

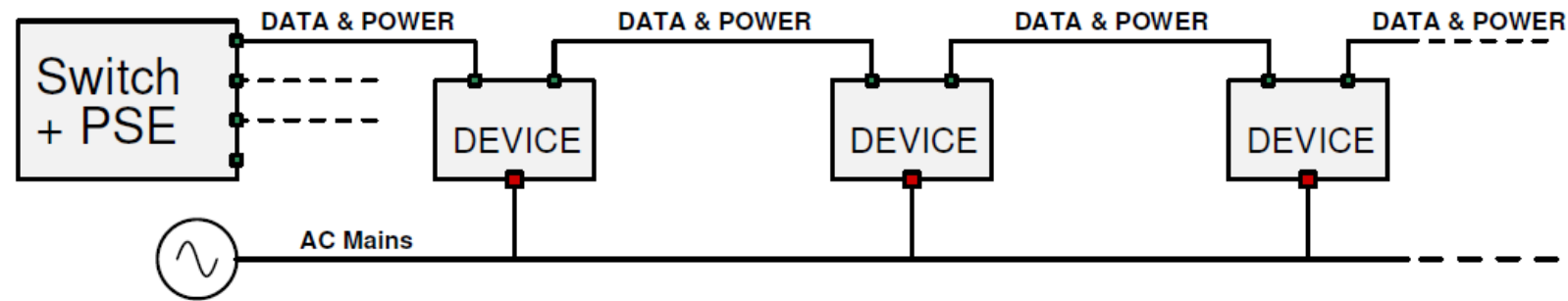
SPMD Usecase Library

Usecases

| Name | Contact | Affiliation |
|---|------------------|---------------------|
| Prof. Lighting controls | Lennart Yseboodt | Signify |
| Industrial Sensor Networks | Christopher Pohl | Beckhoff Automation |
| Industrial In-Cabinet Use Case | Bill Martin | Rockwell Automation |
| Elevators | Ari Kattainen | Kone |
| Building HVAC | David Høglund | Johnson Controls |
| Commercial HVAC | Andrew Rodgers | ACE IoT Solutions |
| Industrial Networked Sensors | Bill Martin | Rockwell Automation |
| IEC/IEEE 60802 - UC10 - 10 Mbit/s end-stations (Ethernet sensors) | Jordon Woods | ADI |

Library

Usecase: Prof. Lighting controls



Devices (luminaires, sensors, ...) are connected in passive linear topology. DALI carries a limited amount of power, and offers bus based data at very low data rate.

Requirements for 10BASE-T1:

1. **Redundancy:** Device fault doesn't interrupt data & power flow
2. **Power:** Mains failure doesn't interrupt data & power flow
3. **Topology:** Linear wiring possible (active or passive)

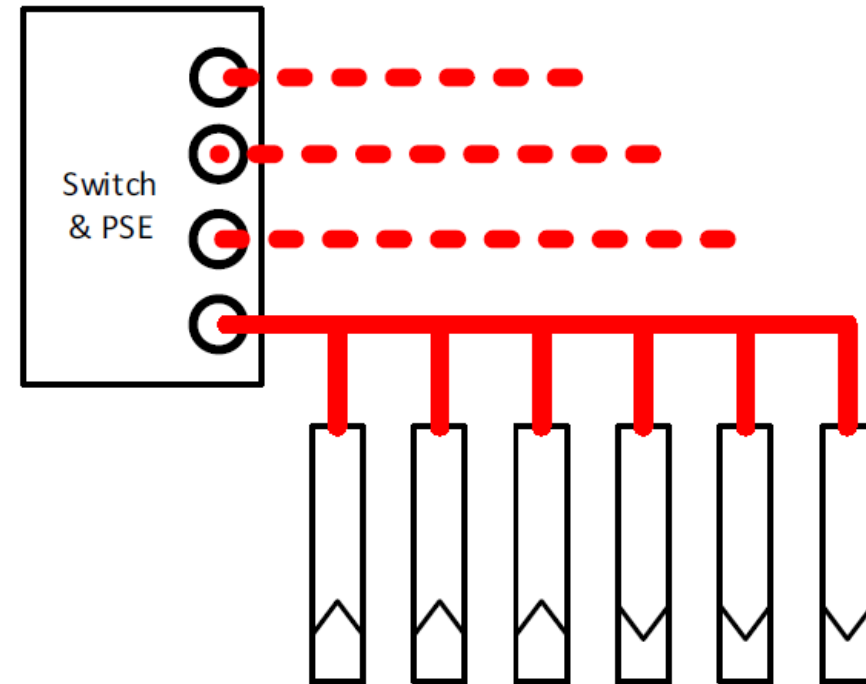
Usecase: Prof. Lighting controls

| Item | Min Value | Desired value | Extra information |
|--|-------------|---------------|---|
| Supported nodes on one mixing segment | 8 | 16 | |
| Minimum supported cable length | 30 | 50 | |
| Acceptable cable gauges | #28 to #23 | | |
| Required power for a node | 5 | More=better | |
| Required initial power allocation | 1W | 1.5W | 1W per current understanding of power requirements of 10BASE-T1 |
| 60V voltage OK ? | Yes | | |
| Interoperability level for the application | Plug&play | | |
| Pass through or T connection | Passthrough | | Passthrough is preferred due to installer familiarity |
| Hotpluggability | Required | | |
| Possible market (in #nodes/year) | | | |
| PTP/1588, TSN | | | |

Usecase: Industrial Sensor Networks

- Lower end multidrop bus **including power**
- Easy to wire in the field
- Small footprint

- Significantly reduce wiring cost
- Allow for more sensors in the field (condition monitoring, predictive maintenance, IIOT, ...)

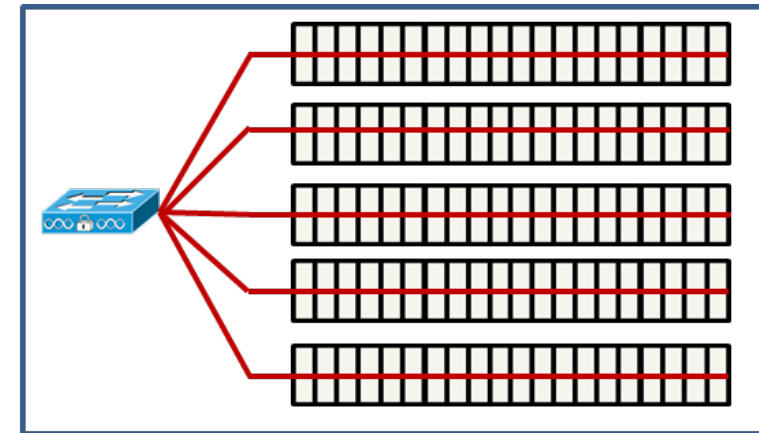


Usecase: Industrial Sensor Networks

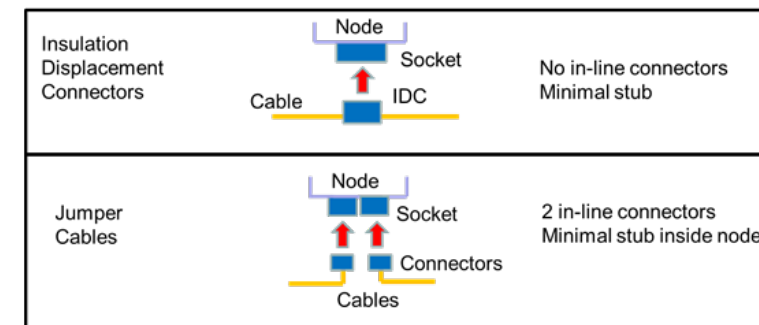
| Item | Min Value | Desired value | Extra information |
|--|--------------|---------------|--|
| Supported nodes on one mixing segment | 8 | 32 | |
| Minimum supported cable length | 50 | 75 | |
| Acceptable cable gauges | #24 to #18 | | |
| Required power for a node | 2W | | Tolerating current peaks from (e.g.) solenoid switching is more important than greater overall power |
| Required initial power allocation | ~0.15W + PHY | ~0.25W + PHY | |
| 60V voltage OK ? | Yes ** | | 24V tolerated in engineered solutions + what kind of tolerance is generally attached to 60V? |
| Interoperability level for the application | engineered | | |
| Pass through or T connection | T | | |
| Hotpluggability | Required | | |
| Possible market (in #nodes/year) | 3 million + | | |
| PTP/1588, TSN | | | |

Usecase: Motor Control Cabinet

- A typical cabinet might contain 5 rows of 20 devices
 - Low port count switch serves the segments.
 - Replace 100 wires with 5 multidrop modular connections
 - Reduces material costs, cabinet size, assembly time, etc.
-
- Low voltage contactor 2020 market projection - \$5B
 - technology.ihs.com/581715/contactors-database-2017
 - Overload protection device 2020 market projection - \$1B
 - technology.ihs.com/515493/overload-protection-devices-database-2017
 - Industrial Edge Networking (Source: IHSMarkit)
 - Ethernet connected nodes CAGR 2016-2021: 15.4%
 - L2 Managed Switches CAGR 2018-2024: 13.9%



Example logical topology

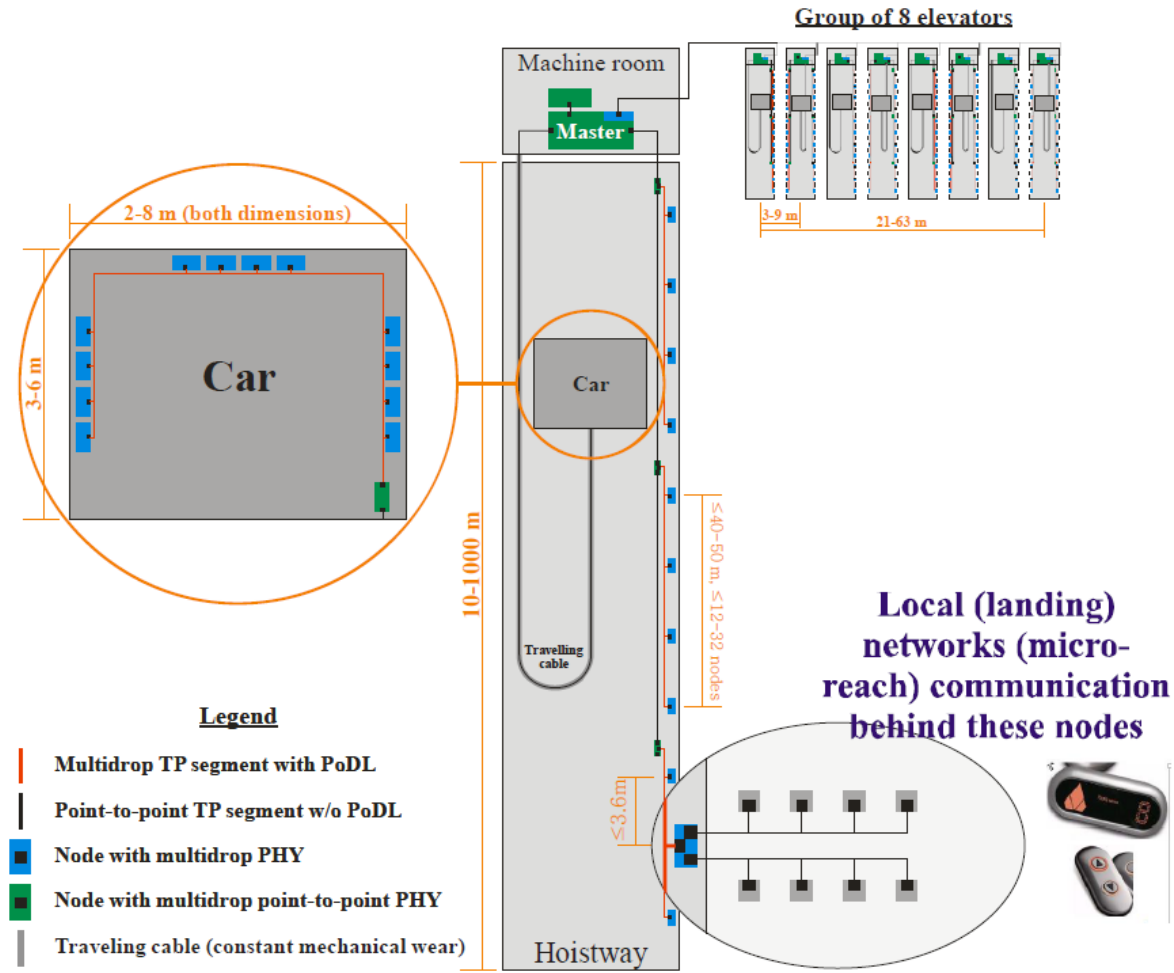


Example connectivity options

Usecase: Motor Control Cabinet

| Item | Min Value | Desired value | Extra information |
|--|--------------|---------------|-------------------|
| Supported nodes on one mixing segment | 40 | 64 | |
| Minimum supported cable length | 25 | 75 | |
| Acceptable cable gauges | #24 -#20 | | |
| Required power for a node | 0.5W | 1W | |
| Required initial power allocation | 0.5W | | |
| 60V voltage OK ? | No | | |
| Interoperability level for the application | Engineered | | |
| Pass through or T connection | T connection | | |
| Hotpluggability | Required | | |
| Possible market (in #nodes/year) | | | |
| PTP/1588, TSN | | | |

Usecase: Elevators



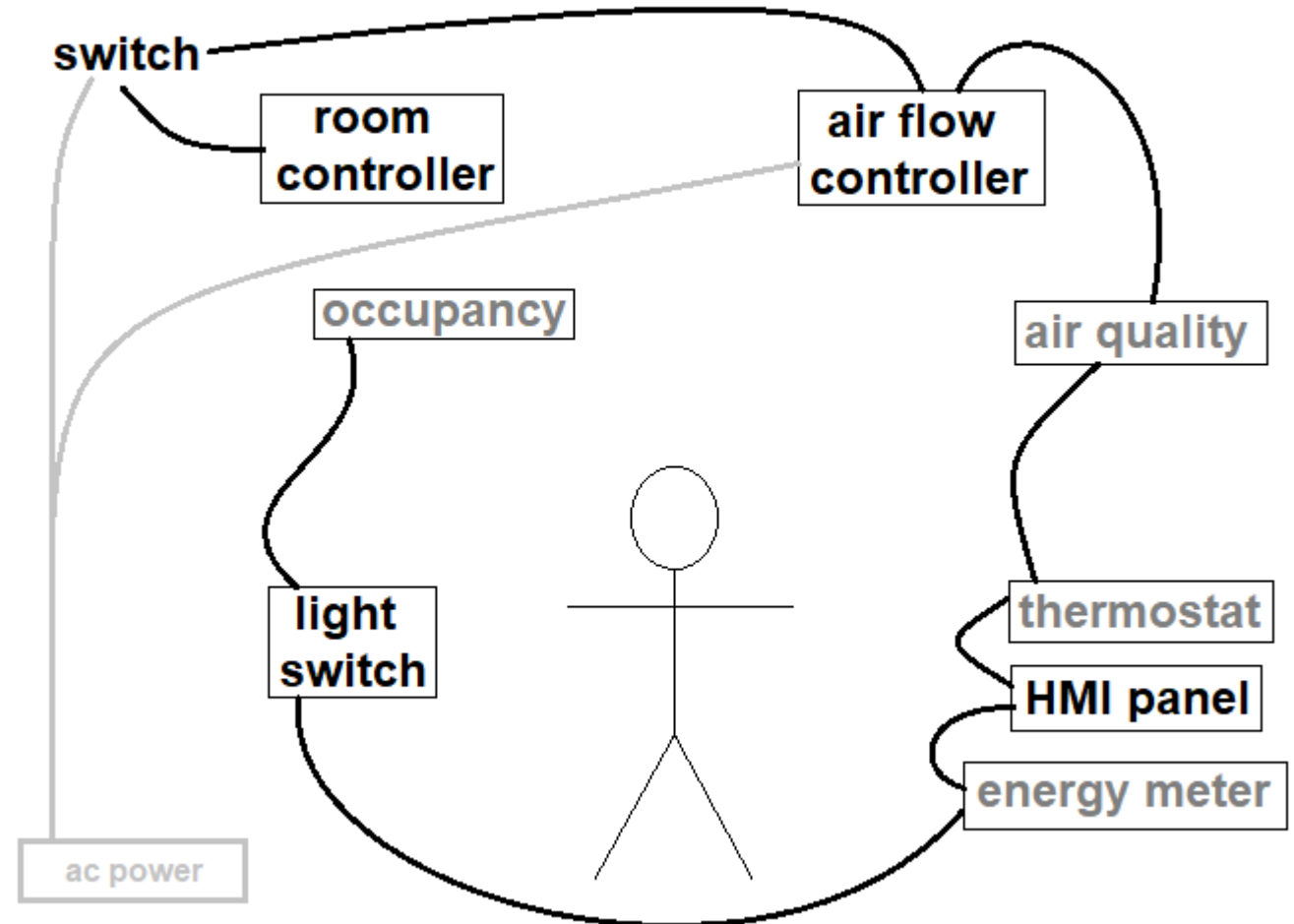
Usecase: Elevators

| Item | Min Value | Desired value | Extra information |
|--|--------------------------|---------------|---|
| Supported nodes on one mixing segment | 16 | 24 | Current RS485 product max config. is 1+16 nodes, 5 m cable between nodes and 100W power at 24VDC and 4A. |
| Minimum supported cable length | 50 | 75 | 4m cable x 12 floors |
| Acceptable cable gauges | 24 to 16 | | Equals to 0,25 to 1,5 mm ² |
| Required power for a node | 5W | More=better | Separate wires for power are acceptable |
| Required initial power allocation | 1W | 1,5W | |
| 60V voltage OK ? | Yes, desired value 24VDC | | Currently 24VDC is standard in Elevator applications. |
| Interoperability level for the application | Engineered | | |
| Pass through or T connection | Pass through | | |
| Hotpluggability | No | | Node physical order in the chain needs to be known. Current solution is separate output to input wire between nodes. |
| Possible market (in #nodes/year) | 30 000 000 nodes | | Total world wide elevators market is 1 000 000 per year having average 30 mixing segment nodes. Currently dominated with RS485, CAN and proprietary serial. |
| PTP/1588, TSN | | | |

Usecase: Building HVAC

- The room controller communicates with the sensors and actuators.
- The air flow controller includes an ac motor.
- The other components are physical IO.

SPE topology



Usecase: Building HVAC

| Item | Min Value | Desired value | Extra information |
|--|--------------|---------------|--|
| Supported nodes on one mixing segment | 8 | 16 | |
| Minimum supported cable length | 30 m | 60 m | Circumference of a room |
| Acceptable cable gauges | 22, 24, 26 | | Typical. We could also use thicker wire. |
| Required power for a node | 2 W | 5 W max | |
| Required initial power allocation | 0.5 W | 1 W | |
| 60V voltage OK ? | yes | | |
| Interoperability level for the application | Plug&play | | |
| Pass through or T connection | Pass through | | The stubs for T would not be long enough. Everything is 0.5 to 1.5 m above the floor. The ceiling height is 2.5 to 4 meters. |
| Hotpluggability | yes | | Can tolerate a 30 sec dropout |
| PTP/1588, TSN | | | |

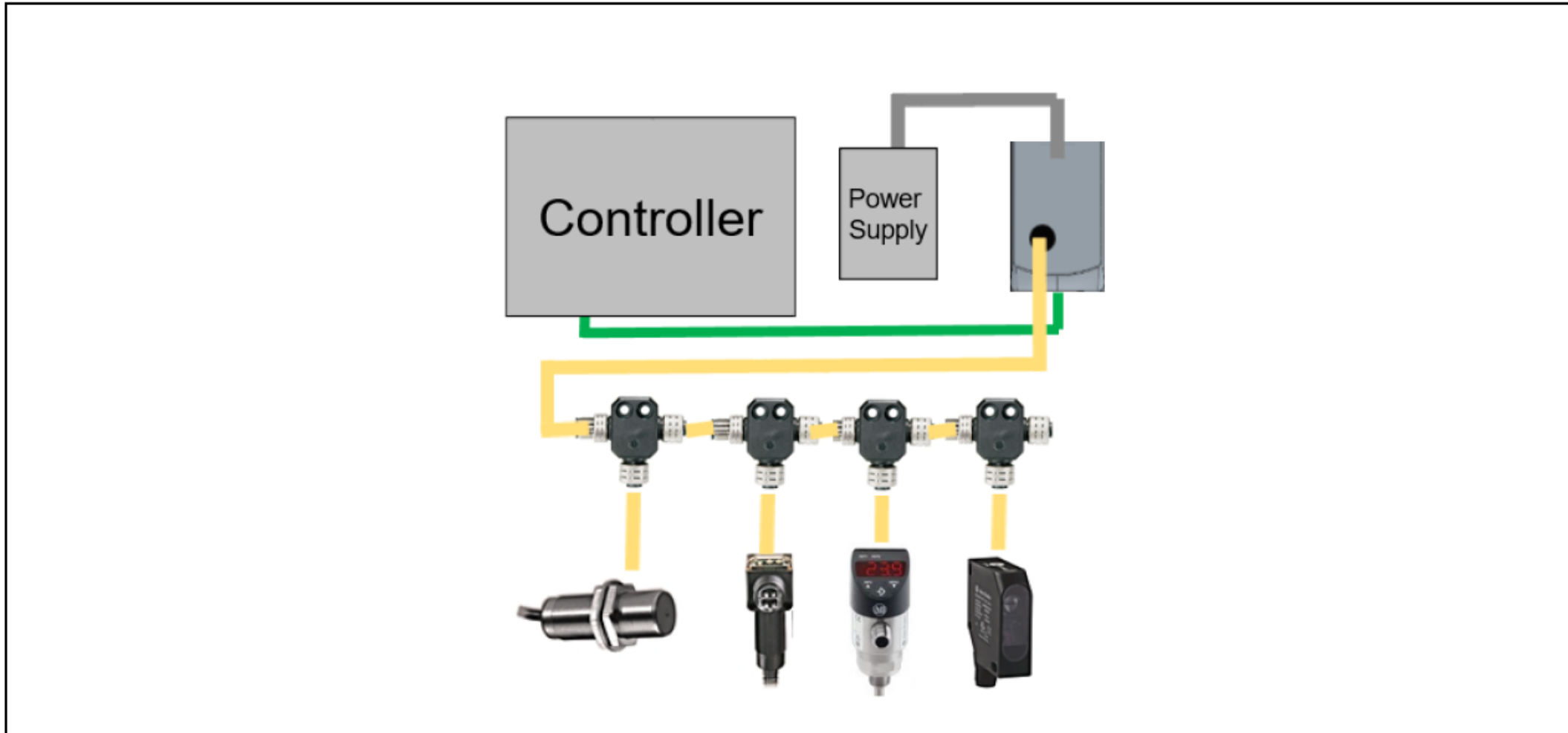
Usecase: Commercial HVAC

Simple use case figure

Usecase: Commercial HVAC

| Item> | Min Value | Desired value | Extra information |
|--|---------------|---------------|--|
| Supported nodes on one mixing segment | 8 | 32 | Replacing MSTP usually seen in VAV and Room thermostat deployments in commercial office buildings |
| Minimum supported cable length | 10m | | |
| Acceptable cable gauges | 20-24 | | Currently deployed with 24ga comms and 20ga 24VAC power cable |
| Required power for a node | 5W | 10W | These devices make rather infrequent adjustments to their outputs, which means the vast majority of the time they may use as little as 1W, but would need to turn a motor occasionally. Coordinating the mixing segment to allow one device to draw additional power for a set amount of time would be acceptable. |
| Required initial power allocation | 1W | | |
| 60V voltage OK ? | Not Sure | | |
| Interoperability level for the application | Plug and Play | | |
| Pass through or T connection | T | | |
| Hotpluggability | Yes | | |
| Possible market (in #nodes/year) | >100,000 | | |
| PTP/1588, TSN | | | |

Usecase: Industrial Networked Sensors



Usecase: Industrial Networked Sensors

| Item | Min Value | Desired value | Extra information |
|--|--------------|---------------|--|
| Supported nodes on one mixing segment | 8 | 32 | |
| Minimum supported cable length | 10 Meters | 100 Meters | |
| Acceptable cable gauges | #24 to #18 | | |
| Required power for a node | 0.5 Watts | 2.0 Watts | |
| Required initial power allocation | 0.5 Watts | 2.0 Watts | |
| 60V voltage OK ? | No | | Existing sensor product line is 24V DC |
| Interoperability level for the application | Engineered | | |
| Pass through or T connection | T connection | | |
| Hotpluggability | Required | | |
| Possible market (in #nodes/year) | 1 Million + | | |
| PTP/1588, TSN | TSN | | |

Usecase: IEC/IEEE 60802 - UC10 - 10 Mbit/s end-station

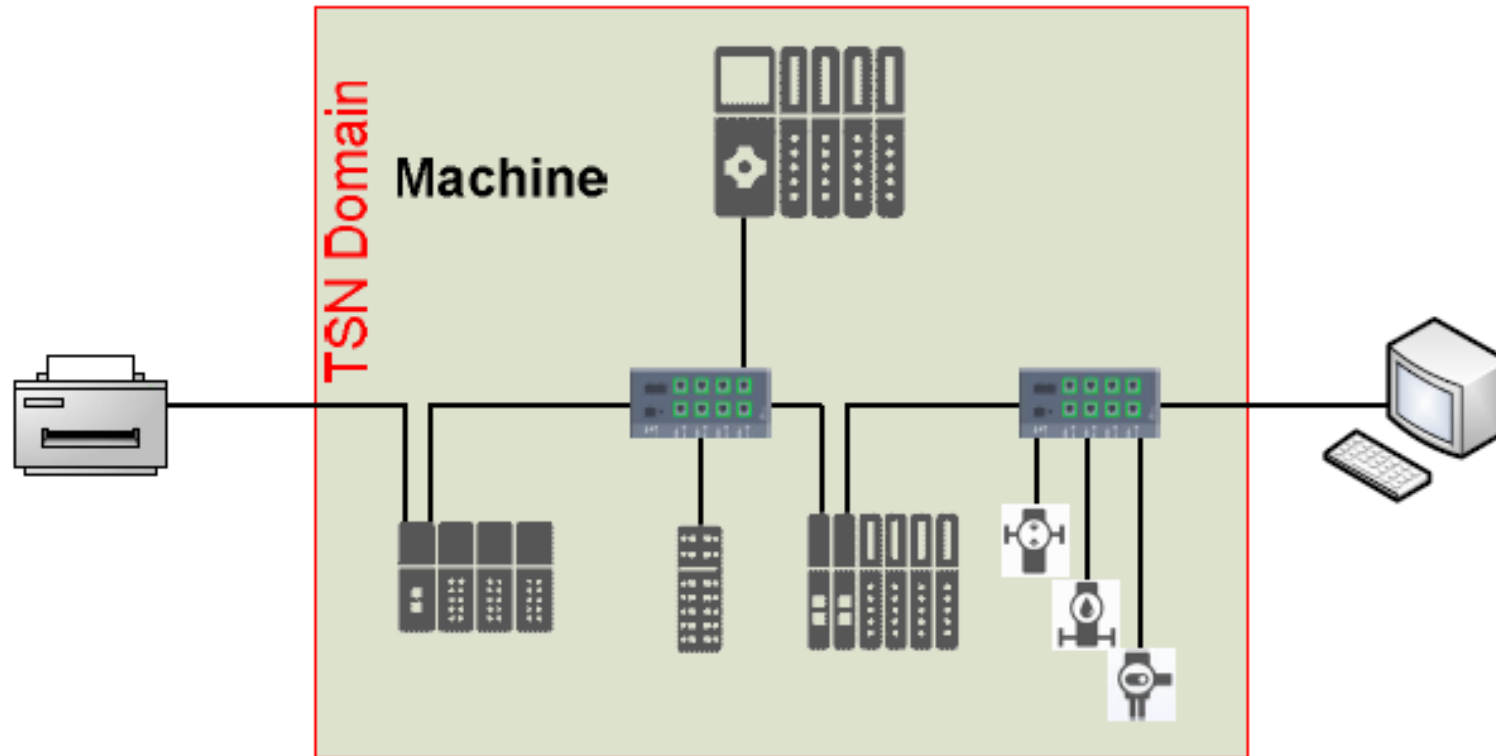


Figure 36 – Ethernet sensors

Usecase: IEC/IEEE 60802 - UC10 - 10 Mbit/s end-station

| Item | Min Value | Desired value | Extra information |
|--|-----------|---------------|-------------------|
| Supported nodes on one mixing segment | | | |
| Minimum supported cable length | | | |
| Acceptable cable gauges | | | |
| Required power for a node | | | |
| Required initial power allocation | | | |
| 60V voltage OK ? | | | |
| Interoperability level for the application | | | |
| Pass through or T connection | | | |
| Hotpluggability | | | |
| Possible market (in #nodes/year) | | | |
| PTP/1588, TSN | | | |

TBD

Supplemental Material

Industrial Sensor Networks: 60V

- Industrial 24V is defined with a tolerance (-15%/+20%)
- This is required for any non-theoretical use case because of
 - SELV is 60V DC and below!
 - All components (e.g. power supplies!) come with a tolerance
 - Varying resistances, e.g. due to cabling
 - Alien noise + communication over power line
 - ...
- Therefore, it looks like 48V (-15%/+20%) to me, allowing for SELV designs
- Also: wide input voltage range supply components up to 60V are readily available

Industrial Sensor Networks: Stub Lengths

- In Indianapolis, up to 10m were discussed
- This is not possible in any practically feasible bus with more than a few 100 kBaud because
 - Impedances at the taps don't match
 - Results in reflections
 - Results in loss of signal strength
 - Can only be handled by a lot of electrical trickery and strict rules... not feasible
- → Stubs must be very few cm

Template

Usecase: <TITLE>

Simple use case figure

Usecase: <TITLE>

| Item | Min Value | Desired value | Extra information |
|--|-----------|---------------|-------------------|
| Supported nodes on one mixing segment | | | |
| Minimum supported cable length | | | |
| Acceptable cable gauges | | | |
| Required power for a node | | | |
| Required initial power allocation | | | |
| 60V voltage OK ? | | | |
| Interoperability level for the application | | | |
| Pass through or T connection | | | |
| Hotpluggability | | | |
| Possible market (in #nodes/year) | | | |
| PTP/1588, TSN | | | |

| Item | Description |
|--|---|
| Supported nodes on one mixing segment | Indicate the numbers of nodes on a single mixing segment. The minimum reflects the number of nodes needed for the usecase to make sense. The desired value represents a natural fit for the application. Both numbers could be the same. |
| Minimum supported cable length | Is the length you need between the two furthest nodes on the mixing segment. |
| Acceptable cable gauges | What cable gauges can be accepted for the application (consider cost, size, bend radius, ...) |
| Required power for a node | How much power is needed in the node to run the application. This is the power level as measured at the connector of the device. Note that there may be a rectifier or other elements that cause some loss (2% to 5% typical). |
| 60V voltage OK ? | Is it acceptable for the input voltage to be up to 60V ? If not, what is the reason ? |
| Required initial power allocation | Because this is a bus powered system, a node needs to be permitted to draw some amount of power after being plugged in. This power is used to communicate with the PSE about the power requirements. The system should be able to operate it's PHY with this power. How much power do you foresee to need for this. This is different from the "Required power for a node" which is about the complete power need of the device. |
| Interoperability level for the application | <p>Choose between "plug&play" or "engineered" system.</p> <p>Plug & play means that a compliant device works when connected to a network of other compliant devices. There is no need for configuration or to verify if devices will be compatible or not.</p> <p>Engineered system means that you will use the standard within your own products or that the end user can determine which devices will work in the system.</p> |
| Pass through or T connection | <p>See slide 4-6 of http://grouper.ieee.org/groups/802/3/SPMD/public/sep19/spmd_cjones_01_0919.pdf</p> <p>If the application cannot be equipped with two connectors, select T connection.</p> <p>If it must be possible to live connect a new node without disconnecting other nodes, also select T connection.</p> |
| Hotpluggability | Should it be supported to connect new devices while the bus is powered and guaranteed that this does not cause devices to be interrupted (eg. Reboot, lose long stretches of data). If not required, select no. |
| Possible market size | Potential market expressed in number of nodes. Do not express this in currency of any kind due to IEEE SA rules. |
| PTP/1588, TSN | Requirement for IEEE 1588/802.1AS Precision Time Protocol (PTP) and Time Sensitive Networking (TSN) |

Thank You