RTT TECHNOLOGY TOPIC
June 2002

The circuit switch to session switch transition

In this month's HOT TOPIC we examine the merits/demerits of circuit switching, the advantages and disadvantages of packet transmission and the possible future transition to session switching. We review possible implications for billing including the longer term transition to quality rather than quantity based billing as a mechanism for realising 'session value'.

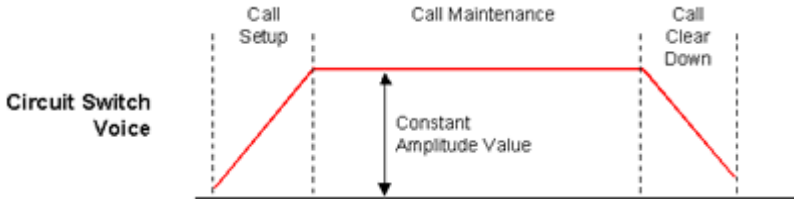

Figure 1 - Circuit Switching

Traditionally, traffic in wireline networks has been circuit switched (see Figure 1). In a circuit switch network, a call is set up between two people using a traffic channel pair (an uplink and downlink channel). The call is set up, maintained, cleared down and then billed. The whole process is controlled using SS7 signalling.

Cellular networks adopted the same switch topology in the 1980's. The traffic channel pair was (and still is) a duplex spaced pair of RF channels - a frequency duplex to which over the years has been added a time and/or code domain duplex.

Circuit switching has been criticised as being wasteful of network and RF bandwidth. Speech has a 35% duty cycle - mostly we don't speak when someone is talking to us and we pause between words, i.e. we are absorbing bandwidth unnecessarily.

Over the radio physical layer, this is not a problem provided DTX (discontinuous transmission) is used. With DTX, RF power is only applied to the channel when voice activity is detected. We are occupying **logical** channel bandwidth. We are **not** occupying **physical** channel bandwidth.

Even so, it has to be said that circuit switching does not use network bandwidth particularly efficiently whether it is supporting voice or data traffic.

Data traffic efficiency is dependent on the **data duty cycle**.

Typically in the internet, **data duty cycle** is quite low, i.e. data transfer is intermittent.

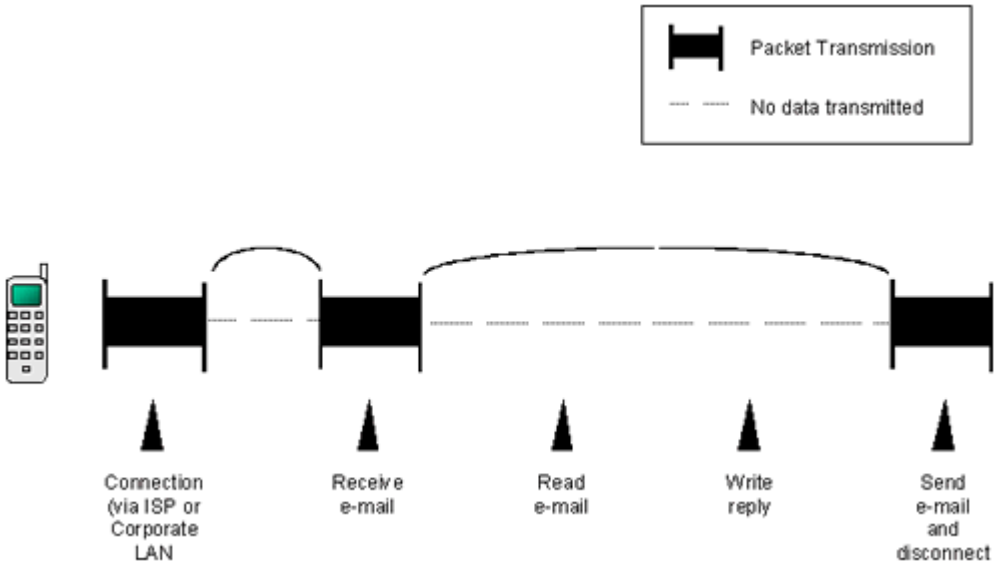

Figure 2 - Packet Transmission (Intermittent Data Duty Cycle)

This is the rationale for using packet transmission (Figure 2) to support 'always on sometimes sending' connectivity'. You only get billed for the bits or rather packets sent - quantity based billed.

Actually, what we really want to achieve (or return to!) is the 'sometimes on always sending' model. We want to increase the **data duty cycle**.

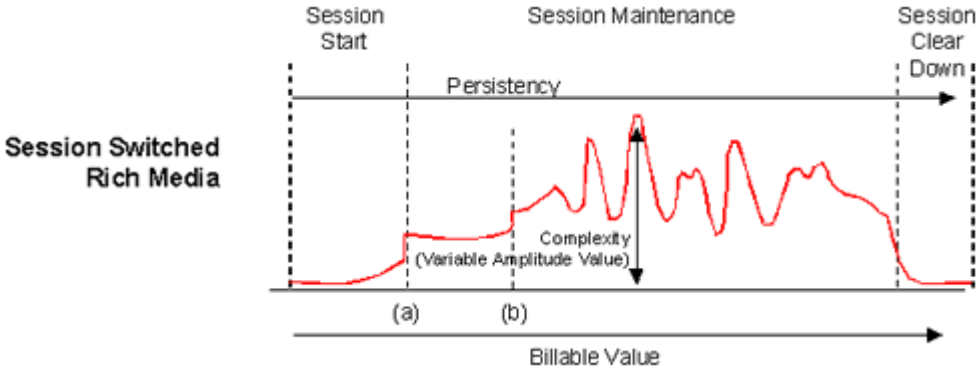

Figure 3 - Session Transmission (Continuous Data Duty Cycle)

Figure 3 shows how a session can be developed in a '3G' exchange. The session is established, for example, initially between two users. The job of the software and the hardware in the handset and the job of the software and the hardware in the network is to increase session value as the exchange progresses. If the exchange starts as an e-mail exchange, the objective is to add voice (preferably high bandwidth audio), image and video.

Figure 3 shows additional code channels being introduced at (a) and (b). Note that each of these channels may be variable rate. The number of per user channels and the variability of the bit rate on each channel determines the session 'amplitude'. Session amplitude is a component of session complexity. Session complexity is a

component of session value. We can increase session complexity by bringing in other users to the exchange (a multi-user to multi-user exchange). As we increase session complexity, we tend to increase session persistency (the session lasts longer). Session complexity and session persistency **together** build session value.

Session value is also determined by session immediacy and session consistency.

Typical end to end delay in a PSTN circuit switch voice call is 35 milliseconds. Typical delay in the Internet is 150 to 200 milliseconds - note also that the Internet introduces delay **variability**.

Delay and delay variability decrease session value by compromising the time dependent properties of the offered traffic mix.

The only way to guarantee that session value is not degraded is to avoid using buffering in the end to end channel, i.e. to provide a 'conversational exchange' - session immediacy.

Session consistency is dependent on the ability of the radio physical layer and the network to respond to rapid changes in session amplitude as a session progresses (in addition to managing the radio physical layer issues like handover and slow and fast fading).

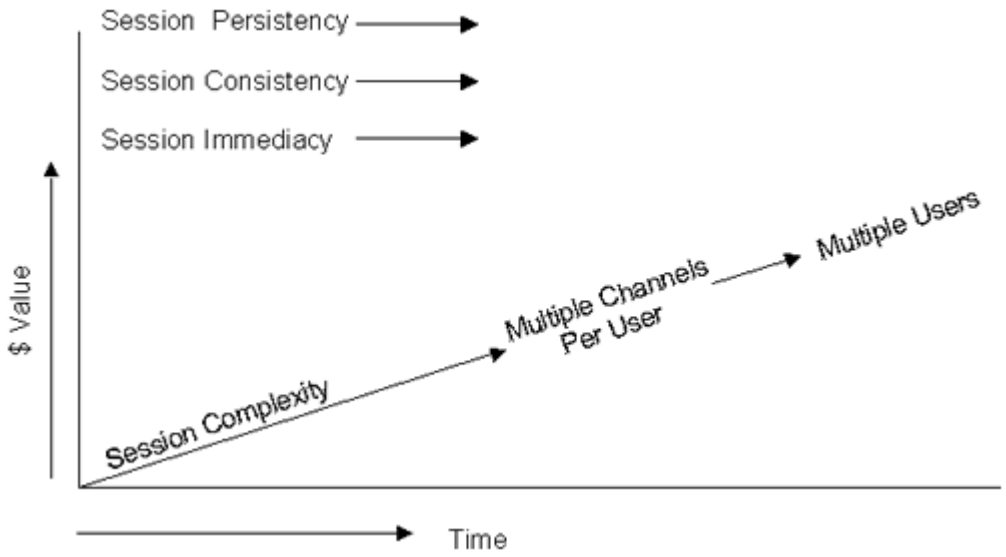

Figure 4 - The Four Components of Session Value

Figure 4 shows the four components of session value - session immediacy, session consistency and session complexity all help to increase session persistency - all together add to session value by increasing the data duty cycle.

Note that system consistency is dependent on effective and **adaptive** session maintenance which is in turn dependent on SS7 signalling implementation or equivalent IP traffic shaping protocols.

Having built session value and having (hopefully) preserved session value, we need

to be able to **bill** for session value.

Billing for session persistency implies a return to duration based billing rather than bit based billing. Billing for session complexity implies the ability to be able to capture and describe session amplitude (amplitude value). In practice, describing any of the four components of session value let alone all four together rapidly becomes over-complex.

It may be easier to use tangible quality metrics that the user can directly experience, ie audio quality, image resolution and colour depth, video resolution, colour depth and frame rate, application integrity and session continuity - the metrics that form the basis for quality rather than quantity based billing.

Summary

It is the job of handset hardware, handset software, network hardware and network software to increase the **data duty cycle**. Adding digital cameras and MP4 encoders (including wide band audio encoding) into handsets increases the uplink duty cycle. High colour depth high resolution displays and high bandwidth display drivers help to increase the downlink duty cycle. As the session progresses, it is the job of the application layer software (in the handset **and** the network) to increase session complexity and session persistency. Session complexity and session persistency together are key ingredients of session value but the preservation of session value is also dependent on delivering session immediacy and session consistency.

As session complexity increases, the cost of delivery increases. Session immediacy also increases delivery cost (bursty bandwidth is expensive bandwidth).

Network operators need to maximise **session margin**. Session margin is the difference between session delivery cost and billable session delivery value.

This requires a shift from quantity based billing to quality based billing using tangible quality metrics which the user can directly experience - how to build and bill session value.

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