Optical CDMA

The simplest configuration, CDMA achieves multiple access by assigning a unique code to each user.

To communicate with another node, user imprint their agreed upon code onto the data. The receiver can then decode the bit stream by locking onto the code sequence.

The principle of optical CDMA is based on spread-spectrum techniques.

The concept is to spread the energy of the optical signal over a frequency band that is much wider than the minimum bandwidth required to send the information.

Spreading is done by a code that is independent of the signal itself.

On optical encoder is used to map each bit of information into the high-rate (longer-code-length) optical sequence.

The symbols is the spreading code are called chips.

The energy density of the transmitted waveform is distributed more or less uniformly over the entire spread-spectrum bandwidth.

The set of optical sequences becomes a set of unique ‘address codes or signature sequences’ the individual network users.

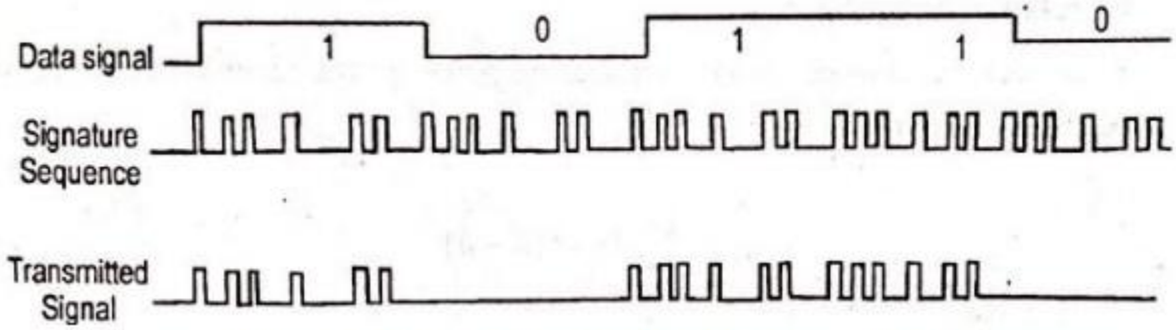

Figure 5.20 Six Chip optical CDMA Encoding Scheme

[Source: htpp://img.brainkart.com]

The signature sequence contains six chips. When the data signal contains 1 data bit, the six-chip sequence is transmitted, no chips are sent for a 0 data bit.

Time-domain optical CDMA allows a number of users to access a network simultaneously, through the use of a common wavelength.

Both asynchronous and synchronous optical CDMA techniques. In synchronous accessing schemes follow rigorous transmission schdules, the produce more successful transmission (higher throughputs) than asynchronous methods where network access is random and collisions between users can occurs.

An optical CDMA network is based on the use of a coded sequence of pulses.

The setup consists of N transmitter and receiver pairs interconnected in a star

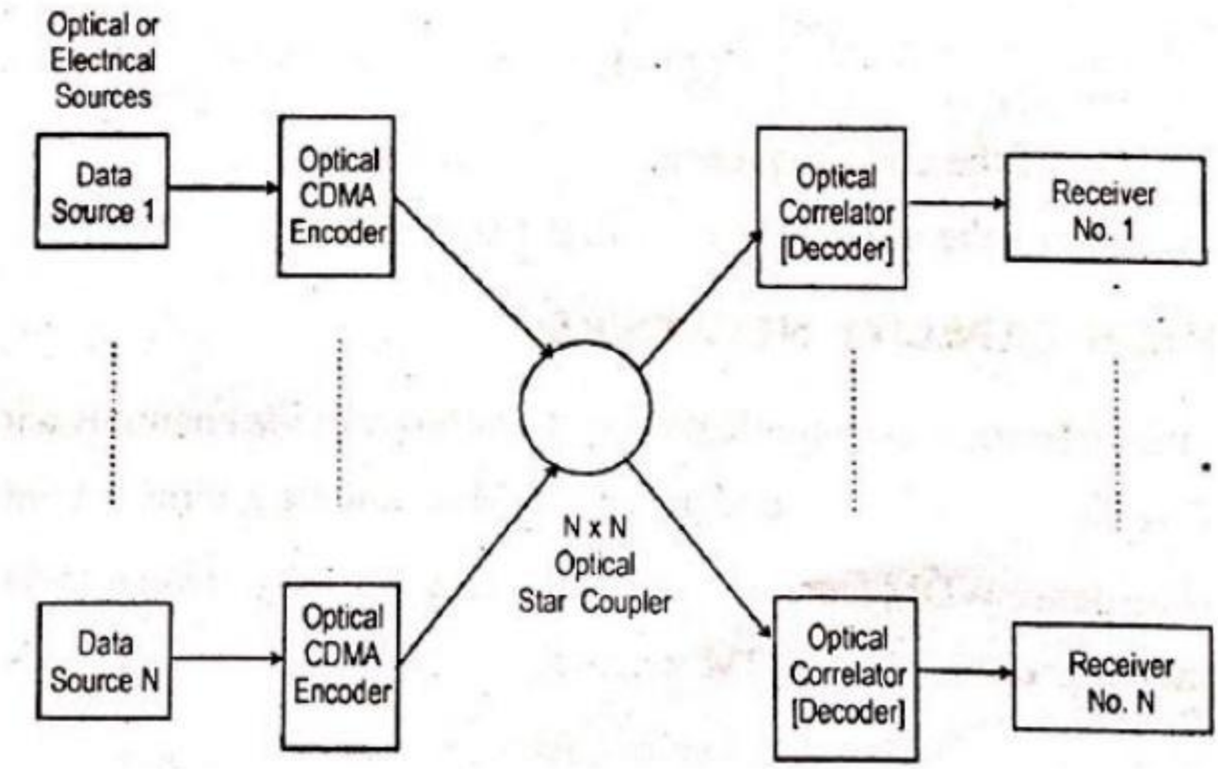

Figure 5.21 Optical CDMA Network Based on Using a Coded Sequence Pulse

[Source: htpp://img.brainkart.com]

To send information from node j to node k, the address code for node k is impressed upon the data by the encoder at node j.

At the destination, the receiver differentiates between codes by means of correlation detection.

Each receiver correlates its own address f(n) with the received signal s(n). The receiver output r(n) is

$$r(n) = \sum_{k=1}^{N} s(k)\, f(k-n) \qquad \text{...(5.57)}$$

If the received signal arrives at the correct destination, then s(n)=f(n).

Equation (5.57) represents an autocorrelation function, if s(n) not equal to f(n) the equation (5.57) represents a cross-correlation function.

For a receiver to be able to distinguish the proper address correctly, it is necessary to maximize the autocorrelation function and minimize the cross-correlation function.

Prime-sequence codes and optical orthogonal codes (OOCs) are the commonly used spreading sequences in optical CDMA systems.

An OOC systems the number of simultaneous user an is bounded by

$$N \leq \left\lfloor \frac{F-1}{K(K-1)} \right\rfloor \qquad \text{... (5.58)}$$

Ultra High Capacity Networks:

Advance of optical communication systems has provide channels with enormous bandwidth at least 25THz and dense WDM technology, ultrafast optical TDM.

To using dense WDM techniques to increase the capacity of long-haul transmission link and ultrafast optical TDM schemes.

These are particularly attractive in LAN or MANs

TDM Schemes To Shared-Media Local Networks have Two Methods:

(1) Bit-interleaved TDM.

(2) Time-slotted TDM.

1. Ultra High Capacity WDM Networks

Two popular approaches are used to achieve increased capacity.

(a) to widen the spectral bandwidth of EDFAs from 30 to 80 nm, by using broadening techniques.

Increasing the capacity of a WDM link is to improve the spectral efficiency of the WDM signals.

Most of the demonstrations use a rate of 20 Gb/s for each individual wavelength to avoid non-linear effects.

Examples are,

(1) A 50-channel WDM system operating at an aggregated 1-T_b/s rate over a 600 km link.

(2) A 132-channel WDM system operating at an aggregated 2.6 T_b/s rate over a 120-km/link.

2. Bit-Interleaved Optical TDM

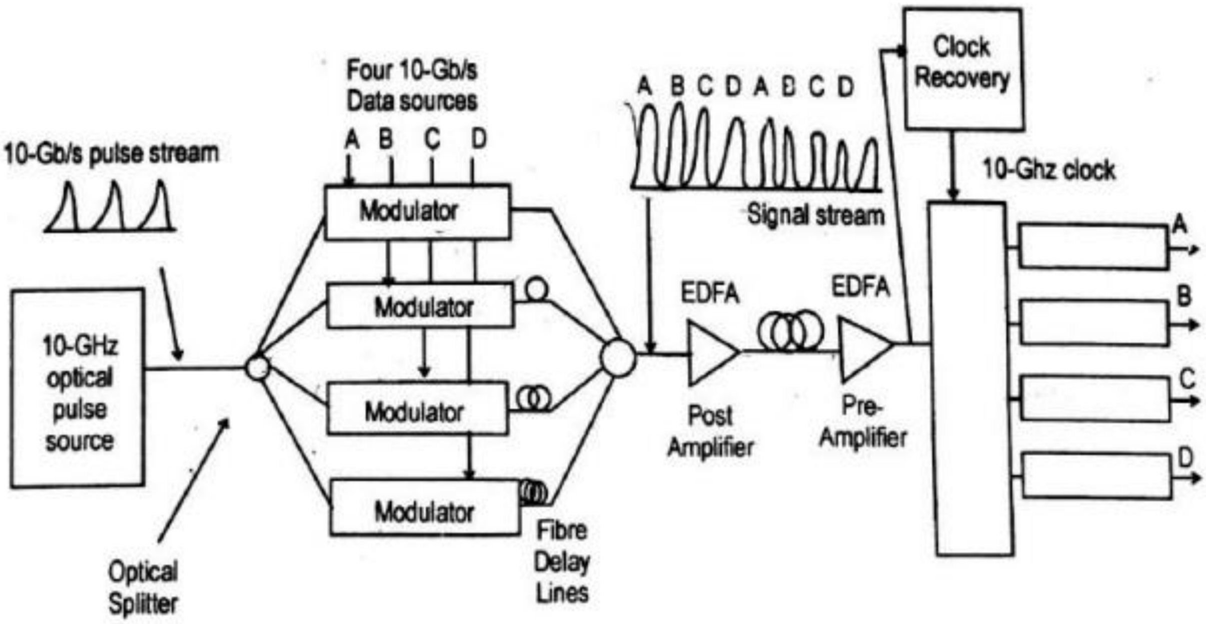

Figure 5.22 Ultrafast Point – Point Transmission System Using Optical TDM

[Source: htpp://img.brainkart.com]

Repetition rate typically ranges from 2.5 to 10 Gb/S, which corresponds to the bit rate of the electric data tributaries feeding the system.

An optical splitter divides the pulse train into N separate streams.

The pulse streams is 10 Gb/S and N=4, each of these channels is then individually modulated by an electrical tributary data source at a bit rate B.

The modulated outputs are delayed individually by different fractions of the clock period, and are then interleaved through an optical combiner to produce an aggregate bitrate of NXB.

Optical post amplifier and preamplifier are generally included in the link to compensated for splitting and attenuation loss.

At the receiving end, the aggregate pulse stream is demultiplexed into the original N independent data channels for further signal processing.

A clock-recovery mechanism operating at the base bit rate B is required at the receiver to drive and synchronize the demultiplexer.