The Internet of Things and Its Impact on The Physical Layer

Presented by:
Maurice F. Zetena III
Vice President Data Center Technology
Leviton Manufacturing

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The Internet

- The Internet is a global wide area network that connects computer systems across the world. It includes several high-bandwidth data lines that comprise the Internet "backbone." These lines are connected to major Internet hubs that distribute data to other locations, such as web servers and ISPs.

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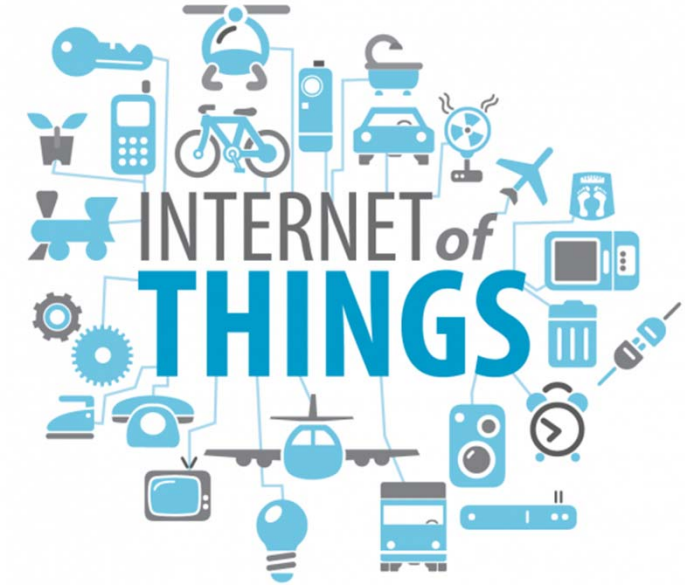
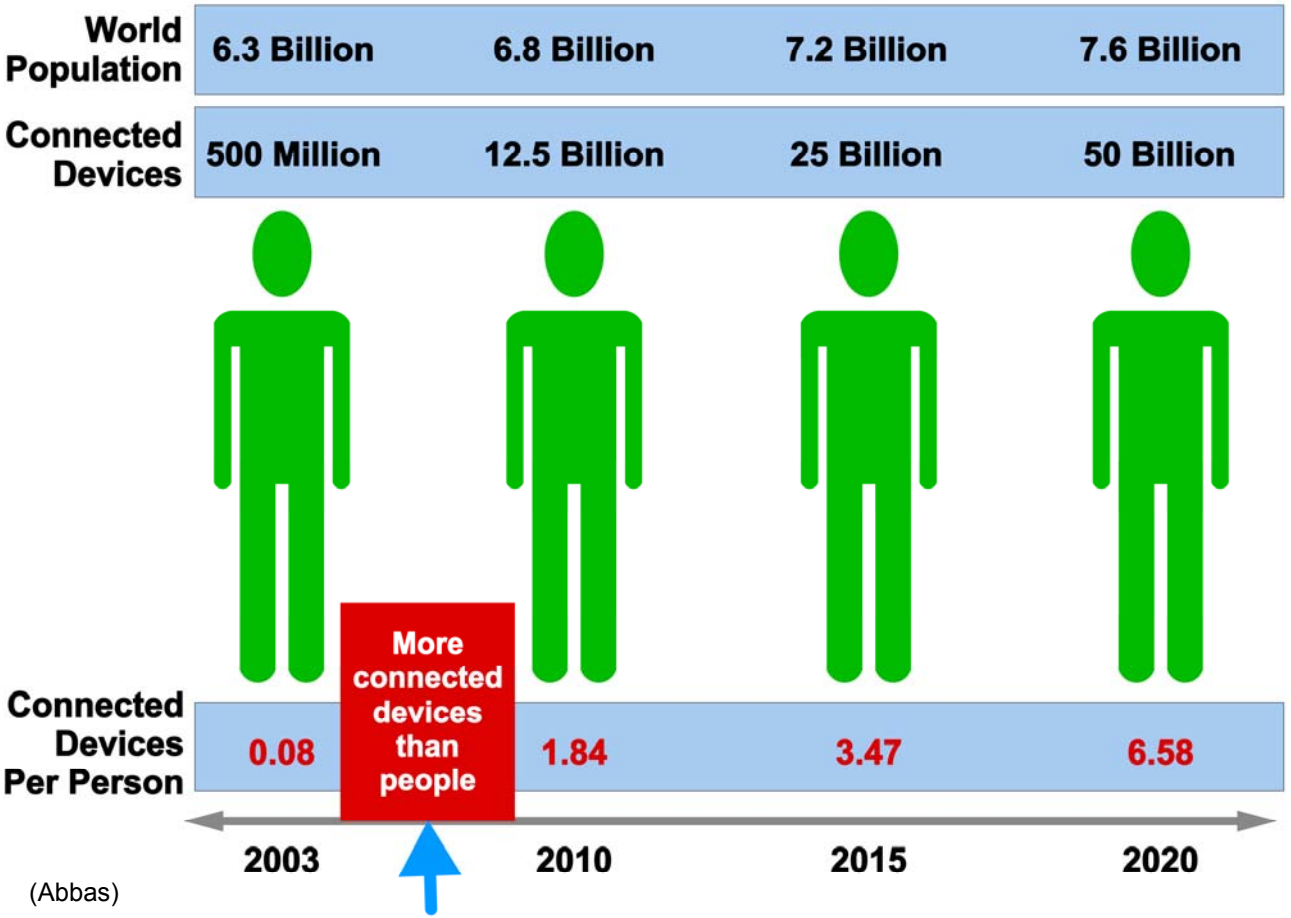
The Internet of Things

- The Internet of Things, commonly abbreviated "IoT," is an umbrella term that refers to anything connected to the Internet. It includes traditional computing devices, such as laptops, tablets, and smartphones, but also includes a growing list of other devices that have recently become Internet enabled. Examples include home appliances, automobiles, wearable electronics, security cameras, and many other things.



The Internet of Things

- Economic impact estimated at $7.1 trillion globally (2020).



(Abbas)

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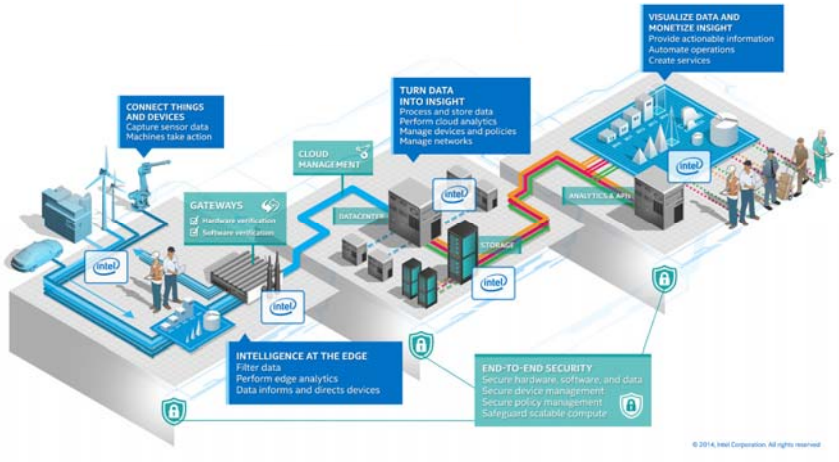
The Internet of Things

- This increase in IoT device usage means:
  - The need for broadband access will be greater than ever.
  - Businesses must have access to broadband networks.
  - Investment in broadband infrastructure to support speed and data demands will be extremely important for these IoT ecosystems to function properly.



(Intel)

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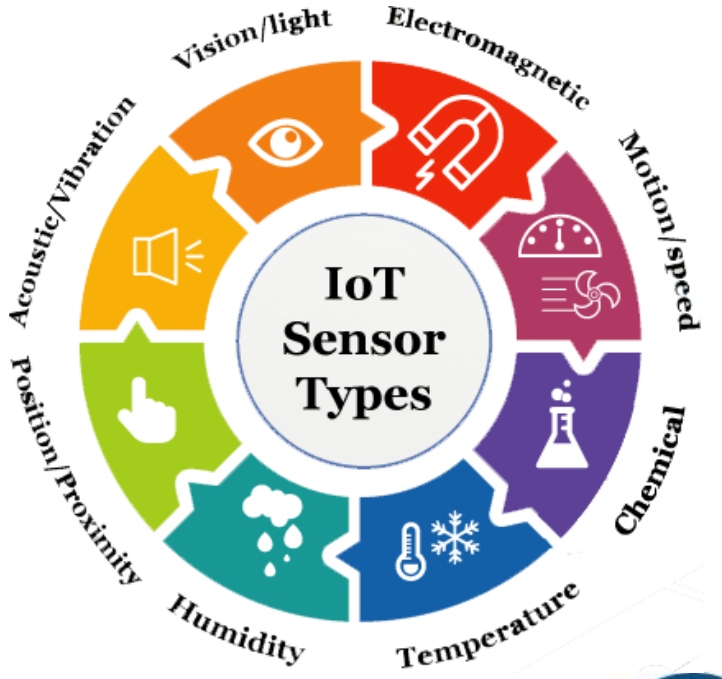
IoT Drivers

- The Internet of Things continues to drive innovation and conversely technology innovations continue to drive the IoT
  - Connected Device Development
  - M2M Development
  - Cloud Computing
  - IPv6
  - Sensors
  - Analytics as a Service



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IoT In The Data Center

- The advent of the IoT and its associated data processing requirements present challenging issues within the Data Center and the physical layer.
- As the IoT continues to evolve, these challenges will continue to increase.
- The IoT generates a huge amount of East-West traffic.
- East-West traffic with the Data Center now accounts for approximately 80% of all data flow.

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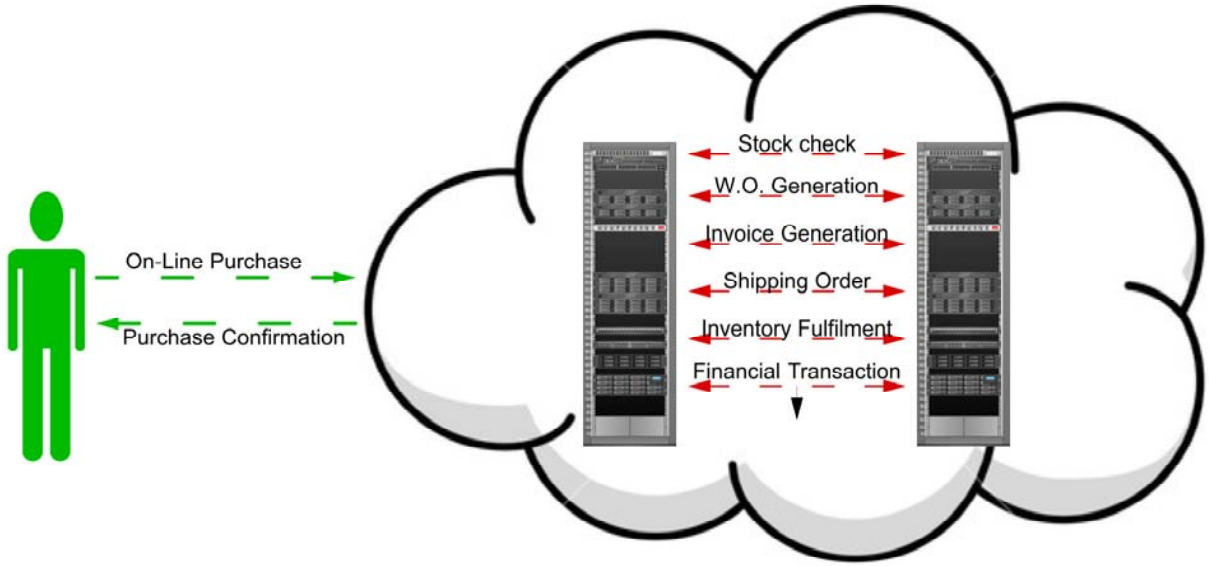
IoT In The Data Center

- The total volume of data generated by IoT will reach 600 ZB per year by 2020, 275 times higher than projected traffic going from data centers to end users/devices (2.2 ZB); 39 times higher than total projected data center traffic (15.3 ZB).



Forbes

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The Transforming Data Center

- We are beginning to see large amounts of consolidation with the Data Center market place.
- Economies of scale provided by very large players, such as AWS, IBM, Google, Microsoft provide efficiencies not available to smaller players.
- Hyperscale Data Centers provide huge advantages such as provisioning not available in smaller centers.
- Oracle co-chief executive Mark Hurd has said he expects 80% of corporate data centers to disappear by 2025.

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The Disaggregated Data Center

- Disaggregated refers to separating compute, storage, networking, and power distribution resources into modules housed in the rack. Traditionally, a server within a rack would each have its own group of resources. When disaggregated, resource types can be grouped together and distributed throughout the rack, improving upgradability, flexibility and reliability while lowering costs.
- Commercial application of this technology is largely based on Intel's Silicon Photonic developments.
- Product development currently includes both active and passive component companies.

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The Disaggregated Data Center

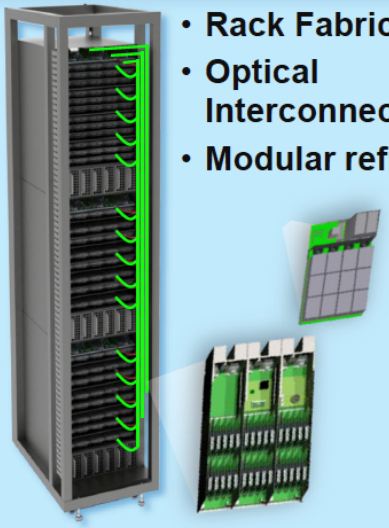
Today

Physical Aggregation

- Shared Power
- Shared Cooling
- Rack Management

Emerging

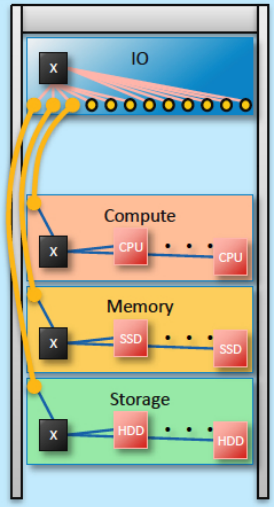
Fabric Integration



- Rack Fabric
- Optical Interconnects
- Modular refresh

Future

Subsystem Aggregation



- Pooled compute
- Pooled storage
- Pooled memory
- Shared boot

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The Disaggregated Data Center

- Today – “Box” servers represent islands of capacity including Power, Cooling, Processor, Storage etc.
- Future – Pooled resources will present as subsystems specific to Processor, Storage, etc.
- Pooled resources are NOT dedicated and can be provisioned as required for the specific task
- Enable End user innovation – *The user will logically assemble physical machines as requirements dictate: Scaling on demand, Purpose built machine, Increase in density.*

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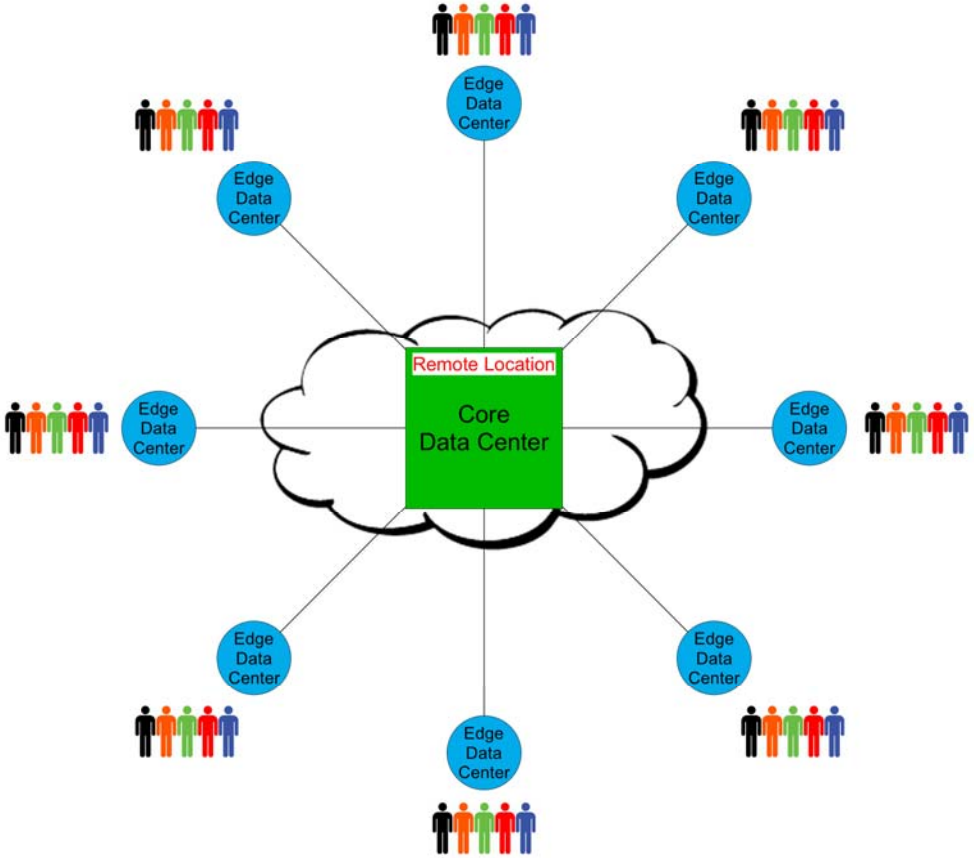
The Edge Data Center

- The Edge Dat : is physically located in clos
- The term “Edg nue to change with technology an
- Use of an Edg ost of bandwidth.
- The IoT and E ications of Micro Data Centers.
- Data is Proces transmitted to the core



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Micro Data Center

- Increasing data volumes and latency “sensitivity” will give rise to micro data centers (<150kW) that will serve as the initial point of interaction with “end users”.
- In this role they will function as screening and filtering agents for edge facilities to move information to and from a localized area. More specifically they will determine what data or “requests” are passed on to data centers above them in the hierarchy and also deliver “top level” (most common) content directly to end users themselves.
- The primary impact of this “localization” of delivery will be levels of latency below what is currently achievable.

Micro Data Center

- Micro data centers are the granular-level or rack-level configuration of data centers.
- Offered as plug and play units with all the components and devices of a traditional data center:
  - Compact facility with on board cooling
  - Telecommunication and storage systems
  - Security
  - Fire suppression
  - Uninterrupted Power Supply (UPS)

Micro Data Center

- Micro data centers can be deployed outdoors / indoors and in rugged terrains including oil platforms and shipboard.
- The micro data center is a micro modular design that helps to minimize the physical footprint and energy consumed by the brick and mortar model.

Huawei Micro DC

WBMMF (OM5): Overview

- Wideband Multimode fiber (WBMMF) is a Fiber Optic standard that has been developed by ANSI/TIA as a response to escalating data rates seen in environments such as Data Centers and now known as OM5.
- The OM5 Standard was approved and published in June 2016 as the ANSI/TIA-492AAAE standard.
- This fiber optic standard was developed to address the requirements of SWDM Technology by optimizing multiple frequency ”channels” within the glass.

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WBMMF (OM5): Overview

- TIA-492AAAE specifies the raw glass fiber performance.
- ISO/IEC OM5 and TIA 568.3D specify the cabled fiber performance containing WBMMF.
- Wideband multimode fiber can support:
  - Wavelength division multiplexing (WDM) across the 840 – 953nm wavelength range
  - Backward compatible with OM4 multimode fiber at 850nm

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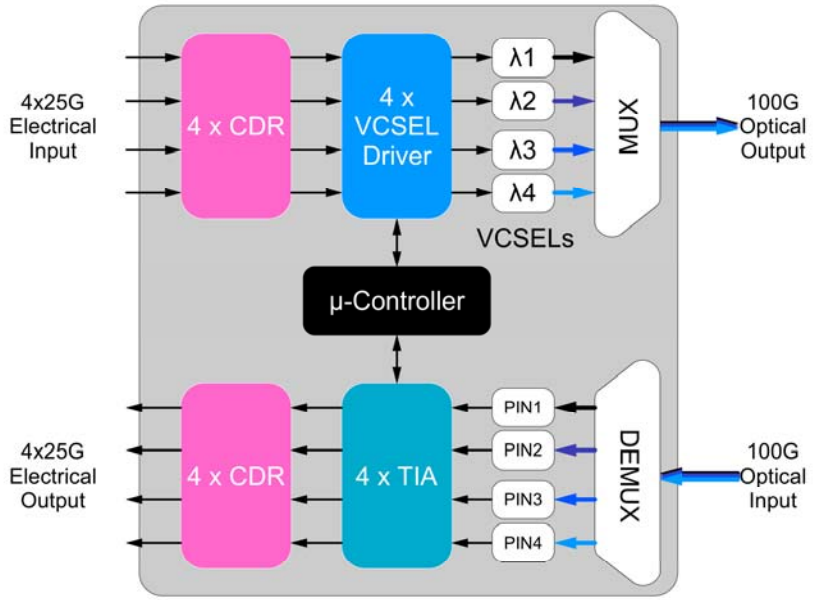
SWDM: Overview

- Shortwave wavelength division multiplexing (SWDM) is a technology that uses multiple VCSELs operating at different wavelengths (λ lambda).

- SWDM4 transceivers using LC duplex connectors multiplex and de-multiplex the signal to allow implementing 2 cores to provide 40G (4λx10G) or 100G (4λx25G) data in a single module.



SWDM

WBMMF (OM5): Overview

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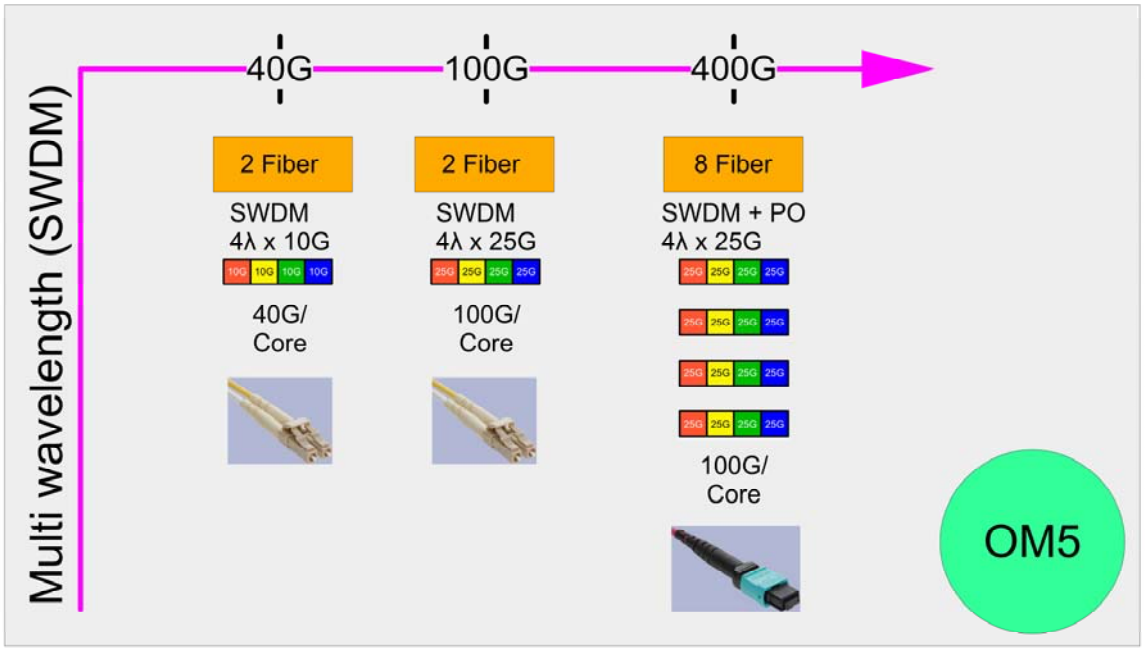
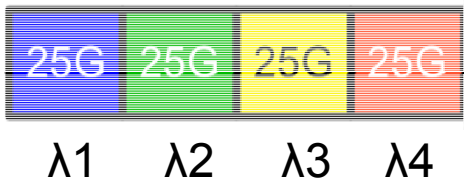
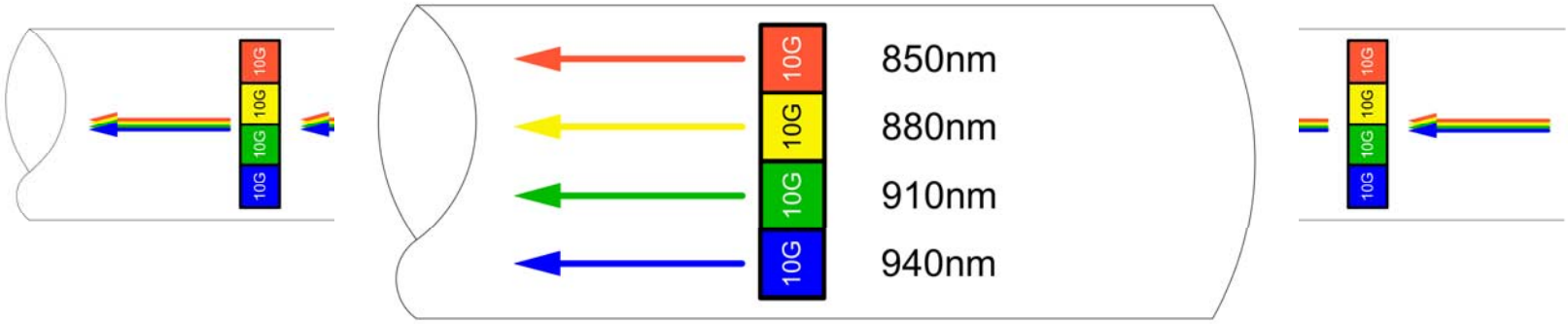




WBMMF (OM5): Overview

- SWDM utilizes a single Multimode fiber core to transmit 4 different wavelengths
- Potential wavelength grids are defined as 850nm (λ_1), 880nm (λ_2), 910nm (λ_3) and 940nm (λ_4), with a spacing of 30nm

Simplified Example of a 40G Fiber Core utilizing SWDM



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Technology: OM4 vs OM5

- When implementing Parallel Optics, OM5 offers little advantage over OM4
- OM5 Advantages are mainly tied to SWDM usage

Fiber cable type ISO/IEC 11801	Glass fiber specification TIA-492AAAx
OM1	TIA-492AAAA
OM2	TIA-492AAAB
OM3	TIA-492AAAC
OM4	TIA-492AAAD
OM5	TIA-492AAAE (WBMMF)

Fiber cable type ISO/IEC 11801	Glass fiber specification TIA-492AAAx	Core diameters (µm)	IEEE 802.3 link distance					IEEE 802.3 link distance		
			1000-SR	10G-SR	40G-SR4 & 100G-SR10	100G-SR4 & 400G-SR16	50G-SR & 200G-SR4*	40G-SR4 & 100G-SR10	100G-SR4 & 400G-SR16	50G-SR & 200G-SR4*
OM1	TIA-492AAAA	62.5	275m	33m						
OM2	TIA-492AAAB	50	550m	82m				100m	70m	70m
OM3	TIA-492AAAC	50		300m	~~100m~~	~~70m~~	70m	150m	100m	100m
OM4	TIA-492AAAD	50		400m	150m	100m	100m	150m	100m	100m
OM5	TIA-492AAAE (WBMMF)	50	no spec	400m	150m	100m	100m			

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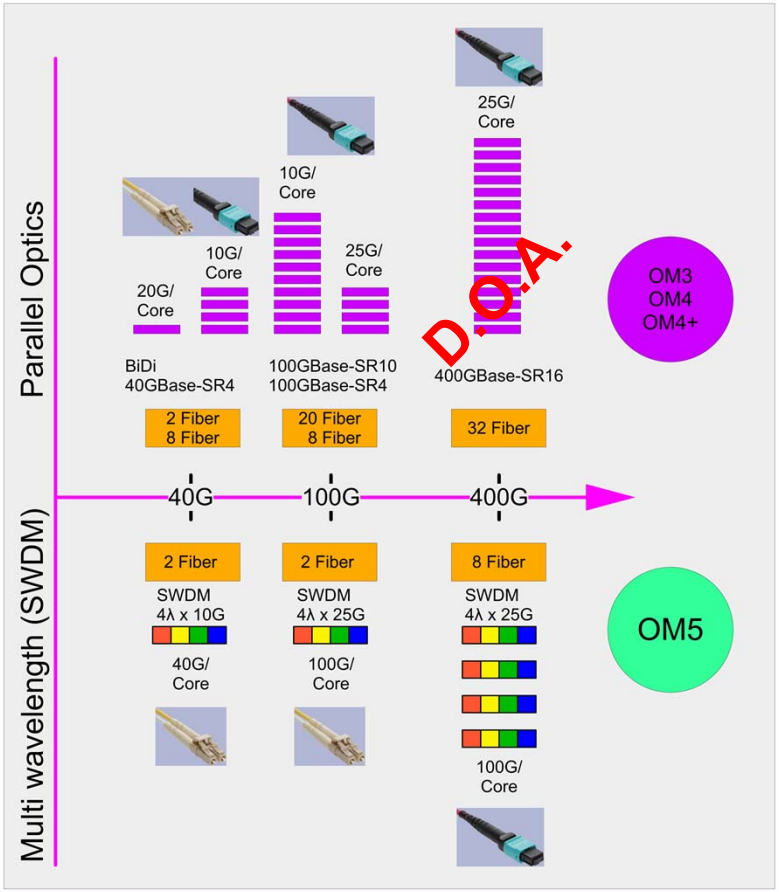
Decision Drivers



- Points: Parallel Optics:
  - OM3 & OM4 compatible
  - Allows for Break-out of ports
    - 40G ports Break-out (4 x 10G channels)
    - Next Server speed increase will be to 25G – 100GBase-SR4 (4 x 25G channels)
  - Acceptable number of cores
  - 8 Cores for 100G
  - Lower cost
- Points: SWDM:
  - OM5 required
  - Break-out of ports not available
  - Over 100G may require MPO
  - SWDM + Parallel = MPO
  - 8 Cores for 400G
  - Increased Cost

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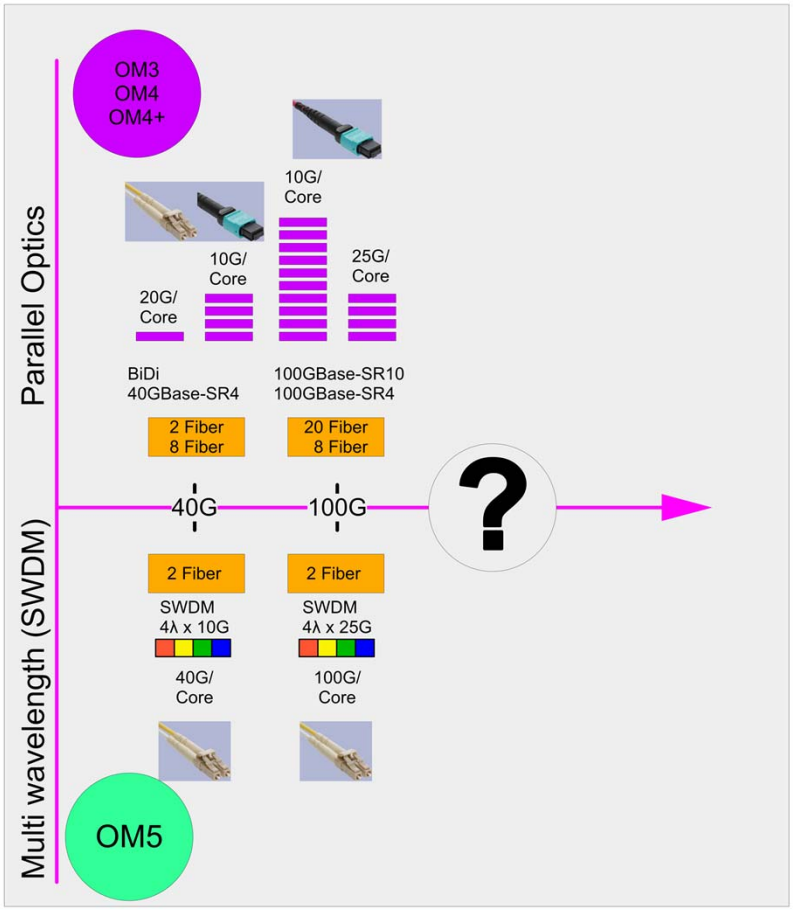
A Case for Single Mode



- After 100G the choice of media becomes less clear when looking at available Fiber Optic media choices including Multimode vs. Single Mode
- Single Mode allows very high bandwidth to be implemented
- Single Mode infrastructure is less expensive than Multimode
- Single Mode transceiver cost is decreasing
- Future standards for high bandwidth SWDM are not fully defined

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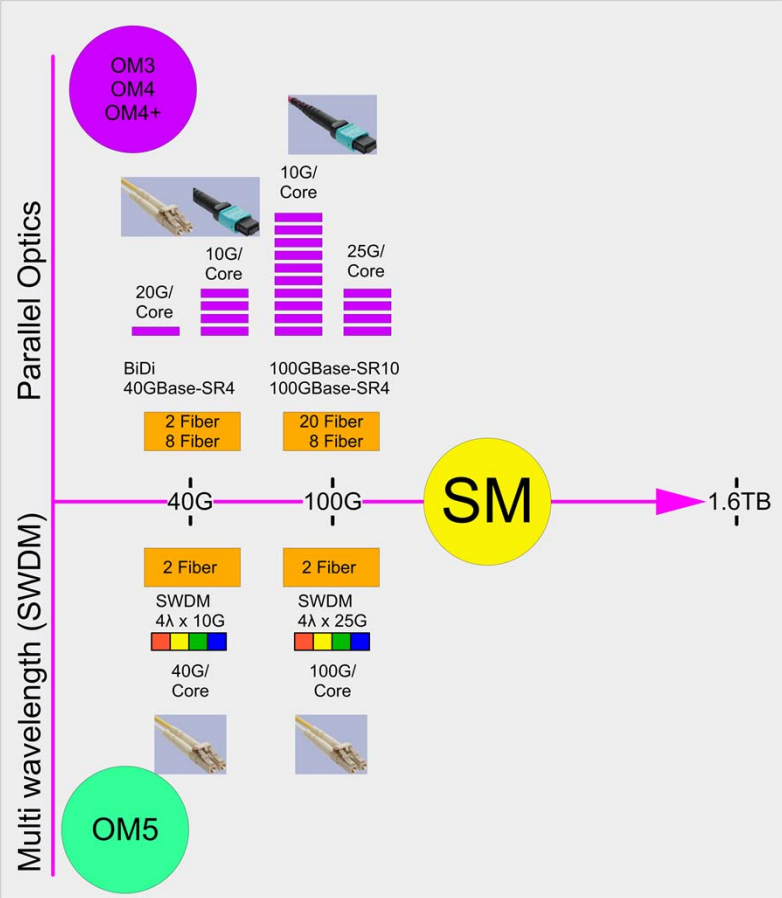
A Case for Single Mode



- Single Mode may represent the most efficient migration strategy after the 100G threshold.
- Single Mode will allow very high bandwidth applications and migration.
- Many Hyper-Scale Data Centers are currently implementing Single Mode infrastructure.
- OM5 represents advantages when utilized in an SWDM environment.
- OM4 can be utilized with SWDM
- Unless implementing SWDM, Parallel Optics & OM4 to SM migration strategy may represent most efficient migration path.

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OM5: Is It The Right Choice?

- Physical layer medium choices are no longer agnostic to technology.
- WBMMF fiber market pricing is estimated to be 2.5x OM3 and 2x OM4
- OM5 (WBMMF) greatest advantage is when coupled with SWDM technology implementation.
- Without SWDM usage OM5 implementation offers very limited advantages over OM4.
- 40G SWDM4 transceiver market pricing is expected to the be same as 40G-Bidi (duplex MMF solution)
- 40G SWDM4 reach:
  - 40G solution has a demonstrated reach of 300 meters on OM3 fiber and 400 meters on OM4 fiber.
  - With long reaches on standard OM3/OM4…little justification to need WBMMF
  - Data Center applications over 300/400 meters will likely go with single mode fiber

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Conclusion

- **The Internet of Things is still evolving, and while there is currently some ideas as to how it will be implemented and further developed, it's possible that it may evolve into something beyond our imagination. The forces driving IoT growth and development have the potential to move it in many varied directions.**

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Questions?

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