Code-adaptive Transmission Accounting for Filtering Effects in EON

G. Meloni, L. Potì, N. Sambo, F. Fresi, F. Cavaliere

ONDM 2015

Introduction

- In elastic optical networks (EONs), **distance adaptation**: trade-off between spectral efficiency and the all-optical reach
  - solutions based on different modulation formats: e.g., PM-16QAM and PM-QPSK → such techniques may require transponders supporting multiple modulation formats
- Recently, distance adaptation through **code adaptation**: code redundancy is tuned based on the optical reach (the larger the length the more the redundancy)
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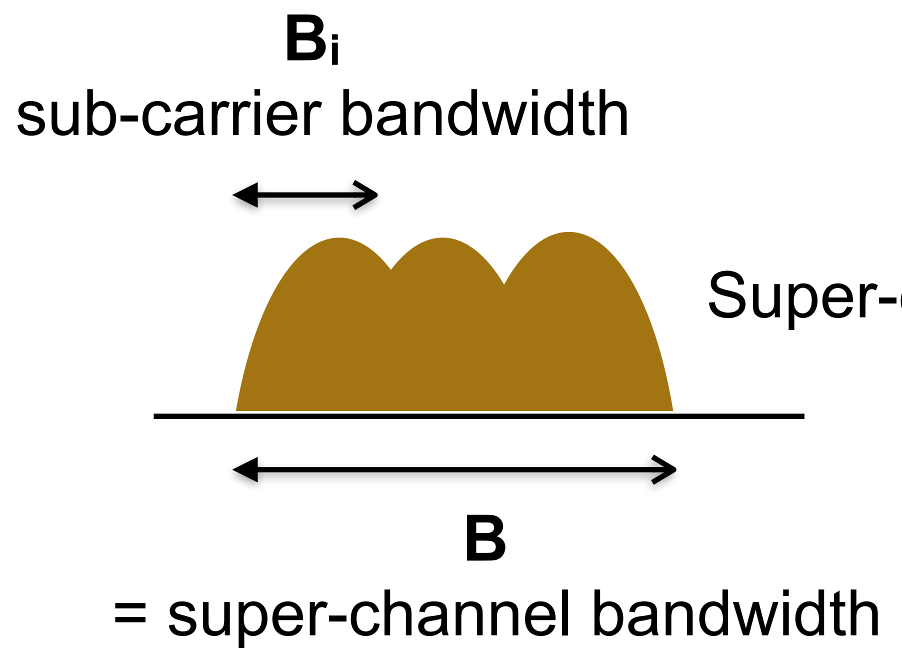
<u>In this paper</u>

- We demonstrate the concept of code adaptation for distance adaptation considering time frequency packing transmission
- Coding is selected to satisfy quality of transmission (QoT), also considering detrimental **filtering effects**
- **High spectral-efficiency: e.g., 6.6 b/s/Hz with PM-QPSK**
- Code adaption is also hitlessy performed to re-act to the degradation without the need of any re-routing

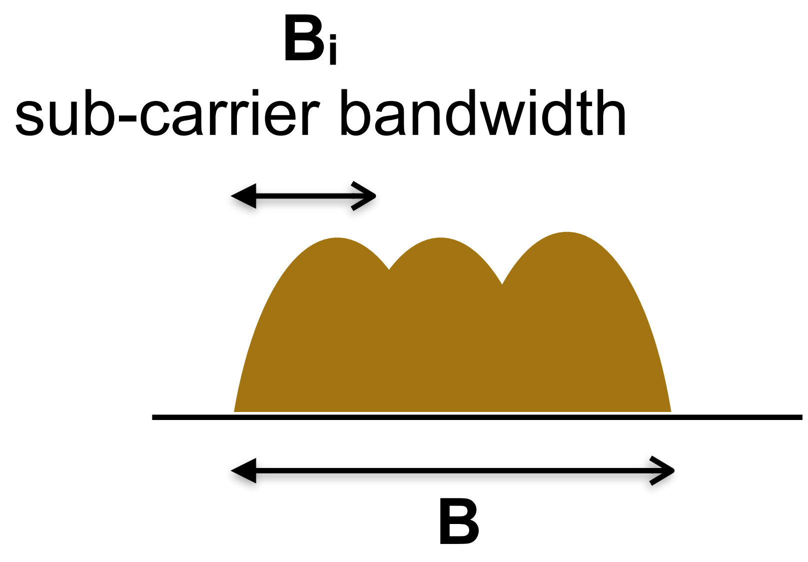
Scenario



Super-channel made of **N** PM-QPSK sub-carriers

- **c_i = code rate** f/b where b − f bits of code are transmitted each f bits of information
  - Code rate (i.e., redundancy) affects the ability to correctly receive the information transmitted over an all-optical path, also traversing a certain number of nodes, thus considering filters (spectrum selective switches —SSSs).
- **R_i =** sub-carrier bit rate: it includes information and coding
- Super-channel **information rate: $N \times c_i \times R_i$**

Setting code, sub-carriers, and filters



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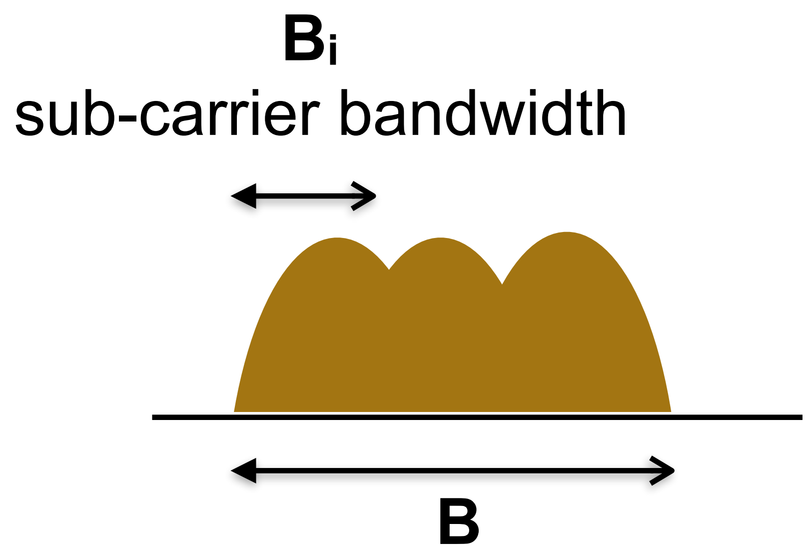

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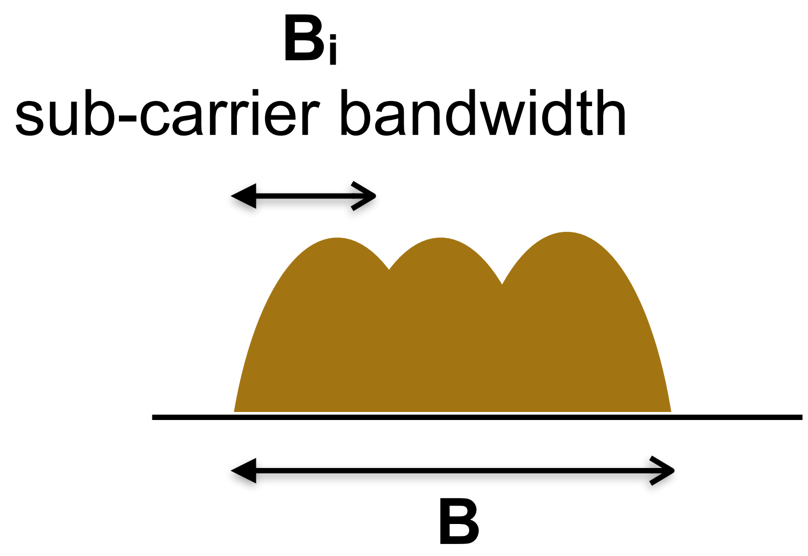

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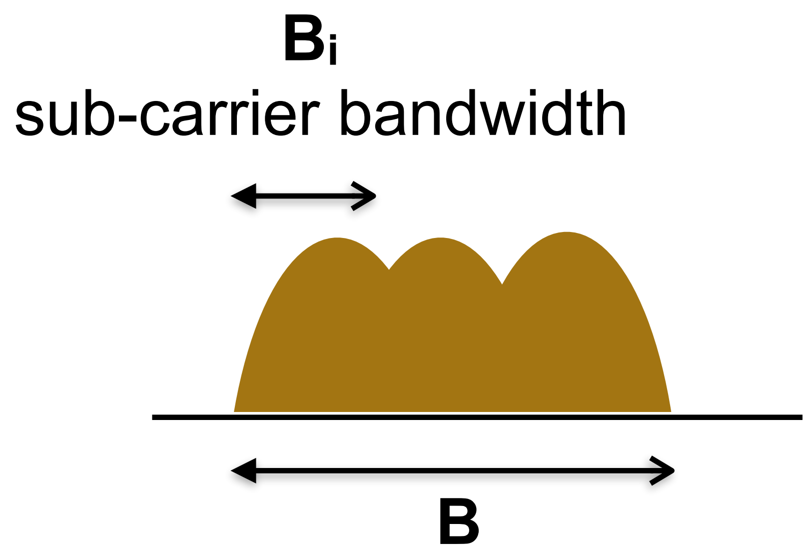

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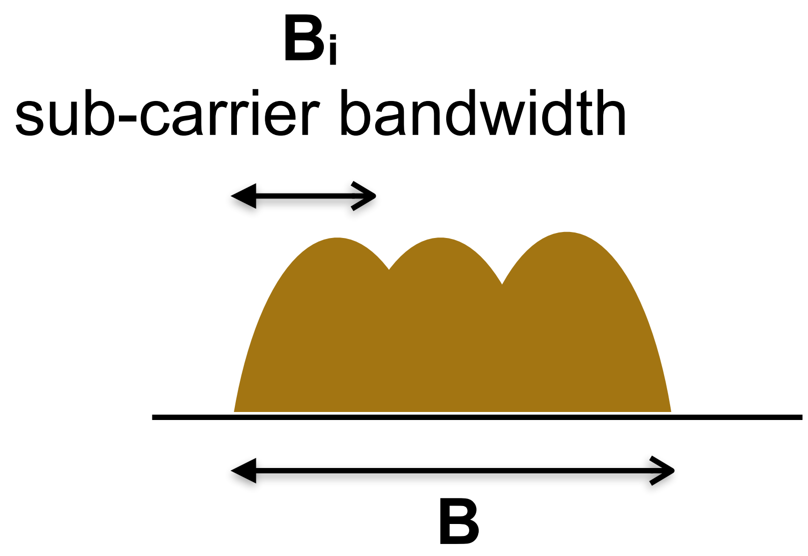

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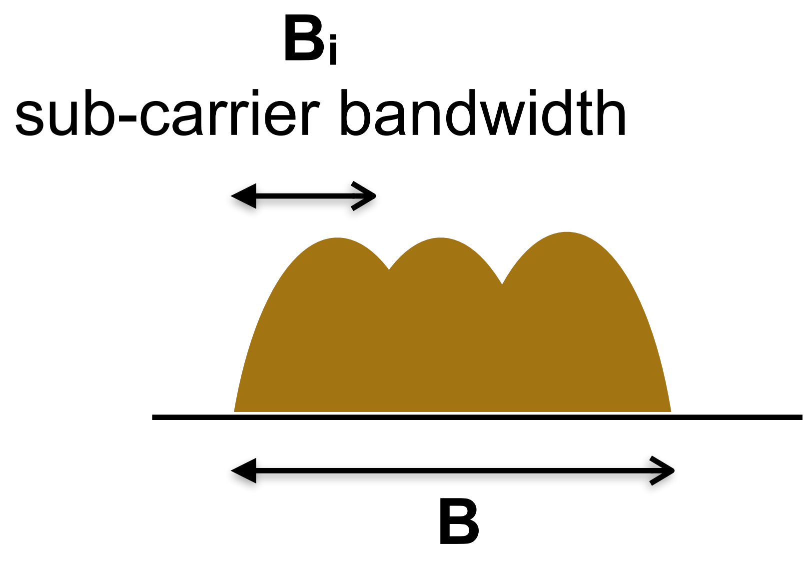

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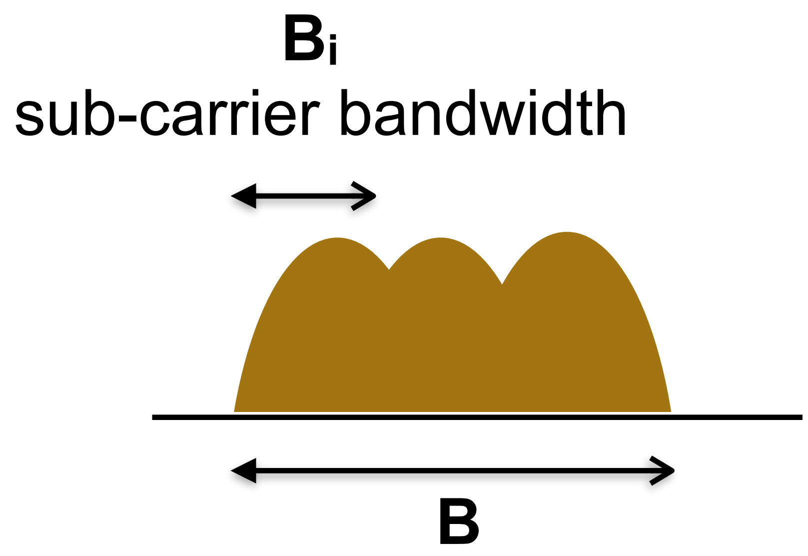

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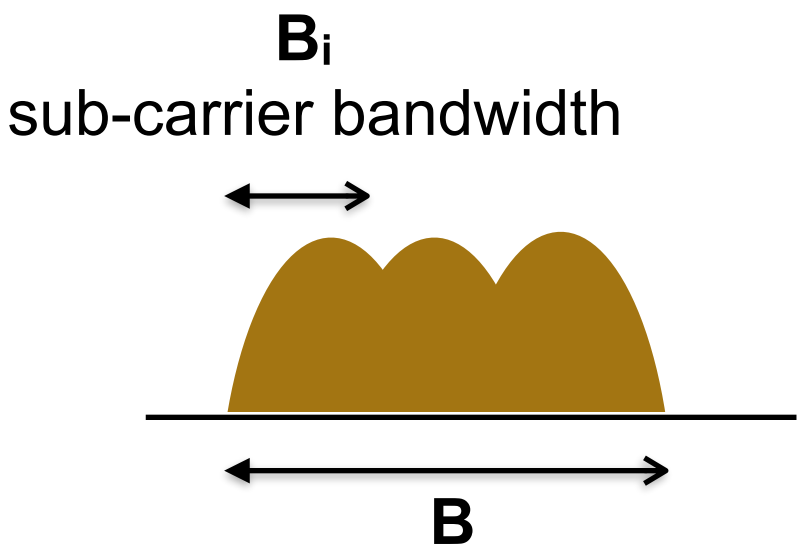

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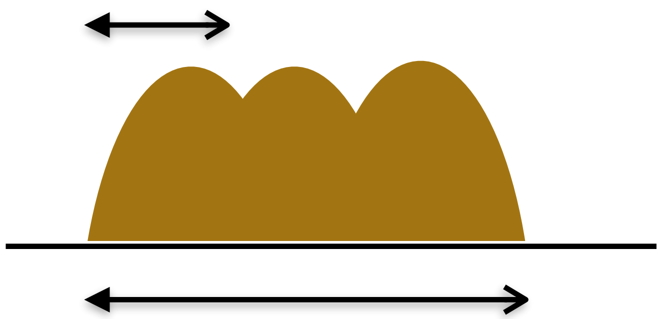

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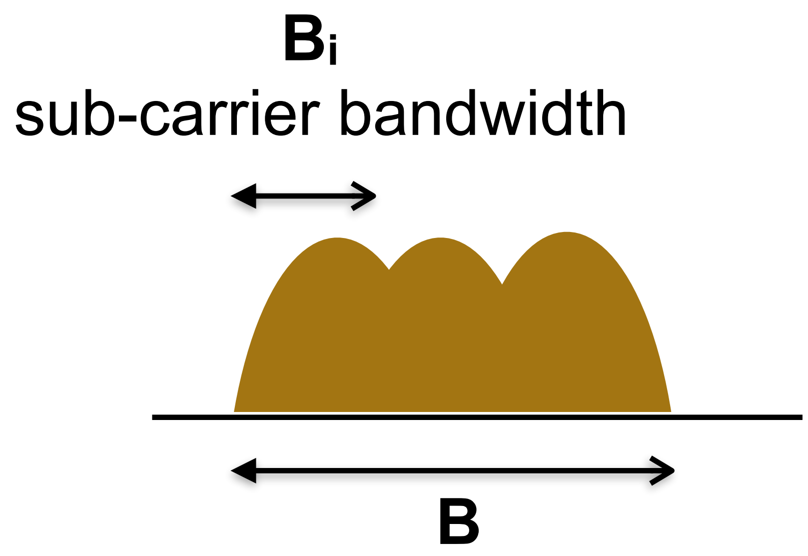

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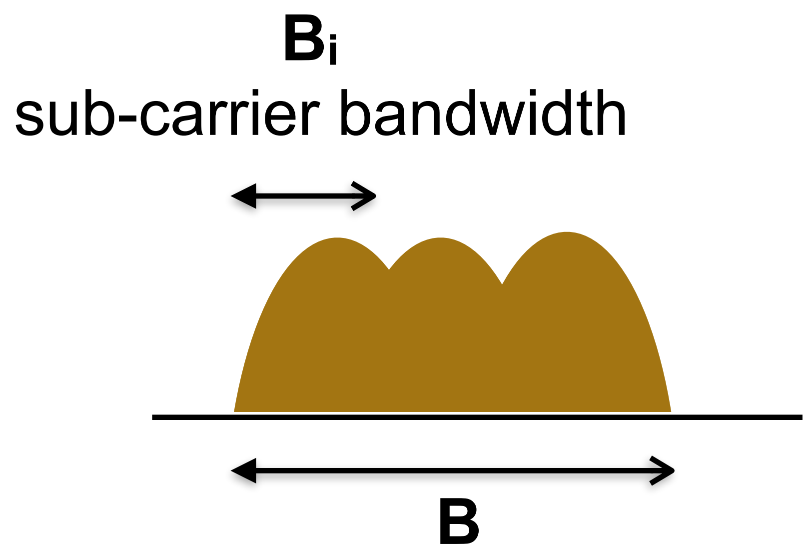

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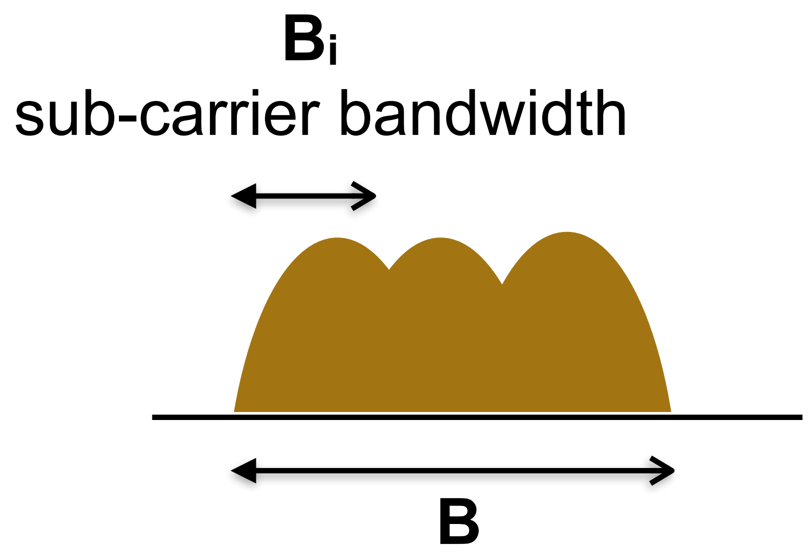

Example

Such code assures acceptable QoT on one hop path.
ITU-T *m* defines the switched bandwidth: $B \leq m \times 12.5$GHz

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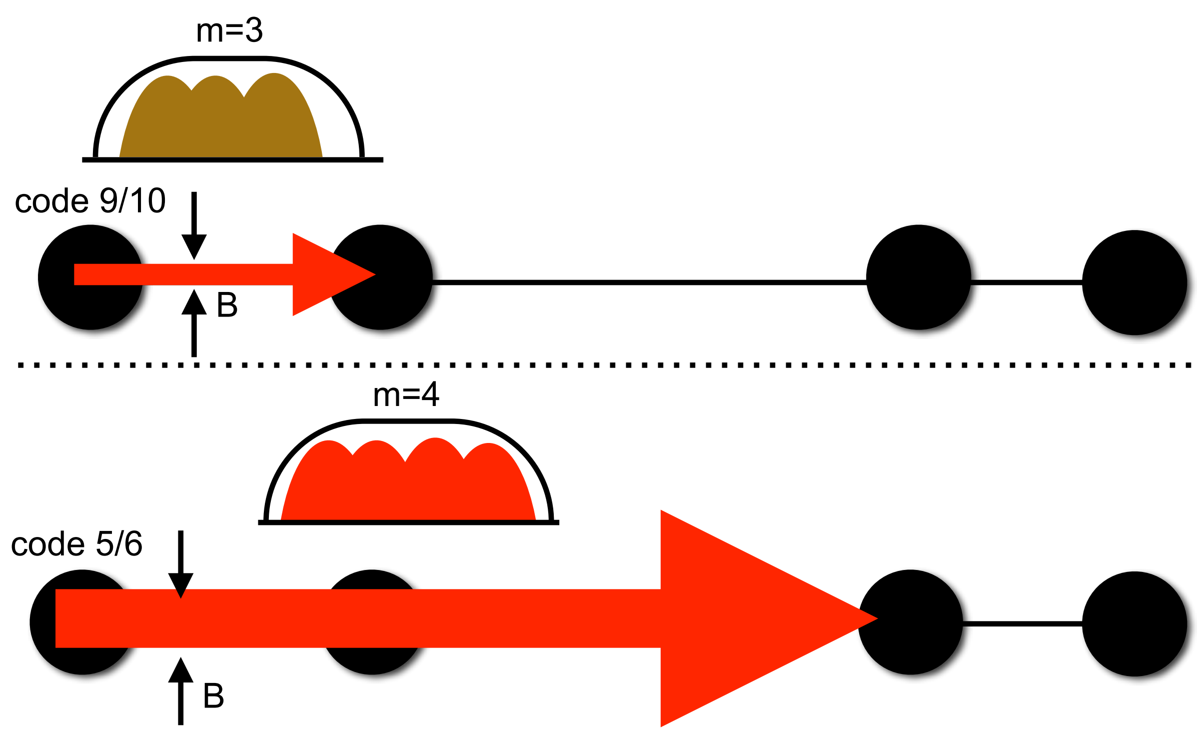

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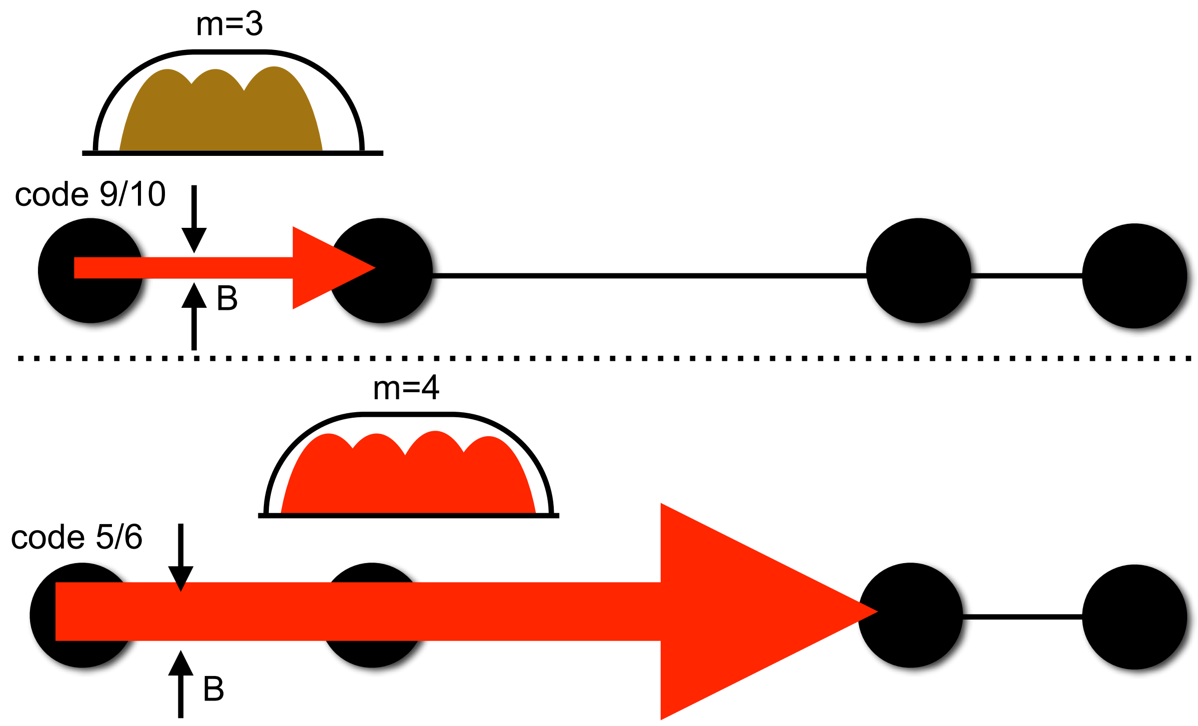

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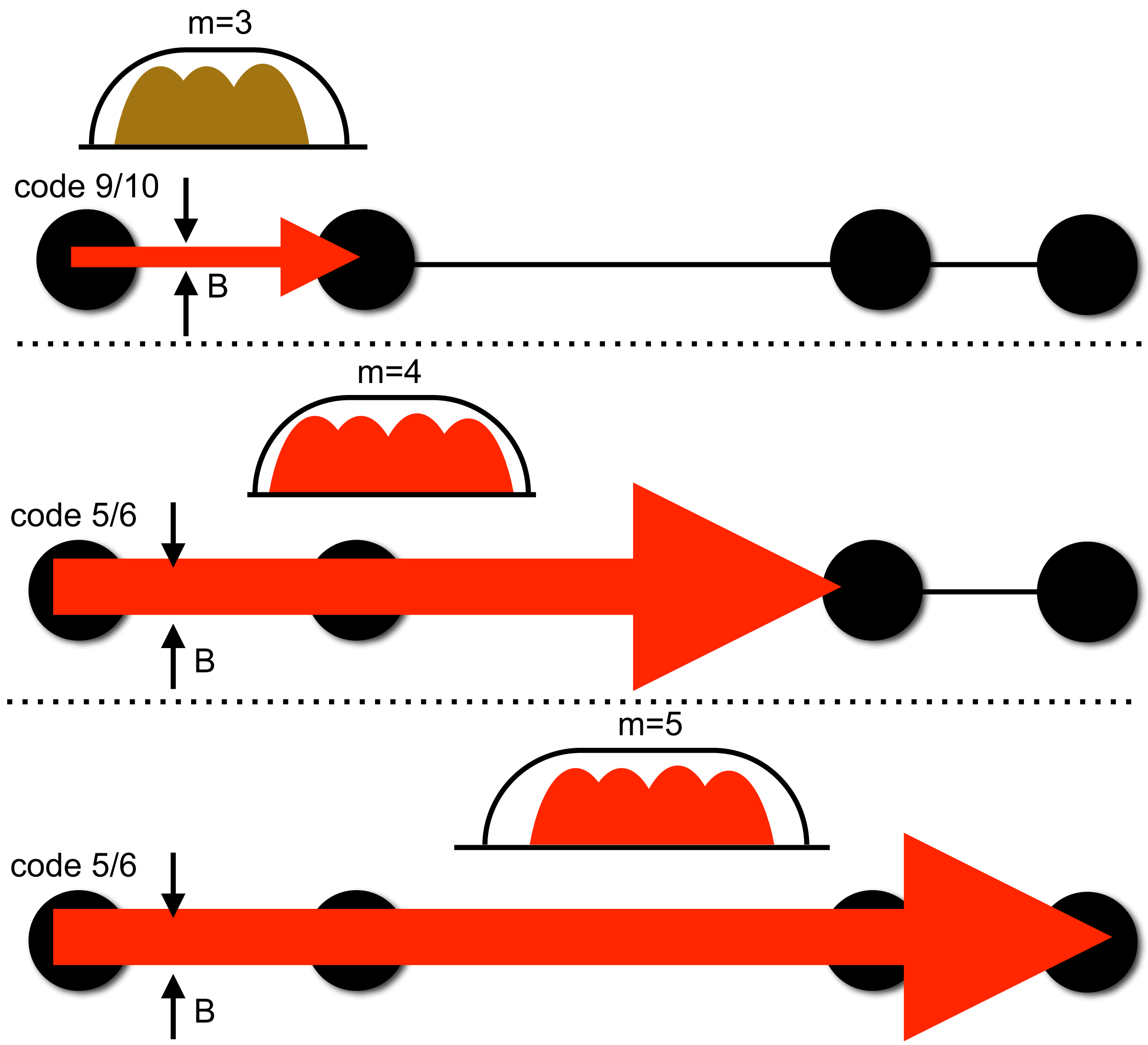

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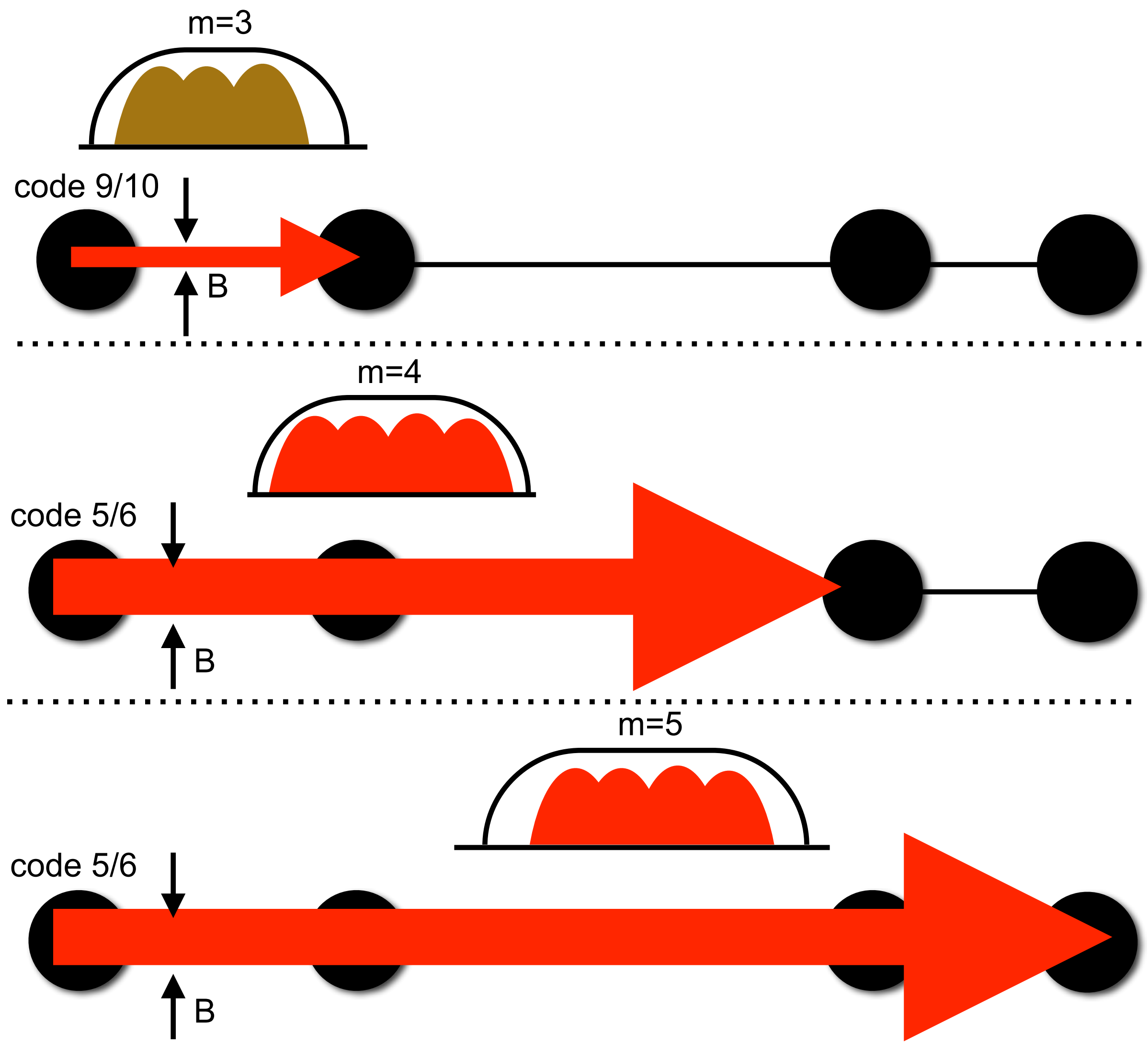

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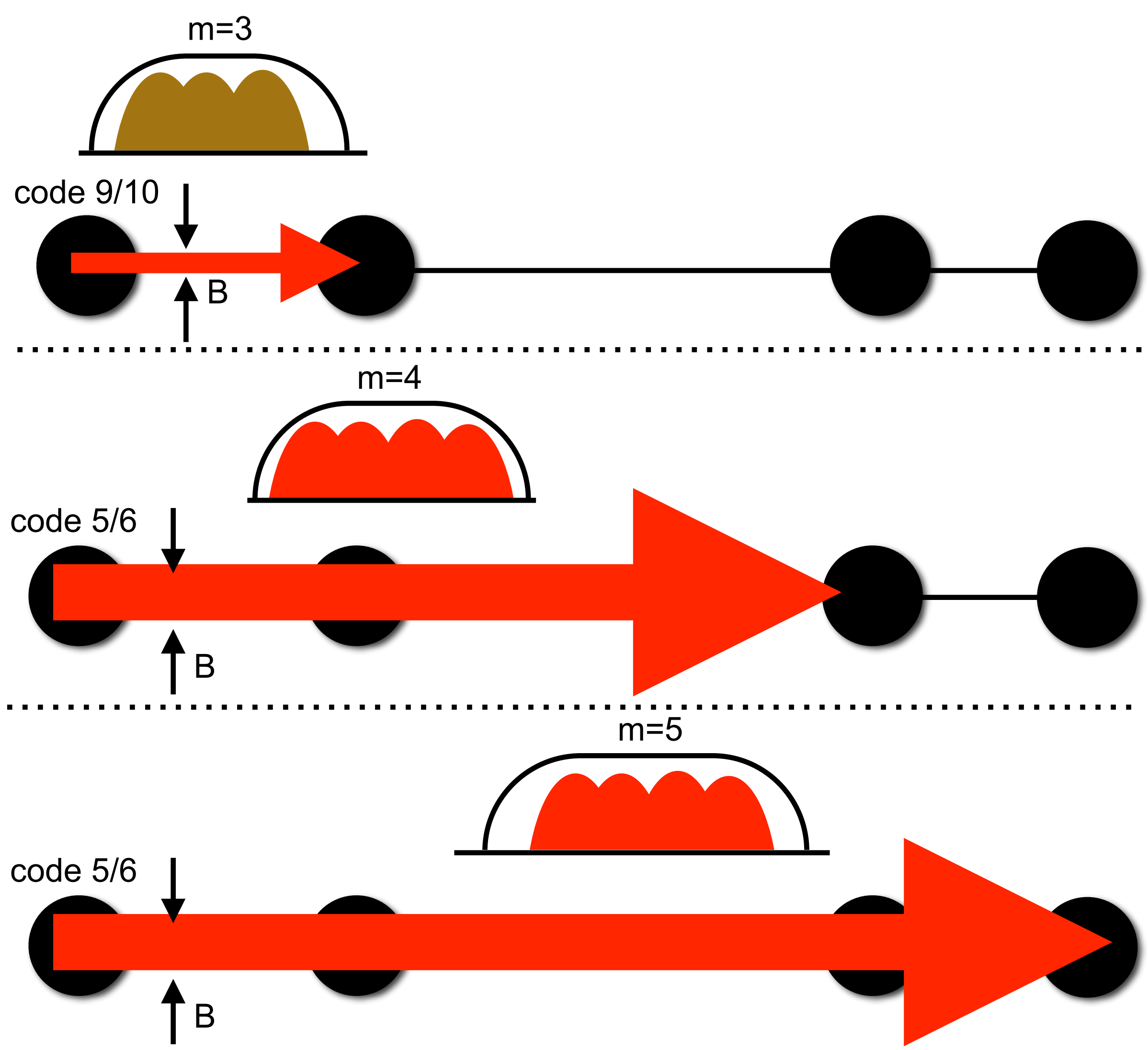

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Summary: code → number of carriers → super-channel bandwidth → ITU-T *m*

Time frequency packing

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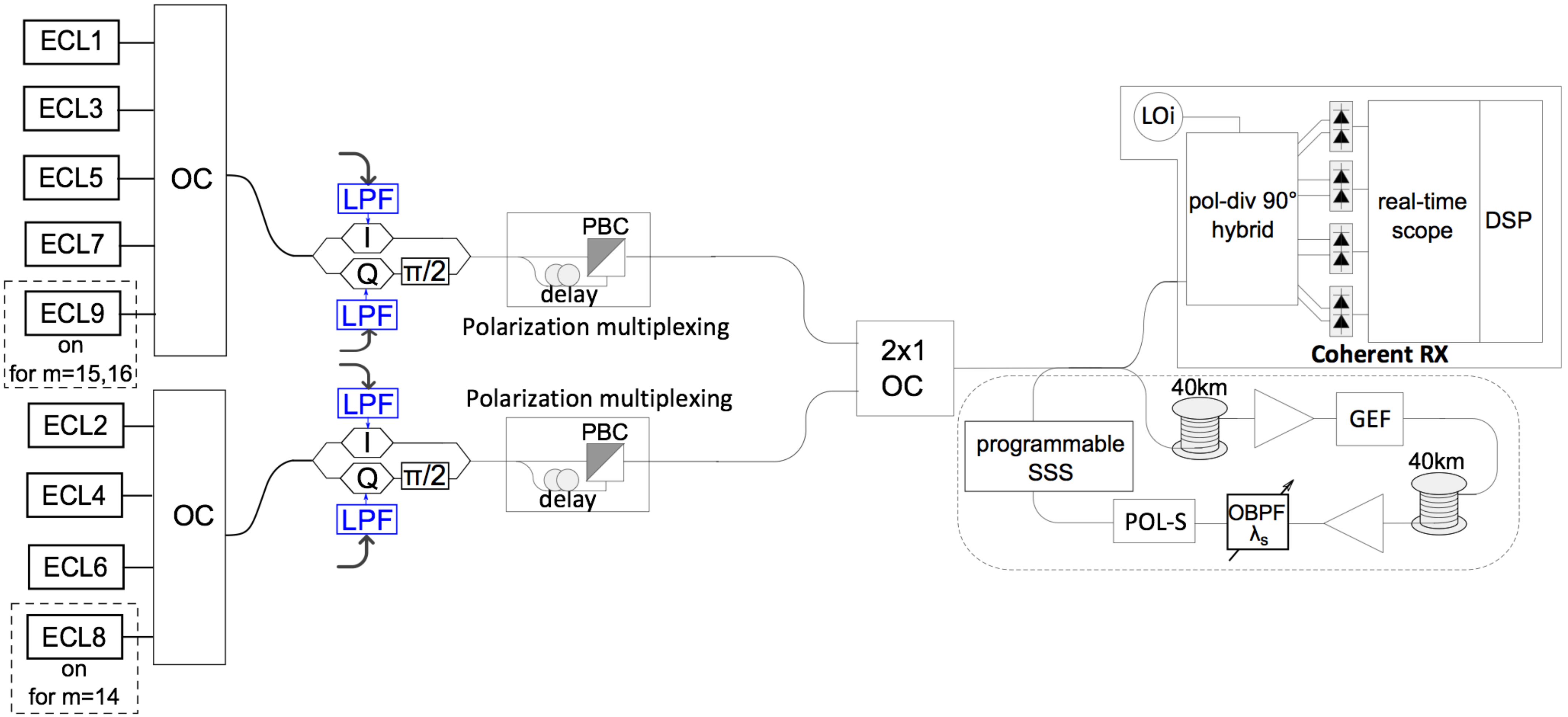
Experimental set up



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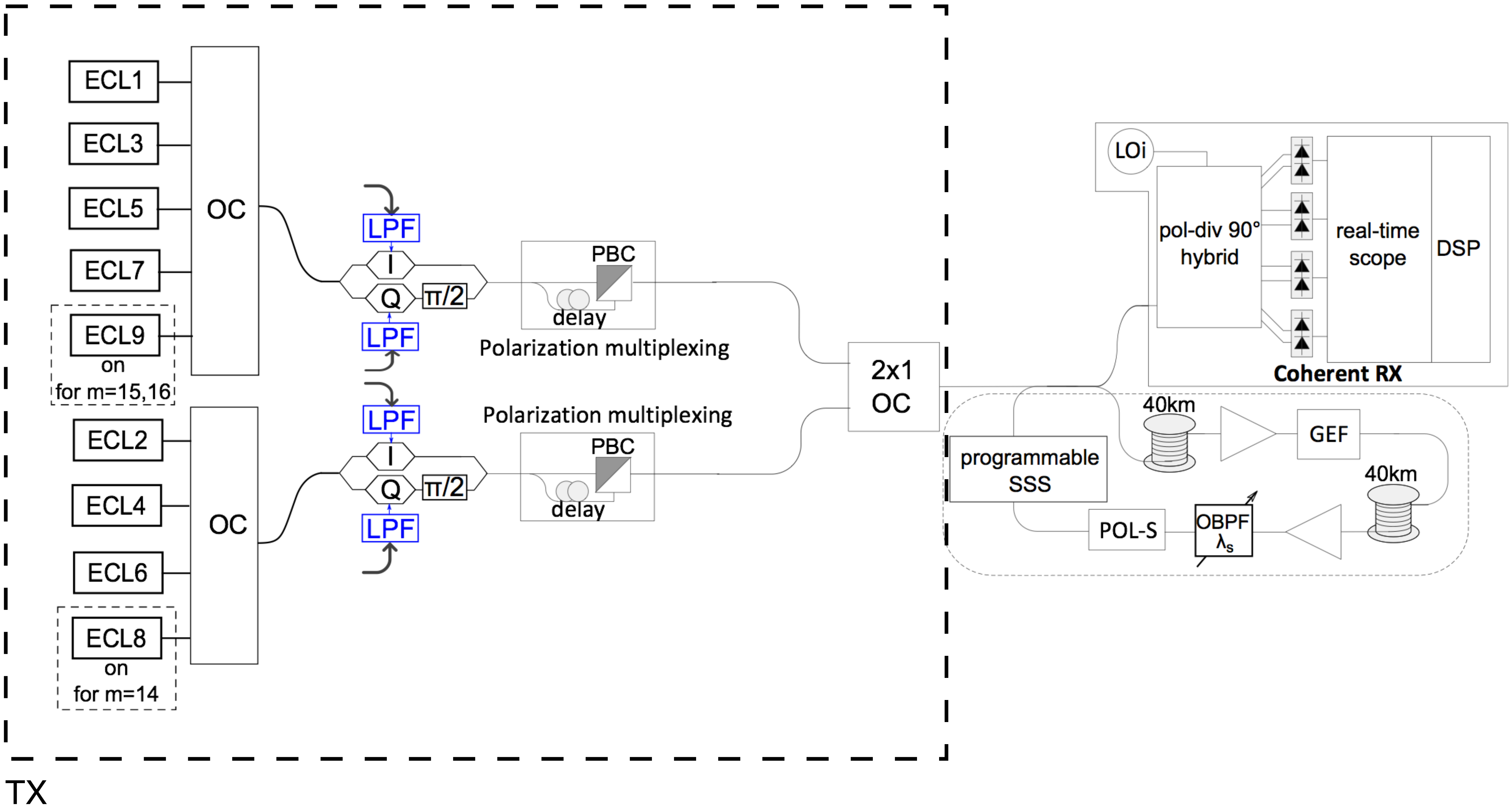

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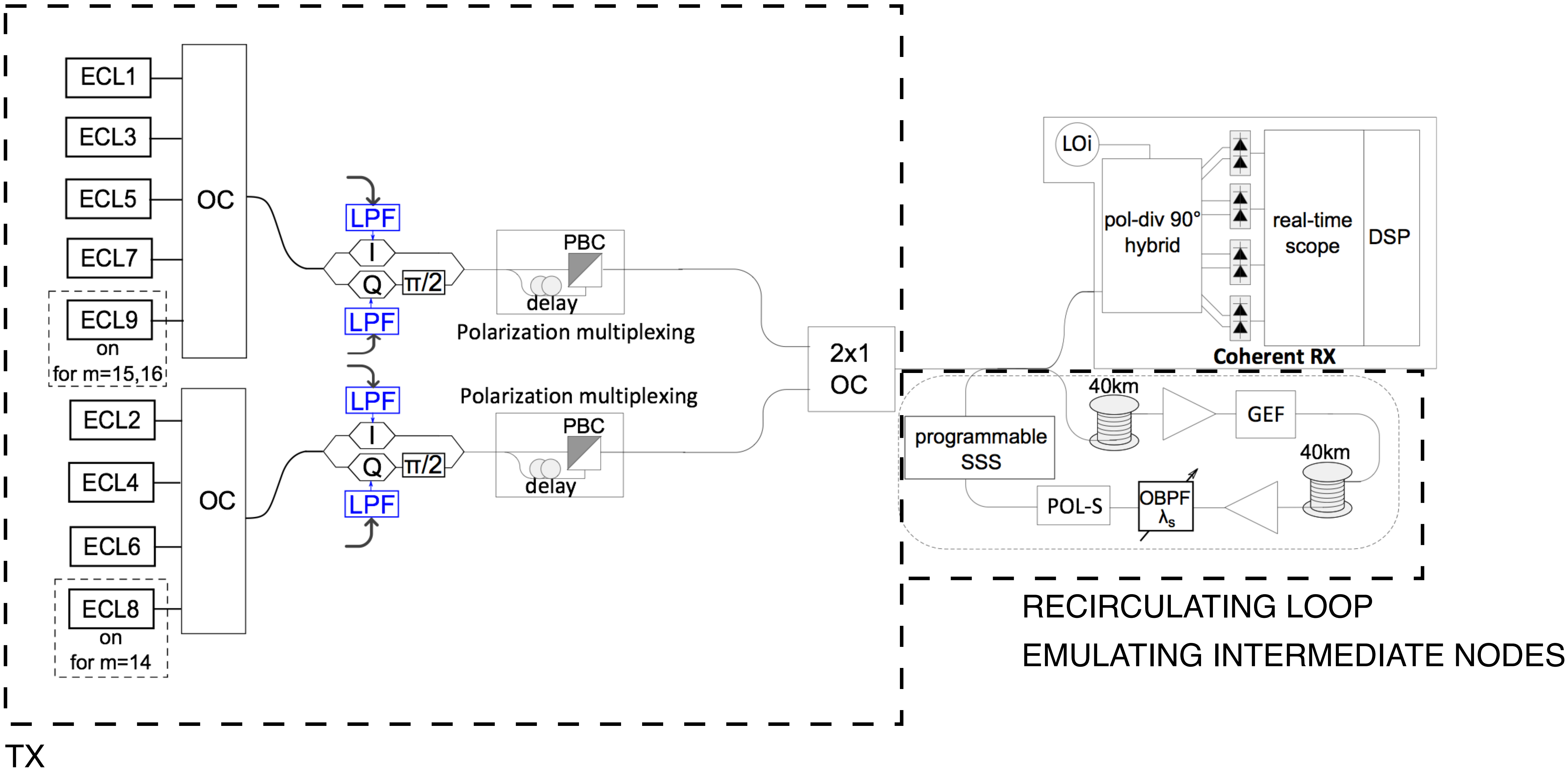

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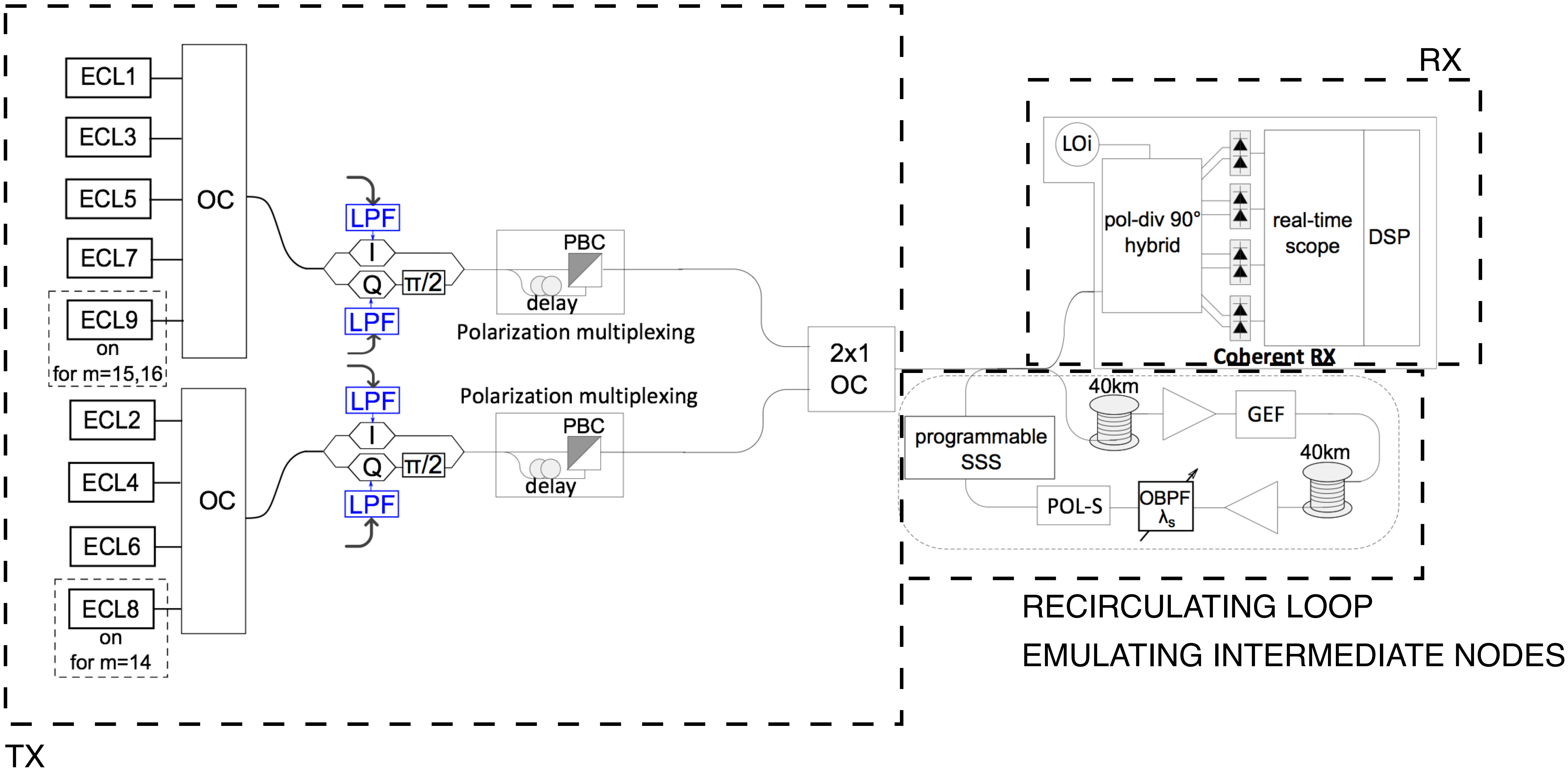
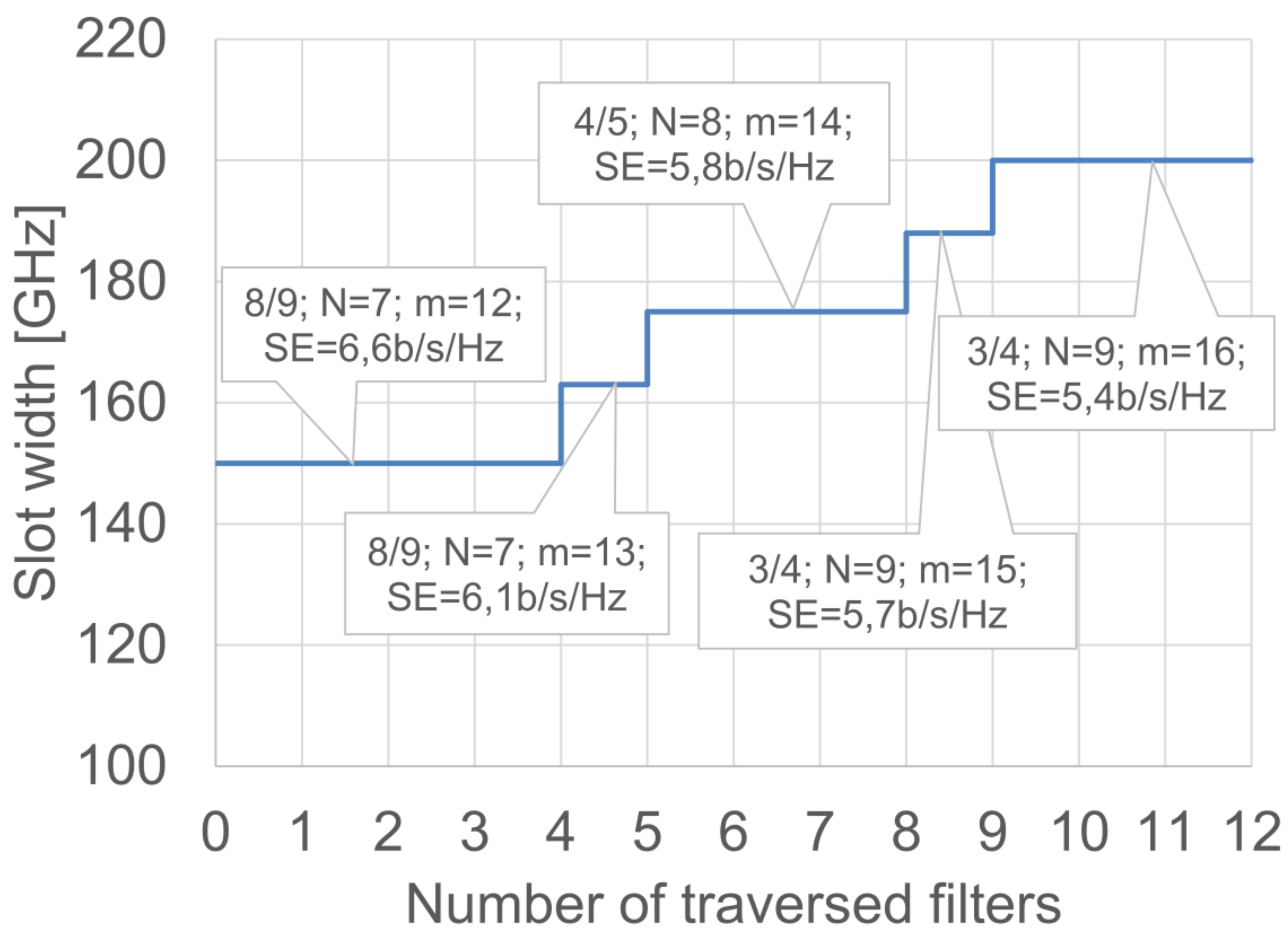


Measurements

- 1Tb/s information rate
- Error-free transmission after decoding



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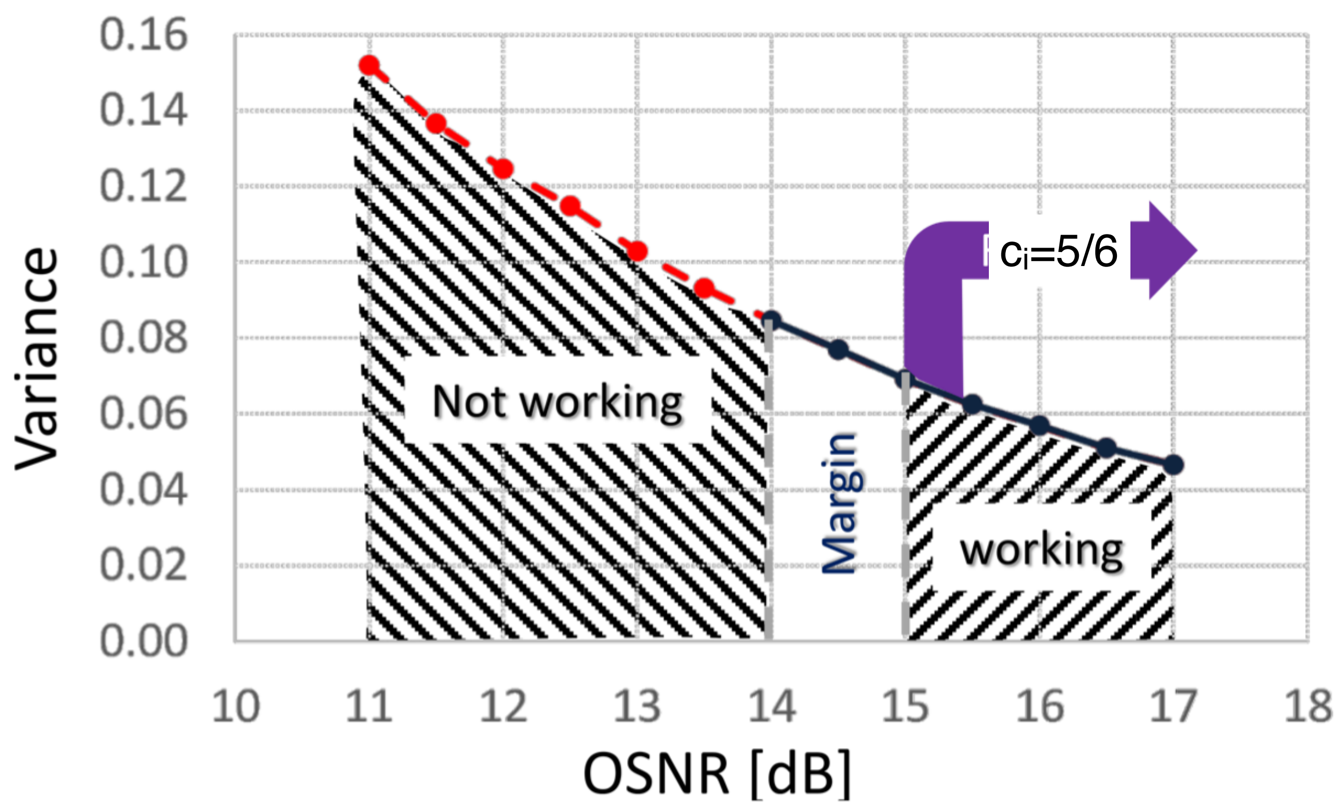
- WHAT is MONITORED?

Symbol **VARIANCE**

Relation between variance and OSNR



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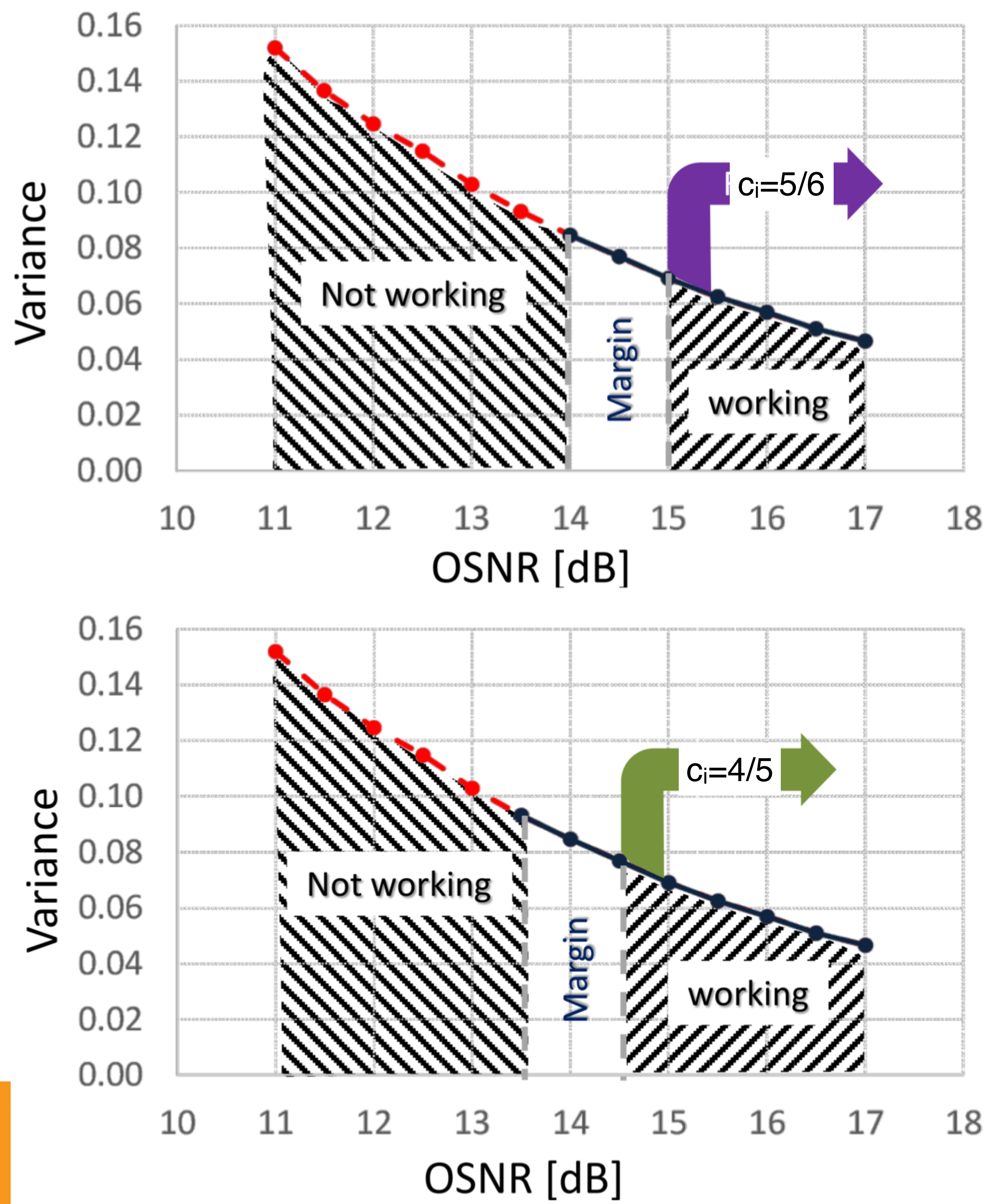

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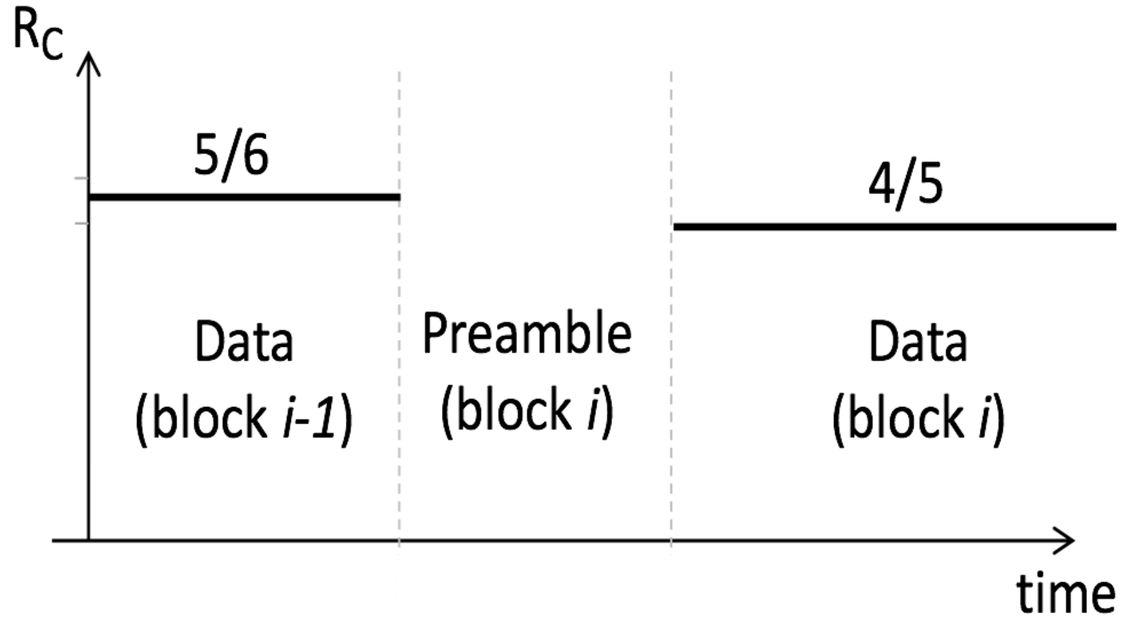

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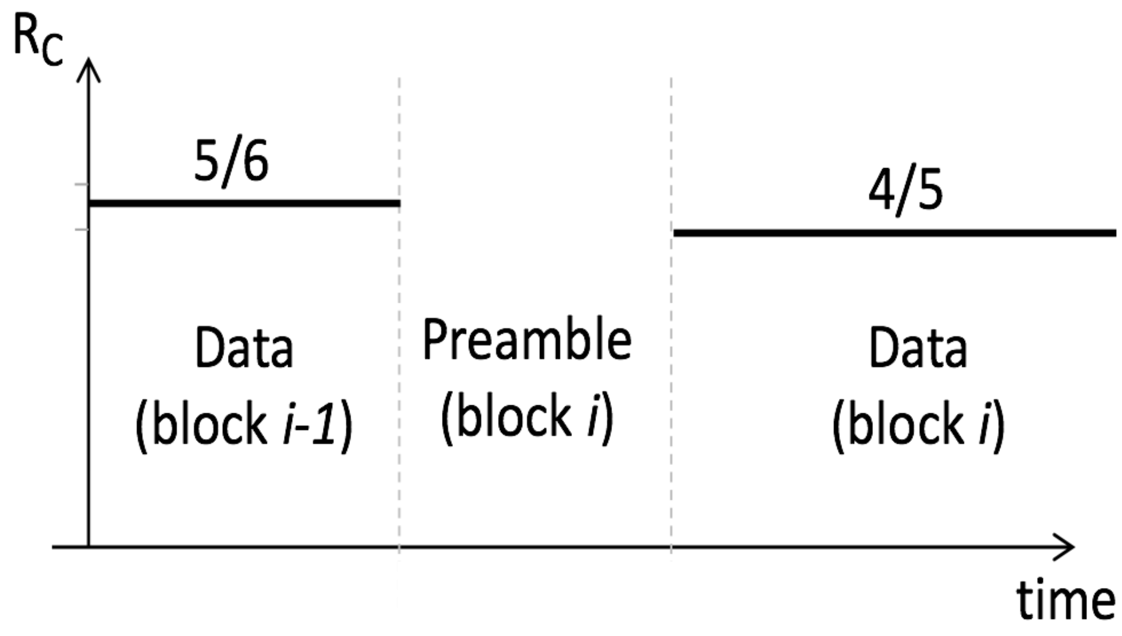

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- After, TX starts transmitting with the new code
- Hitless code-adaptation without performing complex and time- consuming re-synchronization procedures (e.g., as in the case of modulation format adaptation) is demonstrated

Conclusions

- Distance adaptation is demonstrated in EONs with proper selection of code
- Filtering effects must be considered
- Hitless code adaptation is demonstrated to re-act against soft-failures:
  - no re-routing, no change of modulation format
- Failure monitoring is enabled by variance monitoring

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ORCHESTRA

Optical peRformanCe monitoring enabling dynamic networks using a Holistic cross-layEr, Self-configurable Truly flexible appRoAch

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