Putting quality in the frame

Gerard Delaney examines the architecture and technologies behind 3G video services, and the methods which can be employed to address the technical challenges in its delivery

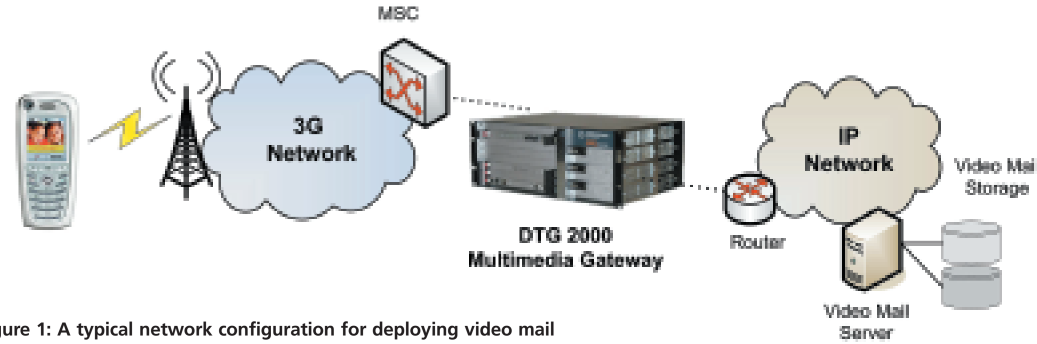

Figure 1: A typical network configuration for deploying video mail

As mobile operators upgrade their networks from 2.5G to 3G and next generation cellular networks, video services are regarded as a key differentiator in increasing the Average Revenue Per Unit (ARPU). Enhanced video services such as real-time video calling, video mail, video-on-demand and interactive video services are exciting and new features that were not feasible on previous networks.

However, as with other new technologies, these new services have created operational complexities and technical challenges that didn't exist before. Issues such as call setup time, lip sync and video corruption have become taboo words.

This article will look into the architecture and technologies behind launching these services and provide insight into some of the technologies that have been developed to solve these issues.

Video mail

Video telephony provides 3G users with the benefit of next-generation communications, letting people share meaningful moments visually. It complements the video telephony experience by allowing the video call to be completed when the other party cannot take the call. Mobile operators view video mail as an extension of the voice mail service available today and are aggressively launching the service where 3G networks are available. Video mail provides additional customisation features such as personalised greetings, celebrity greetings and other types of innovative visual effects that mobile operators can use to target specific customers such as youth and business people.

Video mail architecture is similar to existing voice mail architectures. Depending on the vendor, video mail can be an extension or upgrade to existing voice mail systems.

Video mail servers are typically installed in the IP networks. A multimedia gateway can provide the connectivity between a video mail system and the 3G subscriber.

Video mail works similarly to voice mail. When the called subscriber is not available to answer the call, the caller is routed to a video mail system where a customised video greeting is played back to the caller asking the subscriber to leave a video message. The video message is typically stored in a compressed format on the video mail system.

Video streaming

Streaming live or pre-recorded content over wireless networks has become an increasingly popular service over the past few years and has been embraced by the

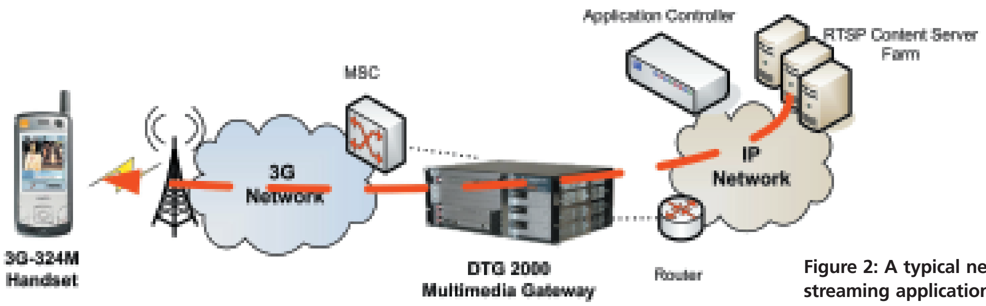

Figure 2: A typical network configuration for streaming applications

mobile operators as one of the key revenue generating applications. Typical applications include live and pre-recorded TV, real time content such as traffic and weather, security and surveillance and entertainment portals to name a few.

Content streaming has typically been done over packet switched services (PSS) in the 2 and 2.5G networks and the Quality of Service (QoS) has been inconsistent depending on the network capacity, network busy load and other factors. With the launch of 3G networks and services, mobile operators are increasingly using the circuit switched services (CSS) where real-time video telephony services are used. Streaming using Circuit Switched Services (CSS) provides several advantages over packet technology. The most important advantage is consistent quality of service provided by synchronous 64Kbps. Other advantages include easy access for Dial-a-clip type services and simplified billing. This type of service typically utilises a streaming server for content storage and delivery, which are controlled by RTSP protocol.

Multimedia video gateway

As seen by the above network configurations, the multimedia gateway is an important element in deploying both video mail and video streaming services. The video gateway provides the signalling and medial transcoding between the 3G mobile subscriber and the video mail or streaming platforms.

Understanding video corruption

In case of video mail storage/retrieval and video streaming applications, video and voice media are typically stored in a compressed format on a server. The voice bit streams transmitted by the 3G-324M handset can be in the compressed format of GSM-AMR or G.723.1 (EVRC for 3GPP-2). The video bit streams can be in the compressed format of H.263 (3GPP) or MPEG4 (optional in 3GPP but recommended in 3GPP-2).

The 3G-324M service makes use of transmission mechanisms that do not employ 'retransmission requests' in the presence of noise/errors. This applies for both voice and video. The absence of 'retransmission requests' in voice communication is not unusual. However for video, corruptions in the bit stream of a video frame not only affect the present picture being processed but can also affect many subsequent video frames that are being encoded using predictive coding.

Compression technologies overview

Predictive video coding is a key technique in modern video compression that allows an encoder to remove temporal redundancy in video sequences by compressing video frames utilising information from previous frames.

Typical video compression technology utilises I-Frames and P-Frames. Reference I-Frames are full frames that are followed by P-frames. P-frames are much smaller as they carry incremental changes with respect to the last I-frame transmitted and hence the compression of the video bit stream.

3G-324M service

Most video communication protocols (including that ▶

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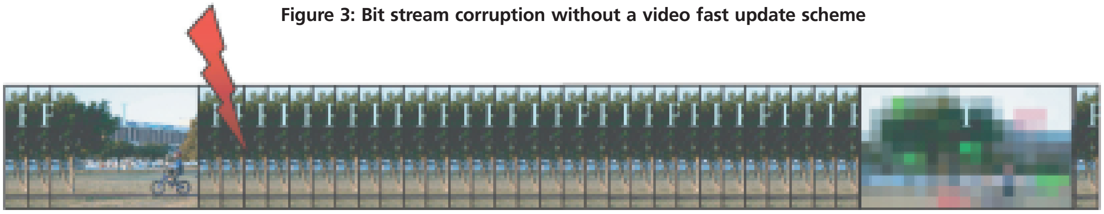
Figure 3: Bit stream corruption without a video fast update scheme



used in 3G-324M) do not rely on 'retransmission requests' because their command and control protocol includes an error recovery scheme based on what is called 'video-fast-update' request. This requests the transmitter side to encode the next video frame using the so-called I-Frame. The 'video-fast-update' technique limits any corruption to a very short period of time, hopefully unnoticeable by the subscriber, allowing the video quality to be restored quickly.

In a typical 3G-324M service, reference I-frames are normally 130 frames apart, which at 13fps is equivalent to an I-frame once every 10 seconds. If video frames get corrupted in the air interface, the receiving handset or terminal will request an Intra frame (I-frame) to be retransmitted. If bit stream corruption occurs without any fast update scheme it could mean up to 10-13 seconds of video is transmitted before a clear image is visible. The diagram above shows typical interleaving of I-Frames and P-Frames and what happens if an error occurs in a P-Frame.

A video mail or content streaming server may be unable to process these requests as I-frames and P-frames are already computed, and their re-computation requires real-time video encoding which is beyond the digital processing capabilities of video mail servers. This means that when a subscriber is retrieving a video mail message or viewing a streaming content, the subscriber will continue to encounter video corruption for up to 10 seconds till the next I-frame is transmitted (usually every 130 frames).

A common approach is to request regular I-frames from the terminal in case corruption is present. This leads to a reduced frame rate of 3-5 fps regardless of error conditions and furthermore, errors in the bitstream can still mean 4-6 seconds of corruption which doesn't provide a high quality experience for the caller. Effectively, more frequent I-Frames reduces the frame rate to unacceptable levels and also doesn't solve the problem.

The solution

A possible solution is a multimedia gateway incorporating Video Refresh, a patent-pending technology that minimises the duration of video corruption that may occur due to air interface interference and noise. Video Refresh technology is able to process the I-frame requests received from the access device and allows recovery from video corruption in about 200-500ms.

In case of a video mail application, such a gateway can also detect video corruption during the deposit of messages on the video mail server and can generate an I-frame request to reduce the extent of corruption of the deposited video message. This solution allows the video frame rate to be dynamic while addressing video corruption.

Enhanced video services for the third generation mobile networks are an important differentiator to mobile operators as they migrate their customer base to these higher revenue-generating services.

Addressing quality of service issues such as call setup delays and video corruption are key to delivering and deploying a high quality customer experience. Solutions designed to address these issues have become the cornerstone of video mail and video content streaming solutions that are being deployed today. ■

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