RADWIN *FiberinMotion®*

Train-to-Ground Wireless Broadband Communications

Ron Porter, Transportation Solution Expert

THE WIRELESS CONNECTIVITY CHOICE

General

- RADWIN is a leading provider of ***Sub-6 GHz broadband wireless solutions*** for telecom operators, transportation, public safety, critical facilities, oil & gas
- Offers ***carrier class*** high capacity, wireless solutions for fixed and mobile connectivity
- Complete portfolio of point-to-point, point-to-multipoint and mobility solutions
- Proven installed base in over 150 countries
- Global presence with offices in major locations and a network of partners

RADWIN Target Markets

Carrier Market:

High-capacity access and backhaul connectivity to underserved urban and rural environments and advanced small-cell Non-Line-of-Sight (NLOS) backhaul in dense urban environments

Vertical Market:

broadband wireless transmission for government and enterprise, including fixed and mobile video and data applications

Public Transportation:

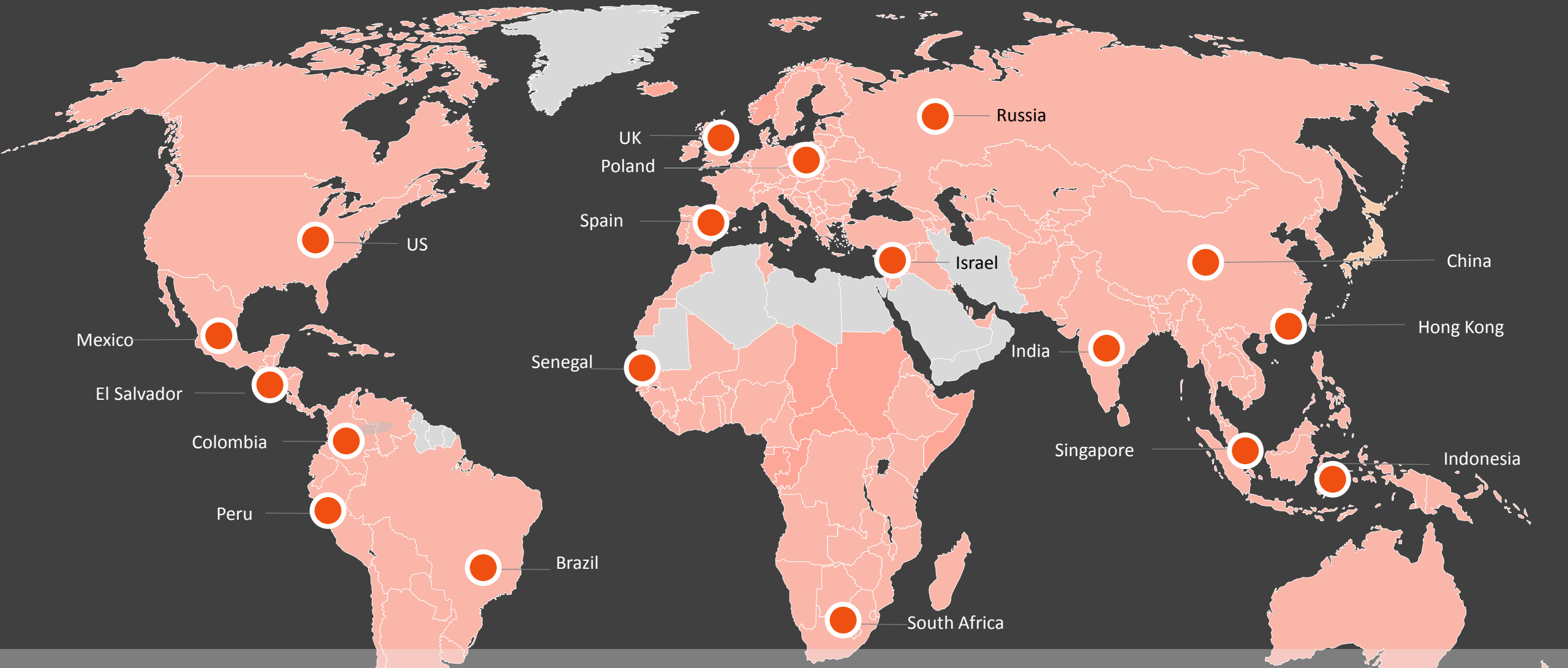
Highly reliable wireless train-to-ground communications, including complex environments addressing winding underground tunnels and NLOS scenarios

Honolulu Light Rails

Rome Metro

Moscow Metro

Ukraine Railways



Deployed in Over 150 Countries

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RADWIN Solutions for Vertical Markets

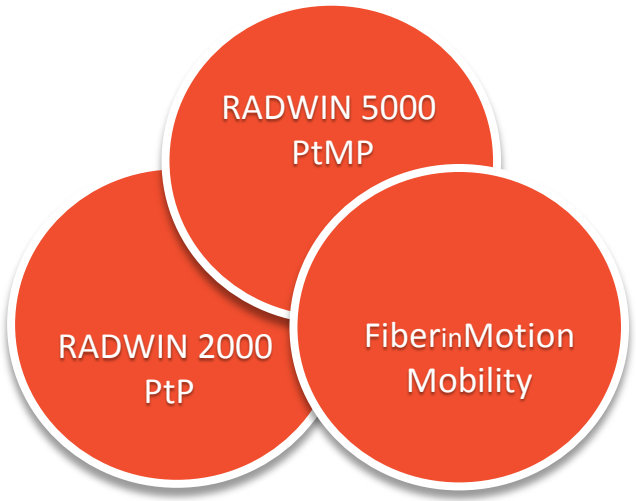
Public Transportation

Public Safety

Municipalities

Oil & Gas

Airports



Utilities

Mines

Education

Finance

Maritime & Ports

THE WIRELESS CONNECTIVITY CHOICE

RADWIN SOLUTIONS FOR RAIL & METRO

RADWIN

Broadband Services for Transportation

OPERATIONS

- Signaling and CBTC
- PA systems
- Information offload at Depot
- Maintenance information

SAFETY & SECURITY

- Real time CCTV
- Level crossing real-time view by the driver
- Stations view by the driver

PASSENGER SERVICES

- Internet access (Wi-Fi)
- PIS - Passenger Information Systems (news, weather, commercials)
- VOD- Video On Demand

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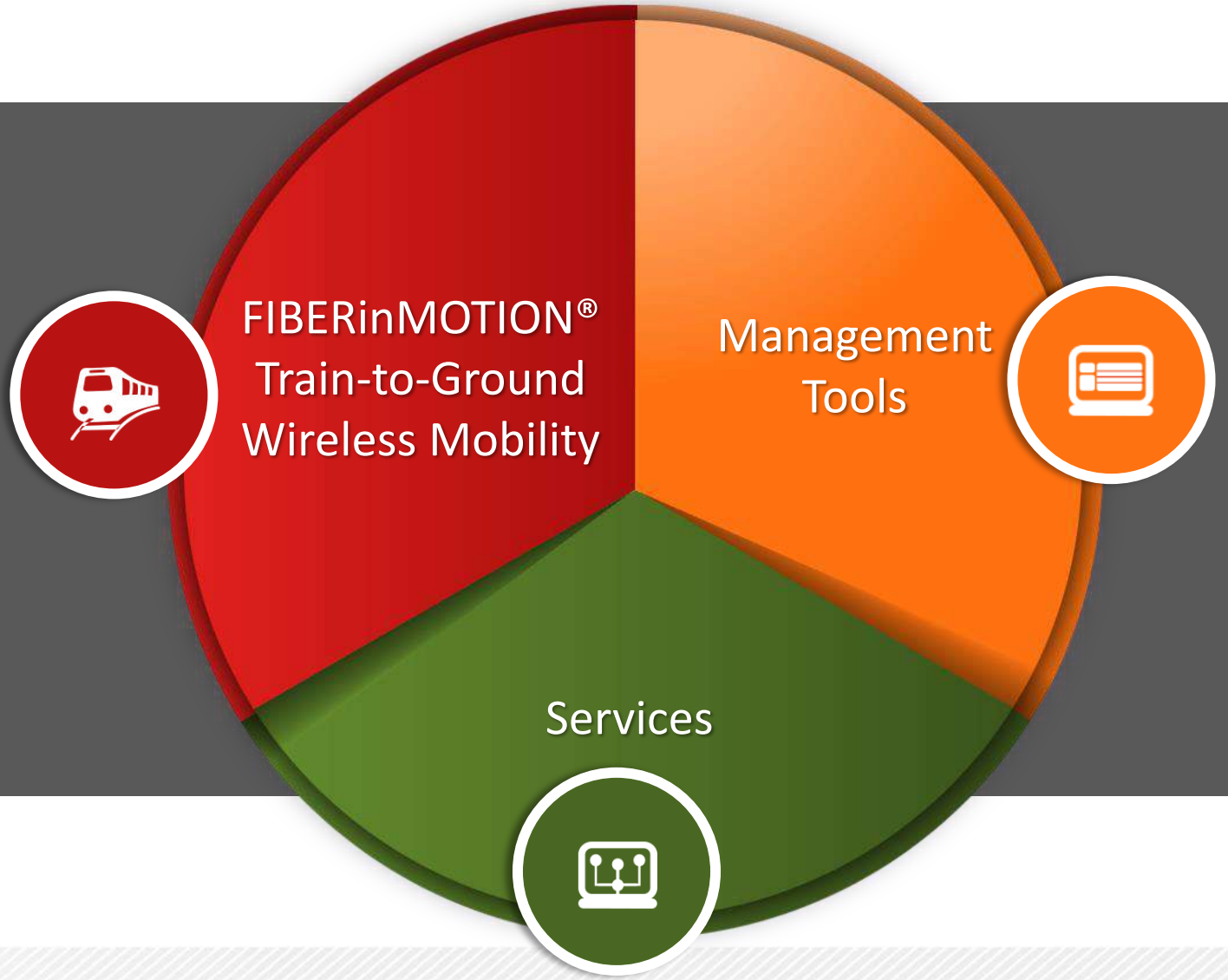
Complete Solution for Train-to-Ground Communications



RADWIN FiberinMotion Solution Architecture - Underground

- Radio Mobile unit (HMU) installed inside the train, connected to 2 special train antennas installed on top
- Optional dual radio + antennas to improve redundancy and coverage

- Radio Base Stations (HBS) deployed along the tunnel, supporting multiple trains simultaneously
- 2/4 antennas
- Optional redundancy

RADWIN FiberinMotion Solution Architecture – Above Ground

- Radio Base Stations (HBS) deployed along the route, supporting multiple trains simultaneously
- 2/4 antennas directed eastbound and westbound for extended coverage
- Optional redundancy

- Radio Mobile unit (HMU) installed on-board the train, connected to 2 x train antennas installed on top
- Optional dual radio + antennas to improve redundancy and coverage

RADWIN FiberinMotion Highlights (1)

- High capacity: Installed and proven to deliver up to 100Mbps per Base Station / Mobile Unit
- Extended coverage for each Base Station
  - Up to 1Km/0.6miles underground
  - Up to 5Km/3miles above ground
- High speed – up to 300 KMH / 190 MPH
- Uplink / Downlink configurable asymmetric traffic
- Guaranteed bandwidth per train
- Seamless handover < 50msec (without a controller)

RADWIN FiberinMotion Highlights (2)

- Guaranteed bandwidth per train
- QoS over the air, enabling prioritization of multiple services
- Optional redundancy 1+1
- Low & fixed latency and jitter
- IP67 outdoor support
- Support of railway standards
  - EN 50155, EN 61373, EN 50121
- Multiband support in a single H/W
- Customization capabilities (special frequencies, architecture, etc.)

RADWIN Solutions for Rail & Metro – Management Tools

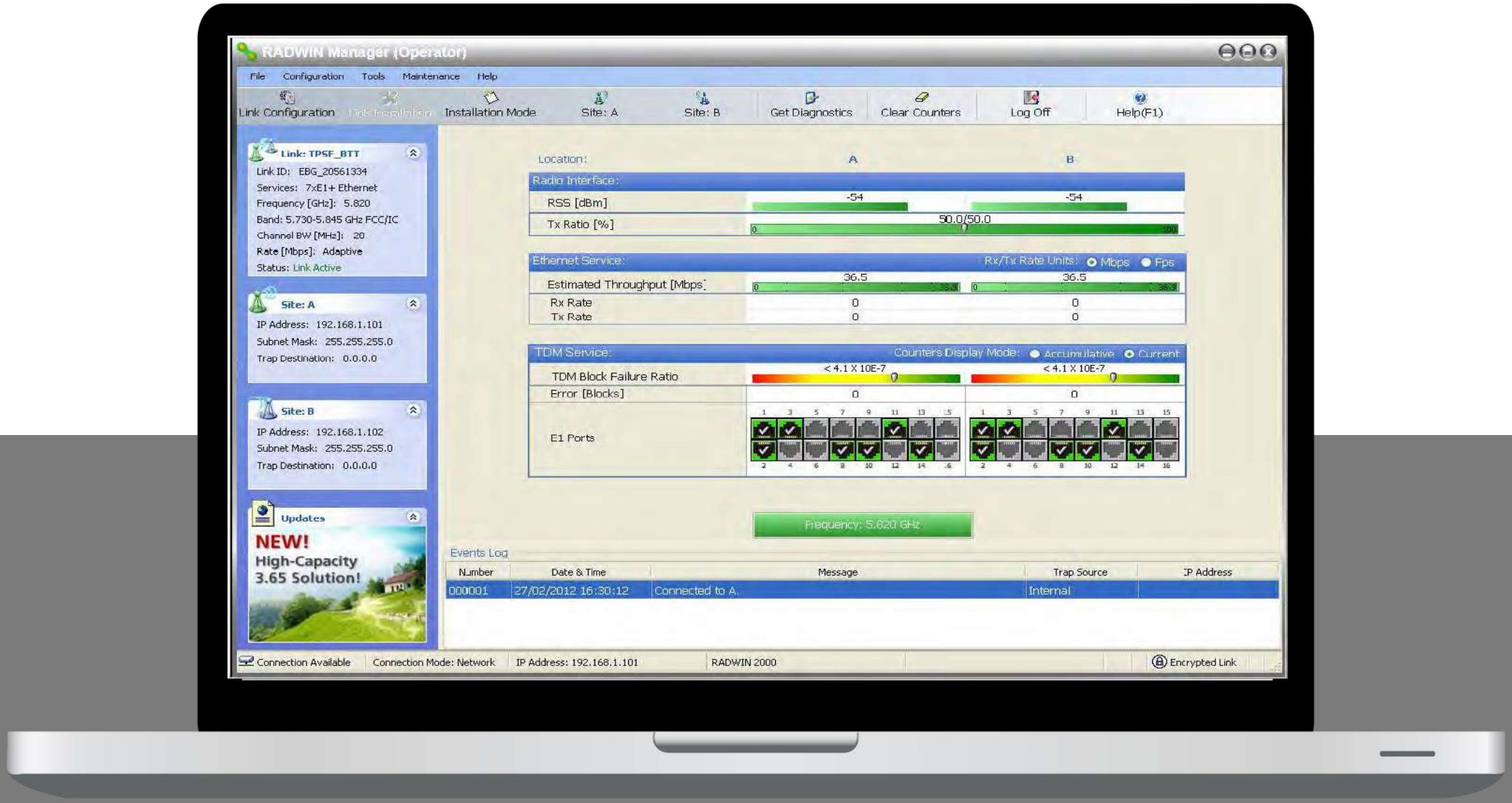
MANAGEMENT TOOLS

- Network Planner
- Radio Network Management
- Real-time Performance Monitoring
- Offline Analysis application
- Drive Test Tool

1. RADWIN Manager

- SNMP based local and remote management
- Management of a complete Link with a single IP address
- On Line Monitor of the air interface and the services

- Supports Traps and Alarms
- Includes:
  - Local and remote
  - “Over the air” SW upgrade for multiple links
  - Performance Monitoring
  - Active Alarms
  - Backward compatibility


RADWIN Manager (Operator)
File
Configuration
Tools
Maintenance
Help
Link Configuration
Link Installation
Installation Mode
Site: A
Site: B
Get Diagnostics
Clear Counters
Log Off
Help(F1)
Link: TPSF_BTT
Link ID: EBG_20561334
Services: 7xE1+ Ethernet
Frequency [GHz]: 5.820
Band: 5.730-5.845 GHz FCC/IC
Channel BW [MHz]: 20
Rate [Mbps]: Adaptive
Status: Link Active
Site: A
IP Address: 192.168.1.101
Subnet Mask: 255.255.255.0
Trap Destination: 0.0.0.0
Site: B
IP Address: 192.168.1.102
Subnet Mask: 255.255.255.0
Trap Destination: 0.0.0.0
Updates
NEW!
High-Capacity
3.65 Solution!
Location:
A
B
Radio Interface:
RSS [dBm]
-54
-54
Tx Ratio [%]
50.0/50.0
Ethernet Service:
Rx/Tx Rate Units:
Mbps
Fps
Estimated Throughput [Mbps]
36.5
36.5
Rx Rate
0
0
Tx Rate
0
0
TDM Service:
Counters Display Mode:
Accumulative
Current
TDM Block Failure Ratio
< 4.1 X 10E-7
< 4.1 X 10E-7
Error [Blocks]
0
0
E1 Ports
Frequency: 5.820 GHz
Events Log
Number
Date & Time
Message
Trap Source
IP Address
000001
27/02/2012 16:30:12
Connected to A.
Internal
Connection Available
Connection Mode: Network
IP Address: 192.168.1.101
RADWIN 2000
Encrypted Link

2. RADWIN RNMS Network Management

Features	PLATINUM
Managed Links	Up to 10,000
Managing Clients	10
Automatic Network Discovery	✓
Hierarchical Network Views	✓
Performance Monitoring and Trend Reports	✓
Scheduled Report Generation	✓
User Access Control Management	✓
Distributed Polling Agent Architecture	✓
SNMP Protocols v1, v2c and Secure SNMP v3	✓
Remote Java Console Connection to RNMS Server	✓
Backup Server	✓
Support Services	Advanced support including onsite service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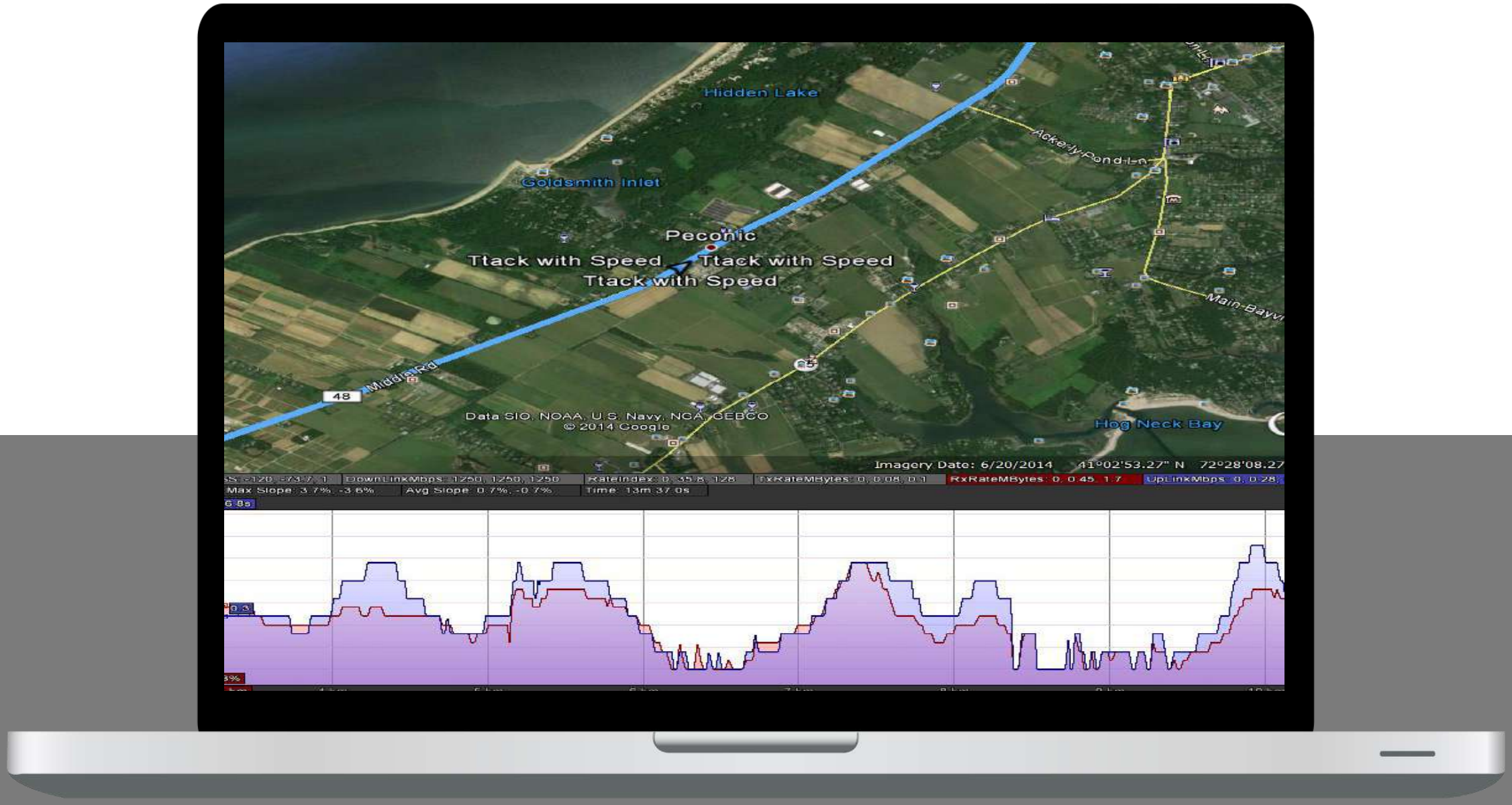
3. RADWIN Drive Test Tool

Drive Test Tool

- Data collected while driving along the track can be aggregated and displayed in a KMZ summary file:
  - RSS, data rate, speed, GPS location, etc.
- Used for advanced analysis and troubleshooting

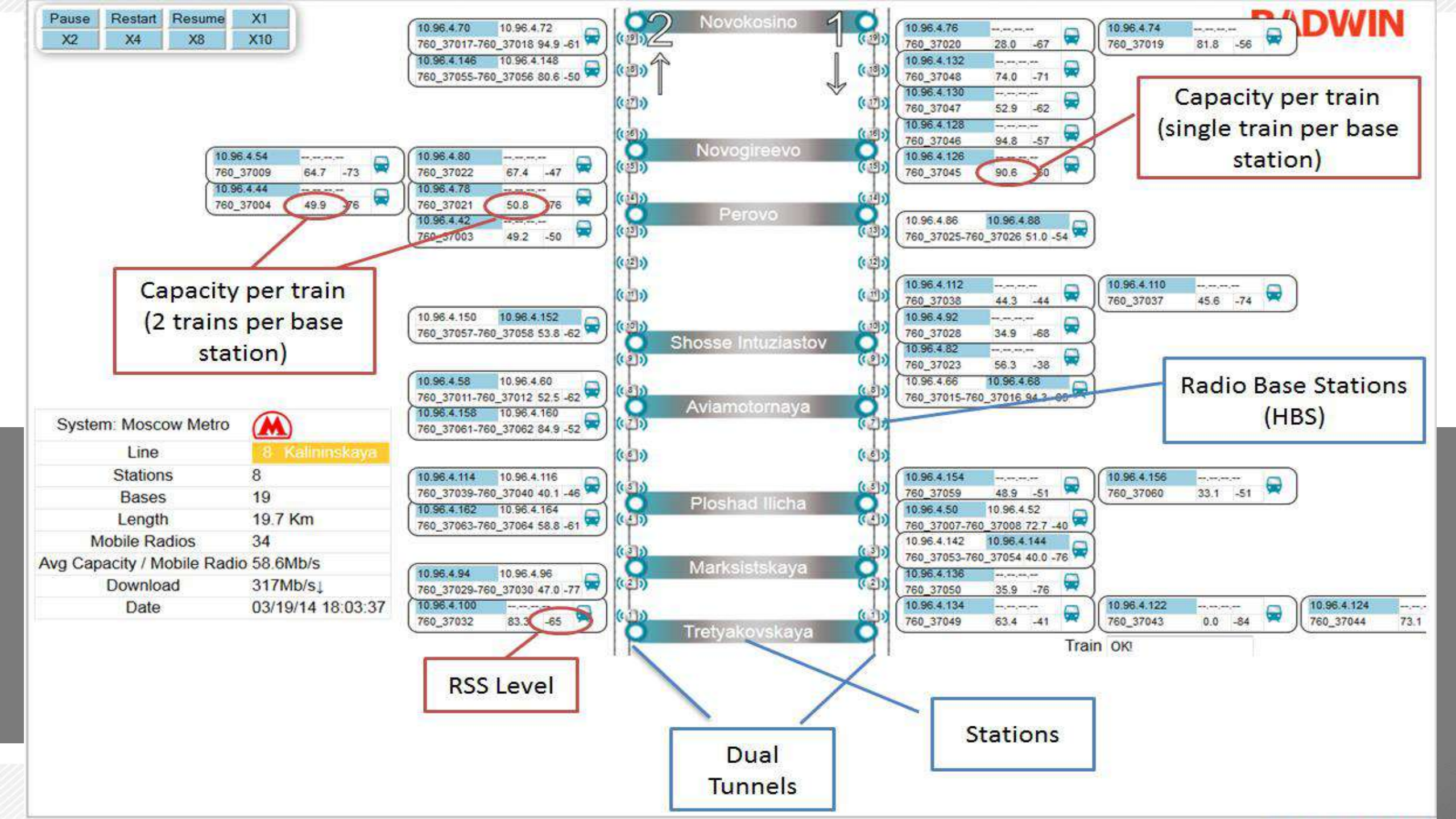

Hidden Lake
Goldsmith Inlet
Peconic
Ttack with Speed
Ttack with Speed
Ttack with Speed
Ackerly Pond Ln
Main Bayv
Middle Rd
48
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
© 2014 Google
Hog Neck Bay
Imagery Date: 6/20/2014 41°02'53.27" N 72°28'08.27
Max Slope: 3.7%, -3.6%
Avg Slope: 0.7%, -0.7%
Time: 13m 37.0s

4. Real Time Monitoring Tool

Real time monitoring tool

- Snap shot tracking and monitoring
- Location, RSS, data rate
- Trains distribution along the track
  (connection to bases)
- Customized per rail/metro system

RADWIN


Pause
Restart
Resume
X1
X2
X4
X8
X10
Novokosino
Novogireevo
Perovo
Shosse Intuziastov
Aviamotornaya
Ploshad Ilicha
Marksistskaya
Tretyakovskaya
10.96.4.70 10.96.4.72 760_37017-760_37018 94.9 -61
10.96.4.146 10.96.4.148 760_37055-760_37056 80.6 -50
10.96.4.54 760_37009 64.7 -73
10.96.4.44 760_37004 49.9
10.96.4.80 760_37022 67.4 -47
10.96.4.78 760_37021 50.8
10.96.4.42 760_37003 49.2 -50
10.96.4.150 10.96.4.152 760_37057-760_37058 53.8 -62
10.96.4.58 10.96.4.60 760_37011-760_37012 52.5 -62
10.96.4.158 10.96.4.160 760_37061-760_37062 84.9 -52
10.96.4.114 10.96.4.116 760_37039-760_37040 40.1 -46
10.96.4.162 10.96.4.164 760_37063-760_37064 58.8 -61
10.96.4.94 10.96.4.96 760_37029-760_37030 47.0 -77
10.96.4.100 760_37032 83.3 -65
10.96.4.76 760_37020 28.0 -67
10.96.4.74 760_37019 81.8 -56
10.96.4.132 760_37048 74.0 -71
10.96.4.130 760_37047 52.9 -62
10.96.4.128 760_37046 94.8 -57
10.96.4.126 760_37045 90.6
10.96.4.86 10.96.4.88 760_37025-760_37026 51.0 -54
10.96.4.112 760_37038 44.3 -44
10.96.4.110 760_37037 45.6 -74
10.96.4.92 760_37028 34.9 -68
10.96.4.82 760_37023 56.3 -38
10.96.4.66 10.96.4.68 760_37015-760_37016 94.3 -65
10.96.4.154 760_37059 48.9 -51
10.96.4.156 760_37060 33.1 -51
10.96.4.50 10.96.4.52 760_37007-760_37008 72.7 -40
10.96.4.142 10.96.4.144 760_37053-760_37054 40.0 -76
10.96.4.136 760_37050 35.9 -76
10.96.4.134 760_37049 63.4 -41
10.96.4.122 760_37043 0.0 -84
10.96.4.124 760_37044 73.1
Train OK!
System: Moscow Metro
Line 8 Kalininskaya
Stations 8
Bases 19
Length 19.7 Km
Mobile Radios 34
Avg Capacity / Mobile Radio 58.6Mb/s
Download 317Mb/s↓
Date 03/19/14 18:03:37
Capacity per train (single train per base station)
Capacity per train (2 trains per base station)
Radio Base Stations (HBS)
RSS Level
Dual Tunnels
Stations

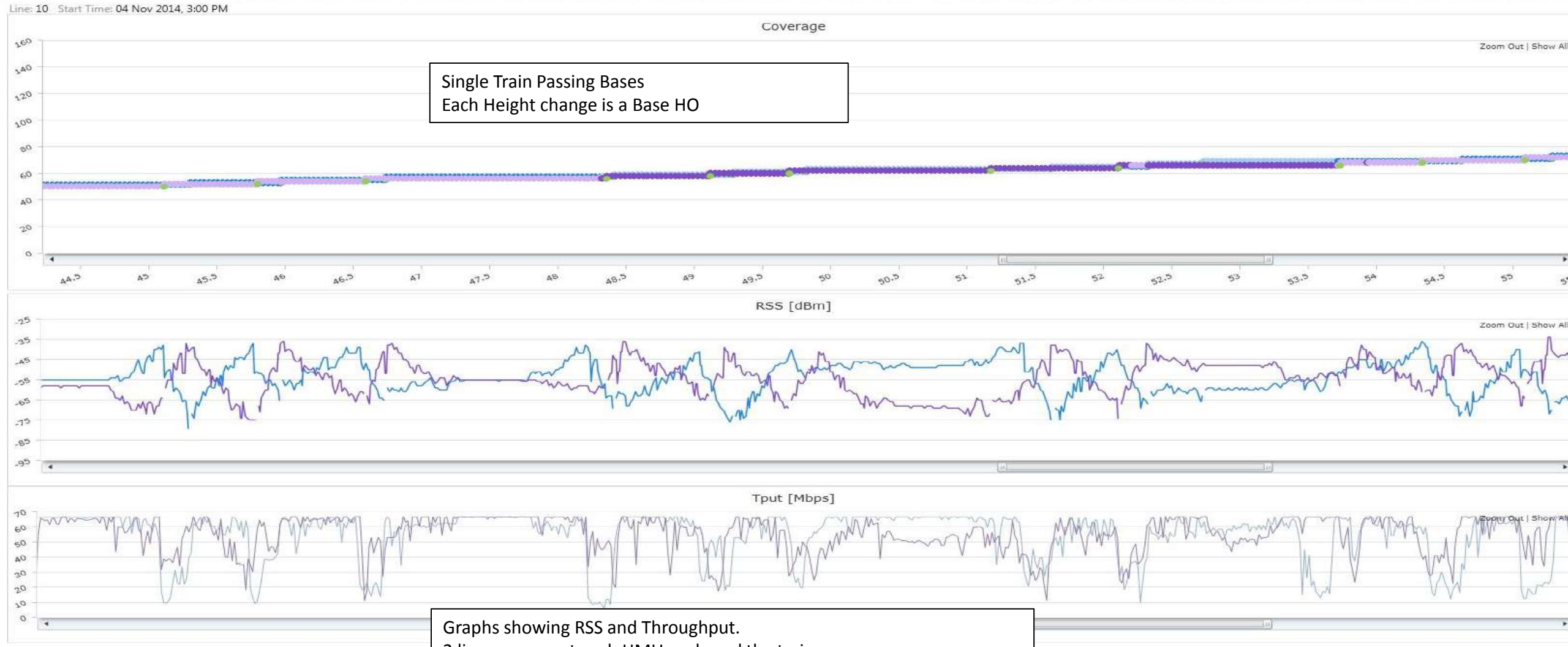
5. ALPM – Air Link Performance Monitoring

ALPM – Air Link Performance Monitoring tool (offline database analysis)

- Accumulation of all relevant events to enable in-depth analysis and performance optimization during implementation as well as on-going operations

RADWIN

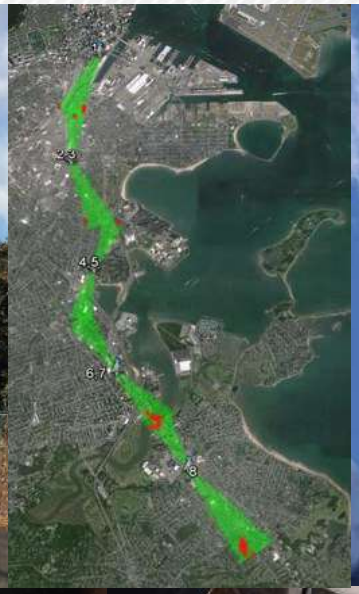

Air Link Performance Monitoring (Viewer)
Line: 5 Start Time: 02 Apr 2014, 7:00 AM
Coverage
10.56.1.95
37.98
RSS [dBm]
Train Data Ch1/Ch2: -56/-61
Tput [Mbps]
Potential Downlink: 58.679
Potential Uplink: 27.602
Actual Uplink: 27.159
Max MCS
Uplink Rate: 7
TS: 1436/1488 (95%)
High/Low: 7/2
Downlink Rate: 6
TS: 52/52 (100%)
High/Low: 6/6
Legend
Inter Base Handoff
Syncloss
Intra Train Handoff
Passive Unit (Coverage)
Trains to Follow
10.56.4.32
-None-
Charts
Coverage
RSS
Tput
MCS
Use right click on charts to add / remove series
Channels on RSS Data
Max Of Both
Resolution
More Data on this Range


Line: 10 Start Time: 04 Nov 2014, 3:00 PM
Coverage
Zoom Out | Show All
Single Train Passing Bases
Each Height change is a Base HO
RSS [dBm]
Zoom Out | Show All
Tput [Mbps]
Towers Chart
Open View
Graphs showing RSS and Throughput.
2 lines represent each HMU on-board the train
System automatically assures, the HMU with higher data rate is the active one per train
Typical throughput – 70Mbps per train

RADWIN Solutions for Rail & Metro - Services

Services

- Radio Planning
- System Design (networking and synchronization aspects)
- Site Survey
- On the Job Training
- POC, trials on-site support
- Network commissioning
- Performance analysis
- Post-sales services
- Customization (radio, networking, synchronization, management tools)

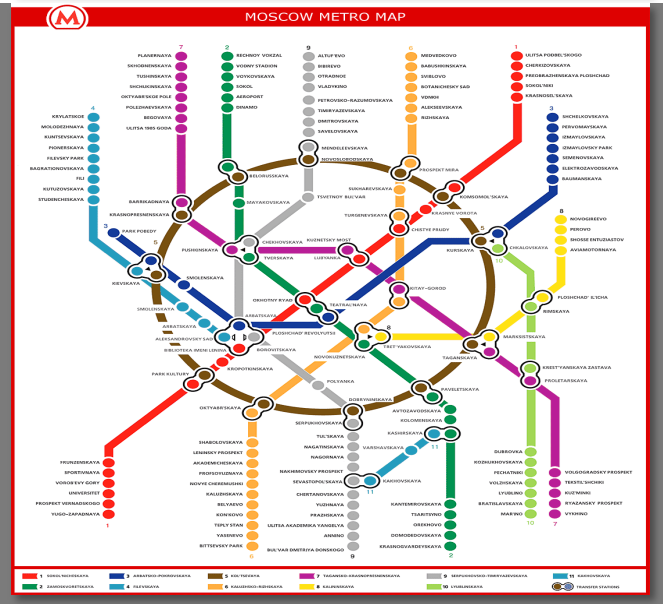




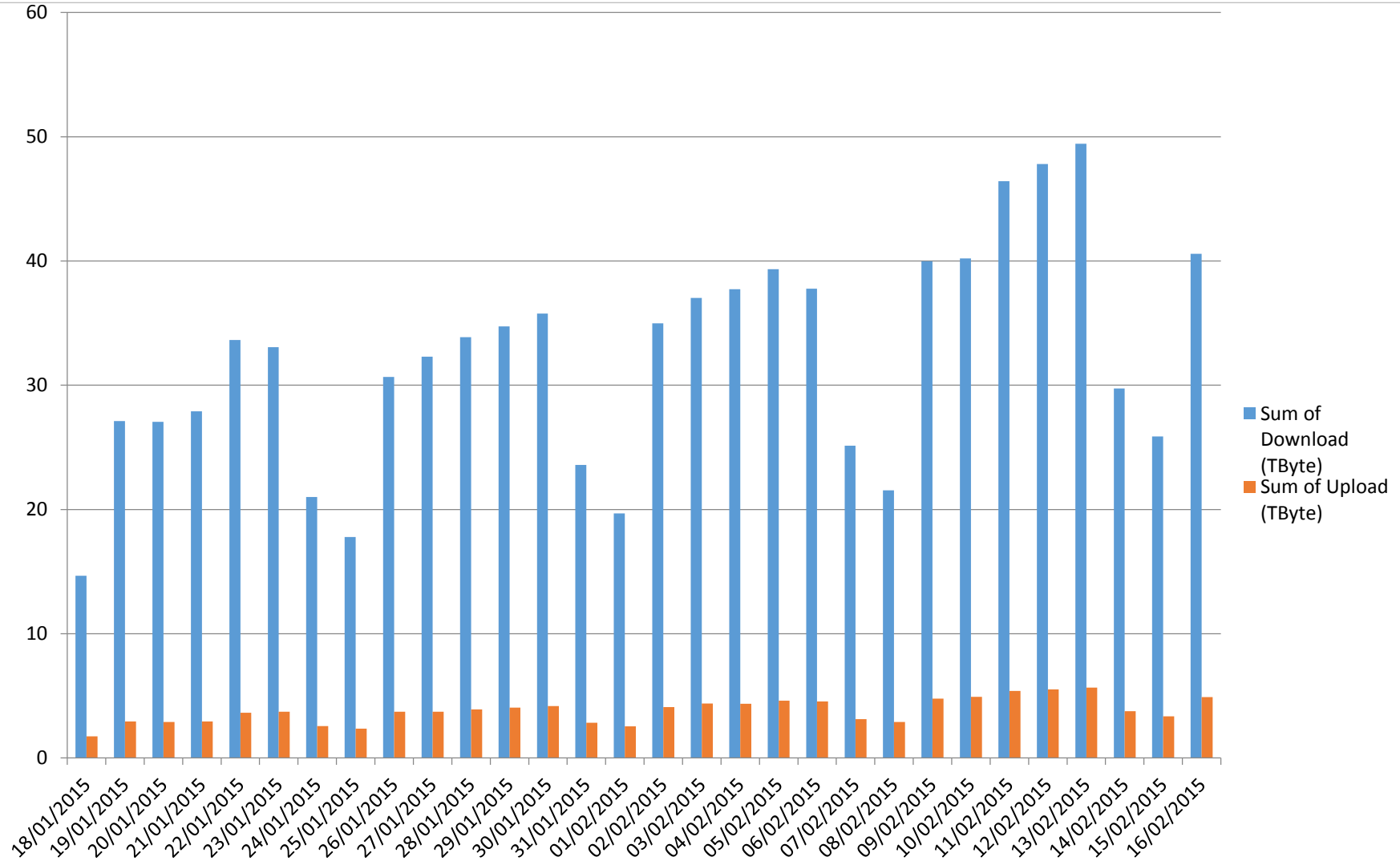
CASE STUDY EXAMPLES

Metro Moscow (Russia): Broadband Wi-Fi for Passengers

- No. 3 in the world (9 million passengers/day)
  - 12 lines
  - 700 trains
  - 180 stations
  - 325Km / 200Miles length
- RADWIN Train-to-Ground solutions chosen after evaluation thanks to capacity and coverage
- Deployment of entire project in 14 months !
- Current performance:
  - 90 Mbps per Base station
  - Base station every ~900 meters



Moscow Metro – Daily Traffic Statistics



Moscow Metro: Usage of 45TB per day….and growing!

Honolulu Light Rail – New Project

- New line – elevated train over 20 KM
- Requirements for real-time connectivity: 35Mbps per train
- Applications include: CCTV, PA and operational data
- RADWIN won after successful trials, demonstrating highest capacity and longest coverage
- Implementation expected during 2015-2016

RADWIN

Broadband Wi-Fi on Trains - Europe

Application:

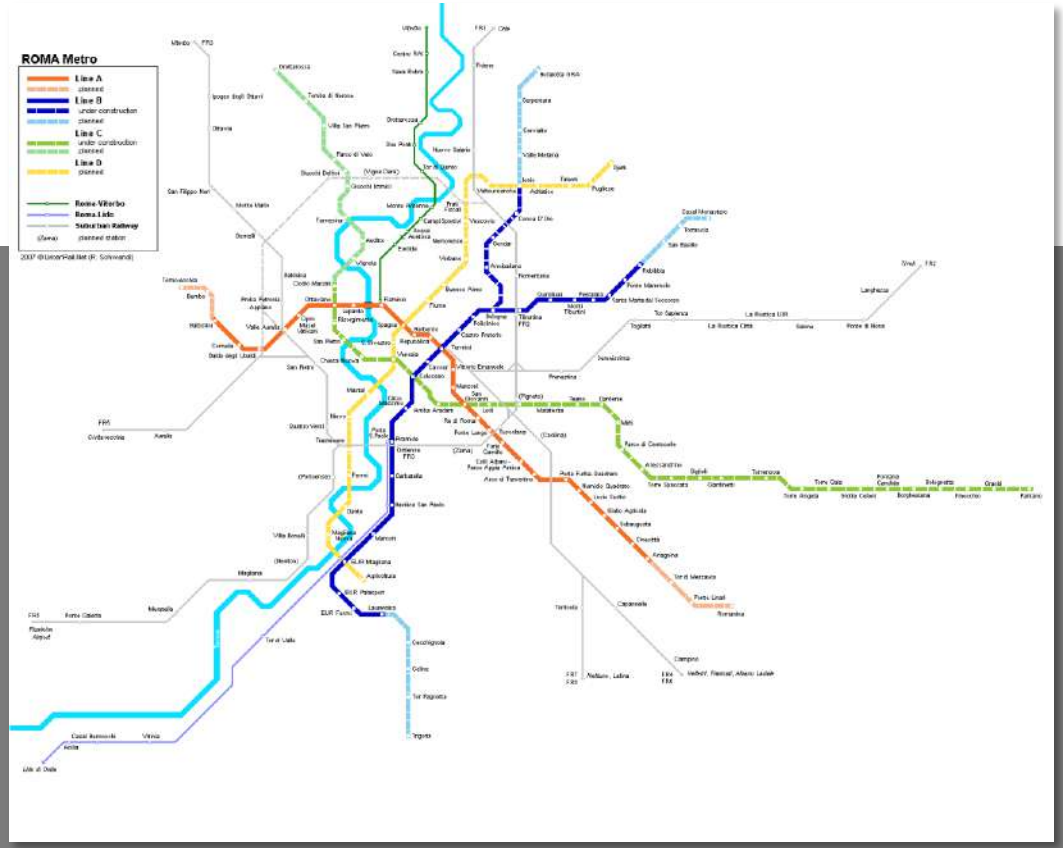
- High-speed Internet access on-board trains travelling along 1,350 Km / 850 Miles of tracks
- 70% of the wayside network deployed

RADWIN Solution:

- Up to 35Mbps per train over distances of up to 5 KM between base stations (20MHz)
- RADWIN 2000 point-to-point used for backhaul to fiber termination points
- Frequency Re-Use – single frequency customized solution

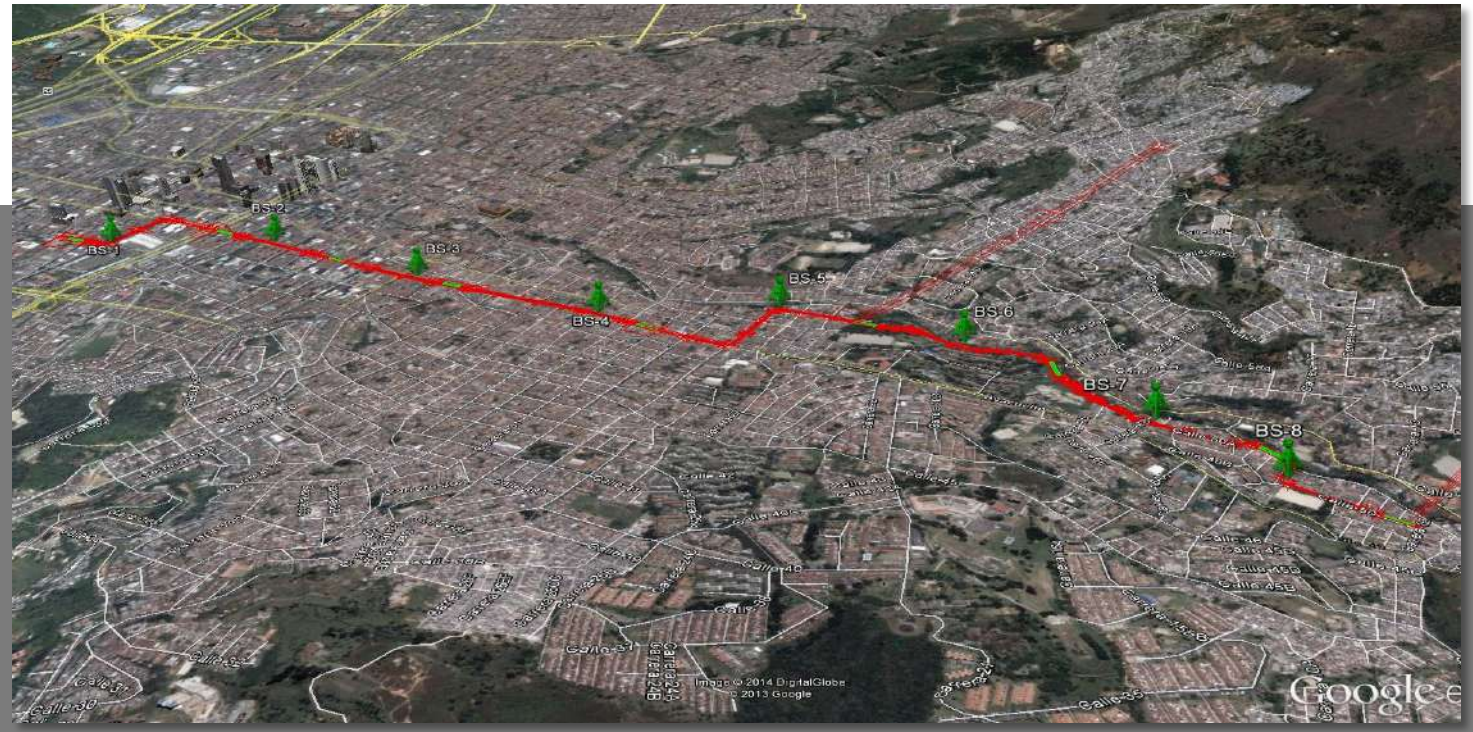
Rome Metro

- Project funded by the EU to enhance security in Rome Metro (Pandora project)
- Provide real-time CCTV in Line A
- 36KM line, 38 trains
- Trial for 1st section conducted successfully
- Complete deployment planned by 2016



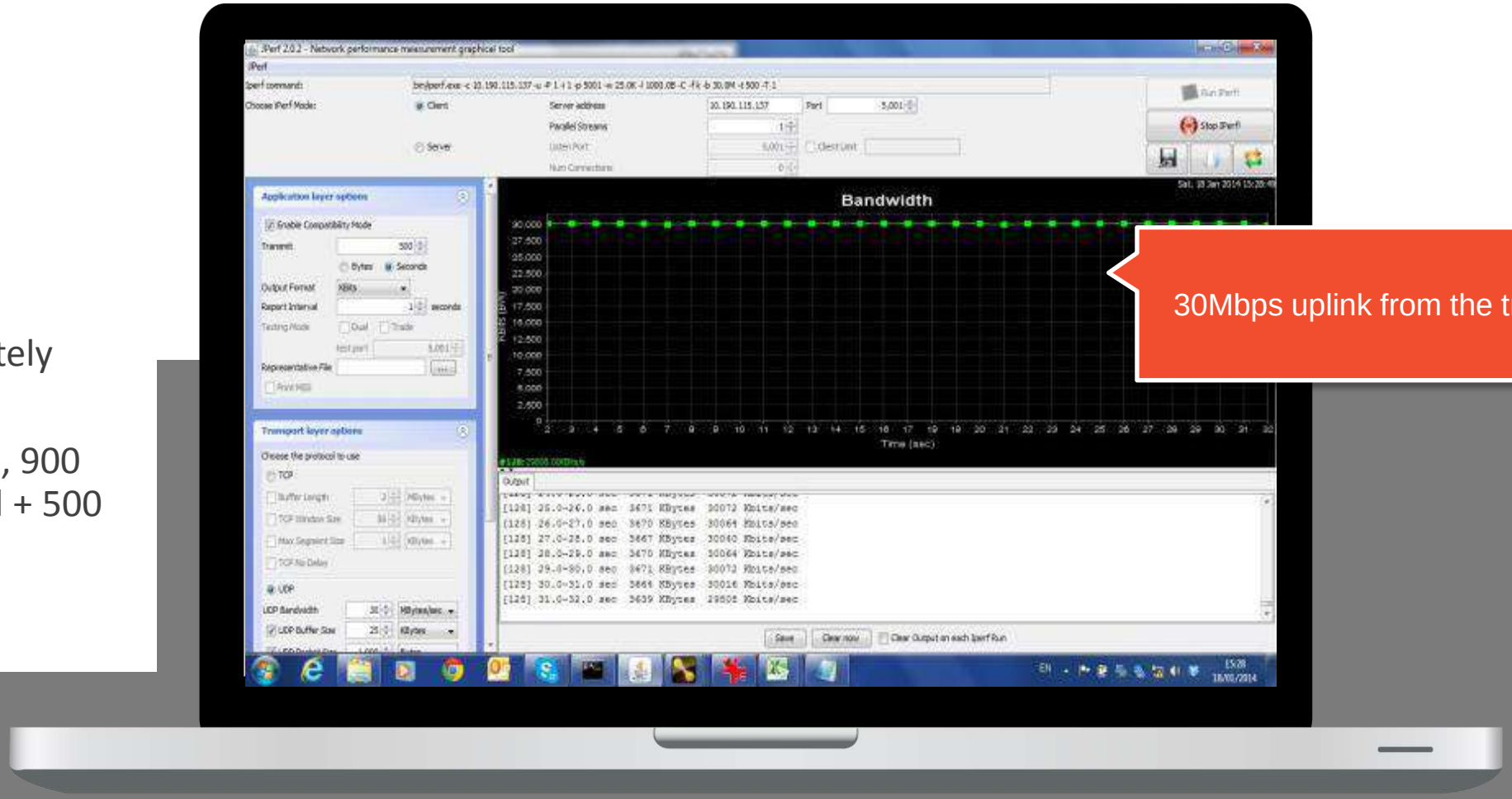
Metro Medellin – New Project

- New line under construction
- Provide real-time CCTV
- Implementation expected during 2015

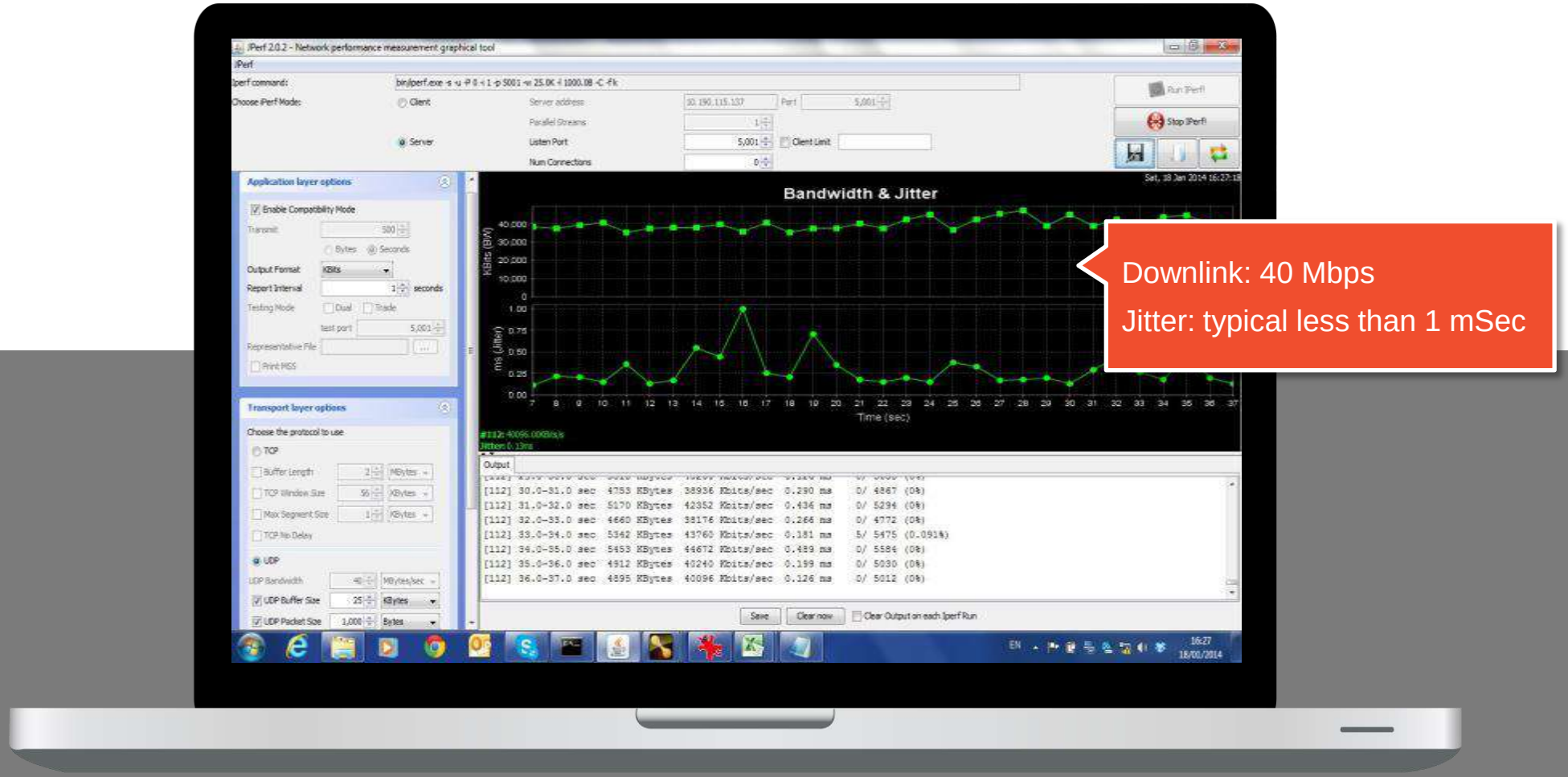


Recent Trial results (Metro Operator in APAC): Uplink Capacity

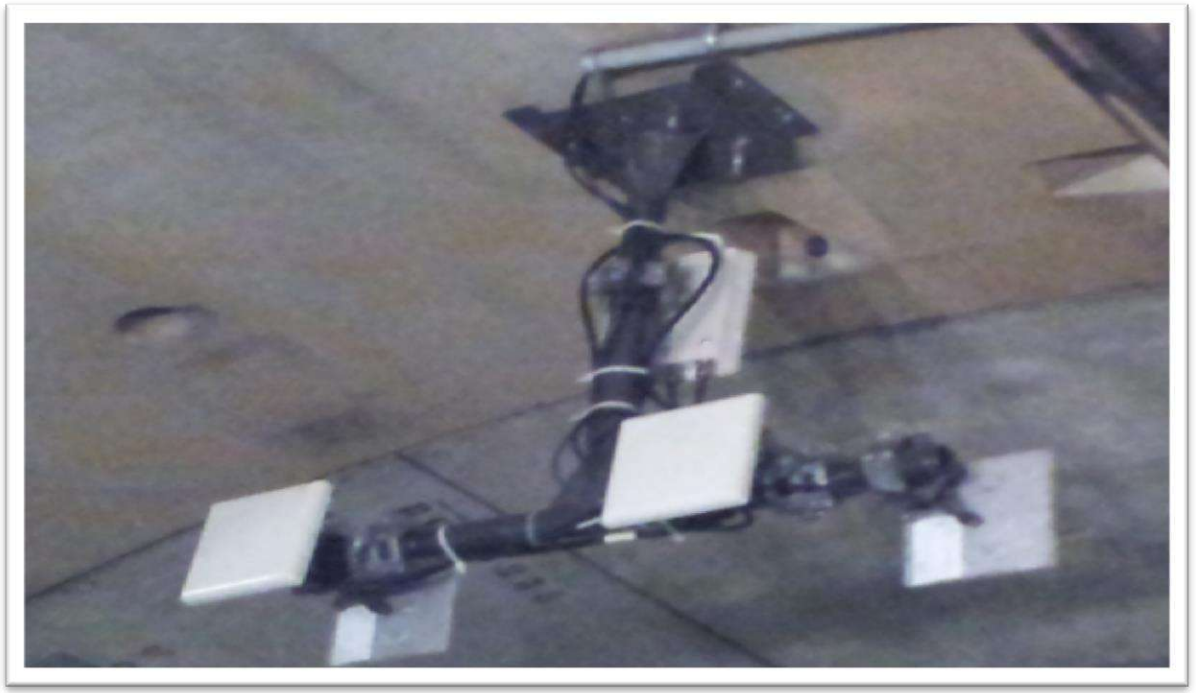
- Two sites approximately 0.9 Km apart
- Total track of 1.4 km , 900 meter above ground + 500 meter tunnel
- 5.8 GHz, 40 MHz



Recent Trial Results (Metro Operator in APAC): Downlink Capacity (Simultaneous) & Jitter

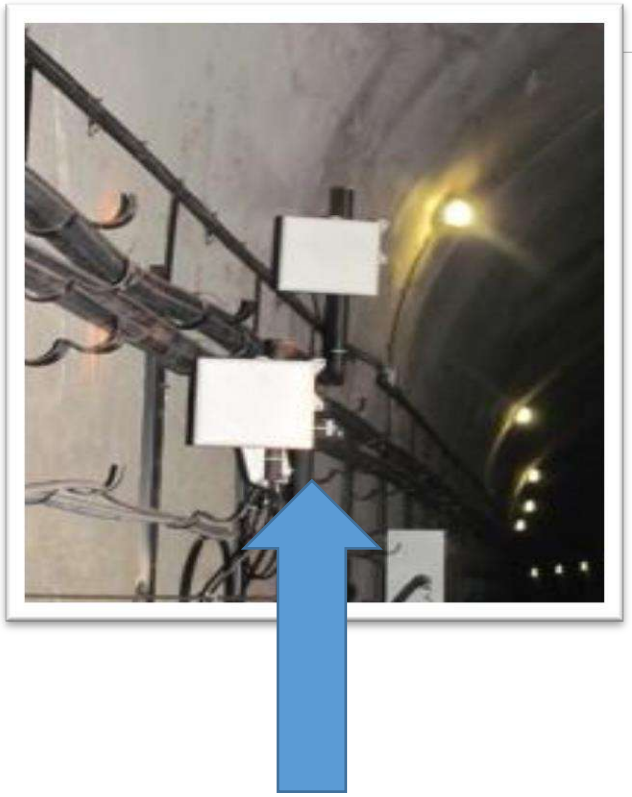


Ceiling Installation Examples

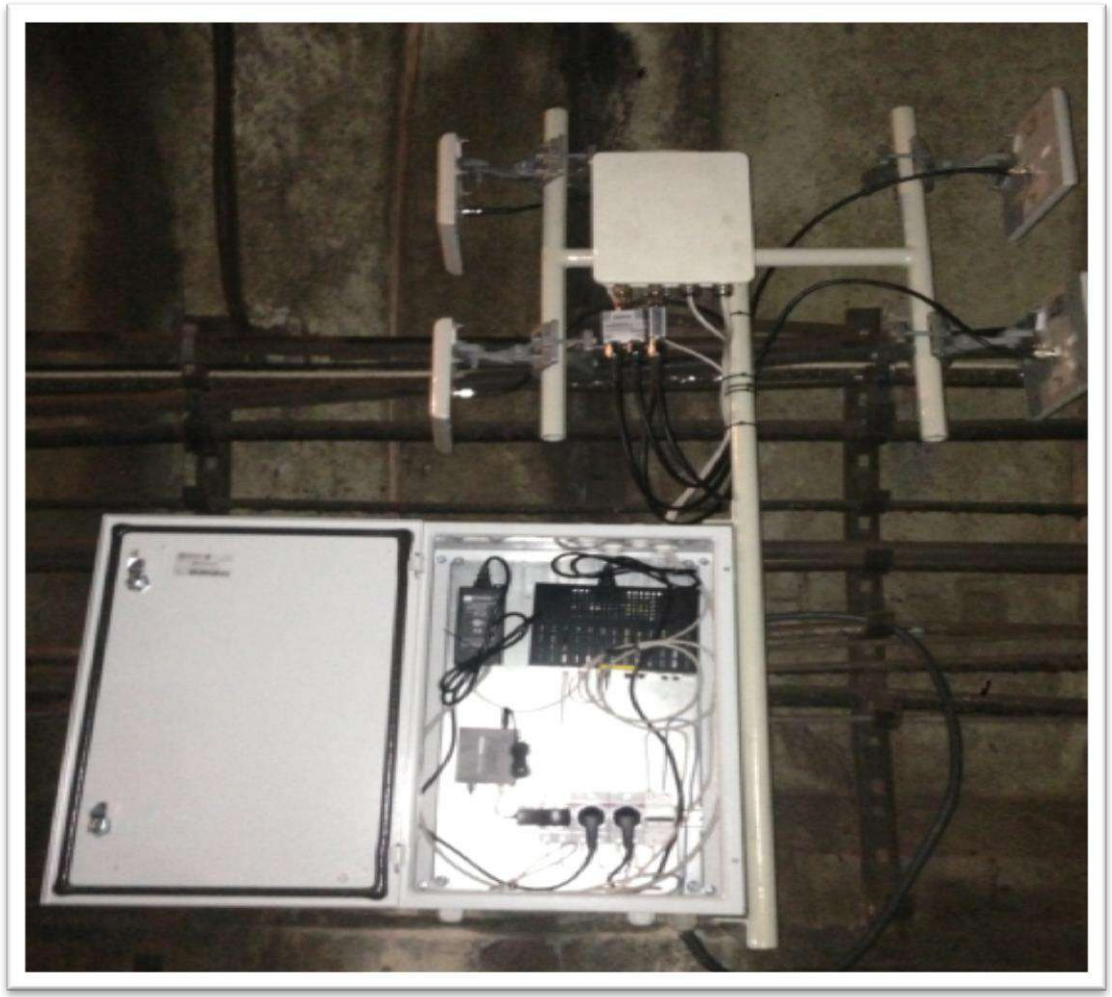


Way-side installation

Side Installation Examples



Flat panel antenna
19 x 19 x 3 cm



Tunnel Installation

Any Questions?

RADWIN