# CS442 Mobile Computing, Networking & Applications

## Quiz 1 (due October 11th)

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**[10 points] 1. What is your main takeaway message from the Meraki story?**

The story of how Meraki found a breakthrough and expanded as a large company was quite interesting. But, I felt really overwhelmed (and also tensed) when the professor said that 'people are consistent', that people who were awesome in college will keep being successful afterward. Moreover, people who weren't awesome, have little chance to be great later too. Professor claimed it quite seriously, and I had to ask myself, 'am I an awesome person? are people around me awesome?' Clearly, people attending this class were bright people. I was immensely impressed with self-introductions on facebook. I thought I should do my best to keep up. The message really motivated me.

**[15 points] 2. The Darwin Phone paper argues for a "collaborative inference" concept for mobile sensing.**

**(a) Why did it use speaker recognition as an example application?**

The authors state in the paper that the intention is not to design a new speaker recognition algorithm, *but to show how Darwin improves a mobile sensing application inference quality.* Darwin uses many devices (with a microphone in this problem) to acquire data from diverse situations, apply distributed computing and collaborate to enhance inference quality. Audio sensed data is sensitive to the characteristics of the environment and sensor context of the device, so speaker recognition can be an appropriate example to elaborate on the concept.

**(b) What other mobile sensing applications do you think would benefit from collaborative inference, and why?**

I believe the concept of collaborative inference can be utilized on various tasks of computer vision. While the paper itself suggests the friend tagging application (face recognition task), I think we can improve the depth estimation problem if we use several devices at one time. There are many approaches to handle the depth estimation problem, i.e. estimating how far the objects are positioned from a given image. It is well-known that stereo images give much more information than a monocular image. If we can acquire data from several cameras (visual sensors) from different

perspectives, I believe we can more precisely estimate depth. This can lead to many applications; we may create 3D modeling of a statue from photos or construct a 3D map from dashcam data.

Referred E. Miluzzo, et al., "Darwin Phones: the Evolution of Sensing and Inference on Mobile Phones," *ACM MobiSys* 2010.

**[10 points] 3. Which features do you want from 6G cellular networks? Be specific and detailed ("faster! would not be enough).**

When cellular network moved on from 4G to 5G, it didn't just get 'faster' but enhanced on latency and capacity. I suspect massive, instant data processing will be available in 6G cellular networks. People expect that the network service no longer set its service purpose for human use, but aim for artificial intelligence or IoT technology. Applications such as the automated driving system in real traffic may be possible in 2030.

Referred news article, http://www.hani.co.kr/arti/science/future/891460.html

**[20 points] 4. (a) What is the hidden terminal problem?**

Let's say there are two transmitters A, B where they cannot hear each other. and there's a receiver C between them so that it can hear from both A and B. The transmitters may send a packet to C simultaneously since they are not aware of each other's presence. Then the signal crashes on C. B are the hidden terminal to A and vice versa.

The hidden terminal problem is that, even if the medium is free near the transmitter, it may not be free near the intended receiver.

( A ( C ) B )

A thinks C is free, but actually, C is busy due to B.

→ Collision possible (B is a hidden terminal to A)

**(b) What is the exposed terminal problem?**

Let's say there are a transmitter X is near a transmitter A. If X wants to transmit a signal to a receiver Y (which A cannot reach), it would hold back while A is busy because X does not know if A is transmitting to Y. X doesn't know if A can reach Y.

The open terminal problem is that, even if the medium is busy near the transmitter, it may be free near the intended receiver.

( Y ( X A ) B)

X thinks Y can be busy due to A, but actually, Y is free

→ unnecessary hold back possible. (A is an exposed terminal to X)

**(c) Wi-Fi uses RTS/CTS to handle hidden terminals. Does it completely eliminate the hidden terminal problem? Why/why not?**

No. the RTS/CTS mechanism used by the 802.11 wireless networking protocol assumes that all terminals have the same transmission ranges. A transmitter might receive RTS, and does not receive CTS by another transmitter successfully. Then the transmitter can later initiate transmission to it, and the hidden terminal problem remains.

**(d) Other than RTS/CTS, which methods can mitigate hidden terminals? What are the pros and cons of those approaches?**

We can add more terminals or rearrange their position. Or, we can increase the output power so that the terminals can hear each other. Either way, we can mitigate hidden terminal problem, but the solutions are quite costly.

**[10 points] 5. Why doesn't TCP work well in wireless networks?**

Transmission Control Protocol (TCP) assumes that most packet losses are due to congestion since wired links offer a virtually error-free transmission medium. In a wireless network, however, packet losses are more often due to line breaks, routing path changes, high error rates, and transient link connectivity. (It is because wireless links are highly sensitive to general interference or direction of propagation. The errors are more frequent and bursty.) So reducing the congestion window doesn't work well in wireless networks.

Referred B. S. Bakshi, et al. "Improving performance of TCP over wireless networks," *Proceedings of 17th International Conference on Distributed Computing Systems*, 1997.

**[20 points] 6. (a) To obtain accurate 3D coordinates, how many unobstructed line-of-sight GPS satellite signals one needs to receive and why?**

Signals from 4 satellites are needed; the position can be acquired by the distances from 3 satellites, but we need the fourth one to correct clock errors and obtain accurate 3D coordinates including elevation.

**(b) What is war-driving?**

(In terms of localization) war-driving is the act of locating and possibly exploiting connections to wireless local area networks while driving. While war-driving, you use local access point to map your

location.

Referred https://searchmobilecomputing.techtarget.com/definition/war-driving

**(c) What is dead reckoning?**

In navigation, dead reckoning is the process of calculating one's current position by using a previously determined position and advancing that position based upon known or estimated speeds over elapsed time and course. (Wikipedia)

In other words, determining one's position by previous position and information from an acceleration sensor or other movement sensors.

Referred https://en.wikipedia.org/wiki/Dead_reckoning

**[15 points] 7. What are some of your favorite smartphone apps? Find out whether they perform cloud offloading and for which tasks. If no such public information is available, write what should be offloaded and why.**

Twitter is the social media application I use the most. I found here that twitter uses cloud offloading to reduce the time for transmitting data. They learned that most of the latency was due to "transit" component. They expanded the edge network by utilizing the public cloud (Google cloud, as either TCP/HTTPS proxy) Points of Presence (PoP) edges and handle some traffics by offloading to a public cloud provider's backbone.

Referred https://blog.twitter.com/engineering/en_us/topics/infrastructure/2019/expand-the-edge.html