Hierarchical CUC/CNC management model

Amin Abdul
Molex Canada

April 2020

Overview

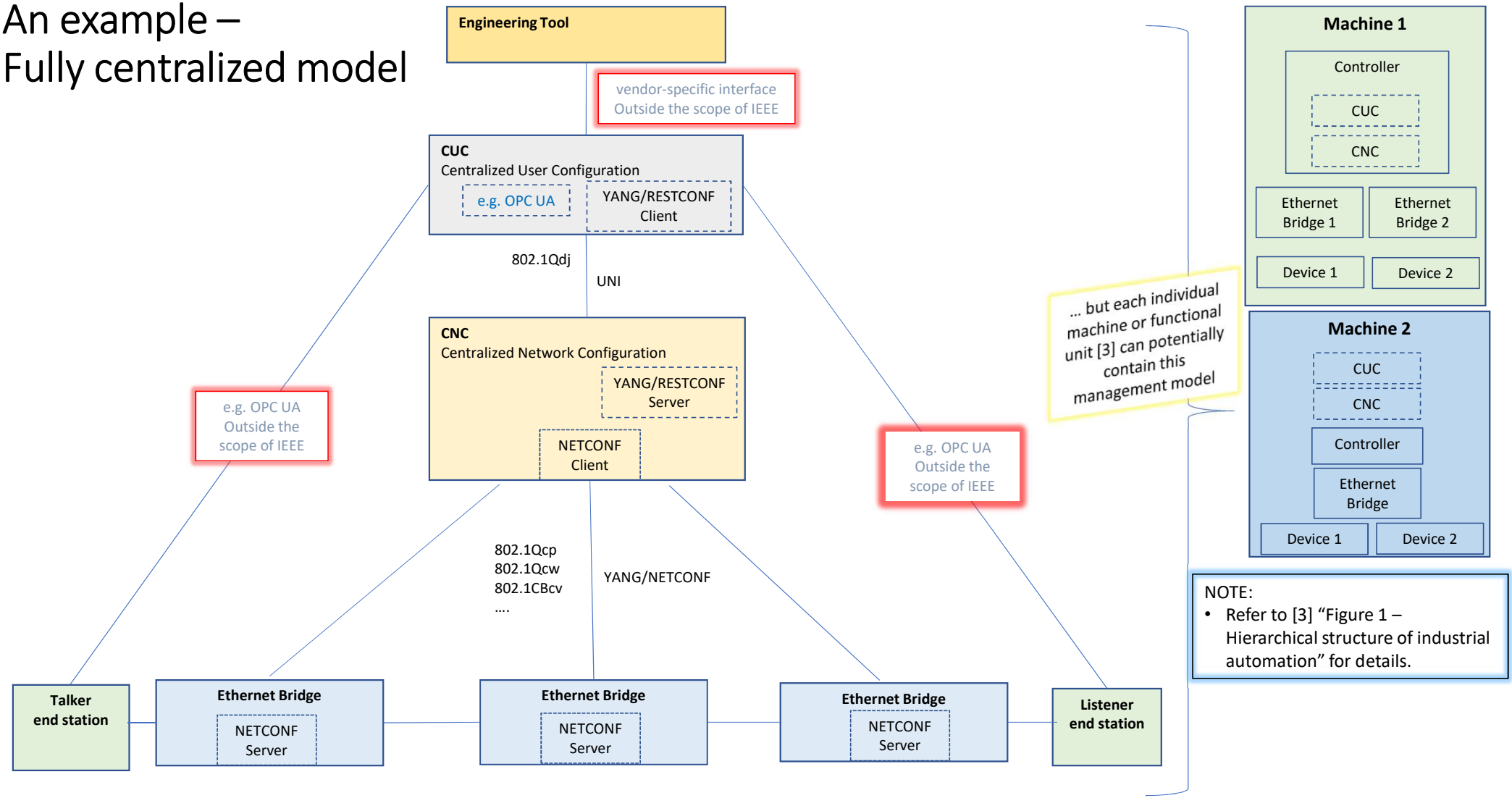
Problem statement: It seems that neither IEEE standards nor “IEC/IEEE 60802 D1.1 TSN Profile for Industrial Automation” is prescribing any reference management model which deals with the hierarchical CUC/CNC scenario.

Goals:

- Abstract system models for configuration and monitoring in hierarchical CUC/CNC scenario.
- Identify requirements, gaps and potential remedies.

- Disclaimer – some or all models in this presentation may be known to the working groups.

An example – Fully centralized model

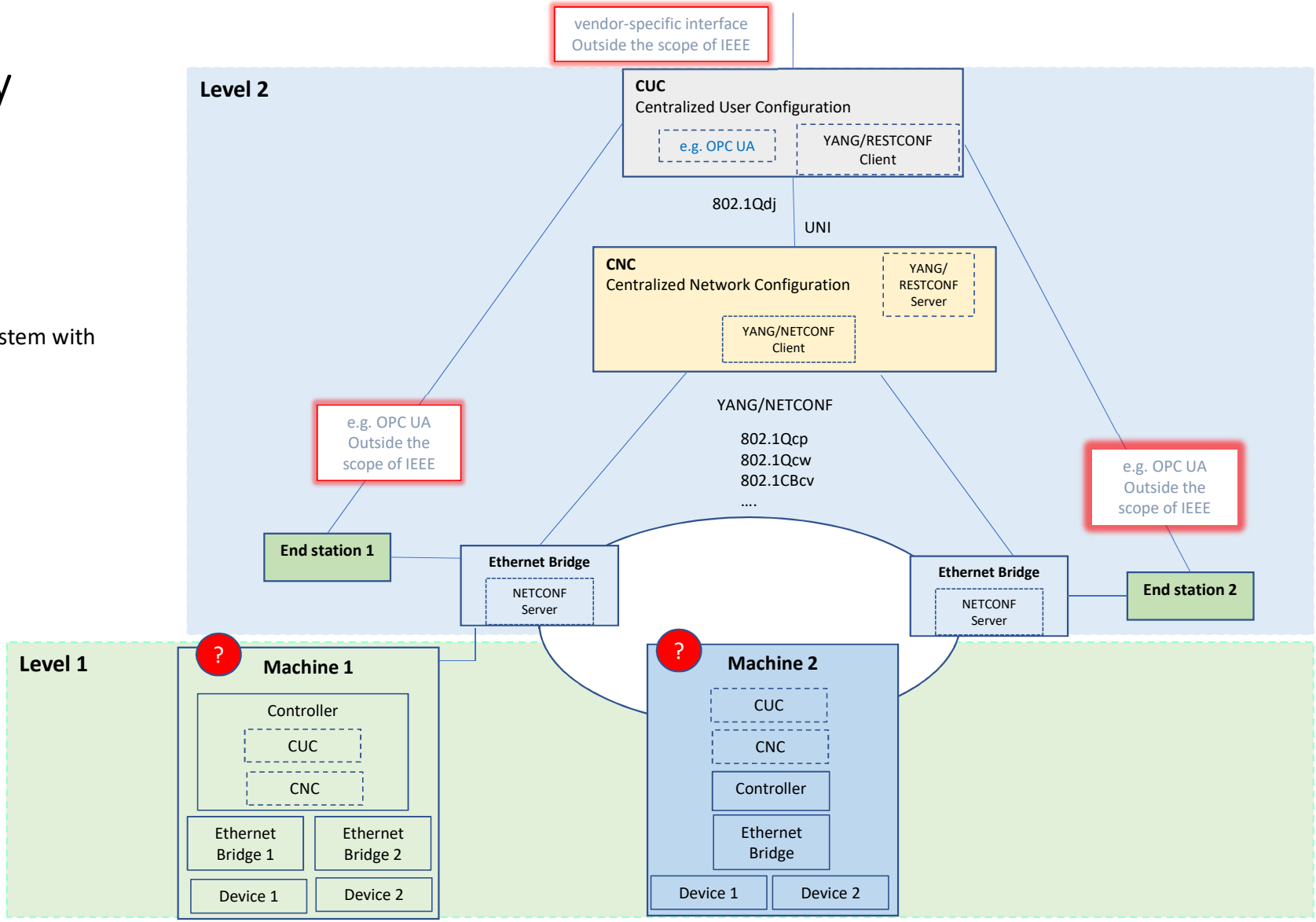


NOTE:

- Refer to [3] “Figure 1 – Hierarchical structure of industrial automation” for details.

An example – 2-level hierarchy

Q. How to model “Level 1” system with respect to “Level 2”?



Generalized view – N-level hierarchy

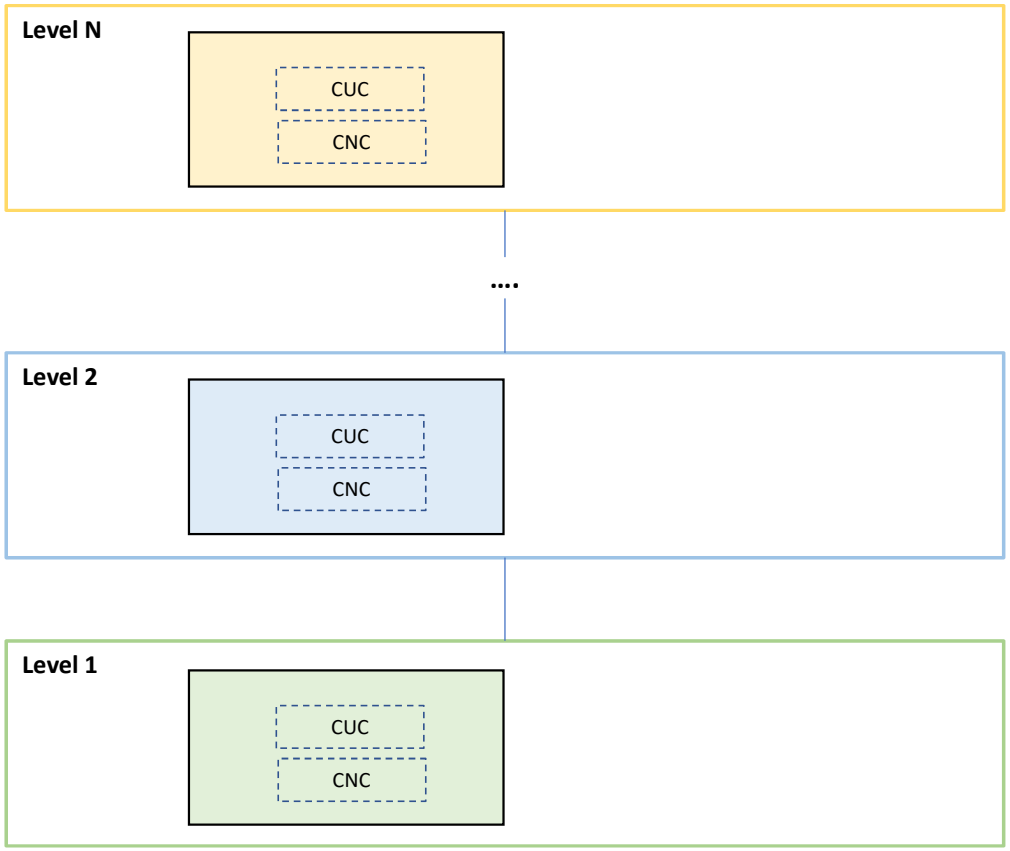
Problem:

- CUC/CNC network view and scope may varies between levels.
- CUC/CNC capabilities may varies between levels.
- CUC/CNC policies may varies between levels….

Aim:

- N-level system hierarchy is aiming for consistency and 1st level of interoperability (refer to [3] – Figure 3) in configuration and monitoring domains.

Q. How to model “Level K-1” system with respect to “Level K”?



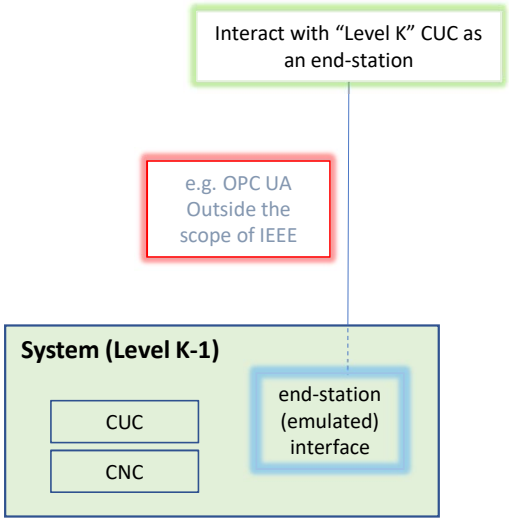
How to model “Level K-1” system with respect to “Level K”?

- Depending on the system personality resides at “Level K-1”.
- System can be model as
  - an end-station
  - a bridged-end-station

System as an end-station [1]

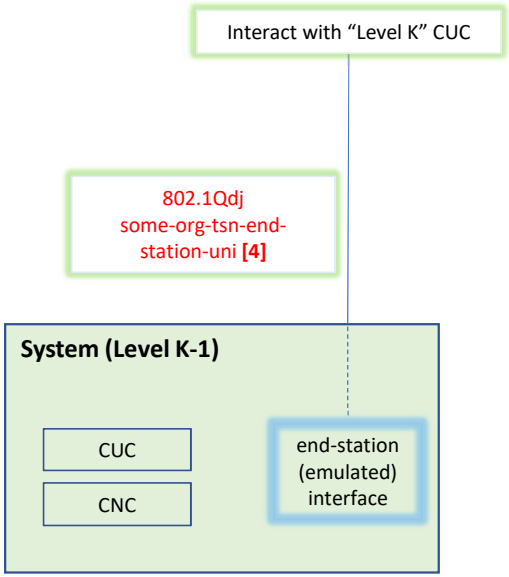
- System acts as a single monolithic entity.
- Options:
  - Model as an end-station with respect to “Level K” CUC (option 1 and 2).
  - Model as “Level K-1” CUC with respect to “Level K” CNC (option 3).

Option 1:



- Constraint: System at “Level K-1” and CUC at “Level K” can interoperate only if they agree on the common user-to-user interface.

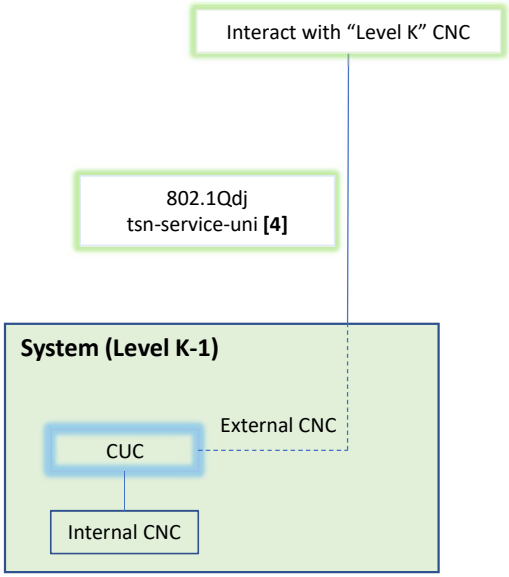
Option 2:



- Constraint: System at “Level K-1” and CUC at “Level K” can interoperate only if they have common understanding of some-org-tsn-end-station-uni.

System as an end-station [2]

Option 3:



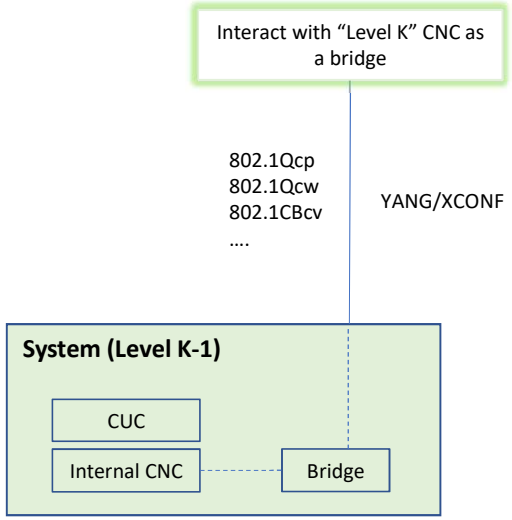
- “Level K-1” CUC differentiate between internal and external CNC.
- Assumptions:
  - CNC at “Level K” is capable of accepting requests from multiple CUC.
  - 802.1Qdj working group will take care of YANG model - tsn-service-uni.

System as a bridged-end-station [1]

- XCONF → NETCONF/RESTCONF

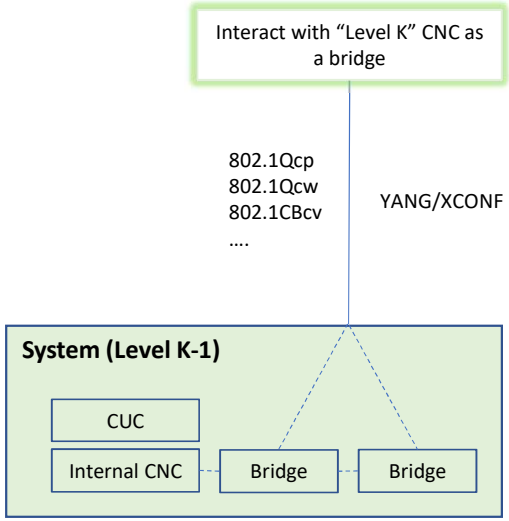
- System acts as a single monolithic entity with respect to internal details but acts as a Bridge for pass-through traffic.
- Options for end-station entity:
  - Bridged-end-station system model adds ieee802-dot1q-tsn-end-station-uni [4] option to the "system as an end-station" list.
- Options for Bridge entity:
  - System expose Bridge(s) directly via YANG/XCONF (option 1 and 2)
  - Constrained based exposure (option 3 and 4).

Option 1 (single Bridge):



- Superimposed end-station models from the "system as an end-station" + ieee802-dot1q-tsn-end-station-uni.
- Direct access to Bridge management interface may not be feasible.
- Bridge personality is control via internal and external CNC which may trigger such as resource ownership issues, conflicting configuration requirements …
- External CNC may invalidate certain assumption(s) made internally.

Option 2 (Multiple Bridges):

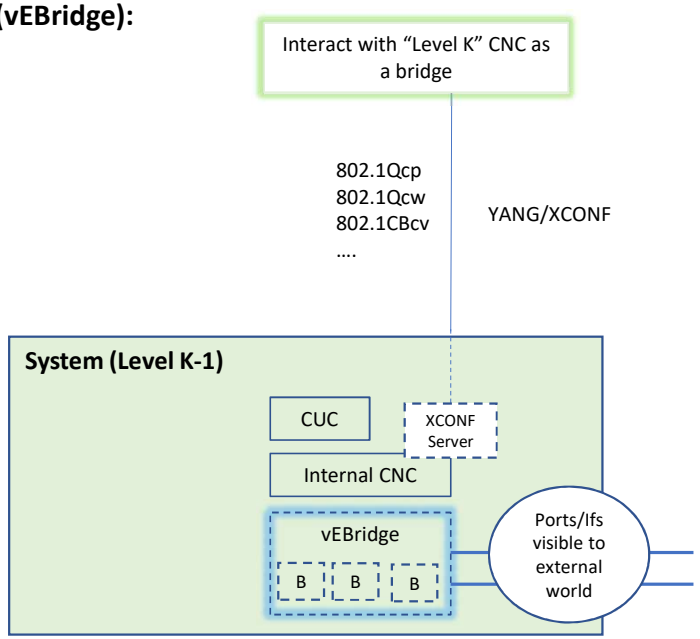


- Superimposed end-station models from the "system as an end-station" + ieee802-dot1q-tsn-end-station-uni.
- Direct access to Bridge(s) management interface may not be feasible.
- Bridge personality is control via internal and external CNC which may trigger such as resource ownership issues, conflicting configuration requirements …
- External CNC may invalidate certain assumption(s) made internally.
- Invalidate bridged-end-station model due to the exposure of multiple internal bridges.

System as a bridged-end-station [2]

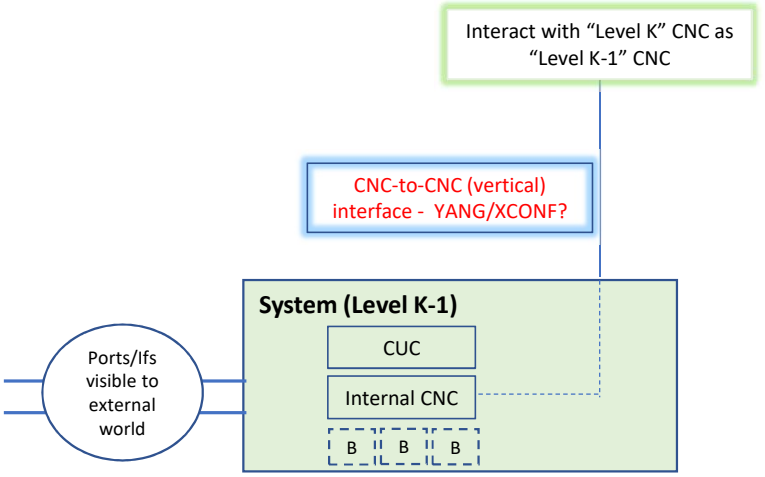
- vEBridge → virtual External Bridge

Option 3 (vEBridge):



- Superimposed end-station models from the "system as an end-station" + ieee802-dot1q-tsn-end-station-uni.
- Controlled Bridge(s) visibility via the concept of vEBridge.
- Internal CNC should implement the concept of vEBridge to avoid ownership issues.
- Constraints:
  - System internally manage the composition of vEBridge.
  - Concept of vEBridge?
  - YANG model for vEBridge?

Option 4 (CNC-to-CNC):

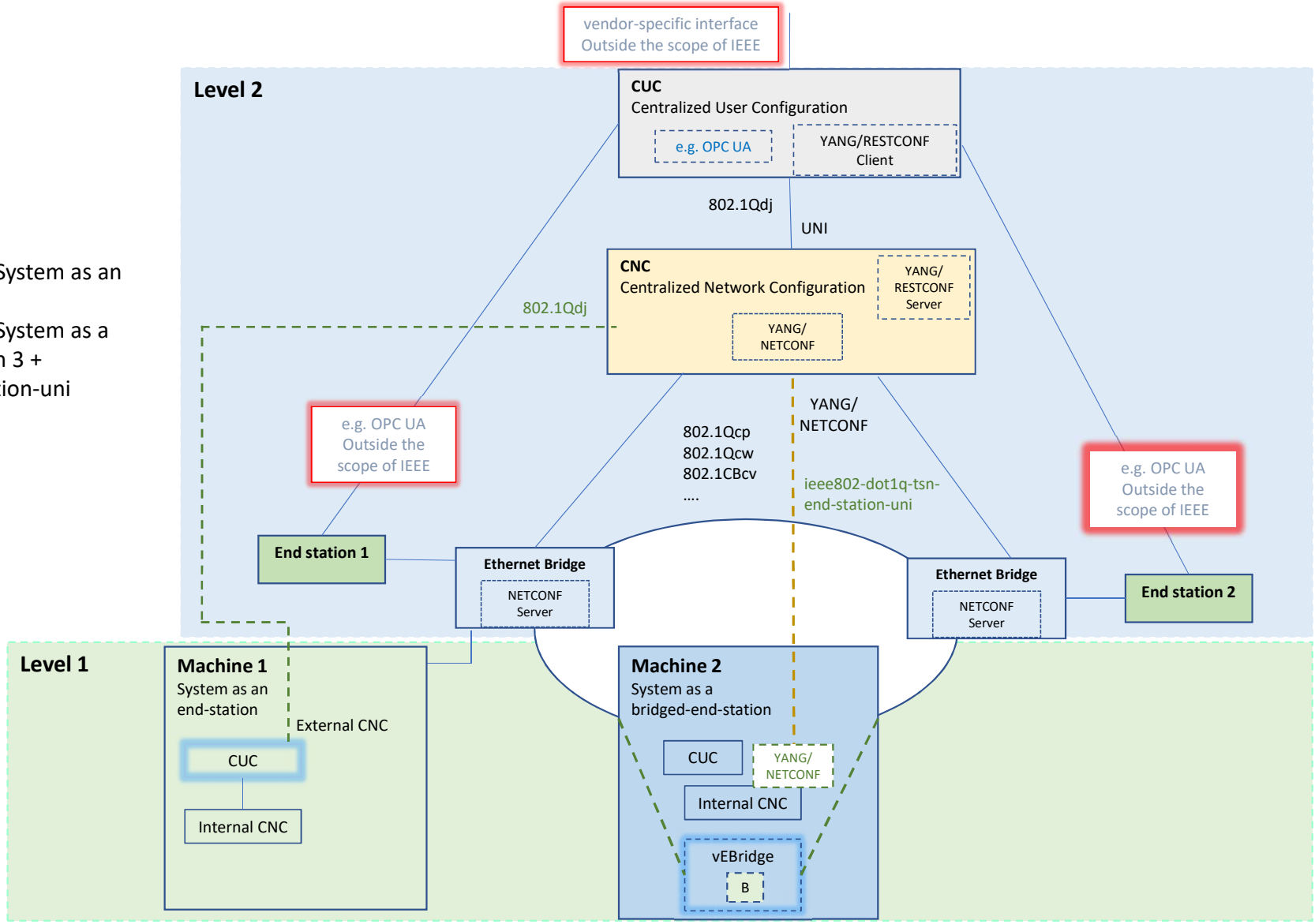


- Superimposed end-station models from the "system as an end-station" + ieee802-dot1q-tsn-end-station-uni.
- Internal CNC control the visibility of internal infrastructure via YANG model.
- Constraints:
  - CNC-to-CNC (vertical) interface – YANG model/XCONF?

Q. There is any existing IEEE standard which address the concept of vEBridge.
Q. There is any on-going work on defining an vertical interface between "Level K CNC" and "Level K-1 CNC".

An example – Updated 2-level hierarchy

- Machine 1 is modelled as “System as an end-station” option 3.
- Machine 2 is modeled as “System as a bridged-end-station” option 3 + ieee802-dot1q-tsn-end-station-uni



Conclusions

1. “System as an end-station” recommendation: Option 3.
2. “System as a bridged-end-station” recommendations:
   a) Option 4:
      a) Bridge entity: CNC-to-CNC (vertical) interface.
      b) End-station entity: “System as an end-station” option 3 or ieee802-dot1q-tsn-end-station-uni [4].
   b) Option 3:
      a) Bridge entity: vEBridge.
      b) End-station entity: “System as an end-station” option 3 or ieee802-dot1q-tsn-end-station-uni [4].

Gaps:

- CNC-to-CNC (vertical) interface and corresponding YANG data model
- Concept of vEBridge and corresponding YANG data model

Notes:

- IEEE 802.1Qdj [5] (limited info - work in progress).
- ieee802-dot1q-tsn-end-station-uni [4] (limited info - work in progress).

Thank you

Questions…

References

1. IEEE802.1Qcc-2018
2. http://www.ieee802.org/1/files/private/60802-drafts/d1/60802-d1-1.pdf
3. http://www.ieee802.org/1/files/public/docs2018/60802-industrial-use-cases-0918-v13.pdf
4. http://www.ieee802.org/1/files/public/docs2019/new-kehrer-TSN-Configuration-Enhancements-0319-v01.pdf
5. https://1.ieee802.org/tsn/802-1qdj/
6. http://www.ieee802.org/1/files/public/docs2018/60802-stanica-convergence-coexistence-0718-v03.pptx
7. http://www.ieee802.org/1/files/public/docs2018/60802-woods-QccConfig-0918-v01.pdf
8. http://www.ieee802.org/1/files/public/docs2019/60802-Hantel-TSN-IA-Domains-Constructability-0519-v01.pdf
9. http://www.ieee802.org/1/files/public/docs2019/60802-chen-TSN-management-0119-v00.pdf