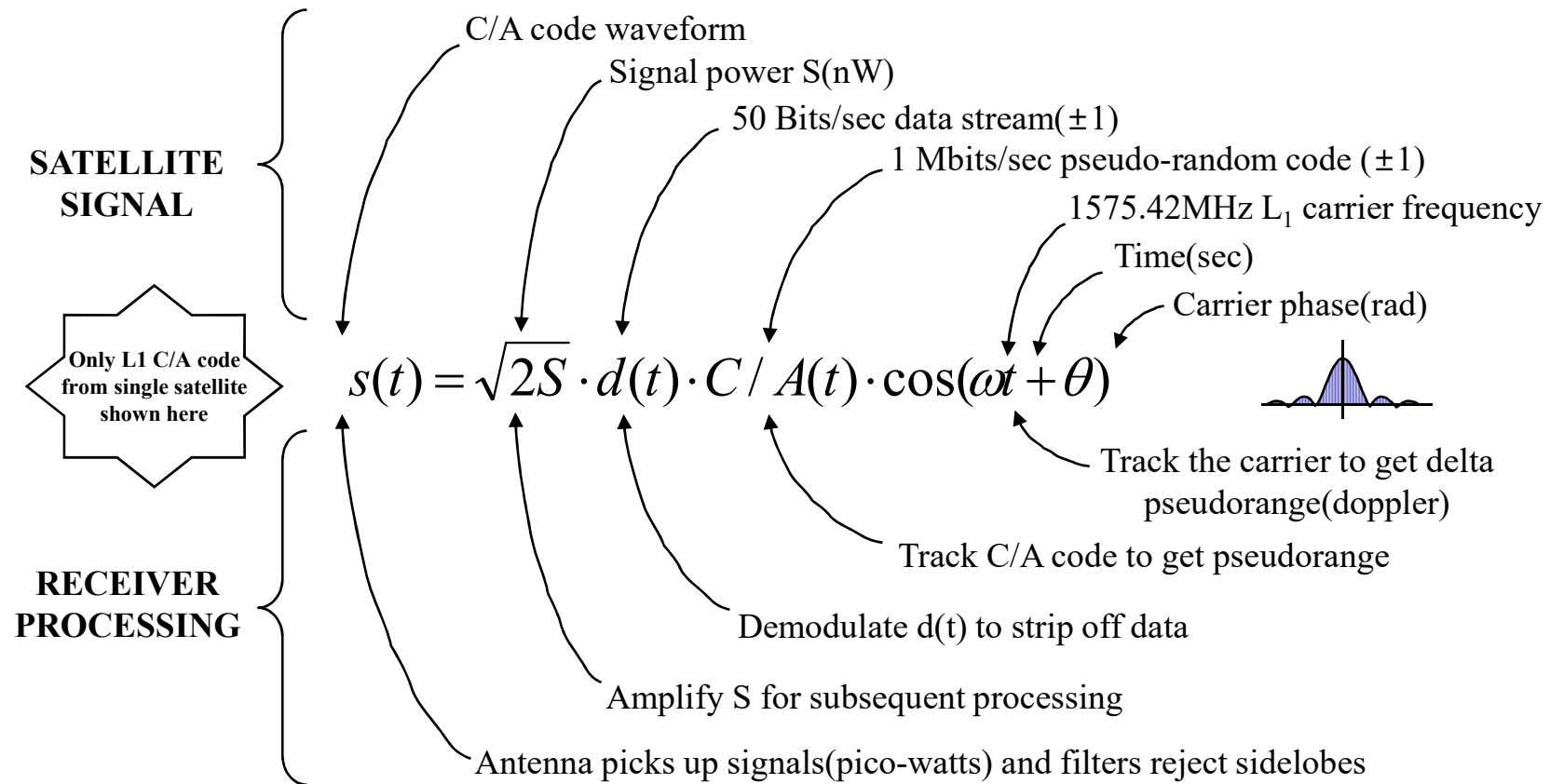


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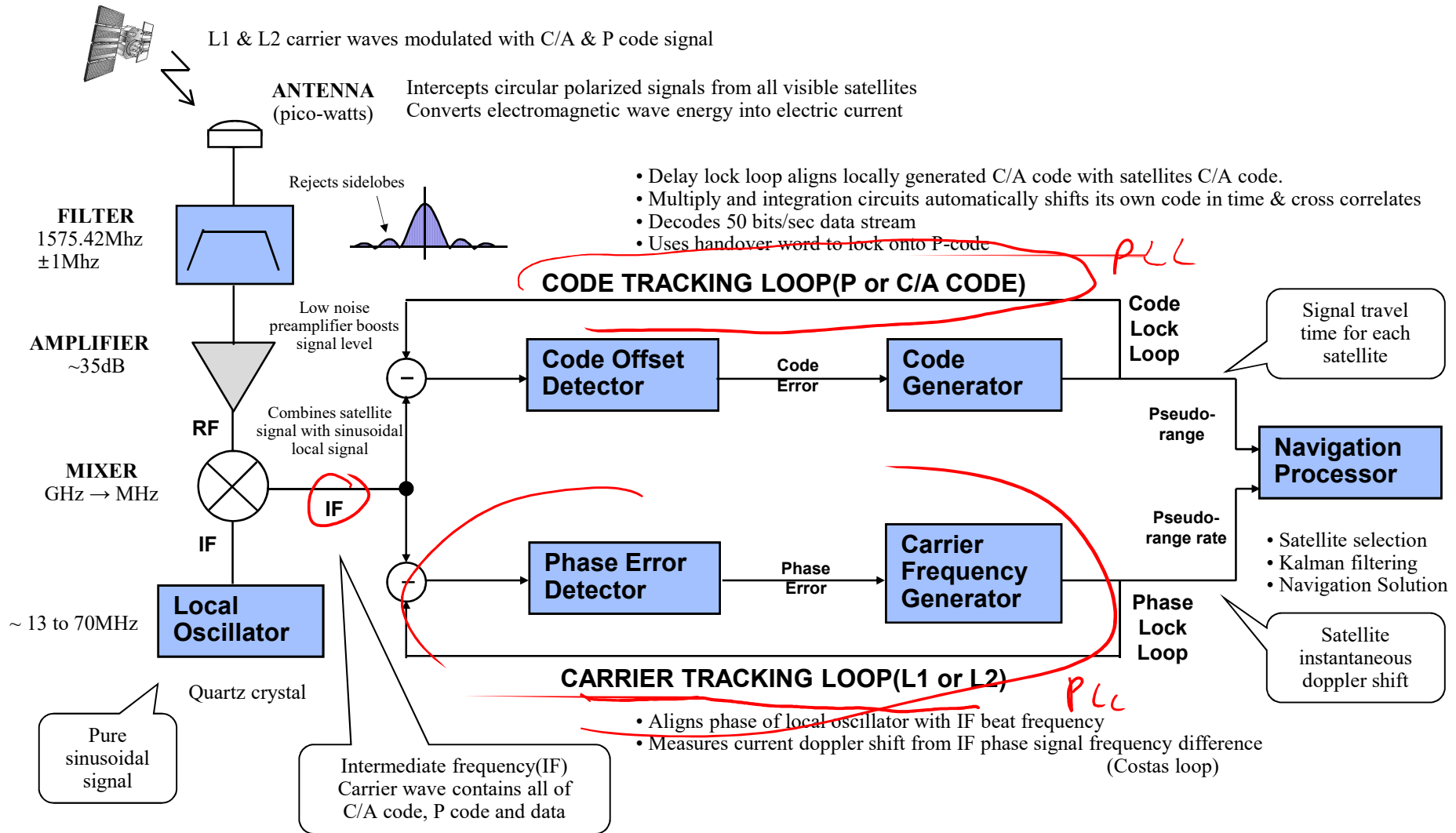
# Il Ricevitore GPS

*Pierfrancesco Lombardo*

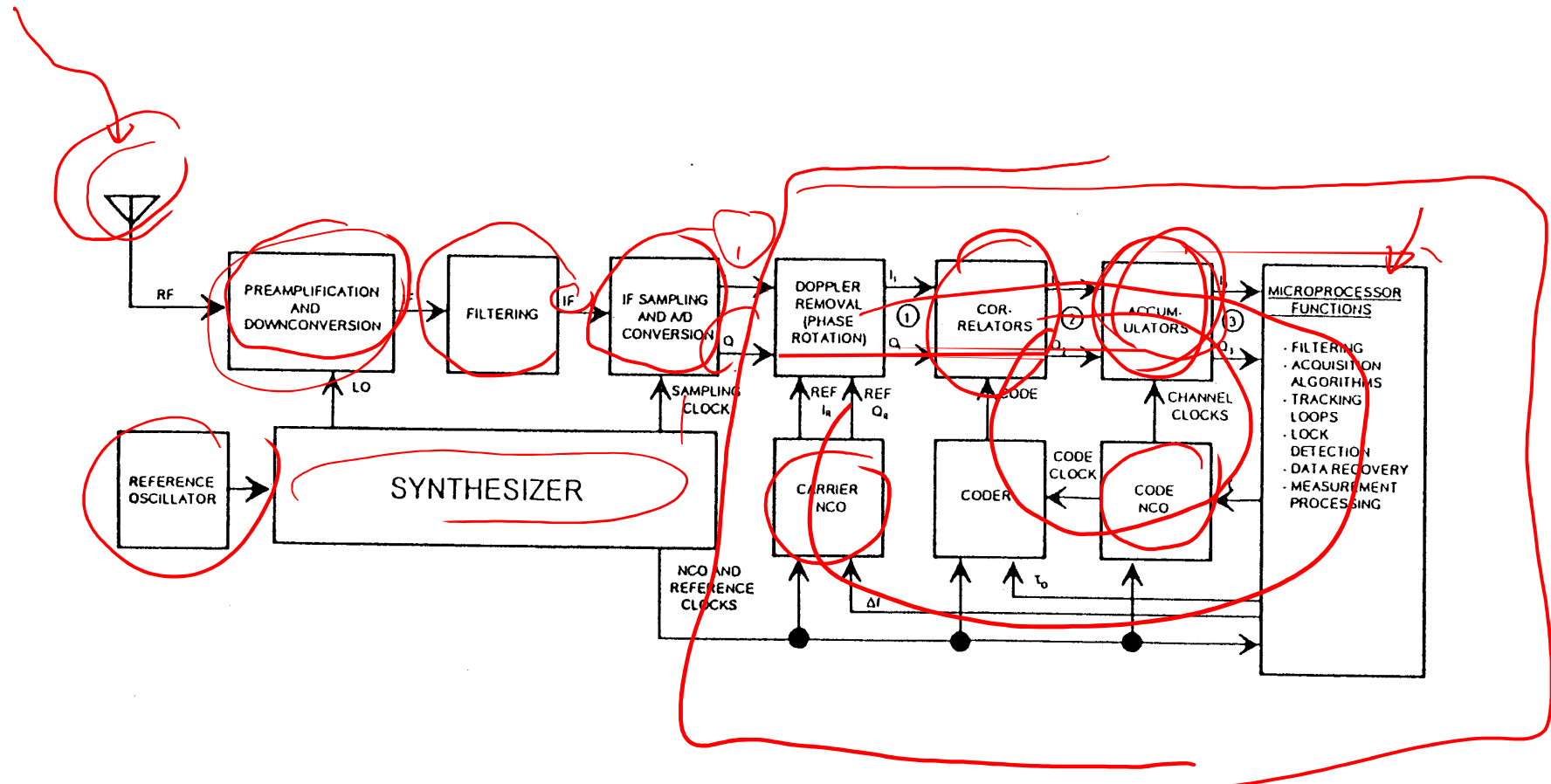
# Elaborazione del segnale GPS nel ricevitore



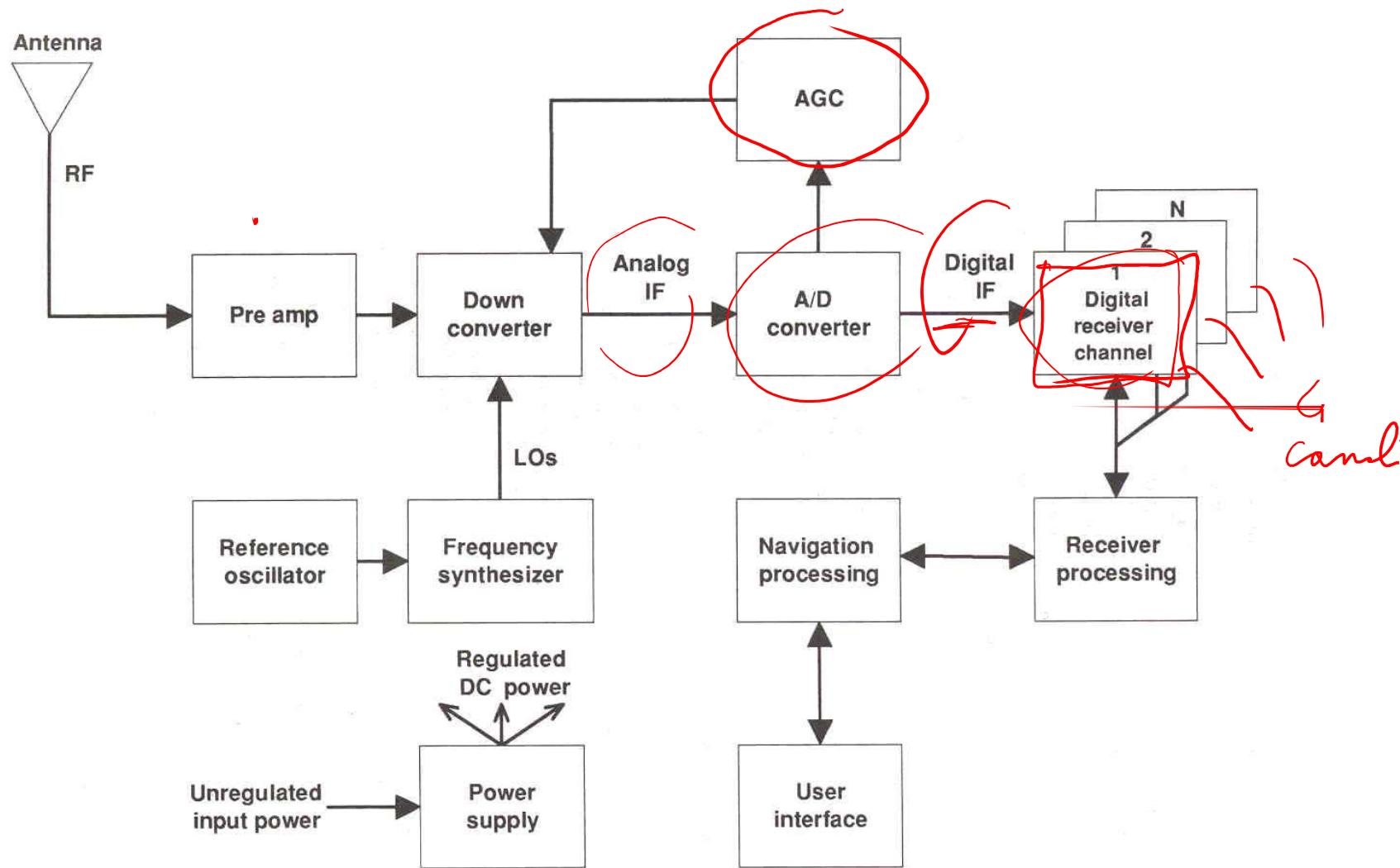
# Funzioni del ricevitore GPS



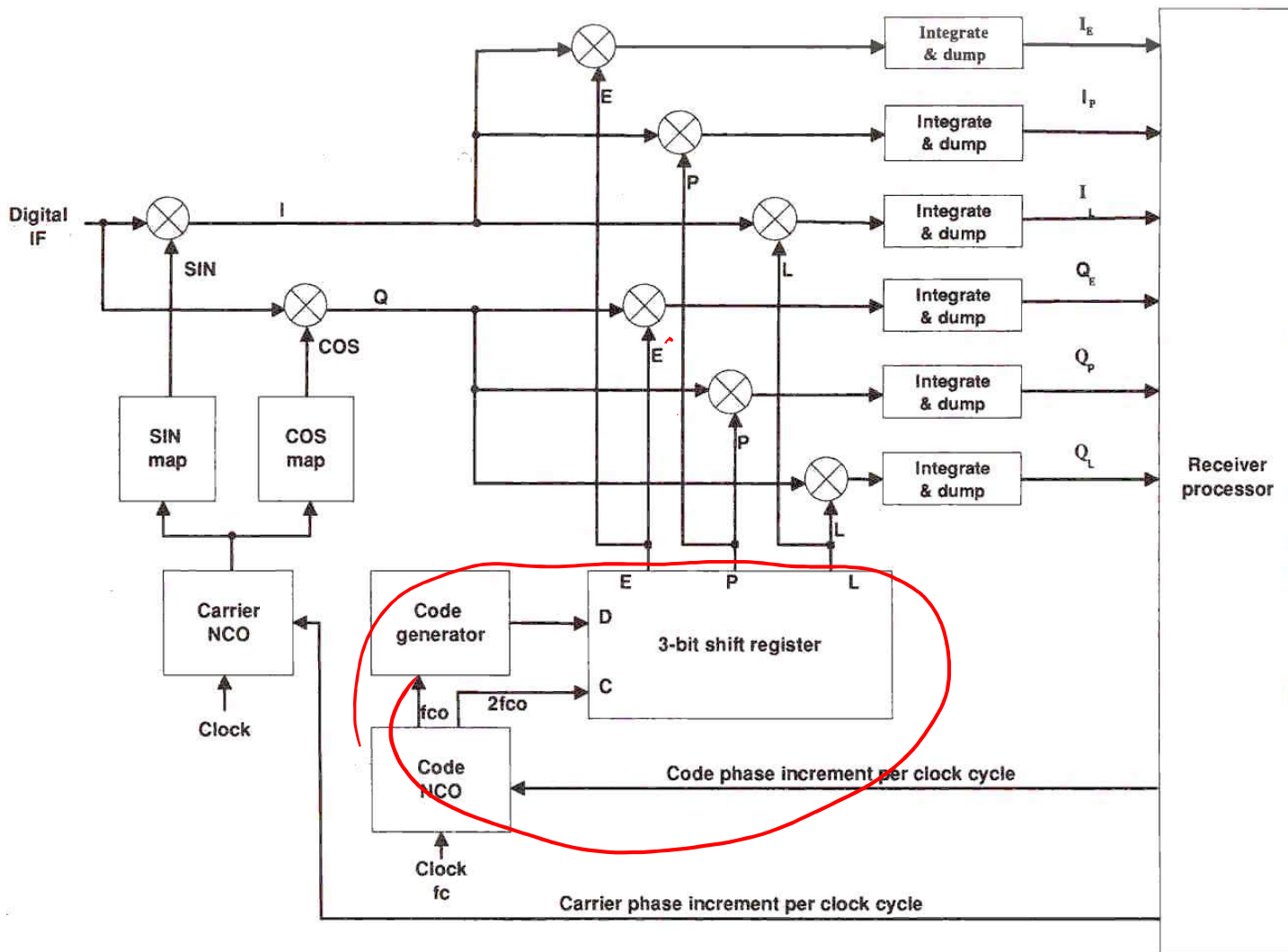
# Diagramma a blocchi funzionali del ricevitore GPS



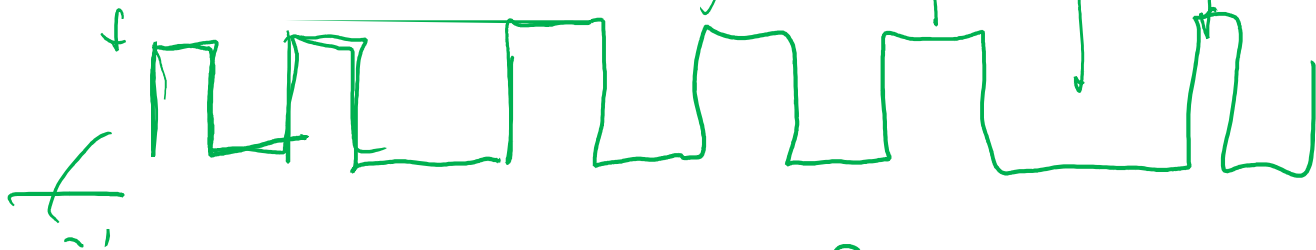
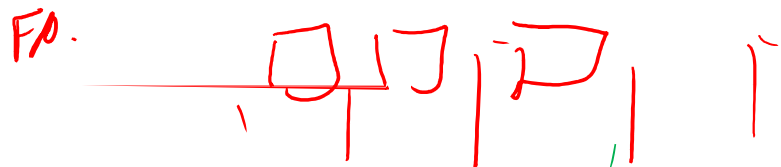
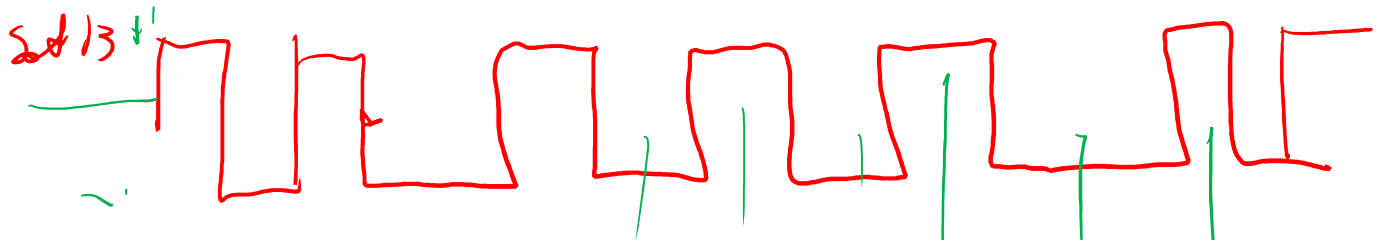
# Sezioni Analogica e Digitale del ricevitore GPS



# Schema del ricevitore GPS -Analogico



# T4FF



$$h(\nu) = S^{\text{eff}}(-t)$$

→ autobcm

1023

2046 pulse

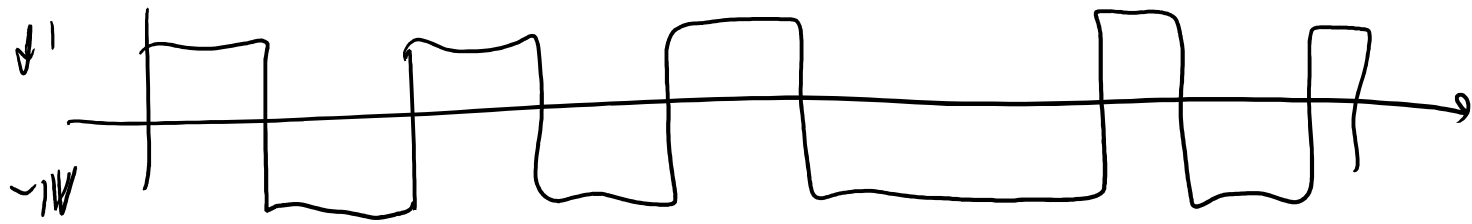
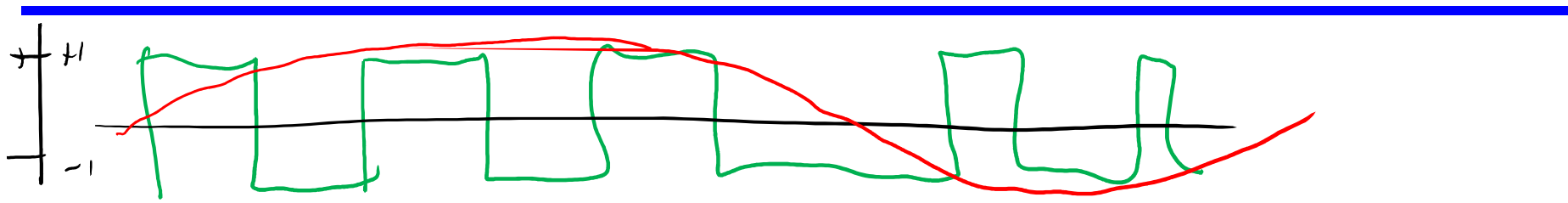
1 ms

A-GPS

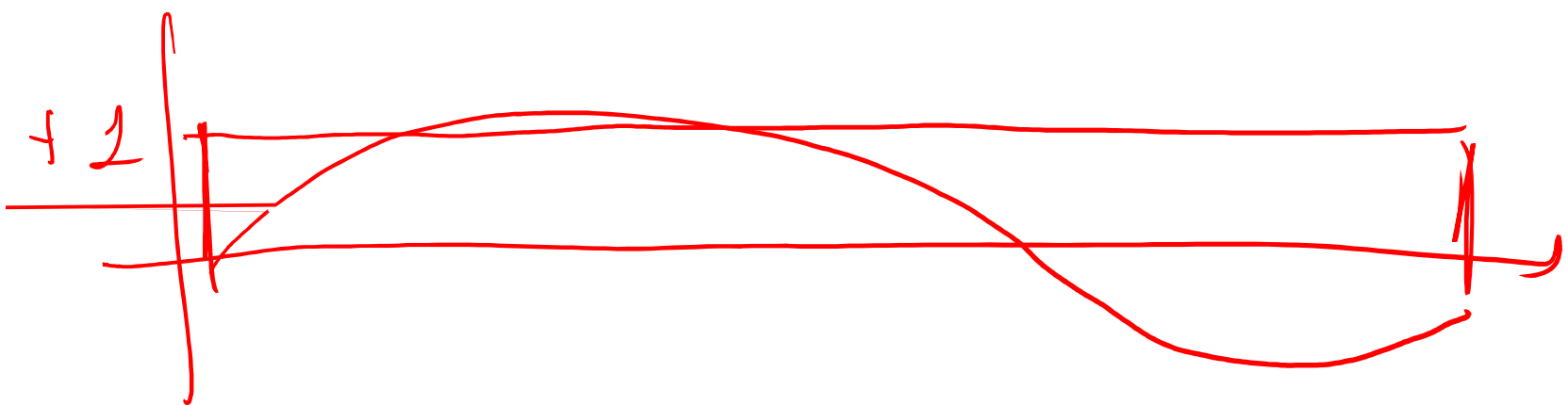
2 s

$$13 \times 20 = 260$$

3 min



1kHz



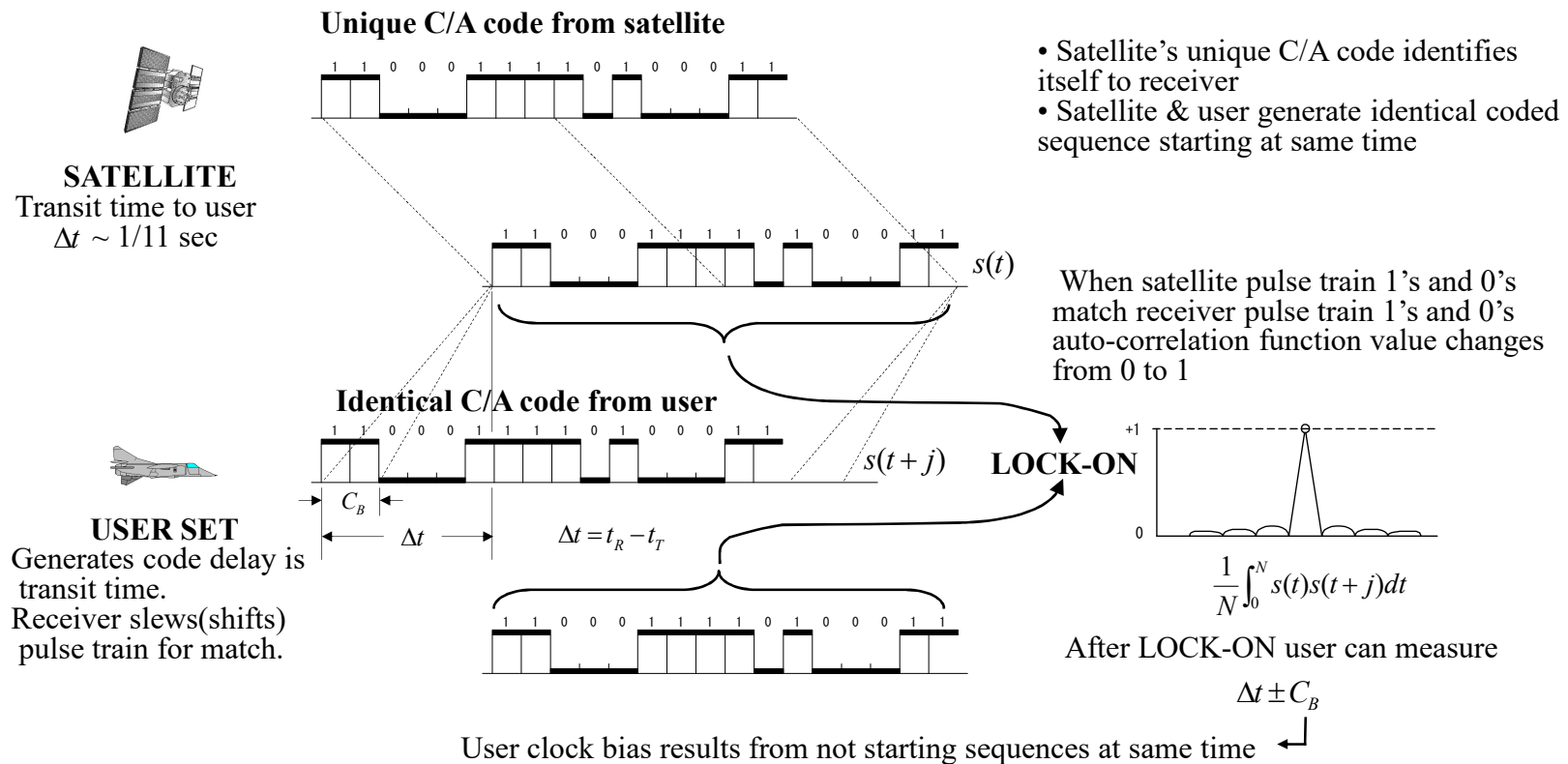
1213



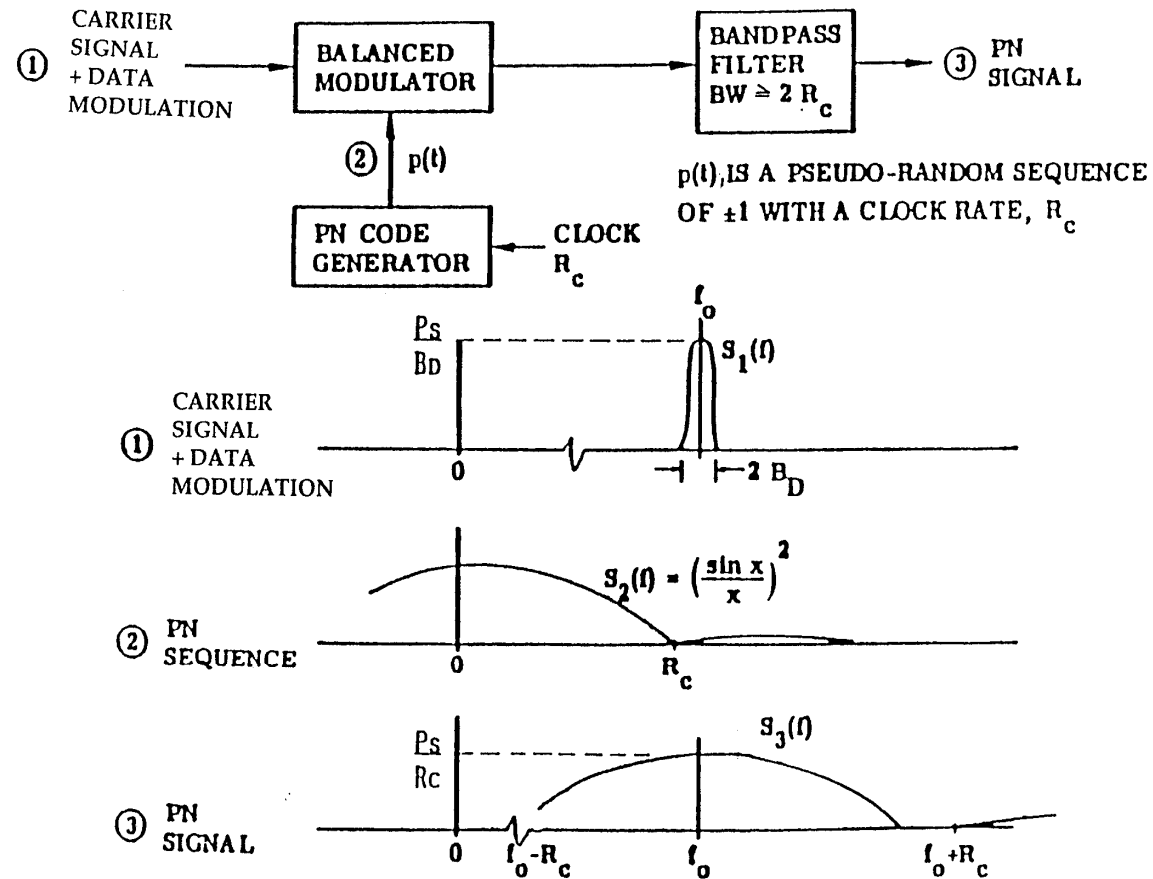


# Compressione dei codici con filtro adattato

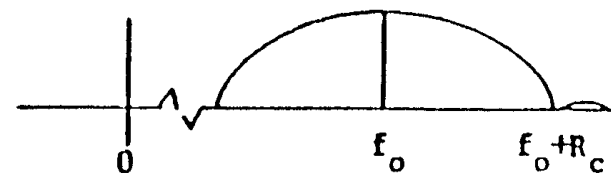
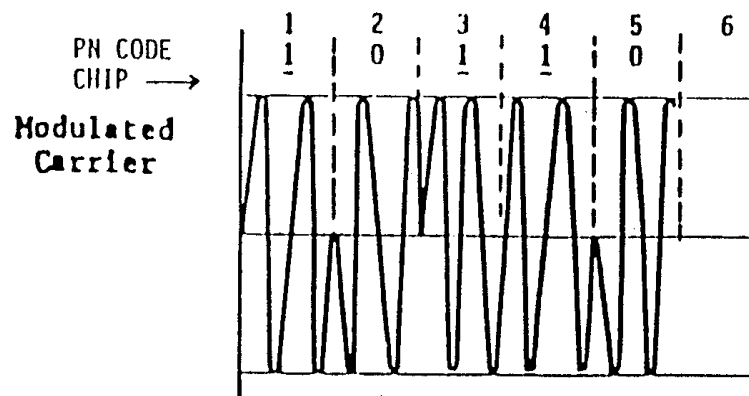
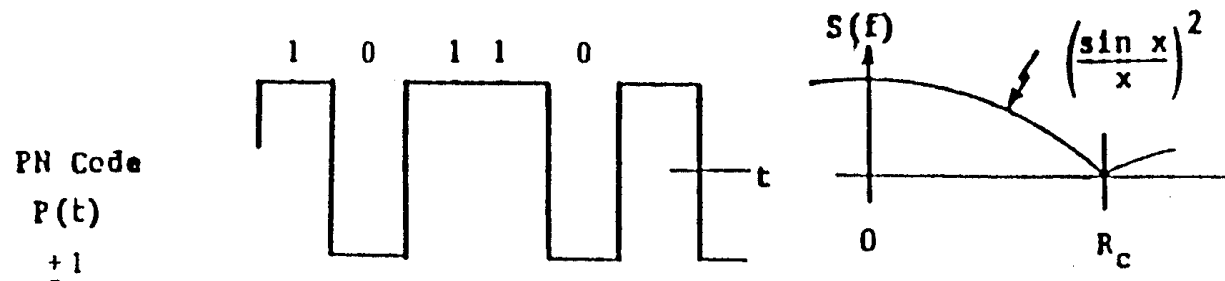
Real-time Code Matching is Used to Identify Satellite and Measure Signal Travel Time



# Richiamo sulla espansione di banda con i PRN

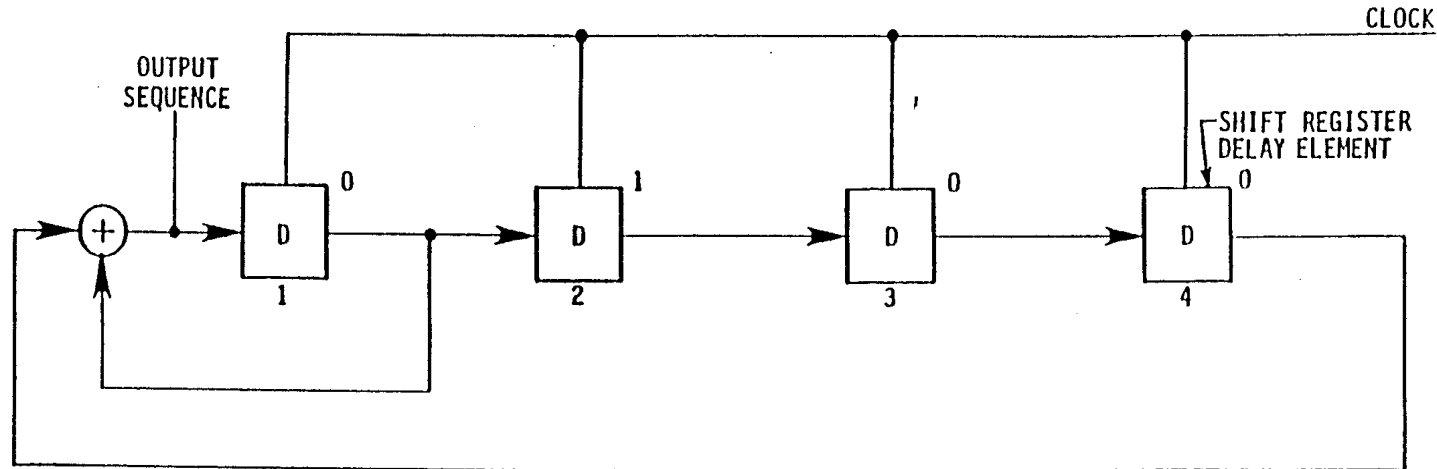


# Codici e forme d'onda PRN

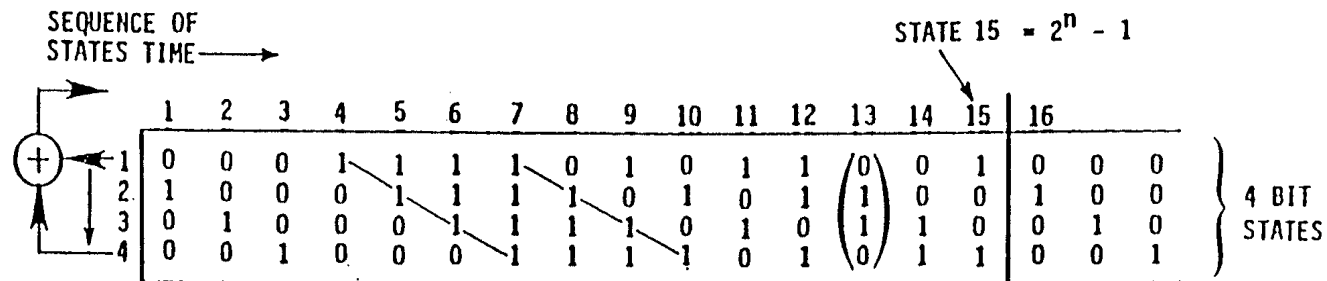


# Rigenerazione di PRN nel ricevitore

n = 4 FOUR STAGE FEEDBACK SHIFT REGISTER

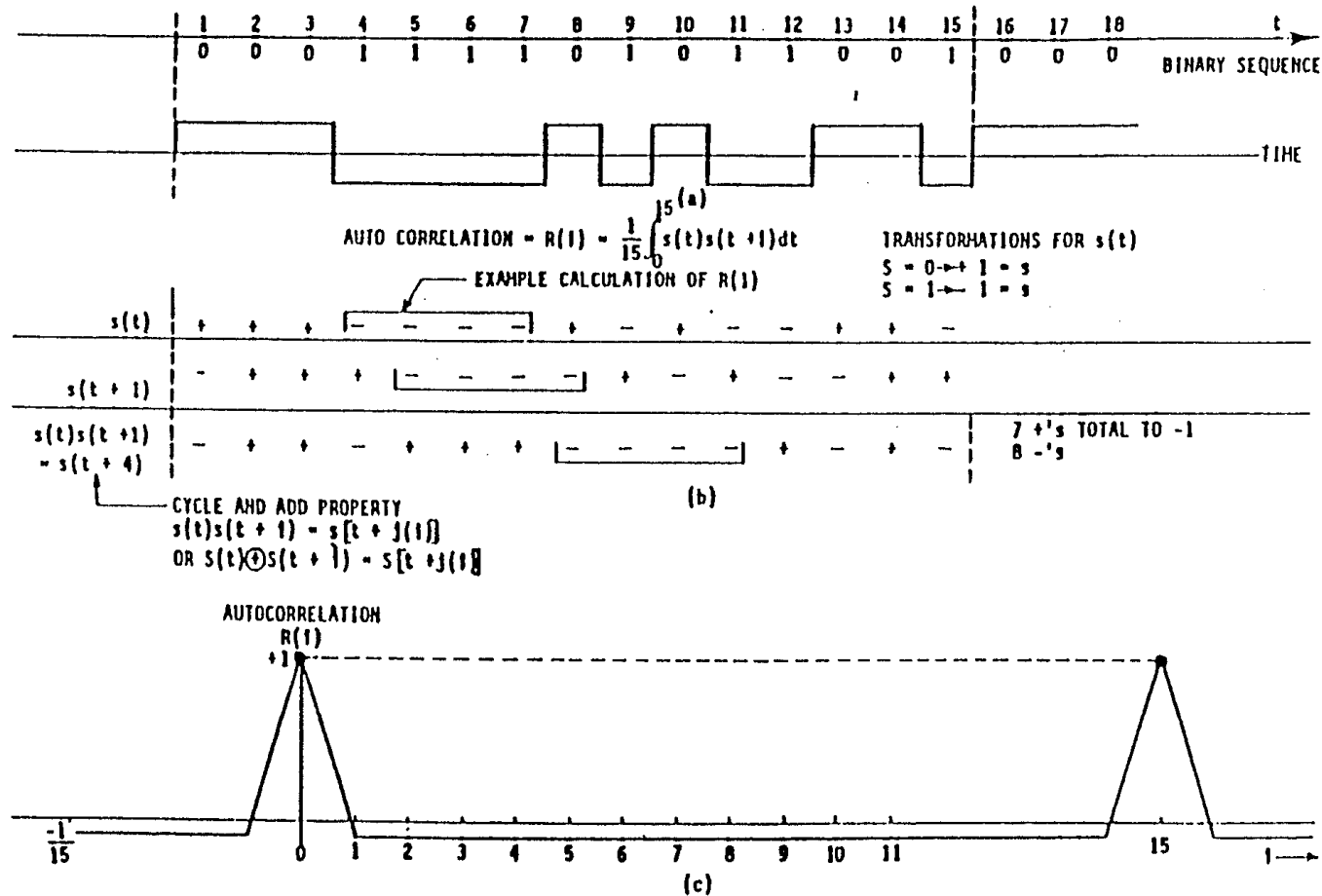


(a)

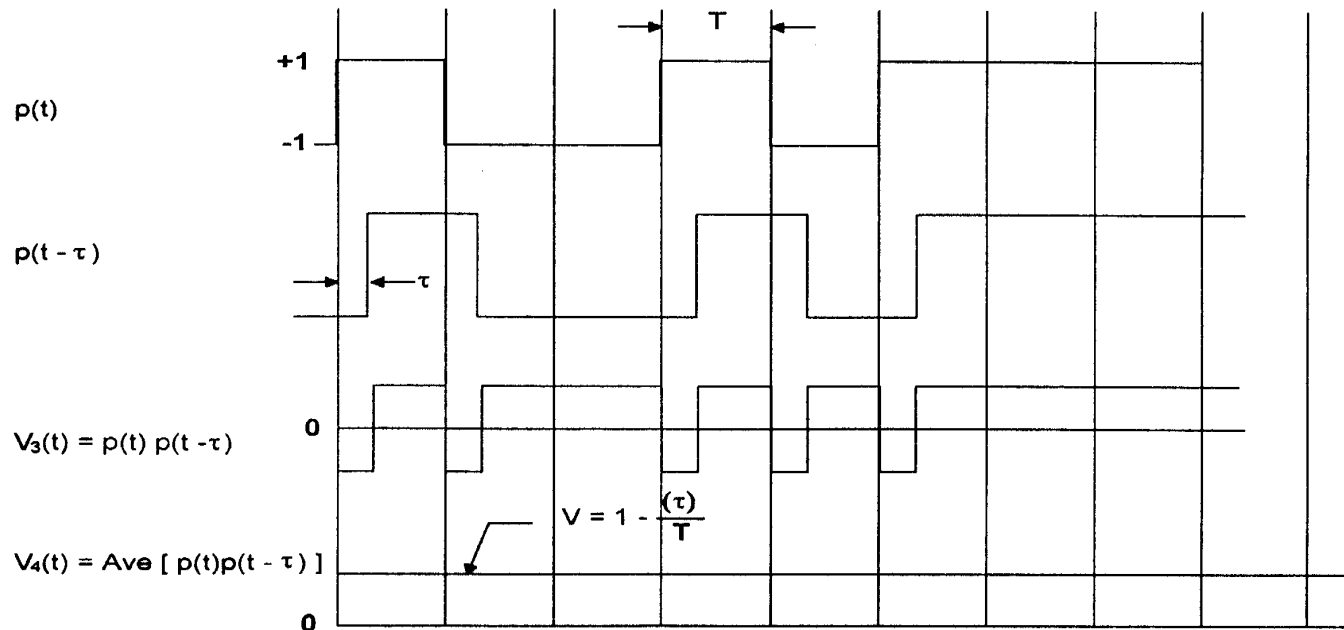
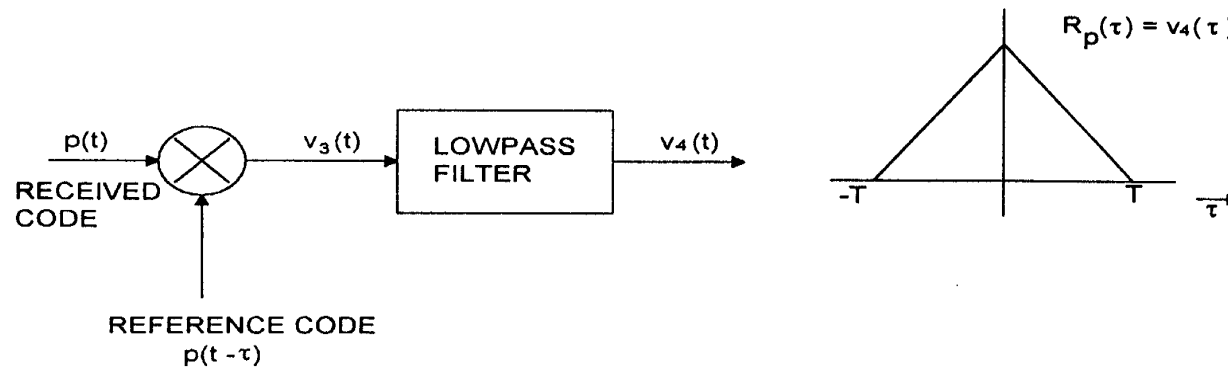


(b)

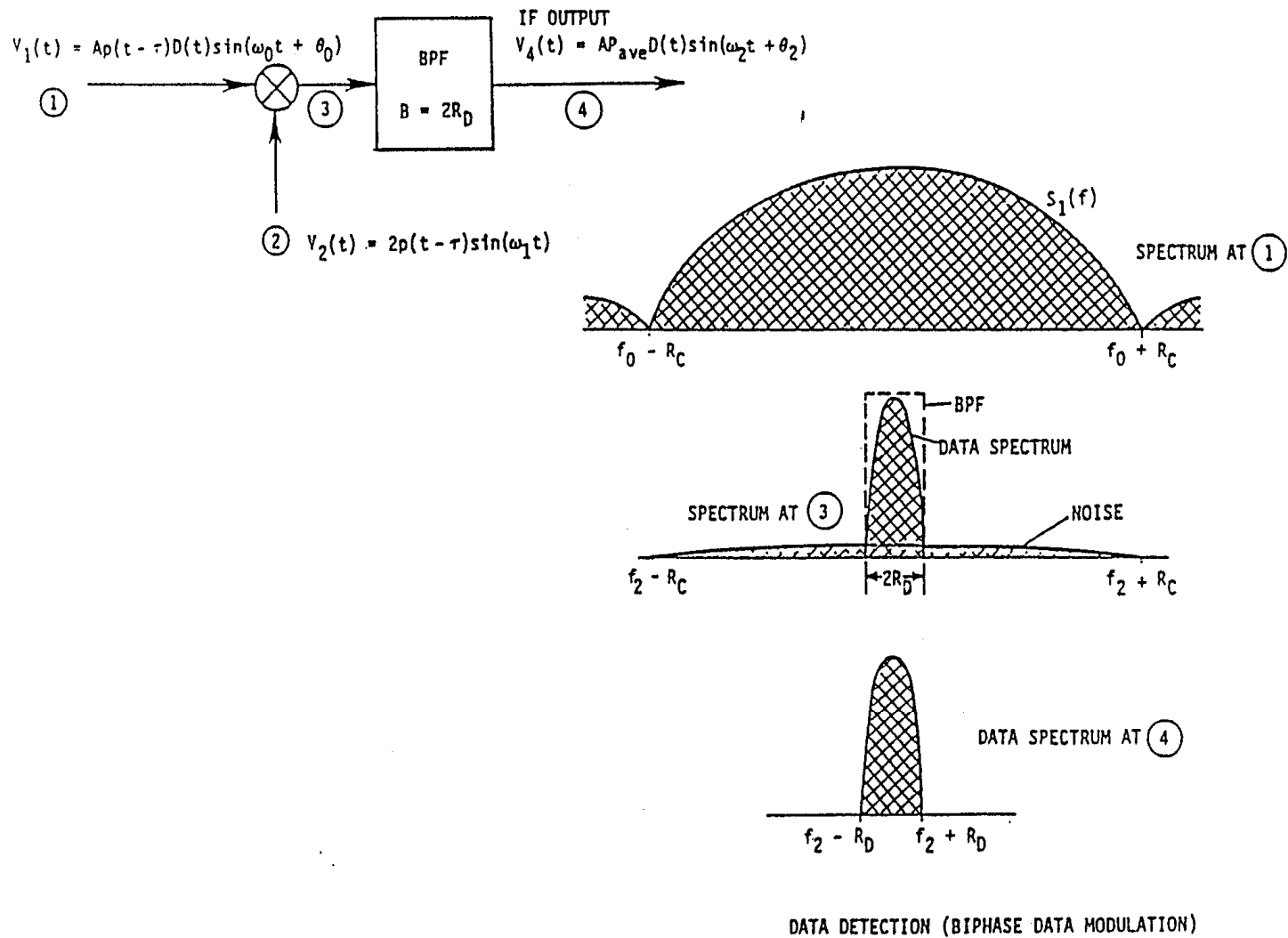
# Uscita del filtro: Autocorrelazione di PRN



# Forme d'onda in un correlatore di codice PRN



# Compression dello spettro e demodulazione



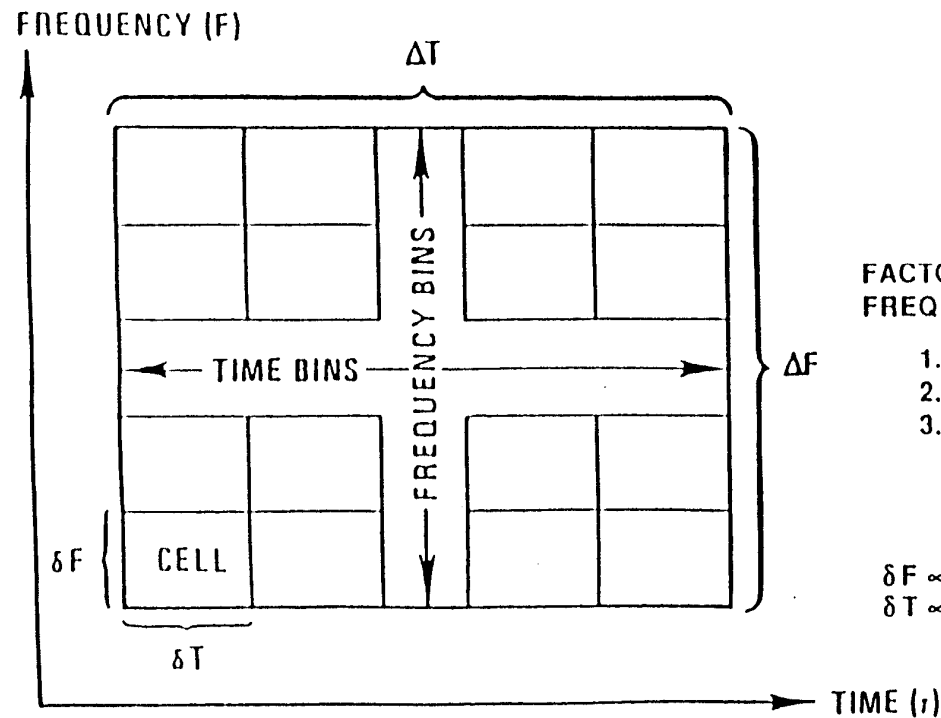


# Aggancio del codice C/A

Ricerca: limiti sulle zone di incertezza

## FACTORS DETERMINING LIMITS OF TIME UNCERTAINTY

1. RELATIVE CLOCK TIMING (CODE EPOCH)
2. PROPAGATION DELAY
3. RELATIVE CLOCK INSTABILITY



## FACTORS DETERMINING LIMITS OF FREQUENCY UNCERTAINTY

1. RELATIVE OSCILLATOR FREQUENC
2. DOPPLER FREQUENCY
3. RELATIVE OSCILLATOR INSTABILIT'

$$\delta F \propto (\text{DETECTOR BANDWIDTH})$$

$$\delta T \propto (1 / (\text{CODE RATE}) \text{ or possibly } 0.5 \text{ chi})$$

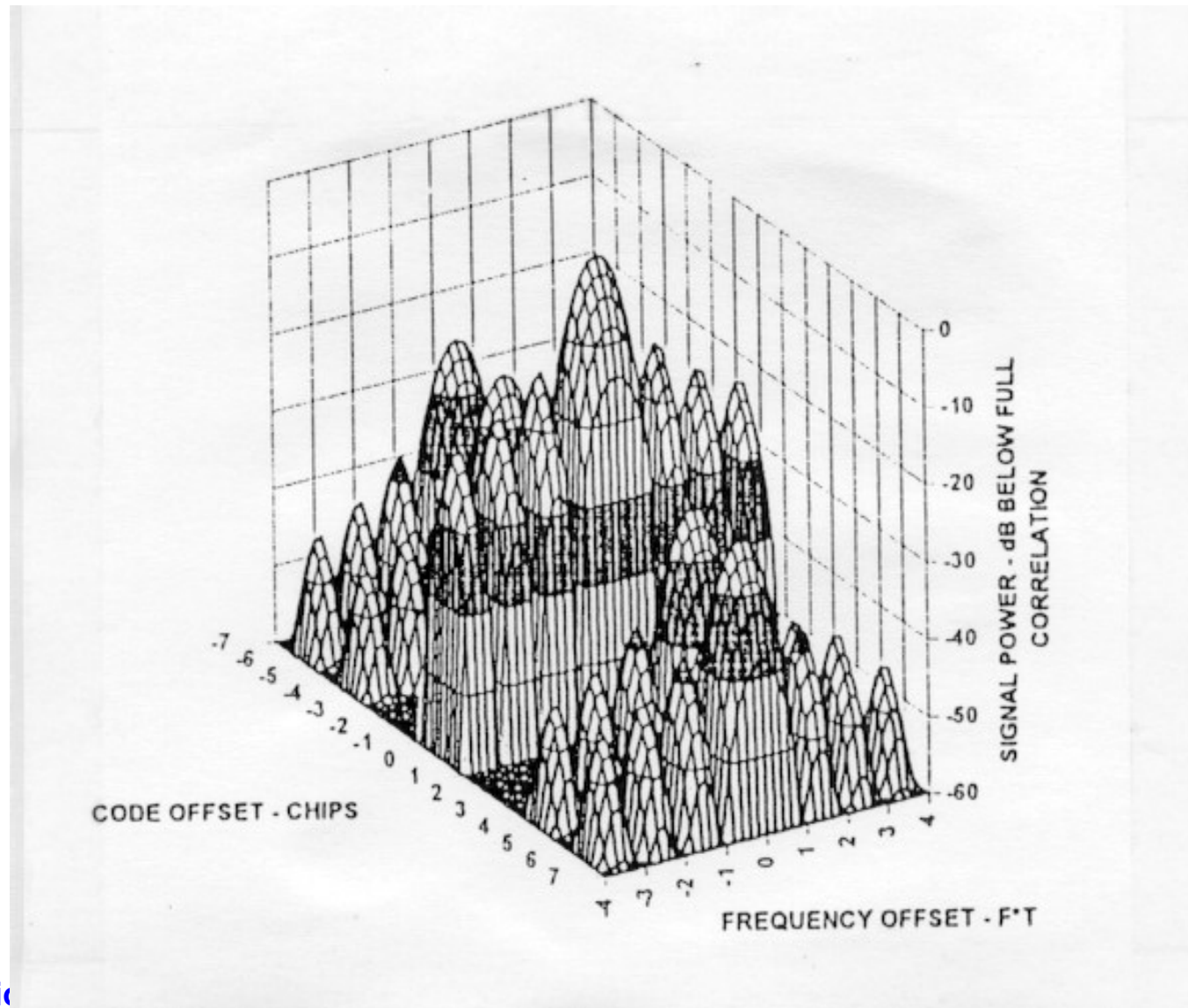
# Algoritmo di ricerca

---

- Frequenza portante
  - Assegna allo NCO la frequenza Doppler di portante stimata
- Frequenza di codice
  - Assegna allo NCO di codice la Doppler di codice stimata
- Generatore di codice
  - Inizializza il generatore di codice allo pseudorange stimato (meno l'incertezza)
- Sweep Rate
  - Assegna allo NCO di codice la frequenza di codice + sweep rate
  - oppure, salta di passi di codice (steal clock cycles),
  - Cerca a partire dai ritardi più piccoli per evitare multipath
- Misura la potenza

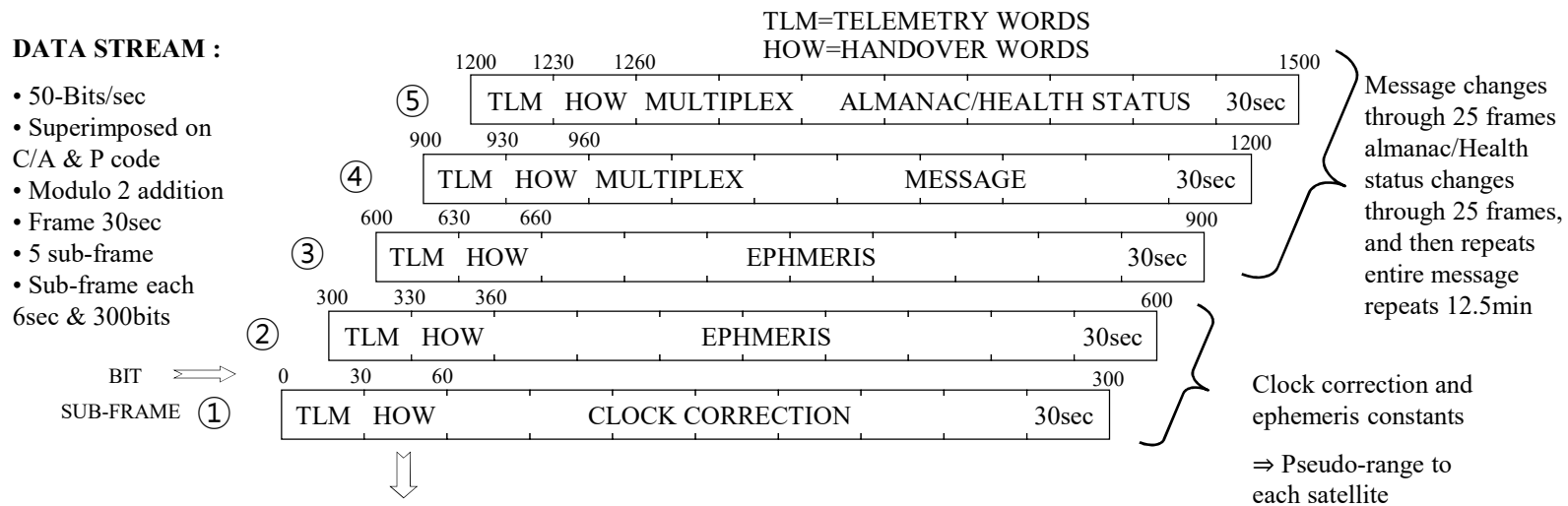
$$P_L = \sum_{k=1}^L (I_k^2 + Q_k^2)$$

# Ricerca bidimensionale

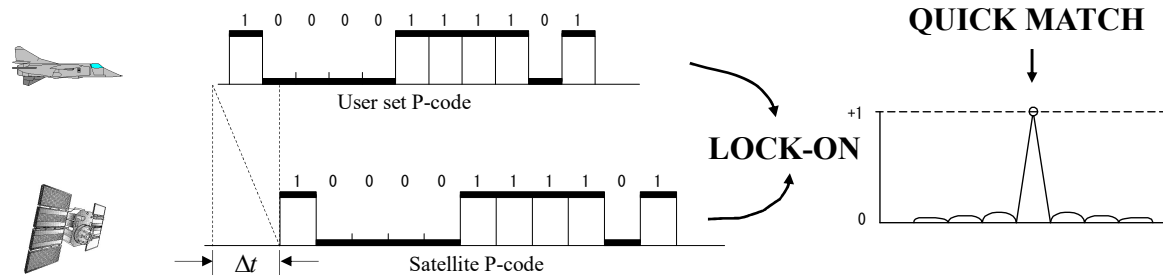


# Aggancio e compressione del codice P

P-Code Receivers Match to C/A Code First and Then Decode 'Handover Word' to Match to P-Code



“HANDOVER WORD” contains a set of constants allowing user receiver to generate current P-code.

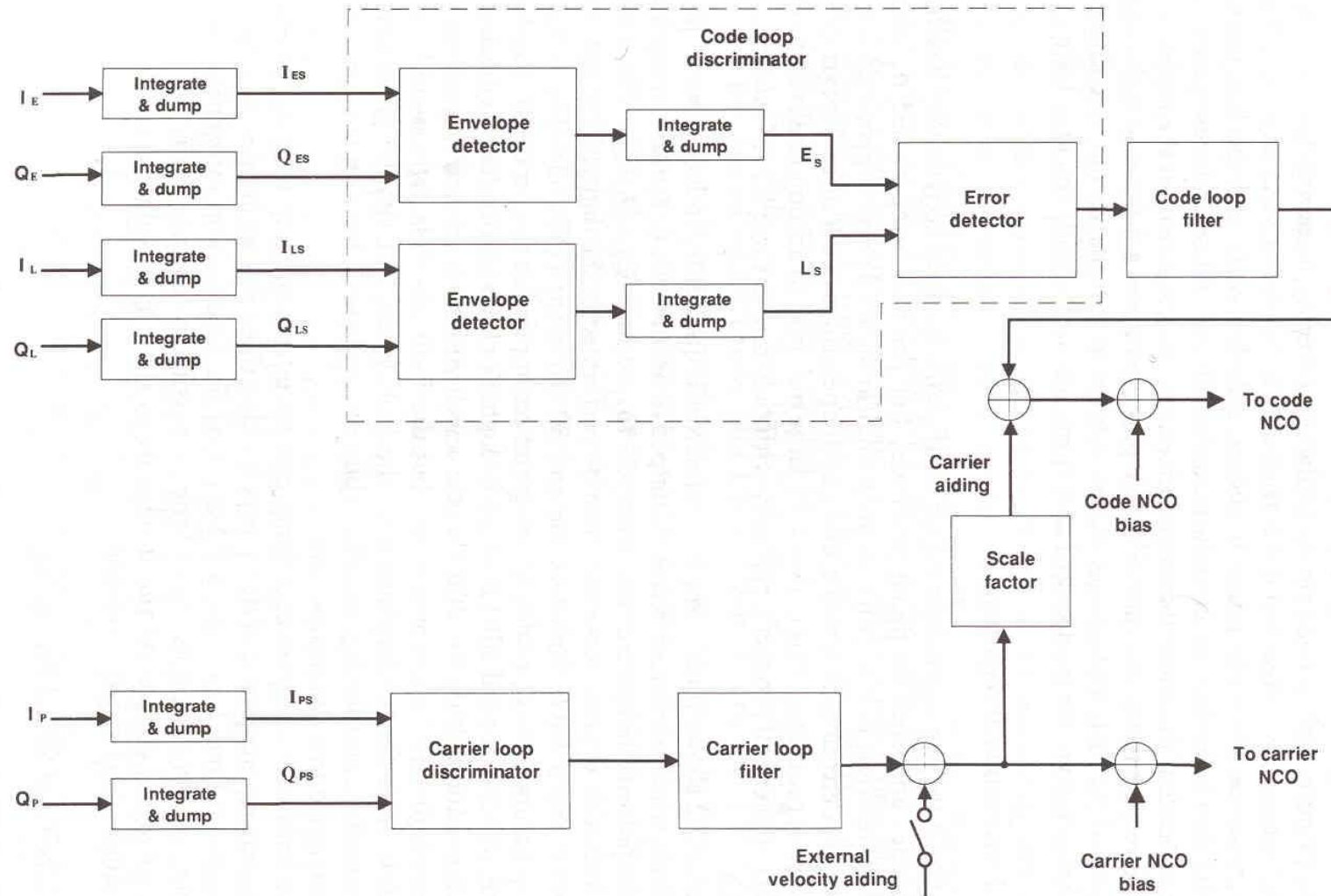


# Loop di Tracking

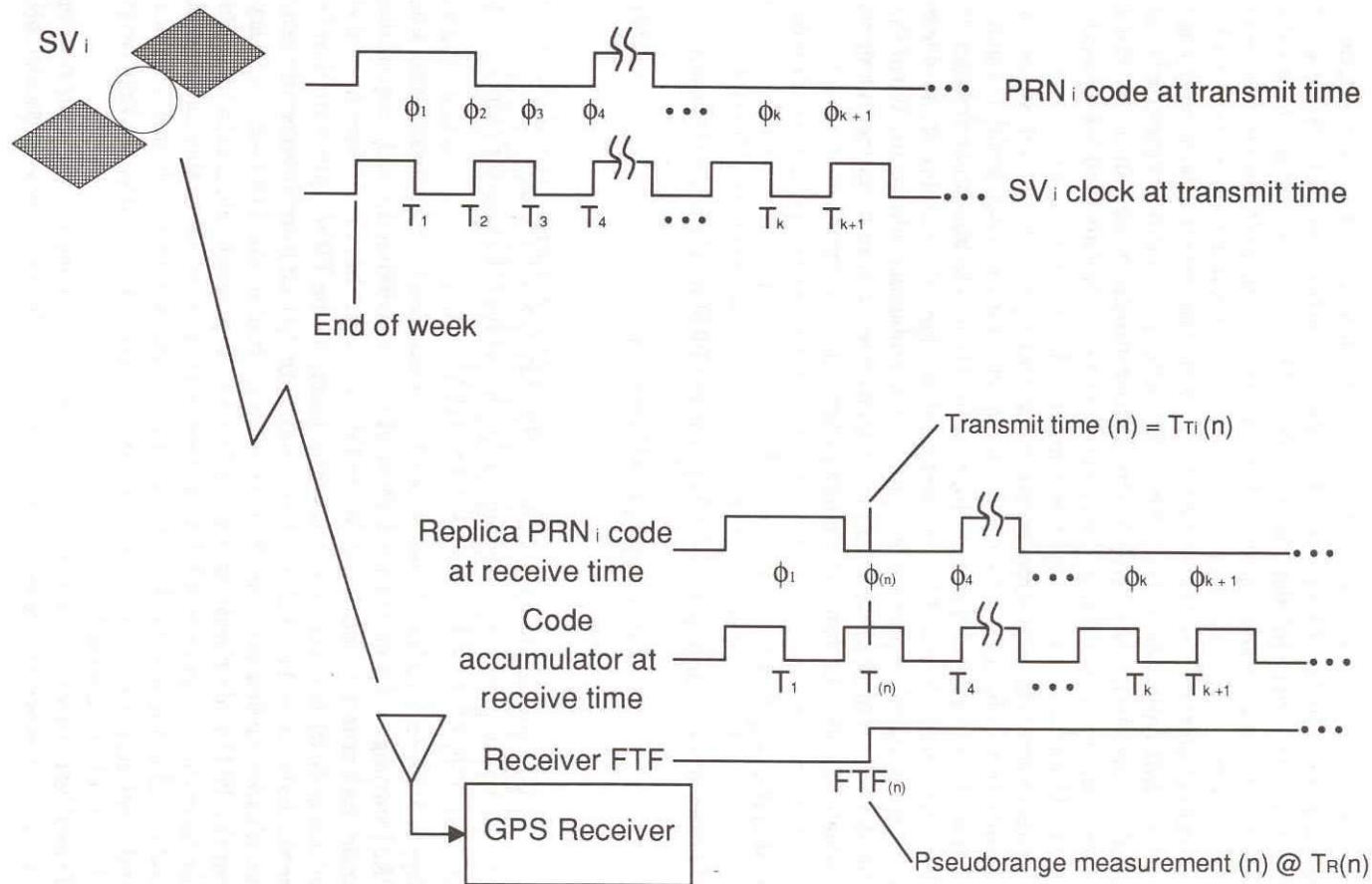
---

- Loop di tracking della portante
  - Phase lock loop (PLL)  
*(necessario per demodulazione coerente I&Q)*
    - Sensibile alla dinamica dell'utente
    - Serve anche a misurare accuratamente la fase della portante (che cambia con la Doppler)
  - FLL (Frequency Lock Loop)
    - Più robusto alla dinamica dell'utente
    - Tollera stress dinamici
- Loop di tracking del codice
  - l'accuratezza richiesta è molto migliore dell'inverso della banda (cioè della larghezza dell'impulso compresso):  $1/1\text{MHz}=1\mu\text{s} \leftrightarrow 300\text{ m}$
  - Serve avere accuratezza migliore di 1/100 di tale valore
  - Con semplice rivelazione su impulso singolo dovrei avere un SNR elevatissimo
  - La soluzione è nella media su tanti impulsi (che aumenta lo SNR equivalente)
  - Si deve però tenere conto della dinamica satellite utente, quindi LOOP di TRACKING
- DLL (Delay Lock Loop)

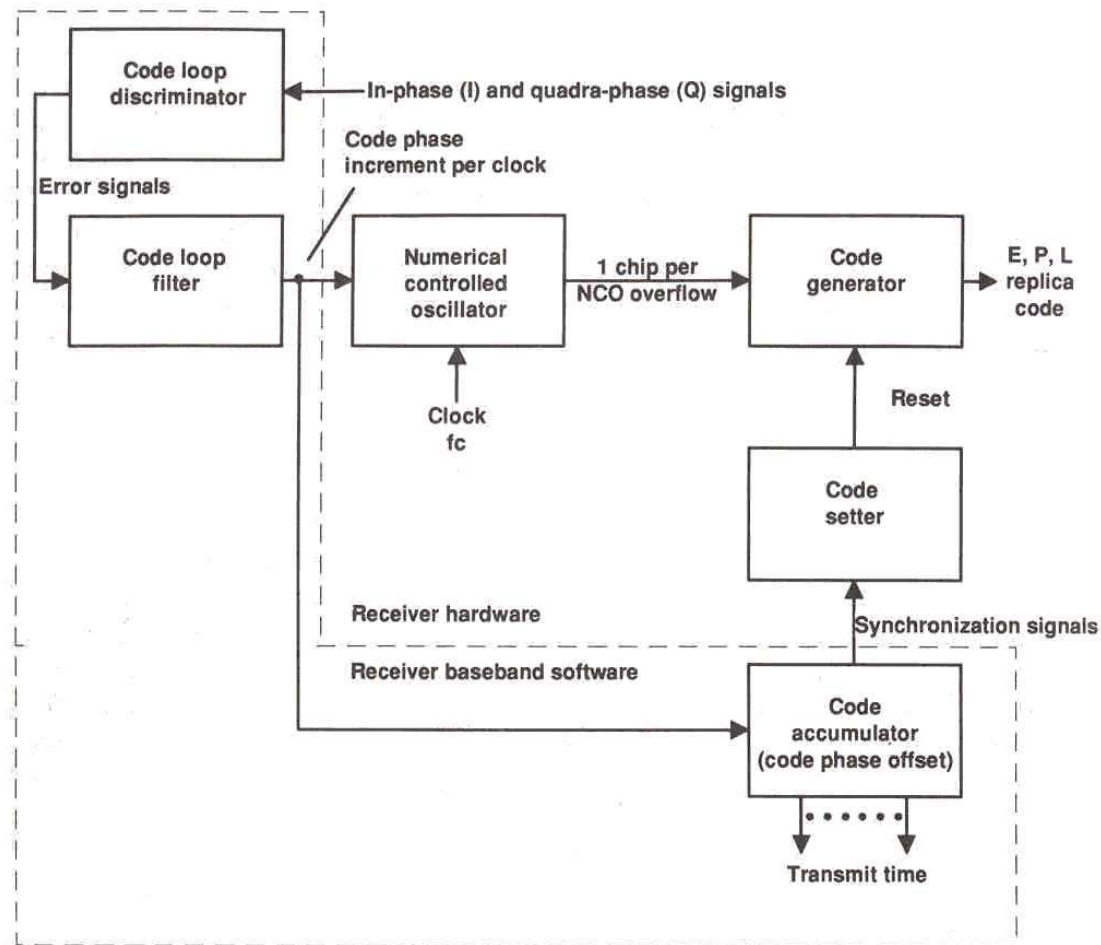
# Porzione in BB del ricevitore - Digitale



# Relazione fra uscita del DLL e pseudorange

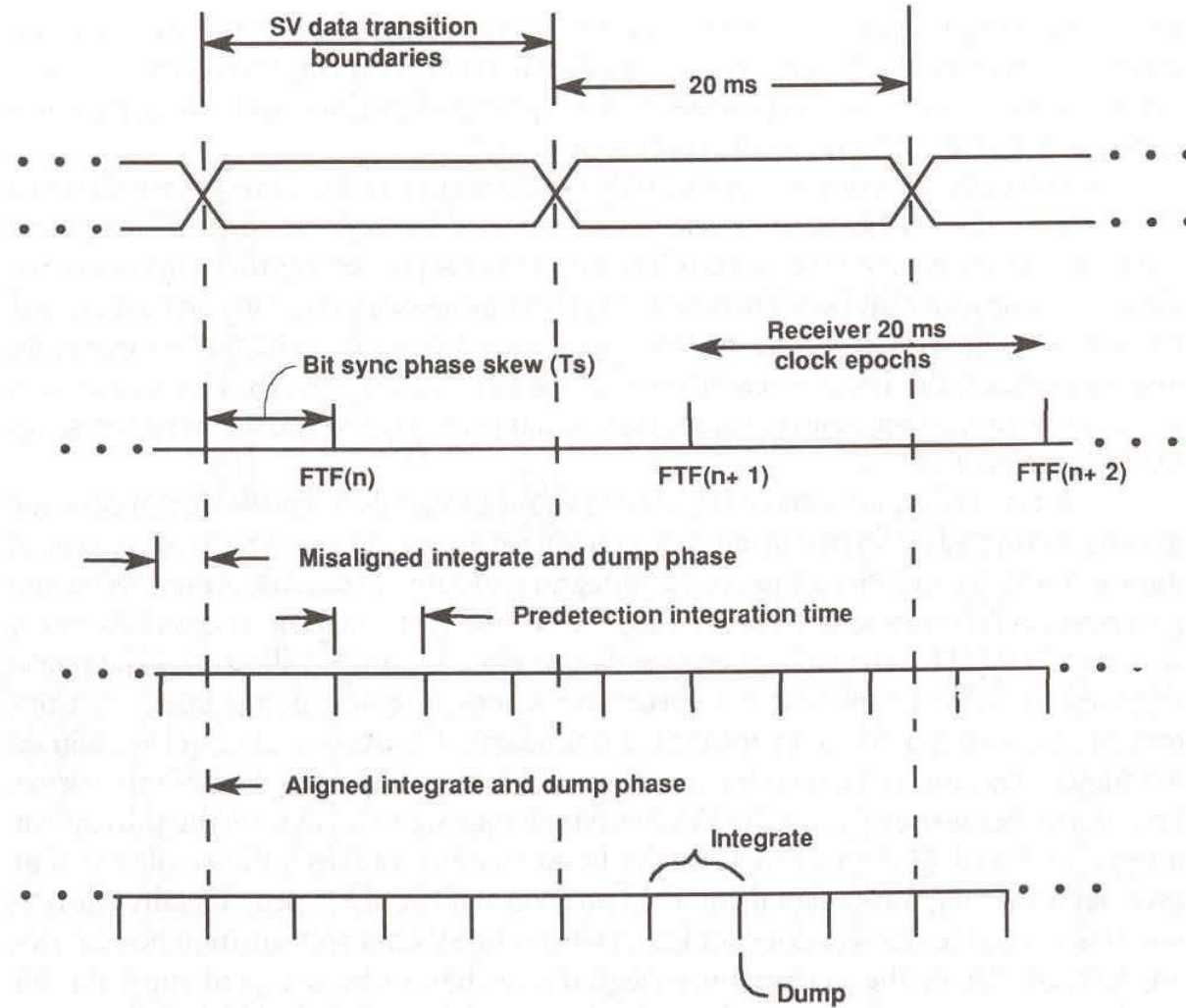


# Relazione fra uscita del DLL e pseudorange

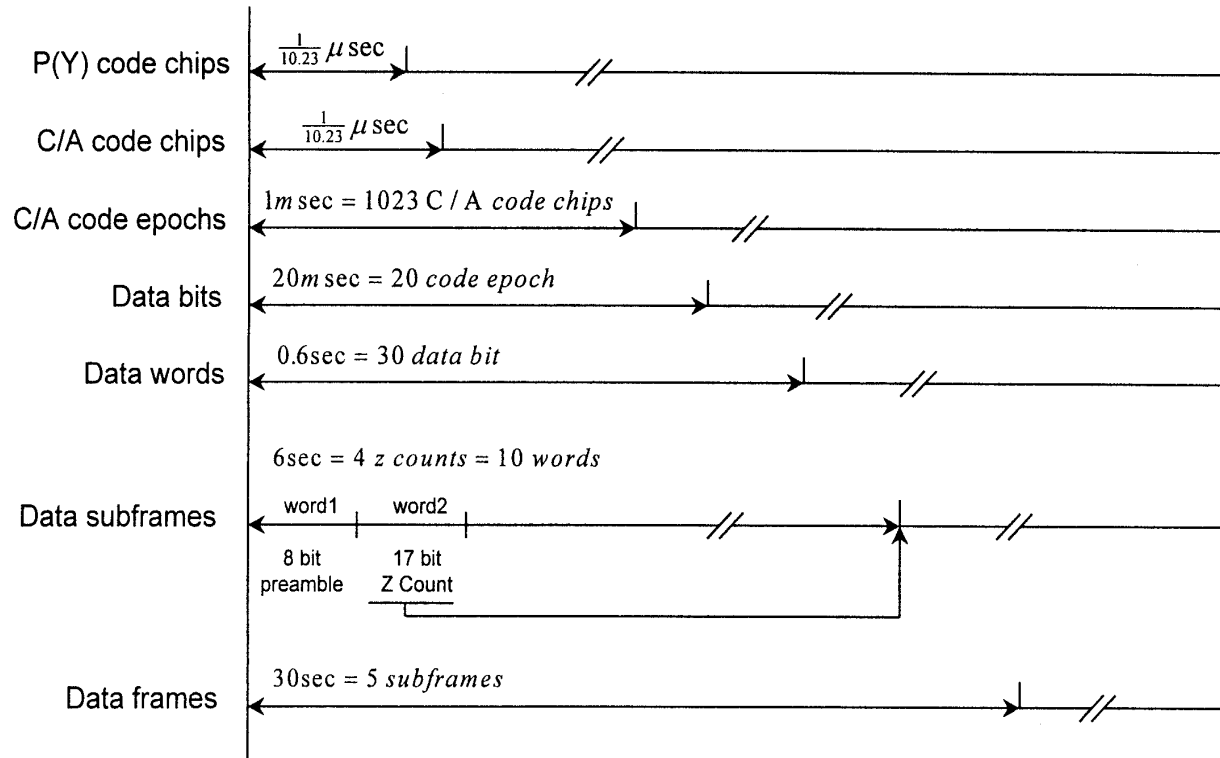




# Integrazione pre-detection



# Temporizzazione



# Acquisizione del segnale

