25G PHY TYPES

Jeff Slavick, Avago

Adee Ran, Intel

Goals

- Move towards a decision about number of PHY types
- Satisfy the project objectives:
  - Define a single-lane 25 Gb/s PHY for operation over links consistent with copper twin axial cables, with lengths up to at least 3m
  - Define a single-lane 25 Gb/s PHY for operation over links consistent with copper twin axial cables, with lengths up to at least 5m
- Satisfy the CSD, especially:
  - Broad market potential
    - Broad sets of applicability
  - Economic Feasibility
    - Consideration of installation costs
    - Consideration of operational costs (e.g., power consumption)
- Address other apparent needs:
  - Low-latency operation
  - Interoperability

Use cases

- **Engineered network**
  - Primary optimization factors: cost, power, latency…
  - Supported and desired modes are known in advance and pre-configured.
  - Interoperability is guaranteed by design.
- **Plug-and-play**
  - Primary optimization factors: install/service time, user experience.
  - Users may care little about selecting options and configuring modes – "make it work"!
  - Interoperability is assumed by compliance with a standard.

Modes, Optional, Mandatory?

- *Mode*: one out of several behaviors allowed by the standard
- *Optional mode*: a mode that may or may not be implemented by a compliant device
  - Example: clause 74 Base-R FEC is optional for most 10G PHYs.
- *Mandatory mode:* a mode that must be implemented by a compliant device
  - A mandatory mode may not be used in some cases, another mode (optional or mandatory) can be used instead.
  - Example: operation without clause 74 is mandatory; it must be selected if partner does not support clause 74.
- Some modes have to be used on both ends to interoperate
  - This can be done by auto-negotiation, e.g. usage of clause 74 in current PHYs.
  - Can also be done using management, e.g. "disable training".

Auto-negotiation

- **Clause 73 defines information passed and priority-based resolution**
  - HCD determines PHY choice.
  - FEC ability/request bits determine usage of FEC.
  - EEE ability bits determine usage of LPI.
- **Management can control which supported abilities to advertise**
  - This is out of scope of clause 73 (and 802.3 in general).
  - Partial advertisement typically *reduces* interoperability.
- **Link should be resolved in a single pass if abilities match**
  - This is the spirit of clause 73.
  - This is what users expect as normal behavior.
  - Multi-pass management algorithms might not be interoperable.

FEC

- The encoding "menu" includes
  - **RS-FEC**: required to meet the 5 m objective, high latency, largest gate count
  - **Base-R FEC**: is required to meet the 3 m objective, medium latency, low gate count
  - **No FEC**: Although not part of the project objectives, there is an apparent desire to enable it in adequate links. (See andrewartha_3by_01a_0115)
- Decoding and encoding must match… AN can be used for that
  - What should be advertised?
  - What are the resolution rules?
- <u>Which mode is mandatory?</u>

Possible paths for single PHY

Single PHY type (CR)

This choice must be made by the task force!

One mode

Multiple modes, only Base-R FEC mandatory

Multiple modes, only RS-FEC mandatory

Multiple modes, no mandatory FEC

Low latency or 5 m reach?

Impacts Broad Market Potential

Unsuitable for engineered networks

5 m reach objective not guaranteed (depends on an optional feature)

Unconventional, might confuse the market

Over-design

Impacts Economic Feasibility

Unsuitable for engineered networks

No guaranteed common capability even for 3 m

Impacts interoperability

Unsuitable for plug-and-play

Possible paths for multiple PHYs

Multiple PHYs (CR-L and CR-S)
Advertise capabilities through AN

This choice can be made by vendors!

Single capability device – only CR-S

Single capability device – only CR-L

Dual capability device – both CR-S and CR-L

Optimized for low latency

No over-design

Can be used for networks using only CA-S cable assemblies (engineered)

Optimized for maximum reach and support of other standards

Can be used with dual-capability device over any cable

Optimized for interoperability

Can be used with any single-capability device over compliant cables for the common operating mode

May have higher cost

Idea can easily be extended to three PHY types

AN resolution

- If we go towards several PHY types, which can be advertised separately through AN – we should address HCD resolution.
  - If only one capability is common to both partners – the resolution is clear.
  - If more than one capability is common, one should be selected based on priority.
  - Does it matter which one has higher priority?
    - Current clause 73 has predefined priorities for each PHY – not user selectable. This prevents deadlock situations.
  - What if we set a priority order, but a user has different preferences?
    - Possible solution: disable advertisement of undesired modes
    - Other solutions can involve reading media type and advertising accordingly.
- If we go to one PHY type, HCD is not an issue
  - If several FEC options are available, a FEC resolution is still required.
  - Simple rule in 73.6.5 may be sufficient, or we may need new logic.

Decision making flowchart
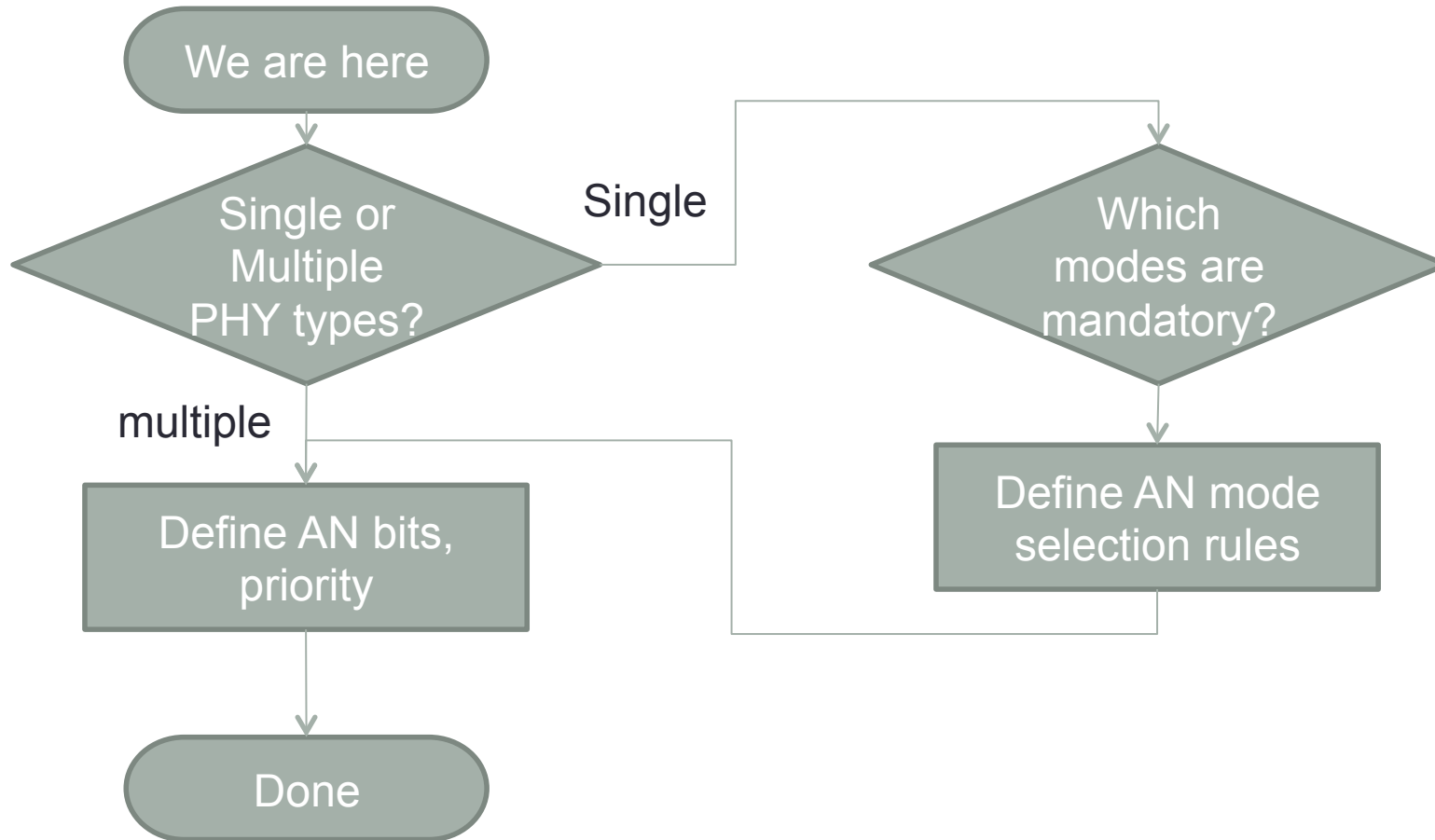
PCS, FEC area cost and performance

	Gates	% of total	35 dB BP	3m Cable	5m Cable
Clause 49	45k	9%	No way	Possibly	No way
Clause 74	80k	15%	Doubtful	Likely	Doubtful
Clause 108	400k	76%	Likely	No problem	Likely
Total	525k				

	Area	PCS % of PHY
PMD/PMD	X	
Cl 49	X * 0.05	4.5%
Cl 49, 74	X * 0.13	11.7%
Cl 49, 74, 108	X * 0.65	34.8%