Trust-based Adaptation in Complex Service-oriented Systems

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Environment and Motivation

- Open and **dynamic** Environment
  - humans **and** resources (e.g., 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
  - activity and task assignments

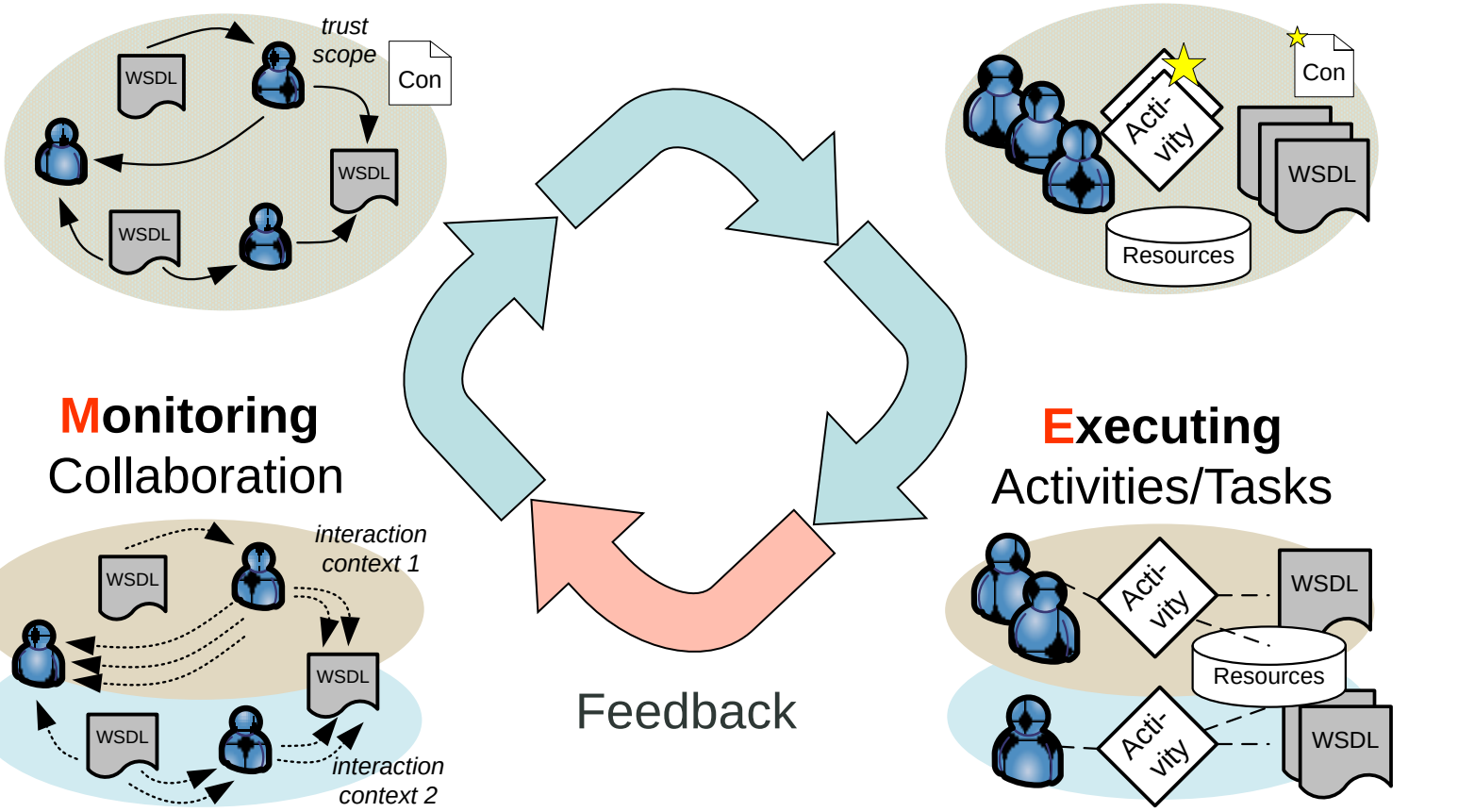
Definition of (Social) Trust

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

The Cycle of Trust

Analyzing Interactions
Establishing Trust Network

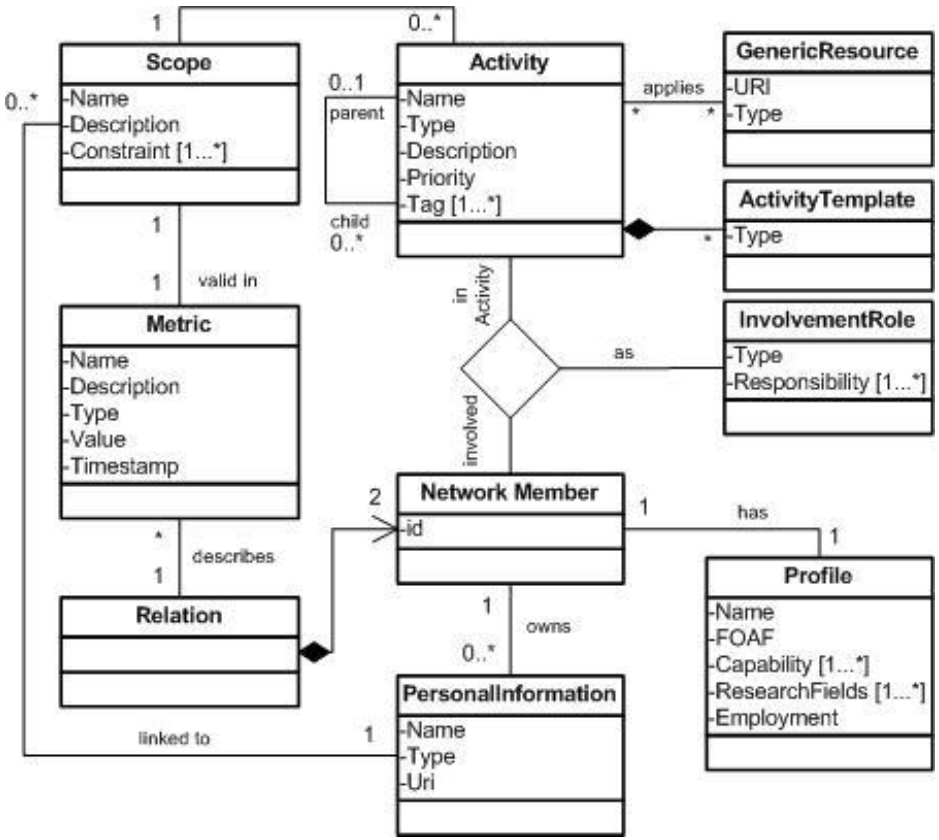
Trust-aware
collaboration **p**lanning



[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.

Foundational Concepts (1/2): Flexible Ad-hoc Collaboration

- Activities
  - describe work that dynamically emerges during collaboration
  - are performed collaboratively
  - determine the context of interactions
  - are a means to structure information in flexible collaboration environments

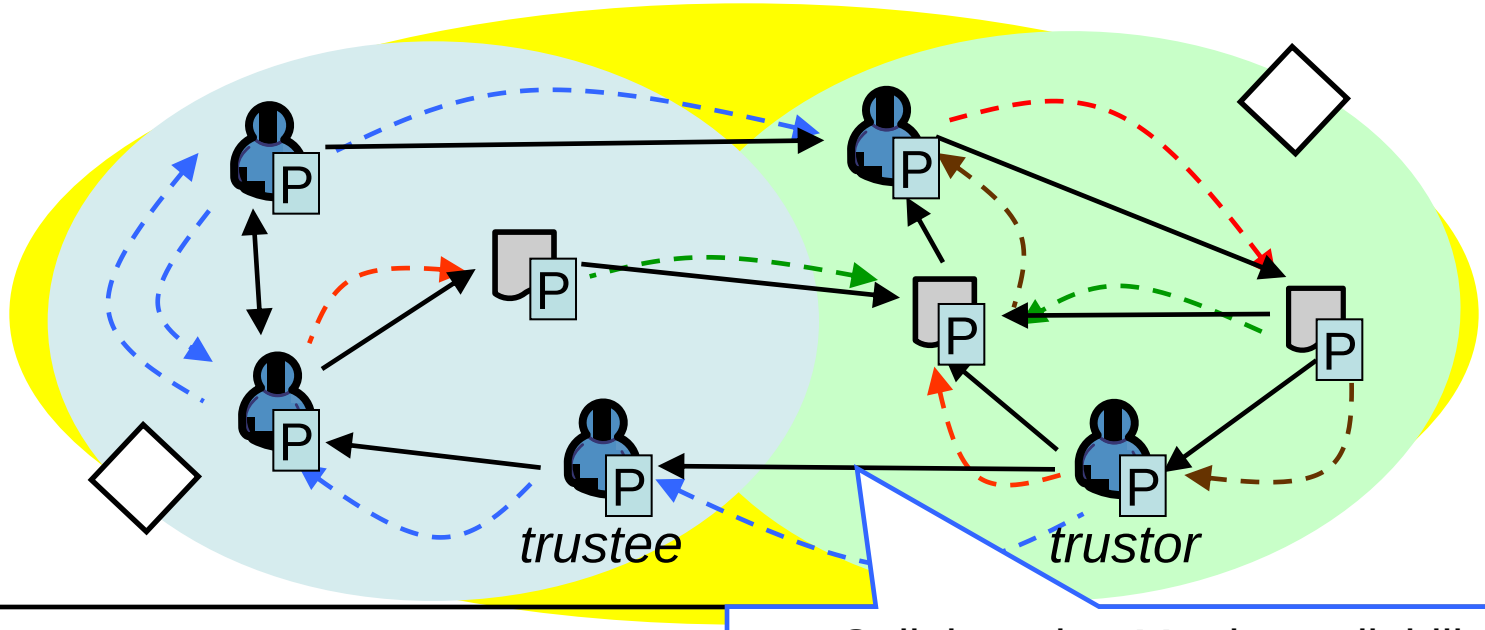


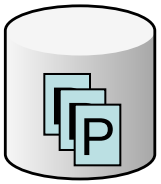
Foundational Concepts (2/2): Mixed System

- Mixed System
  - Mix of human- and software services collaboration
  - Humans provide services using SOA concepts
- Human-Provided Services (HPS)
  - User contributions as services
    - Service description with WSDL
    - Communication via SOAP messages
  - Example: Document Review Service
    - Input: document, deadline
    - Output: review comments

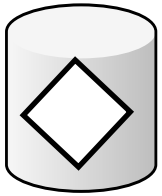
[EEE] D. Schall, H.-L. Truong, S. Dustdar. *The Human-Provided Services Framework*. IEEE 2008 Conference on Enterprise Computing, E-Commerce and E-Services (EEE), Crystal City, Washington, D.C., USA, 2008. IEEE.

Collaboration Network Concepts





Skills and Capabilities



Activity Data

Collaboration Metrics: reliability, responsiveness, success rate, collected experience, joint activities,…
→**Personal TRUST Inference**
(see later)

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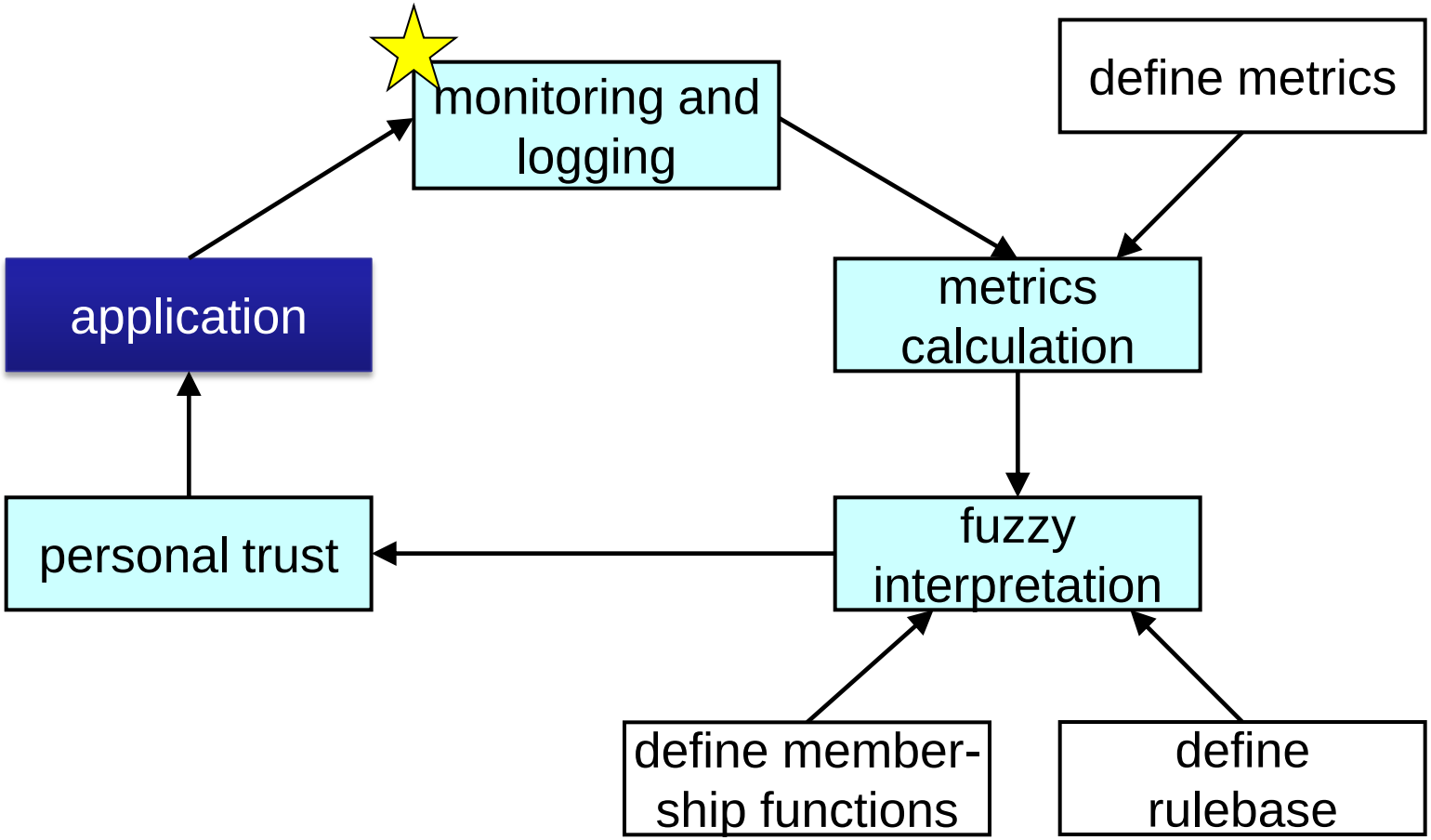
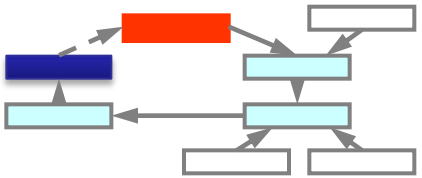
Trust-based Adaptation



Dynamic Trust (1)

Monitoring and Logging



Trust Provisioning and Configuration

Metric Calculation and Trust Inference

Activity Management

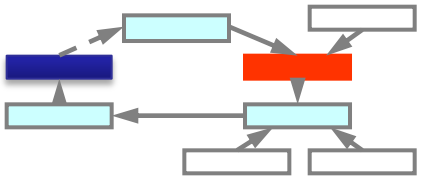
Distributed SOAP Interaction Monitoring

```
<soap:Envelope
 xmlns:soap=...
 <soap:Header>
   <vietypes:timestamp value="2009-03-05T15:13:21"/>
   <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 ...?</rfs:requ>
    <rfs:generalterms>...</rfs:generalterms>
    <rfs:keywords>...</rfs:keywords>
    <rfs:resource url= "..."/>
   </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.

Dynamic Trust (2)

Calculate Metrics



- Define Metrics
  - emergency support: fast and reliable responses
  - neglect others, e.g., costs
- Calculate Metrics in the scope interactions (here: requests for support (RFSs))
  - **average response time**

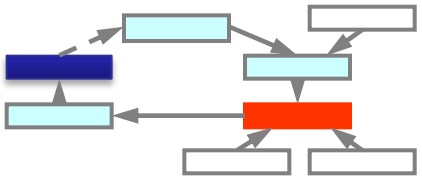
$$t_r^s = \frac{\sum_{rfs \in RFS} (t_{receive}(rfs) - t_{send}(rfs))}{|RFS|}$$

  - **activity success rate**

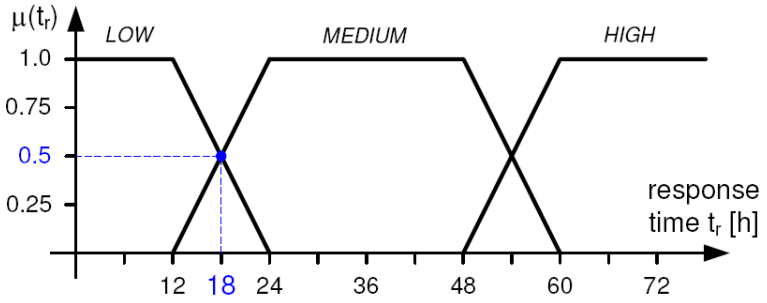
$$sr^s = \frac{num(sRFS)}{num(sRFS) + num(fRFS)}$$

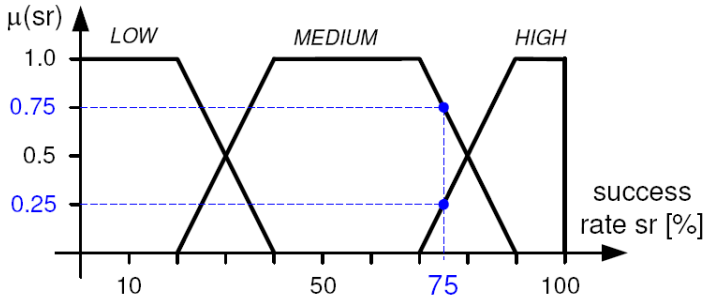
Dynamic Trust (3)

Fuzzy Interpretation



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





  - define rule base

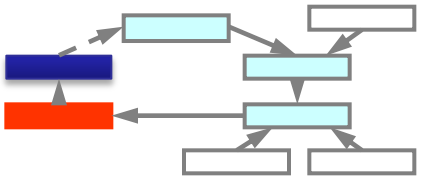
```
if t_r is low    and sr is low    then trust is low
if t_r is medium and sr is high   then trust is high
```

  - mapping of values, inference and defuzzification

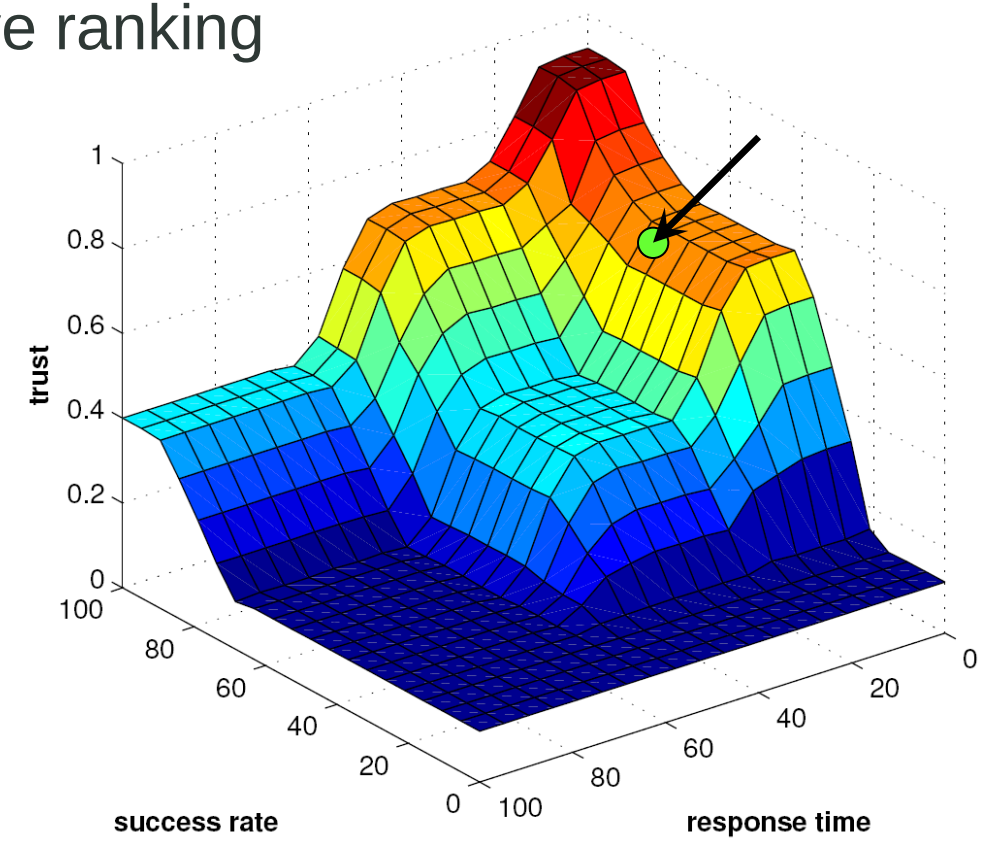
[SAC10] F. Skopik, D. Schall, S. Dustdar. *Trustworthy Interaction Balancing in Mixed Service-oriented Systems*. 25th ACM Symposium on Applied Computing. Sierre, Switzerland, 2010. ACM.

Dynamic Trust (4)

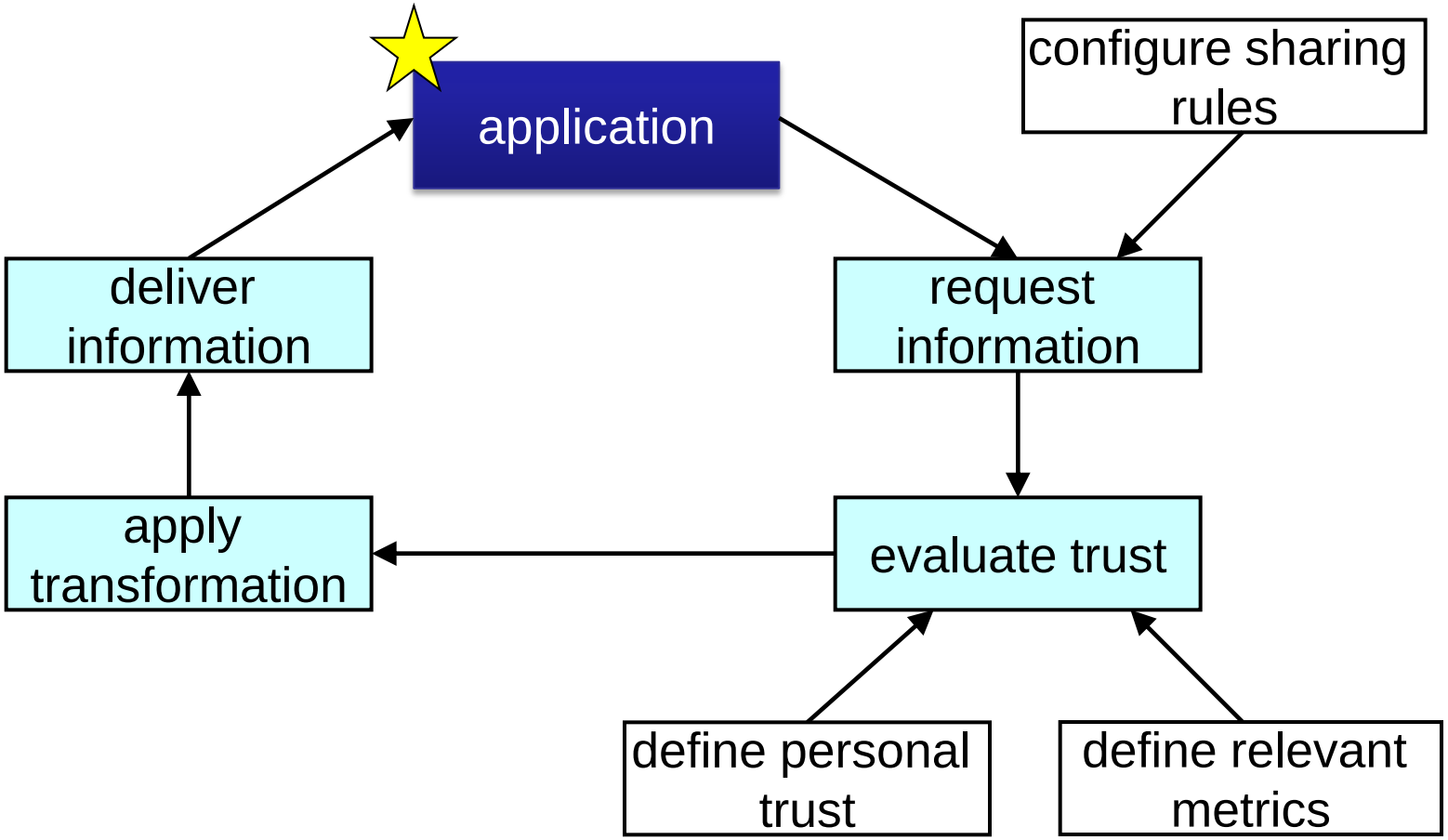
Personal Trust



- What is the meaning of trust in the scenario?
  - absolute limits
  - relative ranking

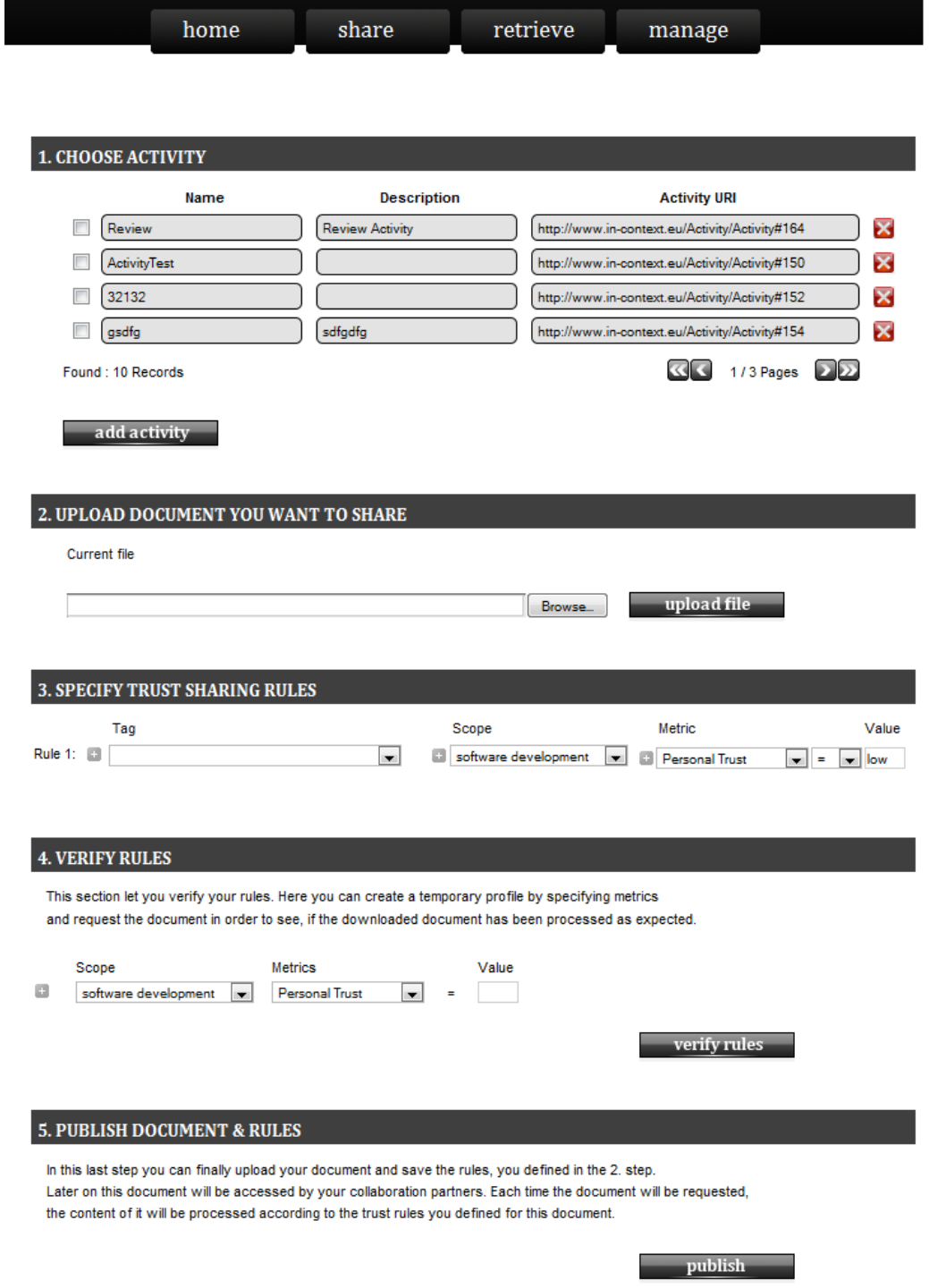


Application of Dynamic Trust



Sharing Configuration

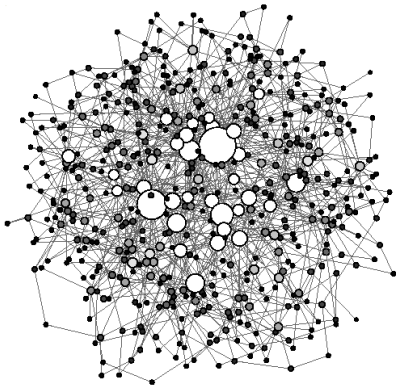
1. Choose Activities
   determine the scope of sharing rules
2. Select Document
   document is shared in collaborations. Some parts need to filtered based on **trust**
3. Specify Sharing Rules
   tags identify parts in (XML-based) document
4. Verify Rules
   to test the effect of rules
5. Publish Document and Rules



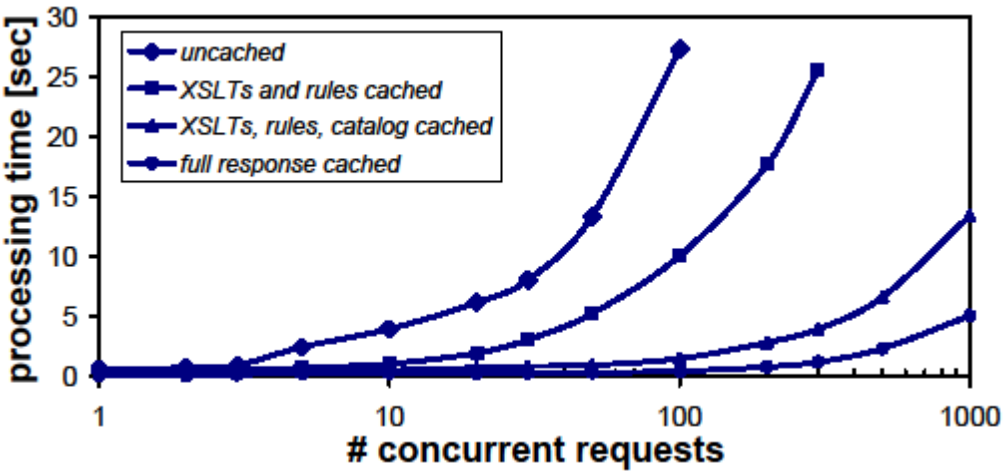
Evaluation

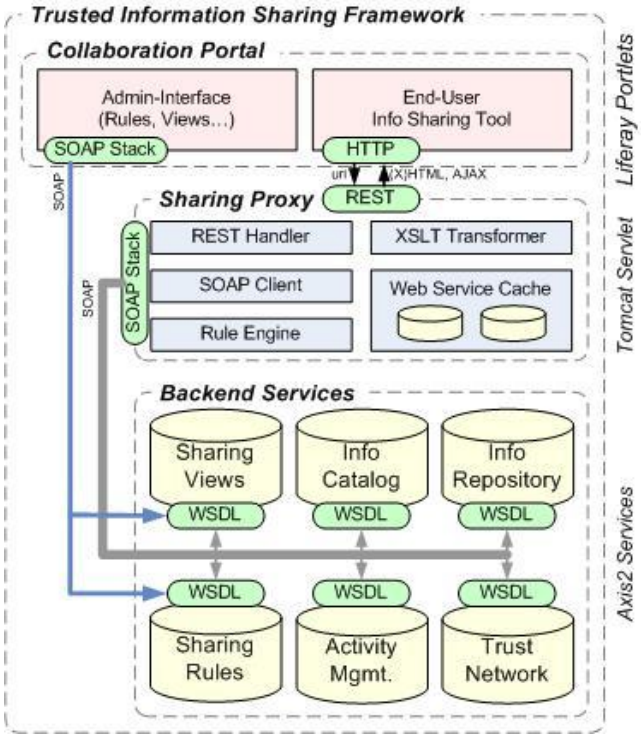
(see paper for details)

1. Generate Interaction Graph
   - reflecting collaboration scenario
   - scale-free structure (science collaborations)



2. Feed into Sharing Framework
3. Measure End-to-End Performance





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Conclusion and Future Work

- Concept of trust in
  - Activity-centric flexible collaboration
  - Service-oriented environment (Mixed Systems)
- Trust inference approach
- Information sharing based on dynamically evolving trust

- Future Work
  - Applications in real end-user environments (EU FP7 project COIN)

Thanks!

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