CDMA2000
Uplink

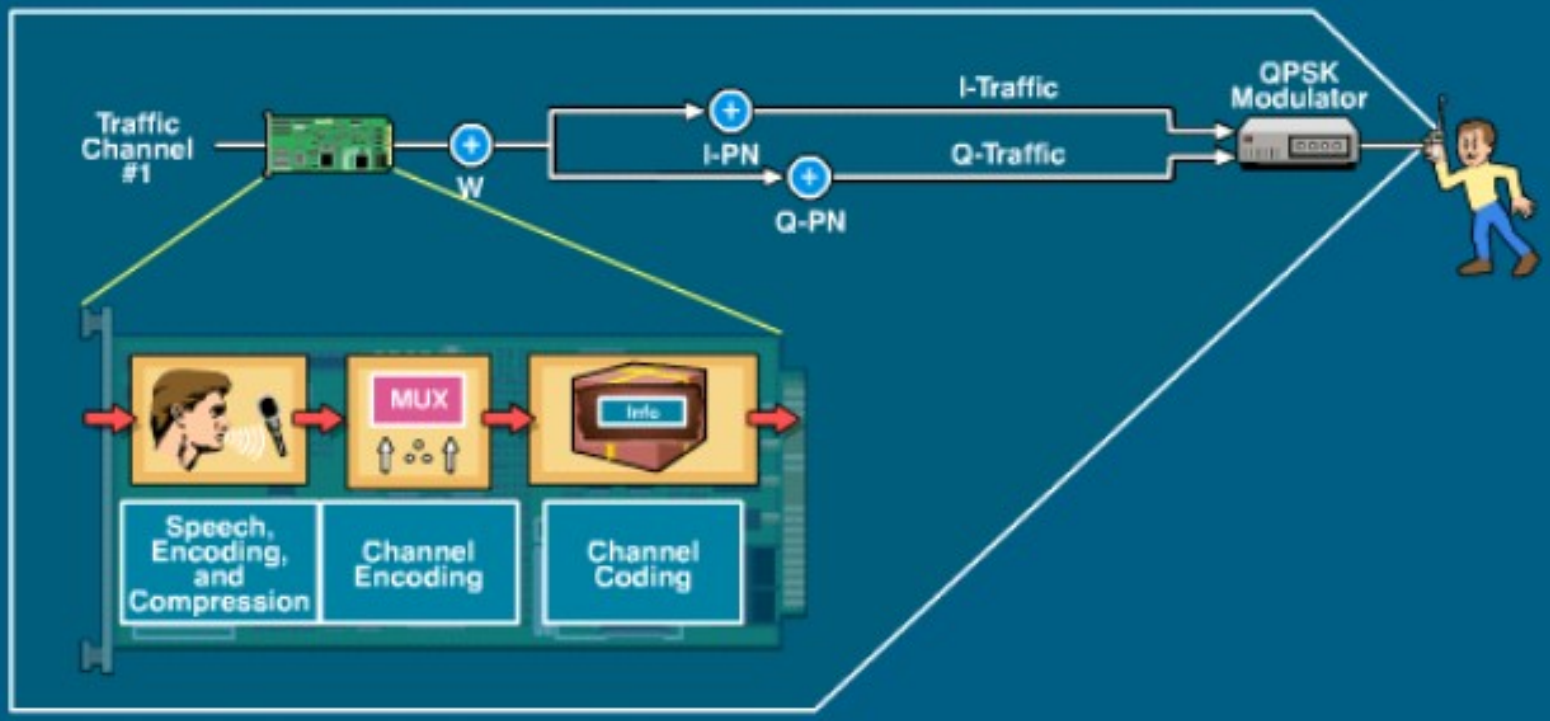
CDMA2000 RADIO TECHNOLOGY
UNIT LESSONS

- CDMA2000 Forward Radio Carrier (Downlink)
  - Pilot, Sync, Paging, and Fundamental Channels
  - Supplemental Channels
    - Packet Mode Operation
    - Configuration and Data Rate Options
  - Multi-Carrier Operation
- **CDMA2000 Reverse Radio Carrier (Uplink)**
- CDMA2000 Evolution to 1xEV-DO and 1xEV-DV

cdmaOne (1.25 MHz) REVERSE CARRIER
ONLY ONE CHANNEL AT A TIME

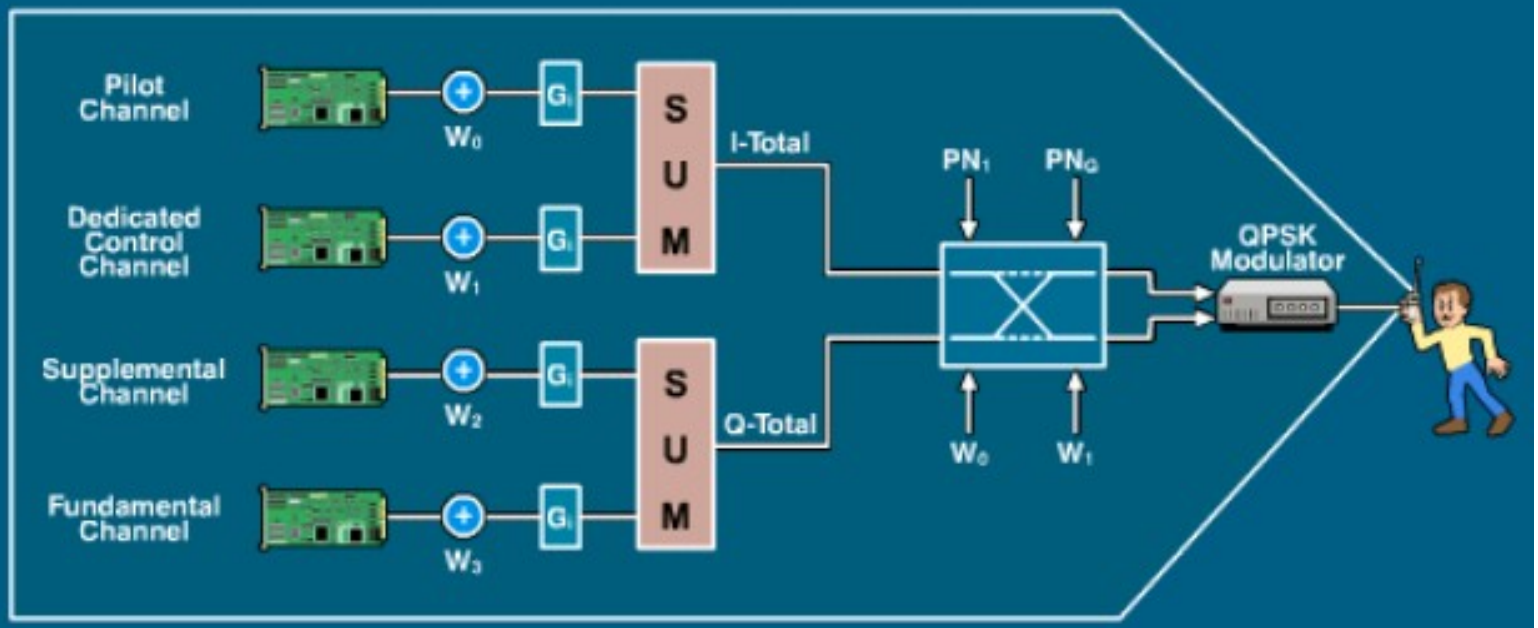
Only ONE channel at a time

- Traffic Channel - During a call
- Access Channel - For signaling and messages, when idle



⊕ = Exclusive-OR Operation
W = Walsh Code
I = In - Phase Component
Q = Quadrature (90°) Phase Component
G_i = Per Channel Individualized Gain
PN = Pseudonoise Code Sequence

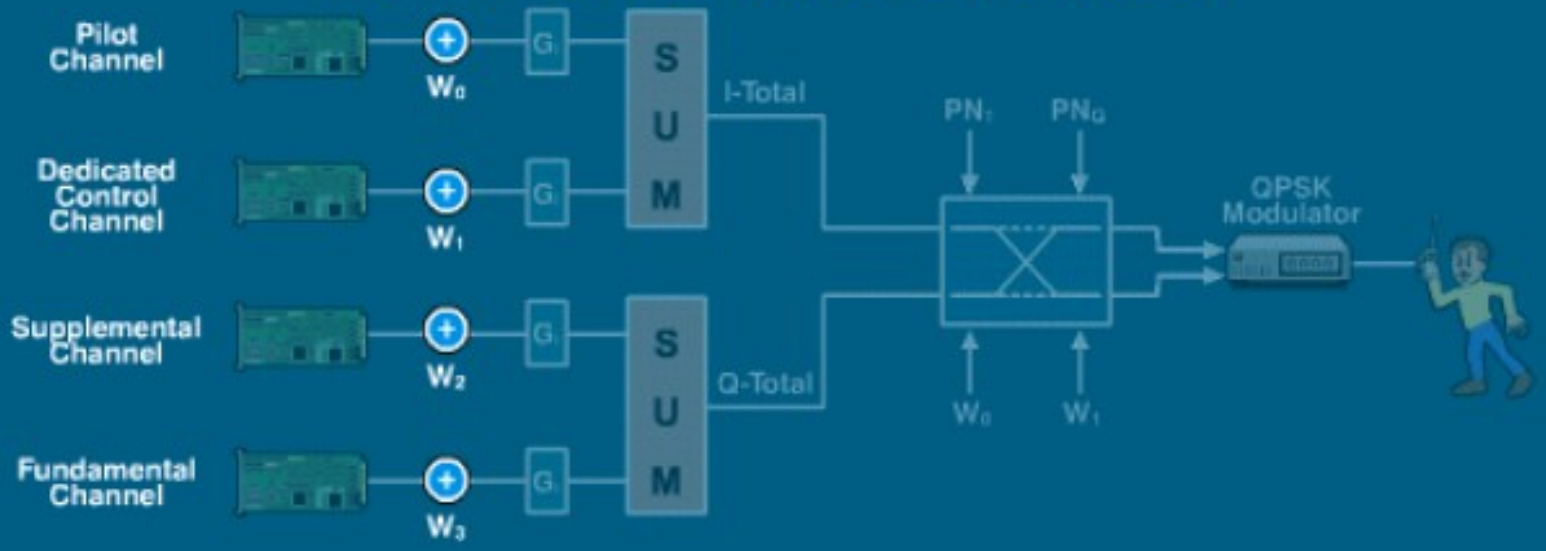
CDMA2000 REVERSE CARRIER
UP TO 4 CHANNELS* SIMULTANEOUSLY FOR DATA



⊕ = Exclusive-OR Operation
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*Or more, since multiple Supplemental Channels may be allocated

FOUR WALSH CODES
FOR FOUR REVERSE CHANNELS

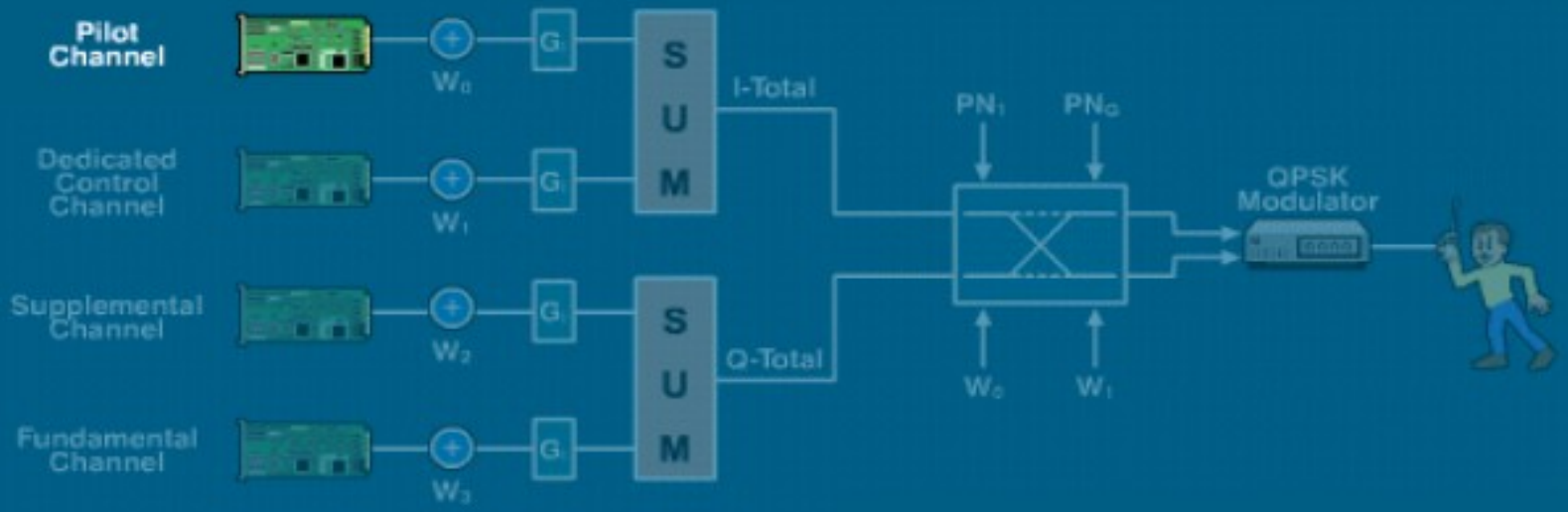


Four Walsh Codes create up to four* orthogonal Reverse Channels for each user

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*Or more

NICE TO HAVE A PILOT !



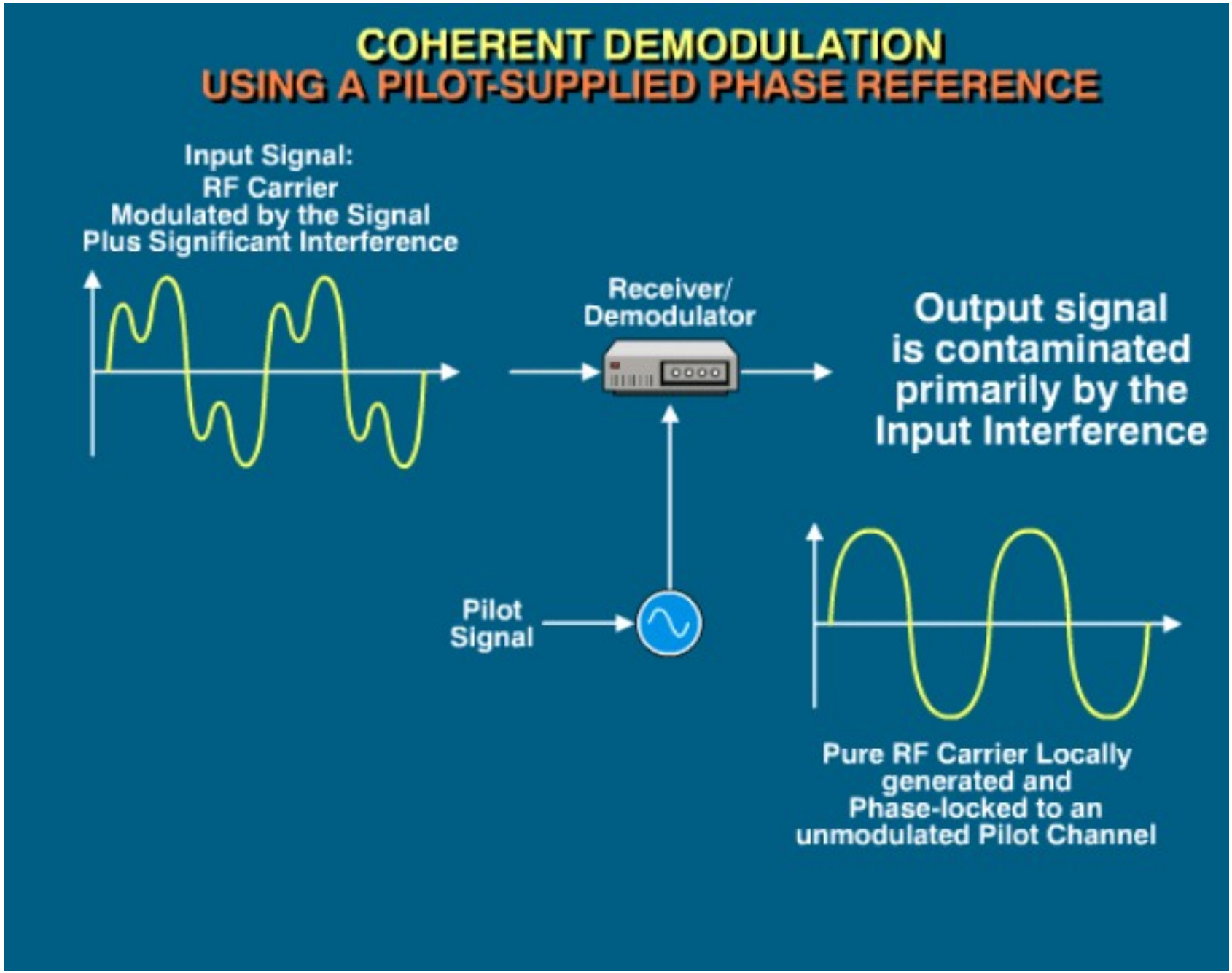




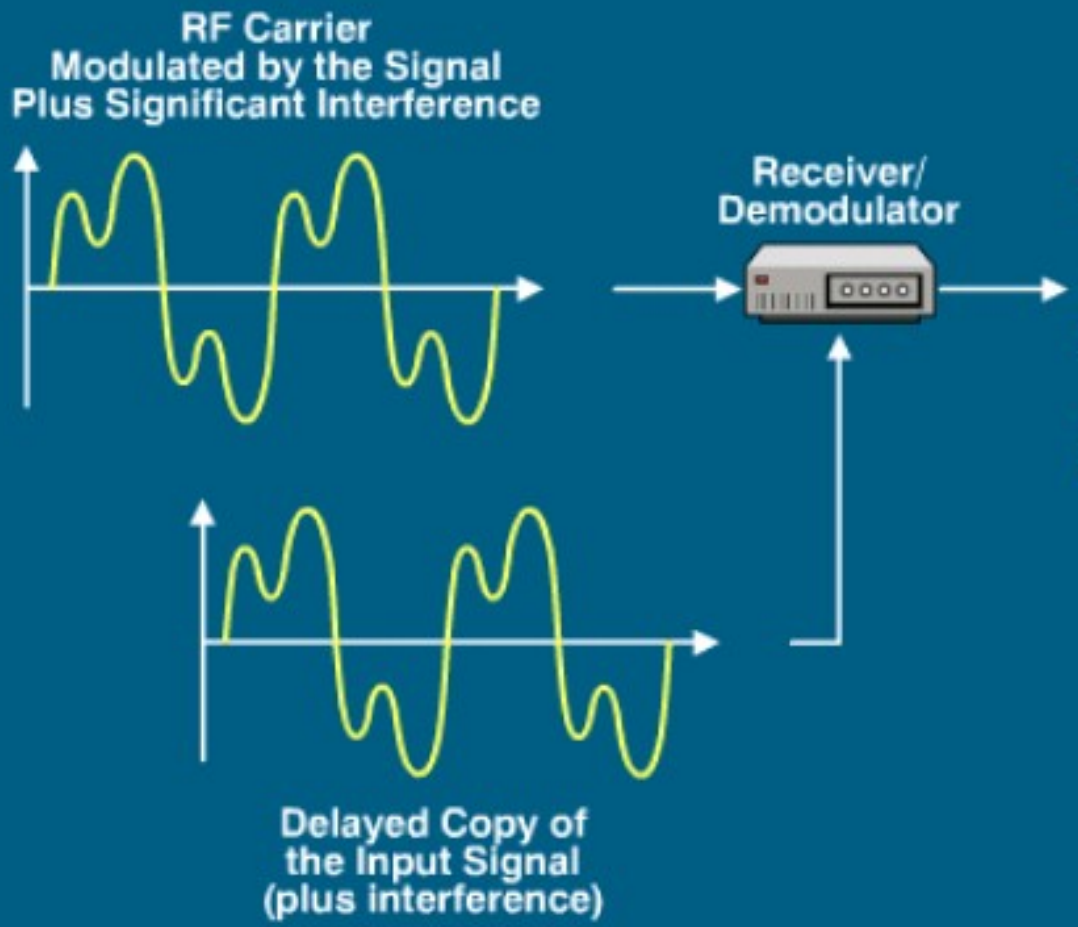
The Pilot Channel provides:

- A phase reference to the Base Station (BS)
  - Allows coherent demodulation at the BS
  - Improves performance by up to 2x (3dB)
- A constant (Pilot) signal power that the BS can use for accurate handset transmit power control

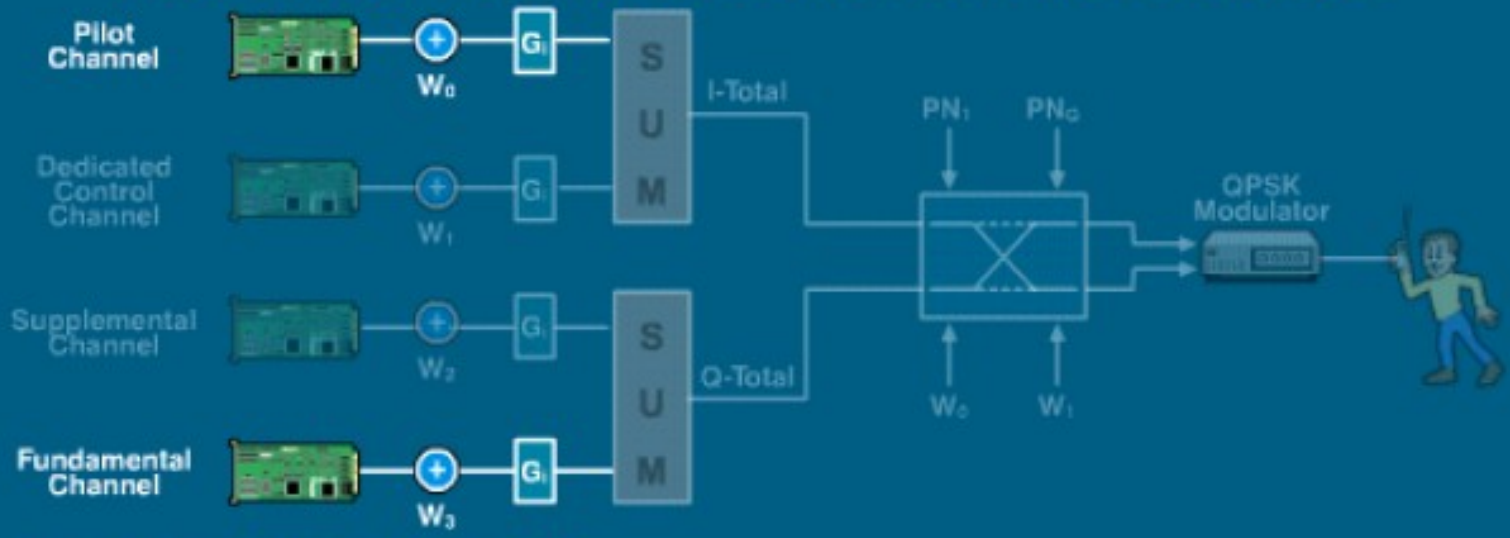
COHERENT DEMODULATION
USING A PILOT-SUPPLIED PHASE REFERENCE



NON-COHERENT DIFFERENTIAL DEMODULATION
DETECTING PHASE CHANGES FROM THE PREVIOUS VALUE



REVERSE FUNDAMENTAL CHANNEL
PLUS PILOT WITH FORWARD POWER CONTROL

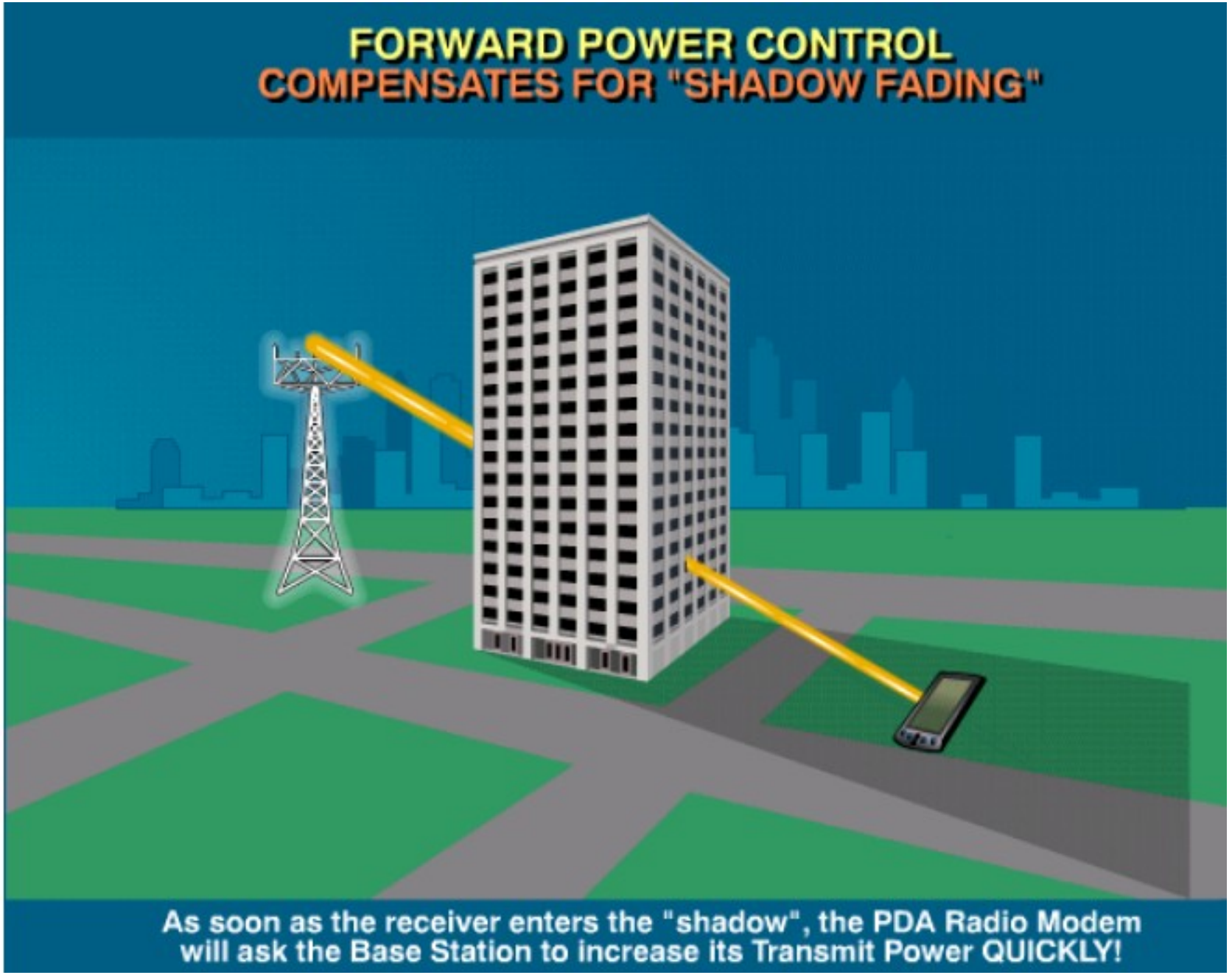


- Fundamental Channel
  - Essentially the SAME as cdmaOne
  - SAME 9.6 Kb/s and 14.4 Kb/s Channel Rates
  - For Voice, low bit rate Data, and signaling

- Pilot Channel includes Time Multiplexed Power Control bits
  - Allows the mobile to control the Base Station Channel Power 800 times per second

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FORWARD POWER CONTROL
COMPENSATES FOR "SHADOW FADING"



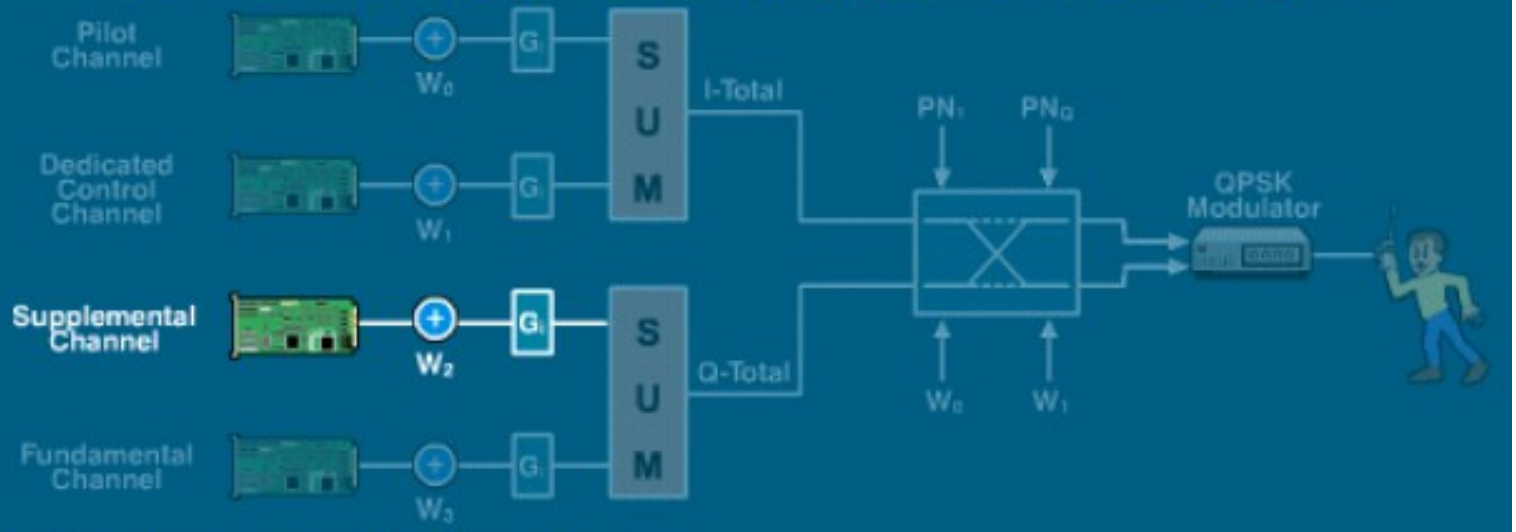
As soon as the receiver enters the "shadow", the PDA Radio Modem will ask the Base Station to increase its Transmit Power QUICKLY!

FAST-FORWARD* POWER CONTROL GIVES ALMOST 2x CAPACITY INCREASE

- Fast forward (downlink) power control by the mobile of the per-channel base station transmitted power
  - 800/sec for CDMA2000 compared to less than 50/sec for cdmaOne
- Enables the base station to transmit about half the power per channel since less power margin is required to handle fading
  - Mobiles can get the base station to ramp up power on its (the moble's) channel rapidly when fades occur
  - Allows the base station to be transmitted to almost 2x as many mobiles before it reaches its power amplifier limit
- Gives almost 2x capacity improvement on the forward link (downlink) compared to 2G CDMA

*Fast reverse power control was implemented in 2G CDMA to solve the "near/far" problem, so the enhancement in 3G is the addition of similarly fast power control on the forward link

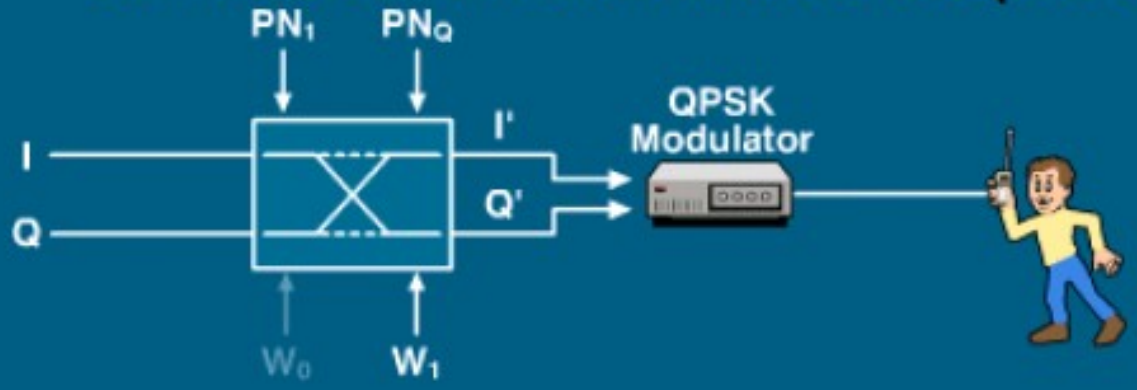
REVERSE SUPPLEMENTAL CHANNEL
PLUS PILOT, FUNDAMENTAL, AND/OR CONTROL



- **Supplemental Channel**
  - For high bit rate Data, Multimedia, etc.
- **MUST also have:**
  - Fundamental Channel and/or a Dedicated Control Channel for most of the control/signaling
  - Pilot Channel - For coherent demodulation and Forward Power Control

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G_i = Per Channel Individualized Gain
PN = Pseudonoise Code Sequence

HYBRID PSK (HPSK) OR ORTHOGONAL COMPLEX QPSK (OCQPSK)



- "Complex Scrambling" takes potentially unbalanced* I and Q inputs and tends to "smear" them across the outputs in a more balanced manner with:

$$I' = (I \times PN_I - Q \times PN_Q)$$
$$Q' = (Q \times PN_I + I \times PN_Q)$$

- Combining the 2-bit orthogonal Walsh codes into the process provides additional improvement

CDMA2000
MAJOR CHARACTERISTICS

Nominal Bandwidth [Hz]	1.25M	3.75M	7.5M	11.25M	15M
Radio Evolved From	ANSI TIA/EIA-95 (formerly IS-95)				
Network Infrastructure Evolved From	ANSI TIA/EIA-41 (formerly IS-41)				
Services Evolved From	ANSI TIA/EIA-95 (formerly IS-95)				
Chip Rate [c/s]	1.2288M	3.6864M	7.3728M	11.0592M	14.7456M
Max User Bit Rate*** [b/s] (Single Code or Channel)	307.2K	1.0368M	2.0736M	2.4576M	2.4576M
Max User Bit Rate** [b/s] (Multicode)	~614K	~2M	~4M	~6M	~8M
Frequency Re-Use	Universal (1/1)				
Coherent Demodulation on both Fwd and Rev Links?	Yes, using continuous Pilot Channels				
Inter-Cell Synchronization Required?	Yes				
Frame Time [msec]	20 msec typically; also 5 msec option for control				

*IS-2000 is TIA name for the CDMA2000 standard
**Only achievable under near-ideal conditions, e.g., minimum intercell interference and congestion, low speed, etc.
***Assuming 100% redundancy for Forward Error Correction

END OF LESSON 5