IEEE 802.3 SPMD 10SPE Multidrop Enhancements Study Group

OBJECTIVES FOR THE ELEVATOR/ESCALATOR AND AUTOMOTIVE SEGMENTS
TOPOLOGY DISCOVERY (RANGING)

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GENEVA
v11

Presenters

- Gergely Huszak (Kone)
- Ari Kattainen (Kone)

Supporter

- Piergiorgio Beruto (Canovatech)

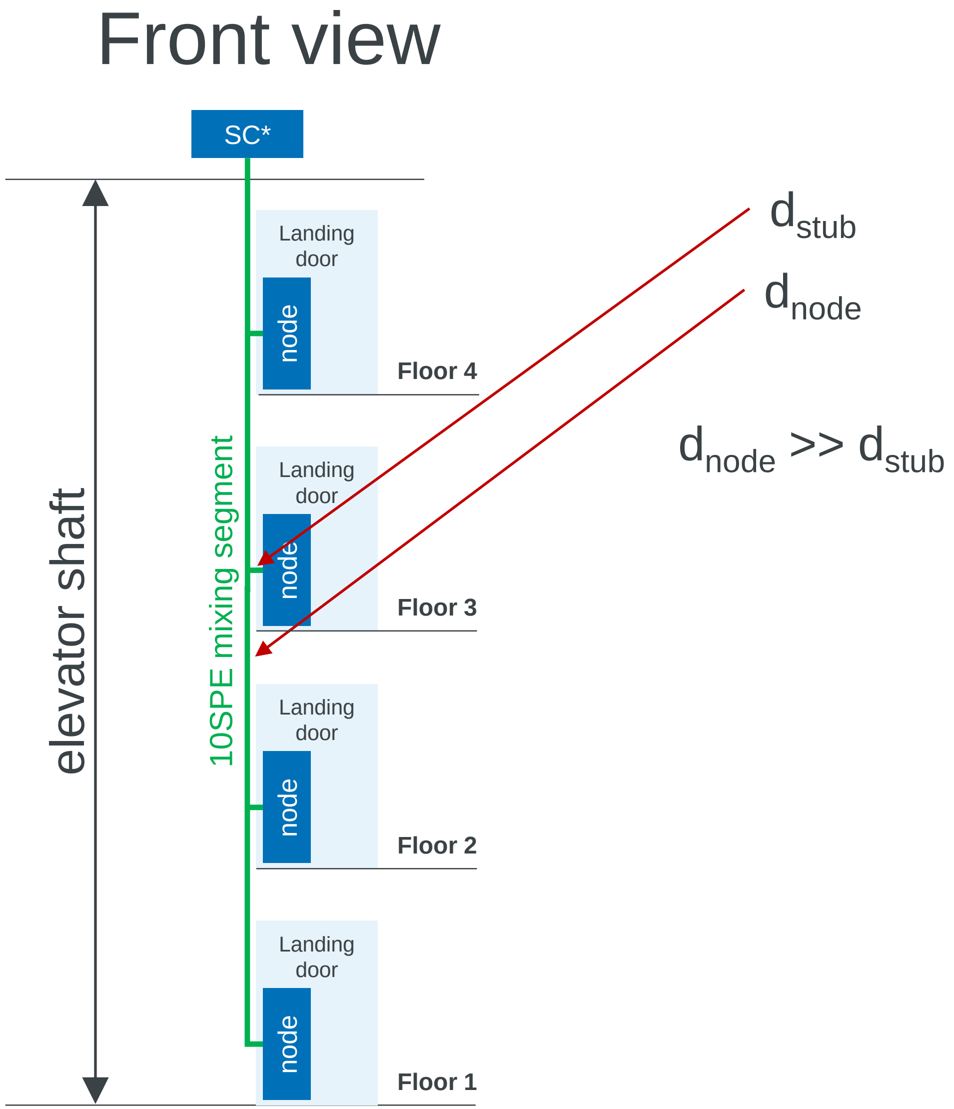
Topology discovery: ranging (1/2)

- Permits **measuring** the absolute and/or relative wire length (**distance**) of remote PHYs from the source's perspective over a mixing segment, which is an enabler things like:
  - assigning:
    - floor numbers to nodes in an elevator shaft
    - seat number to nodes in a train
    - door and light ID to nodes in a car
  - manufacturing nodes without hardware setup elements (DIPs, rotaries, jumpers) or manufacturing-time configuration steps, as nodes are configured as per their physical location
  - supervising network on a regular basis ("on-demand" execution)
- Most notable technical parameters would be **resolution, precision and speed** (execution time)
- It would preferred to be run in conjunction with PLCA BEACON, to **eliminate** the possibility of "in-band" **interference** (with normal communication/bus cycles)

Topology discovery: ranging (2/2)

- Execution could be “on-demand” (upon powerup and/or on a regular basis)
- Would be an optional feature
- Preferred to work in conjunction with “PHY-ID auto-configuration”
- Not currently (15 January 2020) covered yet by visible effort/objectives
  → **This presentation proposes listing this as an objective**

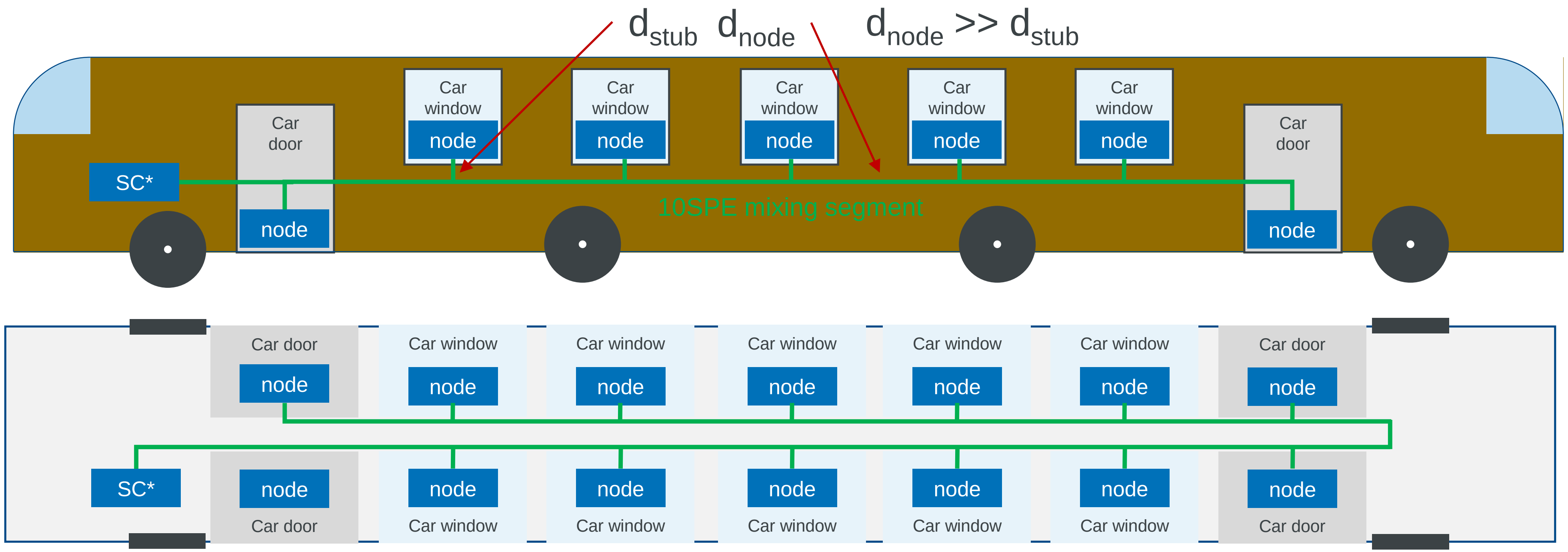
Use case: elevators



* Segment Coordinator

Use case: trains and buses

Side and top views



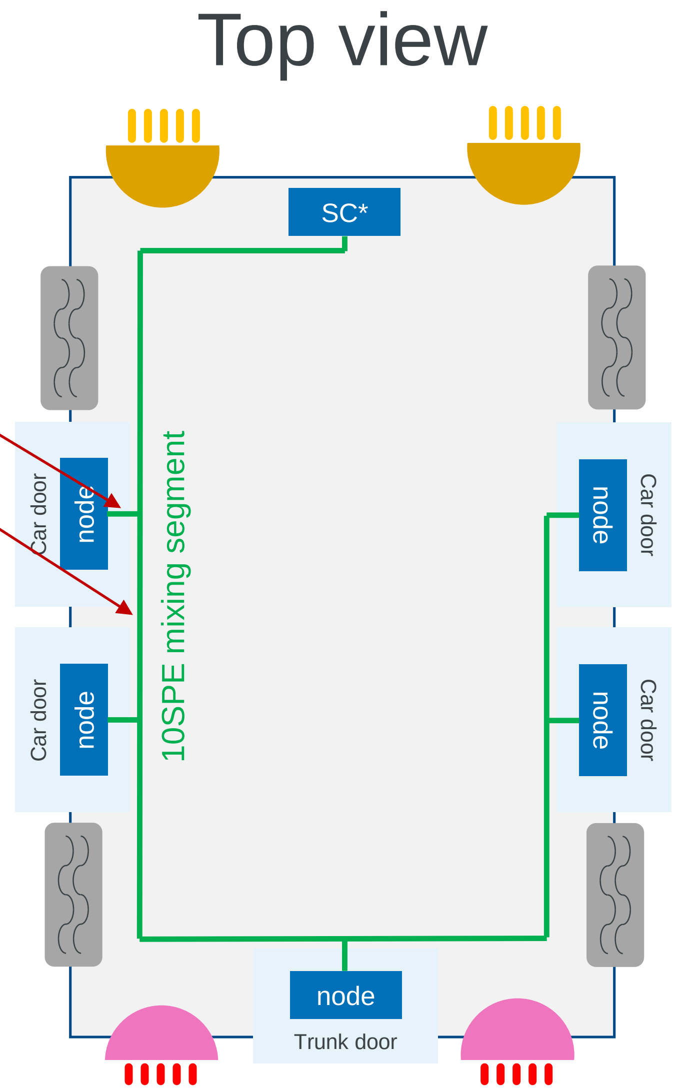
Result: each physical node can be assigned location-specific function (configuration) as SC can detect each node’s physical location through ranging. For example – due to wiring rules – the top-left node in the train car can receive its function-specific configuration at first boot, without need for additional hardware element/processes

Use case: cars

d_{stub}

d_{node}

$d_{node} >> d_{stub}$



* Assumption

Advantages

- Common software may be used in the “off-the-shelf” nodes, without any need for factory pre-configuration
- Mapping between each node and its function/configuration is done based on the output of the topology discovery, e.g. for trains:
  - First node is known to belong to a specific door (seat etc.)
  - Last node is known to belong to a specific door (seat etc.)
  - Intermediate nodes are known to be window control nodes in the order of their physical appearance
- Additionally, PHY-ID could be assigned based on node’s distance and/or its physical order

Pre-requisite

- There should be a margin between minimum achievable measurement precision and minimum node distance, which however could be an implementation decision
- For precise (absolute) distance measurement cable parameters (wave propagation speed) may need to be known, however in most use-cases approximate (proportional) distance could be sufficient

A possible means of operation (example)

- PHYs would include only the most atomic set of services, based on which use case-specific complex application logic (e.g. RollCall, network monitoring etc.) could be implemented
- An example topology discovery would look as follows:
  - Segment coordinator (SC) enumerates its peers, forming a list of MAC addresses
    Note: this is done using higher-layer services
  - SC iterates through this list one-by-one (node-by-node) sequentially, requesting each peer to short their BI_DA+/- (behind the coupling caps) for a defined period of time
  - SC suspends initiating new PLCA cycle
  - Within the expiry of the time window SC emits a properly shaped pulse train
  - SC measures the first large reflection (TDR, FDR etc.) and provides an relative and/or absolute distance figure (statistical methods could discard extreme values and to increase precision)
- This method requires either pre-configured PHY-IDs (to be able to run the protocol that collects MAC addresses), or previous knowledge of the MAC addresses.
  Optionally, improved method could work also in a segment that has no PHY-IDs assigned (see earlier note on “Preferred to work in conjunction with “PHY-ID auto-configuration”)

Technical feasibility

- It is up to the study group to weigh this, but presenter previously consulted with multiple experts who did not seem to have pointed out anything precluding a simple solution
- Increase of node complexity would affect only “measurer” (typically segment coordinator)
- Multiple technical solutions exist (see previous slide)

Thank you for your kind attention
Any questions?

Backup slides

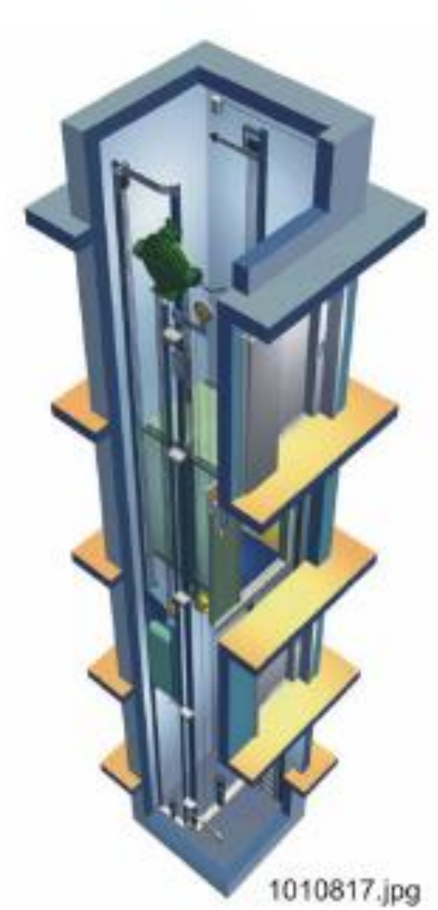
Presenters’ areas of interest during/since the 802.3cg project

- Increased TX voltage: to support larger reach, more node and increased capacitance ✓
  - Already covered by “Objectives(2)/1: “Specify increased node count for the PLCA RS”*
- PHY-ID auto-configuration: in industrial world, it is often preferred to minimize node-specific explicit software customization (parametrization/configuration) ✓
  - Already covered by “Objectives(2)/2: “Specify→ an optional PLCA node ID allocation method”
- Churn-resilience: network monitoring and supervision ✓
  - Similar efforts visible for power**
  - **Presenters may be able to propose solution for this** (see separate presentation)
- Topology discovery (ranging) ✘
  - Proposed herein

* http://www.ieee802.org/3/SPMD/public/jan1520/8023_spmd_objectives.pdf

** http://www.ieee802.org/3/SPMD/public/jan1520/spmd_01_011520.pdf

A typical elevator



Layered architecture (bottom-to-top):

- User I/O and sensors
- Lift and motion control
- Group control
  - Single units are often linked into groups of 2-16 single units via networks
- Site control and supervision
  - Groups are often linked into site control and supervision groups via networks
- Cloud
  - Sites are monitored and controlled remotely

Possible network schematics of an elevator