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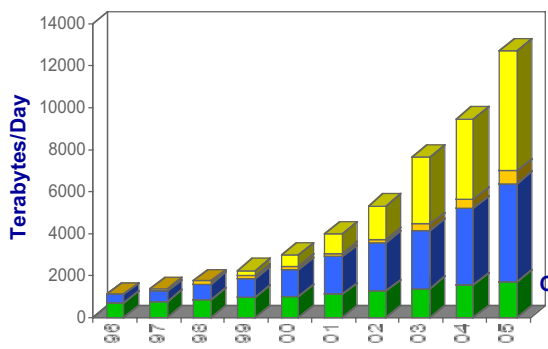
Revolutionary Communications

Will Stewart
Chief Scientist, Marconi



Communications Traffic Forecast (1996)-2005


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CAGR 1996-2005

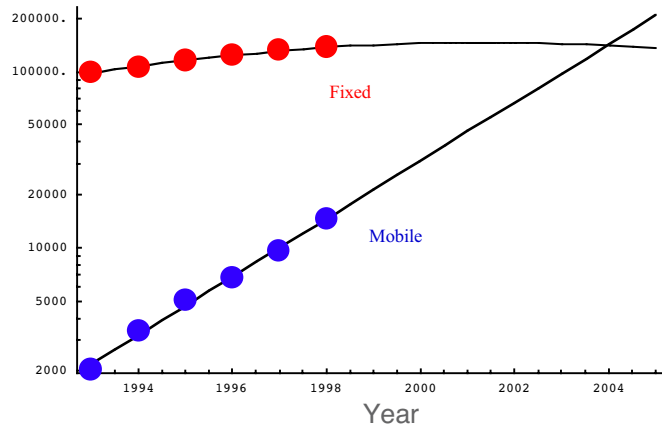
- Internet 95.8%
- Voice over IP 30%
- Data Traffic 30%
- Circuit Switched 12.1%

Source : Renaissance Analysis



UK Mobile (voice) growth, OfTEL

MegaMinutes pa



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How much data?



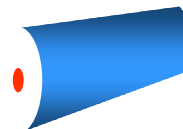
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About 40,000 movies have been released in the US - at 4GigaBytes/movie (DVD) this is about 10^{15} bits
= 1000 TeraBit ~ 1 MovieBrain



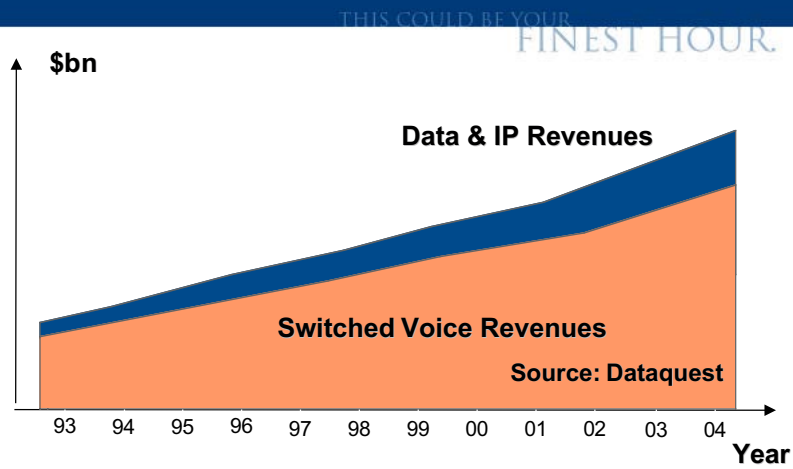
1 MB/minute MP3 file

A 10 Terabit (10^{13})/sec optical link will transmit this in about 2 minutes!



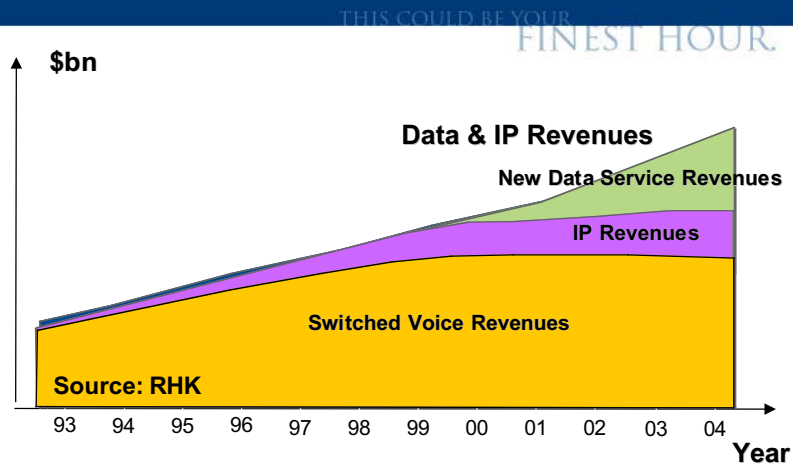
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Service Provider Revenues



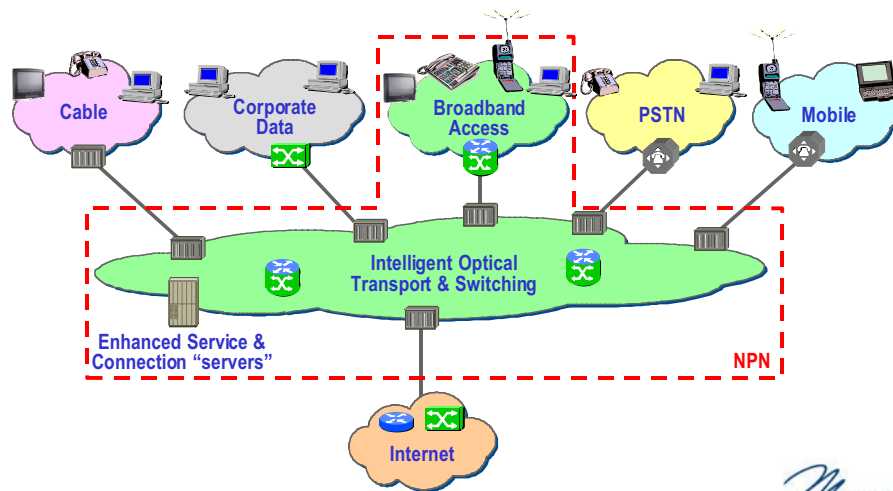
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Service Provider Revenues/2



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New Public Network Architecture



Key Issues

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- Transport capacity -> Photonics
 - Switching -> shift functions to the optical layer (transparency)
 - Mobility -> Mobile, IP

 - Control moving to the edge
 - IP quality of service -> MPLS/MPLamS
 - Integration with legacy systems

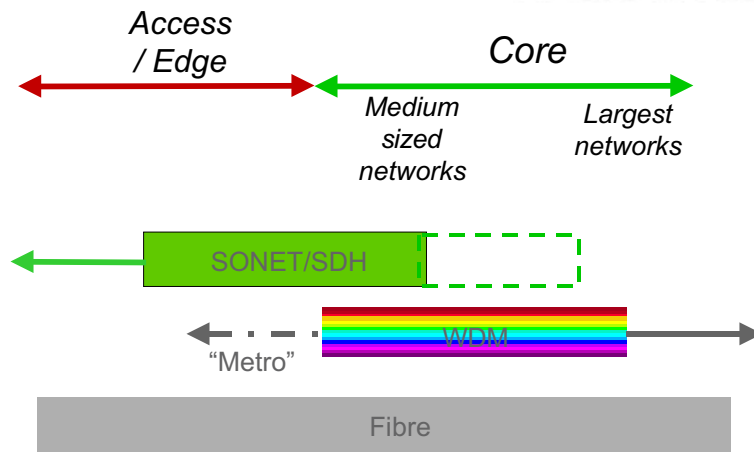
NPN Applications

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Application Class	DEMAND FOR:							
	Speed/user	Low Latency	Low Delay	Potential user base	AGR	Network info	Security	Network Control
Telephone	64k	L	H	Billions	12%	Low	M	N
ASP, remote support, (Luminate, Xdrive, Medical)	?	H	H	100's k	109%		H	
Video/TV (BBC..)	10-250M	L	no	100's M			L	
Radio (Live 365, realplayer)	64k-?	L	L	100's M			L	
Internet	50k-10M	H	M	10'sM	96%		L	
Games	50k-10M	H	M	100's M	100%		M	
Online Auctions (Ebay, Dovebid)	64k-10M	H	H				H	
e-commerce	?	H	M	100'sM			VH	
Exotic Caching (Akamai, ValueClick)		H	H			H	H	M
Games support (Powerplay)		H	H	100'sM		H	M	H
Grid Computing/Thin client (Synchron)	?1-10M	M-H	M	?		H	M	M
Freecalls	64k	L	H	Billions		H	M	L
Positional data/WAP	10-300k	H	M	100's M	14%?	H	L	L

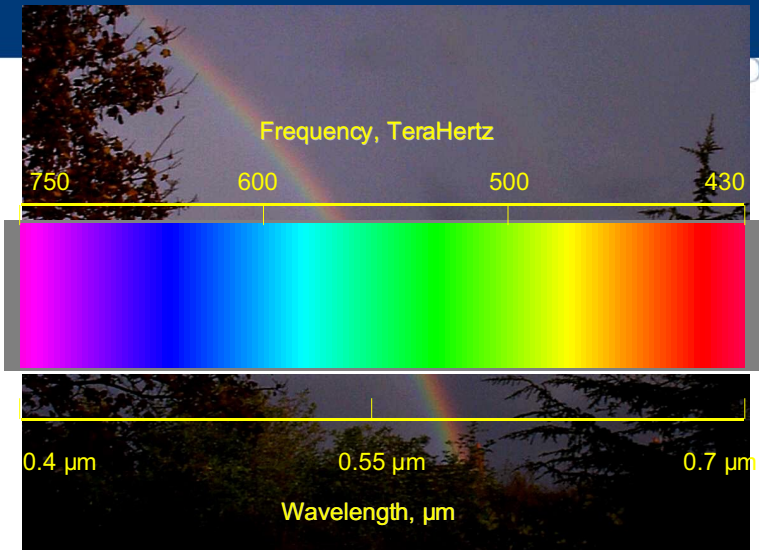
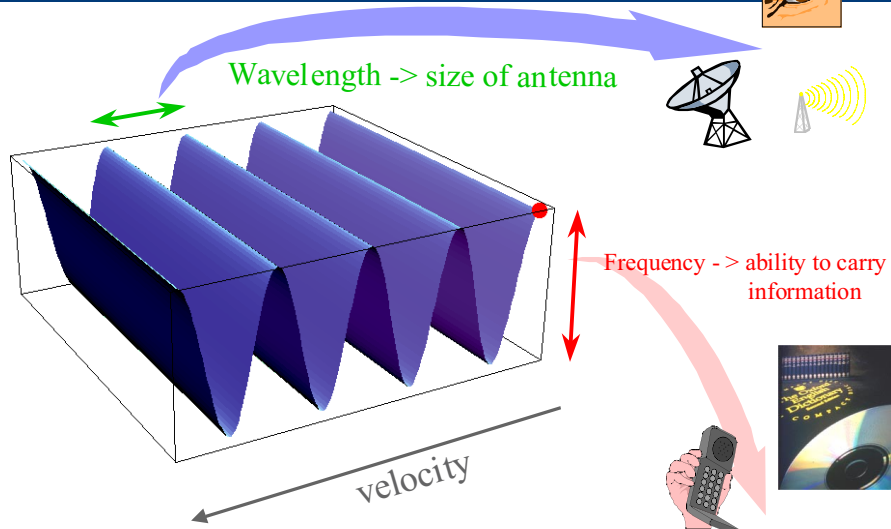
Deployment Trend of SONET/SDH and WDM

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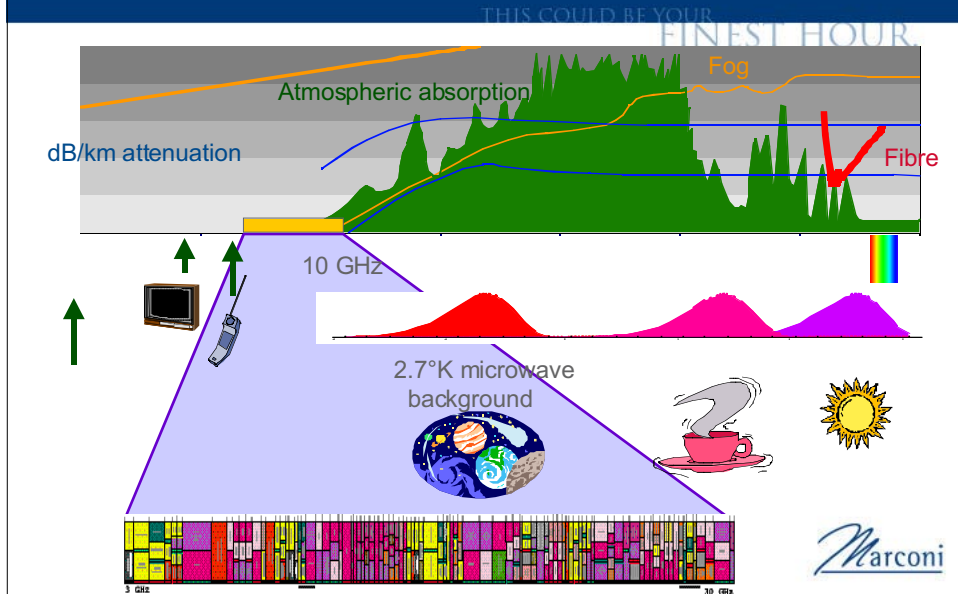


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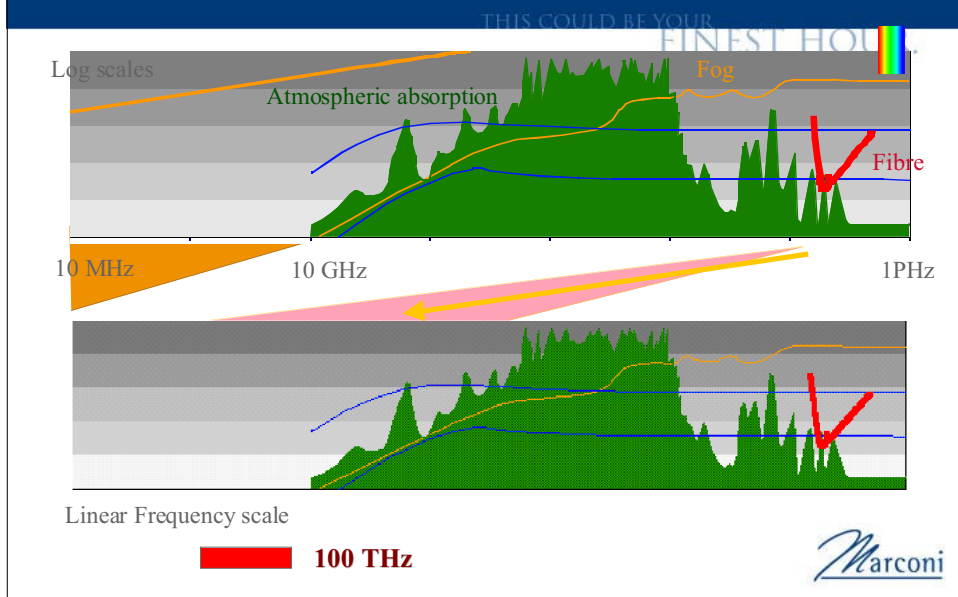
Wave Characteristics

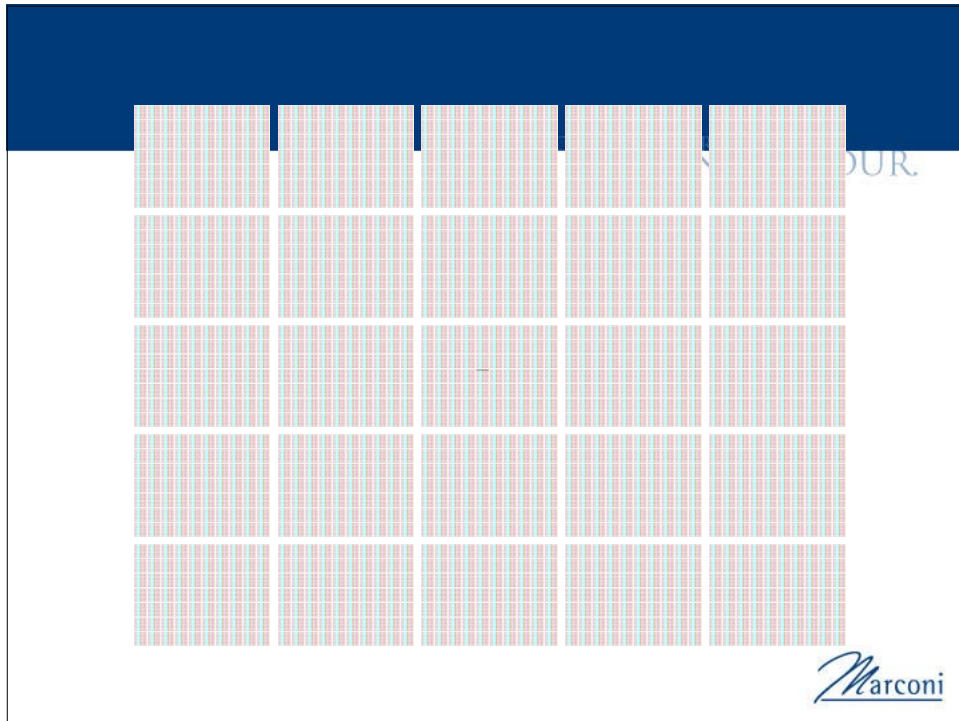
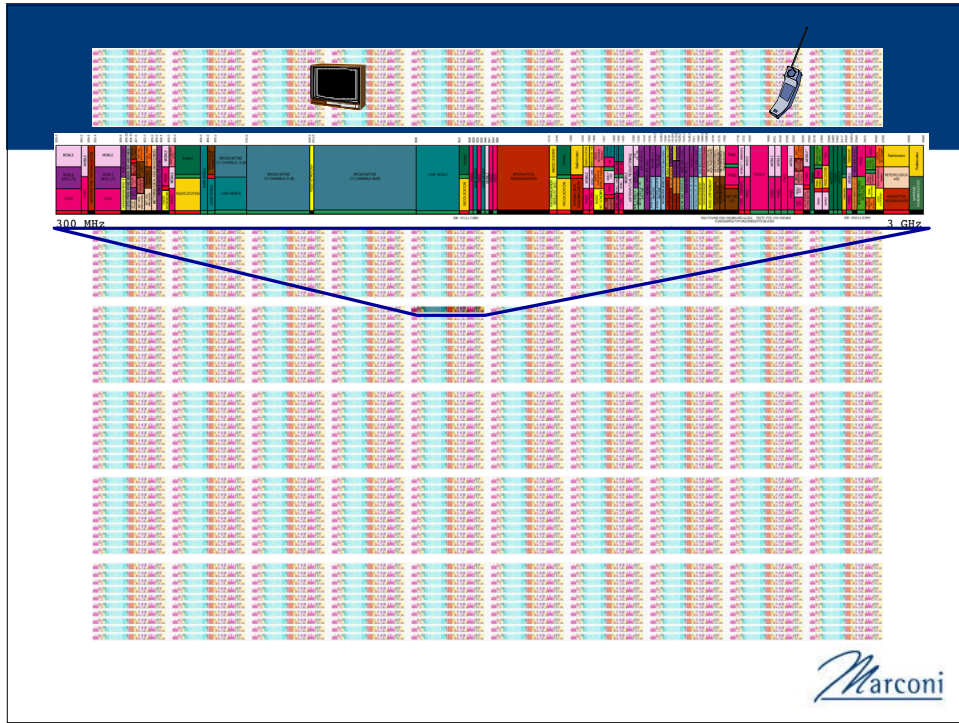


The Electromagnetic Spectrum



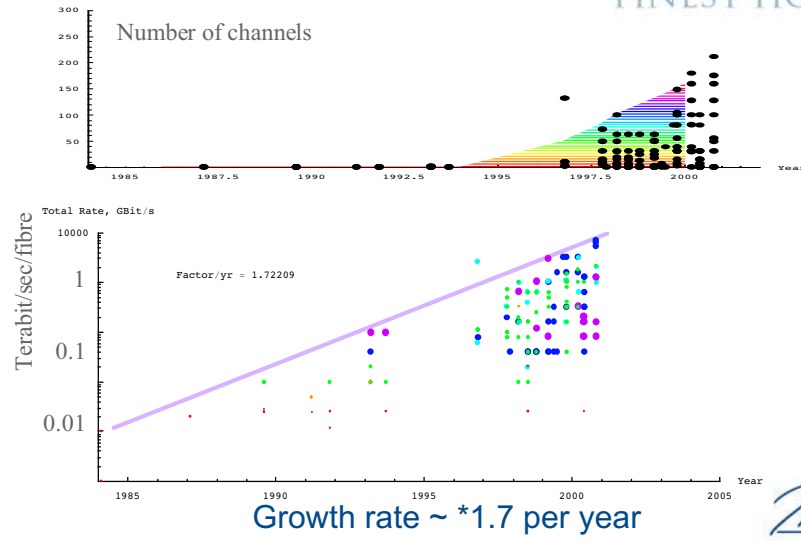
Electromagnetic Information





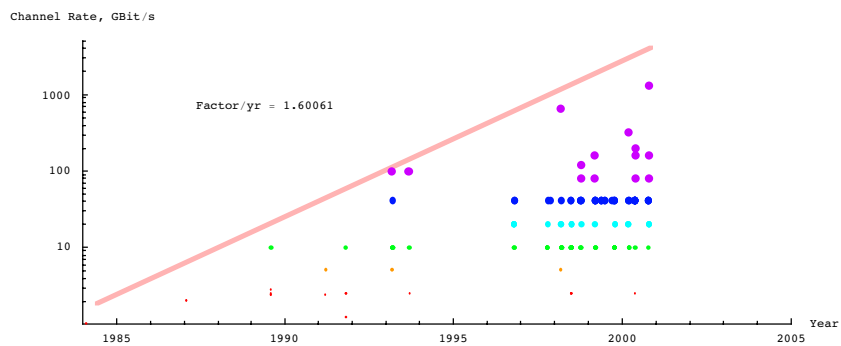
Optical Fibre Capacities

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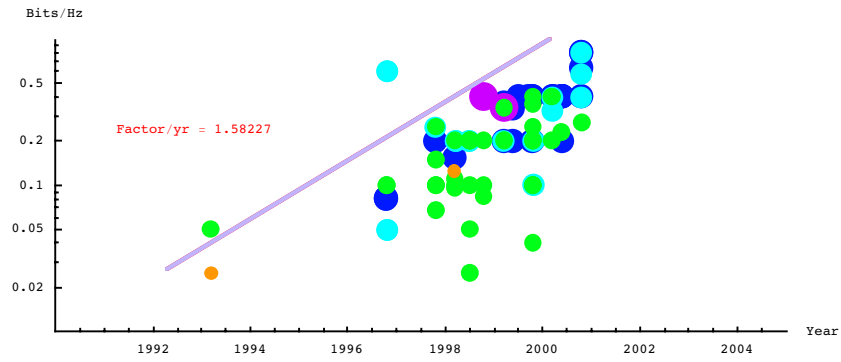
Channel Rate

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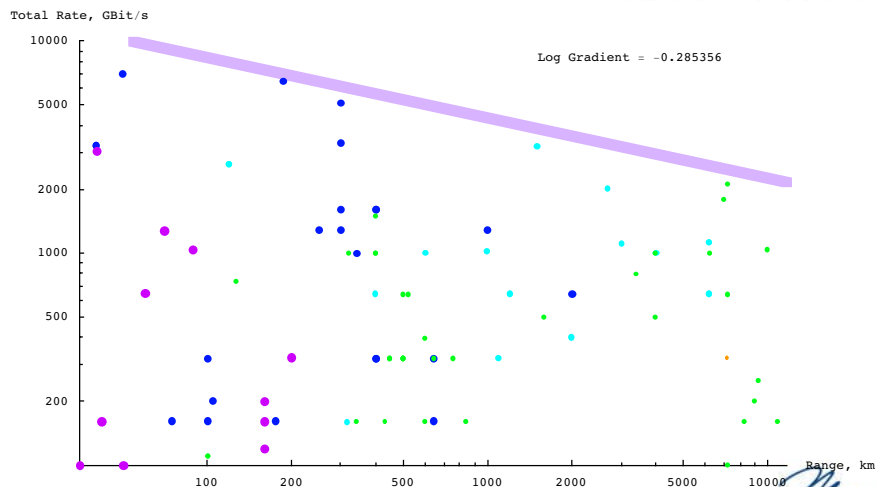
Spectral Efficiency Bits/sec/Hz

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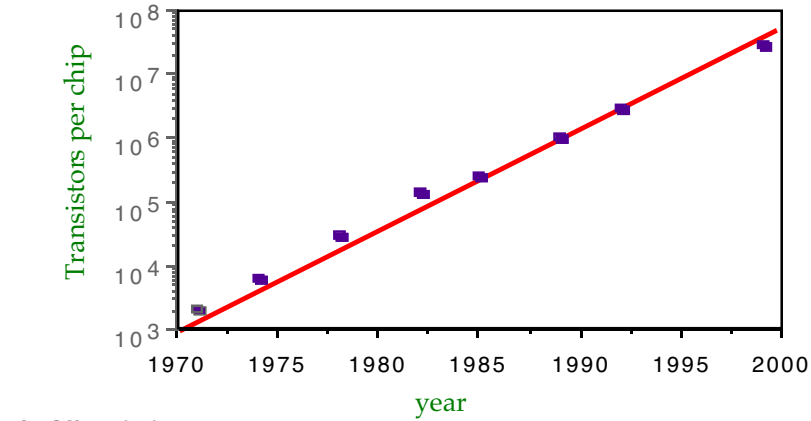
Rate v range

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Moore's Law

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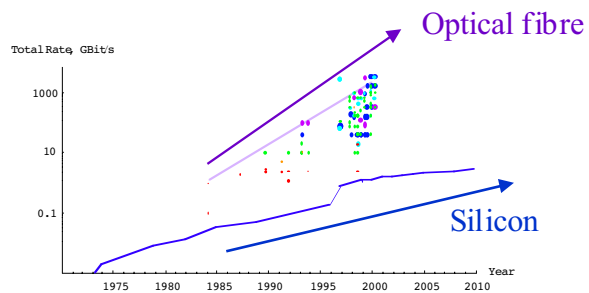
Growth rate ~ *1.4 per year

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New Optical Networks

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The growth in optical fibre capacity (60-80% pa) is outstripping The (Moore's law) growth in processor speeds (~25% pa and falling)*



Sources: fibre: reported data major conferences
Silicon: International roadmap 1999

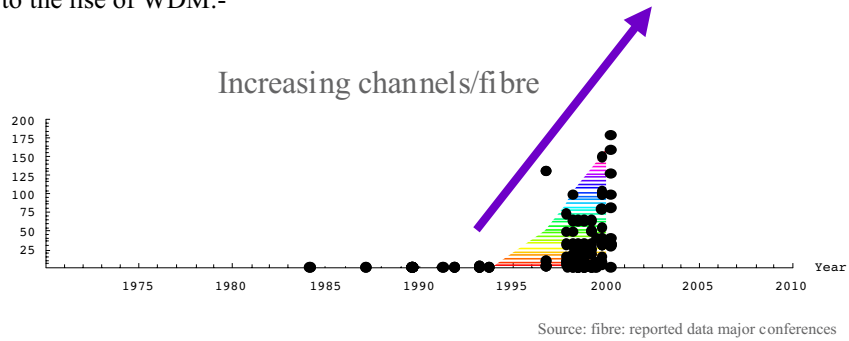
*classic x2/18 months includes increasing chip sizes!

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New Optical Networks

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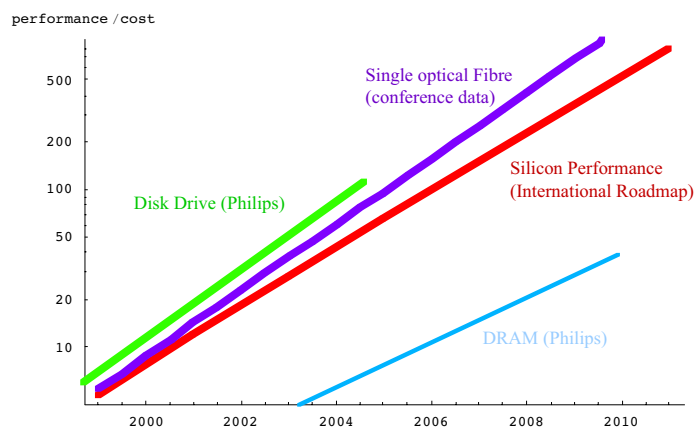
This led in the mid-90's
to the rise of WDM:-



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Trends Performance v cost for Fibre and Silicon

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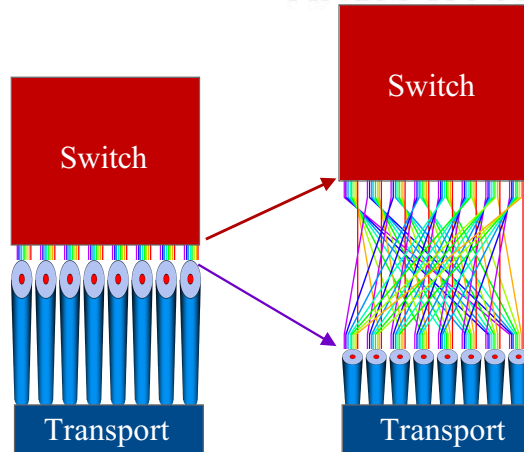


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Dense WDM for switching

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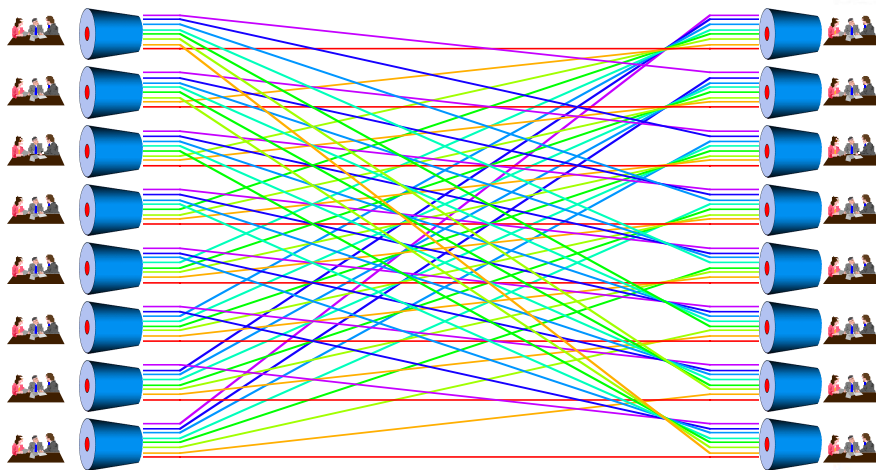
But now the processors in switches cannot cope with the fibre data delivery rate and some of the the switching functions are moving into the optical regime:-



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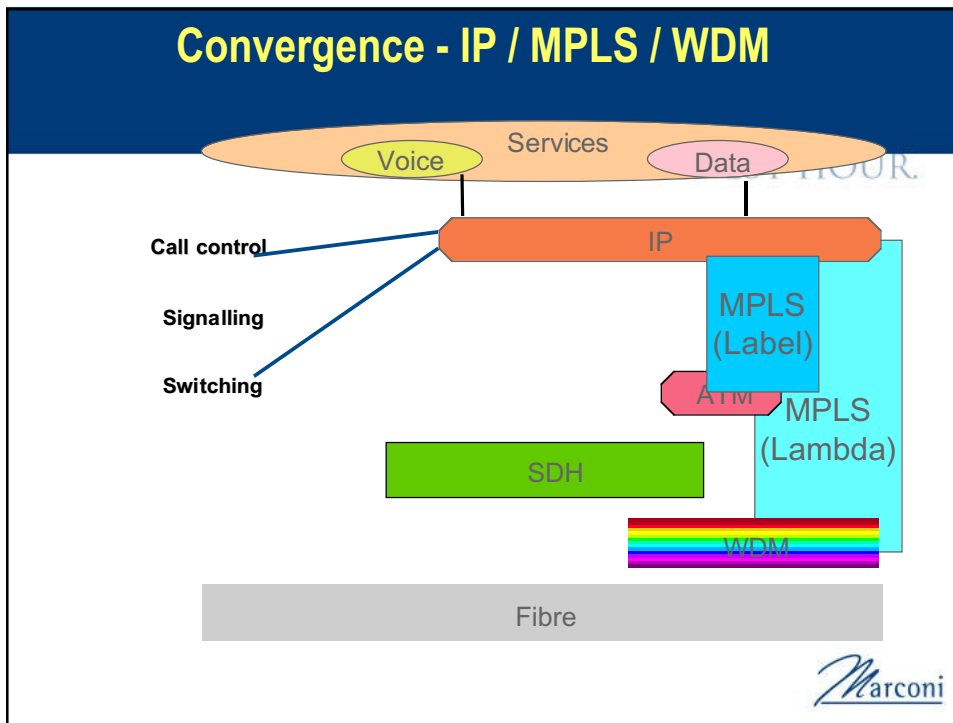
Dense WDM for routing

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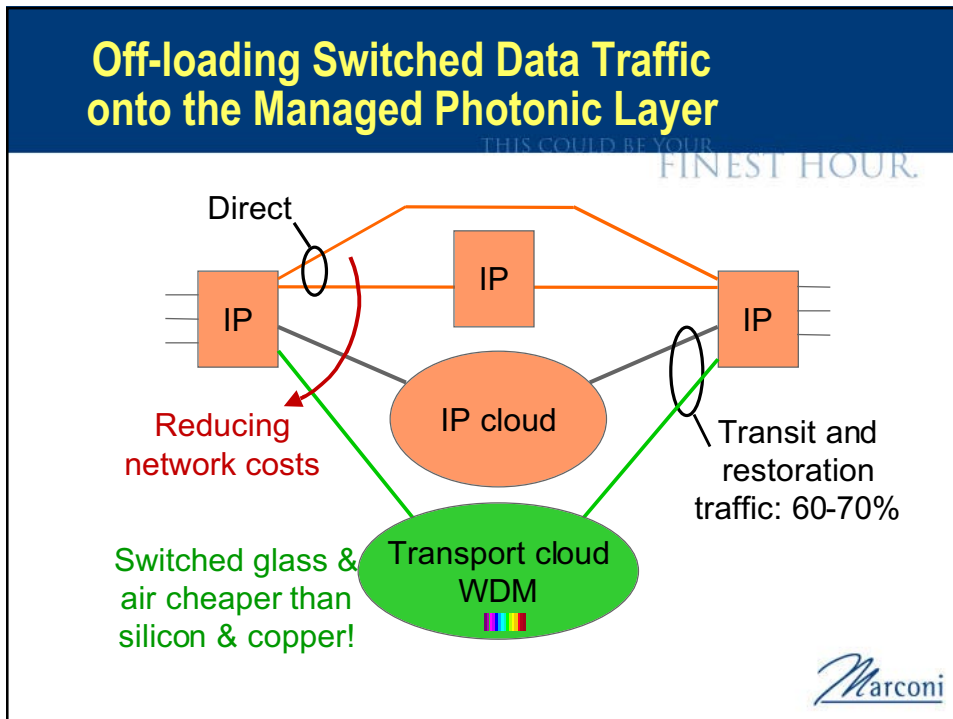


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Convergence - IP / MPLS / WDM



Off-loading Switched Data Traffic onto the Managed Photonic Layer



New Optical Networks

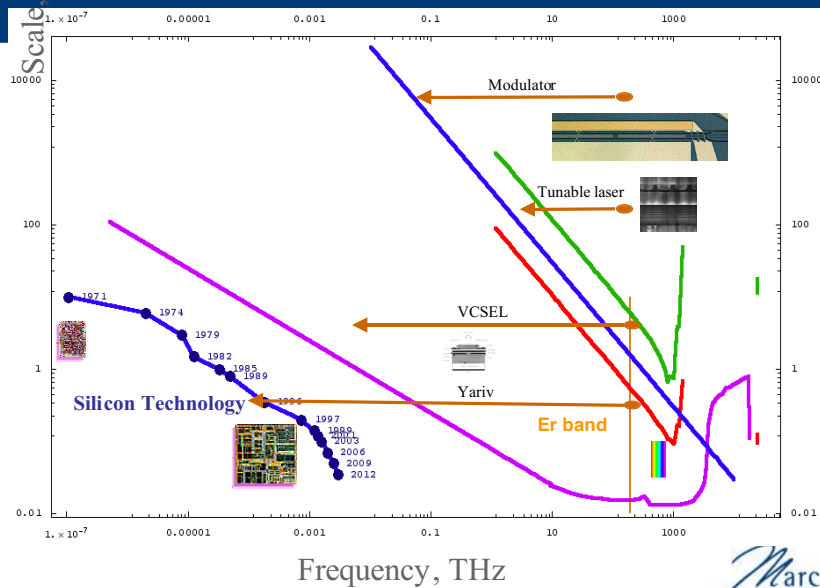
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New Technologies:-

- Control MPLS
 - Lasers
 - Detectors
 - Electrical XCs
 - Optical ADMs
 - SDH networks
-
- **MPLambdaS**
 - **tunable lasers**
 - **tunable detectors**
 - **wavelength translators**
 - **Optical XCs -> wavelength-selective OXCs**
 - **Optical ADMs**
 - **Static WDM overlayed SDH -> Dynamically reconfigurable SDH/WDM**

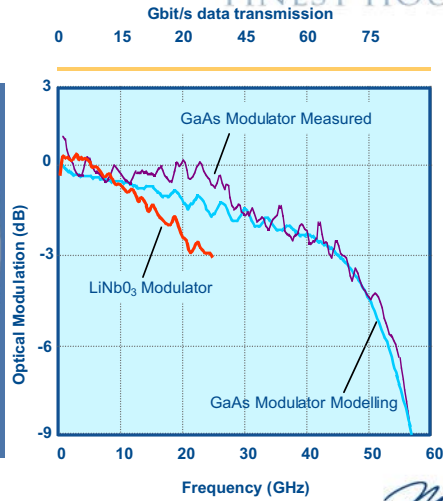
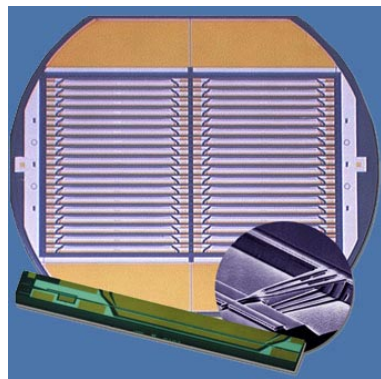
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Scale v speed for Electronics & Photonics



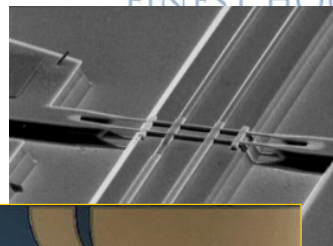
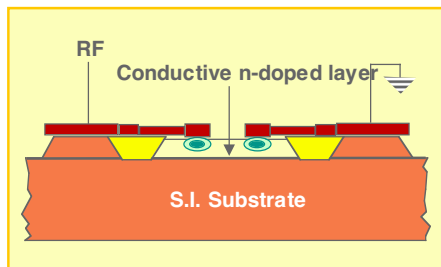
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GaAs Modulator RF Response



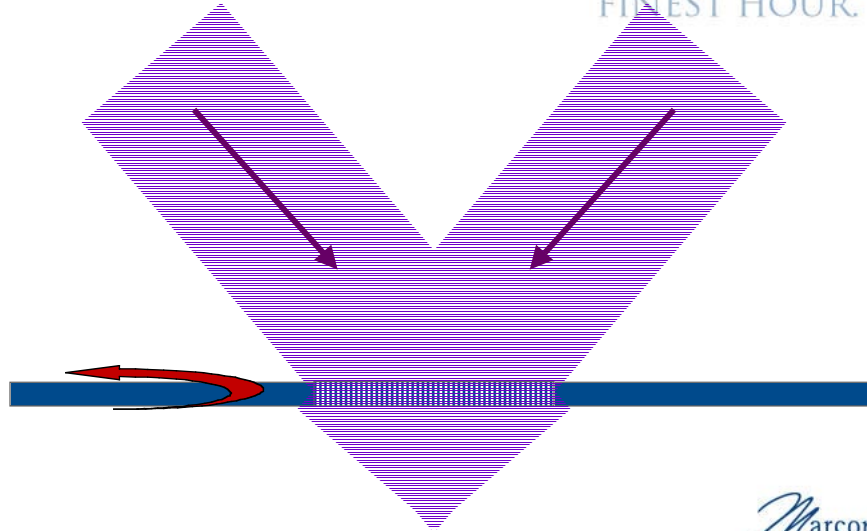
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GaAs/AlGaAs Mach-Zehnder Modulator



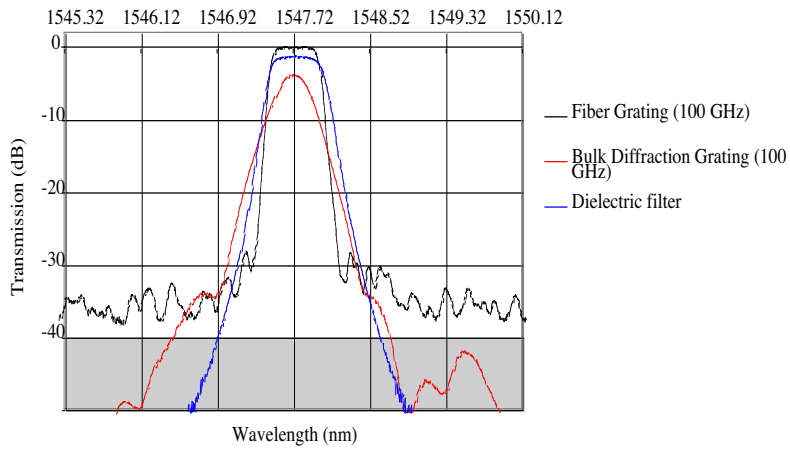
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Fiber Grating Holographic Fabrication Technique



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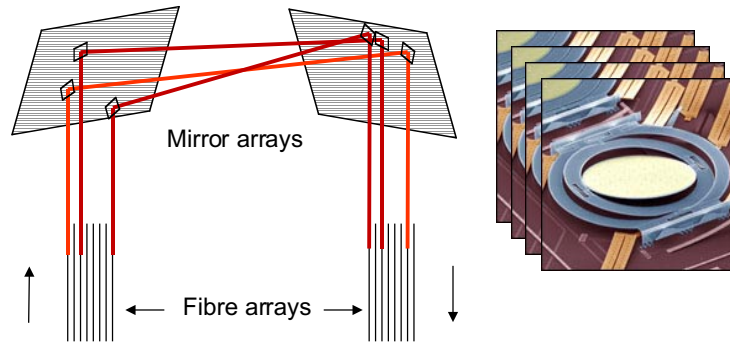
Performance of actual filters



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3D MEMS OXC

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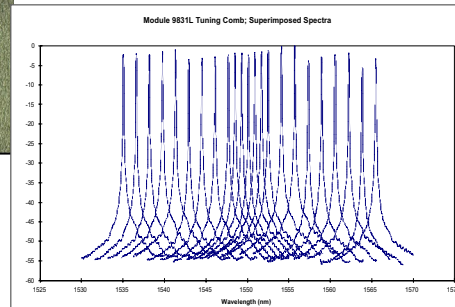
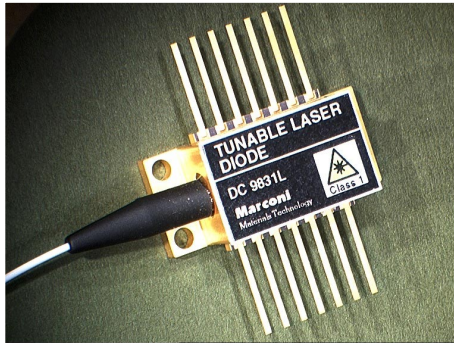


- 256 ports \longrightarrow > 1,000 ports

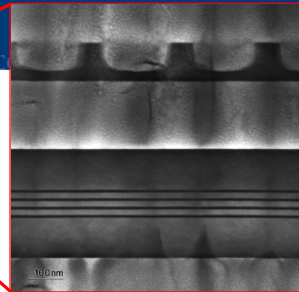
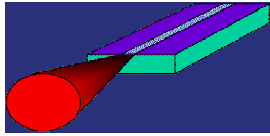
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SG-DBR Tunable Laser Source

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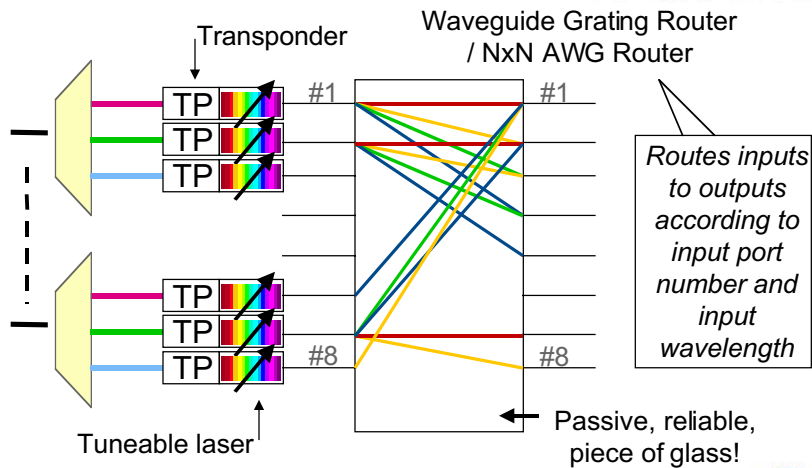


Laser Structure



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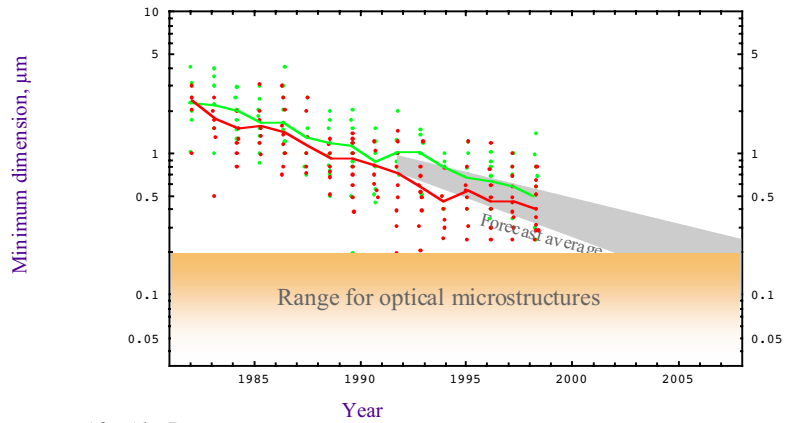
Principle of Optical Cross-connect Based on Tunable Laser and Passive Router



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Minimum IC structure dimensions

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(as reported at the IEEE SSC conference)

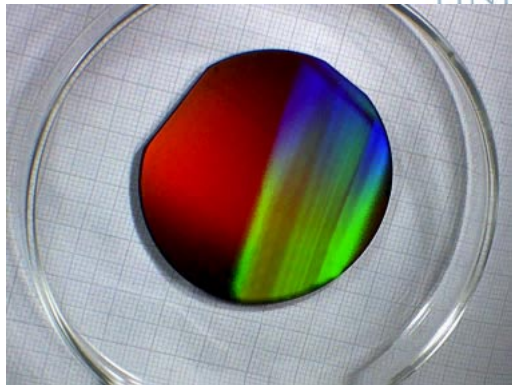


After Alec Broers

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Zoom Movie

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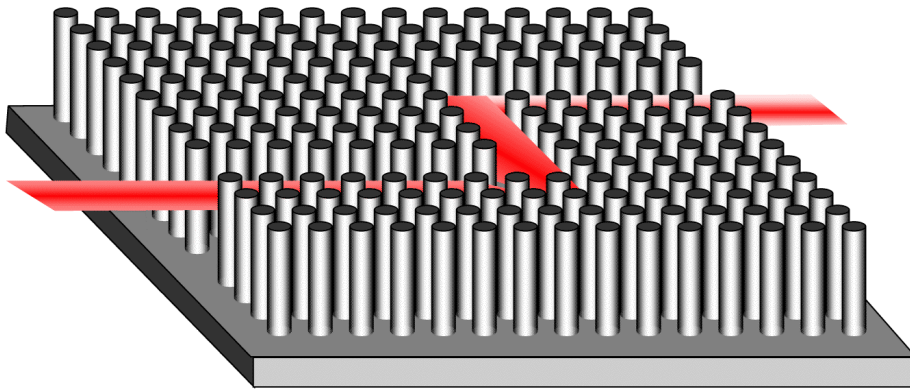


All actual pictures of electronic devices
(movie by Richard Beanland)

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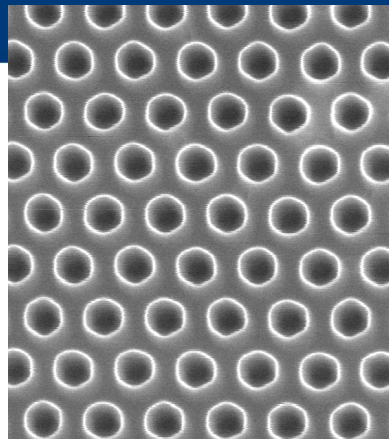
pbg integration technology

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High confinement implies dense circuits without crosstalk
-- needed to match electronic densities and switch performance

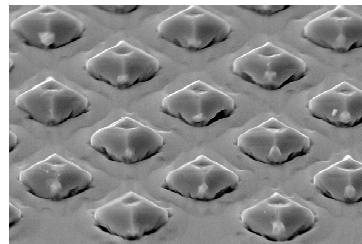
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Self-assembled Pyramid
Array (Imperial College)

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Hole Array (Glasgow)



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