STATUS QUO OF DYNAMIC NETWORK MANAGEMENT WITH YANG-BASED CONFIGURATION MODELS

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SECURE CONNECTIONS
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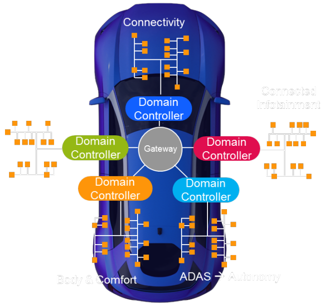
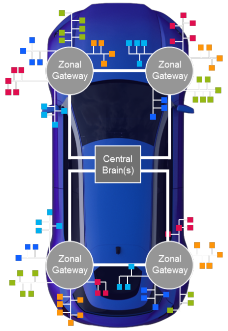
Motivation

- **Zonalization**



Zonalization



- **Service-Orientation**

Trend to service-based communication

Field-upgradability of features

DDS

SOME/IP

- **Fault Tolerance**

Reaction to faults at run-time

Heterogenous redundancy in the network

➢ Large Ethernet backbone networks
➢ Increasing number of switches and hops
➢ Co-existence of heterogenous traffic

➢ Run-time changes for networking configuration
➢ Dynamic resource management

➢ Fail-over handling
➢ Predictive monitoring

→ Efficient programmatic interface for network configuration is needed

→ YANG models can be used as a common language to describe devices and data

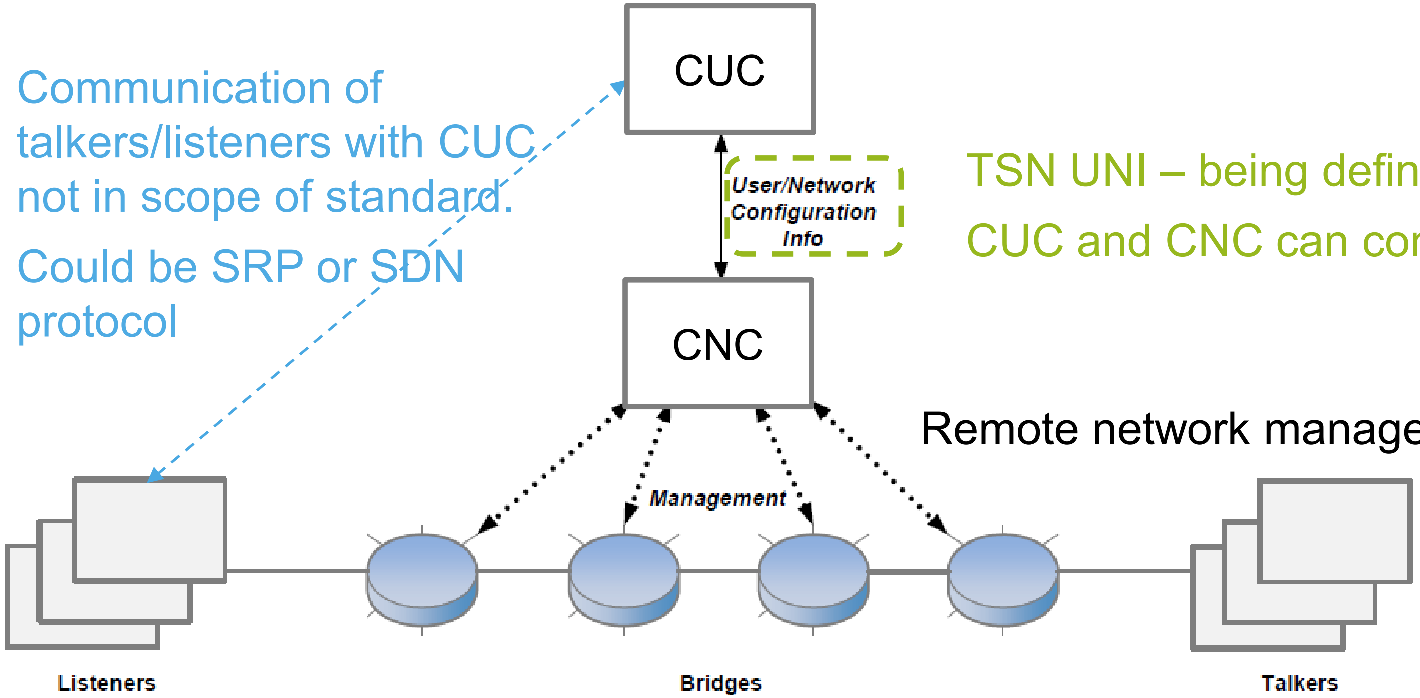
WHAT IS YANG?

- Modeling language designed for configuration, state, notifications and RPCs of a networking device
- Standardized by the IETF as RFC 7950 as a response to the heterogenous management interfaces in the market
- YANG models for various standards and devices are defined by
  - IETF
  - IEEE
  - MEF, ETSI, BBF, ODP, …
  - Vendors like Cisco, Fujitsu, Juniper, Huawei, Nokia, Ciena …
- Data instances of the YANG models can be used for dynamically managing switches, routers etc. using SDN protocols like NETCONF/RESTCONF

SDN ARCHITECTURE ACCORDING TO IEEE 802.1Qcc

Communication of talkers/listeners with CUC not in scope of standard.

Could be SRP or SDN protocol



TSN UNI – being defined in IEEE 802.1Qdj

CUC and CNC can communicate over e.g. RESTCONF

Remote network management protocol

Configuration Steps

1. CNC discovers topology and bridge capabilities
2. CUC learns and accumulates talker/lister requirements
3. CUC sends accumulated stream list to CNC
4. CNC configures TSN features in each bridge

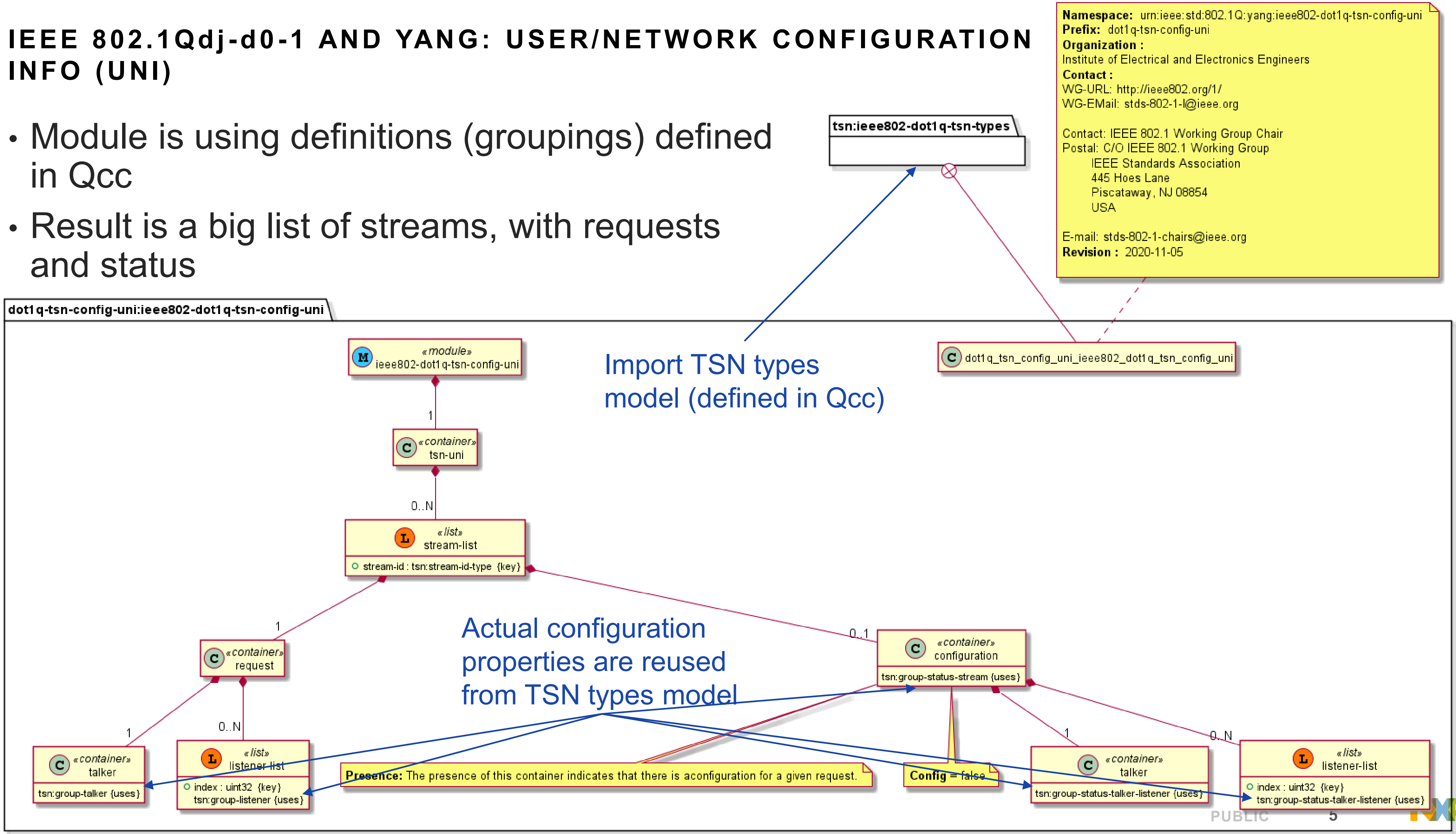
Changes in the network

CUC: Centralized User Configuration

CNC: Centralized Network Configuration

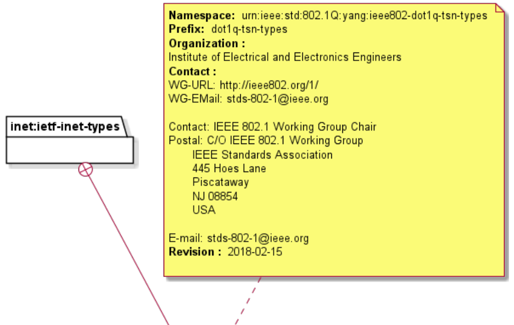
IEEE 802.1Qdj-d0-1 AND YANG: USER/NETWORK CONFIGURATION INFO (UNI)

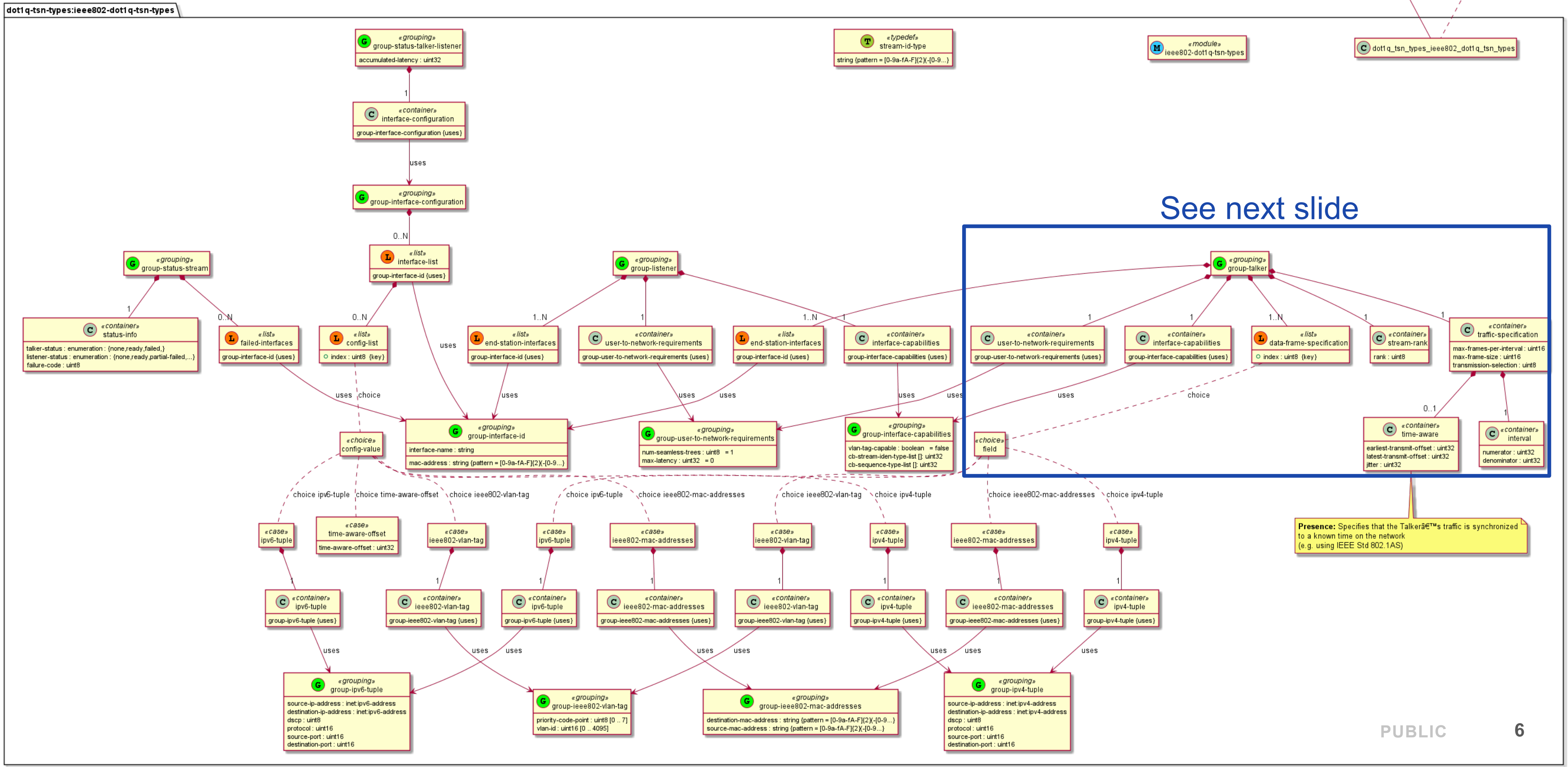
- Module is using definitions (groupings) defined in Qcc
- Result is a big list of streams, with requests and status



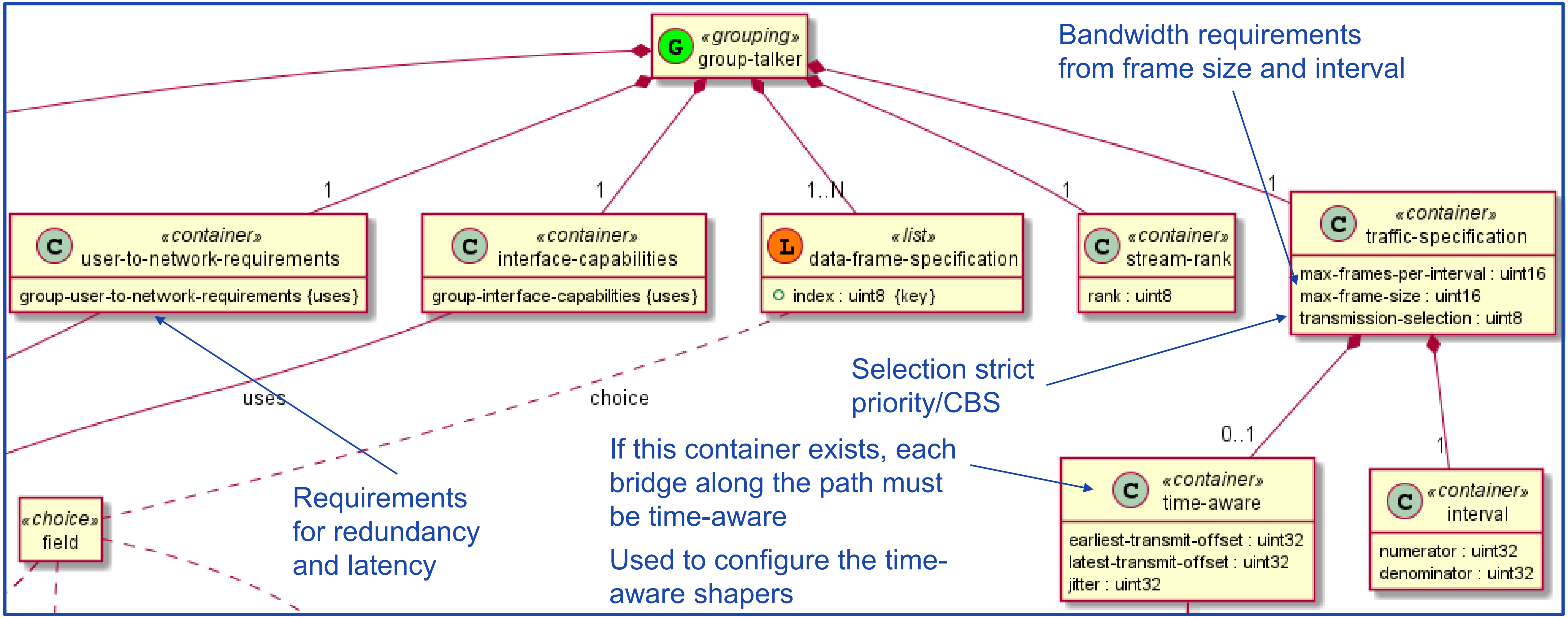
IEEE 802.1Qcc TSN TYPES (FOR REFERENCE)

Model is too extensive to visualize in a presentation → snapshot





IEEE 802.1QCC TSN TYPES – TALKER MODEL (PARTIAL)



Bandwidth requirements from frame size and interval

Selection strict priority/CBS

Requirements for redundancy and latency

If this container exists, each bridge along the path must be time-aware

Used to configure the time-aware shapers

PUBLISHED IEEE YANG MODELS (PARTIAL)

IEEE project	Description
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 (e.g. definition of a VLAN ID) • ieee802-types.yang (e.g. definition of MAC address) • …
802.1Qcr-2020	Asynchronous Traffic Shaping • ieee802-dot1q-ats.yang • ieee802-dot1q-stream-filters-gates.yang (part of Qci, but was needed for Qcr)
802.1Qcx-2020	YANG Data Model for Connectivity Fault Management • Updates to all models of the Qcp project • …
802.1X-2020	Port-Based Network Access Control • ieee802-dot1x-types.yang • ieee802-dot1x.yang
802.3.2-2019	YANG Data Model Definitions • ieee802-ethernet-interface.yang • …

DRAFT IEEE YANG MODELS

IEEE	Description	Stage
802.1Qcw	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	Draft
802.1Qdj	Configuration Enhancements for Time-Sensitive Networking • https://1.ieee802.org/tsn/802-1qdj/	Draft
802.1ABcu	LLDP YANG Data Model • ieee802-dot1ab-types.yang • ieee802-dot1ab-lldp.yang	Draft
802.1AEdk	MAC Privacy protection • ieee802-dot1ae.yang • ieee802-dot1ae-types.yang	Draft
802.1ASdn	YANG Data Model (depends on YANG model from 1588e)	PAR
802.1CBcv	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	Draft
802.1CBdb	FRER Extended Stream Identification Functions • ieee802-dot1cb-mask-and-match.yang	Draft
1588e	MIB and YANG Data Models • ieee1588-ptp.yang	Draft

YANG STATUS INTERMEDIATE SUMMARY

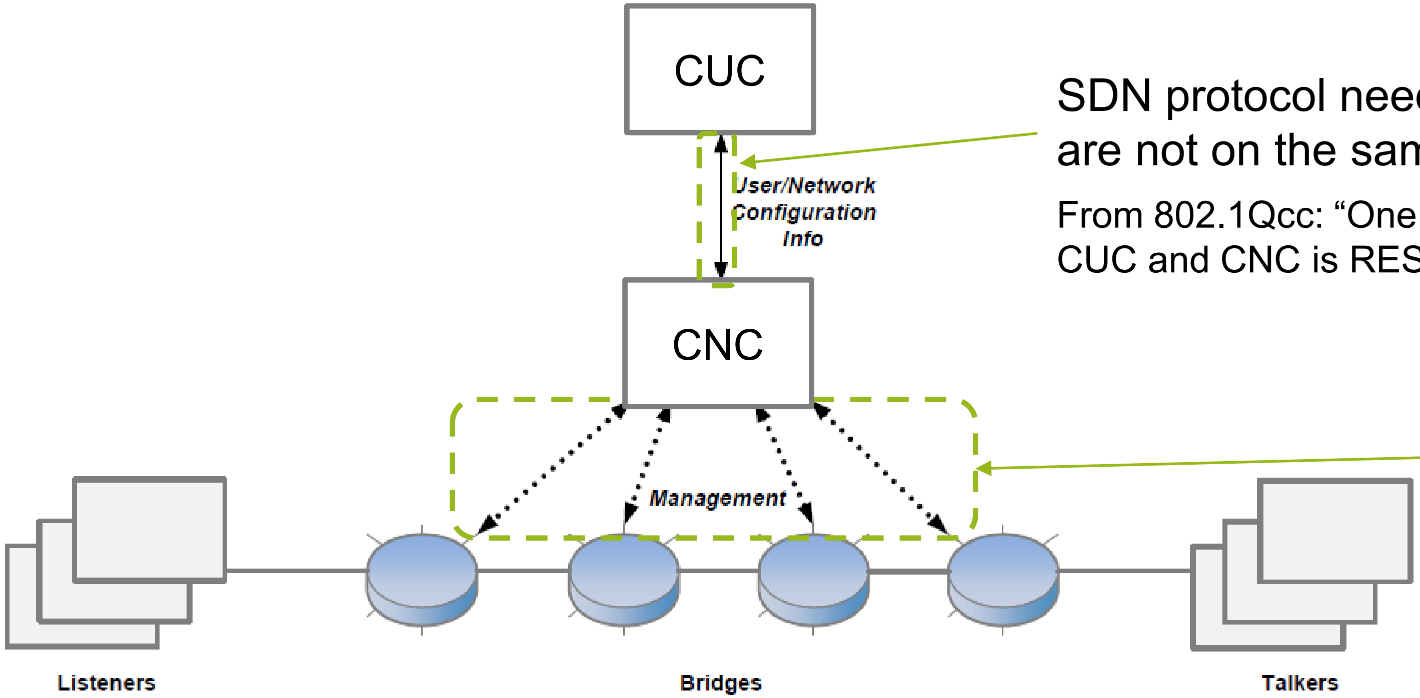
- IEEE standardization of YANG models is on a very good track
- As of today, it is possible to build a full TSN system with the existing (draft) models
- It will take a small number of years to reach full standardized situation

- However, there is more than just networking features based on IETF and IEEE
  - AUTOSAR, Avnu Alliance, and Open Alliance all specify additional networking features which are not covered by existing models

In addition to models, more is needed for a successful YANG ecosystem (tools, Software Development Kits, …)

→ For dynamic use cases, a transport mechanism for YANG data is needed

SDN ARCHITECTURE – YANG DATA TRANSPORT



SDN protocol needs to be used, if CUC and CNC are not on the same device

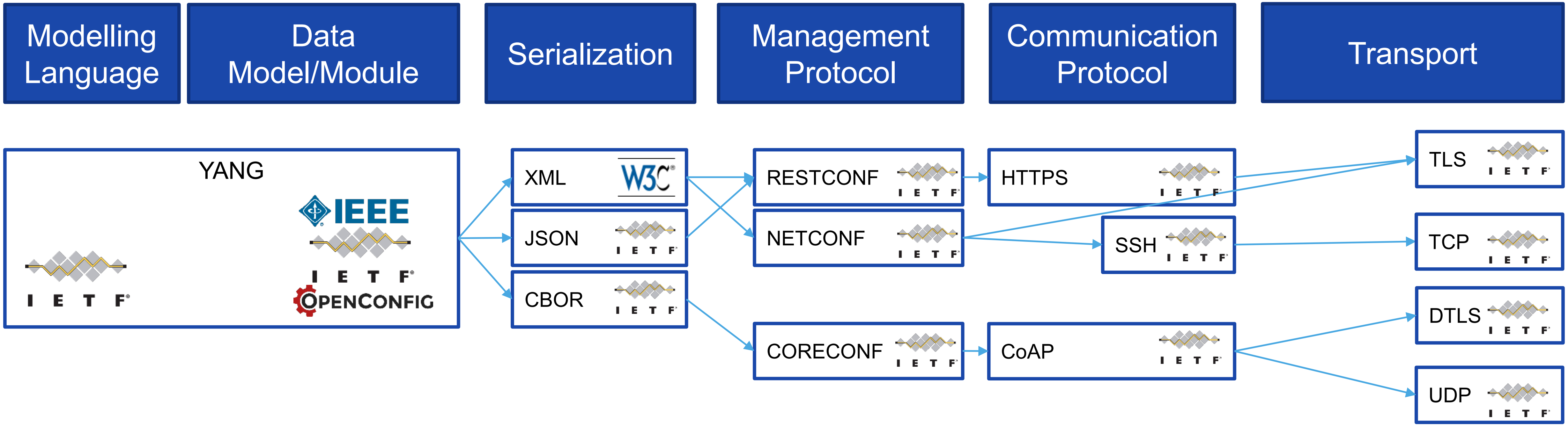
From 802.1Qcc: “One protocol explored for the UNI between CUC and CNC is RESTCONF”

From IEEE 802.1Qcc: “Examples of a remote network management protocol include Simple Network Management Protocol (SNMP), NETCONF, and RESTCONF”

SNMP is outdated and does not support YANG

→ Next slides show introduce the YANG capable SDN protocols

YANG SDN PROTOCOL ECOSYSTEM



Models are the common denominator and root of SDN protocols discussed here

Concrete data instances need to be described in a machine-readable format

Provide mechanism to retrieve state and modify configuration

Data transfer

Mechanism for (secure) transport

X-CONF COMPARISON

	NETCONF	RESTCONF	CORECONF
Year of Standardization	2006	2017	>= 2021
Transport Layer	(SSH)/TLS	HTTPS	DTLS
Header format	XML	XML/JSON	Binary
Payload format	XML	XML/JSON	CBOR
Datastores	All	Running only	Running only
Distributed Configuration	yes	no	no
Locking	yes	no	No
Capability Discovery	yes	yes	yes
REST interface	no	yes	yes

- Selection of NETCONF/RESTCONF is probably a question of preference
  - NETCONF has a longer history and better support
  - If you like web programming, REST, and json, then RESTCONF is better suited
- CORECONF enables SDN style of operations for constrained devices like microcontrollers

CONCLUSIONS AND SUMMARY

- **SDN:** Current trends like zonalization, service orientation, and fault-tolerance lead to the need for programmatic access to the network's configuration and state
- **YANG:** Data modeling language perfectly fits this use case, and is widely adopted by standardization bodies
- **IEEE & YANG:** Great progress on TSN modelling. While not all models are finalized, full prototypes can be built with the existing draft models
- **SDN & YANG**: Good scale of SDN management protocols available from big application processors to constrained microcontrollers

Next steps:

- Definition of Automotive use-cases and requirement
- Closing gaps in models where necessary
- Build the infrastructure needed for YANG deployment

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