1.264 Lecture 36 (Solutions)

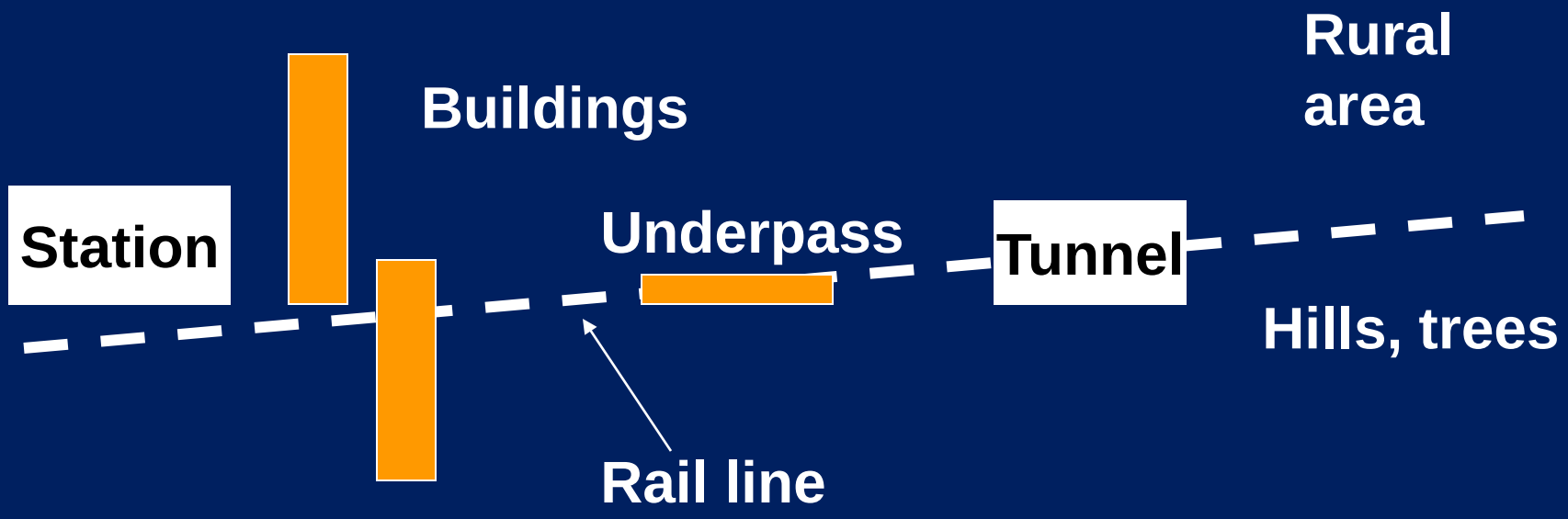
Telecom: Wireless networks

Next class: Green chapter 31,33, 36, 39. No exercise.

Exercise

- **Design a system for an intercity rail passenger train to provide Internet access to its passengers and operating crew. Address each challenge:**
  - **Metro areas: frequent physical obstructions, such as underpasses, tall buildings**
  - **Tunnels**
  - **Rural areas: gaps in cellular coverage, trees, hills obstruct line of sight**
  - **Multiple applications: what to do when a user wants to download a 200MB file**
  - **Network changes: train goes through many networks of varying quality at varying speeds**
  - **Reception in passenger cars: metal car bodies affect signal**

Exercise


Buildings
Rural area
Station
Underpass
Tunnel
Hills, trees
Rail line

Solution

- Metro area:
  - Multiple cellular data carriers
  - Server on train chooses best signal, maintains continuity
  - Use WiFi (wireless LAN) at stations
- Tunnels (short ones):
  - Server on train caches Web content, handles email via store and forward
  - Long tunnels require leaky fiber and/or base stations
- Rural areas:
  - Multiple cellular data carriers, and satellite services
- Within train:
  - Antennas mounted on multiple cars, wireless LAN between cars so any antenna can serve all cars
- Server, applications:
  - On train server manages traffic, ensures ‘fairness’
  - Server handles authentication and billing
- (How do long distance trucking, buses do this?)

Solution example

PointShot Wireless RailPoint System

Metropolitan Areas

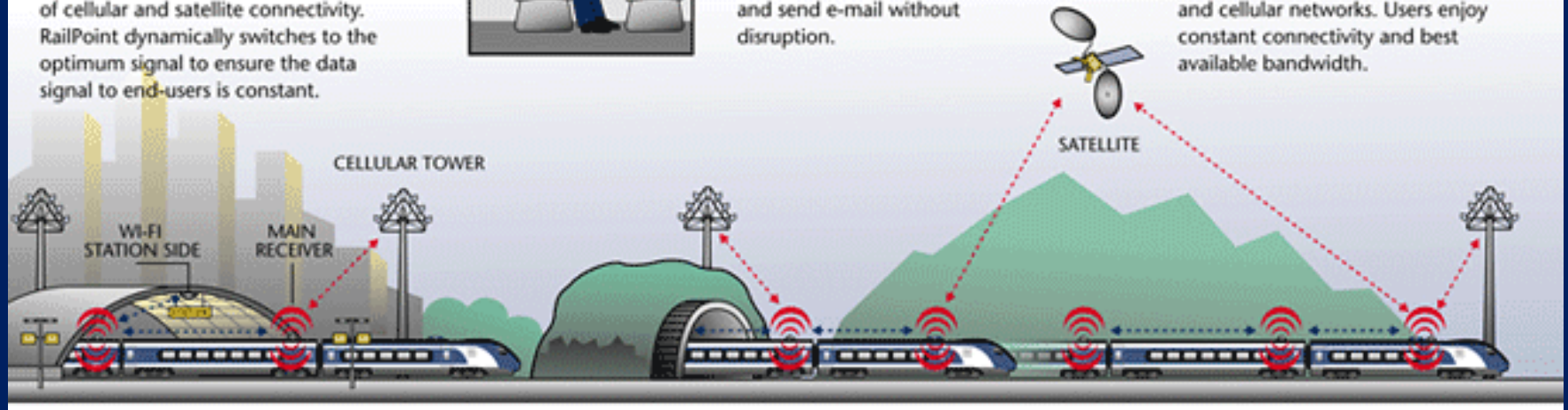
Challenge: Frequent physical obstructions
Solution: Patented WAN integration technology. RailPoint Server maintains contiguous data signal as the train moves along the route, using a combination of cellular and satellite connectivity. RailPoint dynamically switches to the optimum signal to ensure the data signal to end-users is constant.

Tunnels

Challenge: Network holes
Solution: When networks are not available, RailPoint performs web content caching and mail store-and-forward. Users continue to view web pages and send e-mail without disruption.

Rural Terrain

Challenge: Gaps in cellular coverage; hills and trees obstruct line-of-sight
Solution: RailPoint's WAN integration technology performs dynamic link quality assessment and seamlessly switches between available satellite and cellular networks. Users enjoy constant connectivity and best available bandwidth.



In-Car Coverage

Challenge: Cellular and all other external wireless signals are impeded by metal rail cars
Solution: Patented wireless inter-car bridging. RailPoint Server relays signals to the RailPoint bridges located in each car, which distribute the signal to individual users.

WAN Challenges

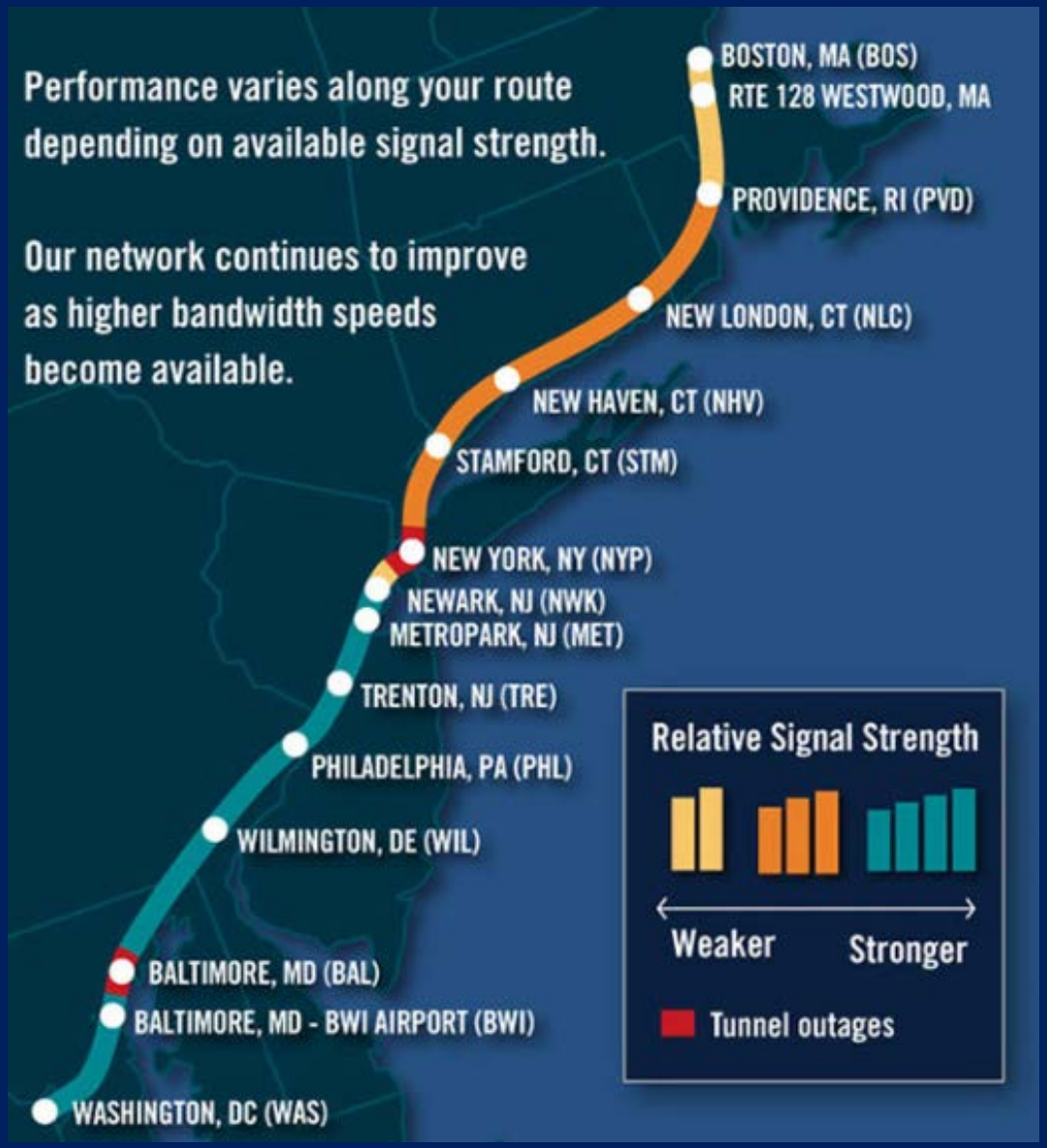
Challenge: Networks change frequently along a train route, with variable train speed and signal quality
Solution: WAN integration technology manages disparate wireless networks along the route. RailPoint Server selects the best possible connections to support throughput requirements.

Multiple Onboard Applications

Challenge: Multiple users engaged in various applications
Solution: RailPoint traffic management analyzes, classifies and prioritizes traffic according to the application so optimum throughput is assured. Open-architecture platform supports multiple applications.

www.pointshotwireless.com

Solution example: Amtrak wireless coverage



Source: Amtrak

Exercise

- In a warehouse, what type of LAN would you set up (ad hoc, BSS, ESS), and why?
  - Assume there are forklifts and other vehicles operating
  - Assume there are pick/pack stations, conveyors, etc.
- Would you try to lay out the network to minimize handoffs, or is that not important? Why or why not?
- With 802.11b, how would you stream video from 25 forklifts/vehicles in the warehouse?
  - Assume your video is 1.5 Mbps

Solution

- Set up an ESS, to allow handoffs and to connect all devices/stations to the WAN if needed
- Lay out the network to cover aisles/areas that minimize handoffs
  - Communications is not continuous in wireless LAN handoffs
- Video: 802.11b is 11 Mbps, or 5.5 Mbps practically
  - You need 25 * 1.5 Mbps, or 37.5 Mbps, or at least 8 BSS, which is one AP for every 3 vehicles in an area
  - Because of interference, fading, etc. you may need more
  - If you use 802.11n, at 100 Mbps nominal or 50 Mbps actual, you may find 2 APs sufficient (1 for redundancy)

Exercise

- Assume LTE can provide 20 Mbps to areas with industry/warehousing to each location served
  - Assume 100 locations in the cell
  - Assume each has 10 Web users (1 Mbps), 1 Web/data server (5 Mbps), limited videoconference/video (4 Mbps)
    - Total bandwidth for each location is 10 Mbps (1+5+4)
- Compare LTE to:
  - DSL (1.5-13 Mbps, asymmetric)
  - CATV (30-300 Mbps, asymmetric but shared over all 100 users
  - T1 over copper (1.5 Mbps, symmetric)
  - Gigabit Ethernet MAN (1 Gbps, symmetric)
- Can LTE solve the 'last mile' problem sometimes?

Solution

- An average user needs 10 Mbps
  - DSL (1.5-13 Mbps) may meet it in some cases, but usually not. DSL usually 3-6 Mbps
  - CATV has 30-300 Mbps, but 100 users *10 Mbps= 1 Gbps. CATV would need many segments; not effective.
  - T1 over copper (1.5 Mbps) is not enough
  - Gigabit Ethernet MAN is plenty, of course
  - LTE (20 Mbps) is sufficient if bandwidth is available. In lower and medium density areas, it should be ok.
    - A cell can handle 100+ channels at 20 Mbps
  - LTE appears to solve the 'last mile' problem for residences (low/medium density) and low/medium density small business, but not major bandwidth users

Exercise

- **You operate a diamond mine in northern Canada and need 20 Mbps to remotely monitor and diagnose mining equipment, provide Internet and some video for employees, handle email and files, etc.**
  - **Compare GEO, big LEO, little LEO, broadband LEO, MEO to meet your needs**
  - **Where would the other end of the satellite link connect? Does it matter? Options are your corporate HQ, a large peering point, etc.**

Solution

- If you need 20 Mbps up and down in northern Canada:
  - GEO offers max 18 Mbps down and 4 Mbps up, and not in all areas.
  - Polar areas are strange: beams are turned off from lack of demand but could possibly be turned on
  - You might need 5 connections, which would be expensive…but a diamond mine can probably pay it
  - Big LEO and Little LEO are low bandwidth
  - MEO does not offer data services
  - Broadband LEO (Teledesic) failed
- Probably connect near corporate HQ to use MAN from ground station to HQ for cost, bandwidth, security reasons

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