

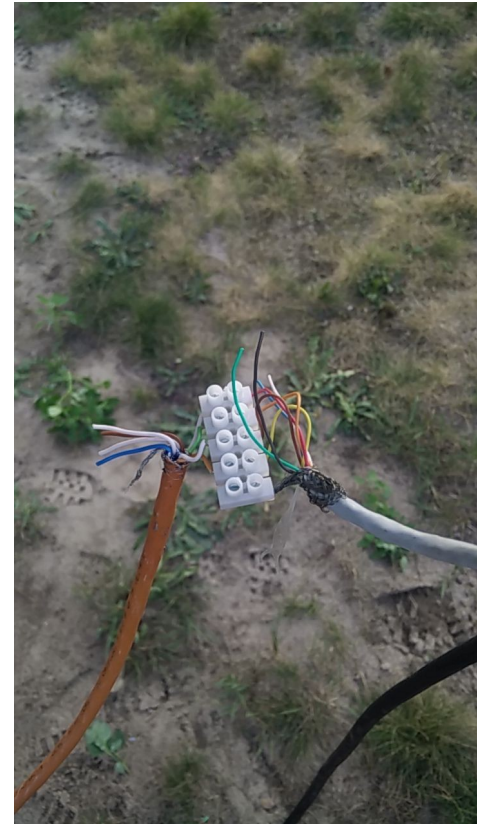
Implementing cooperative link diagnostic

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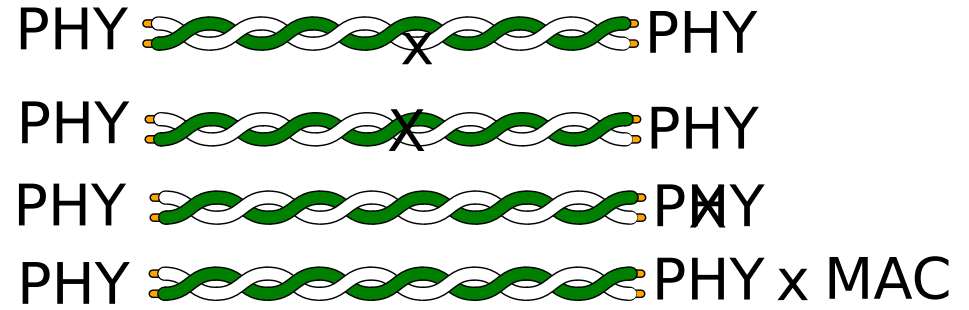
What could possibly go wrong?!

- Industrial and building automation challenges:
 - 10Base-T1L: 1000-2000 meter copper twisted pair.
 - Remote devices are hard to access
 - Mechanical and thermal stress
 - In field repair attempts
 - Animals



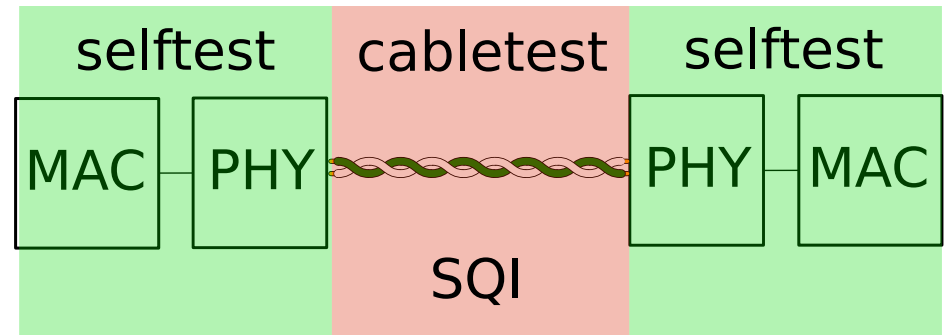
Variants of “broken”

- One of cables of twisted pairs is open
- Complete twisted pair is open.
- Short withing pair
- Short between pairs
- Short to ground
- ... many more ...



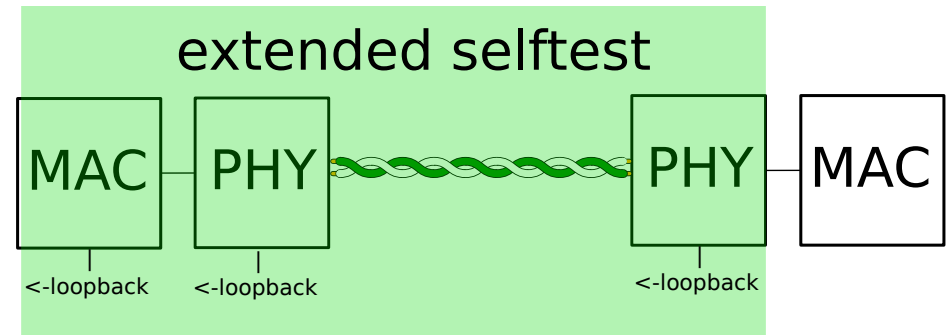
Currently available diagnostic

- selftest:
 - `ethtool -t eth0`
- cabletest
 - `ethtool -c eth0`
- SQI
 - `ethtool eth0 | grep -i sqi`



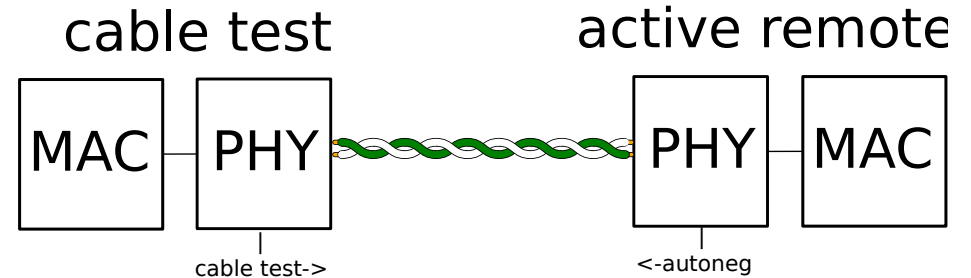
Extending selftest

- It is possible to extend selftest. Local and remote system should cooperate with each other.
- remote PHY should be able to enable external loopback on request
- How to communicate with remote system?



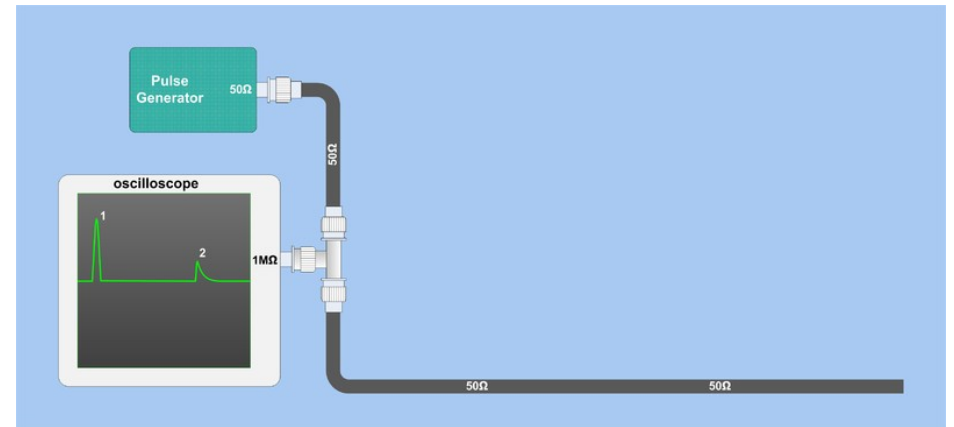
Optimizing cable test

- No problems If cable is completely damaged or remote system is off
- If remote system is active, cable test is disturbed by autoneg FLPs.
- We need to understand more about cable testing and autoneg to optimize it.

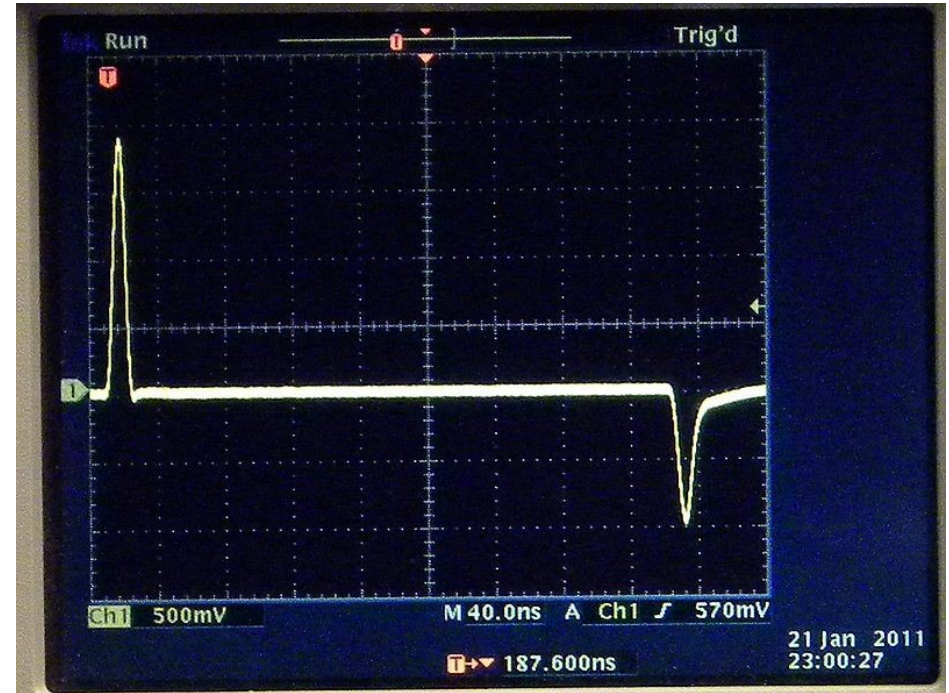
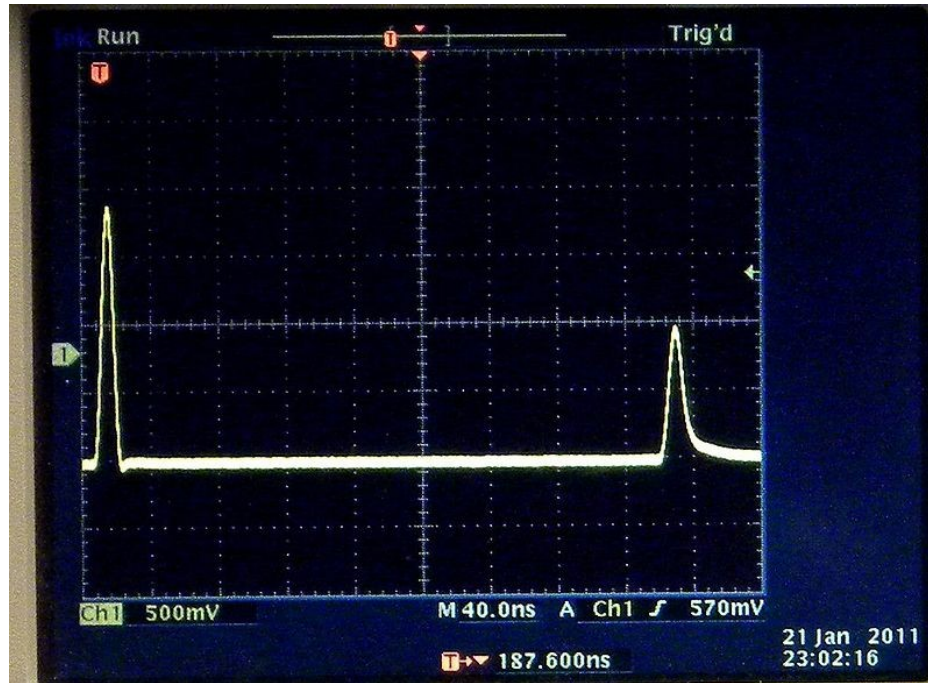


Cable diagnostic with TDR

- Time-Domain Reflectometry
- PHY is pulse generator and oscilloscope
- Precision depends on sampling rate
- Usual PHYs can get about ~80cm precision.



TDR: Open/Short recognition



TDR vs Autoneg



Variants of “broken”

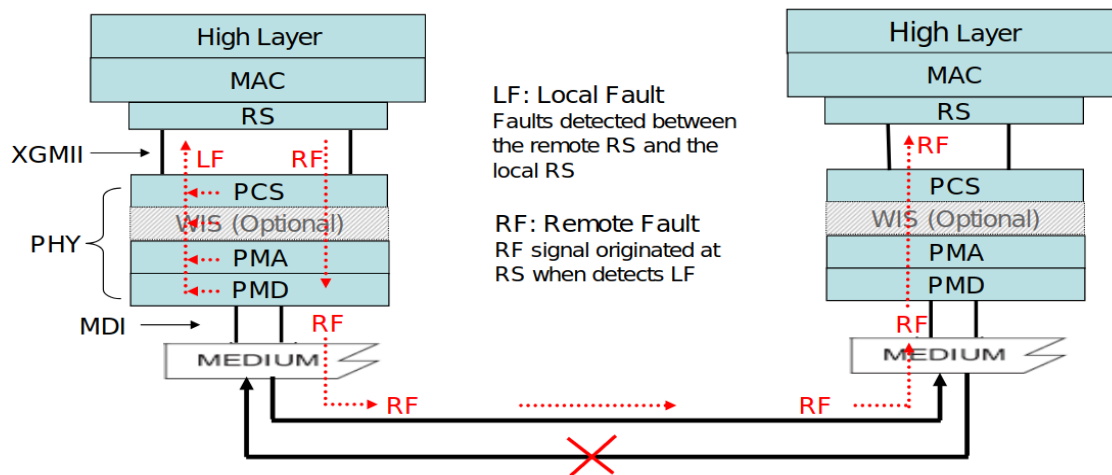
- No signal
 - Good for cable testing. No interference from link partner.
 - No special handling is needed.
- Some signal is present
 - Cable testing is disturbed by autoneg pulses, attempt to create link or manually configured link.
 - Proposal: For the autoneg, use “remote fault” flag to request a “silence window” on the wire.



It is not a new idea

PHY Monitoring in 802.3ae

- **There is a Link Fault Signaling mechanism in 10GE**
 - Reside in Reconciliation Sublayer (RS)
 - To monitor link status between local RS & remote RS and perform link status notification
 - Sublayers within the PHY are required to detect faults that render a link unreliable



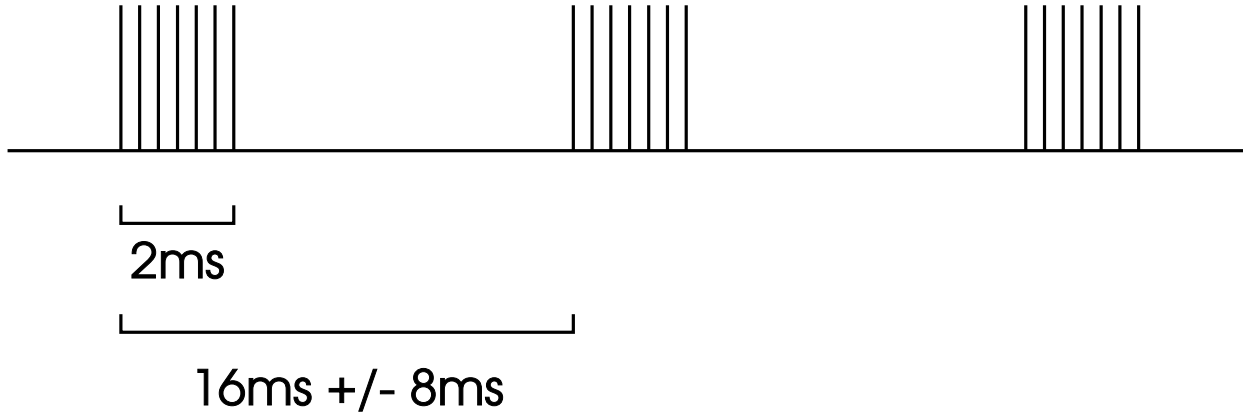
How this works

- Autonegotiation pulses run at lower frequency and less affected by partially damaged twisted pair.
- IEEE 802.3 defines standard to communicate by using autoneg pulses.
- How about to run IP over autoneg? ;)

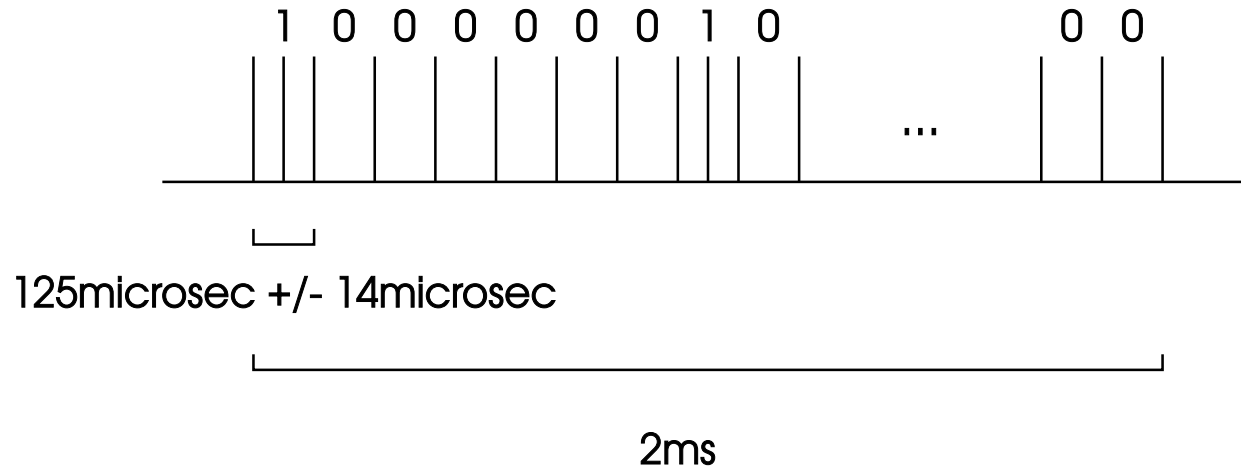


Autoneg FLP (Fast link pulses)

max 33 pulses



FLP: Link code word



Link code word

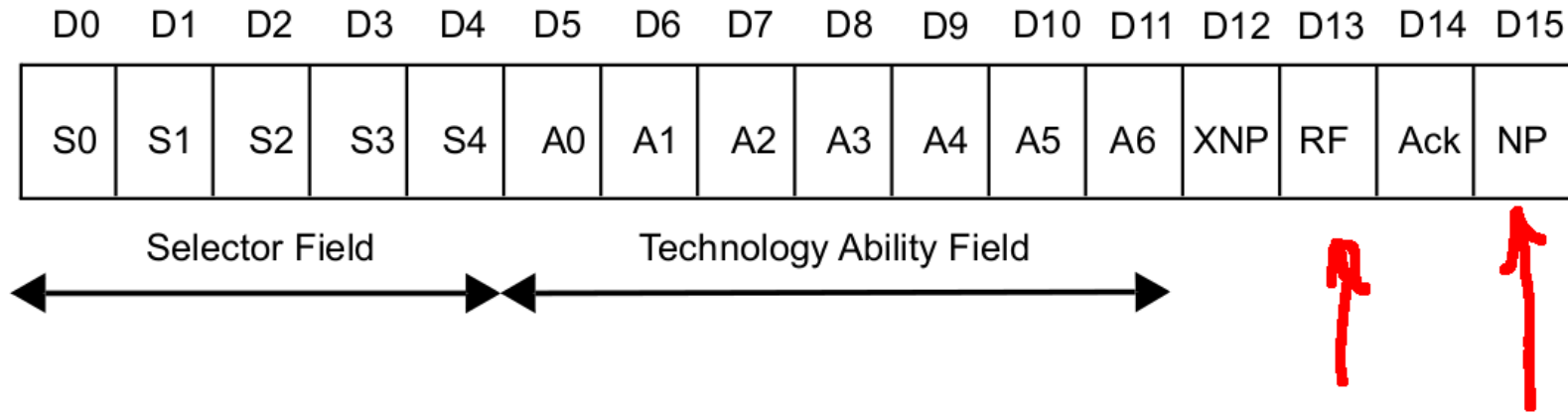


Figure 28–7—Base Page encoding



Link code word

- We can use “remote fault” (RF) flag to notify about some error state.
- If we want to be more specific we need read/write own pages and set “next page” (NP) flag.
- I can image to have following requests:
 - Silent autoneg for X amount of time
 - Enable remote loopback on the PHY or MAC
 - ...More ideas?...



Other pages

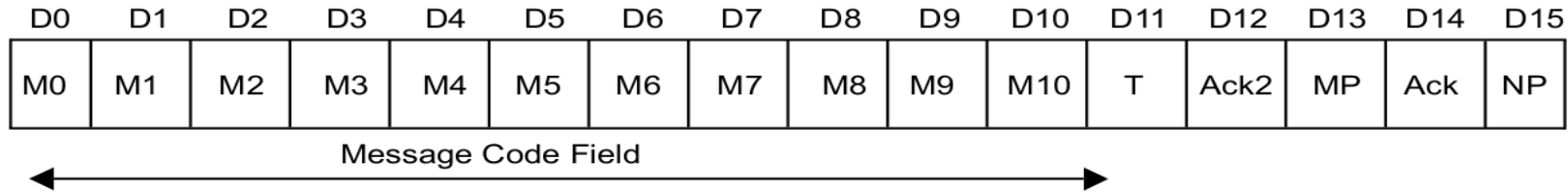


Figure 28–11—Message Page encoding

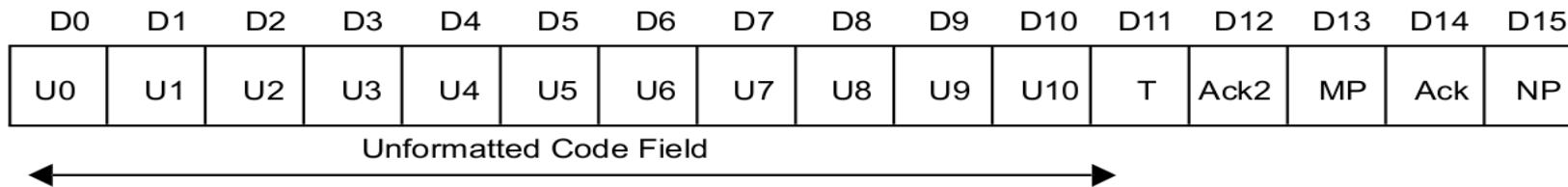


Figure 28–12—Unformatted Page encoding

Extended pages

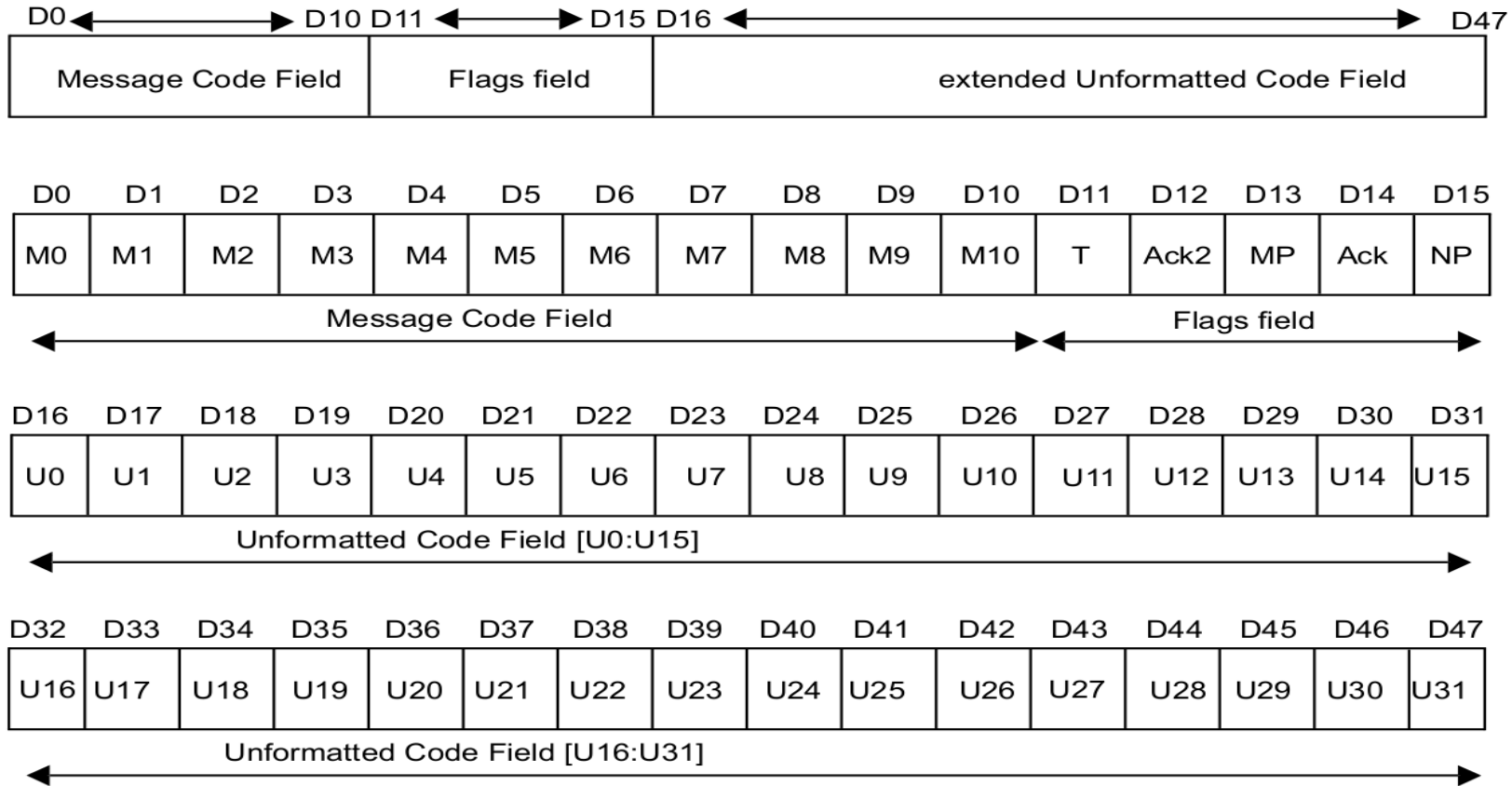


Figure 28–13—Extended Message Page encoding



Kernel integration

- Initial patch set (v1) was exporting every thing to the user space.
- For v2 patches I'll need to move RF handling to the kernel.



Patch v1: add remote fault support



- <https://lore.kernel.org/all/20220608093403.3999446-1-o.rempel@pengutronix.de/>

Thank you!

Questions?

