Thunderbolt 4/3 USB4 Type C Cable

Lislax Technology
www.lislax.com

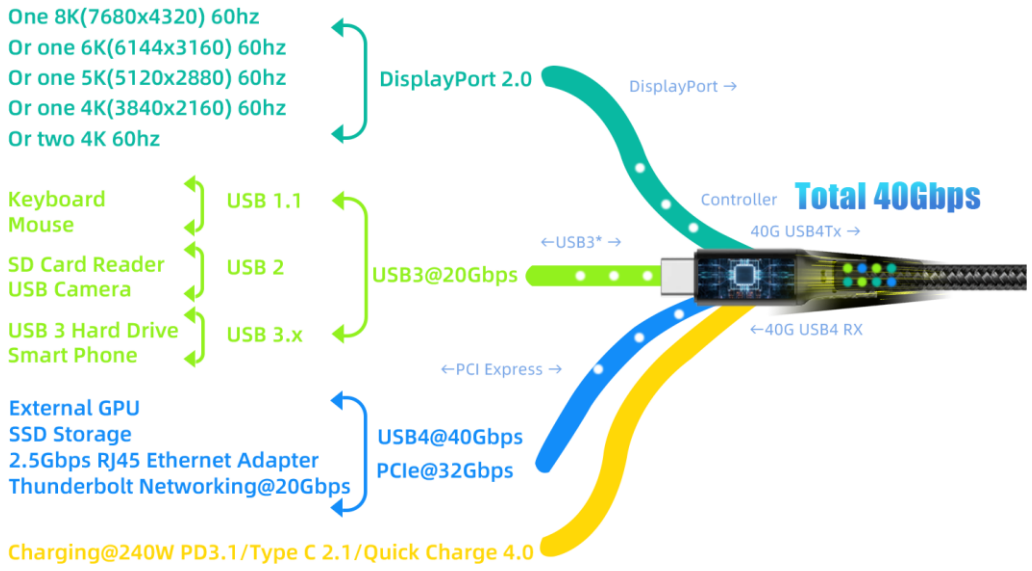
Thunderbolt is a technical protocol. The version has been developed to thunderbolt 4. The devices that support it generally have thunderbolt marks, which is a patented technology of Intel. USB4 is developed by the USB-IF on the basis of the thunderbolt 3 that has been publicly authorized by Intel. USB4 is the latest technical protocol of the USB-IF. Those companies that are not authorized by Intel thunderbolt 4, such as AMD, support USB 4 with zen3 +. The highest specifications of thunderbolt 4 and USB 4 are generally the same, but the minimum specifications of thunderbolt 4 are higher than USB4 (the USB-IF is open to various manufacturers to have different implementations according to needs), Moreover, the test indicators of thunderbolt are relatively strict, and it can be understood that USB4 is an open source version of thunderbolt 4. However, thunderbolt 4, USB4 and USB 3.2 all use USB type C (hereinafter referred to as USB C) as the physical interface carrier, that is, different technologies under the same physical carrier.

Thunderbolt technology is widely used in Intel CPU based computers and Apple computers. The advantage of the physical interface of USB C is that the data channels are quite abundant, which facilitates high-speed data transmission and becomes the most universal and excellent interface.

Thunderbolt USB C Cable is not just a bunch of metal wire, it has some chips inside to support and match the communication and charging of both sides.

1. Thunderbolt Docking Station

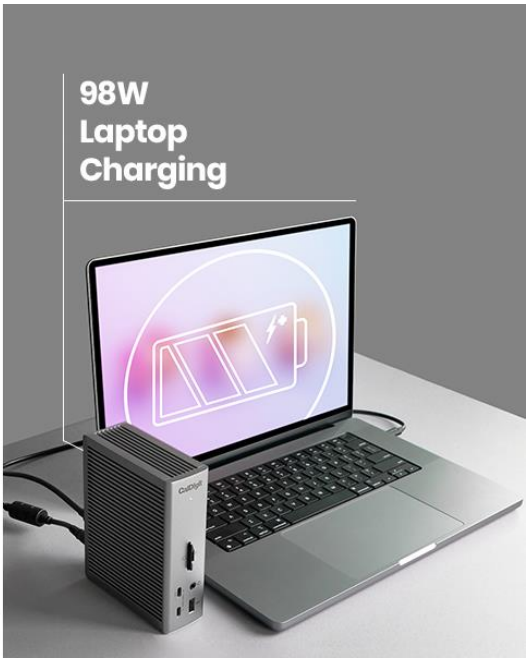
All in one. The specifications of LisLax are as follows:



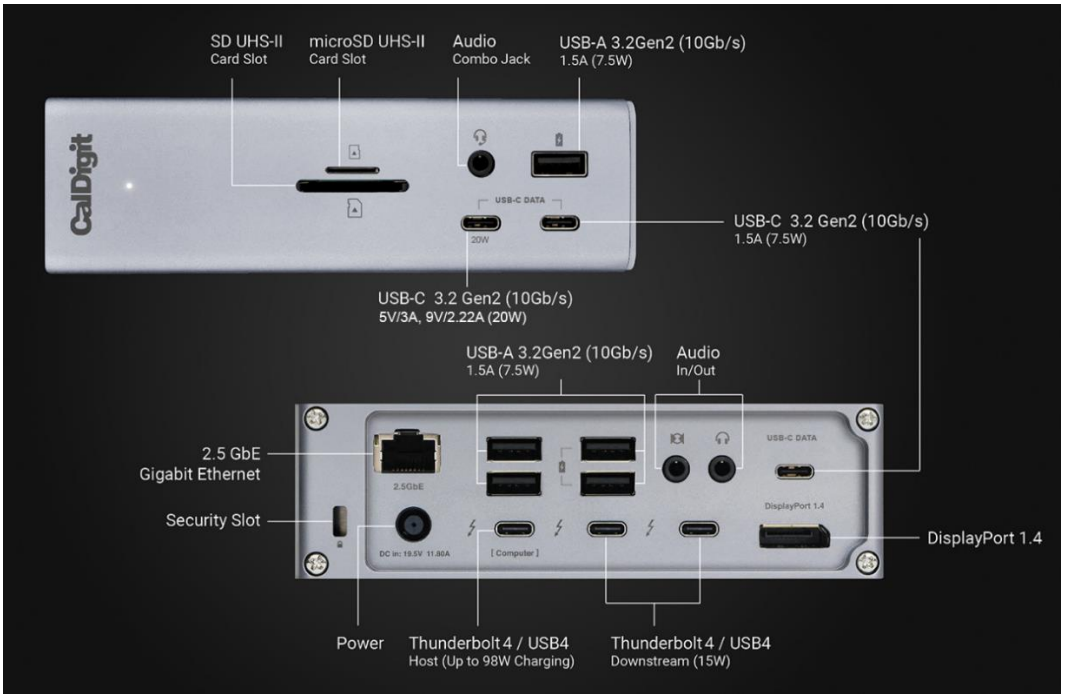
Thunderbolt/USB4 technology provides powerful bandwidth transmission capability. USB C is like a bridge, through which a variety of data packets pass. Each channel has a peak bandwidth, but the combined bandwidth will not exceed 40Gbps. When DisplayPort, PCIe or USB 3.X are transmitted at the same time, DisplayPort data packet transmission will take priority.

Take CalDigit TS4 as an example:

Docking is connected to the thunderbolt USB C main port on the PC, which not only supplies the power charging of the PC but also in charge of the high-speed data transmission, which simplifies the connection of the PC. Docking can bring some devices, such as storage, eGPU, personalized keyboard and mouse, display, high-speed network adapter, SDCARD, etc. In addition to supporting thunderbolt standard devices, it also supports USB4, USB 3 and other backward compatibility.



Please note that the thunderbolt port of docking is connected to the computer to distinguish between the primary port and the secondary port, that is, the port circled in the left figure above is the primary port. Only the computer connected to this port can see all the devices connected to docking. Because docking has independent power supply, docking will provide 98W charging capacity to the primary port at the same time, and the power supply capacity of other ports is not more than 15W.



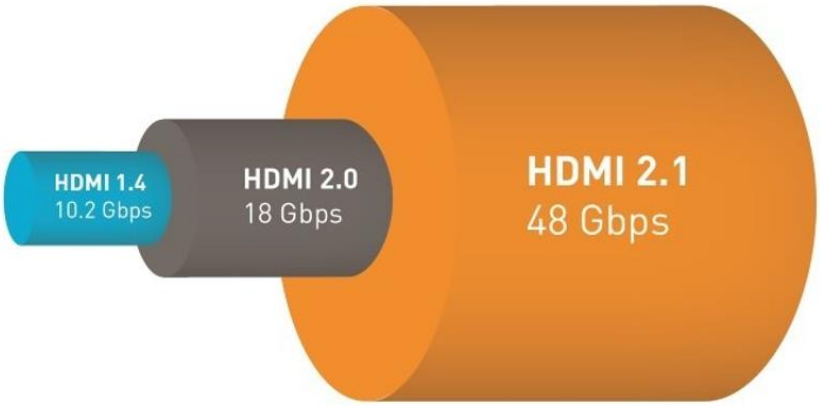
Other laptops B can be connected to the secondary USB C, and laptops B and host A are connected to form a thunderbolt networking LAN.

2. Display

To understand display, you must first understand the input interface types of displays monitor on the market. Currently, there are mainly the following HD interfaces on the market:

HDMI:

As the most common interface, HDMI is also subdivided into different standards and corresponding specifications of wires.



1080p - Also known as Full HD, this means there are 1920 pixels displayed across the screen horizontally

and 1080 vertically.

4K - This has 3,840 horizontal pixels and 2160 vertical pixels …this is around 4 times that of Full HD.

8K - This gives a resolution of 7680 by 4320… that's four times that of 4K and 16 times that of full HD!

HDMI wire specification:
HDMI 1.4
Bandwidth = 10.2 Gbps
Can run at 1080p at 60Hz or 4k at 30Hz

HDMI 2.0
Bandwidth = 18 Gbps
Can run at 1080p 240Hz or 4k at 60Hz

HDMI 2.1 (ALSO KNOWN AS ULTRA-HIGH SPEED)
Bandwidth = 48 Gbps
Can run at 4k at 120Hz or 8k at 60Hz

If the display monitor has only HDMI interface, to directly output video to the display monitor through USB C port.
Method 1:
A USB C to HDMI converter in the figure below is required, and the USB C to HDMI converter and the HDMI cable also need to match the corresponding specifications. For example, the 8K HDMI cable wire is at least the HDMI 2.1 specification, and the high specification cable and interface are backward compatible.

Method 2:
If it is connected to docking like CalDigit TS4 docking, you can make use of the DisplayPort interface of docking by using a DP to HDMI converter in the figure below. At the same time, the converter and HDMI cable wire should also match the above corresponding specifications.

DisplayPort(DP)：

If the display monitor supports DP interface, you can use a USB C to DP converter like the right figure above. The corresponding wires should also match certain specifications.

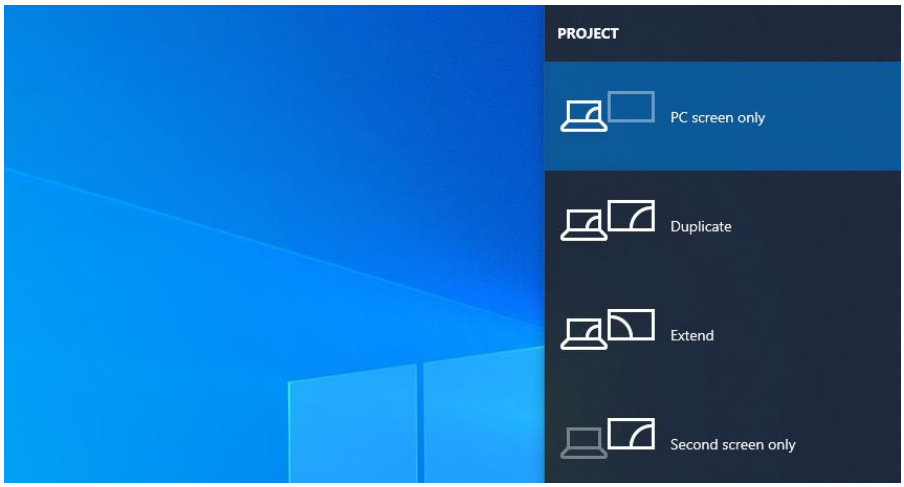
Features	DisplayPort 1.4	DisplayPort 2.0
Max Resolution	8k @ 60Hz	16k @ 60Hz
Max Bandwidth	32.4 Gbps	80 Gbps
Max Bit Rate	4Gbps	10Gbps,13. 5Gbps and 20Gbps
Color Resolution	4:2:0 & 4:2:2	4:4:4

USB C：

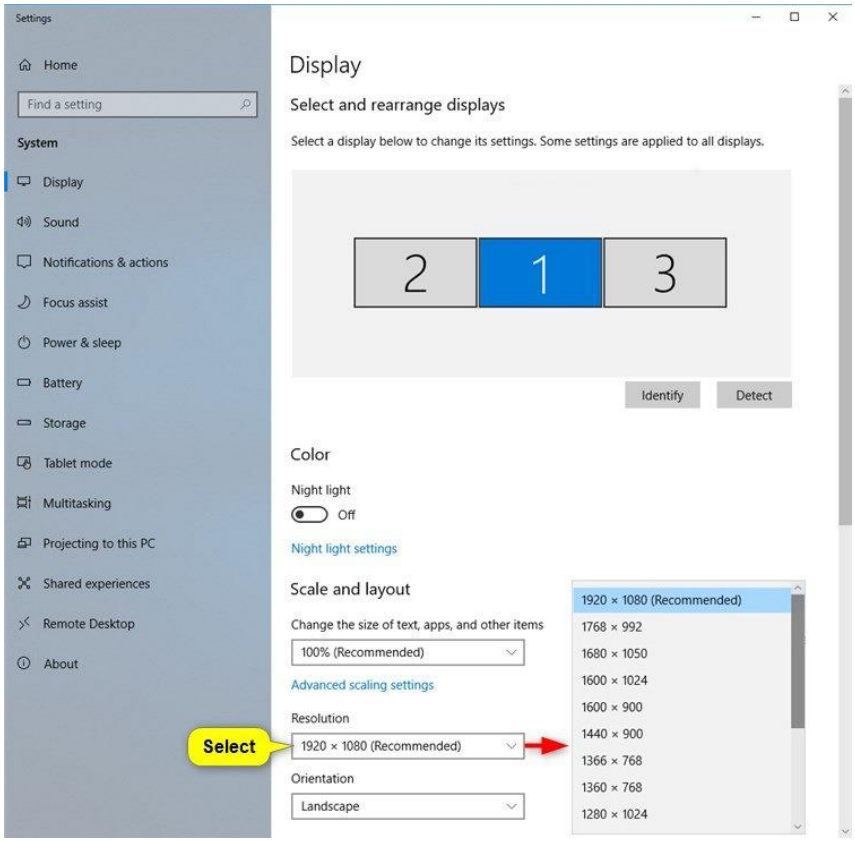
If the display monitor has a USB C interface, and it has a thunderbolt icon, such as Samsung tu87f series 32 inch 4K UHD Pro monitor, it can be directly displayed.

How to operate on PC?

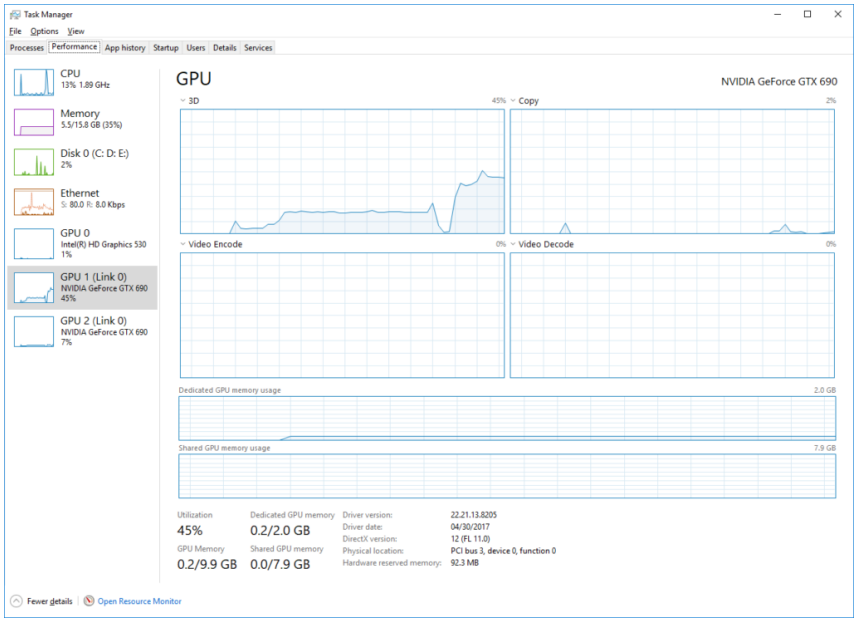
On Windows 10



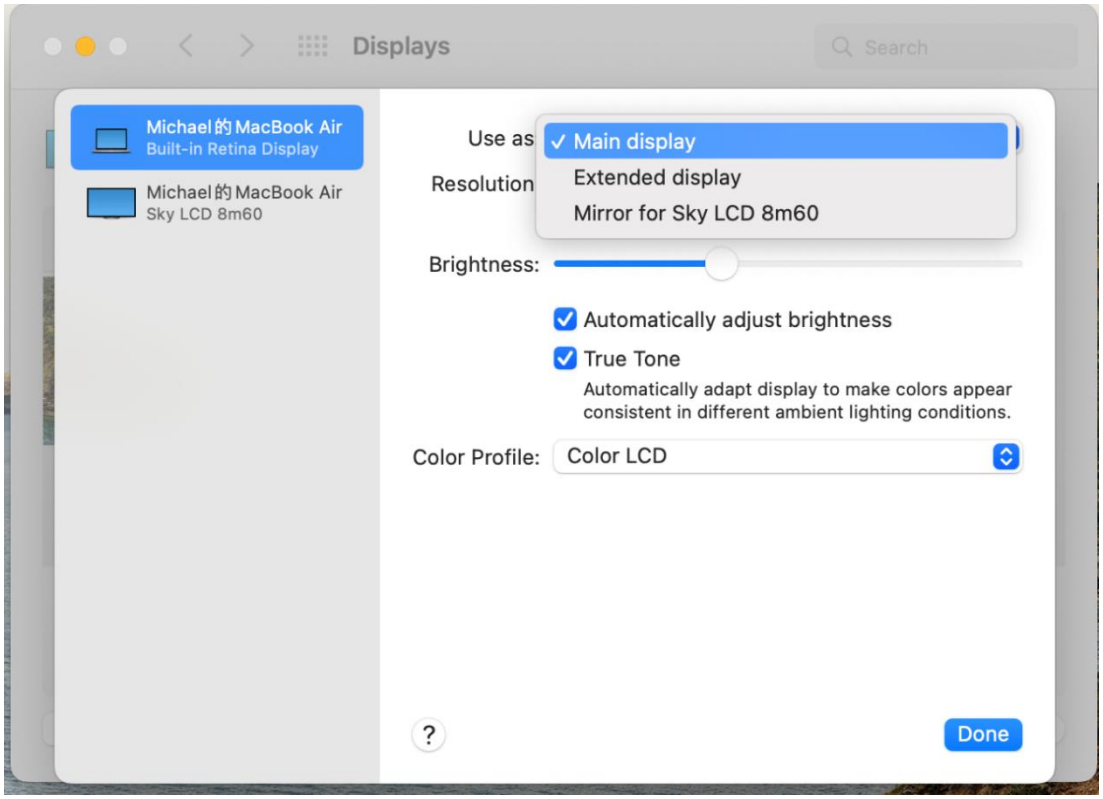
After connecting the display monitor, you can switch different displays and display modes through keyboard shortcut keys. You can manage multiple displays through setting -> display menu, such as changing the resolution.



If you find that the operation is not as smooth as before after connecting the peripheral monitor, please check whether your GPU is power enough. For example, check the GPU occupancy rate of the task manager.

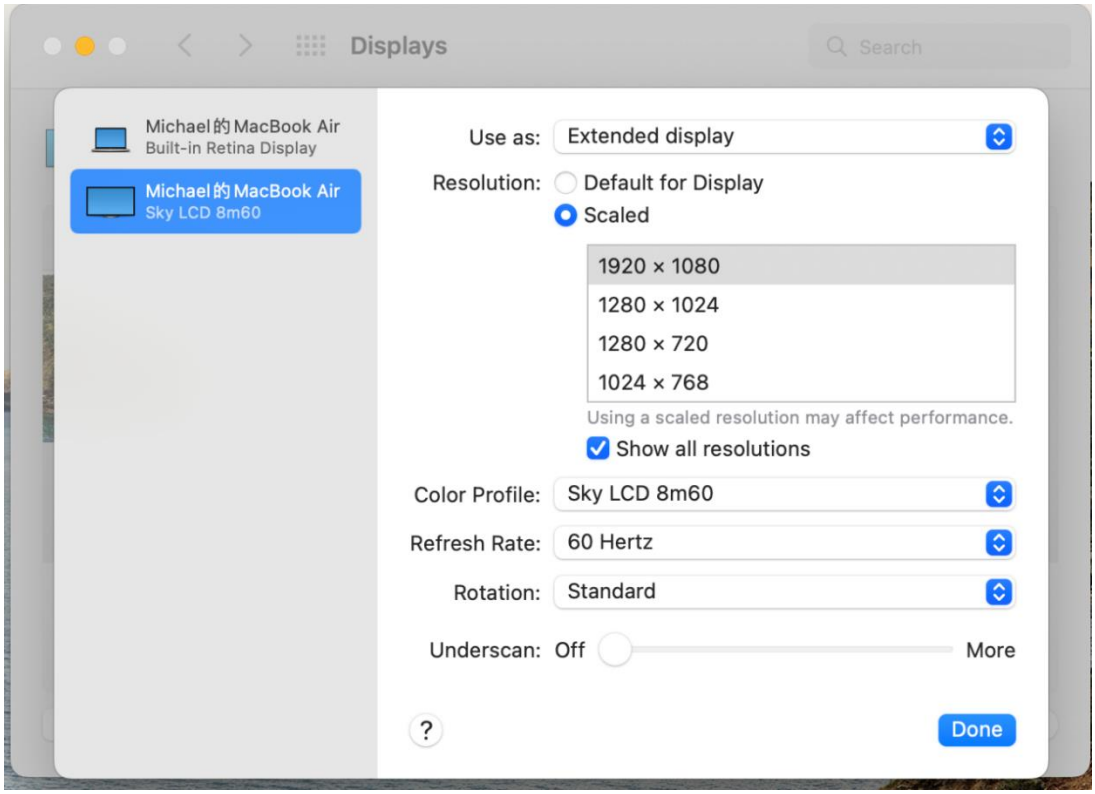


On Apple MacOS:



As shown in the above figure, the MacOS main display and the external display use different screens (or different resolutions). If the “Mirror for” option is set, the internal and external displays use the same content and the same resolution.

When selecting the second display, you can set its resolution and other options separately.



Please note that thunderbolt 4 only support up to 2 external display monitors.

FAQ:
The 8K 60Hz bandwidth is up to 48Gbps, while the thunderbolt 4 standard is only 40Gbps, and not all the bandwidth in the 40Gbps is allocated to the DP channel. However, the thunderbolt 4 can transmit 8K 60Hz video up to 48Gbps?
Answer: It should be noted that 48Gbps is only the theoretical peak bandwidth, and the image is dynamic, and its bandwidth is also dynamic. For example, compared with the static image video, the bandwidth occupation is small, and the dynamic video has a relatively high bandwidth. The thunderbolt technology can adjust the output bandwidth according to the image change. Therefore, in general, thunderbolt can meet most 8K 60Hz video requirements.

Can those non-standard resolutions and refresh rates be supported?
Answer: It supports. USB C cable only focuses on the maximum bandwidth not exceeding its upper limit, and it has nothing to do with the DisplayPort packet content.

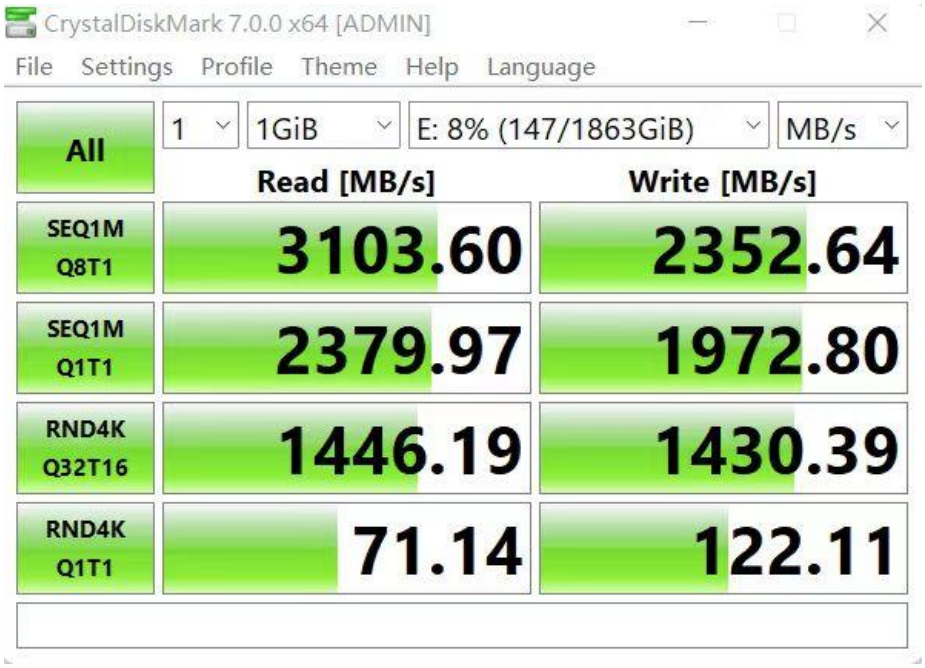
3. Storage

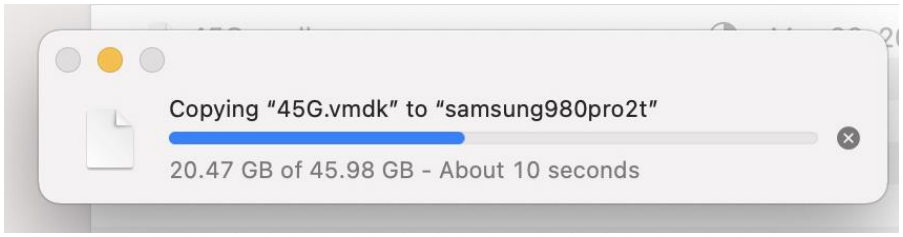
The storage uses PCIe channel, and its peak bandwidth is 32Gbps, that is, 32Gbps / 8 = 4Gbyte per second.

SSD Storage:

The storage capacity of the PC can be expanded by using thunderbolt external SSD NVMe drive, as shown in the following figure:

The following is our laboratory test data:





There are several factors that affect the transmission performance of SSD:

1. Thunderbolt 4 is faster than thunderbolt 3. It is better to use Thunderbolt 4 equipment and wires than thunderbolt 3, such as Thunderbolt enclosure drive and PC. Because the PCIe channel of thunderbolt 3 is only 16Gbps, while the PCIe channel of thunderbolt 4 is 32Gbps
2. PCIe version of NVMe, PCIe 4 has twice the performance of PCIe 3.
3. For the memory bandwidth of PC side, try to use DDR5 memory.
4. The local storage on the PC side should keep up with the performance of the external SSD, because the data read and written are generally written back to the local storage.
5. Selection of operating system and file system.
6. Enable Cache Setting.

   How to enable write caching on Windows 10:

   Connect your external storage device to the computer

   Right-click My Computer or This PC, and then click Manage.

   Select Device Manager.

   Expand Disk Drives.

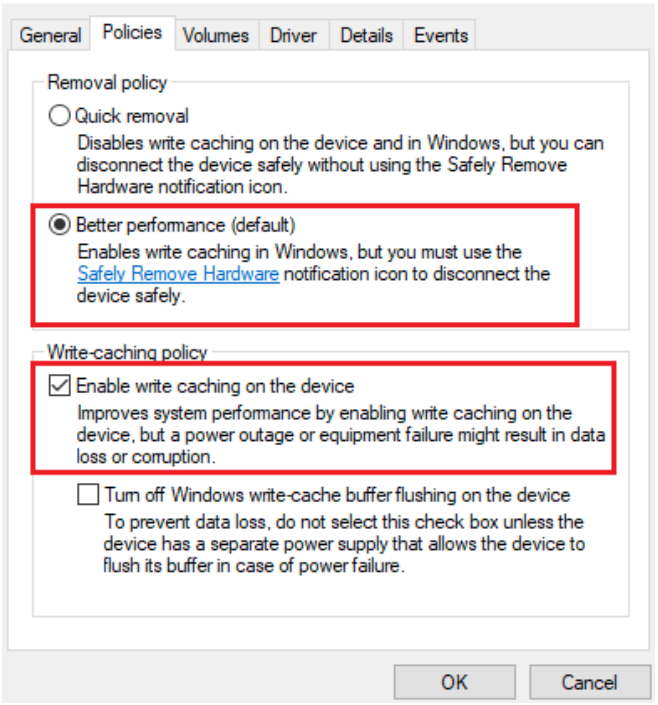
   Right-click the drive on which you want to turn disk write caching on or off, and then click Properties.

   Click the Policies tab.

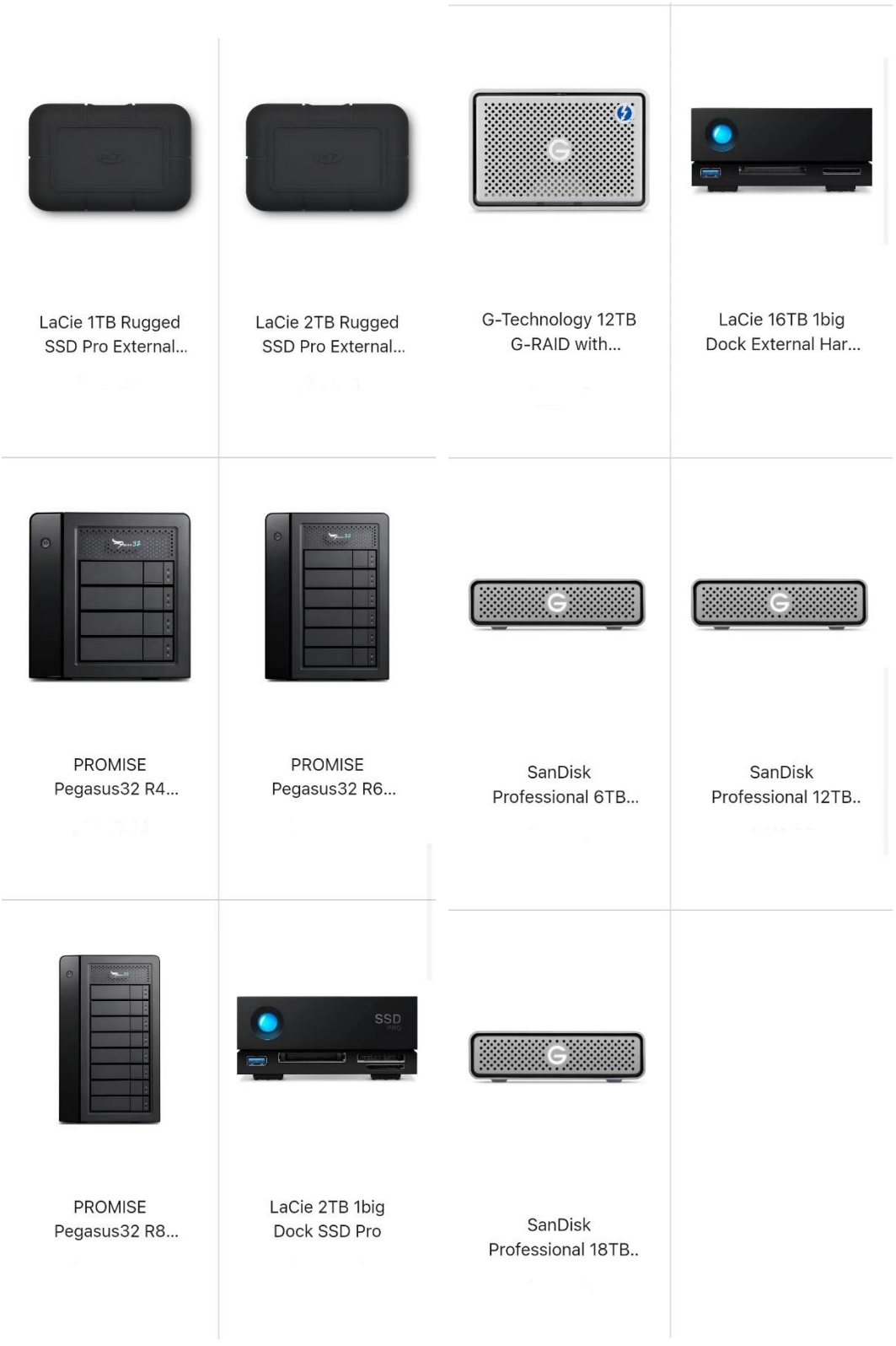
   Click to select "Better performance"

   Click to select "Enable write caching on the device"

   Click OK.



Direct-attached storage (DAS):



Compared with network attached storage (NAS), by using thunderbolt USB C, the storage transfer performance of DAS is far higher than that of the NAS with only 1Gbps. The DAS itself generally has multiple slots built in and is presented to the PC as a single storage through the internal hardware RAID technology. In addition, multiple DAS can present multiple storage on the PC with Daisy Chain technology. You can also merge multiple DAS storage disks into

one disk through software RAID. For example, it can be referenced on Windows 10 https://recoverhdd.com/blog/creating-software-raid-in-windows.html

4. Power Charging

Our LisLax cable supports 240W charging, but it needs to match the capabilities of the connected devices, and it is also limited by the capabilities of both ends. Here are charging protocol lists supported by LisLax:

Power Delivery 3.1(PD3.1):

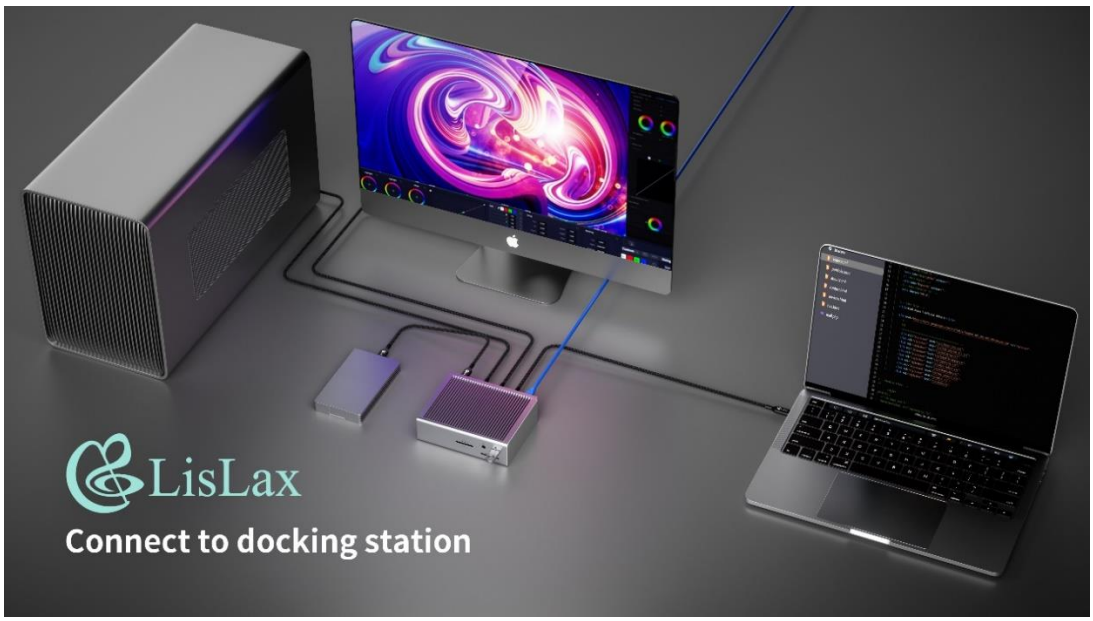
Type C 2.1

When both ends of the cable support the above two protocols, the cable has the application conditions to give full play to its 240W, that is, supports up to 48V/5A.

Quick Charge 4.0: when the connected device is QC4.0 standard, it supports high-power charging of up to 100W.

5. eGPU

eGPU is External Graphics Processing Unit. It means that a graphics card doesn't mount on PC's main board slot directly, instead, it connects to PC via USB C, you can learn more from https://egpu.io



Why do I need eGPU? Application scenario:

1. When the performance of PC built-in graphics card cannot meet the demand
2. Flexible replacement of different graphics cards
3. Handheld game machine running 3A games
4. Perform advanced AI Artificial Intelligence operations or training

eGPU solution can solve those problem, because eGPU uses 32Gbps PCIe channel.

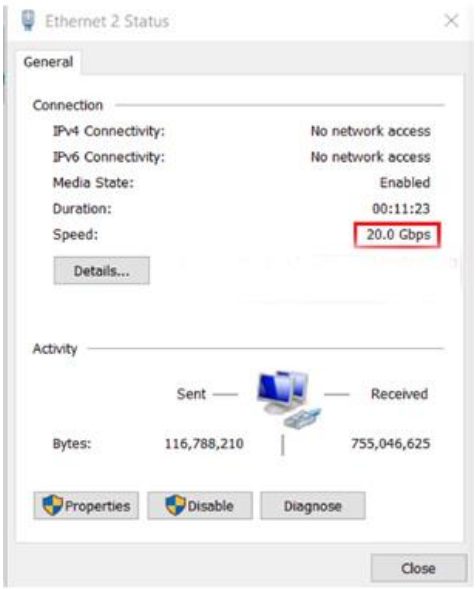
But using an external GPU doesn't give you the same performance as it would if you had the same GPU mounted internally. How much performance do you lose, then? Estimates put the

loss at around 10 to 15 percent.

Please note that Apple M1 and M2 series do not support external GPU.

6. Thunderbolt Networking

Thunderbolt networking means that two PCs are connected through USB C, and then the two PCs automatically form a TCP / IP LAN. Thunderbolt technology will automatically assign LAN IP addresses to both ends.

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- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
[  5] 273.00-274.00 sec   161 MBytes  1.35 Gbits/sec
[  7] 273.00-274.00 sec   154 MBytes  1.29 Gbits/sec
[  9] 273.00-274.00 sec   162 MBytes  1.36 Gbits/sec
[ 11] 273.00-274.00 sec   155 MBytes  1.30 Gbits/sec
[ 13] 273.00-274.00 sec   157 MBytes  1.31 Gbits/sec
[ 15] 273.00-274.00 sec   163 MBytes  1.37 Gbits/sec
[ 17] 273.00-274.00 sec   164 MBytes  1.38 Gbits/sec
[ 19] 273.00-274.00 sec   162 MBytes  1.36 Gbits/sec
[ 21] 273.00-274.00 sec   167 MBytes  1.40 Gbits/sec
[ 23] 273.00-274.00 sec   164 MBytes  1.38 Gbits/sec
[ 25] 273.00-274.00 sec   166 MBytes  1.39 Gbits/sec
[ 27] 273.00-274.00 sec   157 MBytes  1.32 Gbits/sec
[ 29] 273.00-274.00 sec   158 MBytes  1.33 Gbits/sec
[ 31] 273.00-274.00 sec   166 MBytes  1.39 Gbits/sec
[ 33] 273.00-274.00 sec   158 MBytes  1.33 Gbits/sec
[SUM] 273.00-274.00 sec  2.36 GBytes  20.2 Gbits/sec
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The figure above, we used iperf in the laboratory to obtain the highest transmission speed through multi-threaded testing. The results show that the LAN transmission of up to 20Gbps is 20 times that of ordinary gigabit RJ45 network cable. Why to use multithreading test? Because iperf consumes CPU resources, a single thread cannot fully utilize 20Gbps

bandwidth.

How to use thunderbolt networking?

After using USB C to connect two laptops, a new network connection and IP address will be automatically generated on both sides of the PC after a few seconds.

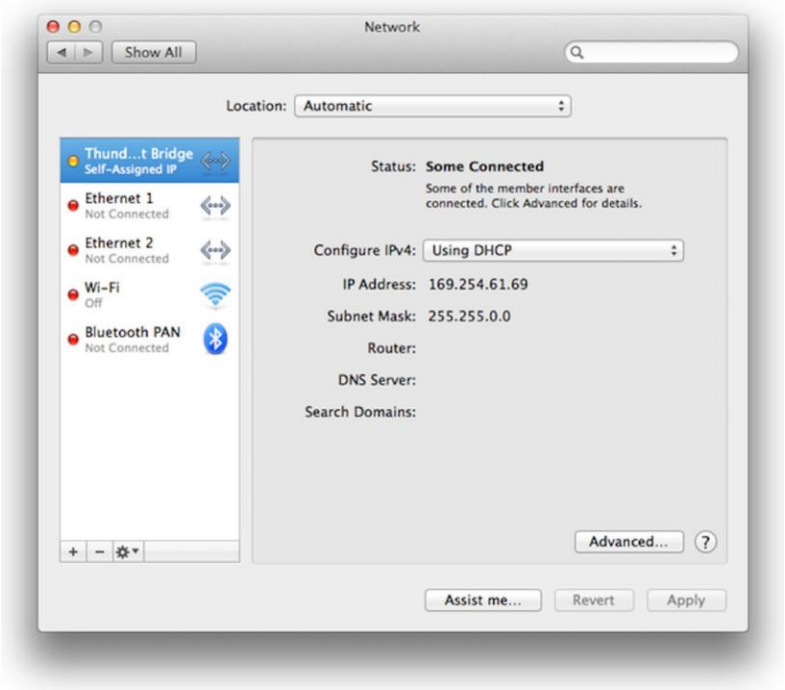
On Windows:

First check the IP addresses of the network connections of both side, and then test whether they are connected by cmd ping.

IP based access application is widely used. One of the common applications is network neighborhood or Samba / CIFS protocol to share the disks of the other side. For example, the connected laptop is divided into A (assuming its IP is 169.254.1.100) and B (assuming its IP is 169.254.1.200). On laptop B, Windows 10 “My Computer” device can share directory and account password information. On laptop A, through “My Computer”, enter \\169.254.1.200 in the address bar to access.

Another common application is remote desktop, which makes it easy to manage another laptop.

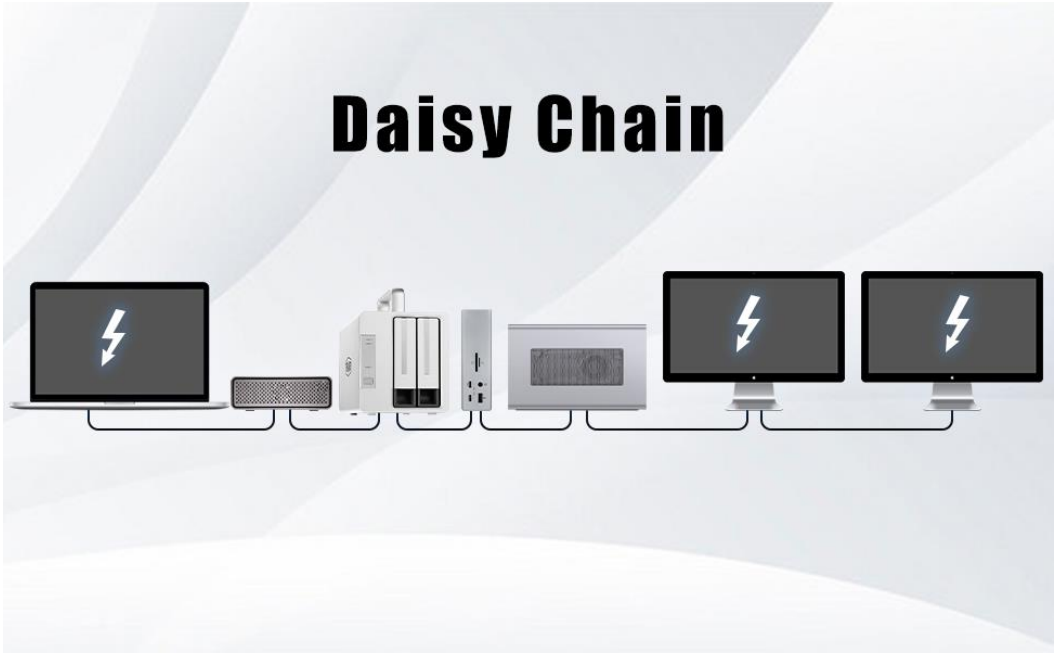
On MacOS:



You can find the network interface in the settings. Thunderbolt bridge is the network connection automatically generated by the system.

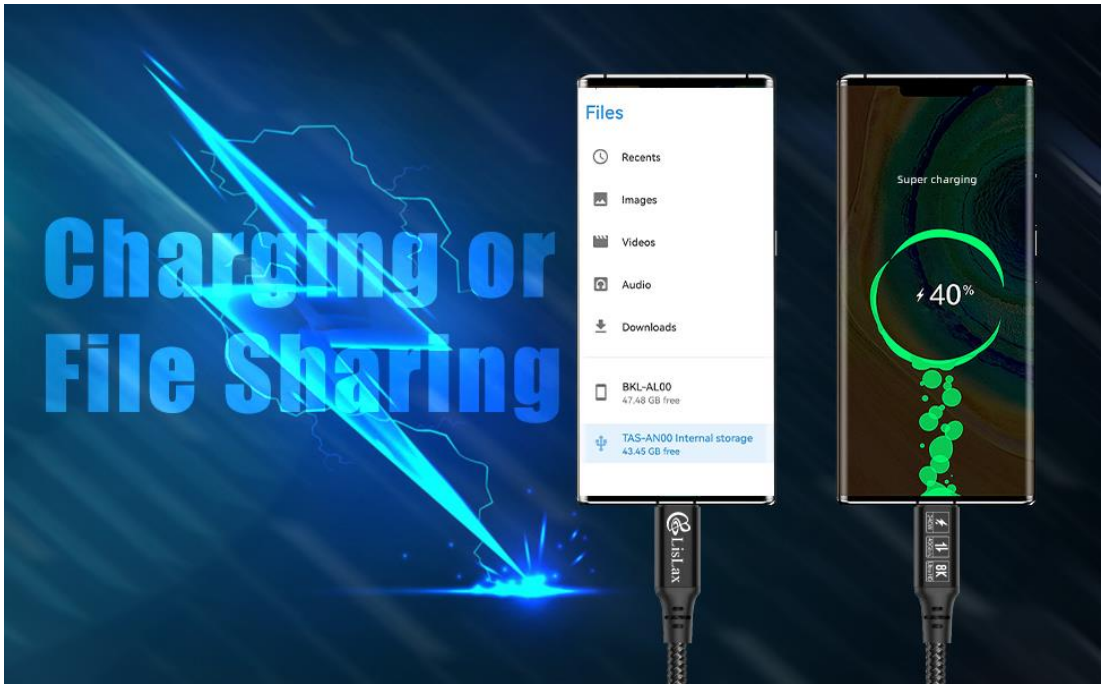
7. Daisy Chain

It refers to interconnecting multiple devices with thunderbolt USB C interfaces, provided that the intermediate interconnected devices have at least two thunderbolt USB C interfaces, as shown in the following figure:



It must be noted that the display must be placed at the end of the interconnection. The maximum number of interconnected devices is 6, and the maximum number of displays is 2. Daisy Chain intermediate interconnection nodes are a bit like hubs in the network.
Its common applications are DAS and multi – display

8. Smart phone interconnection



At present, most mobile phones do not support thunderbolt or USB4 standards. When two smart phones are connected, LisLax USB C cable is downgraded to USB 3.x or even USB 2(depend on the smart phone). At this time, one side can charge the other side or share one its storage to the other side for access.

For example, for Android, you can find relevant options in the drop-down menu, such as setting reverse charging or file transfer.