

2016 KITIS Seminar - GPS



**ACCELERATING DECISIONS,
POWERING INNOVATION.**

송윤상 차장

Topic 1

What is GPS?
History of GPS

Topic 2

Why does GPS matter?

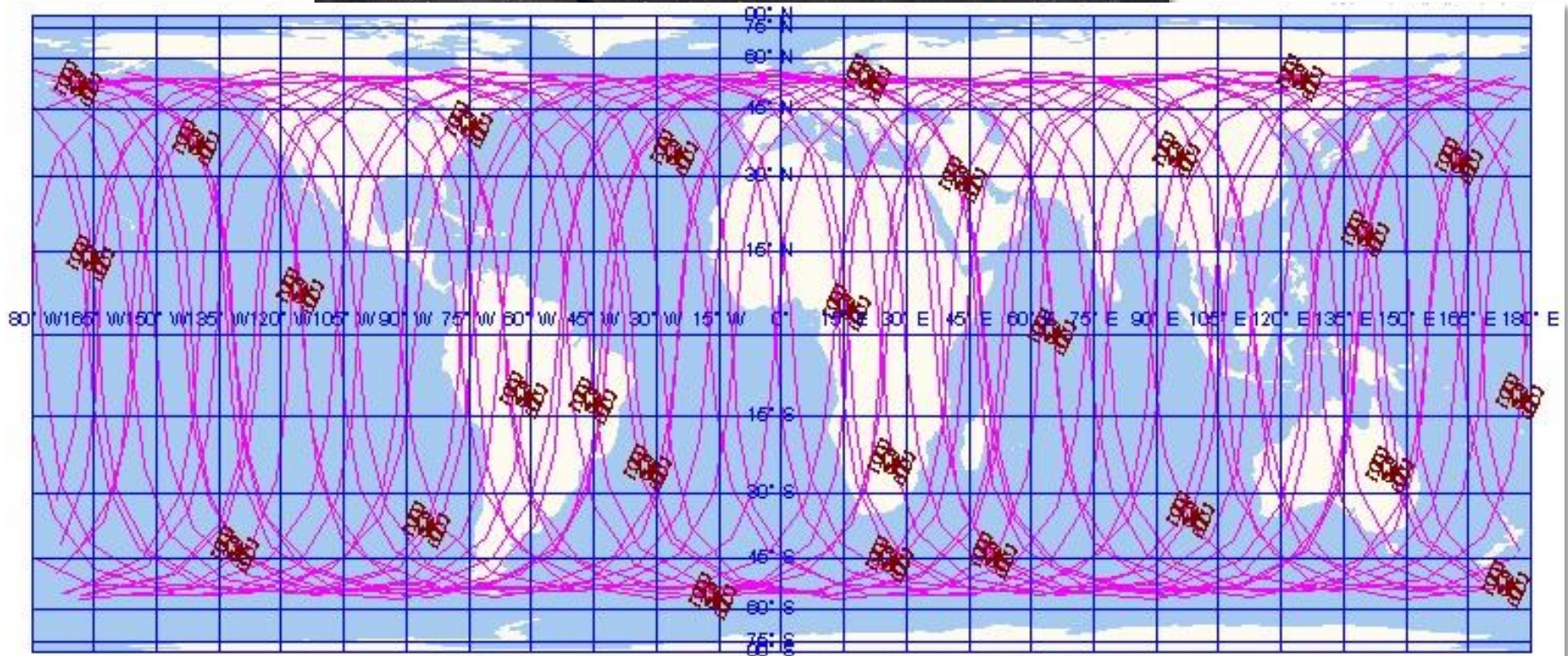
Trend 3

New tech info. for GPS

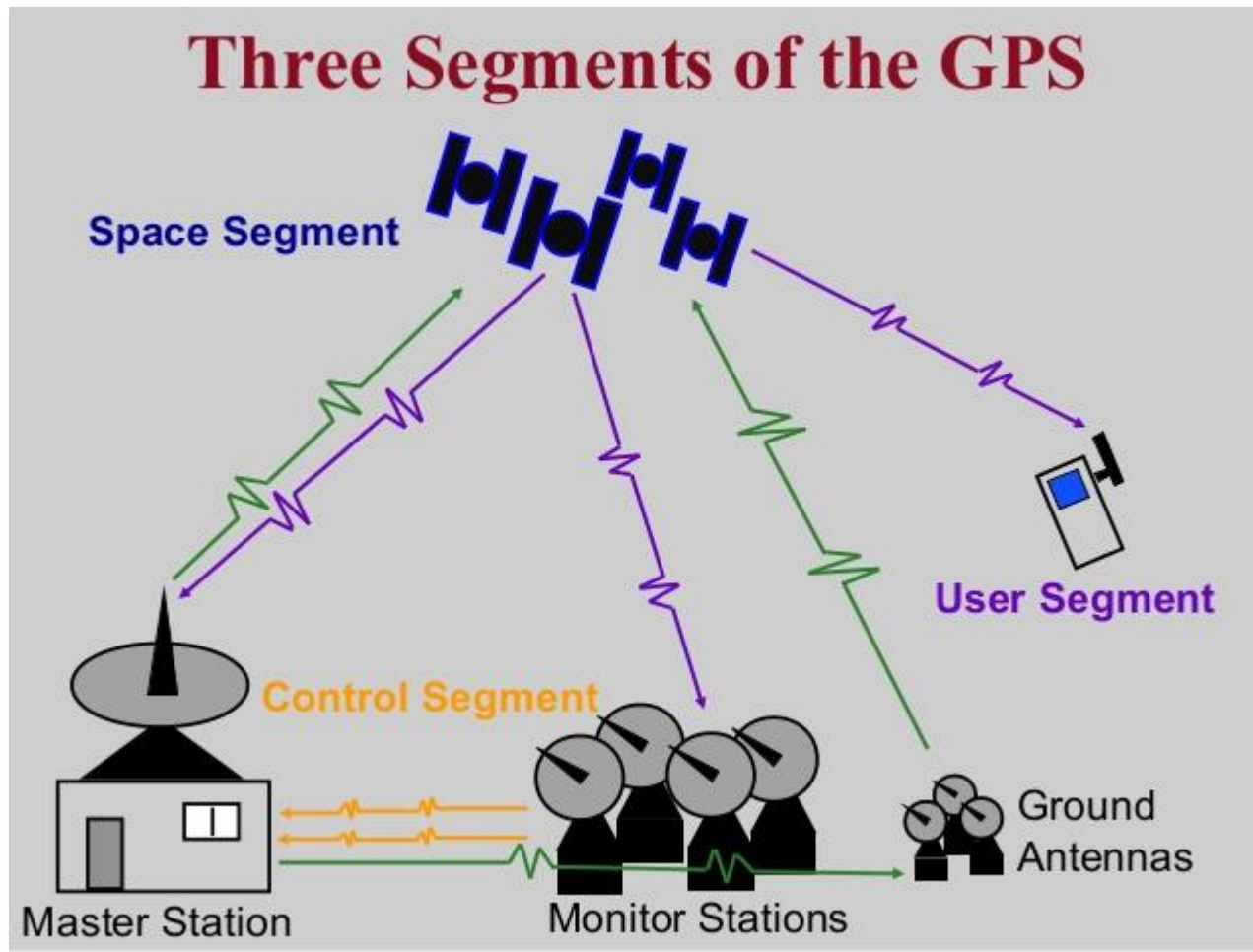
GPS

Global Positioning System





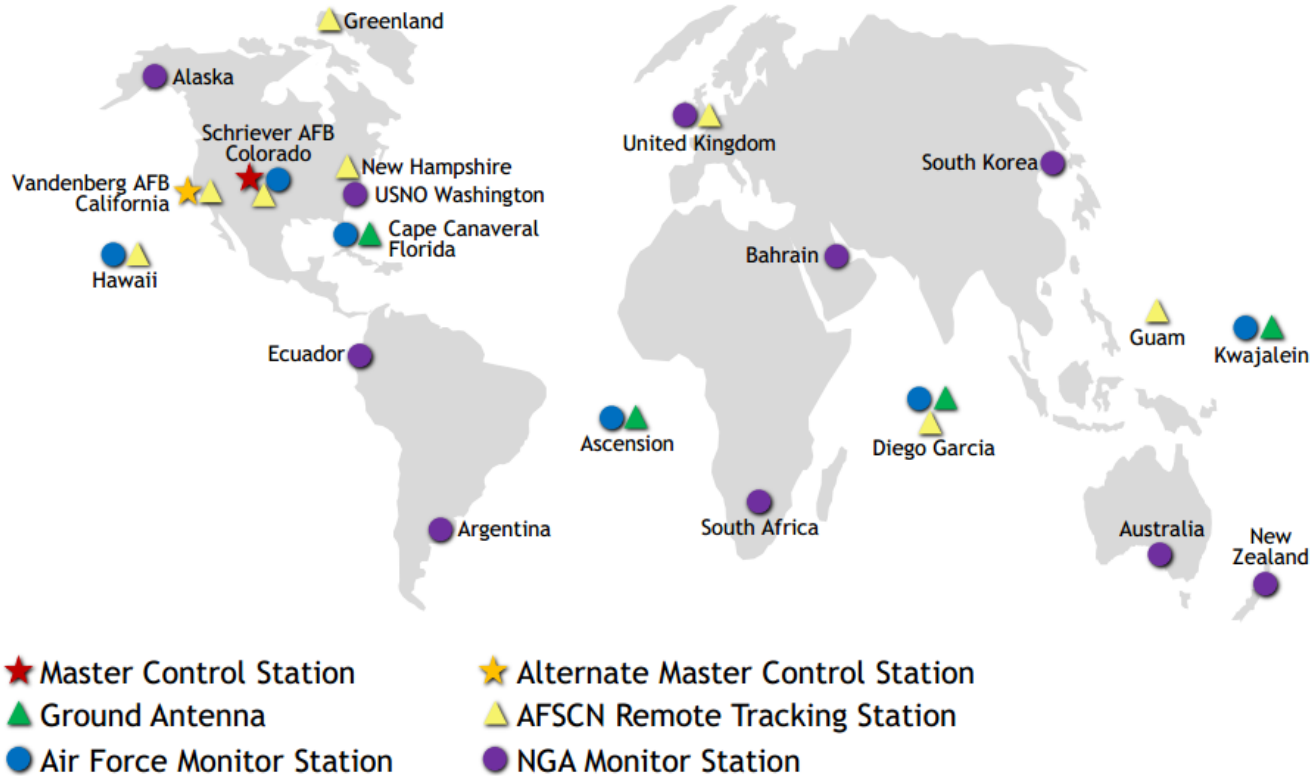
Global Positioning System Satellites and Orbits



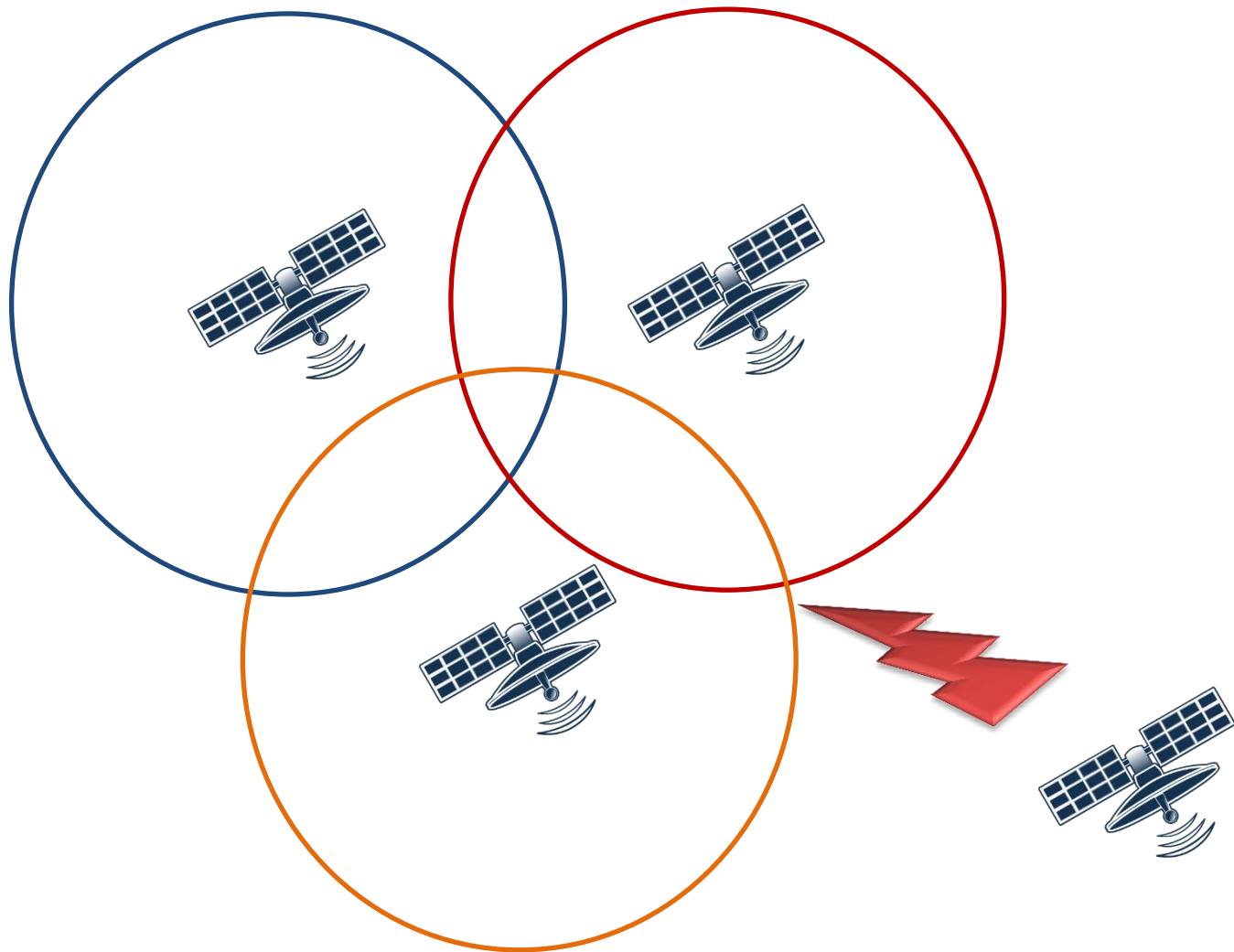
출처: gps.gov

Control Segment

GPS Control Segment



출처: gps.gov



History of GPS

Global Positioning System

1957년 소련의 위성발사 성공에 자극

미 국방부의 NAVSTAR GPS에서 시작

1978년 최초의 GPS 위성 발사 성공 (Block-I)

1983년 민간 분야 무료 개방

1989년 Block-II GPS 위성 발사 성공

1990년 방해코드 삭제

1994년 현 시스템 완성 (24)

1997년 Block-III 위성, 새로운 P/M-code, S-code

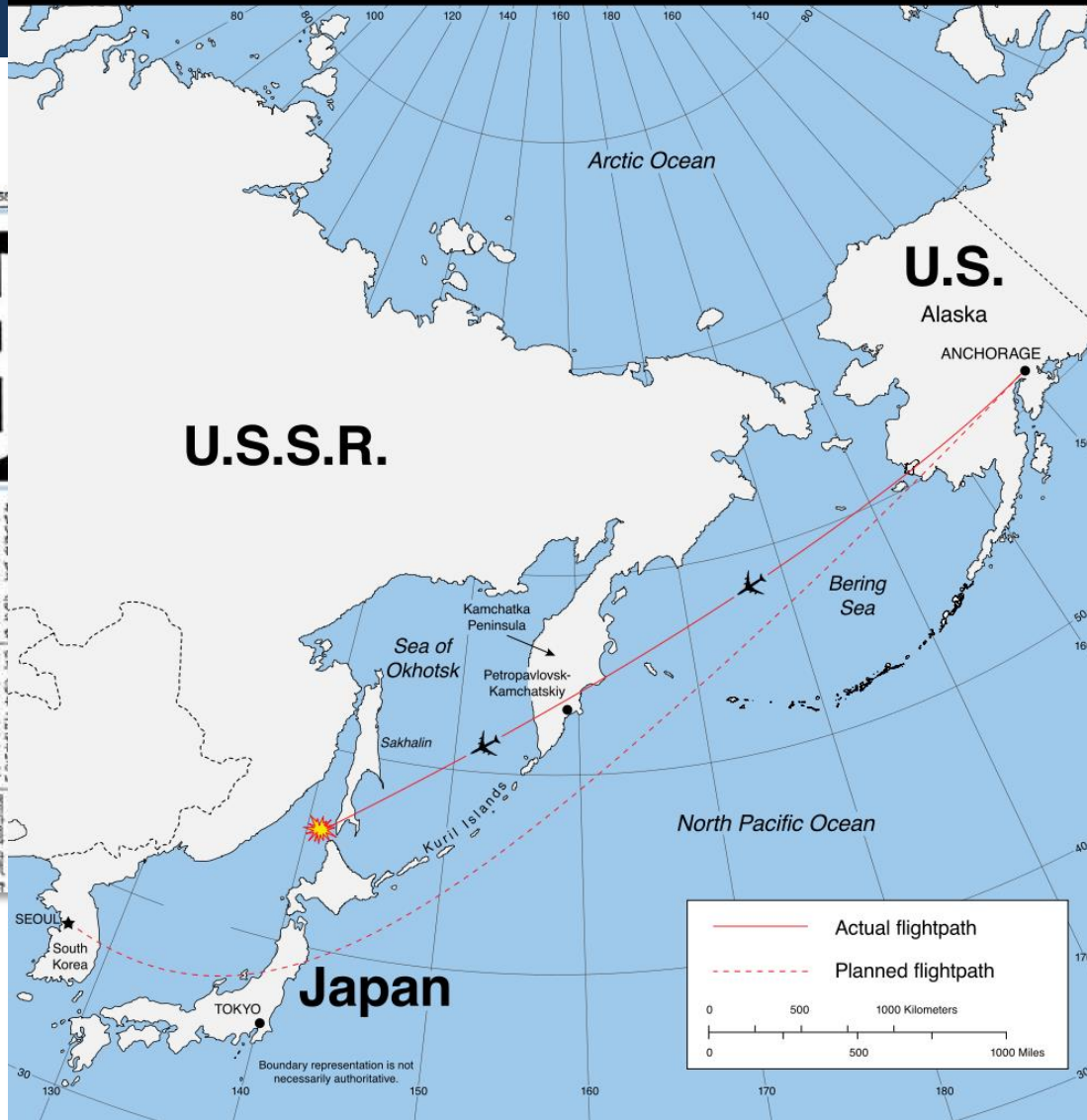
사건 사고들

두 번의 항공 사고

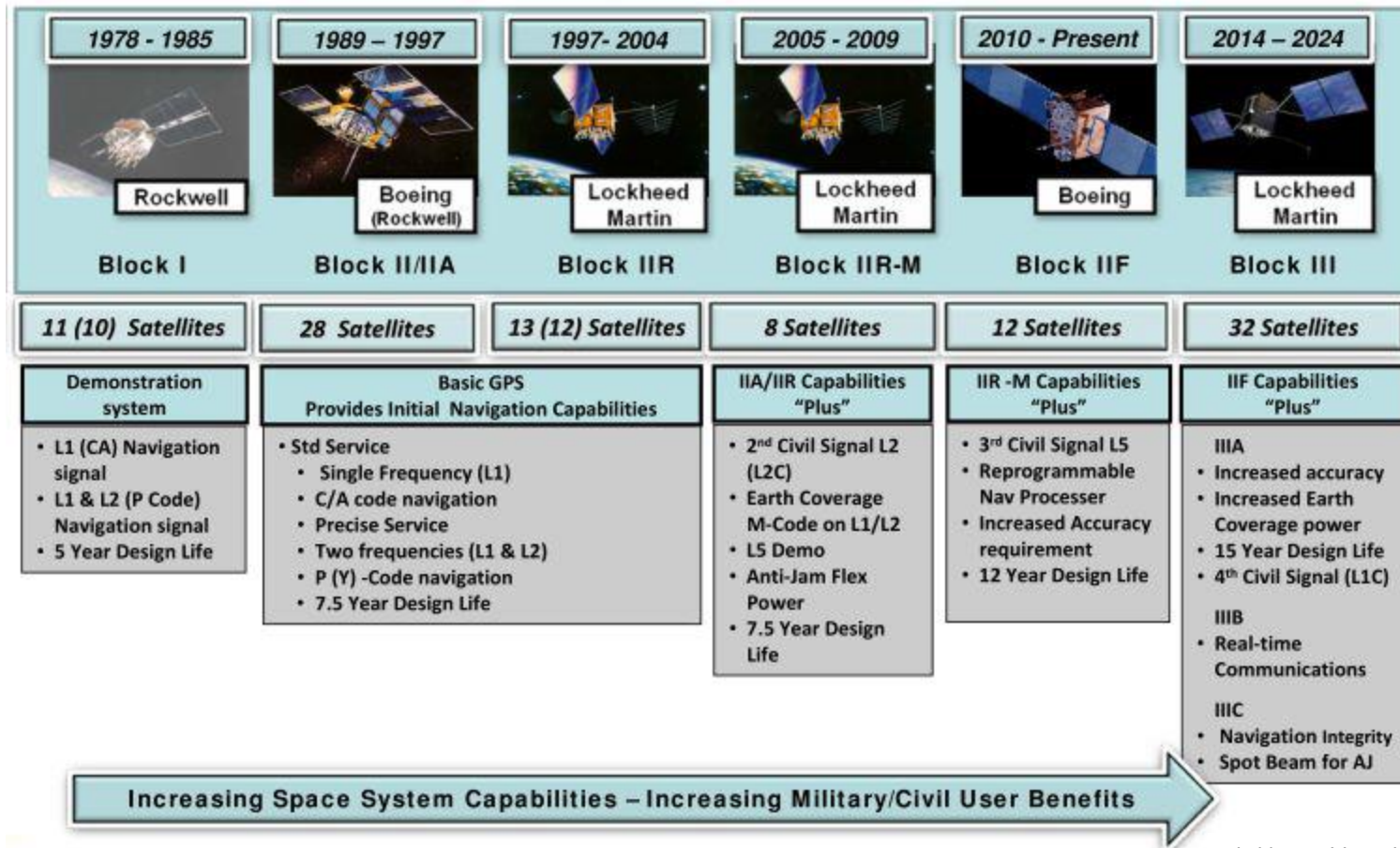


사건 사고들

KOREAN AIRLINES FLIGHT 007, 01SEP1983



GPS 위성의 발전



출처: Lockheed Martin

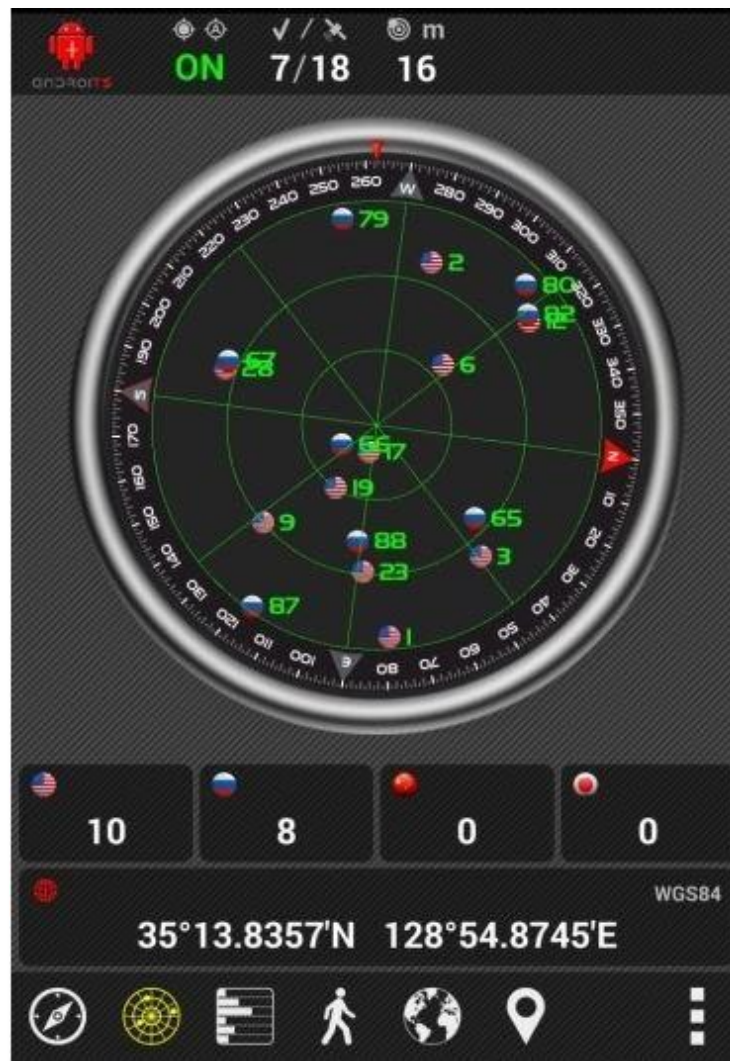
GPS? GNSS?

Global Navigation Satellite System

GPS	미국. 31개 위성. 94년 완성
GLONASS	러시아. 24개 위성 운용 중. 95년 완성
GALILEO	EU. 30개 목표. 2020년 목표. 한국 참여
베이더우(北斗)- COMPASS	중국. 19개. 2020년까지 30개 목표
IRNSS	인도. 7개. 오차범위 20m
QZSS	일본. 3개 정지위성. 2002년부터 시작

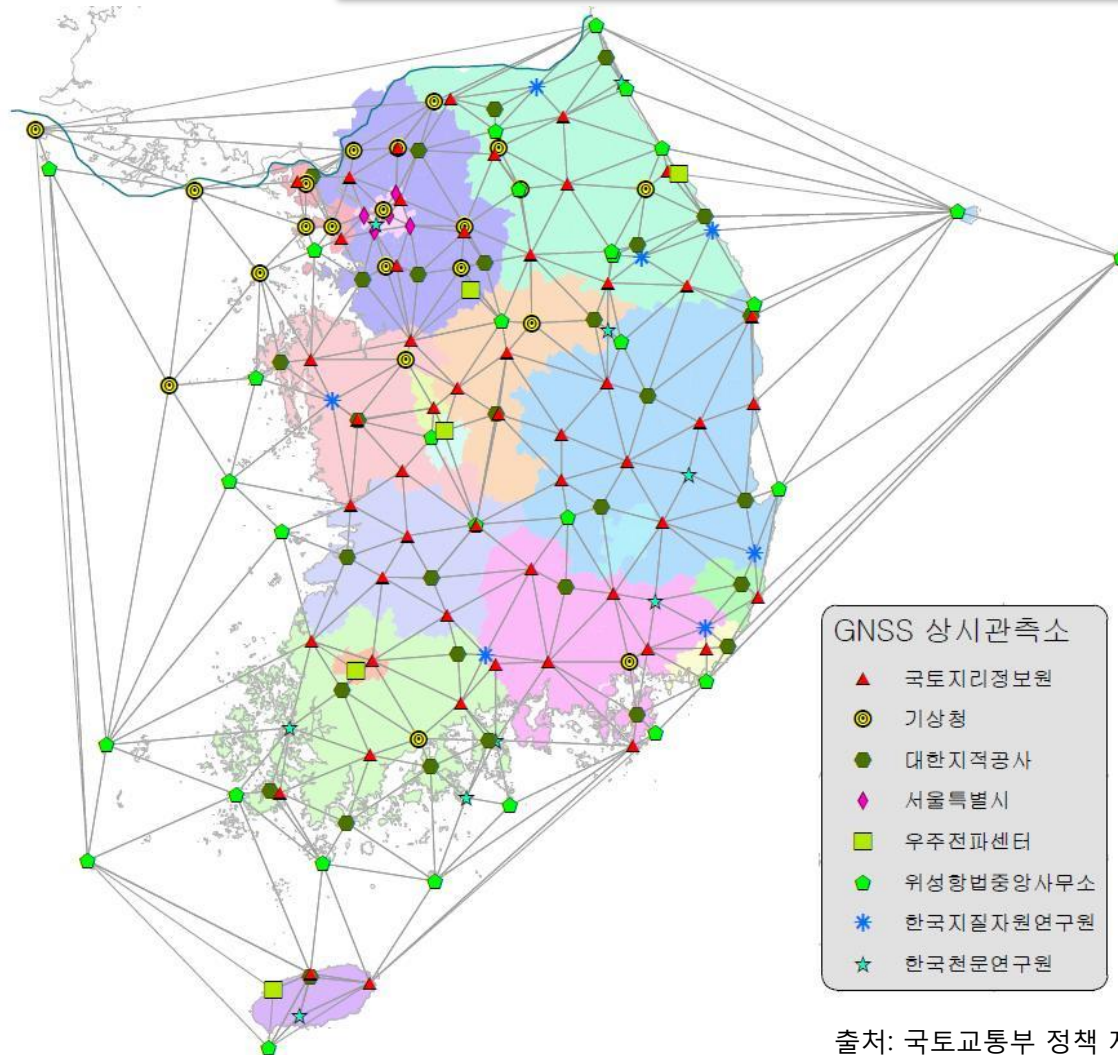
GNSS

Global Navigation Satellite System



국내 GNSS 활용 현황

전국 165개소 운영 중. (2014년 5월 기준)



출처: 국토교통부 정책 자료 2015

국내 GNSS 활용 현황

전국 165개소 운영 중. (2014년 5월 기준)

기관명	활용분야	개수
국토교통부	측량 및 공간정보	55개소
국토교통부(산하기관)	지적측량 및 공간정보	30개소
미래창조과학부	우주전파재난 대응	5개소
미래창조과학부((산하기관)	지질분야 연구	9개소
미래창조과학부(산하기관)	천문분야 연구	9개소
해양수산부	항법 및 수로측량	31개소
기상청	기상기후	21개소
서울시	지적측량 및 공간정보	5개소

출처: 국토교통부 정책 자료 2015

GPS 오류 원인

위성시계 오차	1.5~3.6m
위성 궤도 오차	1 m
지구 전리층 오차	5~7 m
지구 대류권 오차	0.5~0.7 m
노이즈 오차	0.3~1.5 m
멀티패스 오차	0.6~1.2m

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GPS 오차 수정

지역보정 GPS (Local Area Differential GPS, LAD GPS)

광역보정 GPS (Wide Area Differential GPS, WAD GPS)



IEEE

SAE
INTERNATIONAL



키티스産學研情報(株)
KITIS Info. & Co., Ltd

Topic 2

Why does GPS matter?



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미국 FAA "서울 인근 비행시 GPS교란 대비해야"

연합뉴스 | 2015.11.08. | 네이버뉴스 | [🔗](#)

FAA는 "민간항공기가 (인천 FIR에서 비행하던 도중) GPS의 간섭과 교란을 경험했다는 보고가 있었다"며 만약 같은 경험을 한 비행종사자가 있다면 즉각 FAA에 보고해 달라고 요청했다. 이 권고는 미국 항공회사와 FAA의...

- 미국 FAA "서울 인근 비행시 GPS교... SBS TV | 2015.11.08. | 네이버뉴스
- 美 FAA "서울 인근 비행시 GPS 교... 아시아경제 | 2015.11.08. | 네이버뉴스
- 미국 FAA, "서울 인근 비행시 GPS... 인천일보 | 2015.11.08.
- 美 연방항공청, "서울 인근 비행 시 G... YTN | 2015.11.08. | 네이버뉴스

[관련뉴스 7건 전체보기 >](#)



국산 명품 무기, 북한 GPS 교란 공격에 취약

KBS TV | 2015.10.12. | 네이버뉴스 | [🔗](#)

<앵커 멘트> 우리나라 대부분의 국산 무기는 GPS 교란 공격에 취약한 상용 GPS를 장착하고 있습니다. 교란 방지장비까지 장착해도 수km 이내에서는 GPS가 먹통이 될 수 있지만 군용 GPS로의 교체작업은 더디기만...

- 국산 무기, 북한 GPS 교란 공격에 ... KBS TV | 2015.10.12. | 네이버뉴스

안규백, "해군함정 97% 적 GPS교란에 취약" 뉴스한국 | 2015.09.22. | [🔗](#)

아직까지 해군 함정의 97%가 북 전파교란에 취약한 GPS를 사용한다는 것은 큰 문제다. 신속한 대책을 강구해야 한다"고 말했다. <저작권자 © 뉴스한국, 무단전재 및 재배포 금지>

민간용 (C/A) Code	항재밍 능력 없음. 해킹 가능
군용(P) Code	항재밍 능력 보통. 해킹 불가
차세대 군용(M) Code	항재밍 능력 강력. 해킹 불가

군용(P) Code

미국 정부가 대외군사판매 방식으로
판매한 무기 체계에만 사용 장착 가능

차세대 군용(M) Code

미국 정부 판매 무기 중 최신예 전투기 및
구축함 이상의 함정에만 사용 장착 가능

한국 자체 개발 무기

군용 Code 사용 불가.
500kg 이상, 비행거리 300km 이상의
유도무기 및 정찰기에 사용 금지



한국 자체적인 군사용 GPS Code 수신장비 개발 불가
미국산 군용 Code 수신 장비 정비 시 관련정보 의무 제공

북한의 GPS 교란 대응책은?

군용 GPS Code의 빠른 도입

GPS 외 GLONASS, GALILEO 등 기타 GNSS 활용

독자적인 항법위성 체계 구축

북 교란 시설 타격 대응 방안 수립

교란 회피 기술 개발

Trend 3

New tech info. for GPS



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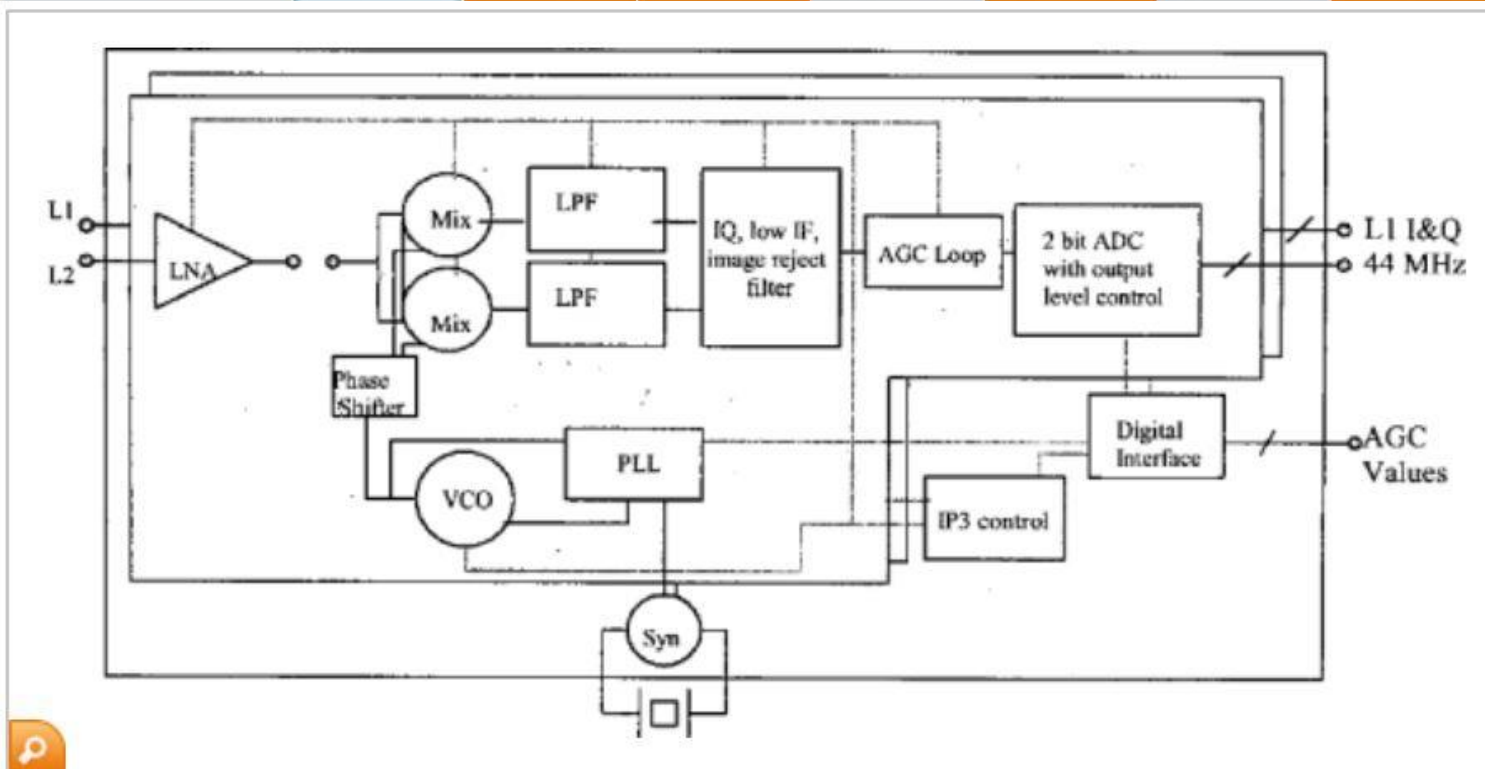


Figure 1: Flexible Honeywell GPS front end ASIC architecture for two or more (e.g. L5) frequency channels can be extended from handheld commercial to military applications (LPF-Low Pass Filter, AGC Automatic Gain Control, ADC-Analog to Digital Converter, IP3-3rd order Intercept Point, VCO Voltage Controlled Oscillator, Mix-Mixer, PLL-Phase Locked Loop, LNA-low noise amplifier, Syn-synthesizer)

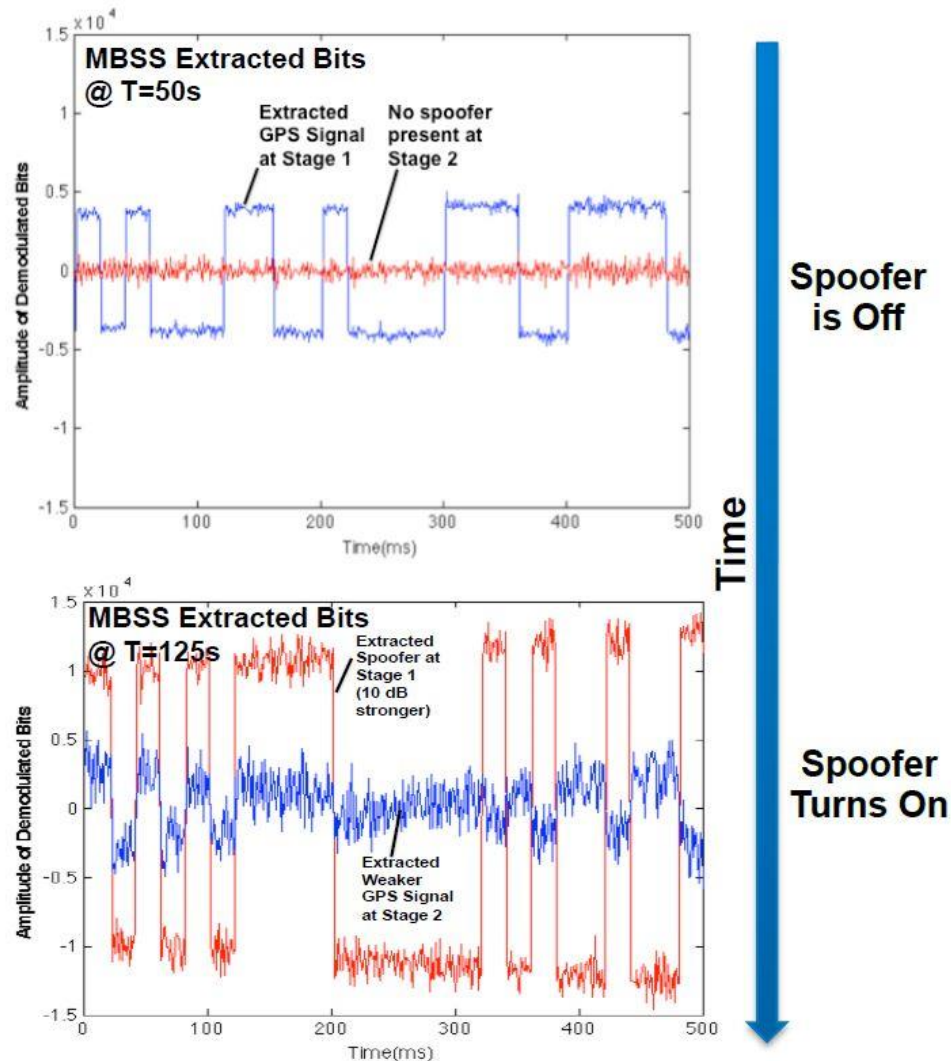


Figure 7: Example of MAGIC Processing involving Blind Demodulation of the original GPS signal and Spoofers (Spoofers turns on at T = 80s).

QUICK
PREVIEW

The efficiency of
elementary
arrays should
arrays should
antennas
guidelines
designs
performance

This paper
Gupta, I

© 2010 IEEE

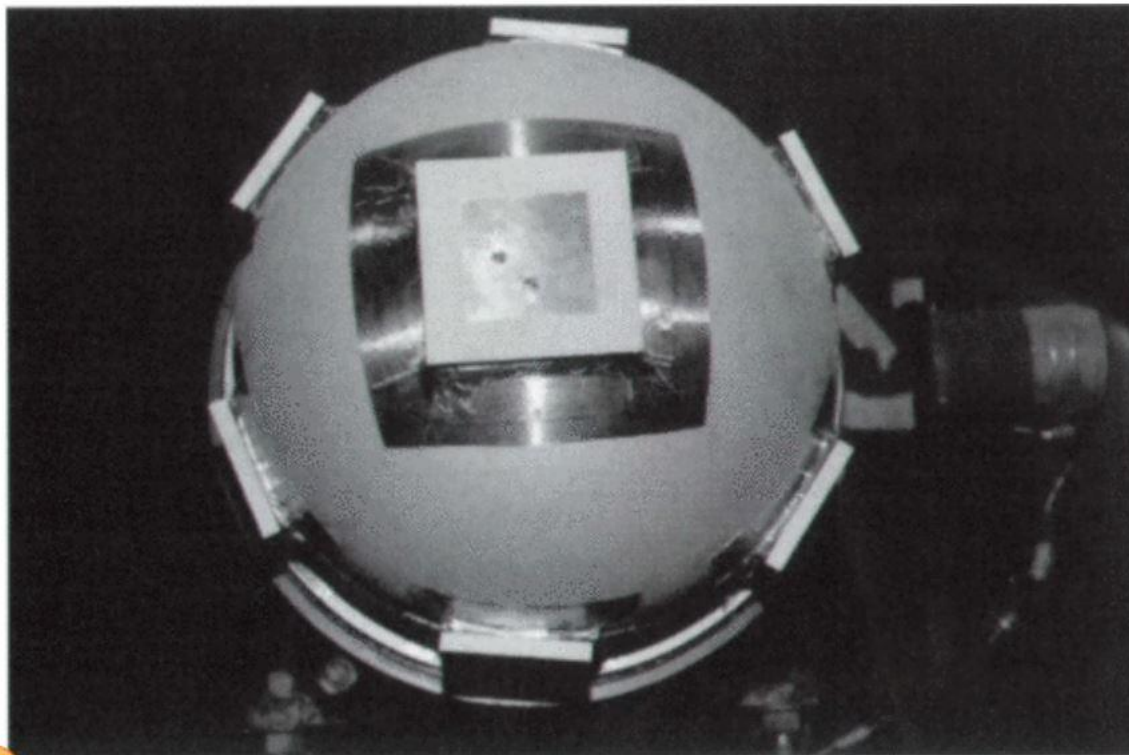


Figure 25. The experimental, seven-element, non-planar antenna array.

6-DOF Trajectory Generator

50

9

The power spectrum of the tracking jitter introduced by the jammer is denoted as $G_J(\omega)$, and is given by

$$G^B(\omega) = |H(\omega)|^2 J(\omega) / 4P^2$$

where $J(\omega)$ is the power spectrum of the jamming signal. This noise PSD is approximately flat over the relatively small loop bandwidth; therefore, the tracking sleaze introduced by the jammer can be written as:

$$\sigma_J^2 = \frac{1}{2\pi} \int_{-\infty}^{\infty} G_J(\omega) d\omega = \frac{J(0)}{2P^2} B_L$$

Where B_L is the tracking loop bandwidth in Hz. The above equation becomes the basis of the jamming effect simulation of the present invention.

The carrier-to-noise ratio C/N_0 impacts the GPS tracking loops and thus dominates the accuracy of the measured pseudorange and pseudorange rate values. That the positioning errors are a function of the carrier to noise ratio, C/N_0 , ensues. The power density, i.e. watts per unit frequency, is often used to characterize the bandlimited white noise. Thus the carrier to noise ratio, C/N_0 , can be defined as the ratio of the power of the signal to the power density of the noise. A new ratio, the signal-to-noise ratio, is defined to account for the frequency spread of the noise power. The signal-to-noise ratio is the ratio of the power of the signal to the total power contributed by the noise i.e. $S/N_0 = C/(N_0 \cdot B)$ where B is the bandwidth.

The carrier to noise ratio and the signal to noise ratio are used in the present invention to characterize a receiver's performance under jamming conditions. If the jamming power and its frequency content are known, then their effect can be translated to an equivalent noise degradation of the C/N_0 ratio which, in turn, directly impacts a receiver's performance characterization.

The carrier to noise power ratio (C/N_0) will be deteriorated due to the introduction of the in-band radio frequency interference on a GPS receiver channel. The carrier tracking threshold is a carrier to noise ratio level, at which the GPS receiver channel loses tracking of signals due to radio jamming noise. The better anti-jamming performance a GPS receiver has, the lower carrier tracking threshold is. The distance between the unjammed C/N_0 and the carrier tracking threshold is used as a measure of the anti-jamming performance of a GPS receiver in the present invention.

The effective signal-to-noise density S/N_0 , when considering jamming, is given by

$$\frac{S}{N_0} = \frac{S}{N_{0T}} + \frac{s}{N_{0J}} \text{ (dB/Hz)}$$

10

noise including jamming signal bandlimited at intermediate frequency (IF). The spectral density of wide- and narrow-band jamming noise at IF can be represented as:

$$S_J(f) = \frac{P_J}{f_u - f_l}; \quad f_l \leq f \leq f_u$$

where f_u and f_l are the upper and lower frequency limits, respectively; and P_J is the total jamming noise power. After the correlation processing in a GPS receiver, the spectral density of the jamming noise is

$$N_{0J}(f) = \frac{P_J}{f_u - f_l} \int_{\max[-B_I/2, f-f_l]}^{\min[B_I/2, f-f_u]} S_C(f') df'$$

where B_I is the IF bandwidth. CW interference has a spectral density of the following form:

$$S_J(f) = P_J \delta(f - f_J)$$

where f_J is the frequency of the jammer. Thus, the post correlation noise density is

$$N_{0J}(f) = P_J S_C(f - f_J)$$

The jammer-to-signal (J/S) ratio can be computed using the following formula

$$\frac{J}{S} = \frac{\frac{P_J}{4\pi R^2} A G_J(a_{z_J}, e_{l_J}) G_S(a_{z_J}, e_{l_J})}{P_S G_S(a_{z_S}, e_{l_S})}$$

where,

$$\frac{J}{S} = \text{Jammer-to-signal power ratio;}$$

P_J =Jammer power (watts); A =Effective GPS antenna aperture area

$$\left(= \frac{c^2}{4\pi f^2}, m^2 \right)$$

f is L1 or L2; R =Range to jammer (m); P_S =GPS signal power at antenna (watts); $G_J(a_{z_J}, e_{l_J})$ =Jammer gain in the GPS receiver direction; $G_S(a_{z_J}, e_{l_J})$ =GPS antenna gain in the jammer direction; $G_S(a_{z_S}, e_{l_S})$ =GPS antenna gain in satellite direction.

The carrier-to-noise power ratio in the absence of jam-

44

I/O
Interface

IMU Integrated
em

42

A Study and Analysis through

Sooncheol
Hyundai Motor

CITATION: I
Vehicle Usage

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Abstract

Customer vehicle usage is a fundamental element of a durable vehicle.

The extant method for considering a considerable number of series of sensors (e.g., GPS, microphone, and accelerometer) and then to analyze the data is not efficient.

To solve the problem, an integrated system to analyze vehicle usage that can process data from various sensors installed on a vehicle was developed.

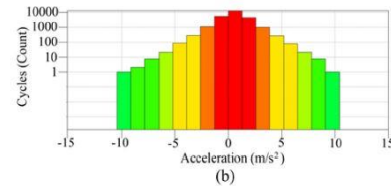
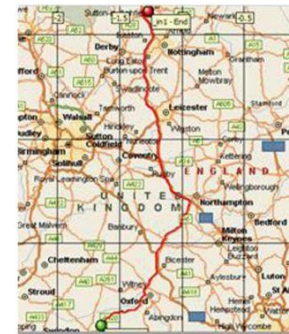


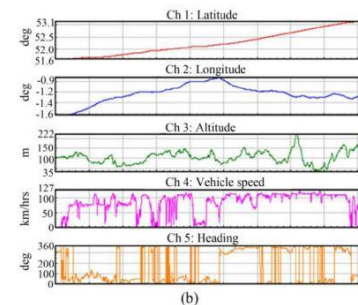
Figure 8. (cont.) Comparison of commercial software and smartphone Level Crossing counting: (a) nCode GlyphWorks (Non-Real time); (b) Smartphone (Real time)

Analyzing GPS Data

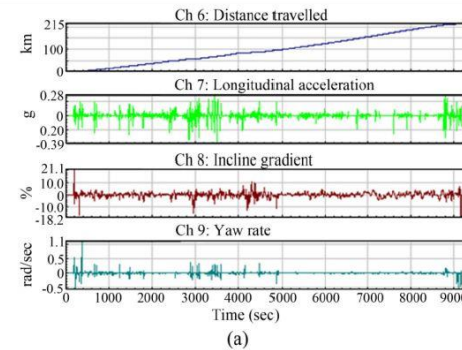
The raw data measured from the GPS is depicted in Figure 9. Using the Glyphworks and python software, the distance, cornering acceleration, road gradient, and yaw rate can be calculated (Figure 10(a)). Vehicle speed, braking power, engine power, and steering angle distribution can also be calculated (Figure 10(b)).



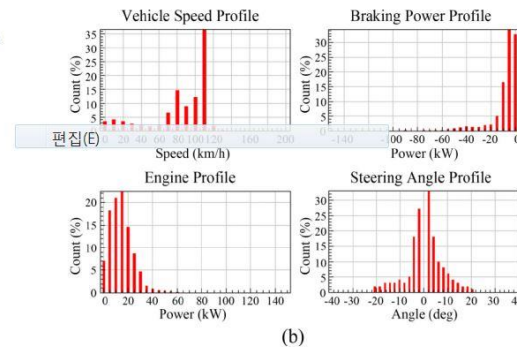
(a)



(b)



(a)



(b)

Figure 10. Post data processed from the GPS raw data

Conclusions

Through this research, data from a variety of sensors attached to a smartphone were collected, and a new concept of integrated system that can analyze data was developed to examine customer vehicle usage.

Based on comparison with the existing method to measure customer vehicle usage, the integrated system to examine customer vehicle usage using a smartphone was validated, and the reliability of data measured through accelerometer, gyroscope, and GPS sensors was secured.

A Bluetooth dongle was manufactured that could receive CAN information directly from a vehicle so that it could exchange data with a smartphone. As a result, engineering data can be analyzed through Rainflow counting and Level Cross counting by processing signals of data on a real-time basis collected from an accelerometer, gyroscope, and GPS.



Q & A

With KITIS,
The window is open,
Finding Answer!