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Management of Lambda-Connections in Optical Networks

BANDWIDTH ON DEMAND

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Information Society
Technologies



How to develop a vision



What would Beethoven have said?

- What is Bandwidth?
- Why would I care?
- I' m a composer!
- You'd better listen to my music!
- You're wasting your time!



Is there a demand?

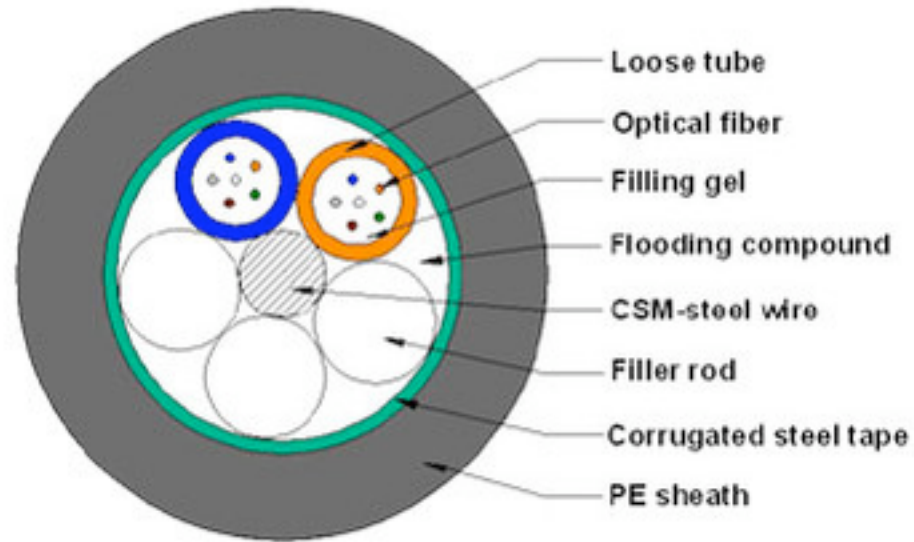


What is the supply?

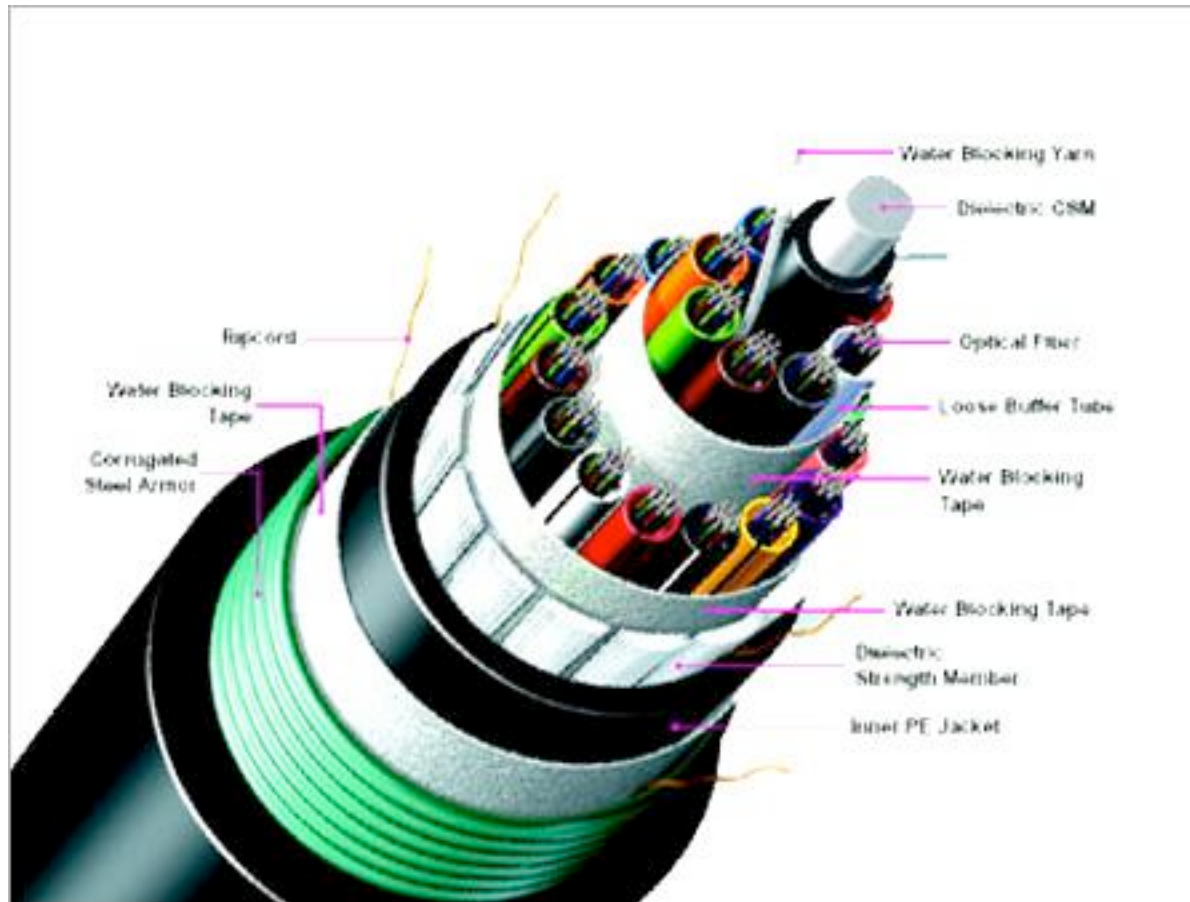
- 10 years from now
- Internet has an optical core
 - Optical fibers
 - Optical switches



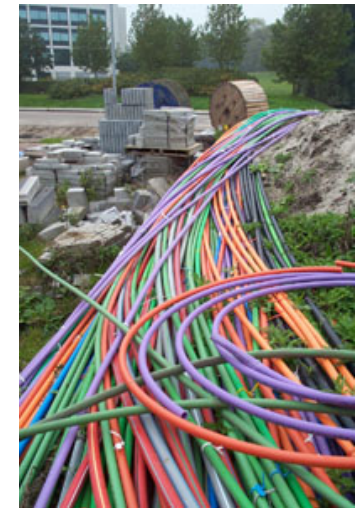
Optical fibers



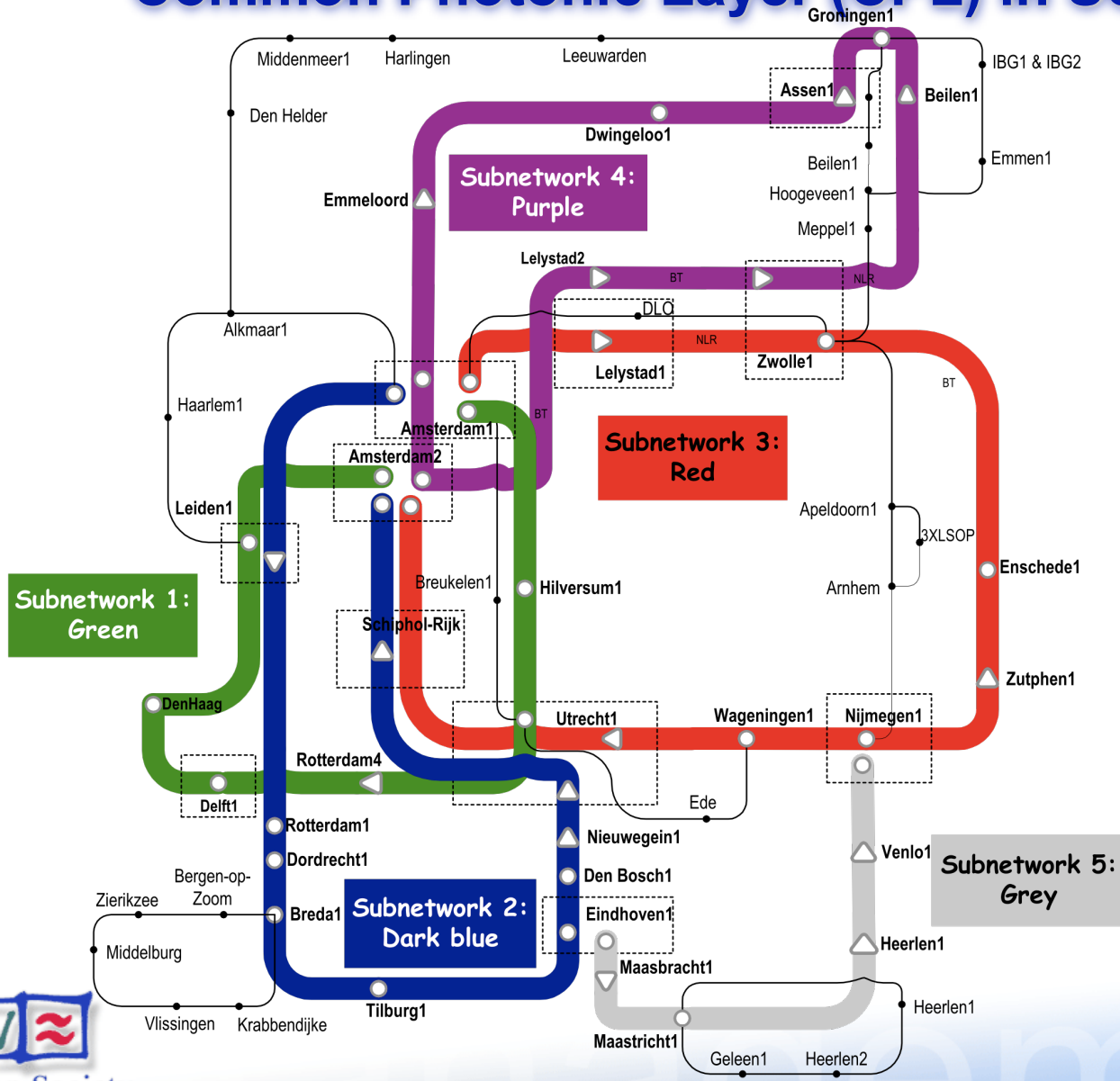
Optical fibers



Laying of fiber near/at Science Park Amsterdam



Common Photonic Layer (CPL) in SURFnet6



Slide by Erik-Jan Bos
SURFnet



Potential optical fiber capacity

- **Single wavelength (λ):**
 - Current: 10-40 Gbps
 - Lab: 160 Gbps
 - 10 years: 1 Tbps?
- **Number of wavelengths per fiber:**
 - Current: up to 160
 - 10 years: 1000?
- **Number of fibers per cable:**
 - Current: 64 (long distance)
 - 10 years: 1000?
- **Number of cables per duct:**
 - 12?



Potential optical fiber capacity

- current:

$$40 \times 10^9 \times 160 \times 64 \times 12 \approx 5 \times 10^{15}$$

5 Pbps

- future:

$$10^{12} \times 10^3 \times 10^3 \times 12 \approx 10^{19}$$



Potential optical fiber capacity

- Example: the Netherlands
 - 5 Million houses
 - Each using by 1 Gbps
 - Required capacity: 5×10^{15}
- Backbone in the Netherlands
 - Total length: 5000 Km
 - 10 to 100 Euro / meter
 - Total costs: 50 to 500 Million Euro



Optical fibre: costs

The fibers
for a nation-wide
optical backbone
would cost the same
as a few kilometers of
highway



Optical switching

Now:

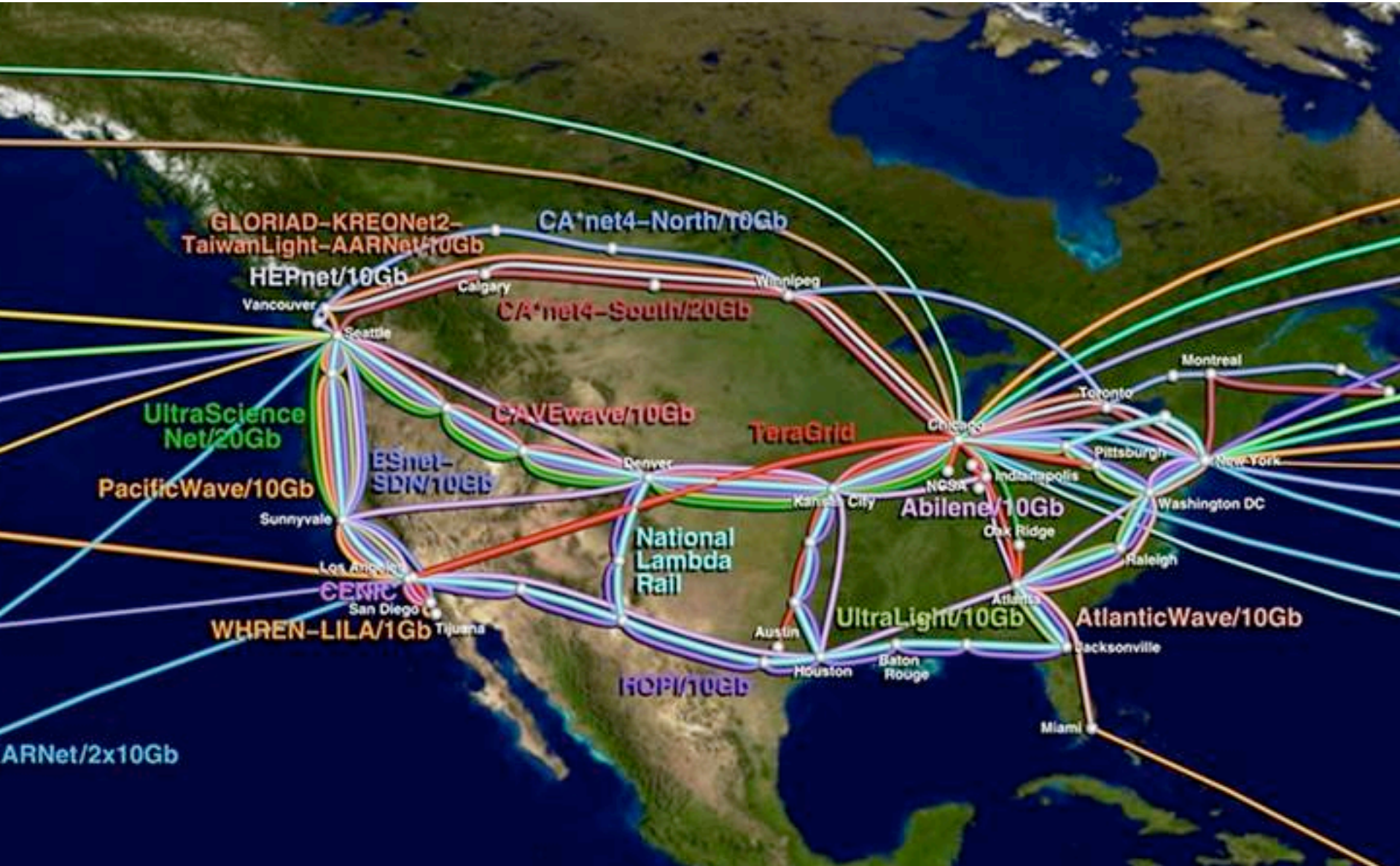
- Lambda switching

Future:

- Optical burst switching
- Optical packet switching

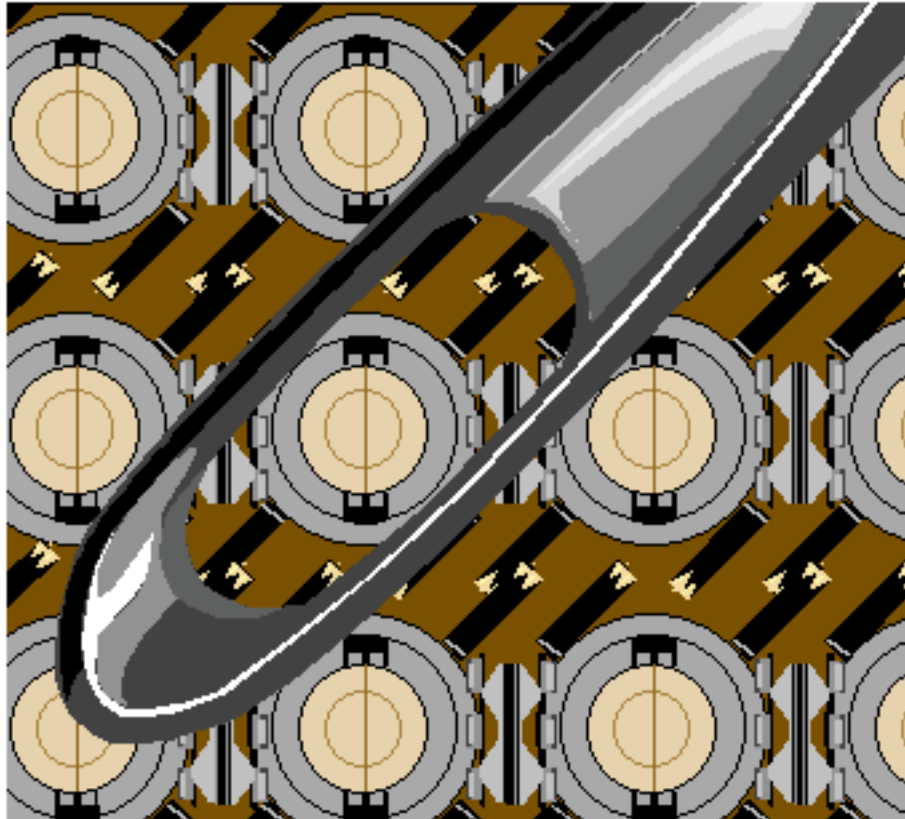


Global Lambda Interconnection Facility

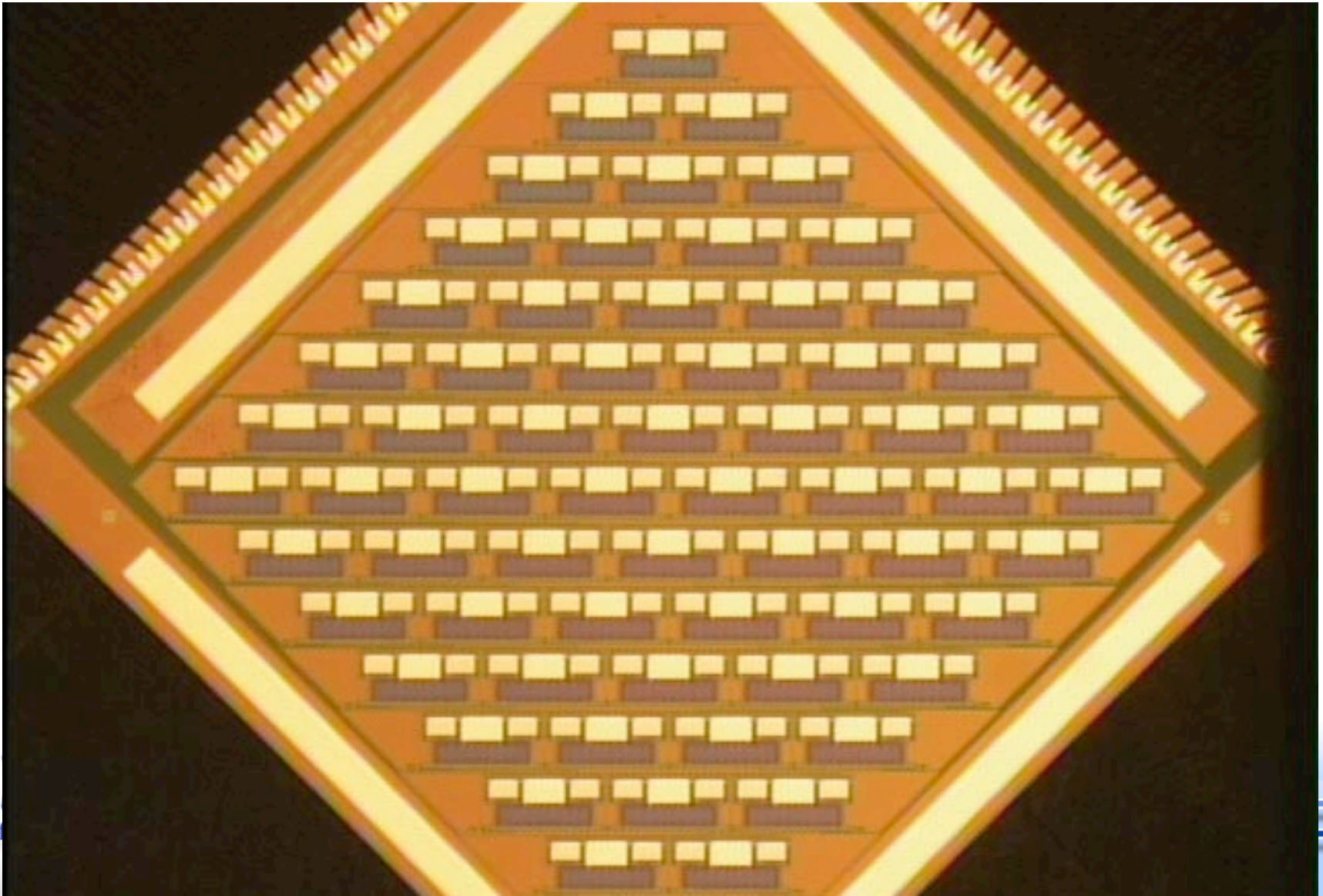


Optical Switches

From Computer Desktop Encyclopedia
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Optical Switches



Optical Switching

- Costs will be determined by lasers / receivers
- What happened to the price of lasers in CD players?



What if ...

The optical network core would consist of

- small number of core routers
- nearly fully connected
- core routers connected via rings
 - data keeps circling on the ring
 - until receiver is able to accept it
 - flow control for free



Would bandwidth be used?

- Sure!
- Paradigm shift:
 - Offload the servers / load the network
 - From client-server to P2P
 - P2P TV
 - P2P Email
 - P2P Storage of (localized) shared data
 - P2P ...
- But
 - **Users demand applications**
 - **Users do not demand bandwidth**



Summary

- Bandwidth is cheap
 - Unlike oil, gas, food etc:
- There will be enough for every one
 - unlike capacity of highways
- Bandwidth, once available, will be used
- But users don't care about bandwidth
- Users care about applications
- Users might hardly be willing to pay for bandwidth



Conclusion

BANDWIDTH ON DEMAND



Acknowledgements

