

# **Towards Quality of Experience- based Reputation Models for Future Web Service Provisioning**

Future Internet Architectures: New Trends in  
Service Architectures - 2nd Euro-NF Workshop  
and Future Internet Cluster meeting  
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# Agenda

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- Objectives
- QoE characterization
- Reputation systems
- Applications

# Objectives

- Motivations - “Observations leading to inspiration”
  - **P2P model** - web services become user generated - Web2.0 – ASP provides a service skeleton filled and shaped up with user content and logic, which brings the communication model to P2P-like service
  - **Challenges** – continuous development of self accelerating technologies increases the complexity of contemporary web service – service interoperability → Web3.0
  
- Goal
  - ***We are aiming to apply reputation systems in order to fill the gap between perceived user satisfaction of composite web services and particular (not related) QoE measures – QoE cross-layer management***
  
- Benefits
  - Based on reputation values we may assess several QoEs for web services of Future Internet and predict users’ satisfaction, react prior to QoE degradation
  - Future Internet paradigm – reputation as service with an automation, virtualization, programmability

# Related work

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- SecMon EuroFGI
  - End-to-End Quality and Security Monitoring System
- QoEWeb EuroNF - Quality of Experience and User Behaviour Modelling for Web Traffic
  - Quantification of QoE for web traffic, based on passive measurements (observations) within an operator's network and active measurements in a test laboratory
  - Description of an appropriate model for the (timely) behaviour of web user satisfaction / impatience which builds upon feedback of the user-perceived quality based on the measurements
  - Application of the derived user model to identify impact of QoE on system performance in business environments like wireless networks with shared capacity
  - Quantification of reputation management applying the derived model in order to allow provider/operator to react before the user-related reputation gets critical

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- Objectives vs. Future Internet
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# QoE characterization

- A challenge is to find a QoE measures for composite Web service
- Capabilities of a web service environment vs. QoE
  - User dependent – users' perception, expectations, attitudes, context, terminal capabilities
  - Service dependent – service content, presentation, service context, network resources,
- Subjective and objective metrics of QoE
  - Full Reference (FR) metrics
    - Off-line analysis allows for comparison QoE and QoS related parameters
    - FR metrics deliver the highest accuracy, but require high computational effort.
  - No Reference (NR) metrics
    - Online situation with sole focus on the resulting quality as perceived by the end user e.g. evaluated through questions, or the user's representative, e.g. an algorithm
    - Network conditions may impact to the evaluation giving a low accuracy
  - Reduced Reference (RR) metrics
    - On-line analysis of the outcome and income parameters on application and/or network level
    - Promising candidates to build QoE to QoS relationships

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# Reputation Systems

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## ■ Notions

- **Reputation** is a perceived grade of trustworthiness to a particular peer created by their historical behaviour during observations and interactions with third party peers in the given context and time
- **Reputation system** collects and manages evidence of peers' activity in order to support decisions systems.
  - With respect to delivered QoEs RS may isolate QoS metrics from users' application and influence the network resource sharing scheme, e.g routing processes in the P2P services and networks (overlay), multimedia coding...



# Reputation capabilities

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- Capabilities of reputation
  - Subjectivity vs. objectivity - *system architecture*
    - Reflects subjective opinions in societies and yield general scoring of a particular behavior (*distributed*)
    - Generalization (*centralized*) – collects, aggregates, correlates and evaluates measures – innate features for assessing users' satisfaction with composite web services – satisfaction is usually expressed with QoEs – user or network reputation
  - Sensibility – response time, dynamics, memory of history (QoE measures reactive and not aware of history)
  - Mathematical methods of evaluation - classification

# Reputation classification

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- Probabilistic
  - Bayesian networks
  - Subjective logic
- Fuzzy logic
- Deterministic

# Reputation – probabilistic model

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- Bayesian networks
  - Centralized system – objectivity
  - Statistical updating of probability density functions (PDF)
    - Binominal – two values: positive, negative
    - Multinomial – *longevity factor* reflecting a history of observations
- Subjective logic
  - Decentralized systems
  - Triple *Uncertainty, belief* and *disbelief* are introduced
    - Binominal
    - Multinomial
  - Transitive reputation
    - Operators *discounting* and *fusion*
- Long-term evaluation limiting the sensibility
- Statistical correlation within a complex service set

# Reputation – fuzzy model

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- Decentralized or centralized
- Fuzzy logic based reputation uses of fuzzy functions in order to reflect subjective opinions of rare events (experience)
- Fuzzy measures expresses a trust and reputation
  - Subjective and objective measure
- Transitivity
- Context aware
- History of observations
- Moderated generalization – weighted aggregation of the reputation
- Innate capability of linguistic value mapping into the fuzzy functions

# Reputation – deterministic model

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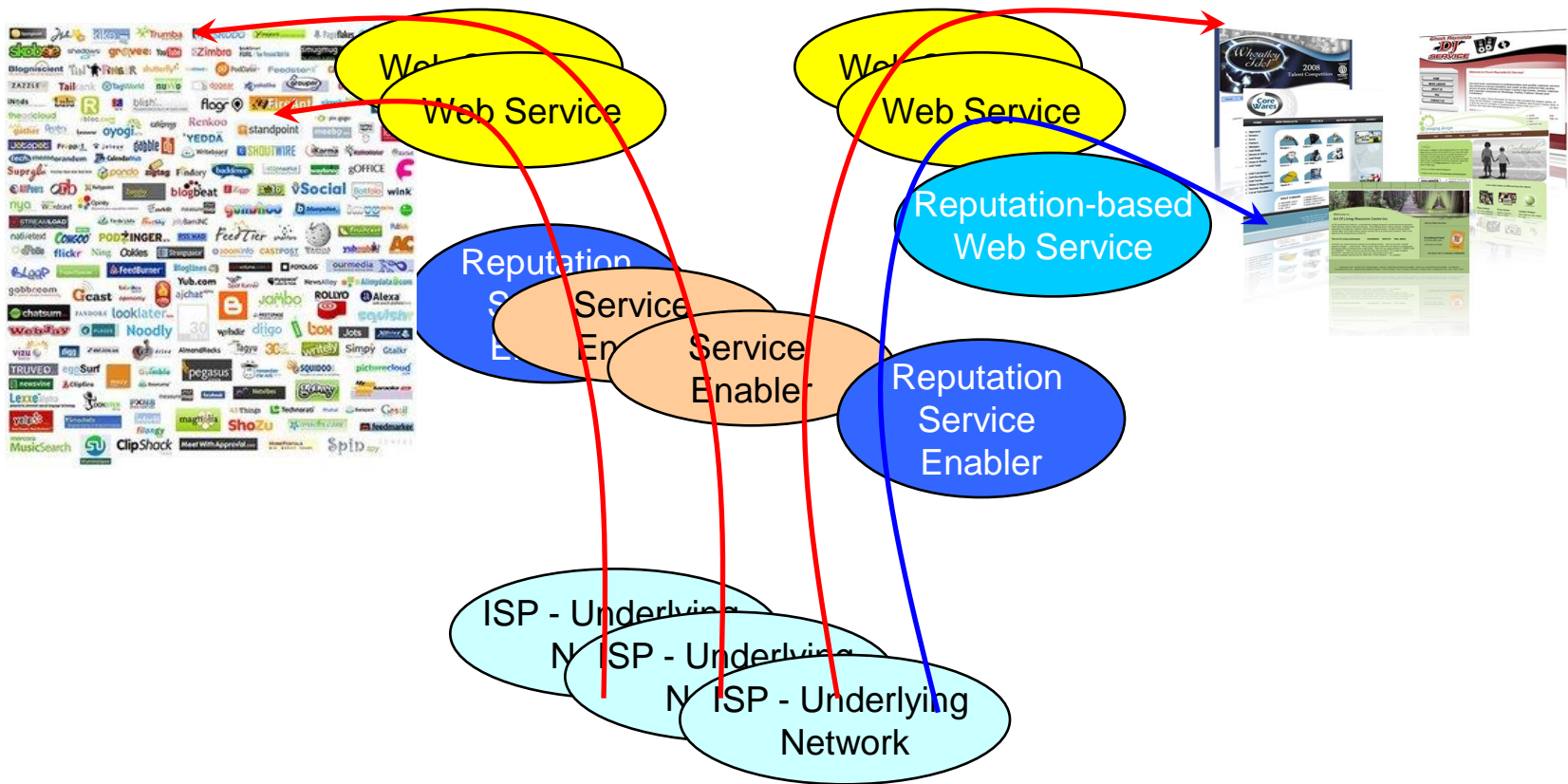
- Decentralized or centralized
- Reflects a trust
- Subjective opinions generalization
- Transitivity of reputation – recommendation with credibility of recommenders
- Context aware
- Moderated history of collected opinions
- Dynamics and sensitivity time dependent
  - Virtual time quantum

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# Applications - Reputation Systems as a service



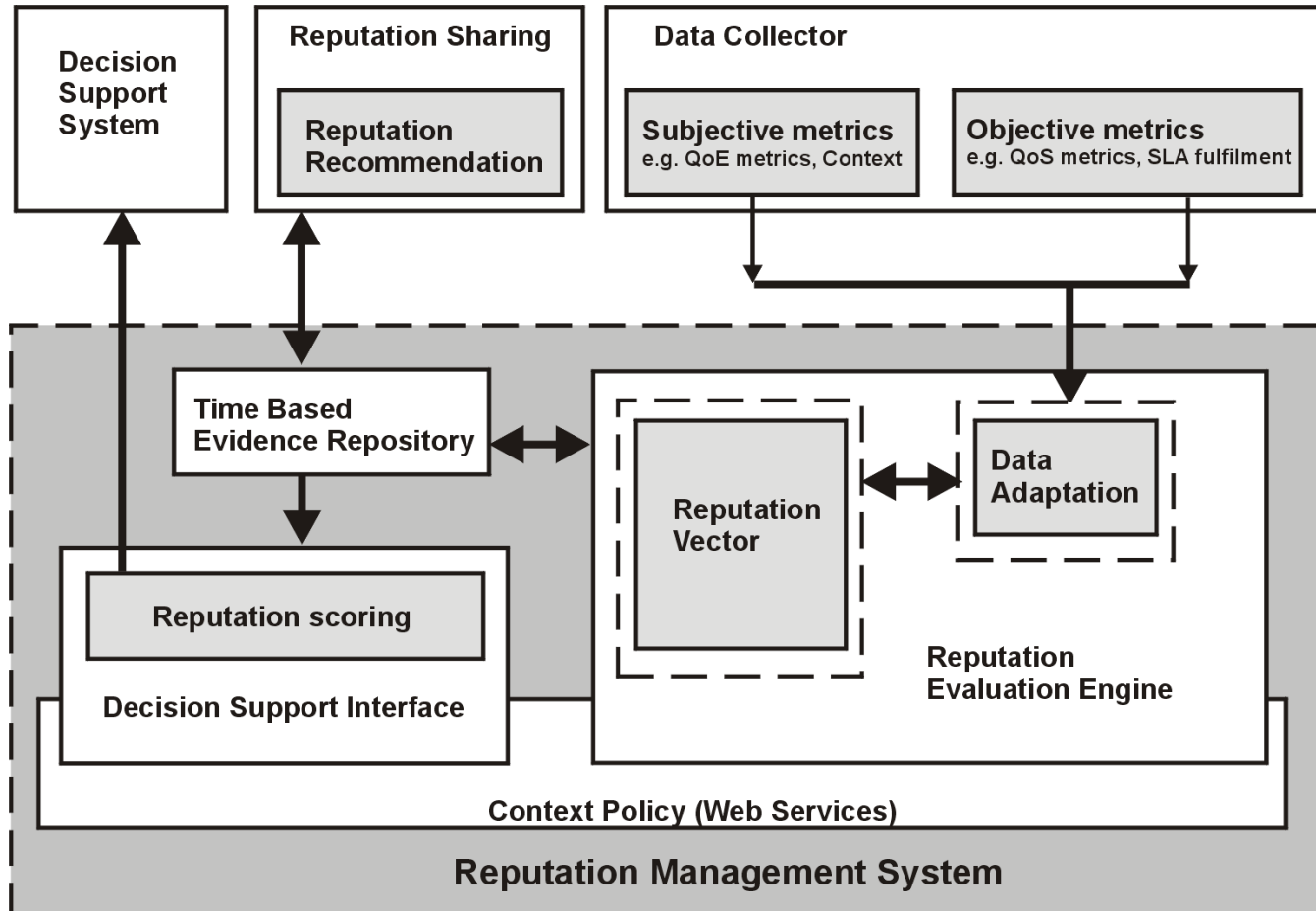
# Reputation Systems modules

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- **Data collector** - gathers QoE, QoS related metrics
- **Reputation evaluation engine** – programmable module for *adapting* and *normalizing* data to emphasize the characteristic features of QoE measures
- **Reputation vector** – internal metric, which reflects a history and context of the scoring and being stored in an **evidence repository**
- Reputation metrics are exchanged between interested parties with **reputation sharing subsystem**
- **Decision support interface** – provides the evaluation or prediction of QoEs metrics for a particular user with a context of services in given timeframe



# Reputation Systems framework



# Summary

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- QoE – aware complex web services provision can be supported/managed with reputation systems
- Reputation is a cross-layer aware service with capabilities of automated evaluating of QoE - for taking care of users' satisfaction and efficient managing of network resource sharing
- Can be applied for distinguishing user expectations and network performance – valuable and beneficial feedback for respectively ASP (other users) and ISP
  - Based on reputation values we may assess several QoEs for web services of Future Internet and predict users' satisfaction, react prior to QoE degradation
- Defining a particular QoEs for web services is a challenging area covered by ongoing research

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# Thank you!

## **Towards Quality of Experience-based Reputation Models for Future Web Service Provisioning**

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