Public Forum

Indoor Deployments of Small Cell Sites

October 28, 2011

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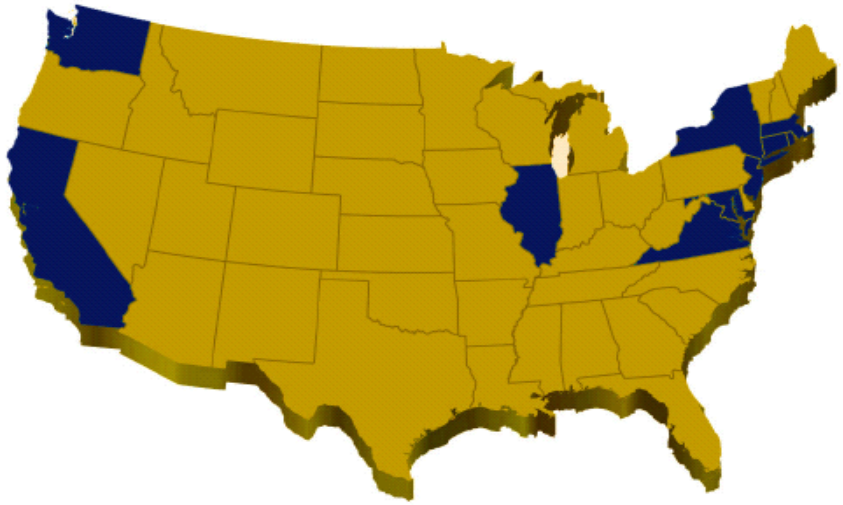
Lyn Lansdale

VP, Strategic Business Services
Avalon Bay

About AvalonBay Communities

- **Manage, develop, build, redevelop and acquire/sell quality apartment communities**
- **Own about 55,000 rental apartments in 186 communities in premier urban U.S. markets**
- **Major markets include: DC, Boston, NYC, Chicago, Seattle, San Francisco, LA, & San Diego**
- **S&P 500 Company**
- **Average rent of $1900 per month**
- **Average length of residency is ~18 months**



(1) 2011 Estimated

Impact of Poor Wireless Reception

- **Issues**
  - **Public safety radio reception requirements on owner/builder**
  - **Subterranean areas typically have reception issues**
  - **Increased demand for Cellular phone coverage (smart devices)**
  - **Carriers experiencing network capacity issues**
  - **LEED certified communities (LoE glass/foil-back insulation block signal) built w/ materials that impede reception**
  - **Multiple providers in single location w/ fractured customer base**

- **Problem for Apartment Owners**
  - **Lost leases - Prospects often check signal before leasing**
  - **Increased vacancy cost/increased turnover cost**
  - **Increased construction costs w/ public safety requirement**
  - **Cost to provide residents femto cells or pay for landline service**
  - **Industry residential turnover rate of ~ 60%**
  - **Bandwidth management not our core business nor core competency**

Costs to Correct Poor Reception

- Survey and Installation Expense
- Preliminary signal survey - ~$7.5k
- Time and delays related to design and approval
- New construction must be surveyed again after building is up
- Carriers will not pay for system in multifamily communities - not enough customers
- Some carriers require bi-directional antennas; some (AT&T) require a base transceiver station; dual system increases expense ~ $60k
- Proposals have ranged from $200k - $300k and can be much more
- Often can't get certificate of occupancy without public safety reception
- Future carrier antenna changes and/or new construction may impact reception at later date w/ additional costs
- Femto cells in resident apartments may create interference
- Retrofit solution is particularly expensive

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Robert Juliano

VP & CIO

Brandywine Realty

Our Stakeholders

TENANTS:

In 2009, ~50% of 25-29 year olds had no landline…

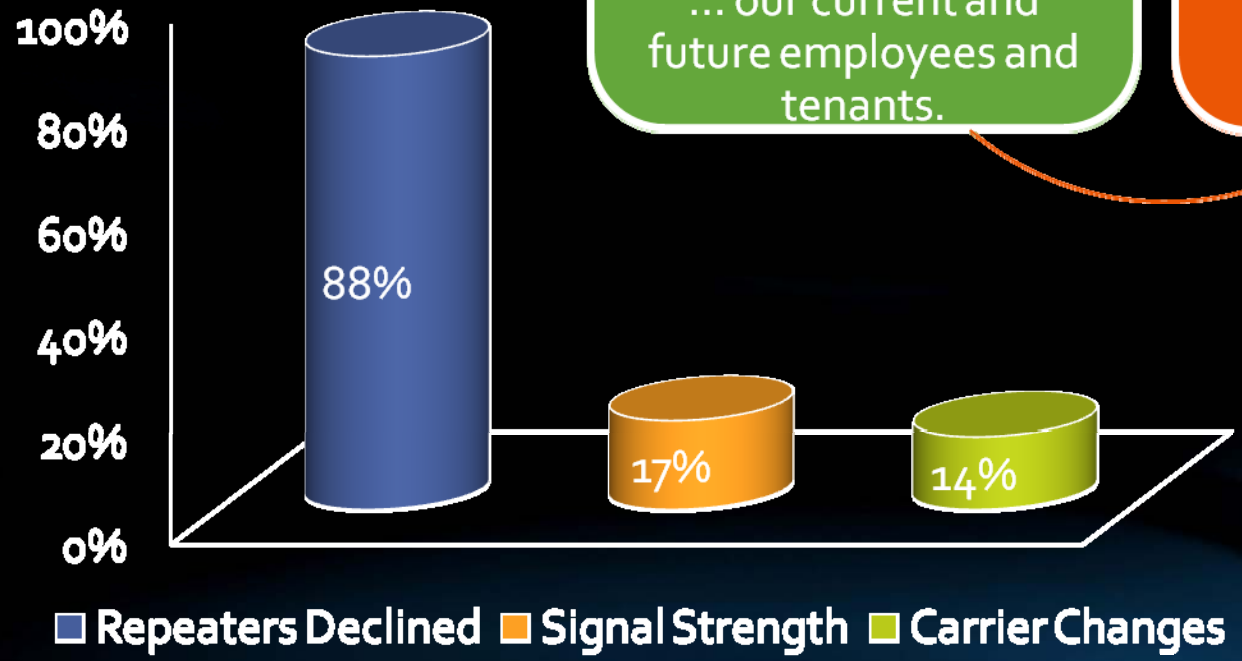
… our current and future employees and tenants.

OPERATIONS:

308 properties
35.5 million square feet

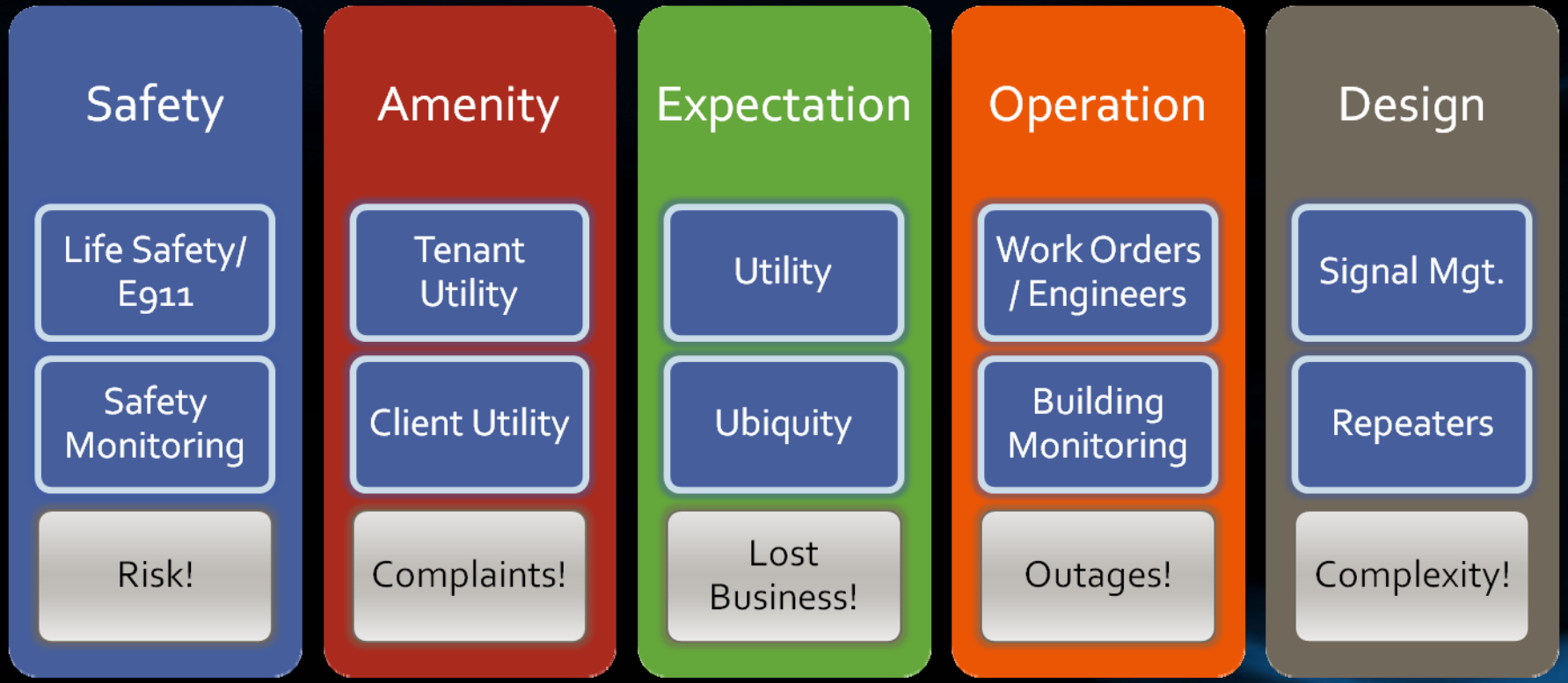
10,000 work orders monthly

All via wireless



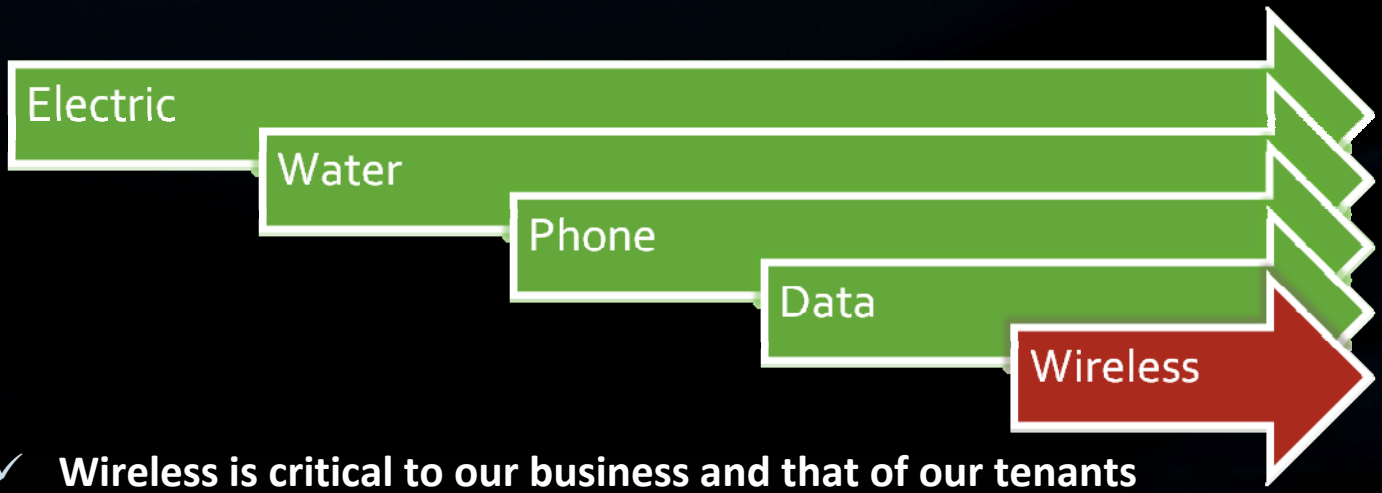
2009 – 2011 Impact ~$500,000

Opportunity & Cost



Tenants – Clients – Owners – Managers - Developers

Ubiquity & Utility



- ✓ **Wireless is critical to our business and that of our tenants**
- ✓ **Wireless is increasingly a utility and expected to be ubiquitous**
- ✓ **Spending on signal management is a drain on profitability for us and for our customers**
- ✓ **Managing a non-standardized, fractured, continually-evolving service is not useful, profitable, or a core business**
- ✓ **Wireless voice and data must converge**
- ✓ **Property managers do not want to own bandwidth management**

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Tormod Larson

VP & CTO

Extenet Systems

Extenet Systems Inc.

- Background
  - Builds, owns and operates Open Distributed Networks
  - Headquartered in Lisle, Illinois
  - Founded in 2002
- Open Distributed Networks
  - Infrastructure for multiple uses and customers
  - DAS, Remote Radio Heads and Small Cells
  - Enhance wireless services for its customers
- Leader and Innovator
  - Strong patent portfolio including iDuct®
  - First commercial LTE DAS's in the US
  - Named by The Wall Street Journal as #5 of Nation's Top 50 VC-Backed Companies

Outdoor Network Example

Las Vegas Strip, NV

- ✓ Managed huge capacity requirements and complied with unusual aesthetics
- ✓ Flexibility/scalability
- ✓ Time to market

Indoor Network Example

Chicago, IL

- ✓ 4.5M sq. ft.
- ✓ Class A office space
- ✓ iDuct implementation
- ✓ High capacity
- ✓ Dominance over macro
- ✓ Minimum interruption
- ✓ Time to market
- ✓ Best in class

Outdoor Networks

Business Model

Network Architecture

- Central Hub
- Fiber Network
- Node
- Antenna

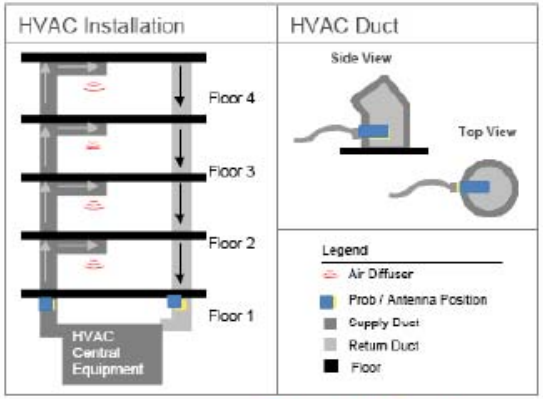
Applications

- Coverage and capacity challenged area
- Brings the network closer to the user
- Improves QoS and data throughput

Indoor Networks

Business Model

Network Architecture



- Central Hub
- Fiber Network
- Node
- Antenna

Applications

- Commercial Real Estate
- Government
- Healthcare
- Higher Education
- Hospitality
- Sports & Entertainment

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Steve Lilley

Wireless Practice Manager
Presidio Networked Solutions

Presidio Networked Solutions: Mobility and Wireless Solutions

- Presidio's suite of Advanced Mobility Solutions and Services:
  - Design and Assessment
  - Wireless Surveys
  - Wi-Fi Voice
  - Location Services (RFID)
  - Guest Access
  - Outdoor Campus and Metropolitan Area Solutions (Bridge and Mesh)
  - Security Assessment and Remediation
  - NAC Integration
  - Wireless IDS/IPS
  - Remote Operations Services

Evolution of Wi-Fi

- Embedded wireless is now pervasive – welcome to the Connected World
- IDC says 1.1 billion Wi-Fi clients in next 3 years

Point Applications
- **Inventory Management**
- **Barcode Scanning**

~~802.11 (1997)~~
2Mbps

Mobile Data
- **Email**
- **Web browsing**

~~802.11b (1999)~~
11Mbps

Business Ready
- **Voice, Video, Data**

~~802.11ag (2003)~~
54Mbps

Next Gen Wireless
- **Ubiquitous mobile computing**

~~802.11n (2009)~~
300 to 600Mbps

Wi-Fi Device Proliferation

PRESIDIO.

Challenges of Wi-Fi

- The spectrum is dynamic
  - You are breathing the physical layer
  - RF reflects off things
  - RF is absorbed by things
  - It is a shared medium
  - Not all RF is going to be your RF
- Explosion in number of connected devices
- Bandwidth requirements are growing fast, but spectrum is fixed
- Key is to maximize performance in available spectrum

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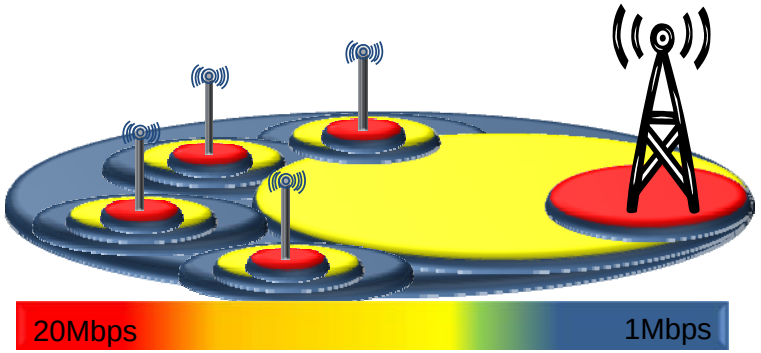
Ken Falkenstein
VP, Wireless Technology
Comcast

Small Cells and the Cable Industry

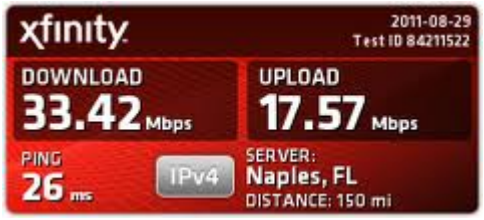
Small cells are a critical technology for addressing mobile broadband growth

- Current spectrum efficiency is approaching theoretical limits
- Limited new licensed and unlicensed spectrum opportunities
- Cellular standards are integrating small cells including WiFi
- Deployment challenges : space, power, backhaul



Cable is uniquely positioned to deploy small cells

- *Aerial cable plant* – Coaxial and optical cable in many areas in need of stronger signal and more capacity
- *DOCSIS 3.0 technology* – Supports line power and high speed IP traffic backhaul
- *Field Technician Workforce* – Skilled workforce with tools and process for rapid deployment



comcast

xfinity

Comcast Approach to Small Cells: WiFi

Outdoor	SMB	Residential	Roaming
Initial, foundational coverage	**Supplement and improve presence**	**Depth and breadth**	**Expand beyond Comcast footprint**
•High foot traffic areas •Utilize aerial cable plant •Backhaul, power, mounting	•"Pause and linger" venues •Private SMB network and XFINITY WiFi capability	•Augment CM platform •Private home network and XFINITY WiFi capability	•Strategic partnerships to extend availability
			(Example potential partners)
10,000's small cells **Outdoor**	**100,000's small cells** **Indoor – Small Enterprise**	**1,000,000's small cells** **Indoor – Residential**	**1,000,000++ small cells** **Outdoor and Indoor**

Perspectives on Business Models

Retail (present offerings)

- Xfinity WiFi available to all Xfinity Internet customers at no additional charge
- WiFi roaming in North-East Corridor partner networks available to all Xfinity Internet customers at no additional charge

Commercial (potential opportunities)

- Cellular offload via WiFi for mobile network operators
- Cellular offload via integrated cellular radio (e.g., LTE radio integrated into strand mounted WiFi access point with fast and secure cellular traffic transport back to mobile operator core)

Challenges to business model

- 2.4GHz WiFi spectrum crowded – unable to ensure "carrier grade" offload services
- 5.0GHz WiFi spectrum propagation – unreliable coverage

Potential solutions

- Allocation of additional spectrum (below 2GHz) for "carrier grade" WiFi – "lightly licensed" spectrum
  - Precedents include FCC Memorandum and Order FCC 07-99 related to the 3650-3700MHz band
  - Non-exclusive national licenses, fee based AP registration, inter-operator contention based protocols
- Allocation of additional unlicensed spectrum (Part 15)

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Iyad Tarazi

VP, Network Engineering & Technology
Sprint Nextel

Sprint's Commitment to Small Cells

Home FemtoCell Applications

Low power, Desktop device, Home ISP network

- ❑ 2007 initial launch
- ❑ More than 500k deployed
- ❑ Expected to surpass 1M by 2013

Enterprise FemtoCell Applications

Low/Med power, Wall mount, Enterprise ISP

- ❑ Successful Beta Program
- ❑ Launch in November 2011.
- ❑ Yearly deployments in the thousands.

Indoor PicoCell Applications

Med/High power, carrier provided backhaul

- ❑ Wimax deployed 2011
- ❑ LTE coming in 2012

Outdoor PicoCell Applications

High power, carrier provided backhaul

- ❑ Wimax deployed 2011
- ❑ LTE coming in 2012

5-C's of Small Cells Opportunities:

- ❑ ***Coverage Benefits***: traditional macro systems aren't enough
- ❑ ***Cost Reduction***: operators must do more with less
- ❑ ***Customer Satisfaction:*** consumers demand high voice and data performance
- ❑ ***Conservation:*** Lower power consumption and extended handset battery life is eco-friendly
- ❑ ***Capacity:*** Targeted capacity where the user demands it.

Challenges Remain

Significant advances have been made but more progress is needed

❑ *Technology*

- *Cost of small cell devices must continue to be reduced to drive large scale adoption*
- *GPS location is challenging in many indoor environments*
- *Need to accelerate the movement to IP networks to simplify core development*
- *Continued improvement in LTE interference management to allow for the reuse of spectrum*

❑ *Deployment*

- *Building access rights for public venues and for external coverage*
- *Availability, price and flexibility of backhaul sharing*
- *Evolution of Network sharing concepts on a wide scale basis*

❑ *Scalability*

- *Business model still has maturity to achieve*
- *Must realize true vendor interoperability and consumer choice*
- *Simplification of core network integration*

Sprint's Hosting Plans

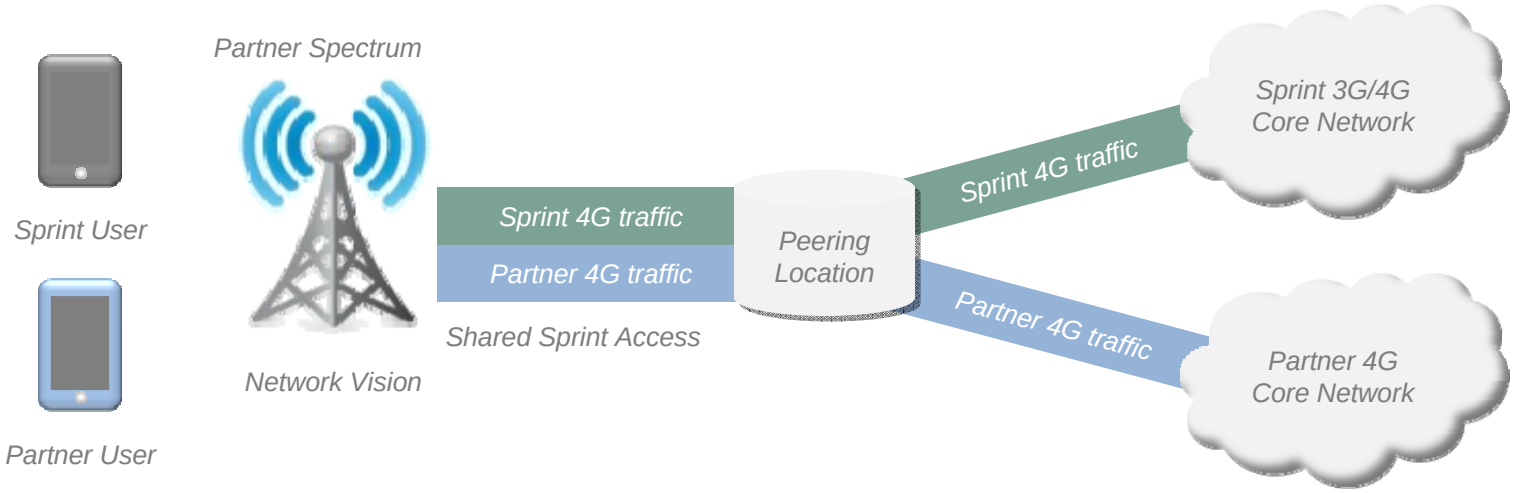
Public Network Partner

•Spectrum is owned by Partner, leased to Sprint

- Sprint is responsible for building, operating, and managing the network under a spectrum hosting arrangement
- Both Sprint and Partner share in improved economics and scale of the network

Proposed Small Cell Strategy

- Sprint and other carriers can share a common equipment infrastructure to increase deployment scale.
- Sprint owned and managed spectrum is deployed within the common infrastructure extending the value and utilization of the existing spectrum.
- Flexible building access and backhaul sharing costs arrangements are required.



Sprint will continue to look for opportunities to develop small cell technology.

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