How will PET be tested?

Priority Encoding Transmission will be tested in the interworking of experimental high-performance gigabit testbeds, public commercial ATM services, private LAN networks, and a variety of stations. The Bay Area Gigabit users group network implemented over the Pacific Bell ATM service; the BLANCA/XUNET-gigabit and Sequoia-2000 testbeds; and the Internet network are samples of the heterogeneity at ICSI and the University of California at Berkeley. Sending workstations will multicast encoded messages with information containing their best quality images, messages will be partially discarded by congested networks, over-flooded buffers, and receiver time-outs.

Present Status

A general encoding/decoding algorithm for implementing this scheme for any set of user priorities has been developed by Jeff Edmonds and Michael Luby of ICSI, and Madhu Sudan of IBM. The algorithm is based on polynomials over finite fields. Two methods for users to specify priorities have been investigated: a bit form and a fractional form. A user specification in fractional form consists of the following. For each information object, the user specifies the fraction of the encoding p needed to recover the object. Implicitly, the closer p is to zero the higher the priority of the object. Suppose there are information objects with sizes $b_1, ..., b_k$ and the user specifies fractions $p_1, ..., p_k$, respectively. The algorithm will encode the message into segments of total length $E = \sum_{i = 1, ..., k} b_i/p_i$. The algorithm has been shown to be optimal in the sense that there is an information-theoretic proof that *any* scheme to implement these priorities *must* have a total encoding length of at least E.

Several prioritizing specifications have being given as examples for image encoding applications. The algorithm shows promise of being practical.

Research Issues

PET is a new algorithm that requires a feasibility demonstration, benchmark evaluations for a variety of software and hardware platforms. The search is open for faster algorithms, implementations and applications in heterogeneous networks.

Example

Let's consider the transmission of a six megabit image where the information is arranged into five information objects containing all the 64 DCT (Discrete Cosine Transform) coefficients. The image is encoded into 24,220 segments of 48 bytes each, resulting in an encoding 1.55 times larger than the image. Table 1 shows the fraction of the encoding needed to recover the information objects.

Table 1: Example for image encoding

Information objects	No. of coeff.	Fraction of encoding needed	Fraction of message decoded
O1	2	.17	.03
O1&O2	6	.33	.09
O1-O3	14	.76	.22
O1-O4	30	.85	.47
O1-O5	64	.93	1.00

Tutorial: Polynomials over a Finite Field

To transmit three coefficients (5,3,1) we create a polynomial $P(x) = 5 + 3x + x^2 \mod 7$ and evaluate it at a subset of the points $x = 0, 1, 2, 3, 4, 5, 6$. The receiver recovers the coefficients (5,3,1) by an interpolation process from any received set of three values of $P(x)$. The transmitter sets the redundancy by sending more than three points. As an example, the receiver can interpolate the polynomial from $P(1) = 2$, $P(3) = 2$, $P(5) = 3$.

Hint: Interpolate by adding the three polynomials $P(x) = f_1(x) + f_2(x) + f_3(x) \mod 7$, where

$$f_1(1) = 2, \quad f_1(3) = 0, \quad f_1(5) = 0$$

$$f_2(1) = 0, \quad f_2(3) = 2, \quad f_1(5) = 0$$

$$f_3(1) = 0, \quad f_3(3) = 0, \quad f_3(5) = 3.$$

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