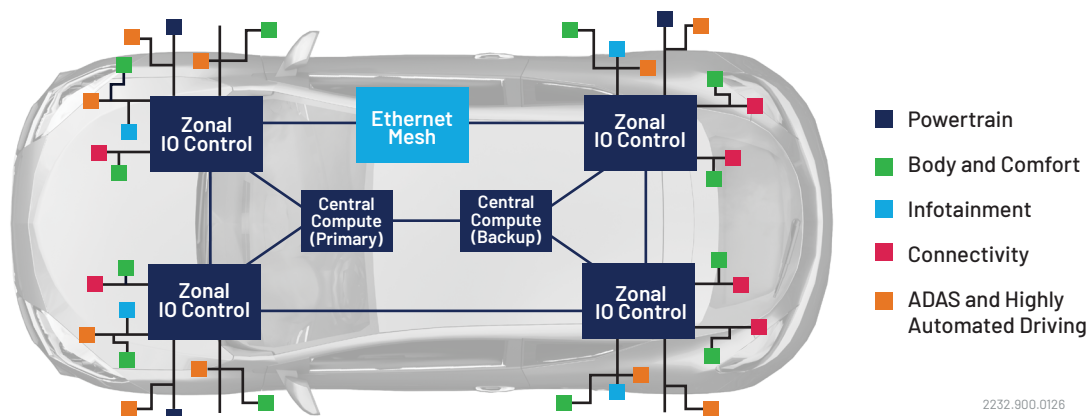


# Testing Challenges and Strategies for 10BASE-T1S Environments

## Technology Overview

10BASE-T1S, developed as part of the IEEE 802.3cg-2019 standard, provides the missing link for an Ethernet-only in-vehicle network. It enables Ethernet-to-the-edge connectivity and addresses the needs of zonal-based architecture.

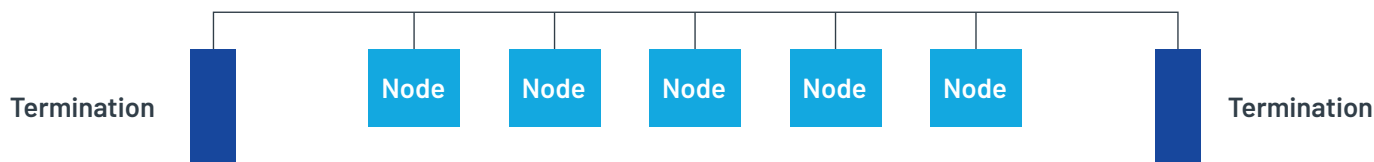


Sensors, Actuators and Compute ECUs in a Zonal E/E Architecture

One of the unique aspects of 10BASE-T1S is its support for multidrop technology. This bus implementation, where all nodes are connected over the same unshielded twisted pair cable, reduces cost by requiring only a single Ethernet PHY in each node. It eliminates the need for switches or gateways towards legacy network technologies.

10BASE-T1S technology provides a 10 Mbps, multidrop transmission medium that can include up to at least eight transceiver nodes. The transceiver nodes connect to a common mixing segment of up to at least 25 meters.

To ensure efficient network access, 10BASE-T1S utilizes Physical Layer Collision Avoidance (PLCA) instead of the traditional CSMA/CD procedure. PLCA implements a time-controlled mechanism where a designated “coordinator node” transmits a beacon to signal the start of a transmission cycle. Each node is assigned a fixed transmission slot, preventing access collisions on the bus and ensuring deterministic maximum latency. This approach enables optimized utilization of the available 10 Mbps bandwidth.



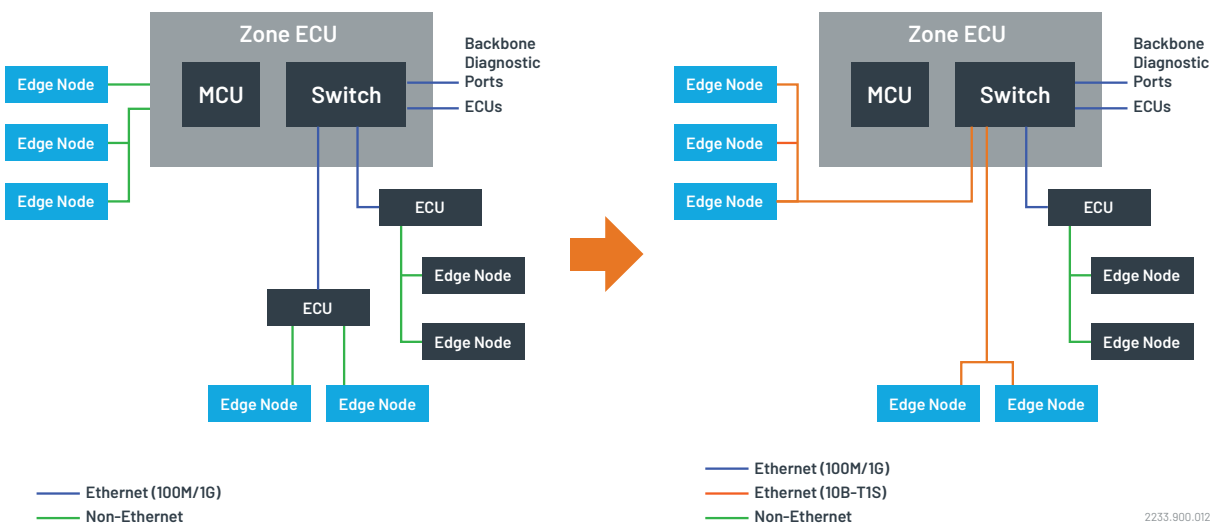
Physical Layer Collision Avoidance (PLCA) ensures efficient network access

## Paving the Way for Intelligent, Autonomous, and Software-defined Vehicles

10BASE-T1S Ethernet brings a range of advantages that make it highly suitable for a broad and varied range of automotive applications, encompassing sensors and actuators across multiple domains.

10BASE-T1S technology is helping to boost software-defined vehicles in the following ways:

- **Cost Efficiency:** reduces wiring costs and complexity by allowing multiple devices to share a single cable, this is particularly advantageous in the constrained spaces within vehicles.
- **Scalability:** supports flexible network topologies, making it easier to scale and expand networks as more sensors and actuators are integrated into automotive systems.
- **Enhanced Zonal Architectures:** enhances zonal architectures by providing efficient communication pathways within defined zones of the vehicle.
- **Deterministic Network Performance:** provides deterministic network performance, which is crucial for bus technology, and ensures reliable and predictable communication between devices, which is essential for safety-critical automotive applications.
- **Seamless Integration:** contributes to the advancement of automotive (E/E) architectures through seamless integration into existing automotive networks. This supports the evolution of more sophisticated and interconnected vehicle systems:



10BASE-T technology supports the evolution of interconnected vehicle systems

## Physical Layer Collision Avoidance (PLCA)

Physical Layer Collision Avoidance works with a CSMA/CD MAC to prevent collisions among half-duplex stations, called PLCA nodes, thus improving network utilization.

The following describes how PLCA process works:

- **Unique Local IDs:** each node on the network segment (collision domain) is assigned a unique Local ID.
- **Transmit Opportunities:** nodes are granted transmit opportunities in sequence based on their Local ID.
- **PLCA Coordinator:** the node with Local ID = 0 is the PLCA coordinator, its role is to send out a periodic synchronizing signal called a BEACON onto the physical media.
- **PLCA Followers:** all other nodes, known as PLCA followers, synchronize their operations based on the BEACON sent by the coordinator.
- **Counting Transmit Opportunities:** once the BEACON is received, all nodes begin counting transmit opportunities starting from zero. Each node detects its turn to transmit by counting the number of opportunities that have passed since the BEACON was sent.
- **PLCA Bus Cycle:** after a fixed number of transmit opportunities, the PLCA coordinator sends another BEACON, starting a new cycle. A cycle consisting of a BEACON followed by a fixed number of transmit opportunities is known as a PLCA bus cycle.

This process ensures that each node gets a chance to transmit in an orderly manner, avoiding collisions and improving overall network efficiency.

## 10BASE-T1S Automotive Applications and Integration

- Sensor and Actuator Interaction
  - 10BASE-T1S is well-suited for communication with sensors and actuators due to its ability to support short-distance, low-power connections. These devices often generate and require real-time data, which 10BASE-T1S technology handles efficiently.
- High-Performance ECU Processing
  - Data from sensors and actuators connected via 10BASE-T1S is processed by high-performance ECUs. These ECUs can be part of a switch or a backbone network that operates at higher speeds, ensuring that safety-critical data is transmitted and processed rapidly.

## Testing Challenges in a Multidrop Network

- **Multidrop Mode Validation:** it is crucial to validate the scale and performance of 10BASE-T1S in multidrop mode to ensure reliable communication across multiple nodes.
- **PLCA Configuration:** optimal configuration of PLCA is necessary to meet application requirements for latency and throughput. This involves fine-tuning parameters to balance performance and efficiency. PLCA can introduce variable delays in the transmission path, therefore it is essential to ensure frames are received in the correct order according to the PLCA cycle.
- **Max Burst Count:** testing must verify frame order and latency when max burst count is set to different values for nodes. Delays need to be measured to ensure they fall within expected limits, considering the number of nodes and the configured transmit opportunity (TO) timer.

## Key Testing Considerations

Key testing considerations of 10BASE-T1S applications include:

- **Scale and Performance in Multidrop Mode:** validating the network's ability to handle multiple nodes communicating simultaneously.
- **PLCA Configuration:** ensuring optimal settings for latency and throughput
- **Frame Order:** verifying frames are received in the correct order according to the PLCA cycle.
- **Latency:** measuring latency to ensure it meets expected limits under various conditions. Factors affecting latency include the number of nodes on the segment, the TO timer configuration, and frame sizes.
- **Throughput:** testing throughput to ensure it meets performance expectations, considering node activity and frame sizes.

By addressing these challenges and thoroughly testing the specified areas, 10BASE-T1S environments can be optimized for reliable and efficient performance in automotive and other applications.

## Test Setup and Configuration Guidelines

VIAMI T1S test solution offers flexible configuration options, supporting both Point-to-Point (P2P) and multidrop modes. Key highlights include:

### Multidrop Setup

- **PLCA Coordinator:** in a multidrop setup, one node must be designated as the PLCA Coordinator, while all other nodes are configured as PLCA Followers.
- **Support for multiple nodes:** VIAMI test ports can connect to a T1S multidrop bus with up to 8 nodes, these test ports can function as either the PLCA Coordinator or a Follower node.
- **Integration with external devices:** VIAMI test ports support configurations where an external device or port acts as the PLCA Master while all VIAMI ports operate as PLCA Followers.

### Configuration Requirements

- **Alignment:** all nodes on a multidrop bus, including VIAMI and/or external devices, must be configured in alignment. The two nodes at the physical ends of the bus need to apply bus end termination.
- **Unique Node IDs:** one node must be the PLCA Coordinator (LOCAL\_ID=0) while all other nodes must have unique Node IDs.

### Traffic and Latency Management

- **Burst Configuration:** each node can be configured to support either single packet transfers (Burst=1) per PLCA bus cycle or bursts of up to N packets, depending on the network traffic and latency demands.
- **Timers:** each node has two timers to set the wait duration for its Tx and Tx Burst opportunities. While there is an option to move away from the suggested default settings, this requires full network knowledge and careful configuration to avoid misalignment.

By adhering to these configuration guidelines and utilizing the flexible capabilities of VIAMI T1S test solution, network administrators can ensure optimal performance and reliability in both peer-to-peer (P2P) and multidrop environments.

The screenshot shows the configuration interface for the VIAMI T1S test solution. It is set to 'Multidrop' mode. The 'PLCA Enable' checkbox is checked, and the 'Node Role' is set to 'Coordinator'. Other settings include 'Node Count' (4), 'Local ID' (0), 'Max Burst Count' (10), 'Burst Timer (in Bit Time)' (128), and 'Tx Opportunity Timer (in Bit Time)' (32). A yellow warning box states: 'It is recommended to leave Opportunity and Burst Timers at its default values.' The 'PLCA Status' is 'Regular BEACON Activity'.



Automotive C2 Appliance



Automotive M1 Appliance

Learn how to boost your 10BASE-T1 adoption with [VIAMI C2 Appliance](#) and [M1 Appliance](#), offering flexible number of ports and a wide range of Single Pair Ethernet (SPE) interfaces from 10M to 10G, in a compact form factor.



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