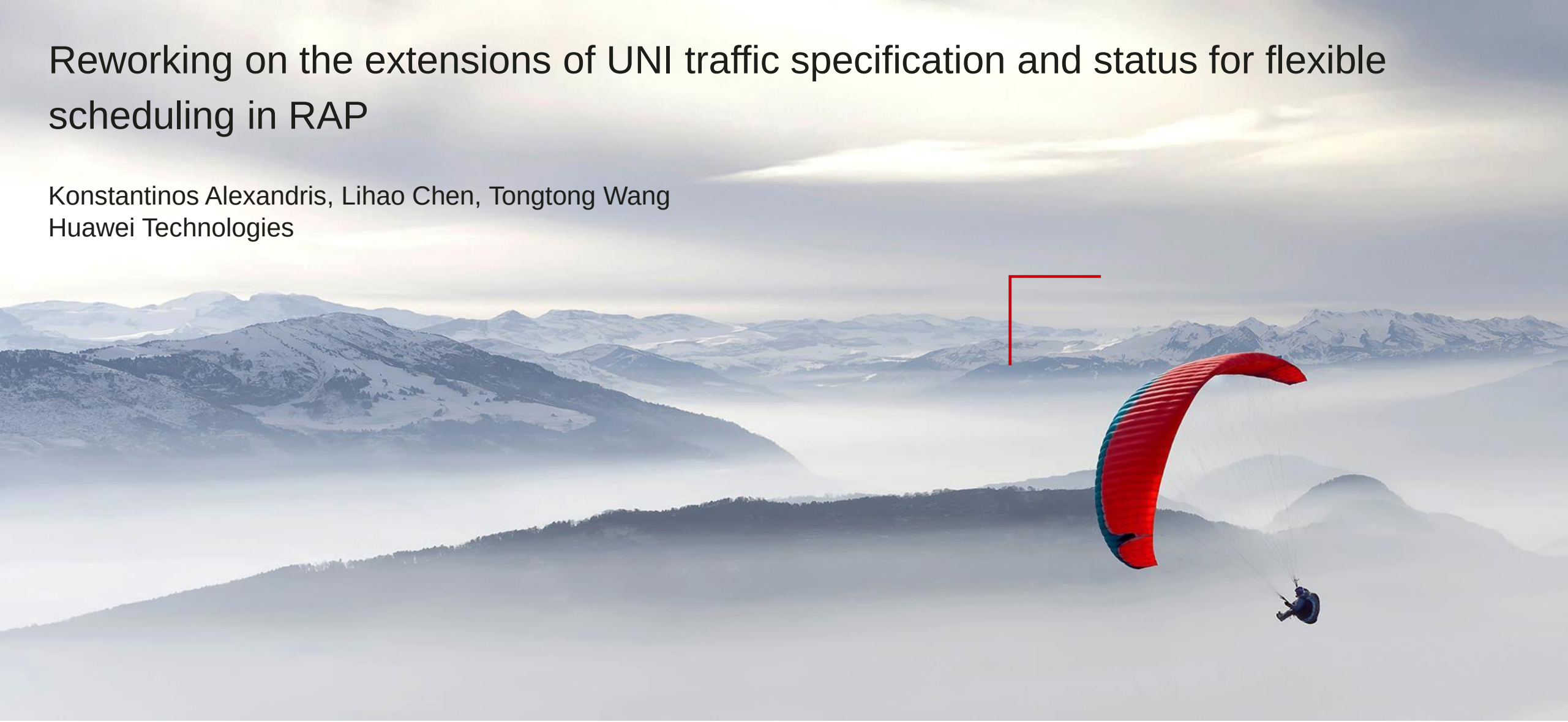
Reworking on the extensions of UNI traffic specification and status for flexible scheduling in RAP

Konstantinos Alexandris, Lihao Chen, Tongtong Wang
Huawei Technologies



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Introduction

- **Variation** in traffic characteristics has not been thoroughly investigated in existing traffic specification (**TSpec**) TLVs [1].
- Common **resource allocation** schemes need to be reworked to support traffic fluctuation.
- **Plug & produce** concept creates incentives to enable interoperable **flexibility** in traffic engineering.
- Fresh **streams** arrival stands in need of **incremental** (online) **scheduling** mechanisms.
- Under such operational regime, **QoS** control mechanisms are currently missing**.**
- Present **Tspec** TLVs focus only on **static allocation**, while there is no palpable understanding on how to cover systematically **adaptive** resource allocation.

[1] 802.1Qcc-2018. https://standards.ieee.org/ieee/802.1Qcc/5784/

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Background in IEEE P802.1Qdd

Talker Announce attribute TLV (ANNOUNCE_STREAM.request)

Encodes a set of parameters followed by a series of sub-TLVs part of those are related to Tspec (**MSRP or Tocken Bucket option, see 99.5.3 [2]**):

- **MSRP Tspec sub-TLV** is limited to basic parameterization excluding Transmission Selection field described in 802.1Qcc-2018 [1]:
  - + **Interval**
  - + **MaxFramesPerInterval**
  - + **MaxFrameSize**
- **Token Bucket Tspec sub-TLV** compared to MSRP option is more advanced and provides the following parameters:
  - + **Maximum Transmitted Frame Length**
  - + **Minimum Transmitted Frame Length**
  - + **Committed Information Rate (CIR)**
  - + **Committed Burst Size (CBS)**

IEEE Std P802.1Qdd

	Octet	Length
StreamId	1	8
StreamRank	9	1
AccumulatedMaximumLatency	10	4
AccumulatedMinimumLatency	14	4
Data Frame Parameters sub-TLV	18	11
Token Bucket TSpec sub-TLV or MSRP TSpec sub-TLV	29	19 or 7
0 or 1 Redundancy Control sub-TLV	variable	variable
0 or 1 Failure Information sub-TLV	variable	variable
0 or more Organizationally Defined sub-TLVs	variable	variable

Figure 99-12—Value of Talker Announce attribute TLV

	Octet	Length
MaxTransmittedFrameLength	1	2
MinTransmittedFrameLength	3	2
CommittedInformationRate	5	8
CommittedBurstSize	13	4

Figure 99-14—Value of Token Bucket TSpec sub-TLV

	Octet	Length
Interval	1	4
MaximumFramesPerInterval	5	2
MaximumFrameSize	7	2

Figure 99-15—Value of MSRP TSpec sub-TLV

[2] https://www.ieee802.org/1/files/private/dd-drafts/d0/802-1Qdd-d0-6.pdf

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P802.1Qdd – RAP: Extensions of UNI traffic specification

Objective: Incremental (online) scheduling upon new stream arrival in the network (e.g., plug a new device on the fly).

- Would be useful to add data rates and burst size min/max values in the Tspec of UNI ?
- Parameters already been proposed (max value): Committed Information Rate (CIR), Committed Burst Size (CBS).
- New parameters to be added (min value): Minimum Information Rate (MIR), Minimum Burst Size (MBS).
- Flexibility in resource allocation: Based on such upper/lower bounds, could we define a set of values where still talker's QoS is sustainable (i.e., not limited to CIR/CBS values) ?

What about ANNOUNCE_STREAM.request within a set of discrete QoS values ?

- Agile network management to return a target value of information rate R(t) and burst size S(t) tailored to talkers' value set and the availability of network resources.
- A Talker to announce a set of discrete QoS values in the network and RAP procedures to reserve resources accordingly within that range:

$$R(t) \in R = \{R\_1, \ldots, R\_N\}, \quad S(t) \in S = \{S\_1, \ldots, S\_N\}, \quad \text{where} \quad \text{MIR: } R\_1, \text{ CIR: } R\_N \ \& \ \text{MBS: } S\_1, \text{ CBS: } S\_N.$$

- Feasibility in admission of streams to be guaranteed within talkers disseminated QoS range.

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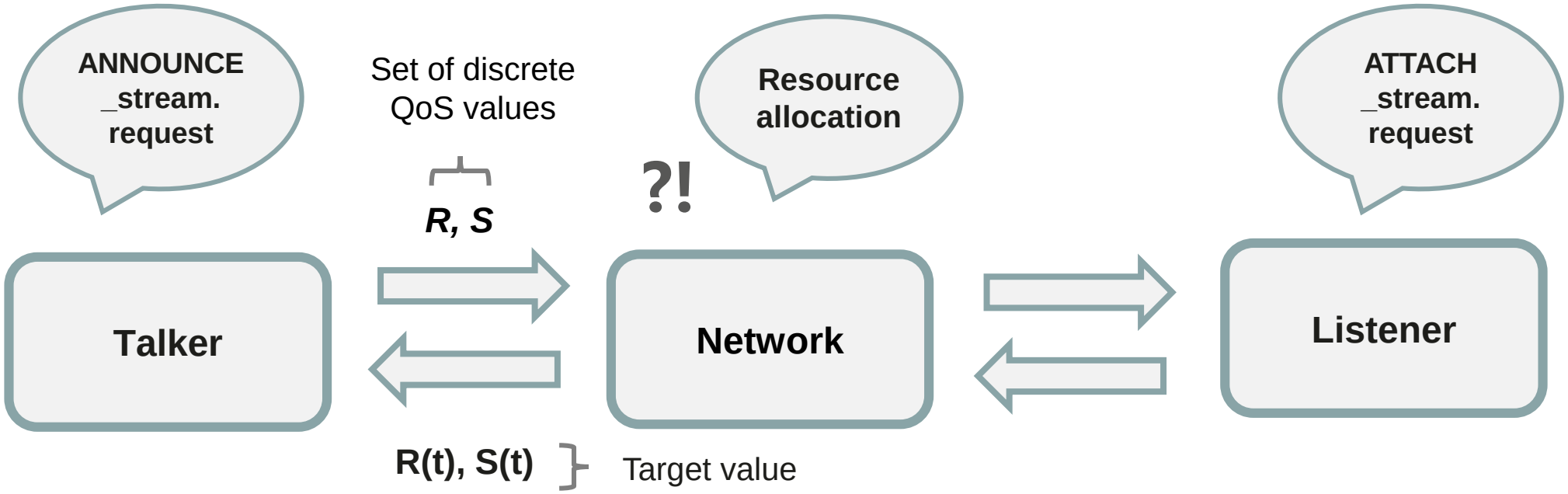
Talker/Listener to Network – New stream reservation



- **Talker announce** comprises a discrete QoS value set bounded by Tspec **min/max** values.
- **Listener attach propagation** manages the resource allocation/de-allocation *hop-by-hop* based on the announced QoS value set and available capacity in the network.
- The **target values** to be returned are chosen by the announced value set.
- An indication shall be sent in case a stream **can or cannot be admitted** in the network.

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Example - New stream reservation (1/5)

Bridges: A, B, C

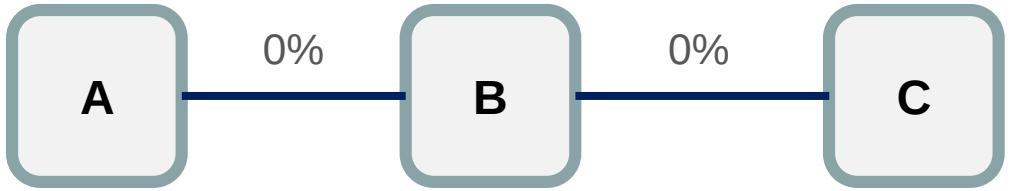
Link capacity: 100 Mbps

Target rate R(t) ∈ *R* = {R_1, … , R_N} Mbps

MIR: R_1 & **CIR:** R_N

Resource allocation:

Upstream E2E signaling process
(see 99.3.5.1 in P802.1Qdd/D0.6).



Additional remarks:

1. Initially, the link utilization is 0%, since no talker/listener pairs are connected.
2. Incrementally, we start adding user pairs in the network (i.e., new stream arrival).
3. For the sake of brevity, we skip the talker announce request procedure assuming that has been preceded.

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Example - New stream reservation (2/5)

Bridges: A, B, C

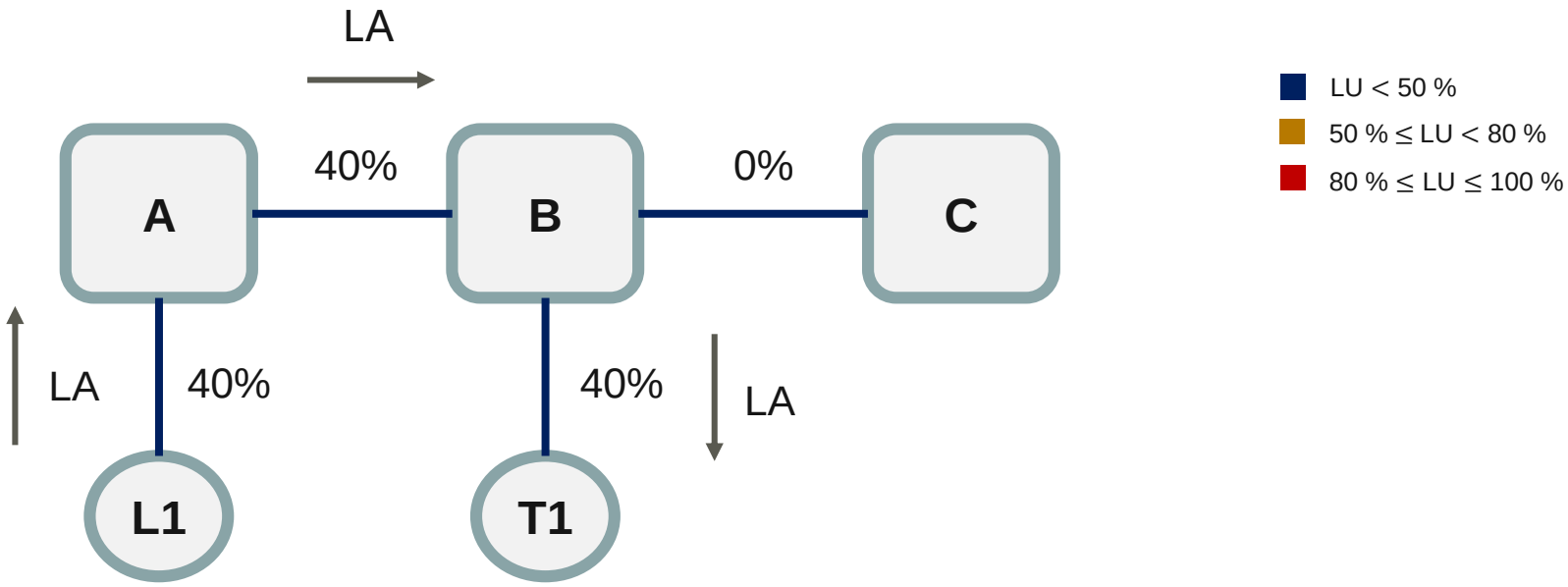
Link capacity: 100 Mbps

New stream: T1 → L1

T1 target rate = 40 ∈ {20,40} Mbps

Link utilization (LU%):

Estimation is depicted assuming relevant network resources will be reserved.



LA: Listener attach

Reservation path: L1 → A → B → T1

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Example - New stream reservation (3/5)

Bridges: A, B, C

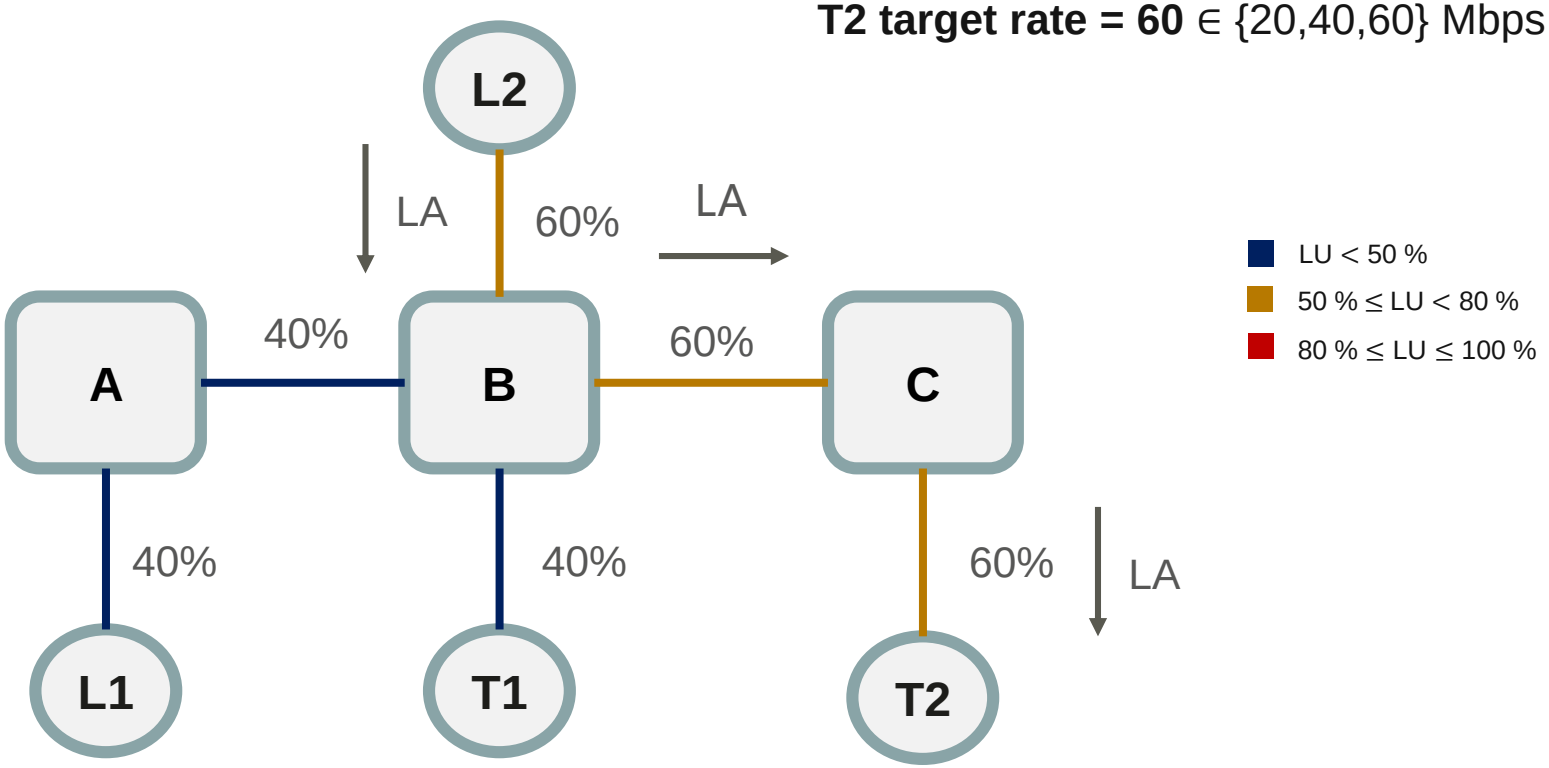
Link capacity: 100 Mbps

New stream: T2 → L2

T2 target rate = 60 ∈ {20,40,60} Mbps

Resource allocation:

T1→ L1 stream has been accepted and a new stream reservation is on-going.



LA: Listener attach

Reservation path: L2 → B → C → T2

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Example - New stream reservation (4/5)

Bridges: A, B, C

Link capacity: 100 Mbps

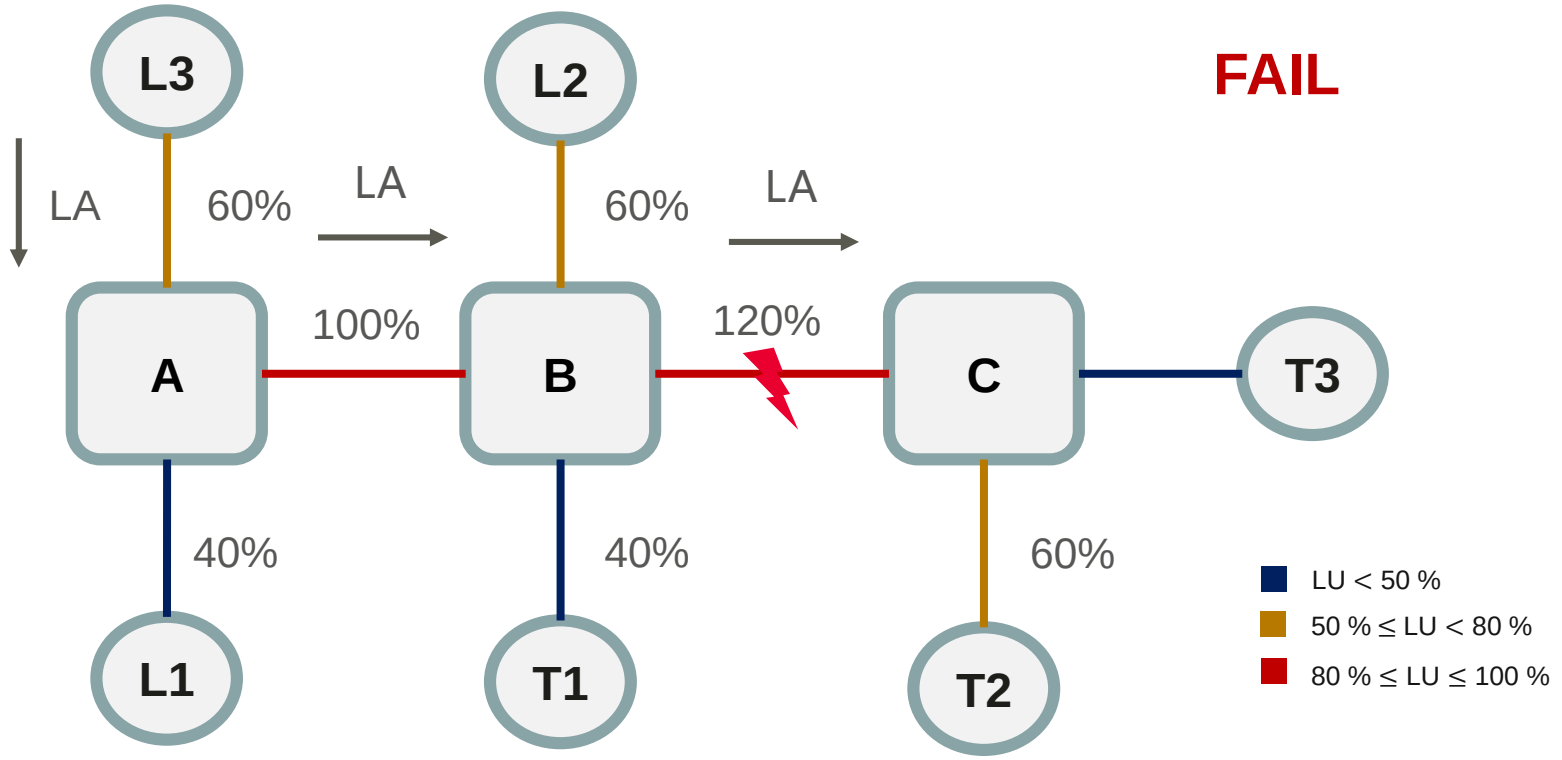
New stream: T3 → L3

Resource allocation:

- 2 existing streams (accepted).
- 1 new appears.

B → C: Reservation step failed!

T3 target rate = 60 ∈ {20,40,60} Mbps



LA: Listener attach

Reservation path: L3 → A → B → C (No available resources)

Worst case: Upstream direction needs to be fully traversed for re-configuration of the target rate.

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Example - New stream reservation (5/5)

Bridges: A, B, C

Link capacity: 100 Mbps

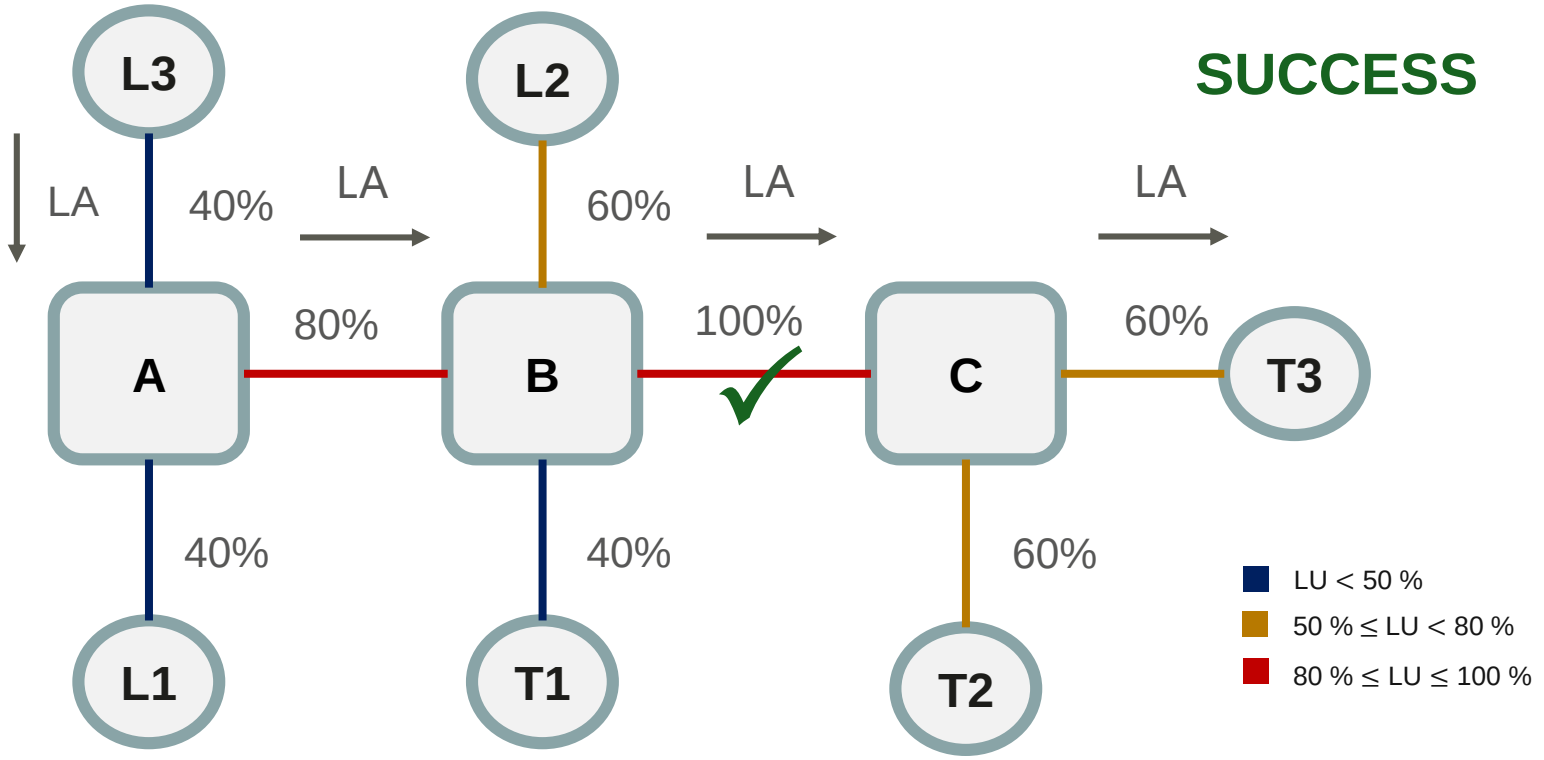
New stream: T3 → L3

T3 target rate = 40 ∈ {20,40,60} Mbps

Resource allocation:

B → **C**: Reservation step successful!

Pick up a rate less than CIR allows admission of the stream.



LA: Listener attach

Reservation path: L3 → A → B → C → T3 (Available resources)

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Summary – Contribution & Next steps

- P802.1Qdd Tspec TLVs have been reworked to enable flexibility in network resource allocation.
- Advanced mechanisms are discussed including adaptive traffic engineering within a pre-determined range of values.
- Modification of the current RAP schemes is required to leverage the Tspec extension proposal.

How to proceed?

- Proposed work to be coordinated within P802.1Qdd and further discussions to follow.
- Strongly correlated with current Tspec definition that supports only **CIR/CBS** parameterization:
  - Token Bucket TSpec sub-TLV includes the aforementioned attributes.
  - Related record issues in Annex Z.8.

1. **MIR & MBS** parameters inclusion to be considered as an upcoming contribution in the draft.
2. **Discussion:** Consider a set of discrete QoS values (***R, S***) as part of the Tspec TLV bounded by **CIR/CBS** and **MIR/MBS**.
   - Incremental adjustment of upcoming streams to improve schedulability subject to network capacity constraints.
   - Resilience in reservations is offered by such parameters that define a range within QoS is sustainable.
3. **Future work:** Devise relevant YANG modules. Preliminary proposal in former presentation [3].

[3] https://www.ieee802.org/1/files/public/docs2022/new-alexandris-extension-traffic-specification-TSN-UNI-0722-v01.pdf

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Thank you.