

CSE 222a, Spring 2017

Midterm 1 quiz for April 26, 2017

Name:

Possible solutions

PID:

NOTE: Questions are on both sides of the paper. For short answers, only the response in the provided box will be graded. If you are using your computer, disable wifi/cellular connection. There are three multi-part questions.

Allowed resources:

- Papers and notes (printed or on your computer) in PDF or word processor format (*.pdf, *.txt, *.tex, *.rtf, etc). Local copies only.

Resources that are not allowed:

- Documents stored in Google Docs, Microsoft 365, anything online
- Any communication with anyone (IM, GChat, G+ hangouts, shared docs)
- Any web browser open
- Exchanging or sharing notes during the exam.
- Smartphones are not allowed.

Note: These are one possible set of solutions. Other answers may be acceptable.

1. Basics (3pt)

1.1 (0.5 pt) The protocol described in the Cerf & Kahn paper is in a sense a mixture of IP and TCP, ensuring that data arrives to the destination process/application reliably. This reliability guarantee helps many applications, but can hurt others. Mark the types of applications whose performance might be HURT by having to rely exclusively on reliable data delivery:

- (a) A daily backup of data to an off-site datacenter
- (b) Live streaming video and audio of a sports event
- (c) Sending position updates within a large multiplayer 1st person “shooter” videogame
- (d) Transferring a picture from a mobile phone app to a social media site

1.2 (0.5 pt) The introduction of a common “Internet header (IP header)” to packets on the Internet solved the problem of:

- (a) Hosts sending unauthorized “spam” emails
- (b) Hosts sending packets to destinations that are down/crashed
- (c) Hosts having to understand every possible sub-network protocol to communicate across networks
- (d) Packets getting dropped within the network

1.3 (2 pt) Describe, using the terms “sliding window”, “timeout”, “acknowledgement”, and “sequence number” how TCP ensures that data arrives reliably and in-order to the destination.

In TCP, each byte of data is associated with an increasing **sequence number**. TCP sends a limited amount of data in one or more packets to the receiver at any given time, called a **sliding window**. When data arrives to the receiver in order (at the expected sequence number corresponding to the left edge of the window), then the receiver sends back an **acknowledgement**. When the sender sends data, it starts a timer. If that timer expires before an acknowledgement is received, then the sender re-sends the data. This is called a TCP **timeout**. If a packet arrives to the receiver out of order, the receiver sends an acknowledgement corresponding to the left window back to the sender, and is permitted to drop the out of order packet.

2. Active and software-defined networks (4 pt)

2.1 (2 pt) Programming the network using the “ANTS” system (Wetherall) starts with a program P at the sending host of type T. Using the “type” and “previous address” fields of the capsule header, describe how an Active Node in the network which doesn’t have program P gets a copy of that program.

The program P starts at the client host. The **type** of P is determined via a hash function on the contents of P. When the client sends the capsule into the network, the **previous address** field is set to the IP address of the client. When an active node gets the capsule, and if it doesn’t have a copy of P, it sends a request to the client (identified by the previous address field) for P. When that active node forwards the capsule, it puts its IP address into the previous address field. That way subsequent active nodes get P from the previous active node.

2.2 (2 pt) How is a network information base (NIB) stored in an Onix instance different from the routing table that traditional routers employ to perform routing?

- Routing tables contain rules for a given router to forward packets. Routing tables only make “sense” from the point of view of a given network device, and have a subset of global knowledge. On the other hand, the NIB contains a global view of network state
- Routing tables only contain routes, whereas the NIB might have transient state like traffic rates
- Routing tables can be inconsistent with each other, whereas the NIB supports consistent updates
- Routing tables only support longest prefix matching. ONIX, via the NIB, can support more configurable policies.

3. Routing and Software defined networking (8 pt)

3.1 (2 pt) A key aspect of Paxson's analysis is understanding routing asymmetry, in which the routers on the path from A to B differ from the path from B to A. What are two possible reasons for why this might be?

- Hot potato routing
- The two directions might have genuine cost differences (e.g., different latencies, bandwidths, costs, etc).
- One direction might be a different technology than the other (e.g., optical fiber vs. satellite)
- ISPs might be doing traffic engineering, and so one direction might have a different path than the other direction.

3.2 (1 pt) Imagine that one observes the route between two nodes A and B every 1 second. Ten consecutive observations are: {R1, R1, R2, R1, R1, R1, R1, R2, R1, R1}. Route R2 is:

- (a) Persistent
- (b) Prevalent
- (c) Both persistent and prevalent
- (d) Neither persistent nor prevalent

3.3 This graph is taken from the Paxson paper, and depicts the prevalence of the dominant route, as observed at host, city, and AS-level granularity.

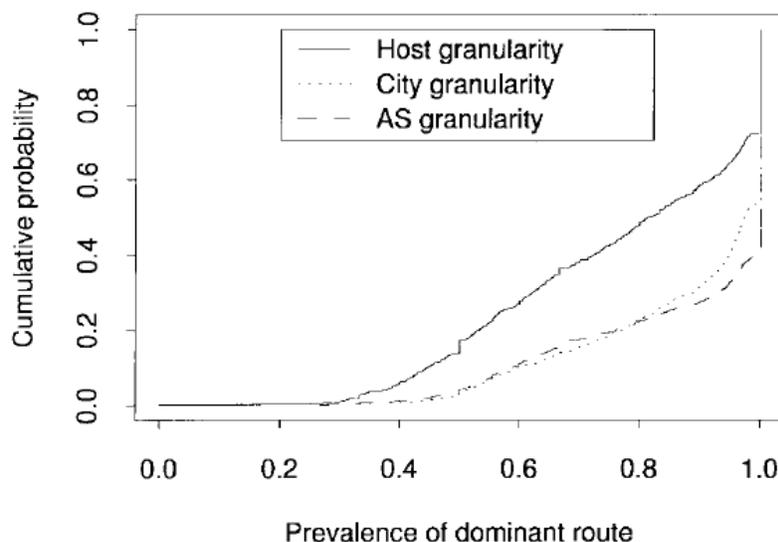


Fig. 6. Fraction of observations finding the dominant route, for all virtual paths, at all granularities.

Name: _____

3.3.1 (1 pt) For half the virtual paths measured, the same route was observed at the City granularity:

(a) 20% of the time

(b) 40% of the time

(c) 82% of the time

(d) Nearly all the time

3.3.2 (1 pt) Virtual paths at the City and AS granularity are more stable than at the Host granularity

(a) True

(b) False

Name: _____

3.4 (3 pt) RCP is designed to be incrementally deployable. What benefits does an ISP receive when: (1) pairwise iBGP sessions between border routers are replaced with a single iBGP session from each border router to a centralized RCP service, (2) eBGP sessions with neighboring ASes are terminated at the RCP server, rather than at border routers, and (3) neighboring ASes also use RCP, and routing information is exchanged directly from one RCP server to another?

1. Instead of requiring N^2 iBGP sessions, instead you only need N sessions, which increases scalability
2. Instead of RCP only "seeing" the routes that the border router exports via iBGP, the RCP service now has complete visibility into all advertised routes, and can send potentially customized routes to different border routers
3. No need to even use eBGP, can do anything