

Interference and Coverage Issues

Jack Unger

President - Ask-Wi.Com, Inc.

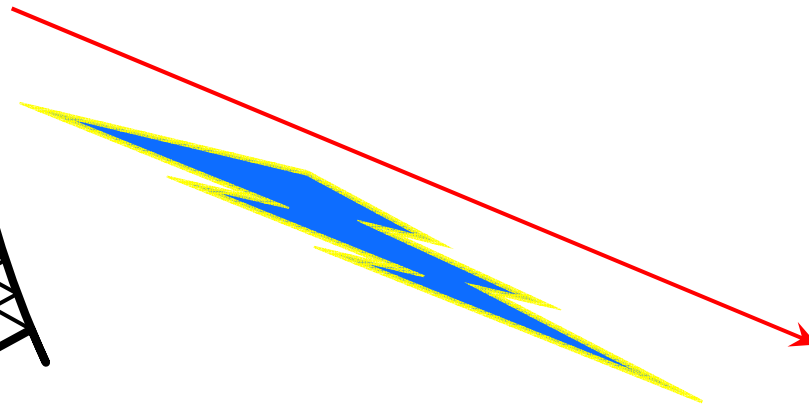
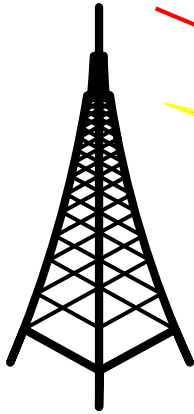
junger@ask-wi.com

(818) 227-4220

Muni Coverage = Reliable Service

Reliable Downlink

Transmit

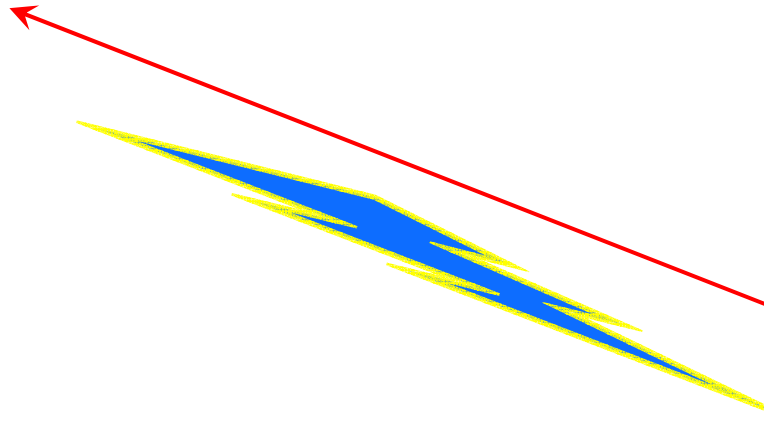
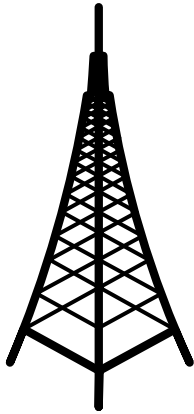


Receive

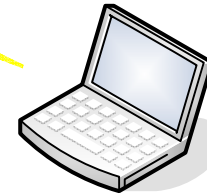


Reliable Uplink

Receive

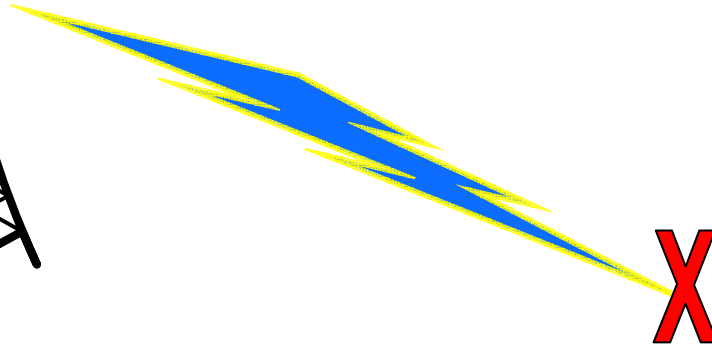
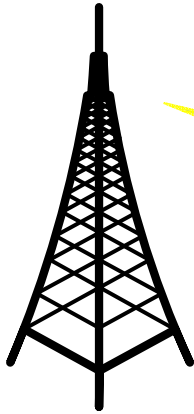


Transmit



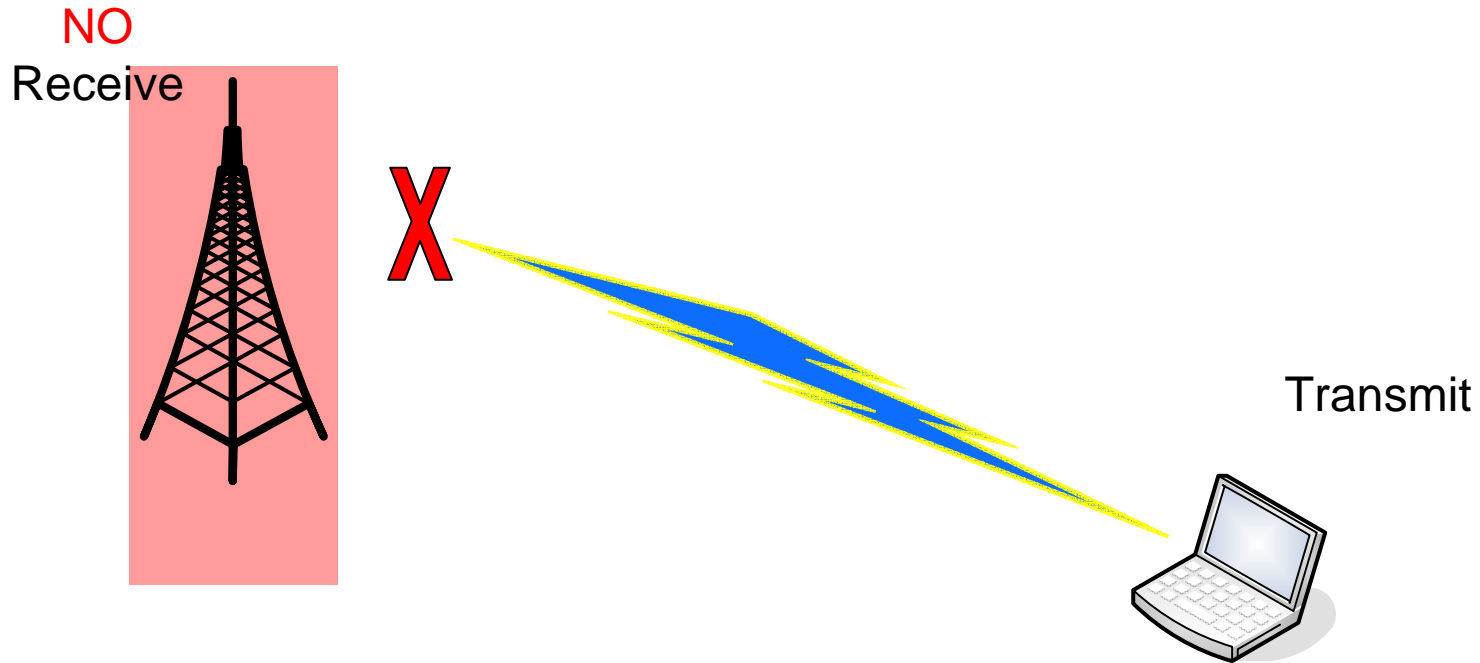
Downlink Interference

Transmit

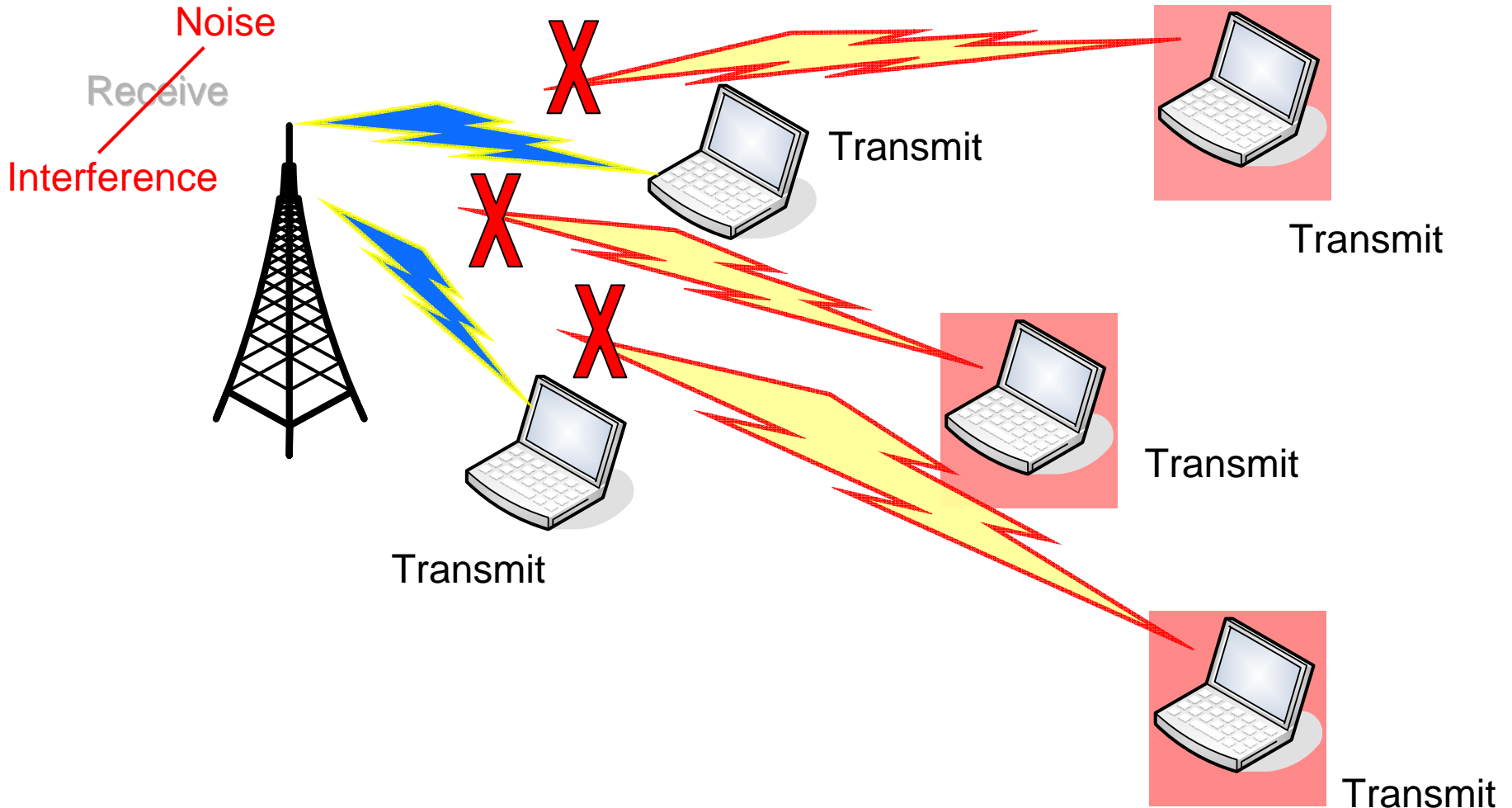


NO
Receive

Uplink Interference



Coverage Reduction

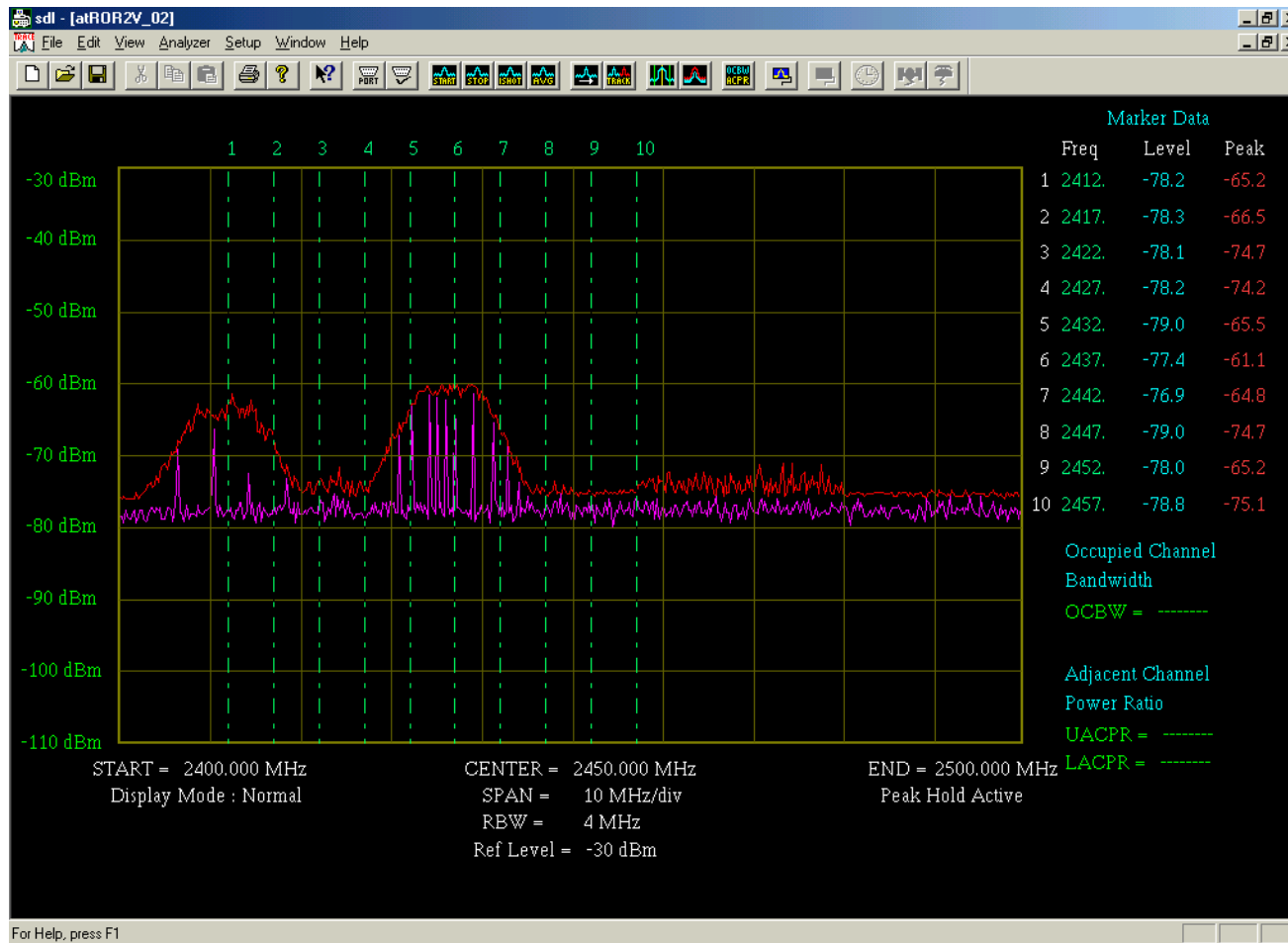


Why Does Noise and Interference Prevent Packet Reception?

Signal-to-Noise Ratio

$$\frac{S}{N} \qquad \frac{s}{N}$$

S Bigger than N (High SNR)



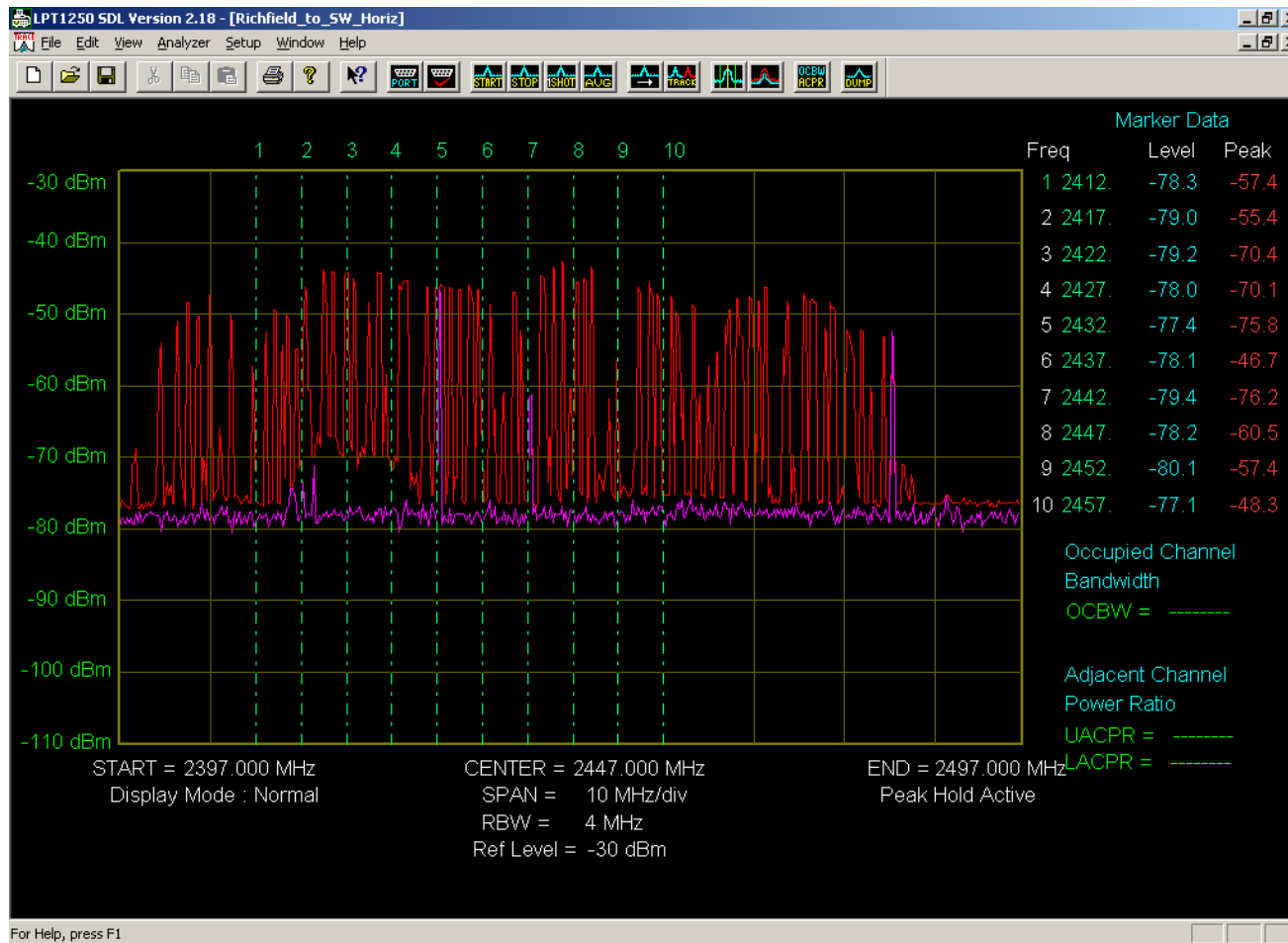
What Makes S Big ?

- High transmit power
- High gain antenna
- Few or no obstructions
- Good receiver sensitivity

What Makes S Small ?

- Low transmit power
- Low gain antenna
- Obstructions
- Low receiver sensitivity

N Bigger than S (Low SNR)



What Makes N Big ?

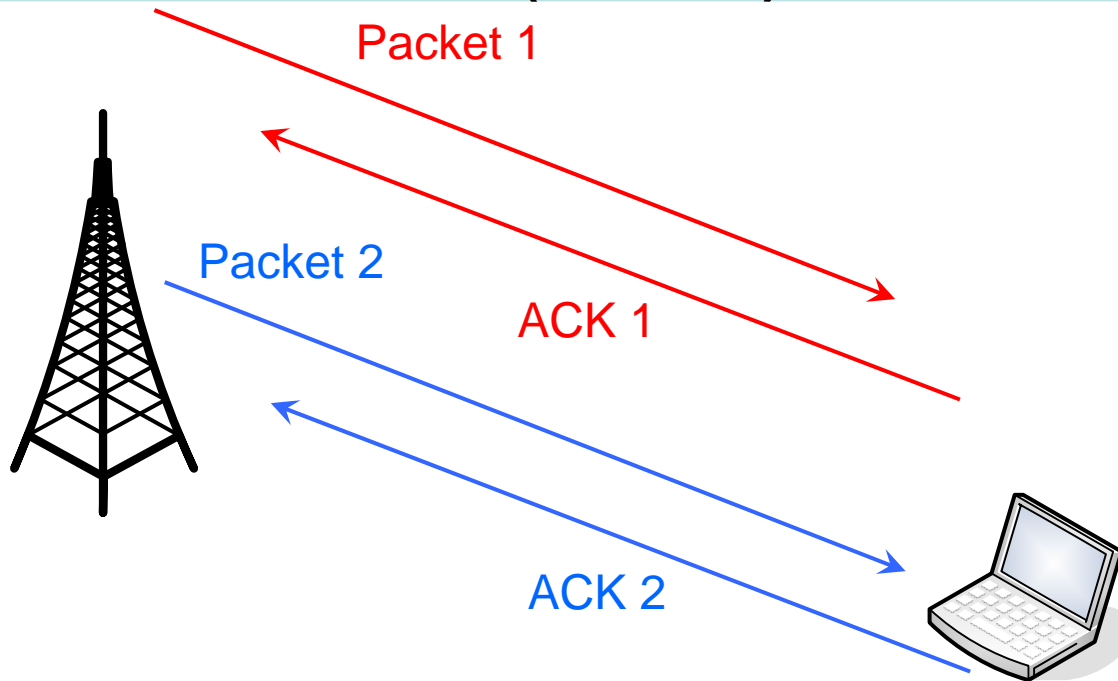
- Noise from other networks (private and public)
- Noise from same-network access points
- Noise from non-network sources (microwave ovens, cordless phones, point-to-point links, etc.)
- Too many end-users contending for access to too few access points
- Backhauling on 2.4 GHz (backhaul contends with with customer packets)
- Omni-directional antennas (exposed to noise from all directions)
- Vertically polarized antennas (exposed to vertically polarized noise)
- “Dumb” access point antenna technology
- Access point coverage area too large (Antenna too high and exposed to too much noise)
- Access point coverage area too small (Too much noise from nearby access points)

What Makes N Small?

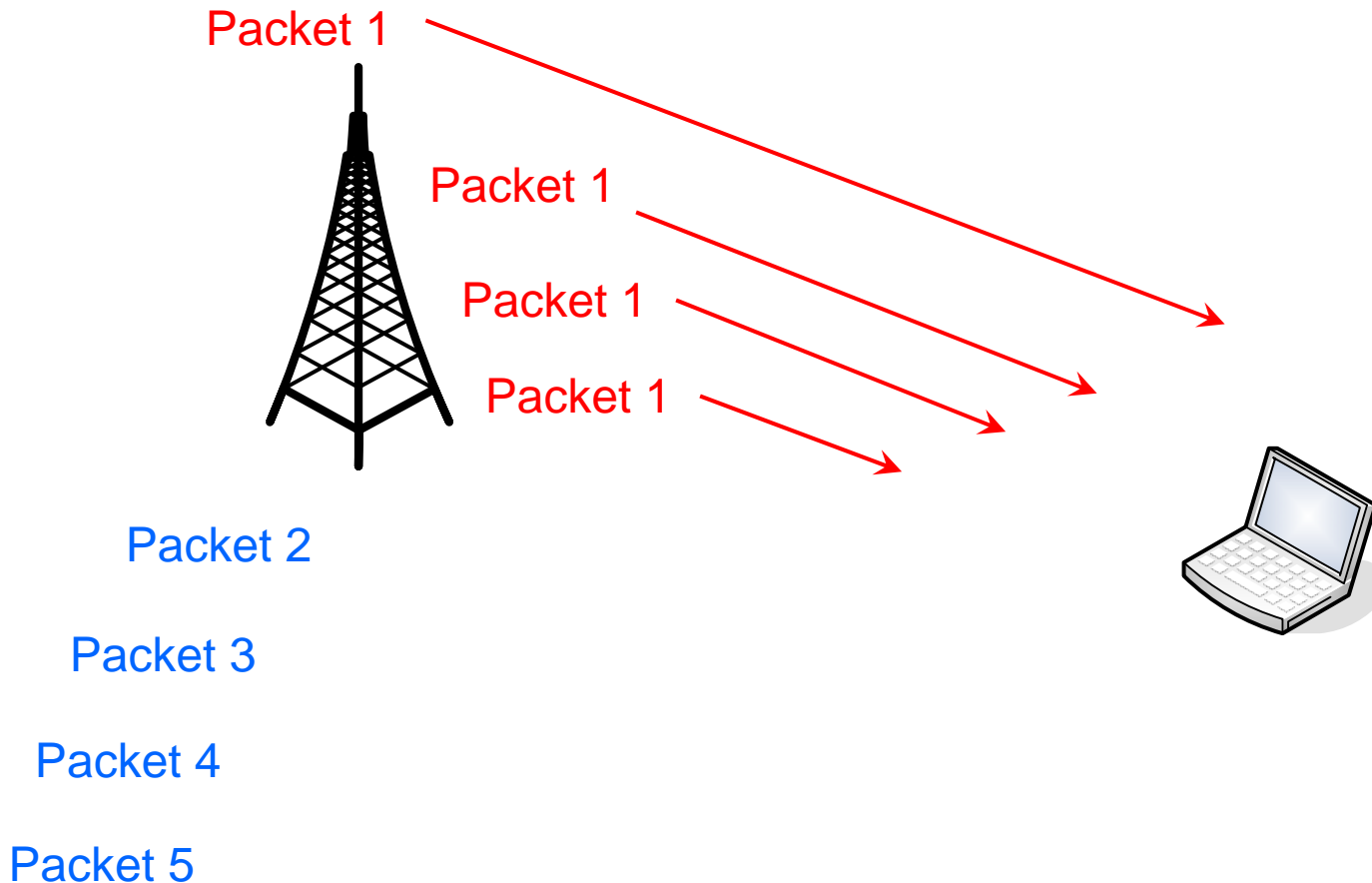
- No other nearby networks
- Few same-network access points
- Few non-network noise sources
- Low number of end-users sharing the available access points
- Backhauling on 5 GHz or backhauling using copper or fiber
- Directional antennas
- Horizontally polarized antennas
- “Smart” access point antenna technology

Why Does Low SNR Reduce Throughput?

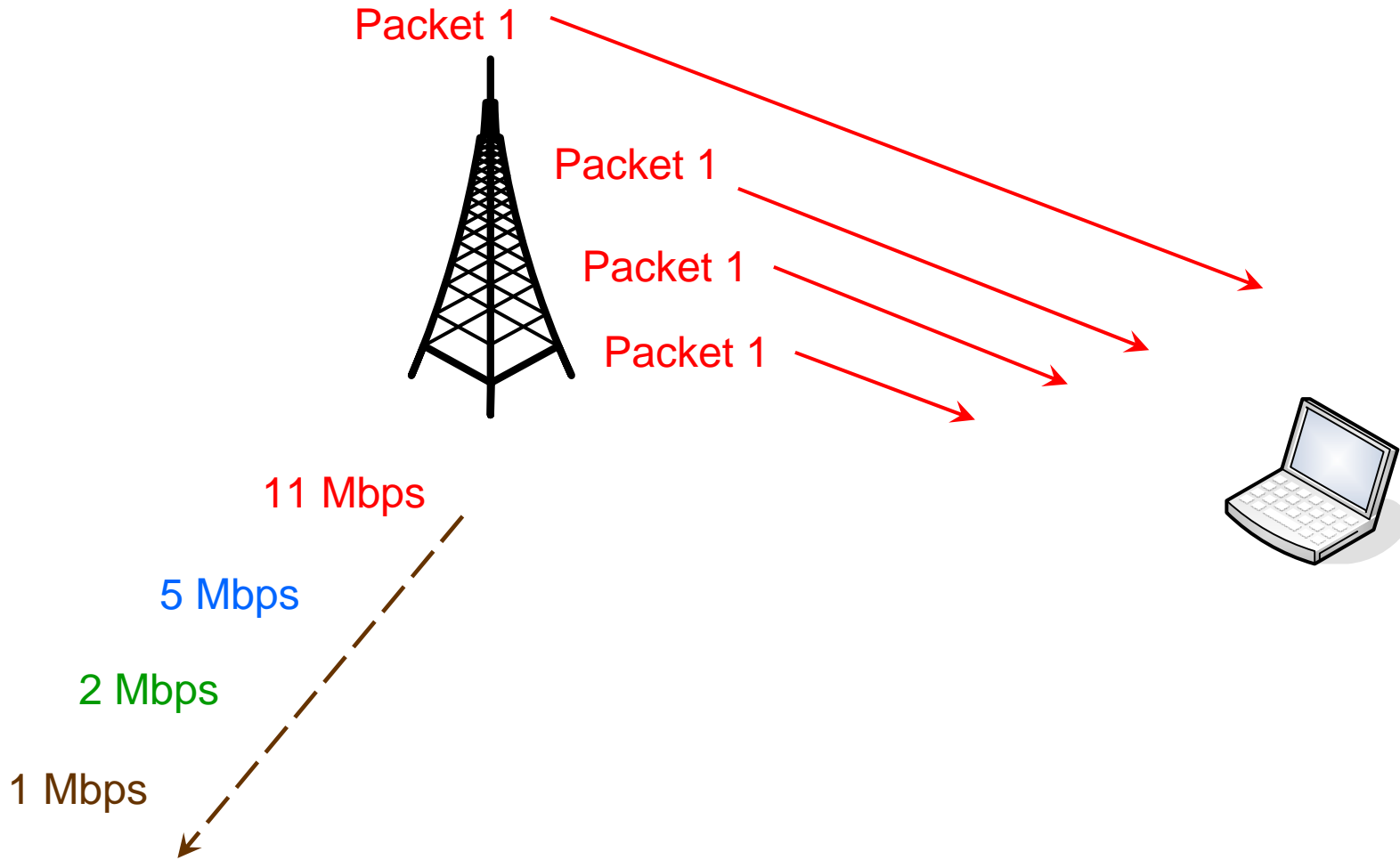
Packet Acknowledgement (ACK)



Packets Not Acknowledged (No ACK)



Automatic Data Rate Fallback



What City Employees Can Do

- Understand the limitations of license-free technology
- Bandwidth is limited; use wireless as a supplement to, not as a replacement for wired
- Write realistic, achievable RFPs
- Set reasonable end-user expectations; manage those expectations proactively
- Research your existing, local wireless service providers and consider including them in your plans
- Actively promote end-user education
- Lobby the FCC to provide more license-free frequencies
- Understand the limitations of and expect changes to the “free” buildout model

What Equipment Manufacturers Can Do

- Provide mesh equipment that offers non-2.4 GHz backhaul options (fiber, copper, licensed)
- Offer directional antennas (not just omnis)
- Offer horizontally-polarized antenna options
- Offer smart antenna systems
- When advertising and marketing, communicate throughput and coverage capabilities accurately
- Actively promote end-user education

What Network Designers Can Do

- Communicate throughput capabilities accurately
- Be aware of the interference environment and design with it in mind
- Actively promote end-user education
- Encourage the use of better CPE devices
- Don't use 2.4 GHz for backhaul except for low-traffic networks (meter reading, etc.)
- Use 5.3 GHz, 5.8 GHz, copper, fiber, dsl, licensed frequencies for backhaul
- Avoid using 4.9 GHz public safety frequencies to backhaul commercial Internet traffic
- Integrate effective network monitoring into your system
- Build enough test time into your deployment schedule

What Existing WISPs Can Do

- Maximize your wireless experience
- Reach out to your City Government and offer your wireless expertise
- Offer to be part of the interference reduction effort

What End-Users Can Do

- When using public Wi-Fi indoors; place your wireless laptop near a window facing the nearest wireless node
- To improve reliability, be willing to try an external wireless device on your laptop
- Use the in-house wired network where one is available; use wireless only when needed
- Minimize the use of other in-house 2.4 GHz wireless devices and access points
- Practice in-house interference management (set non-overlapping channels on nearby access points)

What Businesses Can Do

- Do support your city's efforts to deploy Wi-Fi
- Don't expect Muni Wi-Fi networks to meet your everyday fixed-location business needs
- Do provide virtual private network (VPN) capability for your mobile employees who use public Wi-Fi hotspots

What Journalists Can Do

- Gain a technical understanding that will allow you to report accurately
- Avoid the use of overly general terms (“blanket the city”)
- Interview a range of people
- Test the deployed system for yourself
- Provide your contact information in your articles so readers can give you feedback

Focused Action is Needed

- Don't assume that any Muni Wi-Fi problems will solve themselves
- Technology improvements will arrive slower than the increase in the use of wireless devices
- Noise will continue to increase rapidly with the continued rapid growth in the use of wireless devices
- Without focused action on the part of ALL stakeholders, increasing noise levels could continue to reduce the coverage range and the reliability of wireless devices

Focused Action is Needed

- Throughput estimates will always be overly optimistic
- Coverage estimates will always be overly optimistic
- Noise and Interference will always be the most significant factors limiting reliable coverage
- More license-free spectrum will always be needed to attempt to meet throughput expectations in the presence of increasing interference levels
- Better CPE will always be needed
- Better frequency planning and coordination is a constant need
- Better education is a constant need.