Exploiting Packet Replication and Elimination in Complex Tracks in 6TiSCH LLNs

draft-papadopoulos-6tisch-pre-reqs-01

Georgios Z. Papadopoulos
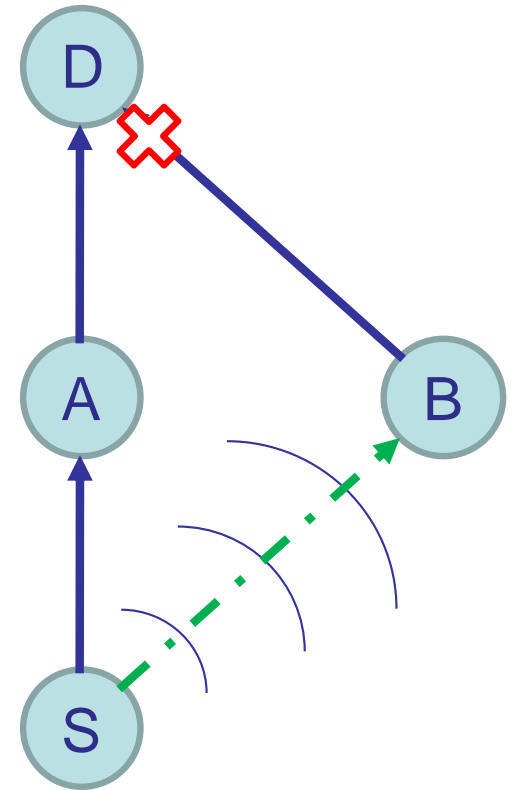Nicolas Montavont
Pascal Thubert

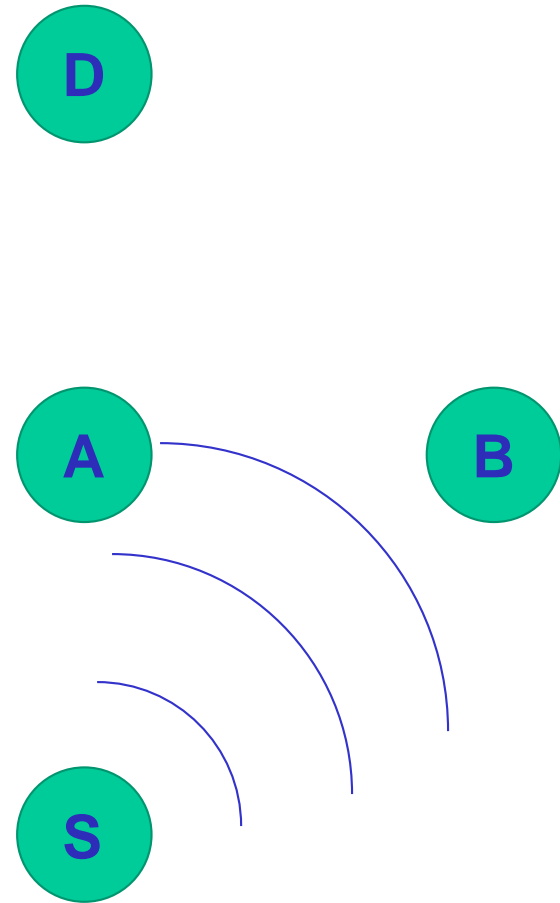6TiSCH interim, 26 January 2018

Toward Determinism

- Reliable communication;
- Low jitter performance;

Toward Determinism

- Reliable communication;
- Low jitter performance;
- Packet Replication Elimination
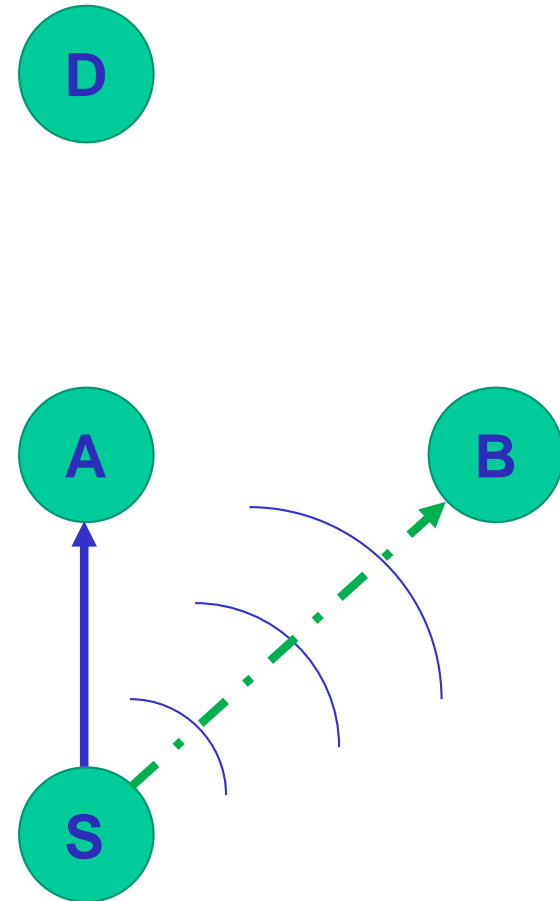 - Overhearing
  - Replication
  - Elimination

Wireless Topology

Promiscuous Overhearing

- ## Overhearing
  - – Wireless medium is broadcast
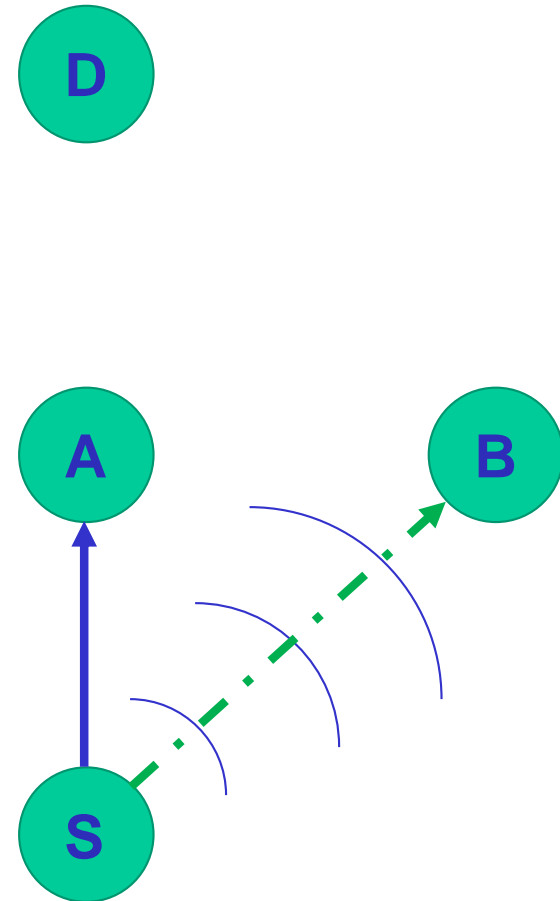 - – any neighbor of a transmitter may overhear a transmission

Promiscuous Overhearing

- ## Overhearing
  - – Wireless medium is broadcast
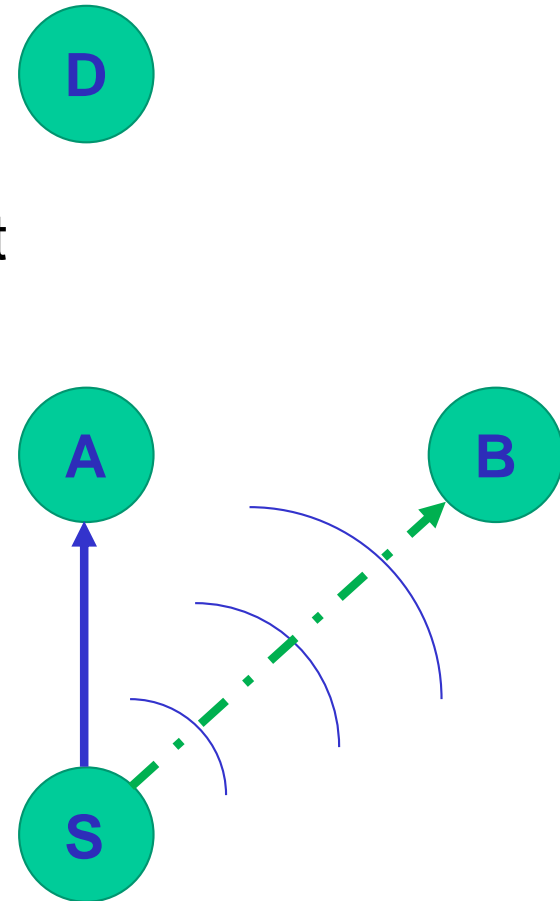 - – any neighbor of a transmitter may overhear a transmission

Requirement:
➢ Cell Reservation for multiple receivers;

Packet Replication

- ## Replication
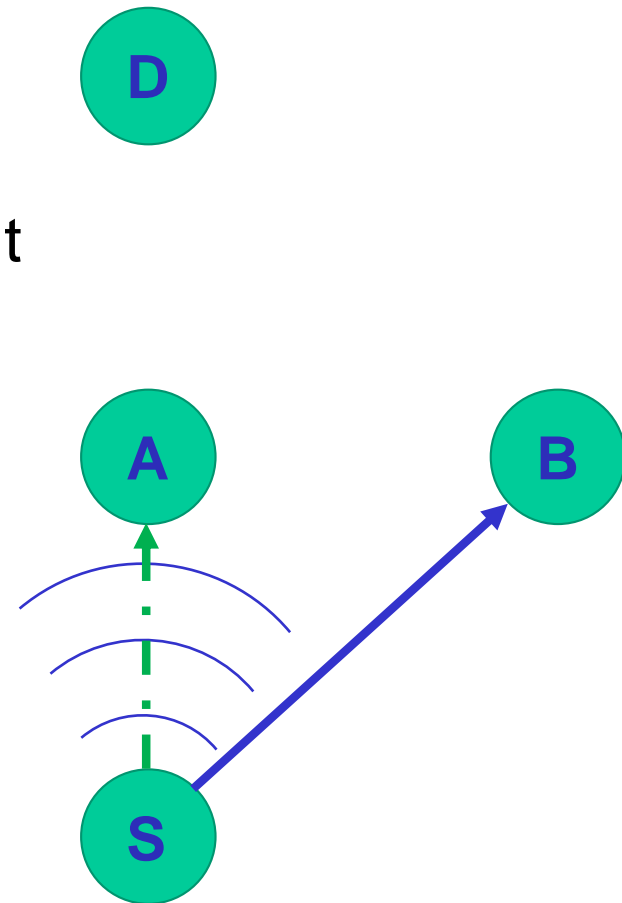 - – Data packet is transmitted to both Default & "Alternative" Parent

Packet Replication

- ## Replication
  - Data packet is transmitted to both Default & "Alternate" Parent

D

A   **B**

Requirement:
- ➤ Alternative Parent Selection;
- ➤ RPL DIO can be extended to provide information for the parent set [1];

S

[1] R. Koutsiamanis, G. Z. Papadopoulos, N. Montavont and P. Thubert, "RPL DAG Metric Container (MC) Node State and Attribute (NSA) object type extension," Working Draft, IETF Secretariat, Internet-Draft draft-koutsiamanis-roll-nsa-extension-01, January 2018.

Packet Elimination

- ## Elimination
  - – Discard the duplicated packet the "previously received packet"
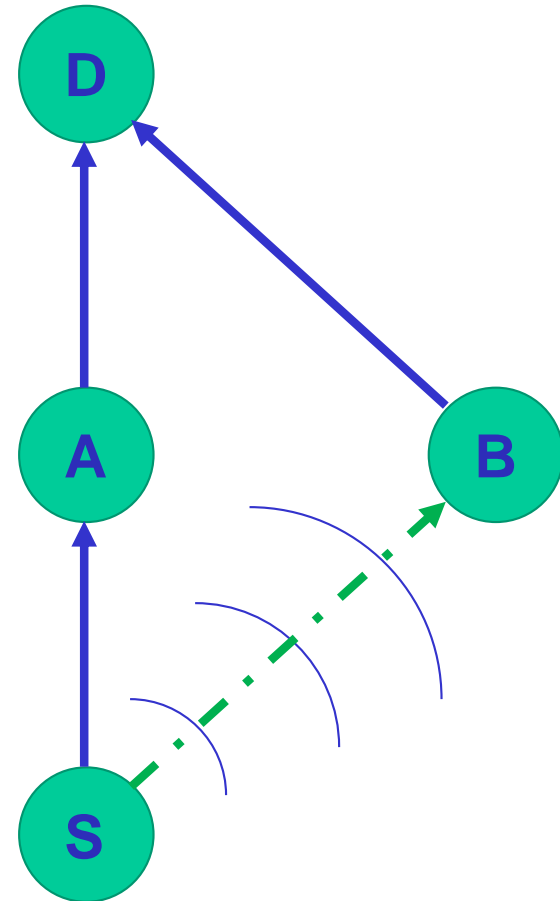
Packet Elimination

- ## Elimination
  - – Discard the duplicated packet the "previously received packet"

Requirement:
➢ Tagging Packets for Flow Identification;
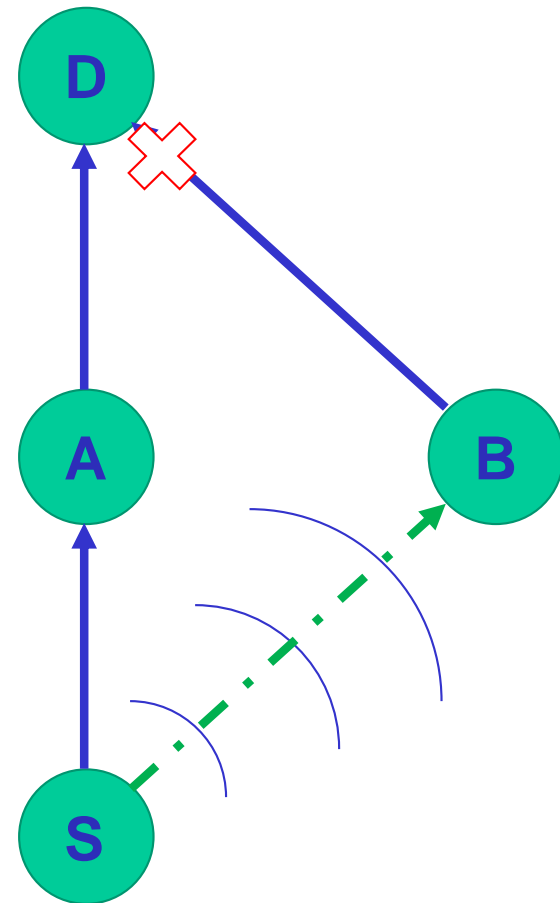
TSCH Schedule: example

Channel offset

	0	1	2	3	4
3		**S → A, (B)**			
2					B → D
1			**S → B, (A)**		
0	EB			A → D	

Slotframe

Requirement:
➢ Cells with multiple receivers;
➢ Single ACK, the Default Parent;
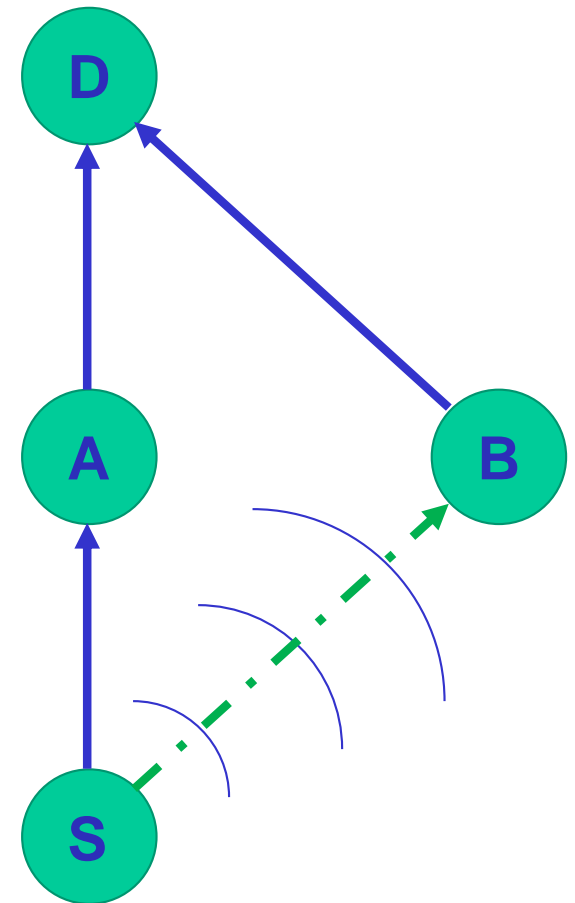
Summary of Requirements

- **Alternative Parent Selection;**
  - routing protocol should allow for 6TiSCH nodes to select multiple parents i.e., AP(s)

  - **Propagated Information;**
    - RPL DODAG Information Object (DIO) message format SHOULD be extended

- **Cell Reservation;**
  - Cell reservation with two receivers

- **Cells without ACKs;**
  - only one parent MUST acknowledge the data packet (to avoid ACK collisions)

- **Packet Elimination.**
  - Tagging Packets for Flow Identification should be employed

Implementation Status

- Partially this draft is implemented in Contiki OS
  - ✓ DIO extension
  - ✓ Alternative Parent Selection
  - ✓ Overhearing
  - ✓ Replication
  - ✓ Elimination
  - ❖ Work in progress (decentralized) TSCH scheduler to any topology

Simulation Results

- Implemented in Contiki OS over Cooja

- 8 nodes, 2 paths topology

- ❖ Work in progress to **any** topology

Elimination
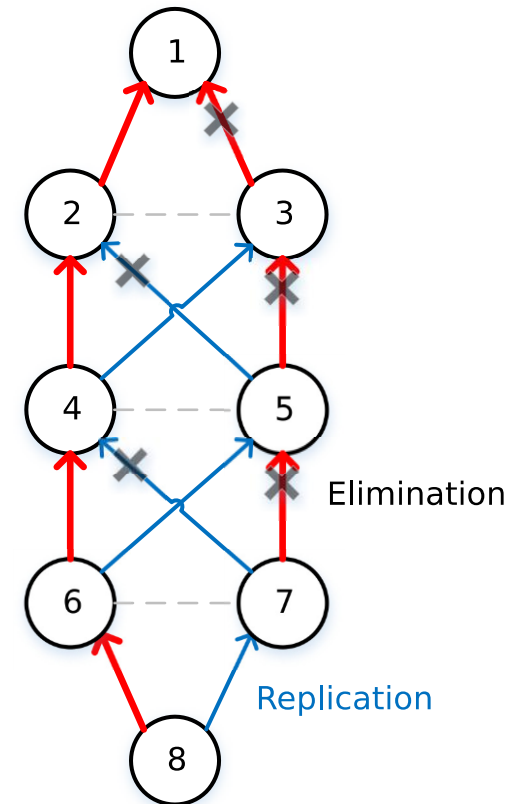
Replication

PDR Performance

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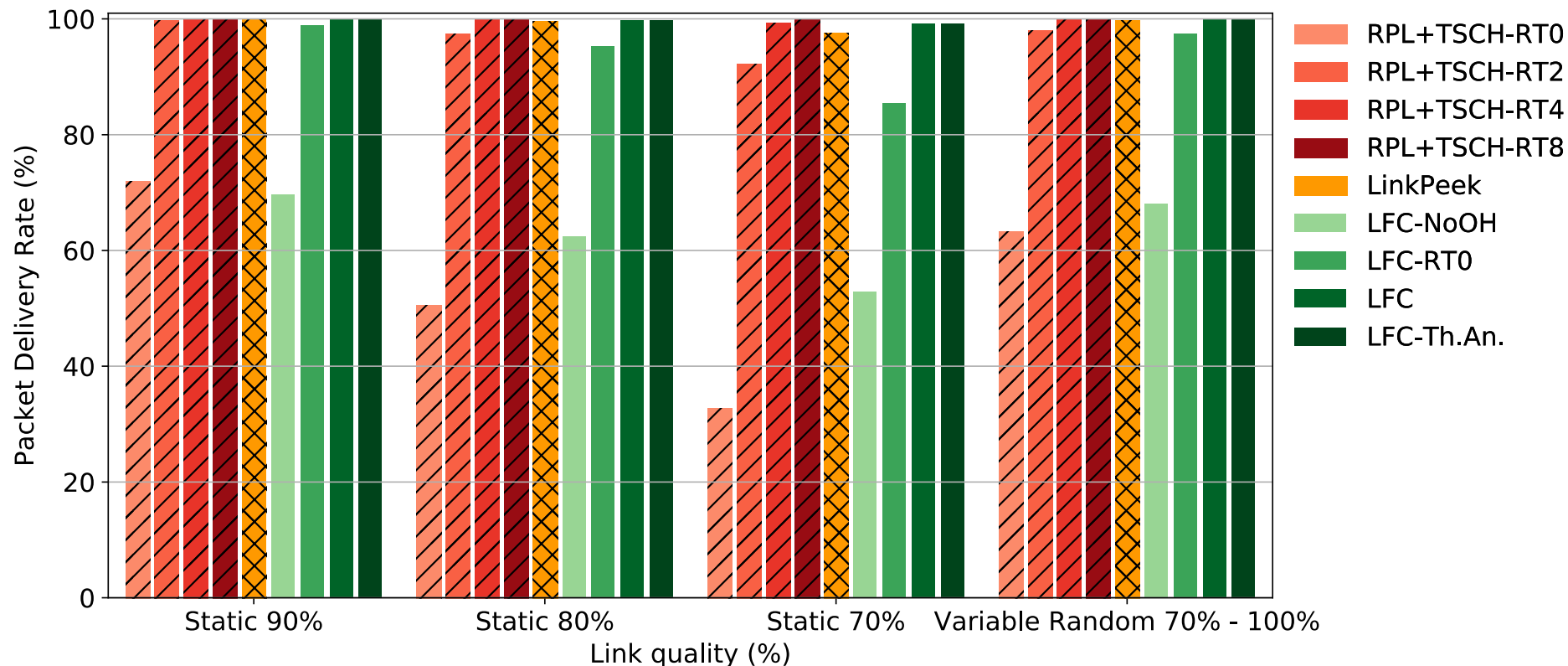
Delay Performance

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Jitter Performance

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Feedback

- Is it relevant in 6TiSCH WG?
- Volunteers to REVIEW the draft (to identify more requirements that we are missing);
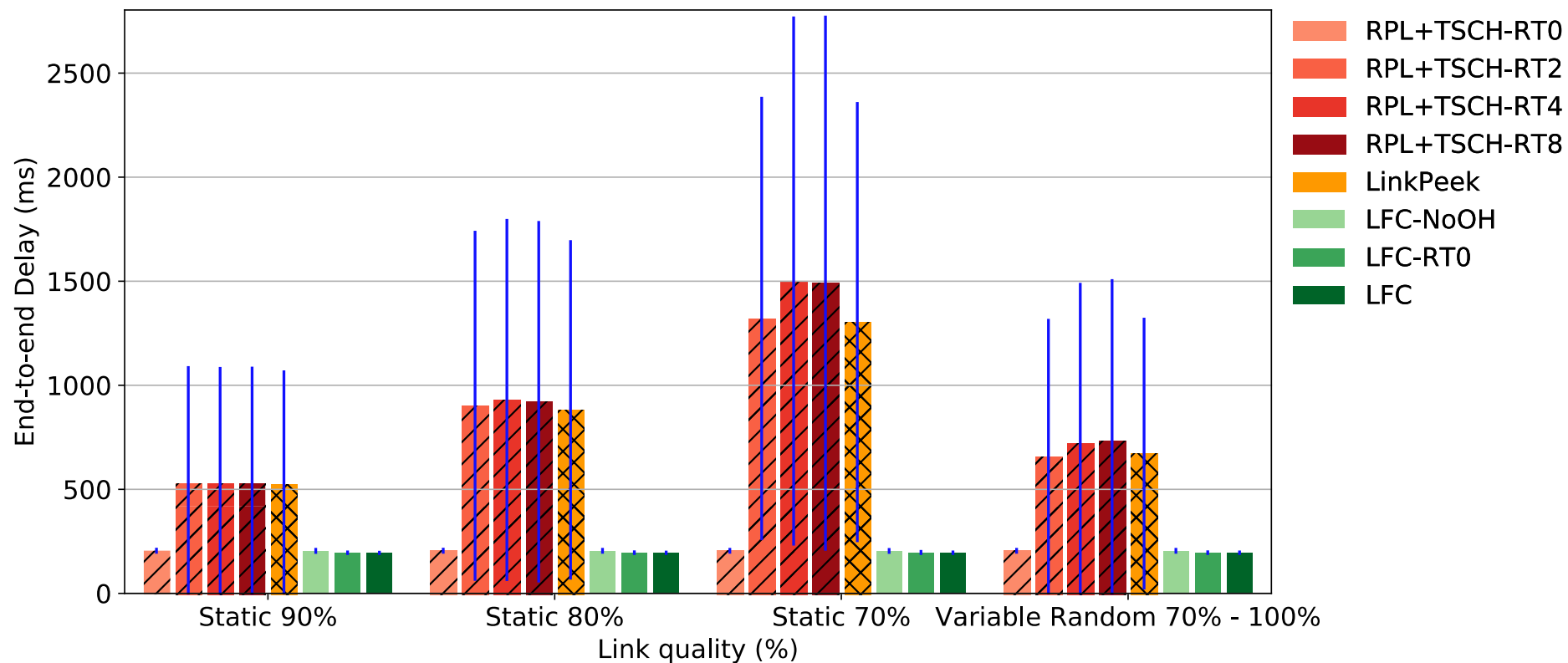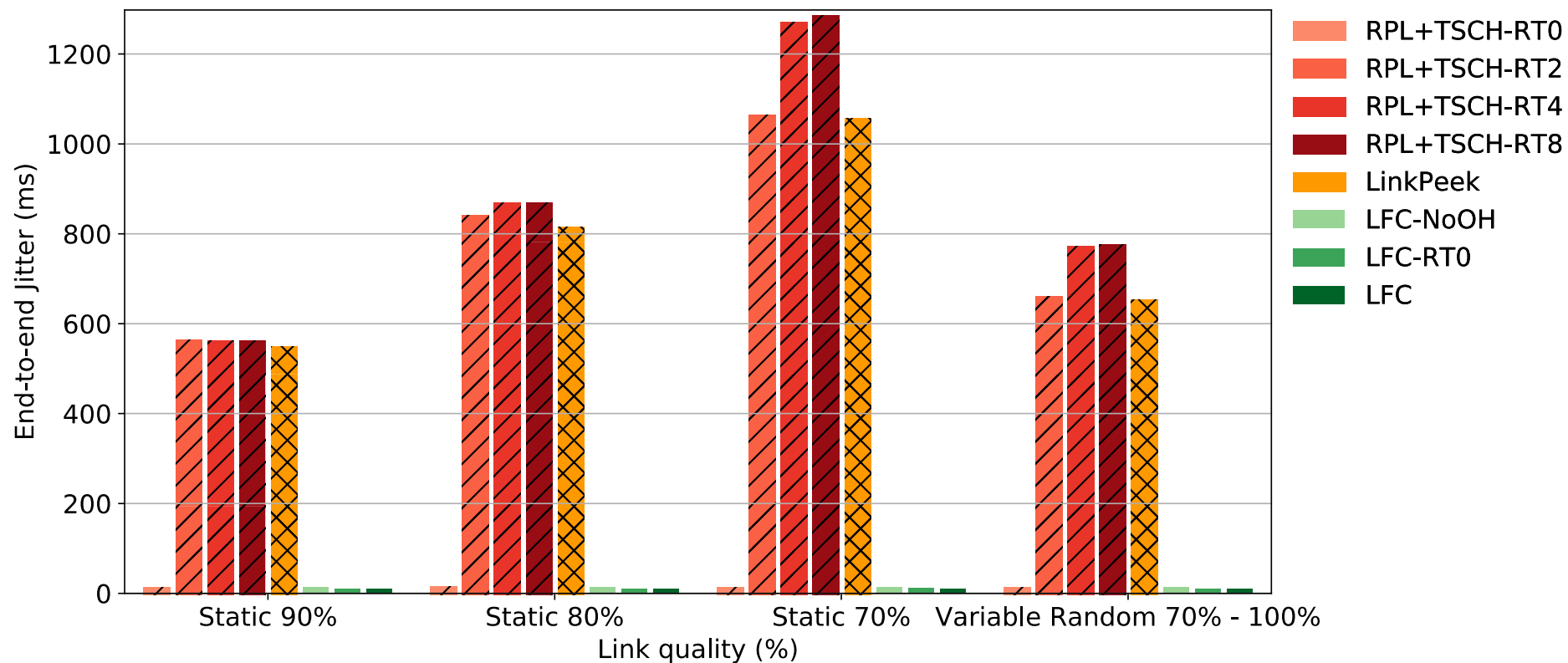
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Backup

- DIO extension to support Alternative Parent Selection

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Alternative Parent Selection

One possible option is to select the Alternative Parent as the one having common *ancestor*

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DIO Format Example

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
RPLInstanceID								Version Number								Rank															
G	o	MOP			Prf			DTSN								Flags								Reserved							
DODAGID																															
DAGMC Type (2)								DAGMC Length																							
DAG Metric Container data																															

MC/NSA Format Example

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
Routing-MC-Type (1)								Res Flags					P	C	O	R	A				Prec				Length (bytes)						
Res								Flags						A	O	PNS type (1)								PNS Length (bytes)						
PNS IPv6 address(es) ...																															

- ## Parent Node Set (PNS)
  - NSA Option
  - PNS type = 1 (8 bits)
  - PNS Length = # of PNS addresses x IPv6 address size (8 bits)
  - PNS IPv6 addresses = 1 or more IPv6 addresses