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CAPTURE ALL IVN TRAFFIC FROM BENCH TO FLEET

How validation teams capture, correlate, and trust in-vehicle network data — from bench to HIL to fleet — without disrupting the systems they are trying to validate.

Why traditional capture approaches fall short

Modern vehicle validation is no longer about observing a single network in isolation. Today's E/E architectures combine legacy buses such as CAN, LIN, and FlexRay, Automotive Ethernet variants such as 100BASE-T1 and 1000BASE-T1, and increasingly high-bandwidth sensor and camera links. Proper IVN network capturing requires these data streams to be time-aligned and correlated. As architectures move toward centralized and zonal designs, more ECUs, sensors, and compute nodes must coexist on shared infrastructure, which makes validation workflows more complex and timing-sensitive than before.

For testing and validation engineers, this creates a practical challenge: It is no longer enough to ask whether traffic was logged. The real question is whether the recorded data can be trusted to reflect what actually happened in the vehicle, at the right moment, and in the right sequence. In distributed automotive systems, timing accuracy is foundational because time-sensitive communication, distributed control, and sensor fusion all depend on coherent timing across the network.

Traditional logger-centric approaches often become a bottleneck in exactly the places where engineers need confidence most. Critical startup frames may be transmitted before the logger is fully ready. Separate tools can create non-coherent timestamps across buses. Sudden bursts or sustained throughput can overwhelm downstream recording systems. Capture Modules mitigate this by employing **output traffic shaping,** ensuring consistent and **loss-free** logging even under **high-bandwidth** conditions. And setups that work on the bench do not always scale cleanly into HIL rigs, test vehicles, or fleet deployments. The results are incomplete traces, longer debugging cycles, and reduced confidence in the findings.

This playbook is written for engineers who need a better way to observe in-vehicle communication across protocols, across domains, and across validation stages. Rather than presenting features in isolation, it focuses on the recurring validation problems engineers face, what robust capture must deliver in each case, and how modular capture architectures can help teams scale from isolated setup validation to system-level visibility.

"Fast, reliable multi-bus testing. Technica Engineering's Capture Modules integrated seamlessly, triggered cost savings via direct collaboration, and delivered stable, maintenance free logging – no signal or message loss observed."
Global OEM based in China

Intended audience and scope

Who this guide is for

- **Testing and Validation Engineers** who are responsible for observing and troubleshooting in-vehicle communication across multiple buses and domains.

- **Network Architects** who need to ensure capture workflows remain scalable as architectures evolve toward Automotive Ethernet networks (e.g. 100BASE-T1, 1000BASE-T1) and AVB/TSN-enabled Ethernet backbones, mixed-criticality traffic, and zonal designs.

- **System Integration and HIL Engineers** requiring better observability without replacing stable but aging validation infrastructure.

What this guide covers

This guide focuses on **real validation scenarios.** It shows where modular capture points fit into validation topologies, why those placements matter, what problems they solve, and what "good capture" should enable from the engineering point of view.

What this guide does not cover

This is not a full standards manual, nor a protocol tutorial. It is a practitioner resource for engineers who need to recognize common capture bottlenecks, understand what robust measurement architecture looks like, and identify which setup pattern may best fit their own validation workflow.

This playbook draws on Technica Engineering's experience across ADAS and E/E architecture validation programs. It focuses on validation architecture decisions, not on tool configuration or step-by-step instructions.

What makes automotive network validation harder today

Modern validation teams are dealing with a very different problem than they were even a few years ago. As vehicle architectures grow more complex and validation programs scale from bench to fleet, the cost of not solving them compounds at every stage. The following challenges appear repeatedly across bench setups, HIL rigs, and vehicle programs.

01

Startup data loss
ECUs transmit before the logger is ready. The first seconds are lost.

02

Fragmented timelines
Separate tools, separate clocks. Cross-domain correlation becomes guesswork.

03

Bandwidth overload
Burst traffic from ADAS and Ethernet backbones overwhelms the recording chain.

04

Mixed protocol coexistence
CAN, LIN, FlexRay, and Ethernet must be captured and correlated in the same workflow.

05

Bench-to-fleet scalability
Setups that work on the bench don't always survive the move to HIL or fleet.

06

Proprietary data lock-in
Closed formats mean more time converting data and less time analysing it.

1. You can't capture what happens before your logger is ready

Many ECUs transmit important initialization, wake-up, or diagnostic frames immediately after power-up. If the logger or recording chain is not ready in time, the trace begins after the most critical event has already happened. That can derail root-cause analysis before it even starts.

2. Multiple tools create multiple time realities

When CAN, LIN, FlexRay, Ethernet, and sensor links are captured by separate tools or loosely integrated workflows, timestamps are not always directly comparable. That becomes a problem when engineers need to determine which event happened first, which event triggered another one, or whether an observed delay is real or an artifact of measurement.

3. High-bandwidth traffic stresses the logging chain

ADAS, sensor fusion, central compute, and Ethernet backbones generate large amounts of traffic. In such environments, sudden bursts or sustained throughput can overwhelm downstream recording systems, increase the risk of data loss, or make installations harder to scale. Validation therefore needs a capture path that can absorb complexity without shifting the burden entirely to the data sink.

4. Legacy and modern networks must coexist

Validation environments rarely start from scratch. Most teams still need to work across a mix of CAN, LIN, FlexRay, Ethernet, sensor interfaces, and older HIL assets. The challenge is not only to support each bus type individually, but to create a workflow where data from all of them can be recorded, correlated, and analyzed together.

5. Scaling from bench to HIL or fleet car, testing is often not seamless

A setup that is manageable on a workbench can become difficult to maintain when moved to a HIL system, or fleet test vehicle. Interface count, wiring complexity, physical space, logger constraints, and reconfiguration effort can all increase, which slows down validation rather than accelerating it.

6. Proprietary toolchains create data you can't easily share, correlate, or reuse

As validation toolchains become broader and more distributed, engineers benefit from capture approaches that align with open communication and synchronization standards rather than locking data into isolated paths.

Scenario 1 - Capture of early ECU startup and wake-up sequences

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Validation context

ECUs can begin transmitting critical information immediately after power-up. Startup diagnostics, initialization states, wake-up communication, TC10-related activity, or early bus signaling may all occur before a conventional logger is fully initialized. If the first meaningful event is not recorded, engineers can end up diagnosing a symptom without access to the trigger.

Why traditional capture approaches struggle

Data loggers can take multiple seconds to boot up. ECUs start transmitting immediately. That gap is a blind spot exactly where validation often needs the most confidence. Engineers investigating intermittent startup issues may have a trace file, but not the part of the sequence that actually explains the behavior. This is especially problematic for boot-time diagnostics, network wake-up, and early handshaking where milliseconds matter.

What a robust setup should provide

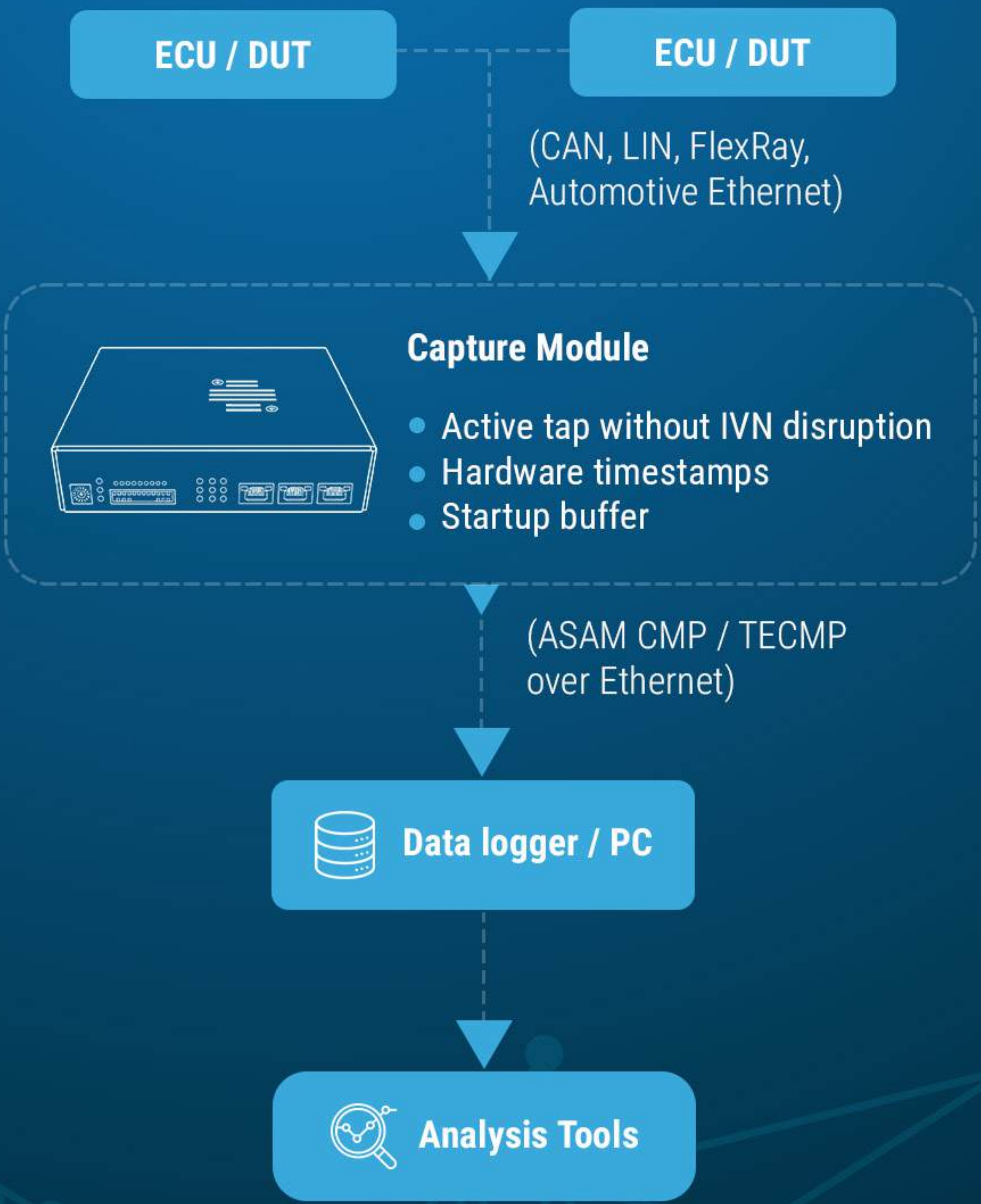
For startup analysis, the capture point should already be in the live communication path, ready to observe traffic from the first frame onward. It should include built-in startup buffers and high-speed startup logic to ensure early data is captured from the moment the system powers up, even if the recording sink is not yet ready, and timestamping those events close to the physical interface so the timing sequence remains meaningful. **Hardware-based timestamping** is especially important when the purpose of the test is to analyze the exact start of communication and the sequence of the messages, rather than just detect that traffic existed.

How Capture Modules help

Placed inline, Capture Modules can **become part of the live network** path rather than depending on a later software stage to reconstruct events. This means startup traffic can be preserved, early communication can be recorded even before the logger is fully available, and timing integrity can be maintained close to the interface. From an engineering standpoint, that increases confidence that the trace reflects the system under test rather than the limitations of the recorder.

Scenario 1 - Capture of early ECU startup and wake-up sequences

Setup topology - inline capture with startup buffering



Scenario 1 - Capture of early ECU startup and wake-up sequences

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Outcomes enabled

- Reliable visibility into the first ECU frames after power-up.
- Better analysis of wake-up behavior, startup sequences, and timing-related anomalies.
- Reduced risk of misdiagnosing startup issues based on incomplete traces.
- Greater confidence in reproducibility when chasing intermittent boot-time problems.

> "Capture early start-up traffic before your logger is ready"

Scenario 2 - Multi-protocol correlation across CAN, LIN, FlexRay and Ethernet

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Validation context

A vehicle fault rarely stays neatly inside one bus. An issue observed on Ethernet may be triggered by a CAN event, a LIN wake-up, a FlexRay state change, or a synchronization mismatch elsewhere in the system. As vehicles become more connected and cross-domain by design, engineers increasingly need a **single, trustworthy timeline** across multiple communication technologies.

Why this is hard in practice

When different interfaces are captured by separate tools, the analysis often becomes a manual stitching exercise. Timestamps may be based on different clocks, logging may begin at slightly different times, and exported files may not line up cleanly. In a modern automotive network where deterministic timing and decentralized synchronization matter, those inconsistencies can slow down debugging and weaken confidence in cause-and-effect conclusions.

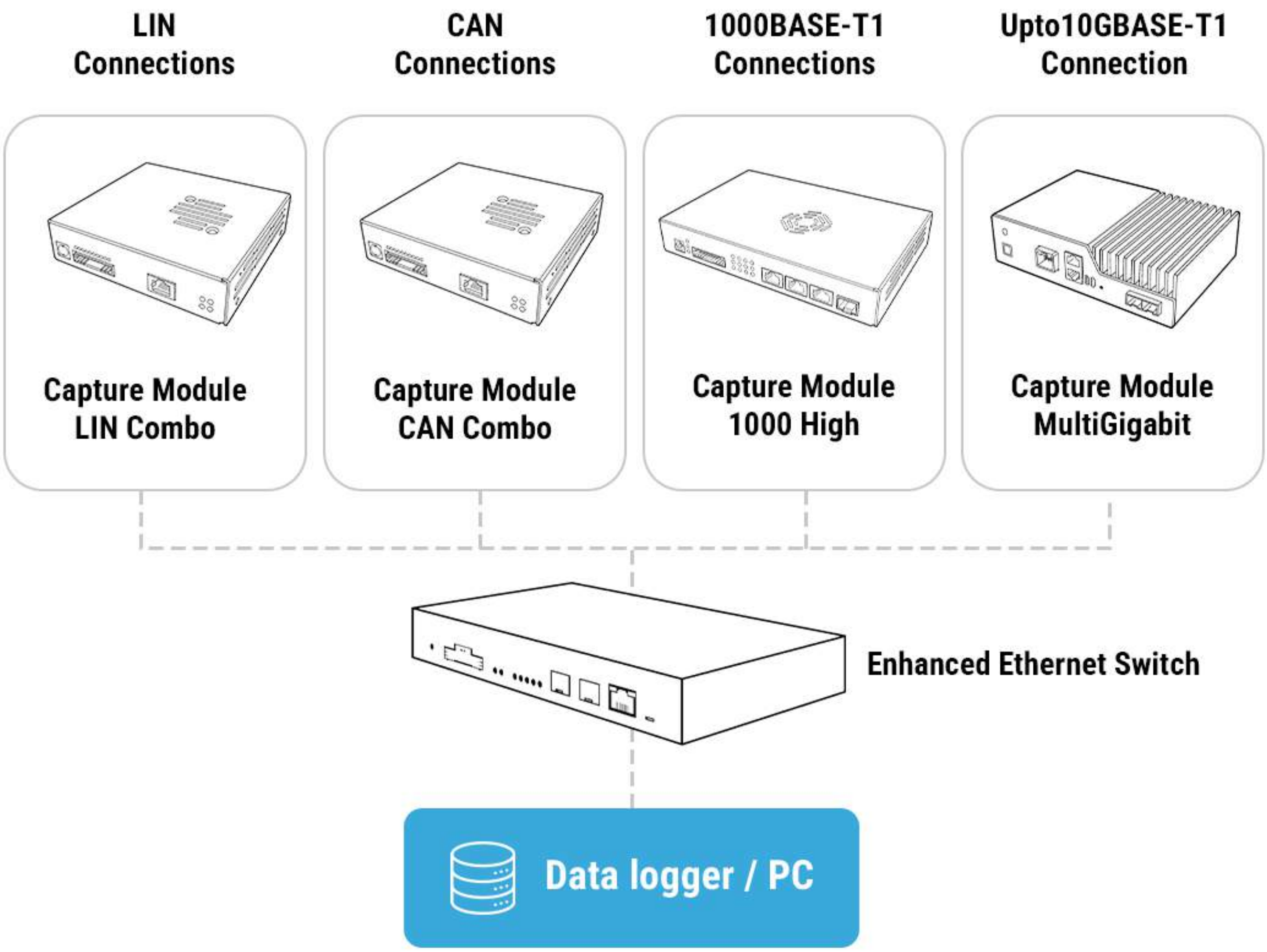
What a robust setup should provide

Engineers need capture points that **timestamp traffic at the source and align to a common time base.** They also need a topology that reduces the number of direct recorder connections as the number of measurement points grows. This is where synchronized capture and scalable aggregation become more valuable than a collection of isolated point tools.

How Capture Modules help

Each Capture Module can timestamp traffic close to the interface it monitors, while synchronization is achieved using gPTP, enabling alignment to a shared time base across all capture modules. Combined with scalable Ethernet-based transport, this enables a single correlated timeline across heterogeneous traffic sources and reduces the integration burden on the data sink.

Scenario 2 - Multi-protocol correlation across CAN, LIN, FlexRay and Ethernet



Outcomes enabled

- A single, time-synchronized timeline across CAN, LIN, FlexRay, and Automotive Ethernet.
- Faster cross-domain root-cause analysis when symptoms span multiple buses.
- Better confidence in distributed timing and trigger sequence analysis.
- Confident scaling from bench validation to complex vehicle-level setups.

Scenario 3 - High-bandwidth ADAS camera and sensor validation

Validation context

ADAS and automated driving architectures generate large volumes of data and depend on precise coordination between sensors, compute nodes, and network infrastructure. Camera, radar, lidar, and other high-bandwidth links must often be analyzed, not only on their own, but in relation to the wider in-vehicle network. In these systems, timing, throughput, and deterministic behavior become system-level concerns rather than isolated link concerns.

Why this is hard in practice

High-speed links are less tolerant of intrusive observation. Engineers need to see what is happening on the link without affecting signal behavior or creating a measurement artifact. At the same time, troubleshooting often requires correlation between the sensor path and other network events elsewhere in the vehicle. This means the capture approach must be both transparent at the link level and integrable at the system level.

What a robust setup should provide

For ADAS and high-bandwidth sensor validation, engineers need an inline capture point that can sit directly in the path, observe communication without altering expected behavior, and forward the measured data into a broader analysis workflow. That workflow must still allow the sensor link to be related back to Ethernet and the rest of the vehicle network.

How Capture Modules help

Capture Modules designed for high-bandwidth or SerDes-related setups can be placed directly in the communication path, acting as an active tap, enabling non-intrusive observation of sensor and control traffic without causing interference on the network while feeding the data into a common Ethernet-based logging and analysis environment. This improves the engineer's ability to understand not just the link in isolation, but its behavior in context.

Scenario 3 - High-bandwidth ADAS camera and sensor validation

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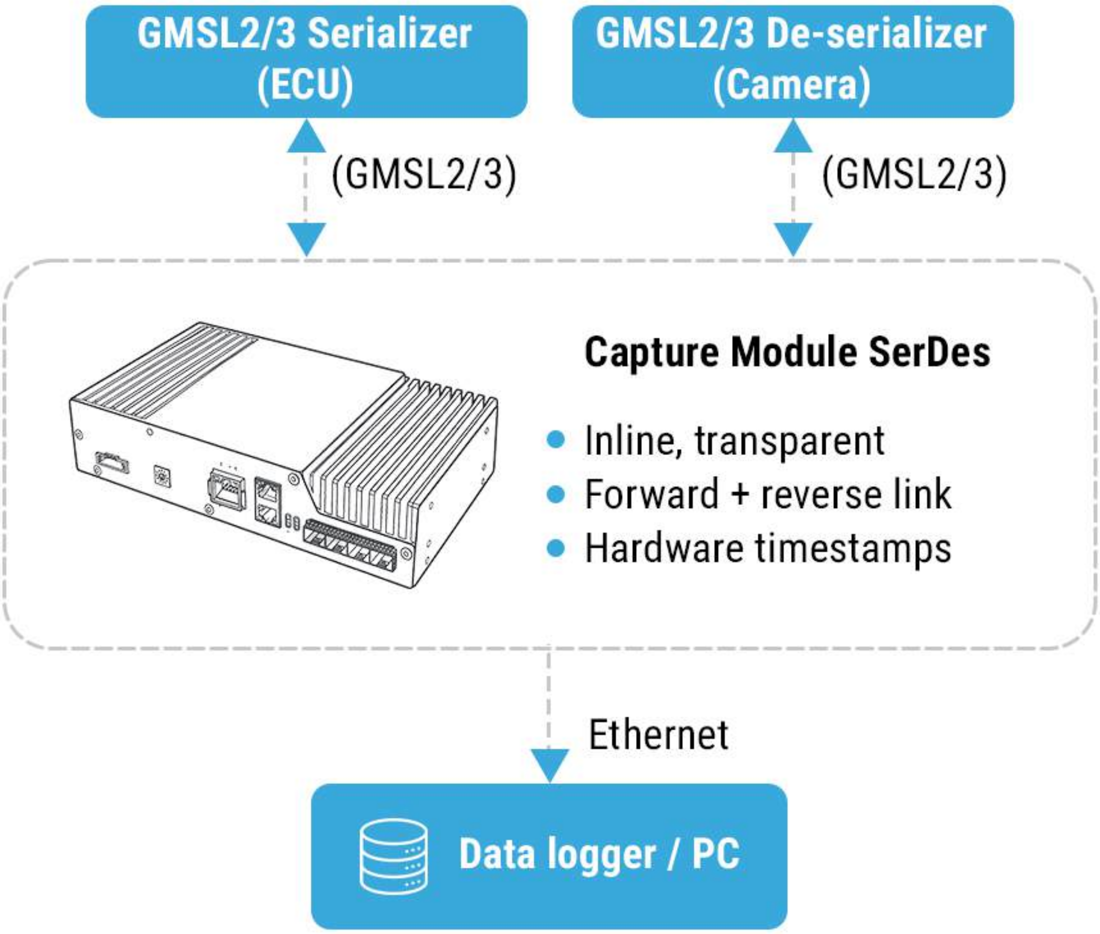


Outcomes enabled

- More complete observability for camera and sensor communication paths.
- Better system-level correlation between sensor links and in-vehicle network traffic.
- Reduced risk of measurement-induced behavior changes during debugging.
- Higher confidence when investigating intermittent ADAS communication issues.

Scenario 4 - Continuous operation for long-duration and fleet testing

Validation context

Some problems only appear after long runtime, repeated ignition cycles, environmental variation, or real-world operating conditions that cannot be reproduced reliably on demand. This makes long-duration and fleet testing essential for many validation programs — but it also raises the bar for measurement stability and installation practicality.

Why this is hard in practice

As test duration increases, so do the operational demands on the measurement chain. The setup must survive restart events, remain stable through ignition cycles, and scale across multiple domains without creating excessive installation effort. Intermittent faults are already difficult to isolate; if the logging architecture itself becomes fragile over time, engineers lose confidence in the data they are trying to use.

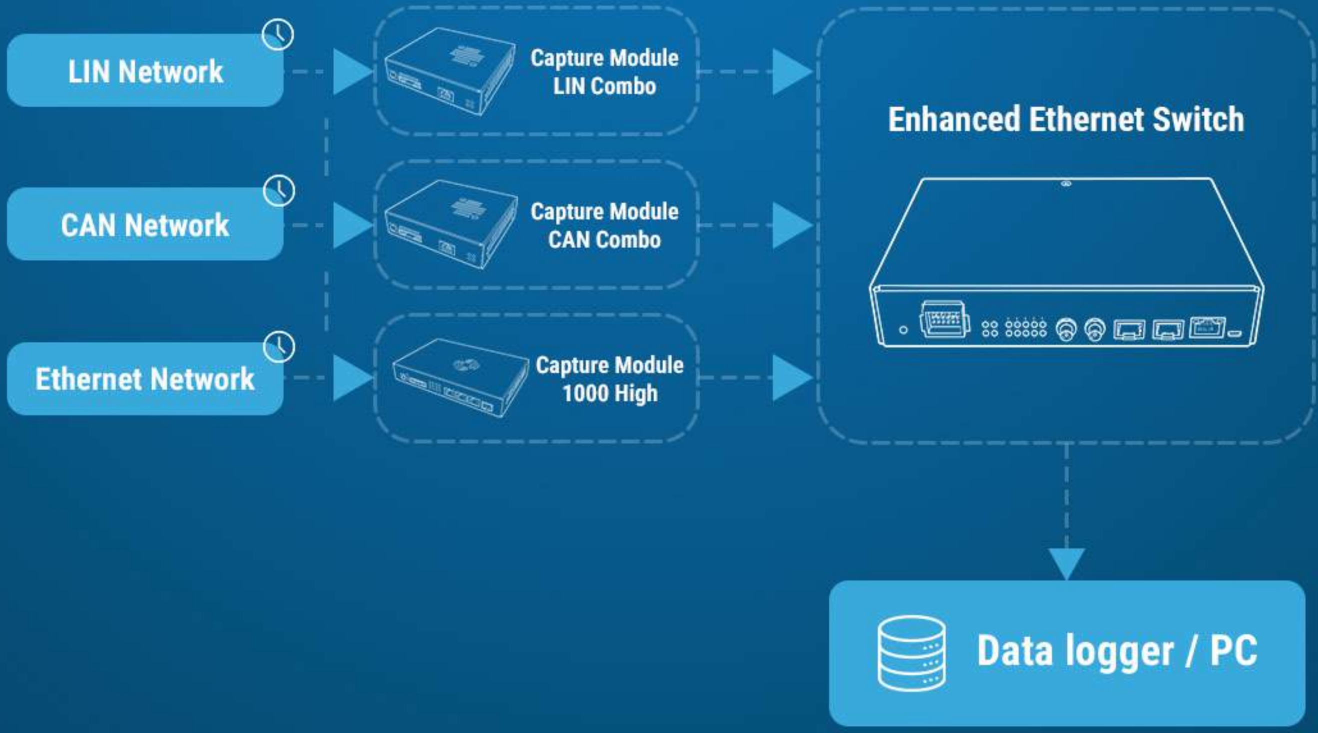
What a robust setup should provide

For long-duration testing, engineers need a capture architecture that supports continuous in-vehicle operation, automatic startup behavior, and scalable installation across domains. A modular and cascaded measurement topology helps reduce physical complexity while preserving broader visibility into the vehicle network.

How Capture Modules help

Capture Modules can support continuous operation as part of a modular measurement path, making it easier to extend visibility across multiple parts of the vehicle while keeping installation manageable. Because the capture function is separated from the data sink, the architecture is easier to adapt as the scale of the test expands. Keeping the whole network tightly time-synchronized.

Scenario 4 - Continuous operation for long-duration and fleet testing



Outcomes enabled

- Better support for intermittent issue investigation in real operating conditions.
- Improved resilience across ignition cycles and long-duration operation.
- More scalable installation across multiple domains in the vehicle.
- Reduced rework when moving from pilot recording to broader fleet deployment.

Scenario 5 - Bringing Ethernet into legacy HILs without re-architecting the entire bench

Validation context

Many organizations have mature HIL environments that still provide strong value, but those systems were often not designed for the volume, protocol diversity, and Ethernet behavior of modern vehicle architectures. Replacing everything is expensive, disruptive, and rarely realistic. The more practical question is how to extend visibility while preserving existing investments.

Why this is hard in practice

Traditional HIL setups can be limited in scalability, rely on manual steps, or deliver late feedback when newer network behavior is being introduced. At the same time, validation teams still need to analyze legacy traffic and modern Ethernet-based communication together because vehicle architectures usually evolve incrementally, not all at once.

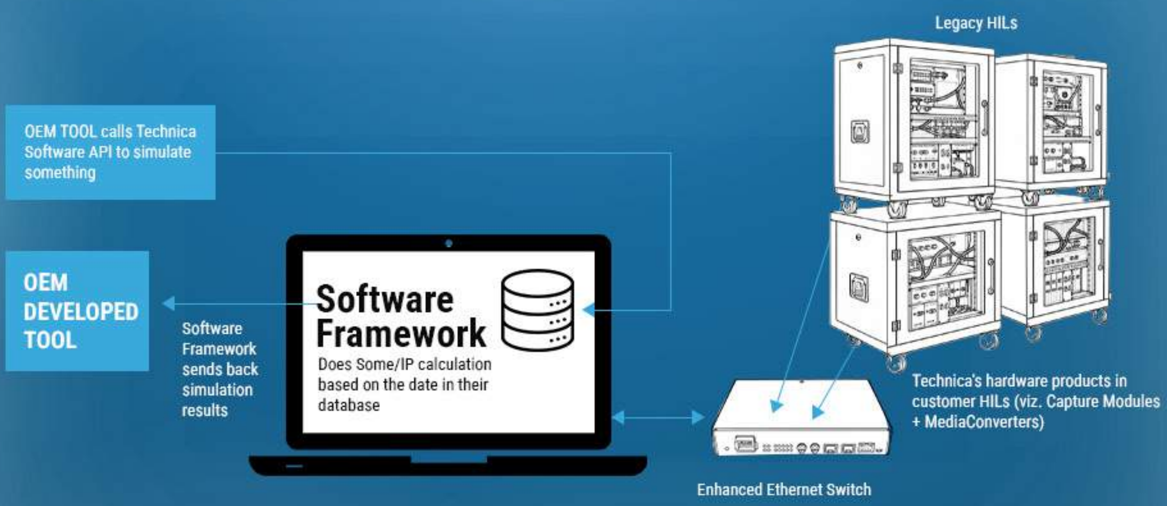
What a robust setup should provide

For HIL modernization, engineers need a way to add capture capability around the existing environment without changing the complete rig architecture. The goal is to preserve deterministic behavior where needed, reuse as much of the existing infrastructure as possible, and extend observability toward newer protocols and system interactions.

How capture modules help

Capture Modules can be introduced as an incremental visibility layer rather than a full replacement of the test bench. This makes it possible to observe Ethernet and mixed-protocol traffic alongside legacy networks, helping teams extend the life and usefulness of their HIL investments while preparing for more modern validation needs. Multiple Capture Modules can be cascaded with time synchronisation propagated through the chain, extending observability across interfaces without requiring additional logger ports.

Scenario 5 - Bringing Ethernet into legacy HILs without re-architecting the entire bench



A scenario where physical interfacing to ECUs and aggregation to the central PC was enabled by Technica's Capture Modules and Enhanced Ethernet Switches

Outcomes enabled

- Extended life for existing HIL infrastructure.
- Better coexistence of legacy buses and Ethernet-centric validation.
- Lower disruption than a complete re-architecture of the test environment.
- A more realistic path toward gradual modernization.

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Building validation workflows that keep up with vehicle architectures

The long-term value of a measurement architecture is not only in what it can observe today, but in whether it can evolve with the vehicle programs it supports. Automotive networks are moving toward higher data rates, broader Ethernet adoption, zonal layouts, centralized compute, and more software-defined behavior. That means validation workflows must become more modular, more reusable, and more standards-aware over time.

Standards such as **ASAM CMP (Capture Module Protocol)** define a standardized approach for transporting captured in-vehicle network traffic from capture modules to data sinks. In parallel, Technica Engineering uses its own protocol, the **Technically Enhanced Capture Module Protocol (TECMP),** which was developed prior to the definition of ASAM CMP. Both protocols encapsulate captured data into standard Ethernet frames and enriches it with metadata such as hardware timestamps, interface identifiers, and packet counters, enabling scalable and distributed measurement setups. Standards such as **gPTP** support time synchronization, which is critical for building trust in cross-domain timing analysis. Together, these kinds of foundations make it easier for engineers to create workflows that are both practical in the present and adaptable for future architectures.

For validation teams, this is not an abstract standards conversation. It directly affects setup effort, correlation accuracy, data sink flexibility, and the ability to expand from one bench experiment to a broader program without rebuilding the entire chain. In other words, scalable capture is not just about logging more data — it is about enabling better engineering decisions with less friction.

See Technica's Capture Modules in action – LIVE

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FREE WEBINAR

Capture complete IVN traffic across the validation journey
Deterministic in-vehicle network logging from bench to HIL, to fleet

Date: Tuesday, June 17, 2026
Time: 1:00 PM Stuttgart | 4:30 PM Mumbai | 7:00 AM Detroit
Format: Live technical walkthrough + demo

In the webinar, you'll see:

- How hardware timestamping enables deterministic logging and trustworthy analysis across distributed in-vehicle networks.
- Techniques for multi-bus correlation using time synchronization and cascading architectures.
- How to reliably capture ECU startup traffic, TC10 wake-up events, and intermittent faults that are often missed by traditional setups.
- How the internal buffering feature of Capture Modules allows for the storage of early and transient data when downstream systems are not yet ready.

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Explore the full Capture Modules portfolio, including technical specifications and variant details

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