

Proposals to extend RINEX 3.x Navigation Messages

- **Proposal #1: RINEX 3 Format extension to support CNAV(Based on Proposal by Peter Steigenberger, Oliver Montenbruck and Uwe Hessels)**
- **Proposal #2: to create a new Generic Navigation file format (Ken MacLeod)**
- **Proposal #3: support raw navigation files (encode in hex)**

Proposed New R3.04 Navigation message structures

Option #1:

Current message line

G01 2013 06 24 02 00 00 4.127621650696e-05 4.661160346586e-12 0.000000000000e+00

Proposed message

G01 CNAV C2C

* <<< Column 80

Types	Description	Constellations and signals	Comment
LNAV	Legacy navigation msg	GPS/QZSS L1 C/A GLO L1 C/A	Navigation message that follows is R3.03
CNAV	GPS/QZSS CNAV	GPS/QZSS L2C/L5	Navigation message that follows is R3.04
CNV2	QPS/QZSS CNAV2	(GPS)/QZSS L1C	Navigation message that follows is R3.04
INAV	Galileo integrity navigation msg	GAL E1/E5b	Navigation message that follows is R3.03
FNAV	Galileo free navigation msg	GAL E5a	Navigation message that follows is R3.03
D1, D2	BeiDou MEO/IGSO and GEO nav msgs	BDS B1 (B2/B3?)	Navigation message that follows is R3.03
GEO	Legacy SBAS navigation msg	SBAS L1	Navigation message that follows is R3.03
SAIF	QZSS SAIF	QZSS L1 SAIF	
LEX	QZSS LEX	ZQSS LEX	

Existing GPS R3.03 Navigation Message

#	Field 1	Field 2	Field 3	Field 4
0	Clock epoch	a_f0	a_f1	a_f2
1	IODE	C_rs	Δn	M
2	C_uc	e	C_us	va
3	t_oe	C_ic	Ω	C_is
4	i	C_rc	ω	d Ω /dt
5	di/dt	codes-on-L2 flag	w_oe	L2P data flag
6	SV accuracy	health	TGD	IODC
7	t_tm			

1. Fields marked in Black are the same as in the legacy messages and in the new CNAV message, units are also the same
2. Fields marked in Red have no matching data in CNAV message
3. Fields marked in Blue are discussed here: va rather than (Δa); t_oe = t_oc so t_oe is not required; w_oe not required as t_oe is replaced by t_oc; SV_accuracy replaced by UDRE parameters, health field also replaced
4. Units stay the same

Extend the Navigation message body and reuse fields that are not used in CNAV message

#	Field 1	Field 2	Field 3	Field 4
0	Epoch (clock and eph)	a_f0	a_f1	a_f2
1	da/dt	C_rs	Δn	M
2	C_uc	e	C_us	\sqrt{a}
3	t_op	C_ic	Ω	C_is
4	i	C_rc	ω	d Ω /dt
5	di/dt	dn/dt	URAI_NED0	URAI_NED1
6	URAI_ED	signal health	TGD	URAI_NED2
7	ISC_L1CA	ISC_L2C	ISC_L5I5	ISC_L5Q5
8	t_tm			flags (reserved)

1. da/dt: a dot
2. \sqrt{a} : square root of a vs Δa
3. t_op: Time of Prediction
4. dn/dt: n dot
5. User Range Accuracy, Non-Elevation Dependent accuracy estimates: URAI_NED0, NED1, ED, NED2
6. Signal health: three bits L1, L2, L5
7. Inter-signal Corrections: ISC_L1CA, L2C, L5I5, L5Q

Some information from CNAV not in proposed message

- Currently the R3.x header contains Ionosphere and UTC parameters. Should this information be moved to the body of the message, since for BeiDou the Iono data can be broadcast more often than once a day and the existing method is not ideal?
- Earth orientation parameters are also not supported

Option #2

- The content of the message is not grouped. Should we develop new messages that group the data into logical blocks such as:
 - Nav message type (uses header record similar to that shown on first page)
 - Message time
 - Blocks present message (8 blocks (11110000))
 - Block #1: Alerts/Health/Integrity/L2C Phasing
 - Block #2: Keplerian Elements
 - Block #3: Cartesian Elements
 - Block #4: URA
 - Block #5: Clock/UTC
 - Block #6: Group Delay/Iono
 - Block #7: EOP
 - Block #8: Almanac
- Legacy messages would be supported using the same technique that was proposed on slide 2

Proposed Generic Navigation File Format (GPS CNAV example shown)

Message Type

Constellation (G)	PRN(01)	Message/Version(CNAV)	Signal/Source (L2C)
Blocks Present Flag (11111100)/11110000			

Message Time

MESSAGE TOW	WNn		

Block 1 Alerts/Health/Integrity/ L2C Phasing

"ALERT" FLAG	L1 HEALTH - 1 BIT	L2 HEALTH - 1 BIT	L5 HEALTH - 1 BIT
Integrity Status Flag	L2C Phasing		

Block 2 URA Block

URAEed INDEX	URANED0 INDEX	URANED1 INDEX	URANED2 INDEX

Proposed Generic Navigation File Format (GPS CNAV example shown) Continued...

Block 3 Keplerian Elements

top	toe	DA	A
D n0	D n0	M0-n	e _n
W _n	W0-n	i0-n	D W
i0-n - DOT	cis-n	cic-n	crs-n
crc-n	cus-n	cuc-n	

Block 4 Clock/UTC/

t _{oc}	af0-n	af1-n	af2-n
A0-n	A1-n	A2-n	DtLS
t _{ot}	WN _{ot}	WNLSF	DN
DtLSF			

Proposed Generic Navigation File Format (GPS CNAV example shown) Continued...

Block 5 Group Delay/ Iono

TGD	ISCL1C/A	ISCL2C	ISCL515
ISCL5Q5	a0	a1	a2
a3	b0	b1	b2
b3	WNOP		

Block 6 EOP

tEOP	PM-X	PM-X	PM-Y
PM-Y	DUT1	DUT1	

Block 7 Cartesian Block (SBAS/GLONASS)

X	X Vel	X Acc	Y
Y Vel	Y Acc	Z	Z Acc
Z Vel			

Proposed Generic Navigation File Format (GPS CNAV example shown) Continued...

Block 8 Almanac Block

Almanac1	Almanac2	Almanac...	

Option #3 (Oliver)

- Develop a binary or hex encode raw RINEX navigation message that allows the storage of every message frame with additional meta data (receive time signal source etc)
 - Useful for integrity monitoring radio occultation etc
 - RTCM already support raw binary navigation messages... this could be extended....

Conclusions/Questions?

- Even if we decide to adopt a new RINEX navigation file format, we need to continue to support R3.03 navigation files
- Which of the options listed above do we want to pursue?
 - Do we need a new navigation file format (Option #2 very big change) or do we patch in the data as shown in the first proposal (Option #1)?
 - Do we create a new file name for the new Navigation messages (will definitely be a new RINEX version)?
 - Do we need to support the Earth Orientation Parameter information?
 - Do we add an almanac message to the new structure?
- Do we need to support the encoding of raw navigation frames in hex for example or should this be done by the RTCM SC104 (binary)?