

# Smart cities and ZigBee

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# Outline

- Presentation
- Previous experiences
- Conclusions from them
  - Standardization is needed
- Opportunities for ZigBee and Smart City development

# Presentation

- Ubiquitous Internet Technologies Unit a joint research group made joining efforts from i2CAT Foundation and a research group from UPC
- Working in bringing wireless Internet to the small devices such sensors for more than 6 years
- Participating in IETF as authors of several drafts and the ISO working group working on WSN
- Ongoing pilots in several cities.

# Previous experience in smart cities

- Deployed a smart city pilot in Sant Vicenç del Horts as a live laboratory. 2008
  - 80 sensors and 3 gateways reporting temperature, relative humidity, road traffic, parking occupation, bus location and waste container occupation.
  - Project Funded by the Catalan Autonomous Government of Catalonia and made in collaboration of the Sant Vicenç dels Horts Municipality
  - Three generations of hardware developed
  - Main features
    - Based on Telos mote and TinyOS
    - Backhaul based on intermittent mains power of light posts
    - Routing with AODV using quality metrics
      - Able to work with 19 hops

# Previous experience in smart cities

- Collaboration with Urbiotica (a smart city provider, see <http://www.urbiotica.com>) on building its backhaul network and the radio interface for sensors nodes. 2010
- Development of an opportunistic solution for facilitating the smart city deployment. 2011
  - Ultra low power consumption
    - Based on a radio triggered wake-up
  - Infrastructure-less
    - Use of public transportation buses for collecting the data from sensors and transmitting
  - For delay tolerant data
  - Parking place estimated as the public bus moves
  - In collaboration with Orange and Orange Labs Spain

# Previous experience in smart cities

- Development of “universal” WSN gateway
  - Funded by the Catalan Autonomous Government and with the collaboration of Abertis Telecom, AIA (Aplicaciones en Informatica Avanzada), i2CAT, UPC, Doxa Consulting, Aventura and the IMI representing the Barcelona Municipality
  - Multiple interfaces to Internet
    - Network Interfaces such Ethernet, Wi-Fi, serial or cellular
    - CoAP and HTTP REST with JSON, XML and CSV
  - Multiple interfaces to WSN
    - ZigBee
    - Raw IEEE802.15.4
    - 6LoWPAN/RPL/CoAP

# Previous experience in smart cities

- Development of a WSN gateway based on Java. 2011
  - Usage of a raw IEEE802.15.4 interface
  - OSGi based
  - Supports
    - 6LoWPAN
    - RPL
    - IPv6
    - CoAP
  - Uses HTTP REST and CoAP for Internet connectivity to exchange data
  - Uses of HTTP REST for management data
- Embedded intelligence
  - Combining sensor information with external info (such whether conditions or whether predictions)
  - Easy to create logic that mixes sensor data, configuration data of sensor and actuators
    - Control logic in the gateway
    - Control logic on the sensor node itself

# Conclusions

- Lack of consolidated standards: Multiplicity of providers with proprietary gateways offering specific data
- Alternatives to move data from gateway to central element
  - HTTP, XMPP, MODBUS
- Lots of sensors and actuators. More than any other WSN scenario of usage.
- Up to hundreds of sensor and actuators nodes connected to a gateway acting as a controlling element and using Internet protocols.
- One administrative domain with several controlling elements
- Topology based on simple devices (such RFDs) connected to routers (such FFDs) that defines a tree oriented topology enriched with mesh connectivity to enhance reliability
- Most of the connectivity is between gateway to sensor. Direct connectivity is also relevant to take simple decisions that can be distributed.
- Static network
- Most of the data collected allows delays of minutes or even days in reaction
  - Possibility to use opportunistic mechanisms to collect and deliver data
  - Get profit of collaborative data capturing by citizens
- Need of enriched semantic data to benefit third party exploitation of data and OpenData initiatives.
- Standards for WSNs are becoming complex. A profiling is needed.
- Even a standard exists lots of interpretations can be assumed.

# Opportunities for ZigBee and Smart City development

- Standard are needed , particularly at the application layer.
  - Lots of sensor parameters types already encountered on the ZigBee Cluster Libraries.
- Back-office has to be standardized also or at least made flexible to support specific arrangements.
  - The usage of Internet based protocols is recommended
- Some existing standardization ongoing works have to be finished
  - IETF works on 6LoWPAN, RPL and CoAP
  - ZigBee Smart Energy Profile V2.0
- Standards for WSNs are becoming complex.
  - A profiling is needed.
- Even a standard exists lots of partial implementations can be assumed.
  - A certification criteria or a certification is needed.
- WSN platforms are too limited to deal with multiplicity of standard interpretations .
  - Needs of WSN protocol implementation on higher performance platform such gateways
  - Provides rapid protocol adaptation in front of protocol lack of maturity.
- The need to incorporate a more robust radio interface
  - IEEE802.15.4e is on the way
- To extend standards to support opportunistic networking
  - Infrastructure less solutions can be feasible and interesting

Thanks for the attention

Questions and comments are wellcome

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# List of parameters and devices.

## Additional slide

- Watering
  - Moisture measurement
  - Temperature
  - Ambient humidity
  - Water consumption monitoring
- Pollution monitoring
  - Gasses
    - NO2, CO, CO2
  - Suspension particles
  - Grey water contamination
    - Throwing contaminants throw the pipe
  - Radiation
- Whether
  - Temperature
  - Ambient humidity
  - Rain
  - Wind
- Noise pollution
  - Level of noise
  - Frequencies of noises
- Parking
  - Status
    - Magnetometer, Ultrasounds
  - Usage
    - Available/reserved
  - Car identification
    - RFID based
    - Automatic payment
- Lighting
  - Light sensor
  - Frequencies
  - Information about events
    - Parking availability
    - Presence of ice
    - Ongoing works
- Actuation
  - Activation/deactivation
    - Lights, pass, irrigation
  - Information transfer
- Waste management
  - Waste level
    - Ultrasound distance
  - Identification
- Solar radiation
  - Ultraviolet
- Infrastructure monitoring
  - Vibration
  - Movement
  - Spills
    - Gas, Water, Electricity
  - Lights
  - Waste containers
  - Traffic lights
- Traffic
  - Flow
  - Road occupation
    - Magnetometers
    - Ultrasound
- Signaletics
  - Textual panels
  - Lights
  - Traffic signals
- Access control
  - Vehicle identification
  - Pass control
  - Car plate identification
- Security
  - People on public places
  - Early fire alarm
  - Entering restricted areas
- Accessibly
  - Orientation for the blind
    - Way to find services
    - Traffic light information
  - Parking info for wheel chair users
- Flood alert