Further IEEE802.1Qcc Discussions

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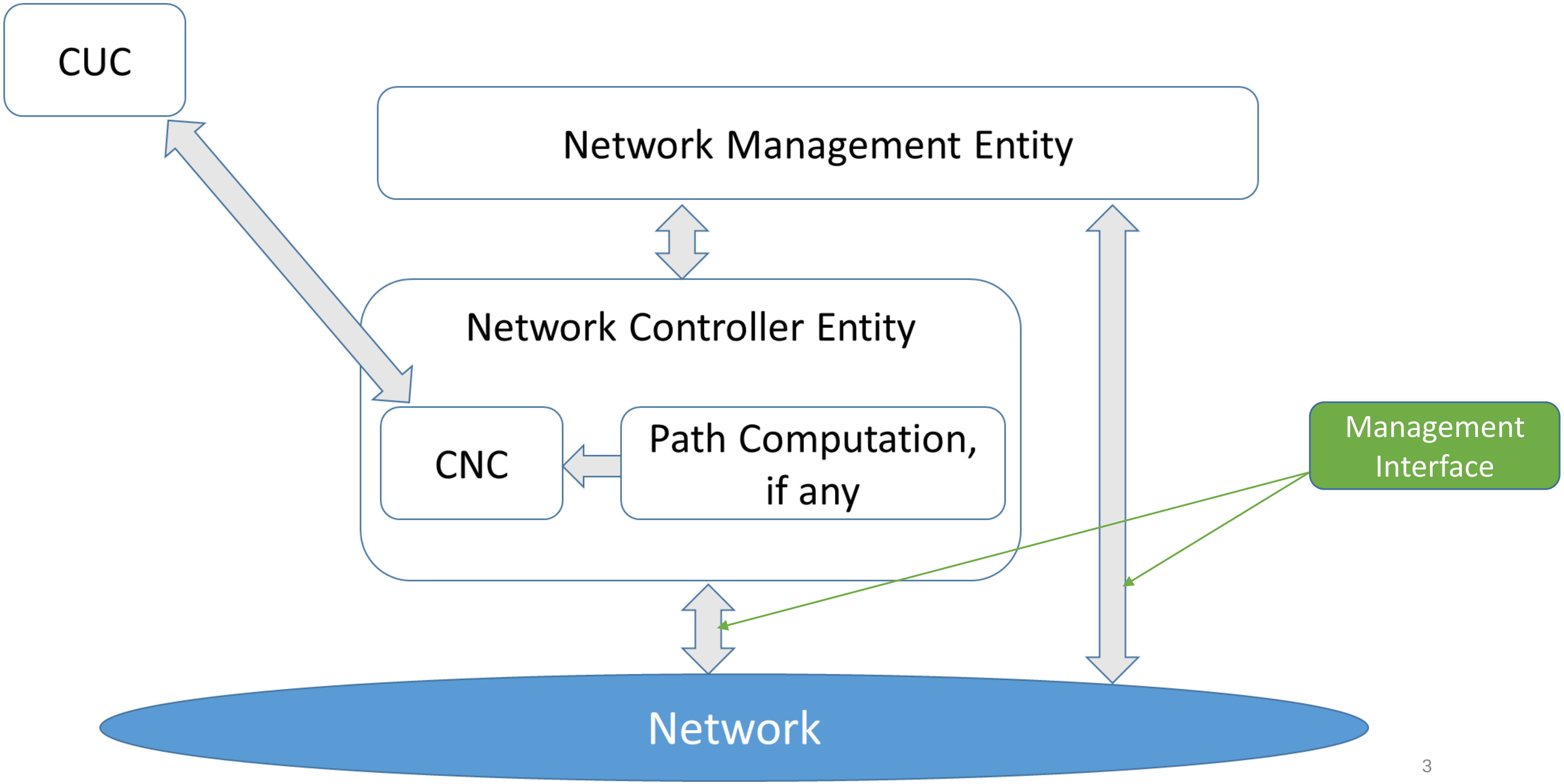
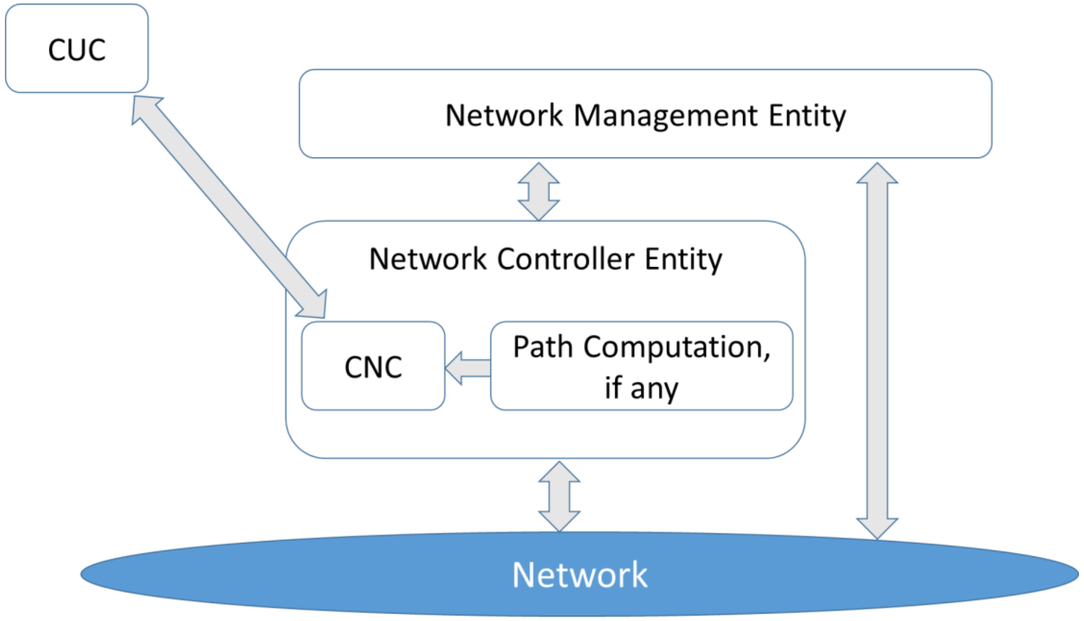
Background

- There have been on-going discussions regarding Network Configuration & Stream Configuration
  - http://www.ieee802.org/1/files/public/docs2018/60802-Steindl-Configuration-0718-v02.pdf
  - http://www.ieee802.org/1/files/public/docs2018/60802-woods-QccUNI-0718-v01.pdf
  - http://www.ieee802.org/1/files/public/docs2018/60802-Steindl-ConfigurationModelAlignment-0718-v01.pdf
- Further contributions regarding the capabilities of IEEE802.1Qcc were requested.
- As importantly, an understanding of what is not configured by IEEE802.1Qcc is desired.
- It was felt that a contribution on the current capabilities of IEEE802.1Qcc would help facilitate further discussion.

Management Model



Proposed Management Model

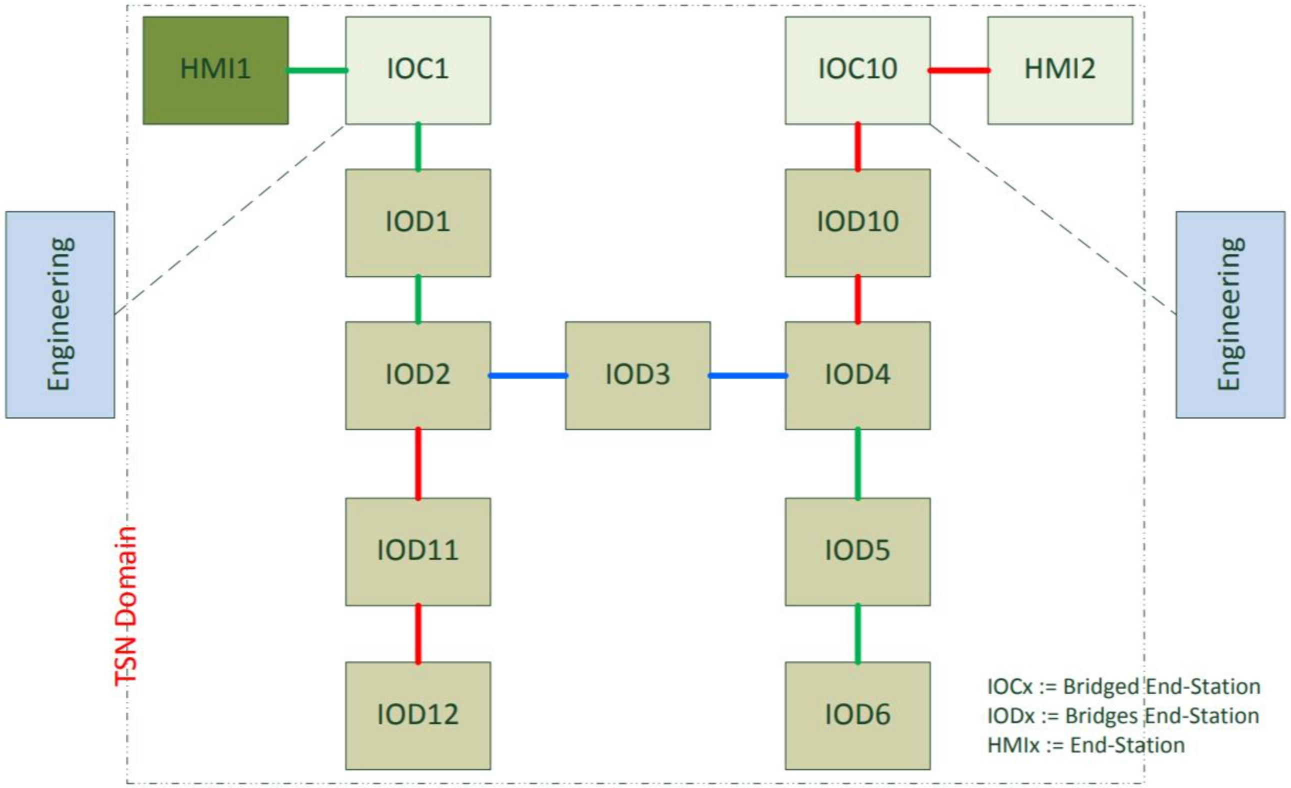


- CUC: A centralized entity that discovers end stations, retrieves end station capabilities and user requirements, and configures TSN features in end stations. A CUC exchanges information with a CNC in order to configure TSN features on behalf of its end stations.
- CNC: A centralized component that configures network resources on behalf of TSN applications (users).
- Path Computation: Provides path information to configure TSN streams (e.g. IEEE802.1CA).
- Network Management Entity: Provides:
  - Static configuration of all managed objects (e.g. configuration of paths)
- Management Interface: Provides access to all IEEE802.1 and IEEE802.3 managed objects via a standard data model (MIB, YANG) and a standard management protocol (SNMP, Netconf, Restconf, etc.)

Centralized Configuration Benefits

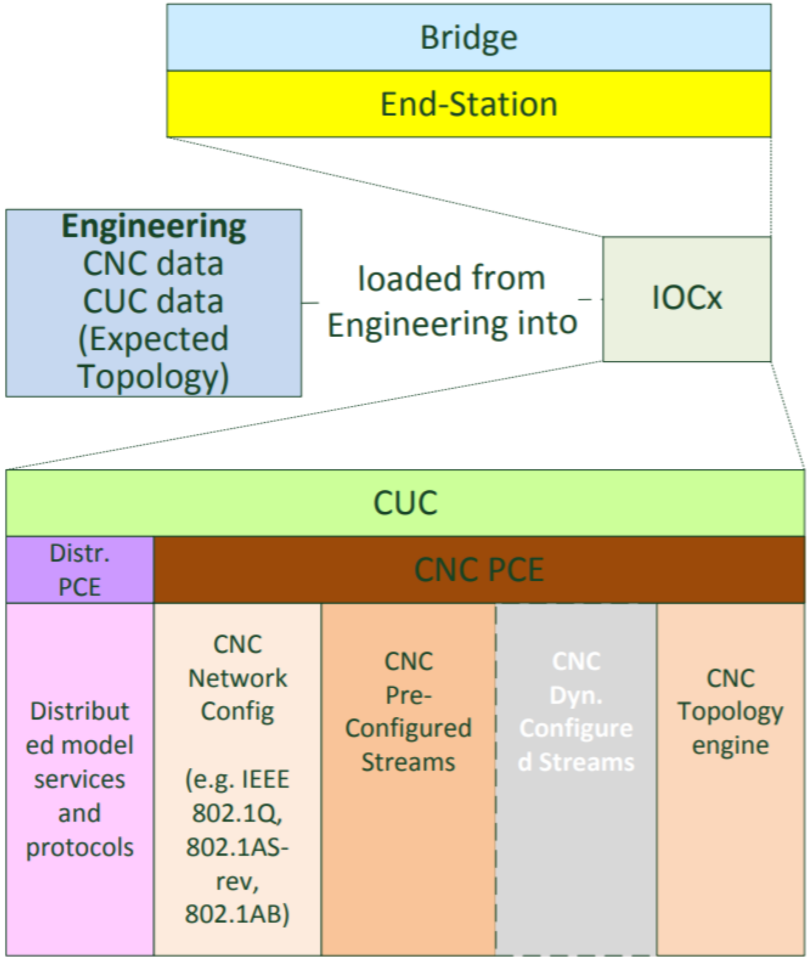
- There are two fundamental benefits to using a CNC :
  - The CNC has a comprehensive view of the network, which enables benefits that are not possible otherwise.
    - A CNC can compute worst-case latency from Talker to each Listener.
    - A CNC can calculate complex schedules based upon traffic requirements.
  - The CNC can abstract away the nitty-gritty details of network configuration (i.e. make things easier).
    - Scheduling and other traffic shaping.
  - The CNC and the UNI are intended as abstractions. The 802.1 technologies used to realize the user and network requirements are just a means to an end. To be compliant, the CNC need only;
    - Support the use of a remote management protocol.
    - Support the managed object definitions and encodings for Stream reservation remote management
    - Support the use of at least one protocol for User / network configuration information that complies with the requirements for protocol integration defined in 46.2.
      - YANG, SRP or Both
  - There are no conformance requirements for the CUC specified in IEEE 802.1Qcc.

Terminology



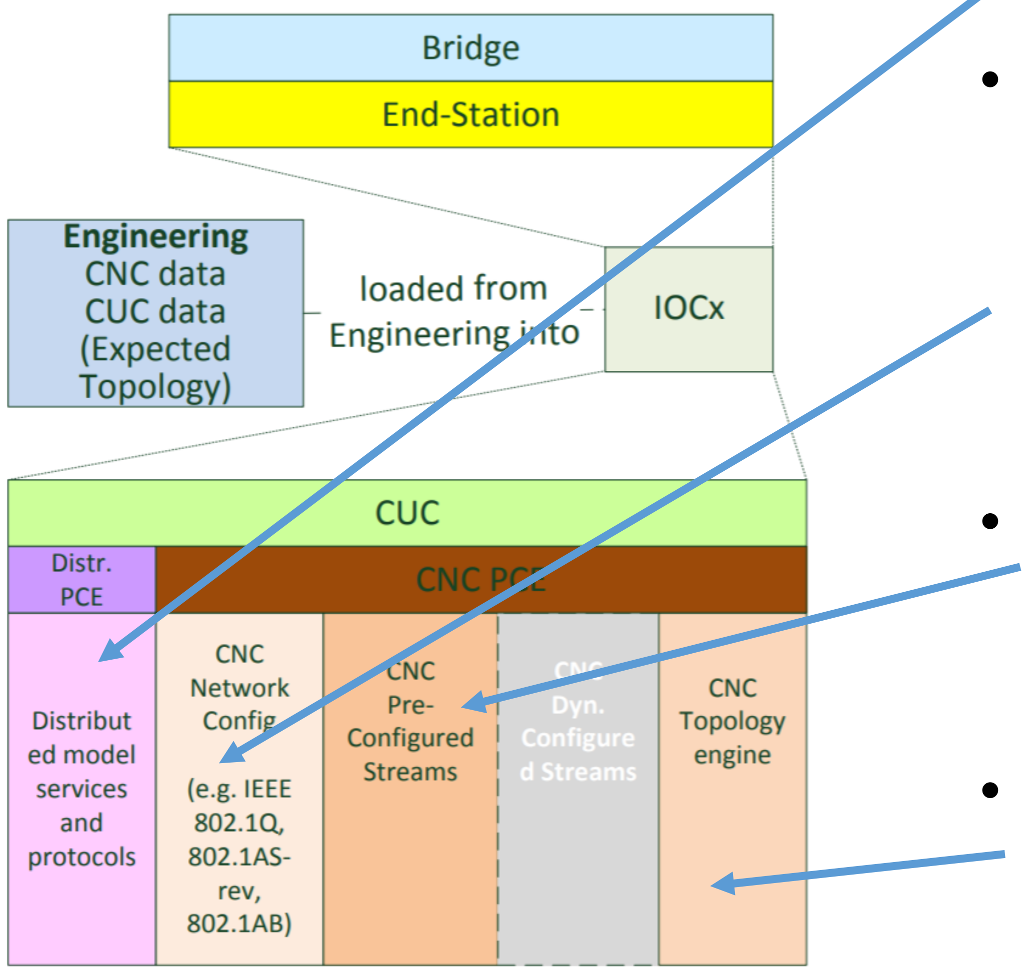
- IOC: I/O Controller. A bridged end-station.
- IOD: I/O Device. A bridged end-station.
- HMI: Human-Machine Interface. An end-station
- Engineering: On-off line engineering tool.

Network and Stream Configuration



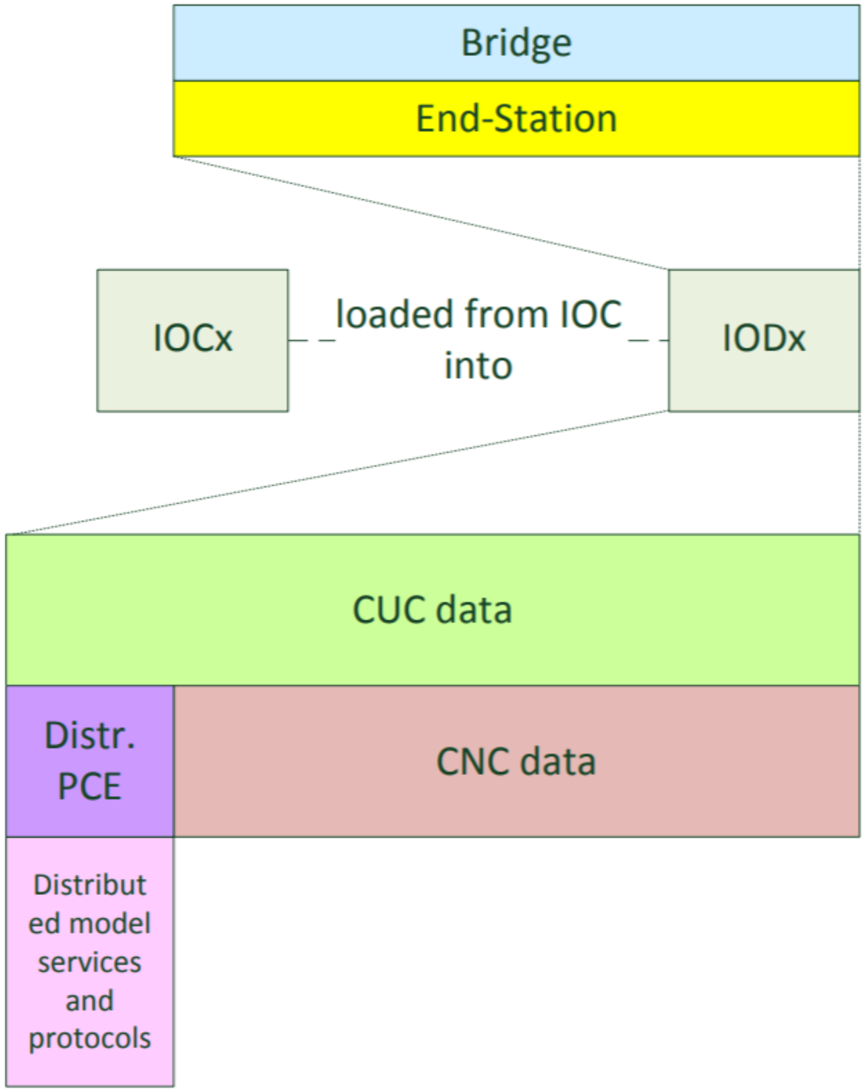
- IOC loaded by engineering, with CUC, CNC and if required by customer with expected topology data. Engineering is afterward removed from the system.
  - This requirement in in line with the centralized model.
- IOCs topology engine discovers topology and uses it together with the loaded CNC data to create data which is loaded into any bridge and end-station.
  - Again, this is consistent w/ the centralized model. Specific data model for passing topology data between the CNC and CUC is not defined.
  - If LLDP is used for discovery, the CNC can learn the topology via it's management interface. Note: Some industrial "brown field" protocols do not make use of LLDP
- IOCs CNC portion loads the bridge in the TSN domain and IOCs CUC portion the end stations with their stream information.
  - This is consistent w/ the definition of a CUC from 802.1Qcc

Network and Stream Configuration - Questions



- This function should interoperate with Dynamic configuration of streams (i.e. hybrid model)
- The UNI currently contains no user parameters which could be used for configuration of 802.1AS-Rev or 802.1AB.
  - Static configuration of the 802.1AS-Rev spanning tree could presumably be accomplished by the management entity
  - The CNC could use LLDP to become topology aware
- Not certain how this function would interoperate with Dynamic configuration of stream.
  - How to ensure the CNC doesn't overwrite, yet remains aware of, static configurations
- Not quite sure what this function represents. Seems to contradict the requirement stating the IOC will provide topology information.

Network and Stream Configuration



- IOD loaded by IOC, with CUC and CNC data. CNC data is persistent stored in IOD.
  - Consistent with the hybrid model. There may be a bit of a terminology issue here.
    - The centralized network / distributed user model is similar to the fully distributed model, in that end stations communicate their Talker/Listener requirements directly over the TSN UNI.
  - That said, I see no reason this approach won't work.
- CNC data configures the local bridge and end-station.
  - This is consistent w/ the hybrid model.
- CUC data is used for stream establishment and may be dynamically changed by the IOC over time.
  - Again, this is consistent w/ the hybrid model.

Stream establishment - distributed

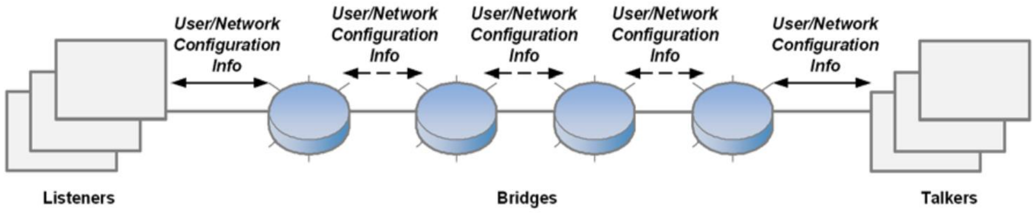
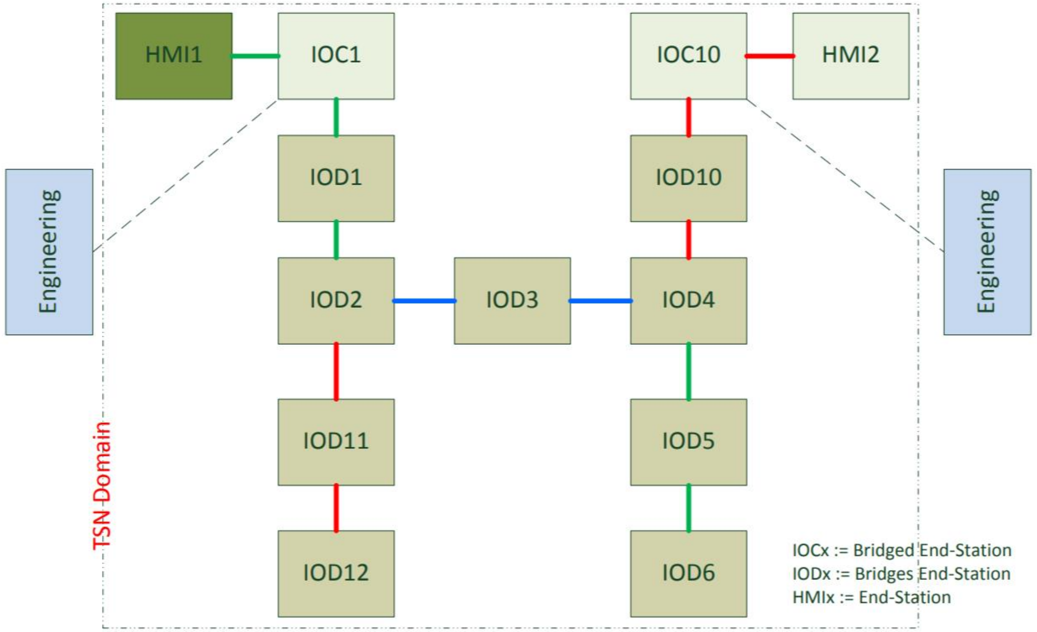


Figure 46-1 — Fully Distributed Model

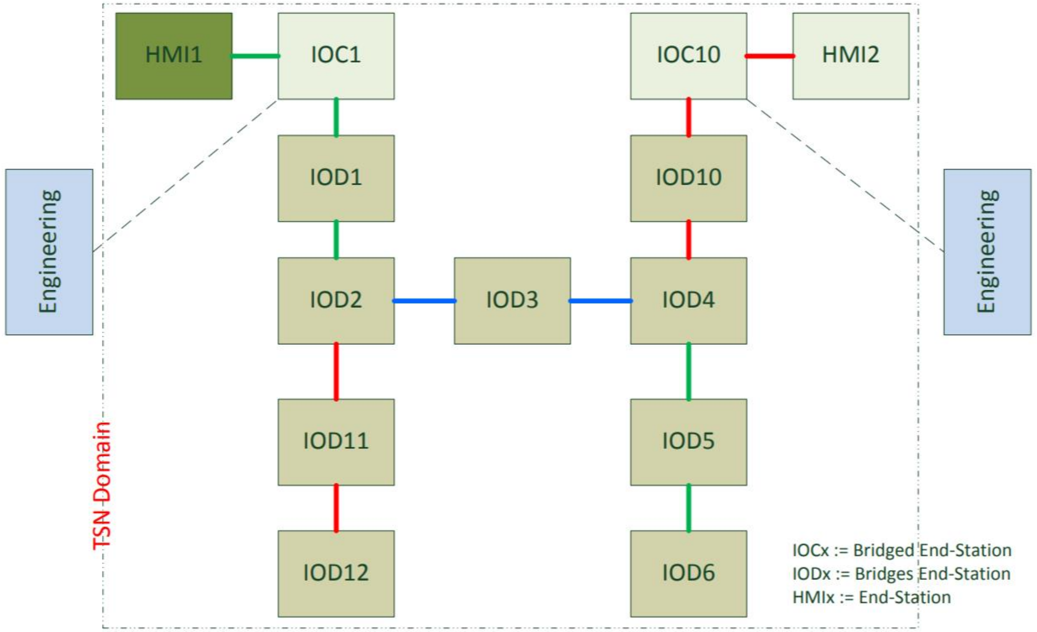
- End-stations use a to-be-specified UNI interface defined for the distributed stream establishment to setup paths and streams.
  - Consistent with the distributed model.
- Using CUC data and CNC data, e.g. network cycle, reduction ratio and sequence as criteria's.
  - Again, a bit of a terminology issue (i.e. CUC data and CNC data vs. end station requirements).
  - UNI will need to be expanded to include these criteria.
- Allows us to get rid of end-station -> CUC/CNC, together with the CNC -> CUC communication.
  - Agreed.

Multiple CNCs



- Each IOC is loaded from its Engineering with its devices and the TSN domain setup.
- Thus, each IOCs CNC is able to configure all bridges and end-stations with the provided TSN domain CNC data, and uses its CUC data to setup the streams.
- If two or more IOCs (and thus two or more CNCs) are in one TSN domain, each one is able to configure the whole TSN domain.

Multiple CNCs



- This is where things get tricky.
- This topology and associated requirements requires a level of cooperation between CNCs.
- If this is truly a requirement the 60802 joint project needs to:
  - Establish a common set of rules governing CNC behavior when multiple CNCs are present
  - Establish a communication interface between CNCs. At a minimum, each CNC would need to be aware of the other's presence in the network.

Centralized model

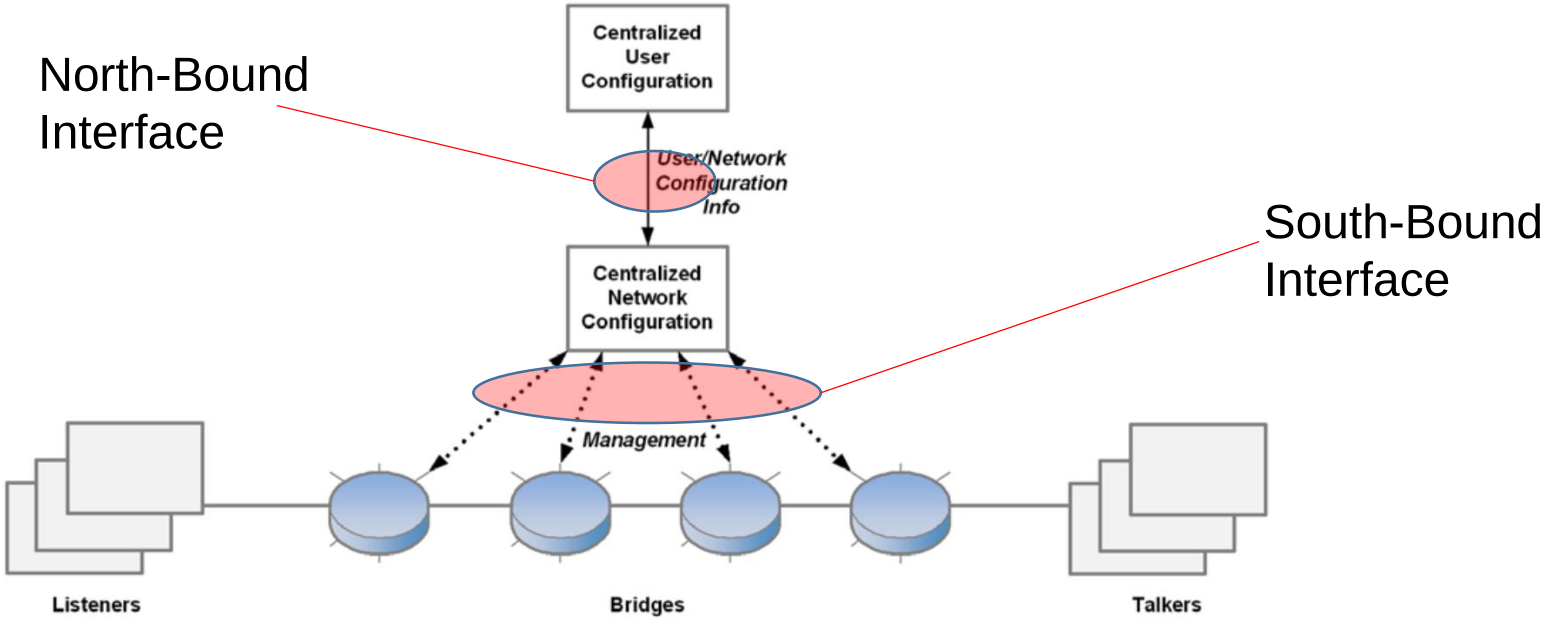


Figure 46-3 — Fully Centralized Model

- The following TSN features can be configured by Bridges using this model:
  - Credit-based shaper algorithm
  - Scheduled traffic
  - Frame Replication and Elimination for Reliability (IEEE Std 802.1CB)
  - Frame preemption
  - Per-stream filtering and policing
  - Cyclic queuing and forwarding

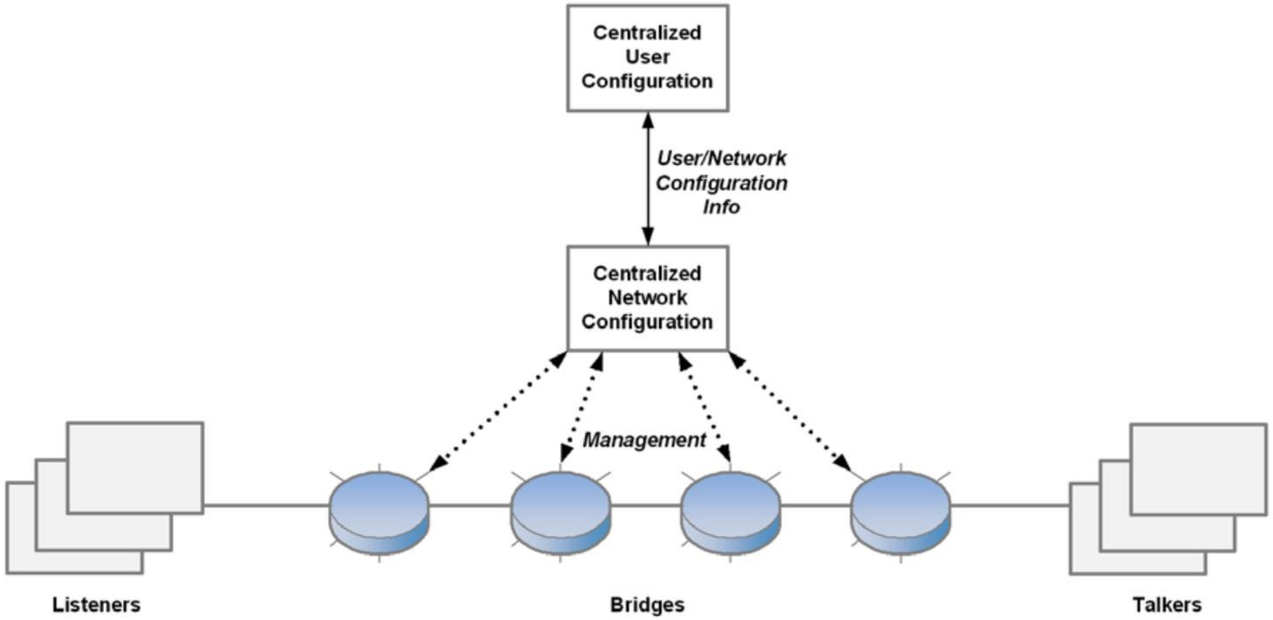
South-Bound Interface (management)

- For the sake of discussion, let's think of the South-bound interface as management:
  - Supports one or more standard management protocols (netconf, restconf, SNMP).
  - Supports one or more common data model.
- Therefore, it can be assumed that the CNC can control all TSN feature via standard management variables.
- It can be further assumed that the CNC can gather bridge/port capabilities via management, but not end device capabilities or user requirements.
- A final assumption, the CNC is topology-aware via an unspecified mechanism.
- However, does the CNC have all of the information needed to decide how the network is to be configured?

North-Bound Interface (UNI)

- The North-bound interface provides the following user input to the CNC
  - Talker Group
    - Stream Identification
    - End Station Interfaces
    - Data Frame Specification
    - Traffic Specifications
    - User to Network Requirements
    - Interface capabilities
  - Listener Group
    - Stream Identification
    - End Station Interfaces
    - User to Network Requirements
    - Interface capabilities
  - Status Group

Centralized network / distributed user model (hybrid model)



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?

Preemption

- Northbound Interface
  - There is no user input provided for preemption.
  - However, required traffic characteristics are provided.
- Southbound Interface
  - Managed objects are available to determine capabilities and override defaults.
- Conclusion
  - Preemption is negotiated on a link-to-link basis.
  - Based upon traffic/stream requirements and upon an understanding of capabilities, the CNC could, in theory, take advantage of preemption when performing network calculus or scheduling.
  - No change or addition to the UNI is required.

Per-stream filtering and policing

- Northbound Interface
  - There is no user input provided for selection of filters/policers, constraints, etc.
- Southbound Interface
  - Managed objects are available to determine capabilities and override defaults.
- Conclusion
  - Is user input required to configure PSFP (i.e. do we need to change the UNI)?
    - Debatable. For instance, the CNC could assume:
      - Policing of bandwidth from Talker to Listeners is always required when available
      - No frame of the Stream is forwarded outside the ports between Talker and Listeners
    - This would allow the CNC to configure PSFP based upon traffic requirement and the shaping mechanism selected.
    - Would a set of common assumptions be adequate for industrial use cases?
  - Since Cyclic queuing and forwarding uses PSFP, the conclusion also applies to this feature.

Time synchronization

- Northbound Interface
  - There is no user input provided for configuration of time synchronization.
- Southbound Interface
  - Managed objects are available to determine capabilities and override defaults.
- Conclusion
  - IEEE 802.1AS is a “plug and play” technology.
    - Spanning tree is established via BMCA
    - BMCA also selects the best available source of time
  - PIEEE802.1AS-REV provides port settings which allow the user to establish the spanning tree (i.e. determine which ports will act as master and which as slaves).
  - AS-REV also provides for additional time domains which can be used to enable some form of grandmaster redundancy.
  - Is user input required to configure These features (i.e. do we need to change the UNI)?
    - Debatable:
      - See http://www.ieee802.org/1/files/public/docs2016/cc-cummings-time-sync-uni-0316-v02.pdf
    - Certainly in needs to happen somewhere, but does it require a centralized overview of the network (should the job belong to the CNC)?

Conclusions

- The requirements for configuration as outlined by http://www.ieee802.org/1/files/public/docs2018/60802-Steindl-ConfigurationModelAlignment-0718-v01.pdf are for the most part, supported by existing mechanisms.
- Consistent terminology for the various management entities needs to be agreed upon.
- The concept of multiple CNCs in a network is not well-address and may be an appropriate subject for the 60802 joint project.

Thank you