Wi-Fi Goes to Town

NSF Wireless Cities Workshop

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Seamless, high speed data all over the metro

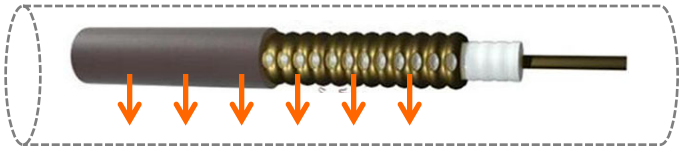
- New York metro: 660 mi. of track, 1.7bn annual ridership
- London Underground: 250 mi. of track, 1.3bn annual ridership

- **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

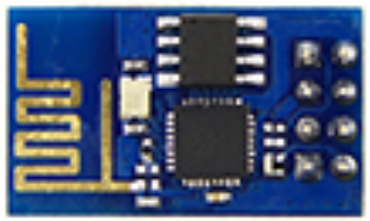


The commoditization of Wi-Fi

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

- ESP8266, China





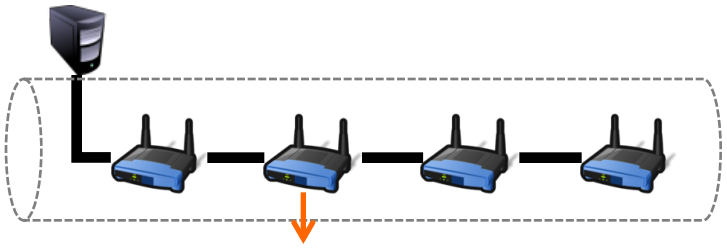

Two points on the design space

- Two extreme network/antenna topology design points:

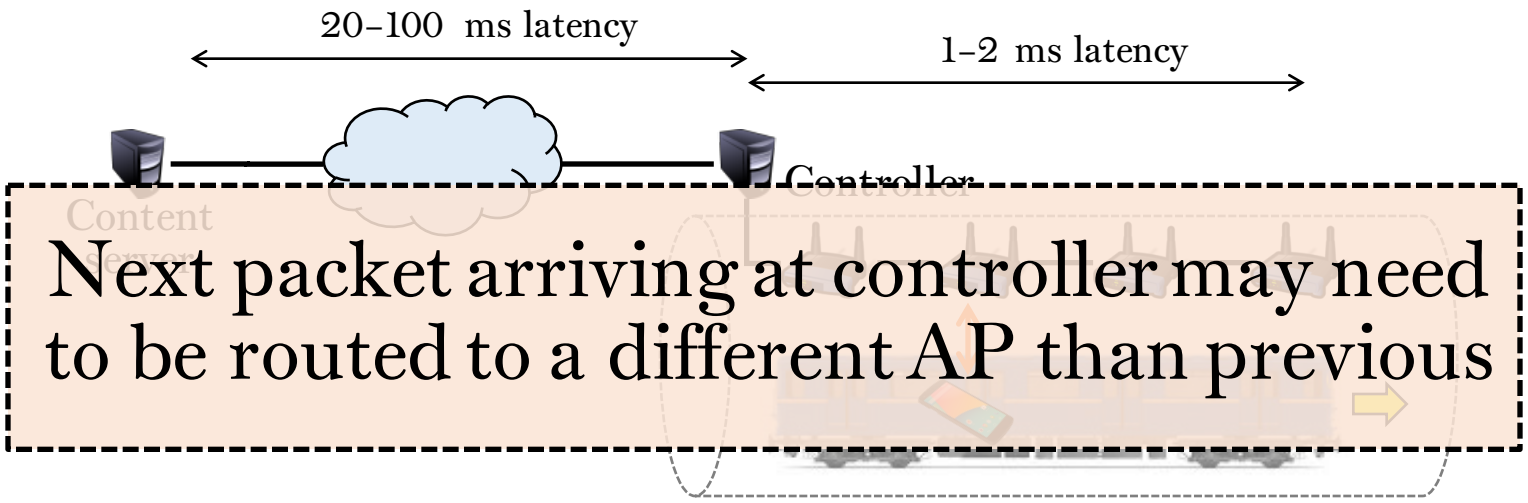
1. Leaky feeder cable running along length of tunnel radiates energy along its length

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

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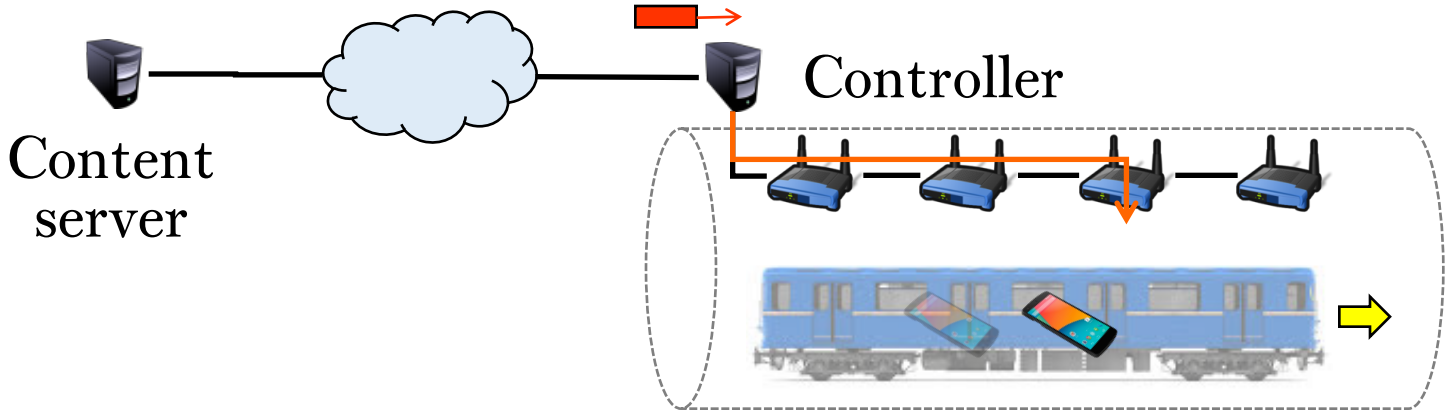
1. Estimate "clusters" of mobiles on same train
2. Estimate velocity of train
3. Send in-flight packet to the the right AP at the right time



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/$)