

# Small Cells and Het-Nets *The Wave of the Future?*

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## Agenda

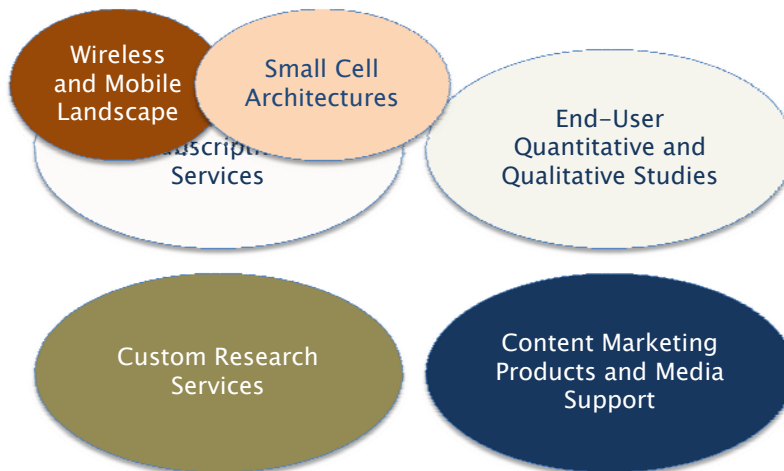
- Introduction
- Why LTE bandwidth is increasing
- What consumers do On-the-Go
- Where and when the bandwidth is used
- Why Small Cells...and what are they?
- Deploying a Small Cell
- Small Cell Costs
- Future architectures

Source: iGillottResearch, Inc. 2015

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## iGR's Products and Services



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Source: iGR Research, Inc. 2015

## iGR's Core Tenets

*Things to remember every day as you get out of bed*

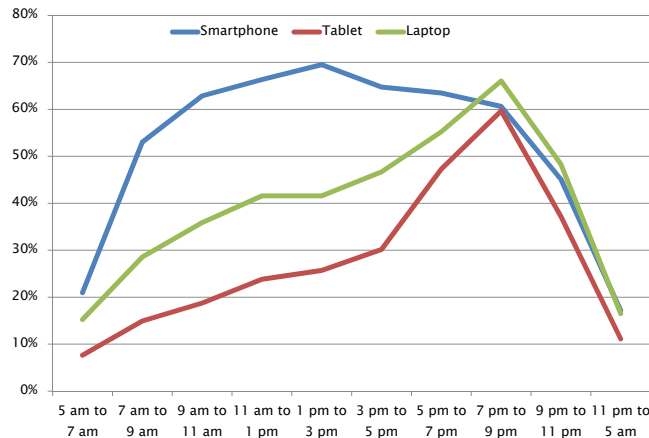
- ▶ The needs of the end-user are king, from the prepaid customer to the large global corporation
- ▶ The ability to offer and deliver a range of content to all types of mobile platforms (including connected cars and wearable devices) is essential
- ▶ Network bandwidth needs to be made available where and when the user demands it, not simply where the operator is able to make service available
  - This includes inside buildings, in the home and in the air
- ▶ Mobile is an integral part of any Cloud or IoT architecture, product or service
- ▶ Old and existing security and privacy rules apply to the new world of IoT, mobile devices, networks, services and content
- ▶ The device market is highly competitive, with effectively two brands dominating the mobile space globally
  - New market entrants need clear market and product differentiation in order to even get noticed, never mind succeed
- ▶ All content, services and communities will be available from all devices, regardless of location, time of day, or type of broadband connection
- ▶ New technologies are penetrating the ICT industry faster than ever, and the rate of change is accelerating
  - For example, mobile network virtualization is now a reality and the next few years will see mobile architectures transformed with the application of SDN and NFV

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Source: iGR Research, Inc. 2015

## Time Periods when Device Usage Occurs



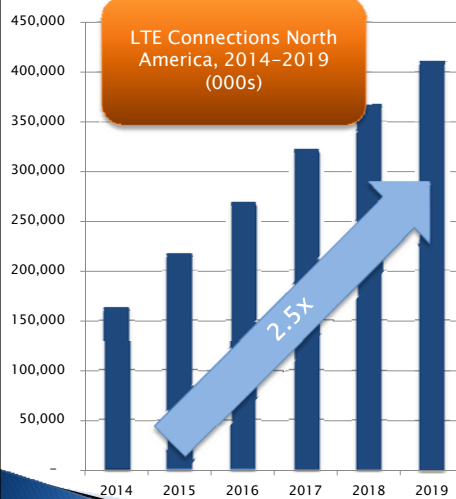
Smartphone used almost the whole time people are awake!

Tablet increasingly used at home in the evening – remember this point

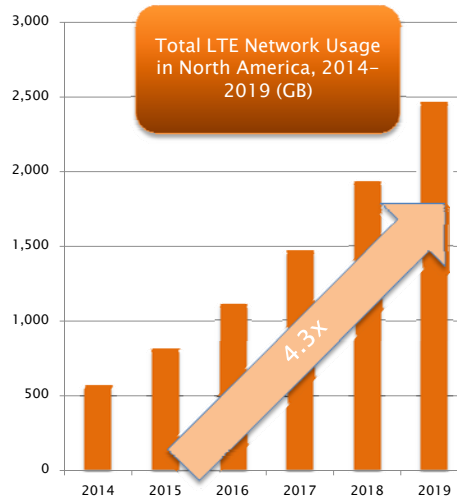
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## The Rise of LTE and Bandwidth

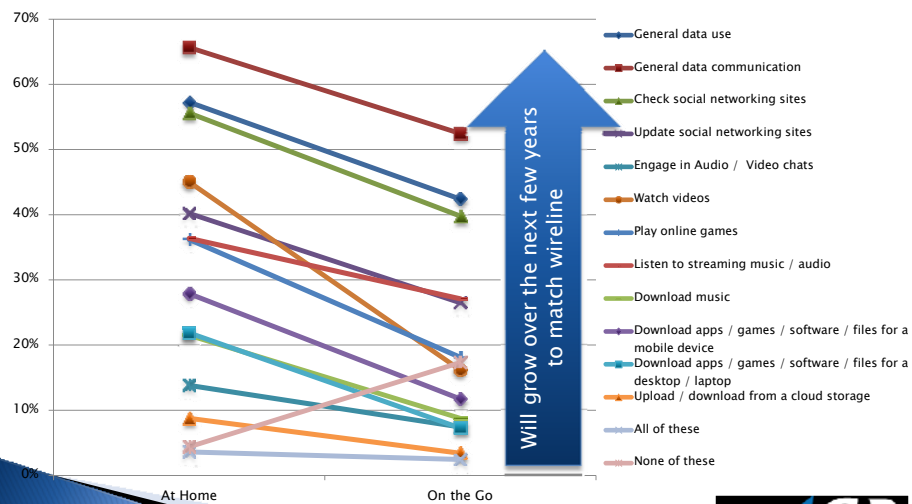


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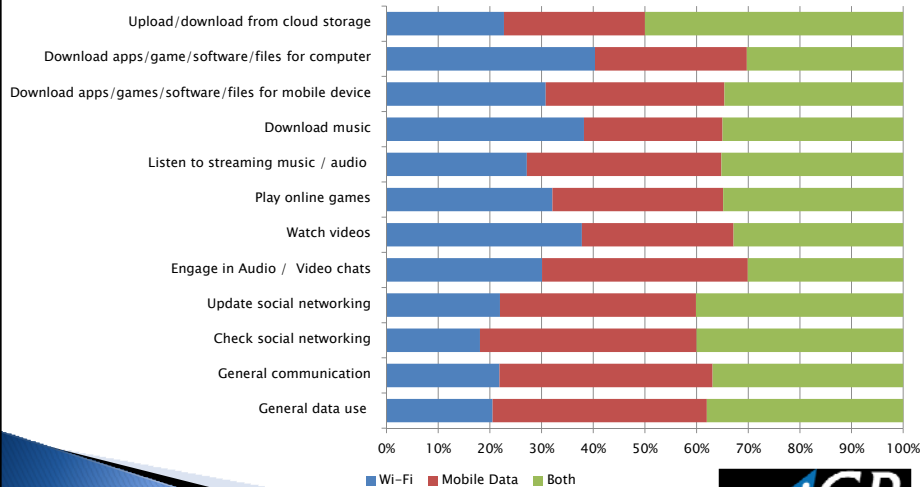
## Difference in Activities – Wired versus On-the-Go *U.S. Consumer Survey, 2015*



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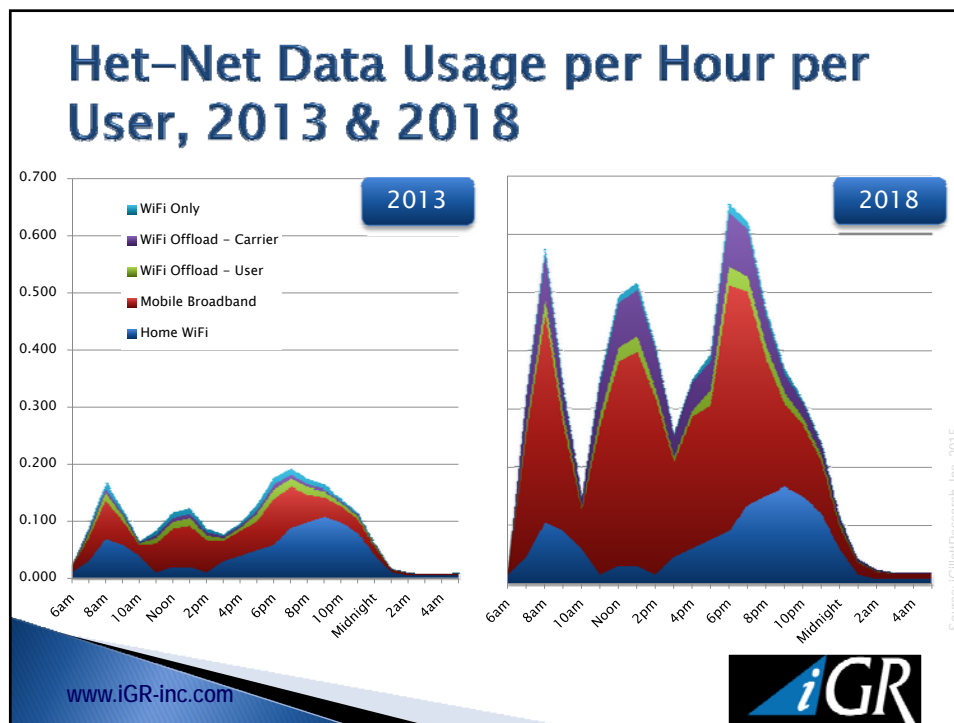
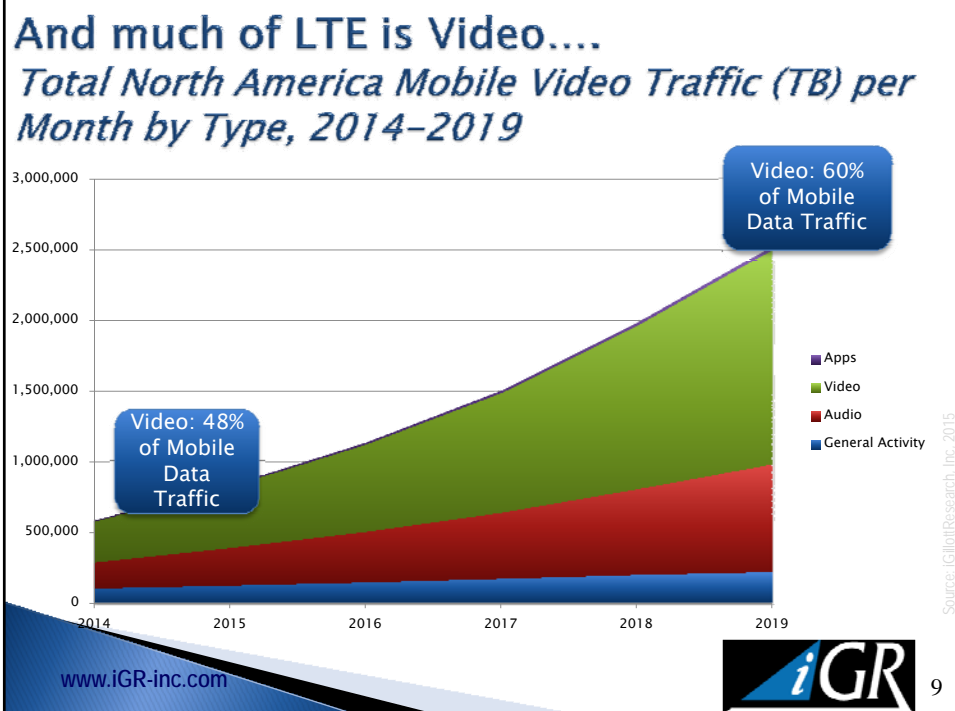
## Type of Network Used for the Given "On the Go" Activity *U.S. Consumer Survey, 2015*



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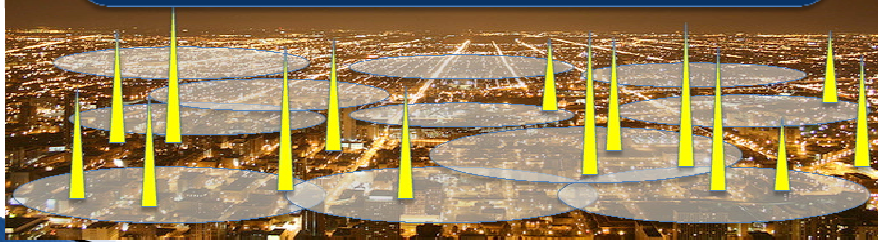
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## Small Cells to Address Hot-Spots and Not-Spots

Macro networks cover metro areas relatively well  
 But LTE devices tend to be used statically - video  
 Creates capacity demand hotspots  
 Hotspots move over time as people move  
 Not spots also exist and need to be addressed  
 iGR has model for bandwidth demand – network capacity for  
 a given area



Source: iGR Research, Inc. 2015

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## Small Cells? Yes! Now, what is a 'small cell'?

Solution	Description	Technology	# of Users	Cell Radius
<b>DAS</b>	Typically fed by a macro or micro base station. High power, multi-frequency, multi-carrier	UMTS, HSPA+, LTE	Up to 1,800 users per base station	Up to 3 miles
<b>WiFi</b>	A wireless access point connects a group of wireless devices to an adjacent wired LAN	802.11b/g/n; AC (forthcoming)	Up to 200 users per a 3-radio access point	65 feet
<b>Microcell</b>	Short-range base station used for enhancing indoor and/or outdoor coverage	UMTS, HSPA+, LTE	32 to 200 users	Up to ~1 mile
<b>Metrocell</b>	High-capacity, low power device that fills in coverage holes within buildings	UMTS, HSPA+, LTE	16 to 32 users	10,000 to 20,000 square feet
<b>Picocell</b>	Typically used for indoor applications such as office buildings, airports and malls	UMTS, HSPA+, LTE	32 users	Up to 750 feet
<b>Femtocell</b>	A small, low-power cellular base station typically used for a home or small business	UMTS, HSPA+, LTE	4-6 users	40 feet

Source: iGR Research, Inc. 2015

Source: AT&T's Antenna Solutions Group, 2014

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## Small cell requirements

- ▶ Low cost, small form factor
- ▶ Light enough to be mounted in exposed and/or precarious locations (poles, building sides, roofs, etc.)
- ▶ Resistant to the elements and to tampering
- ▶ Tolerate sway (from wind); this also applies to wireless backhaul systems
- ▶ Low power operations so as to provide targeted coverage/capacity
- ▶ Capable of monitoring the surrounding RF landscape to manage and reduce interference from neighboring cells
- ▶ Fast and easy installation that can be done by skilled or semi-skilled individuals who may (or may not) be employees of the mobile operator needing the small cells
  - This also applies to the backhaul connection, particularly if the installation requires a wireless backhaul system
- ▶ Once powered on, the small cell should connect to the server that authenticates the device and then provisions its main parameters, updates firmware/software if required, etc.
- ▶ Self-provisioning of radio access network (RAN) parameters
- ▶ Low latency backhaul, to support the LTE X1 and S2 interfaces, and support for multiple synchronization methods

Source: iGR Research, Inc. 2015

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## Locations for Small Cells

Major \$\$\$ factor

- ▶ iGR assumes that small cells will most likely be deployed into dense urban, urban or heavily populated suburban areas
- ▶ Buildings, and their roofs, are ideal for small cell deployments
- ▶ Exterior building walls are also a possibility
- ▶ Street furniture
  - Broad term that refers to any number of items typically seen in an urban landscape – benches, bill boards, bus stops, traffic barriers, traffic lights and signs, light poles, utility poles, garbage cans, etc.
  - Some of the above are suitable for small cell deployment. Some are not
  - Deployable assets boils down to street fixtures that have elevation and access to power – poles of numerous variety, bill boards, water towers, etc.
- ▶ Not all street poles (non traffic related) are created equal. In short, there are a few types of entities that own those poles:
  - ILECs (the incumbent local exchange carrier)
  - Utilities
  - Municipalities
  - On utility poles, small cells (and any backhaul) would have to be attached in the communications space where all the communications providers have their gear
  - Note that lamp/light posts may not have enough additional power/circuits to drive the small cell attached to it. This would be an issue discovered in the site location process
  - Back-up power is typically not provided for in the current small cell deployments
- ▶ Adhere to any zoning provisions related to the placement of small cells and permitting process
  - May also be building codes and landmark and historic preservation codes, aesthetic requirements, power, environmental and safety regulation

Source: iGR Research, Inc. 2015

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# Backhaul

Major \$\$\$  
factor

- ▶ Options: Wired or Wireless
- ▶ Within each of those types, there are multiple options
- ▶ Fiber appears to be the preferred backhaul for cellular systems regardless of their type, but fiber is:
  - Not always where it is needed
  - Very expensive to get to where it is needed, particularly for outdoor deployments where trenching is required
- ▶ Note that fiber tends to be plentiful in urban areas and relatively scarce in rural areas
- ▶ Some small cells might be backhauled to a nearby macro cell site requiring that the bandwidth of the existing macro backhaul be increased
- ▶ Mobile operator may have multiple co-located small cells serving different "pain points" from a rooftop
  - May require a combination of wireless technologies (LOS and NLOS), backhaul architectures (star, ring, etc.) along with local aggregation
  - No single backhaul topology will be optimal in all use cases
  - Flexibility is critical to successful deployments

Source: iGR Research, Inc. 2015

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# Bandwidth required

- ▶ LTE macrocells require a minimum of 100 Mbps and iGR expects that to scale rather quickly to 1 Gbps or even 10 Gbps as LTE devices increasingly penetrate the market
- ▶ Backhaul architecture for LTE has to support two interfaces:
  - S1: the interface from LTE eNBs to the EPC (the EPC includes the S-GW and the MME)
  - X2: the interface connecting eNBs to other eNBs that are typically organized into logical groups
- ▶ Current generation of small cells support only one omnidirectional cell and one carrier per site
  - Amount of backhaul required for a single LTE carrier (10x10 MHz) would be lower than what would be required for an LTE macrocell

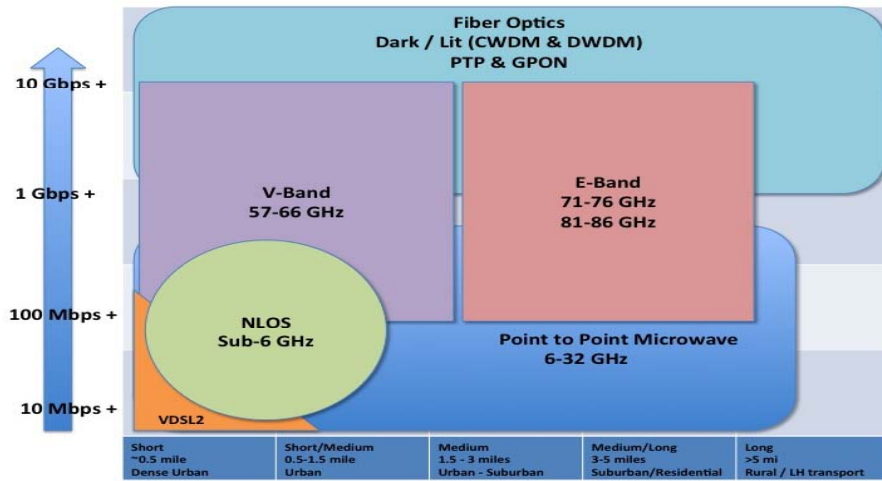
Source: iGR Research, Inc. 2015

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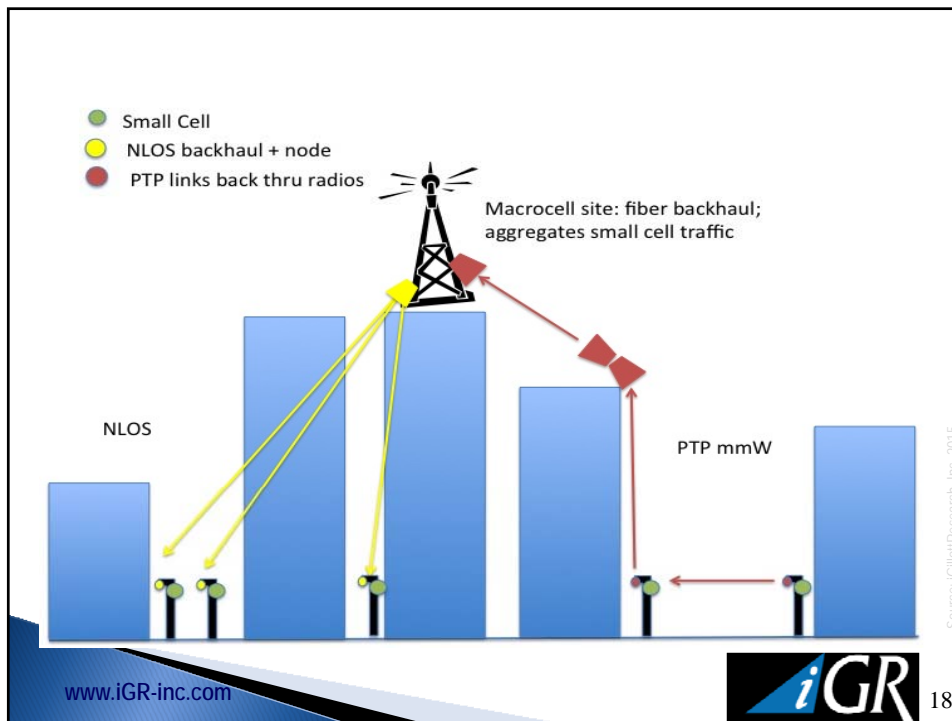
## Small Cell Backhaul Capabilities and Use Cases, Wired and Wireless



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Source: iGR Research, Inc. 2015

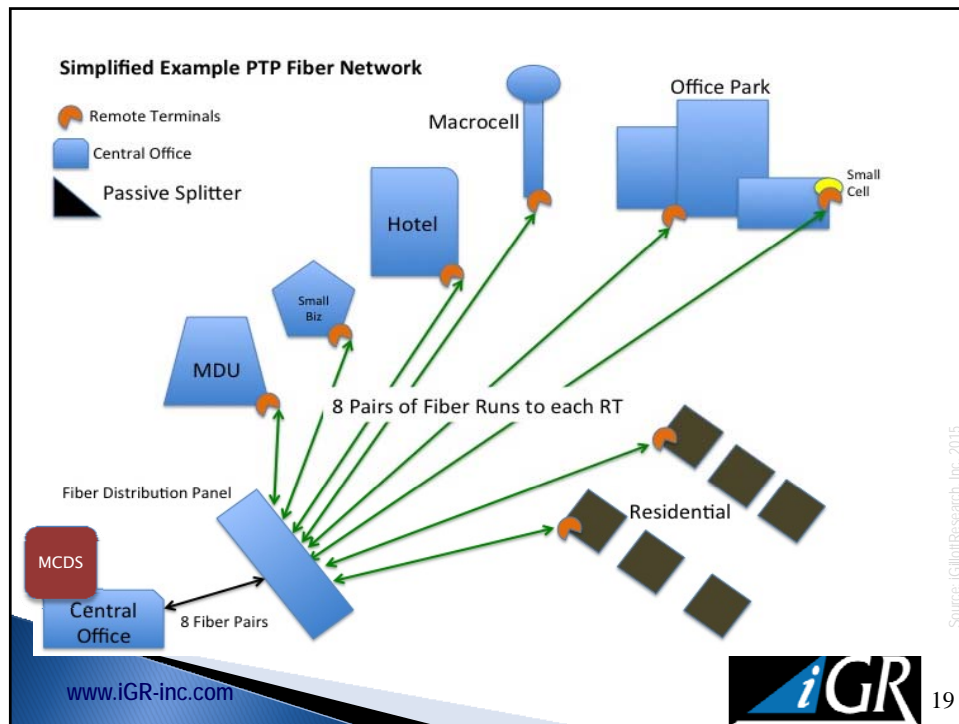


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Source: iGR Research, Inc. 2015



## Cost Scenarios

- Scenarios modeled includes the costs for 10, 50 and 100 cell deployments
- Location scenarios are:
  - Existing pole
  - New pole
  - Building wall
  - Building roof
- Type of small cells are:
  - LTE multimode
  - LTE RRH
- Types of backhaul are:
  - Lit fiber, aerial and trenched
  - Dark fiber, aerial and trenched
  - Lit fiber (transfer pricing), aerial and trenched
  - Dark fiber (transfer pricing), aerial and trenched
  - Wireless backhaul, point to multipoint

39 Scenarios modeled

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## Example: LTE Metrocell Existing Pole (Lit Fiber, Aerial)

Cost item	Configuration	
Type of Small Cell	LTE multimode	
Location	Existing pole Make-ready One attachment	
Backhaul	Lit fiber Aerial Leased 500 feet 25 Mbps	
Installation requirements (per site)	One installer Bucket truck	
Capital expenses	1 Cell	\$xxxxx
	10 Cells	\$xxxxxx
	50 Cells	\$xxxxxxx
	100 Cells	\$xxxxxxx
Operating expenses (per year)	1 Cell	\$xxxxx
	10 Cells	\$xxxxxx
	50 Cells	\$xxxxxxx
	100 Cells	\$xxxxxxx

Source: iGR Research, Inc. 2015

## Example: LTE Metrocell Building Roof (Wireless Backhaul)

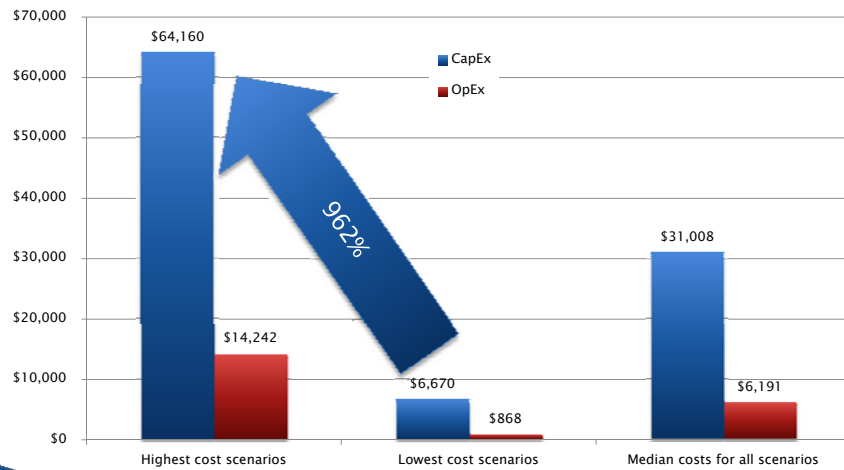
Cost item	Configuration	
Type of Small Cell	LTE Metrocell	
Location	Building roof Make ready One attachment	
Backhaul	Wireless Backhaul 25 Mbps	
Installation requirements (per site)	One installer	
Capital expenses	1 Cell	\$XXXX
	10 Cells	\$XXXXX
	50 Cells	\$XXXXXX
	100 Cells	\$XXXXXX
Operating expenses (per year)	1 Cell	\$XXXX
	10 Cells	\$XXXXX
	50 Cells	\$XXXXXX
	100 Cells	\$XXXXXX

Source: iGR Research, Inc. 2015

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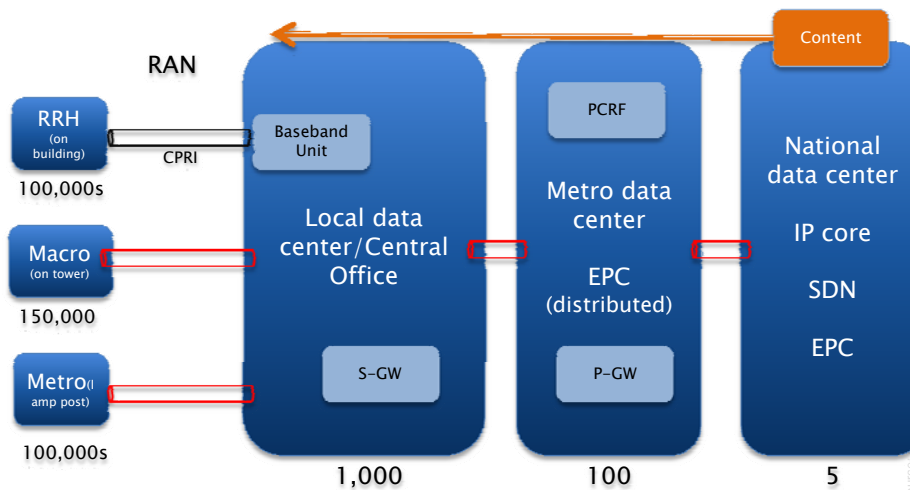
## Small Cell Deployment Cost Ranges



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## Future Architecture



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*Questions?*

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