



Bari, 2-3 dicembre 2013

www.greencityenergy.it



Knowledge Representation Methods for Intelligent Buildings and Smart Cities

Michele Ruta, Floriano Scioscia, Giuseppe Loseto, Eugenio Di Sciascio

DEI, Politecnico di Bari, Bari, Italy



- Home and Building Automation (HBA): state of the art
- Ambient Intelligence vision
- Knowledge-based HBA: framework and approach
- Agent Framework
- Conclusion and future work

Goal

- Increase comfort and building efficiency
- Decrease waste and maintenance costs
- Integration of different home systems

Most important HBA standards:



ZigBee (HA Profile)



LonWorks



X-10

EIB/KNX



- low cost
- widespread
- ethernet support (KNXnet/IP protocol)



Classic Domotics

- Static and not flexible architectures
- Constrained interoperability
- Reduced functionalities and scenarios
- User-driven interaction (low autonomicity)



Agent-based Domotics

- Flexible and scalable
- Services and resources accessible via agent-oriented frameworks
- Concurrency, cooperation, negotiation enabled



Semantic-based Domotics

- Improved interoperability
- Rich description of user/service profiles
- Decentralized architecture supporting autonomous device-driven interactions



Knowledge-based agent framework for Home and Building Automation (HBA) [Ruta *et al.*, IEEE-TII, 2011]:

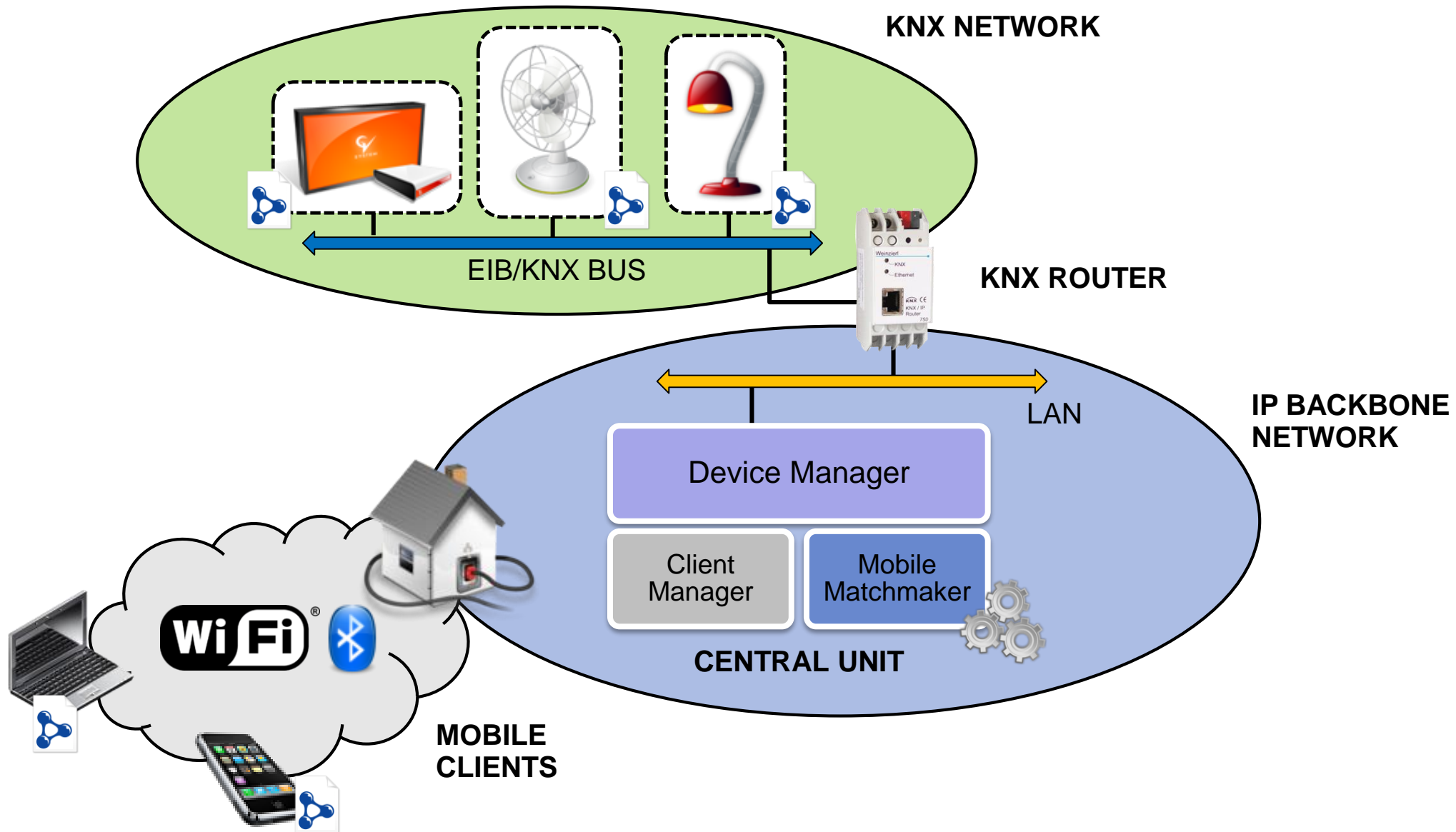


- home self-configuration through collaboration of autonomous smart agents
- semantic annotation of user profiles, device settings and appliance behaviors w.r.t. an OWL-DL ontology modelling typical home environments

Smart profiling agent (running on smartphones) [Loseto *et al.*, WOA, 2013] able to:



- perform a multimodal (*i.e.*, involving several heterogeneous data sources) and continuous sensing without human intervention
- mine the user habits automatically and build a logic-based daily profile exploited in context-aware HBA applications



- Semantic-based enhancement of EIB/KNX protocol standard [Ruta *et al.*, IEEE ICM, 2011]:
 - integration of a semantic micro-layer preserving a full backward compatibility
 - advanced service and resource discovery support
- Logic-based negotiation process to:
 - adapt concept covering [Ragone *et al.*, JWSR, 2007] to select one or more functionalities whose combination fills the user/device request
 - negotiate on available home and energy resources through a user-transparent and device-driven interaction
 - discover the (set of) elementary services that maximize the overall utility
 - support non-expert users in selecting home configurations ranked w.r.t. a global utility



Prototypical Testbed representing a small set of home environments equipped with different KNX-compliant off-the-shelf devices



Testbed



Main Panel

Camera

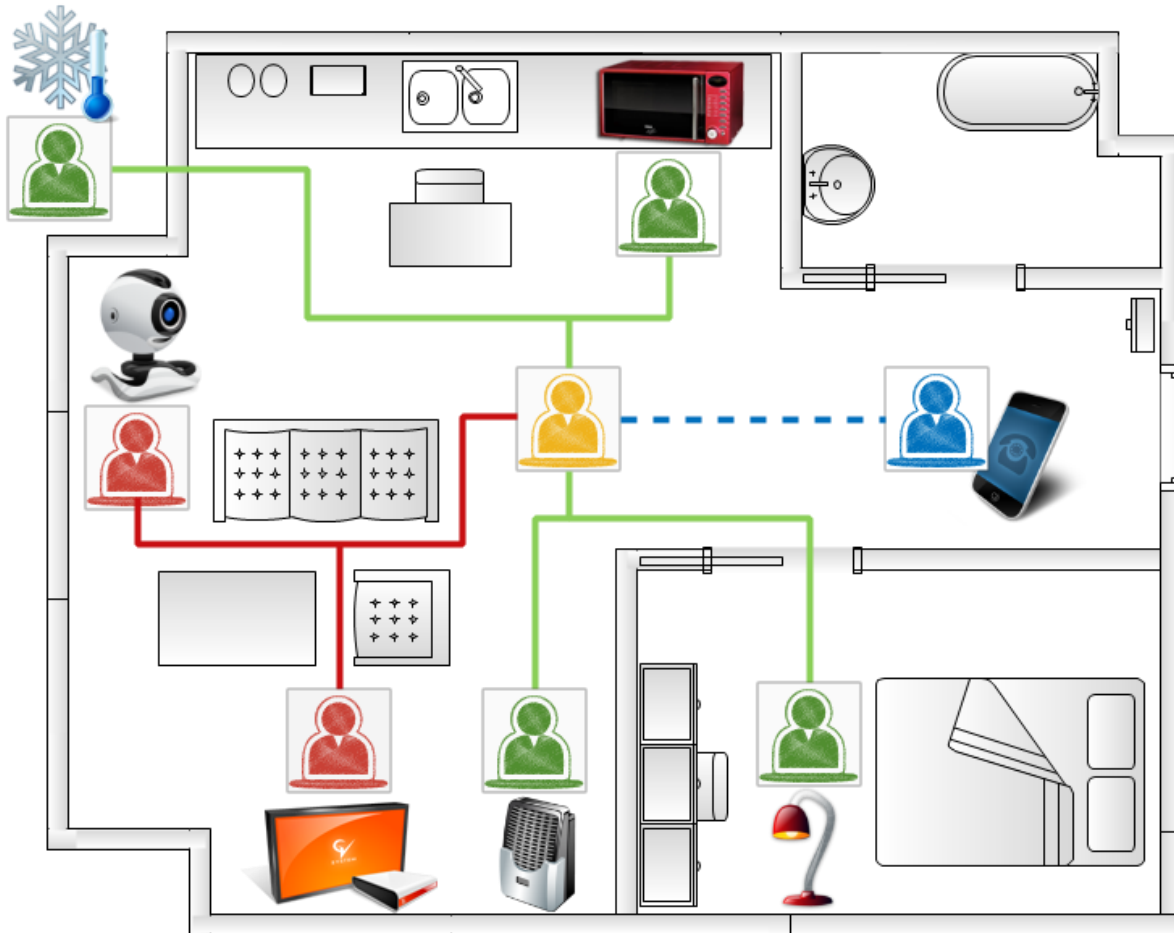


Weather Station



Alarm





User Agent
(WiFi communication)

exposes user needs and preferences



Mediator Agent

acts as a mediator in a negotiation round



KNX Device Interface Agent
(Semantic enhanced KNX protocol)

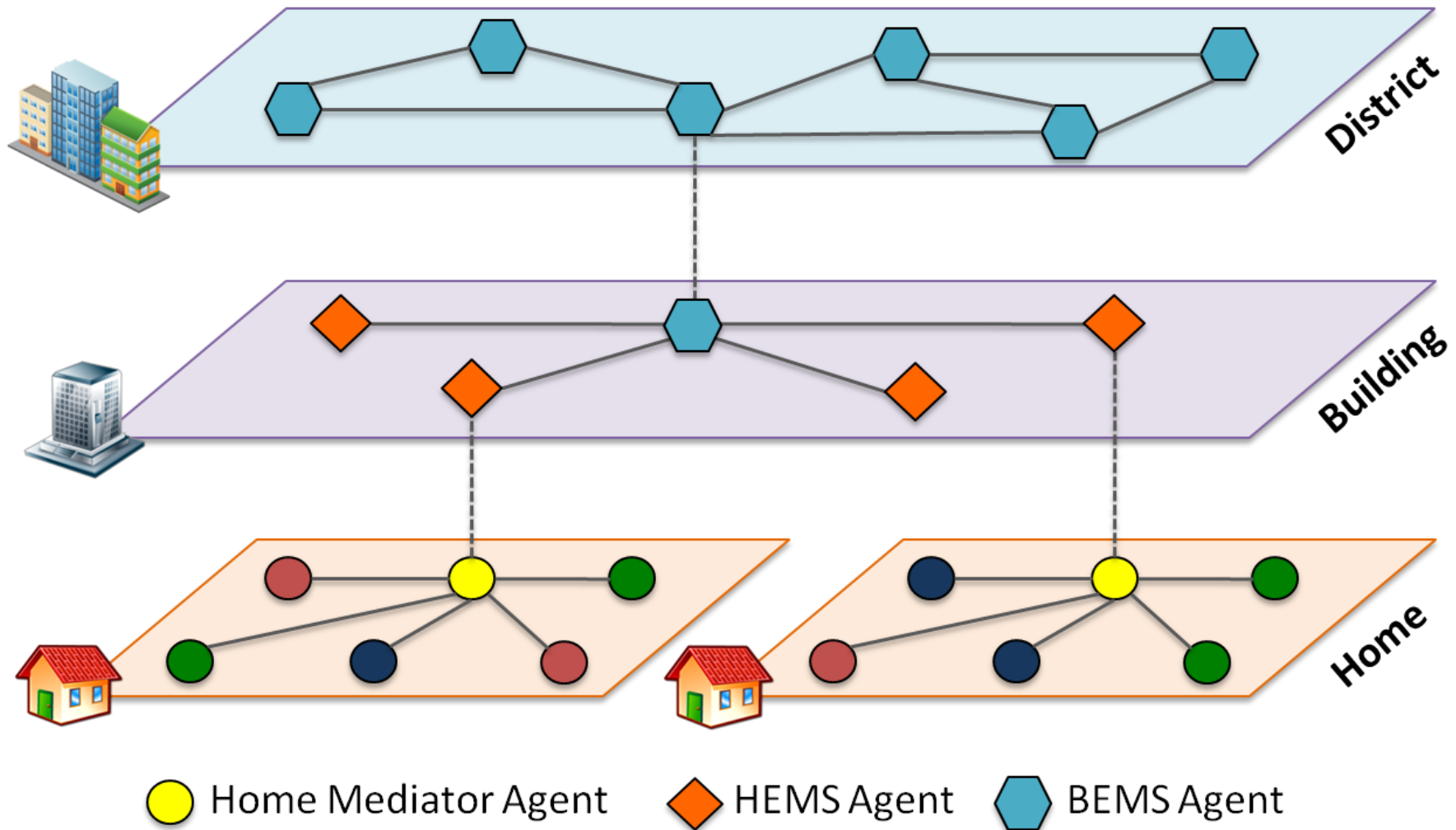
supports KNX enhancements in case of legacy appliances



Smart Device Agent
(Direct communication over IP network)

sends semantic-based requests to the mediator agent for negotiating a home profile

Framework extension for home, building and district energy management in a Smart Grid vision



- Integrate to the general framework:
 - additional domotic **protocols** (Lonworks, ZigBee)
 - Semantic Sensor Networks (SSN) based on Constrained Application Protocol (**CoAP**) protocol [Ruta *et al.*, IEEE iThings, 2013]
- Improve the automatic **user profiling** module
- Extend the prototypical testbed toward the proposed **Smart Grid** vision with new off-the-shelf devices and sensors
- Evaluate the approach with a **large-scale simulation** campaign within a Neighborhood Area Network (NAN)
- Mine data about electric **energy consumption** for energy-based home and building profiling (progetto **ResNovae** “Reti, Edifici, Strade - Nuovi Obiettivi Virtuosi per l’Ambiente e l’Energia” – PONREC 2007/2013, d.d. 84/Ric.)