Production-ready Diagnostics with Apex.OS

Apex.AI

Industry standard diagnostics for ROS 2

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Agenda

1. Introduction
2. Apex.OS Diagnostics Architecture
3. Use-cases & Demos
4. Summary
5. Q & A

Apex.OS introduction

Mobility and Industries

Applications / Functions

Application runtime framework

Apex.Grace

Automotive-grade, real-time, reliable software development kit, certified to the highest level of automotive safety (ISO 26262 ASIL D). API-compatible with ROS 2. Provides freedom of choice of SOC and RTOS.

Communication framework

Apex.Ida

Complete communication solution for in-vehicle and cloud communication, supporting all relevant vehicle buses and protocols, including CAN, SOME/IP, DDS, zero-copy IPC, MQTT and more.

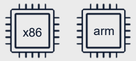
Apex.OS

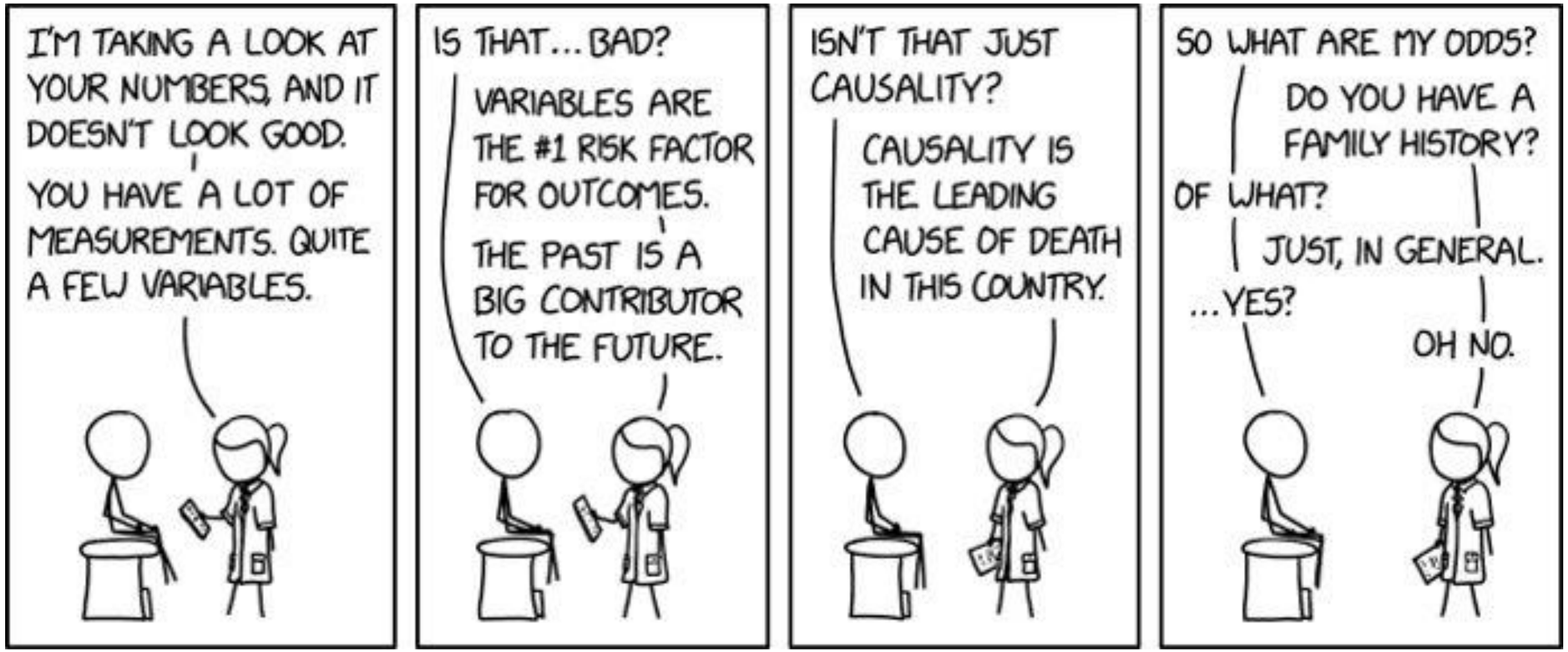
Operating system

RTOS — Blackberry QNX, Green Hills INTEGRITY, Linux, SYSGO PikeOS, other (POSIX-based)

Computing

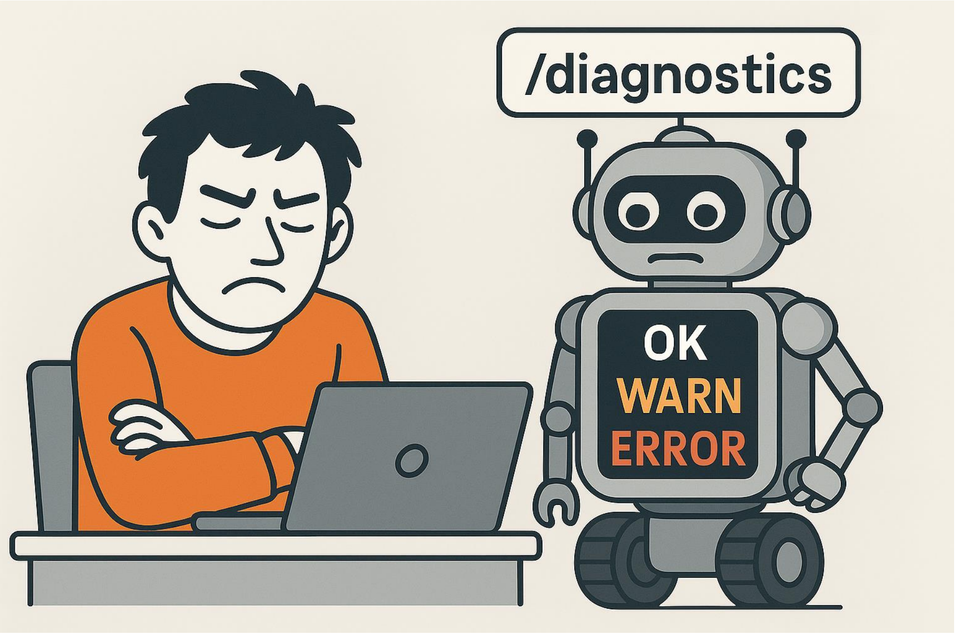
SoC — NVIDIA, NXP, Qualcomm, Renesas, Texas Instruments, other (ARM-based architecture)





ROS 2 Diagnostics: Minimal API, Maximum Ambiguity

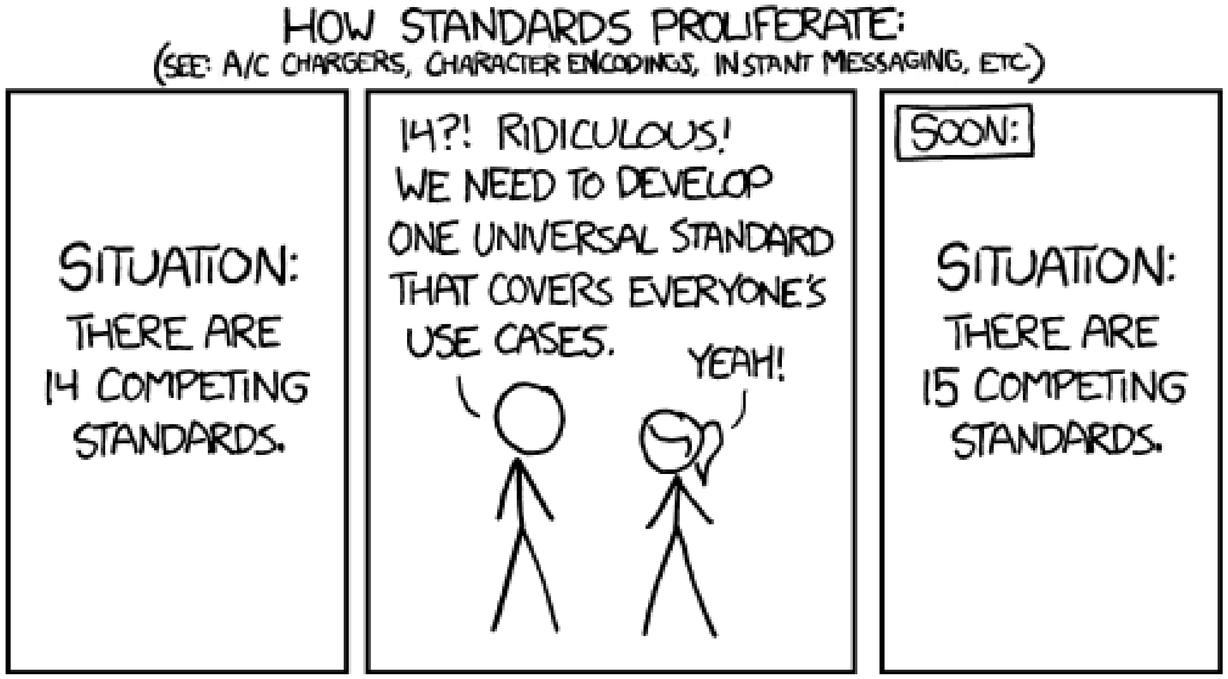
- ROS 2 diagnostics can tell your robot feels **kind of** unwell.
  No tests, no procedures, no history => **No diagnosis** !
- Just turn it OFF and ON again. No errors!! Great !?
- Robots are getting smarter (Hello Physical AI!) — their **diagnostics shouldn’t stay dumb.**
- **Apex.OS brings the medical-grade checkup that ROS 2 has been missing.**



There has to be a better way of doing Diagnostics !

New Diagnostics Standard? No!

- **This is a solved problem** with certified diagnostic systems available in every workshop. (Remember your car's last TÜV inspection?)
- In automotive, diagnostics is full triage: **codes, causes, context, and persistency**
- Robotics needs the same **attention to detail** !
- The physical infrastructure already exists to diagnose and service your robots, **if we use the same standard!**



Apex.OS integrates standardized vehicle diagnostics into ROS 2

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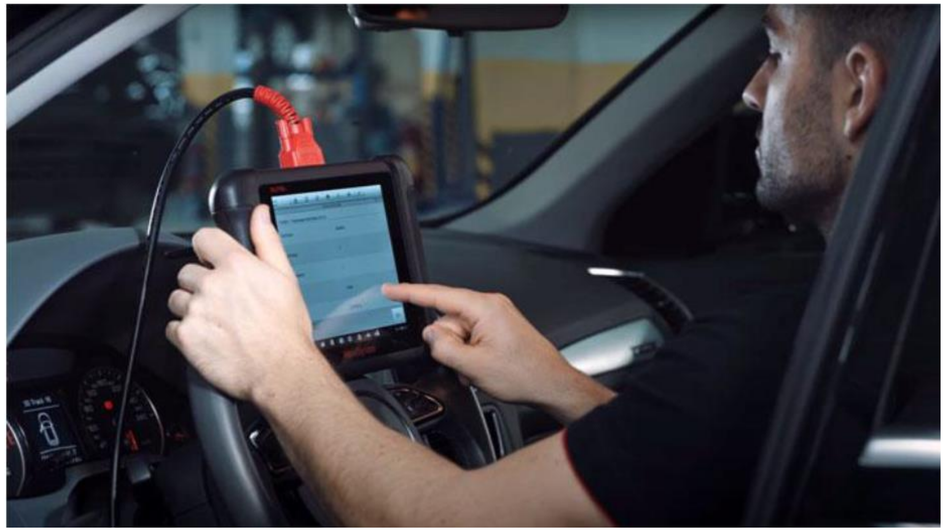
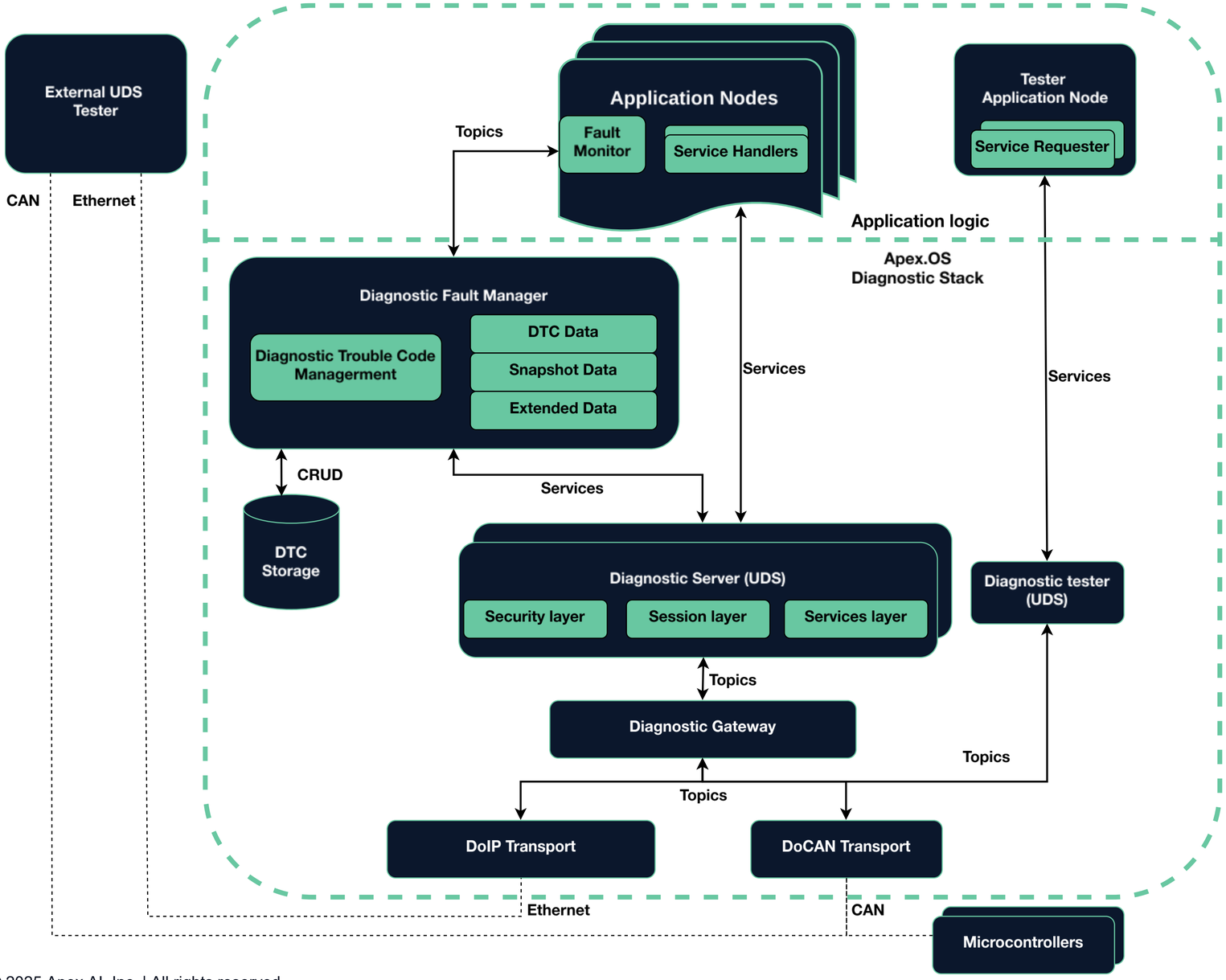
Apex.OS Diagnostics Architecture

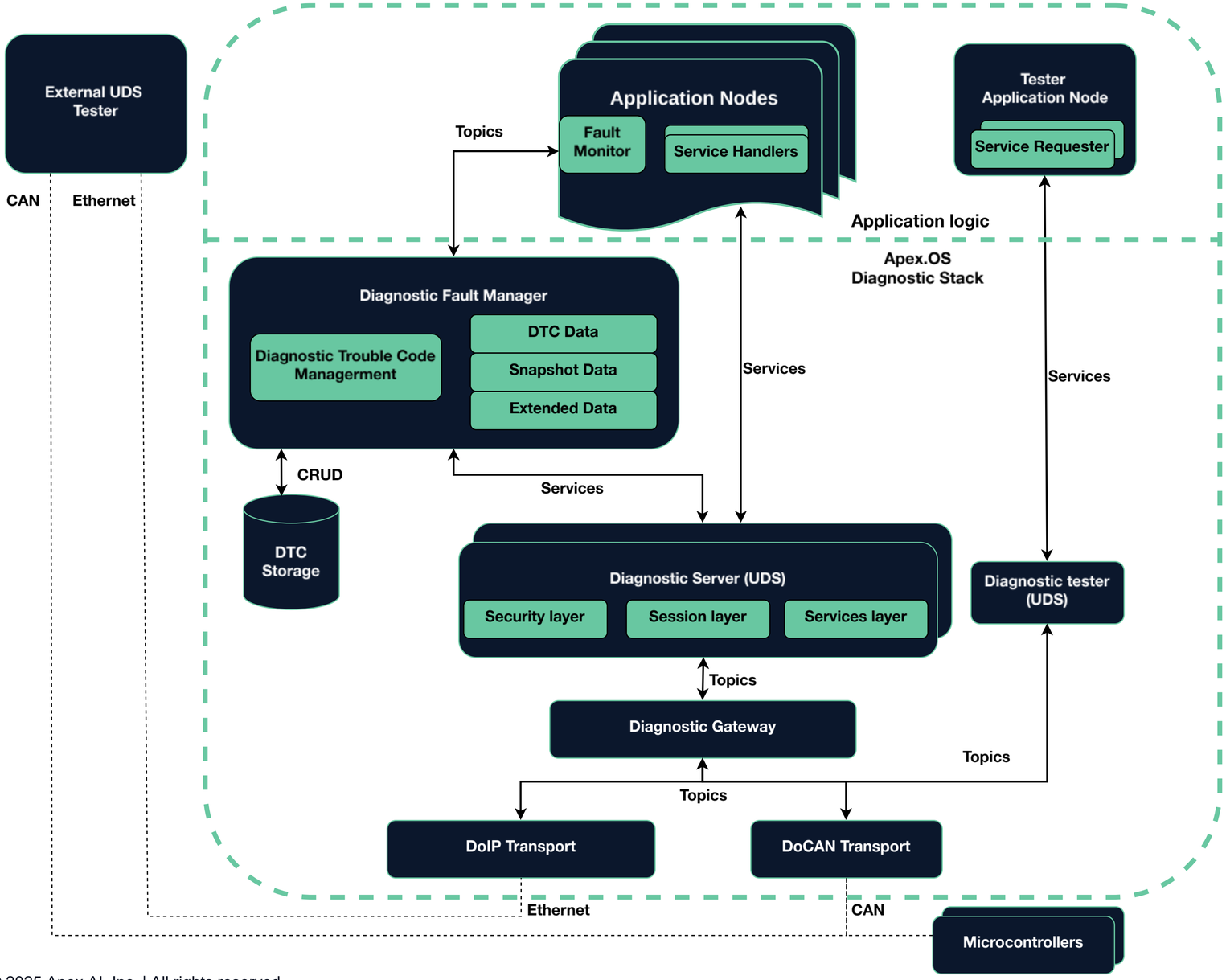


Apex.OS Diagnostics Overview



- Production ready diagnostic stack aligned with **automotive diagnostic standards**
  - **ISO 14229 (Unified Diagnostic Services),**
  - **ISO 13400 (Diagnostics over IP),**
  - **ISO 15765 (Diagnostics over CAN)**
- Modular architecture built on top of ROS 2 communication primitives such as Topics and Services.
- A diagnostics stack that allows not just monitoring and fault management, but also calibrating parameters during production and post-market servicing.

Apex.OS Diagnostics Architecture



Key Modules:

- **DoIP/ DoCAN transport** Nodes convert frames to ROS 2 msg and publish it on topics.
- **Gateway** routes the requests to the right server.
- **Diagnostic Server** implements the **UDS** protocol and ensures secure access control while fetching the application node data.
- **Diagnostic fault manager** detects and persists the faults and context
- **Diagnostic tester** provides a ROS 2 native way of communicating with the Diagnostic stack

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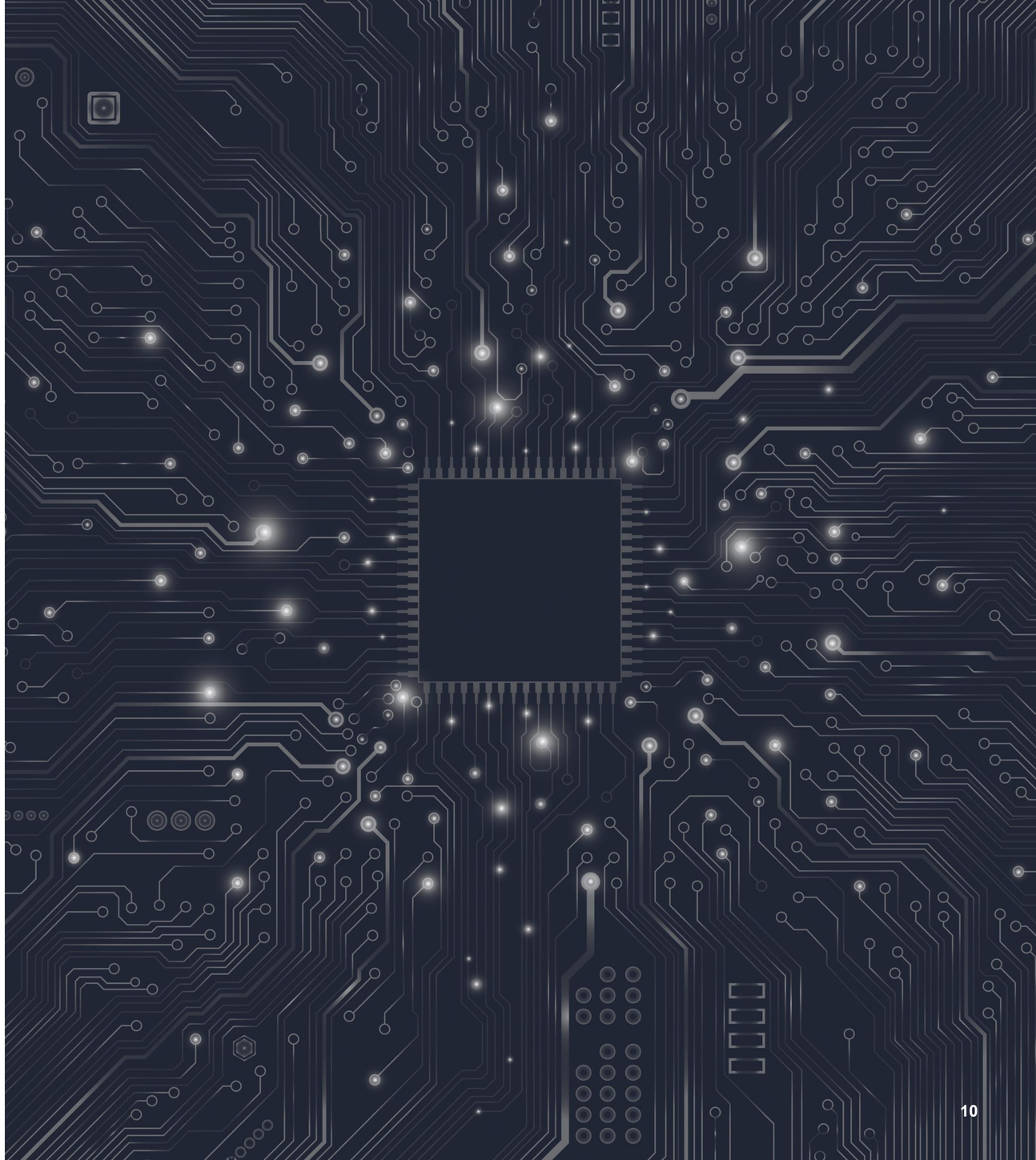
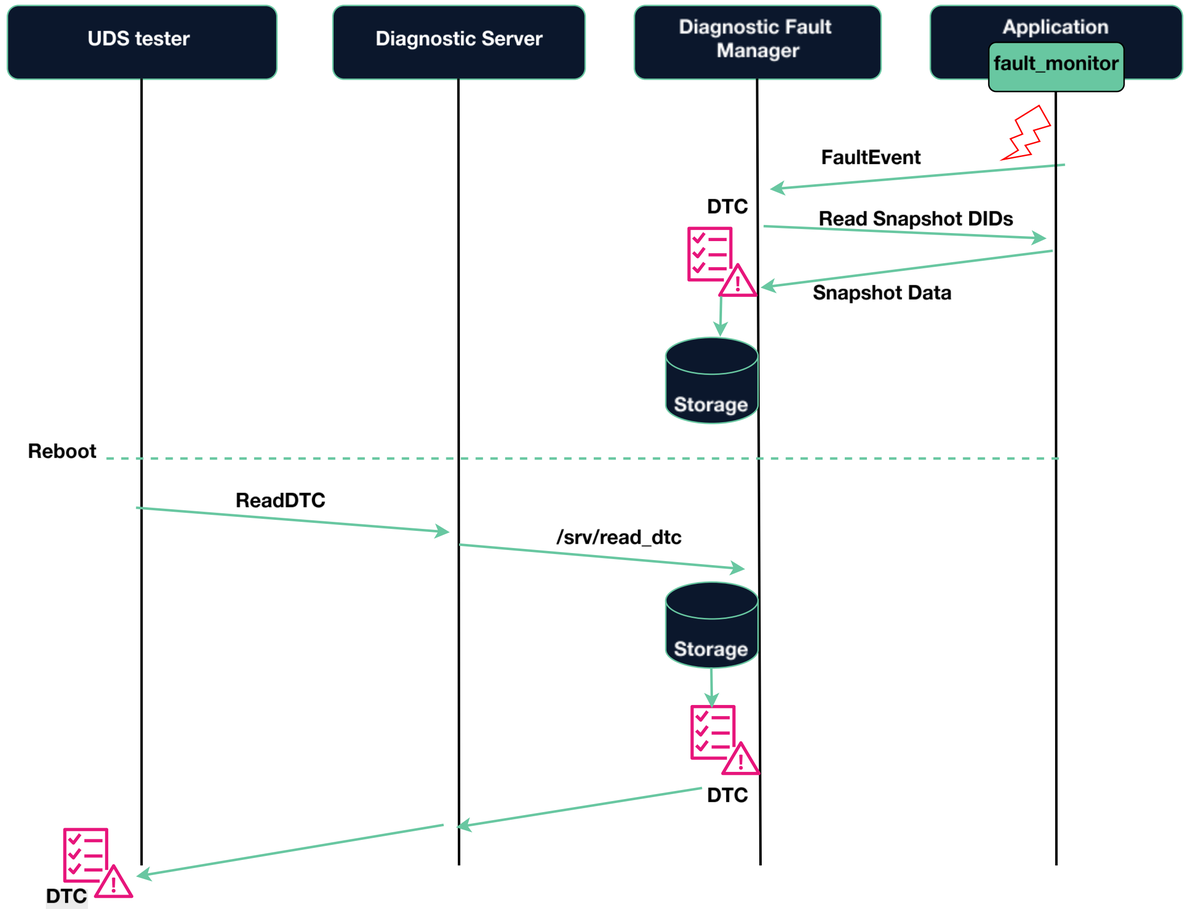
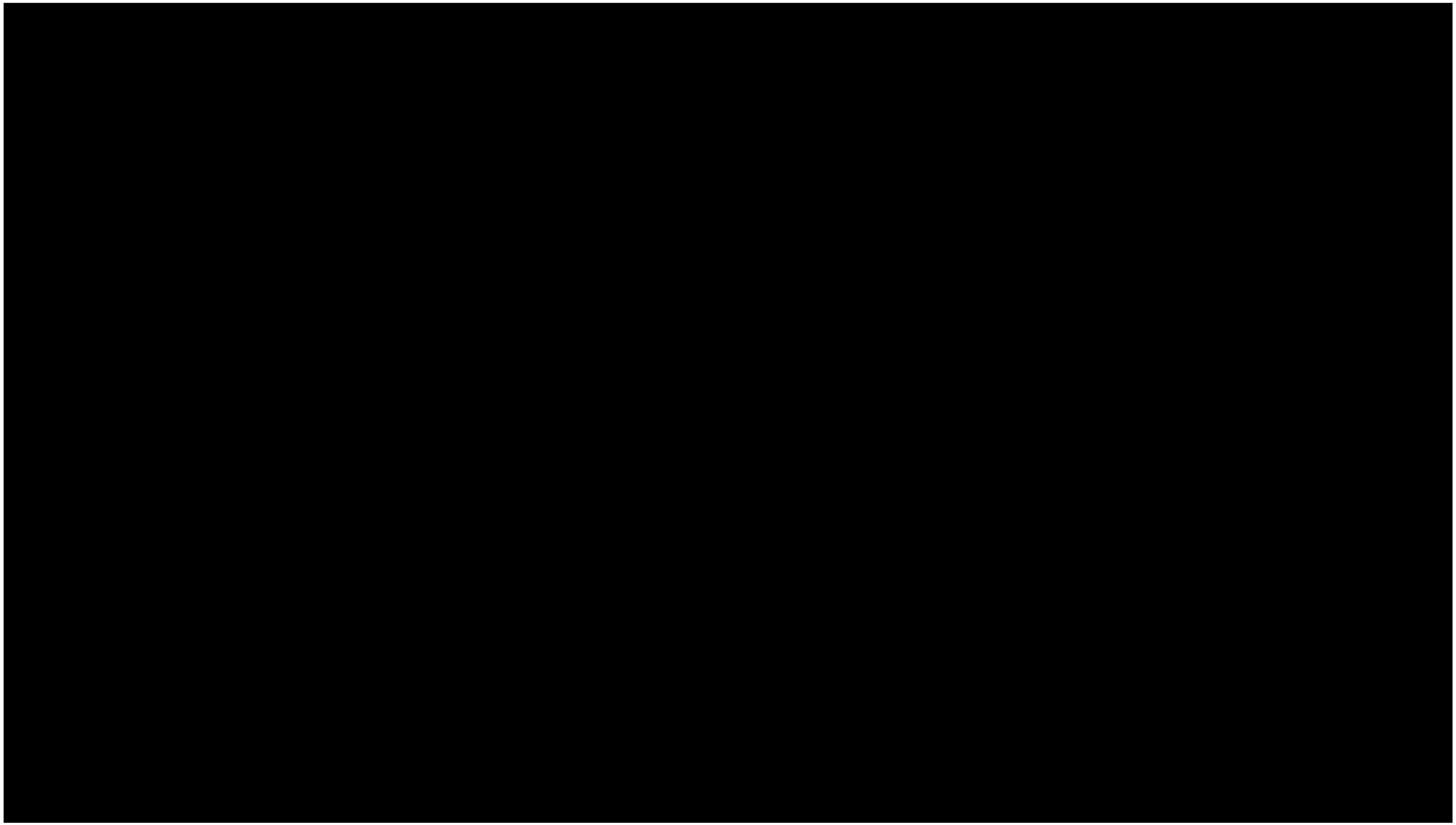
Use-cases & Demos



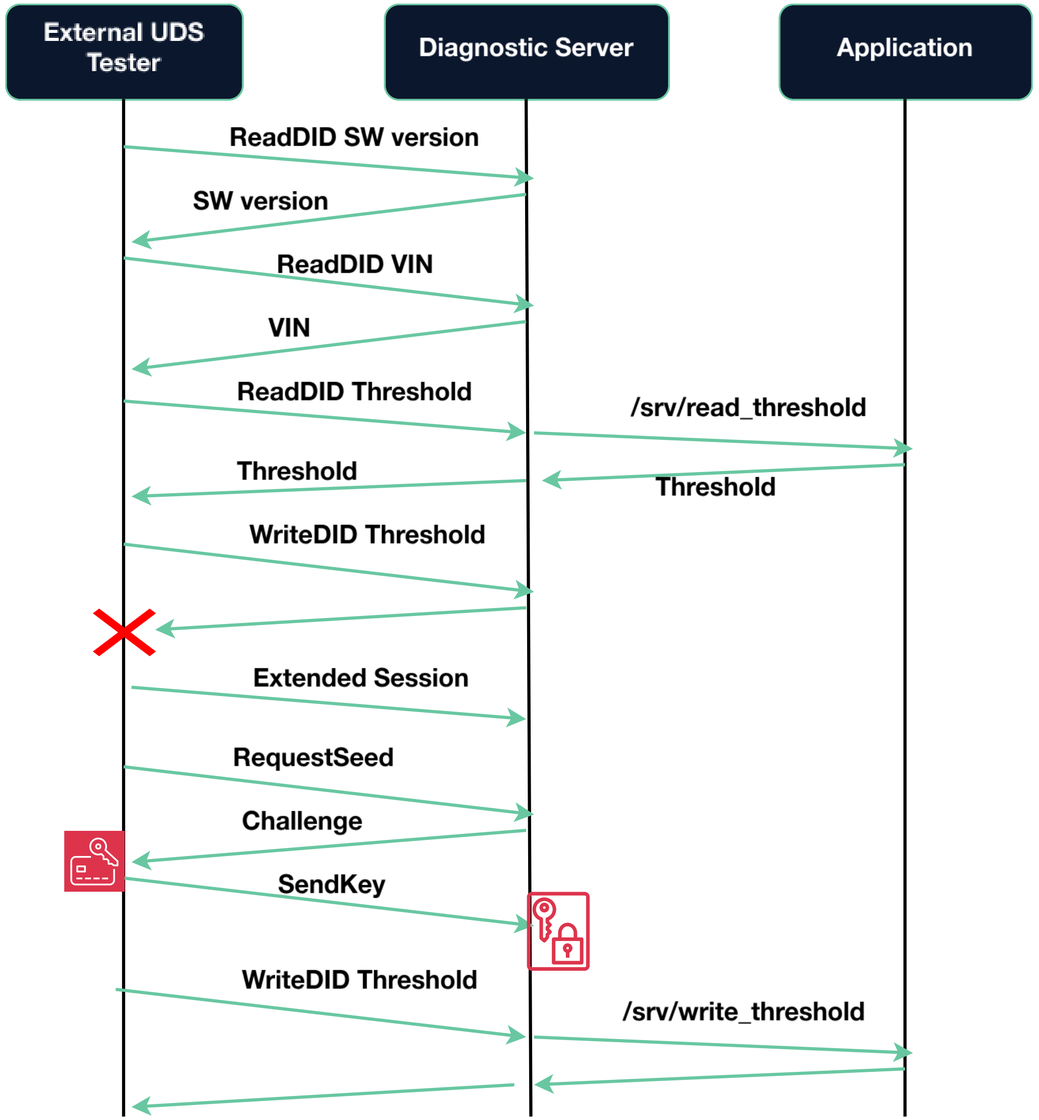
Fault management



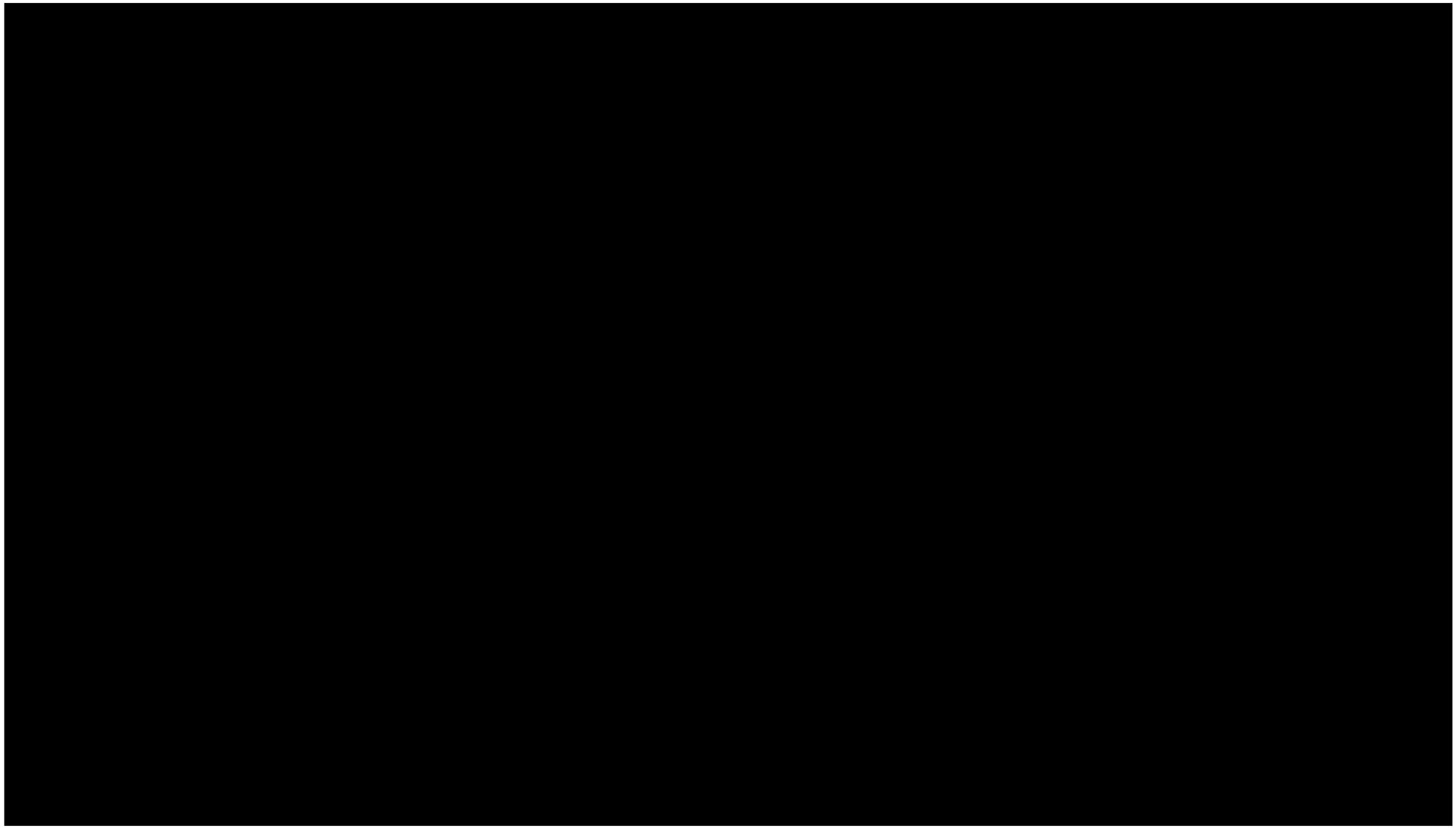
Fault management Demo



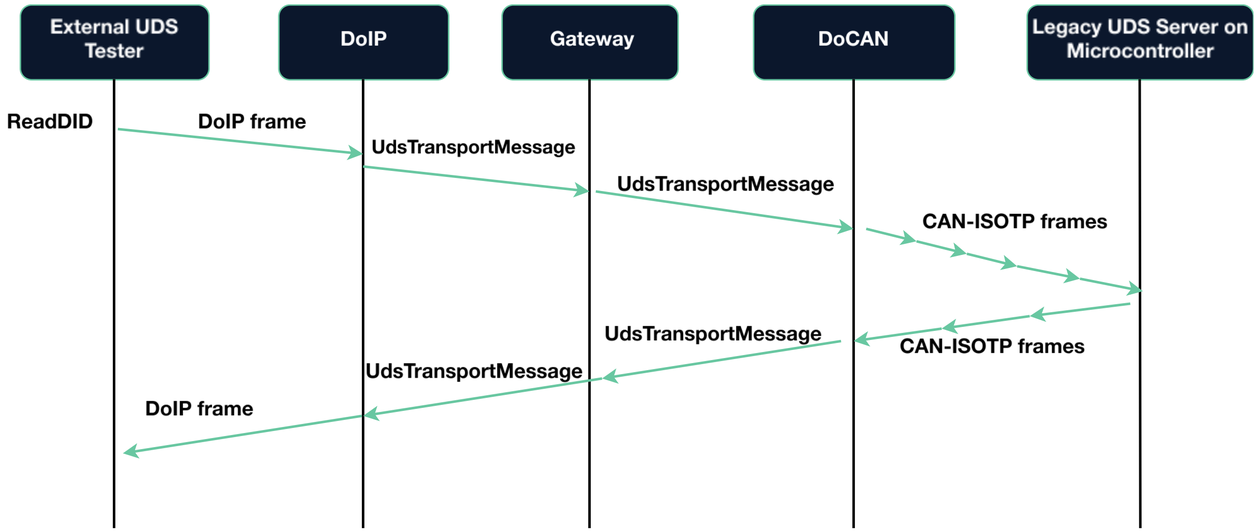
Secure Access and Diagnostics



Secure access and Diagnostics Demo

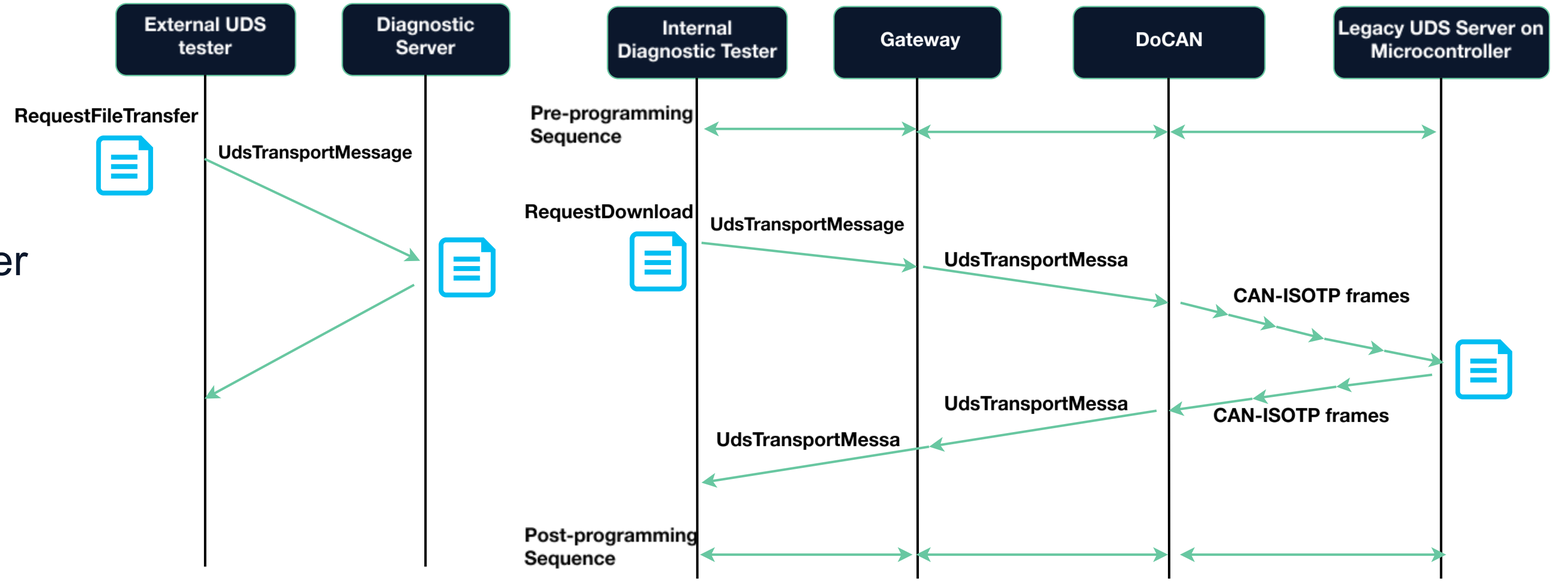


Mixed network topology and software update

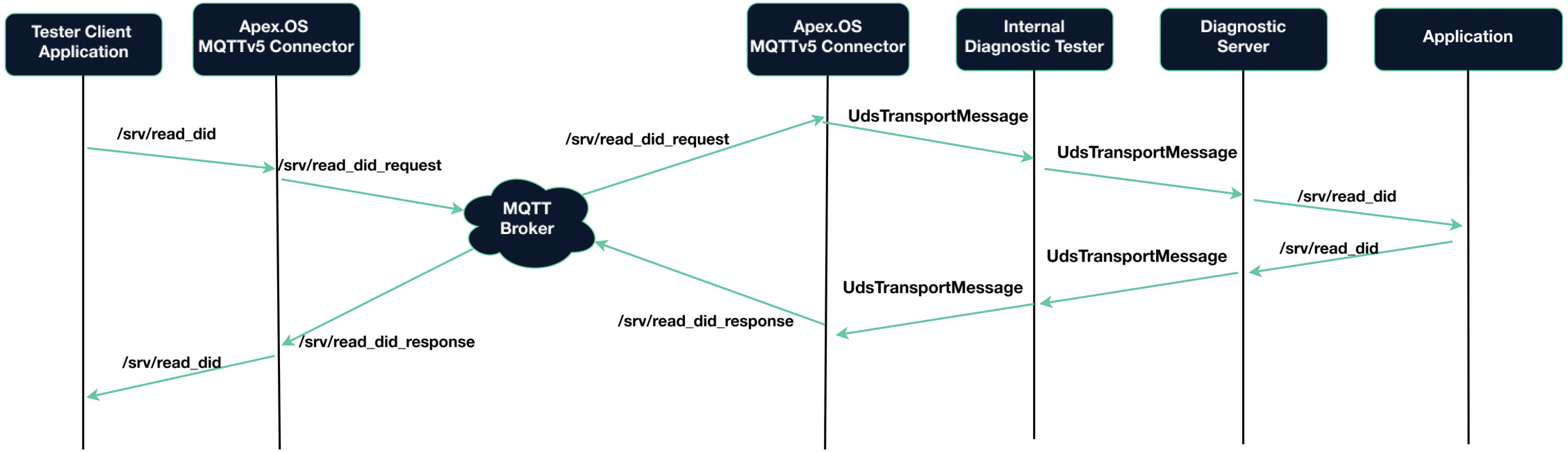


- An External UDS tester connected over ethernet can be used for diagnosing a legacy microcontroller that is connected to target board via CAN

- UDS Services such as RequestFileTransfer and RequestDownload can be used for doing a software update.



Remote diagnostics



- Connecting the Diagnostic stack to the Apex.OS MQTT connector, remote diagnostic capabilities can also be realized.

ROS 2 integration

- Abstracts away UDS protocol specific logic and ROS 2 developers can focus on the business logic using the topics and service interface.
- Enables ROS 2 systems to interface with off-the-shelf diagnostic equipment to enable service and maintenance

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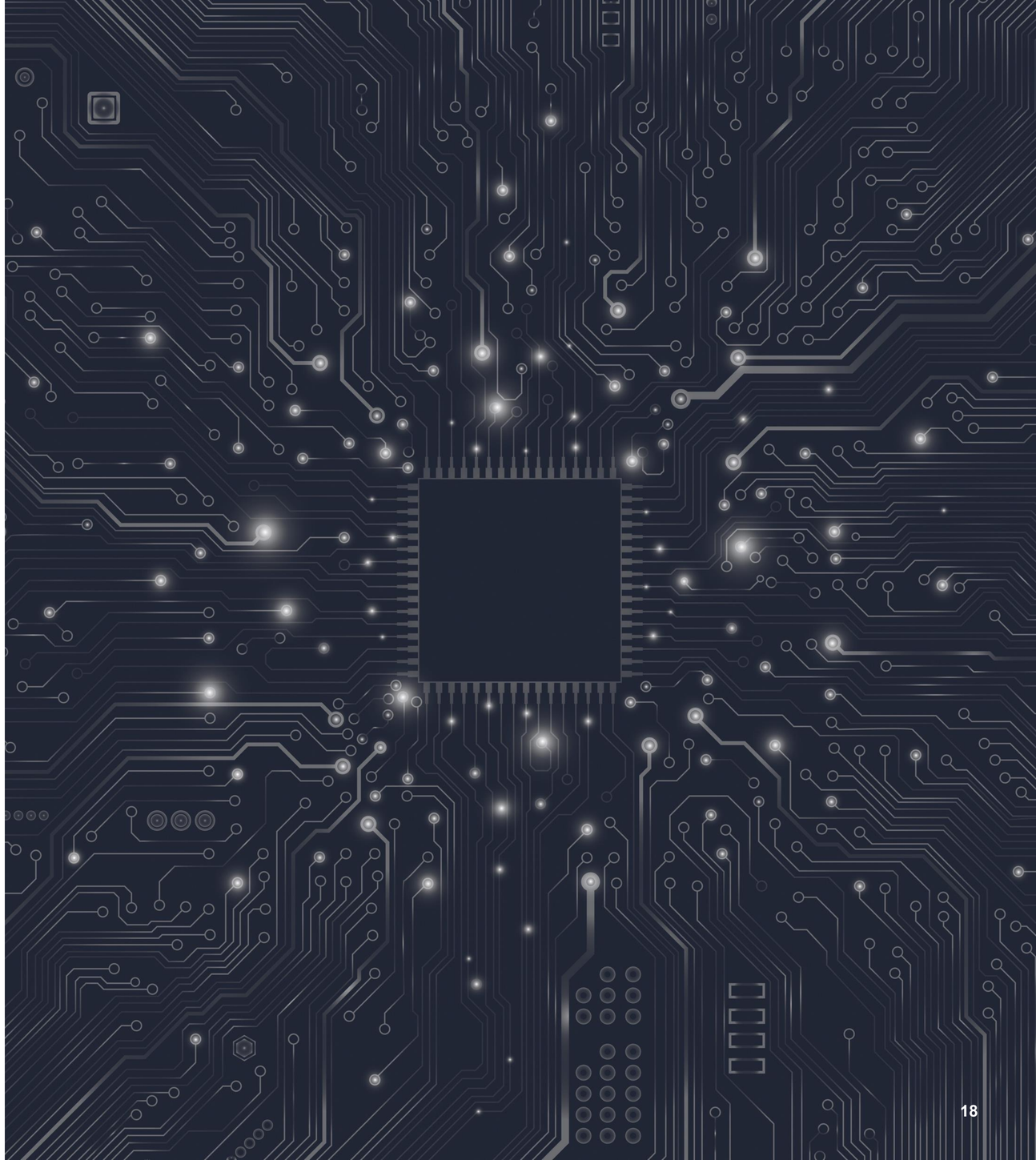
Summary and next steps



Summary and next steps

- **Apex.OS extends ROS 2** with an **ISO-standard compliant diagnostics framework**, bridging robotics middleware with automotive-grade fault management.
- Apex.AI plans to open-source parts of our Diagnostics stack.
- We plan to continue to update our diagnostics stack with newer standards such as ASAM SOVD.

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