Center for Spatial Information Science
The University of Tokyo

International Committee on
Global Navigation Satellite Systems

AIT
Asian Institute of Technology

Position Output Data Formats

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Training on GNSS – Course (T141-30), Organized by: GIC/AIT, S4D/CSIS and ICG, held at: GIC/AIT, Thailand from 23 – 26 JAN 2018

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Data Formats: NMEA, RINEX

References: https://www.nmea.org/
http://freenmea.net/docs

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National Marine Electronics Association (NMEA) Format

- NMEA is format to output measurement data from a sensor in a pre-defined format in ASCII

- In the case of GPS, It output GPS position, velocity, time and satellite related data

- NMEA sentences (output) begins with a "Talker ID" and "Message Description"

  - Example: $GPGGA,123519,4807.038,N,01131.000,E,1,08,0.9,545.4,M,46.9,M,,*47
  - "$GP" is Talker ID
  - "GGA" is Message Description to indicate for Position Data

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NMEA Data Format

GGA - Fix data which provide 3D location and accuracy data.
$GPGGA,123519,4807.038,N,01131.000,E,1,08,0.9,545.4,M,46.9,M,,*47

Where: GGA Global Positioning System Fix Data

123519	Fix taken at 12:35:19 UTC
4807.038, N	Latitude 48 deg 07.038' N
01131.000, E	Longitude 11 deg 31.000' E
1 Fix quality:	
	0 = invalid ,
	1 = GPS fix (SPS),
	2 = DGPS fix,
	3 = PPS fix,
	4 = Real Time Kinematic
	5 = Float RTK
	6 = estimated (dead reckoning) (2.3 feature)
	7 = Manual input mode
	8 = Simulation mode
08	Number of satellites being tracked
0.9	Horizontal dilution of position
545.4,M	Altitude, Meters, above mean sea level
46.9,M	Height of geoid (mean sea level) above WGS84 ellipsoid
(empty field)	time in seconds since last DGPS update (empty field) DGPS station ID number
*47	the checksum data, always begins with *

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Serial Configuration of NMEA

- Baud rate   : 4800
- Parity   : None
- Data bits   : 8
- Stop bits   : 1
- Handshake   : None

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RINEX Data Format

- Receiver Independent Exchange Format (RINEX) is a data exchange format for raw satellite data among different types of receivers.
  - Different types of receivers may output position and raw data in proprietary formats
  - For post-processing of data using DGPS or RTK it is necessary to use data from different types of receivers. A common data format is necessary for this purpose.
  - Example: How to post process data from Trimble, Novatel and Septenrtio receivers to compute a position?
- RINEX only provides Raw Data. It does not provide position output.
  - User has to post-process RINEX data to compute position
  - Raw data consists of Pseudorage, Carrierphase, Doppler, SNR
- RINEX basically consists of two data types
  - "*.*N" file for Satellite and Ephemeris Related data.
    - Also called Navigation Data
  - "*.*O" file for Signal Observation Data like Pseudorange, Carrier Phase, Doppler, SNR
    - Also called Observation Data

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RINEX "N" File for GPS

```
     2.11              NAVIGATION DATA    GPS(GPS)              RINEX VERSION / TYPE
cnvtToRINEX 2.90.0   convertToRINEX OPR   05-Jul-17 03:38 UTC  PGM / RUN BY / DATE
---------------------------------------------------------     COMMENT
    0.8382D-08   0.2235D-07 -0.5960D-07 -0.1192D-06           ION ALPHA
    0.8602D+05   0.6554D+05 -0.1311D+06 -0.4588D+06           ION BETA
   -0.931322574615D-09-0.355271367880D-14    405504     1947 DELTA-UTC: A0,A1,T,W
    18                                                         LEAP SECONDS
                                                               END OF HEADER
32 17 05 01 00 00   0.0-0.400723423809D-03-0.110276232590D-10 0.000000000000D+00
    0.370000000000D+02-0.806250000000D+01 0.455840416154D-08-0.192420920137D+01
   -0.353902578354D-06 0.111064908560D-02 0.826455652714D-05 0.515371503258D+04
    0.864000000000D+05-0.782310962677D-07 0.675647076441D-01-0.838190317154D-07
    0.958529124300D+00 0.221156250000D+03-0.265074890978D+01-0.796390315710D-08
   -0.389659088008D-09 0.100000000000D+01 0.194700000000D+04 0.000000000000D+00
    0.240000000000D+01 0.000000000000D+00 0.465661287308D-09 0.370000000000D+02
    0.795120000000D+05 0.400000000000D+01 0.000000000000D+00 0.000000000000D+00
24 17 05 01 00 00   0.0-0.341213308275D-04-0.454747350886D-12 0.000000000000D+00
    0.100000000000D+02 0.787812500000D+02 0.459340561950D-08 0.167267059468D+01
    0.404566526413D-05 0.564297637902D-02 0.102464109659D-04 0.515370226479D+04
    0.864000000000D+05-0.782310962677D-07 0.108986675687D+01 0.484287738800D-07
    0.945651423640D+00 0.170906250000D+03 0.490563049326D+00-0.815641117584D-08
   -0.128933942045D-09 0.100000000000D+01 0.194700000000D+04 0.000000000000D+00
    0.240000000000D+01 0.000000000000D+00 0.279396772385D-08 0.100000000000D+02
    0.792180000000D+05 0.400000000000D+01 0.000000000000D+00 0.000000000000D+00
```

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RINEX "N" File for QZSS

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RINEX "N" File for GLONASS

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RINEX "N" File for GALILEO

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RINEX "N" File for BEIDOU

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RINEX "O" File GPS, GLONASS, GALILEO, QZSS, SBAS

```
     2.11                OBSERVATION DATA    Mixed(MIXED)     RINEX VERSION / TYPE
cnvtToRINEX 2.90.0   convertToRINEX OPR   05-Jul-17 03:38 UTC PGM / RUN BY / DATE
-------------------------------------------------------------- COMMENT
KMBA                                                           MARKER NAME
KMBA                                                           MARKER NUMBER
DM                       UT                                    OBSERVER / AGENCY
5536R50102               TRIMBLE NETR9        5.20             REC # / TYPE / VERS
                         UNKNOWN EXT                           ANT # / TYPE
 -3955510.8982    3357111.6791   3697796.5495                 APPROX POSITION XYZ
         0.0000          0.0000          0.0000               ANTENNA: DELTA H/E/N
    1       1       0                                          WAVELENGTH FACT L1/2
    8      C1      C2      C3      L1      L2      L3      P1      P2   # / TYPES OF OBSERV
    1.000                                                      INTERVAL
 2017       5       1       0       0    0.0000000      GPS    TIME OF FIRST OBS
 2017       5       1      23      59   59.0000000      GPS    TIME OF LAST OBS
    0                                                          RCV CLOCK OFFS APPL
   18                                                          LEAP SECONDS
   59                                                          # OF SATELLITES
  G01 23351 23350       0 23350 46694       0       0 23344   PRN / # OF OBS
  G02 22293     0       0 22293 22286       0       0 22286   PRN / # OF OBS
  G03 19633 19632       0 19632 39259       0       0 19627   PRN / # OF OBS
  G05 25303 25302       0 25299 50599       0       0 25297   PRN / # OF OBS
  G06 24709 24708       0 24709 49411       0       0 24703   PRN / # OF OBS
  G07 27766 27764       0 27764 55505       0       0 27741   PRN / # OF OBS
```

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RINEX "O" File, Continued from previous slide

```
     S37 86400        0      0 86400        0        0        0        0      PRN / # OF OBS
     S40 56700        0      0 56700        0        0        0        0      PRN / # OF OBS
CARRIER PHASE MEASUREMENTS: PHASE SHIFTS REMOVED                              COMMENT
                                                                             END OF HEADER
 17  5  1  0  0  0.0000000  0 19G10G12G14G15G18G24G25G31G32R01R02R03
                               R11R12R13S28S29S37S40
   21375379.406 7  21375388.078 9                         112328384.475 7  87528640.180 9
                                   21375388.41448
   20991588.469 7  20991594.418 9                         110311559.942 7  85957091.970 9
                                   20991594.71548
   23097788.500 6                                         121379711.146 6  94581624.25147
                                   23097793.85247
   24539464.648 6  24539473.480 8                         128955722.954 6 100484989.893 8
                                   24539473.66046
   21890081.000 6                                         115033147.870 6  89636240.02147
                                   21890086.53547
   22760846.398 6  22760855.313 9                         119609048.681 6  93201876.319 9
                                   22760854.86347
   20303284.266 7  20303294.227 9                         106694510.219 7  83138615.317 9
                                   20303294.01248
   23440741.258 6  23440748.211 8                         123181935.734 6  95985961.100 8
                                   23440748.62147
   21395760.742 7  21395769.145 9                         112435502.496 7  87612113.685 9
                                   21395769.30548
```

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