Optical Wireless Convergence

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A Challenge

Location A

RF Waveguides
Coaxial Cable
Optical Fiber

Location B

\( f_{RF} \)
A Challenge [2]

Location A

RF Waveguides
Coaxial Cable
Optical Fiber

All - point to point technologies
Largely proprietary (unique) format for transmission
Unique end point devices $\rightarrow$ higher costs

Location B

**Location A**
- Standard Ethernet
  - 100BaseT
  - GigE copper
- Managed fiber

**Location B**
- GigE fiber
- Managed fiber

Digitalization & Packetization
- f_{RF}
- Depacketize & synchronization
- Analog
Radio Digitizing Technique

Base Station Interface

Base Station

Mix Radio Signal To Baseband

Digitize Radio Signal

Packetize digitized Radio Signal

Ethernet Network

Remote Radio Head

Depacket digitized Radio Signal

Digital Analog Conversion

Mix Radio Signal To RF

Synchronization
Cellular Signal Distribution Scheme

BSI

Gigabit Ethernet Switch + Summing Node

RRH

Sector β

Sector α

Downlink sector α

Downlink sector β

Uplink sector α

Uplink sector β
Cellular Signal Distribution Scheme

- BSI
- Downlink sector α
- Downlink sector β
- Uplink sector α
- Uplink sector β
- RRH
- RRH
- RRH
- Sector β
- Sector α
Cellular over Gigabit Ethernet

Digitized CDMA/UMTS/GSM RF signal is distributed in-building through switched Gigabit Ethernet packet data network using LAN CAT5/fiber cables (potentially existing). Same system can transport CDMA 1X, EV-DO, or UMTS signals.

Interface to BTS through baseband I/Q or RF radio input and output. (no modification of BTS required)

Remote Radio Heads (RRHs) based on handset technology and powered over CAT5 cable radiate downlink signal and receives uplink signal.
Macrocellular distribution

Radio distribution for outdoor macrocells and hot spots [Hoteling]

GigE Switch

Shared Sector

GigE Fiber, EPON, Managed fiber, etc.

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BSI: base station interface  
RRH: remote radio Head  
GES: gigabit Ethernet switch  
AP: 802.11 access point
Direct BTS Driven Application

A BTS or at least one sector of a BTS is dedicated to driving the network for either in-building coverage or hoteling of BTS’s.

The BTS interface would be RF initially, but can be digital CPRI or built into BTS.

Delay in downlink can be compensated by timing advancement in BTS.

Off-the-shelf GigE switches can be used in the network.
RF Repeater Application

Signals received over the air for re-broadcasting over desired coverage area

Requires very small delay to avoid upsetting air-interface (standard calls for < 5 us)
Conclusion

Market Opportunity

- The In-building market for wireless coverage is growing and with easy to install and cost effective solutions such as we have presented here will accelerate.
- Hoteling for macrocellular coverage has clear advantages which can be enabled with this technology

Key advantages to this approach

- Take advantage of Gigabit ethernet equipments, components and CAT5/fiber medium
- Software sectorization for capacity management and growth
- Intelligent management of reverse-link for interference protection
- Transport RF bandwidth: air-interface agnostic and future proof.