Mobile Backhaul: Ethernet Gets Real
Ethernet Solutions & Mobile Backhaul

1. The Backhaul Arena
2. Current Backhaul Strategies & Technologies
3. The Migration to Ethernet-based Backhaul
4. The Outlook

Informed Direction Within a Changing Landscape
SECTION 1:

THE MOBILE BACKHAUL ARENA:
DRIVERS, PROJECTIONS & CHALLENGES
Generalized Mobile Backhaul Architecture

Source: New Paradigm Resources Group

Informed Direction Within a Changing Landscape
Fundamental Growth Factors in the Backhaul Ecosystem

- Cellular subscriber growth
- Mobile data usage, rich media apps
- Wireless technology standards (HSPA+, LTE, 4G...)
- FTTH/N = fiber deep in networks
- Evolution of core capacity & convergence

End Users

Cellular / Mobile Data SP

Broadband Wireless SP

Site Owner

Backhaul Transport SP

Core Network SP

NET BACKHAUL GROWTH = ▲▲▲▲
Driving Current Backhaul Growth

Mobile Subscribers by Carrier

Prime Opportunity: Independent Mobile Carriers
Prime Opportunity: Out of Franchise Territory - Mobile
Prime Opportunity: Out of Franchise Territory - Mobile

Source: New Paradigm Resources Group, Inc.

Informed Direction Within a Changing Landscape

© New Paradigm Resources Group, Inc.
While mobile data has gained popularity in recent years…
the greatest impact will come with further smartphone adoption.
The Backhaul Market: Revenue Projections


Source: New Paradigm Resources Group, Inc.
### Key Players in the Backhaul Market

#### Selected Prime Movers in the Backhaul Services Market

<table>
<thead>
<tr>
<th>Sector</th>
<th>Key Backhaul Providers</th>
</tr>
</thead>
<tbody>
<tr>
<td>ILEC</td>
<td>• AT&amp;T</td>
</tr>
<tr>
<td></td>
<td>• CenturyLink (Embarq)</td>
</tr>
<tr>
<td></td>
<td>• Qwest</td>
</tr>
<tr>
<td></td>
<td>• Verizon</td>
</tr>
<tr>
<td></td>
<td>• Windstream</td>
</tr>
<tr>
<td>Cable MSO</td>
<td>• Cox Communications</td>
</tr>
<tr>
<td></td>
<td>• Time Warner Cable</td>
</tr>
<tr>
<td></td>
<td>• Comcast</td>
</tr>
<tr>
<td>CLEC</td>
<td>• Level 3</td>
</tr>
<tr>
<td></td>
<td>• Optimum Lightpath (unit of Cablevision)</td>
</tr>
<tr>
<td></td>
<td>• tw telecom</td>
</tr>
<tr>
<td></td>
<td>• XO</td>
</tr>
<tr>
<td>Fiber Network Rollups &amp; Legacy Utility Fiber</td>
<td>• American Fiber Systems (AFS)</td>
</tr>
<tr>
<td></td>
<td>• FPL Fibernet (unit of Florida Power &amp; Light)</td>
</tr>
<tr>
<td></td>
<td>• IP Networks</td>
</tr>
<tr>
<td></td>
<td>• Zayo Bandwidth</td>
</tr>
<tr>
<td>Fixed Wireless &amp; Hybrid (Wireless plus Fiber)</td>
<td>• Conterra Ultra Broadband</td>
</tr>
<tr>
<td></td>
<td>• FiberTower</td>
</tr>
<tr>
<td></td>
<td>• Telecom Transport Management (TTM)</td>
</tr>
</tbody>
</table>

Source: New Paradigm Resources Group, Inc.
Key Challenges for Mobile Backhaul

Mobile Backhaul Challenges include:

- Provided over TDM-based circuits
- Copper transmission medium dominates
- Fiber deployment costs
- Matching capacity with demand challenges
- Deployment timeframes

Mobile backhaul market future is bright, but isn’t without speed bumps.
SECTION 2:
CURRENT BACKHAUL STRATEGIES & TECHNOLOGIES
Predominant Physical Medium to Cell Site

2007
- Copper
- Fiber
- Fixed Wireless

2013
- Copper
- Fiber
- Fixed Wireless

Source: New Paradigm Resources Group, Inc.

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## Legacy Copper Loops (T1s)

| **Pros** | | **Cons** |
|---|---|
| • Facilities in place: BH providers’ capital costs sunk | • Finite capacity—relatively low |
| • Max distance = miles | • Stepwise bandwidth |
| • Well-understood technology, OAM well-defined | • Per unit capacity cost = linear |
| • Engineered to carry voice | • Service outages |
| | • Engineered to carry voice—not data |
| | • Lease from ILEC |

| **Provided By** | **Incumbent LECs: AT&T, Verizon, IOCs** |

Source: New Paradigm Resources Group, Inc.
Carrying the Traffic: Competing Physical Media

Fiber to the Site

<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Highly scalable bandwidth</td>
<td>• High buildout costs</td>
</tr>
<tr>
<td>• Capacity ↑ = per unit cost ↓</td>
<td>• Long construction intervals</td>
</tr>
<tr>
<td>• Future-proof technology</td>
<td></td>
</tr>
<tr>
<td>• Adjunct to broad corporate NGN strategy (FTTx)</td>
<td></td>
</tr>
<tr>
<td>• Map smoothly into core networks (fiber)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Provided By</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Cable MSOs</td>
</tr>
<tr>
<td>• Fiber Network Operators</td>
</tr>
<tr>
<td>• CLECs</td>
</tr>
<tr>
<td>• Incumbent LECs: Verizon, AT&amp;T, major ILECs</td>
</tr>
</tbody>
</table>

Source: New Paradigm Resources Group, Inc.
### Carrying the Traffic: Competing Physical Media

#### Fixed Wireless (Microwave)

<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
<th>Provided By</th>
</tr>
</thead>
</table>
| • No trenching costs  
• Lower OPEX, invariable with mileage  
• Scalable bandwidth  
• Max distance = miles, not limited by physical facilities  
• Rapid deploy & turn-up  
• Reuse old gear at other sites | • Spectrum costs  
• Capacity constraints (~1 Gbps)  
• Require clear line of sight  
• Carriers’ skill set may be low for self-provisioning  
• CAPEX: install antennae at cell site, aggregation | • Fixed Wireless / Hybrid providers  
• Self-provisioned by wireless carriers |

Source: New Paradigm Resources Group, Inc.
### Carrying the Traffic: Competing Physical Media

**Ethernet over Copper**

<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
<th>Provided By</th>
</tr>
</thead>
</table>
| • Underlying facilities in place: No physical buildout  
• Max distance = miles  
• Greater capacity than legacy T1s  
• Ethernet interface: facilitates migration to all-Ethernet | • CAPEX: deploy gear at MTSO/CO and cell site  
• Relies on availability, quality of copper facilities to sites  
• Smaller capacity bump than FW or fiber | • IOCs  
• CLEC(s)  
• Supporting role for Tier 1 carrier |

*Source: New Paradigm Resources Group, Inc.*
SECTION 3:
MAKING ETHERNET FOR MOBILE BACKHAUL REAL: 
THE MIGRATION
Spring 2008: All US mobile carriers see need for Ethernet but none have concrete migration plans. What changed?

- Technology advancements and standardization
  - IEEE 1588v2 and ITU Synch-E standards for Ethernet timing, synch
  - Metro Ethernet Forum specifications

- Media aids migration
  - Ethernet over copper and PDH (T-1)
  - Increased fiber, fixed wireless at cell sites

- Mobile data surpasses voice traffic
  - Pressure to migrate increases
  - Ethernet used for data only
  - Voice increasingly becomes a data app
### Wireless Providers Rank
By Number Cell Sites

<table>
<thead>
<tr>
<th>Rank</th>
<th>Provider</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Verizon Wireless *</td>
</tr>
<tr>
<td>2</td>
<td>AT&amp;T Mobility</td>
</tr>
<tr>
<td>3</td>
<td>Sprint Nextel</td>
</tr>
<tr>
<td>4</td>
<td>T-Mobile</td>
</tr>
<tr>
<td>5</td>
<td>US Cellular</td>
</tr>
<tr>
<td>6</td>
<td>Leap Wireless</td>
</tr>
<tr>
<td>7</td>
<td>MetroPCS</td>
</tr>
<tr>
<td>8</td>
<td>Clearwire</td>
</tr>
</tbody>
</table>

* Includes unreduced Alltel network
The majority of wireless sites are located in Tier 1 carriers’ franchise territories

Source: New Paradigm Resources Group, Inc.
Migrating to Ethernet-based Backhaul: The Deployers - Backhaul Providers

Backhaul Provider Market Share (% of Cell Sites Served)

Source: New Paradigm Resources Group
### Migrating to Ethernet-based Backhaul: Provider Strategies & Ethernet Deployment

<table>
<thead>
<tr>
<th>Sector</th>
<th>Backhaul Positioning &amp; Strategy</th>
</tr>
</thead>
</table>
| Tier 1 Telcos, IOC      | • Dominant legacy BH providers  
• Access to most sites; accumulated expertise  
• Leveraging fiber builds, Ethernet for new business                                                   |
| Cable                   | • Targeted and Strategic Focus  
• Leveraging fiber plant: near neighborhoods, etc.  
• Competing on price, opportunistic  
• Lead with Ethernet, T1 circuit emulation                                                            |
| CLEC, Fiber Network     | • Network flexibility to carry TDM, Ethernet, both  
• Routes concentrated in and around urban areas  
• Regional or national presence: one partner, many markets                                             |
| FW Carrier              | • Exploit gaps in other BH provider architectures  
• Ideal are neutral sites with multiple carrier collocation  
• Emphasize time to turn-up, scalable bandwidth                                                          |

Source: New Paradigm Resources Group, Inc.

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SECTION 4:

Ethernet for Mobile Backhaul: The Outlook
Backhaul Architectures

- PSTN
- POP
- Mobile Switching Center
- High-Load Site: Near Network, Fiber Served
- Carrier Aggregation Ring
- Copper Only: EoC Opportunity
- Copper Only: Ethernet Capable
- Fiber: Ethernet Ready
- Cell Towers
- Fixed Wireless Link to Remote Tower: Ethernet Capable

Source: New Paradigm Resources Group
Ethernet for Mobile Backhaul: The Outlook

Carrier-Sites Using Ethernet for Backhaul (2003-2013)

Source: New Paradigm Resources Group, Inc.
Ethernet for Mobile Backhaul: Concluding Thoughts

- Data traffic growth (= backhaul demand) keeping pace with projections
- Carrier Ethernet model is now established and accepted
- Mix of copper, fiber, wireless transport used as needed and available
- New entrants key role in pushing Ethernet into Backhaul solutions
- Long-term pressure & movement to Ethernet continues - but faces capex tradeoffs, wireless carrier decision-making
New Paradigm Resources Group, Inc.

Informed direction

...within a changing landscape

Thank You!

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Providers address the flood of data demand using one of three strategies:

**Data Offload**
- Maintain legacy T1 access for voice
- Alternate access sourced for data
- Maintain parallel networks initially, converge over time

**Hybrid**
- Maintain legacy T1 gear in place at site
- T1 over Ethernet using circuit emulation for all traffic
- Migrate to all-Ethernet over time

**Flash Cut**
- Replace legacy T1 gear at site
- Flash cut to Ethernet access for all backhaul traffic