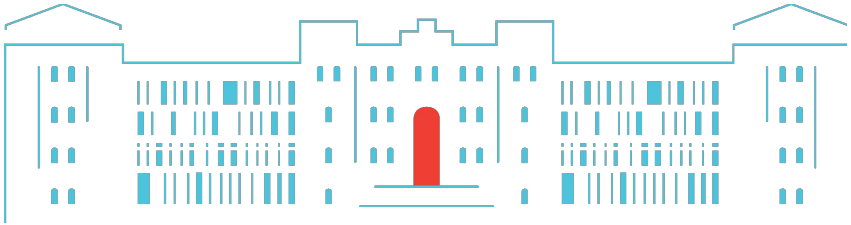
Quality of Service Extension Block to Bundle Protocol



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17.03.2024

Earth-Moon Link Challenges

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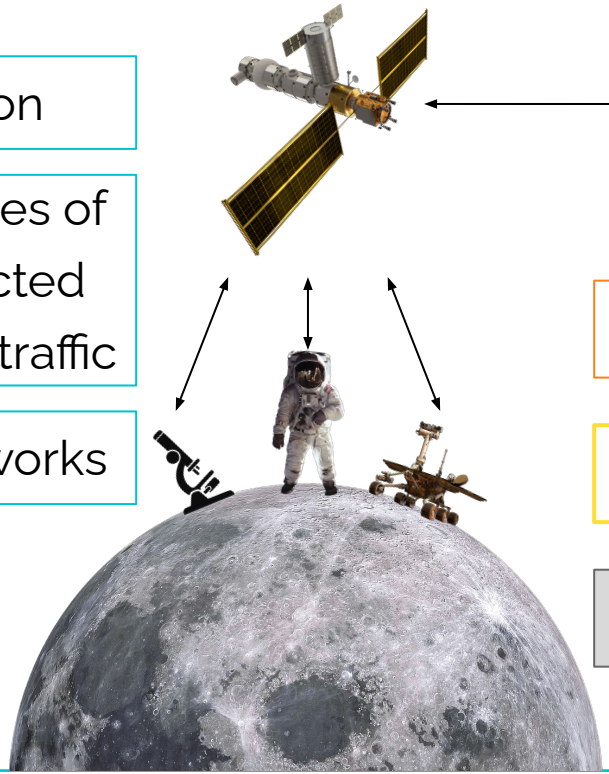
Congestion

Different types of interconnected devices and traffic

Several networks



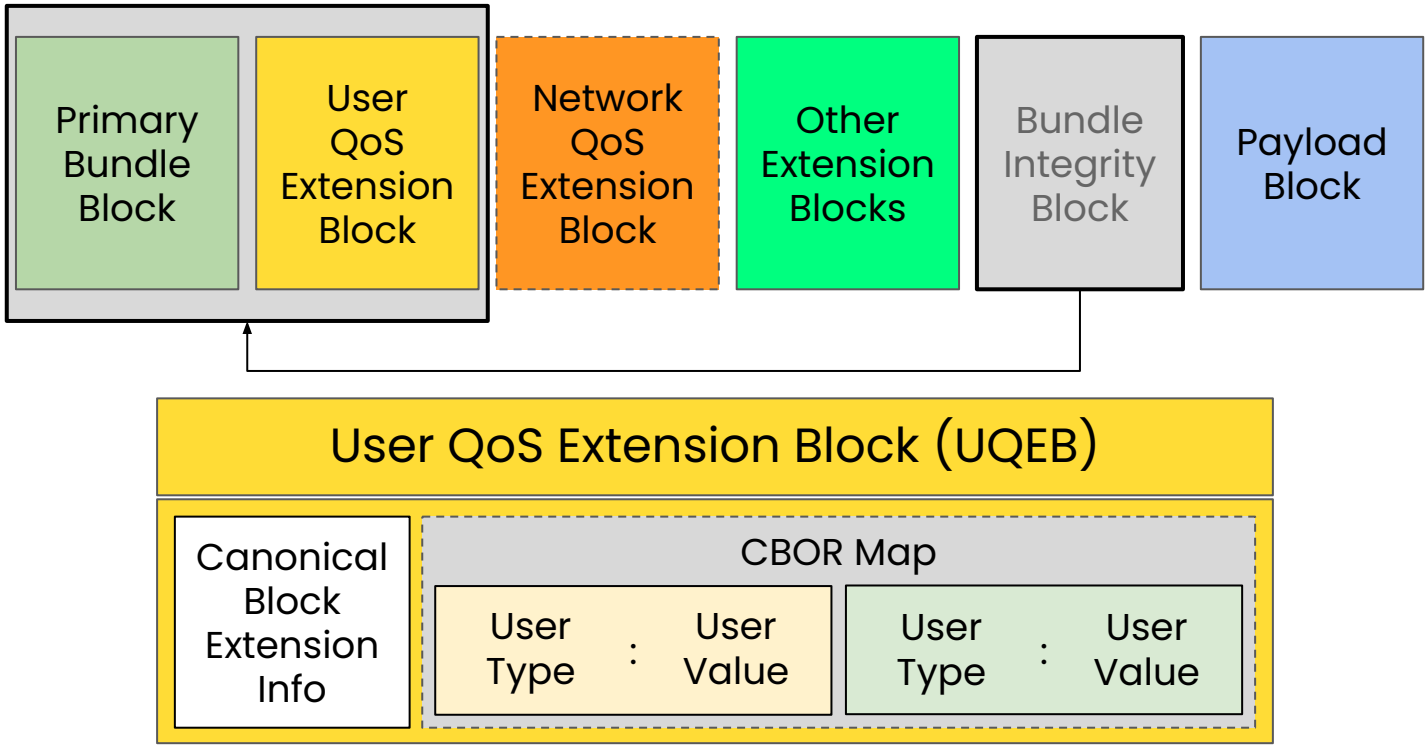
Bundle Protocol (BP)

Need for QoS Management

QoS Extension Block to BP

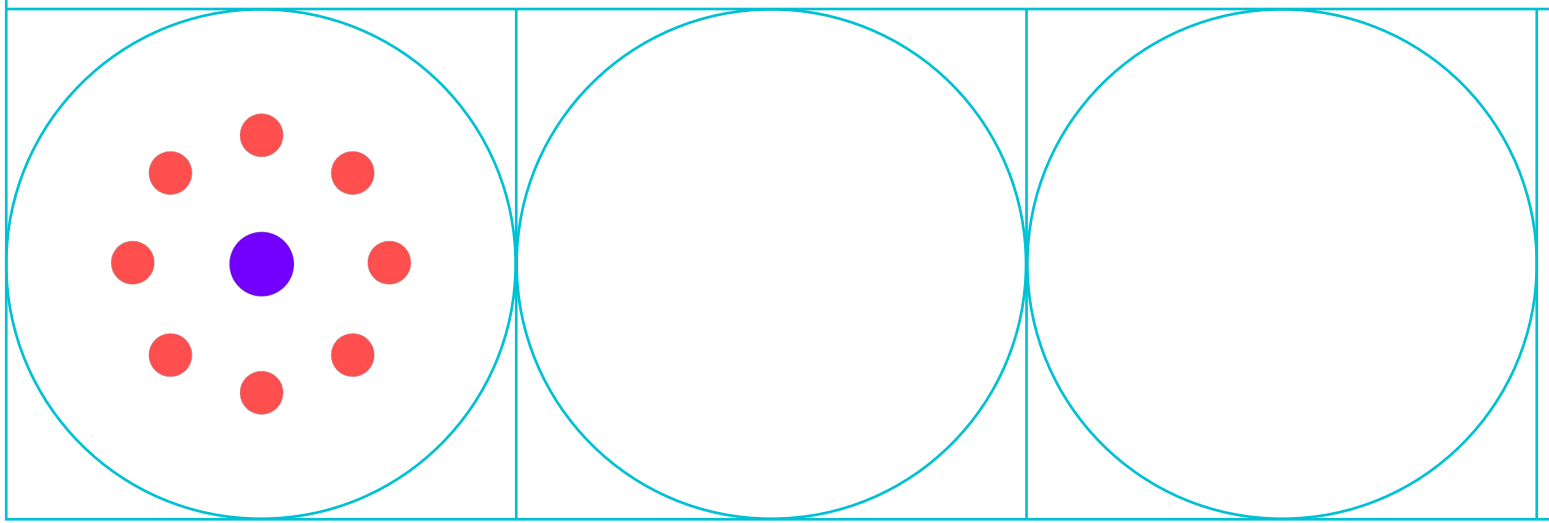
ESA. Terrae Novae. https://www.esa.int/Science_Exploration/Human_and_Robotic_Exploration/Exploration/Terrae_Novae_Europe_s_exploration_vision

QoS BP Extension Proposal



Burleigh, S., K. Fall, and E. Birrane, III. "RFC 9171: Bundle Protocol Version 7." (2022).

Content



User QoS Extension Block (UQEB)

Key	Value
Traffic Prioritization	00
Required Reliability	01
Latest-Only Delivery	02
Bundle Storage	03
Reserved for Future Use	04 — 23
Unassigned	24 — 2^{64} - 1

For 1-Byte CBOR Tiny Field Encoding compact representation

UQEB Values

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Key	Value
Traffic Prioritization	
Required Reliability	
Latest-Only Delivery	
Bundle Storage	

UQEB Values: Traffic Prioritization

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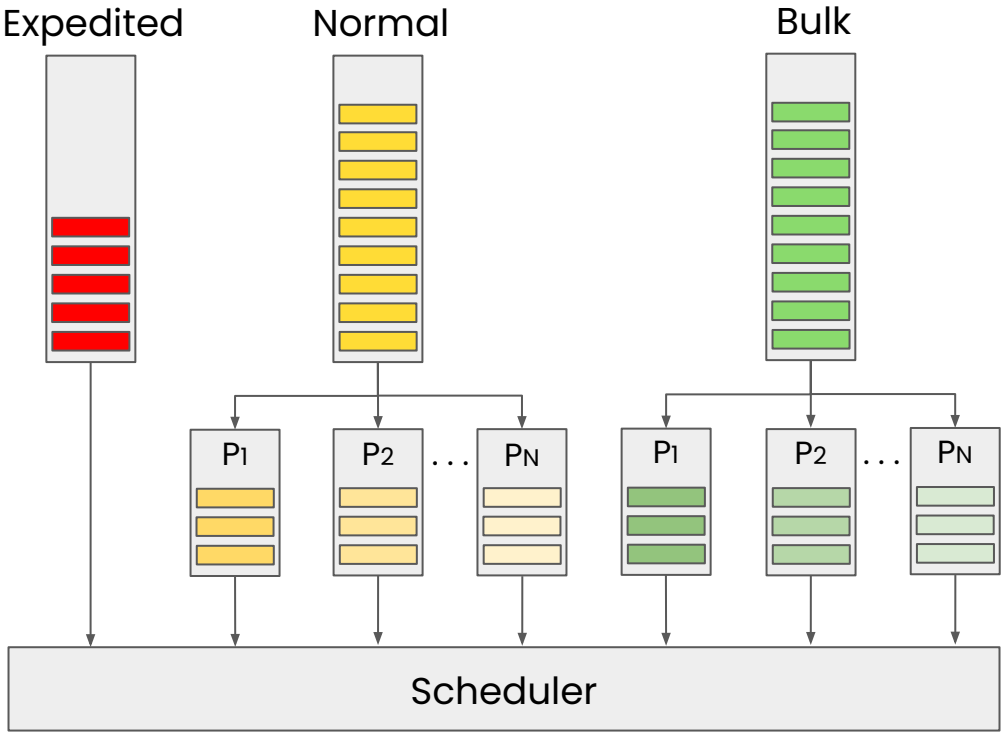
Key

- Traffic Prioritization
- Required Reliability
- Latest-Only Delivery
- Bundle Storage

Value

Information Type	Values
Expedited	0
Normal	1 - 12
Bulk	13 - 23
Unassigned	24 - 2^64-1

UQEB Values: Traffic Prioritization Workflow



"Normal" will only be serviced if "Expedited" is empty, and "Bulk" will only be accessed if both "Expedited" and "Normal" are empty

A fair scheduling algorithm is implemented within each type to avoid data starvation

UQEB Values: Reliability

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Key

- Traffic Prioritization
- **Required Reliability**
- Latest-Only Delivery
- Bundle Storage

Value

Information Type		Values
Reliable	ARQ	0
	ARQ if possible	1
	Reserved for future use	2 - 11
Unreliable	Reserved for future use	12 - 21
	No ARQ if possible	22
	No ARQ	23
Unassigned		24 - 2^64-1

Selection or configuration of CLA with respect to ARQ capabilities

UQEB Values: Latest-Only Delivery

ComNets TUHH

Key

- Traffic Prioritization
- Required Reliability
- **Latest-Only Delivery**
- Bundle Storage

Value

Information Type	Values
All valid	0
Latest-only	1
Reserved for future use	2 - 23
Unassigned	24 - 2^64-1

Binary flag

Baumgärtner, Lars. "Dtnmqtt: A Resilient Drop-In Solution for MQTT in Challenging Network Conditions", 2024.

UQEB Values: Bundle Storage

ComNets TUHH

Key

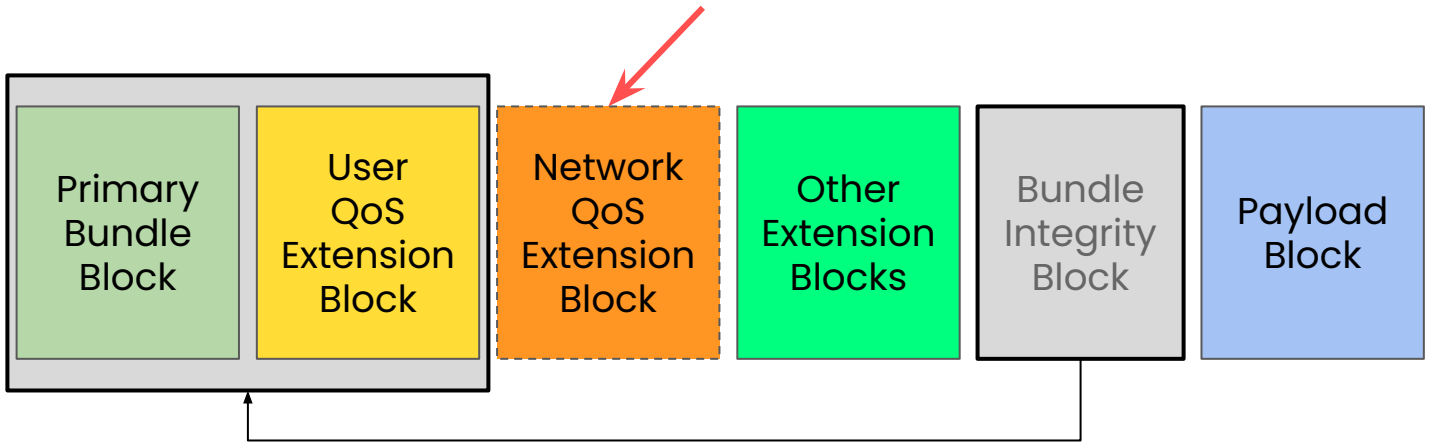
- Traffic Prioritization
- Required Reliability
- Latest-Only Delivery
- **Bundle Storage**

Value

Information Type	Values
CLASS0	0
CLASS1	1
. . .	. . .
CLASS23	23
Unassigned	24 - 2^64-1

If a bundle does not have a bundle storage class assigned, the class is taken as CLASS11 by default.

Network QoS Extension Block (NQEB)

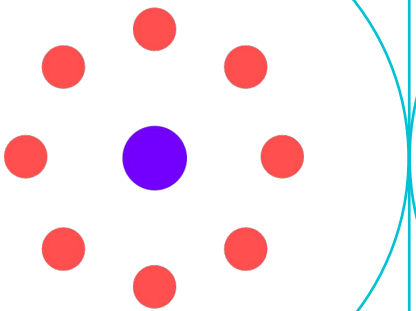


NQEB could translate UQEB into internal policy and optimize the decision process for the intermediate blocks of a network

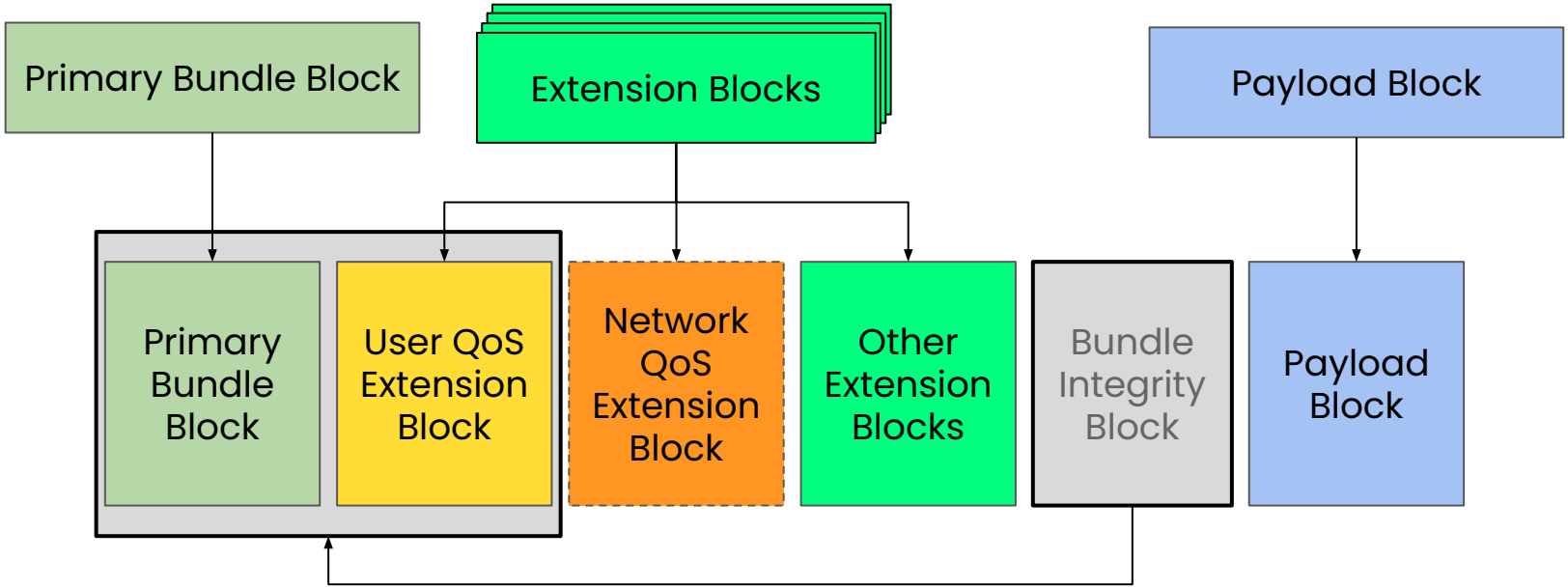
All values are reserved for local use to give the individual networks maximum flexibility

Burleigh, S., K. Fall, and E. Birrane, III. "RFC 9171: Bundle Protocol Version 7." (2022).

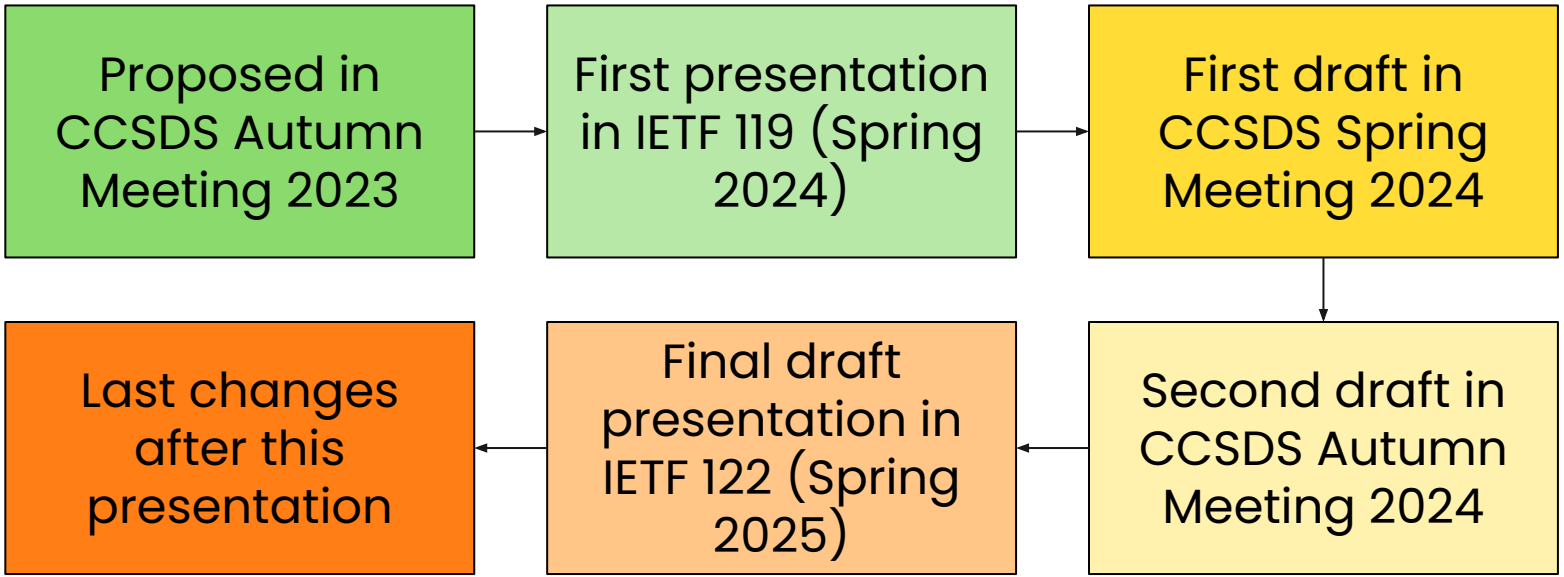
Conclusion & Next Steps



Conclusion


Primary Bundle Block
Extension Blocks
Payload Block
Primary Bundle Block
User QoS Extension Block
Network QoS Extension Block
Other Extension Blocks
Bundle Integrity Block
Payload Block

Orange Book Timeline



Questions?

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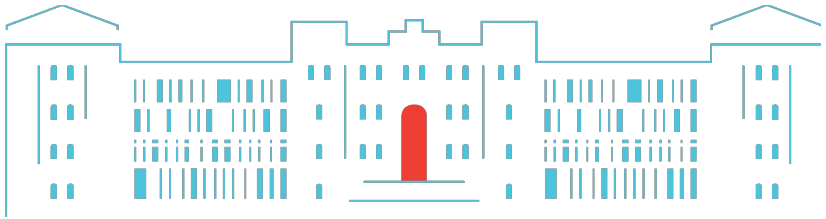
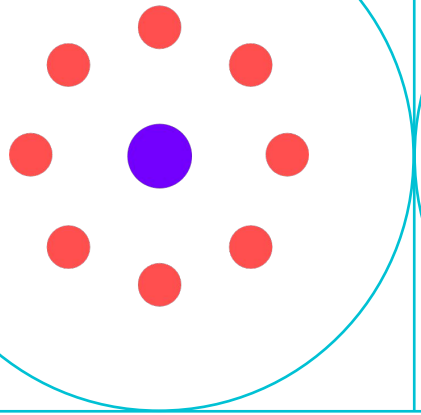
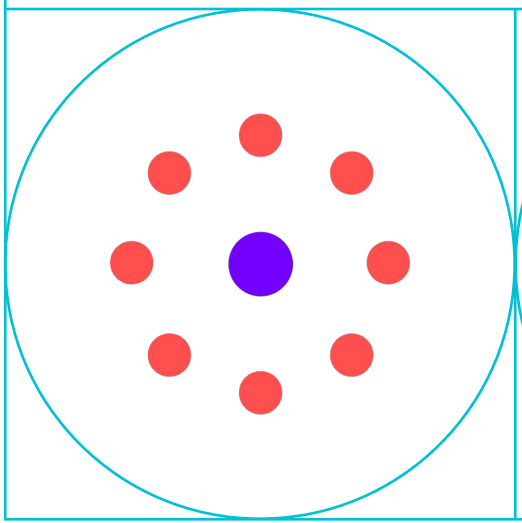


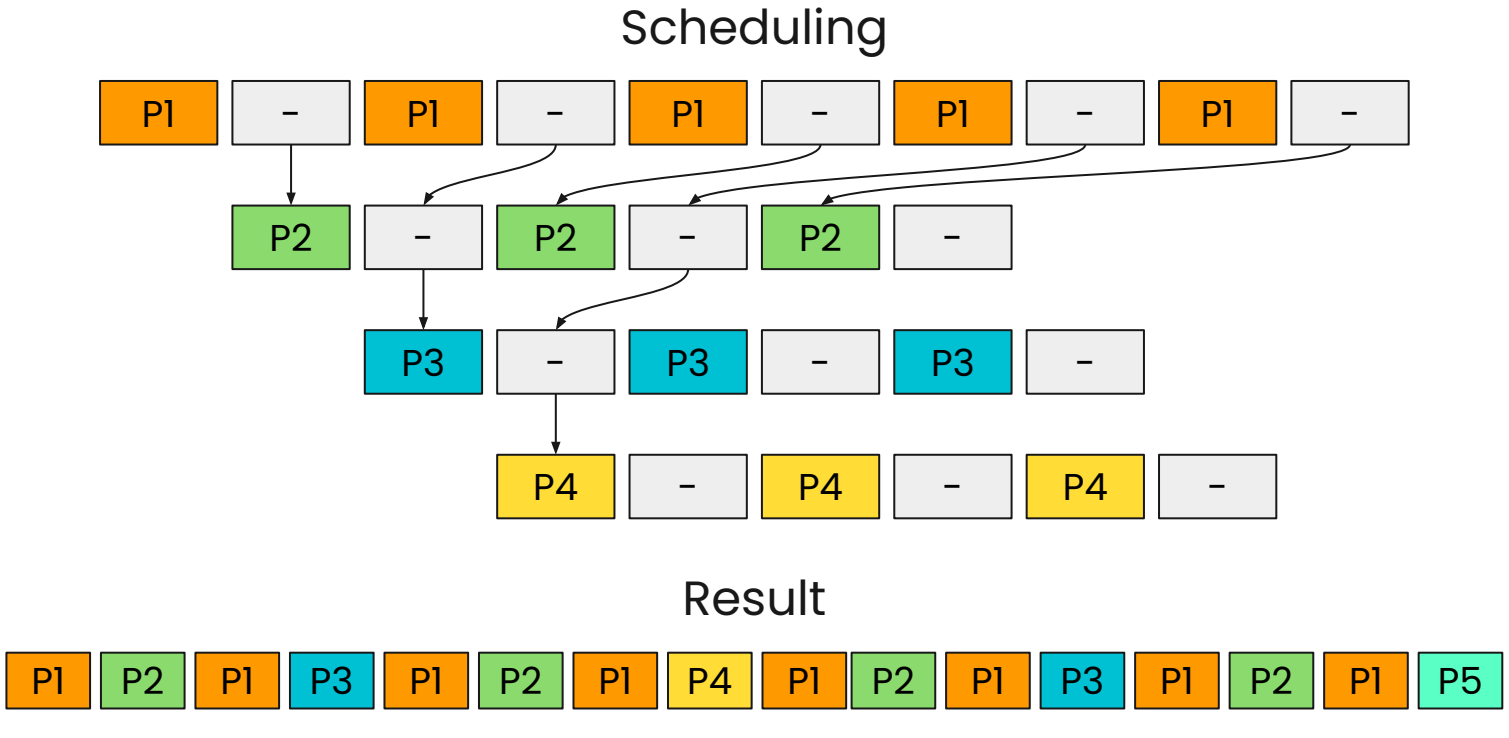
EXTRA SLIDES



Scheduling Algorithm

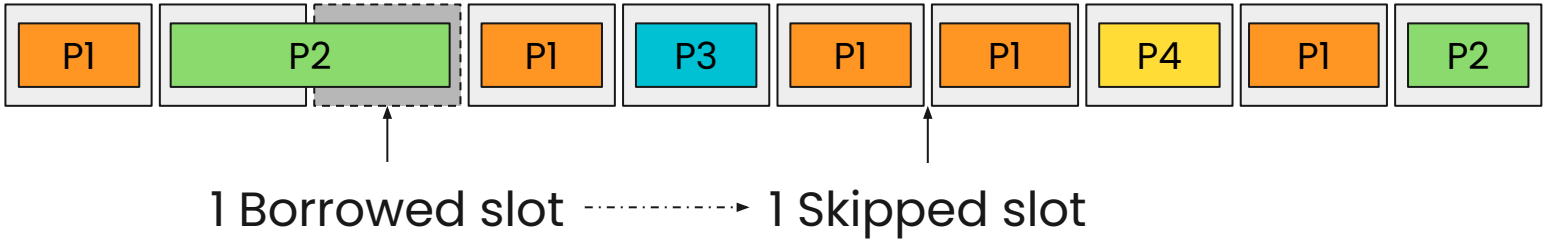


Nested Interleaving Scheduling Algorithm



Volume-Based Approach

If the size of one bundle is bigger than the slot size, the following slots allocated to that priority will be skipped until it “makes up for it”

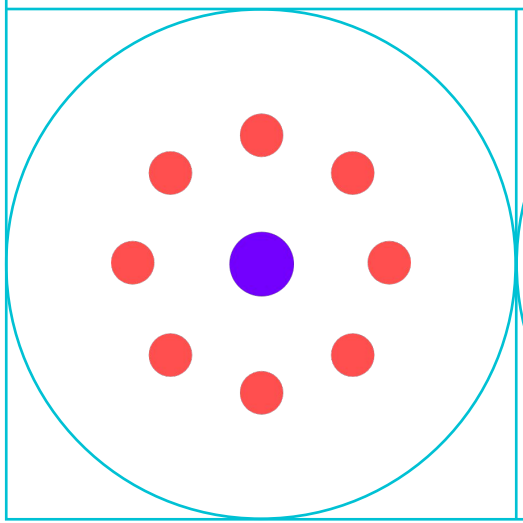


Original Schedule

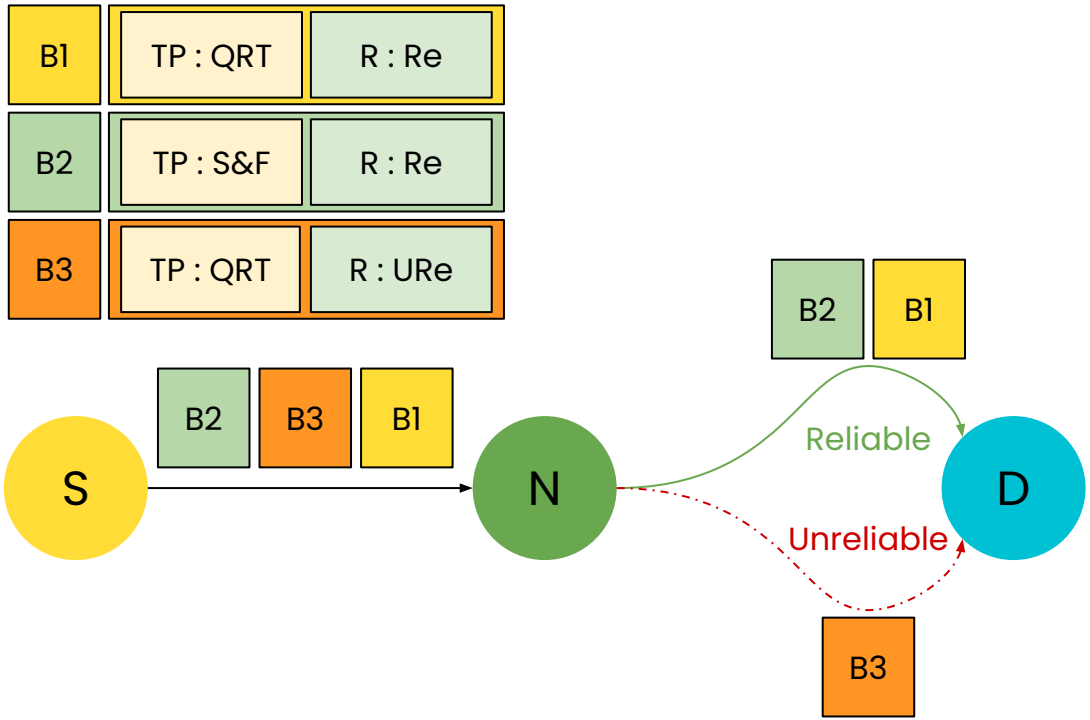
Advantages

- Fairness
- Better time-distributed transmissions
- Volume-based approach due to bundle sizes disparity
- Granularity with the two-level scheduling approach

Examples



UQEB Usage Example



B*x*	-	Bundle number *x*
D	-	Destination
N	-	Node
QRT	-	Quasi-Real-Time
R	-	Reliability
Re	-	Reliable Tranmission
S	-	Source
S&F	-	Store-and-Forward
TP	-	Traffic Priority
URe	-	Unreliable Transmission

NQEB Usage Example