

# **Intel Light Peak Technology Overview**

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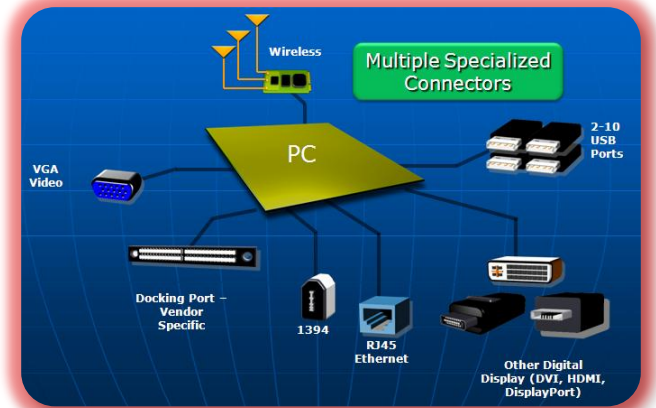
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# Outline

- Intel's vision for Light Peak
  - I/O challenges
  - Key benefits
  - Usage models
- Light Peak technology overview
  - Protocol architecture
  - Light Peak controller
  - Light Peak platforms
- Light Peak research in Intel Labs
  - Direct networks
- Summary

# Today's I/O Challenges

- Continued demand for more bandwidth
- Desire for more flexible designs, thinner form factors and new usage models
  - Too many different cables and connectors
- Demand for simplified connectivity



# Intel's Vision for Light Peak

- Create a cost effective, scalable, high speed I/O interconnect
  - Scalable bandwidth, cost, power for broad use for 10+ years
  - Wide range of devices (handhelds, laptops, PCs, CE, & more)
- Enable new innovative architectures
  - Support multiple protocols simultaneously
  - Balanced platform where external I/O bandwidths keep up with internal interconnects
- Key benefits
  - Bandwidth scaling from 10 Gb/s to higher speeds over the next decade
  - Single, flexible cable that can carry several I/O protocols
  - Economies of scale from a single solution

# Usage Models Summary

## Driving Innovation in four Focus Areas



### **Flexible System Designs *and* Thinner Form Factors**

More flexibility and choice for notebooks and all-in-one *I/O expansion* at home or office  
*Extended graphics* in dock or display for higher performance at home or office



### **Media Connectivity & Creation**

Create broadcast quality media by connecting *high bandwidth* and low latency AV devices to your mobile and DT PC, with accurate time sync for real-time processing



### **Faster, More Efficient Media Transfer**

Less waiting to sync or transfer during media creation & consumption (higher BW)  
Low overhead reduces system power and provides better multi-tasking while editing



### **Cable Simplification**

Simplify connections across PC, CE, and phone devices

# Usage Models Explained (1)

## Fastest External Storage



### Flash Trends

~2011	~2015
Read: 4.5Gbs	Read: 10Gbs
Write: 4.5Gbs	Write: 10Gbs

- Sync between PC and external storage
- One thin cable with small connector
- Headroom for future bandwidth scaling

## I/O Partitioning

Display



USB Ports  
Camera  
Microphone  
Touch Screen  
Flash Card Bay  
External Storage

Dock



Power Brick



- I/O expansion for home and office
  - Many I/O, display and storage connections
- Reduces cable confusion

# Usage Models Explained (2)

## Media Creation

Pro  
Monitors



Storage  
Arrays



Digital  
Cameras



DSLR  
Cameras



Video  
Capture

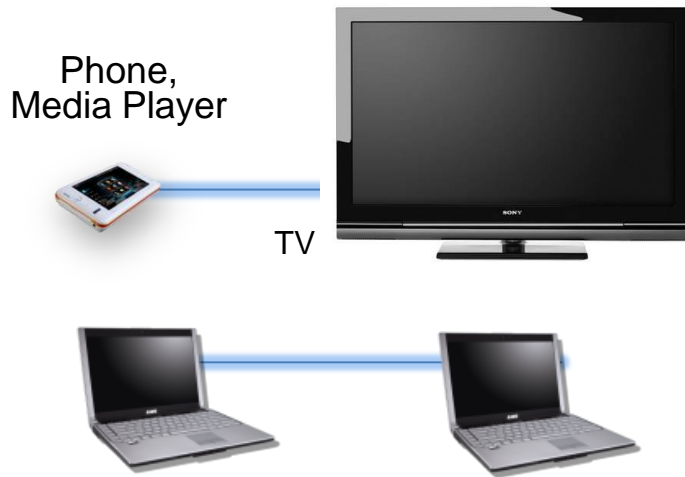


- Capture, mix, and process uncompressed HD, 2K/4K, and 3D video
- Create music on your PC that feels and sounds like it was recorded on vintage hardware
- More AV I/O, DSP headroom, and storage performance
- No RFI or ground loops
- Lowest latency
- Accurate time synchronization

Create  
broadcast  
quality media  
on a PC

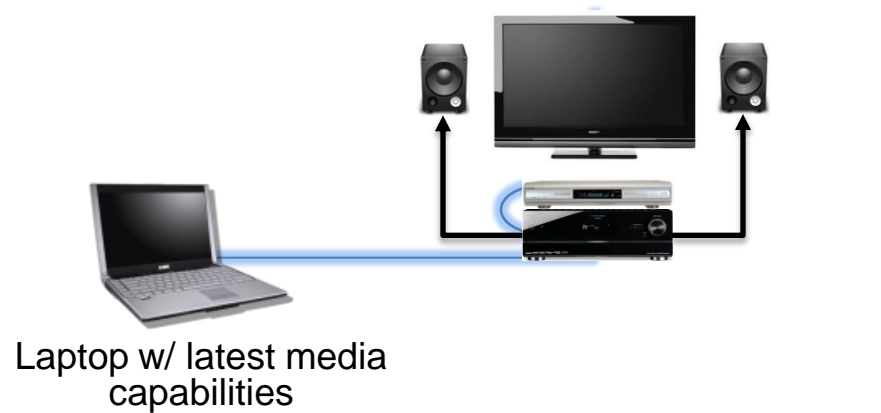
# Usage Models Explained (3)

## Peer-to-Peer



- Many connected computing devices
  - Not hub and spoke
  - More symmetric vs. asymmetric
- Enables device-device connectivity
- Enables PC-PC connectivity

## Simplified Connectivity



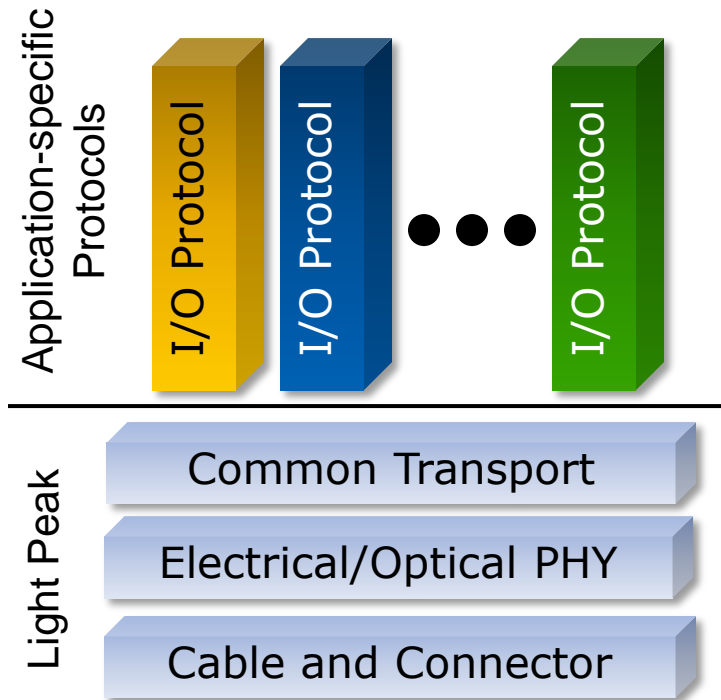
- Play the latest media from your laptop to TV
- High data rate video capture from integrated camera
- Single, thin cable to TV from entertainment center



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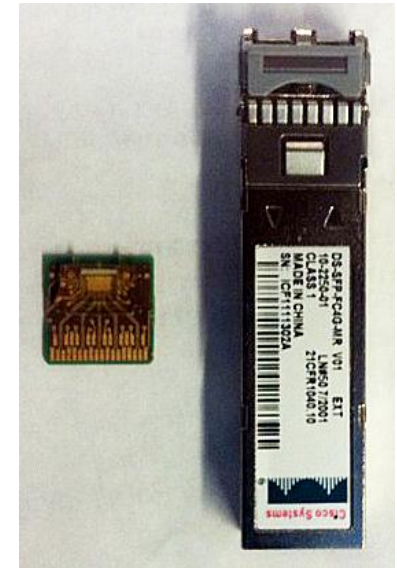
# Architecture at a Glance



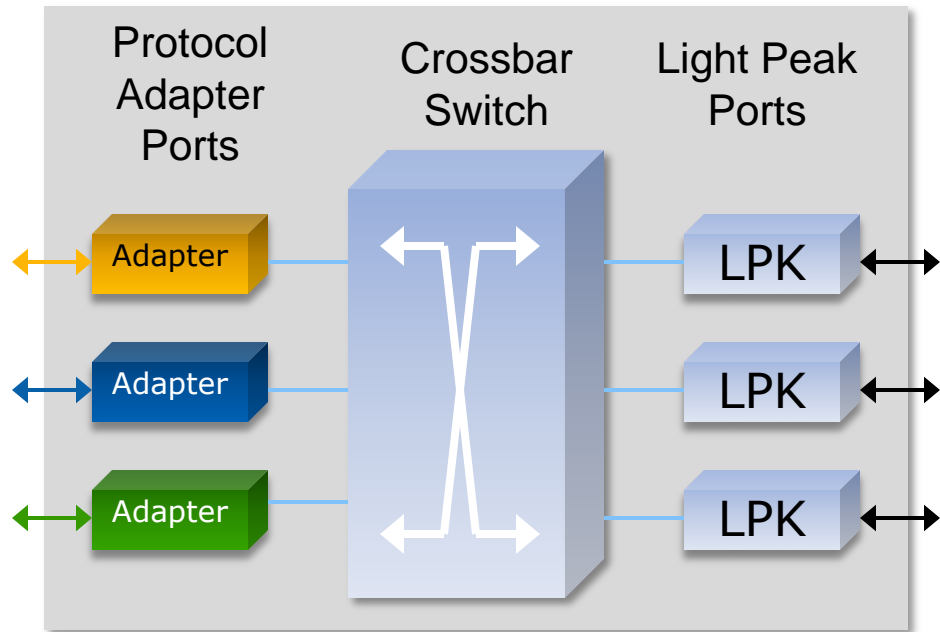
- Efficient transport
  - Packet switched multiplexing
  - Establish all routing at setup
  - Cheap switching
- Virtual wire semantics
  - Performance isolation between higher level protocols (QoS)
  - Error recovery provided by mapped protocol
- Flexible topologies
  - Any graph topology
  - Peer-to-peer

# Bringing Optical to Mainstream

- Designed for PC requirements, not telecom
  - PC lifetimes and operating temperatures
  - Smaller form factor
  - Power management for less power consumption
- Relaxed optical specs for yield improvement
  - Higher laser power for manufacturing tolerances
  - Wider spectral widths
- Designed for High Volume Manufacturing
  - Simplified mechanical design
  - Automated manufacturing and test lines
  - Higher laser power allows for automated assembly



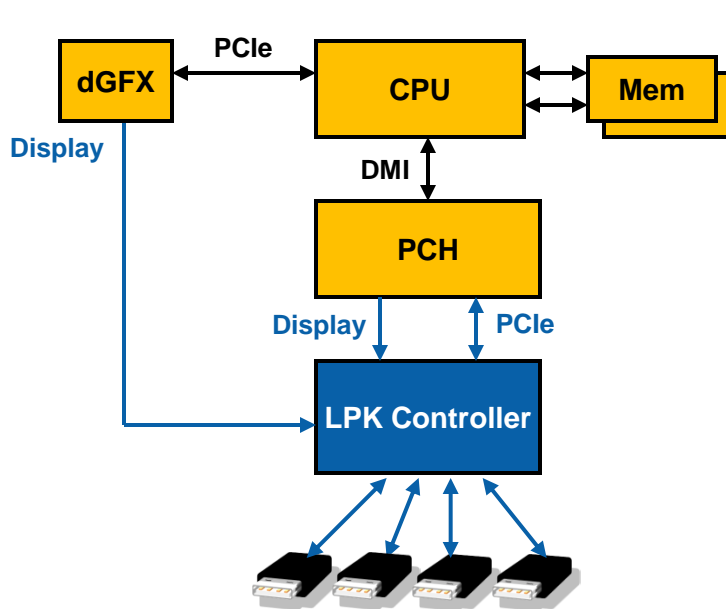
# Light Peak Controller



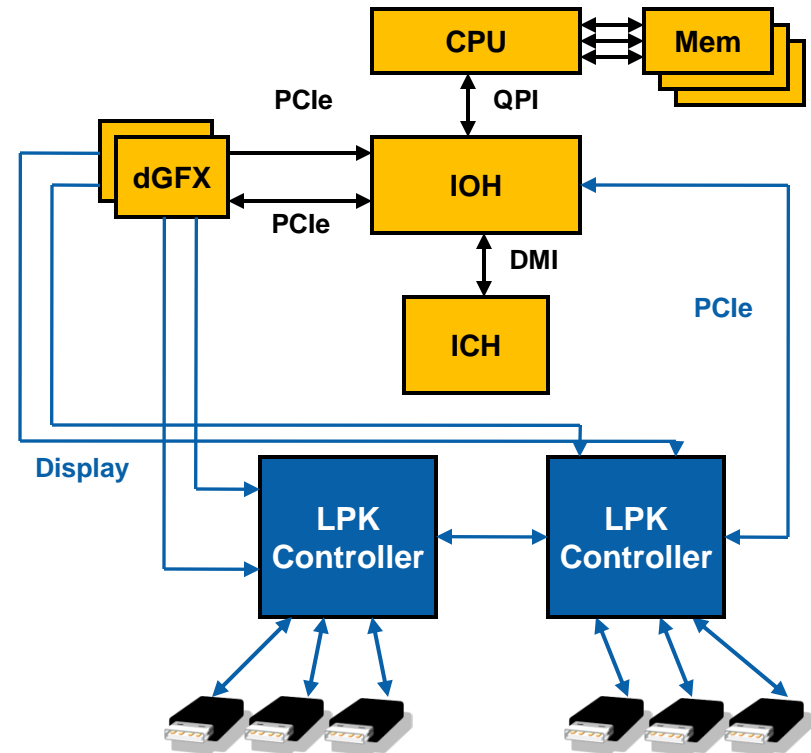
- Basic implementation unit containing:
  - A crossbar switch
  - One or more Light Peak ports
  - One or more protocol adapter ports
- Host controller
  - Typically multi-protocol and multi-port
  - Includes a software interface
  - Optimized for host side implementations
- Peripheral controller
  - Could be single protocol and single port
  - Optimized for a particular usage

# Example Platforms

## Mobile



## Enthusiast/Workstation



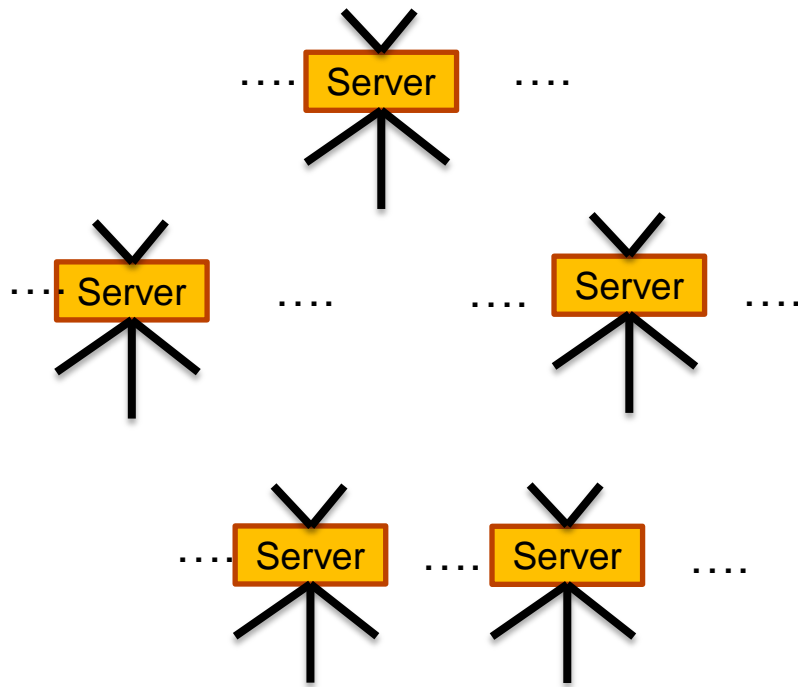
# Development Status

- Light Peak is on track for 2011 products
  - First products expected in 2011
  - No OS changes required
- Initial usage models focus on performance & simplification
  - Faster media transfer and creation
  - Flexible designs, thinner form factors and simplified cable connections
- Momentum continues to increase across the industry, with vendors demonstrating prototype devices

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# Direct Networks of Servers

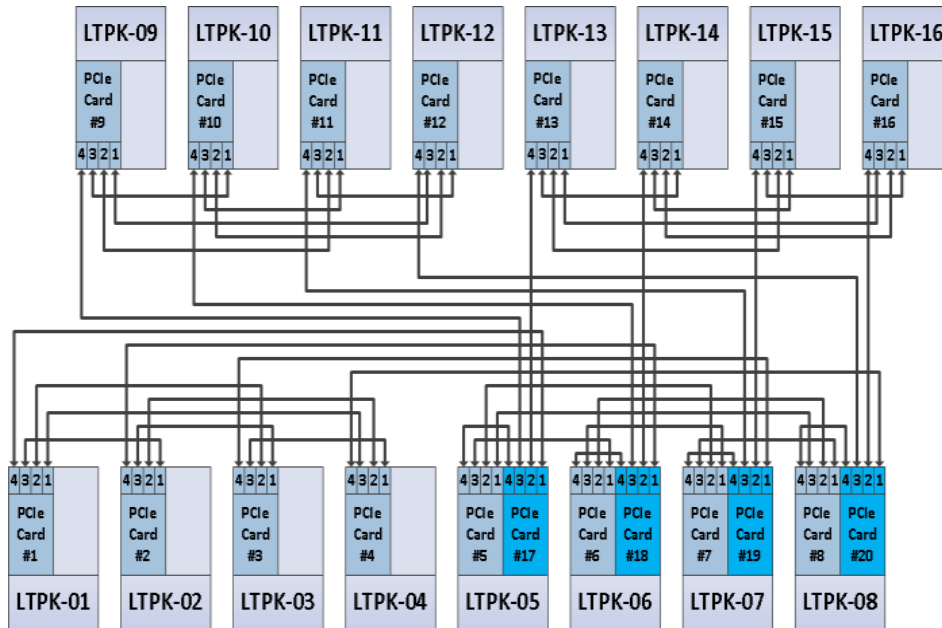


- Goal: Build a high-bandwidth, fault-resilient, low-cost network that can deliver performance isolation across applications
- Approach
  - Integrate low-radix switches into server platforms
  - Interconnect servers directly using multi-path topologies
- Why Light Peak?
  - Small buffers and tables enable cheaper switching components
  - Bandwidth allocation and performance isolation
  - Flexible topologies and multi-path enables better resiliency



# Research Questions

## Light Peak Direct Networks Prototype



- Topologies for larger networks with fixed degree
- Traffic analysis
  - Delays, throughput, fairness, multi-path, QoS
- Failure recovery
- Interworking with Ethernet
- Performance studies with actual workloads

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- Light Peak is a new high-speed interconnect technology developed by Intel that consists of a *multi-protocol transport architecture* and an *electrical/optical physical layer*
- Key Benefits of Light Peak include:
  - Simpler connectivity
  - High bandwidth
  - Flexible system architectures
- For more information...
  - <http://www.intel.com/go/lightpeak>
  - *Direct Networks Prototype Leveraging Light Peak Technology.* Sreenivas Addagatla, Mark Shaw, Suyash Sinha, Prashant Chandra, Ameya Varde, Michael Grinkrug. In proceedings of Hot Interconnects 2010.