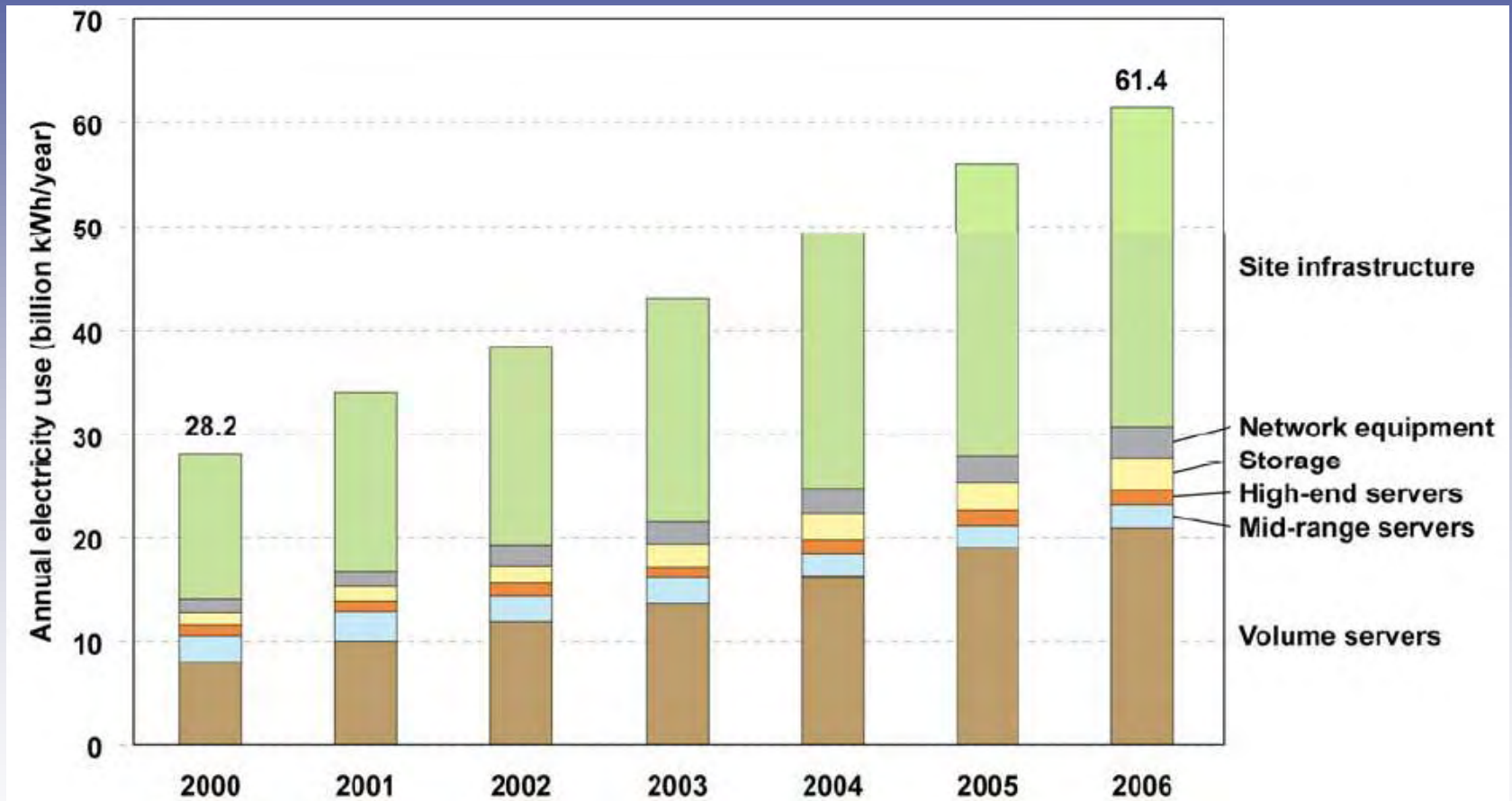


ITU – IEEE – OIF Improved Energy Efficiency of Very High Speed Networking

Francesco Caggioni



Datacenter Energy Usage

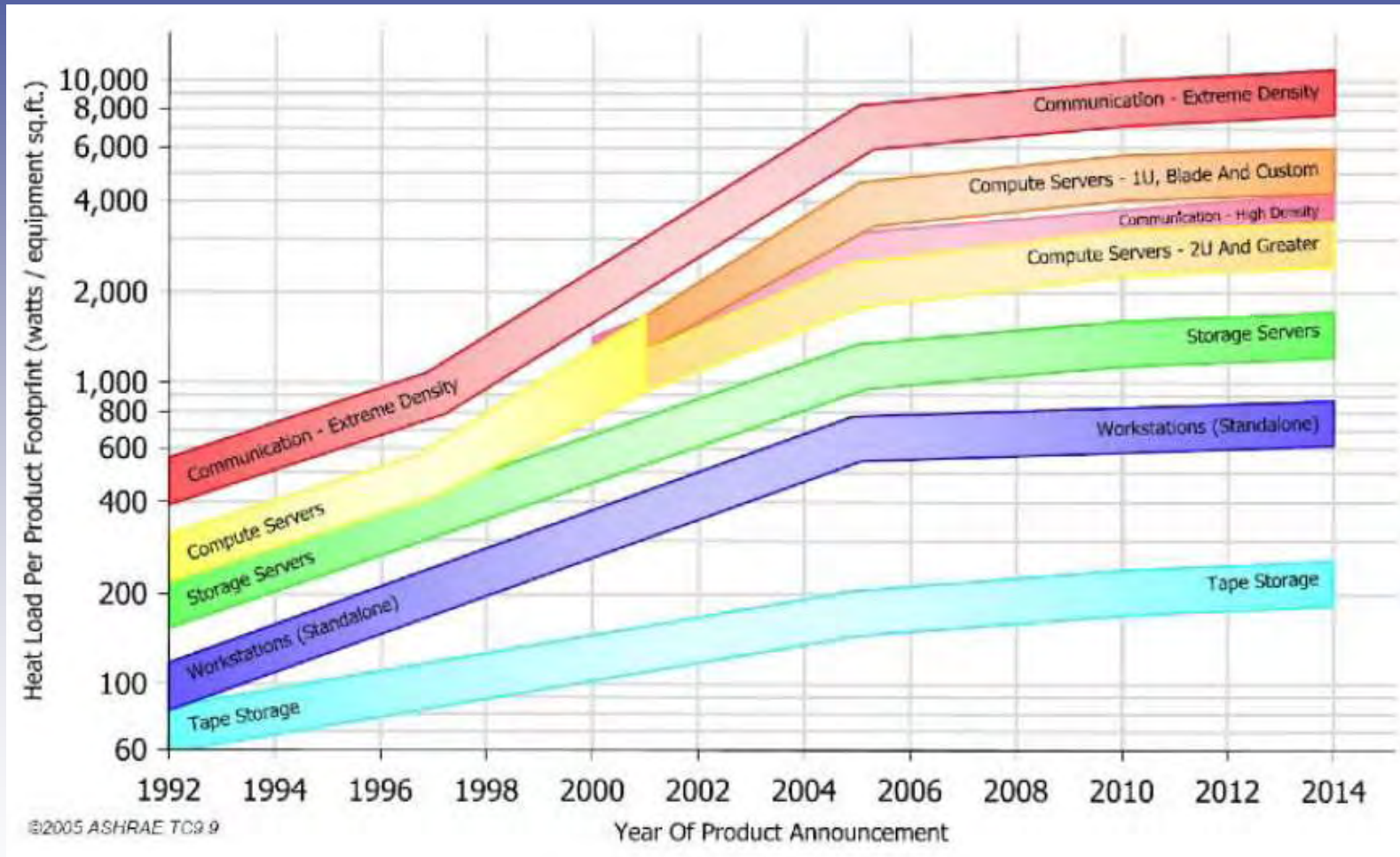


Source: EPA

Is Energy Efficiency important in Networking?

- Networking accounts for only 5% of Datacenter Energy Usage.
- In 2006 that was 3 billions kW/h or the equivalent of more than 1Mil House-holds.
- For every Watt used by equipment in Datacenter, another Watt gets used to get rid of heat produced.

Equipment Power Density

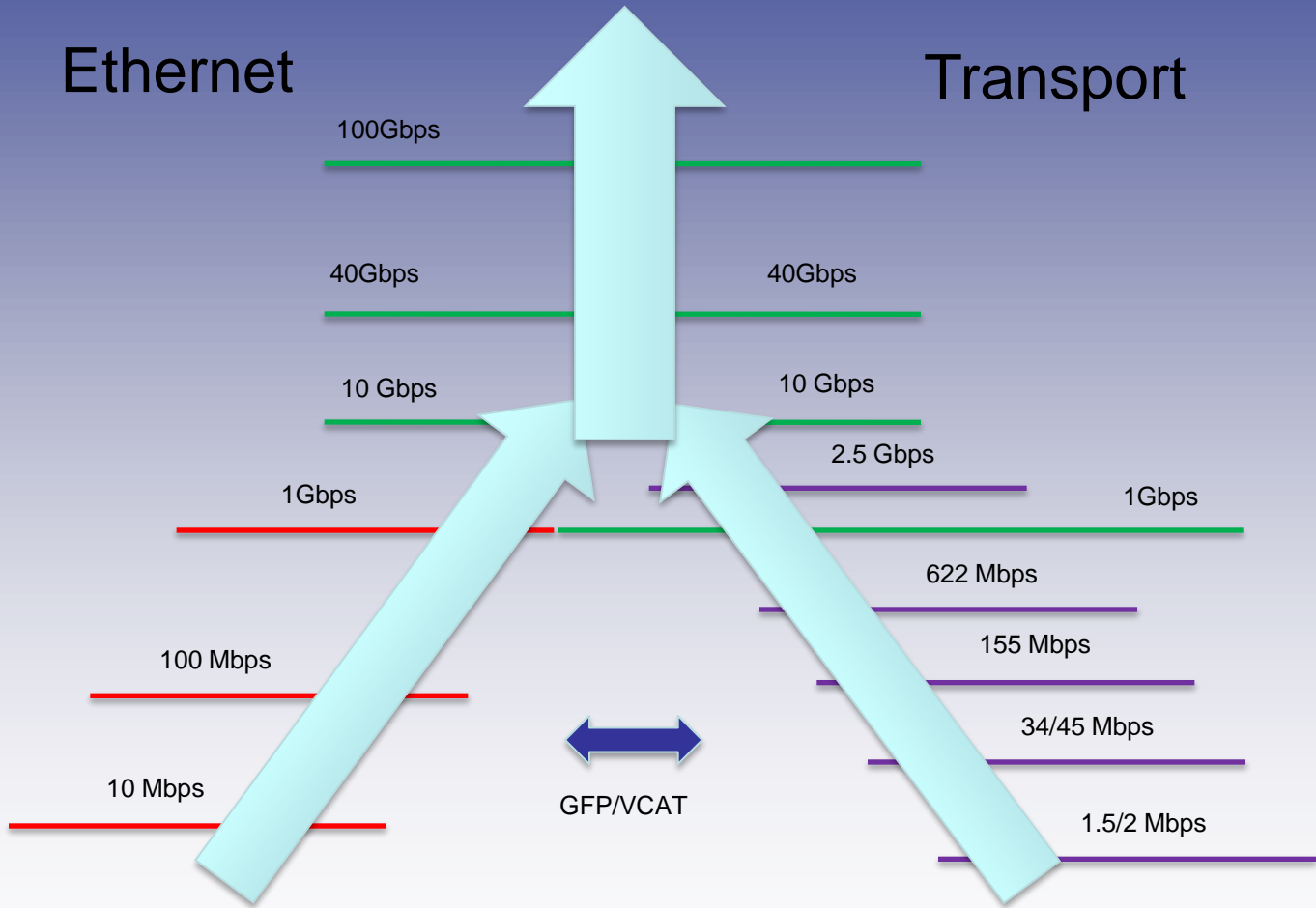


Spectral
Efficiency



Energy Efficiency

Convergence



Scalable/Adaptable

Physical Layer Technology Evolution Independent



Multi Lane Distribution (PCS)

ITU G.709 OTN

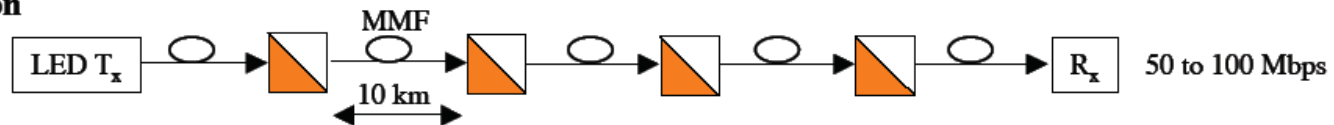
Optimized for Transport of Ethernet
Reuses Components from Ethernet World
Reliable Communication



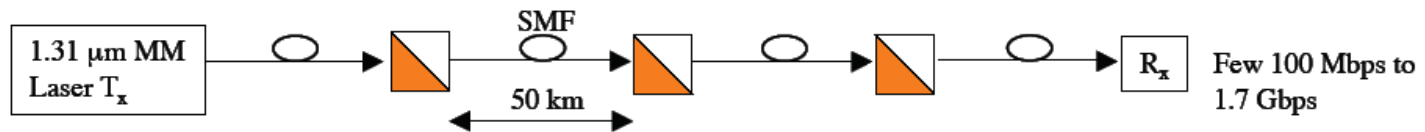
Multi Lane Distribution – OTN
Mandatory FEC
1 Gbps Ethernet Transport

Evolution of Optical Transport Networks

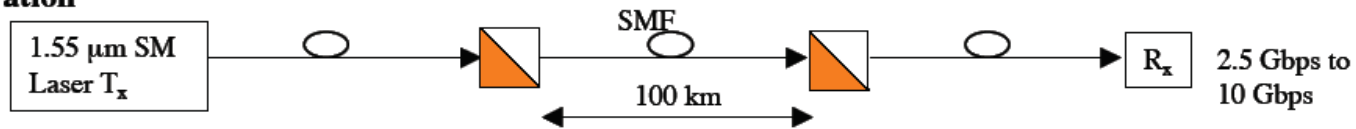
1st Generation



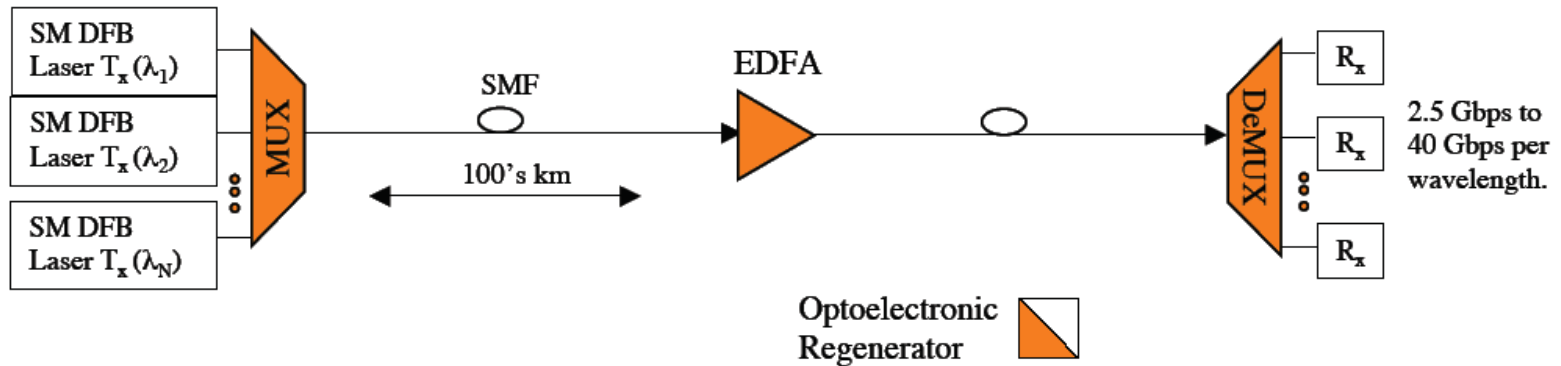
2nd Generation



3rd Generation



4th Generation



Optical Technology Evolution & Revolution

Tomorrow



Modulation



Polarization Mux



Coherent Receiver



Multiple Carriers



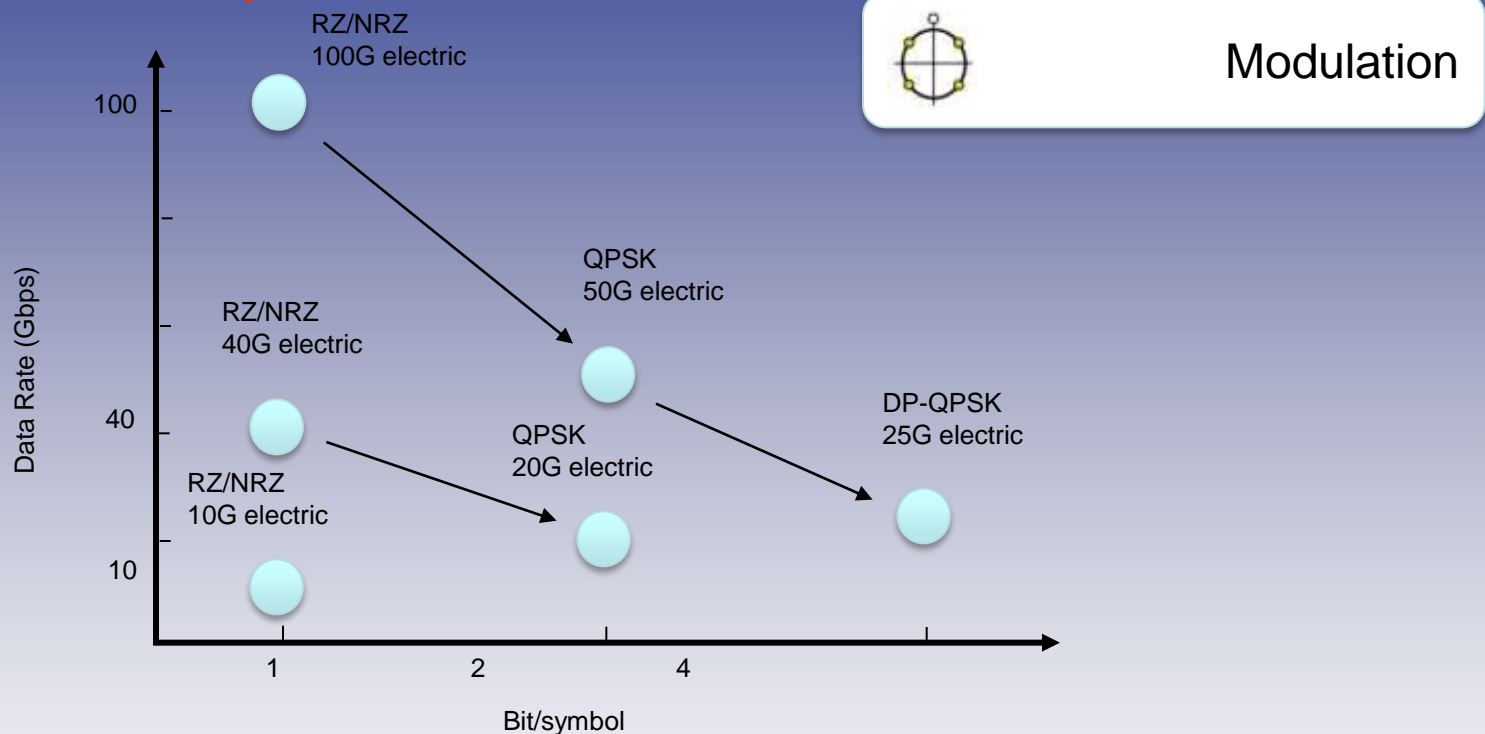
Digital Equalization



Forward Error Correction

Yesterday

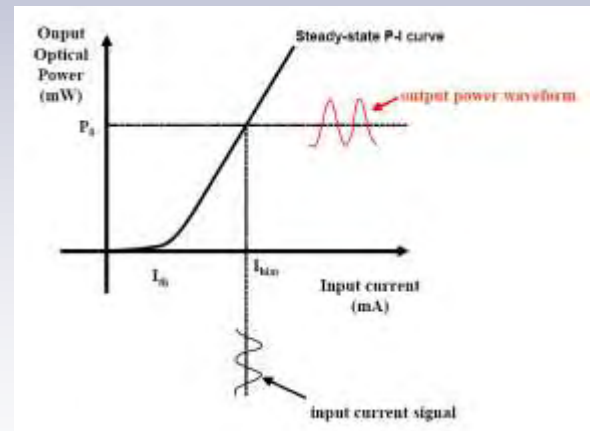
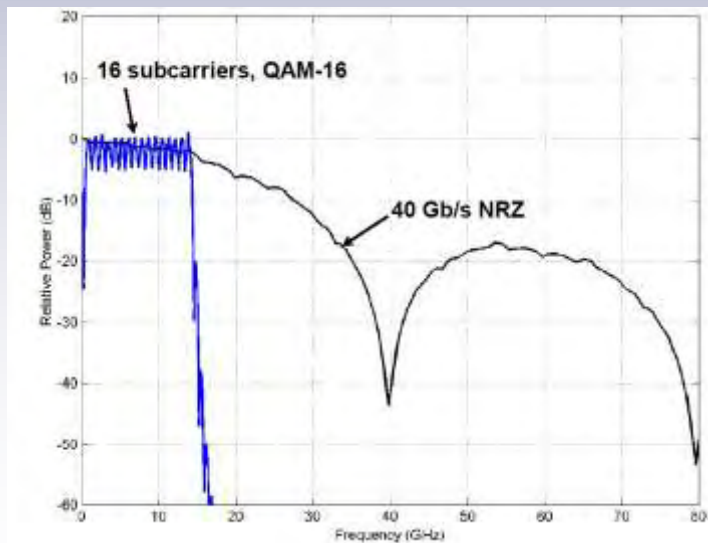
Modulation formats for long haul transport



- Long haul transport of 100G serial will require multi-level modulation (X bits per symbol) to run over existing long-haul networks

Multiple carriers - OFDM

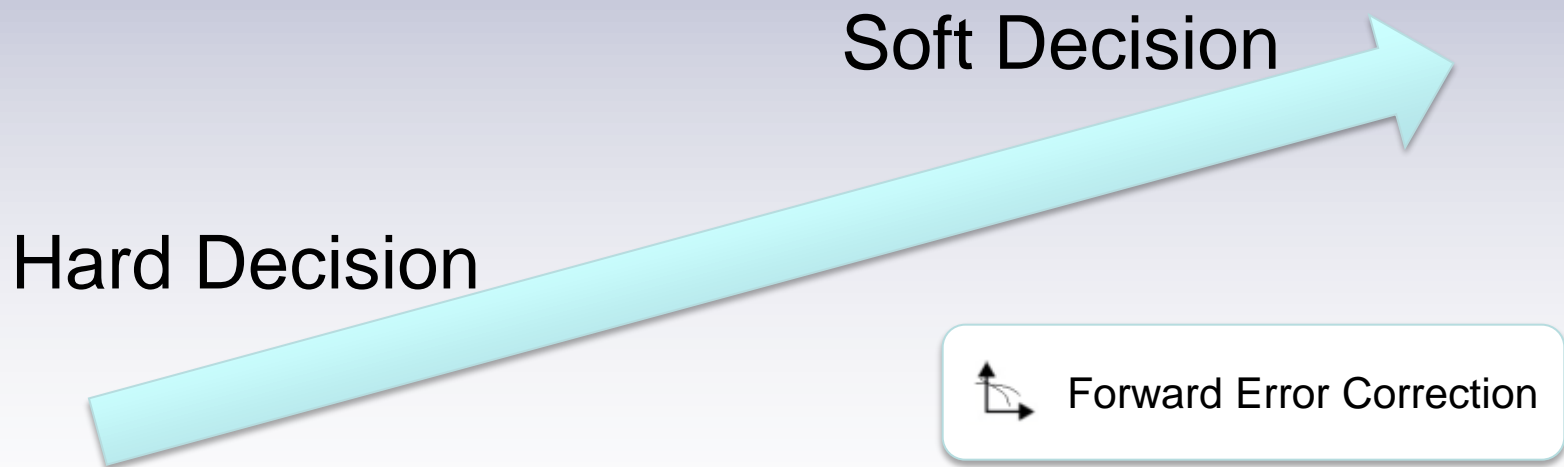
- Orthogonal Frequency Division Multiplexing (OFDM) in the optical layer is at its infancy but it has a proven feasibility and high spectral density in well-known applications such as wireless LAN and digital video broadcasting.
- The challenge is to scale the DSP intensive calculations at high rates as well as getting RF signal into the optical domain cost effectively.



Multiple Carriers

Forward Error Correction

- Forward error correction (FEC) is a system of error control for data transmission, whereby the sender adds redundant data to its messages. This was the BIG addition from Sonet/SDH to OTN. This allows the receiver to detect and correct errors (within some bound) without the need to ask the sender for additional data.



CONCLUSIONS

- Convergence of Datacom and Telecom is really happening.
- Real challenges are ahead of us to continue serving the growing demand of Information Exchange.
- Complexity is increasing (and so will reward) in both Optical and Electronic domain.
- Higher Spectral Efficiency Increases Energy Efficiency of the network.