

WCAM IST-2003-507204

DELIVERABLE D6.4 – MULTIMEDIA TRIAL ASSESSMENT

PART 4 – WLAN MEASUREMENTS AT BONLIEU

1 WLAN measurements at Bonlieu

The WLAN campaign measurements took place in Bonlieu over two days (Monday the 6th and Thursday the 7th) at Bonlieu. Two types of measurements were performed:

- Static with unicast links
- Mobile with unicast link

For both case measurements, the server, connected on an access point, transmits data to the clients. For the static case, 4 clients (4 laptops), numbered from 1 to 4, were considered, whereas for the mobile measurement was only using 1 client (one tablet PC). The initial static measurement was designed as in Figure 1. However, due to hardware failure (one laptop had a faulty network access PCMCIA slot and problems occurred when the wireless CardBus was inserted), only 3 clients were using during the static measurements (client number 1 missing).

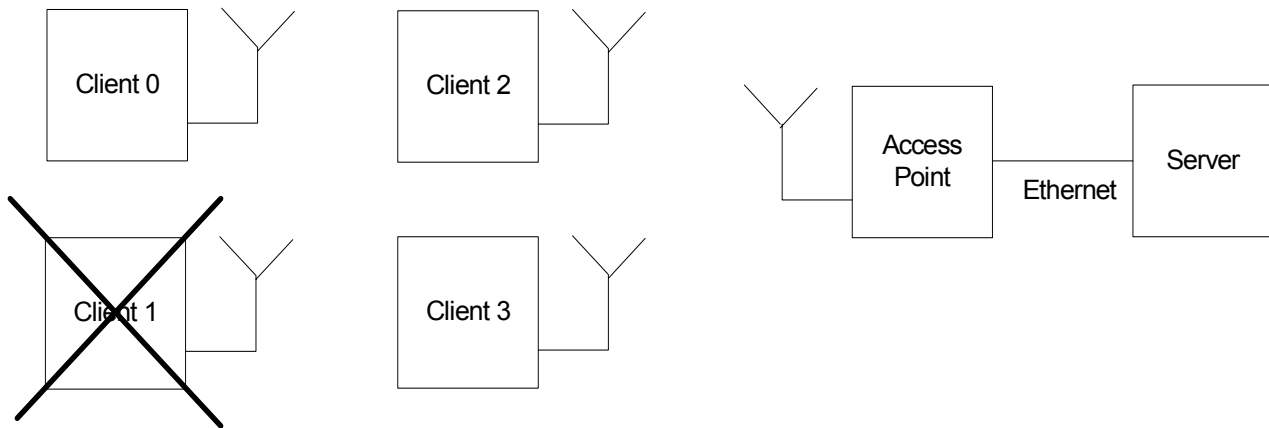


Figure 1 : Static Measurement design

1.1 Illustrated Report



Measure session in the lobby of the Theatre via the tablet PC



1.2 Collected Data

1.2.1 Static Scenarios

For the static measurements, all the clients have the same request to the server, in terms of packet size and bit rate, and two scenarios were considered. The first scenario (scenario 1) consists of an increasing load of the network, as illustrated in Figure 2. Client 0 starts the transmission. Clients 2 and 3 join the network after 30 and 50 seconds respectively. A second scenario was considering all the clients joining the network at the same time, as shown in Figure 3. Scenario 2 corresponds in fact to the final part of scenario 1 where the server transmits to the three clients. However, the 2nd scenario was interesting in order to differentiate packet loss due to hardware failure (internal to each laptop, loss appearing marginally at each client) from loss due to channel conditions and environments (loss occurring at the same time at each client). This 2nd scenario is not going to be further studied since it was a way for us to tune the client hardware configurations, like disabling/enabling features.

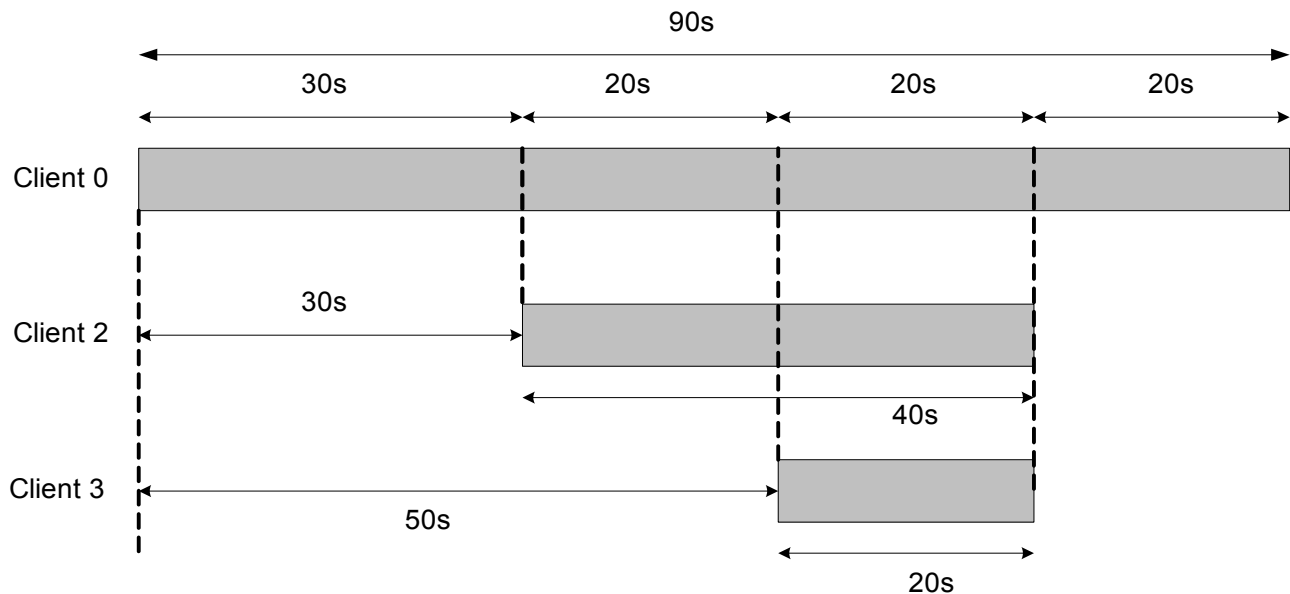


Figure 2 : Static Scenario 1, corresponding to an increasing load
60s

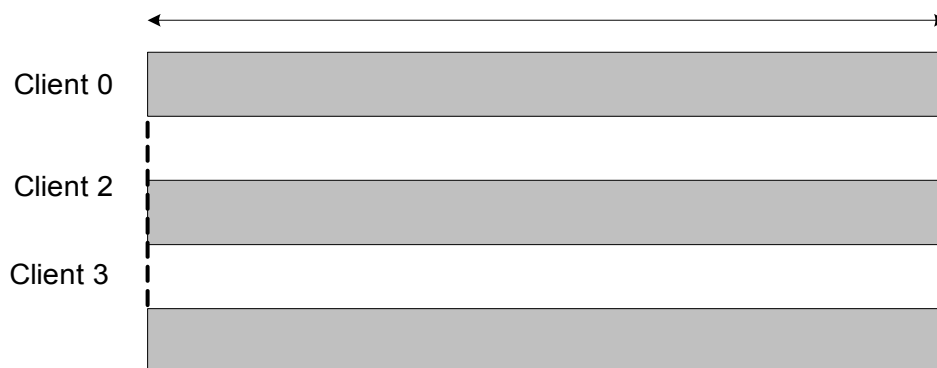


Figure 3 : Static Scenario 2, with simultaneous transmission

1.2.2 Mobile Scenario

A simple scenario was chosen for the mobile measurements, with only one mobile client moving away from the server, going at the back of the Bonlieu building and then back in.

1.2.3 Varying Parameters

During this measurement campaign, various parameters were used in order to see the capacity of the network. Unicast UDP links have been mainly considered. However, some broadcast tests were performed in order to identify issues. Logged data is not available for the broadcast links. For the Unicast links, two different types of transmission were considered:

1. "Dummy" data with fixed packet size were sent (the study can be found in section 1.3)
 - The influence of the packet size was studied: 300, 600, 900 and 1200 bytes
 - The influence of the transmitting bit rate was also studied: 500kbits/s, 1, 2, 5 and 8Mbits/s
2. Video sequences encoded at 1Mbit/s were transmitted. Different encoding parameters were studied, especially, the maximum size of a NAL unit: 168, 352, 536, 720, 904, 1088, 1272 and 1476 corresponding to 1, 2, 3, 4, 5, 6, 7 and TS packets respectively after the insertion of NAL, TS and PES headers.
 - When fixed packet size were transmitted (no alignment), the influence of the size of the transmitted packet was studied: 200, 400 and 800 bytes
 - The influence of the NAL alignment requirement was also studied

1.2.4 Technical Issues

During the setup of the network, various issues arose. Among them, the following are worth mentioning:

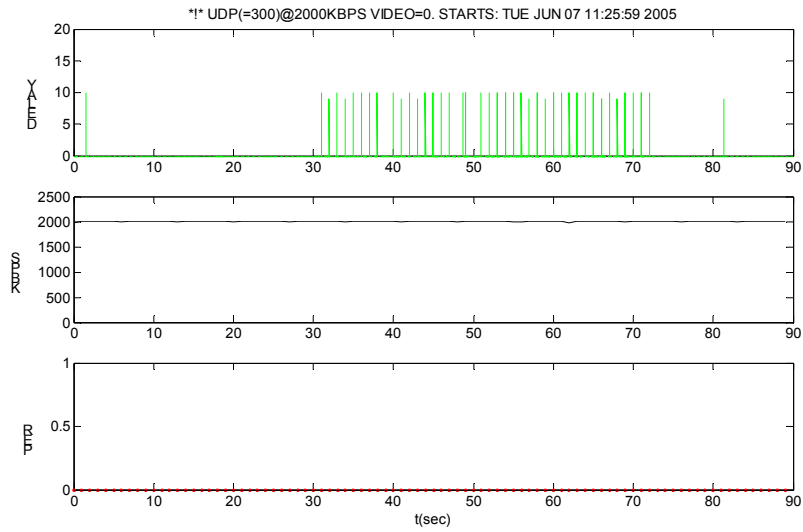
- Because of the Ethernet link between the server and access point, the software suite reports a link speed of 100 Mbits/s (the Ethernet speed) and not the actual link speed at the access point (from 1 to 54Mbits/s). This is due to the architecture of the software suite that stores the link speed statistics at the server, and not at the receiver, the server and the access point being physically separated. It is therefore not possible to know the link speed (and link adaptation) at which the access point transmits the data, unless a fixed mode is manually set.
- Switch and Ethernet link -> Multicasting
- Two possibilities were offered to control the card driver: either the Windows driver or the Belkin Utility. They do not support the same functionalities and do not provide the same level of access. The Windows driver do not provide low level access to the MAC, whereas the Belkin Utility was offering more MAC features and was computing PHY statistics. However, the software suite used for the logging was also using low level access at the PHY and was therefore colliding with the Belkin Utility. It was noted 10 to 20% packet loss even in the best channel conditions. These losses were due to the fact that the software suite was not able to access the driver when the Belkin Utility was using it, and was therefore reporting losses, even though packets were received correctly. It was then critical to switch off the Belkin Utility in order for the software suite to perform accurately.
- Anti-virus had to be switched off and the power saving mode had to be tuned in order to reduce CPU consumption.
- Variations in clock speed were reported and are thought to be due to the power saving modes at the server.
- Our WCAM WLAN was cohabiting with the official Annecy 2005 networks. Efforts were made so that they do not collide and different channels were used. However, it has been noticed that a private wireless networks was sometimes present on the same channel than ours. This has therefore led to some interference, creating occasional bursts.

1.3 Radio Results

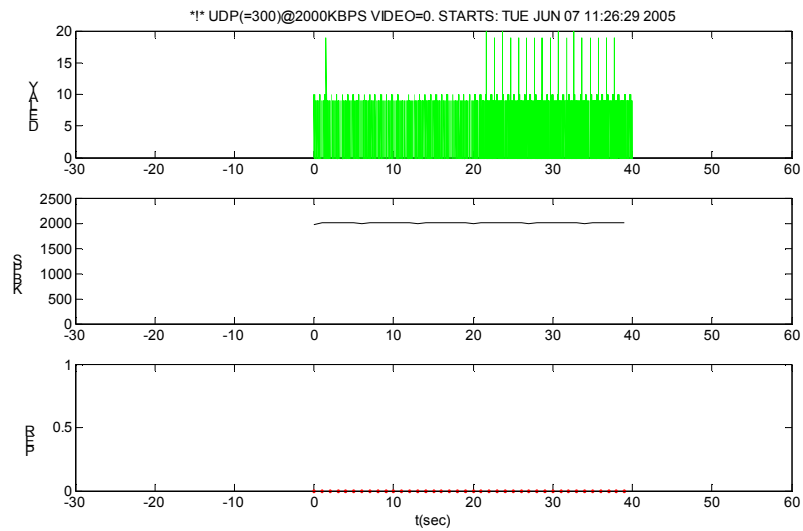
In this section, some samples of results are given for the radio measurements, i.e. with “dummy packets”.

1.3.1 Static Measurements

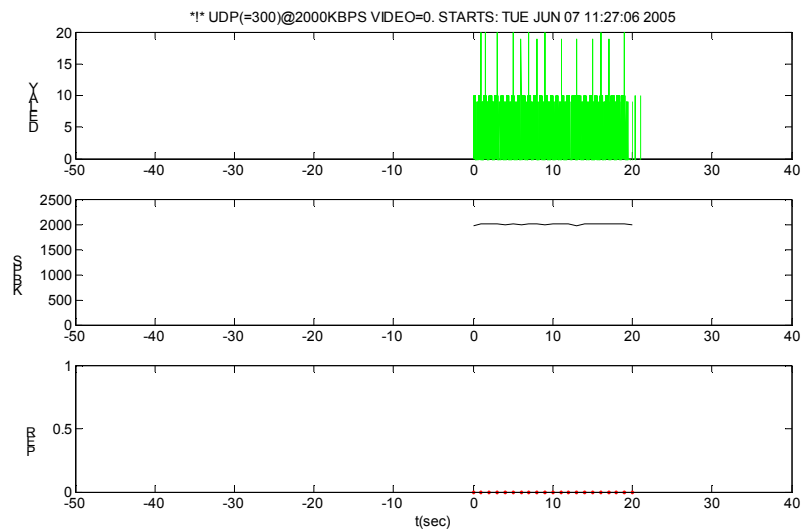
1.3.1.1 Increasing load – Packet Size = 300 bytes at 2Mbps/s



a) Client 0



b) Client 2

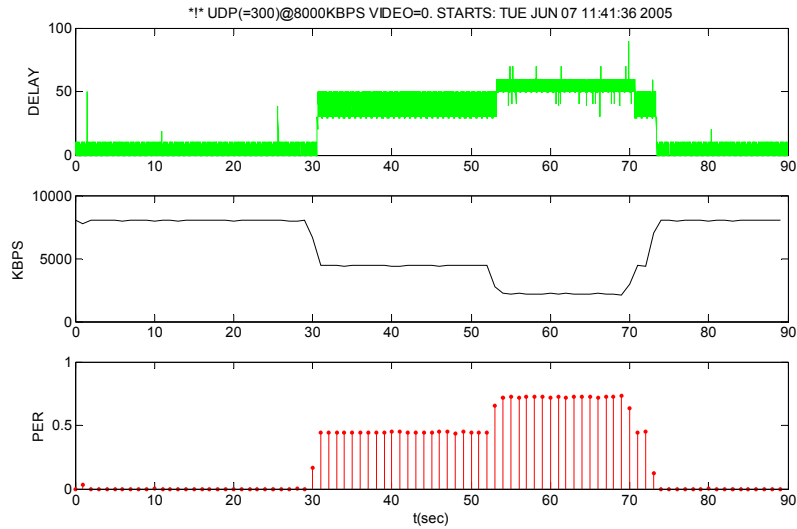


c) Client 3

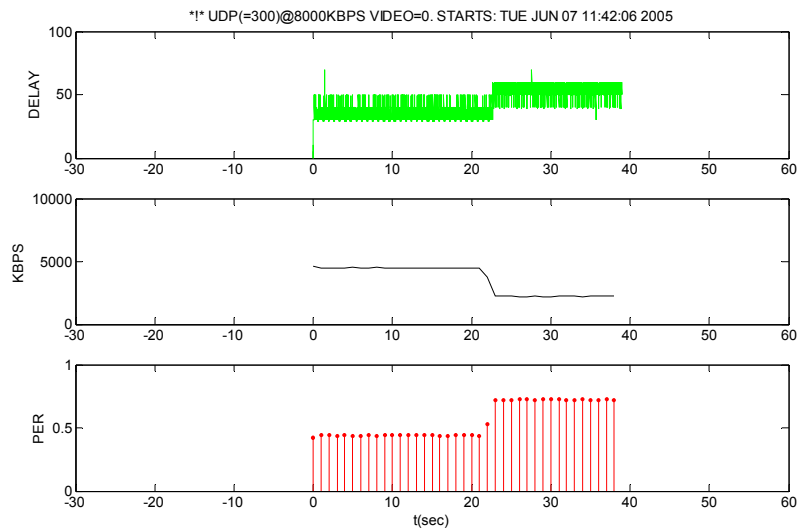
Figure 4: Increasing load, Packet Size = 300 bytes, at 2Mbits/s

With a small packet size (300 bytes), it can be seen that the target rate of 2Mbits/s for each client (a total load of 6Mbits/s) can be supported without any packet loss. Delays are small, and are building up only when several clients are joining the network.

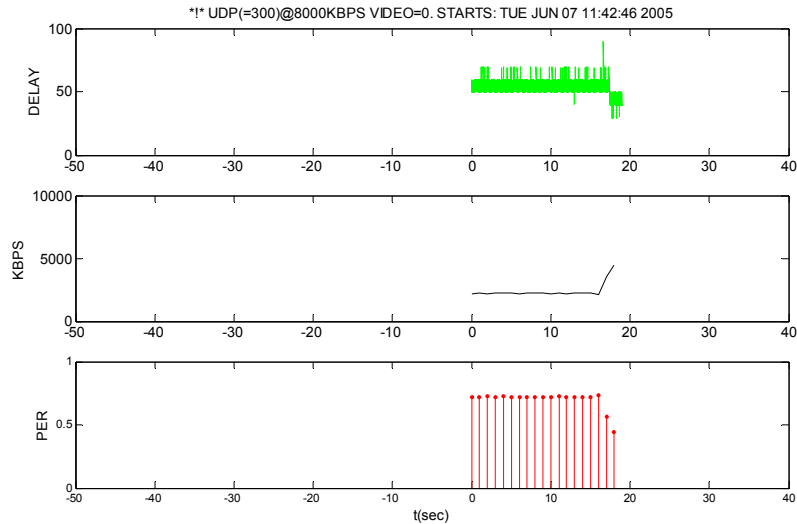
1.3.1.2 Increasing load – Packet Size = 300 bytes at 8Mbits/s



a) Client 0



b) Client 2

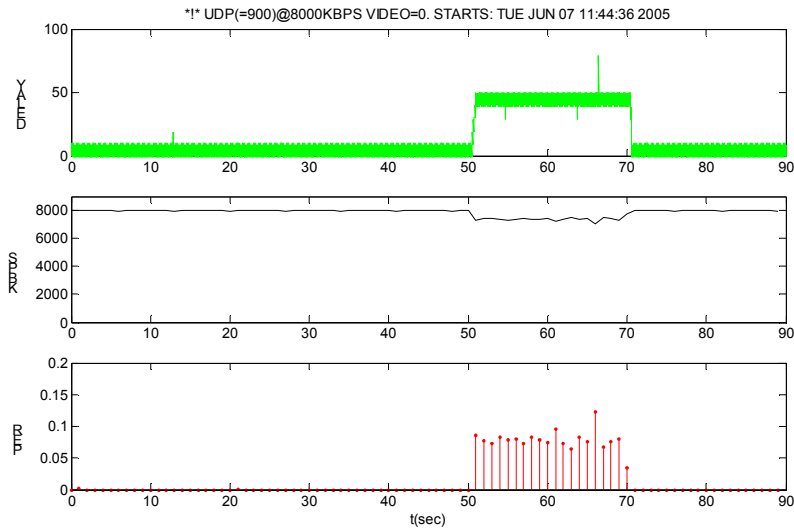


c) Client 3

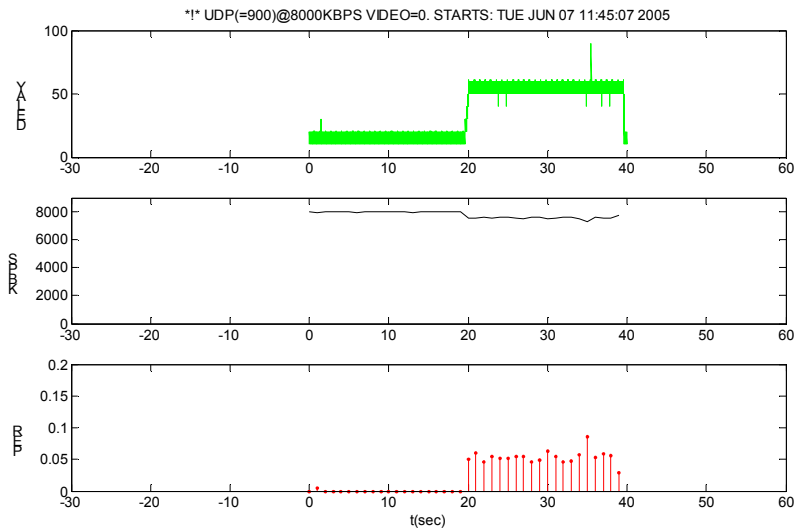
Figure 5 : Increasing Load, Packet Size = 300 bytes, at 8Mbits/s

It can be seen that with small packet size, the network can support one client at 8Mbits/s. However, when the second client joins in, the target rate can not be kept to 8Mbits/s and drops down to around 5Mbits/s at both clients. The packet error rate goes up to almost 0.5, and delay appears. When the third client joins in, the target rate drops further down to 1.8Mbits/s for the three clients and the PER goes up to 0.8. It is clear that the network can not support 3 links at such high rate when small packets are transmitted.

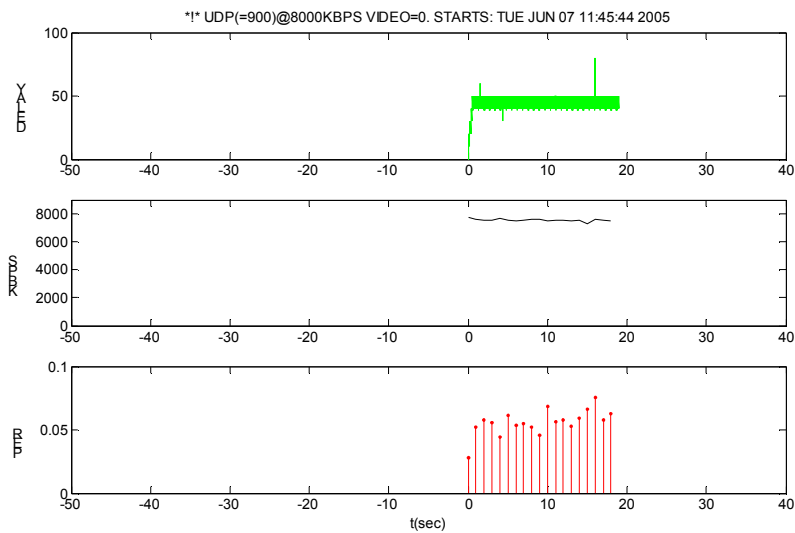
1.3.1.3 Increasing load – Packet Size = 900 bytes at 8Mbits/s



a) Client 0



b) Client 2

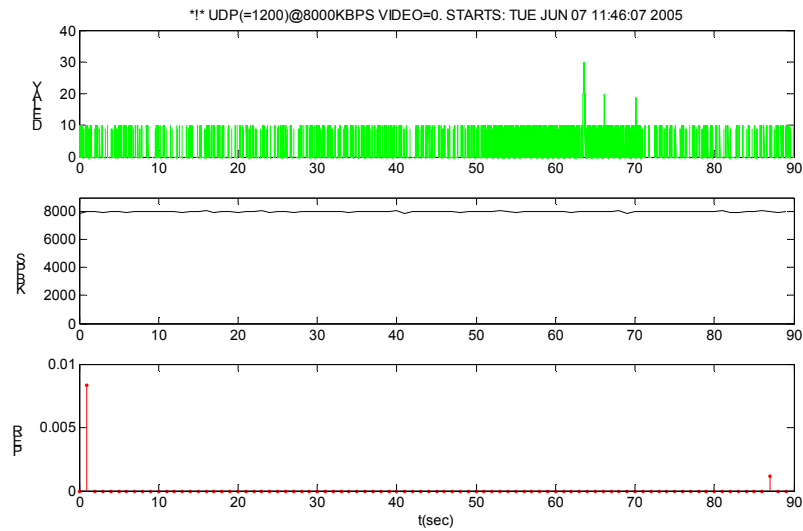


c) Client 3

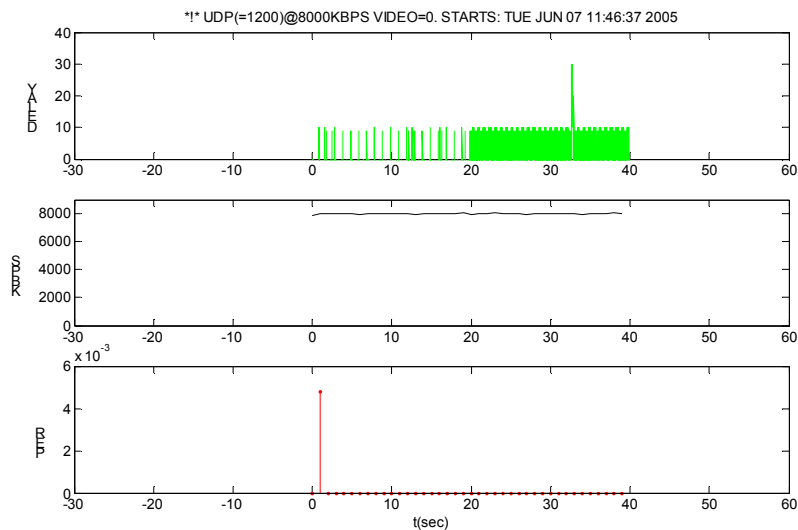
Figure 6 : Increasing load, Packet Size = 900 bytes, at 8Mbits/s

It can be seen, that, for a same target rate of 8Mbits/s, packets of 900 bytes allow two clients on the networks without any reduction in the received rate nor in the packet loss. However, when the third client joins in (the total load being 24Mbits/s), lost packets appear, the PER reaches 5% at the three clients and the target rate is slightly reduced to 7.5Mbits/s. Delay also appears and reaches 50ms. Therefore, as the packet length increase up to 900 bytes, higher rates (up to 16Mbits/s) can be reached, but three clients at 8Mbits/s will experience some packet loss and delay.

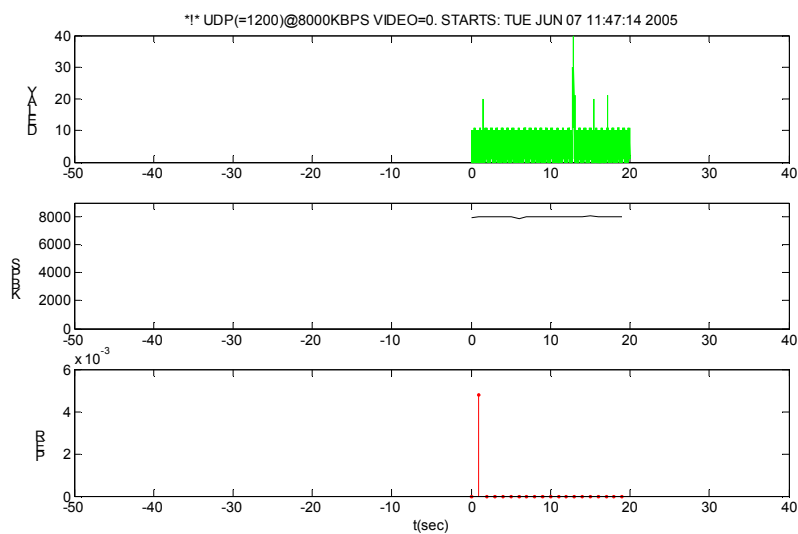
1.3.1.4 Increasing load – Packet Size = 1200 bytes at 8Mbits/s



a) Client 0



b) Client 2



c) Client 3

Figure 7 : Increasing load, Packet Size = 1200 bytes, at 8Mbits/s

With a packet size of 1200 bytes, the three clients are able to receive each 8Mbits/s without any packet loss. Delay experienced is very small.

1.3.1.5 Broadcast Measurements

Figure 8 shows the PER and the received rate in the case of broadcast link with a packet size of 600 bytes. The results presented correspond to client 0, since all the other clients received the same data.

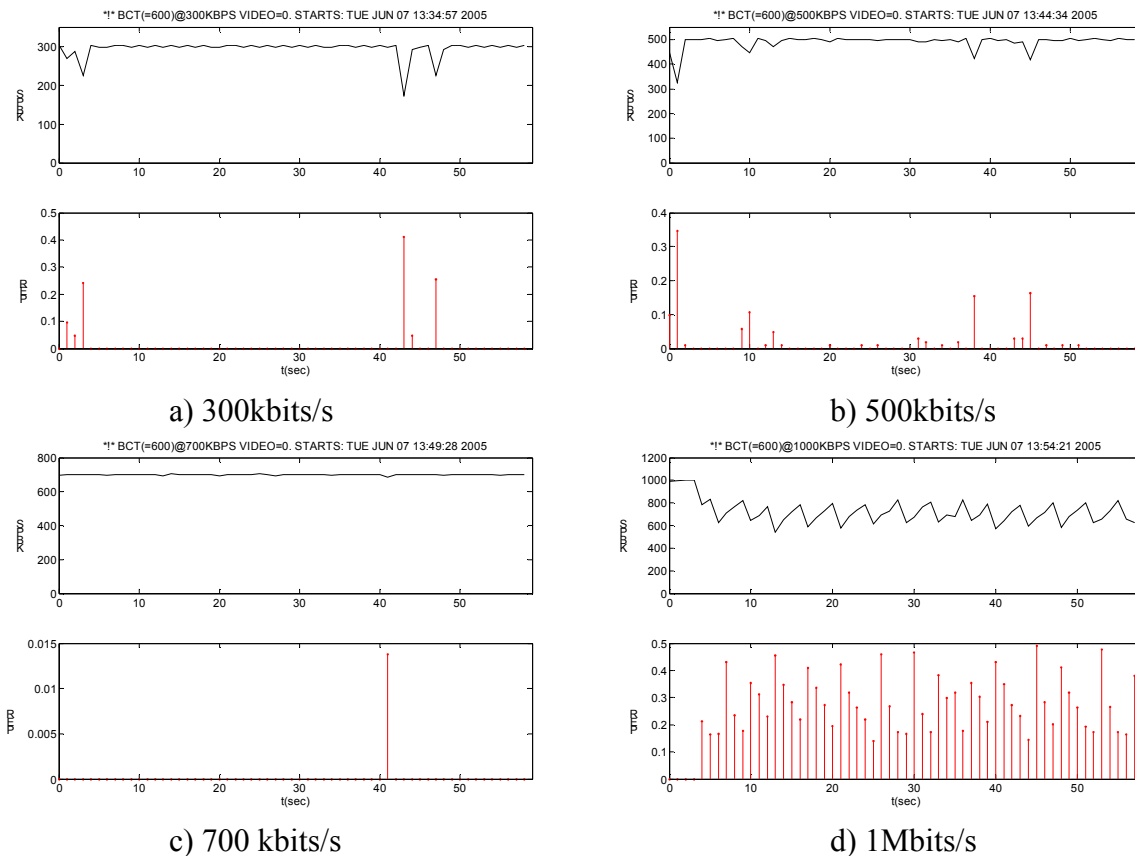
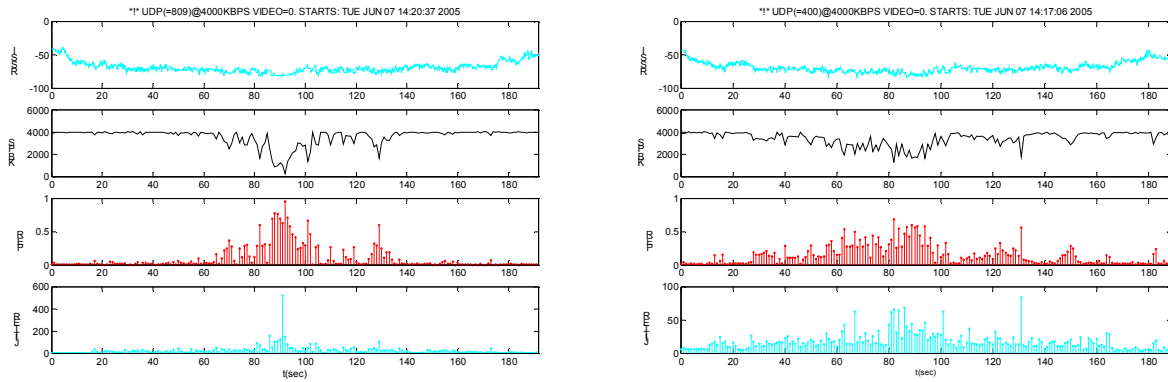


Figure 8 : Broadcast Measurements with Packets of 600 bytes

It can be seen that bit rates of 300, 500 and 700 kbits/s can be supported by the network. Only transmission errors are noticeable. These errors can be even insignificant. However, a bit rate of 1Mbits/s can not be supported. Because of the Ethernet link between the AP and the server, it was not possible to log the transmission speed. However, the presented results for broadcast show that it is likely that the AP uses the lowest transmission common mode to all the clients, i.e. 1Mbits/s with IEEE 802.11b. Because of the MAC overhead, 1Mbits/s can not even be reached. This ensures the reception of the data for all the clients, even those located at the edge of the covered area. This is therefore not really appropriate for video transmission, especially if high video bit rate is required, since it reduces considerably the transmitted rate. Note that it is very difficult to implement a link adaptation algorithm for the case of a broadcast link, since the transmitter does not any feedback concerning the channel conditions. Moreover, since all the clients receive the same data, it is not possible to adapt on a client basis.

1.3.2 Mobile Measurements

Mobile measurements data were collected with the client walking away from the access point (the starting point being the location of the four laptops of the static measurements), going outside in a park and looping back in. Two different packet sizes were studied (with dummy packet): 400 and 800 bytes at 4Mbits/s, as shown in Figure 9.



a) Packet Size = 800 bytes

b) Packet Size = 400 bytes

Figure 9 : Sample of Mobile measurement at 4Mbps/s

It can be seen that, as the client move away from the access point, the RSSI decreases and the packet loss rate increases. The peak in PER for both cases corresponds to the point where the client is the farthest away from the access point. As the PER increases, the received rate decreases as there are less receive packets. It should be noted that the quickly changing conditions (number of people walking around for e.g.) make the comparison difficult if not impossible.

1.3.3 “Near/Far” UDP Unicast Experiment

Because, it was not possible to find out the operating mode with network configuration used with Ethernet link between the server and the AP, a “Near/Far” experiment has been performed. Two static clients and a mobile client, all with UDP unicast links, were used in order to characterise the behaviour of link adaptation algorithm. No logs are available for this “tuning” experiment; however the following remarks were made upon the observation process. As the mobile client is moving away from the AP, the reception of the mobile client obviously are getting worse. More surprisingly, the two static clients close to the AP were also experimenting bad reception. This is explained by the fact that the AP is apparently using the same link speed for all the clients and is adapting its link speed using overall statistics. Therefore, if one client is experimenting bad channels conditions, this affects the overall statistics of the network. The AP then switches down the mode, reducing the link speed for the all the clients. The original bit rate for all the static clients can not then be supported.

1.4 Conclusions and Recommendations

After the radio measurement and data collection trial, the following points can be highlighted. The influence of the packet size has been shown for the capacity of the network:

- It is not possible to support several high data rate unicast links with small packet size.
- However, if packets are large enough, the network can support 3 UDP unicast links at 8Mbps/s each.

Broadcast measurements have shown that the AP used for the trial is using the lowest mode (with the lowest bit rate but greater reliability) to ensure that all the clients can received the transmitted data, at the expense of a low transmission speed. In order to avoid the “near/far” problem as explained in section 1.3.3, the link adaptation mechanism for unicast link should be performed on a peer client basis, using stats on a MAC address basis rather than overall statistics. By considering each unicast link independent, the AP is able to adapt every single link separately, and any change in one link will not affect the other clients.