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Communication Networks

RAP Extensions for the Hybrid Configuration Model

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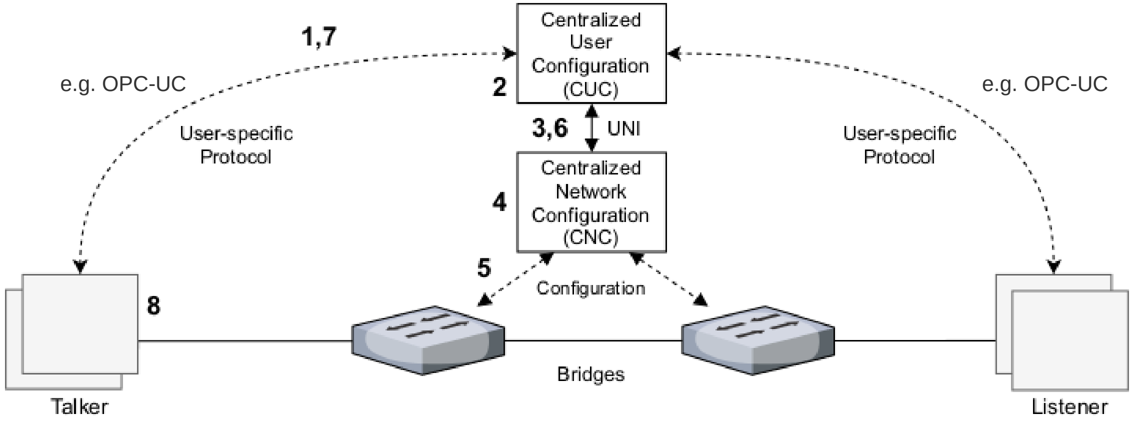
http://kn.inf.uni-tuebingen.de

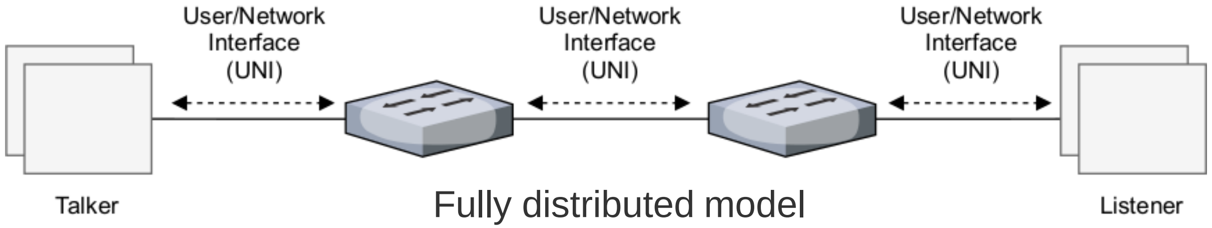
Configuration Models of TSN

- Three configuration models
  - Fully centralized
    - Central (logical) entities
      - Central User Configuration (CUC)
      - Central Network Configuration (CNC)
    - Admission control is based on a global view
      - Per-flow scheduled traffic for ultra low latency



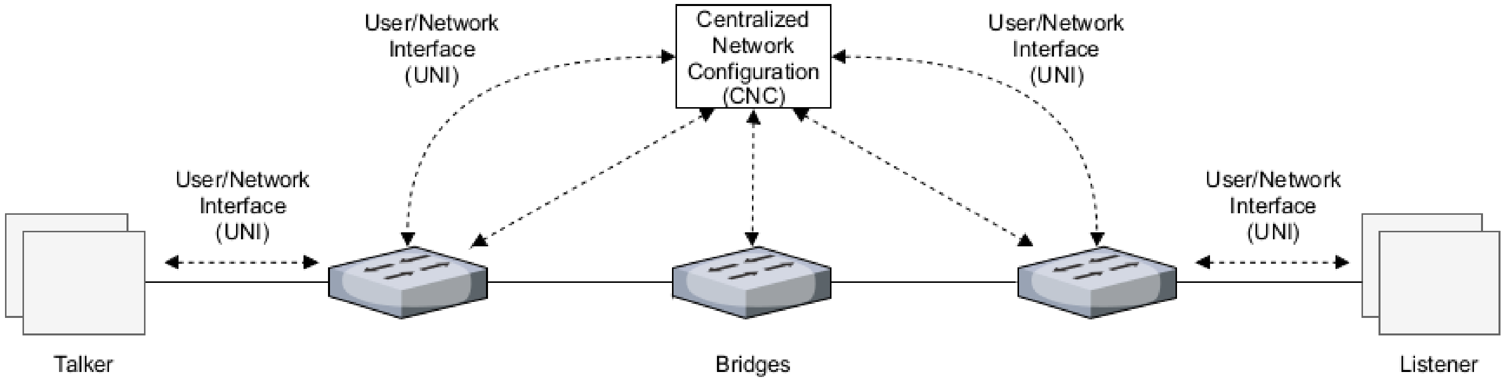
Fully centralized model

  - Fully distributed
    - Distributed signaling
      - Resource Reservation Protocol (RAP) (This work is based on Draft 0.4)
    - Admission control is based on local information
      - Traffic Shaping, limited scheduling


User/Network Interface (UNI)
User/Network Interface (UNI)
User/Network Interface (UNI)
Talker
Listener

Fully distributed model

Hybrid Configuration Model


User/Network Interface (UNI)
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User/Network Interface (UNI)
Talker
Bridges
Listener

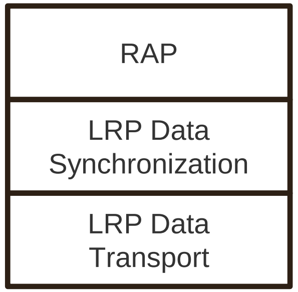
Centralized network/distributed user model

- Signaling
  - End stations: signal stream properties using a distributed signaling protocol (e.g., RAP)
  - Edge bridges: ensure that requests are directly forwarded to the CNC
  - CNC: takes admission control decision and notifies end stations
- Advantage
  - End stations using distributed signaling have access to globally optimized per-flow scheduled streams

- **Research Question: Is RAP ready for the hybrid configuration model? What is missing?**

Resource Reservation Protocol (RAP)

- Resource Reservation Protocol (RAP)
  - Dynamic, distributed signaling protocol for future TSN (IEEE P802.1Qdd D0.5)
  - Overcomes limitations of the Stream Reservation Protocol
    - More streams, more TSN mechanisms (shapers, support for path redundancy, …)



RAP

LRP Data Synchronization

LRP Data Transport

Figure: RAP + LRP protocol stack

- Link-Local Registration Protocol (LRP) (IEEE 802.1CS)
  - Protocol for persistently distributing data through the network

- Distributed model: Replicate “stream requests” of talkers and listeners along streams path

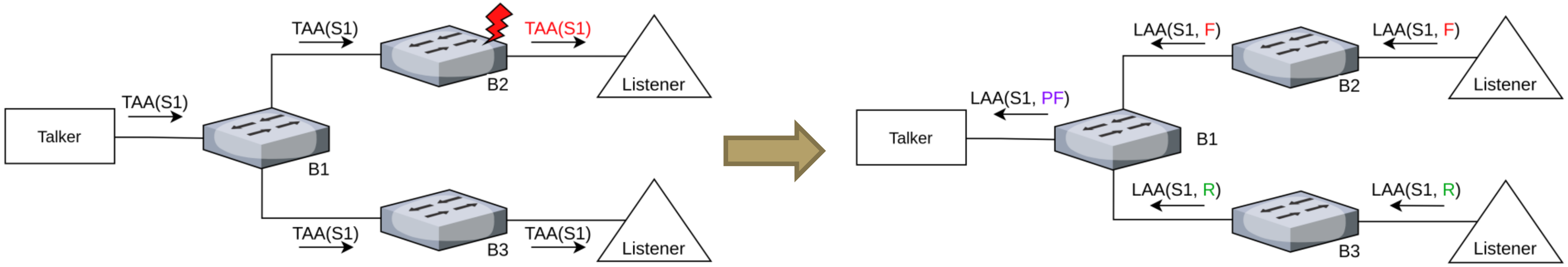


Figure: Reservation process with RAP in fully distributed model (TAA = Talker Announce Attribute, LAA = Listener Attach Attribute)

Resource Reservation Protocol (RAP)

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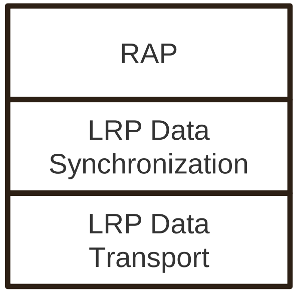
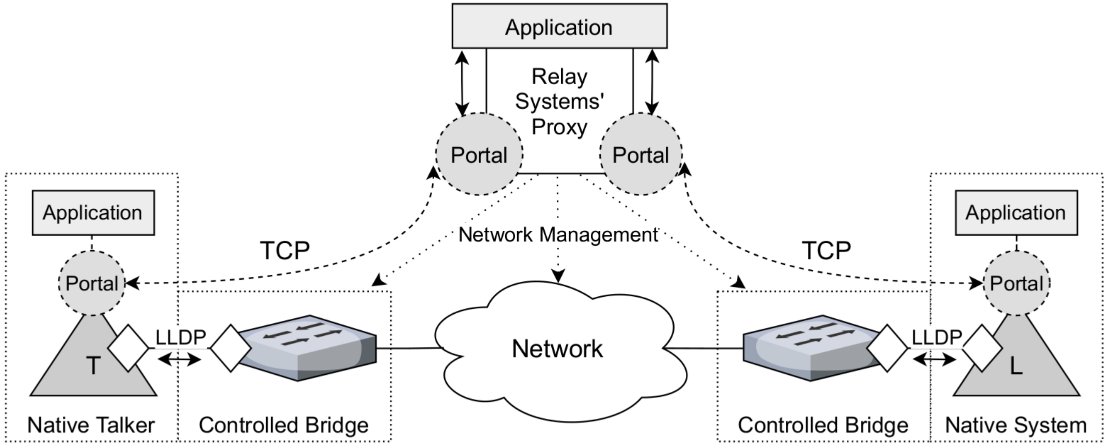


Figure: RAP + LRP protocol stack

- Link-Local Registration Protocol (LRP) (IEEE 802.1CS)
  - Protocol for persistently distributing data through the network

- Hybrid model: Transport “stream request” of talker and listener to CNC using **LRP Proxy Mode**
  - Edge bridges via LLDP
    - Application information
    - Address information of proxy (IP + Port)
  - End stations connect via TCP
  - End stations and Proxy exchange RAP attributes



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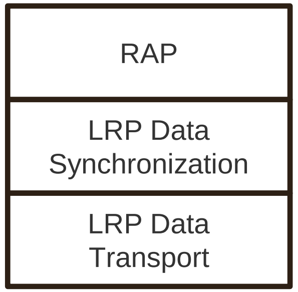


RAP

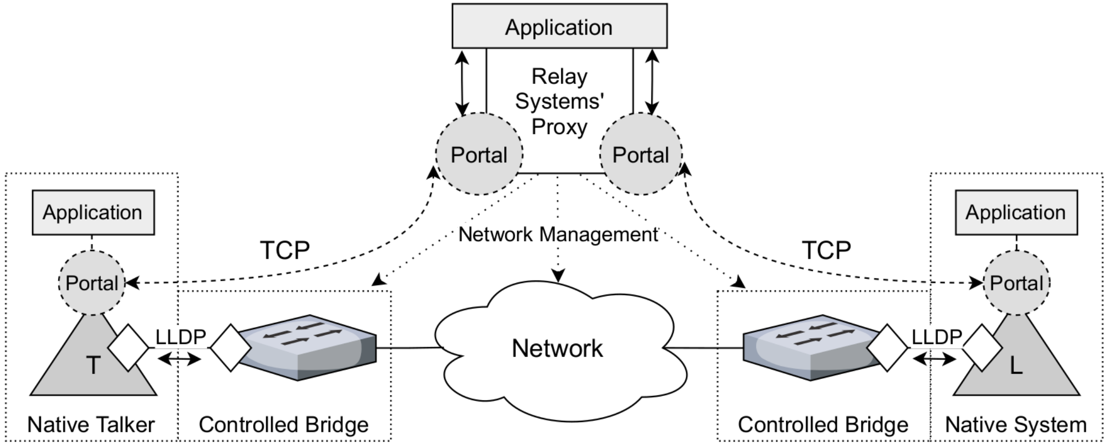
LRP Data Synchronization

LRP Data Transport

Figure: RAP + LRP protocol stack

- Hybrid model: Transport “stream request” of talker and listener to CNC using **LRP Proxy Mode**

- **RAP Proxy System**
  - **What does it do?**
  - **Where is it located in hybrid model?**
  - **Is RAP’s data model complete?**

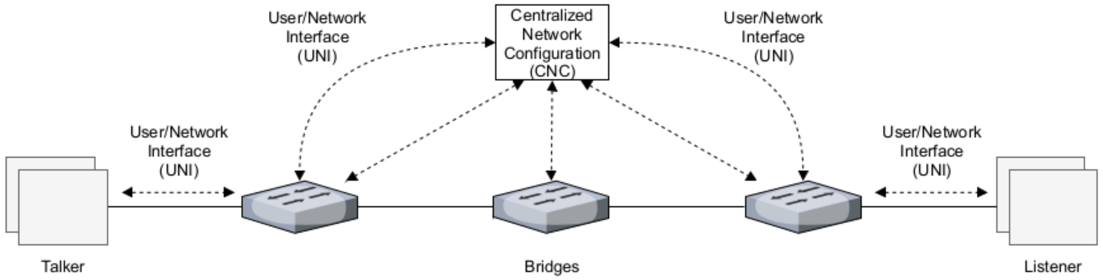


Where to place the RAP Proxy?

- Model as in standardization
  - RAP-CNC would additionally have to
    - Speak RAP ("user-specific protocol")
    - Keep track of new stream requests
    - Trigger resource reservation procedure
    - → Tasks of a CUC in fully centralized model!

- We propose a RAP-CUC
  - Handles LRP+RAP signaling
  - Extract information relevant for admission control
  - Manage life-cycle of streams
  - Handle resource reservation procedure with CNC

- Advantage
  - CNC has the same responsibility in all models
    - CNC does not handle any user-specific protocol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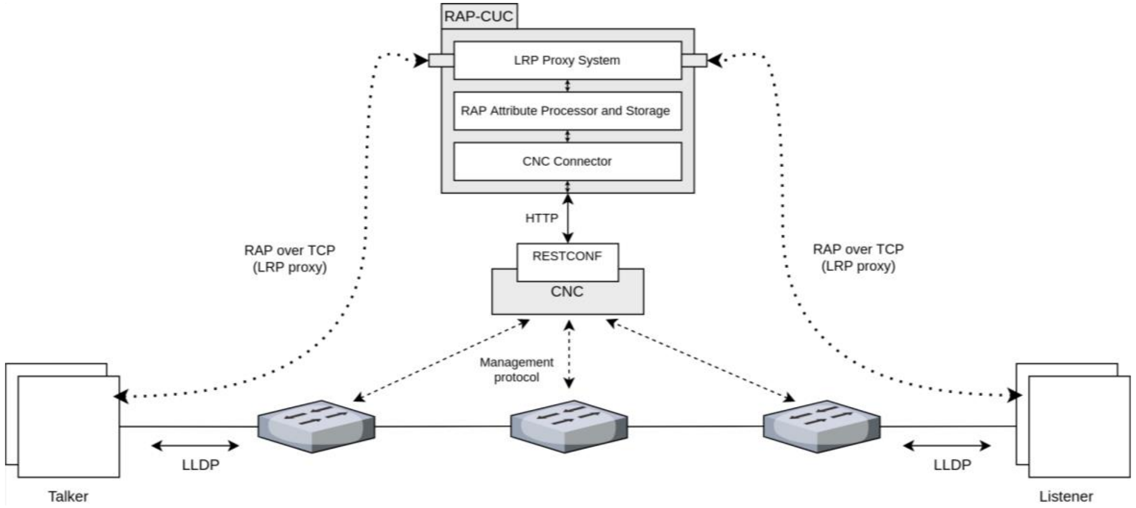
Abstract model

Specific implementation



Architecture of a CUC

- Protocol Connector (PC)
  - Connects to end stations and performs user-specific signaling
- Stream Management (SM)
  - Manages the life cycle of a stream
  - Generic function
- CNC Connector (CNCC)
  - Requests resources from a specific CNC implementation
  - Webhook Handler
    - Callback for notifying finished computations
- Modular design
  - Allows support for additional user-specific protocols or CNCs

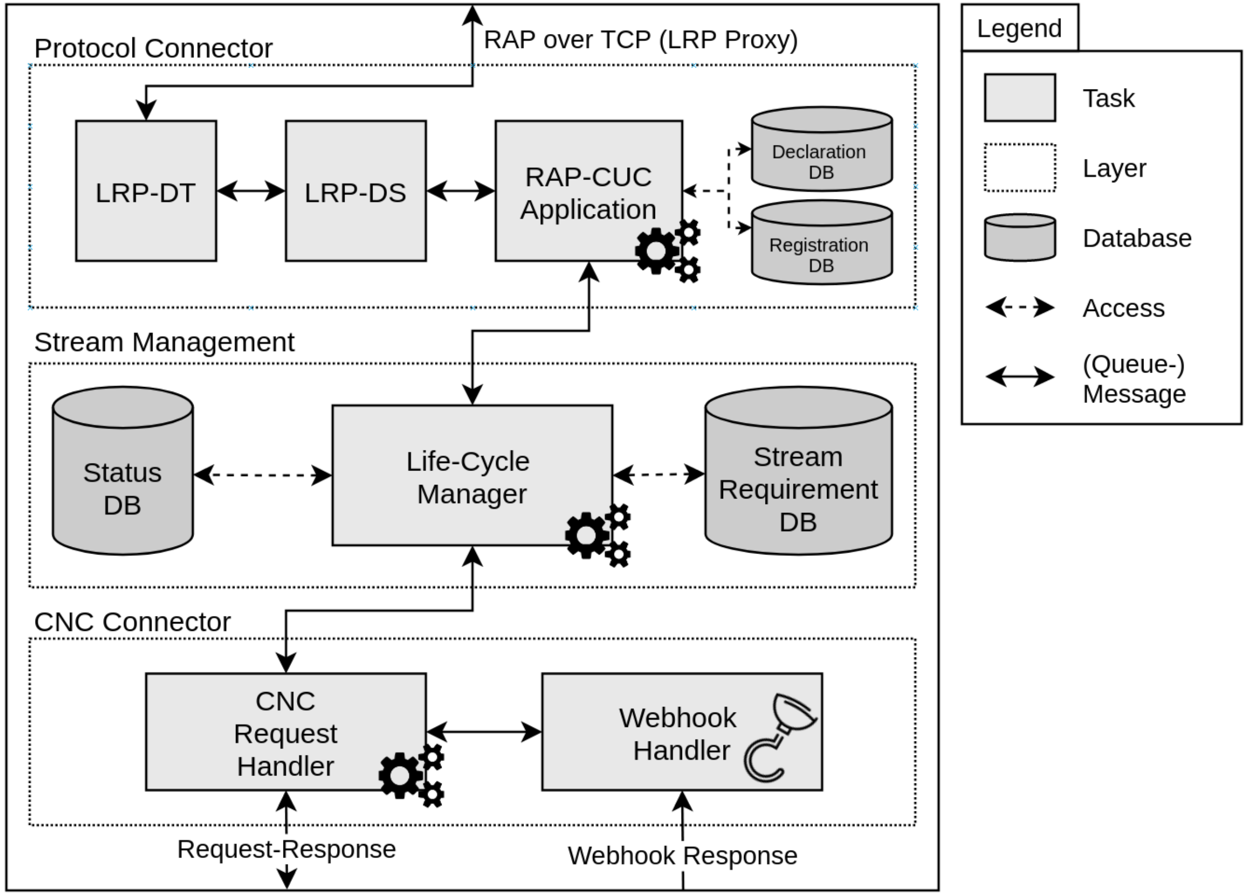


Figure: Architecture of RAP-specific CUC entity

Data Model Comparison

- RAP must include data defined by the TSN User/Network Interface (UNI) (IEEE Std 802.1Qcc)
  - We compare the data required for reservation of
    - Per-flow scheduled streams using time-aware end stations
    - With the MSRP Traffic Specification of RAP

- User → Network (stream properties, QoS requirements)
  - Missing data can be included in MSRP Traffic Specification

- Network → User (reservation status, configuration data)
  - RAP lacks an option to transport configuration data to the end stations
    - E.g., transmission start of a stream to the Talkers
  - Missing data can be attached to Listener Attach Attribute

🟨 group-listener 🟧 group-talker

	Part of UNI (U→N) for per-flow scheduled streams
⬜	Stream-id
🟧	Talker's MAC address
🟧	Data-frame-params: priority, VLAN ID, Dest. MAC
⚡ 🟧	Traffic-specification: interval (resolved in D0.5)
🟧	Traffic-specification: max frames per interval
🟧	Traffic-specification: max frame size
⚡ 🟧	Time-aware: earliest-transmit offset
⚡ 🟧	Time-aware: latest-transmit offset
⚡ 🟧	User-to-network-requirements: maximum latency
🟨	Listener's MAC address
⚡ 🟨	User-to-network-requirements: maximum latency

Summary

- We analyzed RAP for its applicability in the hybrid configuration model
  - We redefined the hybrid model by adding a CUC including the RAP Proxy
  - We propose an architecture for a CUC entity
  - We analyzed the data model of RAP and proposed extensions to support per-flow scheduling in the hybrid model

- A partial implementation of the RAP-CUC is published on GitHub
  - https://github.com/uni-tue-kn/rap-cuc
    - It can be used for developing prototypes with other user-specific protocols and other CNC entities

Thank you for your attention. Questions?

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