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Title:

Information Age Assessment Applied to Anti-Terrorism/Force Protection

Topic:

Assessment Tool & Metrics

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Abstract

The Information Age Framework for Assessment, inspired by John Zachman, posits a new way to account for the value of information-intensive investments by focusing not just on the current process or product but on the increased ability of the organization to perform its mission and adapt to a changing environment.

The "Warfighter's Associate" is a future concept of a robotic assistant to the warfighter that would leverage the advantages of robotics to improve the effectiveness of the warfighter – much as a police dog improves the performance of the policeman acting alone. This capability will be shown to powerfully and positively affect the performance of a war fighting organization.

This paper addresses how a Warfighter's Associate would provide an Anti-Terrorism/Force Protection (AT/FP) capability and how the Associate should be appropriately assessed to understand its true benefit in a networked environment (like FORCEnet for the US Navy, or the Global Information Grid (GIG) for the US DoD).

The Problem

To provide an example of how the Information Age Framework for Assessment could be used to assess a capability. To demonstrate how the value of net-centric investment can be assessed.

The concept of a "Warfighter's Associate" from H.R. (Bart) Everett, et al, is used[1] as an example capability. The Associate is a long term concept of a robotic assistant that provides useful functionality with minimal command and control overhead.

The Approach

First, the Zachman Enterprise Architecture Framework will be briefly introduced to familiarize the reader with the "six primitive interrogatories" and the idea of an enterprise –wide conceptual model.

Second, the Information Age Framework for Assessment will be presented. This is a useful framework for developing assessment questions and capturing the contribution of network-centric components.

Third the Information Age Framework for Assessment's metrics will be related to six primitive interrogatories. This table presents a guide that a team can use to develop assessment questions since it indicates which relationships in an enterprise–wide conceptual model correlate with which metrics.

Fourth, having established the Information Age Framework for Assessment, the concept of a Warfighter's Associate is introduced. The "Warfighter's Associate" is a future concept of a robotic assistant to the warfighter that would leverage the advantages of robotics to improve the effectiveness of the warfighter – much as a police dog improves the performance of the policeman acting alone.

Finally, the use of a Warfighter's Associate is described, and suggested Information Age Framework for Assessment metrics are given.

Introduction to the Zachman Enterprise Architecture Framework

John Zachman spent his career at IBM leading large projects. In a bid to understand IT projects, and resolve problems related to coordination and comprehension that seemed endemic, he investigated how other professions build complex things (skyscrapers and ships specifically). From his investigation he was able to generalize the interaction of all these people into a simple schema. The people fit into a few common roles (planner, owner, designer, builder, and subcontractor). The columns are based on the "six primitive interrogatories" (who, what, when, where, why, and how).

[1] Everett, H.R., and E. Pacis, "Towards a Warfighter's Associate: Eliminating the Operator Control Unit," SPIE Proc. 5609: Mobile Robots XVII, Philadelphia, PA, October 26-28, 2004.

The framework is a powerful mechanism for resolving conflicts during project conception because each cell (role, interrogative pair) is unique. Uniqueness is very important precondition to successful requirements definition and requirements management. Uniqueness allows changes to be made without introducing conflicts that would otherwise arise from the same data variable's data value appearing in multiple locations and possibly holding multiple conflicting values. Uniqueness also allows efficient consistency checks which aid developing a complete set of requirements.

The order of the columns is not important.

The level of resolution and detail increases at lower rows. For example the Contextual and Conceptual level models could be lists or hierarchies. In a software-intensive enterprise the Logical level could be expressed as Unified Modeling Language (UML) models. (The graphic is available at zifa.com.)

	WHAT Data	HOW Function	WHERE Network	WHO People	WHEN Timing	WHY Motivation
Contextual Planner						
Conceptual Owner						
Logical Designer						
…						

Figure 1: Zachman Framework

Why Enterprise Architecture is Fundamental

The idea seems deceptively simple, intuitive even: use the six primitive interrogatives to describe your existing or proposed enterprise.

What, the Product Model
Every enterprise has a product whether it is a physical item or a service. In DoD C4ISR parlance this is data, whether it is intelligence, orders, tracks, geographic system information, or actionable information.

How, the Execution Model

The "what" does not just happen to appear. The "who", need a "how", to create the "what." In DoD C4ISR parlance this is an activity model – a functional decomposition of mission, task, and activities to achieve an objective.

Where, the Distribution Model
The "who," "what," and "how" occur at a location, a group of locations, or within a network; all these are aspects of the distribution model. In DoD C4ISR parlance this is captured at a very high level in operational concept graphics and frequently not considered much after that. This may reflect the fact that historically the logistics portion of DoD has not been as closely tied to C4ISR as the operational elements. Distribution is, however, as critical to DoD as it is to Wal-Mart, the world's most successful retailer.

Who, the People Model
People are indispensable. They are the workforce, the investors, the owners, and the customers. It is certainly a good idea to know who your "who" will be. In DoD C4ISR parlance this is often equivalent to command nodes.

When, the Temporal Model
Clearly all things take time, sometimes that is the critical factor between success and failure and other times it is not significant. The Temporal Model captures those instances when it is critical. In DoD C4ISR parlance this is captured in event trace or state transition diagrams.

Why, the Motivational Model
"Why" is perhaps the most crucial, political, difficult, and incendiary part of the primitive interrogatories The Motivational Model demands clarity. This is key source of conceptual integrity as described by Brooks in the famous classic "The Mythical Man-month."[2]

Enterprise Architecture is fundamental because these six interrogatories *exist* for your enterprise. The question is, "Do you know them?" Failure to manage these relationships will inevitably create incongruities in the organization. There will be functions that are not performed or performed by multiple entities, data that is not accessible to all necessary users, and so forth.

The Metrics Defined

John Zachman has found such widespread interest for his work in Enterprise Architecture not just because it is useful high-level schema for describing the classification of an organization's information. His work addresses the fundamental issues that are central to success in the Information Age.

Information Age

[2] Frederick Phillips Brooks. 1975. The **Mythical Manmonth** -- essays on software engineering, Reading, Massachusetts: Addison-Wesley.

Defense acquisition has changed significantly over the last 20 years, especially with regard to Information Technology. In the latter days of the Cold War, DoD was a significant player in IT and developed significant computational hardware to address its needs. Since then the exponential growth in commercially available computing power and the equally significant drop in price has radically changed the landscape. Not only has stand-alone computing power been revolutionized, but so has distributed computing, due to advances in networking and middleware.

Revolutionary new architectures are available today which are reshaping not just the world of commerce, but also government and the military.

This new Information Age world needs a new paradigm to assess the value of networked systems and organization level investments.

In the Industrial Age the measures of success were Better, Faster, and Cheaper. Before deciding whether to invest in a new mill or factory, the owner would consider those metrics when determining his return on investment. What goes without saying in this view of the world is that the product is the same, only Better, Faster, and Cheaper.

In the Information Age, where the network has replaced the steam engine as the primary organizing element, producing the same product Better, Faster, and Cheaper will result in a commodity. A commodity is a standardized item which typically does not command a premium, but rather trades at a price determined almost solely by supply and demand. Companies can, and do, make money in commodities, but it is generally a low-growth and low-margin business, where the market relentlessly demands efficiency.

The military equivalent of becoming a commodity in the Information Age would be still using carpet bombing to prepare the battlefield. The size of the bombs might have increased; the planes may become more efficient in delivering ordinance; the dynamic of warfare would not have changed. The enemy would be able to adapt, collateral damage would be severe, and the "yield" of the bombing campaign would only marginally improve.

Precision strike with rapid retargeting is perhaps the most publicized example of Information Age concepts applied to warfare. Is it Better, Faster, and Cheaper? Absolutely; but those three measures are inadequate to measure the value of Precision Strike, and are especially inadequate at identifying the contribution of C4ISR to enabling Precision Strike.

To identify the new ROI components for the Information Age, we return to one of the fathers of Enterprise Architecture, John Zachman. In his symposiums he has identified Integration, Alignment, and Flexibility as the Information Age ROI metrics.

The Information Age Framework for Assessment

The Information Age Framework for Assessment is given below:

1. The Industrial Age Metrics

   These metrics apply to a well defined product or process produced by a system as shown in Figure 2: Quality, Timeliness, and Efficiency of a System. The scope and nature of the system is determined relative to the product.

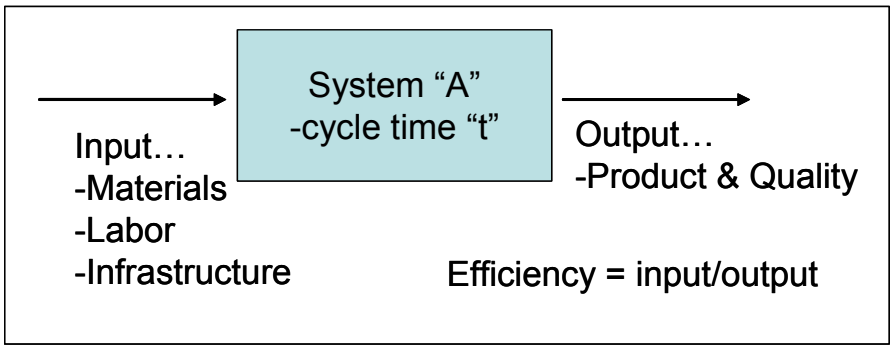

Figure 2: Quality, Timeliness, and Efficiency of a System

1.1. Quality ("Better"): Quality, especially in a manufacturing environment, is defined as the "absence of defects". For example, when the Lexus LS400 automobile was originally introduced, it established Lexus immediately as a manufacturer of high quality automobiles, in part, because the gaps between the doors and the body were smaller and more even than other cars at the time. Lexus had established an industry benchmark for body panel fit.

1.2. Timeliness ("Faster"): Timeliness is the time required to execute a step in a plan or process. The convention here is that faster is better. This could be the time to deliver an item or a service.

1.3. Efficiency ("Cheaper"): Efficiency is broadly defined as the ratio of output over input. Typically an investment can be justified based on efficiency if for a relatively small investment (increase in input) the increase in output is greater.

2. The Information Age Metrics

The metrics apply to a "system of systems" or enterprise that may exhibit emergent behavior and network effects. Emergent behavior is behavior that cannot be predicted from knowledge of the elements and interactions. This behavior is usually observed from a higher level and is the result of own limitations in complex systems analysis. Network effects derive from the integration of previously autonomous entities and the leverage that certain entities will achieve when they adapt to the networked environment. Integration, alignment, and flexibility are meaningful metrics for an enterprise as shown in Figure 3: Integration, Alignment, and Flexibility of an Enterprise. The scope and

nature of the system of systems is determined relative to the enterprise's mission or capability being considered.

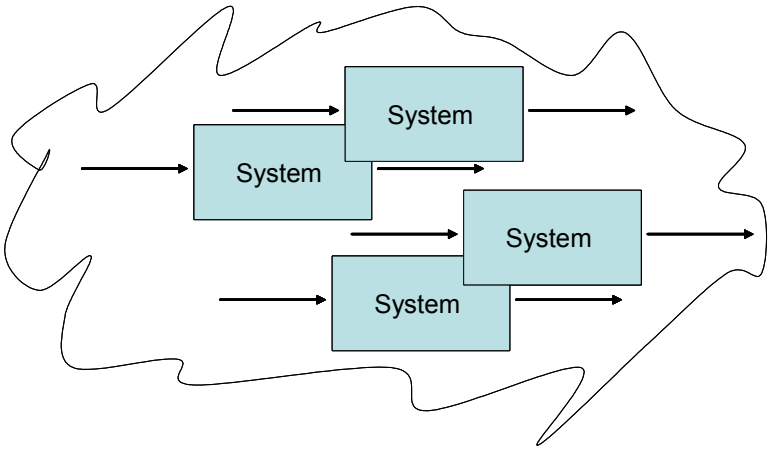

Figure 3: Integration, Alignment, and Flexibility of an Enterprise

2.1. Integration

2.1.1.1. Integration in Connectivity: Connectivity is the ability to exchange symbols between nodes (syntax). This level of integration allows nodes (an individual, an organization, or a system) to exchange symbols with another node.

2.1.1.2. Integration in Meaning: Meaning refers to when symbols are exchanged they convey the same content (semantics). This level of integration requires that connectivity be present and that the nodes have the same interpretation of the symbols.

2.1.1.3. Integration in Rules: Rules refer to when participants receive the same content, under the same conditions, and then they will take appropriate action (cognitive processes). This is the highest level of integration and requires that integration in connectivity and meaning are also present.

2.2. Alignment: Alignment is the extent to which an organization reflects the owner's intent.

2.3. Flexibility – Flexibility is the ability of the enterprise to change with a minimum of disruption in terms of cost, schedule, or function.

Enterprise Architecture Interrogatories vs. Information Age Framework

During the development of assessment strategies, certain patterns have emerged repeatedly when creating measures of effectiveness (MOEs). MOEs are developed to support the assessment of a critical operational issue (COI). The metrics that are actually

used to obtain the measurements fit within one of the Information Age Framework for Assessment metrics mentioned above.

The most critical relationships that we have experienced in our development of C4ISR systems are shown in Figure 4:

	who	what	when	where	why	how
Quality		x			X	
Timeliness			x			
Efficiency		x				x
Integration: Connectivity				x		
Integration: Meaning		x				
Integration: Rules					X	x
Flexibility		x	x		X	
Alignment	x				X	

Figure 4: Interrogatories vs. Assessment Measures

The Warfighter's Associate

Having established the Information Age Framework for Assessment, the concept of a Warfighter's Associate is now introduced.

The Warfighter's Associate is a long-term concept of a supervised autonomous robot which employs a natural-language interface for communication with (and oversight by) its human counterpart.

Robots that are currently fielded in Iraq and Afghanistan are teleoperated. That is, their precise movements are remotely controlled by operators. This level of fine grain control requires the operator (a warfighter in a hostile environment) to focus on an operational control unit (OCU). This level of focus may severely degrade the warfighter's situational awareness (SA) of the area around him and also lead to an overly myopic focus on the immediate task at hand.

Beyond teleoperated is reflexive teleoperation where there is low-level sensor assist. ROBART II introduced this level of operation in a research environment in 1990 with doorway seek and penetrate behaviors (i.e to locate a doorway to the left, right, or center and enter).[3]

A supervised autonomous robot could ultimately be able to execute high-level behaviors subject to human supervision such as equipment repair in hostile conditions, evacuation of wounded soldiers under fire, as well as providing language translation and knowledge base access for which networked computers are ideally suited. The robot would require

[3] Everett, H.R., and E. Pacis, p.11.

supervision due to human's ability to quickly reason under changing conditions and for accountability to higher authority. In certain scenarios it could be envisioned that the supervised robot would operate under a command and control paradigm similar to "command by negation" as used in task force or composite warfare commander operations. In this paradigm orders are given, actions are taken, and unless the actions are unsatisfactory when judged by those issuing the orders, no further direction is provided until new orders are issued.

The Warfighter's Associate would have a natural language interface to facilitate interaction with the warfighter. Since wartime communications are frequently not unstructured but must rather conform to certain community-specific protocols, it is not envisioned that the Warfighter's Associate must understand truly unstructured speech. As is the case with a police dog, a few well defined commands can successfully control some very complex behaviors.

The Warfighter's Associate would also require relatively unconstrained mobility. Mobility is influenced both by the means of locomotion and the size of the unit. Depending on the operational parameters that must be satisfied the unit could be wheeled, tracked, or have legs. It is also possible that it would be a composite unit composed of multiple robots with different sizes and means of mobility.

The Warfighter's Associate would need to have seamless navigation between the outdoors (where GPS is available) and indoor environment. In general, the unit must be able to determine where it is, where it needs to go, and how to get there (i.e. localization, path planning, and collision avoidance). These problems have already been largely solved with the need now to develop small and energy-efficient sensors.

The Warfighter's Associate would need to have the endurance to perform as part of a team without burdening it with a heavy logistics tail.

The Warfighter's Associate frame of reference must be compatible with the warfighter's. As mentioned in the outdoors the robot has available GPS which is also used by the warfighter and corresponds directly to the environment at hand. In indoor environments there is not such a universal frame of reference. Great progress has been made on augmented virtuality (where additional information is made available to augment a created representation of the environment (as in in-situ mapping)).

Current Related Technologies

SLAM

Simultaneous localization and mapping (SLAM), a relatively new approach to indoor localization undertaken within the research community over the past several years, now enables robotic platforms equipped with laser and/or stereo ranging systems to build an accurate map as they explore an unknown environment, and to keep themselves localized within that map at the same time. Figure 5 shows the SLAM map of Battery Woodward,

an underground WW-II bunker at SSC San Diego, after the robot has made one pass down each of the main hallways, and further explored one T-shaped room on the right.

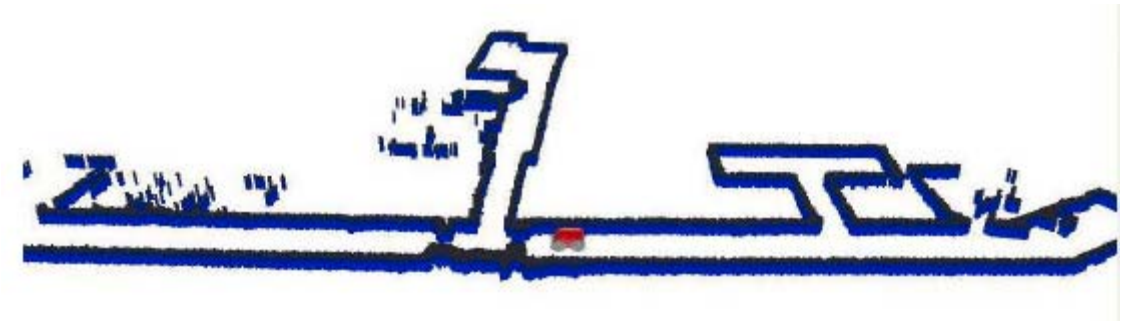

Figure 5: Mapping a WWII Coastal Defense Gun Battery

GPS

The GPS (Global Positioning System) is a "constellation" of 24 well-spaced satellites that orbit the Earth and make it possible for ground receivers to determine their geographic location with accuracy within one (1) meter with special military-approved equipment. The use of GPS receivers on outdoor robots is well established and has essentially solved the exterior localization problem. Also extensive GPS compatible maps are available.

C/JMTK

The "National Geospatial-Intelligence Agency's (NGA) Commercial Joint Mapping Toolkit (C/JMTK) program …is the next-generation geospatial and visualization toolkit for the Department of Defense's (DoD) Command and Control (C2) Network Centric Warfare System. It replaces the government-developed mapping software package, Joint Mapping Toolkit (JMTK). C/JMTK is a comprehensive toolkit of software components for the management, analysis and visualization of map and map-related information. The toolkit leverages the technical benefits and economies of scale of commercially-based geospatial applications with common, servicesbased software architectures consistent with the DoD Joint Technical Architecture (JTA).

C/JMTK is used for the development of map and imagery components of larger mission applications."[4] This a key building block in developing a robotic command and control capability that is seamless with existing systems and does not require additional support or training.

Current Related Robotic Programs

MDARS

[4] "Geo-spatial Solutions for Command and Control: Commercial/Joint Mapping Toolkit", p.1 http://www.cjmtk.com//Docs/d-00252.pdf

A mature robot which exhibits some of the characteristics of an AT/FP Warfighter's Associate is the Mobile Detection and Assessment and Response System (MDARS) developed for the Product Manager, Force Protection Systems (PM-FPS). MDARS performs autonomous security missions for blue forces. It is able to monitor an area for intruders and check bunkers for appropriately locked doors, as well as perform automated inventory function using Radio-Frequency Identification (RFID) technology.

Figure 6: MDARS Exterior Robot

FIRRE

Following on the success on the MDARS is the Family of Integrated Rapid Response Equipment (FIRRE), an advanced technology demonstration program intended to develop a family of affordable, scalable, modular, and logistically supportable unmanned systems to meet urgent operational force protection needs and requirements worldwide. The near-term goal is to provide the best available unmanned ground systems to the warfighter in Iraq and Afghanistan. The overarching long-term goal is to develop a fully-integrated, layered force protection system of systems for our forward deployed forces that is networked with the future force C4ISR systems architecture. The intent of the FIRRE program is to reduce manpower requirements, enhance force protection capabilities, and reduce casualties through the use of unmanned systems. FIRRE is sponsored by the Office of the Under Secretary of Defense, Acquisitions, Technology and Logistics (OUSD AT&L), and is managed by the Product Manager, Force Protection Systems (PM-FPS).

In FY-04, SSC San Diego tasked the Idaho National Engineering and Environmental Laboratory (INEEL[5]) under a Memorandum of Agreement to assist in porting over and enhancing the SRI International SLAM solution while incorporating their robust collision avoidance scheme.

GIG and FORCEnet

[5] "On February 1, 2005 the Idaho National Engineering and Environmental Laboratory and Argonne National Laboratory-West became the Idaho National Laboratory (INL)." – www.inel.gov as of 11 Mar 2005.

The command and control element of FIRRE utilizes the Commercial/Joint Mapping Toolkit (C/JMTK) for displaying 3D map data and for tracking asset placement and movement. It will export real-time situational awareness data to the military network via the Joint Global Command and Control System (GCCS-J). As such it will be positioned to benefit from the enhanced global communication infrastructure, semantic networking, and web services of the Global Information Grid (GIG) and service specific initiatives (FORCEnet for the Navy).

Applying Information Age Assessment to the Warfighter's Associate

Let us return to Figure 4: Interrogatories vs. Assessment Measures. We can consider how the Warfighter's Associate would positively contribute to an AT/FP capability.

First, to assess the quality of the capability, we are primarily concerned with the how well the product (the "what") satisfies the requirements (the "why"). In particular, let us consider a MDARS-type scenario where the Associate supports the security detail. The product in this case is the observation, assessment, identification, and response to intruders or unacceptable conditions. A supervised autonomous robot that is able to perform these tasks without needing rest, being distracted by socializing, becoming bored, or engaging in inappropriate behavior (such as insider threats) would produce a uniformly high-quality product.

Metrics that could be used to assess the quality of the security detail are:

- Percentage of intrusions detected.
- False Positive rate of intrusions detected.
- Kilometers of surveillance performed without mechanical failure.

Next let us consider timeliness (the "when"). One aspect of timeliness is being able to predict performance. A robot can have well defined performance parameters, as well as predictable availability. Timeliness also comes from quickness. A robot, or a composite robot, can be developed to have much faster response times than a human can have to a particular situation.

Metrics that could be used to assess the timeliness of the security detail are:

- Percentage of required on-the-spot log-ins made within allowable time windows.
- Response time to an intrusion report.
- Percentage of time Associate is available for security detail on time.

The remaining Industrial Age metric, efficiency, relates the input ("how") to the output ("what") of the system. In the context of an AT/FP capability, efficiency is largely driven by manpower costs required to provide the security services provided. Here the manpower cost reduction from the automation of the security monitoring and response tasks is significant. This has traditionally been the major motivator for robotic security. An additional consideration is that the Associate, when equipped with a lethal or non-lethal response capability, can provide a "stand-off" capability for the warfighter.

Reducing injury rates would also positively contribute to the efficiency of a Warfighter Associate AT/FP capability.

Metrics that could be used to assess the efficiency of the security detail include:

- Operating costs of a squad over a period of time.
- Life-cycle costs of a squad.
- Historical or projected injury rates.

Turning to the Information Age metrics, the first to consider is integration in connectivity. Connectivity is the ability to exchange symbols between nodes (the "where"). Simply exchanging symbols is of little utility without knowing how they relate. Therefore integration in connectivity also includes syntax. While this is primarily in the realm of communications and networking the Warfighter's Associate can act as a node to extend the network to where it may not otherwise be. As an example, a composite robot or a fleet of robots, with perhaps a master and slaves, would be able to explore a hardened bunker and through a relay function maintain connectivity with the broader world. This has definite application in AT/FP. In the case of security patrols within an occupied formerly hostile bunker they would be able to establish and then maintain communications to support surveillance while the facility is secured. This would be of great benefit in the case that it may be connected by tunnels to hostile forces or still contain hostile forces within it. The robots could also provide warning of chemical, biological, or radiological threats if equipped with those sensors.

Metrics that could be used to assess integration in connectivity of the security detail include:

- Percentage of internetworking among the detail.
- Percentage of desirable external nodes that are connected.

Once connectivity is established we need to consider integration in meaning. This level of integration exists at the level of semantics (the "what"). The Associate could contribute very significantly here by providing situational awareness to the warfighter. By leveraging developments in geographic information systems such as the C/JMTK, the Associate can provide geo-registered or augmented virtuality information from many sensors, including but not limited to visual ones. Not only would the Associate be able to provide a commonly understood representation of its situation, it would also be able to incorporate the knowledge that it has of the warfighter. In this case it could contribute to the blue force tracking picture to improve the SA of all concerned. This knowledge is critical in reducing or preventing fratricide, allowing cooperation, and aiding teaming behaviors.

Metrics that could be used to assess integration in meaning of the security detail include:

- Percentage of reporting nodes using standard symbols and formats.
- Percentage of war fighters with the same situational awareness.
- Percentage of message content using standard nomenclature and judged to be unambiguous by the recipients.

The highest level of integration is in rules. It is at this level that the context of the message becomes important and decisions are made. At this level the interaction of the supervised autonomous robot and the warfighter becomes critical as they use the means at their disposal (the "how") to satisfy the goals of the mission (the "why"). One advantage of a robot with respect to rules is that they will be executed consistently. Consistently does not necessarily mean predictably. Under the same conditions, with the robot's control software in the same state configuration, the same result should ensue. Therefore if a robot is to be given a lethal response capability its control software must be rigorously designed and tested to account for all possible states that could lead to a lethal decision. Also its operating environment must be well known to the extent that it influences that state space. Once that level of assurance can be obtained the robot offers a very high degree of integration in rules with respect to lethal decisions. Below there in terms of consequences are all the other rules of engagement or business rules that a warfighter must conform to. Having achieved integration in connectivity and meaning, the Warfighter's Associate's integration in rules provides a reliable reporting and assessment mechanism to the chain of command.

Metrics that could be used to assess integration in rules include:

- Responsiveness of the organization to a change in the number or nature of intrusions detected and assessed as hostile. While increasing the efficiency of detections (through reduced costs) or improving the quality of detections (reduced delays through improved sensors and networking) is a significant benefit of this concept, the improvement of the organization as a whole in its ability to respond within the same rule set is what needs to be evaluated here. For instance, as a result of detection and assessment of a hostile threat the organization may raise its defense posture and also change its rules of engagement (ROE). This ability to have adaptive ROE derives from the Information Age integration of the force.
- The degree to which the organization responds correctly to various threats. Since recent exercises have shown that AT/FP doctrine remains immature and base security forces are unsure of the rules of engagement, especially with respect to lethal force,[6] it is imperative to improve the force's understanding. Reducing the number of occurrences of unauthorized use of force, or inappropriate use of force (such as not using lethal force when confronted with a weapon of mass destruction (WMD) threat) are significant components to improving the quality of AT/FP and improving the efficiency of operations by avoiding the costs associated with unauthorized or inappropriate use of force. To achieve these results the organization must have a well developed set of rules (from doctrine to tactics, techniques, and procedures).
- The responsiveness of the organization to reports of missing or unaccounted for stockpiles. Improving the accuracy of inventory reports is a key quality metric for depot organizations. The ability of the organization to respond to those reports and optimize the execution of its mission is the Information Age aspect to be

[6] SOLID CURTAIN 2004 QUICKLOOK/LL/AAR, Whitaker, Jeffery FLTFORCOM N347, Monday, December 13, 2004 9:51 (email distribution)

assessed here. A Warfighter's Associate with an MDARS-type inventory role could provide current status to the GIG for use by purchasing, accounting, and planning tools that could take automated action based on shortfalls or surpluses. In an active depot this could also include consumption rates for different items. When combined with other logistics information it can provide guidance for adjusting purchases or acquisition policies.

Flexibility, "The ability of the enterprise to change with a minimum of disruption in terms of cost, schedule, or function," is the information age equivalent to the interchangeable piece parts of the industrial revolution. For the Warfighter's Associate it would be achieved through the use of modularity in physical and software components. Already robots deployed with Explosive Ordinance Disposal (EOD) teams in Iraq have interchangeable adapters for different circumstances; much more is possible.

Metrics that could be used to assess flexibility include:

- The reduction in the number of single points of failure through the use of redundant or similar networked systems. The Warfighter's Associate could provide alternative means of communication and situational awareness that could still operate after the warfighter's organic means have failed.
- The ability to scale an operation up or down in size with minimum of disruption in terms of cost, schedule, or function, as judged by user or analysis. For example, the ability to change the number of Warfighter's Associates rapidly as inventory levels or threat levels change relative to the time and expense of changing personnel levels.
- The number of possible functional modules that can be used.
- The number of tasks that can be handled by the same Associate or tasks that could not be performed with an acceptable level of risk without an Associate.

Alignment, "the extent to which the organization reflects the owner's intent," is both a quality that is frequently talked about, professed to be pursued, and difficult to quantify. John Zachman would probably say that it arises from having well developed and consistent models that reflect the actual organization and that satisfy the owner's requirements. In our experience it is certainly dependent on all the interrogatories but it is primarily dependent on the relationship between the staffing and role definitions (who) and the requirements model (why). The Warfighter's Associate can help execute the mission of the organization as directed by the warfighter; however, alignment depends on the warfighter understanding the doctrine, mission, commander's intention, and the focus of effort.

Conclusion

The Zachman Enterprise Architecture Framework was introduced to provide the context for the Information Age Framework for Assessment. The Assessment Framework was shown to yield a far more insightful and valuable assessment result than simply considering the Industrial Age metrics alone. Using the Information Age metrics of

integration, alignment, and flexibility it is possible to appreciate and value the contribution of an investment in a networked node.

The Warfighter's Associate concept was used to demonstrate the use of the Information Age Framework for Assessment. In particular, the concept of a Warfighter's Associate was discussed in the context of an AT/FP mission. Using the Framework it was shown that while the Associate improves the quality, timeliness, and efficiency of the immediate operation, its' most significant value would arise in contributing to improved connectivity and flexibility. Alignment would still depend primarily on the warfighter.