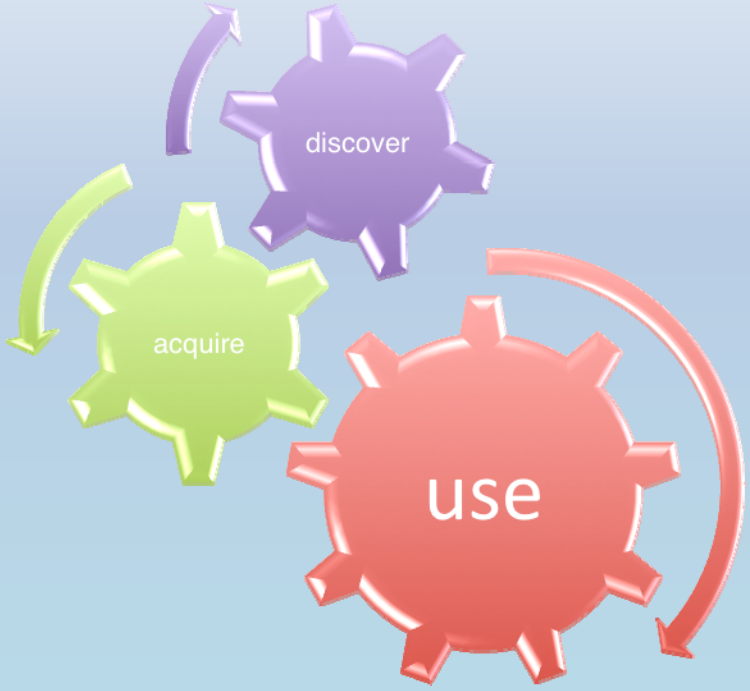
Managing the Assured Information Sharing Lifecycle

Tim Finin, UMBC

08 June 2009



http://aisl.umbc.edu/show/resource/id/498/

2008 MURI project

University of Maryland, Baltimore County (Lead Inst.)

T. Finin (Lead), A. Joshi, H. Kargupta, A. Sherman, Y. Yesha

Purdue University

E. Bertino (Lead), N. Li, C. Clifton, E. Spafford

University of Texas at Dallas

B. Thuraisingham (Lead), M. Kantarcioglu, L. Khan, A. Bensoussan, N. Berg

University of Illinois at Urbana Champaign

J. Han (Lead), C. Zhai

University of Texas at San Antonio

R. Sandhu (Lead), J. Massaro, S. Xu

University of Michigan

L. Adamic (Lead)

Summer 2008 start

Motivation for AIS

- **9/11** and related events illustrated problems in managing sensitive information
- Managing **Web** information & services with *appropriate security, privacy and simplicity* is increasingly important and challenging
- Autonomous **devices** (mobile phones, routers & medical equipment) need to share, too
- Moving to **EMR**s is a national goal, but raises many privacy issues
- Business needs better models for **DRM**

Need to Know, Need to Share

- Traditional information security frame-works are based on *“need to know”*

- The 9/11 commission recommended moving from this to *“need to share”*

Need to Know, Need to Share

- Traditional information security frame-works are based on *"need to know"*

  Unless you can prove that you have a prearranged right to access this information, you can't have it

- The 9/11 commission recommended moving from this to *"need to share"*

  I think this information may be important for you to accomplish your mission and would like to discuss sharing it with you

Beyond the talking point

- There's a lot bundled into *"need to share"*
- For it to be more than a talking point, we must understand it technically, and
  - Explore its feasibility and desirability
  - Understand the ramifications, including risks and benefits
  - Develop, prototype and evaluate techniques, tools and systems to promote it

Many underlying problems

Many barriers hinder or prevent information sharing:

- Sharing takes effort and maybe has risks. Why should I bother?
- How can I constrain how shared information is used?
- How do I know what information is available to me?
- Do I understand what the information means?
- Is the information accurate and timely?
- How can I safely let others know what I have to share?
- We're under attack and I need this information to prevent a disaster!

Our research themes

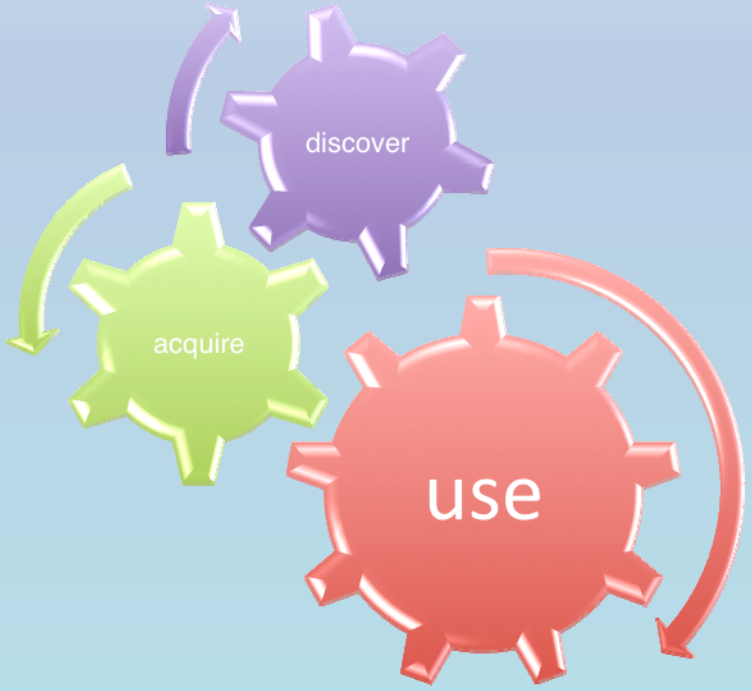
- An information value chain of producers & consumers yields an assured information sharing **lifecycle**
- *Policies* for trust, access and use grounded in sharable **semantic models** operating in a **service oriented** architecture accelerate sharing
- New **integration** and **discovery** techniques are required to assure information **quality** and **privacy**
- Understanding and protecting the ***social networks*** promotes adds information diffusion and security
- **Incentives** for information sharing are required

Assured Information Sharing Lifecycle

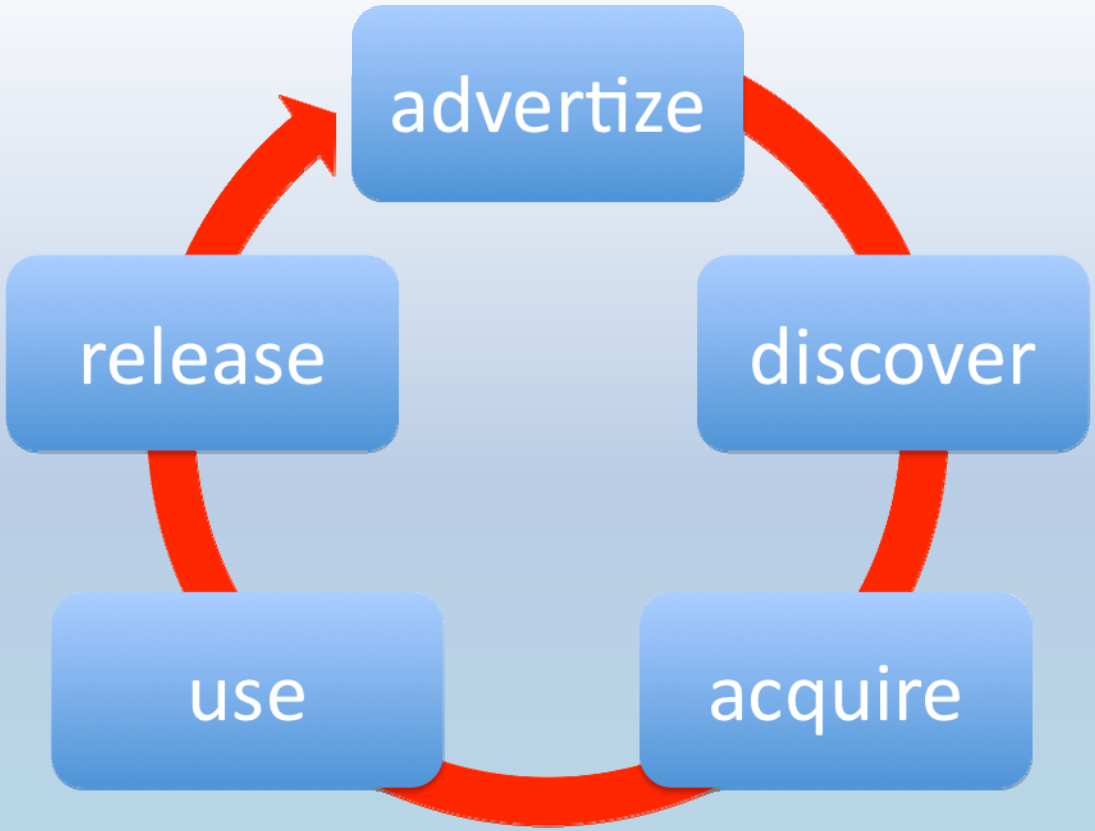
There is a lifecycle to assured information sharing that comprises information

- Advertising and discovery
- Acquisition, release and integration
- Usage and control

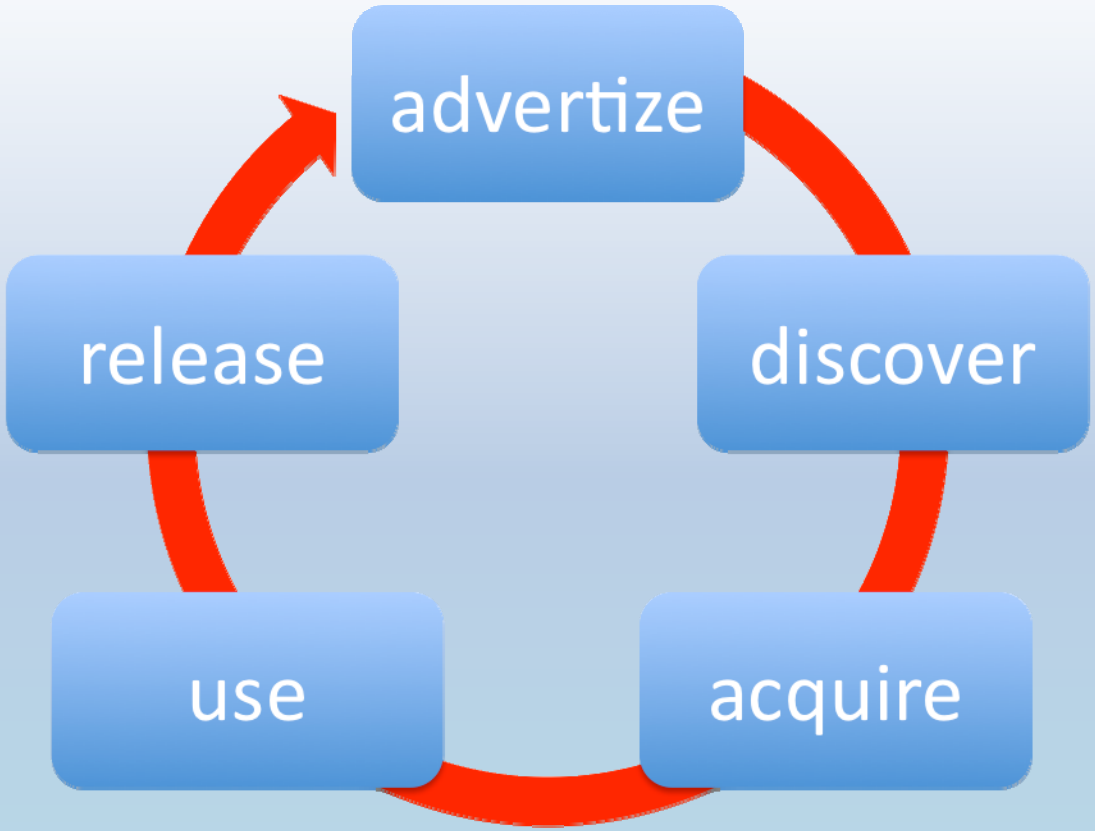
These phases realize an information sharing value chain with a network of producers and consumers



Information value chain



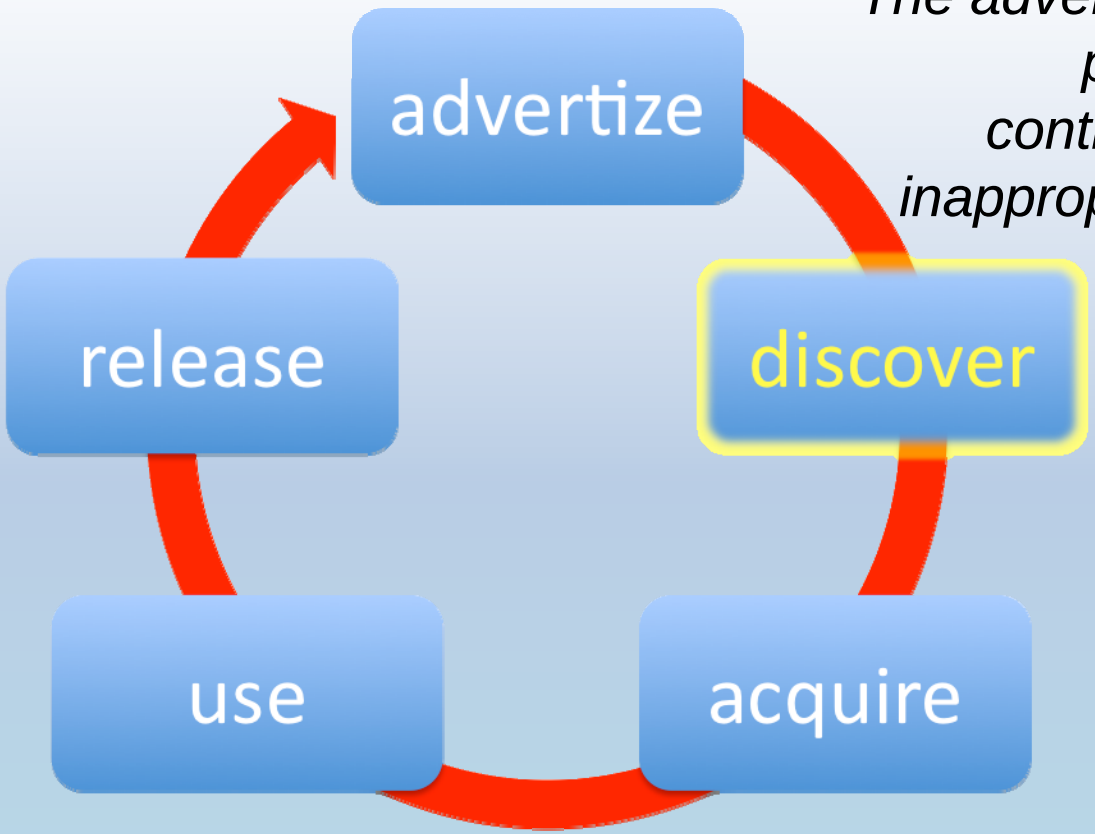
Information value ~~chain~~ web



Potentially, everyone is both an information consumer and producer

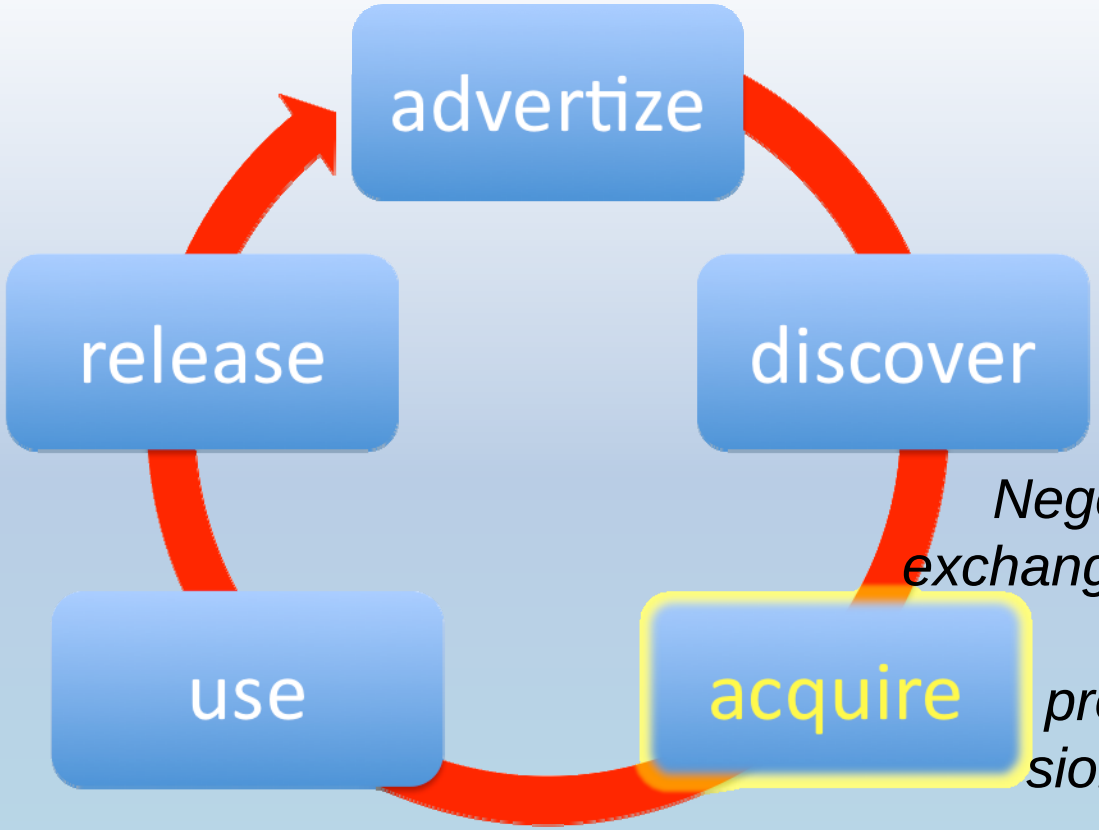
Information value ~~chain~~ web

The advertizing/discovery process must be controlled to prevent inappropriate disclosure



A system discovers information it can use from the advertisements of others

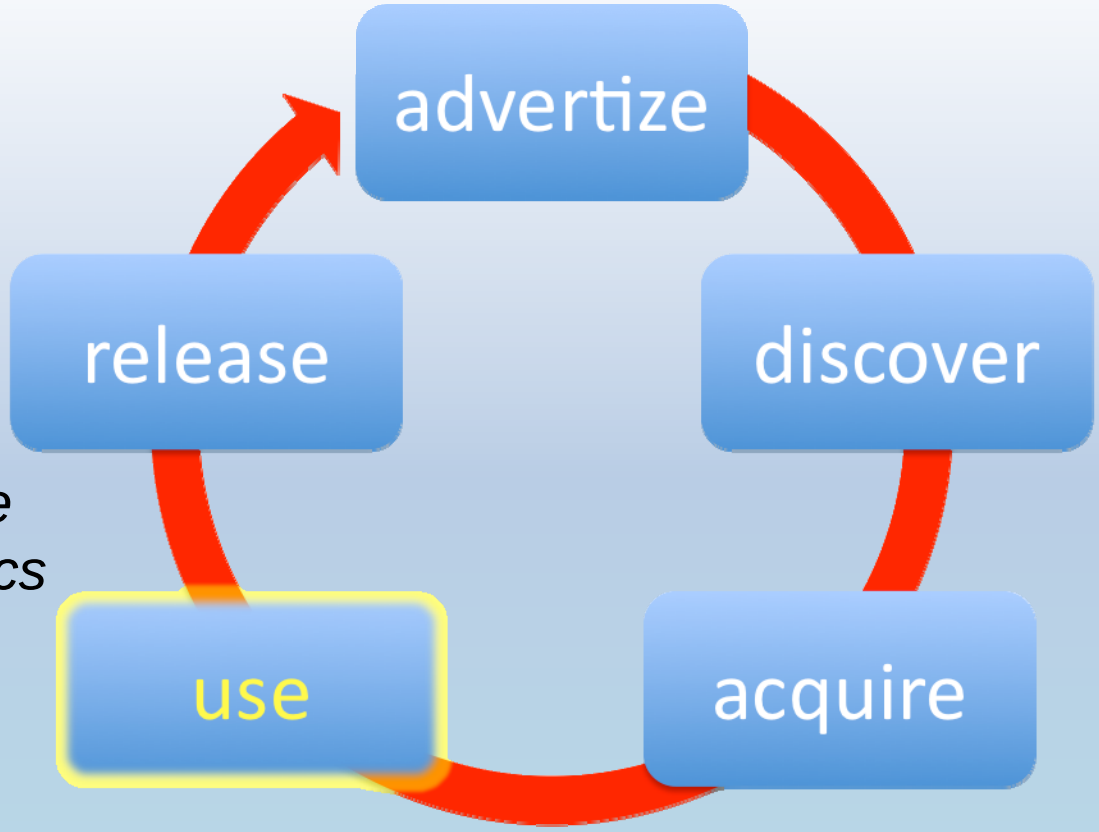
Information value ~~chain~~ web



Negotiation involves exchange of credentials & certificates, producing permis-sions & obligations

The principles negotiate a policy for the information's acquisition and use

Information value ~~chain~~ web

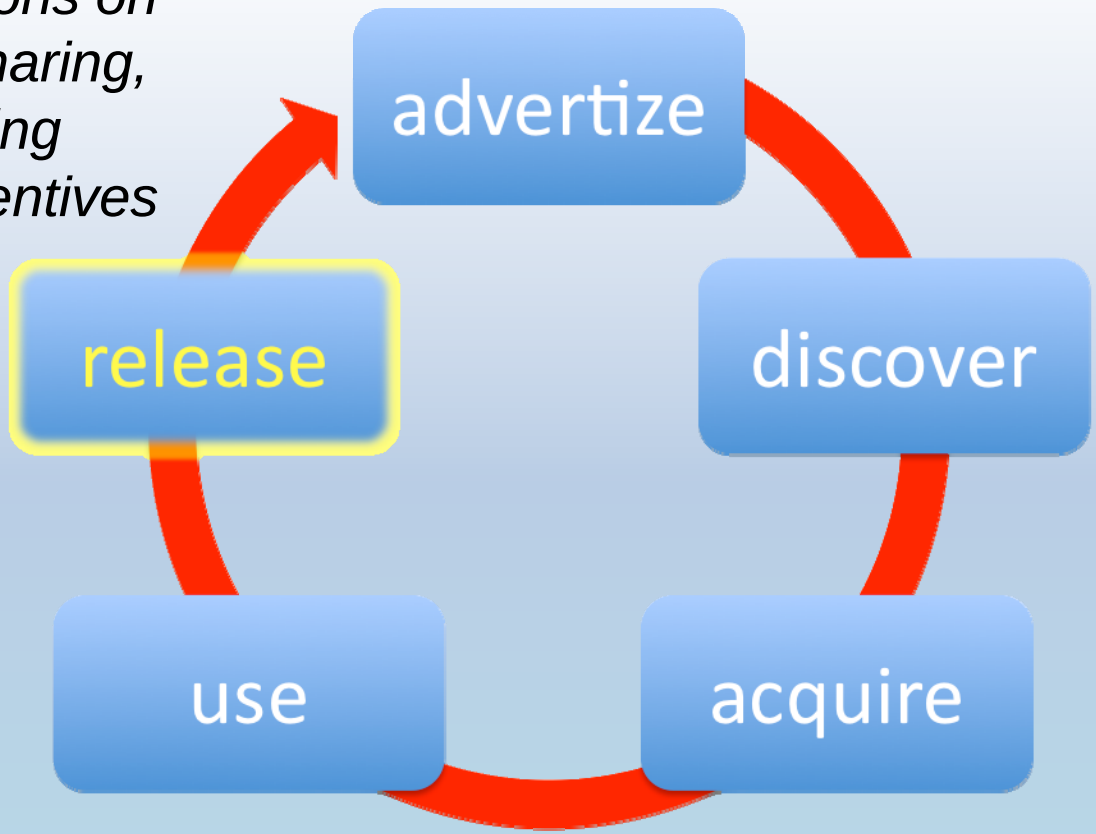


We must assure correct semantics and information quality

The information is used, often resulting in the discovery of new knowledge

Information value ~~chain~~ web

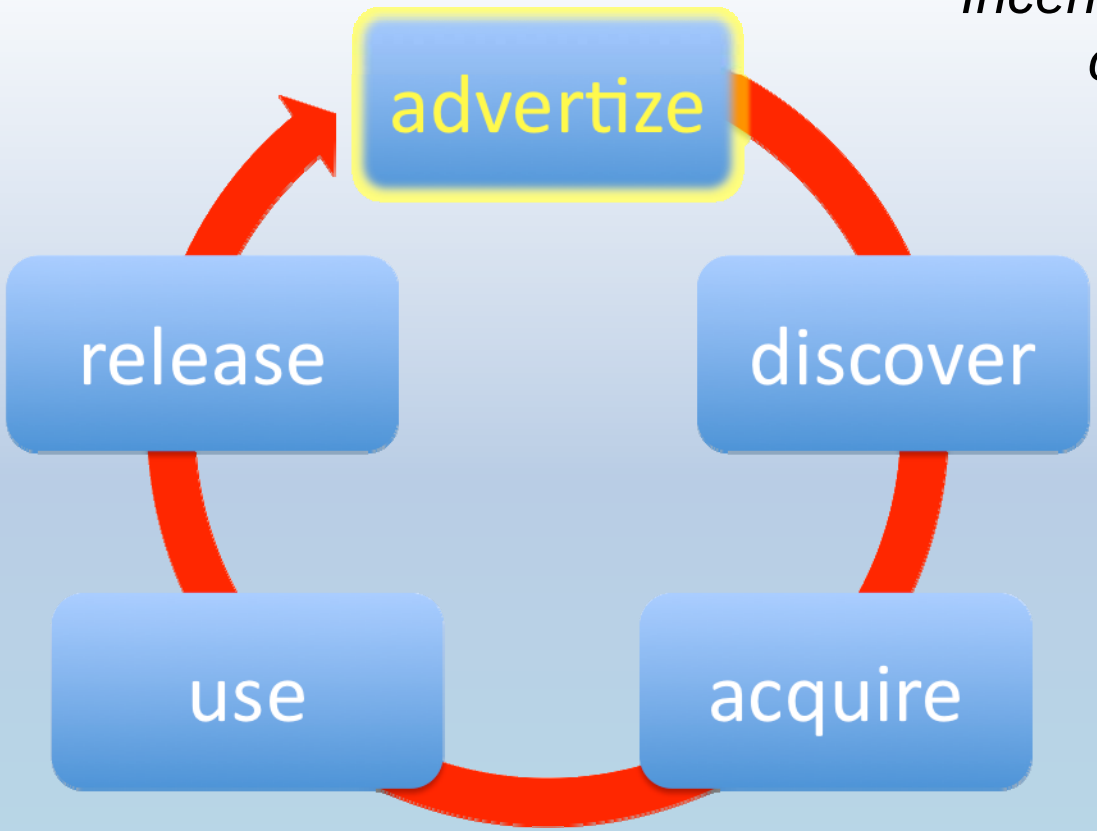
Enforce obligations on usage and re-sharing, privacy-preserving summaries, incentives for sharing



which is screened, adapted and summarized for possible release

Information value ~~chain~~ web

Incentives encourage offering to share information



and appropriately characterized in advertisements for others to find

Our AISL research areas

We've organized our research into four major areas

- New policy models, languages and tools
- Datamining, data quality and privacy preserving systems
- Social networks and incentives
- AIS service/agent oriented infrastructure

And will evaluate our work in several integrated applications in the out years

Sample of AISL Recent Results

① New models, architectures, languages & mechanisms for trustworthiness-centric AIS (UTSA, Purdue)

② EXAM: environment for XACML policy analysis and management (Purdue)

③ Techniques for resolving conflicting facts extracted from different resources (UIUC, Purdue)

④ Study of information sharing motivation and quality in online forums (Michigan, UTD)

⑤ Inferring access policies from logs (UMBC)

⑥ Privacy policies in mobile/social information systems (UMBC)

⑦ AIS infrastructure (ALL)

But wait, there's more

- At ISI 2009 two papers from UTD
  - Ryan Layfield, Murat Kantarcioglu and Bhavani Thuraisingham, *On the Mitigation of Bioterrorism through Game Theory*, 10:15 Tuesday
  - Raymond Heatherly, Murat Kantarcioglu and Bhavani Thuraisingham, *Social Network Classification Incorporating Link Type Values*, 10:40 Wednesday
- See http://aisl.umbc.edu/ for more

1

Trustworthiness-centric AIS Framework

- **Objective:** create a trustworthiness-centric assured information sharing framework
- **Approach:** design models, architectures, languages and mechanisms to realize it
- **Key challenges, management for:**
  - ***Trustworthiness*** and ***risk*** for end-user decision making
  - ***Usage***, extending simple access control
  - ***Attacks***, including trustworthiness of infrastructure services
  - ***Identity*** extending current generation
  - ***Provenance*** for managing trustworthiness of data, software, and requests

1

Group-Centric Secure Info Sharing

Dissemination-Centric	Group Centric
• Traditional model • Attributes & policies attached to objects (*"sticky policies"*) • Policies enforced as objects disseminated from producer to consumer	• New model • Objects & subjects brought together as a group for sharing • Simultaneous co-presence for access • Two metaphors: se-cure meeting room; subscription service

1

Progress on g-SIS

- Developed a formal model for a g-SIS system using linear temporal logic (LTL)
  - e.g., events for subjects (join, leave) and objects (add, remove), requests (read), Authz(s,o,r), …
- Specify core properties g-SIS must satisfy
  - e.g, Simultaneity, Provenance, Persistence, Availability, …
- Specify additional group op. properties
- Prove specifications satisfy correct authorization behavior using model checker
- See SACMAT 2009 paper

EXAM

- The management and consolidation of a large number of policies can be an impediment to SIA
- EXAM is a prototype system for policy analysis and management, which can be used for
  - policy property analyses
  - policy similarity analysis
  - policy integration
- Focus on access control policies in XACML (Extensible Access Control Markup Language)
- Analyzer combines advantages of existing MTBDD-based and SAT-solver-based techniques

MTBDD = Multi-Terminal Binary Decision Diagram

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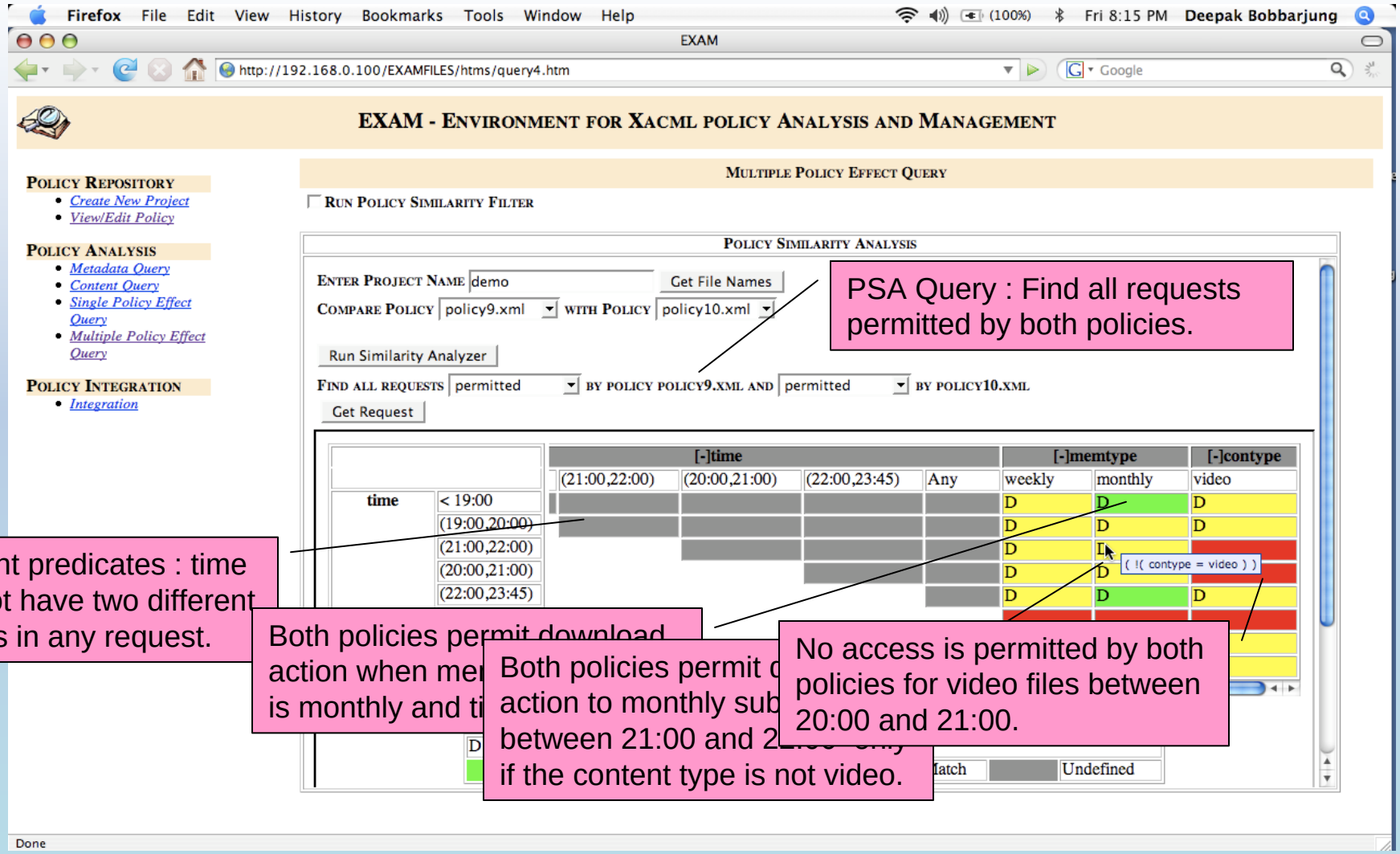
Policy Similarity Analysis



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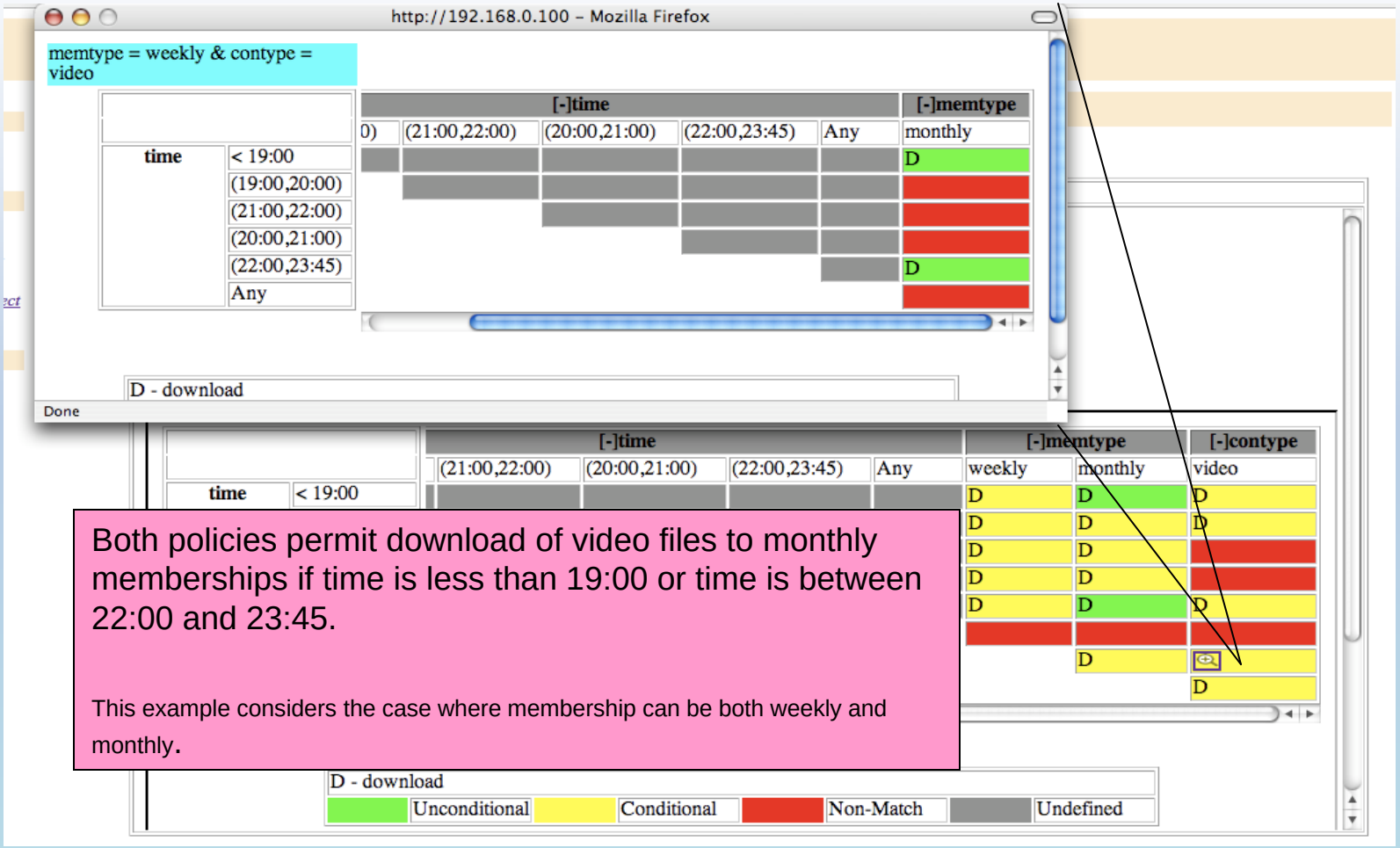
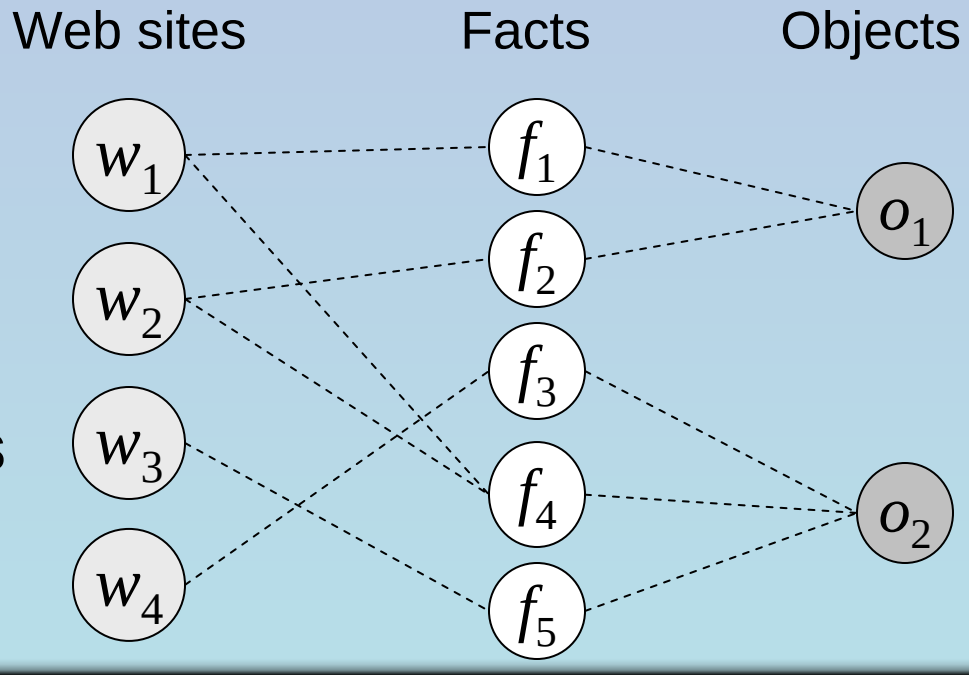
EXAM - PSA Example



To be demonstrated at SACMAT 2009

Truth Discovery with Multiple Conflicting Information Providers

- **Problem:** Multiple information provider may provide **conflictive** facts on same object
  - Given different author names for a book, which is **true fact?**
- **Heuristic Rule 1**: The false facts on different web sites are less likely to be the same or similar
  - False facts are often introduced by random factors
- **Heuristic Rule 2:** A web site that provides mostly true facts for many objects will likely provide true facts for other objects



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Truth-Discovery: Framework Extension

- Multi-version of truth
  - Democrats vs. republicans may have different views
- Truth may change with time
  - A player may win first but then lose
- Truth is a relative, dynamically changing judgment
  - Incremental updates with recent data in data streams
- Method: Veracity-Stream
  - Dynamic information network mining for veracity analysis in multiple data streams
- Current Testing Data Sets
  - Google News: A dynamic news feed that provides functions and facilitates searching and browsing 4,500 news sources updated continuously

3

Truth-Discovery: Framework Extension

- **Multi-version of truth** *A common semantic model helps here*
  - **Democrats vs. republicans may have different views**
- **Truth may change with time**
  - **A player may win first but then lose**
- **Truth is a relative, dynamically changing judgment**
  - **Incremental updates with recent data in data streams**
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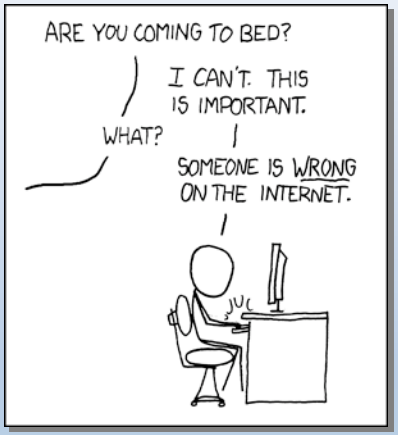
4

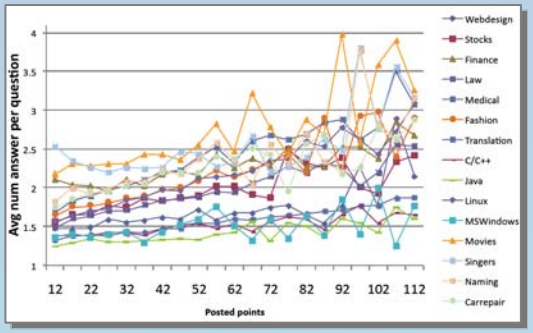
Motivation & quality in information sharing

- Analyzed online Q&A forums: 2.6M questions, 4.6M answers and interviews with 26 top answerers
- Motivations to contribute include: altruism, learning, competition (via point system) and as a hobby
- Users who contribute *more often* and *less intermittently* contribute higher quality information
- Users prefer to answer unanswered questions and to respond to incorrect answers
- **We can use this knowledge to design better incentive systems to encourage information sharing**

NAVER 지식iN 지식과 내가 함께 커가는 곳

Knowledge iN

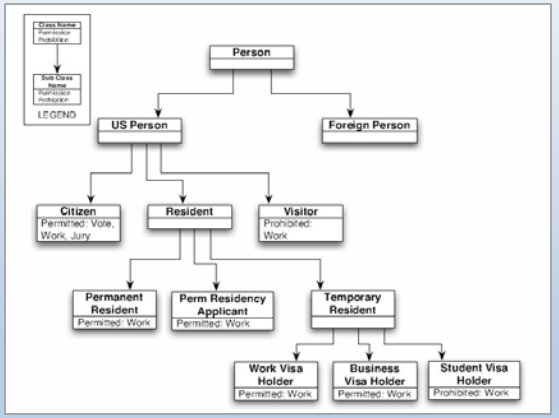




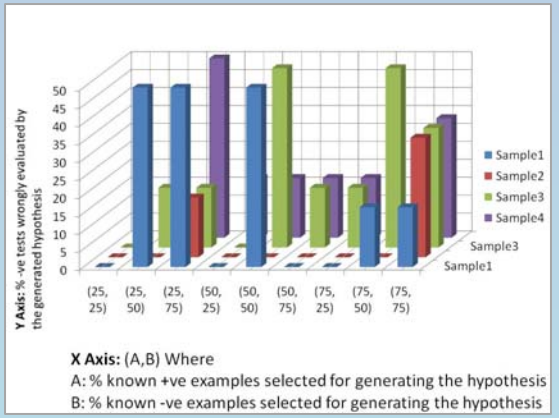
Inferring RBAC Policies

- **Problem:** A system whose access policy is known is more vulnerable to attacks and insider threat

  Attackers may infer likely policies from access observations, partial knowledge of subject attributes, and background knowledge



- **Objective:** Strengthen policies against discovery
- **Approach:** Explore techniques to propose policy theories via machine learning, including ILP and SVMs



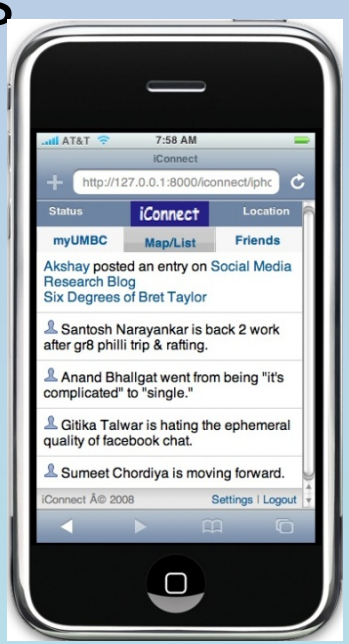
- **Results:** promising initial results for simple Role Based Access Control policies

Privac… …computing

- **Proble…** …d integrate sensiti… …sers which they w… …with others
- **Objec…** … system for inform… …e enabling end us… …olicies
- **Appro…** …r iConne… …e in a Univ…
- **Exam…** …xact locatio… …nt activity …

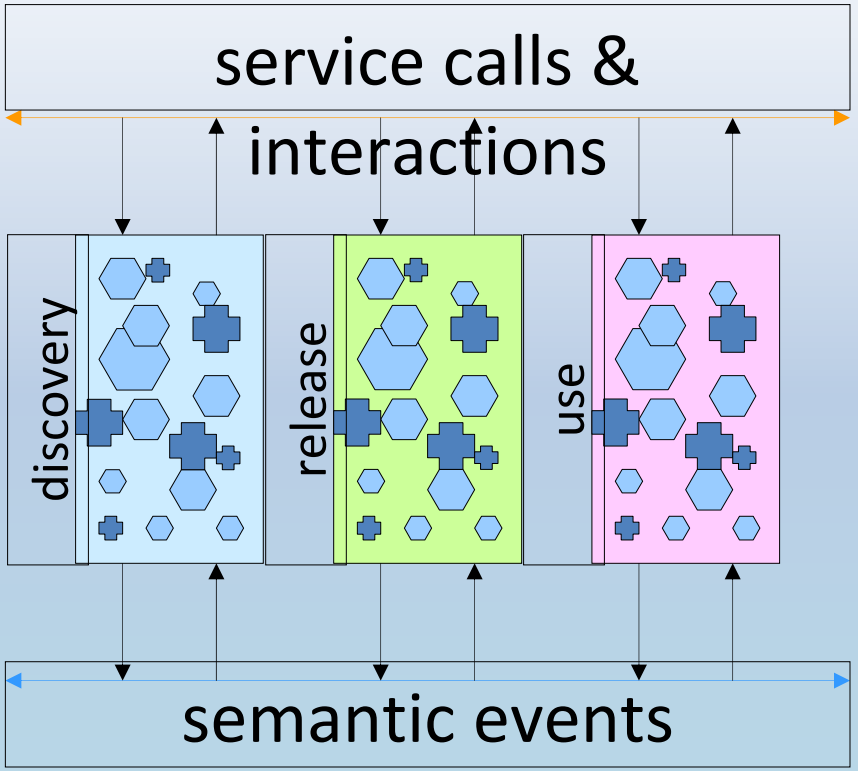
Policies compiled to RDF N3 rules

```
# Share location with teachers 9-6 weekdays
    if on campus
{ REQ a rein:Request
REQ rein:resource LOCATION.
?T a TeachersGroupStuff.
?R a UserStuff; log:include
{ LOCATION a tu:Location; USERID a tu:Userid }.
REQ rein:requester WHO.
?T a TeachersGroupStuff; log:includes
 { [] t:member [ session:login USERID ] }.
LOCATION loc:equalTo :UMBC .
  WHO :requestTime ?time.
  "" time:localtime ?localTime.
  ?localTime time:dayOfWeek ?day.
  ?day math:notlessthan "1".
  ?day math:notgreaterthan "5".
  ?localTime time:hour ?dtime.
  ?dtime math:notlessthan "9".
  ?dtime math:notgreaterthan "18".
} => { WHO  loc:can-get LOCATION }.
```

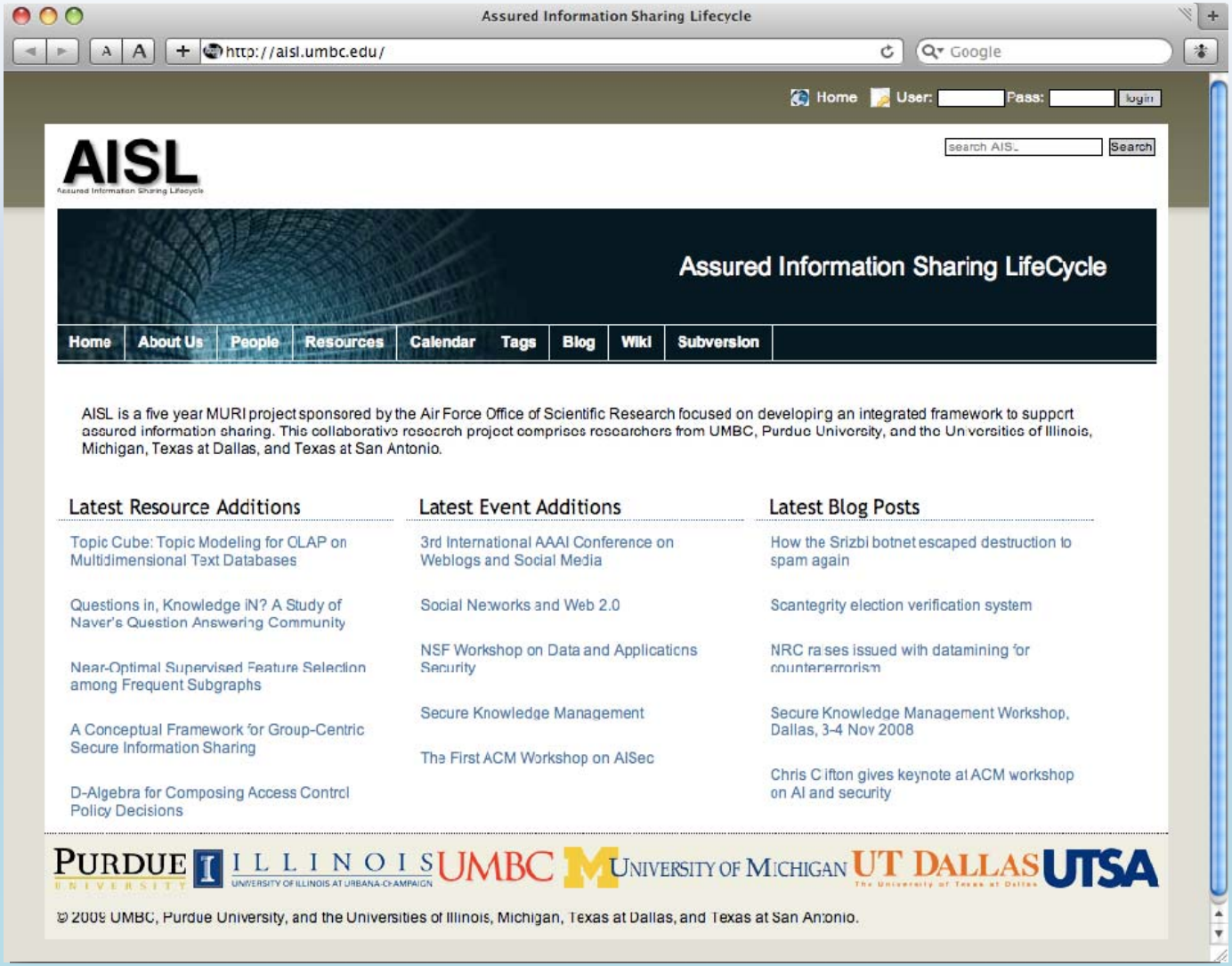


AIS Service Oriented Architecture

- An event-based model allows components to share **context**
- **Shared semantic models** for descriptions, communication and policies
- Initial prototype uses **Apache Axis2** SOA Framework
- Host policy tools as services
- TODO: add enhanced agent-based protocols for advertising, negotiation and argumentation



This was just a sample of the ongoing work, see http://aisl.umbc.edu/ for papers & more



Conclusions

- Assured information sharing in open, heterogeneous, distributed environments is increasingly important
- Computational policies can help
- Semantic Web technologies offer a way to share common policy concepts, policies & domain models
- Data quality and privacy-preserving techniques must be addressed
- Social aspects are important: networks, incentives
- For more information, see http://aisl.umbc.edu/
- Slides: http://aisl.umbc.edu/show/resource/id/498/