Ethernet Mobile Backhaul Solution

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The World is Changing

The Mobile Internet
- Inflection point around device ownership
- Truly anywhere, anytime, any-device access
- Driving network changes in the Enterprise
- Enabling access to the cloud
- Driving the next wave of service provider investment

Adopted from Morgan Stanley Technology Adoption Life Cycle
Changing Network Access

**Unit Shipments of Desktop PCs + Notebook PCs vs. Smartphones, 2005 – 2013E**

- **2012E: Inflection Point**
- **Smartphones > Total PCs**

Note: Notebook PCs include Netbooks. Source: Katy Huberty, Ehud Gelblum, Morgan Stanley Research. Data and Estimates as of 9/10
2G, 3G and 4G Data Rates and Backhaul

**2G Phones**
- iPhone original, Moto Razor
- < 56 Kbps per connection

**3G Devices**
- iPhone 3+, Droid, iPad, Kindle
- Up to 200 Kbps per connection

**4G Devices**
- Sprint HTC EVO 4G
- Up to 1 Gbps per connection

Two Trends: (1) Connection speed per device growing toward 1 Gbps (2) Shift to Ethernet for Mobile Backhaul
Market Beginnings….

Backhaul Networks Must Support 2G and 3G through 2025

Sources: Infonetics, CDG
True 4G Mobile Backhaul Architecture

Extreme Networks Ethernet Mobile Backhaul Solution for Next Generation Mobile Networks

Fiber and Microwave Ethernet Backhaul to Resilient Synchronous Gigabit Ethernet Rings
Mobile Base Station Requirements

- Impacts of bad synchronization on wireless network
  - Corrupt data
  - Dropped calls
  - Co-channel interferences
  - Slow handover between cells
  - Speech clipping (loss of speech segments)

\[
F_1 + f_2 \quad T_1 \quad +/\- 50\text{ppb}
\]

\[
F_1 \quad T_1 \quad +/\- 50\text{ppb}
\]

\[
\text{BTS}_2 \text{ drifts outside 50ppb window}
\]

\[
\text{Mobile cannot lock to } \text{BTS}_2 \text{ and call is dropped}
\]

\[
\text{BTS}_1
\]
Synchronization Techniques

Frequency transfer
- Network Synchronous
- Differential Clock Recovery
- Adaptive Clock Recovery
- Synchronous Ethernet

Time transfer
- NTP – Network Time Protocol v4
- IEEE 1588v2 (also known as Precision Time Protocol, PTP)
True 4G Backhaul Requirements & Benefits

**Requirements**

**Next-Generation Timing**
- G.8262 Synchronous Ethernet
- IEEE 1588v2 Precision Time Protocol

**Carrier-Grade Resiliency**
- Ethernet Automatic Protection Switching (RFC 3619)
- ITU G.8032 Ethernet Ring Protection
- ITU G.8031 Link Protection
- MPLS-TP

**Benefits**

**Next-Generation Timing**
- Exceptional Voice Quality
- Foundation for Mobile Video
- Outstanding Subscriber Experience

**Carrier-Grade Resiliency**
- Resilient Microwave Rings
- Standards-Based Protection
- Ensure Service Level Agreements
Sync Trends

Synchronization: Preferred Solutions

- IEEE 1588
- Synchronous Ethernet
- T1/E1
- GPS
- Other

## Mobile Operator view of Sync Techniques

| GPS receiver at every node | Deliver frequency and time (up to 50ns accuracy claimed)  
|                           | Not always viable (indoor cells)  
<table>
<thead>
<tr>
<th></th>
<th>Expensive oscillators required ($$$) for periods of unavailability (not 99.999% solution)</th>
</tr>
</thead>
</table>
| **Network synchronous Sync Ethernet** | Use the PHY clock from bit stream (similar to SDH/PDH), each node recovers clock  
|                           | Only deliver frequency and not phase  
|                           | Independent from network load  
|                           | **Represent an excellent SDH/PDH replacement option --> viable ‘interim’ solution**  |
| **Packet –based In-band synchronization (adaptive clock recovery)** | The clock is reconstructed using the packet inter-arrival rate (i.e. leaky bucket algorithm)  
|                           | Inexpensive solution  
|                           | Subjected to network load conditions, not ‘always-on’ and deliver frequency (not phase)  
|                           | **Could represent a viable ‘interim’ solution only in certain scenarios**  |
| **Packet –based Out-of-band synchronization** | Clock information is transmitted via dedicated timing packets (master <-> slave)  
|                           | ‘Always-on’ solution (even without traffic data)  
|                           | Ubiquitous solution (works over any transport technology)  
|                           | Can deliver frequency and phase (FDD and TDD systems)  
|                           | Major protocols: IEEE 1588v2, IETF NTP version 4  |

IEEE 1588v2 represents the most promising ‘long-term' solution (in conjunction with Sync Eth)
True 4G Backhaul Requirements & Benefits

100X Capacity Increase
- GE to 10 GE and Beyond
- Low Latency for LTE
- Layer 2 Switching, QoS, and IPv6

Ease of Operation
- T1/E1 Pseudowire
- ITU Y.1731
- IEEE 802.3ah, 802.1ag

Benefits
100X Capacity Increase
- True 4G Performance Unleashed
- Investment Protection
- Support High Bandwidth Enterprise Applications

Ease of Operation
- Support for 2G, 3G and 4G
- Simplified Troubleshooting
- Outstanding Subscriber Experience
E4G Value Proposition

Cell Site

- Base Stations
- Transport
- TDM Mux
- TDM Pseudowire
- Switch
- Router
- Timing Source
- Alarm Unit
- NID

Cell Site

- Base Stations
- Transport
- E4G-200

E4G-200 connects to various network components such as Base Stations, Transport, TDM Mux, TDM Pseudowire, Switch, Router, Timing Source, Alarm Unit, and NID, providing a comprehensive network solution for cellular sites.
E4G Product Detail
Interfaces and Modules
### E4G Physical Dimensions

<table>
<thead>
<tr>
<th>Platform</th>
<th>Height</th>
<th>Width</th>
<th>Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>E4G-200</td>
<td>1RU 1.75 in 4.45 cm</td>
<td>17.3 in 43.9 cm</td>
<td>10 in 25.4 cm</td>
</tr>
<tr>
<td>E4G-400</td>
<td>1RU 1.75 in 4.45 cm</td>
<td>17.3 in 43.9 cm</td>
<td>17 in 43.2 cm</td>
</tr>
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True 4G Backhaul Requirements & Benefits

Requirements

Next-Generation Timing
- G.8262 Synchronous Ethernet
- IEEE 1588v2 Precision Time Protocol

Carrier-Grade Resiliency
- Ethernet Automatic Protection Switching (RFC 3619)
- ITU G.8032 Ethernet Ring Protection & ITU G.8031 Link Protection
- MPLS-TP

Platform

<table>
<thead>
<tr>
<th>E4G-200</th>
<th>E4G-400</th>
</tr>
</thead>
<tbody>
<tr>
<td>All GE ports</td>
<td>All GE &amp; 10GE ports</td>
</tr>
<tr>
<td>Clocking Module Required</td>
<td>Included on Base Unit</td>
</tr>
<tr>
<td>All GE ports</td>
<td>Future s/w release</td>
</tr>
<tr>
<td>Future s/w release</td>
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## True 4G Backhaul Requirements & Benefits

### Requirements

**100X Capacity Increase**
- GE to 10 GE and Beyond
- Low Latency for LTE
- Layer 2 Switching, QOS, and IPv6

**Ease of Operation**
- T1/E1 Pseudowire
- ITU Y.1731
- IEEE 802.3ah, 802.1ag

### Platform

<table>
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<tr>
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<th>E4G-200</th>
<th>E4G-400</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ports</td>
<td>12 GE ports</td>
<td>28 GE + 6 10 GE ports</td>
</tr>
<tr>
<td>Latency</td>
<td>4µsec – 80 µsec</td>
<td>4µsec – 80 µsec</td>
</tr>
<tr>
<td>Features</td>
<td>All XOS features</td>
<td>All XOS features</td>
</tr>
</tbody>
</table>

**E4G-200**
- Optional module for 16 TDM ports
- CCM in h/w, DM & LM in h/w
- XoS supported (CCM in h/w)

**E4G-400**
- Optional module for 16 TDM ports
- CCM in h/w, DM & LM in s/w
- XoS supported (CCM in h/w)
Port Timing Selection on E4G
E4G-200 Configuration

- Serial Console / OOB Management Ethernet
- 8 x 10/100/1000BASE-T
- 4 x 100/1000BASE-X
- 2 x DC Power Euro-style connector
- 15 pin D-sub Alarm connector
- Optional Module: 16 x RJ48c for TDM E1 or T1
- Optional Module: Advanced Clocking with 2 x SMA connectors for 1PPS and 10MHz

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E4G-400 Configuration

- **OOB Management Ethernet / USB port**
- **Serial Console**

- **20 x 10/100/1000BASE-T**
- **4 x 10/100/1000BASE-T**
- **4 x 100/1000BASE-X**

- **Slot A** - 10GE ports for uplinks or stacking
- **Slot B** for TDM or 10GE ports
- **Dual Fans** (Included)
- **Power Supply** (Included)
- **Optional Redundant Power Supply**
E4G-400 Modules

Slot A Modules

- **XGM3S-2xf**
  2 x XFP with SyncE for Stacking or Data Links

Slot B Modules

- **XGM3SB-4sf**
  4 x SFP+ with SyncE for Data Links

- **PWMB-16T1E1**
  2 x MWRJ21 with Fan-out to 16 TDM ports
# E4G Family Comparison

<table>
<thead>
<tr>
<th>Connections</th>
<th>E4G-200</th>
<th>E4G-400</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1/E1 Ports</td>
<td>16</td>
<td>16</td>
<td>2G/3G Investment Protection</td>
</tr>
<tr>
<td>Gigabit Ethernet Ports</td>
<td>12</td>
<td>28</td>
<td>3G/4G Price-Performance</td>
</tr>
<tr>
<td>10 GbE Ports</td>
<td>N/A</td>
<td>6</td>
<td>Unleash True 4G Mobile Backhaul</td>
</tr>
</tbody>
</table>

## Ethernet Backhaul Features

<table>
<thead>
<tr>
<th>Feature</th>
<th>E4G-200</th>
<th>E4G-400</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ExtremeXOS® Operating System</td>
<td>Yes</td>
<td>Yes</td>
<td>Extensive Layer 2 Switching and Reduced Operational Complexity</td>
</tr>
<tr>
<td>EAPS, G.8032</td>
<td>Yes</td>
<td>Yes</td>
<td>Carrier Grade Resiliency for Outstanding Subscriber Experience and Resilient Microwave Rings</td>
</tr>
<tr>
<td>Synchronous Ethernet, 1588v2</td>
<td>Yes</td>
<td>Yes</td>
<td>Next-Generation Timing Enables Low-Cost Packet Alternative to SONET/SDH Backhaul</td>
</tr>
<tr>
<td>TDM Pseudowire</td>
<td>Yes</td>
<td>Yes</td>
<td>Investment Protection - Enables Packet Backhaul to Support 2G/3G TDM Services</td>
</tr>
<tr>
<td>IPv6 today &amp; future MPLS-TP</td>
<td>Yes</td>
<td>Yes</td>
<td>4G Investment Protection</td>
</tr>
</tbody>
</table>

![E4G-200 Cell Site Router](image)

![E4G-400 Cell Site Aggregation Router](image)
Thank you