

# 600 MHz Incentive Auction: Market Variability Analysis

Prepared for T-Mobile, USA  
by Roberson and Associates, LLC

# Summary

## 1. Background:

- The 600 MHz Incentive Auction may not yield the same amount of spectrum for LTE in all market areas.
- Roberson and Associates conducted an analysis of the feasibility of different band plans in adjacent geographic areas (“Market Variability”)

## 2. Approach:

- Scenarios: DTV channel 46 operating in a) Seattle; b) Miami
- Use real-world, terrain-based propagation model to assess the number of usable LTE cell sites in channel 46 in adjacent market areas.

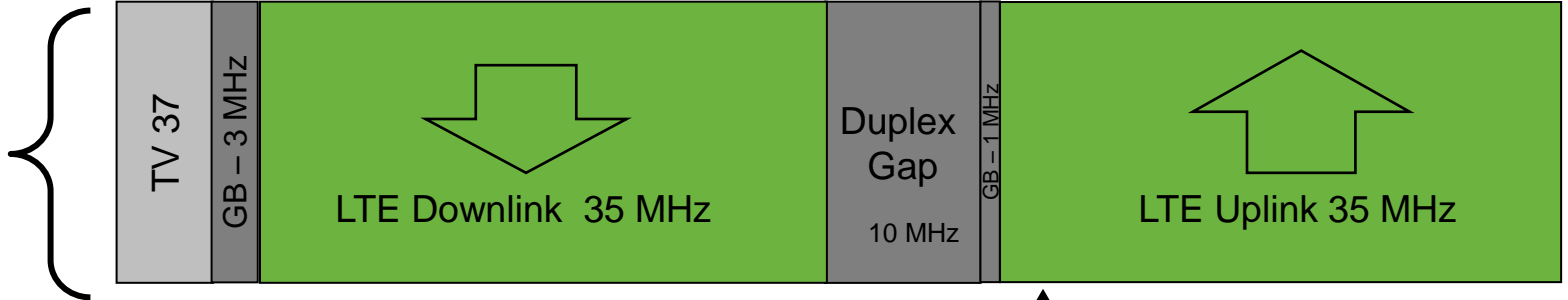
## 3. Conclusion: Market Variability – not ideal – but Feasible

- Valuable markets could be made available for auction by taking into account the terrain, topography, and distances that separate wireless market boundaries.
- Regionally determined protection zones to prevent interference from TV stations into LTE networks based are viable.
- The lowest common denominator market should not cap the recovery of spectrum for a majority of the nation.

# Market Variability Scenario

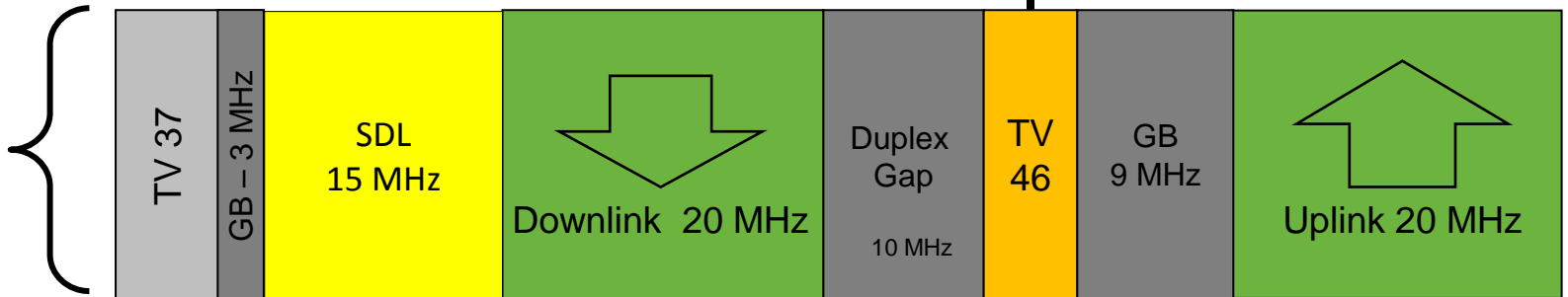
## Spokane

Desired  
Bandplan  
35x35 MHz  
LTE



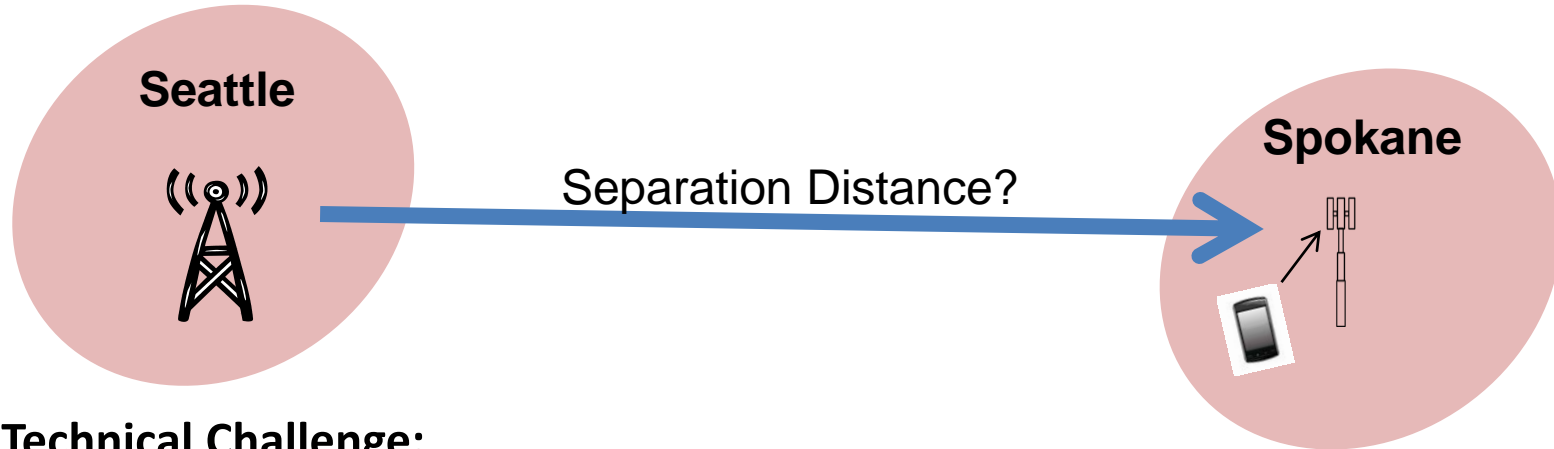
## Seattle

Reduced  
(Variable)  
Bandplan  
20x20MHz  
LTE



What distance separation is required for successful LTE operation?

# Translating Exclusion Zones into Manageable Regions



## Technical Challenge:

- Kilowatt TV transmitters transmitting into base station receivers, often above clutter, designed to receive microwatt power levels. Various estimates in record of required separation of 110 - 500 km.
- Proposed solutions so far only focus on large radius, circular exclusion zones that don't consider terrain, topography, or wireless market boundary areas

## Requirements for Region-by-Region Variation:

- **Must** protect the TV station service contour, as determined by the FCC's *TV Study* software
- **Must not** impair LTE uplink operation for wireless industry

# Scenario: Pacific Northwest (Seattle)

- One high power TV station remains in Seattle above channel 37
  - TV station repacked into Channel 46, per T-Mobile band plan proposal, keeps transmitting at 1 million watts
- Examined the interference potential to 3 nearby Economic areas:
  - Spokane EA: 1M Pops
  - Richland EA: 800k Pops
  - Portland EA: 3.3M Pops

# Determining the Required Separation Distance: Terrain Based Propagation Model

## **Three step process:**

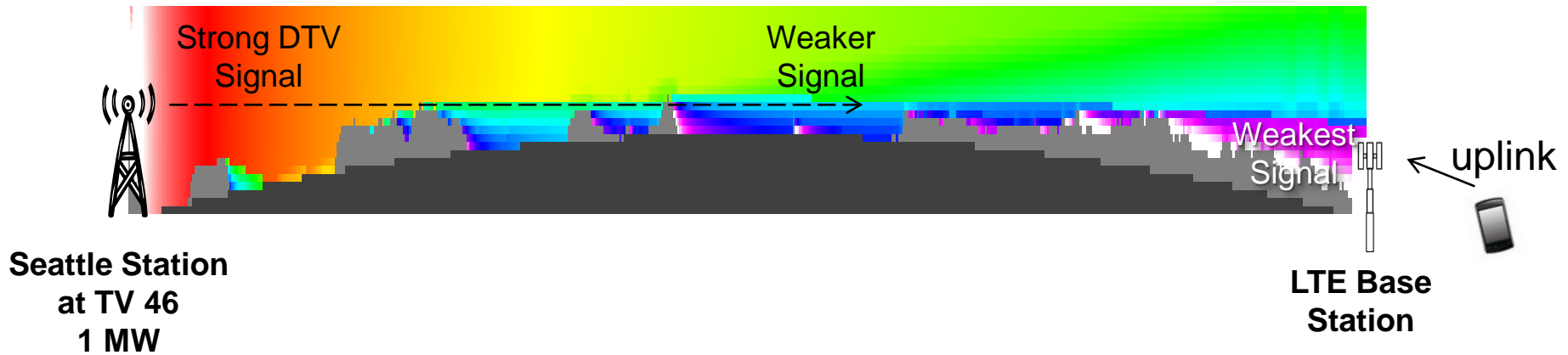
1. Set an appropriate Interference Protection Criteria (IPC) for LTE
2. Run a radio frequency propagation model from the TV station transmitter to the LTE base station
3. Calculate the link budget analysis based upon steps #1 and #2 to determine the interference risk

# Step 1: Determine Interference Protection Criteria (IPC)

- Subject to debate and opinion about what is an appropriate level of signal strength
- This analysis applies three different categories and uses conservative values:
  1. No predicted risk of interference
  2. Low risk
  3. Potential risk

Note – calculation of the values is a separate slide

## Step 2: Run TV Station Propagation Model



- Point-to-point calculation between TV base station and LTE base stations using ITM Longley Rice propagation model and 3 arc-second terrain data.
- Use actual TV station transmitter parameters (location, height, antenna pattern, power output) and base station parameters (location, height).
- Clutter or weather influenced ducting are not considered, but neither factor is outcome determinate in the analysis



## Step 3: Link Budget Calculation to Determine if IPC Satisfied

KING Transmit Power (1 MW ERP)	90	dBm
KING antenna gain (in direction of cell)	-6.06	dB
Computed Path Loss to Cell Site (ITM)	230.20	dB
Received Power at Antenna	-146.26	dBm
Receive Antenna Gain (worst case)	15	dB
Receiver Power at LTE Base Receiver	<b>-131.26</b>	dBm

Note – this link budget was based on a cell site 288 km from the TV Transmitter antenna.

Step 4: Repeat Steps 1-3 for all 1500+ sites in the study EAs and for each of the five different TV stations in Seattle located above channel 37 that could be repacked to Channel 46.

# Interference Protection Criteria

**No Predicted Risk:** signals at or below -122 dBm

- Rationale – link budget calculation of LTE site

**Low Risk:** signals between -121 dBm and -100 dBm

- Rationale – reduced gain of 15 dB from LTE site antenna and up to 7 dB additional attenuation from clutter

**Possible Risk:** signals stronger than -100 dBm

Note – we attempted to be conservative in setting the criteria. We think there is room for debate and opinion about the exact values to define the low risk and possible risk signal strength criteria.

# Results for T-Mobile Sites Near Seattle

Market	Sites in a Market Subject at Risk for Interference		
	Limited/No Risk	Low Risk	Potential Risk
Spokane EA	99%	1%	0%
Richland EA	96%	4%	< 1%
Portland EA	64%	35%	< 1%

- Simulation results suggest Spokane and Richland EA could readily support market variability, providing access to 1.8M POPs even if one of the TV station currently operating in Seattle was repacked into Channel 46.
- Simulation results suggest the Portland EA could potentially support market variability, providing access to another 3.3M Pops even if one of the TV station currently operating in Seattle was repacked into Channel 46.

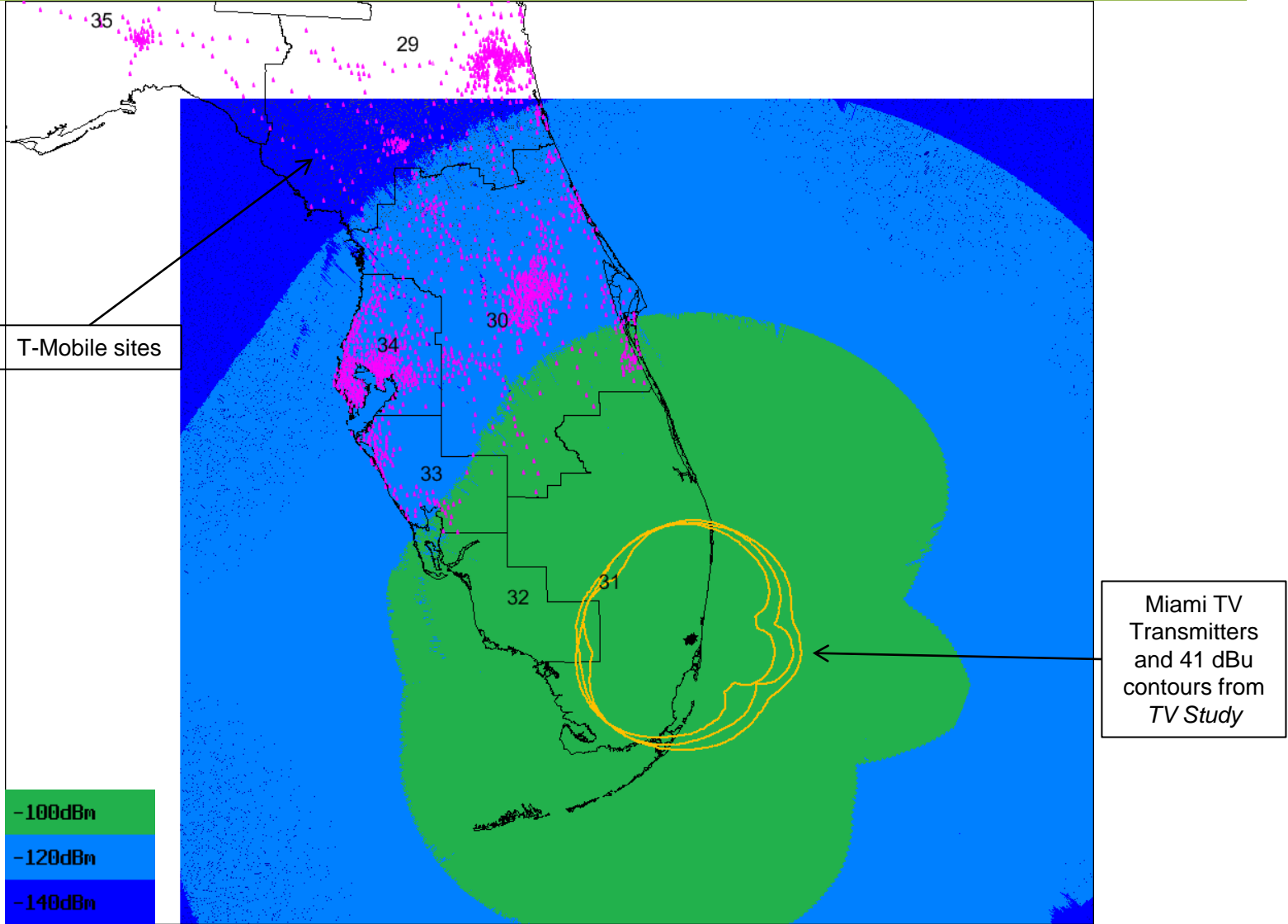
# Results for T-Mobile Sites Near Miami

Market	Sites in a Market Subject at Risk for Interference		
	Limited/No Risk	Low Risk	Potential Risk
Tallahassee EA	100%	0%	0%
Jacksonville EA	91%	9%	0%
Tampa EA	10%	90%	0%
Orlando EA	3%	91%	6%
Sarasota EA	<1%	95%	4%

- Simulation results suggest Jacksonville and Tallahassee EA could readily support market variability, providing access to 3M POPs even if one of the TV station currently operating in Miami was repacked into Channel 46.
- Simulation results suggest the Tampa EA could potentially support market variability, providing access to another 2.7M Pops even if one of the TV station currently operating in Miami was repacked into Channel 46.

# BACKUP

# Area Plot Miami



# Area Plot Seattle

-100dBm

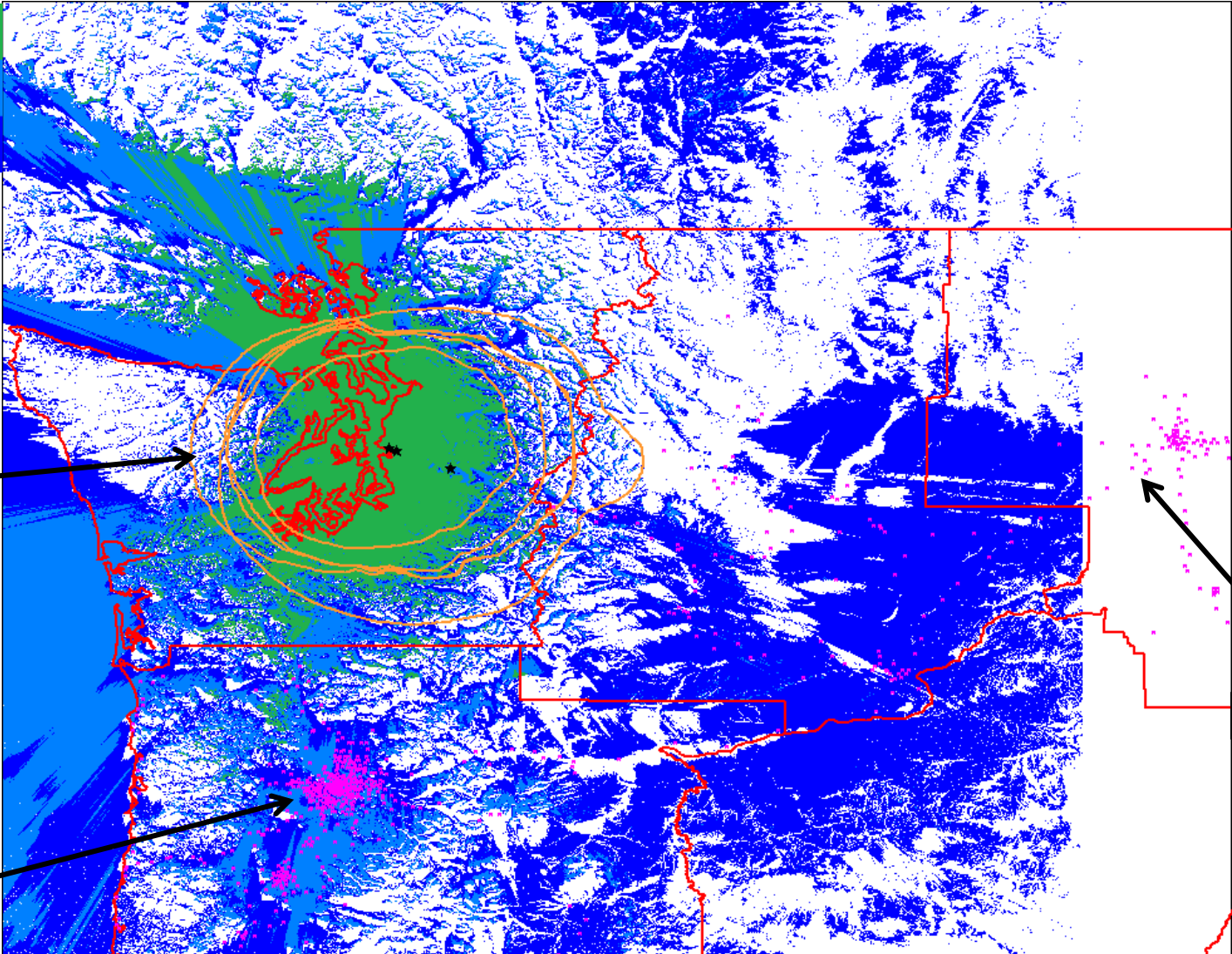
-122dBm

-140dBm

Seattle TV Transmitters and 41 dBu contours from TV Study

T-Mobile sites

T-Mobile sites



# LTE Site Link Budget Calculation

Parameter	10 MHz	5 MHz
LTE Base Station Receiver Noise Figure (dB)	3	3
Noise Floor (kTB)(dBm)	-101	-104
Interference to Noise for 1 dB desense (dB)	6	6
Received Signal Power at Receiver for 1 dB rise (dBm)	-107	-110
LTE Antenna Antenna Gain (maximum) (dB)	15	15
Received Signal Power at Antenna (dBm)	-122	-125

Based on requirement that interference be at least 6 dB below the noise floor to keep the noise rise less than or equal to 1 dB.

Propagation analysis tool used predicts signal power at the antenna. Predicted values weaker than those given by “Received Signal Power at Antenna” will result in acceptable system performance.



# Typical KFFV Terrain Profile

SPLAT! Terrain Profile Between SP09068E and KFFV (304.53° Azimuth)

