Xarxes de computadors II

Presentaciones

Presentaciones

- 17 matriculados: 7 grupos de 2 personas y 1 de 3
- 15/17 minutos por grupo + 3/5 debate
- 4 y 6 de Junio
- Participación obligatoria a todas las presentaciones
- Se evalúa también la participación en los debates

- Criterios de evaluación
- 1 nota común para todo el grupo sobre el contenido de la presentación
- 1 nota individual sobre como se ha presentado
  - Dominio del tema: sabe realmente de lo que habla?
  - Capacidad de síntesis: ha dicho realmente algo sustancial en sus minutos?
  - Exposición ordenada: el hilo argumental tiene realmente un hilo?

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- **Calendario**
  - **Antes del 18/5 enviar un correo con el tema elegido y día preferido para la presentación (si el 4 o el 6)**
  - **Entregar limite de la presentación es el 3 de junio a las 23.59 (independientemente del día elegido para presentar)**

Estructura

- Portada: introducción de los miembros del grupo y del tema a tratar (1)
- Índice de la presentación: de que se va a hablar y en que orden (1)
- Escenario: presentación del entorno que se va a tratar (1/2)
- Tema/problema: identificación del problema/tema concreto dentro del entorno anterior que se va a tratar (1/2)
- Solución/argumentación: descripción de la o las soluciones (4/5)
- Comparativa: entre las soluciones presentadas y con otras alternativas (2/3)
- Conclusiones y líneas futuras (1)
- Bibliografía (1)

- Material de backup (n)

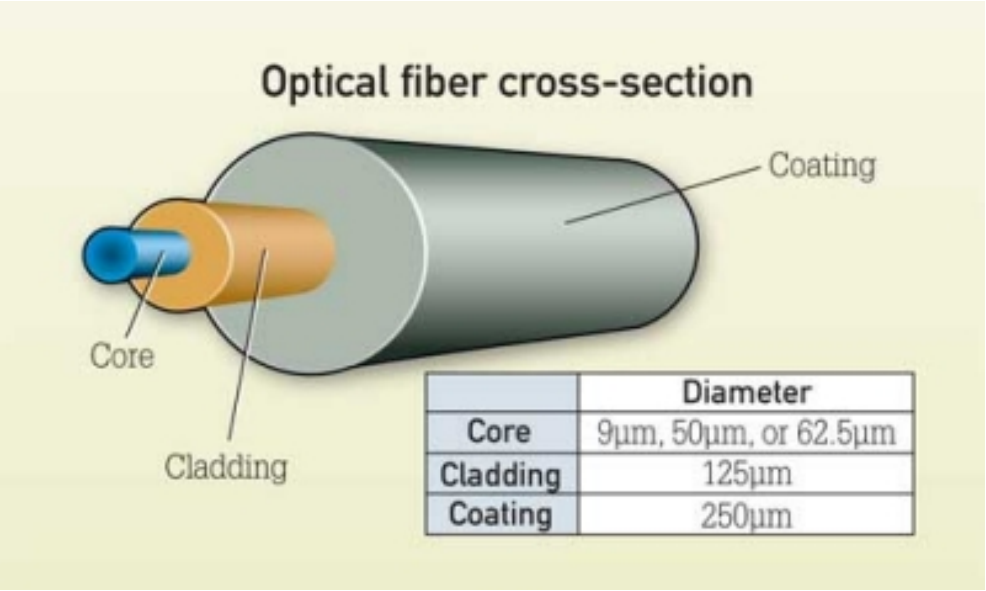
Temas presentaciones

- Debe ser un tema actual de investigación
- De libre elección pero claramente relacionado con los conceptos y temas explicados en XC2
- Ejemplos

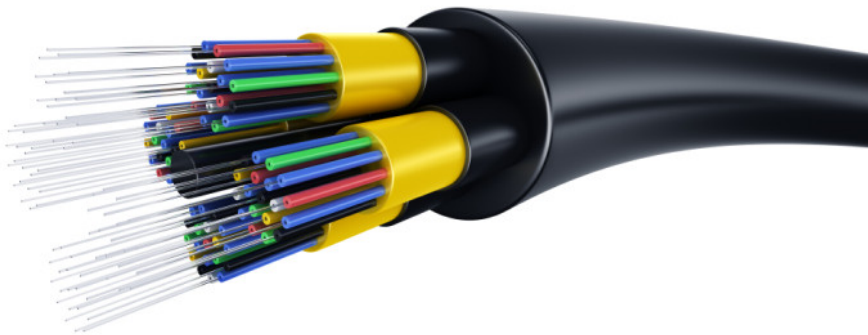
1) Alternativas a IP: ICN, RINA, etc.
2) Protocolos de encaminamiento en redes ópticas (flexibles, multi-núcleo, etc.)
3) Mejoras del BGP
    1) Overlay (VXLAN, LISP, BIER multicast, etc.)
    2) Compact routing
    3) Greedy geometric routing
4) Sostenibilidad en Internet
    1) En redes locales
    2) En redes troncales
5) Redes programables SDN
6) Virtualización de funciones de red NFV

Optical fibre

- Fibra óptica y conectores



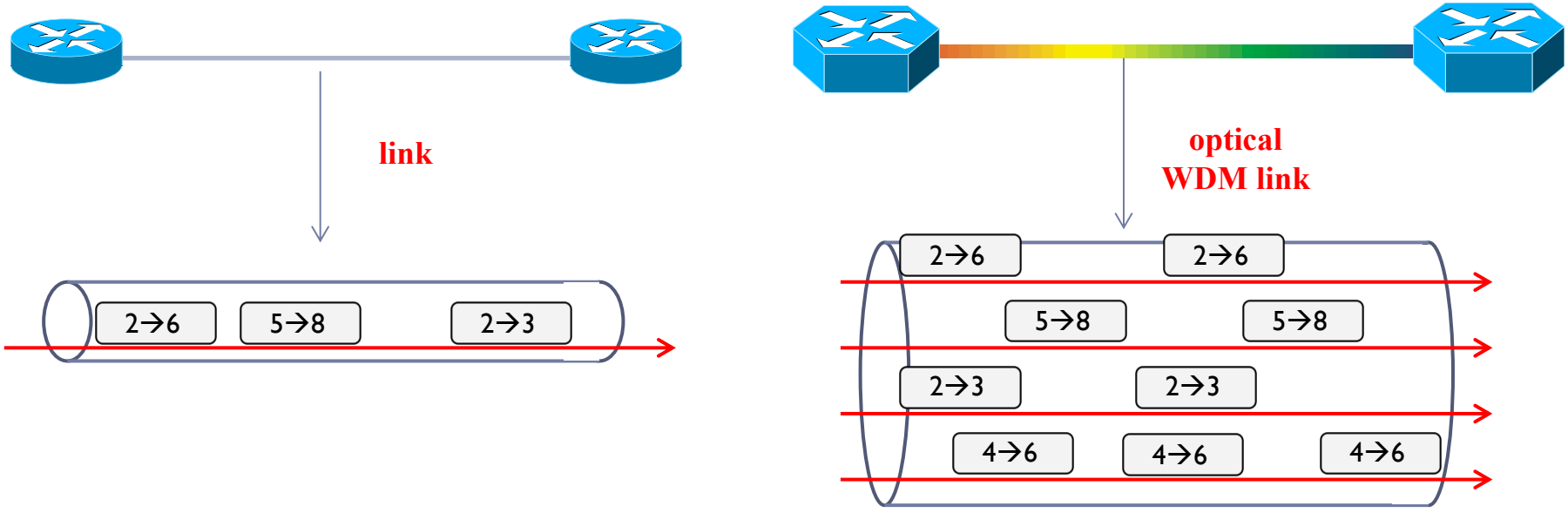
	Diameter
Core	9µm, 50µm, or 62.5µm
Cladding	125µm
Coating	250µm



- The outer jacket may contain one or multiple fibres
- The plastic coating protects the fibre
- The cladding keeps the optical signal in the fibre
- The core is where the optical signal passes
  - Cladding and core are silicon (it is not a conductive medium, there is no electricity)

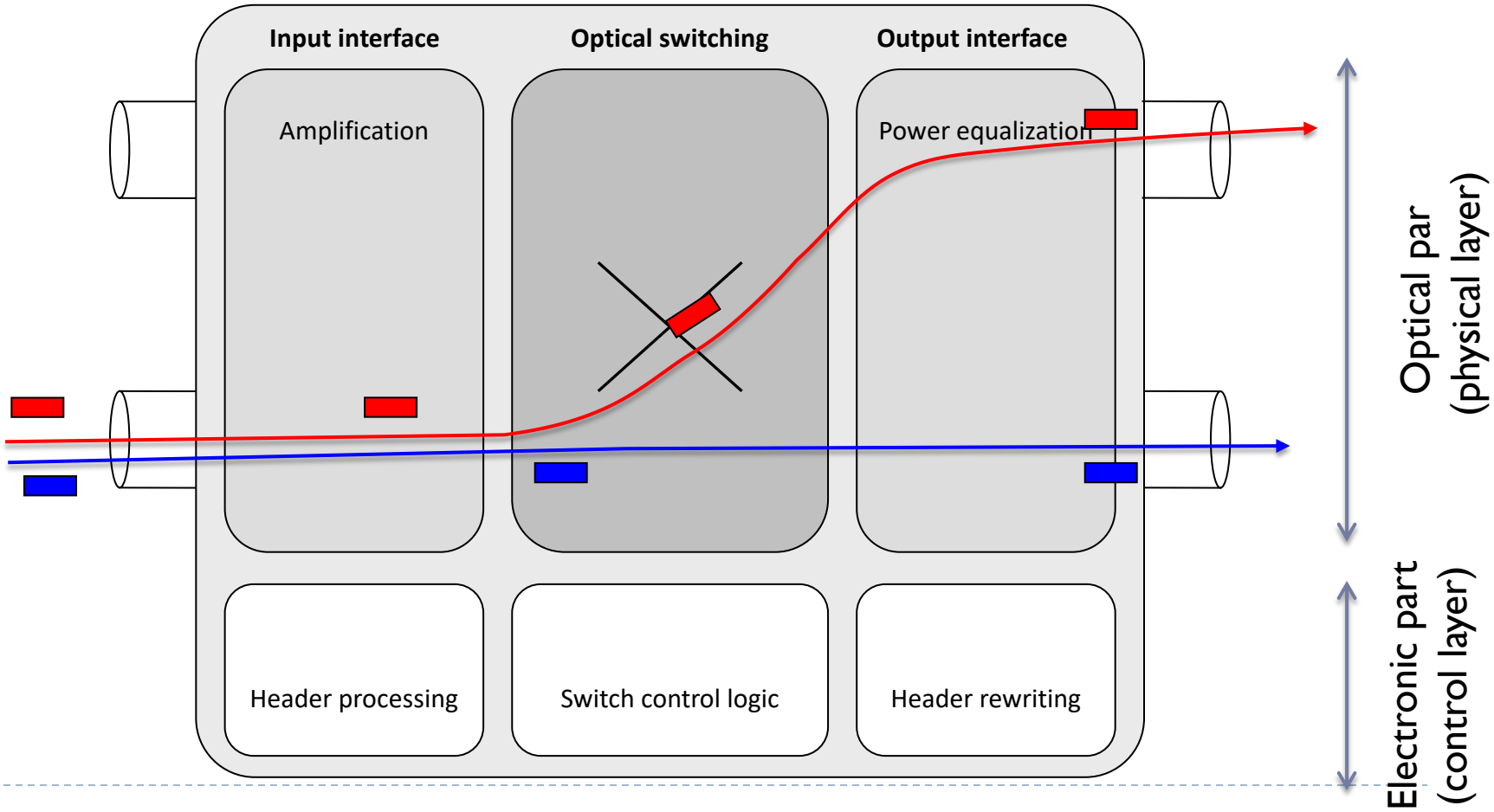
Scenario

- Optical networks
  - very high capacity
  - possibility to transmit many signal at the same time at different wavelengths (80–160 wavelengths per fiber) -> Wavelength Division Multiplexing (WDM)
  - the bitrate of each wavelength can be: 2.5, 10, 40, 100, 400 Gbps



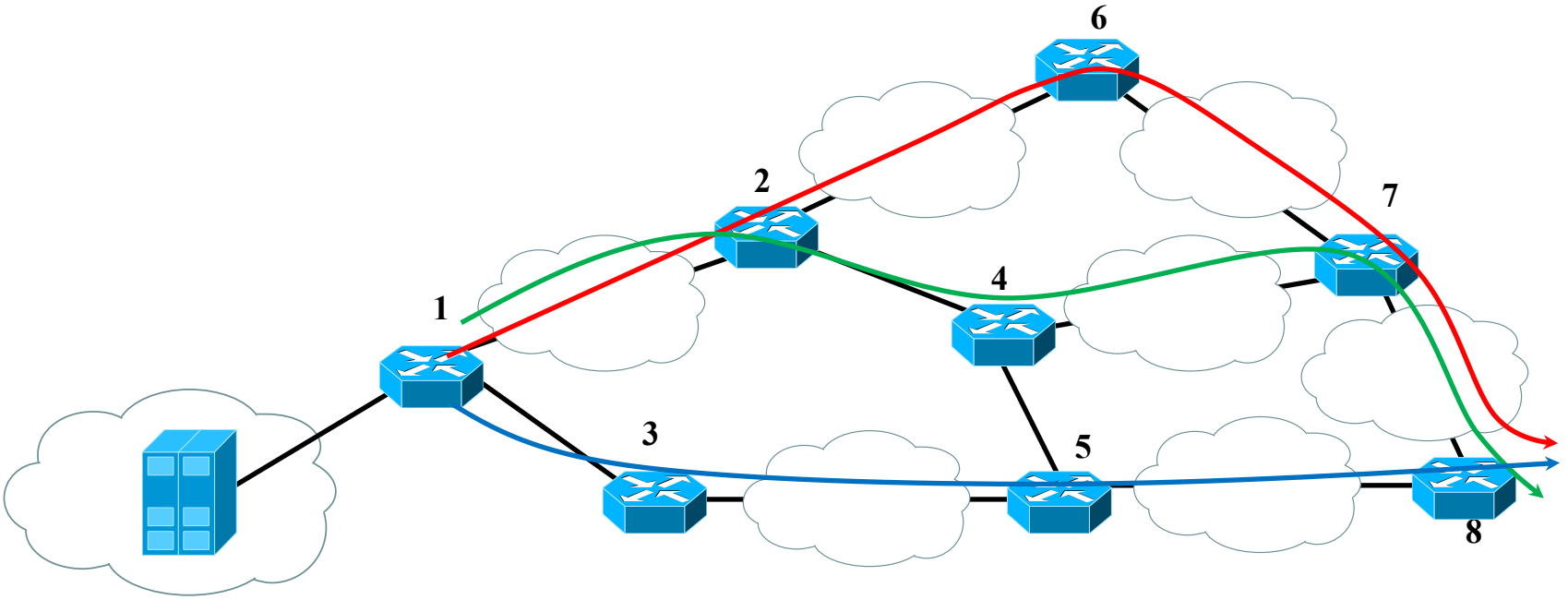
Optical router (ROADM or WXC)

- Packets flow through the nodes without any change
- The path inside the node is almost fix and determined in advance



Problem formulation (1/4)
the RWA problem

- The problem becomes a Routing and Wavelength Assignment (RWA) problem since it requires
  - selection of the path between source and destination
  - selection of the wavelength at each link from source to destination
  - the resulting path + wavelength is called **lightpath**



RWA solution

- RWA is NP-complete
- Apply approximate algorithms
- Decouple the routing and the wavelength assignment into two sub-problem
  - find optimal routing paths (by means e.g. of optimization technique)
  - apply simple wavelength assignment solutions like first-fit

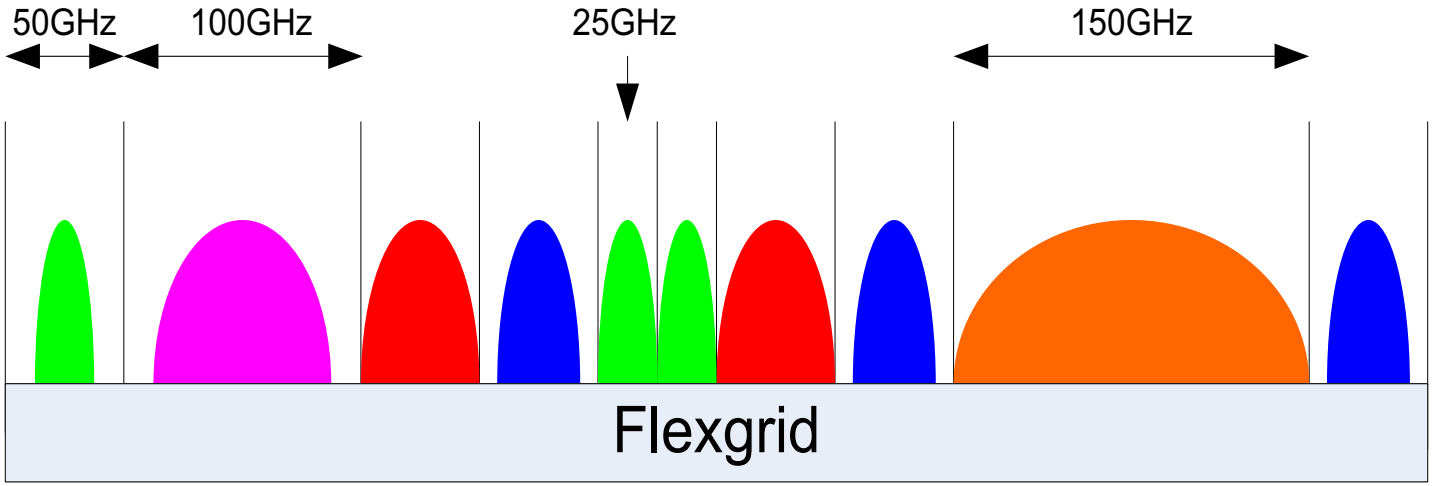
WDM but

- 100 Gbps is expected to meet operator needs in the short to medium term, but traffic growth will lead to mixed line rates including 400 Gbps and 1 Tbps in the long term
- Existing DWDM systems are inflexible in two distinct ways:
  - The transponder has a fixed bit rate – for example of 10 Gbps or 40 Gbps.
  - The spectral width of each wavelength signal cannot extend beyond the fixed ITU grid width used in the system (e.g. 50 GHz)

  - Large bandwidth demands will have to be divided up so that they can be carried over the fixed grid
  - This results in a highly inefficient use of the network capacity

Flexible Optical Network

- An elastic optical transport network based on a combination of Bandwidth Variable Transponders and Flex-grid might enable a more flexible optical spectrum use
- Grid boundaries could be set in the most appropriate place

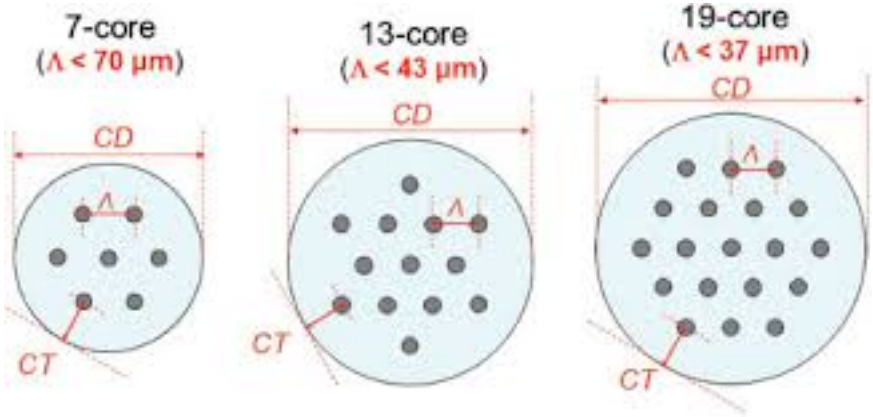


Flexible Optical Network

- The routing problem becomes a Routing and Spectrum Assignment (RSA) problem
- Determine a route and a spectrum width subject to
  - Spectrum continuity constraint (i.e., the same slots must be used in all the links of the path)
  - Spectrum contiguity constraint (i.e., the slots must be contiguous in the spectrum)
- As RWA, RSA is NP complete
  - Apply approximate algorithms
  - Decouple the routing and the spectrum assignment into two sub-problem

Multi-core fibres

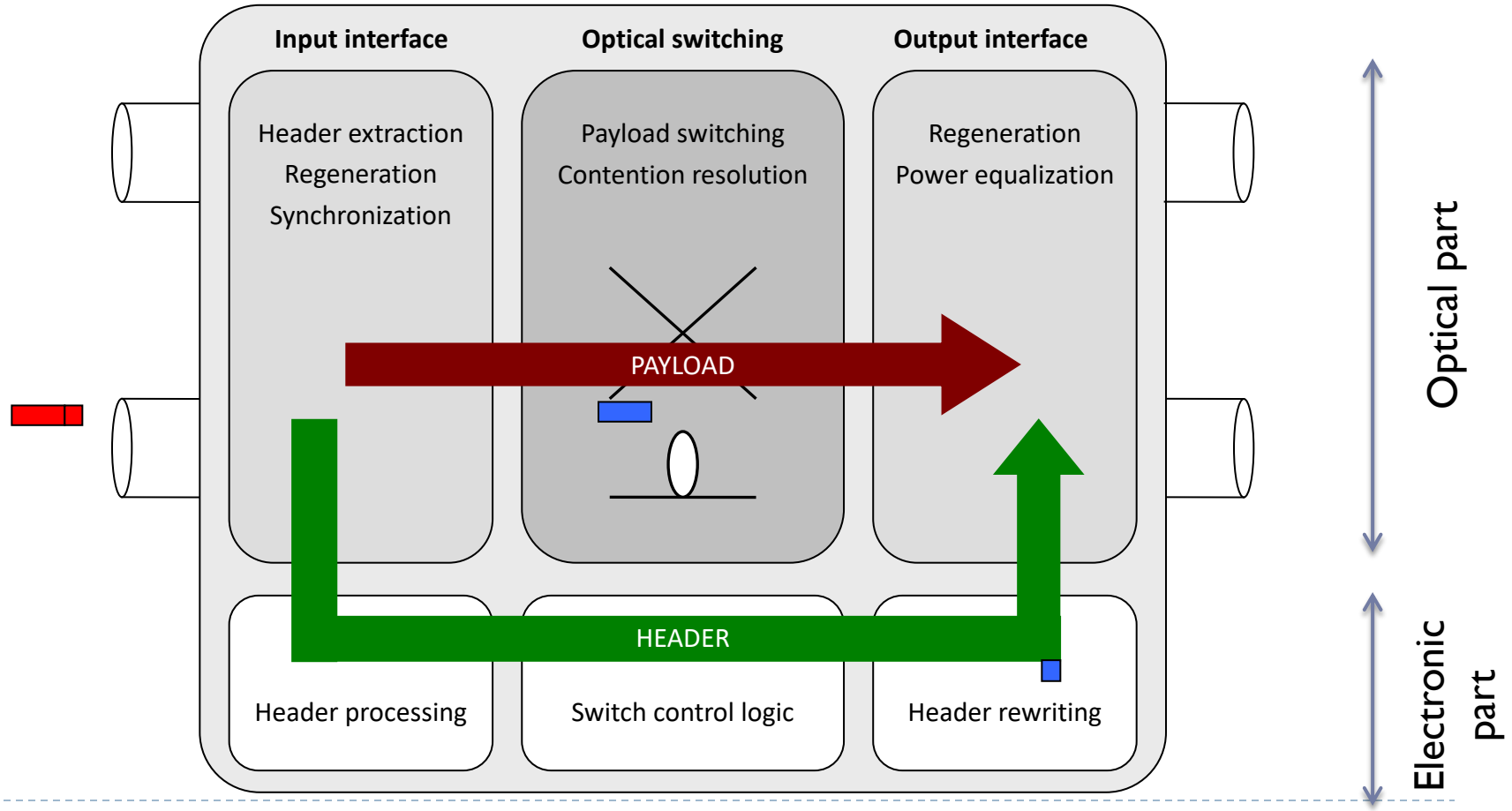
- One single cladding but multiple cores



- Besides route and spectrum, multi-core fibres introduce a third dimension: the space
- The problem becomes a routing, spectrum and core assignment problem

Optical packet switching

- Implementation of conventional Internet packet switching techniques in the optical domain
- The path of the packets through the node is determined packet by packet



Optical packet switching

- Problems
  - There is no optical RAM for buffering the optical packets
    - Slow light
    - Fiber Delay Lines
    - No buffering at all
  - Optical switching at the ns scale
  - Wavelength converters to change the wavelength of the optical packets

- Now some interest for data center interconnection networks
  - Low latency
  - High throughput
  - High flexibility
  - High bandwidth dynamics

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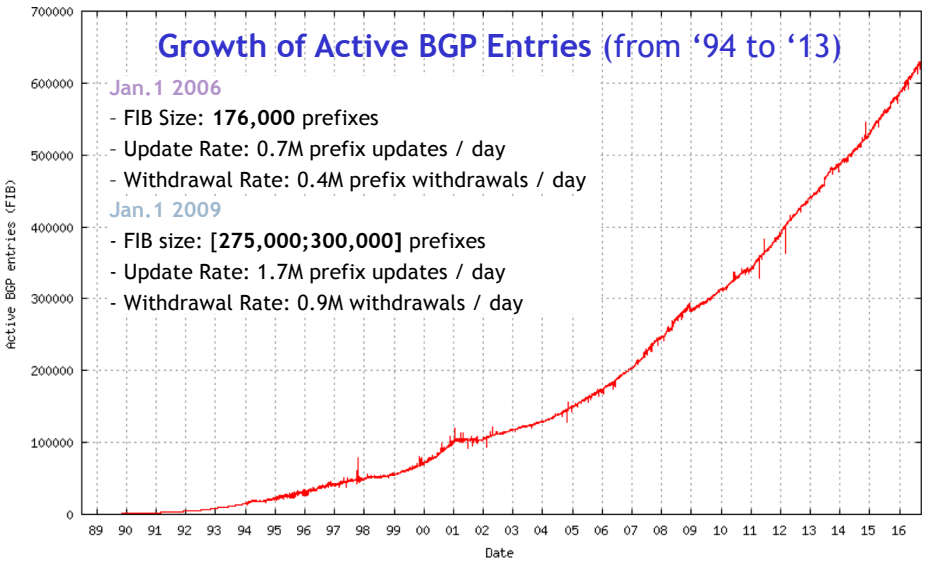
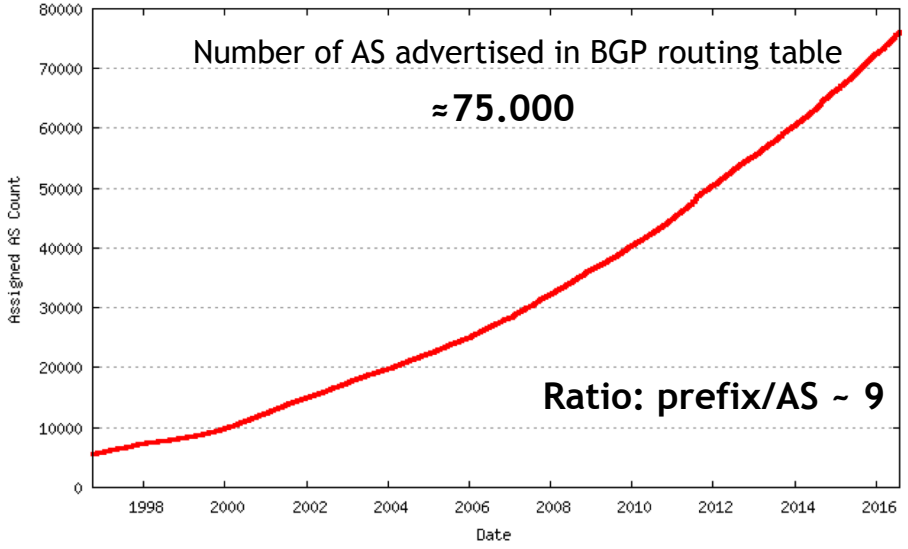
Current situation (1/2)

- Traffic
  - Traffic volume (per month): Exabytes
  - Traffic growth rate: 50% (+/- 5%) per year
- Routing tables size
  - Growth rate: 15%-25% per year
  - Number of active RT entries: 630k (2017)
- Autonomous Systems (AS)
  - Growth rate: 10% per year
  - Number of advertised AS: 75k (2017)
- Average AS-path length: steady ~3.4

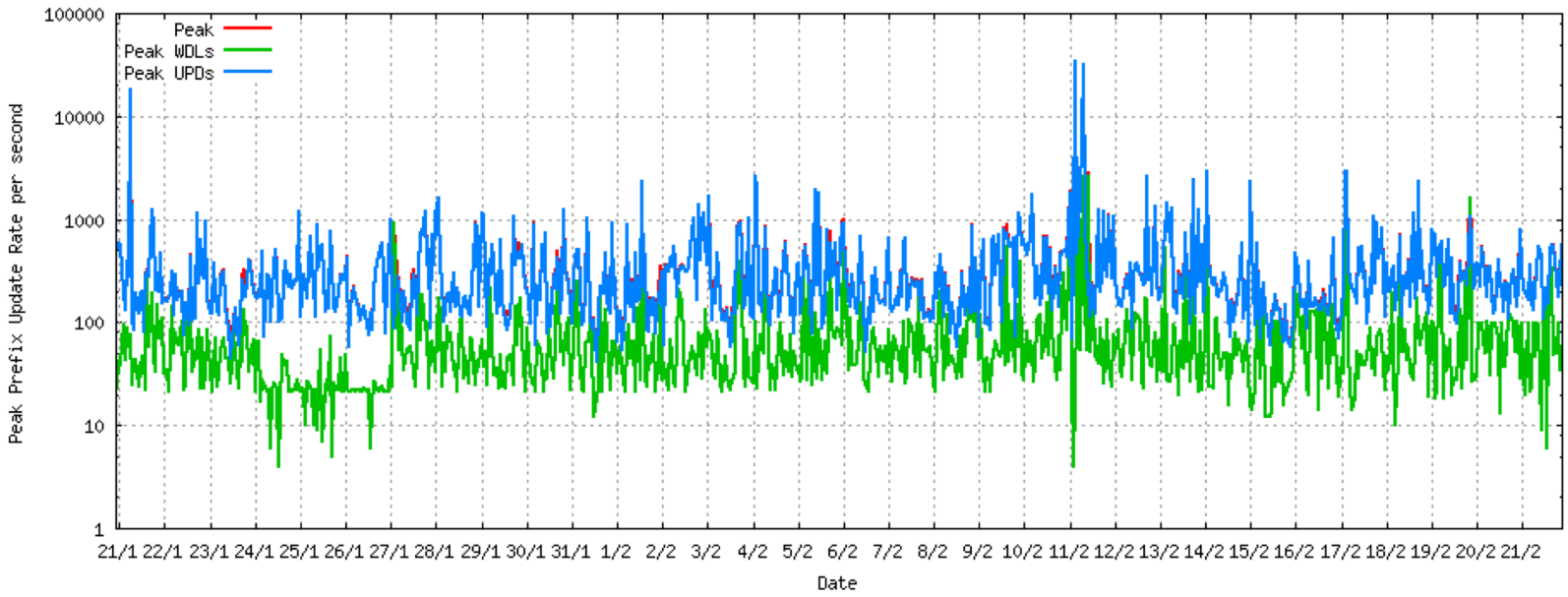




Source: BGP Routing Table Analysis Reports - http://bgp.potaroo.net

Current situation (2/2)

- Dynamics BGP updates (routing convergence)
  - Between Jan.2006 and Jan.2009: prefix update and withdrawal rates per day increased by a factor of about 2.5
  - Average: 2-3 per sec. – Peak: O(1000) per sec.



Solutions space: evolutionary vs. revolutionary

Short-term solutions

- Geographical routing
- Overlay routing such as **LISP, SDN**

Compact Routing

- **Name dependent schemes**: e.g. TZ scheme, BC scheme, etc.
- **Name independent schemes**: e.g. Abraham scheme

Name routing

- **Information-centric network**
- **Content-centric network**
- **Named-data network**

Greedy Geometric Routing

- **Updatefull**: Internet topology graph embedding into hyperbolic plane (requires full view topology graph)
- **Updateless**: graph constructed from hidden hyperbolic space yielding to scale-free topologies

Recursive InterNetwork Architecture

- **Radical change of the Internet architecture:** The problem is in the Internet protocols

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Presentaciones