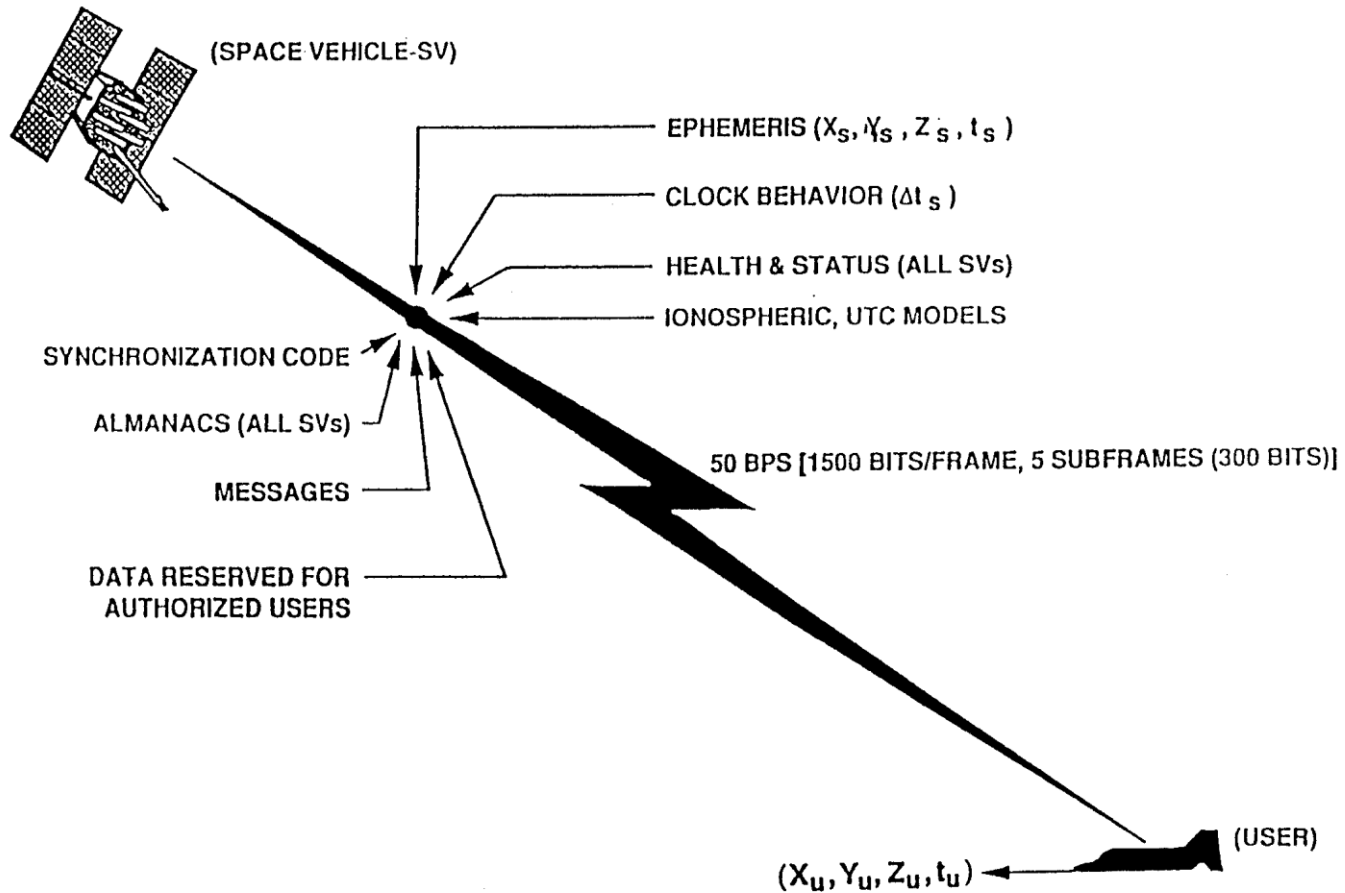

Il Messaggio di Navigazione GPS

Contenuto del Messaggio di Navigazione



Riassunto dei parametri del segnale GPS

Parameter	Rapid acquisition → Precision	
	C/A Signal	P Signal
Code clock rate, R_C	1.023 Mbps	RP = 10.23 Mbps
Code length	1023	$\approx 6 \times 10^{12}$
Data rate, R_D	50 bps	50 bps
Transmission frequency	L1	L1, L2
<p>Data includes :</p> <ul style="list-style-type: none"> Telemetry Satellite ephemeris Satellite clock correction Ionospheric model Synchronization information for resolving C/A code ambiguities <ul style="list-style-type: none"> - Preamble - Time Almanacs Encrypted data for authorized users <p>Precise, 2 hour rule-of-thumb duration data ←</p> <p>Less accurate, 2 week rule-of-thumb duration data ←</p>		

$L1 = 154$
 $L2 = 120$
 R_P
One week
 Total 38 weeks
 32 for SV
 5 for pseudolite

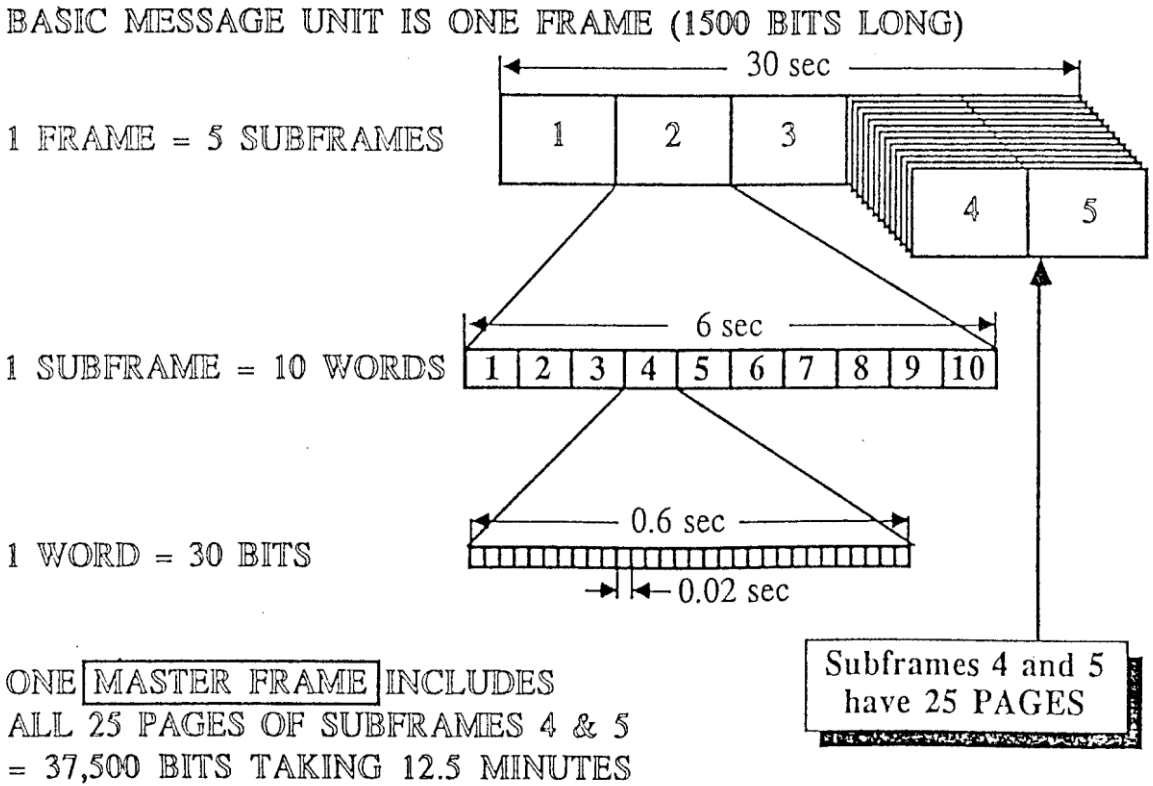
Messaggio di navigazione GPS

- il messaggio di navigazione a 50 Hz è sovrapposto ad entrambi i codici P(Y) e C/A ed estratto dal ricevitore insieme allo pseudorange (ed eventuali altre misure).
- Esso contiene dati specifici per il satellite che lo trasmette ed informazioni comuni a tutti i satelliti.
- Il messaggio contiene: tempo di trasmissione del messaggio, Hand Over Word (HOW) per la transizione dal codice C/A al P(Y), correzione di clock, effemeridi e stato di salute per il satellite che trasmette, almanacco e salute per tutti i satelliti, coefficienti per il modello di ritardo ionosferico e coefficienti per calcolare lo UTC.

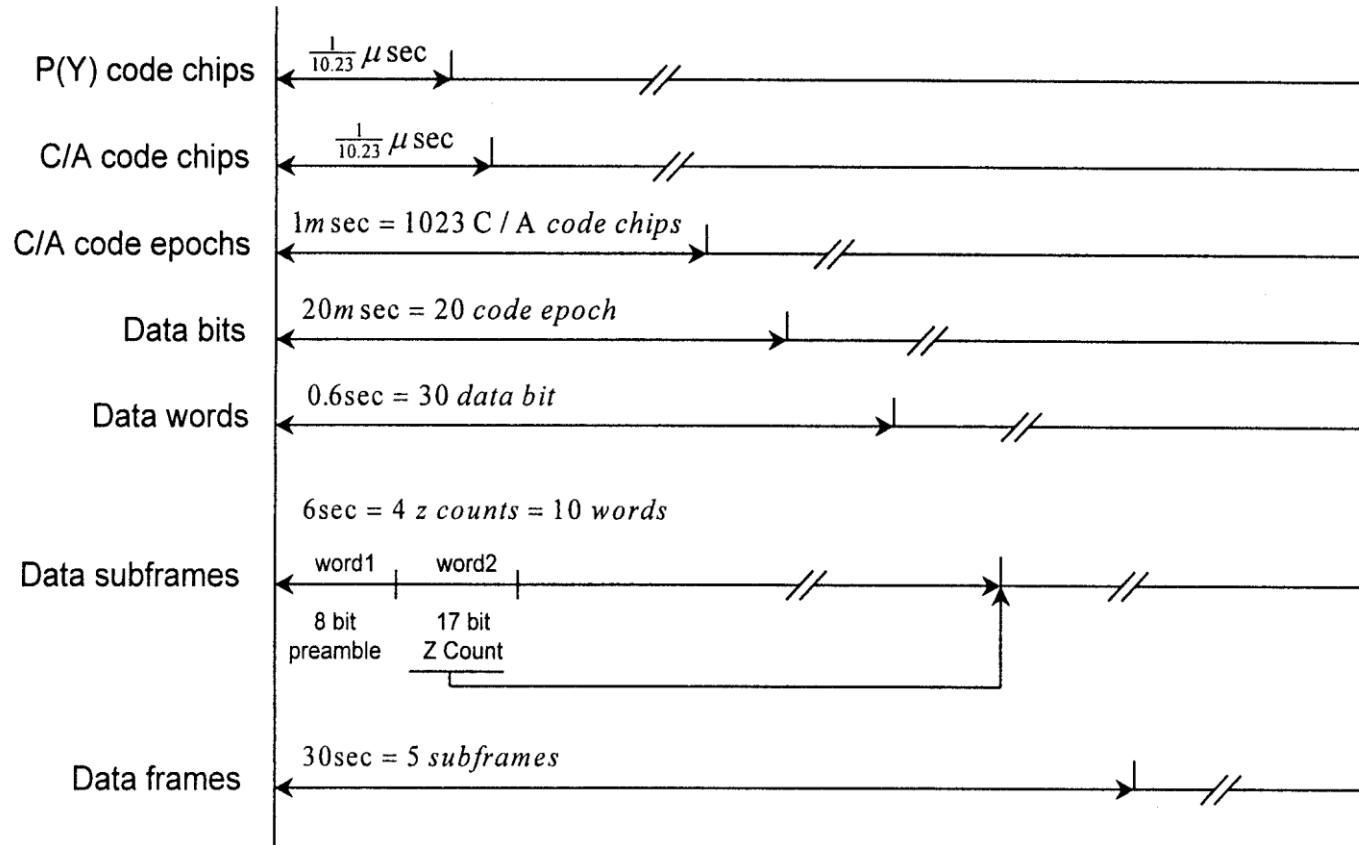
Temporizzazione del messaggio di navigazione:

- il messaggio di navigazione è composto di 25 frames di dati
- ogni frame (1,500 bits) è suddiviso in 5 subframes di 300 bits ciascuno.
- Alla frequenza di trasmissione di 50 Hz, sono necessari:
 - 6 secondi per ricevere un subframe,
 - 30 secondi per ricevere un frame, e
 - 12.5 minuti per ricevere tutti i 25 frames.
- **Subframes 1, 2, e 3** hanno lo stesso formato di per tutti i 25 frames. Ciò permette di ricevere i dati critici, specifici per il satellite entro 30 secondi.
- **Subframes 4 and 5** hanno dati che cambiano con un ciclo di frames. Essi contengono dati comuni a tutti i satelliti e meno critici per il ricevitore.

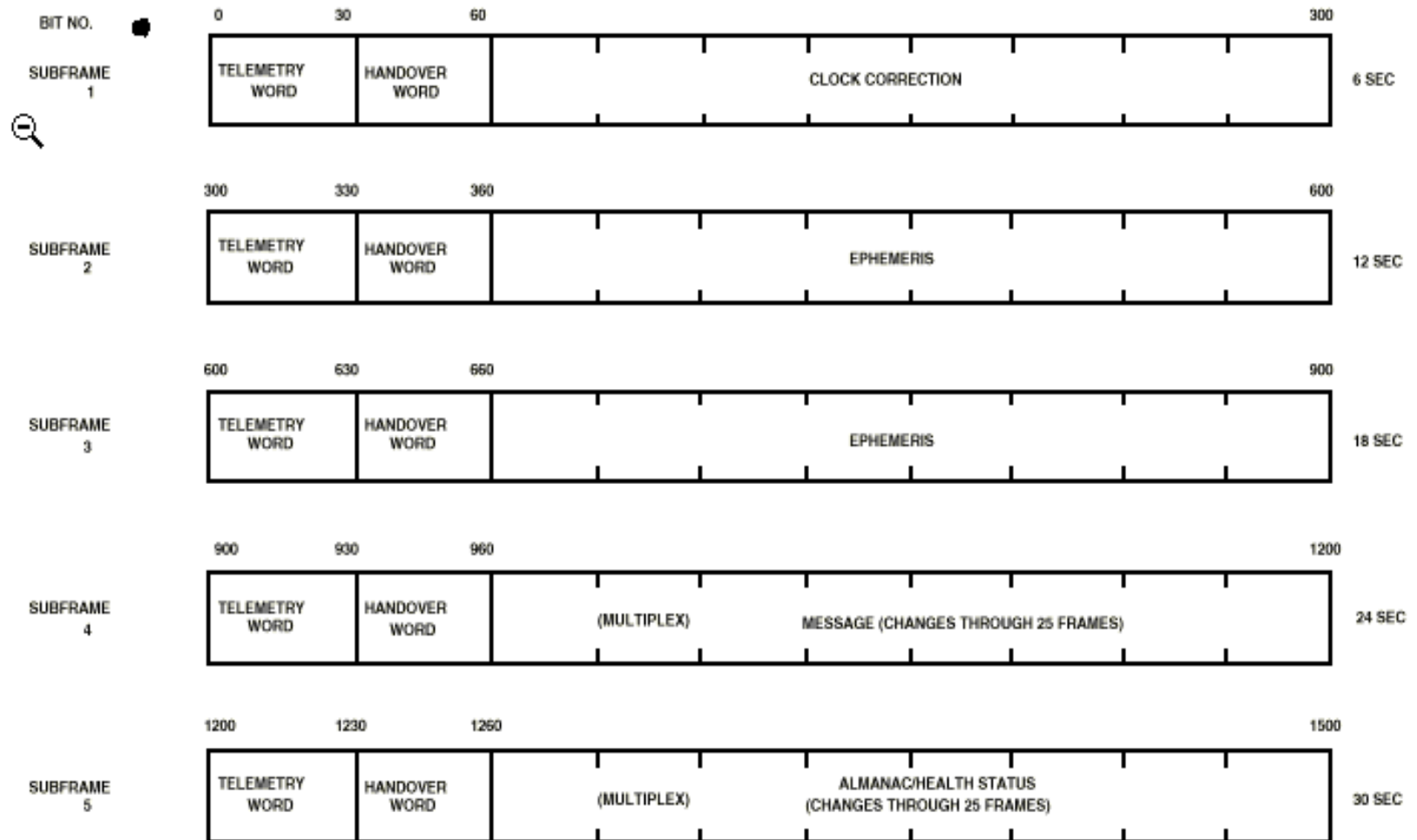
Struttura del messaggio di navigazione



Relazioni temporali fra codice, dati, subframe, e frame



I subframe del Messaggio di navigazione GPS



*12.5 MINUTES BEFORE THE ENTIRE MESSAGE REPEATS

Contenuto dei subframe

- **Subframe 1:** correzioni del clock per il satellite + parametri di salute del satellite ed accuratezza del segnale trasmesso.
- **Subframe 2 e 3:** effemeridi usabili per calcolare la posizione del satellite nelle due ore successive.
- **Subframe 4 e 5:** almanacco dei satelliti (informazioni orbitali a bassa accuratezza) e correzioni degli orologi a bassa accuratezza, stato di salute e configurazione (sintetici) di ogni satellite, messaggi di testo utente, e coefficienti per il modello ionosferico e conversione fra tempo GPS e tempo UTC.

Effemeridi GPS trasmesse (I)

Time parameters

t_{0e}	Reference time, ephemeris parameters [s]
t_{0c}	Reference time, clock parameters [s]
a_0, a_1, a_2	Polynomial coefficients for clock correction (bias [s], drift [s/s], drift-rate (ageing) [s/s ²])
IOD	Issue of Data, arbitrary identification number

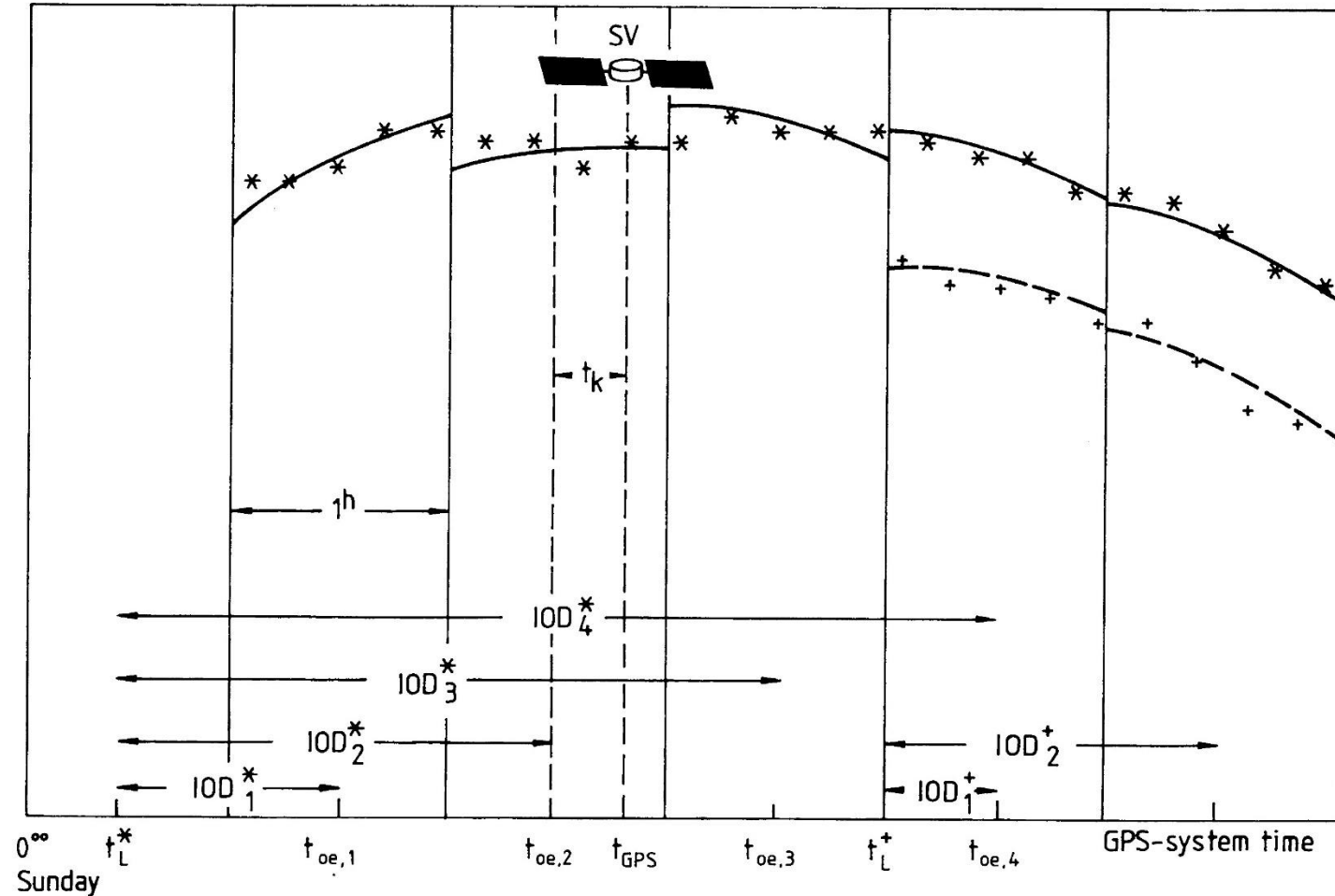
Keplerian parameters

\sqrt{A}	Square root of the semi-major axis [m ^{1/2}]
e	eccentricity [dimensionless]
i_0	inclination angle at reference time [semicircles]
Ω_0	Right ascension of ascending node at reference time [semicircles]
ω	Argument of perigee [semicircles]
M_0	Mean anomaly at reference time [semicircles]

Perturbation parameters

Δn	Mean motion difference from computed value [semicircles/s]
$\dot{\Omega}$	Rate of change of right ascension [semicircles/s]
\dot{i}	Rate of change of inclination [semicircles/s]
C_{us}	Amplitude of the sine harmonic correction term to the argument of latitude [rad]
C_{uc}	Amplitude of the cosine harmonic correction term to the argument of latitude [rad]
C_{is}	Amplitude of the sine harmonic correction term to the angle of inclination [rad]
C_{ic}	Amplitude of the cosine harmonic correction term to the angle of inclination [rad]
C_{rs}	Amplitude of the sine harmonic correction term to the orbit radius [m]
C_{rc}	Amplitude of the cosine harmonic correction term to the orbit radius [m]

Effemeridi GPS trasmesse (II)



Formato RINEX – Navigazione (I)

TABLE A3

GPS NAVIGATION MESSAGE FILE - HEADER SECTION DESCRIPTION			
HEADER LABEL (Columns 61-80)	DESCRIPTION	FORMAT	
RINEX VERSION / TYPE	- Format version (2.10) - File type ('N' for Navigation data)	F9.2,11X, A1,19X	
PGM / RUN BY / DATE	- Name of program creating current file - Name of agency creating current file - Date of file creation	A20, A20, A20	
* COMMENT	Comment line(s)	A60	*
* ION ALPHA	Ionosphere parameters A0-A3 of almanac (page 18 of subframe 4)	2X,4D12.4	*
* ION BETA	Ionosphere parameters B0-B3 of almanac	2X,4D12.4	*
* DELTA-UTC: A0,A1,T,W	Almanac parameters to compute time in UTC (page 18 of subframe 4) A0,A1: terms of polynomial T : reference time for UTC data W : UTC reference week number. Continuous number, not mod(1024)!	3X,2D19.12, 2I9	*
* LEAP SECONDS	Delta time due to leap seconds	I6	*
	Last record in the header section.	60X	

Formato RINEX – Navigazione (II)

TABLE A4		
GPS NAVIGATION MESSAGE FILE - DATA RECORD DESCRIPTION		
OBS. RECORD	DESCRIPTION	FORMAT
PRN / EPOCH / SV CLK	- Satellite PRN number	I2,
	- Epoch: Toc - Time of Clock	
	year (2 digits, padded with 0	
	if necessary)	1X,I2.2,
	month	1X,I2,
	day	1X,I2,
	hour	1X,I2,
	minute	1X,I2,
	second	F5.1,
	- SV clock bias (seconds)	3D19.12
	- SV clock drift (sec/sec)	
	- SV clock drift rate (sec/sec ²)	
BROADCAST ORBIT - 1	- IODE Issue of Data, Ephemeris	3X,4D19.12
	- Crs (meters)	
	- Delta n (radians/sec)	
	- M0 (radians)	
BROADCAST ORBIT - 2	- Cuc (radians)	3X,4D19.12
	- e Eccentricity	
	- Cus (radians)	
	- sqrt(A) (sqrt(m))	

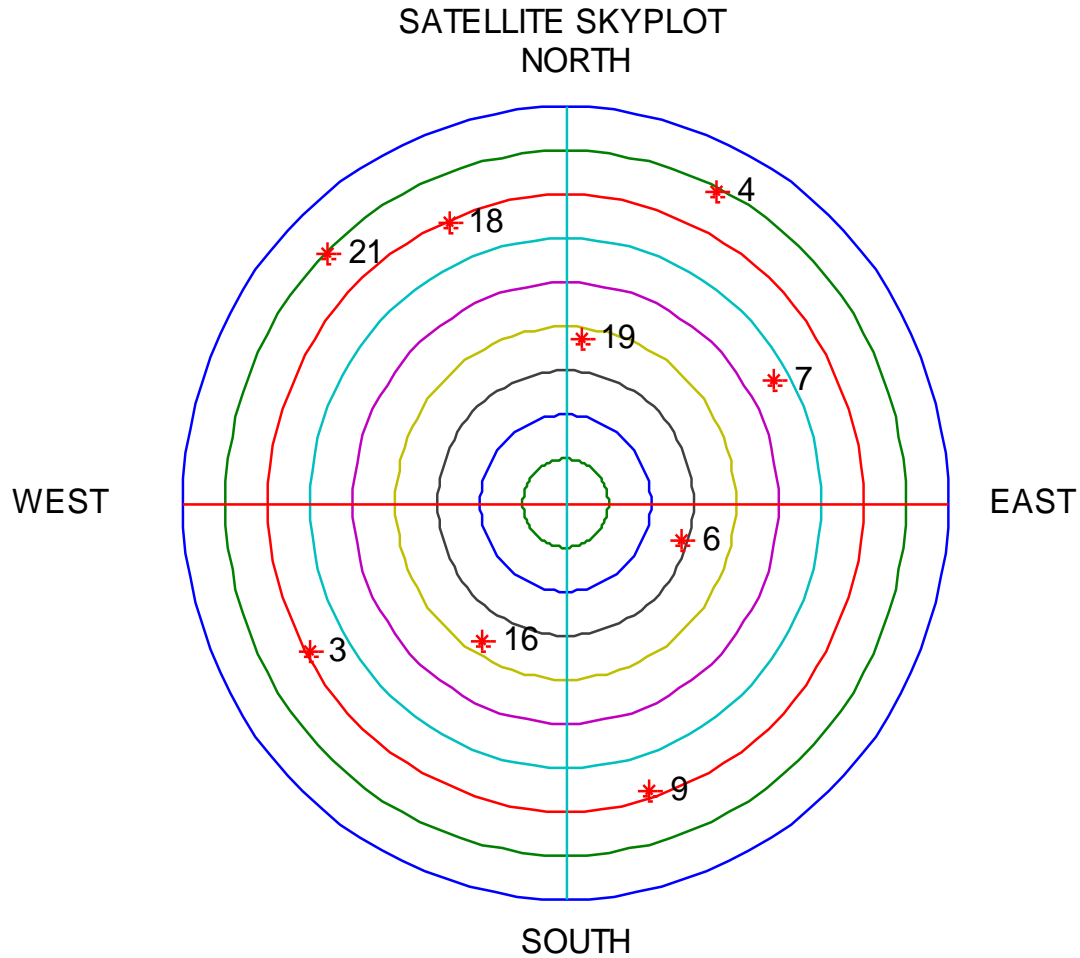
Formato RINEX – Navigazione (III)

BROADCAST ORBIT - 3	- Toe Time of Ephemeris (sec of GPS week)	3X, 4D19.12
	- Cic (radians)	
	- OMEGA (radians)	
	- CIS (radians)	
BROADCAST ORBIT - 4	- i0 (radians)	3X, 4D19.12
	- Crc (meters)	
	- omega (radians)	
	- OMEGA DOT (radians/sec)	
BROADCAST ORBIT - 5	- IDOT (radians/sec)	3X, 4D19.12
	- Codes on L2 channel	
	- GPS Week # (to go with TOE)	
	Continuous number, not mod(1024)!	
	- L2 P data flag	
BROADCAST ORBIT - 6	- SV accuracy (meters)	3X, 4D19.12
	- SV health (bits 17-22 w 3 sf 1)	
	- TGD (seconds)	
	- IODC Issue of Data, Clock	
BROADCAST ORBIT - 7	- Transmission time of message *)	3X, 4D19.12
	(sec of GPS week, derived e.g.	
	from Z-count in Hand Over Word (HOW)	
	- Fit interval (hours)	
	(see ICD-GPS-200, 20.3.4.4)	
	Zero if not known	
	- spare	
	spare	

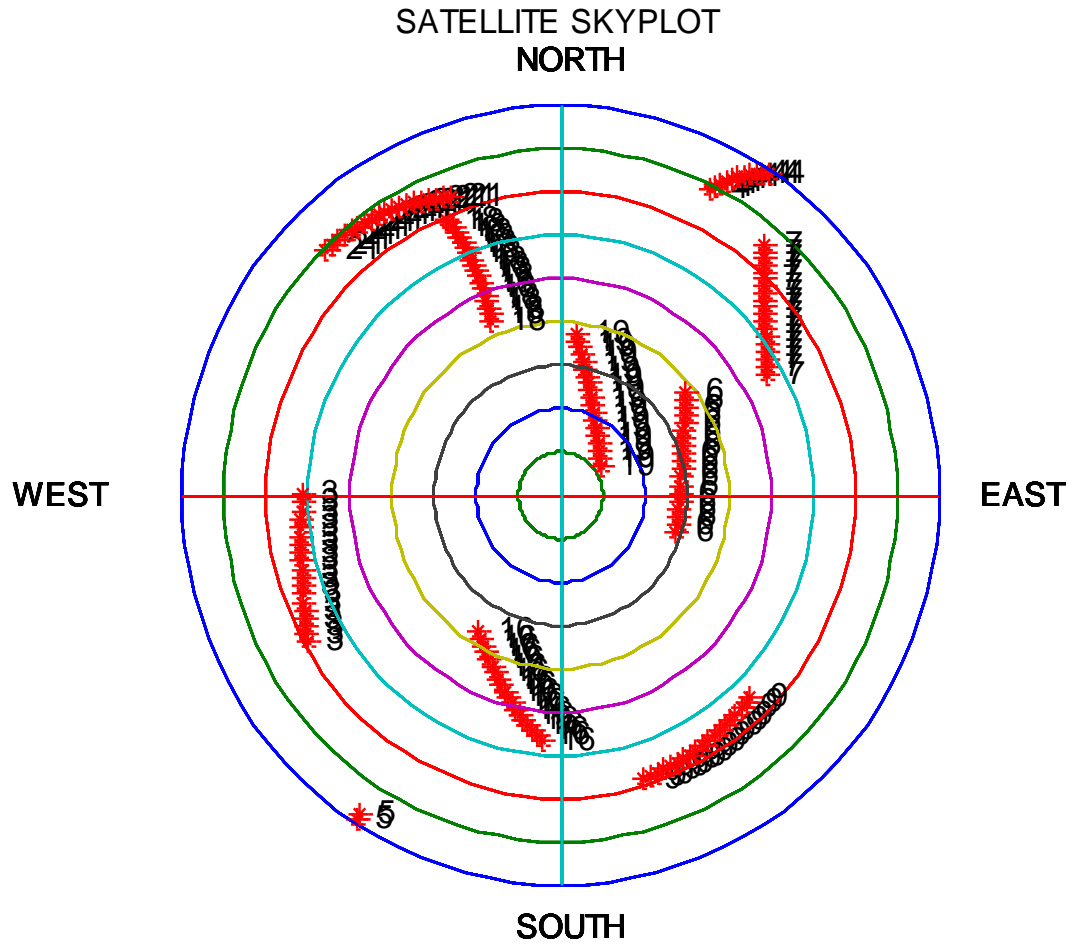
Formato RINEX – Navigazione (IV)

```
+-----+
|                                     GPS NAVIGATION MESSAGE FILE - EXAMPLE                                     |
+-----+
----|----1|0---|----2|0---|----3|0---|----4|0---|----5|0---|----6|0---|----7|0---|----
2.10          N: GPS NAV DATA          RINEX VERSION / TYPE
XXRINEXN V2.10      AIUB          3-SEP-99 15:22      PGM / RUN BY / DATE
EXAMPLE OF VERSION 2.10 FORMAT          COMMENT
      .1676D-07      .2235D-07      -.1192D-06      -.1192D-06          ION ALPHA
      .1208D+06      .1310D+06      -.1310D+06      -.1966D+06          ION BETA
      .133179128170D-06      .107469588780D-12      552960      1025 DELTA-UTC:
A0,A1,T,W
      13
                                          LEAP SECONDS
                                          END OF HEADER
6 99  9  2 17 51 44.0 -.839701388031D-03 -.165982783074D-10 .000000000000D+00
      .910000000000D+02      .934062500000D+02      .116040547840D-08      .162092304801D+00
      .484101474285D-05      .626740418375D-02      .652112066746D-05      .515365489006D+04
      .409904000000D+06      -.242143869400D-07      .329237003460D+00      -.596046447754D-07
      .111541663136D+01      .326593750000D+03      .206958726335D+01      -.638312302555D-08
      .307155651409D-09      .000000000000D+00      .102500000000D+04      .000000000000D+00
      .000000000000D+00      .000000000000D+00      .000000000000D+00      .910000000000D+02
      .406800000000D+06      .000000000000D+00
13 99  9  2 19  0  0.0 .490025617182D-03      .204636307899D-11      .000000000000D+00
      .133000000000D+03      -.963125000000D+02      .146970407622D-08      .292961152146D+01
      -.498816370964D-05      .200239347760D-02      .928156077862D-05      .515328476143D+04
      .414000000000D+06      -.279396772385D-07      .243031939942D+01      -.558793544769D-07
      .110192796930D+01      .271187500000D+03      -.232757915425D+01      -.619632953057D-08
      -.785747015231D-11      .000000000000D+00      .102500000000D+04      .000000000000D+00
      .000000000000D+00      .000000000000D+00      .000000000000D+00      .389000000000D+03
      .410400000000D+06      .000000000000D+00
----|----1|0---|----2|0---|----3|0---|----4|0---|----5|0---|----6|0---|----7|0---|----
```

Visualizzazione costellazione (I)



Visualizzazione costellazione (II)



Visualizzazione costellazione (III)

