Public Forum

Indoor Deployments of Small Cell Sites

October 28, 2011

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Jay Weitzen
VP, Technology
Airvana

Why Small Cells?

Table 1: Link Budget Calculations for Macrocell Network

a) Thermal Noise Level   -174 dBm/Hz

b) Target Data Rate: 2 Mbps

c) Receiver Noise Figure: 10 dB

d) Required Signal To Noise Ratio: 10 dB

e) Target RSSI=a+10Log10(b)+c+d   -91 dBm

f) Exterior Shadowing Standard Deviation   10 dB

g) Suburban Building penetration loss   10 dB

h) Shadowing Margin @ 75% cell edge (0.675 s)   7 dB

i) Indoor Shadowing Standard Deviation   10 dB

j) Indoor Shadowing margin (90% reliability,1.3s)   13 dB

k) Required RSSI= e + g + $(h^2+j^2)^{0.5}$ -66 dBm

l) Effective Radiated Power   56 dBm

m) Maximum Path loss for typical macrocell data (k + l)   122 dB

Assuming the Cost-231 model at 1900 MHz and 30 meter base station antenna heights (100 feet) and other default suburban parameters, the macrocell radius required to provide this level of coverage is approximately 0.5 km.

Providing Very High data rates, indoors with high reliability, requires very high cell density. Femtocells and other Small Cell solutions provide "deep coverage" (could include wifi, wimax and cellular technology)

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Mobile Broadband. **Everywhere.**

Types of Small Cell Devices

- Residential Femtocells
  - 3 to 8 simultaneous connections (rab's)
  - Most support both Voice and 3G data, with 4G femtocells under development
  - Use Residential Broadband with secure tunnel for transport
  - Managed like cable modems via TR-69
  - Ad hoc deployment
  - 10 to 17 dBm total power
  - Flat Architecture
- Enterprise Femtocells (higher capacity, larger coverage than residential femtocells)
  - 16 to 32+ simultaneous connections
  - Managed by TR-69 just like cable modems
  - Most support active hand-in and handout, may support soft handout
  - IP backhaul like residential femtocells
  - Ad-hoc deployment
  - 23 dBm typical, but higher power possible
  - Indoor Coverage Solution
  - Flat Architecture

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Mobile Broadband. Everywhere.

Types of Small Cells (cont'd)

- Picocell/Femtocells (hybrid between self deploying femtocell and pico cell which is a "real" base station)
  - 128 + simultaneous connections
  - May Be indoor or outdoor
  - Are actually small base stations
  - Higher Transmitter powers
  - May be ad hoc or planned deployments
  - May be flat or hierarchical architecture
  - IP based backhaul
- Small Cells (next generation for indoor solutions, have advantage of DAS, and femtocells)
  - Centralized processing, but IP remote to transmitters
  - Take the place of Pico-cells, DAS, etc
  - Flat Architecture
  - Self Optimizing
  - Capacity comparable to picocells
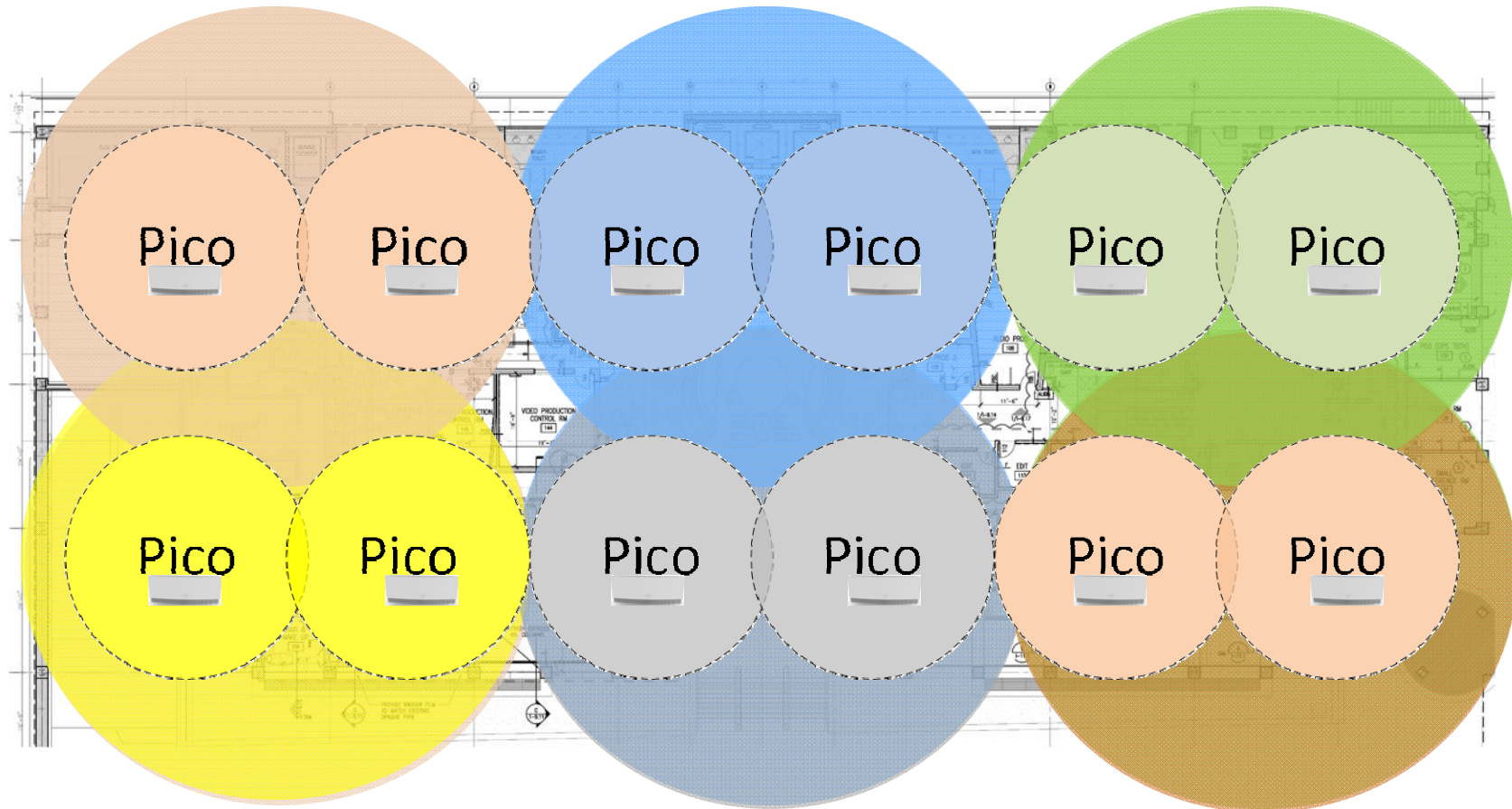
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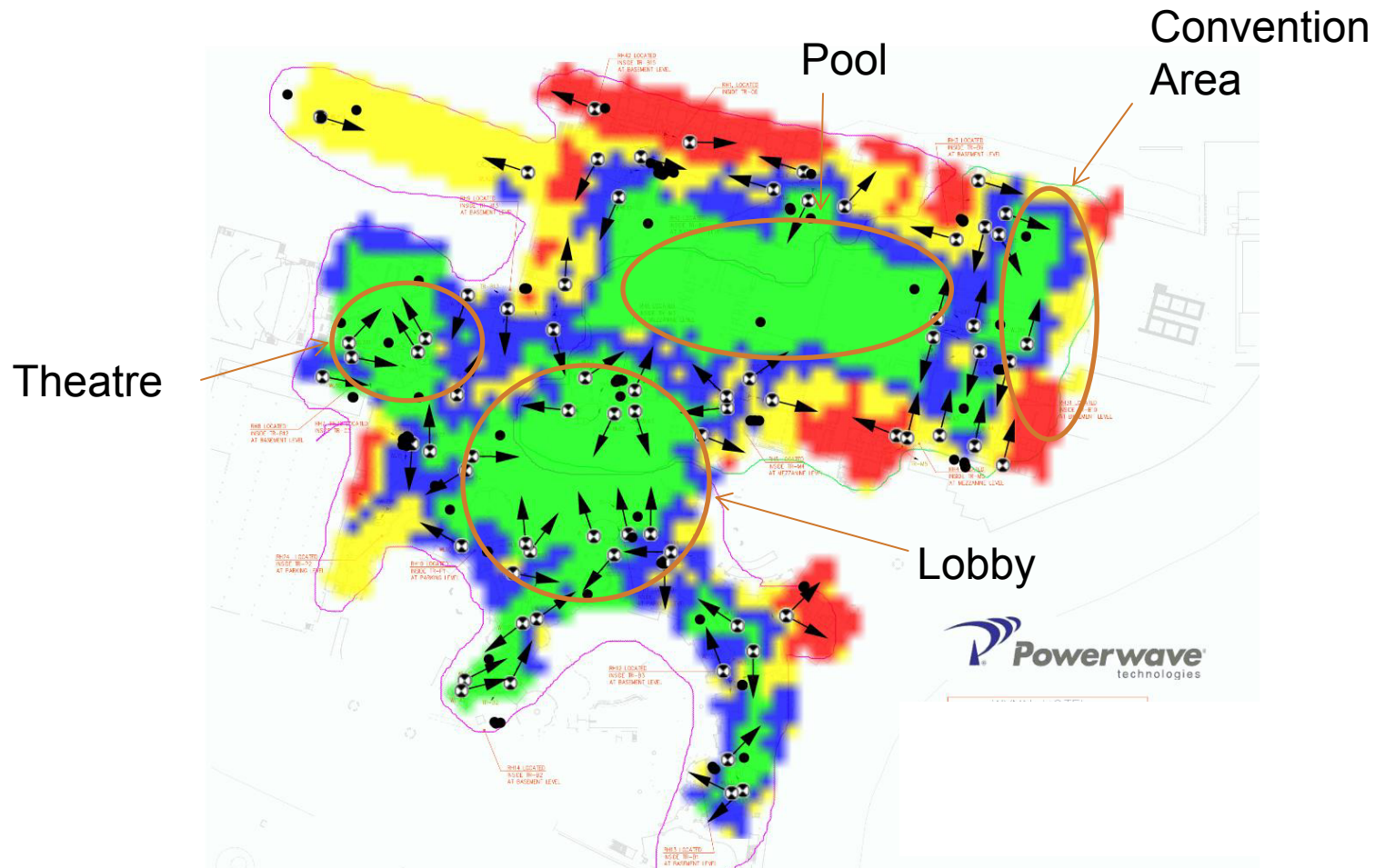
Keith Kaczmarek
VP/GM Global Wireless Solutions
Powerwave Technologies

DAS & Small Cell Coverage and Capacity Growth

- **Add LTE PICO (700 and AWS) for 4G capacity upgrade**

Powerwave technologies

Picocell 4G Coverage Overlay

4G/Wi-Fi Picocell can be overlaid on the DAS in specific high capacity Hot Spots to increase performance and capacity

Capacity Impact of Smaller Cells
12x capacity, 15x UL capacity, 5x less UL transmit power (extended battery life)

► Current Centralized Macro

- Cell size = 1 square mile

- 1x1 ReUse, 10 MHz channels

11 Pico Cells

	Mbps/mil^2	Spectral Efficiency	Average Data Rate
DL	15 Mbps/mil^2	1.5b/s/hz	300kbps
UL	7 Mbps/mil^2	.7 b/s/hz	140kbps

	Mbps/mil^2	Spectral Efficiency	Average Data Rate
DL	180 Mbps/mil^2	1.7b/s/hz	3.6Mbps
UL	111 Mbps/mil^2	1 b/s/hz	2.2Mbps

System Performance evaluations based on 57 sector wrap-around simulations per 3GPP methodology.

Powerwave technologies

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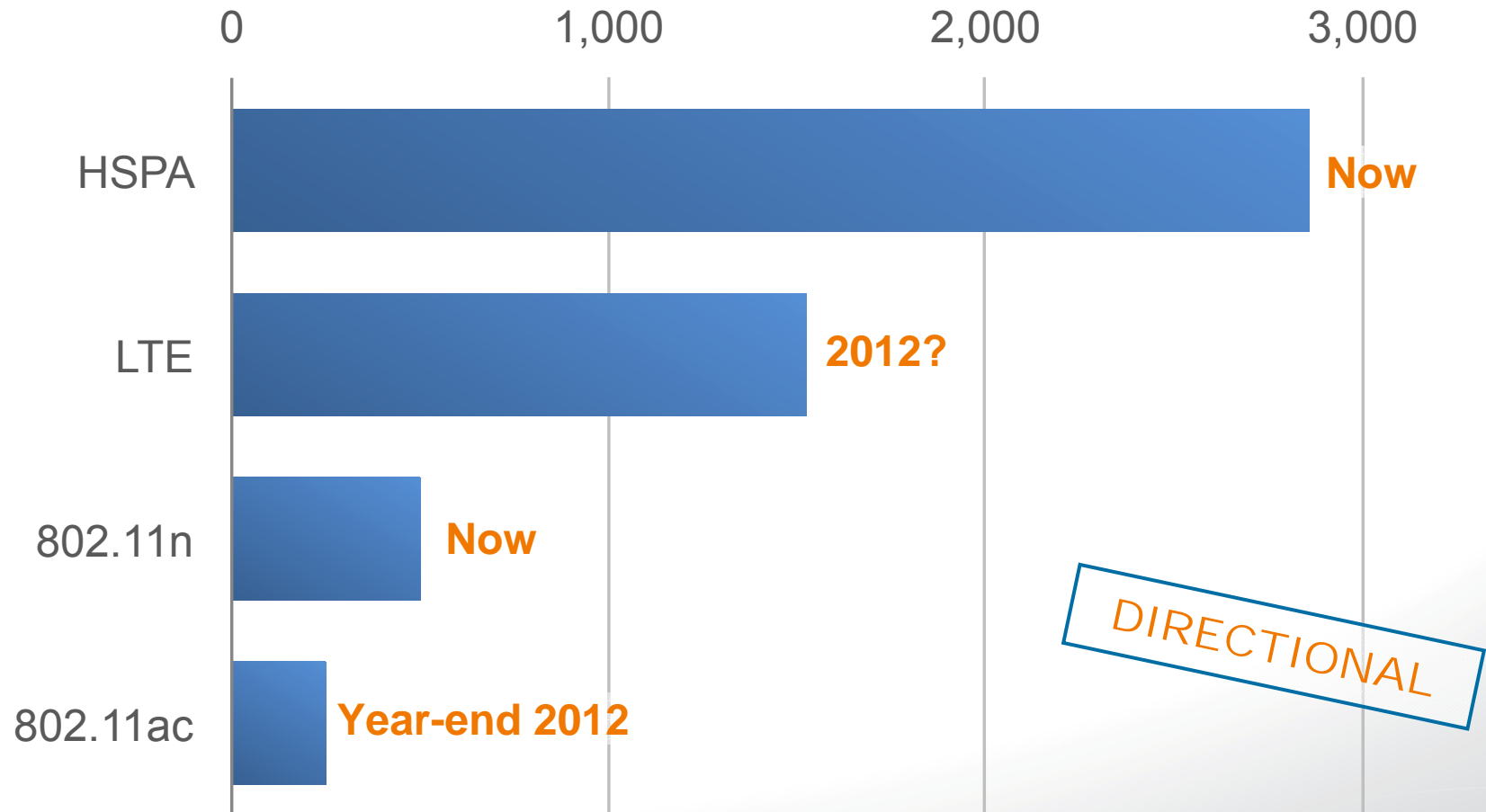**October 28, 2011**

Steven Glapa
Senior Director of Field Marketing
Ruckus Wireless

The driver of Wi-Fi's growing popularity

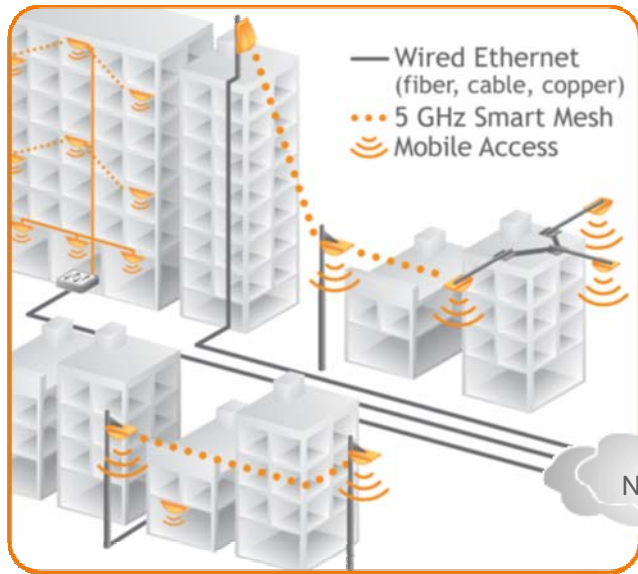Small-cell Infrastructure Capex, US$/Mbps/km² and Availability

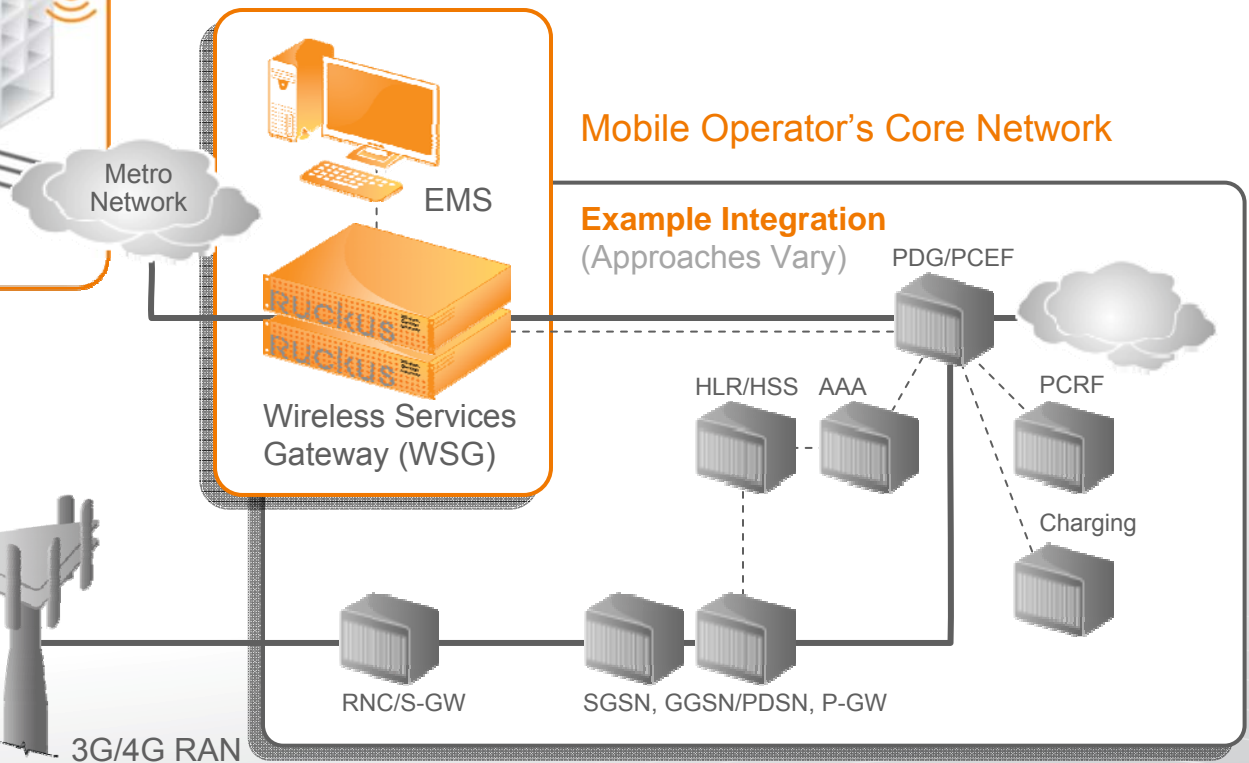Source: operator and TEM benchmarking, Ruckus back-of-the-envelope analysis.

Wi-Fi / cellular integration model

Wi-Fi Radio Access and Smart Mesh Backhaul Network

- Wired Ethernet (fiber, cable, copper)
- 5 GHz Smart Mesh
- Mobile Access

Key Features:

- Packet data offloaded to best-efforts network (voice, SMS stay on licensed spectrum)
- Automatic authentication with cellular credentials
- Integration with existing mobile core for authentication, policy definition/enforcement, and billing
- Gateway for mobility event caching and session integration

Packet Data

Metro Network

EMS

Mobile Operator's Core Network

Example Integration
(Approaches Vary)

PDG/PCEF

Wireless Services Gateway (WSG)

HLR/HSS   AAA

PCRF

Charging

Voice, SMS/MMS

3G/4G RAN

RNC/S-GW

SGSN, GGSN/PDSN, P-GW

Unprecedented carrier deployments

PCCW
~10,000 APs in Hong Kong since 2007
IPTV over Wi-Fi; 20% average, 80% peak offload

tikona Digital Networks
45,000 APs in 38 cities pioneering wireless broadband access in India

Designing The Future
KDDI
Self-build 3GO
120,000 APs in Tokyo (part 1 of 3)
WiMAX backhaul

towerstream
Wholesale 3GO from 4,000 points of presence in top 10 US cities

Wi-Fi Powered by **The Cloud** A BSkyB owned company
Retail/wholesale 3GO in London
30,000+ APs upgrade for >20 Mbps service

中国电信 CHINA TELECOM
Project underway to cover 30 million people in Chongqing province

Many more coming soon…

Ruckus

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Jim Seymour
Senior Director of RAN Strategy
Alcatel Lucent

Jim Seymour
Senior Director
Wireless CTO Organization
October 28, 2011

Alcatel·Lucent

Introduction to Small Cells Portfolio

INNOVATIVE TECHNOLOGY

- 3G/LTE/MIMO
- Outdoor for indoor coverage
- AAA with beam forming
- High average spectral efficiency (4 to 6 bits/s/Hz)
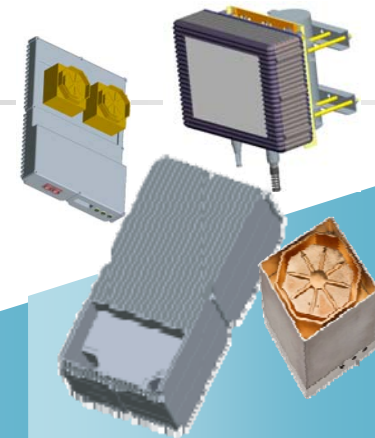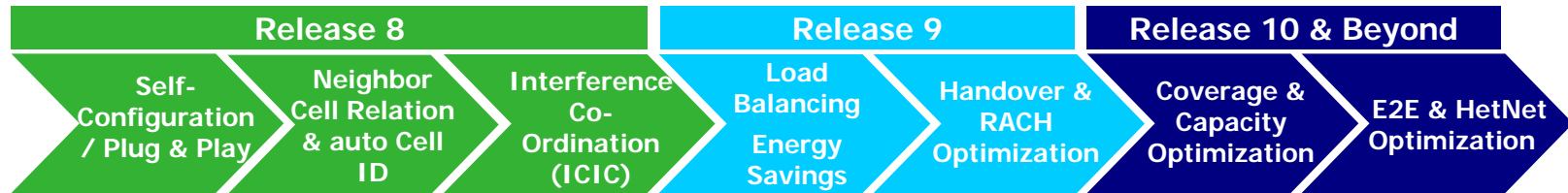- Many users

INDOOR SMALL CELLS

- Multiple technologies (3G, Wi-Fi, 4G)
- Integrated or external omni directional antennas
- Rx div /MIMO
- Small cell nets
- 8 to 64 users

OUTDOOR SMALL CELLS

- Ruggedized design
- Multiple technologies (3G, Wi-Fi, 4G)
- Range: about 2 KM at 120m/h
- 16 to 128 users

ENTERPRISE CELLS

- Multiple technologies (3G, Wi-Fi, 4G)
- Integrated or external omni directional antennas
- Small cell nets
- 8 to 64 users

HOME CELLS

- 3G technologies
- Integrated omni directional antenna
- 4 to 8 users

An Evolution Toward Heterogeneous Networks

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Self-Optimizing Networks (SON)

Innovations Continue with Focus on HetNets

| Release 8			Release 9		Release 10 & Beyond	
Self-Configuration / Plug & Play	Neighbor Cell Relation & auto Cell ID	Interference Co-Ordination (ICIC)	Load Balancing Energy Savings	Handover & RACH Optimization	Coverage & Capacity Optimization	E2E & HetNet Optimization

Plug & Play Femtocell

Automated Neighbor Cell Relation

Inter-Cell Interference Cancellation based on Inter-cell Negotiation
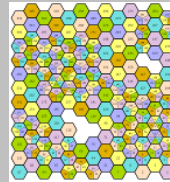
- Reduces Hand Over failure
- Improves throughput/QoE
- Performance increase in call set up

Self-Organizing/Optimizing Networks, a Bell Labs Research Innovation

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Rupert Baines
VP, Marketing
Picochip

Leader in femtocells & small cells

Leadership
Shipping in volume, carrier-qualified, field-proven, 80% market share

Bath

Widest portfolio…
from low-cost residential to highest-performing metro

>50 femtocell customers…
 including ip.access/Cisco & Alcatel-Lucent

Cambridge

LTE shipping now, roadmap to SoC

femtoforum

Beijing

PICOCHIP

Example: Picochip enabled Home/Small Business Cells

Sagem/ Vodafone

ALU/Vodafone

ALU/Optus

Cisco / AT&T

ALU/TIM

Foxconn/ Softbank

Argela/Avea

ALU/Telefonica

ALU/Vodafone Small Enterprise
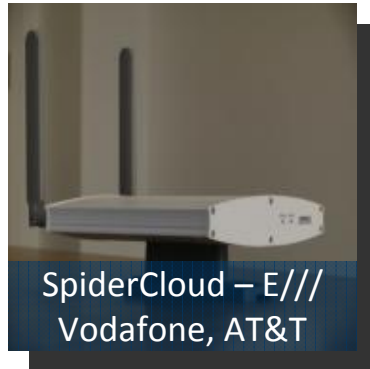

ALU /Etilsat Small Enterprise

ALU/TIM Small Enterprise

PICOCHIP

Example: Picochip enabled Enterprise/Metro/Rural Cells

Contela/ SKTelecom

ZTE / CuC

ip.access/ T-Mobile

ALU/ Vodafone

IPAccess/ T-Mobile

SpiderCloud – E/// Vodafone, AT&T

ALU/ AT&T

Airspan - LTE

PICOCHIP

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