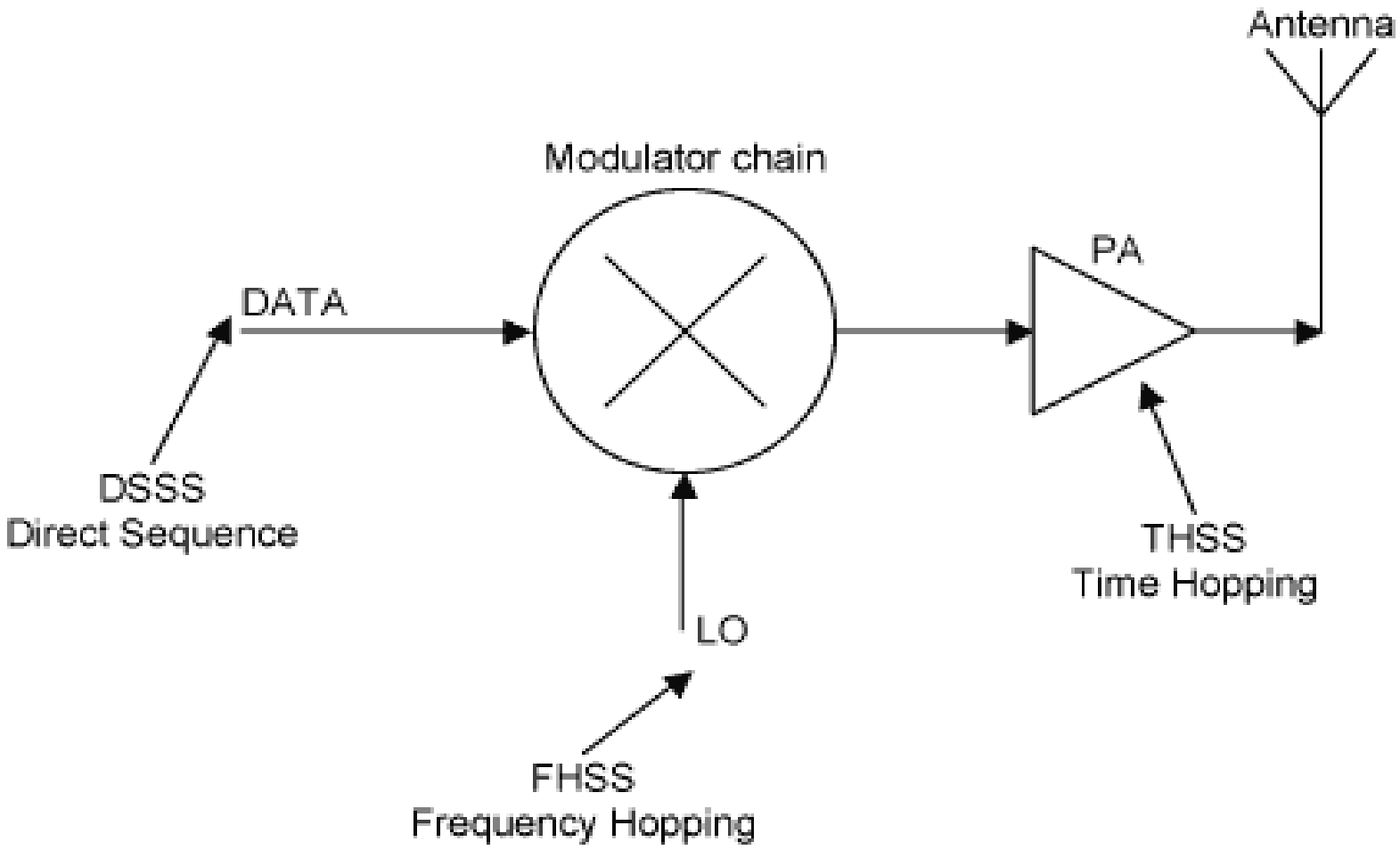
TYPES OF SS TECHNIQUES

THE FUTURE LIES WITHIN

INTRODUCTION

- There are four basic types classified according to the point of insertion of PN code
  - Direct Sequence spread spectrum (DSSS)
  - Frequency hopping spread spectrum(FHSS)
  - Time hopping spread spectrum (THSS)
  - Hybrid techniques



Direct Sequence SS

DSSS

DIRECT SEQUENCE SYSTEMS (DSSS)

- It uses a locally generated pseudo noise code to encode digital data to be transmitted
- The speed of the code sequence is called the *chipping rate* which is measured in cps
- The amount of spreading is dependent upon the ratio of chips per bit of information (which is the processing gain Gp for DSSS)
- A direct sequence modulator is then used to double sideband suppressed carrier modulate the carrier frequency to be transmitted The resultant DSB suppressed carrier AM modulation can also be thought of as binary phase shift keying (BPSK)
- At the receiver, the information is recovered by multiplying the signal with a locally generated replica of the code sequence.

DSSS(CONTD)

INPUT:

dt is binary data with symbol rate Rs=1/Ts

PNt is PN code with chip rate Rc=1/Tc

SPREADING:

$$TXb = dt.PNt$$

The effect of multiplication of dt with a PN sequence is to spread the baseband bandwidth Rs of dt to a baseband bandwidth of Rc.

DESPREADING:

Now TXb is received signal then

Recovered data=dr=TXb.PNr

When PNr=PNt

$$dr = (dt.PNt).PNt = dt$$

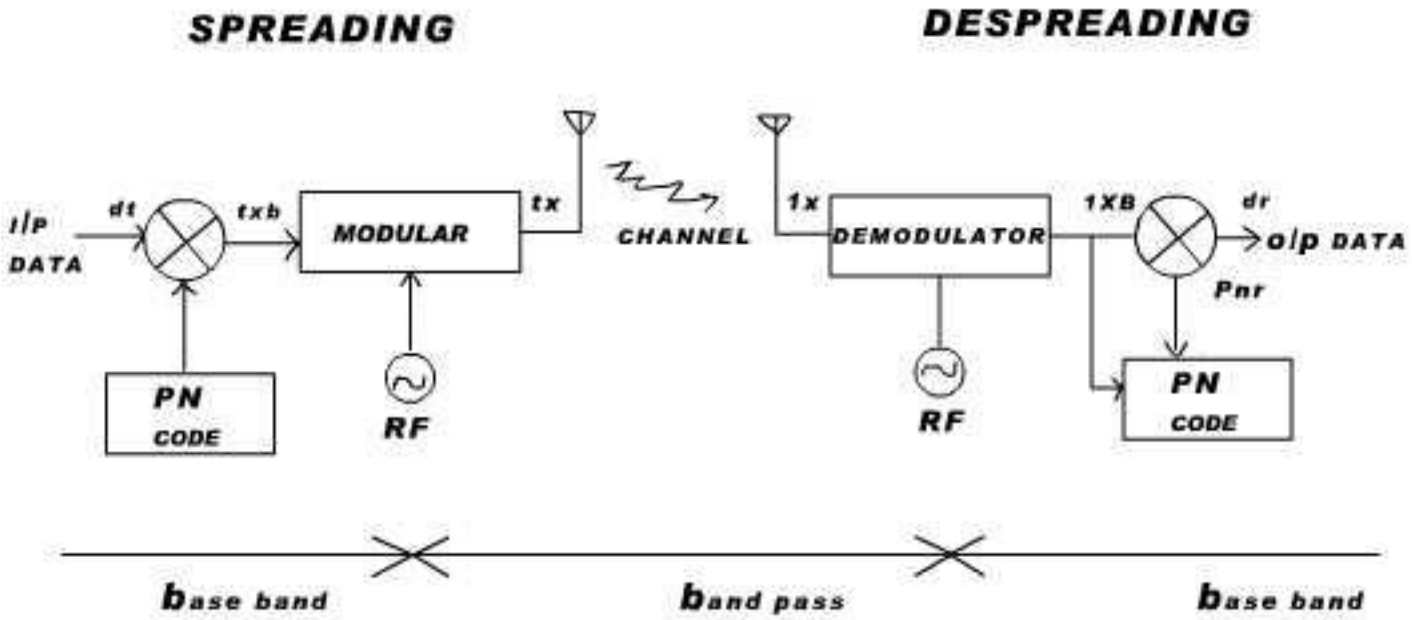
DSSS (Contd)

- The effect of multiplication of the spread spectrum signal rxb with the PN sequence pnt used in the transmitter is to despread the bandwidth of rxb to Rs

- If pnr ≠ pnt, than there is no despreading action. The signal dr has a spread spectrum. A receiver not knowing the PN sequence of the transmitter cannot reproduce the transmitted data (it will basically produce yet another version of the spectrum spread of the original signal - with a different code).
- The multiplier output becomes:

$$dr = rxb \cdot pnr = (dt \cdot pnt) \cdot pnr$$

For BPSK modulation the building blocks of a DSSS system are



DSSS (contd)

- **ADVANTAGES**
  - Simple hard ware implementation
  - Best noise and anti jam performance
  - Best discrimination against multi path
  - Do not require a high speed fast setting frequency synthesizer
- **DISADVANTAGES**
  - Requires wide band channel with little phase distortion
  - Long acquisition time.
  - Fast code generator needed.
  - Near –far problem

Frequency Hoping Systems

FSSS

FREQUENCY HOPPING SYSTEMS

- Carrier frequency shifting is discrete increments in a pattern dictated by a code sequence. The transmitter jumps from frequency to frequency within some predetermined set; the order of frequency usage is determined by a code sequence.
- A frequency hopped system, unlike direct sequence one, can use both analog and digital carrier modulation and can be designed using conventional narrow band radio techniques

FHSS DETAIL

- A pseudo-noise sequence pnt generated at the modulator is used in conjunction with an M-ary FSK modulation to shift the carrier frequency of the FSK signal pseudorandomly, at the hopping rate Rh
- The transmitted signal occupies a number of frequencies in time, each for a period of time Th (=1/Rh), referred to as *dwell time*
- FHSS divides the available bandwidth into *N* channels and hops between these channels according to the PN sequence
- The transmitted bandwidth is determined by the lowest and highest hop positions and by the bandwidth per hop position

TYPES OF FHSS

- **Slow hopping:**
  - The symbol rate Rs of MFSK signal is an integer multiple of the hop rate Rh. That is there are several symbols on each frequency hop.

$$Rs=nRh$$

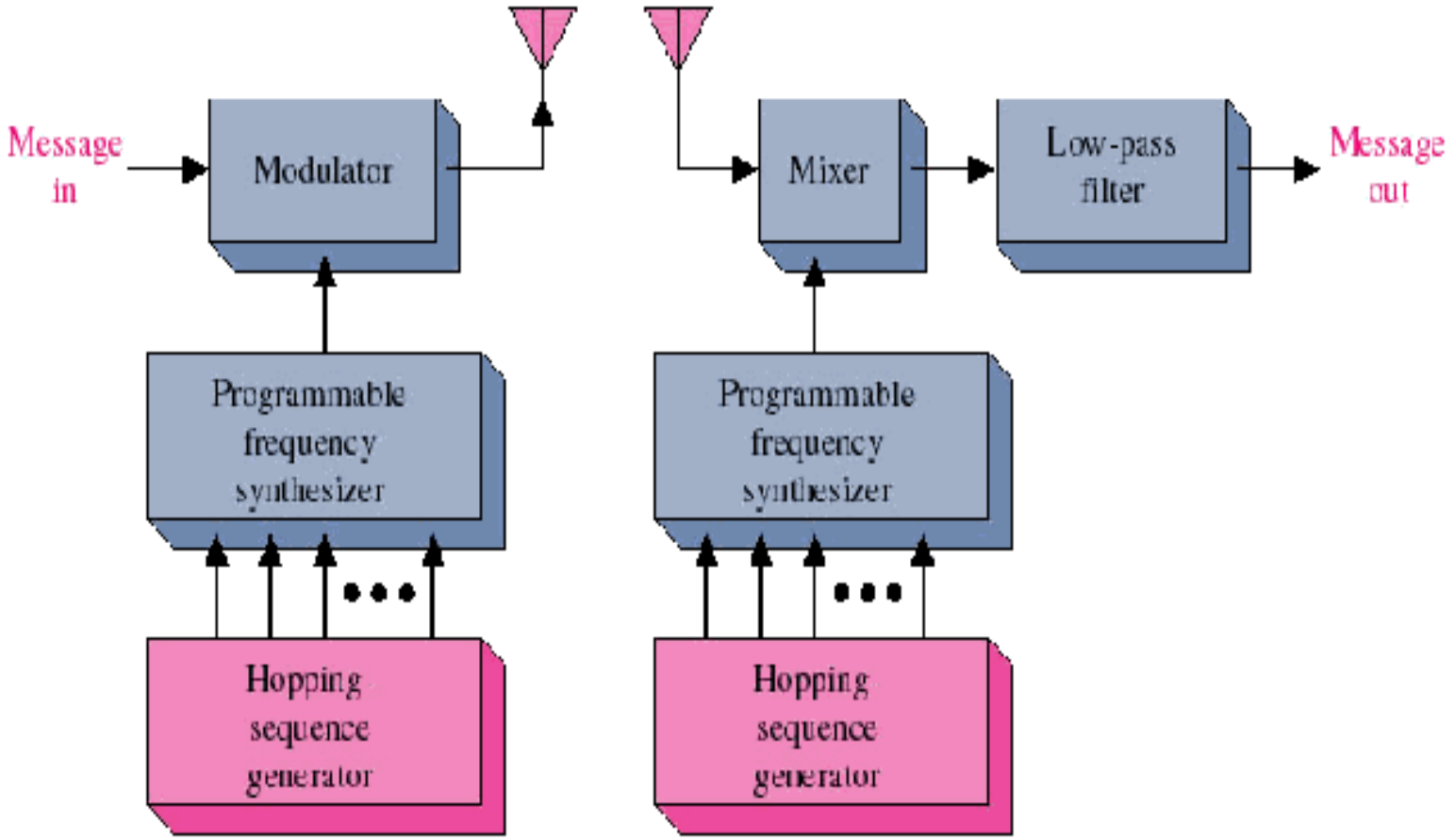
Where n is +ve

- **Fast hopping**
  - The hop rate is an integer multiple of the symbol rate of MFSK that is in one symbol frequency will hop several times

$$Rh=nRs$$

Where n is +ve

FHSS BLOCK DIAGRAM



FHSS (CONTD)

Advantages

- Provide the greatest amount of spreading.
- Can be arranged to avoid portions of the spectrum (i.e. those occupied by other systems or being the most affected by frequency selective fading)
- Have a relatively short acquisition time because the chip rate is considerably less in the frequency hopping system.
- It is not as much affected by the near far problem as DSSS is

Disadvantages

- Requires a complex frequency synthesizer in order to generate the hops
- Always requires error correction.
- Only the average power is spread; the narrowband interference is either eliminated completely or not reduced at all.

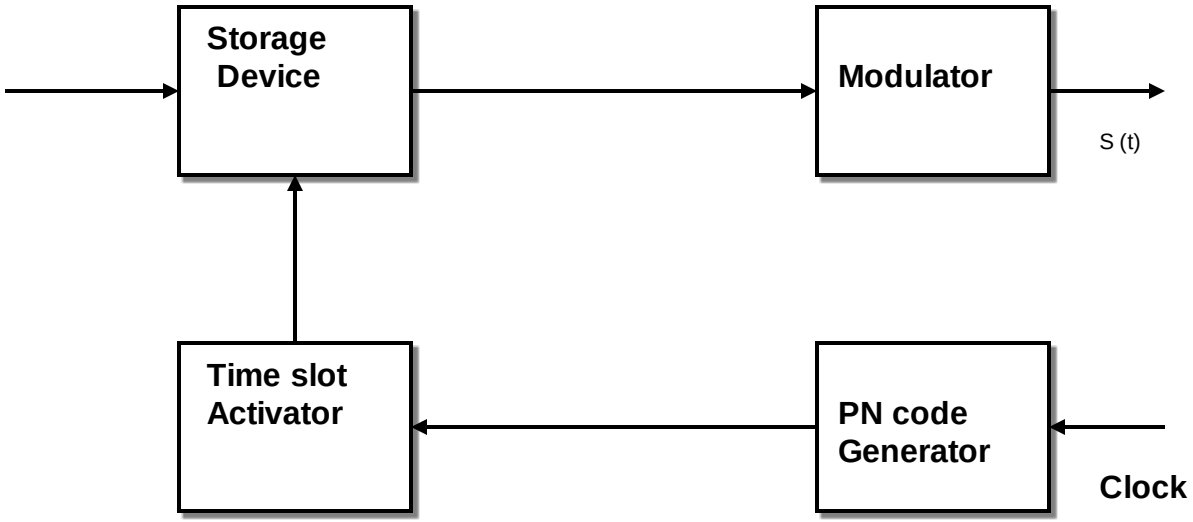
Time Hoping Systems

TSSS

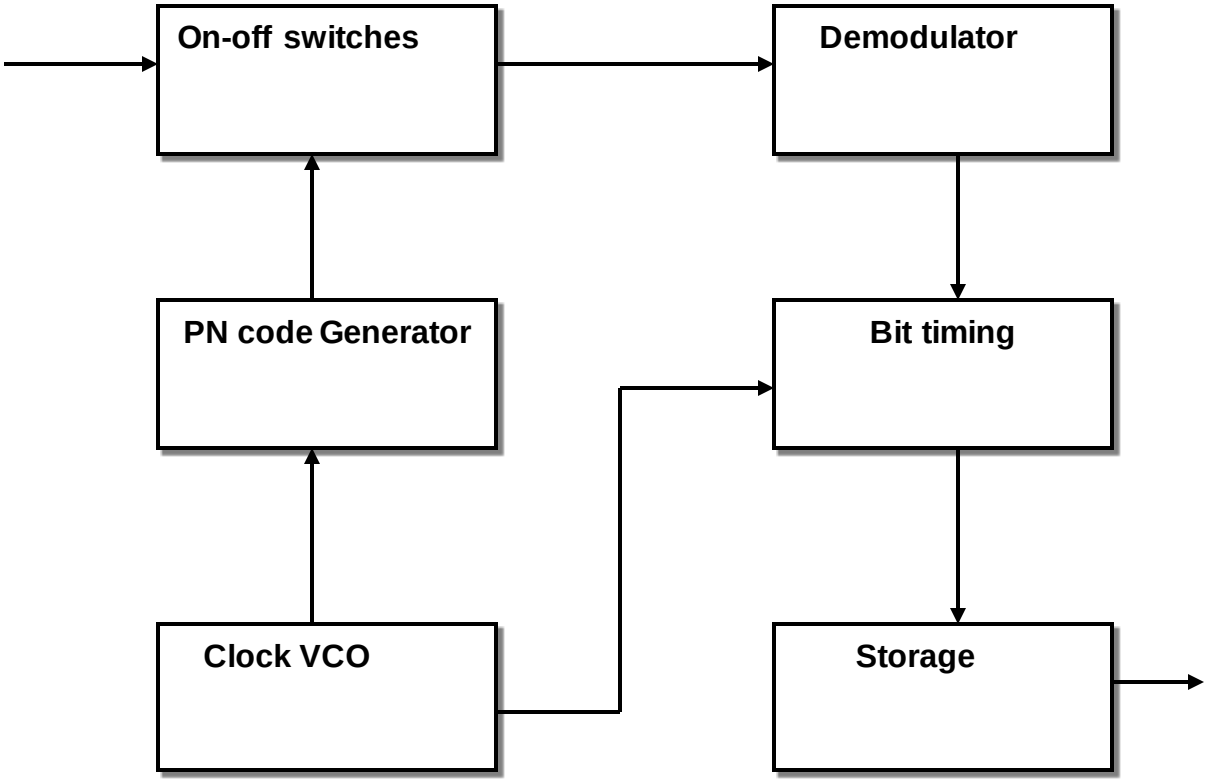
TIME HOPPING SYSTEMS

- A time hopping system is a spread spectrum system in which the period and duty cycle of a pulsed RF carrier are varied in a pseudorandom manner under the control of a coded sequence
- Time hopped spread spectrum systems have found no commercial application to date. However, the arrival of cheap random access memory (RAM) and fast micro-controller chips make time hopping a viable alternative spread spectrum technique for the future.
- Time hopping is a system in which burst signal are initiated at pseudo random rate. In this the transmitter is switched ON and OFF by a code sequence. The main difference between a frequency hopping and time hopping system is that in the former the transmitted frequency changes at each code chip time in the later the frequency changes occurs only at zero/ one transitions in the code sequence.

TRANSMISSION OF THSS



THSS RECEIVER



THSS (contd)

- **Advantages**
  - Has a high bandwidth efficiency as compared to FH and DSSS.
  - Its implementation is simpler than that of FHSS
  - Near-far problem can be avoided in a coordinated system
- **Disadvantages**
  - Has a very long acquisition time.
  - Also requires error correction

Hybrid Techniques

FHSS+THSS

HYBRID TECHNIQUES

- Hybrid systems use a combination of spread spectrum methods in order to use the beneficial properties of the systems utilized. Two common combinations are direct sequence and frequency hopping. The advantage of combining the two methods is to capitalize on characteristics that are not available from a single method.