IJFEAT

INTERNATIONAL JOURNAL FOR ENGINEERING APPLICATIONS AND TECHNOLOGY
TITLE: THUNDERBOLT TECHNOLOGY

Rozina N Khan[1], Sakshi S Khure[2],Kiran H kumbhar [3],Umesh W Kaware[4]

[1]*Student, Department of Elec. & Telecomm. Engg. JDIET Yavatmal, Maharashtra, India,*
rozinakhan198@gmail.com
[2]*Student, Department of Elec. & Telecomm. Engg, JDIET Yavatmal, Maharashtra, India,*
sakshikhure000@gmail.com
[3]*Student, Department of Elec. & Telecomm. Engg, JDIET Yavatmal, Maharashtra, India,*
kirankumbhar8788 @gmail.com
[4]*Head of Department, Department of Elec. & Telecomm. Engg, JDIET Yavatmal, Maharashtra, India,*
umeshkaw@rediffmail.com

Abstract

Thunderbolt is an interface which is used to connect peripheral devices to the computers. Thunderbolt technology may be a new, high-speed, dual-protocol I/O technology designed for performance, simplicity, and adaptability. Thunderbolt essentially combines PCI Express and DisplayPort into a replacement serial data interface which will be carried over longer and fewer costly cables. The interface was originally designed to use flexible glass fiber cables, but a version using conventional copper wiring was also developed to furnish the specified 10 Gb/s bandwidth at lower cost.

Index Terms: Thunderbolt; PCI Express; DisplayPort.

--- *** ---

1. INTRODUCTION

Thunderbolt began at Intel Labs with an easy concept; create an incredibly fast input/output technology that almost anything can plug into. Thunderbolt is the most powerful, most flexible I/O technology ever in a personal computer. High speed, long distance, dual protocol I/O interface is possible.PCI Express and DisplayPort through a single connection. First used in Apple Mac Book Pro laptops. It gives 10 Gbps of full duplex bandwidth per channel.

Thunderbolt is the brand name of a hardware interface developed by Intel (in collaboration with Apple) that allows the connection of external peripherals to a computer. Thunderbolt 1 and 2 use the same connector as Mini DisplayPort (MDP), whereas Thunderbolt 3 re-uses the USB-C connector from USB. It was initially developed and marketed under the name Light Peak, and first sold as part of a consumer product on 24 February 2011.

Thunderbolt combines PCI Express (PCIe) and DisplayPort (DP) into two serial signals, and additionally provides DC power, all in one cable. Up to six peripherals may be supported by one connector through various technologies.

Fig-1: Thunderbolt cable

1.1 Key features

- Data transfer of 10Gbps bi-directional, dual channel is possible
- Data & Video on single cable with Dual-protocol (PCI Express and Display Port)

- Compatible with existing Display Port devices
- Low latency with highly accurate time synchronization
- Uses PCIe and Display Port protocol software drivers
- Power over cable for bus-powered devices (electrical cables only)

1.2 Commercial launch

Thunderbolt I/O interface was launched by Apple in 2011 using the Apple-developed connector as Mini DisplayPort, which is electrically identical to DisplayPort, but uses a smaller, non-locking connector. Though the Thunderbolt trademark was registered by Apple, full rights belong to Intel which subsequently led to the transfer of the registration from Apple to Intel. The other companies also launched their thunderbolt compactable devices by the end of 2013 or in early 2014.

2. WORKING

2.1 Protocol Architecture

Thunderbolt technology is predicated on a replacement architecture with full-duplex links. Thunderbolt port is capable of providing the complete bandwidth of the link in both directions. no sharing of bandwidth between ports or between upstream and downstream directions. The Thunderbolt protocol physical layer is responsible for link maintenance including hot- plug detection, and data encoding to provide highly efficient data transfer. The heart of the Thunderbolt protocol architecture is that the transport layer. DisplayPort and PCI Express protocols are mapped onto the transport layer. Mapped protocol packets between a source device and a destination device could also be routed over a path which will cross multiple Thunderbolt controllers. At the destination device, a protocol adapter recreates the mapped protocol during a way that's indistinguishable from what was received by the source device. Thunderbolt technology-enabled product devices appear as PCI Express or DisplayPort devices to the OS of the host PC. So available standard drivers are capable of using them.
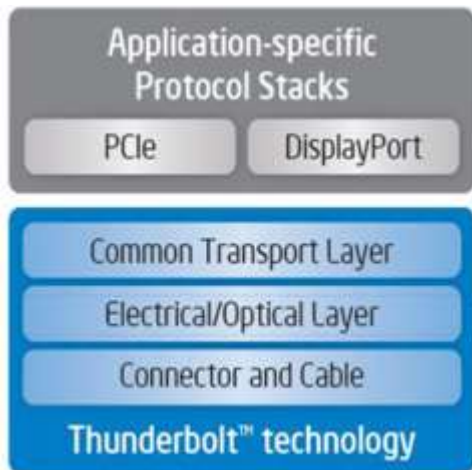
The main focus of Thunderbolt comes on two layers, Physical layer and Transport layer. The Thunderbolt protocol physical layer is responsible for link maintenance including hot-plug detection, and data encoding to provide highly efficient data transfer. The physical layer has been designed to introduce very minimal overhead and provides full 10Gbps of usable bandwidth to the upper layers. Hot-plugging means, plug-in a peripheral or another computer to a computer while the machine is hot, while the machine is working, Physical layer is actually responsible for that. With thunderbolt can make a daisy chain network of up to 7 elements. The link maintains is comes under the physical layer, including data encoding to provide high efficient data transfer, to enable the amazing speed of thunderbolt.

2.2 Controller Architecture

Host side Thunderbolt controllers have one or more DisplayPort input interfaces, a PCI Express interface in conjunction with one or more Thunderbolt technology interface. ??? one chip, the host-side controller enables system vendors to simply incorporate Thunderbolt technology into their designs.
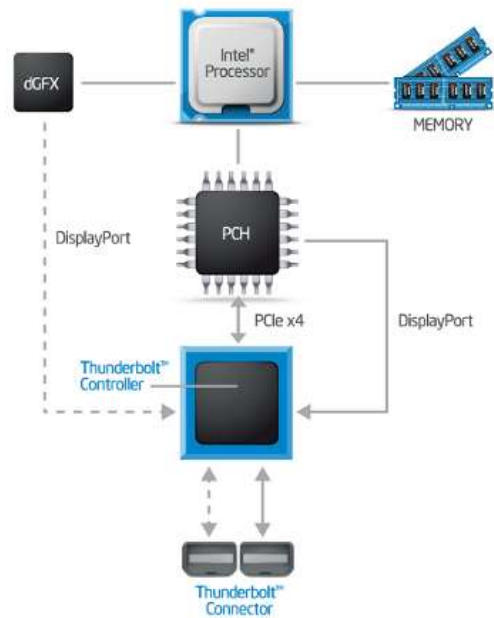

Fig-3: Controller architecture

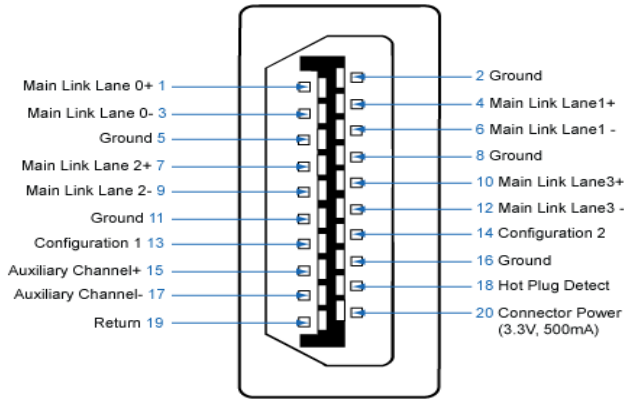**Fig-2: Protocol architecture**

3. PIN DIAGRAM

Fig-4: Pin diagram

4. THUNDERBOLT VS EXISTING I/O INTERFACE

Thunderbolt gives you two channels on an equivalent connector with 10 Gbps of throughput in both directions. Ultra-fast, ultra-flexible Thunderbolt 2 pushes that to twenty Gbps. You can move data to and from peripherals up to twenty times faster than with USB 2 and up to 12 times faster than with FireWire 800. You also have quite enough bandwidth to daisy-chain multiple high-speed devices without employing a hub or switch. For example, you'll connect several high-performance external disks, a video capture device.
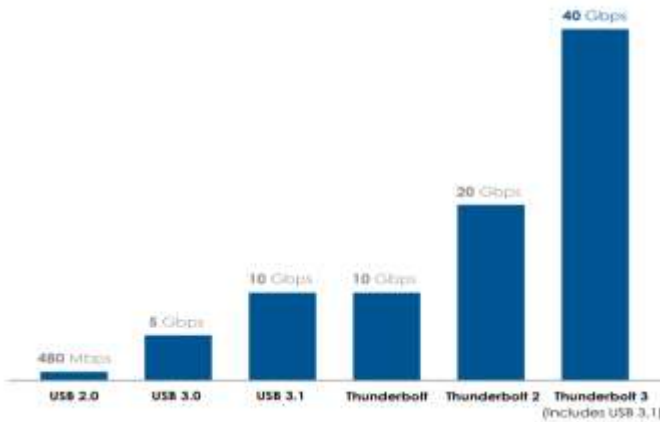

Fig-5: Thunderbolt vs existing i/o interface

5. ADVANTAGES

* Three-in-one technology

* Faster data transfer rates

 * Graphic-based expansion capability

 * Daisy-chaining

* Support for USB-C

6. DISADVANTAGES

* Confusion with standard USB

 * Small product ecosystem

 * Expensive

 * Security vulnerability

7. APPLICATIONS

 * Connecting one or more displays

 * High performance networking

* Thunderbolt storage

 * USB storage

* External graphics

 * Docking

8. CONCLUSION

 Thunderbolt technology brings a replacement balance of performance, simplicity and adaptability to finish users and merchandise designers alike. Due to cost factor, it is out of reach for an average product for now, USB still more popular which is practically free. At the present it's running at electrical standard but it'll be at optical standard in end of the day.

REFERENCES

[1]. Jerry Gao, Hengju Cheng, Hui-Chin Wu, Guobin Liu. Edmond Lau, Li Yuan, Christine Krause, "Thunderbolt Interconnect – Optical and copper", IEEE journal of Lightwave Technology, 2016.

[2]. J. Gao, H. Cheng, H. Wu, G. Liu, E. Lau, Li Yuan, C. Krause, "2X25G Low Power Optical IC for Thunderbolt Optical Cable Technology", IEEE journal, 2016.

[3]. Apple-India, "Thunderbolt next generation high speed technology", Apple website,2011

[4].Thunderbolt   Technology   brief", www.thunderbolttechnology.net, 2016

[5]. Apple-India, "Thunderbolt next generation high speed technology", Apple website

[6]. Andrew Ku," everything you need to know about thunderbolt" Tom's hardware, 2014

[7]. Intel,"Thunderbolt Ready-upgrade program for PC, Motherboard, workstation computers", Benchmark review.com, 16 Nov 2013.

[8]. James Gilbraith, "Promise preps for MAC Pro with Thunderbolt 2" macworld.com, 16 Sep 2013

[9]. Jason Ziller, "Thunderbolt Technology update" Intel, 8 April, 2015

[10]. Gordon Mah Ung, "Thunderbolt vs. USB 3.0 "maximumpc.com, 29 Jan 2015