



Wi-Fi Goes to Town

NSF Wireless Cities Workshop

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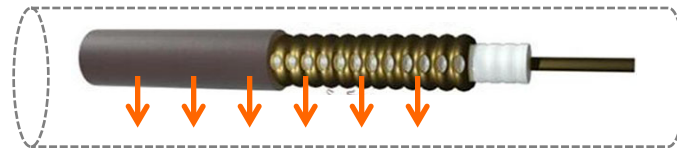
Princeton University

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

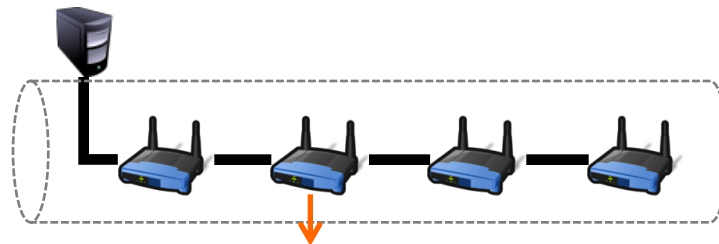
- Two extreme network/antenna topology design points:

1. Leaky feeder cable running along length of tunnel radiates

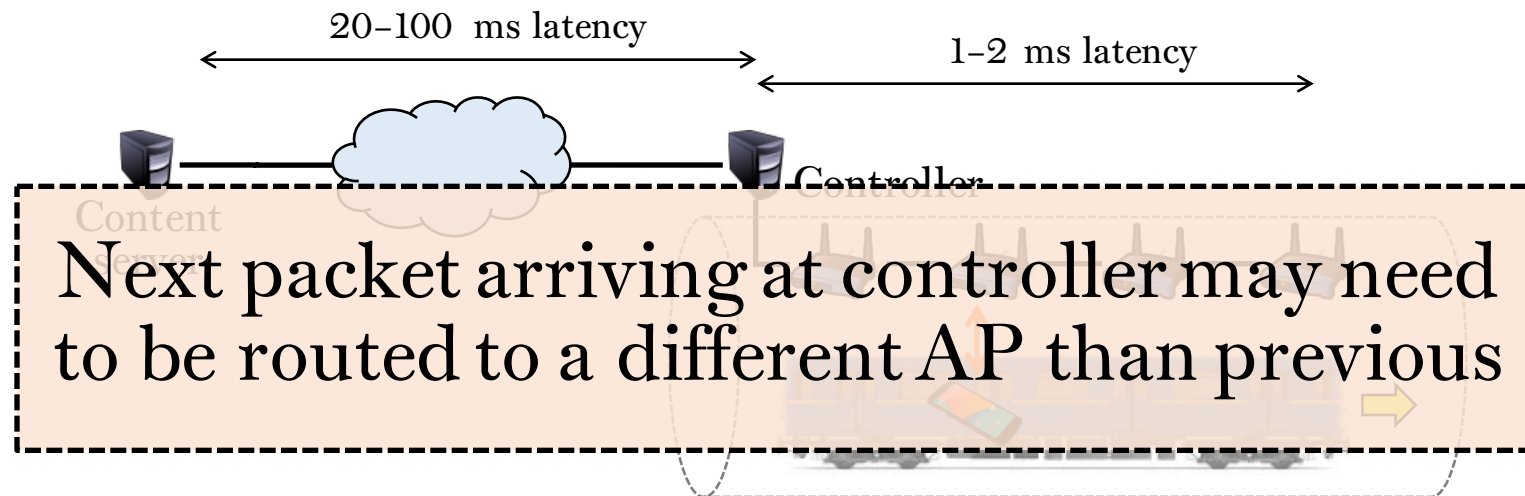
energy along its length

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

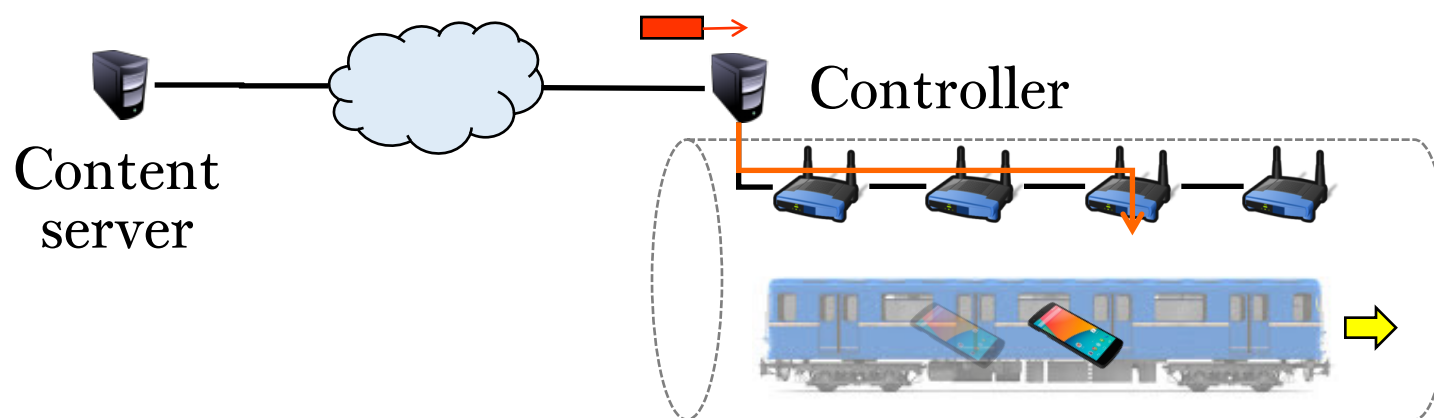


- Train at **30 mph** travels **eight ft.** in an Internet round-trip time
 - TCP timeouts → large inter-packet spacing to a given client



Wi-Fi Goes to Town

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/\$)