

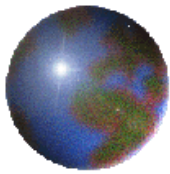
Universal Serial Bus



- Teknik Antarmuka Komputer -

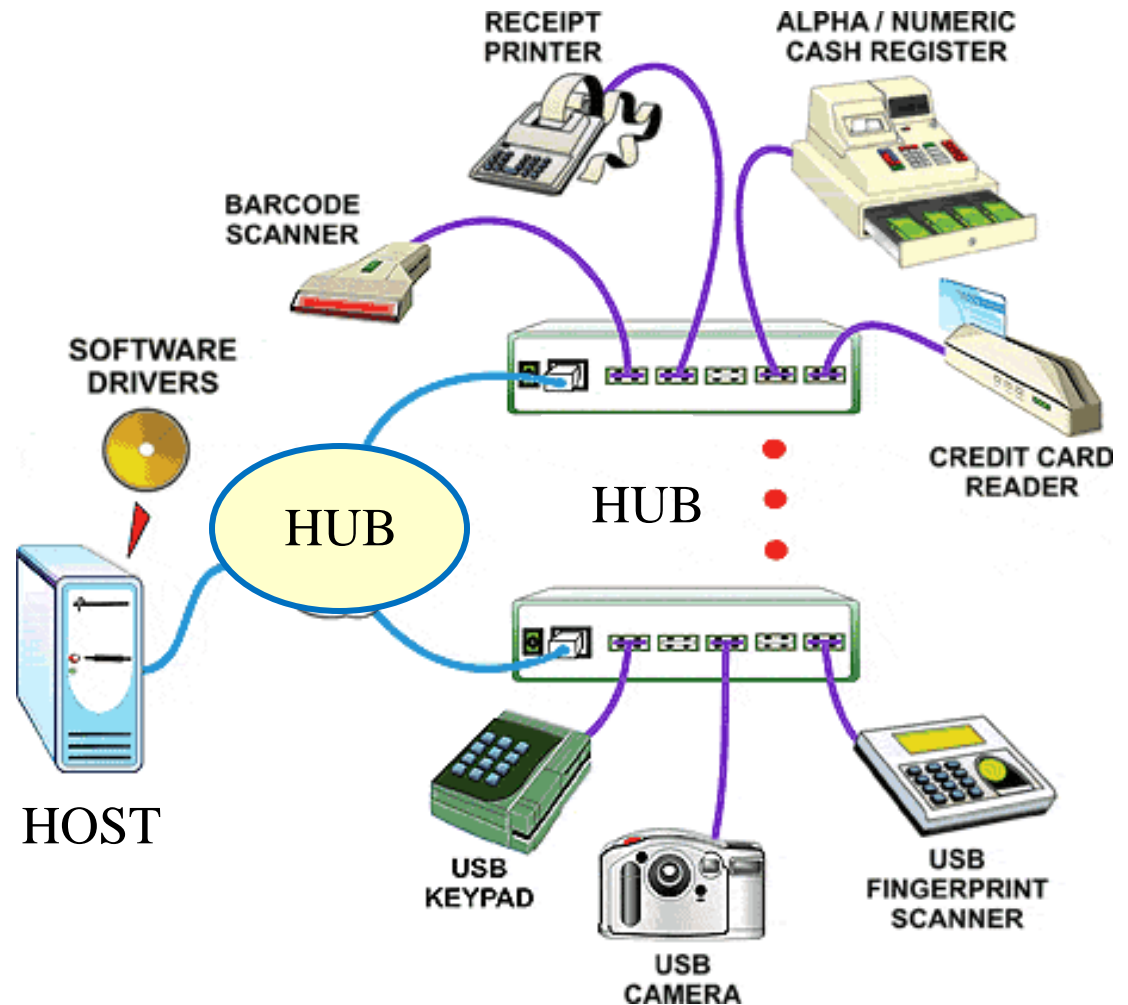


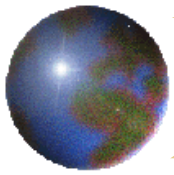
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Brawijaya University



USB Overview

- ✚ HOST
- ✚ HUB
- ✚ DEVICES
(127 max)





USB Progress

✚ USB 1.0

Low Speed (1.5 Mbps)

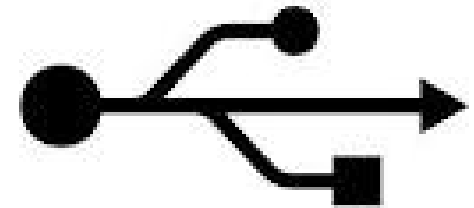
Full Speed (12 Mbps)

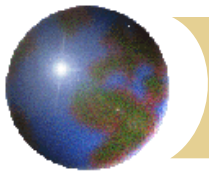
✚ USB 2.0

High Speed (480 Mbps)

✚ USB 3.0

Super Speed (5 Gbps)

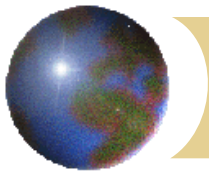




Spesifikasi



- ✦ Sinyal: 5 volt DC
- ✦ max. voltage: 5 V ($\pm 5\%$)
- ✦ max. current: 500-900 mA
- ✦ Cable: 4 wires (8 wires for superspeed)
- ✦ Protocol: **Serial**
- ✦ Connector: Unique
- ✦ Designer: **Compaq, DEC, IBM, Intel, Microsoft, NEC and Nortel**

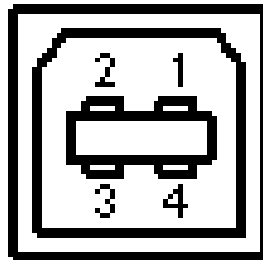


Hardware Specification

(PIN OUT)

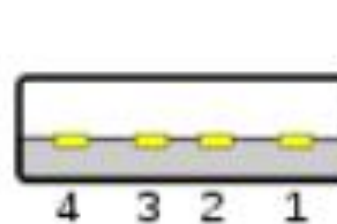


A type
(to Host)

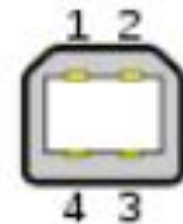


B type
(to Device)

Pin	Name	Cable color	Description
1	VBUS	Red	+5 V
2	D-	White	Data -
3	D+	Green	Data +
4	GND	Black	Ground



Type A



Type B



Mini-A



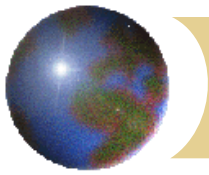
Mini-B



Micro-A



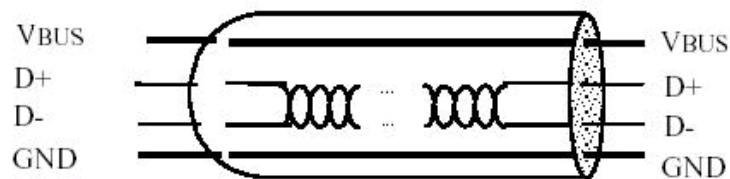
Micro-B

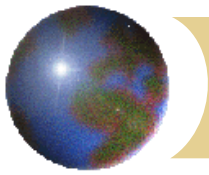


Connector



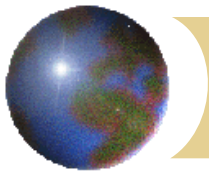
D+/D- Twisted Pair





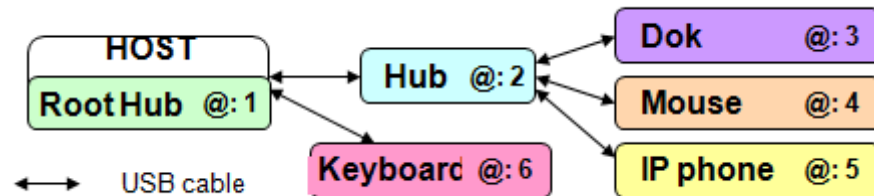
The Transaction Protocol is Host Based

- ⊗ Host based token polling
 - ⊗ Data from host-to-function and function-to-host
 - ⊗ Host handles most of the protocol complexity
 - ⊗ Peripheral design is simple and low-cost
- ⊗ Robustness
 - ⊗ Handshake to acknowledge data transfer and flow control
 - ⊗ Very low raw physical bit error rate ($< 10^{-10}$)
 - ⊗ CRC protection plus hardware retry option
 - ⊗ Data toggle Sequence bits
- ⊗ Bounded transfer characteristics
 - ⊗ Data transfer bandwidth and latency prenegociated
 - ⊗ Flow control for peripheral buffer management
- ⊗ No asynchronous message/interrupt from the peripheral

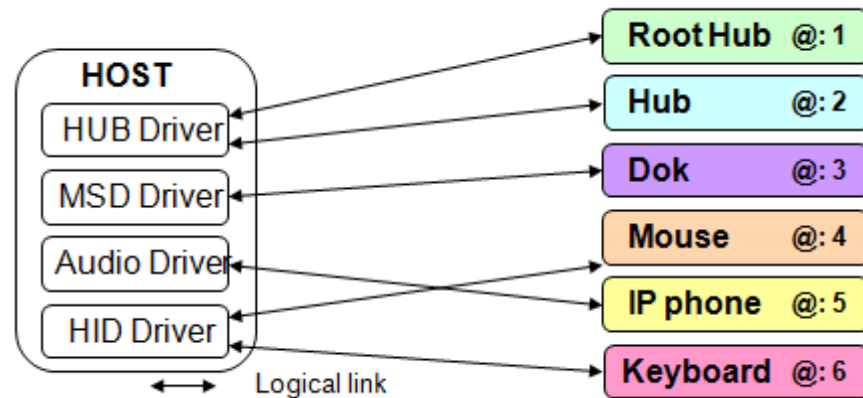


USB Topology

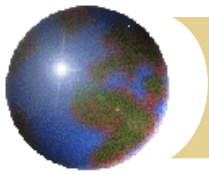
- ✿ A unique device address is assigned to each USB device
- ✿ Physical tiered star network:



- Logical network:



- Each device sees all traffic generated by the host
- A device does not see data sent by another peripheral

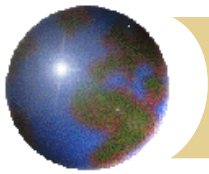


USB Transfer

- ⊗ A device has several endpoints
- ⊗ Each endpoint is assigned to a logical pipe with the host
- ⊗ Each pipe is characterized by:
 - ⊠ Device address
 - ⊠ Endpoint number
 - ⊠ Transfer type
- ⊗ Transfer type:

Type	Direction	Packets per frame	Max Packet Size
Control	Bidir	Several	64 Bytes
Bulk	Unidir	Several	64 Bytes
Isochronous	Unidir	One	1024 Bytes
Interrupt	Unidir	One max	64 Bytes

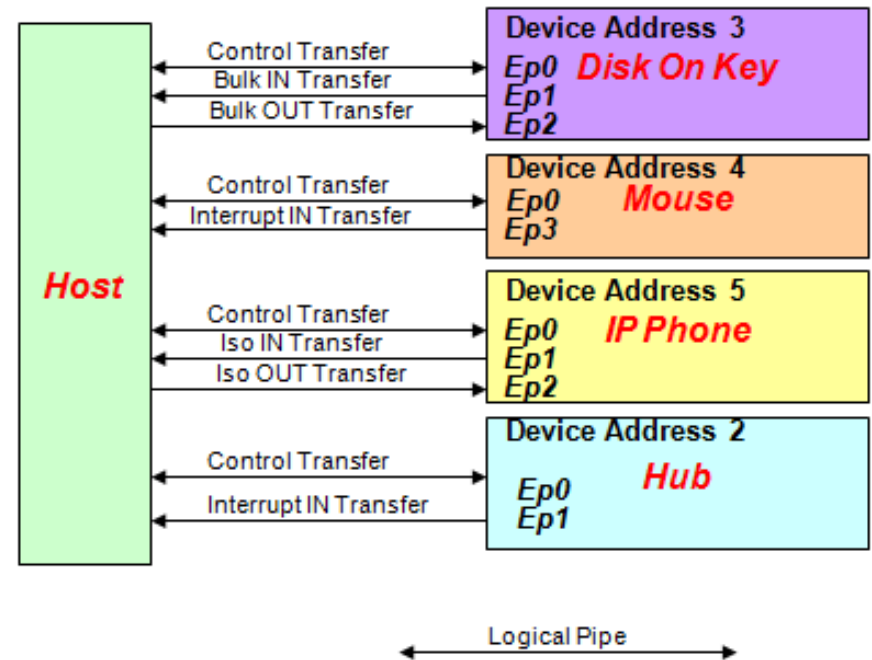
- Control: configuration/command/status type communication
- Bulk: large amounts of data at highly variable times
- Isochronous: constant-rate, error tolerant transfers
- Interrupt: send or receive data infrequently but with bounded service periods

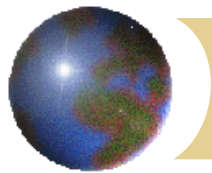


USB Pipe

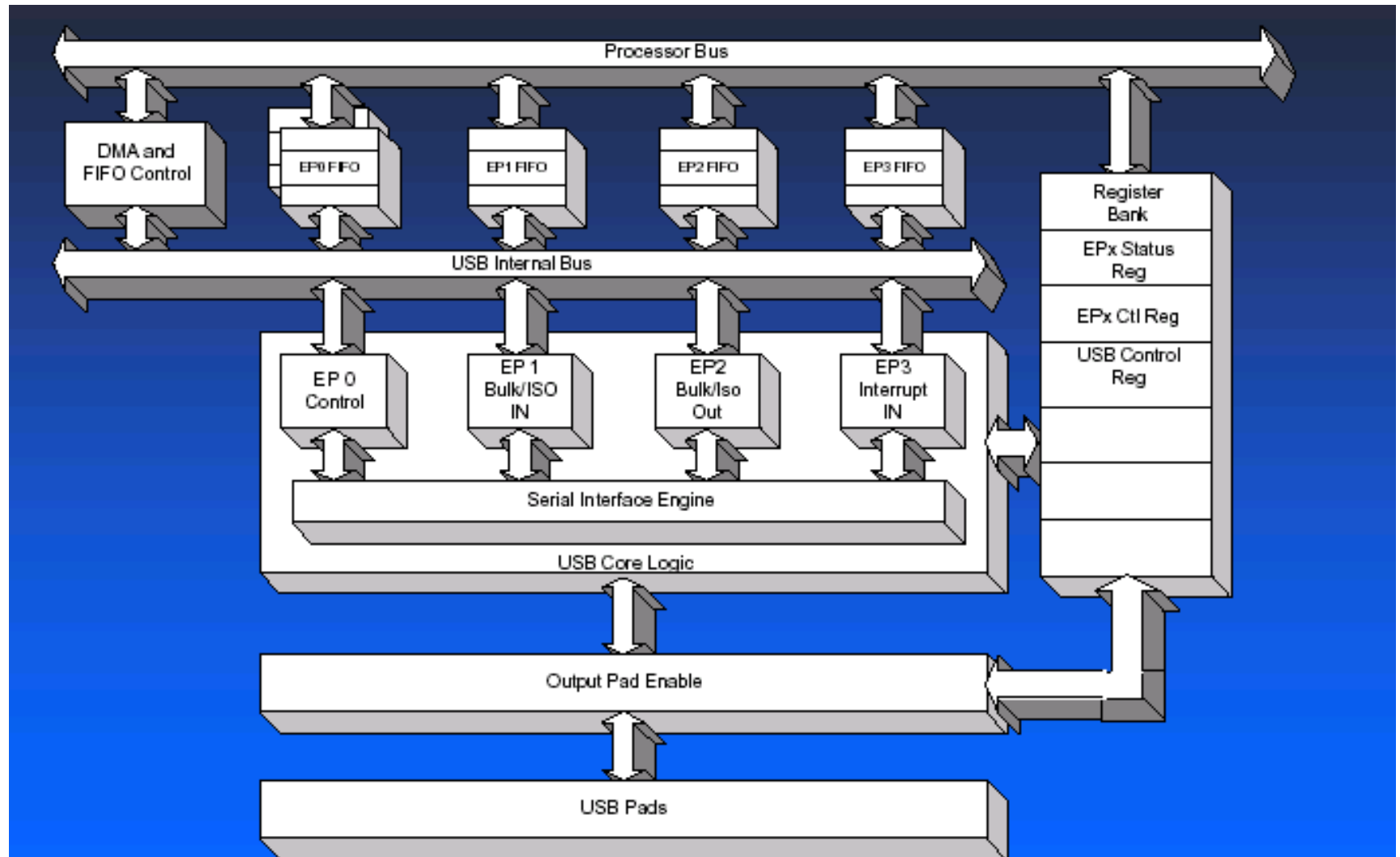
- ⊕ Device address is affected by the host
- ⊕ Endpoint configuration depends on the device implementation
- ⊕ Time multiplexing of transfer is under host control

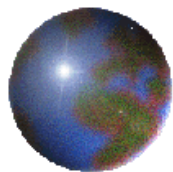
✓ Transfer	F	Bulk	ADDR	ENDP	Bytes Transferred
20	S	OUT	2	1	31
✓ Transfer	F	Bulk	ADDR	ENDP	Bytes Transferred
21	S	IN	2	2	36
✓ Transfer	F	Bulk	ADDR	ENDP	Bytes Transferred
22	S	IN	2	2	13
✓ Transfer	F	Bulk	ADDR	ENDP	Bytes Transferred
23	S	OUT	2	1	31





USB Controller





USB transactions

- A transfer is composed of one or several transactions
- Example of control transfer (several transactions)

Transfer	F	Control	ADDR	ENDP	bRequest	wValue	wIndex	Data	Time Stamp
19	S	GET	2	0	0xFE	0x0000	0x0000	1 byte	00003.6908 7345

Transaction	F	SETUP	ADDR	ENDP	T	D	TP	R	bRequest	wValue	wIndex	wLength	ACK	Time	Time Stamp
67	S	0xB4	2	0	0	D->H	C	I	0xFE	0x0000	0x0000	1	0x4B	24.417 μ s	00003.6908 7345

Transaction	F	IN	ADDR	ENDP	T	Data	ACK	Time	Time Stamp
68	S	0x96	2	0	1	1 byte	0x4B	20.417 μ s	00003.6909 1310

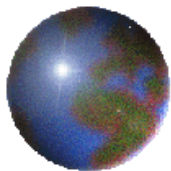
Transaction	F	OUT	ADDR	ENDP	T	Data	ACK	Time	Time Stamp
69	S	0x87	2	0	1	0 bytes	0x4B	234.250 μ s	00003.6909 2535

} Setup Stage
 } Data Stage
 } Status Stage

- Example of bulk transfer (one transaction)

Transfer	F	Bulk	ADDR	ENDP	Bytes Transferred	Time Stamp
20	S	OUT	2	1	31	00003.6911 1590

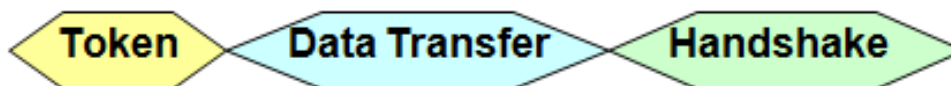
Transaction	F	OUT	ADDR	ENDP	T	Data	ACK	Time	Time Stamp
70	S	0x87	2	1	0	31 bytes	0x4B	192.083 μ s	00003.6911 1590



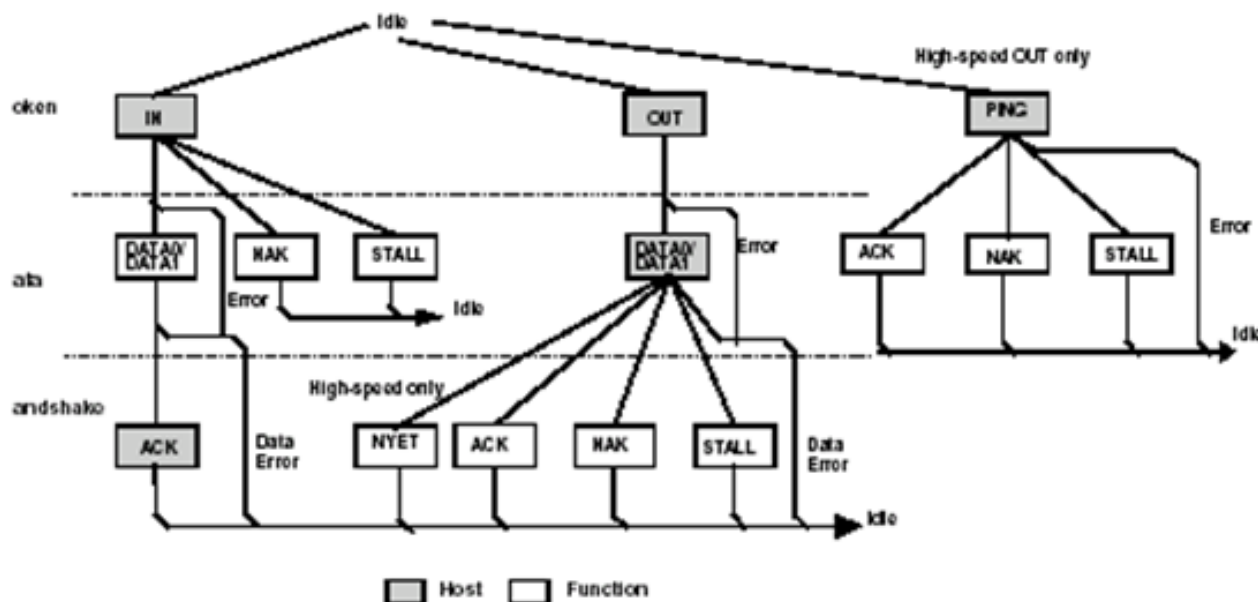
USB Transactions (1)

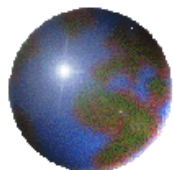
■ A transaction is made of 3 packets

- Token: device address, endpoint number, transfer type
- Data : data to be sent
- Handshake: acknowledge



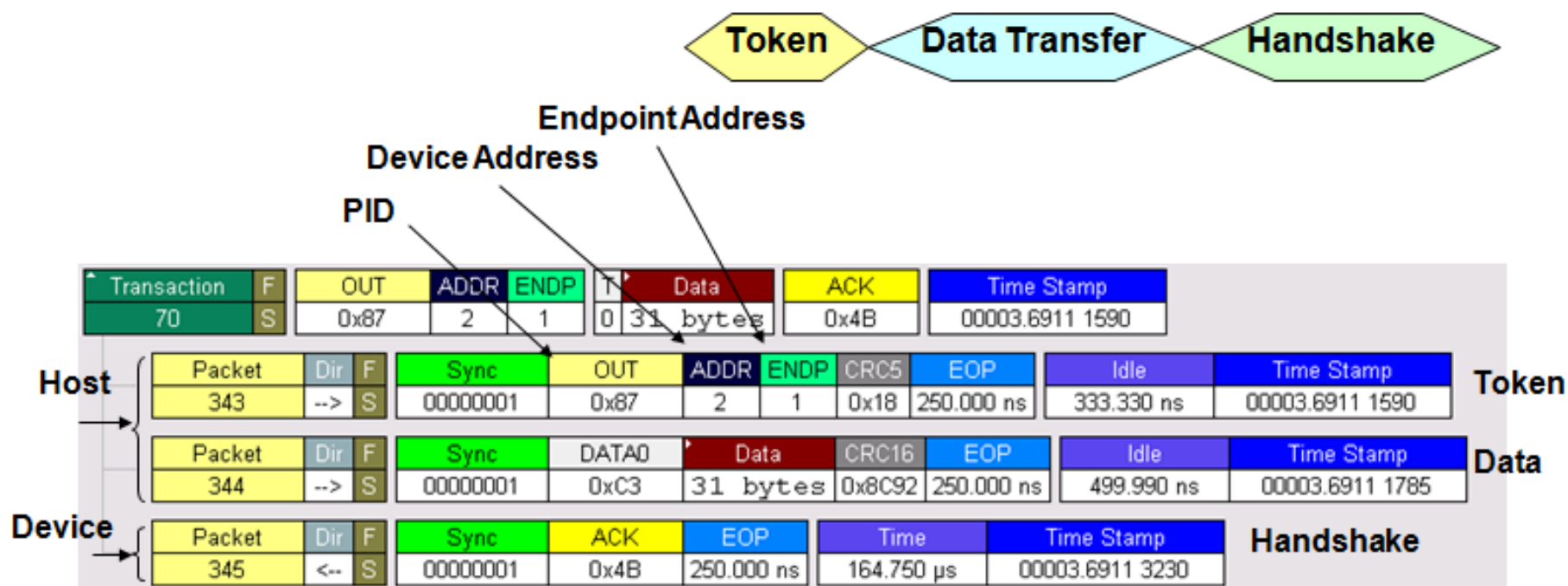
■ Example of bulk transaction:

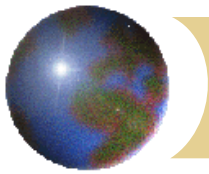




USB Transactions (2)

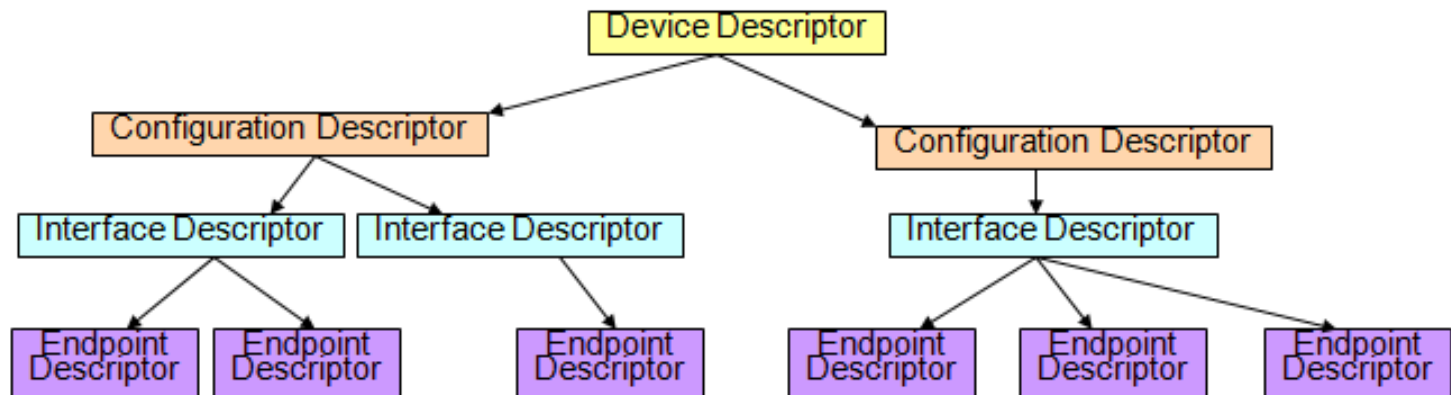
- Example of bulk OUT transaction:

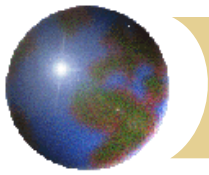




Device descriptor

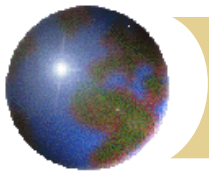
- ❖ The USB Host stacks uses the descriptor retrieved from the device to find the corresponding driver.
- ❖ Windows looks for a matching Vendor ID/Product ID in its .inf library
- ❖ If not found, it will search for a matching class driver
- ❖ If not found then it will request the user to insert a CD to install the corresponding driver





USB class drivers

- ✿ Building on top of the USB specifications, there are Device Class Specifications from the Device Working Group
- ✿ Matching device class requirements allow use of standard host class drivers provided by Windows or Linux
- ✿ Each class driver specifies the endpoint configurations required
- ✿ Existing class drivers:
 - ✦ Audio class (speakers, ...)
 - ✦ HID (keyboard, mouse, ...)
 - ✦ Mass Storage (disk on key)
 - ✦ Printer class
 - ✦ Smart Card CCID
 - ✦ Communication Data Class



tugas

- ✚ CRC (penjelasan, jenis, prosedur)
- ✚ Data toggle sequence (NRZI)