



Dynamic Trust in Mixed Service-oriented Systems

- Models, Algorithms, and Applications -

PhD Defense, June 18th 2010, Vienna, Austria

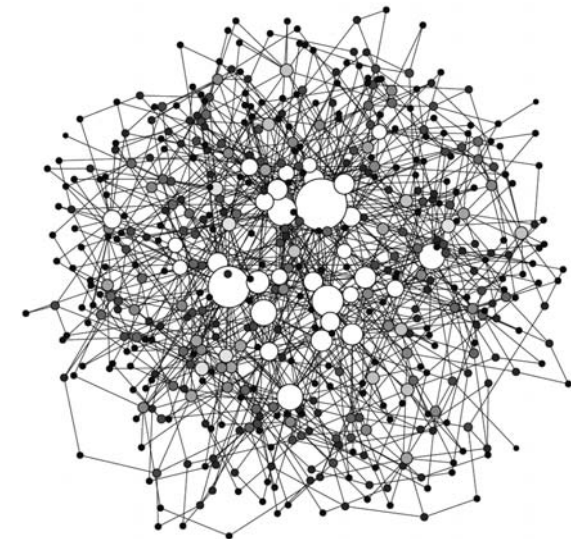
Florian Skopik

Advisors: Prof. Schahram Dustdar, Prof. Frank Leymann

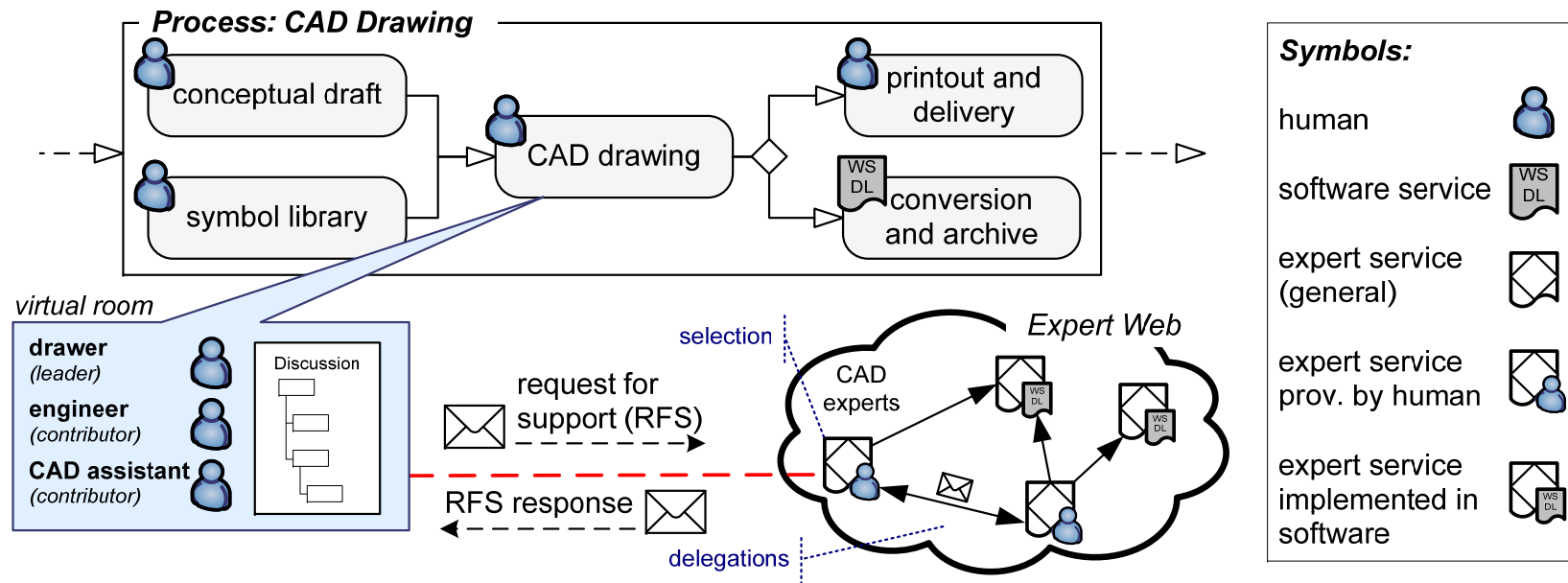
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Environment and Motivation

- Open and **dynamic** Web-based environment
 - Humans **and** resources (e.g., Web services)
 - **Joining/leaving** the environment **dynamically**
 - Humans perform **activities** and **tasks**
- Massive **collaboration** in SOA/Web 2.0
 - Large sets of **humans** and **resources**
 - Dynamic **compositions**
 - Distributed communication and coordination
- Keep track of the **dynamics** to control
 - Future interactions
 - Resource selection
 - Compositions of actors
 - Disclosure of information



Motivating Scenario: The Expert Web



- How do actor discovery and selection mechanisms work?
- What is the technical grounding for the proposed Mixed System?
- How can actors be flexibly involved in a service-oriented manner?
- How do interactions and behavior influence future collaboration?

[PDP10] F. Skopik, D. Schall, S. Dustdar. *Trusted Interaction Patterns in Large-scale Enterprise Service Networks*. 18th International Conference on Parallel, Distributed, and Network-Based Computing. Pisa, Italy, 2010. IEEE. 3 of 31

Structure of Presentation

Challenges in Collaborative SOA

- Loose coupling

flexible collaborations

environment model

- Discovery

dynamic properties

metrics

context

network structure

- Dynamic binding

selection

TRUST

Automatic inference of personal trust

Bootstrapping trust

definition
meaning
applications

- Collaborative mixed service-oriented systems
 - Interaction models
 - **Delegation patterns**
- Social trust and reputation models
 - **Definitions and metrics**
 - **Inference approach**
 - Temporal Evaluation
- Trust mining and prediction
 - **Bootstrapping**
 - **Interest and expertise mining**
 - Trust and reputation mining on the Web
- Trust-based service-centric applications
 - **Expert discovery** and ranking in virtual communities
 - Trusted information sharing/disclosure
 - Trust-based interest group formation

11 conference papers
1 journal paper

[IS] F. Skopik, D. Schall, S. Dustdar. *Modeling and Mining of Dynamic Trust in Mixed Service-oriented Systems*. Information Systems. Accepted for publication, March 2010. Elsevier.

Definition of Dynamic Trust

- Trust reflects an **expectation**
 - one actor has about another's future behavior
 - based on **previous interactions**
 - to **perform particular activities** dependably, securely, and reliably.

[WEBIST] F. Skopik, H.-L. Truong, S. Dustdar. *VieTE – Enabling Trust Emergence in Service-oriented Collaborative Environments*. 5th International Conference on Web Information Systems and Technologies (WEBIST). Lisbon, Portugal, 2009. INSTICC.

[ICWE] F. Skopik, H.-L. Truong, S. Dustdar. *Trust and Reputation Mining in Professional Virtual Communities*. 9th International Conference on Web Engineering (ICWE). San Sebastian, Spain, 2009. Springer.

Flexible Collaborations

- **Traditional** project management (PM)
 - **Predefined** processes and *work breakdown structures*
 - Most important steps (tasks) are planned
 - Temporal order and dependencies
- Underneath the PM layer: **ad-hoc** activities
 - Structures to describe loosely coupled collaborations
 - Not modeled in advance
 - Emerging when performing tasks
 - User-defined
- Typical Example: Expert Web
 - Collaboration partners are discovered based on availability
 - Temporal constraints are dynamically set based on urgency
 - Required resources are flexibly selected based on RFS

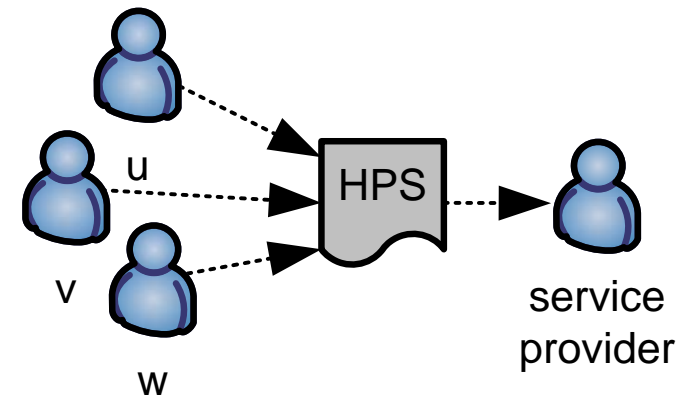
Mixed Systems Approach

- Fundamental concepts
 - Mix of human- and software services collaboration
 - Humans provide services using SOA concepts
- Expert Web Scenario
 - Humans provide support in a service-oriented manner
 - Expert actors 'implemented' in software
 - knowledge bases
 - expert systems
 - oracles with reasoning capabilities
 - One harmonized environment to enable interactions between humans and software components (SOA)

[PDP10] F. Skopik, D. Schall, S. Dustdar. *Trusted Interaction Patterns in Large-scale Enterprise Service Networks*. 18th International Conference on Parallel, Distributed, and Network-Based Computing. Pisa, Italy, 2010. IEEE.

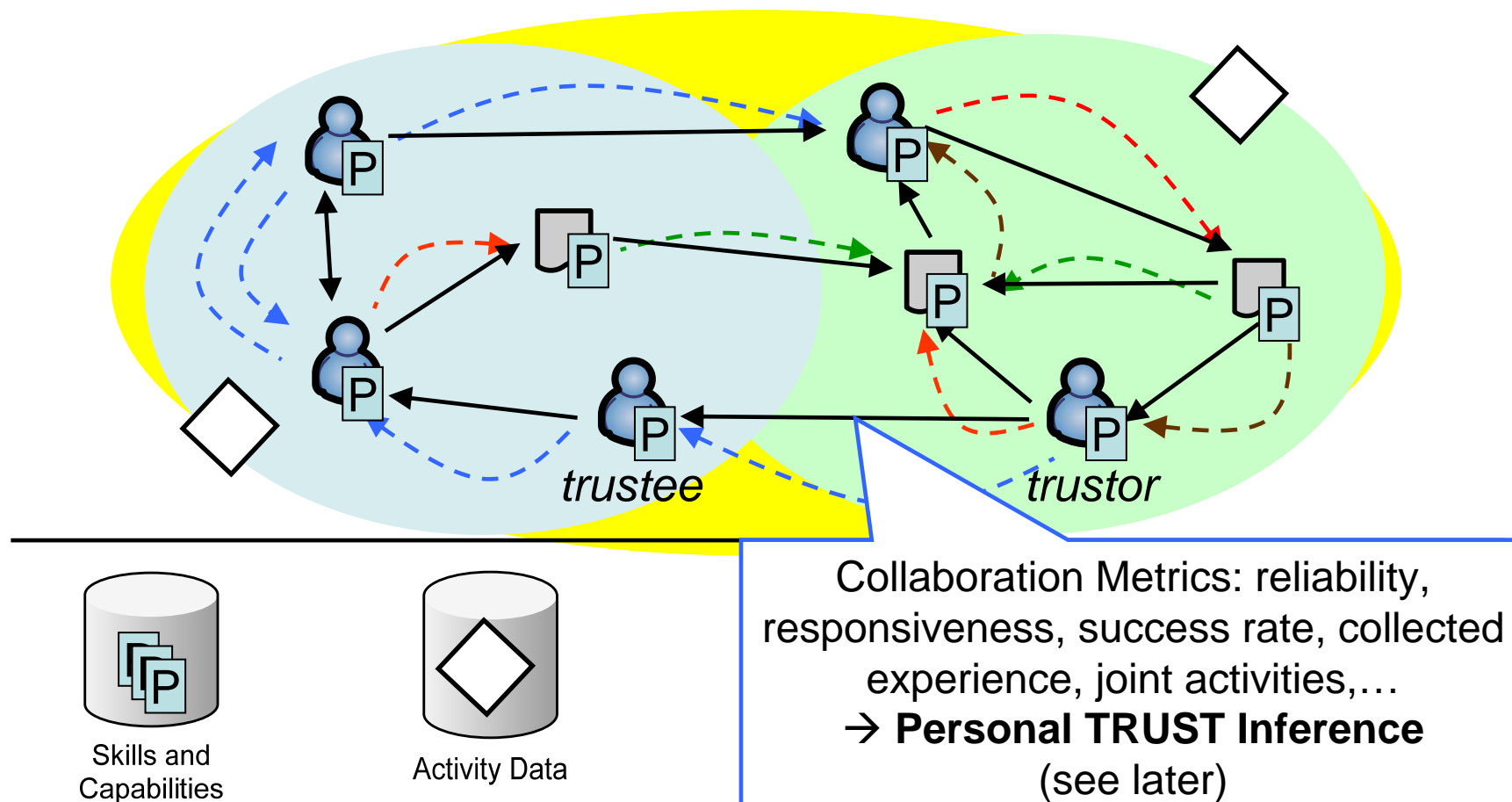
Human-Provided Services (HPS)

- User contributions modeled as services
 - Users define their own services
 - Reflect willingness to contribute
- Technical realization
 - Service description with WSDL (capabilities)
 - Communication via SOAP messages
- Example: Document Review Service
 - Input: document, deadline, constraints
 - Output: review comments



[EEE] D. Schall, H.-L. Truong, S. Dustdar. *The Human-Provided Services Framework*. IEEE 2008 Conference on Enterprise Computing, E-Commerce and E-Services (EEE), Crystal City, Washington, D.C., USA, 2008. IEEE.

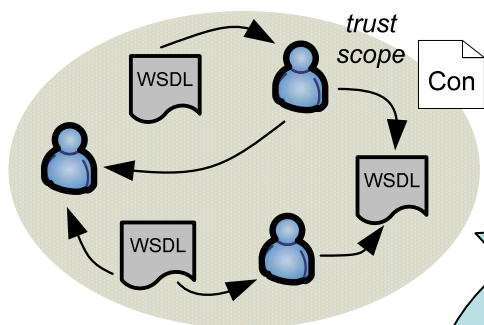
Collaboration Network Concepts



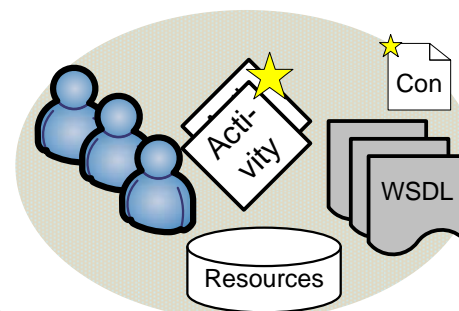
[IS] F. Skopik, D. Schall, S. Dustdar. *Modeling and Mining of Dynamic Trust in Mixed Service-oriented Systems*. Information Systems. Accepted for publication, March 2010. Elsevier.

The Cycle of Trust

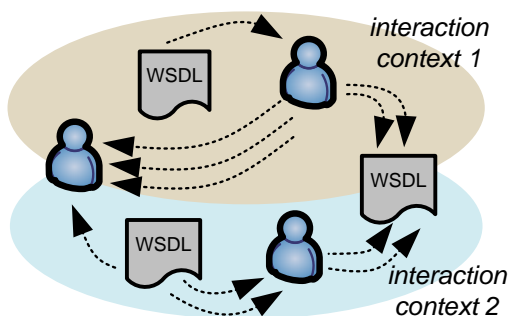
Analyzing Interactions
Establishing Trust Network



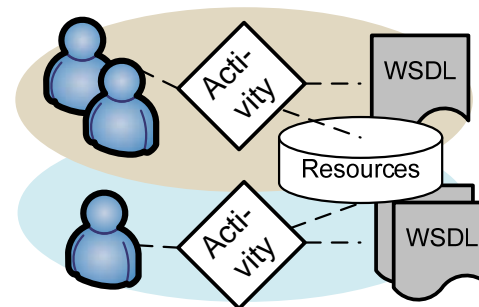
Trust-aware
collaboration **planning**



Monitoring
Collaboration



Executing
Activities/Tasks



[SEAA09] F. Skopik, D. Schall, S. Dustdar. *The Cycle of Trust in Mixed Service-oriented Systems*. 35th Euromicro Conference on Software Engineering and Advanced Applications. Patras, Greece, 2009. IEEE.

Structure of Presentation

- Loose coupling



environment
model

- Discovery



metrics

monitoring

network structure

- Dynamic binding



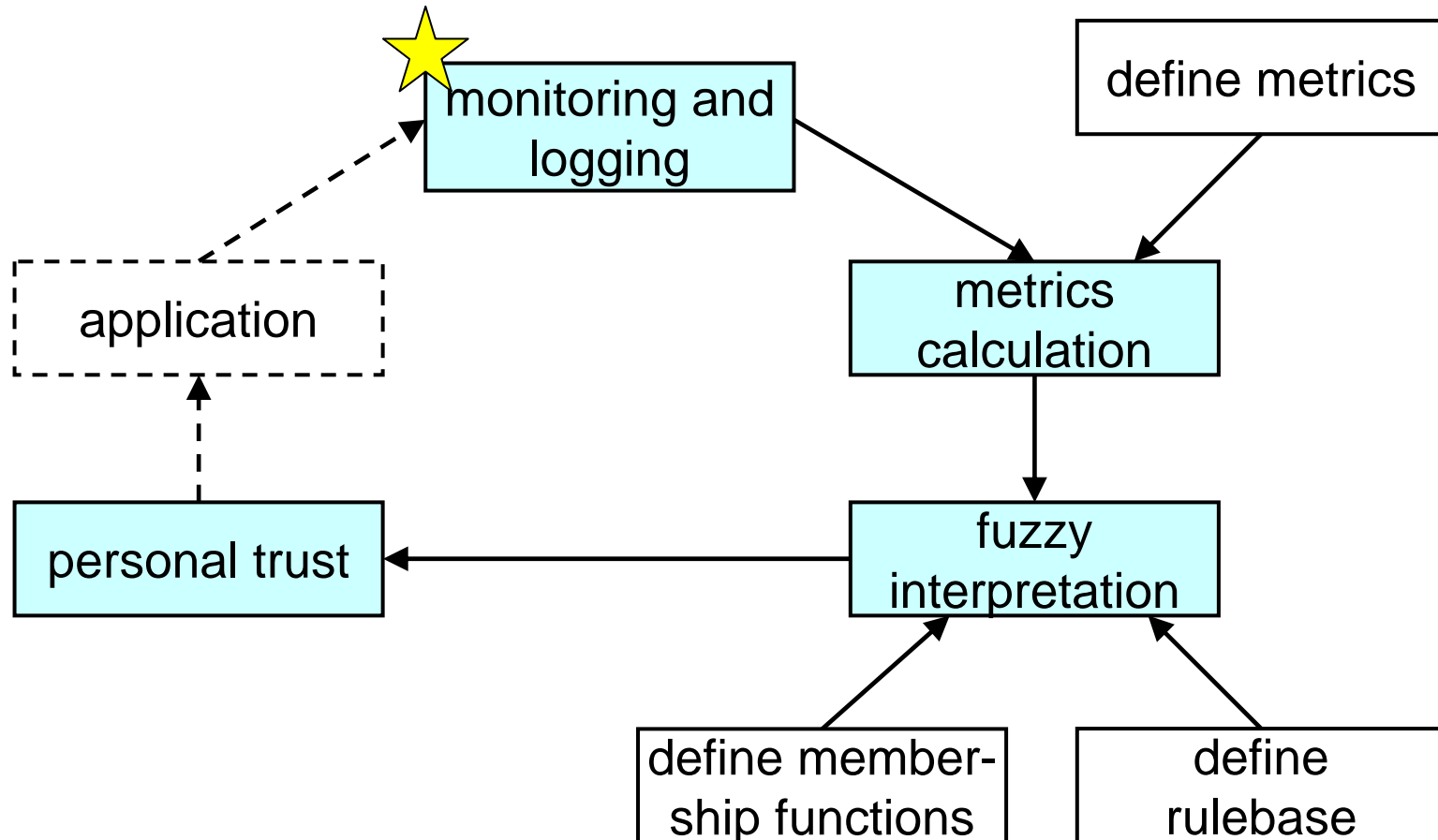
TRUST

definition
meaning
applications

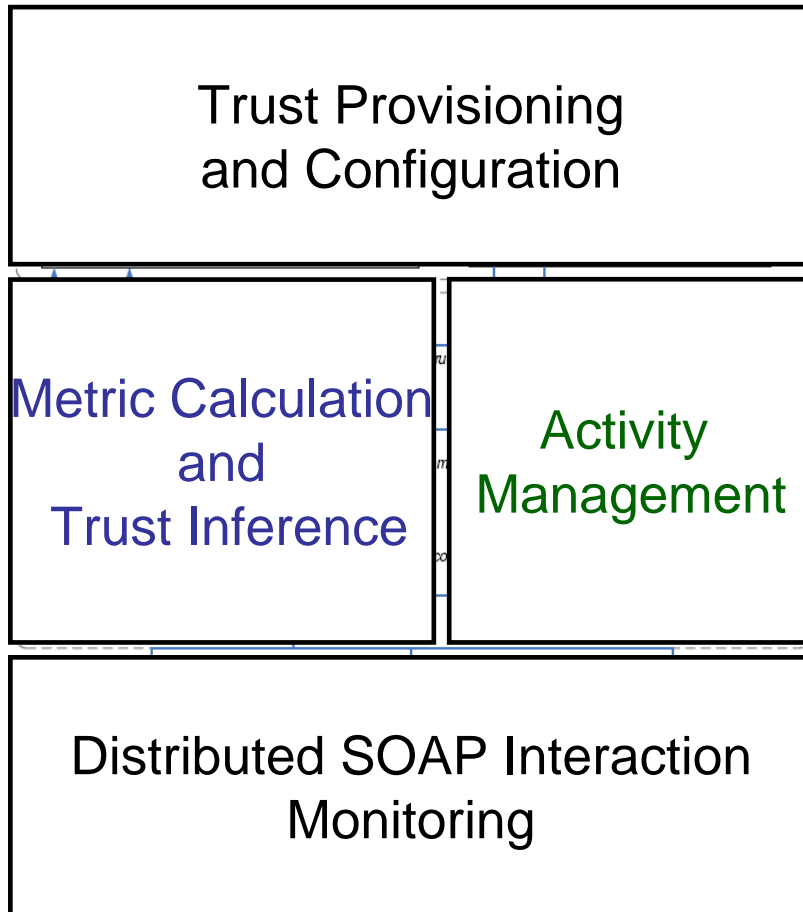
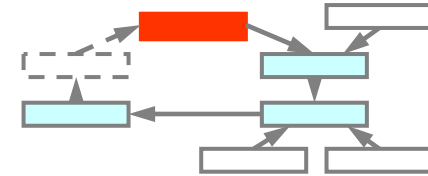
**Automatic inference
of personal trust**

Bootstrapping
trust

Trust Inference Overview



[SAC10] F. Skopik, D. Schall, S. Dustdar. *Trustworthy Interaction Balancing in Mixed Service-oriented Systems*. 25th ACM Symposium on Applied Computing. Sierre, Switzerland, 2010. ACM.

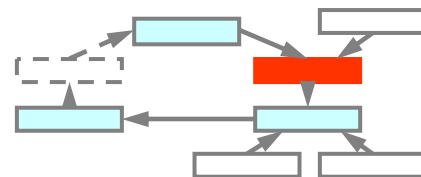


```

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  xmlns:soap=...
  <soap:Header>
    <vietypes:timestamp value="2010-06-18T10:59:00"/>
    <vietypes:delegation hops="3" deadline="..."/>
    <vietypes:activity url="http://.../Activity#42"/>
    <wsa:MessageID>uuid:722B1240-...</wsa:MessageID>
    <wsa:ReplyTo>http://.../Actor#Florian</wsa:ReplyTo>
    <wsa:From>http://.../Actor#Florian</wsa:From>
    <wsa:To>http://.../Actor#Daniel</wsa:To>
    <wsa:Action>http://.../Type/RFS</wsa:Action>
  </soap:Header>
  <soap:Body>
    <hps:RFS>
      <rfs:requ>Can you review my slides?</rfs:requ>
      <rfs:generalterms>review, ...</rfs:generalterms>
      <rfs:keywords>computer science, ...</rfs:keywords>
      <rfs:resource url="http://.../phd-defense.ppt"/>
    </hps:RFS>
  </soap:Body>
</soap:Envelope>

```

[SAC10] F. Skopik, D. Schall, S. Dustdar. *Trustworthy Interaction Balancing in Mixed Service-oriented Systems*. 25th ACM Symposium on Applied Computing. Sierre, Switzerland, 2010. ACM.



- Measure collaboration attitude
 - Define metrics that describe trustworthy behavior
 - Calculate metrics upon captured interactions

- Example Scenarios

$$t_r^s = \frac{\sum_{rfs \in RFS} (t_{receive}(rfs) - t_{send}(rfs))}{|RFS|}$$

- Expert Web : *fast and reliable responses*

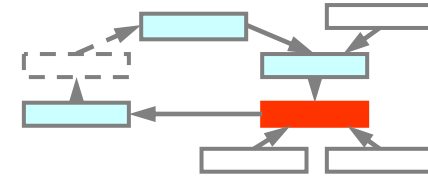
- Average response time
 - (Activity support) success rate

$$sr^s = \frac{num(sRFS)}{num(sRFS) + num(fRFS)}$$

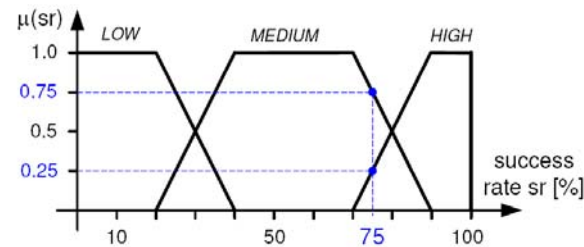
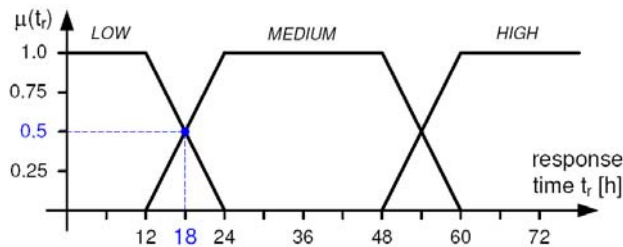
- Information disclosure in science collaboration:
matching interests and beneficial behavior

- Interest/expertise profile similarity
 - Reciprocity: mutual 'give and take'

[TR10-1] F. Skopik, D. Schall, S. Dustdar. *Adaptive Information Disclosure in a Dynamic Web of Trust*. Under review for publication. Technical Report TUV-1841-2010-3, 2010.

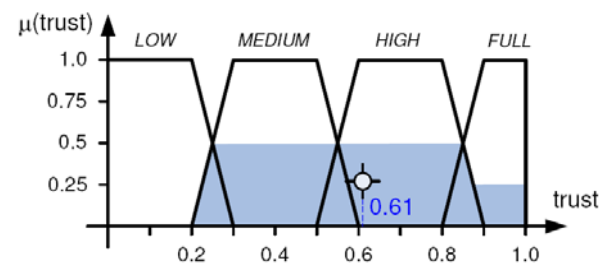
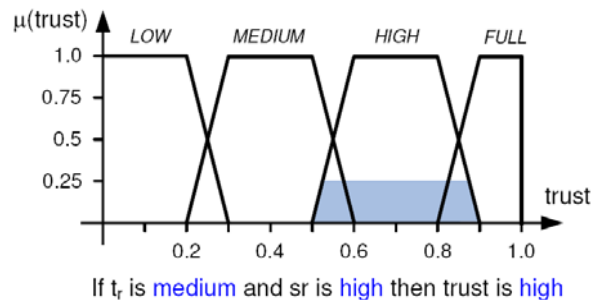


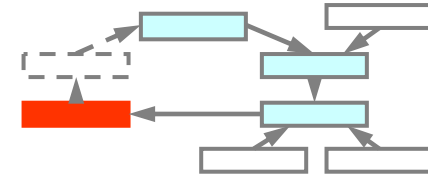
- Interpretation using fuzzy set theory
 - define membership functions (SLA, best practice)



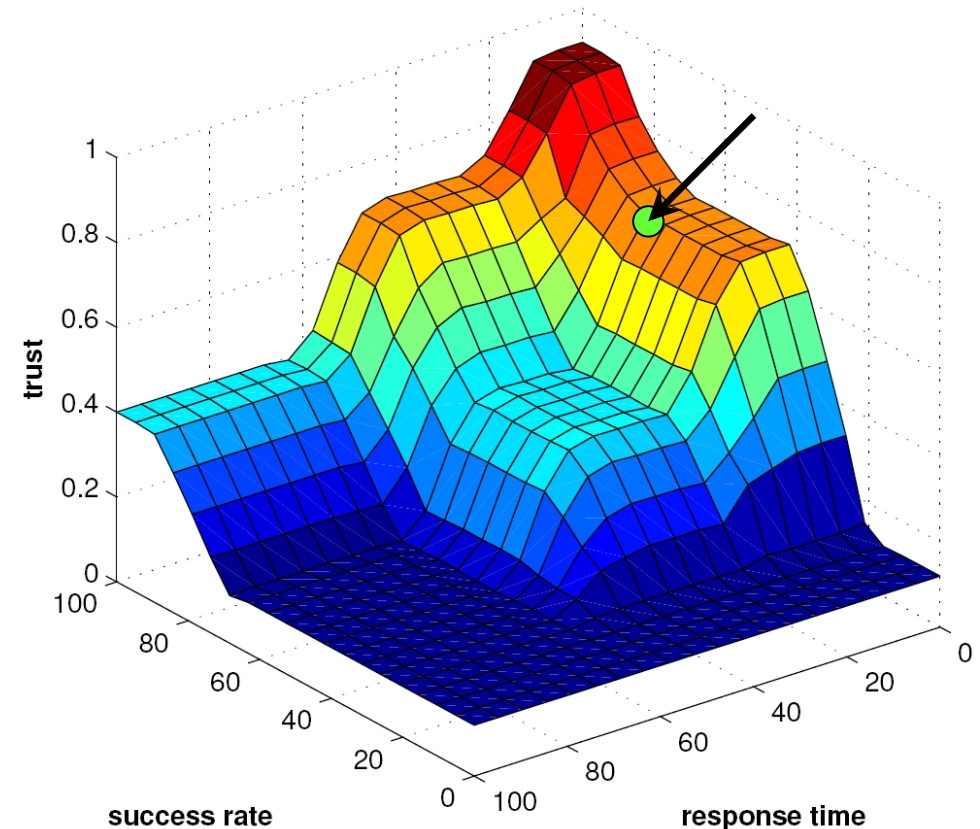
- define rule base
 - if t_r is low and sr is low then $trust$ is low
 - if t_r is medium and sr is high then $trust$ is high

- mapping of values, inference and defuzzification

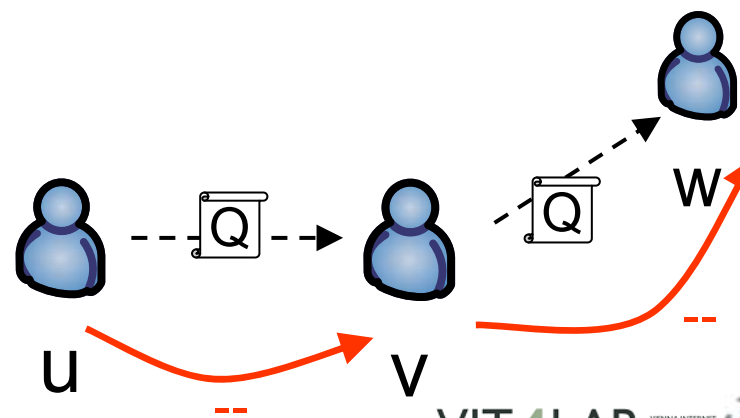
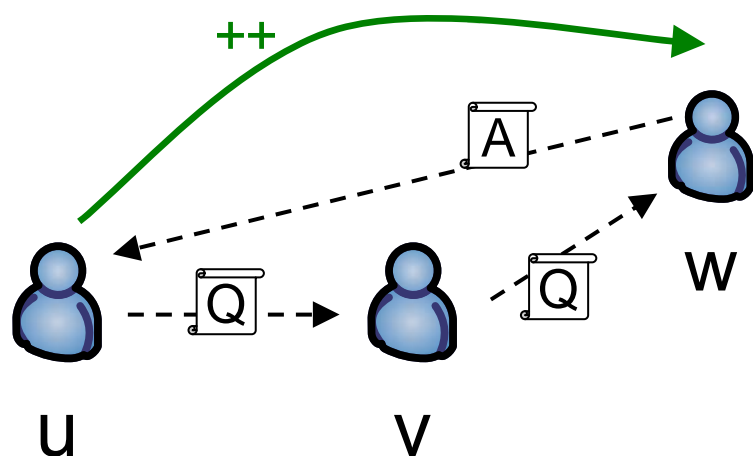




- What is the meaning of trust in the given scenario?
 - **absolute trust limits** (e.g., pre-defined constraints for collaboration)
 - **relative ranking** (e.g., who is the most trusted expert from one's personal perspective?)

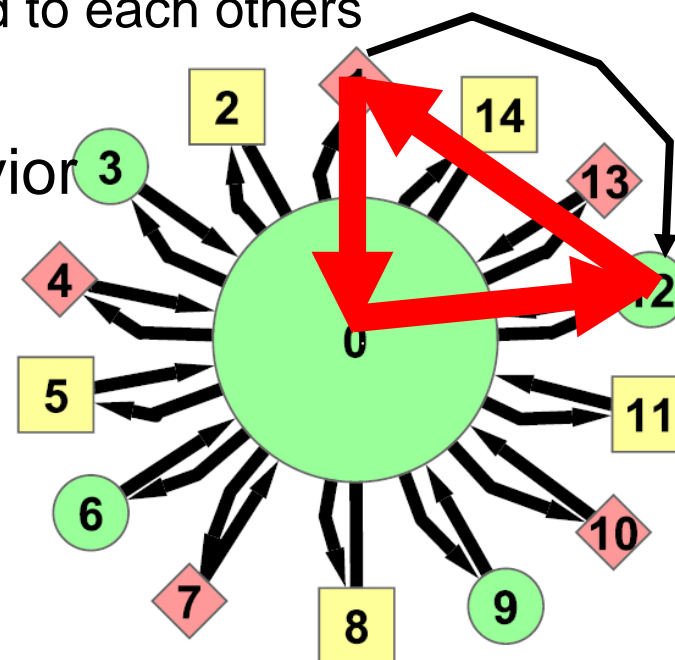


- Problem: Usually, always the most trusted expert is selected
 - Successful interactions lead to more trust: “The rich get richer”
 - Multiple selections lead to temporary overload
- Solution: Balancing through delegations (triadic interaction pattern)



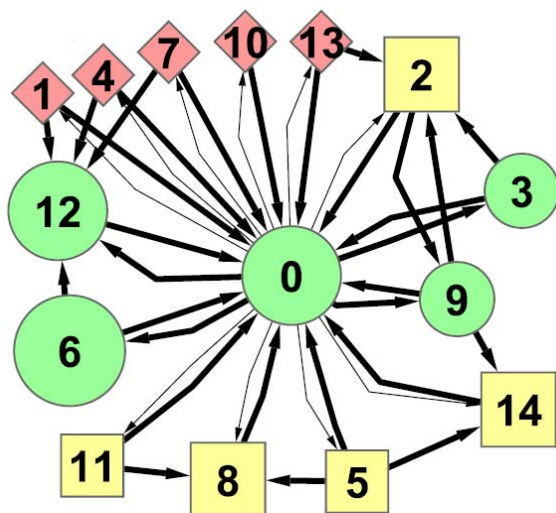
Evaluation: Interaction Balancing (1/3)

- Group formation through invitations
 - All members are connected to initiator 0
 - All members send requests to the initiator
 - Initiator delegates requests using the *Triad pattern*
 - Delegation receiver responds to the initial requester
 - On Success, members get introduced to each others
- Simulation of different actor behavior
 - Fair players (green)
 - Erratic actors (yellow)
 - Malicious attackers (red)

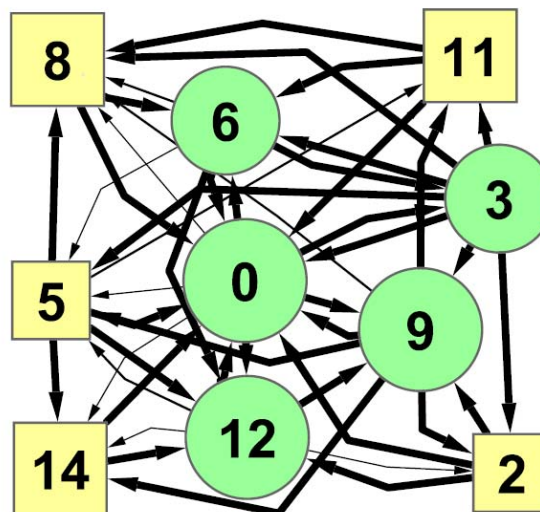


Evaluation: Interaction Balancing (2/3)

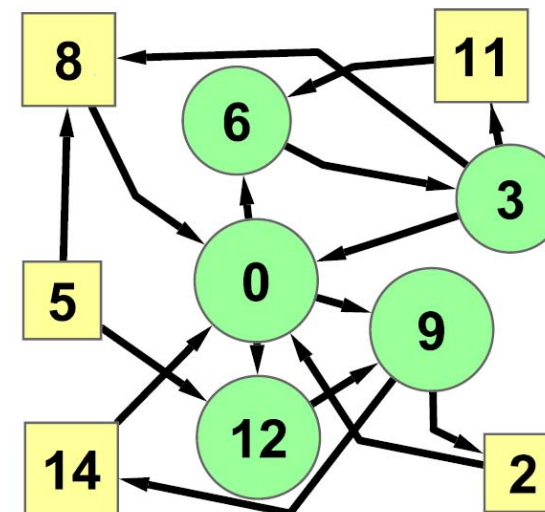
- Round-based simulation ($r=250$)
 - One request per round per actor sent *and* served or delegated.
 - Untrustworthy actors are punished and excluded from the community after $r=100$.



(b) intermediate $n=100$



(c) balanced $n=250$



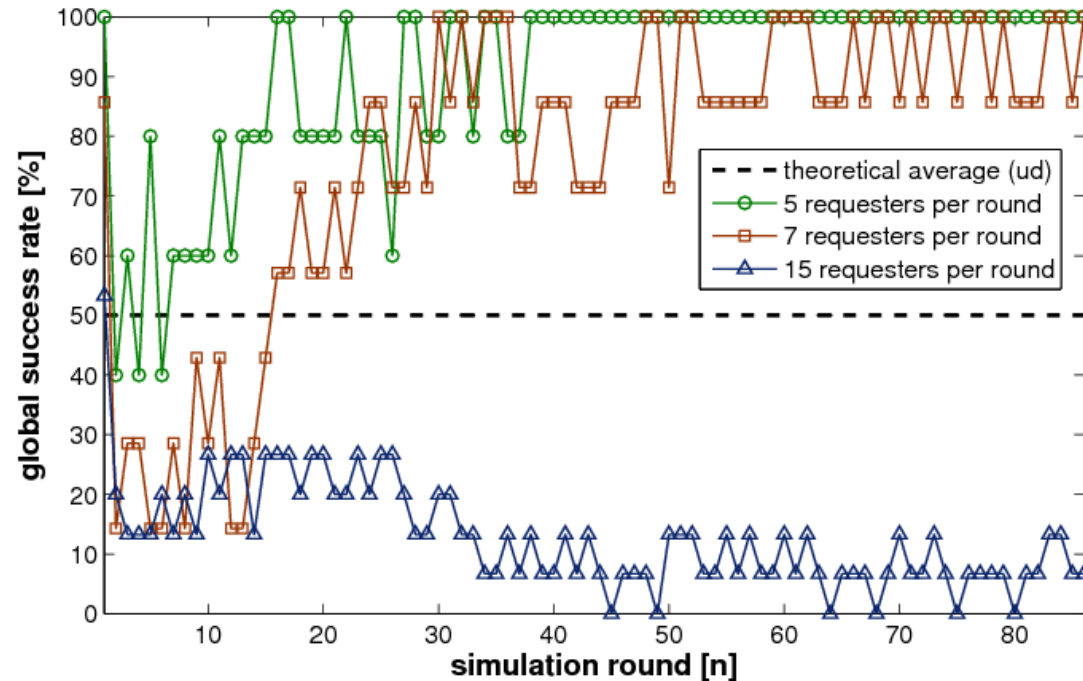
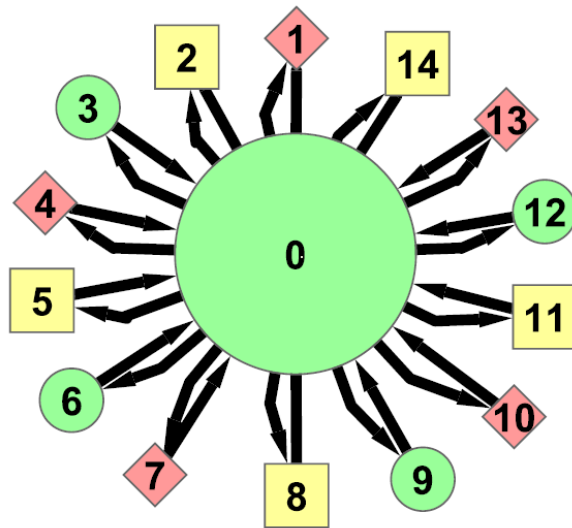
(d) balanced (reduced)

Detailed simulation setup and experiment results in:

[SAC10] F. Skopik, D. Schall, S. Dustdar. *Trustworthy Interaction Balancing in Mixed Service-oriented Systems*. 25th ACM Symposium on Applied Computing (SAC). Sierre, Switzerland, 2010. ACM.

Evaluation: Interaction Balancing (3/3)

- **Global success rate:** amount of finished tasks.
- Varying number of requesters in the network



- RFS: sending, delegating, and processing takes exactly one round.
- RFSs (and delegations) are considered failed if not replied after 15 rounds.

Structure of Presentation

- Loose coupling

flexible collaborations

environment model

- Discovery

dynamic properties

metrics

monitoring

network structure

- Dynamic binding

selection

TRUST

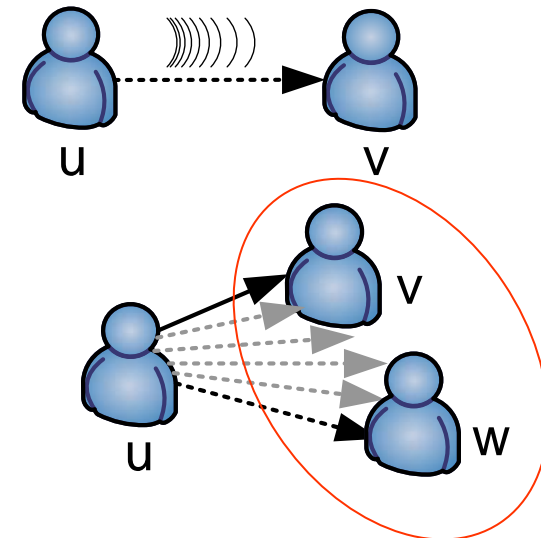
Automatic inference of personal trust

Bootstrapping trust

definition
meaning
applications

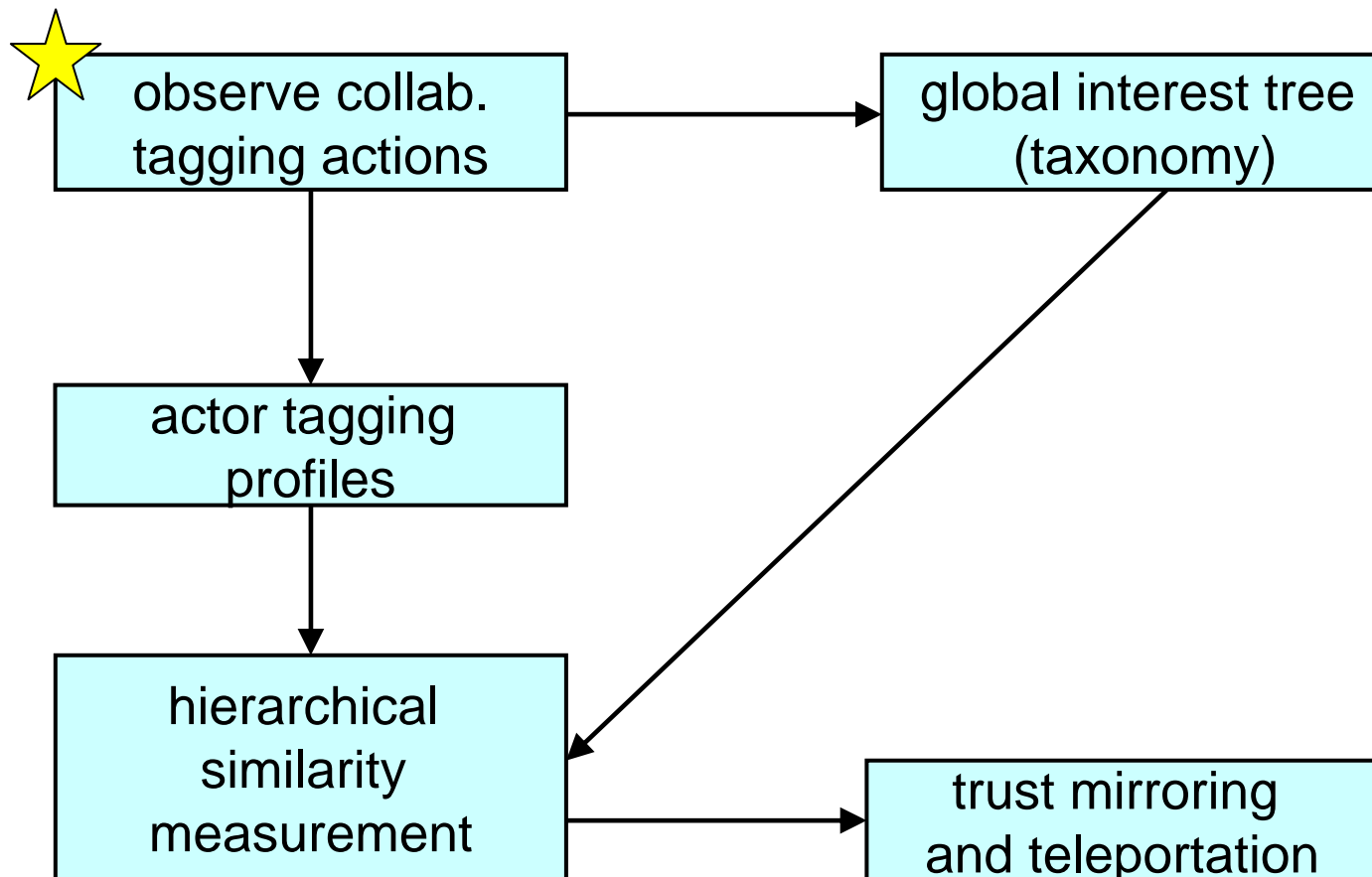
Bootstrapping of Trust

- **Problem:** What if no interactions with a potential collaboration partner have been captured?
- Trust Mirroring
 - people tend to trust 'similar minded' persons
 - calculation of interest similarities
- Trust Teleportation
 - people benefit from trust relations in actors from the same group (i.e., advanced trust due to similar profiles as existing trustees)



[WISE09] F. Skopik, D. Schall, S. Dustdar. *Start Trusting Strangers? Bootstrapping and Prediction of Trust*. 10th International Conference on Web Information Systems Engineering (WISE). Poznan, Poland, 2009. Springer.

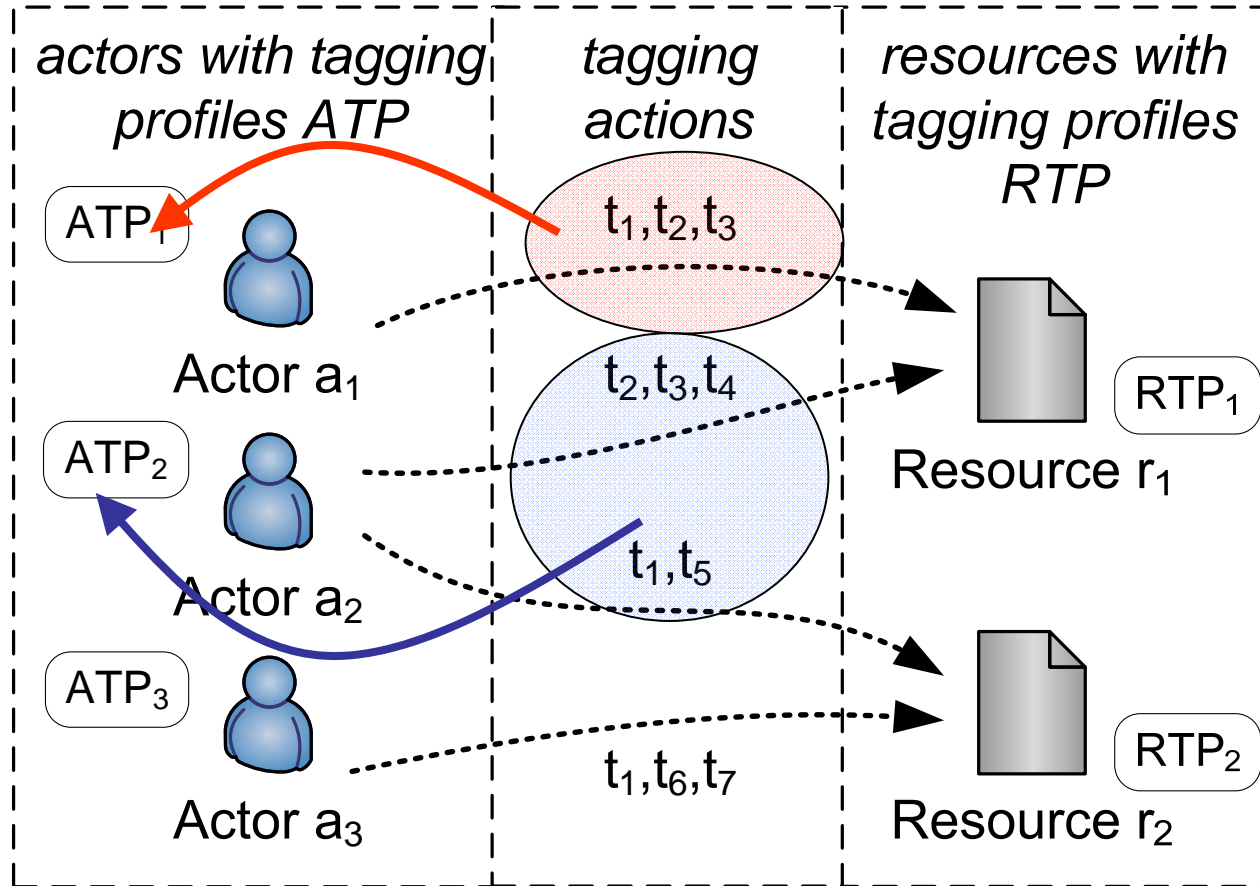
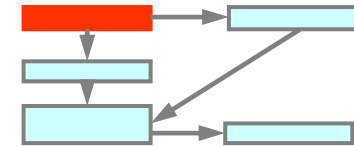
Bootstrapping Trust Overview (through similarity of tagging behavior)



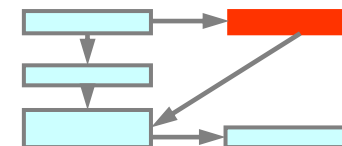
[WISE09] F. Skopik, D. Schall, S. Dustdar. *Start Trusting Strangers? Bootstrapping and Prediction of Trust*. 10th International Conference on Web Information Systems Engineering (WISE). Poznan, Poland, 2009. Springer.

Bootstrapping Approach (1)

Observe Collaborative Taggings



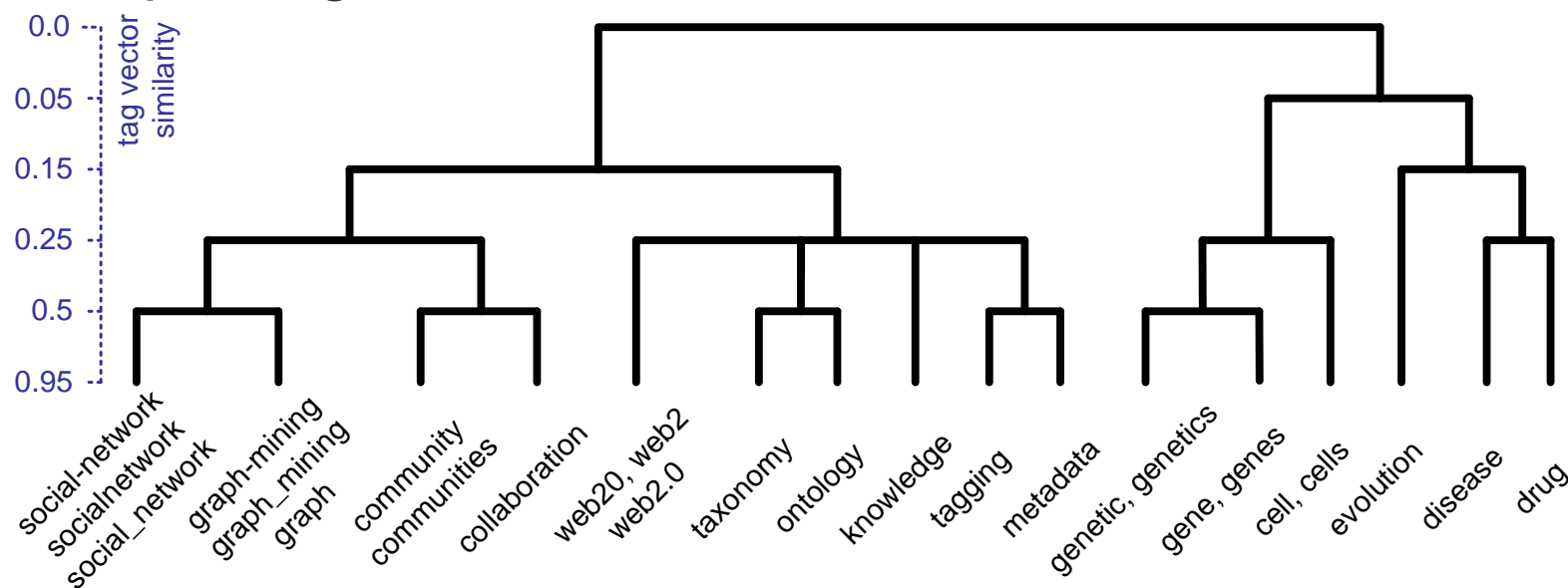
Dynamic tagging profiles characterize actors.
Problem: Compare tagging behavior (usage of tags)!

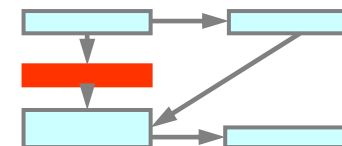


- Use tagging actions (actor—**tag—resource**)
 - degree of tags' co-occurrence determines closeness
 - clustering: compare tag frequency vectors (tf*idf)
 - different similarity thresholds → hierarchy

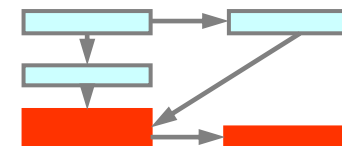
■ Global interest tree

- express global areas of interests and relations

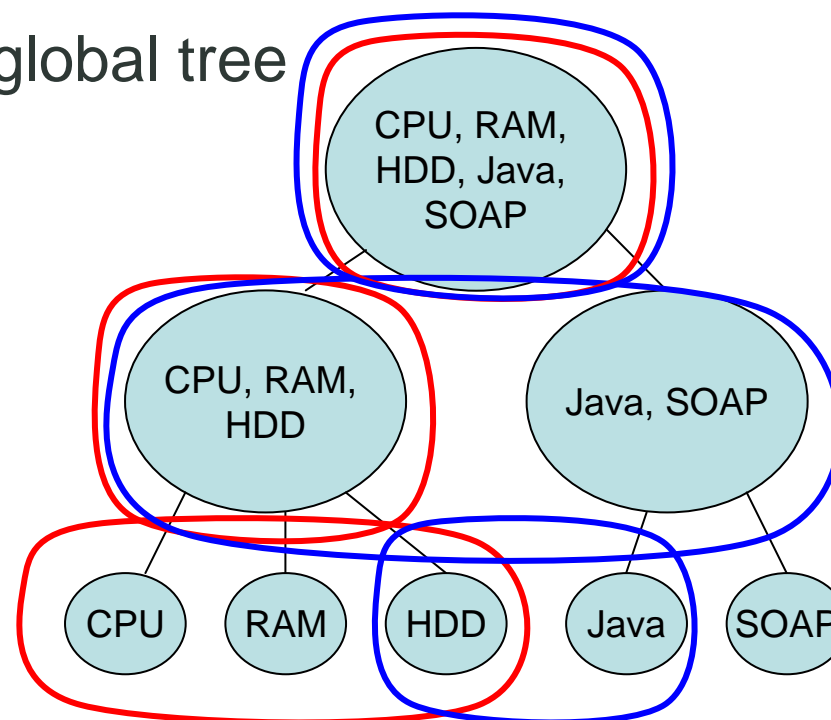




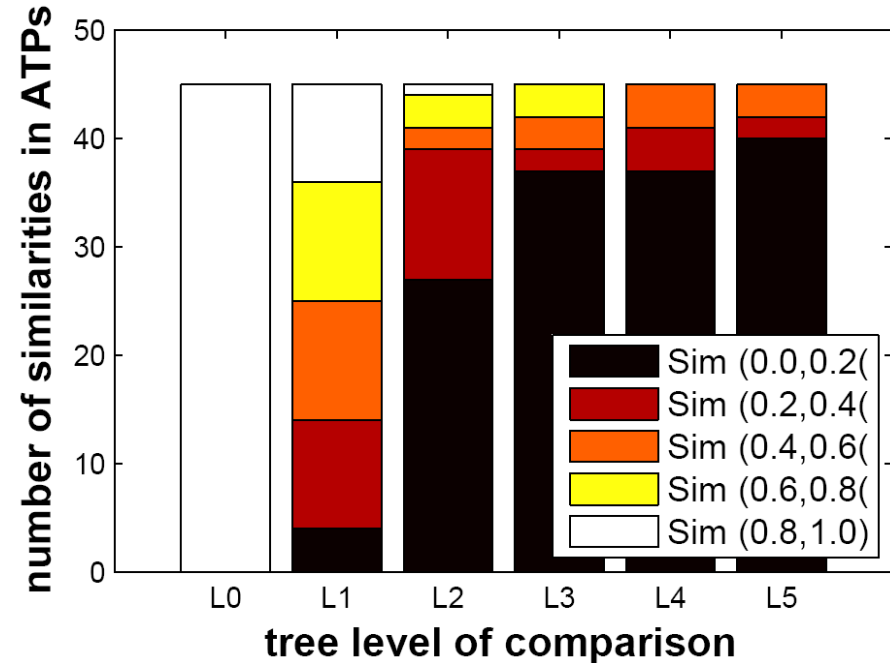
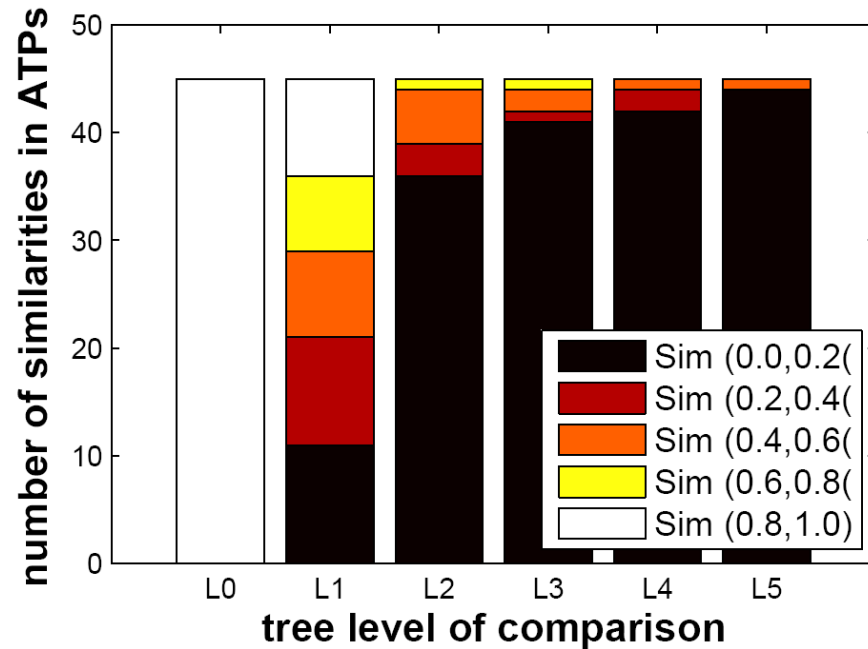
- Actor tagging profiles (ATPs)
 - describe mainly used tags of an actor
 - tag usage vector
- A) General ATPs
 - use tagging actions (**actor—tag—resource**)
 - independent from resources
- B) Tailored ATPs
 - use tagging actions (**actor—tag—resource**)
 - used tags on a specified subset of resources
 - “What is someone’s understanding of a given resource set?”



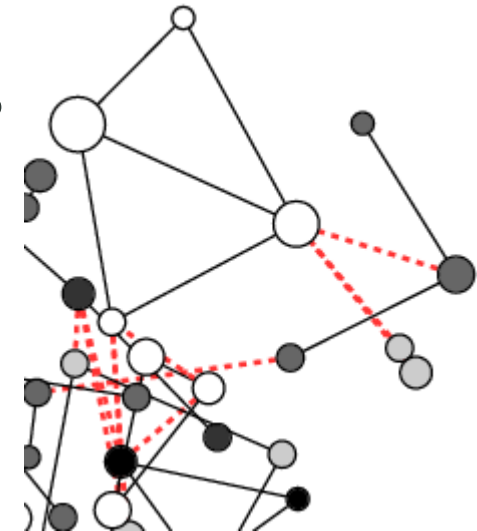
- Hierarchical similarity measurement
 - weighting of ATP vectors wrt. the global interest tree
 - cosine-similarity of profile vectors
 - on different levels of the global tree
- Result: two outputs
 - similarity in $[0,1]$
 - reliability of similarity (dep. on level of comp.)
- Apply profile similarities
 - trust mirroring
 - trust teleportation



Evaluation: Bootstrapping



- Compare ATPs of **citeulike** users
 - 45 comparisons (all with each other)
 - General ATP similarity (left fig.)
 - Tailored ATP similarity (right fig.)
(tags used on SNA papers only)



Conclusion

- **Delegation** patterns lead to an emergence of trust
 - No traditional point-to-point relations only (see balancing)
- **Behavior models** and patterns influence trust
 - Social metrics: interest similarity, reciprocity, ...
 - Temporal properties: actor uniformity, reliability, ...
 - Context awareness of metrics and relations
- **Discovery and selection** of trustworthy partners
 - Bootstrapping mechanisms
 - Network structures: recommendation, reputation
 - Personal experience: trust
- Various applications of dynamic **system adaptations**
 - Information disclosure
 - Resource allocation
 - Actor compositions

Thank you.

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