Wi-Fi Goes to Town

NSF Wireless Cities Workshop

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Seamless, high speed data all over the metro

- New York metro: 660 mi. of track, 1.7bn annual ridership
- London Underground: 250 mi. of track, 1.3bn annual ridership

- **Seamless data coverage** across the network: *through tunnels*, station platforms?
  - Hostile radio environment: multipath fading

- Hundreds simultaneously streaming video, downloading files, gaming
  - How can we most effectively scale up bits/s/Hz/$
  - …under mobility: the train is moving at up to 40 mph
Networking tunnels

1. Leaky feeder cable running along length of tunnel radiates energy along its length
The commoditization of Wi-Fi

- Falling analog and digital logic cost (Craig) →
  - Today: $5 Wi-Fi + system-on-chip module; tomorrow, ⌀

- ESP8266, China
Two points on the design space

- Two extreme network/antenna topology design points:
  1. Leaky feeder cable running along length of tunnel radiates energy along its length.
    
    **Key tradeoff:** Increasing spatial reuse of the wireless medium versus overhead of handoff.
  2. Many low-cost, small-cell APs with a wired backhaul.
Problem: Handoff at speed

• Train at 30 mph travels **eight ft.** in an Internet round-trip time
  • TCP timeouts → large inter-packet spacing to a given client

Next packet arriving at controller may need to be routed to a different AP than previous
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1. Estimate “clusters” of mobiles on same train
2. Estimate velocity of train
3. Send in-flight packet to the the right AP at the right time
The bigger picture

• Billions of Wi-Fi devices, hotspots

• Human mobility and data consumption in self-driving cars, metro, train, bus

• Handoff clients seamlessly between devices
  • Location tracking and prediction, often at speed
  • Fast switching to maximize spectrum efficiency and cost (bits/s/Hz/$)