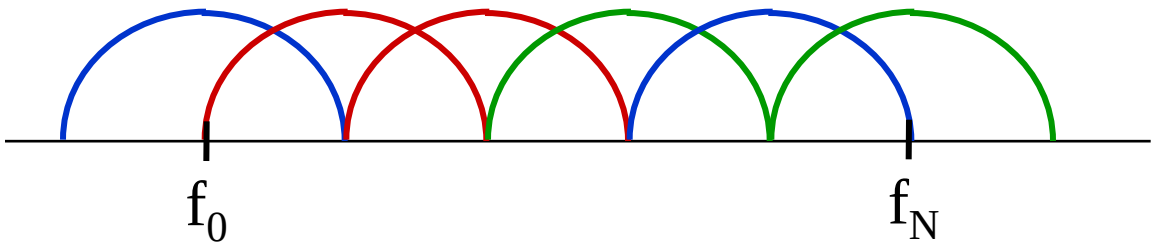
Wideband Multiple Access

Adaptive OFDM-FDMA

- In multiuser systems these subchannels can be allocated among different users…… Multiuser OFDM
- Different subcarriers assigned to different users
  - Assignment can be orthogonal or semiorthogonal



- The fading on each individual subchannel is independent from user to user
- Adaptive resource allocation gives each their “best” subchannels and adapts optimally to these channels
- Multiple antennas reduces interference when multiple users are assigned the same subchannels

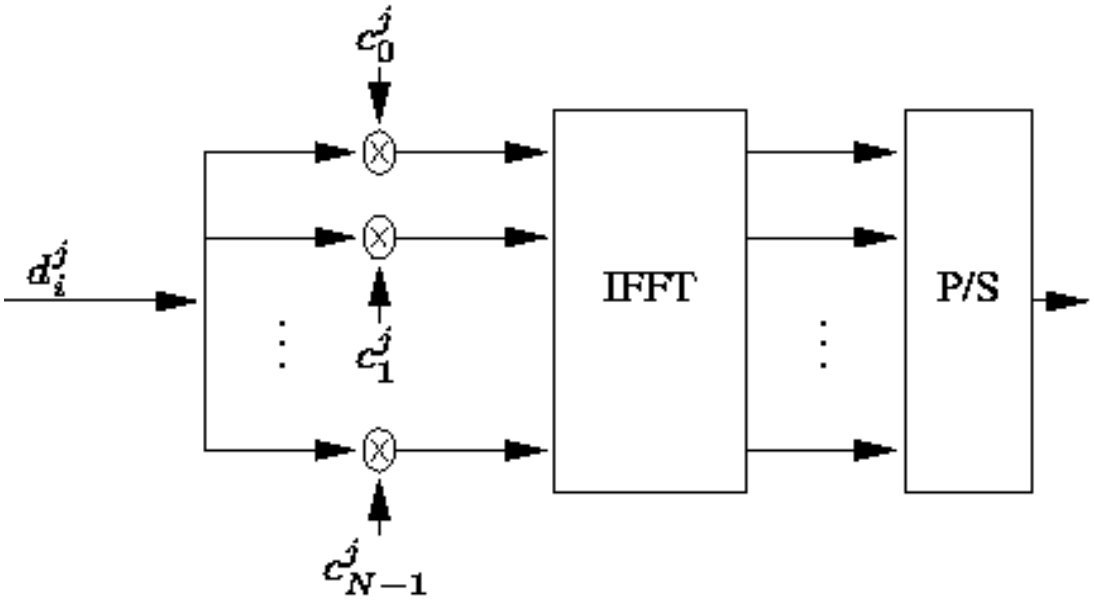
CDMA-based schemes

- Can combine concepts of CDMA and OFDM
- Reap the benefits of both techniques
- In 1993, three slightly different schemes were independently proposed:
  - MC-CDMA (Yee, Linnartz, Fettweis, and others)
  - Multicarrier DS-CDMA (DaSilva and Sousa)
  - MT-CDMA (Vandendorpe)

Multicarrier Code Division Multiple Access (MC-CDMA)

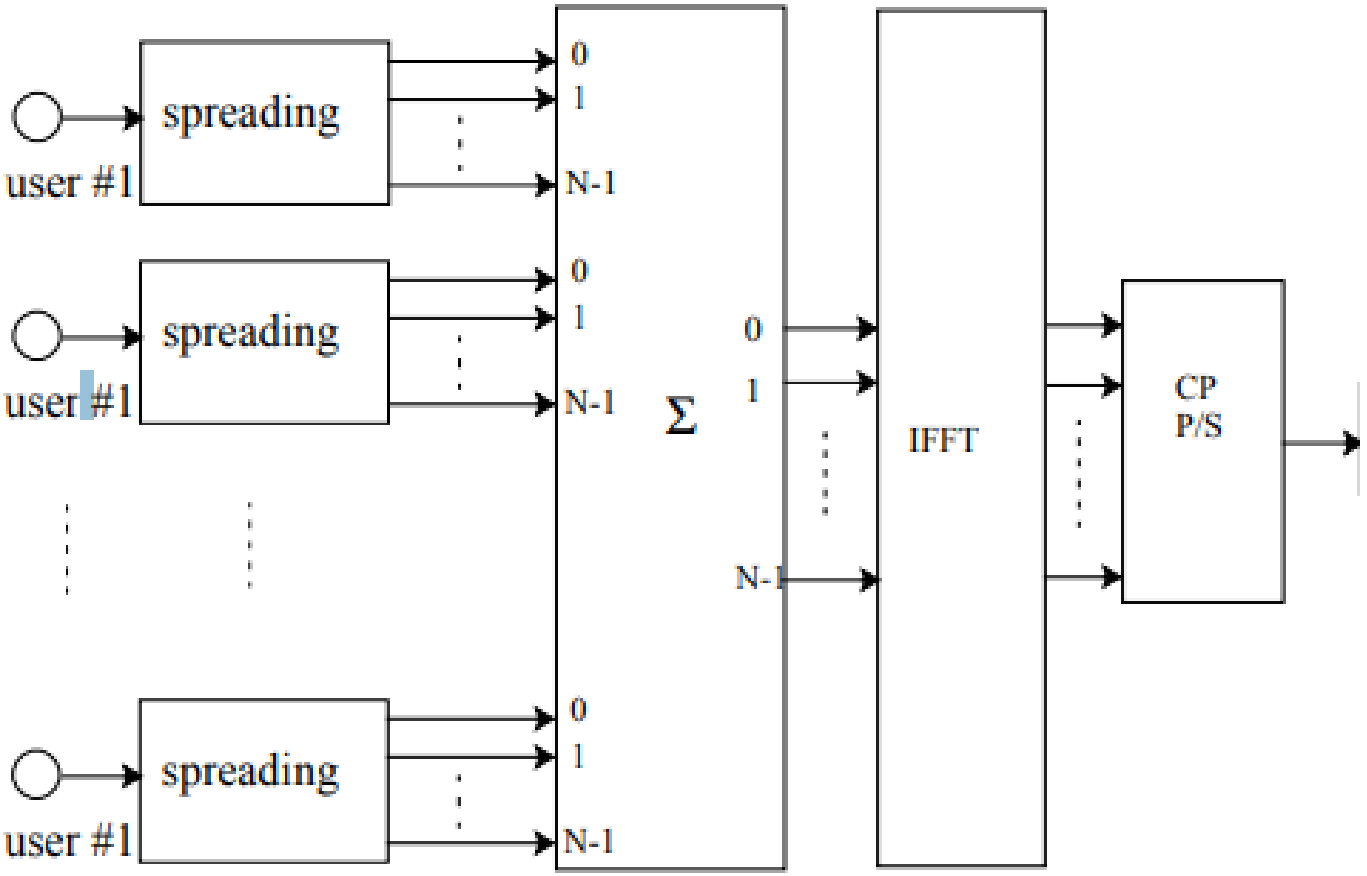
- Combination of CDMA-OFDM to provide multi user capability
- Frequency Diversity avoids deep fades. Each bit is transmitted simultaneously on many different subcarriers
- MC-CDMA applies spreading sequences in frequency domain. The original information becomes spreaded in frequency domain directly
- Simple receiver structure

MC-CDMA Transmitter



- The bit duration T of the data is much longer than the PN sequence chip duration Tc. Normally N=T/Tc may be equal to 32, 64, 128 or higher
- One data bit is modulated in the band of N modulators.
- The distance between subcarriers is equal to the chip rate or its multiple

MC-CDMA transmitter for Base Station



- Upper bound of N

The IFFT order has to be at least as high as the highest number of chips per bit for a single user. Moreover, IFFT order should be high enough to ensure that the over head cased by the circular prefix was possibly small N>> CP length

- Lower bound of N

$N << 1/(T_c * f_D)$

f_D is the maximum doppler frequency

- The problems of the signal reception for mobile station receiver and for base station receiver are different.
- The problem of channel estimation for the uplink in MC-CDMA system is rather complex
  - downlink has to estimate only one channel from a certain portion of received signal
  - uplink has to estimate many channels from the equivalent portion of the signal
  - signals coming from the different users are not synchronized in time
  - ICI for every user may have different range and should be cancelled separately.

MC-CDMA in indoor wireless radio networks

- MC-CDMA is a suitable modulation technique in the indoor environment.

- Multiple access is achieved with different users transmitting at same set of subcarriers but with spreading codes that are orthogonal to the codes of others.

ADVANTAGES OF MC-CDMA

- Easier implementation for high data rate services than DS-CDMA by the increased signaling interval

- Suitable for indoor wireless environment: small delay spread and small Doppler spread

- Fading resistance using frequency diversity

- MC-CDMA gathers nearly all energy scattered in subcarriers

PROBLEMS IN MC-CDMA

- High Peak-to-Average Envelope Power Ratio
  - Nonlinear amplification - spurious power
  - Power inefficient

- Sensitive to carrier frequency offset : Difficult to deploy for high speed vehicles

- Sensitive to phase noise

- Low frequency reuse factor than DS-CDMA