EXHIBIT 35

The VCR-ET(tm) Technical Summary

Introduction.

This report is a technical summary of the technology used in the VCR-ET (ET). The technology is summarized specifically for the use of individuals who have a need to understand the technology behind the ET but do not have the necessary time to study all of the engineering details. As such, this report is appropriate to gain a fairly high level of understanding of the ET and may be used as a basis for most strategic decisions involving the ET.

Enabling Technologies.

GeneSys.

Several references will be made to various technologies from the GeneSys family. GeneSys refers to a family of technologies from Production Services Inc (PSI), Tucson, AZ. The GeneSys technologies incorporated in the ET are SIX, ADA, and the GeneSys Modulator.

Capture.

Capturing refers to the capturing of the entire program, both video and audio. The video signal and the audio signals are sampled at a sufficient rate to provide a high-quality captured program on the ET. This high sampling rate will often be referred to as *video rate* or *real-time*. This type of capturing is typically accomplished with high speed Analog-to-Digital Converters (ADCs) also known as *flash converters*. Many commercial products use such converters thus providing confirmation that this is easily accomplished for the ET. Examples include PSI's SIX and frame-grabbers for computers, which capture a single frame of NTSC/PAL video for use in the computer. Audio may be similarly captured using flash ADCs.

Compression.

The storage of all of the captured data that makes up a video program would require tremendous amounts of storage. For this reason, the ET compresses the data as much as possible. This allows the entire program to be economically stored on several types of commercially available storage media. This is the key enabling technology and as work on the ET progresses the amount of compression will continue to increase and therefore storage requirements will decrease. The first obvious goal is to compress the data sufficiently to store it on standard media. However, as storage requirements continue to decrease, the cost of the ET will drop and the goal of offering a full-featured consumer version of the ET will soon be realized. Dramatic decreases in storage requirements will also bring about applications of this technology that have not yet been conceived.

Enabling Technologies.

<u>Compression (continued).</u>

Ample evidence exists to show that the necessary compression techniques necessary for the ET will quickly be developed. Some examples follow.

<u>Apple Computer</u>[1]

Apple computer reportedly uses a proprietary software compression algorithm to achieve a compression of 533:1 of video data. This video may the be decompressed at 30 frames/sec for playback. They allude to not having the ability to compress the data in real-time but admit to be interested in that technology as well.

<u>Intel</u>[1,2]

Intel's Digital Video Interactive (DVI) has been widely publicized. Intel compresses video data at ratios up to 120:1 for storage on and playback from optical media such as CD-ROMS. Like Apple, Intel is not able to compress the video in real-time.

<u>Universal Video Communications Corp (UVC)</u>[2]

UVC has demonstrated a real-time video teleconferencing system using its VP-2000 video workstation. Although computer-based and aimed at different applications, the VP-2000 has some similarities to the ET in that it has the ability to compress and decompress video data in real-time. This real-time compression/decompression works at only 15 frames/sec but has demonstrated compression ratios as high as 200:1.

<u>VCR-ET's compression techniques.</u>

The ET obviously differs from these similar technologies in its applications. For example, all are aimed primarily at computer applications while only the ET is aimed at the broadcast industry and the consumer market. Also, the ET will boast higher compression ratios and higher quality video than some of the others. The ET also differs in its compression techniques.

The ET compounds several different techniques to offer maximum real-time compression of the data. These techniques are outlined here but explained in further detail later. First, several human perception factors are taken advantage of to sample the data at lower than usual sampling rates while maintaining the quality of the image. This immediately compresses the data by 2X. Second, two of the GeneSys technologies are used consecutively, further compressing the data by more than 14X. Finally, a proprietary compression technique, dubbed D2D, compresses the data by approximately 40X. This compounding of compression techniques yields a total video compression of approximately 1150:1. In theory,

that figure may be improved a great deal more. The audio portion of the program is compressed in a slightly different manner but will be compressed by at least 14:1. All compression is handled in hardware and is completed at video rates. For reference, this translates to only 112 MegaBytes of storage for a high-resolution (400x480) video with better than CD quality audio (21 bits/sample compared to CD's 16 bits/sample). Or, 14.28 hours of programming may be stored on an 800 MB CD-ROM. And using the GeneSys modulator two hours of programming may be transmitted on a TV broadcast in only 35 seconds.

Transmission.
In the previous section it was pointed out that by using ET technology programs may be broadcast in less than real-time. In fact, broadcasting two hours of video in 35 seconds corresponds to a 1,050% increase in broadcast transmission bandwith. This phenomenal advancement stems from two factors. First is the 1150:1 compression of the data that the ET achieves. Second, use of the GeneSys Modulator further increases the transmission rate.

Software.
Naturally, a great deal of software development is required. The compression algorithms must be completed and tested before being committed to hardware. Application software must be written for use in the ET's proposed first application, the video library. ET-Communications will maintain a staff of software engineers to handle software development. They will use the latest Computer Aided Software Engineering (CASE) tools to ensure timely and proper development of the necessary software.

Video library.

There are many potential applications for the VCR-ET. The eventual goal is nothing less than a full-featured home version that will in effect be a completely digital VCR complete with editing and transmitting capabilities (thus the ET in the name). But it is important to have a focus, a specific application for the first prototype. That focus will be a concept called the *video library*. With the video library, there will be a home unit and a head unit which is maintained at the broadcast location (see Figure 1). A library of ET-compressed video is kept at this location. The head unit has the storage for this library as well as the compression hardware necessary to build the ET library from a library of video tapes or standard broadcast transmissions. The head unit also contains the necessary software to maintain customer accounts and service customer download requests. Through the home unit, the user is able to dial up the library and request a video. Upon servicing this request, the head unit puts the ET-compressed video in a transmission queue. At the next available transmission slot, the video is transmitted to the requestor. Note that the transmission time is 30-40 seconds for a typical two hour video. The home unit receives the ET-compressed video and stores it on it's self-contained storage medium from which it can be decompressed and viewed at any time. With this configuration, the user is able to start/stop the video at will, much as one would do with a standard VCR.

Such an exciting application for the ET will serve several purposes. First, it serves as an excellent testbed for developing the ET technology. Second, when the prototype is complete, it provides ET-Communications with an instantly marketable product that will provide the company with the income to continue ET research and develop new applications.

Compression Techniques.

The most technically advanced portion of the ET is the capture and compression. Figure 2 shows the compression pipeline. The NTSC/PAL signals are first input into SIX which achieves an analog 4:1 compression of the incoming signals without loss of information. Next, the signals are passed to ADA which accomplishes the analog-to-digital conversion and also achieves approximately 3,58:1 compression. Finally, the signal is compressed with the proprietary Delta 2-Dimensional (D2D) compression. D2D is still under research but will provide compression between 10:1 and 80:1. At this point the data is fully compressed and may be stored on the media or transmitted. The figure shows a modulator at the end of the pipeline. The GeneSys modulator functionally increases broadcast bandwith by 6X. The compressed video along with the increased bandwith yields a 30-40 second transmission time for two hours of typical ET video.

Compression Techniques (continued).

Delta Compression.

The key to the compression pipeline is the D2D compression. In order to understand D2D compression, the concept of delta compression must be understood. Research has shown that in typical video only a small portion of the picture changes from frame to frame. There are often scene changes, in which the entire picture changes between frames, but on the average little of the image changes between frames. This remains true (although to a lesser extent) even for video containing fast motion. A rather conservative estimate is that an average of only 5% - 20% of a picture changes between frames. Standard Delta compression (sometimes referred to as *temporal filtering*) takes advantage of this by storing only the differences between frames. Due to overhead to implement such a concept, this method would yield less than the expected 10:1 compression for 10% average change.

D2D Compression:

The term for D2D (Delta Two Dimensional) compression now becomes apparent. The difference between consecutive frames (called a *delta frame*) is indeed used. But this delta frame may be stored without the usual overhead and in fact, it may be compressed even further. Each delta frame is compressed using a two dimensional run-length compression. Looking at a delta frame digitally, binary ones are stored for pixels that have changed and zeros for those that have not. At this point, the delta frame appears to be an ordinary bitmap like those used in a computer graphics image; ones represent pixels that are on, zeros represent those that are off. Run-length encoding simply stores a code that the next 80 pixels are on, for example, rather than storing all 80 pixels. Doing this both vertically and horizontally compresses many images by 20:1. Note that this compression will not work well on some images. A checkerboard pattern, for example, has no 'runs' of the same pixels. However, recall that this image is a delta frame. Another characteristic of delta compression ensures that the average frame will have runs of the same pixels and thus compress well. It has also been shown that the pixels that do change between frames are bunched together. Thus, those pixels are marked with a one, they are already grouped together, and the two-dimensional run-length encoding compresses the delta frame quite well. It has been estimated that this D2D compression will achieve compression ratios between 10:1 and 80:1.

SIX.

SIX performs an analog compression of the incoming signal by subsampling. It achieves a 4:1 compression without significant loss of resolution. SIX is emulated with an analog based neural network.

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ADA.

ADA accomplishes the analog-to-digital conversion of the signal. In doing so, it effectively compresses the data by approximately 3.58:1. ADA is modeled with an analog based neural network.

Block diagram summary.

Figure 2 shows the signal as it passes through the compression pipeline, the storage media and the modulator, at which point it is fully compressed and may be transmitted. The compression pipeline consists of SIX, ADA and D2D. First, note that the three NTSC/PAL input signals are not sampled at the same rate. If the frequency of the Y signal is F, studies have shown that the I signal may be sampled at F/3 and the Q signal at F/6 without human-perceptible loss of information[3]. Next, SIX effectively does a 4:1 analog compression and functionally lowers the sampling rate by another 4X. Then ADA digitizes the signals and in doing so compresses the data by approximately 3.58:1. Finally, the signal is D2D compressed by approximately 40:1. Note that the audio path is not shown, but it is compressed with SIX and ADA (D2D is applicable only to video). The fully compressed program is now ready for storage and/or transmission as shown in the figure.

Parameters.

Many parameters were taken into account to arrive at the estimates in this report. Certain sampling rates are assumed, estimated compression ratios are used. In this section, the parameters used in these estimates are discussed as well as a range of reasonable values. Note that the estimates in this report use a mid to high-end value for all these parameters thus ensuring a high quality program. However, if the lower values are used the storage estimates may be decreased dramatically.

Video resolution.

Estimates assume 480 lines per frame are sampled. Each line is sampled 400 times. Such values achieve a very high-quality image, even more than today's advanced VCRs. The number of lines could conceivably range between 350 and 525. The number of samples per line could be 250-512.

Sampling rates.

The YIQ video signal is used due to the study that shows that the signals may be sampled at FREQ, FREQ/3 and FREQ/6[3]. With more study on human perception, these values could change. In these estimates the audio signal was assumed to be sampled at 4 samples/line. Using SIX and ADA, the audio portion of the program has an effective resolution of 21 bits/sample compared to CD's 16 bits/pixel. The audio sampling rate might be range between 2 and 4 samples per line.

D2D compression.

Previous sections have pointed out that D2D compression is expected to yield 10:1 to 80:1 compression. The estimate of 40:1 is actually fairly conservative. Figure 3 shows an interesting effect of pipelining all the compression techniques. While the D2D compression is the key technology for the ET, the success of the prototype does not completely rely on it. The graph shows that a D2D compression ratio anywhere between 10:1 and 40:1 yields a reasonable total storage value. This is because other compression techniques are used in the compression pipeline. Thus this pipeline not only gives the ET its extremely high compression levels but it protects it from being completely reliant on D2D compression. Also, note that D2D compression ratios beyond 40:1 or 50:1 really are at the point of diminishing returns; the work expended to increase D2D compression from 50X to 80X would yield insignificant decreases in total required storage. This is because the video is already so highly compressed that further compression would generate little benefit.

Reference frames.

The single disadvantage of D2D compression stems form the goal of using the ET as a digital VCR with random-access editing capabilities. To illustrate this, consider a simple video where there are no camera changes. The entire video is based off of the first frame and all the rest of the frames are simply delta frames. Since each delta frame is based on the previous frame the ET would have to start at the first frame and generate each new frame just to get to the last frame. Therefore, if the user wanted to alter or delete the last frame, this would mean waiting two hours to get from the first to the last frame, which is obviously unacceptable. To solve this, the ET stores *reference frames*. Every X seconds the ET stores a complete (non-delta) frame for reference. An entire frame is also stored if most of the frame has changed since the last frame. In this manner, the user will have to wait at most X seconds to get at any frame. The overhead for one reference frame every three seconds is included in the 112 MB storage estimate. In fact, if reference frames were not required, the total storage would be a mere 88 MB. It is reasonable to store a reference frame every 1-3 seconds.

<u>Total storage, transmission times.</u>
The total required storage and transmission times for a two
hour program are summarized below. Worst case assumes the
highest quality program along with the lowest compression.
Best case assumes the lowest quality image and the highest
compression. In the center is the estimate referred to
throughout this document. Storage is given in MegaBytes.
Transmission time in seconds is given in parentheses.

Worst Case	Estimate	Best Case
428 MB (136 sec)	112 MB (35 sec)	36 MB (13 sec)

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Summary

The VCR-ET was originally conceived as an idea far ahead of its time. It was thought for some time that technology would need to catch up with the ET's lofty goals in order to produce it. But recent research shows that the ET is completely feasible even today. This report has outlined all of the necessary technologies, the *enabling technologies*, that go into the ET. Most are commercially available. For those that will be developed by ET-Communications, evidence is presented showing that these new technologies are also attainable.

The ET has the potential to be as important a technology as those that currently receive a great deal of press, such as High Definition Television (HDTV). And like these other, often-discussed technologies, research and development of the ET will spill into other areas. While HDTV research will offer new high-resolution displays, the ET will offer unheard of compression ratios. While HDTV will offer great improvements in the quality of video, ET will change the way consumer's receive TV programming. ET-Communications believes the applications and the effects of the ET are astounding and that ET technology is currently within reach.

Endnotes

1. MacWEEK; 22 August 1989; pg 1, 6;
"Video: Where Apple's Headed"

2. Electronic Engineering Times; 27 February 1989; pg 1, 164;
"System puts real-time squeeze on color video".

3. Image Transmission Techniques, pg 79;
Academic Press, New York, 1979.