Agenda

• Introduction of Cambium Networks
• Cambium Solution
• Case Study & Summary
Who is Cambium Networks?

• 12+ Years of technical innovation and market leadership

• Focused exclusively on Fixed Wireless Broadband
  – PTP (“Orthogon”)
  – PMP (“Canopy”)

• A Mission Critical Heritage
  – Application Requirements
  – Product Quality and Reliability
  – System Architecture

• Global
  – +4 MILLION Subs Installed in 120+ countries

• 240+ Associates
  – Rolling Meadows, Illinois
  – Ashburton, England
Key markets of Video Surveillance

- **Government – Federal/State/Local**
  - Provide asset protection, access control, safety monitoring for government facilities and assets, includes border security, critical infrastructure security and ports (airport, Seaport), town halls, Museums and prisons.

- **City Surveillance**
  - Provide crime prevention, remote area monitoring, license plate recognition, face recognition, for all areas and public spaces.

- **Transportation**
  - Provide traffic management and crime prevention, includes major highway, street and intersections, airports, railways, bus stations, ferry terminals and associated infrastructure and grounds.

- **Utilities**
  - Provide asset protection, access control and safety monitoring, includes all facilities involved with the production and distribution of gas, electricity, water and heat, and sewage treatment.

- **Commercial**
  - Provide remote area monitoring and crime prevention, includes hotels, restaurants, office complexes, manufacturing plants, warehouses and other industrial premises.
Major Applications

- Round-the-clock surveillance of high crime areas.
- Real-time video feeds into patrol cars or fire vehicles to provide mission-critical information to first responders.
- Extensive, 24-hour outdoor monitoring of locations ranging from port facilities to airports to supply depots to nuclear power plants.
- Traffic surveillance solutions ranging from identifying traffic violators to providing early warnings of tie-ups due to accidents or weather.
- Comprehensive monitoring of off-the-beaten-path locations on corporate, educational and medical campuses.
“Our rule of thumb is that wireless systems are exceptionally cost efficient, sometimes offering savings of 80 percent over wired networks.” Says Bob Zakarian, CEO, Community WISP.
Wireless - A New Picture of Quality and Economy

• High Capacity
  – Up to 90 Mbps per sector, support 10-15 HD cameras per sector

• Proven Reliable
  – Wireless video surveillance networks are demonstrating their high levels of reliability and performance in a wide variety of public and private safety and security applications.

• High Secured link
  – AES Encryption

• Scalability and Flexibility
  – Easy to extend existing network and add Cameras
  – Easy to adjust camera location as needed, not limited by cable infrastructure

• Exceptional Cost Saving
  – Simplifies access to many areas where Wired infrastructure is not available, difficult to access, or not even allowed
  – No need for trenching or leased line

• Easy installation and operation
  – Quick and simple to deploy, saving time is just as critical as saving dollars
• Point-to-Point
• Point-to-Multipoint
• Linear
Cambium’s Industry Leadership in Video Surveillance

• Thousands of Wireless Video Surveillance Deployments around the world!

• Video Use-cases touching every vertical (Government, City Surveillance, Utility, Transportation, Commercials, etc.)
Market Leader of wireless Infrastructure used in Video Surveillance

Market Share Estimates for Suppliers of Wireless PTP used in Video Surveillance

- Cambium Networks, 17.7%
- Company C, 9.8%
- Company R, 7.9%
- Company U, 6.9%
- Company A, 6.7%
- Company I, 4.8%
- Company P, 4.8%
- Company W, 1.8%
- Company F, 1.8%
- Company R, 2.3%
- Others, 35.4%

Market Share Estimates for Suppliers of Wireless PMP used in Video Surveillance

- Cambium Networks 9%
- Company A 9%
- Company I 9%
- Company R 6%
- Company P 5%
- Company U 5%
- Company C 3%
- Company R 3%
- Company F 2%
- Company A 2%
- Others 47%

Source: IMS Research
## A Complete Suite of Wireless Solutions

<table>
<thead>
<tr>
<th>FEATURE</th>
<th>PTP 230</th>
<th>PTP 250</th>
<th>PTP 500</th>
<th>PTP 600</th>
<th>PTP 800/i</th>
<th>PTP 810</th>
</tr>
</thead>
<tbody>
<tr>
<td>RF Bands (GHz)</td>
<td>5.4, 5.8</td>
<td>5.4, 5.8</td>
<td>5.4, 5.8</td>
<td>2.5, 5.4, 5.8</td>
<td>6 ~ 38</td>
<td>6 ~ 38</td>
</tr>
<tr>
<td>Max. Throughput (Mbps)</td>
<td>50</td>
<td>256</td>
<td>52 /105</td>
<td>150/300</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. LOS Range (miles)</td>
<td>80 with reflector</td>
<td>34</td>
<td>155</td>
<td>124</td>
<td>Frequency Dependent</td>
<td>Frequency Dependent</td>
</tr>
<tr>
<td>Max. NLOS Range (miles)</td>
<td>NA</td>
<td>NA</td>
<td>6</td>
<td>5</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Key Features</td>
<td>Sync Standards</td>
<td>Sync iDFS 2x2 MIMO</td>
<td>Sync iDFS Fiber I/F FIPS 140-2 OOBM TDM/T1 2x2 MIMO</td>
<td>Split Mount or All- Indoor FIPS 140-2</td>
<td>Native Ethernet Native TDM (T/1/E1/STM1) XPVC</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FEATURE</th>
<th>PMP 100</th>
<th>PMP 100</th>
<th>PMP 320</th>
<th>PMP 430</th>
<th>PMP 450</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency Bands</td>
<td>900 MHz</td>
<td>2.4, 5.2, 5.4, 5.8 GHz</td>
<td>3.5, 3.6 GHz</td>
<td>5.4, 5.8 GHz</td>
<td>2.4, 5.4, 5.8 GHz</td>
</tr>
<tr>
<td>Maximum Ethernet Data Rate</td>
<td>4 Mb/sector 24 Mb/tower</td>
<td>14 Mb/sector 84 Mb/tower</td>
<td>48 Mb/sector 192Mb/tower</td>
<td>50 Mb/sector 200 Mt/tower</td>
<td>90 Mb/sector 1Gbps/tower (dual AP ring)</td>
</tr>
<tr>
<td>Maximum LOS Range</td>
<td>40 mi (64 km)</td>
<td>5 mi (8 km)</td>
<td>35 mi (56 km)</td>
<td>24 mi (38 km)</td>
<td>5 mi (8km)</td>
</tr>
<tr>
<td>NLOS Capability</td>
<td>YES</td>
<td>NA</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
</tbody>
</table>
Key Product differentiators from Cambium

• **Complete wireless solution** that can be mission critical with 5 9’s reliability:
  – PTP and PMP provide both backhaul and last mile solutions
  – Licensed and Unlicensed frequency band, 2.4 GHz – 38 GHz
  – LOS, nLOS and NLOS capability with outstanding performance, no one can compete

• **Outstanding Security Protection**
  – AES 128/256 bit encryption
  – FIPS 140-2 certification

• **Industry Leading Radio Performance** to meet video streaming requirements:
  – High radio performance, including i-OFDM, AMOD, MIMO, DSO, Tx power and Rx Sensitivity, Cyclic Prefix, Low latency and jitter, etc.

• **Ruggedized Small Product Footprints**, easily pass municipal outdoor esthetics ordinances
Technology Fits Video Surveillance Challenge

• Scalability
  – GPS Synchronization ➔ Avoid self-interference, provide high frequency re-use

• Video Packet Burse
  – Large VC queues ➔ Ensure Ingress buffers can handle excessively large bursts from video

• Multicast & Unicast Support
  – AP/RM isolate ➔ Filters to support multicast and unicast of video streams in both directions

• Enhanced QoS
  – Support DSP and 802.1p to assure perfect video streaming
PTP PORTFOLIO

License-Exempt and Defined-Use Licensed Solutions

PTP 100, 200, 230, 250
PTP 500, 600

Traditional Licensed Microwave Solutions

PTP 800 & 810

2.4 to 6.05 GHz
6 to 38 GHz

Cambium Networks
PTP 600 SERIES

Premier, High-Capacity Solutions and Excellent Choices for

- High-speed connectivity and backhaul
- NLOS and long-distance LOS performance
- Over water and desert terrain
- High interference environments
- Multiple-PTP nomadic applications

PTP 600

- License-exempt and defined-use licensed bands
- 2.5 GHz for EBS programs
- 4.5 & 4.8 GHz NATO Band IV for Defense
- 4.9 GHz for public safety
- 5.4, 5.8 and 5.9 GHz license-exempt bands
- Up to 300 Mbps aggregate
- Up to 124 mi range
- FIPS-197 128/256 AES (optional)
- FIPS 140-2 and UC-APL
- ATEX and HAZLOC certified
- IP 66 rated enclosures
- IPv6/IPv4 Dual Stack Option

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PTP 600 NLOS TECHNOLOGY

Multiple-Input Multiple-Output (MIMO) – 2x2 MIMO enhanced link budget / dual payload

*Intelligent* Orthogonal Frequency Division Multiplexing (*i*-OFDM) – Resists interference and signal fading

Fast Predictive Adaptive Modulation – Reacts quickly to changing conditions

Dynamic Spectrum Optimization (DSO) – Automatically switches to the clearest channel

High Spectral Efficiency – High throughput with minimal spectrum usage

Best-in-Class Radios – Highest system gain in the category

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NLOS AND LOS

Line-of-Sight (LOS)
Up to 155 miles

near-Line-of-Sight (nLOS)
Up to 25 miles

Non-Line-of-Sight (NLOS)
Up to 6 miles

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PMP 450

- 4th Generation (4G) of PMP product family from Cambium
- Dramatically increases overall *system capacity*
  - *Up to 1Gbps of tower bandwidth available.*
  - *Can support any symmetrical or asymmetrical speed*
- OFDM MIMO provides near Line of Sight (nLOS) and LOS access
- *Software defined radio design* allows for rapid coverage of new/existing frequency bands both licensed and unlicensed
- Utilizes *GPS synching capability* to achieve maximum spectral efficiency and very low latency *supporting VoIP and video*
- Installation and turn up in days, not weeks and months
## PMP 450: Key System Features

<table>
<thead>
<tr>
<th>Radio Performance Features</th>
<th>Advantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dual Band (5.4 and 5.8 GHz)</td>
<td>One high performance SKU to cover both bands</td>
</tr>
<tr>
<td>High-Efficiency Canopy MAC</td>
<td>Higher payload capacity and efficient spectrum use</td>
</tr>
<tr>
<td>2x2 MIMO w/ Migration Path</td>
<td>High capacity and link budgets with path to MU-MIMO in the future</td>
</tr>
<tr>
<td>Consistent Very Low Latency</td>
<td>Reliable support of voice and video applications</td>
</tr>
<tr>
<td>GPS Synchronization</td>
<td>Network scalability and self-interference avoidance</td>
</tr>
<tr>
<td>Interoperability</td>
<td>Seamless operation with existing PMP 430 SMs</td>
</tr>
<tr>
<td>nLOS Connectivity</td>
<td>Enhanced coverage over challenging terrain</td>
</tr>
</tbody>
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GPS Synchronization

- AP and SM communication is synchronized (all APs and SMs have controlled alternating communication) – reducing self interference
  - All SMs within a network
  - All APs within a cluster
  - All APs on a tower (multiple clusters)
  - All APs on all towers in the network

- Enables channel re-use and easy to deploy multi-sector, multi tower networks (minimal tower separation)

- Use the same number of channels to serve a higher number of users
PMP 450 Remote Module Tiers

RMs fully upgradeable from 4 to 60+ Mbps
Software keys available to easily move between tiers
Burst bucket has increased from 500 Mb to 2.5 Gb!
Amount of burst can be fully managed per RM
Video Surveillance in Petroleum field

• **PROFILE**
  – Cook Inlet, Alaska

• **Challenge**
  – Long range performance over water
  – Proven performance in harsh conditions
  – Low maintenance and low total cost of ownership.

• **RESULTS**
  – 99.99% IP Availability
  – No field maintenance work required

“The Cook Inlet project is a very important that enables business while preserving the environment,” said Linda Peters, Chief Operations Officer of Cambium Partner ProComm. “ProComm has helped hundreds of businesses design and deploy wireless connectivity for video surveillance, data transfer and VoIP connectivity. Cambium equipment lives up to those expectations.”
Green Bay – Citywide Security Surveillance Network

• **PROFILE**
  – Green Bay, Wisconsin

• **Challenge**
  – Citywide video surveillance network
  – Meet high security requirement
  – Easy scalable

• **RESULTS**
  – Allowing the city to cost effectively expand the original network to provide coverage of the entire Green Bay area.
  – Enabled the police to speed response and situational awareness, increase productivity without staffing increase, and measurably reduce operational expense.

“I’ve worked with a lot of technologies,” says Jason Pedersen, Broadband Sales Engineer, Baycom. “With its advanced encryption and high rate of interference tolerance, the Cambium Networks solution is more secure, more stable, easily expandable, and has the greatest capabilities.”
Cool Down Local Trouble Hotspots

• **PROFILE**
  – Western Downs, Queensland in Australia

• **Challenge**
  – Crime prevents in identified hotspot, especially in one particular street in the vicinity of the library, a hotel and a bank branch.
  – Need to overcome tree foliage as a line-of-sight issue

• **RESULTS**
  – Tara now has a robust, flexible system with the ability to expand rapidly without incurring significant capital expenses.
  – Increased public perceptions of security around the areas being monitored.

“We offered a Wireless IP CCTV solution to provide ... a robust flexible system and the ability to expand rapidly without incurring significant capital expenses. The Cambium product was the perfect solution for the CCTV opportunity presented.” Vern Elms, Managing Director, EZI Communications
Wireless Network Helps to Keep Drivers Safe

- **PROFILE**
  - City of Dallas, TX

- **Challenge**
  - High rate of accidents at major city intersections
  - Large city with noisy environment and LOS issues
  - Need for efficient monitoring while keeping costs low

- **RESULTS**
  - Efficient data delivery in high interference, obstructed areas
  - Reliable backbone for flawless backhaul operations
  - Improved traffic safety
  - Increased revenue for the City
Why Cambium Networks?

• **Proven Solution**
  – Deployed in more than 10,000 networks in 150 countries around the world. They are proven to work in harsh conditions in desert locations, high altitude winter applications, and over water.

• **Reliable Performance**
  – Support AES encryption and authentication control, to deny access to unauthorized “sniffers”.
  – Rugged Cambium Networks wireless broadband solutions perform over time. With millions of modules deployed around the world, Cambium Networks wireless broadband equipment demonstrates a less than 1% field failure rate.

• **Cost Effective**
  – Less Time and labor, wireless technology means that video surveillance systems can be installed in a matter of hours instead of months required to pull cable and deal with construction issues.
  – Cambium Networks solutions can scale from small tactical coverage areas to city wide networks without removing and replacing equipment.

• **Completed Portfolio**
  – Product lines support fully licensed, lightly licensed and unlicensed spectrum
  – Product support for both Point to Multi-point, and Point to Point, with adaptive and user configurable throughput.
Thank You!

Cambium Networks

www.cambiumnetworks.com