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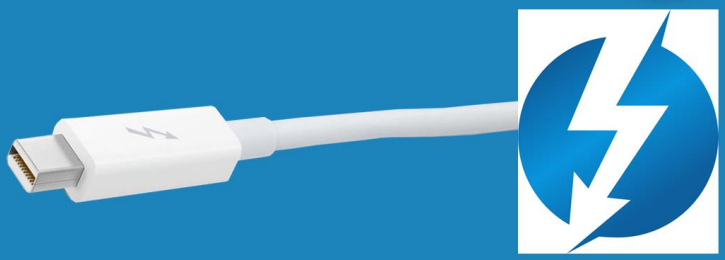

Thunderbolt

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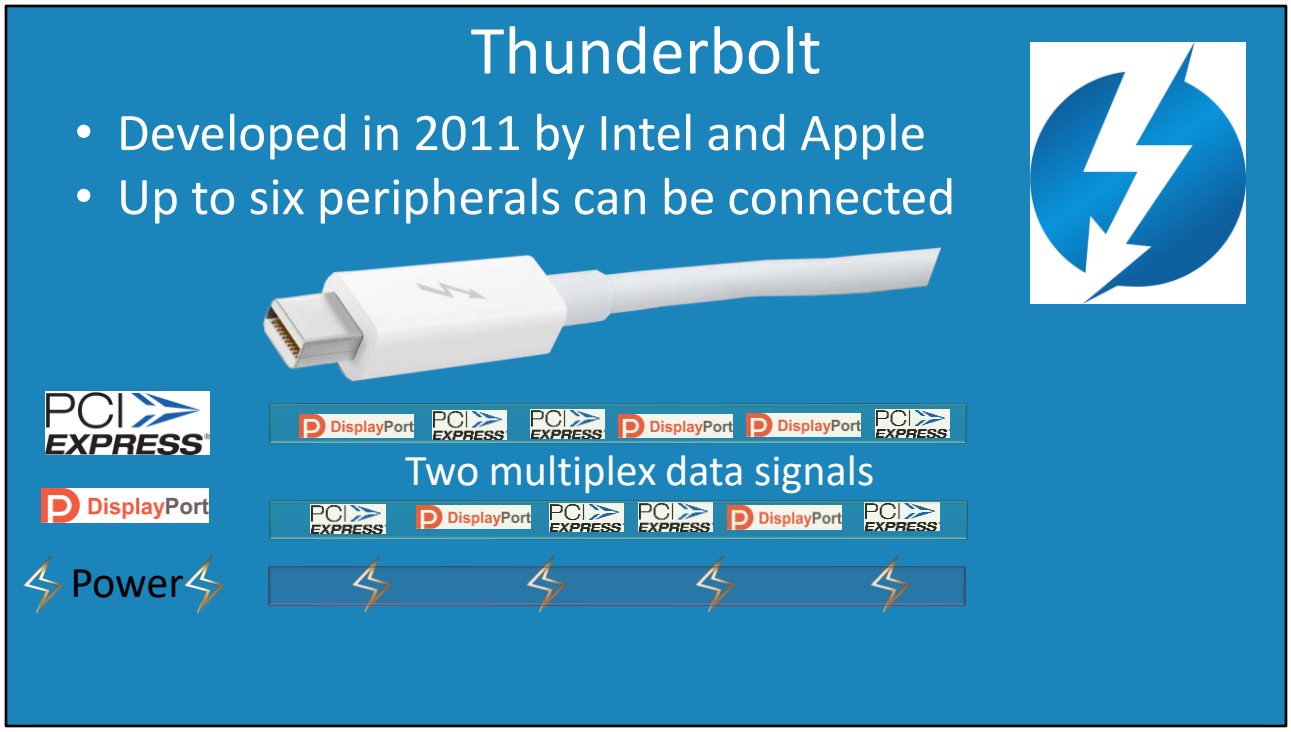
In this video from ITFreeTraining, I will look at Thunderbolt. Thunderbolt allows devices to be connected to your computer at high speed. It has some advantages, but is not that commonly used, other than with Apple computers. We will look at what Thunderbolt is and why it has not taken off.



0:20 Thunderbolt is the name of a hardware interface that was developed by Intel and Apple in 2011. It superseded another technology called FireWire. FireWire is not covered in the exam objectives, but essentially is a high-speed connection that was not that popular and is now obsolete, so you will rarely (if at all) come across it nowadays. Thunderbolt uses the lightning icon. This is not to be confused with the Lightning cable. The Lightning cable is a name only and does not use the lightning symbol on its cable. In a different video I will cover the Lightning cable.

Thunderbolt uses two multiplex data signals to transmit data. It can transmit PCI Express or DisplayPort data, using packets to transfer the data. Thunderbolt is available in copper and fibre. If using the copper version, Thunderbolt can also transfer power over the cable.

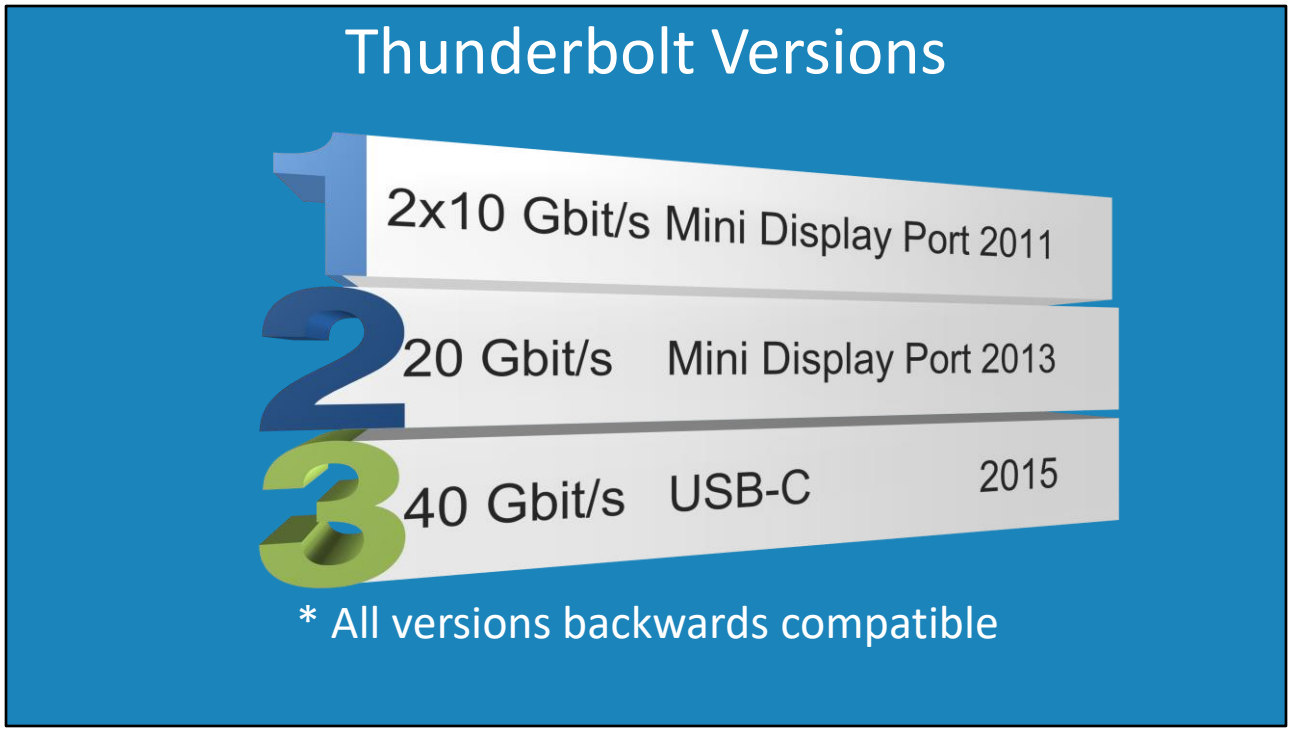
Multiplex means that it can take multiple signals and combine them together. When the multiplex signal reaches the other end, the packets that contain each signal are separated into their original signals. PCI Express uses packets to transmit data and so does Display Port. So essentially Thunderbolt is sending these packets down the data lines to the other end. At the other end, it works out which packet is which and divides them back up into their separate signals.

PCI Express and DisplayPort can support more than one lane. Thunderbolt supports two separate lanes, so divides the incoming lanes into these two lanes. Thunderbolt can transfer data from one or more devices from PCI express or Display Port.

Using this approach allows up to six peripherals to be connected together. One device is simply connected to the next device in a daisy chain. If data is received by a device and it is not for that device, it will be sent on to the next device in the chain.

Since DisplayPort supports audio, audio can also be transferred through Thunderbolt using DisplayPort. Since Thunderbolt also supports PCI Express, a USB device can be connected via PCI Express. To think of it simply, a Thunderbolt USB Hub could be connected to a Thunderbolt connection. The Thunderbolt USB hub would use Thunderbolt to transmit a PCI Express signal to the computer. The hub is essentially connecting to the computer using PCI Express, Thunderbolt is providing the mechanism of transmitting the PCI express signal between the two. So, essentially, the PCI Express connection is using Thunderbolt to piggyback the PCI express connection. You can see that even though ThunderBolt is limited to PCI Express and Display Port, these can be expanded to support a lot of different devices.

There have been three different versions of Thunderbolt. Let's have a look at the differences between them.

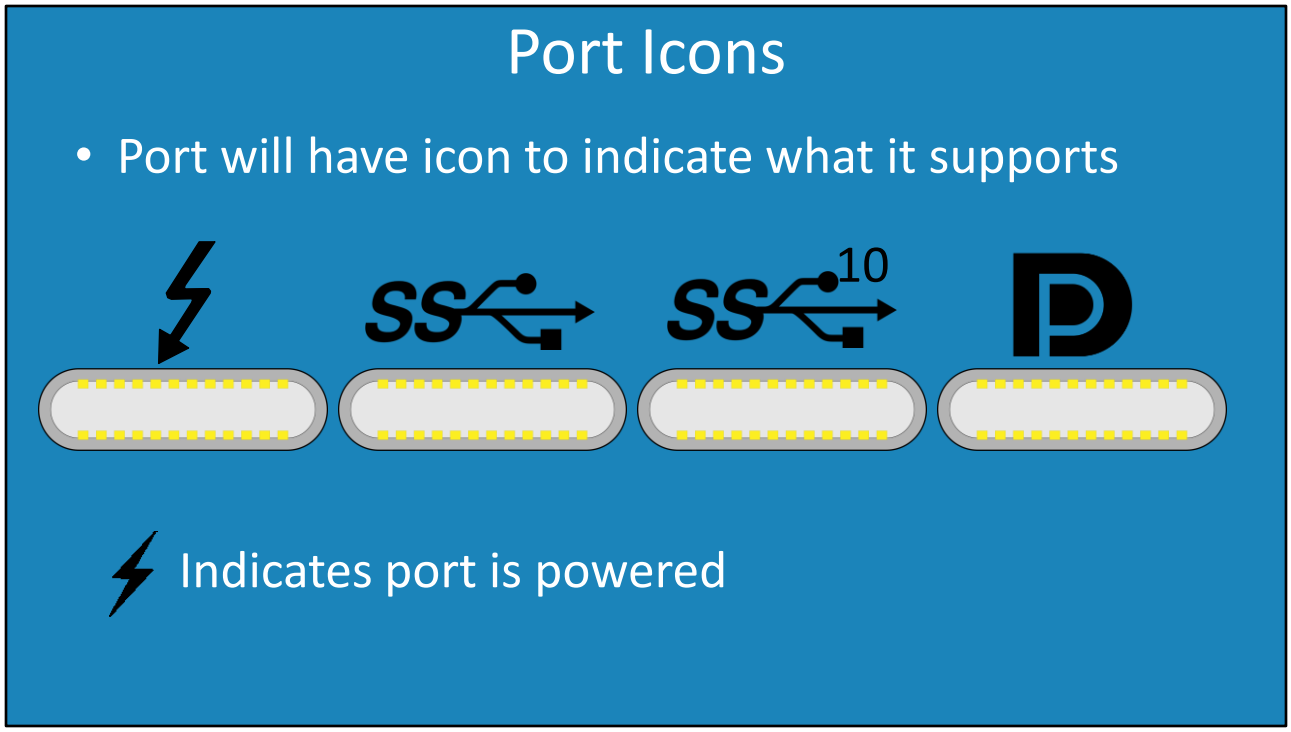


3:16 The first version of Thunderbolt was released in 2011. This version used the mini DisplayPort. It has two data lines which both run at a speed of 10 Gigabits per second. The data lines run independently and cannot be combined together. This limits the amount of data that it can transfer. For example, the one DisplayPort could only transfer a maximum of 10 Gigabits per second. You could have two displays both running at 10 Gigabits per second. However, you could not combine both together to have a single display running at 20 Gigabits per second.

In 2013 the second version of Thunderbolt was released. This version still used the mini DisplayPort and two data lines running at 10 Gigabits per second. However, both data lines could now be combined together to form a virtual data line running at 20 Gigabits per second. Since all the bandwidth could be used, version 2 supported higher resolutions for a single display than version 1 could.

In 2015, version 3 was released. Version 3, as before, has two data lines but is able to transfer data at 40 Gigabits per second. However, this version uses the USB-C connection.

Regardless of which version your computer supports, all versions are backwards compatible. It is just a matter of having the right cable. The computer will detect what is connected on the other end and use the required version. The only other problem is that, if USB and Thunderbolt both use the USB-C connector, how do we tell the difference between the two?



4:55 Since the USB-C connection can be used for many different types of connections, you will often find the connection is labeled to indicate what it supports. Thunderbolt will be labeled with a lighting icon with an arrow on the end.

USB will have a number of different types of icons which determine which version of USB it supports. The USB-C connector also supports other connection types. For example, the DisplayPort.

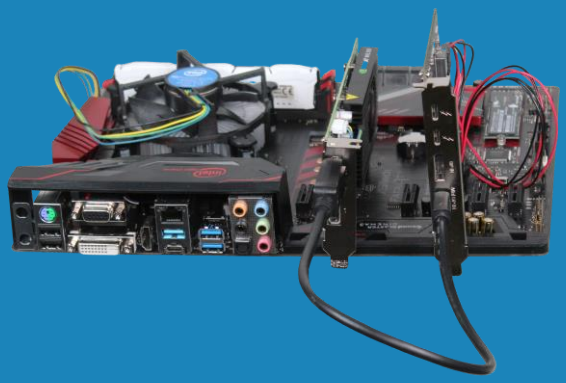
In some cases, the port may be powered. If this is the case, the port may have an electricity bolt next to it to indicate it is powered. In any case, the port should have some sort of icon to indicate what it supports. In some cases, the port may have multiple icons to indicate it supports multiple connection types.

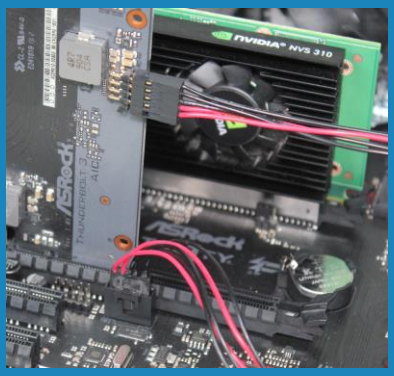
With high-speed ports, it is unlikely they will support many different connection types. This is because high-speed technology, like Thunderbolt, requires a controller to operate it. The controller needs to be connected to the computer via a high-speed connection. Although it is possible to have multiple controllers connected to the same port, given that it is new technology, it costs more to implement, so you will find the computer will have a limited number of these ports. Generally, if you are going to have two high-speed controllers, these would be connected to their own ports. It is easier to implement this way rather than attempting to combine them into the one port. You will generally find that, with older technology, it is more likely that it will be combined into a single port. As the technology gets older, it becomes less costly to implement.

Thunderbolt is more common on Apple computers; on PC computers it is not that common. It is possible to add Thunderbolt using an expansion card on some computers.

Expansion Card

- Requires motherboard/vendor support
- Difficult to get working





6:45 To do this, first you need motherboard and vendor support. Some motherboard manufacturers will supply a Thunderbolt card for their motherboards. Don't assume, however, it will work with your motherboard. Many Thunderbolt cards have an additional cable that runs from the Thunderbolt card to the motherboard. So first, the motherboard needs to support this cable and second, the motherboard needs to support that Thunderbolt card. There may be multiple Thunderbolt cards supplied by the manufacturer, and you need to ensure the motherboard supports the Thunderbolt card you purchased.

Once the Thunderbolt card is installed, the Thunderbolt card is connected to the video card. So, to get it to work, you need a motherboard that supports it and a card from the manufacturer that supports that motherboard, but you're not finished yet. Once installed, you will need to configure it in your BIOS. Some BIOSes require particular settings configured that may be difficult to find. You may also need a BIOS upgrade. So, you can understand that the whole process is difficult to get working.

In our testing we were not able to get our Thunderbolt card working. It would not even detect in Windows, although it appeared to be working in the BIOS. It seems that, although a lot of people have had success getting their cards to work, a lot of people have also had a lot of problems with them. If I were to do it again, I would personally look at purchasing a motherboard that already had Thunderbolt support included, rather than attempting to add it. This would have potentially saved a lot of headaches trying to get it to work.

In The Real World

- Mostly used on Apple computers
- May be found in high-end laptops/desktops
- USB 3.2/Gen 2x2/SuperSpeed 20Gbps
  - Runs at 20Gbps
- USB 4 will run at 40Gbps using USB-C connector
  - Estimated to be on market late 2020/early 2021
- Thunderbolt 4
  - No estimated date

8:24 In the real world, you will find that Thunderbolt is mostly found on Apple computers. If you are going to find it on a PC, you most likely will find it in high-end laptops or desktops. As not all high-end PC devices will have it, you may have to shop around to find one.

If you have been in computing a long time, you maybe remember FireWire. Similar to USB at the time, but it ran faster than USB. For this reason, you would find FireWire only on devices that needed more speed. For example, you would often find it on video cameras that needed the extra bandwidth to transfer the video.

Nowadays, however, you will find that the top end of USB runs at 20 Gigabits a second. This is half the speed of Thunderbolt 3, but still fast enough for even big bandwidth transfers like video. Since USB is so fast and so common, Thunderbolt has not gained that much market share. To try to gain more market share, Thunderbolt version 3 has been made royalty-free, so the manufacturer does not have to pay a fee to add it to a computer or a device. This is an attempt to try and increase its market share. Back in the day, FireWire had a fee that needed to be paid per port which limited where it was used and the number of ports a computer would support. Making Thunderbolt royalty-free may make it more popular than FireWire was back in the day, but only time will tell.

At present Thunderbolt 3 is twice as fast as USB, however USB 4 is promised to run at 40 Gigabits per second and use the USB-C connector. It is estimated that USB 4 will be on the market by late 2020 to early 2021. So if you need the extra speed, you can wait till then or purchase Thunderbolt devices. However, Thunderbolt tends to be more expensive than USB.

If the trend continues, Thunderbolt version 4 should be faster again, however currently there is no estimate on when the specification will be finalized and when we may start seeing it used in computers. If I were to attempt to predict the future, I would say that USB will be the dominate port used in the market and Thunderbolt will be found in Apple computers and sometimes in a PC when high speed is required. This was the trend when FireWire was around and only time will tell if the trend will repeat itself.

That concludes this video on Thunderbolt. I hope you have found this video useful. Until the next video I would like to thank you for watching.

References

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