HYBRID INTERLEAVER

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A new communication system bit interleaver should allow 100 percent rated throughput for digital channels time-multiplexed among several user terminals.

This technique called a hybrid interleaver, would be especially beneficial for time-multiplexed defense communication systems which operate in hostile environments where purposeful attempts may be made to interrupt vital messages.

Military channels are often hindered by amplitude fading and other multiply contiguous error generating anomalies. Multiple bit per symbol waveforms, encoded bit interleaving and error correction coding can enhance the robustness of signals when these conditions occur. For example, a decoder's effectiveness is aided by interleaving the encoded bits to make the error distribution it sees more uniform.

Classical interleaving is based on the block and convolutional approaches. Each type has inherent advantages and disadvantages. Block interleaving permits 100 percent rated time-multiplexed channel throughput but requires four times more memory and twice as much delay as the convolutional approach. On the other hand, convolutional interleaving impairs multiplexing.

Hybrid interleaving capitalizes on the advantages of both these interleavers while avoiding their respective drawbacks. It offers the 100 percent multiplexing efficiency of the block, yet, like the convolutional interleaver, operates with 75 percent less memory capacity and creates half the delay.

A block interleaver consists of two rectangular arrays of memory with two commutators, one for loading the data and the other for reading it. Data is loaded by the input commutator into one plane using a raster scan, while being read from the second plane by the other commutator. The second plane's raster scan is orthogonal to the first plane's. At the end of each pair of scans, the data is transferred from the input to the output plane.

The memory array of a convolutional interleaver is organized in a right triangle with the input commutator on one of the sides and the output commutator on the hypotenuse. Data is shifted one memory cell per commutation cycle along rows perpendicular to the input until it arrives at the output.

When two or more terminal users employ a multi-bit per symbol waveform, the beginning and end of the first person’s transmissions will contain many partially used symbols. As a result, the next terminal user on the multiplexed channel must wait til the first’s interleaver is emptied before starting to transmit. Moreover, a span of partially used channel time is created during this transition between users.

Hybrid interleaving fully utilizes all bits of a terminal’s channel symbols throughout its transmission time. Such efficient packing permits multiple terminals to transmit contiguously on a channel.

This new concept combines the organizational features of both block and convolutional forms. Two planes and commutators of a block interleaver provide the input and output. These input-output structures are connected by a set of convolutional interleavers.

While one block’s worth of data is being loaded by the input, another is being read by the output commutator. Once this input-output commutator cycle is completed, each bit is shifted one memory cell dowm the rows of the convolutional interleavers connecting the two blocks.

Two design constraints are imposed on the size of the input and output planes to avoid the multiplexing inefficiency of the classical convolutional interleaver. Each plane must be an integer submultiple of the encoded data block size. Also, the length of the output commutator raster scan must be an integer multiple of the number of bits per channel symbol.

The interleaver’s time span is the ratio of the total bits in the hybrid structure to the uncoded data rate. By selecting the length of the longest row of the interconnection between the two blocks, a user can determine the desired span of interleaving.

Among its commercial applications, this intervention could provide efficient multiplexing for heavily time-shared M-ary modulated telephone voice circuits, especailly those on high throughput channels hampered by amplitude fading.