Framework for GMPLS and path computation support of sub-wavelength switching optical networks

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Motivation and goal of the draft

- **Metropolitan-regional networks**: expected traffic flows will occupy the fraction of a wavelength

- **Sub-wavelength data transport technologies** which allow the switch of **transparent** sub-wavelength data-sets may be the solution and are becoming to be **mature**

- First **commercial** versions available (e.g. Intune Networks)

- More prototypes announced

- Commercial key **components are available**: fast tunable lasers and fast optical switches

- **Goal of this draft:** define the **framework** for enhancements and extensions to the GMPLS protocols and procedures, to allow the automatic control of sub-wavelength optical switches

Sub-wavelength optical networks

- What do sub-wavelegth optical networks allow?
  - Time-shared use of individual or multiple wavelengths of a transparent optical network infrastructure
  - Transparently switch multiple label switched paths (LSPs) over the same wavelength of any link.
- What is the granularity of sub-wavelegth optical networks?
  - Optical time-slices/packet/bursts/flows vs. e.g. wavelegths in WSON
- What are the benefits?
  - Statistically multiplex data sets at optical level (switching is performed optically)
  - Reduce the need of O/E/O conversions
  - Reduce the data processing at nodes
  - Reduce transport delay
- There are different approaches:
  - Slotted / non slotted
  - Flow switching..

Motivation to standardize

- Subwavelength transport technologies have been in the last decade in a research stage.

- First start-ups have emerged.

- So.. data plane is still vendor specific… but…

- How can the IETF help?
  - Specify a **transport-agnostic GMPLS control plane** able to control and provision different sub-wavelength optical transport networks on a generic way.

- What would be the benefit?
  - This would deliver **interoperability between different sub-wavelength transport networks** but also **between sub-wavelength and WSON** networks.

Sub-wavelength network resource control

- Broad time scale structured in three levels
  - Duration of the LSP
    - Short lived (e.g. minutes) or long lived (e.g. days, hours)
    - Controlled by the GMPLS
  - Optical frame (in a repeating cycle)
    - Microseconds/milliseconds duration
    - Controlled by sub-wavelength optical transport plane
    - Accommodate fixed (i.e. optical time-slots) or flexible (i.e. optical packets, time-slices) data-sets
  - Time slice
    - Fixed/flexible portion of a frame
    - Controlled by sub-wavelength optical transport plane
    - An LSP can be associated with a number of time-slices per frame
    - Multiple LSPs can share the same wavelength
- GMPLS and specific sub-wavelength optical transport control functions vertical interworking
  - Overlay model
 - Augmented model

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Network resource modelling [1]

- GMPLS control plane cannot be aware of the detailed sub-wavelength network resource availabilities
  - GMPLS operational dynamics (i.e. procedures and protocols) are slower than the sub-wavelength ones
  - Potential fast variations of sub-wavelength availabilities need to be smoothed
  - Specific aggregation procedures need to be performed by the sub-wavelength optical network transport plane control functions

- Aggregated and summarized description of sub-wavelength network resources at the GMPLS layer, to:
  - Enable the exchange of sub-wavelength TE routing information
  - Allow signaling and configuration of multiple LSPs sharing the same wavelengths

- A sub-wavelength optical network link should be described at least by:
  - The list of available wavelengths
  - For each wavelength, a sub-wavelength TE parameter accounting the free wavelength capacity

Network resource modelling [2]
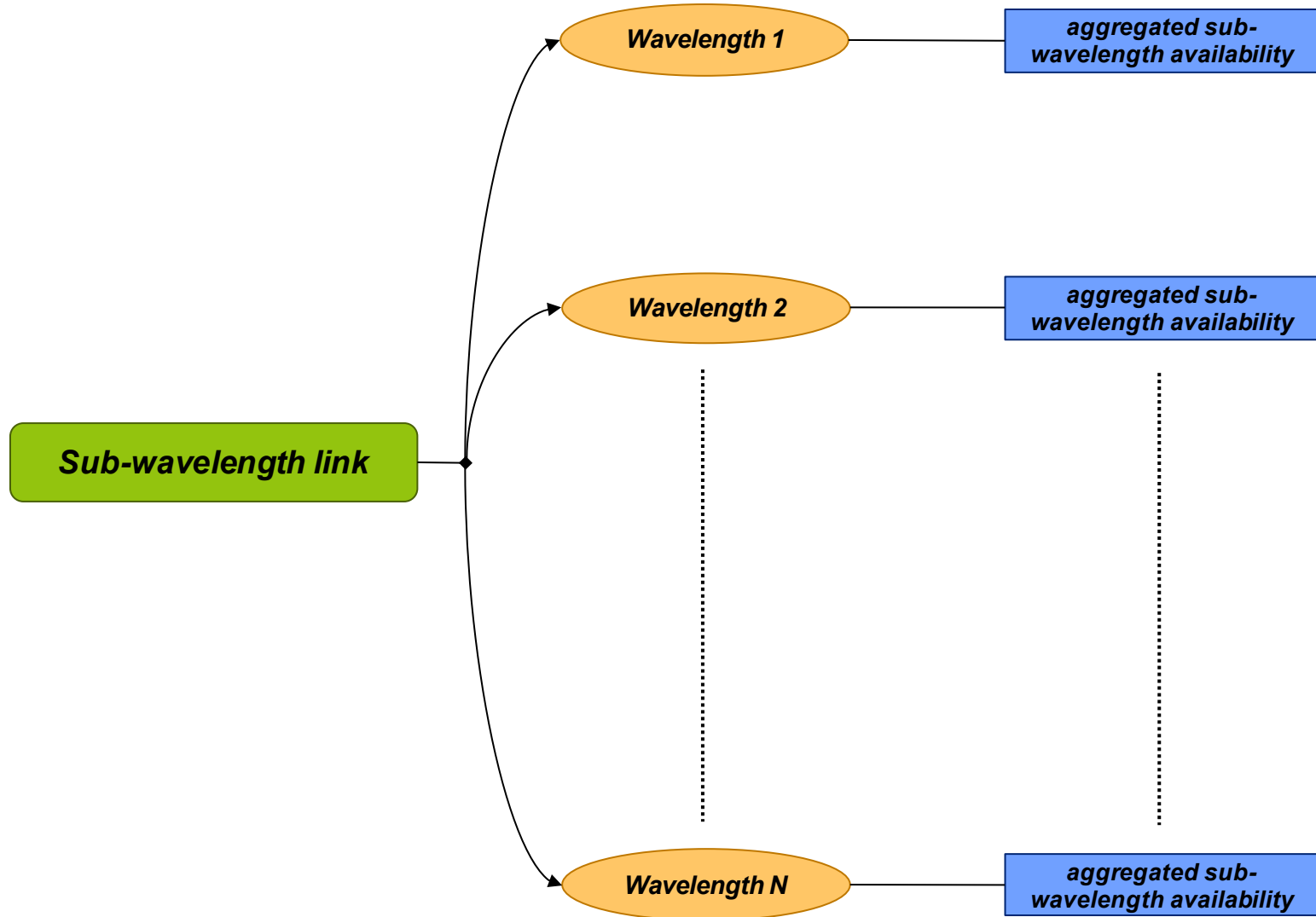
GMPLS implications [1]

- The sub-wavelength switching granularities are not natively supported by GMPLS

- A sub-wavelength enabled GMPLS control plane should be responsible for the end-to-end resource reservation and routing across multiple sub-wavelength technologies
  - The key challenge is the definition of procedure and protocol extensions valid for any kind of sub-wavelength technology
  - A set of requirements to be evaluated for GMPLS enhancements have been identified
    - Signaling impact and requirements
    - Routing impact and requirements

GMPLS implications [2]

- Impact on signaling
  - Definition of a sub-wavelength label
    - Different formats and encodings depending on specific technologies
  - Sub-wavelength traffic profiling
    - Identification of the specific sub-wavelength granularity requested for an LSP
    - Identification of sub-wavelength traffic requirements (bandwidth, delay, jitter, etc.)
- Impact on routing
  - Sub-wavelength awareness in the route computation process
  - Advertisement of aggregated and summarized sub-wavelength availabilities
    - Compliant with the sub-wavelength network resource modeling
  - Support of a new Switching Type
    - Sub-Wavelength Switching Capability
  - Support of a potential set of new LSP Encoding Types
    - to identify different sub-wavelength technologies and encoding formats

Next steps

- Get feedback and involvement from vendors and operators
- It is the right time to tackle the control plane standardization?
- And to further continue the technical work…
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