Visual Analytics – Past, Present, and Future

Where Visual Analytics Has Been and Where It Might/Could/Should Be Going

("Change" Is the Order of the Day)

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Homeland Security

Why am I here?

What do I know?

Leo Szilard
and “the facts”

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Homeland Security Mission

- Lead unified national effort to secure America
- Prevent terrorist attacks within the U.S.
- Respond to threats and hazards to the nation
- Ensure safe and secure borders
- Welcome lawful immigrants and visitors
- Promote free flow of commerce

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Science and Technology (S&T) Directorate Goals

Consistent with the Homeland Security Act of 2002

- Accelerate delivery of enhanced technological capabilities to meet requirements and fill capability gaps to support DHS Agencies in accomplishing their mission
- Establish a lean and agile GS-manned, world-class S&T management team to deliver the technological advantage necessary to ensure DHS Agency mission success and prevent technology surprise
- Provide leadership, research and educational opportunities and resources to develop the necessary intellectual basis to enable a national S&T workforce to secure the homeland

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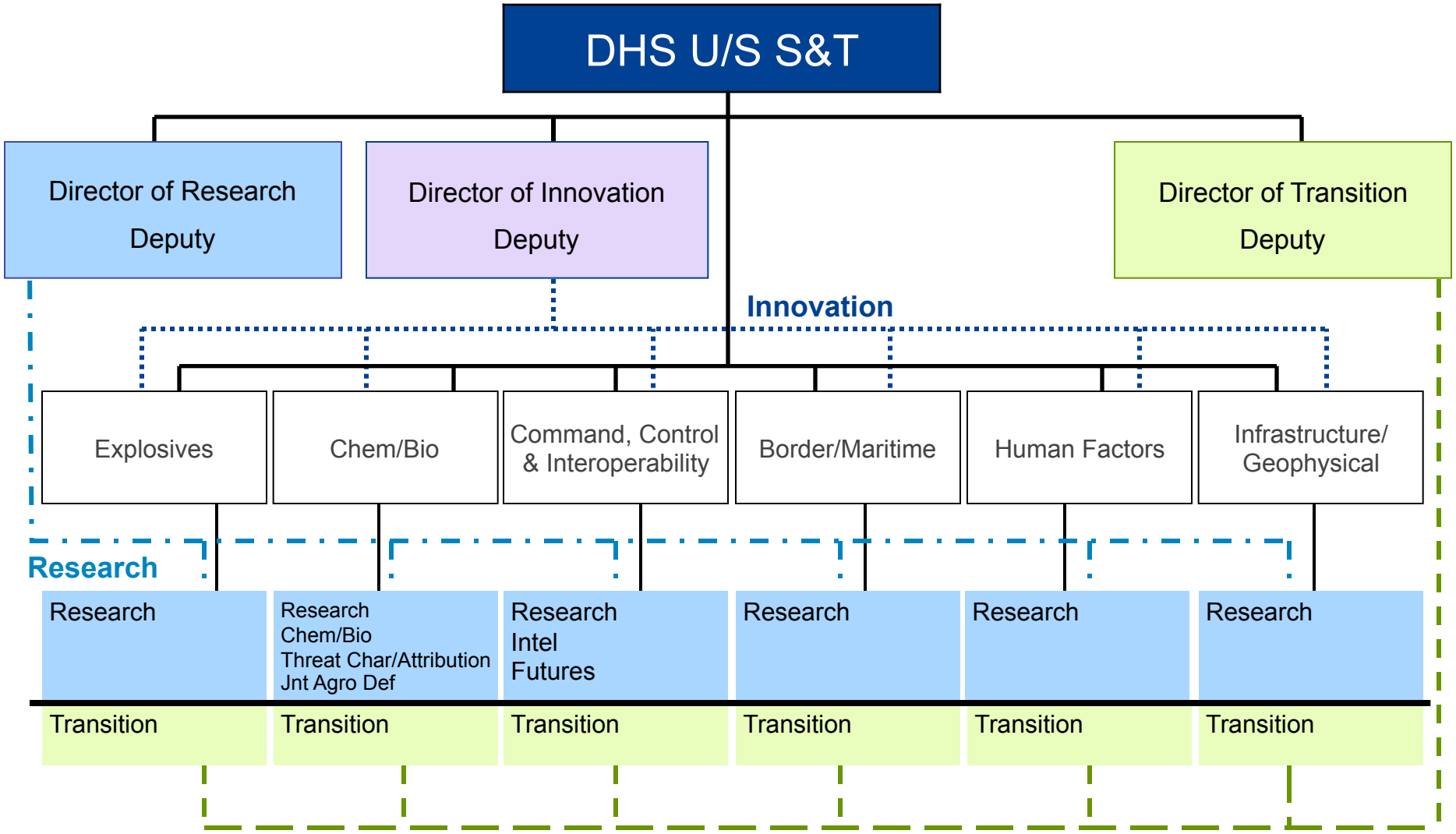
DHS S&T Directorate: Organization



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Revised 4/8/08

Command, Control and Interoperability

Mission
Through a practitioner-driven approach, the Command, Control and Interoperability (CCI) Division creates and deploys information resources to enable seamless and secure interactions among homeland security stakeholders.




Vision
Stakeholders have comprehensive, real-time, and relevant information to create and maintain a secure and safe Nation.

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Command, Control and Interoperability

Information

Detect

Manage

Analyze/Visualize

Protect

Share

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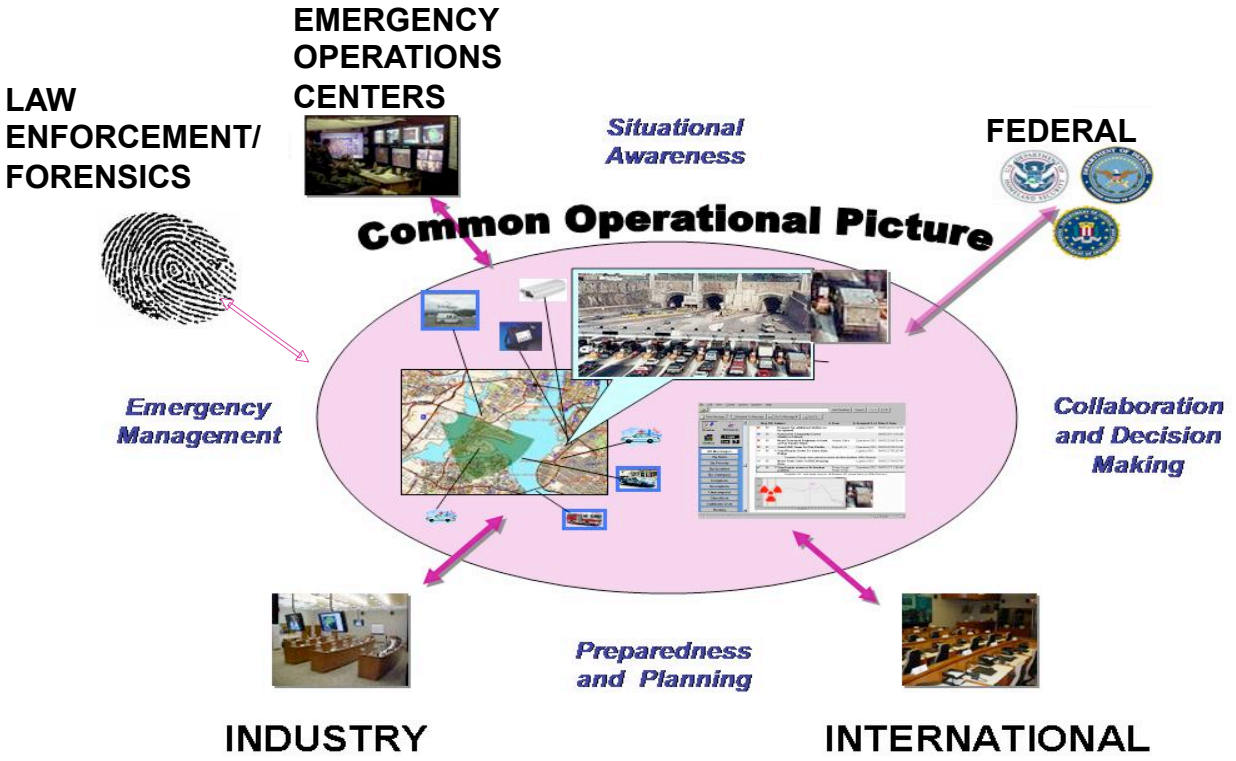
Command, Control and Interoperability

Mission - Transform new and promising concepts into real operational capabilities that strengthen communications interoperability, improve Internet security and integrity, develop sensors and investigative tools, and accelerate the development of automated capabilities to help identify potential national threats.

Customers - Local, tribal, state, and Federal emergency responders that plan for, detect, and respond to all hazards, as well as private-sector partners that own, operate, and maintain the Nation's cyber infrastructure.



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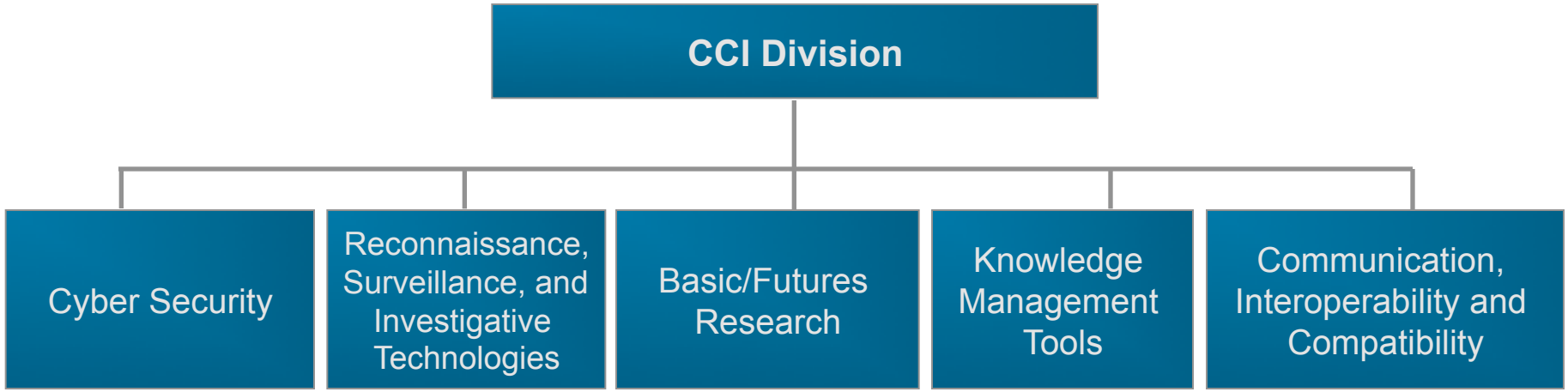
CCI Division Organization

Managed by the Department of Homeland Security's (DHS) Science and Technology Directorate, CCI delivers on its mission through five thrust areas.



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Communications, Interoperability, and Compatibility

Voice Interoperability –
Creating the capacity for increased levels of interoperability by developing tools, best practices, and methodologies that emergency response agencies can put into effect immediately.

Data Interoperability –
Improving incident response and recovery
by developing tools and messaging
standards that help emergency responders
manage incidents and exchange information
in real time.

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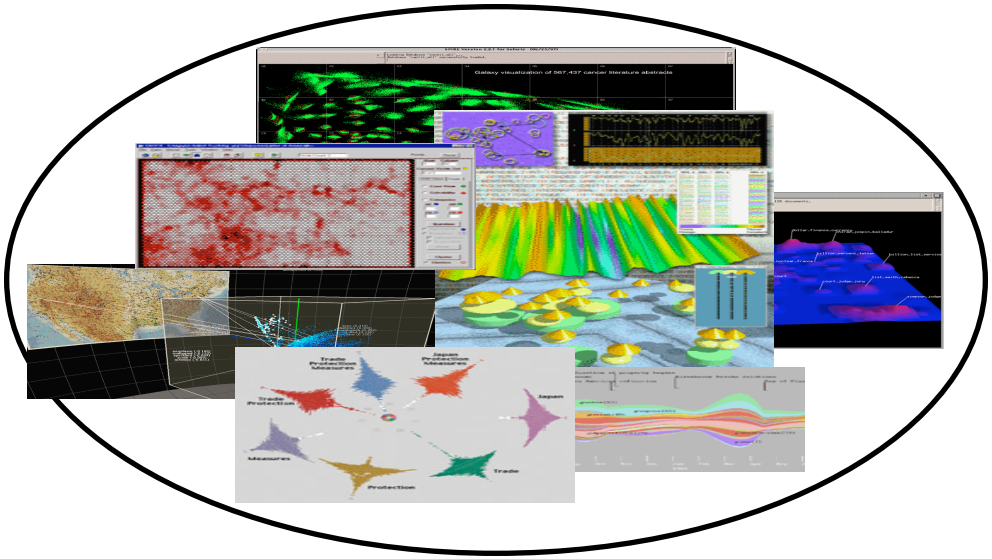
Knowledge Management



- Provides knowledge management capabilities to reduce the risk of terrorist attacks and to prepare for and respond to natural and man-made disasters.

- Develops tools and methods to process and analyze massive amounts of information that are widely dispersed and in multiple forms.

- Works collaboratively to complement efforts in the intelligence, law enforcement, and homeland security communities.

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Reconnaissance, Surveillance, and Investigative Technologies

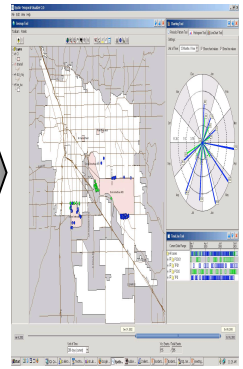
- Develops and evaluates individual sensor technologies, fusion of multiple sensors, and examination of new sensor technologies.

- Develops integrated technology platforms to collect, share, and disseminate information.

- Develops advanced investigative and crime scene forensic tools.

- Supports technical rationale for policies and privacy issues associated with applications.

- Initiates R&D activities with intelligence and defense organizations.



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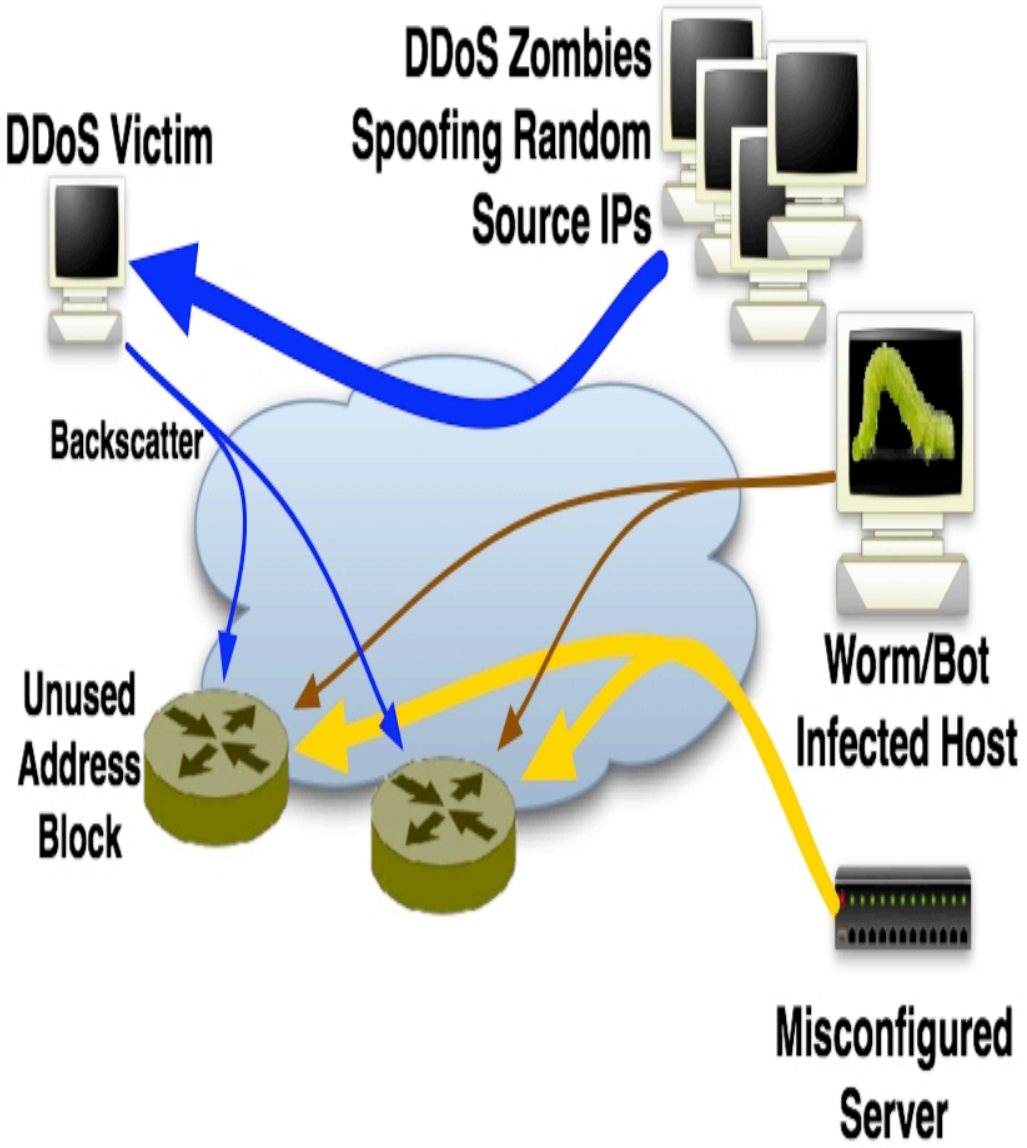
Cyber Security

- Secures critical infrastructure, and coordinates efforts to improve the existing cyber infrastructure.

- Focuses on priorities established in the President's *National Strategy to Secure Cyberspace,* as well as needs identified by critical infrastructure external stakeholders.

- Addresses cyber security requirements in support of DHS operational missions in critical infrastructure protection.



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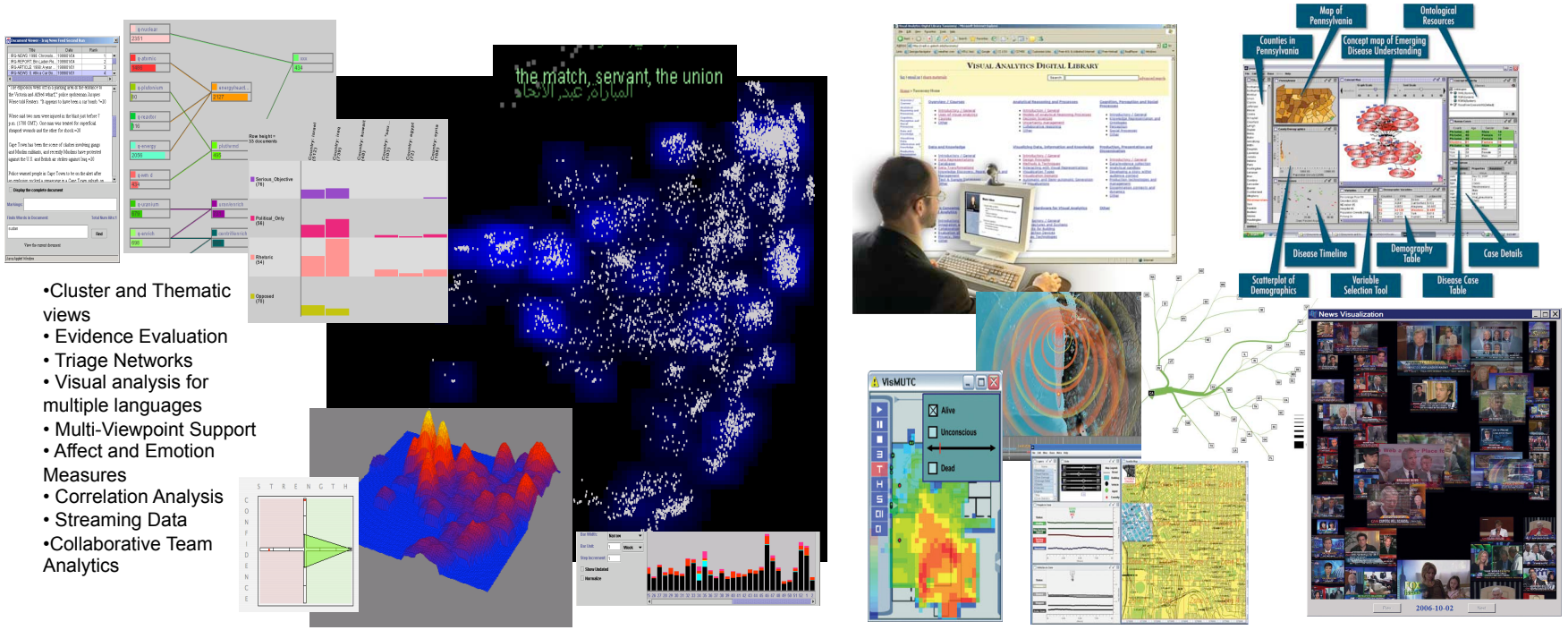
Basic/Futures Research



- Cluster and Thematic views
- Evidence Evaluation
- Triage Networks
- Visual analysis for multiple languages
- Multi-Viewpoint Support
- Affect and Emotion Measures
- Correlation Analysis
- Streaming Data
- Collaborative Team Analytics

- Conducts research on information and intelligent systems to address problems associated with synthesizing information and deriving insight from massive, dynamic, ambiguous, and diffuse data sets

- The objective is support for an effective risk management approach to homeland security based on comprehensive, timely threat awareness and decision making informed by accurate consequence analyses

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Basic/Futures Research Program Areas

- **Visual Analytics, Precision Information Environments**

  Visually based mathematical methods and computational algorithms for discovering, comprehending, and manipulating diverse data and applying the resulting knowledge to anticipate terrorist incidents or catastrophic events and guide response and recovery activities

- **Discrete-Element Computing, Privacy and Forensics**

  Simpler, more efficient software algorithms and hardware architectures for extracting and managing data, assessing threats and consequences, ensuring information privacy, securing the cyber infrastructure, and ensuring telecommunications interoperability

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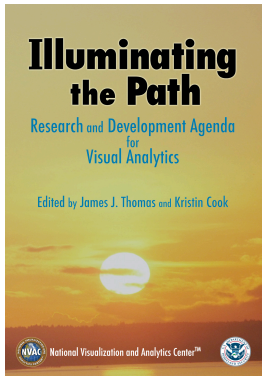
HIGHLIGHTS

• Canada-USA Collaboration - Collaborative Activity Agreement (CAA) under existing Canada USA treaty between DHS S&T and Defense Research and Development Canada

• Visualization and Analytics Complex – The National Visualization and Analytics Center (NVAC), 5 university-based RVACs, 2 GVACs, and 20 industry partners

• National Research and Development Agenda



Alexander Pope
Essay on Criticism

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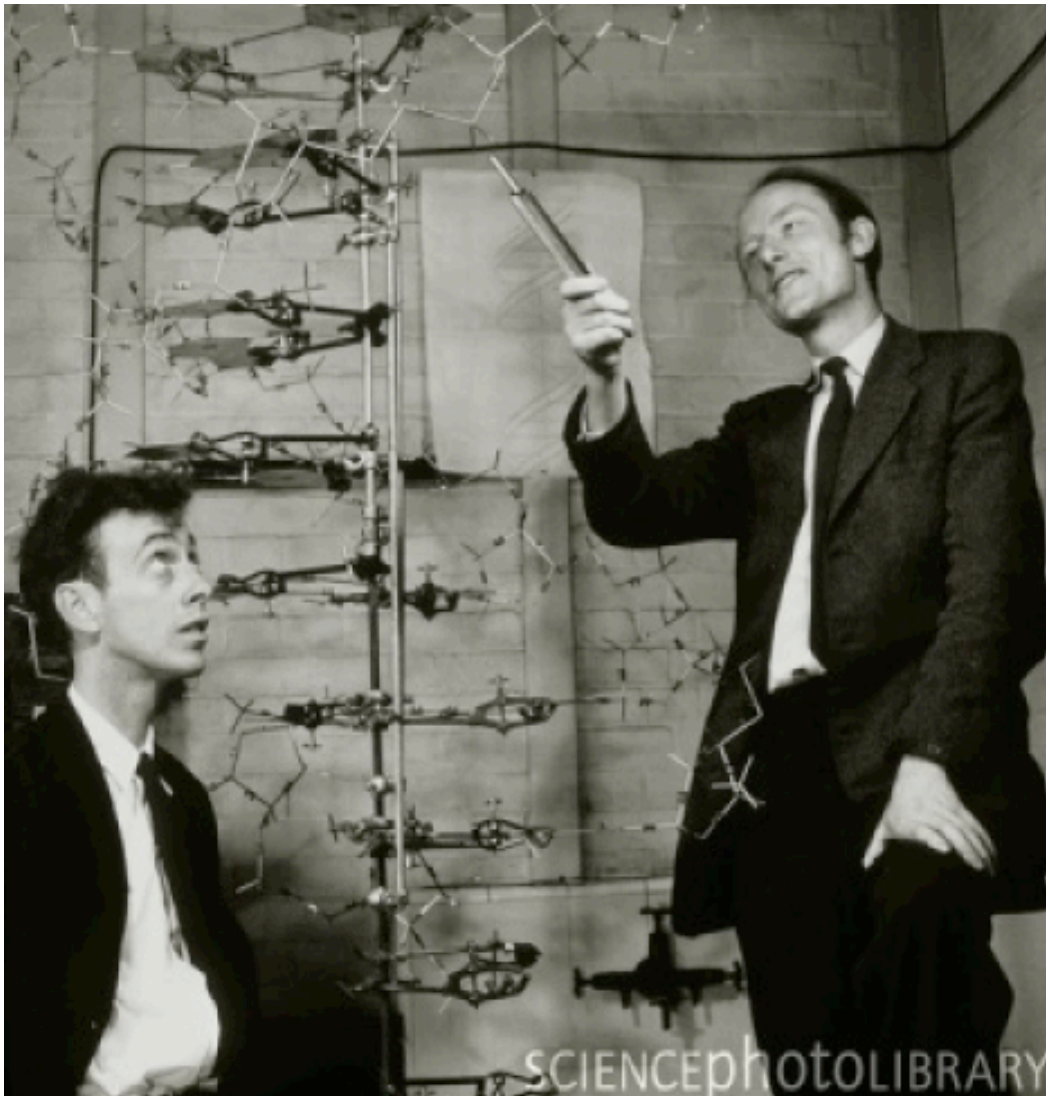

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CCI Mission Areas and Challenges

- Information analysis
- Knowledge management
- Threat assessment
- Situational awareness
- Decision support
- Information sharing
- Interoperable communications
- Surveillance and investigative operations
- Cyberinfrastructure protection

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The Homeland Security Environment

- Department of Homeland Security
  - 22 components, 7 operational agencies
  - 185,000 personnel
- Federal Government Partners
  - 15 Intelligence Community agencies
  - 11 Law Enforcement Community agencies
  - 350,000 personnel
- Tribal, Local, and State Partners
  - 80,000 public safety, public health, emergency response, law enforcement agencies
  - 750,000 homeland security practitioners

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New Dimensions of Homeland Security

Time Scale – short to long-lived

- incident to development to crisis
- attack to epidemic to global change

Consequence - limited to extensive

- local to regional to national to global
- human to group to society

Action -

- preparation to prevention to response
  - to remediation
- prediction to anticipation to warning to detection

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Scenarios/Use Cases

- Identification
  - Surveillance, Borders, Forensics
- Human Scale
  - Behavioral (Psychosocial), Economic
- National/Global Scale
  - Resources, Environment, Zoonoses, Food
- Communications, Sharing
  - Interoperability, Public Safety
- Awareness/Management
  - Situational, Exercises, Training

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Research to Reality (R2R)

- Three Essential Elements
  - Technology Suites
  - Commercialization Partners
  - Grants Funding
- Continuing Technology Refresh Process
  - National Laboratory and University Research
  - Industry Research, Support, and Training
- Constant On-Site Interactions
  - Local, State, Tribal, Federal Partners
  - PANYNJ, ARJIS, Seattle NWRTC

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The Data Problem

Reverend Robert Evans

and Supernovae

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Selected Societal Drivers and Observations

- Scale of Things to Come:
  - Information:
    - In 2002, recorded media and electronic information flows generated about 22 exabytes (10^{18}) of information
    - In 2006, the amount of digital information created, captured, and replicated was 161 EB
    - In 2010, the amount of information added annually to the digital universe will be about 988 EB (almost 1 ZB)
  - A Forecast of Worldwide Information Growth Through 2010: IDC
  - National Open Source Enterprise - Intelligence Community Directive No. 301, July 11, 2006
  - UC Berkeley School of Information Management and Systems: How Much Information, 2003

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Selected Societal Drivers and Observations

- Scale of Things to Come:
  - Information:
  - Drivers of Digital Universe:
    - 70% of the Universe is being produced by individuals
    - Organizations (businesses, agencies, governments, universities) produce 30%
      - Wal-Mart has a database of 0.5 PB; it captures 30,000,000 transactions/day
    - The growth is uneven
      - Today the United States accounts for 41% of the Universe; by 2010, the Asia Pacific region will be growing 40% faster than any of the other regions

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Selected Societal Drivers and Observations

- Scale of Things to Come:
  - Information:
  - Drivers of Digital Universe:
  - Kinds of Data:
    - About 2 GB of digital information is being produced per person per year
    - 95% of the Digital Universe's information is unstructured
      - 25% of the digital information produced by 2010 will be images
    - By 2010, the number of e-mailboxes will reach 2 billion
      - The users will send 28 trillion e-mails/year, totaling about 6 EB of data

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Selected Societal Drivers and Observations

- Scale of Things to Come:
  - Information:
  - Drivers of Digital Universe:
  - Kinds of Data:
  - Interaction:
    - Today's interaction designed for point and click on individual items, groups(folders), and lists
    - Today's interaction assumes user knows subject, concepts within information spaces, and can articulate what they want
    - Today's interaction assumes data and interconnecting relationships are static in meaning over time
    - Today's interaction is one way initiated
    - Today’s interaction (WIMP) designed over 30 years ago

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The Pressures Produced by the Changing Digital Universe

- Organizations will need to develop information- (or data-centric) computing architectures
- The population with access to corporate information will become diffuse (Globalization)
- Information networks will grow to include sensor, surveillance, and identification data
- Information security and privacy will become paramount concerns
- In 2006, only 20-30% of the digital universe is subject to compliance rules and standards or security; by 2010 enterprises and organizations will have to worry about security, privacy, compliance, and reliability for about 85% of the Digital Universe

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What Does the Digital Universe Mean?

- Co-mingling of user-created and organization-managed information
- Network flows will prevail; information will continue to be unstructured
- Need for ever more sophisticated techniques for
  - Accessing
  - Classifying and Structuring
  - Managing
  - Securing
  - Searching
  - Organizing
  - Interacting

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How Do We Preserve Knowledge in the Coming Digital Universe

- Permanence of digital data
  - Accessibility
  - Preservation
  - Replacement – 10-year lifetime
- Scholarly information represented 0.37% of the digital information flow in 2003
- Is our collective memory becoming more inclusive but shorter?
- Interaction relies on classifying, searching and understanding
- Traditions: Recording information must give way to maintaining rational thought
- Visual analytics techniques become even more critical

Harnessing the Power of Digital Data (2008)
Interagency Working Group on Digital Data, National Science and Technology Council, Office of Science and Technology Policy

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Knowledge Management

Charles Hutton and the Gravitational Constant

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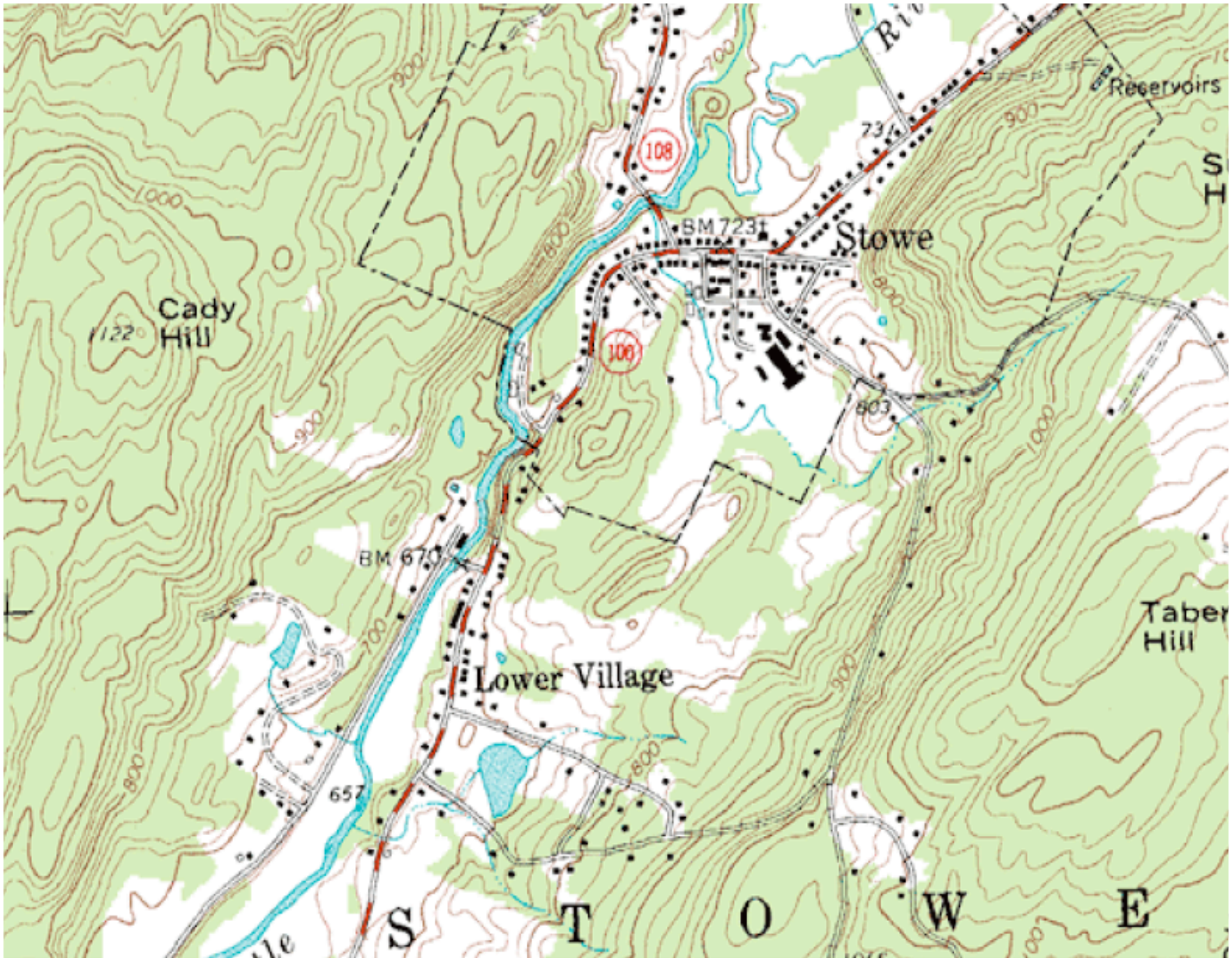
Reservoirs
108
BM 723
Stowe
Cady
Hill
1122
100
803
BM 670
Lower Village
657
Taber
Hill
S T O W E

Market Drivers

- *Old View*
  - Inventory Model
  - Warehouses, Databases
  - Permanence
  - Interrogation

- *New View*
  - Supply Chain Model
  - On-Demand
  - Perishability
  - Customization

DATA DELUGE

REAL (JUST IN) TIME DELIVERY

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Market Pressures

- *Problems/Challenges*
  - Vastness
  - Vagueness
  - Variety/Variability
  - Verifiability
  - Vintage
- *Opportunities*
  - Velocity
  - Visibility
  - Validity
  - Value

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Time, Space, and Place

- Enterprise of Information
- Reasoning
  - identity, location, context, sense, control, history
- Optimization Models
- Decision Theory

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Information Overload Made Simple

Dennis Overbye and Thermodynamics

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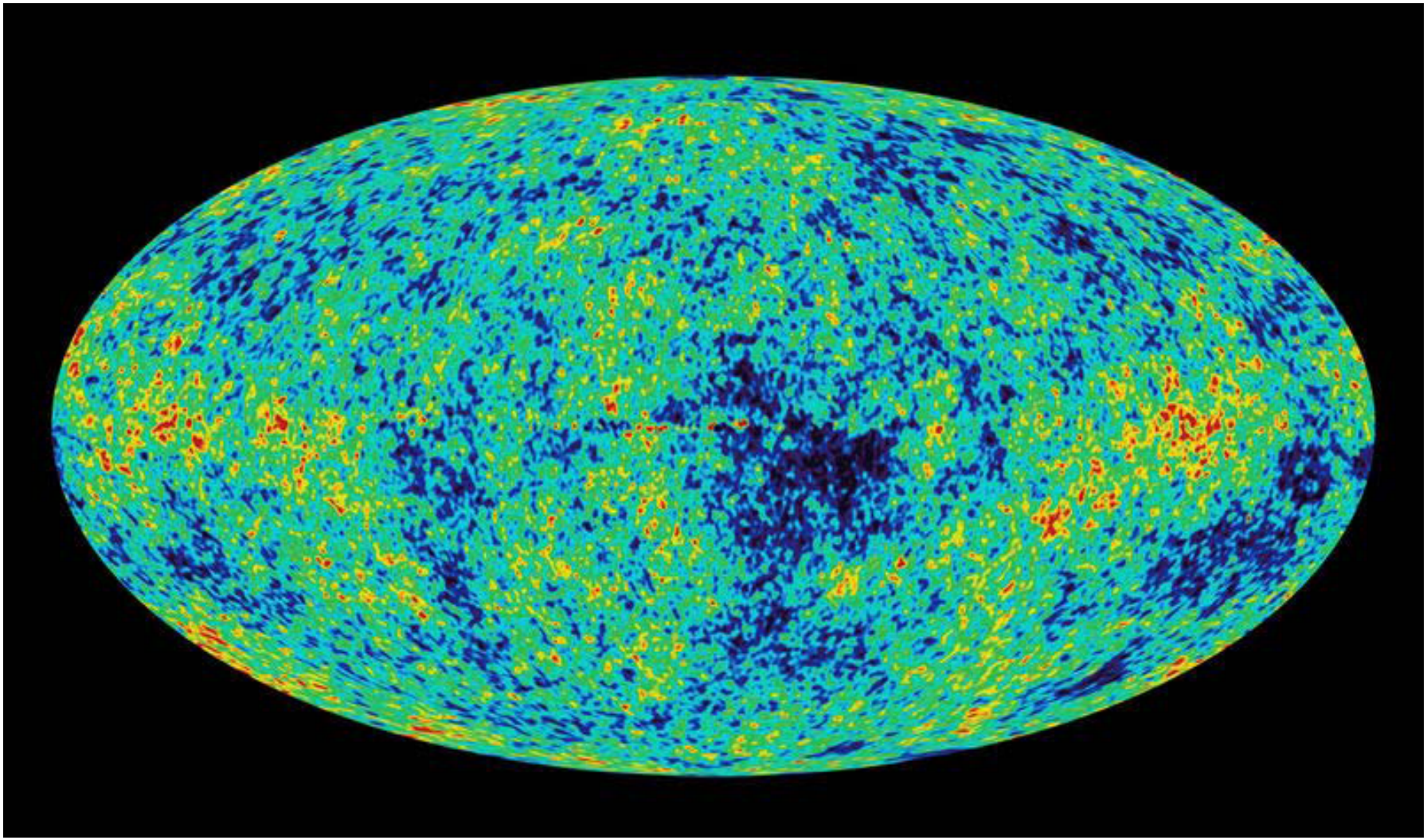

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Post-Modernism

Fundamental tenets:

Core feature is fundamentally linguistic-cultural beings

Objectivist-Rationalist Model

(Plato “fetishizing” representation and algorthmic reasoning)

holy trinity

Blank slate
Noble savage
Ghost in the machine

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The Post-Modernist Paradigm Shift

Wrong-headed Propositions:

- Duality
- World as text (or thought as language)
- Visual means bandwidth
- Representation and Objectivism
- Context for language
- Digital, algorithmic
- Culture determines perception

The comprehension of human sentences cannot be reduced to simply the algorithmic transformation of strings of symbols

John Searle – **Mind: A brief introduction**

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The Way Out - Neuroscience

Human cognition – A modern view:

Not Platonic, Cartesian but Aristotelian

Nonpropositional, embodied image schemas

Imagistic structures grounded in sensory-motor schemas

Perception

From representational models toward enacted, embodied models

Perception = Action = Cognition

Perception is not simply passive representation of the external world … but is inextricably bound up with embodied action

William James – **Pragmatism**

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Evolutionary Pressures

Architecture of the human brain:

- Finely tuned administration of an organism's behavior
- Fast and frugal heuristics
  - AI and robotics have taught us something
- Visual systems and task-relevant information
- Cognition implemented in multi-dimensional spatial formats
  - Lacking discrete symbolic representations

What we see at any given moment is a partially elaborated representation of the visual scene, only immediate relevant information is explicitly represented

Patricia Churchland – Neurophilosphy:
Toward a united science of the mind-brain

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Visual Analytics – What We Mean

Decision-making and judgment formation:

Automatic, image-based systems

Fast
Computationally frugal
Reliable

Pragmatic, embodied heuristics

Modal basis for knowledge

Analog = image
Digital = amodal symbol

Successive paradigms tell us different things about the population of the universe and about that population's behavior

Thomas Kuhn – **The Structure of Scientific Revolutions**

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Discrete Sciences

Charles Joseph Minard and Napoleon's March

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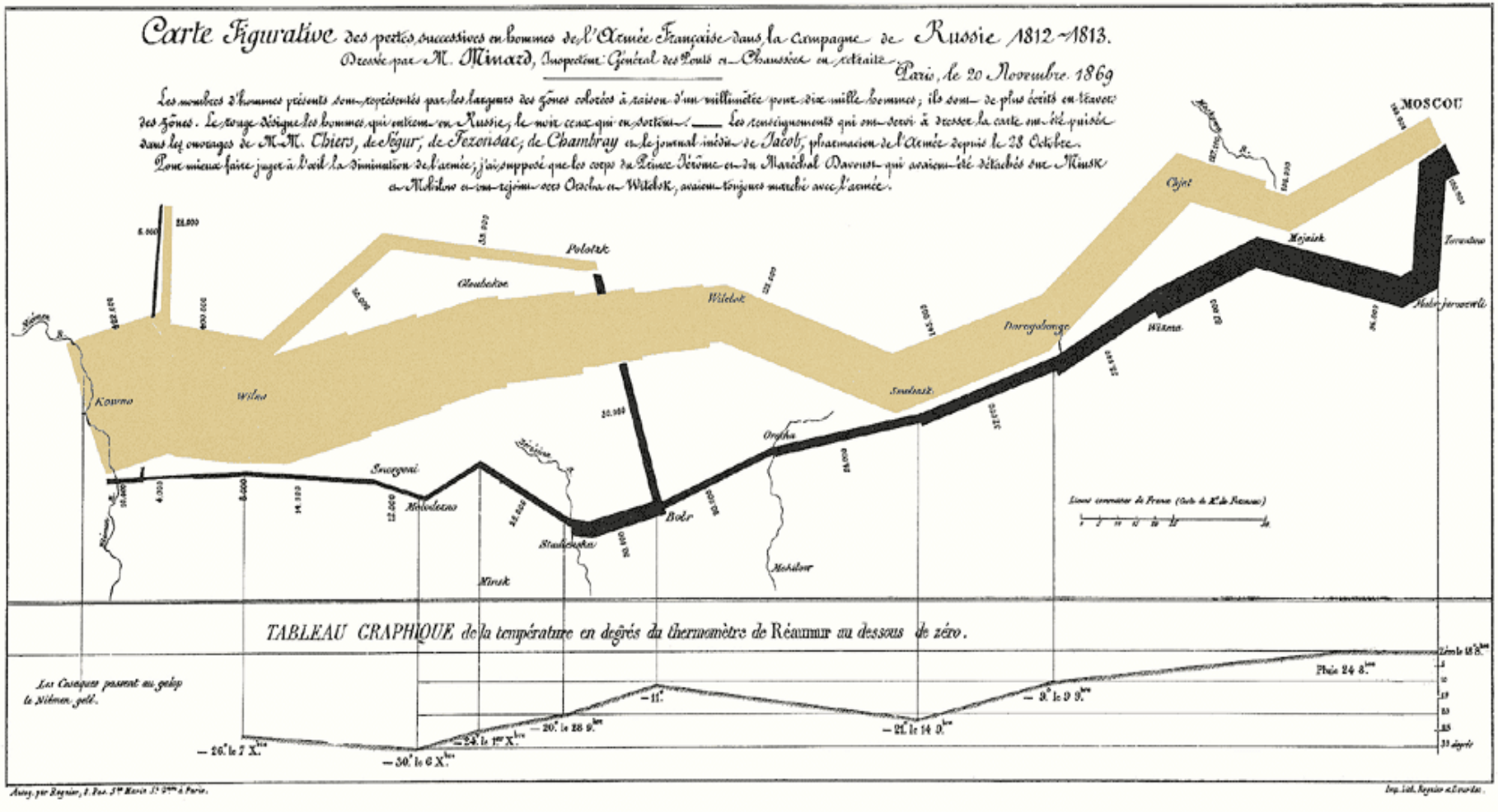

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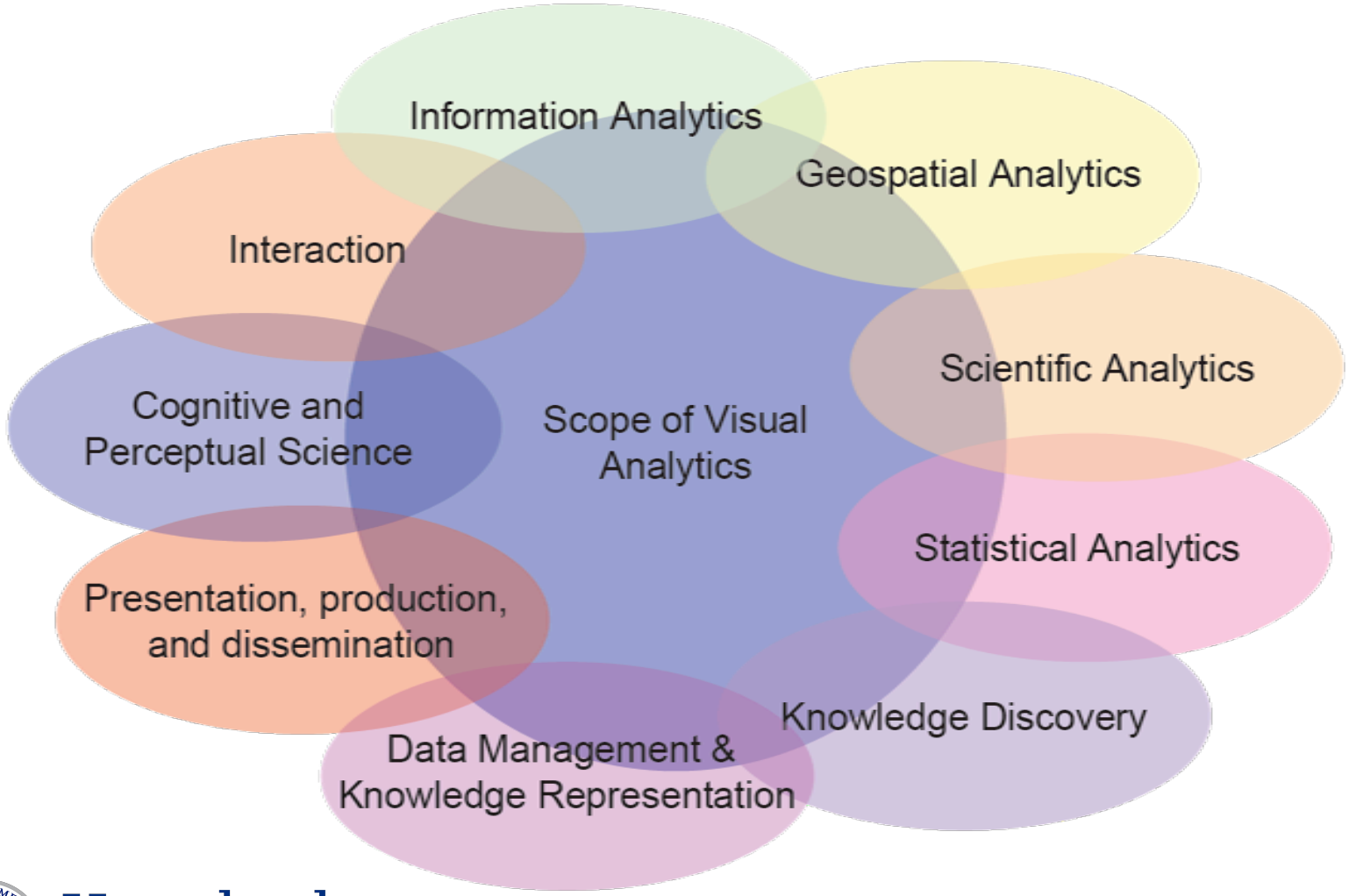
Scope of Research – Multi-Disciplinary



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Research Opportunities (1 of 2)

- **Dynamic, on-Demand Data Processing and Visualization**: Capability for real-time management, analysis, and visualization of selected data in multiple forms and from multiple, diverse sources. These techniques would automatically select, rank, and correlate only those data relevant for purpose-driven decision-making.
- **Hypothesis-driven Analysis**: This capability would include three elements: automated retrospective analysis of collected or extant data using pre-selected hypotheses; automated generation of alternative hypotheses by constant updating of data; and prospective analysis of potential risks and threats using data-derived hypotheses.
- **Visualization of Structured, Unstructured, and Streaming Data**: Capability for integrated visual analysis of free text, database records, audio, video, imagery, transactional data, geographical data, and sensor information. The focus on this effort is twofold: development of a single, scalable framework for visual analytics and establishment and validation of reliable performance metrics for visual processing of data.
- **Mathematics of Discrete and Visual Analytics**: Development of the mathematical foundations for discrete processing and simulation and for visual analytics. This will provide a rigorous scientific basis for future algorithm development.

Research Opportunities (2 of 2)

- **Scalable Filtering and Dissemination**: Techniques for secure, privacy-aware identification and dissemination of information among international, federal, state, tribal, and local agencies. This includes advanced methods, processes, and procedures that ensure sharing of information for immediate decision-making by multiple partners under a range of technical, political, and organizational parameters
- **Visualization and Simulation of Data**: Application of visualization techniques, discrete mathematics methods, and game theory to diverse information, including development of new approaches to simulating multiple threats or disasters.
- **Mobile and Light-Weight Information Analytics and Sharing**: Information discovery, dissemination, and decision-making tools capable of being tailored for diverse homeland security applications and software architectures. These techniques need to focus on a range law enforcement, public safety, public health, and emergency response applications.

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The Future World – Part 1

Necessary and Sufficient Conditions :

1. No personal computers; no WIMPS; that is, single-layer or flat interactions prevail
2. Access to tailored information is complete on public screens or on individual displays
3. Communications, information networks automatically, dynamically establish and maintain communities of interest
4. Interaction with information, data is mediated not by bandwidth but by cognitive properties
5. When a search for information is required, that search is enabled by images, graphs, multimodal forms

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The Future World – Part 2

Necessary and Sufficient Conditions for [Knowledge] Discovery:

1. [All] data, information from all disciplines, sources is available/accessible and indexed
2. [All] processes, controls are understood at a basic level (mature paradigm)
3. Modeling, simulation, gaming environments are more finely grained
4. Interactions become, replace experiments
5. Tailored collaborations are dynamically established, resourced

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The Precision Information Environment

- The Precision Information Environment represents a new way to engage first responders from multiple organizations and on multiple levels in preparing for and responding to homeland security incidents.
- It combines three-dimensional real world and synthetic world environments; GIS (geographical information system) capabilities; information, in the form of text documents, structured database records, video, images, audio, and instrumentation or sensor data; modeling and simulation capabilities; and visual analytics tools in a common, real-time interactive environment.
- The PIE is also tailorable to the user; that is, it operates on multiple levels, ranging from the large-scale situation room (or COP) to analyst workstations to laptops to portable, handheld devices with the precision necessary to provide that user with relevant, immediate information.
- This effort would rely on the visual analytics and discrete science tools and technologies being developed by BFR and would integrate them into a comprehensive yet common set of capabilities usable by tribal, local, state, as well as federal officials.
- So, the PIE will allow multiple individuals, from the state or national-scale incident commander to the public safety worker or emergency responder, to cooperate and collaborate and, more importantly, make specific decisions based on up-to-date and tailored information.

Precision Environments – Research Areas

Necessary and Sufficient Conditions for Precision Information Environments:

1. Synthetic world and real world co-exist, are co-equal
2. Physical and information spaces are co-existent
3. Modeling and simulation capabilities apply to both
4. Streaming, dynamic data are available, accessible in real-world time
5. Environment is tailored, suited for multiple user groups on a dynamic basis
6. Information spaces are multimodal
7. Multiple users and manifold uses are managed simultaneously

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Visualization and Analytics

James Watson
and T7 Phage

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How to Approach the Future

- "The List"
- What's In and What's Out
- FYs 2004 – 2008 and FYs 2009 – 2013
- The Old and the New
- Accomplishments and Vision

References

Jorge Luis Borges – from **The Garden of Forking Paths**
to **Shakespeare's Memory**
Steven Pinker – **The Stuff of Thought**

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Past

Reading List
VAC Map
NVAC Advisory Board
Homeland Security
End of Post-Modernism
Funding Increase – Arithmetic
Digital Data – 1 ZB
Tools
Analytical
Data Deluge
Globalization
Analyst
Consortium
Massive Data
Demonstrations
VAC Wall
Dashboard
Broadest Bandwidth
Decisions
Links
Private Device
Human-Machine Interaction

Future

Reading Assignment
International Map
International VAIE Advisory Board
Global Security
Big/Deep History
Funding – Geometric
Digital World – N/A
Environment
Prospective, Predictive
The Library of Babel
Multi-lateralism
Homeland Security Professional
VIEWork
Precise Data
R2R
VAC: the Series
PIEs
Cognitive/Perceptual Science
Critical Judgments
Actions
Public Information
Human-Data-Model Interaction

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VAC Map

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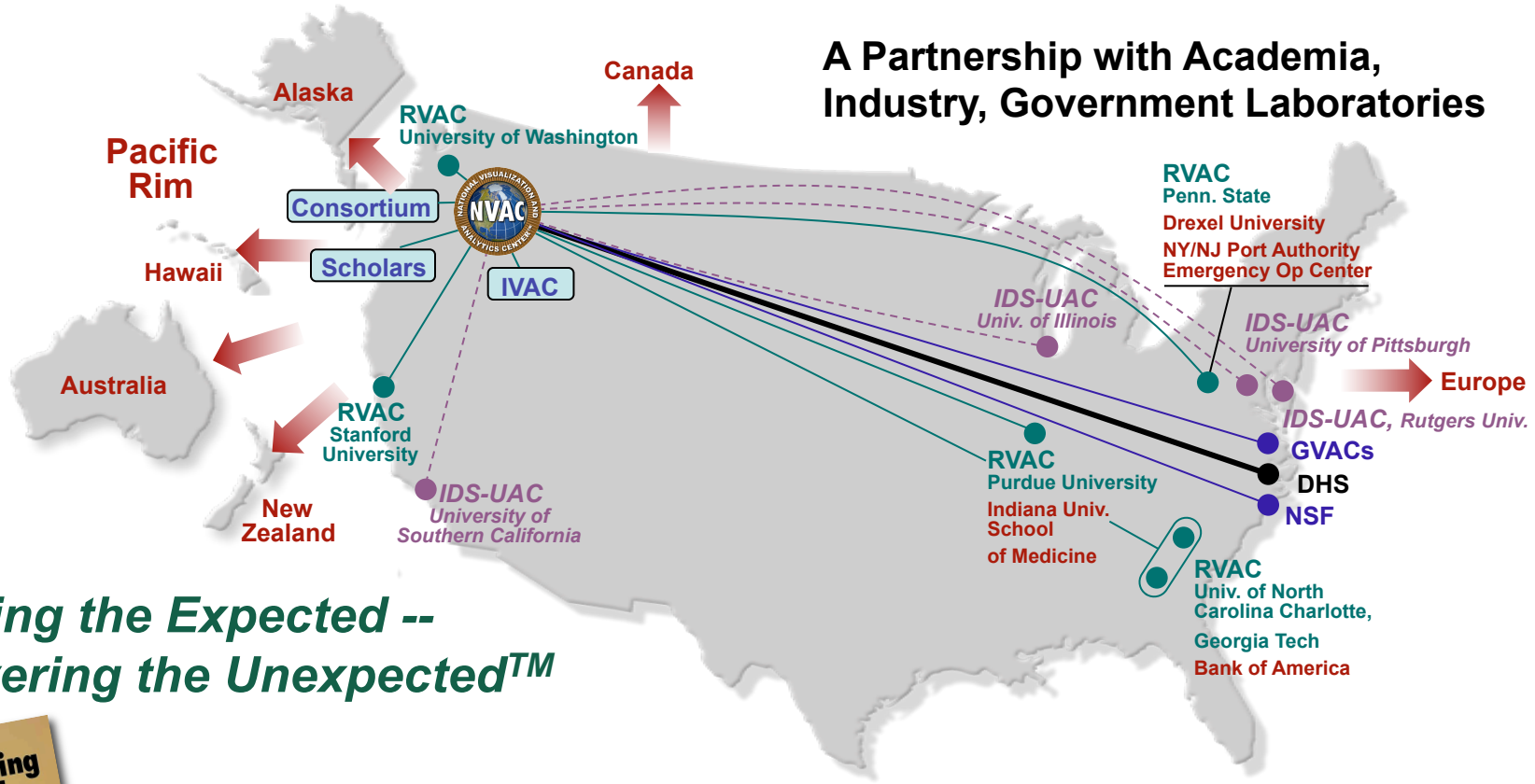
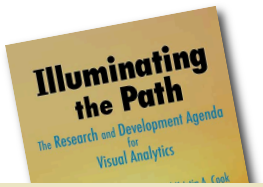
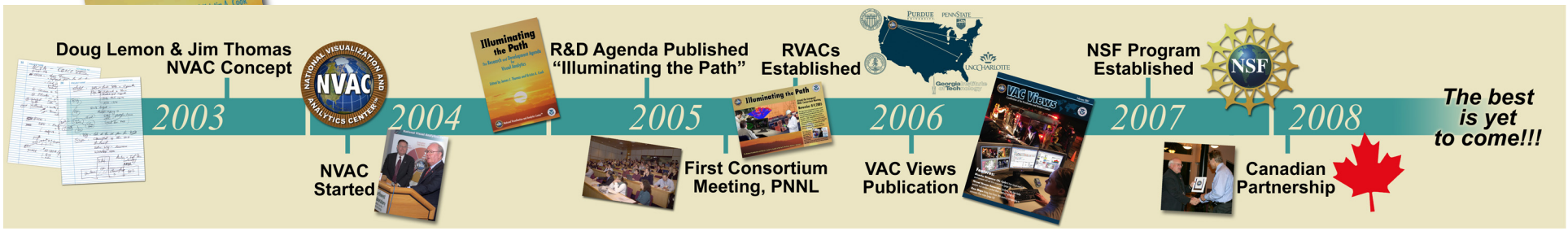


Detecting the Expected -- Discovering the Unexpected™





International Map

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Funding Increase - Arithmetic

FYs 2004-2008

DHS Investments

• NVAC for 5 years @ $4M/yr	$20M
• RVACs (5) for 3 years @ $4M/yr	$12M
• IDS UACs (4) for 2 years @ $3.4M/yr	$6.8M
• FODAVA for 1 year @ $750k/yr	$0.75M
• Total DHS Investments	$40M

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Funding – Growing Interest

2008 VAST

- Publications:
  - Submissions 70
  - Published 21

- Contributions
  - US Government Agencies:
  - DHS
  - IARPA
  - NSF
  - NIH
  - DoE
  - NGA
  - NIST

- International Contributions
  - Germany
  - China
  - India
  - Switzerland
  - Italy
  - Austria
  - Spain
  - Netherlands
  - Croatia
  - New Zealand
  - Australia
  - Ireland
- Industry
  - Tableau
  - Oculus
  - IBM
  - NVIDIA
  - Microsoft
  - SPADAC
  - PalantirTech
  - Vision Systems Inc

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Funding – Investments

VAST 2008

Investments in Kind

• 70 submissions @ 1 FTE @ $250k	$20M
• 73 contest entries @ $100k	$7.3M
• 10 Posters @$150k	$1.5M
• 8 Industry papers @ $500k	$4M
• Total – Technical Publications	$33M
• Total – Submitted Work	$130M

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Funding – Joint Programs

FODAVA (NSF)

- 5-year Joint Program @ $1.5M/yr $7.5M

Canada

- DRDC Cooperative Activity Agreement

Germany

- BMBF Agreement

European Union

- European Commission Framework 7

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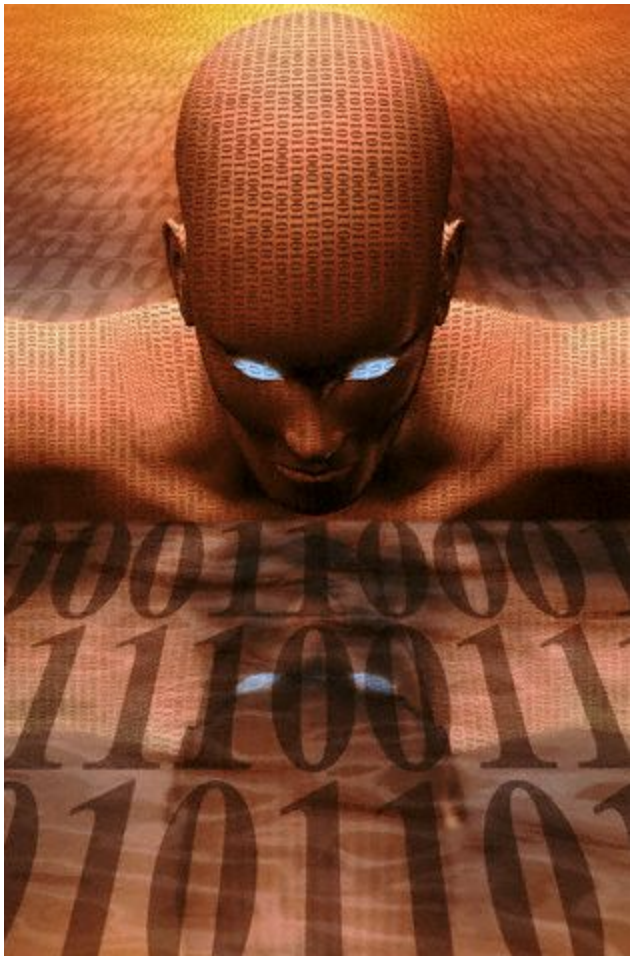
- In 2006, the amount of digital information created, captured, and replicated was 161 EB
- In 2010, the amount of information added annually to the digital universe will be about 988 EB (almost 1 ZB)
- About 2 GB of digital information is being produced per person per year
- 95% of the Digital Universe's information is unstructured
  - 25% of the digital information produced by 2010 will be images

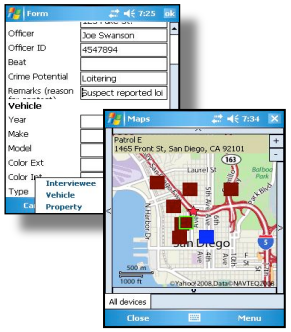
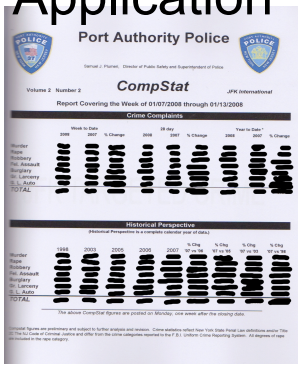
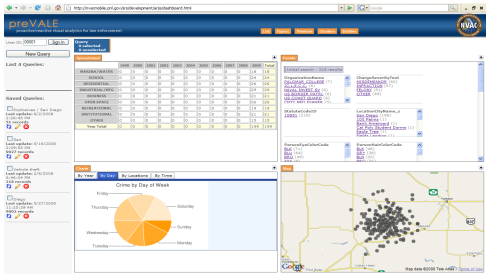
Homeland Security

Digital World



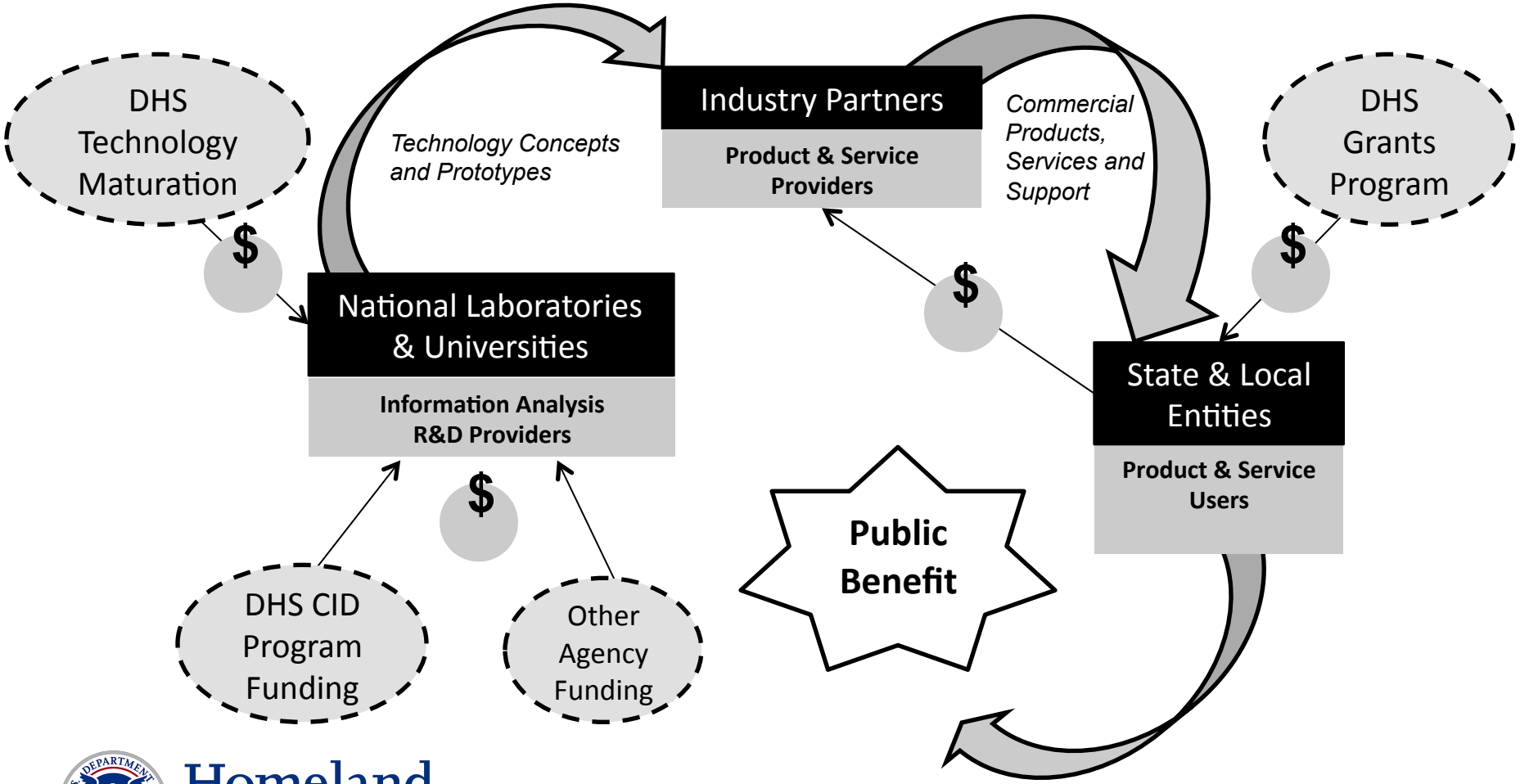
Homeland Security

Demonstrations

LEIF Solution Suite		
Mobile Awareness	Commanding Officers Application	preVALE
		
ARJIS	PANYNJ	ARJIS
Seattle	ARJIS	PANYNJ

Homeland Security

Research to Reality (R2R) Technology Transition Model



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Digital Data – 1 ZB
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Homeland Security

Analytic Cycle Project Map

Visual Analytics Centers and Programs
March 2008 Compendium

Key
NV: NVAC/PNNL
PS: Penn State
PD: Purdue
SF: Stanford
UG: UNCC/GT
UW: U. of Washington
IL: U. of Illinous
PT: U. of Pittsburg
RU: Rutgers
US: USC

Projects are listed once, while they often could be in multiple places

Vertical order has no implications
e.g. Geospatial supports National Missions

SIMULATION
UW2: JITC3, AR responders
UW1: RimSim, Simulation

FINANCE
UG7: Financial Analytics

DATA BASE
UC3: Information Store

TEMPORAL
SF3: Scalable Temporal Databases
PD13:Temporal Disease Surv.

SURVEILLANCE
PD8: Surveillance:video
PD9: Smart Video Surv.
PS10: Geo NewsWire

SENSOR
RU7: Nuclear Sensor Detection
RU6: Inspection Algorithms
RU9: Entropy Bio-surveillance

MOBILE
PD4: Mobile CCI
NV5: SRS-Mobile
PD6: In-Field Mobile

ANIMAL AND HUMAN HEALTH
PD11: Zoonotic Disease Spread
PD12: Animal Health
PS8: Health GeoJunction

HETEROGENOUS/IR
NV14: Synthesis
NV17: Audio
SF2: Heterogenous Info Spaces
IL1: Search Paradigms, IR

MULTIMEDIA
UG8: ResultMaps
UG4: Multimedia Analytics

CYBER
SF5: IRIS Scalable Network Security
PD14: Network Flow Security
UC5: E-mail Org and People Analytics

CYBER
IL4: Deep Web Analytics
SF1: Scalable Transactional Analytics
RU1: WEB/Virtual Communities

GEOSPATIAL
PS12: GeoViz Toolkit
PS11: Improvise
PS15: ConceptVista
PS13: CiteSpace
PS7: Geo-Info Retrieval

GEOSPATIAL/IMAGE
PS9: Visual Computation
PS1: Geo-Knowledge
IL6: Image Analytics
UC1: Geospatial Multiple Media

OUTREACH AND EDUCATION
NV4: Education
RU11: New Jersey Outreach
NV1: Consortium
RU12: K-12 Education
PD15: Education Initiative
RU13: Undergraduates
RU5: Lab for Port Security
UG9: Digital Library
RU14: Summer Reconnect Conf
IL8: Data Science Summer Inst.
NV2: Conferences

IMAGE/VIDEO
UG5: Image/Video Theme/Temporal Analytics

GRAPH AND REASONING
SF4: Perceptual Efficiency
RU10: Semantic Graphs
RU3: Learning Decision Making
UC4: Context Based Trust
PD10: Social Networks
IL5: Streams, link analytics
PS14: SemanticNetSA

GRAPH AND REASONING
UG1: Reasoning Decision Making
NV9: Semantic Graphs
NV16: ProSPECT
UG2: STAB: Investigative Analytics
RU1: Universal Information Graphs

REGIONAL
NV6: Law Enforcement
PS16: NeoCities
UW3: Medical Supply Analytics
PD5: Personnel Tracking
PD3: Disaster Response
RU4: Law Enforcement, Stat. Graphics
PD7: Mobile: Emergency Response
UW4: Coast Guard Command VA

PRIVACY
PD2: Privacy and Anonymized Data
RU8: Privacy Preserving Models

TEXT
PS2: Extraction
PS3: Fact Extraction
PT2: Extraction Opinion
PS5: Context Discovery
IL3: Contextual Text Analytics
UC2: Patterns in Text
UC4: Context Based Trust
PT3: Information Extraction
PT1: Opinion/Sentiment Analytics

VISUAL COMMUNICATION
NV13: Active Products

TEXT
PS6: TexPlorer
NV18: IN-SPIRE
NV12: Un/Str Text Analytics

DATA INGEST
NV19: UPA
NV15: First Look
PD1: Data Integration

EVALUATION
NV7: Threat Stream Generator
NV8: Evaluation

NATIONAL
PS4: FEMARepVIZ
NV11: Assessment Wall
IL7: Monitoring People/Events
UG3: Global Terrorism DB Analytics
NV10: Electric Power Grids
UG6: JIGSAW, Investigative Analytics

MATH/SEMANTIC FOUNDATIONS
NV3: NSF-FODAVA

Data Ingest Preparation → Data Representation & Transformation → Visual Exploration and Analytics → Dissemination and Collaboration

Homeland Security

Homeland Security Professional

- Department of Homeland Security
  - 22 components, 7 operational agencies
  - 215,000 personnel
- Federal Government Partners
  - 15 Intelligence Community agencies
  - 11 Law Enforcement Community agencies
  - 350,000 personnel
- Tribal, Local, and State Partners
  - 80,000 public safety, public health, emergency response, law enforcement agencies
  - 750,000 homeland security practitioners
  - 2.3 million extended personnel

Homeland Security

Homeland Security

- Terrorism
- Natural Disasters
- Manmade Disasters

Homeland Security

Global Security

- Slow Catastrophes
  - Food
  - Energy
  - Environment
  - Economic Stability
- Commodity Security
  - Oil
  - Water
  - Other Natural Resources
- Climate Change

Homeland Security

Consortium

Homeland Security

VIEWork

Industry Consortium

Examples

- MCC – Microelectronics and Computer Technology Corporation (1982 – 2000)
- Sematech (1988 – present)

Features

- Member/Partner Contributions
- Government/Industry Partnerships
- Shared Resources/Shared Results/Exclusive Rights
- Managed for Profit

Homeland Security

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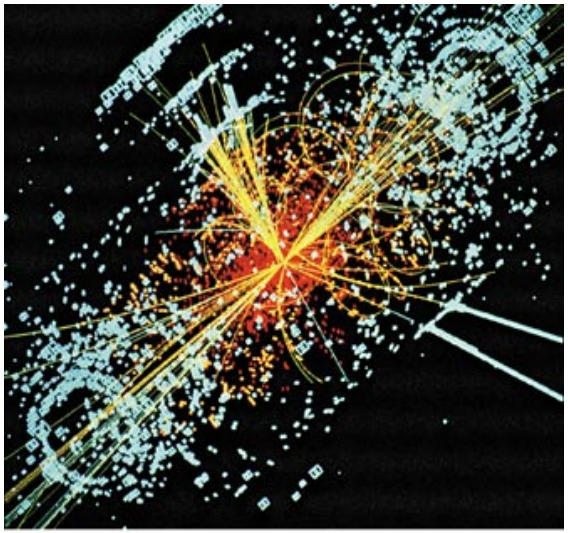
Data Deluge



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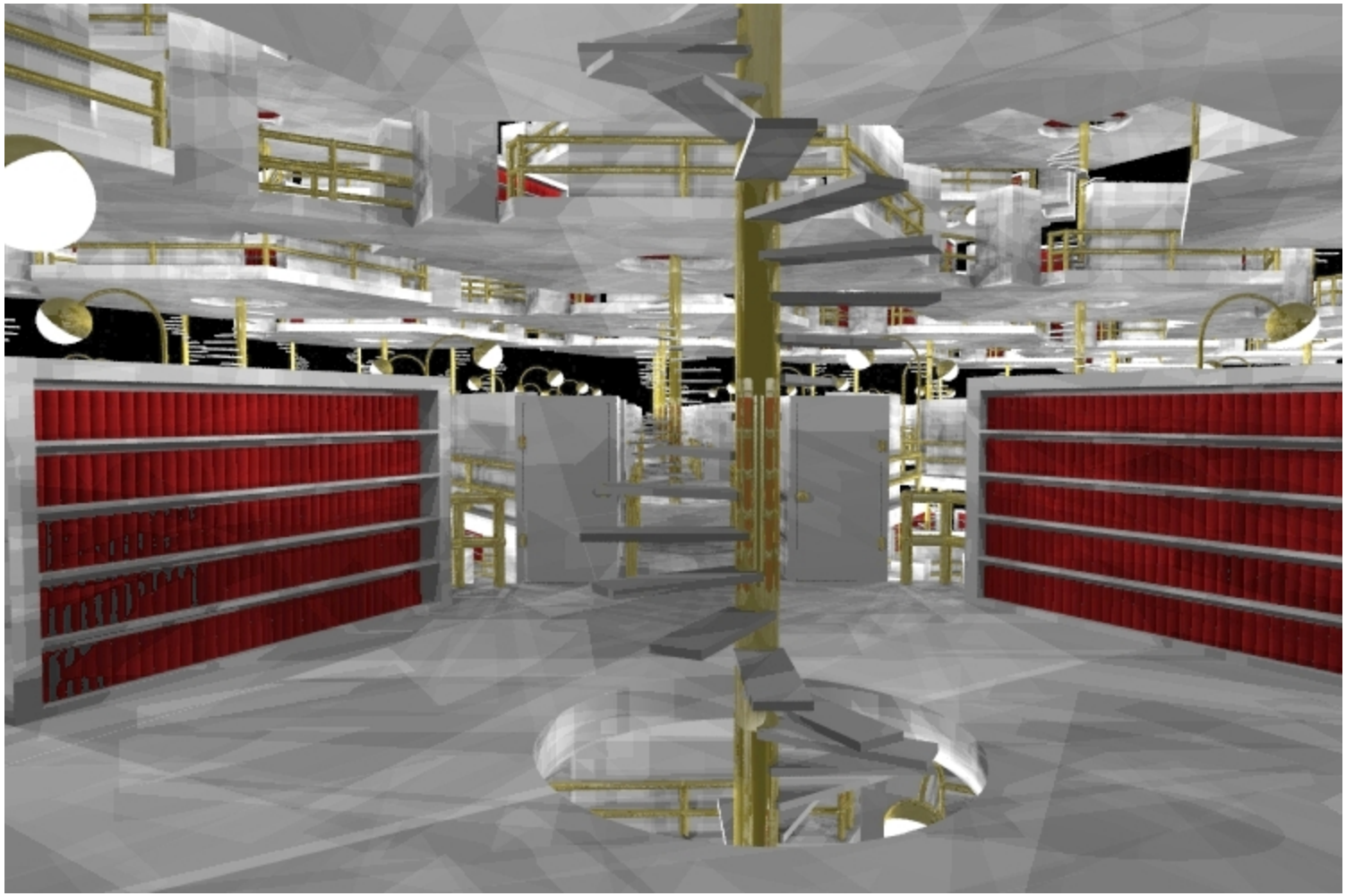
The Library of Babel



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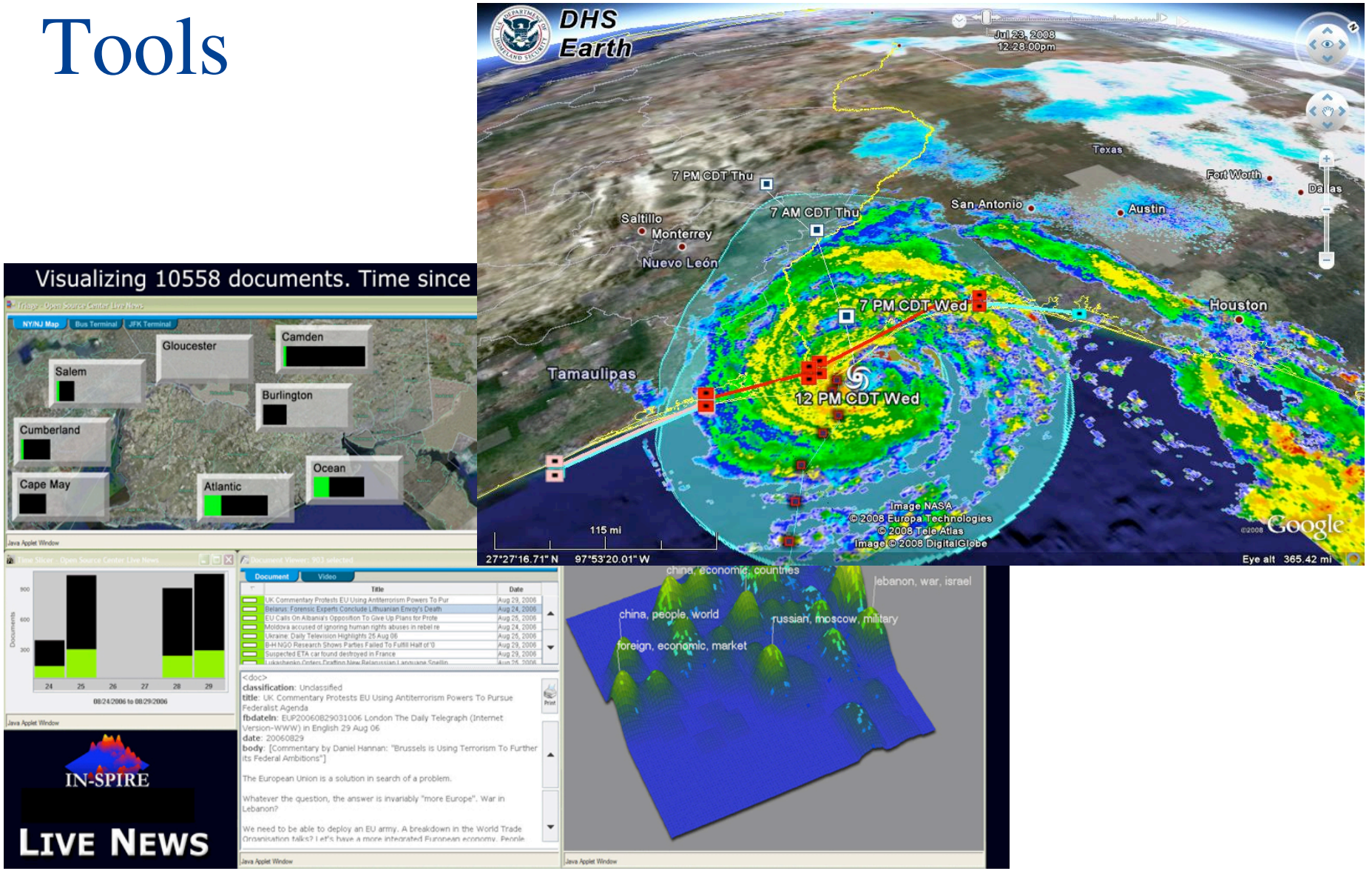
Tools



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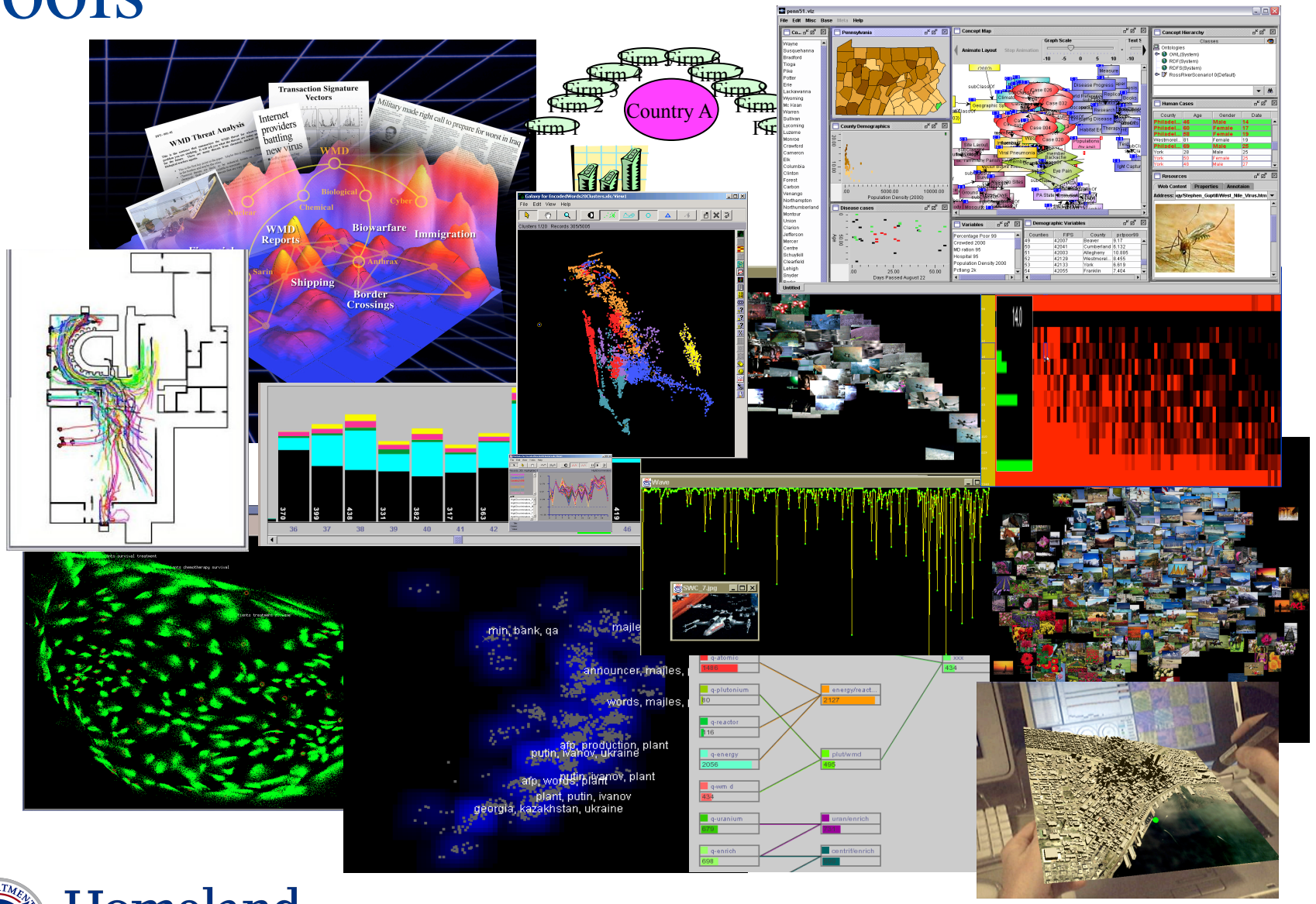
Tools



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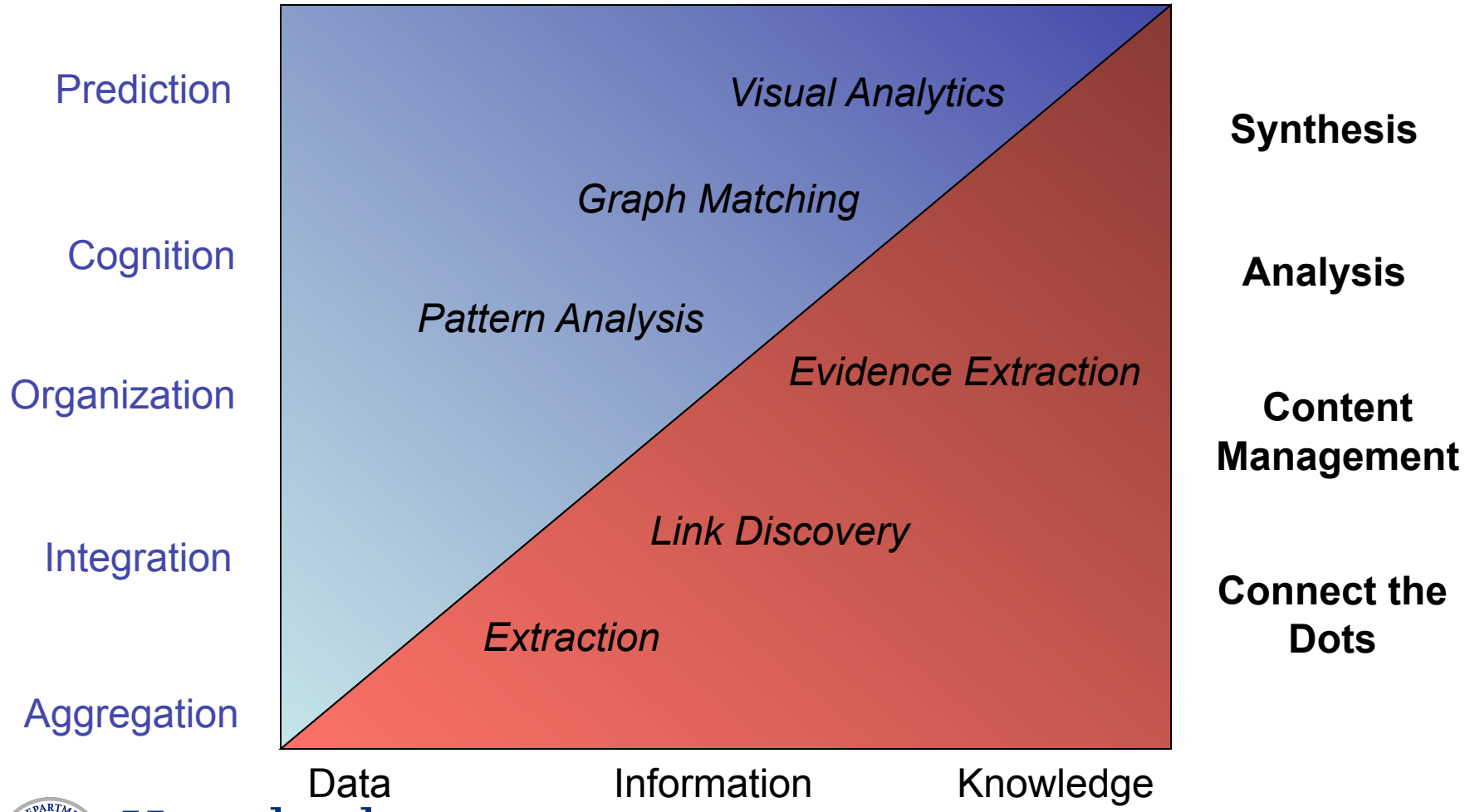
Environment

Homeland Security

Analytics



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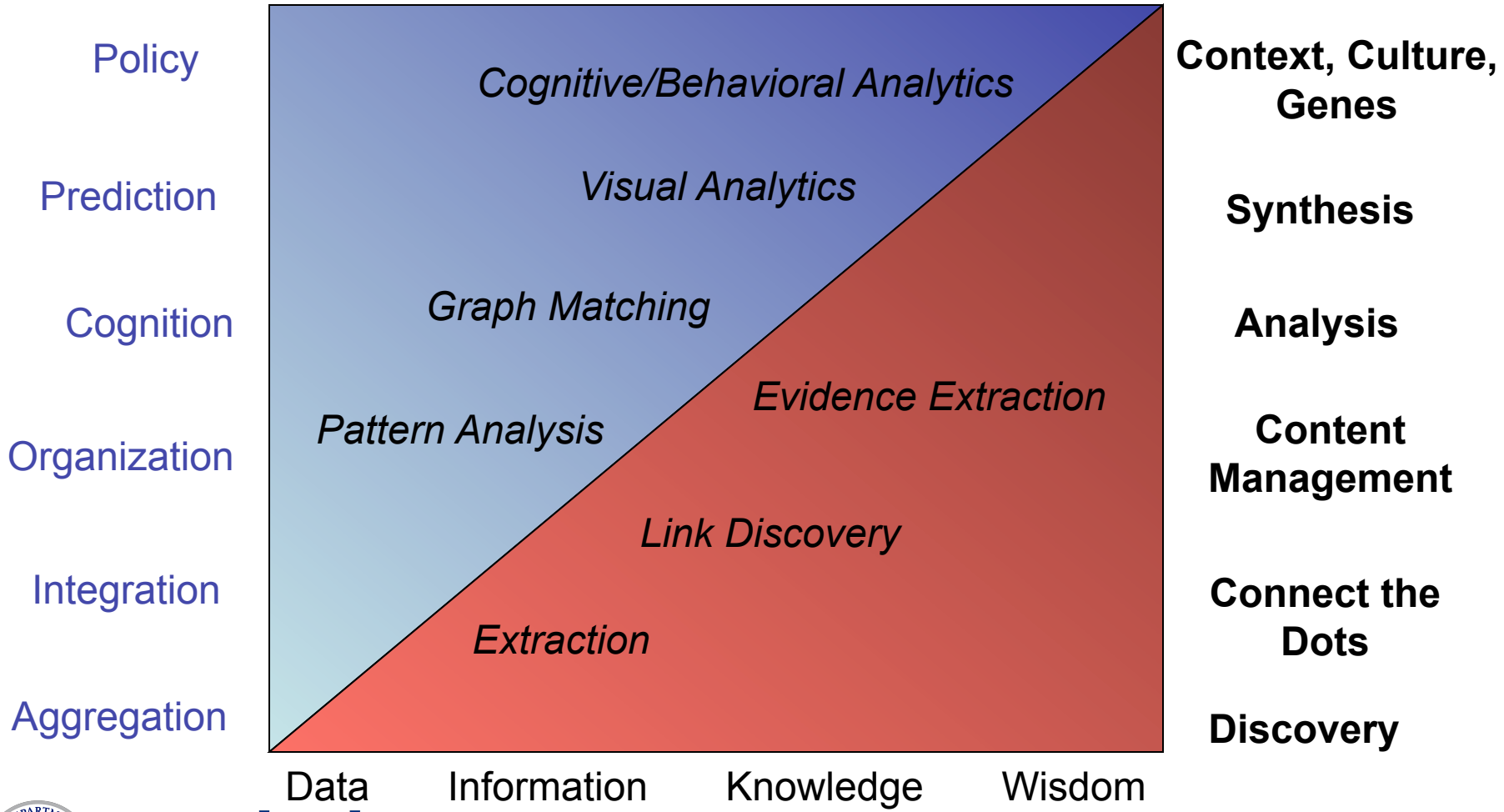
Predictive, Prospective



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- Richard Rubenstein – **Aristotle's Children**
- Charles Freeman – **The Closing of the Western Mind**
- Ronald White – **Lincoln's Greatest Speech**
- Anthony Kenny – **Medieval Philosophy**
- John Derbyshire – **Unknown Quantity**
- Dennis Overbye – **Lonely Hearts of the Cosmos**
- Daniel Smail – **On Deep History and the Brain**
- Ian Ayres – **Super Crunchers**
- David Christian – **Maps of Time: an introduction to big history**
- Edward Slingerland – **What Science Offers the Humanities**
- Steven Pinker – **The Blank Slate**
- Thomas Kuhn – **The Structure of Scientific Revolutions**
- E.O. Wilson – **Consilience: the unity of knowledge**
- Louis Menand – **The Metaphysical Club**
- John Searle – **Mind: a brief introduction**
- William James – **Pragmatism**
- Patricia Churchland – **Neurophilosophy: toward a united science of the mind-brain**
- Joan Magretta – **What Management Is**
- Paul Seabright – **In the Company of Strangers**
- Jeremy Gray – **The Hilbert Challenge**
- Nicholas Ostler – **Empires of the Word**
- Alan Weisman – **The World Without Us**
- Alexander Pope – **Essay on Criticism**
- Emily Dickinson
- Robert Browning
- A bunch of Greek philosophers

Homeland Security

Reading Assignment

SELF-STUDY

The man who acquires an encyclopedia does not thereby acquire every line, every paragraph, every page, and every Illustration; he acquires the *possibility* of becoming familiar with one and another of those things. If that is the case with a concrete, and relatively simple, entity, then what must happen with a thing which is abstract and variable – *ondyant and divers*?

Jorge Luis Borges
Shakespeare's Memory

Homeland Security

Where Shall We Head?

To speak is to commit tautologies

Jorge Luis Borges
The Library of Babel

Homeland Security

Divining the Future

Homeland Security

The Future of Analytics

a
World-wide Enterprise
in
Science and Technology
for
Cognitive Analytics (Philosophical Analytics, Cognitive Philosophy),
Which provides
Precisely Tuned
Knowledge
for
Assuring
the
[Quality of] Existence
of
Individuals, Communities, Societies, Cultures, Countries,
and their
Physical World

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The Future Is (Y)ours

Homeland Security

Emily Dickinson

Time and Eternity

Homeland Security

Homeland
Security

Homeland
Security

CCI Mission Space

Division Mission: Through a practitioner-driven approach, CCI creates and deploys information resources to enable seamless and secure interactions among homeland security stakeholders

- A practitioner-driven approach is defined as a process where the needs of end-users drive the creation of information resources
- Information resources include standards, frameworks, tools, and technologies
- Enabling seamless and secure interactions means enhancing the ability to communicate, share, visualize, analyze, and protect information
- Stakeholders include all local, tribal, state, Federal, international and private entities engaged in homeland security

DHS Drivers: OI&A, OIP, FEMA, ICE, CBP, USCG, S&T; federal, state, and local public safety, health, law enforcement, and emergency response organizations; NSF, ODNI, CIA, and NSA; DRDC, BMBF

End-Users: OI&A, OIP, FEMA, ICE, CBP, USCG, S&T; federal, state, and local public safety, health, law enforcement, and emergency response organizations

Homeland Security

Challenge

My Last Duchess

by Robert Browning

That's my last Duchess painted on the wall,
Looking as if she were alive. I call
That piece a wonder, now: Frà Pandolf's hands
Worked busily a day, and there she stands.
Will 't please you sit and look at her? I said
'Frà Pandolf' by design, for never read
Strangers like you that pictured countenance,
The depth and passion of its earnest glance,
But to myself they turned (since none puts by
The curtain I have drawn for you, but I)
And seemed as they would ask me, if they durst,
How such a glance came there; so, not the first
Are you to turn and ask thus. Sir, 't was not
Her husband's presence only, called that spot
Of joy into the Duchess' cheek: perhaps
Frà Pandolf chanced to say, 'Her mantle laps
Over my lady's wrist too much,' or 'Paint
Must never hope to reproduce the faint
Half-flush that dies along her throat:' such stuff
Was courtesy, she thought, and cause enough
For calling up that spot of joy. She had
A heart -- how shall I say? -- too soon made glad,
Too easily impressed; she liked whate'er
She looked on, and her looks went everywhere.
Sir, 't was all one! My favour at her breast,
The dropping of the daylight in the West,
The bough of cherries some officious fool
Broke in the orchard for her, the white mule
She rode with round the terrace -- all and each
Would draw from her alike the approving speech,
Or blush, at least. She thanked men, -- good! but thanked
Somehow -- I know not how -- as if she ranked
My gift of a nine-hundred-years-old name
With anybody's gift. Who'd stoop to blame
This sort of trifling? Even had you skill
In speech -- (which I have not) -- to make your will
Quite clear to such an one, and say, 'Just this
Or that in you disgusts me; here you miss,
Or there exceed the mark' -- and if she let
Herself be lessoned so, nor plainly set
Her wits to yours, forsooth, and made excuse,
-- E'en then would be some stooping; and I choose
Never to stoop. Oh, sir, she smiled, no doubt,
Whene'er I passed her; but who passed without
Much the same smile? This grew; I gave commands;
Then all smiles stopped together. There she stands
As if alive. Will 't please you rise? We'll meet
The company below then. I repeat,
The Count your master's known munificence
Is ample warrant that no just pretence
Of mine for dowry will be disallowed;
Though his fair daughter's self, as I avowed
At starting, is my object. Nay, we'll go
Together down, sir. Notice Neptune, though,
Taming a sea-horse, thought a rarity,
Which Claus of Innsbruck cast in bronze for me!

Insight and Precision

Despite the limited insights that an individual can gain into his (or another's fate), there is also a way in which the vast interaction of the Trojan War can be plotted with almost mathematical precision, as if it were an extremely complex and elusive algebraic formula in game theory. It is this formula that Homer means to reveal to us, a deliriously elaborate three-dimensional [or four-dimensional] portrayal of human affairs, which can show us just how each rounded figure has played his or her part and how each one's part has interacted with the others' parts to make the story that we have. Homer, therefore, intends to offer us prognostication in reverse, insight after the fact.

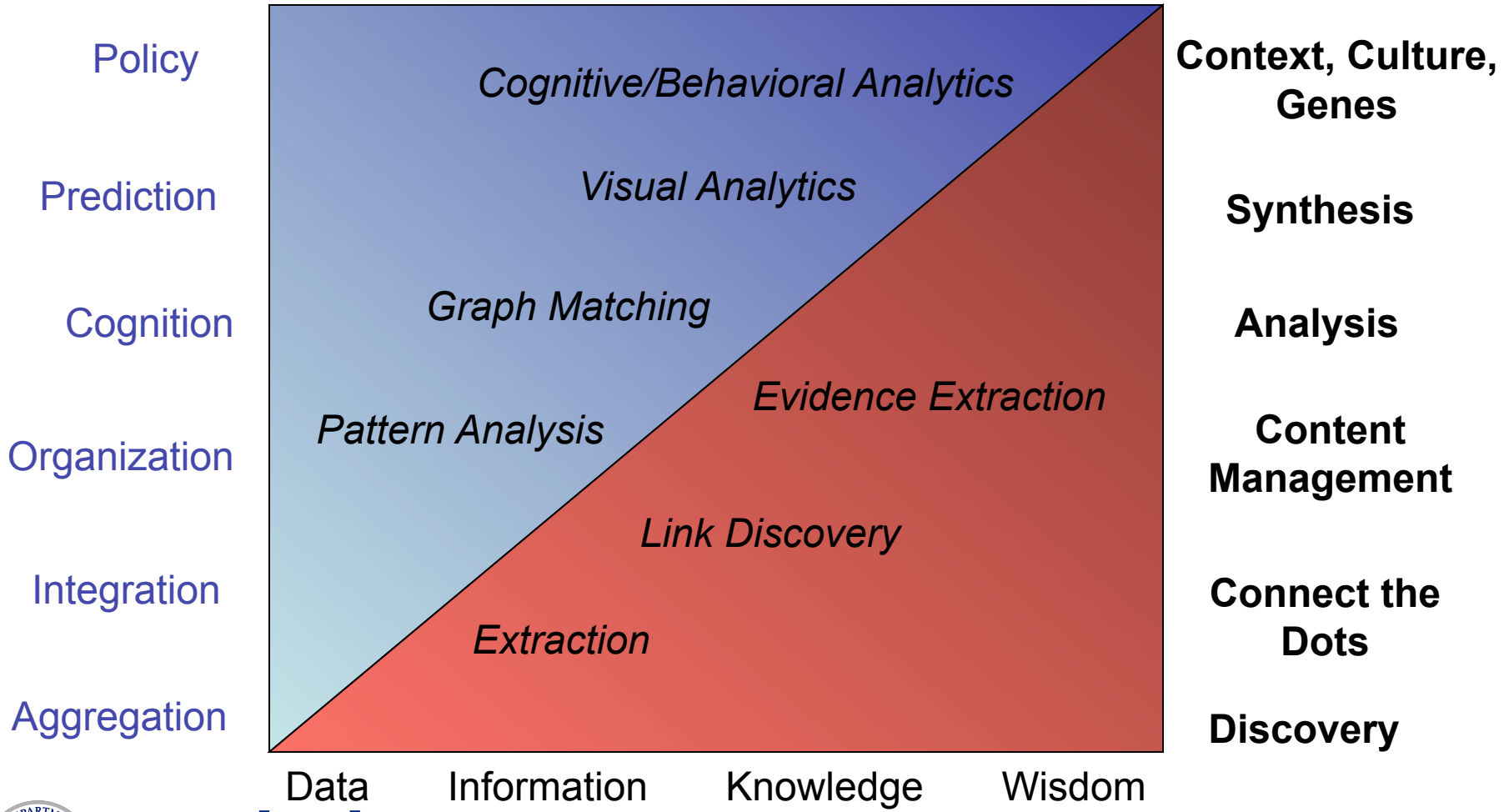
Thomas Cahill
Sailing the Wine-Dark Sea

Homeland Security

Homeland
Security

Homeland
Security

Predictive, Prospective Analysis



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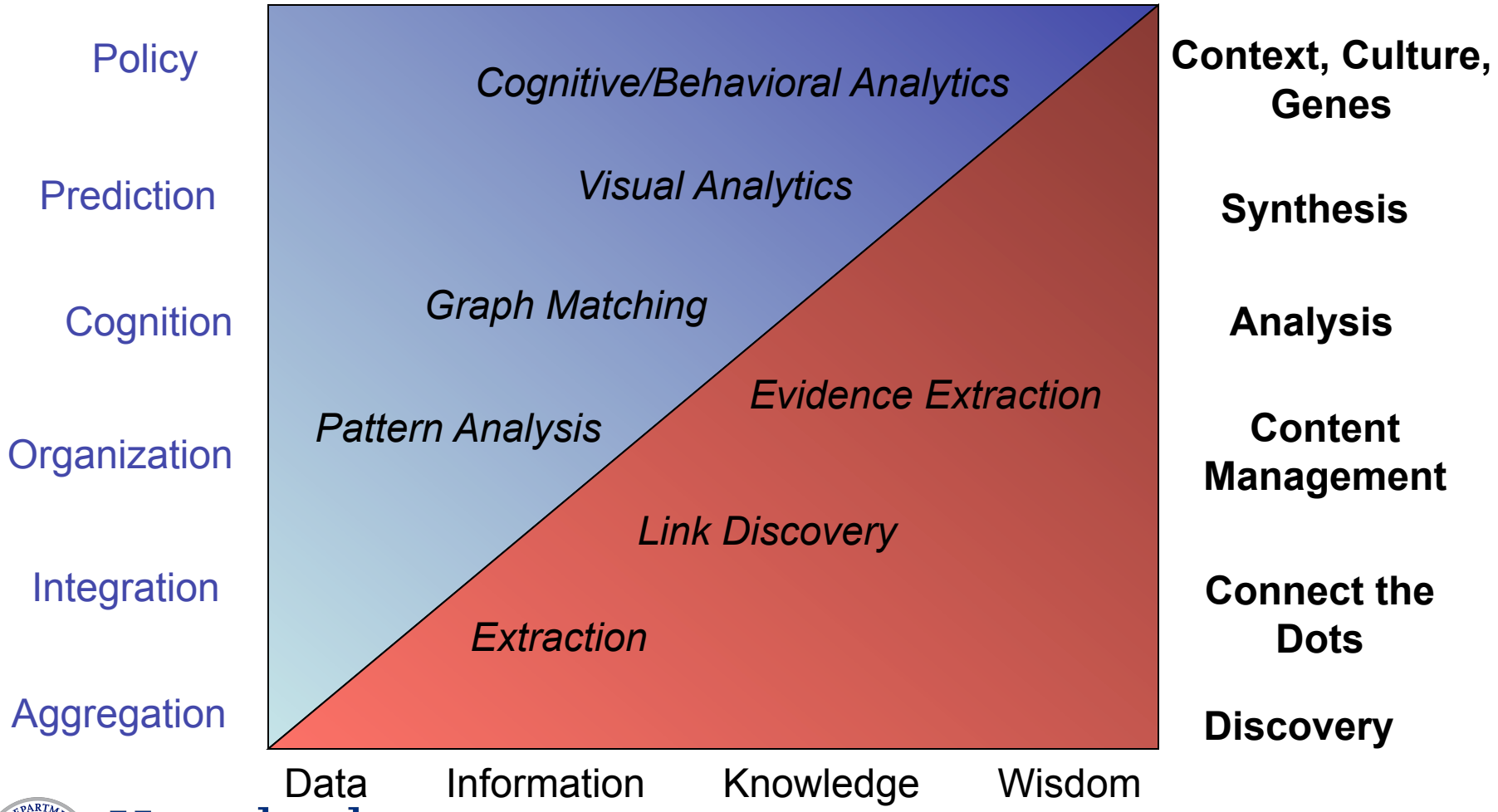
Predictive, Prospective



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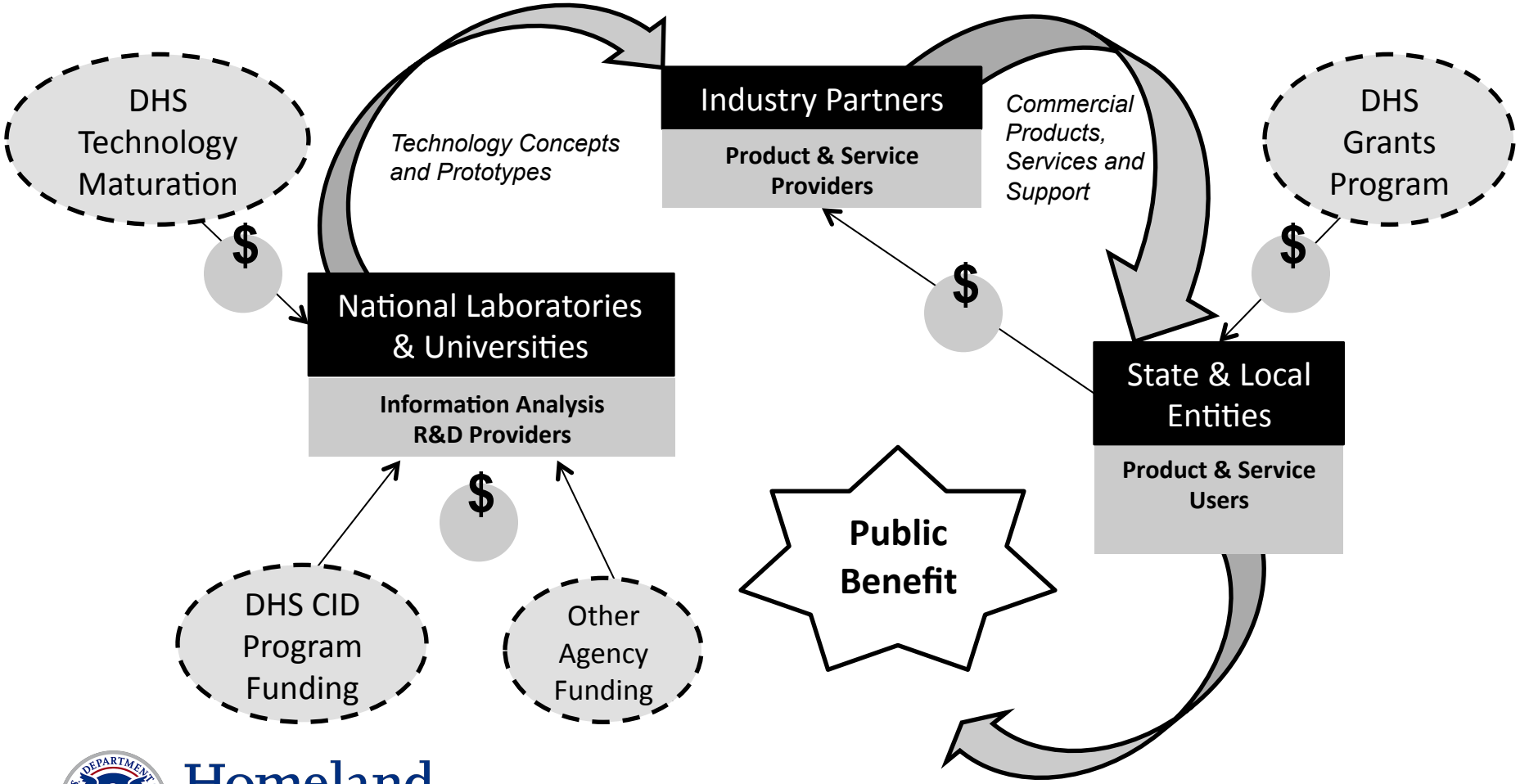
Research to Reality (R2R) Technology Transition Model



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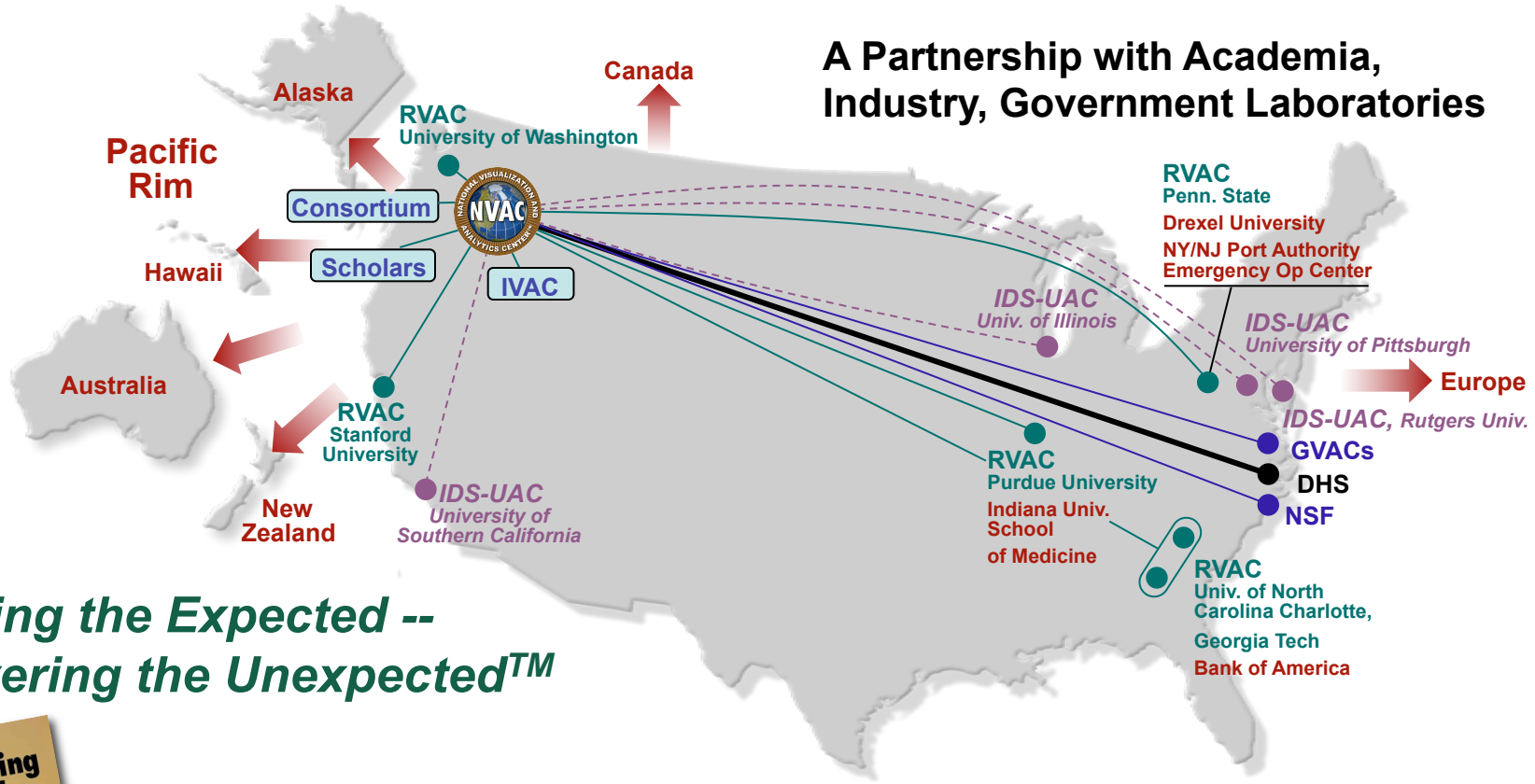
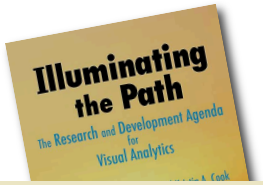
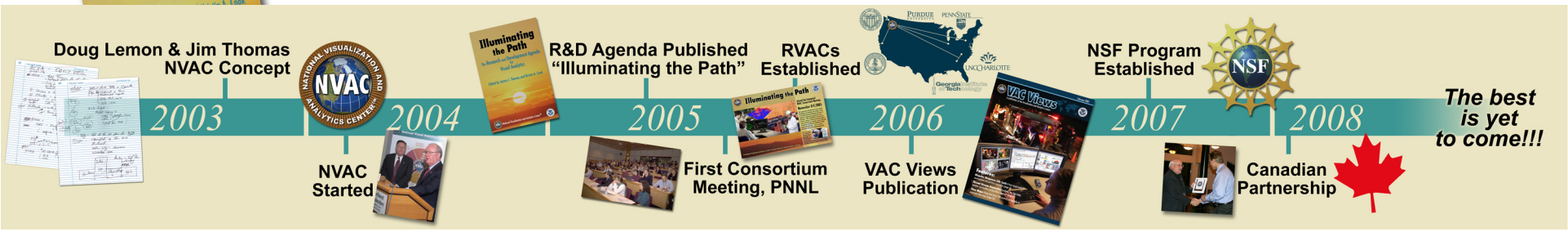
The VAC Enterprise

Homeland Security



Detecting the Expected -- Discovering the Unexpected™

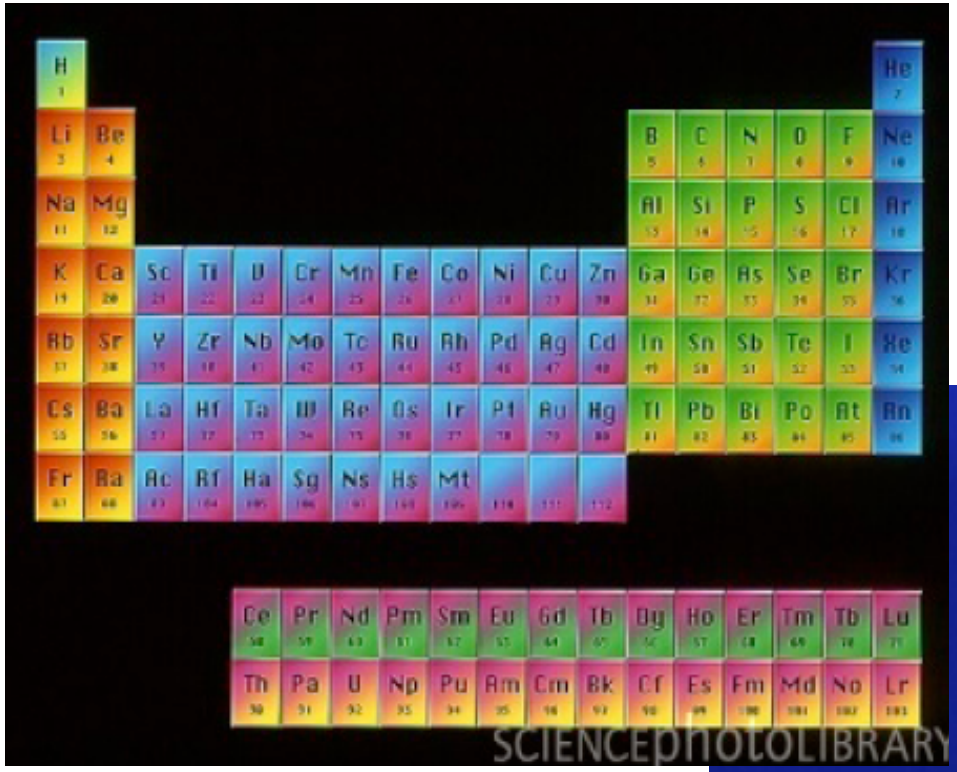


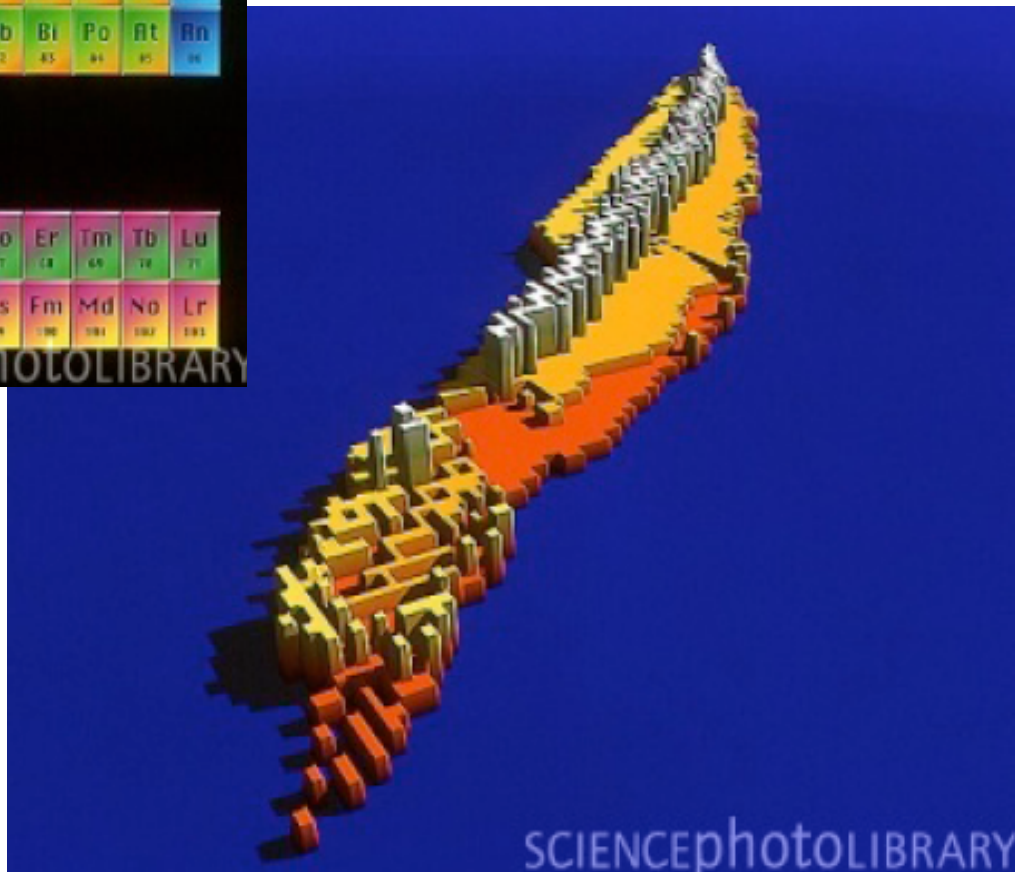


Discrete Sciences

Dmitri Mendeleyev and the Periodic Table

Homeland Security





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Consortium

Homeland Security

Today's Consortium Members

Precise Data

Necessary and Sufficient Conditions for Interaction :

- No personal computers; no WIMPS; that is, single-layer or flat interactions prevail
- Access to tailored information is complete on public screens or on individual displays
- Communications, information networks automatically, dynamically establish and maintain communities of interest
- Interaction with information, data is mediated not by bandwidth but by cognitive properties
- When I do search for information, that search is enabled by images, graphs, multimodal forms

Homeland Security

Precise Data

Necessary and Sufficient Conditions for Precision Information Environments:

- Synthetic world and real world co-exist, are co-equal
- Physical and information spaces are co-existent
- Modeling and simulation capabilities apply to both
- Streaming, dynamic data are available, accessible in real-world time
- Environment is tailored, suited for multiple user groups on a dynamic basis
- Information spaces are multimodal
- Multiple users and manifold uses are managed simultaneously

Homeland Security

The Post-Modernist Paradigm Shift

Wrong-headed Propositions:

- Duality
- World as text (or thought as language)
- Visual means bandwidth
- Representation and Objectivism
- Context for language
- Digital, algorithmic
- Culture determines perception

The comprehension of human sentences cannot be reduced to simply the algorithmic transformation of strings of symbols

John Searle – **Mind: A brief introduction**

Homeland Security

Whither Post-Modernism - Neuroscience

Human cognition – A modern view:

Not Platonic, Cartesian but Aristotelian

Nonpropositional, embodied image schemas

Imagistic structures grounded in sensory-motor schemas

Perception

From representational models toward enacted, embodied models

Perception = Action = Cognition

Perception is not simply passive representation of the external world … but is inextricably bound up with embodied action

William James – **Pragmatism**

Homeland Security

Big/Deep History - Evolutionary Pressures

Architecture of the human brain:

- Finely tuned administration of an organism's behavior
- Fast and frugal heuristics
  - AI and robotics have taught us something
- Visual systems and task-relevant information
- Cognition implemented in multi-dimensional spatial formats
  - Lacking discrete symbolic representations

What we see at any given moment is a partially elaborated representation of the visual scene, only immediate relevant information is explicitly represented

Patricia Churchland – **Neurophilosphy: Toward a united science of the mind-brain**

Homeland Security

Big/Deep History – What We Mean

Decision-making and judgment formation:

Automatic, image-based systems

Fast
Computationally frugal
Reliable

Pragmatic, embodied heuristics

Modal basis for knowledge

Analog = image
Digital = amodal symbol

Successive paradigms tell us different things about the population of the universe and about that population's behavior

Thomas Kuhn – **The Structure of Scientific Revolutions**

Homeland Security