

W6: Analysis of Data Rates and Modulation Formats using Wireshark

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Abstract—For our assignment, we have not only captured packets in Delft but also in Mumbai, India. We see a few differences in the characteristics of similar types of packets but from these two different places. In this report, we hope to elaborate on the differences and also provide some other general observations.

I. 802.11B

We saw maximum number of packets belonging to this type. These packets typically have the lowest data rates.

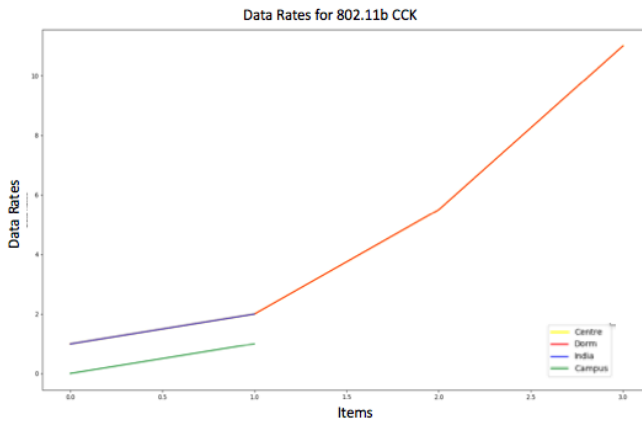


Fig. 1. Data Rates v/s Modulation types for PHY type 802.11n in India

- Data Rates: 1, 2, 5, 11 Mbps
- Modulation: DSSS

A. Observations

- 1) India: Data Rates are 1 and 2 Mbps. These rates are constant irrespective of the location. The packets are of all types including Beacon Frames, Probe Response, Data and QoS. This version constitutes the highest percentage among all the different protocols which leads us to believe that this is the popular choice of protocol in India currently.
- 2) Delft Centre: The data rates for packets varies significantly in comparison to other areas. This may be attributed to the innumerable distinct access points present residentially and commercially alike. Here too it remains the protocol of choice. This leads us to believe that this may be the protocol of choice for residences and small businesses at many places globally.
- 3) TU Campus: This protocol is not the most popular in the TU Campus. It remains the version with the least data rate at 1 Mbps. However a unique feature is that that a provision is made to support higher data rates ranging from 2 Mbps - 54 Mbps (Supporting DSSS).

- 4) Dorms: Similar to Delft Centre, a range of data rates is observed. However the number of packets having these higher data rates are extremely small. In fact they are restricted to a select few SSID's and are seen only for QoS packets. Most other packets are Beacon Frames with a data rate of 1 Mbps.

B. Modulation: CCK(Complementary Code Keying)

CCK is the only modulation technique observed in all packets irrespective of their location. CCK was developed specifically for 802.11b. It enables higher data rates over short distances which makes 802.11b suitable for residences and small businesses. Also the data rates captured by us (1,2,5,11 Mbps) specifically are DSSS modulated.

C. Take Aways

802.11b is the remains choice of protocol in India. But not limiting its popularity there, it also remains a strong choice for residences and small businesses in Delft. However, its popularity decreases on campus in favour of more evolved protocols with higher data rates over larger distances.

II. 802.11G

This version is the second most popular version. There is still a transition in phase from the older 802.11b to this version. It uses a different modulation type giving it advantages over its predecessor.

- Data Rates: 6, 9, 12, 18, 24, 36, 48, 54 Mbps
- Modulation: OFDM

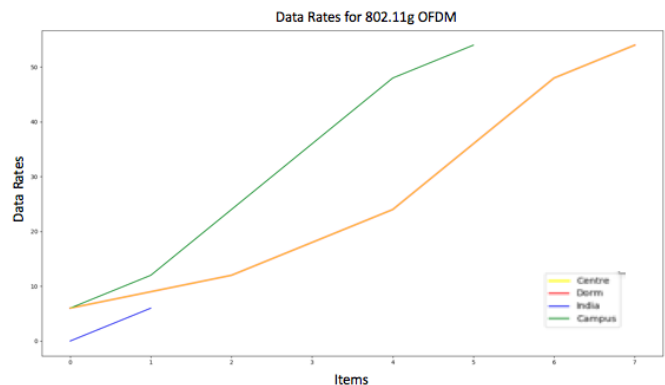


Fig. 2. Data Rates for 802.11g OFDM

A. Observations

- 1) India: We see negligible amounts of packets following this version (less than 0.1%). They were Beacon Frames and Probe Responses from the same source.
- 2) Delft Centre: A large number of packets of this version are found here. They are mainly QoS and Acknowledgement packets. A minor number of packets are also Probe Requests. The large number suggests that a shift is in process from the older 802.11b to 802.11g.
- 3) TU Campus: Majority of packets captured are of this version. this can be attributed to higher data rates as the university is in constant need of it. We also see that the university skips a few intermediate data rates (9 and 18 Mbps) All the types of packets mentioned earlier display this version on the campus. This also suggests that the university stays to the trend in terms of the protocols in use for their WiFi needs.
- 4) Dorms: The dorms follow an identical distribution in terms of data rates and the number of packets as Delft centre. This may be due to Delft being a very small area and hence the service (hardware and software) providers are the same for the centre as well as the dorms

B. Modulation: OFDM (Orthogonal Frequency Division Multiplexing)

OFDM is the modulation type displayed by all packets of this version. OFDM uses a very low symbol rate which makes guard intervals between symbols affordable. This in turn reduced inter-symbol interference (ISI).

C. Take Aways

We see how OFDM is the only Modulation type used for the advantages mentioned above. These advantages make OFDM, and by extension 802.11g a more preferred protocol for WiFi networks as compared to 802.11b despite having similar indoor () and outdoor ranges.

III. 802.11N

We see this protocol only being used in India. It is the newest version out of all the versions that we have captured capable of supporting the highest data rates.

- Data Rates: Upto 288 Mbps/ Upto 600 Mbps
- Modulation: MIMO-OFDM

A. Observations

- 1) India: We only see QoS packets being sent over the network using this version. As is clear in the specifications, it has the maximum data rates (Upto 144,444 Mbps), but it starts from as low as 6 Mbps. Hence it covers the largest range. Note that both CCK and OFDM modulations remain separate and distinct from each other.

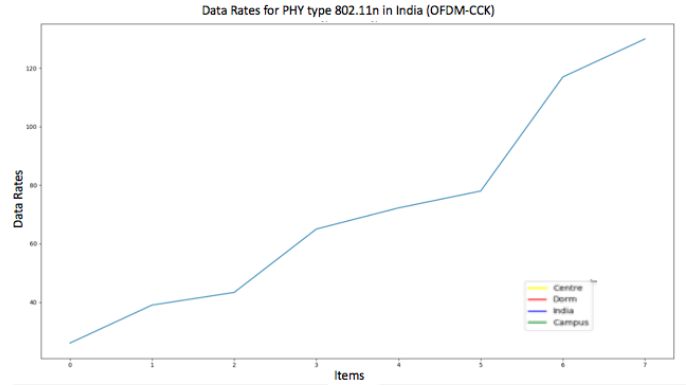


Fig. 3. Data rates v/s Modulation types for PHY type 802.11n in India(OFDM-CCK)

B. Modulation: Dynamic CCK-OFDM

We only see Dynamic CCK-OFDM modulation used for this version. We also see this version restricted to only 64-QAM modulated signal. As is apparent, this modulation is a hybrid of CCK and OFDM. This means that the Header/Preamble of the packet is CCK modulated, but the payload of the packet is OFDM modulated. A transition is made from CCK to OFDM. A transition from CCK modulation to OFDM modulation is made between the Preamble/Header and the Payload.

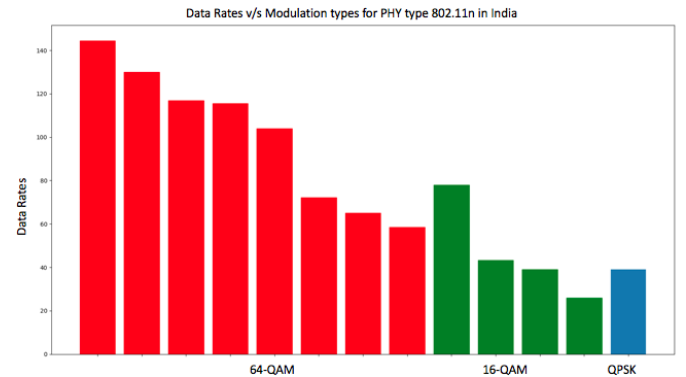


Fig. 4. Data Rates v/s Modulation types for PHY type 802.11n in India

- 1) 64-QAM (Quadrature Amplitude Modulation): MCS indices: 6, 7, 13, 14, 15
6 bits of information are carried per symbol. This helps in increasing the data rates. This is evident as we see the highest data rates are displayed by packets modulated in this scheme.
- 2) 16-QAM (Quadrature Amplitude Modulation): MCS indices: 3, 4, 12
4 bits of information are carried per symbol. We see a lower number of different data rates modulated in this scheme. They also on average display lower data rates.
- 3) QPSK (Quadrature Phase Shift Keying): MCS index: 10
In QPSK, two bits are modulated at once selecting a carrier phase shifts. It allows the signal to carry twice

as much information as ordinary PSK using the same bandwidth. However, it has lower data rate capacity than Amplitude Modulation techniques, and only one index is available of this type in our data set.

C. Take Aways

We only see this modulation type in India. This may be attributed to the fact that only there were we connected to the network while in monitor mode, while at other places we were monitoring without being connected to the network. It has a superior data rate as well as range. This is also the only version where we see digital modulation types being used.

IV. LEGACY 802.11 DSSS

We see this packet only in Delft. It is the oldest and the crudest version of the 802.11 protocol. However, seeing it being in use even today tells us about the longevity of the protocol.

- Data Rates: 1, 2 Mbps
- Modulation: DSSS

A. Observations

- 1) Delft Centre: We see many packet of this type from various SSID's. The most popular packets are QoS and Acknowledgement. However we also see a small number of Beacon Frames and Probe Requests and Responses.
- 2) TU Campus: At the campus, there are a couple of SSID's that continuously transmit these packets. They are mainly Beacon Frames and Probe Requests and Responses. They are tudelft-dastud and TU-visitor. Eduroam and portable hotspots also sporadically transmit these packets.
- 3) Dorms: Here we see a distribution similar to the campus.

B. Modulation: DSSS (Direct Sequence Spread Spectrum)

DSSS spreads signal makes the resulting wideband channel more noisy, allowing for greater resistance to unintentional and intentional interference. It is one of the most basic modulation techniques and is replaced by more advanced techniques in the future versions.

C. Take Aways

Although Wireshark does not provide data rates for packets of this version, they usually offer data rates of 1 or 2 Mbps. This version is not observed in India at all.

V. CONCLUSION

While there is not much difference between the environments in Delft itself, there is some between India and Delft. We observed that legacy 802.11, 802.11b, 802.11n and 802.11g are the standards that are widely being used. We see that 802.11n is completely absent in Delft. The data rates are on an average lower in India than in Delft. We also see negligible amounts of packets using 802.11g in India while we see a huge number of users in Delft. It indicates that

while Delft has adopted the latest version i.e 802.11g India still lags behind in that aspect. Interestingly, Delft is still using the oldest legacy 802.11 DSSS standard which was not found in India.

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