# Network view of embedded specific challenges for non-embedded network developers

Oleksij Rempel – ore@pengutronix.de

# Who am I?

- Part of kernel hacker team @pengutronix
- Doing continues R&D and kernel mainlining

# Who are you?

- Who is working with:
  - Not embedded:
    - HW for servers?
    - Workstations?
    - Other categories?
  - Embedded:
    - Things nailed in the buildings? (Industrial)
    - Things driving on the roads or fields? (Automotive, agriculture, transportation)
    - Things going on the water or seas? (marine)
    - Things flying in the air? (aerospace – aircraft)
    - Things flying in the space? (aerospace – spacecraft)
    - Other categories?

# What is embedded?

Embedded developer

# What is embedded?

- Build-in in to something?
- Designed (reduced?) to fit special task?
- Consumes less power or has less CPU power compared to something?
- Uses specially configured system to make one job but doing it as good as possible?
- May have networking connection but not always connected to the internet or intranet.

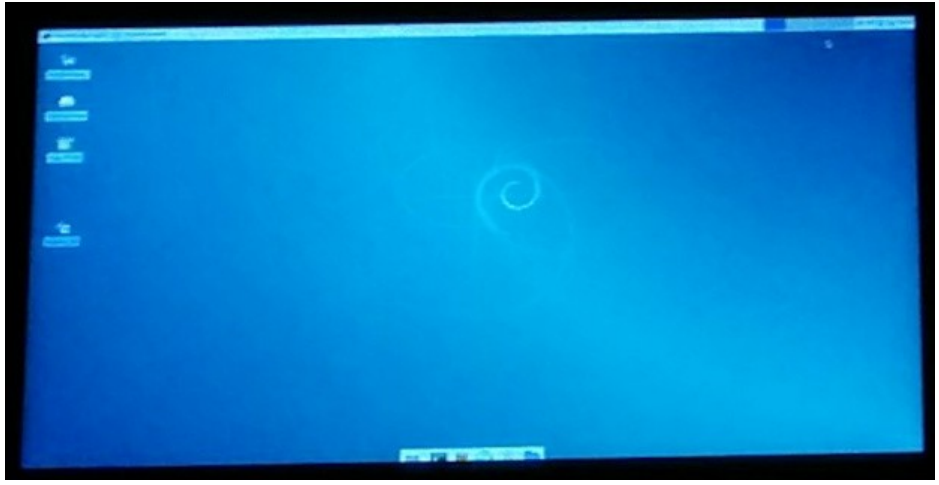
# What is embedded? (Automotive)

- On the right side:
  - It is build in
  - It is Linux (vw.os)
  - Can be called “Embedded Linux”?
- On the left side
  - Nothing is embedded :)

# What is embedded? (Agricultural)

- We may have Linux based ISOBUS terminal in the tractor
- We may have even Linux based controller in the trailer.
- It is build in, so can be counted as embedded as well


# What is embedded?

# What is embedded?

- It is build in
- There is Linux (Debian) in it
- Looks more like workstation configuration of system
- Counting as embedded?

# What is embedded?

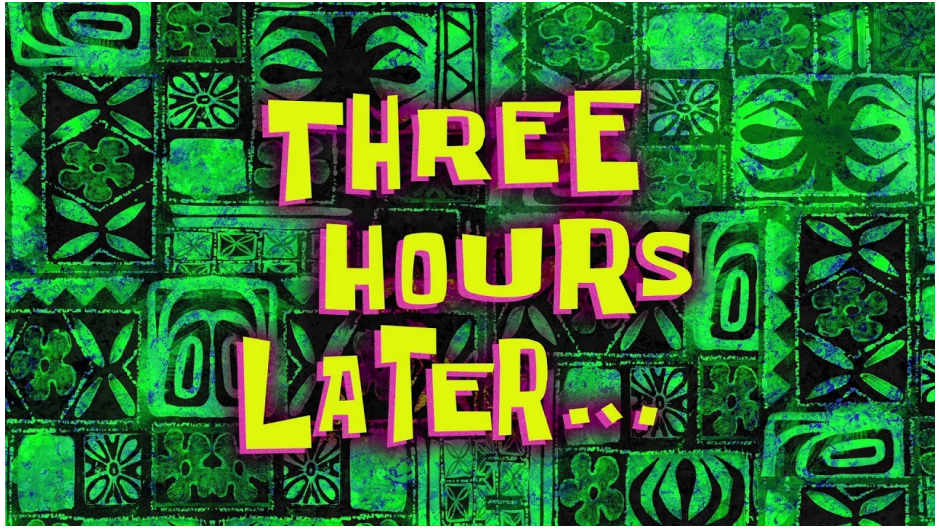
- Everything is kind of build in
- Designed for server tasks
- Counting as embedded ;) ?
- At least some part can be counted as embedded:
  - Switches
  - Management
  - Networking adapters with huge software stack in it (Linux as FW)

# What is embedded?

- Build-in to the (on the) wall
- Single use task (show off :)) or gaming.
- Embedded?

# What is embedded?

- ???
- Hard to define what is embedded.
- Single or limited use case?
- Even if it is kind of embedded, a multipurpose OS can be used.

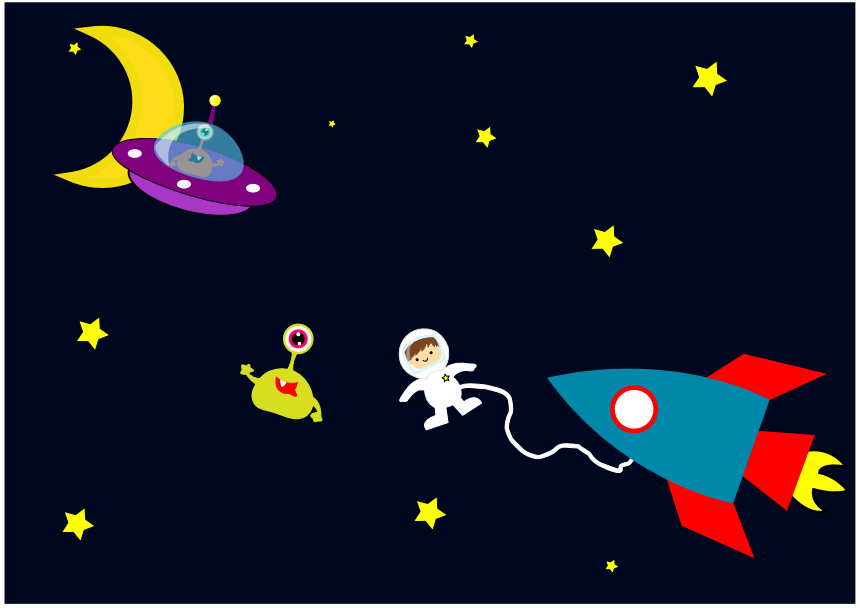


# Why this talk?

- Different, limited use cases and challenges, potentially rare for community, reviewers and maintainers.
- With OSS and mainlining, our work may affect each other.
- For example: fq_codel good for tcp, bad for CAN

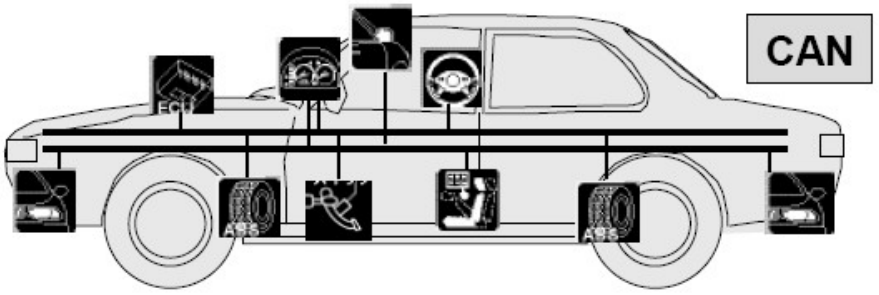
# Crossing worlds

- Closed source kept worlds isolated
- With open source and mainlining strategies, different kind of busses and protocols from automotive, industrial or building automation fields are going to the Linux Kernel
- Community and maintainers need to deal with new technologies.



# How is it related to netdev?

- Sensors, actuators and controllers are interconnected
- Automotive, industrial, automation, etc. In all these fields, exotic busses are slowly replaced by Ethernet
- One of those busses is mainline: CAN! :)



# Reducing things to bare minimum

- Reducing:
  - Weight
  - Cost
  - Power consumption

# Automotive

- For long time used different kinds of busses, for example CAN, CAN FD, LIN, FlexRay, etc
- Speed:
  - LIN ~ 20Kbit/s
  - CAN ~ 500Kbit/s
  - CAN FD ~ 5Mbit/s
  - FlexRay ~ 10Mbit/s

# Automotive

- 10Mbit/s is not enough!
- Sensors, cameras and infotainment need more bandwidth
- New technology is needed. Why reinvent the wheel? Use Ethernet!
- Existing Ethernet standards were not suitable. So we have new single pair Ethernet standards: XXXBaseT1X

# Automotive: weight

- In some cars the cable harness can reach ~70KG
  - Multiple twisted pairs per link is not an option. Welcome to the 10/100/1000Base-T1 world.
  - Use one twisted pair (T1) to deliver power and save even more weight – Power over Data Line (PoDL)
  - Reduce even more weight with 10Base-T1S multi-drop Ethernet (no bridge is needed).

# Automotive: High timing requirements

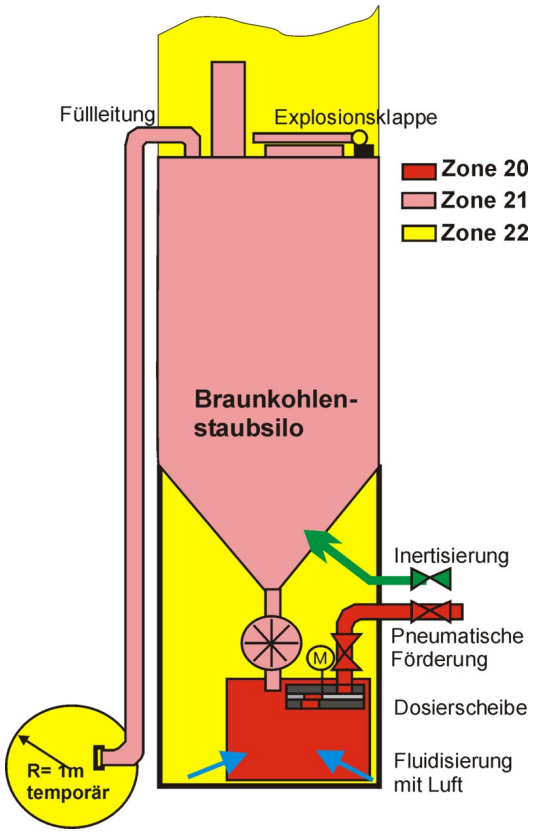
- Link between Ethernet PHYs should be created within some milliseconds. Autonegotiation can’t be used here. This results in more configuration requirements:
  - Since no autoneg can be used, PHYs have predefined clock role: clock provider, clock consumer.
  - Some PHYs in the clock consumer role can’t be accessed over MDIO until clock provide PHY is enabled.
  - Predefined clock role may affect ability to run cable diagnostic. Cable test can be done from clock provider PHY.

# Explosion protection

- hazardous locations
  - gases, vapors, dust, fibers
  - Electrical equipment installed in such locations could provide an ignition source

# Explosion protection

- Different classification methods and standards
- Example of UK zones:
  - ignitable concentrations of dust/fibers/flyings are:
    - Zone 20 - long periods of time
    - Zone 21 - likely to exist
    - Zone 22 - unlikely to exist



# Explosion protection

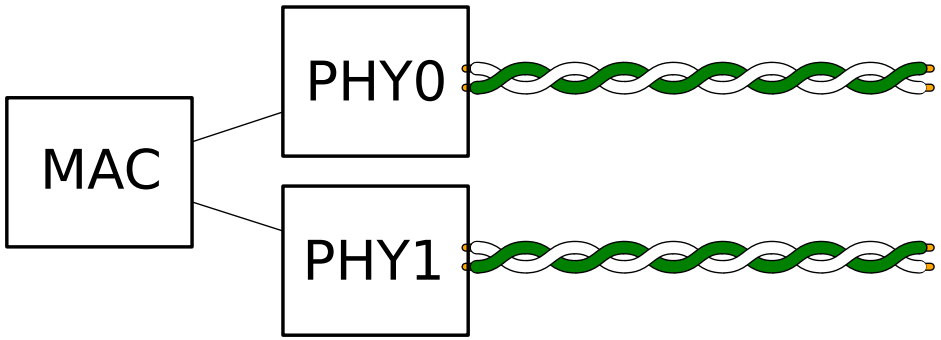
- Depending on electronic device classification, different requirements:
  - Flame proof
  - Sand filled
  - Encapsulated
  - Non-sparking

# Explosion protection

- Ethernet with configurable transmit amplitude 10Base-T1L:
  - 1.0Vpp (mandatory), 2.4Vpp (optional)
  - For Ex, only 1.0Vpp must be used
  - Some devices refuse link if the link partner is advertising 2.4Vpp support.

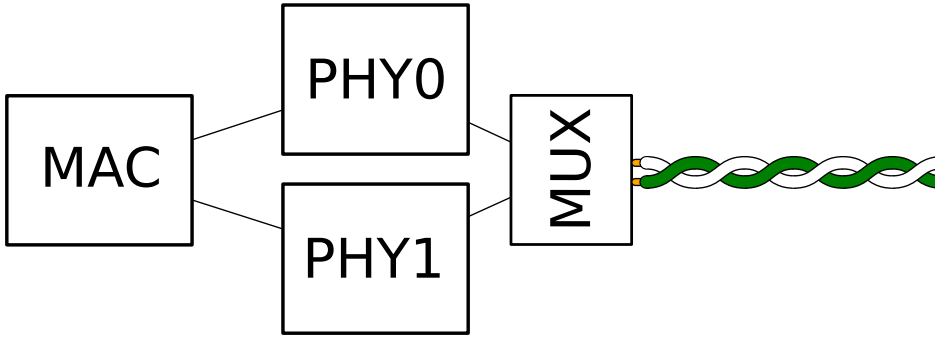
# Link redundancy: one MAC, > 1 PHYs

- Breaks assumptions: we have only one PHY per MAC
- Good enough to handle cabling issues.
- Reduces: cost, power consumption and maybe even weight.
- New challenges: how to represent it in the use space?



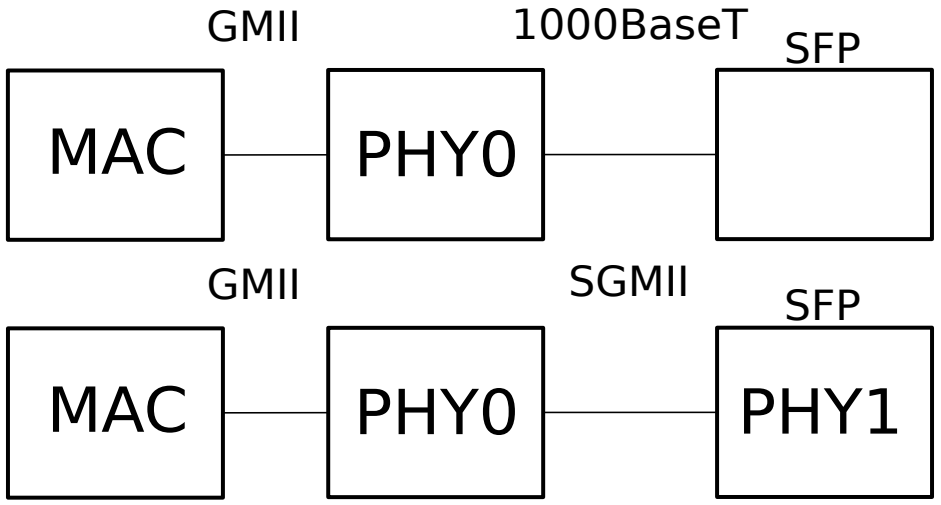
# Extended functionality: one MAC, > 1 PHYs

- Not all PHYs implement needed functionality.
- Only way to create some product is to combine PHYs
- Use cases:
  - 10Bast-T1L + 100BaseT1
  - CAN + Single-Wire CAN



# Extended functionality: converting things

- With SFP things getting even more interesting :)
- Converting GMII/RGMII to SGMII or 1000BaseX
- Some times MAC, PHY0 and SFP have a communication chain like: MDIO→I2C→MDIO



# How all of this affects Linux?

- More link modes (some are mainline 100BaseT1, 1000BaseT1, 10BaseT1L)
- More configuration options are needed:
  - master/slave role configuration (already mainline)
  - 1.0Vpp/2.4Vpp amplitude configuration
  - Potential preferred amplitude configuration? See:

    https://www.ieee802.org/3/cg/public/Sept2018/Graber_3cg_07b_0818.pdf
  - Avoid link based on existing capability instead of missing caps. (If 2.4Vpp is present – don't link)
  - Handle multi-partner 10BaseT1S link? Welcome back 10Base2 :)

Thank you!

Questions?