Diseño de sistemas USB

para el entorno de trabajo digital

CRESTRON

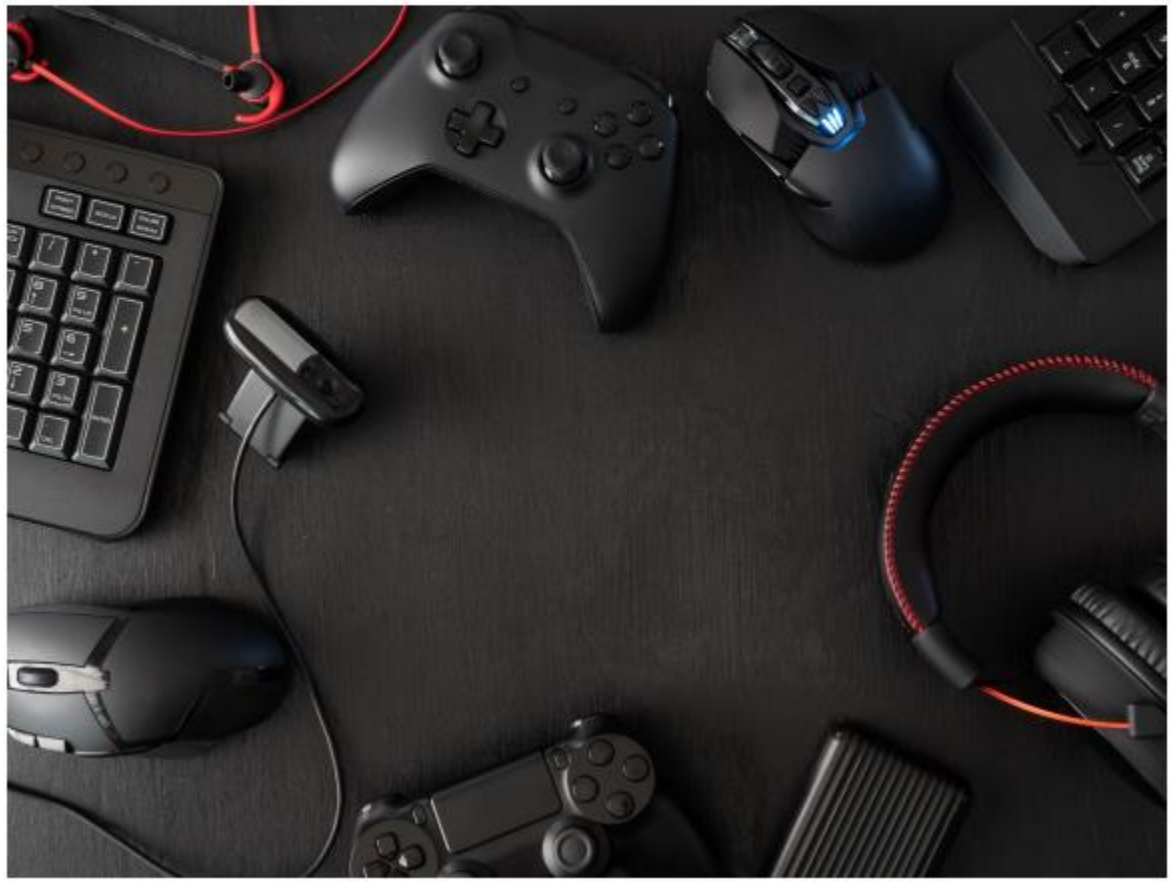
Presentación

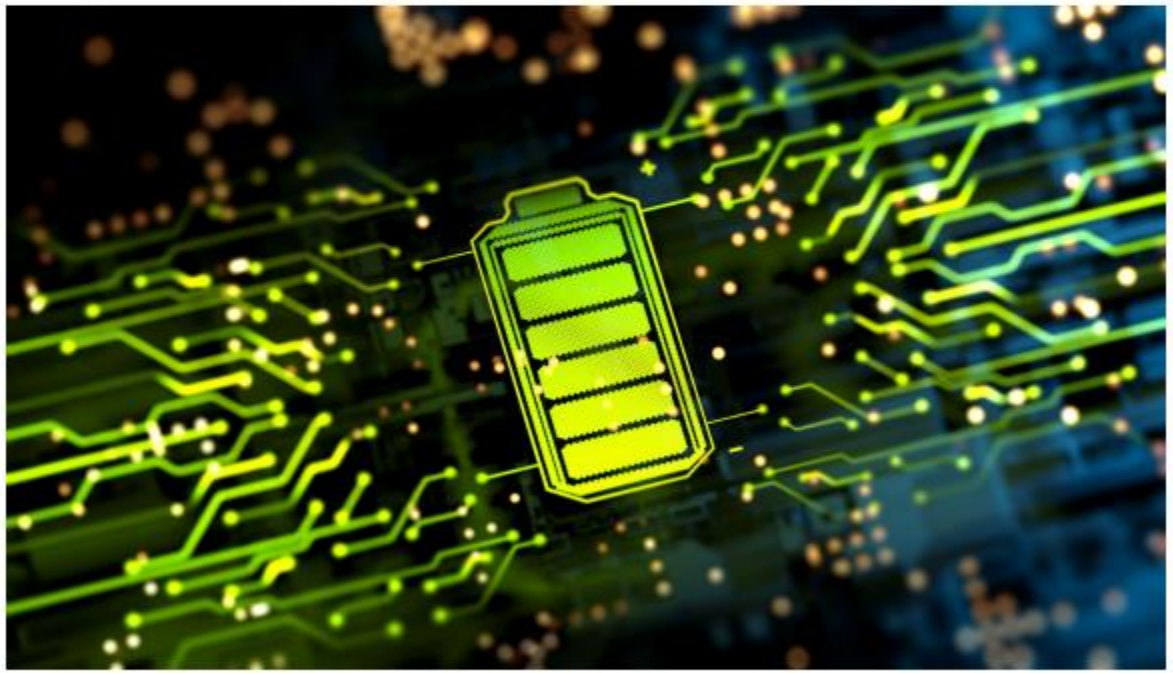
- Oscar García
  - Regional Sales Manager

Agenda

- **Historia de USB**
- **Conectores**
- **Alimentación**
- **Datos**
- **Tiers y Hubs**

USB





Historia

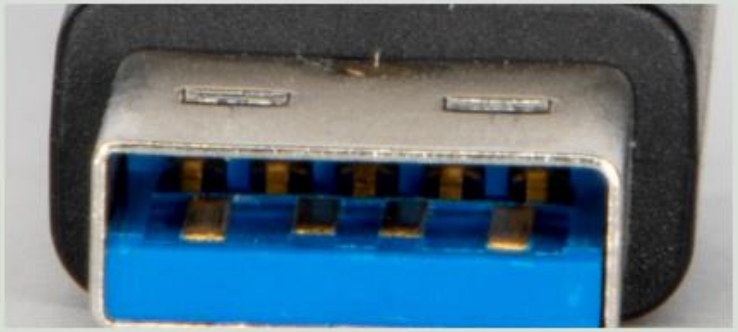
- Un grupo de siete empresas comenzaron el Desarrollo de USB en 1995: Compaq, DEC, IBM, Intel, Microsoft, NEC y Nortel
- Reemplazaría las conexiones propietarias
- Reemplazaría a los puertos serie tradicionales.
- Proporcionaría alimentación.
- Permitiría conexión y desconexión en caliente.

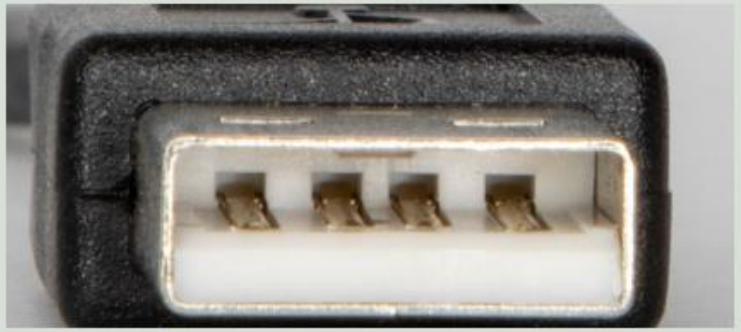
Historia

Name	Release date	Maximum transfer rate	Note
USB 0.7	11 November 1994	?	Pre-release
USB 0.8	December 1994	?	Pre-release
USB 0.9	13 April 1995	Full Speed (12 Mbit/s)	Pre-release
USB 0.99	August 1995	?	Pre-release
USB 1.0-RC	November 1995	?	Release Candidate
USB 1.0	15 January 1996	Full Speed (12 Mbit/s), Low Speed (1.5 Mbit/s)	
USB 1.1	August 1998		
USB 2.0	April 2000	High Speed (480 Mbit/s)	
USB 3.0	November 2008	SuperSpeed USB (5 Gbit/s)	Also referred to as USB 3.1 Gen 1[25] and USB 3.2 Gen 1 × 1
USB 3.1	July 2013	SuperSpeed+ USB (10 Gbit/s)	Includes new USB 3.1 Gen 2,[25] also named USB 3.2 Gen 2 × 1 in later specifications. Last version to support Type A connector.
USB 3.2	August 2017	SuperSpeed+ USB dual-lane (20 Gbit/s)	Includes new USB 3.2 Gen 1 × 2 and Gen 2 × 2 multi-link modes.[36] Requires Type C connector.
USB4	August 2019	40 Gbit/s (2-lane)	Includes new USB4 Gen 2 × 2 (64b/66b encoding) and Gen 3 × 2 (128b/132b encoding) modes and introduces USB4 routing for tunnelling of USB3.x, DisplayPort 1.4a and PCI Express traffic and host-to-host transfers, based on the Thunderbolt 3 protocol

Entendiendo el USB

Conectores





Emparejando Conectores

- Lo universal en las conexiones macho – hembra!!!

Receptacle \ Plug	USB A	USB 3.0 A SS	USB B	USB 3.0 B SS	USB Mini-A	USB Mini-B	USB Micro-A[1]	USB Micro-B	USB 3.0 Micro-B	USB-C
USB A	Yes	Only non-SuperSpeed	No	No	No	No	No	No	No	No
USB 3.0 A SS	Only non-SuperSpeed	Yes	No	No	No	No	No	No	No	No
USB B	No	No	Yes	No	No	No	No	No	No	No
USB 3.0 B SS	No	No	Only non-SuperSpeed	Yes	No	No	No	No	No	No
USB Mini-A	No	No	No	No	Deprecated	No	No	No	No	No
USB Mini-AB	No	No	No	No	Deprecated	Deprecated	No	No	No	No
USB Mini-B	No	No	No	No	No	Yes	No	No	No	No
USB Micro-AB	No	No	No	No	No	No	Yes	Yes	No	No
USB Micro-B	No	No	No	No	No	No	No	Yes	No	No
USB 3.0 Micro-B SS	No	No	No	No	No	No	No	Only non-SuperSpeed	Yes	No
USB-C	No	No	No	No	No	No	No	No	No	Yes

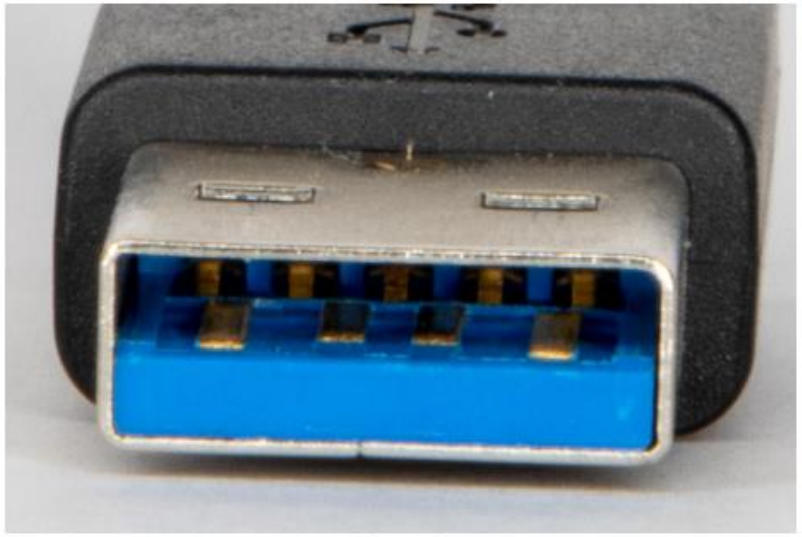
^1 No corresponding Micro-A receptacle was ever designed.

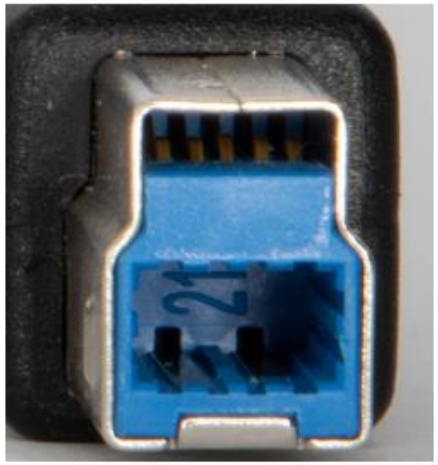
USB 1.1 y USB 2.0

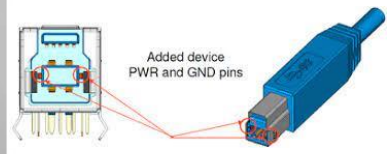
Pins

1. +5vdc
2. Data –
3. Data +
4. Ground

USB 3.0







Pin	Color	Signal name		Description
		A connector	B connector	
Shell	—	Shield		Metal housing
1	Red	VBUS		Power
2	White	D−		USB 2.0 differential pair
3	Green	D+		
4	Black	GND		Ground for power return
5	Blue	StdA_SSRX−	StdB_SSTX−	SuperSpeed receiver differential pair
6	Yellow	StdA_SSRX+	StdB_SSTX+	
7	—	GND_DRAIN		Ground for signal return
8	Purple	StdA_SSTX−	StdB_SSRX−	SuperSpeed transmitter differential pair
9	Orange	StdA_SSTX+	StdB_SSRX+	
The USB 3.0 *Powered-B* connector has two additional pins for power and ground supplied to the device.[53]				
10	—		DPWR	Power provided to device (Powered-B only)
11			DGND	Ground for DPWR return (Powered-B only)

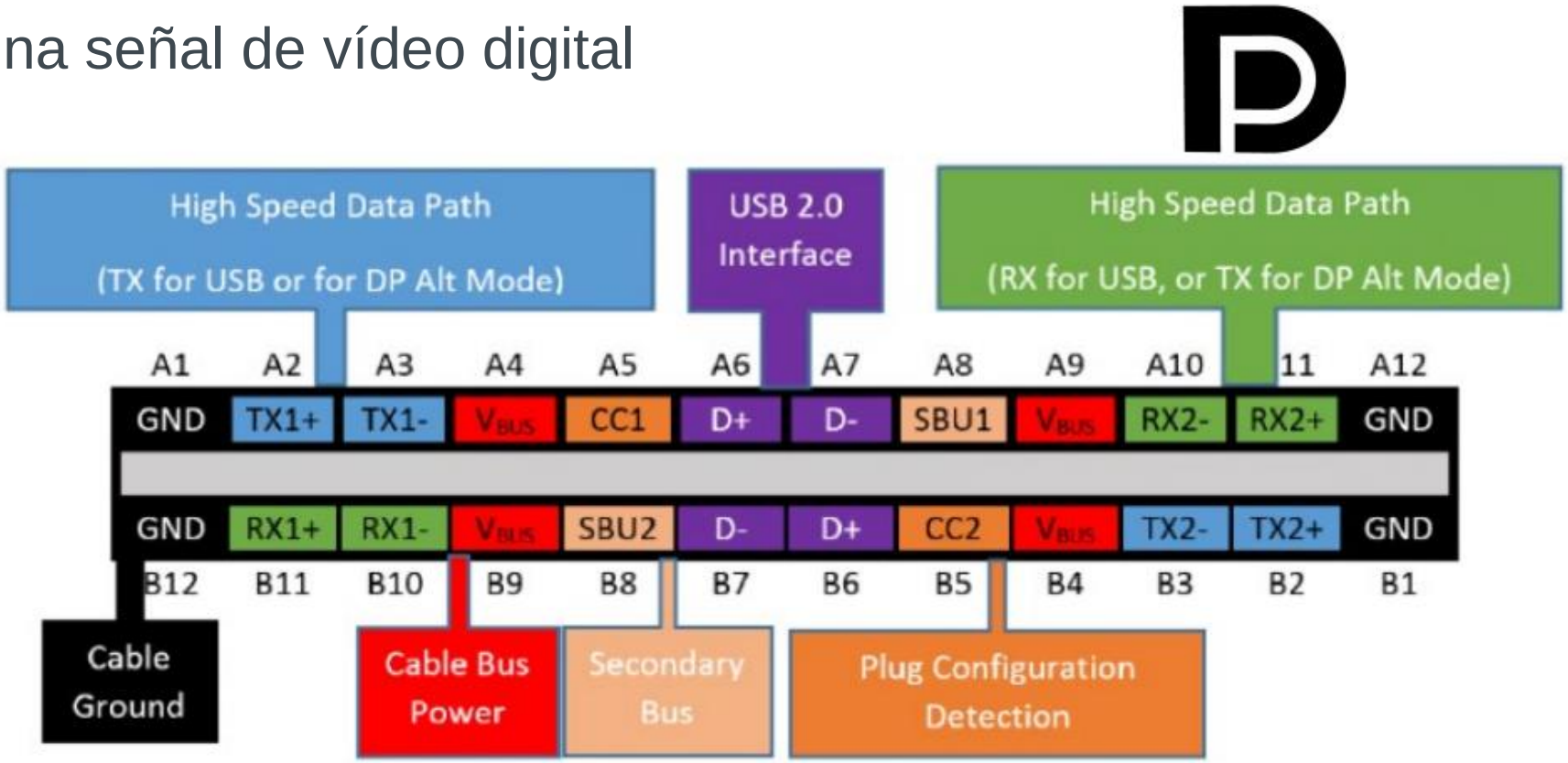
USB-C

Full-featured USB 3.2 and 2.0 Type-C cable wiring

Plug 1, USB Type-C		USB Type-C cable					Plug 2, USB Type-C	
Pin	Name	Wire color	No	Name	Description	2.0[a]	Pin	Name
Shell	Shield	Braid	Braid	Shield	Cable external braid	✓	Shell	Shield
A1, B12, B1, A12	GND	Tin-plated	1	GND_PWRrt1	Ground for power return	✓	A1, B12, B1, A12	GND
			16	GND_PWRrt2		✗		
A4, B9, B4, A9	V_{BUS}	Red	2	PWR_V_{BUS}1	V_{BUS} power	✓	A4, B9, B4, A9	V_{BUS}
			17	PWR_V_{BUS}2		✗		
B5	V_{CONN}	Yellow	18	PWR_V_{CONN}	V_{CONN} power, for powered cables[b]	✓	B5	V_{CONN}
A5	CC	Blue	3	CC	Configuration channel	✓	A5	CC
A6	Dp1	Green	4	UTP_Dp[c]	Unshielded twisted pair, positive	✓	A6	Dp1
A7	Dn1	White	5	UTP_Dn[c]	Unshielded twisted pair, negative	✓	A7	Dn1
A8	SBU1	Red	14	SBU_A	Sideband use A	✗	B8	SBU2
B8	SBU2	Black	15	SBU_B	Sideband use B	✗	A8	SBU1
A2	SSTXp1	Yellow[d]	6	SDPp1	Shielded differential pair #1, positive	✗	B11	SSRXp1
A3	SSTXn1	Brown[d]	7	SDPn1	Shielded differential pair #1, negative	✗	B10	SSRXn1
B11	SSRXp1	Green[d]	8	SDPp2	Shielded differential pair #2, positive	✗	A2	SSTXp1
B10	SSRXn1	Orange[d]	9	SDPn2	Shielded differential pair #2, negative	✗	A3	SSTXn1
B2	SSTXp2	White[d]	10	SDPp3	Shielded differential pair #3, positive	✗	A11	SSRXp2
B3	SSTXn2	Black[d]	11	SDPn3	Shielded differential pair #3, negative	✗	A10	SSRXn2
A11	SSRXp2	Red[d]	12	SDPp4	Shielded differential pair #4, positive	✗	B2	SSTXp2
A10	SSRXn2	Blue[d]	13	SDPn4	Shielded differential pair #4, negative	✗	B3	SSTXn2

Vídeo a través de USB-C

- Displayport Alternate mode.
- Transporta una señal de vídeo digital



Thunderbolt incorpora DP alternate mode

Diseños USB

Ejercicios de diseño

- **Ejercicio 1:** Diseñar una sala Huddle con un display y una barra UC-SB1-CAM que hay que extender a una mesa donde habrá una caja de conexión.

- **Ejercicio 2:** Diseñar una sala Huddle con un display y un Sistema de audio compuesto con un speakerphone de sobremesa y una cámara independiente. Se requiere extension de señal entre la mesa y la cabecera de sala. Se desea tener dos tomas en mesa: una USB-C y otra hdmi+USB-A.

Entendiendo el USB

Alimentación

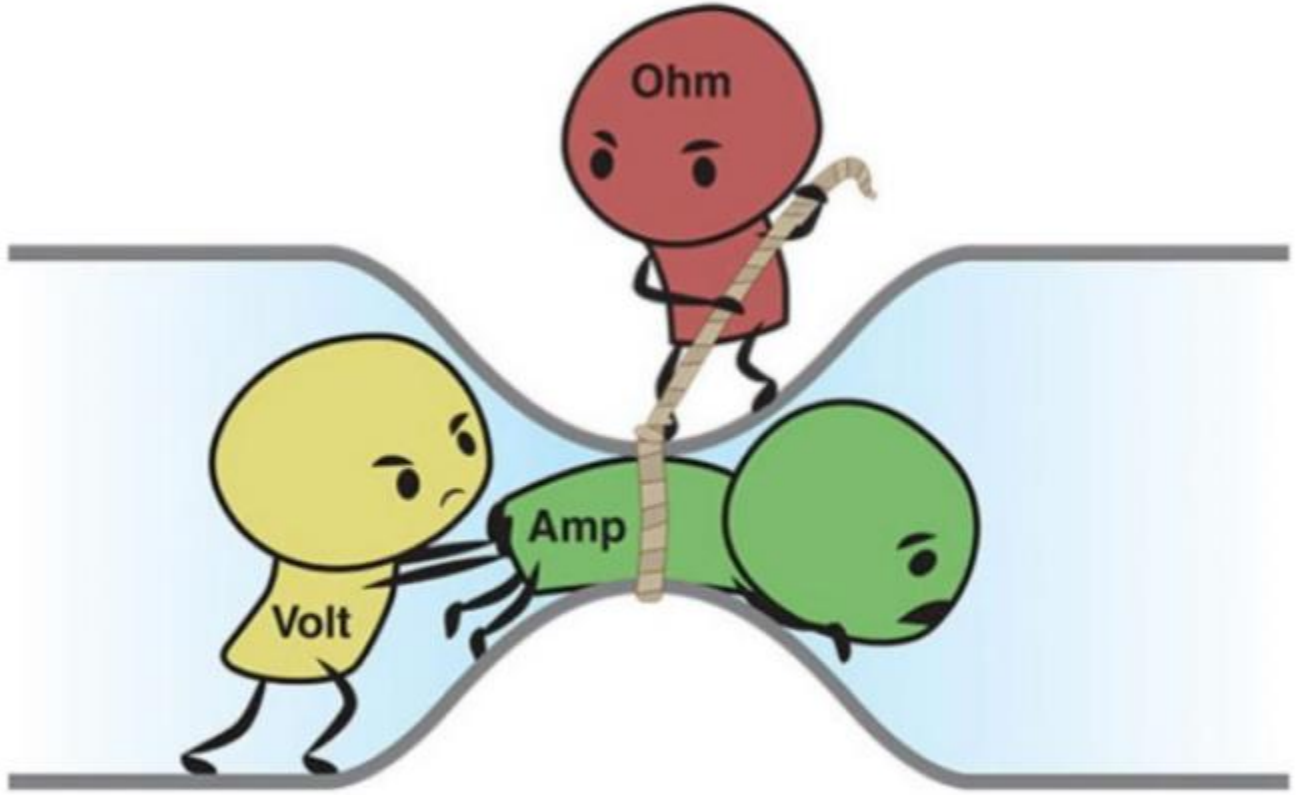
- La potencia que se puede entregar por un conector USB varía y es necesario tenerla en cuenta.
- Los dispositivos tienen una especificación de potencia
- Puede haber dispositivos (Webcams) que requieran una potencia alta.
- Si se conectan varios dispositivos a un hub cada uno de ellos consume potencia.
- La distancia del cable USB también atenua la potencia.

USB power standards

Specification	Current	Voltage	Power (max.)
Low-power device	100 mA	5 V[a]	0.50 W
Low-power SuperSpeed (USB 3.0) device	150 mA	5 V[a]	0.75 W
High-power device	500 mA[b]	5 V	2.5 W
High-power SuperSpeed (USB 3.0) device	900 mA[c]	5 V	4.5 W
Multi-lane SuperSpeed (USB 3.2 Gen 2) device	1.5 A[d]	5 V	7.5 W
Battery Charging (BC) 1.1	1.5 A	5 V	7.5 W
Battery Charging (BC) 1.2	1.5 A	5 V	7.5 W
USB-C	1.5 A	5 V	7.5 W
	3 A	5 V	15 W
Power Delivery 1.0/2.0/3.0 Type-C	5 A[e]	20 V	100 W
Power Delivery 3.1 Type-C	5 A[e]	48 V[f]	240 W

a. ^ a b The V_{BUS} supply from a low-powered hub port may drop to 4.40 V.
b. ^ Up to five unit loads; with non-SuperSpeed devices, one unit load is 100 mA.
c. ^ Up to six unit loads; with SuperSpeed devices, one unit load is 150 mA.
d. ^ Up to six unit loads; with multi-lane devices, one unit load is 250 mA.
e. ^ a b >3 A (>60 W) operation requires an electronically marked cable rated at 5 A.
f. ^ >20 V (>100 W) operation requires an electronically marked Extended Power Range (EPR) cable.

Más potencia y más ancho de banda equivale a limitación de cable



If the amp (current draw) was smaller, it would fit without resistance

Diseños USB

Ejercicios de diseño

- **Ejercicio 3:** Diseñar una sala Huddle con un display y una barra UC-SB1-CAM que hay que extender a una mesa donde habrá una caja de conexión por USB-C y además requieren presentación y videoconferencia inalámbrica mediante USB-C

Entendiendo el USB

Datos

Rate Name	Old Name	First publication (Standard)	Encoding	Data pairs	Nominal Rate	USB-IF Marketing Name[84][85][86]	Logo
Low-Speed		USB 1.0	NRZI	1 HDx	1.5 Mbit/s	Basic-Speed USB	
Full-Speed					12 Mbit/s		
High-Speed		USB 2.0			480 Mbit/s	Hi-Speed USB	
USB 3.2 Gen 1×1	USB 3.0; USB 3.1 Gen 1	USB 3.0	8b/10b	2 FDx	5 Gbit/s	SuperSpeed USB 5Gbps	
USB 3.2 Gen 2×1	USB 3.1 Gen 2	USB 3.1	128b/132b	2 FDx	10 Gbit/s	SuperSpeed USB 10Gbps	
USB 3.2 Gen 1×2		USB 3.2	8b/10b	4 FDx ×2	10 Gbit/s	—	
USB 3.2 Gen 2×2			128b/132b	4 FDx ×2	20 Gbit/s	SuperSpeed USB 20Gbps	
USB4 Gen 2×1		USB4	64b/66b[a]	2 FDx	10 Gbit/s	—	
USB4 Gen 2×2			64b/66b[a]	4 FDx ×2	20 Gbit/s	USB4 20Gbps	
USB4 Gen 3×1			128b/132b[a]	2 FDx	20 Gbit/s	—	
USB4 Gen 3×2			128b/132b[a]	4 FDx ×2	40 Gbit/s	USB4 40Gbps	

Tipos de transmission de Datos

- **Tranferencia isócrona:** Garantizan un data rate permanente (para hacer streaming de datos con un ancho de banda fijo) pero pueden tener pérdidas de datos (audio y video en tiempo real)
- **Tranferencia interrumpida:** Dispositivos que necesitan garantizar respuestas rápidas (sin latencia) como ratones y teclados (HID).
- **Bulk transfer:** Transferencias esporádicas y muy grandes de datos que usan el ancho de banda disponible por el controlador en ese momento sin necesidad de un ancho de banda garantizado o transferencias sin latencia.

Enumeración

- Cuando un dispositivo USB se conecta por primera vez a un host controller USB comienza el proceso de enumeración.
- La enumeración comienza enviando una señal de reset al dispositivo USB.
- También se determina la clase de dispositivo (*Device Class*)
- El bitrate del dispositivo USB se determina durante este reseteo.
- Tras el reset, la información del dispositvo USB se lee por el host y se asigna al dispositivo una dirección única de 7 bits.
- Como máximo se pueden manejar 127 dispositivos con direcciones de 7 bits.

Clases de dispositivos (*Device class*)

Class	Usage	Description	Examples, or exception
00h	Device	Unspecified[46]	Device class is unspecified, interface descriptors are used to determine needed drivers
01h	Interface	Audio	Speaker, microphone, sound card, MIDI
02h	Both	Communications and CDC control	UART and RS-232 serial adapter, Modem, Wi-Fi adapter, Ethernet adapter. Used together with class 0Ah *(CDC-Data)* below
03h	Interface	Human interface device (HID)	Keyboard, mouse, joystick
05h	Interface	Physical interface device (PID)	Force feedback joystick
06h	Interface	Image (PTP/MTP)	Scanner
07h	Interface	Printer	Laser printer, inkjet printer, CNC machine
08h	Interface	USB mass storage, USB Attached SCSI	USB flash drive, memory card reader, digital audio player, digital camera, external drive
09h	Device	USB hub	High speed USB hub
0Ah	Interface	CDC-Data	Used together with class 02h *(Communications and CDC Control)* above
0Bh	Interface	Smart Card	USB smart card reader
0Dh	Interface	Content security	Fingerprint reader
0Eh	Interface	Video	Webcam
0Fh	Interface	Personal healthcare device class (PHDC)	Pulse monitor (watch)
10h	Interface	Audio/Video (AV)	Webcam, TV
11h	Device	Billboard	Describes USB-C alternate modes supported by device
DCh	Both	Diagnostic device	USB compliance testing device
E0h	Interface	Wireless Controller	Bluetooth adapter, Microsoft RNDIS
EFh	Both	Miscellaneous	ActiveSync device
FEh	Interface	Application-specific	IrDA Bridge, Test & Measurement Class (USBTMC),[47] USB DFU (Device Firmware Upgrade)[46]
FFh	Both	Vendor-specific	Indicates that a device needs vendor-specific drivers

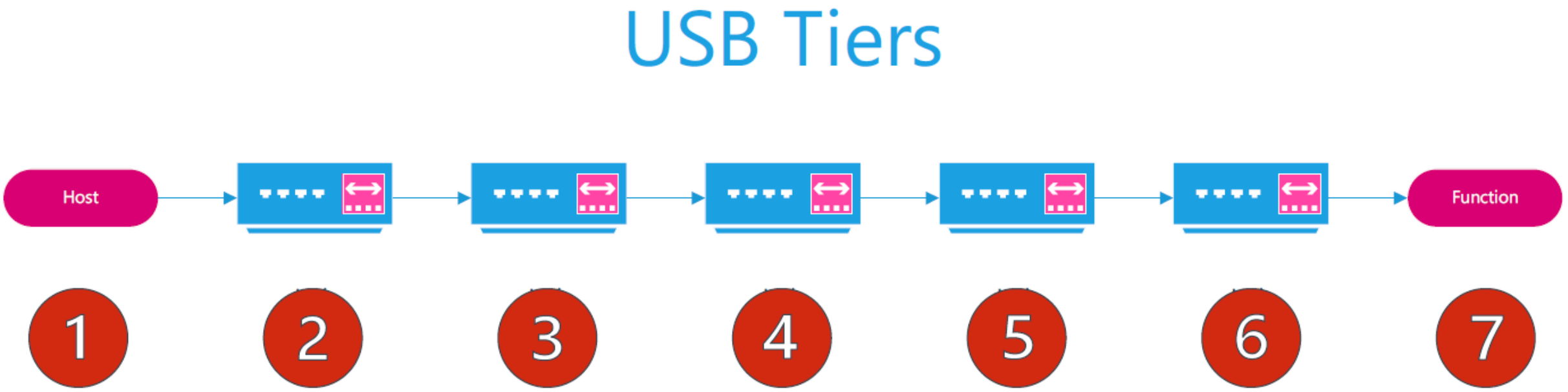
Diseños USB

Ejercicios de diseño

- **Ejercicio 4:** Diseñar un Sistema en el que es necesario tener multiples tomas BYOD en una mesa de presidencia y utilizar la misma cámara y el Sistema de captación de audio con un Sistema MTR.

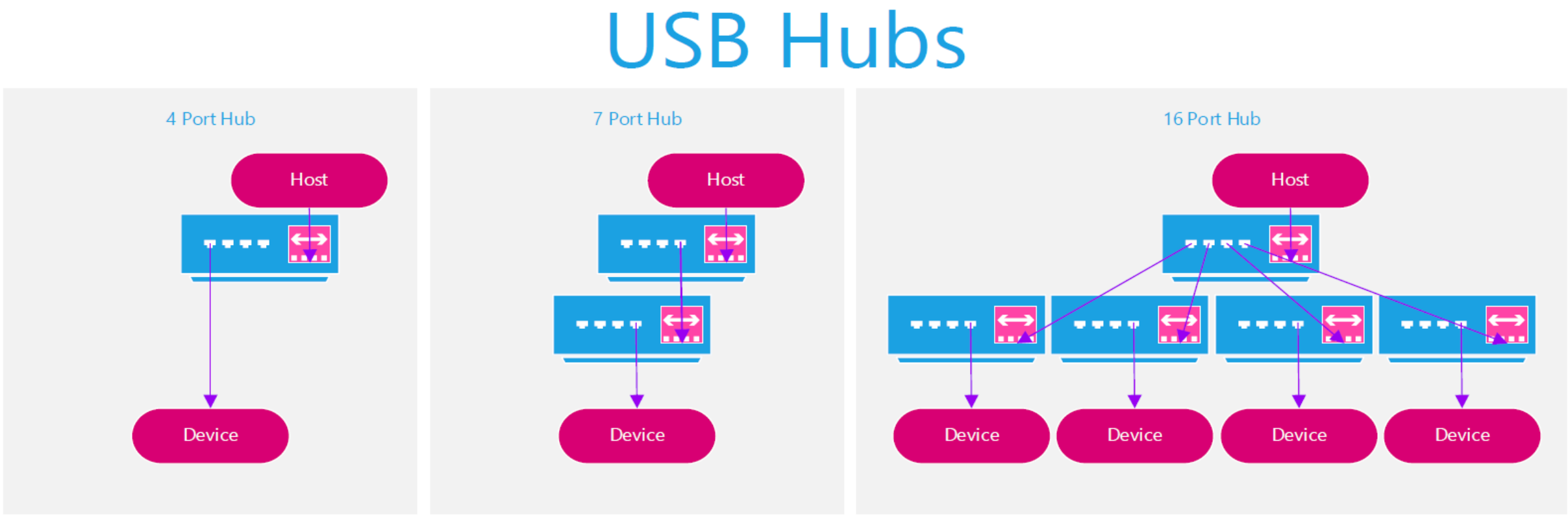
Entendiendo el USB

Tiers USB



Entendiendo el USB

Hubs USB


USB Hubs
4 Port Hub
Host
Device
7 Port Hub
Host
Device
16 Port Hub
Host
Device
Device
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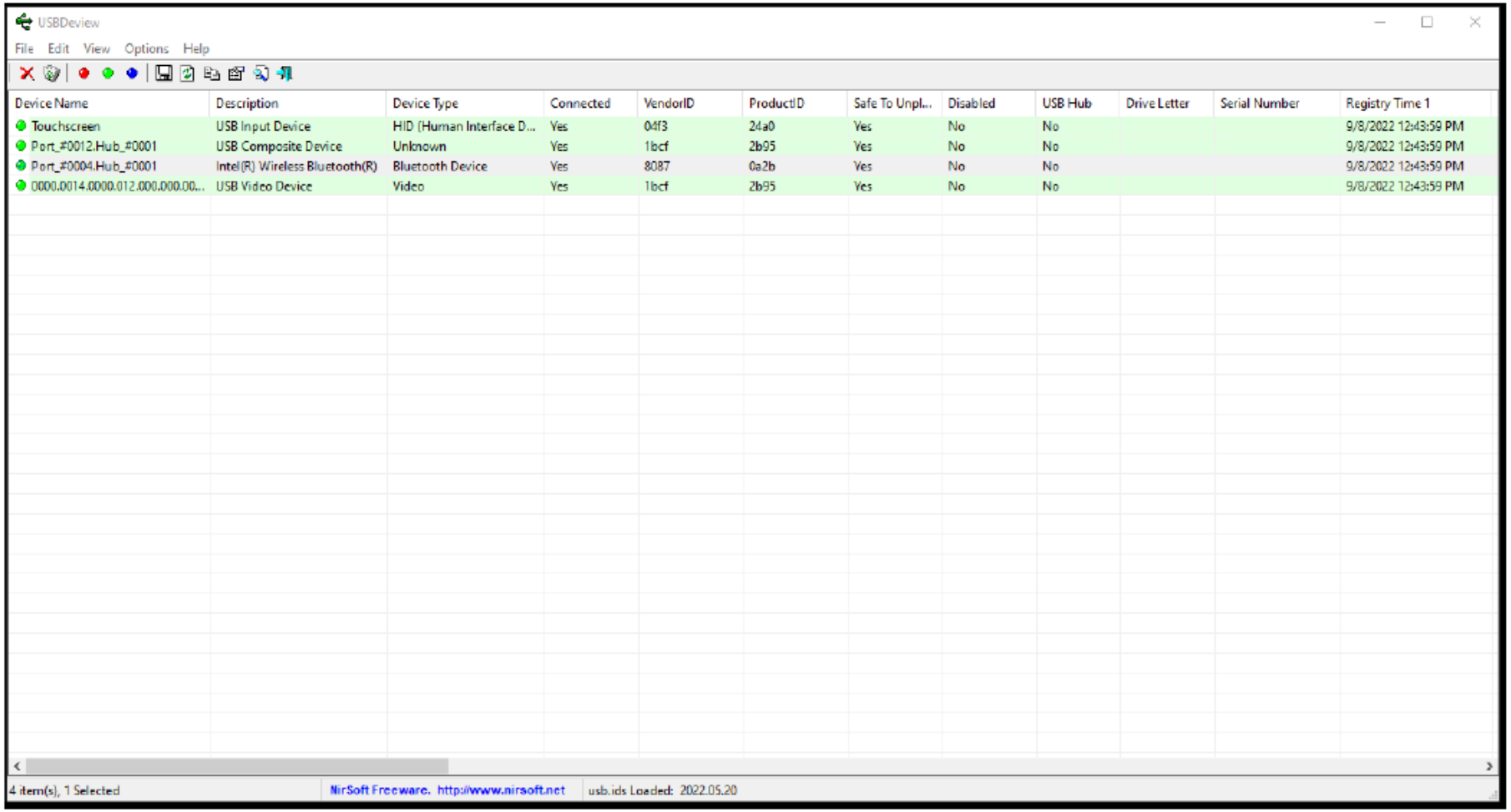
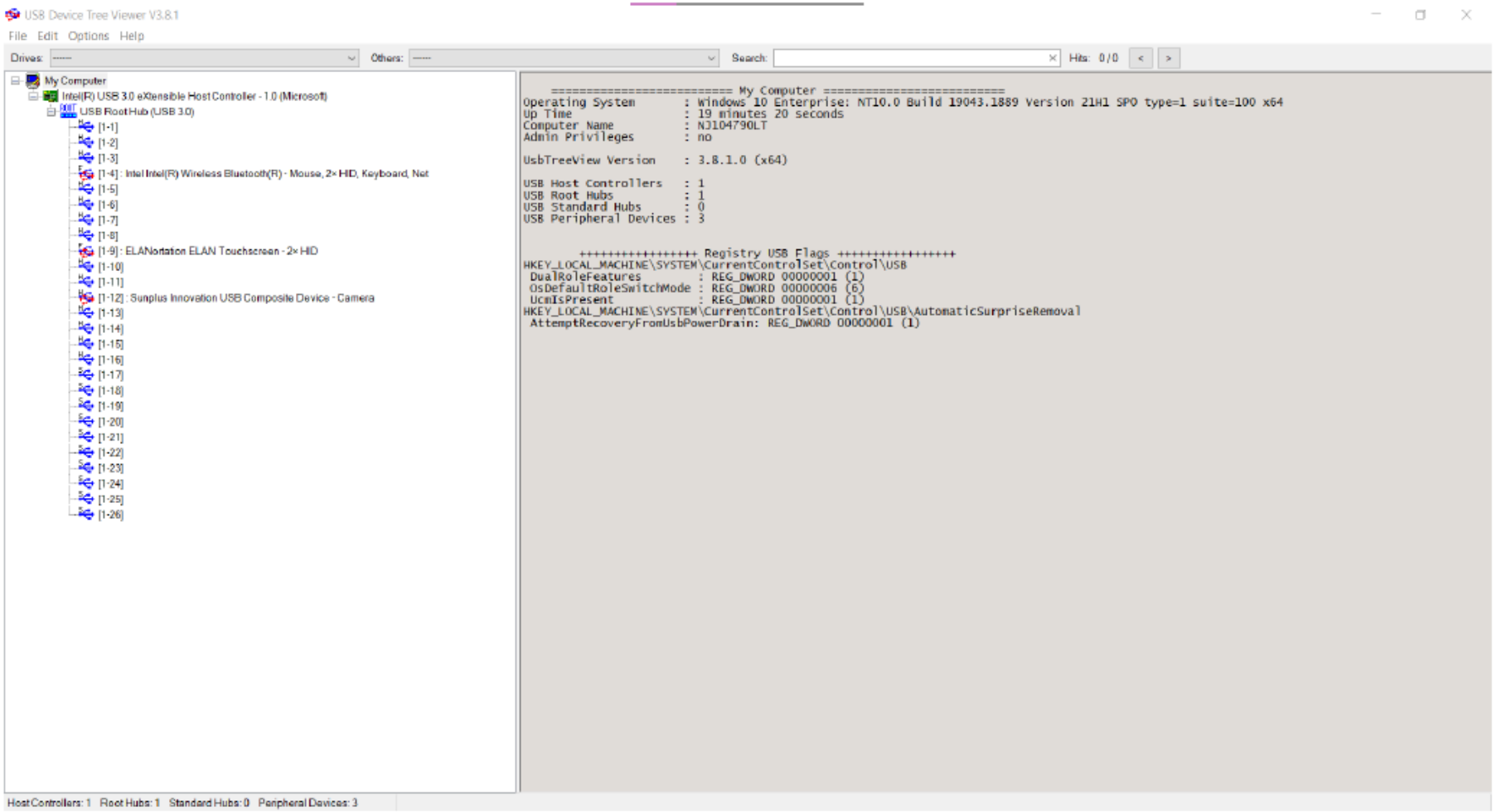
Device

USBDeview


USBDeview
File Edit View Options Help
Device Name | Description | Device Type | Connected | VendorID | ProductID | Safe To Unpl... | Disabled | USB Hub | Drive Letter | Serial Number | Registry Time 1
Touchscreen | USB Input Device | HID (Human Interface D... | Yes | 04f3 | 24a0 | Yes | No | No | | | 9/8/2022 12:43:59 PM
Port_#0012.Hub_#0001 | USB Composite Device | Unknown | Yes | 1bcf | 2b95 | Yes | No | No | | | 9/8/2022 12:43:59 PM
Port_#0004.Hub_#0001 | Intel(R) Wireless Bluetooth(R) | Bluetooth Device | Yes | 8087 | 0a2b | Yes | No | No | | | 9/8/2022 12:43:59 PM
0000.0014.0000.012.000.000.00... | USB Video Device | Video | Yes | 1bcf | 2b95 | Yes | No | No | | | 9/8/2022 12:43:59 PM
4 item(s), 1 Selected
NirSoft Freeware. http://www.nirsoft.net
usb.ids Loaded: 2022.05.20

USB Device Tree view



Entendiendo el USB