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Impact of Multi-wavelength sliceable transponders in Elastic Optical Networks

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Work Description

This work evaluates the utilization of a new **sliceable bandwidth variable transponders** technology based on **multi-wavelength laser source** (MW-SBVT), compared with the current architectures based on **multiple laser sources** (ML-SBVT).

A **routing and spectrum assignment** (RSA) **scheme** specifically designed for multi-wavelength technology is also proposed.

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Outline

- Transponder architecture differences
- Routing and spectrum assignment schemes
- Simulation results
- Conclusions

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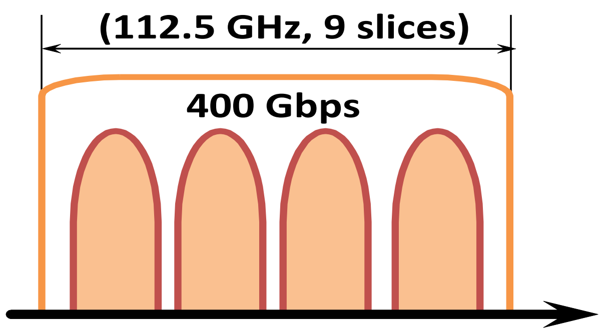
Transponder Architectures

Multi-lasers (ML) SBVT

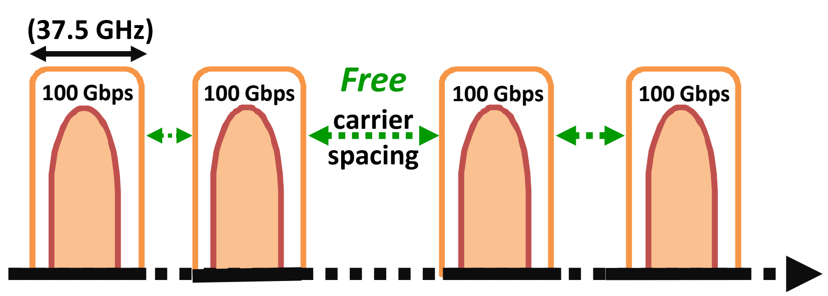
– One laser per carrier (expensive).

– Significant frequency drift among carriers.



400Gbps super-channel using ML-SBVT

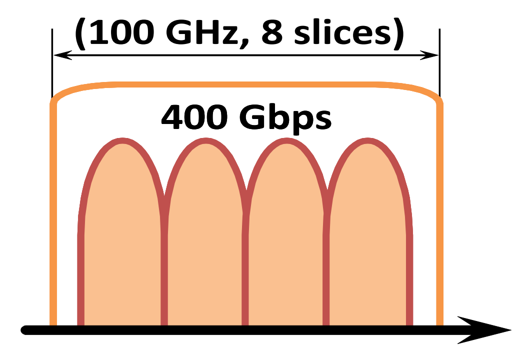
+ Full and independent tunability of each carrier



Multi-wavelengths (MW) SBVT

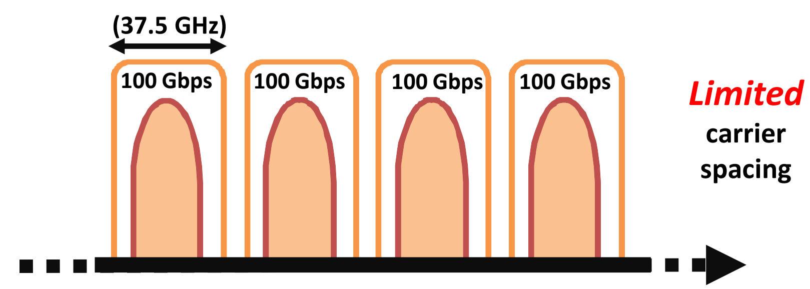
+ One laser generates multiple carriers (*cheap*).

+ Lower frequency drift among carriers, thus *higher spectrum compression*.



400Gbps super-channel using MW-SBVT

– Limited tunability of the carriers.



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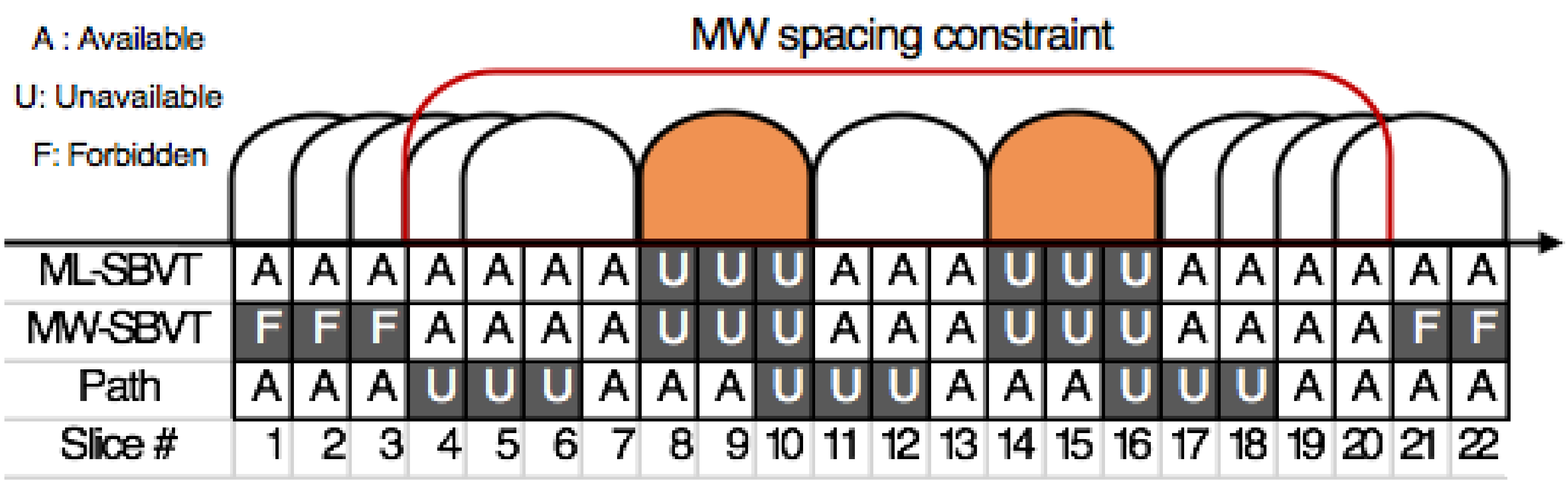
MW-SBVT spacing limitation

Interdependence among carriers generated by a single MW source:

Limited spacing among carriers!!

The allocation of the successive carriers is limited by the carriers previously allocated.



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MWU-RSA scheme

Multi-Wavelength **Unaware** Routing and Spectrum Assignment (MWU-RSA) scheme, steps:

Given: Source, Destination, Connection Capacity

Route and spectrum selection

- Compute **k-shortest(+1) paths** from source to destination.
- For each path compute the ***path spectrum map***: list of all the possible frequency slots supported by the path for the given connection request.
- Select the **least congested path**, the one having the largest number of available frequency slots.
- Select the **first available frequency slot** (first fit).

Return: Path, Frequency slot

Proposed MWA-RSA scheme

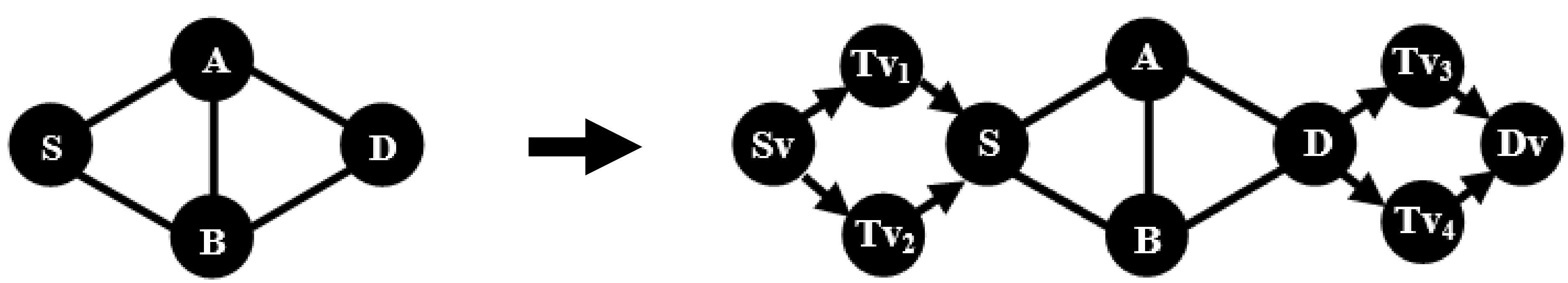
Multi-Wavelength **Aware** Routing and Spectrum Assignment (MWA-RSA) scheme, steps:

Virtual graph creation

- Create a **virtual source node**(Sv) and a **virtual destination node**(Dv)
- For each transponder create a new **virtual node**(Tv_i) and a couple of **virtual directed links**
- For each virtual link couple, compute a **spectrum map** based on the transponder state and the connection parameters (e.g. bandwidth).

Route and spectrum selection

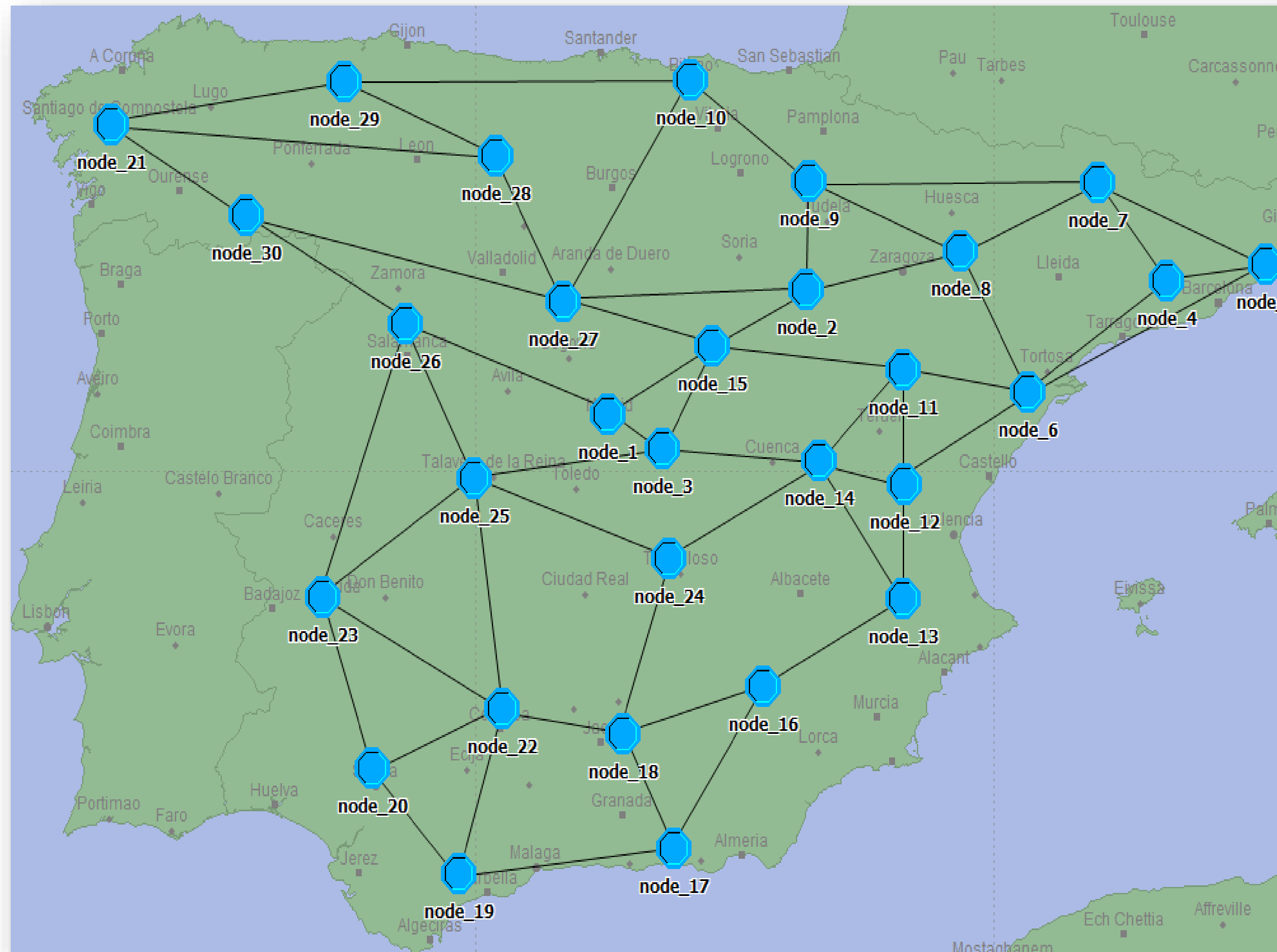
- Compute **k-shortest(+1) paths** from **virtual source** to **virtual destination**.
- For each path compute the ***real*** and the ***virtual path spectrum map***s.
- **Order the path list** from the least to the most congested considering the real path spectrum map, in case of equally congested, from the most to the least occupied transponder.
- Loop the path list applying the **first fit** selection to **the real path spectrum map** and check if it matches the virtual path spectrum map, until a match is found.
- In case no match found, repeat the loop applying the **first fit** directly to **the virtual path spectrum map**.



Real Graph **Virtual Graph**

Simulation scenario

- OPNET Modeler
  - RSVP-TE
  - OSPF-TE
  - PCEP
- Spanish Topology
  - 30 nodes
  - 56 bidirectional links
  - 256 slices(3.2 THz) per direction
- Traffic
  - Uniform traffic matrix
  - Poisson traffic with 1h mean holding time
  - 400Gbps, 100Gbps connection requests
- Transponders
  - 4 carriers per transponder
  - Maximum carrier spacing:
    50GHz for MW-SBVT
    None for ML-SBVT



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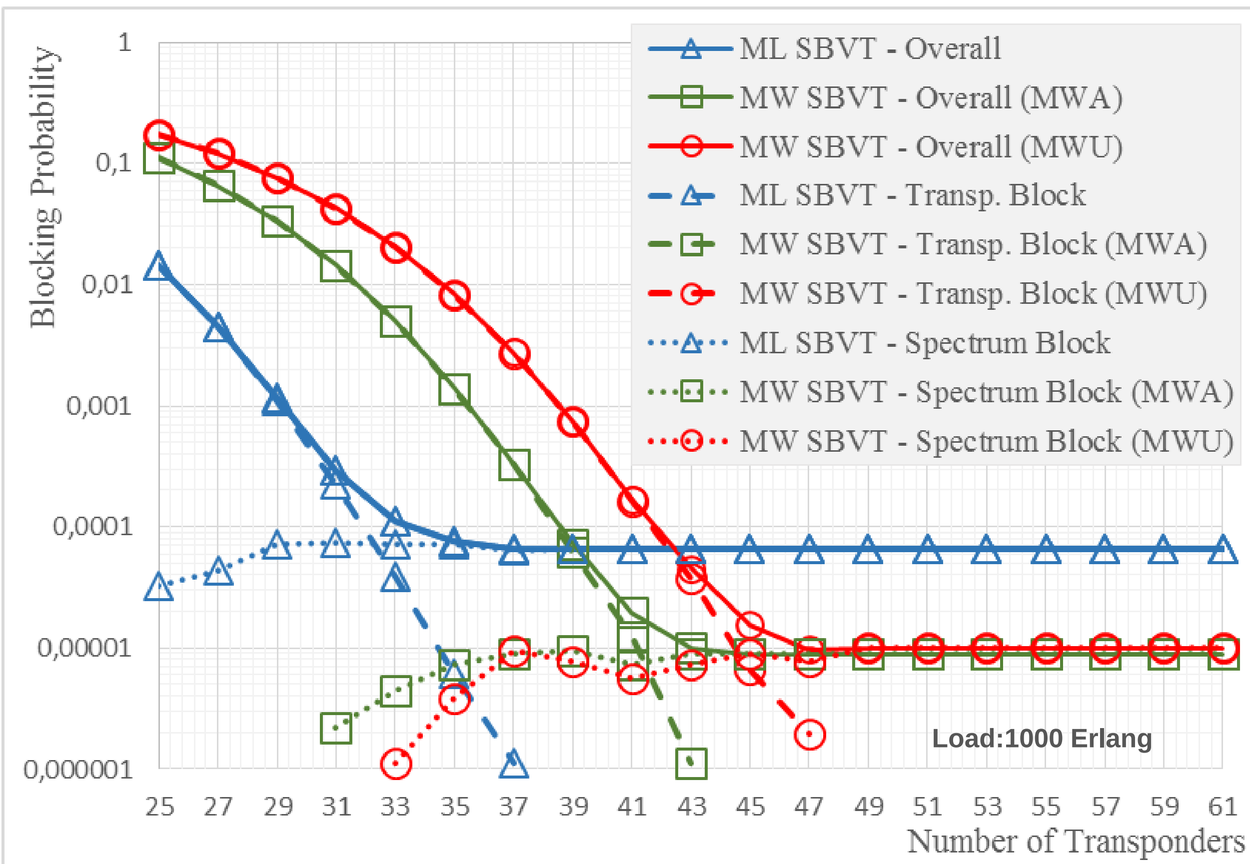
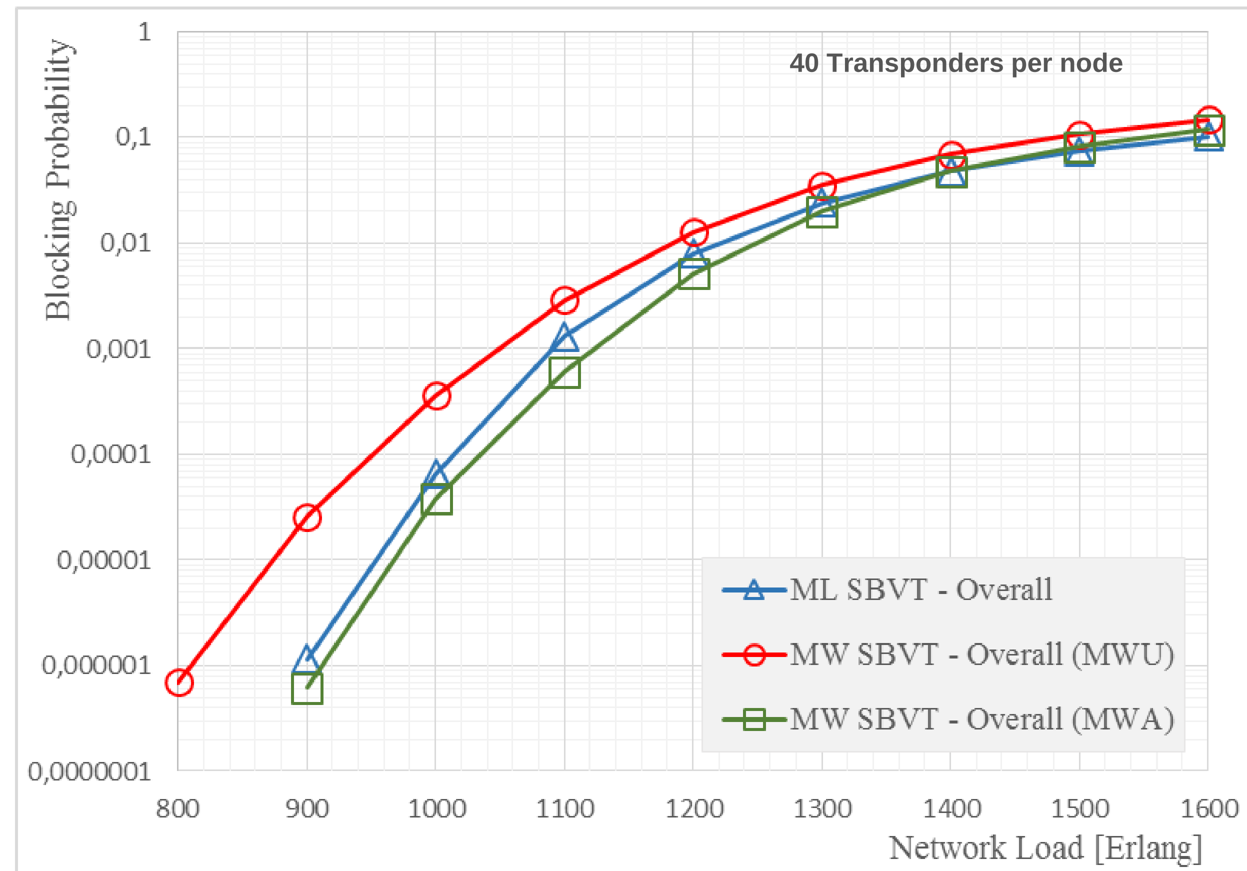
Mixed traffic scenario (100,400 Gbps)





- MW-SBVT achieves lower spectrum blocking probability thanks to the higher spectrum efficiency
- MWA-RSA reduces the blocking gap between the two technologies

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Conclusions

Results shows that MW technology is competitive with ML one in terms of blocking probability.

MW technology could be a valuable solution to increase the spectrum efficiency while reducing the cost of the network equipment.

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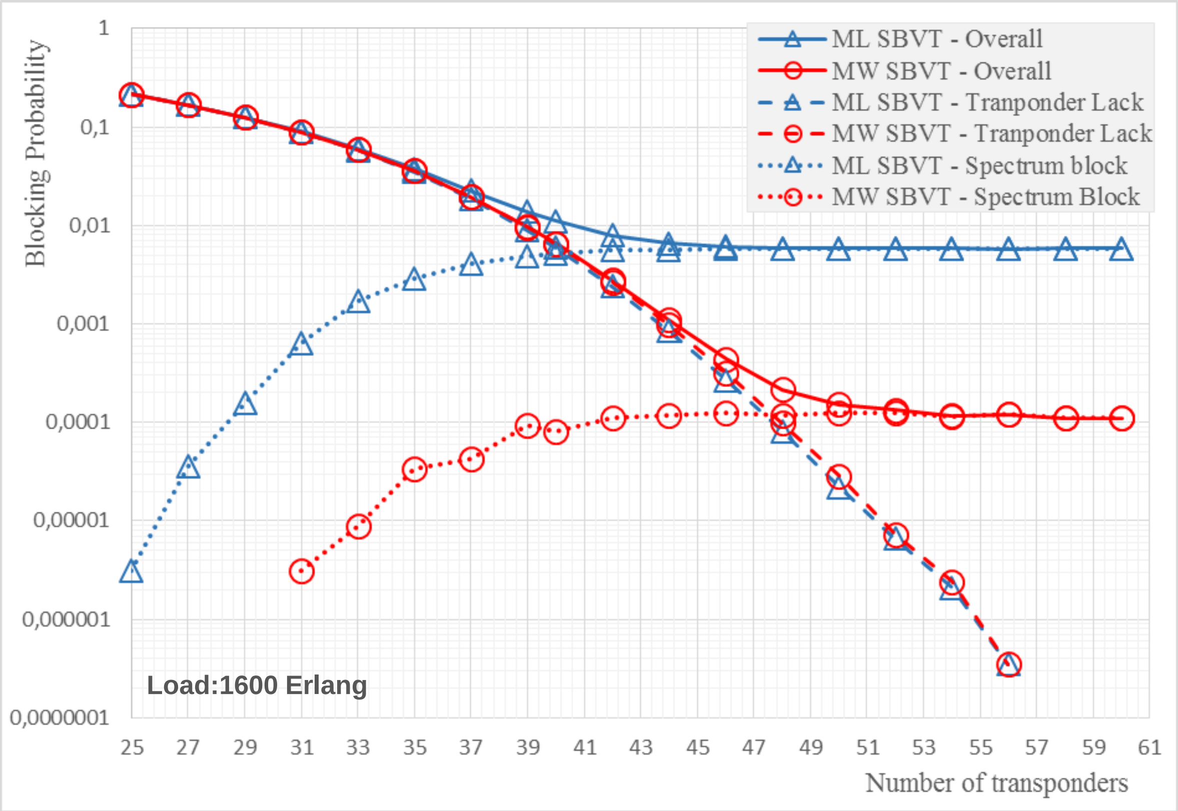
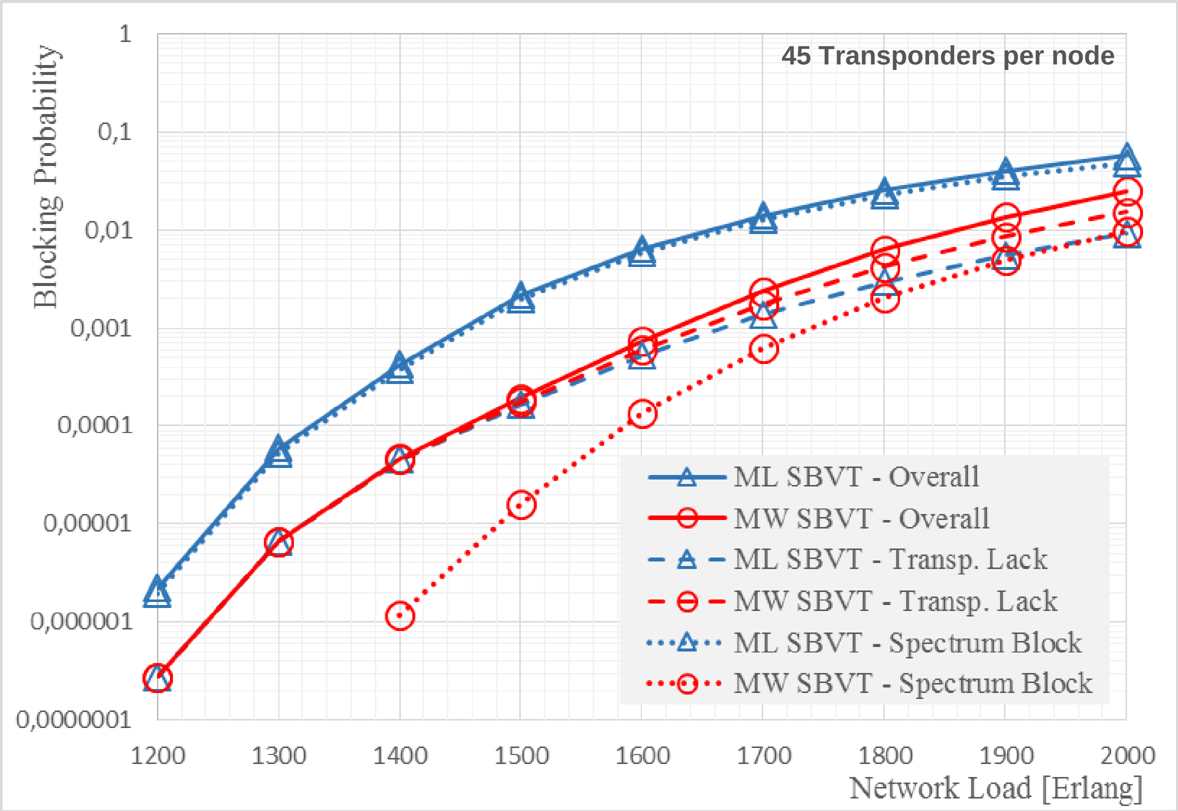
Single traffic scenario (400Gbps)





– More than one order of magnitude gain in terms of blocking probability achieved by MW-SBVT through spectrum compression.