Project Sentinel

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In Partnership with
Washington Hospital Center

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Partnering Organizations

- **Georgetown University and Medical Center**
  - ISIS Center and Univ. Info. Service
- **Washington Hospital Center – ER-ONE**
  - Emergency Department IT group
- **Washington University, St. Louis**
  - Clinical Research IT Group – WS/PIDS
- **Northwestern University, Chicago**
  - Imaging Group- IHE and Authentication/Authorization
- **Kitware, Inc, NY**
  - Open Source
- **TATRC, US Army**
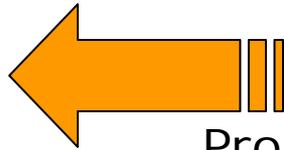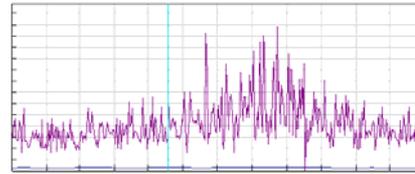 - Knowledge Dissemination and ImTK

Presentation Team

- Seong K. Mun, PhD – Georgetown
- Chad La Joie – Georgetown
- Eugen Vasilescu, PhD – Georgetown
- Fred Prior, PhD – Washington Univ.

Project Sentinel

Baseline or Heightened Case Project 2 and 3
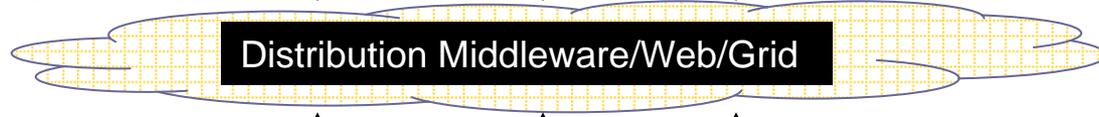
Applications /use case

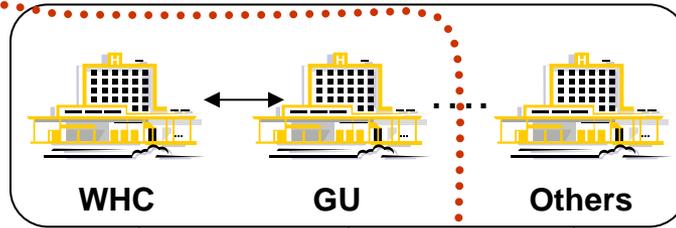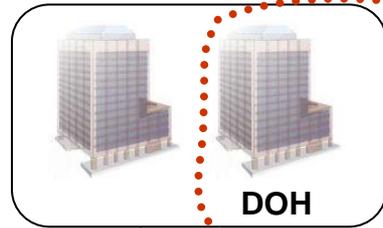Authentication /Authorization Middleware Project 4

Project 6

Information Distribution

Distribution Middleware/Web/Grid

Government Agencies

Hospitals

Acquiring Sites

DOH

WHC   GU   Others

Future Data Sources/Argus

PIDS

Project 5

Data Sources

Mosquito   Avian

Satellite Inquiry   International Threat Info

Patient Info
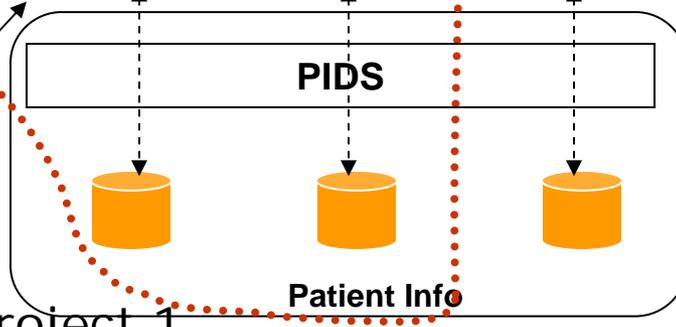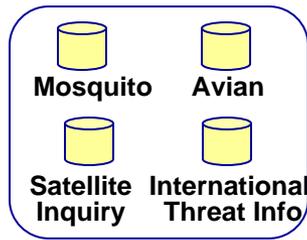
Project 1

Project Theme: Disease Surveillance

(1) Scalability of IT key applications

(2) Ability to share essential information across multiple organizations

(3) Ability to access clinical, public health and surveillance data

(4) Contract research to share insights into IT issues in healthcare and public health

Project Summary

Project 1: Creating the Collaboratory
Azyxxi at GUMC then Microsoft Acquisition

Project 2: Public Health /Surveillance
Many Limitation; Poor Data, No Baseline
Gave Birth to Argus for Global Surveillance

Project 3: Advanced Visualization
Tested Many Tools for Various Users- Info Overload

Project 4: Shibboleth /Middleware – User Identity Management
Brought Shibboleth (I2), Proactive Perspective
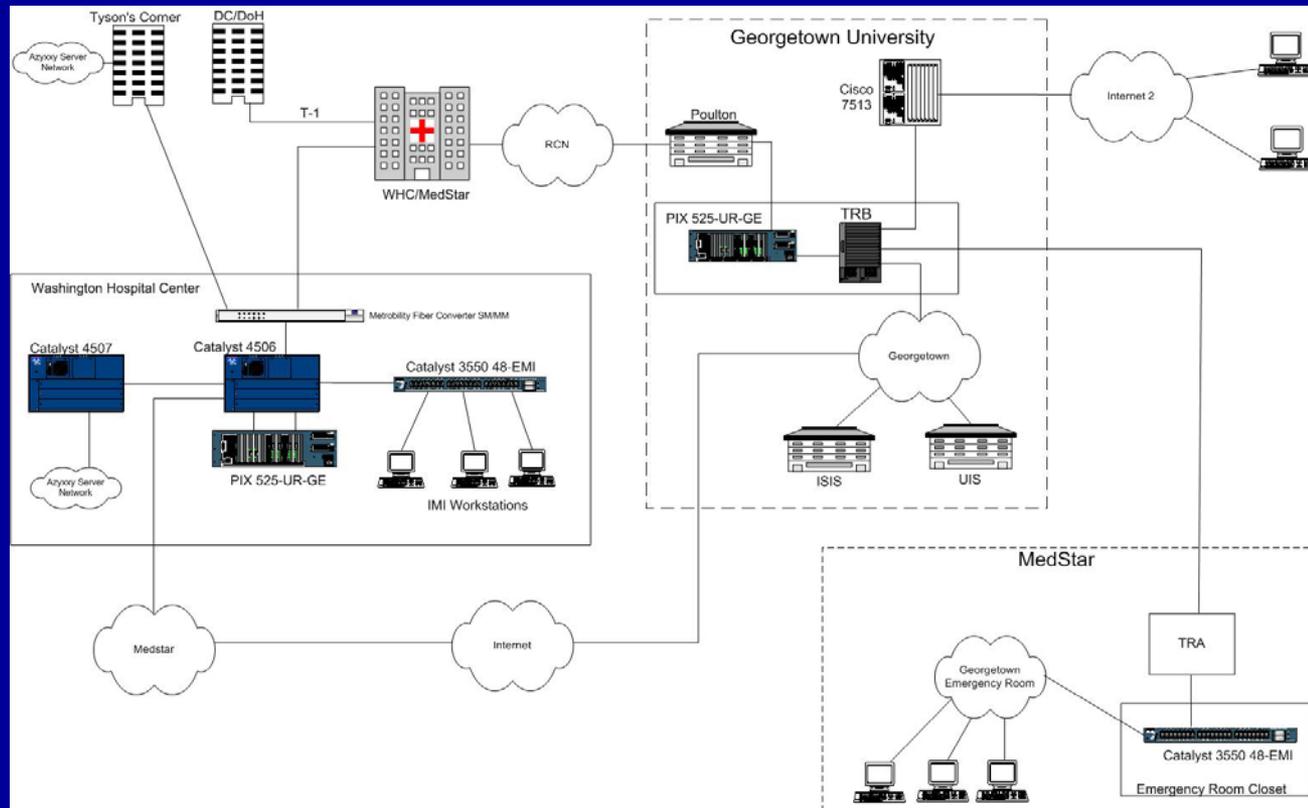**To IHE, Reactive Security Health Community**

Project 5: PIDS/Grid Services- Patient Identity Management
Web Services and Grid Services Converging

Project 6: Knowledge Dissemination and Sustainability
Sustainable Translational Research Community

Project 1:
Establishing Connectivity

Entire GU's indirect amount was invested back into the Project to install the IT infrastructure at Georgetown Hospital.

Creating the Collaboratory

Developing tools to enable collaboration

- Multi-institutional viewing
- Interactive electronic white board
- De-identification/pseudoanonymization
- Embedded multimedia teleconferencing and messaging
- Alerts and Alarms
- Embedded surveillance graphic
- Data visualization and analysis
- Integrated access to online resources such as AHRQ guidelines and PubMed

Project 2
Syndromic Surveillance -2005

- The entire field of biosurveillance is still *experimental*.
- Out of thousands of data elements generated during any given patient's visit to a medical facility, less than twenty (e.g., chief complaints, ICD9 codes) have been evaluated for use in surveillance.

- Key questions:
  - what constitutes a *baseline* for a given disease?
  - What constitutes a real threat?
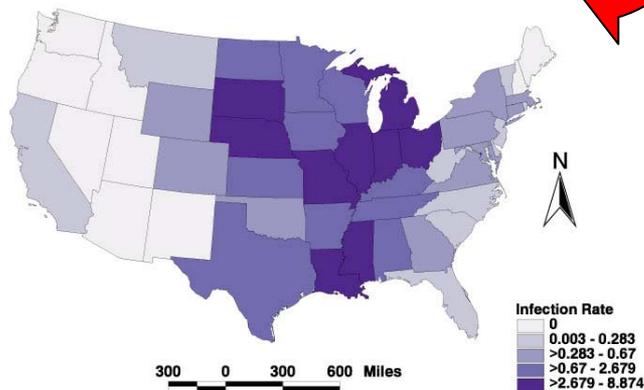 - How does one communicate?

Role of Environment: Micromapping of West Nile Virus
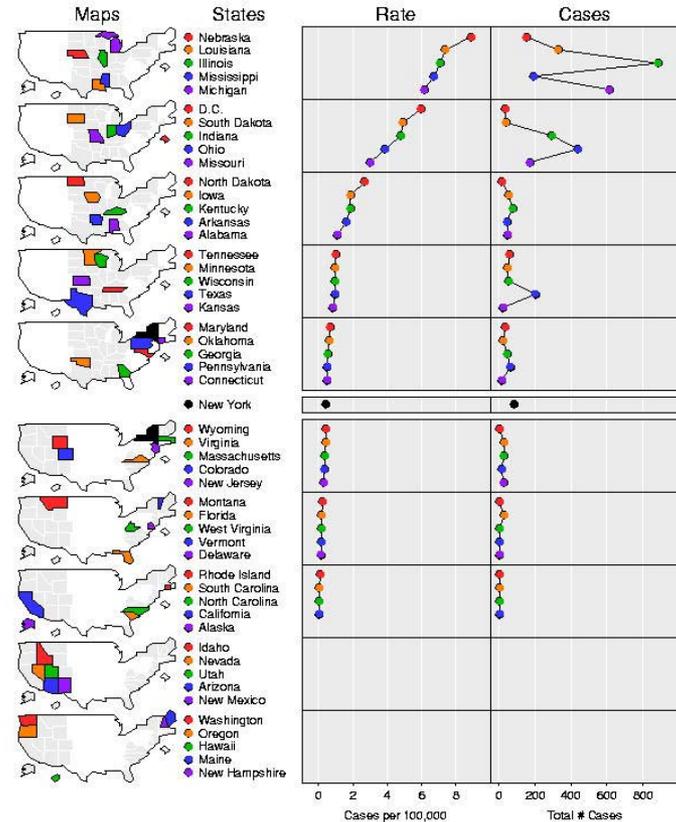

West Nile Virus in the United States, 2002

Verified avian, animal, and mosquito infections during 2002, October 2, 2002

Pattern indicates human case(s)

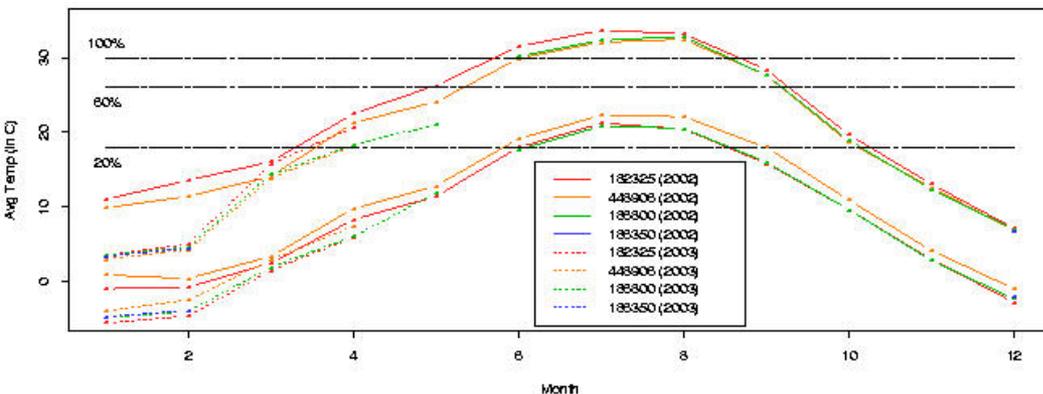Human West Nile Infection Rate (Cases per 100,000)

Infection Rate
0
0.003 - 0.283
>0.283 - 0.67
>0.67 - 2.679
>2.679 - 8.874

300   0   300   600 Miles
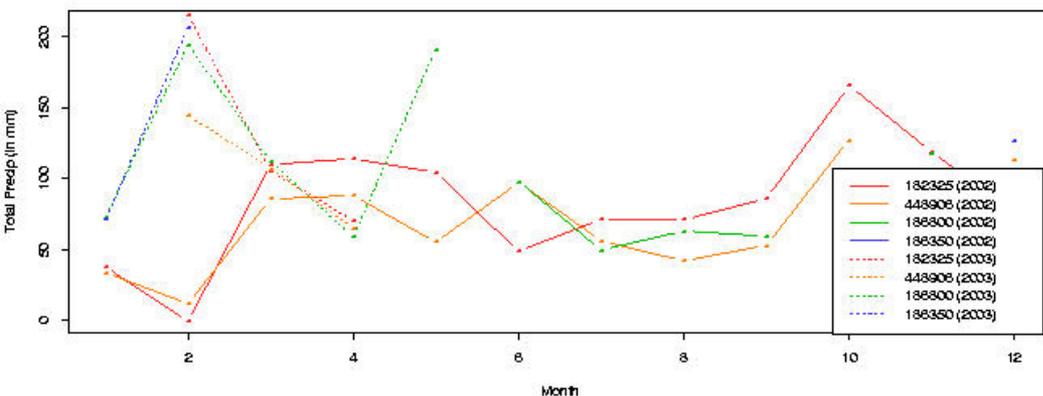
West Nile Virus 2002
Lab–Positive Human Cases

Project Vanguard
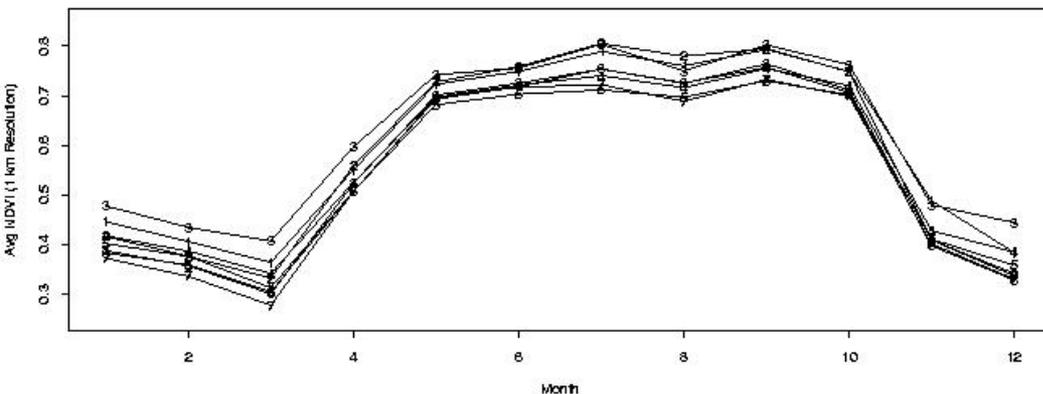
Average Min & Max Temperatures per Month in 2002 & 2003

Total Precipitation per Month in 2002 & 2003

Average NDVI for DC Wards 1 through 8 in 2002

Linking with Non Traditional Data

WNV transmission In DC occurred within a *specific* enviro-climatic context

WNV transmission occurs in a *specific* temporal-spatial context

**Remote sensing
Weather data
Mosquito Collection**

Project 2
Syndromic Surveillance- Pneumonia

Conducted a study (n= 120,000 patients) to explore additional "objective" markers of disease as proxy indicators of pneumonia: oxygen saturation and temperature.

C-statistic for selected models

Temperature cutoff O2Saturation cutoff	100.4	99.5	99	98.5	98
95	0.759	0.745	0.761	0.738	0.705
96	0.775	0.769	0.769	0.752	0.725
97	0.785	0.774	0.770	0.755	0.732
98	0.766	0.756	0.747	0.732	0.707

All results were obtained using SAS software version 8.

0.785

Low incidents rate at ER
Missing data
System Novelty
Lack of standard methods of data entry
Lack of baseline data

Limitations

- Low sensitivity
  - limited ability to detect a few number of events (Anthrax 2001)
- High false positives
  - costly, wasted resources, psychological effects – desensitization
- Low positive predictive value (low number of events)
- Low utility of alternative data sources

State of Syndromic Surveillance

- Literature:
    - **Over 150 funded syndromic surveillance programs. *~1% of them actually reporting statistical evaluations of the data.***
    - **Serious concern has been expressed in regards to validation… can we answer the "so what" of our effort?**

- Diagnosis Evolves

- Need additional basic statistical and epidemiological research in defining requirements for syndromic surveillance.

Limitations

- Statistical methods
  - Lack of reliable specific detection algorithms and longitudinal data to account for:
    - Fast spreading agents and slow spreading agents
    - Common and uncommon events
    - Seasonality
    - Varying latency of infectious agents

New Issues and Questions –Avian Flu

For Hyper-communicable disease time is short
How does one account for translocation of biothreats?
Early indicators and warning at the point of origin needed.
Improve situation awareness at all levels.

Global Argus: Based on Social Disruptions on Internet– Daughter of Sentinel

- ❑ **Epidemics cause social disruption.**
- ❑ **Social disruption is a common feature that can be tracked and used *in lieu* of direct reporting of disease:**
  - ➢ **Direct Markers**
    - • **Unusual disease reported**
  - ➢ **Indirect Markers**
    - ▪ **Demand for medical services**
    - ▪ **Local perception of threat**
    - ▪ **Official acknowledgement of threat**
    - ▪ **Official action against threat**
    - ▪ **Integrity of infrastructure**

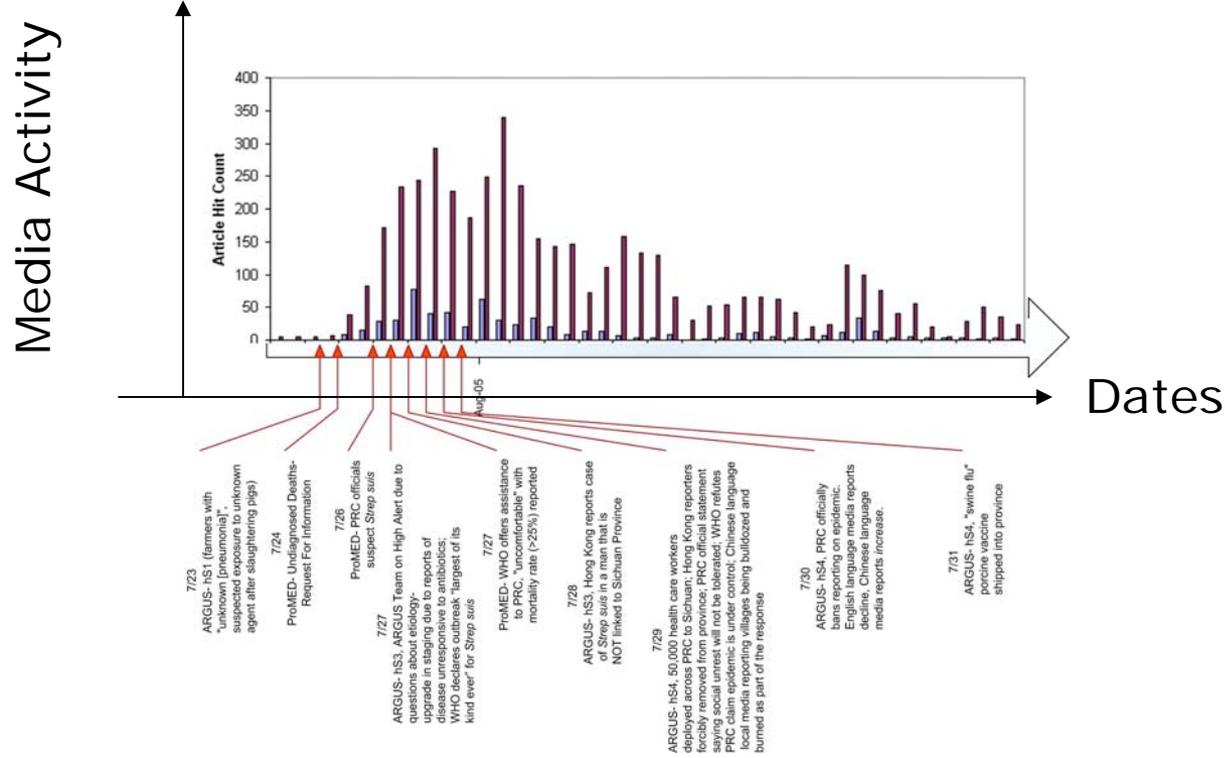Separately funded by the Federal Government

System Capability

- **Sources:**
  - **Media articles (local sources are key) on Internet Sites**
  - **Satellite imagery**
  - **Weather data**
  - **Air transportation data**
  - **Animal Health Data**
  - **Access to additional static, near-real time and real time data**
- **Web Scanning Power:**
  - **> 6,500 scripted sources to-date; continual source acquisition**
  - **1 million articles/day accessed with over 220,000/day archived**
  - **36 analysts fluent in ~45 languages**

  Structured reports in case files
  For longitudinal Study

Media Activity vs. Time Evolution of Events

Argus Watchboard™

Welcome, *jwilson* | ➤ *Home* | ➤ Reports | ➤ Tools | ➤ Administration | ➤ Work List | Logout

- Argus Watchboard Biological Event World Map -
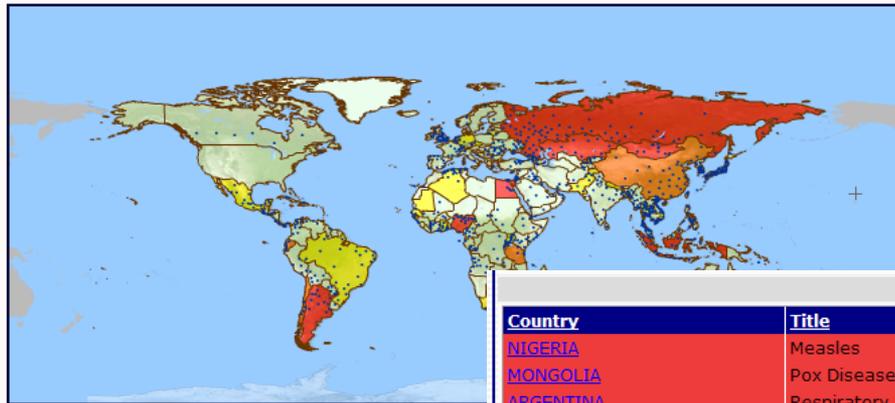
Levels
- 🟥 Warning
- 🟧 Watch
- 🟨 Advisory

-Biological Event Country Reports-

Country	Title	Date
NIGERIA	Measles	6/20/2007
MONGOLIA	Pox Disease; Suspicious Biological, Chemical Research	6/18/2007
ARGENTINA	Respiratory Disease, Bird Die-Off	6/22/2007
RUSSIA	Equine Influenza, Undiagnosed Disease, Alleged Intentional Poisoning	6/22/2007
INDONESIA	H5N1 Avian Influenza	6/23/2007
EGYPT	**H5N1 Avian Influenza**	**6/24/2007**
CHINA	Suspected Vaccine Failure	6/22/2007
CHILE	Respiratory Disease	6/19/2007
TANZANIA	Rift Valley Fever	6/19/2007
ECUADOR	Suspected Vaccine-Associated Illness	6/21/2007
CZECH REPUBLIC	H5N1 Avian Influenza	6/21/2007
RWANDA	Bird Die-Off	6/21/2007
BAHAMAS, THE	Bird Die-Off	6/21/2007
PANAMA	Undiagnosed Disease (Human, Bull); Bird Die-Off	6/21/2007
NEW ZEALAND	Respiratory Illness	6/22/2007
SENEGAL	Unexplained Deaths (Human)	6/18/2007
HONG KONG	H5N1 Avian Influenza	6/17/2007
BANGLADESH	H5N1 Avian Influenza	6/18/2007
ALGERIA	Undiagnosed Disease (Camels)	6/20/2007

>150 users from 50 organizations
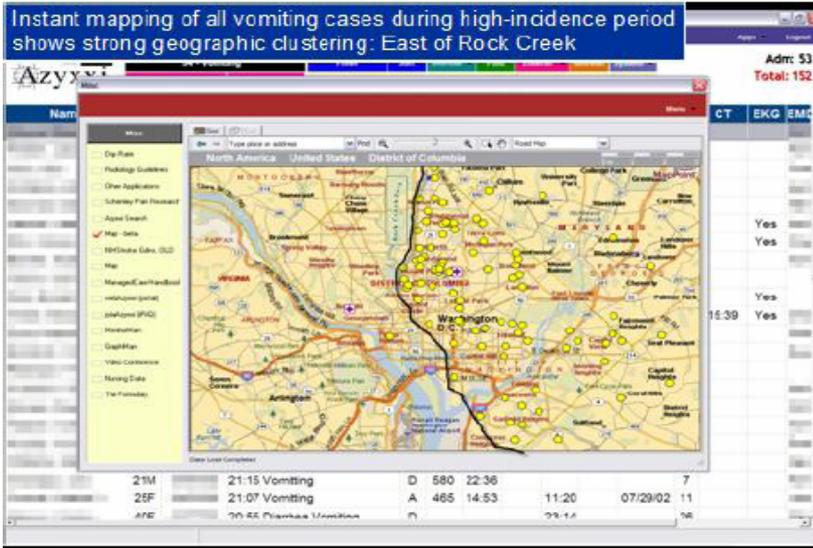
The Wilson-Collmann Scale

- **Stage 1-** unifocal biological event
- **Stage 2-** multi-focal biological event
- **Stage 3-** biological event is inducing infrastructure strain
- **Stage 4-** social collapse
- **Stage P-** observation of a country assuming preparatory posture

Staging	Public Health Analogy
Stage 1	"Outbreak"
Stage 2	"Epidemic"
Stage 3	n/a
Stage 4	n/a
Stage P	n/a

Project 3 - Advanced Visualization

Investigate the use of software that could serve as a platform for the unification of a broad variety of heterogeneous data into a single geospatial platform based on:

GIS visualization


Fully integrated and embedded MapPoint

GeoFusion - 2 layers (zip code & street maps) are added to the satellite image; disease incidence is plotted with red bars; terrain features are scaled to be larger
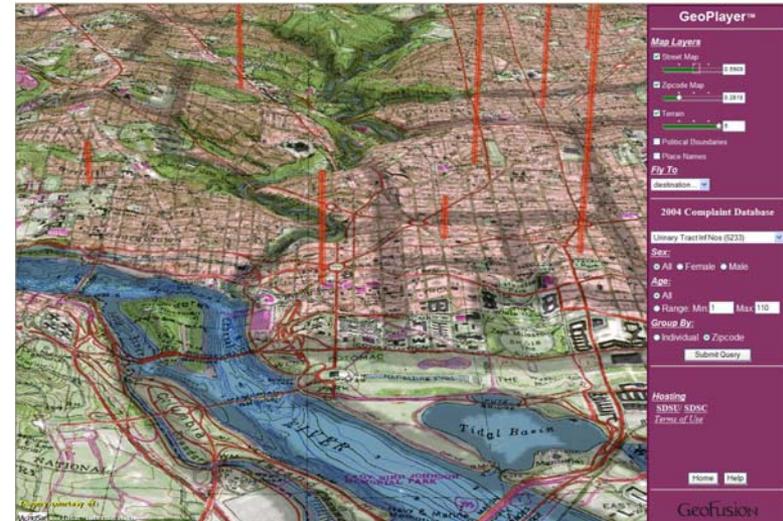
Successful for investigating events from a geophysical perspective once a specific cohort was identified BUT GIS investigations did not yield fruitful information (investigation fatigue) – need an automated marker for identifying potentially geospatially interesting events

OpenDX: IBM

Chief Complaints by Day of Year
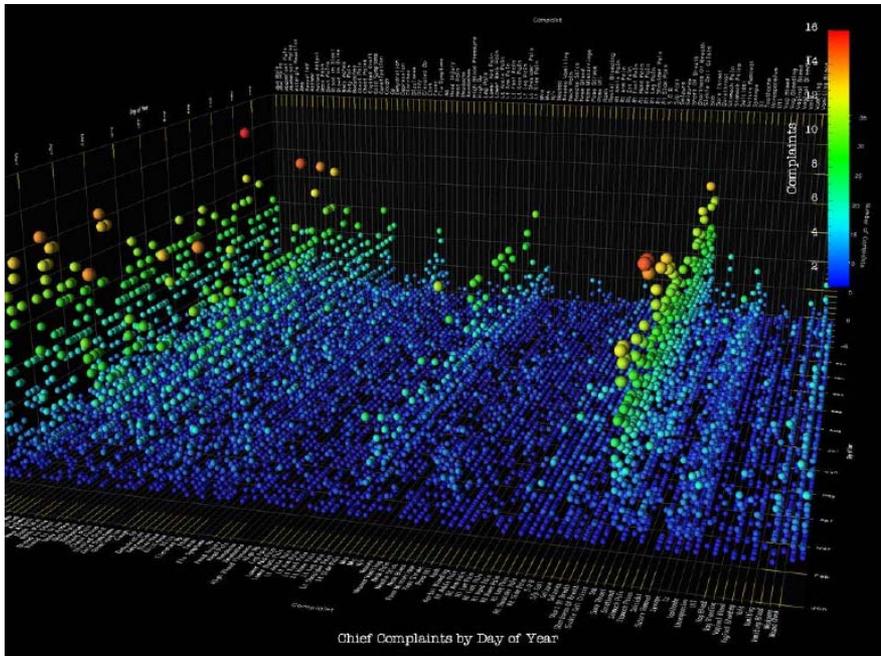
5th dimension graphing tool
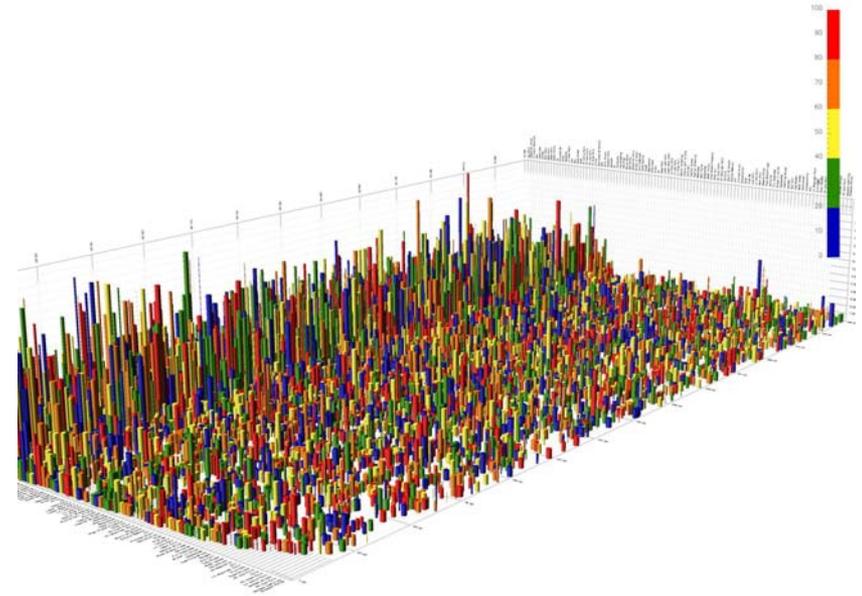
Cylindrical bar charting

does not support on-the-fly analysis or video creation and analysis
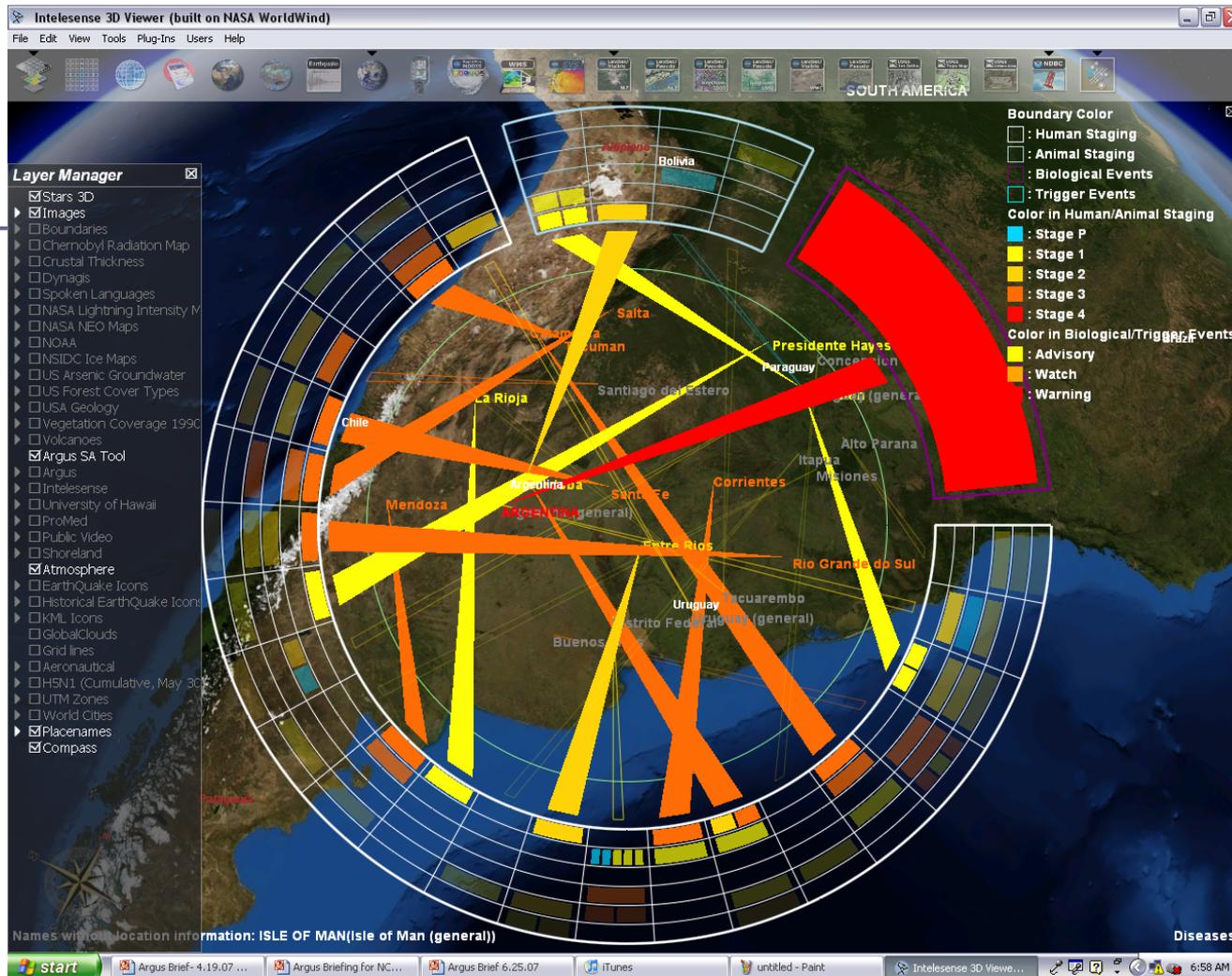
Miner3D
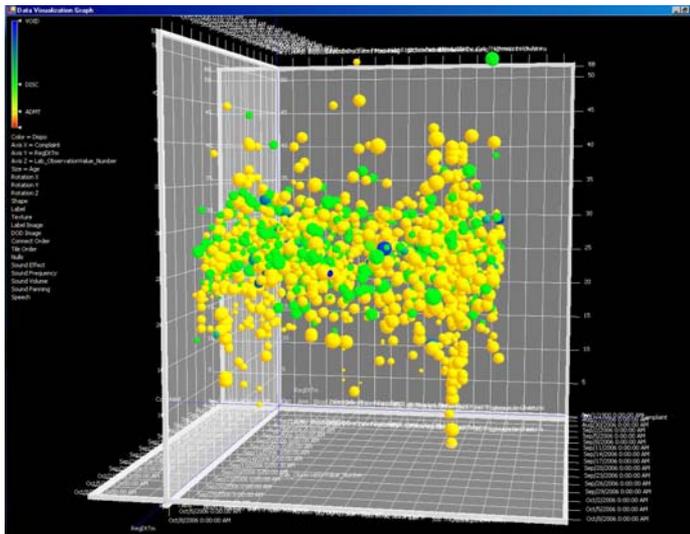
Bicarbonate Level vs Time and Date
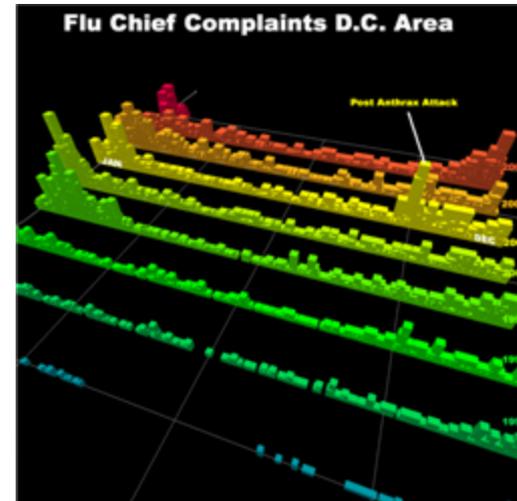
Flu Chief Complaints in the DC Area

Allows up to 15 dimensions of data to be plotted into a single 3-D space
Dimensionality is increased using color, shape, vibration, size, audio, labels etc...
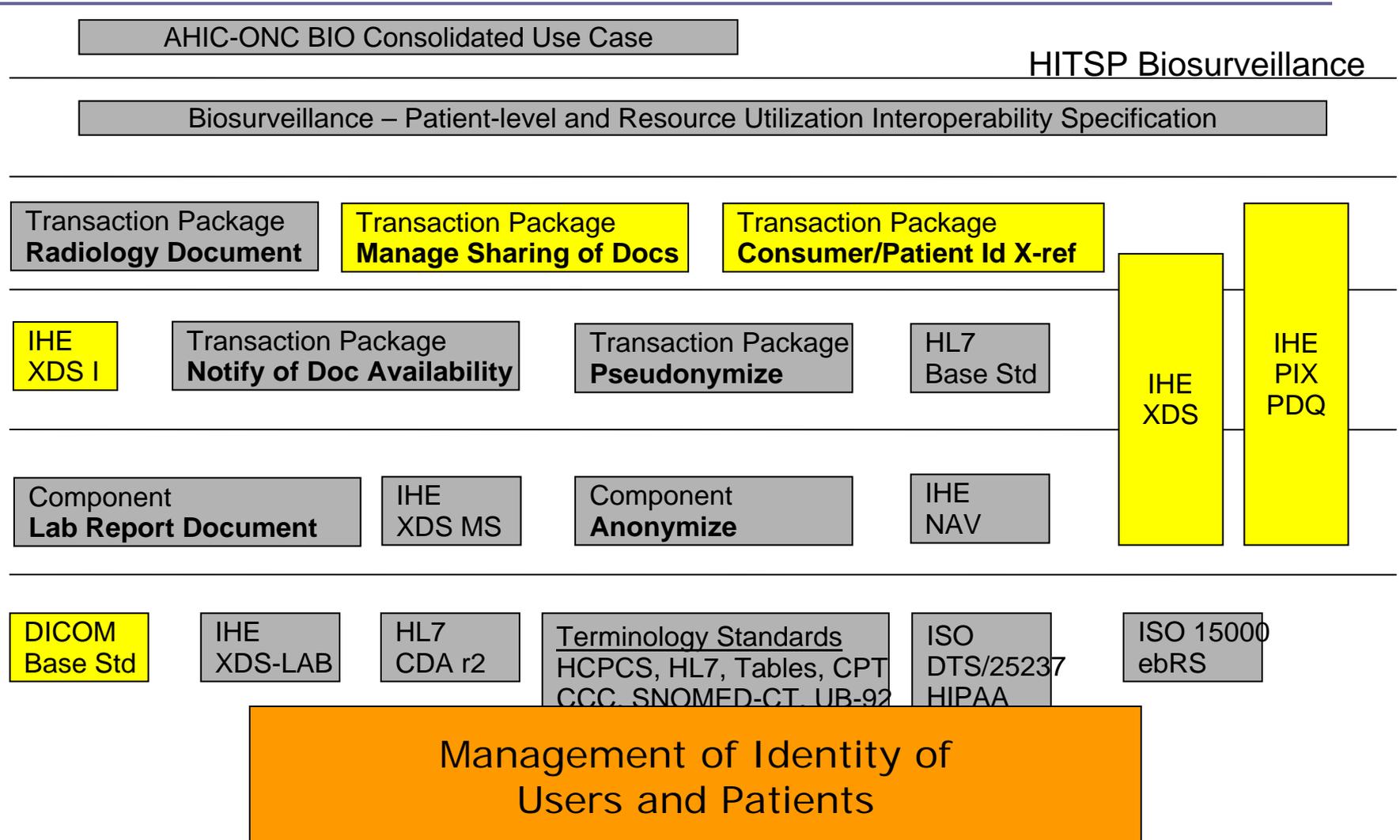
World Wind- NASA
In Depth Access to Complex Data Coupled with Global GIS

Surveillance IT Interoperability Efforts

- Healthcare Information Technology Standards Panel (HITSP) Biosurveillance Interoperability Specifications

- HITSP Security and Privacy Construct Relationship Document for Biosurveillance, Electronic Health records and Consumer Empowerment Use Cases.

- Harmonized Use Case for Biosurveillance (Visit, Utilization and Lab Results)

Looking at IT Issues for Information Sharing

Sentinel Projects within the HITSP Framework

AHIC-ONC BIO Consolidated Use Case

HITSP Biosurveillance

Biosurveillance – Patient-level and Resource Utilization Interoperability Specification

| Transaction Package **Radiology Document** | Transaction Package **Manage Sharing of Docs** | Transaction Package **Consumer/Patient Id X-ref** | IHE XDS | IHE PIX PDQ |

| IHE XDS I | Transaction Package **Notify of Doc Availability** | Transaction Package **Pseudonymize** | HL7 Base Std |

| Component **Lab Report Document** | IHE XDS MS | Component **Anonymize** | IHE NAV |

| DICOM Base Std | IHE XDS-LAB | HL7 CDA r2 | Terminology Standards HCPCS, HL7, Tables, CPT CCC, SNOMED-CT, UB-92 | ISO DTS/25237 HIPAA | ISO 15000 ebRS |

Management of Identity of Users and Patients

Project 4:
Federated Organization & User Authentication/Authorization using Shibboleth

- Investigate mechanisms allowing healthcare professionals, at different organizations, to access patient medical record/information.

- Protect type/amount of information based on policies.

- Allow for a "state-of-emergency" policy.

Address lack of multi-organizational support in current standards.

Technical Approach

- Use IHE SOAP-based document sharing (XDS.b)
- Employ IHE user identification profile (XUA)
- Trust between organizations established using Shibboleth federation mechanisms

Secure, multi-organizational, document-centric sharing

Record Sharing Environment
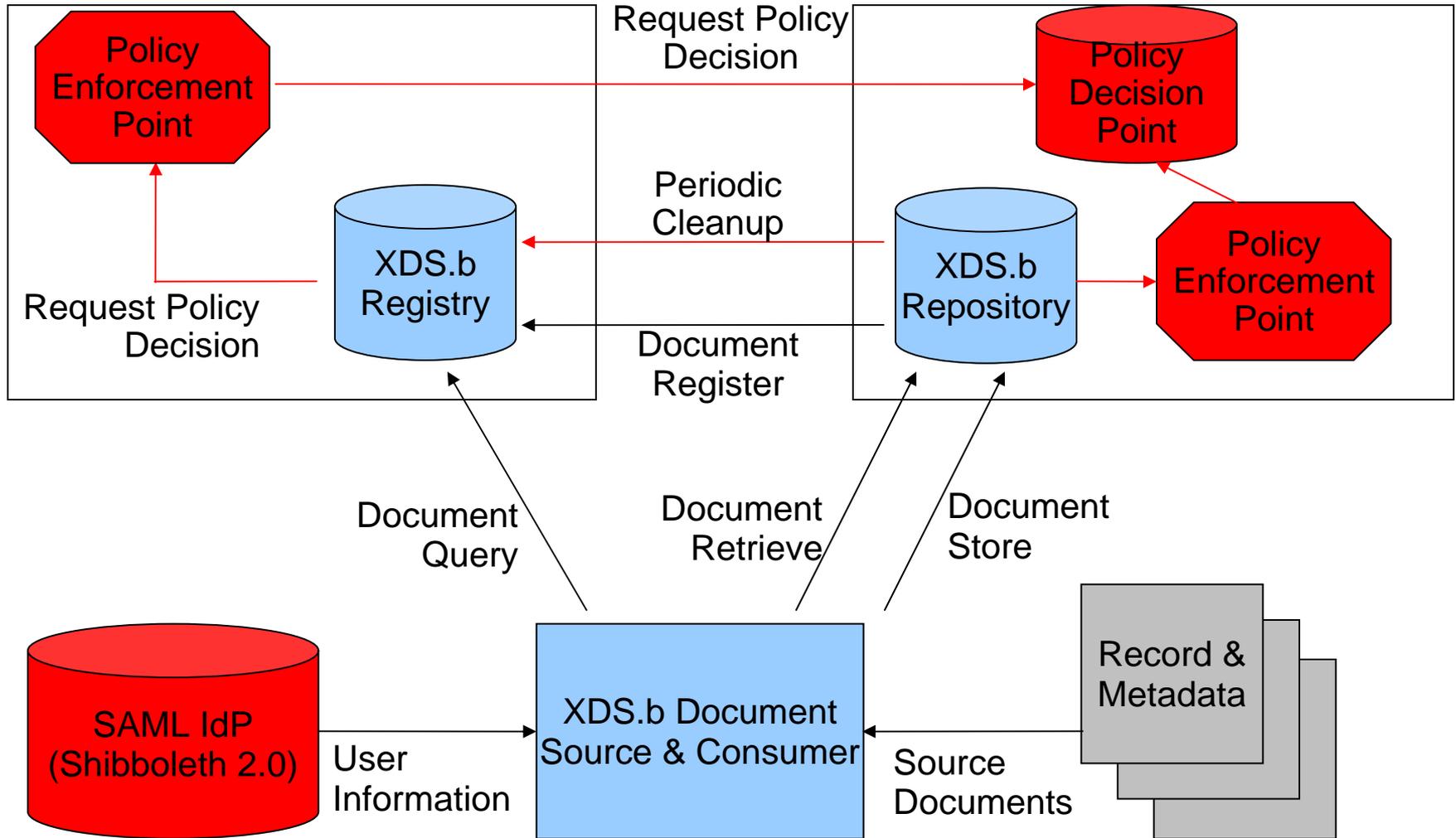
Sentinel Contributions

- Influence development of Shibboleth software
  - Provide input on non-browser based uses
  - Help develop 7 infrastructure libraries for use in XML parsing, web services, SAML processing, and user attribute aggregation
  - Greatly expanded trust and credential handling code; already seeing adoption by other projects

Researchers at Shib 2 or eAuth 2 sites could participate immediately.

Sentinel Contributions

- **Provide domain knowledge to IHE profiles**
  - Help identify spots in XDS.b protocol that would be difficult to implement, such as large file support.
  - Provided nearly all of the information for the XUA SAML 2.0 profile also compliant w/ eAuth2
- **Detailed architecture/implementation guide**
  - Indicates key requirements left un/under-specified by IHE documentation
  - Provides pros and cons of model
  - Lays out methods for creating the XDS "federation" and reasonable policy guidelines it

Lessons Learned

- Message-based data sharing limits analysis that may be performed at any given time.
- Existing medical systems are not built to support federated access or information sharing.
- The current audit-based security model must incorporate proactive access control to allow for the secure sharing of data outside an enterprise.
- Access policies need to be enforced at both the registry and repository but must be maintained at the repository.

Project 5:
Grid Service for Data Sharing & Interoperability

- Pioneer Grid technology in clinical environments in a dual capacity: routine and emergency (biodefense mode)
- Focus on Identification and Correlation of Individual Clinical data appearing in different organizations/entities
  - Start by relying on a PIDS (Person Identification Service) standard
  - Bring the standard within the IT infrastructure of Web Services and Grid environments
- Initial Tasks
  - Extend PIDS to Web Services and then Grid environments, call the resulting specification WS/PIDS
  - Support other clinical services (i.e. lexical) and related standards (HL7 3X, RIM) in Grid environments
- Refocused Tasks
  - Address mainstream data grid standards (WSRF)
  - Validate WS/PIDS in research and clinical domains

Technology Description: Grid and Web Services Convergence

Grid environments become Web Services ++ and GT4 (the latest Globus toolkit) includes WSRF (Web Services Resource Framework) – as grid approach to standardized state support

© Globus Alliance
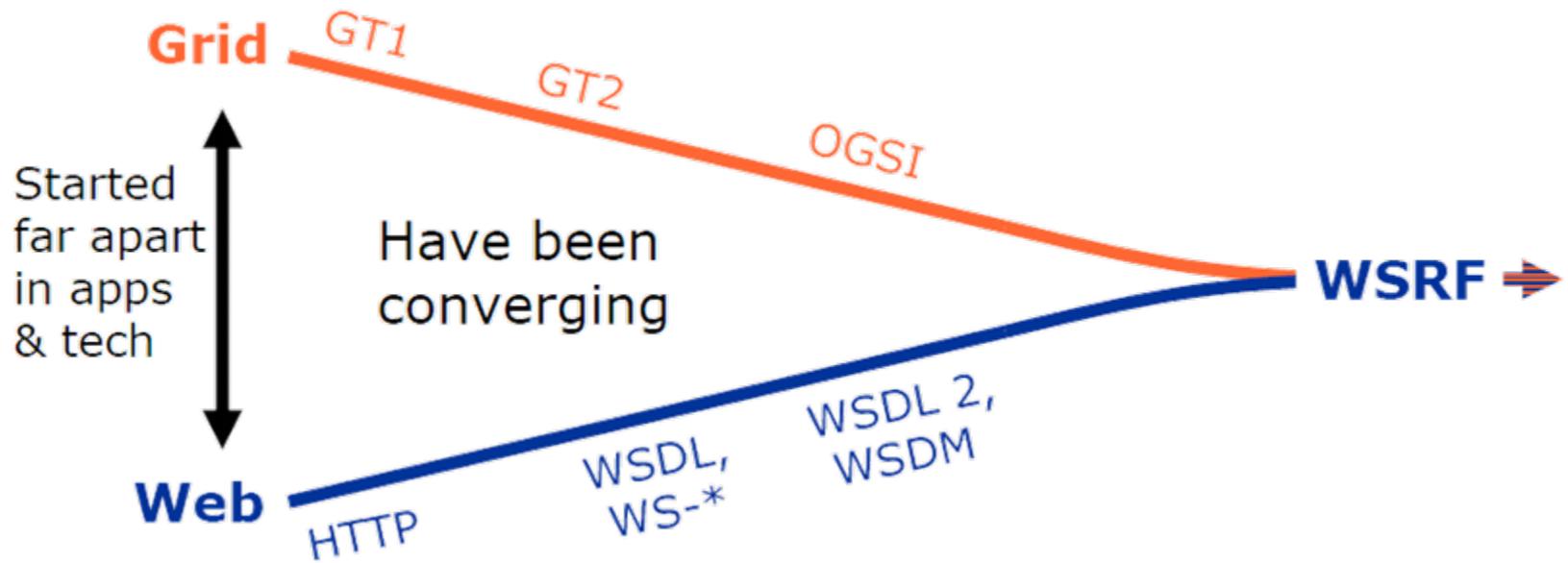
Technology Description: WS/PIDS

- WS-I Compliant Web Service specification
- Translate CORBA PIDS semantics to Web Services including hierarchical support for clinical domains
- Compatible with latest Globus toolkit including the handling of state via Web Services Resource Framework standard

Sentinel Contributions

- Specification and implementation backed up by comprehensive and validated use cases in typical clinical environment including
  - Assigning IDs to patient
  - Searching, matching merging of patient information
  - Correlating IDs within different domains
- IHE Patient Identifier Cross Reference (PIX), Patient Demographic Query (PDQ) compatibility

Current Implemented General Architecture for WS/PIDS: Web Services using .NET and J2EE clients
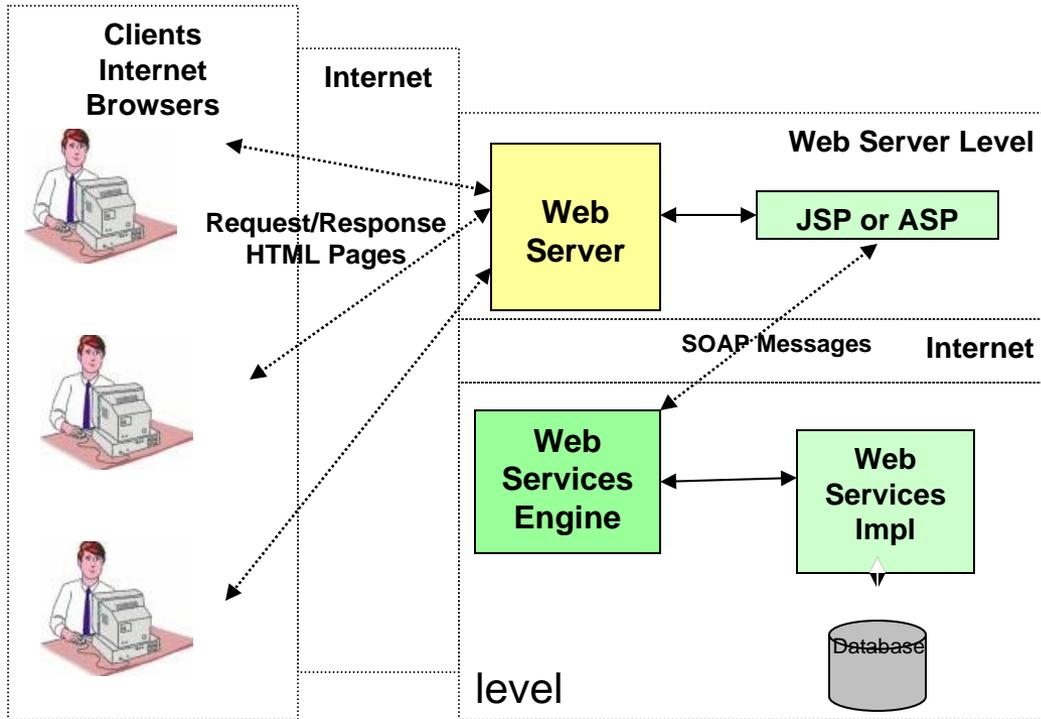
Sentinel Contributions

- Entity Identification Service – EIS (RFP issues by OMG/HL7)
  - Capabilities are PIDS based:
    - Metadata Interface
    - Entity Management Interface (manages entity information)
    - Query Interface
  - Initial submission deadline: 9/07, revisions 11/07

Lessons Learned

- Lack of standards for (patient) identification within web environments is a central issue in clinical environments
- Agility of the web participants may create divergence with established directions and new mainstream priorities
- Real live implementations uncover new valid requirements that may enhance standards usability. For WS/PIDS:
    - Need for domain management capabilities
    - Need for flexible "linking" of ids

Future Activities

- Enhance and Validate WS/PIDS
  - By adding appropriate features (linking, domain management, insuring its applicability in a particular clinical domain
  - By providing interoperability features (such as PIX or PDQ front-end wrappers)
  - Align WS/PIDS with Entity Identification Service (EIS)

Project 6: Knowledge Dissemination

- Share Lessons Learned
  - Publications
  - Conferences
- Transition to sustainable real-world applications
  - Find compelling business cases
  - Identify sustainable incentives
  - Institutionalize leadership
  - Build successive relevant technology blocks
  - Focus on multi-use, standards-based technologies
  - Proactively contribute to key Technology Communities
  - Move toward a clear target with deliberate actions

Applying Sentinel Technologies to Clinical/Translational Research

□ WS/PIDS technology allows the Center for Clinical Imaging Research at Washington University to uniquely identify participants in clinical trials:

- Correlate identity across trials
- Correlate identity between research and clinical domains
- Manage participant identity and data anonymization for multi-center clinical trials

http://ccir.wustl.edu/

Technology Overlap

Biosurveillance

Clinical Practice

Sentinel Technologies &

Core Lessons Learned

- Web services-based identity correlation
- Secure data sharing for multi-organizational environments
- Infrastructure requirements
- Open source, open architecture approach

Clinical/Translational Research

- The Sentinel Team has sponsored two successful conferences to explore application domains and begin to develop a community
  - MCIM 2006 broadly explored potential application domains & gaps between needs and existing products
  - MCIM 2007 focused on clinical trial management and the needs of Translational Research

Image (Information) Management Toolkit

- Promotes Development of Robust Software for Multi-center and Multimedia Information Exchange to support Clinical/Translational Research, Biosurveillance and Clinical Practice

- Involves Academia, Industry and Government

- Engages an International Community of Developers

- Promotes Open Source, Open Architecture, Open Science

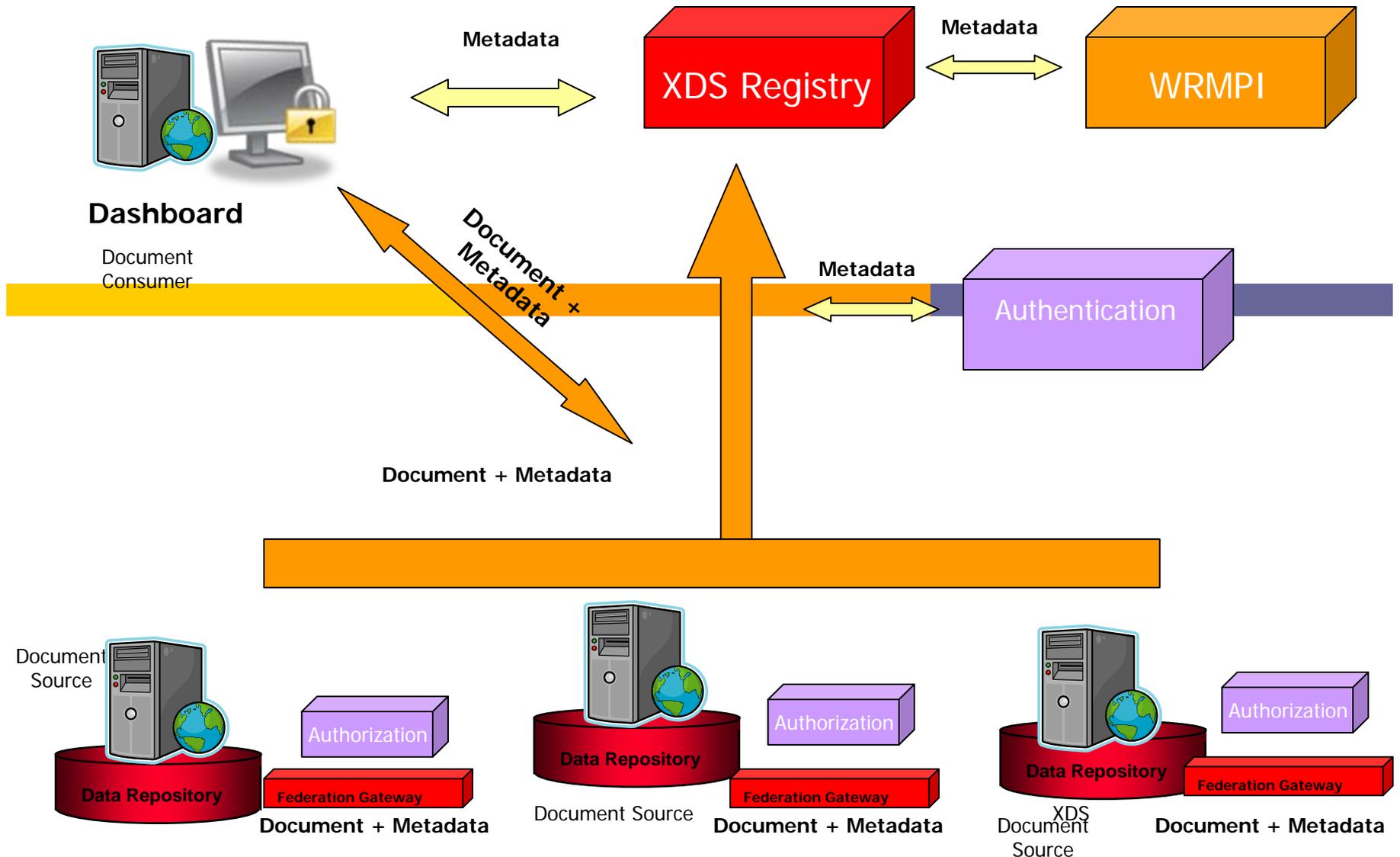- Leverages Sentinel technologies and existing standards and frameworks (HL7, DICOM, IHE,OASIS)

http://imtk.org

ImTK Information Sharing Environment

In Closing

- Syndromic Surveillance –Scientific Challenge
- Global Surveillance – Operational Challenge
  - Who should have what information for what action?
- Scalability
  - Single Org Perspective Does Not Scale Up -HITSP
- Sentinel Introduced New IT Tools from Internet community to Healthcare
  - Legacy System, Legacy Standards, Legacy Concept

NLM should promote adoption and adaptation of state of the art Internet/Web/Grid technologies in healthcare.

Key Members for Project Sentinel

- Seong K. Mun, PhD – P.I.
- Craig F. Feied, MD – Co-P.I.
- Mark Smith, MD – Co-P.I.
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- Adil Alaoui, MS
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- David Channin, MD
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- Walid Tohme, PhD
- Jae Choi, PhD
- Kevin Cleary, PhD
- Jane Blake, MA