GGE2012 Advanced Surveying (Course Note)

GNSS Intro.

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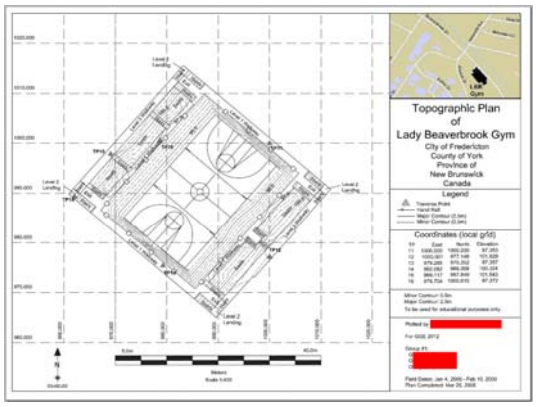
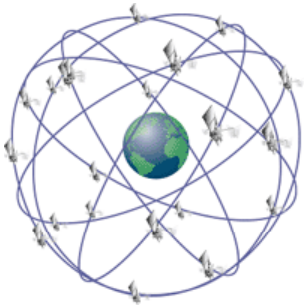




GNSS (Global Navigation Satellite System)

- **Expectation during our 2nd Session**

1. Fully understand the "BASIC" principles of extraterrestrial positioning system.
2. Use GPS devices without any big trouble.
3. Understand the right usage and right recording procedure, and antenna phase center.
4. Understand the basic processing with the data.
5. Understand and "MANAGE" possible error sources of GPS positioning.

6. CAN CHOOSE THE RIGHT METHODOLOGY according to your eng. expectation!!!

GNSS (Global Navigation Satellite System)

Extraterrestrial Positioning Systems

- The Past
  - · Optical Systems
  - · Radio Navigation System(early type)
- The Present
  - · Transit, ARGOS(Doppler Shifts)
  - · Global Positioning System
  - · GLONASS
  - · SLR, LLR, VLBI, *What else?*
- The Modernized (Mixed?)
  - · Galileo(Europe), QZSS(Quasi-Zenith-regonal, Japan),
  - · Beidou-2 or Compass(China), GPS L2C, L5

GNSS (Global Navigation Satellite System)

GPS

· GPS is a space-based navigation system designed by the U.S. military to provide

- Autonomous Geo-Positioning
- 3 ~ 10 Meter Accuracy
- Worldwide Coverage
- Availability 24 Hours Per Day
- Low End-User Cost
- Military Security

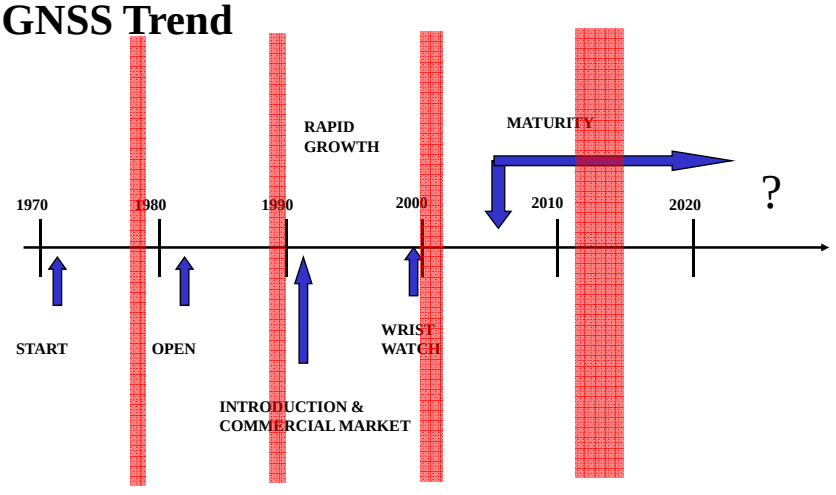
GNSS (Global Navigation Satellite System)

History of GPS

- 1960's USN : Transit and Timation; USAF : 621b
- 1973 Sec of Defence Orders Timation & 621b Merged Into the NAVSTAR (NAVigation Satellite for Timing And Ranging) GPS
- 1973-1979 Phase I : Concept Validation
- 1977, Jun. First Launch of NTS-2 (Navigation Technology Satellite 2)
- 1978, Feb. First Block I Navstar GPS SV Launched
- 1979-1985 Phase II : Full Scale Development & Test
- 1984 Open To Civilian without Charge(Pre. Reagan)
- 1985- Phase III : Production and Deployment
- 1989, Feb. First Block II Navstar GPS SV Launched
- 1993, Dec. DOD Declares IOC
- 1995, Jul. DOD Declares FOC
- 2000, May Turn off the Selective Availability (SA), *what is SA?*
- Present CA, L1, L2, P1, P2, plus L2C, L5 (modernized)

GNSS (Global Navigation Satellite System)

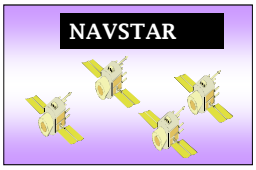
GNSS Trend



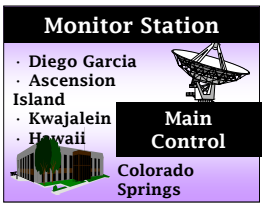
GNSS (Global Navigation Satellite System)

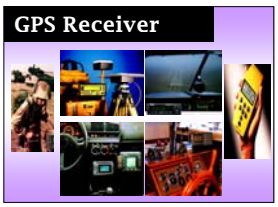
GPS System Configuration

- The Global Positioning System Consists of Three Major Segments
  - The Control Segment(MCS, MS)
  - The Space Segment(NAVSTAR)
  - The User Segment(GPS Rx)



Control → Space → User





GNSS (Global Navigation Satellite System)

GPS Space Segment

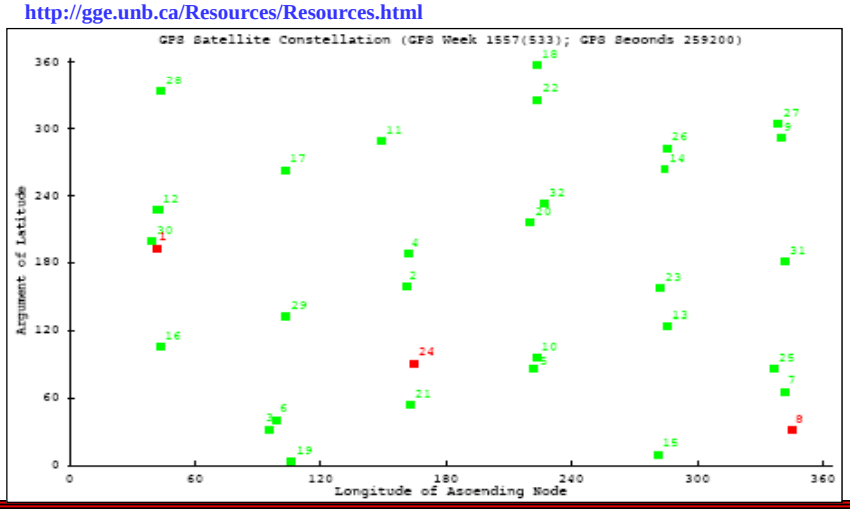
- Physical Characteristics
  - Rockwell International
  - > 1,500 Kg (Block II), > 2000 Kg (Block IIR)
  - 7.5 years lifespan
  - L1 : 1575.42 MHz / L2 : 1227.60 MHz
  - Block I (11), Block IIR(from 1997), Block IIR-M (from 2005)
  - 2 Atomic Clock (Cesium3,4, Rubidum1,2,3)

- Orbital Parameters
  - a : 26,561.75 km (period : ~12h mean sidereal time)
  - e : less than 0.02
  - I : 55 degree
  - Orbital plane & constellation
    - 4 satellites/plane, 6 plane with 60 degree separation
    - 24 Full Deployment(Operation 21, Backup 3)

GNSS (Global Navigation Satellite System)

Latest Information of Space Segment

For update or up-to-date information, visit our department website time to time, http://gge.unb.ca/Resources/Resources.html



GNSS (Global Navigation Satellite System)

Engineering Application of GNSS

- Crustal Movement – plate tectonics
- Precision agriculture – tractor's location
- Water, or Dam monitoring – tilt of water table
- Construction vehicle location – optimal use of materials
- Control networks – known points for traversing

What others (up-to-dated)?

Autopilot, Robotic lawn mowing, Gantry-Crane Auto-Steering, Formation Flying (spaceborne), UAVs (unmanned aerial vehicle, e.g. Israel), LEO orbit, Indoor tracking, Remote Sensing(e.g. SAR)

GNSS (Global Navigation Satellite System)

What does GPS provide?

- Instant horizontal positions to **an accuracy of 3-10 meters** (95% of the time) (easy)
- Instant positions to **an accuracy of 1-2m** (*differential GPS*) (relatively easy, setup cost) : Based on "code" pseudoranges
- Post processed positions to **an accuracy of a few centimeters** (*Kinematics and Stop & Go*) (hard)
- Instant positions to **an accuracy of a few centimeters** (*real-time kineamtics*, very hard) : Mainly by"phase" pseudoranges

[Professionals]

- Post processed positions to **an accuracy of a few millmetres** over a few kilometres (very hard) by "phase"
- Post processed positions to **an accuracy of a few millmetres** over a few hundred kilometres (extremely hard) : by"phase" pseudoranges (RTK in mm level is still very challenging!!!)

GNSS (Global Navigation Satellite System)

Advantages of Satellite Navigation (relatively)

- All weather. Works in rain, clouds, sun, snow, any space weather, etc. – Textbook, Papers, Internet, etc. *(Is this "really" works "WELL" in any weather?)*
- Provides coordinates on a global system.
- 24 hours capability
- World-wide availability
- No subscription fee (GPS,GLONASS)
- No line of site needed between terrestrial points