

Electrical, Computer, and Systems Engineering

ECSE-6600: Internet Protocols

Spring 2002

Problem Set 1- Due Wednesday, January 31st, 2002

[Tape-delayed students ONLY: Due February 7th 2001]

I. Reading Assignments:

a) (10 pts) Discuss why a circuit-switched transmission system in the age of computers does not conform to the end-to-end principle.

In the age of computers, circuit-switched transmission system does not conform to the end-to-end principle because computation is cheap and more functionality can be economically moved to higher levels of the system.

However, if the end-to-end principle is qualified to include a compromise between available technology, cost and performance, then we can say that in the early 1900s circuit-switched transmission system conformed to the end-to-end principle. This is because placing intelligence at the end points would not have been feasible since it was very costly and nearly impossible technologically. Placing this intelligence at the network level made a reasonable cost-performance compromise at the time. But as the technology evolved, the entrenched functionality in the network did not move out to higher-levels, thus becoming increasingly inconsistent with the end-to-end principle.

b) (10 pts) Consider the quality of service (QoS) problem, where (loosely specified) the “function” expected from the system is a “performance guarantee,” which suggests that some kind of network support to guarantee performance is necessary. Discuss how one would go about applying the end-to-end principle for determining the functional decomposition of such a system.

In the QoS problem, the functional specification of the problem also includes a performance requirement (eg: guaranteed bandwidth, delays etc). To support QoS, the network has to provide functions like service isolation, reservation of resources etc, i.e., some critical functions need to be placed in the network..

Observe that the end-to-end principle talks only about correctness/completeness and stays clear of saying anything about performance. So the QoS problem does pose a dilemma in the application of the end-to-end principle. One way to reconcile this dilemma is to observe that the performance requirement may be stringent (eg: give me an equivalent of a telephone circuit) or less stringent (eg: give me priority service). If the specification is less stringent, then the network support can be minimized. Else, for tighter performance guarantees, one needs to place more complex functions in the network.

c) (15 pts) Clark’s paper has an ordered set of goals that drove the Internet design philosophy. Discuss how the Internet’s design would be if the ordering of goals were totally reversed.

- Accountability will be on top of the new list of goals. This would facilitate easier monitoring of network resources, pricing and billing schemes, but require more complex functions to be placed inside the network.
- The current IP architecture is not fully auto-configurable, and did not bother too much about management functionality. As a result, administration and management cost of IP networks is somewhat higher than what would be possible if were designed for manageability and auto-configuration. But the focus on simple data- and control-planes also kept the overall architecture simple and hence was adopted rapidly.
- IP has not yet succeeded in providing end-to-end support for multiple types of services. The experience with telephony and ATM networks shows that a focus on these aspects would make the network very costly and complex.
- IP does support a wide variety of networks, though it is somewhat hard to map IP and its routing protocols to networks like ATM which are VC-oriented and do not support broadcast.

d) (10 pts) In order to achieve interconnection across networks, IP makes certain assumptions about individual networks. What are these assumptions? (Cerf-Kahn/Clark papers)

The basic assumption IP makes about individual networks is that each network is a packet switching network that is capable of processing, forwarding and broadcasting packets.

- Each network may have distinct ways of addressing
- Each network may accept data of different maximum size
- The success or failure of a transmission and its performance in each network is governed by different time delays in accepting, delivering, and transporting the data.
- Within each network, communication may be disrupted due to unrecoverable mutation of the data or missing data
- Status information, routing, fault detection, and isolation are typically different in each network.

e) (10 pts) Summarize the arguments against doing fragmentation/reassembly as a "common case" function. (Mogul paper)

-Fragmentation causes inefficient use of resources: since the number of packets in the network is increased.

-Loss of fragments leads to degraded performance: if one fragment is lost the whole packet will be retransmitted.

- Efficient reassembly is hard: especially when fragments are lost

f) (10 pts) Explain why circuit-switching:

- does not need headers

A circuit switched network, fixes a path between sender and receiver. Moreover, it uses TDM multiplexing throughout the network. All data blocks follow the same path, and multiplexing is done by carefully coordinating the timing of data blocks. Hence no headers are needed.

- does not need to exploit statistical multiplexing gains (esp. temporal multiplexing gains)

In circuit switched networks, (voice) traffic is smooth and the average is not very different from the peak rate.

- does not need to worry about the congestion control problem

When a connection is established, all the resources needed are reserved, i.e., capacity is always larger than PEAK demand. Circuits may be blocked if resources are not available.

II. Addressing:

a) (15 pts) Assume an ISP has an address block: 128.20.224.0/19. It has two customer networks of size 2000 nodes each, three customer networks of size 1000 nodes each. Assuming that the ISP allocates sequentially from the beginning of its address space, what are the prefix allocations for these customers. The remaining customer networks have a size of 250 nodes each. How many remaining customers can be supported? (Addressing 101: subnet/supernet masks/allocation)

Ans: 2 networks of size 2000: 128.20.224.0/21, 128.20.232.0/21

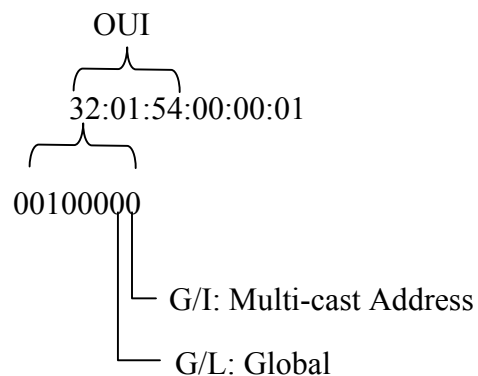
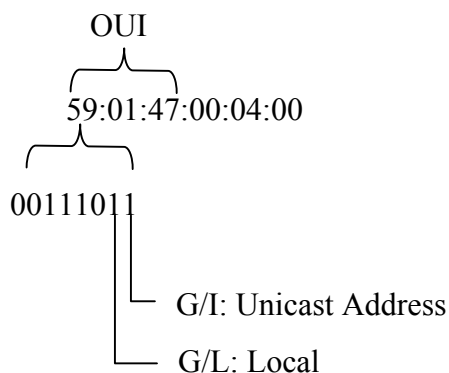
3 networks of size 1000: 128.20.240.0/22, 128.20.244.0/22, 128.20.248.0/22

Remaining address space: 128.20.252.0/22 10 bits available. And 250 nodes=>8 bits host ID and 2 bits network ID, therefore 4 networks can be supported

b) (10 pts) Analyze and comment on the structure of the following two MAC addresses:

59:01:47:00:04:00

32:01:54:00:00:01



Can a bridge use the structure in these addresses to intelligently forward packets? Why or why not?

No. Both MAC and IP are interface addresses but MAC addresses do not encode network addresses (i.e. not hierarchal) whereas IP does. Therefore IP can forward to “networks”, rather than to interfaces, which facilitates scalable forwarding. (i.e. fewer forwarding entries, lesser control traffic, no need for broadcasts etc)

c) (10 pts) Explain why the address structure in IP enables scalable forwarding and routing, compared to Extended LANs/bridges with IEEE LAN addresses.

MAC addresses are flat with no structure or hierarchy, so it does not scale. IP addressing is hierarchal and scales. Classful addressing uses a fixed length network address, and hence has limited scalability and could waste host numbers and network numbers. Classless addressing with CIDR/supernetting is more scalable since it allows variable lengths for the host and network parts of the address. Therefore, address aggregation can be done at any prefix boundary (not necessarily at 24- or 16-bit boundaries) to reduce the total number of routing entries in the Internet. Packets in the core of the Internet are forwarded to these aggregated addresses (i.e. prefixes).