Comm-Tract
Voice/Data/Video Networks

Fairhaven
Massachusetts

Comm-Tract Corp

Town of Fairhaven
Broadband Study Committee

Informational Working Session

3-26-19

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Agenda

- Introductions
- Review of Broadband Study Committee Objectives/Topics
  - FMAN as starting point for FTTX Network?
  - Fiber vs. other wireless broadband (cellular) technologies?
  - Budgeting FTTX or FTTH Network for Fairhaven?
- Fairhaven Fiber Optic Municipal Area Network:
  - Technology
  - Applications
  - ROI
  - Comm-Tract Overview
- Wireless Industry Trends – Cellular migration to 5G
  - Types of Cell Sites
  - Cellular Networks – Architectures
  - Carrier requirements for Cell Sites
- General Discussion – Q+A
- Next Steps/Action Items

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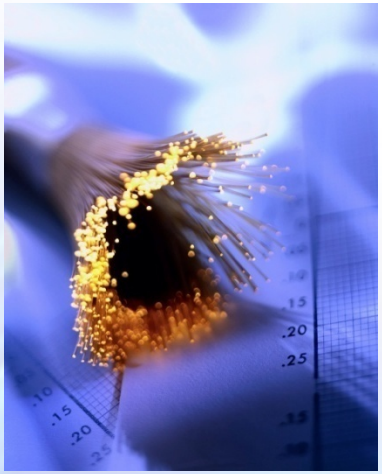
Overview of a Fiber Optic Municipal Area Network



- **Private Fiber Network:**
  - **Schools**
  - **Town and city departments**
  - **Police**
  - **Fire**
  - **Emergency Services**
  - **Public Works**
  - **Libraries**
  - **Other locations such as communications towers, parks, recreation facilities, and other municipal agencies**
- **Designed and Deployed for Municipal Use:**
  - **Supports all communications needs of the municipal, and generally exclusively used only for municipal applications**
  - **Typically owned by the City or Town, or operating lease and/or financed facilitated by Comm-Tract.**

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Overview of a Fiber Optic Municipal Area Network

- **Municipal Applications Supported:**
  - **Data applications**
    - **MUNIS and other financial systems, tax systems, student management systems, water and sewer systems, surveillance systems, email systems, domain systems, VLANS of any type, data storage systems, access layer security systems, other data applications, and high speed access to the internet**
  - **Voice applications**
    - **IP Telephony or VoIP of any type (centralized or distributed), legacy digital and analog PBX systems, stand alone phone systems, and multi megabit (10mbps, 40 mbps, 100mbps and up) voice access to carriers.**
  - **Cable TV**
    - **Connects all production and distribution sites for the municipal cable TV studio, and remote sites. Provides access to cable companies such as Comcast, Verizon, Time Warner, Charter and others for distribution to the public**
  - **Security and other Video applications**
    - **Provides high bandwidth transport of all video applications for security cameras, traffic control cameras, and other secured video requirements.**

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Overview of a Fiber Optic Municipal Area Network

- **Municipal Applications Supported:**
  - **SCADA applications**
    - **Monitoring of reservoirs, water supplies, and other secured access to municipal owned sites**
  - **Smart Grid applications**
    - **The network supports all manner of smart grid applications that are often provided by the independent utility for the city or town. Optimization of electrical power needs for the community, meter reading and controls, and centralized management of the utility systems for diagnostics and repairs to the system.**
  - **Wireless applications**
    - **High speed network backbone that supports radio dispatch and radio traffic for police and fire departments**
    - **Broadband delivery of video, and surveillance traffic to emergency response vehicles**
    - **Provides network backbone and infrastructure for other wireless applications like traffic cameras, wireless coverage for public Wi-Fi, DAS and other wireless edge applications.**

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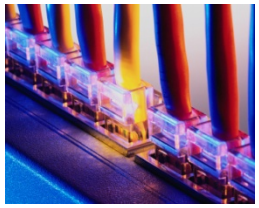
Technological Advantages of Fiber Optic Networks



- **Unlimited Bandwidth**
  - **Dependent only on the switching and/or electronics deployed at the end point buildings or sites**
  - **Typical municipal networks today operate at a minimum of 1gbps at each site with standard GBIC interface to Cisco/HP/and other switching platforms**
  - **Many Municipals are adopting 10 to 100gbps**
  - **Speeds in excess of 100gbps are easily attainable with optical transport and switching**
- **Reliability and Quality**
  - **Fiber Optics is the preferred transmission medium for all communications worldwide today**
  - **All major carriers (Verizon, ATT, Sprint, etc.) use fiber optic networks**
  - **High quality glass (SMF 28E) and 25 Year Full Warranty**
  - **Figure 8, ADSS, Strand types of OS2 Single Mode Fiber**

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Technological Advantages of Fiber Optic Networks

- **Carries all Telecommunications Securely**
  - **Switching and/or electronics deployed at the end point buildings control network**
  - **Any and all types of telecommunications data, voice and video traffic is integrated on the network**
  - **Physically separate fibers by department and secured**

- **Redundancy**
  - **Most networks deployed are designed with redundancy of fiber pathways in the architecture**
  - **A disaster which would damage a fiber cable is protected by designing the network to carry all the traffic interrupted on a secondary and redundant path.**
- **Long Term Investment**
  - **All Fiber materials and workmanship is covered under a 25 year warranty from the manufacturer.**
  - **Life span well in excess of 35 years**

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Return on Investment
Fiber Municipal Area Network

- **Case Study: Town in Massachusetts**
  - **Investment in private fiber network: $214,000**
  - **Investment in new layer2/3 switching: $178,000**
  - **Investment in VoIP system: $187,000**
  - **Total investment: $579,000**
  - **Supports 22 School, Town, Police, and Fire locations**
  - **Areas of Recurring Cost Savings: ($255,210/yr)**
    - **Internet access across all buildings ($66,000/yr)**
    - **Voice services (Centrex) 700 lines, and support on stand alone phone systems ($134,400/yr)**
    - **Security and Surveillance lines for transmission ($29,040/yr)**
    - **Police and Fire Radio Dispatch and Alert telephone lines ($8,320/yr)**
    - **Water and Sewer Department application telephone lines ($5,210/yr)**
    - **Cable TV access lines: ($12,240/yr)**
  - **Additional Recurring Costs added: $39,100/yr**
    - **High Bandwidth redundant access to Carriers $31,600/yr**
    - **Fiber Maintenance and Restoration Services $7,580/yr**

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Return on Investment
Fiber Municipal Area Network

- **Case Study: Town in Massachusetts**
  - **Additional funds received from Comcast license renegotiation: $185,000 (INET discontinued)**
  - **Additional funds received from grant: $ 138,570**
  - **Total additional funds: $ 323,750**
- **Final ROI:**
  - **Capital Investment less Additional Funds/Cost Savings/yr ($597,000 - $323,750)/($255,210 - $39,100) =**
  - **1.18 years or about 14 months**
- **Summary:**
  - **The fully deployed fiber municipal area network paid for itself in a little over a year. The network has now been up and operating for two years, and is saving the town roughly $216,000 per year as compared to the previous networking expenses incurred by the town**

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Some Other Comm-Tract Fiber Municipal Area Network Customers

- Town of Abington
- Town of Andover
- Town of Auburn
- Town of Barnstable
- Town of Bellingham
- Town of Boxborough
- Town of Canton
- Town of Charlton
- Town of Dedham
- City of East Providence
- City of Gloucester
- Town of Harwich
- Town of Hopkinton
- Town of Ipswich
- City of Lawrence
- City of Lynn
- Town of Lynnfield
- Town of Marshfield
- Town of Marblehead
- City of Methuen
- Town of Medway
- Town of Melrose
- City of Newton
- Town of North Andover
- City of Northampton
- Town of Norton
- Town of Plymouth
- City of Quincy
- Town of Reading
- City of Revere
- Town of Saugus
- Town of Sharon
- Town of Stoughton
- Town of Seekonk
- Town of Wayland
- Town of Weston
- Town of West Springfield
- Town of Weymouth

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Comm-Tract Overview

- Serving New England Region since 1980
- High quality Telecommunications Infrastructure solutions for 35 years.
- Installed base of over 4800 separate projects
- Over 1600 Customers
- 34 million feet of fiber installed
- Over 150 fiber municipal area networks deployed
- Over 2.5 million ports of data/voice/video
- 50 Employees
- Private and profitable company
- Specializing in Government, Education, Enterprise, Medical, Finance and Service Provider markets.
- No Debt or Venture Capital

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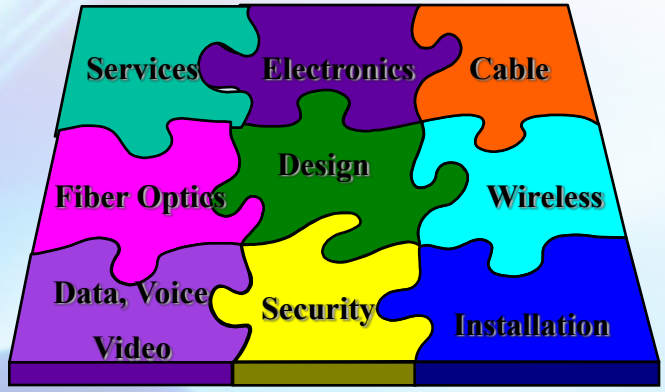
Comm-Tract Capabilities

- High Performance Structured Cabling Systems
- Fiber Optic Infrastructure Networks
- Wireless Infrastructure Networks
- DAS Cellular Networks
- Data Center and CO design and build out
- Local Area Networks
- Municipal Area Networks
- Converged IP Networks
- VoIP CPE, and Services
- Broadband Wireless Networks
- FTTX Fiber Networks
- Security Access Layer Solutions
- CCTV/Video Network Solutions



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Comm-Tract Capabilities

- **Project Management Services**
- **CAD Engineering**
- **Technical Staff Augmentation**
- **Help Desk Services**
- **LAN and WAN Network Assessments and Monitoring**
- **Network Maintenance Agreements**
- **Network Warranty Agreements**
- **Testing and Verification Services**
- **Custom Professional Services tailored to our Client's specific needs.**

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Comm-Tract Resources

- **Professionally Trained & Certified Engineers & Technicians**
  - BICSI Registered Communications Distribution Designers (RCDD)
  - BICSI RCDD LAN Specialists
  - BICSI Technicians
  - BICSI Installers
  - Fiber Optics Engineers and Technicians
  - Wireless Specialists

- **Network Infrastructure Specialists**
- **Superior Analysis, Design, Engineering, and Implementation**
- **Experienced, Professional and Accountable**

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Comm-Tract Partners

CORNING

HUB Technical Services

ADC KRONE

CHATSWORTH PRODUCTS, INC.
An Employee-Owned Corporation

ORTRONICS

CBE technologies

ANIXTER

Atrion

SideBand Systems

CommScope

Belden

Berk-Tek
AN ALCATEL COMPANY

PRESIDIO
Be Secure in the Knowledge

AMP NETCONNECT

General Cable

GALAXY
Integrated Technologies, Inc.

PANDUIT

molex
one company › a world of innovation

NetTeks
Technology Consultants, Inc.

CSC
Communications Supply Corporation

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Wireless Industry Trends

Wireless Industry Trends
Antennas and Towers

Three major network shifts are occurring:

- From Voice to Data
- From Outdoors to Indoors
- From Macro to Metro/Micro

Implications for Carrier Networks:

- Site Configuration Trends
- Densification
- Concealment and tower safety issues
- More fiber at the tower sites
- Multi-band, multi-technology networks
- Overloading towers and mounts
- Indoor installations (DAS, Small Cells)
- Backhaul and power issues for urban densification
- Fitting more complex network equipment into a smaller footprint
- Components supporting better heat management and efficiency

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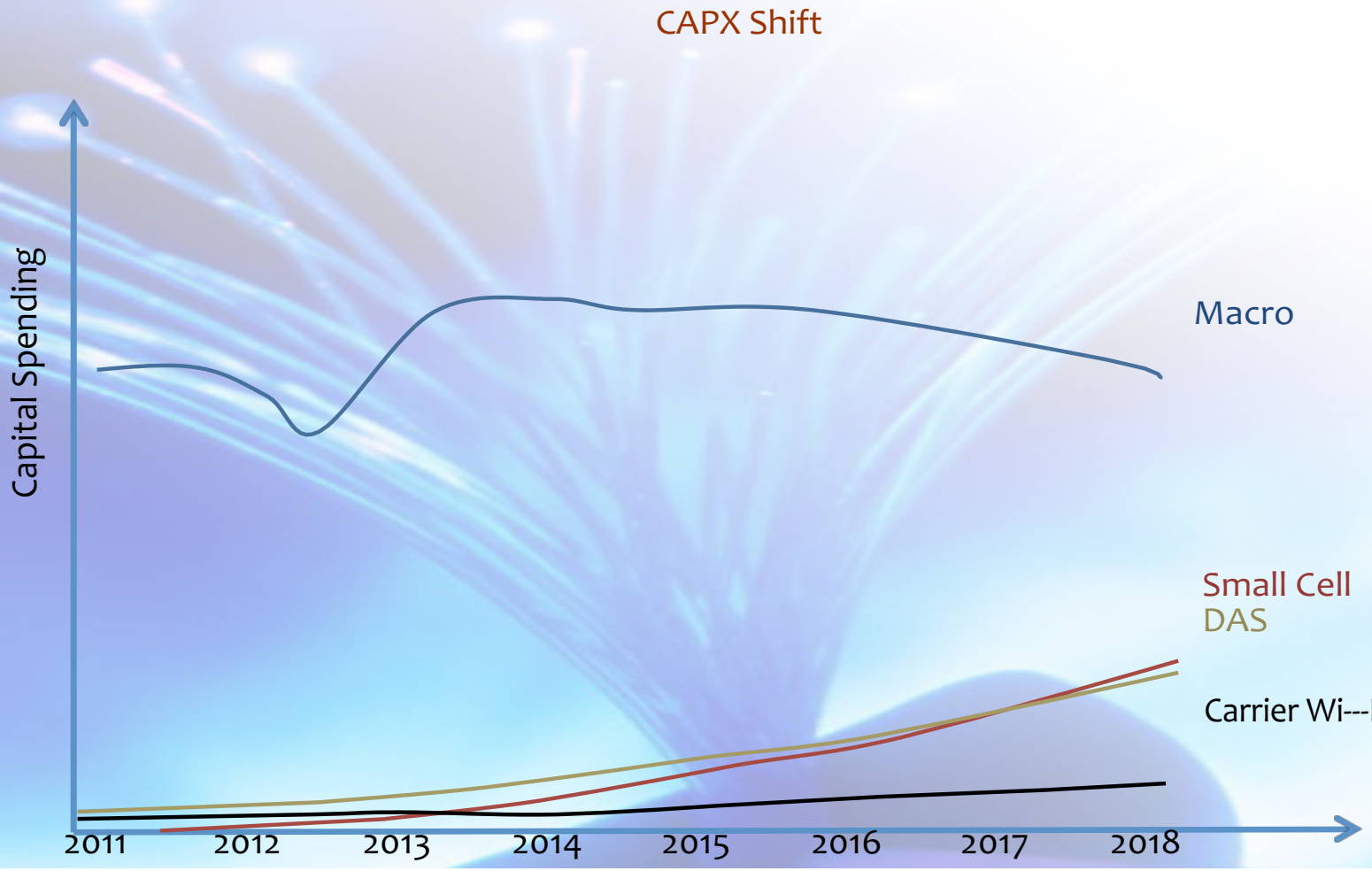
Wireless Industry Trends
Capital Spending Shift



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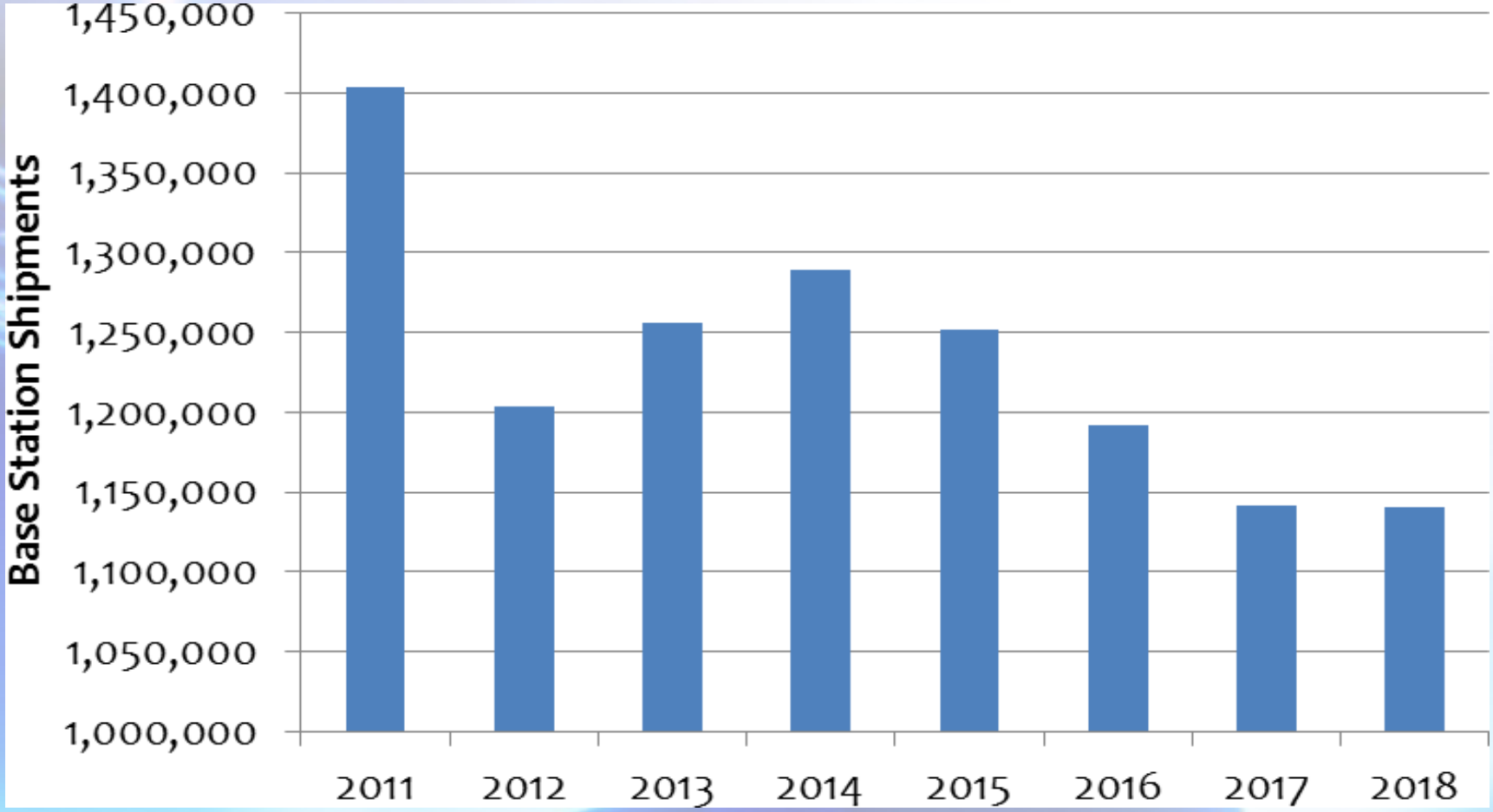
Wireless Industry Trends
Uneven Macro Deployments



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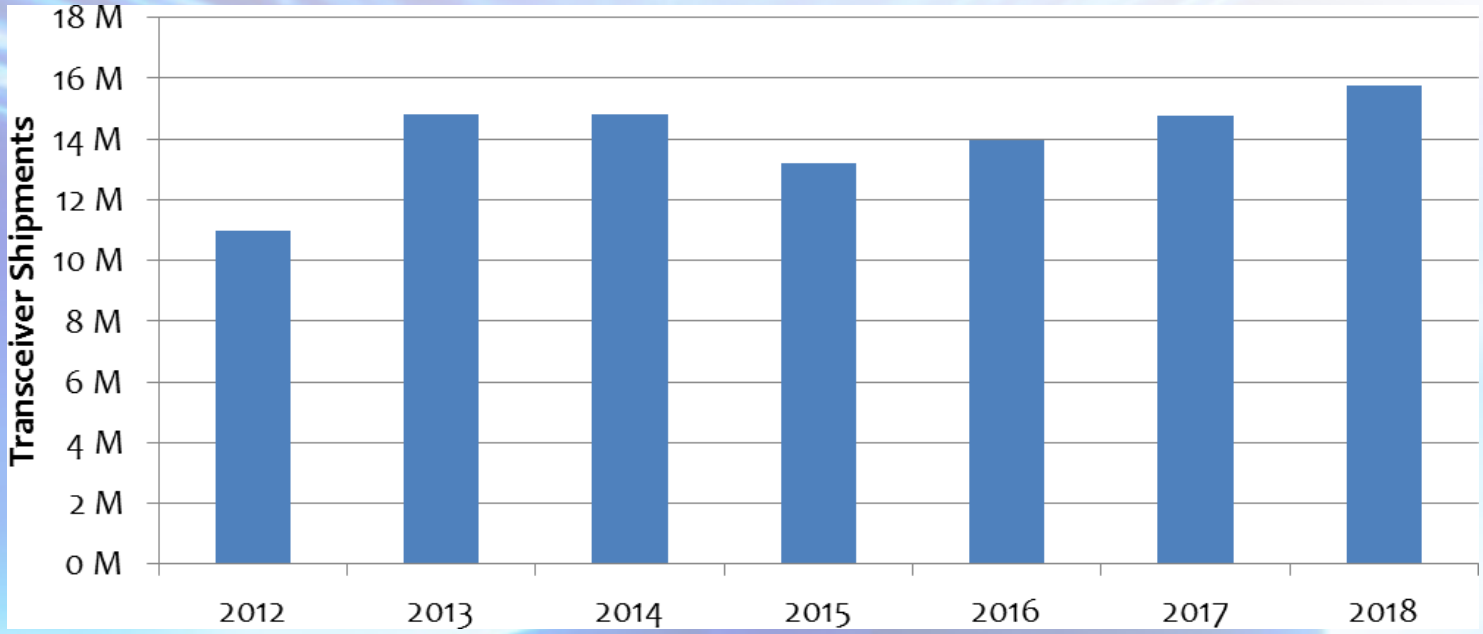
Wireless Industry Trends
Macro Receivers Up

Macro base station spending is down, however the number of transceivers is increasing

- More mobile data
- New frequency bands
- MIMO and AAS drive more transceivers at lower power



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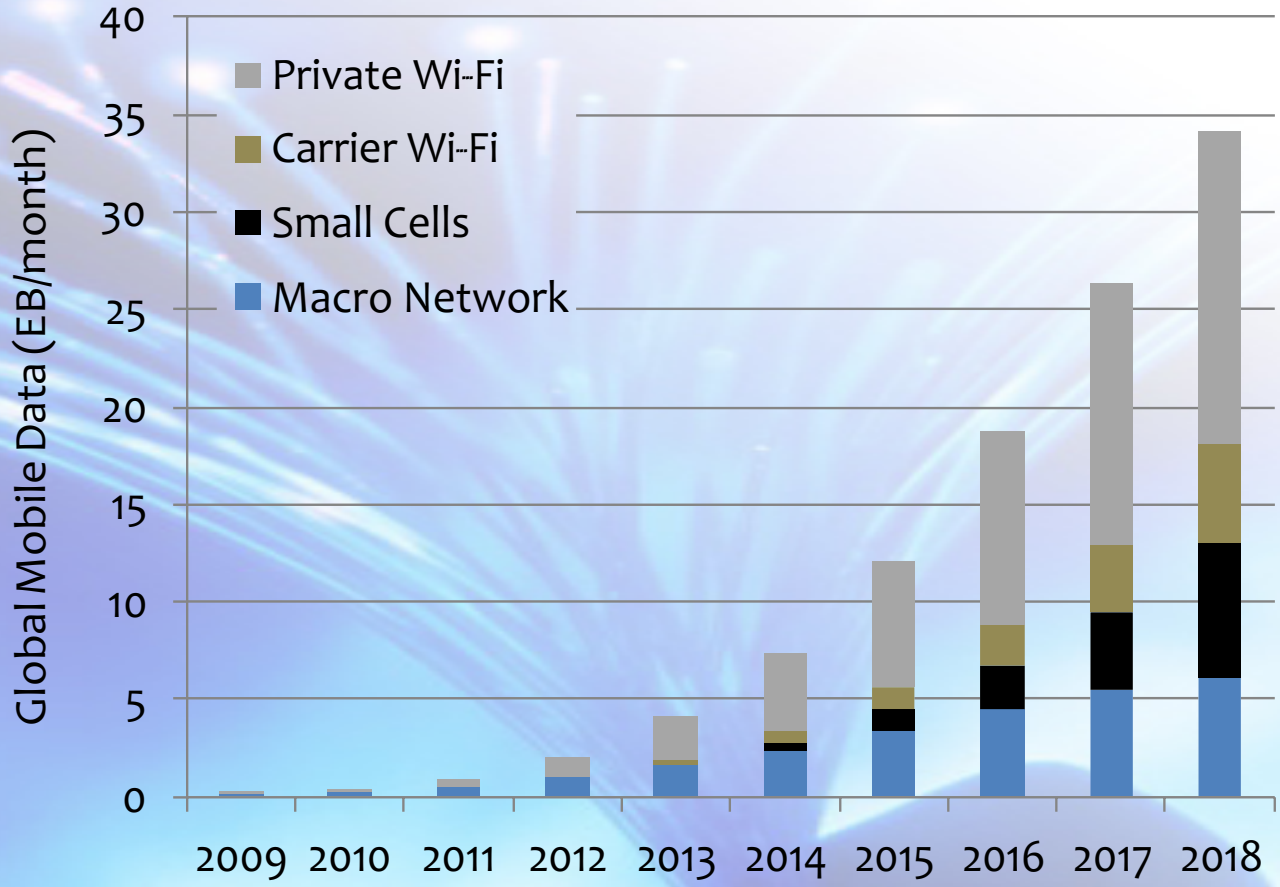
Wireless Industry Trends
How Traffic Moves Now



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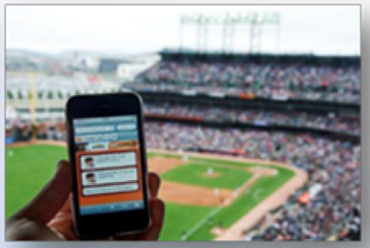
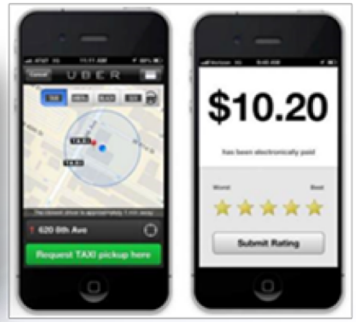
Wireless Industry Trends
Increasing # of Devices





Pushing the the need for more speed and capacity across wireless networks

- *Additional broadcast locations required; and closer to the handset*
- Ongoing growth in tower and traditional macro sites
- Robust DAS networks at high capacity venues
- Small cells to improve coverage, quality and capacity
- Wi-Fi offload

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Wireless Industry Trends
Tower and Macro Infrastructure

- Ongoing growth in required broadcast locations
- More complex and sensitive RF requirements
- Increased usage of Remote Radio Heads located closer to the antennas
- Cost effective backhaul solutions
- Permitting and zoning processes continue to be a challenge, particularly in certain markets leading to increasing concealment and stealthing requirements

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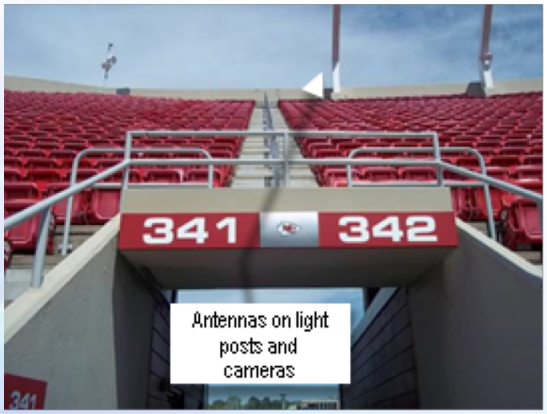
Wireless Industry Trends
DAS (Distributed Antenna System)

- Neutral host model
- Technology continuing to evolve, including FTTA
- Robust design standards
- Cost effectiveness
- Venue requirements
- Concealment of antennas



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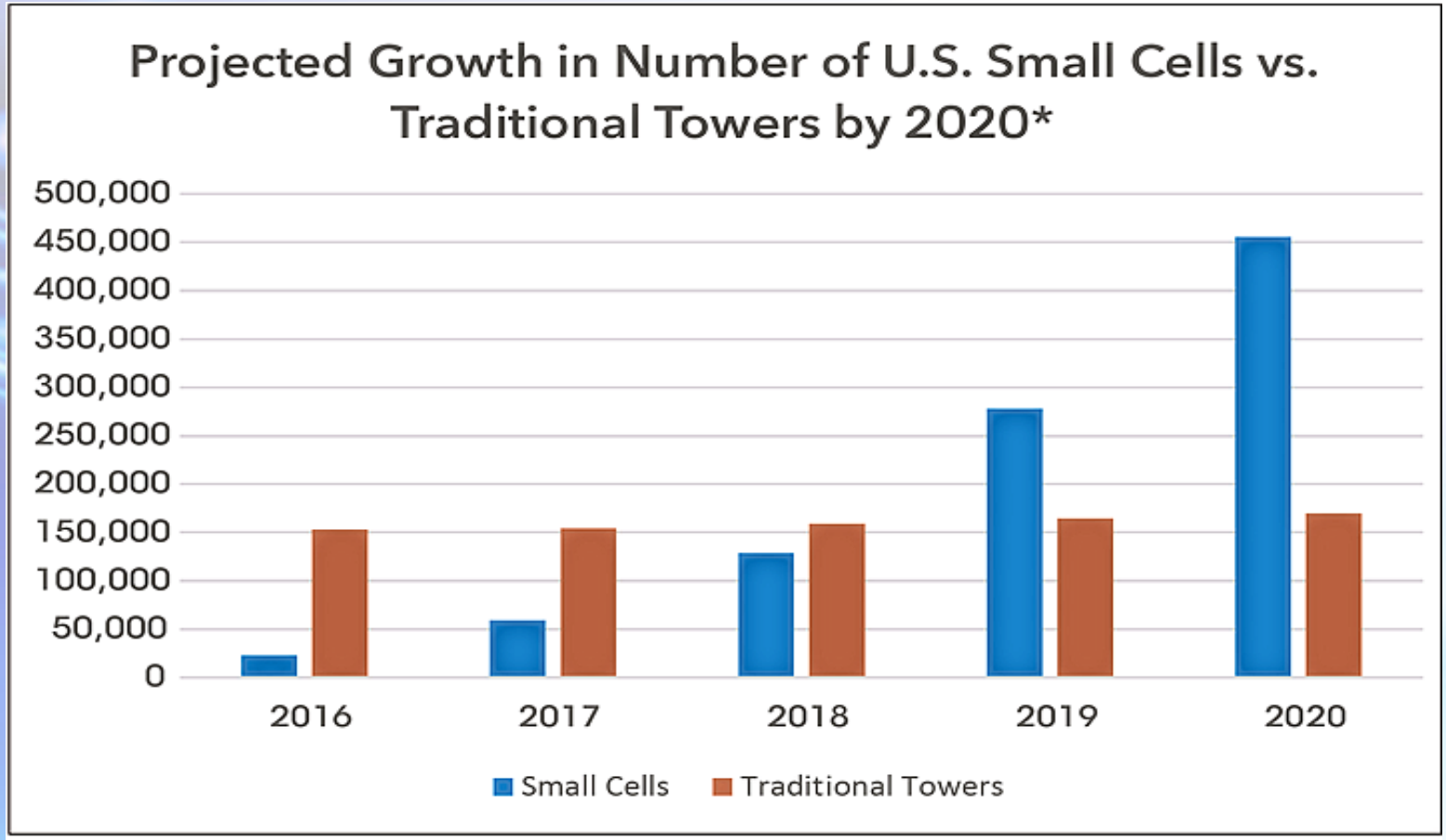
Wireless Industry Trends
Small Cell and Wi-Fi

Small Cell Trends:

- Hardware development still in early stages
- Narrowband to broadband
- Deployment challenges to be addressed
- Unit cost
- Lease rights
- Power
- Backhaul

- **Wi-Fi Trends:**
- Not all networks created equal
- Higher density designs
- Integration with venue CRM
- Carrier offload and auto-authentication not prevalent yet

Wireless Industry Trends
Small Cells



Source: Kagan Research, an offering of S&P Global Market Intelligence

*Projections assume ideal regulatory conditions

Bloomberg BNA

Types of Cellular Sites

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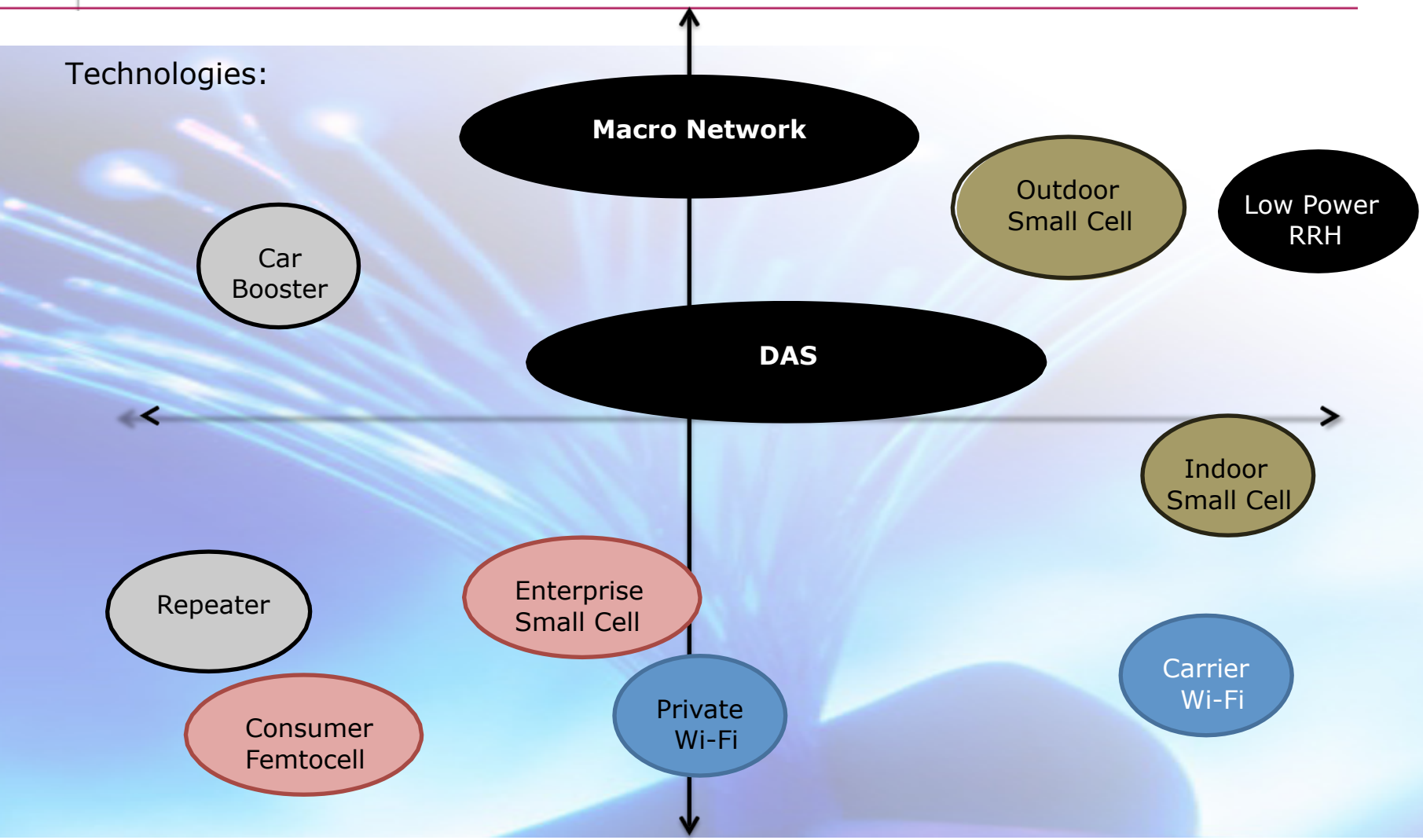
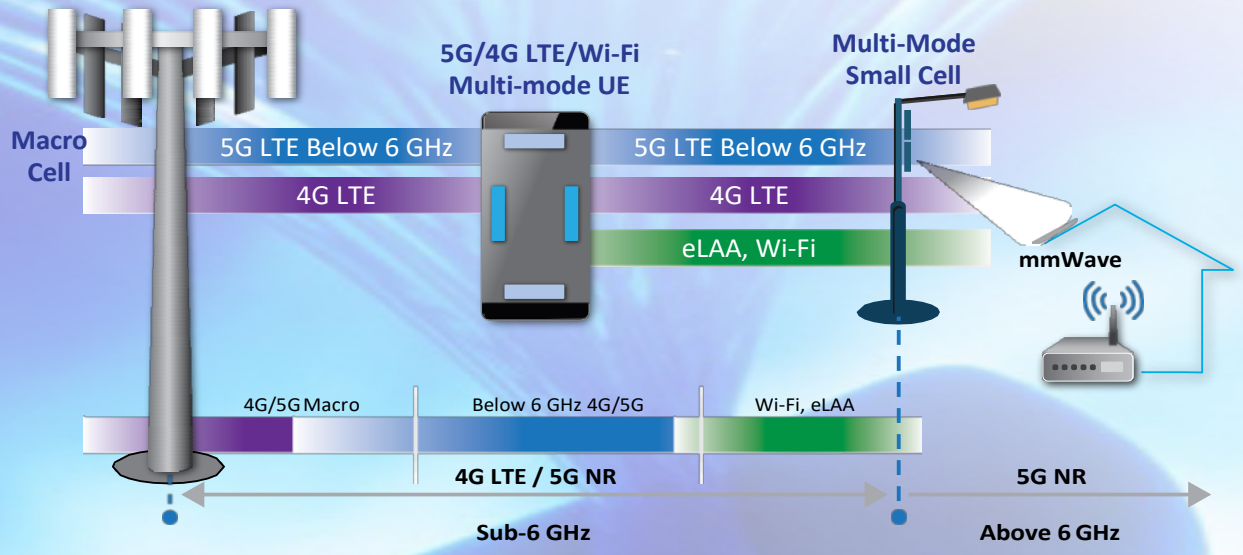
Types of cell Sites
Each Technology has a Role



Small Cells

- Today - Typically single band and MIMO capable.
- Next-generation - multimode, multiband, higher order modulation MIMO-capable, smaller, lighter, and will consume less power.
- Designed to be part of the heterogeneous network that combines many diverse wireless data technologies operating over a wide range of licensed and unlicensed spectrum.

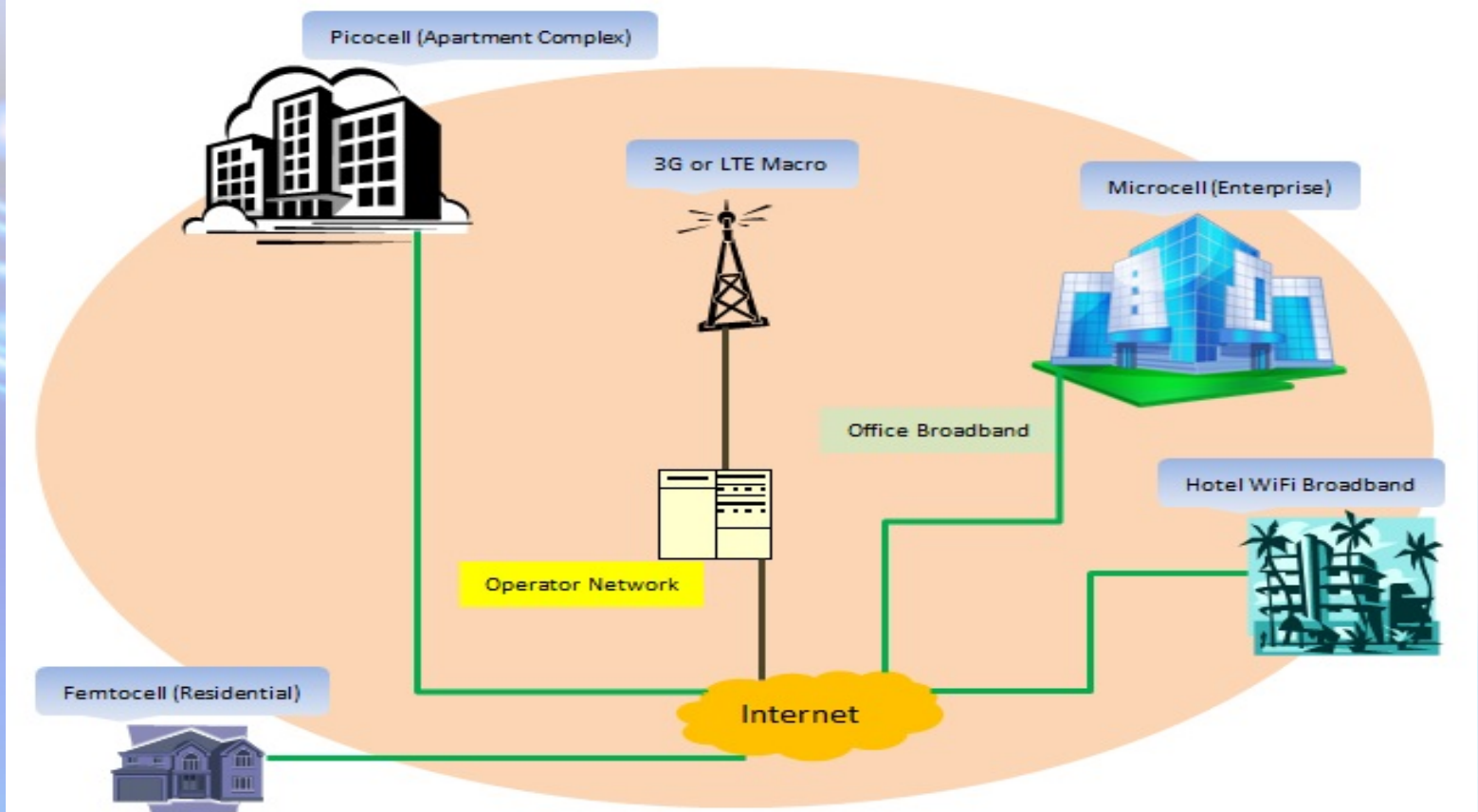


Small Cells

Small Cell Categories:

- **Metro cell**
  - Power – 5W
  - Coverage Radius – Up to 1000’
  - Capacity – Up to 200 Users
  - Primary Use – Outdoors
- **Picocell**
  - Power – 1W
  - Coverage Radius – Up to 750’
  - Capacity – Up to 64 Users
  - Primary Use - Indoors
- **Femtocell**
  - Power – .1W
  - Coverage Radius – Up to 60’
  - Capacity – Up to 6 Users
  - Primary Use - Indoors

Small Cells



Wireless Network with Small Cells

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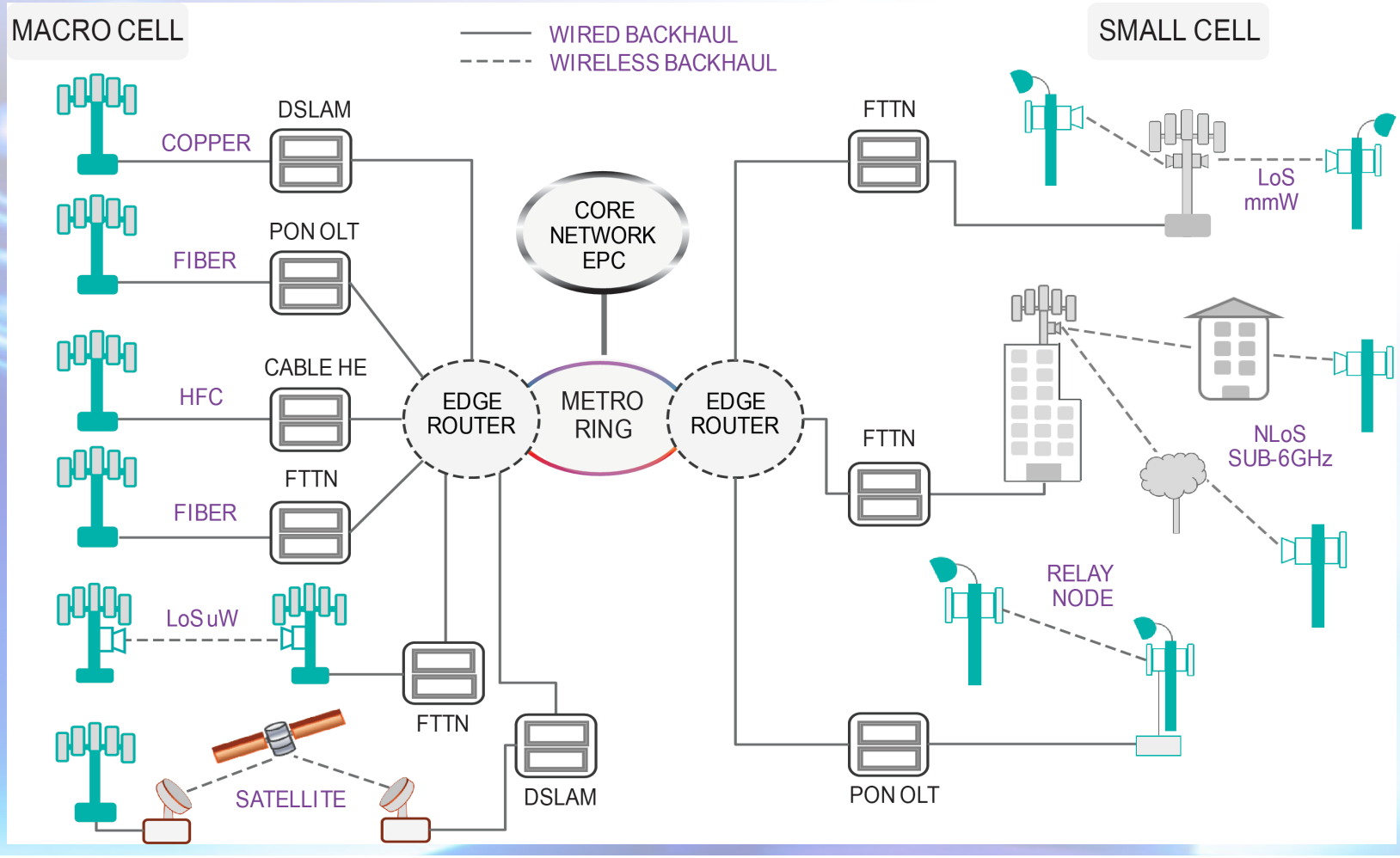
Small Cells
Integration into Macro Cell Network

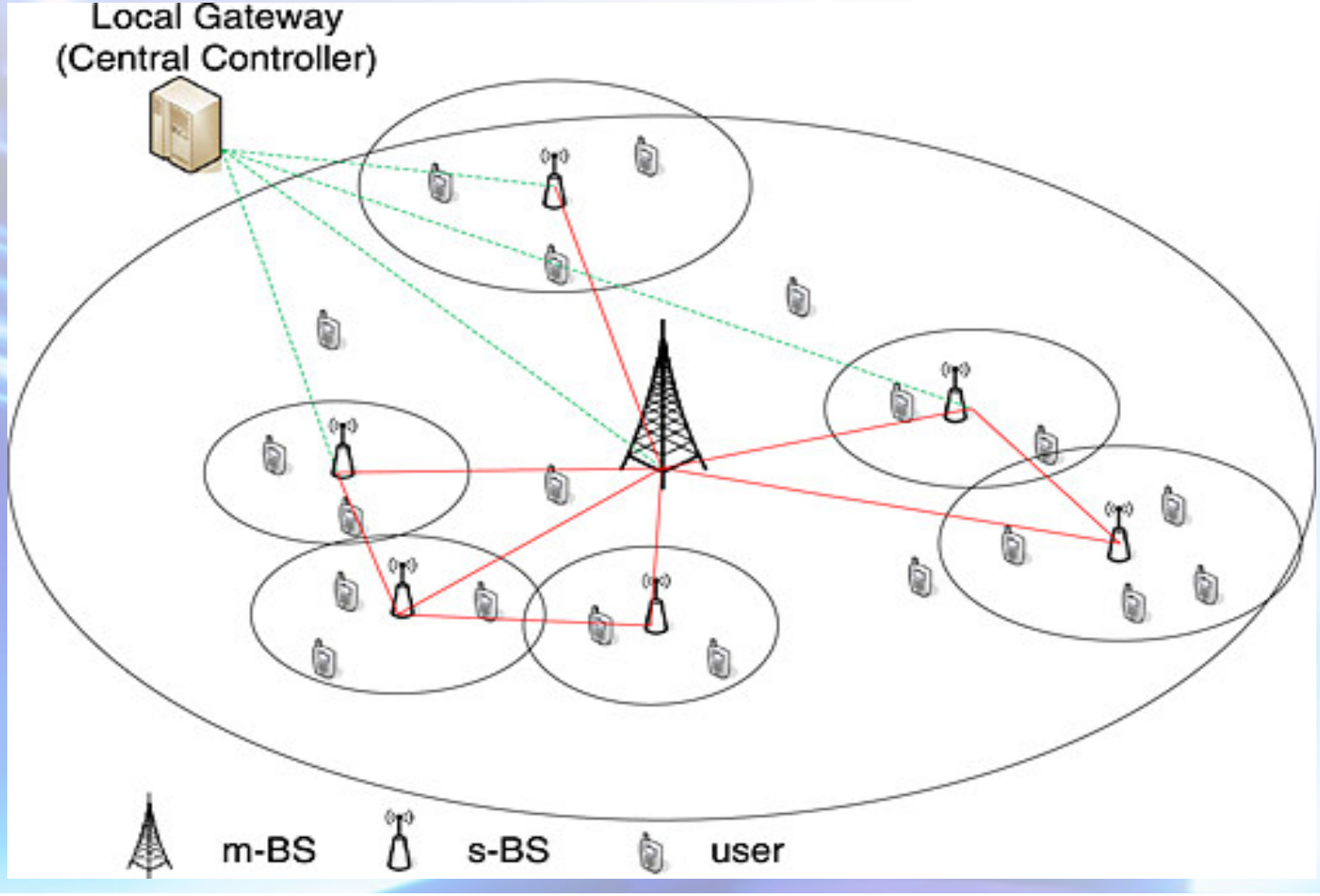


Macro Cells

Macro Cells

- A M**acro Cell** is a cell in a mobile phone network that provides radio coverage served by a high power cell site (tower, antenna or mast).
- Generally, Macro Cells provide coverage larger than Micro Cell.
- **Macro Cell** base stations have power outputs of typically tens of watts.

Macro Cell



Cellular Network Architecture

Cellular Network Architecture

- The high-level network architecture of **LTE** is comprised of following three main components: The User Equipment (UE). The Evolved UMTS Terrestrial Radio Access Network (E-UTRAN). The Evolved Packet Core (EPC).

- A **cellular network** or **mobile network** is a communication network where the last link is wireless. The network is distributed over land areas called cells, each served by at least one fixed-location transceiver, known as a **cell** site or base station

- **Base Transceiver Station (BTS)** – It is actually the antenna that you see installed on top of the tower. The BTS is the Mobile Phone's access point to the network. It is responsible for carrying out radio communications between the network and the Mobile Phone. ... A BTS is assigned a Cell Identity

- **Mobile Equipment (ME)** – This refers to the physical phone itself

- **What is a Cell?** – A base station (transmitter) having a number of RF channels is called a cell. Each cell covers a limited number of mobile subscribers within the cell boundaries (Coverage area). Approximately a Cell Radius is 1 to 30 Km

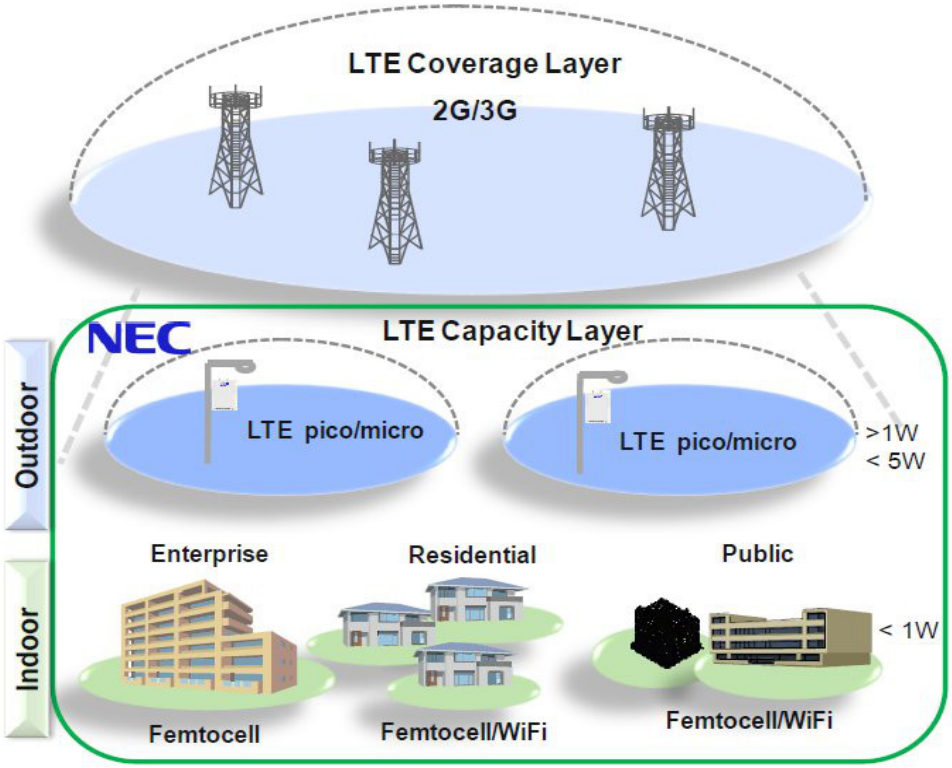
Cellular Network Architecture

- **Base Station Controller (BSC)** – The BSC controls multiple BTS's. It handles allocation of radio channels, frequency administration, power and signal measurements from the MS, and handovers from one BTS to another. A BSC also functions as a "funneler". It reduces the number of connections to the Mobile Switching Center (MSC) and allows for higher capacity connections to the MSC. A BSC may be collocated with a BTS or it may be geographically separate. It may even be collocated with the Mobile Switching Center (MSC)

- **Mobile Switching Center (MSC)** – The MSC is the heart of the GSM network. It handles call routing, call setup, and basic switching functions. An MSC handles multiple BSCs and also interfaces with other MSC's and registers. It also handles inter-BSC handoffs as well as coordinates with other MSC's for inter-MSC handoffs.

Heterogeneous Architecture

LTE Small Cell & Het-Net



The small cell solutions will be key element of a sustainable mobile broadband business

Heterogeneous network

Coverage Layer (lower frequency) + Capacity Layer (higher frequency and small cells)

Small Cell benefits include:

- ✓ Big capacity
- ✓ High performance
- ✓ Easier operation
- ✓ Faster deployment
- ✓ Low TCO
- ✓ New services
- ✓ Additional revenue

Challenges include:

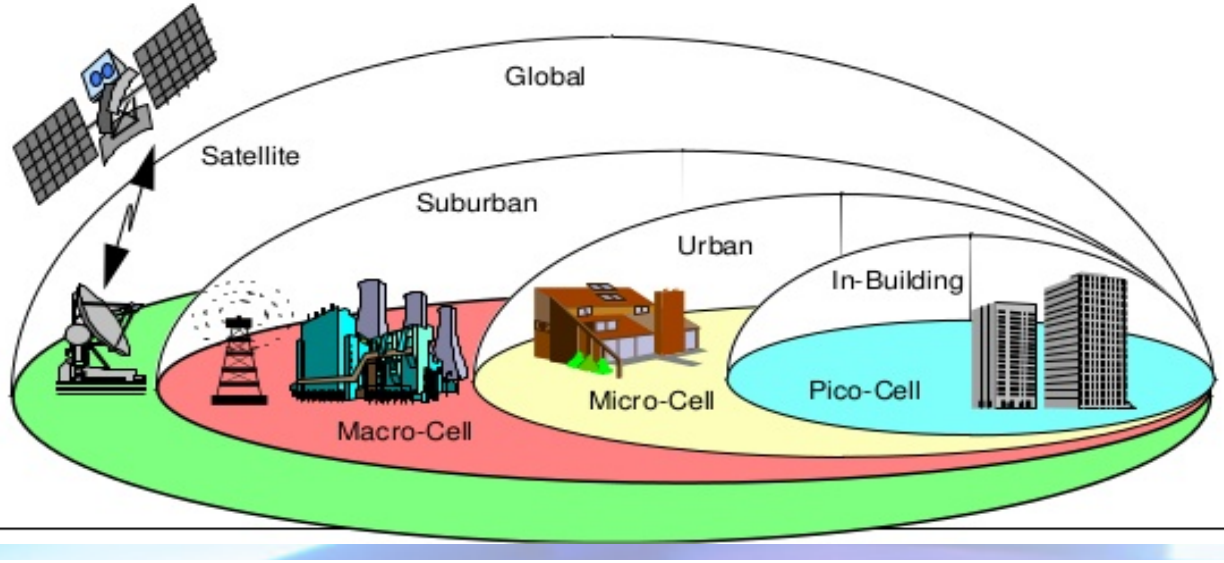
- ✓ Interference
- ✓ Resource management
- ✓ Multi vendor SON & management
- ✓ Backhaul

- ✓ **Mind Set Change!**

Heterogeneous Architecture

3G UMTS

- Types of Cells and Base station to use them
  - Cells will operate in a hierarchy overlaying each other



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Cell Site Types - Fairhaven

Cell Sites - MetroCell

- **Metro Cell**
  - Miniature version of the traditional Macro Cell.
  - Compresses the attributes of a cell tower like radios and antennas into a low power, portable and easy to deploy radio device.
  - Metro Cells typically have a range varying from 10 meters to a few hundred meters
  - Offload traffic from the macro network in a high density short range environment or to strengthen the range and efficiency of a mobile network.
  - The terms Small Cell, Micro Cell and Metro Cell are commonly used interchangebly.

Cell Sites - Small Cells

- **Augmented coverage and capacity.** Superior in-building and cell edge performance – Contemporary wireless networks regularly face issues of poor coverage inside buildings and in areas far away from the cell tower. Small cells significantly improve the overall experience in such circumstances.

- **Easier technology integration** – Small cells can be integrated with all flavors of 3G, LTE, LTE-Advanced and Wi-Fi technologies.

- **Long term solution for the operator** – Even though more base stations and state-of-the-art technologies can be deployed to temporarily resolve network congestion issues, the demand will generally exceed the supply. However, small cells are designed to offer adequate network resources to handle growing data demand for a few years within a specific environment.

Cell Sites - Small Cells

- **Higher spectrum bands are welcome** – Recently, the mobile network providers have been fighting a battle for the lower band spectrum below 1 GHz. But since limited propagation characteristics are not an issue for these miniscule networks, and more bits/Hz are required, spectrum over 2 GHz is considered good. The FCC in US has been pushing for 3.5 GHz spectrum for small cell networks. Some stakeholders have asked for unlicensed spectrum for such networks.

- **Attractive business case** – The reduced capital and operational expenditure (CAPEX/OPEX) involved in the small cell ecosystem has made them a tempting business proposition for the mobile service provider. Studies have shown that the cost of radio equipment for small cells could be just one-tenth of the corresponding costs for a Macro Cell. The ease, flexibility and swiftness of deployment make such networks even more appealing.

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Cell Sites - Metro Cell

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Cell Sites of Concern to Newton
Metro Cell

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Cell Sites of Concern to Newton
Metro Cell

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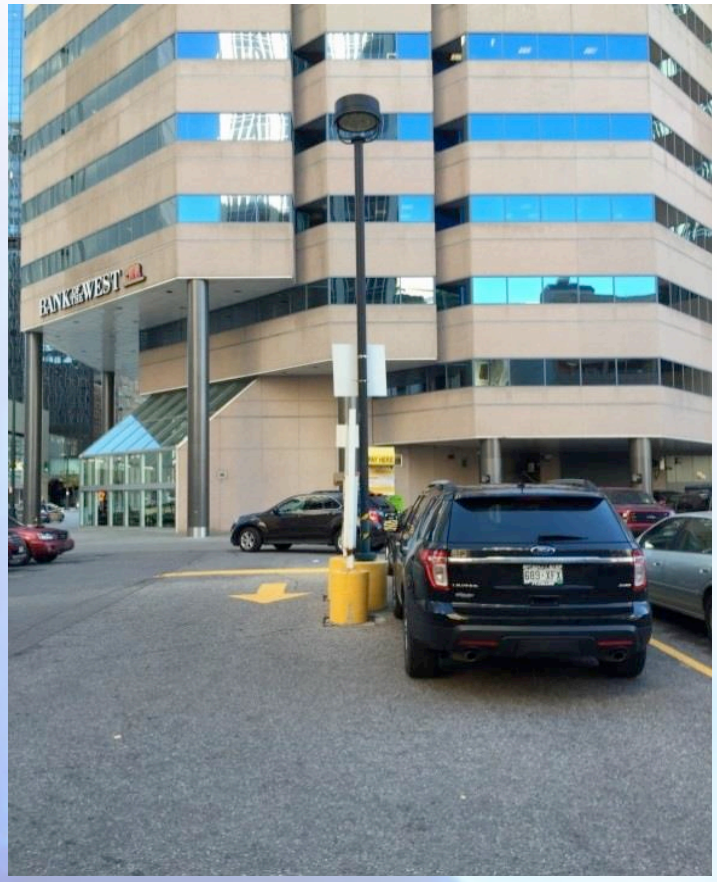
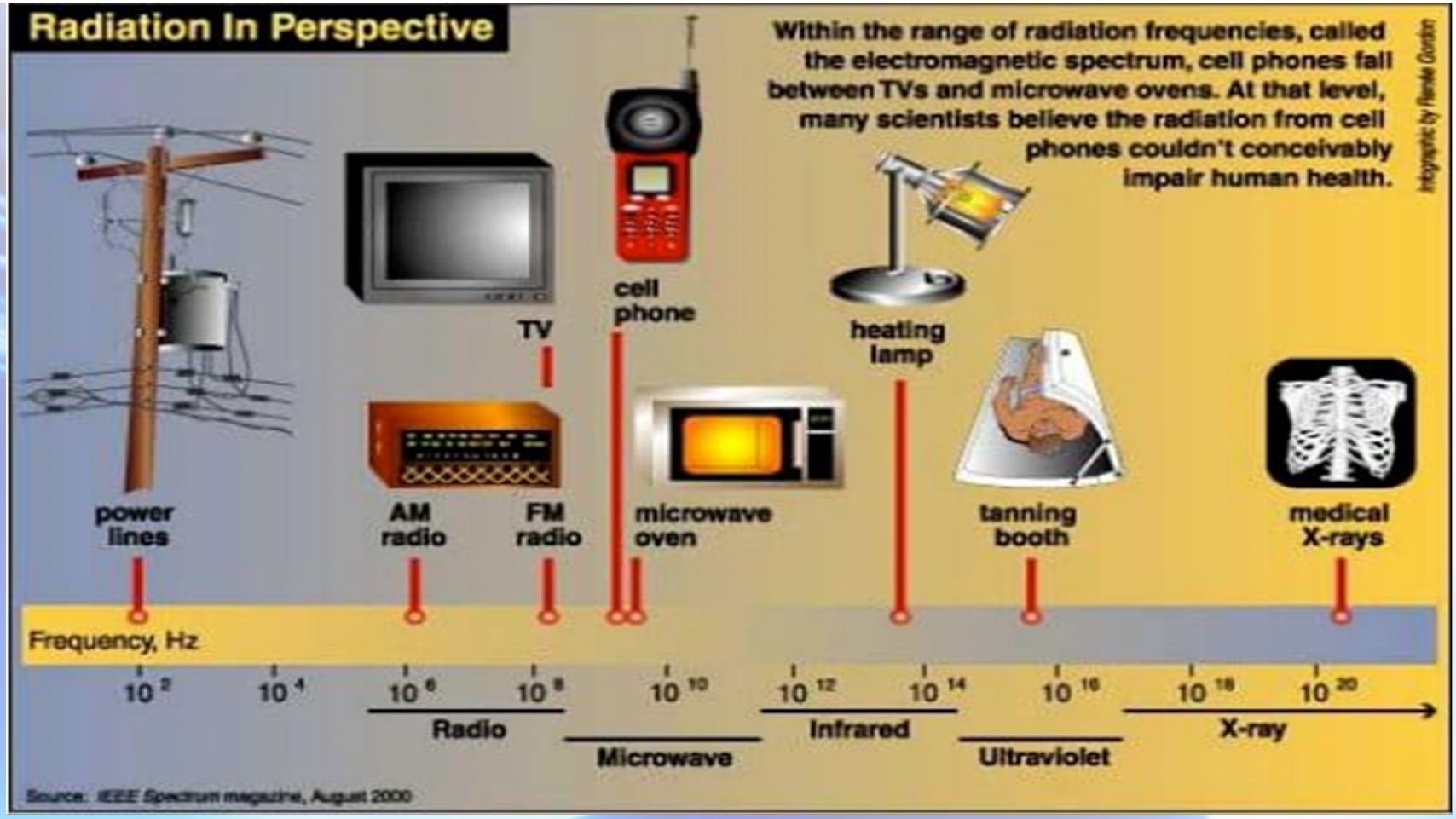
Cell Sites - Metro Cell



Cell Sites - Radiation



Cellular Site Requirements

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Cell Site Requirements
Overall Carrier Priorities

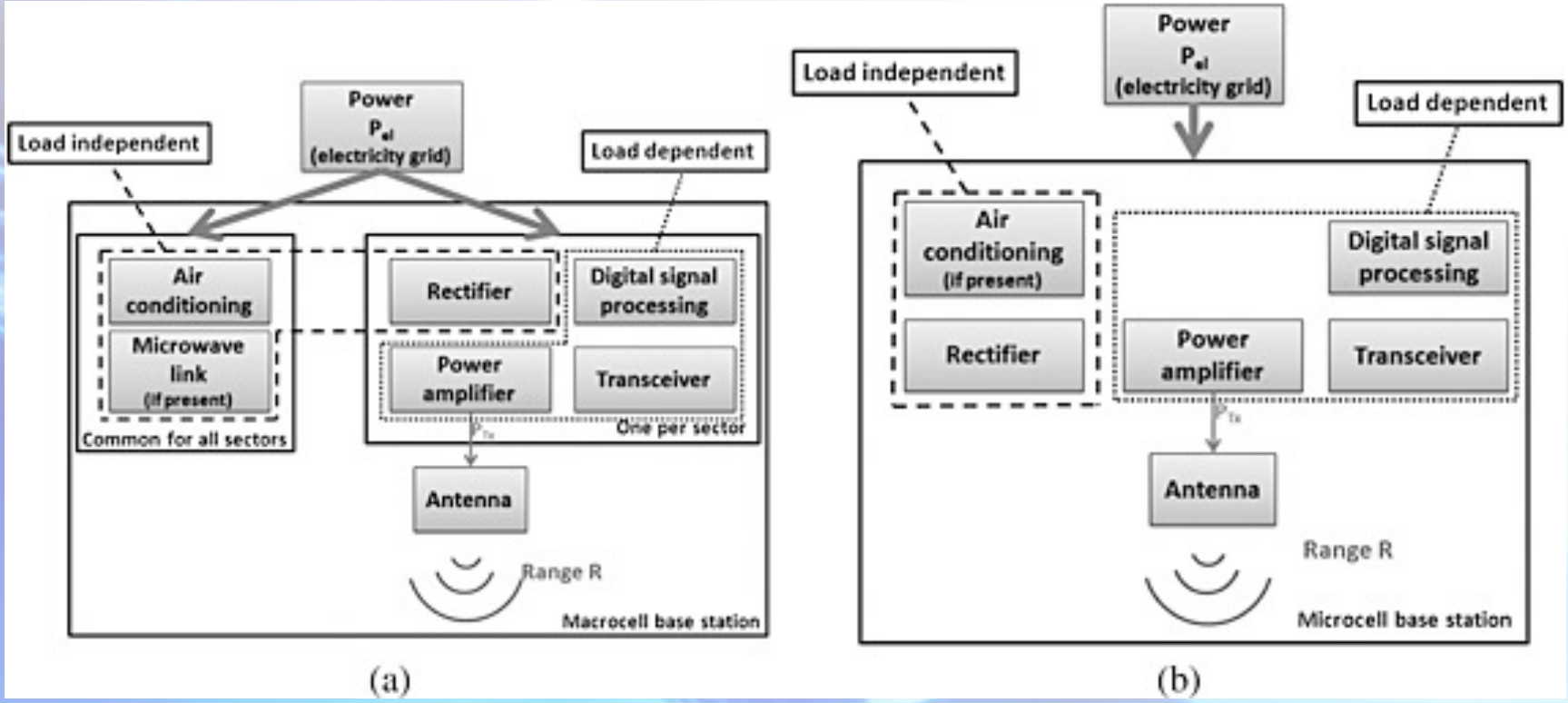
- **Available Azimuths**
- **Equipment Area**
- **Ease of Construction**
- **Construction Cost**
- **Structural Capacity**
- **Ease of Leasing**
- **-** Prefer small property owners, faster and simpler lease process
- **Cost of Leasing**
- **Ease of Access**
- **Preferred RAD Center**
  - Center of Radiation at desired height of Antenna
- **Cost of Expansion/Modification**
- **Proximity to Residential Areas**
- - Residential more valuable due to demand and zoning restrictions

Cell Site Requirements
Verizon Priorities

- **Land for Tower Sites**
  - Leased Area 100’ by 100’
  - 100’ to 500’ from Major Road
  - Zoning Classification that allows for communications structures
  - Power and Backhaul facilities
  - Access to facility 24 by 7 by 365

- **Building or Rooftop Sites**
  - Minimum 3 to 4 stories tall
  - Zoning Classification that allows for communications structures
  - Power and Backhaul Facilities
  - Flat Roof, capable of handling 150lbs per SQ FT
  - 20’ by 30’ area on roof, or ground immediately next to the building
  - Access to facility 24 by 7 by 365

Cell Site Requirements



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Voice/Data/Video Networks

Acknowledgements

- RCR Wireless
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- T Mobile
- Verizon
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- Kagen Research
- Technopedia
- Rohde and Schwarz
- Harris Consulting

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