WELCOME
KEY MOBILE BACKHAUL CAPABILITIES FOR LTE AND LTE-ADVANCED

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Radio Access Network Evolution

Several evolutionary paths to scale RAN coverage and capacity

Many options for...
- Increased coverage and capacity
MOBILE BACKHAUL
KEY TO SUCCESS IN AN ERA OF GROWING SUBSCRIBER DEMAND

- More flexibility
- More scalability
- More operational simplicity

Each evolutionary step has an impact on backhaul - preparation is key
AGENDA

1. Small cells: Flexibility and rapid scaling
2. Cloud RAN: CPRI fronthaul transport
SMALL CELL BACKHAUL
REMOMING THE BARRIERS TO DEPLOYMENT
SMALL CELL BACKHAUL CHALLENGES
SOME TYPICAL SMALL CELL SITE CONSIDERATIONS

- **Service availability/QoS**
  - 3G, LTE, LTE-A Wi-Fi

- **Environment**
  - Indoor, outdoor
  - Temperature extremes

- **Site acquisition**
  - Right of way, trades access restrictions

- **Power**
  - AC, DC, surge, holdup, PoE

- **Backhaul Media Access**
  - Microwave (LOS, NLOS, P2P, P2MP)
  - Fiber (P2P, GPON)
  - Copper (VDSL, bonding)

- **Networking**
  - Security
  - Topology
  - QoS, multiple operators

- **Demarc/OAM**
  - Test/turn-up, monitoring
  - Fault detection & correction

- **Timing/sync**
  - GPS, Sync E, 1588v2

Site ‘customization’ impacts deployment velocity, management and costs
NEED CONSISTENT OPERATIONS OVER ANY MEDIA

Cell site

Backhaul options

- Microwave
- Ethernet
- GPON, EPON
- Bonded XDSL
- CWDM/DWDM

MTSO/ controller site

Microwave

Ethernet

GPON, EPON

Bonded XDSL

CWDM/DWDM
SMALL CELL BACKHAUL CHALLENGES
POWERFUL NEW OPTIONS AT SUB-6 GHz

N-LOS and n-LOS via multiple diverse paths

Point-to-multipoint

Advanced beamforming and interference cancellation

Broadening the applicability and cost-effectiveness of this technology
SMALL CELL BACKHAUL CHALLENGES
N-LOS IS PROVING ITSELF

**Predictable**
- Urban trial experiences show good, predictable throughput
- Effective mapping tools essential

**Unlicensed operation**
- 5.8 G bands used in dense urban metro areas
- Advanced interference management

**Easy installation and alignment**
- Smart beamforming reduces skillset and manpower requirements
- Adaptable power over Ethernet (PoE)
SMALL CELL BACKHAUL CHALLENGES
AGGREGATE BACK INTO THE MACRO WITH 60-80 GHz

Line of sight
Unlicensed or lightly licensed
High capacity, low latency

Street-to-street
Macro-to-street
Fiber access

Broadening the applicability and cost-effectiveness of this technology
SMALL CELL BACKHAUL AGGREGATION DEVICES
IMPORTANT ATTRIBUTES FOR RAPID SCALING

Networking flexibility
- Any media
  - Cu, Fiber, Microwave
- Flexible networking
  - Ethernet, IP/MPLS

End-to-end solution
- Massively scalable head end
  - Tens of thousands of devices
- Comprehensive management
  - Automatic, service aware

Security
- Multi-level
- Hardware encryption

Operational simplicity
- Fully outdoor, power efficient
- Proactive SLA monitoring

Synchronization
- Extensive range of techniques
- Integrated GPS and grandmaster

Enabling cost-effective coverage and capacity in mobile networks
CASE STUDY 1
OUTDOOR SMALL CELL BACKHAUL

Issues and challenges
• Capacity increase is the principal need
• Extending a macro backhaul network in dense metro areas
• Scalable sync needed (frequency, phase, ToD)
• Support for eMBMS and VoLTE
• Measuring and monitoring SLAs (e.g. delay)

Solution approach
• Metro Ethernet, xDSL, LOS and NLOS microwave media, with consistent operations and OAM
• Traffic stream aggregation via the macro network
• Integrated GPS, with 1588 sync distribution
• IPv6, IP multicast, and advanced QoS
• X2 interface support improves performance
CASE STUDY 2
INDOOR SMALL CELL BACKHAUL

Issues and challenges
• Leverage standard Internet access, secure backhaul for rapid in-building deployment
• Secure user traffic
• Secure OAM traffic
• Distribute accurate synchronization

Solution approach
• User traffic over IPSec tunnels from small cells to SeGW and head end MBH router
• OAM traffic over IPSec tunnel originated from VPRN
• Line rate NAT-T
• Integrated GPS receiver and GM
AGENDA

1. Small cells: Flexibility and rapid scaling
2. Cloud RAN: CPRI fronthaul transport
WHAT IS A C-RAN?

• **Cloud** RAN
  - Virtualized, elastic resources

• **Centralized** RAN
  - Consolidation of hardware at hub sites

• **Clean** RAN
  - Reduced environmental footprint

__[Also known as a V(irtualized)-RAN]__
THE CELL PROLIFERATION PROBLEM

3G  →  LTE  →  LTE-A

Capital cost
Inter-cell interference
CENTRALIZED, POOLED BASEBAND PROCESSING
C-RAN FOR LTE ADVANCED

- Better scaling and efficient hardware usage
- Improved spectral efficiency and QoE
- Total cost of ownership gains

Centralized, pooled baseband processing

Advanced interference management between radios

CPRI fronthaul transport

Needs low latency, high capacity transport
COMMON PUBLIC RADIO INTERFACE (CPRI) TRANSPORT OVERVIEW

CPRI summary
- A digital interface standard for encapsulating antenna samples sent between a radio (RRH) and a baseband unit (BBU) that performs the digital processing of those signals

Characteristics
- Signals are interleaved in a low latency TDM-like fashion
- Originally designed for point-to-point optical interconnection
- Bit rates in multiples of 614 Mb/s up to 9.6 Gb/s
- Container nesting supported
- Includes alarms and timing/synchronization
INTEGRATED CPRI FRONTHAUL AND ETHERNET BACKHAUL

Outdoor environment

Outdoor environment

Macro cell or MTSO

IP/MPLS Ethernet backhaul

Low delay, high capacity (optical) fronthaul

End-to-end packet backhaul

Uniquely differentiated capability
CASE STUDY 3
C-RAN CPRI FRONTHAUL

Issues and challenges
• Outdoor devices needed, e.g. for stadium deployment
• Require high capacity and low latency
• Fiber must be conserved
• Maximize integration with IP/MPLS network

Solution approach
• Compact, rugged form factors
• Wavelength-based approach can deliver 10 Gb/s and sub ms transport
• CWDM is efficient and operationally simple
• Combined Ethernet/IP/MPLS and CWDM solution in macro site
SMALL CELL BACKHAUL FLEXIBILITY: RANGE OF MEDIA OPTIONS
OUTDOOR, INDOOR AND C-RAN DEPLOYMENTS

- Broadband and Ethernet
- GPON/xDSL
- Metro Ethernet
- Microwave
- CPRI fronthaul
- Aggregation and transport
- Controllers/gateways
- BBU
- Professional services

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WINNING IN AN ERA OF GROWING SUBSCRIBER DEMAND

- More flexibility
- More scalability
- More operational simplicity

A comprehensive solutions approach is needed
KEY TAKEAWAYS

• Backhaul deployments support, and generally should lead, the high scale deployment of advances in the radio layer.

• Small cells can leverage highly variable media, NLOS microwave is an important part of the tool set.

• An integrated fronthaul and backhaul architecture will effectively support LTE-Advanced and prepare for 5G.