

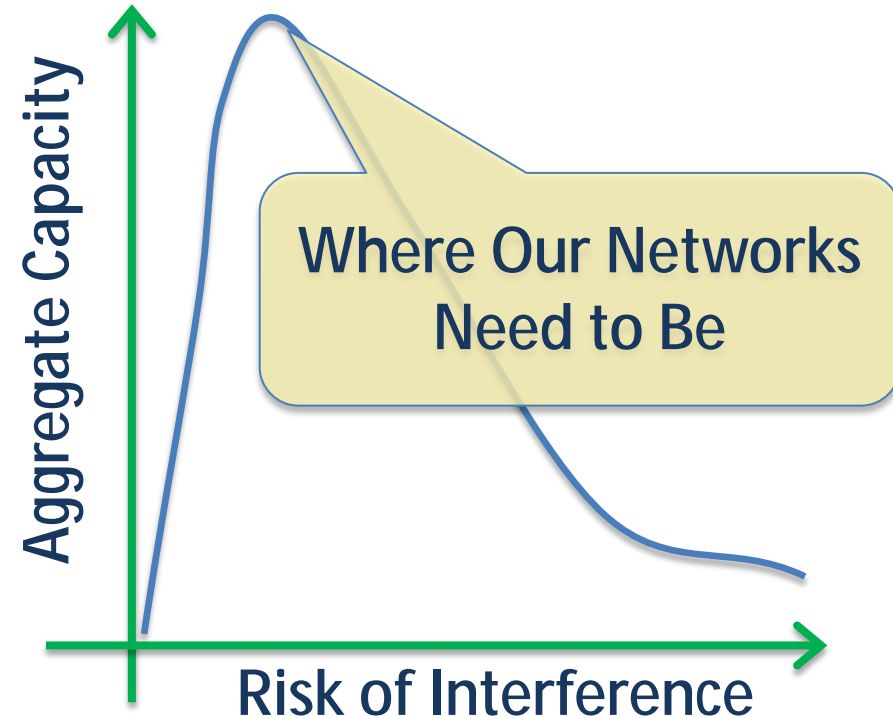
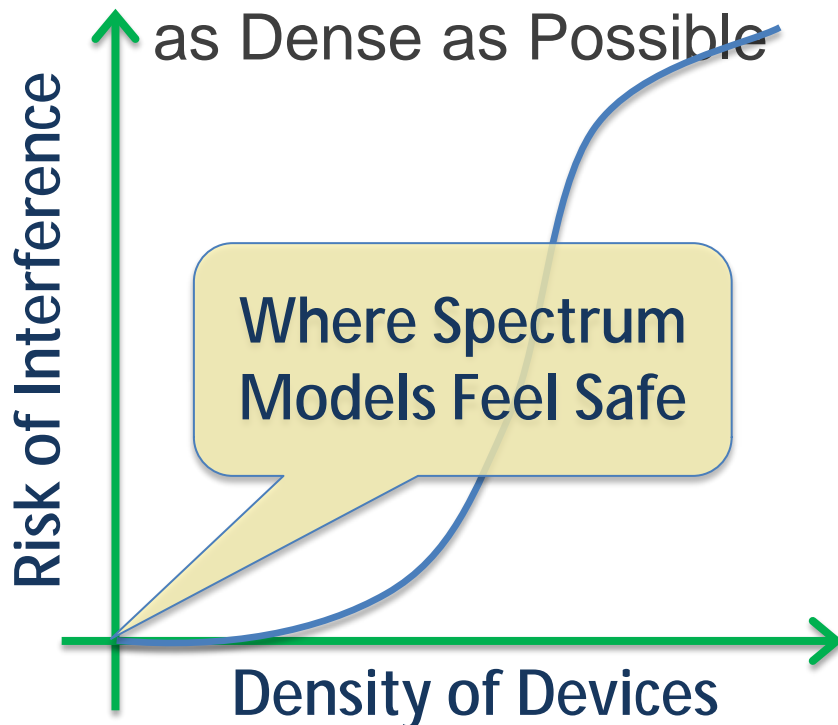


Thoughts on Propagation Uncertainty, its Impacts, and some Mitigations

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What's Wrong with Current Models

- They are Very Good at Protection – Maybe Too Good!
- In a World that is Shifting from a Coverage to Capacity Focus, they Ill Serve the Necessity to make Deployments as Dense as Possible



Challenge: Massively Increase Density, While Not Creating Unacceptable Risk to Other Usages By Ditching "Worst Case" Analysis

Real World Deployments can Achieve Much Greater Density



Google Micro-path Model Data

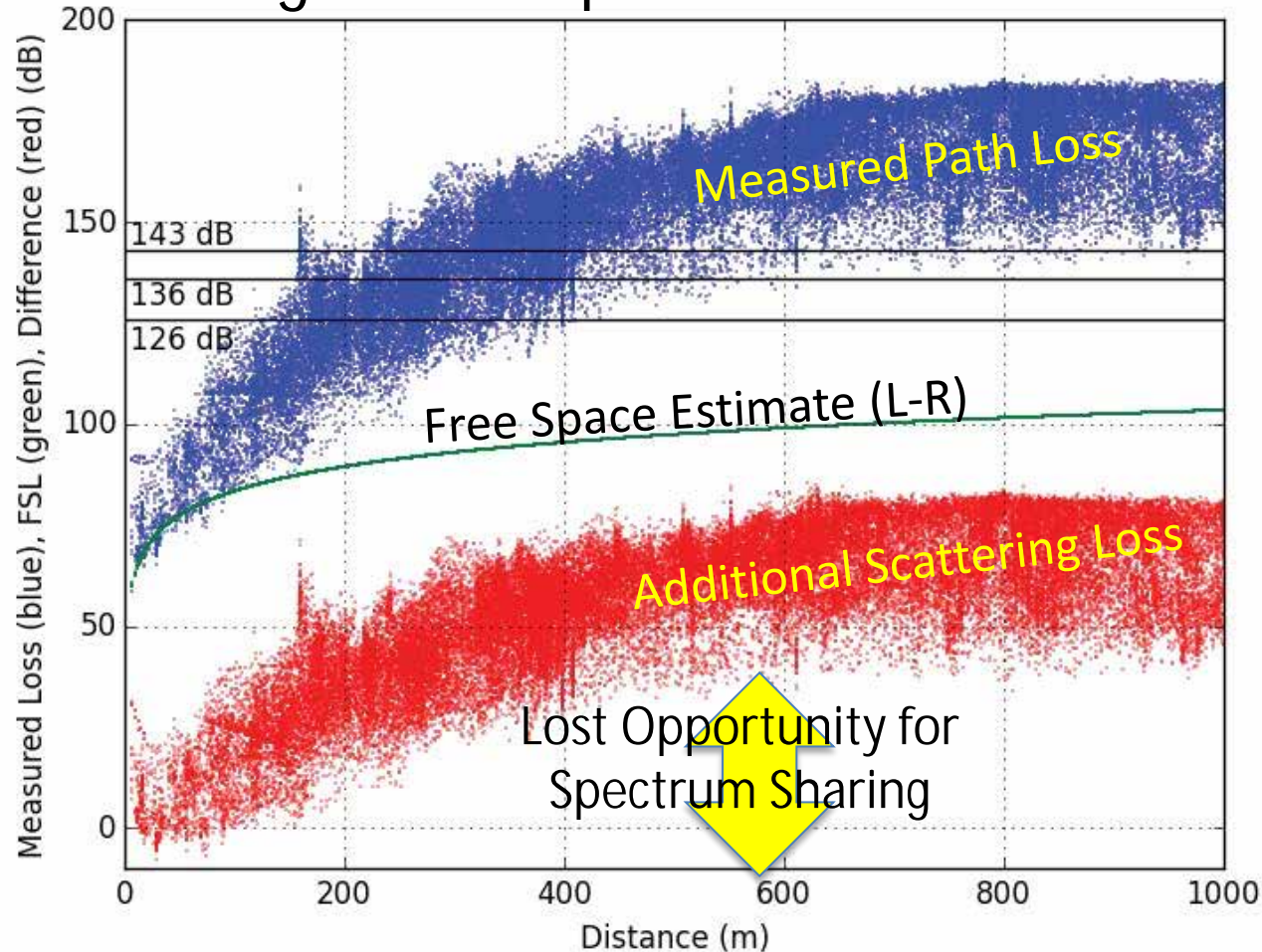
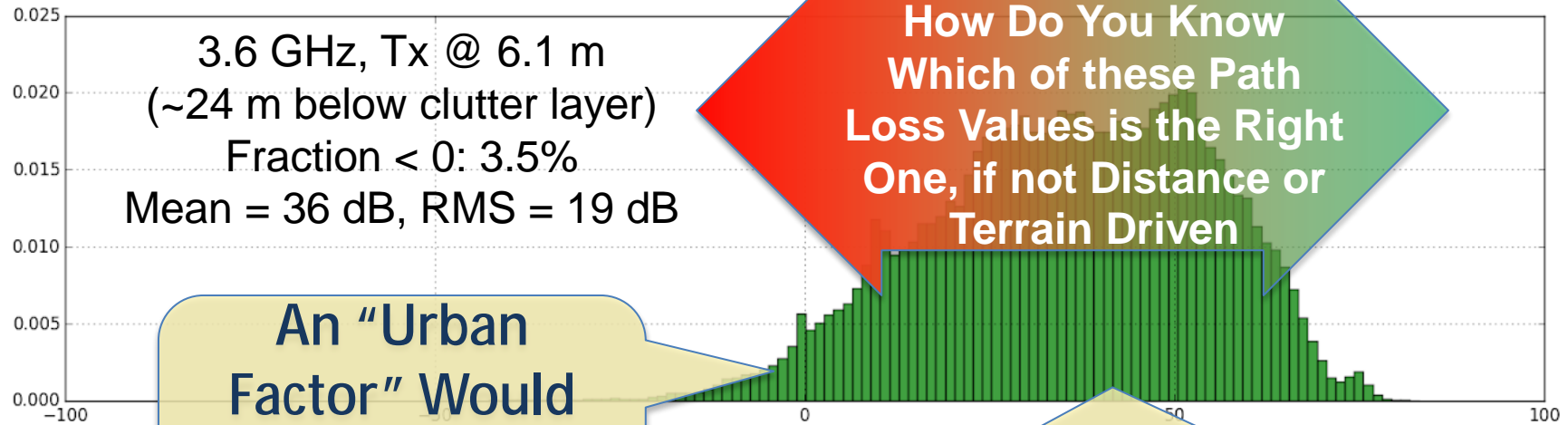


Chart 1: Propagation Loss Measured in Mountain View, California

From Google Ex-Parte filing on Feb 16, 2016

- We have collected over 2,500,000 propagation points in dense/semi-dense environments
- Data shown is for benign environment with low buildings in MTV
- 30 dB in r^2 is 2^5 (32 times) in range, and 2^{10} (1,000 in density) impact
- Regress against Google Earth path analysis (buildings, trees, ...) to Create Models for Each Path Disturbance

Why We Have to Leave Generic Models Behind Us



Conclusion: Propagation Above 3 GHz is All about the Actual Path – Generic Models Can Not Exploit Any Opportunity Created Since Humans Started to Build RF Scattering and Absorbing Structures

Four Phases of Making Propagation Analysis Approach Reality



1. Geo Knowledge Based Path Analysis
 - Distance and terrain Less Relevant than Obstructions
2. “Big Data” Mining of Facts About Every Specific Environment, and Even Each Unique Building
 - We Collect Billions of Data Points and Don’t Use them!
3. “Artificial Intelligence” Learning of Actual Effects that Never Occurred to Human Engineers
 - Computers “Learn” Faces and Objects – We Don’t Teach Them
4. Devices that Solve their Own Problems, without Human Prediction
 - We Really Do Need Cognitive Radios, Empowered with Local Decision-Making