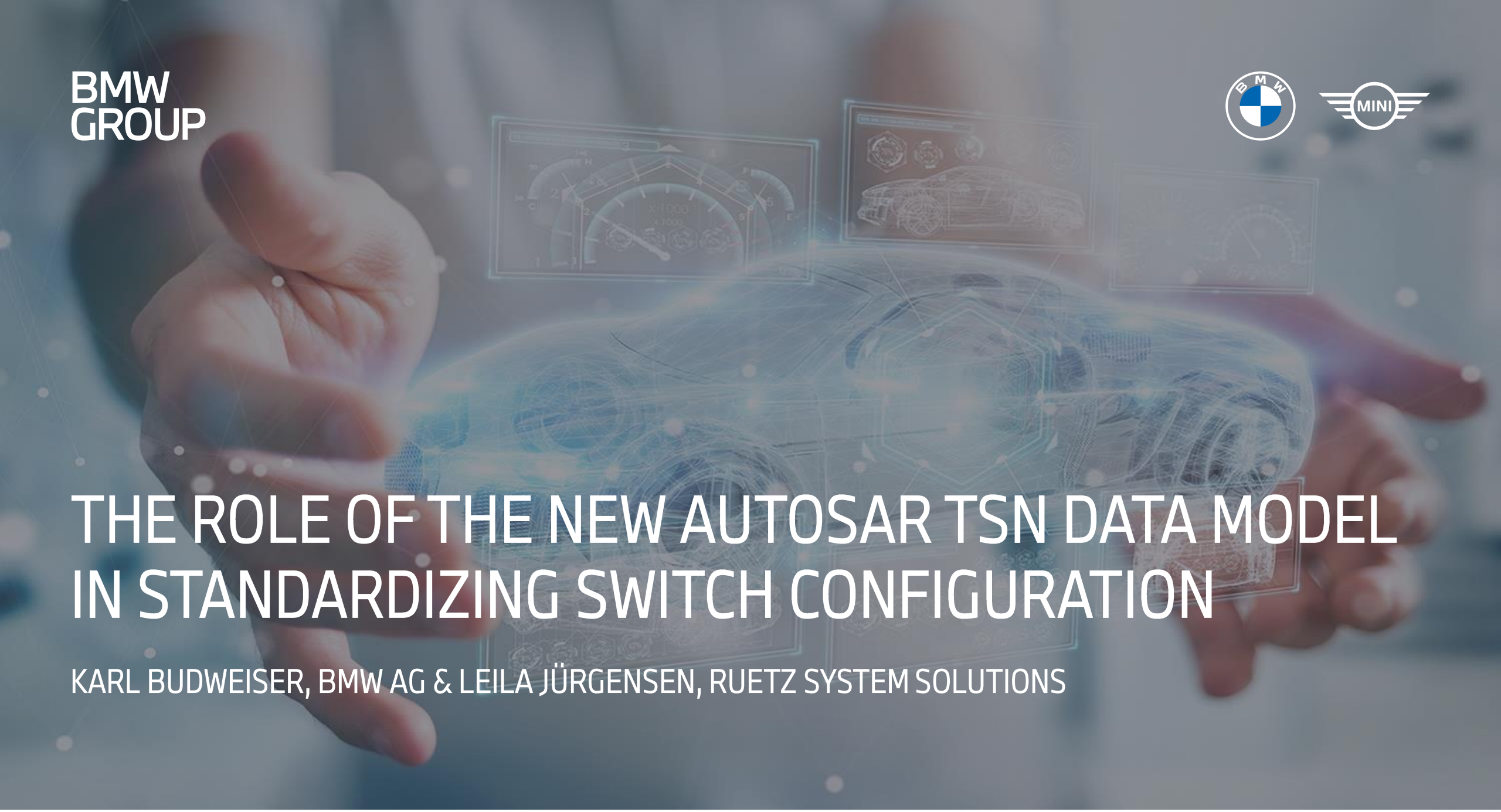

THE ROLE OF THE NEW AUTOSAR TSN DATA MODEL IN STANDARDIZING SWITCH CONFIGURATION

KARL BUDWEISER, BMW AG & LEILA JÜRGENSEN, RUETZ SYSTEM SOLUTIONS

AGENDA.

1. **Motivation for a Standard Configuration Model**
2. Intro to the AUTOSAR TSN Configuration Model
3. Different Approaches for Switch Configuration
4. Application Notes for TSN Configuration
5. Summary & Prospects

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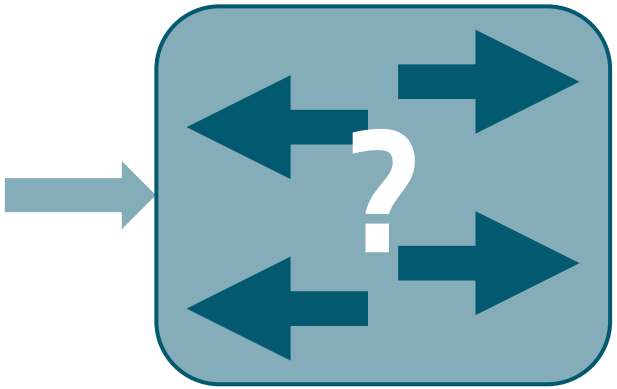
MOTIVATION FOR A STANDARDIZED SWITCH CONFIGURATION MODEL. **QUESTIONS AND ANSWERS.**

Who is concerned about the way switches are configured today? Explain why?



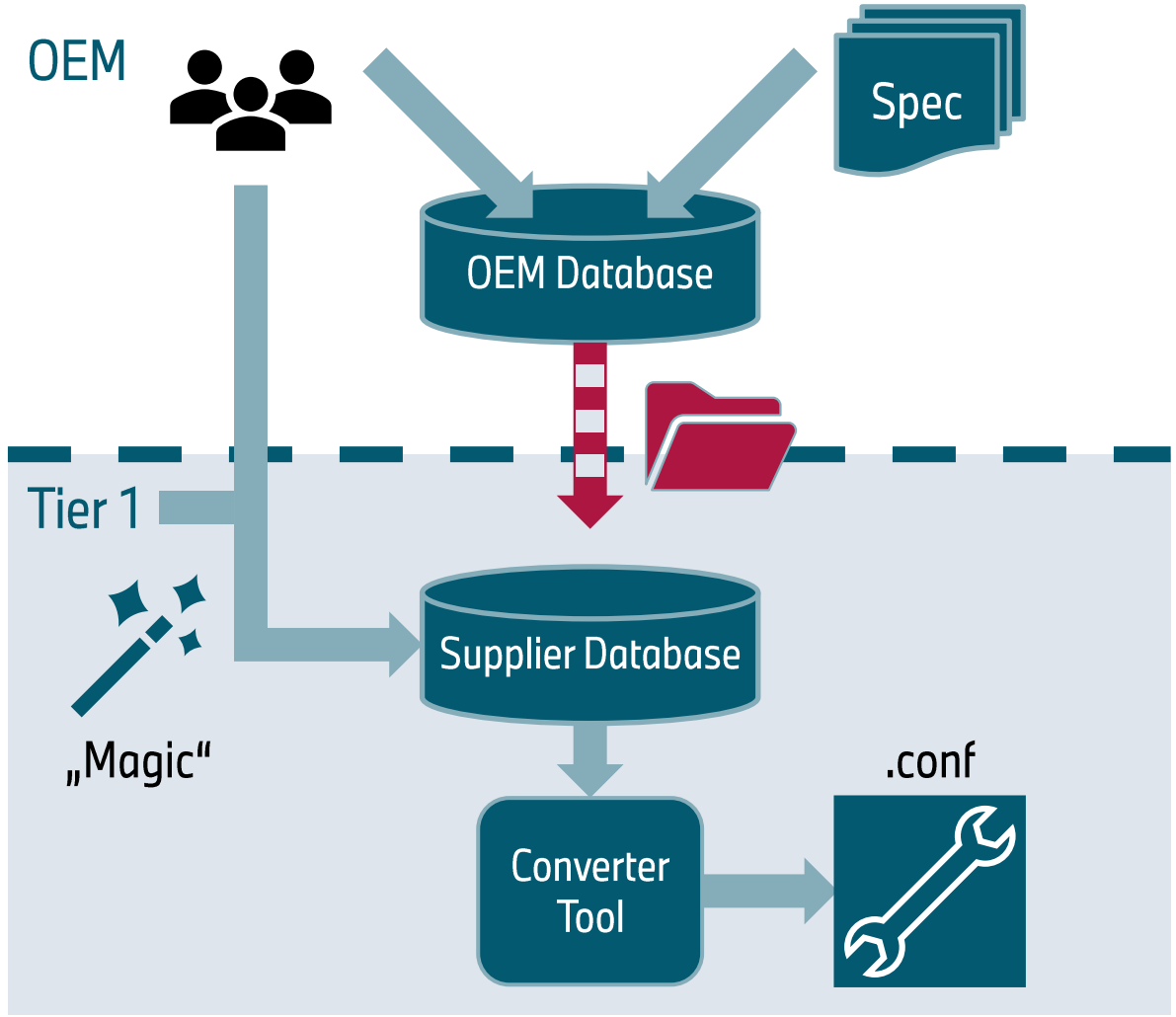
MOTIVATION FOR A STANDARDIZED SWITCH CONFIGURATION MODEL. **SYMPTOMATIC "WORKFLOW"** FOR SWITCH CONFIGURATION.

Who is concerned about the way switches are configured today? Explain why?

- Lack of a coherence in the tool chain
  - Slow and error-prone development cycle
  - Inconsistencies regarding test and validation
- No interchangeability due to unaffordably-costy, hand-crafted switch configuration
  - No resilience against supply chain shortages
  - Cost-down measures that cannot be exploited
- ...

Do you want to rely on "magic"?

Symptomatic configuration "workflow"



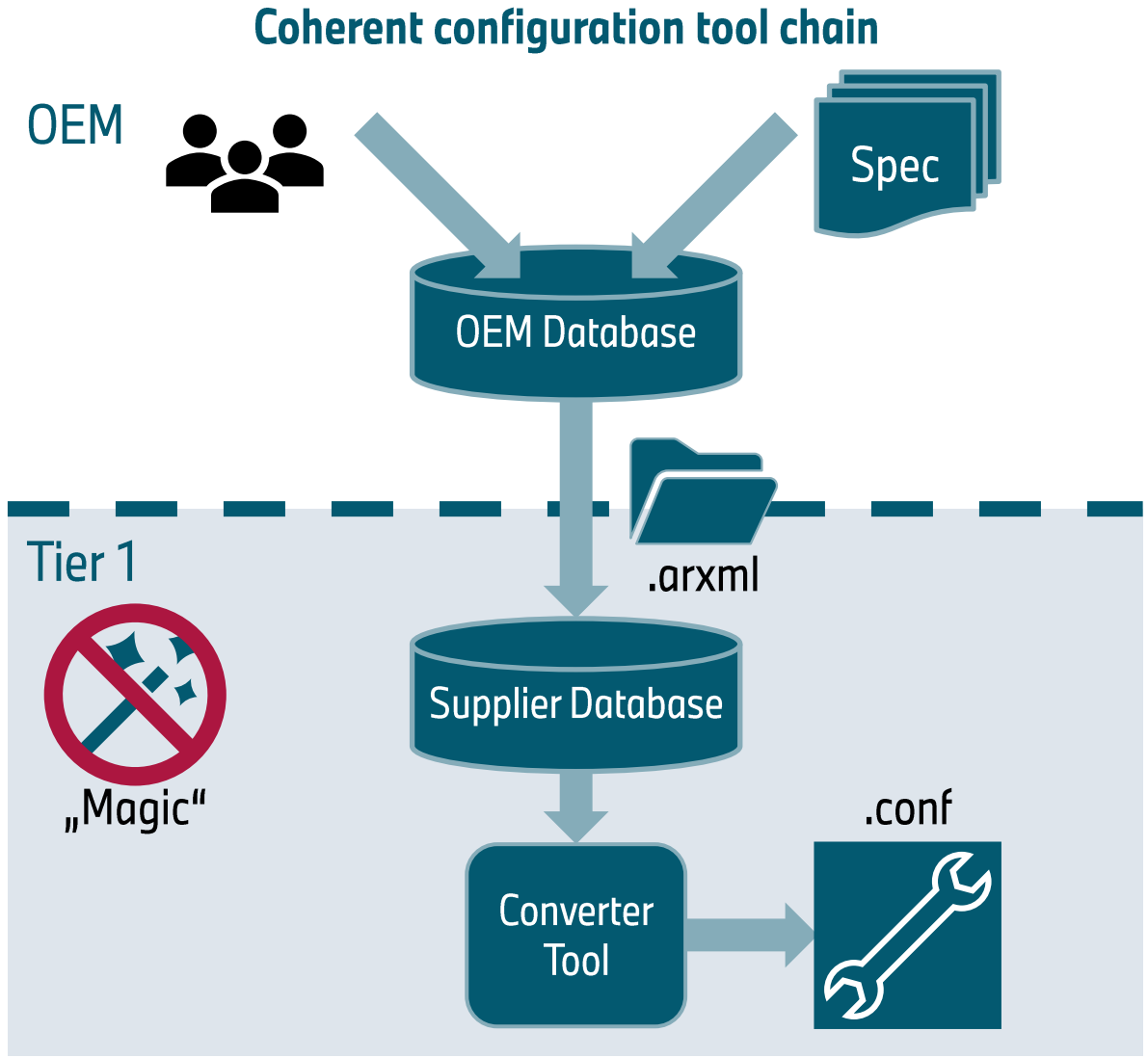
MOTIVATION FOR A STANDARDIZED SWITCH CONFIGURATION MODEL. **COHERENT TOOL CHAIN** FOR SWITCH CONFIGURATION.

Who is concerned about the way switches are configured today? Explain why?

- Lack of a coherence in the tool chain
  - Slow and error-prone development cycle
  - Inconsistencies regarding test and validation
- No interchangeability due to unaffordably-costy, hand-crafted switch configuration
  - No resilience against supply chain shortages
  - Cost-down measures that cannot be exploited
- ...

Do you want to rely on "magic"?

→ If you don't want to **rely on magic,** we need an adequate configuration model supported across the industry.



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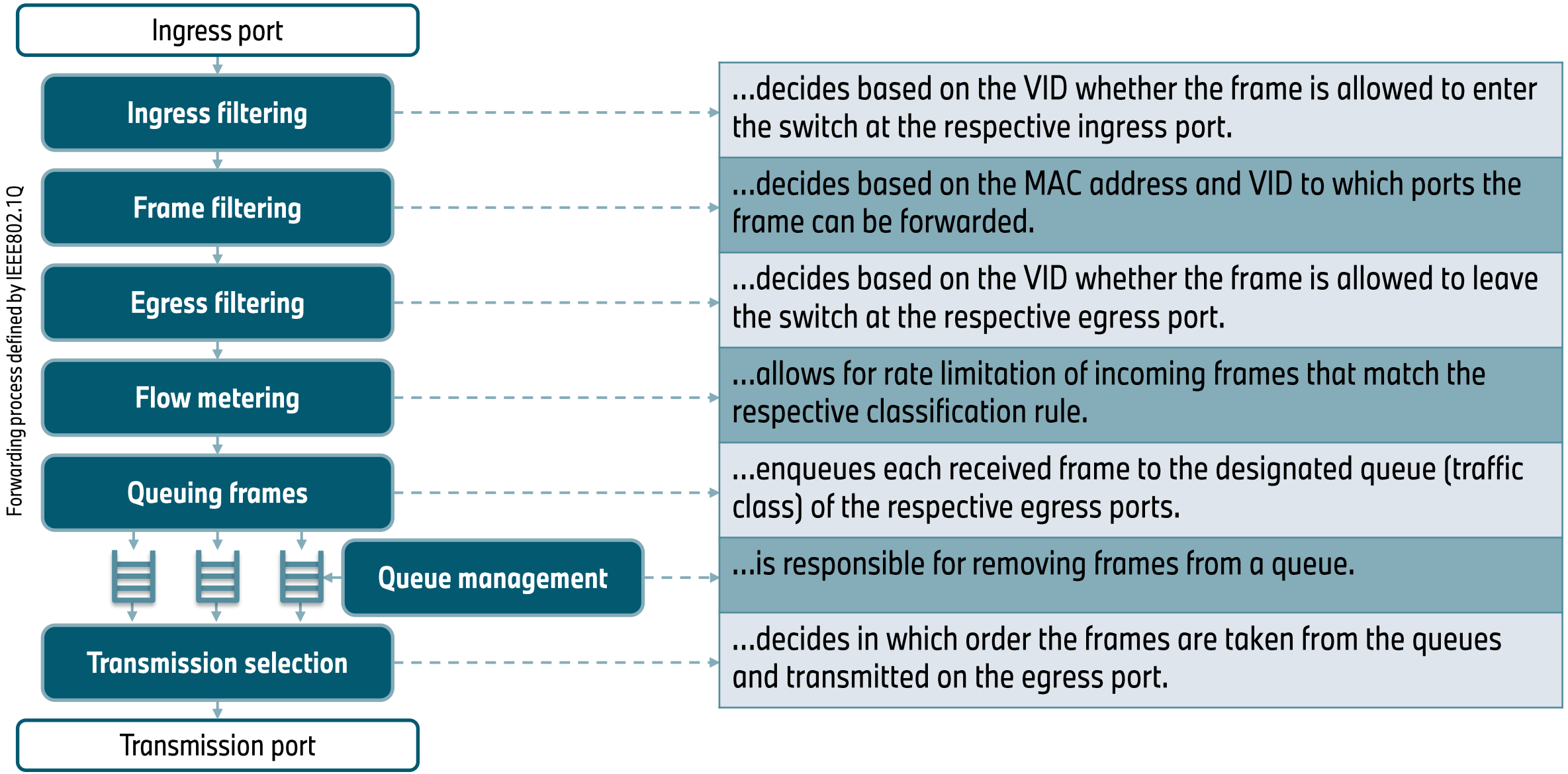
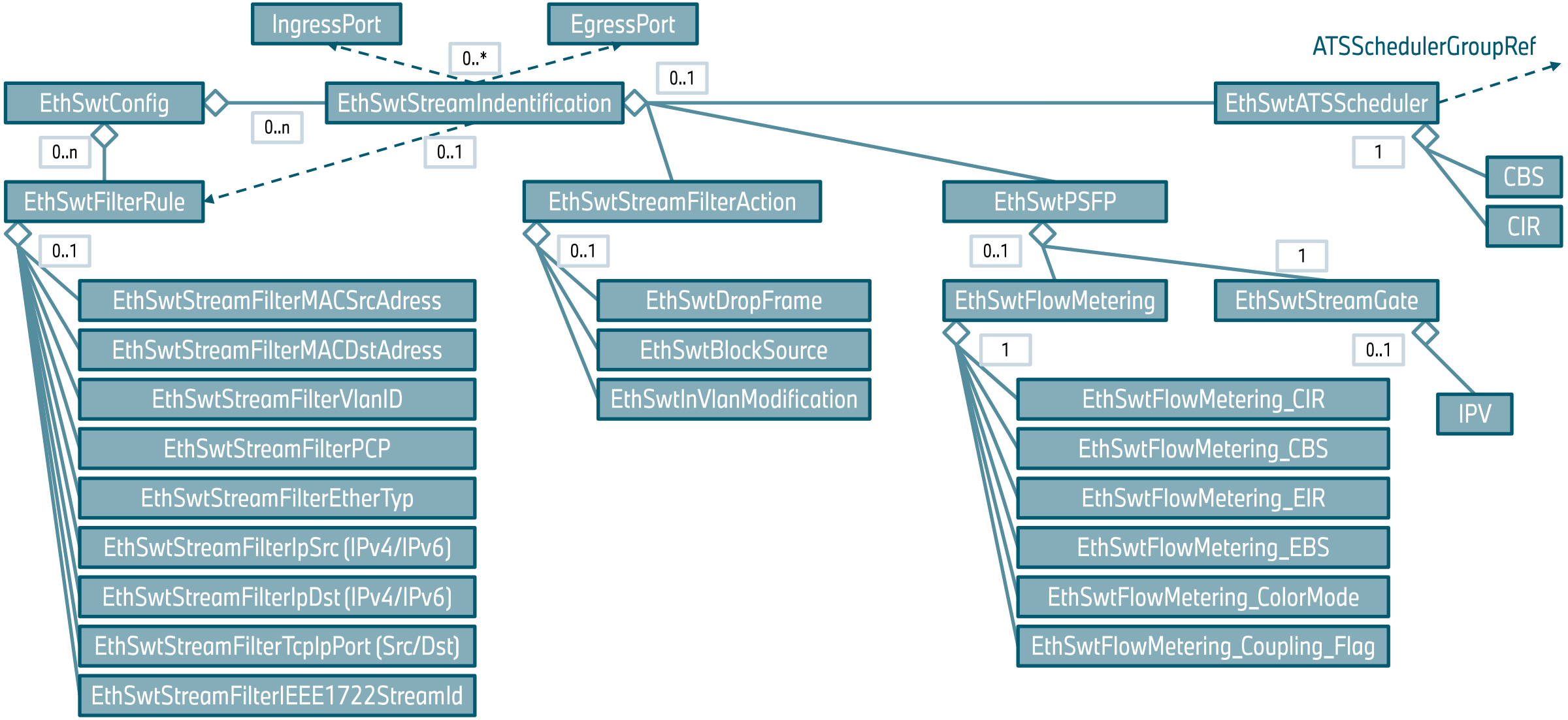
THE **PROCESS MODEL** FOR ETHERNET SWITCHES.

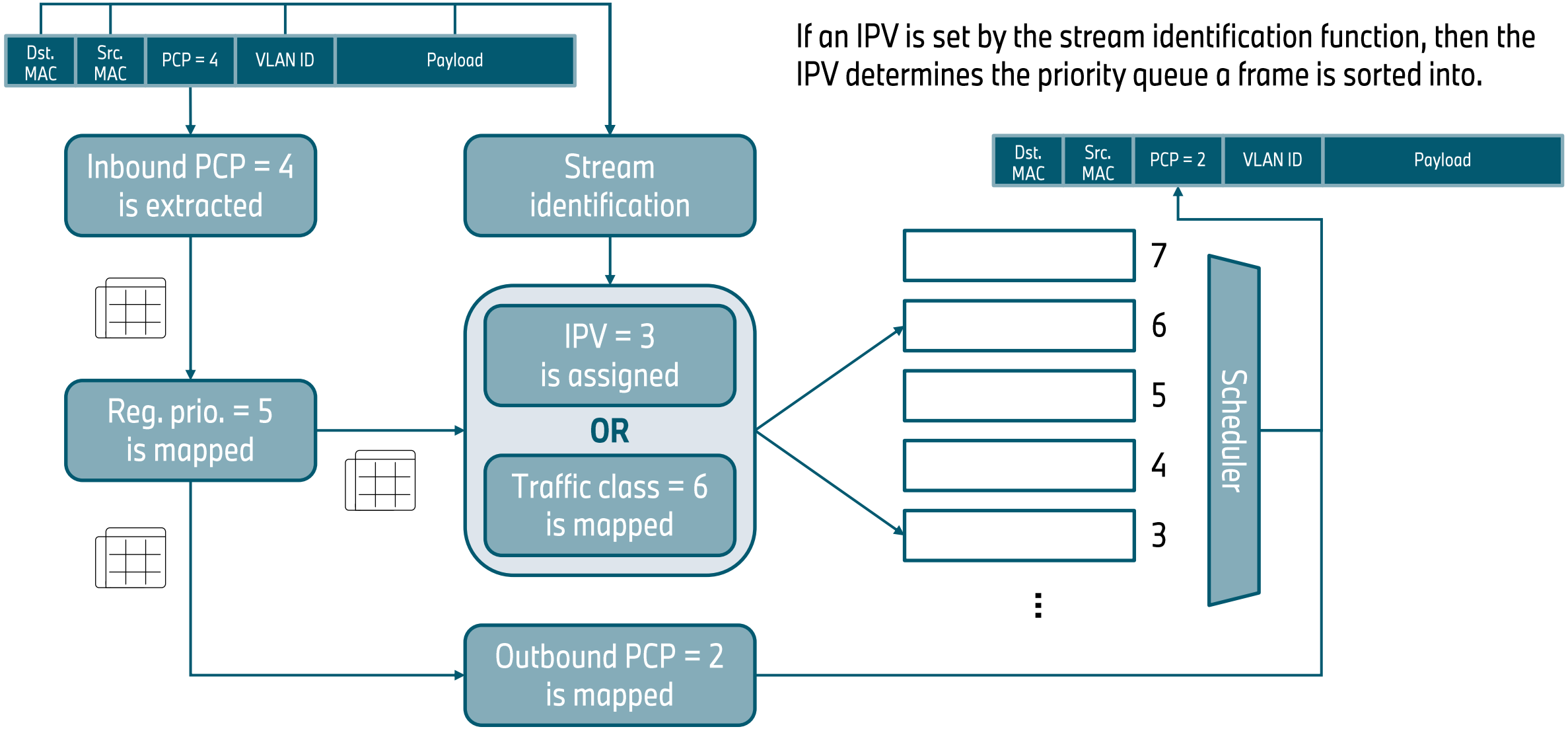


THE **AUTOSAR TSN DATA MODEL** FOR ETHERNET SWITCHES AT A GLANCE. MODEL EXCERPT FOR FLOW METERING & QUEUING.

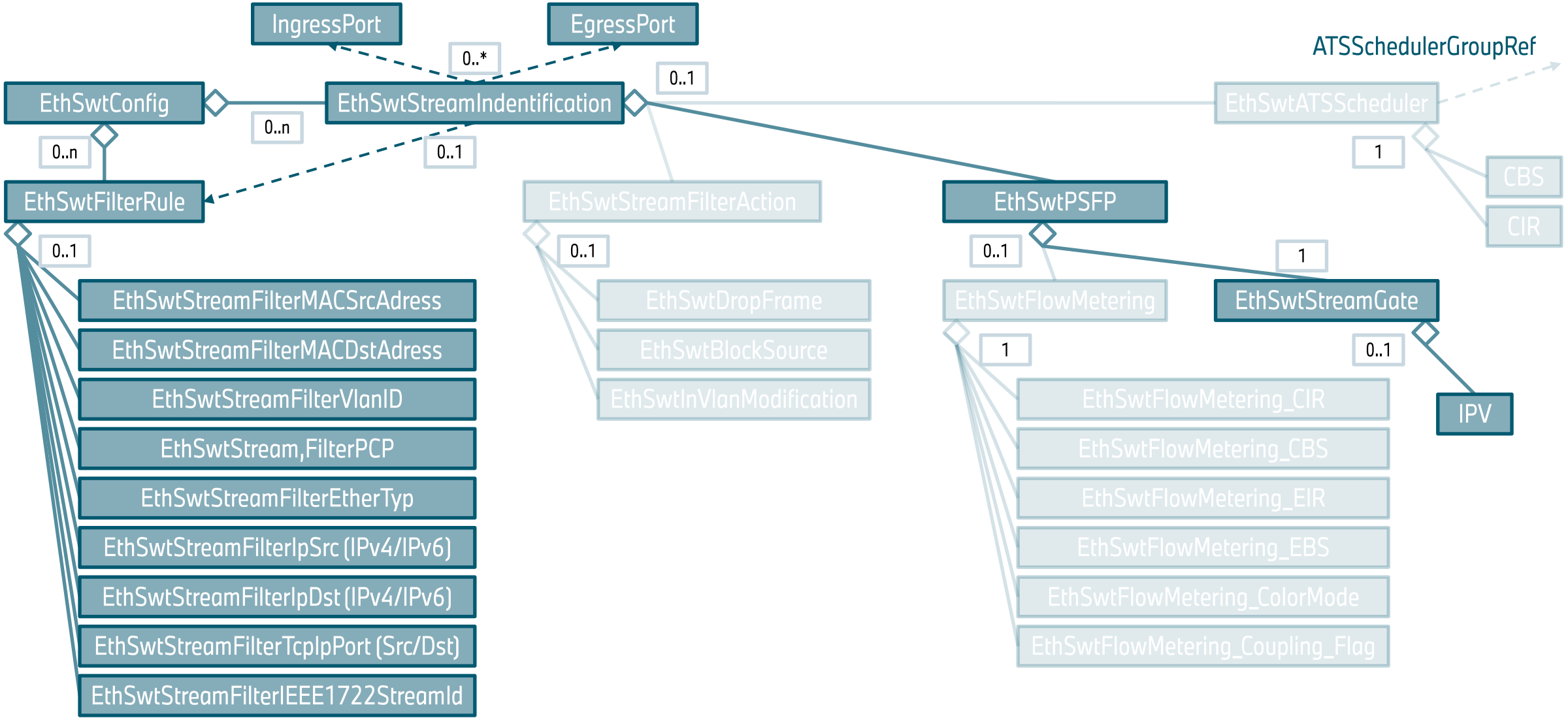


THE AUTOSAR TSN DATA MODEL FOR ETHERNET SWITCHES AT A GLANCE. ILLUSTRATION OF (RE-)PRIORITIZING AND QUEUING.

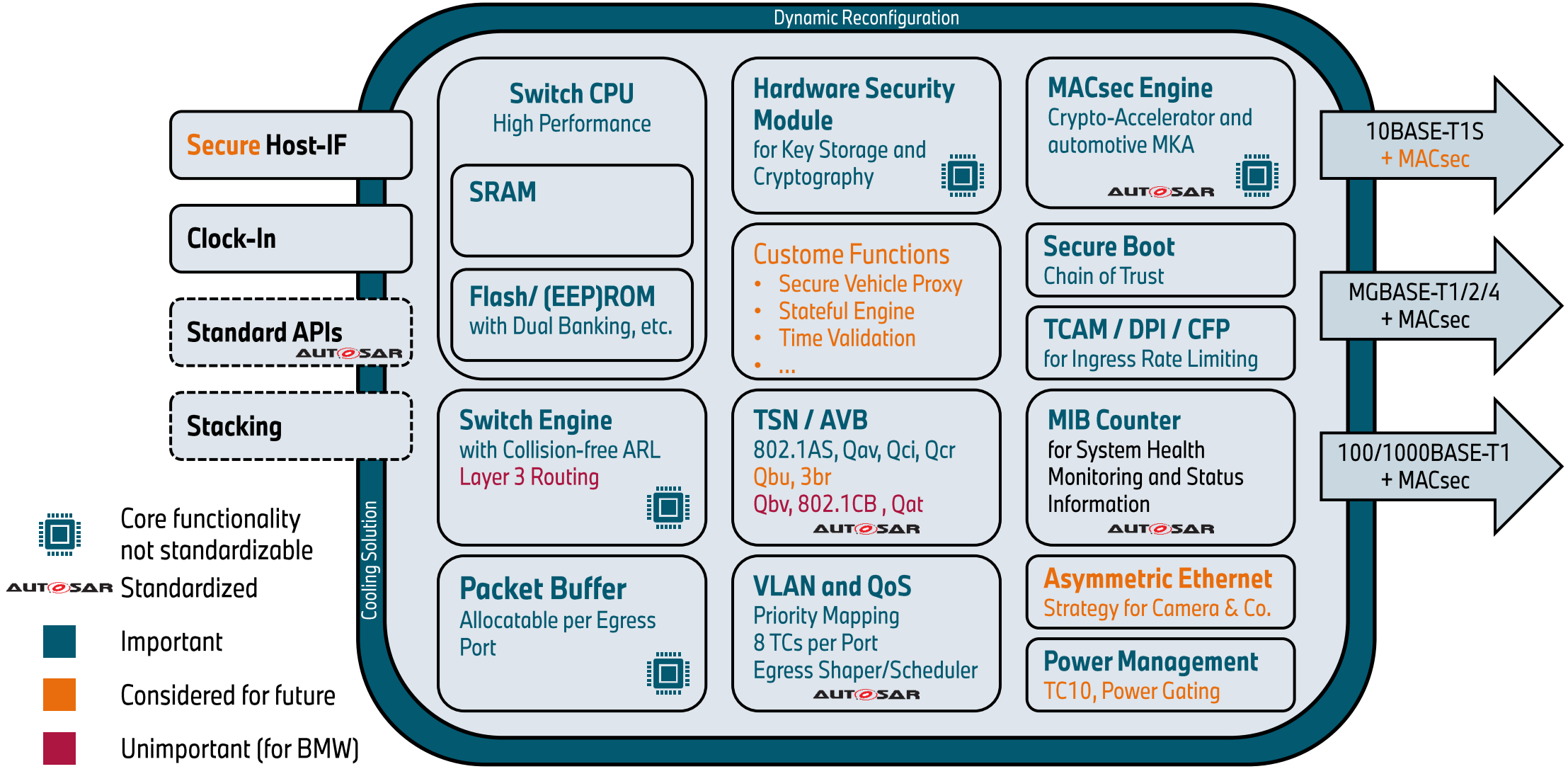
If an IPV is set by the stream identification function, then the IPV determines the priority queue a frame is sorted into.



THE AUTOSAR TSN DATA MODEL FOR ETHERNET SWITCHES AT A GLANCE. MODELLING (RE-)PRIORITIZING AND QUEUEING.



FUNCTIONAL BLOCK DIAGRAM OF AN ETHERNET SWITCH. STATUS QUO OF FEATURE SUPPORT IN AUTOSAR.



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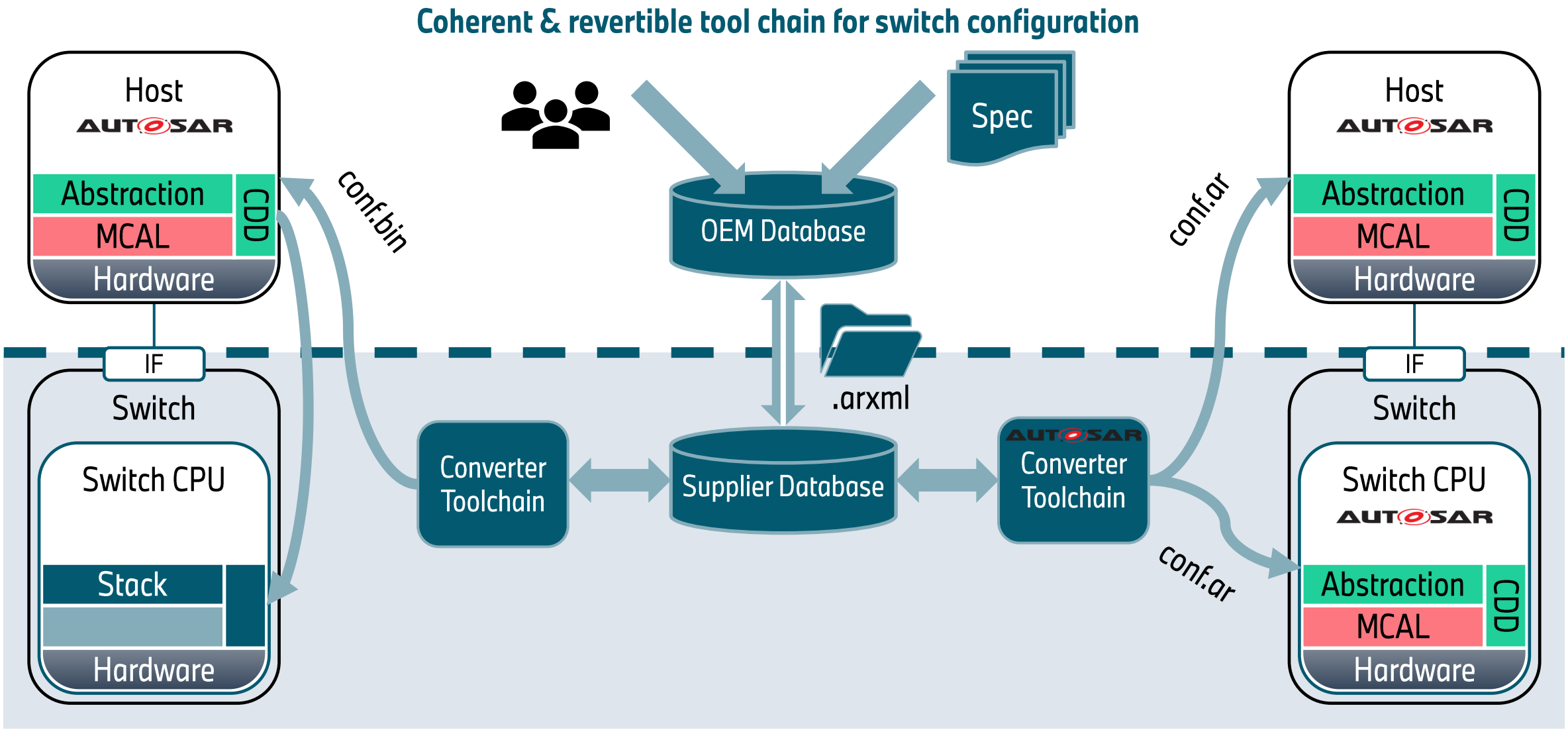
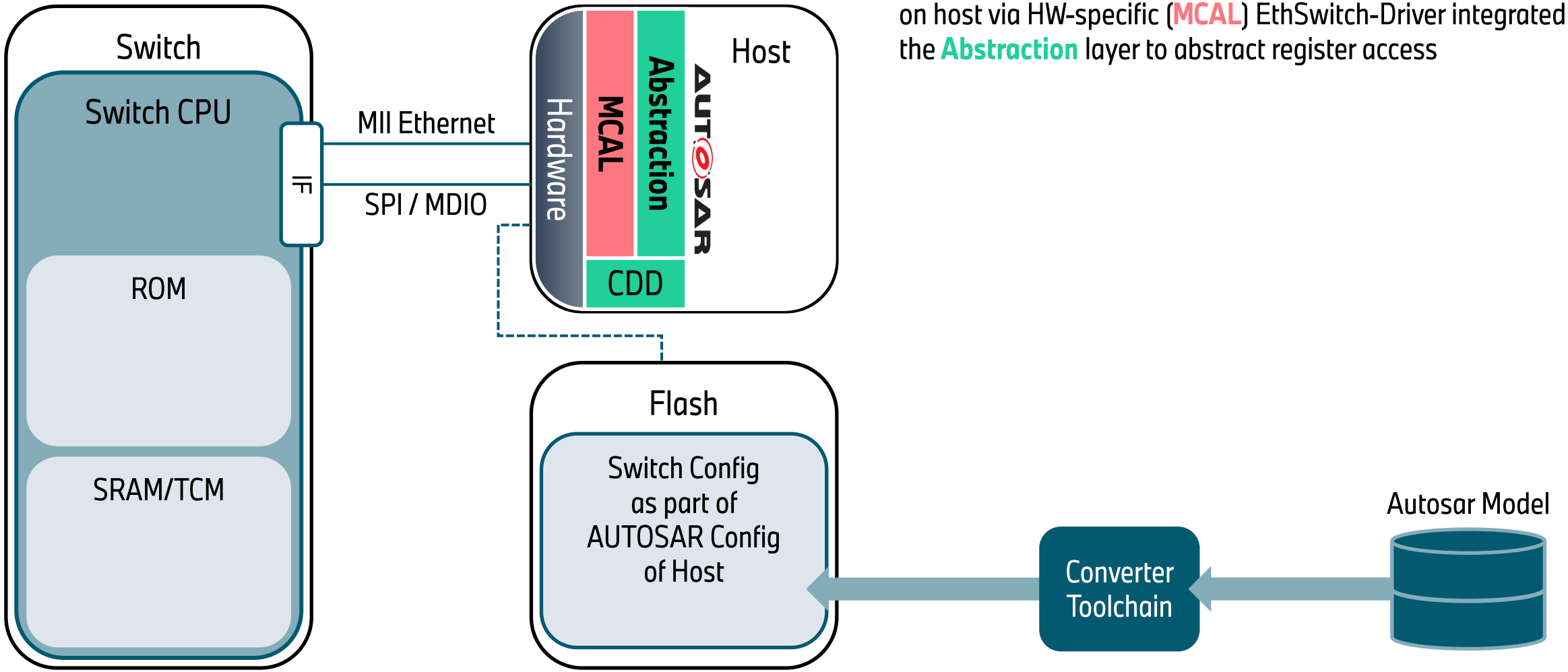
DIFFERENT APPROACHES FOR SWITCH CONFIGURATION. PRINCIPAL METHODS.



AN OVERVIEW OF DIFFERENT SWITCH CONFIGURATION APPROACHES. SWITCH MANAGEMENT, RE-CONFIGURATION & FLASH UPDATES.

- **Unmanaged Switch:** AUTOSAR-based switch management on host via HW-specific (MCAL) EthSwitch-Driver integrated in the Abstraction layer to abstract register access



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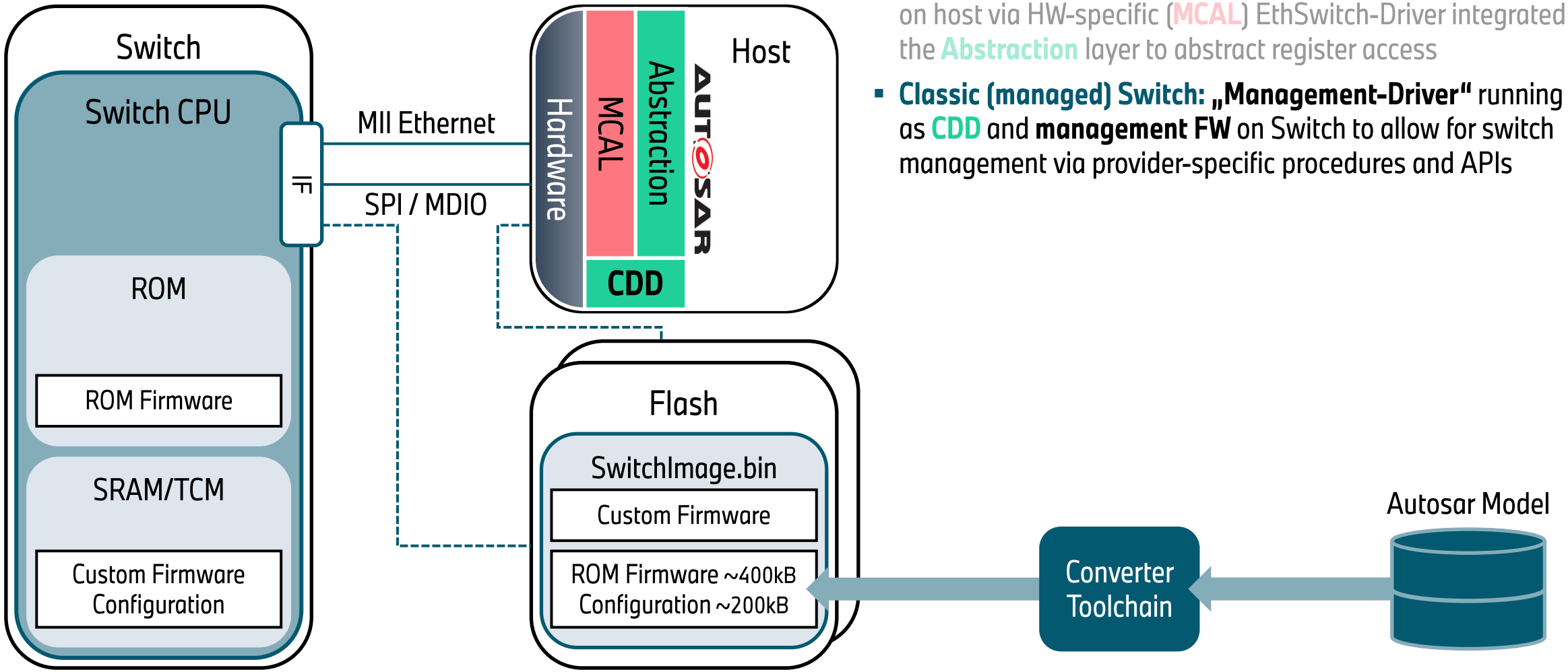

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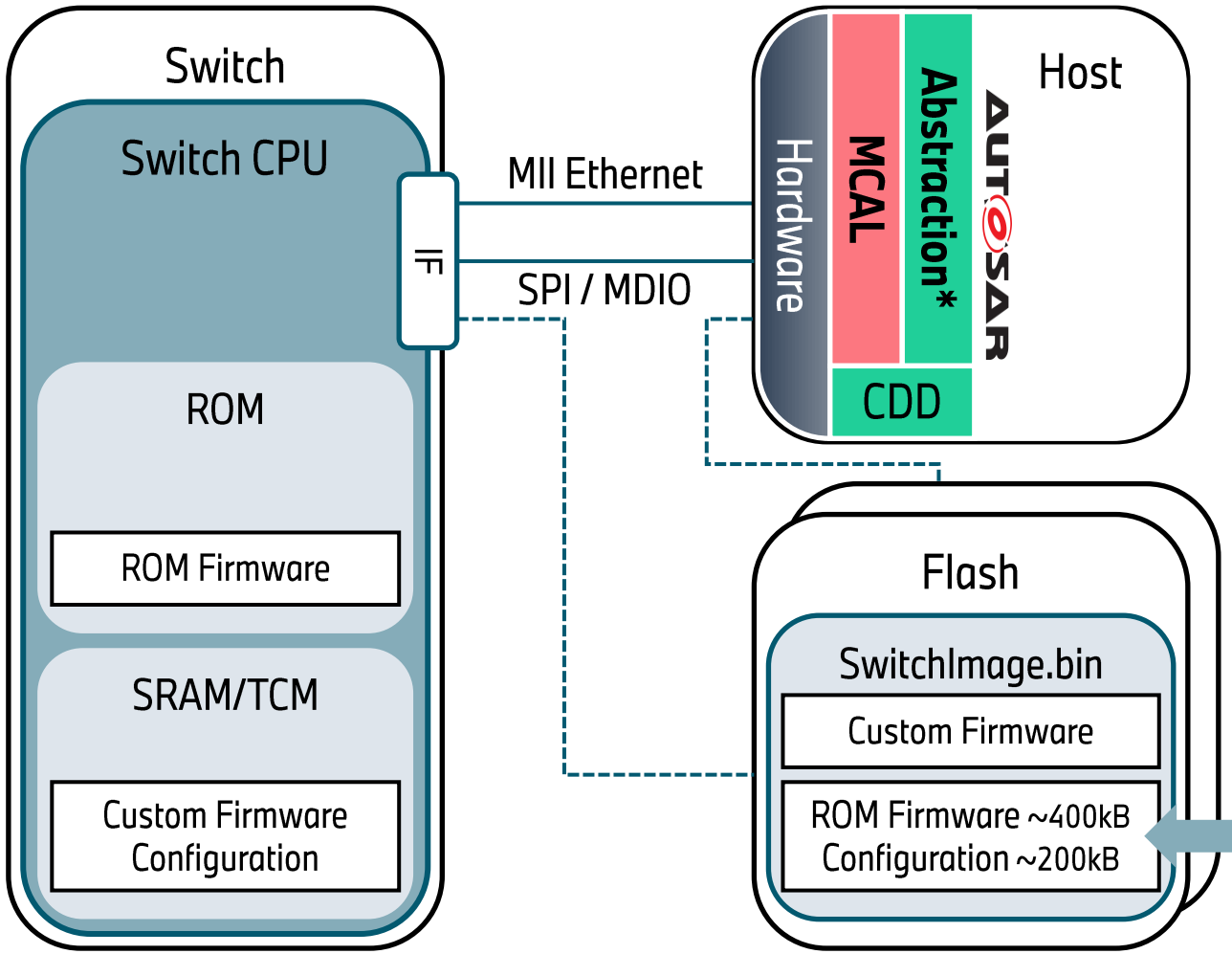

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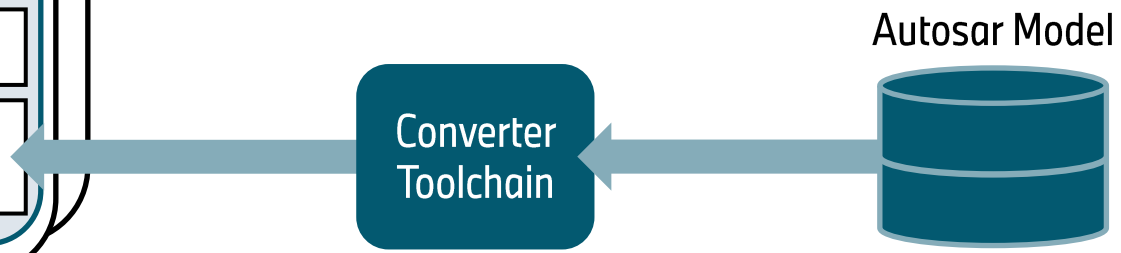
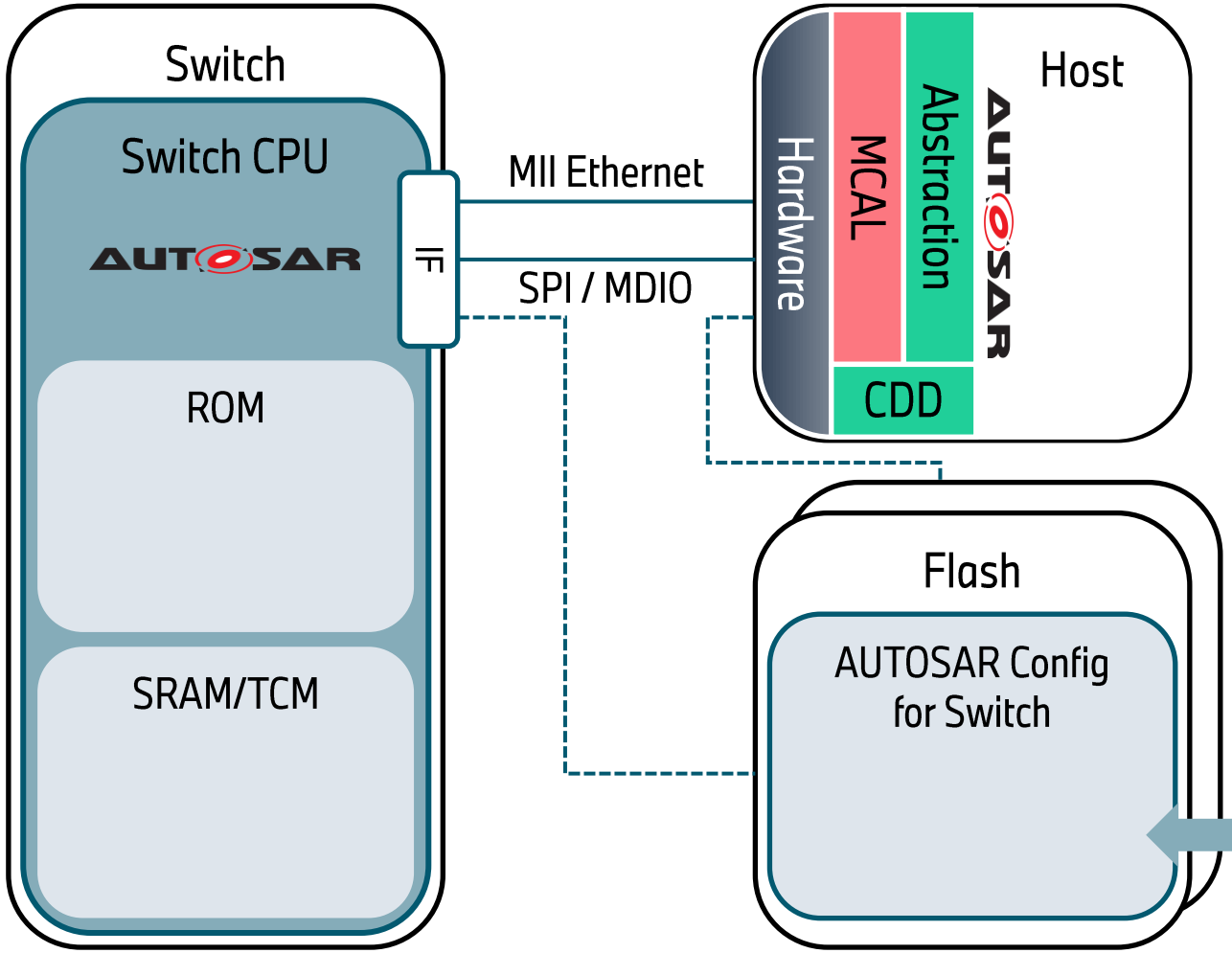
- **Hybrid (managed) Switch: Provider-specific EthSwitch-Driver “extension”** that transforms standardized AUTOSAR APIs for switch management into provider-specific APIs
  - → Switch is/appears fully AUTOSAR-compliant to host



AN OVERVIEW OF DIFFERENT SWITCH CONFIGURATION CONCEPTS. SWITCH MANAGEMENT, RE-CONFIGURATION & FLASH UPDATES.



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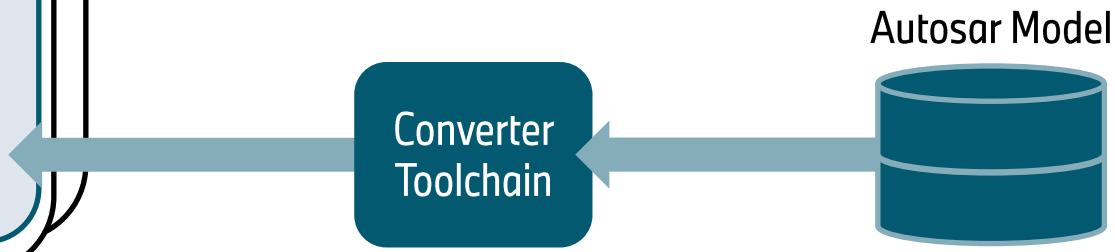
- **AUTOSAR (managed) Switch:** Fully **AUTOSAR-compliant management SW** on host and switch that allows the host for management via well-defined AUTOSAR APIs (only!)



A COMPARISON OF DIFFERENT SWITCH CONFIGURATION CONCEPTS. THE TRUTH BEHIND THE DIFFERENT VARIANTS.

	Unmanaged Switch	Classic Switch	Hybrid Switch	AUTOSAR Switch
Host CPU utilization	⊖ ⊖	⊕ ⊕	⊕ ⊕	⊕ ⊕
Memory foot-print	⊕ ⊕	⊕ ⊕	⊕	⊕
Extensibility of feature set	⊖ ⊖	⊕ ⊕	⊕ ⊕	⊖ ⊖
Compliance, Inter-Op & Co	⊖ / ⊕	⊕	⊕	⊖ / ⊕
Start-up limitations / speed	⊖ ⊖	⊕ ⊕	⊕ ⊕	⊕
Debugging standards	⊕	⊖	⊖ / ⊕	⊕
Know-how transfer	⊕ ⊕	⊖ ⊖	⊕	⊕ ⊕

→ All variants leverage from a standardized configuration model equally!

→ A hybrid managed switch unites many advantages of both classic managed and fully AUTOSAR-compliant switches.

A COMPARISON OF DIFFERENT SWITCH CONFIGURATION CONCEPTS. EVALUATION BACK-UP.

- **Unmanaged Switch:** AUTOSAR-based switch management on host via a HW-specific EthSwitch-Driver to abstracts register access for configuration and other functions:
  - ± Lightweight solution in terms of **memory foot-print** because of single flash but tendency to waste available **CPU resources**
  - \+ Well-known AUTOSAR paradigms with steep **learning curve** even for **debugging** (XCP, DLT, etc.)
  - \- Limited **degree of freedom (monolithic Stack, AUTOSAR release cycle)**
  - \- limitations of **sequential start-up**
- **Classic (managed) Switch:** Proprietary „Management-Drivers“ running on Host (Client) and management FW on Switch (Server) to allow for lean switch management, re-configuration, flash updates, etc. via provider-specific procedures and APIs:
  - \+ Lightweight solution in terms of **memory foot-print** and **CPU utilization** (no “bulky”, monolithic stack on switch)
  - \+ Customized solution with highest **degree of freedom (modular FW)**
  - \+ No limitations of **sequential start-up** due to parallelism
  - \- Flat **learning curves** due to lack of standardization (incl. debugging)
- **Hybrid (managed) Switch:** Provider-specific “wrapper/extension” for AUTOSAR APIs inside the Host’s MCAL/Abstarction layer that transforms standardized AUTOSAR APIs for switch management to provider-specific APIs making the switch and its management FW appear AUTOSAR-compliant:
  - ± Decent solution in terms of **memory foot-print** and **CPU utilization** (no stack on switch, only **“backdoor”** on host) with optimization potentials
  - \+ Higher **degree of freedom** (incl. debugging)
  - \+ No limitations of **sequential start-up** due to parallelism
  - \+ Easy **transfer of basic know-how**
- **AUTOSAR (managed) Switch:** Fully AUTOSAR-compliant management SW on host and switch that allows the host for management via well-defined AUTOSAR APIs (only):
  - \+ Pretty lightweight solution in terms of **memory foot-print** and **CPU utilization**, but bulky AUTOSAR stack on switch
  - \+ No limitations of **sequential start-up** due to parallelism, but constraints from AUTOSAR paradigms (integrity check routines)
  - \+ Steep **learning curve** even for **debugging** (XCP, DLT, etc.)
  - \- Limited **degree of freedom (monolithic Stack, AUTOSAR release cycle)**

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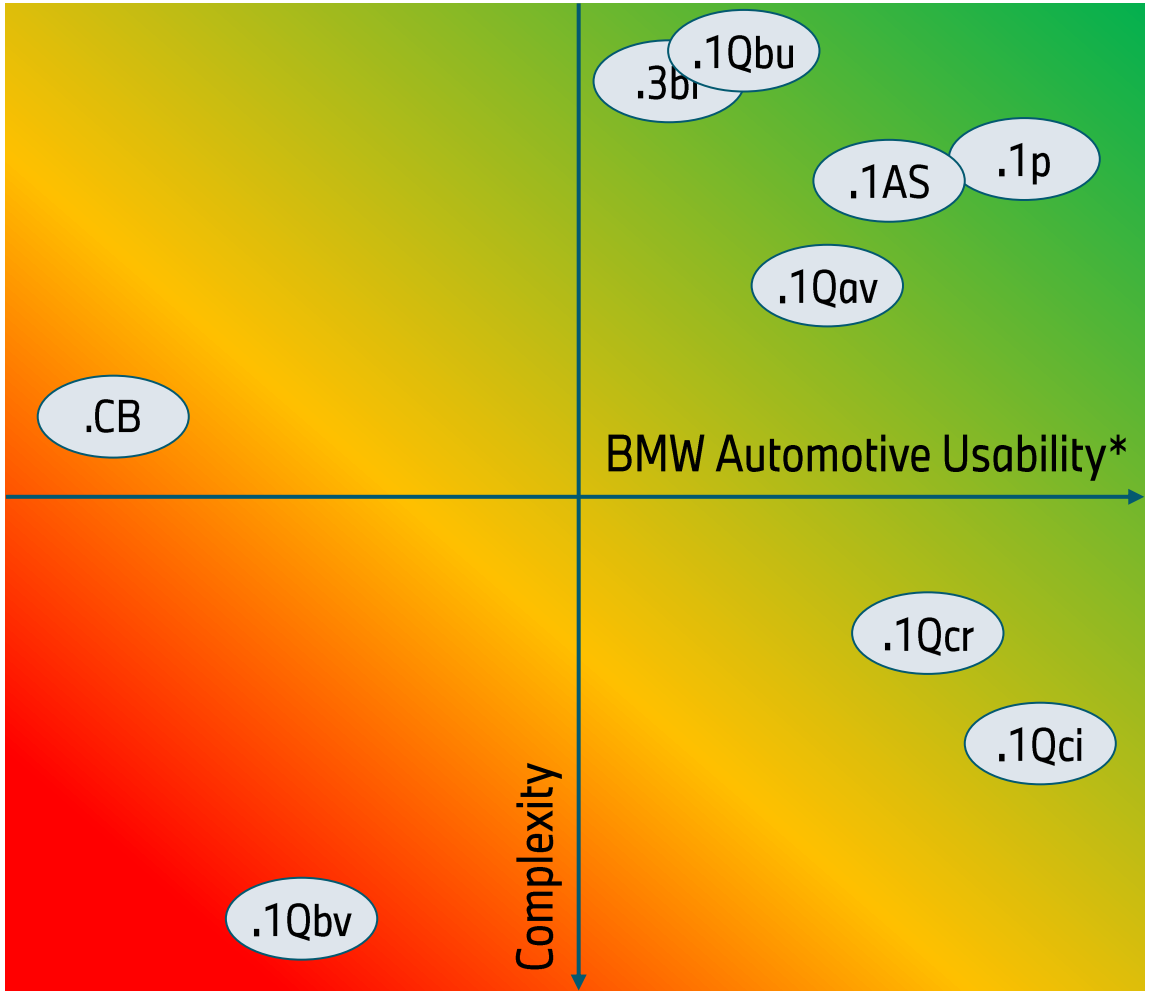
IMPORTANT APPLICATION NOTES FOR A RISK-AVERT TSN CONFIGURATION. COMPLEXITY VERSUS USEABILITY OF SELECTED TSN FEATURES.



https://www.ieee802.org/1/files/public/docs2021/dg-budweiserBMW-RiskaverseChoiceForTSN-1021-v02.pdf

* This classification of IEEE 802 TSN features is subjective.

Common TSN pitfalls:

- Some TSN features like .Qbv require E2E support
  - TSN can limit the number of available semiconductors
  - TSN requires strictly coordinated HW selection processes
- Some TSN features like .1Qbu/.3br & MACsec have dependencies, the standards still need to resolve
- TSN testing eco-system has yet to evolve
- Data models still need to include timing constraints of applications, etc. to derive automatically a priori the best configuration

Risk-avert approach:

- Prefer those TSN features that are easier to deal with:
  - Simulations show that TSN features like .1p & .Qav seem to be sufficient to meet automotive timing requirements
- Use the TSN features suiting your established networking paradigms
- Do not try to solve problems you don't have with TSN
  → TSN is a like tool-box - do not try to use each and every tool

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THE ROLE OF A STANDARDIZED CONFIGURATION MODEL FOR SWITCHES. OPPORTUNITIES AND **RETURN ON INVEST**.

Advantages of a standardized configuration model for Ethernet switches:

- Facilitating **interchangeability** of switch semiconductors:
  - Increased resilience against supply chain shortages
  - Cost reduction potentials upon HW-changes (incl. ECU refurbishment)
- Establishing a cross-industry, **multi-vendor market** for Ethernet switches:
  - Fair competitive chances and remedy from de facto vendor-locks
- Faster **time-to-market** through coherent development process and shared **responsibility model**
- Easier **Customer support** for semiconductor providers and Tier 1's
- Excelling **system complexity** by transitioning to model-based development
  - Model as ground truth for both system development and test and validation
  - Model as enabler for simulation-based network verification approaches or early prototyping

Although the AUTOSAR configuration model for switches is not yet complete it can **pay off**, regardless the exact approach.

→ Ready to **invest** in the **AUTOSAR configuration model** for switches and a **coherent tool chain**?


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THANK YOU FOR YOUR ATTENTION.