RTCM SC-104

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New GNSS signals – opportunities for new PNT applications and improved robustness

Swedish Radio Navigation Board – RNN

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RTCM

- **Radio Technical Commision for Maritime Services.**
- **At the start 1947, US Government Advisory Committee. Now, international non-profit standards organization.**
- **Well-known committee RTCM SC-109 Electronic charts (ECDIS)**

- **RTCA Radio Technical Commission for Aeronautics (still US Government Advisory Committee!!)**

RTCM SC-104 active working groups 1

- BeiDou
- Biases
- Coordinate transformation
- DGNSS Beacon Services
- GALILEO
- GLONASS
- Integrity Monitoring for High Precision Applications (also SC-134)

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RTCM SC-104 active working groups 2

- Internet Protocol
- Network RTK
- NMEA Messages
- Private Messages
- QZSS
- Rinex
- State Space
- Version 3

RTCM SC-104 active working groups 3

- SBAS for Maritime Applications
- Interoperability
- IRNSS
- NDF (Navigation Data Frame)

Multiple Signal Message

- **Generic message for all satellite systems**
- **Developed by Gleb Zyryanov Ashtech Moscow**
- **Buildt on an idea of "rough range"**
- **Header**
-

64 bitar

satellite mask

32 bitar

signal mask

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

cellmask

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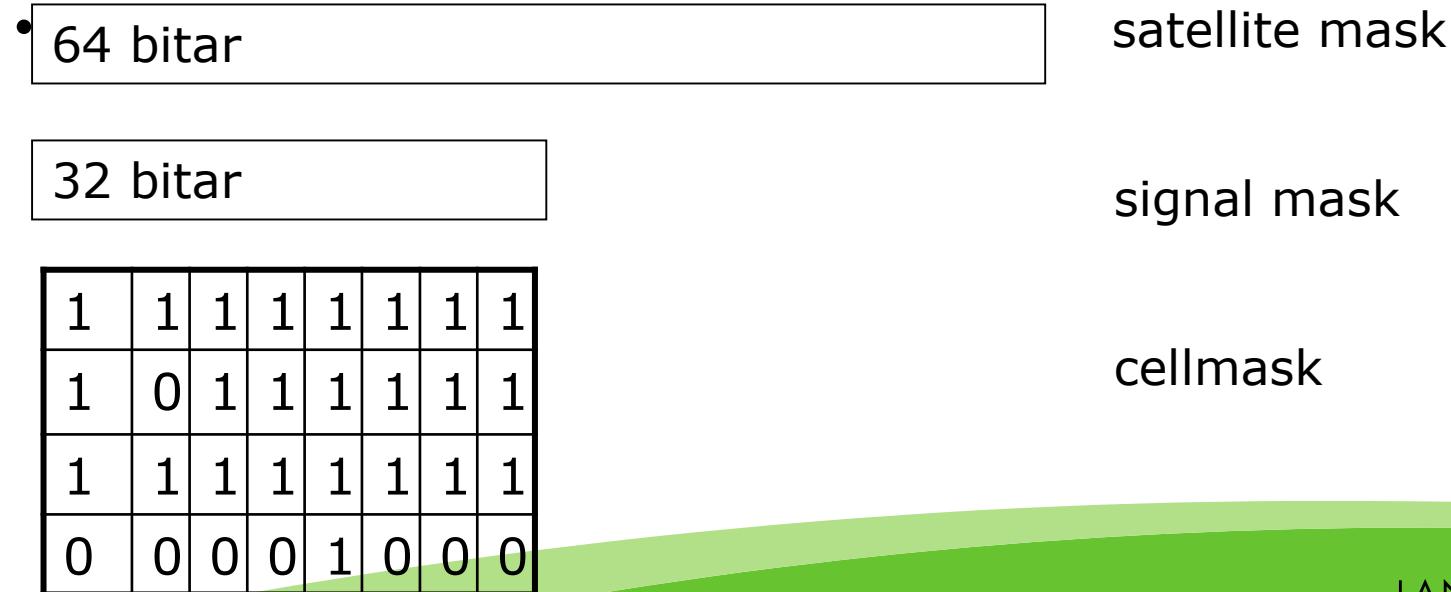
MSM 4 and 5

- **Rough ranges 8 + 10 bits   Modulo one light millisecond** (299792.458 m)
- **Fine pseudorange 15 bits resolution 2 cm**

- **Fine phase 20 bits resolution 0.6 mm**

- **CNR 6 bits resolution 1 dB**

MSM overview

MSM1	Compact PR	169+sat*(10+16*sig)
MSM2	Compact Phase	169+sat*(10+27*sig)
MSM3	Compact PR + Phase	169+sat*(10+42*sig)
MSM4	Full PR + Phase + CNR	169+sat*(18+48*sig)
MSM5	Full PR+Phase+CNR+Dop	169+sat*(36+63*sig)
MSM6	HP PR+Phase+CNR	169+sat*(18+65*sig)
MSM7	HP PR+Phase+CNR+Dop	169+sat*(36+80*sig)

SSR State Space Representation

- **Original plan 2009??**
- **Phase 1: Basic orbit and clock corrections, satellite code bias**
- **Phase 2: Vertical TEC messages to support single frequency receivers**
- **Phase 3: Slant TEC, troposphere, satellite phase bias. RTK-PPP**

SSR 2

- **Phase 1 published RTCM 10403.1 2011**
- **Satellite phase bias moved from phase 3 to phase 2**
- **Phase 1+2 out since 2015 and in experimental use**
- **Phase 3 Satellite phase bias with ambiguity resolution, slant TEC and troposphere still unfinished!**

Safe and Precise Augmentation Messages (SAPA)

- **RTCM lookalike format**
- **Developed by York University Canada and Sapcorda**
- **60% less bandwidth than RTCM SC 104**

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Integrity of Trimble's RTX service Ulrich Weinbach et al. ION-2018

Trimbles RTX Fast
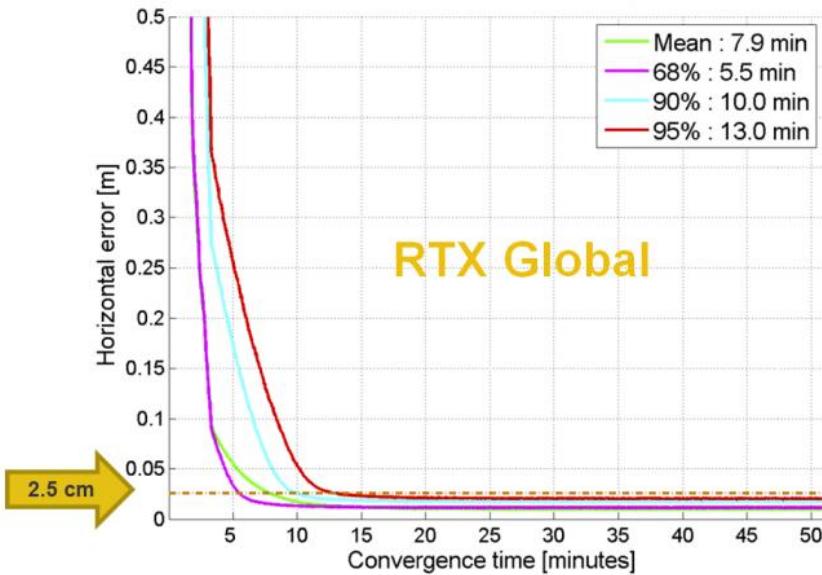
CenterPoint RTX Standard (globally)
GPS GLN BDS GAL QZSS
1 Month – 54 Stations - 24786 Convergence runs
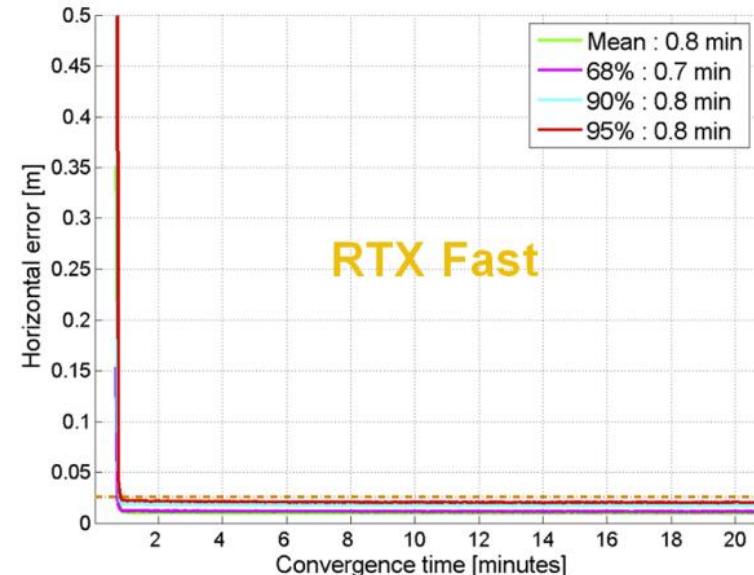
CenterPoint RTX Fast (Europe)
GPS GLN BDS GAL QZSS
1 Month – 22 Stations – 28391 Convergence runs

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Trimble's RTX Fast 2