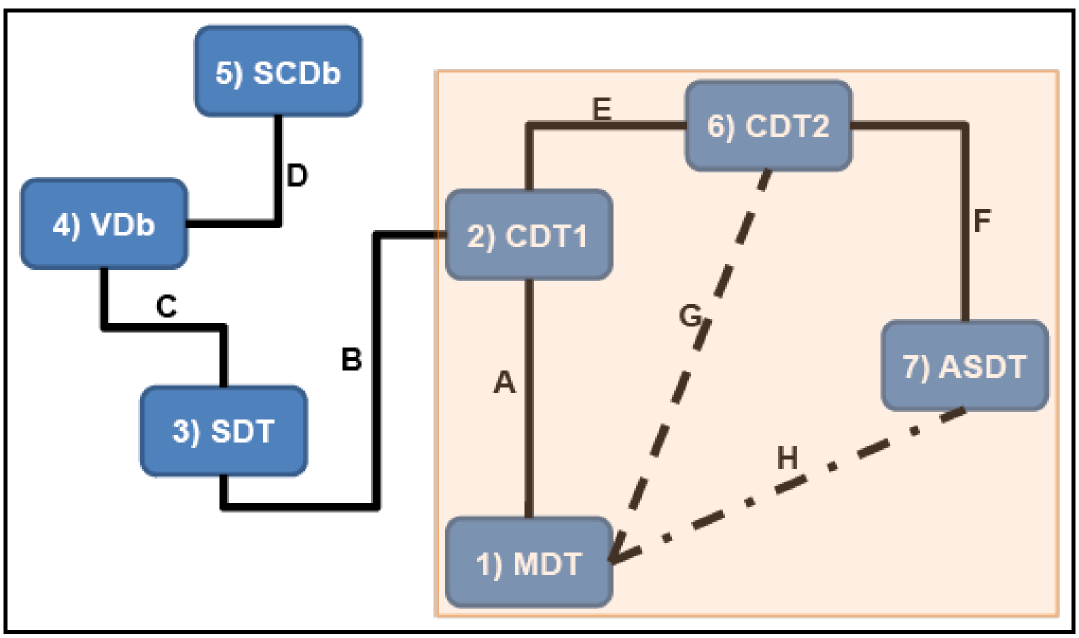

Figure 21. Example of an Information Asset, InfoA 4

Figure 22 illustrates a simple InfoA where substitutability may modify value. The failure of InfoA 4 allows InfoA 5 to act as a substitute and the LEO to continue with the mission capability task. From an organizational perspective, this substitution temporarily decreases the value of InfoA 4 from *4 – High Impact* to a lower level of *3 – Significant Impact*, because the organization decision makers recognize the substitute is available. Likewise, the InfoA 4 value is decreases because the LEO recognizes that the substitute is available to accomplish the mission capability task, from an individual perspective. The LEO is able to execute the *mission capability 4* with InfoA 5 (MDT, CDT2, ASDT, and links G, F), which has a value of *5 – Critical Impact*. Should the InfoA 5 system or link be in degraded or failure status, the LEO will be unable to conduct a request for air surveillance support in accomplishing *mission capability 4.*

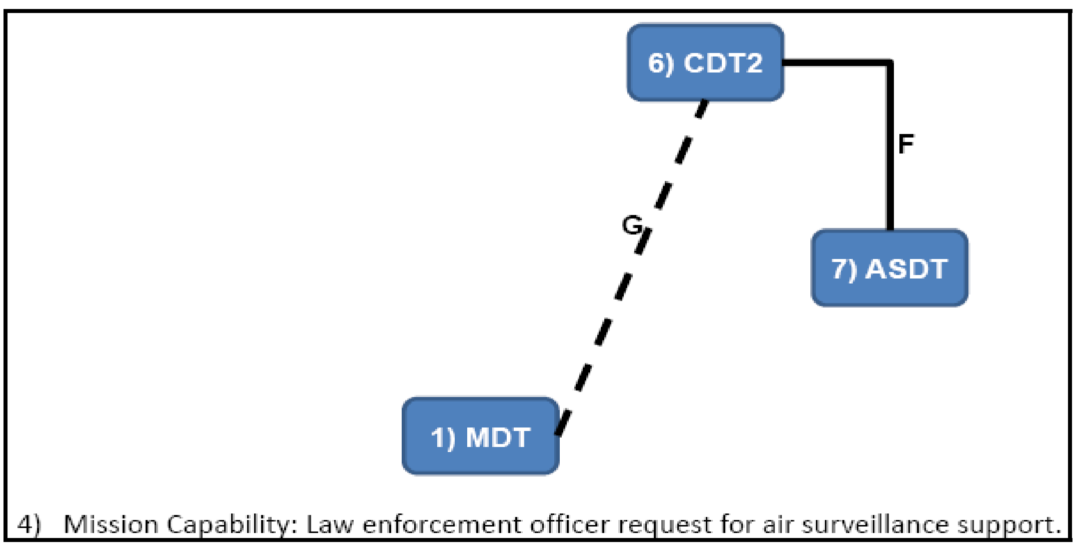

Figure 22. Example of an Information Asset, InfoA 5

Figure 23 illustrates a simple InfoA where the dynamic nature of realism intervenes to add weight on contextual and temporal factors. At this point in the example scenario the LEO has a requirement to communicate and direct the actions of air surveillance to capture a fleeing criminal. This dynamically changes the original value of InfoA 6 (MDT, ASDT, and link H), as illustrated in Table 8, of *4* for a *High Impact*, both contextually and temporally, in the accomplishment of *mission capability 5*. The new requirement for the LEO to coordinate with air surveillance support to capture the fleeing criminal changes the value of InfoA 6 to, as illustrated in Table 8, *5* for a *Critical Impact*.

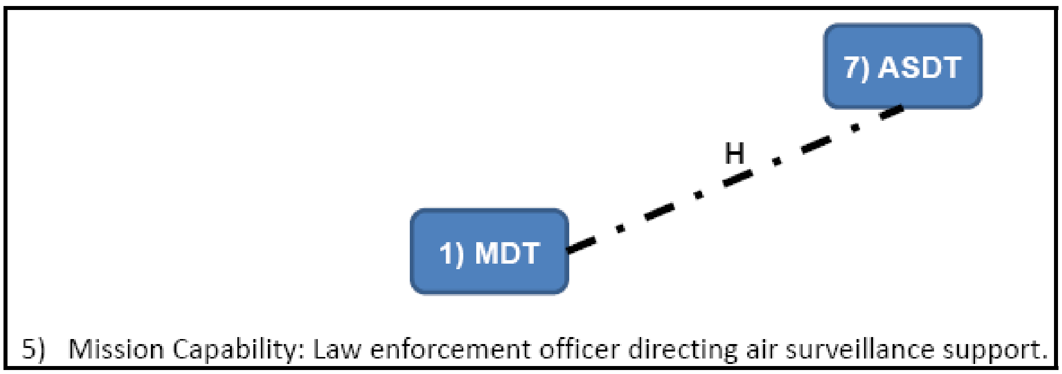

Figure 23. Example of an Information Asset, InfoA 6

Binding an InfoA to the CIMIA program visual presentation can be understood with InfoA 6. In the final portion of the comprehensive example, InfoA 6 has a value of 5- *Critical Impact;* moreover, should a component be in degraded or failure status, then the LEO will be unable to coordinate air surveillance support to capture the fleeing criminal as expressed in *mission capability 5*. If InfoA 6 becomes degraded or in failure status the CIMIA visual presentation tool will notify CDT2 with red *5 Severe -- Critical Impact* alert banner, similar to the illustration in Figure 12.

An example of binding an InfoA to the time cycle may be understood from the InfoA 6 scenario. The time cycle for InfoA 6 is measured in hourly increments, such as with a 24 hour clock, and represents one area along the temporal spectrum from seconds to multi-year. Figure 24 illustrates that over a 24-hour time cycle, InfoA 6 is at a peak value of 5- *Critical Impact* for only a short period of two hours. This two-hour window represents the part of the scenario where the LEO is coordinating air surveillance efforts to capture the fleeing criminal; however, the other periods of time are a steady lower value of 1 – Low Impact representing the non-use of the ASDT.

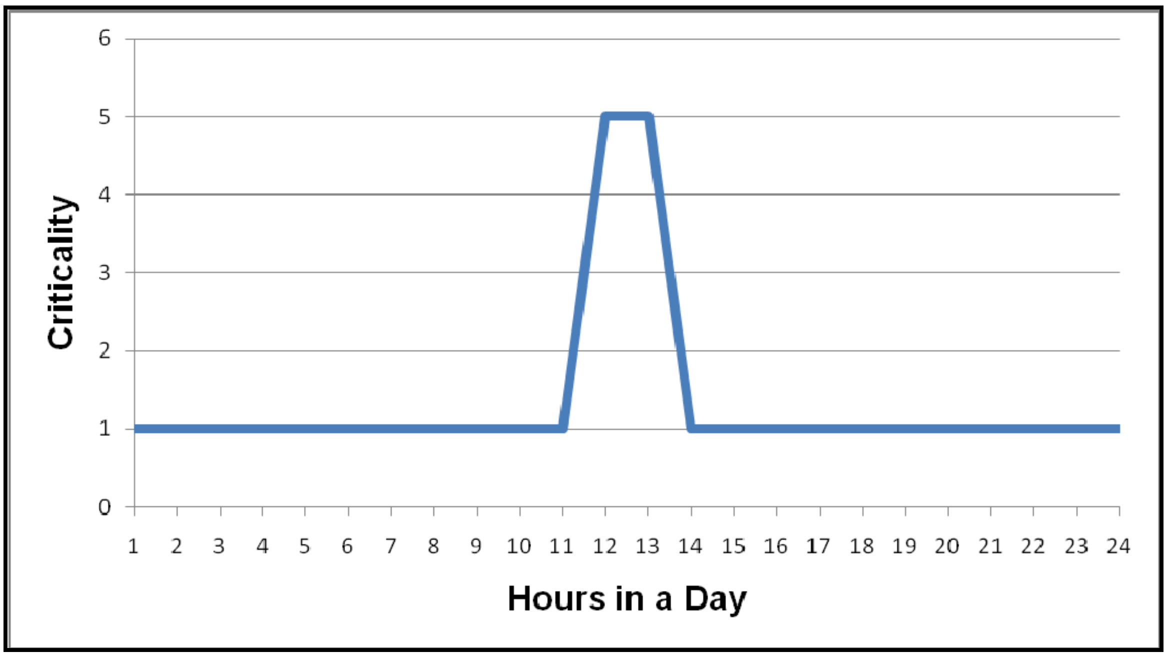

Figure 24. Time-Cycle Binding Example 1 for InfoA 6

A modification of the mission capability task for, InfoA 6 allows an illustration of the time binding and criticality error. Applying a new mission capability to InfoA 6, such as the LEO requesting air support for escorting dignitaries through the city, allows an exhibit of time cycle binding and criticality error. Figure 25 illustrates, over a 24-hour cycle, the LEO preparation slowly increases the value of InfoA 6 until a peak period when the LEO is escorting the dignitaries through the city and then the gradual decline of InfoA 6 value as the LEO conduct post activities. This new view of time cycle binding demonstrates how the IAV model may translate to the realistic and dynamic environment of the real world. During the planning stages of the new InfoA 6 scenario allows planners to visualize the potential periods when the InfoA must be maintained, bolstered, or prevented from failing. Figure 26 is a mirror opposite of Figure 24 and illustrates that should InfoA 6 be in a degraded or failure status during the lowest point then the mission capability may fail.

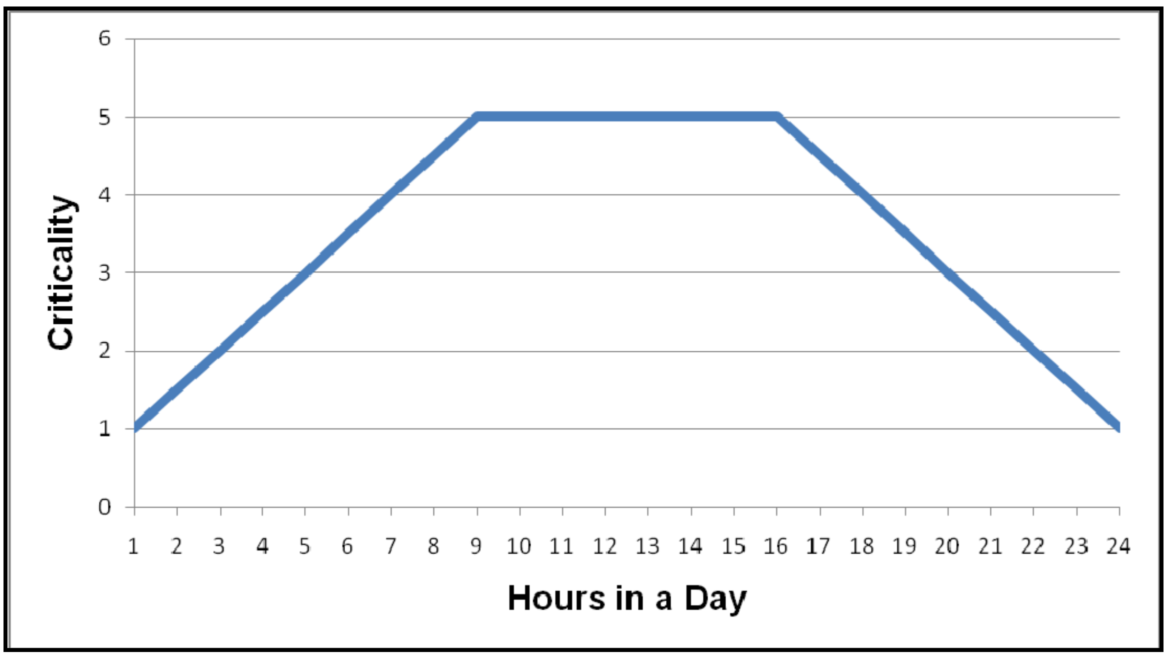

Figure 25. Time-Cycle Binding Example 2 for InfoA 6

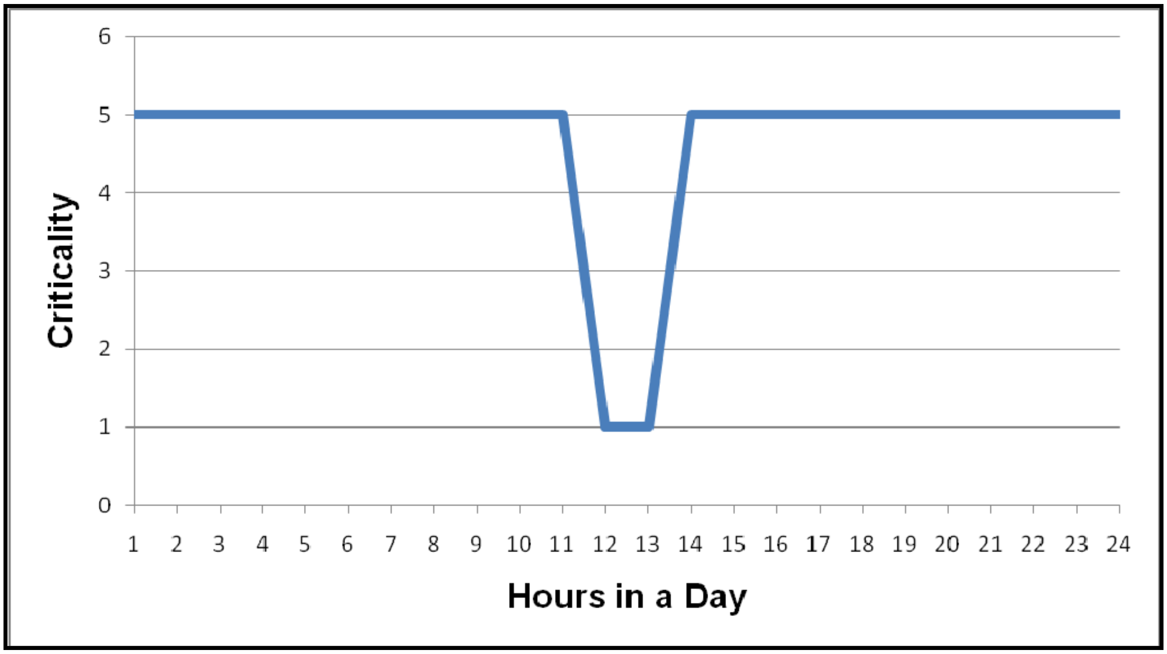

Figure 26. Criticality Error Example for InfoA 6

IAV Model Comprehensive Example Summary

The comprehensive example has demonstrated the key IAV model concepts of aggregating qualitative factors to a single InfoA value, aggregation across multiple InfoAs, individual and organization perspectives, InfoAs that are static and dynamic, and binding InfoAs to the CIMIA program.

Chapter Summary

This chapter has sought to uncover the subjective nature of qualitative measures for human behavior quantification and develop commonalities among various public and government sector methodologies for adaptation to the IAV model. An examination of existing subjective methodologies identified commonalities that demonstrate the trustworthiness and defensibility the discipline processes within the respective discipline and these commonalities translate to proposed IAV methodology as a real possibility. The IAV model quantification of InfoAs is a multi-step process including: developing factors, scaling factors, aggregating factor values, aggregating across InfoA values, and binding InfoA value to mission impact alerts. The IAV model factors of accessibility, availability, confidentiality, contextual, essentiality, integrity, non-repudiation, substitution, and temporal with the application of a criticality scale may be able define a single standardized value InfoAs; resulting in the ability to compare differing InfoAs from separate organization and units. The further aggregation of separate InfoA value through the tactical, operational, and strategic domains provide critical cyber-battlespace awareness to decision makers.

V. Conclusions and Proposals

Chapter Overview

This chapter discusses the conclusions of the IAV methodology through the proposed CIMIA solutions, proposed IAV methodology, and proposed IAV implementation, and then addresses research limitations with future research areas.

Proposed CIMIA Solutions

The impetus for the IAV methodology is founded in the goals outlined by the CIMIA program, such as linking infrastructure to mission, near real-time incident notification, incident trend analysis, and predictive incident effect forecasting (Thiem 2005; Fortson 2007). Fortson brought CIMIA forward extensively with the development of the five phase mission impact assessment model. The independent, but collaborative, CIMIA model functions are: 1) Information Asset Identification (IAI) is the realization that an information asset exists and needs to be documented; 2) Information Asset-to-Mission Mapping (IAMM) is the process of documenting the internal and external connections of the information asset; 3) Information Asset Valuation (IAV) is the process of establishing a standardized and comparable information asset criticality value; 4) Damage Assessment (DA) is the presentation of cyber battlespace awareness with near real-time information asset status for decision makers to act upon, and 5) Damage-to-Mission Assessment/Impact Reporting (DMAIR), is the information asset historical archive for trend analysis and *what-if* scenario forecasting (Fortson 2007). A CIMIA program decision support tool may be able to bond the infrastructure-to-mission and the separate functions of communications-to-operations through single visual presentation for decision makers.

The IAV methodology is the CIMIA function that connects the other functions. The IAV methodology enables decision makers to determine if an identified InfoA merits further resources to maintain, monitor, and protect. The IAV methodology allows scoping InfoA mission mapping activity through determining the minimum and maximum number of connections; additionally, without the IAV methodology, mission mapping may result in analysis paralysis as all the connection possibilities are thoroughly researched. The core task for CIMIA is the DA providing effective assessment information to decision makers and the IAV methodology with a single InfoA value at the heart of providing this actionable visual information to decision makers. The IAV methodology, again with a single InfoA value that enables comparison across the spectrum of different InfoAs, enables trend analysis and future mission impact forecasting. Trend analysis benefits from the ability of reviewing InfoAs over time to determine where costs could be saved through reduction or elimination of InfoAs; additionally, trend analysis benefits from identifying those InfoAs that merit more investment to assist in mission success. One of the potentially more powerful IAV methodology functions will be a *what-if* forecasting capability which allows planners to visually identify those InfoAs with the greatest impact to mission success. The *what-if* capability may be utilized to add or remove InfoAs from a given plan to determine the mission impact prior to actual implementation. The ultimate goal for the IAV methodology is to provide foundational research solutions which may be implemented in the CIMIA program through a decision support tool utilized by decision makers.

Proposed IAV Methodology

The proposed IAV methodology covers the subjectivity of human behavior valuation, contributions of other disciplines, framework, and single InfoA value.

Value is a human behavior with quantitative measurement challenges but the IAV methodology proposes qualitative measurement with the understood subjectivity issues. Complete valuation of an InfoA including the intrinsic and intangible aspects pose major problems for current physical-based valuation methods. The significant growth of InfoAs throughout the cyber environment enables mission accomplishment but the physical methods need to catch up to the growth. The IAV methodology credibility rests with the naturally subjective qualitative measures and how these are validated. The reviewed discipline processes demonstrate a defensible methodology to be a methodology where practices have been validated and accepted by the discipline utilizing the methodology. Decision makers whom need this critical InfoA value from the DA function must be able to rely upon the underlying methodology; moreover, this methodology must be as near a fact-based methodology of value estimation as may be developed. Without a defensible methodology, decision makers will not have trust in the valuation process. The result may be for decision makers to rely on personal estimations based on their own beliefs and not the established documented valuation estimations.

The IAV methodology proposes that the term *information asset*, or InfoA, is the convergence of information tangibles, information intangibles, and information flow to materialize as a functional entity that enhances the mission capability through physical and intrinsic contribution. A common definition is the starting point for compatible interaction among the users of CIMIA and specifically users of the IAV methodology in reference to InfoA discussion.

Contributing Disciplines

The foundation of initial investigation into the IAV methodology is discovery research where analysis of other disciplines may provide answers; and, this research examined the three disciplines of accounting, legal, and military. The contribution of these long standing disciplines and processes revealed methodological commonalities of pre-planning, documentation, qualitative measure categories (QMC), and subject matter expert (SME). It is from these adaptation criteria that each discipline recognizes their processes as subjective, yet trusted, and result in a defensible methodology. A discipline accepting the results of a process methodology, as demonstrated by the reviewed disciplines, establishes the defensibility of the methodology.

Utilizing these same adaptation criteria, the IAV methodology research provides pre-planning, documentation, and QMC. The IAV methodology research has examined InfoA valuation, which is just one form of forethought about the valuation topic area; certainly, future research will continue to contribute to the area of pre-planning. The development of this research is the beginning of the documentation process. This IAV methodology research has identified nine potential QMC valuation factors that are utilized to calculate an overall InfoA value. IAV methodology research has identified the SME as those individuals with the experience and knowledge whom are currently bridging the infrastructure-to-mission gap and bonding the separate functional areas of communications-to-operations. It is from these long standing discipline processes making use of the adaptation criteria that will enable the IAV methodology to be subjective, but credible, methodology.

Framework

The IAV framework builds from the pre-cursor, or sequential, activities of InfoA identification and mission mapping to development of a single InfoA value. The SME applies and aggregates InfoA factors to arrive at a single value. The IAV framework factors for InfoA value are: 1) Accessibility, cannot logically get to the InfoA; 2) Availability, can access but cannot use the InfoA; 3) Confidentiality, information communicated should be kept from exposure traversing the InfoA; 4) Contextual, specific situation or circumstances compel importance of the InfoA; 5) Essentiality, indispensable facilitator for executing the mission with the InfoA; 6) Integrity, information communicated is free from flaws though traversing the InfoA; 7) Non-repudiation, information communicated is actually from originator though traversing the InfoA; 8) Substitutability, existence of an alternate InfoA; and 9) Temporal, the effect time has on the effectiveness of the InfoA to execute the mission. The commonly utilized Likert scale is utilized by the SME to measure the level of importance each factor contributes to the overall value, and the scale levels are: 1 – Non-Critical Impact, 2 – Low Impact, 3 – Moderate Impact, 4 – High Impact, 5 – Critical Impact. The InfoA factor value mixture is the factors with applied scale, utilizing an averaging calculation establishes the single InfoA.

The factor scale serves three purposes: 1) it is the scale for measuring each individual factor, 2), it is the scale for measuring the overall InfoA value calculated, and 3) it is the scale that matches up to the CIMIA criticality alerts. The single InfoA value is immediately recognizable by decision makers as the criticality of the InfoA to the mission impact. Having this one scale serve all three purposes bind the IAV model to the CIMIA model.

The three domains of tactical, operational, and strategic utilize the IAV framework to establish InfoA value for prioritization efforts. At the initial tactical level, the SME attributes each factor with a value from the scale which calculates to a single InfoA value. The tactical level may have more than one InfoA. Once each InfoA has an established value, a prioritization is required to determine which InfoA, or InfoAs, are most vital to mission accomplishment. The single InfoA value enable the tactical level to compare these differing InfoA based on the same measurement standards for prioritizing the most important InfoA. The operational level receives InfoA values from the number of tactical level entities and must also prioritize these many InfoA values. The IAV framework enables the operational level to utilize the same prioritization procedure as the tactical. Likewise, as the many InfoA values input to the strategic level, the IAV framework enables prioritizing. It is the single, comparable InfoA values of the IAV methodology which enables the tactical, operational, and strategic domains to prioritize the multitude of InfoAs.

Single Comparable InfoA Value

The IAV methodology establishes a single InfoA value which serves the purpose of comparison and decision maker ease of use. Establishing a single InfoA value enables decision makers to compare the many differing InfoAs. In example, InfoA 1 may be an aircraft intelligence system and InfoA 2 may be a computer database system, but the use of similar IAV framework measurement criteria allows these two different InfoAs to be compared based on value to the mission. Decision makers would benefit from having a single, recognizable, reference value for each InfoA. This single recognizable reference value for each InfoA should enable decision makers to quickly and easily understand the importance of relationship of this InfoA to the mission.

Proposed IAV Implementation

The IAV methodology would benefit, as well as provide benefit, through implementation in well defined work centers at the tactical and operational levels. Some examples of well defined work centers are: Combined Air Operations Center, Joint Air Operations Center (JAOC), Air Operations Center (AOC), Battle Staff, and Command Post (CP). The smaller work centers have the best chance of maintaining a nimble and effective IAV methodology growth in supporting decision makers, planners, and the overall mission.

Limitations/Future Research

The most appropriate method for transferring the limitations and future research of this thesis is through expansion of the CIMIA tool functionalities (IAI, IAMM, IAV, DA, and DMAIR) through the eyes of a planner. A planner may be either deliberate as a strategic and operational planner with an operational mission plan or proactive/reactive as a tactical planner with an immediate surveillance air tasking order.

The first CIMIA phase is information asset identification, or the IAI, and is the comprehension that an InfoA actually exists (Fortson 2007). There is an IAV methodology research limitation in that it is difficult to match the IAV methodology to IAI without a working or absolute understanding of IAI. An area of research that should be undertaken to understand, and scope, is the complexity of IAI in reference to manual human requirements and computer automation of this function. Ultimately, identification of an InfoA is a human decision. In a manual process the human planner will identify an InfoA through manual inputs to CIMIA. Through the automation of IAMM functionality, discussed next, where the InfoA is automatically presented to the planner, the human planner will still need to confirm the validity of that InfoA. Various reasons exist for a planner to reject a pre-identified InfoA with one reason being an InfoA that falls out of individual or organizational perspective of mission necessity.

The second CIMIA phase is information asset mission mapping, or the IAMM, and is the process of documenting the internal and external connections, or linkages, of the identified InfoA (Fortson 2007). From this researcher's perspective, IAMM is one of the more difficult parts of CIMIA that needs to be researched and scoped. Many network mapping software tools exist to map networks, servers, and data, and presumably IAMM will be automated to present human planners with potential InfoAs identified in the IAI functionality of CIMIA. In addition to the human planner input to guide the mapping process, hopefully, human planners will be able to force the mapping as necessary where the automation is not capable of connecting the linkage. Similar to IAI, there is an IAV methodology research limitation in that it is difficult to match the IAV methodology to IAMM without a working or absolute understanding of IAMM.

The third CIMIA phase, IAV, is perhaps, the function which connects the other phases together. This research into IAV methodology seeks to establish a valuation methodology for InfoAs that planners may trust and have faith in during the decision making process. The IAV methodology puts the IAI and IAMM functions to work while providing vital InfoA status to the DA and DMAIR functions.

This thesis paper's proposed IAV methodology solution, or some variant, will require a *Joint* solution that is capable of serving beyond the DoD to a more broad government service on the whole for national security. Future IAV methodology research into other Services (Army, Navy, Marine, and Coast Guard), government agencies (IRS, NSA, etc.), and public sector would be a significant contribution to the InfoA valuation research.

A limitation of the IAV research, and an area for future research, is the ability to locate and survey the personnel who currently bridge the communications and operations disconnect. A survey would be a vital tool for validating the utility of the IAV methodology and the IAV framework valuation factors and factor scale. Based on this initial research an example survey was constructed, see Appendix B (Rehg 2007). Locations such as Air Operations Centers (AOC), Combined Air Operation Centers (CAOC), Joint Air Operations Centers (JAOC) and the newly introduced Cyber

Command may be readily filled with these knowledgeable personnel. Once located, these knowledgeable personnel will be instrumental in validating the IAV model factors as well as developing refined factor consensus through a Delphi study. The planners will have the cross-community knowledge, communications-to-operations, making them capable of deciding the InfoA factor value mixture when establishing an overall organizational InfoA value. As this research has exposed the scope and limitations of IAV methodology, further research will be necessary to move the IAV methodology forward.

The fourth CIMIA phase is damage assessment, or the DA, and is the presentation of cyber battlespace awareness with near real-time InfoA status (Fortson 2007). The core of this function is the presentation of the InfoA status to the planner and needs to take into account the differing possible perspectives; moreover, the goal should be to provide the best possible presentation that works with the thought processes of the planner. In the end, the IAV model must integrate with the planner's working and thought processes to achieve maximum decision making effect with minimum time loss.

The last CIMIA phase is the damage-to-mission assessment and impact reporting, or the DMAIR, and is the historical archive for trend analysis and *what-if* scenario forecasting (Fortson 2007). Where the DA was looking at the present, DMAIR is really two separate functions looking at the past and future. As CIMIA performs, over time, historical data will develop that will enable a trend analysis of the InfoA values and the resulting impact on the mission. A future area of IAV methodology research is how to store the current InfoA value such that timeless retrieval and relevant display are possible. The *what-if* scenario development functionality, through the manipulation of InfoA in a degraded, failure, or battle eliminated context, will enable planners to shape the mission effectiveness over a given period of time prior to execution of the plan. The IAV methodology would improve with further research into the effect of time on the dynamic nature of the IAV methodology.

Chapter Summary

This chapter discusses the conclusions of the IAV methodology through the proposed CIMIA solutions, proposed IAV methodology, and proposed IAV implementation, and then addresses research limitations with future research areas. The IAV methodology research attempts to assist the AF and DoD with an automated DSS tool to provide a better understanding of the relationship between communications infrastructure and operations mission impact. This research has been conducted under the mentorship, and benefit of, the Air Force Research Laboratory (AFRL) CIMIA program. The IAV methodology seeks to define the term information asset (InfoA) as the convergence of information tangibles, information intangibles, and information flow to materialize as a functional entity that enhances the mission capability. The IAV model research attempts to quantify the InfoA through attributing factors with assigned weights for calculation of an overall value. IAV research examines existing non-military and military valuation methodologies for adaptability to the IAV model. The intention of this work is the development of foundational methodologies supporting the creation of an automated CIMIA DSS tool to provide near real time cyber environmental awareness for effective decision making prior to, during, and post cyber incident situations.

Appendix A: Intangible Assets Classes (FASB141 2001:28)

1) Marketing-related intangible assets
   a) Trademarks, trade names
   b) Service marks, collective marks, certification marks
   c) Trade dress (unique color, shape, or package design)
   d) Newspaper mastheads
   e) Internet domain names
   f) Non-competition agreements
2) Customer-related intangible assets
   a) Customer lists
   b) Order or production backlog
   c) Customer contracts and related customer relationships
   d) Non-contractual customer relationships
3) Artistic-related intangible assets
   a) Plays, operas, ballets
   b) Books, magazines, newspapers, other literary works
   c) Musical works such as compositions, song lyrics, advertising jingles
4) Pictures, photographs
   a) Video and audiovisual material, including motion pictures, music videos, television programs
5) Contract-based intangible assets
   a) Licensing, royalty, standstill agreements
   b) Advertising, construction, management, service or supply contracts
   c) Lease agreements
   d) Construction permits
   e) Franchise agreements
6) Operating and broadcast rights
   a) Use rights such as drilling, water, air, mineral, timber cutting, and route authorities
   b) Servicing contracts such as mortgage servicing contracts
   c) Employment contracts
7) Technology-based intangible assets
   a) Patented technology
   b) Computer software and mask works
   c) Unpatented technology
   d) Databases, including title plants
   e) Trade secrets, such as secret formulas, processes, recipes

Appendix B: IAV Example Survey (Rehg 2007)

I. Create your code.

Understanding the sensitivity of maintaining your privacy, and anonymity, a disposable code will be generated as a marker for this survey. The code will be used to link this survey to your previous or future surveys in this study.

Your name and/or demographic information are NOT required on the survey for any purpose. Please do not provide such information.

Your code consists of the first 2 letters of your mother and father's first names, and the numerical month and day of your birthday. An example is below:

Example:	
	Mother's first name: Jane
	Father's first name: John
	Birth month and day: January 1st (01/01)
Your Code would be: jajo0101	

After developing your unique code, write it in the boxes below, and continue to the next page.

First two letters of Mother's first name		First two letters of Father's first name		Your Birth Month and Day (do not include the year)			

PRIVACY NOTICE

In accordance with AFI 37-132, Paragraph 3.2, the following information is provided as required by the 1974 Privacy Act

Authority: 10 U.S.C. 8012, Secretary of the Air Force; powers and duties; delegation by; implemented by AFI 36-2601, Air Force Personnel Survey Program.
Purpose: To obtain information regarding the attitudes and knowledge of personnel enrolled in the fundamentals of acquisition management course, and evaluate the effectiveness of acquisition program manager education and training.
Routine Use: A final report will be provided to AFIT/LS. No analysis of individual responses will be conducted and only members of the research team will be permitted access to the raw data. Reports summarizing trends in large groups of people may be published.
Participation: Participation is VOLUNTARY. No adverse action will be taken against any member who does not participate in this survey or who does not complete any part of the survey.

II. Overall Information Asset Valuation (IAV) methodology. Using the scale below, indicate the extent that you agree with the following statements. Use the blank space at the beginning of each statement to record the number of your choice.

1 Strongly Disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly Agree

___ 1. I am able to understand the concept and practical application of the IAV model.

___ 2. I understand the definition of an information asset.

___ 3. I believe the IAV model will be helpful in the execution of my duties.

___ 4. I believe the IAV model is unusable in the execution of my duties.

___ 5. My performance may be improved with the IAV model or similar device.

___ 6. My duties require me to determine the mission impact of cyber incidents.

___ 7. I am part of a team that determines the mission impact of cyber incidents.

___ 8. I have no need of knowing mission impact resulting from cyber incidents.

___ 9. I (my team) frequently scramble to determine the impact of cyber incidents.

___ 10. I (my team) frequently make estimation in determining the impact of cyber incidents.

II. This portion of the survey contains questions related to the qualitative information asset factors of the Information Asset Valuation (IAV) methodology. Using the scale below, indicate the extent that you agree with the following statements. Use the blank space at the beginning of each statement to record the number of your choice.

1 Never	2 Seldom	3 Occasionally	4 Frequently	5 Almost Always

___ 11. I would use the factor "Accessibility" as characterized by the question, "how easily can I get use of this asset?"

___ 12. I would use the factor "Availability" as characterized by the questions, "how often can I get use of this asset?"

___ 13. I would use the factor "Confidentiality" as characterized by the question, "would exposure be detrimental?"

___ 14. I would use the factor "Contextual" as characterized by the questions, "who and how the asset is used?"

___ 15. I would use the factor "Essentiality" as characterized by the questions, "can I function without it?"

___ 16. I would use the factor "Integrity" as characterized by the question, "can the communicated information be corrupted?"

___ 17. I would use the factor "Non-repudiation" as characterized by the questions, "is this really the originator?"

___ 18. I would use the factor "Substitutability" characterized by the questions, "is there an alternative source?"

___ 19. I would use the factor "Temporal" as characterized by the questions, "how does the importance of the information change as a function of time?"

III. Information Asset Valuation (IAV) methodology factor scale. Using the scale below, indicate the extent that you agree with the following statements. Use the blank space at the beginning of each statement to record the number of your choice.

1	2	3	4	5	6	7
Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

___ 20. It is easy to understand how the factor scale is utilized.

___ 21. The factor scale is appropriate and flexible enough for my duties.

___ 22. My duties require a scale with more levels for greater specificity.

___ 23. The factor scale as an alert system of mission criticality will be easy to use.

___ 24. It is difficult to distinguish among the levels.

___ 25. My duties require a simpler factor scale.

Part IV. Work Experiences. Please look at the following duty titles/areas and rate those that apply to your current position. <u>If a duty title/area does not apply, there is no need to assign a number to it.</u>

1	2	3	4	5	6
Almost Never	Once in a while	Occasionally	Usually	Quite Often	Almost Always

Since arriving at your job, to what degree have you been involved with or worked with…

<u>I. AOC, CAOC, JAOC.</u>

Deal with cyber incidents ___
Analyze cyber incidents ___
Assign mission impact of incidents ___
Work cyber incidents for Operations ___
Work cyber incidents for Communications ___
Work cyber incidents for other ___

<u>II. Battle Staff, Command Post, Similar</u>

Deal with cyber incidents ___
Analyze cyber incidents ___
Assign mission impact of incidents ___
Work cyber incidents for Operations ___
Work cyber incidents for Communications ___
Work cyber incidents for other ___

58. Please write any comments below that you would like to provide about your AFFAM class and / or your work experiences (use additional paper if necessary):

<u>Thank you for taking the time to complete the survey</u>! Please put your survey into the pre-addressed return envelope and put it in official mail, or place it in a separate envelope and mail to:

CIMIA Project
AFIT/ENV
2950 Hobson Way
Wright-Patterson AFB, OH 45433

Appendix C: Glossary

ABA – American Bar Association
ABAJD – American Bar Association Judicial Division
AOC – Air Operations Center
AF – Air Force
AFRL – Air Force Research Laboratory
AFForm – Air Force form
AFI – Air Force Instruction
AFMAN – Air Force Manual
AFMCL - Air Force Master Capabilities List
AFNOSC – Air Force Network Operations and Security Center
AFPAM – Air Force Pamphlet
ARC – Archival Research Catalog
ASDT – Air Support Data Terminal
AUTL – Army Universal Task List
BCE – Base Civil Engineering
BCE-WOM – Base Civil Engineering Work Order Management
CAOC – Combined Air Operations Center
CAPM – Capital Asset Pricing Model or alternate Capital Asset Pricing Model
CCIR – Commander's Critical Information Requirement
CERCLA – Comprehensive Environmental Response Compensation and Liability Act of 1980
CDT – Central Dispatch Terminal
CIL – Critical Information Listing
CIP – Critical Information Program
CJCS – Chairman Joint Chiefs of Staff
CJCSM – Chairman Joint Chiefs of Staff Manual
CNSI – Classified National Security Information
DA – Damage Assessment
DHS – Department of Homeland Security
DMAIR – Damage-to-Mission assessment/Impact Reporting
DoD – Department of Defense
DoDD – Department of Defense Directive
DSS – Decision Support Software
EES – Enlisted Evaluation System
EO – Executive Order
EPR – Enlisted Performance Reporting
EPS – Engineering Performance Standards
FBA – Federal Bar Association
FASB – Financial Accounting Standards Board
FMV – Fair Market Value
FV – Fair Value
GAAP – Generally Accepted Accounting Principles

GASB – Government Accounting Standards Board
HSAS – Homeland Security Advisory System
HTTM – Helpdesk Trouble Ticket Management
IGBV – International Glossary of Business Valuation
InfoA – Information Asset
IAI – Information Asset Identification
IAMM – Information Asset Mission Mapping
IAV – Information Asset Valuation
IP – Intellectual Property
IRS – Internal Revenue Service
IT – Internet Technology
JAOC – Joint Air Operations Center
JCS – Joint Chiefs of Staff
JFC – Joint Force Commander
LEO – Law Enforcement Officer
MAJCOM – Major Command (United States Air Force)
MDT – Mobile Datalink Terminal
NARA – National Archives and Records Administration
NCC – Network Control Center
NOSC – Network Operations and Security Center
NSA – National Security Agency
OPSEC –Operational Security
ORM – Operational Risk Management
OWG – Operations Working Group
PFW – Performance Feedback Worksheet
PME – Professional Military Education
PMO – Program Management Office
QMC – Qualitative Measurement Categories
R&D – Research and Development
R&DV – Research and Development Value
SCDb – State Criminal Database
SCL – Sales Contact Listing
SDT – State Dispatch Terminal
SME – Subject Matter Expert
TR – Treasury Regulation
UCC – Uniform Commercial Code
UJTL – Universal Joint Task List
UNTL – Universal Naval Task List
USC – United States Code
U.S.C. – United States Code
USPTO – United States Patent and Trademark Office
VDb – Vehicle Database
WACC – Weighted Average Cost of Capital

Bibliography

ABA. (2007). "The American Bar Association (ABA)." Retrieved September 20th, 2007, from www.abanet.org.

ABAJD. (2007). "The American Bar Association (ABA) Judicial Division." Retrieved September 20th, 2007, from http://www.abanet.org/jd/.

AFForm910 (2007). Air Force Form (AF Form) 910 Enlisted Performance Report (AB thru TSgt), Washington: HQ USAF**:** 2.

AFForm911 (2007). Air Force Form (AF Form) 911 Enlisted Performance Report (MSgt thru CMSgt), Washington: HQ USAF**:** 2.

AFForm931 (2007). Air Force Form (AF Form) 931 Performance Feedback Worksheet (AB thru TSgt), Washington: HQ USAF**:** 2.

AFForm932 (2007). Air Force Form (AF Form) 932 Performance Feedback Worksheet (MSgt thru CMSgt), Washington: HQ USAF**:** 2.

AFI10-701 (2007). Air Force Instruction (AFI) 10-701 Operations Security (OPSEC), Washington: HQ USAF**:** 38.

AFI21-116 (2005). Air Force Instruction (AFI) 21-116 Maintenance Management of Communications-Electronics, Washington: HQ USAF**:** 210.

AFI32-1001 (2005). Air Force Instruction (AFI) 32-1001: Civil Engineering Operations Management, Washington: HQ USAF**:** 10.

AFI33-115V1 (2006). Air Force Instruction (AFI) 33-115 Volume 1: Communications and Information Network Operations (NETOPS), Washington: HQ USAF**:** 84.

AFI36-2406 (2005). Air Force Instruction (AFI) 36-2406 Personnel Officer and Enlisted Evaluation Systems (EES), Washington: HQ USAF**:** 160.

AFI90-901 (2001). Air Force Instruction (AFI) 90-901: Operational Risk Management, Washington: HQ USAF**:** 7.

AFPAM90-902 (2000). Operational Risk Management (ORM) Guidelines and Tools, Washington: HQ USAF**:** 105.

AICPA. (2007). "The American Institute of Certified Public Accountants (AICPA)." Retrieved September 20th, 2007, from www.acipa.com.

Andreissen, D. (2004). Making Sense of Intellectual Capital: Designing a Method for the Valuation of Intangibles. Burlington MA, Elsevier Butterworth-Heinermann.

Berry, J. (2004). Tangible Strategies for Intangible Assets: How to Manage and Measure Your Company's Brand, Patents, Intellectual Property, and Other Sources of Value. New York NY, McGraw-Hill.

Bossaerts, P. (2001). "Experiments with financial markets: Implications for asset pricing theory." American Economist **45**(1): 17-32.

CA1976 (1976). Copyright Act of 1976. United States, United States Congress, Library of Congress.

CJCSM3500.04D (2005). Universal Joint Task List (UJTL), Washington: Joint Staff.

Cooper, B. L., H. J. Watson, et al. (2000). "Data warehousing supports corporate strategy at First American Corporation." MIS Quarterly **24**(4): 547-567.

Davenport, T. H. and L. Prusak (2000). Working Knowledge: How Organizations Manage What They Know. Boston, MA, Havard Business School Press.

DHS. (2008). "Homeland Security Advisory System (HSAS)." Retrieved August 16, 2007, from http://www.dhs.gov/xinfoshare/programs/Copy_of_press_release_0046.shtm.

DMCA (1998). Digital Millenium Copyright Act of 1998 United States, United States Congress, The Library of Congress.

Drucker, P. F. (1993). Post-Capitalist Society. New York, NY, HarperCollins

EO13292 (2003). Executive Order (EO) 13292 - Further Amendment to Executive Order 12958, as Amended, Classified National Security Information. National Archived and Records Administration, Washington: Federal Register Vol. 68, No. 60.

FASB141 (2001). Statement of Financial Accounting Standards No. 141, Financial Accounting Standards Board (FASB), *Business Combinations*. Norwalk CT, Statement of Financial Accounting Standards No. 141, Financial Accounting Standards Board (FASB) of the Financial Accounting Foundation.

FASB142 (2001). Statement of Financial Accounting Standards No. 142, Financial Accounting Standards Board (FASB), *Goodwill and Other Intangible Assets*. Norwalk CT, Financial Accounting Standards Board (FASB) of the Financial Accounting Foundation.

FBA. (2007). "Federal Bar Association (FBA)." Retrieved September 20th, 2007, from www.fedbar.org.

FECA (2005). Family Entertainment and Copyright Act of 2005. United States United States Congress, The Library of Congress.

Fortson, L. W., Jr. (2007). Towards the Development of a Defensive Cyber Damage and Mission Impact Methodology. Graduate School of Engineering and Management. Wright-Patterson AFB OH, Air Force Institute of Technology (AFIT)**:** 255.

GASB. (2007). "Governmental Accounting Standards Board (GASB)." Retrieved September 20th, 2007, from www.gasb.org.

Gray, C. F. and E. W. Larson (2003). Project Management: The Managerial Process. New York, NY, McGraw-Hill

Hawkins, D. E. and S. Rajagopal (2005). Sun Tzu and the Project Battleground: Creating Project Strategy From 'The Art of War'. New York, NY, Palgrave Macmillan.

Hitchner, J. R. (2003). Financial Valuation: Applications and Models. New York, J. Wiley.

Horony, M. D. (1999). Information system incidents: the development of a damage assessment model. Graduate School of Engineering and Management. Wright-Patterson AFB OH, Air Force Institute of Technology (AFIT)**:** 66.

IGBV. (2007). "International Glossary of Business Valuation (IGBV) Terms." from http://bvfls.aicpa.org/Resources/Laws+Rules+Standards+and+Other+Related+Guidance/Other+Guidance/International+Glossary+of+Business+Valuation+Terms.htm.

King, A. M. (2002). Valuation What Assets are Really Worth. Hoboken, NJ, Wiley.

King, A. M. (2006). Fair Value for Financial Reporting Meeting the New FASB Requirements. Hoboken NJ, Wiley.

Kopp, R. J. and V. K. Smith (1993). Valuing Natural Assets: The Economics of Natural Resource Damage Assessment. Washington DC, Resources for the Future.

Larribau, T. (2007). "A New Form of Air Warfare." Air and Space Power **XXI, No. 3**(Fall): 131.

Lee, V. A. and P. J. Bridgen (2002). The Natural Resource Damage Assessment Deskbook: A Legal and Technical Analysis. Washington DC, Environmental Law Institute.

Leedy, P. D. and J. E. Ormrod (2005). Practical Research: Planning and Design. Upper Saddle River, NJ, Person Education.

Madden, M. S. (1992). Toxic Torst Deskbook. Chelsea MI, Lewis Publishers.

Meredith, J. R. and S. J. Mantel (2006). Project Management: A Managerial Approach. Hoboken, NJ, Wiley.

Miller, D. (2005). Black Hat: Physical Device Security. Rockland, MA, Syngress.

Moore, P. G. (1969). Principles of Statistical Techniques. Cambridge, London, Cambridge University Press.

Nichols, R. K., D. J. Ryan, et al. (2000). Defending Your Digital Assets Against Hackers, Crackers, Spies and Thieves, McGraw-Hill.

Patton, M. Q. (1990). Qualitative Evaluation and Research Methods. Newbury Park, CA, Sage.

Poltorak, A. I. and P. J. Lerner (2002). Essentials of Intellectual Property. New York, Wiley.

Porter, J. H. and R. J. Hamm (1986). Statistics: Applications for the Behavioral Sciences. Belmont, CA, Brooks/Cole.

Rehg, M. T. (2007). Air Force Fundamentals of Acquisition Management Course: Course Effectiveness Survey. U. S. A. Force, Air Force Institute of Technology (AFIT)**:** 9.

Roche, J. (2005). The Value of Nothing: Mastering Business Valuations. London UK, LES50NS Financial

Rockman, H. B. (2004). Intellectual Property Law for Engineers and Scientists. Hoboken NJ, Wiley.

Shaw, A. K. (2007). A Model For Performing Mission Impact Analysis of Network Outages. Department of Electrical and Computer Engineering. Wright-Patterson AFB OH, Air Force Institute of Technology (AFIT)**:** 82.

Sirkin, R. M. (2006). Statistics for the Social Sciences. Thousand Oaks, CA, Sage.

Stevens, M. M. (2007). "Interactive Textbook on Clinical Symptom Research." from http://painconsortium.nih.gov/symptomresearch/chapter_7/sec2/cmss2pg1.htm.

Strauss, A. and J. Corbin (1990). Basics of Qualitative Research: Ground Theory Procedures and Techniques. Newbury Park, CA, Sage.

Thiem, L. S. (2005). A Study to Determine Damage Assessment Methods or Models on Air Force Networks Graduate School of Engineering and Management. Wright-Patterson AFB OH, Air Force Institute of Technology (AFIT)**:** 63.

TR. (2007). "United States Department of Treasury Regulation 20.2031-1." Retrieved August 9th, 2007, from http://www.taxalmanac.org/index.php/Treasury_Regulations,_Subchapter_B,_Part_20_-_Index.

UCC (2004). Uniform Commercial Code (UCC). (Retrieved September 1, 2007 from Cornell University Legal Information Institute), The American Law Institute and the National Conference of Commissioners on Uniform State Laws, Article 9 Secured Transactions, Part 1 General Provisions, Subpart 1 Short Title, Definitions, and General Concepts, Definitions and Index of Definitions, UCC§9-102.

USC15 (2000). United States Code (USC) Title 15 Commerce and Trade, Chapter 22 Trademarks, Subchapter III General Provisions. United States, Office of the Law Revision Counsel of the U.S. House of Representatives. USC15§1117 Trademarks.

USC17 (2000). United States Code (USC) Title 17 Copyrights, Chapter 5 Copyright Infringement and Remedies. United States, Office of the Law Revision Counsel of the U.S. House of Representatives. USC17§504 Copyrights.

USC18§1831-9 (1996). United States Code (USC) Title 18 Crimes and Criminal Procedure, Part I Crimes, Chapter 90 Protection of Trade Secrets, Office of the Law Revision Counsel of the U.S. House of Representatives. USC18§1831-9 Protection of Trade Secrets.

USC35§271 (2000). United States Code (USC) Title 35 Patents, Part III Patents and Protection of Patent Rights, Chapter 28 Infringement of Patents. United States, Office of the Law Revision Counsel of the U.S. House of Representatives. USC35§271 Patents Infringement.

USC35§284 (2000). United States Code (USC) Title 35 Patents, Part III Patents and Protection of Patent Rights, Chapter 29 Remedies for Infringement of Patent and Other Actions. United States, Office of the Law Revision Counsel of the U.S. House of Representatives. USC35§284 Patents Damages.

USPTO. (2005). "United States Patent and Trademark Office (USPTO): General Information Concerning Patents and Glossary." Retrieved September 1, 2007, from http://www.uspto.gov/web/offices/pac/doc/general/index.html#patent
http://www.uspto.gov/main/glossary/index.html#p.

Wong-Jiru, A. (2006). Graph Theoretical Analysis of Network Centric Operations Using Multi-layer Models. Department of Aeronautics and Astronautics. Wright-Patterson AFB OH, Air Force Institute of Technology (AFIT) 81.

Yin, R. K. (2003). Case Study Research: Design and Methods. Thousands Oaks, CA, Sage.

Vita

MSgt Denzil L. Hellesen enlisted in the United States Air Force in 1991. While stationed at Ramstein AB, Germany, he completed his undergraduate studies at Park University of Parkville, Missouri. His 2003graduatation from Park University earned him a Bachelor of Science degree with a high honors in Management and Accounting. He received training from the 81st Communications Training Squadron, Keesler Air Force Base, Mississippi, in August 1996.

His first communications assignment was at Whiteman Air Force Base, Missouri. While there, he worked as a Telecommunications Operations Center supervisor at the 509th Communications Squadron, Network Control Center. From the Air Force Institute of Technology, his post-graduation assignment is to the Air Force Communications Agency, Scott Air Force Base, Illinois.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 074-0188

The public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of the collection of information, including suggestions for reducing this burden to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to an penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.
PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From – To)*
27-03-2008	Master's Thesis	September 2006 – March 2008

4. TITLE
An Analysis of Information Asset Valuation (IAV) Quantification Methodology for Application with Cyber Information Mission Impact Assessment (CIMIA)

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
Denzil L. Hellesen,
Master Sergeant, USAF

5d. PROJECT NUMBER
JON #08-123

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAMES(S) AND ADDRESS(S)
Air Force Institute of Technology
Graduate School of Engineering and Management (AFIT/EN)
2950 Hobson Way, Building 640
WPAFB OH 45433-7765

8. PERFORMING ORGANIZATION REPORT NUMBER
AFIT/GIR/ENV/08-M11

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Air Force Research Laboratory
Capt. Larry W. Fortson, Cyber Programs Manager
Human Effectiveness Directorate (AFRL/RHX)
2255 H Street, Bldg 248, WPAFB OH 45433 (937) 904-5737

10. SPONSOR/MONITOR'S ACRONYM(S)
AFRL/RHX

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED.

13. SUPPLEMENTARY NOTES

14. ABSTRACT
The purpose of this research is to develop a standardized Information Asset Valuation (IAV) methodology. The IAV methodology proposes that accurate valuation for an Information Asset (InfoA) is the convergence of information tangible, intangible, and flow attributes to form a functional entity that enhances mission capability. The IAV model attempts to quantify an InfoA to a single value through the summation of weighted criteria. Standardizing the InfoA value criteria will enable decision makers to comparatively analyze dissimilar InfoAs across the tactical, operational, and strategic domains. This research develops the IAV methodology through a review of existing military and non-military valuation methodologies. IAV provides the Air Force (AF) and Department of Defense (DoD) with a standardized methodology that may be utilized enterprise wide when conducting risk and damage assessment and risk management. The IAV methodology is one of the key functions necessary for the Cyber Incident Mission Impact Assessment (CIMIA) program to operationalize a scalable, semi-automated Decision Support System (DSS) tool. The CIMIA DSS intends to provide decision makers with near real-time cyber awareness prior to, during, and post cyber incident situations through documentation of relationships, interdependencies, and criticalities among information assets, the communications infrastructure, and the operations mission impact.

15. SUBJECT TERMS
Information Valuation, Information Asset, Asset, Information Tangible, Information Intangibles, Information Flow, Subjective Assessment, Qualitative, Cyber

16. SECURITY CLASSIFICATION OF: a. REPORT	b. ABSTRACT	c. THIS PAGE	17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON / 19b. TELEPHONE NUMBER *(Include area code)*
U	U	U	U	134	Michael R. Grimaila, PhD, CIV, USAF (937) 255-3636, ext 4800 (Michael.Grimaila@afit.edu)

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39-18