GUARANTEEING INTEROPERABILITY OF EFFICIENT AND FLEXIBLE WAKE-UP/SLEEP IN A 100BASE-T1 ENVIRONMENT

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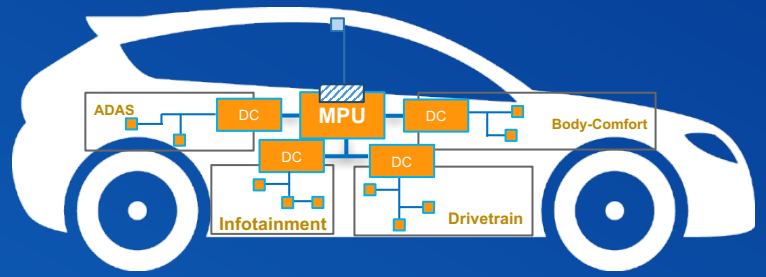
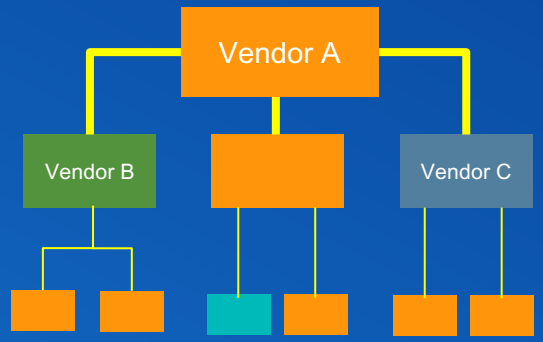
Ethernet
Domain-Based Network





1. Typical automotive networks → heterogenous
2. Multiple Ethernet vendors involved
3. **Is interoperability guaranteed?**

OPEN TC10 Wakeup/Sleep Rational

Pragmatic and fast way of enabling/disabling ECUs

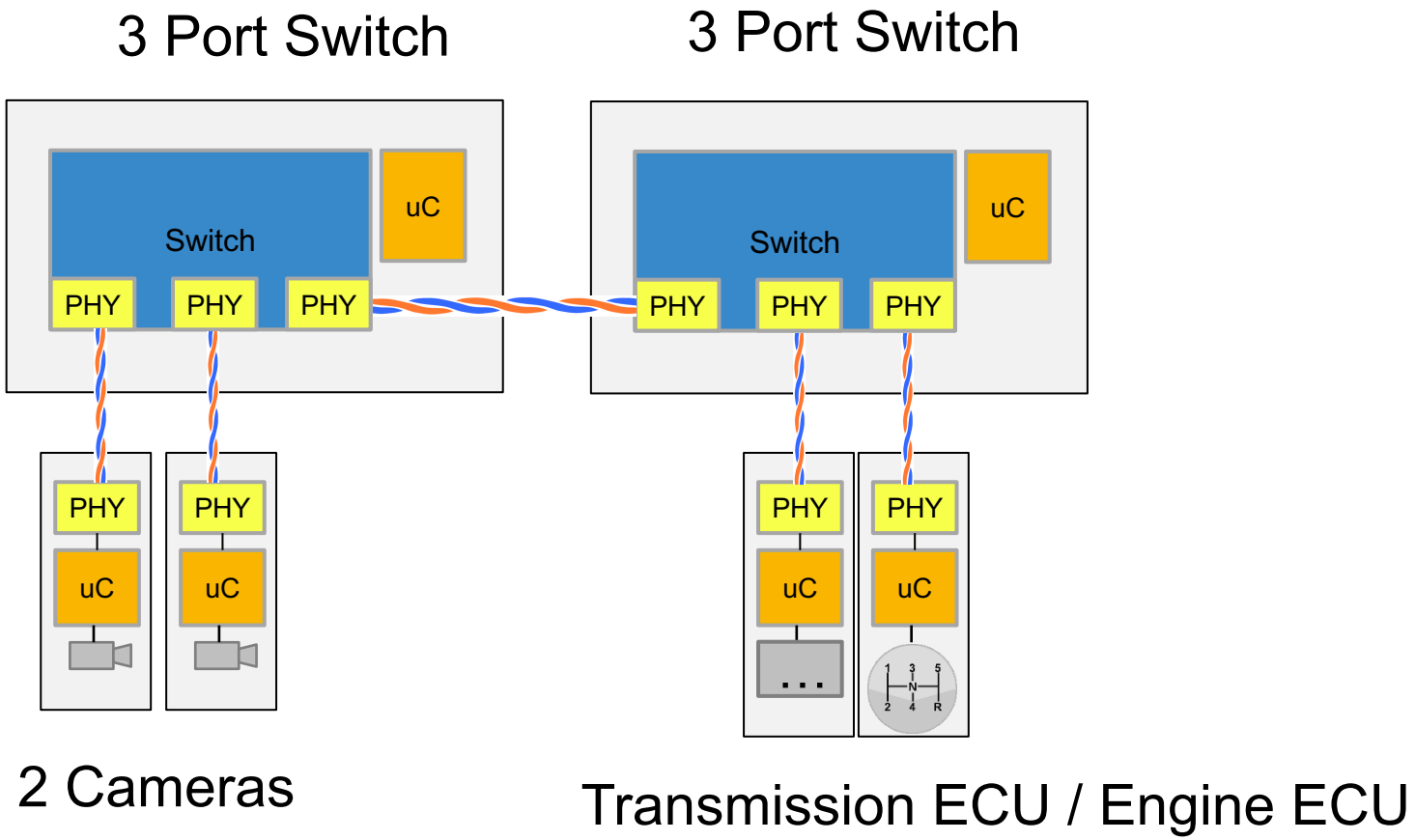
1. Support ***fast*** **wake-up** and wake-up request **forwarding** to support a global wake-up on **layer 1**

2. Support controlled **link shutdown** to hibernate selected parts of network

[1] *https://ec.europa.eu/clima/policies/transport/vehicles/cars_en*

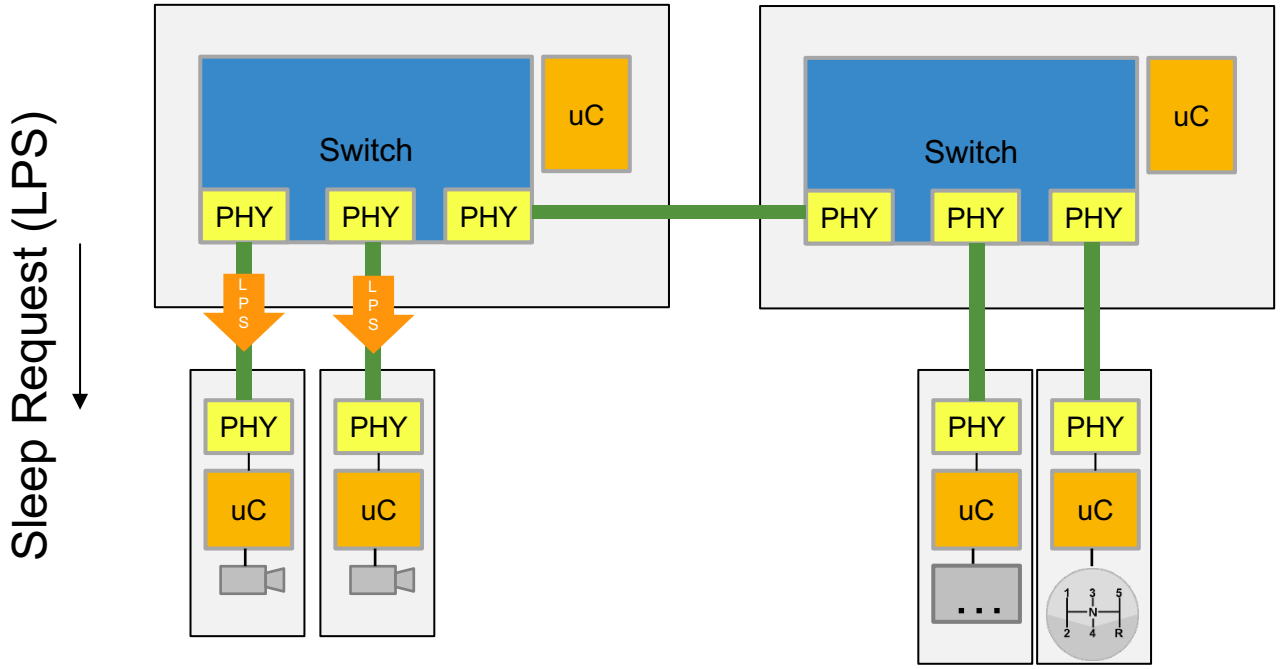
OPEN TC10
Primitives & Mechanisms

Example Topology



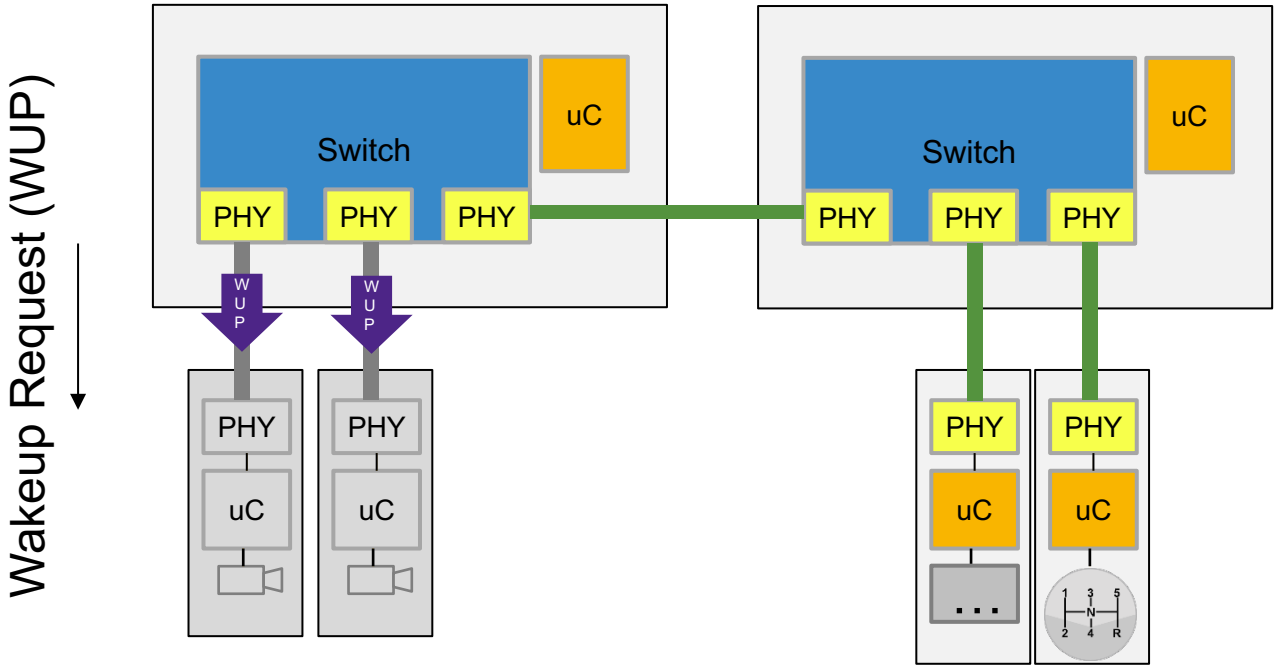
Sleep over Active Link

Use-case: Switch needs to power-off cameras



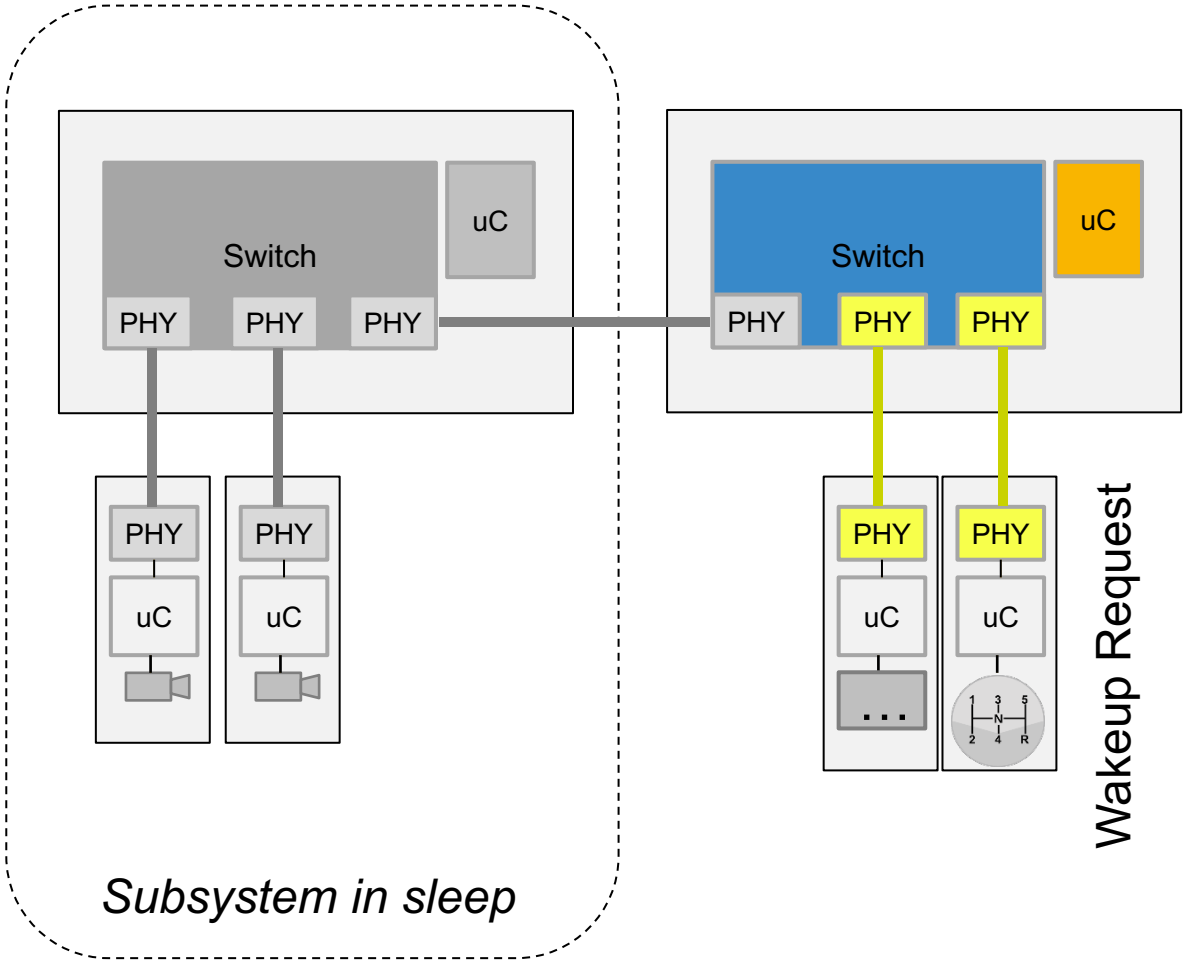
Wakeup over passive link

Use-case: Switch wakes up cameras



Wakeup Forwarding over active and passive link (WUP and WUR)

Use-case: Wakeup event at gear selector wakes entire system



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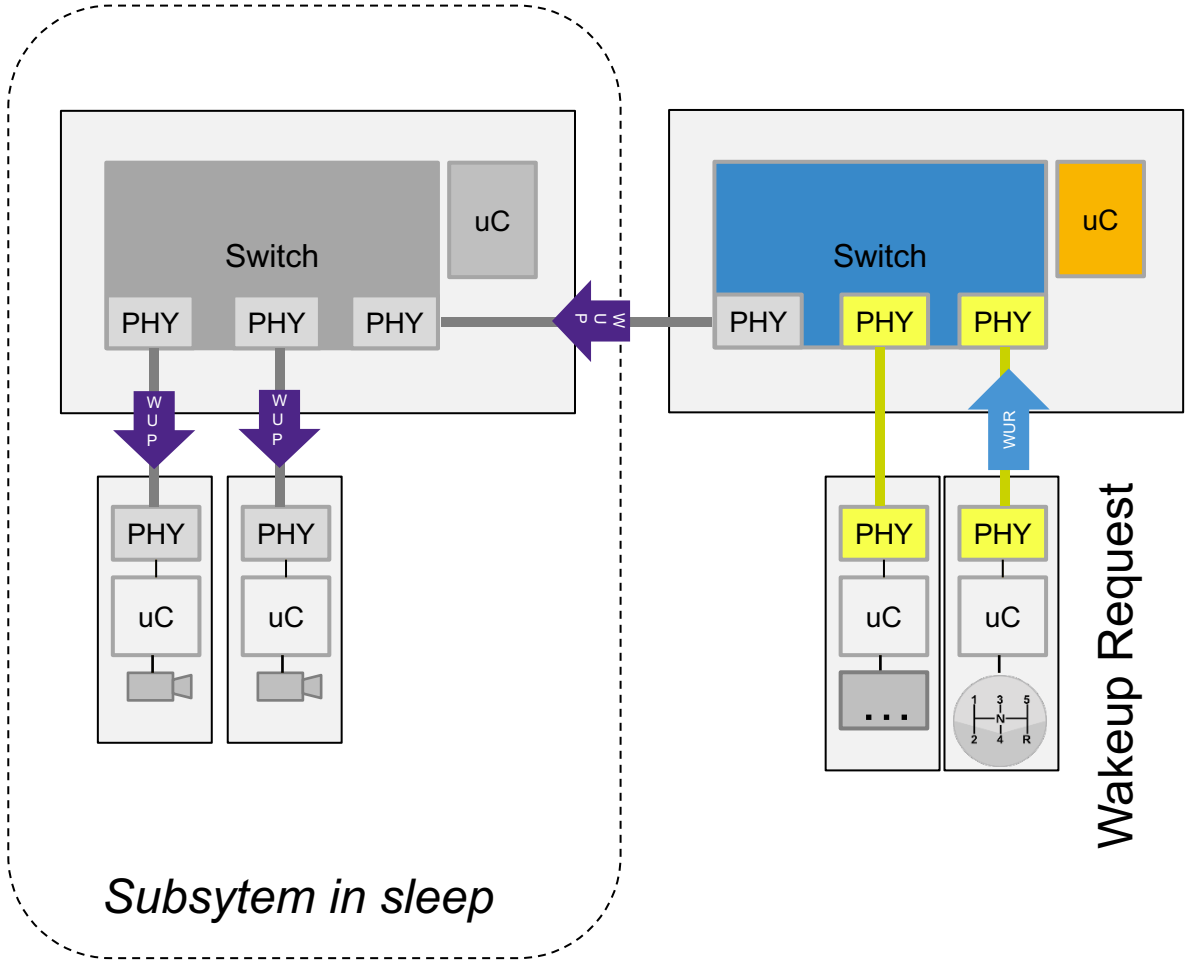
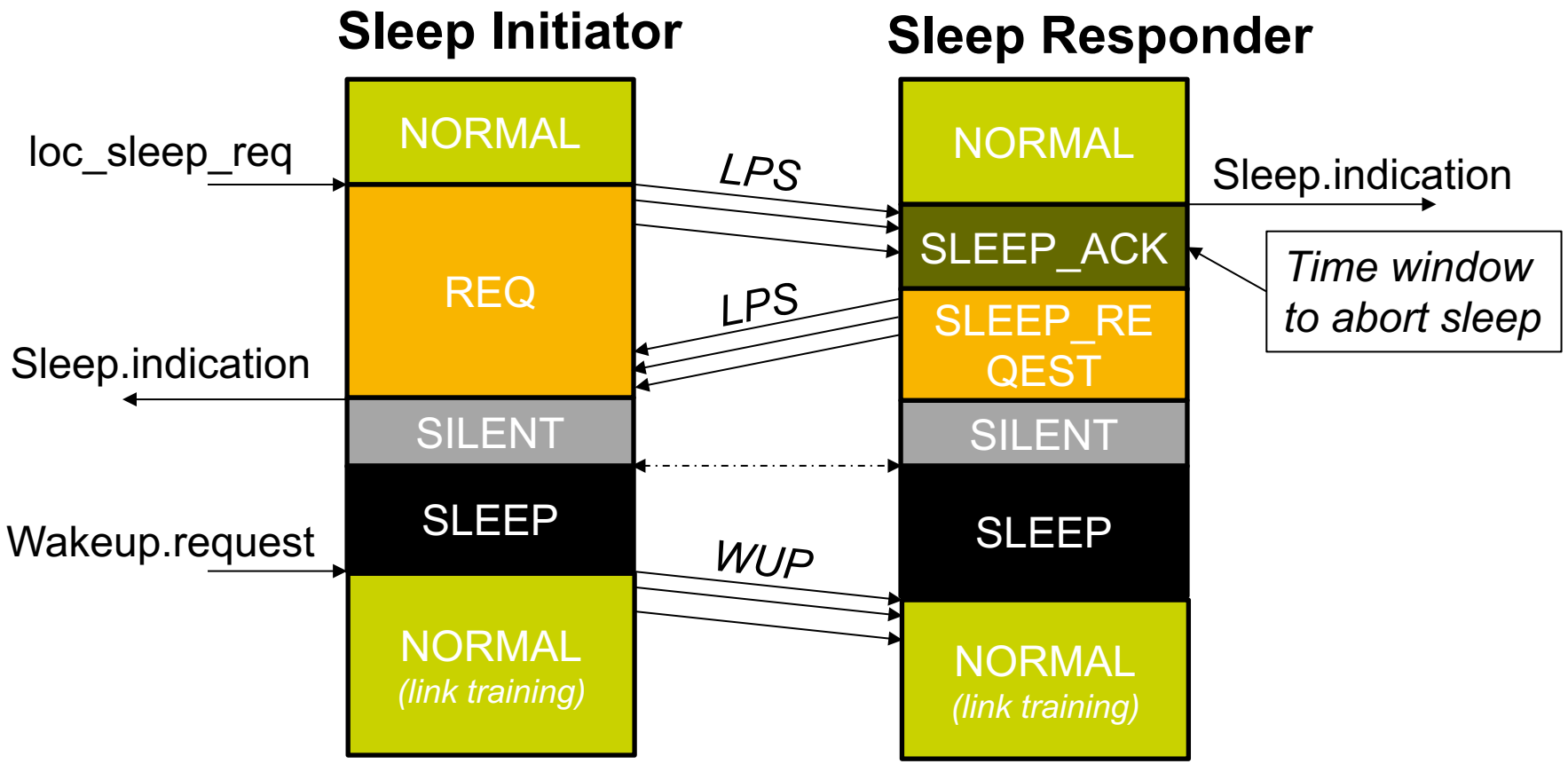


Sleep Handshake

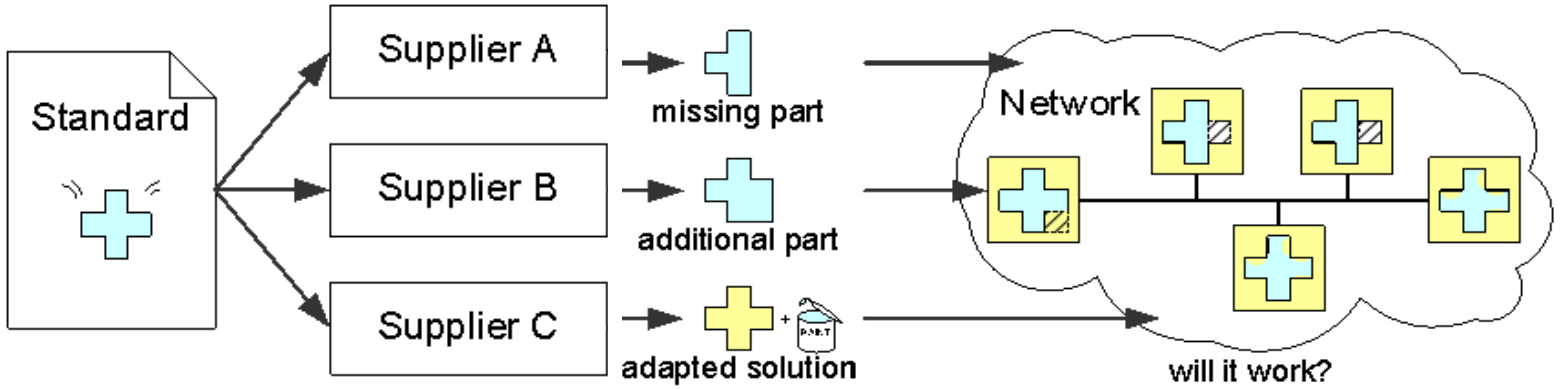


Sleep Handshake

Each state is associated with defined timing
→ Interoperatility test ensures correctness across vendors

Interoperability

Interoperability Challenges



Multi-Supplier-Solutions

- (Mis-)Interpretation is especially a problem in an environment in which products of different suppliers have to interoperate
- One single specified standard can be interpreted differently by different implementers, because:
  - Human language itself is ambiguous
  - A specified standard might contain coverage gaps, missing details
  - The implementer might misunderstand the specification

Wake-up/Sleep IOP Test Suite

Facts and Numbers

- 13 Test cases
- Reflecting in 46 instances
  - Master/Slave, Swapped Polarity , Channel Type

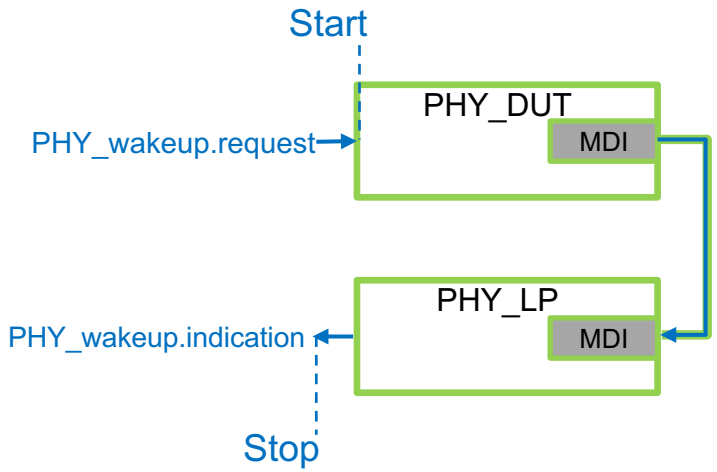
Test Groups

Test Group	Number of test cases
Wake-up reception and signalizing	3
Wake-up transmission	3
Wake-up forwarding	5
Sleep	2

Timing Measurement - Wake-up

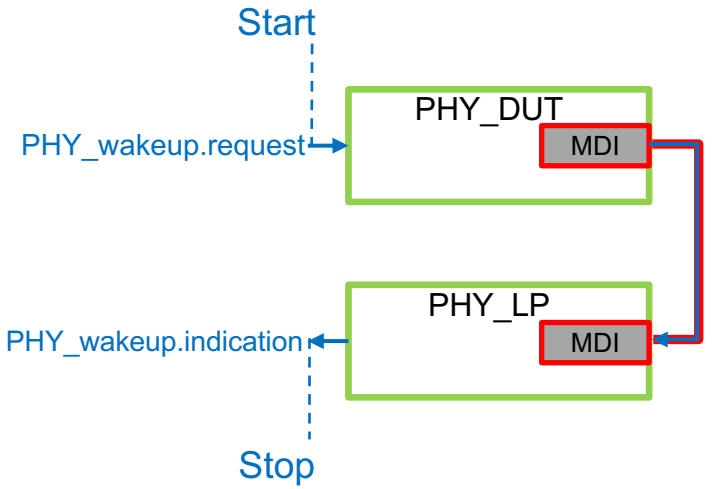
Wakeup over an active link

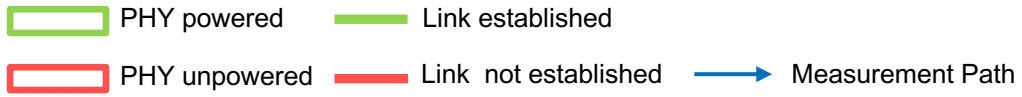
- TWU_Link_active
- <1ms



Wakeup over a passive link

- TWU_Link_passive
- <2ms

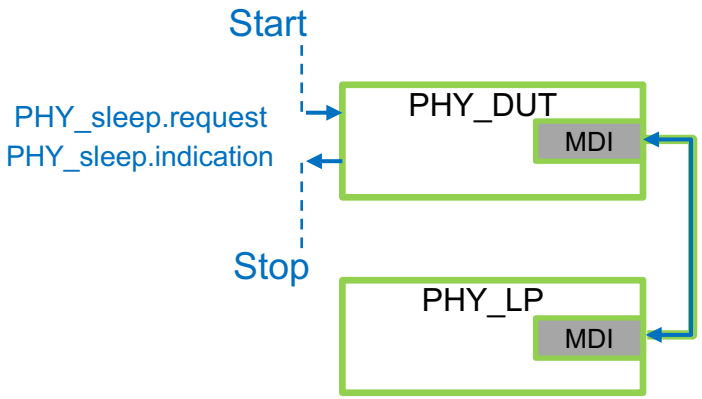




Timing Measurement - Sleep

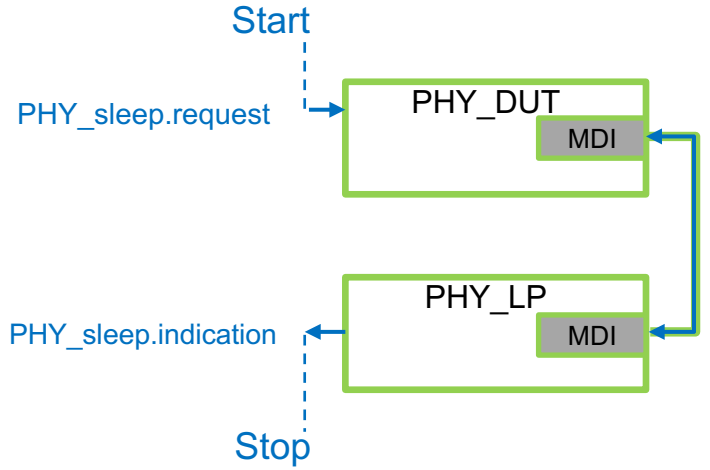
Local sleep request

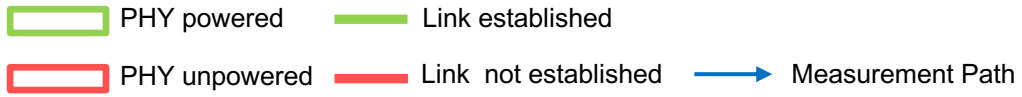
- T_LinkSleep
- <16ms



Remote sleep request

- T_LinkSleep
- <24ms





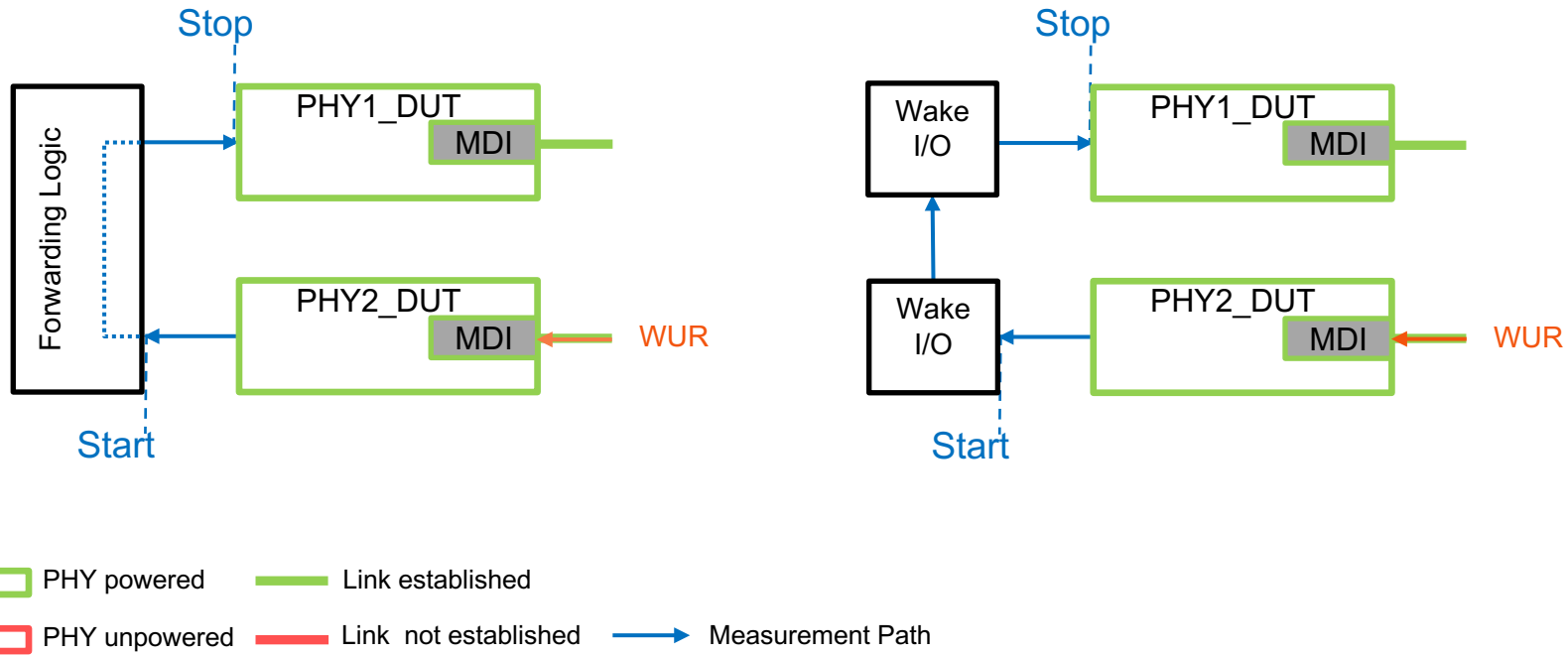
Timing Measurement – Forwarding

Wakeup forwarding integrated

- TWU_Forwarding
- <1ms

Wakeup forwarding via optional I/O

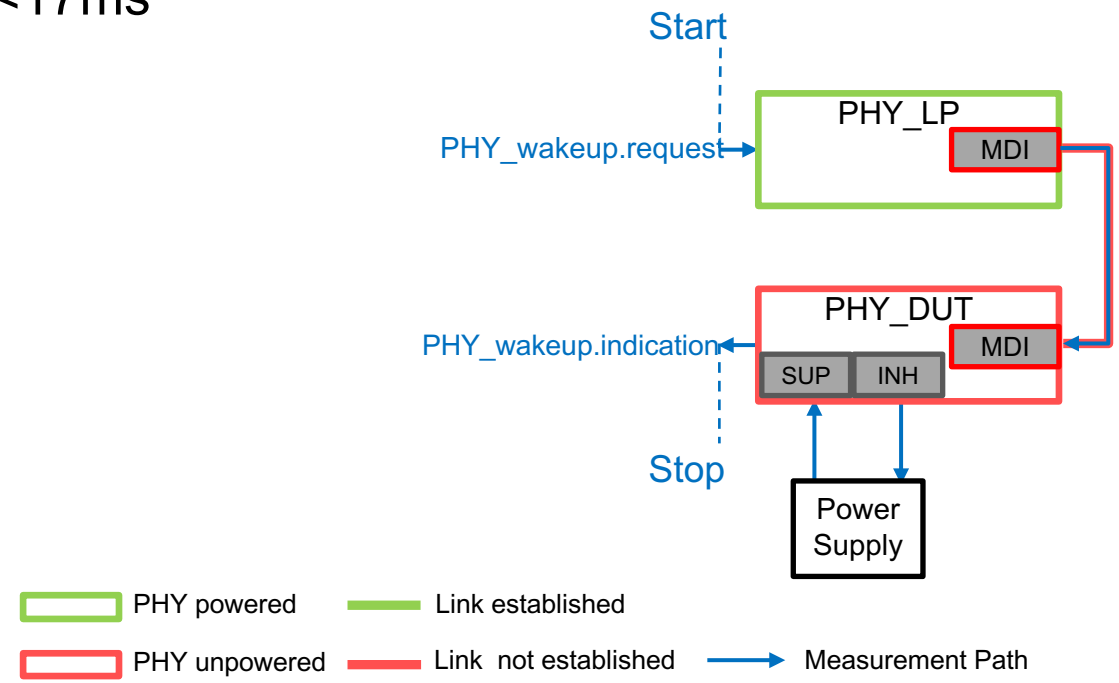
- TWU_WakeIO
- <1ms



Example: Reception of a Wakeup Pulse

Reception of a Wakeup Pulse (WUP)

- TWU_Link_passive + T_Powersupply_Stable + T_PHY_Initialization
- 2ms + 5ms + 10ms
- <17ms



Conclusion

- Wakeup & Sleep over dataline will eventually **replace legacy ‚wakeup lines‘**
  - Seemless **transition** / co-existance possible
- Advanced use-cases: **wakeup forwarding**
- **Scales** to other Ethernet physical layers
- Interoperability integrated into **OPEN Alliance TC-1 IOP**
- Concept specification from OPEN TC10 transfered to **ISO 21111-2**
- IOP tests will be **available from 01/2018**

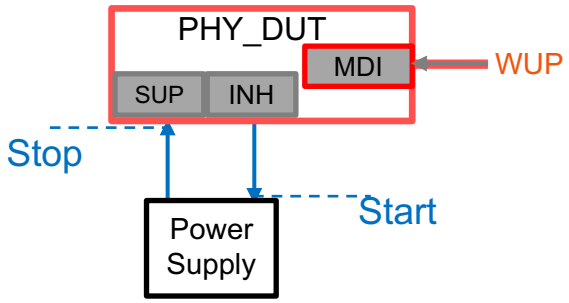
Questions?

BACKUP

Timing Measurement

Power Supply Stable

- T_Powersupply_Stable
- 90% of nominal value
- <5ms



PHY Initialization

- T_PHY_Initialization
- <10ms