Geospatial Information Management Research at the University of Texas at Dallas

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The University of Texas at Dallas

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Outline

- **Introduction to the Research (CS Perspective)**
  - **Bhavani Thuraisingham**
- **Geospatial Data Mining**
  - **Latifur Khan**
- **Geospatial data research in the Department of Geography**
  - **Fang Qiu**
- **Working toward producing a UTD-wide presentation involving CS, Geography and Geosciences departments in 3 schools (Engineering, Social Sciences, Natural Sciences)**
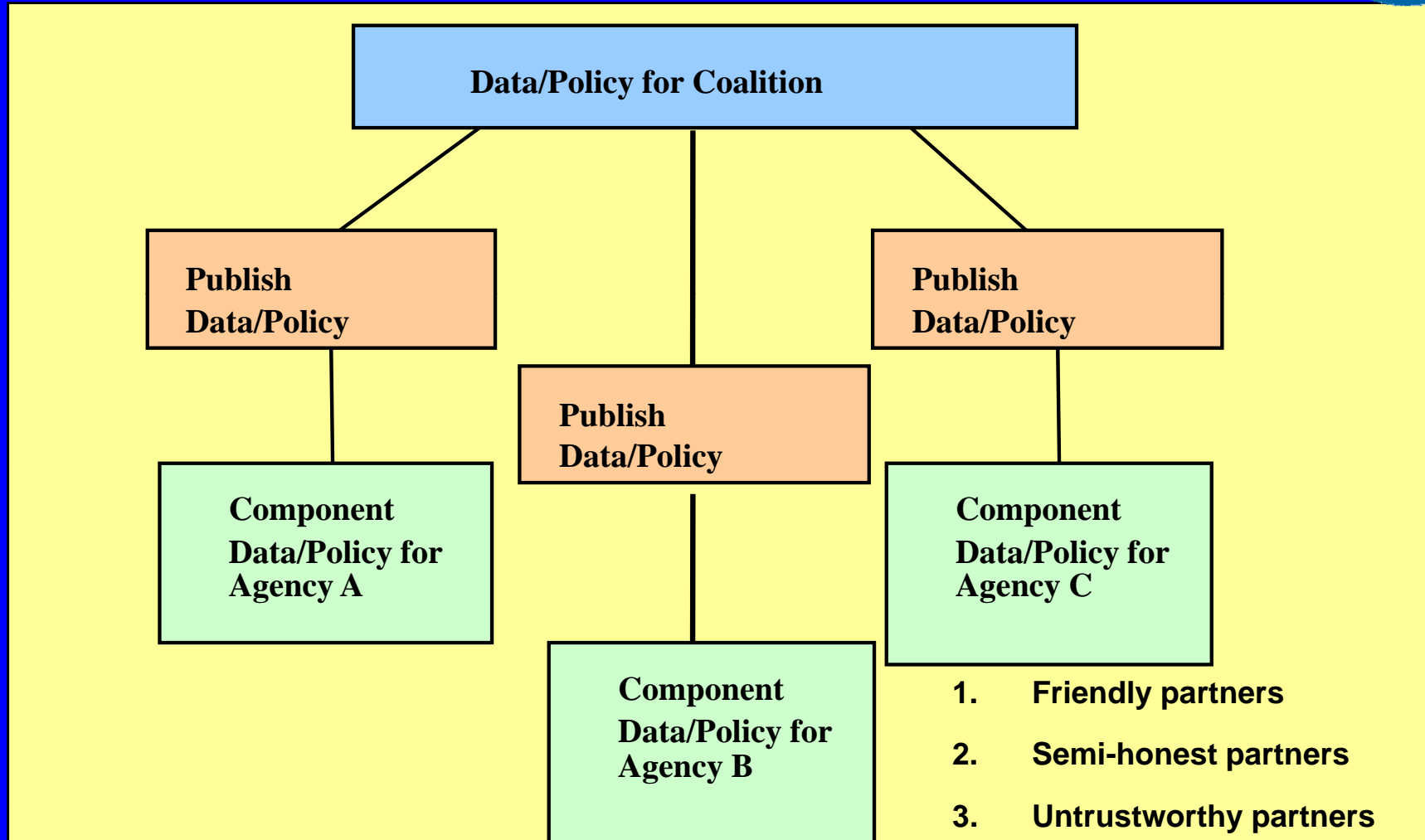
Introduction to the Research

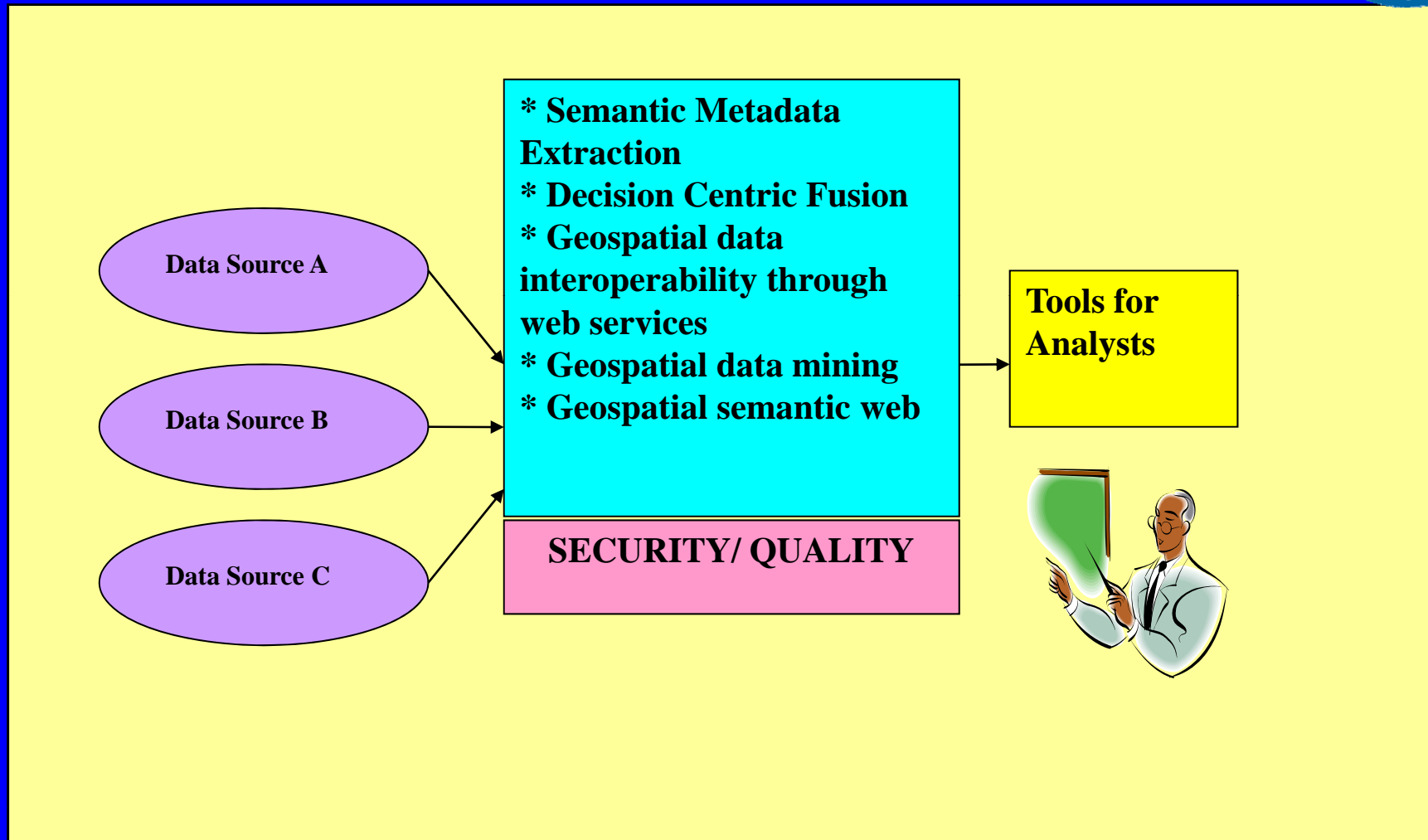- **Vision for Assured Information Sharing**
  - **Our ultimate goal involving structured, semi structured and unstructured data**
- **Vision for Geospatial Data Management**
- **Geospatial Data Mining: Early Research**
- **Approaches to Geospatial Data Integration**
- **Geospatial Semantic Web**
- **Geospatial Data Security**
- **Education (CS)**
- **Technical Accomplishments (CS)**
- **Future Plans**

Vision: Assured Information Sharing

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                        │    Data/Policy for Coalition     │
                        └─────────────────────────────────┘
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           ┌──────────────┐      ┌──────────────┐      ┌──────────────┐
           │ Publish      │      │ Publish      │      │ Publish      │
           │ Data/Policy  │      │ Data/Policy  │      │ Data/Policy  │
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                 |                      |                      |
         ┌──────────────┐        ┌──────────────┐      ┌──────────────┐
         │ Component    │        │ Component    │      │ Component    │
         │ Data/Policy  │        │ Data/Policy  │      │ Data/Policy  │
         │ for Agency A │        │ for Agency B │      │ for Agency C │
         └──────────────┘        └──────────────┘      └──────────────┘
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1. **Friendly partners**

2. **Semi-honest partners**

3. **Untrustworthy partners**

Vision for Geospatial Data Management

Data Source A

Data Source B

Data Source C

* Semantic Metadata Extraction
* Decision Centric Fusion
* Geospatial data interoperability through web services
* Geospatial data mining
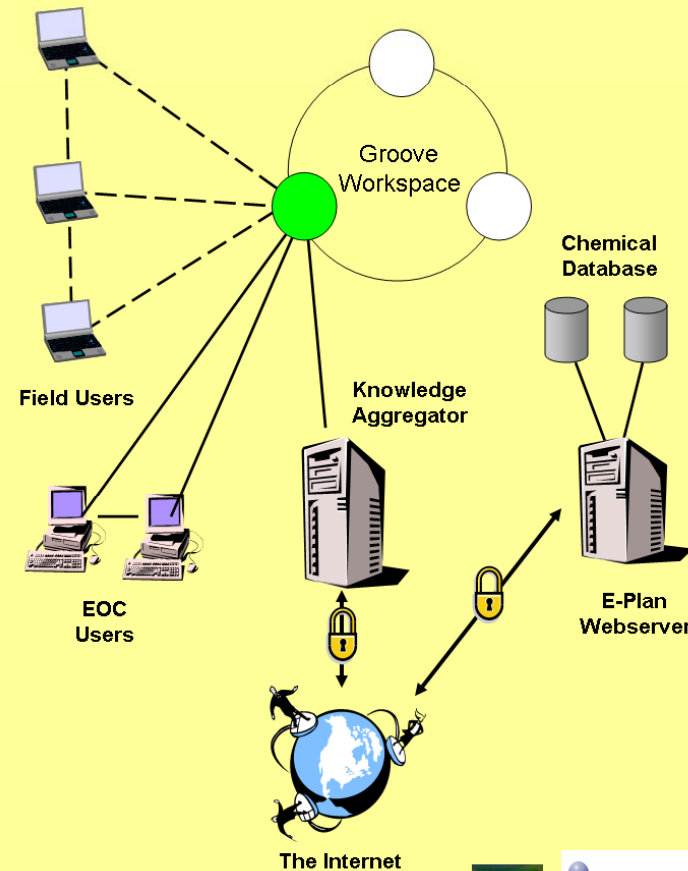* Geospatial semantic web

SECURITY/ QUALITY

Tools for Analysts

Early Research in Geospatial Data Mining: Change Detection

- **Trained Neural Network to predict "new" pixel from "old" pixel**
  - **Neural Networks good for multidimensional continuous data**
  - **Multiple nets gives range of "expected values"**
- **Identified pixels where actual value substantially outside range of expected values**
  - **Anomaly if three or more bands (of seven) out of range**
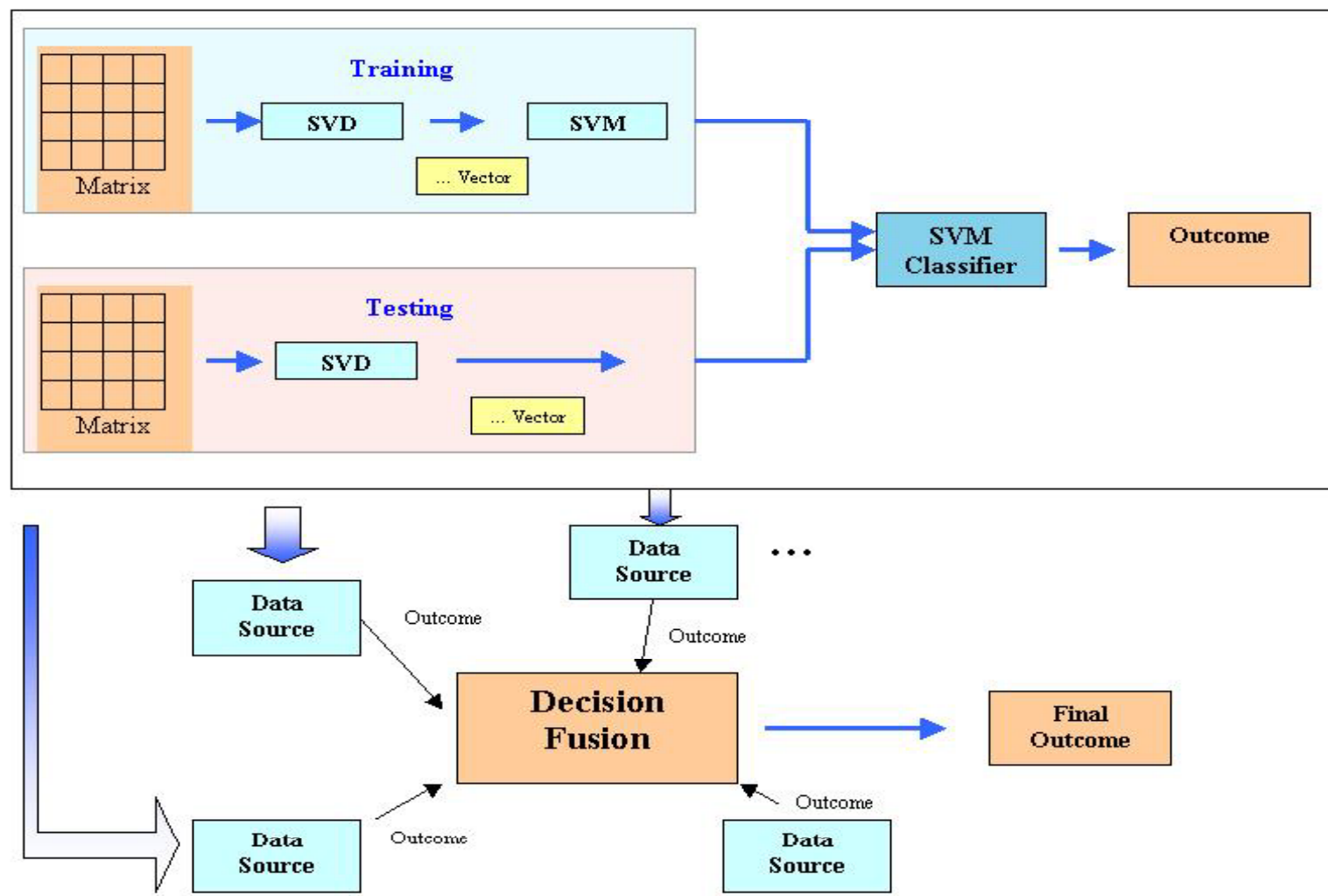- **Identified groups of anomalous pixels**

Geospatial Data Integration - I

- **On-site chemical spill management teams face a number of challenges**

  - **Multiple sources of data at a variety of security levels**

  - **Overlapping areas of authority**

  - **Time-critical objectives**

- **We have recently completed a project to integrate UTD's E-Plan system with CH2M Hill's iCIT solution**

  - **Knowledge aggregator that connects E-Plan's secure chemical reference web interface with iCIT's collaboration environment**

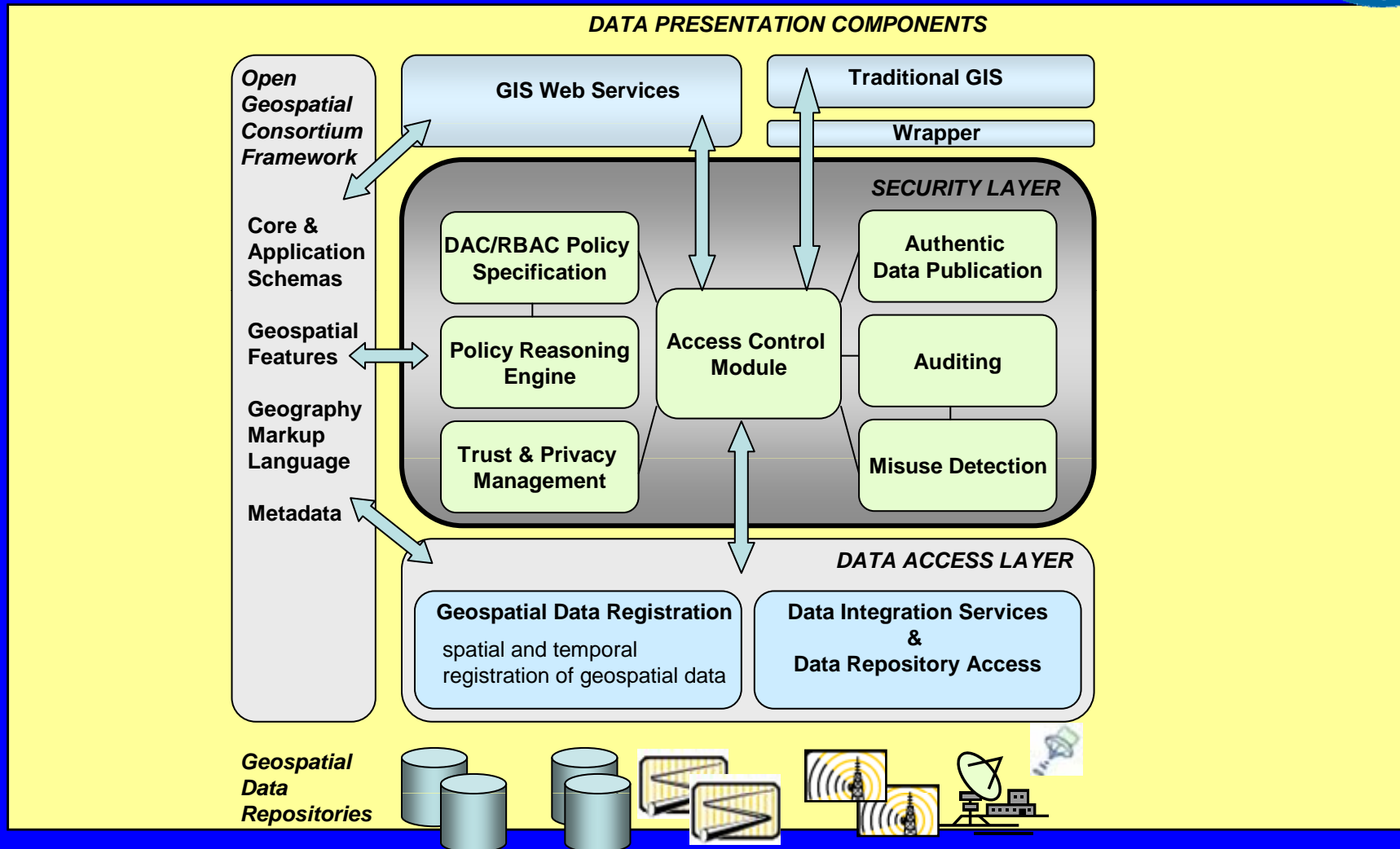 - **Information is only made available to authorized individuals**

Groove Workspace

Field Users

EOC Users

Knowledge Aggregator

Chemical Database

E-Plan Webserver

The Internet

UTD   CH2MHILL

Geospatial Data Integration - II

Framework for Geospatial Data Security (Joint with UCDavis and Purdue U.)

DATA PRESENTATION COMPONENTS

Open Geospatial Consortium Framework

- Core & Application Schemas
- Geospatial Features
- Geography Markup Language
- Metadata

GIS Web Services

Traditional GIS

Wrapper

SECURITY LAYER

- DAC/RBAC Policy Specification
- Policy Reasoning Engine
- Trust & Privacy Management
- Access Control Module
- Authentic Data Publication
- Auditing
- Misuse Detection

DATA ACCESS LAYER

Geospatial Data Registration
spatial and temporal registration of geospatial data

Data Integration Services & Data Repository Access
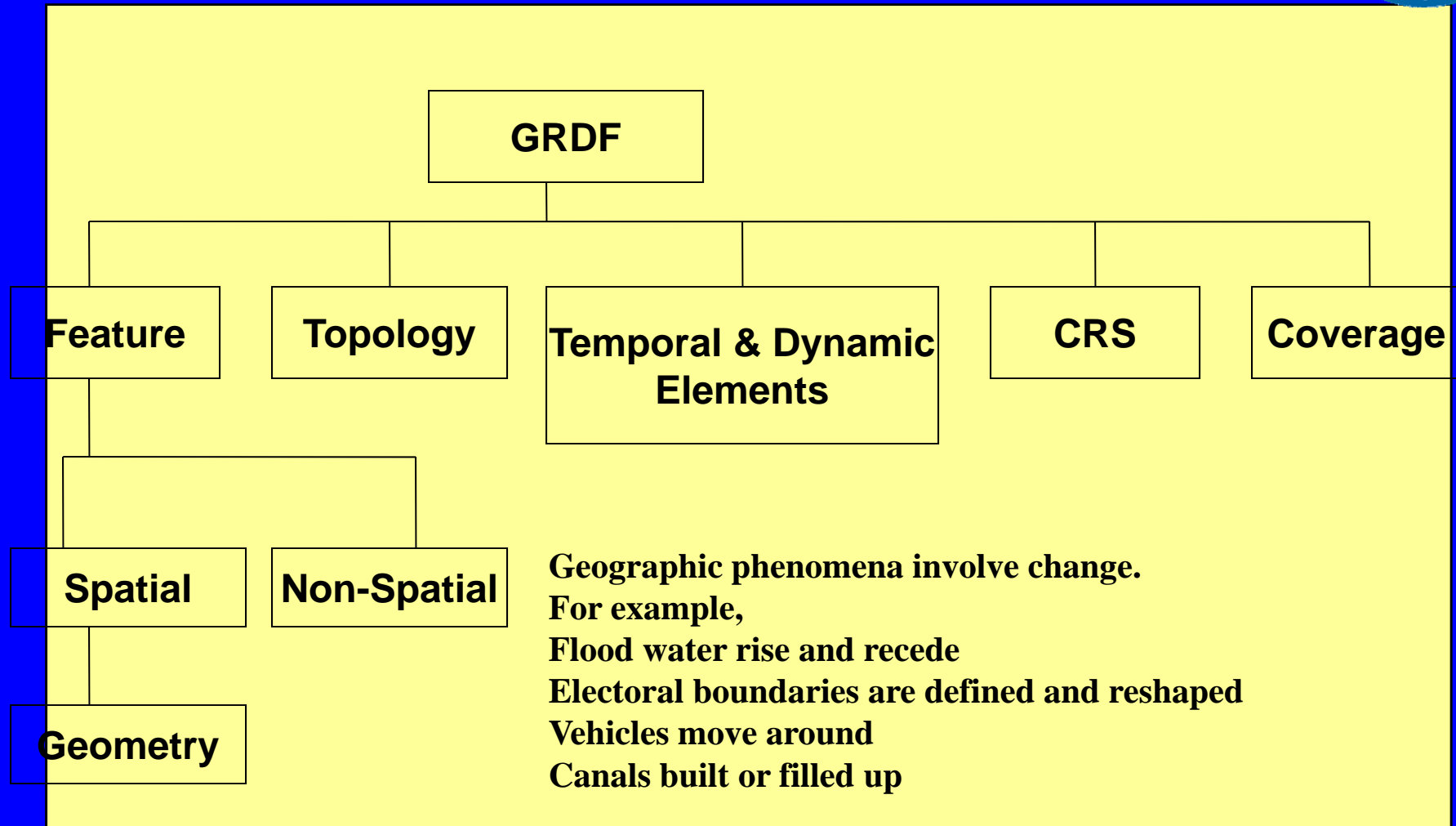
Geospatial Data Repositories

Semantic Web: GRDF

- **The strength of RDF lies in the ease of composition with which RDF based formalisms can be integrated with other similar languages.**

- **On the Semantic Web, the goal is to minimize human intervention and to make way for machines to perform rule based automated reasoning.**

- **We are developing GRDF for geospatial data representation**

- **Why not use GML?**

GRDF Model

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                          ┌──────────┐
                          │   GRDF   │
                          └────┬─────┘
     ┌──────────┬──────────────┼──────────────┬──────────────┐
┌────┴────┐ ┌───┴────┐ ┌───────┴────────┐ ┌───┴───┐ ┌────────┴────┐
│ Feature │ │Topology│ │Temporal &      │ │  CRS  │ │  Coverage   │
└────┬────┘ └────────┘ │Dynamic Elements│ └───────┘ └─────────────┘
     │                 └────────────────┘
 ┌───┴──────────┐
┌┴────────┐ ┌───┴─────────┐
│ Spatial │ │ Non-Spatial │
└────┬────┘ └─────────────┘
┌────┴─────┐
│ Geometry │
└──────────┘
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Geographic phenomena involve change.
For example,
Flood water rise and recede
Electoral boundaries are defined and reshaped
Vehicles move around
Canals built or filled up

Education in CS Department

❖ **Some Relevant Courses**
  - ❖ Database management
  - ❖ Data Mining
  - ❖ Visualization
  - ❖ Multimedia Information Management
  - ❖ Geospatial data management
  - ❖ Data and Applications Security

❖ **Future Courses**
  - ❖ Geospatial semantic web
  - ❖ Geospatial data mining
  - ❖ Geospatial data security

❖ **Joint Graduate Program in GIS**
  - ❖ CS, Geosciences, Geography

❖ **Oracle Center for Excellence in Geospatial Data**

Technical and Professional Accomplishments

❖ **Publications of research in top journals and conferences, books**

  ✓ IEEE Transactions on Knowledge and Data Engineering, IEEE Transaction on Software Engineering, IEEE Computer,
  IEEE Transactions on Systems, Man and Cybernetics, IEEE Transactions on Parallel and Distributed Systems, VLDB Journal, 7 books published and 2 books in preparation including one on UTD research (Data Mining Applications, Awad, Khan and Thuraisingham)

❖ **Member of Editorial Boards/Editor in Chief**

  ✓ Journal of Computer Security, ACM Transactions on Information and Systems Security, IEEE Transactions on Dependable and Secure Computing, IEEE Transactions on Knowledge Engineering, Computer Standards and Interfaces - - -

❖ **Advisory Boards / Memberships**

  ✓ Purdue University CS Department, - - -

❖ **Awards and Fellowships**

  ✓ IEEE Fellow, AAAS Fellow, BCS Fellow, IEEE Technical Achievement Award, IEEE Senior Member, - - -

Some Plans

- **Raytheon funded research on Geospatial semantic web and Geospatial data mining**

- **Research on Geospatial Data Security - submitted to NSF**
  - **Representation based on GML**

- **Algebraic Geometry based techniques for geospatial data mining-to be submitted to NGA under NURI**

- **UTD funded research on developing GRDF (Geospatial Resource Description Framework)**

- **Geospatial Data Surveillance based on UTD funded research on Video Surveillance**

- **Integrate research into current project funded by AFOSR on Assured Information Sharing and second project on Data Provenance**

- **Work with OGC, Oracle and Raytheon to accomplish the goals in the agenda (April 24, 2006 meeting)**