CONSERN

COOPERATIVE AND SELF-GROWING ENERGY-AWARE NETWORKS

CONSERN Report to RRS: Achievements and Impact

Recall CONSERN Vision

- Energy efficient and dependable operation at the level of cooperating wireless elements, network compartments and networks as a whole is becoming an increasingly difficult objective
- Existing solutions are optimized for a single purpose:
  - Expensive and lack flexibility,
  - Flexibility would allow creating hybrid solutions without needing significant effort.
- **CONSERN aims at developing and validating a novel paradigm for purpose-driven small scale wireless networks characterized by a service-centric evolutionary approach introduced here as an energy-aware self-growing network,**
- Main innovation and impact are **in the direction of achieving significant energy gains in cooperative heterogeneous wireless networks while paving the way for scalable self-growing network paradigms**.

Project Facts and Figures

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- Project plan: Close to the end of the project (30/09/2012)
- Latest Deliverables
  - D1.3: Applied Market Evaluation, Business Models and Impact Assessment (on-going)
  - D2.3: Network and Terminal Energy Awareness in a Self-Growing Environment (on-going)
  - D3.4: Cooperation Mechanisms for Dependable Energy-Aware Networking (Delivered)
  - D4.4: Documentation of final self-growing architecture, functions, interfaces and procedures (on-going)
  - D5.3: System Specifications, Test Cases and First Validation Results (Delivered)
  - D5.4: Report on Validation and Evaluation of Results (on-going)

Share Project Achievements (1/3)

- **Development and optimisation of cooperative mechanisms for heterogeneous distributed elements in a small-scale, purpose-driven network** based on:
  - Techniques for energy efficient bi-directional wireless communication,
  - Distributed decision-making,
  - Support of spontaneous ad-hoc cooperation,
  - Rules on cooperating reaction to configuration changes,
  - Increased system-level dependability,
  - Balancing autonomic capabilities and cooperative operation.
- Potential Impact to RRS
  - Interfaces and information exchange for planned and ad-hoc cooperation of heterogeneous wireless objects,
  - Functional requirements for cooperative management and control.

Share Project Achievements (2/3)

- **Underlying mechanisms for scalable, energy efficient, heterogeneous self-growing network paradigms and study the potential market impact of such paradigms.**
  - Node- and network-level mechanisms for energy optimisation,
  - Enable sensing, detection, identification and classification of adjacent wireless networks for potential integration/utilisation in the self-growing process,
  - Cross-network communication and algorithms for sharing network resources,
  - “Survive” major changes in underlying network topologies and capable to extend and learn from these changes,
  - Dynamic add/remove functionality and to integrate these into an enclosing architecture,
  - Determine the expected benefit of the self-growing paradigms,
  - Main beneficiary identification and optimisation of the socio-economic impact,
  - Business impact, market assessment players’ benefits for the considered network paradigms.
- Potential Impact to RRS
  - Interfaces and information exchanges for sensing and integrating wireless networks in the area, in the self-growing process
  - Cases for network resources sharing – respective functional architecture

Share Project Achievements (3/3)

- **Development and presentation of Proof-of-Concept based on the selected scenarios**.
  - Requirements for demonstrating measurable and significant energy gains at system level,
  - Select scenarios and algorithms that will be showcased,
  - Integrate developed functionalities enabling the validation and proof-of-concept through hardware/software integration platforms,
  - Define metrics for quantifying and validating the achieved gains.
- Impact to RRS
  - Revisit use cases, functionalities and information exchange in the view of technical feasibility studies and extended experimentation outcomes.

CONSERN Integrated Proof of Concept

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- Mechanisms and solutions for energy efficiency, cooperative control and self-growing from WP2, WP3 and WP4 respectively
- Indicatively….
  - System Idle Time Estimation
    - APs autonomously adjust their scanning rate following the rate of appearance of events
  - Access Points Clustering
    - APs select a Cluster Head which manages the network
    - Self-Organization based on topology information derived from local sensing modules
  - Cooperative Power Control
    - APs collaboratively decide the optimal transmission rate in order to reduce overall interference
  - Access Points On/Off
    - The Cluster Head periodically evaluates the overall usage of network resources and directs APs to switch on or off.

CONSERN Integrated Proof of Concept

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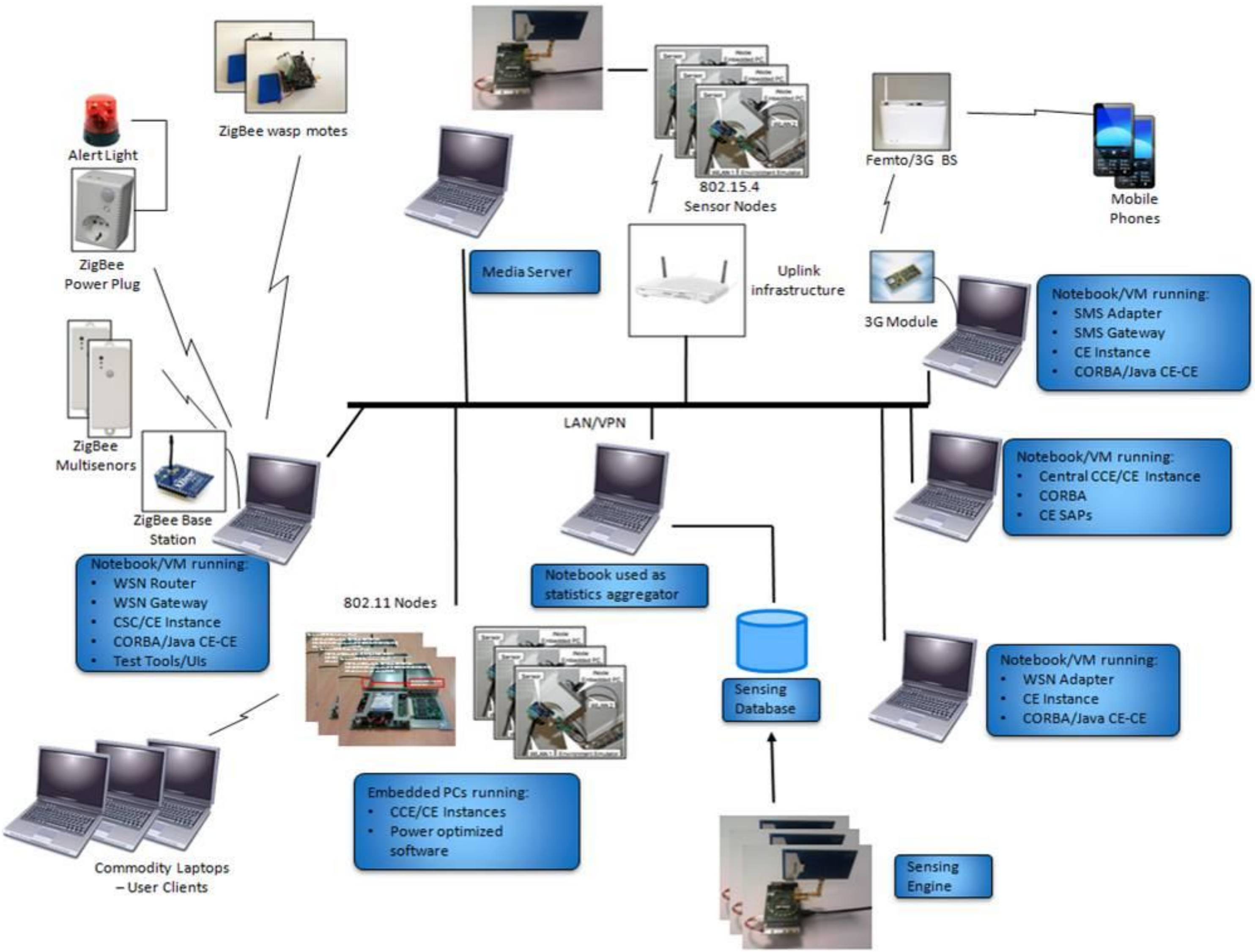
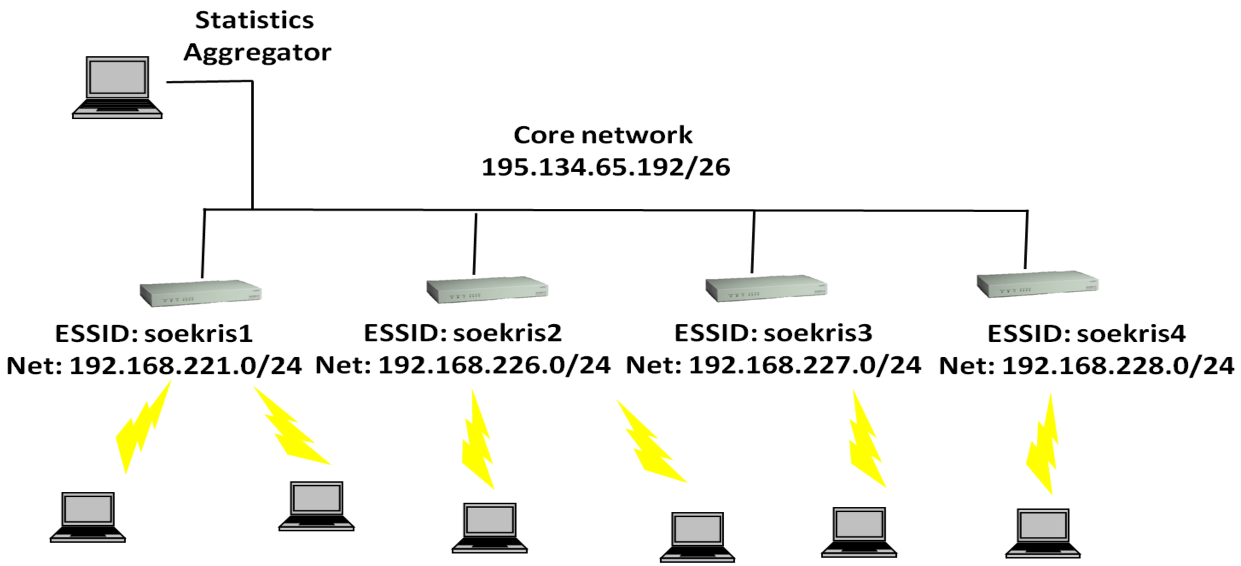
Test bed Architecture



CONSERN Integrated Proof of Concept
Expected Behaviour

- System Idle Time Estimation
  - APs will scan based on the rate of events appearance; devices will scan less often yet they will be able to identify almost the same events as an “always-on” scanner.
- Access Points Clustering
  - Selection of a device which will undertake the task of network organization and it’s holistic management
- Cooperative Power Control
  - The TxPower of each device will be adjusted according to network conditions, monitored interference and coverage requirements.
- Access Points On/Off
  - APs will be directed to switch their RFs off or on according to network conditions and coverage requirements. In this experiment, APs should start shutting down as soon as people start to depart.

CONSERN Integrated Proof of Concept Experimentation



- Four linux-based router-APs deployed in the building
- Two wireless interfaces
  - One is deployed as an Access Point at 5.5Mbps
  - The second is used to monitor the environment
- CONSERN algorithms run in the background and adjust the operation of the device
- Duration
  - Experiment was initiated on May 28th , 11:00 CET
  - Experiment ended on May 28th, 23:00 CET

- ~15 researchers accessing the internet through these APs
- Commodity laptops – no special equipment
- Mobile devices and tablets
- Overall aggregated network traffic raged from 1 to 10 Mbps
- User needs varied, from internet browsing to video streams and torrent downloads

Summary View on Results

Algorithm	Synopsis
System Idle Time Estimation	A reduction of more than 50% in monitoring loops in conjunction with an event detection level higher than 90%
Cooperative Power Control	15% to 35% reduction in the TxPower of participating APs
AP Switch On/Off	15% reduction in the energy required by the network.