Weekly Report (2010-05-16)

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I. What I am doing this week

- Think more about the radiation protection in wireless networks.
- Learn Stochastic Lyapunov Optimization.
- Read some interesting papers on Cognitive Radio.

New results:

- No affirmative evidence is found to prove the radiation hazard to human health. So I cannot validate the idea of radiation protection in wireless networks.
- Some but not many work have proposed the application of cognitive radio in wireless mesh networks.

II. Throughput Maximization in Dynamic Wireless Ad-Hoc Mesh Networks with Cognitive Radio and Network Coding

There have been a number of work addressing the application of wireless ad-hoc mesh networks with cognitive radio, in which the secondary users are organized as an ad-hoc network coupled with some access points and gateways to connect the network backbone. Although some of them consider the mobility of wireless devices, the network "churn", which is borrowed from P2P network representing the join and leave activities of nodes, is not discussed in any literature.

A. Potential Problem

Here, I give a simple application scenario to motivate the "churn" in wireless ad-hoc mesh networks. Suppose we have a large expo with numerous exhibition halls. A number of access points are deployed to provide wireless connection to the network backbone. Each exhibition hall is equipped with one wireless device, which is the primary user in the network, periodically uploading the current status, e.g. number of visitors in site, to a server. When the visitors enter the expo, they can turn on their wireless devices, e.g. PDA, to connect to the wireless network. They can enquiry the server about the status of exhibition halls to decide their visiting schedule. For example, if the visitor is interested in hall A and B but finds that there is a long queue waiting for the entrance at A while there is no delay at B, the wise decision is to make a reservation for A and visit B first.

The whole process requires the server to deliver the data to the visitor through some access point. But, some visitor may be too far away from any access point such that the wireless device cannot be covered by access points or the data rate is too low. So a wireless ad-hoc network composed of visitor devices can help to conduct

a multi-hop transmission in order to cover all visitors or enhance the data rate. Thus we need a wireless **Ad-Hoc Mesh** network.

For a large expo, e.g. 2010 Shanghai Expo, we may have a huge number of visitors online in the network. The throughput should be maximized in order to provide stable and fluent service. **Throughput Maximization**.

The visitors may be moving during the transmission and they may connect to and disconnect from the wireless network randomly. So we have a **dynamic** network. The main challenge here is how to deal with the network "churn" properly. Current algorithms for wireless ad-hoc mesh networks cannot be applied directly to the "churn" problem since they assume a fixed set of secondary users.

B. Additional Issues

The server can **multicast** the data to the visitors that are currently waiting for the enquiry result. *Structured Network Coding*. which has a unique feature that we can recover the same portion of data as the portion of coded packets received, can be implemented (For example, the original data is segmented and coded into 100 code blocks or packets, we can recover 20% of the data if we receive 20 code blocks or packets). So we can ignore the packet sequence number and treat each incoming packet as new information. In this way, we can view the packet transmission as a data flow and simplify the optimization problem.

C. Cross-layer Optimization

We need a cross-layer optimization for the proposed problem:

- Flow control at the transportation layer.
- Routing at the network layer.
- Channel allocation and power control at the link or MAC layer.