ISTAS 2016

INVITATIONAL SYMPOSIUM ON TRUSTED AUTONOMOUS SYSTEMS

Australian Government
Department of Defence
Science and Technology

SURVIVING THE UNPREDICTED
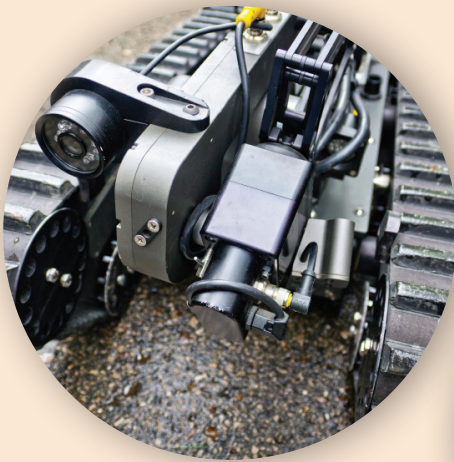
Program

DST GROUP

Science and Technology for Safeguarding Australia

Dr Alex Zelinsky

Chief Defence Scientist
Defence Science and Technology Group

Dr Alex Zelinsky was appointed Chief Defence Scientist and head of the Defence Science and Technology (DST) Group (then DSTO) in March 2012. Before joining DST he was Group Executive for Information Sciences at the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and Director of CSIRO's Information and Communication Technologies Centre. Dr Zelinsky was Chief Executive Officer and co-founder of Seeing Machines, a high-technology company developing computer vision systems. The company is listed on the London Stock Exchange and was a start-up from the Australian National University in Canberra, Australia, where Dr Zelinsky was Professor of Systems Engineering.

Dr Zelinsky researched in robotics and computer vision at the AIST Electrotechnical Laboratory in Japan and has taught and conducted research in computer science at the University of Wollongong, New South Wales, Australia. He started his career as a Systems Engineer with BHP Steel International. Dr Zelinsky has extensively advised Federal and State governments in Australia, including as a member of the Australian Government's Defence Industry Innovation Board. He has served on the advisory panels to the Australian Research Centre (ARC) Centre for Vision Science and the ARC Centre of Excellence for Autonomous Systems. Dr Zelinsky completed his Bachelor of Mathematical Sciences (Honours) and Doctor of Philosophy at the University of Wollongong, NSW. In 2009, Engineers Australia named Dr Zelinsky Professional Engineer of the Year (Sydney Division) and he has been included in Engineers Australia's list of the 100 most influential engineers since that year. In 2013 he was awarded the prestigious Pearcey Medal, the ICT industry's premier prize for lifetime achievement.

Major General Stuart Smith, AO, DSC

Deputy Chief of Joint Operations

Major General Stuart Smith gained scholarship entry to RMC Duntroon in 1981, graduated to the Royal Australian Infantry Corps in 1984, and completed a variety of appointments with the light and mechanised battalions of The Royal Australian Regiment. He attended the British Army Command and Staff College in 1996 before serving as a staff officer with 3 Brigade in Townsville, Army Headquarters in Canberra and 1st Division/ Deployable Joint Force Headquarters in Brisbane. In 2002 he served as the Chief of Army Liaison Officer to the Australian Government Senate Committee Foreign Affairs, Defence and Trade. He has wide command and operational experience. He served with the United Nations as a Military Observer in Lebanon and Syria in 1993 and as Commanding Officer of the 1st Battalion The Royal Australian Regiment in East Timor in 2003. He conducted Humanitarian Assistance/Disaster Relief Operations as the Chief of Staff of Australian Joint Task Force 629 following the earthquake/tsunami in Indonesia in 2004, and as Commander 3 Brigade following Cyclone Yasi in North Queensland in 2011. He was the Deputy Commander of Australian Joint Task Force 633 (Afghanistan) in 2008 and returned as the Commander (Middle East) in 2012. From Oct 2012 to November 2015 he was appointed Commander 1st Division/Deployable Joint Force Headquarters. On 18 November 2015 he assumed his current appointment as the Deputy Commander Joint Operations Command.

He is a graduate of the Australian Institute of Company Directors and Australian Defence College. Major General Smith has the tertiary qualifications Bachelor of Arts (1984), Master of Business Administration (2000) and Diploma Defence and Strategic Studies (2006). He was appointed as a Member of the Order of Australia in 2005 for exceptional service to the Australian Army and the Distinguished Service Cross in 2013 for his command of Joint Task Force 633. In 2015, he was elevated as an Officer in the Order of Australia (AO) for distinguished service as Commander 3rd Brigade and Commander 1st Division. Major General Smith is married to Karen and they have three adult children. His interests include Australian Literature and Australian Rules Football.

Dr Jason Scholz

Research Leader – Trusted Autonomous Systems
Defence Science and Technology Group
Trusted Autonomous Systems – Surviving the Unpredicted

Dr. Jason Scholz leads research in cognitive psychology, decision aids, decision automation and autonomy, and the integration of human and machine decision-making within the Defence Science and Technology Group. Dr. Scholz also leads a strategic research initiative on trusted autonomous systems and chairs an international science and technology autonomy strategic challenge group. He has provided scientific innovation, technology prototypes, risk assessments and advice on new and in-service Command and Control (C2) capabilities to the Department of Defence and National Security organisations to improve C2 for operational and strategic headquarters, national security, joint logistics and preparedness. Significant achievements of the branch include operational transition of the Vital Planning and Analysis (VIPA) system, development of a wide range of decision aids to enhance situation awareness and planning, and psychological instruments for measuring individual cognitive styles in the formative education of Commanders.

Jason has over fifty refereed publications and several patents, covering research in telecommunications, digital signal processing, artificial intelligence and human decision making. He is passionate about the potential for machine learning based on neuroscience insights, human cognitive enhancement, anti-fragile organisations and is driven to achieve the transition of validated innovative technology and techniques into Defence.

Dr Josh Bongard

University of Vermont

Josh Bongard is a professor at the University of Vermont and a 2010 PECASE awardee. He received his Bachelor's degree in Computer Science from McMaster University, Canada, his Master's degree from the University of Sussex, UK, and his PhD from the University of Zurich, Switzerland. He served as a postdoctoral associate under Hod Lipson in the Computational Synthesis Laboratory at Cornell University from 2003 to 2006. He is the co-author of the popular science book entitled *"How the Body Shapes the Way We Think: A New View of Intelligence"*, MIT Press, November 2006. (With Rolf Pfeifer). He is also the co-author of *"Designing Intelligence: Why Brains Aren't Enough"* (with Rolf Pfeifer and Don Berry). In 2007, he was named to the MIT Technology Review TR35 as one of the top 35 innovators in the world under the age of 35.

Day One – Monday 09 May 16
Welcome and Opening Address

1000	Registration and Morning Tea	
1040	**Welcome**	**Dr Alex Zelinsky** Chief Defence Scientist Defence Science and Technology Group
1100	**Opening Address**	**Major General Stuart Smith** Deputy Chief of Joint Operations Australian Defence Force
1130	**Keynote Address**	**Professor Josh Bongard** University of Vermont
1230	Lunch	

Theme One – Autonomy Resilience

1330	**Scene Setting**	**Dr Jason Scholz** Research Leader Trusted Autonomous Systems Defence Science and Technology Group
1340	**Theme Keynote**	**Dr Darryn Reid** Theme Leader Autonomy Resilience Defence Science and Technology Group
1440	**Presentation One**	**Associate Professor Adrian Pearce** University of Melbourne
1510	Afternoon Tea	
1545	**Presentation Two**	**Dr Toby Murray** Data61
1615	**Presentation Three**	**Dr Brandon Pincombe** Defence Science and Technology Group
1645	**Q&A Session**	
1715	Networking Session	
1900	**Symposium Dinner**	**Dr Todd Mansell** Chief – Joint & Operations Analysis Division Defence Science and Technology Group

Dr Darryn Reid

Theme Leader – Autonomy Resilience

Defence Science and Technology Group

Unpredictable Outcomes in Unstructured Environments: The Future of Machine Reasoning

Darryn J Reid has been with DSTO since 1995, and has worked in nonlinear dynamics, parallel and distributed computation, machine learning and artificial intelligence, interoperability, formal logics, modelling, simulation, optimisation and optimal control, electronic warfare, missile targeting and control, command support systems, hardware design, algorithmic complexity, computability, model theory, stochastic modelling, formal ontology, object-oriented and functional programming, crowd modelling and military theory. He holds the degrees of Bachelor of Science in Mathematics and Computer Science, Bachelor of Science with First Class Honours in Mathematics and Computer Science, and Doctor of Philosophy in Theoretical Computer Science from the University of Queensland. He has strong research interests in pure and applied mathematics, theoretical and applied computer science, philosophy, military theory and economics. In other words, he knows just enough to realise how ignorant he is. He is currently trying to age as disgracefully as possible, with the support of his beautiful wife Julie and son Tyler.

Associate Professor Adrian Pearce

University of Melbourne

Social Planning for Trusted Autonomy

Adrian Pearce is a researcher and innovator in planning and scheduling. His research has improved the efficiency and robustness of a range of applications including production scheduling for mining, supply chain optimisation, robotics, logistics and air traffic management. He has contributed deeply in research on reasoning about actions within the field of artificial intelligence. In conjunction with colleagues in the Melbourne School of Engineering and Optimisation Group, he has made fundamental breakthroughs in the ability to perform collaborative planning and scheduling. His research tackles optimisation problems, including more efficient and productive supply chain management for agile mine scheduling and cognitive robotics applications in defence. He is presently the Director (acting) of the Defence Science Institute.

Dr Toby Murray

Data61

Software Verification for Trustworthy Autonomous Systems

Toby Murray is a Lecturer in the Department of Computing and Information Systems at the University of Melbourne, and a Senior Researcher at Data61. His research focuses on how to build highly secure computer systems, in particular by using formal verification and novel programming languages. He led the team at NICTA (now Data61) that completed the world's first proof that a general purpose operating system kernel could enforce data confidentiality, for the seL4 kernel, and has since played a leading role in the development of the COGENT programming language for verified systems programming. His current work includes building and verifying the security of seL4-based cross domain devices, in collaboration with DST Group. He holds a D.Phil. in Computer Science from the University of Oxford, and a Bachelor of Computer Science with First Class Honours from the University of Adelaide.

Dr Brandon Pincombe

Defence Science and Technology Group

Scenarios for Trusted Autonomous Systems

Brandon Pincombe is head of Land Organisational and Management Science at DST Group. He holds an honours degree in mathematics from the University of Wollongong and a PhD in applied mathematics from the University of Adelaide. Brandon joined DST Group in Secure Communication Branch and worked around the interface between computers and people; moving later to be an operations researcher working with the Australian Army. His research interests have been strongly influenced by the complexity of land warfare and the irreducible uncertainty of the future: hence an interest in scenarios.

Day Two – Tuesday 10 May 16
Theme Two – Machine Cognition

0700 - 0830	Breakfast	
0900	**Scene Setting**	**Dr Ian Dall** Theme Leader Machine Cognition Defence Science and Technology Group
0910	**Theme Keynote**	**Professor Marcus Hutter** Australian National University
1010	**Presentation One**	**Professor Bob Williamson** Australian National University
1040	Morning Tea	
1110	**Presentation Two**	**Professor Claude Sammut** University of New South Wales
1140	**Presentation Three**	**Dr Glennn Moy** Defence Science and Technology Group
1210	**Q&A Session**	
1230	Lunch	

Theme Three – Trusted Human-Synthetic Partnerships

1320	**Scene Setting**	**Dr Glen Smith** Theme Leader Trusted Human-Synthetic Partnerships Defence Science and Technology Group
1330	**Theme Keynote**	**Dr David Aha** US Naval Research Laboratory
1430	**Presentation One**	**Professor Janet Wiles** University of Queensland
1500	**Presentation Two**	**Dr Ben Knott** US Air Force Office of Scientific Research
1530	Afternoon Tea	
1600	**Presentation Three**	**Dr Michael Skinner** Defence Science and Technology Group
1630	**Q&A Session**	
1700	**Student Research Poster Competition**	
1830	Social Function – Lou Miranda Estate	

Dr Ian Dall

Theme Leader – Machine Cognition
Defence Science and Technology Group

Ian Dall is currently Group Leader Situation Assessment, Defence Science and Technology and Machine Cognition Theme Leader for Project Tyche. He received his Bachelor's degree in Electrical Engineering from the University of Queensland in 1978 and his PhD in adaptive non-linear systems from the University of Adelaide in 1991. He has worked on Over-The-Horizon-Radar, data and information fusion, multimedia, virtual reality and immersive environments, information integration and exploitation and narrative generation. His interests include automated reasoning, machine learning, cognitive architectures and novel algorithms.

Professor Marcus Hutter

Australian National University

Unifying Foundations for Intelligent Agents

Marcus Hutter is Professor in the Research School of Computer Science at the Australian National University in Canberra, Australia. He received his PhD and BSc in physics from the LMU in Munich and a Habilitation, MSc, and BSc in informatics from the TU Munich. Since 2000, his research at IDSIA and now ANU is centred on the information-theoretic foundations of inductive reasoning and reinforcement learning, which has resulted in 100+ publications and several awards. His book "Universal Artificial Intelligence" develops the first sound and complete theory of AI. He also runs the Human Knowledge Compression Contest.

Professor Bob Williamson

Data61

The Future of Machine Learning

Bob Williamson is the Chief Scientist and leader of the Machine Learning and Analytics program at Data61. He is also a Professor in the Research School of Computer Science at Australian National University. He received a Bachelor of Electrical Engineering from QUT in 1984 and a Masters of Engineering Science (Electrical Engineering) from UQ in 1986. In 1990 he obtained a PhD in Electrical Engineering from UQ. He joined ANU as a postdoctoral fellow in the Department of Systems Engineering in 1990 and held a series of appointments before becoming a professor and head of the Computer Sciences Laboratory, Research School of Information Sciences and Engineering at ANU. From 2003 to early 2006 Professor Williamson was the Director of NICTA's Canberra Research Laboratory and in 2006 was appointed Scientific Director. He is a fellow of the Australian Academy of Sciences and recently led the creation of a report on Technology and Australia's Future. His scientific research focusses upon machine learning, in particular building compositional foundations for ML, by relating different machine learning problems.

Professor Claude Sammut

University of New South Wales
Machine Learning for Control of Autonomous Vehicles

Claude Sammut is a Professor of Computer Science and Engineering at the University of New South Wales. His early work on relational learning helped to the lay the foundations for the field of Inductive Logic Programming (ILP). With Donald Michie, he also did pioneering work in Behavioural Cloning. His current work focusses on developing machine learning methods for autonomous robots. He has been heavily involved in robotics competitions, which are valuable tools for evaluating robot performance. UNSW teams have been champions five times in the RoboCup Standard Platform League and have won numerous awards for the best autonomous robots in the Robot Rescue competition. Claude was elected to the board of trustees of the RoboCup Federation and will be the general chair for RoboCUp 2019, to be held in Sydney.

Dr Glennn Moy

Defence Science and Technology Group
Machine-Learning and Recommender Systems for Command and Control of Autonomous Vehicles

Glennn Moy is a Research Scientist in the Decision Sciences Branch of DST Group. Glennn obtained his PhD in theoretical Physics from the Australian National University (ANU), for which he received an Australian Institute of Physics "Award for Postgraduate Excellence" and the ANU "John Carver Award". After undertaking a number of post-doctoral positions, Glennn began his work with DST Group with a research focus on Command and Control (C2). During his career at DST Group, Glennn's C2 research has included support for Evacuation Modelling, the development Joint Task Force Planning Tools, and deployments as an Operations Analysist for the Australian-led "Regional Assistance Mission to Solomon Islands" (RAMSI). In his current research, Glennn is exploring the potential role of machine-learning techniques to provide recommendations for, and control of, complex autonomous systems.

Dr Glen Smith

Theme Leader – Trusted Human-Synthetic Partnerships
Defence Science and Technology Group

Dr Glen Smith joined DSTO in 2001 after more than two decades lecturing and researching cognitive psychology and individual differences. He is a research psychologist with more than 60 publications in international refereed journals with more than 1500 citations covering cognition in ageing, mental retardation, behavioural genetics and magnetic resonance imaging. His university studies were at Adelaide University, where he gained first class honours in Computing Science, and then in Psychology before completing his PhD which included winning a scholarship to Oxford University for 6 months. In 2011 he was appointed Head of the group he currently leads, which is now called Command Intent. The group researches promoting effective and efficient cognition by military commanders.

Dr David Aha

Naval Research Laboratory

Goal Reasoning for Machine Cognition

David Aha received his PhD from the University of California, Irvine in 1990, where he studied instance-based learning algorithms and created the UCI Repository for Machine Learning Databases. He then held post-doctoral research positions at: the Turing Institute of Strathclyde University in Glasgow, Scotland; The Johns Hopkins University's Applied Physics Laboratory in Laurel, Maryland; and with the University of Ottawa in Canada. He joined the Naval Research Laboratory (NRL) in 1993 and now leads the Adaptive Systems Section of the NRL's Navy Centre for Applied Research in AI. His research interests include intelligent agents (e.g., goal reasoning), machine learning (e.g., deep learning, statistical relational reasoning), planning, computer vision, and related topics. David participates in several academic and DOD research communities, has (co-)organized 31 international meetings, has served as AAAI Councillor and on the editorial boards for four journals, and frequently serves on the program committees for AI conferences. His group has pioneered research on goal reasoning, its theoretical analysis, its implementation in intelligent agents, and its application to the control of autonomous unmanned vehicles.

Professor Janet Wiles

University of Queensland

Human-robot interactions: Social moments and social micro-abilities

Janet Wiles holds a Ph.D. from the University of Sydney, and is Professor of Complex and Intelligent Systems at the University of Queensland. The research group studies fundamental issues in how information is transmitted, received, processed and understood in biological and artificial systems. Her research interests include complex systems in biology and neuroscience, artificial and natural intelligence, language, and social robotics.

Dr Benjamin Knott

Air Force Office of Scientific Research

Trust in Autonomous Systems

Ben Knott is the leader of the Trust and Influence program at the United States Air Force Office of Scientific Research. The Trust and Influence program is motivated by recent technological advances in the area of unmanned and autonomous systems, and the strategic environment that the U.S. Air Force is expected to face in the future; a significant departure from that which has dominated most of its history. Rapid advances and proliferation of advanced autonomous systems are expected to fundamentally change the way the Air Force operates. To address these challenges, the Trust and Influence program invests in the development of the theoretical and empirical foundations of reliance and contemporary influence. Specifically, the program is concerned with investigating the mechanisms by which humans establish, maintain, and repair trust in other agents, both human and machine. Trust and Influence invests in the discovery of the foundational concepts of effective influence, deterrence, trust-building, trust calibration, and counter-terrorism operations. He holds a PhD in Experimental Cognitive Psychology from the Catholic University of America.

Dr Michael Skinner

Defence Science and Technology Group

Human Autonomy Teaming – Enhancing Supervisory Control of Multiple Assets in Challenging Environments

Michael Skinner is a Senior Research Scientist in the Aerospace Division of the Defence Science and Technology Group with a PhD in Cognitive Psychology. He is a Human Factors researcher with 20 years of experience investigating ways to enhance warfighter performance, workload, and situation awareness through effective interface design and training. He is currently a lead on the Human Autonomy Teaming Project under Program Tyche and the National Lead on a 4-nation collaborative research project on Monitoring and Controlling Multiple Assets within Complex Environments.

Day Three – Wednesday 11 May 16
Theme Four – Embodied Intelligence

0700 - 0830	Breakfast	
0900	**Scene Setting**	**Dr Simon Ng** Theme Leader Embodied Intelligence Defence Science and Technology Group
0910	**Theme Keynote**	**Professor David Johnson** Australian Centre for Field Robotics University of Sydney
1010	**Presentation One**	**Dr Jan Barca** Monash University
1040	Morning Tea	
1110	**Presentation Two**	**Dr Kin-Ping Hui and Dr Robert Hunjet** Defence Science and Technology Group
1140	**Presentation Three**	**Dr David Battle** Defence Science and Technology Group
1210	**Q&A Session**	
1230	Lunch	
1300	**Panel Session**	**Keynote Presenters**
1430	Closing	
1500	**Farewell and Departure**	

Dr Simon Ng

Theme Leader – Embodied Intelligence
Defence Science and Technology Group

Dr Simon Ng has a Bachelor of Science and a Bachelor of Engineering from Monash University. He completed his Doctoral Thesis in 1998, studying mechanisms for ionic conduction in solid polymer electrolytes, and worked as a Post-doctoral Fellow at CSIRO, developing techniques to measure chemical reactions in cementitious systems using non-destructive microwave characterisation. In 2001 he joined the Defence Science and Technology Organisation as a research scientist in Military Experimentation and Systems, contributing to Army, Air Force and Joint Force-level experimentation and analysis programs. In 2004, he moved to Joint Systems Analysis Branch and led the S&T development of information integration concepts and system designs for AIR7000, Australia's Future Maritime Patrol and Response Capability. He has been the National Lead on TTCP JSA TP4 Systems Engineering for Defence modernisation, has spent time examining organisational systems design for space operations and has also enjoyed a stint as Associate Director for the Defence Science Institute at the University of Melbourne. Most recently, he has had the privilege of leading the Unmanned Aerial Systems Group within DST Group's Aerospace Division, exploring the role of autonomy in enhancing Defence capability and reducing risk in an increasingly complex operational environment. Simon is the theme lead for Embodied Intelligence in DST Group's Program Tyche.

Dr David Johnson

University of Sydney

Robust Situation Awareness: From Active Sensing to Coherent Active Perception

Dr David Johnson has been working with radar systems and sensor data since 2001. He began his career with Roke Manor Research Ltd: then Siemens' UK R&D facility and now part of the Chemring group. During his time at Roke Manor, David worked on a number of civil and defence projects relating to radar and avionic systems with a particular focus on small target detection in clutter. In 2006, David moved to Australia to undertake a PhD at the Australian Centre for Field Robotics, part of the ARC Centre for Excellence in Autonomous Systems. Following the completion of his PhD, David was employed within the Rio Tinto Centre for Mine Automation (RTCMA), leading the development of compact radar systems and algorithms to enable automated terrain reconstruction by unmanned vehicles operating in complex unstructured environments. Since late 2014, working with industry, DSTO and some quantum physicists, David has begun to build his own group in the area of embedded multi-spectral coherent signal processing.

Dr Jan Barca

Monash University

Monash Swarm Robotics Laboratory - A Prelude

Jan Barca's major research interests are in the areas of swarm robotics, swarm intelligence and distributed sensing. He is currently the Director of Monash Swarm Robotics Laboratory and is involved in a wide range of research projects on swarms of UAVs, climbing robots and swarm intelligence. He has also been involved in several research projects on distributed control of ground moving vehicles. Jan Barca has published work at several international conferences and in high level journals. He has also managed projects in both industry and academia.

Dr Kin-Ping Hui & Dr Robert Hunjet

Defence Science and Technology Group

Survivable autonomous communications in contested RF urban environments

Ping Hui joined DST Group in 1998 as research engineer. He received his Bachelor of Science in Engineering in 1989 and Master of Philosophy in Engineering in 1994 both from University of Hong Kong, and then completed a PhD with the Adelaide University in the topic of network reliability estimation in 2005. Since joining DST Group, Ping contributed to various research and development in wireless communication networks. Currently, he leads a research project on autonomous, fully-distributed solution to support survivability of MANETS in presence of challenges. His research interests include optimisation techniques and machine intelligence in autonomous control.

Robert Hunjet received his Bachelor of Engineering (Computer Systems) with first class honours from The University of Adelaide in 2001, his Graduate Certificate in Engineering (Communications Technologies) from the University of South Australia in 2004, and his PhD on Adaptive Network Topologies from The University of Adelaide in 2014. Robert joined Defence Science and Technology Group in 2001 and has conducted research in power efficiency, capacity and survivability of MANETS. He has received the 2004 Technical Cooperation Program Achievement Award for his work on military Quality of Service and a 2015 DST Group Commendation for S&T excellence for his work on the use of self-organisation to enhance wireless network performance and survivability in highly contested RF environments.

Dr David Battle

Defence Science and Technology Group

Deep Ray – A Multi-Role Autonomous Underwater Vehicle for Persistent Surveillance

David Battle began his research career developing innovative technologies for the remote inspection of the original High Flux Australian Reactor at the Lucas Heights Laboratories in Sydney. Following a PhD in high-frequency acoustic imaging at The University of Sydney, he was a post-doc at Scripps Institution of Oceanography in La Jolla California for two years, during which time he completed the graduate course in Computational Ocean Acoustics at the Marine Physical Laboratory. For the next three years, he was a Research Engineer in the Laboratory for Autonomous Marine Sensing Systems at The Massachusetts Institute of Technology. In addition to teaching and research at MIT, he managed the MIT component of the PLUSNet program – the first major foray of the US Navy into autonomous networked undersea warfare. Today, David heads the DST-Group Maritime Division's Unmanned Systems and Autonomy Group in Sydney, working predominantly in areas of mine countermeasures (MCM), rapid environmental assessment (REA) and anti-submarine warfare (ASW).

Notes