School of Engineering

Replacing CAN: How Single-Pair Ethernet and TSN Enable the Next Generation of Embedded Systems

Institute of Embedded Systems

12.02.2026 | Kilian Brunner

Customer Evolution

Limited Bandwidth

Everything is customized

Bare-Metal & Difficult to Maintain

Higher Bandwidth

Standardized models

Zephyr-Based & Easy to Maintain

Bringing two worlds together – where are the corners?

10BASE-T1L

cabling

- 10 Mbit/s data rate
- Harsh Environments
- Long cable runs (> 1500m) with TP copper cabling
- Sub-µs time synchronization (IEEE 1588 / 802.1AS)
- Cyclic data transmission
- Full duplex communication
- Power and data

In a nutshell

Ethernet world

- High data rates
- Support of IP
- Economies of scale
- Mainstream Technology
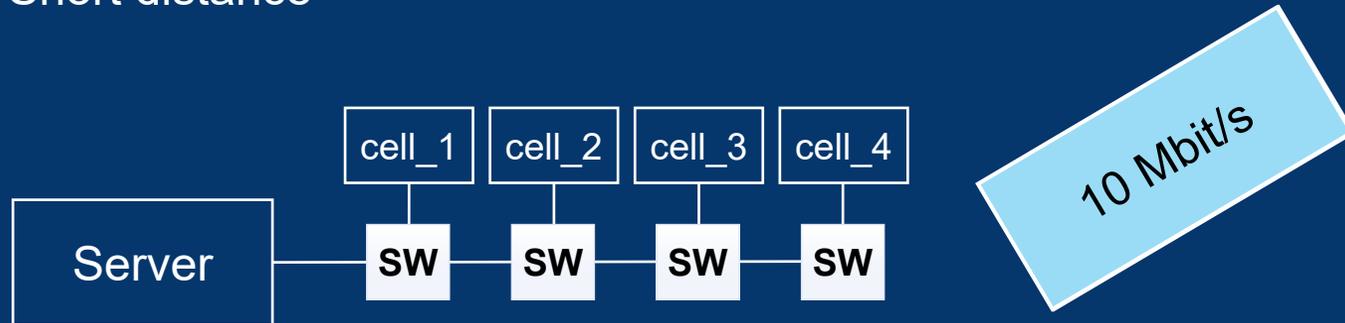- Supports Time Sync
- Power over Ethernet

10BASE-T1L

**CAN
(Field bus world)**

- Harsh environments
- Optimized Framing
- Long copper runs
- Tailored to application
- Proven Technology
- Low Power / Embedded

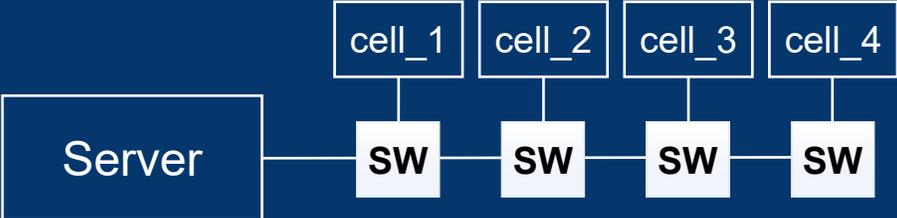# Limitation in Bandwidth with CAN (Distance)

Short distance
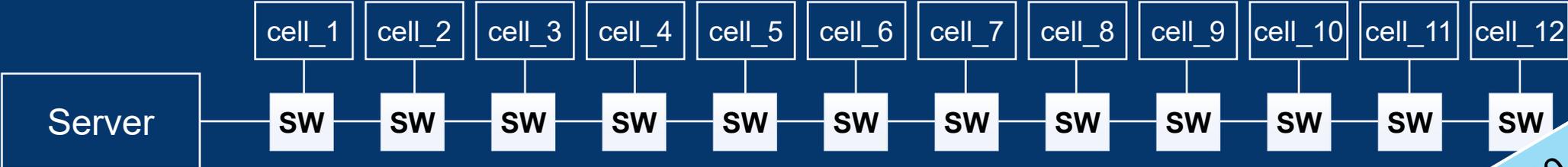

Long distance

Limitation in Packets per sensor

CAN:

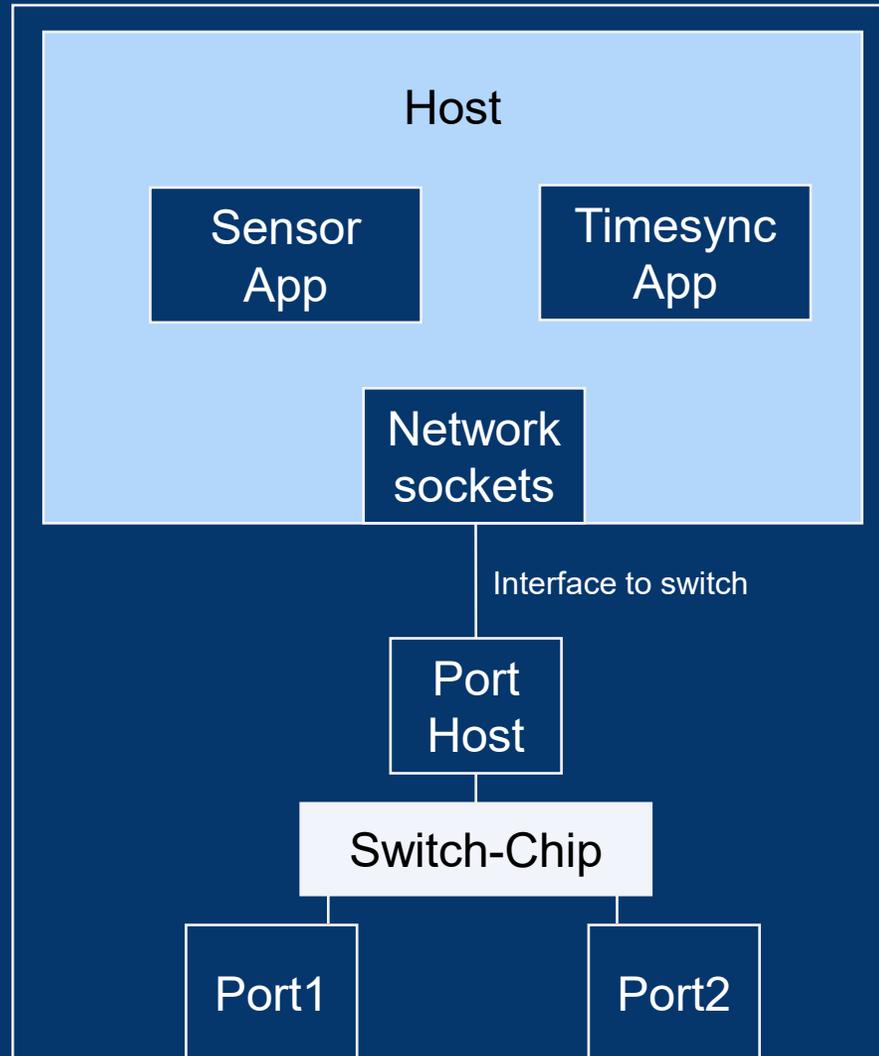50 kBit, 64 Bit Data -> 350 Packets/s
1 MBit, 64 Bit Data -> 7000 Packets/s

Ethernet:

10 MBit, 46 Byte Data -> 14800 Packets/s

Small system

3700 Packets/sens

Big system

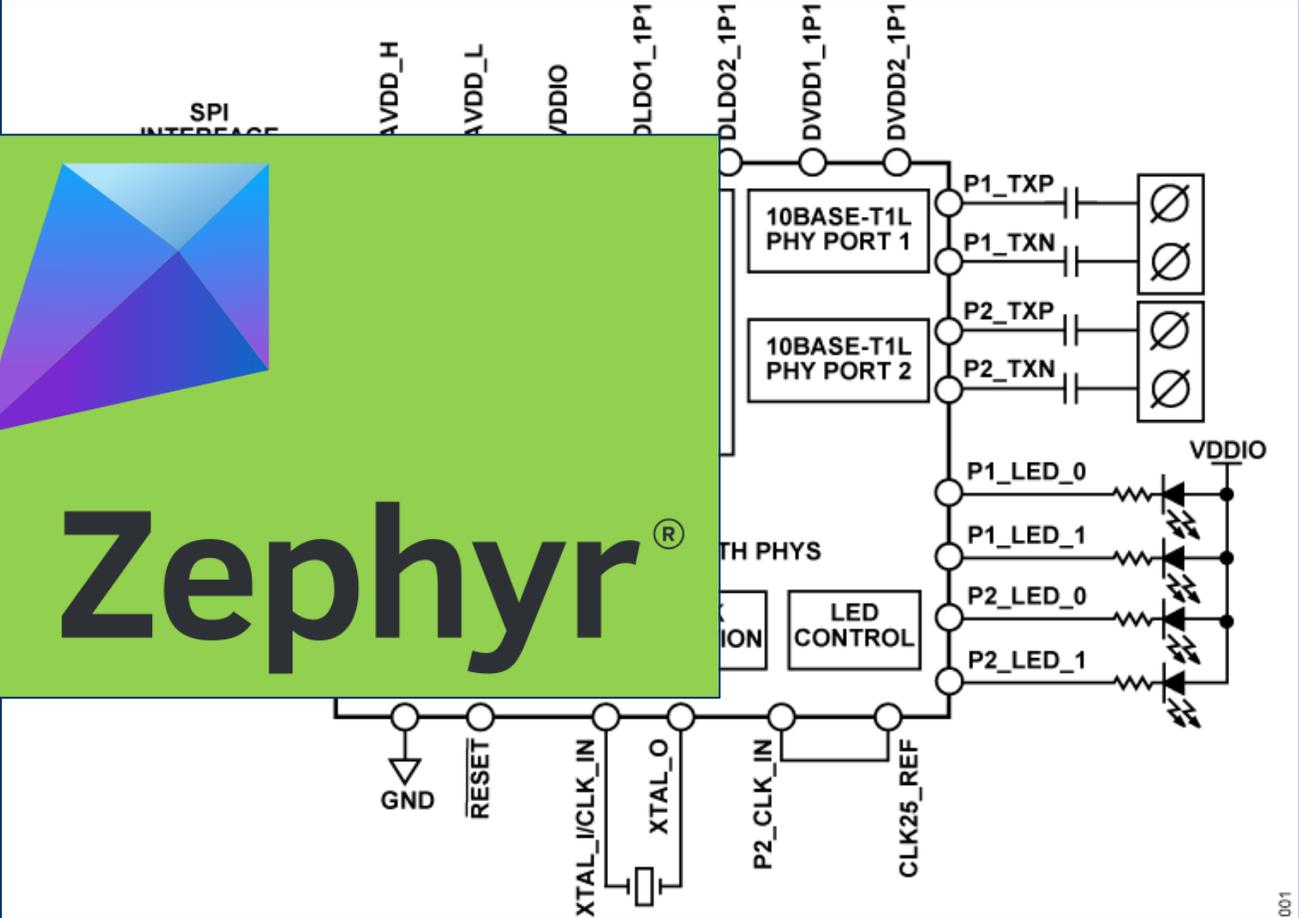1230 Packets/sens

Simplified System Design

On Zephyr:

– Sensor-App

– Timesync-App

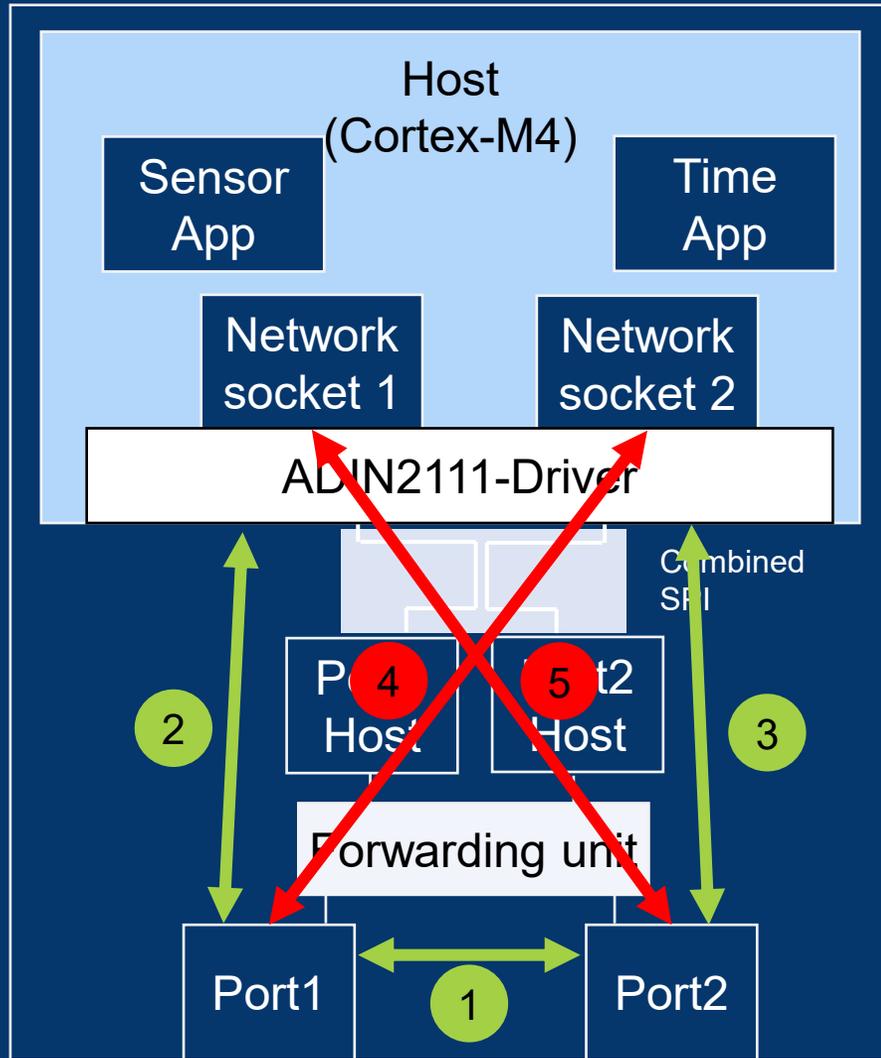– Communication Sockets

On the Switch Chip:

– Standardized Interface
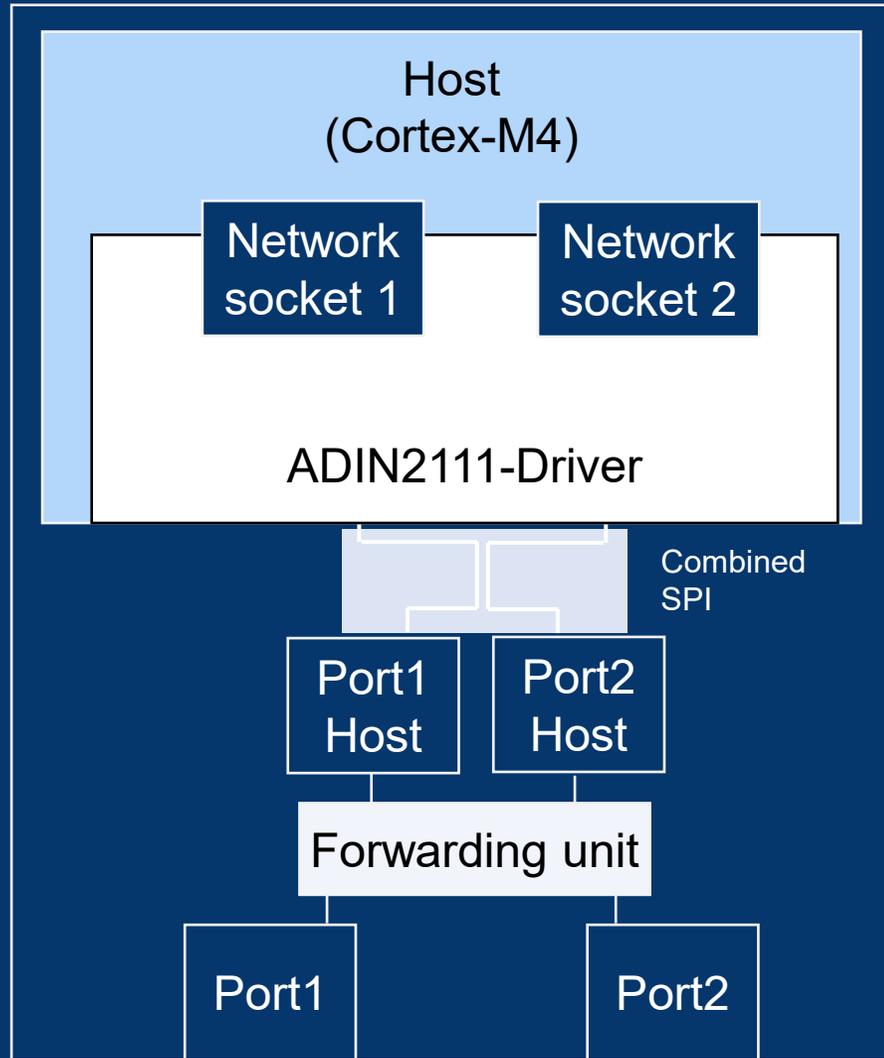
– Packet Offloading

Looking for a Switch-Chip

ADIN2111 and current capability in Zephyr

1. Offloading Traffic is supported

2.&3. Communication from socket to Port works
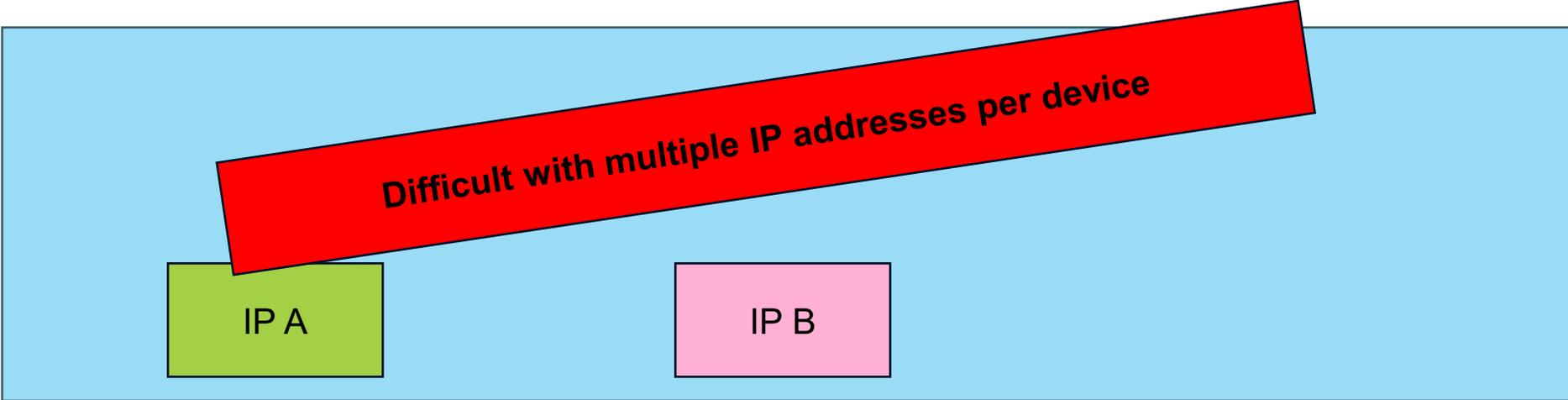
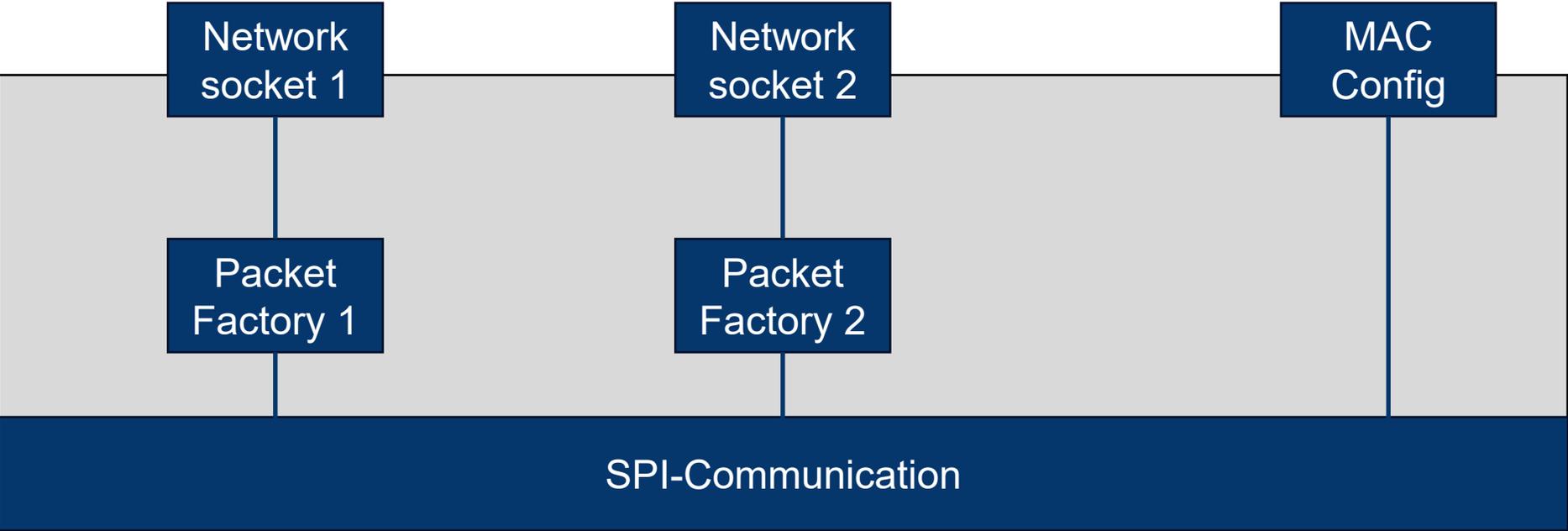4.&5. No cross communication

What does the current Zephyr Driver?

- Straight-forward design
- Connects Host-Ports to Network-Sockets
- Does all SPI communication

How this works in real life:

User Space

Driver

IP A

IP B

Difficult with multiple IP addresses per device

Network socket 1

Network socket 2

MAC Config

Packet Factory 1
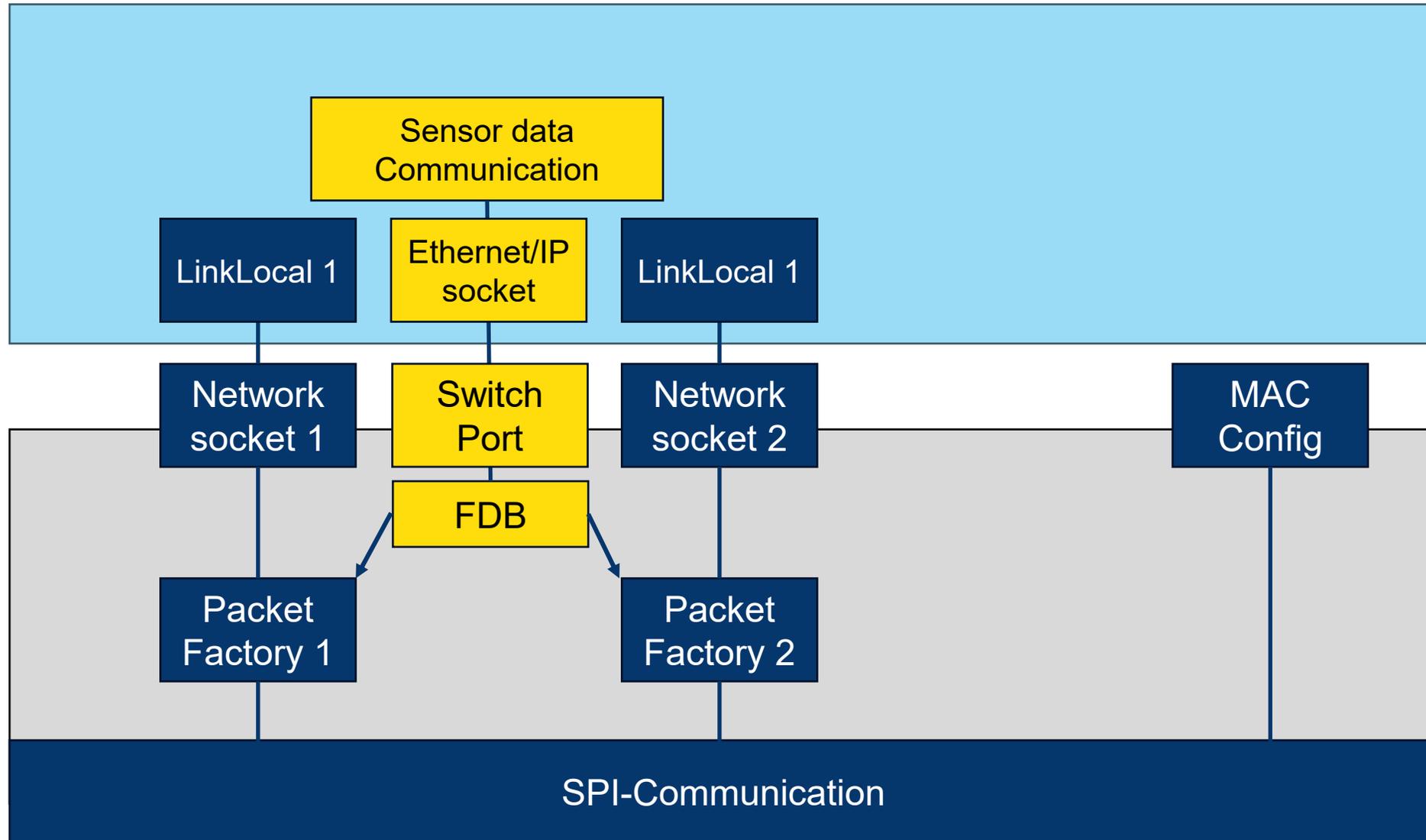
Packet Factory 2

SPI-Communication

How to solve the challenge?

1. Connect to developer of Driver

2. Connect to Analog Devices (ADI)

3. Currently extending the Driver (at ZHAW and ADI)
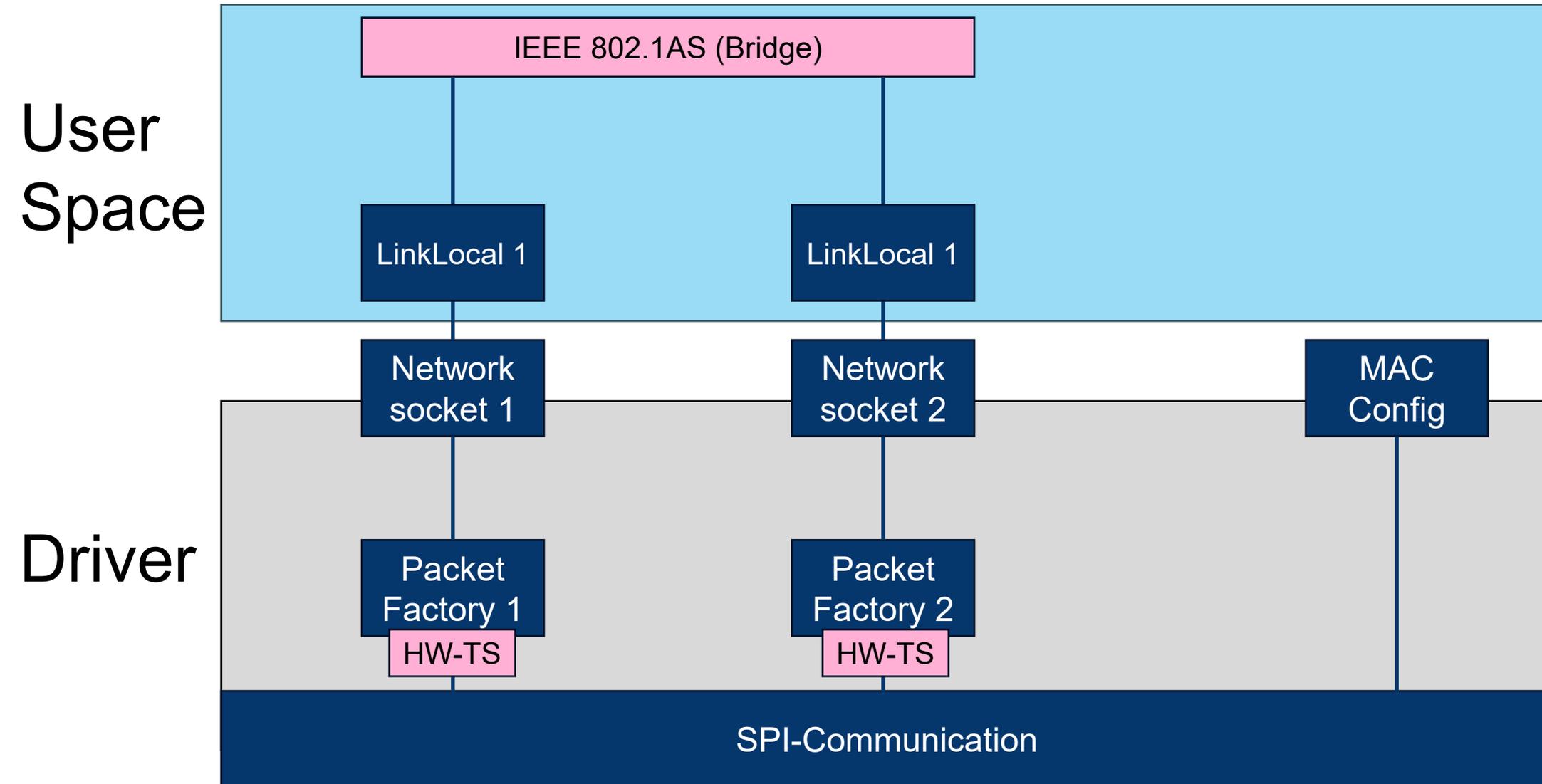
4. Plan to push to Zephyr-Project
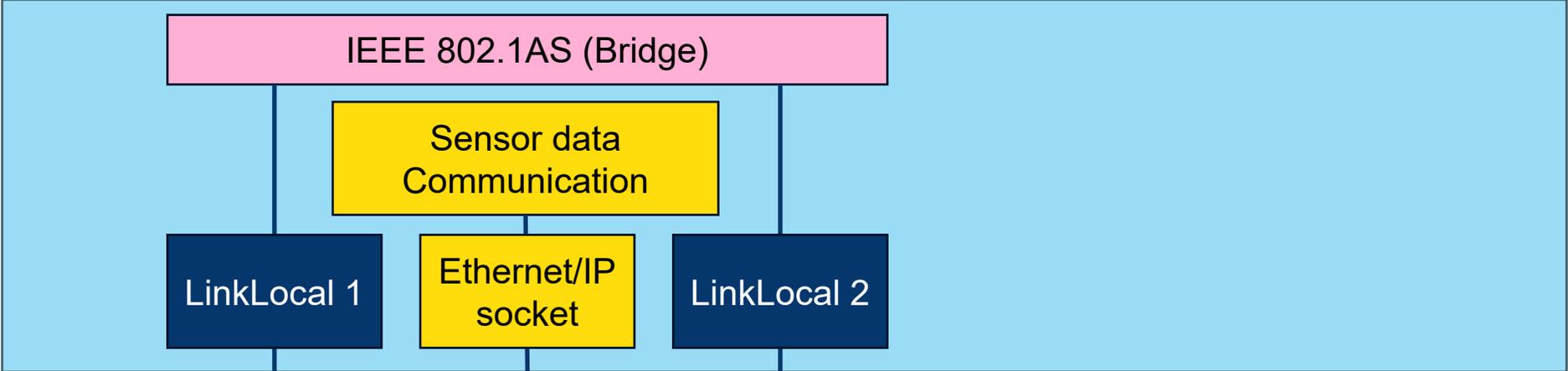
Add single IP address per Node (by ADI)

Add Timesynchronization (by ZHAW)

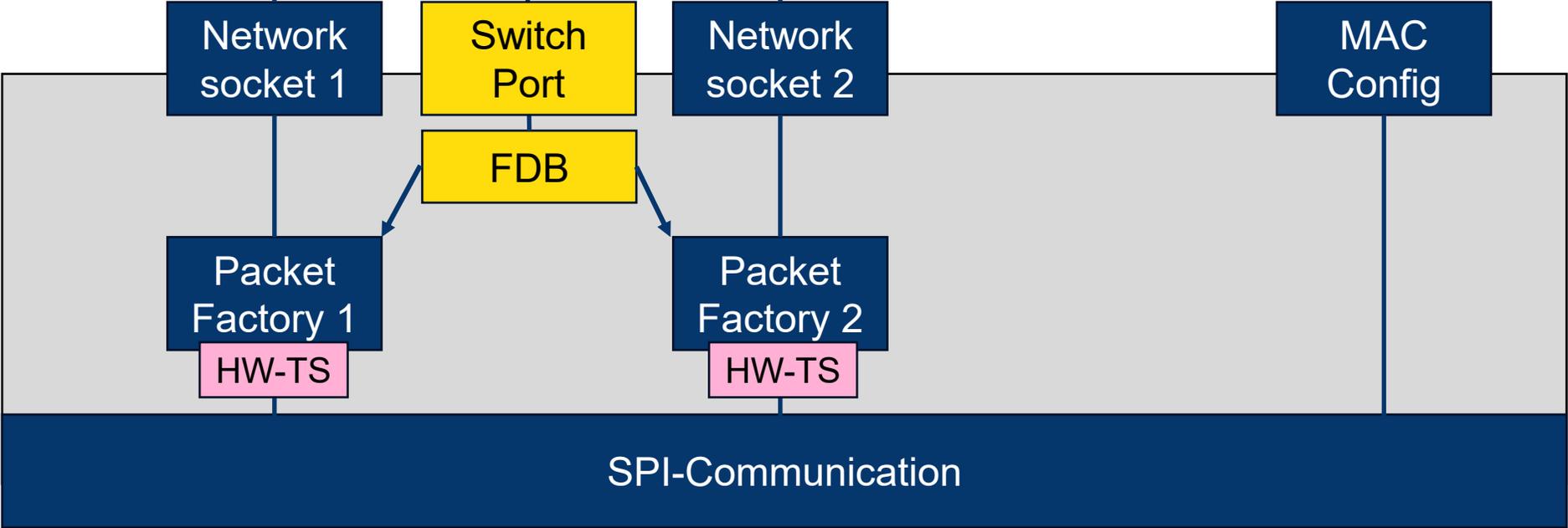# Full system (long term support by ADI, planned)
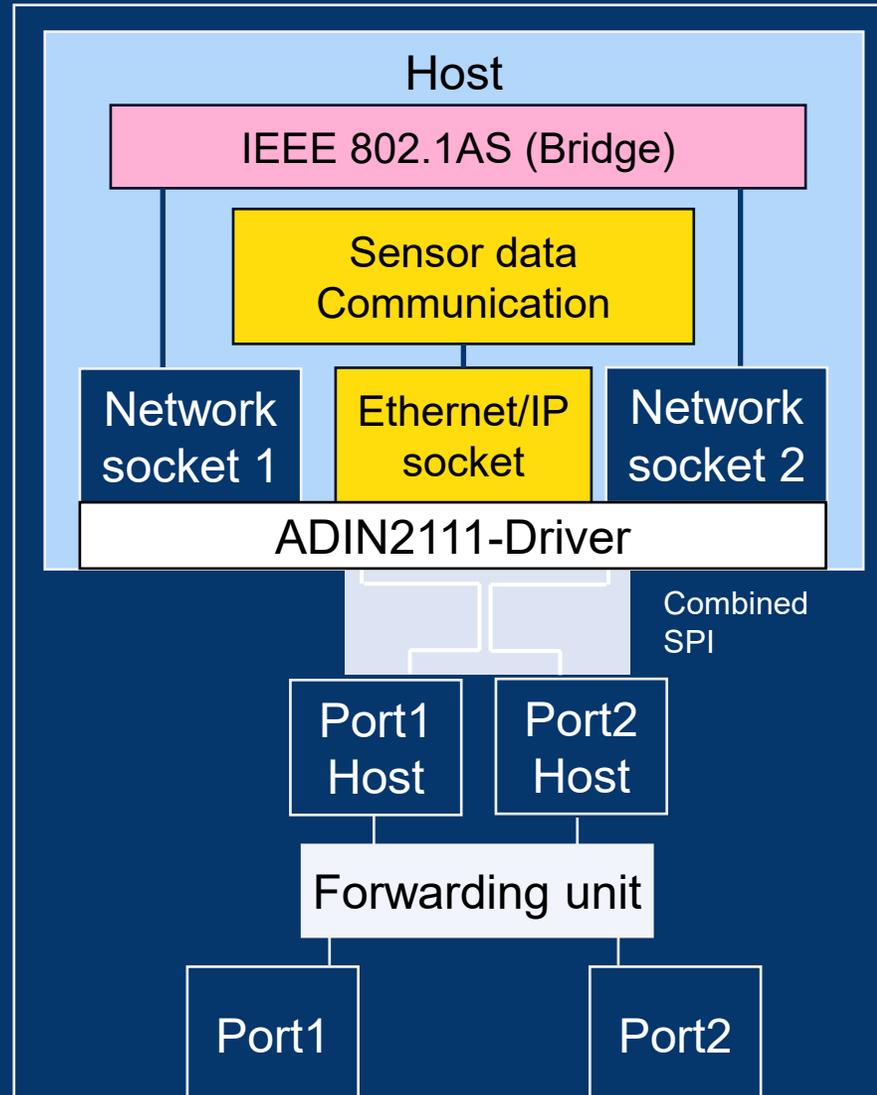
Extend Zephyr Driver

- Sensor-App

- Communication Sockets

- Timesync-App

- Offloading Traffic

Thank you.

Zurich University of
Applied Sciences

ZHAW School of Engineering
Institute of Embedded Systems

Kilian Brunner, MSc ZFH ICT
Research Associate

Technikumstrasse 9 | PO Box
8401 Winterthur, Switzerland
Tel. +41 58 934 75 91
kilian.brunner@zhaw.ch
www.zhaw.ch/engineering

What we have

```
-- west build: building application
[1/319] Preparing syscall dependency handling

[2/319] Generating include/generated/zephyr/version.h
-- Zephyr version: 4.2.0 (/home/ctc/zephyrproject/zephyr), build: v4.2.0
[319/319] Linking C executable zephyr/zephyr.elf
Memory region         Used Size    Region Size   %age Used
          FLASH:       149568 B        2 MB          7.13%
            RAM:       153856 B      192 KB         78.26%
       IDT LIST:          0 GB       32 KB          0.00%
```

Agenda

1. Introduction traditional measurement system

2. Challenges, Future-readiness

3. Adding Ethernet / TSN to Corex-M4

4. Implementing Timesynchronization in Zephyr

5. Extend Ethernet Switch driver of ADIN2111
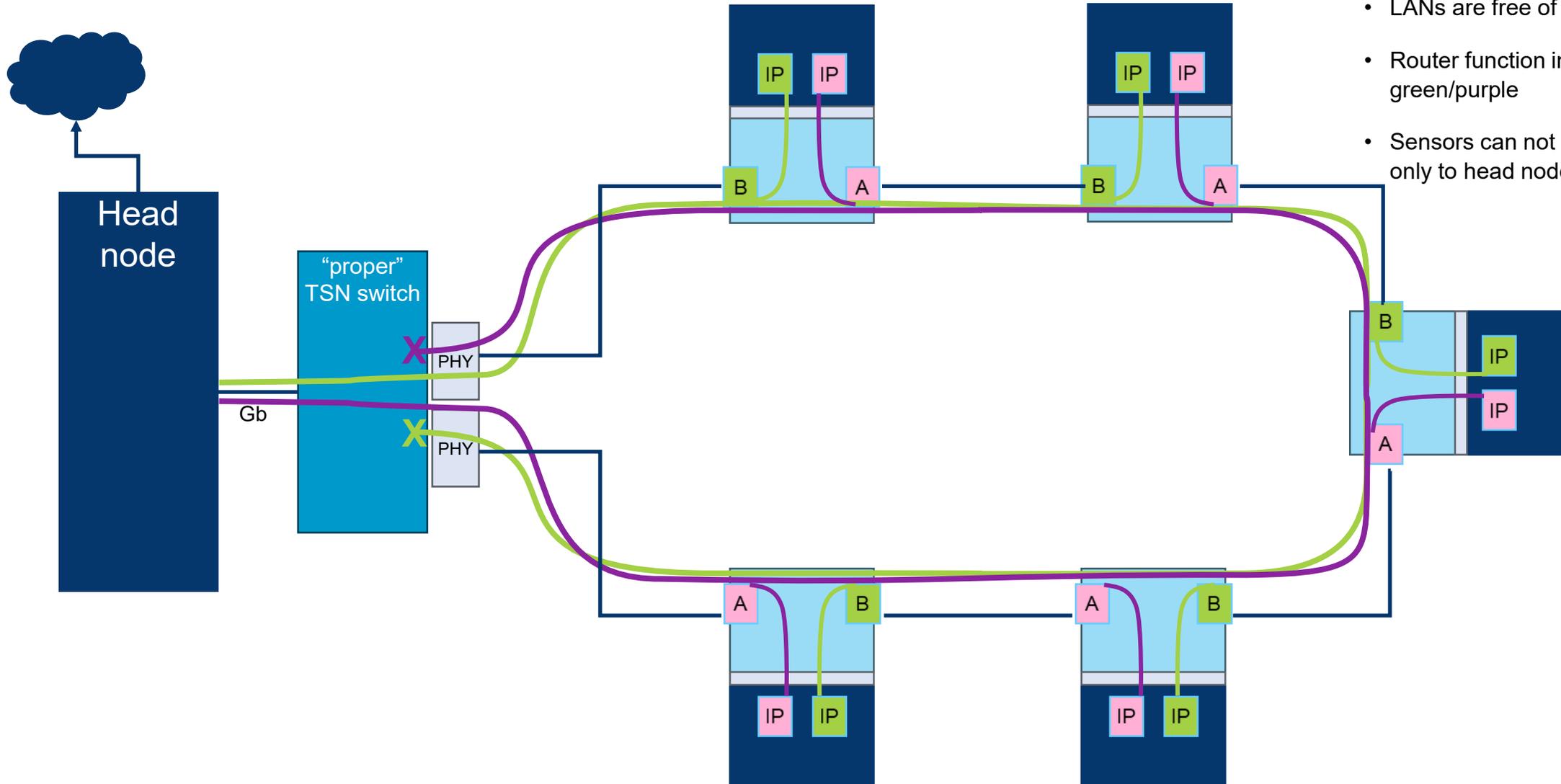
Solve Bandwidth-Distance Dependency

Small distance (fast)
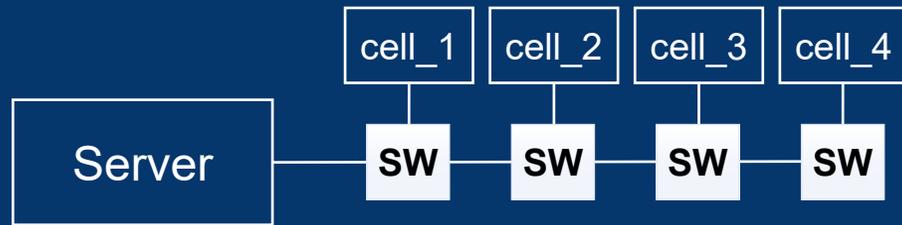
Big distance (slow)

ADIN 2111 in a line / ring topology

- Clockwise LAN
- Counter-Clockwise LAN

- LANs are free of loops (logical lines)
- Router function in head node handles green/purple
- Sensors can not talk to each other, only to head node and beyond