MikroTik Nv2

New and Improved Wireless Networking with Nstreme Version 2

Presented by David Savage
MikroTikSA (MikroTik Certified Training Partner)

About MikroTikSA

- We are a MikroTik Certified Training Partner
  - Not owned by MikroTik Latvia!
- We specialise in building high speed wireless networks, delivering industry leading SLA services, and offer training on various networking system
- David Savage has over 20 years experience in the IT industry, and has been working with MikroTik for the past 6 years

What to expect today

Wireless Protocols

802.11a/b/g Data Rates

Media Access Techniques

Nstreme

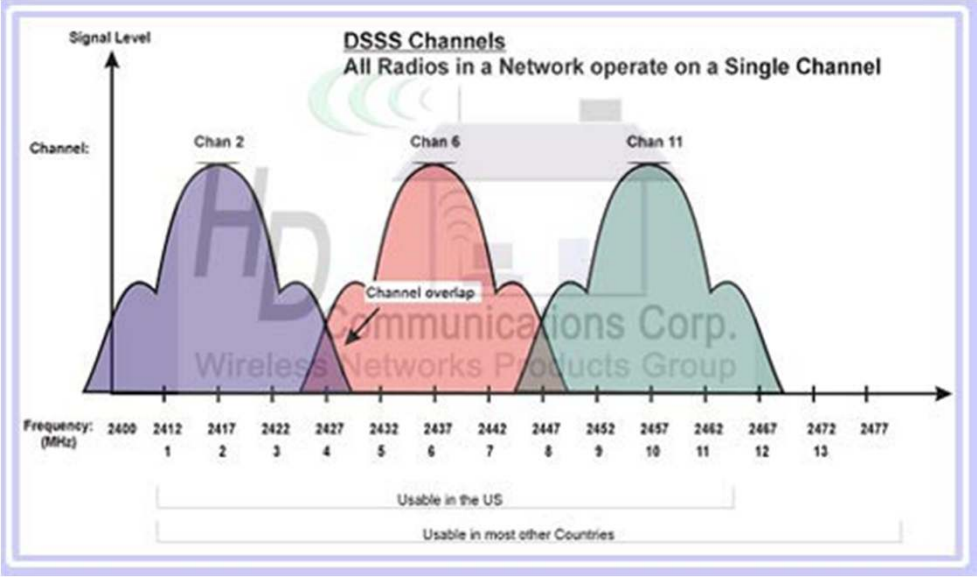
Nstreme Dual

802.11n Features

Nstreme Version 2

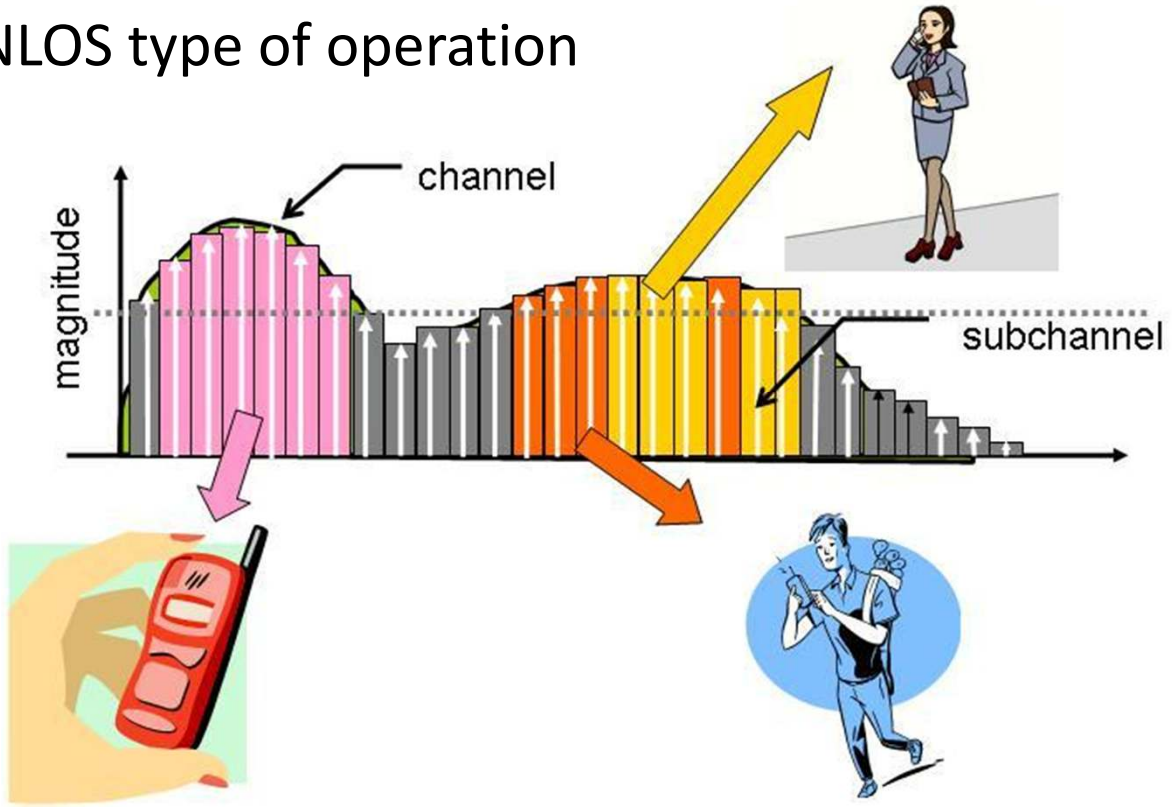
Wireless Modulation Techniques

- DSSS – Direct Sequence Spread Spectrum 802.11b
  - Uses the full bandwidth as a single carrier
  - Susceptible to noise anywhere in the band, noise anywhere in the channel can cause the entire transmission to drop



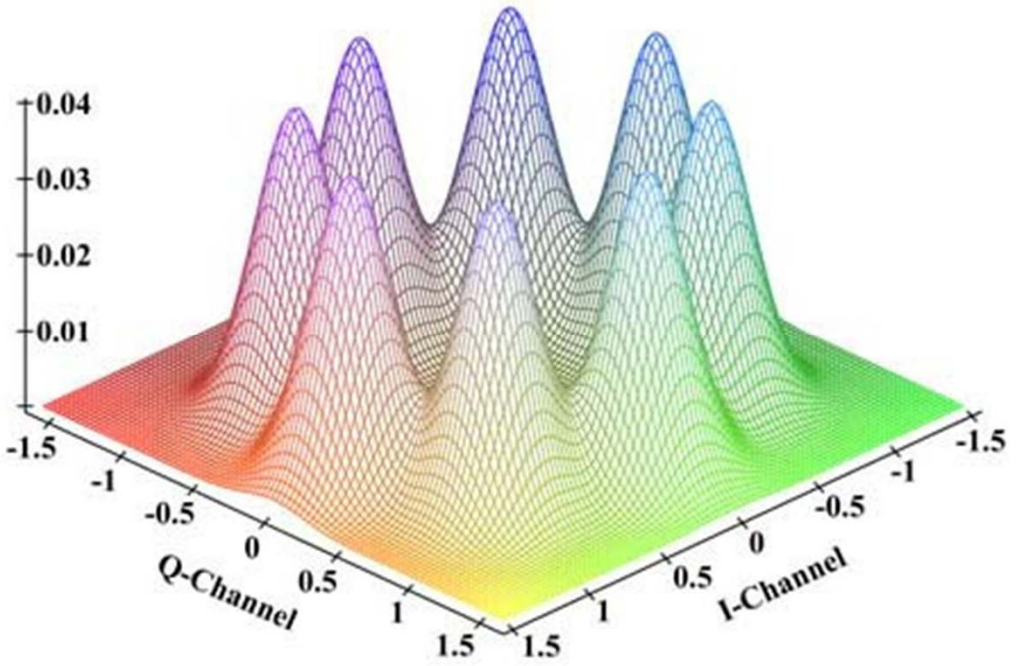
Wireless Modulation Techniques

- OFDM – Orthagonal Frequency Division Multiplexing 802.11a/g
  - Chops the bandwidth up into multiple smaller carriers
  - More resistant to noise than DSSS
  - Allow NLOS type of operation



Wireless Modulation Techniques

- PSK / QAM – Phase Shift Keying / Quadrature Amplitude Modulation 802.11N
  - Uses multiple phases to carry the signal
  - Allows much greater density of data for the same bandwidth
  - Allows for MIMO technology to increase either data rate or reliability



802.11 Data Rates

802.11a/b/g

- This is the default wireless operating mode
- Compatible with all other non-proprietary 802.11 wireless products and vendors
- Actual data rate (under ideal conditions) is about half of the “air rate” (shown sync rate)
  - Often leads to confusion as many quote the air rate when selling the product or link, and this can never be delivered as actual file transfer speed
- Features WDS mode for extending layer 2 networks using a AP’s as “repeaters”
- Features a “turbo” mode that can use more frequency bandwidth to increase the data rate

802.11a/b/g Data Rates

Standard	Frequency / Range	Bandwidth	Channel Spacing	Air Rate (Max)	Actual Rate
802.11B	2.4Ghz 2312-2599Mhz	22Mhz	5Mhz	11mbps	5.5
802.11G G-Turbo	2.4Ghz 2312-2599Mhz	22Mhz 44Mhz	5Mhz	54mbps 108mbps	27 54
802.11A A-Turbo	5Ghz 4920-6100Mhz	5Mhz 10Mhz 20Mhz 40Mhz	5Mhz 10Mhz 20Mhz	13.5mbps 27mbps 54mbps 108mbps	6.75 13.5 27 54
802.11N	2.4/5Ghz 2312-2599Mhz 4920-6100Mhz	5Mhz 10Mhz 20Mhz 40Mhz	5Mhz 10Mhz 20Mhz 2 x 20Mhz	37.5mbps 75mbps 150mbps 300mbps	18.5 37.5 75 150

802.11n

- 802.11n is supported in MikroTik from ROS ver4.x onwards
- It uses PSK and QAM to provide much higher data rates than 802.11a/b/g
  - It packs many more bits into a waveform, so interference will have a big effect on performance
- It allows for MIMO to increase bandwidth even further
  - MIMO is not required for 802.11n to work
  - MIMO can increase performance in low noise situations
  - MIMO can increase reliability in high noise situations

MIMO

- Multi In Multi Out is a method of getting increased bandwidth and/or increased reliability
- It uses multiple antennas on both the sending and receiving side to increase the amount of data that can be sent and received
- It uses a technique called SDM (Spatial Division Multiplexing) to combine the signals received from multiple antennas into a cohesive set of data
- NOTE: in itself MIMO does not increase the link speed
  - it increases the number of spatial streams that can be used, allowing higher data rates by increasing the number of paths that data can travel along

802.11N Rates

Standard	Frequency / Range	Bandwidth	Channel Spacing	Air Rate (Max)	Actual Rate
802.11B	2.4Ghz 2312-2599Mhz	22Mhz	5Mhz	11mbps	5.5
802.11G G-Turbo	2.4Ghz 2312-2599Mhz	22Mhz 44Mhz	5Mhz	54mbps 108mbps	27 54
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Media Access Techniques

802.11a/b/g/n

Nstreme

NV2

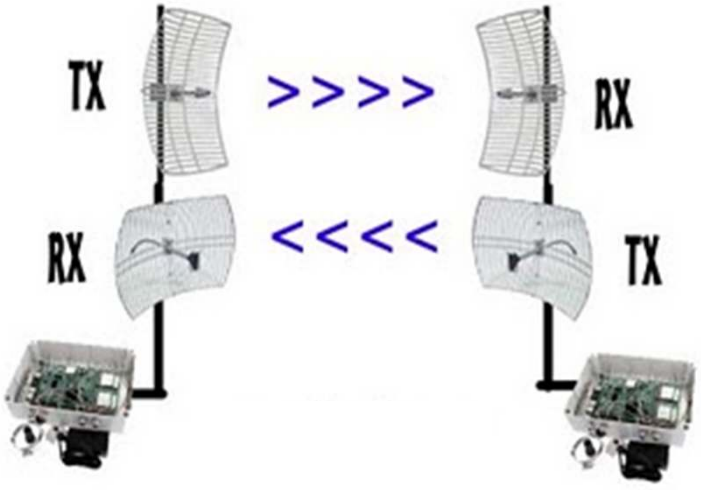
Media Access Techniques – 802.11abgn

- CSMA/CA – Carrier Sense Multiple Access with Collision Avoidance
- Modified version of CSMA/CD (Ethernet) protocol
- Collision Avoidance is used to improve CSMA performance by not allowing wireless transmission of a node if another node is transmitting
  - this reduces the probability of collisions due to the use of a random truncated backoff time.

Nstreme

- Nstreme is MikroTik's proprietary (i.e., incompatible with other vendors) wireless protocol created to improve performance on both point-to-point and point-to-multipoint wireless links.
- Benefits of Nstreme protocol:
  - Client polling
  - You can disable CSMA
  - No protocol limits on link distance
  - Smaller protocol overhead per frame allowing super-high data rates
  - No protocol speed degradation for long link distances

N-Streme Dual Protocol



MikroTik proprietary wireless links works with a pair of wireless cards (Atheros chipset cards only) – one transmitting, one receiving

Benefits / Drawbacks of Nstreme Dual

- Capable of very high speed Full Duplex transfer
- 2 cards per end allow different TX and RX frequencies, allowing for better separation
- Capable of transparent bridging with no special setup
- Not detectable in wireless scans, uses MAC addresses to connect, not SSID
- Requires multiple antennas per side, dual polarised antennas not the best solution
- Requires very high speed routerboards for best performance

Nstreme Version 2 (NV2)

- MikroTik proprietary protocol that uses TDMA (Time Division Multiple Access) as the MAC level data carrier
- It replaces and is not compatible with CSMA/CA and Nstreme
- NV2 deploys multiple timeslots per transmission cycle that are assigned to clients at the beginning of each transmission
- Each client may only transmit in his own timeslot
- Strict timeslot control ensures each client has a fair chance of transmitting or receiving data

Nstreme/NV2 Rates

Standard	Frequency / Range	Bandwidth	Channel Spacing	Air Rate (Max)	Actual Rate (Nstreme rate) mbps
802.11B	2.4Ghz 2312-2599Mhz	22Mhz	5Mhz	11mbps	5.5 (7)
802.11G G-Turbo	2.4Ghz 2312-2599Mhz	22Mhz 44Mhz	5Mhz	54mbps 108mbps	27 (37) 54 (74)
802.11A A-Turbo	5Ghz 4920-6100Mhz	5Mhz 10Mhz 20Mhz 40Mhz	5Mhz 10Mhz 20Mhz	13.5mbps 27mbps 54mbps 108mbps	6.75 (9) 13.5 (18) 27 (37) 54 (74)
802.11N	2.4/5Ghz 2312-2599Mhz 4920-6100Mhz	5Mhz 10Mhz 20Mhz 40Mhz	5Mhz 10Mhz 20Mhz 2 x 20Mhz	37.5mbps 75mbps 150mbps 300mbps	18.5 (28?) 37.5 (50?) 75 (100?) 150 (200?)

802.11n Features

Frame Aggregation

Block Acknowledgement

Channel Bonding

MIMO

Frame Aggregation

- 802.11a/b/g requires an Acknowledgement (ACK) for each frame that gets sent
  - This allows high reliability, but at high data rates the overhead can be more than the actual data
- Nstreme gets around this to an extent by using Framer Policy to allow more packets per frame
- 802.11n uses Aggregation of MAC Service Data Units (AMSDU), Aggregation of MAC Protocol Data Units (AMPDU) and Block Acknowledgement (BA) as mechanisms to increase data throughput on wireless links

Aggregation of Mac Service Data Units

- MSDU aggregation relies on most Access Points and most client protocol stacks using Ethernet as their "native" frame format.
- It collects Ethernet frames to be transmitted to a single destination and wraps them in a single 802.11n frame.
  - This is efficient because Ethernet headers are much shorter than 802.11 headers.
- Combining multiple (Ethernet) data frames into a single frame decreases the overhead, allowing higher data rates

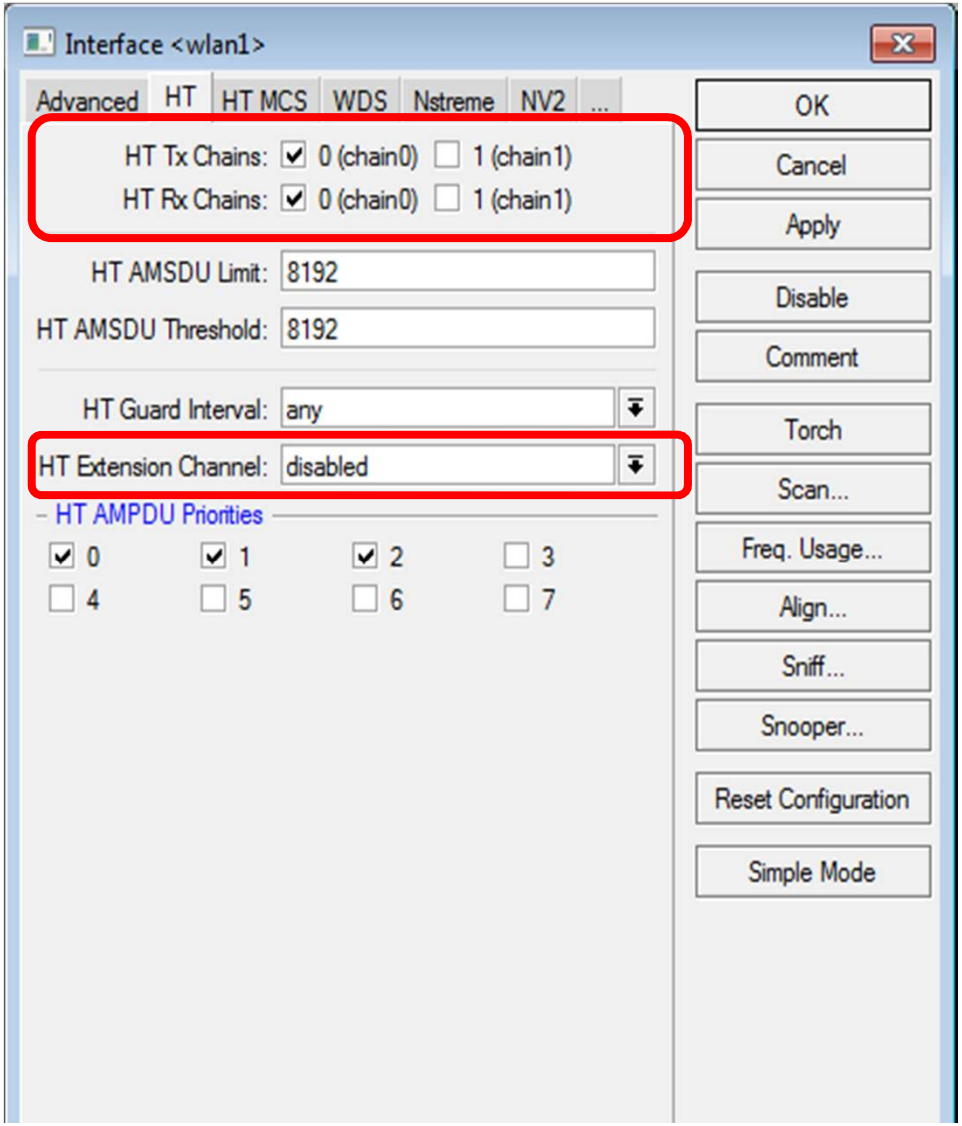
Aggregation of Mac Protocol Data Units

- MPDU aggregation also collects Ethernet frames to be transmitted to a single destination, but it wraps each frame in an 802.11n MAC header
- This is less efficient than MSDU aggregation, but it may be more efficient in environments with high error rates, because of ***block acknowledgement (BA)***.
- Instead of transmitting an individual ACK for every MPDU, multiple MPDUs can be acknowledged together using a single BA frame.
- This mechanism allows each of the aggregated data frames to be individually acknowledged or retransmitted if affected by an error.

Channel Bonding, Chains

- By default 802.11n uses 20MHz of bandwidth
- Channel Bonding adds additional 20Mhz channel to the existing channel
- The additional channel is placed below or above the main channel frequency
- It is backward compatible with existing 20Mhz clients
  - A connection will be made to the main channel
- Allows the use of higher data rates
- TX/RX chains (MIMO) – number of antennas that are being used

Wireless settings



- Possible antenna modes are 1x1, 1x2, 2x1, 2x2
- Extension channel is below or above frequency

Nv2

What is Nv2

Nv2 Compatibility

Nv2 co-existence

Nv2 vs 802.11 vs Nstreme

Nv2 Support in ROS

Nstreme Version 2

- Nv2 is a MikroTik proprietary wireless protocol for use with Atheros 802.11 wireless chips.
- Nv2 is based on TDMA (Time Division Multiple Access) instead of CSMA (Carrier Sense Multiple Access)
- TDMA solves hidden node problem and improves media usage, thus improving throughput and latency, especially in PtMP networks.
- Nv2 is supported for Atheros 802.11n chips and legacy 802.11a/b/g chips starting from AR5212, but not supported on older AR5211 and AR5210 chips.
  - Both 11n and legacy devices can participate in the same network and a hardware upgrade is not required to implement Nv2

Nstreme Version 2

- Media access in a Nv2 network is controlled by the Nv2 Access Point.
- The AP divides time into fixed size "periods" which are dynamically divided in the downlink (data sent from AP to clients) and uplink (data sent from clients to AP) portions, based on queue state on AP and clients.
- Uplink time is further divided between connected clients based on their requirements for bandwidth.
- At the beginning of each period the AP broadcasts a schedule that tells clients when they may transmit and the amount of time they can use.

Nv2 Compatibitily

- Nv2 protocol is not compatible with any other wireless protocols or implementations, either TDMA based or any other kind, including Motorola Canopy, Ubiquiti Airmax and FreeBSD TDMA implementation.
  - **only Nv2 supported and enabled devices can participate in a Nv2 network**.
- Regular 802.11 devices will not recognize and will not be able to connect to an Nv2 AP.
- RouterOS devices that have Nv2 support will see Nv2 APs when running a wireless scan, but will only connect to a Nv2 AP if properly configured.

Nv2 Co-existence

- As Nv2 does not use CSMA technology it may disturb any other networks on the same frequency. In the same way other networks may interfere with an Nv2 network, because all other signals are considered noise.
- Unlike 802.11 CSMA, the TDMA protocol is “always on”, so it is always transmitting, so the chance of interference is much higher

Nv2 Key Points

- The key points regarding compatibility and coexistence:
  - only RouterOS devices will be able to participate in an Nv2 network
  - only RouterOS devices will see an Nv2 AP when scanning
  - Nv2 networks will disturb other networks in the same channel
  - Nv2 networks may be affected by any (Nv2 or not) other networks in the same channel
  - Nv2 enabled device will not connect to any other TDMA based network

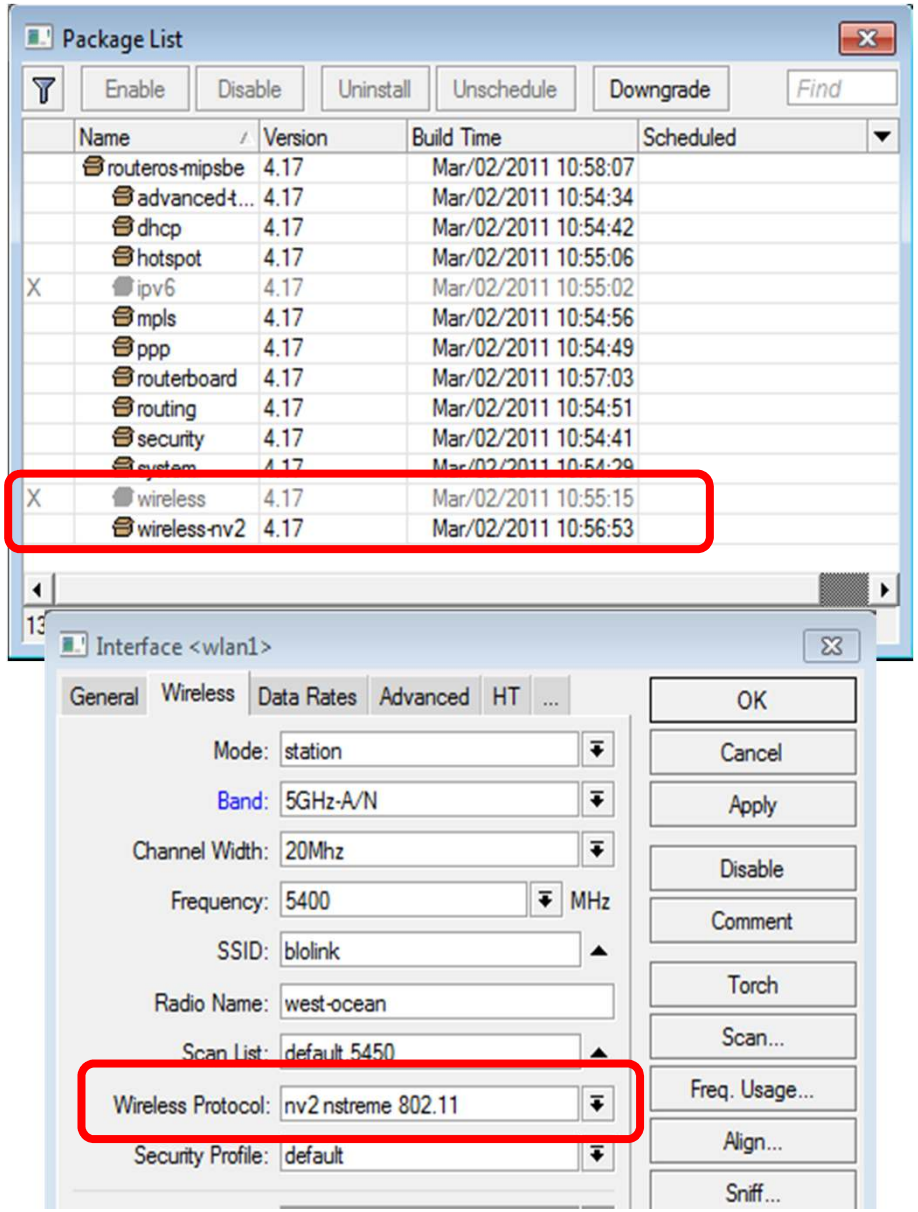
Nv2 vs 802.11

- Media access is scheduled by the AP - this eliminates hidden node problem and allows a centralized media access policy
  - AP controls how much time is used by each client and can assign time to clients according a policy as opposed to each device contending for media access.
- Reduced propagation delay overhead
  - no per-frame ACKs significantly improves throughput, especially on long distance links
- Reduced per frame overhead
  - Nv2 implements frame aggregation and fragmentation to maximize assigned media usage and reduce per-frame overhead

Nv2 vs Nstreme

- Reduced polling overhead
  - Nv2 AP broadcasts an uplink schedule that assigns time to multiple clients, instead of polling each client.
  - this can be considered "group polling“, reduced per-client polling means more time for actual data transmission
  - This improves throughput, especially in PtMP configurations.
- Reduced propagation delay overhead
  - The uplink schedule is based on estimated distance (propagation delay) to clients
  - This improves throughput, especially in PtMP configurations.
- More control over latency
  - reduced overhead, adjustable period size and QoS features allows for more control over latency in the network.

Nv2 Support in ROSv4



- Nv2 support in ROS is provided in the Wireless-Nv2 package (ROSv4)
- Once enabled a new field will be enabled in the wireless interface settings
- The Wireless Protocol field is used to set Nv2 behaviour for AP and Client as set out in the table
- Native Nv2 support is available in ROSv5

Lab vs Outdoor Performance

- MIMO setup: Test each chain separately before using both chains simultaneously
- MIMO can deliver better performance or better reliability, but rarely both
- For dual chain operation use a cross polarization for each chain
- When used dual-polarized antennas, the recommended isolation of the antenna is at least 25db
- Nv2 seems to perform better in situations where noise is high but signal strength is good (of course it is best when noise is low!)
- When signal is poor or in extremely high noise situations, 802.11n with or without Nstreme may deliver better results, experimentation is required
- Nstreme in high noise areas can add a lot of latency to deliver higher speeds, real time traffic like VOIP will suffer

Q & A