



MICROCHIP

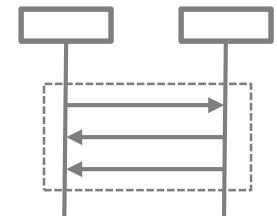
10 Mbps Single Pair Ethernet (10SPE – 10 BASE-T1S)

Martin Miller, Senior Manager, Automotive Information Systems

IEEE Ethernet & IP @ Automotive Technology Day

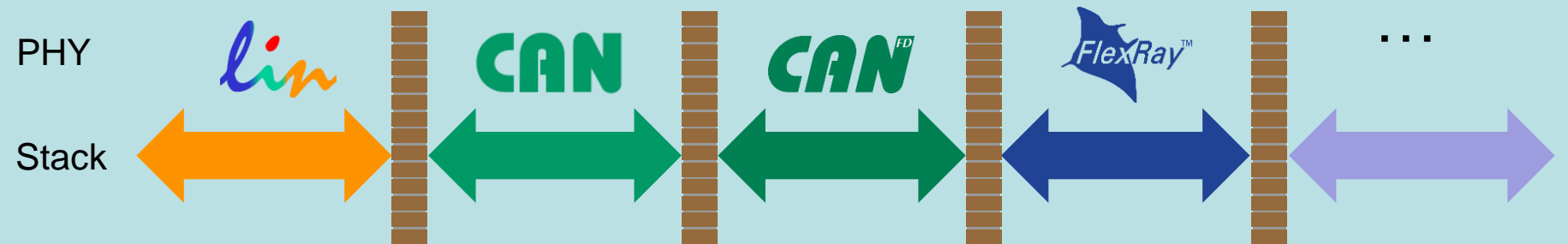
Motivation

- **Ethernet/IP-based Network everywhere**
 - WWW, IT, Automation, IoT, Cars etc.
 - Scalable bandwidth, various PHY layer options, proven SW stacks
- **Security and safety are essential**
 - Security framework
 - Safety framework
- **Service-oriented architecture manages complexity**
 - Encapsulation of functions and data
 - Unifies communication
 - Re-usability and movability of services
- **Innovative applications drive data rates**
 - Legacy implementations run out of steam

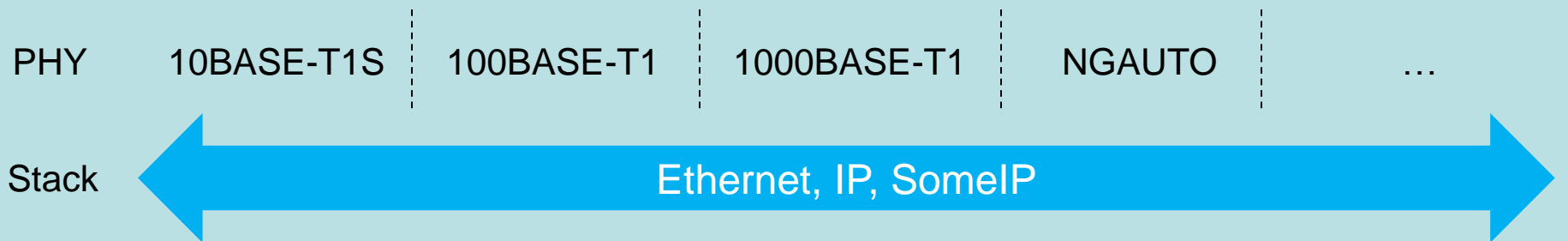


Why is Ethernet needed?

Legacy

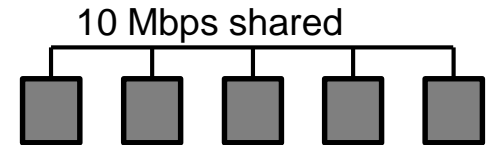


Ethernet



Why not 100BASE-T1?

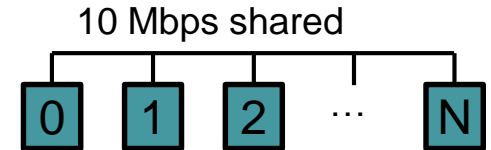
- **10BASE-T1S enables multi-drop (bus line)**
 - No switches
 - Less cables
 - 10 Mbps shared
 - Half-duplex
 - Up to at least 8 nodes
 - Up to at least 25 m
 - Stubs up to 10 cm
 - Arbitration scheme for optimized data throughput and transmission latency



Optimized data throughput on the bus line

- **Goals**

- Full bandwidth utilization
- Reduce latency
- Quality of Service (QoS)

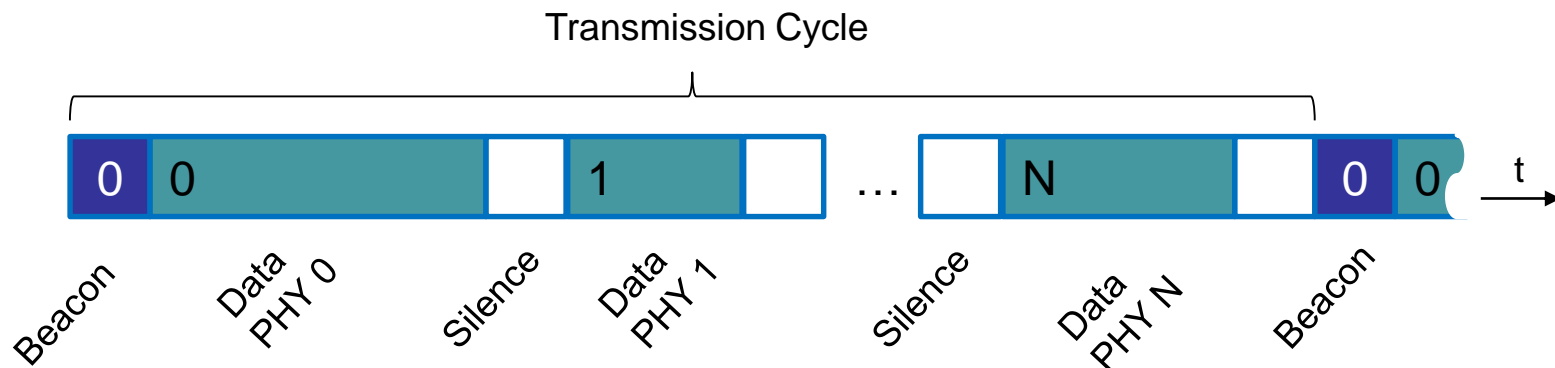


- **Principle**

- Avoid physical collisions on the medium by organizing the media access
 - Called Physical Layer Collision Avoidance (PLCA)

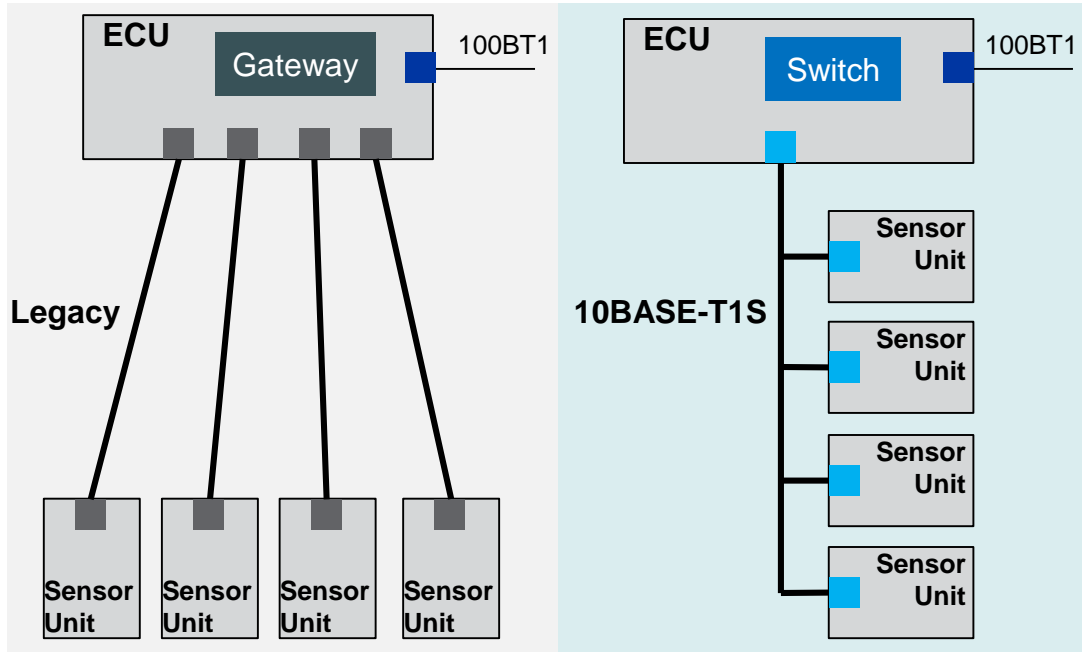
- **How it is done**

- Only the PHY that owns a transmit opportunity is allowed to send data
- Transmit opportunities are given in a round robin manner
- A new cycle of transmit opportunities is started when the master node sends a BEACON
- Works on top of Carrier Sense Multiple Access/Collision Detection (CSMA/CD)



Impact on Cabling

- Legacy PHY/transceiver
- 10BASE-T1S PHY
- 100BASE-T1 PHY



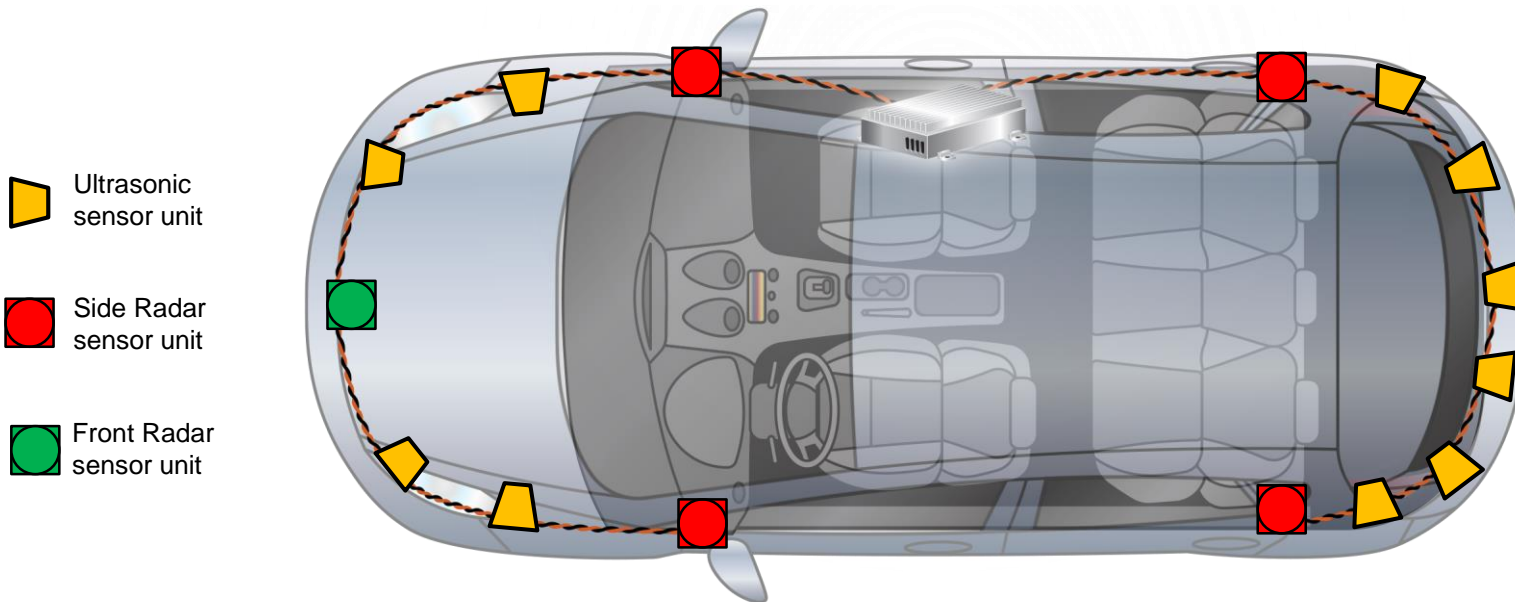
Benefits of 10BASE-T1S

# PHYs	8	5	Fewer PHYs
# Connectors ECU	4	1	Fewer connectors and less connector space on ECU
Cabling	4 cables	1 bus line	Less cabling, extendability, scalability
Bandwidth	< 10 Mbps	10 Mbps	More bandwidth
Ethernet-based network	no	yes	Seamless integration into overall Ethernet architecture
Gateways	yes	no	Eliminates need to translate messages

Scalability

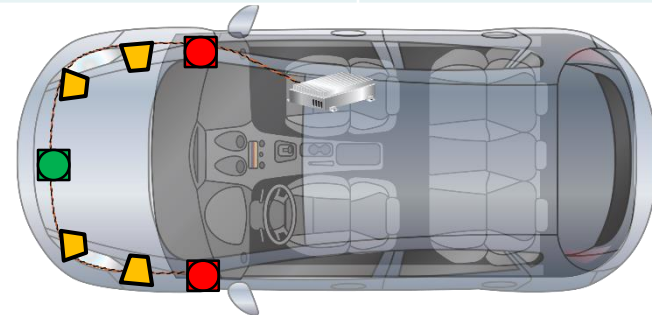
- **Minimum required connector space at ECU**
- **Bus line can be expanded by additional sensor units**
- **Assembly options don't change central ECU**

Example: Ultrasonic and Short Range Radar



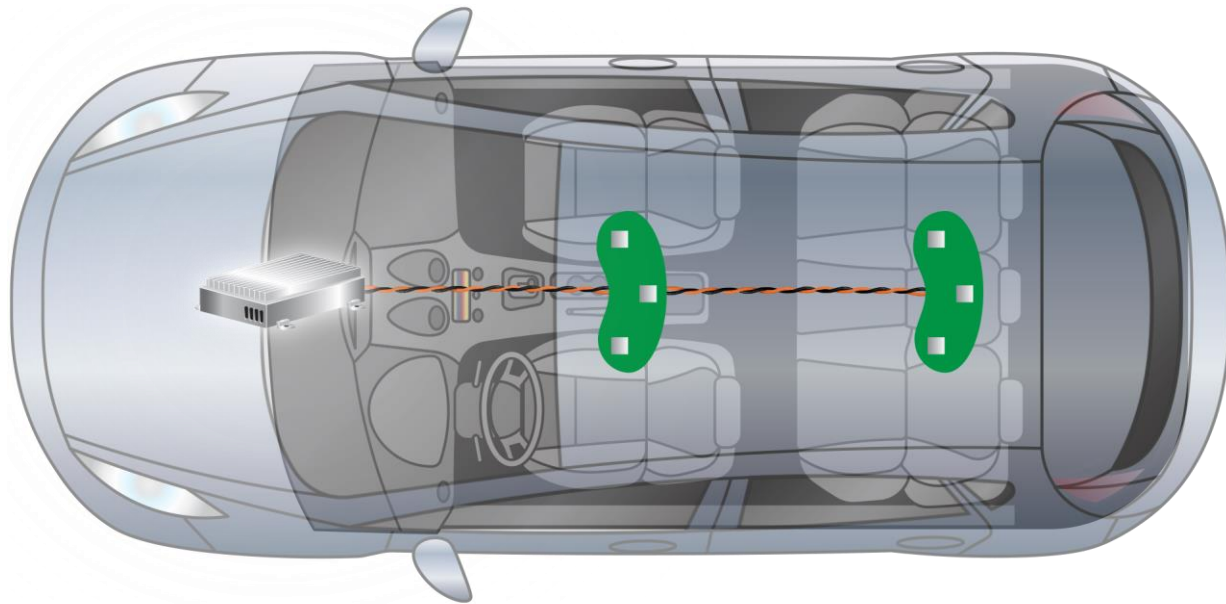
Example Radar/Ultrasonic

	Ultrasonic	Side Radar	Front Radar
# Sensors	4	2	1
Bandwidth	0.3 Mbps	1.5 Mbps	3.5 Mbps
L1 Packet Length	84	148	148
# Packets per Sensor per Second	446	1267	2956
Latency	624 us	624 us	624 us



Example: Hands Free Microphones

- Three Sensors on one PCB
- Two PCBs connected to an ECU
- 1722 AVTP as transmission protocol



Example: Hands Free Microphones

	Per PCB	Total
# Sensors	3	6
Sample Frequency	48 kHz	48 kHz
Samples per Packet	3*24	3*24
L1 Packet Length	206	206
# Packets per second	$48 \text{ kHz} / 24 = 2000$	4000
Latency (= sample collection + packet transmission)	$500 \text{ us} + 2 * 165 \text{ us} = 830 \text{ us}$	830 us
Bandwidth	3.3 Mbps	6.6 Mbps

Application Overview

- Hands free microphones
- Active speakers
- Noise vibration harshness
- Parking ECU
 - Radar
 - Ultrasonic
- Engine ECU
- Body ECU
- Active suspension
- Steering/braking system
- Charging units for electric cars
- Traffic sign recognition



- **Key Features**
 - Multi-drop
 - No collisions
 - Deterministic low latency

- **Enabling expansion of Ethernet technology to many additional applications**



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Thank you!