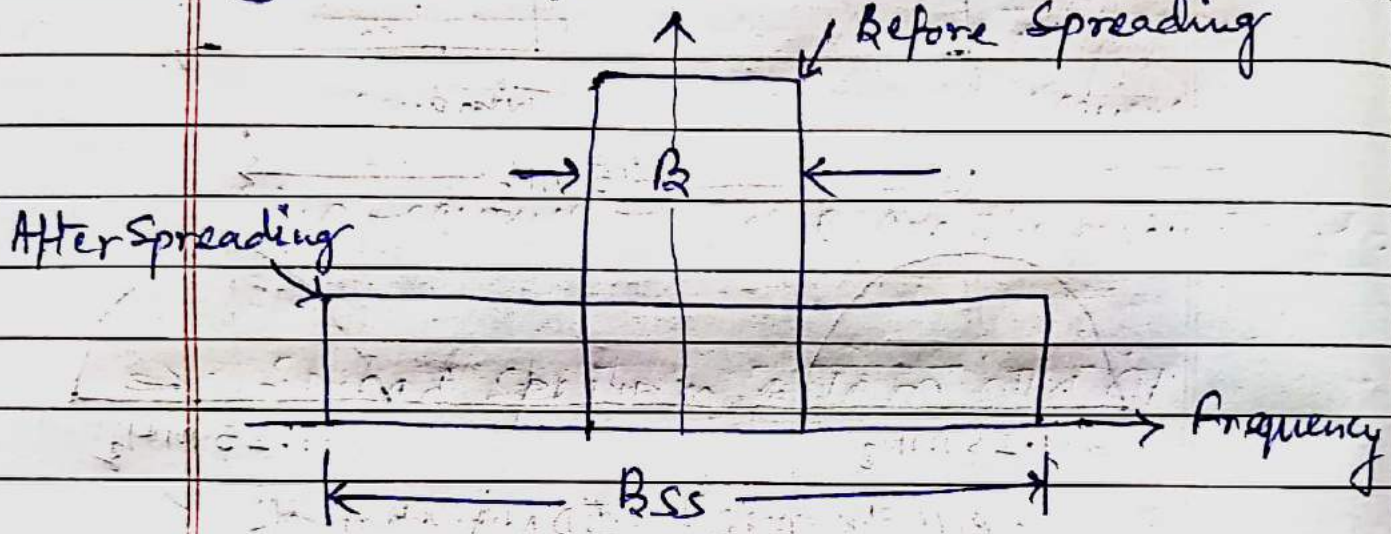
# Spread Spectrum Multiple Access (SSMA) →

Spread spectrum Technique में Transmit की गई Information Signal की Bandwidth को higher frequency सिग्नल Codes को inject कर spread Bandwidth को spread कर दिया जाता है इससे Bandwidth 10 से 100 गुना तक बढ़ जाती है।




$B_{ss} \gg B$

Spreading factor/Processing gain $L = \frac{B_{ss}}{B}$

For Analog Spreading

For Digital Signal Spreading $L = \frac{T_b}{T_c}$ ← Bit Duration, ← Chip Time

BW Spreading के लिए Code Techniques प्रयोग की जाती है - जैसे

Pseudo Noise Sequence or Pseudo Random Sequence

(PN) (PRN)

BW Utilization को प्राप्त करने के लिए

- Multiplexing
  - FDM
  - TDM
  - CDM
  - WDM
- Multiple Access Scheme
  - FDMA
  - TDMA
  - CDMA → SS used
  - SDMA
  - IDMA

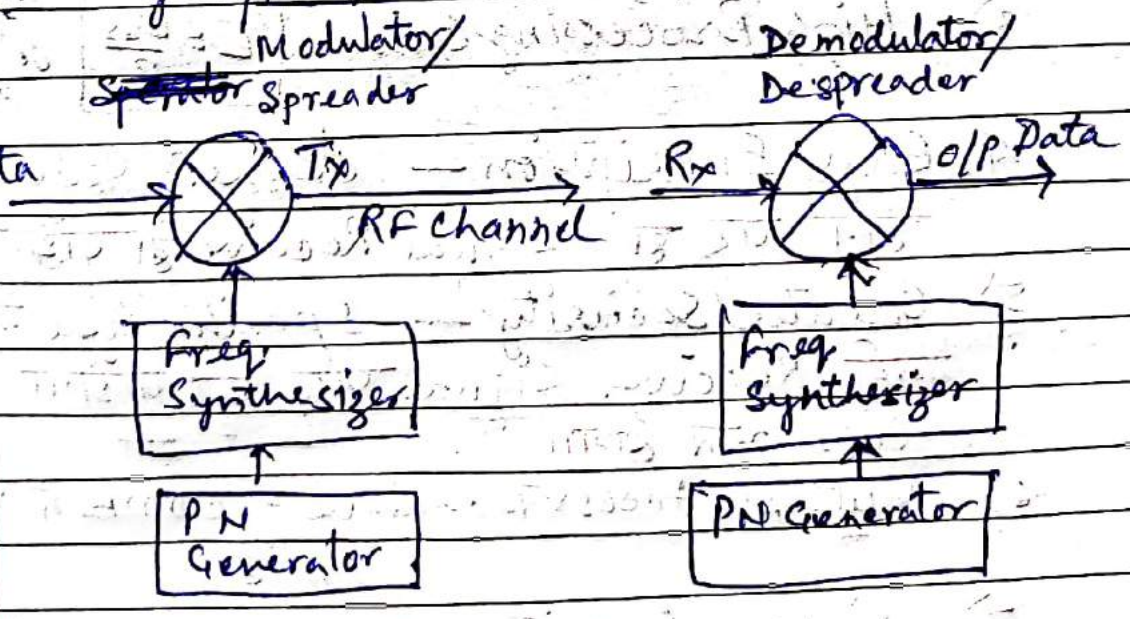
FDMA तथा TDMA में निम्न Drawbacks थे।

1) Concentrated spectrum के कारण इसमें Data को easily Detect कर Hack करने की संभावना अधिक थी।

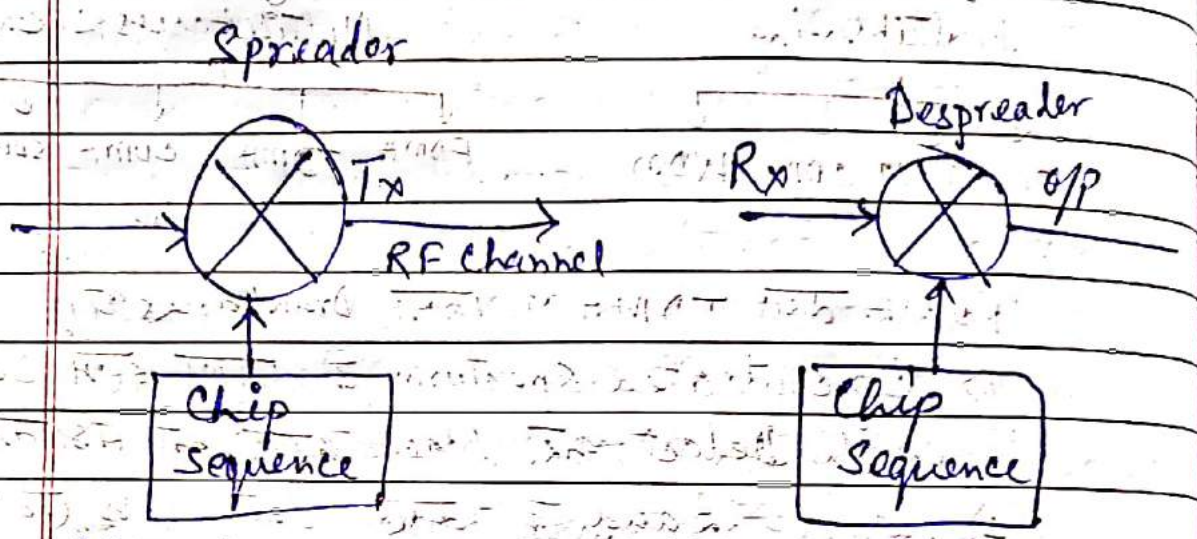
2) Narrow Band के कारण data loss एवं Jamming की संभावना अधिक है।

उक्त Draw Backs को समाप्त करने के लिए CDMA में SS Technique प्रयुक्त की, इन Draw Backs को दूर किया गया।

⇒ Analog I/P signal Spread Spectrum Block Diagram



⇒ Digital I/p signal SS Block Diagram




Chip Sequence → These are the modulator codes

⇒ Spread spectrum के लिए लाभ हैं

1) Immunity to Jamming
2) Low Interference
3) High Processing Gain $L = \frac{B_{ss}}{B}$ or $L = \frac{T_b}{T_c}$
4) Easy Encription — desired Code ज्ञात होने पर ही signal Receive हो पायेगा।
5) Greater Security — Specific Code के कारण वही Receiver signal प्राप्त कर पायेगा जिसे Code ज्ञात होगा।
6) Multiple Access Technique - CDMA में प्रयोग किया जाता है
7) Channel Capacity Increase - capacity C =

$\therefore C = B \log_2 \left[1 + \frac{S}{N}\right]$

Bandwidth (B) higher होती है तब capacity C भी अधिक होती है

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⇒ Spread Spectrum Principles:—
These following properties are needed for a signal to be spread spectrum Modulation —

1) The signal occupies a bandwidth much larger than is needed for the information signal.

2) The spread spectrum modulation is done using a spreading code, which is independent of the data in the signal.

3) De-spreading at the receiver is done by corelating the received signal with a synchronized copy of the spreading code.

⇒ Basically two type of spread spectrum techniques are used —

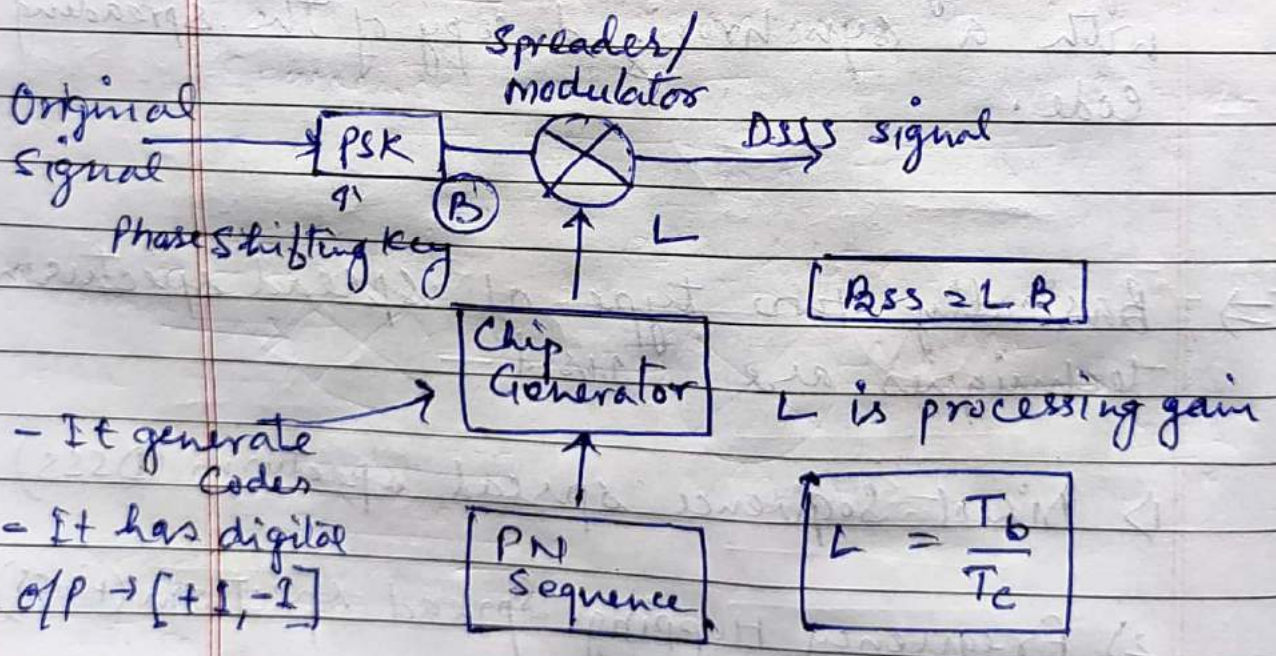
1) Direct Sequence spread spectrum (DSSS)

2) Frequency Hopping Spread spectrum (FHSS)

## ⇒ DSSS →

The digital Data is directly coded at a much higher frequency. The code is generated pseudo randomly (PRN), the receiver knowns how to generate the same code and correlates the received signal with that code to extract the data. BPSK (Binary Phase Shift Keying) is widely used Digital Modulation scheme fo spread spectrum systems.

→ BER (Bit Error Rate) को [illegible] (Decrease) Bandwidth चौड़ा करने के लिए DSSS को उपयोग किया जाता है (Over FHSS)




### Block Diagram of DSSS

Ques - Original I/P signal is 101 and spreading code is 01011 Then the O/P waveform to be transmitted

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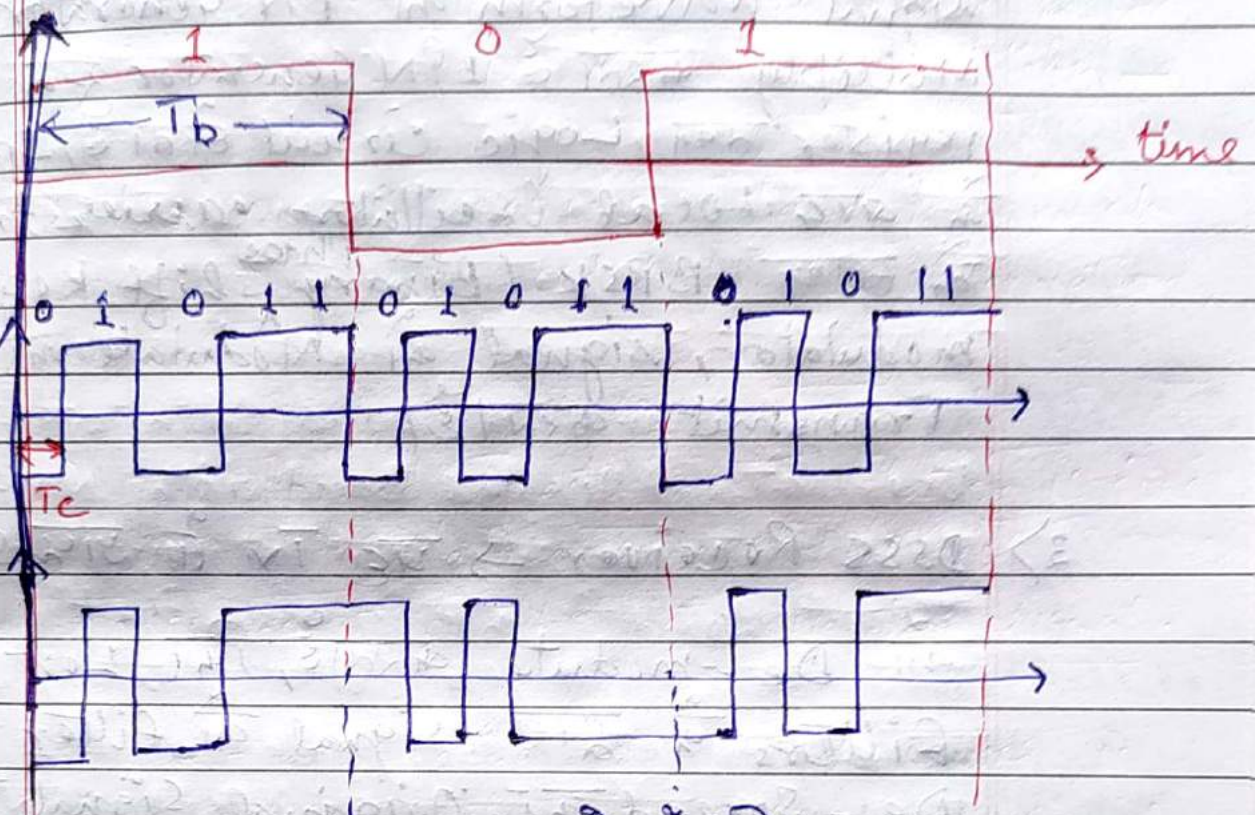
## Waveforms of DSSS




D/P code पाने के लिए X-NOR ing करते हैं I/P signal और Spreading code की, उपरोक्त waveform से स्पष्ट होता है कि Bandwidth spreading करती है।

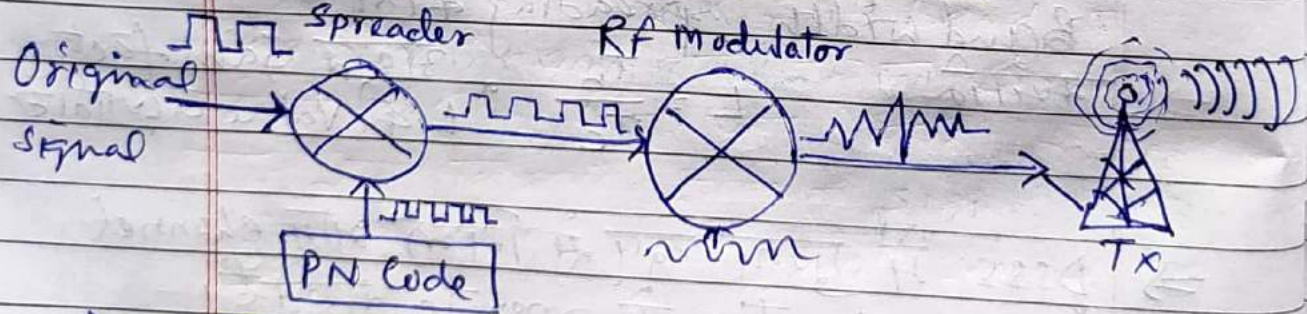
क्योंकि $L = \frac{T_b}{T_c}$ ; अर्थात Gain factor L की value बढ़ जाती है

⇒ DSSS में मुख्य रूप से निम्न आठ channel को एक Direction में operate कराते हैं।

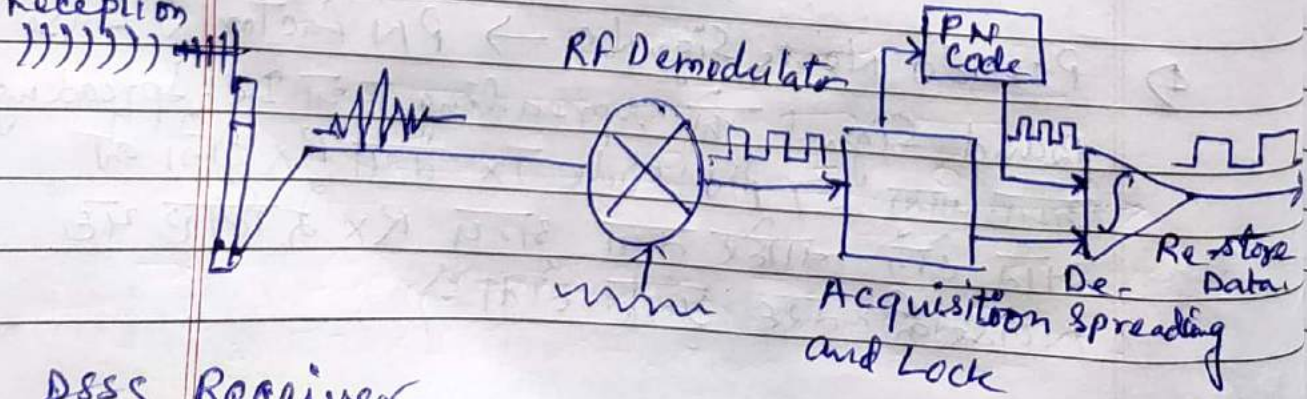
1) Pseudo Noise Signals → PN factor से Base Band Signal को spreading तथा De-spreading किया जाता है। PN code Tx तथा Rx दोनों को ज्ञात होने चाहिए तथा अन्य Rx के लिए यह Noise की तरह प्रतीत होता है।

2) Dsss Transmitter → यह Base Band signal waveform को PN Generator से Multiply करता है। PN Generator एक Shift register तथा Logic circuit होता है। Spreading के बाद Local Oscillator carrier freq. के साथ BPSK (Binary Phase Shift Keying) modulator, signal को Modulate करके Transmit करता है।

3) Dsss Receiver → यह Tx से प्राप्त Signal को De-modute करता है, फिर Low pass Filters के द्वारा signal को filter करके De-Spread कर 'Original Signal प्राप्त किया जाता है। Receiver End में PN Sequence Code, Tx में PN sequence code एक समान होने चाहिए।




DSSS Transmitter




DSSS Receiver

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Processure —

⇒ Signal Transmission steps →

1) A Pseudo Random Code generated, different for each channel and each successive connection.
2) The Information data Modulates the Pseudo-random Code (The Information data is 'Spread')
3) The resulting signal modulates the carrier.
4) The modulated Signal ~~Modu~~ is amplifies & broadcast.

⇒ Signal Reception Steps →

1) The carrier is received and amplifies.
2) The received signal is mixed with Local carrier to recover the spread digital signal.
3) A Pseudo random code is generated, matching the anticipated signal.
4) The receiver acquires the received code and Phase Locks its own code to it.
5) The received signal is correlated with the generated code, extracting the information data.

⇒ Advantages

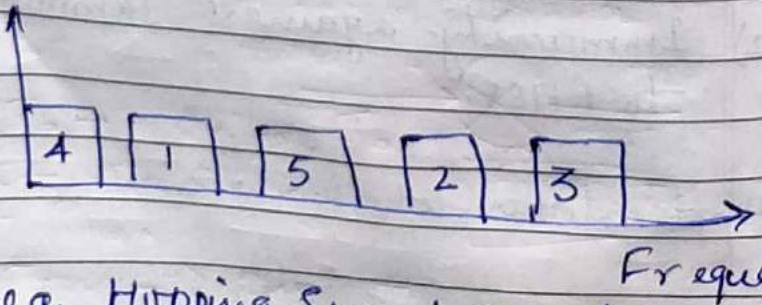
1) Better Security.
2) Immunity against Jamming compared to FHSS.

⇒ Applications of DSSS →

CDMA — 2G
— 3G.

## ⇒ Frequency Hopping Spread spectrum (FHSS)

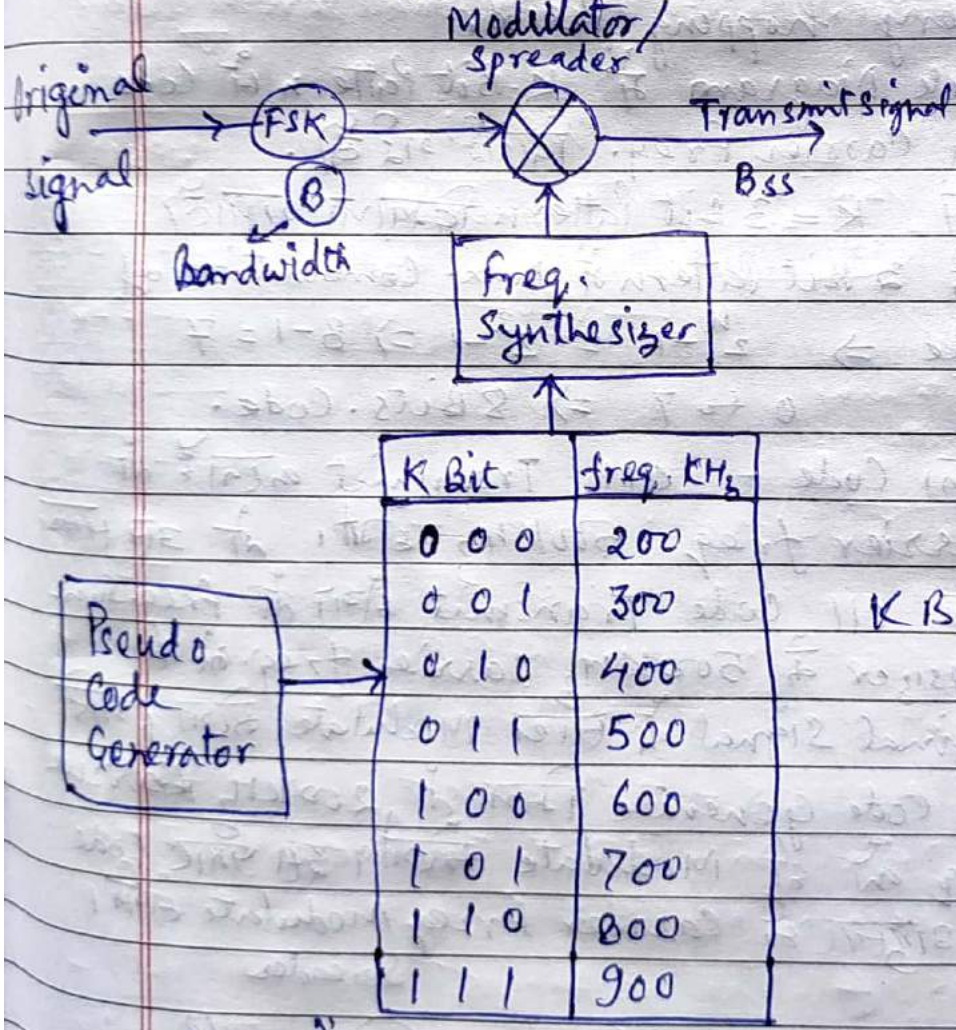
FHSS में प्रत्येक Bit Code के लिए अलग-2 carrier Freq allotted होती हैं। इस प्रकार User का Voice Signal एक Carrier से दूसरे Carrier में जम्प (Hop) करता है। Total N Hoping के पश्चात् यह चक्र Repeat होता है। यदि Original Signal की Bandwidth B है तब User को Allocated Bandwidth N×B होगी। FHSS में Transmitter तथा Receiver allot की गई Band के क्रम में agree होते हैं। माना प्रथम Bit (group of Bits), Sub Band-1 पर तथा दूसरा Bit, Sub Band-2 पर Transmit किया जाता है तो intruder (अनधिकृत व्यक्ति) अपने Receiver को Sub-Band-1 पर tune करता है तथा signal Receive करता है परन्तु दूसरा Sub-band प्राप्त नहीं कर पाता है क्योंकि दूसरे Sub Band की carrier Freq अलग होने पर Signal किस Carrier पर प्राप्त होगा, Intruder को ज्ञात नहीं होगा, इसलिए signal Hack नहीं हो पाता है तथा ज्यादा secure होता है।




Freq. Hopping Spread Spectrum.

प्रत्येक SubBand पर दाय समय (call time), 400 ms अथवा अधिक होता है प्रत्येक Carrier Frqu. (or Subband) का selection PN Sequence द्वारा किया जाता है Receiver पर Same PN Code Apply कर Signal को De-hop कर original Signal प्राप्त किया जाता है

⇒ Block Diagram of FHSS →

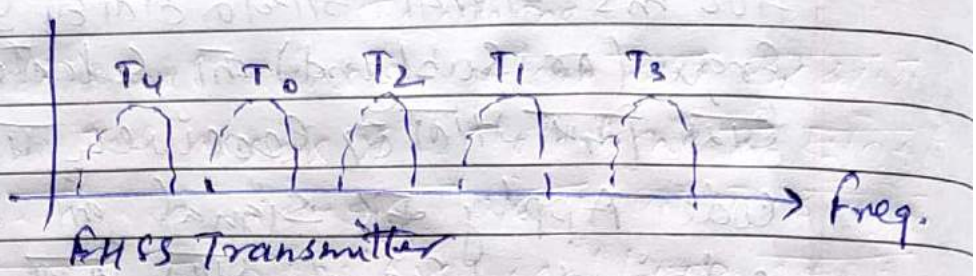



| K Bit | freq. KHz |
|---|---|
| 0 0 0 | 200 |
| 0 0 1 | 300 |
| 0 1 0 | 400 |
| 0 1 1 | 500 |
| 1 0 0 | 600 |
| 1 0 1 | 700 |
| 1 1 0 | 800 |
| 1 1 1 | 900 |

Pseudo Code Generator → K Bit pattern Generator.

FHSS में माना Total N No. of Carrier freq. हैं। तो Original Signal की Bit एक समय में एक Carrier Frqu. के साथ Modulate करेंगे तथा दूसरे ही क्षण इसी Signal Bit के साथ अलग Carrier freq. Modulate करेंगे तथा Transmit भी करेंगे इसप्रकार अलग-2 Carrier Freq., Signal code के अनुसार Jump

करेगी। जैसे




A Pseudo random Generator called PN, Suppose it creates a K-Bit Pattern for every hopping Period.

Block Diagram में K-Bit Pattern से Code तथा Carrier Freq. दिखाई गई है।

इसमें K = 3 Bit Pattern दिखाया गया है।

यदि 3 Bit Pattern में max. Combination of Code ⇒ $2^K - 1 = 2^3 - 1 \Rightarrow 8 - 1 = 7$

0 to 7 ⇒ 8 Bits. Code.

माना Code - 011 Transmit करना है तो carrier freq 500KHz होगी। तो उस समय तब 011 code Transmit होगा तो Freq. Synthesizer से 500KHz carrier freq को ही Original Signal के साथ Modulate करेगा। यदि 000 Code generate किया तो 200KHz Carrier freq को ही Modulate करेगी। इसी प्रकार Code के अनुसार ही Carrier Freq. Modulate होगी।


If,

Tc ≤ Tb → Fast Hopping

Tc ≥ Tb → Slow Hopping

⇒ Applications - 1) Bluetooth

2) JTRS (Joint tactical Radio system).

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## ⇒ Comparison of FDMA/TDMA/CDMA

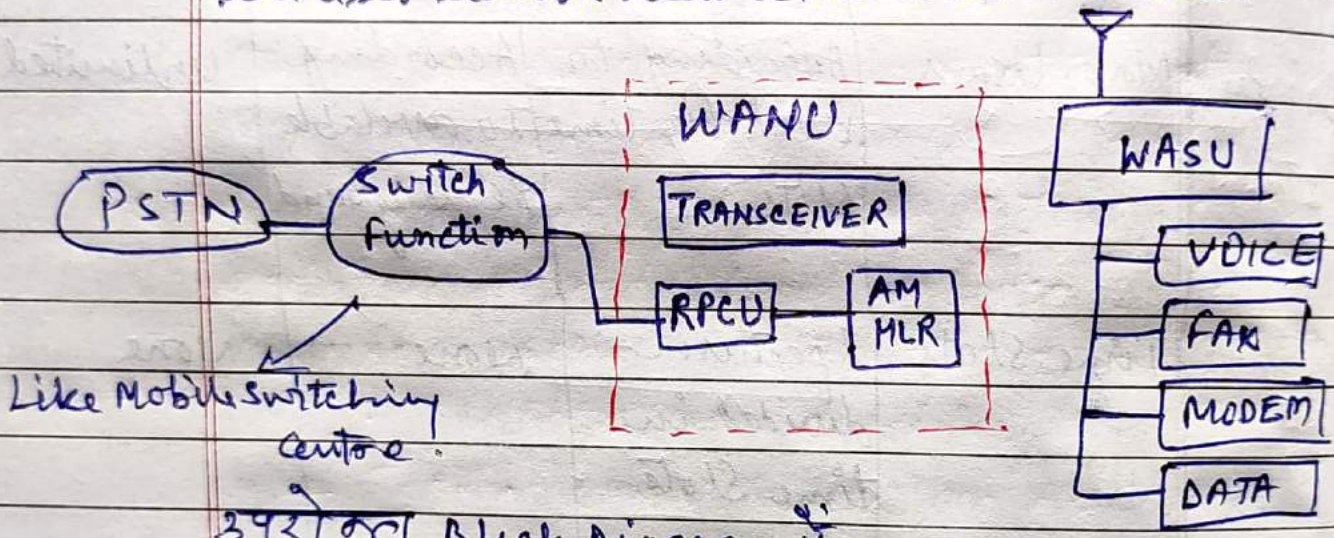
| Multiple Access Characteristics | TDMA | FDMA | CDMA |
|---|---|---|---|
| Spread Specturm | NO | NO | Yes (Orthogonal Code) |
| frequency | Constant | Assigned Per User | Constant |
| Max. Users | According to avilable time slots | According to avilable frequency band | Unlimited |
| Time slots | Specturm divided in time Slots | None | None |
| Idle channels | Vacant channels | None | None |
| Duplexers | Not Needed | Needed both in base stations and User equipment | Need in both in base station and user equipment. |

# ⇒ INTRODUCTION OF WLL

Telephone

Traditional wired system द्वारा दूरदराज या isdated areas में telephone की सुविधा देना एवं रख रखाव बहुत महँगा होता था। इसलिए इस तकनीक को Wireless Local Loop तकनीक द्वारा Replace किया गया।

WLL is a two way communication service to a user station near a small service area.




उपरोक्त Block Diagram में –

→ WANU (Wireless Access Network Unit) - यह Telephone Exchange में होता है जिसमें RPCU (Radio Packet Control Unit) Signal Controlling के लिए होता है तथा AMHLR → Data base है जिसमें Subscriber की Detail Data रहता है Transceiver, Transmit तथा Receive करता है।

→ WASU (Wireless Access Subscriber Unit) – यह Subscriber के घर में Instal होता है जिसे Antenna जो Signal Receive तथा Transmit किया जाता है।

Features – Audio Services, Audio Data Service via Modem, Fax Service.

Adv – → Reduce operating and maintenance cost.

→ Technology is available in both downtown and remote and isolated areas.

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There are four type systems.

1) Satellite-Based Systems :→ These systems provide telephony services for rural communities and isolated areas such as islands. Satellite systems are designed for a Gaussian or Rician channel with K factor greater than 7 dB. These systems can be of two types - Technology designed specifically of WLL applications and technology piggy backed onto mobile satellite system as an adjunct service of these.
The former offers quality and grade of service compared to wireline access, but it may be expensive.
The later promises to be less costly but, due of bandwidth restrictions, may not offer the quality and grade of service comparable to plain old Telephone service (POTS).
An example of a satellite based technology specifically designed for WLL is the telephone Earth Station (TES) technology.

Advantages :→
* Low Bit Rate of voice and data.
* Low Cost Mobile terminals.
* It provides quality and grade service for WLL applications.

Disadvantages → (1) The number of satellites and propagation delay put restrictions on the system design.
(2) Handover capability is needed.

⇒ (a) CELLULAR BASED SYSTEM –

These systems provide large power, large range, median subscriber density, and median circuit quality WLL services. Cellular WLL technologies are primarily used to expand the basic telephony services.

This approach offers both mobility and fixed wireless access from the same cellular platform.

For relatively sparsely populated rural and even urban settings, WLL technologies based on existing cellular systems can be economical and rapidly deployable. They include much sophisticated technology (and therefore overhead bandwidth) not necessarily required for the WLL application. The resultant limited user bandwidth represents a fundamental limitation of such systems for WLL.

Advantages —

1) They provides fixed wireless ~~and~~ access and mobility.
2) They can be rapidly deployed in rural and urban area.
3) They provide large power and operating range.
4) They provide medium circuit and medium subscriber density.

Disadvantages —

1) They are not recommended for deployment indoors and in picocells.
2) Air Interface is complex.
3) The user bandwidth is limited.

→ FIXED WIRELESS SYSTEM — These systems are proprietary radio systems designed specifically for fixed wireless applications, which may or may not be extensible to PCS or cordless.
The primary disadvantage of the cellular approach is its limitation on toll quality voice (new toll quality vocoders designed for cellular technologies may eliminates this problem.), and signaling transparency.
FWA (Fixed Wireless Access) systems for zonal areas are designed to cover the local telephone area directly from the PSTN switches. The systems for rural areas provide connection at the remote ends of rural links to the end users.

→ Advantages — (1) Less expensive.
(2) It can be easily installed.
(3) The installation time need is less.

Disadvantages —

Limitation of toll quality and signaling transparency.

## MICRO CELLULAR-BASED SYSTEMS:—

These systems provide low power, small range, high subscriber density and high circuit quality WLL services. These technologies are considered to facilitate rapid market entry and to expand the capacity of the existing infrastructure.
They are typically operated at 800 MHz, 1.5 GHz, 1.8 GHz and 1.9 GHz frequency bands compared with the cellular based WLL, more base stations are required to cover the same service area. Operators may consider Low-Tier WLL technologies when an existing infrastructure is in place to support backhaul.
For densely populated urban environments, WLL technologies based on existing low-tier PCS radio technologies.

Advantages — 1) High subscriber density.
2) Low power
3) High circuit quality.

Dis-advantages —
Transmission cost is more.

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## ⇒ Comparison of 1G to 5G Technology.

| GENERATION | SPEED | TECHNOLOGY | KEY FEATURES. |
|---|---|---|---|
| 1G (1970-1980s) | 14.4 Kbps | AMPS, NMT, TACS | Voice Services only. (Analog Switching) |
| 2G (1990-2000) | 9.6/14.4 Kbps | TDMA, CDMA (called GSM.) | Voice & Data Service SMS, Lower data Rate Internet, Roaming (Digital switching) |
| 2.5G to 2.75G (2001 to 2004) | 171.2 Kbps 20-40 Kbps | GPRS | Voice, Data, Mobile internet and email Services. |
| 3G (2004-2005) | 3.1 Mbps 500-700 Kbps | CDMA2000, UMTS and EDGE | Voice, Data, Multimedia, Smart Phone applications, Faster web browing, Vedio calling and TV Streaming. |
| 3.5G (2006 to 2010) | 14.4 Mbps 1-3 Mbps | HSPA | All the services from 3G enhanced Speed and more mobility. |
| 4G (2010 Onwards) | 100-300 Mbps 3-5 Mbps 100 Mbps (Wi-Fi) | WiMAx, LTE and Wi-Fi | High speed, High Quality Voice, HD Multimedia, 3D Gaming, HD Video conferencing and World-Wide roaming. |
| 5G [Expected Soon] | 1 to 10 Gbps | LTE Advanced Schemes, OMA and NOMA | Superfast mobile internet low latency network for missing critical applications etc. |

AMPS → Advance Mobile Phone System.
NMTS → Nordic Mobile Phone Syetam.
TACS → Total Access Communication System
TDMA → Time Division Multiplexing Access. ] G.S.M
CDMA → Code Division Multiplexing Access. ]

GSM – Global System of Mobile Comm.
GPRS – General Packet Radio Services.

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UMTS – Universal Mobile Telecommunication System
EDGE – Enhanced Data GSM Evolution.
HSPA – High Speed Packet Access → Down Link
                                → Up Link
LTE → Long Term Evolution
WiMAX → Worldwide Interoperability for Microwave Access. (उच्चारण)
Wi-Fi → ~~Wireless~~ Wireless Fedelity (Wrong)
This is Phrase, a Brand name of IEEE 802.11 Standard.
OMA – Open Mobile Alliance
NOMA – Non orthogonal Multiple Access
ओमदीम