

## USB4 Fundamentals

### Training

#### Let MindShare Bring “USB4 Fundamentals” to Life for You

Universal Serial Bus (USB) is a widely used cabled IO bus and is found in systems ranging from embedded controllers to servers. While USB 3.2 is the current specification for USB 2.0 and Enhanced SuperSpeed (ESS) bus operations, USB4 adds a new capability: interleaved USB 3.2, PCI Express, and DisplayPort packets on a single USB4 link. These two additional IO protocols are important because they are optimized for specific peripheral types. PCIe is well suited to devices requiring scalable bus performance and support for peripheral DMA and interrupts (neither of which is allowed in USB 3.2). DisplayPort sources time-critical video data with built-in support for MST (multi-stream transport) for chaining monitors, etc.

While USB 3.2, PCIe, and DisplayPort are all important interfaces in current generation platforms, smaller form-factor tablets, notebooks, thin laptops are space-limited for both internal peripherals and external IO connectors. The result: a move towards consolidating multiple IO protocols and even power delivery over a single high-performance physical interface. This, in turn, enables peripherals such as SSDs, high resolution (and multiple) displays, LAN adapters, and even GPUs to be connected externally---often using a dock.

USB4 builds on the approach taken by Intel's Thunderbolt 3 to solve the problem of supporting multiple IO bus protocols and power delivery, even if only a limited number of connectors may be available.

The USB4 approach:

- Provide 10/20/40 Gbps link bandwidth to support a high performance USB4 peripheral, an attached USB4 hub and its downstream facing ports, or a dock with exposed PCIe/DP/USB 3.2 functions.
- Tunneled USB 3.2, PCIe, and DisplayPort packets are interleaved and share a USB4 link transparently (the link remains in the USB4 alternate mode negotiated at startup).
- USB4 host, hub, and peripheral device internal routers and protocol adapters encapsulate native USB 3.2, PCIe, DisplayPort source traffic into USB4 packets, route the USB4 traffic through the fabric, then extract and deliver the native USB 3.2, PCIe, and DisplayPort packets to the targets.
- The USB4 connection manager, operating through the host interface, generates USB4 control packets as needed for the purposes of USB4 configuration and testing.
- USB4 hosts/hubs/devices are required to support a number of features which are actually defined in the USB Type-C (USB-C) and USB Power Delivery (USB PD) specifications.

This MindShare Fundamentals course presents a high-level overview of the USB4 architecture, including hosts, hubs, and peripherals as well as link traffic and the role of the USB4 connection manager.

#### You Will Learn

- USB4 motivations and goals
- Host, hub, peripheral device architecture
- USB4 link and its USB-C receptacles/cables
- The layered USB4 protocol
- USB4 host interface and connection manager role
- Tunneled and control packets
- Role of USB4 configuration spaces

## Who Should Attend?

This USB4 Fundamentals course is designed for managers, FAEs, and others needing overview-level coverage of USB4 features and terminology. MindShare also offers a four-day course that covers the full range of USB4 topics, including the low-level details.

**Course Length:** 1 Day

## Course Outline:

- USB4 Motivations, Goals, Key Specifications
- USB4 History: Thunderbolt's Contribution
- USB4 Fabric Elements
  - Links, Routers, Hosts, Hubs, Devices
  - Topologies
- USB4 Adapters
  - Protocol Adapters
    - PCIe, USB3, DP
  - Lane Adapters
  - Control Adapters
- USB-C Interconnect: Dual-bus Topology Plus Power
  - USB4/ESS Signals and Sideband Channel Signals
  - Legacy USB 2.0 Signals
  - VBUS Device Power and VCONN Cable/Connector Power
- Protocol Tunneling and Functional Layers
  - Tunneling USB 3.2 (ESS) traffic
  - Tunneling DisplayPort (DP) traffic
  - Tunneling PCI Express (PCIe) traffic
  - Configuration Layer, Host Interface Adapter Layer, Protocol Adapter Layer, Transport Layer, Physical Layer (Logical and Electrical)
- USB4 Connection Manager and interactions with Host Interface
- USB4 Traffic Types
  - TLPs (Tunneled packets, control packets, link management packets), Ordered Sets, Low Frequency Periodic Signaling (LFPS), Transactions (sideband)
- USB4 Configuration Spaces
- USB4 Paths and an overview of TLP routing
- USB4 Flow Control and Quality of Service (QoS)
- Intro to inefficiencies of tunneling protocols

## Recommended Prerequisites

Some background in USB 3.2, USB-C and Power Delivery, or Thunderbolt 3 protocols is very helpful.

## Course Material:

Downloadable PDF version of the presentation slides