TUESDAY PRESENTATION DETAILS

1:00 - 1:30 Tues

040

Schneider, Hubert
Anglin, Dale
Baumgarten, Erik
Dinh, John
Hall, Mark
Raytheon

Track 1

Raytheon Reference Architecture (RA): Enabling Timely & Affordable Customer Solutions

The complexity of Command and Control in today's information-driven world demands robust, well designed systems to orchestrate the timely exchange of information, employment of resources, and collaboration between units. Customers are demanding architecture-based solutions for their mission needs. Raytheon has made significant investments in a corporate level, enterprise-wide initiative called RayMAP (Raytheon Mission Architecture Program) to respond to these demands. RayMAP coordinates Reference Architecture (RA) efforts across multiple business units and programs. These RAs are being used to promote commonality, reuse, interoperability, increased responsiveness and affordability in systems and enterprises. Using the Raytheon Enterprise Architecture Process (REAP), standardized architectures can be defined, described, evolved, and assessed throughout Raytheon and was used to develop several RAs. A key Raytheon RA is the Command and Control Reference Architecture (C2 RA) developed using REAP and an activity based methodology. C2 RA artifacts have been captured in the Unified Modeling Language using Rhapsody as a modeling tool. The C2 RA is easily tailored, is extensible, and can be applied to Department of Defense (DoD) and non-DoD situations and solutions. This paper describes the process Raytheon used to tailor and evolve the C2 RA to build more timely and affordable customer solutions, including lessons learned.

017

Lenahan, Jack
Nash, Mike
Charles, Phil
SPAWAR

Track 8

Beyond Reactive Planning: Self Adaptive Software and Self Modeling Software in Predictive Deliberation Management

The purpose of this paper is to examine an approach to planning which extends beyond the traditional reactive planning state space. We present the following hypothesis: predictive deliberation management using self adapting and self modeling software will be required to provide mission planning adjustments after the start of a mission. Self adaptive software evaluates its own behavior and changes behavior when the evaluation indicates that it is not accomplishing what the software is intended to do, or when better functionality or performance is possible1. Self modeling systems construct their own abstractions as a basis of computational intelligence2. In order to provide a proper process context for the evolution of software toward this level of autonomy, and in alignment with the proposed planning maturity models3, we put forth a concept of a NCW C2 Software Maturity Model. This new C2 software maturity model will take software beyond the service oriented paradigm into a new era of software designing its own replacements or modifications in order to satisfy new command and control requirements.

1:00 - 1:30 Tues

004

Barton, Robert
BAE Systems PLC - Future Systems
Whittington, Dick
Salamander Organization

Track 6

Informing high level trades - some novel techniques

In the increasingly complex acquisition environment that characterises Defence, the ability to make good trade off decisions is often limited by time and resource. The resulting outcome can often be disastrous in the area of command and control improvements, many of which are relatively low in real cost terms but can have disproportionately high impact on Military Capability. Trade - off techniques have tended to rely on spread sheets and military judgement, with OA not always playing the definitive role that it should. The analysis and decision process is then compounded by the need to maintain big ticket items on long commitments, forcing "salami slicing", cancellation of small - medium scale projects (often the command and control elements) and an inability to compare "apples with oranges", or as some observers have put it "apples and Wednesdays"! Over the last two years a number of new techniques have been developed which generate a set of consistent views which, in turn, enable a much more objective basis for analysis, quality trade - off and decision making. These have been developed by direct working with the customer, to ensure that they represent practical solutions. The use of SMEs to help develop the tools and techniques has increased responsiveness and encouraged innovation. The paper will outline the work undertaken and the types of visualisation and decision aids that have been developed showing how these have been used in practice to gradually enhance the overall process.

116

Ng, Ee Chong
DSO National Laboratories
Thunholm, Peter
National Defence College, Sweden
Cheah, Mervyn
Future Systems Directorate, Singapore
Tan, Kin Yong
Future Systems Directorate, Singapore
Chua, Nency
Defence Science and Technology Agency, Singapore
Chua, Ching Lian
DSO National Laboratories, Singapore

Track 7

Exploring alternative Edge versus Hierarchy C2 Organizations using the ELICIT platform with Configurable Chat System

The Edge Organisation is a subject that warrants much research and experimentation within the C2 research community. By combining the ELICIT Multiplayer Intelligence Game with the use of CHAT, we designed an experiment to test the effect of different rules of information-sharing, communication, and decision-making on the performance and behaviour of three different permutations of Edge versus Hierarchical Organizations. Our main findings suggest that when an intelligence organization is tasked to analyze incoming data and decide on an interpretation of these data, the edge organization outperformed both the traditional hierarchy and the edge-hierarchy hybrid over decision speed, decision accuracy and level of shared correct awareness of the threat situation. The hybrid organization and the traditional hierarchy performed equally well on decision accuracy and shared awareness, but the former made decisions faster than the latter. One possible explanation for our results is that in the hierarchical structure, the processing of information takes place in two different levels subsequent to each other in time, but in the

Edge there is only one processing level. Through this experiment we also demonstrated how intra-organizational behavior and command chain leadership issues can be addressed through introduction of different CHAT configurations to complement the ELICIT platform.

1:00 - 1:30 Tues

112

van Veen, Maarten
van Fenema, Paul
Grant, Tim
NLDA

Track 3

User Perspectives on the Design Logic in Military Training Simulators

In our ICCRTS 2007 paper 'On Regarding 21st Century C2 Systems and their Users as Fallible ePartners' we argued that there is a limit to what can be done to eliminate errors in C2 systems, and we should view human actors and the system together as electronic partners. The development and use of C2 systems has become, over the past decades, a complex area of inquiry with different thoughts on how to dominate in a coordinated fashion in warfare. Designers of increasingly sophisticated C2 systems follow a certain logic that becomes 'blackboxed' into the technology. We want to open this black box and investigate what decisions designers made and how users make sense of them. We take the emerging field of Modeling & Simulation as our principal object of study. Technically sophisticated simulators have become an indispensable method for tactical military training. This study seeks to initiate a discourse on (dis)advantages, choices, interpretations and constraints associated with complex information systems in military modeling & simulation. To this end we are conducting a comprehensive, qualitative study on the use of a simulator for constructive training. This paper describes our research approach and summarizes our initial findings.

042

Warne, Leoni
DSTO

Track 2

The Human Terrain of NCO

This paper follows on from the paper presented at ICCRTS 2004: Warne et al "The Future Warrior", www.dodccrp.org. It discusses the outcomes of an Interview Program investigating the human dimension of Network(er) Centric Operations (NCO). This paper gives an overview of the findings in terms of the skills and attributes required for the 'networker' in NCO, as perceived by the warfighters themselves. The interviews indicate that issues of trust, teaming skills, skills in communicating and handling information; knowledge of Joint and Coalition capabilities, tempo tolerance, cultural awareness and sensemaking skills were most highly valued. Furthermore, several issues not previously identified in the literature emerged in interviews with the Australian Defence Force (ADF) including the importance of: prior operational experience, Joint, Coalition and CIMIC training/exercise experience, developing informal and social networks underpinned by strong relationship building skills and the ability to tolerate ambiguity. These and other human characteristics and behaviours are linked to the tenets of NCO in an attempt to better understand the human requirements in the NCO environment. This work has led to the creation of a Model of the Human Dimension of NCO which is the subject of a later paper.

1:00 - 1:30 Tues

163

Desouza, Kevin
Roy, Sumit
Lin, Yuan
University of Washington

Track 5

Performance Measures for Edge Organizations: A Preliminary Report

Taking an information-processing view of organizations, we address the need for building a robust set of performance measures for Edge Organizations (EOs). Alberts and Hayes in Power to the Edge: Command, Control in the Information Age conceptualized EOs as information-intensive entities whose performance is directly related to their ability for agile information processing. We ask the question, how can we measure the information-processing capacities of EOs? To this end, in this research-in-progress paper, we examine (1) the technical dimension of information flows, (2) the human-dimension of information flows, and (3) the socio-technical dimensions of information flows. The technical dimension represents movement of information between two machine nodes and can be informed by drawing on performance measures for telecommunications network theory. The social dimension represents the movement of information between two human nodes for which we examine the literature on social networks for performance measures. Finally, the socio-technical dimension represents movement of information between human and technical nodes or vice versa. To develop measures for these information flows we must not only extend, and customize, the performance measures from telecommunications networks and social networks, but also draw on measures in the disciplines of decision sciences, information sciences, and organizational science, among others.

097

Louvieris, Panos
Mashanovich, Natasha
Collins, Catherine
White, Gareth
Faulkner, Mark
Levine, Jerry
Henderson, Stewart
University of Surrey

Track 9

Exploring Joint Usability and Decision Effectiveness using a Networked-Enabled Virtual Collaborative Working and Visualisation Environment for Military Planning

This paper concerns the use of a Collaborative Working and Visualisation Environment (CWVE), i.e. using virtual collaborative desks (VCDs), for the development of shared situational awareness using a common operational picture to support collaborative military planning in joint command and control situations. Joint usability, critical task and situational awareness assessment methods are employed to determine the effectiveness of this CWVE in supporting commanders' joint decision making. With reference to the British Army's seven questions estimate process and intelligence preparation of the battlefield, together with employing a small military judgement panel for the simulation experiment, the research focuses on the how effectively networked VCDs highlight commander's critical information requirements and their purpose including the commander's evolving requests for information during planning; and, how collaborative technologies might improve joint decision effectiveness in the specification and delivery of planning products, such as: the decision support overlay, decision support matrix and the synchronisation matrix within a distributed HQ environment in order to enable distributed working. As a result of this research a joint usability framework has been developed. This research has military significance in terms of enabling synchronised joint decision making in resilient agile distributed HQ groups and thereby reducing security risk of commander and staff.

1:30 - 2:00 Tues

029

Hone, Geoffrey
Whitworth, Ian
Farmilo, Andy
Cranfield University

Track 1

The Awareness-Order-Action cycle and Battle-space Awareness

We have argued (Hone, Whitworth, Martin; 2006) that Awareness is best considered in terms of Battle-space Awareness, but also seen as a component of a larger Awareness-Order-Action (AOA) cycle. A key factor in the AOA cycle was the influence of culture and doctrine on multi-force and multi-national operations. At a time when a number of "Cycle" models (e.g. OODA, ODOA, OPAM, RUDE) are in use – and many of which are probably best related to specific aspects of combat – we believe that insufficient attention is being paid to fostering a general awareness of the battle-space, or to integrating such awareness into a generic model of the combat process (particularly from the viewpoint of ground and littoral combat). Developed from the 3-Q model of awareness (Hone, Martin and Ayres, 2006), the AOA Cycle is offered as a means of exploring the way in which information flow, as well as the influences of culture and doctrine, can affect combat events. This requires a new approach to the assessment of awareness, and in particular to the separate awareness of "Blue" versus "Red" forces, and such an approach can be enabled by the 3-Q model amongst others.

044

Jagiello, Jerzy
Tay, Nicholas
Eronen, Marko
DSTO

Track 8

A Robotic Middleware

A software middleware concept has been applied to the robotic software development process in order to overcome problems with interoperability and portability of software components between different vendor robotic platforms. An architecture has been proposed and a prototype was built. The architecture is designed to allow control of motion and perception, and provide a common interface for communication. Additionally the architecture provides the ability to use agents for specialized and complex tasks. Experimentation with the prototype demonstrated the applicability and value of the middleware approach in the robotic domain. In providing a high level interface to hide the particular details of specific platforms the middleware allows development of re-usable software components which can be used across different platforms. The middleware also enhances the interoperability between robotic platforms.

011

Gill, Kate
Dstl

Track 6

Towards a Model of Capability Trading for UK Defence

Trading is the defence term for altering the Balance of Investment (BOI) between military capability components to maximise effectiveness. Trading is a social activity, and as such the trading activity needs to consider the individual's contribution as well as the activity process itself. The trading process has taken place in the military domain for many years and is well documented and traceable. However, the effectiveness of the process and the success of the trading decision are less well observed and documented. Military capability is delivered using a combination of factors (e.g. equipment, training, logistics and information). In the UK military context, these factors are collectively known as the Defence Lines of Development (DLOD). Trading is the mechanism used to adjust the levels of investment in each of the

DLODs to achieve the required military capability outcome in the most effective way. This paper examines the problem space of trading and outlines the findings of an initial exploration of the practical experiences of trading practitioners, using personal confidence rating as a metric. An emerging model is proposed, which could be used for low fidelity long-term projections of trading decisions in support of long term BOI assessment.

1:30 - 2:00 Tues

080

Duncan, Matthew
Jobidon, Marie-Eve
Defence Research and Development Canada Toronto

Track 7

Spontaneous Role Adoption and Self-synchronization in Edge Organizations Using the ELICIT Platform

This research used the ELICIT platform (Parity, 2006a) to investigate spontaneous role adoption and self-synchronization in Edge organizations. Behavioural indicators associated with explicit roles in a Hierarchical organization (e.g., Team Leader, Team Member, etc) were compared with the same indicators derived from members of an Edge organization (e.g., no explicit roles or structure). The extent to which behavioural indicators from subjects in the Edge organization matched those in the Hierarchical organization would signal spontaneous adoption of Hierarchical roles by Edge members. On the other hand, the extent to which behavioural indicators in the Edge organization failed to match any found in the Hierarchical organization would signal the formation of Edge-specific role adoption. Subjects in a Hierarchical organization were given explicit instructions on role function. Behavioural indicators were found that effectively clustered members by role (i.e., indicators which grouped Team Members, Team Leaders, and the Cross-team Coordinator into separate clusters). These role-specific indicators were then compared to indicators drawn from members of an Edge organization who were given no explicit role instructions. This paper reports the results of this research which indicate that spontaneous role adoption and self-synchronization can occur in Edge organizations and that the ELICIT platform can be used to assess it.

115

Staal, Odd Martin
Nielsen, Martin Normann
Brathen, Karsten
Norwegian Defence Research Establishment

Track 3

Experimentation with Network Enabled Joint Tactical Training

This paper describes the Joint Air Defence Training Simulation (JADE) II, an experimental synthetic exercise performed in late October 2007. The exercise provided training for an Anti-Air Warfare (AAW) organization including two naval frigate AAW teams, an air surveillance and combat management team at a Control and Reporting Centre (CRC) and two combat aircraft pilots, training air-maritime cooperation and coordination procedures. The synthetic exercise was enabled by interconnecting stand-alone training simulation systems and their voice and tactical data link systems, creating the JADE II Joint Tactical Training Capability Prototype (JJTTCP). The JADE II experiments evaluated the JJTTCP's ability to provide relevant and cost-effective training. For this purpose, a set of subjective and objective data were collected. The paper outlines the experimental setup employed to measure training effectiveness, and describes the JJTTCP. The results of the JADE II experiment were positive, indicating that a network enabled training capability, like the one described, can provide relevant and realistic joint tactical training. The training can be improved in terms of reduced cost and increased availability and it can increase the value of live joint exercises. In addition, it enables trainees to explore and understand network enabled concepts of their domain, and the command and control organization and functions in and adjacent to their domain.

1:30 - 2:00 Tues

084

West, Bruce
Army Research Office
Bowman, Elizabeth
Rivera, Brian
Army Research Laboratory

Track 2

The Human Dimension of Networks

This paper describes a research plan that will examine the linkage between the physical and human (cognitive and social) domains of a network as they relate to human decision-making. This strategy has three components: theory, computation/simulation and experiment/observation. We will extend the most recent methods of statistical physics to non-stationary, renewal stochastic processes that appear to be characteristic of the interactions among nodes in complex networks and we will pursue the phenomenon of synchronization, whose mathematical formulation has recently provided insight into how complex networks reach accommodation and cooperation. The theoretical analyses of complex networks often elude analytic solutions and require large-scale simulation and computation to analyze the underlying dynamic process. We will use agent-based modeling to simulate the dynamics of such complex networks, particularly models of dynamic decision-making under conflicting constraints and with incomplete information. We will develop decision-making scenarios from which to extract large amounts of data for analysis, for the development of theoretical models and the construction of large-scale computer simulations, as well as, optimal data processing techniques to guide the theoretical analysis. We expect that the theory, computation/simulation and experiment/observation components will inform and refine one another in an iterative way through intense collaboration.

075

Bay, John
Air Force Research Laboratory

Track 5

Disruptive Effects of Net-Centricity on Command and Control

This paper explores the potential for net-centric operating environments to disrupt traditional practices in command and control. We conclude that at least two major disruptive effects are likely: information non-attribution and control decentralization. Information non-attribution reverses the assumption that commands are issued from an individual entity to an individual entity. In net-centric worlds, orders will be issued to a resource pool, and information will be gleaned from an infosphere. The military command hierarchy must therefore get accustomed to issuing orders to "nobody in particular," and commanders will lack an individual subordinate with whom to attribute the responsibility. Conversely, they must accept information from the infosphere without the trust inherited from known reliable providers. Control decentralization is a tendency for decision-making to migrate to the "edges" of the organization, where the most direct sensors and effectors are physically located. Net-centricity directly empowers those closest to the action by giving them access to information of quality and quantity that is potentially equal to or better than that available in command centers. Together, these effects of net-centricity suggest disruptive changes in command and control practices that must be modeled and explored as the vision of net-centric command and control becomes a reality.

1:30 - 2:00 Tues

141

Grande, Darby
Stelzer, Emily
Patterson, Michael
Tyler, Sherman
Levchuk, Georgiy
Aptima
Lee, John
Hoffman, Joshua
University of Iowa

Track 9

Supporting Adaptive C2 Structures in Time-critical Environments

As technological advances allow automation of many operations, human operators supervise systems with increasing breadth of scope. In these complex environments, decisions regarding resource assignment to tasks, goal prioritization and coordination strategies during unexpected events become unwieldy as the problem spaces grow. In this paper, we describe the development of technology to support teams of operators controlling teams of unmanned vehicles (UVs) in their global resource planning and re-planning. These teams include a several coordinating Littoral Combat Ships, a mixture of autonomous vehicle types, typically with a range of differing capabilities, and management by multiple human operators attempting to achieve several high-level goals. Using the results of a Cognitive Work Analysis, we extend our work in organization design and analysis to give real-time support to the operators.

2:00 - 2:30 Tues

058

Heier, Jeff
MITRE

Track 1

Mashup the OODA Loop

This paper provides an overview of several Web 2.0 applications and how they can be constructed via mashups to augment current Army Command and Control (C2) processes via the Observe, Orient, Decide, and Act (OODA) Loop concept. As defined by Wikipedia, a mashup is a Website or application that combines the content from more than one source into an integrated presentation. The benefits include (1) faster correlation of current data, (2) an ability to obtain previously unavailable data, and (3) an authoring environment that encourages end users (soldiers) to develop and share applications without having to wait during the traditional lengthy software development cycle.

099

Landsman, Seth
Mulgund, Sandeep
MITRE

Track 8

Design Patterns for Net-Centric Applications

Numerous efforts are now under way to define techniques for exposing data in a net-centric manner. Such efforts will provide C2 decision-makers with access to unprecedented amounts of real-time operational information, helping to make possible the net centric vision of improved mission effectiveness through shared situation awareness and self-synchronization. However, relatively little attention is being paid to strategies for consuming and exploit that data effectively and efficiently. Guidance such as the DoD's Net-Centric Data Strategy (NCDS) suggests how best to expose mission data in a net-centric environment, but what are the right approaches for building user-facing tools and capabilities? Such capabilities will make it possible to transform, visualize, and realize shared sensemaking over net-centric data. As the diversity and

number of entities needed to realize effective C2 for complex endeavors grows, establishing agile and practical design guidance for building user-facing capabilities becomes critical. This paper discusses an effort to establish design patterns – identifiable, repeatable prescriptions for solving commonly occurring software design problems – for realizing agile net-centric consumer applications. The effort described herein centers on the development of a User Defined Operational Picture (UDOP) capability, a collaborative tool that enable agile consumption of net-centric data sources to support time-critical decision-making in crisis situations.

2:00 - 2:30 Tues

255

McEver, Jimmie
Martin, Danielle
Hayes, Richard
Evidence Based Research

Track 6

Operationalizing C2 Agility: Approaches to Measuring Agility in Command and Control Contexts

Modern military operations are characterized by highly dynamic environments, complex strategic, operational, and tactical situations, a rich and evolving mix of allies and adversaries, inherent and sometimes massive uncertainty, and high risk. This combination of factors requires that military forces must continually transform and adjust to remain highly effective in extremely fluid environments. This capability, known as agility, is emerging as a key attribute of the forces and organizations that will enable them to respond to the nature of modern operations. In an everyday language sense, agility as a concept is well understood. However, operational definitions of agility, needed to enable unambiguous recognition and measurement of the different aspects of agility have been lacking. This paper lays the groundwork for a unifying approach for measuring and experimenting with agility and its enabling factors by suggesting definitions of agility and its associated attributes that are amenable to measurement, and describing potential approaches to agility measurement and description.

079

Ruddy, Mary
Meristic
Nissen, Mark
Naval Postgraduate School

Track 7

New Software Platform Capabilities and Experimentation Campaign for ELICIT

ELICIT is the Experimental Laboratory for Investigating Information-sharing Collaboration and Trust. A project of the Command and Control Research Program (CCRP) within the Office of the Assistant Secretary of Defense (NII), the ELICIT project developed an online multi-user software platform for conducting experiments in information-sharing and trust. The initial version of the software allowed researchers to model and experiment with a limited set of Command and Control (C2) organizations, processes and approaches in a computer-instrumented environment. The ELICIT software has since been enhanced to allow organization type to be configurable, thereby allowing researchers to experiment with a wider variety of C2 organizations, processes and approaches. In addition, the software has been further enhanced to support software agents as well as human participants, greatly expanding the avenues for research. Although the introduction and use of ELICIT remain relatively recent events, considerable research has been conducted already using this experimentation platform, and the C2 Research Community is gaining commensurate experience and insight into sound research design. Building upon such research and experience, we develop a multidimensional campaign for continued experimentation using the ELICIT platform. The campaign is populated with recent studies and guides future researchers toward high-payoff research areas that can be addressed using ELICIT.

2:00 - 2:30 Tues

142

Oh, Regine
Sanchez, Susan
Lucas, Thomas
Wan, Hong
Purdue University

Track 3

Efficient Experimental Design Tools for Exploring Command and Control Organizational Structures

Armed forces around the world are considering radical transformations to their structures and strategies because of the information revolution and the changing global environment. Senior leadership continually face decisions on how best to structure, modernize, organize, and employ forces in an increasingly uncertain future. For many of these problems analytical methods are not applicable, and large-scale experimentation is not feasible. Simulation provides a valuable tool for addressing these types of problems. One key characteristic of these decisions is the large number of factors, and interactions between factors that impact decision makers. Traditional simulation approaches are not designed to deal with this many factors, therefore the results are often incorrect or misleading. In this paper we introduce and implement efficient design of experiments techniques to analyze C2 organizational models and pursue optimal settings for different performance measures. This allows analysts to rapidly identify the important factors within the simulation, employ an experimental design to fully explore the simulation space efficiently, and design the systems with desired optimal performances with the simulation model. This effort dramatically increases the breadth and depth of insights possible when the simulation output data are analyzed, while reducing the time required for performing a study.

125

Oros, Carl
Naval Postgraduate School

Track 2

Mitigating C2 Complexity through Semantic Communications: A Model-based Communication Network Approach

Fundamental to the concept of Network Centric Warfare lies the precept that shared awareness, collaboration, and self-synchronization can be attained through the networking of knowledgeable, geographically and hierarchically dispersed entities. The DoD GIG Architecture Vision is the prime policy directive chosen to realize this goal. Consistent with the tenants of NCW, the GIG architecture framework envisions highly responsive, agile, adaptable, and information-centric operations. These desirable net-centric attributes are prescribed to be implemented via a Smart Pull methodology. However, a pull architecture not only must contend with the demands of disseminating diverse, timely information to numerous entities, but more importantly it must address the cognitive bandwidth limitations inherent to users searching for, discovering, and pulling contextually relevant, mission critical information. This paper provides an alternative operationalized Model-based C2 network approach where entities share a dynamic model of the environment and information is smartly Pushed via VIRT services to relevant entities when user defined Conditions of Interest occur. Mission thread semantics are used to generate an ontology that supports a contextually rich data structure capable of supporting the information requirements of diverse actors and entities united in the endeavor.

2:00 - 2:30 Tues

109

Liu, Jing
Zhou, Wei
Chen, Honghui
Luo, Xueshan
National University of Defense Technology

Track 5

Assessment of Hierarchical Command and Control organization structures

Assessment of C2 organization structures becomes very important now. On the one hand, the suggestion to develop newly networked organization structures seems to be accepted by most people; on the other hand, almost all the C2 organization structures are actually pyramid hierarchical ones. Concerning a specified military organization, whether its C2 structure is suitable or not? How to select a "better" structure for it from several candidates? Many issues require to be answered. In this paper, we propose a methodology to quantitatively analyze hierarchical C2 organization structures. Firstly, we associate the assessment with the task that the assessed military organization is expected to perform by mapping the task into the group military units that are needed to perform it directly. Secondly, we suppose that a military organization with a good C2 structures can responses tasks quickly and forms the required group units cooperating effectively. Then by affecting the information transmitting speed and the communicating quality of the different group units the C2 structure affect the organization's reactivity and cooperation efficiency respectively. The approach is based on multi-dimensional tree (MDT) that is introduced to describe the C2 hierarchical structures of military organizations.

171

Regal, Robert
Pacetti, Don
SPAWAR

Track 9

Extreme C2 and Multi-Touch, Multi-User Collaborative User Interfaces

The purpose of this paper is to introduce two things, the concept of Extreme C2 and a technological implementation for this collaborative, net-centric concept. Extreme C2 is a concept that applies elements of the eXtreme Programming (XP) concept. This collaborative development technique can increase the adaptability and quality of software, something of high value in the complex domain of enterprise software. When fused with net-centric concepts, Automated Battle Management Aids (ABMAs) and new human interface techniques, the application of this concept to C2 should be able to produce similar benefits for planning in military operations, particularly complex, multi-faceted operations. This concept will be demonstrated through the use of a multi-touch, multi-user interface screen built on top of net centric services. The paper will provide the results of a case study from a SPAWAR Charleston experiment about Operationalizing FORCEnet. We will evaluate the impact of Extreme C2 with Multi-Touch Multi-User (MTMU) technology on metrics like agility and speed of decision.

2:30 - 3:00 Tues

038

Czarnecki, Jonathan
Naval War College, Monterey

Track 1

The Failed Thermostat: The Illusion of Control in an Information-Rich Age

The concept of command and control is central to modern warfare. Command is a legal and behavioral term referring to a designated individual leader's responsibility and accountability for everything the leader's unit of command does and does not do. Control is a regulatory and scientific term denoting the

ability to manage that which is commanded. This paper investigates the use of certain types of control with operating environments that overwhelm commanders' abilities to do their job – lead and succeed in battle.

2:30 - 3:00 Tues

167

Schneider, John
AgileDelta

Track 8

Efficient XML: Taking Net-Centric Operations to the Edge

As the military shifts toward network-centric operations, the vision of sharing common information objects between command centers, aircraft, maritime vessels and mobile land forces over a single global network seems closer than ever. One of the fundamental challenges of achieving this vision is bridging the gaps between enterprise C2 systems that can use net-centric web technologies and tactical C2 systems that require more efficient data representations. Efficient XML addresses this challenge by optimizing net-centric web technologies for environments with limited bandwidth, processing power and/or battery life. Efficient XML is the basis for the emerging World Wide Web Consortium (W3C) standard for Efficient XML Interchange (EXI) and independent measurements indicate it can make XML data small and fast enough for the most demanding tactical applications. The U.S. Navy's 2006 Joint Rapid Architecture Experiment (JRAE) and the U.S. Air Force's 2006 Joint Expeditionary Force Experiment (JEFX) independently assessed the utility of Efficient XML for military applications, measuring XML data transfer speeds over 100 times faster using less than 1% the bandwidth. This paper describes the challenges we face using XML on tactical networks, describes how Efficient XML addresses these challenges and provides real-world results achieved during JRAE '06 and JEFX '06.

026

Farmilo, Andy
Whitworth, Ian
Hone, Geoff
Cranfield University

Track 6

Analysis and planning using the HTA Tool

At the 12th ICCRTS, an approach to agile planning was presented (Farmilo, Whitworth and Hone, 2007), that made use of the planning function in THE HTA TOOL – a freeware task analysis tool developed at Cranfield University. The capability of the tool has now been extended so as to provide the ability to handle high-level analyses of complex operations, such as multi-force or multinational. Different forces (and/or different nationalities) can be color-coded so that individual patterns of actions, tasks, or responsibilities, can be easily identified, traced throughout the analysis, and related to other force components. A second extension to the tool has enabled the non-availability of particular assets to restrict the scope of the planning function in a way that indicates the relative merits of these assets. The proposed use is not intended to replace existing tools designed for detailed planning, but the paper will discuss the direct benefits of using this type of computerized application, look at examples of mission planning and how these utilize the additional features of the tool.

2:30 - 3:00 Tues

144

Manso, Marco
EDISOFT
Nunes, Paulo
CINAMIL

Track 7

ELICIT and the Future C2: Theoretical Foundations for the Analysis of ELICIT Experiments

ELICIT, a research and experimentation programme developed for the CCRP, is a game-based simulation that provides a network-centric environment for a small group or organization using one of two different C2 approaches: Hierarchy and Edge. This paper provides the theoretical foundations for the analysis of ELICIT experiments, using NCW tenets and theory and the C2 Conceptual Reference Models recently developed by ASD-NII/OFT (2006, Alberts and Hayes) and NATO SAS-050 Research Group (2006, NATO SAS-050) as a conceptual framework. A mapping between ELICIT and these reference models variables and metrics is presented regarding the relevant domains: Information (richness, reach, security and interactions), Cognitive and Social (individual and shared awareness and understanding and quality of interactions).

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Borgers, Erik
Spaans, Mink
Voogd, Jeroen
TNO Defence
Hieb, Michael
George Mason University
Bonse, Remco
Utrecht University

Track 3

Using a Command and Control Language to Simulate Operations in a Multi-Agent Environment

One of the most effective tools in planning complex operations between different organizations is a simulation of what is to be done. Given a common intent, a simulation provides a basis for understanding the different elements of an operation, and thus enables flexibility as a plan is developed and implemented. The state of the art in simulation is with multi-agent environments. Our work is in developing the abilities of agents so that they reason and act correctly in the simulation. We describe an agent engine called 2APL and its communication protocols. One of the most critical problems in simulating military operations is communicating the intent of what is to be achieved to an agent. This intent can be transmitted effectively between humans, but is problematic when working with agent implementations, due to the large amount of interpretation a human performs. We use a language called the Command and Control Lexical Grammar (C2LG), derived from a body of work called Battle Management Language for its precision and C2 semantics. In this paper, we present our experience in using the C2LG and assess the language for use with simulation agents for developing more effective simulations for Complex Endeavors.

2:30 - 3:00 Tues

245

Versailles, David
Research center of the French Air Force

Track 2

Sharing awareness and problem solving: introducing the concepts of embodied knowledge, epistemic and pragmatic action

This contribution will elaborate on the interpretation of shared awareness on the basis of the asymmetry between information and knowledge. It will sketch the main elements associated to the implementation of knowledge computation in the C2 cycle on the basis of the aspects associated to knowledge assets codification and contextualization. Even though the concepts of situation awareness and shared awareness have become now a commonplace in the scientific literature, the concept of awareness remains often considered as a "buzzword" labeling a range of cognitive processes. Relevant definitions may be divided into two classes corresponding to State vs. Process duality. Endsley's conceptual contribution focuses on individual appreciations and confronts "situation awareness" to "situation assessment". Defining and modeling SA has recently evolved to take into account team cognition specificities and to consequently build up team situation awareness (TSA). Teamwork requires information gathering, information sharing, knowledge mobilization and team convergence toward a concrete action. Networking and computational capabilities available at all levels of the military systems on a battlefield and in the C2 chain have come to a turning point where creation, formalization, and distribution of information may be assessed as problem solving features and integrated into a broader investigation of decision making.

176

Ntuen, Celestine
Gwang-Myung, Kim
Park, Eui
North Carolina A&T State University

Track 5

Evaluation of Organizational Designs with Network-Centric Philosophy

The concept of network-centric warfare (NCW) is an evolving construct that has altered the military organizational landscapes. In the asymmetric information domains, there are few studies that actually relate the daily agitations of each of the command centers to the vulnerability of the entire C2 structure. In addition, there are no existing studies that use daily events and incidents to understand the vulnerabilities of each organizational structure. This paper reports on the use of network and organizational theories to derive vulnerabilities of organizational structures based on probabilistic events on each C2 center. Vulnerability is calculated as a function of information surprisal. The results of an empirical study comparing organizational structure designs in terms of vulnerabilities are presented.

2:30 - 3:00 Tues

188

Gustavsson, Per M.
Saab
Hieb, Michael
George Mason University
Eriksson, Patric
More, Philip
De Montfort University
Niklasson, Lars
University of Skövde

Track 9

Machine Interpretable Representation of Commander's Intent

The Network-Centric approach envisioned in the Global Information Grid enables the interconnection of systems in a dynamic and flexible architecture to support multi-lateral, civilian and military missions. Constantly changing environments require commanders to plan for missions that allow organizations from various nations and agencies to join or separate from the teams performing the missions, depending on the situation, as missions unfold. The uncertainty within an actual mission, and the variety of potential organizations that support the mission after it is underway, makes Command Intent (CI) a critical concept for the mission team. With new and innovative information technologies, CI can now be made available to the team of organizations in a coalition environment. Using a flexible and linguistically based approach for representing CI allows Intent to be interpreted and processed by all participants – both humans and machines. CI representations need to be able to express mission team's purpose, the anticipated End-State of the mission and desired key tasks. In this work, the expression of CI is developed to enable the structure and dynamics of collaboration support.

3:30 - 4:00 Tues

175

Ntuen, Celestine
North Carolina A&T State University

Track 1

The Process of Sensemaking in Complex Human Endeavors

This paper presents an approach to organizing the sensemaking process. The approach uses a set of cognitive constructs that translates tacit knowledge to the focal knowing of the objective world. The sensemaking process is also viewed as a robust method for developing training tools for the battle staffs critical thinking skills for various levels of problem complexities. At each stage of the sensemaking process, we have attempted to illustrate the efficacy of the available sensemaking constructs and paradigms. In addition to training application, the sensemaking process can be used to support knowledge representation for constructive modeling and simulation of sensemaking tasks.

246

Nitsche, Thomas
FGAN/FKIE

Track 8

Efficient Information Publishing in Service-Oriented C2IS based on Subject Managers

In this paper we introduce the concept of subject managers. In a service-oriented C2 Information System (C2IS), subject managers handle all the information providers of a specific subject, ranging from data in raw form (e.g., weather or intelligence) to evaluated form (e.g., politics or economics). An important class of information is georeferenced information. In this special case the concept of subject managers coincides with that of region services. In order to handle the potential information overload, a user of the C2IS can

thus locate the appropriate information providers within the overall Global Information Grid (GIG) that are relevant for his current mission and can efficiently subscribe to them.

3:30 - 4:00 Tues

027

Whitworth, Ian
Hone, Geoff
Farmilo, Andy
Cranfield University

Track 6

Assessing the Order Process

Key to the success of an operation is clear, accurate, complete and timely dissemination of orders, plans to effect those orders, and the encapsulation of command intent. A focal requirement within current army doctrine is that orders are recorded and passed in written form, yet our investigations have found that this is frequently not the case, neither within exercises or live missions. Other forms of communication, particularly verbal, are used to varying degrees although this appears to have led to a lack of consistency in approach. The situation for multi-national and multi-force efforts is even less clear. At the 12th ICCRTS an approach to assessing the transmission of command intent was presented (Hone, Whitworth and Farmilo, 2007). This approach, including the assessment software, have received positive feedback, particularly for their ease of use. This paper will discuss its potential application as an impartial method of post-exercise assessment in the training of junior officers and cadets. Plans to research into the use of different forms of communication for transmitting orders, and the implications for multinational and coalition operations will also be described.

202

Brickner, Michael
Sheffer, Dganit
Pamam Human Factors Engineering
Sirkis, Amit, Israel Defense Forces

Track 7

Better decision making through representation and reduction of uncertainty in C3I information system

Battle Management Systems (BMS) have enhanced the availability of battlefield information. Yet, commanders may not always be aware of BMS limitations and may consider displayed information as an undivided representation of the world; whereas, in reality BMS information tends to be uncertain (e.g., incomplete, only partially accurate). Some sources of uncertainty may be anticipated and presented to the operator (e.g., information acquisition time). It was hypothesized that displaying this uncertainty may enhance commanders' decision-making. Two training and six experimental scenarios presented realistic urban battlefield simulations, while maintaining a well controlled experimental setup. Each scenario contained five, forced-choice, decision point. Decisions could be good, medium or bad, based on operational outcomes. Before each decision the operator could opt to ask for additional information (e.g., from an unmanned aerial vehicle [UAV]). Sixteen company or brigade commanders of the Israel Defense Forces were divided into an experimental uncertainty group and a control group for the five hour experiment. Uncertainty representations did not produce better overall decisions; however, in seven out of 30 decision points it had a significant positive effect. Using additional information significantly improved decisions, nevertheless, several subjects rarely requested any additional information, resulting in poor performance. Subjects rated the experimental setup as realistic and relevant and expressed a desire to be presented with uncertainty information as an optional information layer on BMS.

3:30 - 4:00 Tues

105

Levchuk, Georgiy
Grande, Darby
Levchuk, Yuri
Aptima
Pattipati, Krishna
UCONN
Kott, Alexander
DARPA

Track 3

Mission Plan Recognition: Developing Smart Automated Opposing Forces for Battlefield Simulations and Intelligence Analyses

A key challenge for battlefield simulation is the estimation of enemy courses of action (COAs). Current adversarial COA development is a manual time-consuming process prone to errors due to limited knowledge about the adversary and its ability to adapt. Development of decision aids that can predict adversary's intent and range of possible behaviors, as well as automation of such technologies within battlefield simulations, would greatly enhance the efficacy of training and mission rehearsal solutions. In this paper, we describe the development of OPFOR agents that can intelligently learn BLUEFOR's mission plan. This knowledge will allow OPFOR agent to reason about the intent of BLUE and counteract accordingly to prevent/influence the future BLUEFOR's operations by affecting current operations, challenging BLUE's resources, and preparing OPFOR for future battles.

077

Vick, Shon
Cantu, Osbaldo
Mashariki, Amen Ra
Steen, Christopher
Johns Hopkins University Applied Physics Laboratory

Track 2

Expanding the Dynamic Collaboration in Teams of Portal and Non-Portal Based Users Using Semantic Based Tools and Constructs

Collaboration is integral to effective C2. Previous JHU/APL research focused on dynamic collaboration within a portal environment between homogeneous users. This paper details continued research on how both non-homogenous, disadvantaged users, operating in a mobile environment as well as portal based users could share information for effective C2. It also addresses how the effectiveness of this integration could be enhanced using semantic tools and constructs. The work on non-portal based applications treats the effect of team members operating with unequal capabilities potentially using different devices. It explores the adoption of RSS, mobile devices, and other technologies. Various architectures are explored including the Java 2 Micro Edition (J2ME) and associated technologies for evaluation of collaboration tools and technologies. The portal based work is centered on a geo-spatial display and an associated messaging system. Various directions enhancing collaboration were considered that would enable integrating deeper semantic content into the information shared for C2. Such tools for future evaluation are Wikis, Blogs and semantic based messengers. Among the benefits with the provision of semantic meta-data are personalized presentation of content (e.g. based on personal preferences), intelligent search, improved interoperability between systems (e.g. integration of several applications in a federated process, or with the support of smart agents).

3:30 - 4:00 Tues

226

Park, Chulwoo
Pattipati, Krishna
University of Connecticut
Kleinman, David
Naval Postgraduate School

Track 5

Holonic scheduling concepts for C2 organizational design for MHQs with MOC

The purpose of this paper is to present a C2 holonic reference architecture (HRA) that is applicable to Navy maritime headquarters (MHQ) with maritime operations center (MOC) for assessing, planning and executing multiple missions and tasks across a range of military operations. The control architecture consists of three levels: strategic level control (SLC), operational level control (OLC) and tactical level control (TLC). In addition to coordination within each level, two specific coordination layers are identified at the SLC-OLC and the OLC-TLC interfaces. The SLC-OLC interface layer resolves coordination issues associated with selecting and managing multiple missions (simultaneous or sequential), while the OLC-TLC interface layer is used to resolve coordination and synchronization issues associated with asset allocation and task scheduling for each mission. The proposed architecture conforms with the concepts of centralized assessment and guidance, distributed and collaborative planning, and decentralized execution in that it employs centralized decision making at the strategic level, collaborative planning at the operational level, and negotiation mechanisms at the tactical level. We employ Markov decision process (MDP) approach to decide on missions to be executed and their sequences at the SLC-OLC layer (coordination of future plans), while group technology and a nested genetic algorithm-based multi-objective optimization techniques for asset allocation and task scheduling at the OLC-TLC layer (coordination of future operations and current operations).

191

Lincourt, David
Peukert, Hans
Kowalkiewicz, Marek
SAP

Track 9

Situational Common Operating Picture for Collaborative Sensemaking

Timely, accurate and relevant information is a key contributor to making good decisions in complex endeavors. Thereby, it is often necessary to put structured and unstructured information originating from multiple entities and sources into a certain context – often the whole is more than the sum of its parts. Combining information from different sources can help answer different questions such as what? (for instance road "diamond" unavailable) why? (contextualization with news that roads are clogged due to an evacuation), to whom (contextualization with re-assignment of sustainment responsibilities), etc. In certain situations decision makers are only able to detect certain patterns if they are exposed to different information. Pre-defining such patterns or scenarios generically proves difficult. Often they have to react to unexpected, critical circumstances that cannot be pre-modeled. Hence, a system to support agile collaborative sensemaking in such situations by fulfilling ad-hoc information demands must provide means to identify relevant information blocks and contextualize information on the fly. We propose that decision makers need to be able to interact with the system in a non-technical way, with an intuitive user interface and an easy to use situational Common Operating Picture composite application.

4:00 - 4:30 Tues

228

Marsay, David
QinetiQ

Track 1

Complexity concepts for Command and Intelligence

While it is generally recognized that an understanding of complexity is essential to the development ofeffective Command and Intelligence, there are no accepted, credible, models or metaphors to draw upon.This paperdiscusses the desiderata forsuch models and metaphors emerging from current work on command battlespace management (CBM) and ISTAR, describes a tentative modelofcomplexity based on a school playground, and gives some deductions for the nature ofuncertainty, collaboration, adaptation and consideration of effects, with particular attention to the implications for all-source intelligence problem analysis, multi-hypothesis testing, target identification and classification.

050

Christensson, S Anders
Swedish National Defence College

Track 4

Instruction sets to use and test a transformation towards an agreed end non-failing state

For a joint force commander to find the instructions set to civilian and military organizations that transform a failing state towards an agreed end state is a problem. The overwhelming amount of dynamics, interactions and generative capabilities hidden in this, is cognitively difficult task to grasp for commanders and practitioners. One difficulty is to represent the initial scene for the failing state. To use this expressed terminology so that practitioners can use it to follow the development in the dynamics, interactions and generative capabilities. To allow practitioners to experiment with their instructions sets and elaborate with these instructions sets as they are incrementally testing them in order to met expressed end state for the non-failing state. A possible solution to support this process of finding the instructions set has been developed. During several explorative exercises the incremental designed systems has bean used and proven to be supportive in qualitative terms. Practitioners have in qualitative terms expressed their experiences of its use through out planning in four different exploratory exercises.

184

Moon, Il Chul
Kim, Eunice
Carley, Kathleen
Carnegie Mellon University

Track 6

Automated Influence Network Generation and the Node Parameter Sensitivity Analysis

An influence network is a directed graph extensively used for Effects-Based Operation. It contains nodes that represent events and links that encode causal relationships among events. It propagates the likelihood of each event through promotion or inhibition by its parents. As a subject matter expert often builds this network by hand, we helped simplify the influence network generation in Organization Risk Analyzer. The resulting influence network is generated from a multi-mode, multi-plex organizational network structure, and the generation scheme is based on assessing event flows and evaluating the factors on task management of the organization. To support the soundness of such network genera-tion, we provide sensitivity analysis of baseline probabilities, a major parameter of the model, by bootstrap sampling of the leaf nodes and propagating different levels of as-signed parameters. Finally, we provide an example of analysis by utilizing the introduced generation method and a dataset from 1998 US embassy bombing in Kenya.

4:00 - 4:30 Tues

016

Tolk, Andreas
Old Dominion University
Diallo, Saikou
Virginia Modeling Analyses & Simulation Center

Track 7

Community-of-Interest (COI) Model-based Languages enabling Composable Net-Centric Services

Net-centric services shall be designed to collaborate with other services used within the supported Community of Interest (COI). This requires that such services not only be integratable on the technical level and interoperable on the implementation level, but also that they are composable in the sense that they are semantically and pragmatically consistent and able to exchange information in a consistent and unambiguous way. In order to support Command-and-Control with Composable Net-centric Services, the human-machine interoperation must be supported as well as the machine-machine interoperation. This paper shows that techniques of computer linguistic can support the human-machine interface by structuring human-oriented representations into machine-oriented regular expressions that implement the unambiguous data exchange between machines. Distinguishing between these two domains is essential, as some requirements are mutually exclusive. In order to get the "best of both worlds," an aligned approach based on a COI model is needed. This COI model starts with the partners and their respective services and business processes, identifies the resulting infrastructure components, and derives the information exchange requirements. Model-based Data Engineering leads to the configuration of data exchange specifications between the services in form of an artificial language comprising regular expressions for the machine-machine communication. Computer linguistic methods are applied to accept and generate human-oriented representations, which potentially extend the information exchange specifications to capture new information not represented in the system requirements. The paper presents the framework that was partially applied for homeland security applications and in support of the joint rapid scenario generation activities of US Joint Forces Command.

218

Dean, David
Vincent, Alasdair
Mistry, Beejal
Dstl
Spaans, Mink
Petiet, Peter
TNO

Track 3

A process for placing the human at the centre of the constructive simulation

This paper will describe different aspects of human behaviour and characteristics that can be represented by modelling techniques, based on ongoing work within the UK Defence Science and Technology Laboratory (Dstl), the Nederland's Organisation for Applied Scientific Research (TNO) and the US Naval Postgraduate School (NPS). It will then propose how these characteristics can be used within a range of different types of constructive simulation, in particular agent based models. Importantly, it will also consider an integrated process of experimentation and analysis to validate and maintain development of human factors representations within constructive simulations.

4:00 - 4:30 Tues

086

Sturm, John
NuParadigm Government Systems

Track 2

Potential Benefits & Implications of Privacy Protection and Anonymity for Command & Control through "Hidden Communications Services"

As the style of warfare has changed to support sudden regional conflicts and ad hoc humanitarian missions for disaster relief (e.g., Hurricane Katrina), so has the style of Command & Control (C2) needed to incorporate civilian intelligence sources (non-government organizations-NGOs) and embrace government authorities. It is difficult to predict in advance what sources of intelligence will be used, and if one is communicating with "small civilian cells"; the Internet might be the only available channel. However, the need still exists to protect the sources & methods employed for intelligence gathering from disclosure. Likewise the deployment of military resources, such as naval vessels, needs to be protected even if serving civilian aid. One possible method of protecting intelligence and C2 communications would be through the creation of a "Hidden Communications Web Service" in which the source and destination of IP messaging was kept hidden/anonymous, but authentication and authorization for access could be maintained as needed. The concept of "Onion Routing" (Tor) was developed several years ago by Goldschlag, Reed, and Syverson at the Naval Research Laboratory to provide anonymity on the Internet and has led to many "civilian" implementations world-wide through open-source software (e.g., Tor).

096

Grant, Timothy
Netherlands Defence Academy
Essens, Peter
van der Kleij, Rick
TNO

Track 5

Reducing Operational Planning Cycle Time Using BPR and Concurrent Engineering

This paper reports on on-going research aimed at contributing to the development of a new conceptual model of planning by reducing the cycle time for operational planning by an order of magnitude or more. Experience in other domains show that this should be feasible using technologies such as intelligent planning and scheduling, simulation, and concurrent engineering. Business process re-engineering methods and cycle time reduction techniques are applied to the illustrative example of the Royal Netherlands Army's Decision Making Process. The results show that it is not sufficient to flatten or to plan concurrently at all levels of the organizational hierarchy. The planning process within each unit must itself be streamlined. The paper investigates incremental and radical measures for reducing the cycle time of the planning process. It makes recommendations for comparing a variety of planning processes, for further study of specific radical measures, and for concept development and experimentation.

205

Zhao, Ying
Kotak, Chetan
Zhou, Charles
Quantum Intelligence

Track 9

Semantical Machine Understanding

Semantical Machine Understanding is the foundation for automatic sense and decision making of multinational, multicultural, and coalition applications. We show an innovative semantical machine understanding system that can be installed on each node of a network and used as a semantic search engine. Innovations of such a system include 1) text mining: extract concepts and meaning clusters based

on contexts using pattern recognition and machine learning; 2) meaning learning: extract knowledge patterns that link human labeled meaning to raw data. The knowledge patterns can be applied to predict future data; and 3) collaborative meaning search: incorporate humans and machines to form a collaborative network to search and enhance the meaning iteratively. In this paper, we also show the feasibility of using a semantic search architecture and discuss the two ways it is drastically different from current search engines: 1) indexes embedded in agents are distributed and customized to the learning and knowledge patterns of their own environment and culture. This allows data providers to maintain their own data in their own environment, but still share indexes across peers; 2) Semantic machine understanding enables discovery of new information rather than popular information.

4:30 - 5:00 Tues

074

Genik, Lynne
Lefebvre, Julie
DRDC
Froh, Mike
RatworX

Track 1

Coalition Computer Network Defence (CND) Common Operating Picture (COP) Concept

This paper defines a conceptual Coalition Computer Network Defence (CND) Common Operating Picture (COP), its concept of operations, and identifies research challenges for providing such a capability. A Coalition CND COP consists of two aspects of information assurance (IA) in a coalition environment: technologies for secure information exchange and the automated exchange of multinational CND information; this paper focuses on the latter. Situational awareness (SA) is a vital part of CND, providing an understanding of the status of networks. CND SA encompasses IA information including available information technology (IT) services, IT infrastructure, vulnerabilities, safeguards, exploits, threats, alarms, and incidents. All of this information can contribute to a Coalition CND COP. We identify four reasons for automating the information exchange: human resistance to sharing, rapid events, a large information exchange volume, and information complexity. Scenarios involving a Coalition CND COP are presented to illustrate improved operational capabilities, including clearer SA, more efficient use of resources, and more effective CND action. It is shown that even a small amount of information sharing can have significant benefits. Finally, a number of research areas supporting a Coalition CND COP capability are detailed and prioritized.

031

Hansberger, Jeff
ARL

Track 4

The Distributed Cognitive Components of C2

Distributed cognition (Hutchins, 1995a) is a theoretical framework that explains cognitive activities embodied and situated within the work setting and the artifacts used in the environment. Distributed cognition emphasizes the distributed nature of cognitive phenomena across individuals, tools/technologies, and internal/external representations. The unit of analysis goes beyond the cognitions of a single individual and focuses on the functional system as a whole. Distributed cognition examines the relation between individuals, the task environment, and artifacts used for task completion. Among some of the distributed cognitive attributes are: 1) Coordination across agents; 2) situation assessment; 3) mental models; 4) memory demands; 5) adaptability; and 6) workload management. Command & Control (C2) systems can greatly benefit when examined and analyzed as a distributed cognitive system through its emphasis on these cognitive attributes of the system. The theoretical and analytical implications of applying this approach to C2 systems will be discussed based on recent application and analysis to a series of C2 experiments.

4:30 - 5:00 Tues

186

Taylor, Richard
DSTO

Track 6

Computability Issues of Efficiency and Effectiveness of Organisational Models

Building on methods from computability theory we show that any useful question about the efficiency or effectiveness of computational organisational models can have no solution method, algorithm, or program that generates correct answers for all such models and their inputs. Bounds on the extent to which a given method can generate correct answers are also provided. One way to ensure computable methods apply is to define an organisational question the resolution of which limits the operation of an organisational model to a finite time. In this case however we show that there is no way in general of speeding up the analysis apart from simply running the organisation, or a model of it, for the specified time.

018

Kingston, Gina
Hew, Patrick
DSTO

Track 7

Designing "Killer Applications" of NCW – A process to support creation and innovation

Research on Network-Centric Warfare (NCW) has largely focused on the development, implementation and impact of the supporting technical network. However, there are very few published examples of war fighting advantages arising from NCW perspectives, particularly of paradigm changes in warfare arising from innovative, network-centric concepts. This paper presents initial thoughts on a process for developing network-centred concepts for the future military, from case studies in the Australian context. In the authors" experience, it is not enough to develop a single concept; but necessary to articulate the landscape of possible options. The authors had to rethink their tools and thinking processes as a result, drawing upon the software development field for its experience in new product development.

256

Robledo, Luis
Godoy, Eduardo
Chilean Army

Track 10

SIGEN: Simulation for Training and Management on Emergency Situations

SIGEN is a modern network simulation software designed by the Chilean Army Simulation Center, the Northern Catholic University, and sponsored by the National Emergency Office from the Ministry of Internal Affairs, which allows management training between the components of an organization, through the interaction of their different roles under a given initial situation, and monitoring their reactions from further specific missions, reports or given information. This tool is designed to work with organizations and institutions in emergency management, under strenuous situations, allowing real time and after-action reviews.

4:30 - 5:00 Tues

065

Nyamekye, Kofi
Integrated Activity-Based Simulation Research

Track 2

Information Content for Adaptive Network Performance for C4ISR Systems-of-Systems: Queuing Theory and Axiomatic Design Approach

The paper presents information content for adaptive network performance for C4ISR systems-of-systems (SOS) using queuing theory and axiomatic design approach. The paper first summarizes the network types or configurations, the network classifications and the network properties. It also emphasizes that the network infrastructure is part of integrated systems-of-systems design and not as stove-piped systems. Drawing on the previous author's work, the paper emphasizes that the axiomatic design, integrated with Service-Oriented Architecture-Based Department of Defense Architecture Framework (SOA)-Based DODAF, establishes the scientific framework for designing integrated C4ISR systems-of-systems (SOS), of which the network infrastructure is a subsystem. The queuing models are presented for the network performance, and information content from AXIOM 2 of axiomatic design, is employed for the network optimization. The effect of information overload, on the network performance for the Net-Centric SOS, is also presented. The paper discusses that the Service-based modeling and simulation, and experimental tests are needed to generate the data for the queuing models for network performance and optimization of the C4ISR SOS. Intelligent decouplers that can provide extra bandwidths in the network to reduce information overload, and thus permit the network to dynamically adjust itself to uncertainties, has been discussed. The Design Navigation Method has been discussed for experimental and simulation design, and for optimization, under scenarios of multi-functional requirements (FRs) and interaction effects among the design parameters (DPs). Such an integrated queuing modeling and axiomatic design approach, is critical for designing and operating complex civil-military endeavors.

244

Shilling, Chris
Slavin, David
Pfizer International
Shamir, Eitan
Kings College
Linkov, Igor
USA Engineer RDC

Track 5

Enabling Organizational Innovation: Scientific Process and Military Experience

Increasing information richness and the changing socio-political environment in recent years have resulted in changes in corporate structure and organization. The growing challenges of organizational and technological complexities require the development of new organizational concepts. The effects of a combination of high complexity and high uncertainty have been recognized before in military settings. To take advantage of new technologies and manage information complexity, a theory of Network Centric Operations was developed. Mission Command and Network Centric Operations formulate organizational structure across functional domains (physical, informational, change this cognitive and social), in a way that is also applicable in a business setting. In response to an increase in decision complexity and regulations, academia has developed risk assessment and multi criteria decision analysis tools for use in military and industrial settings. We believe that the combination of military science with multi-criteria decision analysis and risk assessment has the potential to dramatically improve the credibility, efficiency and transparency of strategic and tactical decisions in industrial settings. This paper summarizes the military concepts of MC and NCO, and links them with mental modeling, risk assessment and decision analysis tools. Application of the combined framework for the pharmaceutical industry is also discussed.

4:30 - 5:00 Tues

219

McCubbin, Christopher
Cost, R.Scott
Dale, Markus
Worley, Paul
Bankman, Daniel
Johns Hopkins University Applied Physics Laboratory

Track 9

Extending Service Oriented Architectures to Edge Networks with Active Metadata and Swarming

Much work has been done on perfecting Service-Oriented Architectures (SOAs) in the case of connected networks and networks which have full-time access to centralized service directories. Networks which have sparse connectivity, mobile nodes, and limited bandwidth cannot use this model for a SOA. Many of today and tomorrow's tactical networks will have these limitations. We have designed and built a SOA which combines the advantages of swarming technology and active metadata, extending SOA and service invocation capability to these tactical edge networks. Autonomous mobile nodes within our swarming architecture also have the capability to reconfigure the edge network topology to optimize service response time, while at the same time completing complementary tasks such as area search. Our architecture is modeled on the successful Representational State Transfer (REST) architecture for Web Services. Metadata and service invocation are there for every lightweight and are capable of easily being transported through the limited-capability swarming network. Service responses can either be transmitted via direct link, if one exists, or can be transported via mobile swarming nodes for network delay-tolerance. We present the results of testing our architecture in a Chem Bio scenario during an officially-sponsored autonomy experiment.

5:00 - 5:30 Tues

111

Joseffson, Anders
Marklund, Joakim
Swedish Armed Forces Headquarters
Hansson, Lars-Åke
Swedish Defence Research Agency

Track 1

IDC2—a new C2 concept within the framework of a Network Based Defence Concept

The purpose of this paper is to introduce a network based Command and Control (C2) concept for the design and development of C2 methods, developed with and for the tactical levels of command, in the Swedish Armed Forces (SwAF). The concept - Integrated Dynamic Command and Control (IDC2) - contributes to the SwAF's ongoing transformation towards a network oriented capability. The purpose of IDC2 is to increase efficiency and adaptability in a networked C2 environment, ultimately to better realise operational outcomes. This is achieved through timely and adequate holistic understanding, within and between all levels of command, regarding what is to be achieved and why, greater flexibility in C2 and the choice of C2 method. IDC2 emphasize improved dialogue to gain a deeper understanding, through new means of communication. Integrated C2 involves synchronization of adequate C2 activities. Thereby, the synergy of the collective intellectual capacity contributes to a more comprehensive situational understanding, which supports adaptability and increased precision in the execution of operations. The Manoeuverist Approach and Mission Command still remain central pillars of the SwAF Approach to Operations, and IDC2 is a concept to improve the approach through a robust, network-based infrastructure for exchange of information in a non hierarchical way.

5:00 - 5:30 Tues

055

Valaker, Sigmund
Braathen, Karsten
FFI

Track 4

An Exploratory Study of Transactive Memory System Development in a Geographically Distributed Temporary Organization

As part of measuring training effectiveness of distributed simulation based training and exploring the impact of communication condition on military organizing, we conducted an exploratory investigation of transactive memory system (TMS) development in a distributed temporary organization comprising one Control and Report Center (CRC) and two frigate Anti-Air Warfare (AAW) teams. The JADE II joint tactical training capability prototype facilitated this investigation. TMS have been proposed as an important way in which organizations enable information processing. However, there is to our knowledge little research on TMS development in a military context. Specifically, whether exposing an organization to multiple training sessions in a short period of time would enhance a TMS were investigated in this study. Furthermore the impact of perceived task complexity, safety organizing and perceived media richness on TMS was investigated. The impact of TMS on mutual understanding and perceived situation awareness was also measured. The tentative findings suggest that differences in routines and vocabulary between CRC and the AAW organization on joint tasks necessitated this kind of training. Being able to make unforeseen events and coordination problems into an occasion for learning and develop shared vocabulary and routines seem to be particularly important for this kind of temporary and distributed organizations.

030

Hone, Geoffrey
Whitworth, Ian
Farmilo, Andy
Cranfield University
Swift, David
HQ Land Forces

Track 6

The Case for Coarse-grained After Action Review in Computer Aided Exercises

With rare exceptions, the use of a machine mediated instructional overlay is under-exploited in Computer Aided Exercises (CAX), such as Virtual and Constructive variants of simulation. In the latter, flagging, replay and alternating eye-points are well understood and widely used. Thereafter, however, the Exercise Controller (EXCON) is usually faced with a comprehensive log of every event that occurred during the CAX as his only after action resource to inform feedback to his trainees – a potential morass of data. Conversely, while such data may provide an exhaustive summary of what happened, it often provides little assistance to the EXCON as to why it occurred as it did – at least, not within a short enough time-frame likely to be of use in a training context, as contrasted with Operational Analysis of "War Gaming" where longer delays are generally more acceptable. The authors discuss two simple tool-based approaches that can enable an EXCON to offer a very fast, albeit, coarse grained, assessment of trainee performance in a CAX, so that trainees can better appreciate the consequences of their decisions. The first of these approaches can also be run as a trainee commander starts to prepare plans, thus allowing the EXCON to render a "before-and-after" judgment. It is argued that this will enhance the learning effectiveness of the After Action Review (AAR) in CAX.

5:00 - 5:30 Tues

137

Uruguay, André
Lessa, Nilton
Santos, Carmen
Instituto de Estudos Avançados
Costa, Paulo
George Mason University

Track 7

C2OLISEU—A Meta-Model for Research and Development of Complex Network Centric Operations

Complexity in net-centric systems is a clear and increasingly present trend in C2 development. Yet, support for research and development inside the dynamics of complex net-centric systems has been relatively shy. Addressing this issue, the present work introduces C2OLISEU, a meta-model designed to express concepts associated with network-centric systems operations, providing a meta-model that encompasses the four key domains of network centric operations: social, cognitive, information and physical. For the social and cognitive domains, a set of basic concepts is derived from well-established paradigms in computational organization theory and artificial intelligence. Concepts within the information domain are conveyed via a subset of the DoDAF framework's concepts for the operational and systemic views of C2 architectures. Finally, as a means to consistently support the physical domain, the meta-model includes a preliminary set of C2 metrics derived from the classic principles of war. We argue that C2OLISEU metrics will help to better characterize complex and adaptive systems trajectories, thus enabling the study of edge organizations. Further, by using concepts derived from DoDAF, the C2OLISEU meta-model greatly improves the understanding of research results by both systems engineers and managers, thus eliminating unwanted cognitive entropy and fostering the innovation process.

063

Lofdahl, Corey
BAE Systems

Track 3

Synthesizing Information for Senior Policy Makers using Simulation: Working through an EBO example with system dynamics

Modern computer systems have made ever-increasing amounts of processing power available to senior governmental decision makers, but this technology has at times overwhelmed them with large amounts of hard-to-interpret data. Modeling and simulation generally, and System Dynamics (SD) specifically, addresses data overload by "boiling down" the data and synthesizing information at the macro-level. This capability is demonstrated by showing that SD applies to Effects Based Operations (EBO) problems and by addressing an EBO example problem. In so doing, specific requirements are detailed and defined including visualization, quantification, data acquisition, system complexity, system integration, and model Verification, Validation, and Accreditation (VV&A). The paper concludes that, given the large amount of work that has gone into developing the SD methodology, current policy-tool development efforts that address fundamentally similar policy questions are likely to prove unsuccessful. An alternate path of using system dynamics as the policy tool of first choice, identifying requirements and gaps based on that effort, and then developing tools informed by those gaps will likely prove more successful.

5:00 - 5:30 Tues

207

Masi, Denise
Fischer, Martin
Garbin, David
Noblis

Track 2

GETS Survivability Analysis

The ability to communicate during emergencies is essential for government personnel. The mission of the National Communications System (NCS) includes planning for and provisioning National Security/Emergency Preparedness (NS/EP) communications for the federal government under all circumstances, including crisis or emergency, attack, recovery, and reconstitution. In support of its mission, NCS runs several emergency telecommunications priority service programs for federal government users, including the Government Emergency Telecommunications Service (GETS) and is currently investigating the need to evolve the GETS program toward IP capability. This study is an analysis of the survivability objectives for Next Generation Network (NGN) GETS Voice Services. We used IP-SURVIV, a Noblis Survivability Analysis tool, to analyze throughput and connectivity of a network topology similar to major ISP backbone as network elements are disabled. Three failure scenarios were analyzed: random electronics failures, directed / terrorist attacks, and natural disasters. Throughput and connectivity were examined under each scenario, and worst case results will be incorporated into survivability objectives for the network service providers.

100

Herranz, Joaquín
Desouza, Kevin
Roy, Sumit
University of Washington

Track 5

Coordination Strategies for Edge Organizations

This paper provides a critical analysis of coordination strategies related to Alberts and Hayes' (2003) conceptualization of Edge Organizations (EOs). According to Alberts and Hayes (2003), EOs offer a high-contrast alternative form of coordination when compared to hierarchical structures for command and control (C2). In this view, EOs resemble networks in their form and in their decentralized, adaptive, and dynamic functioning. This paper examines and extends current theoretical understanding of coordination strategies for EOs by providing a three-part analytical critique. The first part examines the EO concept from the critical perspective of organization theory. The second part questions the notion of EOs as an archetypical network form that is best able to combat terrorist organizations. We argue that terrorist organizations represent a range of organizational forms rather than a single network form. Consequently, EOs should likewise represent an adaptive range of organizational forms and coordination strategies. The third part provides a conceptual framework that builds upon the previous critiques and identifies a range of coordinating strategies for EOs that would enable leaders to use an analytical model in determining the strategic and operational trade-offs associated with different coordination strategies in multi-actor complex endeavors. We argue that the effectiveness and efficiency of the EO is related to its coordinating strategy. Consequently, the EO needs to be agile enough to choose the right coordinating strategy given the conditions of its internal and external environments. The internal environment includes the work and task allotments, while external environment considers the issues of coalition partners, goals, strategies, etc. Our paper contributes to building a more robust EO framework by providing a critical analysis of coordination strategies related to Alberts and Hayes' (2003) re-conceptualization of military organizations as EOs.

5:00 - 5:30 Tues

225

Loomis, Jeremy
Porter, Rob
Hittle, Audie
Desai, Chetan
White, Russ
ProLogic

Track 9

Net-centric Collaboration and Situational Awareness with an Advanced User-Defined Operational Picture (UDOP)

Historically, government organizations have developed "operations centers" as hubs for command and control functions. Over the past decade there has been significant interest in shared situational awareness and collaboration as well as improvement in networking capabilities, which has resulted in concepts and terms such as Common Operational Picture, Common Relevant Operational Picture, and User-Defined Operational Picture. These 'pictures' make operational information available directly to an individual's desktop (outside the operations centers). This paper defines and introduces the technology concepts for a User-Defined Operational Picture (UDOP) that enable collaboration by providing visual situational awareness to end-users working within an operational Network-Centric environment that is offering an increasing number of web service-enabled information sources. UDOPs are created, visualized, augmented, tailored, and shared by the organization to enhance situational awareness and support collaborative and hierarchical decision-making. The UDOP architecture supports 2D, 3D, and 4D (3D + time) visualization using COTS technologies. Implementation of a robust and flexible UDOP system relies on several key system design patterns that include Service Oriented Architecture (SOA), plug-in mechanisms, layer/filter models, and loose coupling. This paper will also describe one reference implementation of a UDOP system by reviewing an operationally deployed capability called Global Awareness Presentation Services (GAPS).

WEDNESDAY PRESENTATIONS

11:30 - 12:00 Wed

007

Moffat, James
Dstl

Track 1

The Response to Hurricane Katrina: A Case Study of Changing C2 Maturity

In work with NATO colleagues, I have developed a Maturity Model of NATO Network Enabled Capability (NEC) Command and Control (C2). This model consists of a number of levels of increasing C2 Maturity, ranging from Conflicted C2 to Agile C2, which reflect the NEC journey towards the 'NEC Mature' state, through increasing levels of agility. To validate this Maturity Model, I examined the case study of Hurricane Katrina, based on the following authoritative reports in the public domain. The US House of Representatives created a bipartisan committee to investigate the preparation for and response to Hurricane Katrina. In addition there was an independent report to the President led by the Department for Homeland Security. A report commissioned by the US Government examined the implications for the US Army and National Guard. In terms of our Maturity model, examples were observed of all Maturity Levels, during the build up to and immediate aftermath of the landfall of the hurricane, with the balance towards the Conflicted end. These maturity levels also changed over time in general. The key factors marking out these differing Maturity Levels were identified, where possible, and are consistent with the current NATO NEC C2 Maturity Model.

146

Hutchins, Susan
Kendall, Anthony
Bordetsky, Alex
Naval Postgraduate School

Track 4

Understanding Patterns of Team Collaboration Employed To Solve Unique Problems

'Macrocognition' is a nascent area of knowledge engineering that focuses on understanding how cognition emerges in natural environments. One goal for studying macrocognition is to understand the complexity entailed in inter- and intra-individual cognition. The goal of the research reported here is to better understand how team collaboration influences and facilitates the team's task performance. In this paper we describe our analysis of several complex team collaboration tasks: (a) firefighters from the Fire Department of New York on September 11, 2001, (b) air warfare teams on an Aegis ship, and (c) the team collaboration entailed in conducting Maritime Interdiction Operations. Team communications that transpired during three complex problem solving situations were analyzed to understand how teams collaborate to create new knowledge and decide on a course of action during complex, one-of-a-kind problems. Communications were analyzed using definitions of cognitive processes included in a conceptual model of team collaboration. These processes include: (1) individual knowledge building, (2) developing knowledge interoperability, (3) developing team shared understanding, and (4) team consensus. The way the team's cognitive behavior maps to the model of team collaboration is discussed along with differences in patterns of collaboration for different decision-making domains.

11:30 - 12:00 Wed

212

Hodicky, Jan
Frantis, Petr
University of Defence Brno

Track 8

Virtual Reality Devices in C2 Systems

The situational awareness and decision making support is the main objective of C2 system. Thus, the presentation layer architecture of C2 systems is one of the most important features for common understanding of a battlefield situation. The commander should have the option to choose the appropriate form of data presentation and interaction in the C2 system. The current state of the art in presenting of information is set by the US Force XXI Battle Command Brigade and Below (FBCB2) system and its new presentation layer component Command and Control in 3 dimensions (C3D) that renders the battlefield information into a 3 dimensions (3D) environment in real time. The paper deals with the Czech approach to the improvement of presentation layer in the currently used C2 system. It involves using an existing virtual reality presentation engine (designed for virtual simulators) as an additional presentation layer. This work has already been started as a defense research project that plans to deliver results in 2008. The currently developing presentation layer extends the 3D visualization of the battlefield situation and adds virtual reality (VR) device integration, supporting an interaction within the C2 system. The architecture utilizes head-mounted display, data gloves and motion tracking systems. The paper describes the current situation in this outgoing project, and then discusses the technical aspects of the solution.

130

Powell, Walter
Laskey, Kathryn Blackmond
Adelman, Leonard
Dorgan, Shiloh
Johnson, Ryan
George Mason University
Klementowski, Craig
Yost, Rick
VIECORE
Visone, Daniel
Braswell, Kenneth
TEC

Track 7

Evaluation of Advanced Automated Geospatial Tools: Agility in Complex Planning

In an era of limited funding, a rapid development and procurement process is necessary to provide warfighters with performance-enhancing tools. It is essential to accurately assess the value of the tools we develop, and to use this assessment to shape future research and development efforts. To assist its research and development efforts, the U.S. Army Topographic Engineering Center (TEC) is sponsoring a series of experiments to evaluate the value of its suite of Advanced Automated Geospatial Tools (AAGT), the Battlefield Terrain Reasoning and Awareness – Battle Command (BTRA-BC) Tools. The first experiment in this series, which was presented at the 12th ICCRTS, demonstrated the benefits of an AAGT in a strictly terrain analysis scenario. Building upon the results of the first experiment, the second experiment will evaluate the value of an AAGT in a more complex planning environment and with a scenario that requires more complex decision making. This paper discusses the scope of the second experiment, its hypotheses, and the experimental design.

11:30 - 12:00 Wed

128

Woodley, Robert
Gosnell, Michael
Noll, Warren
21st Century Systems

Track 3

Adding Culture to Command Decisions

It is well understood that local culture can drastically affect the types of responses to various military actions in foreign countries. However, attempting to predict culturally-influenced reactions is extremely difficult or narrow in scope (based off specific previous experiences). This work proposes a dynamic game-theoretic framework with culturally-defined probabilistic payoff matrices to predict inter-cultural threat responses. It will be shown that initial payoff matrices can be constructed from the World Values Survey (WVS) data. WVS provides standardized data collected from some 80 countries over the 6 occupied continents. Specific political action questions in the WVS are used to create culturally-specific probabilistic response tendencies for non-force, non-lethal force, or lethal force responses. These responses are combined to provide the initial game-theoretic payoff matrices which are then used in simulations. The results of various dynamic cultural interactions are discussed in relation to potential command decisions based on the potential for indicated types of responses.

083

Bowman, Elizabeth
Thomas, Jeffrey
ARL

Track 2

C2 of Unmanned Systems in Distributed ISR Operations

This paper describes a series of experiments to investigate issues of human-robot teaming and network centric operations. Experiment objectives were coordinated to address issues within and among the physical, communications, information, and human (cognitive/social) domain layers of the network. Objectives spanned the cognitive, social, and physical domains of the network. In the cognitive domain, researchers tested a predictive performance tool for robotic operators and measured operator situational awareness and workload during missions as these conditions related to reliance upon unmanned surveillance technologies. In the social domain, we documented the ad hoc development of social, task, and knowledge networks during missions. These human dimensions of the network were juxtaposed to the agile computing infrastructure operating over a Future Force surrogate network and an 802.11 network. Results show that many challenges exist across the layers of the network domain architecture. Primary among these is to develop a mobile ad hoc network (MANET) to support mobile and extended vehicle/dismount ranges in a variety of terrain conditions. In the cognitive/social domain, we need to understand what information Soldiers need from a network, when this information is of maximum use, and what form the information should take for maximum situational awareness and decision making.

11:30 - 12:00 Wed

150

Barker, Joseph
Woodley, Robert
Noll, Warren
21st Century Systems
Frantz, Albert
AFRL

Track 5

Multi-agent System for Rapid TST Decision Support

Our adversaries understand the need to limit their exposure time to preying USAF eyes. The enemy hides, exposes only during the briefest of time and then hides again. As the enemy adapts to our technology and finds methods to minimize their exposure, the F2T2EA "kill chain" had to be compressed from hours, to seconds. Obvious impediments to fast Time Sensitive Targets (TST) engagement are aircraft strike time and administrative delay in the kill chain. 21st Century Systems, Incorporated is developing RPAT Technicians to compress the F2T2EA timeline for support to near-instantaneous planning assessment and airborne weapons assignment for a team distributed in a ground control center and airborne control platform. Reactive planning against TSTs requires prior lists of "what-if" and "what-to-do" which will naturally accelerate the manual decision process. RPAT Technicians work inside the human decision loop to support the need for immediate answers. The key component of the system is the Decision Agent for Rapid TST, or DART. DARTs encapsulate human and pre-calculated knowledge in order to provide rapid, low-cost recommendations during emerging events. Supporting Technician agents interface with information systems and gather the data needed by DARTs for generating recommendations.

056

Hudgens, Bryan
Bordetsky, Alex
Naval Postgraduate School

Track 9

Feedback Models for Collaboration and Trust in Crisis Response Networks

Scholars have devoted increasing efforts to understanding crisis response networks (Denning 2006a, 2006b; Stephenson and Schnitzer 2006), especially in the case of networks comprised of disparate members who acknowledge no higher organizational authority. Coordination within disaster response networks is difficult for several reasons, including the chaotic nature of the crisis, a need for the various organizations to balance shared goals (crisis amelioration) and organization-specific goals, and the lack of a central organizing authority (Denning 2006a, 2006b; Stephenson and Schnitzer 2006). More recently, scholars (Stephenson and Schnitzer 2006) have suggested crisis response networks might be able to coordinate effectively in the absence of a central organizing authority. Grounded in general system theory (e.g., Bertalanffy 1962, 1968; Kast and Rosenzweig 1972; Senge 1990; Weinberg 1975), and particularly the use of feedback loops (Masuch 1985; Richardson 1999), this paper seeks to understand whether feedback loops comprised of reciprocal resource commitments can engender greater trust and commitment among organizations responding to a crisis. This paper describes a campaign of experimentation set in the Maritime Interdiction Operation, an experimental campaign operated by the Naval Postgraduate School's Center for Network Innovation and Experimentation.

1:00 - 1:30 Wed

162

Kramer, Franklin
Starr, Stuart
Wentz, Larry
NDU

Track 1

Towards a (Preliminary) Theory of Cyberpower

In the 2006 Quadrennial Defense Review, a request was made to have the Center for Technology and National Security Policy (CTNSP), National Defense University (NDU), develop a theory of cyberpower. It was noted that there was a need to develop a holistic framework that would enable policy makers to address cyber issues in proper perspective.

To satisfy that tasking, CTNSP convened five workshops, drawing on experts from government, industry, academia, and think tanks. Those workshops addressed a broad set of issues related to the evolution of cyberspace, cyberpower, cyberstrategy, and institutional factors that influence those factors (e.g., governance, legal issues). To develop the desired theory, this paper systematically addresses five key areas. First, the paper defines the key terms that are associated with cyberpower. Particular emphasis is placed on the terms "cyberspace", "cyberpower", and "cyberstrategy". Second, the paper categorizes the elements, constituent parts, and factors that yield a framework for thinking about cyberpower. Third, the paper explains the major factors that are driving the evolution of cyberspace and cyberpower. To support that effort, the paper presents strawman principles that characterize major trends. Fourth, the paper connects the various elements of cyberstrategy so that a policy maker can place issues in proper context. Finally, the theory anticipates key changes in cyberspace that are likely to affect decision making. In view of the dramatic changes that are taking place in cyberspace, it is important to stress that this effort must be regarded as a preliminary effort. It is expected that the theory will continue to evolve as key technical, social, and informational trends begin to stabilize.

067

Eggenhofer, Petra
Huber, Reiner
Richter, Sebastian
Universität der Bundeswehr München

Track 4

Communication Processes and Patterns in High-Performing Networked Teams—A Qualitative Analysis

The performance of networked teams depends both on the quality of the information infrastructure and team processes such as information sharing, sense-making, and collective decision-making. Communication represents a core factor enabling information exchange, development of shared mental models, discussion of options, and joint decision-making. Moreover, communication serves socio-emotional purposes such as trust building and the development of cohesion. This study explores the behavioral and leadership patterns emerging in the communication processes of teams playing a networked simulation game in which players had to identify targets randomly distributed over a virtual area. As sensors differed in coverage and precision, the team members needed to communicate and cooperate to develop shared awareness and arrive at the best possible decision. The recorded chat message data were content-analyzed and used for validation of existing team decision-making models. The results show that effective teams could be differentiated from less effective teams in terms of task-knowledge coordination, communication patterns, and emergent role structures. The results also suggest that certain communication behaviors influence team performance to a different degree depending on the phase of the decision process. The results of this study contribute to current knowledge on relationships between communication processes and performance outcomes, and have practical implications for network-enabled collaboration training.

1:00 - 1:30 Wed

092

Koons, Jack
Bordetsky, Alex
Naval Postgraduate School

Track 8

Knowledge Flow Mesh and its Dynamics: A Decision Support Environment

The exciting advances in modern communications and networking ability have spawned a revolution in decision support systems within the greater network centric framework. Note the ongoing development and operational use of unmanned aerial vehicles (UAVs) in the Global War on Terror and the geographically distributed C2 environment. Sensor saturation and the maturation of mobile technology has advanced at rate in which the current crop of decision and sense making technology has failed to pace against. This leads to one of the most interesting questions pertaining to the current field of decision support systems: Which one is best suited for today's rapidly adapting and evolving network centric tactical situations? In this paper we introduce the concept of knowledge flow mesh dynamics within a decision support environment, which we argue is the logical heir to a new type of decision support system as seen through the network centric lens. Using the ongoing work by the Naval Postgraduate School (NPS) and United States Special Operations Command Tactical Network Topology (TNT) Field Experimentation as a framework for exploration, we offer a systems approach to identifying those criteria which form the basis for the new decision support system. It is our goal that this model be incorporated in future versions of the NPS TNT Field Experiments for validation.

170

Ntuen, Celestine
Gwang-Myung, Kim
North Carolina A&T State University

Track 7

A Sensemaking Visualization Tool with Military Doctrinal Elements

The Army's Center of Battlefield Excellence in Human-Centric Command & Control Decision Making is exploring how to use information visualization to enable collaborative sensemaking. The goal is to provide a common operating picture with shared situation awareness in the context of dynamic task situations. We have developed a Sensemaking Support System (S3), a prototype sensemaking visualization tool with situation understanding capability and knowledge discovery components. We experimentally validate the utility of the tool through series of experiments from a set of minimally constructed stories (MCS) that contain the saliencies of unstructured battlefield information dynamics. The results show the followings: (a) the perception rating of S3 with respect to sensemaking cognitive measures was highly significant; b) the problem scenarios (MCS) were highly significant; and there were noticeable interaction effects between the cognitive measures and the problem types. Generally, the S3 software needs further improvement in representation fidelity of problems that mimic battle field situations. This is shown by the poor weighted ratings in a more chaotic scenario MCS3.

1:00 - 1:30 Wed

148

Levchuk, Georgiy
Skarin, Bruce
Serfaty, Daniel
Aptima
Pattipati, Krishna
University of Connecticut

Track 3

SECURE: Stochastic Enhanced Control of Unstable Regional Environments

In this paper, we present a conceptual integration of pattern classification, dual control under uncertainty, and social dynamics simulation technologies to address the problem of instability management. We conceptually designed a model called Stochastic Enhanced Control of Unstable Regional Environments (SECURE) to provide effective real-time early-warning and decision analysis for monitoring, assessing, forecasting, and preventing the regional conflicts and instability. Our current work is focused on validating the model against real-world and synthetic datasets, and will be reported in future publications. The SECURE calculates the indicator of a power balance in the area of interest based on the interaction network that defines the state of and relationships among the groups, organizations, institutions, and individual members of the society. Using this indicator, SECURE tracks the dynamics of the society of interest over time and develops robust dynamic action strategies to maintain stability and prevent crises. SECURE solution is based on the concept of dual control, a judicious integration of actions to influence the state of the environment of interest as well as to gain more knowledge about the true state of the environment. SECURE is enhanced with the social dynamics simulation models to generate possible dynamics of the society. Such dynamics form the models that are used by the predictive and decision algorithms to recognize and control current and future state of the environment.

180

Kalloniatis, Alexander
DSTO

Track 2

A New Paradigm for Dynamical Modelling of Networked C2 Processes

A new type of mathematical model for studying synchronisation of interacting C2 processes across complex networks is proposed. The approach surrenders the requirement to distinguish the various products of individual C2 processes (for example planning, execution of strategic, campaign or tactical activities to name a few), but does distinguish the time-scales of and interactions between individual processes. This enables representation of interacting C2-processes from across the strategic-operational-tactical spectrum of command within a mathematically elegant and compact model. More specifically, C2-processes within a given system must be self-synchronised while C2-processes for two adversaries must seek to outpace each other, as in Boyd's original OODA loop for air combat. It is argued that for C2-systems undertaking genuine Complex Endeavours this is an appropriate and manageable approach to modelling. The paper discusses how standard mathematical analysis enables the study of self-synchronisation and stability within the friendly C2-system in this approach. This will then enable assessment of different network structures and dynamical requirements for possible C2-systems of the future.

1:00 - 1:30 Wed

039

Carreño, José
Galdorisi, George
Siordia, Antonio
SPAWAR

Track 5

Leveraging Emerging Technology to Maintain Corporate Situational Awareness

Emerging web-based technologies present large organizations with a number of not-well-defined opportunities and challenges. Social networking utilities such as Facebook, LinkedIn, and personal weblogs have proliferated—becoming key information mediums for a younger generation entering the workforce. Nevertheless, large, established organizations are still coming to grips with the utility of Web 2.0 technologies. One possible context in which these tools can be successfully applied is in the knowledge management domain, specifically in providing enhanced situational awareness throughout a complex organization. This paper will address how a collaborative group of analysts at the Space and Naval Warfare Systems Center, San Diego is applying the "power to the edge" concepts by leveraging Web 2.0 technologies. Tasked with ensuring that Center leadership as well as those at the working level have the requisite situational awareness to succeed in a competitive and complex business environment, the Decision Support Group methodically developed products to ensure data from an increasingly diverse environment is transformed into useful information that facilitates decision-making, both in strategic and business development contexts. By taking the theory espoused by CCRP to push information to the "edge," and using emerging technology, the DSG ensures that information flows down to those who need it.

003

Winkowski, Dan
Krutsch, Michael
MITRE

Track 9

Collaborative Data Objects Enhanced Chat in Support of Net-Centric Collaboration

Today, chat is being used to form collaborative communities, within and across disparate groups, (e.g., DoD, Allies, Coalition Partners, State and Local Governments, Non-Governmental Organizations, Private Voluntary Organizations) working on shared purposes towards common goals. Collaborative Data Objects (CDOs) is a new, open, standards track, technology that brings chat into a net-centric world and improves the value of this light weight ubiquitous tool. CDOs are a method of adding tailored structured data (e.g., location, target, manifest, incident assessment task) to unstructured, conversational chat without disrupting the value that chat currently provides the DoD. In addition to organizing and providing a container for data focused conversations, CDOs provide a mechanism to expose the data, and the conversations, taking place in chat following the net-centric data mandate and turning chat into a DoD information service. Finally, the CDOs technology provides a mechanism for users within chat to invoke enterprise information services through the context of the CDO data structures and defined CDO specific actions. This capability reduces cognitive disruptions from application switching, eliminates re-keying errors, allows web service results to be integrated into the collaborative discourse, and provides a means to drive external applications (e.g. GIS displays). We believe that CDO-enabled chat is the new "command-line" of the enterprise.

1:30 - 2:00 Wed

232

Skarda, Bryan
Mills, Robert F.
McDonald, Todd
Strouble, Dennis
AFIT

Track 1

Operationalizing Social Engineering for Offensive Cyber Operations

This paper takes the stance that social engineering is an under appreciated tool that is available for use. As the Air Force steps into the cyber arena with the creation of a new Cyber Command, the cultivation and employment of all possible methods to achieve supremacy in that domain must necessarily achieve primary concern. Answering the implicit challenge in this statement, we explore social engineering. We start with a discussion on the background of social engineering, reviewing the exploits of Kevin Mitnick who is perhaps the most famous hacker in the United States and who made many of his biggest breakthroughs using social engineering techniques. We will also discuss the essence of social engineering, persuasion, and review some research being done at Stanford University by Dr. Fogg on a new area of study called Captology. We will explore Influence Operations, a term we believe implicity points to social engineering. Goes further into the realm of Influence Operations, drawing explicit parallels between concepts widely accepted in the Air Force and concepts familiar to the social engineer. Finally, takes social engineering and introduces a conceptual framework to apply it to the real world, a practical method for planning operations and performing Battle Damage Assessments (BDA) afterwards. This application and evaluation model is the real contribution of the research effort as it provides a starting point for the Air Force to begin formulating an implementation plan for offensive social engineering.

120

Waldenström, Christofer
Swedish National Defence College

Track 4

What Is Difficult in Naval Sensemaking?

This article is concerned with what decision makers perceive as difficult in military sensemaking. To answer this question interviews with 9 Swedish navy officers were conducted using issues from military planning manuals together with mission activities as basis for the questions. The results show that the respondents perceive difficulties in mainly three areas: the enemy (enemy forces, enemy courses of action); own courses of action; and, initiation of replanning. Looking at the reason for the perceived difficulties, uncertainty emerged as a major cause and the difficulties were linked to uncertainty in two ways: they were either caused by uncertainty or they could cause uncertainty. Sensemaking require two things of people: they have to come up with an idea of what to do, and they have to make sure that the idea accomplishes the mission. This study shows that what is difficult in sensemaking is not coming up with something to do; what is difficult is ensuring that the idea accomplishes the mission. Therefore support for sensemaking should focus on helping people in what they find difficult in deciding what will accomplish the mission.

1:30 - 2:00 Wed

107

Entin, Elliot
Weil, Shawn
Aptima
Hutchins, Susan
Kleinman, David
Hocevar, Susan
Kemple, William
Pfeiffer, Karl
Naval Postgraduate School

Track 8

Two Types of ISR Commands Under Two Different Mission Intensities: Examining ESG Concepts

The U.S. Navy is developing new maritime strategies and command structures to guide transformation efforts, to ensure the security of the global maritime commons in the new network-centric era, and to fit the challenges of the 21st century. The addition of an intelligence, surveillance, and reconnaissance (ISR) commander is one such innovative structural innovation that is under consideration. To empirically investigate different conceptualizations of ISR officers, we contrasted an ISR officer who coordinated--but did not own—ISR assets with an officer that coordinated—and owned—all ISR assets under low and high intensity mission conditions. Four teams comprised of three active duty officers were assigned to coordination or command ISR conditions and participated in two 90 minute experimental sessions using the Distributed Dynamic Decision-making simulator. The findings show that when task intensity was high the percentage of tasks correctly processed was higher when the ISR officer was a commander than a coordinator. We also found attack accuracy to be higher and action latency lower when mission intensity was high and the ISR officer was a commander. Implications for command and control organizations are discussed.

045

Miller, Gregory
Kujawski, Edouard
Naval Postgraduate School

Track 7

Integration of the Dynamic Model of Situated Cognition in the Design of Edge Organizations

Much of the R&D in Network Centric Warfare has been on technology. Improvements in connectivity and processing speed challenge the integration of technological and human elements into a single C2 framework. The Dynamic Model of Situated Cognition (DMSC) was developed as an analysis method explicitly representing the human-technology relationships. It takes into account that sensors are susceptible to errors and to attack; inaccurate data from technological systems may propagate as misinformation to decision-makers. Any organization, including edge organizations, then makes decisions under uncertainty. This paper analyzes the use of signal validation to address shortcomings of technological systems. The sensor system should present validated information to operators; and, when it cannot, it should identify uncertain information. Signal validation filters the blue forces' sensor errors and red forces' information warfare misinformation. As a result, the blue forces are presented with synthesized validated data or are informed it is uncertain. The impact of signal validation on knowledge flows and quality of decision-making in Command and Control processes using the DMSC is simulated with the computational modeling environment POW-ER (Project, Organization, and Work for Edge Research).

1:30 - 2:00 Wed

151

Waltz, Ed
BAE Systems

Track 3

Situation Analysis and Collaborative Planning for Complex Operations

Complex operations are conducted in environments that must be represented by large-scale systems of systems that include non-physical systems (e.g. political and, social networks, economies, information flows) intertwined with physical systems (e.g. infrastructures, military systems, etc.) that are adaptive and exhibit emergent (unexpected) behavior. Planning for such systems requires adaptive and robust approaches that are based in a comprehensive study of both the structure and the dynamics of these systems. This paper describes analysis and planning tools developed and evaluated in the DARPA Conflict Modeling, Planning and Outcomes Exploration (COMPOEX) Program for complex operations. The tools enable systems of systems analysts to compose conceptual, then computational models of regional and nation-level situations to explore the behavior of their interacting systems. The flexible simulation architecture allows agent-based models, systems dynamics models, Bayesian networks, linear program models, and other discrete-time models to be composed into an integrated political-military-economic-social-infrastructure and information (PMESII) simulation. The paper describes the concept of operations, the analysis and planning tools, and provides the results of formal experiments conducted with operational interagency teams on planning exercises using PMESII models across a range of lines of effort.

147

Singh, Gurminder
Naval Postgraduate School

Track 2

Hastily-Formed Networks for First Responders

First responders who participate in humanitarian assistance and disaster relief missions have many special requirements which are not common in normal civilian operations. These include the ability to get going with their mission with minimal infrastructure, tight-loop and frequent communication, light-weight equipment, ability to scale-up the team when needed, and finally, the longest-running and lightest power source for their equipment. We present a system called TwiddleNet, which harnesses the power of mobile devices, primarily smart phones, to enable 1) instant content capture and publish, 2) full owner control of content, and 3) search, view and download of content. TwiddleNet is most useful for first-responder networking and information sharing tasks which require immediate content capture and dissemination. TwiddleNet can be scaled up or down depending on the needs of the mission. The entire system can be run on handheld devices to support a small first-responder team, or on a mix of handheld devices and server-class computers to link together a large number of smartphones sharing images, music, videos and mobile-blogs. TwiddleNet is designed to support the first 48-72 hours of first responder missions. As a result, TwiddleNet assumes little infrastructure and provides sufficient redundancy to operate on alternate mechanisms.

157

Scacchi, Walt
Jensen, Chris
University of California, Irvine

Track 5

Governance in Open Source Software Development Projects: Towards a Model for Network-Centric Edge Organizations

Open source software development (OSSD) is a community-oriented, network-centric approach to building complex software systems. OSSD projects are typically organized as edge organizations that lack an explicit management regime to control and coordinate decentralized project work. However, a growing number of OSSD projects are developing, delivering, and supporting large-scale software systems that are

displacing proprietary software alternatives. The U.S. Department of Defense is now committed to the adoption and deployment of software-intensive systems with open architectures and OSS components for application areas including command and control systems. Recent empirical studies of OSSD projects reveal that OSS developers often self-organize into organizational forms we characterize as evolving socio-technical interaction networks (STINs). These STINs emerge in ways that effectively control semi-autonomous OSS developers and coordinate project activities to produce reliable and adaptive software systems. In this paper, we examine how practices and processes enable and govern edge organizations like OSSD projects when coalesced and configured as contingent, socio-technical interaction networks. In so doing, we draw on results from two ongoing case studies of governance activities and elements in a small and a large OSSD project.

1:30 - 2:00 Wed

035

DeStefano, Chad
Lachevet, Kurt
Carozzoni, Joseph
AFRL

Track 9

Distributed Planning in a Mixed-Initiative Environment

The USAF Command and Control (C2) is undergoing a transformation to enable a full-spectrum, joint warfighting capability. To be able to meet the future challenge of employing forces anywhere in the world in support of national security objectives, the USAF requires a highly synchronized, distributed planning and replanning capability that is flexible to adapt to any level of conflict. This paper describes an in-house program underway at the USAF Research Laboratory Information Directorate that is developing technologies to support the concepts of Network-Centric Operations (NCO). The research focus of this program is on the concepts and architecture needed to support the distributed, mixed-initiative planning required for NCO. Our system builds upon distributed blackboards and multi-agent systems to provide automated opportunistic planning capabilities for distributed C2 operations. An extensible UML model of plans has also been developed to support human-machine dialog for mix-initiative planning. The plan representation is object oriented, recursive, and supports plan fragment operations, a key concept for distributed planning. This paper will also discuss our future research directions, including the encoding of human-planner experience and expertise for rapid formation of distributed expert planning teams.

2:00 - 2:30 Wed

132

Powell, Gerald
Matheus, Christopher
Ulicny, Brian
Dionne, Robert
Kokar, Mieczyslaw
Lorenz, David
VIStology

Track 1

An Analysis of Situation Development in the Context of Contemporary Warfare

This paper is the result of an analysis of the Situation Development process as carried out today by the US Army in both conventional and unconventional (e.g., asymmetric, counterinsurgency and urban) warfare. Definitions of situation development in current field manuals and other doctrinal documents are almost exclusively confined to its application to conventional warfare in which the enemy is clearly defined, its operational strategies and tactics are well understood, the activities occurring on the battlefield can be finely monitored with deployed sensors and observers, and situations unfold over hours or days. In confrontations faced by today's military the enemy is often poorly defined and hard to differentiate from civilians, its modes of operation are evolving and lack a standardized military doctrine, its activities must be

gleaned primarily from human intelligence, and situations develop over months or years. The analysis outlined in this paper attempts to define situation development in a way that accounts for the new face of contemporary warfare. In addition, we present a breakdown of the situation development process to help elucidate various aspects of the problem that make it particularly challenging in the context of unconventional warfare.

2:00 - 2:30 Wed

139

van den Heuvel, Gijs
Grant, Tim
Soeters, Joe
Netherlands Defence Academy

Track 4

Research Model of Cultural Influences on Information Sharing via C2 Systems

Culture has been defined in many ways, but it is principally viewed as the fundamental system of meanings shared by members of a specific society, distinguishing one group or category of people from another. Complex endeavors are characterised by the great diversity of groups and categories of people involved. Collaboration between different nations, different branches and even groups or people from civilian organizations is inevitable. To work together effectively, they must share information. Information sharing is a complex process, even within one culture. Therefore, it can be expected that during complex endeavors, the challenges with information sharing are likely to be exacerbated due to cultural differences. The purpose of this paper is to propose a research model for experimentation to measure the influences of national, organizational, and professional cultures on information sharing via information technology during complex endeavors. The proposed model extends existing models in the literature. The paper motivates the research by recalling the centrality of information sharing in network-centric operations. A model, extended to cover 21st century military needs, is proposed. A possible programme of experimentation is developed based on the extended research model. The paper concludes by recommending a way ahead.

154

Boury-Brisset, Anne-Claire
DRDC

Track 8

Concepts and technologies for a knowledge environment supporting situation awareness

Military commanders and staff operating in a net-centric command and control setting are overwhelmed by an increasing number of information sources that are made available to them. Significant research has been achieved for a few years to provide military decision makers and operators in command centers with knowledge management tools and services that help gain situation awareness, such as enterprise knowledge portals. Many challenges remain in order to improve knowledge management services and provide users with information that is relevant to their operational goals in order to enable a better comprehension and interpretation of ongoing situations in context. Semantic technologies and ontologies can play a role in supporting information integration, annotation of unstructured information sources, enhanced search and retrieval from heterogeneous sources, and intelligent notification that would highlight key information or events without overwhelming the users. The paper reports on research aimed at building a knowledge environment for enhanced situational awareness, leveraging from recent advances in Web technologies. We will review the requirements for knowledge management services, and we will highlight promising techniques, technologies and standards related to service-oriented architectures, Semantic Web, ontologies, and intelligent agents, that could be used in this context.

2:00 - 2:30 Wed

002

Smith, Kip
Linköping University

Track 7

The Impact of Remote C2 on Soldiers' Performance and Trust in their Leader

An extreme implementation of remote command and control (C2) for the dismounted infantry would extract the platoon leader from the platoon and rely on mediated communication between foot soldiers and their leader(s). A review of Social Impact Theory predicts that extracting the platoon leader would produce decrements in soldier performance. This paper discusses an experiment that tests the prediction that immediacy (proximity) matters and the claim that trust partially mediates its impact in a simulated C2 setting. There are three findings. First, active duty soldiers completed oral commands more quickly when collocated with an unfamiliar leader than when that leader was sheltered at a remote location. Second, a questionnaire on trust in the leader revealed greater levels of trust in the collocated condition. Third, a set of regression equations reveal that trust mediates the influence of immediacy on the speed with which soldiers executed direct orders. These findings support arguments against plans that would extract platoon leaders from the field and replace them with remote C2 of platoons.

005

Schubert, Johan
Luigi Ferrara
Pontus Hörling
Johan Walter
Swedish Defence Research Agency

Track 3

A Decision Support System for Crowd Control

In this paper we describe the development of a decision support system for crowd control. Decision support is provided by suggesting a control strategy needed to control a specific current riot situation. Such control strategies consist of deployment of several police barriers with specific barrier positions and barrier strengths needed to control the riot. The control strategies are derived for a set of pre-stored example situations by using genetic algorithms where successive trial strategies are evaluated using stochastic agent-based simulation. The optimal control strategy for the current situation is constructed by first finding the best linear combination of pre-stored example situations. The optimal strategy is given as the same linear combination of associated strategies.

160

Gateau, Jamie
Bordetsky, Alex
Naval Postgraduate School

Track 2

Extending Simple Network Management Protocol (SNMP) Beyond Network Management: A MIB Architecture for Network-Centric Services

The promise of the Global Information Grid (GIG) includes connecting sensors, shooters and decision-makers who may not be physically co-located in a manner efficient for combat employment, decision-making and information sharing. Current information architecture strategies, such as Network-Centric Enterprise Services have started down one path, requiring the implementation of a Service Oriented Architecture (SOA) and all the requisite underpinnings thereof. These are, for an organization the size of the DoD a very large problem set in and of themselves. An additional unfortunate side effect of choosing a conventional SOA as the backdrop for the GIG is that only those devices capable of running an entire webserver/database stack are able to participate in the architecture, effectively excluding computationally constrained devices. Additionally, the connectivity requirements in a conventional SOA restrict

participation by bandwidth-constrained and intermittently connected entities. This paper investigates one possible solution, utilizing SNMP as the language and mechanism for sharing data between disparate systems. Specific decision-support MIBs will be developed to allow transmission of decision-specific information in both push (TRAP/SET) and pull (GET) directions.

2:00 - 2:30 Wed

012

Liebowitz, Jay
Ivanov, Emil
Johns Hopkins University

Track 5

Extending Cross-Generational Knowledge Flow Research in Edge Organizations

Today's organizations need to be adaptive and agile in order to deal with the rapidly changing environment and competitive pressures. Part of the challenge in doing so is examining the knowledge flows and knowledge gaps within the organizations, especially cross-generational knowledge flows. This paper is an extension of the authors' previous work in cross-generational knowledge flow research in edge organizations. Specifically, the current research is applying ontologies in this domain to then construct a survey instrument for application in two edge-like case organizations (one in the military and one in industry). Social/organizational network analysis is then used to gain insight into cross-generational knowledge flows in these organizations in order to recommend findings on the critical success factors needed to ensure positive cross-generational knowledge flows in edge organizations.

087

Kilian, James
Lockheed Martin

Track 9

Planning for Task Assignment Agility in Large Heterogeneous Teams

There are many circumstances in which a mission revolves around preventing the deployment of an adversary's assets. Ballistic/tactical missile defense, blockades, force protection, checkpoints for controlled area access and air defense applications all fit this paradigm. In these sorts of problems, uncertainty around the expected behavior of the adversary can be substantial. In their recent book, Alberts and Hayes distinguish between complicated and complex endeavors. In a complex situation, causal relations may no longer be well-understood and directly available for analysis. They may also be characterized by instability in the sense that small perturbations in initial conditions or temporal behaviors result in large changes in the resulting mission outcomes. In response, agility of planning and decision-making systems becomes paramount over notions of static optimality. A cooperative co-evolutionary computation approach to planning is derived here that is directed toward achieving agility in the task assignment configurations of large heterogeneous teams. Architectural context is also discussed in terms of fitting co-evolutionary computation strategies engaged in complex endeavors into Service-Oriented Architectures (SOA) and Event-Driven Architectures (EDA).

2:30 - 3:00 Wed

138

Gualtieri, James
Elm, William
Peffer, Jay
Resilient Cognitive Solutions

Track 1

Network-Centric Analysis and Representation Requirements for Successful Effects Based Operations

Achieving Effects Based Operations (EBO) desired impact requires a revolution in how EBO is conceptualized and represented to C2 decision-makers. An "effect" is the functional outcome, event or consequence that results from specific physical actions (Joint Publication 1-02). The relationships between the physical components of the adversary's system-of-systems are complex and must be represented as a set of many-to-many functional linkages, in order to make effective EBO targeting decisions. Current EBO conceptualizations tend to be based on physical metaphors (e.g., maps with icons), which mask the relationships between adversary systems, as well as mask the multi-functional capabilities of a single physical asset. Further, most current EBO assessments degrade into physical damage on target. The many-to-many functional-to-physical relationships form a network that can be characterized by its large number of disparate entities and which must be understood, in order to predict cascades of effects and other network behavior. Failing to identify network interactions and functional alternatives to C2 decision-makers may falsely lead them to the conclusion that the application of combat power to a single target will lead to the removal of that capability. The defining element necessary for achieving effects includes emphasis on developing support tools and a knowledge model capable of accurately representing the adversary's system-of-systems. This paper will outline an approach for conceptualizing and representing the many-to-many functional relationships inherent in EBO and offer visualization tools that enable C2 decision-makers to effectively execute EBO.

019

Johansson, Björn
Combitech AB
Nilsson, Susanna
Linköping University

Track 4

Augmented Reality as a tool to achieve common ground for network based operations

In complex collaborative situations, such as crisis management, actors from different domains and organizations must work together. This is especially evident in network based operations where virtually anyone in an organization should be able to contact someone else. However, collaborative work across organizational borders is not simple and confusion regarding use of terminology is not rare. This position paper presents a multi-user Augmented Reality (AR) application, where AR is used as a tool to aid cross-cultural communication in networked operations. AR is a technique that merges real and virtual information and presents it in the field of view of the user. An individual can thus look at a physical object at the same time as the AR-system overlays that particular object with a digital image, literally replacing its appearance with something else. Other objects such as text can also be placed in the field of vision. Earlier research has shown that humans normally have to spend significant effort at establishing a shared understanding, a common ground, when entering a collaborative activity. The larger the cultural differences and the competence level of the involved is, the more effort is needed. In future, network-based, operations, it is highly likely that people from different organizations, backgrounds or even countries will have to cooperate in ad-hoc situations. This paper suggests a way of using AR as a tool for enabling cooperation between users with different backgrounds by presenting personalized representations of for example map objects in a command center. By doing so, valuable time that normally would be spent on debating the meaning of an object, like when a military commander has to explain a military symbol to a civilian decision maker, can be reduced. Even differences in language could to some extent be bridged.

The paper explains the potential of AR in a collaborative scenario and suggests a design for a simple experiment to test the assumptions described.

2:30 - 3:00 Wed

173

Spetka, Scott
ITT Corp/SUNYIT
Flynn, Christopher
AFRL

Track 8

High Productivity Computing Systems for Command and Control

The most significant issue underlying all future command and control (C2) architectures is the ability to develop software that can harness the next generation of processors. Multicore processors, scaling into thousands of processors per chip will soon be prevalent in all C2 systems. The success of C2 systems will depend on our ability to adapt to the new processor technology. Existing C2 systems that implement scientific codes for image processing and many other applications have been a dominant user of high performance computers (HPCs) for several decades. However, increasingly diverse C2 applications are now also being adapted to HPCs, due to dropping prices and increased availability. The goal of the DARPA High Productivity Computing Systems (HPCS) program is to develop high performance computers that are substantially easier to program, thereby reducing software development cost and time to solution. We employ a publication/subscription information management (PSIM) system in a case study to compare new HPCS approaches to parallel code implementation with existing techniques. The PSIM system requires intensive CPU cycles and communications bandwidth, for brokering XML information objects between publishers and corresponding subscribers. The study compares two new HPCS languages, Chapel (Cray) and X10 (IBM), with the Message Passing Interface (MPI) standard.

088

North, Paul
Forsythe, Steve
Frey, Tim
Iny, Mandy
Ockerman, Jennifer
Pafford, Michael
Salamacha, Christine
Warfield, Joseph
Johns Hopkins University Applied Physics Laboratory

Track 7

Experimentation via the Use of an Executable Workflow Model to Evaluate C2 Decision Quality

This paper presents results of a Johns Hopkins University Applied Physics Laboratory (JHU/APL) multi-year command and control (C2) evaluation project. Results were based on experimentation conducted in FY07 to evaluate C2 decision quality during the execution of an emulated Prompt Global Strike (PGS) process via the use of an executable workflow model. The model characterized the activities of the Transition-To-Target (TTT) phase of the PGS process. It represented the sequencing relationships among the phase elements in the form of a workflow. Execution of the model drove a visual representation of workflow completion status, which was used to synchronize the actual conduct of the process by participants in response to a series of scenario-driven events. The model was also used to automatically record the responses of participants as they monitored execution of the TTT phase of the PGS, which were later used to analyze the effects of certain types of event data on the quality of decisions made by the participants during experimentation. Our experimental results demonstrated that our evaluation framework, and in particular, the use of an executable workflow model served as an effective means for evaluating decision quality associated with C2 processes.

2:30 - 3:00 Wed

156

Levchuk, Yuri
Lubyansky, Alexander
Aptima

Track 3

Cultural Agent Model to Predict inHabitant Opinion Reactions (CAMPHOR): Building and Applying a Dynamic Human Terrain Map

One of the strategic goals for the United States armed forces is to win over the hearts and minds of the population in a military theater of operations. Special Operations Forces (SOF) perform missions in part to help win this battle for hearts and minds. In order to be more effective in attaining this goal, SOF team leaders need easy and rapid access to accurate, timely, and detailed intelligence about the effect of mission actions on the opinions of the local population.

In this paper, we describe a methodology and a tool to improve the ability of intelligence officers to support SOF team leaders by providing an accurate and robust computer simulation of cultural dynamics that estimates the effect of SOF actions on local opinion. Social identity theory, theories from cognitive and social psychology, and theories related to social network analysis inform the structure of the model. Data architecture helps users to populate the model even without complete, high-quality data. With both model and data architecture, intelligence officers will be able to efficiently and effectively support SOF operations in pre-deployment, during mission planning, and in the field.

140

Grande, Darby
Levchuk, Georgiy
Stacy, E. Webb
Aptima
Kruger, Martin
ONR

Track 2

Identification of Adversarial Activities: Profiling Latent Uses of Facilities from Structural Data and Real-time Intelligence

Intelligence Preparation of the Battlefield (IPB) provides critical support for military planning and decision making. In both offensive and defensive operations, the IPB process gives a decision maker information about the enemy, including potential courses of action, as well as information about the environment in which he is working. Physical structures that can support repetitive crimes (such as IED supply chains or illegal drug trafficking) provide important information for C2 planning. Activities of interest must be situated somewhere, and the physical structures present in any given location change slowly. Knowledge of those structures and their capabilities therefore provide an effective lens through which to view activities, and therefore an effective means for attacking the problem.

In this paper we discuss the Facility Identification via Networks with Adaptive Links (FINAL) technology that Aptima is developing to find facilities associated with adversarial actions and discover the intent for their use. Based on algorithms that perform probabilistic network pattern identification from partial knowledge about network nodes, links, and their attributes, FINAL profiles the use of facilities by combining networks of data describing actual conditions and more abstract network models of repetitive crimes.

2:30 - 3:00 Wed

131

Holsapple, Clyde
Li, Xun
University of Kentucky

Track 5

Understanding Organizational Agility: A Work-Design Perspective

This paper introduces a unified theoretical model of organizational agility and investigates the attributes of knowledge-intensive work-design systems, which contribute to achieving and sustaining organizational agility. Even though there has been considerable research on the topic of agility, these studies are not unified regarding their conceptualizations of agility and/or tend to adopt fairly limited views of agility dimensionality. Here, we organize a review of existing definitions and conceptual models of organizational agility, and proceed to advance a relatively comprehensive model built from a work-design perspective. This new model offers a theoretical platform for understanding organizational agility. This paper further investigates those attributes of a work design system that contribute to organizational agility. A knowledge-intensive work-design system is an example of an edge organization. Its governance mechanism (participant engagement governance, network governance, and system dynamic governance) involves three work-design levels: strategic, operational, and episodic. We contend that an entrepreneurial governance pattern has attributes contributing to organization agility, whereby the impetus for its work-design efforts stem not from some deep hierarchical authority pattern, but rather is distributed among participants and through their networking dynamics. These attributes allow each participant positioned at the edge of the system to stay alert and respond to environing trends and forces, on behalf of the system and in concert with the system. Results of an illustrative case study are reported.

101

Risser, Matthew
Smallman, Harvey
Pacific Science & Engineering Group

Track 9

Networked Collaborative Intelligence Assessment

There is a recognized need to improve the exchange of information among the intelligence community; however, the barriers to effective sharing are high. One barrier is the lack of dedicated collaborative intelligence assessment tools and concepts of operation for their usage. As part of the Office of Naval Research (ONR) Collaborative Knowledge Interoperability (CKI) program, we are developing a networked collaborative intelligence analysis tool called JIGSAW (Joint Intelligence Graphical Situation Awareness Web). JIGSAW contains a shared graphical workspace for analysts to post and share their assessments to structure and facilitate their collaboration. This paper examined alternate JIGSAW collaborative architectures, who can see what and who can talk to whom, to determine their effect on collaborative assessment. In a four week in vivo evaluation, a web-based JIGSAW prototype was used by a Naval Postgraduate School (NPS) decision support class to work ten quasi-topical strategic analysis problems. Two design factors were manipulated: (1) the presence or absence of others' assessments in the visual workspace and (2) a centralized or decentralized collaborative discussion architecture mediating analyst discussions. Collaborative assessments were tracked over time and measured by a novel dispersion metric. The results revealed that the nature of the discussion architecture affects how quickly the assessment of analysts converges over time. Further, there was a noticeable trend to shift assessments towards confirming the hypotheses in the problems, suggestive of group confirmation bias. The results of the study can be used to inform the design of networked collaborative analysis systems to address decision biases and facilitate effective information exchange.

3:30 - 4:00 Wed

164

Levchuk, Yuri
Freeman, Jared
Levchuk, Georgiy
Aptima

Track 8

Applying A2C2 Framework to C2 Challenges of Maritime Headquarters with Maritime Operation Center

The Maritime Headquarters with Maritime Operations Centers (MHQ with MOC) is an Enabling Concept for Maritime Command and Control and the associated CONOPS. A Maritime Headquarters (MHQ) will perform both operational-level warfighting and fleet management/Title X activities supported by a Maritime Operations Center (MOC). The MHQ with MOC architecture development effort is currently under way for the Commander, SECOND Fleet (C2F), to specify the MHQ with MOC organizational relationships and operational nodes, activities/processes, information exchange requirements and associated systems, interfaces and communications links for a maritime headquarters with a maritime operations center within the FYDP, targeting full capability during the 2015 - 2020 timeframe. The initial phase of the architecture development is focusing on the maritime headquarters' operational-level warfighting responsibilities. A follow on effort will expand the scope of the MHQ with MOC architecture to incorporate fleet management activities/requirements and address the maritime headquarters fulfilling the role of a Joint Task Force (JTF) Commander.

049

Donovang-Kuhlisch, Margarete
Small, Michael
IBM

Track 4

Hybrid Collaborative Information Environments (CIE) for enhanced Decision Support

The implementation of effective decision support for network-enabled coalition operations is not a question of maintaining a set of isolated tools, but addresses the challenge of modelling and constantly enhancing an optimizing business process in itself. The quality of that process can be measured by its ability to sense and to respond to situations critical to the operation in order to continually improve and hasten progress to the operation's desired end state. Agile, adaptive collaboration on the cognitive and information domain among coalition members during operation needs to be accompanied by innovative anticipation tools, which in a state-of-the-art fashion are implemented as software agents within virtual and augmented reality (VR/AR) environments. This paper describes the technologies and core enterprise services for the implementation of hybrid CIE between human communities of interest and software agents and positions them within an architecture framework for sense & respond decision support: web-enabled ontologies, ontology-based semantic integration of real world and VR/AR, complex context and semantics sensitive event processing as well as activity and user sensitive computing. In addition, it reflects on the expected capability gains by adopting such an architecture.

032

Hansberger, Jeffrey
Schreiber, Craig
Spain, Randall
ARL

Track 6

C2 Network Analysis: Insights into Coordination & Understanding

The distributed cognitive framework (Hutchins, 1995) provides a structured and theoretical approach for analyzing cognitive characteristics beyond that of a single individual to that of a system comprising of

multiple individuals, tools, and the task environment. Among some of the attributes of a distributed cognitive system are: 1) coordination across agents 2) mental models, 3) situation assessment, 4) memory demands, 5) adaptability, and 6) workload management. This paper will address recent efforts, tools, and approaches on measuring and analyzing two of these distributed cognitive attributes through network analysis, coordination across agents and mental models. Network analysis was applied with different methods and emphasis to both attribute areas. The analysis of the coordination across agents applied network analysis to analyze the patterns of interactions across human and technological agents over-time. Collecting data related to coordination over time required specific capabilities that was not readily found among observational data collection tools and therefore required a custom program that we designed. Description of the requirements and implementation of this new observational network analysis tool as well as methods to visualize longitudinal network change is addressed. The analysis of mental models also utilizes a basic network analysis approach, namely structural knowledge. The examination of structural knowledge to assess individual mental models will be discussed to provide insight into understanding. Specifically applied to C2, this analysis can provide insight into the commander and/or staff's understanding.

3:30 - 4:00 Wed

051

Hafsoe, Trude
Johnsen, Frank
Norwegian Defence Research Establishment

Track 7

Reducing Network Load through Intelligent Content Filtering

Future international military operations will be more complex than traditional operations undertaken by just one nation; military units from different nations will have to cooperate with not only with each other but also with local governments and civil organizations in order to reach common goals and to ensure a shared understanding of each other's task and domain responsibility. One characteristic of such endeavors is that each organization brings with it its own information and communication systems. Interconnecting these communication systems will lead to an increase in the total amount of information available to users of these systems. One of the main challenges when building an information infrastructure to support such operations is to ensure information superiority; all users must get access to the information they need to perform efficiently, while at the same time avoiding that the user is flooded with irrelevant information. Making sure that only relevant information is transmitted is even more important in tactical systems, where communication resources are very limited. This paper describes the use of several different types of content filtering as a measure for reducing the network load, and presents the results of our experiments with content filtering in disadvantaged grids performed at NATO CWID 2007.

073

Stevens, Chiesha
Heacox, Nancy
Pacific Science & Engineering Group

Track 10

Using NATO Human View Products to improve Defense Support to Civil Authority (DSCA)

In this paper, we first provide background information about the four key phases of an interagency response to a crisis situation. This section introduces the concept of interagency crisis response and explains the ideal conditions under which crisis situations can be improved as well as the potential problems associated with each response phase. Second, we introduce Defense Support to Civil Authority (DSCA) and discuss the reasons that military-civilian operations in crisis scenarios can be especially problematic. Third, we describe the results from DSCA events during the FORCEnet Sea Trial experiments, also known as Trident Warrior (TW), in 2006 and 2007 and provide recommendations for improving interagency collaboration. Finally, we introduce the NATO Human View Architecture as a

unique tool to support and align our DSCA recommendations and facilitate improvements in military-civilian collaboration.

3:30 - 4:00 Wed

235

Ekman, Olof
Uhr, Christian
Lund University

Track 11

Crisis Specific Social Networks: The Interplay between Organisational Legitimacy and Personal Trust

Interpersonal trust has been recognized as key for co-ordinating multiple actors in non-hierarchical contexts, such as in endeavor specific social networks with multiple and culturally different actors. Despite this recognition, post response evaluations more often than not find that trust has been detrimentally fragile. We argue that such networks may build interpersonal trust through transfer when network members are new to each other, and that such transfer is related to how network members (trustors) perceive the legitimacy of the organization to which the trustee is associated. According to our view, an organization seen as legitimate (by trustors) in a specific endeavour may provide its representative (the trustee) with a starting capital of trust, but that this capital is fragile to cultural enactment. We base this on observations that suggest that, even if an organization is trusted, its culture may carry fundamentally different interpretative frames and that these frames, if enacted, may quickly erase a network members' starting capital of trust. We propose a model for this interaction in multicultural endeavours, building our argument on recent literature and illustrate our thoughts with participating observations from humanitarian relief efforts in Zaire, Kosovo the Tsunami response and a chemical discharge response in Sweden.

108

Koons, Jack
Bekatoros, Nikolaos
Nissen, Mark
Naval Postgraduate School

Track 5

C2 for Computer Networked Operations: Using Computational Experimentation to Identify Effects on Performance in Organizational Configurations within the Larger Network-Centric Environment

The role of computer networked operations (CNO) has taken on greater importance with the rise of network-centric warfare. Comprised primarily of defense, attack, and exploitation, the technological capabilities are growing exponentially, as is the rate of data exchange, yet the organizational configurations supporting CNO are slow to anticipate and react. This presents a serious issue in terms of command and control (C2), as such organizations do not fit well with their highly dynamic environments, nor are they suited well to the missions and expectations placed upon them. Contingency Theory offers excellent potential to inform leaders and policy makers regarding how to bring their C2 organizations and approaches into better fit, and hence to improve CNO performance. The key research question is, which organizational configurations provide the best CNO performance within the network-centric environment? Building upon a half century of rich, theoretical and empirical research in Contingency Theory, we construct computational models of CNO set within different organizational configurations taken from both theory and practice, and we employ the method of computational experimentation to examine the comparative performance of such different configurations. Results elucidate important insights into CNO C2, suitable for immediate policy and operational implementation, and expand the growing empirical basis to guide continued research along these lines.

3:30 - 4:00 Wed

114

Kruse, John
MITRE
Helquist, Joel
Utah Valley State College
Adkins, Mark
Accenture

Track 9

Large-Scale Collaboration for Ill-Structured Problems

Traditionally, military forces have relied on deconfliction to drive down complexity and situation awareness burdens. Network-Centric Operations (NCO), however. depend on thoughtful orchestration through improved situation awareness and self-synchronization. Commanders are expected to understand the situation, their superior's intent and anticipate the actions of those around them in a complex and volatile environment. To successfully meet these rigorous requirements, the net-centric organization must facilitate much higher levels of ad hoc, time-sensitive collaboration. Commanders and staffs need to quickly build and dissolve sophisticated links with many operational partners as they contend with ill-structured problems in a complex battlespace. Current collaboration tools are limited in that they force a tradeoff between the complexity of the collaborative engagement and the number of participants. Tools that can handle large numbers of active users only support simple collaboration (e.g., chat), while those that support complex interactions (e.g., whiteboard) are quite limited in the number of parallel users they can realistically support. In this paper, we propose a new model that can integrate large numbers of users in complex collaboration. This effort leverages the proven Group Support Systems pattern while addressing the problems that have kept such systems from moving into the mainstream.

4:00 - 4:30 Wed

015

Gunn, Kevin
Dandashi, Fatma
Edwards, David
MITRE

Track 8

A Service Oriented Architecture (SOA) Approach to Department of Defense Architecture Framework (DoDAF) Architecting

The scenario: (1) you have an environment with some idea of the requirements to transfer information in support of decision-making; (2) you know most of the "players" who will produce and consume this information, but perhaps not all of them; (3) there are existing automated systems in place that facilitate some of the information exchanges, and some systems that are planned or assumed; and (4) you are required to invest your budget constrained funds to migrate to a service-oriented architecture while maintaining your current capabilities. This paper starts with describing the "traditional" DoDAF approach to establish a common understanding of the problem space. We then define an approach toward guiding the infrastructure and investment plans toward a service-oriented solution.

4:00 - 4:30 Wed

066

Eggenhofer, Petra
Huber, Reiner
Lechner, Ulrike
Richter, Sebastian
Römer, Jens
Universität der Bundeswehr München

Track 4

The Effects of Individual and Team Characteristics, Organizational Design, Team Building and Trust on the Performance of Small Networked Teams

The ability to collaborate is one of the key variables underlying the tenets of network-enabled operations. Research findings suggest that the effectiveness of networked teams depends on command and control (C2) structure, the degree of virtuality, interaction means, human factors such as personality, competencies and attitudes of team members, trust, reciprocity, altruism, and resulting group dynamics. However, little is known as to which degree C2 structure affects team performance when information is ambiguous, and about the moderating role of human factors. This paper describes a multi-factorial research design developed to analyze the impact of C2 structures (hierarchy versus edge), reward structure (collective versus individual), and the degree of information quality on team performance, moderated by trust, reciprocity, altruism, personality-related team composition, and cohesiveness. The research design involves the application of a 2 x 2 x 2 experimental design to create eight experimental conditions under which team performance is measured using the simulation tool ELICIT ('Experimental Laboratory for Investigating Collaboration, Information-sharing, and Trust'), and assessment of the moderating effects of personality, trust, and cohesiveness. In addition, qualitative interaction analyses will be conducted to advance the current understanding of team processes. The results will enrich the existing knowledge of relations between C2, personality-related team composition, trust and related attitudes, robustness of teams vis-à-vis unfavorable information conditions, and collaborative decision-making.

153

Peffer, Jay
Tittle, James
Gualtieri, James
Elm, William
Resilient Cognitive Solutions

Track 6

How costly is your C2 Coordination? Assessing the coordination requirements within Command and Control

As the size and complexity of Command and Control (C2) domains continues to increase, new approaches (e.g., Net-Centric Warfare) have been proposed to dynamically recruit additional resources by creating distributed teams to handle rapidly changing situations. Although the added flexibility does have the potential to create C2 structures capable of responding to a wide array of challenges, this addition of distributed team members creates new coordination costs. The performance of the C2 team is impacted by the additional cognitive demands now required for team coordination and collaboration, in addition to the fundamental decisions of the domain.Recently, Voshell, Woods, Prue, and Fern (2007) have proposed Coordination Loops as a means of specifying the requirements for supporting distributed cognitive work. This paper will detail an extension of Coordination Loops from a functional perspective, to understand the relationship between coordination needs and the stress they place on specific decisions within a work domain (e.g. Emergency Management). By mapping organizationally defined roles onto a functional, goal-means decomposition of the domain, both the inherent information needs of the domain and the additional information needs for coordination can be understood in the same context. This approach yielded unique insights were gathered about coordination assessment and design to reduce cognitive and coordination workload.

4:00 - 4:30 Wed

052

Johnsen, Frank
Hafsøe, Trude
Norwegian Defence Research Establishment

Track 7

Using NFFI Web Services on the tactical level: An evaluation of compression techniques

Blue force tracking is recognized as one of the most important aspects of the Network Enabled Capabilities (NEC) concept. In complex endeavors where several different nations take part, blue force tracking is important to avoid possible blue-on-blue situations. To facilitate interoperability between nations, NATO has specified a format for exchange of friendly force tracking information; NATO Friendly Force Information (NFFI). Part of the NFFI specification is an XML schema to allow the exchange of blue force tracking information using a Web service. To make systems interoperable at all levels, it is desirable to use XML encoded NFFI also at the tactical level. XML, while being a standardized way to structure data, leads to large text documents that need to be exchanged. At the tactical level bandwidth is scarce, and measures must be taken if one is to use an NFFI Web service. By compressing the XML document it requires less bandwidth to transmit the same amount of information over the network, and it becomes feasible to use NFFI also at the tactical level. We have evaluated several different compression techniques on a set of tracks encoded as NFFI XML documents. It is clear that NFFI is very compression friendly, and the compression rate increases with the number of tracks contained in the NFFI document. In this paper, we present the results from our compression technique evaluation.

216

Trent, Stoney
Voshell, Martin
Fern, Lisa
Stephens, Robert
United States Military Academy

Track 10

Designing to Support Command and Control in Urban Firefighting

Recent fire disasters (e.g. 2000 Fireworks Factory, Enschede, NL; 2001 World Trade Center Attacks, NYC; 2007 Airline crashed into fuel warehouse, Sao Paolo, BR) have highlighted the need for support to incident commanders in emergency response situations. Contrary to technologists who introduce designs which are often clumsy and do not support critical tasks, human factors engineers take a problem-centered approach. This research and design project begins with a functional analysis of firefighting based on observations, interviews, doctrinal literature reviews, accident analysis, and simulations. The functional analysis then provides the design requirements for systems to support command and control for urban firefighters. These systems include personal tracking/alerting/communication devices, an interface for incident commanders, vehicular interfaces for fire companies, and an overarching architecture to support cross-echelon and interagency coordination. Recommendations are also made for improving Emergency Operations Centers. Findings from this project will provide unique insight for military command and control and inform decision makers about a design approach that applies to the development of future complex human-machine systems.

4:00 - 4:30 Wed

133

Larsson, Annika
Cranfield University
Rasmussen, Louise
Klein Associates

Track 11

Social sensemaking in multinational groups: a common ground approach

Research efforts to investigate culture in military command and control, or indeed in any form of headquarters, are of crucial importance now that both peacekeeping and warfighting are carried out on a multinational basis. One aspect of working in a coalition headquarters is doing collaborative planning, where the group needs to understand what they as a group have been told to do (i.e., the commander's intent) and what their part in the task is. This requires understanding the meaning of the task, and forming enough common ground to be able to coordinate group efforts. Meaning cannot be understood independently from communication, and is also reliant on coordination between both parties. We propose a theory of social sensemaking; that behaviours to create common ground are based on sensemaking strategies, and that specific strategies are used to uncover the knowledge necessary for finding sufficient and necessary common ground.

028

Kuusisto, Rauno
Finland Futures Research Centre

Track 5

Analyzing the Command and Control Maturity Levels of Collaborating Organizations

In this paper we present a methodology to evaluate collaboration relationship maturity level on emergent cross-organizational networks. The methodology is based on the command and control maturity level model presented by Alberts & Hayes (2007). A human information exchange meta-model (Kuusisto 2004) is applied to this maturity model. We show that maturity level of potential or actual collaboration situation can be evaluated by making key word and key expression analysis both of released information content of certain organizations, and of the contents of the discussions between various organizations during their collaboration situation. We show that the knowing the topics of released information and discussions will be relevant information to guide collaboration support system design. The advantage of this kind of methodology is twofold. It does not require great amount of detailed data, and it responds immediately to the changes of interaction relationships. The analysis of the maturity level of the collaboration situation or potential can be made on-line thus giving opportunity to make fast development of collaborating processes and services.

172

Chamberlain, Samuel
ARL
Keltz, Ilean
MASO

Track 9

Lessons Learned in Using and Adapting an Information Exchange Data Model

A primary objective of the Global Force Management Data Initiative is the deployment of a suite of information sources called organization servers (OS) that provide default organizational and forces structure data for the Department of Defense (DOD). The data in the OSs are produced and maintained by the agencies across the DOD who are responsible for this information. From the net-centric perspective, these seven sources are seven URLs on the Global Information Grid. The GFM Community of Interest (COI) made a decision to create a unified front across the suite of OS so that an information consumer can retrieve the managed organizational and force structure data in the same form regardless of

which source was accessed. This decision allows one to present a virtual DOD OS even though multiple sources are used. To accomplish this, a common access format had to be developed and agreed upon. This paper addresses several issues, some contentious, and lessons learned from their resolution which resulted in the creation of the GFM Information Exchange Data Model (IEDM), an augmented subset of an existing IEDM, and its associated transition to an XML Schema Definition (XSD).

4:30 - 5:00 Wed

119

Kohl, Andersonn
Brazilian Army

Track 8

Command and Control Systems Integration: A Brazilian Experience

This paper provides an overview of the Brazilian experience regarding the integration and interoperability among Command and Control systems. It covers examples spanning from the high level of all armed Forces, down to the lowest level, both inside and outside the Brazilian Army. The issues and capabilities related to the physical and link integration within the Army are presented for a range of technologies covering several types of radio frequencies, satellite and networks. The use of the Service Oriented Architectures for systems interoperability, including the civil segment, is also discussed along with the future for C2 process integration.

059

Jacobs, Jim
Lange, Amy
Watts, John
Bryan, John
Irk, Kathie
Raytheon
Sedlmeyer, Robert
Indiana University-Purdue University at Fort Wayne

Track 4

An Architecture for Policy-based C2 Decision Support Systems

At the 11th International Command and Control Research and Technology Symposium (ICCRTS), an architecture was proposed supporting a more flexible, policy-based approach to command and control systems.1 Such a system would be adaptable to ever-changing warfighter needs and different phases of modern conflicts. Policy in its many forms is an essential part of military decision-making with examples such as Commander's Guidance, Rules of Engagement, security restrictions, legal and international policies. Additionally, commanders use policy to shape missions, pair weapons with targets, allocate airspace, and request coordination. As policy use grows in importance, so does the need to flexibly adapt policy and to select the most relevant for the situation at hand. Systems that attempt to support the use of policy must move from hard-coded, predefined structures to more flexible representations expressed in the warfighters' terminology. A demonstration-of-concept architecture was built to explore policy-based decision support, combining a situational awareness ontology, a flexible policy engine with externally defined policies, a context manager, and intelligent agents. These architectural components were integrated with an existing Service Oriented Architecture (SOA)-based targeting tool called the Joint Target Manager and exercised in an experimental environment. This paper discusses this work including lessons learned and next steps in development.

4:30 - 5:00 Wed

203

Cramer, Megan
PMS495 Mine Warfare Program Office

Track 6

Understanding Information Uncertainty within the Context of a Net-Centric Data Model: A Mine Warfare Example

This paper examines the challenge of assessing operational measures of effectiveness given incomplete and often imperfect information. With the migration of software applications towards a service-oriented architecture and net-centric capability, the ability to capture, quantify, and aggregate uncertainty of information within a semantic framework will be integral to conveying the true operational picture. A potential way to represent the uncertainty of available data is through the incorporation of probabilistic information within a C2-focused semantic data structure. This paper establishes a notional framework for associating probabilities within a content-rich data structure and demonstrates this framework for the Mine Warfare operational measures of effectiveness. The management of multiple variable inputs and the improved bounding of uncertainty over time are developed within a Bayesian context. Finally, the implications of introducing a new method for handling uncertainty within an information-centric data model are explored.

200

Gnadt, William
Lockheed Martin

Track 7

SOVEREIGN: An Autonomous Neural System for Goal-oriented Mobile Robot Navigation

Command and control (C2) systems employ autonomous platforms for such tasks as force protection, surveillance, and search and rescue. The result is a growing need for adaptive control systems to focus data collection efforts, and reduce operator workloads, while addressing navigational demands. The SOVEREIGN (Self-Organizing, Vision, Expectation, Recognition, Emotion, Intelligent, Goal oriented Navigation) neural model embodies these capabilities, and is tested in a simplified 3D virtual reality environment. SOVEREIGN includes several interacting subsystems which model complementary properties of cortical What and Where processing streams. As a mobile robot, or animat, explores an environment, visual inputs are processed by networks that are sensitive to visual form and motion in the What and Where streams, respectively. Position-invariant and size invariant recognition categories are learned by real-time incremental learning in the What stream. Estimates of target position relative to the animat are computed in the Where stream, and can activate approach movements toward the target. Motion cues from animat locomotion can elicit head-orienting movements to bring a new target into view. Movement and visual category sequences are stored in working memories which can trigger learning of sensory and motor sequence categories, or plans. Rewarded plans effect a transition to efficient goal-oriented planned control.

057

Heier, Jeff
Schweitzer, James
MITRE
McCallister, James
HQ EUCOM/ECJ67

Track 10

Mashups and Their Use in the Civilian-Military Planning Process

This paper provides an overview of how Web 2.0 applications, specifically mashups, can be used to support Civilian-Military Operations (CMO) in the AFRICOM Theater of Operations to increase the

level of collaboration among the multi-national, transnational, and Non-Governmental Organizations (NGOs). As defined by Wikipedia, a mashup is "a Web application that combines data and/or functionality from more than one source", thus promoting better decision making. Today's complex security environment dictates collaborative execution of civilian and military operations by organizations with vastly different cultures, capabilities, and rules of engagement. However, these separate organizations typically develop communication systems focused on sharing information within their organization. The exchange of information outside their organizations is often very challenging. This paper describes various ways to overcome those challenges through the application of mashups.

4:30 - 5:00 Wed

008

Mahaffey, John
NATO C3 Agency The Hague

Track 11

Integrating Multinational Organizations in Complex Operations: Dampening the Learning Curve

Leo Buscaglia stated "change is the end result of all true learning." On a personal level learning manifests itself as formal and informal education. Learning and updating skills and expertise provides opportunity for the individual expand support to the organization at an individual level. Organizations can learn as well. This is especially relevant with regard to change. When groups of individuals change their actions in support of organizational goals, the organization maintains or enhances its effectiveness [Edmondson, et al, 2006]. Essentially, effective and positive change requires learning and learning facilitates change. Organizational learning is a key requirement for success within a dynamic environment. However, as organizations are made up of individuals, their capability and willingness to learn is a major factor in the development of programs and concepts for organizational training. The multinational organization has an even more difficult task. For these organizations, the development of training programs carry even more complex, especially when participants are characterized by multiple languages, cultures and levels of capability. This paper is about learning organizations, specifically multinational organizations that are thrust into complex operations with limited time and options for learning. The paper will define organizational learning and the learning organization as an entity. This will be followed by a discussion of learning modes with special emphasis on the role of leadership as a critical component in the leadership and management of diverse organizations focusing on a defined set of objectives. The paper will conclude with a review and discussion of these concepts using a multinational military exercise as the model. For the purposes of this paper, the military organization used as the model will be exercise Bold Avenger/Trial Quest 2007 (BAR/TQ 2007) and its constituent national and coalition armed forces.

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Drozdova, Katya
National Security Innovations

Track 5

Emergent Leadership in Network Organizations

Complex security endeavors require more agile organizations (Alberts & Hayes, 2007). Leading and organizing such endeavors presents new challenges. Modern military coalitions and civilian partnerships, for instance, challenge traditional notions of Command and Control (C2). New organization forms and rapidly evolving situations alter "the very logic that relates (C2) problems and solutions" (Alberts & Hayes 2003, 88-89). By studying how C2 networks emerge in specific missions, one can identify C2 design and redesign options that arise for leadership and the network—allowing one to better recognize and shape C2 in action. US Department of Defense's Experimental Laboratory for Investigating Collaboration, Information-sharing, and Trust (ELICIT) provides one platform for such study. It offers a fully-instrumented counterterrorist gaming research environment where individuals configured into different organizations jointly solve analytical tasks. This paper explores the use of ELICIT to examine leadership and emergent leadership in C2 networks. The paper highlights some of the analytical foundations based on organization and network theories and presents experimental research design options. It also discusses

an initial ELICIT leadership experiment approach using military leadership measures and the United States Military Academy (USMA) setting, and develops approaches for further study.

4:30 - 5:00 Wed

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Hansen, Bjørn Jervell
Norwegian Defence Research Establishment

Track 9

Application of Semantic Technologies in Network Based Defence

Semantic technologies can be described as technologies that provide tools and methods to build more adaptive and flexible software by separating the meaning of the information at hand from the source code and the information itself. Examples of such technologies include Semantic Web standards like RDF, OWL, and SPARQL. In a Norwegian Defence Research Establishment (FFI) activity, semantic technologies are studied in order to evaluate how they can be utilised in military applications. Of special interest is their use in providing flexible services within the information infrastructure in the forthcoming Norwegian Network Based Defence (NBD). NBD is the Norwegian adaptation of Network Centric Warfare, and is based upon utilising more extensive information sharing than what is currently being conducted in order to achieve improved shared situational awareness. This in turn is predicted to contribute to increased military effectiveness. An information infrastructure is necessary to implement NBD, and this paper presents our thoughts on how semantic technologies might contribute to solve several challenges in this infrastructure.

5:00 - 5:30 Wed

208

Tieso, John
Thornburg, Charles
Booz Allen Hamilton

Track 8

Managing the Life Cycle of Net-Centric Architectures

Information architecture development has been an integral part of the command and control community for many years, often as an exercise for satisfying legal, regulatory, or internal requirements to 'justify' requirements. The development of architectures has a broader meaning, and a critical purpose, especially in a net-centric environment. Over the past 8-10 years the question of net-centricity, and its relationship to command and control requirements, especially those involving increasingly integrated force execution through joint task forces, and other joint operations, have also increased the need for utilizing lessons learned in previous operations. Many of these operations or actions were documented in architectures, and the information described in these architectures has value, through reuse, in future operations. This paper discusses the life cycle of information architectures, and the concurrent need to organize, sort, maintain, review, and prepare architecture information for reuse. It shows how the data, organized as information, can be applied to other, similar circumstances when required. The paper also points out how frameworks for organizing data, such as the DoD Architecture Framework (DoDAF), the NATO Architecture Framework (NAF), and the Ministry of Defense Architecture Framework (MODAF) can contribute to coalition and multi-national solutions by reuse of existing architectural data.

037

Ford, Anthony
Lawton, James
Air Force Research Laboratory Information Directorate

Track 4

Synthesizing Disparate Experiences in Episodic Planning

Many decisions are actually made by synthesizing previous experience. Often, this involves many different experiences coming together to form a feasible solution. This paper presents a statistical model for

predicting the outcome of solutions based on multiple experiences. In edge organizations, such as emergency first responders, it often requires the expertise of more than one person to form an approach to a complex problem. Unfortunately, each planner only has access to his or her own memories. We propose to use an artificial intelligence decision aide to help bridge this gap, by reasoning over distributed collections of previous experiences. The key research questions that we address include: How can an artificial reasoner form a plan based on several disparate experiences from different sources? How can we gauge the potential efficacy of such a plan? How can we trust this plan if a clear line cannot be drawn to one author? We will also discuss such critical issues as analogies in planning with disparate experiences, civil-military planning by analogy, trust, provenance, and organizational issues in planning.

5:00 - 5:30 Wed

117

Rowe, Neil
Sjoberg, Eric
Adams, Paige
Naval Postgraduate School

Track 6

Automatically Tracing Information Flow of Vulnerability and Cyber-Attack Information through Text Strings

Quick dissemination of information about new vulnerabilities and attacks is essential to time-critical handling of threats in information security, but little systematic tracking has been done of it. We are developing data mining techniques to track the flow of such information by comparing important information-security Web sites, alert messages, and strings in packets to find similar words and sentences. We report on tools we have developed to collect relevant sentences, with a particular focus on comparing sentences from different sources to find patterns of quotation and influence. We report results on some representative pages that indicate some surprising information flows, for which the combination of both word matching and structure matching performed significantly better than either alone. We also report on preliminary work on the front lines of cyber-attack, trying to correlate text in intrusion-detection reports and even attack packets observed on a honeypot with reports of known attacks. These methods could help us automatically locate relevant fixes quickly when being attacked. Our tools will in general enable better design of incident response and incident reporting requirements for organizations, by showing bottlenecks and unused capabilities in the management of vulnerabilities and attacks.

206

Martin, Danielle
McEver, Jimmie
Evidence Based Research

Track 7

Metrics, Analysis and Methods for the Exploitation of ELICIT Experimental Data

The Command and Control Research Program (CCRP) has been involved in experimentation activities to investigate the C2 impact of cognition and collaboration processes, the distribution of decision rights, patterns of interaction, the structures of information flow, and other net centric related concepts. As a part of that effort, the CCRP has sponsored the design and development of a software environment for conducting human-in-the-loop experiments focused on information- and social-domain phenomena. This experimental environment, named ELICIT (Experimental Laboratory for Investigating Collaboration, Information-sharing, and Trust), presents a group of 17 players with an information distribution and assembly problem to explore how people share information and generate shared awareness. Experiments conducted to date using the ELICIT platform have generated a rich set of data, which, given current and emerging interest, is expected to continue to accumulate. To help the community effectively exploit these data, we have conducted illustrative analysis that suggests useful metrics for quantities of interest and methods for data extraction, analysis and visualization. This paper describes a set of metrics, analyses, and methods that may be useful to other members of the ELICIT community of interest, and that demonstrate the types of insights that can be gleaned from ELICIT experimentation.

5:00 - 5:30 Wed

213

Zumel, Nina
Quimba Software
Franco, Zeno
Beutler, Larry
Pacific Graduate School of Psychology

Track 10

Improvisation as a Training Framework for Emergency Managers

This paper describes the rationale and preliminary studies underlying our ongoing effort to develop improvisation-oriented training systems for Emergency Managers, in the context of multi-organizational crisis response. We view improvisation—the ability to "rework knowledge in novel ways under tight time constraints"—as an ideal framework for training emergency managers to cope with the rapidly evolving, complex task of coordinating the response to a large-scale crisis. Our efforts focus on response personnel at the operations center level and higher, rather than the field-response level; it is at these higher levels where many of the problems of coordination and communication, such as those observed in the response to Hurricane Katrina, will arise (Wachtendorf & Kendra, 2006). In this paper, we introduce some empirical findings that have guided the design of our system, and discuss them in the framework of theoretical discussions of improvisation, particularly in the emergency management context. We will discuss the attitudes of professional emergency managers regarding improvisation, perceptions of current training and practice in the field, and precursors to successful improvisation in the crisis management setting. Finally, we will discuss the implications of these findings for the design of emergency management training software systems.

025

Hecking, Matthias
Schwerdt, Christina
FGAN/FKIE

Track 11

Multilingual Information Extraction for Intelligence Purposes

The new deployments of the German Federal Armed Forces cause the necessity to analyze large quantities of intelligence reports and other documents written in different languages. For the monolingual information extraction we have build the ZENON system, which can be used for the (partial) content analysis of English HUMINT reports from the KFOR deployment of the Bundeswehr. In this paper, we present how we extended the ZENON system to do information extraction from texts written in different languages. The general hypothesis behind this work is the claim that information extraction on texts written in different languages yields better intelligence results. We present the main idea of multilingual information extraction and show, how named entity recognition was realized for Dari texts. A Dari-German dictionary extends the capability of the information extraction functionality. This is presented, as well as the morphological analysis of Dari verb groups. After a short introduction, the information extraction and the ZENON project are explained. In the main part of the paper, our approach to realize multilingual information extraction is described in detail. First, we explain our main idea. Then, we show named entity recognition for Dari texts, the integration of the Dari-German dictionary and the morphological analysis of the verb groups. Finally, open problems are discussed.

5:00 - 5:30 Wed

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Miles, Jonathan
Davison, Mike
Dstl

Track 5

Self-synchronisation and the future maritime force

Part of the potential benefit of NEC is based on an assumption that self synchronisation can be applied with advantage. The aim of this paper is to investigate alternative forms of synchronisation to see how NEC might impact the aggregation of low-capability individual units into a highly-capable agile Maritime Force. The alternative forms of synchronisation, from hierarchical- through to self-synchronisation are discussed. Characteristics of swarming (the extreme form of self-synchronisation) are explored and instances of swarming are included in the discussion, both from the natural world and from military history. Finally the appropriateness of self-synchronisation and swarming behaviours is discussed in the context of the maritime environment.

113

Hagiwara, Clifford
Gotaishi, Masahito
Aoki, Kazuo
Nihon University

Track 9

Network-Centric Healthcare Algorithm Development for the Behavior Change in Non-Intrusive way

This study presents an initial health promotional education system model of a Network-Centric healthcare management system which assists physicians or healthcare service providers to supply personalized contents for their patients or the pre-patients of lifestyle disease with precise, tailor-made direction leading to the healthier lifestyle behavior. The features of our trail system of systems are designed to realize the shared situation awareness between the pre-patients and the physicians or healthcare service providers and to release them from "compliance" by achieving self –synchronization. It is expected to encourage them to participate in a real or a virtual community healthcare. The goal of the system is to enable patients to detect the sign of the disease by themselves. Discussions on medical care on information security and human security protections the sensitive and specific clinical and health economics data are also designed in the algorithm of this pre-patients educational system.

THURSDAY PRESENTATIONS

11:30 - 12:00 Thurs

021

Grisogono, Anne-Marie
DSTO
Spaans, Mink
TNO

Track 1

Adaptive Use of Networks to Generate an Adaptive Task Force

Today's defense missions are complex endeavors which are characterized by a large number of disparate entities that include not only various military units but also civil authorities, multi-national and international organizations, non-governmental organizations, contractors, and private volunteer organizations. The effects of interest go far beyond military effects to include social, political, and economic effects. The nature of the participants makes the collective action space complex while the multi-domain effects space also contains complex interactions among effects of various type. In addition, the relationships between and among the action and effects spaces and the multiple scales, in particular multiple timescales, that are involved in these relations further contribute to the complexity of the endeavor. Numerous publications argue that forces as a whole, and their command and control in particular, need to put more emphasis on adaptive properties in order to cope with the complexity and the uncertainties that are part of such endeavors. This paper reflects the thinking of both TNO from the Netherlands and DSTO from Australia about this subject. We recognize that in large organizations such as defense forces, adaptive properties during complex operations do not in general arise spontaneously. Individuals may be inherently adaptive, but organizations are more naturally conservative and often stifle innovation and non-conforming risk-takers. It is necessary therefore to put effort into articulating what we really aspire to in terms of organizational adaptivity, and examining how it may be achieved.

129

Lenahan, Jack
Nash, Mike
Charles, Phil
SPAWAR

Track 4

Improved Decision Making in an Environment of Extreme Uncertainty through the Application of Augmented Cognition

The hypothesis of this paper is as follows: Uncertainty and inconsistency during complex endeavors can be reduced through the application of augmented cognition. An analysis of the genealogy of modern decision aides leads one to conclude that we should only be discussing the capability spectrum of intelligent software agents. We believe that this represents a limited view of the field of automated decision aides and assisted cognition. Instead of asking how smart the software agents can become, we would like to propose the following question: Can we make the human being smarter? Is it possible to improve cognitive functions inside the mind resulting in better selections of decision alternatives and interpretations of events? Is it possible to radically alter human training, development, and education to optimize the potential of every individual? The authors believe that the processes and tools being developed in the emerging field of augmented cognition 1 can be exploited to provide a novel fusion of more capable human beings and exotic software agents. This fusion should result in breakthrough levels of situational awareness and superior decision making in environments of extreme uncertainty.

11:30 - 12:00 Thurs

196

English, Thomas
Naval Surface Warfare Center
Shampine, David
Naval Ordnance Safety and Security Activity
Adams, Julie
Vanderbilt University
Muniak, Charles
Lockheed Martin
Kratovil, Edward
SAIC

Track 6

The Safety of Unmanned Systems: The Development of Safety Precepts for Unmanned Systems (UMS)

In October 2005, the Defense Safety Oversight Council (DSOC), Acquisition and Technology Programs Task Force (ATP TF) established an initiative to help ensure the safety of unmanned systems (UMS). This initiative was established in response to the proliferation of UMS within the Department of Defense (DoD), and a concern for safety when these systems, primarily unmanned air vehicles, were operated over populated areas, or in proximity to other aircraft, both military and civilian, and when configured with weapons or ordnance items. This paper discusses the process that was followed in developing the UMS safety precepts and the associated DoD UMS safety guidelines document. It will also discuss the environment in which UMS are currently employed, the safety concerns with those operational environments and designs, UMS guide objectives, and conclude with an example of a Command and Control/Situational Awareness precept.

009

Barrett, Frank
Nissen, Mark
Naval Postgraduate School

Track 5

Self-Organization and -Synchronization at the Edge: Situated Action, Identity and Improvisation

Self-organization and self-synchronization represent key capabilities for Edge organizations. However, roughly a century of organizations research indicates that self-organization leads often to a lack of complementary action, or even chaos, and that coherent self-synchronization is extremely difficult to achieve in organizations of the scale and complexity envisioned for Edge operations. Indeed, a major role of hierarchical organization—the antithesis of Edge—is to enable effective organization and coherent synchronization of people's activities. However, the majority of research and thinking reflects teleological action in a rational-cognitive framework, in which actors plan and decide before acting. This is incommensurate with the kinds of fluid, rapid, dynamic and often-unpredictable mission-environmental contexts envisioned for Edge organizations. In contrast, the research described in this paper takes a non-teleological, situated-action perspective to develop a basis for self-organization and –synchronization in an Edge organizational context. Such contrasting perspective examines how agents respond to emergent problems and contingencies without the benefit of clear goals or planning, and assumes that organizational members must act often without full awareness of consequences or articulation of purposes. Through extensive literature review (e.g., including pragmatic philosophy, phenomenological philosophy and practice theory), we show how a teleological view of action constrains the dynamics of improvisation, which are critical for self-organization and –synchronization, and how the corresponding identity construction delimits action and improvisational repertoires. We explain why a shift toward self-organization and –synchronization at the Edge requires a non-teleological view of action, and corresponding approaches to organizational design and transformation: such shift marks fundamental

identity change. The article leverages this theoretical understanding to illustrate how a Hierarchy organization can "move" to develop into an Edge. In particular, we articulate a set of maxims stemming from the theoretical integration, and then outline a three-phase approach to creating an Edge organization—an approach that enables its emergence, and supports its growth into and effective operational resource. This leads to important implications and guidelines for C2 policy and practice, as well as continued research, associated with Edge organizations.

11:30 - 12:00 Thurs

095

Huber, Reiner
Richter, Sebastian
Römer, Jens
Lechner, Ulrike
Universität der Bundeswehr München

Track 10

Assessment of C2 Maturity against the Background of Complexity of Disaster Relief Operations: Two Case Studies of the Tsunami 2004 and Elbe Flood 2002

The NATO RTO Research Study Group SAS-065 is currently developing a conceptual maturity model defining C2 maturity levels required to achieve requisite levels of network-enabled capability for complex NATO endeavors. The development of this NATO NEC C2 Maturity Model (N2C2M2) includes a series of validation case studies to investigate whether or not the observations available from case studies support the assumptions underlying the model as a basis for its iterative improvement. This paper presents two case studies on the response to recent natural disasters, the Indian Ocean Tsunami of 2004 and the Elbe Flood of 2002 in Germany, involving military and a variety of non-military entities including non-governmental organizations. Supplemented by various web accounts, both case studies are based mainly on reports by commissions tasked, by the UN and the Saxony state government respectively, to investigate the management and effectiveness of the response operations and make recommendations for improvement. The findings of the case studies are largely in line with the assumptions underlying the N2C2M2, the considerable differences of both operations in terms of scale, degree of preparedness, and the management of response resources notwithstanding. The comparison of the findings of both case studies supports the hypothesis of requisite maturity of C2 in that the lower complexity of the Elbe Flood operational environment enabled better use of available resources even though the structural maturity of the German C2 approach seemed not significantly higher than in the Tsunami case where C2 of international aid was quickly overwhelmed, however, by the high complexity of the operational environment.

217

de Nijs, Han
Williams, Andy
Supreme Allied Command Transformation

Track 11

On the Introduction of Effects Based Assessment into NATO's Processes, Organization and Tools

In 2006 the NATO Military Committee (MC) provided guidance to the two NATO Strategic Commands on key aspects of Effects Based Approach to Operations (EBAO). Whilst Allied Command Transformation (ACT) had already started work on EBAO in its experimental program in 2003, this guidance proved a starting point for EBAO thinking and development throughout ACT and Allied Command Operations (ACO). EBAO introduced 'effects' as a means to focus on outcome, results or end-state of an operation. To ensure this, the need for continuous analysis of the operational environment to provide improved situational understanding, and the necessity of feedback to the commander to allow the choice and synchronization of actions based on their contribution to the achievement of effects, was identified. Earlier feedback mechanisms allowed for a direct, causal relationship between actions and its effects, however, experiments simulating current operational theatres demonstrated that the derivation of appropriate measures for the assessment of effects proved to be a difficult and elaborate. NATO has not emphasized

assessment: campaign assessment is practiced in current NATO operations in Kosovo, Active Endeavour and ISAF, but these assessment practices are lacking the foundation of doctrine, tactics, techniques and procedures, and are short of proper investment in analysis capability—manpower, resources and tools.

11:30 - 12:00 Thurs

118

Sundram, Joshua
Sim, Phua Poh
Rowe, Neil
Singh, Gurminder
Naval Postgraduate School

Track 2

Assessment of Electromagnetic and Passive Diffuse Infrared Sensors in Detection of IED-Related Behavior

Persistent wireless sensor networks can be a cost-effective way to monitor public areas for suspicious behavior and reduce the need for military patrols. We examine here their applicability to the difficult problem of detecting emplacement of improvised explosive devices (IEDs). We first discuss the threat and how wireless sensor networks could help fight it; flexible and adaptable management of the sensor network is essential. We then report some experiments with magnetic and infrared sensors from Crossbow Technologies. We built a network of these sensors and ran human subjects through it engaged in various activities, some involving carrying of ferromagnetic materials. Results indicated that a variety of suspicious activities could be detected, though not all mock IEDs triggered detection, and triangulation was difficult due to the tendency of the signal to quickly saturate. Our network design is such that data can be easily aggregated in larger networks for broad-area automated monitoring of settings such as airports and busy urban areas.

248

Farrell, Philip
Canadian Forces Experimentation Centre

Track 9

New Operations Decision Support Requirements derived from a Control Theory Model of Effects-Based Thinking

New operations such as effects-based approach to operations, comprehensive approach to operations, or net-enabled operations (the Canadian name for Net Centric Operations) promise to facilitate effective interaction between people, technology, and effects while engaging a borderless but networked adversary. These new operations require effective decision support for critical decisions in lieu of potentially large amounts of communications and information sharing. The operations' decision support requirements are derived by looking at Effects-Based Thinking (EBT) from a Control Theory perspective, and then identify the operations' fundamental characteristics in a simple and straightforward manner. The EBT Control Theory perspective has a sequence of effects-based activities – planning, execution, assessment, decision-making, and analysis – expressed as a feedback control system structure. After studying each activity's process, organization, and technology, key decision support requirements are derived as follows: 1) Decision matrices should provide decision options based on desired and current effects. 2) Human-computer interfaces should display the status of effects. 3) Decisions should complement each other and be made known. 4) Staffs should understand their competencies, authorities, responsibilities, and the mission intent. 5) Computer technologies should support communications and information sharing. Arguably, these requirements will provide an engagement advantage when implemented in new operations.

1:00 - 1:30 Thurs

214

Smith, Edward
Clemente, Mark
Boeing
Grisogono, Anne-Marie
DSTO

Track 1

Cajole and Coordinate? C2 in Whole-of: -Government, -Nation, and -Coalition Action

This paper picks up where the succession of papers presented at the 10th, 11th, and 12th ICCRTS left off in ex-amining multi-level, multi-arena, cross stovepipe learning and adaptation in "whole-of:" action. It focuses on the requirements for and impediments to, vertical and horizontal social networking, and the application of insights from the theory of Effects Based Approaches and the science of Complex Adaptive Systems, to identify strategies for developing more effectiveness and coherence in these complex operations. We will explore the three way ten-sion between the individual, authority, and the community, and the nature of a dynamically adaptive approach to what used to be called Command and Control, but now needs a much broader reconceptualization.

136

Berg-Cross, Gary
EM&I
Kwon, Augustine
ICF International
Fu, Wai-Tat
University of Illinois at Urbana-Champaign

Track 4

A Cognitive-based Agent Architecture for Autonomous Situation Analysis

This paper presents a preliminary investigation on a cognitive basis for large scale, distributed intelligent agents with some level of autonomy. We believe that the proposed architecture can better address many known problems of machine based situation understanding. We propose a practical and economically feasible solution of intelligent agents adapting existing agent modeling frameworks, ontologies from semantic web technology as well as reasonable situation domain models. These can be brought together with a suitable cognitive architecture ACT-R (Adaptive Control of Thought—Rational) which could be used to provide key roles in more human-like situational awareness capability in emergency and disaster operations, especially where sensor information is harvested from semantically heterogeneous data sources. Existing situational ontologies and vocabularies can be supplemented by using DOLCE (Descriptive Ontology for Linguistic and Cognitive Engineering)'s formal ontology. This serves as a metalevel ontology that can relate different ontology modules and can generate new categories to extend ontology using agent learning as needed. Semantically-rich Descriptions & Situations ID&S) ontology can also be utilized to provide a theory of ontological contexts that can describe various types of context including non- physical situations, plans, and beliefs, as entities so they can be effectively communicated and understood among agents in order to reach a common situational view. Lastly the paper discusses the potential performance measurement issues and future research for this particular solution.

1:00 - 1:30 Thurs

061

Natter, Mandy
Ockerman, Jennifer
Baumgart, Leigh
Johns Hopkins University Applied Physics Laboratory

Track 6

Review of Cognitive Metrics for C2

Human cognitive knowledge, skills, and abilities are a significant component of complex command and control (C2), hence measuring cognitive aspects of C2 can provide critical value-added. Cognitive measures provide a consistent gauge to measure C2 cognitive effects. These measures can be used to compare cognitive impacts both between and within systems. Also, these measures help to analyze specific cognitive strengths and weaknesses, so that C2 systems can be improved. Likewise, they can be used to analyze training strengths and weaknesses, and improve training so that it is better suited to user needs. This paper summarizes an extensive literature review on macrocognitive metrics that apply to complex C2 assessment. Since a suite of cognitive metrics is required to assess C2 warfighters' actual and perceived effectiveness, guidance is provided on selecting appropriate macrocognitive metrics. Mental constructs researched in complex C2 domains including workload, situational awareness, decision making, and collaboration are highlighted. This paper defines each construct, provides measurement tools and techniques, and reviews the costs and benefits of each technique. The paper concludes with an explanation of how the mental constructs and their metrics are inter-related and suggests using several metrics together to assess and explore C2 in complex endeavors.

161

Clemence, Robert
McEver, Jimmie
Signori, David
Evidence Based Research
Hartley, Dean
Hartley Consultants
Sciarretta, Al
CNS Technologies
Starr, Stuart
Barcroft Research Institute

Track 3

Verification, Validation, and Accreditation (VV&A) of Complex Societal Models & Simulations (M&S)

The goal of this research program was to explore innovative approaches to performing verification, validation, and accreditation (VV&A) of composable political, military, economic, social, information, and infrastructure (PMESII) models. Consistent with that goal, the program focused on two objectives. First, it developed a "baseline" VV&A process that is well-suited to the development and evolution of DARPA's Conflict Modeling, Planning and Outcomes Experimentation (COMPOEX) program. Second, it developed highly accelerated VV&A processes for two conditions, compressed and hyper-compressed VV&A.

To establish the context for these objectives, this paper briefly characterizes the nature of the problem. That is followed by a brief description of the "baseline" VV&A approach that the study team has developed. The bulk of this paper focuses on innovative techniques for performing compressed and hyper-compressed VV&A. It describes the activities that must be performed during "baseline" VV&A to prepare the VV&A Team for compressed and hyper-compressed approaches. That leads to the formulation of several V&V techniques that are well-suited to these circumstances: experimental design, logic traceback,

and model comparison. These methods are described and residual challenges are identified. The paper concludes by identifying residual issues that should be addressed in future research efforts.

1:00 - 1:30 Thurs

221

Dourandish, Robert
Quimba Software

Track 10

Using Demographics to Enhance Command Functions

Whether it's a small town in a conflict zone or a neighborhood in a city inundated by disaster, US commanders are increasingly called upon to directly interact with the civilian population. Often vital to mission success, such interaction are equally complex and complicated due to many factors, such as culture, race, language, or religion that the commander must cope with, but can not either control or influence. Correctly implemented, however, interacting with the locals could yield significant intelligence about the adversary or contribute to winning of the "hearts and minds". Similarly, while supporting civilian emergency response, effective communication can bring calm to a distraught population and help with situation management. A key element of effective communication is tailoring the message to the audience. While nothing takes the place of spending time with the residents of a neighborhood, statistical socio-economic snapshots – demographics – can meaningfully summarize core neighborhood attributes and serve as an excellent reference or starting point for commanders. This paper focuses on how demographics can be used to enhance command functions. We first discuss nature and utility of demographics, including how a few metrics can accurately model significant properties of a large population segment. We briefly discuss how essential demographic metrics could easily be extrapolated for any neighborhood in the world using only open source tools and the Internet. We then discuss how demographics has successfully been used to remediate undesirable, but difficult-to-change behavior, such as smoking cessation. Finally, we conclude with the analysis of typical command functions and suggest where demographic extensions may be most useful.

043

Galdorisi, George
Hszieh, Stephanie
SPAWAR
McKearney, Terry
The Ranger Group

Track 11

Networking the Global Maritime Partnership

The modern-day notion of a "Global Maritime Partnership," first introduced by then-CNO Admiral Michael Mullen at the 2005 International Seapower Symposium as "The 1000-Ship Navy," and later enshrined in the new U.S. Maritime Strategy, A Cooperative Strategy for 21st Century Seapower, is rapidly gaining worldwide currency as many nations and navies seek to work together to combat global terrorism—as well as a host of other issues—in the maritime arena. But neither networking nor global maritime partnerships are new concepts and understanding the history of naval coalition operations and of networking in the maritime environment can help nations and navies understand the challenges to fielding an effective global maritime partnership in the 21st Century. Armed with this historical perspective, coalitions can begin to devise effective solutions to these challenges. One of the biggest challenges to instantiating an effective global maritime partnership is technical—how do the navies of disparate nations that desire to operate together at sea obtain the requisite, compatible C4ISR (command, control, communications, computers, intelligence, surveillance, and reconnaissance) systems that will enable them to truly "network" and make the global maritime partnership a reality. Unless or until the technical challenges to networking navies at sea are addressed by the U.S. Navy and by likely coalition navies, the dream of a global maritime partnership will never be achieved.

1:00 - 1:30 Thurs

098

McMahon, Margaret
Firkin, E. C.
Hagen, G. J.
Raytheon Solipsys

Track 9

Netcentric Operations with Hawaii's Emergency Management Center

This paper describes the Raytheon Solipsys Emergency Management Command System (EMCS) being developed for the Hawaii State Civil Defense's Emergency Management Center (EMC). The EMCS fuses airspace, maritime, and natural disaster data to increase situational awareness, and support early disaster alert or warning. The EMCS receives aircraft radar data from FAA and military sensors. Maritime data is obtained from each ship's Automatic Identification System (AIS), which provides the ship's identity and other specific information. Natural disaster data comes from various sources, including the Pacific Disaster Center (PDC). The fusion of data is done at the Raytheon Solipsys Network Application Integration Facility (NAIF) in Lihue, Kauai, Hawaii. A key component of the EMCS fusion engine is the Multi Source Correlator Tracker (MSCT). MSCT synthesizes track, tactical data link, and sensor information from multiple dissimilar sources to precisely construct a single integrated picture. The integrated results are presented on a modular flexible display system, such as the Tactical Display Framework (TDF). The EMCS implements a netcentric approach to a civil defense mission. Critical data can cross military, civilian and state government network boundaries; data is shared and fused into information essential for emergency preparation and response.

1:30 - 2:00 Thurs

036

Staskevich, Gennady
Hudack, Jeffrey
Lawton, James
Carozzoni, Joseph
AFRL

Track 1

Semantic Interoperability in Distributed Planning

The USAF Command and Control (C2) is undergoing a transformation from a co-located, theater-centric process to one that is worldwide and distributed. A key challenge for this transformation to Globally-Linked Air and Space Operations Centers is developing the ability to collaboratively plan and execute operations with multiple cooperating command centers. This paper describes an in-house program underway at the USAF Research Laboratory Information Directorate that is developing technologies to support the concepts of Network Centric Operations. In particular, research is presented that extends the Object Model Working Group's Core Plan Representation (CPR) framework utilizing semantic technologies to capture planning experiences in both human- and machine-readable form. A key feature of these extensions is common, interoperable plan representation amongst the distributed heterogeneous planning agents. Semantic interoperability of the plan representation is critical to support distributed planning. The initial approach to achieving interoperability is a limited taxonomy for describing key plan-related information. The research presented utilizes open standards semantic technology to encapsulate plans as self-describing semantic objects.

1:30 - 2:00 Thurs

053

Senglaub, Michael
Sandia National Laboratories

Track 4

Automated Decision Support in a Complex Information Space

A decision support architecture and embedded functionality is described that supports a decision maker in very complex environments dealing with massive amounts of disparate data, information and knowledge. To demonstrate some of the existing capabilities a couple of application domains are discussed. The solution to this system is a hybrid solution employing a number of technologies that are based on Peircean reasoning, modal logic, and formal concept analysis. The primary requirement of all the supporting technologies is that they have a basis in mathematical theory which ensures a validation process of the results based on mathematical solutions as opposed to conjecture or some form of utility function lacking verifiability. While the capability is rather robust in its present configuration, areas for further development and some research areas are identified with the intent of defining a complete decision support solution that is adequate for multiple domains and process configurations.

060

Acosta, Edmundo
Nolden, Wes
Gross, Tom
Air Mobility Command

Track 6

A Useful Methodology for Cost-Benefit Evaluations of Cognitive Process Improvements in Complex Command and Control (C2) Endeavors

Proposed solutions to identified C2 gaps can be at a disadvantage in the fierce competition for scarce dollars because they are often considered "soft" benefits (e.g., augmenting human cognition to improve performance). This paper describes a straightforward method to quantify and express "soft" benefits in monetary terms. Within a conventional cost-benefit structure, the proposed approach offers a tool to demonstrate "soft" cognitive improvements in "hard" dollars. This methodology is in use to quantify soft benefits of the Work-Centered Interfaced Distributed Environment (WIDE), a proposed enhancement to the Global Decision Support System. Evaluative experiments (specific to WIDE) demonstrate soft cognitive improvements in measurable values. These metrics are then transformed into dollar values, and incorporated into the benefits portion of the cost-benefit structure. In addition, other potential soft benefits from WIDE are quantified and monetized through cost-estimating techniques. Cost-Benefit Ratios and Return-on-Investment calculations are easily generated. This cost-benefit approach is a tool for advocates to (1) frame discussions of C2 solutions, (2) produce quantified responses to "what-if" challenges, and (3) to argue for the funding of "soft" proposals in "hard" dollar terms.

072

Taylor, Ivan
Petryk, Roman
DRDC

Track 3

Quantitative Models for Performance and Cost of Command, Control, Communications, Computers and Information Systems

Quantitative models of performance and cost for Command, Control, Communications, Computers and Information Systems were built to create viable force development options to help transform the Canadian Forces. A humanitarian operation was used as an example scenario and was broken into vignettes and tasks. The primary tool used to analyze the performance of these tasks was the decision cycle functions of orient, evaluate, decide and implement. It was assumed that the time available to complete this cycle was

tightly constrained for each task in the scenario. The status quo performance was given a nominal value based on the personnel available and the current configuration of technologies. Future technological options will streamline processes, making various systems interoperable by improving communications and information processing hardware, and decision support software. Costs were estimated using models of capital investment, operations personnel and maintenance factors. Force development options were constructed based on the possible tradeoffs between technology and personnel. It was demonstrated that, by introducing new technology, quantifiable performance improvements could be achieved while keeping costs constant, or alternatively, significant cost savings could be obtained without loss in performance.

1:30 - 2:00 Thurs

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Allen, Dave
Chow, Renee
Trinh, Kevin
Farrell, Philip
DRDC

Track 10

Information Management Processes in Support of Major Event Security

Modern threats to national security require a consolidated effort across many government agencies. In particular, to ensure the security for major public events, it is desirable to have an integrated security unit composed of staff from various agencies including: military, law enforcement (federal and provincial), as well as health and public safety agencies. This paper looks at the information management processes required to support the operational centre of an integrated security unit. More specifically, the paper describes the set-up and analytical results obtained from an experiment designed to test specific information management processes. The considered information management processes were developed considering previous national major events as well as various relevant concept of operation documents. The effectiveness of the processes was assessed by measuring: the situation awareness of the individuals participating in the experiment, the level of information shared between the individuals, the quality of the outcomes of the processes and the time required to perform these processes.

127

Iwanska, Lucja
21st Century Systems

Track 11

Automatic Acquisition of Multi-Cultural and Other Normative Knowledge for Modeling Typical Beliefs, Behaviors, and Situations

This paper discusses application of a natural language processing learning algorithm designed to automatically acquire from massive textual data normative knowledge about different cultures and their socio-economic characteristics, geo-political regions, and norms and habits of different population groups. We discuss a general-purpose, domain-independent, knowledge-based approach to modeling cultural and other normative aspects of human beliefs, behaviors, and situations. We present applications in which system-acquired normative knowledge can be used for advanced cultural modeling, enhancing different cultural models obtained via traditional methods such as manual questionnaires, in order to predict culturally correct contextual meanings and to predict likely future actions and reactions.

209

Heickerö, Roland
Swedish Defence Research Agency

Track 2

Terrorism online and the change of modus operandi

One consequense of rapid technological change in an information society is that the socio-economical and technical systems become more vulnerable to information related threats. The cost of electronic and digital

warfare is decreasing and at the same time knowledge about how to conduct information attacks is spreading to a large number of people due to the rapid growth of the Internet. Asymmetry is a characteristic, meaning that it is relatively cheap (generally speaking), to accomplish a cyber attack against a critical system such as SCADA (Supervisory Control And Data Acquisition). On the other hand, it is quite expensive to protect the same system from illegitimate influence. The lower barriers mean that new types of actors, such as hackers, crackers, criminals and cyber terrorist will use information warfare tools to achieve certain goals. In order to reduce dangers and to act proactively it is important to gain knowledge and to develop strategies and tactics for counter action to handle new type of threats and risks in an open society. New methods are required for analysing the motives and driving forces of insurgents in an information arena. The following paper initially discusses the term cyber terrorism and its logic in an asymmetric context. The insurgents' motives, driving forces, usage of information warfare means and weapons are shown. The methods a cyber aggressor could use to plan and conduct an operation and its effects and consequences are described in an actor-target-effect chain. The transformations of modus operandi for cyber terrorism are discussed and exemplified by the case of al-Qaeda and by other terrorist organisations. The paper ends with a short conclusion.

1:30 - 2:00 Thurs

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Adkins, Mark
Grosse, Geoff
Baldwin, Richard
Accenture
Coats, Randy
USAF
Kruse, John
AK Collaborations

Track 9

Network-Centric Command Decision Services (netCDS) for the Component Numbered Air Force (7th Air Force Korea and 13th Air Force)

The structure of the United States Air Force is changing with Headquarters United States Air Force Program Directive 06-09, entitled "Implementation of the Chief of Staff of the Air Force Direction to Establish Force Component Organization," As Component Number Air Forces (C-NAF) operationalize the directive, Command and Control systems must adapt with a network centric environment that supports distributed operations between the tactical and operational levels of war, to include reachback for shared resources and capabilities. C2 systems are required to enable the commanders to quickly focus on priority issues with appropriate and sufficient information to make decisions or to monitor tasks that the AFFOR Staff is executing. The AFFOR Staff requires enhanced situational awareness and collaboration capability to plan, monitor, and sustain operations. This requirement will enable the AFFOR staff to actively think and innovate with a focus on airpower analysis, planning, and execution — not a battle rhythm synchronized around static tools such as briefing slides and spreadsheets. This paper reports an action research case analysis of the employment of a network centric command decision service (netCDS) at the 7th and 13th Air Forces over an 18 to 24 month period. Critical guiding principals for this case analysis are the Network Centric Operations (NCO) framework, technology adoption and the Technology Transition Model as well as decision-making and human communication theories that can be used to examine and explain the behavior of users of network centric operation systems.

2:00 - 2:30 Thurs

085

Clemente, Mark
Boeing

Track 1

NATO: Flirting with a More Comprehensive Approach to Alliance Security

The North Atlantic Treaty Organization (NATO) was formed in 1949 as a hedge against a feared Soviet expansion into Western Europe. That never happened. Now the alliance is expanding east and evolving its focus. With footprints in Iraq, Afghanistan, Darfur, Bosnia, and Kosovo …, there's recognition in the alliance that the nature of collective security has changed. Preventative measures taken well "left of boom" require closer coordination from the disparate entities of NATO—and go well beyond the military tool kit. From the Riga Summit, "… today's challenges require a comprehensive approach by the international community involving a wide spectrum of civil and military instruments …" Easy to say, hard to do. This paper examines how NATO is experimenting with new ideas to address current challenges; as seen through the lens of a recently completed NATO sponsored lecture series on effects based approaches to operations. How can NATO evolve to effect closer cooperation between diplomatic, information, military, and economic functions that poorly interact within nations, much less between nations? The old structures and processes will no longer suffice.

102

Custy, John
SPAWAR
Rowe, Neil
Naval Postgraduate School

Track 4

Conditional Entropy for Deception Analysis

This paper describes how basic concepts from information theory can be used to analyze deception. We show how a general definition of deception can be mapped to a simple communication model known as a Z-channel, and we show that any deception has associated with it a closely related deception we call it's symmetric complement. These ideas allow computation of a specific form of conditional entropy which indicates the average uncertainty, in bits, that a deception imposes on a deception target. This uncertainty provides unique and general insight into a deceptions performance, and also indicates the general counter-deception potential available to a deception target. We then describe two deception-based mechanisms for computer security: the fake honeypot serves to inoculate a computer against intrusions; and the spoofing channel provides a safe and effective means for responding to in-progress computer intrusions. The spoofing channel is of fundamental interest because it is a deception equal to its symmetric complement

070

Martinez, Carlos
Cane, Sheila
Abdul-Rauf, Salwa
Smith, Kevin
Lee, Kristin
MITRE

Track 6

Application of Network Visualization to Identify Gaps in Complex Information System Architectures

This paper follows earlier work aimed at ensuring a connection between the information sharing needs of a large number of participants comprising a distributed command, control, and coordination network and the underlying communications capabilities that they possess; and on the relational model and database built as part of a subsequent effort to analyze the complex relationships involved. The relationships among

participants and their varied means of communications is captured in a relational database, which provides the means to automatically catalog needs and capabilities as well as to enumerate gaps between participants. However, complexity due to the large numbers of entities and relationships makes it difficult to readily identify the most critical gaps, or identify patterns in gaps among various classes of participants by using tabular reports alone. This paper examines the applicability of network visualization techniques linked directly to the underlying relational data elements to analyze and portray information in a more intuitive way, including identification, comprehension, and presentation of participant interdependent relationships and capability gaps. The paper will present a summary of the problem, a discussion of visualization techniques that will be used to conduct analyses, and an assessment of the utility of various visualization approaches. Since the paper is being written on the basis of current ongoing research and analysis in the classified arena, the paper will present notional examples rather than actual results.

2:00 - 2:30 Thurs

082

Arsenault, John
TRICOR Industries
Stephens, Larry
Dynamics Research Corporation

Track 3

Modeling Impacts of Operational Changes on Joint Campaign Effects

Analyses of air mobility capabilities traditionally assess performance across air refueling and airlift capacity over time. Consequently, efforts to improve timeliness and capacity gravitate towards increasing key enablers, (aircraft, C2, etc.). Analytical methods, though, have not adequately applied effects-based protocols to link air mobility execution to impacts on Joint warfighting. This paper describes an integrating approach to applying an effects-based protocol to assess value of air mobility performance (also applicable to other capabilities) to campaign execution. Programmatic support for capabilities gains momentum when results demonstrate direct benefits to joint warfighting effects. This study uses existing air mobility models with US Joint Forces Command's (USJFCOM) campaign model, Joint Analysis System (JAS), to explore and trace how operational actions improve effects-based operations. The paper expands work from the 12th ICCRTS ("Adapting C2 to the 21st Century," paper 184) to get to the "so what" concerns and focus of the Joint Force Commander (JFC), i.e., how air mobility capability changes can improve the JFC's achievement of campaign objectives. JAS variables provide mechanisms to portray changes in air mobility precision and velocity as more than just improvements in delivery times. This paper examines how different operational and campaign models can be used together to correlate operational changes to campaign effects.

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Chaum, Erik
NUWC
Christman, Gerard
OASD (NII)

Track 10

Making Stability Operations Less Complex While Improving Interoperability

Military support for stability, security, transition, and reconstruction as well as humanitarian assistance / disaster relief operations, are as important and complex endeavors as major combat operations. A strategy will be presented, in keeping with US Department of Defense Network Centric Data Sharing policies, to make information sharing during stabilization operations less complex and more effective. This paper exposes how the emerging Stability Operations community of interest can leverage an open standard semantic core for multination command and control information sharing and how it provides an essential, extensible, foundation for communication among international organizations, non-governmental organizations and the military during stability operations. The vision, strategy, and methodology for diminishing complexity and increasing interoperability is presented.

2:00 - 2:30 Thurs

190

Larsson, Annika
Cranfield University
Whiteley, Iya
Systems Engineering & Assessment
Kao, Anne
Poteet, Stephen
Xue, Ping
Boeing

Track 11

A Multidimensional Approach to Studying Cultural Differences and Coping Strategies in a Multinational Coalition Environment

Current and future coalition operations increasingly involve collaboration on operations beyond the traditional battlespace. The challenge is to communicate effectively among multinational teams and to understand each nation's developed communication culture. During multinational collaboration, communications are often via electronic networks. This, as a result, removes physical presence and rich context information with the important verbal, behavioural and cultural cues that are often vital to appropriately interpreting the content of the information. In addition, communication preferences, customs, variations in language use and other linguistic and cultural characteristics may create barriers between nations, even without electronic mediation. In this paper, we propose a multidimensional approach, which would capture major aspects of cross-cultural communication and provide a systematic and a comprehensive method for studying communication preferences and peculiarities in the light of cultural differences. More specifically, we propose to analyze data from cross-cultural, cognitive, and linguistic perspectives. Our approach will identify crucial elements involved in cross-cultural communication. Our approach will also discuss overall and individual strategies in collaborating, which can serve as a basis for training to improve multinational communication effectiveness.

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Kalloniatis, Alexander
DSTO

Track 2

Communications, C2-Entropy and Military Command

The concept of C2-Entropy is introduced, which seeks to build on heuristic principles such as Parkinson's Law, as well as approaches such as Perrow's Normal Accident Theory and Berniker's Organisational Cognitive Thermodynamics. This approach offers a quantitative framework for determining how entropy is distributed between the nodes and links of a C2 organisation. It describes how the complexity of a C2-system can lead to system failures while also giving the framework for understanding its capacity to deal with complex adversaries or environments. An intuitive explanation of "entropy" is given, with an explanation of the underlying formalism of non-equilibrium statistical mechanics. The concept itself is developed through the study of several characteristic historical military engagements—the Milvian Bridge battle, the withdrawal of ANZACs from Gallipoli and the Battle of Jutland. Initial steps in quantitative formulation are taken. The full development of this program of research is ambitious; nevertheless initial conclusions can be drawn about the role of C2 structure in the order/disorder properties of a military force, and the role of Military Command styles, such as Mission Command.

2:00 - 2:30 Thurs

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Hutchins, Susan
Gallup, Shelley
MacKinnon, Doug
Schacher, Gordon
Miller, Scot
Naval Postgraduate School
Freeman, Jared
Aptima
Dunaway, Dan
SYS Corp
Poeltler, Brad
Poeltler Consulting

Track 9

Enhancing Maritime Domain Awareness

A complex mosaic of forces will affect maritime security through 2020. These include economic forces such as (i) illegal international migration–fueled by tremendous population increases in developing countries, (ii) drug smuggling, and (iii) weapons proliferation, as well as (iv) military threats posed by hostile states, failed states, and transnational organizations engaged in intelligence gathering or terrorist activities. The President's National Security Strategy indicates that diverse threats such as these must be countered through an integrated approach: Maritime Domain Awareness (MDA). MDA will engage and shape this dynamic and expansive environment by detecting anomalies and deviations from established trends and patterns in commercial and military traffic, and enabling commanders to take appropriate action before security is compromised or crises erupt. In line with the theme for this year's symposium, C2 for complex endeavors, MDA encompasses a diverse set of organizations, complex processes, and a variety of analytic and collaborative tools. This research reported here will advance organizational structures, procedures and C2 technologies to enhance global MDA. Our approach is to document current MDA capabilities, compare them with the next phase of expected capabilities based on integrating new technologies, and document the gains.

2:30 - 3:00 Thurs

169

Curts, Raymond
Strategic Consulting
Campbell, Douglas
Syneca Research Group

Track 1

Transitioning from "Command & Control" To "Command & Trust"

During the Vietnam War, the Department of Defense Command & Control (C2) processes were confronted by an intensely agile adversary and a growing uncertainty concerning the impact of guerilla warfare on our forces. Such uncertainty resulted in a C2 mindset that pushed the C2 processes into a corner—resulting in the Commander-in-Chief placing the majority of all warfighting resources under his direct control. Forty years later, our current C2 mindset about the Iraq War has changed very little – squeeze the maximum out of every resource and person. Recent implementation of C2 includes the ability to dictate all activities; it seeks to preserve stability, predictability and centralized control. It worked well in World War II against fairly predictable strategies of armored and personnel movements. Today, multi-domain effects space is making our traditional C2 processes less effective. We need a different mindset, a different set of relationships, to reduce the complexity of the endeavors. In previous CCRTS papers the authors suggested alternative forms of C2 to include "Command & Collaborate" and "Command & Self-

Control." In this paper the authors present a revised C2 process they call "Command & Trust" that could result in evolving C2 into the 21st century if properly architected.

2:30 - 3:00 Thurs

076

Salamacha, Christine
Teates, H. Bennett
Johns Hopkins University, Applied Physics Laboratory

Track 4

A Framework for Effective, Interoperable Collaboration

Collaboration is essential for effective command and control (C2). Understanding collaboration and the needs of collaborative groups is fundamental to implementing effective collaboration environments capable of supporting a spectrum of team activities and fostering team effectiveness. Mapping collaboration activities to tools and technologies requires a fundamental understanding of how effective teams operate. Implementing interoperable collaboration environments that provide these capabilities poses unique interoperability challenges. This paper examines the literature concerning effective teams, addresses emerging technologies that make effective, interoperable collaboration feasible, and poses a framework for additional development of the requisite environment to achieve effective, interoperable collaboration. The paper concludes with a discussion of challenges to be addressed through research, prototyping, experimentation and process development to realize effective collaboration required by complex, distributed C2.

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Fiore, Stephen
Rosen, Michael
Salas, Eduardo
University of Central Florida
Letsky, Mike
ONR
Warner, Norm
NAVAIR

Track 6

Macrocognition in Command and Control: Understanding and assessing verbal and non-verbal communications during complex collaborative problem solving

Individual and team knowledge processing issues have typically been undervalued in assessing complex endeavors. The coming emphasis on special operations and the communication demands of effecting "power to the edge" have put the development of metrics for measuring knowledge interoperability at the forefront of assessing the effectiveness of complex endeavors. In this paper we discuss theoretical considerations in the area of macrocognition in teams, that is, cognition in collaborative contexts encompassing internalized and externalized processes occurring during team interaction (Letsky, Warner, Fiore, Rosen, & Salas, 2007). Macrocognition theory encompasses concepts ranging from internalized individual and contextually-bound cognitive processes such as mental model development (Klein et al., 2003), to externalized processes such as solution alternative negotiation (Fiore, Rosen, Salas, Burke, & Jentsch, in press) and we describe how this approach can provide a richer understanding of Command and Control components. For this paper we focus specifically on externalization of cognition and show how understanding and measuring the characteristics of communication patterns can contribute to the diagnosis of effective and ineffective behaviors in Command and Control. We propose that measuring macrocognitive processes is fundamental to: 1) furthering the conceptual understanding of macrocognition that will be needed to develop effective technology to support performance in modern C2; and, 2) managing performance in real-time in modern C2 operations. As discussed later, the need for real-time measurement is much more salient in modern C2 than in its traditional counterpart.

2:30 - 3:00 Thurs

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Allen, Thomas
Starr, Stuart
IDA
Bexfield, James
Office of the Secretary of Defense

Track 3

Perspectives on the Analysis Modeling & Simulation Business Plan

During the past year, the Department of Defense (DoD) has taken major steps to enhance its management of modeling and simulation (M&S) activities. As one facet of that change, it has focused on six functional communities of interest: experimentation, analysis, planning, acquisition, testing, and training. It has charged each functional community with the development of a M&S business plan. The initial result for the analysis community is an Analysis M&S Business Plan designed to support the development, fielding, and application of appropriate M&S capabilities to address national security strategic-level assessment issues. The plan articulates the community's vision and objectives, compares current capabilities to these objectives to identify gaps, draws on the results of surveys to prioritize those gaps, and formulates initiatives to address the highest priority gaps. These initiatives are aggregated into the categories of focused warfare activities to include redressing deficiencies in M&S of Irregular Warfare; cross-cutting activities that address specific aspects of warfare arenas, such as net-centric operations; and analysis M&S management activities such as proposed changes to M&S governance. The product is intended to be a living document that will be updated on a periodic basis to expand its scope and respond to the evolving needs of the broader analysis community.

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Norquist, Bruce
Colorado Army National Guard

Track 10

Common Operating Picture and Planning Environment for Disaster Response

The Common Operating Picture (COP) is a military acronym synonymous with seeing and understanding the battlespace and Joint Operating Area (JOA). When applied to a significant disaster, whether natural or manmade, the COP provides a timely view and perspective of responses within the JOA. In a large scale disaster the challenges of planning, coordinating and executing interagency, international and domestic response elements are compounded by the need for a quick life-saving response. The Common Operational Picture and Planning Environment (COPPE) is a theoretical approach and planning methodology, designed to leverage technology, Geospatial Information Systems (GIS) data and the situational awareness of the COP. The COPPE uses a basic principal to determine the population and critical infrastructure assets within a disaster area on to base response plans. Portions of the COPPE have been prototyped in coordination with the University of Denver ensuring technical viability of the proposed features. There are several technical prototype design issues that have been glossed for brevity. Lastly, the COPPE and its accompanying methodology are described against a mock disaster scenario to demonstrate its effectiveness.

2:30 - 3:00 Thurs

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Schade, Ulrich
FGAN-FKIE
Hieb, Michael
George Mason University

Track 11

A Linguistic Basis For Multi-Agency Coordination

n order to create the desired effects in a complex endeavor concerning a coalition of nations, as well as other agencies, there should be common understanding and a common intent. The creation and communication of this intent is a critical factor in the success of the endeavor, but often is overlooked. In this paper, we describe a language that expresses this common intent developed from a foundation of Command and Control (C2) business logic and generalized for Multi-Agency operations. Such a general language is not as brittle as the common message formats and data models that are currently the focus of interoperability. The abstraction of a language provides the flexibility for sharing intent and relating it to actions and reports, even if varying technology bases are brought by the organizations involved. The language described – the Multi-Agency Operations Language (MAOL) – is composed of three types of grammars covering: 1) Intent; 2) Actions; and 3) Reports. MAOL is designed for automated processing (to support a wide range of functionality including advanced decision support tools). Because the mix of services will not necessarily be known prior to an operation, it is even more important to have a foundation of a well-structured syntax and semantics with clear operational roles defined.

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Grimaila, Michael
Mills, Robert
AFIT
Fortson, Larry
AFRL

Track 2

An Automated Information Asset Tracking Methodology to Enable Timely Cyber Incident Mission Impact Assessment

The use of information technologies to enhance Command and Control (C2) processes has yielded enormous benefits in military operations. Commanders are able to make higher quality decisions by accessing multiple information resources; obtaining frequent updates; and by correlation between resources to reduce battlespace uncertainty. However, the dependence upon information technology creates significant operational risk that is often overlooked and is frequently underestimated. Risk management is the accepted process used to identify, value, and protect critical assets commensurate with their value. Risk analysis, the first step of the risk management process, requires the identification and documentation of organizational resources and determination of their criticality. While risk analysis is conceptually easy to understand, in practice it is difficult to conduct due to the dynamic nature of organizations, the temporal nature of operations, and the inherent subjectivity associated with valuation. In this paper, we propose a scalable, self-documenting, distributed information asset tracking methodology that identifies information dependencies, does not incur significant overhead, and prevents an adversary gaining knowledge from intercepted communications. The method is made feasible via the wide-spread deployment of Host-Based System Security software agents by JTF-GNO and can significantly enhance cyber damage assessment timeliness and accuracy and enables mission impact assessment.

2:30 - 3:00 Thurs

194

de Jong, Jeroen
Hiemstra, Hans
te Marvelde, Arjan
Thales
Burghouts, Gertjan
Schutte, , Klamer
Spaans, Mink
TNO
van Norden, Wilbert
Defence Materiel Organisation

Track 9

Hold Your Fire!: Preventing Fratricide in the Dismounted Soldier Domain

Since WWI, an estimated 15% of all soldiers killed in combat are attributed to fratricide, and recent military operations show no decline. A substantial amount concerns fratricide incidents between dismounted soldiers. However, most techniques introduced to prevent fratricide focus on inter-vehicle identification (IFF systems). In this feasibility study, we propose a decision support system that warns a dismounted soldier about to engage when there is a high risk of fratricide. The project has won the 2007 Innovation Game organized by the Dutch Ministry of Defense (MoD). The system will run on a new platform that is currently in development within the Dutch Soldier Modernisation Programme. This platform enables information exchange between soldiers and the Battlefield Management System (BMS), among which up-to-date soldier position information from GPS. Together with terrain information, also available in BMS, these soldier positions are taken into account when deriving an instant risk estimation for fratricide in the current shooting direction. The system is demonstrated using a simulation in which the village of Marnehuizen, built to train Military Operations on Urban Terrain (MOUT), serves as an example. The Dutch army has expressed great interest in the outcome of the study, and is currently investigating possibilities for actual implementation.

3:30 - 4:00 Thurs

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Hanlon, Brian
DSTO

Track 1

Enhancing Cooperation in Complex Endeavours through Quantum Information Exchange

The realities of complex endeavours necessitate the development of new approaches to command and control. While endeavours comprise entities seeking to cooperate towards overlapping goals, the level of cooperation actually achieved can be variable. Overcoming this limitation requires robust information sharing between participants as an important element of their engagement. Indeed, transformations introduced by the information age are providing such opportunities for organising endeavours. These are often framed around network-centric concepts based on the exchange of classically understood information. However, other information concepts may also be exploited. Novel new approaches, relying on the exchange of quantum information, are now being explored. Applied to bargaining situations represented by Games, the exchange of quantum information can allow for new types of cooperative behaviour to emerge. Directed to competitive domains, such as stock markets, the application of quantum information may introduce techniques for inducing cooperation and avoiding mutually disruptive behaviour. This paper will review the insights gained from the use of quantum information in bargaining situations and explore possible future applications to the command and control of complex endeavours.

3:30 - 4:00 Thurs

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Martinez, Sandra
U.S. Army War College

Track 4

Leadership as an Emergent Phenomenon: A Framework for Complexity and Adaptability

The recognition by some military leaders about the need for a different paradigm of leadership that responds to requirements for adaptability in complex environments has not necessarily translated into action. Existing organizational structures and processes which explicitly and tacitly support current ways of thinking and patterns of behavior often present obstacles to transformation. Nevertheless, changing the framework, structure, and processes in and by which a new generation of leaders are developed is a critical component of the current military cultural transformation. This paper will integrate knowledge from the C2 literature, constructive development theory, and organizational learning to lay the groundwork for an understanding and legitimacy of a new paradigm of leadership and leadership development arising from the application of an understanding of emergent phenomena (complexity theory) in the social sciences. Based on the metaphor of organizations as complex adaptive systems (cas), the paper describes attributes, mind-sets, and behavior that can effectively support organizational adaptability and transformation. Then the compatibility of the Leadership Development Framework (LDF) and the assessment instrument, the Leadership Development Profile (LDP), associated with this framework is delineated, as this measure appears to be one of the few validated leadership development instruments compatible with complexity. Thus, the paper will describe the cognitive basis for organizational adaptability, illustrate the compatibility between the LDF and non-linearity, show how this perspective builds on existing theoretical work and empirical data, and finally outline a proposed inter-institutional pilot project incorporating the LDF at the USAWC.

046

Miller, Gregory
Naval Postgraduate School

Track 6

Alternative Designs for a Joint Command, Control, Communications, Computers, and Intelligence (C4I) Capability Certification Management (JC3M) System

US DoD has tended to design Command & Control (C2) systems without consideration for them to interoperate for synergistic effects; each designed for one warfighting function. As systems have grown biologically into a System of Systems, achievement of mission-level effects has disappointed. Architecting the C2 SoS as a whole is improbable. However, capabilities-based acquisition requires interoperability certification based on delivering a war-fighter capability via SoS. Students at the Naval Postgraduate School examined this problem. Their result is the "Joint Capability Command and Control Management (JC3M)" system. This paper summarizes their efforts. A systems engineering process was applied to elicit requirements, create and simulate alternative solutions, and recommend a solution with life-cycle cost estimates. The simulation tools selected to support the project were CORE to model function and data flow; Arena for timing and resource utilization; and POW-ER (Project, Organization, Work for Edge Research) for organizational design and processes. The use of these tools to complement each other is unique. Results indicated that JTEM Capability Test Methodology (CTM) was projected to have better performance than other alternatives, with the median LCC. The final recommendation is to monitor JTEM CTM for further maturation as it promises improvements in the utility of C4I SoS evaluations.

3:30 - 4:00 Thurs

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Forsythe, Steven
Johns Hopkins University Applied Physics Laboratory

Track 3

A Generalized Command and Control Probability Model

This paper presents results of a Johns Hopkins University Applied Physics Laboratory (JHU/APL) effort on the fundamental theory of C2. Probability models have been used successfully in C2 applications where the objective was to destroy as many targets as possible. A "kill chain model," such as Find, Fix, Track, Target, Engage, Assess (F2T2EA), can be useful in evaluating military systems. Recently, Find, Fix, Finish (F3) has been used as a more general C2 probability model. This F3 model still assumes there is a target. This paper presents a generalized probability model based on the concept that C2 is a resource optimization problem, where a set of "opportunities" are identified and then a schedule of resources is applied towards those opportunities. This more general C2 model can be applied to a wider range of military situations, such as those dealing with asymmetric threats.

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Bell, Michael
Alidade

Track 10

Group Decision Making by Insects and Humans

A model developed by biologists to describe nest site selection by social insect colonies has been generalized and used to explore the group decision-making behavior of humans in organizations such as command staffs, integrated process teams, and other task groups. This decision process consists of an exploration phase, in which team members discover potential solutions to the problem at hand, a recruitment phase, in which advocates for a given solution attempt to persuade their colleagues to support that option, and a "voting" phase, in which a decision may be reached. A main focus of this work is the trade-off between speed and accuracy. For decisions made by a plurality vote with a specified quorum, speed may be increased by lowering the decision threshold (quorum) or by raising the effectiveness of recruiting. In principle, either approach reduces the average decision quality by favoring options discovered early in the process. Perhaps surprisingly, accurate decisions can often be made by much less than a majority vote; a quorum as small as 20% of the group may be sufficient. The process does not require individuals to make direct comparisons of the alternatives or to make highly accurate assessments of their quality.

064

Schwartz, Daniel
Knott, Benjamin
Galster, Scott
AFRL

Track 9

Effects of Visual Communication Tool and Separable Status Display on Team Performance and Subjective Workload in Air Battle Management

Tactical Air Battle Managers, such as AWACS Weapons Directors (WDs), perform as a team to effect command and control (C2) of assigned forces by planning, organizing, and directing operations. Specifically, AWACS WDs must coordinate offensive counter-air, defensive counter-air, and air refueling operations. AWACS WD teams accomplish their C2 function through networked collaboration that is typically supported by monitoring multiple radio communications channels under conditions of moderate to high ambient cabin noise while performing several visual and manual tasks. The purpose of this study is to compare team performance and subjective workload on a simulated AWACS scenario, for two conditions of communication (Voice-only, and Voice augmented with a Visual Communication Tool), and

using two supplementary display conditions (Separable Status Display and No-Separable Status Display). Team performance measures on the AWACS scenario include 1) the percentage of enemy targets that were allowed to penetrate friendly airspace, 2) the percentage of high value assets destroyed (i.e., the air base, infantry units, and tanker aircraft), 3) the percentage of fighter assets that were lost due to fuel depletion or enemy attack, 4) the average time of enemy target prosecution.

3:30 - 4:00 Thurs

124

Muller, Erik
Grant, Tim
Netherlands Defence Academy
Poll, Erik
Radboud University of Nijmegen

Track 2

Multi Level Security, 3.5 decades later

This paper will review the state-of-the-art in research into MLS, almost four decades since their original introduction, based partly on the first authors recent experience in FOB Ripley (Afghanistan). Examples will also include C2 models and systems being developed by the Royal Netherlands Army. Finally, the paper will draw conclusions and recommend further research in order to meet todays, but even more important, tomorrows complex challenges in military operations.

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Donnelly, Brian
Galster, Scott
AFRL

Track 9

Prioritization Taxonomy and Logic for Network-Centric Operations

The effects of network-centric operations would be degraded if not for inherent human or machine sensemaking capabilities. Without knowing the situation or understanding the actors and their disposition and intent, deciding and executing the most appropriate response is a futile activity. Collecting data and creating track information to resolve the intent and disposition of disparate actors is only possible by having an integrated intelligence, surveillance, and reconnaissance (ISR) network of humans and supporting systems. While ISR networks in the military context are becoming increasingly elaborate and more tightly 'networked' to perform their roles for a commander, so, too, must the underlying logic be developed to impart commander's intent on the ISR network such that it functions with the agility needed to keep pace with the dynamic environment. Dynamic networks rely on a foundation of interoperability standards, among which should be a prioritization taxonomy that baselines priorities of actors in the situation and dynamically allocates the ISR resources accordingly to achieve the desired effects. This paper examines the required characteristics of a prioritization taxonomy and proposes a sample framework for implementation.

4:00 - 4:30 Thurs

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Brehmer, Berndt
Swedish National Defence College

Track 1

Command and Control Research is a "Science of the Artificial"

This paper is concerned with the nature and development of a science of Command and Control (C2). The concept of C2 science is discussed from the point of view of Simon's (1996) concept "the sciences of the artificial", i.e., the sciences concerned with how we achieve goals by means of design of artifacts (including our own thinking). Applying Simon's conceptual framework, C2 is analyzed in terms of a goal

(that of producing military effects), an outer system (the system where we seek to produce military effects) and an inner system (the model guiding the C2 process) with an interface in the form of the military system. This is then applied to C2 which is analyzed as a form of design (of military missions) but also as an activity that is itself the result of design (of the C2 system). In the latter analysis, the concept of function is used to partition the complex design task into manageable parts and to specify the design requirements. It is concluded that Simon's concept does indeed provide a useful point of departure for creating a general framework for developing C2 science.

4:00 - 4:30 Thurs

089

Fletcher, Jordan
Sandhoo, Kanwaljit
MITRE

Track 4

Building a Future-Ready Community of Interest

The NAVSTAR Global Positioning System (GPS) provides space-based position, navigation, and time (PNT) to millions of worldwide users. GPS consists of a space segment, user segment and control segment supplemented by a network of monitoring stations and external interfaces, connected by a point-to-point communications network. This network is transitioning to a net-centric information sharing and security environment that will replace the point-to-point network by a service-oriented architecture, connected by a global network known as the Global Information Grid. This is a complex endeavor that requires inter-agency cooperation, communication, and collaboration to ensure integration across the Department of Defense (DoD). The transition to net-centricity has been approached in a very agile fashion. The DoD has introduced the idea of organizing assets and personnel around mission areas in Communities of Interest (COIs) to facilitate this transformation. The DoD has recognized that stringent standards, inflexible rules, and checklists are barriers to innovation and interoperability, so guidance has been kept general and high-level. However, this has resulted in a variety of approaches to COIs and net-centric service development, accompanied by a set of evolving guidance. This situation has caused a level of apprehension to adopting COIs and net-centric development by the acquisitions programs. This paper addresses this issue from the point of view of the authors who were involved in both the program acquisition and net-centric transformation activities. It provides lessons learned from the formation of the GPS COI and their initial net-centric service development activities. The lessons learned provide an example of what issues were faced, how these issues were handled, and what the outcomes of those actions were. These lessons learned are intended to help programs anticipate and respond to future issues and evolving guidance that may arise during net-centric service development.

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Bau, Nico
Gerz, Michael
Glauer, Michael
FGAN FKIE

Track 6

Testing C2 Interoperability: Advancements in Testing of the MIP Baseline 3 Solution

Semantic interoperability of command and control information systems (C2ISs) is critical to combined and joint missions. Thus, in the Multilateral Interoperability Programme (MIP), 26 nations and NATO define a common interface for distributed, heterogeneous C2ISs. In order to support testing, MIP defines a set of test specifications as well as a schedule with fixed test periods. The tests are conducted in bi-or multilateral sessions during which the participating C2ISs switch their roles of being evaluated and evaluating the partner(s). Since interoperability between two systems does not necessarily mean conformance to the specification, these sessions are repeated with multiple partners. Thus, test coordination and execution tends to be time consuming and error-prone. The new MIP Test Reference System (MTRS) provides an infrastructure to perform tests at any time. All test documents are formalized in a way that allows for automatic test execution and describes a test scenario unambiguously. Moreover, the MTRS provides

means for efficient test evaluation and for identifying potential errors in the implementation. In this paper, we will describe the MIP test procedures and their implications on interoperability and conformance. Besides a general overview of the MIP tests and the MTRS, we will provide some insight on the lessons learned while developing and using the MTRS.

4:00 - 4:30 Thurs

081

Fischer, Amber
Denny, Nathan
21st Century Systems

Track 3

VISHON: Vertical Integration of Sensors providing Human-on-the-loop Optimal kNowledge

Today's asymmetric adversaries prefer to operate in urban environments where they attack and then dissipate under the cover of "urban fog." Friendly forces may pursue, but armed pursuit may play to the enemy's benefit. Endangering civilians is often an intended secondary effect of asymmetric and 4GW adversaries. Harassing, wounding, or killing civilians, even if unintended, can create a backlash of public sentiment that erodes indigenous support for friendly forces. Thus, it is essential that friendly forces act with high confidence. Here we introduce VISHON: Vertical Integration of Sensors providing Human-on-the-loop Optimal kNowledge; a simulator modeling a collaborative system of sensors fused to provide vehicle tracking in urban environments. VISHON applies an innovative design for model compression, thus allowing a substantial reduction in processing requirements for the discrete simulation, enabling instantaneous concurrent feedback. Using VISHON, the warfighter can actively engage in solving the problem of sensor allocation and placement in real-time, maximizing confidence in seeking and tracking targets through the urban fog. VISHON will make a significant contribution to warfighters against an asymmetric adversary while minimizing the risk to innocent civilians.

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Baller, Daniel
Lospinoso, Joshua
United States Military Academy

Track 10

Specific Communication Network Measure Distribution Estimation

A new method is proposed to estimate the probability distribution of specific communication network measures. Real world communication networks are dynamic and vary based on an underlying social network, thus reliably estimating network measures is challenging. Two individuals that are socially connected may communicate several times one day, and not at all on another, yet their basic relationship remains unchanged. In this situation, estimates of network measures, such as density, degree centrality and others may be severely affected by the occurrence or absence of observed communication ties between individuals. The communication network of a group of mid-career Army officers is modeled from empirical data using the network probability matrix (NPM) proposed by McCulloh and Lospinoso (2007). The NPM provides a framework to model a communication network by estimating the edge probabilities between two individuals in a network. This framework can model a specific social group regardless of their network topology: random, small-world, scale-free, cellular, etc. Monte Carlo simulation is used with the NPM to generate 100,000 instances of the communication network. A statistical distribution is fit to the density measure. Using this probability distribution, statistically significant changes in density can be detected.

4:00 - 4:30 Thurs

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Hayes, Richard
Owen, Donald
Evidence Based Research

Track 10

Golden Phoenix 07: A Baseline for Assessing Civil Military Coordination for Disaster Response

Marine Air Group 46 (MAG-46) and Los Angeles area first responders conducted a tactical level field event entitled Golden Phoenix 07 which focused on the intricacies surrounding post disaster logistical and communications support. The event was held July 16 through 26, 2007in the Los Angeles vicinity. The Command and Control Research Program (CCRP) of the ASD/NII were invited to collect C2 related data in order to establish a baseline for post-Katrina civil-military response to humanitarian disasters. Working in concert with teams from the Naval Postgraduate School and the Space and Naval Warfare Systems Center San Diego, the CCRP team was augmented by data collectors from the USMC Reserve participating in the training event. Specific goals were to: 1. Develop a baseline of emergency disaster response coordination and control by quantifying demonstrated connectivity and quality of interactions. 2. Measure the impact of the Golden Phoenix event on the level of inter-organizational familiarity and trust. This paper provides details on the development and execution of the assessment and the baseline of civil-military interaction developed from Golden Phoenix 07.

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Pullen, J. Mark
Levine, Stanley
Hieb, Michael
George Mason University

Track 9

Using Web Service-Based Command and Control to Support Coalition Collaboration in C2 and Simulation

The NATO Modeling and Simulation Group Technical Activity 48 (MSG-048) was chartered to evaluate a Command and Control (C2) Language, Coalition Battle Management Language, for Multinational and NATO C2 collaboration supported by modeling and simulation tools. To achieve this, MSG-048 is using an emerging open technical standard based on the US Joint Battle Management Language (JBML) prototype Web services, which were enhanced to meet coalition requirements. An initial demonstration in December 2007 consisted of three different operational national C2 systems interoperating with three different national simulations, supported by the JBML Web services and a C2 Grammar Graphical User Interface. In all, eight software systems from five nations successfully interoperated, showing a high likelihood that the approach can be expanded to support a wide range of coalition collaboration. This capability was achieved in only six months, helped by availability of an Internet Reference Implementation that all parties could use to test from their home laboratories, and a high level of cooperation among technical personnel and military subject matter experts from all participating nations. This paper provides a description of the Web service-based language used, the architecture and components of the overall architecture (with focus on the XML-based language schema), and the use of Web services to support agile and flexible operations.