IEEE 802.3cg 10 Mb/s Single Twisted Pair Ethernet

ELEVATOR/ESCALATOR USE CASE

Introduction (elevators, global)

- Current network solutions:
  - Volume: mainly RS485-, CAN- and simple proprietary solution-based products
  - Sporadic: copper twisted pair point-to-point Ethernet (≤100m)
- On the worldwide market:
  - Currently: ≈850.000 new installations / year: each having avg. 20 serial port interfaces
  - 2020: ≈1.000.000 new installations / year
- Requirements of near-future systems (functional safety, voice and video streaming) can not be met using these networks
- Product's life (market-dependent):
  - life-span is 15-20 years
  - life-time is 15-30 years, replaced/modernized afterwards
- We can estimate that half of the 20 million nodes per year market could be Ethernet-based in ten years' time

Example of current network (ISO OSI)

- L1: RS485, ≤250 kbps (slew-rate limited), ≤4000f (≈1200m), half duplex/multidrop (≤128 PHY)
- Single 18-23AWG stranded shielded twisted pair (copper), with termination
- L2: Manchester, CSMA/CA (p-persistent), 16-bit CRC
- L3-L7: proprietary protocol
- Several types of connectors (pitch in the range of 3-5.08mm)
- Separate wires in the same cable/connector for power and configuration/discovery
- Network may be branched: 1 backbone, single-level branches off of it (each branch with ≤128 PHY)

Why not standard (existing) Ethernet?

- Cabling
  - With parallel cabling: number of wires / m of distance covered
  - With serial cabling: single point (node) of failure
- Reach and speed: outside of the expected range

Planned network: L1 (PHY)

- Commercial solution preferred
- Till then solution should be possible to be implemented in ≤100MHz Cortex-M4/7 without FP, with ADC/DAC and native DSP (or similar)
- High level of flexibility with regards to hardware:
  - Cable
  - Connector (including IDC*)
  - Details: twist, stripping etc.

* Insulation Displacement Connector

Planned network: details

- Elevators: two models used as building blocks
  - Model A: branches (or very simple real systems)
  - Model B: trunk
  - Model A+B: real systems of wide range (distance and number of nodes)
- Self-synchronizing or support for a drift inherent to crystals (200ppm over whole temperature range)
- Framing should allow the following message classes to be supported (in decreasing order of importance):
  - Isochronous: safety monitoring (10/s, max jitter 1ms)
  - Immediate: safety events (≤20/s, delivery within 1ms)
  - Ad-hoc (on-demand): events (≤200/s, delivery within 10ms without safety)
  - Realtime: audio and video (properties are TBD)
  - None (idle): burn unused bandwidth for telemetry, file transfer (no guaranteed service)

Planned network: environment

- Systems:
  - Elevators: Two models
    - Model A: ≤16 nodes, ≤100m
    - Model B: ≤16 nodes, ≤1000m
    - Model A+B: 200(+) nodes, 1000(+)m
  - Escalators: Simple network with few (≤10) nodes and medium reach (≤50m), model A
  - Powerwalks: Simple network with few (≤10) nodes and medium reach (≤100m), model A
- Environmental conditions
  - Industrial conditions, with temperature range of -20°C – +65°C
- Electrical requirements
  - Overvoltage and ground fault protection ±40V
  - Short- and open-circuit protection
  - Electrostatic discharge protection (EN 61000-4-2) 15kV
  - Fast transient protection (EN 61000-4-4) 2kV

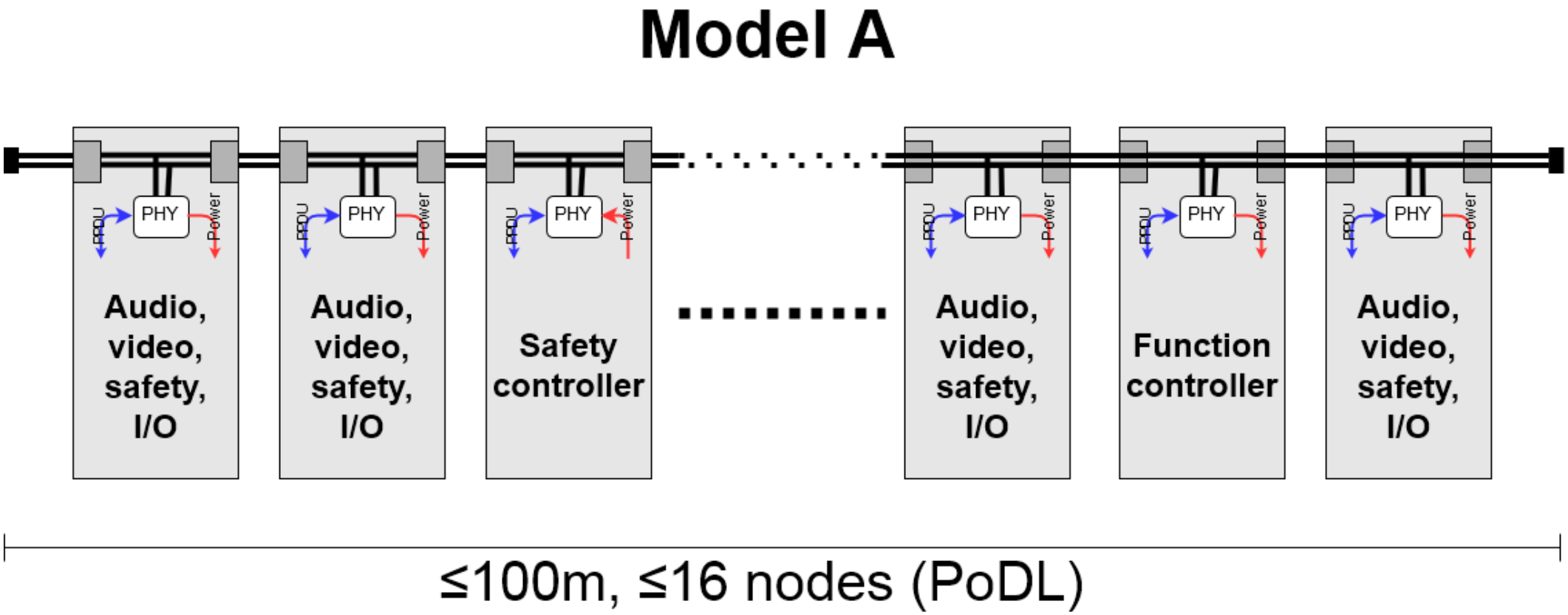
Planned network: on noise

- Sources:
  - Mains: 50 or 60Hz, 1- or 3-phase
  - Motor drive and motor: (in shaft or machine room)
  - Ground loops, cross-coupling of switching transients
- Motors: hoisting (fixed) and doors (moving)
  - AC induction
  - Permanent Magnet AC
- Outside world:
  - Native: wireless devices, gadgets (working within specs)
  - Occasional: vandalism (malicious intent)
- Measurements and demonstration is possible
- Channel model: TBD

Planned network: model A (branches)

- Architecture: Single bus, 1 PHY/node (multidrop)
- Type: single shielded copper TP
  - As target is new device market (or when not, cables are replaced during modernization), there is high level of flexibility adopting external specs on cable and possibly on connectors
- Segment length: ≤100m
- Nodes: ≤16 nodes
- PoDL: ≤50W (avg.), ≤100W (peak)
- Other factors:
  - Native topology discovery: desired (through software): installation-time automatic node self-configuration (based on node order and possibly approximate distance)

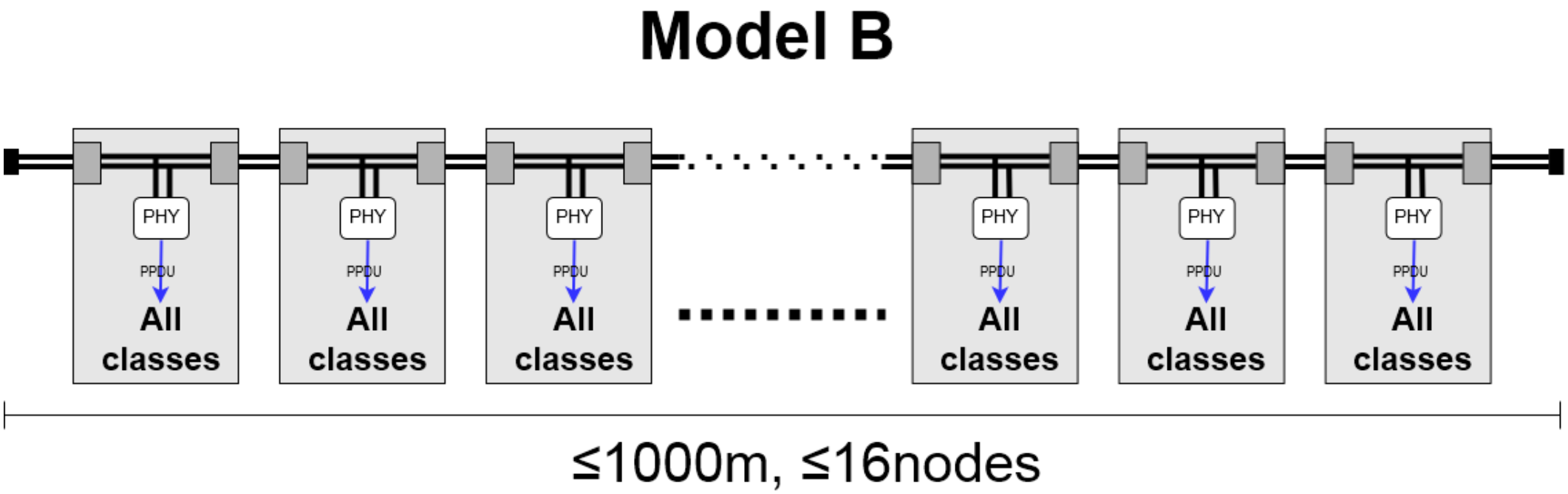
Planned network: model A, diagram



Planned network: model B (backbone)

- Same as model A, with exceptions:
  - Segment length: ≤1000m
  - PoDL not needed
  - Cable may need to be weight-bearing (complete or part of own weight) with or without IDC

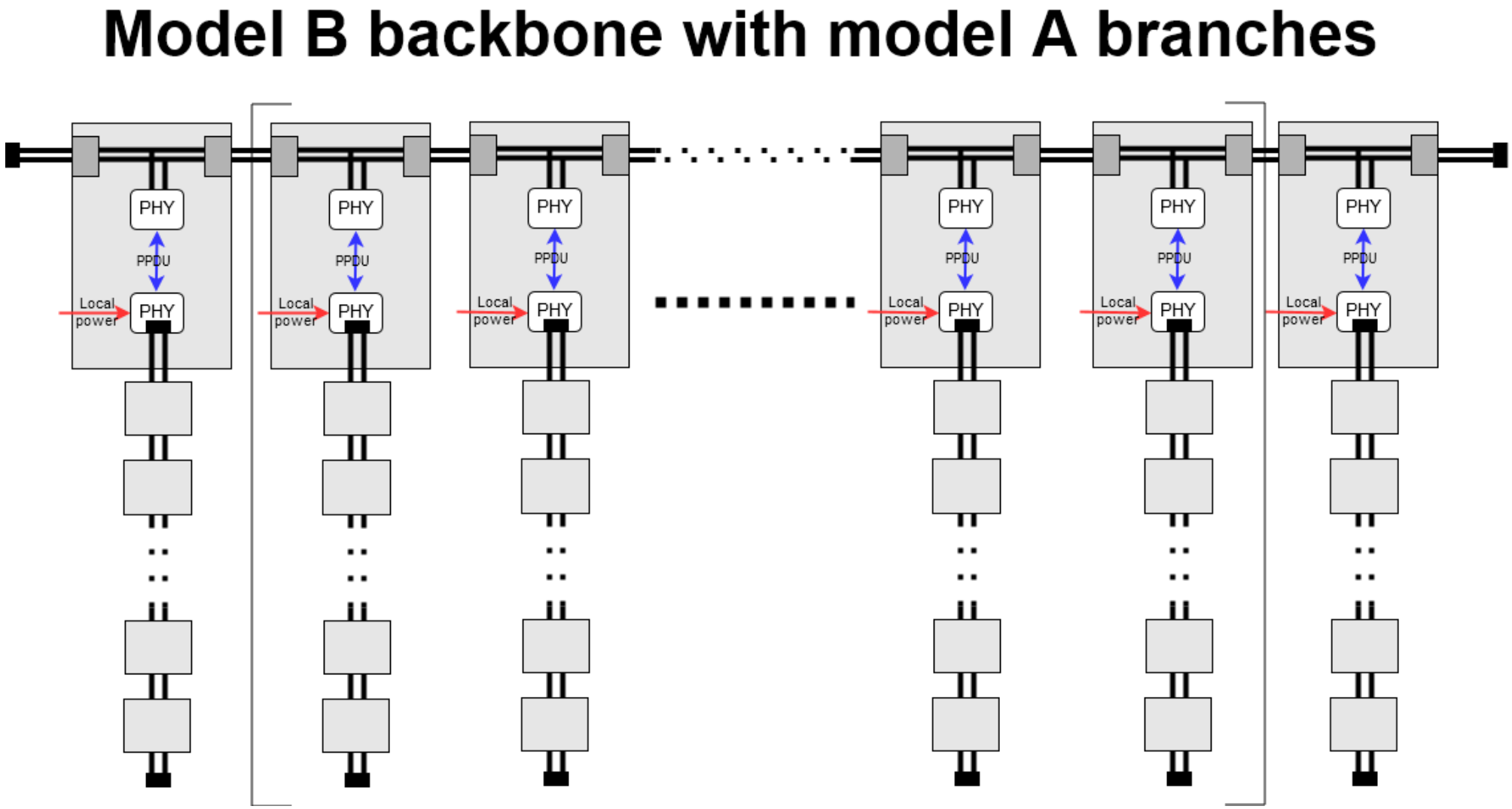
Planned network: model B, diagram



Planned network: hybrid (complete network)

- Single A:
  - Simplest elevators
  - Most of the escalators and power-walks (only power consumption may be an issue)
- A+B:
  - Anything that is beyond the above
  - Number of A segments is determined by system factors (total reach, power consumption)

Planned network: hybrid, diagram



Thank you for your kind attention

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