



**Joint Venture**  
SILICON VALLEY

## **The Role of Small Cell Infrastructure - Charting a Path Forward**

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Prepared for Public Works Officers Institute 2018

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# Agenda



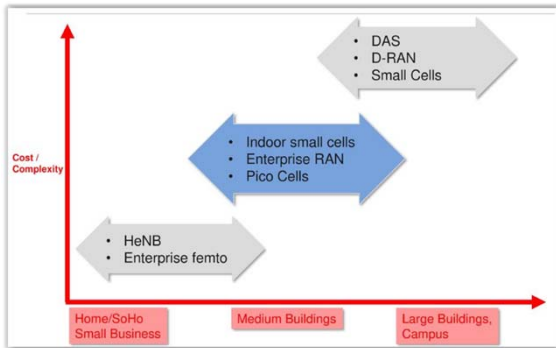
- What is a “small cell”?
  - Definition, technology, use models
  - Purpose
- Socio-economics
- Muni perspective
- Industry perspective

# My Bio



- U.S Coast Guard (ET/ETN)
- B.Sc. Electrical Engineering (@ UC Davis, focus on wireless & RF)
- CEO & Founder, Oku Solutions LLC
- Joint Venture Silicon Valley
- CA Emerging Tech Fund (Advisor)
- NIST GCTC Wireless (Co-Chair)
- Connected City Advisory Board
- Sr. Member: IEEE, RCA

# HetNets



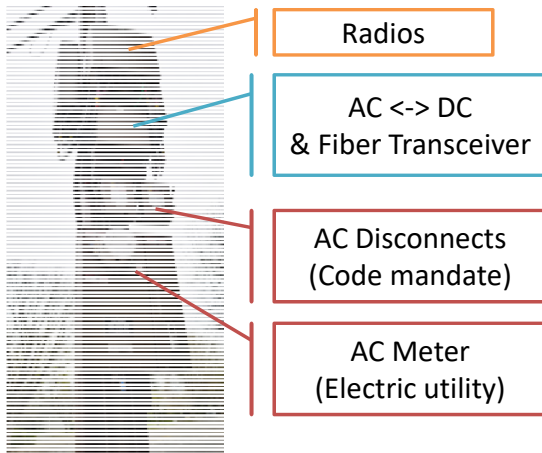
- Heterogeneous Network:
  - Small Cell, DAS, D-RAN, etc
- No *standard* definition
  - “Femto” : Covers a room or small building.
  - “Pico” : Covers a medium(ish) building.
  - “Micro” : Covers a small area, campus, park, etc.
  - “Metro” : Covers a few square city blocks.

# “Small” Cells?

Residential Femto	Enterprise Femto	Pico	Micro	Macro
2 lbs 8 x 10 x 2 Inch	4 lbs 10 x 10 x 4 Inch	10 lbs 16 x 10 x 4 Inch	25 to 35 lbs 19 x 13 x 5 Inch	
4-8 Users	16-32 Users	32-128 Users	128-256	256+
250 Feet	250-500 Feet	0.25 -1 miles	1-2 miles	3+ miles
100mW	200mW	250mW-1W	2W-6W	20+W
DC/POE/USB	DC/POE	POE+/AC/DC	AC/DC	AC/DC

- “Small” refers to coverage area, not equip size – vs macros:
  - Lower power
  - Smaller antennas
  - Typically no backup power source (genset)
  - Size depends on RF power (waste heat)

## Small Cells



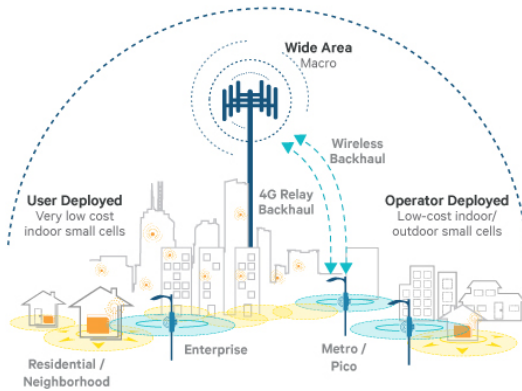
- Approx. 50% of the on-pole equipment is related to AC power, mandated by code, required by utility.
  - Wireless metering is possible, and helps in reducing total equipment volume.

## Small Cells



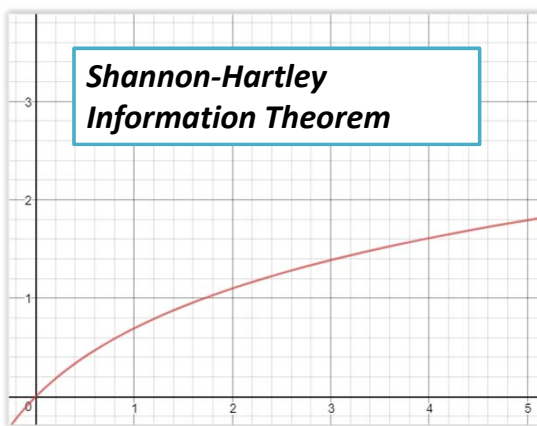
- Integrated pole
  - Equipment in base
  - Antenna shrouded
  - Doubles as light pole
  - No external cabling, conduit, or covers
  - Can be painted to match local aesthetic, or for camouflage.

# Economics



- RF spectrum is *very* expensive
- AWS-3 auction took in approx. \$47B
- *Carriers want to improve performance, without buying additional spectrum*

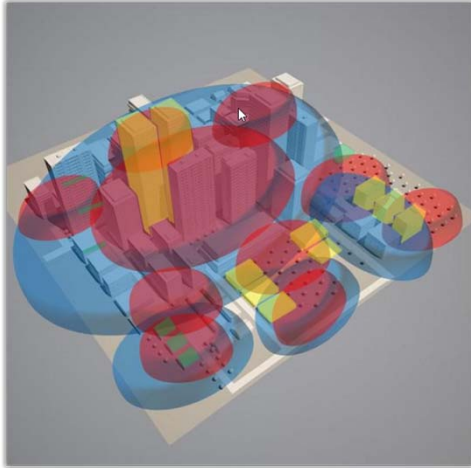
# Spectrum-nomics



$$Information = RF\ Spectrum * \log_n \left( 1 + \frac{Signal}{Noise} \right)$$

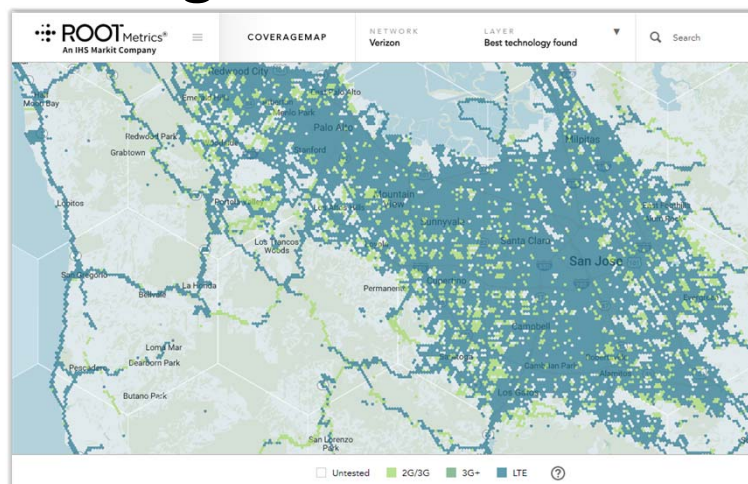
- To increase Information:
  - Add more spectrum (\$\$)
  - Reduce noise (hard to impossible given physics)
  - *Improve/increase signal*
  - *Reduce users/footprint*

## Purpose

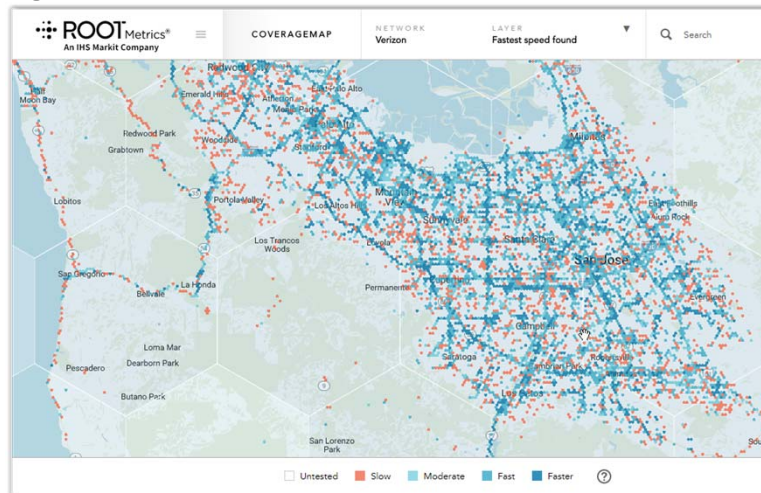


- HetNets are used to:
  - Enhance existing coverage
  - Improve performance
  - Re-use RF spectrum
  - Serve denser population clusters
- HetNets are *not* coverage creation tools.

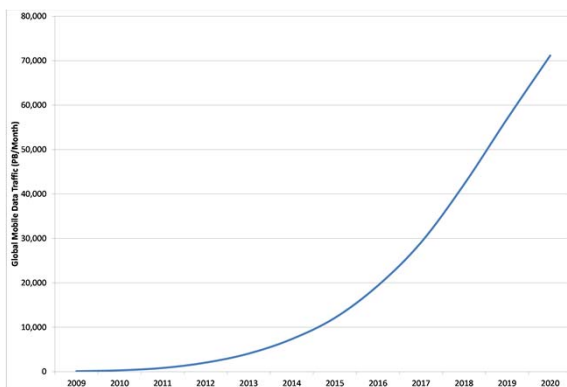
## Data Coverage



# Data Speeds



# Mobile Data



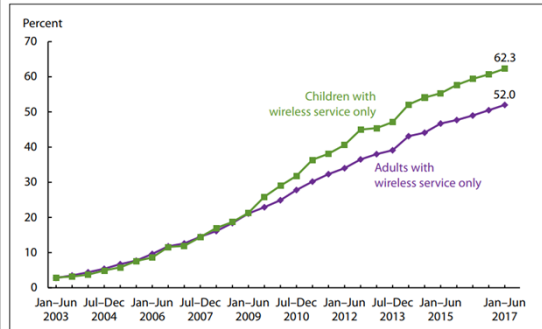
- Data in North Amer.
  - 1.3 EB/month in 2015
  - 9.1 EB/month in 2021
- Usage per Phone
  - 3.7 GB/month in 2015
  - 22 GB/month in 2021

*(Per Cisco VNI, Ericsson Mobility Report, Mobile Experts LLC, etc.)*



# Wireless-Only

Figure. Percentages of adults and children living in households with only wireless telephone service: United States, 2003-2017

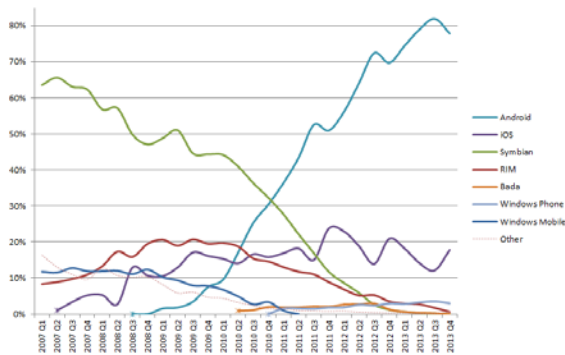


NOTE: Adults are aged 18 and over; children are under age 18.  
DATA SOURCE: NCHS, National Health Interview Survey.

- CDC Wireless Substitution (Bi-annual, June 2017)
- Wireless-only
  - Roommates: 87.9%
  - Poverty: 67.5%
  - Hispanic: 66.3%
  - 46 million children live in wireless-only households.
  - Ages 25-29: 73.3%, 30-34: 74.4%, 35-44: 63.9%

# Wireless-Only

World-Wide Smartphone Sales (%)



- NTIA Census Analysis
  - McHenry, 2016
- Wireless by Income
  - < \$25k : 29%
  - \$25k - < \$50k : 24%
- Smartphone-only Users
  - 14% in CA (per Field Poll, 2016)
  - < \$22k : 25%



## User Profiles



## Muni Challenges



- Is wireless a revenue source, or an economic driver?
- Need to protect aesthetics & respond to resident concerns.
- Lack of technical expertise on staff.

## Industry



- Address exponential user demand.
- Remain competitive.
- *Reduce churn and CoA.*

*Customer Lifetime Value =*

$$\frac{(CAPEX + OPEX + ARPU)}{\text{Churn}}$$

*+ Cost of Acquisition*



## Industry



- Wants to avoid conflict
  - 4G HetNet isn't a one-and-done.
- 5G will require siting density 10x – 20x 4G.
  - Multi-year process won't work at scale.
- If we don't get 4G right, we'll never get to 5G.





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