1 Multiplexing

There are several ways of having several different signals travel across the same communication channel. The collective term for the technique is 'multiplexing'.

Essentially, we need to find a way to divide the carrier channel between several signals. There are several ways to proceed: to divide the frequencies, or to divide the time.

1.1 FDM, Frequency Division Multiplexing

If the carrier signal bandwidth exceeds the bandwidth of the signals we wish to multiplex, then we can partition the carrier bandwidth into 'channels'; and allocate each channel per signal.

For example, if the bandwidth of the carrier channel is 100Mhz, and each of our signals are only 5Mhz, then we can partition the carrier bandwidth into 20 channels, each with 5Mhz bandwidth. All channels can be carried at the same time, independent of each other. This is similar to how broadcast TV works.

A similar ides is Wavelength Division Multiplexing, WDM, which refers to transmitting different colors at the same time over the fiber.

1.2 TDM, Time Division Multiplexing

If the carrier data rate exceeds that of our signals, we can partition the transmission into time slices, allocating a slice per signal. For example, if carrier data rate is 100Mbps, and each of our signals only needs 5Mbps, then we can queue up 20 of these signals, and transmit a bit (or some other block, like octet or a frame) of data from each.

TDM comes in two major flavors: synchronous and statistical TDM (ie: asynchronous).

In synchronous TDM, we take a fixed number of bits from each signal, and splice them into the carrier channel. If data is not available, we transmit garbage. Every signal gets an allocated capacity, wether it uses it or not.

In statistical TDM, we transmit data packets from differnet signals whenever they become available. If no data is available, we don't send anything. Statistical TDM is more efficient than synchronous if there are a lot of users that aren't transmitting data all the time.

Statistical TDM is used by cable modems. Two channels (TV channels) are allocated for data transmission, one channel for sending another for recieving data. Multiple users (usually in the same building/neighbourhood) share those channels in statistical TDM way. This allows for high data rates when nobody else is connected—and hopefully evenly dividing the channel when many users wish to share the capacity. In practice, if the cable company oversells the capacity (has too many users sharing the same channel) the data rate per customer can become noticebly bad.

2 Spread Spectrum

The basic idea behind spread spectrum is to have some random number generator (with shared seed) on both sender and reciever. The random number generator determines which

frequency will be used to transmit the next frame of data. If both sender/reciever are in sync, then they seemingly communicate via random frequencies.

Such transmissions are difficult to jam, and are more robust in presense of multiple users (as in all likelyhood, their frames won't all fall into the same frequency at the same time).