Spectrum Needs for Positive Train Control

Preliminary Results

December 15, 2011

Agenda

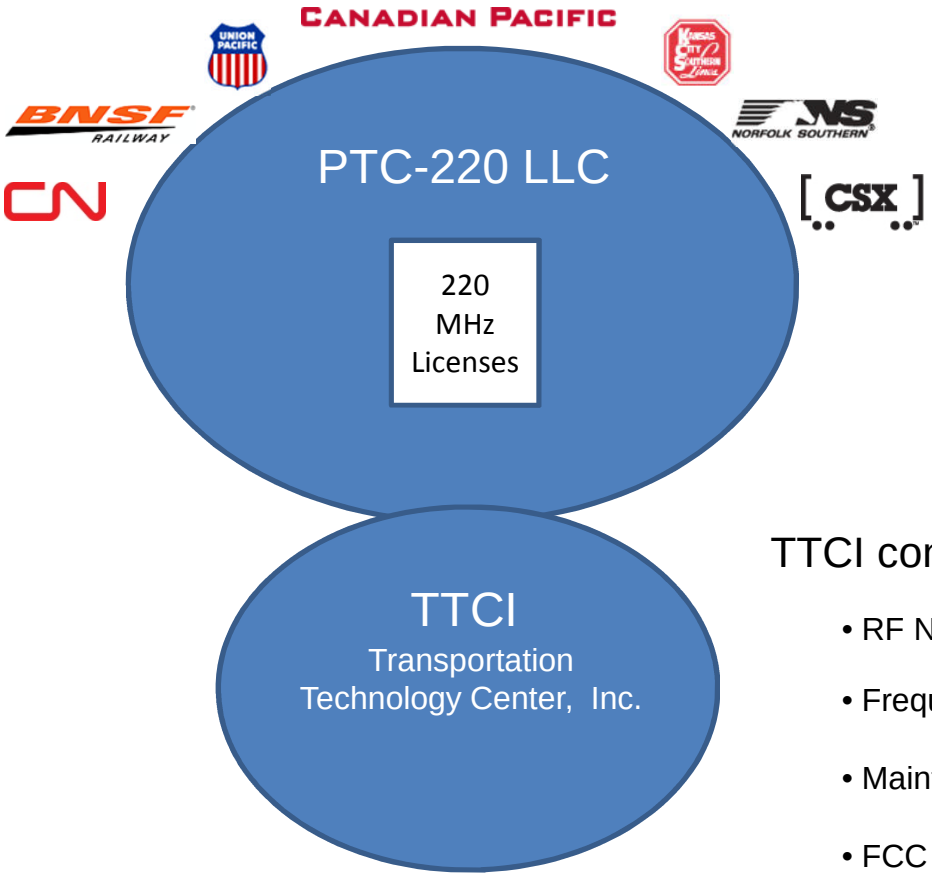
- PTC-220 LLC Update
- Positive Train Control Overview
- PTC-220 Spectrum Holdings
- Spectrum Need—Definition, Process, & Analysis
- Results
- Potential Waiver Requests

POSITIVE TRAIN CONTROL (PTC)

- Required under mandate of Rail Safety Improvement Act of 2008
- PTC must be interoperable across all interconnecting railroads
- Currently 40 rail companies are subject to PTC requirement
- Wireless connectivity to remote assets is a crucial component of PTC
- Industry Interoperable Train Control (ITC) committee named 220 MHz as the designated band for PTC interoperability
- PTC development and deployment schedules are aggressive and complex
- PTC development is not progressing as quickly as anticipated
- Rail industry is working with FRA to address schedule changes

PTC-220 Progress & Achievements

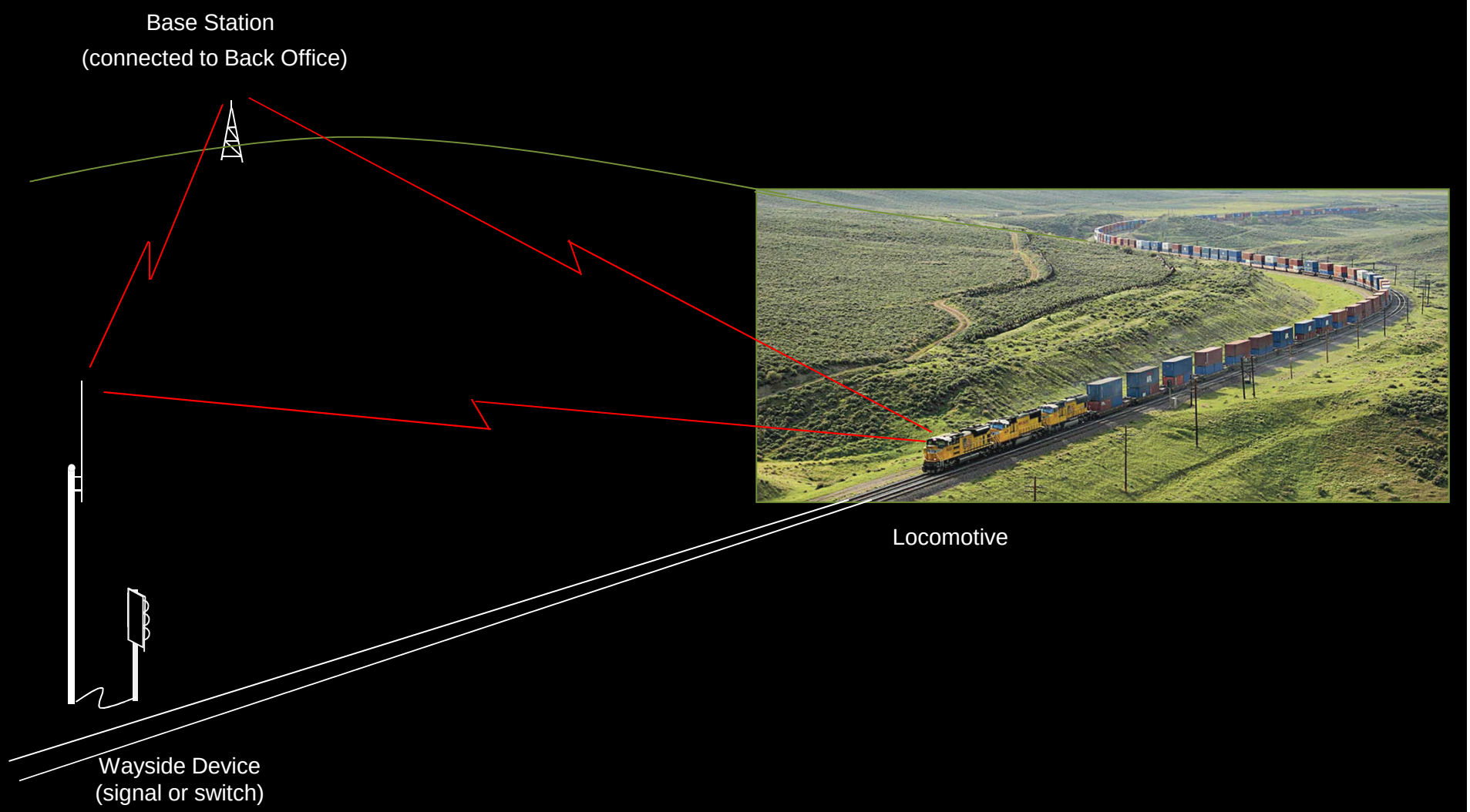
- Initial waivers granted on June 25, 2009 (DA 09-1425)
- Buildout Plan and all progress reports submitted on schedule
- Expanded membership from original 2 to all 7 Class I railroads
- Membership now represents 95% of mandated PTC operations
- Engaged TTCI as primary Engineering Support vendor
- Congested area studies underway with LA and Chicago results
- Working with RF modeling software vendor to accurately model PTC protocols
- 220 PTC radio testing underway in closed and open track environments



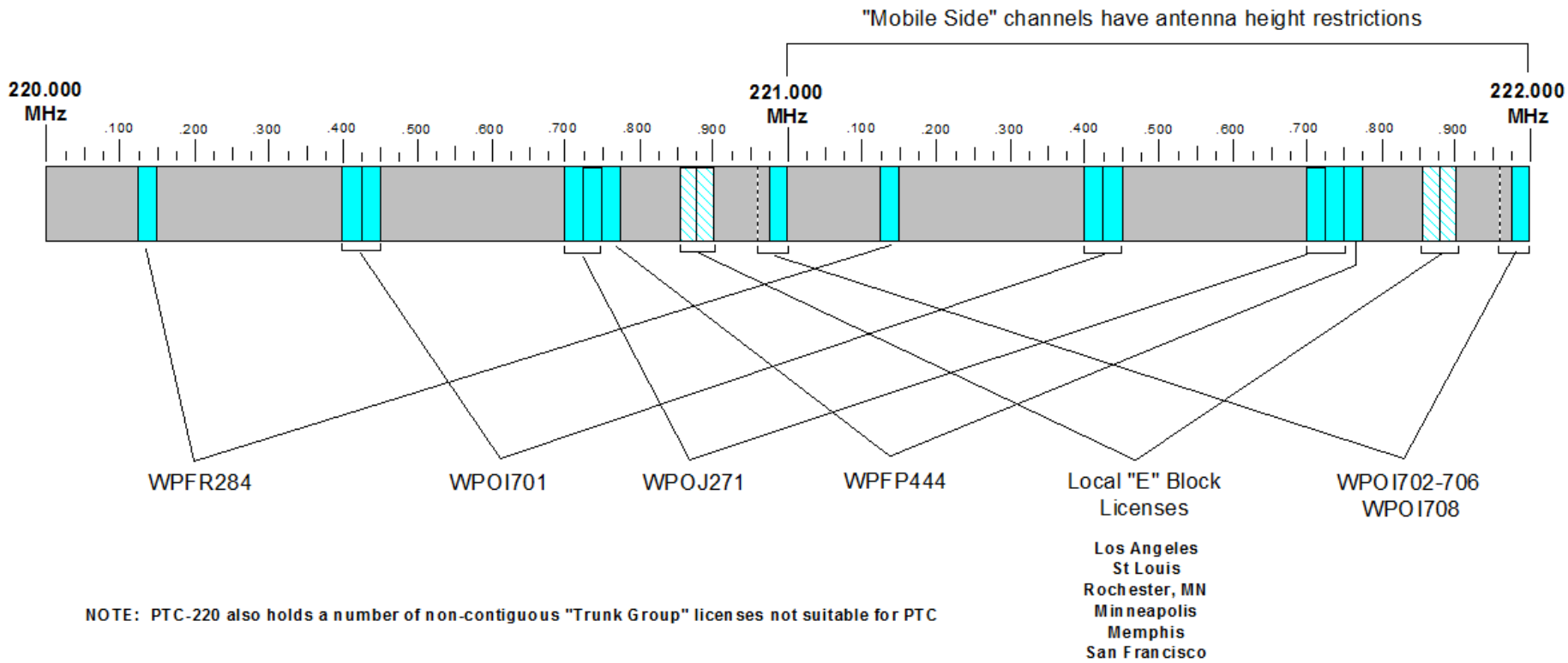
TTCI contracted to PTC-220

- RF Network Engineering
- Frequency/Slot Coordination
- Maintain PTC databases
- FCC Interface

PTC Communication Paths



PTC220 Spectrum Holdings



Los Angeles
St Louis
Rochester, MN
Minneapolis
Memphis
San Francisco

NOTE: PTC-220 also holds a number of non-contiguous "Trunk Group" licenses not suitable for PTC

How Much Spectrum Does PTC Need?

- Much PTC track is isolated and one-dimensional
  - Low offered traffic loads
  - Modest spectrum needs
- Rail activity tends to concentrate around population centers
  - Complex, 2-D track networks
  - More trains
  - More wayside devices
- PTC spectrum need increases with density of rail operations
- PTC-220 identified two areas for initial PTC capacity/spectrum studies:
  - Los Angeles
    - Operators: Union Pacific, BNSF, & Metrolink
    - Expectation for PTC operation in 2012
  - Chicago
    - Many operators, including all Class I Freight roads
    - Worst case in US for rail traffic density
  - Will help create template for design of other congested areas

Track Network
Los Angeles Basin
PTC Rail Lines
50 km
30 mi
34.925711, -118.469224
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Los Angeles Basin

- 2012 PTC Expectation
- Three Rail Players:
  - BNSF
  - Union Pacific
  - Metrolink
- Contractors:
  - TTCI, representing PTC220
  - Parsons, representing Metrolink

- Network design was collaboration between Railroads, Parsons and TTCI
  - TTCI provided modeling of train traffic and PTC Message traffic
  - Parsons did base selection and frequency planning
- Base Station Sharing was fundamental design principle
  - Single PTC Network shared by all operators
  - Maximizes efficient use of spectrum

Chicago Area
Rail Lines
Chicago
Lake Michigan
Chicago River North Branch
Oak Knoll Farm
Air Estates Inc
Ivanhoe
Libertyville
Green Oaks
Rondout
Lake Bluff
Island Lake
Wauconda
Mundelein
Williams Park
Sylvan Lake
Diamond Lake
Crystal Lake
Phyllis Field
Lakewood
Indian Creek
Mettawa
Lake Forest
Lake in the Hills
Cary
Fremont
North Barrington
Vernon Hills
Fox River Grove
Lake Zurich
Prairie View
Half Day
Highwood
Highland Park
Magic Carpet
Kildeer
Aptakisic
Lincolnshire
Huntley
Algonquin
Kuranz RLA
Deer Park
Long Grove
Deerfield
Landings Condominium
Barrington Hills
Barrington
Buffalo Grove
Forest Preserve
Glencoe
Reid RLA
Koppie
Brunner
Carpentersville
Inverness
Wheeling
Northbrook
Palatine
Palwaukee Muni
Winnetka
Gilberts
Dundee
South Barrington
Rolling Meadows
Prospect Heights
Northfield
Kenilworth
Mill Rose Farm RLA
Arlington Heights
Northfield Woods
Glenview
Wilmette
Tyler Creek Forest Preserve
Mount Prospect
Golf
Hoffman Estates
Morton Grove
Evanston
Elgin
Plato Center
Streamwood
Schaumburg
Des Plaines
Skokie
Niles
Elk Grove Village
Park Ridge
Lincolnwood
South Elgin
Bartlett
Roselle
Chicago O'Hare Intl
Rosemont
Keeneyville
Medinah
Itasca
Bloomingdale
Wood Dale
Norridge
Harwood Heights
Wayne
Bensenville
Schiller Park
Wasco
Cloverdale
Addison
Franklin Park
Dupage
River Grove
Elmwood Park
Saint Charles
Carol Stream
Glendale Heights
Stone Park
Elmhurst
Melrose Park
River Forest
Geneva
West Chicago
North Glen Ellyn
Berkeley
Maywood
Oak Park
Fabyan Forest Preserve
Lombard
Hillside
Forest Park
Winfield
Wheaton
Yorkfield
Broadview
Batavia
Highland Hills
Westchester
Hines
Berwyn
Cicero
Mooseheart
Hericks Lake Forest Preserve
Valley View
Oak Brook
Riverside
Warrenville
Brookfield
Stickney
North Aurora
Downers Grove
La Grange
Lyons
Lisle
Westmont
Hinsdale
Chicago Midway Intl
Summit
Eola
Naperville
Countryside
Indian Head Park
Sugar Grove
Aurora
Bedford Park
Hodgkins
Naper Aero Club
Woodridge
Darien
Bridgeview
Montgomery
Brookridge Air Park
Willow Springs
Justice
Hometown
Wheatland Field RLA
Hickory Hills
Evergreen Park
Boulder Hill
Bolingbrooks Clow Intl
Argonne National Laboratory Reservation
Oak Lawn
Burnside
Bolingbrook
Forest Preserve
Palos Hills
Chicago Ridge
Bristol
Flying M Farm
Oswego
Wormley
Lambert
Hastings
Worth
Merrionette Park
Whiting
Lemont
Palos Park
Alsip
Calumet Park
Indiana Dunes
George
Forest Preserve
Yorkville
Day
Romeoville
Crestwood
Blue Island
Robbins
Burnham
East Chicago
Gowles Bog
Orland Park
Riverdale
Dolton
Gary Chicago Intl
Ogden Dunes
Rileys Field
Midlothian
Calumet City
Porter
Chesterton
Plainfield
Lewis University
Phoenix
Oak Forest
South Holland
Gary
Lily Cache
Lockport
Harvey
Markham
Hammond
Crocker
Westhaven
Hazel Crest
Lake Station
Portage
Fernway
Tinley Park
Thornton
Munster
Country Club Hills
Lansing
New Chicago
Crest Hill
Fairmont
Homewood
Highland
Marley
Flossmoor
Glenwood
Liverpool
Forest Park
Holbrook
Hobart
Bushby RLA
Rossis Farm
Joliet
Ridgewood
Arbury Hills
Sunny Crest
Lynwood
Griffith
Ross
Carlson Farm
Shorewood
Mokena
Hoosier Prairie
Griffith-Merrillville
Idylside
Ingalls Park
New Lenox
Olympia Fields
Frankfort Square
Chicago Heights
Wheeler
Joliet Regional
Rockdale
Matteson
Lottaville
Dyer
Schererville
Haley Field
Richton Park
Park Forest
New Elliott
Ainsworth
Wilhelmi Field
Frankfort
Sauk Village
Merrillville
Howell-New Lenox
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Data Zoom 9-0

Chicago

- Most complex US rail area
  - 11 rail operators
  - 4-6 times more complex than LA
  - Nearly 1400 wayside devices
  - 2100 track-miles/800+ route-miles
- Data gathering was enormous task
- Network Design underway at TTCI
  - Final design Feb, 2012
  - Spectrum Needs assessment Nov, 2011

Spectrum Needs Analysis

Enough spectrum is needed to support:

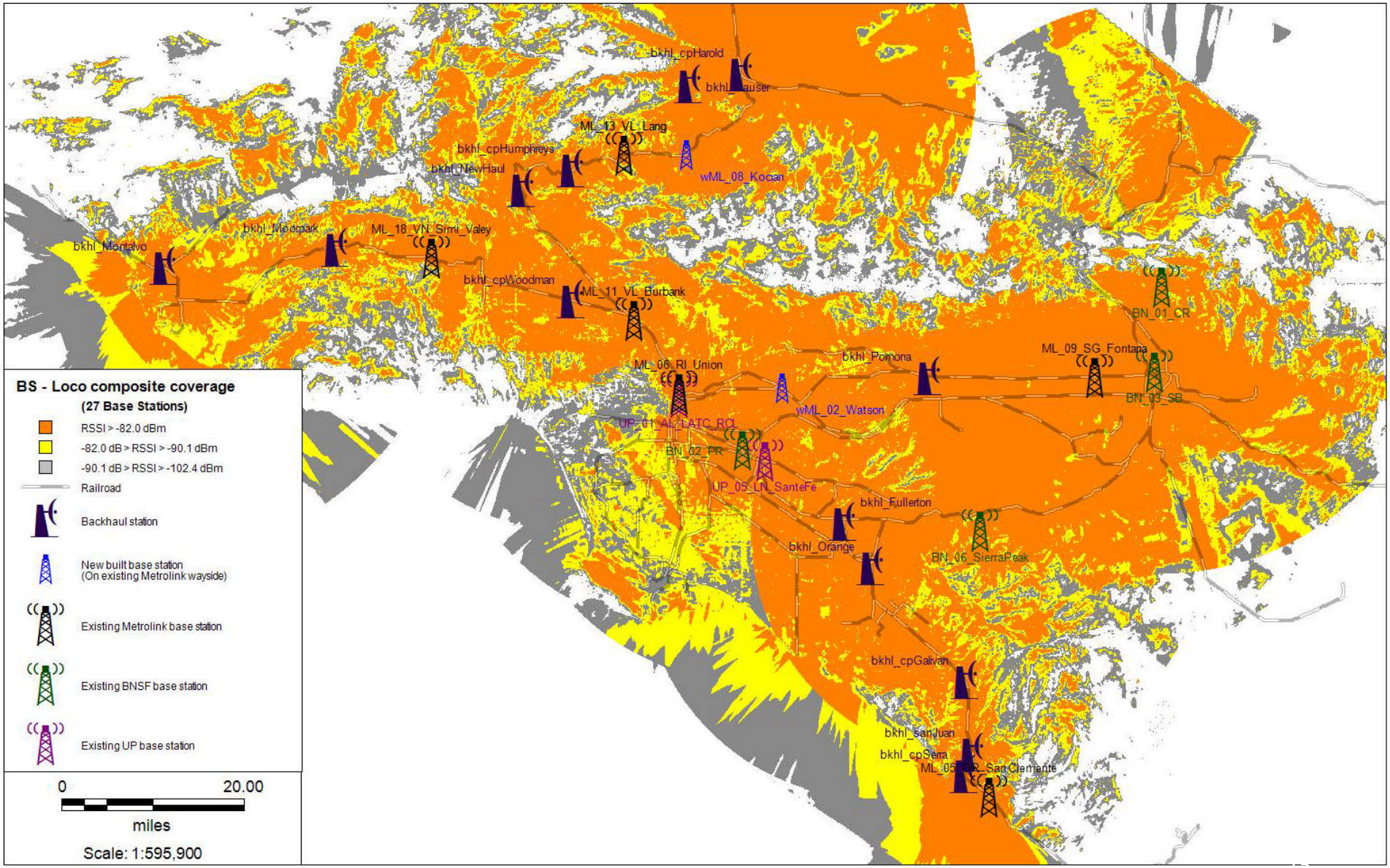
- Full primary coverage of specified design area
  - Minimum required signal strength (from link budgets)
  - Minimum required signal-to-interference ratio
  - Capacity to handle offered load
- Coverage redundancy where needed
- A Frequency Re-Use Plan
  - Minimize Frequencies Required
  - Limit Co-Channel Interference
- Contingency for inaccuracies in modeling
- Flexibility to deal with interference and other channel anomalies
- Anticipated growth

Determining Spectrum Needs

- Define Network Design Area
  - Converging routes are close enough to interact
  - Base stations cover multiple routes
- Collect existing candidate base sites
- Find frequency plan using optimum subset of base sites
  - Consider signal strength and signal/interference ratio
- Determine projected traffic load for each base
  - If any bases are near, at, or over capacity, add constraint and rerun
- Generate frequency/slot plan for wayside stations
- Converge Base and Wayside frequency plans

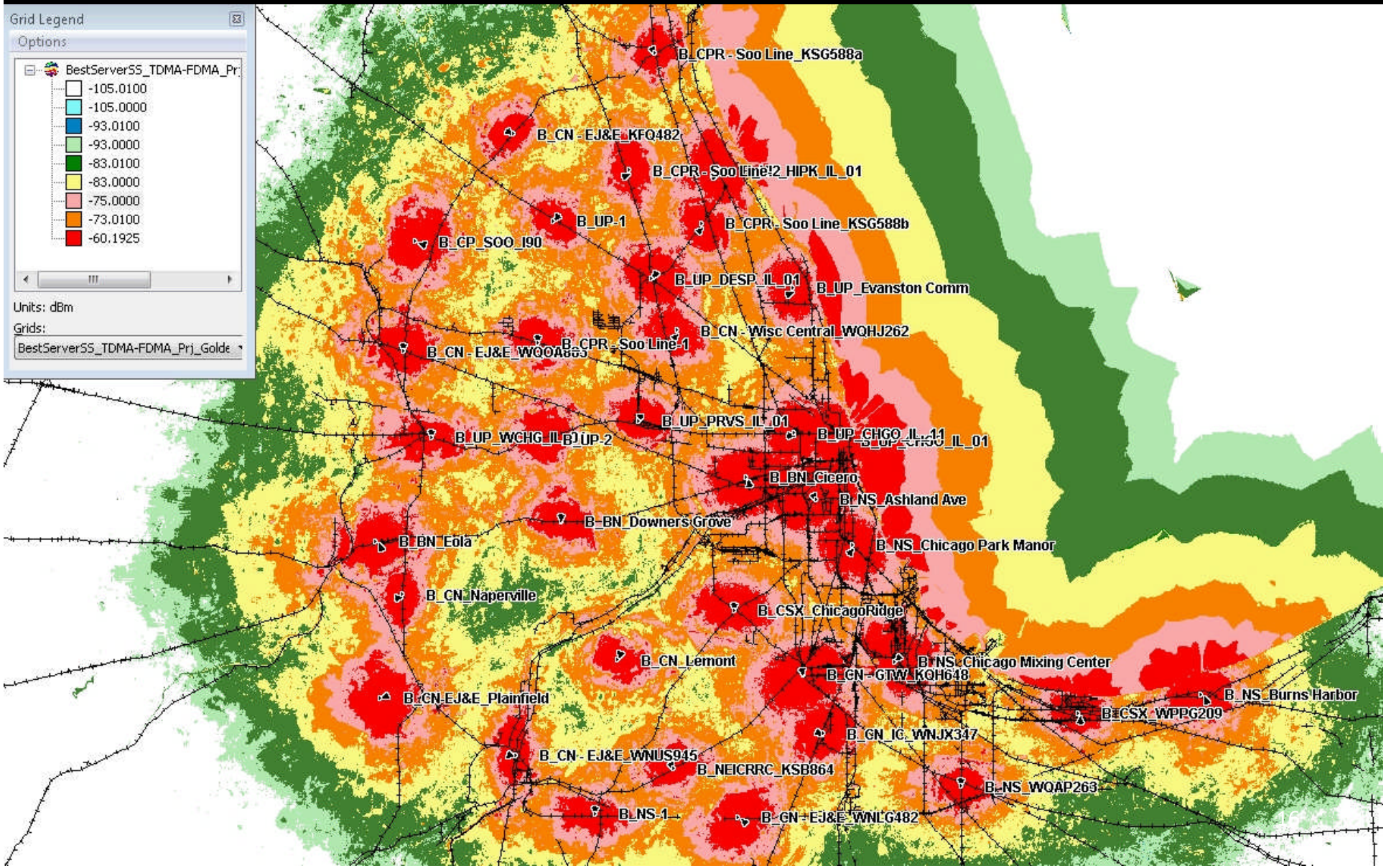
Parsons Full Redundancy Design for LA Area

27 Base Stations



Chicago Single Coverage Plan (Limited Redundancy)

36 Base Stations



Caveats

- These results are all from simulations based on models of train traffic, message traffic, and RF propagation
- Models and analysis tools continue to be refined
- There is no allowance for inaccuracies in the models or the simulations
- There is no contingency for unexpected interference or other channel anomalies
- Analyses are based on projected 2020 traffic levels, but don’t account for other kinds of growth
- Still some uncertainty about relaying wayside->train messages
- PTC protocol development not complete
- No experience yet with real deployments

Total Anticipated Spectrum Needs for Los Angeles and Chicago

(In 25 KHz PTC Channels)

	Simulation	Near Term (2012-2015)	Mid-Term (2016-2020)	Long Term (2021+)
LA*	11 (275 KHz)	19 (475 KHz)	25 (625 KHz)	35 (875 KHz)
Chicago**	19 (475 KHz)	23 (575 KHz)	TBD	TBD

* LA design is based on a Full Coverage Redundancy requirement

** Chicago will likely be deployed with Limited Coverage Redundancy

APTA/Stantec study

Generally agrees with PTC-220 results, allowing for differences in approach

- Addresses transit networks only
- Assumes independent networks
- Adds wayside spectrum needs on top of base needs

Potential Waiver Requests

FCC assistance needed to enhance spectrum efficiency

- Half of PTC220 channels are from upper (mobile) half of 220 MHz band
- Power/antenna height restrictions make them less usable (47 C.F.R. § 90.729(b))
- Less of a factor in LA, due to negative HAATs
- Will be a major factor in Chicago and other congested areas
- Relief from restrictions would make use of existing spectrum more efficient