Wireless Wayside and Train Mesh Networks: Leveraging Investment to Meet Passenger Communication Needs

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Background

- NCTD (Kirk Talbott, now CIO Capital Metro in Austin, TX) Presented the original wayside wireless mesh project to TransITech back in 2005.

- Since then, NCTD installed additional 53 wayside wireless mesh nodes

- Additionally, we're installing 20 wayside cameras under a homeland security project

- And previously we demonstrated the viability of not just having cameras onboard, but a camera that pointed forward and could be accessed through the wireless network

Building on the Technology:
Wireless Passenger Communication Systems

- About 18 months ago, NCTD approached FRA to be a test bed for new technologies envisioned for the Commuter Train
  - Their desire is to eventually promulgate regulations for train mesh
    - Train mesh means not that it communicates with wayside, but that the cars can communicate between themselves across a distance
    - Cars must be able to be combined and disassembled to create on-the-fly networks
    - Emergency responders should be able to communicate with the vehicle
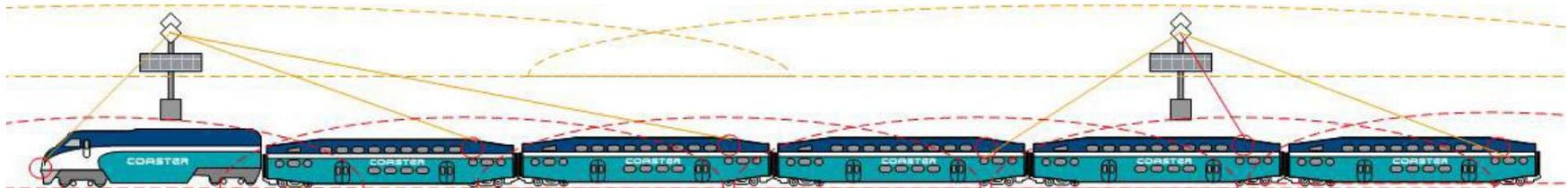   - Mesh network has integrity, even when the train derails and cars are at a distance

    This is a difficult task, as we will discuss

Leveraging the Investment:
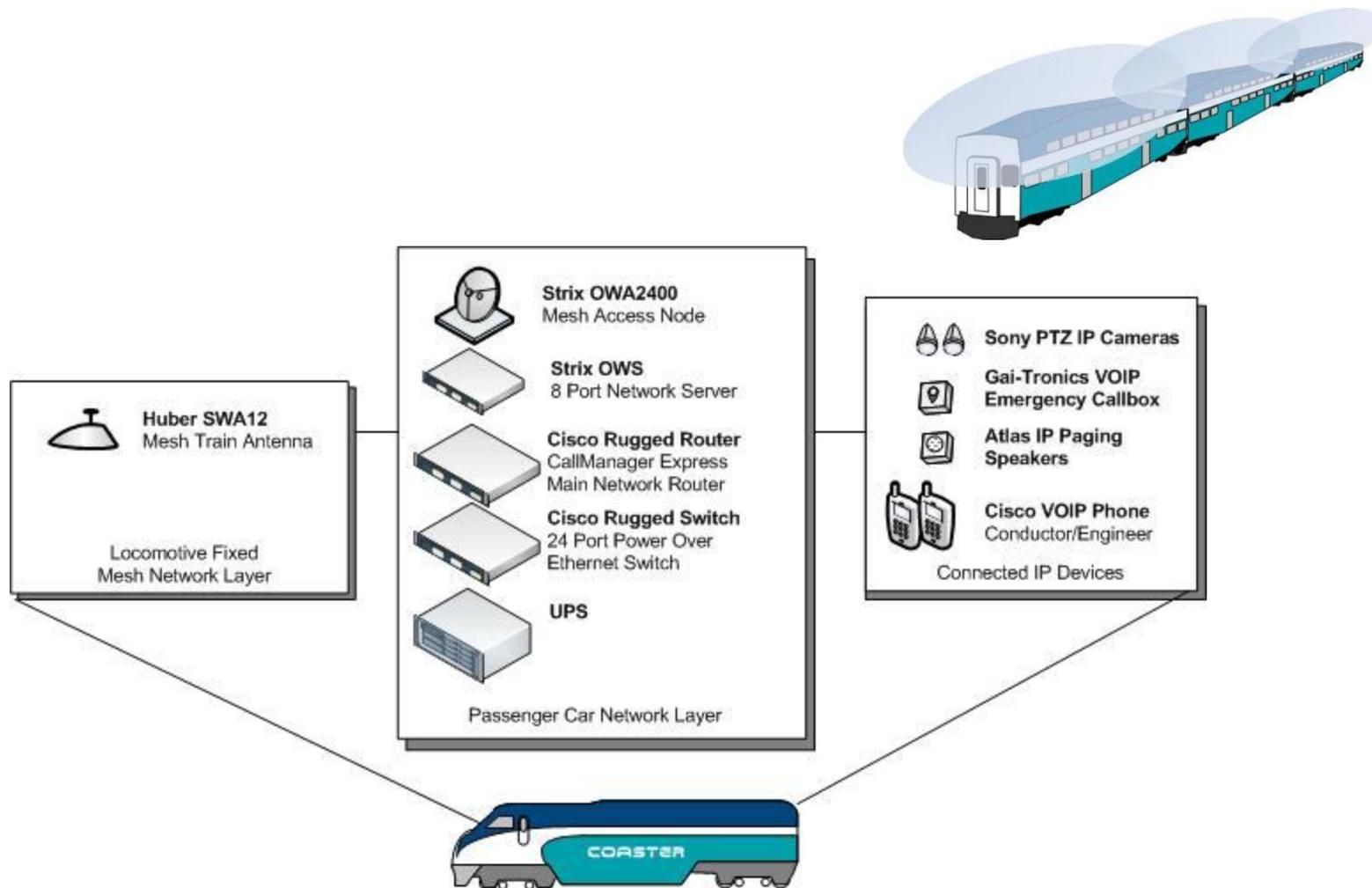## Wireless Passenger Communication Systems

- While FRA is still in discussions with their chosen vendor Difuzion, NCTD is moving forward with a project to implement pieces of the solution as a demonstration project

- Our desire was to leverage our investments made for the Homeland Security Demonstration program, with the VOIP technologies we are implementing as part of our core infrastructure.

- Our COASTER rail stations have not been upgraded in 15 years since the inception of service

- Fear the graphics
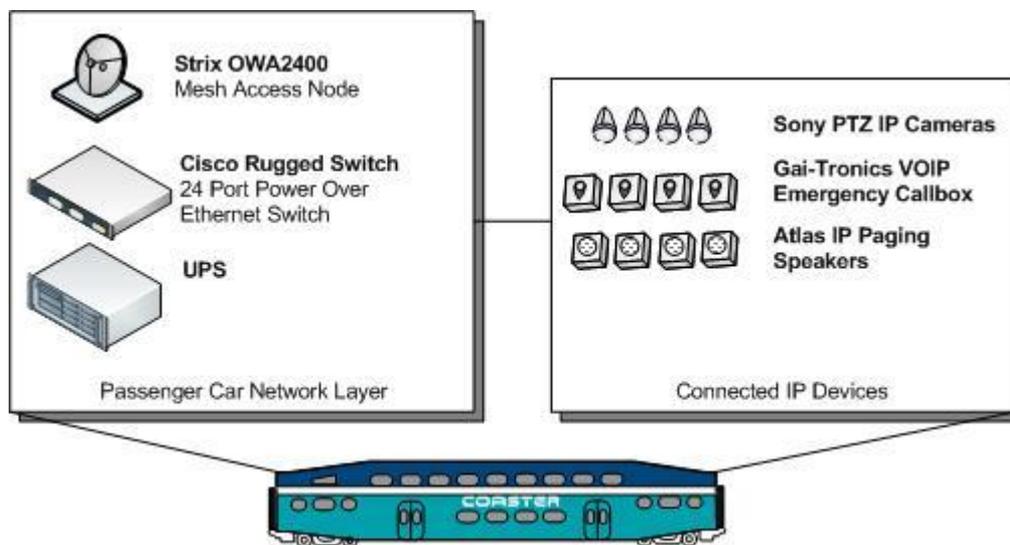
Wireless Passenger Communication Systems: IT Architecture

Locomotive Fixed Mesh Network Layer
- Huber SWA12 — Mesh Train Antenna

Passenger Car Network Layer
- Strix OWA2400 — Mesh Access Node
- Strix OWS — 8 Port Network Server
- Cisco Rugged Router — CallManager Express Main Network Router
- Cisco Rugged Switch — 24 Port Power Over Ethernet Switch
- UPS

Connected IP Devices
- Sony PTZ IP Cameras
- Gai-Tronics VOIP Emergency Callbox
- Atlas IP Paging Speakers
- Cisco VOIP Phone — Conductor/Engineer

Wireless Passenger Communications System: Voice over IP

- Investing in VOIP at the stations, so why not on the train?
  - The NCTD project strives to attain the following goals:
    - A modular, IP-based approach to intercom/PA
    - VOIP core technology, without telephony overhead
    - Packetized voice data
    - Full duplex (two-way) communications
    - Any combination of one-to-one, one-to-many communications simultaneously
    - Scalable, distributed architecture
    - Administration from anywhere on network (inside or outside rail car)
    - IP device addresses may be assigned statically or dynamically
    - Low bandwidth requirements (<100 Kbps per Active Talking Channel)
    - Simplified maintenance is critical to success and full scale implementation

Where are we in the project?

- 12 months into an 18-month estimated effort
- 6 months in rigorous testing with a variety of industry players
- Selected architecture:
  - Combination of industry available, best-in-class tools.
  - Strix nodes for wayside mesh, Strix nodes on the vehicle
  - Cisco Routers with Call manager on the cab cars
  - Huber antennae on the trains
  - VOIP PA POE speakers/callboxes
- In testing on analog-digital signal on some existing speakers
- Have created mesh – on the fly and once associated with a mesh, stays with a mesh until no signal

Where are we in the project?

- Tested and validated the issue of creating and breaking network on the fly
- Tested QOS on the train mesh
- Tested VOIP on the train
- Tested cameras in the train passenger cabin
- Tested VOIP Callboxes
- Tested signal through wireless mesh back to Security Operations
- Tested hand held unit mounting to wireless
- Tested hand held unit access station wireless
- Created monitoring tools for entire network

Why is this project important?

- Demonstrates viability of IP architecture on the train – intermix of voice and cameras
- Demonstrates feasibility of creating network on the fly
- Demonstrates viability of connecting hand helds to network on a moving train
- Could prove very interesting for emergency responders
- Provides possible roadmap for FRA
- May justify my Chief Security Officer's wish for a deployable network-enabled blimp (…. or not)

Challenges in Upscaling

- NCTD has advantage of wayside mesh – 47 miles, but confined number of trains simultaneously

- Upsizing to a larger environment – say where 10 trains are next to one another – may be very challenging

- This architecture, while appropriate for NCTD, is too complicated for most transit agencies to support – goal is one device deployed on a train instead of several

- Project designed to prove concept, but may not be economically-feasible for most entities using current technologies.

- What we are not doing in this environment
  - Internet access for riders
    - Hear that we need this a lot, but do not want to intermix security environment with consumer tools
    - Looking to other options, probably 3G or 4G based
  - Multi-hour survivability of network
    - Provided UPS but target was 1 hour not multiple
    - Technology isn't ready yet for this

Future of the Wireless Mesh Environment

- Gives us foundation for other investments:
  - Hand held units that rely on mesh for mobile tapping
  - E-commerce devices for selling tickets
  - Security PDAs that seamlessly attach to network
  - Possible investment in device that can be deployed airborne to increase survivability of network

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