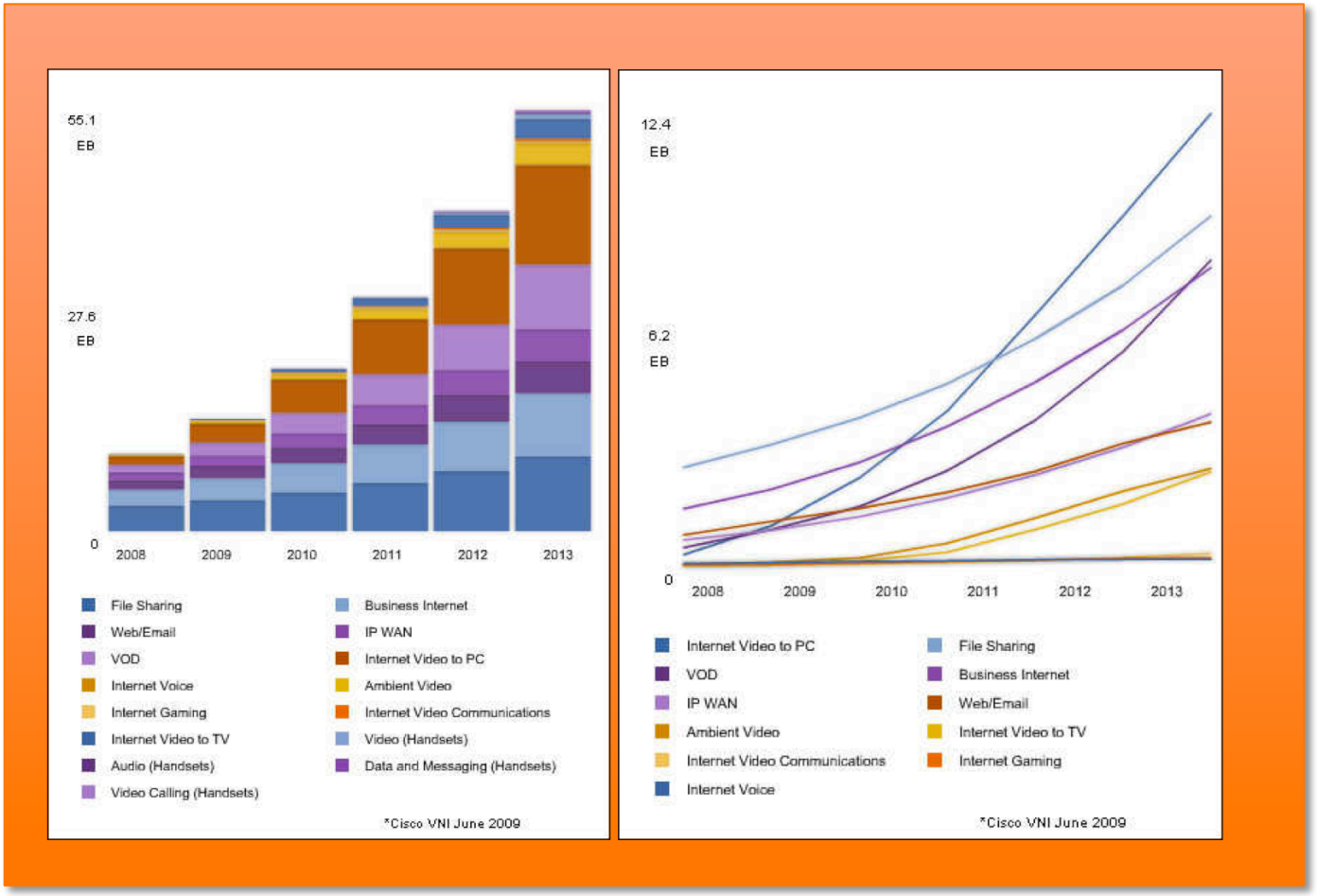
Lecture 1- Introduction to Fiber Optics

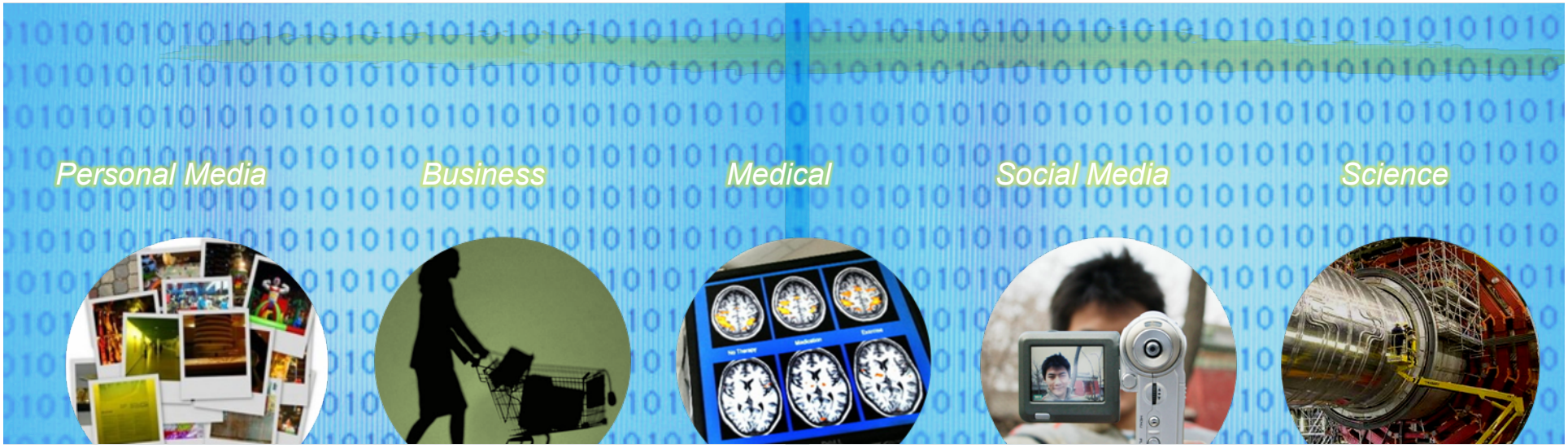
Projected IP Growth

Courtesy G. Epps, Cisco



Its Raining Data

Slide Courtesy Intel



Ave. Files on HD
54GB

Retail Customer DB
600 TB

Clinical Image DB
~1PB

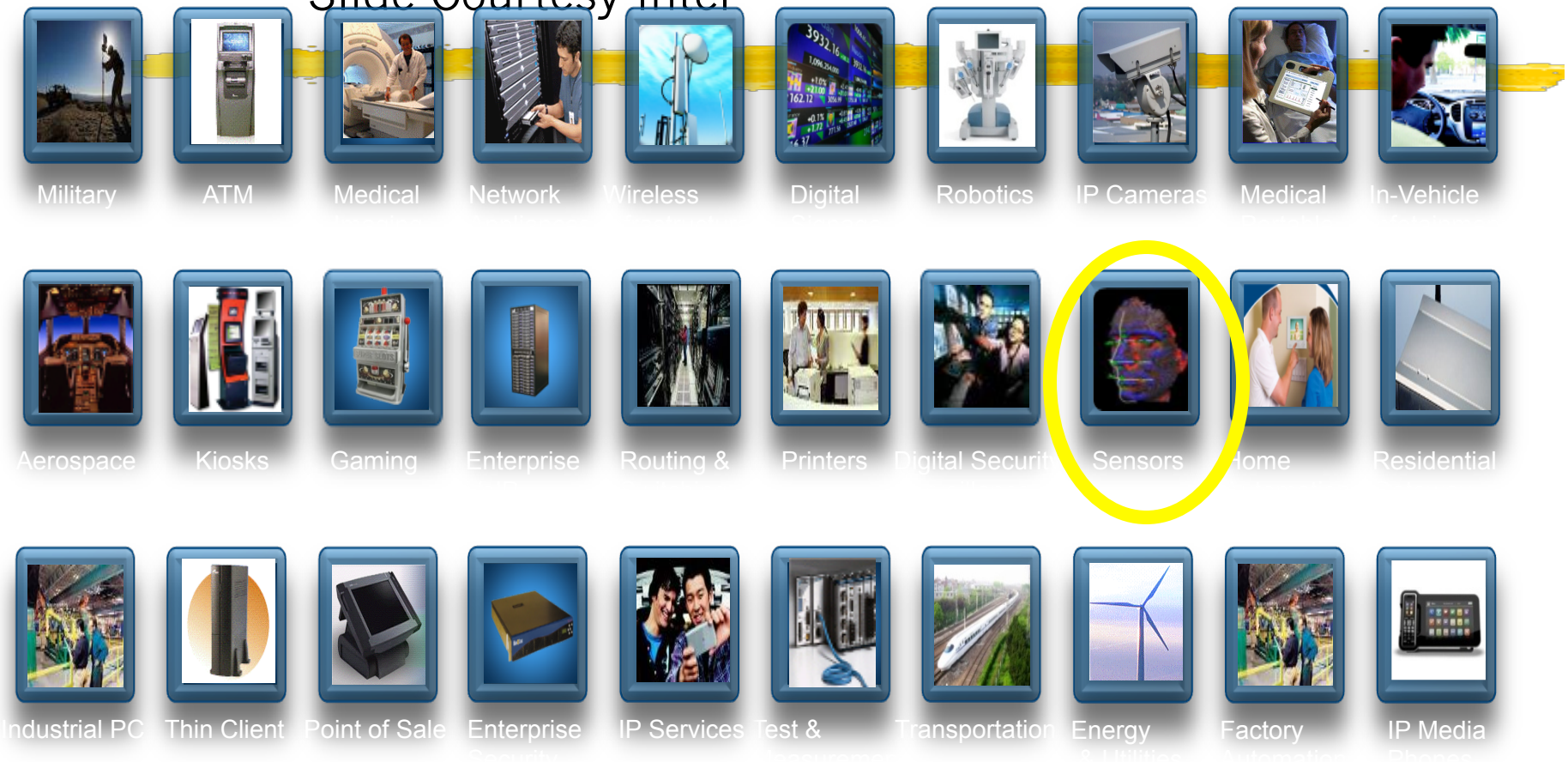
HD video projection
12 EB/yr

Physics (LHC)
300 EB/yr

Estimating the Exaflood, Discovery Institute, January 2008
Amassing Digital Fortunes, a Digital Storage Study, Consumer Electronic Association, March 2008

Billions of New Sources to Come

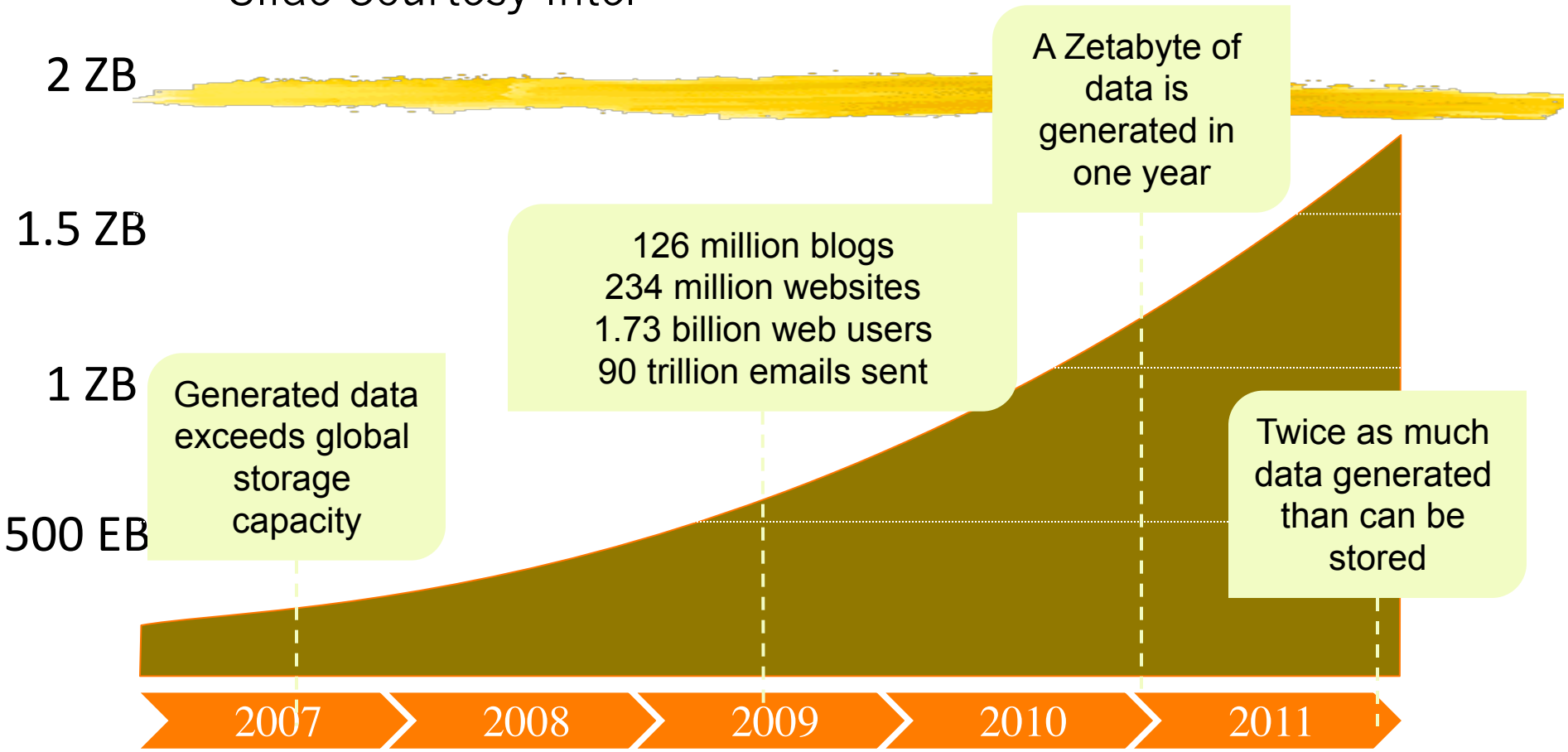
Slide Courtesy Intel



50+ billion devices. <1% connected as of 2009

Global Data Timeline

Slide Courtesy Intel



A **Flood of Data** is being created at a 60% growth rate – may become more than we can handle!

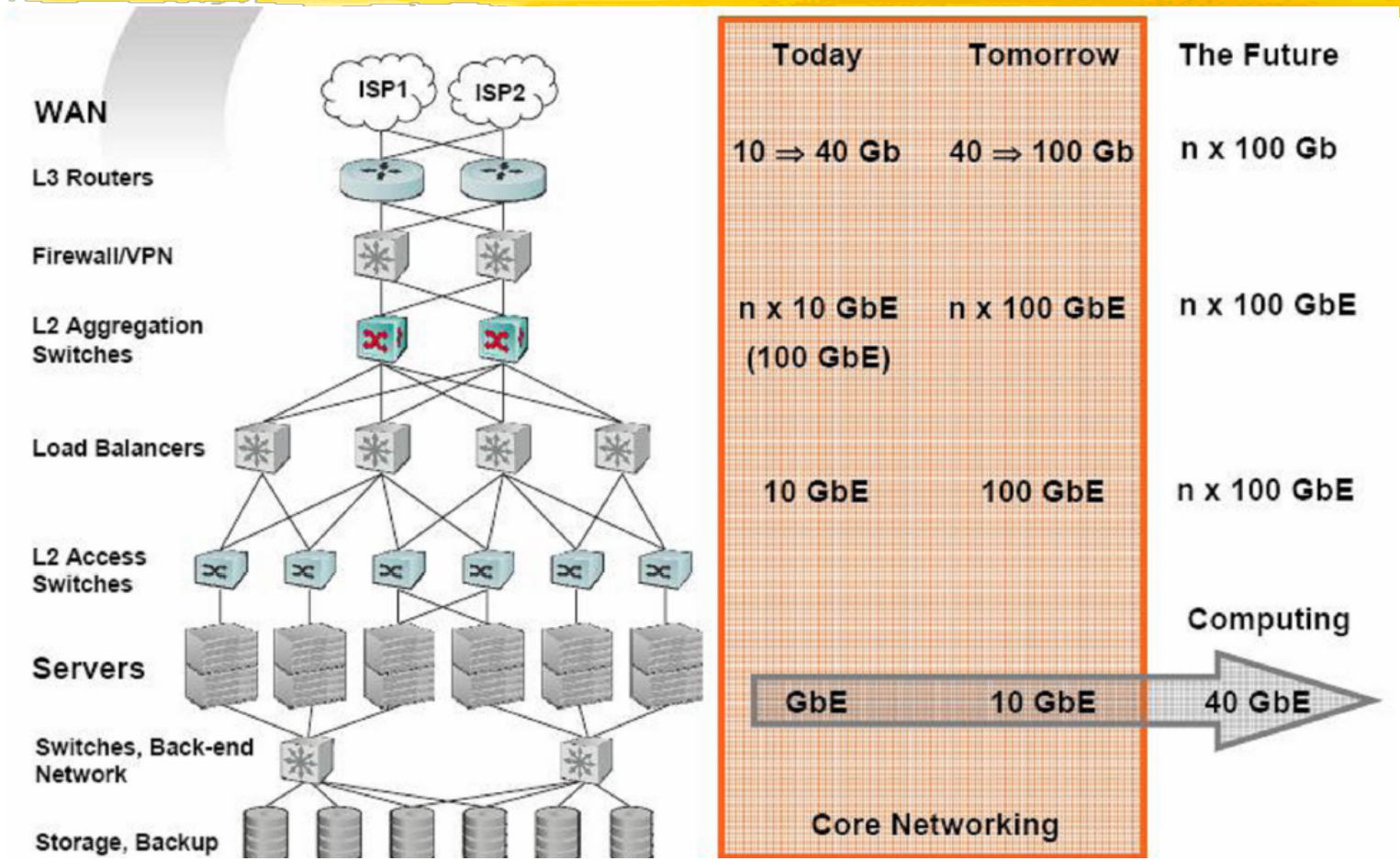
Example: Advanced Video Technology

Slide Courtesy Intel

	24Hz		48Hz		60Hz		120Hz (3D)	
HDR Increase (color depth)	24	48	24	48	24	48	24	48
Today: Full HD 1080p	1.19 Gbps	2.39 Gbps	2.39 Gbps	4.78 Gbps	2.99 Gbps	5.97 Gbps	5.97 Gbps	11.94 Gbps
Tomorrow : Quad HD 2160p	4.78 Gbps	9.56 Gbps	9.56 Gbps	19.11 Gbps	11.94 Gbps	23.89 Gbps	23.89 Gbps	47.78 Gbps

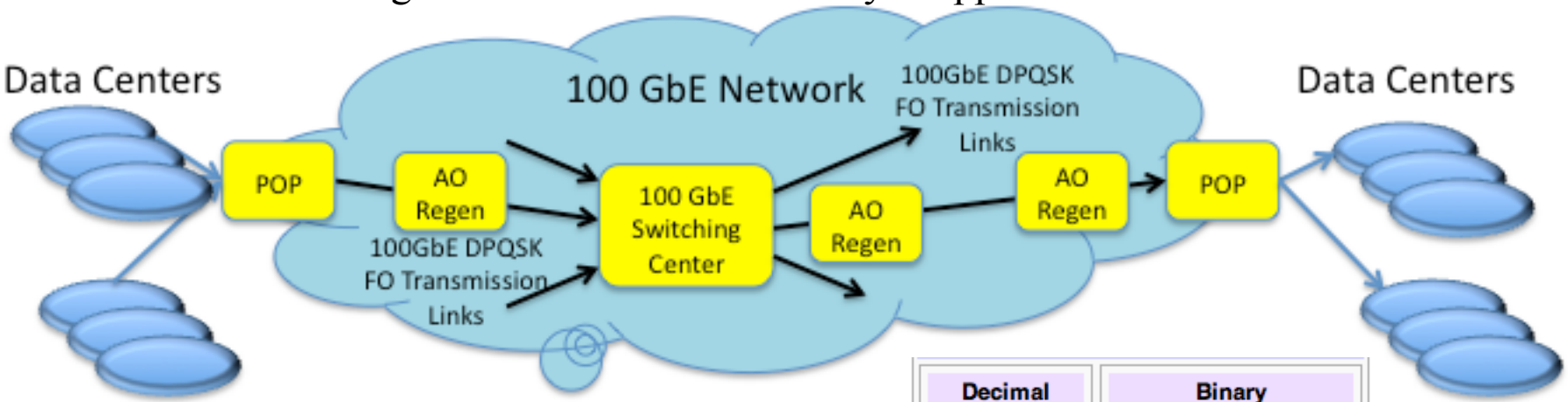
Photonic links could facilitate better TV experiences

Data Center Ethernet Demands



Rationale for Terabit Optical Ethernet

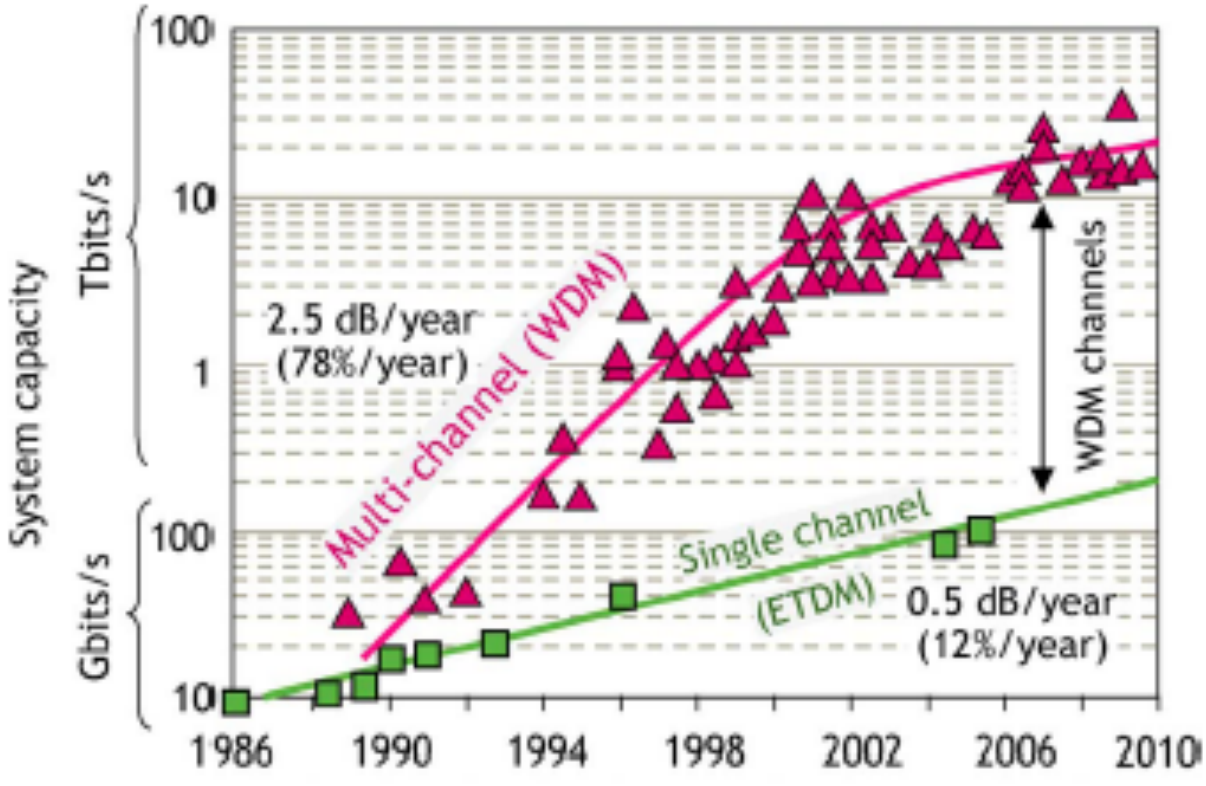
- Commercial Ethernet is rapidly moving to 100Gbps deployment using optical coherent technologies – Slow for future Terabyte Applications !!!



Decimal			Binary		
Value	SI		Value	IEC	JEDEC
1000	k	kilo	1024	Ki kibi	K kilo
1000^2	M	mega	1024^2	Mi mebi	M mega
1000^3	G	giga	1024^3	Gi gibi	G giga
1000^4	T	tera	1024^4	Ti tebi	
1000^5	P	peta	1024^5	Pi pebi	
1000^6	E	exa	1024^6	Ei exbi	
1000^7	Z	zetta	1024^7	Zi zebi	
1000^8	Y	yotta	1024^8	Yi yobi	

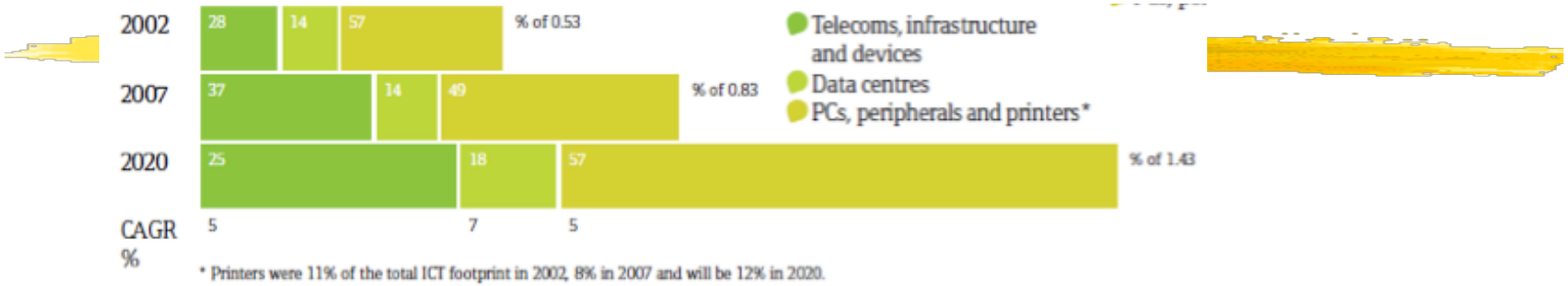
Data centers are talking this capacity!

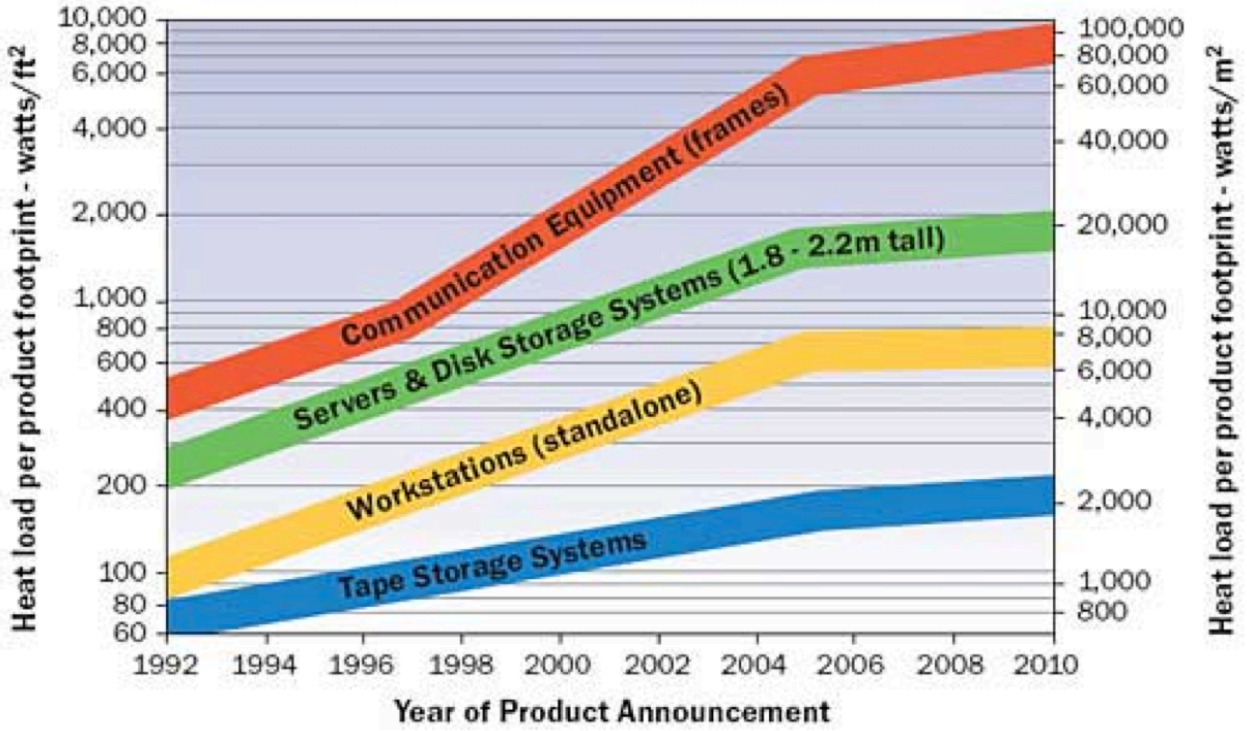
Historical Fiber Capacity



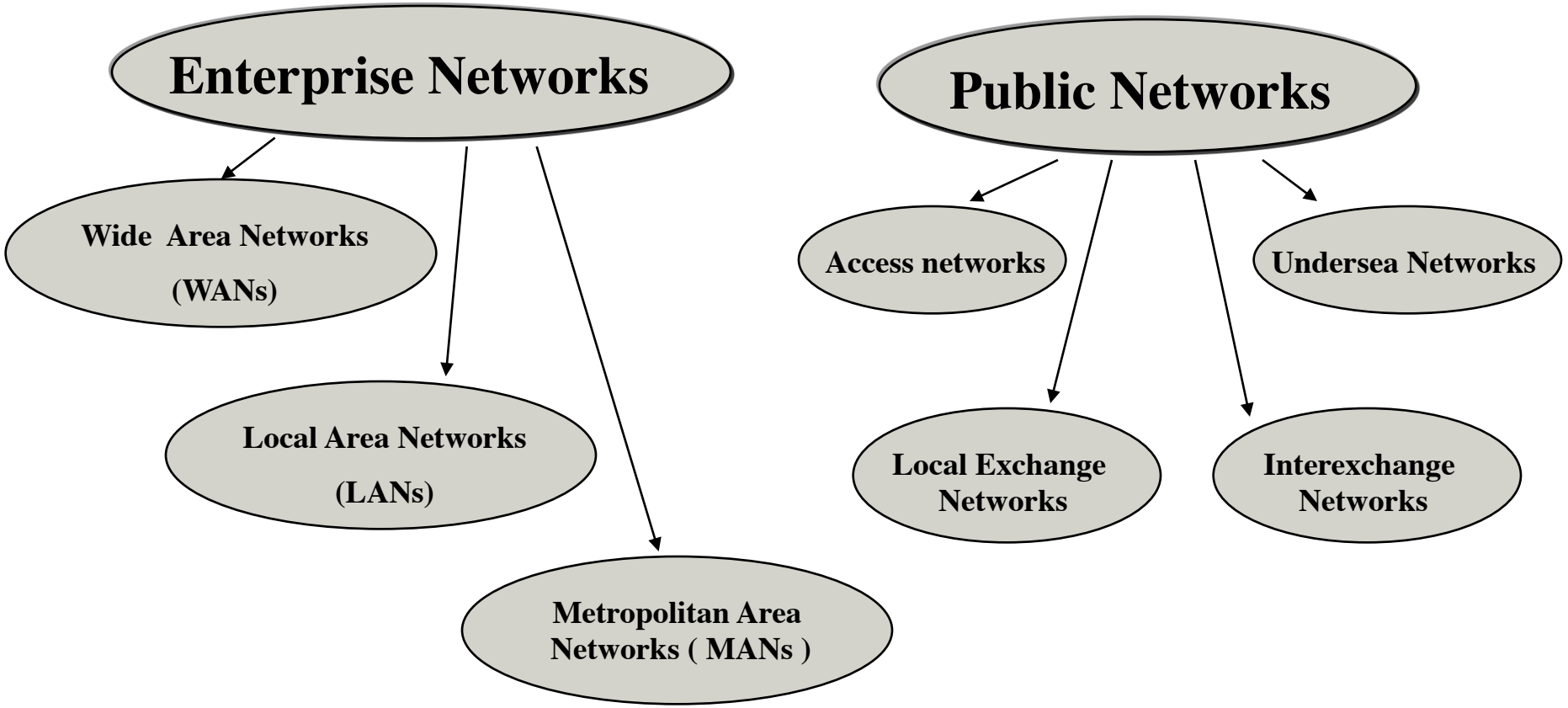
Capacity Limits of Optical Fiber Networks, René-Jean Essiambre et. al., JOURNAL OF LIGHTWAVE TECHNOLOGY, VOL. 28, NO. 4, FEBRUARY 15, 2010

Carbon Footprint Contributions of Information Technologies

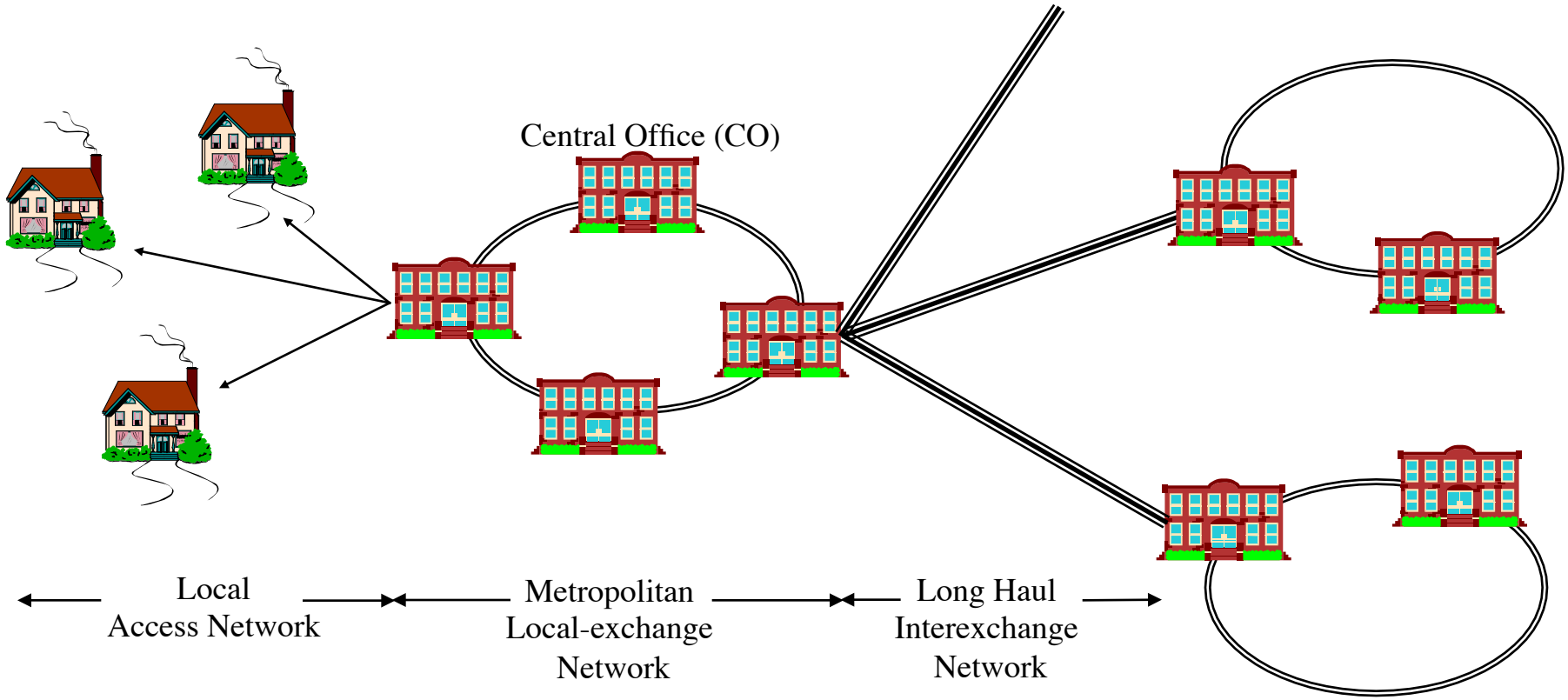




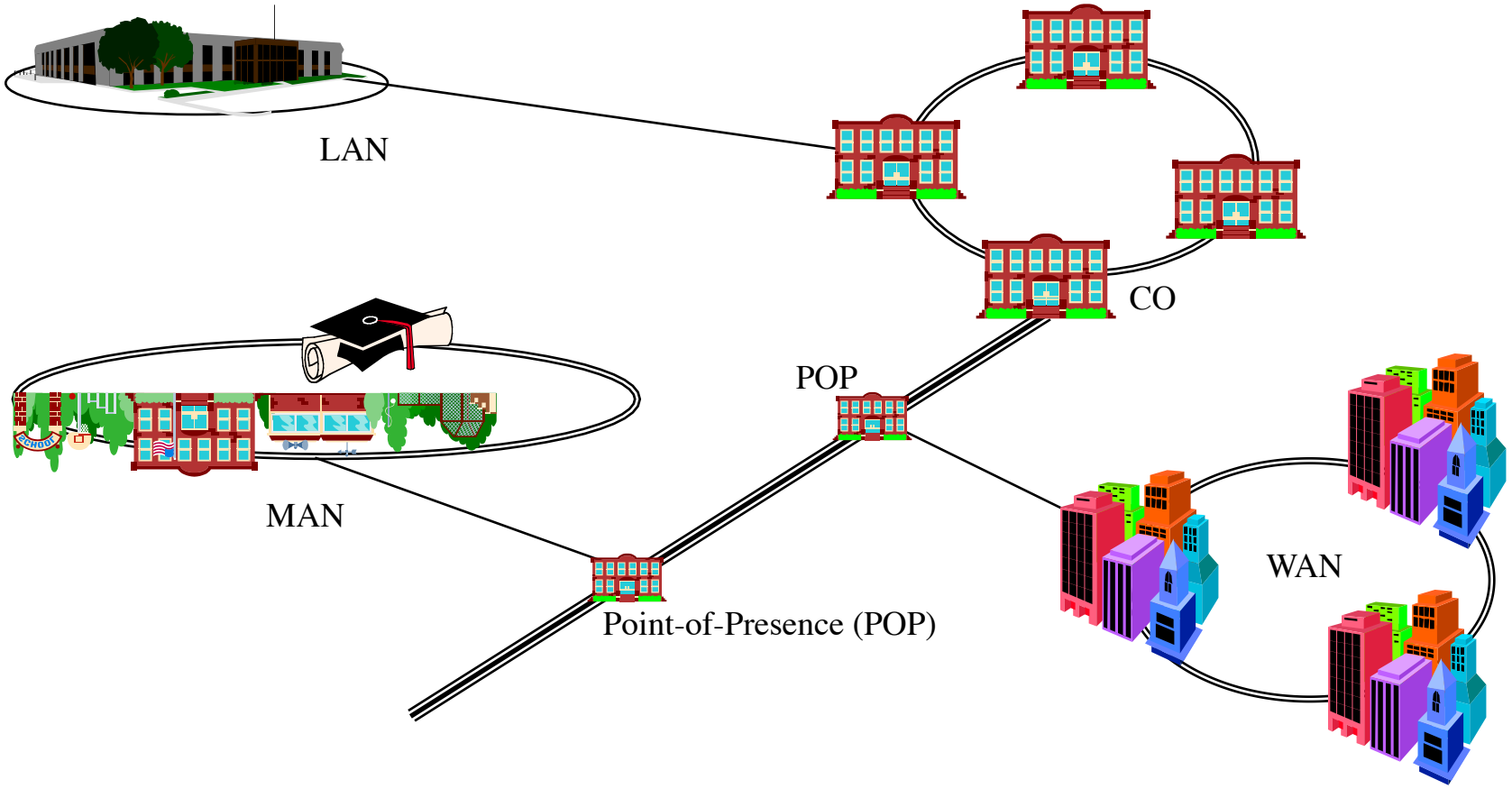
Network Classification



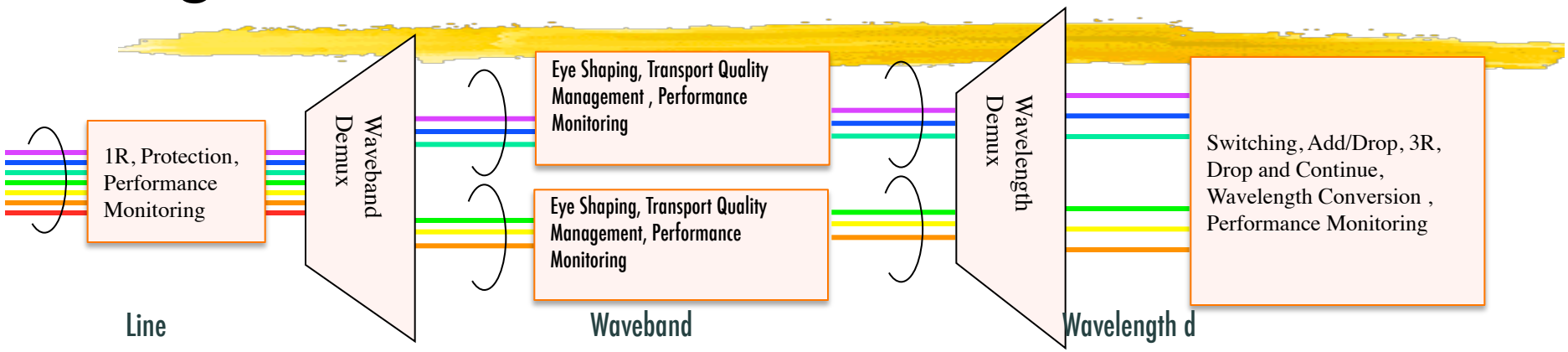
Public Networks



Enterprise Networks



Granularity Driven Function and Node Design



	Line	Waveband	Wavelength
Amplification (1R)	*		
Eye Shaping		*	
Routing/Connectivity/Blocking			*
Switching			*
3R			*
Transport quality management		*	*
Muxing	*	*	*
Service Level			*
Performance Monitoring	*	*	*
Resiliance	*	*	*

Evolution of Fiber-Optic Point-to-Point Transmission