Computer Networks Homework #4

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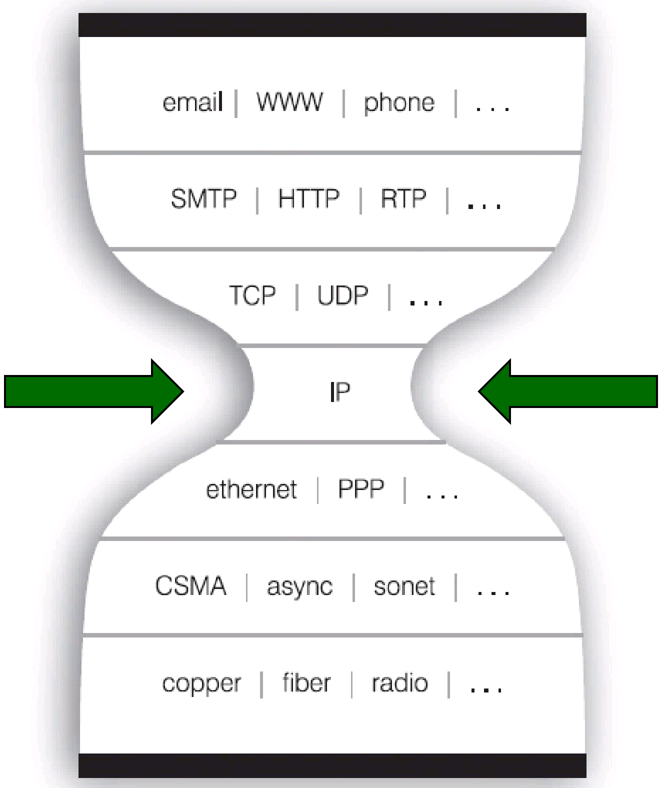
25 November 2010

Internet Protocol Architecture

- Why is the Internet Protocol sometimes described as “narrow waist”? What are the advantages and disadvantages of such an architecture?

Internet Protocol Architecture



Internet Protocol Architecture

- Single common tie between multiple upper and lower layer protocols
- Barrier for evolvement of protocol stack

What kind of switching fabrics are there and how do they work?

- Bus switching
  - Fabric connects ports by means of a bus that is shared among all ports
- Memory switching
  - Fabric connects ports by means of a common memory that is used by all ports
- Crossbar switching
  - Fabric can connect any input port to any output port directly

When and where does buffering occur? What are its effects?

- Input ports:
  - Fabric slower than incoming traffic
- Output ports:
  - Datarate from fabric is faster than outgoing data rate
- Buffering introduces queueing delays and ultimately leads to loss
- Head-of-line blocking: Packet is queued at an input port, following packets must wait until that packet is processed

In an IP datagram: what is the header checksum for and where is it calculated?

- Used for error-checking of the header
  - By intermediate routers
  - By the destination
- Calculated
  - At the source
  - At every intermediate router after decrementing the time-to-live value

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Fragmentation

- Assume you have a 3,600 byte long datagram which needs to be fragmented for a 1,300 bytes MTU. Please fill the following table with the data of the resulting datagrams.

Datagram No.	Length	Frag. Flag	Offset
1	1300 (1280+20)	1	0
2	1300 (1280+20)	1	160
3	1040 (1020+20)	0	320
4			

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Tip: IP Address Conversion (Decimal to Binary)

- Make yourself a table:

Power	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Value	128	64	32	16	8	4	2	1
Rest								
Bit								

- For each octet:
  - Put octet number into first „rest“ cell
  - Bit = (value >= rest ? 1 : 0)
  - $\text{Rest}_{next} = \text{Rest}_{prev} - \text{Bit}_{prev} \times \text{Value}_{prev}$
  - Rinse and Repeat

Tip: IP Address Conversion (Example)

- First octet of 66.135.207.138:

Power	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Value	128	64	32	16	8	4	2	1
Rest								
Bit								

- Result:

Power	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Value	128	64	32	16	8	4	2	1
Rest	66	66	2	2	2	2	2	0
Bit	0	1	0	0	0	0	1	0

Convert the following IP addresses into their binary notion

- 66.135.207.138
  - 01000010.10000111.11001111.10001010
- 192.35.225.7
  - 11000000.00100011.11100001.00000111

Tip: IP Address Conversion (Binary to Decimal)

- Make yourself a table:

Power	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Value	128	64	32	16	8	4	2	1
Bit								
Sum								

- For each octet:
  - Fill the „Bit“ row with the bits of the octet
  - Fill the sum row:
    $Sum_{next} = Sum_{prev} + Bit_{prev} \times Value_{prev}$

Tip: IP Address Conversion (Example)

- Octet 10000110:

Power	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Value	128	64	32	16	8	4	2	1
Bit								
Sum								

- Result:

Power	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Value	128	64	32	16	8	4	2	1
Bit	1	0	0	0	0	1	1	0
Sum	128	128	128	128	128	132	134	**134**

Convert the following IP addresses into their decimal notion

- 10000110.01001100.01010001.00011001
  - 134.76.81.25
- 11011000.10011110.01010111.00010111
  - 216.158.87.23

Tip: Subnet calculations

- Subnet calculations are used to break a given network into smaller pieces
- A (sub-) network mask shows how many bits of an IP address denote the network
  - Decimal: /17
  - Binary: 11111111.11111111.10000000.00000000
  - Hexadecimal: 255.255.128.0

Tip: Subnet calculations

- Given address: 128.30.10.0
  - 10000000.00011110.00001010.00000000
- Given netmask: 17 (= 255.255.128.0)
  - 11111111.11111111.10000000.00000000
- => Network: 128.30.0.0/17
  - 10000000.00011110.00000000.00000000
- => Broadcast: 128.30.127.255
  - 10000000.00011110.01111111.11111111
- => First host: 128.30.0.1
  - 10000000.00011110.00000000.00000001
- => Last host: 128.30.127.254
  - 10000000.00011110.01111111.11111110
- Number of hosts: $2^{15} - 2 = 32{,}766$

Tip: Subnet calculations (Example)

- Given network: 128.30.0.0/17
- Wanted: Four sub networks
- First step: Find new subnet mask
  - To address four networks we need at least two bits ($2^2 = 4$).
  - The new subnet mask is 17+2 = 19
- Second step: Find new network addresses (see next slide)
- Third step: Calculate data for new networks (see previous slide)

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Tip: Subnet calculations (Example)

- New netmask: 19 (= 255.255.224.0)
  - 11111111.11111111.11100000.00000000
- => New network 1: 128.30.0.0/19
  - 10000000.00011110.00000000.00000000
- => New network 2: 128.30.32.0/19
  - 10000000.00011110.00100000.00000000
- => New network 3: 128.30.64.0/19
  - 10000000.00011110.01000000.00000000
- => New network 4: 128.30.96.0/19
  - 10000000.00011110.01100000.00000000
- Number of hosts: $2^{13} - 2 = 8{,}190$

Subnet calculation

- A provider has been assigned the network 128.30.0.0/22 and wants to divide it to accommodate two customers: Customer A has 100 hosts and Customer B has 255 hosts. The remainder should be partitioned in blocks as large as possible. Please fill the following table with the data of the resulting sub networks.

Subnet No.	Network Address	Netmask	Host Range	No. of Hosts
1 Cust. A	128.30.0.0/25	255.255.255.128	128.30.0.1 – 128.30.0.126	126
2 Cust B	128.30.2.0/23	255.255.254.0	128.30.2.1 – 128.30.3.254	510
3 (free)	128.30.0.128/25	255.255.255.128	128.30.0.128 – 128.30.0.254	126
4 (free)	128.30.1.0/24	255.255.224.0	128.30.1.1 – 128.30.1.254	254

Host calculation

- A host has been assigned the IP address 134.76.81.99 and the network mask 255.255.255.240. Please fill the following table with the parameters that result from this assignment.

Network address(in CIDR notation a.b.c.d/e)	134.76.81.96/28
Broadcast address	134.76.81.111

Network Address Translation

- Q: What are the three essential steps a NAT router must perform to provide network address translation?
- Replace source address of outgoing packets
- Remember the corresponding mapping
- Replace destination address of incoming packets

What are the main differences between IPv4 and IPv6?

- Bigger address space in IPv6 (128 bit vs. 32 bit)
- Fixed-length 40 byte header in IPv6
- No fragmentation allowed in IPv6
- No header checksum in IPv6
- Options outside of header in IPv6
- New version of ICMP in IPv6 (ICMPv6)

IP address space

- Q: How large is the IPv6 address space in comparison to the IPv4 address space?
- Increase from 32 to 128 bits
- 340,282,366,920,938,463,463,374,607,431,768,211,456 addresses in total
- 79,228,162,514,264,337,593,543,950,336 times the IPv4 addresses

- Disclaimer: Not a „fair“ comparison as IPv6 addresses are assigned far more coarse grained.

Thank you

Any questions?