Network Computing courses

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ENSIBS - UBS

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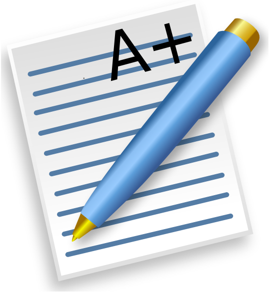
Course details

Objectives

- How do *computers* communicate?
- What are the mechanisms **under** an HTTP request or a telegram message?
- Networks are all around us, better study them!

Course details



Evaluation

- Short test at the beginning of every lesson (5 min) ?
- Project
- Final exam (1 hour)
- All same weighting

Material

- Slides available at teaching.auzias.net (github too)

Presentation Outline

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- **IP:** Internet **Protocol** provides the functions necessary to deliver a package of bits from a source to a destination over a network
- **(world wide) Web: network** consisting of a collection of Internet websites using HTTP

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- **RFC:** Request For Comments (Internet Draft (ID), RFC, Internet Standard)

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- **NAT:** Network Address Translation, router modifying IP address into another IP address.

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- **Thin client: application** where most functions are carried out on a central server

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- **WAN:** Wide Area Networks cover a broad area (Internet)

Topologies

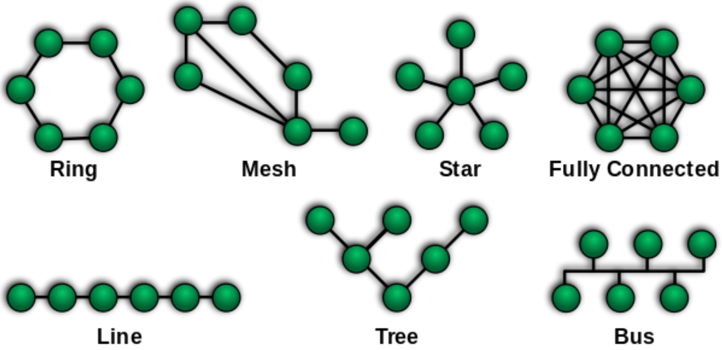

Figure: upload.wikimedia.org

Topologies

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- **Tree:** hierarchical topology, such as a binary tree.

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Bonus

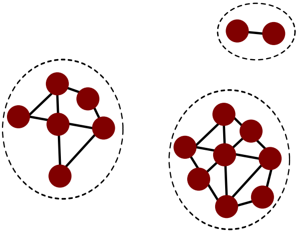

Figure: Disconnected MANET illustration [1]

Bonus

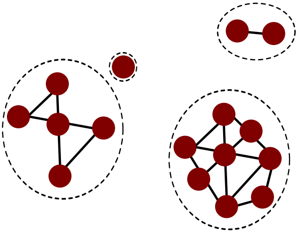

Figure: Store-carry-and-forward [1]

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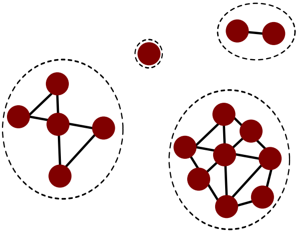

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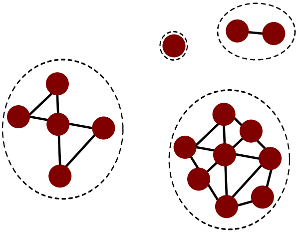

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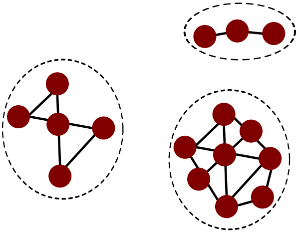

Figure: Store-carry-and-forward [1]

HTTP request/response example

Enter getbootstrap.com in your browser

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Source	Destination	Protocol	Length	Info
192.168.0.48	208.67.222.222	DNS	76	Standard query 0x4797 A getbootstrap.com
208.67.222.222	192.168.0.48	DNS	108	Standard query response 0x4797 A 192.30.252.154 A 192.30.252.153

Figure: DNS request/response

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Source	Destination	Protocol	Length	Info
127.0.0.1	127.0.0.13	TCP	74	36159 > http [SYN] Seq=0 Win=43690 Len=0 MSS=65495 SACK_PERM=1 TSval=12
127.0.0.13	127.0.0.1	TCP	74	http > 36159 [SYN, ACK] Seq=0 Ack=1 Win=43690 Len=0 MSS=65495 SACK_PERM
127.0.0.1	127.0.0.13	TCP	66	36159 > http [ACK] Seq=1 Ack=1 Win=43776 Len=0 TSval=122257 TSecr=12225
127.0.0.1	127.0.0.13	HTTP	356	GET /index.html HTTP/1.1
127.0.0.13	127.0.0.1	TCP	66	http > 36159 [ACK] Seq=1 Ack=291 Win=44800 Len=0 TSval=122259 TSecr=122
127.0.0.13	127.0.0.1	HTTP	354	HTTP/1.1 200 OK (text/html)
127.0.0.1	127.0.0.13	TCP	66	36159 > http [ACK] Seq=291 Ack=289 Win=44800 Len=0 TSval=122259 TSecr=1
127.0.0.1	127.0.0.13	HTTP	357	GET /favicon.ico HTTP/1.1
127.0.0.13	127.0.0.1	HTTP	565	HTTP/1.1 404 Not Found (text/html)
127.0.0.1	127.0.0.13	TCP	66	36159 > http [ACK] Seq=582 Ack=788 Win=45952 Len=0 TSval=122269 TSecr=1

Figure: HTTP request/response

How do messages reach their destination?

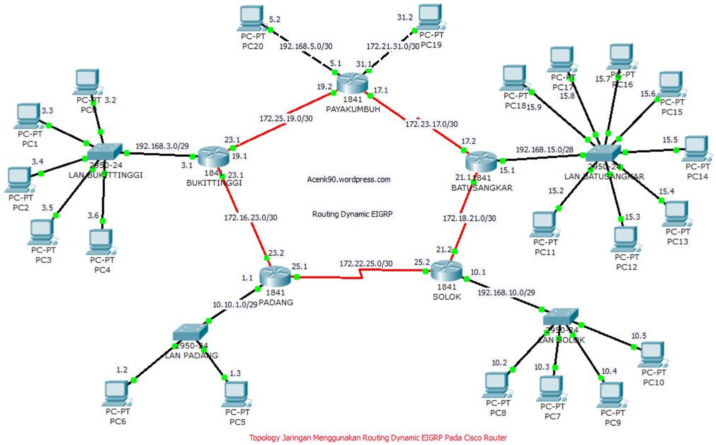


Figure: acenk90.files.wordpress.com

More like this...

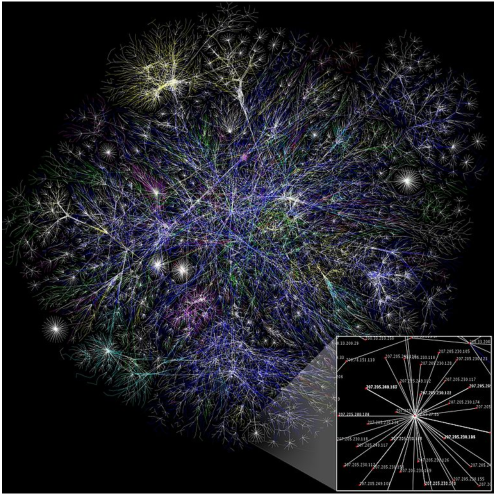


Figure: wikimedia.org

How does it work? From signal to application...

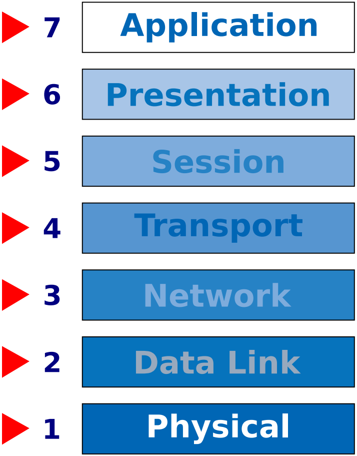
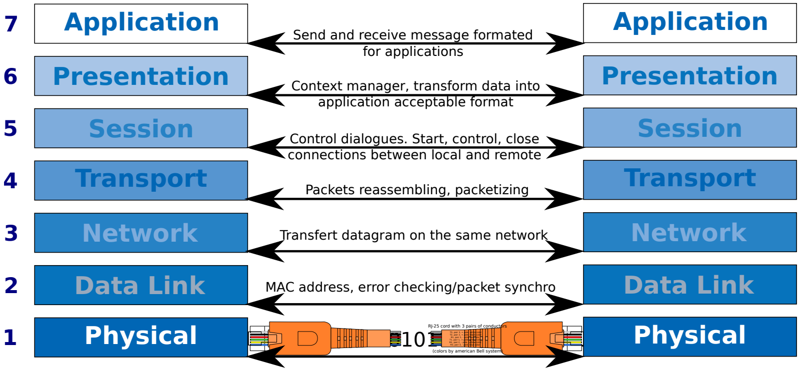
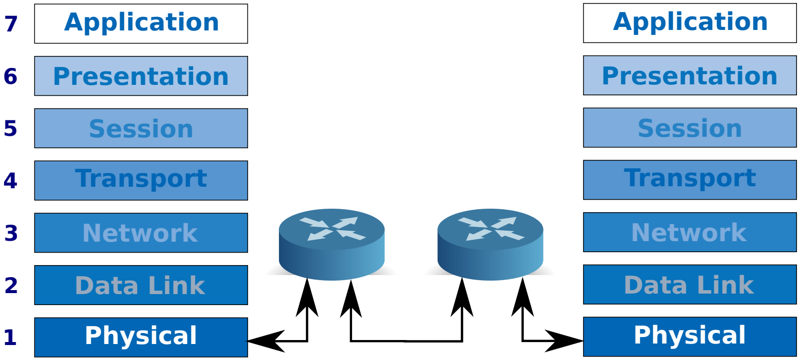


Figure: OSI model

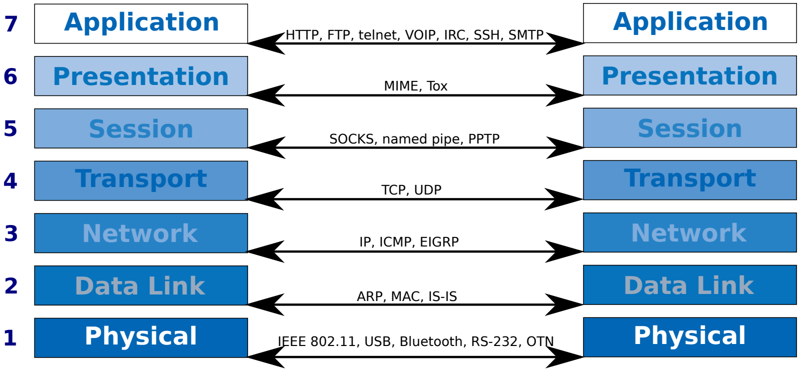
Nth layer communicate with Nth layer..



.. thanks to 3-th layers



One single protocol, one single layer



Encapsulation

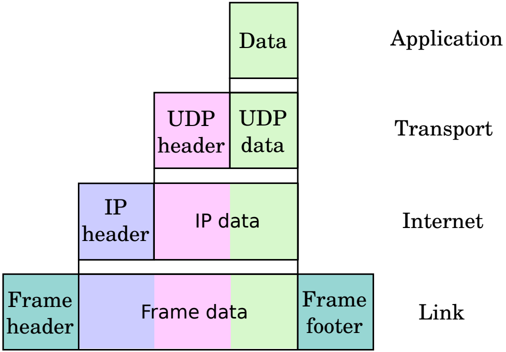


Figure: Encapsulation

Presentation Outline

Aims

- Interface data link layer,

Aims

- Interface data link layer,
- (De)Encode,

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- Transmit: 1 after 0 (after 0 or 1, after 0... or 1)

Hardware medium

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- USB, serial port such as RS-232...

Hardware medium: IEEE 802.3 (Ethernet)

Figure: RJ45 connector

Hardware medium: IEEE 802.15.1 (Bluetooth)

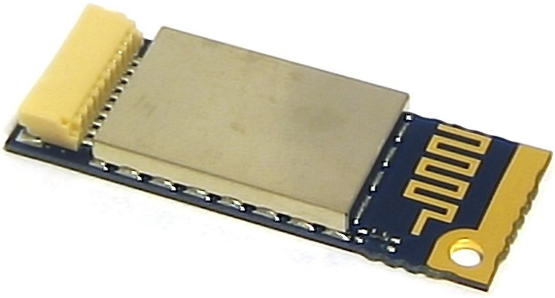

Figure: Bluetooth card

Hardware medium: IEEE 802.15.4 (ZigBee)

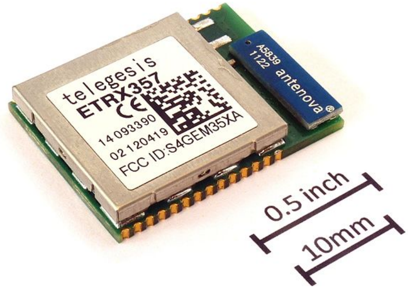

Figure: ZigBee card

Hardware medium: IEEE 802.16 (Wi-Max)

Figure: Wi-Max antenna

Hardware medium: IEEE 1394 (Firewire)

Figure: Firewire connector

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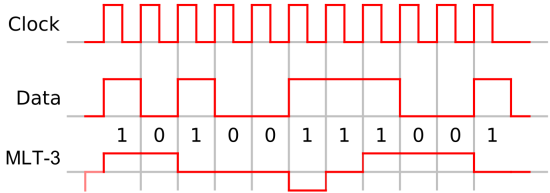

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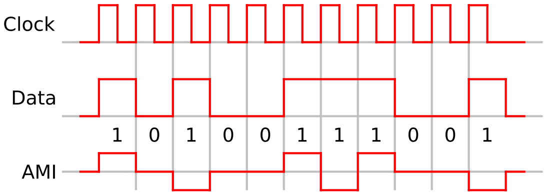

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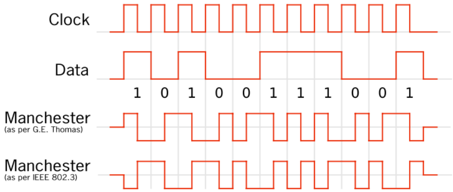

Figure: Manchester

Encoding: Biphase Mark Code

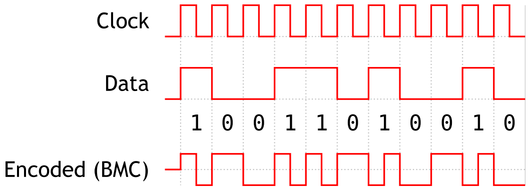

Figure: Biphase Mark Code

Transmitting

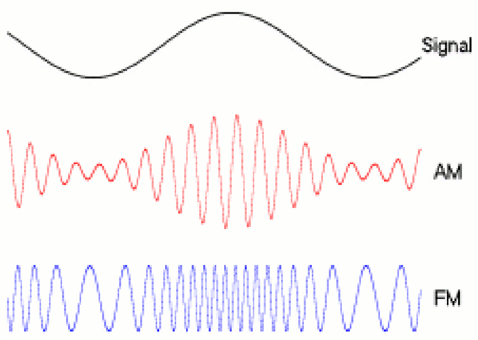

Figure: Amplitude and phase modulation

Error detection

- Repetition (hum...)

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Error correcting

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- MDPC (Multidimensional parity-check code)

Correction: MDPC

Raw data to send: 0x01 02 03 04

0x01	0x02	0x03
0x03	0x04	0x07
0x04	0x06	

Figure: Data received with MDPC

Data sent (with MDPC): 0x01 02 03 03 04 07 04 06

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Layer composition (of its two sublayers)

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   - (transmitting/receiving) protocols, over MAC sublayer, multiplexing

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2. Media Access Control (MAC):
   - physical (hardware) addressing
   - collision detection and retransmission
   - data packet scheduling (and queuing)
   - QoS
   - VLAN

Carrier Sense Multiple Access with Collision Avoidance

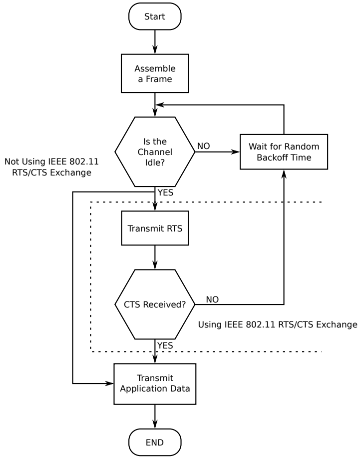

Figure: CSMA CA

Layer 2 Ethernet packet

MAC dest. (6)	MAC src. (6)	VLAN tag* (4)	Ethertype (2)
Payload (42-1500)		Frame check sequence (4)	

Figure: Layer 2 Ethernet packet

optional, Content (size in bytes)

Ethertype 0x	Protocol
0800	IPv4
0806	ARP
0842	Wake-on-LAN
86dd	IPv6

Figure: Data received with MDPC

ARP example

0000	ff	ff	ff	ff	ff	ff	fa	ba	00	ab	ab	af	08	06	00	01
0010	08	00	06	04	00	01	fa	ba	00	ab	ab	af	ac	11	22	37
0020	00	00	00	00	00	00	ac	11	00	f9	00	00	00	00	00	00
0030	00	00	00	00	00	00	00	00	00	00	00	00				

Figure: ARP request

MAC address destination MAC address source Ethertype Hardware type Protocol type OpCode (1 request, 2 reply) IP address source IP address destination

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Figure: ARP reply

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Figure: ARP reply

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- End-to-end packet transmission (data link? Connectionless? Switch? Router?),
- Routing, load balancing

Concepts

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- IP addressing fundamentals,
- Classfull IP addressing,
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- Variable length subnet masks (VLSM),
- Classless inter-domain routing (CIDR).

IP addressing fundamentals

IP address

32 bits (4x4 bytes)

mask	
Networks part	Host part

Figure: IP address parts

IP addressing fundamentals

Masks

- Separates network and host bits,

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IP addressing fundamentals

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- Separates network and host bits,
- MSB **always** are ones and then zeros! 255.254.255.0 is not possible,
- Indicates how many bits are used for the network part:
  - A 8-bit mask leaves 24 bits for the hosts,
  - A 16-bit mask leaves 16 bits for the hosts,
  - A 24-bit mask leaves 8 bits for the hosts,
  - A N-bit mask leaves 32-N bits for the hosts.

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  - A 16-bit mask leaves 16 bits for the hosts,
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- Two different mask (differences seen further):
  - Network mask,
  - Subnet mask.

IP addressing fundamentals

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32 bits (4x4 bytes)

Networks part	Host part

Figure: IP address parts and mask

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ones mask	zeros mask
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Figure: IP address parts and mask

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Is that a host?

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Is that a host?

- Network address,
- Nodes,

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- All addresses have the same network bits,
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- Network address has zeros for host bits,
- Broadcast address has ones for host bits.

Example: network 1

Mask /24	255 11111111	255 11111111	255 11111111	0 00000000
Network address	192 11000000	168 10101000	1 00000001	0 00000000
First nodes address	192 11000000	168 10101000	1 00000001	1 00000001
Last nodes address	192 11000000	168 10101000	1 00000001	254 11111110
Broadcast address	192 11000000	168 10101000	1 00000001	255 11111111

Figure: IP address example 1

Example: network 2

Mask /16	255 11111111	255 11111111	0 00000000	0 00000000
Network address	172 10101100	17 00010001	0 00000000	0 00000000
First nodes address	172 10101100	17 00010001	0 00000000	1 00000001
Last nodes address	172 10101100	17 00010001	255 11111111	254 11111110
Broadcast address	172 10101100	17 00010001	255 11111111	255 11111111

Figure: IP address example 2

Formula

How many ~~hosts~~ nodes with a N-bit mask?

$2^{32-N} - 2$

Formula

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- 24-bit mask: $2^{32-24} - 2 = 2^8 - 2 = 254$ nodes
- 16-bit mask: $2^{32-16} - 2 = 2^{16} - 2 = 65.534$ nodes
- 8-bit mask: $2^{32-8} - 2 = 2^{24} - 2 = 16.777.214$ nodes

Public and private addresses

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- Most of IP addresses

[2] Internet Assigned Numbers Authority

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- No registration needed
- Not routed across the Internet
- Proxy, NAT and private addresses solved IPv4 shortage.

[2] Internet Assigned Numbers Authority

Classful IP Addressing

Class	A	B	C
First octet	1 - 126	128 - 191	192 - 223
First octet pattern 0b	0*	10*	110*
Network mask	255.0.0.0 /8	255.255.0.0 /16	255.255.255.0 /24
IP addresses range	1.0.0.0 126.0.0.0	128.0.0.0 191.255.0.0	192.0.0.0 223.255.255.0
Number of nodes	16777214	65534	254

Figure: Three main classes

Where did 127.0.0.0/8 go ?!

Classful IP Addressing

Class D

- First octet: 224 - 239

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- Everything left

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Class E

- Everything left
- Experimental class.

Reserved addresses

- 0.0.0.0 used in routing (seen further)

Reserved addresses

- 0.0.0.0 used in routing (seen further)
- 127.0.0.0/8: loopback addresses (127.0.0.1 - 127.255.255.254).

Course details

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References

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