

GRUPPO TELECOM ITALIA

Telecom Italia

Bologna, January 2008

ZigBee and WSN challenges

ZigBee and Wireless Sensor Networks technology Challenges

| CLAUDIO BOREAN | Telecom Italia (Research & Trends) |

Summary

- ▶ **Telecom Italia and WSN**
- ▶ **ZigBee Smart Energy**
- ▶ **ZigBee Telecom Applications**
- ▶ **SPINE**
- ▶ **Conclusions**

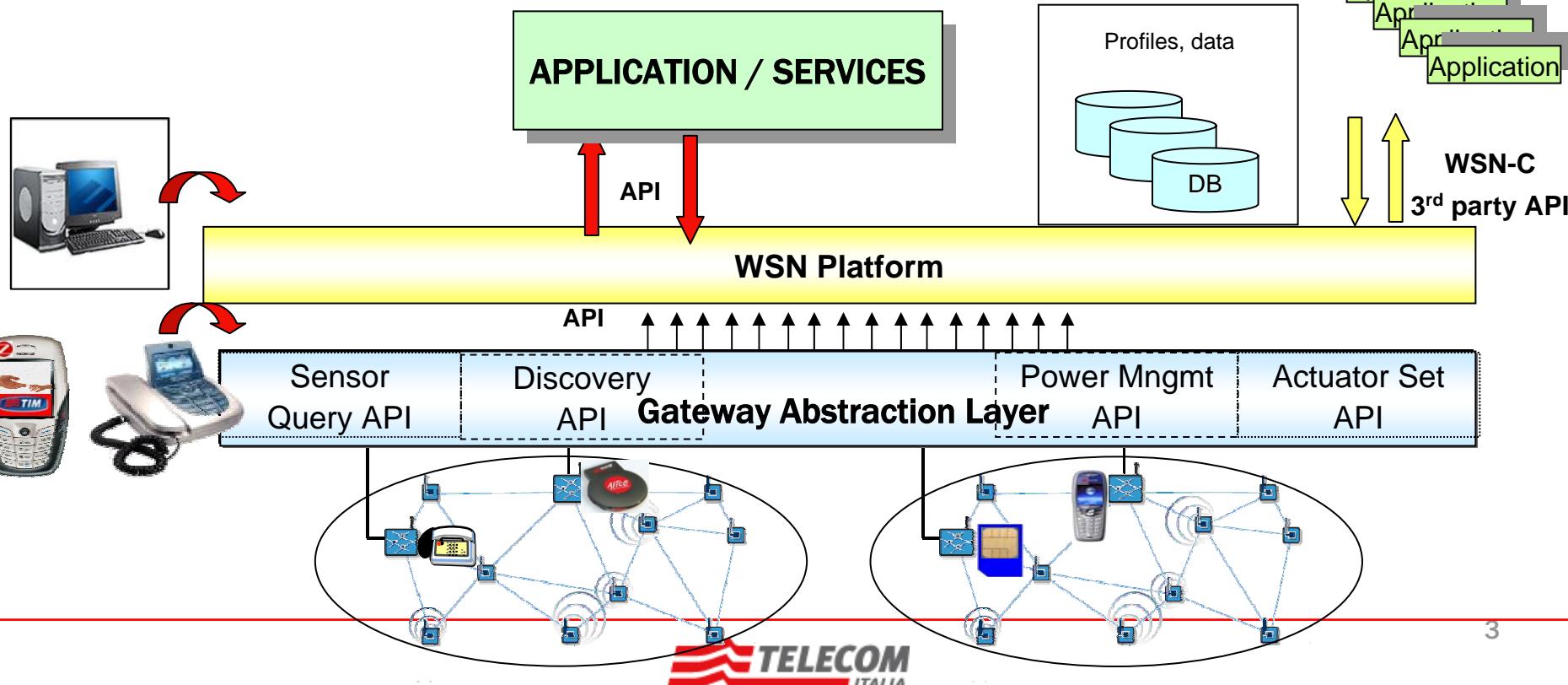
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- ▶ **ZigBee Smart Energy**
- ▶ **ZigBee Telecom Applications**
- ▶ **SPINE**
- ▶ **Next steps**

Operator Reference Model

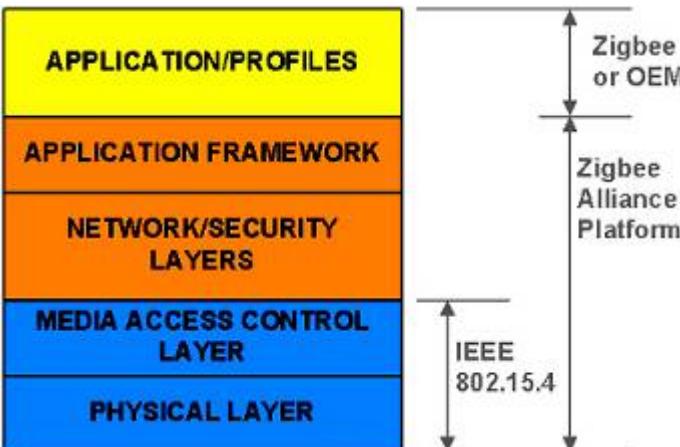
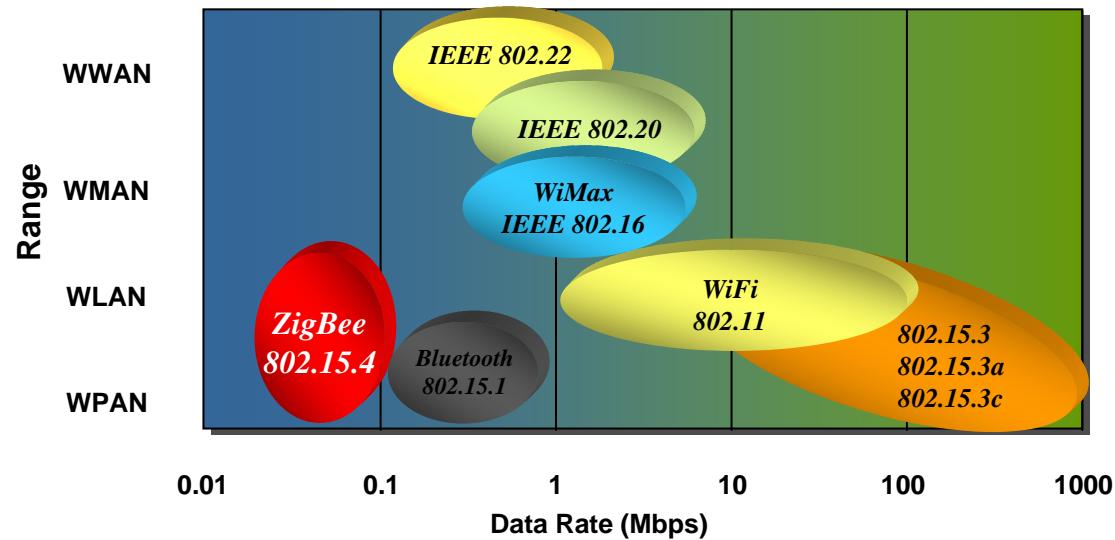
Not just the nodes to build the WSN real applications!

- ▶ Wireless Sensor Networks nodes
- ▶ Gateway
- ▶ WSN Platform (configuration, mgmt, data collection)
- ▶ Privacy & Trust management

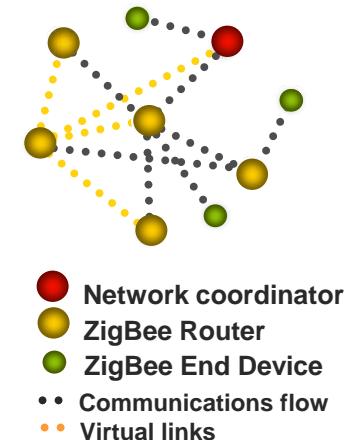


Why ZigBee?

- Open Standard
- Radio + Protocol
- Mesh Networking



- Up to 65,536 network nodes
- Full Mesh Networking Support
- Multiple channels in the global 2.4 GHz band and regional sub 1GHz bands
- 250Kbps data rate



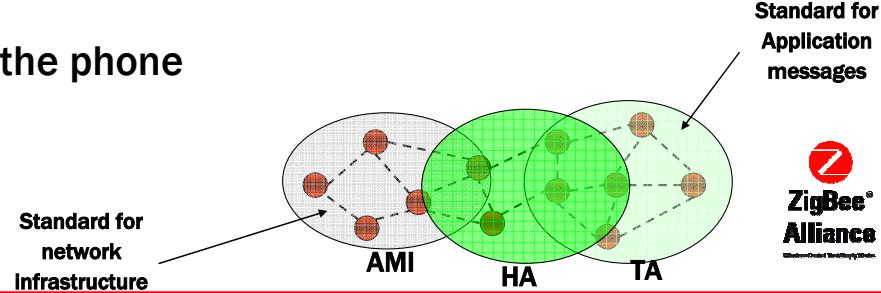
Why ZigBee (II)?

From operator point of view the main ZigBee key-values are:

- ❖ Open **standard** protocol
- ❖ Standard for **Application Messages**
- ❖ Disappeared point-to-point tag-reader concept, no more limitations to star topologies (thousands of nodes) → **Pervasive Ad-hoc Self-organizing Mesh Networks**
- ❖ **High Security Level** (encryption and authentication at all protocol layers)
- ❖ **Chipsets availability**, low cost & low power solution
- ❖ **Wireless Sensor Network evolution**
- ❖ **Easy integration** in appliance/terminals in miniaturized peripherals with integrated antenna

ZigBee Gateway will enable:

- ❖ easy connection of ZigBee networks (PAN) with the operator traditional network infrastructure and information technology
- ❖ sensing and controlling things directly from the phone
- ❖ Creating extended operating networks

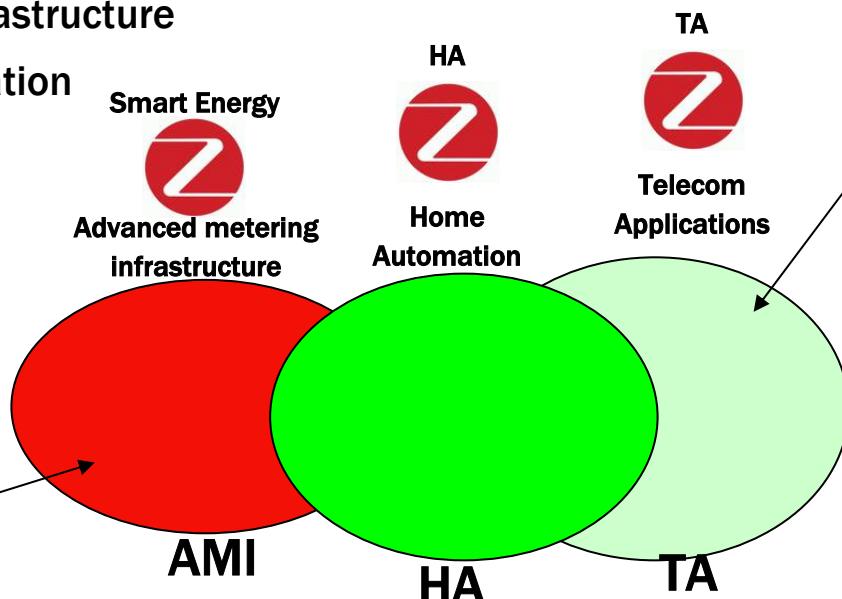


ZigBee and the Academic community

- ▶ Possibility to build both wireless sensor network and applications for different areas, sharing the ad-hoc infrastructure and data format:
 - ▶ Home Automation
 - ▶ Personal Health Care
 - ▶ Telecommunication Applications
 - ▶ Building Automation
 - ▶ Advanced Metering Infrastructure
 - ▶ Wireless Sensor Application

Message specification (ZigBee Cluster Library) is public
And downloadable from website
www.ZigBee.org

Standard for
network
infrastructure



HA specification is public
And downloadable from website
www.ZigBee.org



**ZigBee®
Alliance**

ZigBee Alliance – What is next

► ZigBee PRO has been delivered:

- ▶ Extended addressing and scalability feature
- ▶ Extended application support (fragmentation)
- ▶ Improved reliability and network performances
- ▶ Frequency agility features
- ▶ Hooks for low power routers
- ▶ Open to public

► Open Challenges in ZigBee community:

- ▶ Low power (sleeping) routing features: enable full-battery powered network
 - ▶ Reduce installation costs
 - ▶ Enhance flexibility in applications deployments
- ▶ Extreme low power networks: battery-less systems

► Next steps:

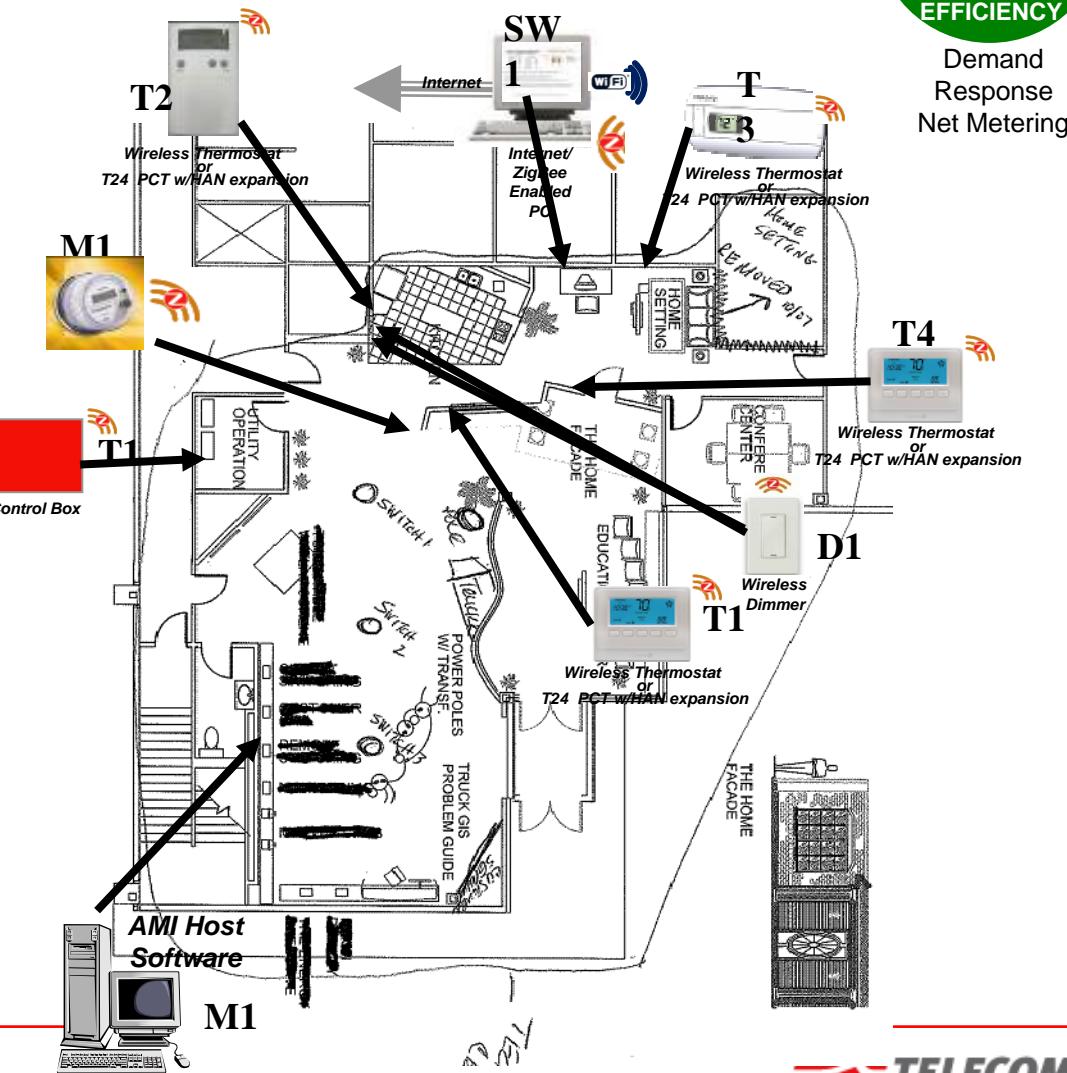
- ▶ Application Profiles are arriving (Smart Energy, Telecom Applications, Healthcare)
- ▶ Enhancements expected for future releases



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Energy Management



ENERGY
MGT. &
EFFICIENCY

Demand
Response
Net Metering

Advanced
Metering
Infrastructure



SMART
ENERGY

Energy resources management using ZigBee communication (Smart Energy Profile):

- load control
- demand response
- data presentation of grid status and real time energy cost
- customer communication
- energy management and metering services

Interoperability demo installed at Centerpoint [Monday, September 10th] Houston.

Telecom Italia and Energy management

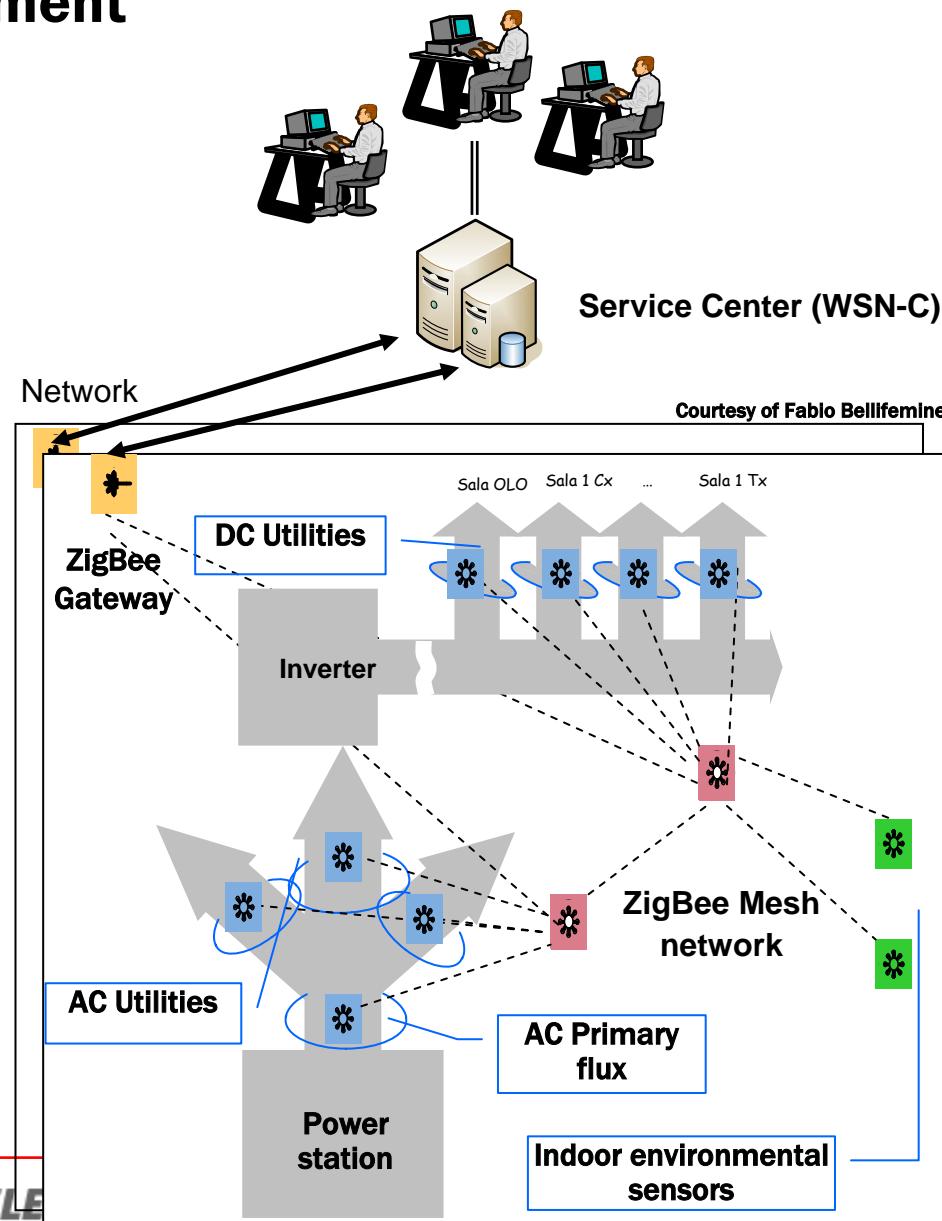
The system enables a real time monitoring through a web interface:

- Indoor **Environmental condition** and outdoor parameters (e.g. light, temperature, humidity, presence)
- Functionality of the **refrigerator systems** (Air Management Unit)
- **Continuous currents** measured in different areas (e.g. commutation, transmission, access)
- **Alternated currents** for conditioning system (e.g. HVAC and free-coolers)

Moreover the system enable to improve the efficiency of the energy system by planning modifications and estimate the value of the WSN

The system is based on a ZigBee Standard Wireless Sensor Network technology.

- Self-configuring short range network
- Low cost
- The battery operated sensors have a **battery-life of years**



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ZigBee Telecom Applications Group

► Scope

- *Telecommunication applications application profile*

► Purpose

- *Study the potential applications using network operator infrastructures and communications terminals, such as cell or fixed phone connectivity*

► COMPANIES:

► TELECOM ITALIA

► HUAWEI

► SAMSUNG

► ORANGE-FT

► ETRI

► KDDI

► OKI

► MOTOROLA

► TELEFONICA



Telecom Italia leads the group
(TLC applications)

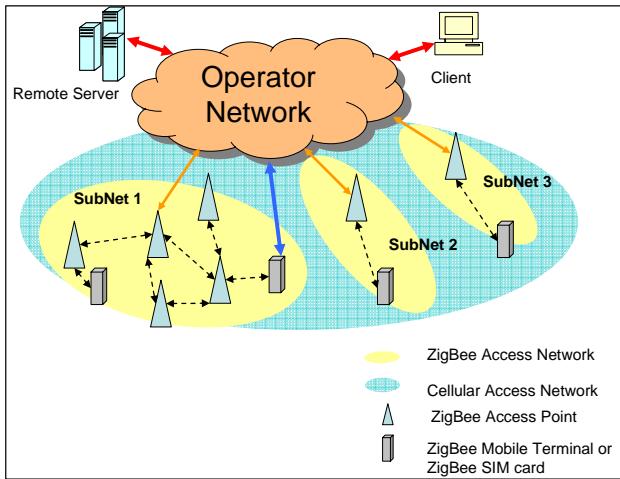


Application for pervasive low power computing

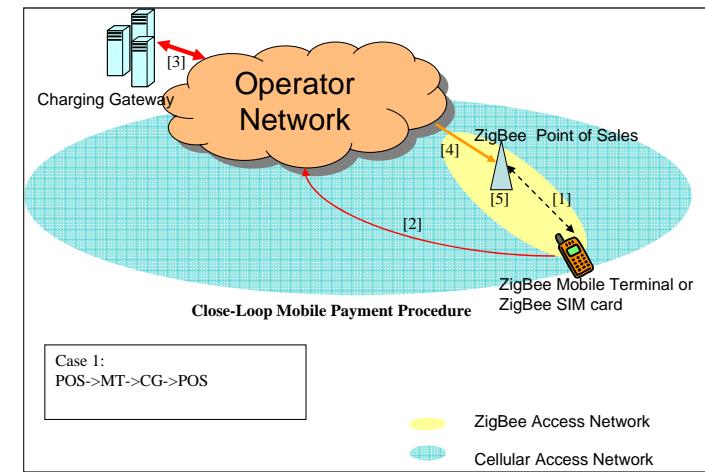


ZigBee Telecom Applications – TA Profile

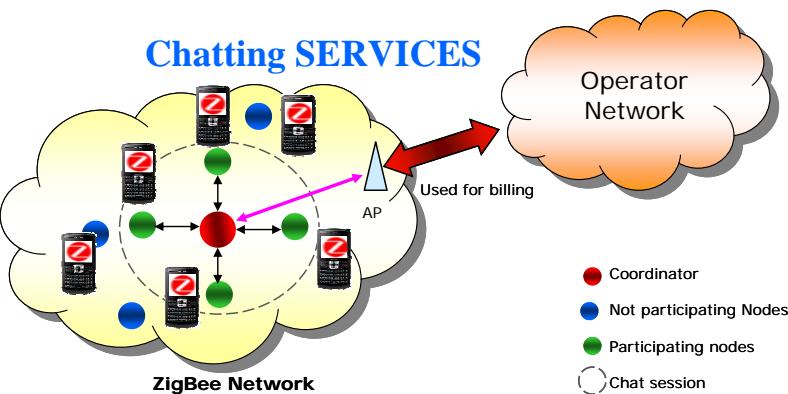
INFO SERVICES



PAYMENTS SERVICES



Chatting SERVICES



Operator Assets:

- Gateways: VDT, ZSIM, AG
- Platform → ubiquitous services

Information delivery

Mobile Payments

P2P small data sharing

Location Based Services

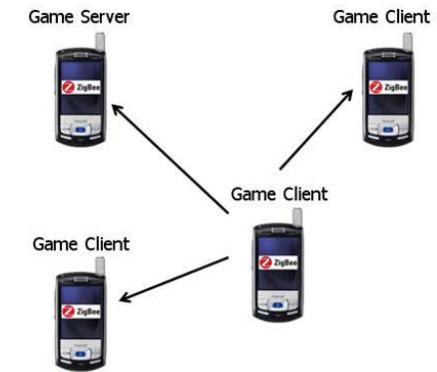
Mobile Gaming

Chatting

VoZ

GAMING and chatting SERVICES

Broadcast DATA



TA specification is in progress in
ZigBee Alliance



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SPINE Signal Processing In Node Environment

► What?

- ▶ It is a **framework** that allows **dynamic configuration** of **feature extraction** capabilities of BSN (Body Sensor Network) nodes via an **OtA protocol**

► Why?

- ▶ **Decrease** development time
- ▶ Great **interoperability** between applications
- ▶ **Open source** (LGPL License) to build a bigger community

► Where?

- ▶ **Download** @ <http://spine.tilab.com>

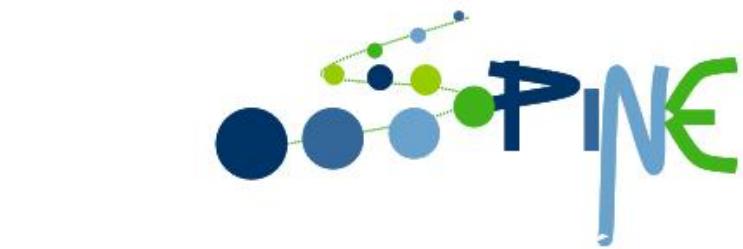
► Who?

- ▶ **Telecom Italia** Labs, **University of Calabria**, University of California at Berkeley (**UCB**), **WSNLab** under sponsorship of Pirelli and Telecom Italia, University of Texas at Dallas (**UTD**), **INTEL** Research Santa Clara

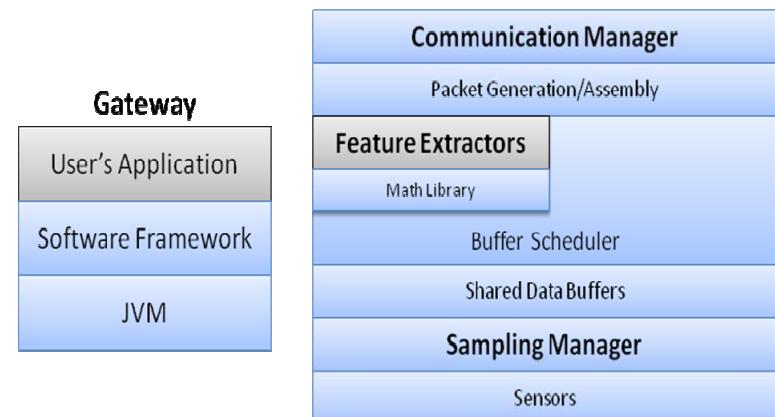
Framework Description

► Gateway side

- ▶ Java-based
- ▶ sensor nodes' management
- ▶ service requests based on application requirements



Sensor Motes



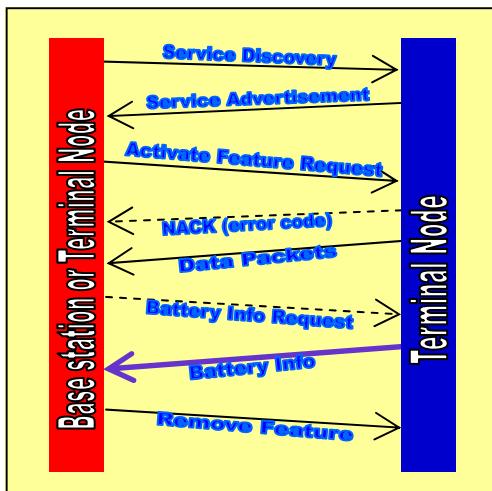
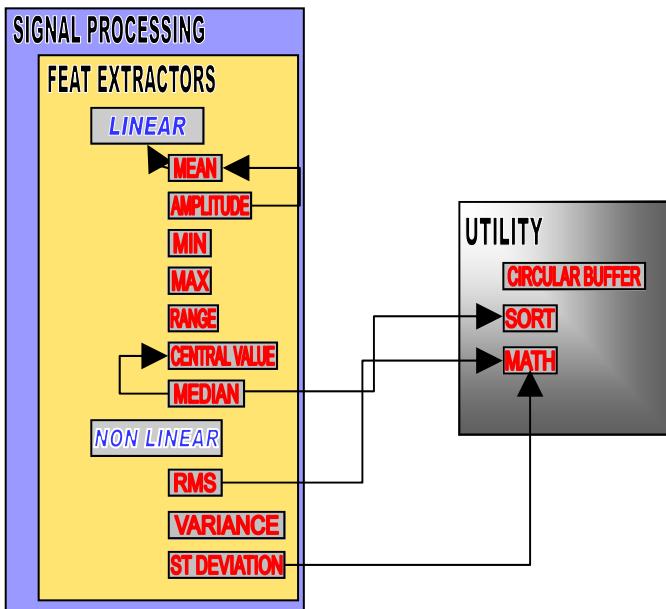
► Nodes side

- ▶ TinyOS-2.0 based
- ▶ Utilities for signal processing
 - ▶ data storage buffers
 - ▶ mathematical function libraries
 - ▶ common feature extractors
- ▶ OtA protocol to transfer data between the nodes and the gateway



Download @ <http://spine.tilab.com>

Spine features



► Circular Buffer

- To make "store" and "loan" operations transparent to the user

► Utility Libraries

- To allow on mote signal processing using those functions

► Feature Extraction Library

- Feature Selection Library has been developed to analyze the signals coming form the onboard sensors

► Job Engine

- Acts as a dispatcher and defines the type of jobs the application need to execute and then it is able of executing them by calling the required component.

► Defined a OtA protocol for

- Service Discovery/Advertisement
- Battery Info Request
- On node Fall detection activation
- Activate/Remove Feature Request
- Data Packet Transmission

► Support of the protocol on the node and on the server side

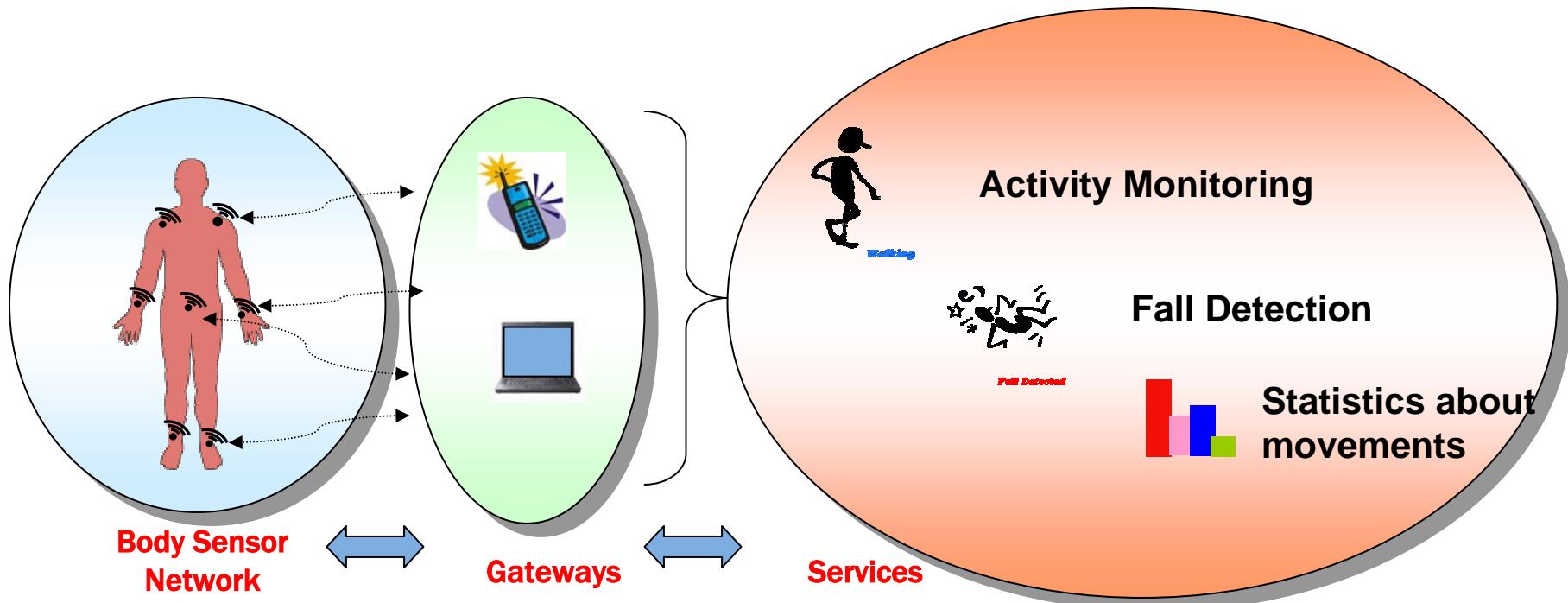
- Java code on the server side provided with a test application to start running SPINE

**SPINE Evolution:
enabling ZigBee and
TinyOs system using
an abstraction layer**

Assisted living application



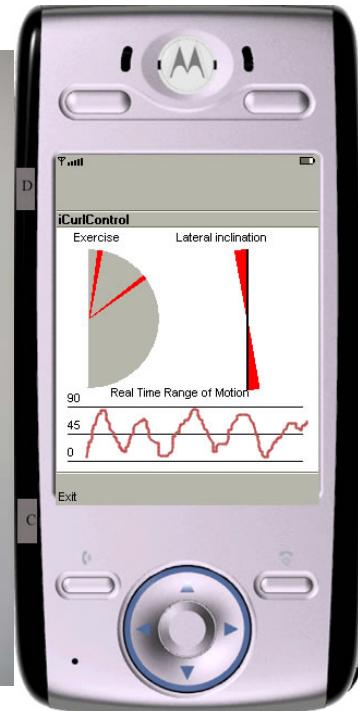
Sensors on the body send data to a central gateway; the gateway then uses those data to classify the action the person is doing. The gateway could be a residential gateway, a Mobile Phone or others



Courtesy of Roberta Giannantonio

Physical therapy application

- ▶ Rehabilitation / fitness exercise
- ▶ Athlete/user follows a predefined pattern
- ▶ Mobile phone application shows:
 - ▶ Performance evaluation (is the patient following the given pattern?)
 - ▶ Position correctness joint range of motion
 - ▶ Quantification of performance (ex. responsiveness to changing patterns)
- ▶ Trainers and doctors love quantification of performance!



This cell phone has a PSI (Phone System Interface) board, supplied by Intel Research, which provides the mobile phone with the same radio interface the sensor nodes have.

Courtesy of Filippo Tempia

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Conclusions

► Why using ZigBee Technology:

- ▶ Proven technology
- ▶ Open standard
- ▶ Many players involved

► Why contributing to SPINE (**Download @ <http://spine.tilab.com>**):

- ▶ Open source community
- ▶ Extendable platform
- ▶ Academic and industrial players



Thank You & Questions?

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