RTT TECHNOLOGY TOPIC
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3 G Compression

In order to optimise channel coding, it is important to characterize the content to be carried on the channel and the way in which the content is compressed. Content is compressed to reduce the amount of storage space needed to store information and the amount of bandwidth needed to transmit information.

We can define content as voice, data, text, image and video. If voice, data, text, image and video are mixed together, we can define the content as complex. The characterisation of complex content is crucial to our understanding of 3G cellular network implementation.

In a wireline network, voice is typically compressed at a ratio of 8 to 1, eg a 64 kbps PCM coded voice stream will be reduced to a 8 kbps voice stream. Similarly in cellular, for example GSM, our voice is put through an A to D converter to produce a 104 k/bit information stream which is then reduced to 13 k/bits – an 8 to 1 compression ratio. Specialised mobile radio systems, for instance TETRA, may have higher compression ratios, for example 20 to 1 (104 k/bits to 4.8 k/bits). As compression ratios increase, the resilience to bit errors on the radio channel decreases (more information is carried per bit, each bit error causes more damage). Usually, (but not all the time) this should be offset by the higher Eb/No obtainable from the lower bit rate. It is true to say that the bandwidth benefits of compression will only be realised when the Eb/No is increased (which in turn creates more co-channel and adjacent channel interference).

For text transfer, for example SMS either ASCII or UCS2 or 4 are used for source coding. Because of the small file size, (160 characters in an SMS message = 1120 bits using the 7 bit ASCII alphabet), SMS compression would not achieve very much. Moving from SMS to a dedicated data traffic channel, you might find a 4 to 1 compression ratio being used to compress 38.4 k/bits on to a 9.6 k/bit channel.

In paging applications, word coding is used occasionally but due to differences in proprietary implementation has never become a mainstream application.

Image compression ratios tend to be higher. Lossless compression is typically only 2:1 or 3:1 but lossy compression can yield ratios of 40:1 or higher. Lossless and lossy compression standards are presently being revised by JPEG (the joint photographic experts group) under the JPEG 2000 standard.

In parallel, JBIG (the Joint Bi-level Image Experts Group) is working on next generation document compression (including scanning and optical character recognition).

Video streaming generally requires far more information to be transferred – this also means we have more ways in which we can compress the information. As a rule of thumb, video compression ratios are increasing by an order of magnitude every 5 years. This has profound implications for designers working on wireless and wireline access and transport systems.

Most video coding systems are variable rate – a complex scene (tree with leaves being blown by the wind) will require a fast encoding rate, a simple scene (blue sky with no moving objects) will require a slow encoding rate.

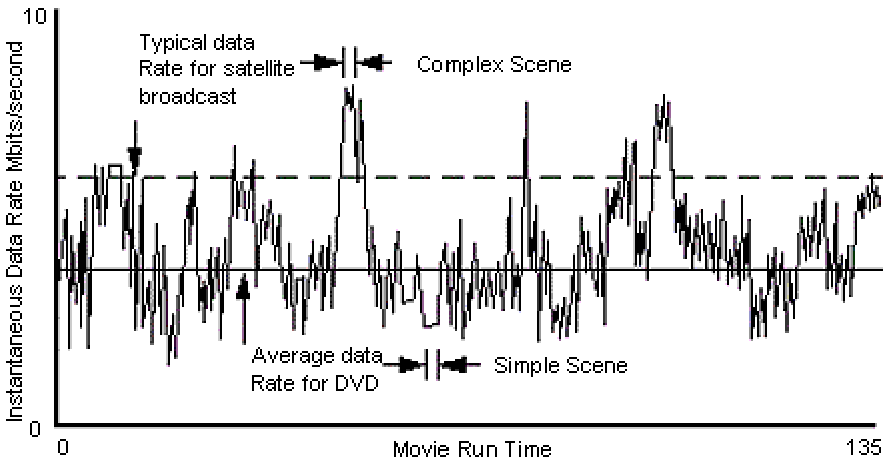

FIG 1

The coding rate is then reduced by using differencing. MPEG2 (used in digital video broadcasting) sends motion compensated difference pictures – ie only the difference value between two successive images is transmitted. When there is motion, the differences increase. Additional spatial compression is obtained by transform coding the differences.

In MPEG 2, motion differences are analysed in 16 x 16 pixel blocks to build up , for example in HDTV, a 1080 line picture with 1920 pixels per line.

Variable rate differential coding schemes are very efficient but need variable rate channels, low error rates and low latency – errors produce compression artefacts (people disappear!), variable delay can cause complete coding chaos – moving objects with trailing edges (note how these trailing edges can be made worse by display refresh rates).

Given that wireless has traditionally been plagued with high error rates and/or highly variable latency, variable rate differential coding has generally been discounted in favour of less efficient constant rate encoders like H320.

This is changing. 3G wireless delivers variable rate channels which theoretically should also be low error rate to give good 'transparent' channel performance (avoiding the need to use send again protocols that introduce variable delay). The channel fading should (if all goes according to plan) be taken out by power control and a bit of interleaving. Variable rate differential coding becomes plausible.

In which case, we need to look at MPEG.

The Motion Picture Experts Group was founded in 1993 initially to codify non-interactive video compression and more recently to codify interactive compression. MPEG proposals are put forward to be ratified as ISO standards and/or ITU recommendations.

MPEG standards with increasing relevance to wireless include:

MPEG 1	CD-ROM compression standard
MPEG 2	DVB (digital video broadcasting) and DVD (digital versatile disk) compression standard
MPEG 3	Officially MPEG 2 Layer 3 but now known as MP3 – the audio streaming standard
MPEG4	Audio **and** video streaming **and** complex media manipulation
MPEG5	Multi-media Hypermedia Standard (MPEG 4 for set top boxes)
MPEG7	Standard for content analysis, identification and description

MP3 is rapidly becoming notorious as the bootlegger's perfect accomplice – 150 CD's can be packed on to an 8 gigabyte hard disk (or more prosaically an hour of music on a 64 m/byte memory card).

MPEG4 takes MP3 and brings video on board and more. MPEG4 (let's call it MP4 for short), is an object based compression technique – you can have still objects, video objects or audio objects. These can be 2 or 3D (3D audio would be surround stereo). The objects can be manipulated – translated, warped or zoomed, using transforms to change the geometric or acoustical properties of the content. It's in effect an on-line real time editing suite.

The significance of MP4 is that it provides the subscriber with the ability to generate and edit his own content and place that content into the public domain.

Note that this is egocentric, not network centric value generation, value coming inwards from the edge of the network, not outwards from the centre.

This in turn will drive localized memory and processor bandwidth requirements in the 'input appliance' (formerly the phone).

MP4 also codifies the QoS requirement of the content – tolerable latency, tolerable channel quality, buffer and timing requirements.

For example, does the transmission need to be isochronous or not, how should the elementary streams from the complex content stream be mapped on to a complex transport channel (a big issue presently in 3G multiplexing code structure design).

MP4 audio coding will use harmonic vector coding between 2 and 4 k/bits, and CELP coding between 4 and 24 k/bits. Video coding will divide down into very low bit rate video (2 – 64 k/bit) and digital TV quality video (64 k/bit to 10 M/bit).

And as a result of the lessons learnt from MP3, MP4 sets out to try and address the content ownership issues by trying to standardise watermarking and content origination/proof of provenance.

Last, but not least, MPEG 7 sets out description standards for content identification – i.e. how to describe content such that it can be tagged in a meta directory.

Compression techniques may well provide the technology trigger for 3G TV and 3G cellular convergence. MP4 will, for sure, substantially change the form factor and functionality of the application layer in user devices which in turn will substantially change the performance required from the 3G physical layer.

Motion Picture Experts Group	www.mpeg.org
Joint Photographic Experts Group	www.jpeg.org
DVD and compression techniques	www.c-cube.com
Multimedia Hypermedia Interest Group	www.mhegcentre.com
European Council interest group promoting MHEG adoption	www.euromheg.org/mheg/
Digital Audio Visual Council	www.davic.org
Digital Television Group	www.dtg.org

Acronyms used in this article:-

PMC Pulse code Modulation
TETRA Trans European Trunked Radio
SMS Short Message Service
ASCII Advance Standard for Communications Information Interchange.

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RTT, the Shosteck Group and The Mobile World are presently working on a number of research and forecasting projects in the cellular, two way radio, satellite and broadcasting industry.

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