



Wireless Access and the Future Internet Concepts and Experimental Validation

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Kassel, March 06, 2009

Wireless Access and the Future Internet

- ▶ Significantly lower costs
 - Enabling internet of things, “trillions” of connected NEDs
 - 1.2 billion mobiles sold per year
 - Mobiles are most commonly used consumer product
- ▶ User centricity
 - Mobile as personal gadget equipped with sensors
- ▶ Faster innovation cycle
 - Replacement rate of mobiles still below 30 months
- ▶ Shared radio channel
 - Interference between radio links
 - Multicasting
- ▶ Mobility, roaming
- ▶ Mainly access and not core network

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Need for Experimental Validation

- ▶ Large scale experimental validation requires justification due to significant costs for radio implementation (dedicated HW)
- ▶ Large scale experimental validation not acceptable for conformance testing of products
- ▶ Evaluation of technologies and concepts?
 - Decision making in research, standardization, product development if other assessment methods (MC simulations) are not available

Need for Experimental Validation

- ▶ Link (AP \leftrightarrow client) pretty well modeled by MC link simulations
- ▶ Access (AP \leftrightarrow multiple clients) approximately modeled by MC link simulations
- ▶ Radio networks (multiple APs \leftrightarrow multiple clients) evaluated by radio network simulations with traffic and link models. Approach is very complex and not always applicable (\rightarrow EASY-C)
 - Multi-link transmissions schemes
 - Mesh and grid networks
- ▶ Multi radio network simulations, heterogeneous access scenarios
 - Simulation methodology under study
 - Will probably require experimental validation
- ▶ Mesh networks
- ▶ Intelligent access / cognitive radio concepts exploiting context information

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Intelligent Access Concepts

Vision:

- ▶ Future wireless landscape will comprise
 - different L1/2 wireless access technologies (partly with small area coverage)
 - three or four large area Radio Access Networks
 - terrestrial broadcast and specialized networks
 - wireless sensor networks
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- ▶ Transport and service coverage will be independent and fragmented
- Need for efficient heterogeneous access taking radio cognition into account and exploiting context /location awareness
(establishing connectivity as service in a SOA concept ??)

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Intelligent Access Concepts

Context-aware intelligent access schemes exploit context information (locally available radio networks, user location, user movement prediction, user profiles, ...) in order to improve the efficiency of network transport services

- Intra-RAT handover
- Inter-Rat handover and network selection
- Scheduling
- Multicast group forming
- Random access and paging
- Link adaptation
- ...
- And ... content adaptation, mobile ads, other apps.

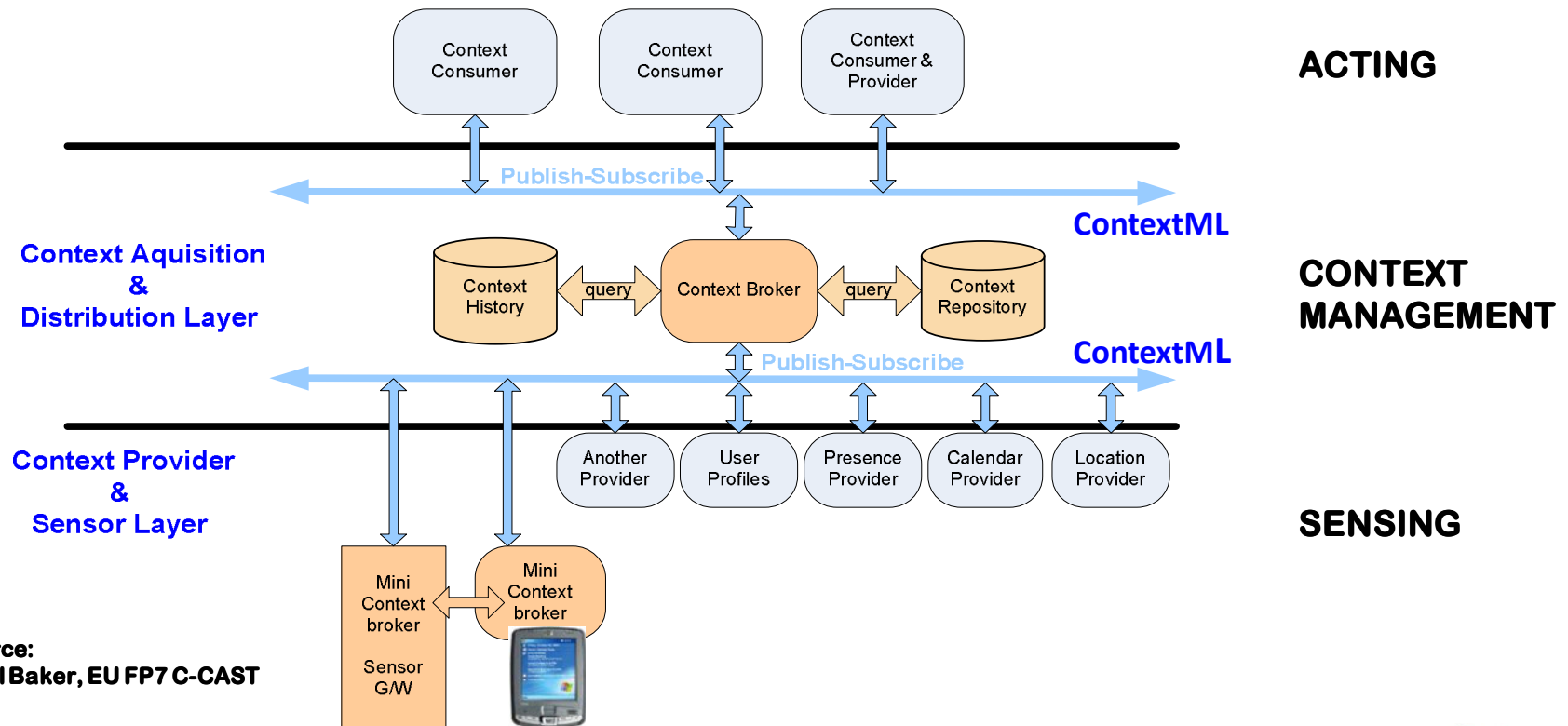
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Intelligent Access Concepts

- Implementation using generic

Context Management Architecture

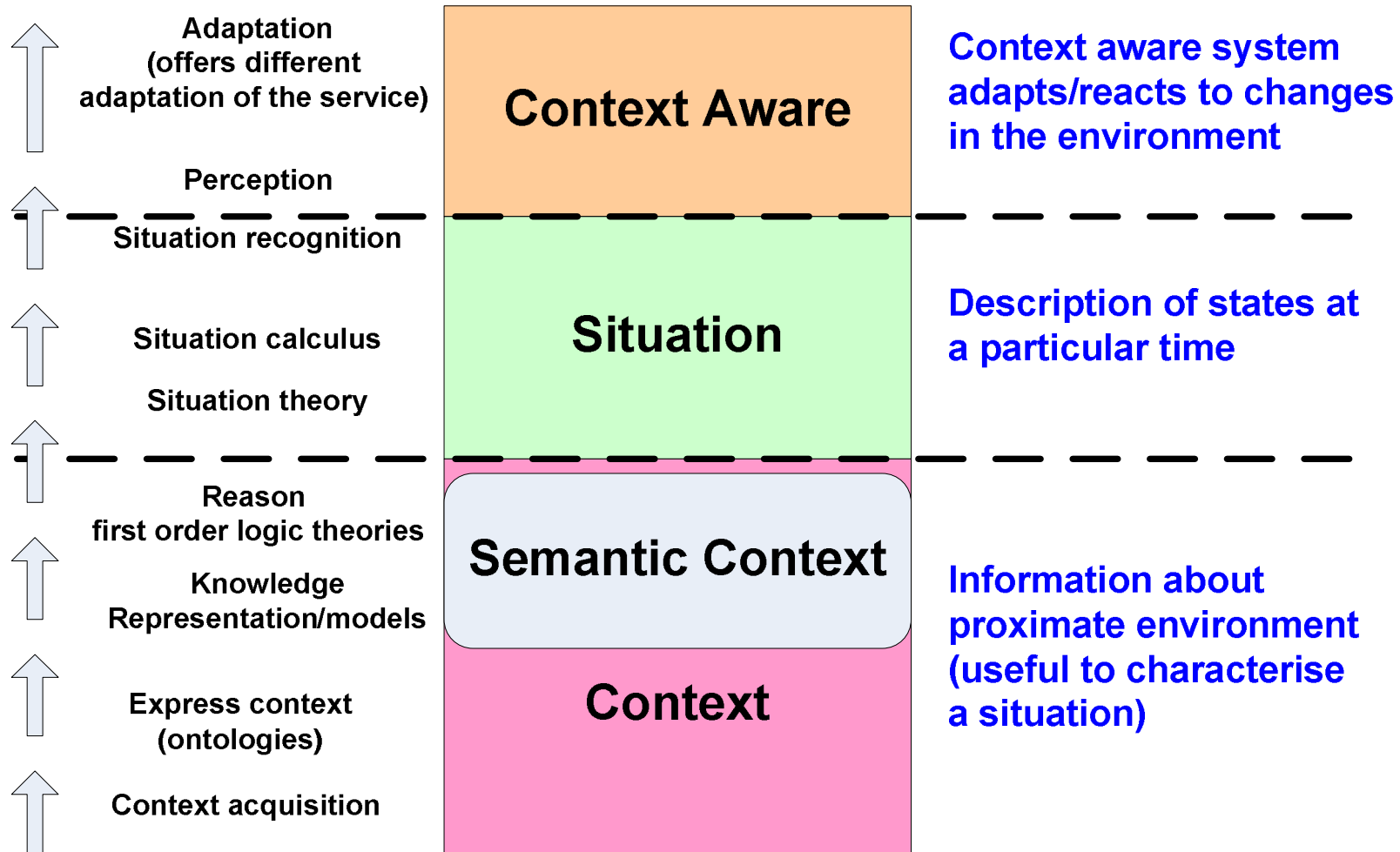


Source:
Nigel Baker, EU FP7 C-CAST

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Context Management – Context Levels

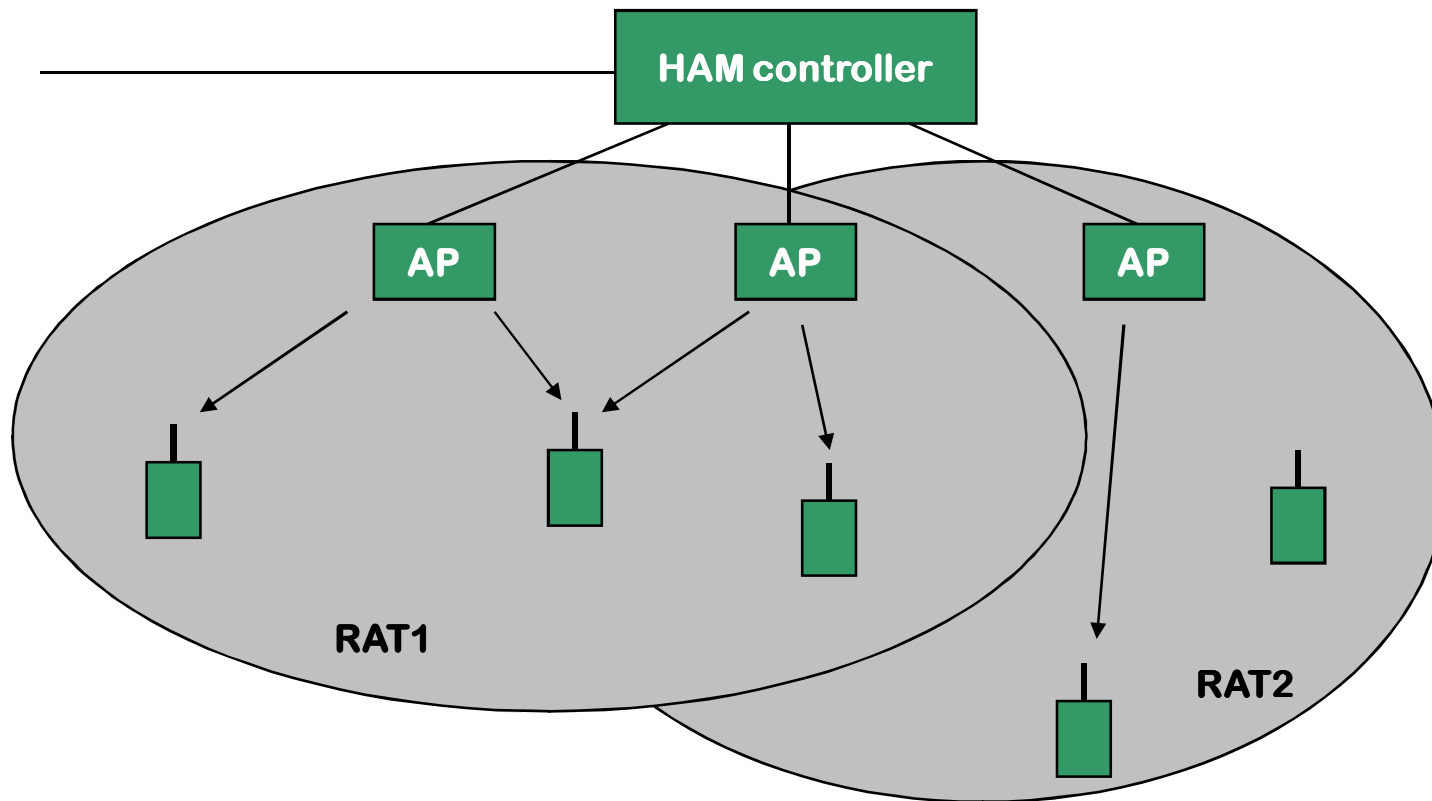


Example:
Nigel Baker, EU FP7 C-CAST

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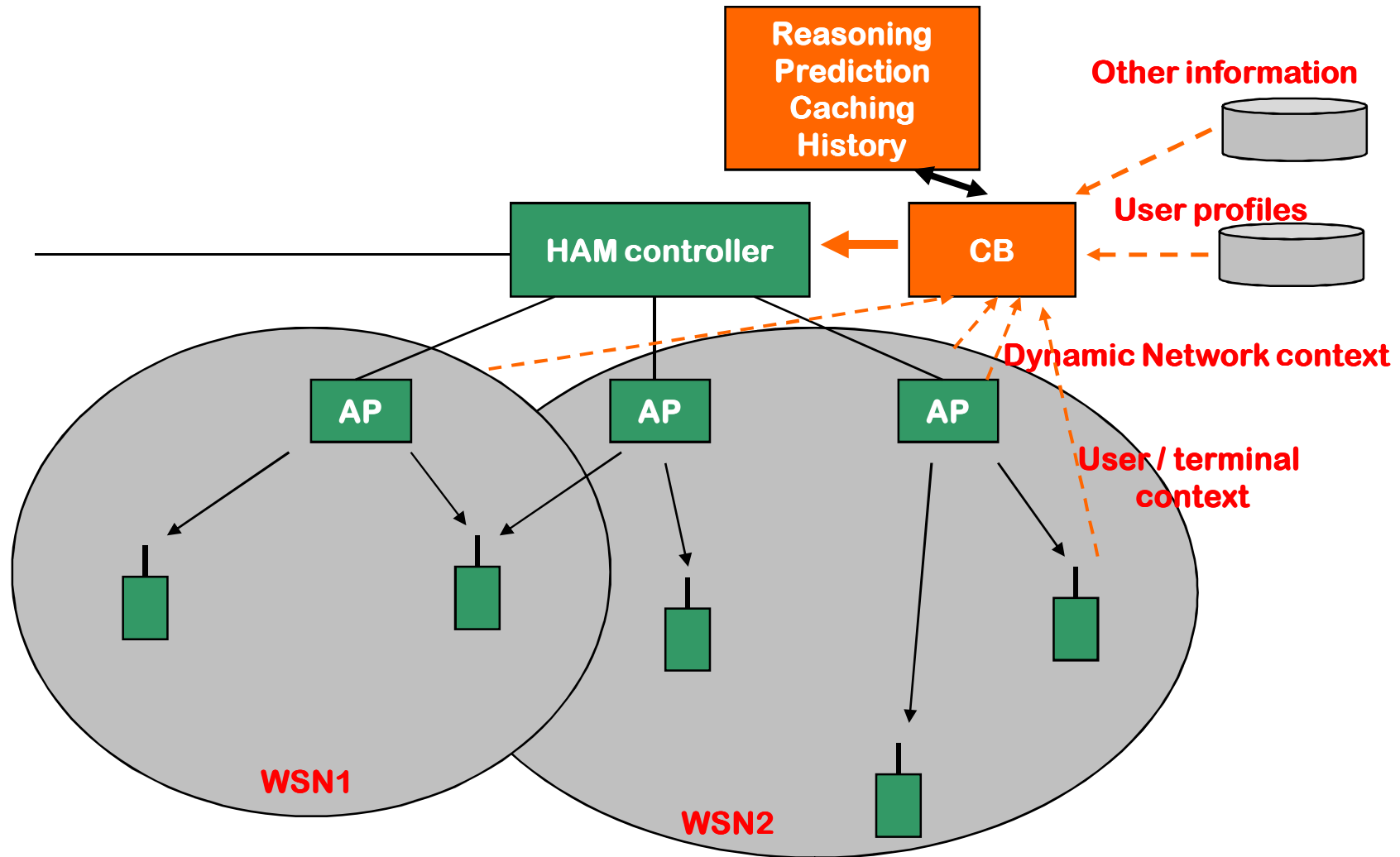
Intelligent Access – System View



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Intelligent Access – System View



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Design Criteria → Experimental Validation

- ▶ Context Management Architecture
 - Open and standardized interfaces (multi-site implementation, ...)
 - Multi-vendor environment
 - quality of context information
 - tracking of performance and availability of context providers
 - Plug-and-play
 - Signaling and management of context flow in radio networks

- ▶ Context-aware multi-radio management
 - Handover between WLAN and cellular (SDR solutions)
 - Link adaptation
 - Network selection
 - ...

Design Criteria → Experimental Validation

- ▶ Validation of prediction and reasoning algorithms
 - Validation against social behavior (not against friendly users)
- ▶ Security and privacy
 - Hidden context providers
 - Tracking of context provider
 - Attacks on WSNs
- ▶ Decentralized and centralized context management
 - Multi-site implementation

Experimental Validation and Demonstration System

- ▶ Setup in Kaiserslautern
 - Lab as test environment
 - Wireless clients
 - Notebooks and mobiles with sensors (temperature, GPS, acceleration, RFID reader, camera, light detector, ...)
 - Multi-RAN with 3 OFDM SDR base stations and four SDR terminals
 - WSNs from different manufacturers with GWs
 - Context Broker
 - HAM server
 - Other apps

- Open interfaces: all context providers, all WSNs, some functionality of context broker, SDRs

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Conclusion

- ▶ Wireless access to future internet = heterogeneous access scenario
- ▶ In order to provide efficient (spectrum), affordable (costs), reliable and seamless access context aware network management concepts will be needed.
- ▶ Design of context aware networks management comprises cross-layer optimization, interaction of transport and context management architecture, and a concept assessment taking the interaction with users / social behavior into account.
- ▶ Experimental validation will need to cover real-world environments and not too friendly users.



Thank You ...

... Any Questions?