Bridging the gap: Exploring configuration methods for software-defined vehicles

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Agenda

Importance of dynamic network configuration

In software-defined vehicles (SDVs)

Real-time adaptability

Predictive maintenance

Dynamic network configuration

Customization and personalization

Optimized performance

Safety and security
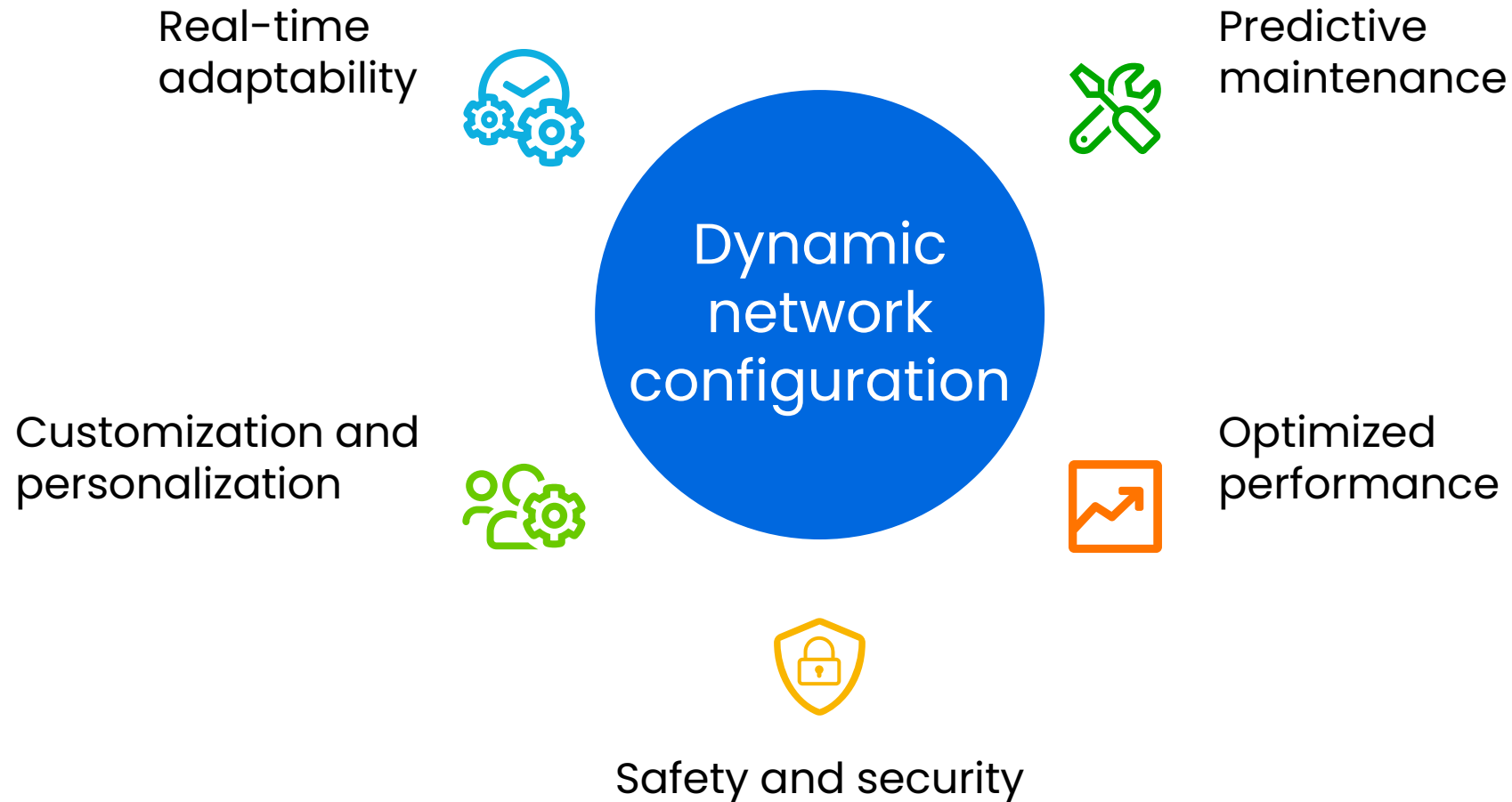
Automated network configuration

When and where is needed
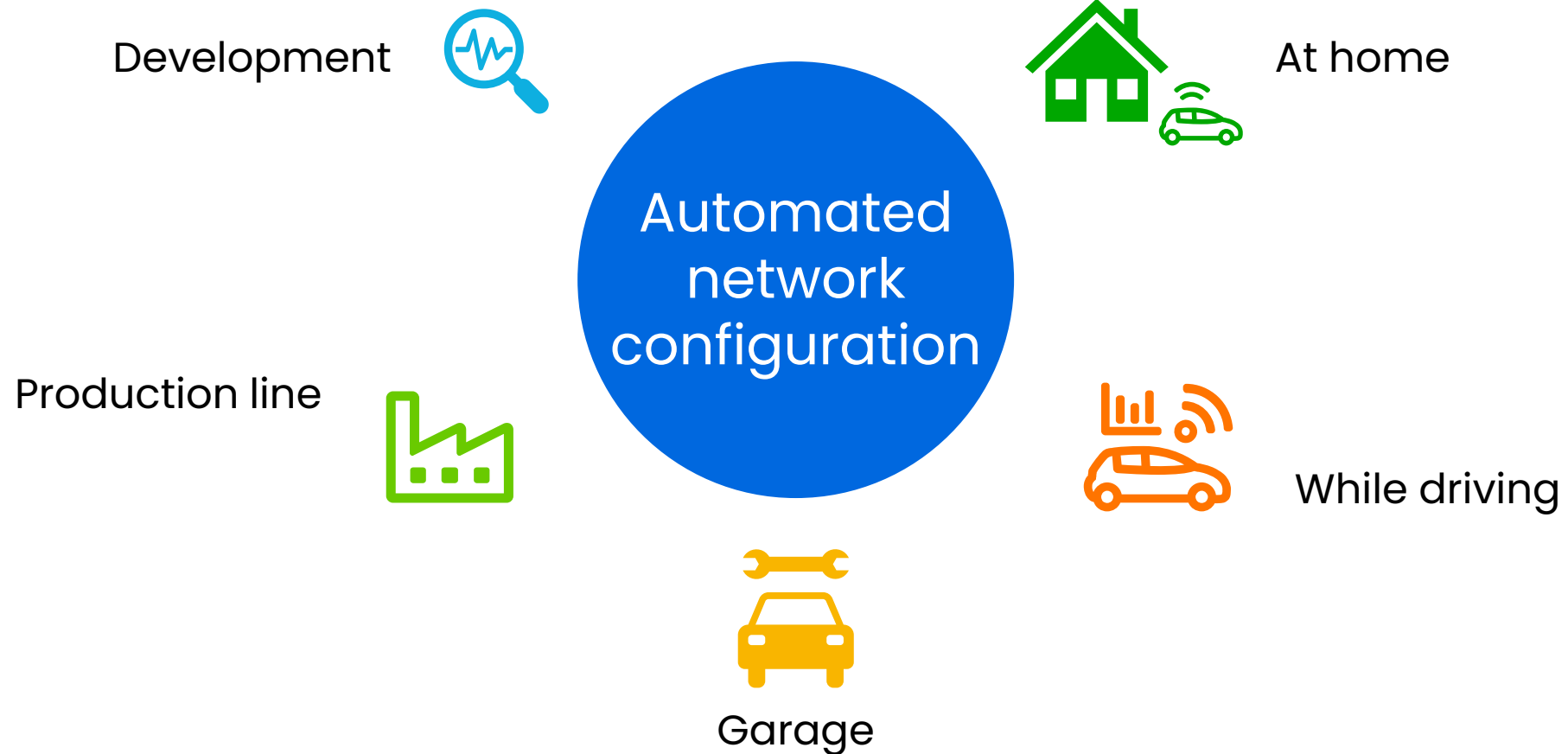
Development

At home

Automated network configuration

Production line

While driving

Garage
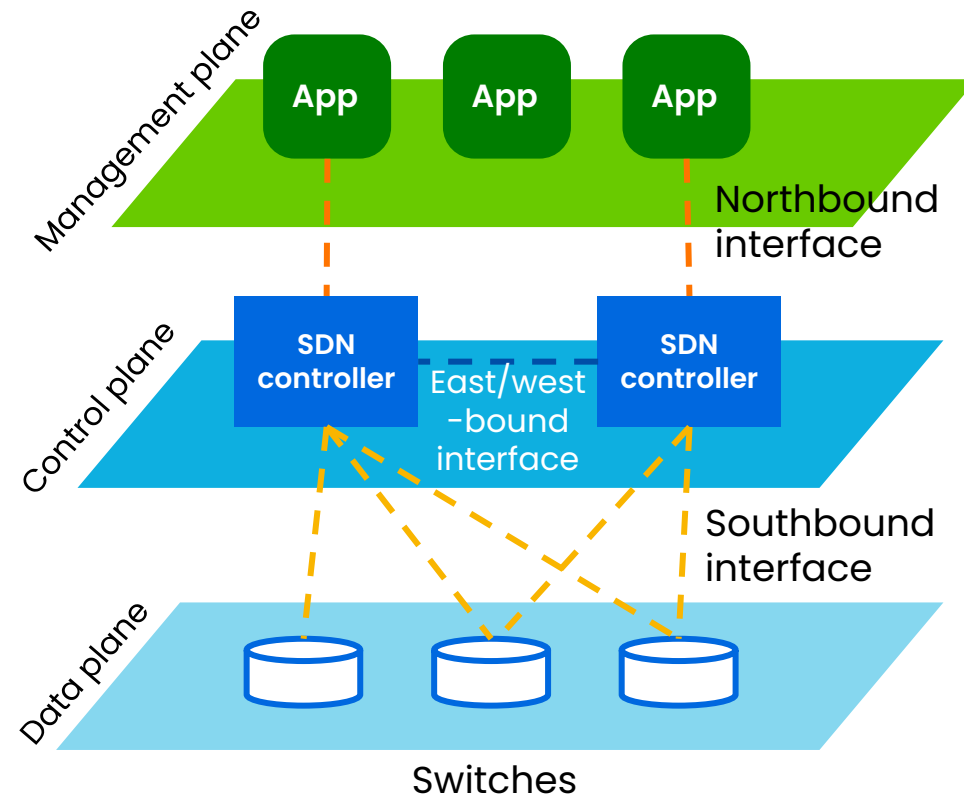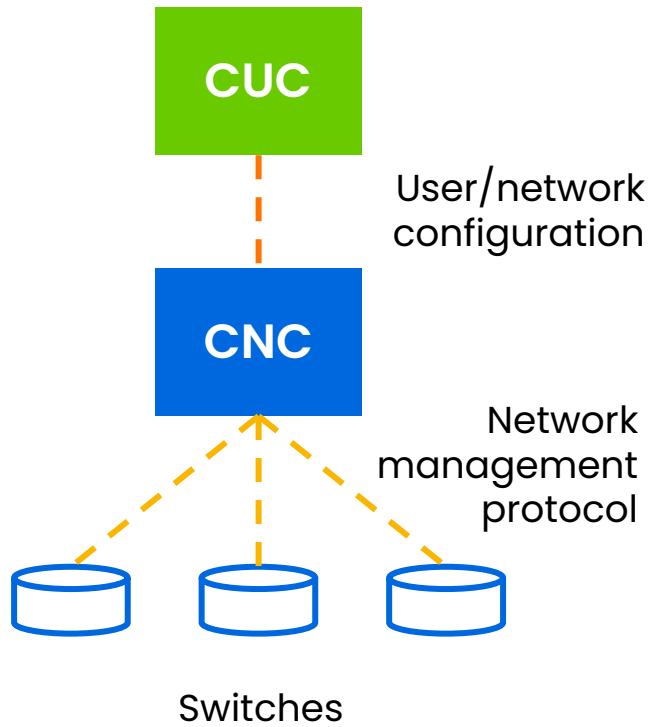
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SDN models

Benefits of a standard configuration model
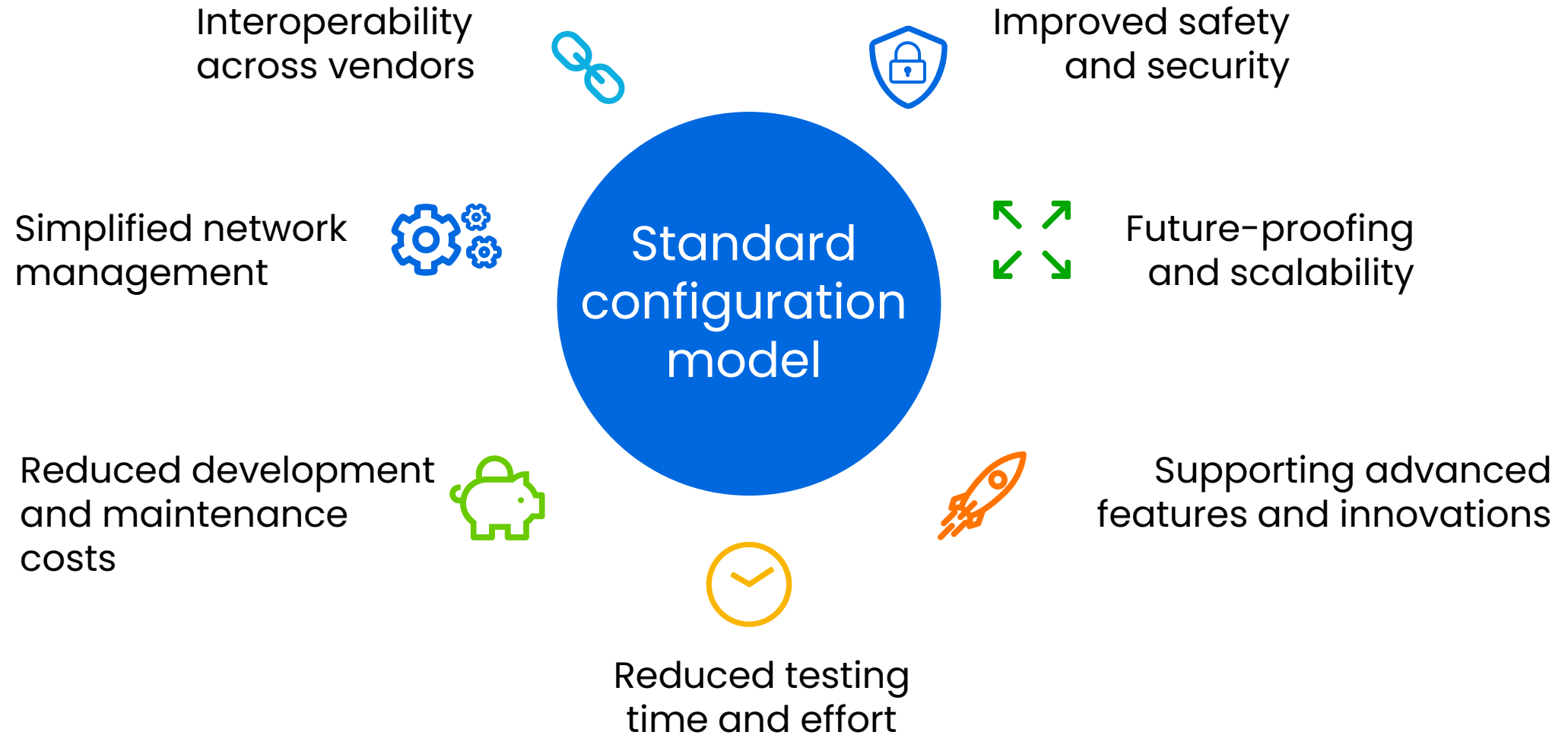
Interoperability across vendors

Improved safety and security

Simplified network management

Future-proofing and scalability

Reduced development and maintenance costs

Standard configuration model

Supporting advanced features and innovations

Reduced testing time and effort

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What is YANG?

- YANG is a **data modeling language**: Defines the structure of network configurations and data.

- **Hierarchical & modular**: Organizes configurations logically, allowing reuse and extensions.

- **Protocol neutral**: Works with NETCONF, RESTCONF, CORECONF and other network management protocols.

- **Extensible**: Supports customizations through augmentations without breaking models.

- **Industry standard**: Widely adopted for interoperable network configurations.

What is AUTOSAR and ARXML?

- AUTOSAR is a **standardized framework** setting a global standard for automotive software architecture.

- **Modular design**: It offers a modular structure for easier system development.

- **Hardware-software separation**: Enables independent development of hardware and software.

- **Safety-focused**: Designed for safety-critical automotive applications.

- **Reusable components**: Promotes reuse of software across multiple vehicles.

- ARXML (**AUTOSAR XML**) is an XML-based file format used in AUTOSAR to define and **exchange automotive system information:**

  - ECU configurations: Specifies Electronic Control Unit (ECU) settings and hardware details.

  - System communication: Manages communication between software components and ECUs.

  - Tool interoperability: Enables different tools to share and process AUTOSAR data.

  - Standard format: Ensures consistency across automotive projects using AUTOSAR.

YANG vs AUTOSAR (ARXML) based SDN

Data model	YANG	ARXML
Serialization	• **XML** • **JSON** • **CBOR**	• **XML** **Recommendations** • Add support for multiple serialization options, including binary.
Management protocol	• **RESTCONF** • **NETCONF** • **CORECONF**	• **No protocol defined** **Recommendations** • Adopt the mng protocols from YANG ecosystem
Transport	• **HTTP(S)** • **CoAP** • **UDP/DTLS** **Recommendations** • Add support for L2 transport (ETH payload)	• **No protocol defined** **Recommendations** • Adopt the trans. protocols from YANG ecosystem

YANG Ethernet switch configuration standards

Standard	Description	YANG modules
802.1Qcc-2018	Stream Reservation Protocol (SRP) enhancements and performance improvements	ieee802-dot1q-tsn-types.yang
802.1Qcp-2018	YANG data model	ieee802-dot1q-bridge.yang ieee802-dot1q-types.yang ieee802-types.yang
802.3.2-2019	YANG data model definitions	ieee802-ethernet-interface.yang
802.1Qcr-2020	Asynchronous traffic shaping	ieee802-dot1q-ats.yang ieee802-dot1q-stream-filters-gates.yang
802.1Qcx-2020	YANG data model for connectivity fault management	ieee802-types.yang ieee802-dot1q-types.yang ieee802-dot1q-bridge.yang ....
802.1X-2020	Port-based network access control	ieee802-dot1x-types.yang ieee802-dot1x.yang
802.1ABcu-2021	LLDP YANG data model	ieee802-dot1ab-types.yang ieee802-dot1ab-lldp.yang
802.1CBcv-2021	FRER: Information model, YANG data model, and management information base module	ieee802-dot1cb-frer.yang ieee802-dot1cb-stream-identification-types.yang ieee802-dot1cb-stream-identification.yang
802.1CBdb-2021	Frame replication and elimination for reliability amendment 2: extended stream identification functions	ieee802-dot1cb-mask-and-match.yang

YANG Ethernet switch configuration standards

Standard	Description	YANG modules
802.1AEdk-2023	MAC privacy protection	ieee802-dot1ae-pry.yang ieee802-dot1ae-secy.yang ieee802-dot1x-eapol.yang
802.1Qcw-2023	YANG data models for scheduled traffic, frame preemption, and per-stream filtering and policing	ieee802-dot1q-preemption.yang ieee802-dot1q-psfp.yang ieee802-dot1q-sched.yang
802.1Qdj-2024	Configuration enhancements for time-sensitive networking	ieee802-dot1q-cnc-config.yang
802.1Qdx-2024	YANG data models for the credit-based shaper	ieee802-dot1q-cbsa.yang ieee802-dot1q-cbsa-bridge.yang
1588e-2024	1588 MIB and YANG modules	ieee1588-ptp-ms.yang ieee1588-ptp-tt.yang
802.1ASdn	AS YANG data model	ieee802-dot1as-gptp.yang
802.1Qdy	YANG for MSTP	ieee802-dot1q-rstp.yang ieee802-dot1q-mstp.yang
802.1AXdz	YANG for link aggregation	

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YANG vs ARXML: Per stream filtering and policing configuration

```
+--psfp-parameters
   +--flow-meters
   |   +--flow-meter-instance-table
   |   |   +--flow-meter-instance-id
   |   |   +--committed-information-rate
   |   |   +--committed-burst-size
   |   |   +--excess-information-rate
   |   |   +--excess-burst-size
   |   |   +--coupling-flag
   |   |   +--color-mode
   |   |   +--drop-on-yellow
   |   |   +--mark-all-frames-red-enable
   |   |   +--mark-all-frames-red
   |   +--max-flow-meter-instances
   +--stream-filters
```

```
+--EthSwtPSFP
|   +--EthSwtFilterMaxSduSizeTable
|   |   +--EthSwtFilterMaxSduSizeEntry
|   |   +--EthSwtFilterMaxSduSize
|   +--EthSwtFlowMeteringTable
|   |   +--EthSwtFlowMeteringEntry
|   |       +--EthSwtFlowMeterCF
|   |       +--EthSwtFlowMeteringCBS
|   |       +--EthSwtFlowMeteringCIR
|   |       +--EthSwtFlowMeteringColorMode
|   |       +--EthSwtFlowMeteringEBS
|   |       +--EthSwtFlowMeteringEIR
|   +--EthSwtStreamFilterTable
|   |   +--EthSwtStreamFilterEntry
|   |       +--EthSwtStreamFilterEntryPosition
```

YANG vs ARXML: Credit based shaper configuration

[ieee802-dot1q-bridge.yang](#), [ieee802-dot1q-cbsa-bridge.yang](#)

[Specification of Ethernet Switch Driver (autosar.org)](#)

```
+--bridge-port
|  +--port-type
|  +--transmission-selection-algorithm-table
|  |  +--traffic-class
|  |  +--transmission-selection-algorithm
|  +--cbsa-parameters
|  |  +--cbsa
|  |     +--cbsa-parameter-table
|  |        +--traffic-class
|  |        +--admin-idle-slope
```

```
+--EthSwtPort
   +--EthSwtPortIdx
   +--EthSwtPortRole
   +--EthSwtPortTimeStampSupport
   +--EthSwtPortEgress
   |  +--EthSwtPortEgressScheduler
   |  +--EthSwtPortQueue
   |     +--EthSwtPortEgressQueueIdx
   |     +--EthSwtPortQueueMinimumLength
   |     +--EthSwtPortQueueTrafficClassAssignment
   |     +--EthSwtPortE..nSelection
   |        +--EthSwtPortE..nSelectionAlgorithm
   |        |  +--EthSwtPortE..nSelectionCBSConfig
   |        |     +--EthSwtP..CBSIdleSlope
   |        |     +--EthSwtP..CBSLowerBoundary
   |        |     +--EthSwtP..CBSUpperBoundary
```

Working with IEEE YANG and AUTOSAR data models

- Lessons learned while working with IEEE YANG and AUTOSAR data models
  - Both models share similarities, but **data conversion is complex**.
  - **Main challenge**: Different structural paths for the same protocol properties.
  - Leaf name differences are less significant.
  - **Harmonization work is needed**!

- Key requirements for an ideal SDV data model:
  1) **Completeness**: Covers major standards.
  2) **Extensibility**: Easily incorporates new standards and vendor-specific settings.
  3) **Supports partial configurations**.
  4) **Flexibility**:
     - Multiple serialization options.
     - Supports various management protocols.
     - Supports multiple transport protocols.

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Summary

- A standard configuration data model:
  - Accelerates time to market by streamlining the development process.
  - Simplifies system complexity through model-based development.
  - Serves as a solid foundation for system development and validation.
  - Enhances resilience against supply chain disruptions.
  - Mitigates vendor lock-in challenges.
  - Lowers overall costs.

- Both IEEE YANG and AUTOSAR provide robust data models for switch configuration:
  - They share many commonalities.
  - However, further harmonization is needed to fully align the two models.

Thank you!

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