ZoneLAB - A Shared Lab Environment with Embedded Systems

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Abstract

The research community will be facing quite large networks consisting of heterogeneous devices and protocols mainly arising from mixing up private customer devices and equipment with public networks. The integration allows for offering services such as automatic network configuration or home control directly in the homes of provider's customers. Most of these devices are embedded and will be controlled by a supervisory network node also realized in an embedded device that is cheap, consumes less energy, is noiseless, robust and quite easy to maintain. Therefore the research community needs very flexible lab environment allowing for demonstration and evaluation of new approaches for those future networks within real scenarios. Currently, the most successful project PlanetLab [3][2] surrounded by different other smaller activities either using PlanetLab as basis or following different ideas [1], address the need for a large scale testbed. However, they lack the support for scenarios like described above.

ZonLAB, as presented in the following, allows for using embedded devices shared between different research projects.

ZonLAB supports different hardware platforms in use for embedded devices. It uses so called encapsulated zones as shown in Figure 1. In this example every zone could be configured to play the role of classical access points with a wired uplink and a wireless cell it provides. Thanks to the high flexibility, it can also be used as a meshed node using a wireless uplink via a second radio card for example.

A group of ZonLAB nodes (20 - 150) controlled by a central entity is called a cluster as shown in Figure 2. The central entity consists of a Cluster Controller (CC) in charge of the communication process and security issues and a Zone Configurator (Z-CON). A Z-Con used to allocate a new project, specifies the zone configuration needed, the logical network structure and points to a template configuration for the initial node configuration when a project starts. Different clusters can be connected by connecting the cluster heads via a supervisory cluster head controller.

In principal, zones are restricted to a certain resource consumption footprint. This includes the consumption of CPU power, RAM, Flash and the usage of physical interfaces.

Every zone user (member of any project) can configure his zone as it would be a regular system. Development of own software is as usual. There are wrapper tools transparently translating system calls not noticeable for the application. As in PlanetLab [3] it will be possible to use raw sockets beside regular network interfaces. Every research project can be enforced to use the lab by consuming a restricted amount of resources for a specified duration.

One of the first labs based on the ZonLAB technology will be set up in the centre of a larger city in Thuringia (Germany). 70 nodes are planned to be installed in domestic environments using regular DSL as uplink. In this case three different zones are used as it is depicted in Figure 3.

One zone is for private users allowing for a local area network as they know it from regular DSL/Wi-Fi access points. The second zone is used for research and demonstrations purposes of new approaches, protocols and services. The third zone is quite special. It is configured to be a control and measurement zone for measurement boxes.

Measurement box are embedded devices too, equipped with a Wi-Fi interface. Via Wi-Fi it connects itself to the measurement zone for configuration. Its task is to request websites, SIP calls or video streams in the research zone and to report the results (e.g. QoS figures) via the research zone..This allows for producing artificial traffic in the network but under more or less real conditions. The number of these boxes is planned to be 50.

The people living in this city can use the research network too, if they want to, in order to try out the services and protocols and thus create real traffic and feedback. Of cause, the private users can also be blocked from the research zone if needed.
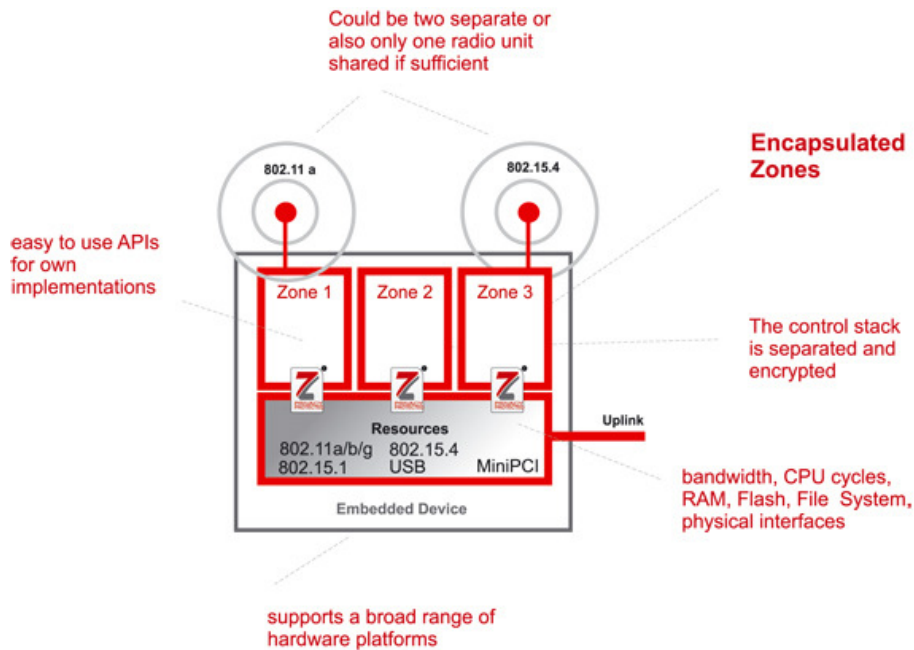
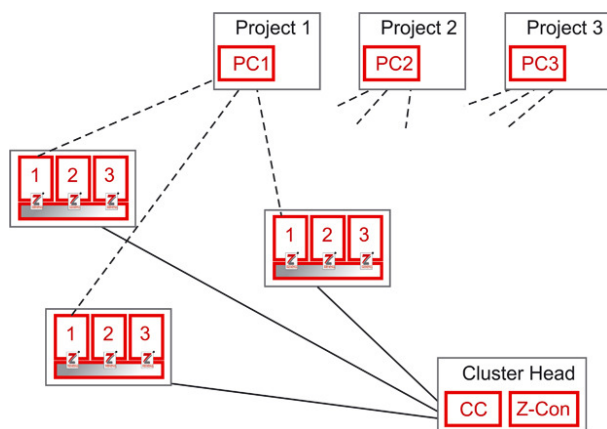**Figure 1 - Schematic picture of a ZonLAB node**

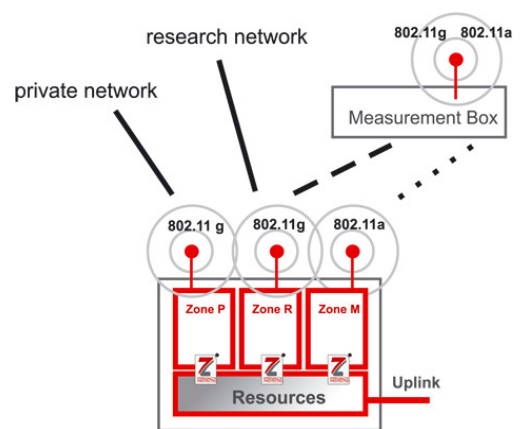**Figure 2 - ZonLAB control structure**

Figure 3 - Configuration of a ZonLAB node in the living lab

Example configuration of a ZonLAB node

A larger example device is based on a MIPs processor with max. 400 MHz, 128 MB of Flash and 64 MB of RAM. The System is equipped with two Ethernet interfaces, 2 Wi-Fi radio modules- A Bluetooth radio module and a Zigbee module is available as extension if needed.

References

[1] Global environment for Network Innovations, http://www.geni.net/
[2] Tom Anderson, Timothy Roscoe. "Learning from PlanetLab", *Proceedings of the 3rd Workshop on Real, Large Distributed Systems (WORLDS)*, November 2006.
[3] PLANETLAB, https://www.planet-lab.org/