Communication Networks II

Seamless Context-Aware Communication Services - Overall Issues

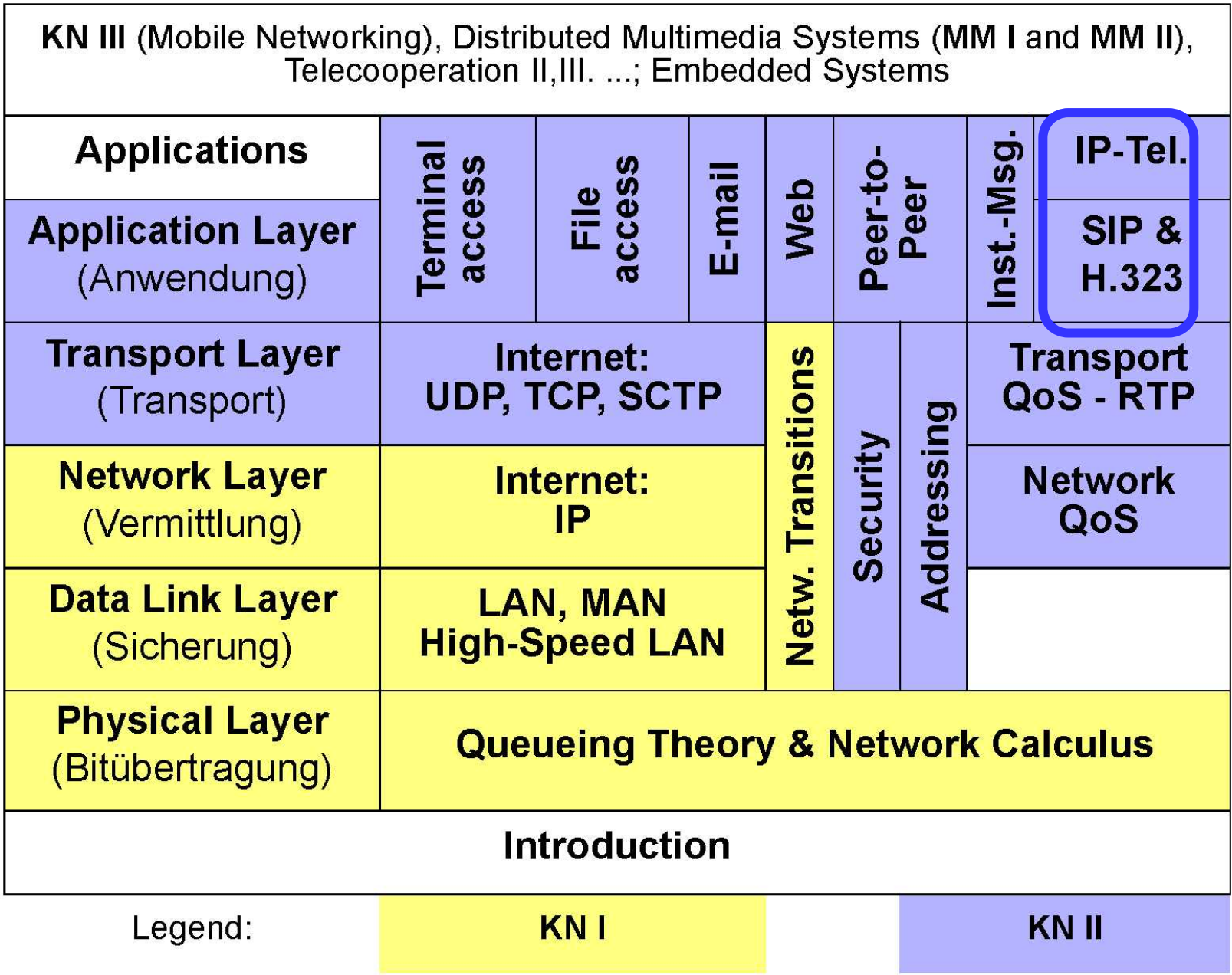
Prof. Dr.-Ing. **Ralf Steinmetz**

TU Darmstadt – Technical University of Darmstadt
Dept. of Electrical Engineering and Information Technology, Dept. of Computer Science
KOM - Multimedia Communications Lab
Merckstr. 25, D-64283 Darmstadt, Germany,
Ralf.Steinmetz@KOM.tu-darmstadt.de Tel.+49 6151 166151, Fax. +49 6151 166152

httc - Hessian Telemedia Technology Competence-Center e.V
Merckstr. 25, D-64283 Darmstadt, Ralf.Steinmetz@httc.de

Overview

Scope


KN III (Mobile Networking), Distributed Multimedia Systems (MM I and MM II), Telecooperation II,III. ...; Embedded Systems
Applications
Application Layer (Anwendung)
L5
Terminal access
File access
E-mail
Web
Peer-to-Peer
Inst.-Msg.
IP-Tel.
SIP & H.323
Transport Layer (Transport)
L4
Internet: UDP, TCP, SCTP
Netw. Transitions
Security
Addressing
Transport QoS - RTP
Network Layer (Vermittlung)
L3
Internet: IP
Network QoS
Data Link Layer (Sicherung)
L2
LAN, MAN High-Speed LAN
Physical Layer (Bitübertragung)
L1
Queueing Theory & Network Calculus
Introduction
Legend:
KN I
KN II

1 Motivation

Philosophical Excurse

Aristotle, Greek philosopher (384 – 322 b.c.)

- formal logic system
  - the Me is making statements about objects of the world (Not-Me)
  - statements are true or false (dualistic construction)
- “tertium non datur” axiom

⇨ one view on the world

- still valid?

Hegel, German philosopher (1770 – 1831)

- multiple ontologies

Günther, German philosopher (1900 – 1984)

- combines polycontextual ontologies and multileveled logic calculus
- each observer may live in different context
- communication with other observers forms shared context

⇨ everything is viewed and valid in a certain context

1.1 What is Context?

Dictionary Definitions

- "set of facts or circumstances that surround a situation or event"
- "the interrelated conditions in which something exists or occurs"
- "sourround text of a unit which gives means to it"

⇨ context (definition) is domain specific

Context in Ubiquitious Computing [adapted from Dey]

- *"Context is any information that can be used to characterize the situation of a subject and its interaction with optional objects. Objects are persons, places, or applications that are considered relevant to the subject."*

1.2 Context in Computing

Areas

- Human-Computer-Interaction (HCI)
- User Interfaces (UIs)

⇨ part of ubiquitous computing

Applications

- context menus in software
- tourist guides
- health care
- intelligent house automation
- seamless communication

1.3 Design Principles

Context-aware systems

- invisibility
  - technology disappears from user's perception
  - use as ordinary "things"
- manual override
  - user keeps control
  - intervention has priority
- feedback
  - decisions must be clear
  - system states must be trackable

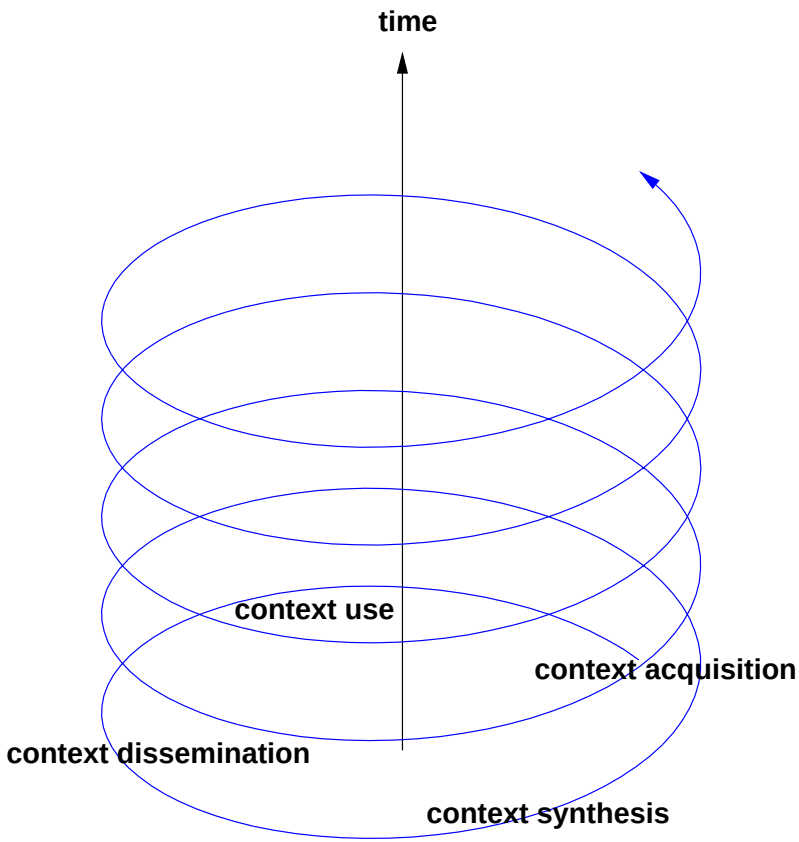
Development

- separation of
  - context acquisition
  - program logic
- re-use of context sources
- discovery of context-sources

2 Context Phases

Spiral Context Model

- acquisition
  - sensors
  - data fusion
- synthesis
  - feature extraction
  - information fusion
- dissemination
  - subscribe/notify
  - storage
- use
  - adaptation
  - controlling



2.1 Context Acquisition

How to get a context?

- usually no direct measuring of a context
- indirect acquisition measuring the characteristic features
  - often only a partly description of a context by context features possible

Sensors

- physical sensors
  - light, capacity, velocity, …
- logical sensors
  - user id, symbolic location, time

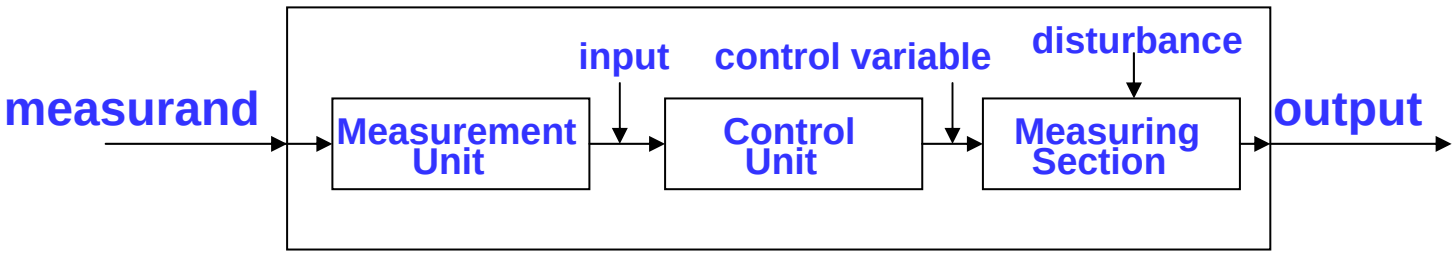
Input

- implicit input
  - automatically sensing
- explicit input
  - user enters information

Sensors

Definition

- *A Sensor is a device that perceives a physical property. It transmits the result as a measurement. A sensor maps the value of some environmental attribute to a quantitative measurement.*



Disadvantages

- Sensor Deprivation
- Limited spatial coverage
- Limited temporal coverage
- Imprecision
- Uncertainty

Sensor Fusion

Definition

- *Sensor Fusion is the combining of sensory data or data derived from sensory data such that the resulting information is in some sense better than would be possible when these source were used individually.*

Advantages:

- Robustness and reliability
- Extended spatial and temporal coverage
- Increased confidence
- Reduced ambiguity and uncertainty
- Robustness against interference
- Improved resolution

Fusion Configuration

- competitive
- complementary
- cooperative

Location Sensors

Location is often used as “primary” context source

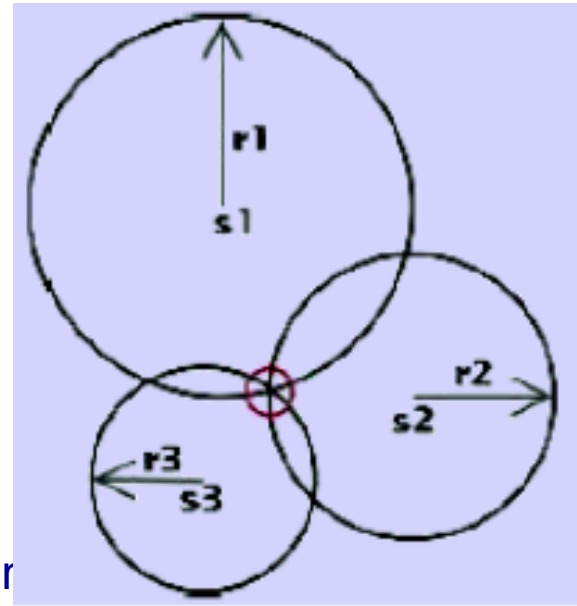
- location used as only context in first context-aware applications
- Categories of location sensing
  - indoor / outdoor usage
  - symbolic / physical position
- Measuring distances
  - trilateration / triangulation / beacons / Cell of origin / proximity

System	Usage area	Method	Accuracy
GPS	Outdoor	Trilateration	< 25m
Mobile phone	Outdoor/indoor	Trilateration	< 125m
Badges	Indoor	Badge	room
Radar/WLAN	Indoor	Trilateration	< 10 m

Trilateration / Triangulation

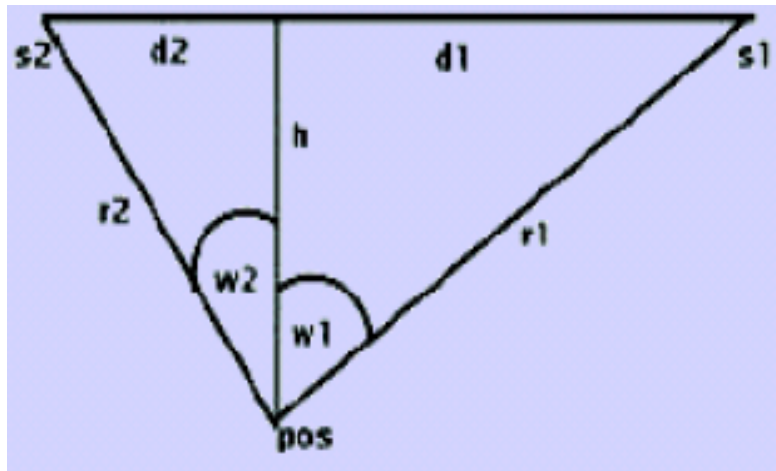
Trilateration

- Distance meassurement to at least 3 reference points
- Meassurement methods
  - Time-of-Flight
    - Distance = Signalspeed * duration
  - Signal decay
    - Signal intensity decreases with distar



Triangulation

- Angle instead of distance
- 2 values needed for location determination



2.2 Context Synthesis

Degree of Abstraction

- sensor value
  - electric value e.g in V, A
- sensor data
  - normalized value e.g. in lux, candela
- (context) information
  - meaningful information e.g. dark, light
- context
  - complex information
  - combined from context information

Generation techniques

- fusion process
- rules, algorithms
- soft computing concepts

Inference methods

- **Definition**
  - *Inference is the act of passing from one proposition, statement, or judgment considered as true to another whose truth is believed to follow from that of the former.*

Multiple inference methods are used:

- Statistical operations
  - min, max, avg, etc.
  - voting methods
- Filtering
  - smoothing, prediction
  - Kalman Filter
- Inference Methods
  - Hypothesis tests (classical inference)
  - Bayesian inference
  - Dempster-Shafer Theory of Evidence
- Soft Computing Methods
  - Fuzzy Logic Rules Systems
  - Neural Nets

Context Representation

Categories of context
- entities whose context is assed
  - places, people, things, …
- context information
  - identity, location, status, time

Modelling of context
⇨ very complex task. Not solved.

Representation of real world
- methods
  - ontologies
  - rule based systems
- modelling
  - notation and model analogue to human perception
    - very complex.
  - notation and model for specific domain
    - simple model
    - only needed context is represented

2.3 Context Dissemination

Context acquisition entity ≠ entity using context
⇨ context dissemination network

- broadcast
  - messages: $m = |M|$
  - routing: $r = m \cdot n = m \cdot |v|$
    - m = #messages, n= #nodes
  - simple routing

- subscription
  - messages: $m = j \cdot s + |M|$
  - routing: $r = j \cdot s + |M|$
    - j = #(joins+leaves), s = #subscriptions
  - stateful operations

Conclusion

- choice depends on
  - dynamic of nodes
    $m \cdot (n-1) < j \cdot s$
  - computational power and storage capacity of nodes

2.4 Context Use

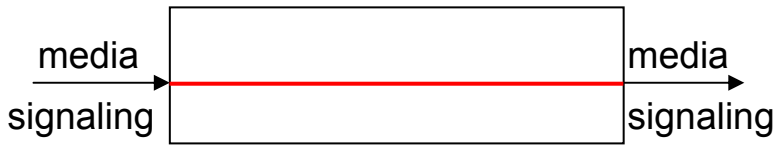
Usage of context

- reduction
  - limit input possibilities
  - display only relevant information to user
  - examples
    - software context menus
    - input in navigation systems
    - filtering incoming calls
- adaptation
  - change program execution to suit current context
  - examples
    - novice/expert mode
- triggering
  - branch depending on context
  - start new actions
  - examples
    - Call Processing Language execution
    - start wipers in car
    - share context with others

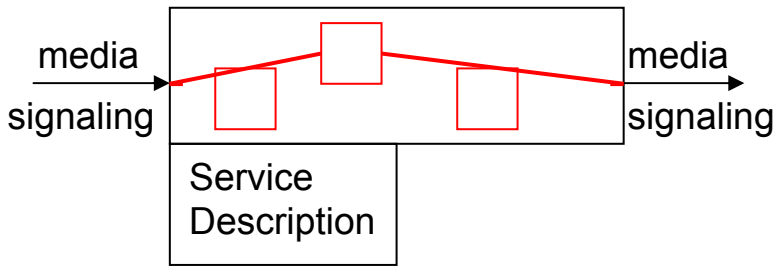
3 Communication Services

Evolution of communication services

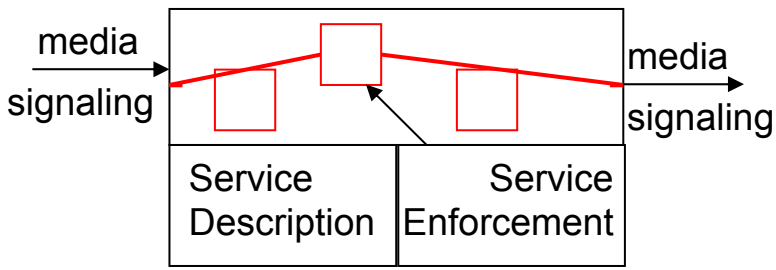
- POTS
  - Basic Call
  - ringing
  - off/on hook



- ISDN/IN
  - Supplementary Services
  - caller id
  - service on/off



- Mobile Telephony
  - Multimedia Services
  - caller groups/ring tones
  - profiles



⇨ manual and explicit actions/switching only few control functionalities

Daily Communication

Observation of Daily Communication

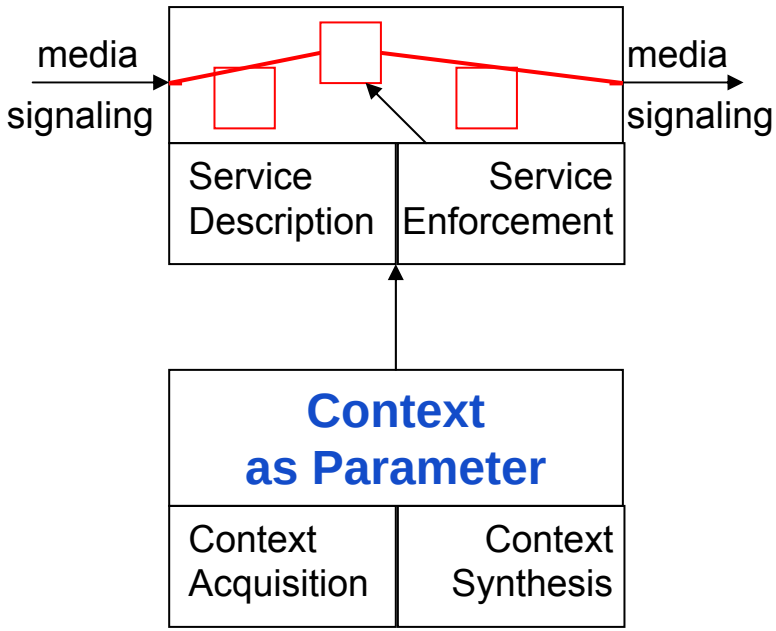
- **irrelevant communications**
  - tele-marketing, surveys, out-of-office announcements
- **annoying disruptions**
  - meetings, dinner, movie, theater, tennis match, etc.
- **caller unaware – not knowing the availability of the callee**
  - lack of coordination leads to phone tag, missed opportunities, etc.
- **interaction overload - decreasing latency increases "junk"**
  - bombarded by irrelevant communications versus noticing timely communications (like flight changes)
- **device overload — e-mail, fax, phone, cell phone, IMS, chats**
  - overwhelmed by managing and choosing the right channel
    - different media = different device = different address

⇨ **communication becomes easier with every additional device?**

3.1 Context-aware Communication Services

New era of communication services

- context used for parameterization of service
- user-centric services



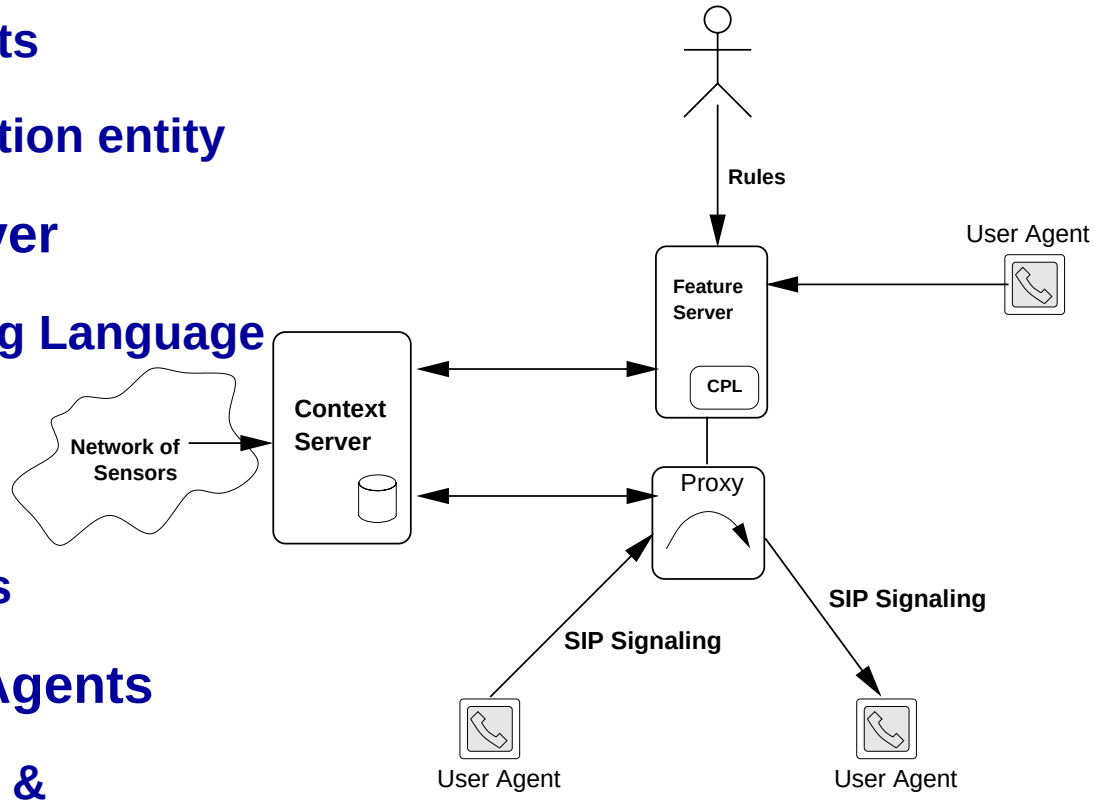
Communication service properties

- implicit input
- invisible helper
- must disappear from users perception

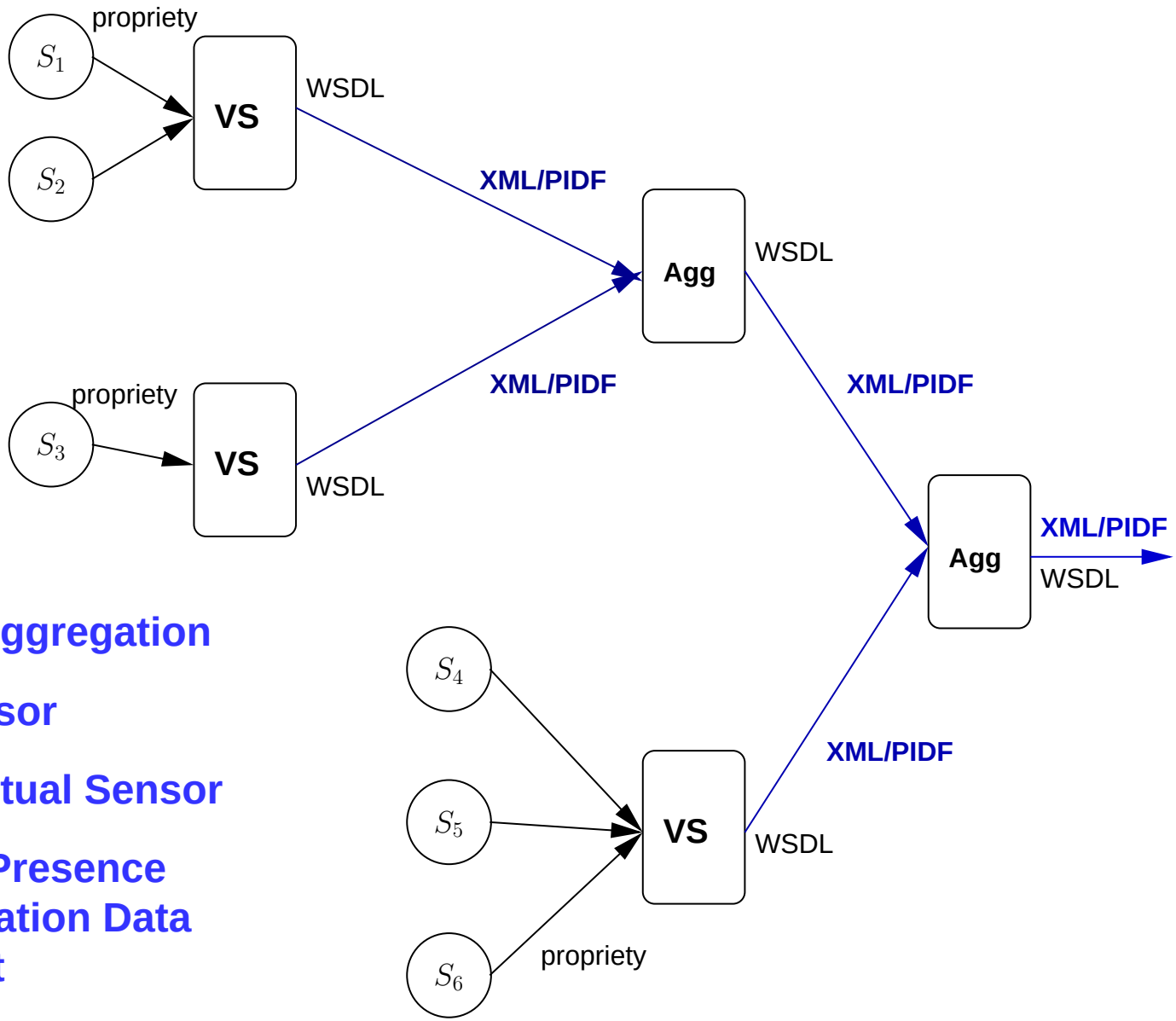
4 Context-aware Communication System

Putting it all together

- **Context Server**
  - **storing contexts**
  - **central integration entity**
- **SIP Feature Server**
  - **Call Processing Language**
- **Rule editor**
  - **allows user to create services**
- **eXtended User Agents**
  - **able to display & user context**



Aggregation Architecture



Agg: Aggregation

S: Sensor

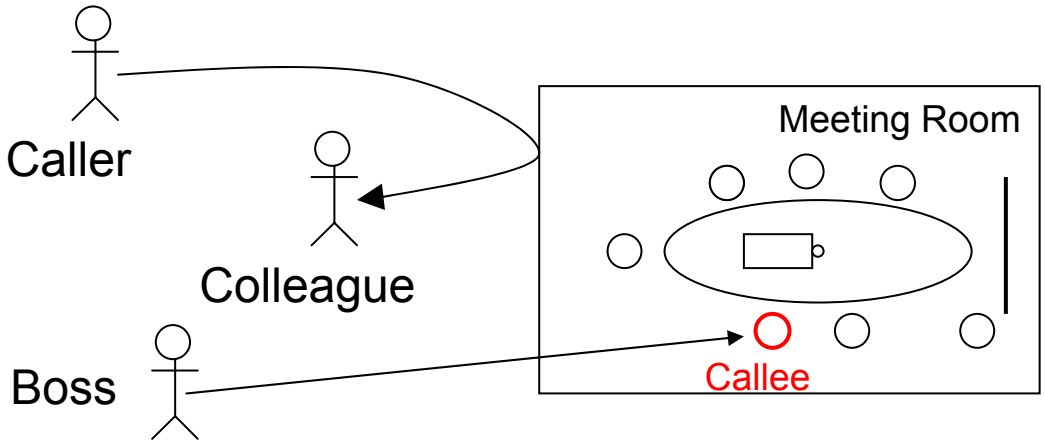
VS: Virtual Sensor

PIDF: Presence Information Data Format

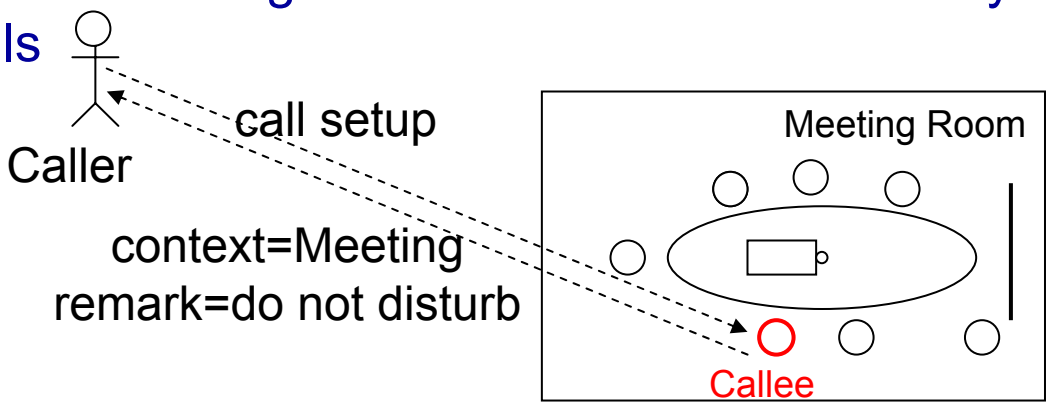
4.1 Innovative Communication Services

2 selected scenarios

- filtering: callee avoids disturbing calls



- context sharing: caller can avoid unnecessary calls



⇨ the use of context information allows a more efficient communication for both – caller and callee