# IDOT Small Cell Deployment Literature Review

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# Outline



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# Objective

*"Investigate types of small cells used and the locations that small cells are placed in municipal settings."*

Focus on the City's concern for:

- Safety of small-cells vis-a-vis RFE
- Costs of small-cells and permitting
- Coverage and density requirements
- Specific small-cell types and technical details

# Outline

## Small Cell

- Low-powered radio-access point.
- It is composed of small radio equipment and an antenna (together, its size could be about the size of a pizza box)
- Its installation requires: A) electrical power source, B) back-haul[a] C) permitted space, and C) small cell itself

[a] Fiber optic cable/microwave transceiving signals to/from macrocell

# Indoor

## Access Points

- Smaller ranges and through-puts
- Offer power over Ethernet (PoE)
- Less than 15W power consumption.
- Zero-touch compliant.
- Typical maximum of 60 users.
- Weight about 500 grams.

Figure: NEC model FPA1624 and Bai Cells Neutral Indoor models.

# Outdoor

## eNodeB

- Larger power consumption of less than 60W.
- Incorporate their own controllers to reduce response times between SC and UE.
- Hardware supports up to 96 users per device.
- Weight of approximately 5 kg.

Figure: eNodeB base-stations.

# Outdoor

## 360 Degree Can Antennas

- Typically mounted on poles and existing structures.
- Maximum power output per input of approximately 150 W.
- Include multiple channels and inputs, greatly increasing bandwidth
- Weight of approximately 10 - 18 kg.

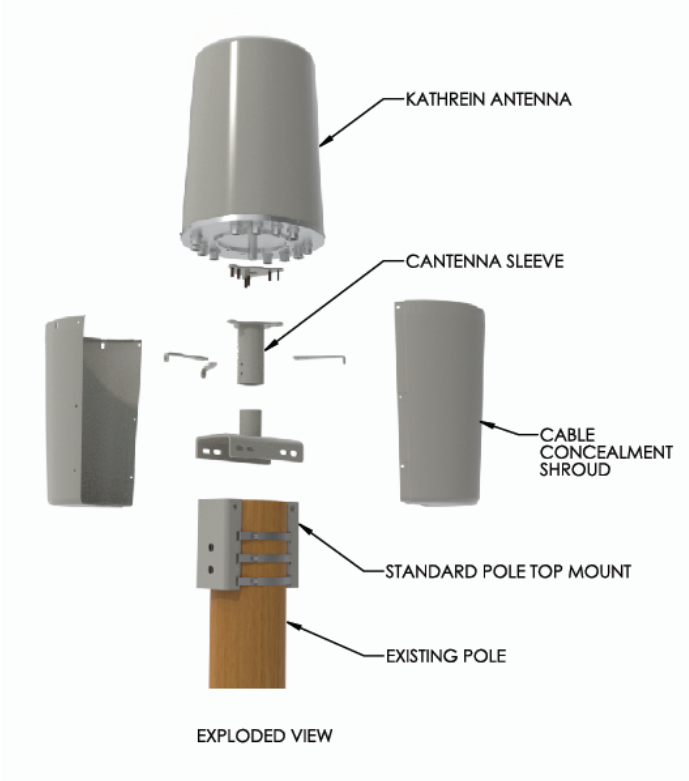


Figure: Kathrein Can-type small cell.

# Outdoor

## Panel-Antennas

- Limited angle of coverage, as specified in the datasheet.
- Weigh significantly less than their omni-directional counter-parts.
- Total maximum power consumption of less than 500 W.
- Include multiple channels and inputs.
- Weight of approximately 1 - 8 kg.

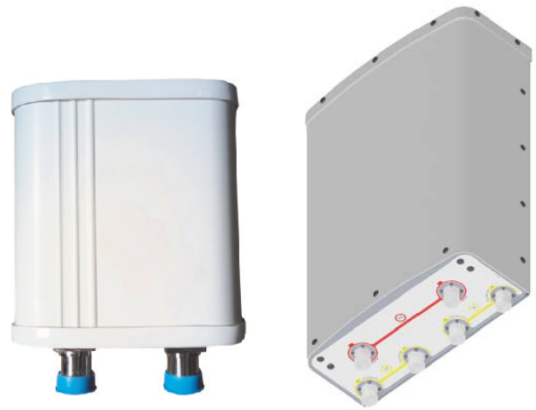

Figure: Panel Type Cells

# Outline

# FCC Regulations

## MPE Limits

- FCC has the authority to set RFE limitations.
- This limit is based on three sources of information:
  - National Council on Radiation Protection and Measurements (NCRP)
  - American National Standards Institute (ANSI)
  - Institute of Electrical and Electronics Engineers (IEEE)
- Specifies an effective radiated power (ERP) of no greater than 500 watts per channel.
- Most towers have ERPs of less than 100 watts per channel.
- Cellular towers limited to MPE level of 580 microwatts per square centimeter.[1]
- It is unlikely that these limitations could be violated under regular operating conditions.

[1] FCC2016-MPEGuidelines: `https://www.fcc.gov/sites/default/files/human_exposure_to_radio_frequency_fields_-_guidelines_for_cellular_antenna_sites.pdf`

# DOT Requirements

## MPE Reports

- DOTs have responded to FCC regulations by requiring MPE reports.
- MPE reports document the worst-case scenario of RFE exposure.
- Reports typically outsourced by carriers to a consulting company.
- To reduce liability, signs are often posted on the devices.

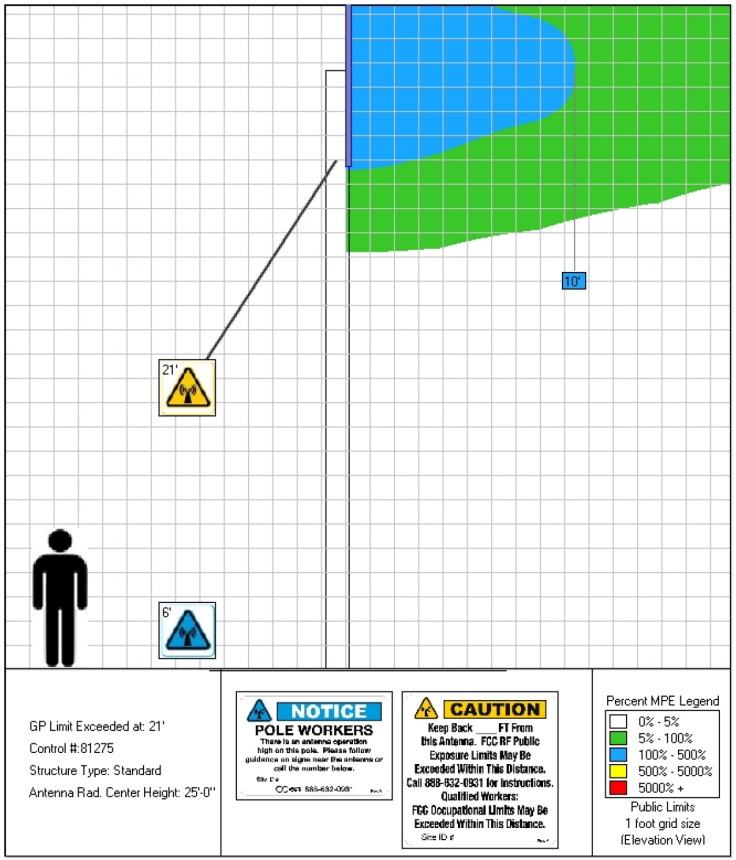


Figure: Crown SC MPE simulation.

# DOT Requirements

## MPE Reports Cont.

- MPE is a function of distance.
- Worst case scenarios reflect the safety of small-cells.

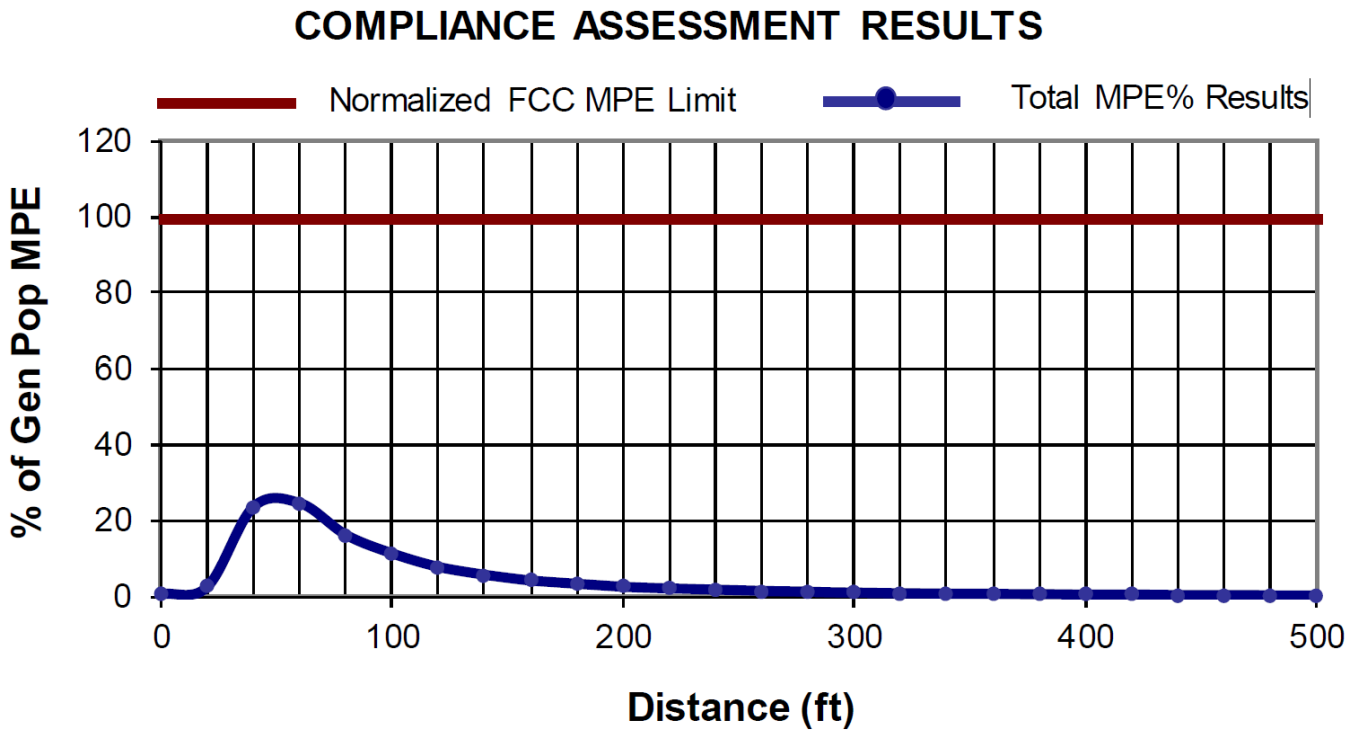


Figure: Pinneacle MPE v. Distance.

# DOT Requirements

## RFE Warning Signs

- Signs are required to be posted close to SC.
- Places at various distances with respect to RFE intensity.

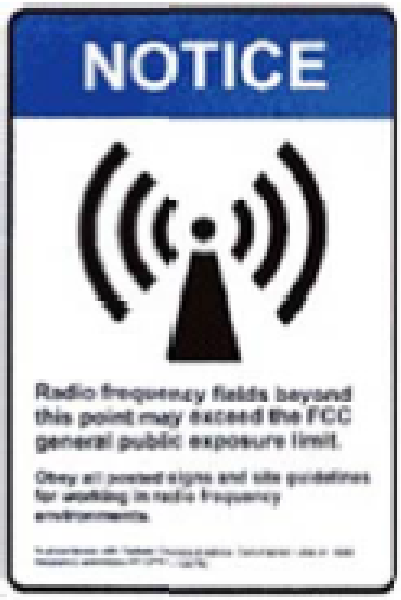




Figure: ExteNet2015-Declaration.

# Outline



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# Carrier Costs

## Permits and Studies

- The costs for DOTs has not presented itself as an issue.
- Carriers shoulder the costs of procuring DOT approval.
- Requests for SC installation result in fees from carriers to DOTs.
- Fees have significantly reduced due to relaxed regulations.
- DOTs are frustrated with loss of revenue but still do not shoulder the costs of equipment.

# Carrier Costs

## Permits and Studies Cont.

| Approval Type | Fee |
|---|---|
| A Wireless Communication Facility - Process 2 fee will be collected at the time of submittal for completeness review, along with the environmental, historic, and administrative fees. | |
| Wireless Communication Facility - Process 2 | $7,552.38[4,8] |
| Environmental Initial Study/Exemption Fee[1] | $1,170.45[4] |
| Historic Resources Review Fee[2] | $187.96 per hour[5] |
| Wireless Communications Facilities (WCF) on City Property[3] | $851.90[4] |
| Mapping Fee (see Section A on Page 9) | $10.00[4] |
| Project Close Out Fee (see Section A on Page 9) | $678.59[4] |
| Records Fee (see Section A on Page 9) | $90.00[6] |
| | |
| During completeness review, the approval process will be confirmed. If the decision process changes, a supplemental invoice will be issued for the correct process listed below, with a credit applied for the Process 2 fee paid. Note: Where the project includes both a Process 4 SDP and Process 4 PDP, the highest fee will apply. | |
| Wireless Communication Facility - Process 3 | $9,441.69[7,8] |
| Wireless Communication Facility - Process 4 (No Planned Development Permit) | $10,078.78[,8] |
| Wireless Communication Facility - Process 4 (With Planned Development Permit) | $10,795.21[,8] |

Figure: San Diego 2019 Wireless Requirements.

# Outline



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# Public Rights of Way

## Limitations to RFE

- RFE concerns drive municipal decisions to limit SC in residential areas.
- San Diego mentioned the risk of suffering lawsuits via ADA.
- DOTs would be well advised to research the litigious concerns over SC placement.

# Public Rights of Way

## Aesthetic Concerns

- Hiding SC antennas in artwork or infrastructure is preferred.
- Some cities require photo-simulations of the installation before DOTs are willing to proceed.

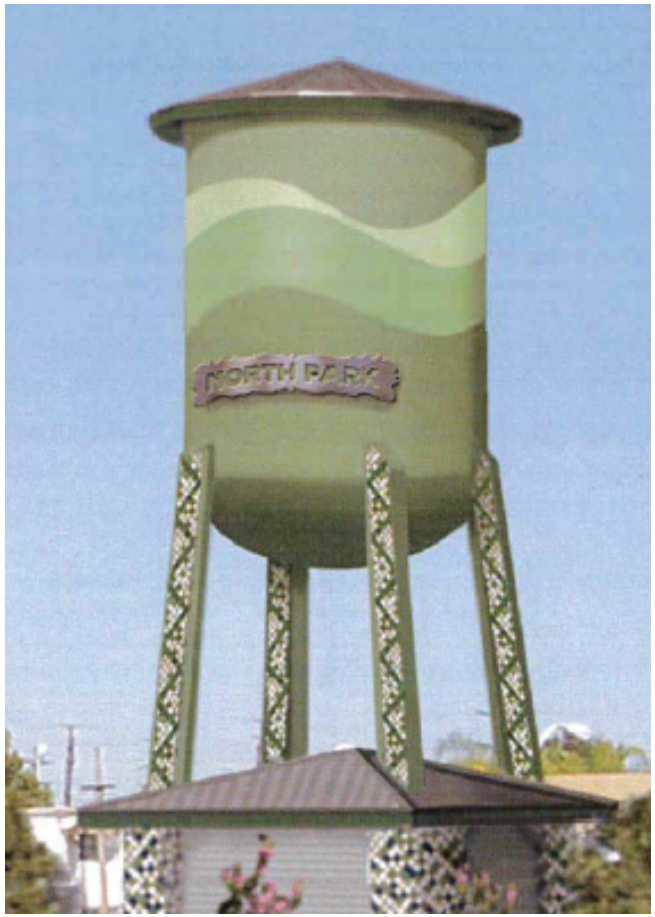



Figure: San Diego North-park Installation.

# Public Rights of Way

## Aesthetic Concerns

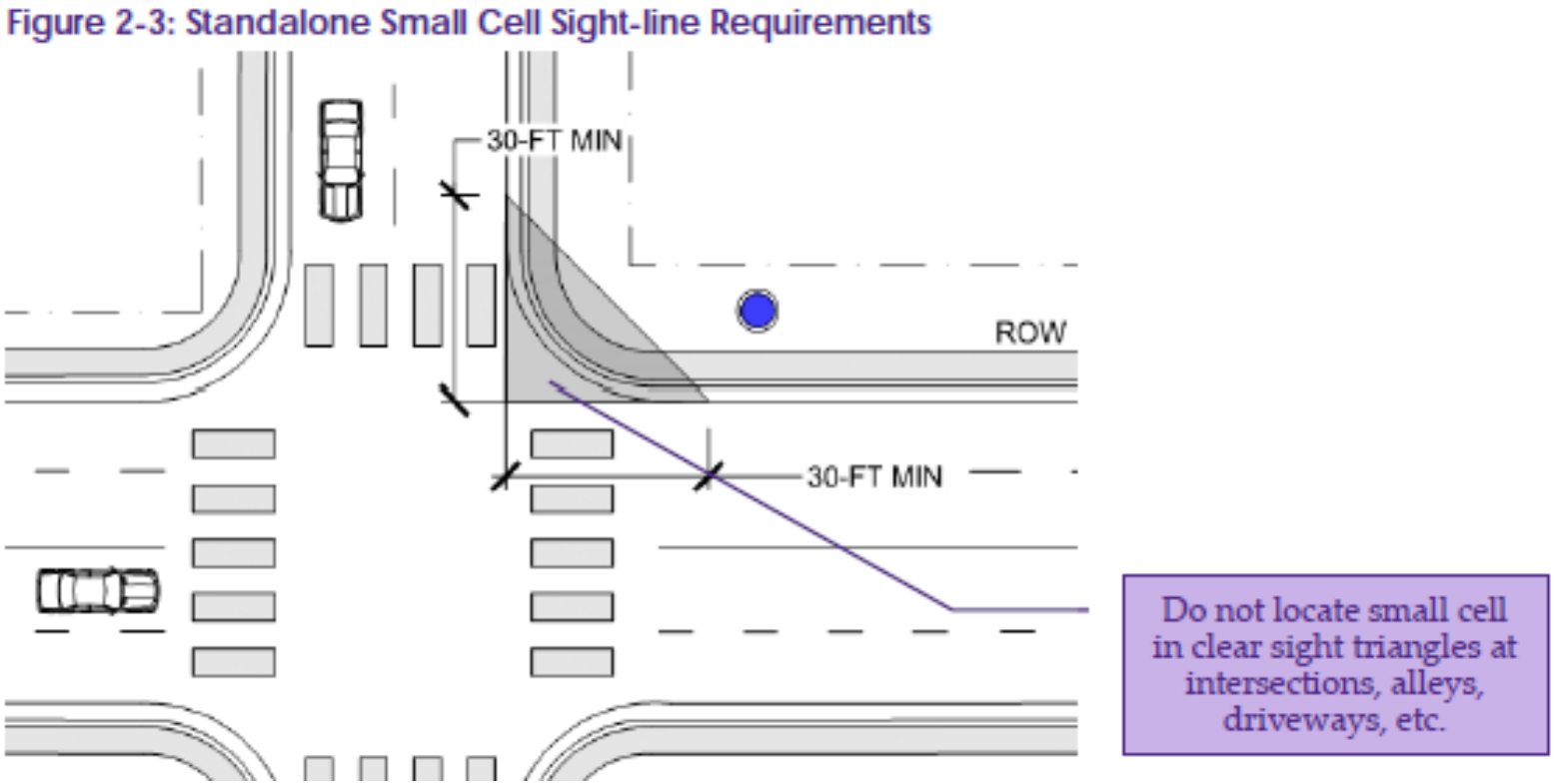



Figure: Denver Line of Sight Requirements.

# Public Rights of Way

## Aesthetic Concerns

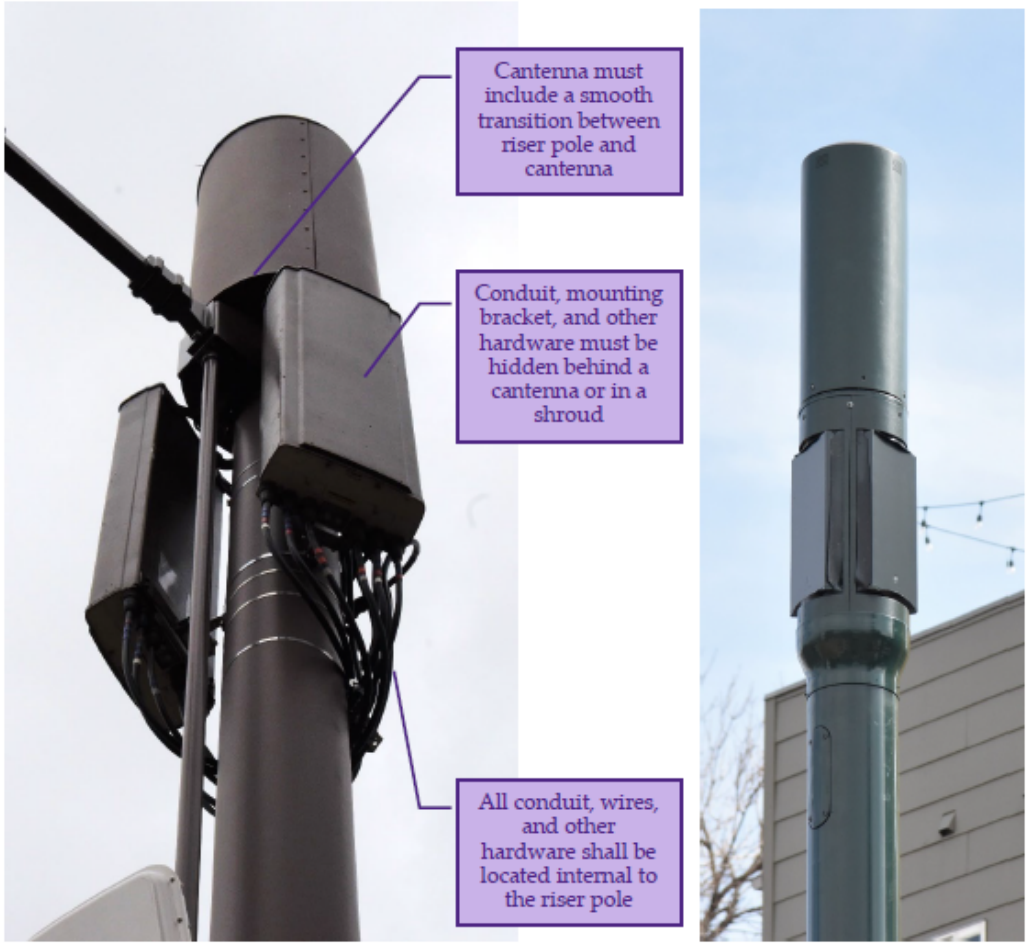



Figure: Denver SC tower standardization.

# Outline

# Rural & Residential Areas

## Lower Density Requirements

- Limits to SC proximity to residential areas affect deployment.
- Lower population densities have requirements for fewer cells.

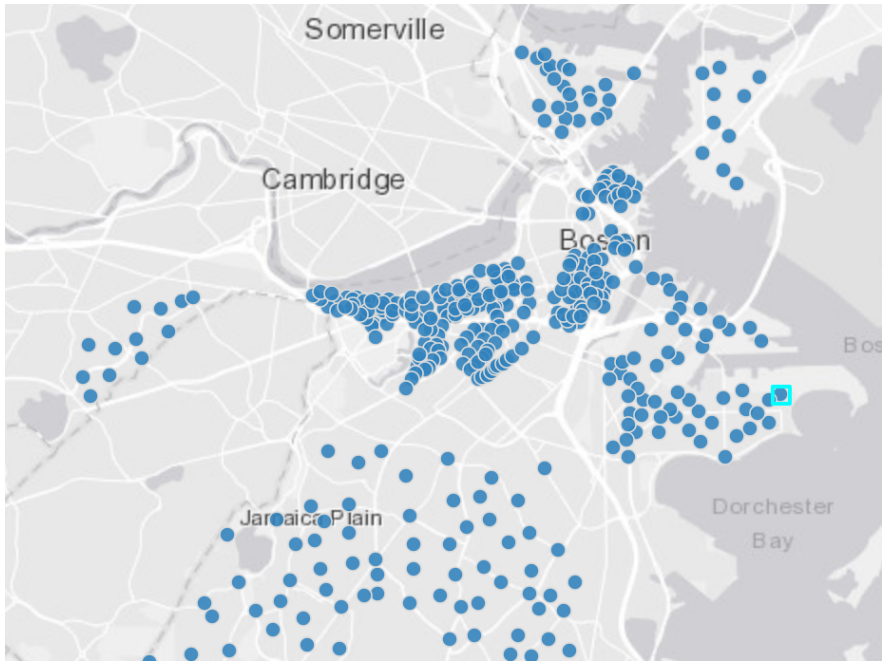



Figure: Boston SC Deployment.

# Urban Areas

## Higher Density Requirements

- Relaxed regulations allow for greater densification.
- Opportunities for smart city technology incentivize SC installation.
- Higher population densities require greater throughput.

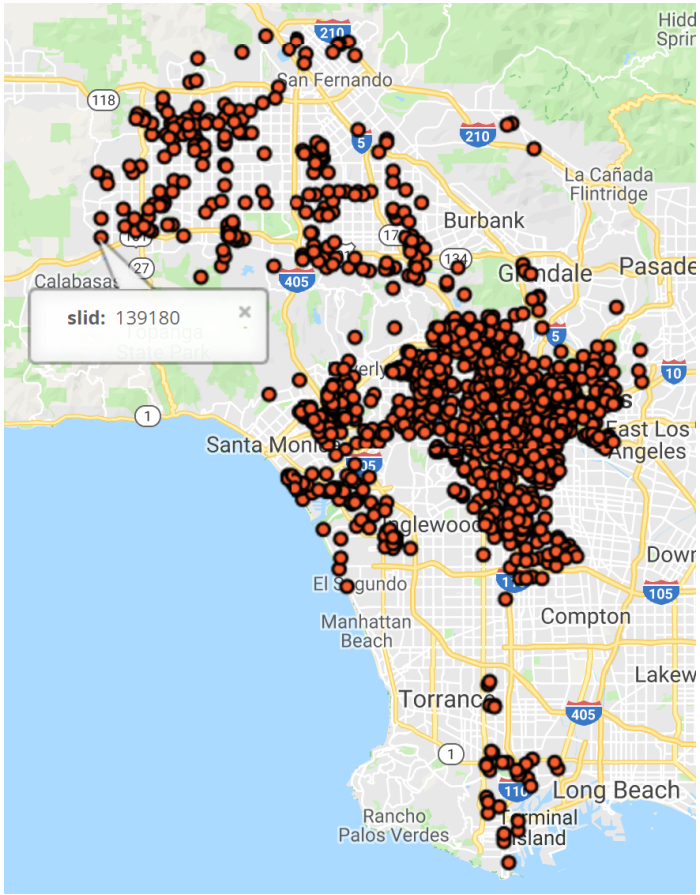
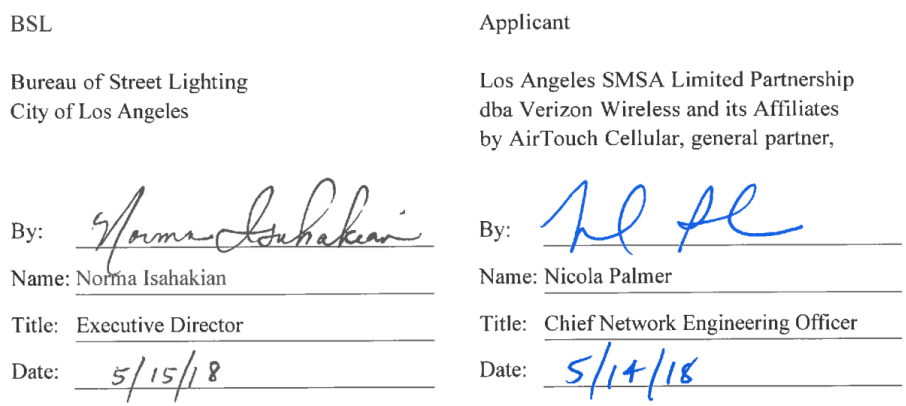



Figure: Los Angeles SC Deployment.

- Los Angeles made a deal with Verizon to streamline SC deployment.
- Reduced permitting delays helped Verizon find optimal locations.
- The city received access to smart city technology at a reduced tax-payer cost.



BSL

Bureau of Street Lighting
City of Los Angeles

By: Norma Isahakian

Name: Norma Isahakian

Title: Executive Director

Date: 5/15/18

Applicant

Los Angeles SMSA Limited Partnership
dba Verizon Wireless and its Affiliates
by AirTouch Cellular, general partner,

By:

Name: Nicola Palmer

Title: Chief Network Engineering Officer

Date: 5/14/18

Figure: Los Angeles BSL-Verizon deal.

# Urban Areas

## City Wide Pre-approval

- Denver created a system whereby most SC sites were pre-mapped.
- Carriers can browse and plan their sites using an API.
- This results in easier deployment processes.

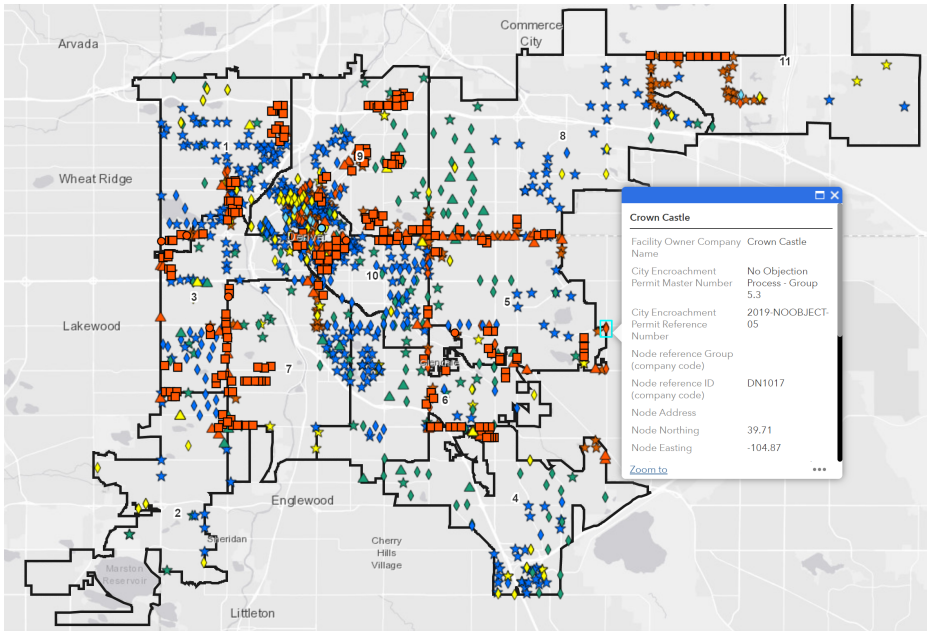



Figure: Denver SC locations.

# Densification Pit

## UDNs Experience Loss of Strength Gradient

- Demand for bandwidth in urban areas is at its greatest.
- Research suggests that UDNs eventually suffer diminishing ASE.
- Considerations must be made before increasing density dramatically.

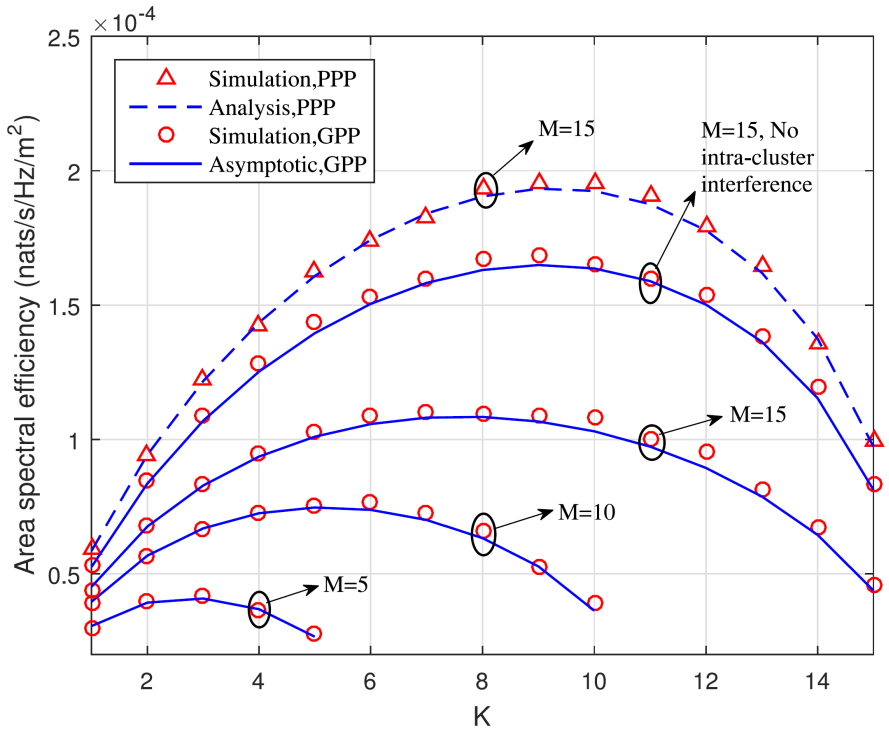



Figure: Los Angeles BSL-Verizon deal.

# Urban Valleys

## SC Simulations for Downtown Areas

- Interference from other SC units can become an issue.
- Research has been conducted to simulate such valleys.
- Polarization has no effect on angle of arrival but did impact angular spread of arrival.
- More packets will be needed to satisfy reflective areas in urban centers.

# For Further Reading I


Austin Dial and Suruz Miah

*Small Cell Installation in Transportation Infrastructure – A Literature Review*.