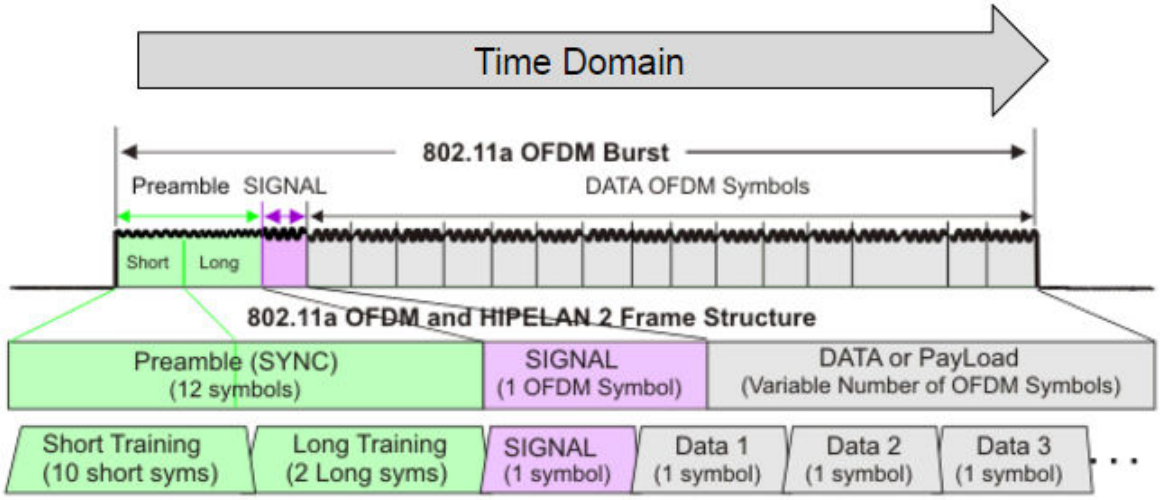
Tony Kapela of 5Nines Talks to Our Section

Tony Kapela spoke to our section in March about wireless. His talk began going over WiFi, including the details of how its packet structure works, OFDM, and channel access (collision avoidance) scheme.



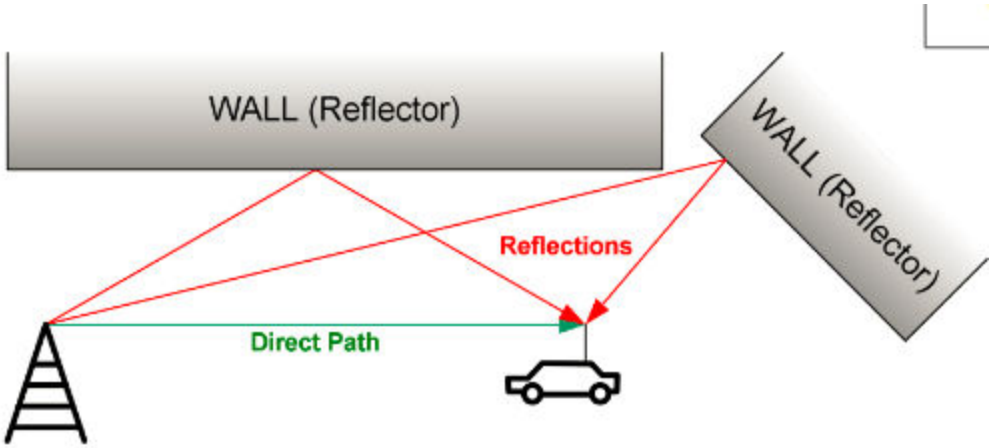
Kapela explained how Wi-Fi is different from WiMAX and LTE in that you only need the RF Channel # and the SSID to configure a network. That's actually pretty amazing.

One is disadvantage to Wi-Fi is there is no provision for handoff to another access point.

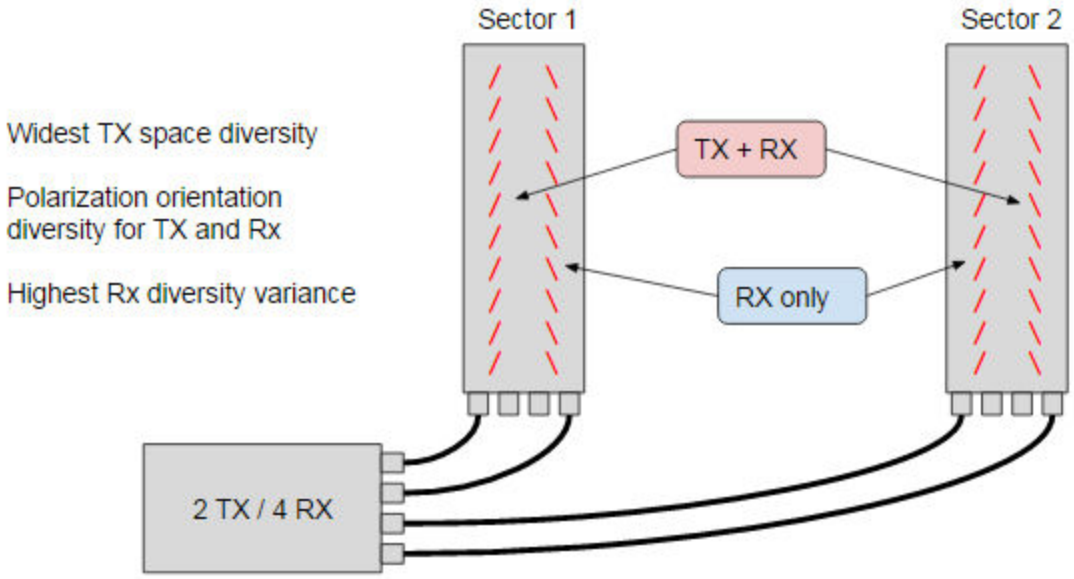
WiMax provides for handoff but is more complicated than Wi-Fi to configure:

- BS ID must be unique within the whole network
- For any given RF channel, the administrator must configure *cell ID*, *segment*, and *IR CDMA offset*.
- WiMax has parameters for when to handoff
    - How much better the SNR must be
    - How good the candidate site SNR must be
    - What the RSSI must be

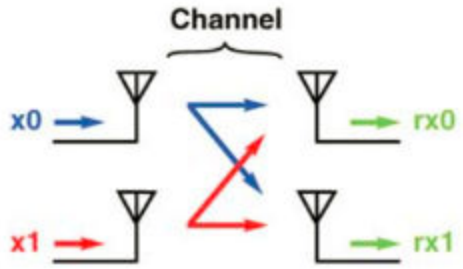
Another huge difference is WiMax tolerates much larger multipath delays spreads.



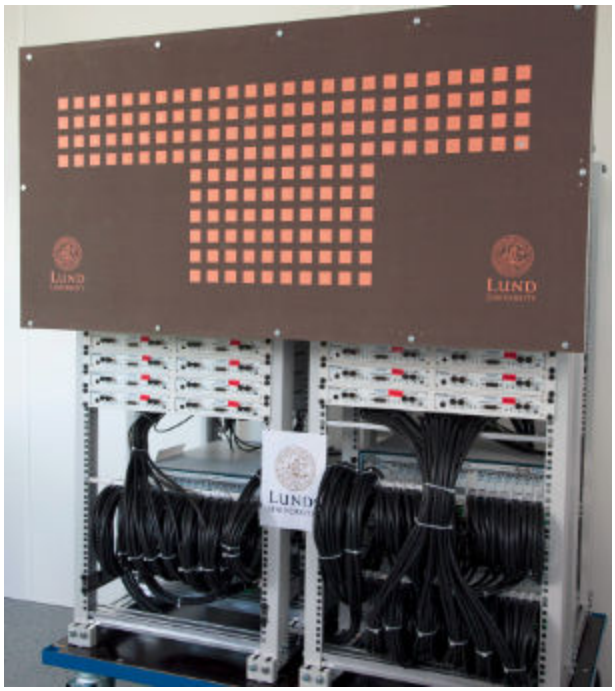
Kapela talked to us about Shannon's Law and then need to get as much data over the air as possible. Most 5Nine's antenna are diagonally polarized, not vertical or horizontal. To get a little added polarization diversity, they have the TX and RX polarization orthogonal to nearby bases' TX and RX antennas.



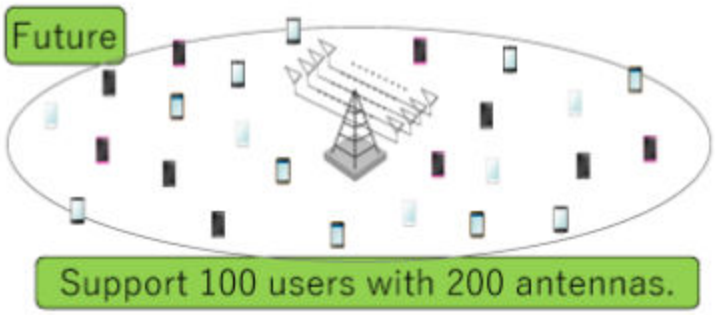
The future is about large-scale MIMO. MIMO is the amazing technology that allows multiple transmitters to send different streams of data at the same time on the same frequency generating a cacophony of interfering signals that a receiver can tease apart by knowing the channel function between each transmitter and receiver. There are consumer WiFi devices that do this with two streams.



Kapela went over examples of very massive MIMO, greater than 100 streams. This seems like it would take an ideal channel with no correlation between the channel functions from each TX antenna to each RX antenna. Kapela explained that this is not necessary. The receiver can send feedback to the transmitter on the channel, so that the transmitter can precondition its transmissions favorably for MIMO.



The TX and RX side each need to have at least as many antennas as streams. When talking to handheld mobile devices, which are too small for many antennas, MIMO is still beneficial because a base station can use its antenna to do beamforming to form the equivalent of a highly directional antenna aimed right at the mobile device.



It is amazing how much data we can cram into a given bandwidth in a given geographical area. Users' demand for data is increasing rapidly, so we will need to keep improving. Despite how much amazing progress has been made since MIMO techniques were first modeled mathematically in the mid 90s, there is still a great deal of room to fit even more data over the air.