6LoWPAN Platform Introduction

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Internet of Things

- The Internet, which is based on the TCP/IP protocol stack and connects computers and mobile devices worldwide, has been very successful and deeply changed our lives.
- Internet of Things, abbreviated as IoT, connects billions of objects that currently are not connected, like your microwave, cars, refrigirators, medical devices.
- Ubiquitos computing and connected things makes everything smarter. Productivity can be improved, wastes and certain disasters can be avoided or reduced. Social life will be changed, just like the current Internet.
- Internet of Things is based on the current Internet technology but it needs adaptation to solve some unique challenges.

Layers of IoT

Just like the Internet can be divided into different layers, roughly, IoT networks can be divided into three layers:

Application layer (some further divide it into application layer and middleware layer) It is responsible for deliverying application specific services to users.

Network layer It connects to other smart devices and servers, transferring and communicating between them.

Perception layer It is the physical layer that gathering sensor information about the environment.

IPv6

- The most successful and widely used IP protocol is called IPv4 with a 32 bit address space. IPv4 has its limitations. One of the biggest limitations is short of available addresses.
- IPv6 is the next generation IP protocol with a 128 bit address space. It is large enough for the foreseeable future and especially important for the billions of devices on the IoT.
- Either manual configuration of IP addresses or setting up DHCP servers are inefficient for rapid configurations of millions of devices. IPv6 supports stateless autoconfigurations, which greatly reduces the configuration time.

IPv6 Cont.

Unlike the dotted decimal form of IPv4 addresses, IPv6 addresses are written in hexadecimal forms. For example:

```
2001:558:6017:83:3521:bdea:e63f:dcfd/60
```

This IPv6 address contains 128 bits with a prefix 60. A prefix in IPv6 is like a net mask in IPv4. The first 60 bits (`2001:558:6017:80`) are network bits to be used to route on the external global Internet. The next 4 bits (03) are subnet bits that is used for internal routing. The remaining 64 bits (`3521:bdea:e63f:dcfd`) are the host identifier to identify a specific host.

Setting up IPv6 networks

There are two ways to set up an IPv6 network.

- A native IPv6 network supported by your ISP. It is confirmed that at least Comcast supports IPv6 networks natively in the Boston area.
- Using some free tunneling services to set up an IPv6 tunnel in an IPv4 network. For example, the Tufts campus network only supports IPv4, tunneling can be used here. The service providers are called tunnel brokers. A popular one is the Hurricane Electric Free IPv6 Tunnel Broker.

Setting up IPv6 networks Cont.

- Unlike a typical IPv4 homework that is only assigned one IPv4 address and all devices are behind a NAT device with private IP addresses, each device on an IPv6 network has a globally routable IP address with end to end connectivity.
- For IPv6 stateless autoconfigurations to work, the host identifiers must be 64 bits. The other 64 bits are used for network and subnet configurations.
- Comcast home users can be assigned a /60 prefix if requested. This is enough to set up an internal IPv6 network with 16 subnets, each subnet supports up to 2^{64} devices theoretically.

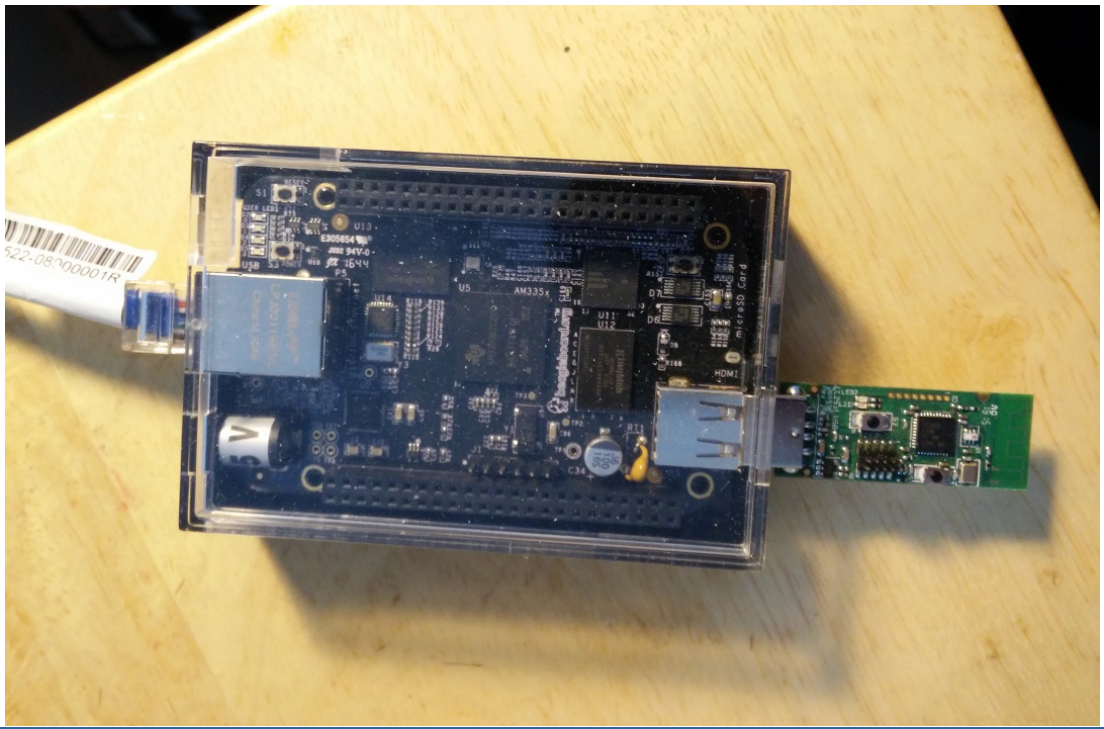
6LoWPAN

6LoWPAN is an emerging technology for the Internet of Things. It is an open standard and allows the IPv6 protocol stack to work on low power sensor networks like IEEE802.15.4.

- It can support applications and protocols based on TCP/IP, which is proven to be working very well for a vast amount of applications.
- IPv6 is used for Internet of Things as it provides a much larger addressing space than the current IPv4 technology and more advanced features. But we cannot directly use IPv6 on low power sensor networks. 6LoWPAN is an adaptation layer that allows the sensor networks to communicate with IPv6 networks.

Border routers

A 6LoWPAN network connects to the external IPv6 network through a border router. In our platform, we use an embedded Linux computer called the BeagleBone Black together with a USB dongle that supports IEEE 802.15.4 to be the border router.



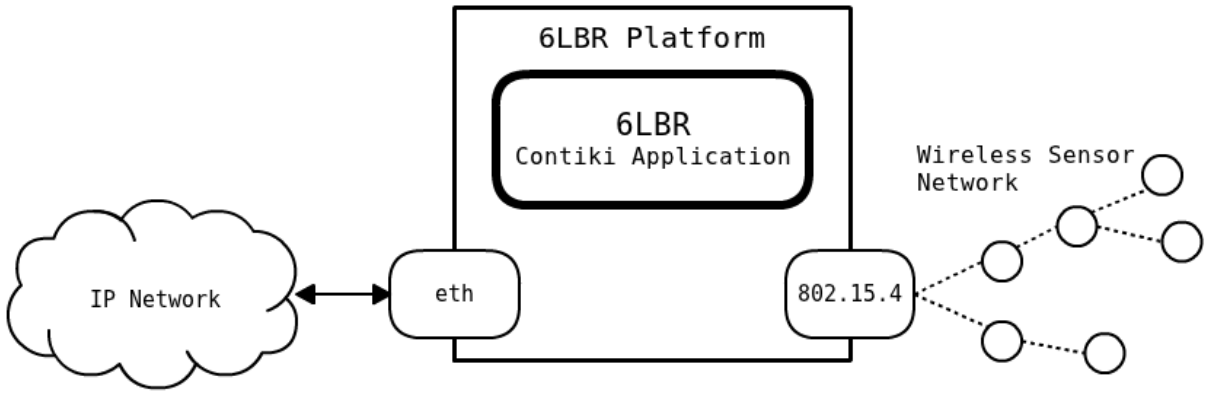
Border routers Cont.

The BBB border router runs a software called 6LBR that is based on the Contiki native platform:

- connects to the 6LoWPAN motes wirelessly with the USB dongle.
- connects to the external IPv6 network using an Ethernet cable.
- does the IPv6 address autoconfiguration using stateless or stateful autoconfiguration supported by the IPv6 networks.
- does the translation between the 6LoWPAN network and the external IPv6 network using header compression and decompression, routing protocols of RPL and other routing protocols supported on the external IPv6 networks.

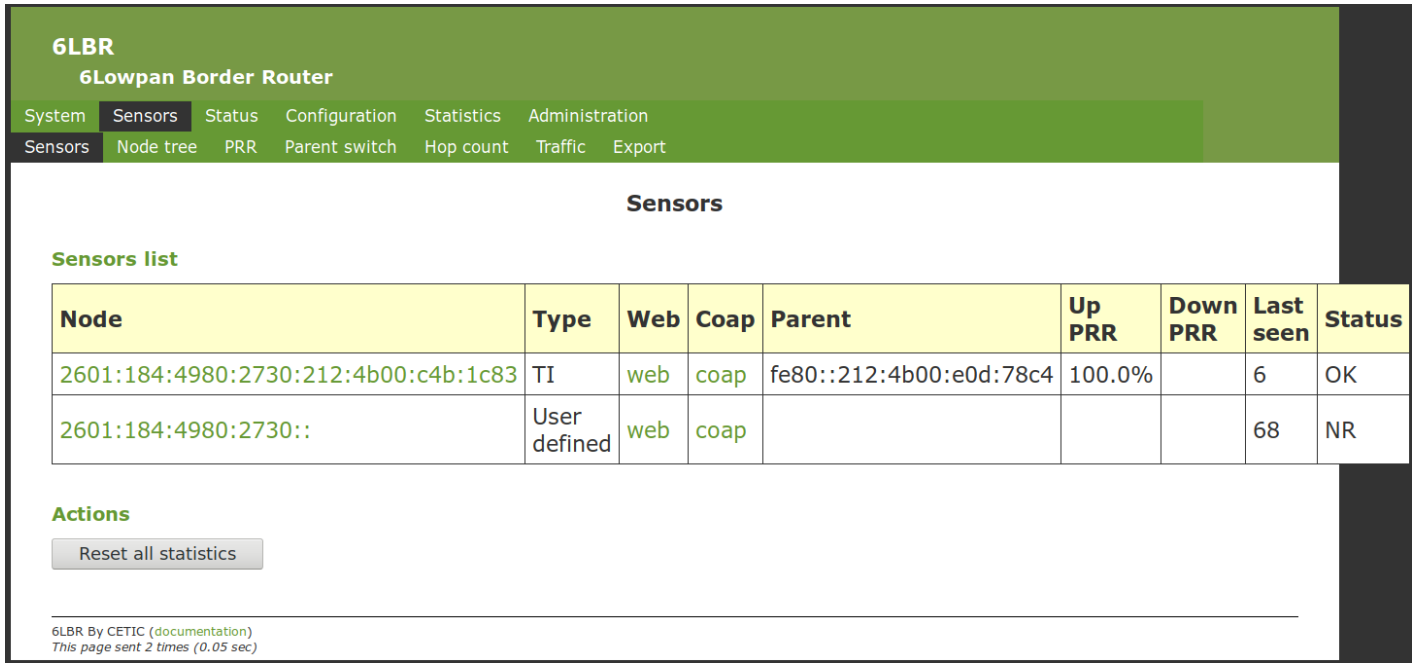
Border routers Cont.

The basic structure of 6LBR is:



Border routers Cont.

6LBR can be configured using a browser. When properly connected, 6LBR shows the topology:



6LBR
6Lowpan Border Router

System | Sensors | Status | Configuration | Statistics | Administration
Sensors | Node tree | PRR | Parent switch | Hop count | Traffic | Export

Sensors

Sensors list

Node	Type	Web	Coap	Parent	Up PRR	Down PRR	Last seen	Status
2601:184:4980:2730:212:4b00:c4b:1c83	TI	web	coap	fe80::212:4b00:e0d:78c4	100.0%		6	OK
2601:184:4980:2730::	User defined	web	coap				68	NR

Actions

Reset all statistics

6LBR By CETIC (documentation)
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Motes

The motes we use on the platform are call SensorTags. A SensorTag is an ultra low power device that runs the latest Contiki operating system and supports 6LoWPAN. It has about 10 different sensors builtin that can monitor temperature, light, sound, movement, etc.

Applications

This platform supports several standard 6LoWPAN application protocols, for example, CoAP and MQTT. With a lot of sensors, it can be used for a lot of potential applications and as a prototype of more research topics:

- Movement detection. For example, intrusion detection and fall detection.
- Temperature and humidity monitoring. For example, smart home and smart buildings.
- Sound monitoring. Intrusion detection, environment monitoring.
- Ambient light detection. A lot of potential applications.

Problems and future work

- The border router routing protocol is not stable and sometimes does not work. We need to debug the source code and make it stable.
- The motes does not work using the default compilation method. We need to figure out the reason.
- Connect the platform with Xiaozheng and Xiaofei's application servers using CoAP to read the sensors.
- Using the platform for more researches like applications and security.

The end

Thank you!