

AUI link training

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Abstract

- Question: Should we consider link training for AUIs in 802.3df?
- Short answer: Yes.
- Long answer: Most Definitely

Background

- Link training between PHYs is part of Ethernet over backplane and copper cable PMDs since 802.3ap (clause 72) and even earlier in the BASE-T family.
- The AUI interfaces (electrical segments in optical PHYs) did without a standard definition of link training for several generations.
 - Some out-of-band methods were defined for C2C starting in Annex 83C, but they were always optional.
 - Training logic implementation was assumed to be an overhead on module “CDR” design.
- After the introduction of 50 Gbps/lane AUIs using PAM4 (802.3bs), some challenges were encountered in integration of hosts and modules.
 - Annex 120E did not specify any negotiation or control on the “output” signaling.
 - Some control was added to modules through management in MSAs after 802.3bs.

100 Gbps per lane (802.3ck)

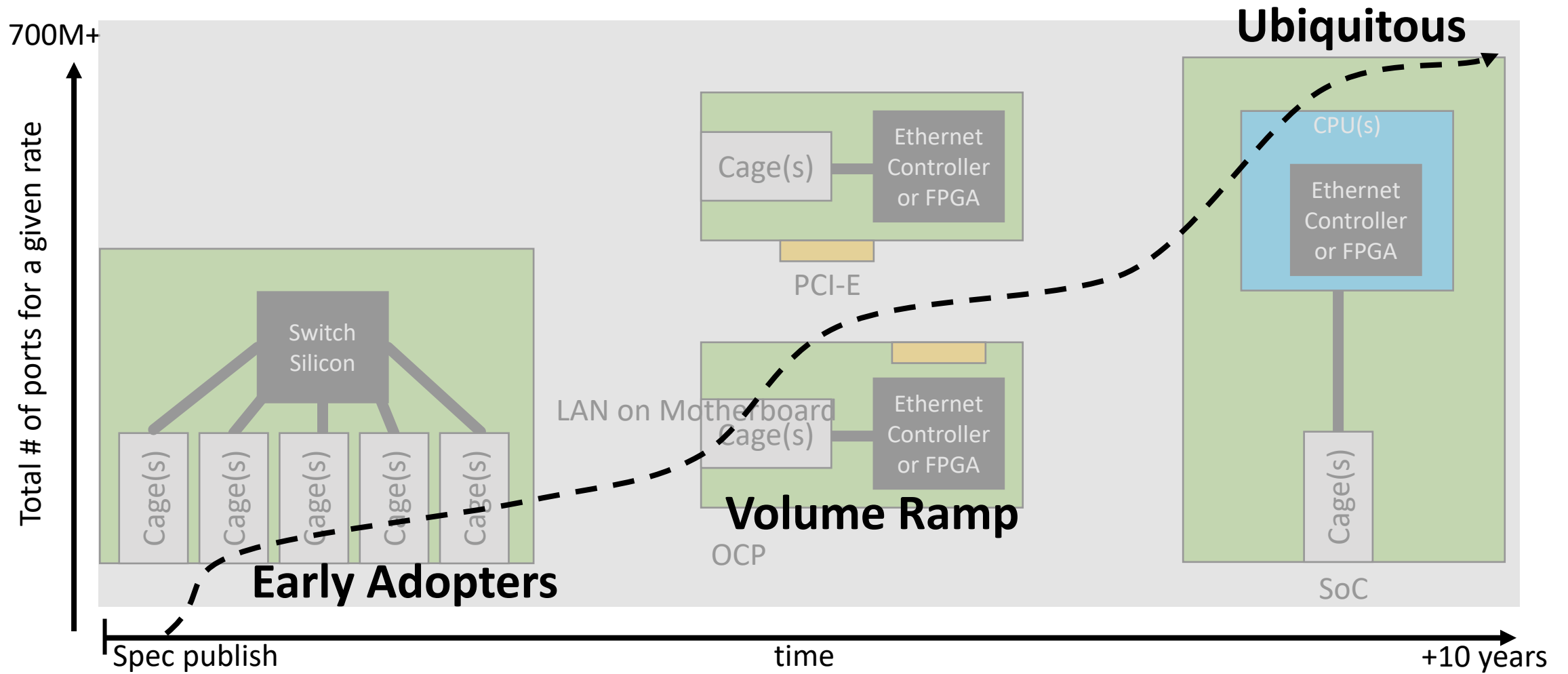
- The idea of having a “long” Tx equalizer (with link training) in C2M was discussed in early stages...
 - 3rd TF meeting in Spokane: Rationale and implication of Tx training was presented in [ran 3ck 01 0918](#), “Decision tree” in [slavick 3ck 02 0918](#)
 - Following the decision tree with straw polls, it was decided not to add link training to C2M for that generation ([lusted 3ck 02a 1118](#))
- Control over the module output was discussed in later stages...
 - [ran 3ck adhoc 01 052720](#) suggested using management interface (e.g. CMIS) to control module output
 - No consensus; concern about the host “touching the module”
 - ... discussion documented in [ran 3ck 01b 0720](#)
 - We ended up with two “module output” settings that the host can select between
- Subsequent discussions about VEC, EH, Vdpp and other output parameters, near-end and far-end, equalization setting in stressed input – what is actually required?
- ... We spent most of the time in the 3ck task force on C2M electrical specs!

OIF

- CMIS Support for Host-Module Link Training project (CMIS-LT)
 - Notes that Ethernet link training operates on end-end link but there is no real support for multi-segment links such as AUI+optics
 - Extends the AUI-S and AUI-L settings, e.g. to improve BER or reduce power
 - Notes that 802.3ck considered link training for AUI but backed out due to complexities in multi-segment links
 - Suggests out-of-band equivalent
- Apparently, there is a problem worth solving in 100 Gbps/lane C2M
- Apparently, the host has to “touch” the module (and maybe vice versa)

Experience in system integration of 100G modules (and earlier)

- “Compliant” output setting and “performance-optimized” output setting are not the same
 - Large (but compliant) output from the host not always tolerated well by modules; smaller (and in-compliant) signal is better
 - Similarly in module output and host input
- Problems seen with long-term FEC performance rather than short-term compliance testing
- Modules have CMIS interface, but configuring each module through CMIS in multi-port switches is an integration nightmare
 - Many levels of separation between the SerDes and the software that handles I2C/CMIS
 - Different settings are required for different boards and different ports
 - A different module may output a different signal (or prefer a different host setting)
- Lack of well-defined startup and training protocol makes interoperability more challenging than in CR/KR mode
 - It’s much easier when everything is in the SerDes
- Burden grows with volume and product proliferation



Forecast of 200 Gbps/lane C2M challenges

- Host-to-module loss can range from <10 dB to >35 dB
 - Front panel pluggable vs. CPO vs. NPO
 - High radix switches vs. smaller NICs
 - PCB host vs. Cabled host
- Test fixtures do not represent real receivers
 - A single “TP4” is not representative of the wide range of hosts
 - HCB output (TP1a) is possibly different from module input
- Methodology concerns
 - How many “settings” and “open eye” tests should be defined for module output?
 - Where is the host output optimized/specified?
 - Are all compliant “stressed eyes” equivalent?

Question restated

- Should we consider link training for AUIs in P802.3df?
- In more detail...
 - Should link training be developed separately from electrical specifications?
 - Can P802.3df handle multi-segment link training?
 - In-band or Out-of-band?
 - What is the electrical specification methodology with link training?
 - ... and possibly other questions
- Time to start the discussion!