CW Testing for Planning and Deployment

The prelude of next Generation Radio Planning

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Our Record Speaks for Itself

- Awarded “Highest Value for Customers” by Frost & Sullivan
- Used, Endorsed and Contracted by all the major names in the Telecom market

- Introduction
- Outdoor radio planning
  - Drivers for measurement based planning
  - Typical CW setup
  - Purposes of CW Drive testing
  - CW Measurement process
- Indoor radio planning
  - Drivers for Inbuilding systems
  - Why perform CW Testing & Model Tuning
  - Business Impact of Model Tuning & CW Testing
  - Typical CW Testing Setup for IBS/DAS applications

Agenda

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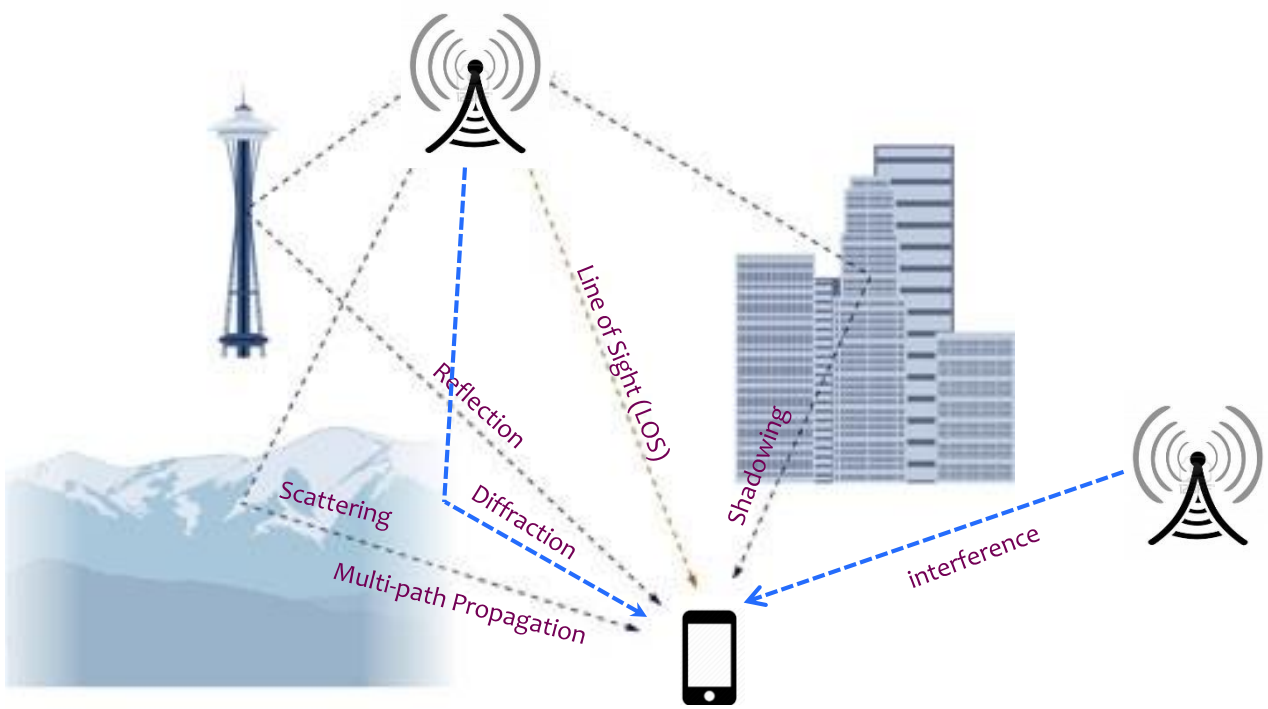
OUTDOOR RADIO PLANNING

CW drive testing for model tuning, site selection and interference assessment.

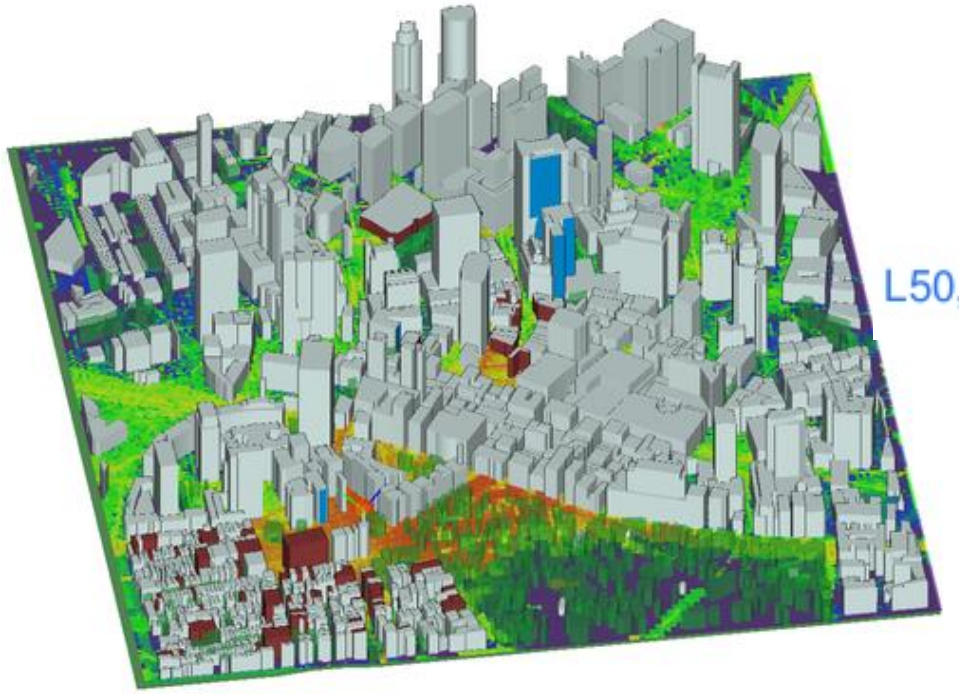
Drivers for measurement based planning approach

- New technologies are susceptible to interference
- Dense network deployment
  - # of Subscribers
  - Data Consumption
  - Limited spectrum allocation
- More bands
- Critical Applications



Outdoor Propagation Channel

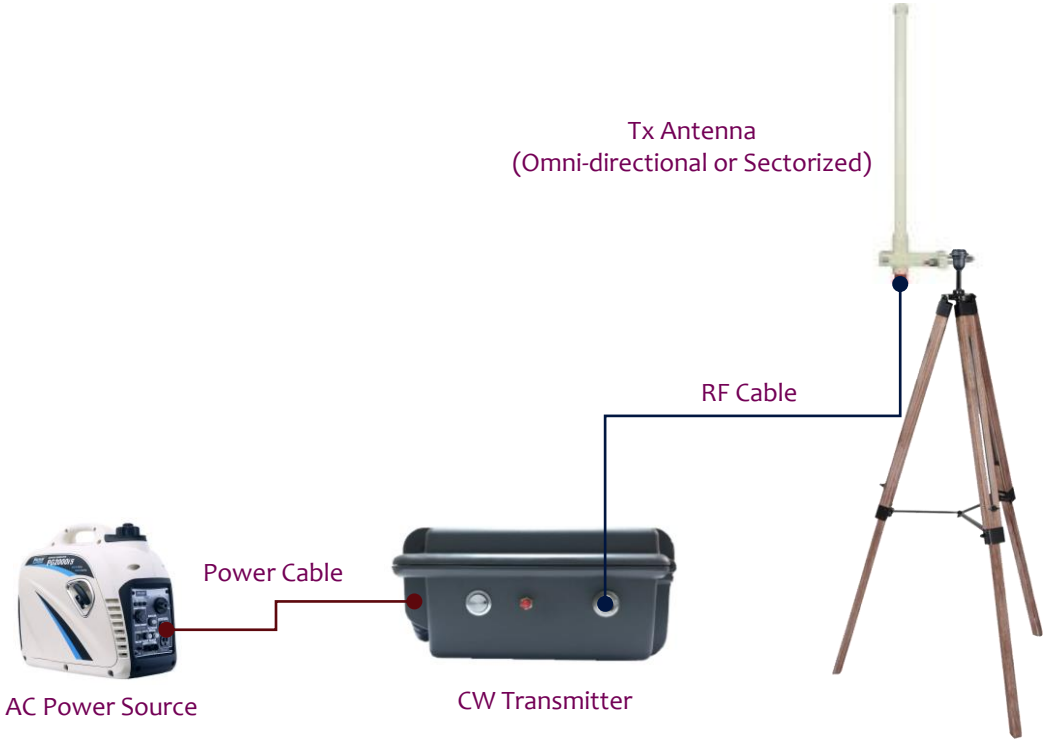
- In radio planning tools, propagation parameters are calculated theoretically
- Outdoor model tuning is needed to achieve minimal error between predicted and measured signal strength



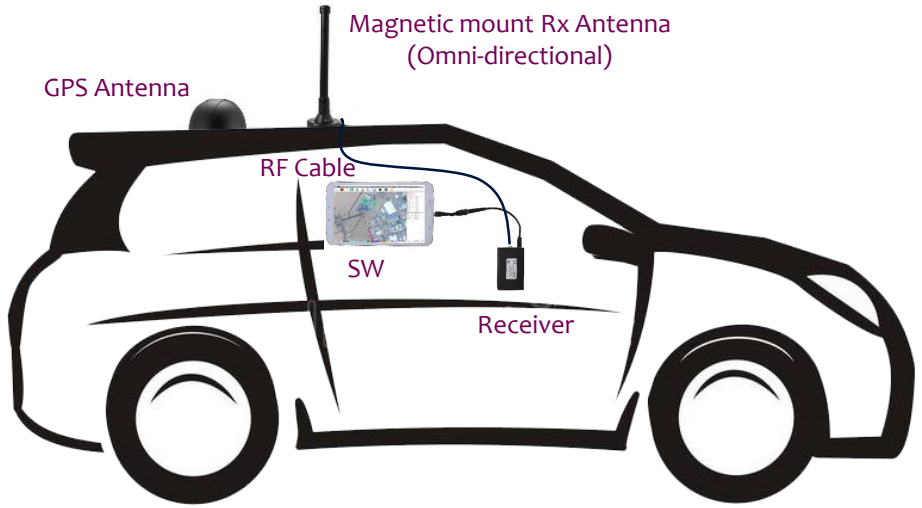
$$L50,_{urban} = 69.55\ dB + 26.16\log(f_c) - 3.82\log(h_t) - a(h_r) + (44.9 - 6.55\log(h_t))\log(d)$$

$$P_{L_{50,Urban}}(dB) = 46.3 + 33.9log_{10}(f_c) - 13.82log_{10}(h_t) - a(h_r) + \left(44.9 - 6.55log_{10}(h_t)\right)log_{10}(d) + C_M$$

Typical CW Testing Setup

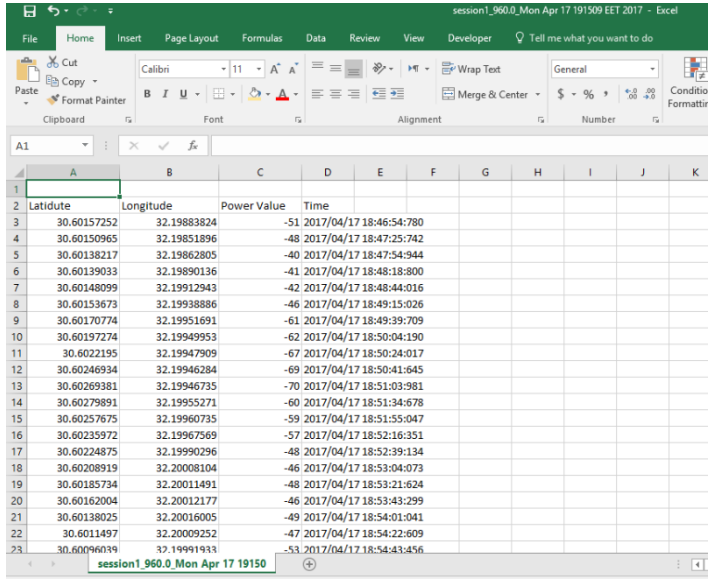


Typical Transmitter Setup



Typical Receiver Setup

Measurement Reporting



Latidute	Longitude	Power Value	Time
30.60157252	32.19883824	-51	2017/04/17 18:46:54:780
30.60150965	32.19851896	-48	2017/04/17 18:47:25:742
30.60138217	32.19862805	-40	2017/04/17 18:47:54:944
30.60139033	32.19890136	-41	2017/04/17 18:48:18:800
30.60148099	32.19912943	-42	2017/04/17 18:48:44:016
30.60153673	32.19938886	-46	2017/04/17 18:49:15:026
30.60170774	32.19951691	-61	2017/04/17 18:49:39:709
30.60197274	32.19949953	-62	2017/04/17 18:50:04:190
30.6022195	32.19947909	-67	2017/04/17 18:50:24:017
30.60246934	32.19946284	-69	2017/04/17 18:50:41:645
30.60269381	32.19946735	-70	2017/04/17 18:51:03:981
30.60279891	32.19955271	-60	2017/04/17 18:51:34:678
30.60257675	32.19960735	-59	2017/04/17 18:51:55:047
30.60235972	32.19967569	-57	2017/04/17 18:52:16:351
30.60224875	32.19990296	-48	2017/04/17 18:52:39:134
30.60208919	32.20008104	-46	2017/04/17 18:53:04:073
30.60185734	32.20011491	-48	2017/04/17 18:53:21:624
30.60162004	32.20012177	-46	2017/04/17 18:53:43:299
30.60138025	32.20016005	-49	2017/04/17 18:54:01:041
30.6011497	32.20009252	-47	2017/04/17 18:54:22:609
30.60096039	32.19991933	-53	2017/04/17 18:54:43:456

CSV format

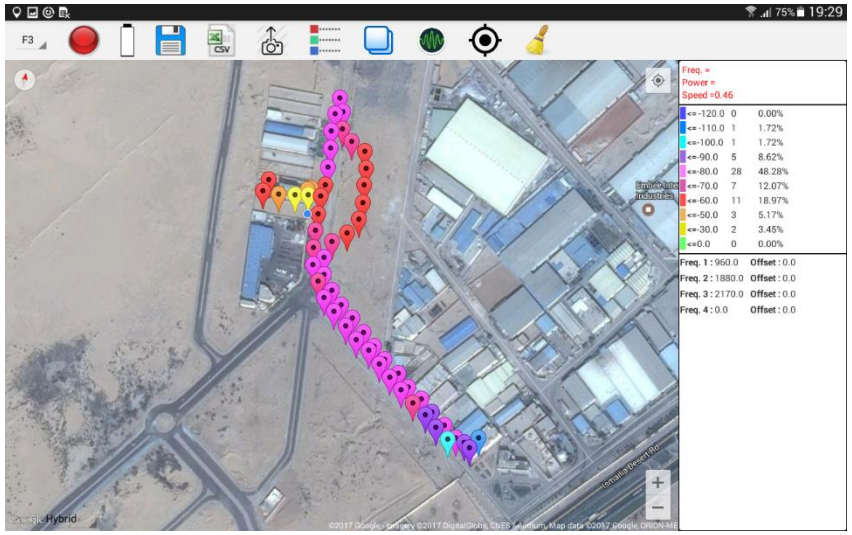


Image format

- Direct exporting to most of planning tools such as Asset, Mentum Planet… etc

InfoVista Forsk TEOCO

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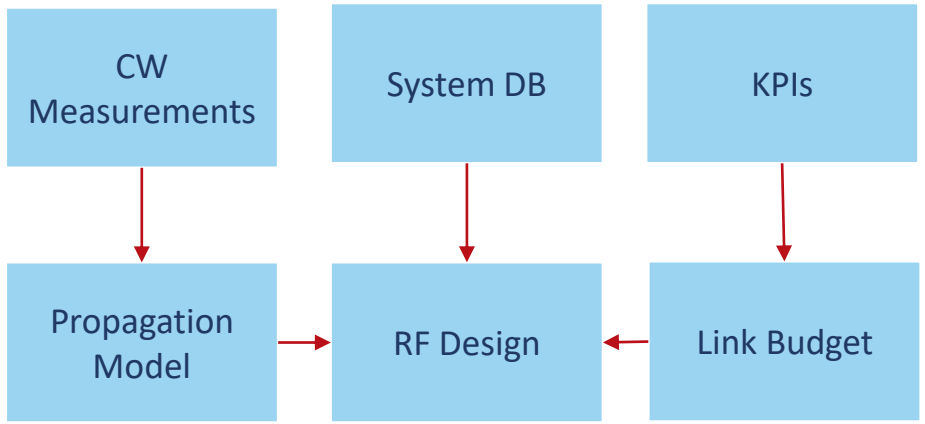
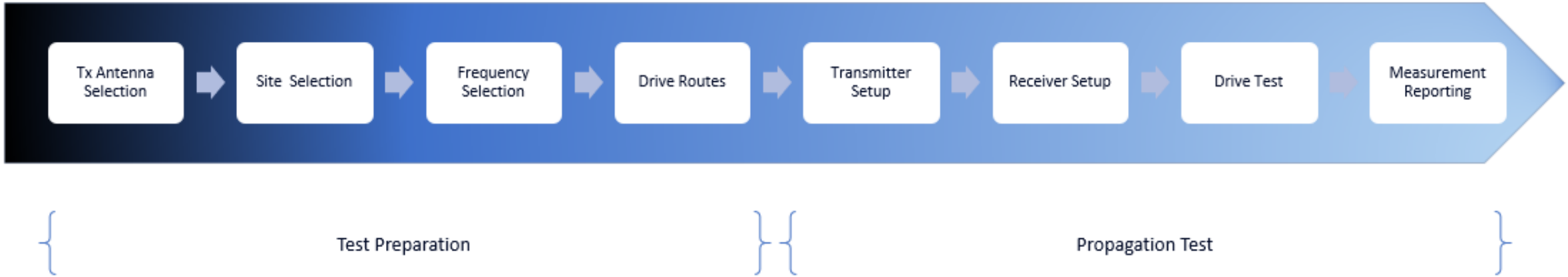
Purposes of CW Drive Testing

- Usually the terrain and clutter data available from the maps are not perfect
- Purposes of CW drive testing
  - Characterization of propagation and fading effects
  - Optimize and adjust the prediction model (Propagation model tuning)
  - Coverage evaluation of candidate sites
  - Assessing Interference & overlaps of candidate sites

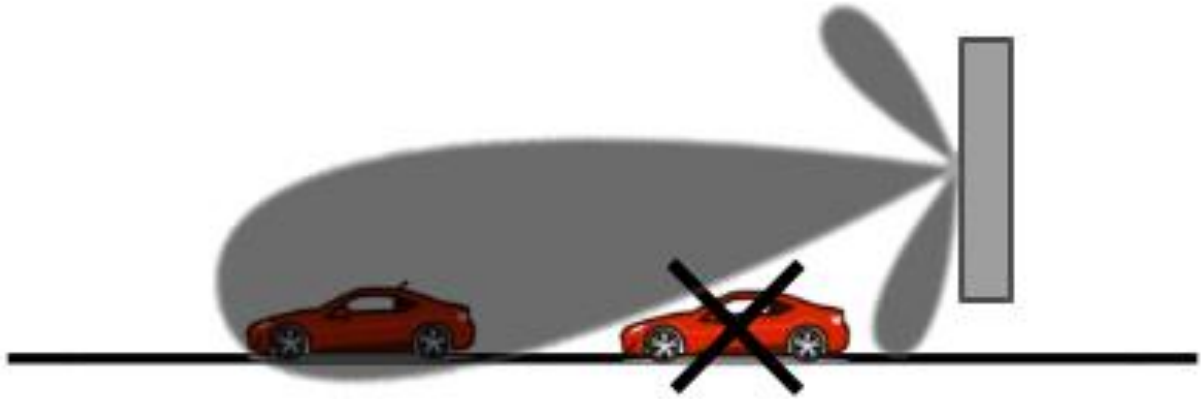


CW Drive Testing Process



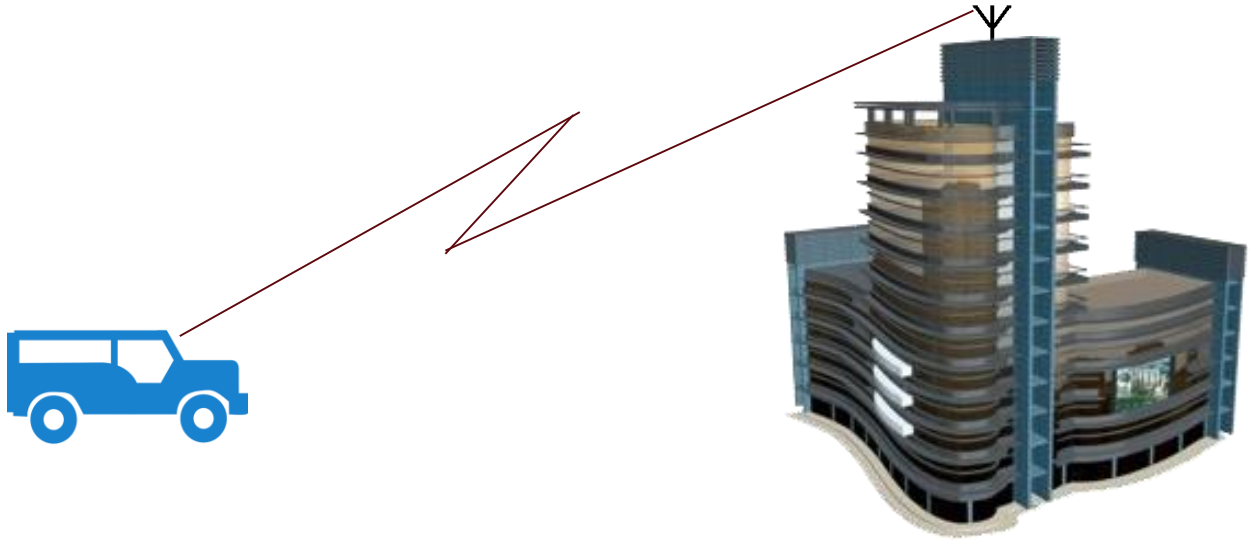
Tx Antenna Selection

- For model tuning, Omni-directional Antenna is highly recommended
- For coverage evaluation of candidate sites, it depends on the BTS Antenna type whether Omni-directional or Sectorized Antennas
- Don’t test drive in the shadow regions



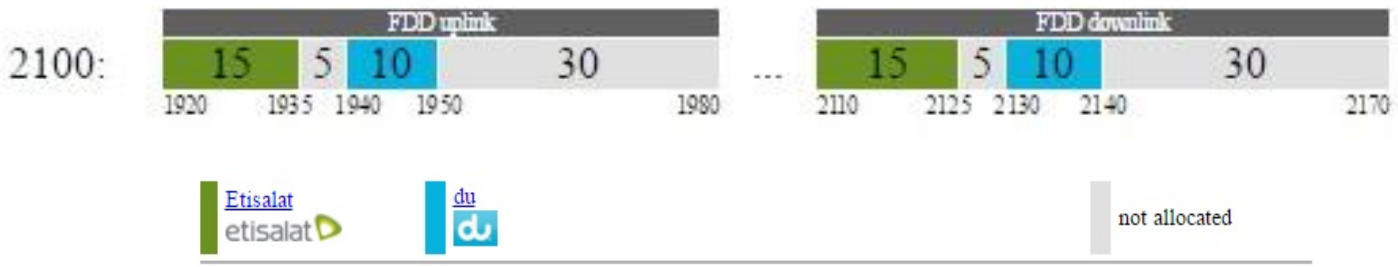
Site Selection

- For propagation model tuning, test site and its height should be distributed within the clutter under study
- For candidate site verification, the actual site configuration should be used.



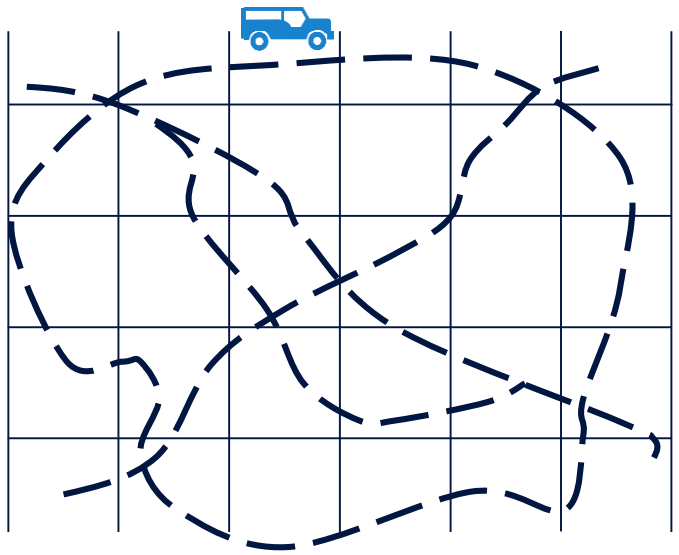
Frequency Selection

- A clear frequency/channel (free of interference or traffic) should be used for CW testing
- Verification is required using spectrum analyzer or suitable receiver



Drive Routes

- Using maps, plan your measurement collection routes prior to CW testing & eliminate duplicate route
- Significant amount of data should be collected for each clutter category



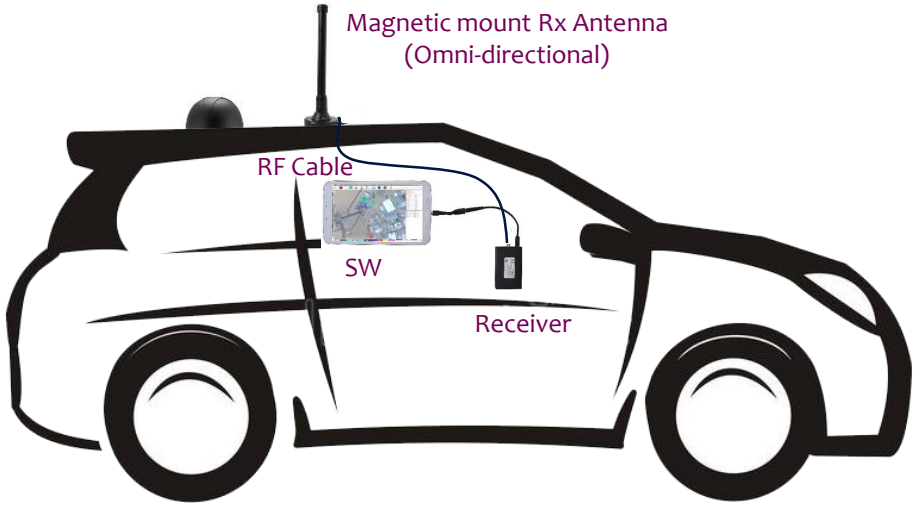
Transmitter Setup

- Tx antenna should be free of any nearby obstacles
- For sites with existing antennas, precaution is required to avoid interference or inter-modulation issues
- For model tuning, maximum Tx power of the CW transmitter is used
- For candidate site verification, the actual BTS power is used
- Interference precaution is required for sites with existing antennas

Typical Transmitter Setup

Receiver Setup

- Receivers with high sample rates are required to comply with Lambda Lee Criteria (36 – 50 samples per 40 Lambda)
- Neighbor cells should be measured as well to analyze coverage overlap & interference existence
- Check the RSSI level close to Tx station to make sure the setup is working properly prior to the test
- GPS receiver is needed to provide location information of each measured sample



Typical Receiver Setup

Drive Test

- Create & initiate a measurement session using data collection SW
- Maintain the car speed according to the configured sample rate
- Follow the drive routes as close as possible
- Use markers to indicate special locations/hot spots or potential interference

Measurement Reporting

- The exported file should contain Latitude, Longitude and RSS levels
- Data averaging may be needed with some data collection SW tools
- Compatibility to different file formats of RF planning tools (Asset, Planet,..etc)is required for successful data importing.
- Graphical plots may be exported for acceptance purpose

System Overview

Main Features:

- Flexible configuration up to 4 port
- Transmit on multiple technologies simultaneously
- Wideband operation; 140 MHz to 5800 MHZ in one unit
- Handheld, AC supplied and Heavy-duty (Battery systems available)

Applications:

Outdoor site modeling (model calibration)
Site verification
Interference assessment
DAS injection/testing

Main Specs

Frequency Band	690 -960 MHz , 1710-1880 MHz , 1920-2170 MHz Cellular Bands and others
Modulation Type	CW (Continuous Wave)
RF Output Power	Up to +47dBm
Overall Amplitude Accuracy	± 1 dB (0.5 dB typ.)
VSWR Protection	10:1
Power Supply	100-240V AC , 50-60 Hz
Ports & Interface	N Type Female, AC Plug, DC Pushbuttons

Single-port Safari

Triple-port Safari

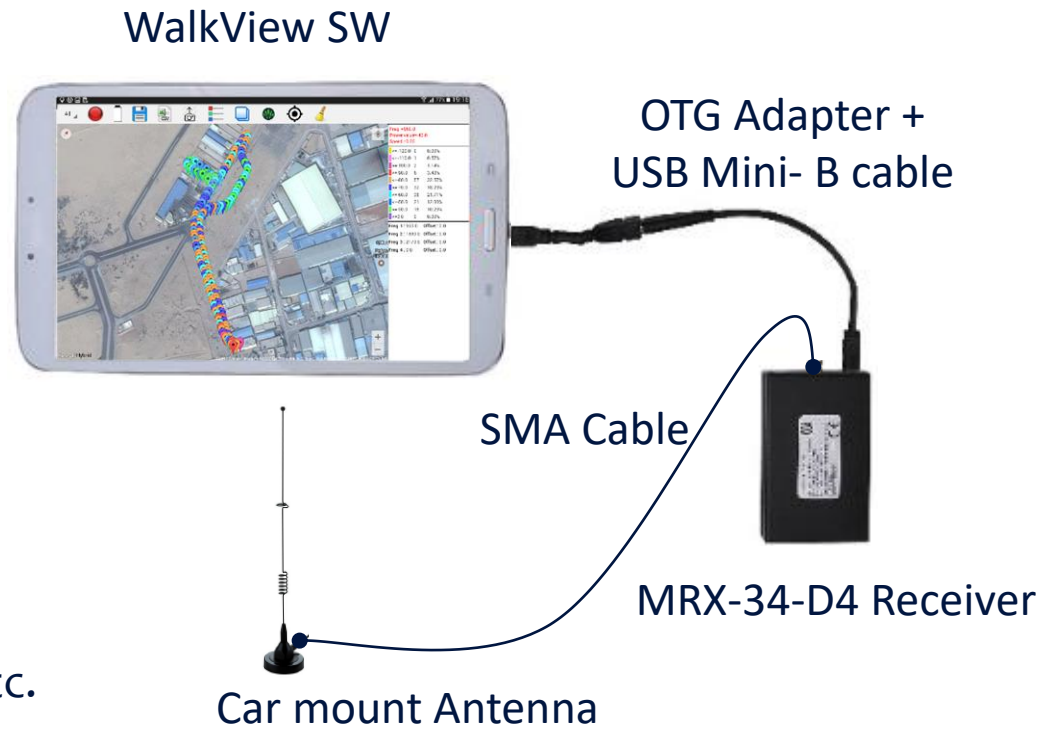
Measurement Collection

MRX CW Receiver

- Pocket-size receiver with high sampling rate
- Multi-Channel Scanning
- 40-λ lee Criteria Support 2000 samples/second

WalkView

- PC/Android Versions
- Mapping measurements on different Floor-Plan formats
- Compatibility with iBwave, Ranplan, MapInfo, Asset, Planet,… etc.
- Indoor and Outdoor Modes with GPS Support



Turn-key Solution

- End-to-end system engineering for all required accessories

Tx Antennas

Rx Mag. Mount antennas

In-line Power Meters

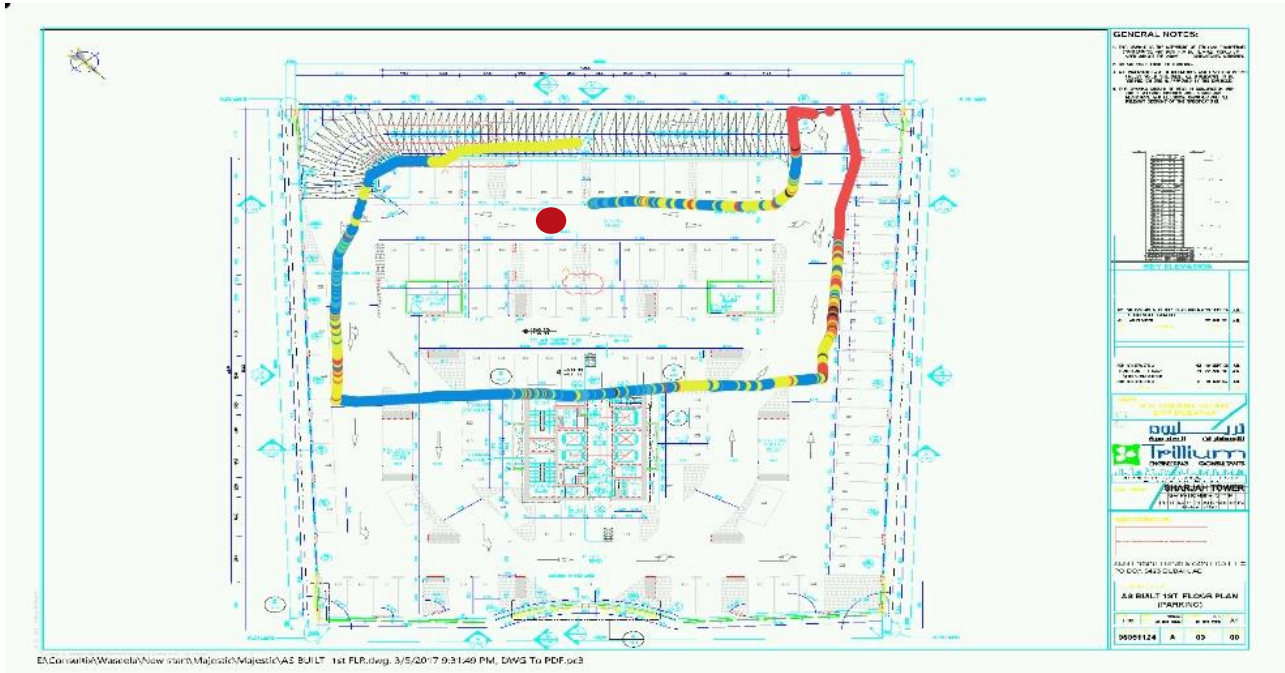
Cables & Adapters

External power supply

Antenna Tripods with mounting plates

Switch Safari to Indoor CW kit

- Unplug the 4-port transmitter from the suitcase
- Use it for indoor CW measurements along with your MRX receiver



INDOOR RADIO PLANNING

That’s where people and things actually are

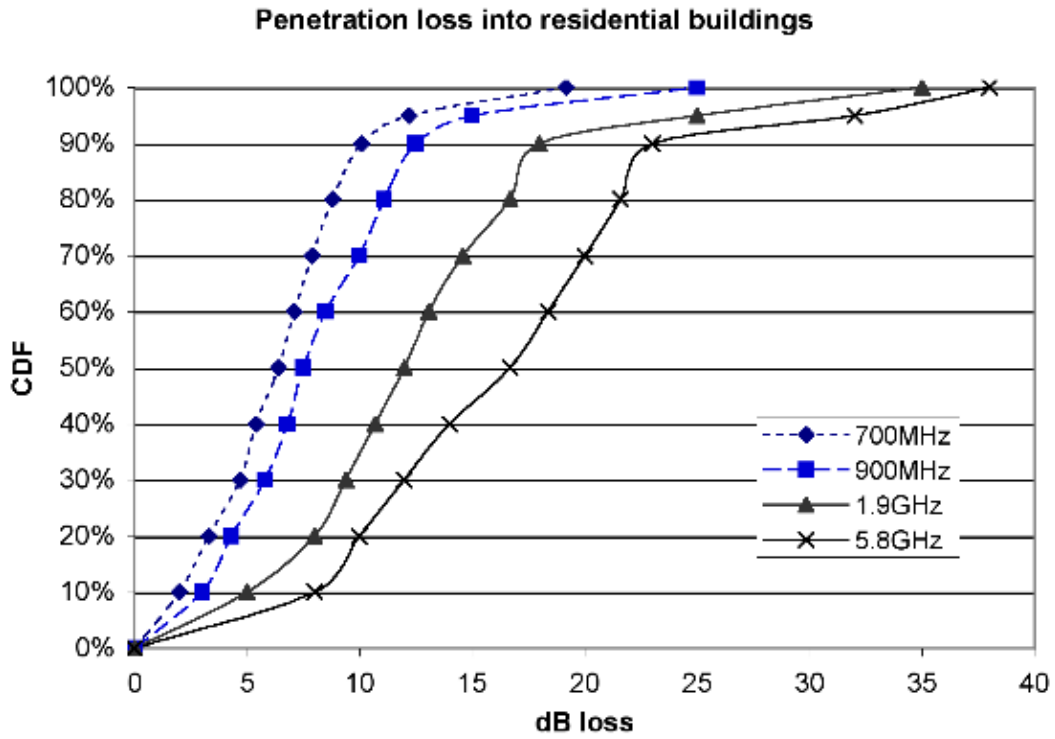
The Inbuilding Market

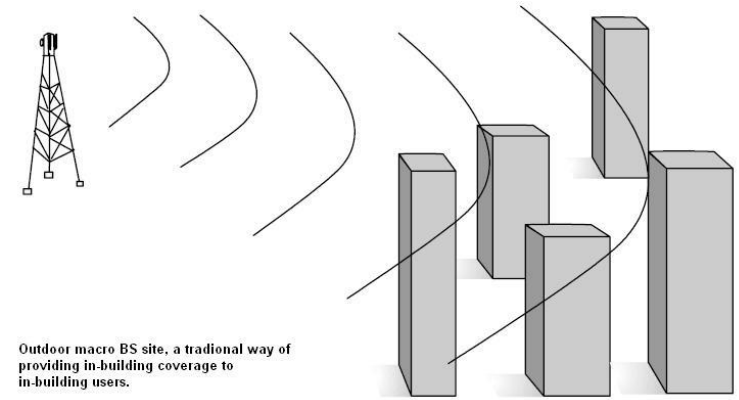
With more than 80% of all traffic originating or terminating indoors, In-building Systems have become a must-have

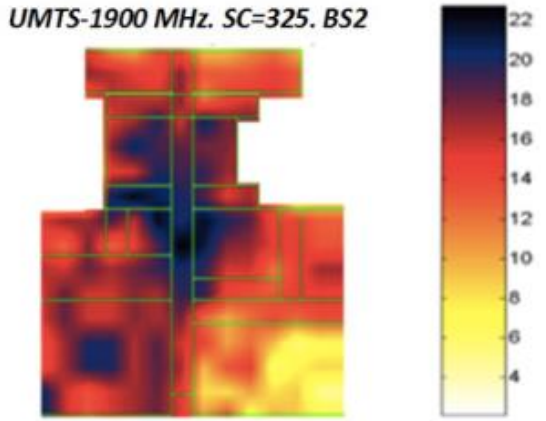
Coverage is needed Everywhere

Myth: IBS systems are needed to increase signal level indoors to compensate for external wall losses

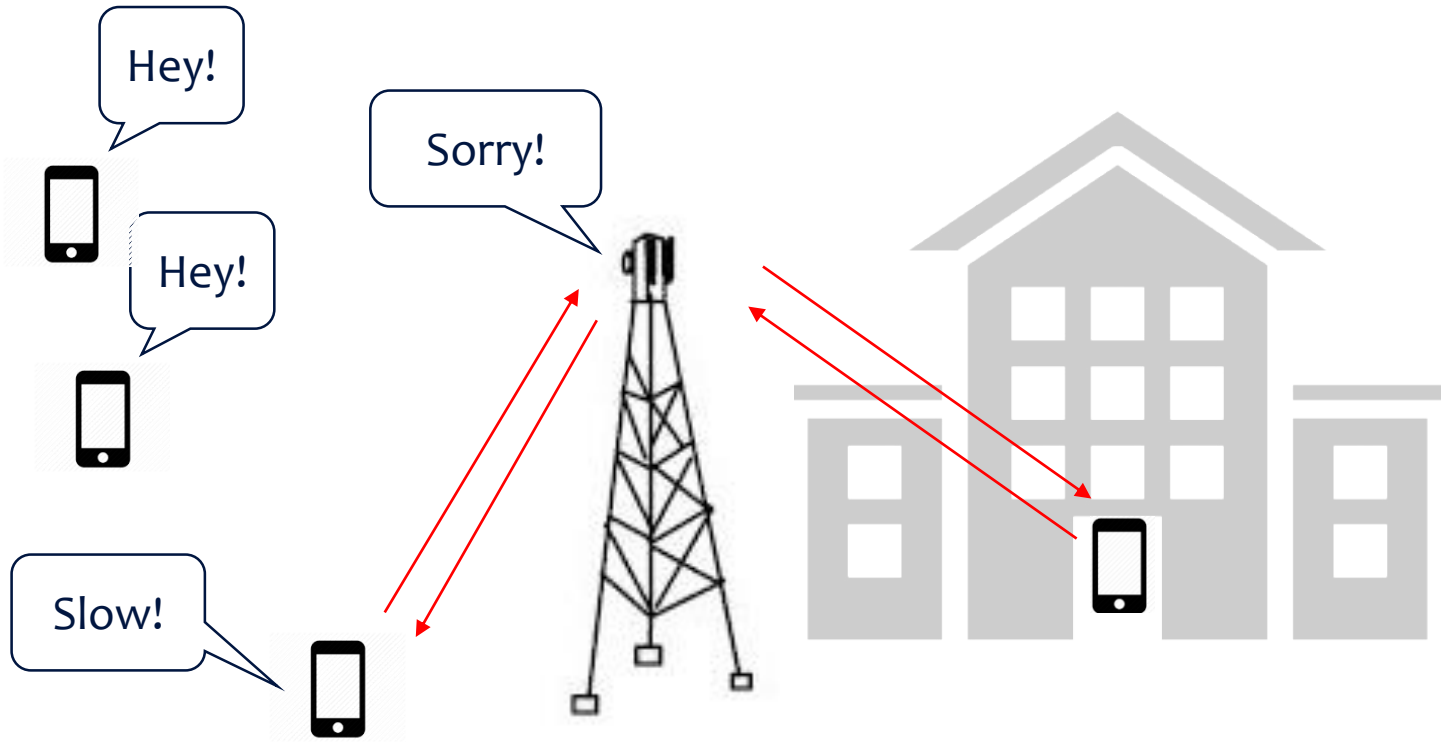
Myth: IBS systems are ~~only~~ needed to increase signal level indoors to compensate for external wall losses



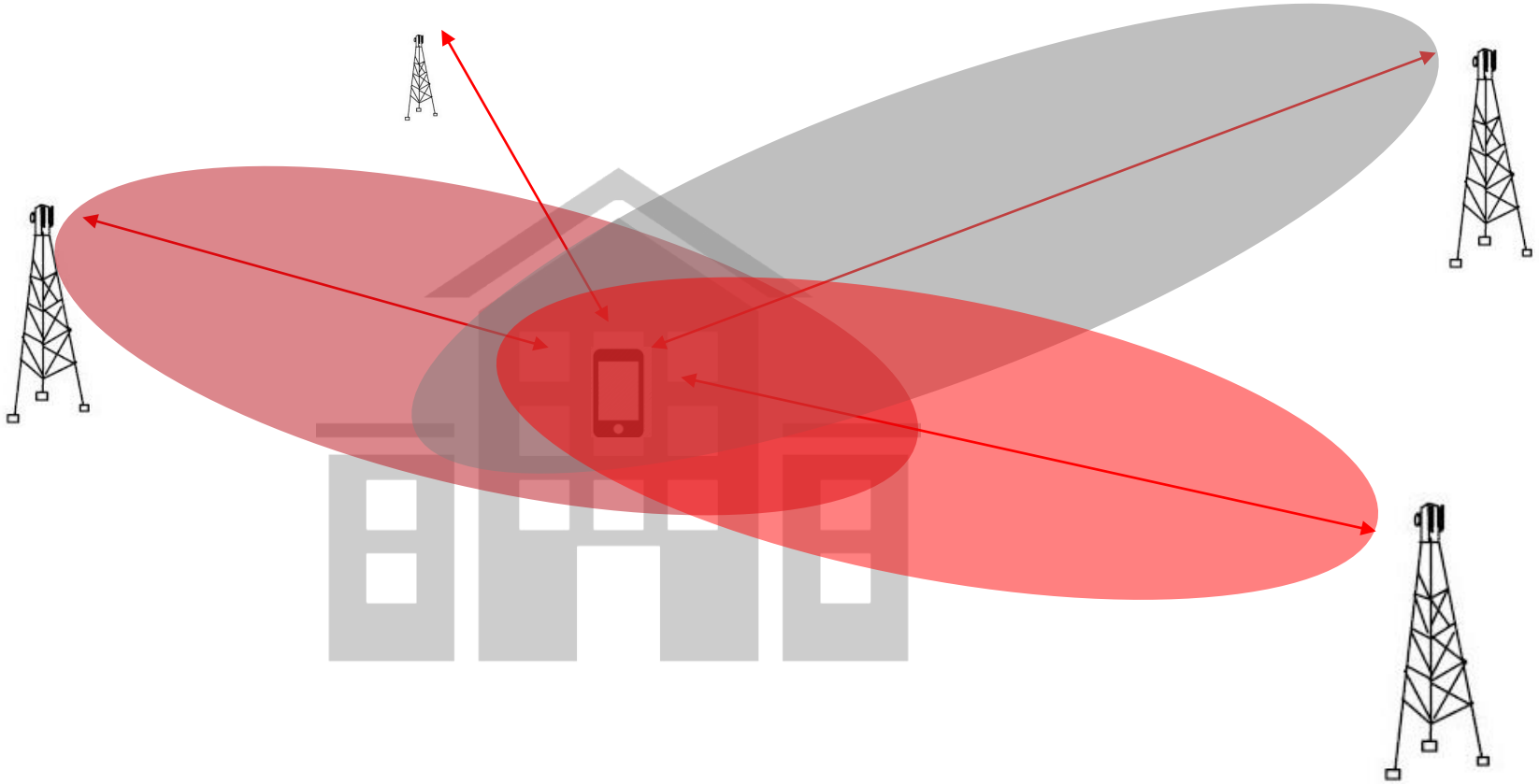




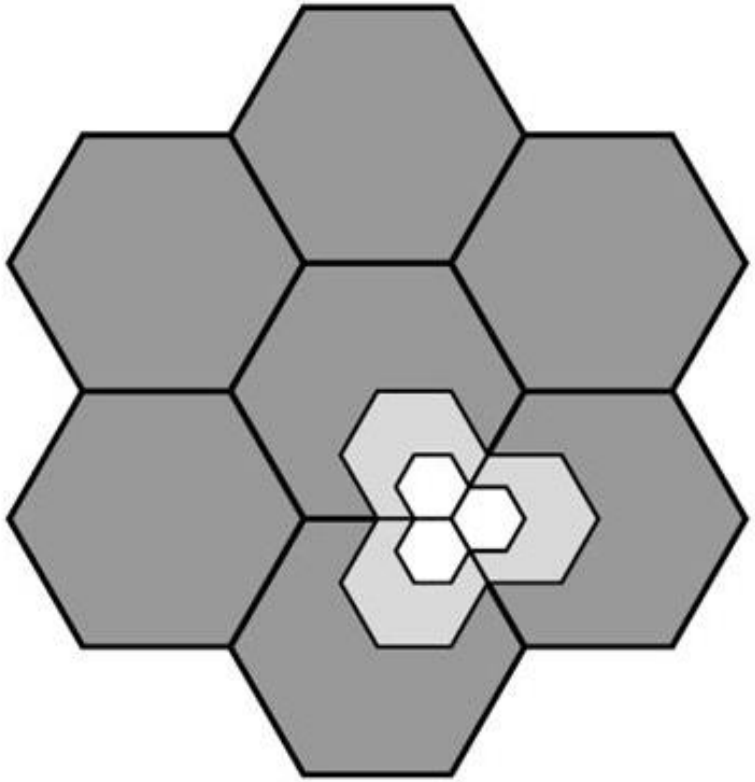
Indoor subscriber loading



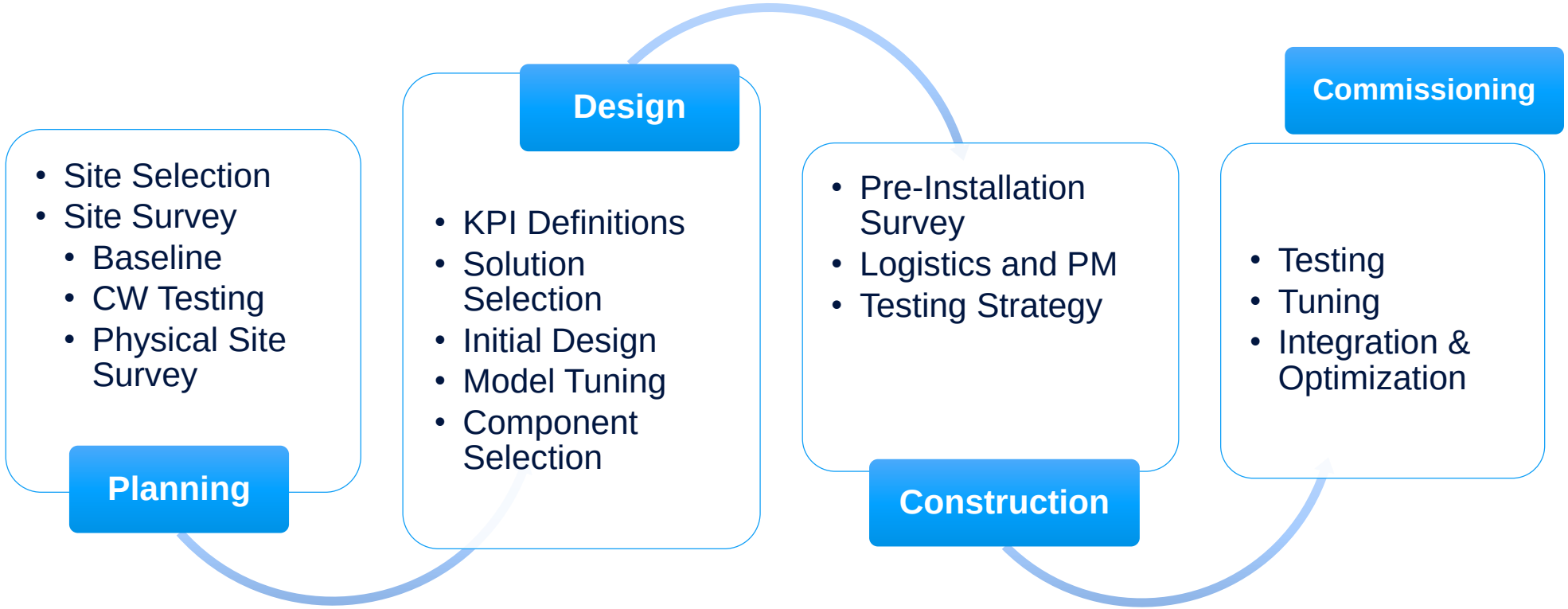
Dominance



Densification



Deployment


Planning
• Site Selection
• Site Survey
• Baseline
• CW Testing
• Physical Site Survey
Design
• KPI Definitions
• Solution Selection
• Initial Design
• Model Tuning
• Component Selection
Construction
• Pre-Installation Survey
• Logistics and PM
• Testing Strategy
Commissioning
• Testing
• Tuning
• Integration & Optimization

Why CW and Model Tuning?

1. Meet your design KPI's and cut network infrastructure costs through tuning/calibrating the propagation model

2. Validating the zone and sector boundaries, and investigate attenuation between adjacent levels

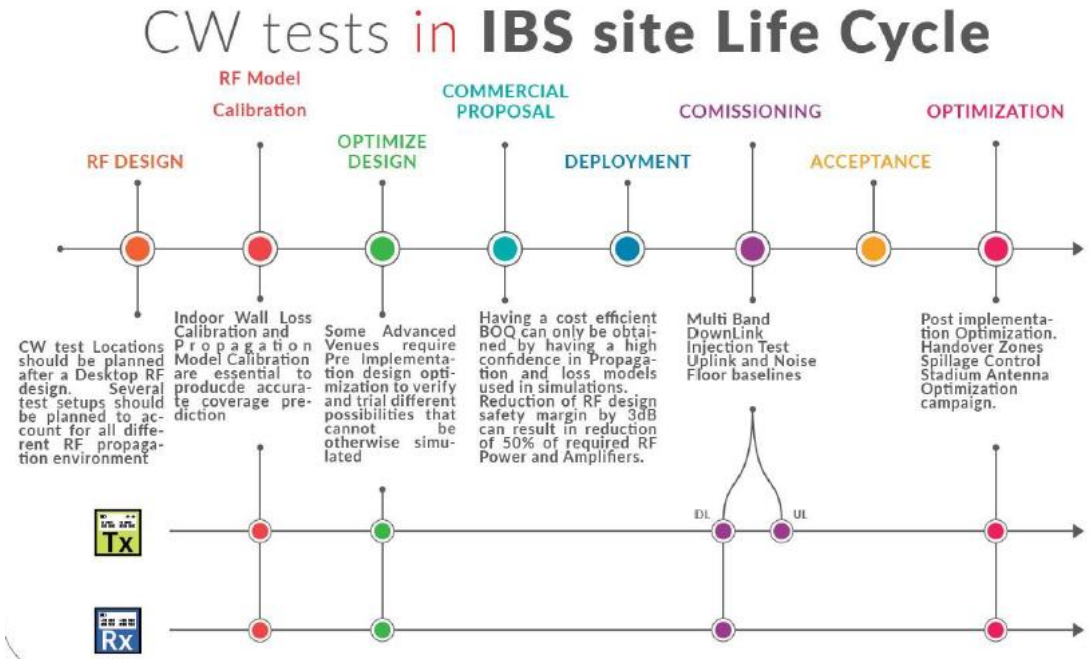
3. Testing of the propagation characteristics of the antenna, in particular to the project building and location under test

4. Investigating spillage (inter-sector interference)

5. Validating Head End DL/UL RF continuity/loss for maximum output at the remote Unit and for adequate SNR at BTS

6. Validating Remote End DL/UL continuity out to remote antennas as well as from remote antennas to DAS Head End in order to balance the impact of line losses and noise

7. Post-build CW testing to make sure the DAS Network meets the design coverage KPI's.

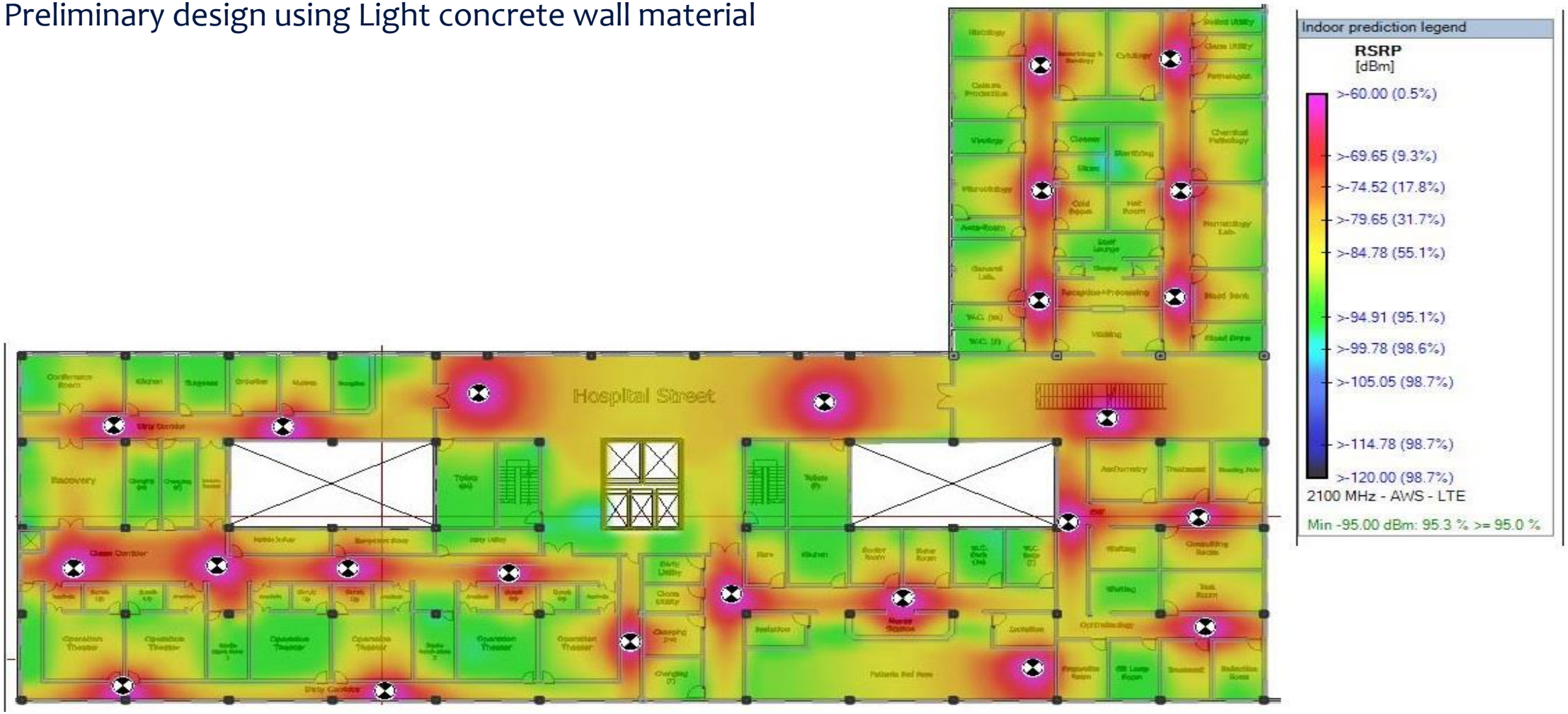


Common prediction mistakes

- Scale
- Body Loss and Fade
- Power Sharing
- Wall Types
- Missing walls
- Inclined surfaces
- Antenna pattern

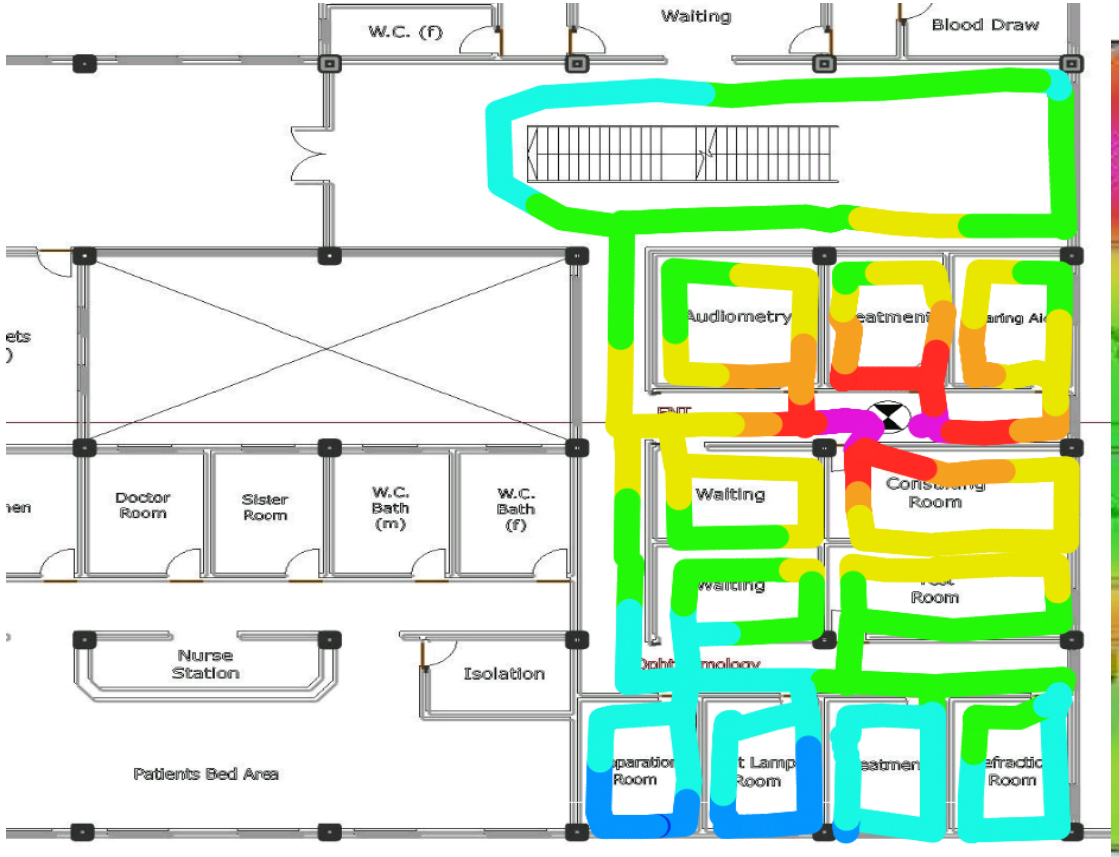
Example of model tuning (incorrect wall type)

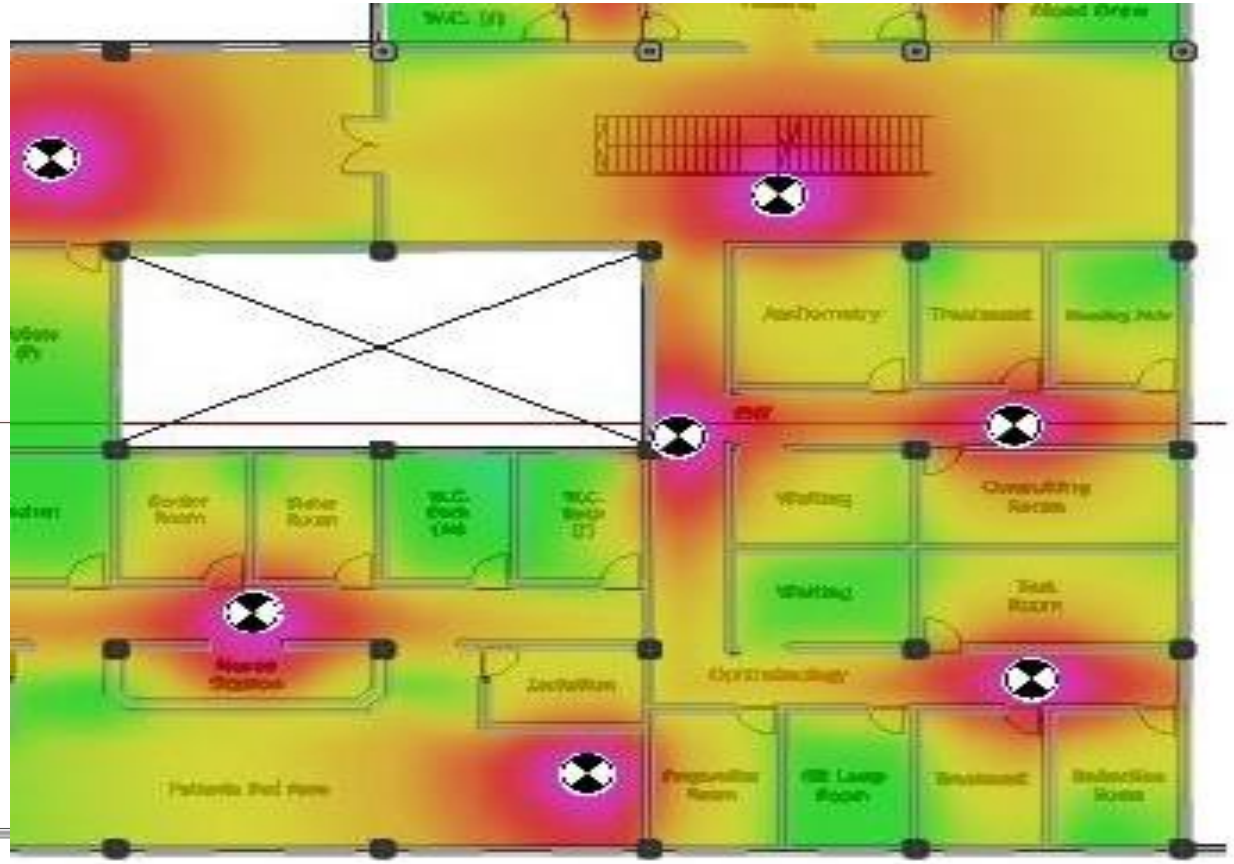
Preliminary design using Light concrete wall material



Example of model tuning (incorrect wall type)

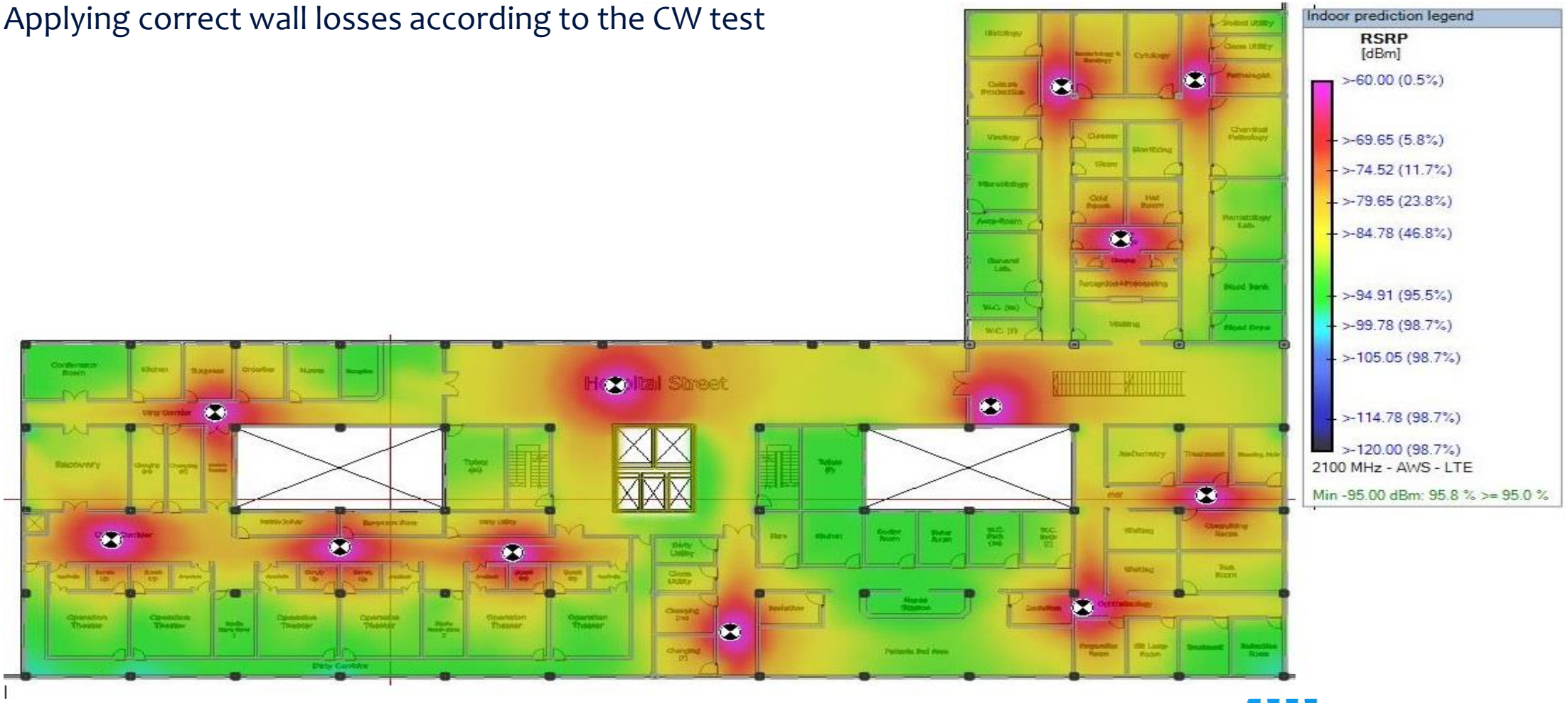
CW measurement of randomly selected antenna





Example of model tuning (incorrect wall type)

Applying correct wall losses according to the CW test



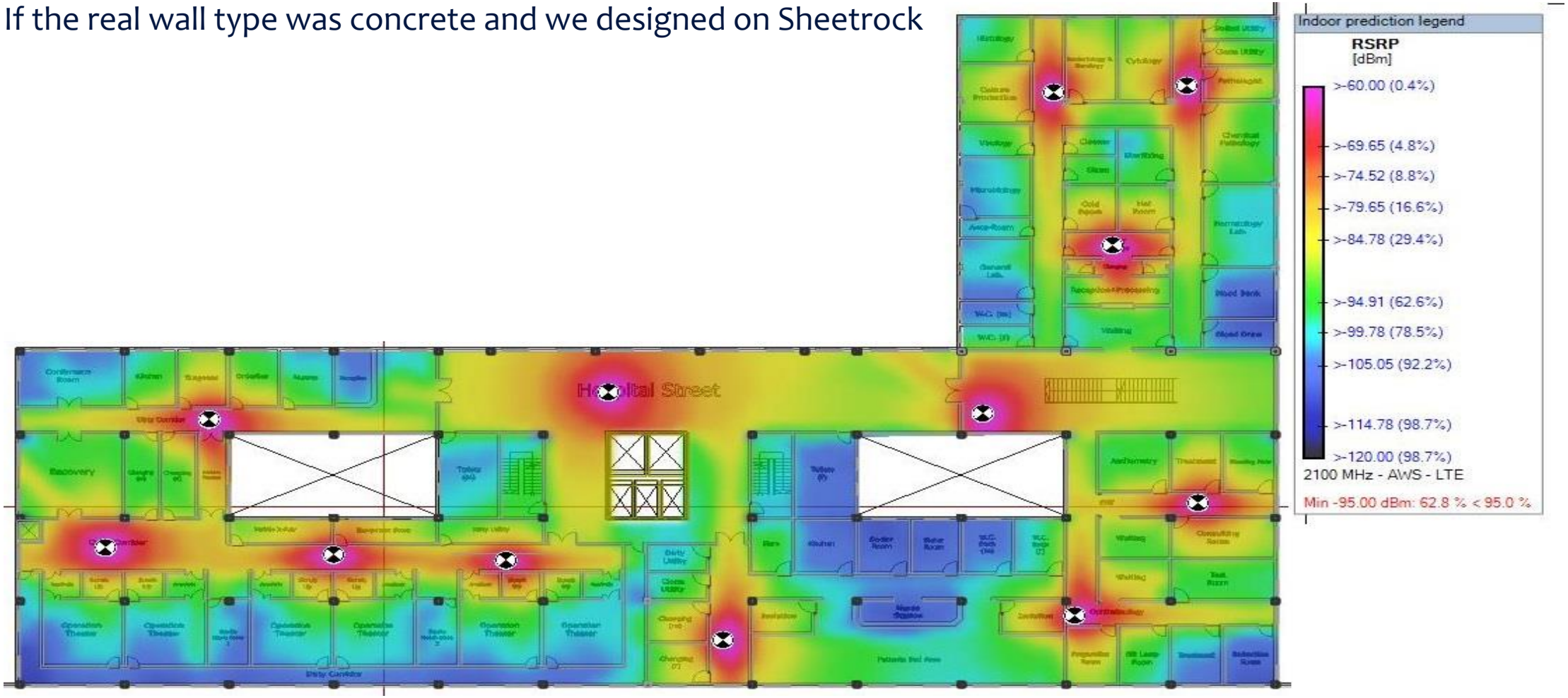
Business impact of model tuning

Effect of improper wall type on deployment cost

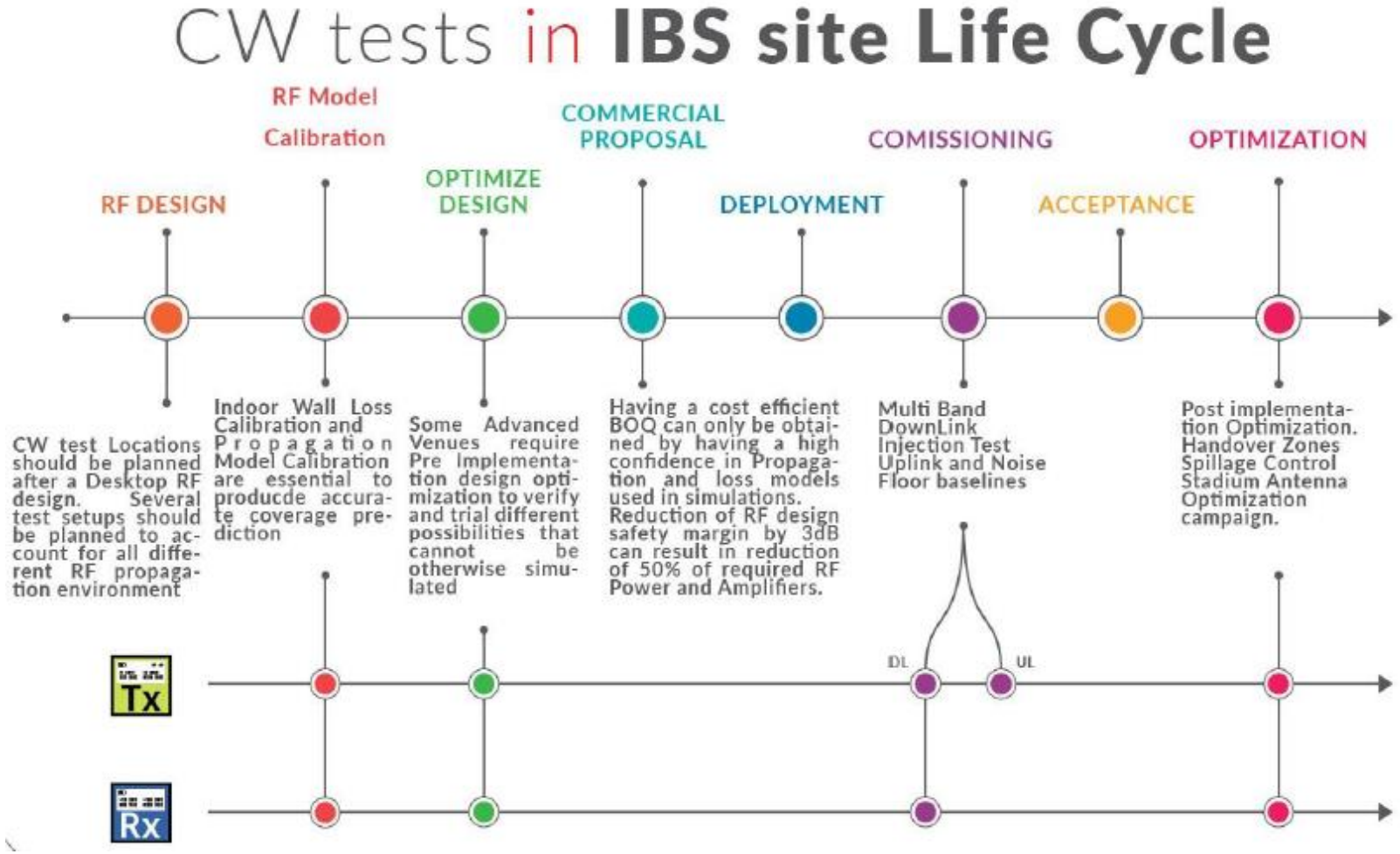
Parameter	Before CW testing	After CW testing
KPI achievement	Achieved	Achieved
Number/Power of remotes	1 x 1Watts	1 x 0.5Watts
Number of antennas	24	12
Installation and BOM Cost	55000 USD	29000 USD
Price difference	0	26000 USD

Business impact of model tuning

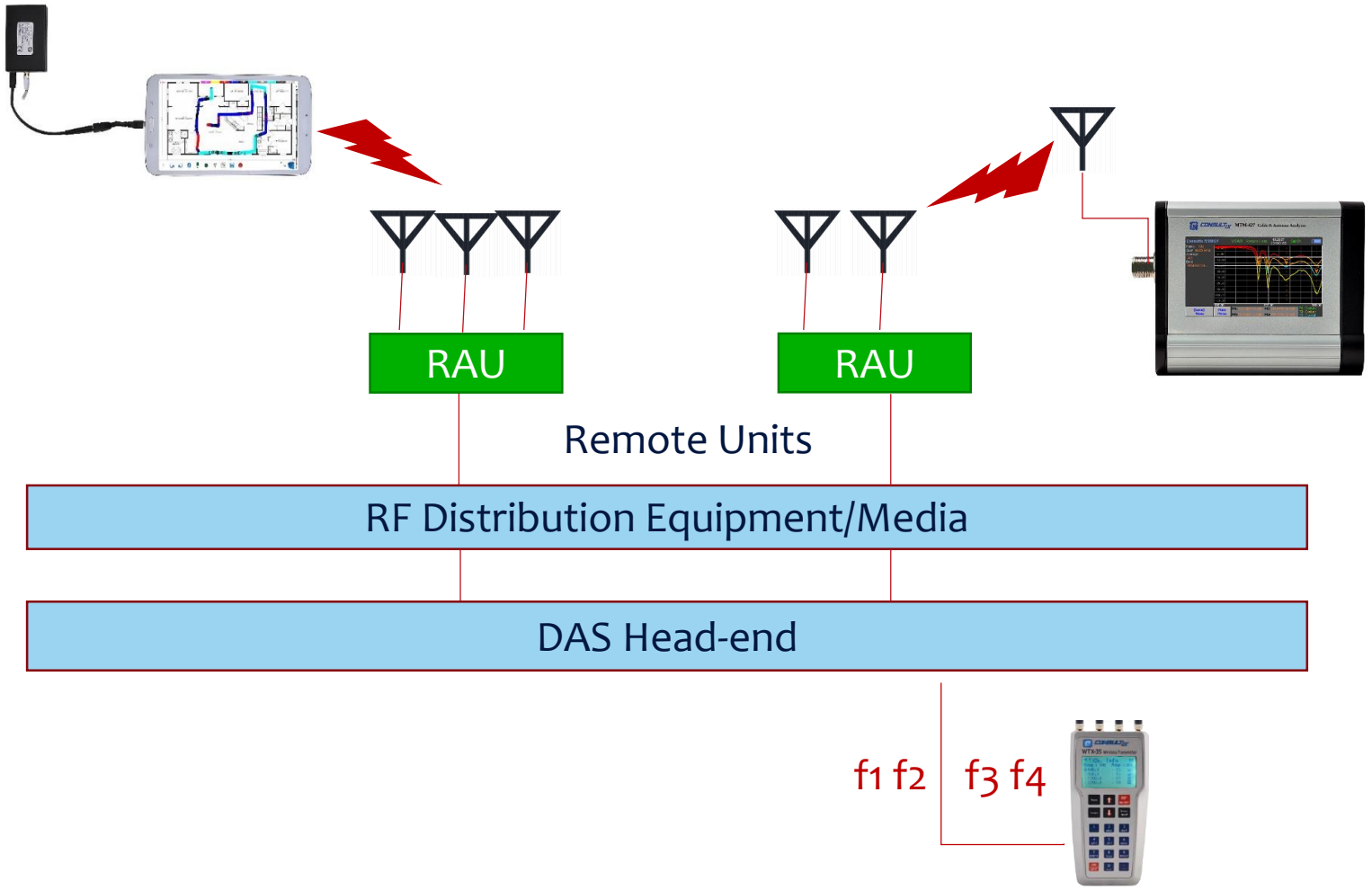
If the real wall type was concrete and we designed on Sheetrock



Typical Setup for Model Tuning & DAS Injection



Typical Setup for Model Tuning & DAS Injection



Typical Setup for Model Tuning & DAS Injection

CellWizard™ CW Kit Overview

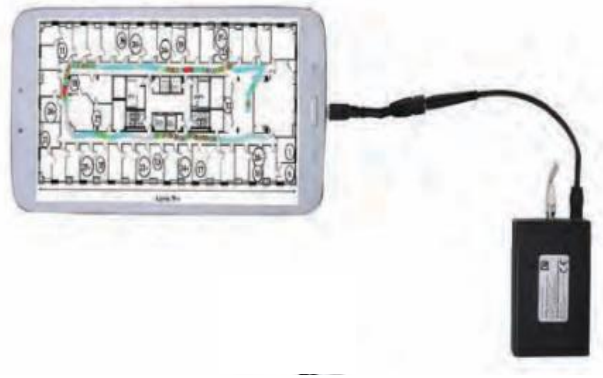
Main Features:

CellWizard™ CW Transmitter

- Multi-Port Transmitters Up to 4 Ports
- High Accuracy
- Portable and Lightweight
- Wideband simultaneous operation Up to 4 GHz

CellWizard™ CW Receiver

- Wideband simultaneous operation Up to 3.9 GHz
- PC & Android Software for Capturing, Logging & Mapping
- Model Tuning Exports Compatible with Various Design tools & Formats



Applications:

- Indoor Model Tuning
- Design Verification
- DAS Commissioning/Injection

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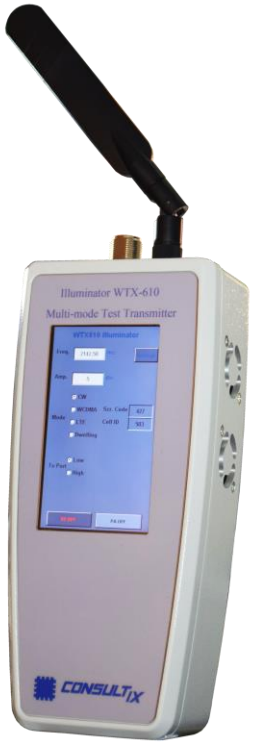
illuminator™ Overview

Main Features:

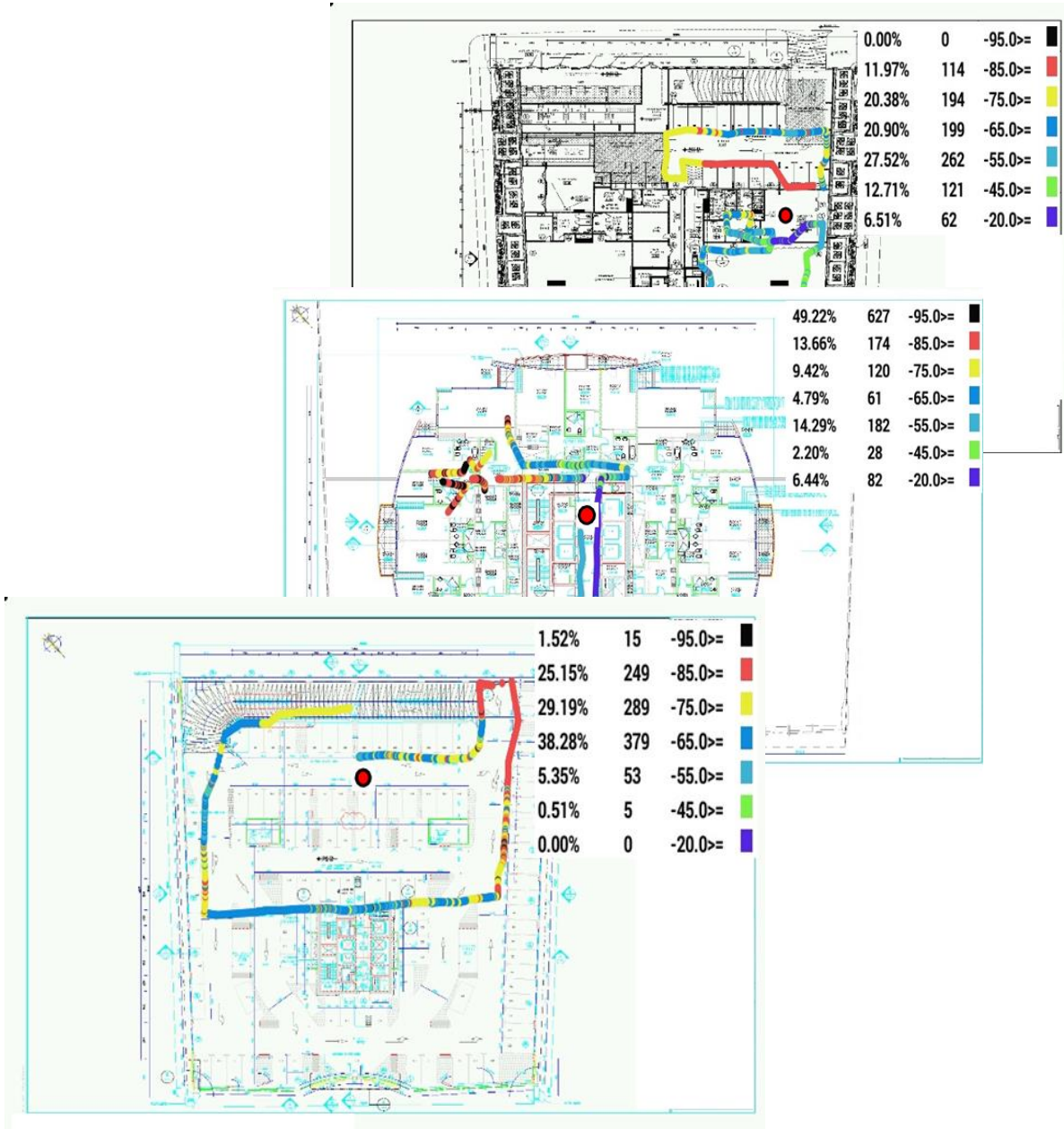
- Multi-Mode Operation; CW, WCDMA & LTE
- Lightweight
- Handheld & Heavy-Duty
- Touch Screen Operation

Applications:

- DAS & Small Cells Radio Planning
- Indoor/Outdoor Model Calibration



WalkView


0.00% 0 -95.0>=
11.97% 114 -85.0>=
20.38% 194 -75.0>=
20.90% 199 -65.0>=
27.52% 262 -55.0>=
12.71% 121 -45.0>=
6.51% 62 -20.0>=
49.22% 627 -95.0>=
13.66% 174 -85.0>=
9.42% 120 -75.0>=
4.79% 61 -65.0>=
14.29% 182 -55.0>=
2.20% 28 -45.0>=
6.44% 82 -20.0>=
1.52% 15 -95.0>=
25.15% 249 -85.0>=
29.19% 289 -75.0>=
38.28% 379 -65.0>=
5.35% 53 -55.0>=
0.51% 5 -45.0>=
0.00% 0 -20.0>=