

*SEMANTIC TECHNOLOGIES FOR
INTELLIGENCE, DEFENSE, AND SECURITY*



STIDS 2016

Semantics in the
Internet of Things



THE 11TH INTERNATIONAL
CONFERENCE
ON SEMANTIC TECHNOLOGIES
NOVEMBER 14 - 16, 2016

Front Ballroom – The Hub
George Mason University
Fairfax, Virginia Campus



Welcome to STIDS 2016

The 11th International Conference on Semantic Technologies for Intelligence, Defense, and Security (STIDS 2016) STIDS provides a forum for academia, government and industry to share the latest research on semantic technology for defense, intelligence and security applications. Semantic technology is a fundamental enabler to achieve greater flexibility, precision, timeliness and automation of analysis and response to rapidly evolving threats.

Semantic technologies are a fundamental enabler to achieve greater flexibility, precision, timeliness and automation of analysis and response to rapidly evolving threats. This year we have the following topics:

- Best practices in ontological engineering
- Collaboration
- Command and Control (C2) and Situation Awareness (SA)
- Cyberspace: defense, exploitation, and counter-attack
- Decision Making
- Economics and financial analysis
- Emergency response
- Human factors and usability issues related to semantic technologies
- Information sharing
- Infrastructure protection
- Intelligence collection, analysis, and dissemination
- Law and law enforcement
- Planning: representation of and reasoning over plans and processes
- Predictive analysis
- Provenance, source credibility, and evidential pedigree
- Resiliency, risk analysis, vulnerability assessment
- Science and technology (biology,health,chemistry,engineering,etc.)
- Sensor systems
- Sociology (social networks, ethnicity, religion, culture, politics, etc.)
- Spatial and temporal phenomena and reasoning
- Uncertainty as it relates to ontologies and reasoning

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STIDS 2016 Keynote Speakers

Tuesday, November 15th, 2016



Dr. Leo Obrst

Dr. Leo Obrst is Chief Scientist for Cognitive Science and Artificial Intelligence in the CogSci & AI department of MITRE's (www.mitre.org) Center for Connected Government (CCG), where he created and led, but now advises the Information Semantics Group (semantics, ontological engineering, knowledge representation and reasoning). He has been involved in projects on Semantic Web rule/ontology interaction, automated reasoning, context-based semantic interoperability, ontology-based knowledge management, conceptual/semantic search and information retrieval, metadata and taxonomy/thesaurus construction for community knowledge sharing, intelligent agent technology, semantic support for natural language processing, and ontology-based modeling of complex decision-making for situational awareness, command and control, cyberspace, information integration and analysis, intelligence and event analysis/prediction. His most recent research is as chief ontologist and chief computer scientist for a US Veteran's Health Administration project on next-generation semantic health care records, and patient-centered clinical support, 2014-present. In 1999-2001, he was director of ontological engineering at VerticalNet.com, a department he formed to create ontologies in the product and service space to support Business-to-Business e-commerce. Leo has worked over 32 years in computational linguistics, knowledge representation, and in the past 21 years in ontological engineering and more recently (since 2001) in Semantic Web technologies. Leo is co-author (with Mike Daconta and Kevin Smith) of the book "The Semantic Web: The Future of XML, Web Services," and Knowledge Management, John Wiley, Inc., June, 2003; co-editor (with Terry Janssen and Werner Ceusters) of the book "Ontologies and Semantic Technologies for Intelligence," IOS Press, August, 2010; and has published many book chapters, conference and workshop papers (over 70 refereed papers) and many reviews. He has organized or been a program committee member on more than 75 conferences/workshops, including Formal Ontology in Information Systems (FOIS), Ontologies for the Intelligence Community (OIC), the Association for the Advancement of Artificial Intelligence (AAAI), and the International Semantic Web Conference (ISWC). He is a Senior Member of AAAI, and a long term member of ACM and LSA.

Tuesday, November 15th, 2016



Dr. Mark Underwood

Dr. Mark Underwood is the CEO and co-founder of Krypton Brothers LLC, a consultancy specializing in Big Data security, rapid intranet exploitation, digital forensics, software quality and domain-specific frameworks. Underwood has served as lead engineer or principal investigator on artificial intelligence projects for DARPA and for Army and Air Force research laboratories. Most recently, he is working with standards organizations to foster information assurance and provenance transparency. Underwood is co-chair of the NIST Big Data Public Working Group's security and privacy subgroup, and was co-chair of the 2015 Ontology Summit focused on the Internet of Things. In 2014, he served on the workshop committee for the IEEE Big Data Conference and moderated several panels. He is a NIST Guest Researcher and currently serves on the ISO/IEC JTC1 Working Group WG9 on Big Data. Other standards and related work: Underwood is a member of the IEEE P 1915.1 Security for Virtualized Environments WG, working on a standard for SDN and NFV security. He is an ASQ Certified Software Quality Engineer. He has participated in reviews of audit practices in the HL7 PASS Healthcare Audit Services ad hoc committee and the 2016 version of the OMG Cloud Standards Customer Council 's Security Standards Whitepaper. In the forthcoming "White paper on Semantic Interoperability for the Web of Things" produced under the aegis of IEEE P2413, he drafted the section on API-first and microservices. Underwood is an advocate for patient-managed health information, including access to automated decision support systems. He is a professional writer whose emphasis is technology and health topics. In recent years, articles have appeared in The Daily Beast, CBS TechRepublic, and Drugstore News for sponsors that range from GE and the Annenberg Center for Health Sciences to Time Warner Cable. He has written recurring columns for Syncsort, Ipswitch and ADP. Underwood also plays electric violin and edits the sites PoetryandScience.com and BigDataStandards.com.

Wednesday, November 16th, 2016



Dr. Erik Blasch

Dr. Erik Blasch (S'98-M'99-SM'05) is a principal scientist at the the US Air Force Research Lab (AFRL) in the Information Directorate at Rome, NY. From 2009-2012, he was an exchange scientist to Defence R&D Canada (DRDC) at Valcartier, Quebec. From 2000-2009, Dr. Blasch was the Information Fusion Evaluation Tech Lead for the AFRL Sensors Directorate - COMprehensive Performance Assessment of Sensor Exploitation (COMPASE) Center supporting AF and DARPA evaluations. Dr. Blasch was previously an Adjunct Electrical Engineering Professor at Wright State University and the Air Force Institute of Technology in Dayton, Ohio teaching signal processing, target tracking, and information fusion (2000-2010). He is also a reserve Lt. Col. with the Air Force Office of Scientific Research (AFOSR) in Washington, DC supporting physics, electronics, and nanotechnology developments. Dr. Blasch served as an AESS BoG member (2010-2013) as the International Chapters Chair and was active in the 2011 AESS Chapters Summit. He is currently an AIAA/AESS representative (2013-2014) and an AESS Distinguished lecturer (2013-2014). Dr. Blasch was a founding member of the International Society of Information Fusion (www.isif.org) in 1998, held various leadership roles in the Fusion conferences, and was the 2007 ISIF President. He was the IEEE Dayton Representative to the Sections Congress (2003, 2005), an IEEE Dayton (2007) and Montreal (2010) AESS Chapter President, an IEEE National Aerospace and Electronics Conference (NAECON) Committee member, and received the IEEE Russ Bioengineering award. He is currently an IEEE AESS track standards panel member, associate IEEE SMC editor (since 2006), IEEE T-AES reviewer, and associate editor for the AESS Magazine. He has focused on robotics, automatic target recognition, targeting tracking, and information fusion research compiling 400+ scientific papers, tutorials, and book chapters. His recent book is High-Level Information Fusion Management and Systems Design (Artech House, 2012). Dr. Blasch received his B.S. in Mechanical Engineering from the Massachusetts Institute of Technology in 1992 and Master's Degrees in Mechanical ('94), Health Science ('95), and Industrial Engineering (Human Factors) ('95) from Georgia Tech and attended the University of Wisconsin for a MD/PHD in Neurosciences/Mech. Eng until being called to Active Duty in 1996 to the United States Air Force. He completed an MBA ('98), MSEE ('98), MS Econ('99), and a PhD ('99) in Electrical Engineering from Wright State University and is a graduate of Air War College ('08). He is a Fellow of SPIE, Associate Fellow of AIAA, and a senior member of IEEE.

Michael Dean Best Paper Award

Thursday, November 16th, 2016



The Michael Dean Best Paper Award was established in 2014 as a recognition to his many and diverse contributions to the STIDS community. The award is presented every year to the authors of the paper chosen by a specially selected awards committee as the best contribution appearing in the conference proceedings. The winner of the award will be announced at a special session on last day of the conference. Consistently with Michael Dean's career achievements, the award emphasizes the excellence of our technical program and contributors, while promoting the continuing efforts of our community to push forward the state of the art in Semantic Technologies for Intelligence, Defense, and Security.

Best Paper Award Committee

The best paper award committee is formed by contributors of the STIDS community that are not only recognized experts in the field, but who also have no involvement or conflict of interests with the authors of the papers accepted for publication at the Conference.

Conference Schedule of Events

Monday – November 14th 2016

9:00 – 9:30	Registration
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Tutorial – Data Exploration with Visual SPARQL Queries

9:30 – 11:30	Exploring Data in the Graph View	Jans Aasman
11:30 – 12:30	Lunch	
12:30 – 14:30	Generate SPARQL Queries Directly from the Graph View	
14:30 – 15:00	Break	
15:00 – 17:00	Modify and Build Visual SPARQL Queries from the Ground Up	

Tuesday – November 15th 2016

08:00 – 09:00	Registration
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09:00 – 09:15	Welcome
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09:30 – 10:30	STIDS 2016 Keynote Address 1: A Whistle-stop Tour of Ontology-based Solutions to Improve Situational Awareness for a Dull, Dirty, Diverse IoT	Leo Obrst Mark Underwood
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10:30 – 10:45	Break
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Research Session A – Chair: Kathryn Laskey

10:45 – 12:05	10:45 – 11:25	Scalable Semantically Driven Decision Trees for Crime Data	Shawn Johnson George Karabatis
	11:25 – 12:05	Using Ontologies to Quantify Attack Surfaces	Michael Atighetchi Borislava Simidchieva Fusun Yaman Thomas Eskridge Marco Carvalho Captain Nicholas Paltzer

12:05 – 13:30		Lunch	
13:30 – 14:50	Research Session B – Chair: André Costa		
	13:30 – 14:10	Developing an Ontology for Individual and Organizational Sociotechnical Indicators of Insider Threat Risk	Frank Greitzer Muhammad Imran Justin Purl Elise Axelrad Yung Mei Leong, D. E. Sunny Becker Kathryn Laskey Paul Sticha
	14:10 – 14:50	A Holistic Approach to Evaluate Cyber Threats	Márcio Conte Monteiro Thalysson Sarmento Alexandre Barreto Paulo Costa
14:50 – 15:05		Break	
15:05 – 16:25	Research Session C – Chair: Richard Markeloff		
	15:05 – 15:45	An Extended Maritime Domain Awareness Probabilistic Ontology Derived from Human-aided Multi-Entity Bayesian Networks Learning	Cheol Young Park Kathryn Laskey Paulo Costa
	15:45 – 16:25	PR-OWL Decision: Toward Reusable Ontology Language for Decision Making under Uncertainty	Shou Matsumoto Kathryn Laskey Paulo Costa
16:25 – 16:45		Break	
16:45 – 18:30		Poster Session / Social Event	

Wednesday – November 16th 2016

09:00 – 09:15	Announcements	
09:15 – 10:30	STIDS 2016 Keynote Address 2	
	Semantic Technologies Research for Data Fusion Applications at AFRL	Erik Blasch
10:30 – 10:45	Break	

Research Session D – Chair: Ian Emmons			
10:45 – 12:05	10:45 – 11:25	Sharing Data under Genetic Privacy Laws	Michael Reep Bo Yu Duminda Wijesekera Paulo Costa
	11:25 – 12:05	Effects-Based Operations Planning Framework: A Knowledge-Based Simulation Approach	André Costa Paulo Costa
12:05 – 13:30	Lunch		
Research Session E – Chair: Paulo Costa			
13:30 – 14:20	13:30 – 13:55	Extended Abstract: A Practical Approach to Data Modeling Using CCO	Rod Moten Bill Barnhill
	13:55 – 14:20	Semantic Cyberthreat Modelling	Siri Bromander Audun Jøsang Martin Eian
14:20 – 14:35	Michael Dean Award Ceremony		
14:35 – 14:50	Final Remarks		

Conference Program

Technical Papers

Research Session A - Chair: Kathryn Laskey

Title: Scalable Semantically Driven Decision Trees for Crime Data

Authors: Shawn Johnson, George Karabatis

Association: University of Maryland

Abstract: When dealing with large volumes of data in organizations, there is always a need to associate data with its appropriate meaning, since the same data object may have different meaning to different users. This creates a problem of delivering search results that is different from a requester's intended purpose. To solve this problem, we propose a parallelizable framework capable of capturing user specified constraints that are both semantically relevant to a search/domain in question as well as contextually relevant to a user and/or organization.

Title: Using Ontologies to Quantify Attack Surfaces

Authors: (a) Michael Atighetchi, (a) Borislava Simidchieva, (a) Fusun Yaman, (b) Thomas Eskridge, (b) Marco Carvalho, (c) Captain Nicholas Paltzer

Association: (a) Raytheon BBN Technologies, (b) Florida Institute of Technology, (c) NYC Air Force Research Laboratory

Abstract: Cyber defenders face the problem of selecting and configuring the most appropriate defenses to protect a given network of systems supporting a certain set of missions against cyber attacks. Cyber defenders have very little visibility into security/cost tradeoffs between individual defenses and a poor understanding of how multiple defenses interact, which, in turn, leads to systems that are insecure or too overloaded with security processing to provide necessary mission functionality. We have been developing a reasoning framework, called Attack Surface Reasoning (ASR), which enables cyber defenders to explore quantitative tradeoffs between security and cost of various compositions of cyber defense models. ASR automatically quantifies and compares cost and security metrics across multiple attack surfaces, covering both mission and system dimensions. In addition, ASR automatically identifies opportunities for minimizing attack surfaces, e.g., by removing interactions that are not required for successful mission execution. In this paper, we present the ontologies used for attack surface reasoning. In particular, this includes threat models describing important aspects of the target networked systems together with abstract definitions of adversarial activities. We also describe modeling of cyber defenses with a particular focus on Moving Target Defenses (MTDs), missions, and metrics. We demonstrate the usefulness and applicability of the ontologies by presenting instance models from a fictitious deployment, and show how the models support the overall functionality of attack surface reasoning.

Research Session B - Chair: Richard Markeloff

Title: Developing an Ontology for Individual and Organizational Sociotechnical Indicators of Insider Threat Risk

Authors: (a) Frank Greitzer, (b) Muhammad Imran, (c) Justin Purl, (d) Elise Axelrad, Yung Mei, Leong, (c) D. E., Sunny Becker, (b) Kathryn Laskey, (c) Paul Sticha

Association: (a) PsyberAnalytix, (b) George Mason University, (c) Human Resources Research Organization, (d) Innovative Decisions, Inc.

Abstract: Human behavioral factors are fundamental to understanding, detecting and mitigating insider threats, but to date insufficiently represented in a formal ontology. We report on the design and development of an ontology that emphasizes individual and organizational sociotechnical factors, and incorporates technical indicators from previous work. We compare our ontology with previous research and describe use cases to demonstrate how the ontology may be applied. Our work advances current efforts toward development of a comprehensive knowledge base to support advanced reasoning for insider threat mitigation.

Title: A Holistic Approach to Evaluate Cyber Threats

Authors: (a) Márcio Conte Monteiro, (a) Thalysson Sarmento, (a) Alexandre Barreto, (b) Paulo Costa

Association: (a) Instituto de Controle do Espaço Aéreo, (b) George Mason University

Abstract: Several vulnerability databases and standards are currently available for assessing the degree of security of IT infrastructures in general. These standards focus on different aspects of the systems, while generally failing to provide support for holistic analyses - a key aspect in ensuring a secure IT infrastructure. This work aims to address this gap by presenting a new methodology for evaluating the overall security risks of a networked system that adopts an ontology-based approach we presented in previous work. We leverage current security standards and databases, while also considering the human factors to build a broader and interconnected view. Our methodology is meant to achieve a more realistic picture of the network security, hence improving situation awareness for its administrators. To illustrate our approach, this paper brings a case study applying the new methodology to a few target networks. The proof of concept is meant to underscore the methodology's effectiveness in assessing the security of the whole network.

Title: An Extended Maritime Domain Awareness Probabilistic Ontology Derived from Human-aided Multi-Entity Bayesian Networks Learning

Authors: Cheol Young Park, Kathryn Laskey, Paulo Costa

Association: George Mason University

Abstract: Ontologies have been commonly associated with representing a domain using deterministic information. Probabilistic Ontologies extend this capability by incorporating formal probabilistic semantics. PR-OWL is a language that extends OWL with semantics based on Multi-Entity Bayesian Networks (MEBN), a Bayesian probabilistic logic. Developing probabilistic ontologies can be greatly facilitated by the use of a modeling framework such as the Uncertainty Modeling Process for Semantic Technology (UMP-ST). An example of using UMP-ST was the development of a probabilistic ontology to support PROGNOS (PRObabilistic OntoloGies for Net-Centric Operational Systems), a system that supports Maritime Domain Awareness (MDA). The PROGNOS probabilistic ontology provides semantically aware uncertainty management to support fusion of heterogeneous input and probabilistic assessment of situations to improve MDA. However, manually developing and maintaining a probabilistic ontology is a labor-intensive and insufficiently agile process. Greater automation through a combination of reference models and machine learning methods may enhance agility in probabilistic situation awareness (PSAW) systems. For this reason, a process for Human-aided MEBN Learning in PSAW (HMLP) was suggested. In previous work, we used UMP-ST to develop the PROGNOS probabilistic ontology. This paper presents an extended PROGNOS probabilistic ontology developed using HMLP. The contribution of this research is to introduce the extended PROGNOS probabilistic ontology and present a comparison between two processes (UMP-ST and HMLP).

Title: PR-OWL Decision: Toward Reusable Ontology Language for Decision Making under Uncertainty

Authors: Shou Matsumoto, Kathryn Laskey, Paulo Costa

Association: George Mason University

Abstract: Decision making is a big topic in Intelligence, Defense, and Security fields. However, very little work can be found in the literature about ontology languages that simultaneously support decision making under uncertainty, abstractions/generalizations with first-order expressiveness, and forward/backward compatibility with OWL—a standard language for ontologies. This work proposes PR-OWL Decision, a language which extends PR-OWL—an extension of OWL to support uncertainty—to support first-order expressiveness, decision making under uncertainty, and backward/forward compatibility with OWL and PR-OWL.

Research Session D - Chair: Ian Emmons

Title: Sharing Data under Genetic Privacy Laws

Authors: Michael Reep, Bo Yu, Duminda Wijesekera, Paulo Costa

Association: George Mason University

Abstract: Clinical medical practice and biomedical research utilize genetic information for specific purposes. Irrespective of the purpose of obtaining genetic material, methodologies for protecting the privacy of patients/donors in both clinical and research settings have not kept pace with rapid genetic advances. When the usage of genetic information is not predicated on the latest laws and policies, the result places all-important patient/donor privacy at risk. Some methodologies err on the side of overly stringent policies that may inhibit research and open-ended diagnostic activity, whereas an opposite approach advocates a high-degree of openness that can jeopardize patient privacy, identifying patient relatives and erode the doctor-patient privilege. As a solution, we present a unique approach that is based on the premise that acceptable clinical treatment regimens are captured in workflows used by caregivers and researchers and therefore their associated purpose can be extracted from these workflows. We combine these purposes with applicable consents (derived from applicable laws) to ascertain the releasability of genetic information. Given that federal, state and institutional laws govern the use, retention and sharing of genetic information, we create a three-level rule hierarchy to apply the laws to a request and auto-generate consents prior to releasing. We prototype our system using open source tools, while ensuring that the results can be added to existing Electronic Medical Records (EMR) systems.

Title: Effects-Based Air Operations Planning Framework: A knowledge-based simulation approach

Authors: (a, b) André Costa, (b) Paulo Costa

Association: (a) Brazilian Air Force Institute of Advanced Studies, (b) George Mason University

Abstract: Planning air warfare operations has always been a complex endeavor. However, as technology evolves at an increasingly fast pace, so does the complexity of managing its resources. In modern air operations, planners have to deal with a highly changing environment influenced by enemy air defenses, weather forecasts, among many other factors, demanding much effort to handle the great number of constraints and uncertainties presented by them. As a result, a number of decision-support systems have emerged attempting to facilitate the planning of air warfare operations. These systems usually rely on a wide variety of methodologies, which sometimes present a challenge in themselves when it comes to assessing the feasibility and effectiveness of the produced plans. Computer simulations are a practical way of providing this assessment, usually by running the resulting plans multiple times and checking the results against key criteria.

Yet, establishing the right criteria, properly accounting for the “fog of war,” and avoiding impractical simulation run times and costs are still major challenges. This paper addresses such challenges by proposing the development of a decision- support framework that combines ontology-based agile knowledge and a simulation-based mission planning methodology that accounts for the inherent uncertainties that air operations face. We avoid costly computation times required by simulation- intensive course-of-action analyzers by initially pruning the solution space through ontological reasoning. Moreover, the approach complies with the Effects-Based Approach to Operations, having a clear correspondence of processes with it. The explanations are focused on a specific scenario concerning intelligence, surveillance, and reconnaissance operations.

Research Session E - Chair: Paulo Costa

Title: Extended Abstract: A Practical Approach to Data Modeling using CCO

Authors: (a) Rod Moten, (b) Bill Barnhill

Association: (a) Datanova Scientific, (b) EOIR Technologies

Abstract: In this paper, we present work in progress on using the Information Domain ontologies of CCO (Common Core Ontologies) as a domain model for land combat. Our goal is to use the domain model as a common semantics for multiple land combat logical models. In the paper, we show how our domain model can be mapped to different logical models in a manner that is less labor intensive than the approach commonly used by users of CCO. We demonstrate our approach by describing how our domain model, which is a domain ontology of CCO, is mapped to logical models created in Ecore and NIEM (National Information Exchange Model).

Title: Semantic Cyberthreat Modelling

Authors: (a) Siri Bromander, (b) Audun Jøsang, (a) Martin Eian

Association: (a) Mnemonic, (b) University of Oslo

Abstract: Cybersecurity is a complex and dynamic area where multiple actors act against each other through computer net- works largely without any commonly accepted rules of engagement. Well-managed cybersecurity operations need a clear terminology to describe threats, attacks and their origins. In addition, cybersecurity tools and technologies need semantic models to be able to automatically identify threats and to predict and detect attacks. This paper reviews terminology and models of cybersecurity operations, and proposes approaches for semantic modelling of cybersecurity threats and attacks.

Tutorial – Data Exploration with Visual SPARQL Queries

Dr. Jans Aasman

Abstract

The free-form nature of Graph style data offers a lot of flexibility for connecting data, but that freedom can also make it more challenging to find interesting patterns or simply navigate through your data. It has become typical for RDF data sets to contain thousands of classes and relationship types, creating challenges to even formulate the analytics and queries you want to perform.

Visual discovery and exploration tools provide a means to make data analyst more effective and the process more efficient. Generating complex SPARQL queries graphically, rather than writing code, offers an onramp to developers learning SPARQL and a means for advanced users visualize complex queries where code may be difficult to follow.

Introduction

In this tutorial we will instruct attendees on how to visually explore and query RDF data sets with Gruff, a free downloadable tool. Gruff, a visual analytics and discovery tool, was developed to specifically address the Graph data exploration challenges in large data sets. The tool is used by analysts in the financial world to find connections between their clients and also to discover fraud. Analysts in the pharmaceutical industry use it to visualize and discover connections between drugs, diseases, and cellular pathways. As part of the tutorial introduction we will cover these use cases and offer demonstrations.

During the tutorial we will touch on other visualization tools, such as Linkurious and Gephi, and how they can be used to view the overall structure in your data. We will touch on ideas to use these tools collaboratively with Gruff and best practices for exploring large RDF datasets. The tutorial will work through the following concepts and attendees will be encouraged to follow along with sample datasets provided or using their own data.

Conference Committees

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