Autonomous Wide-Area Sensor and Actuator Networking

Goal

Create an **autonomous, distributed wide-area sensor and actuator network** for interconnecting different WSN clusters. This is done in order to make use of the information they collect and autonomously actuate over their environment.

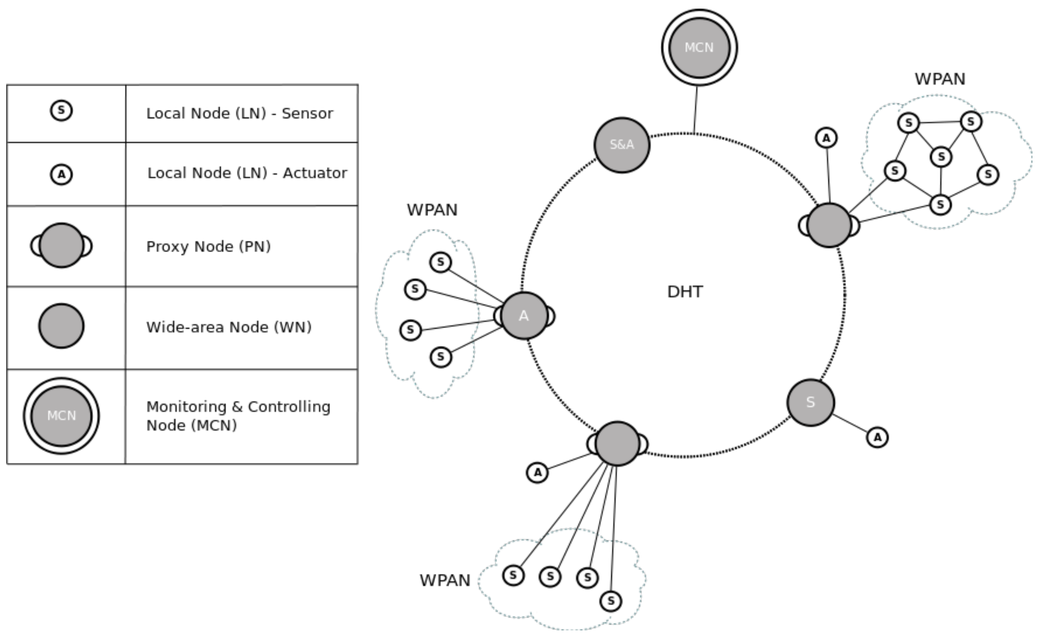
Background

The **Internet of Things (IoT)** is defined as a “loosely coupled, decentralized system of autonomous objects augmented with sensing, processing and network capabilities” [1].

If IoT comprehends a future scenario with billions of interconnected “things”, **Machine-to Machine (M2M)** is one of the technologies to enable that concept. Until now the Internet has revolved around human activities, but it is likely that in the future most of the participants are “things” instead. M2M focuses on that type of communication rather than human one.

Current M2M devices are mostly constrained – in processing power, battery and range – sensor devices. These constraints provoked the creation of adequate link layer protocols, for instance the **IEEE 802.15.4** [2].

The **ZigBee** [7] Alliance developed a full protocol stack on top of 802.15.4 to enable M2M functionality. Other standardization efforts such as IETF developed **6LoWPAN** [3] to enable IPv6 connectivity to sensors. **CoAP** [4] as an application support layer compatible with HTTP is also being standardized.



Architecture

The overall architecture consists on 5 types of devices:

1.Wide Area Node (WN) – Internet enabled device, interconnected with other devices via a Chord DHT [5]. It may have sensors or actuators attached to it.

2.Local Node (LN) – battery-powered ZigBee-based wireless sensor. Each sensor belongs to a Wireless Personal Area Network (WPAN) and is connected to a unique coordinator.

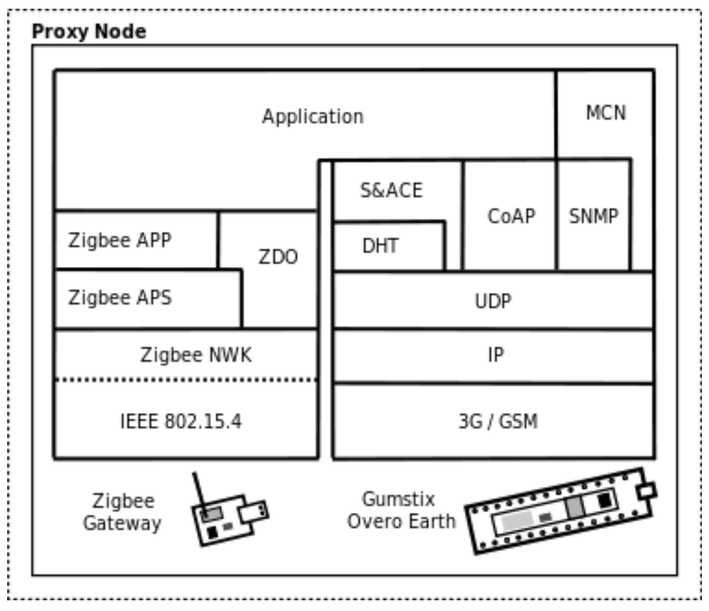
3.Proxy Node (PN) – Both Internet enabled and WPAN coordinator. It also acts as gateway node towards the WPAN, making the WPAN information available to/in the Distributed Hash Table (DHT).

4.Monitoring and Controlling Node (MCN) – It is used to monitor all previous nodes. It is not needed for the network to function. It creates associations between the different devices depending on the use case.

The Protocol Stack of the PN has a ZigBee stack towards the WPAN. The **Sensor and Actuator Communication Enabler (S&ACE)** provides a DHT and DNS-like mechanism to keep track of nodes. **CoAP** is used to set associations and address nodes, based on their URI:

coap://NodeName.OverlayID/Resource

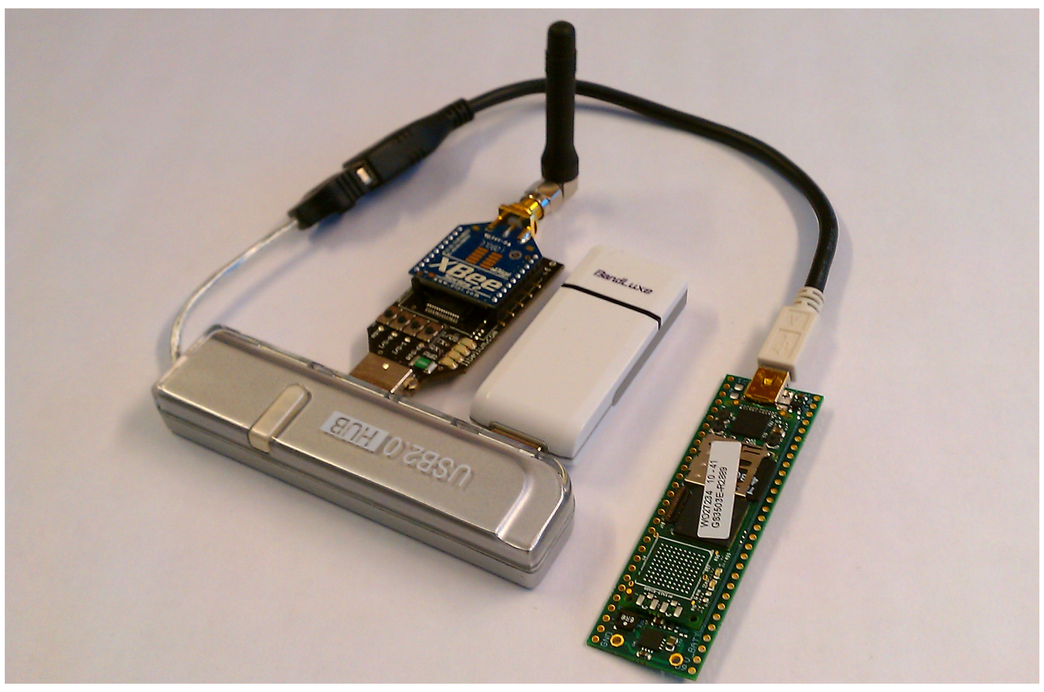
Simple Network Management Protocol (SNMP) is used to manage the devices of the network and is part of the **MCN layer.**



Hardware

The LN is a Libelium Waspmote [6] . It has a low-power Atmel 8-bit microcontroller and can have different sensor boards attached to it. The LN uses ZigBee [7] for communicating with other nodes.

The WN and PN are based on *Gumstix Overo Earth* [8] computer-on-module board mounted on a *Pinto-TH* extension board. It has an ARM Cortex A8 CPU, 256MB of RAM and a 16GB SD card memory. They run a Linux system and a java virtual machine, Cacao. 3G connectivity is provided by a 3G USB dongle. ZigBee connectivity is provided by a USB Xbee tranceiver.



References

IETF standardization: http://tools.ietf.org/html/draft-jimenez-p2psip-coap-reload-01

[1] *Interconnecting smart objects with IP – the next Internet*, 2010.

[2] 802.15.4 *IEEE Standard for Information Technology. Part 15.4. Wireless MAC and PHY specifications for Low Rate WPANs*, 2006

[3] RFC 4944. *IPv6 packets over 802.15.4.* September 2007.

[4] *draft-ietf-core-coap-07*, July 2011.

[5] *Chord: A scalable P2P lookup service for Internet applications,* 2001

[6] libelium.com | [7] zigbee.com | [8] gumstix.com

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