HetNet – The Future of Wireless Networks

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#ONEshow15
## Technology has changed

<table>
<thead>
<tr>
<th>Then</th>
<th>Now</th>
</tr>
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<tbody>
<tr>
<td>35% of American adults have a smartphone</td>
<td>Up to 68% with multiple smart devices</td>
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<tr>
<td><strong>18% of U.S. mobile phone users use mobile banking</strong></td>
<td><strong>51% of smartphone owners have used mobile banking in the past 12 months</strong></td>
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<tr>
<td>$209 billion annual B2C ecommerce sales in the United States</td>
<td>Ecommerce outpaces bricks and mortar store growth - $322 billion in 2013</td>
</tr>
<tr>
<td><strong>Annual Sales on laptops surpasses sales of the declining desktop for the first time</strong></td>
<td><strong>Tablet sales grow faster than PCs ever did – by 52% YOY in 2013</strong></td>
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<tr>
<td>24 hours of video uploaded every minute</td>
<td>100 hours of video uploaded every minute</td>
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<tr>
<td><strong>Social media platforms rise popularity</strong></td>
<td><strong>Social media have 100’s of millions of users</strong></td>
</tr>
<tr>
<td>Global Over-the-Top messaging service users do not exist</td>
<td>More than 1.8 billion photos uploaded and shared every day</td>
</tr>
<tr>
<td><strong>2.5 billion devices with unique IP addresses connected to the Internet</strong></td>
<td><strong>10 billion connected devices</strong></td>
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</table>
Behaviors have changed

In just five years, how has your behavior changed?

- Financial planning and management
- Buying behavior
- Personal entertainment
- Travel and transportation planning
- Purchasing and reading books
- Chronicling life’s events
- Communicating important messages to your family, friends or co-workers
- Managing your health
The Challenge

A stadium that seats 90,000 fans
Now imagine that they all have smartphones...

71% of Americans own smartphones

52% - The pace at which tablets are outgrowing PC’s YOY

1.8 billion photos uploaded and shared every day

100 hours of video uploaded every minute

10 billion devices connected to the internet
MOBILE INTERNET EXPLOSION

AT&T wireless data traffic up 50,000% over past 7 years

100M+ U.S. wireless subscribers
AT&T is one of the leading smartphone providers in the U.S.
Network Business Drivers

Nearly 80% of worldwide data connections initiate inside a building

RF Design strategy must transition from an outside-in to inside-out methodology
What’s in the Toolbox?

- Macro Cell Towers
- Neutral-Host Distributed Antenna System (DAS)
- Small Cells
- Wi-Fi
Wireless Network Solutions

**Traditional Macro**
- Outdoor areas
- High power
- First approach

**Outdoor DAS (oDAS)**
- Alternate to macro tower
- Utility poles, street lights, campus rooftops, parking areas
- High power remotes

**Indoor DAS (iDAS)**
- High concentration indoor areas - Student Union, Stadiums, Arenas
- Low power remotes
- Low profile antennas
What is a DAS?

Distributed Antenna System is a network of amplifiers and antennas that provide voice & data wireless service within a geographic area or structure.

- A DAS is a network of antennas that are placed throughout the facility and are connected with cabling or fiber to a hub.
- The head end allows for multiple wireless service providers to connect radios that transmit at various frequencies.
- Remote units are placed on each floor and are connected to antennas which serve the floor.
- Neutral host DAS enables multiple wireless service providers to use the network at the same time.
What are Small Cells?

Small cells are low-power wireless access points that provide improved cellular coverage and capacity for homes, enterprises, and metropolitan and rural public spaces. They range from femtocells (the smallest) to microcells (the largest).
Small Cell features

Solutions for indoor and outdoor coverage

Cover 7,000-10,000 sq. ft. depending upon building construction

Access open to all AT&T users in range of the device

Each Small Cell can:

• Connect up to 32 devices with each device supporting simultaneous voice and high speed data sessions
• Securely connect to the AT&T network via Ethernet and the Internet
• Handoff calls to other Small Cells (when multiples are deployed)
Comparing Wireless Solution options

**Macro BTS**
The Macro BTS is the RF source primarily used in the macro network. Provides coverage and capacity, it can support a large number of users over a wide area.

**DAS**
The DAS distributes the RF signal across antennas that are remote from the BTS. Primarily used to modify, improve or extend coverage of a site. Provides coverage and capacity, primarily used in large buildings, stadiums, public spaces, airports, outdoor environments with strict zoning, etc.

**Repeaters/Bi-Directional Amplifiers (BDA)**
A BDA is used to boost the cell phone reception by rebroadcasting cellular signals inside of a building. It uses an external directional antenna to capture the RF signal from a nearby cell site. BDA is a coverage only solution and is limited to small to medium sized commercial buildings (<100K sq. ft).

**Small Cells**
Low-powered radio access points that improve indoor and outdoor coverage to increase capacity and offload traffic. Deployments have been underway since the beginning of 2013.

**Femtocells**
Femtocells are small personal BTS providing service over a limited area (5K sq. ft) to a limited number of users (~4). Primarily used in small office / home office or residential areas.

* Repeaters are not available in some markets or venues.
## Small Cell Comparison

<table>
<thead>
<tr>
<th>Solution</th>
<th>Description</th>
<th>Technology</th>
<th># Users</th>
<th>Cell Radius</th>
</tr>
</thead>
<tbody>
<tr>
<td>DAS</td>
<td>Typically fed by a macro or micro base station. High power, multi-frequency, multi-carrier.</td>
<td>UMTS HSPA+ LTE</td>
<td>Up to 1,800 users per base station</td>
<td>Up to 3 miles</td>
</tr>
<tr>
<td>Wi-Fi</td>
<td>A wireless access point connects a group of wireless devices to an adjacent wired LAN.</td>
<td>802.11b 802.11g 802.11n</td>
<td>Up to 200 users per a 3-radio access point</td>
<td>65 feet</td>
</tr>
<tr>
<td>Microcell</td>
<td>Short-range base station used for enhancing indoor and/or outdoor coverage.</td>
<td>UMTS HSPA+</td>
<td>32 to 200 users</td>
<td>Up to ≈1 mile</td>
</tr>
<tr>
<td>Metrocell</td>
<td>High-capacity, low power device that fills in coverage holes within buildings.</td>
<td>UMTS HSPA+</td>
<td>16 to 32 users</td>
<td>7,000 – 10,000 square feet</td>
</tr>
<tr>
<td>Picocell</td>
<td>Typically used for indoor applications such as office buildings, airports, and malls.</td>
<td>UMTS</td>
<td>32 users</td>
<td>Up to 750 feet</td>
</tr>
<tr>
<td>Femtocell</td>
<td>A small, low-power cellular base station typically used for a home or small business.</td>
<td>UMTS</td>
<td>4-6 users</td>
<td>40 feet</td>
</tr>
</tbody>
</table>
## Comparing an oDAS to a Macro Site

**oDAS**
- Small Antenna
- 15’-50’ pole
- Amplifier
- 1 or 2 Batteries
- Small footprint

**Macro Site**
- Large Antenna
- Up to a 200’ Tower
- Fencing
- Shelters or Cabinets
- Air Conditioning
- Many Batteries
- Minimum 50’x100’ footprint or larger
- RF Generator
Summary of network enhancements at Palo Alto & Mountain View, CA:

**Solution:** 3 Polygons with 99 Nodes Total

**Services:** 3G & 4G LTE

**Results:**

- Equipment was painted 2 different colors to better match the surrounding foliage
- Many of the nodes were placed away from street corners to blend-in with surroundings
Sample Small Cell deployment on a Utility Pole

- Outdoor Small Cell
- Two omni-directional antennas
- GPS Antenna & Surge Arrestor
- Equipment installed over 40” below power and 12” above cable TV cable
DAS at the 2015 Big Game: University of Phoenix Stadium Glendale, AZ
Outdoor DAS
Wi-Fi

Many of AT&T’s smartphones will automatically authenticate on AT&T’s Wi-Fi networks, benefits:

**Customer**
- Potentially higher data rates
- Does not count towards wireless data usage

**Venue Owner**
- Potential to create custom “landing” page
- Custom applications
- Revenue opportunities through increased sales

**Carrier**
- Offloads traffic from macro network
- Better wireless spectrum utilization

Source: Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, Feb 2014
Thank you.