APTA International ITS

Best Practices Workshop.

April 17, 2012

Transit Communications Systems

Positive Train Control in the 220 MHz Band

AGENDA

- Introduction
- PTC Overview
- TCRP 220 MHz Spectrum Study
- Q&A

Introduction

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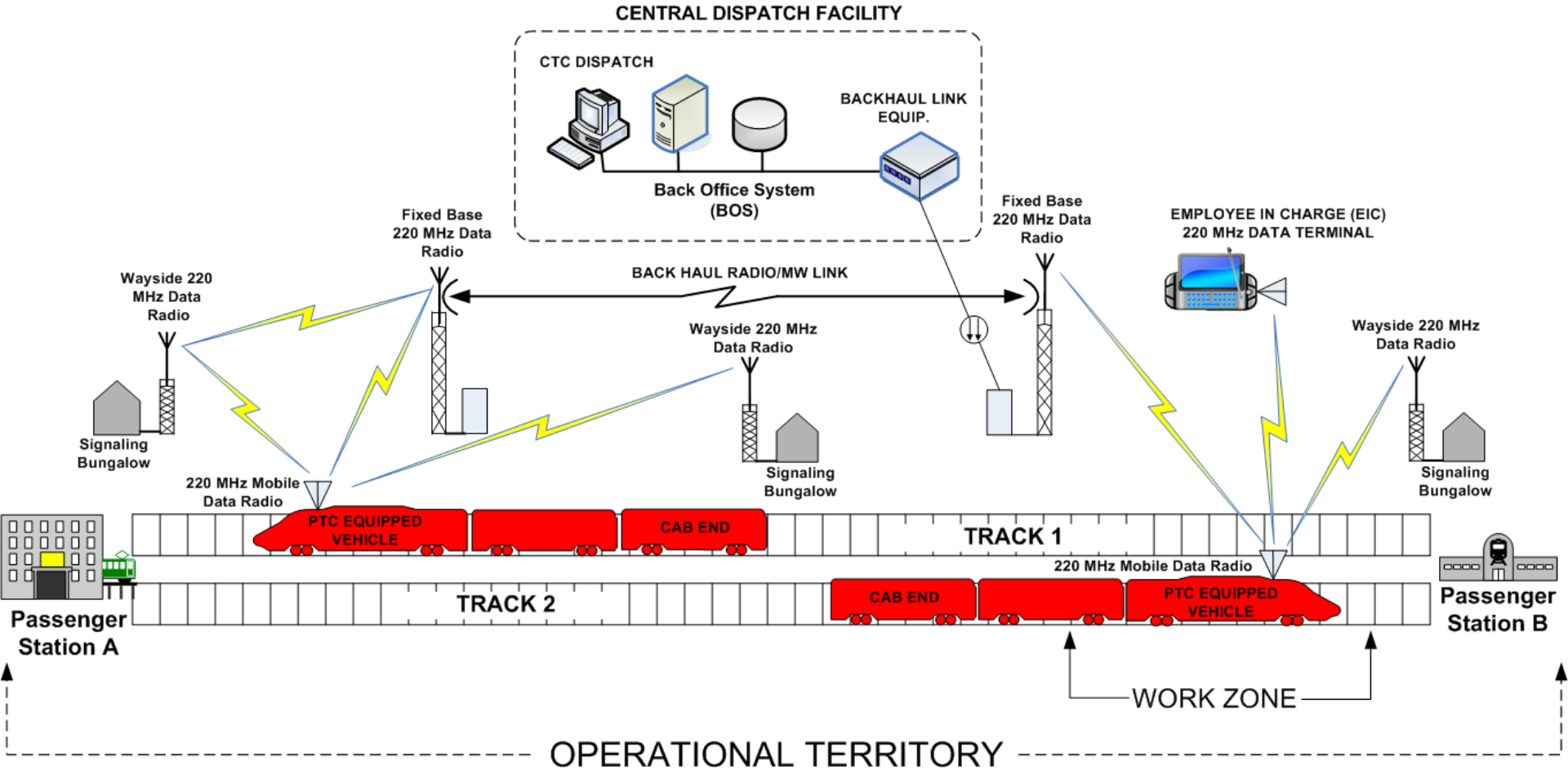
PTC Overview

- **What is Positive Train Control?**
  - Congress passed the Rail Safety Improvement Act (RSIA) in 2008 that mandated "**Positive Train Control**" (PTC) be installed **by the end of 2015** on U.S. Class I rail main lines used to transport passengers and/or Toxic-by-InHalation (TIH) materials (e.g. Chlorine, Ammonia).
  - "Positive Train Control" describes technologies designed to automatically stop or slow a train before certain accidents caused by human error occur.
  - The RSIA mandated that PTC systems must be designed to prevent the following 4 events:
    1. Train-to-train collisions
    2. Derailments caused by **excessive speed**
    3. **Unauthorized** incursions by trains onto sections of track where maintenance or construction activities are taking place
    4. Movement of a train through a track switch **left in the wrong position**.

PTC Overview (Continued)

- **What is Positive Train Control?**
  - A PTC system must be able to:
    - Determine, **in real time**, the location and speed of trains
    - Warn train operators of potential problems
    - Apply the brakes automatically within 15 seconds if the operator does not respond to a warning and fails to stop a train at a signal or slow down for a speed-restricted area.
  - In order to make “real-time” determinations of location and speed, reliable mobile data radio/wireless communications is required for most implementations of PTC.
  - These mobile data radios of course need RF spectrum.
    - Note: The RSIA did not require that the FCC allocate spectrum for PTC use. Therefore rail operators must purchase or lease spectrum from the marketplace.
  - The development of suitable mobile data radio technology and the acquisition of spectrum continues to be in the critical path of meeting the 2015 completion date.

PTC Overview (Continued)



TCRP Study Objective and Purpose

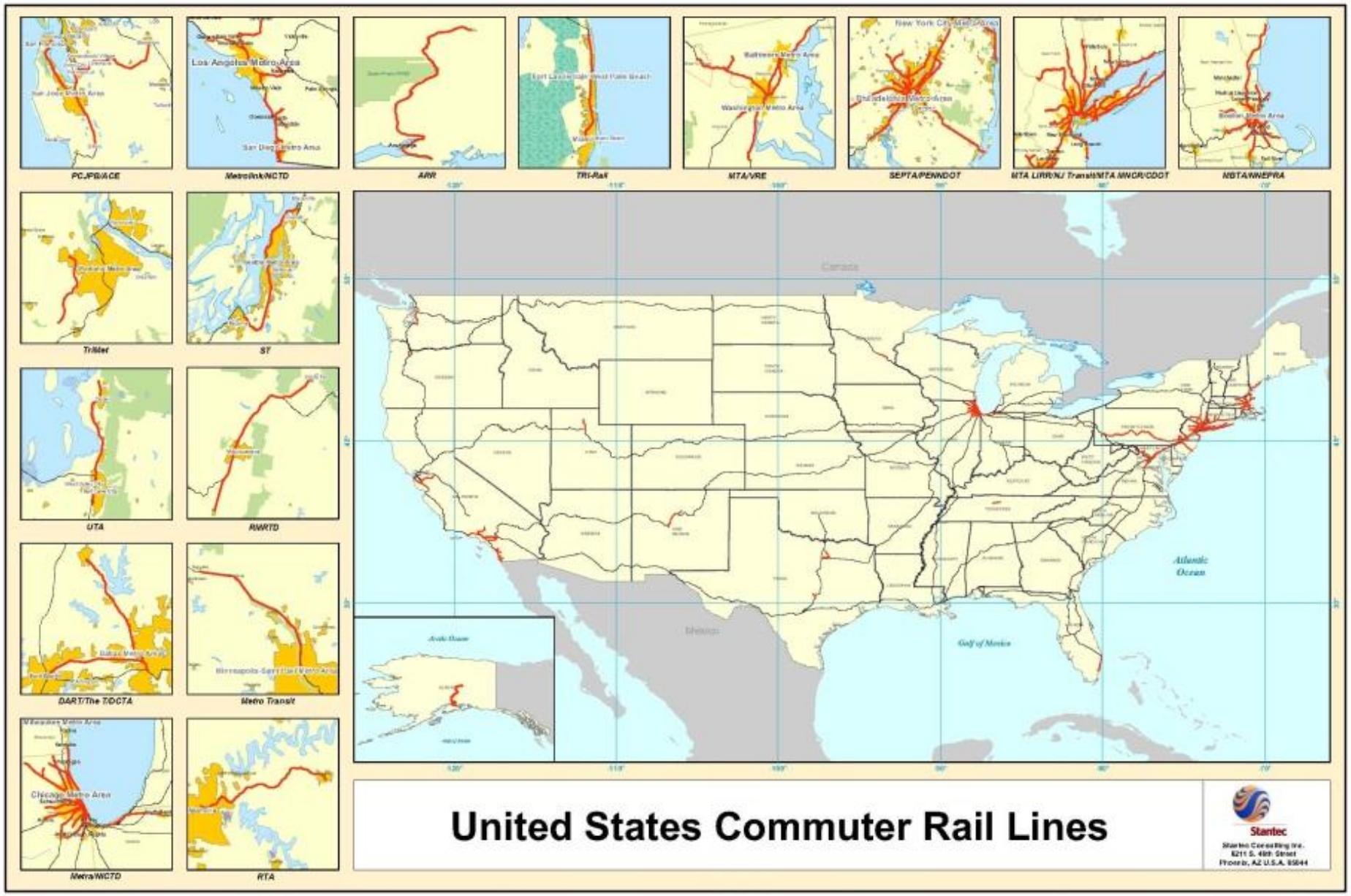
- TCRP Project J6 Task – 079 Completed January 2012
- Objective
  - "*Assess the spectrum needs for implementation of PTC systems by commuter rail providers and providing useful analysis, and the development of spectrum options.*"
- Purpose
  - Provide an initial assessment of the spectrum needed within the identified commuter rail corridors to implement Positive Train Control (PTC) systems based on industry standard RF engineering frequency re-use principals and specifications provided by the manufacturer of the radio equipment.
  - Provide preliminary data for planning and acquisition of spectrum for PTC systems.
  - Provide preliminary spectrum band analysis

Study Coordination and Assumptions

- Coordination
  - Freight Railroads. Study technical assumptions and approach were coordinated with.
    - PTC-220 LLC
    - Meteorcomm
  - Passenger Lines
    - Study assumptions and approach were coordinated with APTA and the Joint Council on Transit Wireless Communications.
- General Assumptions
  - The PTC spectrum needs for freight lines is addressed separately and not part of this study.
  - 28 US Commuter Rail corridors were considered.
  - The Amtrak network was not included in this study except the Philadelphia to Harrisburg line.
  - Assumed ITC 220 Meteorcomm radio parameters on all rail lines.
  - Propagation analysis performed does not represent a design, only an estimate of the quantity of spectrum that is needed to allow a design to be developed by others.

Economic Area (EA) Analysis & Prior Studies

- Passenger Line EA Correlation
  - The initial step was to identify the rail lines and place them on a map using the FRA rail database.
  - The associated EA or multiple EAs were then determined. 20 EAs out of 172 in the US (excluding US territories) are impacted by PTC.
- Prior train control studies
  - 9 studies were found that were determined to be relevant, but none addressed spectrum issues specifically.
    - Governmental: FRA – 2 studies, TRB – 1 study, GAO – 1 report
    - Standards Organizations: IEEE – 1 study, AREMA – 1 White paper
    - Journals: Railway Age Journal - 2 white papers, International Rail Journal – 1 white paper
- Prior PTC Radio Traffic Studies
  - None were available for review, but a few are in progress.


PC/JPB/ACE
Metrolink/NCTD
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TRI-Rail
MTA/VRE
SEPTA/PENNDOT
MTA LIRR/N/ Transit/MTA MNCR/CDOT
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TriMet
ST
UTA
RWRTD
DART/The T/DCTA
Metro Transit
Metra/WICTD
RTA
Canada
Mexico
Atlantic Ocean
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United States Commuter Rail Lines
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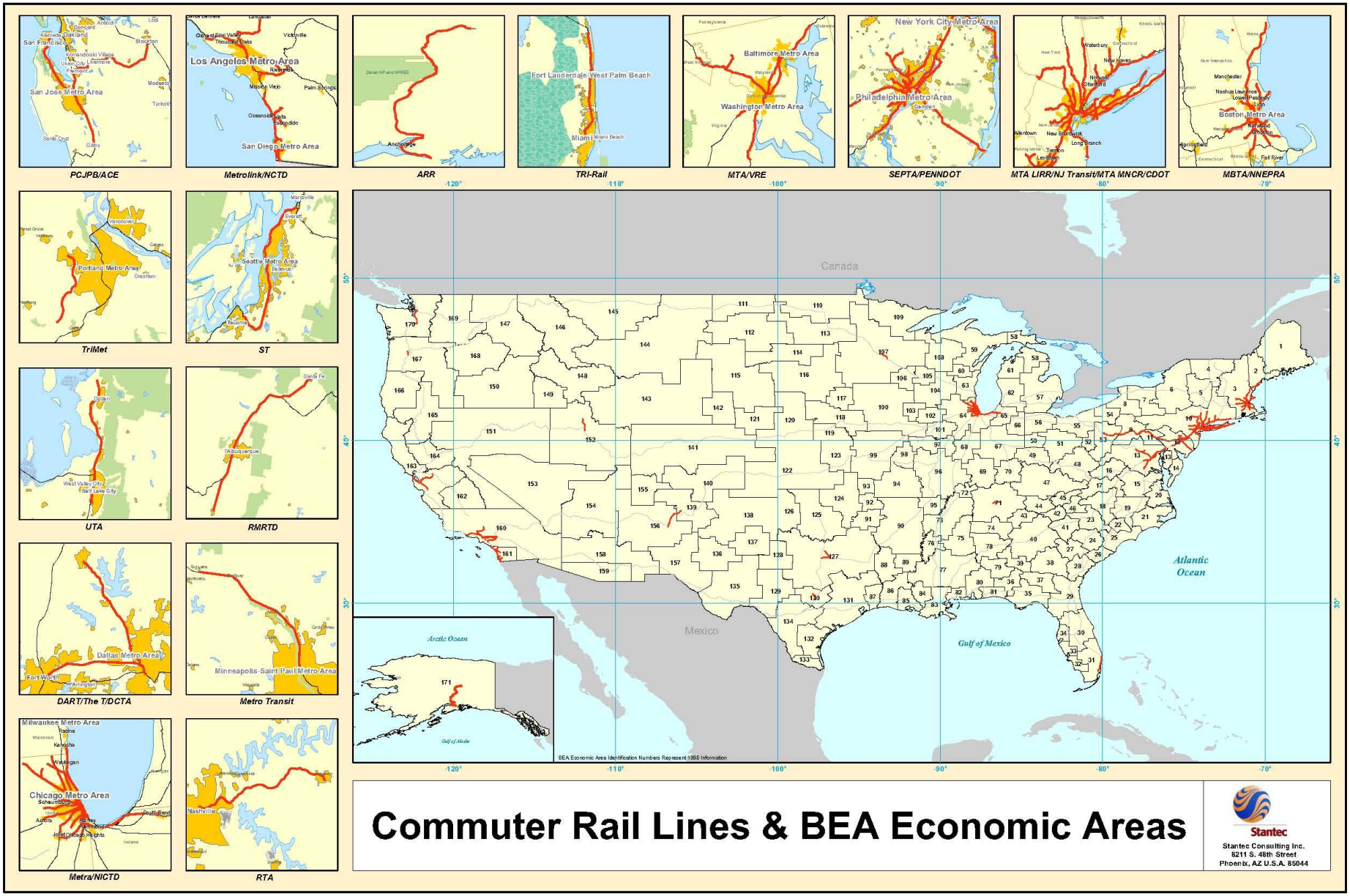
PCJPB/ACE
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SEPTA/PENNDOT
MTA LIRR/NJ Transit/MTA MNCR/CDOT
MBTA/NNEPRA
TriMet
ST
UTA
RMRTD
DART/The T/DCTA
Metro Transit
Metra/NICTD
RTA
Canada
Mexico
Atlantic Ocean
Gulf of Mexico
Arctic Ocean
BEA Economic Area Identification Numbers Represent 1995 Information
Commuter Rail Lines & BEA Economic Areas
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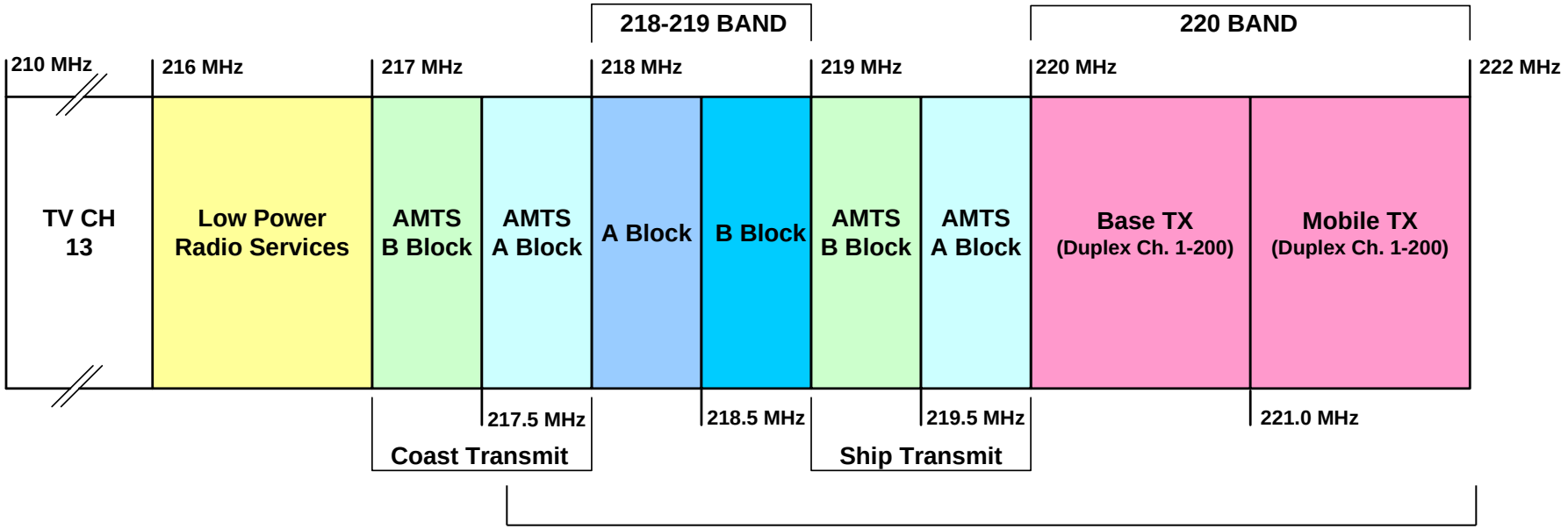
PTC Technology Survey

- 5 PTC technologies were identified. Others are under development.
- Pending FRA Safety Certification.
  1. ITC / I-ETMS using the Meteorcomm PTC 220 radio with an RF bandwidth of 25 kHz (Freight and Passenger lines)
  2. ETMS uses 220 MHz or 160 MHz radios
  3. Modified Cab Signaling – Does not use a 220 MHz radio.
- FRA Safety Certified
  4. ACSES using the GE MDS TD220 Radio with an RF bandwidth of 12.5 kHz (Amtrak Lines). The reduced RF bandwidth of this technology where used, could impact the amount of spectrum needed.
  5. ITCS (i.e. Michigan Line)

Spectrum Analysis

- The 217 to 222 MHz spectrum range has become the de facto industry understanding of the spectrum bands for PTC radio equipment.
- The 218-219 MHz (IVDS) band was his studied as there is spectrum available (FCC auction 89) in many (but not all) areas.



Note: The Meteorcomm ITC radio has a BW of 217.6125 – 221.9875 MHz

Spectrum Estimate

- A spectrum estimate was performed for each of the commuter rail lines and used the following technical assumptions.
- PTC Radio System Configuration
  - 60 foot towers with Nominal 6 dBd gain OMNI antennas placed wayside rail lines.
  - Mountain top radio sites were not considered.
  - Wayside radio coverage was not evaluated (modeled).
  - 25 kHz bandwidth channels used for the ITC 220 radio
  - Each ITC-220 radio would use 8 simplex frequencies.
    - A base control frequency assigned to each base radio in a calculated re-use pattern.
    - One common simplex frequency (identical to all fixed base sites)
    - Six frequencies allocated to each rail line (WIU re-use pattern not determined).
- *The formula for the total spectrum needed per rail line used:*
  - *Total_Channels = Base_chs (calc.) + Common_ch (1) + Waysides_ch (6)*
- Study did not address spectrum for the back-haul communications link (i.e. microwave or radio link) from base sites to dispatch centers or other locations.

Spectrum Estimate (Continued)

- Propagation modeling Settings
  - Longley-Rice ITM model (non-adaptive) at 220 MHz nominal frequency.
  - Land-use data not used (only terrain was considered).
  - 30 meter terrain data used in all corridors
  - 720 radials were calculated for each site.
  - 90% Reliability/Lognormal fading
  - Only wayside Base to Train mobile transmissions were modeled to estimate a frequency re-use pattern.
  - Frequency re-use parameters per MeteorComm LLC guidelines.
  - Base radio power output: 37.5 Watts (average power)
  - ERP calculated between 100 and 150 watts
  - Receive sensitivity and C/I+N (Carrier to Interference + Noise ratio) modeled to achieve 10% PER (packet error rate) per MeteorComm LLC guidelines.

Spectrum Estimate (Continued)

- The spectrum estimates for the 28 rail lines were correlated and aggregated into 20 EAs.

Item	1995 EA Code	Total Spectrum (kHz)
1	2	140
2	3	660
3	10	1,825
4	12	1,025
5	13	800
6	31	325
7	64	740
8	65	210
9	71	250
10	107	275

Item	1995 EA Code	Total Spectrum (kHz)
11	127	825
12	130	250
13	152	300
14	156	375
15	160	500
16	161	325
17	163	675
18	167	250
19	170	425
20	171	425

Spectrum Estimate (Continued)

- Estimate Totals by AGENCY

#	State	Agency	Total Spectrum (kHz)	1995 EA Code
1	NY	MTA Long Island Rail Road (MTA LIRR)	**475**	10
2	NJ	New Jersey Transit Corporation (NJ TRANSIT)	**500**	10
3	NY	Metro-North Commuter Railroad Company	**550**	10
4	IL	Northeast Illinois Regional Commuter Railroad Corporation (Metra)	**600**	64
5	MA	Massachusetts Bay Transportation Authority (MBTA)	**475**	3
6	PA	Southeastern Pennsylvania Transportation Authority (SEPTA)	**450**	12
7	CA	Southern California Regional Rail Authority (Metrolink)	**500**	160
8	CA	Peninsula Corridor Joint Powers Board (PCJPB)	**325**	163
9	MD	Maryland Transit Administration (MTA) [Brunswick and Camden lines Only]	**475**	13
10	FL	South Florida Regional Transportation Authority (TRI-Rail)	**325**	31
11	IN	Northern Indiana Commuter Transportation District (NICTD)	**350**	64 & 65
12	VA	Virginia Railway Express (VRE)	**325**	13
13	WA	Central Puget Sound Regional Transit Authority (ST)	**425**	170
14	TX	Dallas Area Rapid Transit (DART) (TRE LINE)	**275**	127

#	State	Agency	Total Spectrum (kHz)	1995 EA Code
15	CA	North County Transit District (NCTD)	**325**	161
16	UT	Utah Transit Authority (UTA)	**300**	152
17	TX	Fort Worth Transportation Authority (The T) (Planned Cotton belt line)	**300**	127
18	NM	Rio Metro Regional Transit District (RTD) (NM Rail Runner Express)	**375**	156
19	CA	Altamont Commuter Express (ACE)	**350**	163
20	CT	Connecticut Department of Transportation (CDOT) (East shore line)	**300**	10
21	PA	Pennsylvania Department of Transportation (PENNDOT)	**575**	12
22	ME	Northern New England Passenger Rail Authority (NNEPRA)	**350**	2 & 3
23	TN	Regional Transportation Authority (RTA)	**250**	71
24	OR	Tri-County Metropolitan Transportation District of Oregon (TriMet)	**250**	167
25	MN	Metro Transit	**275**	107
26	AK	Alaska Railroad Corporation (ARRC)	**425**	171
27	TX	Denton County Transit Authority (DCTA)	**250**	127
28	TX	Capital Metro	**250**	130

Key Findings

- Deployment of PTC systems within the continental US are located within 20 economic areas out of a total of 171.
  - Initiatives to find or obtain spectrum for passenger rail PTC purposes can be focused within these areas.
- Correlation of the rail corridor spectrum estimate to EAs is suitable for the 220 Band, as spectrum blocks in this band are assigned using this geographic area type.
- Correlation of the rail corridor spectrum estimate to EAs is not suitable for the 218-219 Band, as spectrum blocks in this band are assigned to smaller geographic areas called Cellular Market Areas.
- This study cannot be used to draw conclusions regarding availability of 218-219 spectrum blocks within all areas of each rail corridor.
- Additional technology specific spectrum analysis is needed.

Thank You!

Questions?