

## S-38.3156 Delay-tolerant Networking

Exam 4 January 2011

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Please write readably and answer in English.

There are three classes of questions: (a) expecting (relatively) short answers, (b) expecting more elaborate answers, and (c) a small design task. The questions are marked accordingly.

### Questions:

1. [6p, a] Describe the difference between MANET (Mobile Ad-hoc Network) routing and DTN routing.
2. [6p, b] a) Sketch the bundle protocol stack and describe the respective layers and their functions.  
b) Explain two bundle protocol functions for controlling or monitoring message delivery.
3. [6p, b] Discuss message encapsulation for a DTN Web service.
4. [6p, a] How does an asynchronous API work and why would it be a good fit for DTN networking?
5. [6p, b] Why are simulations used in DTN research? Explain which factors are important to model in a DTN simulator.
6. [6p, a] In which networking scenario is the Licklider Transmission Protocol used? Why?
7. [6p, a] Which security services does the Bundle Security Protocol offer for bundles?
8. [12p,c] The POSTMANet was conceptually proposed as a postal mail-based messaging system using rewritable CDs to bring high volume high delay connectivity to otherwise less well connected places. “Less well connected” depends on the application and may even apply to the Helsinki area.

Assume a typical household with a DSL access link: 1 Mbit/s uplink, 8 Mbit/s downlink capacity, connected via flat-rate, always on. Assume a — legal — video recording application in which people can exchange recordings from public television that they had missed (or they don't have access to because they do not have a digibox). Assume further that recorded contents is not well compressed so that a 90min recording has a mean volume of 4.5 GB stored data, so a 15 minutes news broadcast is 500 MB in size and a full-length movie is some 6 GB.

Let us replace the postal mail service and the CDs by regularly moving buses (with typical schedules) equipped with WLAN connectivity at 100 Mbit/s data rate and a few terabytes of storage capacity. We also ignore protocol overhead and take gross=net data rate.

You want to design a system that enables efficient video exchange for people living close to the bus stops (where buses stop for about one minute). Your system makes use of opportunistic connectivity and store-carry-and-forward delivery.

- a) Sketch the topology of the system.
- b) Which are the potential bottlenecks? How will you address them (at the application and/or DTN protocol layer(s))?
- c) Discuss which types of routing protocols are applicable for the application and which are not (and why). Which one(s) would you suggest to use? Why?
- d) How can you maximize user satisfaction by minimizing transmission delay?
- e) Which further optimizations come to mind?

*(Note: there are many possible solutions.)*