TSG-RAN Working Group 3 meeting #6 **_TSGR3#6(99)955_**
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Agenda Item: 6.5

Title: AAL2 Packetisation and De-packetisation Delay

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1 Introduction

Delay is an important performance parameter for all services; not just real-time. Indeed, it can be the non-real time services that can be effected most by delay. For example, increasing the delay in the TCP/IP feedback loop substantially reduces the throughput of the traffic. Therefore, the delay parameter must be minimised across the UTRAN in order to promoted fast and efficient use of network resources. Therefore the delay study item has begun to examine the performance of different components in the user plane. Once the delay components have been established then optimisation can take place.

Within this paper AAL2 has been examined to determine the performance of the packetisation and de-packetisation of typical voice/data sources expected over the UMTS network. This study examines the segmentation of data packets into CS-PDUs and then multiplexing of AAL streams into an ATM Virtual Channel Connection (VCC). This connection passes a heavily loaded switch and the cell stream is assembled back into packets.

2 Configuration

A simulation was constructed that had a single connection through a highly loaded ATM switch, see figure 2.1

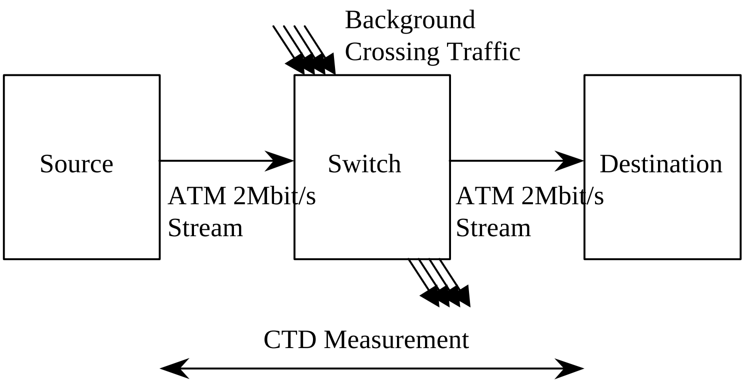

Figure 2.1 ATM network configuration.

The source and destination end-systems have an AAL2 protocol stack. Packet data is fed into the top of the AAL2 protocols stack and the data stream is multiplexed and segmented into ATM cells. The cells are scheduled onto the transmission link at the peak rate of the source. Figure 2.2 shown a pictorial representation of the source. The destination will use the inverse functionality to reconstruct the data packets.

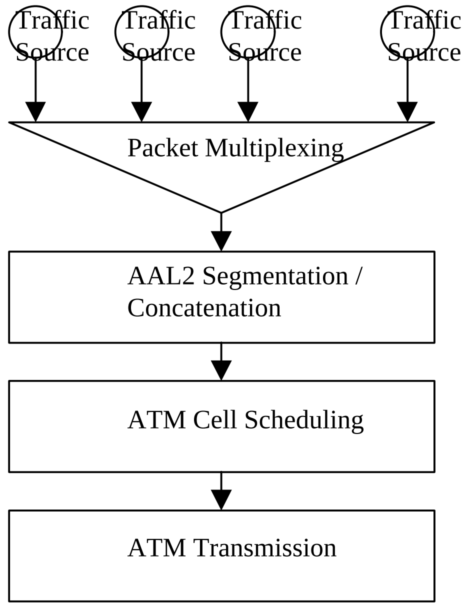

Figure 2.2 Pictorial representation of the source AAL2 protocol stack.

3 Set-up Parameters

The objective of the paper is to demonstrate the delay caused by AAL2 over a loaded ATM network. Five simulations are presented in this paper. Each simulation aims to represent a practical worst case scenario.

The input parameters can be broken down into four main areas.

- Switch characteristics
- AAL2 dimensions
- ATM Peak Cell Rate (PCR) traffic contract
- Source characteristics.

A network operator can control individually, directly or indirectly, the parameters in each of these areas.

3.1 Switch Parameters

Using Connection Admission Control (CAC) mechanisms in ATM and traffic dimensioning the maximum network load and buffer size can be allocated. Real time services in ATM require small buffers to reduced Cell Transfer Delay (CTD) and Cell Delay Variation (CDV), this in turn means that the maximum network load of real time services remains low. The simulations were defined to have:

- Background Network Load = 73.41377%
- Queue Length = 75 cells

Note: the network load is 75% including the foreground test traffic.

3.2 AAL2 Parameters

Within AAL2 a single parameter can be set. This is the AAL2 CU timer period. This increases the efficiency of AAL2 to the detriment of CTD and CDV. Some initial simulations suggested the gain in efficiency is small compared to the negative effect on CTD. In addition, it is probable an ATM connection carrying AAL2 streams would be PCR allocated. Therefore, no monetary advantage is foreseen by increasing the efficiency of the connection by employing a CU_Period greater than 0 across a PCR VCC. However, this assumption may need refining in the future.

Therefore:

- CU_Period = 0 seconds;

3.3 Traffic Contract Parameters

AAL2 connections need an ATM real time bearer. These are normally peak rate allocated. AAL2 is normally used to multiplex a number of low bandwidth connections on to a single VCC. In the following simulations a 2.048 Mbit/s user data pipe is assumed. ATM and AAL2 overhead is assumed to be 9 bytes per cell, that is, 44 bytes of user available payload. An accurate assessment of the AAL2 overhead is difficult, as the AAL2 packet sizes are drawn from random distributions.

Therefore:

- Peak Cell Rate = 2.466909 Mbit/s

3.4 Source Characteristics

The simulations are used to determine the packet delay for a highly loaded connection over a highly loaded ATM network. Hence, the ATM network load is set to 75% of the 155.52 Mbit/s transmission capacity and the connection is set to 75% of a 2.048 Mbit/s virtual channel connection. Therefore an average user traffic rate of 1.536 Mbit/s was set for all simulations. Within each simulation the number of sources and the average bit rate of each source was altered. Table 3.1 describes the traffic sources used.

	Simulation 1	Simulation 2	Simulation 3	Simulation 4	Simulation 5
Average Bit Rate	8kbit/s Voice	32kbit/s Data	64kbit/s Data	144kbit/s Data	384kbit/s Data
Number of Sources	192	48	24	11	4
Talk Spurt ON	NegExp 4 secs	N/A	N/A	N/A	N/A
Talk Spurt OFF	NegExp 4 secs	N/A	N/A	N/A	N/A
Packet Period	10 msecs in Talk Spurt ON	NegExp 224 msecs	NegExp 112 msecs	NegExp 49.77 msecs	NegExp 18.66 msecs
Packet Size	20 bytes	NegExp 896 bytes	NegExp 896 bytes	NegExp 896 bytes	NegExp 896 bytes

Table 3.1 Traffic sources used within the simulations

4 Results

From the simulations two results are reported. These are the end-to-end ATM cell transfer delay (crossing a single 75% Poisson loaded switch) and the end-to-end packet delay over this loaded network.

The cell delay was as expected, being reported in may papers on real-time ATM network simulation. These results are theoretical results based on a large amount of independent sources. The result in figure 4.1 shows the delay distribution across a single switch. The graph does not take into account processing delay within a switch, which adds a constant delay typically of 100 usecs.

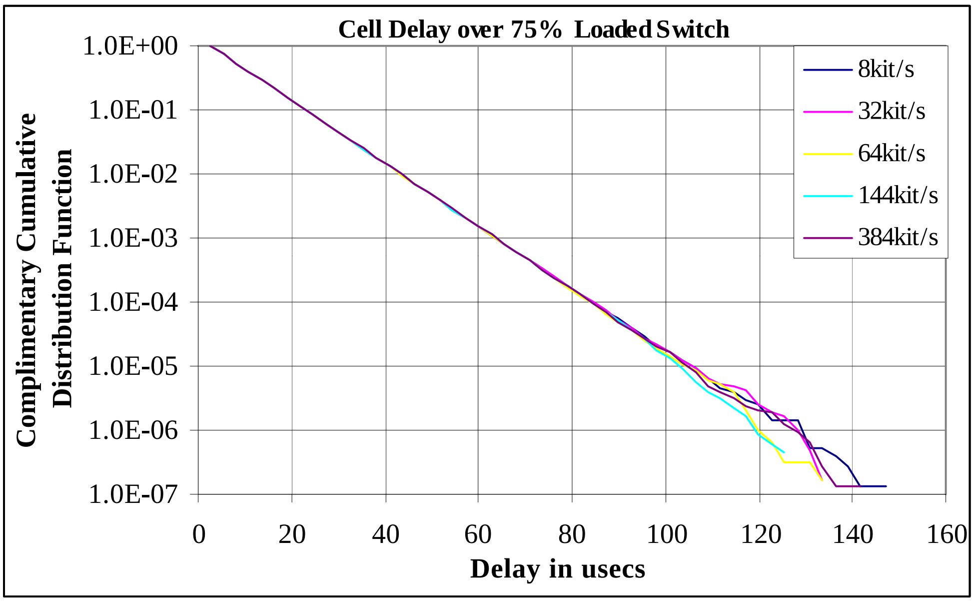

Figure 4.1 End-to-end Cell delay across a single switch.

More interesting to the mobile community is the packet transfer delay across an AAL2 connection. The 2.048Mbit/s (user data capacity) was utilised to 75% with connections of different characteristics. Figure 4.2 shows the difference in delay. It can be seen that the lower rate voice sources can be transferred over AAL2 with a lower performance degradation than the higher rate (and more bursty) sources.

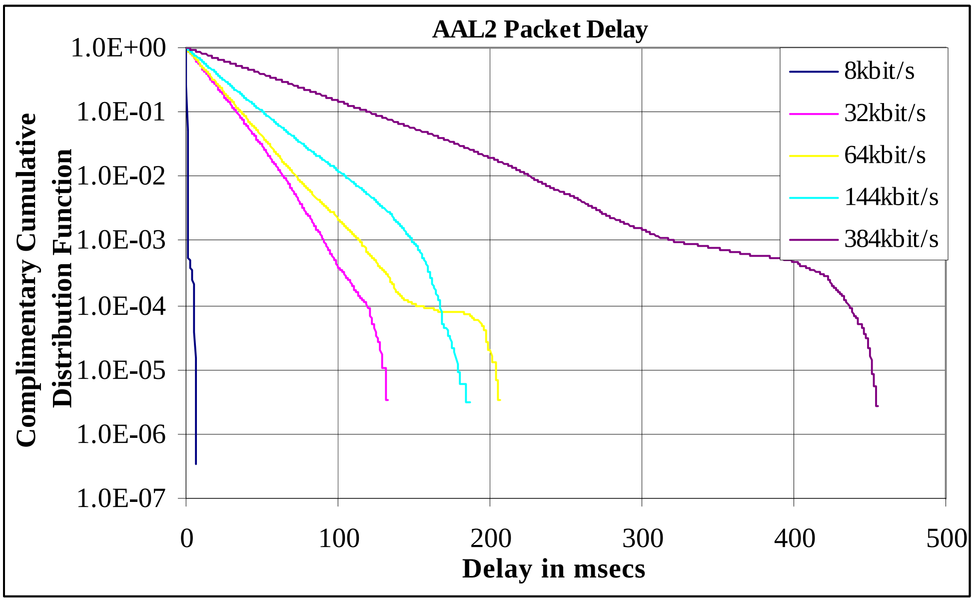

Figure 4.2 Performance degradation caused by an AAL2 Connection

5 Conclusion

The cell delay across the small network simulated is small. A maximum cell delay variation of 120 usecs is deduced. Further to the variable delay is cell processing delay within the switch, this is typically 100 usecs. Therefore the total delay experienced, in an ATM switch is 220 usecs. This cell delay is within the ITU-T limits of real-time traffic of 300 usecs see ITU-T recommendation I.356. The AAL2 packetisation delay across the network varied depending on the source characteristics. It is seen that the 8kbit/s “voice” connections are small, however the data connections reveal a worse delay performance. All delay should be minimised across the network, the AAL2 protocol stack is producing a significant amount of delay for higher bit-rate sources. Further investigations are needed to determine the causes of delay within AAL2 in order to reduce the delay component of the UTRAN. It should be noted that delay of other connection types, for example AAL5 and IP based networks, would probably lead to worse performance characteristics across the network. These connection types need further simulation and testing.

Therefore it is proposed to update TN1 to in Tdoc TSGR3#5(99)800 to:

	8kbit/s	32kbit/s	64kbit/s	144kbit/s	384kbit/s	2048kbit/s
TN1	1msec	120msec	185msec	205msec	450msec	