

Evolution of Cellular Networks

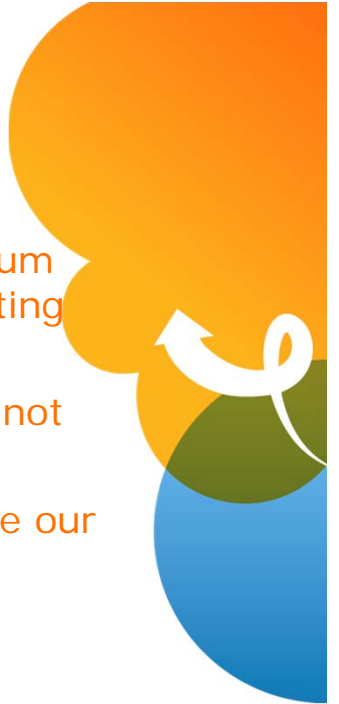
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Problem Statement

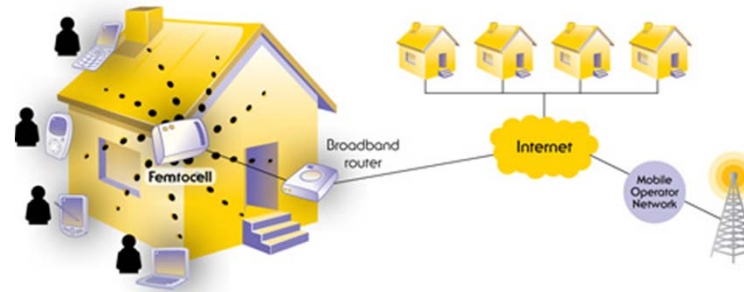
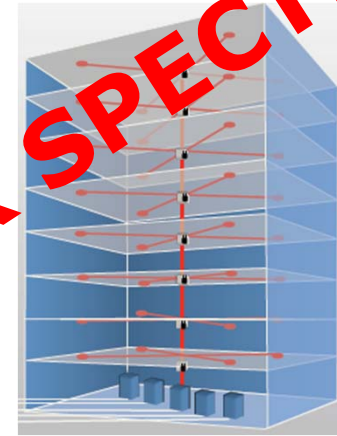
- Traditional methods of expanding mobile capacity – cell splitting and spectrum acquisition – are expensive and time consuming, and zoning issues are limiting deployment
- Complete migration to LTE will significantly improve spectral efficiency, but not sufficiently to meet growing data demands by itself
- Other tools are needed to make better use of existing spectrum and improve our ability to serve growing mobile data capacity demands

- Rapid increase in mobile data use
- Building penetration
- Reduced ability to build macro/outdoor networks
- High concentration of users
- Local services



Enter "Small Cells"

- "Hotspots" where usage is high – indoors and out
- Enterprise
- Home
- Retail locations
- Public gathering places
 - Sports venues
 - Shopping centers
 - Transportation hubs
 - Entertainment districts
 - Urban centers
- Campus environments
- Etc.



Technologies

- Cellular-based
 - DAS systems
 - Distributed NodeB from macro network
 - Repeaters
 - Picocells
 - Femtocells
- Wi-Fi
 - 802.11 a/g, 802.11n
 - Enterprise networks
 - Carrier networks
 - White space?
- Multi-Mode Small Cells



Challenges

- Cost effective deployment methods
- Hetnet deployment planning – indoors and outdoors
- Specialized antennas
- Configurable Multiple band and technology support
- Interference management
- Network management
 - Parameter optimization, SON
 - Hand off and mobility management
 - Many more nodes – larger alarm volume, impact of alarms
 - Dynamic neighbors, cell prioritization
 - Joint planning and operation
- Mobility
 - Load balancing and speed based cell selection/re-selection/handoff
- Cellular-Wi-Fi integration
- Backhaul implementation and monitoring
- User behavior - Note indoor systems may improve the user experience and may thereby change user behavior, resulting in increased overall use.



Key Issues and Challenges

- RAN Topology, Power and Spectrum Utilization
 - Spectrum planning
 - Integration with macro RAN, DAS, Femto and Wi-Fi solutions
 - Interference mitigation
 - Multiband, multi-technology configurable in single platform
 - Combined antenna structure for outdoor microcell
 - Joint planning and operation
 - Load balancing and speed based cell selection/re-selection/handoff
 - Optimization
- Transport Network
 - Backhaul requirements, design and implementation
 - Different locations drives new backhaul methods - NLOS, bonded VDSL, etc.
 - X2 interface routing between macro and metrocell layer
 - Load balancing impacts to X2
- OA&M issues
 - Power and interference management
 - SON required, must operate cross layer
 - Management of new device types, locations, and considerations
 - QoS and Policy support
 - Traffic engineering tool suite
- Integration and other issues
 - Role of Wi-Fi and femtocell
 - Joint planning of Wi-Fi and cellular coverage
 - Indoor and outdoor deployment
 - Multi-vendor environment
 - New deployment locations, antenna types, agreements, and real estate needs
- User behavior - Note indoor systems may improve the user experience and may thereby change user behavior, resulting in increased overall use.



Benefits

If we do this right

- Better coverage and throughput
- Higher capacity – where it is needed
- Easier deployment
- New services
- Lower cost
- Mutually beneficial carrier/building-owner relationships
- Offloads the macro network

