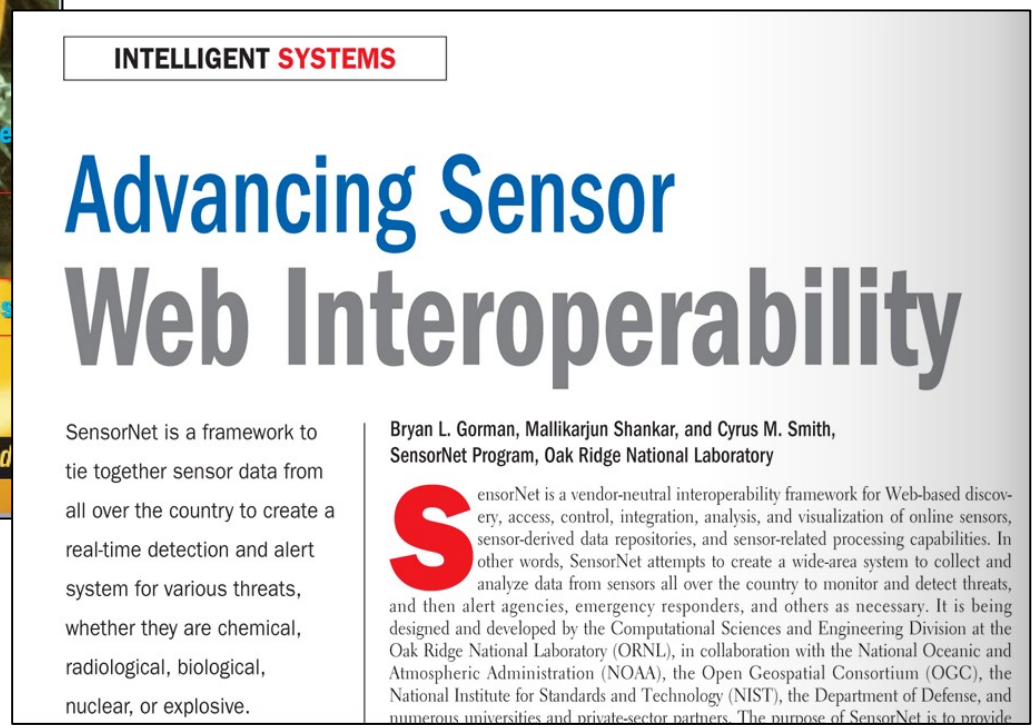
A Review of Oak Ridge National Laboratory's SensorNet Project



INTELLIGENT SYSTEMS

Advancing Sensor Web Interoperability

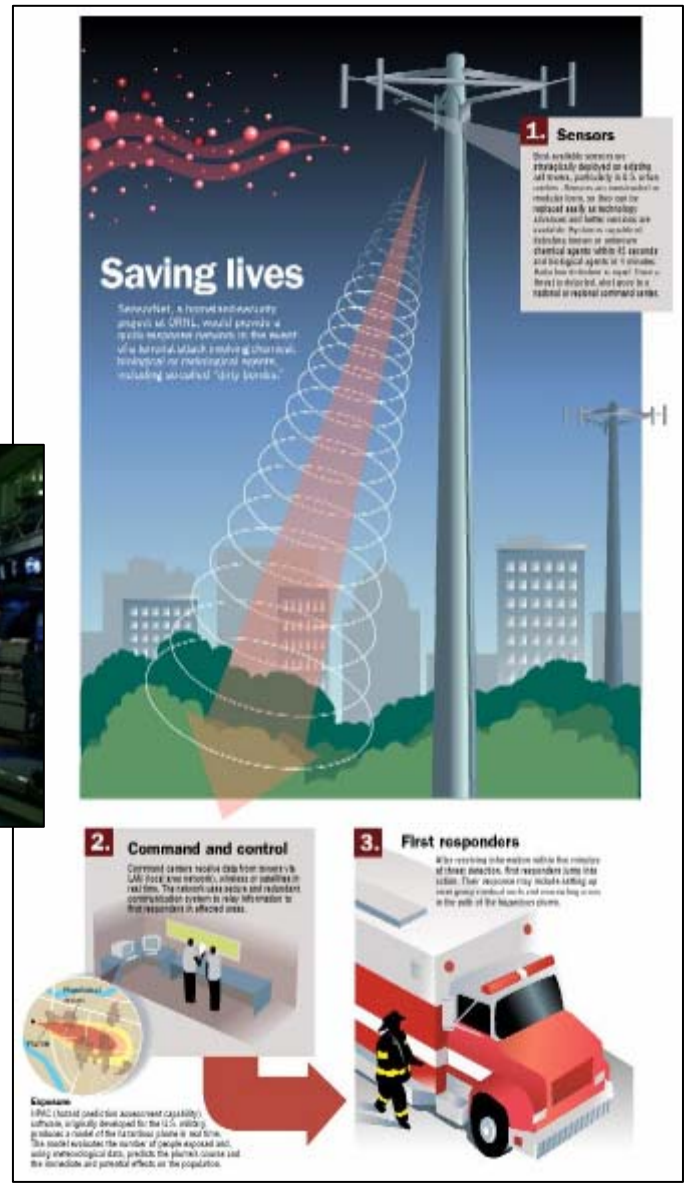
SensorNet is a framework to tie together sensor data from all over the country to create a real-time detection and alert system for various threats, whether they are chemical, radiological, biological, nuclear, or explosive.

Bryan L. Gorman, Mallikarjun Shankar, and Cyrus M. Smith, SensorNet Program, Oak Ridge National Laboratory

SensorNet is a vendor-neutral interoperability framework for Web-based discovery, access, control, integration, analysis, and visualization of online sensors, sensor-derived data repositories, and sensor-related processing capabilities. In other words, SensorNet attempts to create a wide-area system to collect and analyze data from sensors all over the country to monitor and detect threats, and then alert agencies, emergency responders, and others as necessary. It is being designed and developed by the Computational Sciences and Engineering Division at the Oak Ridge National Laboratory (ORNL), in collaboration with the National Oceanic and Atmospheric Administration (NOAA), the Open Geospatial Consortium (OGC), the National Institute for Standards and Technology (NIST), the Department of Defense, and numerous universities and private-sector partners. The purpose of SensorNet is to provide

Bryan Gorman
Oak Ridge National Laboratory
gormanbl@ornl.gov
+1.865.576.4241

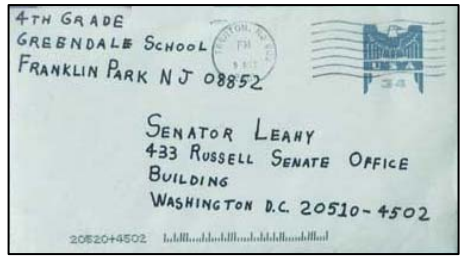
From 2001 to 2003, SensorNet was a proposed strategy to use commercial cell towers as the basis for a nation-wide sensor network for homeland security.

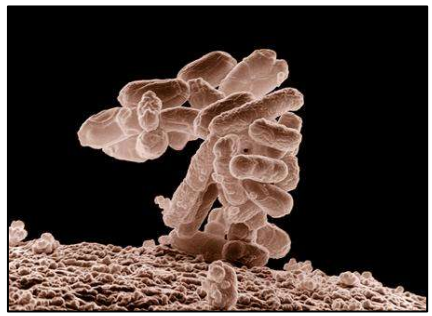


A Re-assessment of the Requirements

The threat of WMD

Many of the threats and challenges of concern to DHS, local law enforcement, health departments, first responders, Weapons of Mass Destruction Civil Support Teams, and HAZMAT crews are long-term, emergent, and dynamic problems that require adaptive and evolutionary solutions.





Organizational and Systems Interoperability

Fact Sheet: National Baseline Survey on Interoperability

Release Date: December 8, 2006

More than two-thirds of emergency response agencies across the nation use interoperable communications, at varying le
results announced today by the Department of Homeland Security's (DHS) SAFECOM program. The National Interoperab
queried interoperable capabilities from 22,400 randomly selected law enforcement, fire response, and emergency manage
agencies nationwide.

GAO Highlights

Highlights of GAO-04-494, a report to congressional requesters

Why GAO Did This Study

One of the five priorities in the President's Management Agenda is the expansion of electronic government (e-government)—the use of Internet applications to enhance access to and delivery of government information and services. Project SAFECOM is one of the 25 initiatives sponsored by the Office of Management and Budget (OMB) to implement this agenda. Managed by the Department of Homeland Security, the project's goal is to achieve interoperability among emergency-response communications at all levels of government, while at the same time realizing cost savings. GAO assessed the government's progress in implementing Project SAFECOM.

What GAO Recommends

April 2004

PROJECT SAFECOM

Key Cross-Agency Emergency Communications Effort Requires Stronger Collaboration

WashingtonTechnology

BUSINESS INTELLIGENCE FOR GOVERNMENT SYSTEMS INTEGRATORS

▶ CURRENT ISSUE ▶ FREE SUBSCRIPTIO

Updated 3:45 PM EST February 2

Login | Register

Search site

GO

Advanced Search

Washington Technology home > web stories

02/16/06

Interoperability, data sharing lacking in Katrina response

Lipowicz

ter

eral government's ineffective response to Hurricane Katrina was partly a failure of
ogy, according to a critical report released this week by a House Select Committee

GCN Home > 08/23/04 issue

Hill, Homeland Security trade barbs over border control tech

By Wilson P. Dizard III, GCN Staff

Story Tools: Print this | Email this | Purchase a Reprint | Link to this page

U.S. Visit "integrates very few of the dozens of key federal databases and fails to provide the interoperability between agencies that is necessary to combat global terrorism," Rep. Jim Turner wrote.

Image: Henrik G. de Gyor

The Homeland Security Department's enterprise architecture
for a border control system came under fire from legislative o
week.

The Government Accountability Office warned that the departn
enterprise architecture is incomplete, and the ranking Democ
House Homeland Security Select Committee condemned DH
the U.S. Visitor and Immigrant Status Indicator Technology vir
system.

In response, DHS officials said the department's enterprise a
a work in progress that is due to be upgraded soon.

And undersecretary for Border and Transportation Security As
rejected Rep. Jim Turner's critique of U.S. Visit, saying DHS h
significant progress in building a layered approach to border
launching a biometric border system for the first time.

GAO's study, Homeland Security: Efforts Under Way to Develo
Architecture, but Much Work Remains, evaluated the first vers
department's enterprise architecture, which DHS released la
[GCN, Sept. 1, 2003, Page 1]. Department officials consistent
they plan to release a second version next month.

The GAO report noted that officials in the department's CIO of
that the first version was rough at best. DHS officials had taken parts of
existing systems blueprints from the department's 22 component agencies and combined them to derive the
first architecture.

United States Government Accountability Office

GAO

Report to the Chairman, Committee on Government Reform, House of Representatives

August 2006

ENTERPRISE ARCHITECTURE

Leadership Remains Key to Establishing and Leveraging Architectures for Organizational Transformation

Understanding Interoperability

Integrated and Interoperable Systems

Boom Box

Stereo System

Tightly-coupled architecture
Integrated components
Monolithic architecture
Homogeneous system
End-to-end design
Autonomous/Stand-alone

Loosely-coupled architecture
Interoperable components
Modular architecture
Heterogeneous systems
Plug-and-Play
Inter-dependent

Representative examples of tightly-coupled and loosely-coupled systems

Integrated Systems

Apple Mac

amazon.com

PBX

Interoperable Systems

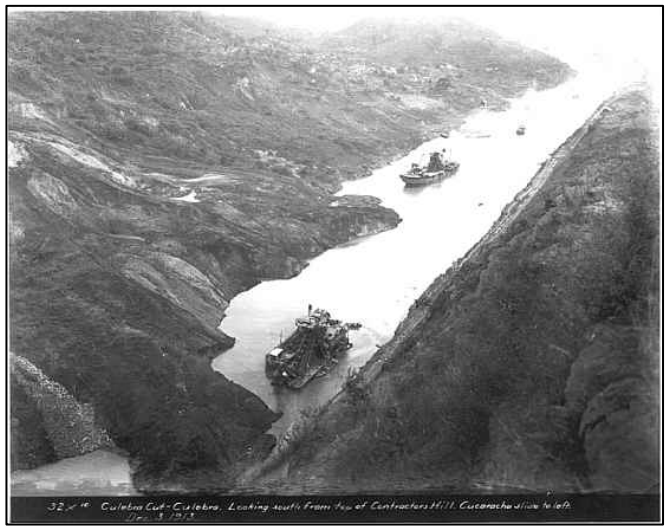
IBM PC

ebay

POTS

UT-BATTELLE

Taking a tightly-coupled integrated design approach to a *bounded and well-defined problem* has led to many successes.

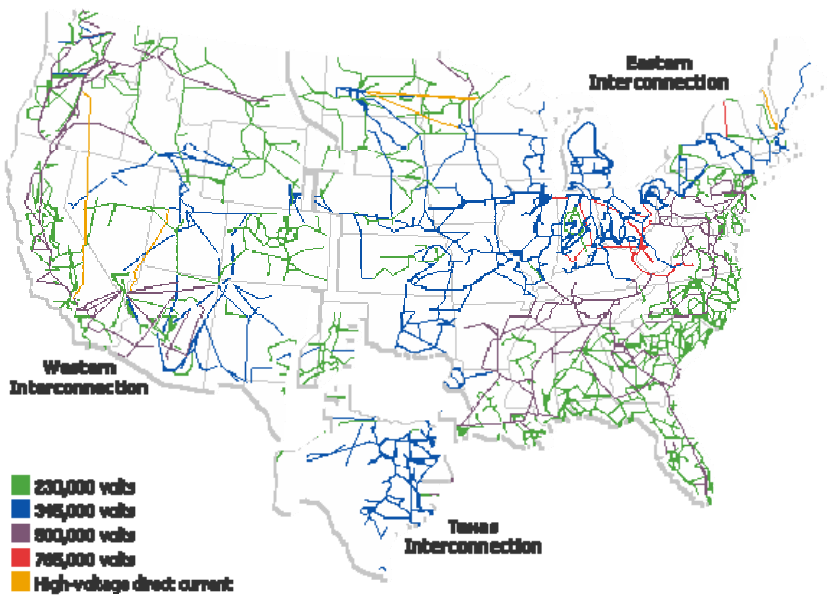


Panama Canal (circa 1911)

Falling Water

USAF F-117 Nighthawk

Taking a *loosely-coupled interoperable design* approach to *unbounded, dynamic problems* has also led to many successes.



North American Electric Power Grid

U.S. Interstate Highway System

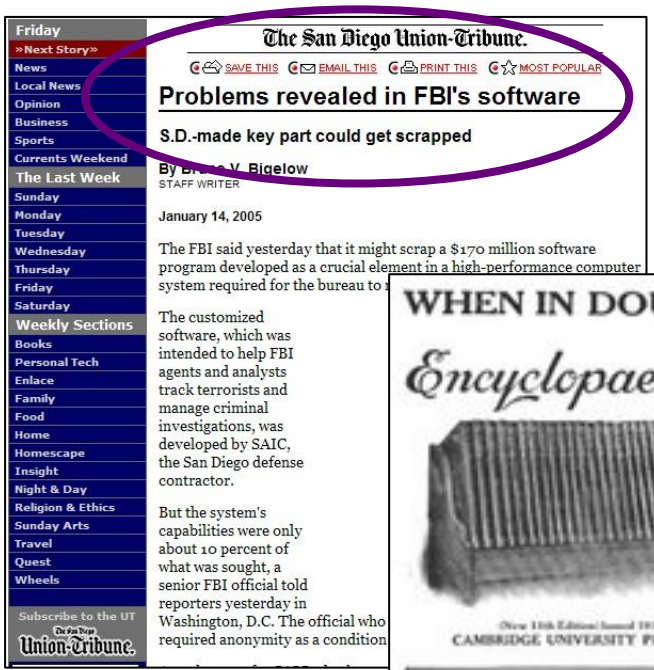
Internet

The “hard lesson” that is learned over and over:

Applying tightly-coupled integrated solutions to *unbounded* or *dynamic* problems is often short-lived, ill-advised, and sometimes catastrophic.

88%** of large IT integration projects **fail or overrun** their target budgets by an average of **66% **Standish Group, 1999**

Germany was able to circumvent the [French] line by passing its Panzers through hills and marshlands which **had been impenetrable to tanks when Maginot made his recommendations. Wikipedia 2006



Friday
»Next Story»
News
Local News
Opinion
Business
Sports
Currents Weekend
The Last Week
Sunday
Monday
Tuesday
Wednesday
Thursday
Friday
Saturday
Weekly Sections
Books
Personal Tech
Enlace
Family
Food
Home
Homescape
Insight
Night & Day
Religion & Ethics
Sunday Arts
Travel
Quest
Wheels
Subscribe to the UT
Union-Tribune.

The San Diego Union-Tribune.

SAVE THIS EMAIL THIS PRINT THIS MOST POPULAR

Problems revealed in FBI's software

S.D.-made key part could get scrapped

By Bruce V. Bigelow
STAFF WRITER

January 14, 2005

The FBI said yesterday that it might scrap a $170 million software program developed as a crucial element in a high-performance computer system required for the bureau to

The customized software, which was intended to help FBI agents and analysts track terrorists and manage criminal investigations, was developed by SAIC, the San Diego defense contractor.

But the system's capabilities were only about 10 percent of what was sought, a senior FBI official told reporters yesterday in Washington, D.C. The official who required anonymity as a condition

WHEN IN DOUBT–“LOOK IT UP” IN
The
Encyclopaedia Britannica

The Sum of Human Knowledge

44,000,000 words of text. Printed on thin, but strong opaque India paper, each volume but one inch in thickness.

CAMBRIDGE UNIVERSITY PRESS (England)

THE BOOK TO ASK QUESTIONS OF

FOR READING OR FOR STUDY

Good News

As the *DEMAND FOR INFORMATION AND RESOURCE SHARING INCREASES*, the customers spurn tightly-coupled, proprietary systems in favor of loosely-coupled interoperable products, services, and commodities.

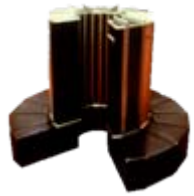
1990's – 2000's

Ethernet

Internet

World Wide Web

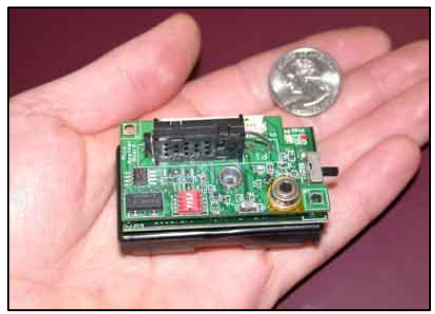
1960's-1990's

PC Local Area Networks	Mainframe and Mini Networks	Supercomputer Networks	On-line Services
			
IBM PC LAN Appletalk Novell	IBM SNA DECNET XNS USENET BITNET	HYPERchannel UltraNet	

The Interoperability of Sensor Networks for Homeland Security

Sensor Networks and Government Programs

Federal research programs are funding the development and deployment of detection and sensor technologies that are connected to **networks.**



Sensor networks are becoming commercially available…

Future Combat Systems Unattended Ground Sensors (UGS)

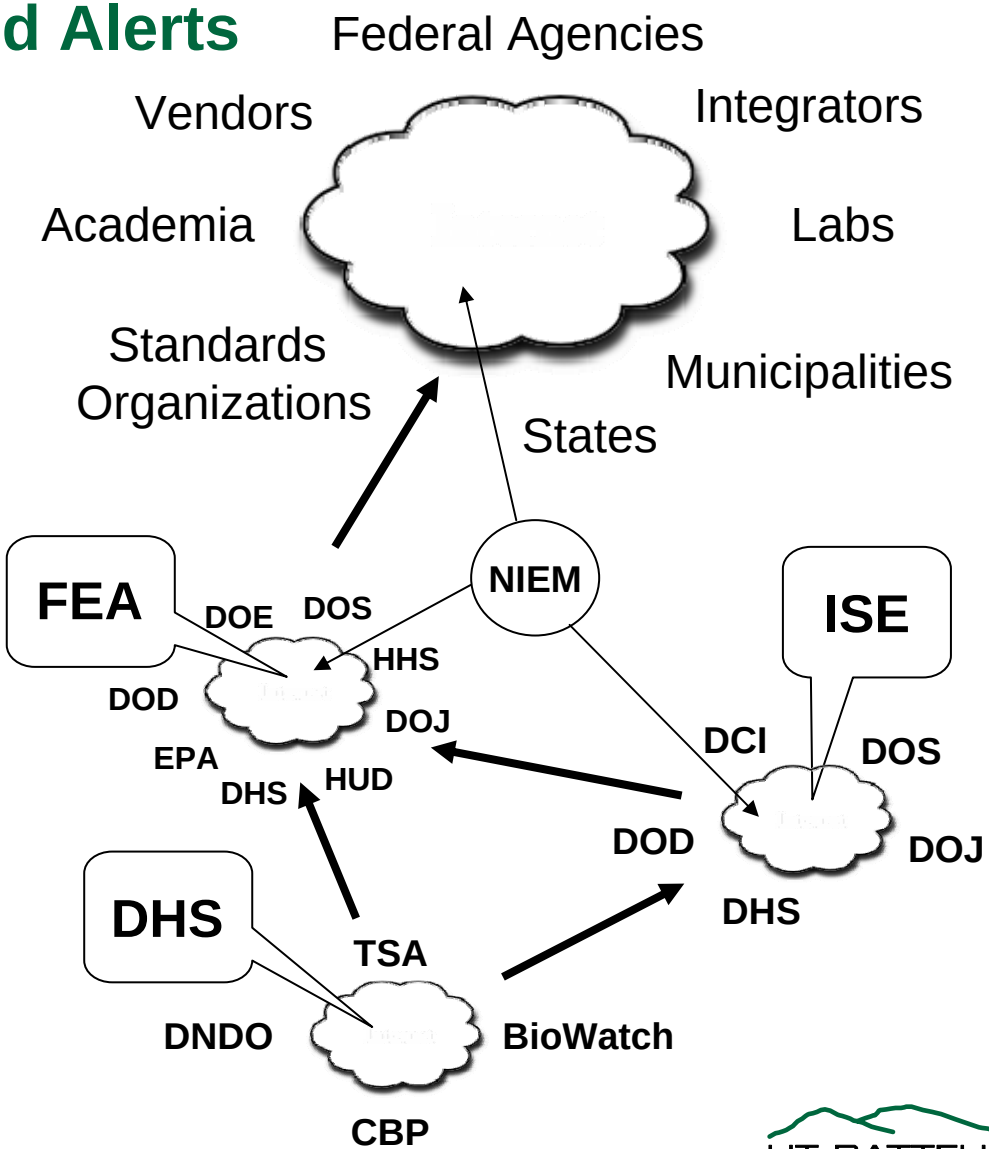
RTI's SensorView provides the capability to command, control, and monitor (locally and remotely) multiple sensors of various types. SensorView also includes GPS and meteorological sensor options.

And others from Northrop Grumman, 3eTI, Sentel, Ensco, MSA.

… but they are not yet interoperable!

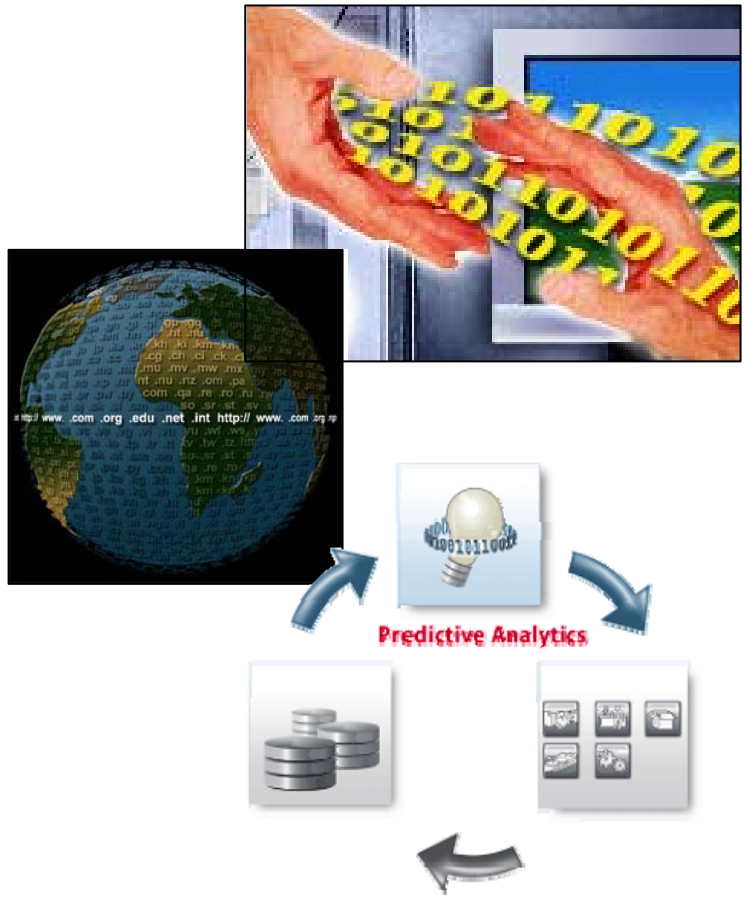
The Growing Need to Share Sensor Information and Alerts

As the demand for sensor information increases with the proliferation of sensor networks and sensor information, users and program managers will look to the commercial market place for interoperable products based on cost-effective **standards** that allow information, application, and resource sharing



An Emerging Global SensorNet

In turn, the commercial availability of interoperable components, networks, applications, and data will allow users to share information from numerous sensor sources with predictive applications and decision support systems ***securely across local, organizational, regional, and national boundaries.***

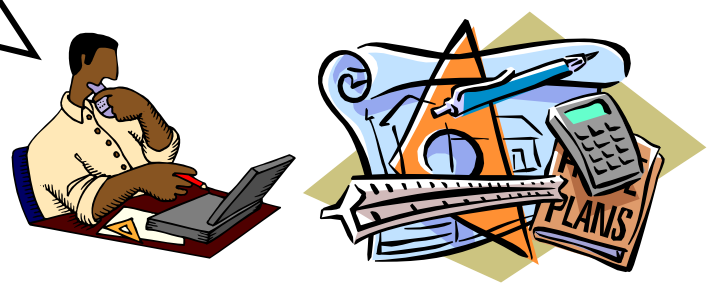


Government Leadership and Commercial Development

The global sensor network will take years to establish and will continue to evolve after it is in place.

The development of a global SensorNet will be led **by government- and commercially-sponsored research** at leading universities and national labs world-wide.

The global SensorNet will be **built by systems integrators, vendors, developers, and communications carriers** using ***commercially-supported and commoditized products***.



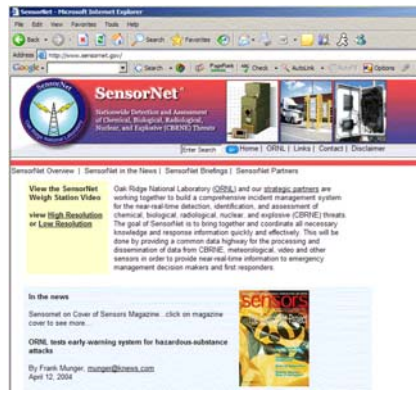
Caveat: The Commercial Market and Standards Adoption

Although the evolution of a commercially-available interoperable framework for sensor networks is inevitable (based on the growing demand for information sharing), the evolution of the market place is non-deterministic and does not address the urgency of the emerging threats and requirements.

What is ORNL doing to support and expedite the commercial adoption of sensor network standards, and what have we accomplished since 2003?

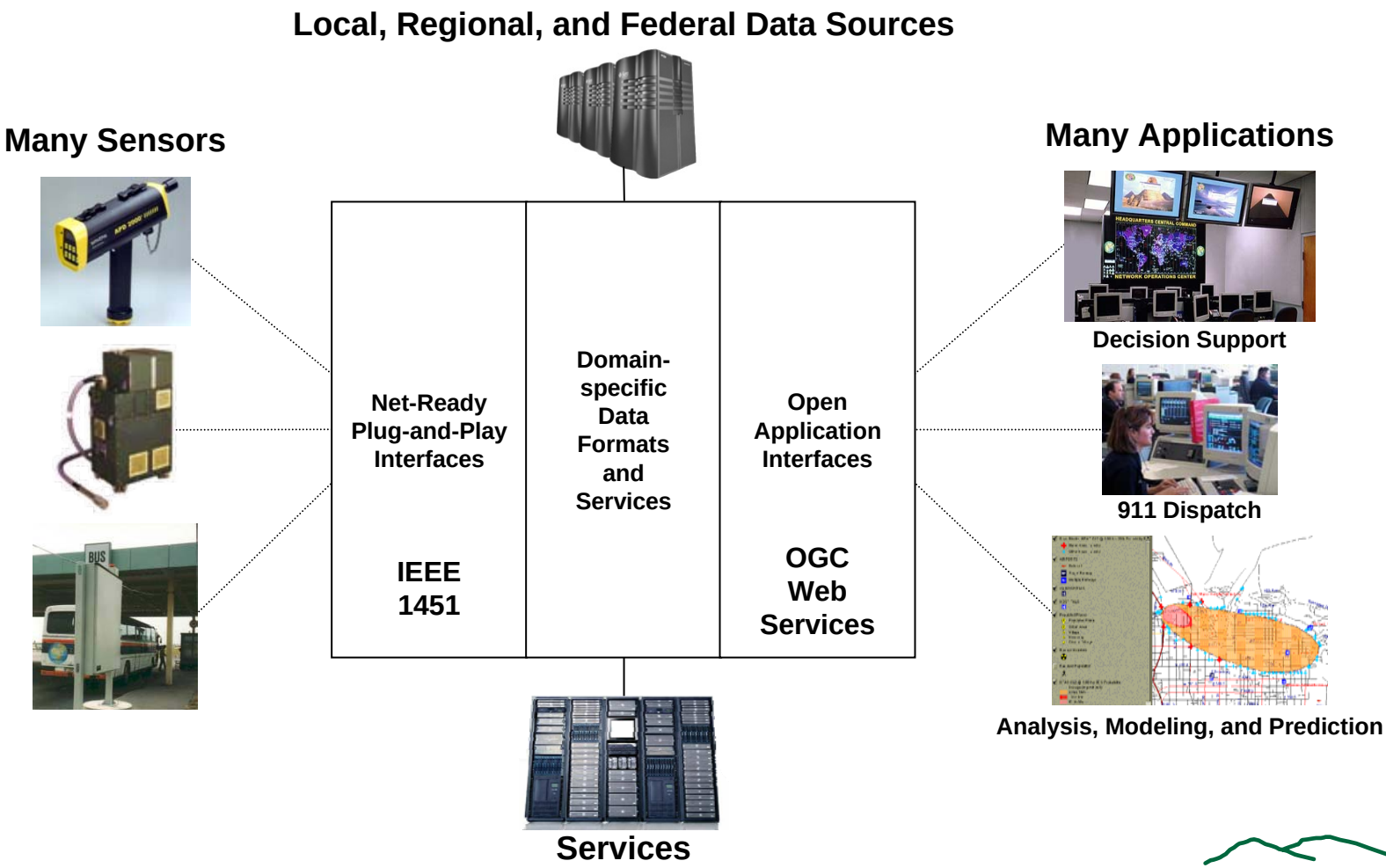
SensorNet since 2003

Since 2003, Oak Ridge National Laboratory (ORNL), in collaboration with the National Institute for Standards and Technology (NIST) and the Open Geospatial Consortium (OGC), has worked to **implement, demonstrate**, and **promote** industry-wide **interoperability** and **information sharing standards** for ubiquitous, cost-effective, and secure sensor networks.



http://www.sensornet.gov

ORNL has developed a standards-based middleware for a sensor network edge device (i.e., the SensorNet node)



… has developed prototypes based on standardized middleware;

… has deployed its standards-based prototypes in DoD and DHS testbeds;

News Release

Media Contact: Ron Walli
Communications and External Relations
865.576.0226

SensorNet prototype system in boot camp at Fort Bragg

OAK RIDGE, Tenn., Feb. 15, 2006 — Fort Bragg could be the model for the nation when it comes to protecting the public through a network that integrates a 911 dispatch system with sensors, alarms and video surveillance.

Oak Ridge National Laboratory's SensorNet, a collection of systems for the detection, identification and assessment of chemical, biological, radiological and nuclear threats, has been installed as part of a project with the Fort Bragg Directorate of Emergency Services. The military base, located in North Carolina, is home to more than 30,000 family members and contains 11 shopping centers, 28 restaurants, a major medical center, 11 churches and 183 recreational facilities.

"Fort Bragg is a city with thousands of residents, more than 20 million square feet of office buildings and all of the associated needs and demands placed on emergency services workers," said Bryan Gorman, a researcher Computational Sciences and Engineering Division. conventional public safety mass notification networks applications invisible to the users."

Strateg
networ

Memphis Business Jou

HOME ONLINE EDITION PRIN

Search Keywords GO Search

EXCLUSIVE REPORTS

Memphis > Print Edition

BUSINESS PULSE SURVEY: Taxes and technology -- how are your taxes prepared?

Alert system to get tested in Memphis

Memphis Business Journal - September 17, 2004 by Amos Maki

Print this Article | Email this Article | Reprints | RSS Feeds | Most Viewed | Most Emailed

An early warning and detection system born out of the first Gulf War will be deployed at the International **Port of Memphis**.

Originally designed for use on a battlefield, the system, called SensorNet, was developed at **Oak Ridge National Laboratory** and is designed to provide critical information to first responders and government officials in case of a terrorist attack or, as is more likely the case in Memphis, a chemical spill or disaster.

Project SeaHawk

A unity of effort.

by CAPT Scott Berson
U.S. Coast Guard Liaison to Project SeaHawk

"The National Strategy for Combating Terrorism" identifies that the terrorist threat is a flexible, transnational network structure, enabled by modern technology and characterized by interconnectivity both within and between groups. In this environment, terrorists work together in funding, sharing intelligence, training, logistics, and planning and executing attacks.'

A Collaborative Effort
Unity of effort drives the strategic actions outlined in the "National Strategy for Maritime Security" (NSMS). Throughout the strategy it calls on the Departments of Homeland Security (DHS), Defense (DOD), and Justice (DOJ) to come together to develop vertically and horizontally aligned solutions to address all-threat maritime security.

… has demonstrated its prototypes at numerous national events;

NFL and NASCAR Events

WATE.com http://www.wate.com

Part two: making SensorNet mobile

February 23, 2005

By TIM MILLER
6 News Anchor/Reporter

KNOX COUNTY (WATE) -- Mobile SensorNet provides surveillance for first responders and homeland security agencies. It's convenient, compact and making a name for itself across the country.

Unlike the fixed sensors, the mobile ones can be packed and taken to a particular event.

When the Tennessee Titans played the Kansas City Chiefs on December 13, 2004 in Nashville, the coliseum was filled with excitement and fans. And mobile SensorNet was also there, making sure terrorists weren't also in the stands with dangerous weapons.

SensorNet Project Leader Tony Turner says, "We supported the Titans security department and in Nashville, the police department, as well as Gen. Humble's homeland security office there in Nashville."

San Diego Mardi Gras

Top Stories

A network of sensors and communications devices developed by UCSD researchers helps law enforcement teams monitor Mardi Gras festivities in the Gaslamp.

Calit2 Researchers Deploy Disaster Communications Network at San Diego Mardi Gras Festivities

IPSN '06

Vanderbilt University - Oak Ridge National Laboratory

Dirty Bomb Detection and Localization

Best Outdoor Demonstration at the IPSN 2006 Conference
Vanderbilt Football Stadium
April 20, 2006

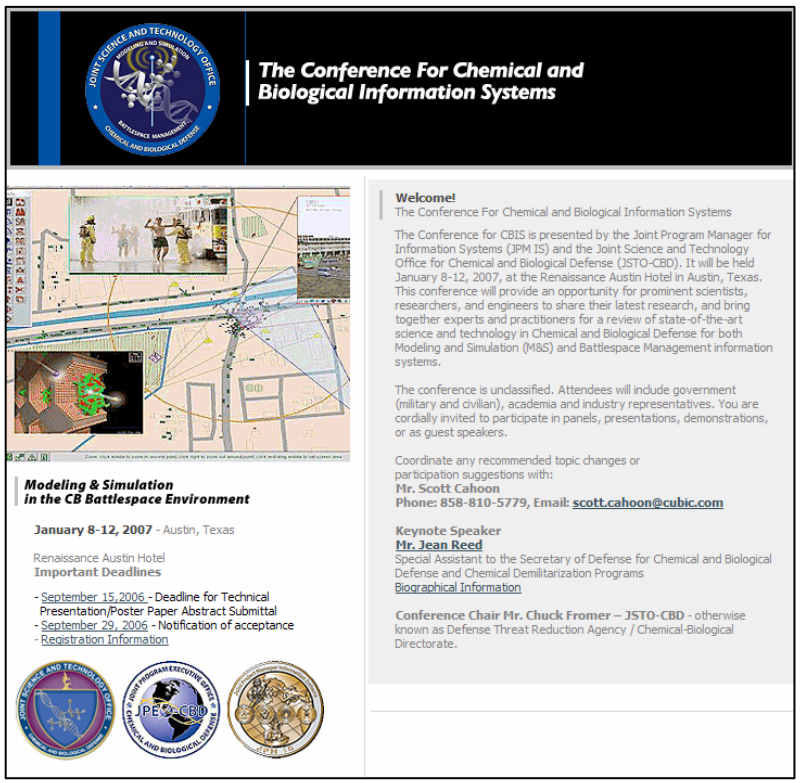
Check out the Google Earth-based user interface

We have showcased several exciting technologies in an integrated demonstration. The demo scenario is as follows: a plain cloth security guard walks around the stadium with a cell phone-integrated radiation detector. The person also carries an XBow XSM mote that we continuously track using an enhanced version of the radio interferometric positioning technique introduced at the ACM SenSys conference in 2005. There are 12 XSMs acting as infrastructure nodes deployed at known positions to enable tracking with ~1m accuracy throughout the stadium. When the radiation detector is in close proximity to a source, it sends an alarm using the mobile phone network. This causes a remote controlled camera to automatically zoom in on the position of the policeman. The large Jumbotron display in the stadium shows the video as well as the Google Earth-based user interface.

Public Service Week
National Mall, WDC

… has participated in numerous presentations and workshops;

Conference for CBIS (2007)



The Conference For Chemical and Biological Information Systems

Modeling & Simulation in the CB Battlespace Environment

January 8-12, 2007 - Austin, Texas

Renaissance Austin Hotel
Important Deadlines

- September 15,2006 - Deadline for Technical Presentation/Poster Paper Abstract Submittal
- September 29, 2006 - Notification of acceptance
- Registration Information

Welcome!
The Conference For Chemical and Biological Information Systems

The Conference for CBIS is presented by the Joint Program Manager for Information Systems (JPM IS) and the Joint Science and Technology Office for Chemical and Biological Defense (JSTO-CBD). It will be held January 8-12, 2007, at the Renaissance Austin Hotel in Austin, Texas. This conference will provide an opportunity for prominent scientists, researchers, and engineers to share their latest research, and bring together experts and practitioners for a review of state-of-the-art science and technology in Chemical and Biological Defense for both Modeling and Simulation (M&S) and Battlespace Management information systems.

The conference is unclassified. Attendees will include government (military and civilian), academia and industry representatives. You are cordially invited to participate in panels, presentations, demonstrations, or as guest speakers.

Coordinate any recommended topic changes or participation suggestions with:
Mr. Scott Cahoon
Phone: 858-810-5779, Email: scott.cahoon@cubic.com

Keynote Speaker
Mr. Jean Reed
Special Assistant to the Secretary of Defense for Chemical and Biological Defense and Chemical Demilitarization Programs
Biographical Information

Conference Chair Mr. Chuck Fromer – JSTO-CBD - otherwise known as Defense Threat Reduction Agency / Chemical-Biological Directorate.

Net-Ready Sensors (2006)

NIST National Institute of Standards and Technology Technology Administration U.S. Department of Commerce

ornl

Summer Workshop
Net-Ready Sensors: The Way Forward

What: The National Institute of Standards and Technology (NIST), the Joint Program Executive Office, Chemical and Biological Defense (JPEO-CBD), and Oak Ridge National Laboratory (ORNL) are sponsoring a two-day workshop on "Net-Ready Sensors: A Way Forward."

When: August 2-3, 2006

Where: Tennessee Room (Room 202, A&B) in Building 5200 on ORNL's campus in Oak Ridge, Tennessee

5th SISPAT (2006)

5TH SISPAT SINGAPORE
INTERNATIONAL SYMPOSIUM ON PROTECTION AGAINST TOXIC SUBSTANCES
st Toxic Substances In Conjunction with 1st International Chemical, Biological, Radiological and Explosives Operations Conference

About SISPAT
Speakers
Programme
Call for Paper
Registration
Accommodation
Social Events
Exhibitions
Sponsorship
About Organisers
Committees
About Singapore
Contact Us
What's New

Purpose of the Symposium

The 5th Singapore International Symposium On Protection Against Toxic Substances (SISPAT) in conjunction with the 1st International Chemical, Biological, Radiological and Explosives Operations Conference (ICOC) aims to create an integrated Operations-Technical (Ops-Tech) Forum to bring together military and industry scientists, military planners, first responders and HAZMAT specialists, medical and public health professionals, veterinarians, specialists in computer risk modelling and planning as well as other professionals from government, academia and industry from around the world who are interested to exchange knowledge and experiences on research and operational issues arising from Chemical, Biological, Radiological, Nuclear and Explosives (CBRNE) Agents. The theme for 5th SISPAT is "**Advancing Science Against Unconventional Threats**" and it aims to encourage a cross-fertilisation of ideas and development of novel solutions from both defence and non-defence partners to neutralise such threats.

… has supported DHS, DoD, and industry sensor standards development and harmonization efforts;

Physics Laboratory
Ionizing Radiation Division

NIST
National Institute of Standards and Technology

ANSI N42.42: Data format standard for radiation detectors used for Homeland Security

The purp
informatic
the XML
radiation
file allows
data elem
and the hi
available.

AN

The follov

Sin

Ra

PR

NIST
National Institute of Standards and Technology, IEEE 1451 Website

What is 1451?
- Introduction
- 1451 Family
- Get 1451 Standards
- Back to 1451 Model

IEEE 1451 Working Groups
- group0
- group1
- group2
- group3
- group4
- group5
- group6

IEEE 1451 Presentation in Conferences and Workshop
- 2005 Sensors GOV Expo/Conference Presen
- 2005 Sensors Proceed
- 2004 Sensors Proceed
- 2004 Workshop on W Sensor Interface Standar

Brief Description of the Family of IEEE 1451 Standards

The **IEEE 1451**, a family of Smart Transducer Interface Standards, describes a set of open, com

JEP-0127: Common Alerting Protocol (CAP) Over XMPP

This JEP specifies a method for sending Common Alerting Protocol (CAP) data over XMPP.

NOTICE: This JEP is currently within Last Call or under consideration by the Jabber Council for advancement to the next stage in the JSF standards process. For further details, visit <http://www.jabber.org/council/queue.php>.

JEP Informati

Status: Propo
Type: Informat
Number: 0127
Version: 0.2
Last Updated:
JIG: Standard
Approving Bo
Dependencie
Supersedes:
Superseded E
Short Name: N

Author Inform

Peter Saint-Andre

Email: stpeter
JID: stpeter@

Boyd Fletcher

Email: Boyd.F
JID: bfletcher@

Home » 2005 OGC User » February, No. 1

Oak Ridge National Laboratory Leads National Effort for Sensor Web Interoperability

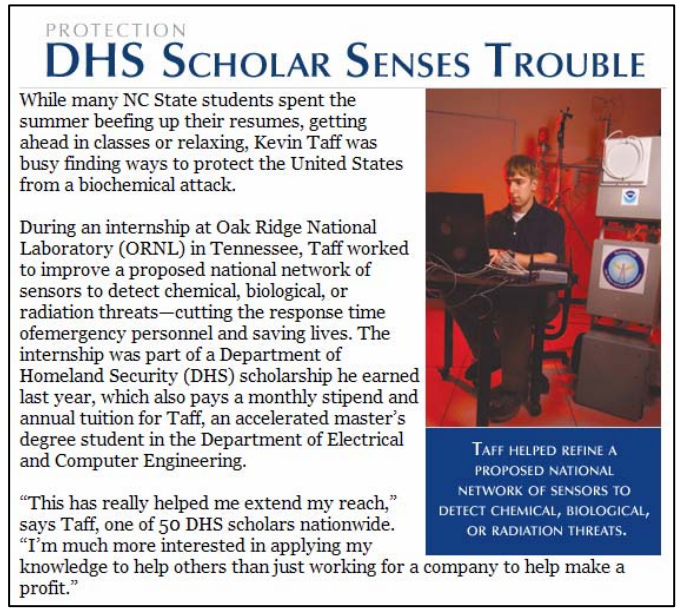
Submitted by Lance Mckee on Sun, 2005-02-06 19:13.

Author: Frank DeNap, Manager
SensorNet Program
Oak Ridge National Laboratory (ORNL)
P.O. Box 2008
Oak Ridge, TN 37831
email: denapfa@ornl.gov

The National Center for Sensor Systems Interoperability (NCSSI) at Oak Ridge National Laboratory (ORNL), along with the National Oceanic and Atmospheric Administration (NOAA), other federal laboratories, universities and private sector partners, is designing and developing SensorNet. SensorNet is a vendor-neutral, evolutionary interoperability framework for web-based discovery, access, control, integration, analysis, exploitation and visualization of multiple online sensors, transducers, sensor-derived data repositories, and sensor-related processing capabilities. The purpose of SensorNet is to provide a comprehensive nationwide system for real-time detection, identification, and assessment of chemical, biological, radiological, nuclear, and explosive hazards. It provides distributed access with multi-level security, information fusion, and common operational picture.

Part of the SensorNet project is deploying a variety of sensors at strategic locations such as military installations, traffic control points, and truck weighing stations. The sensors will be connected by secure and redundant communication channels to local, regional and national operations centers. Automated predictive plume modeling will provide rapid assessments of the direction and impact of toxic airborne releases. The goal is a national system for comprehensive incident management in cooperation with state and local governments.

… has published its research and has provided its standards-based middleware freely to academia and industry;



PROTECTION

DHS Scholar Senses Trouble

While many NC State students spent the summer beefing up their resumes, getting ahead in classes or relaxing, Kevin Taff was busy finding ways to protect the United States from a biochemical attack.

During an internship at Oak Ridge National Laboratory (ORNL) in Tennessee, Taff worked to improve a proposed national network of sensors to detect chemical, biological, or radiation threats—cutting the response time ofemergency personnel and saving lives. The internship was part of a Department of Homeland Security (DHS) scholarship he earned last year, which also pays a monthly stipend and annual tuition for Taff, an accelerated master's degree student in the Department of Electrical and Computer Engineering.

"This has really helped me extend my reach," says Taff, one of 50 DHS scholars nationwide. "I'm much more interested in applying my knowledge to help others than just working for a company to help make a profit."

Taff helped refine a proposed national network of sensors to detect chemical, biological, or radiation threats.

… has collaborated and contracted for the commercial adoption of sensor standards.

ORACLE

Google Earth

INTERGRAPH

IBM

SENTEL
A Wholly Owned Subsidiary of Dimensions International, Inc.

FEDERAL SIGNAL

3e Technologies International

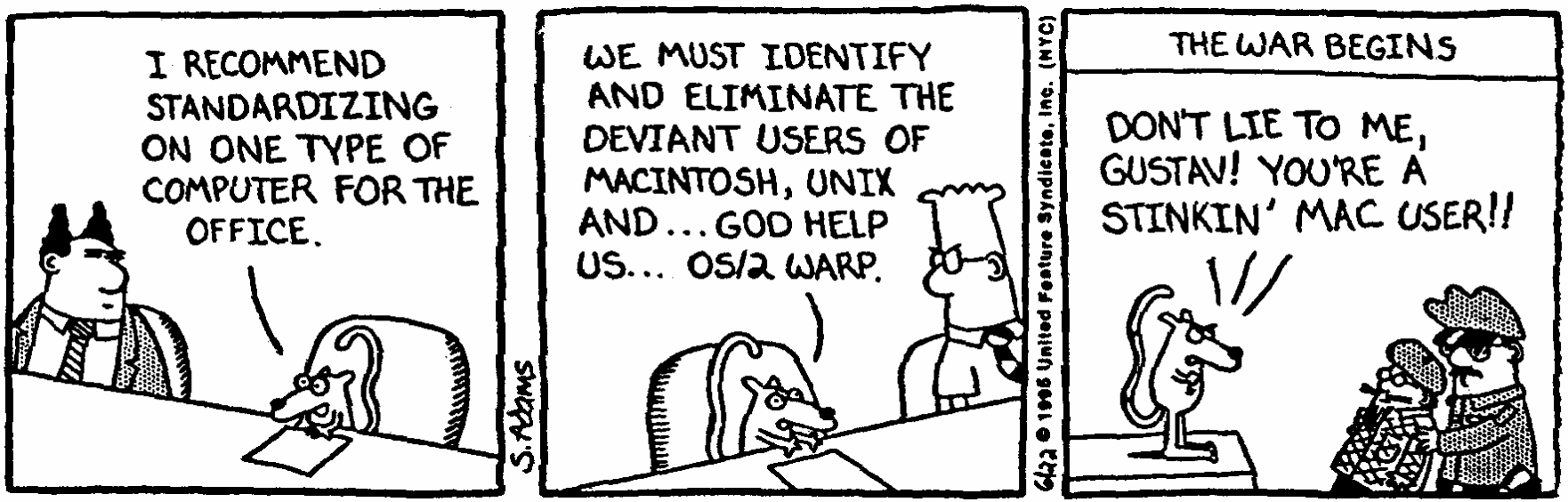
STANLEY Security Solutions

Honeywell

UT-BATTELLE

Lessons Learned (so far)

How the creative community (i.e., researchers and developers) often views standards:



- copied for educational purposes -

Researchers and developers tend to conflate **standards** with **uniformity** (often for good reason) and rebel against any prohibition of their *creative freedom to innovate* and find the *"best"* engineering solution for a problem.

How the technology industry often views standards:

"…the standards process can **slow down development** and implementation of new things."

Mitchell Baker, Chief Lizard Wrangler, Mozilla Corp.

"Competition between standards, we believe, is a very good thing."

Alan Yates, general manager of Microsoft's Information Worker Business Strategy

In a competitive industry, being "first to market" with a technical advantage is a good thing. For many technology firms and research laboratories, standards dilute the competitive advantage of a proprietary or innovative technology. For businesses in particular, standards lower the cost for market entry to competitors, encourage clones, and generally "commoditize" the market for a new technology.

How some sponsors view standards:

Although not always the case, some sponsors view standards development as an ancillary engineering overhead—not a research deliverable that they should pay, particularly without seeing some immediate or direct advantage.

In short, sponsorship to "standardize" research prototypes may be difficult to find.

Standards and interoperability:

Where there are competing standards that address overlapping requirements, it is possible to have two “standards-based” solutions that have their advocates in industry, government, and research.

Competing standards are generally not interoperable.

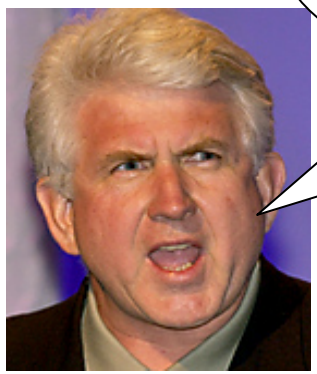
National and International Standards for Sensor Networks

	DoD	DHS	IEEE	OASIS	OGC	DOT	SIA
Activity	JPEO-CBD	Standards Portfolio S&T Directorate	Sensor Interface Standards	Emergency Interoperability Consortium	Sensor Web Enablement	Incident Management	Digital Communications
POC	Prof. Tom Johnson NPS	Dr. Bert Coursey DHS	Mr. Kang Lee, NIST	Ms. Elysa Jones OASIS	Mr. Sam Bacharach OGC	Ann Lorscheider NCDOT	William Snuffer, SIA Hunter Knight, SIA
Standards	JPM-IS Data CBRN Common Data Model NATO NBC Standards (Allied Tactical Publication 45B) STANAG 5523	ANSI N42.32 ANSI N42.33 ANSI N42.34 ANSI N42.35 ANSI N42.38 ANSI N42.42 ASTM E54 AOAC International	IEEE 1451.0 IEEE 1451.1 IEEE 1451.2 IEEE 1451.3 IEEE 1451.4 IEEE 1451.5 IEEE 1451.6	Common Alerting Protocol Emergency Data Exchange Language	Sensor Observation Service Sensor Planning Service Sensor Alerting Service Geospatial Markup Language Web Feature Service	IEEE Std 1512.3-2002 (HAZMAT Standard)	BSR/SIA DC-09-200x BSR/SIA OSIPS-01-200x

There are on-going and, in some cases, *overlapping* efforts to develop sensor standards by national, international, and industry consortium standards organizations. *These efforts are autonomous and self-preserving and sometimes dictated by departmental requirements. In the near-term, they are unlikely to generate a single direction for industry.*

SensorNet: What Next?

Metcalfe's Law



The success of a [standard] is proportional to the square of the number of users of the [standard].

Adoption **by developers and users is ultimately the only** ***meaningful measure*** **of interoperability and a** ***standard's success*****.**

A metric for encouraging market place adoption of interoperability standards

$$\frac{\text{demand}}{\text{vendor resistance}} \times \frac{\text{time}}{\text{costs + complexity}} = \text{adoption}$$

To increase the likelihood of standards adoption, either increase demand and time or reduce vendor resistance, costs, and complexity.

Leverage the standards that vendors and developers are already adopting

Follow the conventions of user-defined requirements and ***"pave the cow paths."***

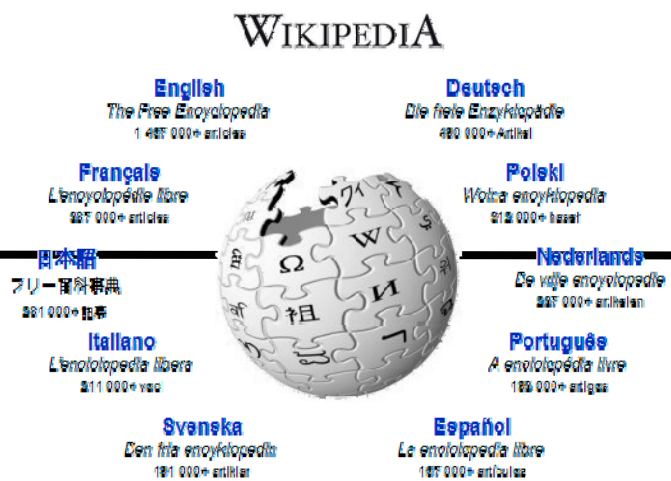
Some standards—a fraction of those that are developed each year—stimulate innovation and are readily adopted by industry.

Examples of standards that have gained traction

Disruptive

Settled/Interoperable

Collaborative Encyclopedia



WWW and Wiki authoring

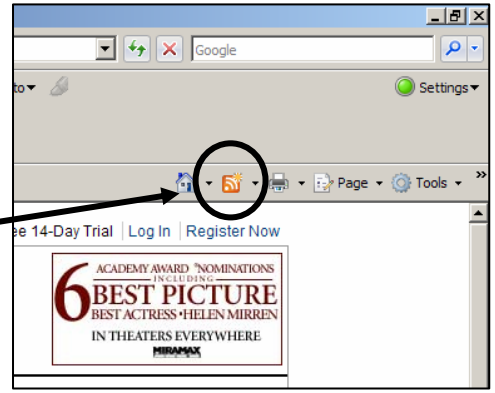
Apple-branded user-interface and look-and-feel

MP3 and USB

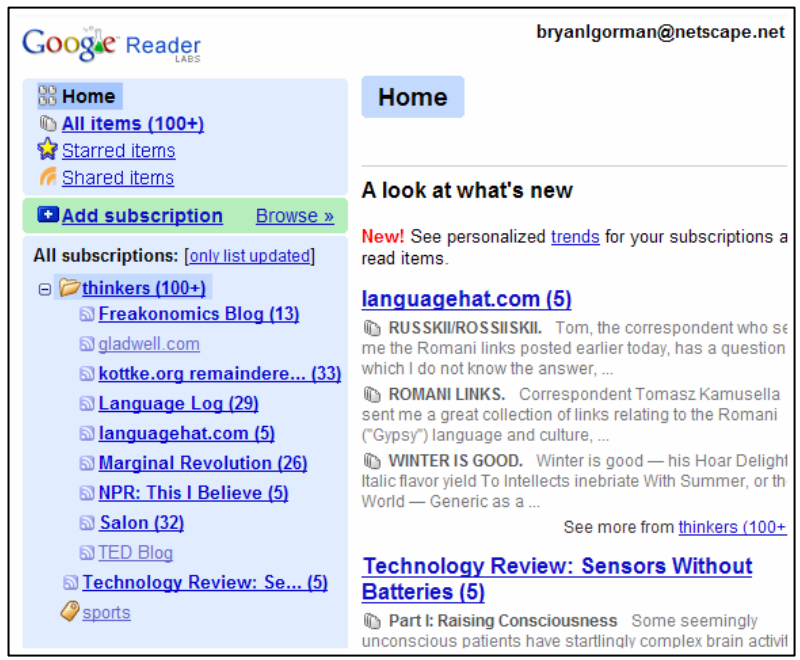
Disruptive

Settled/Interoperable

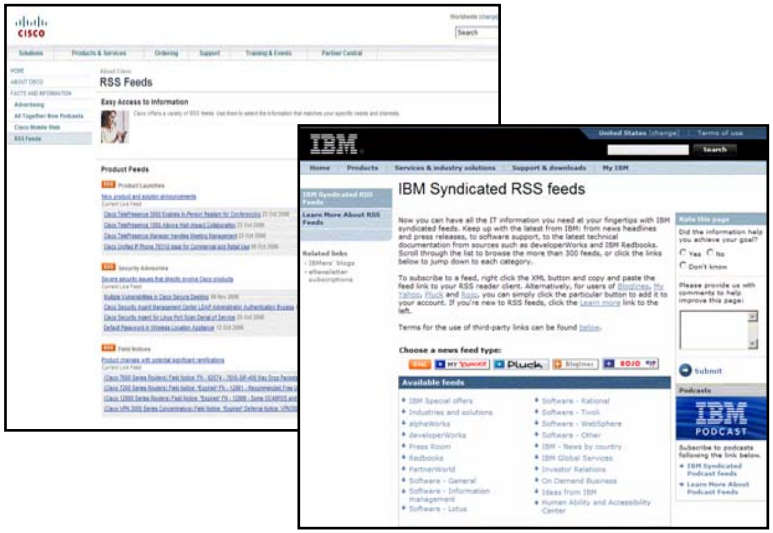
Really Simple Syndication (RSS 2.0)



RSS is a family of web feed formats used to publish frequently updated digital content, such as blogs, news feeds or podcasts.

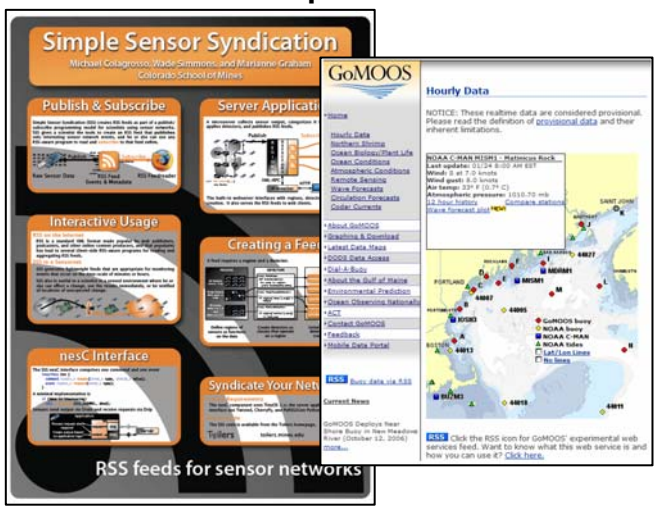


Tech Industry's Use of RSS to Inform Customers of Product Announcements

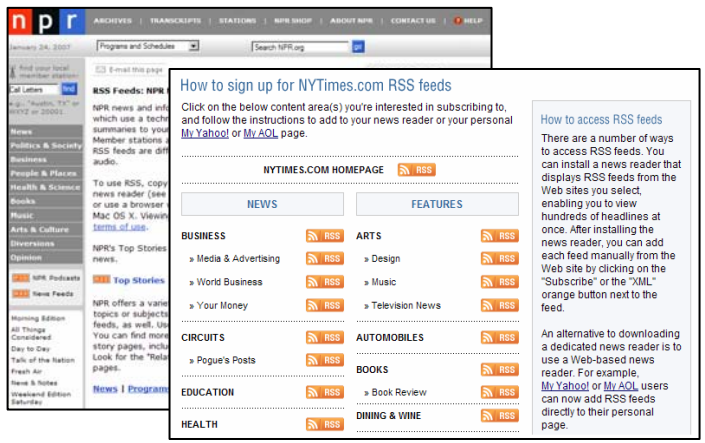


Government's Use of RSS to provide weather and seismic data and alerts

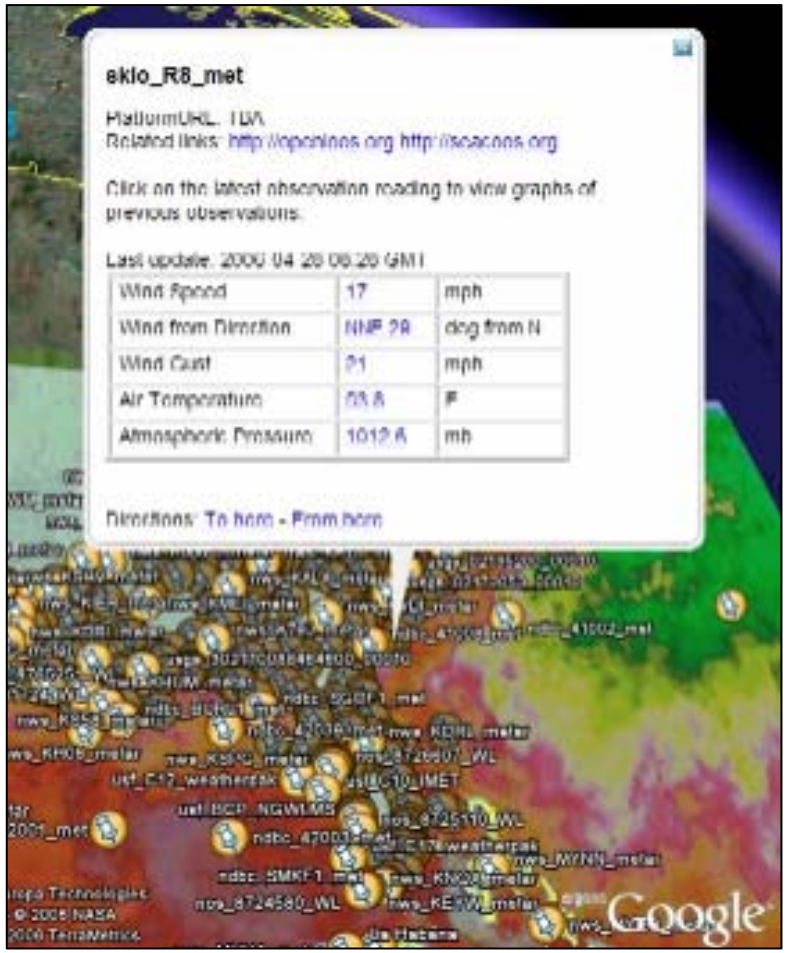
Academia's Use of RSS to provide research data



News Media's Use of RSS to provide news updates



Google Earth's Keyhole Markup Language (KML) and Microsoft's Sensor Description Markup Language (SDML)



Summary: Commercializing Sensor Network Interoperability (cont'd)

- Many of the threats and challenges of concern to DHS are long-term and dynamic and will require evolutionary and interoperable solutions.

- Sensor networks today are not interoperable in a premeditative way.

- Standards development efforts within government, academia, and industry have not yet converged and barriers to adoption and harmonization remain.

Summary: Commercializing Sensor Network Interoperability

- The future global sensor network will be based on fundamental interoperability standards that are adopted by vendors and integrators.

- The present challenge is NOT standards development or re-development; the challenge is the commercial availability of interoperable products.