



PRESENTS

**NETWORLD INTEROP**

AN INTEROP EVENT

# FIXED WIRELESS BROADBAND

...An Architectural Overview, Present and Future.

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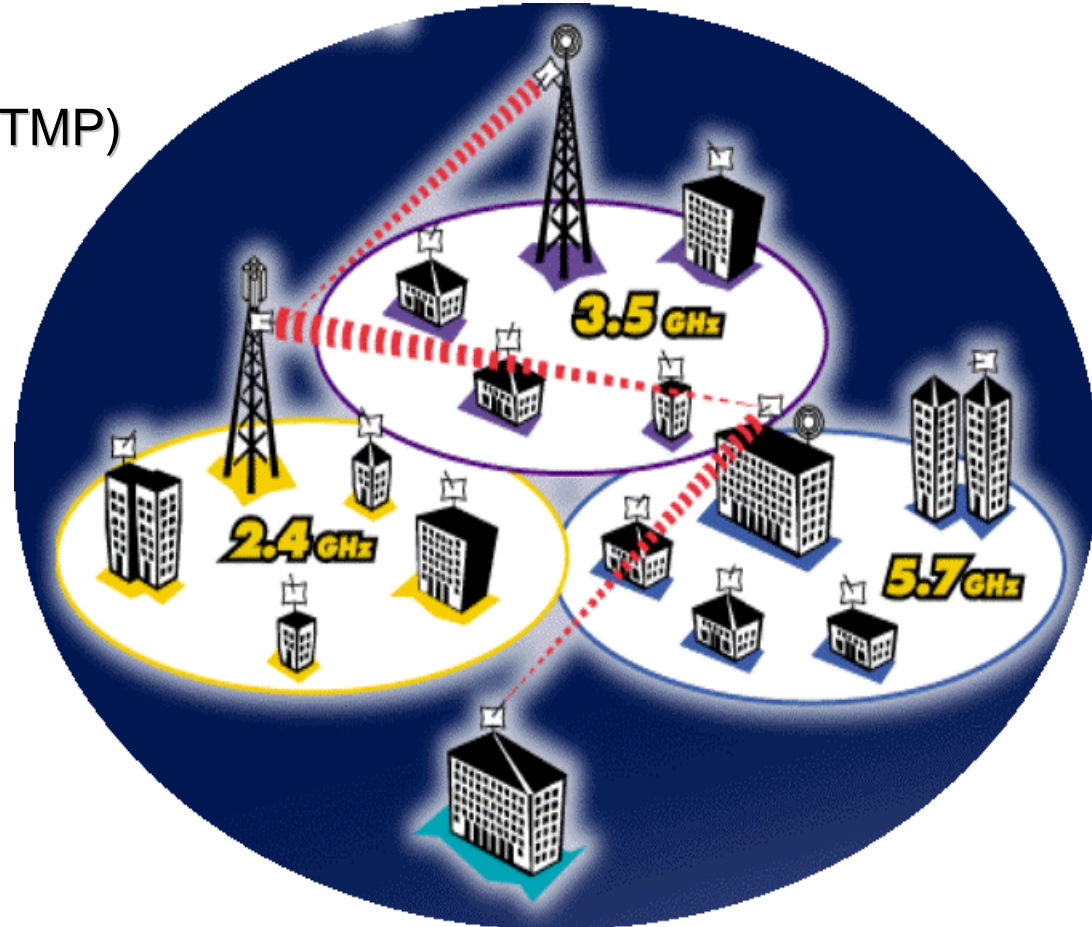
# An “Interactive” Session Covering:

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- Overview of Wireless Broadband
  - Architecture, frequencies, licensed, license exempt
  - Macro, micro, and pico cell architectures
- Performance and functional limitations
  - Line-of-sight considerations
  - Two different solutions
- Wireless ISP revenue model
  - Typical cost and revenue, payback period
  - Impact of the “truck-roll”
- Wireless ISP “traps” (time permitting)
  - And how others avoided them
- Questions and/or open discussion
- Glossary of acronyms and abbreviations

# Wireless Broadband

- Two primary architectural elements
- Access
  - Point-to-multipoint (PTMP)
  - Aka “distribution”
  - Aka “last-mile”
- Backbone
  - Point-to-point (PTP)
  - Aka “Back-haul”



# Wireless Broadband “Backbone”

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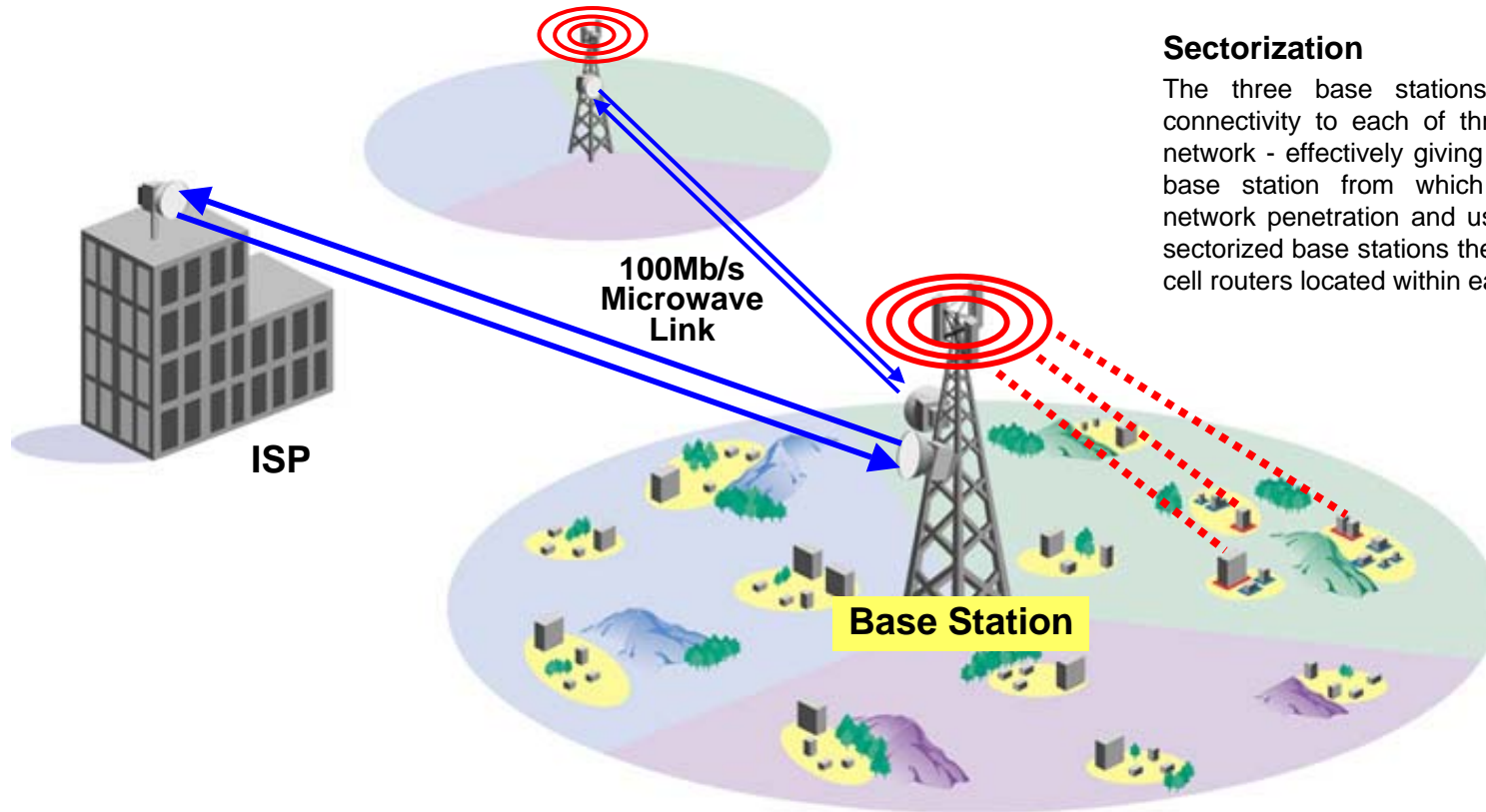
- Point-to-point (PTP)
  - Licensed; 7 to 38 GHz, License exempt; 2.4 or 5.7 GHz
  - Line-of-sight required
- Primary function
  - High-speed feed to POP, and from POP to POP
  - LMDS was a derivation
    - Why did it fail?
- The future: a “hybrid” architecture
  - Use PTP for backbone *and* revenue generation
  - A mix of PTP and PTM to provide a complete business model
- Players in PTP licensed and/or license exempt:
  - Western Multiplex, Netro, Helioss, Wave, Ceragon, Pcom, Proxim

# Wireless Broadband “Access”

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- Point-to-Multipoint Distribution (aka “Last-Mile”)
- Macro-cell; 50 to 100 square mile cells or sectors
  - Usually licensed (, i.e. MMDS or WLL) high-power; 6 to 25 watts
    - **US & Latin America; 2.1, 2.5 to 2.6 GHz**
    - **Europe, Asia, and Latin America; 3.5 GHz**
- Micro-cell; 5 to 10 square mile cells or sectors
  - Usually license exempt ISM (2.4 GHz) or U-NII (5.7 GHz), 1 to 4 Watt
- Pico-cell; 1 to 5 square mile cells
  - Originated by PCS, increasingly common in PTM Access
    - **Higher subscriber density, necessary for NLOS functionality**
- Players in PTM Access:
  - License exempt: BreezeCOM\*, Cisco, Lucent, Nokia, Wave, WiLan
  - Licensed: Airspan, Floware\*, Hybrid, Vyvo, (\*Combined into Alvarion)

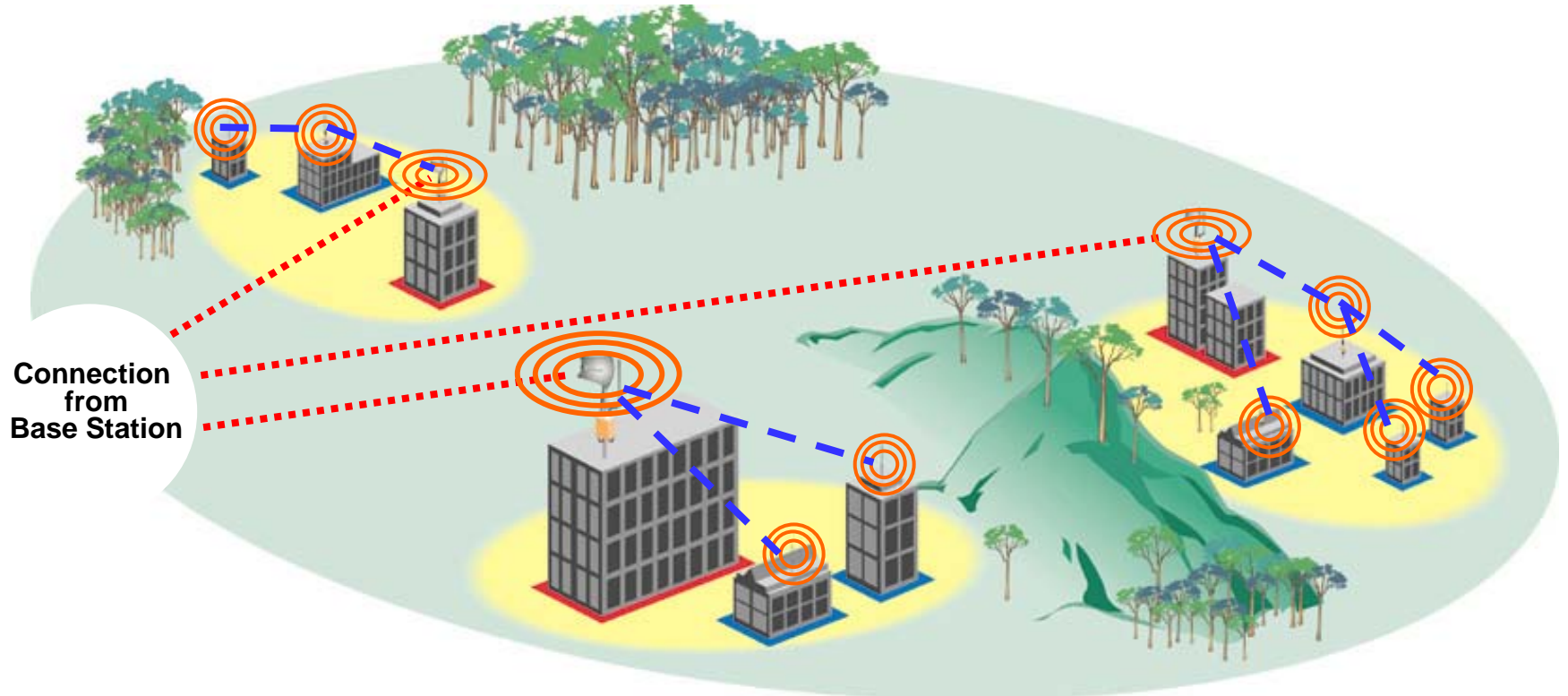
# Complete Wireless Broadband (MAN)



## Sectorization

The three base stations provide 11Mb/s connectivity to each of three sectors of the network - effectively giving the ISP a 33Mb/s base station from which to increase the network penetration and user density. These sectorized base stations then connect to pico-cell routers located within each sector.

# Pico Cell Detail



## Non-line-of-sight Pico Cells

The Pico cell detail illustrates the need for non-line-of-sight solutions. If more than 70% of a given population is to be reached, then a non-line-of-sight solution will be required. Moreover, if an economic model is to be reached, then subscriber self-installation must become a reality. See "debate" slide

# Wireless Broadband Considerations

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- Performance
  - Usually a function of raw data-rate divided by subscriber count
    - Today's systems range from 1 to 11 Mbps
    - Future systems promise 20 to 54 Mbps
- Spectral efficiency
  - Measured in bits per second per hertz
    - Today; less than one
    - Future; as high as three, maybe four
  - Higher efficiency means more channels and more subscribers
- Coverage area, range or cell size
  - Higher the frequency, shorter the range (generally)
- Line-of-sight



# Line-of-Sight; Wireless Broadband's Achilles Heel

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- Wireless broadband could be dominant last-mile solution
  - If the line-of-sight issue could be eliminated, say industry experts
- Makes a truck roll a necessity, complicates logistics
  - Doubling the cost per user
- Inhibits population penetration
  - Today's average less than 70%, often less than 50%
  - This multiplies the impact of a truck roll
    - Cost incurred EVEN if customer not attained
    - Impact on goodwill incalculable
- Even if hardware cost were \$0
  - Economics of broad deployment remain questionable
- The question is *how...*

# Economic Impact of the “Truck Roll”

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Typical revenue model (40 subscribers per sector) w/truck roll:

Base station (1):                      \$3,000 (H/W) + \$2,000 (Install) =  
\$5,000

Subscriber stations (40):      \$1,000 (H/W) + \$500 (Install) =  
\$60,000

Total for 40 node network:    \$65,000

Cost per subscriber (total/40):      \$1,625

Modified revenue model (40 subscribers per sector)  
wo/truck roll:

Base station (1):                      \$3,000 (H/W) + \$2,000 (Install) =

# One “Line-of-Sight” Solution -- OFDM

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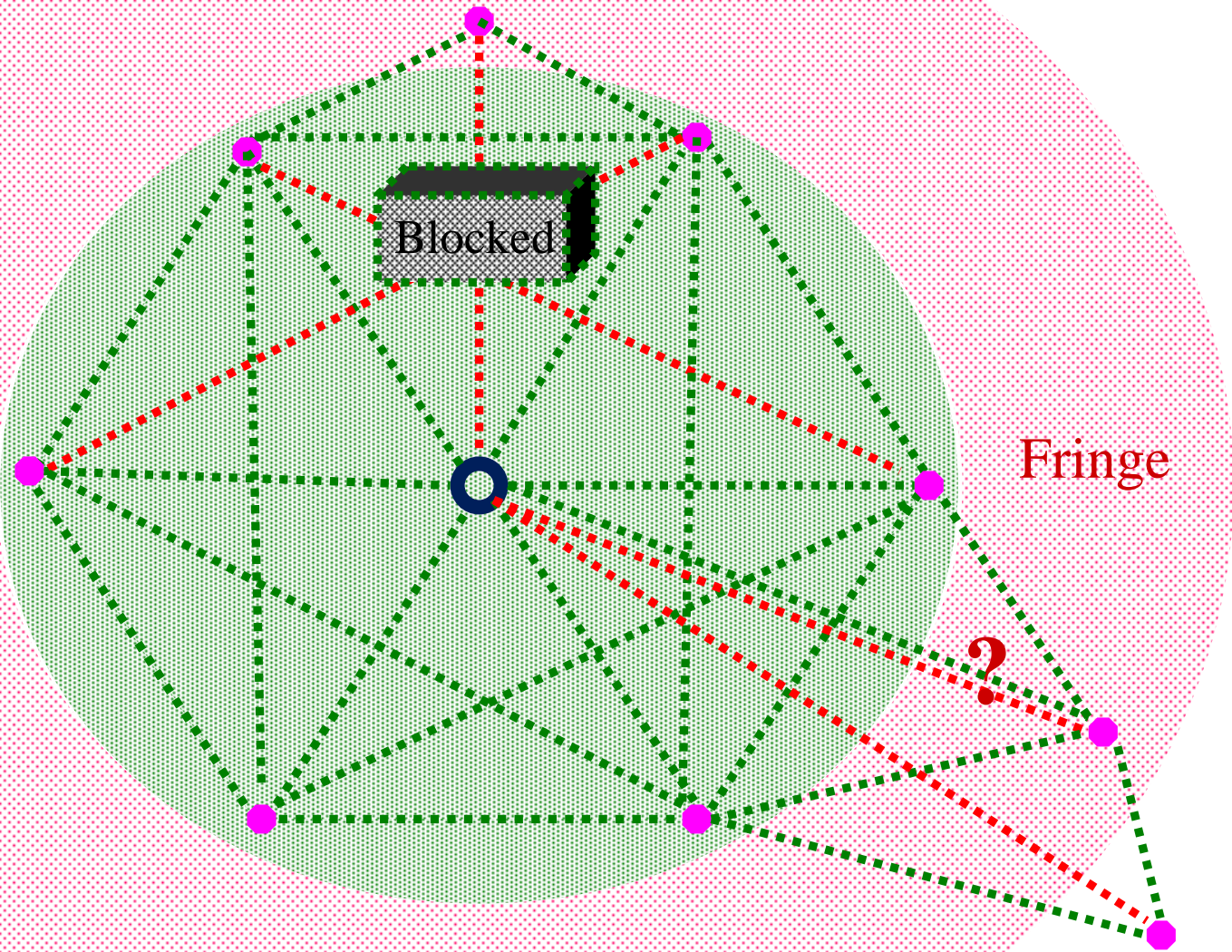
- No question, OFDM is a superior modulation technique
  - Better FEC, BER, multipath propagation
- No question, OFDM improves non-line-of-sight performance
  - Reached population of 75% - 85% (un-reached remains 15% - 25%)
- *Question:* Who determines reached or un-reached?
  - *Answer:* The technician in the truck
- *Question:* Who aligns the directional antenna?
  - *Answer:* The technician in the truck
- *Question:* What happens when neighbor “adds on”
  - *Answer:* One and only path *may* become blocked (call out the truck)
- *Question:* How do fringe subscribers get a link
  - *Answer:* Truck technician spends extra time *or* maybe they don't

# The “Line-of-Sight” Solution – PacketHop<sup>®</sup> (Mesh)

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- PacketHop<sup>®</sup> solves the problem with *software*
  - Permits packets to “find” best path to the POP -- 95% reach
    - Qualitatively, constantly, self-healing, self-configuring
- *Question: Who determines reached or un-reached?*
  - Each transceiver directs packets along one of many multiple paths
- *Question: Who aligns the directional antenna?*
  - With omni-directional antennas, no alignment is required
- *Question: What happens when neighbor “adds on”*
  - The transceiver simply selects an alternate path to the POP
- *Question: How do fringe subscribers get a link*
  - Mount omni and transceiver selects best path to the POP
- *Question: Can PacketHop<sup>®</sup> and OFDM be combined?*
  - Now you get the idea...This is the ultimate solution!
- **Players: Mesh, Nokia, Radiant, Wave, WiLAN**

# PacketHop<sup>®</sup> Graphical Representation



- POP
- Subscriber

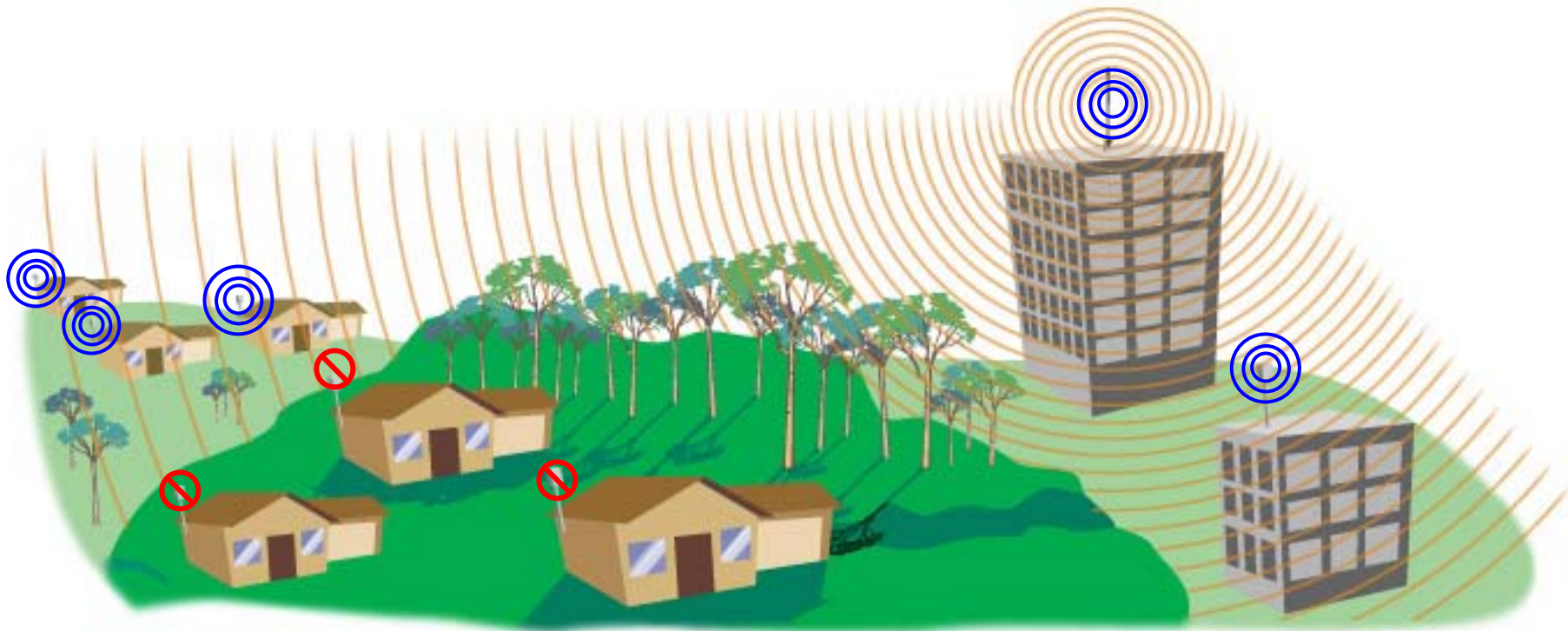
# Without packethop<sup>®</sup>

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# Without packethop<sup>®</sup>

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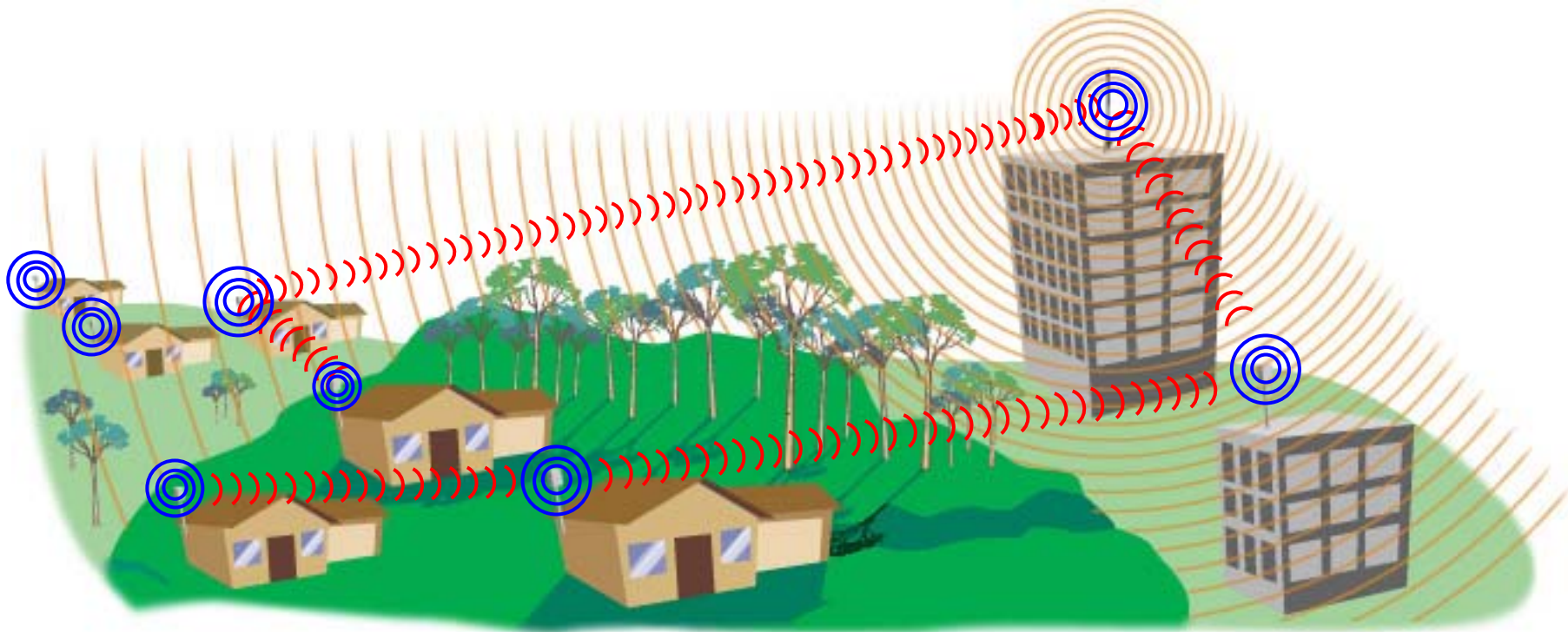


📶 Direct Line Of Sight

🚫 Direct Line Of Sight Blocked







))))) **Blocked Signals Find Shortest  
Alternate Route Around Obstruction**

# Trap #1: Realize Revenue While You Build

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- The major benefit of wireless
  - Scalable: Can serve an infinite number of customers
  - Flexible: Your network can start with a single base station
- Every point on the network can provide revenue
  - Backbone points can serve big bandwidth customers
    - While serving as the hub of a mid-haul network, and so on...
- A major point to consider when raising capital
  - VCs want to see a workable revenue model
  - They've already seen 1000's of network models...

# Trap #2: Thinking Too Big

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- Related to trap number one
  - Wanting to have a large coverage area in place
    - Before turning on the revenue switch
- Pick “less-served” markets
  - Think “bite-size” markets that are bandwidth starved
  - DSL has limited range and coverage
    - Find business and/or higher-end residential districts NOT served
    - Suburban secondary markets are ideal
  - Dissatisfaction with Cable will continue at increasing rate
    - capacity is over-sold, centralized architecture limits re-distributing
    - Cable is also less prevalent in business parks

# Trap #3: Overselling or Underselling Capacity

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- Subscribers may complain about reduced throughput
  - But, this is an example of “high-class” blues
  - In other words; a sign of YOUR success
- Remember, wireless is scalable and flexible
  - When throughput is stretched, simply segment the sector
- Reserve CIR for only the big-bandwidth customers
  - Get paid for this feature
  - Point-to-multipoint wireless does not lend itself well to CIR
    - Occasional interference or surges in demand will affect data-rates

# Trap #4: Using “Bleeding Edge” Technology

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- Don't rush to be on the leading edge
  - They call it “bleeding edge” for a reason
  - Wireless industry is full of “over-promise and under-deliver”
  - Take time to confirm vendor claims
  - Demand references
  - Take advantage of vendor subsidized training programs
- Pick a vendor and stick with them
  - Make your business important to your vendor's business
  - Take advantage of support when available
    - Unbundled doesn't mean unaffordable
    - Often it is invaluable

***Thank you for your attention...***

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***Questions?***

***Discussion?***

# Glossary of Acronyms and Abbreviations

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- BER; bit error rate
- DSSS; direct sequence spread spectrum
- CIR; committed information rate
- FEC; Forward error correction
- FHSS; frequency hop spread spectrum
- Ghz; gigahertz (frequency)
- ISM; industrial, Scientific & Medical
- ISP; internet service provider
- LMDS;
- LOS; line of sight
- MAN; metropolitan area network
- MIR; minimum information rate
- MMDS; multichannel multipoint distribution system
- Mbps; mega-bits per second
- NLOS; non line of sight
- OFDM; orthogonal frequency division modulation
- PCS; Personal Communication System
- POP; point of presence
- PTM; point to multipoint
- PTP; point to point
- QOS; quality of service
- U-NII;
- WISP; wireless internet service provider