5G-XHaul

SODALITE: SDN Wireless Backhauling for Dense 4G/5G Small Cell Networks

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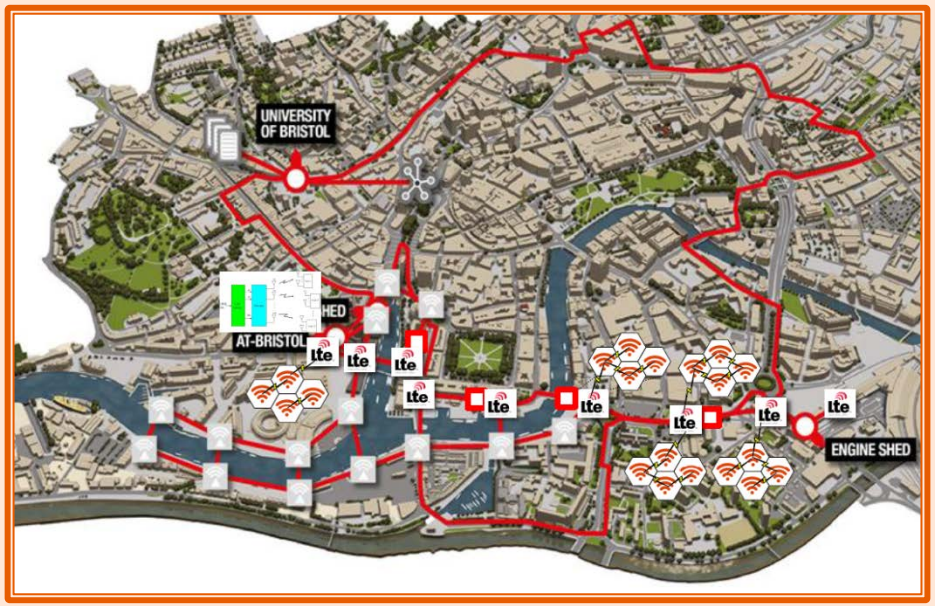


Bristol 5G city testbed with 5G-XHaul extensions

5G PPP

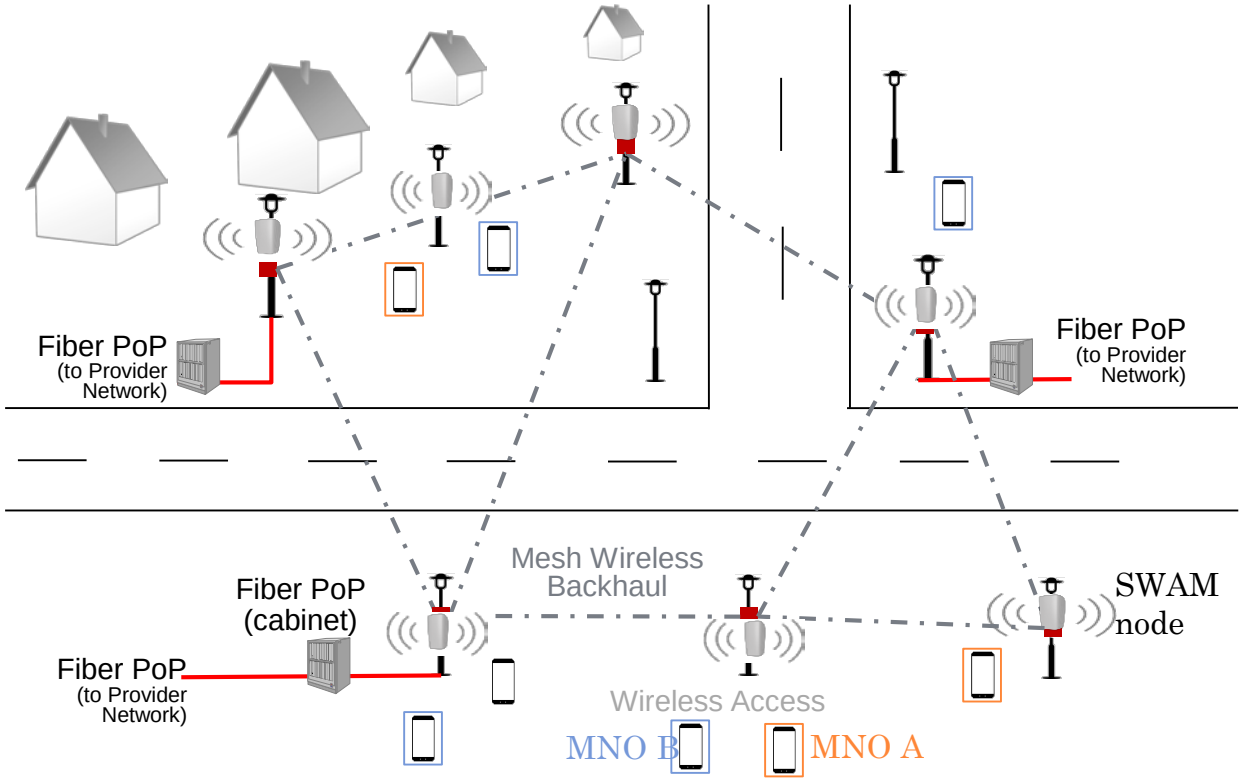
European Commission

Horizon 2020
European Union funding
for Research & Innovation

OUTLINE

- Problem Statement
- SODALITE Architecture
- SODALITE TE Mechanisms
- Experimental Evaluation
- Summary and Conclusions

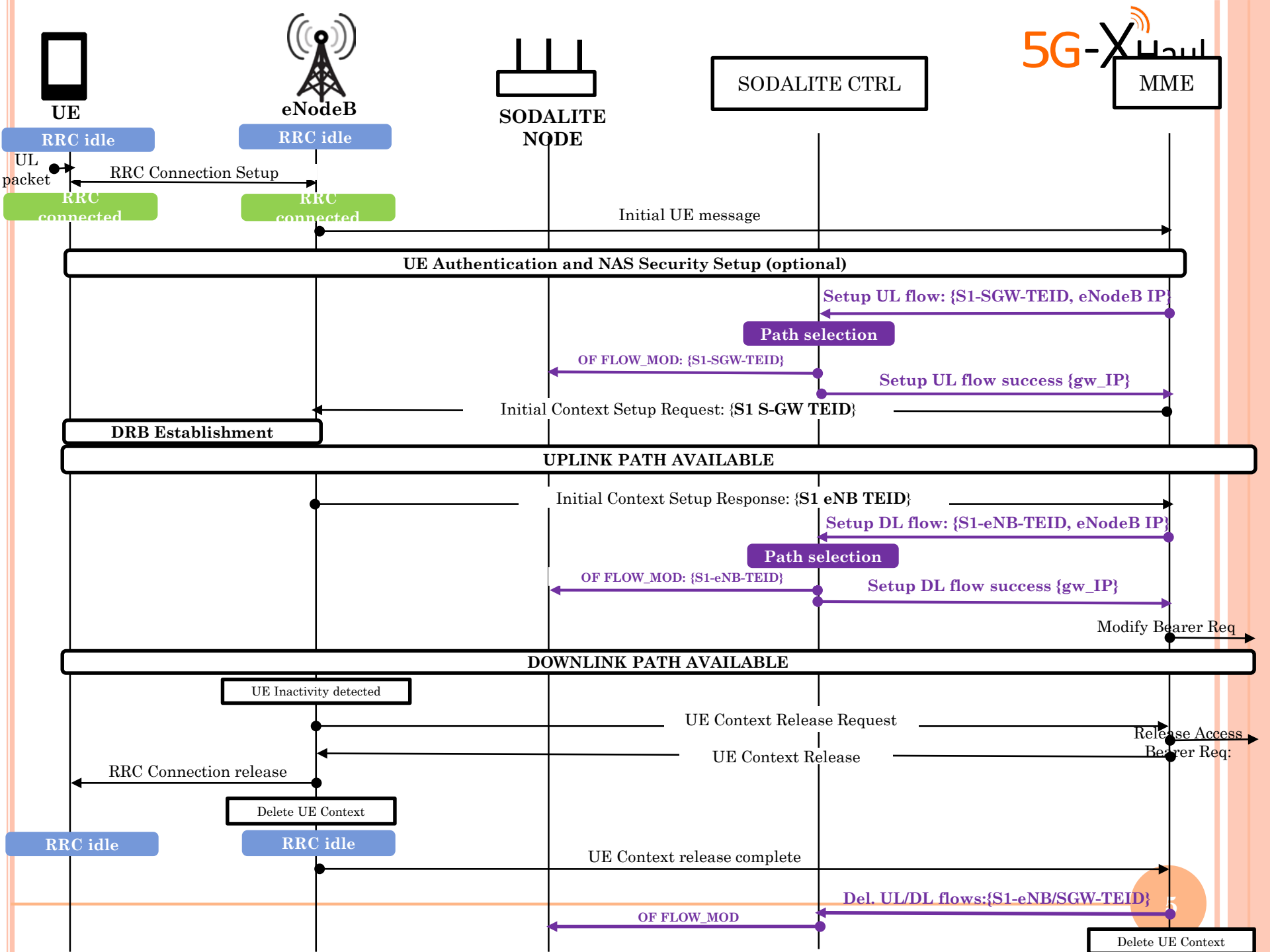
PROBLEM STATEMENT



The wireless backhaul may become the bottleneck !

SODALITE Architecture

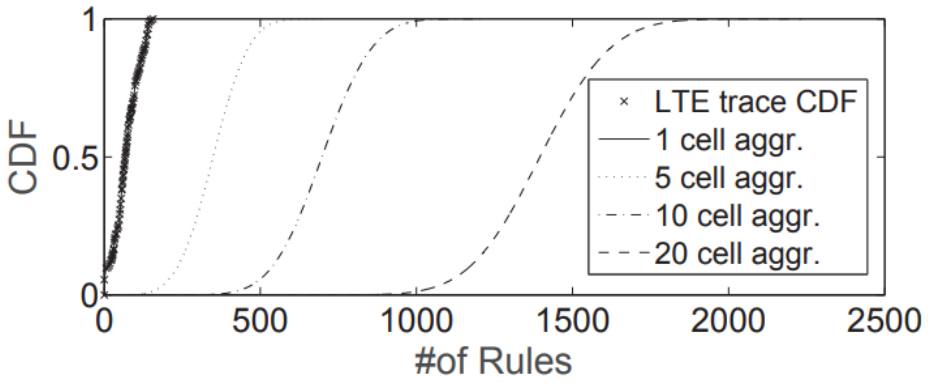
- 4G/5G define QoS through the concept of **bearer**
- In 4G the backhaul network does not have bearer visibility ... backhaul is over-provisioned
- SODALITE proposes to extend the concept of 4G/5G radio bearer to the wireless backhaul
- In practice:
  - Define backhaul flows based on **GTP/TEID** of S1 bearer
  - Use SDN mechanisms to perform routing/TE


UE
eNodeB
SODALITE NODE
SODALITE CTRL
MME
RRC idle
RRC idle
UL packet
RRC Connection Setup
RRC connected
RRC connected
Initial UE message
UE Authentication and NAS Security Setup (optional)
Setup UL flow: {S1-SGW-TEID, eNodeB IP}
Path selection
OF FLOW_MOD: {S1-SGW-TEID}
Setup UL flow success {gw_IP}
Initial Context Setup Request: {S1 S-GW TEID}
DRB Establishment
UPLINK PATH AVAILABLE
Initial Context Setup Response: {S1 eNB TEID}
Setup DL flow: {S1-eNB-TEID, eNodeB IP}
Path selection
OF FLOW_MOD: {S1-eNB-TEID}
Setup DL flow success {gw_IP}
Modify Bearer Req
DOWNLINK PATH AVAILABLE
UE Inactivity detected
UE Context Release Request
Release Access Bearer Req:
UE Context Release
RRC Connection release
Delete UE Context
RRC idle
RRC idle
UE Context release complete
Del. UL/DL flows:{S1-eNB/SGW-TEID}
OF FLOW_MOD
Delete UE Context

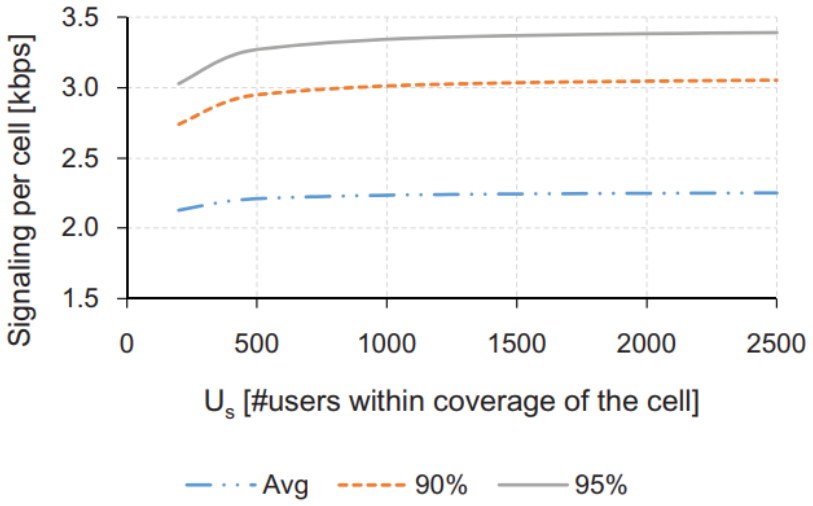
SODALITE ARCHITECTURE

- Main advantage: *„Allows per user-policies in the wireless backhaul“*
- Required Overhead?
  - Analysis based on traces from LTE network in Greece (2 periods of 2 weeks, 30 cells)

entries in fwdg tables in backhaul nodes



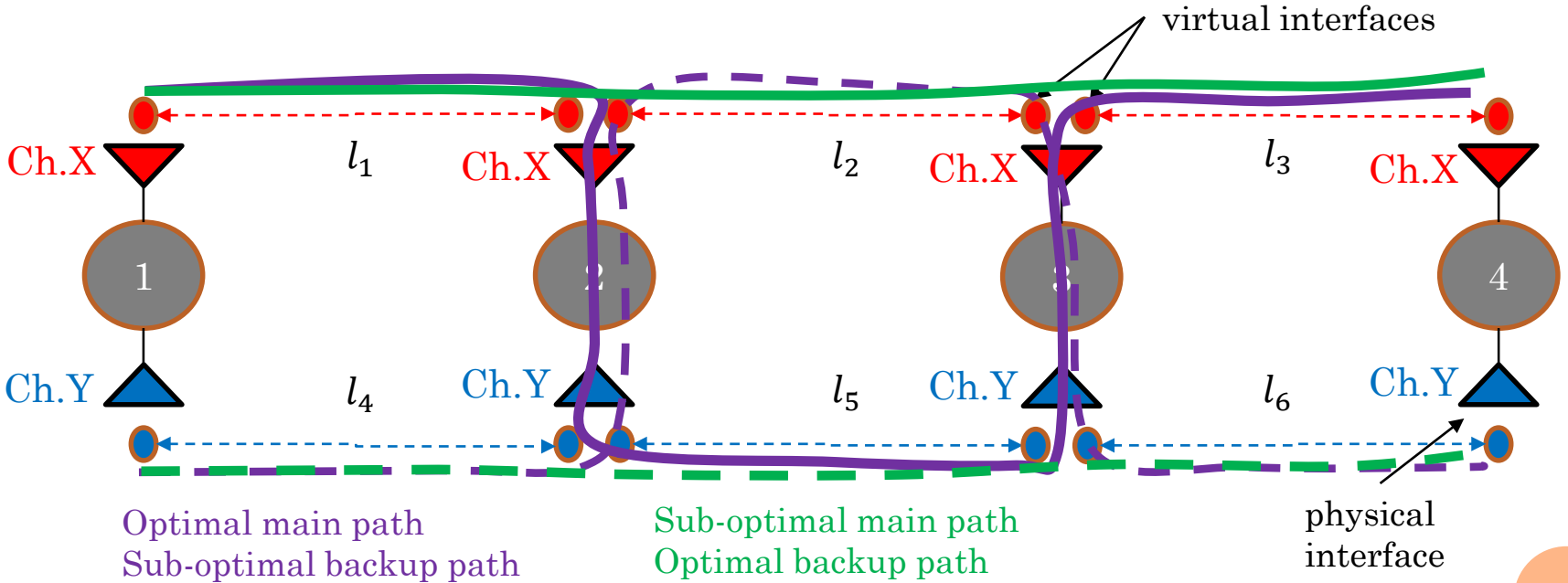
Signaling for flow setup



SODALITE TE Mechanisms

- **Centralized** computation of „main+backup paths“
- **Local Agent** for „fast re-route“

- Centralized main+backup path allocation (sub6). Example:



SODALITE TE MECHANISMS

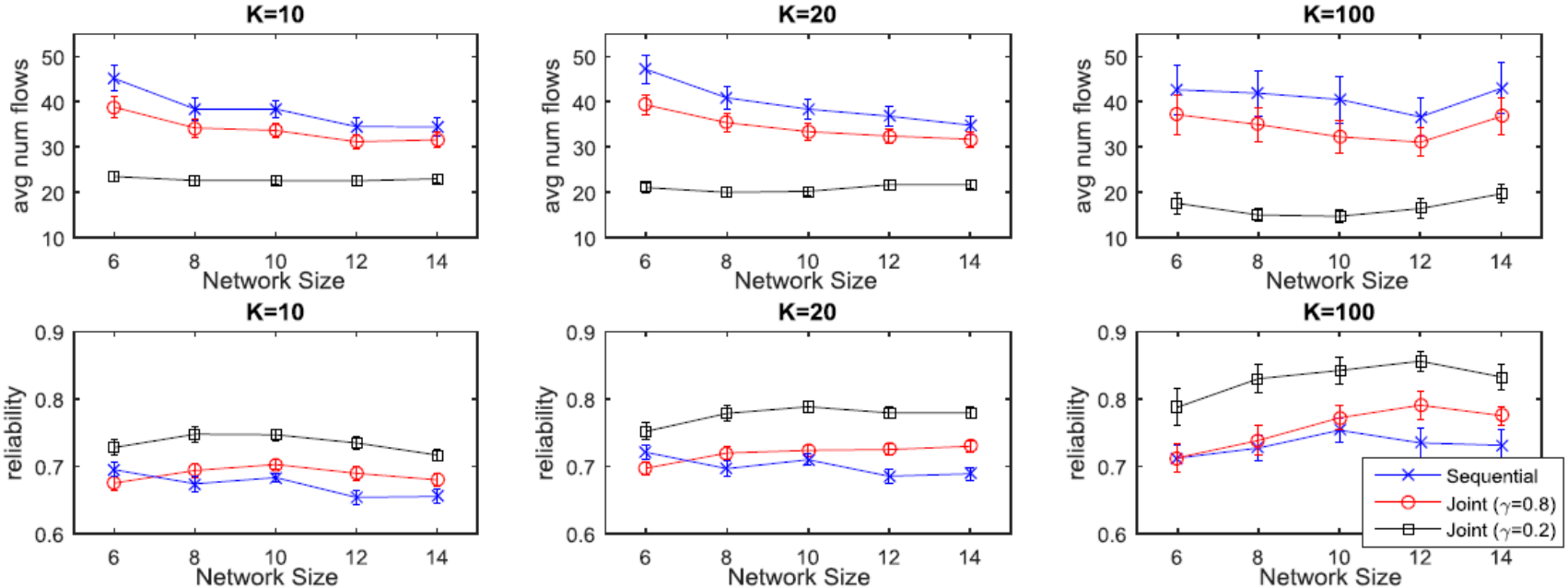
- Problem formulation for path allocation:

$$\boldsymbol{P}_{main} = \underset{1 \le x \le K}{\operatorname{argmin}} \max \boldsymbol{\mu}_{\boldsymbol{P}x} \qquad (\boldsymbol{P}_{main}, \boldsymbol{P}_{backup}) = \underset{x,y}{\operatorname{argmin}} (\gamma \max \boldsymbol{\mu}_{\boldsymbol{P}x} + (1-\gamma)\delta(\boldsymbol{P}_x, \boldsymbol{P}_y))$$

$$\boldsymbol{P}_{backup} = \underset{1 \le y \le K}{\operatorname{argmin}} \delta(\boldsymbol{P}_{main}, \boldsymbol{P}_y)$$

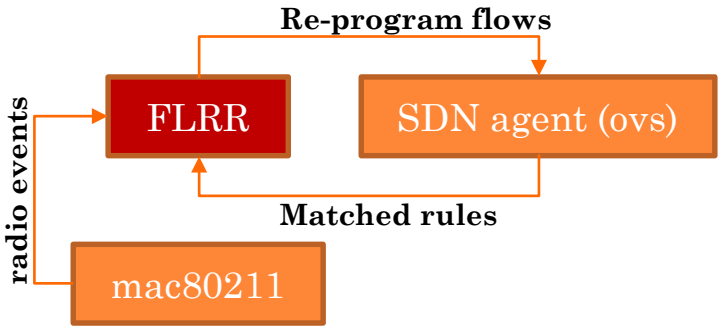
Sequential **Joint**

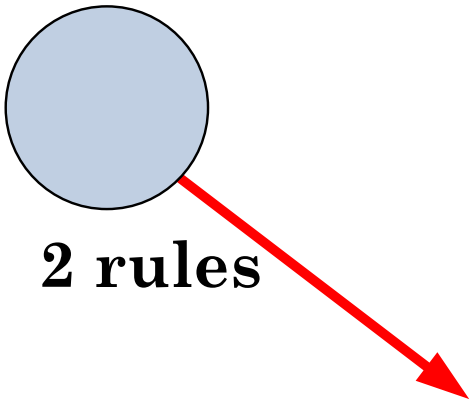
- Heuristic based on selecting **K** paths sorted with WCETT metric:



SODALITE TE MECHANISMS

- **Local Agent** for Fast Re-route



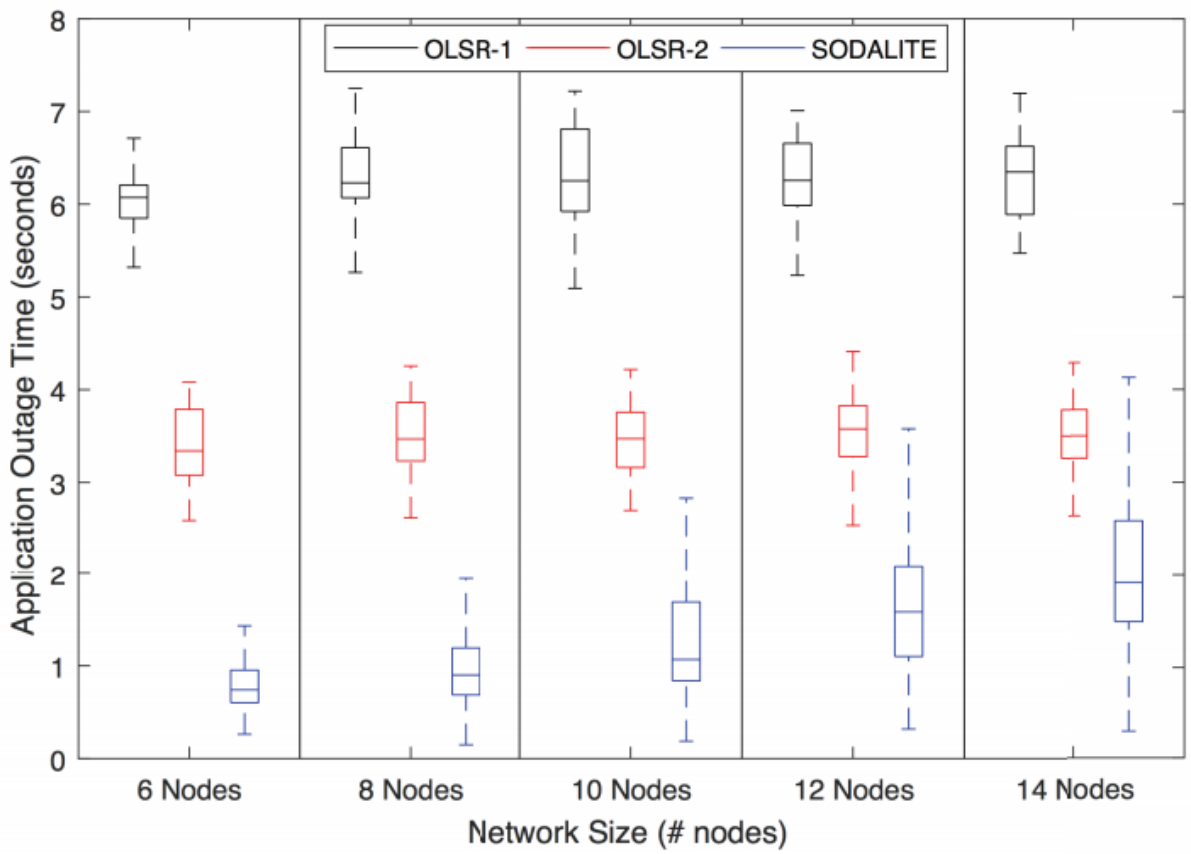


2 rules

1 rule

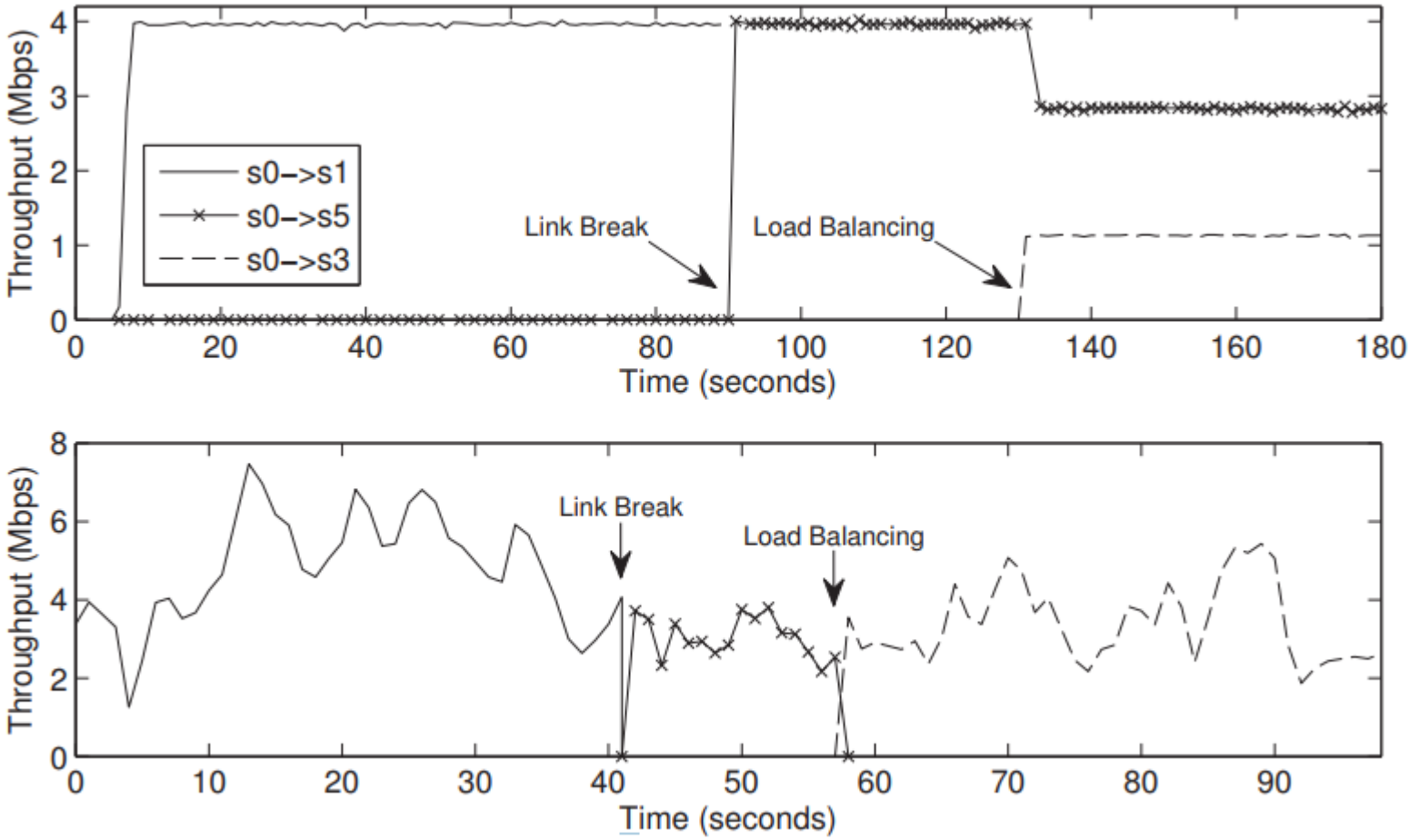
Experimental Evaluation (Sample Results)

- Emulated topologies (real implementation):



Experimental Evaluation (Sample Results)

- LTE testbed (1 eNB, 2 Ues), 8 wireless backhaul nodes:



Summary and Conclusions

- Architecture proposal: Define flows in wireless backhaul, using the GTP TEID
  - Overhead is manageable
- Centralized computation of „main + backup“ paths
  - Performance + Reliability trade-offs
- Local agent for fast recovery
  - Acceptable performance with software agents

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Thanks for
your attention!

Questions?