Performance of interoperator fixed-mobile network sharing

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ONDM 2017

Grant number DEC-2013/08/S/ST7/00576 from the Polish National Science Centre

Introduction

- Fixed-mobile networks are wide-spread, and expensive.
- Operators cooperate and share to cut costs.
- Currently sharing is limited to buildings, masts, etc.
- We proposed the interoperator fixed-mobile network sharing and showed the splendid availability improvement.
- We concentrate on passive optical networks (PONs).

Motivation

- Performance improvement is crucial, especially for the next-generation wireless networks.
- Performance improvement should be economical and scalable.
- Interoperator fixed-mobile network sharing can improve performance by using redundant resources already deployed.

Redundancy is already there!

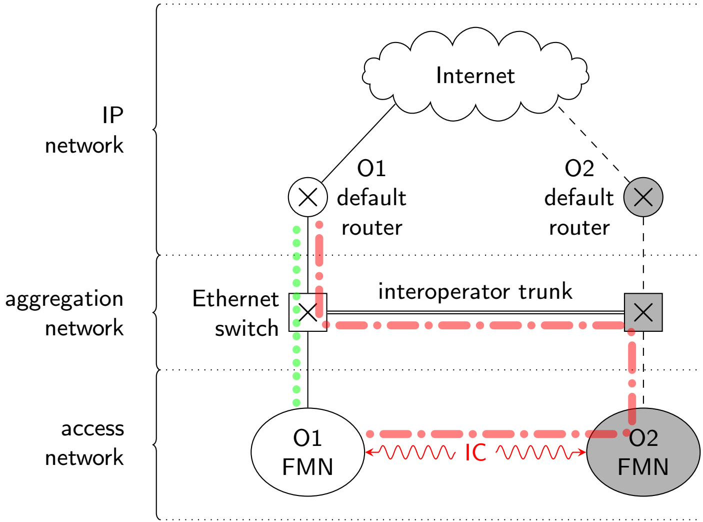
Two separate PON deployments in the same area.

Contribution

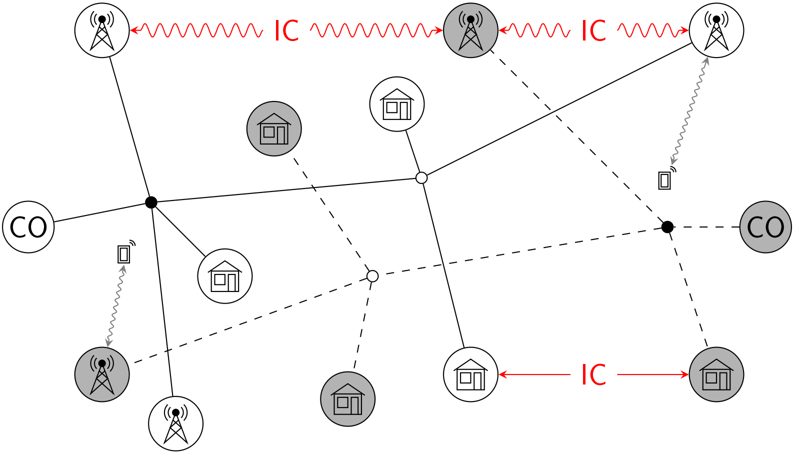
The performance evaluation of the interoperator fixed-mobile network sharing.

The hallmark of our proposed sharing is the interoperator communication in access networks.

Interoperator fixed-mobile network sharing in general



Interoperator sharing in passive optical networks



We need active nodes

- In the proposed sharing we need active remote nodes.
- Active nodes can diverge traffic to the other operator.
- Active nodes are already used to, e.g., extend reach.

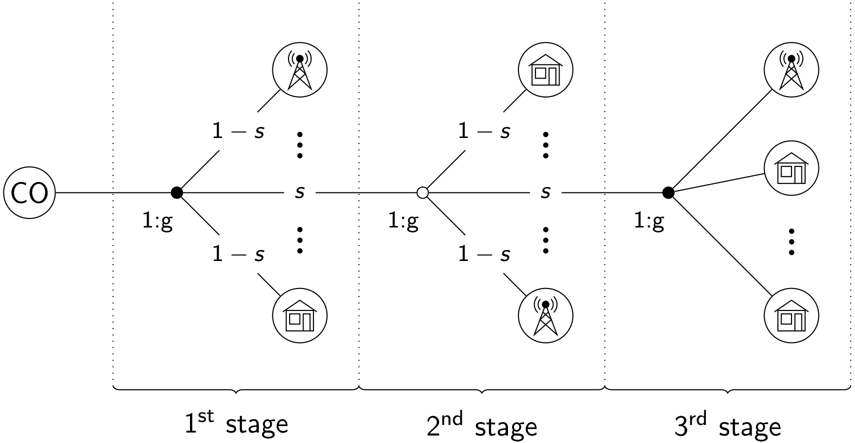
PON performance

- We study the improvement of the PON performance.
- Specifically, we study the upper bound of the improvement.
- PON performance is the average ONU performance, and:

$$\text{ONU performance} = \frac{\text{load serviced by PONs}}{\text{load requested by the ONU}}$$

- PON performance is a function of:
  - l - network load,
  - q - probability that a remote node is active,
  - r - probability that an ONU is interoperator-communicating.
- We study two scenarios:
  - in the first, the locations of active remote nodes are given,
  - in the second, the active nodes are randomly distributed.

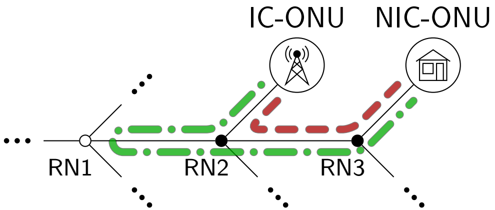
First scenario, and second too



Performance evaluation

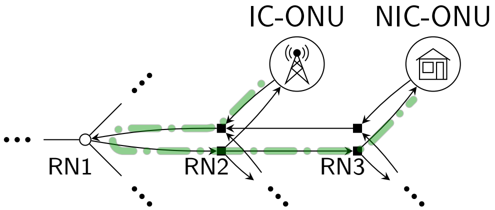
- Numerical evaluation: a mix of analysis and simulation.
- We analytically evaluate a given, concrete network, for a given network load l.
- Network load is evenly distributed among ONUs.
- ONUs with less connectivity options are served first.
- We randomly produce a sample of concrete networks from the populations with the given probabilities:
  - q - a remote node is active,
  - r - an ONU is capable of inter-operator communication.
- We used 204600 concrete networks, and averaged the results.

The problem of shortest paths in PONs with active nodes



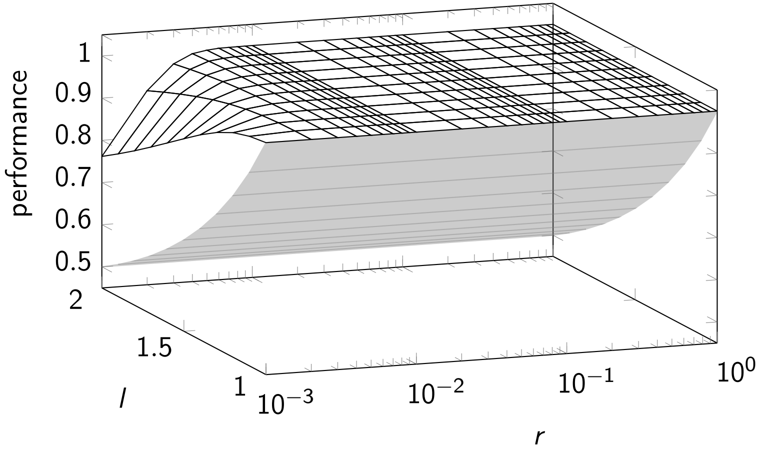
Example of finding a correct shortest path between an IC-ONU (interoperator-communicating ONU) and an NIC-ONU (non-iteroperator-communicating ONU), where • is a passive remote node, ○ is an active remote node, •▬• is the correct path, and ▬ ▬ is the wrong path.

Graph model for shortest paths in PONs with active nodes



Example of modifying a graph by splitting passive remote nodes, where ■ is a split passive remote node, ○ is an active remote node, and •▬• is the correct path.

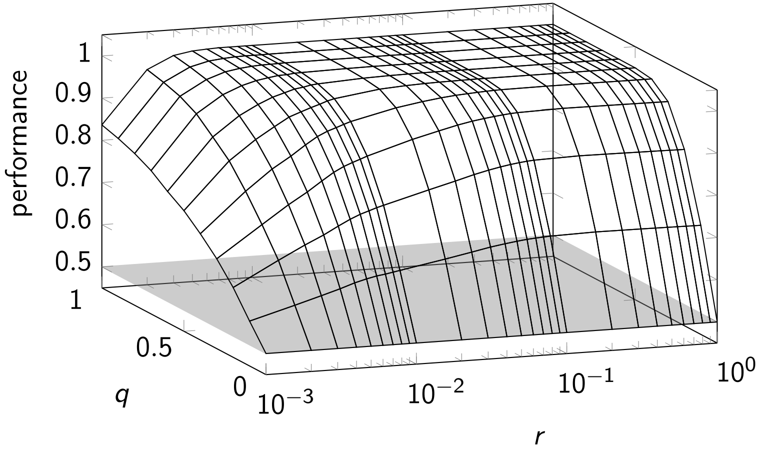
PON performance in the 1st evaluation scenario



l - network load

r - probability an ONU is capable of interoperator communication

PON performance in the 2nd evaluation scenario for $l = 2$



q - probability a remote node is active

r - probability an ONU is capable of interoperator communication

Conclusions

- We evaluated the performance of the proposed sharing.
- The performance could be improved twofold, or even more when there are more sharing operators.
- Upgrades can be rolled out in stages and where needed most.
- The proposed sharing significantly improves availability too.
- There are many problems to research further, for instance:
  - implementation details,
  - sharing rules,
  - optimization.