The International Technology Alliance in Network & Information Sciences

Capstone

17 March 2016

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Greg Cirincione
U.S. Army Research Laboratory

Dr. Dave Watson
IBM-UK

Dr. Dinesh Verma
IBM-US

George Vongas
UK Defence Science & Technology Laboratory

Bottom Line

- The NIS ITA is a unique US-UK collaborative venture
- Achievements enhanced by synergies gained from UK/US collaborations
- Significant advances in the state-of-the-art in network & information science for coalitions
- Technologies exploited using an innovative transition model
- Strong bonds were formed between Alliance researchers that will endure long after the program ends

The ITA Program

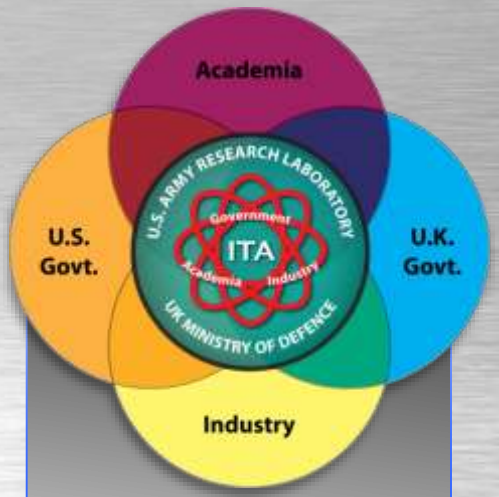
Alliance of US & UK government, industrial & academic researchers to develop underpinnings of network & information science to enhance capabilities to conduct coalition warfare

- Bi-lateral UK MOD – US Army Collaboration
- Key component of governments' national programs
- Integrated US-UK industrial-academic consortium coupled with US ARL & UK Dstl researchers
- Established in Spring 2006 & extended for 5 years in 2011
- $92M over 10 years (equal contributions by US & UK)

A New Way of Conducting International Research Collaboration

Key Attributes

- **An Alliance** enabling joint US-UK technical leadership & research collaboration among government-industry-academia
- **Deep Collaboration** among researchers & leaders throughout the Alliance
- **Multidisciplinary Approach** focused on complex coalition technical challenges
- **Innovative Transition Model** to accelerate affordable exploitation of ITA science results



Achieved results not possible without synergies from robust US-UK collaborations

The ITA Goals

Strategic Goals:

- Enhance distributed, secure, & flexible decision making for coalition operations
- Enable rapid & secure formation of *ad hoc* teams

Coalition Focus:

- Interoperable data acquisition, processing, & management
- Hybrid wireless mobile networking among coalition partners
- Adaptable security for distributed information services
- Positioning & fusion of coalition data to support decision making

Coalition Needs

Coalition operations increasingly prevalent, dynamic & complex

Dynamic Coalitions:

- Rapidly forming teams with different partners
- Adapting to changing missions, tempo, mobility, & membership
- Teams with different cultures, policies, networks & technologies
- Conflicts occur in congested, contested, connected, & constrained battlespace

Challenges:

- Ad hoc coalition teams
- Distributed operations
- Resource constraints
- Data complexity
- Heterogeneity
- Dynamics

The ITA Team

John Pellegrino (ARL)

George Vongas (Dstl)

Alliance/ Consortium Leaders

Dinesh Verma (IBM-US)

Dave Watson (IBM-UK)

Technical Leadership

- **Prof Don Towsley** (UMass)
- **Prof Alun Preece** (Cardiff)
- **Dave Braines** (IBM-UK)
- **Mudhakar Srivatsa** (IBM-US)
- **Gavin Pearson** (Dstl)
- **Ananthram Swami** (ARL)
- **Tien Pham** (ARL)
- **Trevor Benjamin** (Dstl)

ACADEMIA

- Carnegie Mellon University
- City University of New York
- Columbia University
- Pennsylvania State University
- Rensselaer Polytechnic Institute
- University of California Los Angeles
- University of Maryland
- University of Massachusetts

INDUSTRY

- IBM Research
- Applied Research Associates
- Boeing
- Honeywell
- Raytheon BBN Solutions

INDUSTRY

- IBM UK
- Airbus UK Ltd
- Logica CMG
- Roke Manor Research
- Systems Engineering & Assessment

ACADEMIA

- Cardiff University
- Cranfield University
- Imperial College, London
- Royal Holloway University of London
- University of Aberdeen
- University of Cambridge
- University of Southampton
- University of York

Governance & Independent Peer Review

Executive Steering Board (ESB)

Dr. Thomas Russell
ARL

Dr. Chris Gibson
Dstl

- Executive leadership of ITA
- Strategic direction & guidance

Alliance

Collaborative Alliance Managers (CAMs)

Government Researchers

ITA Consortium

Consortium Managers & Researchers

Independent External Peer Review

Assess technical merit, quality, & relevance

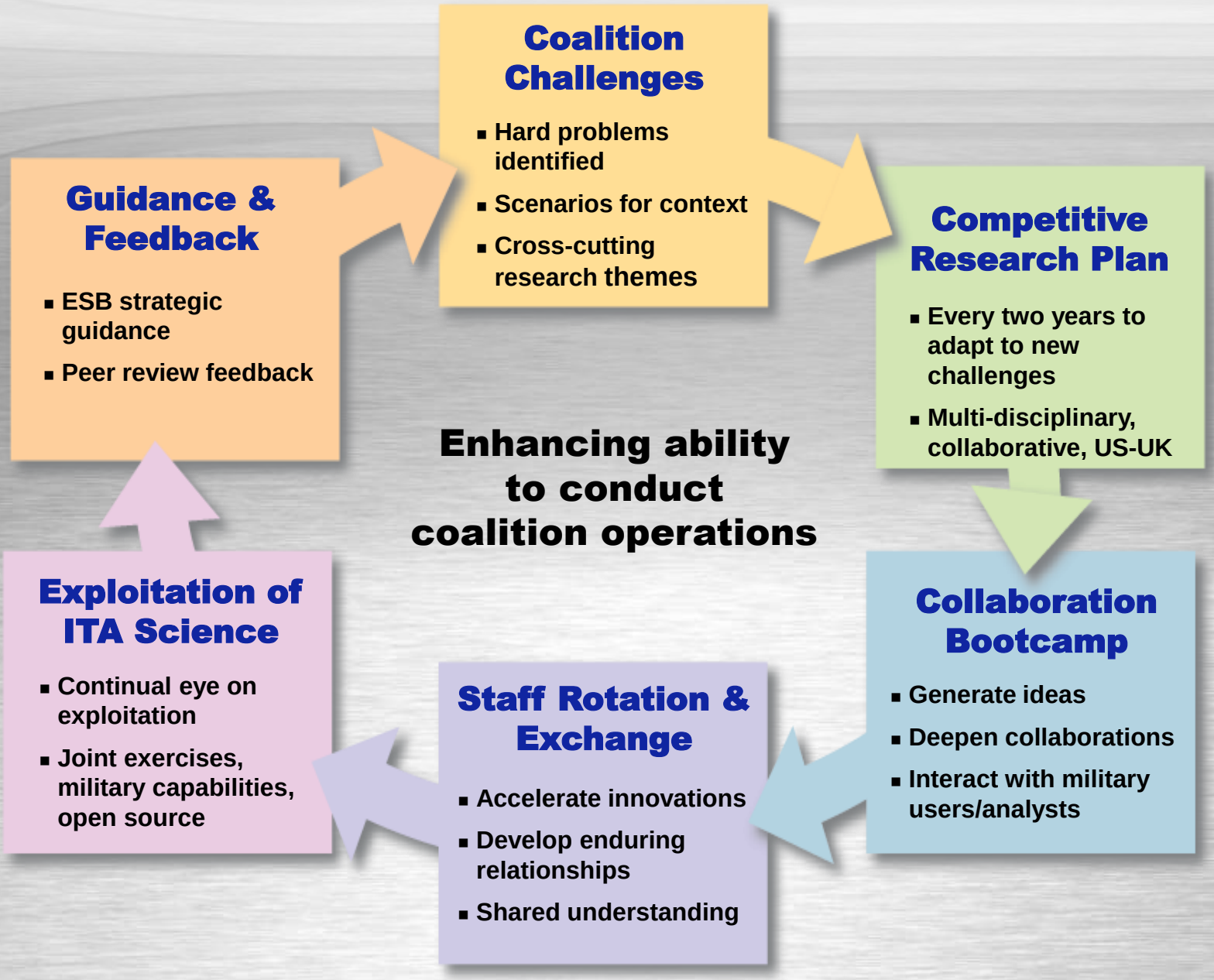
Peer Review Panel

- **Prof. Srikant**, UIUC: Co-chair
- **Prof. Underhill**, retired industry & academia: Co-chair
- Ten US/UK experts (2 government, 8 academic)

First ESB at ARL:

Jack Lemon, Jay Gowens, Paul Stein, Thomas Killion

The ITA Operational Model



Evolution of the ITA Technical Program

Base Program 2006-2011

- Network Theory — TA1
- Security Across a System-of-Systems — TA2
- Sensor Information Processing & Delivery — TA3
- Distributed Coalition Planning & Decision Making — TA4

Extension 2011-2016

- Coalition Interoperable Secure & Hybrid Networks — TA5

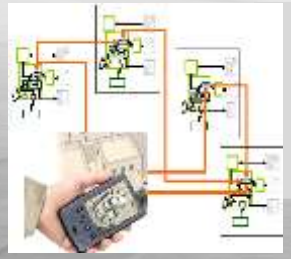
Adaptable & interoperable communications-information services for dynamic military coalitions

- Distributed Coalition Information Processing for Decision Making — TA6

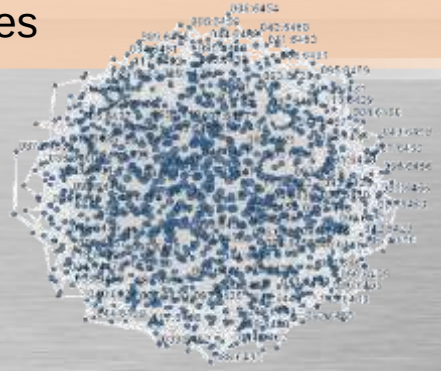
Agile networks of data & information for effective coalition decision making

Adapting to the Emerging Technical Challenges & Coalition Needs

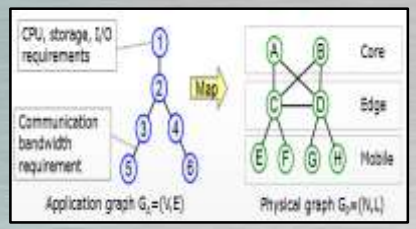
Key Science Results



Distributed Dynamic Federated Database based on "store-locally-query-anywhere" principle that operates in distributed environments enabling the query of collections of coalition information sources

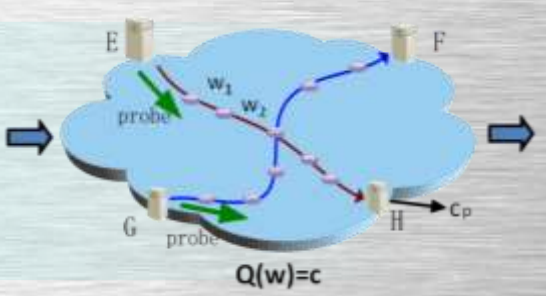


Distributed Dynamic Processing across hybrid heterogeneous coalition networks that harvests computational capacity on-demand while adapting to network dynamics & changes in coalition teams



Homomorphic Cryptographic Techniques for distributed dynamic federated data services that supports data aggregation & outsourced computation among coalitions without decryption

Network Tomography to efficiently infer internal network state from external measurements in heterogeneous coalition networks to support network monitoring, network adaptation, service migration



Impacting the Science for Coalitions

People & Honors

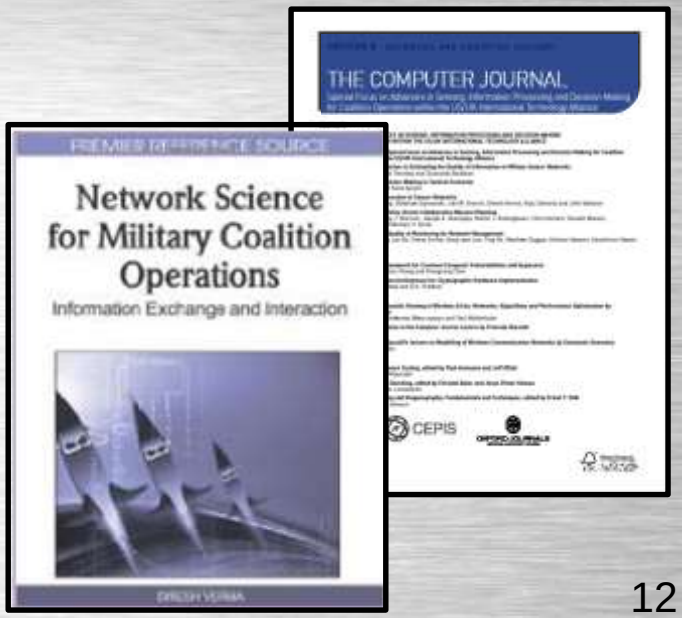
- **45** Fellows (IEEE, ACM, British Computer Society, IBM, ARL)
- **5** Fellows of UK Royal Academy of Engineering
- **1** Member of US National Academy of Engineering
- **15** Achievement awards
- **1** Commendation from MoD Chief Scientific Advisor

Innovations

- **799** Conference publications
- **207** Journal publications
- **~18900** Citations
- **55** Patent disclosures/files

Leadership

- **104** Conferences & Workshops
- **2** Special Issues in Journals
- **31** Journals editorships
- **10** Editors-in-Chief
- **4** Books



Transitioning ITA Science

Research results linked to coalition needs, integrated together & exploited in US & UK

Alliance Synergies Led to Multiple Transition Pathways

ITA Enduring Relationships

Collaborative Publications

37% with US/UK

16% with government

Shared Understanding & Trained Scientists

67 Faculty & Industrial researchers

11 Post doctoral researchers

15 US/UK government researchers

64 PhDs & **14** Masters awarded

Staff Rotation

140 Staff rotations (**91** international)

26 West Point Cadets to IBM-UK for a month (2008-2015)

17 Staff rotations by US/UK Government researchers

1 ARL researcher (Ananthram Swami)
Visiting Professor at Imperial College

Summary

- Pioneering US-UK collaborative venture
- Impact on coalitions with scientific advances & technology exploitation
- Strong bonds will endure

Peer Review Panel Assessment

- Scientific quality of program is impressive
- Well-integrated with excellent collaboration
- An exemplar for any future collaborative research program

The White House Joint Fact Sheet

U.S. - UK Higher Education, Science, & Innovation Collaboration

"Today President Obama and Prime Minister Cameron reaffirmed their shared commitment to strong collaboration in science, innovation, and higher education, highlighting recent joint efforts." …

"**Better Informing Our Troops**: Since 2006, an International Technology Alliance of industrial and academic organizations from the U.S. and UK, led by U.S. Army Research Laboratory and UK Defense Science and Technology Laboratory, have been jointly conducting collaborative research to enhance information-sharing and distributed, secure, and flexible decision-making to improve networked coalition operations. These technologies will be demonstrated during a joint U.S.-UK field trial in the UK in March 2012."

The White House Office of the Press Secretary, March 14, 2012.

ITA Scientific Accomplishments

Advancing the State-of-the-Art in Network & Information Sciences

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Dr. Ananthram Swami
U.S. Army Research Laboratory

Prof. Alun Preece
Cardiff University

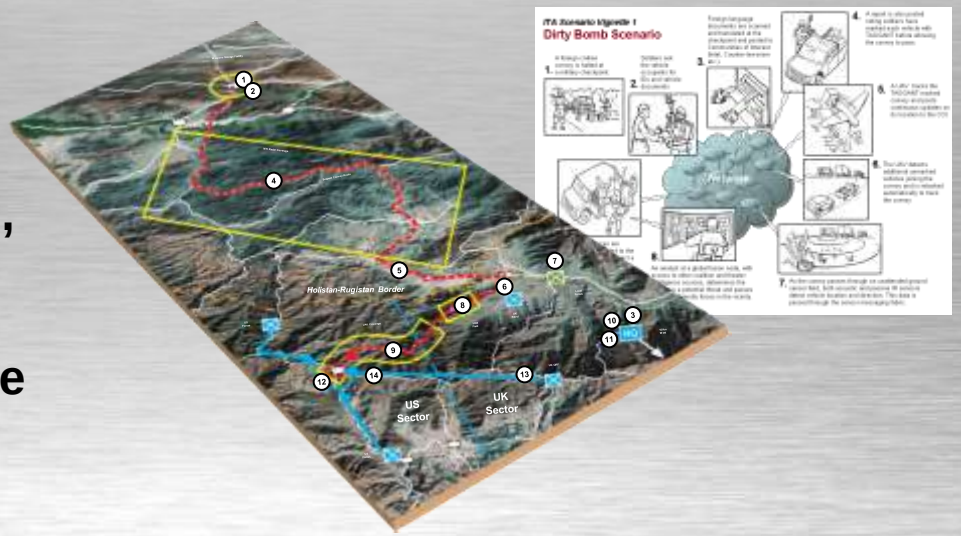
Prof. Don Towsley
University of Mass-Amherst

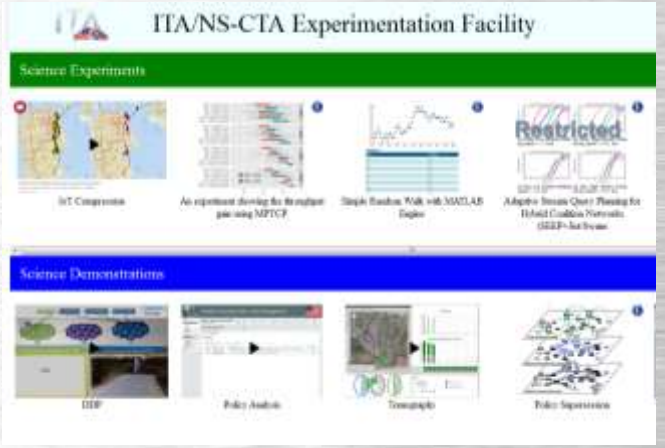
Advancing the State-of-the-Art

Fundamental underpinnings for adaptable & interoperable information networks for effective dynamic coalition decision making

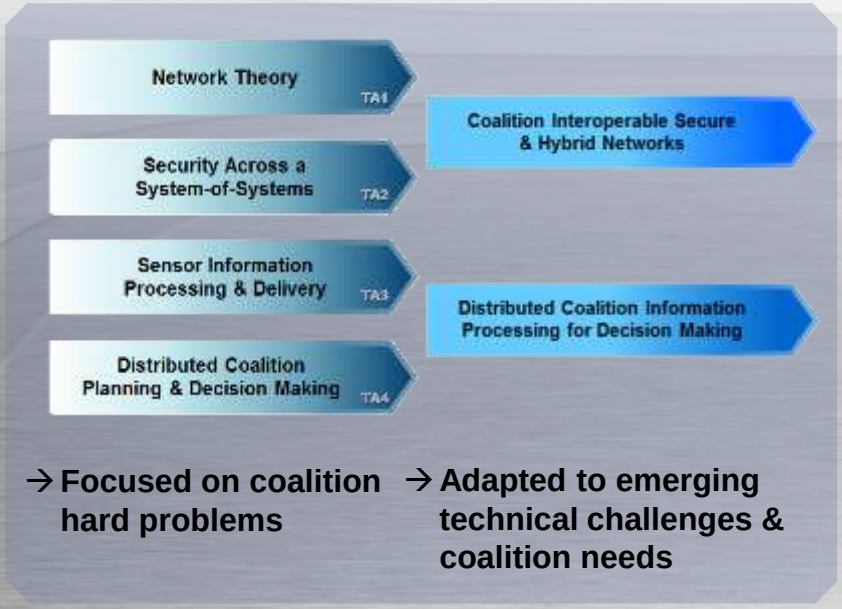
Strategy:

- Identify hard coalition problems, coalition scenarios
- Focus on science gaps to enable ad hoc coalition teams
- Multidisciplinary approach to cross-cutting research issues
- Distributed experimentation



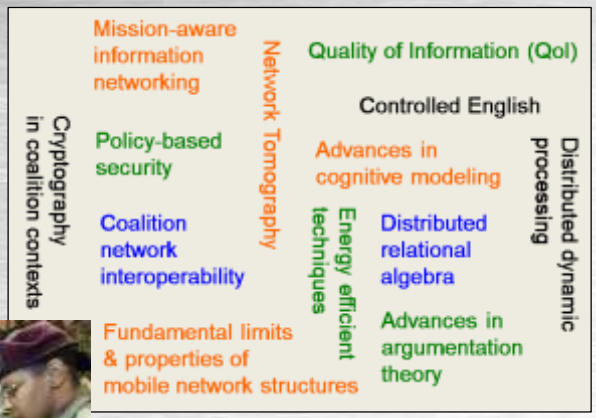


The ITA Technical Program



→ Focused on coalition hard problems

→ Adapted to emerging technical challenges & coalition needs



Key Science Results

Coalition Interoperable Secure & Hybrid Networks

- Network tomography
- Distributed dynamic processing
- Outsourced computation
- Policy-based security

Distributed Coalition Information Processing for Decision Making

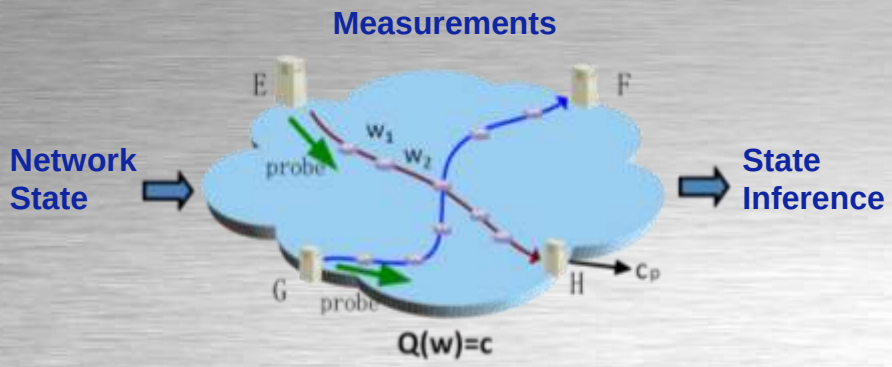
- Distributed dynamic federated databases
- Sensor assignment for missions
- Controlled natural language
- Argumentation theory for reasoning

Network Tomography

Network Tomography to efficiently infer internal network state from external measurements in heterogeneous coalition networks to support network monitoring, network adaptation, service migration

- ARL
- Dstl
- IBM-US
- Imperial
- U Mass

Challenge: No centralized controller, scalability, varying trust among coalition partners



Key Results

- First establishment of topological conditions for identifiability & monitor placement
- Significantly reduced path construction complexity → exponential to linear-quadratic
- Optimal methods for partial coverage under placement & resource constraints
- Easily verifiable topological conditions for failure localization
- Established minimal monitor placement for dynamic networks
- Optimal probing strategies to meet performance bounds

Top Publications: ACM IMC, IEEE ICDCS, IEEE INFOCOM, IFIP Performance, ACM Sigmetrics, IEEE/ACM Trans Networking

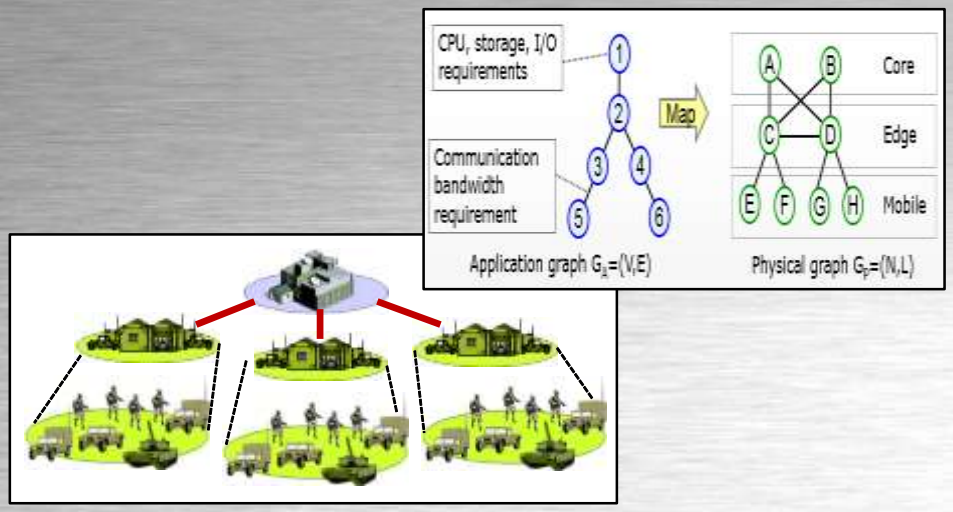
Foundational Network Tomography, 3 Best Paper Awards

Distributed Dynamic Processing

Distributed Dynamic Processing across hybrid heterogeneous coalition networks that harvests computational capacity on-demand while adapting to network dynamics & changes in coalition teams

- ARL
- IBM-US
- Imperial

Challenge: Securely harvest computational resources adaptive to network/application dynamics



Key Results

- **First algorithms to map multiple application graphs to physical graphs**
  - → **Polynomial complexity**
  - → **Poly-log approximation bounds**
- **Migration policy that minimizes total cost under network dynamics**
  - → **Reduces computation time by three orders of magnitude**
  - → **Close to optimal performance with provable constant approximation error**
  - → **Decoupling of migration strategy from mobility model**

Top Publications: IFIP/IEEE Networking, IFIP/IEEE Performance, IEEE ICC, Journal of Perf. Eval

Novel Approaches for Security-aware Distributed Processing

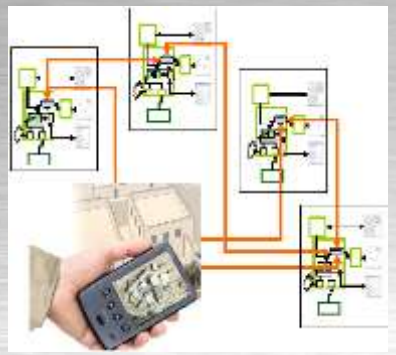
Dynamic Distributed Federated Databases

Distributed Dynamic Federated Database based on "store-locally-query-anywhere" principle that operates in distributed environments enabling query of collections of coalition information sources

- CUNY
- IBM-UK
- RPI

Challenge: On-demand source discovery, scalability, policy-compliance, minimize overhead

1250 Node Gaian Database



Key Results

- Bio-inspired network connectivity for dynamic fault-tolerant query routing → scale-free networks
- Query time scales
  - → Logarithmically with number of nodes
  - → Linearly with number of records retrieved
- Novel metrics to handle complexity of self-organization

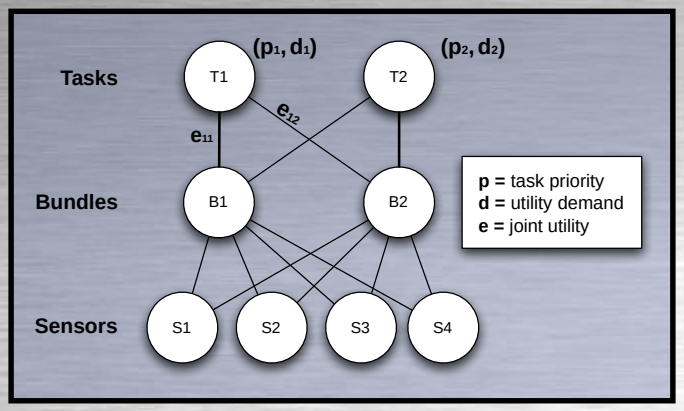
Top Publications: Entropy, Advances in Computational Math, Applied Math Comp, PLoS ONE, Complexity Journal

Sensor Assignment for Missions

- ARL
- Cardiff
- CUNY
- Dstl
- IBM-UK
- Penn State

Sensor Assignment for Missions enabling efficient assignment of assets to multiple concurrent coalition tasks based on policy, resource constraints, ownership, & emplacement limitations

Challenge: Lack of formalism for assigning sensor assets to missions, concurrent missions vs resource/sensor constraints



Key Results

- Generalized distributed network utility maximization to mission-oriented wireless sensor networks
  - → Accounts for interference, power control, scheduling, flows, mission lifetimes
  - → Extended to in-network processing
  - → Analytical proof of convergence
- Innovative task-bundle-asset graph model led to efficient algorithms
- Developed sensor placement algorithms for robust k-coverage

Top Publications: IEEE SECON, IEEE INFOCOM, ACM MC2R, AlgoSensors, IEEE TPDS, Computer Journal, IEEE Intel. Systems

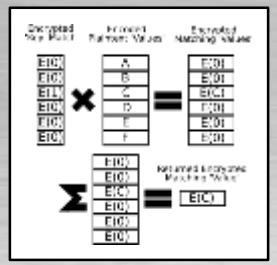
Formal Methods for Assigning Assets Based on Mission Requirements

Outsourced Computation

Homomorphic Cryptographic Techniques for distributed dynamic federated data services that support data aggregation & outsourced computation among coalitions **without decryption**

- CUNY
- IBM-US
- IBM-UK
- RHUL

Challenge: Verifiably outsource computations to an untrusted partner without revealing data or result



Top Publications: Crypto, EuroCrypto, CCS, CCSW, PKC, POPL

Award: Won Secure Outsourcing Competition at 2015 IDASH Privacy & Security Workshop

Key Results

- **First realization of verifiable computing**
  - → **Computationally sound**
  - → **Non-interactive**
  - → **Provides input & output privacy**
- **Extensions**
  - → **Limited storage constraints**
  - → **Verifiable keyword search**
  - → **Multiple clients/data owners**
  - → **Public key setting**
- **Significant acceleration makes it practical**
- **Quadratic Span Programs provide new characterization of NP-hard problems**

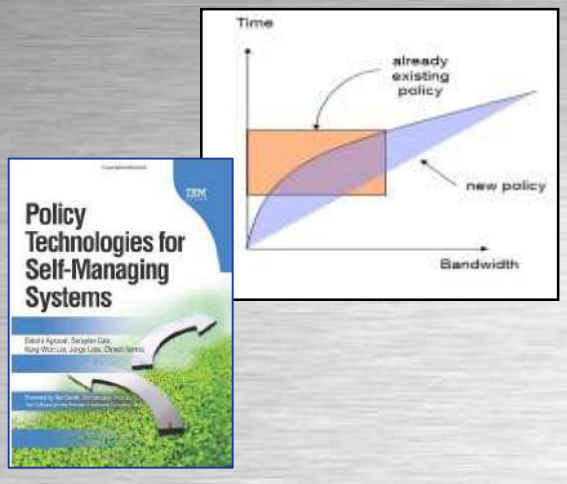
Potentially Disruptive Approach, 2 Best Paper Awards

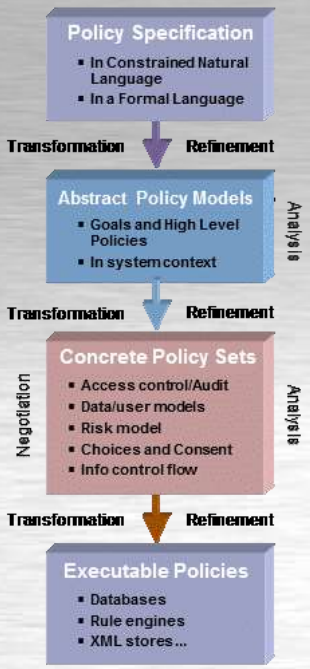
Policy-based Security

- ARL
- Columbia
- Honeywell
- IBM-US
- Imperial

Distributed Policy Analysis & Negotiation techniques for provable security in distributed coalition settings with distributed policy enforcement

Challenge: Understand & control overall effect of policies in distributed systems with partial information





Key Results

- First formal language capable of modeling dynamic regulated systems & temporal authorization/obligation policies
- Algebra for combining policies & abductive proof procedures for policy analysis
- Policy negotiation that guarantees convergence
- Policies to enable secure dynamic community establishment
- Distributed policy enforcement for secure information flows

Top Publications: ASIACCS, IEEE Policy, ACM SafeConfig, IFIP-IM

Automated Security Policy Specification, Refinement, Negotiation, Analysis

Controlled Natural Language

Controlled Natural Language/Controlled English that improves human-machine collaboration by coupling thinking & processing via a language that is human & machine processable

- ARL
- Boeing
- Cardiff
- Dstl
- Honeywell
- IBM-UK

Challenge: Shared understanding between human & machine agents

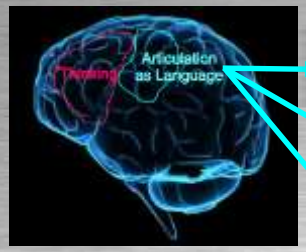
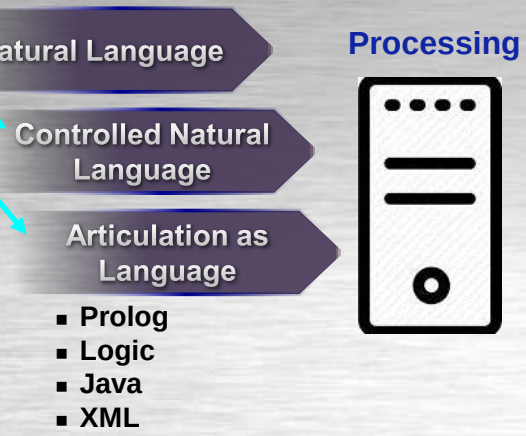


Photo: Sebastian Kaulitzki
Agency: Dreamstime.com



Key Results

- Developed Controlled English (CE), a novel knowledge representation & reasoning formalism
- Enables creation of common, shared conceptual models across coalition
- CE domain reasoning externalizes human problem solving
- CE based conversational approach allows exploitation of structured & semi-structured information

Top Publications: IEEE Intelligent Systems, ACM Mobile Computing & Communications Review

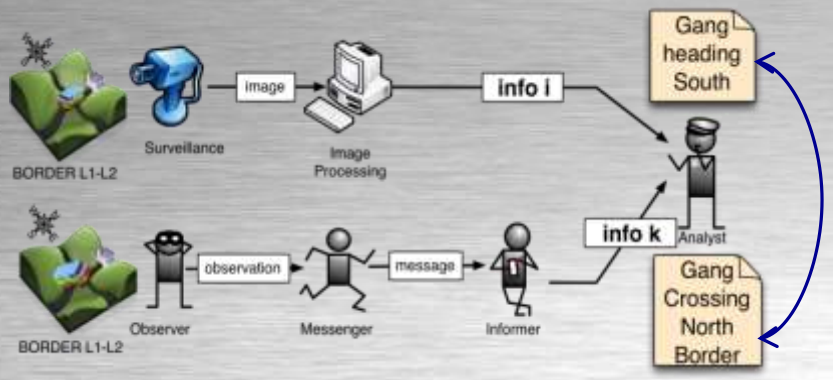
Novel Language for Human-Machine Collaboration, Validated in Case Studies

Argumentation Theory for Reasoning

- Aberdeen
- ARL
- CMU
- Honeywell
- IBM-US
- UCLA

Argumentation Theory enables collaborative construction of hypotheses with ability to exchange arguments & justification while identifying uncertainties to enhance human reasoning in coalition operations

Challenge: Formal methods to incorporate uncertainties in reasoning & provenance frameworks



Key Results

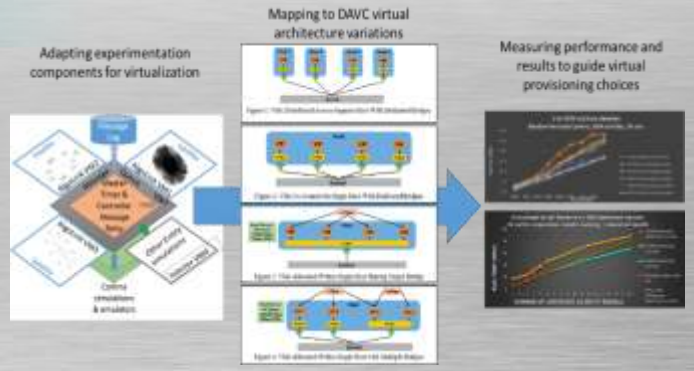
- Models enable agents to extract provenance elements & facilitate reasoning about preferences & information credibility
- Collaboratively construct models taking account of conflicting information & critical questions to avoid cognitive biases
- Provenance graphs of conflicting evidence facilitate principled resolution of conflicts
- Principled use of metrics (reliability, trustworthiness, timeliness, accuracy of derivation) enables conflict resolution

Top Publications: AAMAS, ACM Trans. on IST, ECAI, IEEE Intelligent Systems, IJCAI, Journal of Web Semantics, Pervasive & Mobile Computing

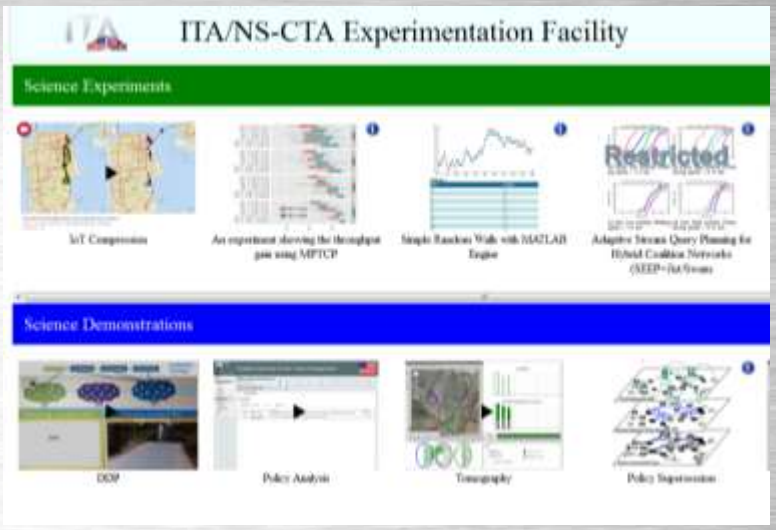
Robust Assessment of Hypotheses & Evidence for Intelligence Analysis

Experimentation

Collaborative Experimentation Workspace for solving complex problems with a distributed infrastructure where researchers can create, run, share & reproduce experiments



- **Experimentation as a Service** to foster re-use minimizing coding, setup & system configuration efforts
- **Dynamically Allocated Virtual Clustering Management System** (DAVC) provides a robust method to create, deploy, & manage virtual clusters of nodes within a cloud environment
- **Suite of Visualization Tools** to simplify visualizing data from different researchers & experiments in a unified manner



Accelerating Innovation with Experimentation

Metrics & Leadership

Innovations

799	Conference publications
207	Journal publications
~18900	Citations
55	Patent disclosures/files
13	Best paper awards

Leadership

104	Conferences & Workshops
10	Journal Editor-in-Chiefs
31	Journal Editorships
2	Special Issues: The Computer Journal on ITA Science for Coalitions & IEEE Intelligent Systems on Coalitions

ITA Organized/Led (selected)

- BIOWIRE Workshop (2007, 2008, 2009)
- IEEE POLICY Workshop (2008, 2009, 2011)
- Knowledge Systems for Coalition Operations Conference (2009)
- IFIP Trust Management (2011)
- SecureCom (2014)
- Intl Workshop on Trust in Agent Societies (2013/2014)
- Intl Workshop on Information Quality & Quality of Service for Pervasive Computing (2015)

Summary

- ITA has defined the state-of-the-art in network/information sciences with new research directions
- Alliance collaborations are key to research results
- Experimentation has accelerated innovation & led to discovery of new scientific challenges

Science Demonstrations & Posters

- Network tomography
- Distributed dynamic processing
- Policy analysis & negotiation
- Outsourced computation
- Argumentation theory for reasoning
- Experimentation

ITA Transitions

Accelerating Results for Greater Impact on Coalition Operations

17 March 2016

Dr. Tien Pham
U.S. Army Research Laboratory

Dr. Dave Watson
IBM-UK

Dr. Dinesh Verma
IBM-US

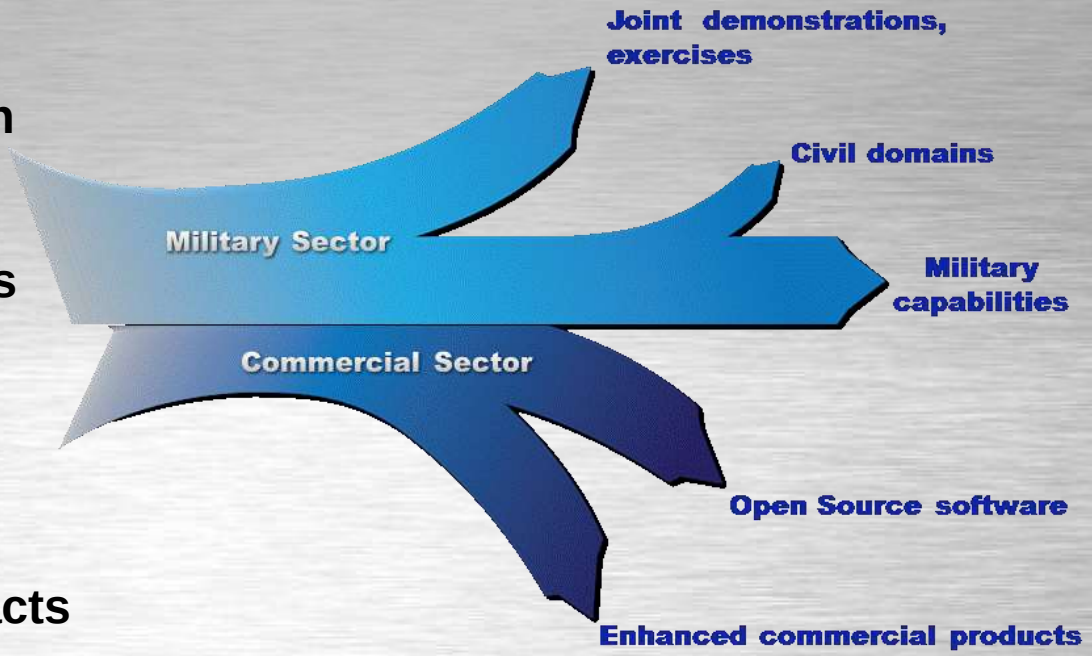
Gavin Pearson
UK Defence Science & Technology Laboratory

Accelerating Results for Greater Impact

Ultimate measure of ITA is the impact its research has on improving our ability to conduct coalition operations

Transition Strategies:

- Continual eye on exploitation of science
- Engage users & stakeholders
- Intensive interaction with analysts/users to develop shared understanding
- Companion transition contracts in both countries



- Exploit multiple pathways in both military & commercial sectors

Impacting the Military Sector

Key Transitions

- Sensor & policy for networking disparate ISR assets
  → OSD Coalition Warfare Program (CWP), PWAS
- Policy controlled information query & dissemination
  → OSD CWP, NATO Intelligence Fusion Centre (NIFC)
- Information fabric
  → UK LOSA RED, UK JBRIDGES
- Agile sensor tasking for intelligence support teams
  → US CERDEC AI-TECD & ExPED
- Human-machine collaborative environment
  → UK police for NATO Summit
- Coalition ISR asset interoperability
  → OSD CWP, Canada (DRDC), NATO STANAG

Demos & Exercises

- US Empire Challenge
- US Camp Roberts
- UK Pershore
- US-led NIFC at Molesworth RAF
- UK NATO Summit, Wales

Networking Disparate ISR Assets

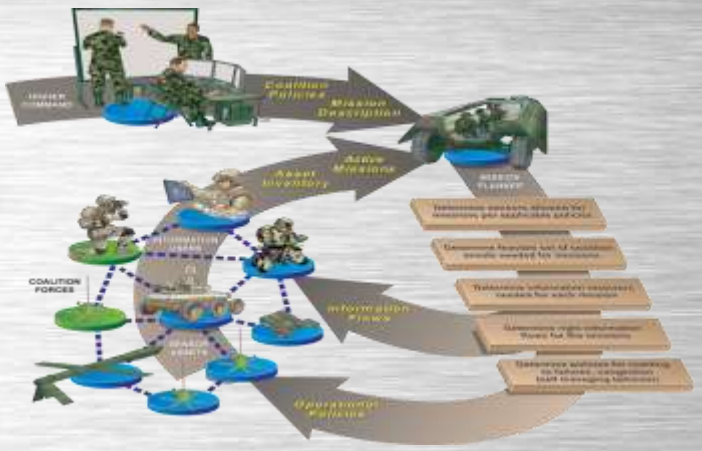
Need Secure coalition ISR/ISTAR interoperability & information sharing to enhance decision making

Capability Policy-controlled infrastructure to network disparate coalition assets

Technologies

- Information Fabric for ISR/ISTAR networks to federate disparate assets
- Policy negotiation & deployment to constrain how ISR assets & data can be used & shared

Camp Roberts



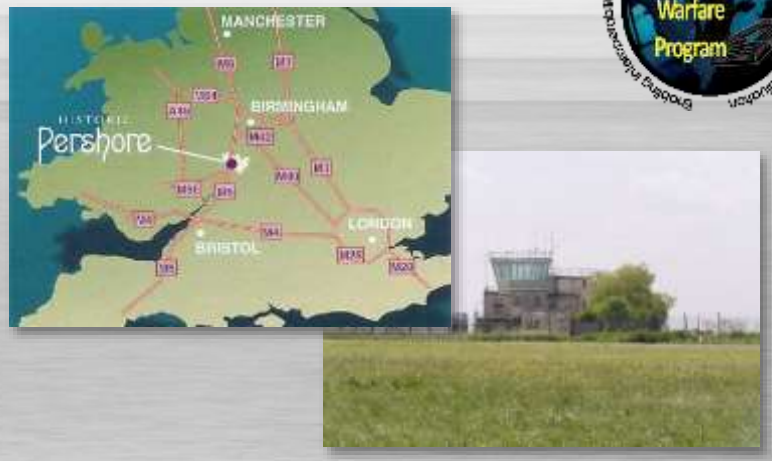
Demonstrated at US Empire Challenge (2010), US Camp Roberts (2011), & UK PWAS (2012)

Joint US-UK, Sponsored by OSD CWP, Endorsed by CENTCOM & SOCOM

PWAS CCD2 Demonstration Pershore, UK

Field Trial 2012

- MoD's Persistent Wide Area Surveillance (PWAS) Capability Concept Demonstrator 2 (CCD2)
- Networking & interoperability of US & UK ISR/ISTAR assets w/policy controlled data sharing
- US Acoustic Arrays (UTAMS) integrated with UK PWAS assets



US Acoustic Sensors Cueing UK EO Sensors

CCD Systems Integration Lab

NATO Intelligence Fusion Centre

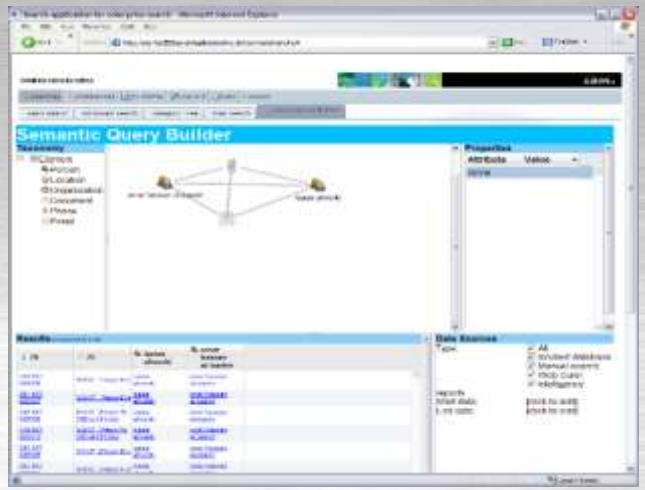
Need Enhanced Processing, Exploitation & Dissemination (PED) for all-source analysts in coalitions

Capability Policy based federated & authenticated access to distributed data

Technologies

- Dynamically distributed federated database (Gaian DB)
- Distributed policy creation & enforcement for rapid changes
- Security extensions to KERBEROS
- Visual Query Builder for Intuitive complex queries

Visual Query Builder with Semantic Search & Link Analysis



Demonstrated on NATO Battlefield Information Collection & Exploitation Systems (BICES) Network

Joint US-UK, Sponsored by OSD CWP, Sponsored by TRANSCOM & EUCOM

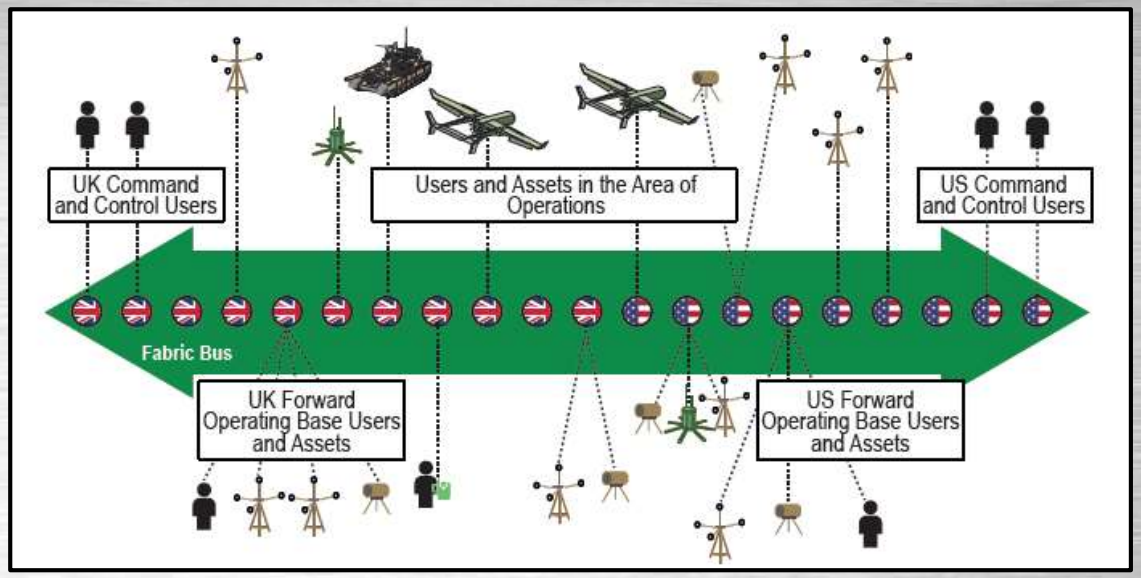
The Information Fabric

Distributed access to information in tactical battlespace

- A service/message integration bus for resource constrained networks
- Connect users to any relevant data source
- Distributed, decentralized, computational lightweight
- Adapts to network fragmentation & varying bandwidth

Enables:

- Asset identification, discovery & management
- Unified access & control
- Policy-based interoperability



Information Fabric Transitions

First draft Land Open Systems Architecture (LOSA) Common Open Interface Land (COIL) DefStan 23-014

- Joint Dstl/ARL (matured via OSD CWP)
- Dstl (scaling)
- UK DE&S (develop & test standard)

LOSA Research, Experimentation, & Development (RED) at Caerwent Wales

Persistent Wide Areas Surveillance (PWAS) Capability Concept Demonstration at Pershore, UK

Edgeware Fabric Open Source

GitHub

UK Exploitation, Sponsored by UK DE&S, Led to Open Source Release

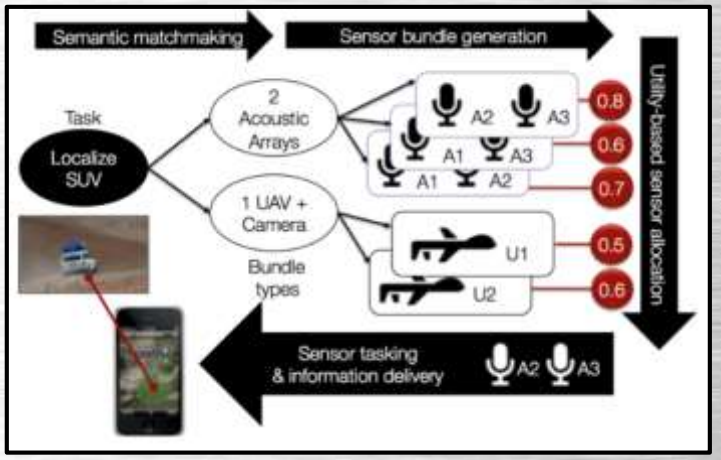
CERDEC Actionable Intelligence TECD

Need Small units need improved capability to collect, process, & exploit critical tactical intelligence at Company & below

Capability Agile sensor tasking for Company Intelligence Support Teams

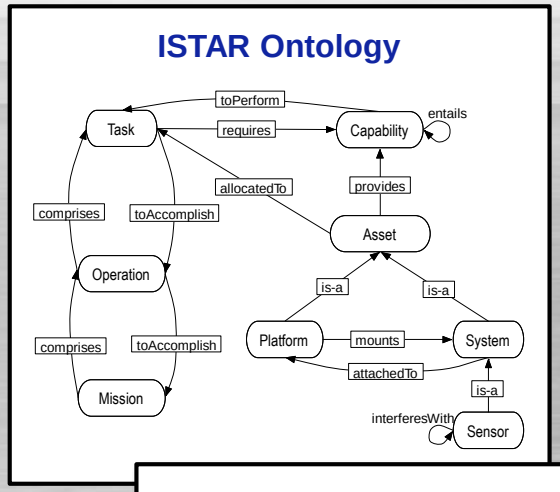
Technologies

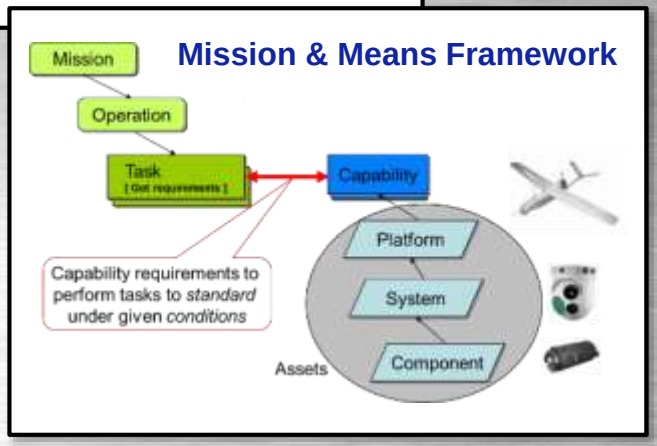
- Sensor Assignment-to-Mission (SAM)
  - Autonomously matching information assets to user needs
  - Information need (not source types)
  - Allows bundling of assets
  - Support dynamic tactical battlespace



Technologies (cont)

- ISTAR ontology
  - Based on Mission & Means Framework
  - OWL ontologies extended with CNL/CE for on-the-fly changes





- SAM demonstrated at AI-TECD demonstration
- Operated over Open Standard Unattended Sensors (OSUS) compliant assets
- Ongoing Effort → CNL providing human information interaction & agile ontologies
  - CERDEC Extensible Processing Exploitation & Dissemination (ExPED) program

Joint US CERDEC-ARL Transition

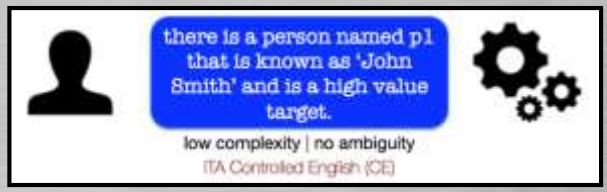
Open Source Analysis for Wales Police

Need Subject-matter experts need tools to make sense of complex, evolving situations in real time, drawing on open source intelligence

Capability Human-information interaction technologies to assist in sensemaking

Technologies

- CE for knowledge representation & reasoning
- Conversational interface for information capture, querying, & sense-making



- Used at the 2014 NATO Summit in South Wales
- Led to establishment of Open Source Communications Analysis Research Centre (OSCAR)
  - Collaboration with 5 UK Police Forces & UK Counter-Terrorism Policing Command

Joint Cardiff University & IBM UK, Led to New Centre

Coalition ISR Asset Optimization

Need Architecture to enable autonomous cross-cueing, shared control & policy for disparate ISR assets at the tactical edge

Capability Architecture, algorithms, & draft interoperability standard for coalitions

Objectives (2016 Start)

- Extend US OSUS for coalition plug & play interoperability
- Algorithms & tools to discover & dynamically match available ISR assets to coalition missions
- Develop baseline for NATO STANAG
- Test & evaluate in Enterprise Challenge 16 (US), Contested Urban Environment 17 (TTCP), Unified Vision 18 (NATO)

DRDC RDDC

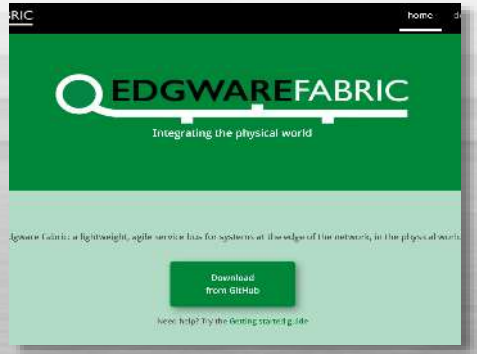
Government of Canada

Joint US-Canada (DRDC), Sponsored by OSD CWP, to Develop NATO Standard

Public Domain & Open Source Software

IBM Open Source Software

- Controlled English (CE) Node & Store
- Information fabric (Edgeware)
- Gaian dynamic distributed federated database
- Fully homomorphic encryption library



UMd Open Source Software

- Information flow release extensions
- IntegriDB for verifying outsourced computing for database queries

Available in Public Domain

- IBM Watson Policy Management Language

Open Source Software Expands the Impact of ITA Technologies

IBM Enhanced Commercial Products

Tivoli Smart Cloud Monitoring

→ Monitors private cloud infrastructures

- **Enhanced with ITA distributed federated dynamic database**

IBM Cloud

Tivoli Netcool/Impact → Network management tool

- Event enrichment, contextual correlation & automation to unify disparate systems
- **Enhanced with ITA policy analysis**

IBM Tivoli software Netcool

ASPN: (Application Service Platform for Networks) → First mobile edge computing platform

- Collaboration between IBM & Nokia Siemens Networks
- Pushing applications, processing & storage to the edge of the mobile network
- **Incorporated ITA distributed dynamic processing**

IBM Nokia Siemens Networks

PureApplication Software

→ For cloud-enabled applications

- A hybrid cloud application platform for cloud enabled applications
- **Enhanced with ITA policy, distributed database, & distributed dynamic processing**

PureSystems

Coalition Technologies Inserted in Commercial Products

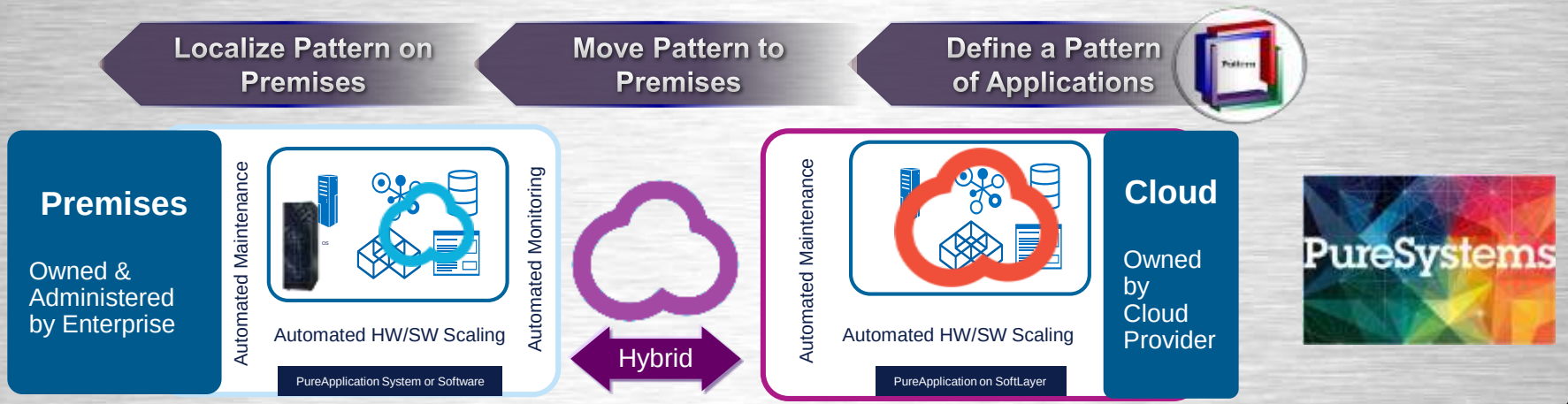
IBM PureApplication System

PureApplication System

- A prepackaged system to enable rapid development of applications
- A building block enabling the IBM hybrid clouds
- Hybrid Clouds enables enterprises to run some applications on premises, & some on a cloud

ITA Enhancements

- **Network Localization** to adapt network configuration → Uses ITA dynamic distributed processing approaches
- **Data Localization** to adapt local data format with a database proxy → Uses ITA distributed federated database technology
- **Policy Controls** to limit data flow between premises & the cloud → Uses ITA policy management library



Summary

- ITA is transitioning a broad set of technologies to both the commercial & military sectors
- Joint US-UK efforts key to enhanced exploitation
- Significant open source software releases expanding impact
- Exploitation will extend beyond the NIS ITA

US-UK Team at PWAS

Transition Demonstrations & Posters

- **Sensor asset matching & dynamic ontologies for CERDEC AI-TECD**
- **Federated data access at the NATO Intelligence Fusion Center**
- **Open Source Communications Analysis at NATO Summit 2014**
- **The information fabric**