Fundamentals of IS-95
DS-CDMA System

- Spread Spectrum
- 코드(직교, PN Code)
- Power Control
- Capacity
- Link Structure

무선전송기술 고려사항

서비스 형태

음성,영상,데이타 전송속도

무선환경

사용 주파수 대역

셀형태(Mega, Macro, Micro, Pico)

요구용량

단말기 및 서비스 가격

Spread-spectrum Communication

A digital communication system is considered to be a SS system if :

the transmitted signal occupies a bandwidth that is larger than the minimum bandwidth required to transmit the information.

The bandwidth spread is accomplished by means of a code which is independent of the data.

Spread-spectrum Communication(cont.)

A major thrust in wide-spread development activity in small scale spread-spectrum networks came from the 1985 FCC ruling(part15) to allow low power unlicensed spread-spectrum radios in ISM (industry, Science, Medical)band. Table below lists the three ISM bands in 900, 2400 and 5700MHz frequency ranges.

Maximum allowed unlicensed power output in the ISM bands is limited to 10 mW and the minimum bandwidth, processing gain and hopping rates are specified.

Carrier frequencies	Bandwidth
902 ~ 928 MHz	26 MHz
2.4 ~ 2.4835 GHz	83.5 MHz
5.725 ~ 5.850 GHz	125 MHz

Spread Spectrum Principles

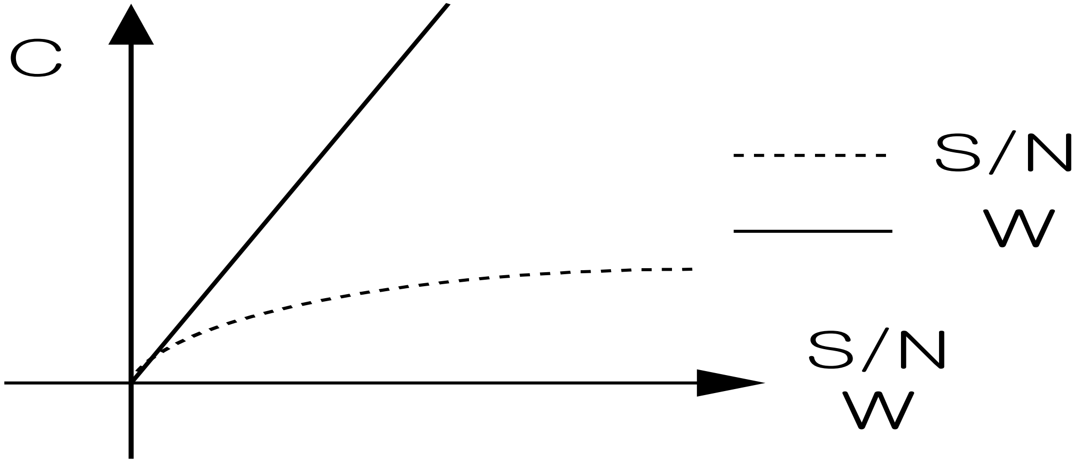
Shannon-Hartly Capacity Theorem

$$C = W \log_2 (1+S/N)$$

C = Capacity (>정보량)

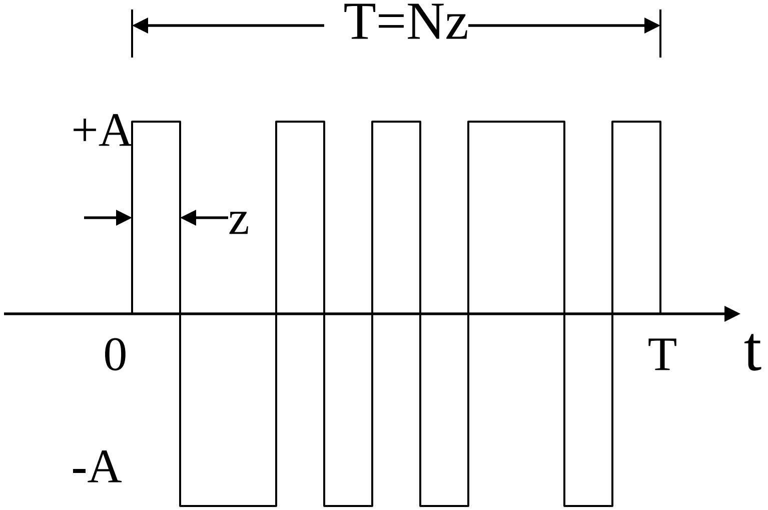
W = Bandwidth (전송대역폭)

S/N = Signal to Noise Ratio

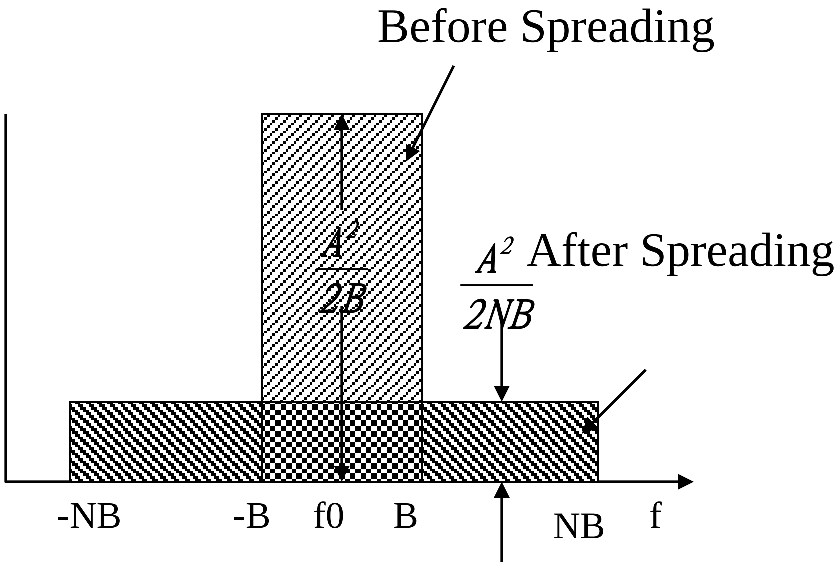


Shannon's Equation

Spread Spectrum Principles

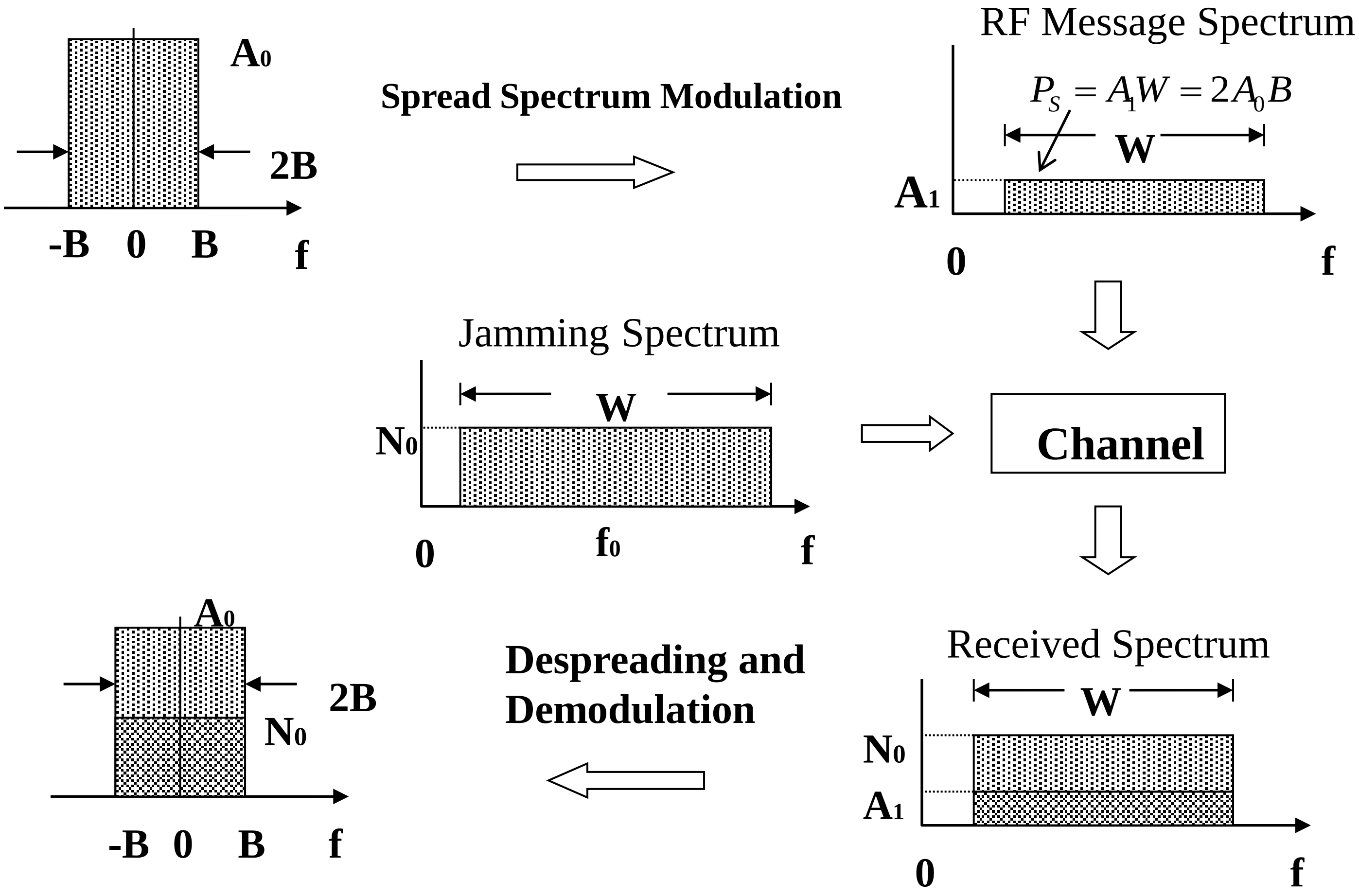


High- speed Pulses transmitted for a single information bit time duration of T seconds



Power Density Spectrum Before and After Spreading

Spread Spectrum Communication System



$$\left(\frac{S}{N}\right)_{data} = \left(\frac{2A_0B}{2N_0B}\right) = \frac{W}{2B}\left(\frac{S}{N}\right)_{SS}$$

$$\left(\frac{S}{N}\right)_{SS} = \frac{A_1W}{N_0W} = \frac{P_S}{P_1}$$

Processing Gain (PG)

$$PG = \frac{BW_{RF}}{R_{infor}} = \frac{Chip - Rate}{Data\ Rate}$$

$$= 10\log\left(\frac{B_{SS}}{B_I}\right)\ (dB)$$

ex) Information bit rate R = 9.6 Kbps

Information B.W B_I = 9.6 KHz

Each bit of 9.6 Kbps is coded by 128 chips

Chip rate = 1.2288 Mbps

Channel B.W B_{ss} = 1.2288 MHz

$$PG = 10\log\left(\frac{1.2288M}{9.6K}\right) = 21dB(128PG)$$

Jamming Margin

$$PG - [\underbrace{L_{sys}}_{\text{Sys. Implementation Loss}} + (S/N)_{out}] = M_j$$

Jamming : The Signal Produced by a jammed and intended to interfere with the reception of a desired signal

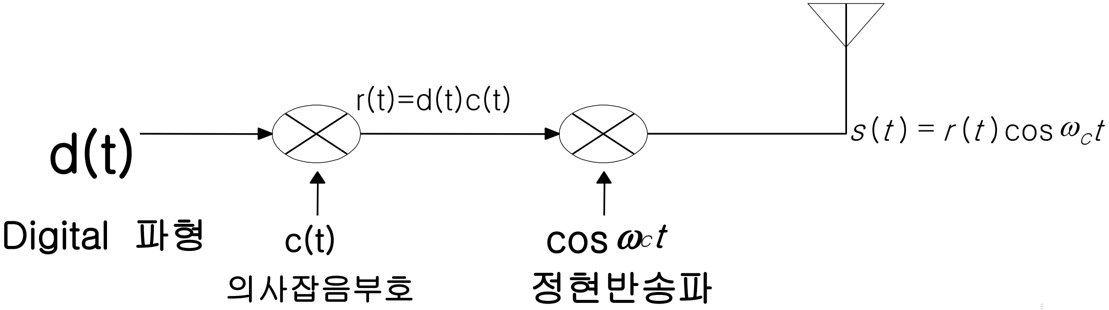
Jamming Margin : The amount of interference a system is able to withstand while producing the required output signal to noise or bit-error-rate

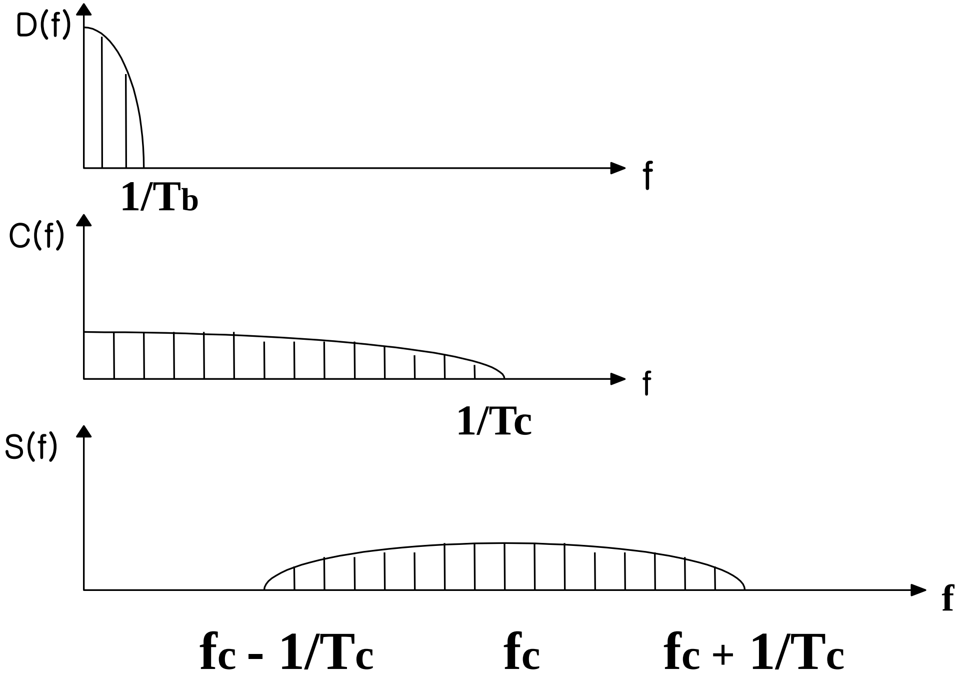
Assume) $PG = 30dB, \quad (S/N)_{out} = 10dB$

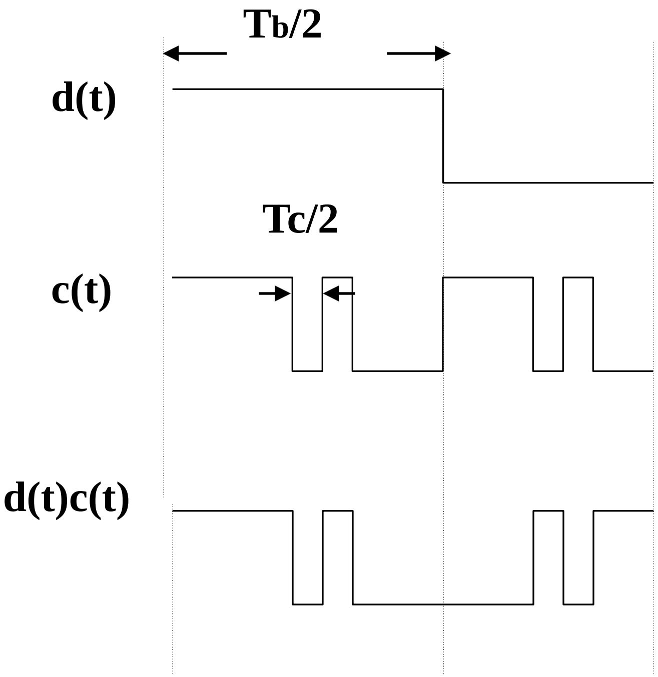
$$L_{sys} = 2dB \implies M_j = 18dB$$

==> it could not be expected to operate with interference more than 18dB above

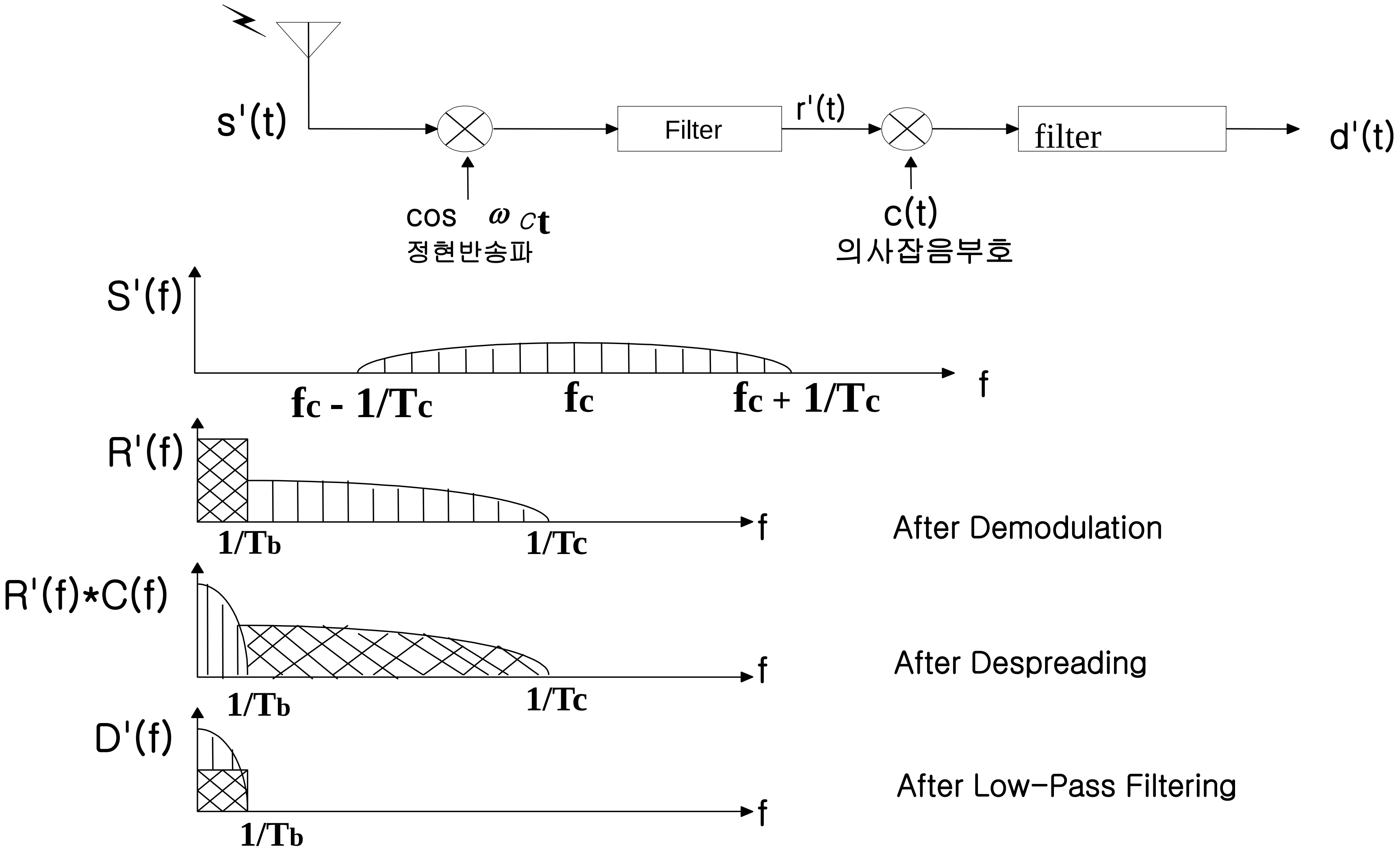
직접 시퀀스확산대역 시스템 구성도(송신단)







직접 시퀀스확산대역 시스템 구성도(수신단)



After Demodulation

After Despreading

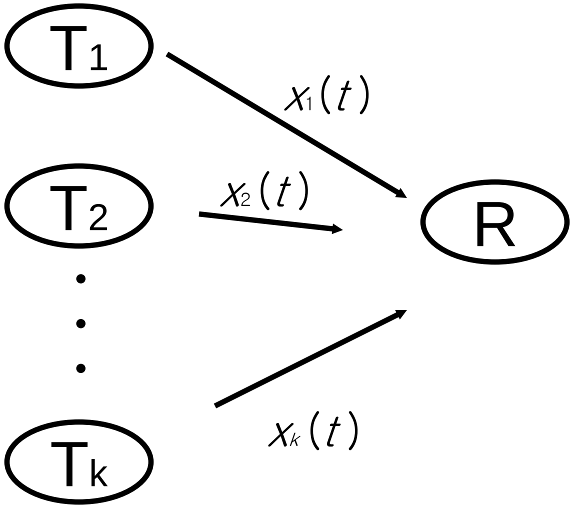
After Low-Pass Filtering

Spread Spectrum (Cont.)

- **Key Features of Spread Spectrum Signaling**

  1) Multiple Access : CDMA
  2) Anti-Jamming (강한 간섭신호에 강함)
  3) Anti-Multipath fading
  4) Difficulty of Detection by an Unauthorized Receiver : 정확한 동기와 코드 필수

Multiple Access (CDMA)

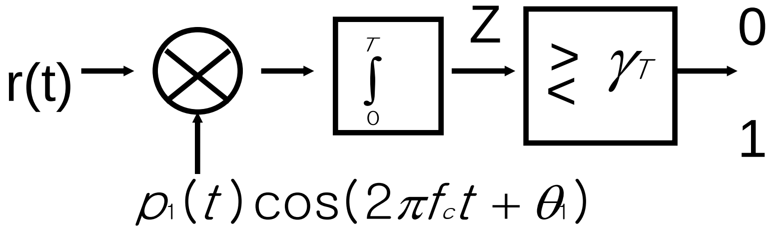


$$X_i(t) = A_i d_i(t) p_i(t) \cos(\omega_c t + \theta_i)$$

$$r(t) = \sum_{i=1}^{K} A_i d_i(t) p_i(t) \cos(\omega_c t + \theta_i)$$

Ignore the path delay for the moment

To detect the d1(t) :



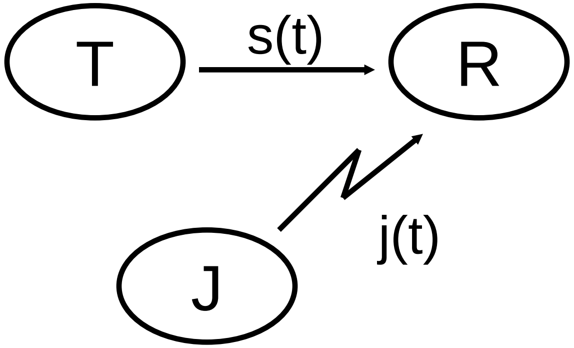
$$Z=\int_0^T A_1 d_1(t)\, p_1^{\,2}(t)\cos^2(2\pi f_c t+\theta_1)\,dt$$

$$+\sum_{k=2}^{K} A_k\int_0^T d_k(t)\,p_k(t)\,p_1(t)\cos(2\pi f_c t+\theta_k)\cos(2\pi f_c t+\theta_1)\,dt$$

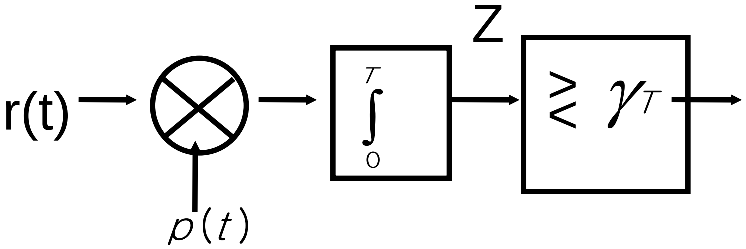
$$=\frac{1}{2}A_1 d_1 T+\frac{1}{2}\cos(\theta_k-\theta_1)A_k d_k\cdot\underbrace{\int_0^T p_k(t)\,p_1(t)\,dt}_{crosscorrelation\approx 0}$$

We need to use PN sequences having low cross-correlation

Anti-Jamming



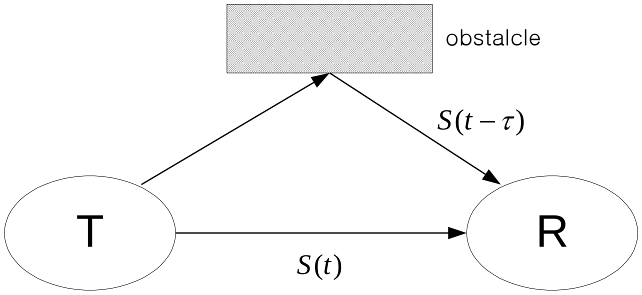
$$r(t) = Ad(t)p(t) + j(t) + n(t)$$



$$Z = \int_0^T Ad(t)\underset{\substack{\uparrow\\ \text{역확산}}}{p(t)}p(t) + j(t)\underset{\nwarrow}{p(t)} + n(t)\underset{\nearrow}{p(t)}dt$$

확산

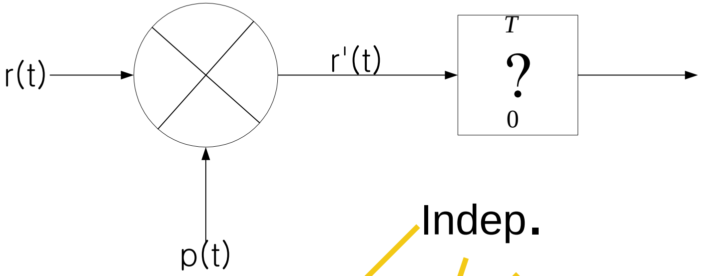
Anti-Multipath



$$s(t) = d(t)p(t)$$

$$r(t) = d(t)p(t) + \underline{d(t-\tau)p(t-\tau)}$$

$$= d_1(t)p_1(t)$$



The direct signal is despread by the local p(t) while the indirect signal is spread by p(t)

Indep.

$$r'(t) = d(t) + \underline{d_1(t)p_1(t)p(t)} \longleftarrow P_1 \;\&\; P \text{ are uncorrelated and } \tau > T_c$$

$$= d'(t)$$

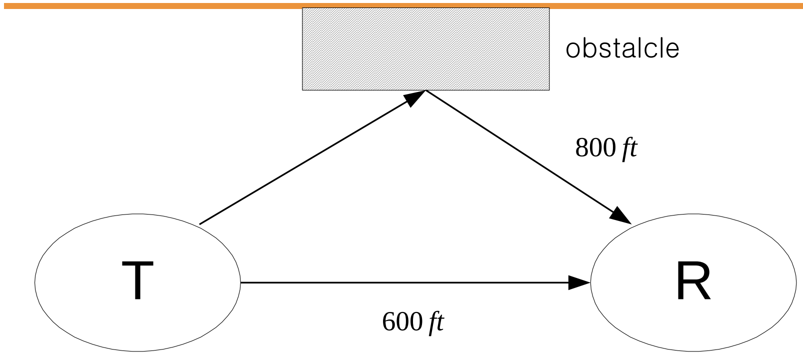
Anti-Multipath(cont.)

- To reject the indirect path components,

  We need $T_c < \tau$

- There is a method of combining the multipath components in a constructive way, so that the received SNR can be increased.(RAKE Receiver)

Anti-MultiPath Example



$$1\,ft = 0.3m$$

$$\frac{d[m]}{c[m/s]} = [\sec],\ \ c = 3\times10^{8}\,m/s$$

200ft separation ⟶ 200nsec time delay

In order to reject the multipath components, we need a chip duration Tc of less than 200 nsec

Tc < 200nsec

In general, we need a higher chip rate(more BW) to reject multipath components of smaller delay

Code in CDMA

- **Orthogonal Code**
  -IS-95에서는 Walsh Code
  - 순방향에서는 채널구분 확산용, 역방향에서는 신호 코딩
- **PN Code (Pseudo-random Noise) Code**
  - IS-95 에서는 Long Code, Short Code
  - W-CDMA에서는 Gold code
  - **Short code**는 기지국 구분용, **Long code**는 가입자구분
  - 단 역방향링크에서는 **Long code**가 채널구분확산코드

Orthogonal Code

Orthogonal functions have **zero correlation**.

Two binary sequences are orthogonal if the process of "XORing" them results in an equal number of 1's and 0's

ex)

0000

0101

0101

Generation of Orthogonal Codes

$$\underset{\text{SEED}}{0} \longrightarrow \begin{array}{c|c} 0 & 0 \\ \hline 0 & 1 \end{array} \longrightarrow \begin{array}{cc|cc} 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 1 \\ \hline 0 & 0 & 1 & 1 \\ 0 & 1 & 1 & 0 \end{array}$$

- Repeat
  - \- Right
  - \- Below
- Invert(diagonally)

Orthogonal codes(hardmard martrix)

1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
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1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1
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1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0
1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0
1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0	1
1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0	1
1	1	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0	1	1	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1
1	1	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0	1	1	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1
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1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0
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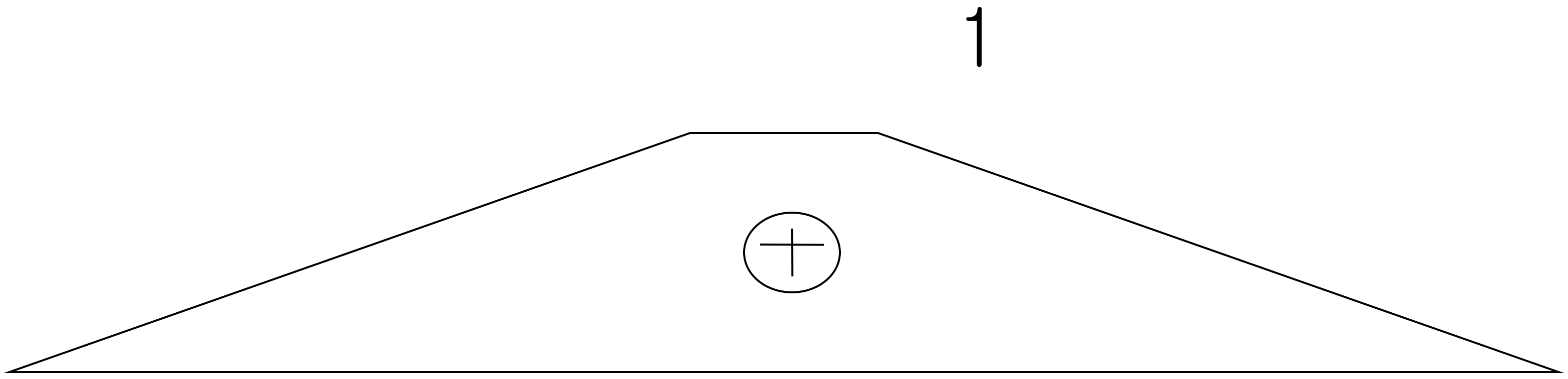
1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	1	1	0	0	1	1	0	0	1	1	0	0	1
1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	1	1	0	0	1	1	0	0	1	1	0	0	1
1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	0
1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	0
1	1	0	0	0	0	1	1	1	1	0	0	0	0	1	1	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0	0	1	1	1	1	0	0	1	1	0	0	0	0	1	1	1	1	0	0	0
1	1	0	0	0	0	1	1	1	1	0	0	0	0	1	1	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0	0	1	1	1	1	0	0	1	1	0	0	0	0	1	1	1	1	0	0	0
1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0
1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0
1	1	0	0	1	1	0	0	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	1	1	0	0	1	1	0	0	0	0	1	1	0	0	1	1	1	1	0	0	1	1	0	0	1	1	0	0	0	0	1	1	0
1	1	0	0	1	1	0	0	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	1	1	0	0	1	1	0	0	0	0	1	1	0	0	1	1	1	1	0	0	1	1	0	0	1	1	0	0	0	0	1	1	0
1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	1
1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	1
1	1	0	0	0	0	1	1	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0	1	1	0	0	0	0	1	1	0	0	1	1	1	1	0	0	1	1	0	0	0	0	1	1	1	1	0	0	0	0	1	1	0	0	1	1	1
1	1	0	0	0	0	1	1	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0	1	1	0	0	0	0	1	1	0	0	1	1	1	1	0	0	1	1	0	0	0	0	1	1	1	1	0	0	0	0	1	1	0	0	1	1	1

Orthogonal Spreading



1

⊕

0110011010011001100110010110011010011001011001100110011010011001

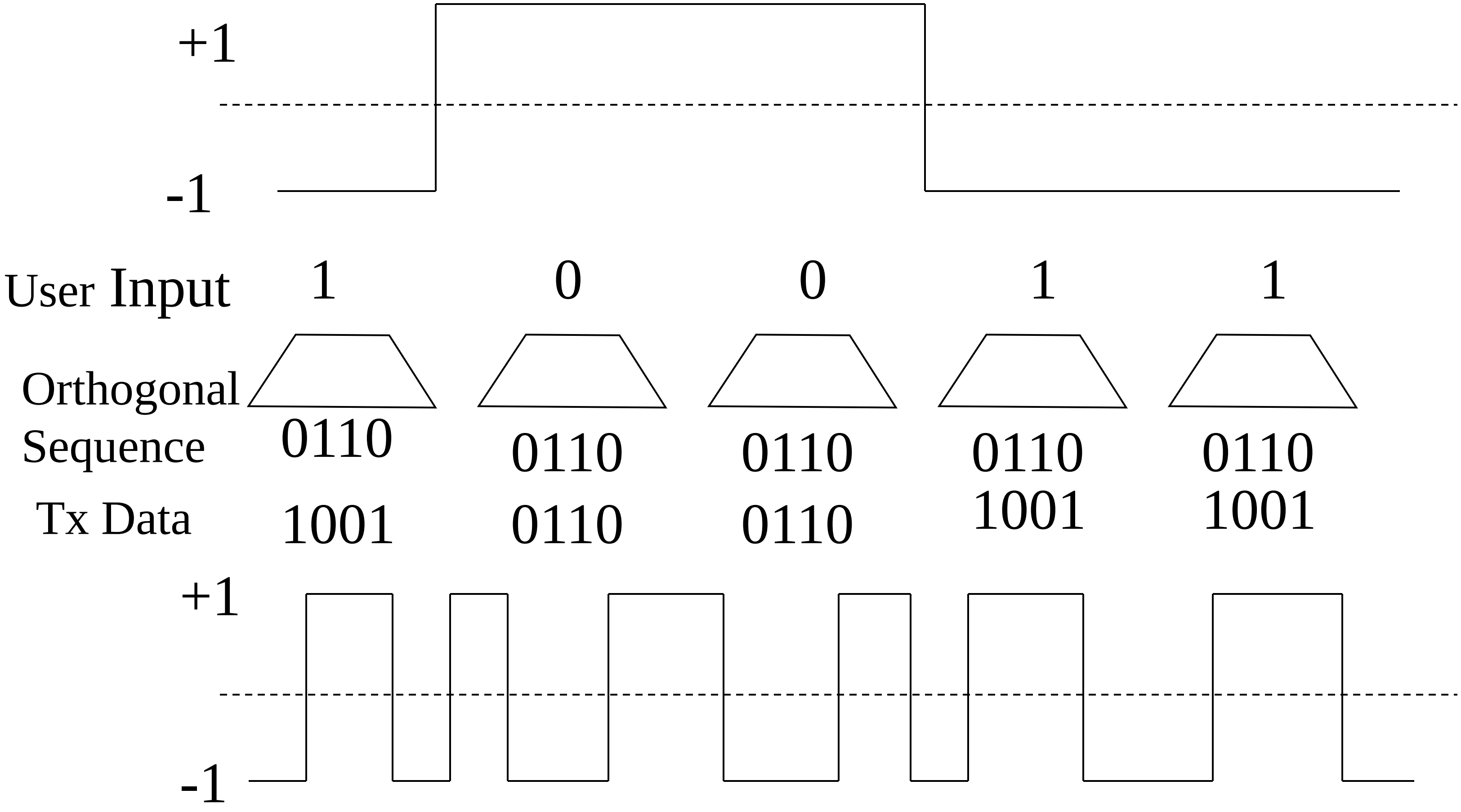
Walsh Function #59

1001100101100110011001101001100101100110100110011001100101100110

Pattern to be Transmitted

Figure 3-4 Orthogonal Spreading

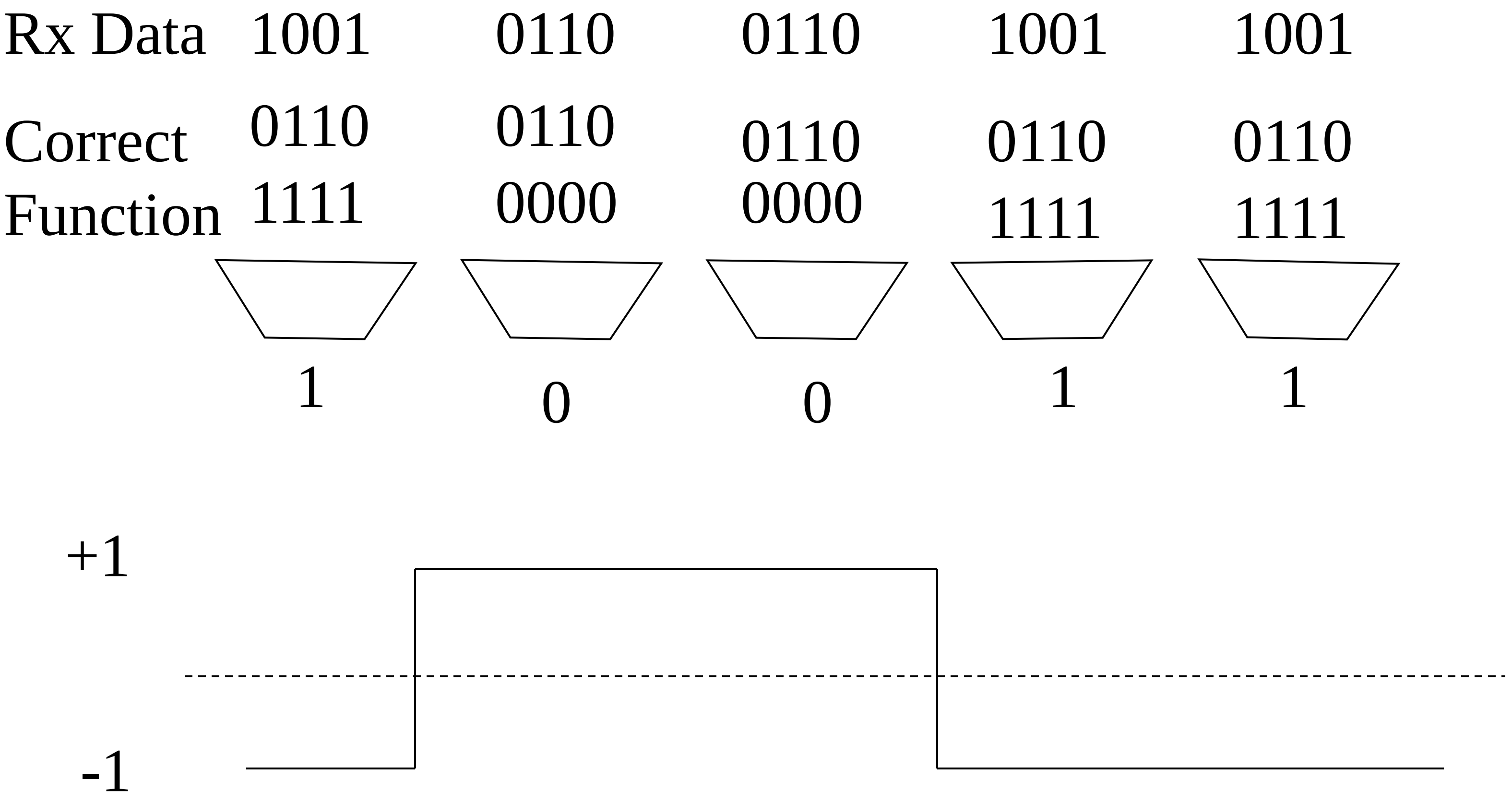
Example of Channelization



User Input	1	0	0	1	1
Orthogonal Sequence	0110	0110	0110	0110	0110
Tx Data	1001	0110	0110	1001	1001

Channelization Using Orthogonal Spreading

De-Spread (역 확산)



Rx Data	1001	0110	0110	1001	1001
Correct Function	0110 1111	0110 0000	0110 0000	0110 1111	0110 1111
	1	0	0	1	1

Recovery of spread symbols

PN Codes

- Two Short Codes($2^{15} = 32,768$)
  - Termed “I” and “Q” codes (different taps)
  - Used for Quadrature Spreading
  - Unique offsets serve as identifiers for a Cell or Sector
  - Repeat every 26.67msec
    (at a clock rate of 1.2288Mcps)

- One Long Code($2^{42} = 4400\ Billion$)
  - Used for spreading and scrambling
  - Repeats every 41 days
    (at a clock rate of 1.2288Mcps)

PN Code의 성질

(1) Maximal length : shift register의 개수가 r 인 경우
한 주기 동안의 시퀀스의 길이는 $2^r - 1$

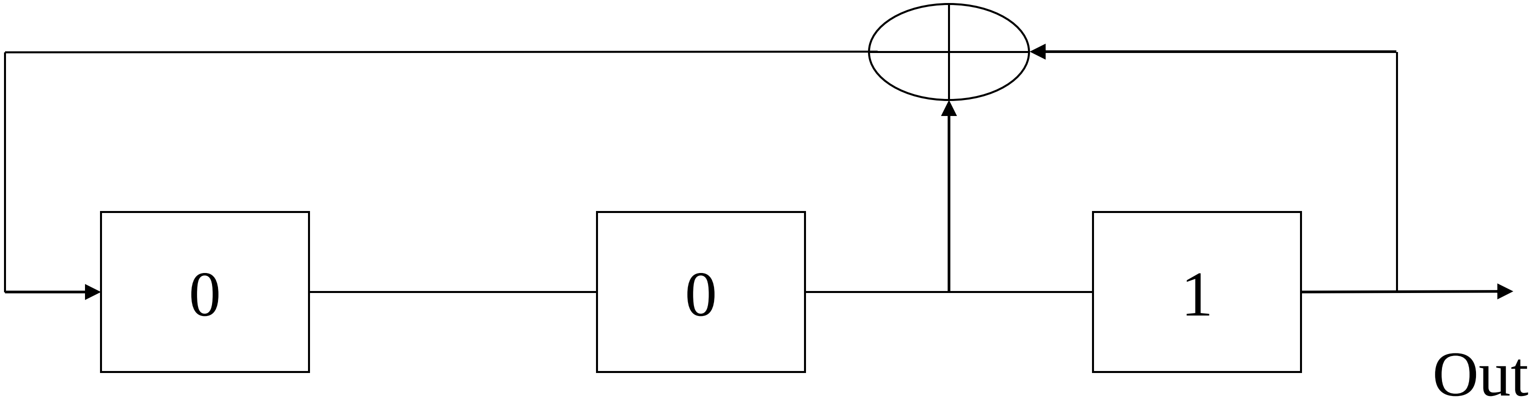
(2) Balance property : $2^r - 1$개의 칩 중
of “0” : $2^{r-1} - 1$

of “1” : 2^{r-1}
항상 **“1”**의 개수가 **“0”**의 개수보다 **1**개 많다

(3) Run property : $2^r - 1$ 개의 칩 중
“1”이나 **“0”**이 계속해서 한번 나온 경우 **: 1/2**
“1”이나 **“0”**이 계속해서 두번 나온 경우 **: 1/4**
“1”이나 **“0”**이 계속해서 세번 나온 경우 **: 1/8 ...**

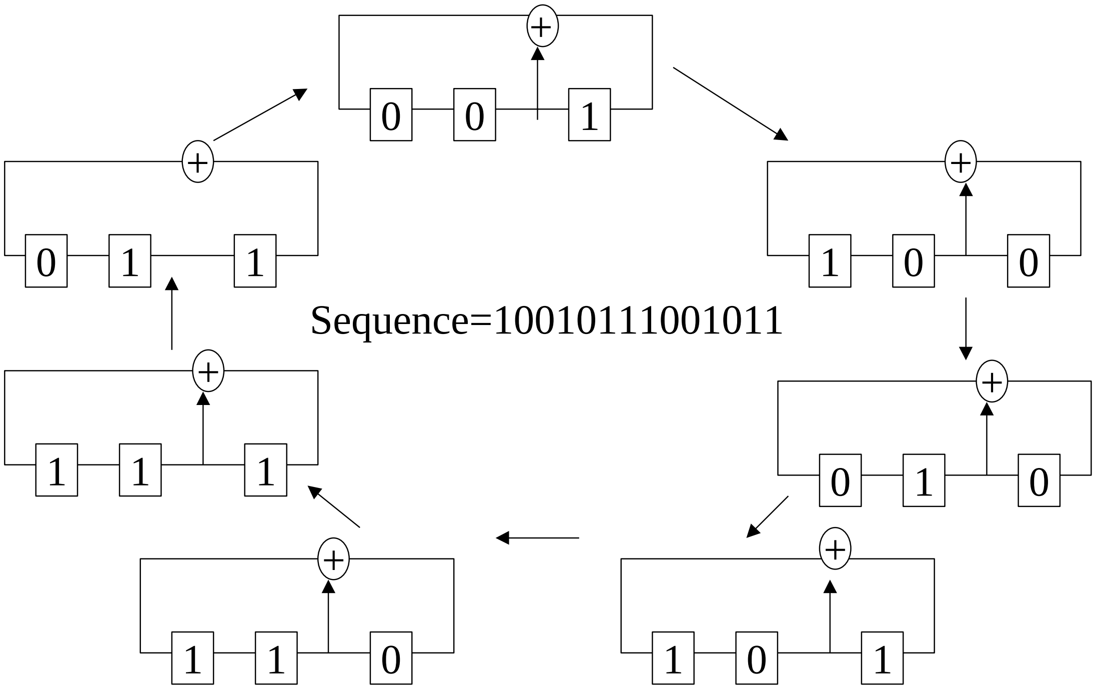
(4) Correlation Property :
Auto Correlation 취했을때 **'0'** 또는 거의 **'0'**에 가까움
(또는 두 시퀀스를 비교했을때 일치**bit**수와 불일치 **bit**수가 **1**개 미만차이**)**

PN Code Generation



- Seed Register with 001
- Output will be a 7-digit sequence that repeats continually : 1001011

PN Code Generation

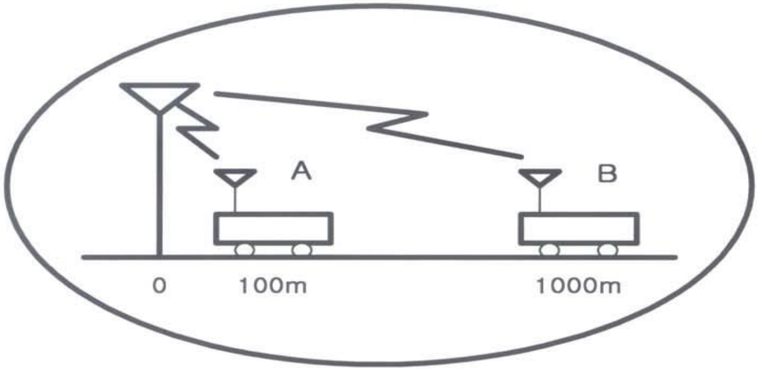


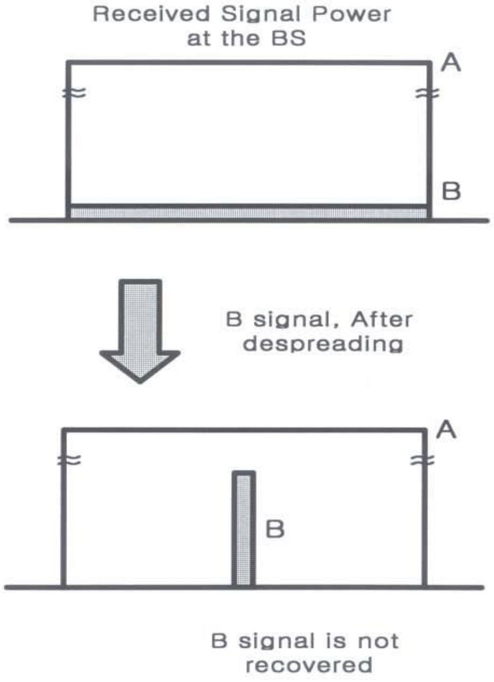
Sequence=10010111001011

Clock Pulse	D3	D2	D1
0	0	0	1
1	1	0	0
2	0	1	0
3	1	0	1
4	1	1	0
5	1	1	1
6	0	1	1
7	0	0	1

Power Control

Near - Far Problem



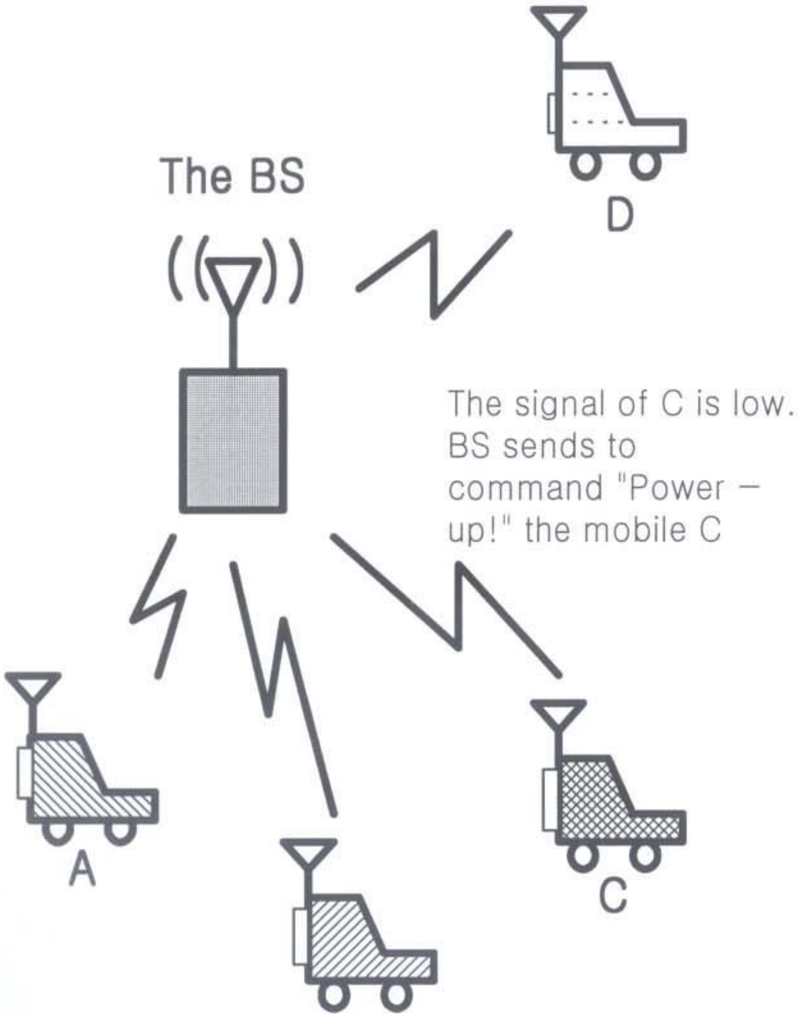


Near - Far Problem

The Received power of the A is $10^3 \sim 10^5$ times more than that of B therefore, B signal is masked by A signal problem

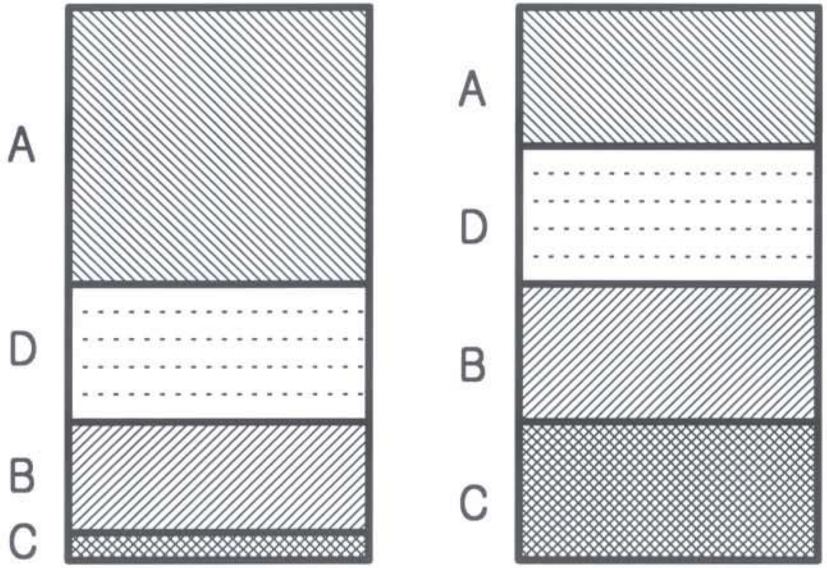
–> 따라서 Power Control 필수적

Reverse Link Power Control



The signal of C is low.
BS sends to
command "Power –
up!" the mobile C

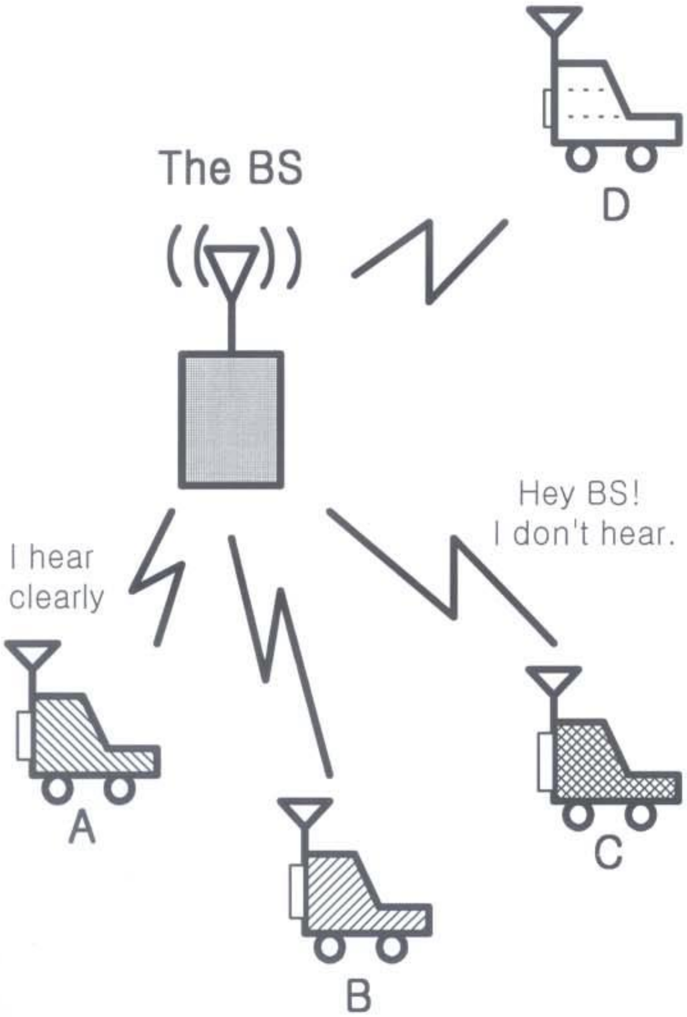
기지국 수신신호



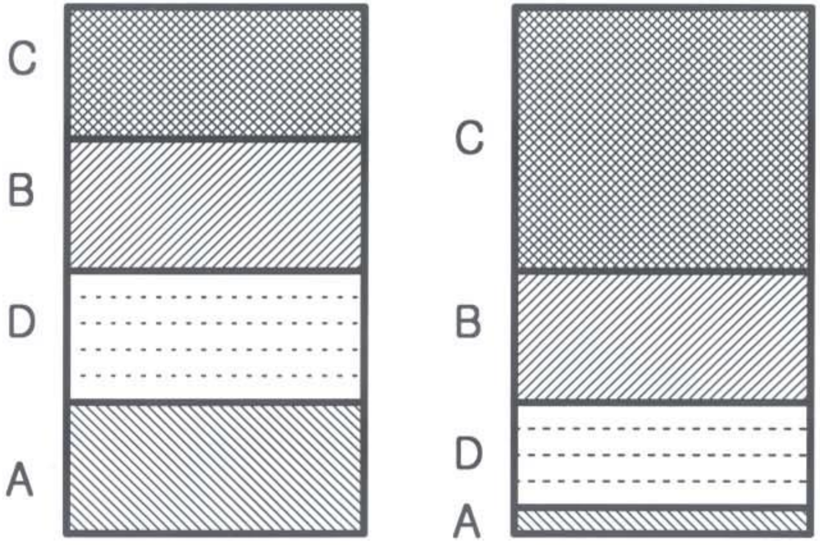
Without reverse
Link Power
Control.

With reverse
Link Power
Control

Forward Link Power Control



Transfer Power at the BS



Without Froward
Power Control
; In this case, C
has experienced
a lot of error

With Forward
Power Control

CDMA에서 용량(Capacity):Reverse link capacity

❖ CDMA 시스템에서 용량 결정요인 : 수신기의 복조방식(min. required Eb/No), 전력제어의 정밀도, 동일 셀 및 인접 셀 내의 타 사용자에 의해 발생되는 간섭전력

❖ 용량계산 : 동일 주파수대역 내에서 간섭을 일으키는 사용자 수

1. Single CDMA Cell 존재 시 Capacity 계산(즉 총 user 수 : M)

Energy per bit / noise power density(E_b/N_0)

E_b = Average modulating signal power (S)×Bit time duration(T)

= S · T , T = 1/R (R : bit rate) = S/R

Noise power density →

$$N_0 = \frac{Total \quad noise \quad power}{Channel \quad 대역폭} = \frac{N}{\boxed{W}}$$

CdmaOne 시스템 1.25MHz

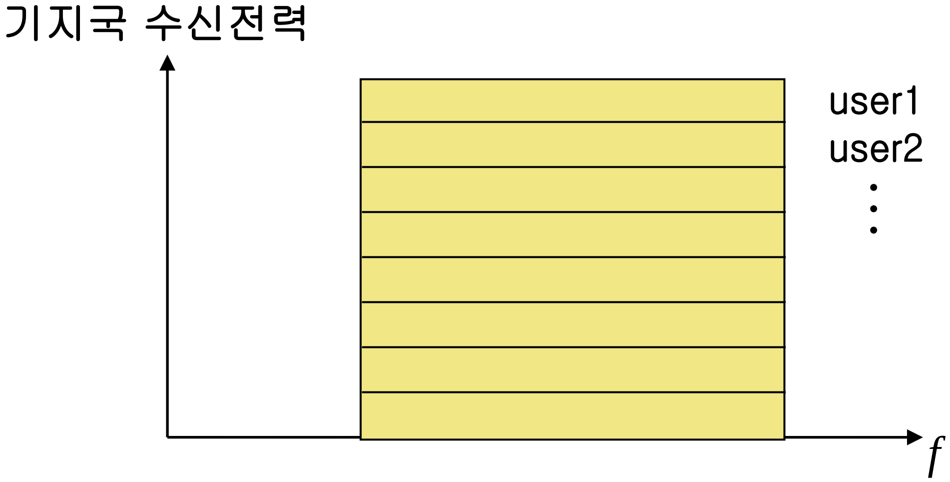
따라서 기지국에서 One user에 대한

$$\frac{E_b}{N_0} = \frac{S}{N} \cdot \boxed{\frac{W}{R}}$$

← Processing gain

CDMA System 에서 Capacity (계속1) :

여기에서 return link의 power control 이 완전하게 일어난다고 가정하면 각 user로부터 기지국에서 수신하는 전력은 모두 동일.



$$\therefore \frac{S}{N} = \frac{S}{S(M-1)} = \frac{1}{M-1}$$

, M은 같은 Cell 내의 모든 User 수

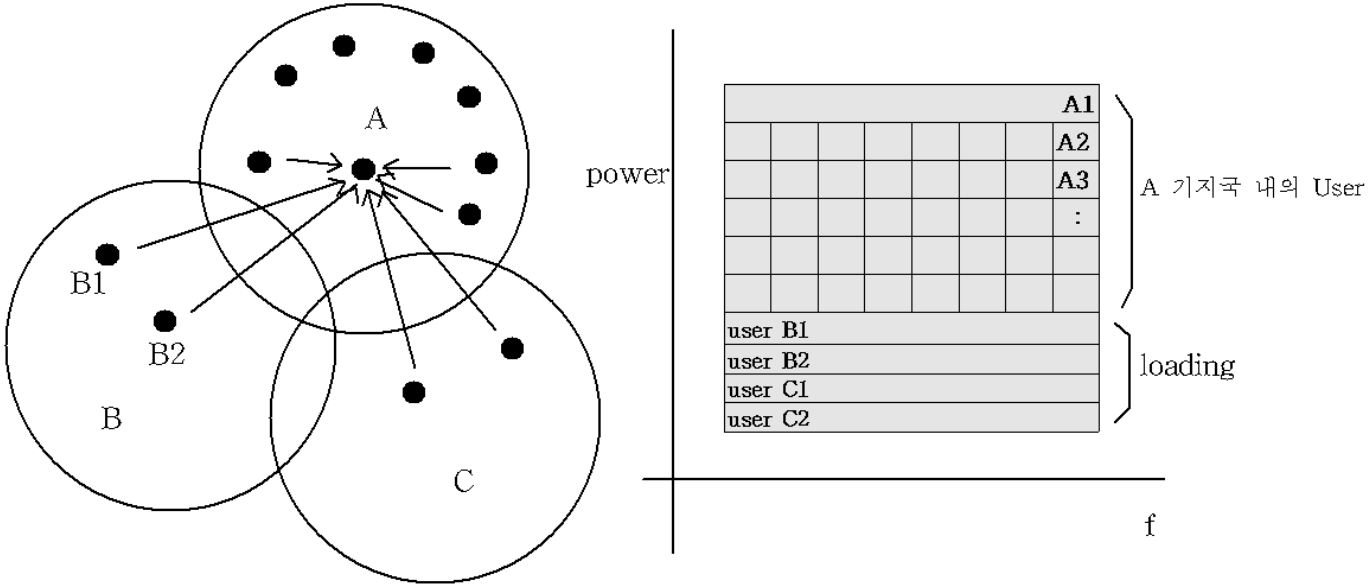
$$\rightarrow \frac{E_b}{N_0} = \frac{1}{M-1} \cdot \frac{W}{R}$$

, User 수가 많으면 M ≈ M −1 <---- (식 1)

$$\therefore \quad M = \frac{(W/R)}{(E_b/N_0)}$$

CDMA System 에서 Capacity (계속2) :

2. 실제 환경에서 **CDMA**시스템은 바로 옆에 같은 주파수를 사용하는 **Cell** 이 많이 존재하므로 이를 고려했을 때 실제 **Capacity**는**?**



A1, A2, A3…. : A Cell 내의 사용자들이 A 기지국에 미치는 Return Link 전력
B1, B2,.. : B Cell 내의 사용자들이 A 기지국에 미치는 Return Link 전력
C1, C2, … : C Cell 내의 사용자들이 A 기지국에 미치는 Return Link 전력

이때 B, C 등 이웃 Cell의 사용자 Return link가 A 기지국에 간섭을 일으키는 것을 loading 이라 하고 **η** : loading factor 로 정의

CDMA System 에서 Capacity (계속3) :

$$\frac{\mathrm{E_b}}{\mathrm{N_0}} = \frac{1}{\mathrm{M}-1}\cdot\frac{\mathrm{W}}{\mathrm{R}}\cdot\left(\frac{1}{1+\eta}\right)$$

<------------------ (식 2)

– Frequency Reuse factor,=1/주파수 재사용효율

– CDMA 시스템의 주파수 재사용 효율, $F = \frac{1}{1+\eta}$

– Note : **η**=0일 때,

Ideal 한 CDMA 시스템의 frequency 재사용 계수는 '1‘ 이나 실질적인 CDMA 시스템에서 간섭을 고려하면 ‘1.6’ 정도임

- 가까운 이웃 Cell 에서 서로 다른 주파수대역 사용해도 **η**=0임.

3. Sectoring factor

$$\lambda = \frac{\text{전방향에서오는}\quad Interference\,\text{합}}{Sector\quad Antenna\,\text{에}\quad \text{의해}\quad \text{수신되는}\quad Interference\,\text{합}}$$

$$\frac{E_b}{N_0} = \frac{1}{M-1}\cdot\frac{W}{R}\cdot\left(\frac{1}{1+\eta}\right)\cdot\lambda$$

<-------------- (식 3)

CDMA System 에서 Capacity (계속4) :

4. Effect of Voice Activity

(식3) 은 모든 user들이 시간대 100% 사용할 때 경우임. 실제 통계적으로 각 user는 통화시 40~50% 시간동안만 얘기한다는 점을 고려하여 variable codec (최대 9.6Kbps(800MHz) 또는 14.4Kbps(pcs 대역)을 사용함으로써 (링크구조 참조)

Reduce transmitted power ⇒ Reduce interference in Return link at B.S.

$$\frac{E_b}{N_0} = \frac{1}{M-1} \cdot \frac{W}{R} \cdot \left(\frac{1}{1+\eta}\right) \cdot \lambda \left(\frac{1}{\upsilon}\right)$$

$$\therefore M = \frac{(W/R)}{(E_b/N_0)} \cdot \left(\frac{1}{1+\eta}\right) \cdot \lambda \left(\frac{1}{\upsilon}\right)$$

- Conclusions :

Fact 1. Capacity(M) ∝ Processing gain (W/R)

Fact 2. $C \propto \frac{1}{\text{Syetem's required} \quad E_b / N_0}$

Fact 3. 이웃Cell 에서의 loading ↓ → Capacity ↑

Fact 4. Sectoring increases Capacity.

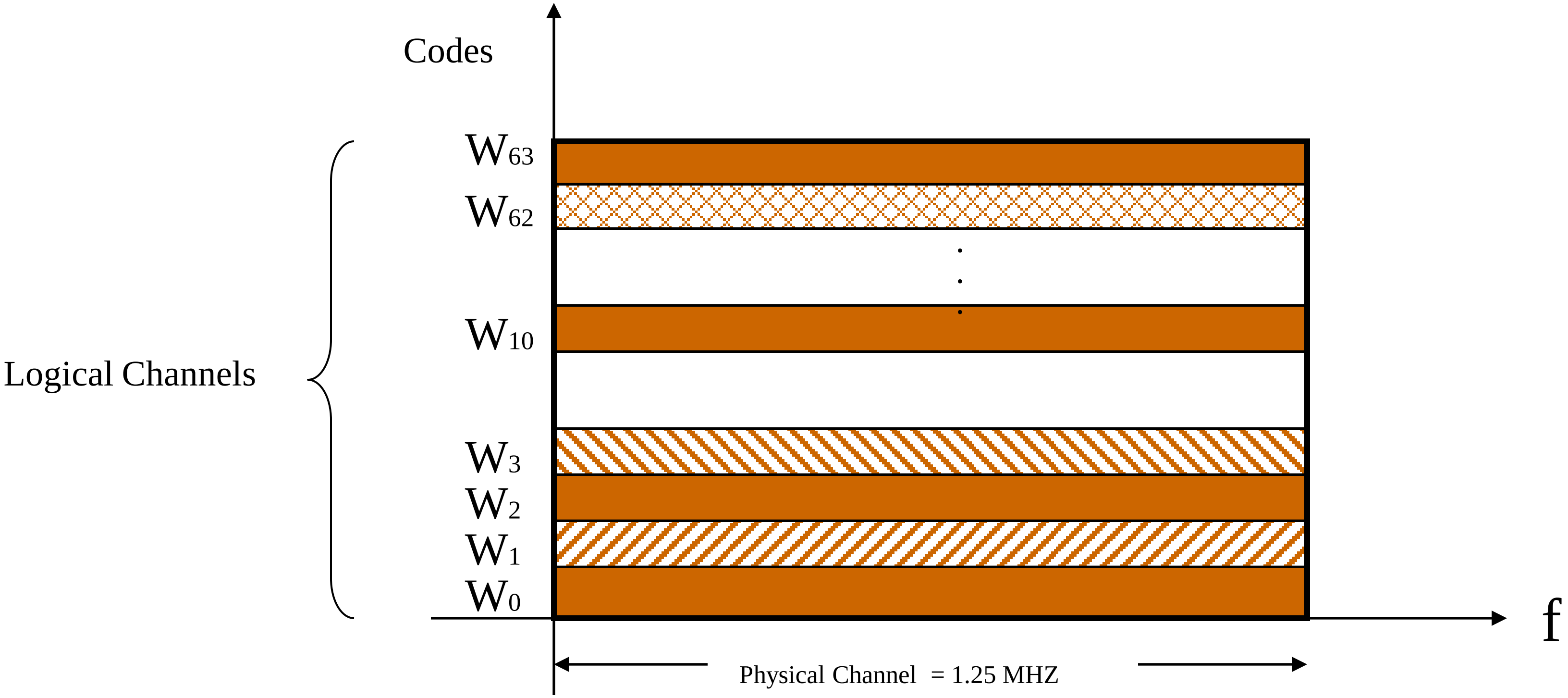
Link Structure

- **CDMA Channel 구조**

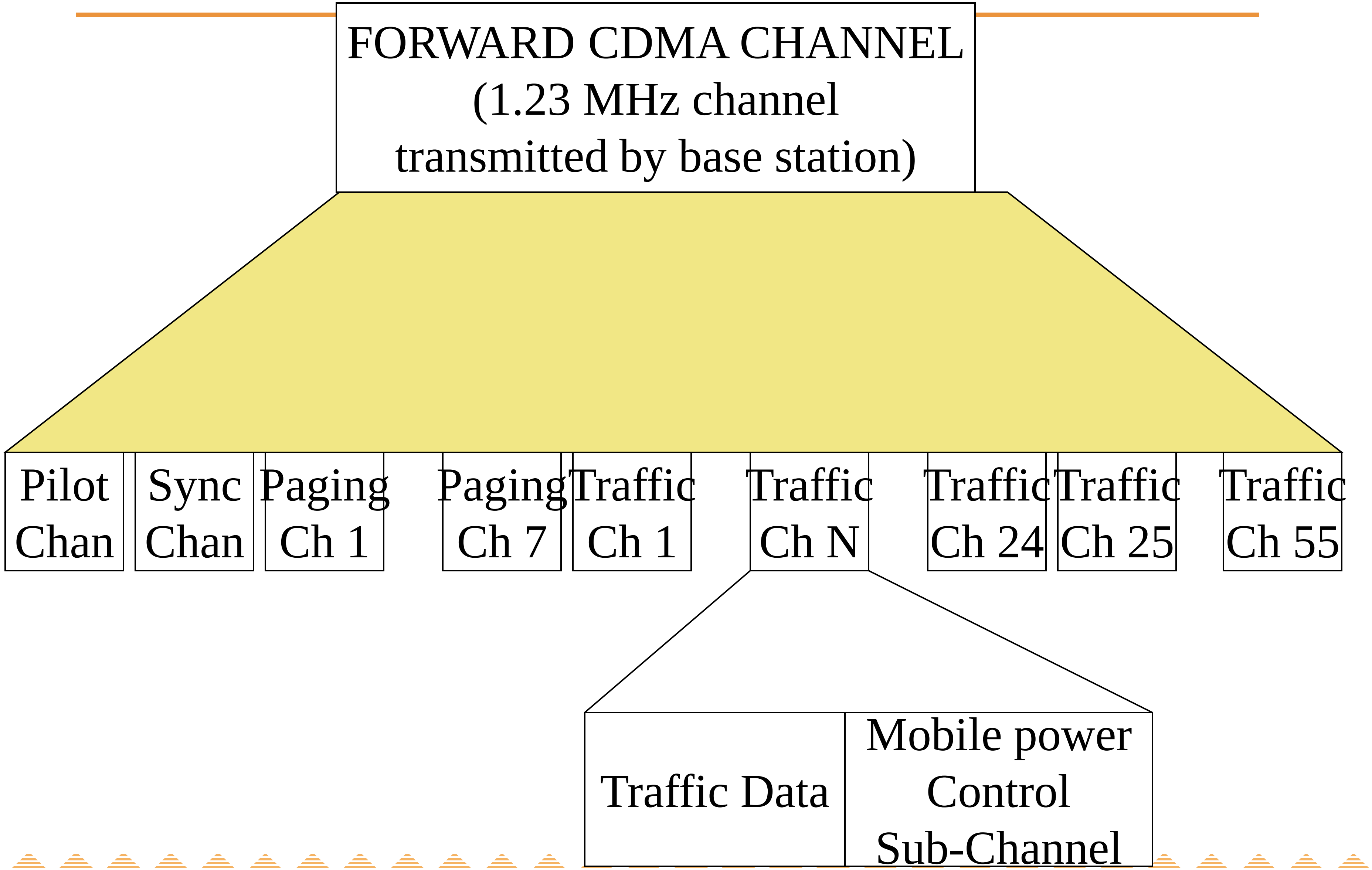
- **Forward Link**
  - **Pilot Channel**
  - **Sync. Channel**
  - **Paging Channel**
  - **Traffic Channel**

- **Reverse Link**

CDMA Physical &Logical Channel



CDMA Channel 구조



FORWARD CDMA CHANNEL
(1.23 MHz channel
transmitted by base station)

Pilot Chan

Sync Chan

Paging Ch 1

Paging Ch 7

Traffic Ch 1

Traffic Ch N

Traffic Ch 24

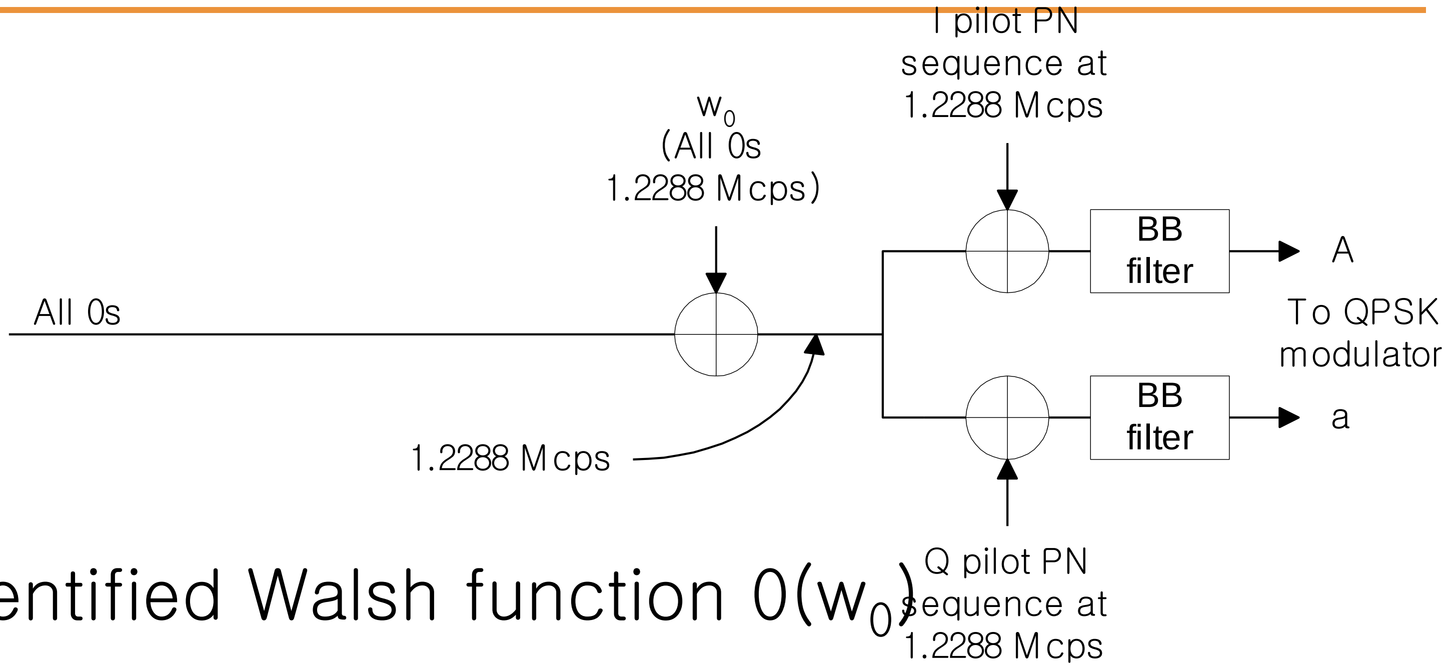
Traffic Ch 25

Traffic Ch 55

Traffic Data

Mobile power Control Sub-Channel

Pilot channel



- Identified Walsh function $0(w_0)$
- No Baseband Information
- Transmitted constantly
- Has unique PN offset for each cell or sector
- Provide the mobile with timing, phase reference & signal strength

Pilot PN sequence offset

- The short PN codes are uniquely offset for each sector(2^{15}=32,768)
- The minimum offset index is 0~511(number of 512)

$$512 = \frac{2^{15}(=32{,}768)}{64}$$

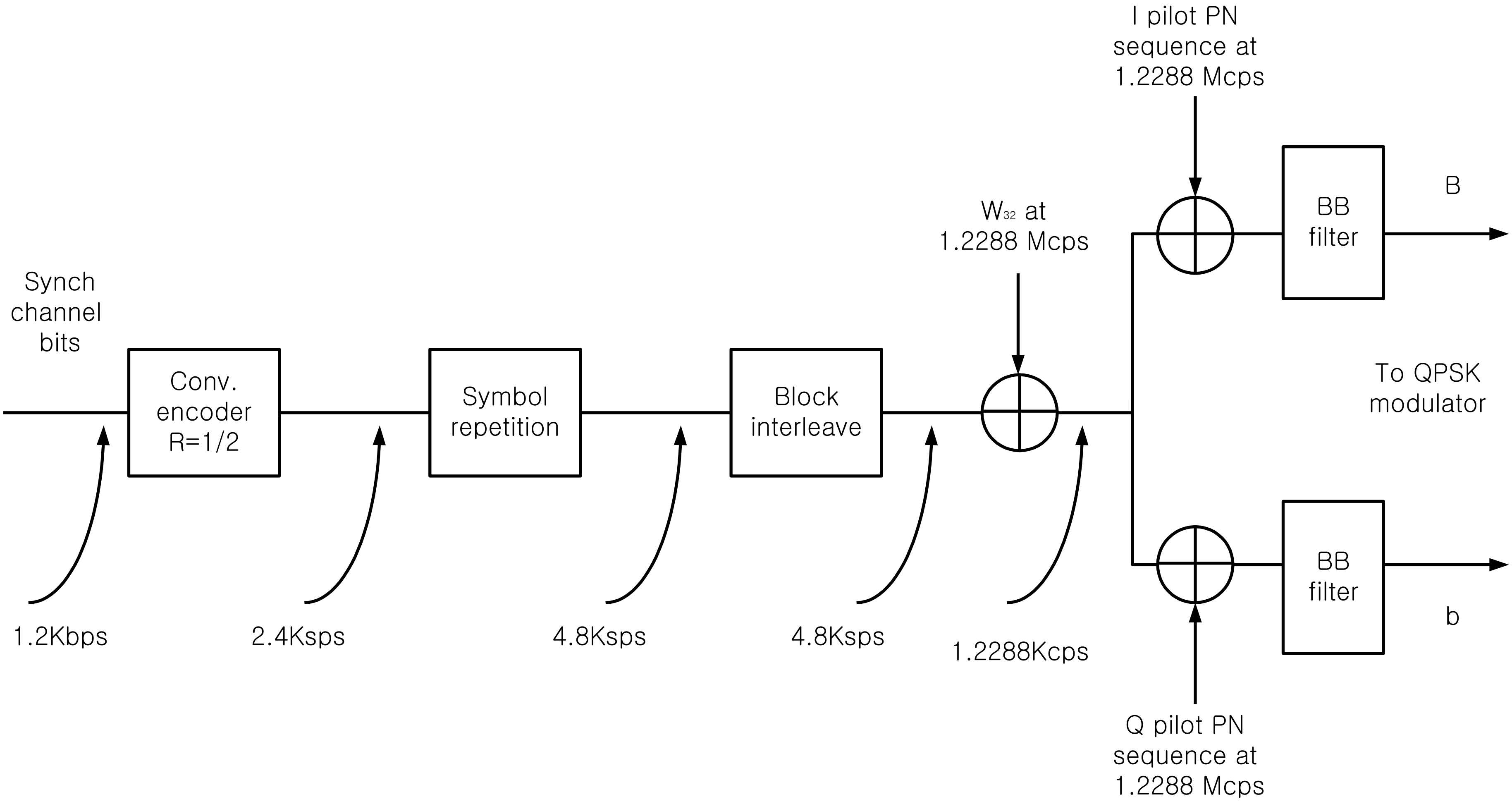
ex) offset index=15

15 × 64 = 960 PN chips

The pilot PN sequence will start 781.25s($960 \times \frac{1}{1.2288M}$)

Note : 교재 6장 348-349쪽, 그림 6-18 참조

Sync channel Block Diagram



Synch channel bits

Conv. encoder R=1/2

Symbol repetition

Block interleave

W_{32} at 1.2288 Mcps

I pilot PN sequence at 1.2288 Mcps

BB filter

B

To QPSK modulator

BB filter

b

Q pilot PN sequence at 1.2288 Mcps

1.2Kbps

2.4Ksps

4.8Ksps

4.8Ksps

1.2288Kcps

Sync. Channel 역할 구성

- **Carries baseband information : Protocol information, 시스템 ID, 망 ID, Pilot 채널 PN offset 정보, 주파수 채널번호, Paging 채널 속도, long code 정보 등의 기지국에서 이동국으로의 여러가지 시스템 구성정보와 Timing 정보 제공**

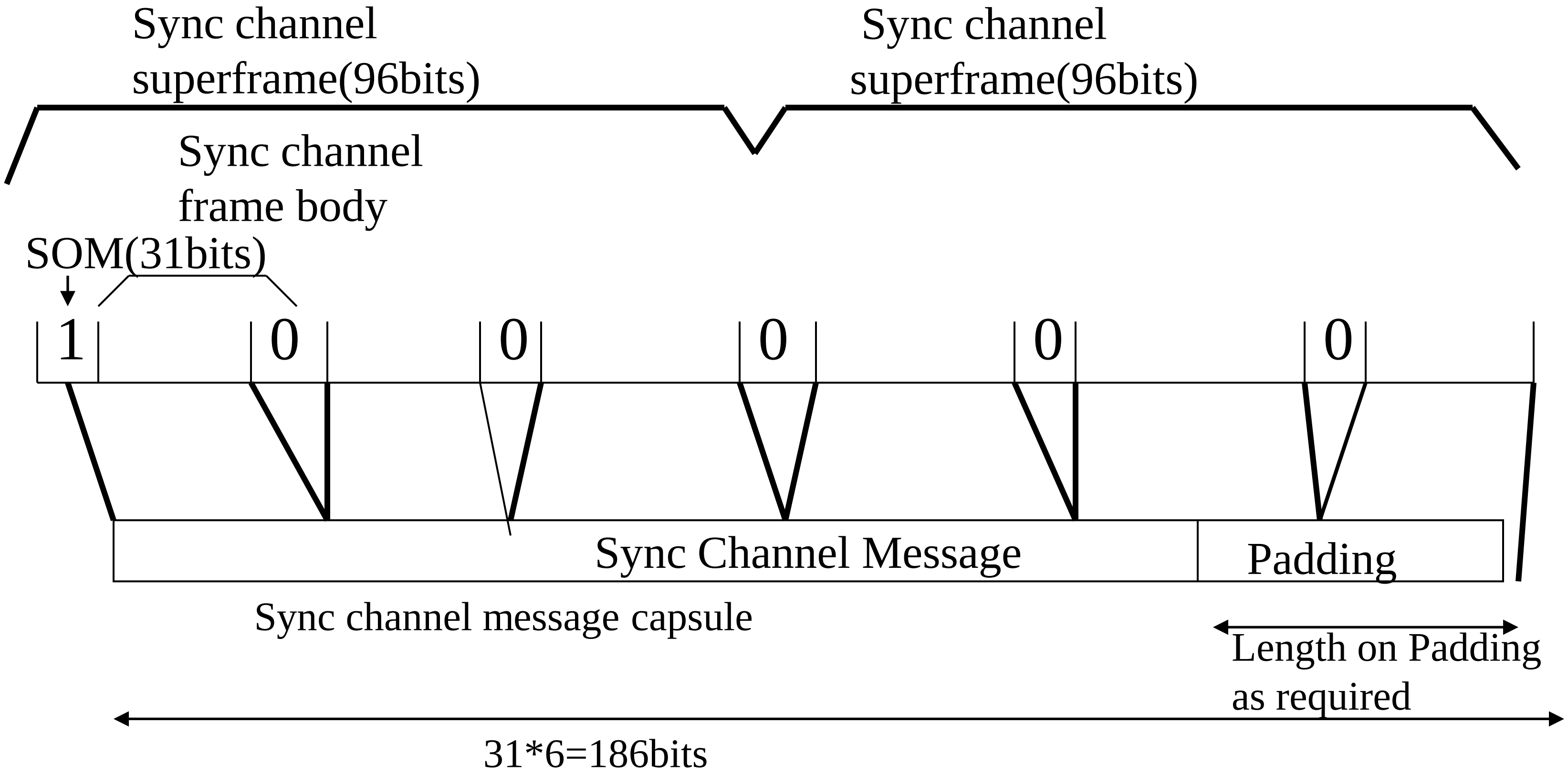
- **Used by Mobile to Synchronize with system**

- **Transmitted in superframes**

  (96 bits with 80 *msec* = 1200bps)

- **Walsh 32사용하여 확산시켜 전송 -> 이동국은 pilot 채널로 기지국을 선택한 다음 Walsh 32 함수로 바꾸어 역 확산함으로써 동기채널 접속**

Sync channel message is structured by Sync Channel Message Capsule(Message+Padding)



Sync channel superframe(96bits)

Sync channel superframe(96bits)

Sync channel frame body

SOM(31bits)

1 0 0 0 0 0

Sync Channel Message

Padding

Sync channel message capsule

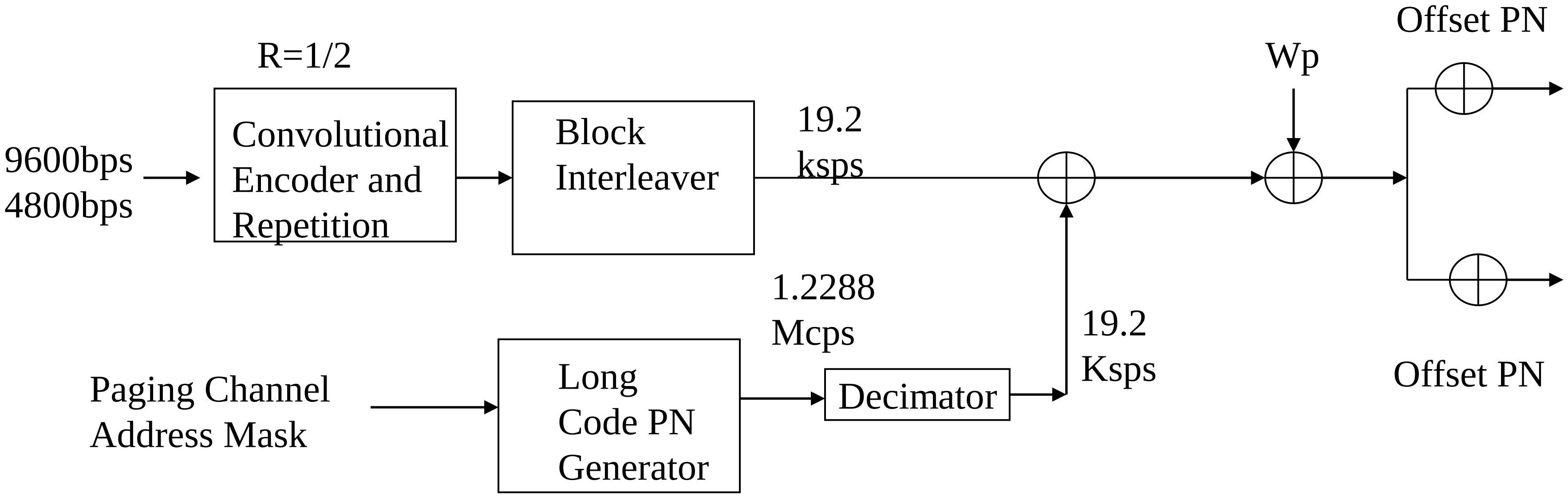
Length on Padding as required

31*6=186bits

- The Sync channel message information

  pilot PN offset -system ID
  System Time -network ID
  Long PN code state -CAI Rev level
  Paging channel Data Rate

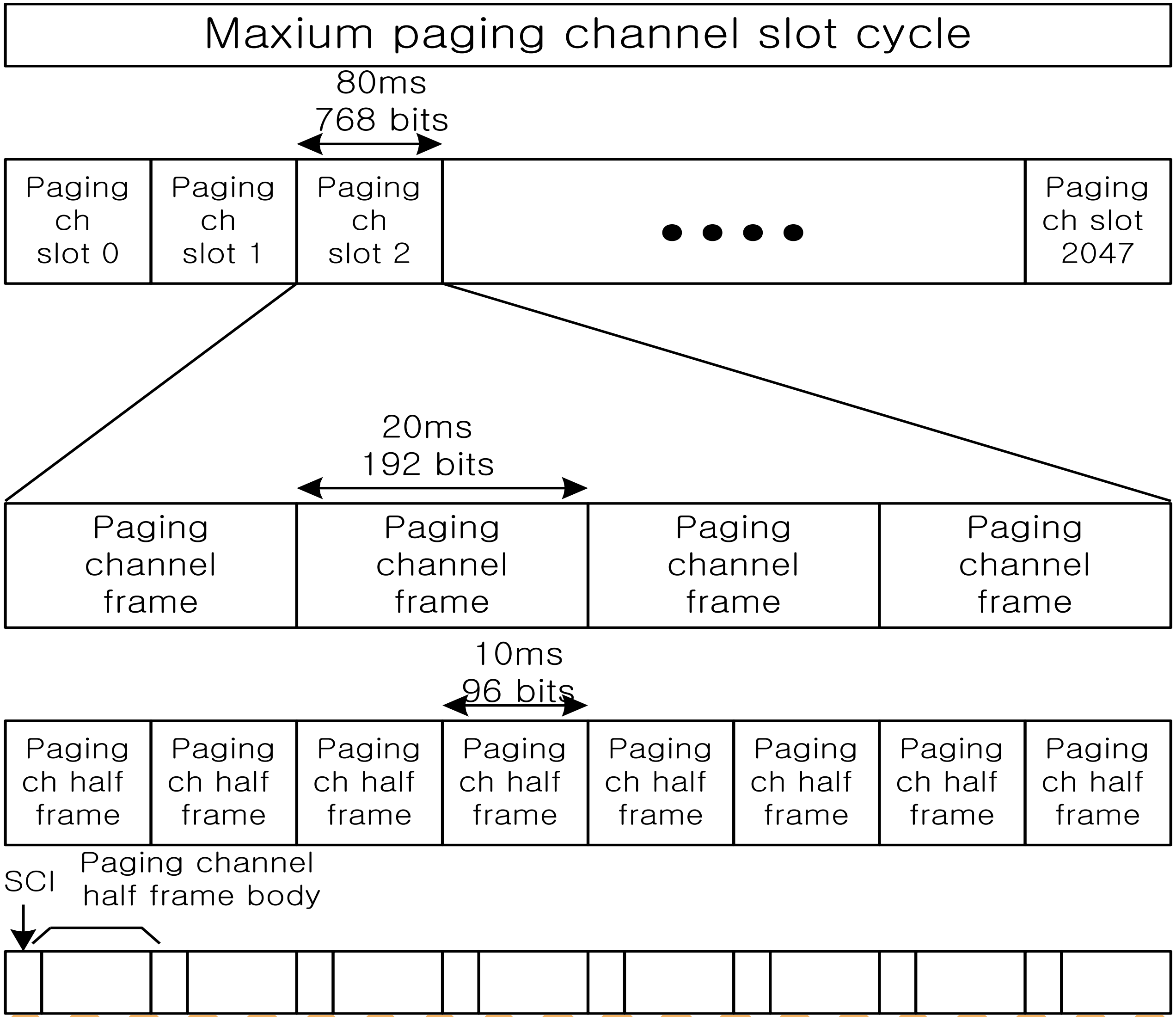
Paging Channel



Used by Base Station to:

- Page a particular mobile or group mobiles
- Transmit Overhead Information
  - System Parameter Message : 핸드오프, 순방향전력제어 파라메터
  - Neighbor List Message
  - Access Parameter Message : 역방향 전력제어, 이동국이 사용할 엑세스채널 파라메터
- Assign Mobile a Traffic Channel
- 전송속도 at 9600 or 4800bps

Paging channel frame structure for a paging channel rate of 9.6Kbps

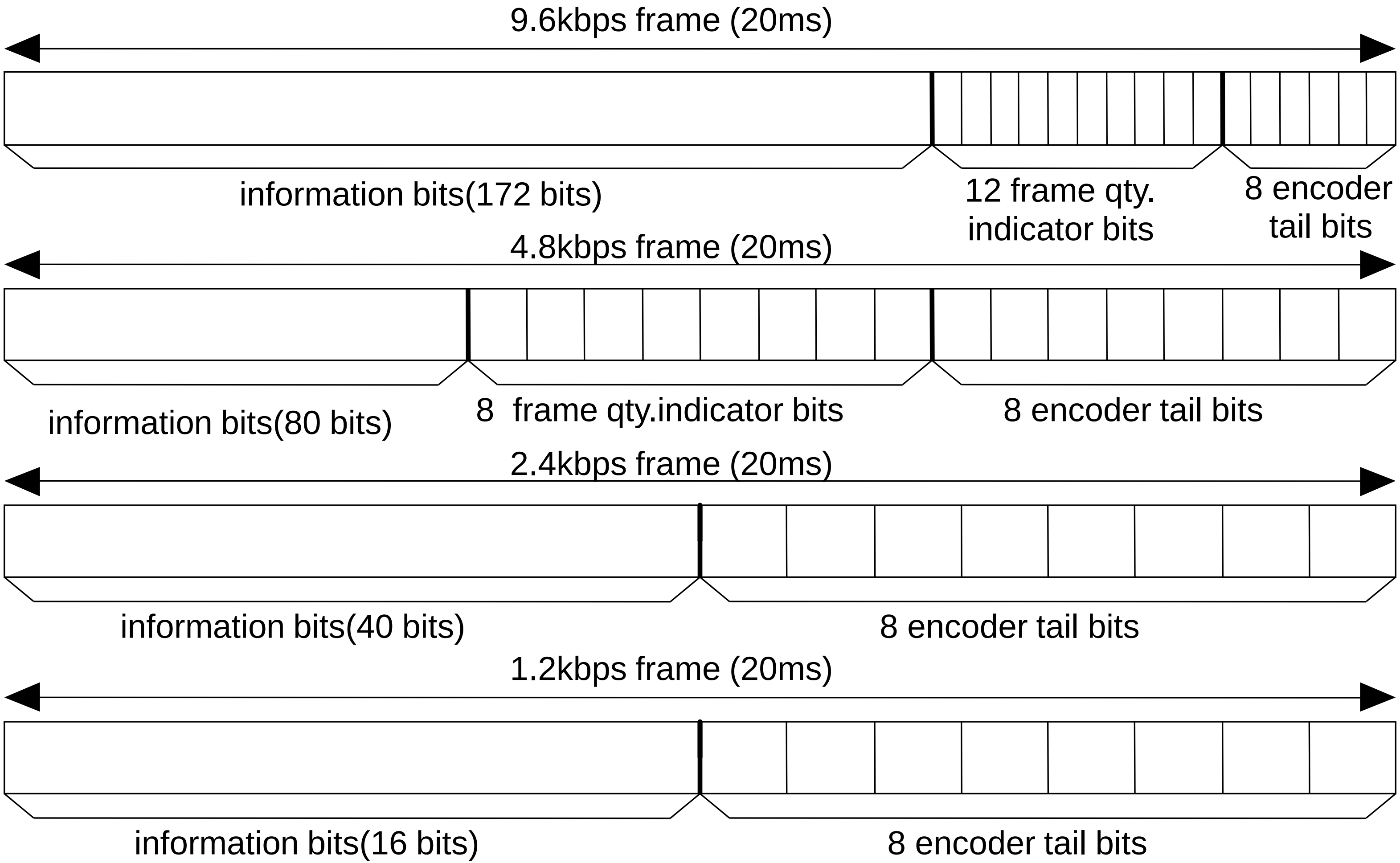


Paging Channel

- Paging channel is divided into 80-ms slots.

  (Total Group = 2,048 slots)
- An 80-ms slots is divided into four paging channel frames
- Each paging channel frame is divided into two paging channel half- frames
- The first bit at half-frame is synchronized capsule indicator (SCI) bit

Traffic 채널 frame structure



9.6kbps frame (20ms)

information bits(172 bits)

12 frame qty. indicator bits

8 encoder tail bits

4.8kbps frame (20ms)

information bits(80 bits)

8 frame qty.indicator bits

8 encoder tail bits

2.4kbps frame (20ms)

information bits(40 bits)

8 encoder tail bits

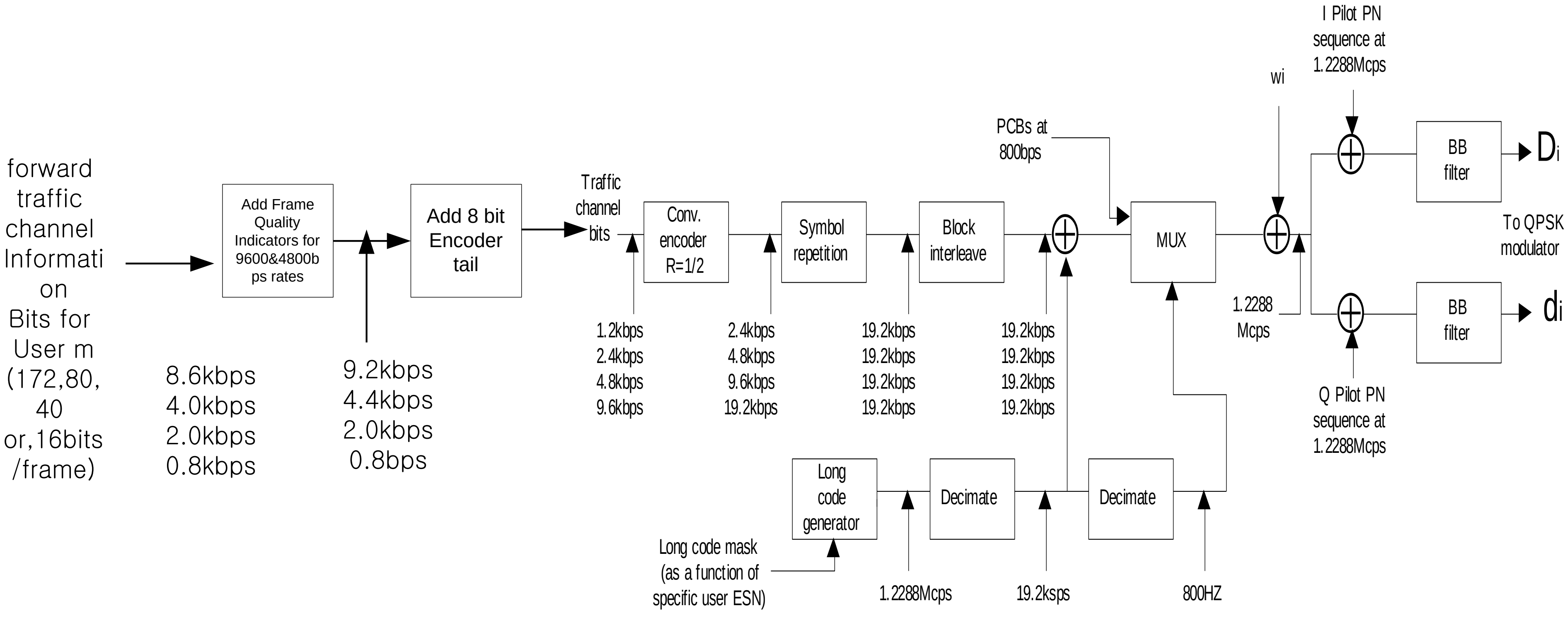
1.2kbps frame (20ms)

information bits(16 bits)

8 encoder tail bits

Traffic channel frame structure for both forward and reverse links

Forward traffic channel



forward traffic channel Information Bits for User m (172,80, 40 or,16bits /frame)

8.6kbps
4.0kbps
2.0kbps
0.8kbps

Add Frame Quality Indicators for 9600&4800bps rates

9.2kbps
4.4kbps
2.0kbps
0.8bps

Add 8 bit Encoder tail

Traffic channel bits

Conv. encoder R=1/2

1.2kbps
2.4kbps
4.8kbps
9.6kbps

Symbol repetition

2.4kbps
4.8kbps
9.6kbps
19.2kbps

Block interleave

19.2kbps
19.2kbps
19.2kbps
19.2kbps

19.2kbps
19.2kbps
19.2kbps
19.2kbps

PCBs at 800bps

MUX

wi

1.2288 Mcps

I Pilot PN sequence at 1.2288Mcps

BB filter

D_i

To QPSK modulator

BB filter

d_i

Q Pilot PN sequence at 1.2288Mcps

Long code generator

Long code mask (as a function of specific user ESN)

Decimate

Decimate

1.2288Mcps

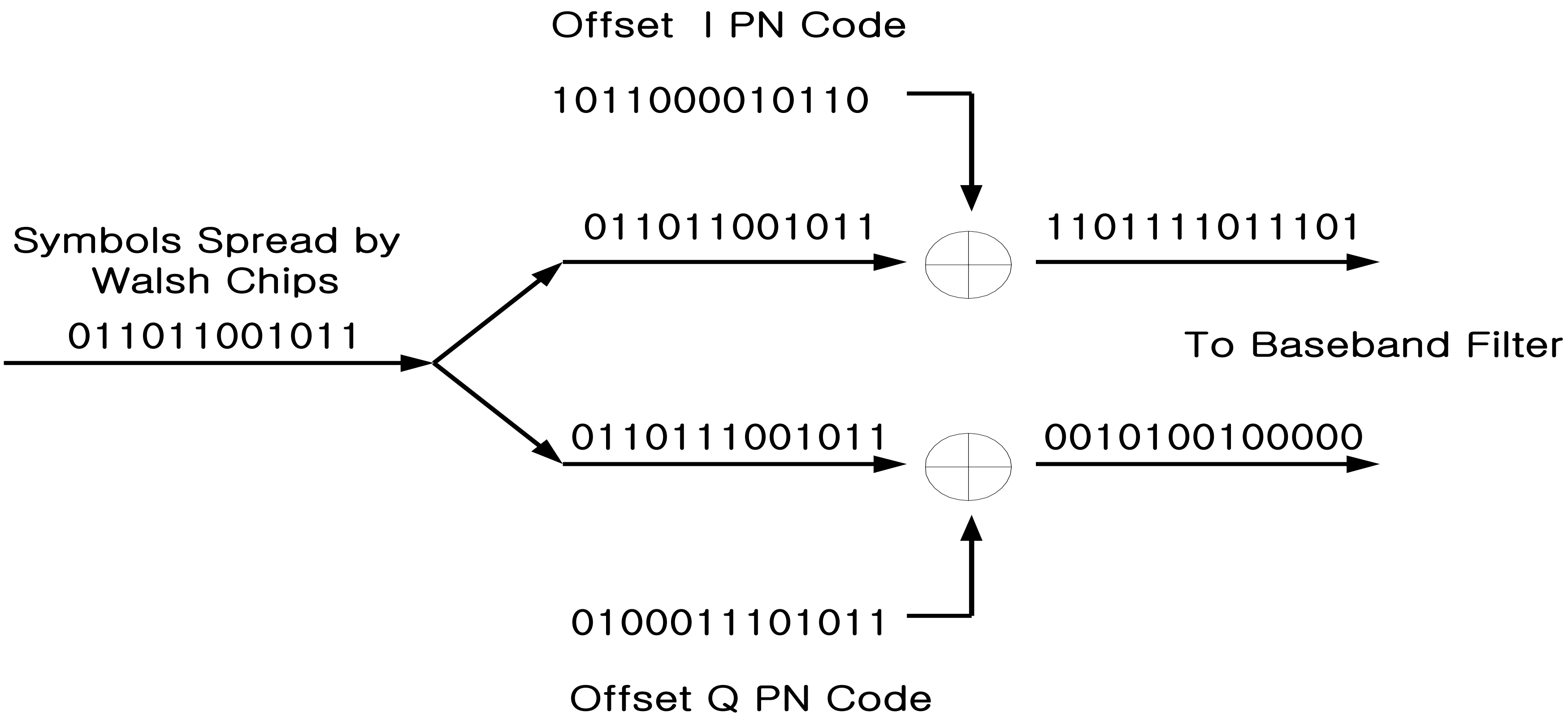
19.2ksps

800HZ

Forward traffic channel

- used to： pass voice, commands, request

Forward Traffic Channel Generation



Offset I PN Code

1011000010110

Symbols Spread by
Walsh Chips

011011001011

011011001011

1101111011101

To Baseband Filter

0110111001011

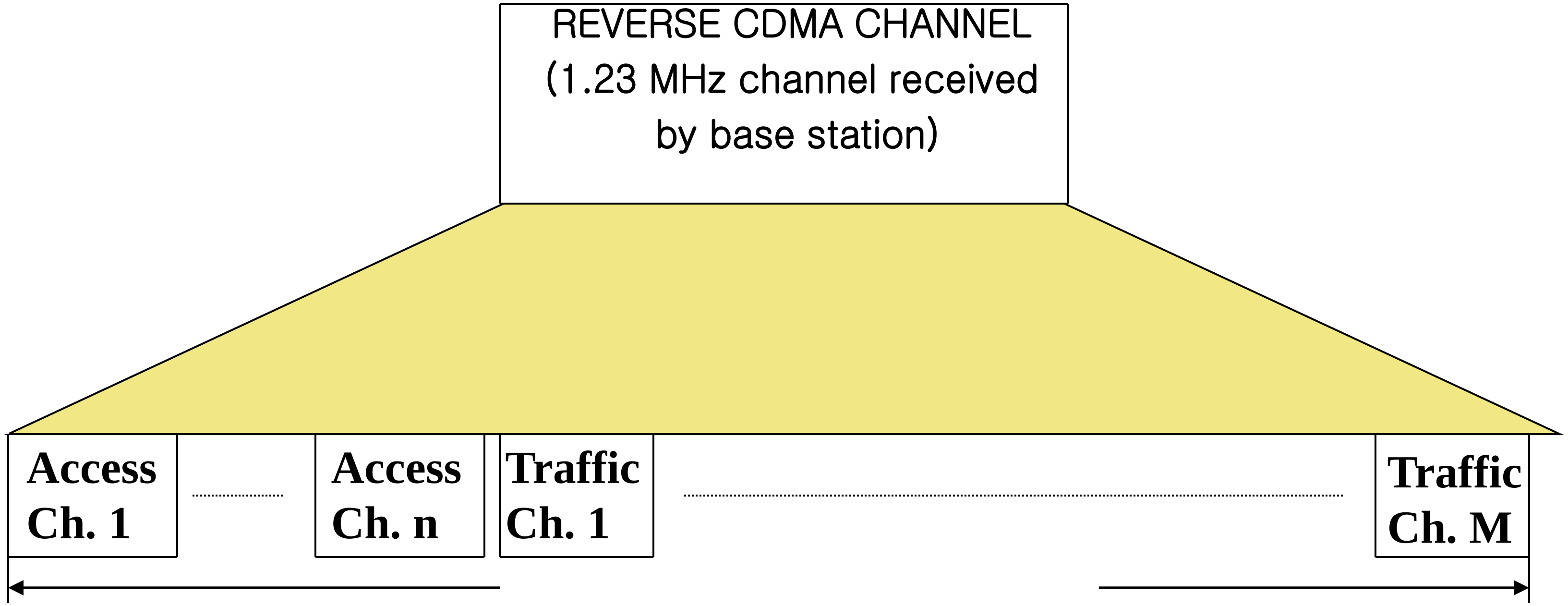
0010100100000

0100011101011

Offset Q PN Code

[Quardrature Spreading]

Reverse CDMA Channel



REVERSE CDMA CHANNEL
(1.23 MHz channel received
by base station)

Access Ch. 1

Access Ch. n

Traffic Ch. 1

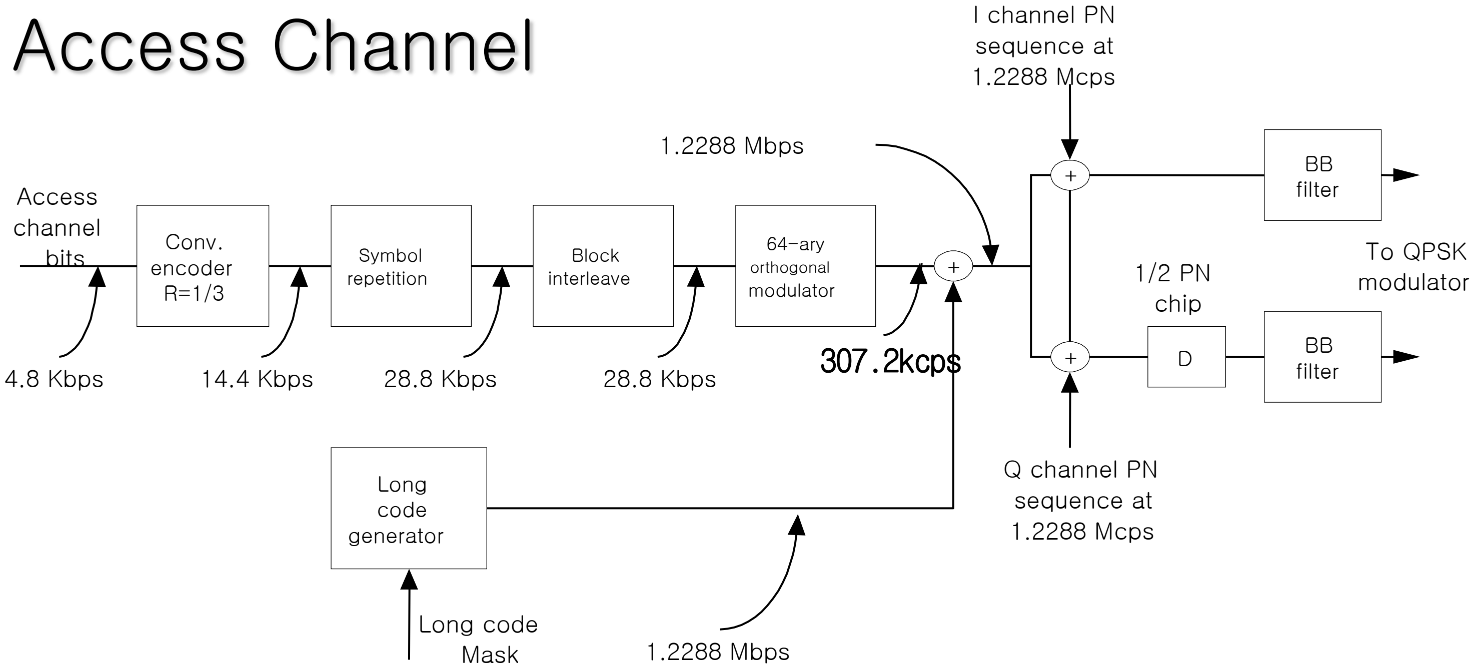
Traffic Ch. M

Addressed by Long Code PNs

Figure 6.1.3.1-1. Example of Logical Reverse CDMA Channels
Received at a Base Station

Reverse Link

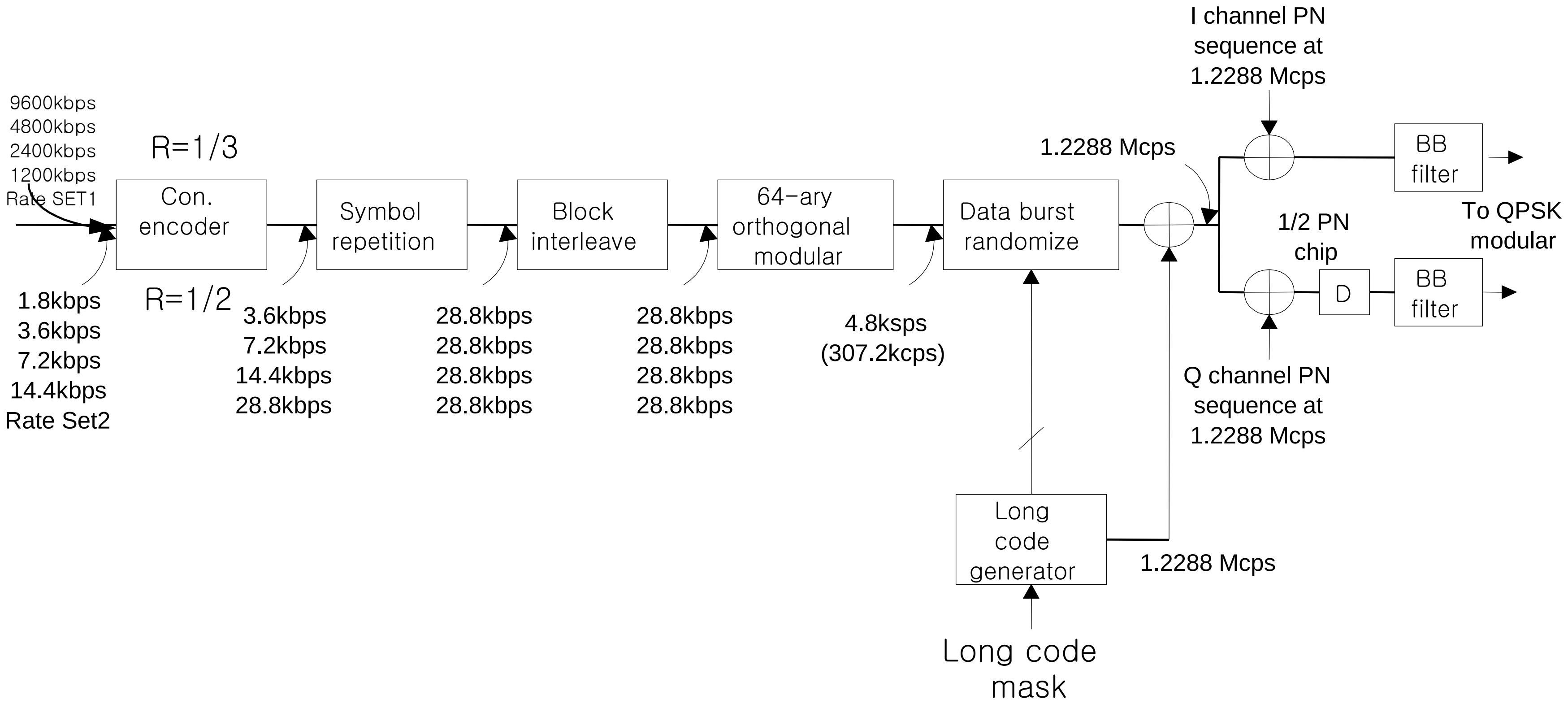
- Access Channel



- Used by Mobile to
  - Access System
  - Originate calls
  - Respond to pager and get the order from the BS
  - Register with system

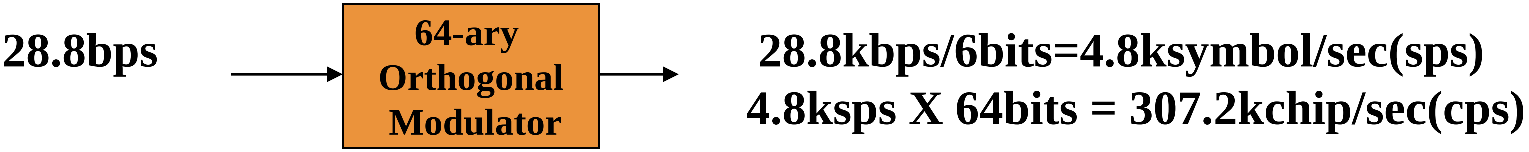
Reverse Traffic Channel(Rate set 2)

- Used to pass voice, commands, and requests from the Mobile to the Base Station
- TX up to 14400 bps



Reverse Traffic Channel(cont.)

- 64-ary Orthogonal Modulator
  - **6 bits** 신호에 따라 **64 bits Walsh** 코드 할당
  - 효과 **:** 순방향 신호에 비해 상대적으로 약한 역방향 신호가 열악한 채널 환경에서 낮은 **BER** 초래**.** 따라서 수신된 **Walsh** 코드에 짝지어진 **6 bits** 신호 복조시 유리함**.**



28.8bps

64-ary Orthogonal Modulator

28.8kbps/6bits=4.8ksymbol/sec(sps)
4.8ksps X 64bits = 307.2kchip/sec(cps)

- Data Burst Randomizer → 교재 **7**장 **418-420**쪽 참조
  - 역방향 링크신호를 **Voice Activity Factor**에 따라 반복하고 **Random**하게 반복 **Bit** 중 **1**개만 전송 **->** 신호 전력 유지
  - 효과 **:** 간섭감소로 기지국 용량증가
  -> 교재 **7**장 **(**그림 **7-17)** 참조