Data and More Data: Inputs to Modern Propagation Prediction Tools

Dr. Roger Skidmore

EDX Technologies, Inc.

July 25, 2019

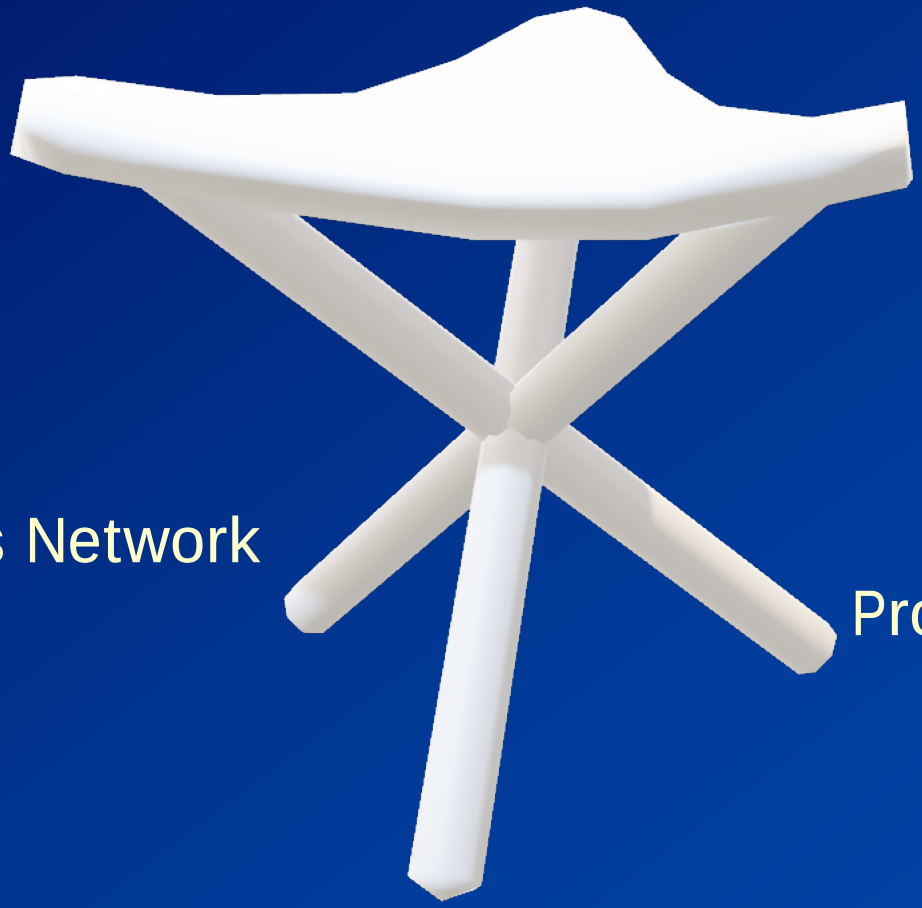
Introduction

- EDX Wireless
  - 30 years of network planning
  - FM radio to LMDS and beyond

- Data demand has not changed much over 30 years
  - Same basic data needed then is the same now
- Data availability and resolution *has* changed

Wireless Network Planning

Wireless Design Tools



RF / Wireless Network Technologies

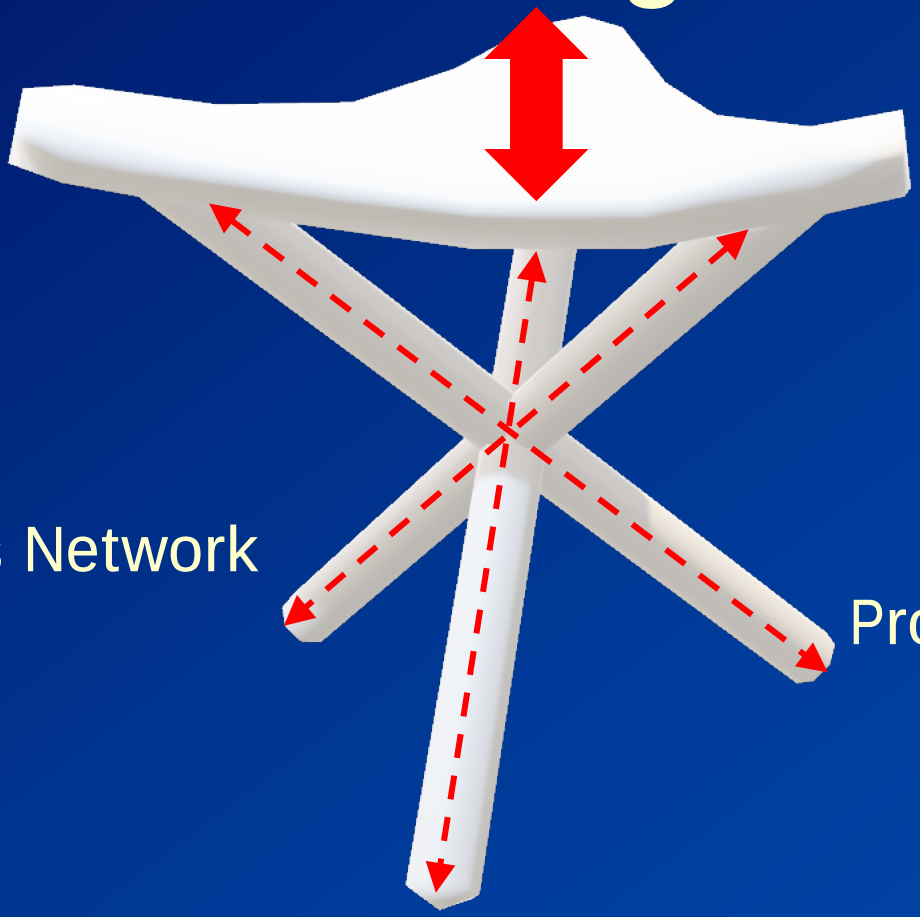
Propagation Models / Theory

Data

Next Generation Wireless Design

Wireless Network Planning

Wireless Design Tools



RF / Wireless Network Technologies

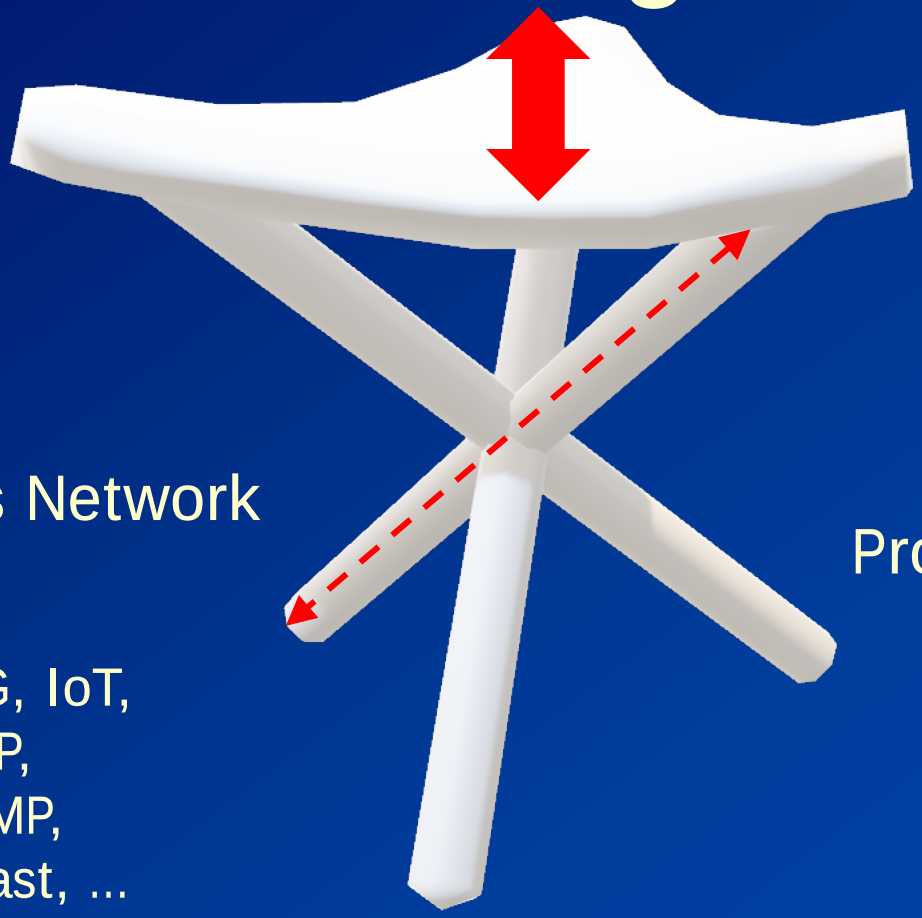
Propagation Models / Theory

Data

Next Generation Wireless Design

Wireless Network Planning

Wireless Design Tools



RF / Wireless Network Technologies

LTE, HetNet, 5G, IoT, Mesh, CBRS, PtP, LoRA, RPMA, PMP, 802.xx, Broadcast, ...

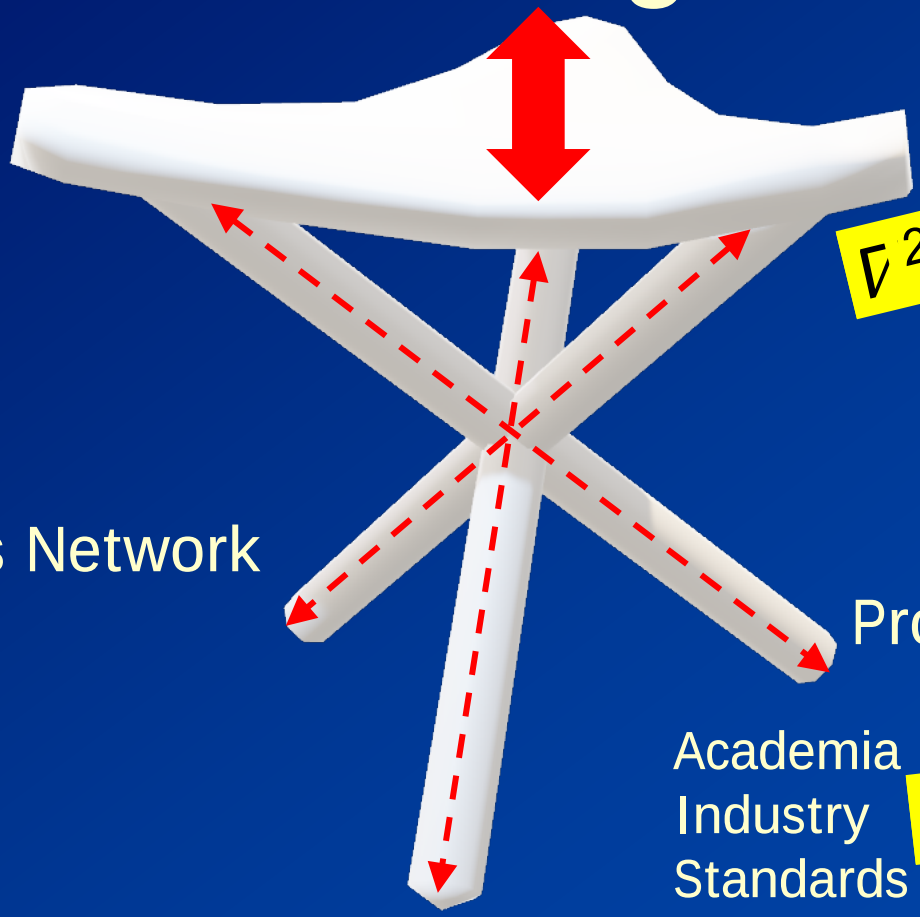
Propagation Models / Theory

Data

Next Generation Wireless Design

Wireless Network Planning

Wireless Design Tools



$$\nabla^2 E + \omega^2 \mu E = 0$$

RF / Wireless Network Technologies

Propagation Models / Theory

$$\nabla^2 \psi + k^2 n^2 \psi = 0$$

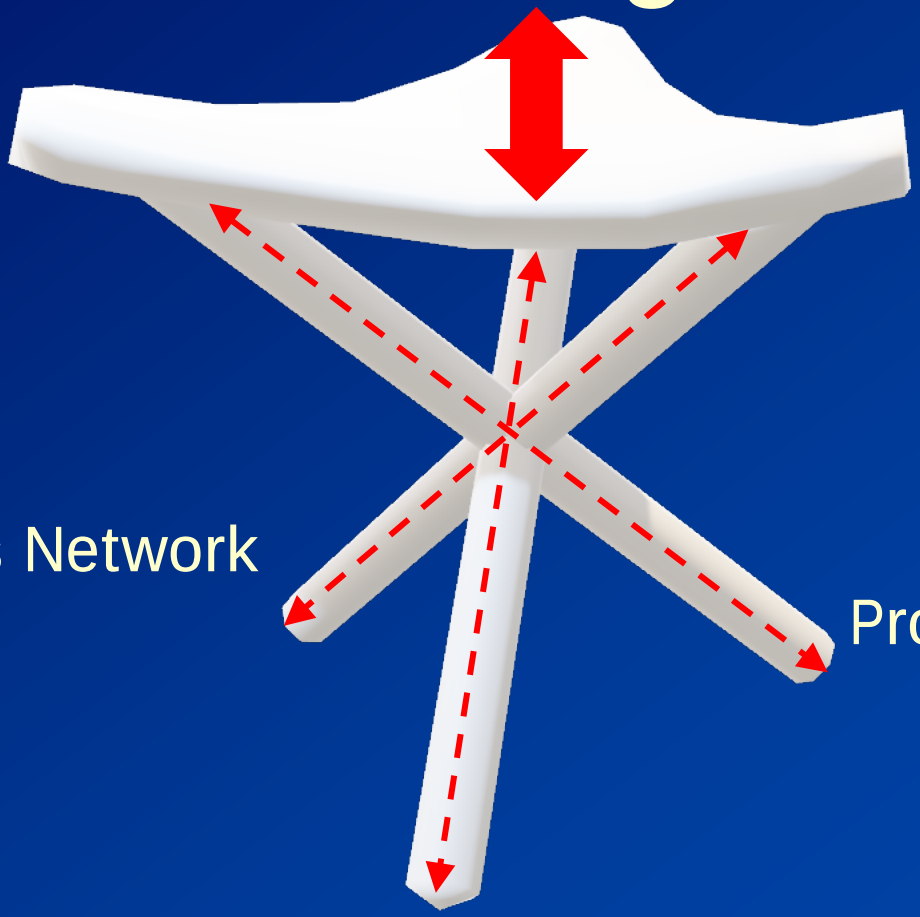
Academia
Industry
Standards Bodies
Government

Data

Next Generation Wireless Design

Wireless Network Planning

Wireless Design Tools



RF / Wireless Network Technologies

Propagation Models / Theory

Data

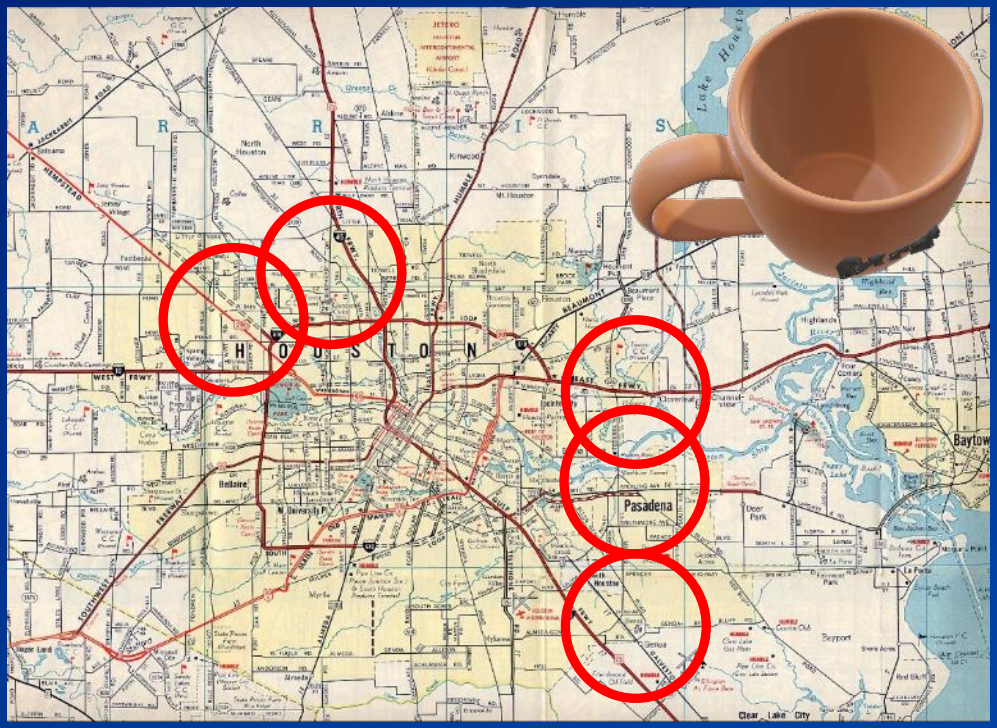
Next Generation Wireless Design

Way Back When...

- The early ‘80s
  - 1G cellular: the first cell towers!
  - What was the best cell planning tool?

Way Back When...

- The early ‘80s
  - 1G cellular: the first cell towers!
  - Geodata == Rand McNally



Software Tools

- Raj Singh/LCC (‘83), Harry Anderson/EDX Wireless (‘85), RadioSoft (’85), etc.

- Leveraged existing computerized geodata to improve the planning process
- The better the data, the greater the improvement

- Treadmill: network operators began wanting more data, better data

Present Day: Data, More Data!

- Explosion in available data useful for wireless network planning
- Data availability has exceeded wireless planning tool capabilities
- In many cases, readily available data is overkill for what is needed
  - "Useful" is subjective

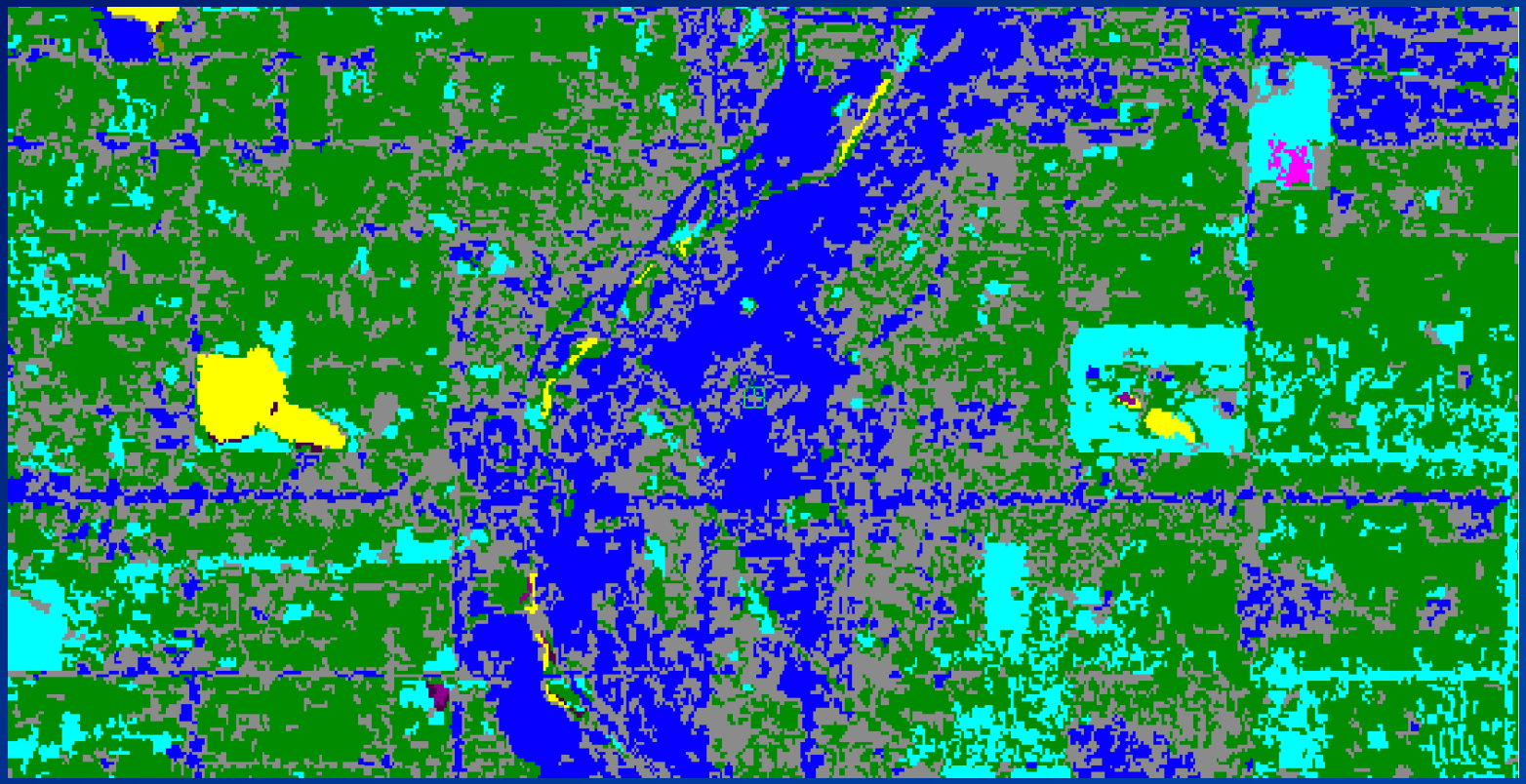
- Cost is King

Fundamental: Physical Environment

- Elevation
  - 30m ~ 10m resolution common today
  - Higher resolution usually not needed
  - Rarely changes significantly

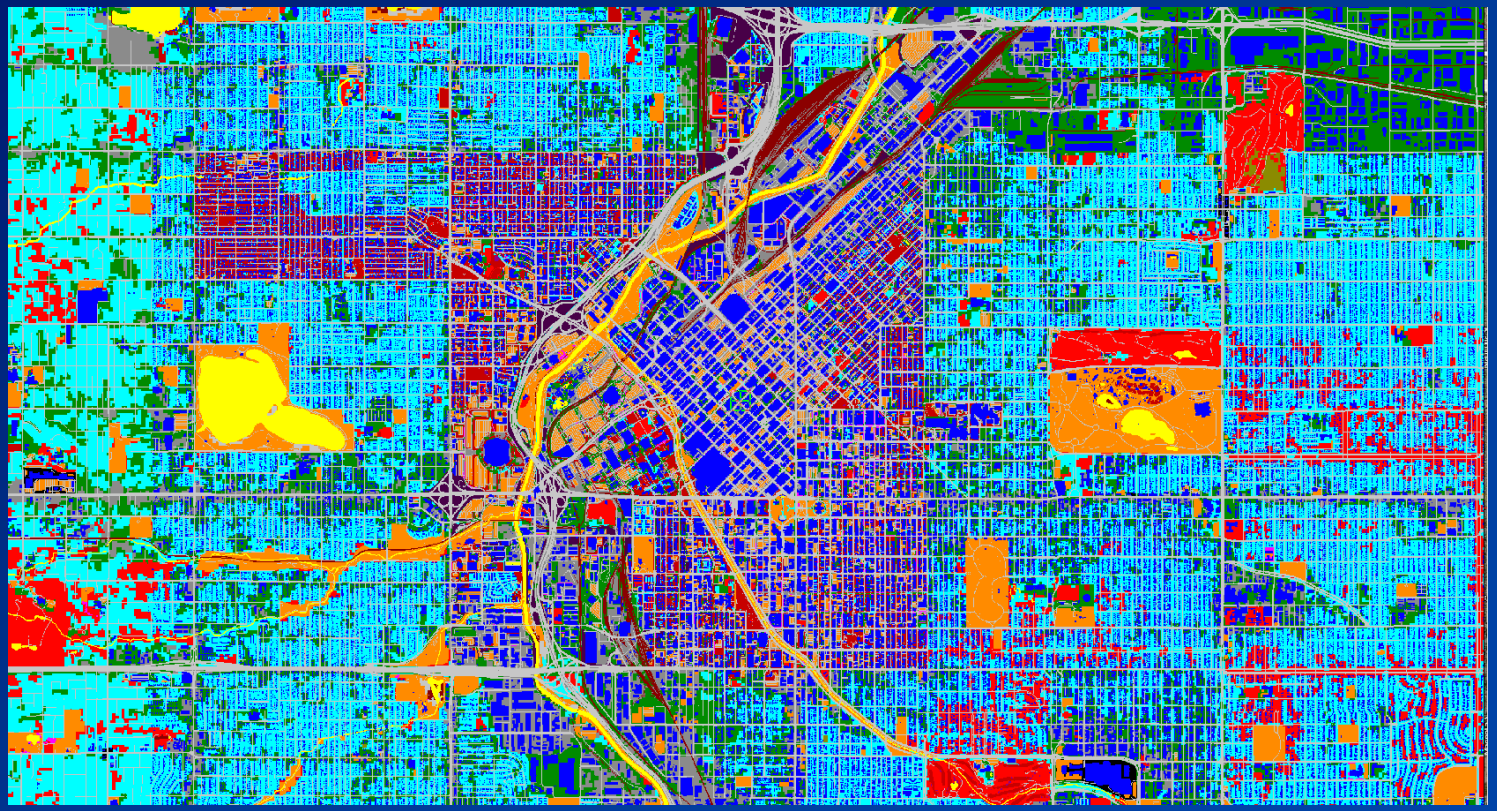
Fundamental: Physical Environment

- Clutter / Land Use
  - 30m ~ 10m common today



Fundamental: Physical Environment

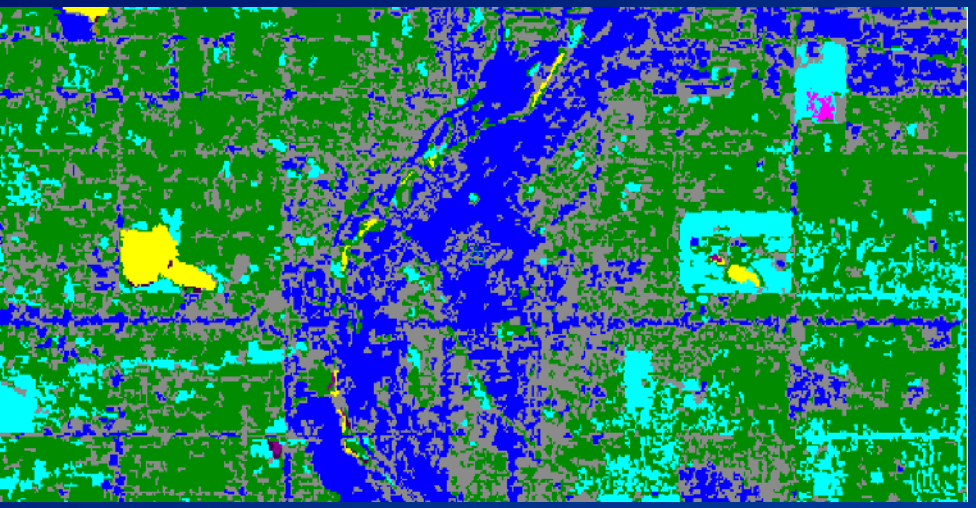
- Clutter / Land Use
  - Higher resolution (1m)



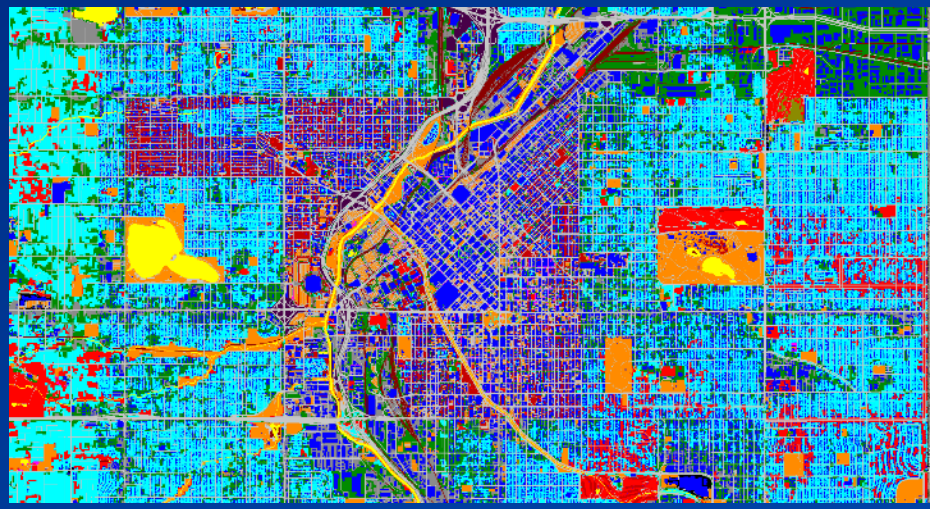
Fundamental: Physical Environment

- Clutter / Land Use

30m resolution



1m resolution



Fundamental: Physical Environment

- In urban / suburban areas, clutter / land use could be constantly changing
  - Higher resolution changes more than lower resolution
  - Regular updates to clutter / land use more important as resolution increases
- Assigning height to clutter categories allows for some degree of 3D overtop of elevation

- Problem: number of clutter categories may stay the same between low and high resolutions
  - Significant impact on direct application of higher res clutter data in planning tools

Fundamental: Physical Environment

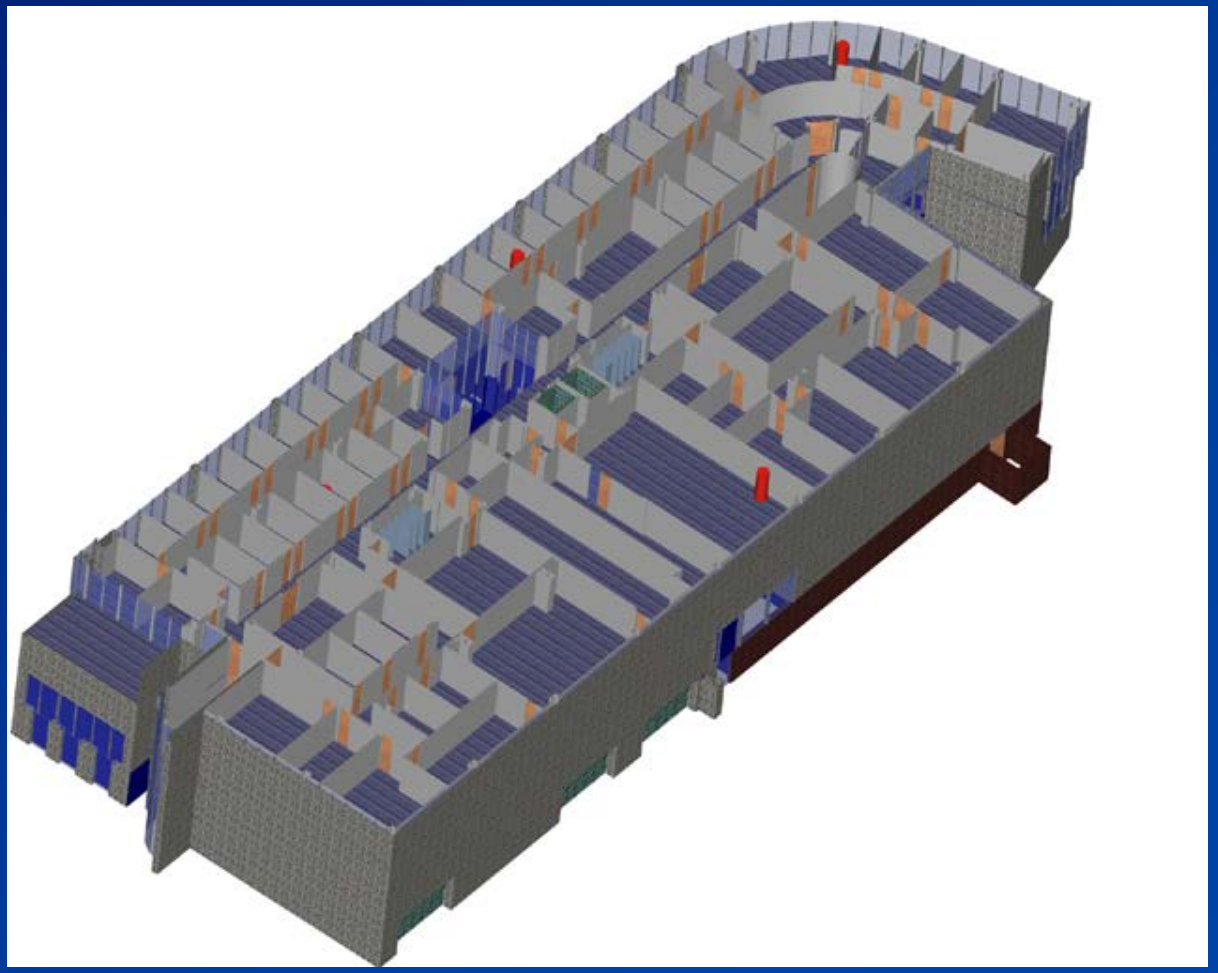
- Digital Surface Model (DSM)
  - 1m resolution available today

Fundamental: Physical Environment

- Vectorized buildings, foliage
  - 30cm resolution (and better) available today

Fundamental: Physical Environment

- 3D Vector Inbuilding Data

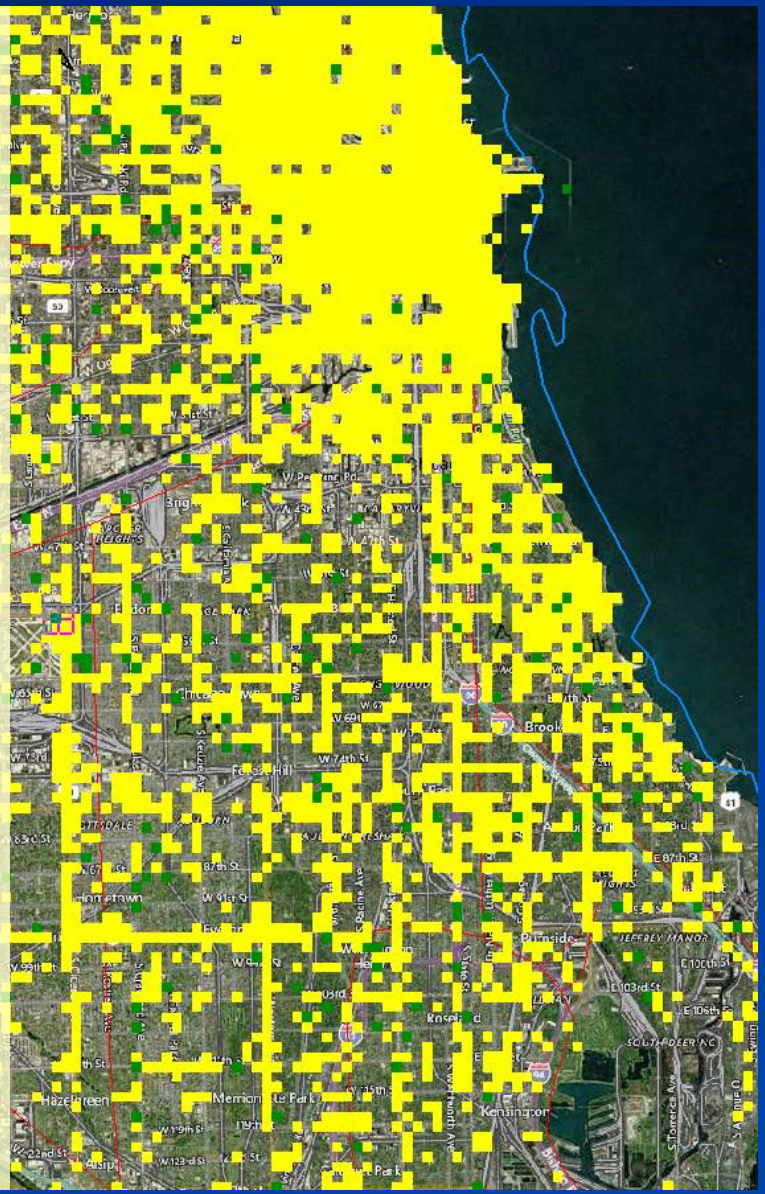


Measurements and More Measurements

- Drive test or walk test data extremely valuable for design confidence
- Empirically-derived propagation models tuned by measurements
  - Measurements allow for site-specific tuning of propagation model
  - Over time, number of propagation model parameters have grown significantly
    - Tuning may be absolutely required in some cases
    - Transportability of tuned model parameters less likely as resolution of clutter data increases

Additional Data

- Fixed network access points
  - Towers
  - Light Poles
  - Fiber drops
- Socio-economic, Census data
- Usage data
- Key usage zones
  - Sports arenas, shopping centers, hospitals, schools, airports, rail stations, etc.
- Traffic
  - Vehicle and pedestrian
- Weather / Seasonal effects
- Infrastructure elements
  - More and more complex every quarter
- Miscellaneous



Resolution, Rate Drivers

- More than ever non-wireless technologies and markets are impacting geodata availability
  - Traditional satellite imaging
  - Augmented Reality (point-cloud capture)
  - Autonomous vehicles
  - Drones (LIDAR, point-cloud capture)
- Availability of computing resources is increasing rate of data capture

Impacts of Higher Res Data

- 2016
  - Majority of EDX customers using free or cheap (low) resolution geodata
- 2017
  - EDX introduced Cirrus: a Data as a Service for high resolution geodata
  - Very successful among our customers

- And then they started using it...

Impacts of Higher Res Data

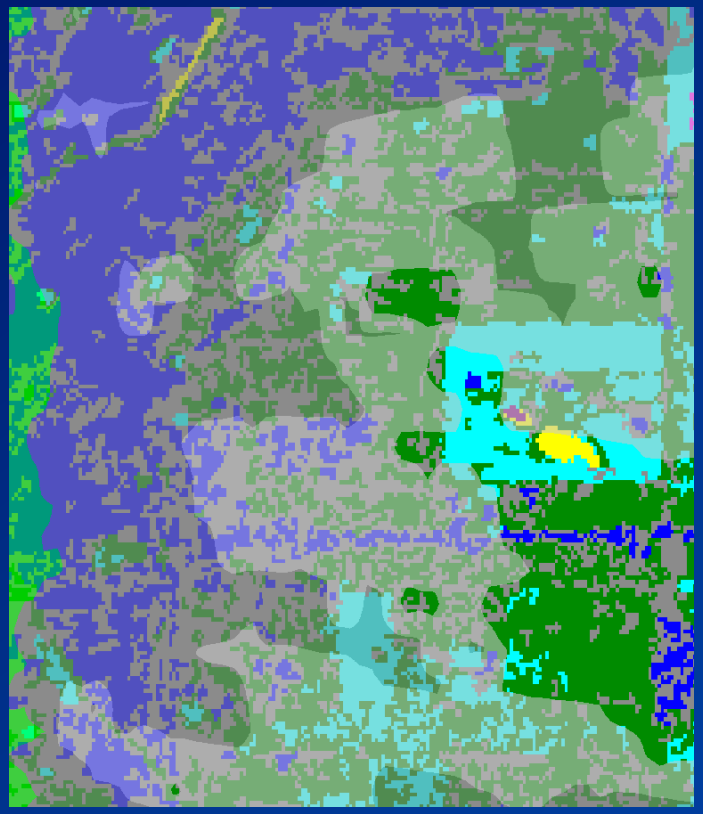
- Data transfer time
- Memory usage to manipulate the data
- Propagation model parameters to accommodate the higher resolution data
- Propagation model computation time

- Most commonly used propagation models were not designed around the resolution of geodata now available

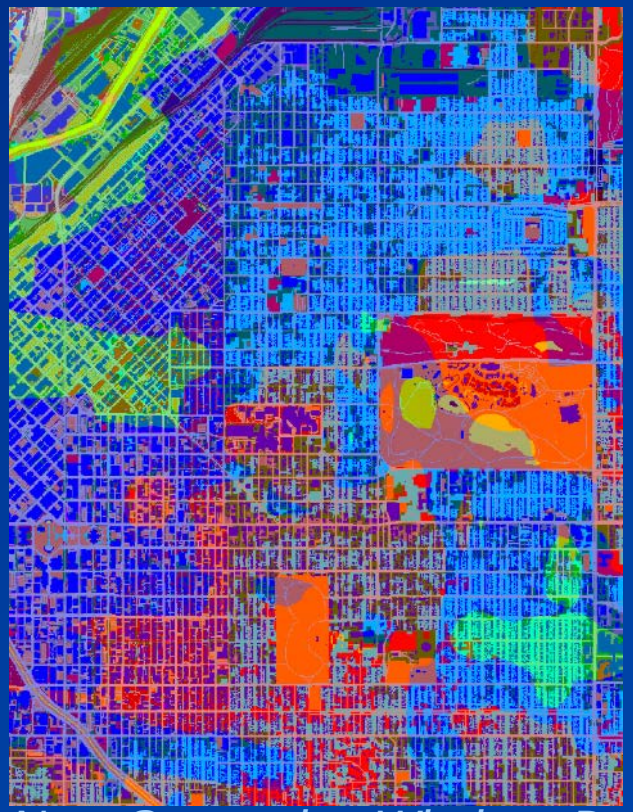
Impacts of Higher Res Data

- Predicted RSSI coverage holding all parameters the same between clutter resolutions

30m resolution clutter



1m resolution clutter



Future of Data

- Incredibly high resolution point-cloud and LIDAR data
- Potential daily geodata refreshing
- Real-time network monitoring
- AI analysis
- Cloud computing resources
- Application of propagation models in routine network management