Extending PoE to the LTC4266

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Agenda

- Motivation
- Power over Ethernet Basics
- PoE Systems
- Current Upstream Support
- LTC4266 overview

Motivation

We build and sell 4G/5G Wireless WAN Routers

- More than 40 different products
- Very long product lifecycles

Currently

- 6 different Linux forks
  - Driven by the chipset vendor
  - Each with a similar set of changes

Ideally

- Single, recent linux-stable version across all chipsets
- This is becoming realistic
  - Chipset support, DSA...

Terminology

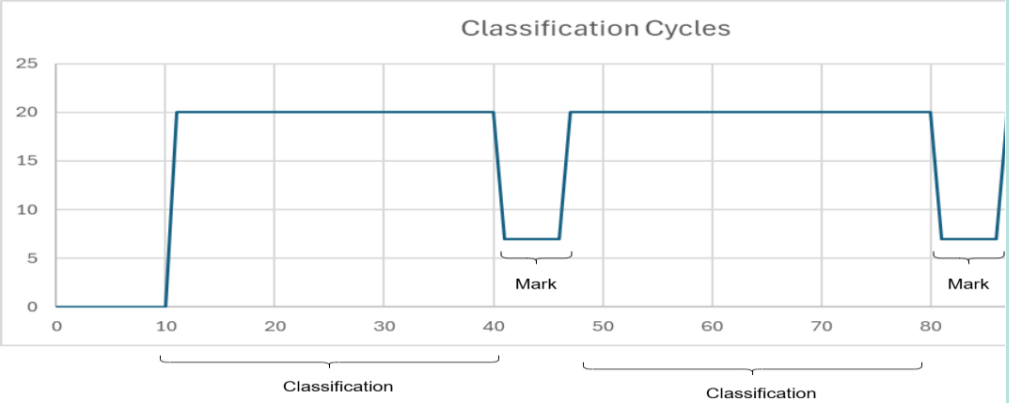
- Power Sourcing Equipment (PSE)
  - Switches/routers
  - Midspans (injectors)
  - Type 1-4 PSEs
- Powered Device (PD)
  - Type 1-4 PDs
- Type 1 & Type 2 devices (Clause 33, 802.3-2022)
  - Power over two pairs
- Type 3 & Type 4 Devices (Clause 145, 802.3-2022)
  - Power over four pairs
- Detection
  - Low voltage check for a PD
- Classification
  - Determine how much power a PD requests

Powering up Powered Devices - Detection

- Ethernet uses differential (AC) signaling
  - Positive, negative for each data signal (4)
  - Transformer for isolation (4)
- Bias the transformer to induce a DC voltage
  - Polarity is defined by which transformers are biased.
- Most ethernet devices are not PDs
- PDs must have a 23.7kΩ – 26.3kΩ between pairs
  - When presented with 2.7-10.1V
- PSEs must accept 19kΩ – 26.5kΩ

Powering up Powered Devices - Classification

- PD Power Requirements
  - Determined by the PD's current draw between 14.5V and 20.5V
- PD and PSE Type
  - Determined by the number of classification pulses



Class	Current (mA)
0	0 to 4 mA
1	9 to 12 mA
2	17 to 20 mA
3	26 to 30 mA
4	36 to 44 mA

Powering up Powered Devices - Type Identification

- Type 1 devices (4W to 15W)
  - 4 classification signatures defined at different current loads
  - Power over two pairs
- Type 2 devices (4W to 30W)
  - Two classification pulses presented by the PSE (if Type 2)
  - PD indicates class 4 both times
  - Type 2 indicates support for LLDP power negotiation
- Type 3 and 4 Devices
  - Power over 4 pairs
  - Build on the Type 2 detection with more classification pulses
    - Type 3 has 4 pulses; Type 4 has 5
  - Enable up to 90W (71.W at the PD)

(Safely) Powering up Powered Devices

- Only allowed after valid detection and classification
- PSE required to power on the device with 400ms of the classification
- PSE limits the current (power) supplied to the device
  - If over limit, will power off the device
- PD is required to draw a minimum amount of current
  - Maintain Power Signature (MPS)

Power over Ethernet - System level

- Multiple PSE ports ends up possibly requiring a lot of power
  - 4 Type 4 PSE ports -> 360W
  - 4 Type 2 PSE ports -> 120W
- Can’t provide the maximum power to all ports at the same time
- How to decide which ports get power and which do not?
  - User decides by setting port priority
- Port Prioritization
  - Static
    - Based on class power allocation
  - Dynamic
    - Based on the device’s current power consumption

Power over Ethernet Support – Current status

- Framework added in 2024
  - Köry Maincent talked about it at EOSS NA 2024 (Link)
  - Support for TI's TPS2388x, Microchip's PD692x0
- Port Prioritization and Power Budgeting merged
- Skyworks Si3474 PSE Chipset is on the mailing list
- LTC4266 is posted as RFC

Significant value in the Power over Ethernet framework

Kernel PSE Framework

- Device driver framework in place today
  - `struct pse_controller` describes a particular PSE controller driver
  - `struct pse_controller_ops` used by the core to get/set PSE driver state
- Userspace API via netlink
  - `ethtool --set-pse eth0 --c33-admin-pse-control enable`
  - `ethtool --set-pse eth0 --c33-pse-avail-pw-limit N`
  - `ethtool --show-pse eth0`

Adding support for LTC4266

- Linear Technology (now Analog Devices)
- Type 2 PSE Controller
- Multiple operating modes:
  - Semi-automatic
- Current limiting support only, not power
  - Complicates power budgeting
  - Still don't have a great solution in RFC series
- Check out the RFC series: link

Questions? Comments?

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