

BMW
GROUP

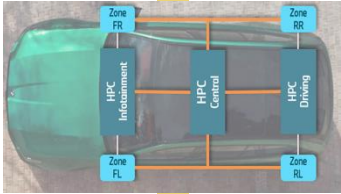


 **technica**
engineering
Member of KPIT Group

A MODERN APPROACH TO AUTOMOTIVE ETHERNET SWITCHES

2025 – VDI AUTOMOTIVE DATA COMMUNICATION, MUNICH
PATRICE ANCEL (BMW), DR. LARS VÖLKER (TECHNICA)

AGENDA.



What's so complicated ?



Improving the Ecosystem



Switch Management & Monitoring



Open-Source Ecosystem



„IT'S NOT ROCKET SCIENCE..."



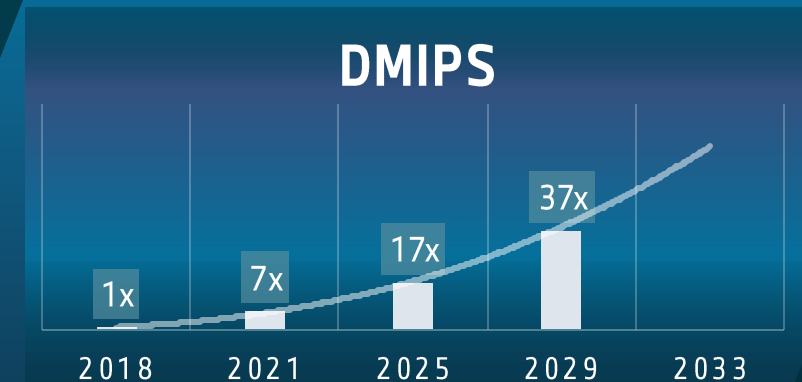
A car today...

- **20,000 components, 100+ ECUs** (Electronic Control Units)
- **100+ Mio lines of code, 50+ microcontrollers**
- **100+ of norms and regulations** (unlike your smartphone)
lifetime requirement (vehicle, battery)
safety, security, emissions, EMC...



- 37x processing power in less than 10 years (like your smartphone)
- Over 7.5m cars in the field: Largest OTA fleet worldwide
- OTA: SW images ~ 9,6 GB. Installed in 20 min (unmatched)

By 2025 the estimated total number of connected vehicles around the world will cross 470 Million *

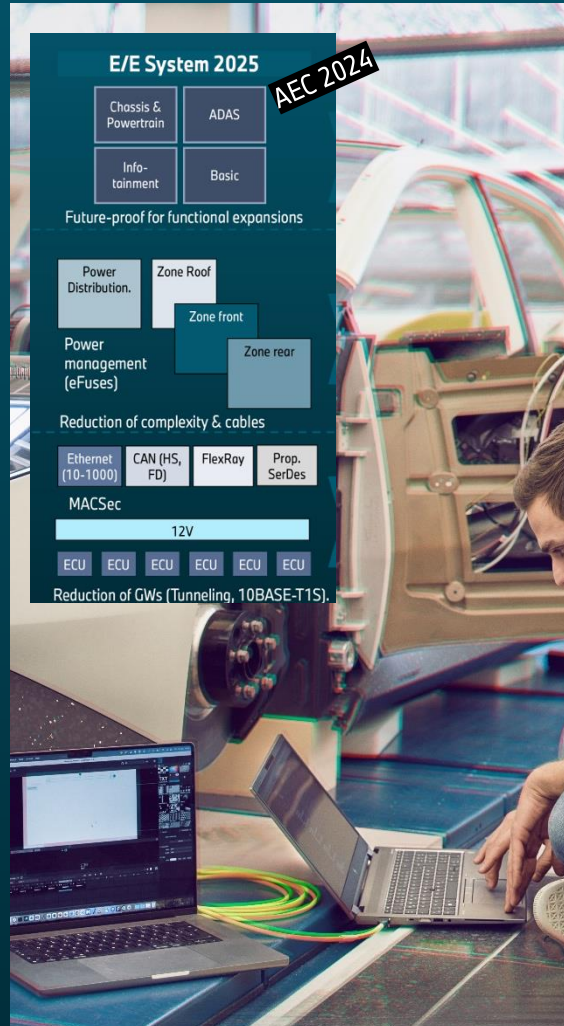


* source: Deloitte

2024-2025 – WHAT HAPPENED SINCE THE LAST 12 MONTHS ?

2025 SOP: The „Neue Klasse“ (EES25 Platform) will take off:

1. **Ethernet-Switches are complex ASICs** (incl. FW) with features like time-sync, security, communication, debug, ... requiring **+++ efforts +++** for integration and testing.
2. **MACsec, 10BASE-T1S are mature.**
3. „Legacy technologies“ (e.g. CAN-FD) can give you a **hard time**, too.

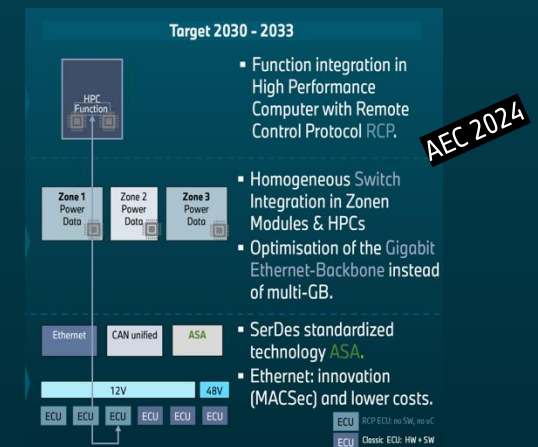


Increased maturity for new technologies (2030 & beyond):

1. The Remote Control Protocol TC18 in the Open Alliance achieved a multi-vendor demonstrator. **RCP will improve SDVs.**
2. In **2 years**, the **ASA-ML offer** grew from 2 to ≥ 10 vendors working on interoperability. SoC Integration done. 1st EMC results outperform current technologies.
3. 1st baseline for **MACsec with 10BASE-T1S (TC17).**



Autosens 2024



WHAT'S NEXT ?



- What will change ?
- How will **zonal architectures** evolve ?

THE E/E ZONAL ARCHITECTURE IS BEEING FURTHER EVOLVED

The „NEUE KLASSE“ will have SOP in 2025.

The key networking technologies are:

- 100MB/1GB Ethernet
- MACsec
- 10BASE-T1S
- SOME/IP
- CAN
- LIN.

BMW's zonal Platform will futher evolve.



1 GB Backbone (or more) & Audio.

Main reason for 1GB is latency and not bandwidth. Zonalisation from chassis or powertrain requires short control loops (1-3ms).

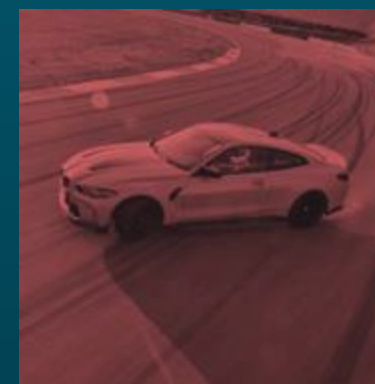
Zonal Audio.



RCP and Ethernet tailoring

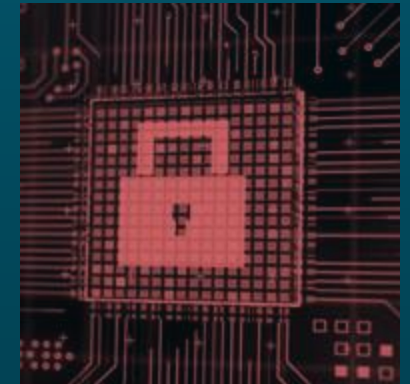
With RCP the apps (SW) are in the HPC. Development's speed & updates ↗, costs ↘.

Ethernet stack tailoring (layer 2) for short control loops.



Time Synchronisation (Ethernet, CAN)

Time sync (secured and safe) is the pillar of our system. Data are worthless if not correctly timestamped. It will be further improved such that task sync will be possible on CAN.



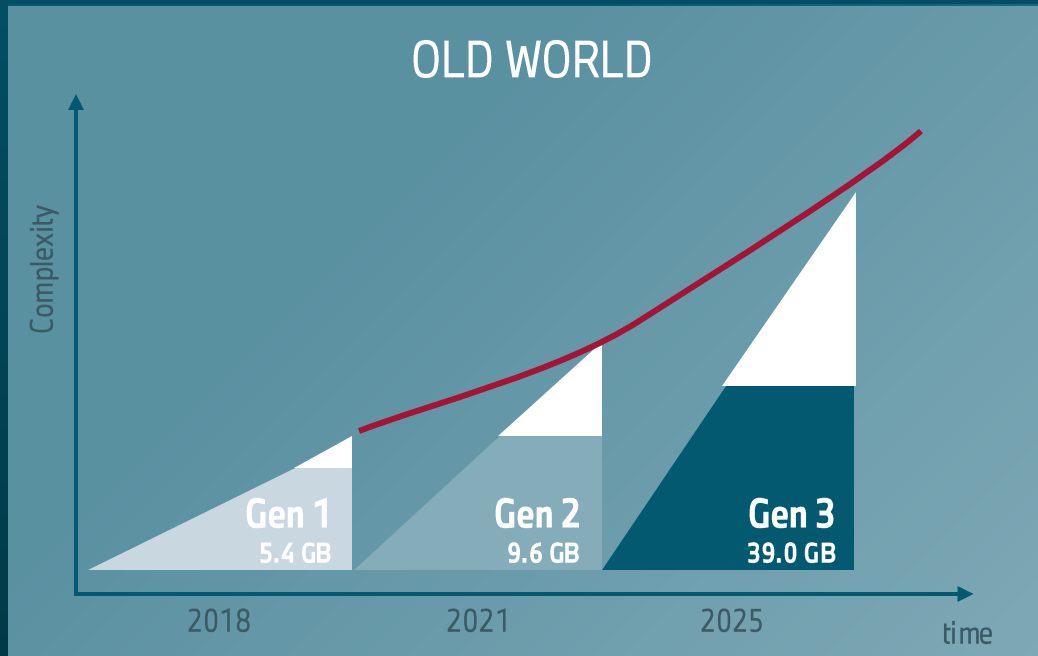
Layer 2 Security (MACsec)

MACsec rollout on 10BASE-T1S required (TC17). Increase standardisation speed & effort.

New & improved technologies

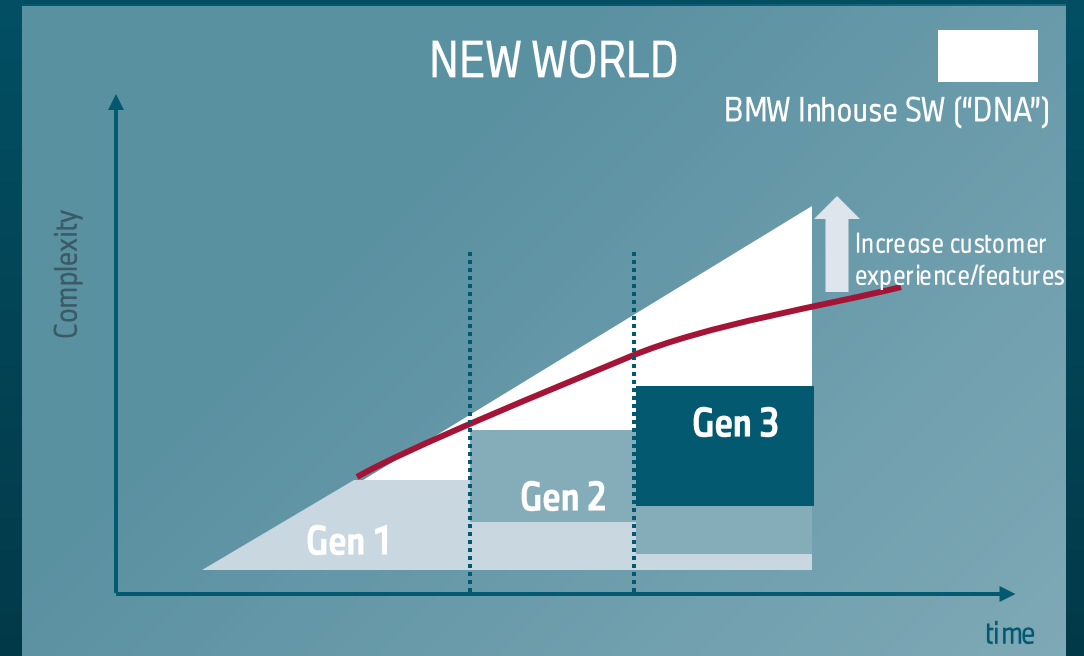
Cross domain zonal topologies

EVOLUTIONARY AND OPEN HARDWARE IS ESSENTIAL TO REDUCE COMPLEXITY AND COSTS WHILE INCREASING CUSTOMER EXPERIENCE



- **Increasing effort** across generations with increasing code size
- **New supplier constellations** bring new platforms (HW & SW) with new semiconductors

VS.



- ... **continuity and reuse of SW & HW**
- ... **Increase of customer experience/features**
- Standards & open ecosystem as strong base

Switch standardization activity addressed in Open Alliance opensig.org **TC19**

WANTED!

System level



Expandable and sustainable solution for E/E evolution.



Simplified and **unified** workflow.

Adapted for multi-party projects and beneficial for all users (ecosystem).

Configuration



Universal configuration and description format.

Automation generation and **checks** in Continuous Integration



Smooth **porting** and **migration** independently from ECU platform

SW Interfaces



SW Reuse for synergy.



Maintenance and compatibility.



Efficient bug finding and fixing

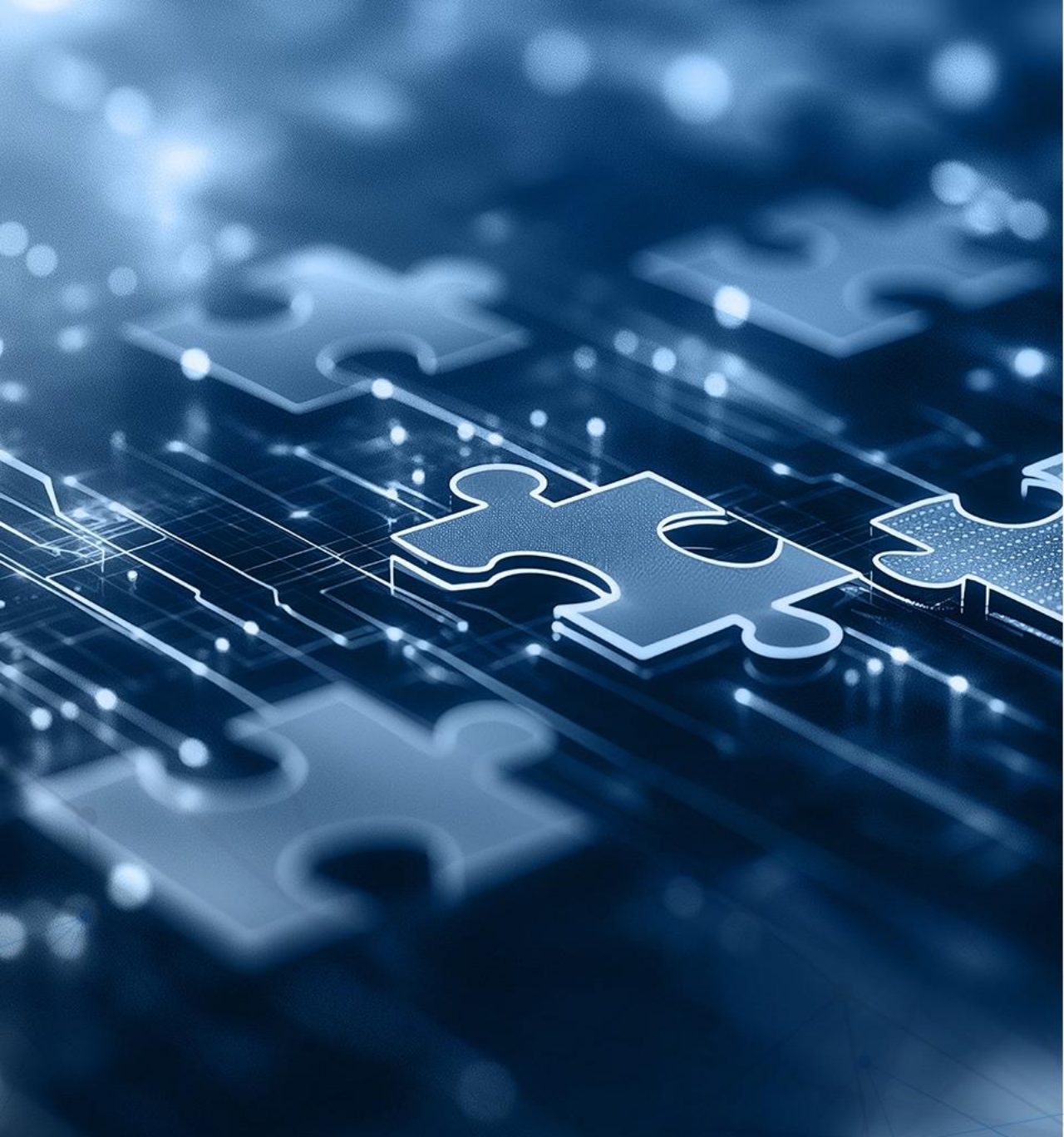
HW abstraction in SW via system-function approach

IVN SYSTEM FUNCTIONS										
Abstraction	Life cycle		Flash, Diagnostic, Safety		Timing		Basic Networking		Security	
	SW API	Configuration	SW API	Configuration	SW API	Configuration	SW API	Configuration	SW API	Configuration
	resetSwitch InitSwitch ...	rst_Timer ...	getTemperature readClg loadClg
TC11 Switch requirement	SW support		HW support		SW support		HW support		SW support	
	Wake-up	...	Update firmware	Flash	SCT	1588	Mirroring	Packet buffer	Secured boot	HSM
	UDP-NM3		New config	Dual banking	Time validation	HW clock	Prioritization	Shaper Scheduler	MKA	MACSec
	Partial Network		Interaction protocol	SPI/SMI	gPTP		AVB	Ports	Firewall, Filtering	Policing
			Monitoring	MIB			Filtering	QoS Queues		TCAM
			Config set change				L3 Routing	ARL		


- Common understanding on system-function
- Reduce **time** and **complexity** in ECU development

With the increase of IVN complexity, the need of a solution is now acute !





IMPROVING THE ECOSYSTEM



- Traditional approach:
 - OEM writes requirements, configurations, and integrates vehicles
 - Tier-1 creates hardware and integrates chips and software into it
 - Tier-2s supply chips, software, etc.

- Main challenges:
 - RFI/RFQ phase are long and delay development
 - e.g., AUTOSAR stack vendors start writing stack features after they have an order
 - Turn-around times config update to software are too long
 - New Tier-1 needs to relearn

- Game changer 1: Configuration as Code
 - Handling config as code allows for agile processes (CI/CD, MRs, nightly builds, etc.)
 - Example: FLYNC [1]
- Game changer 2: Standardized Interfaces
 - Minimize system and software changes, when changes hardware
 - Example: next chapter
- Game changer 3: Open-Source Ecosystem
 - Better access for all partners (e.g., chip vendors)
 - Allows more inhouse development for OEMs
 - Example: later chapter
- Game changer 4: Fully automated test and validation
 - Example: KPIT and Technica Engineering integration and validation insights [2]

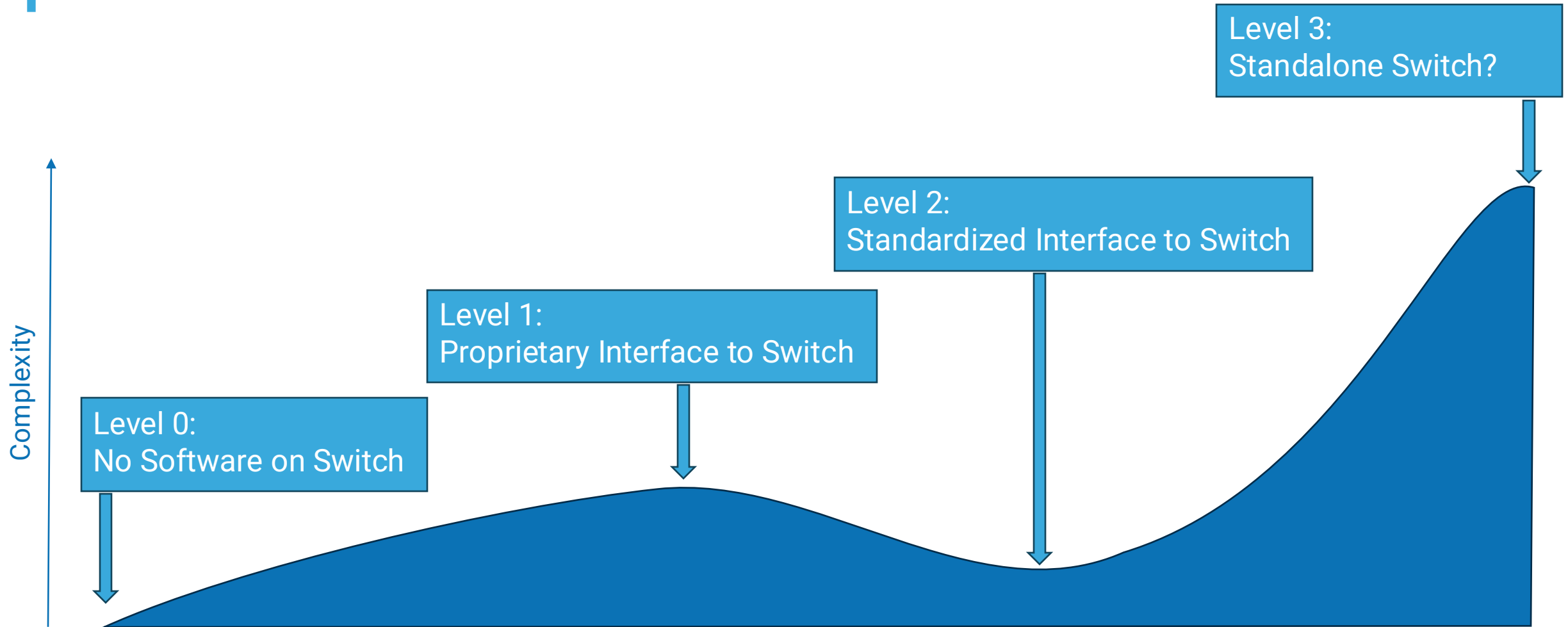
[1] **Automotive Ethernet Switching rebooted** / BMW and Technica Engineering / Feb. 2025 / Automotive Ethernet Congress / Munich.

[2] **SDV strategy has one main KPI: "Speed of change"** / KPIT / Jun. 2025 / Automobil-Elektronik Kongress / Ludwigsburg.

SWITCH MANAGEMENT AND MONITORING

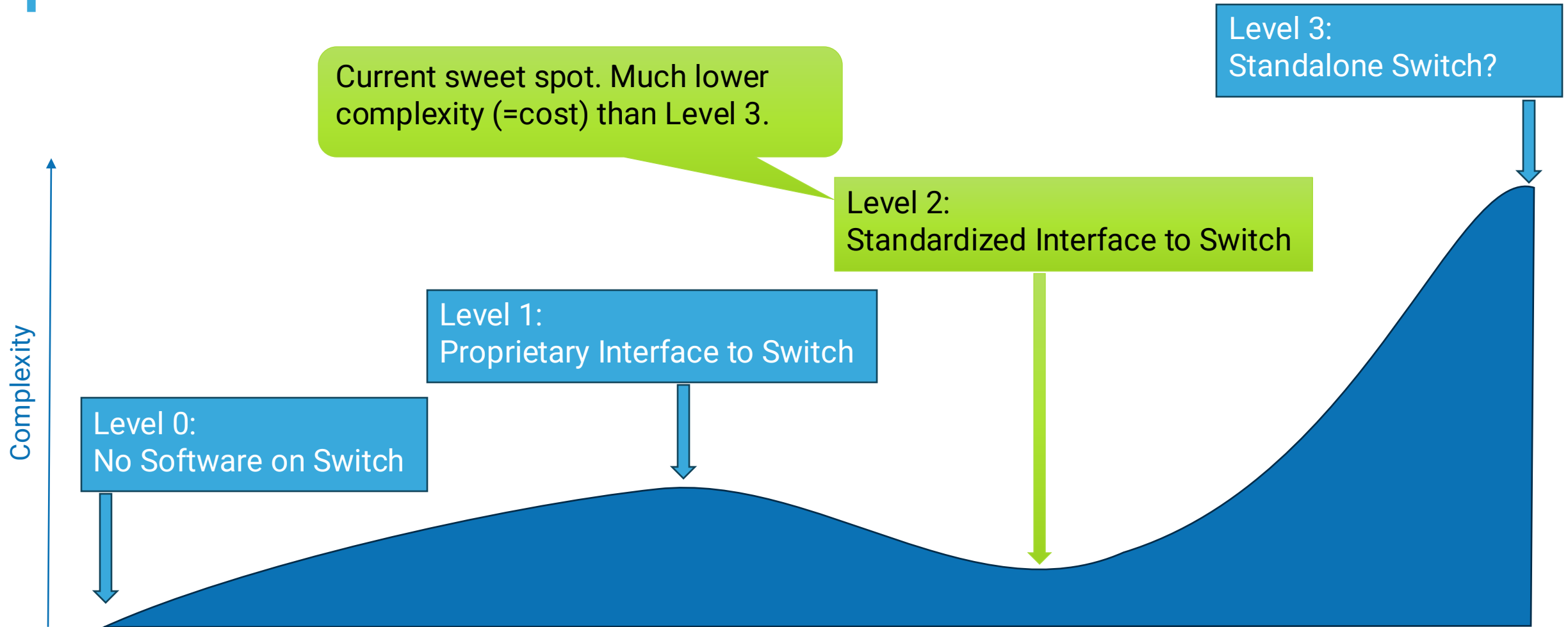
SWITCH MANAGEMENT AND MONITORING

SOLUTION TYPES



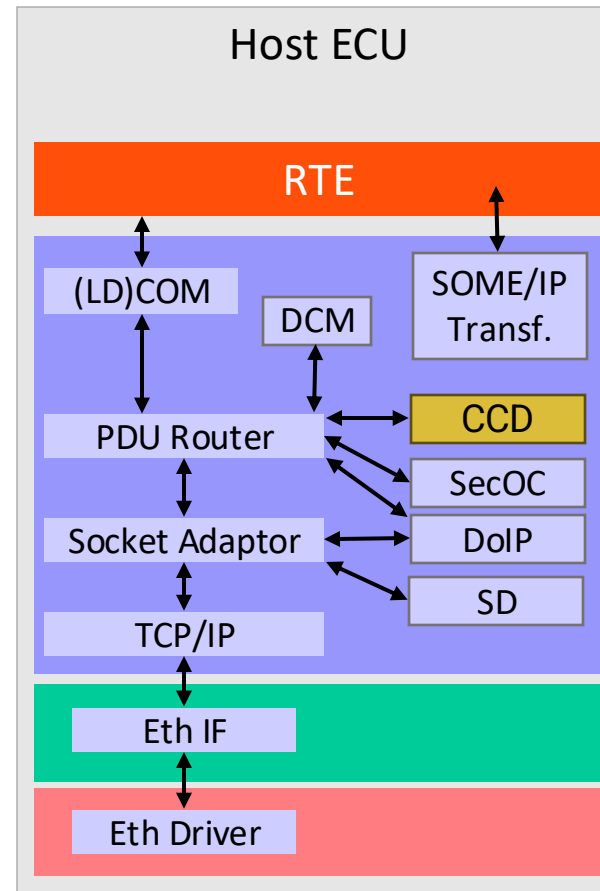
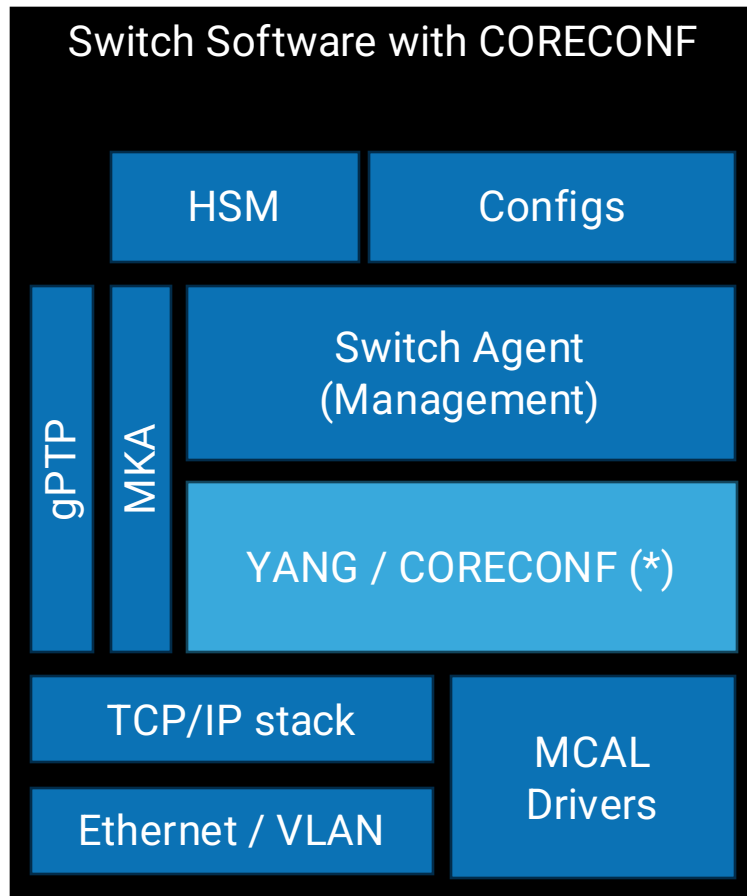
SWITCH MANAGEMENT AND MONITORING

SOLUTION TYPES



STANDARDIZED INTERFACE TO SWITCH

OPTION 1: YANG/CORECONF



Discussion YANG/CORECONF

- Complex protocol, which is getting first support on switches.
- Not present on most Automotive platforms yet (AUTOSAR, etc.).
- Approach was tailored to enterprise networks, which are manually changed a lot (some automation).
- Quite high complexity on Switch and Host.
- Architecture change or CCD needed.

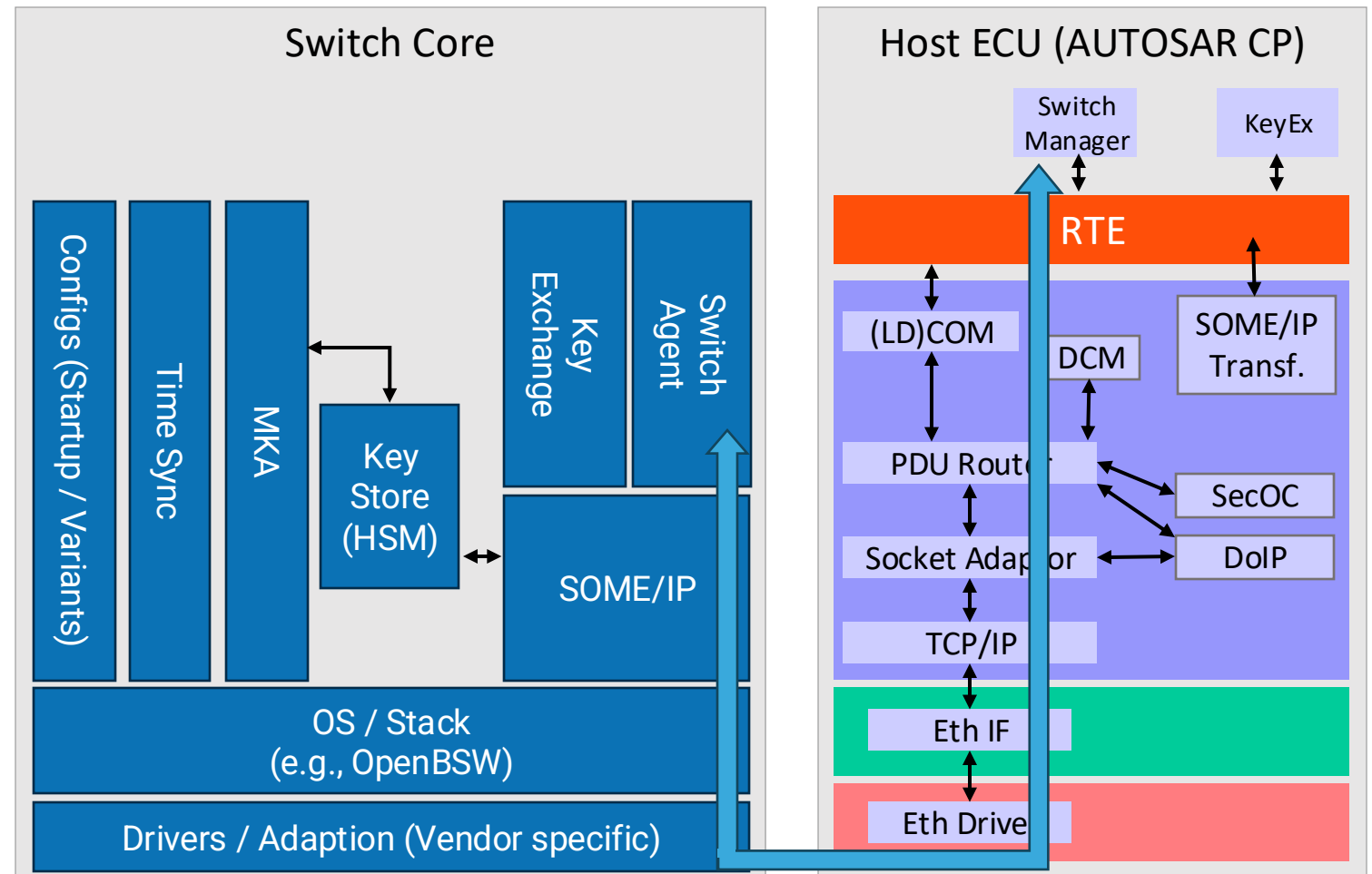
Yet another new protocol?

(*) CORECONF as example for
NETCONF/RESTCONF/CORECONF

STANDARDIZED INTERFACE TO SWITCH

OPTION 2: AUTOMOTIVE FIRST

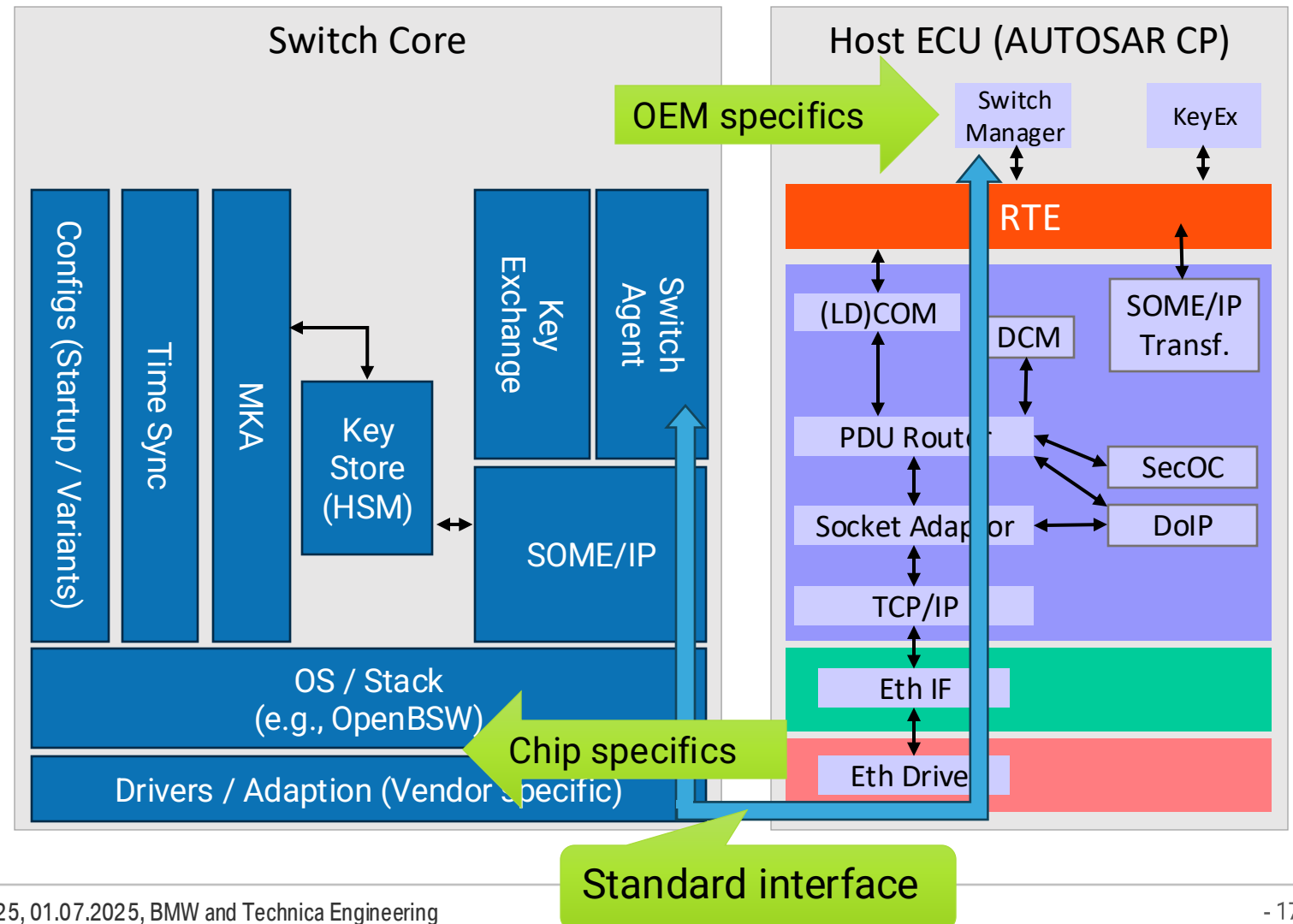
- Just reuse standard that is already available on all platforms!
- For example: SOME/IP.
- Tremendous speedup by using:
 - Already deployed technology
 - Existing processes (configuration)
 - Proven validation and integration



STANDARDIZED INTERFACE TO SWITCH

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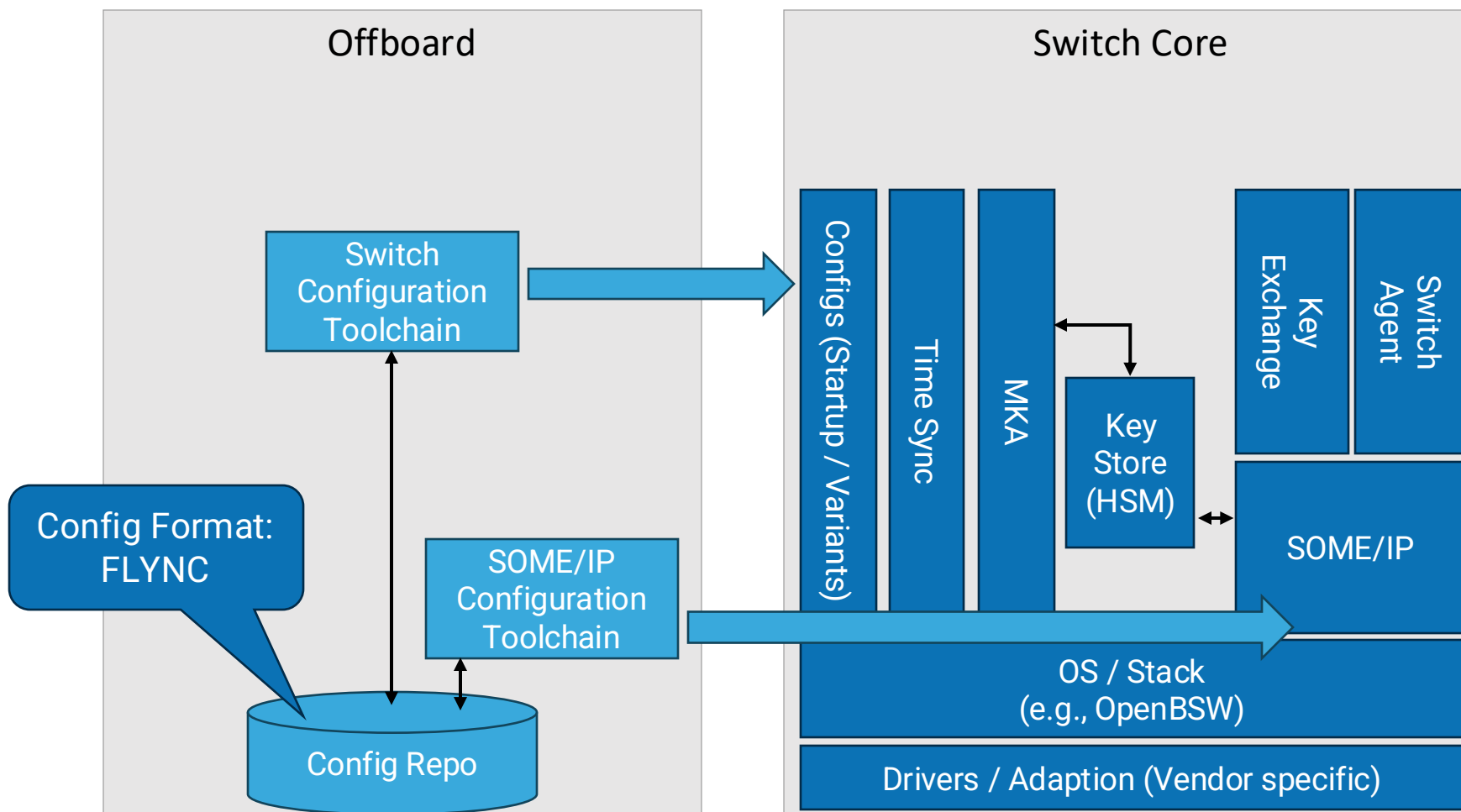
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- Tremendous speedup by using:
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- **Separating specifics of chip and OEM increases development speed**



OPEN-SOURCE ECOSYSTEM

OPEN-SOURCE ECOSYSTEM

OUTLOOK



Leveraging open-source:

- OpenBSW (Eclipse SDV)
- S-CORE (Eclipse SDV)

Starting open-source projects:

- FLYNC (2025/2026)
- Switch Software (2026)

Open-source standards:

- Unlocking the potential of open protocols. Stay tuned.

All dates and details are subject to change.

SUMMARY



SUMMARY

- Switches are key elements in the E/E Architecture
- Evolutionary and open hardware to reduce complexity and costs
- Needed: Improved Workflows, Continuous Integration, Software reuse

- Ecosystem must be improved with focus on time-to-market
- Standardized interfaces for Switch Management and Monitoring is a must
- Open-Source as rocket fuel for faster development

- Do you want to join our journey? Contact us and join TC19!

STANDARDIZATION!

- How can you contribute? Join TC19 today!

- OPEN TC19 got founded in 2025!
 - Software for management and configuration of Automotive Ethernet Switches.
 - More than 50 members joined in the first days alone!

- What do we want to do for Automotive Ethernet Switches?
 - Universal Configuration and APIs.
 - Management.
 - Extensible Software structure and abstractions.

