Status Report for IEEE 802.15.4 and 6LoWPAN in Linux

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Agenda

- Introduction
- Project History
- Mainline Status
- Current Work Areas
- Future Work

Introduction

IEEE 802.15.4 / LoWPAN

- IEEE standard
- Low-Rate Wireless Personal Area Networks
- Specifies the physical and the MAC layer
- Simple addressing but no routing
- Star and Peer-to-Peer topologies supported
- Mesh topologies need some layers on top of these
- Applications are small battery powered devices like sensors

6LoWPAN

- A series of IETF specifications
- IPv6 over LoWPAN
- RFC4944: IPv6 Convergence Layer
- RFC6282: IPv6 Header Compression
- Updates and extensions in other RFC's (see resources slide at the end)

Motivation and Use Cases

- Battery powered sensors might not run Linux but choose a smaller OS
- Main powered appliances might run Linux already and would benefit from native 6LoWPAN support
- Border Routers / Gateways are likely to run Linux
- IEEE 802.15.4 chips could easily be integrated in WiFi accesspoints or routers which already run Linux

Project History

Early Days

- Started in 2008 as linux-zigbee project on Sourceforge
- Mainly driven by Siemens AG
- Kernel code as well as lowpan-tools userspace configuration utilities

ZigBee Relations

- The name itself was very misleading
- The code only implemented the IEEE 802.15.4 layers and no ZigBee protocols or profiles at all
- ZigBee licensing seems incompatible with the GPL so no ZigBee support for the Kernel

Mainlining

- The first steps of mainlining moved the core parts of the sourceforge repo over around 2012
- Main Siemens developers withdraw over time
- Community slowly took over

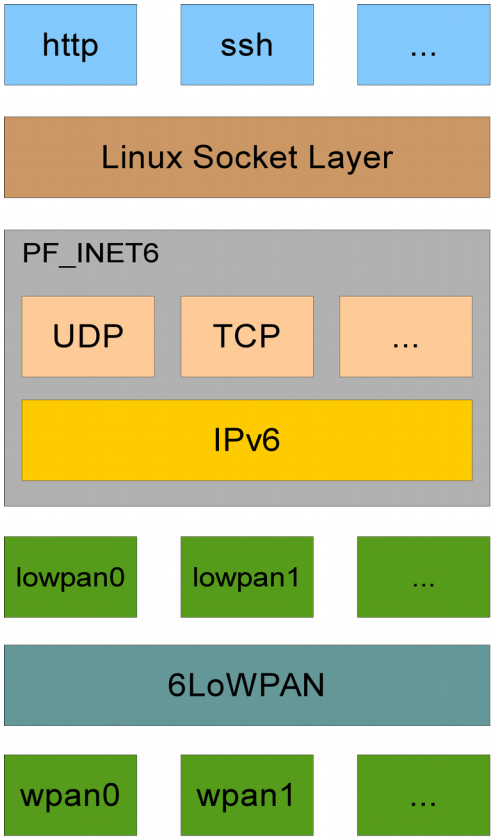
Under New Management

- New project name to avoid confusion: linux-wpan
- New maintainer: Alexander Aring, Pengutronix
- Mailinglist moved to vger like most other Kernel lists
- Patches are now handled on the list and picked up through the Bluetooth tree
- http://wpan.cakelab.org, releases, docs

Mainline Status

Overview

- ieee802154 handles the MAC layer and drivers (wpan0 interface)
- 6LoWPAN sits on top of the wpan devices and acts as convergence layer to be used by the normal IPv6 kernel stack (lowpan0 interface)
- 6LoWPAN transparently handles the fragmentation and defragementation between the different MTU's (127 vs 1280) as well as compressions



Source: Alexander Aring

Current Mainline Status

- Basic ieee802154 layer with drivers for various chips (at86rfxxx, mrf24j40, cc2520)
- 6LoWPAN implementation
- IP Header Compression
- Connection between Linux devices works
- Connection to Contiki devices works

6LoWPAN Compressions

- Fragmentation handling is only one part
- A IPv6 header alone is 40 bytes which means it would use almost 1/3 of a ieee802154 frame
- Re-use of the 64 bit wpan address and various other compressions brings the smallest header down to 3 bytes
- On top there are compression modes for UDP and others

Bluetooth LE Relationship

- IETF specification for IPv6 over Bluetooth LE
- Still in draft phase (draft-ietf-6lo-btle)
- Common code is thus shared between the wpan and Bluetooth subsystems

Current Work Areas

Overview

- Main work areas right now:
  - New netlink framework nl80215 (Major part done)
  - ieee802154 cryptography layer on top of nl802154
  - Improvements in frame parsing and creation

New Netlink Interface - Kernel

- nl802154 is the netlink interface between Kernel and userspace
- Used for configuration (PAN ID, short address, etc)
- Inspired by nl80211 from the wireless developers
- Aligning these two should help to make the code easier to understand for already established hackers as well as newcomers

New Netlink Interface - Userspace

- Available since Kernel version 3.19
- Needs a new userspace tool: iwpan
- Also inspired and aligned with iw from the wireless community
- Old netlink interface still available but considered deprecated

MAC Layer Cryptography

- The IEEE802.15.4 specification defines AES 128 bit cryptography to encrypt and or authenticate the transmitted data
- 8 different security policies are defined (AES-CBC-MAC and AES-CCM in various length)
- Almost all transceivers implement this in hardware
- While the Kernel will handle the interface to the hardware nl802154 needs to be extended to handle AES key setting, etc

Next Header Compression

- RFC6282
- 6 LoWPAN Next Header Compression (NHC)
- Describes various compression formats
- Kernel framework allows for different modules to handle one compression and decrompression format each
- Mix and match different modules/formats
- Only UDP NHC is implemented right now

Future Work

IEEE 802.15.4

- Implement missing parts of the spec
  - Coordinator support in MAC layer and wpan-tools
  - Scan for available PANs
  - Expose more MAC functionality through nl802154
- Improve existing drivers and add support for new chips

6LoWPAN / NHC

- Run time configuration of NHC (Handled by loading and unloading modules right now)
- Implement more NHC modules for other compression schemes

Miscellaneous

- Routing Protocol for Low-Power and Lossy Networks (RFC6550)
  - SimpleRPL, unstrung, linux-rpl as current implementations
- Neighbor Discovery Optimization for 6LoWPAN (RFC6775)
- Test with more high level protocols on to (CoAP, MQTT, etc)

Related work

- ContikiOS implements 6LoWPAN as well (Kernel implementation origins from it)
- Threads uses parts of 6LoWPAN for their protocol
- 6LoWPAN over powerline

Resources

- RFC4919: 6LoWPAN Problem Statement
- RFC4944: Transmission of IPv6 Packets over IEEE 802.15.4 Networks
- RFC6282: Compression Format for IPv6 Datagrams
- RFC6550: RPL: IPv6 Routing Protocol for Low-Power and Lossy Networks
- RFC6775: Neighbor Discovery Optimization for 6LoWPAN
- RFC7400: 6LoWPAN-GHC: Generic Header Compression for 6LoWPAN

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