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Should GNSS Become a National Critical Infrastructure ?

Ooi Wei Han, Noordin Ahmad, Shahrizal IM

National Space Agency (ANGKASA)

Ministry of Science, Technology and Innovation (MOSTI)

Outline..

- GNSS and applications
- GNSS Infrastructure setup in Malaysia
- GNSS Vulnerability / Impact
- International Overview
- The way forward



ANGKASA Campuses



Langkawi National Observatory, Kedah



National Planetarium, Kuala Lumpur

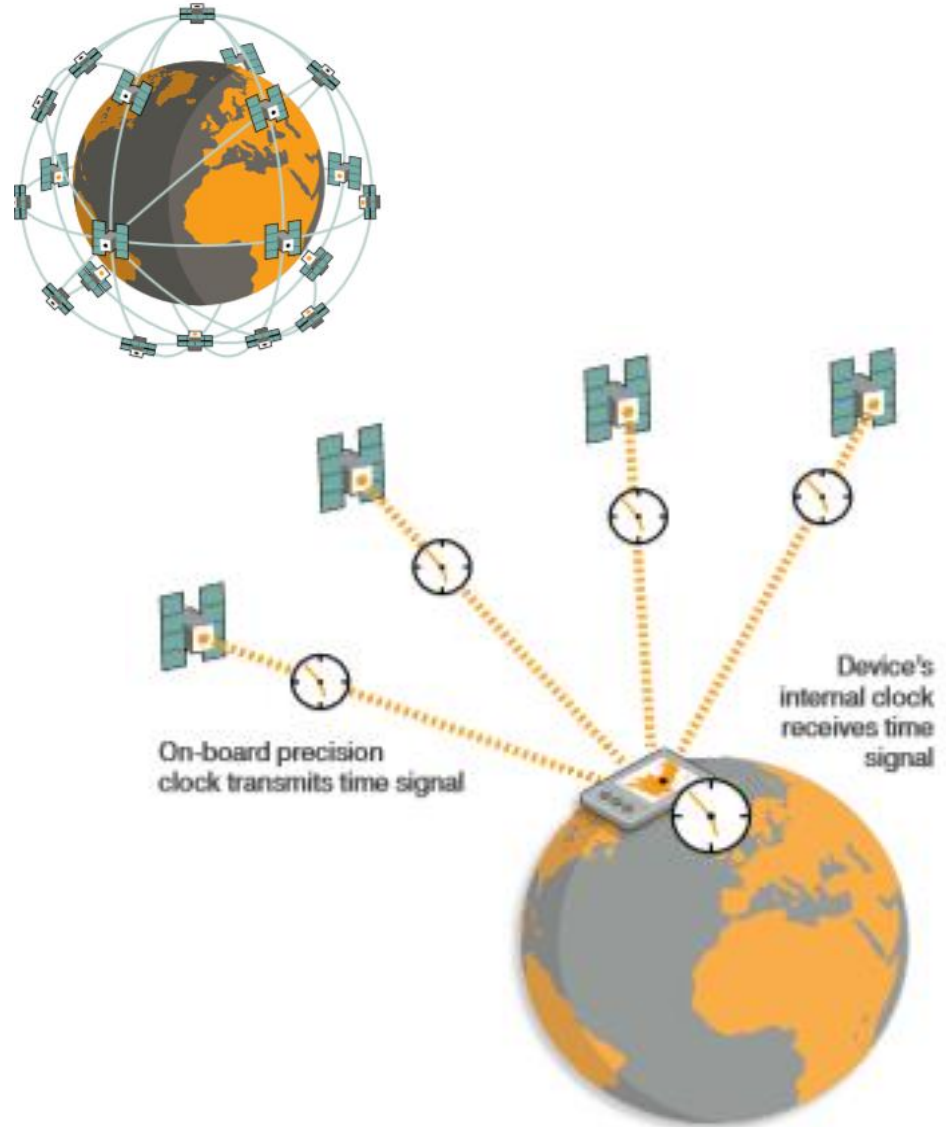


National Space Centre, Banting, Selangor

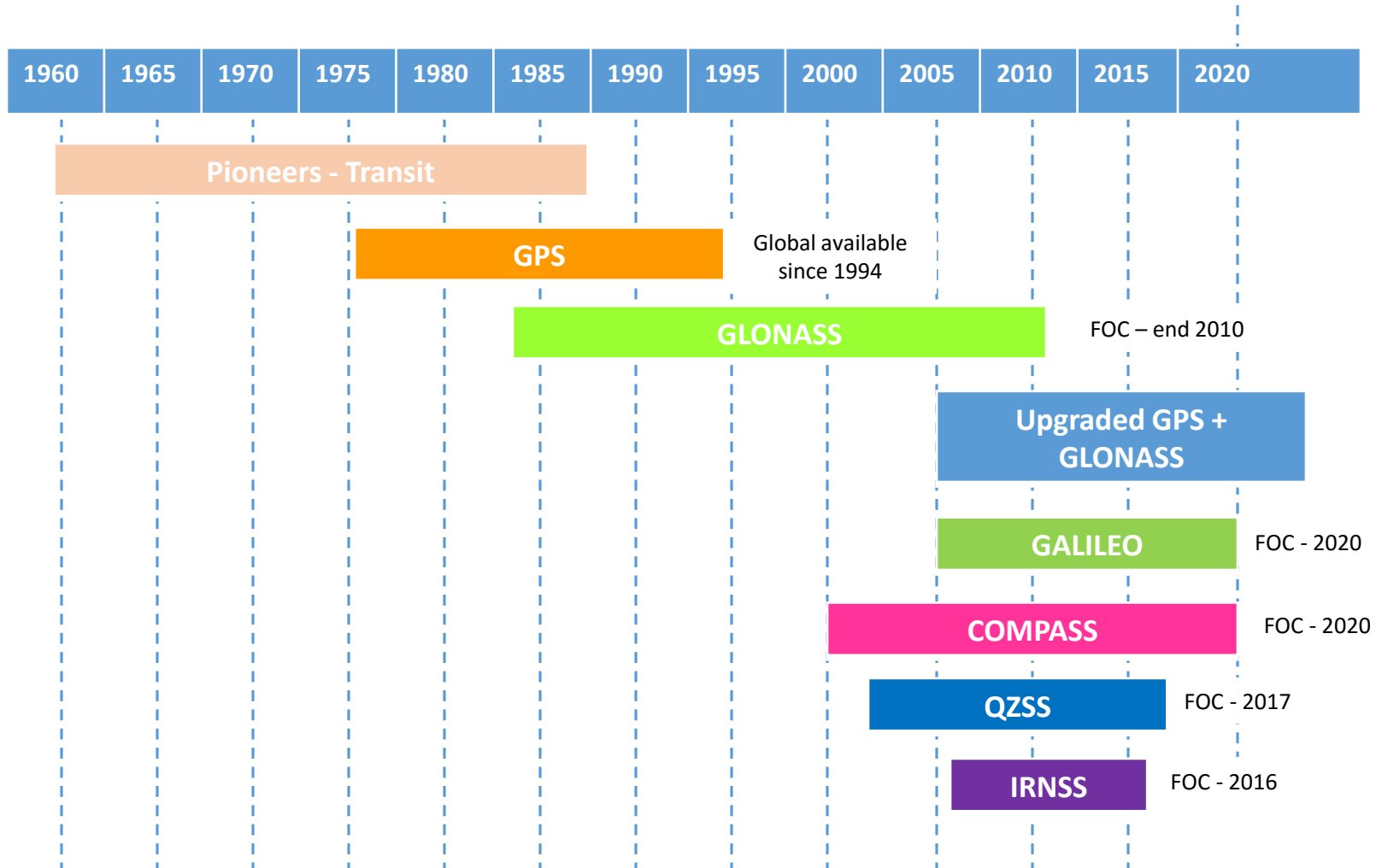


Introduction

- GNSS provide 2 essential pieces of information; position and time.
- The most well-known navigation satellite is GPS. Anything enabled with a GPS receiver can be used for navigation.
- It requires a minimum of 4 satellites. The current system capable to deliver accuracy from centimetre to meter level.



The Eras of GNSS



GNSS Applications

NAVIGATION

Air Transportation

Terrestrial
Transportation

Marine
Transportation

ENERGY AND FOOD SUPPLY

Fisheries

Fuel
extraction

Precision
Agriculture

ADVANCED TECHNOLOGIES

Timing

Scientific

Autonomous
vehicles

SAFETY OF LIFE

Defence

Surveillance

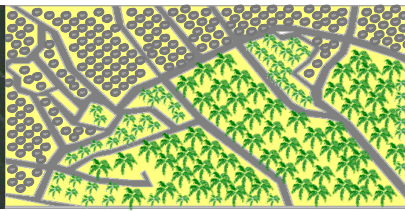
Emergency
Services

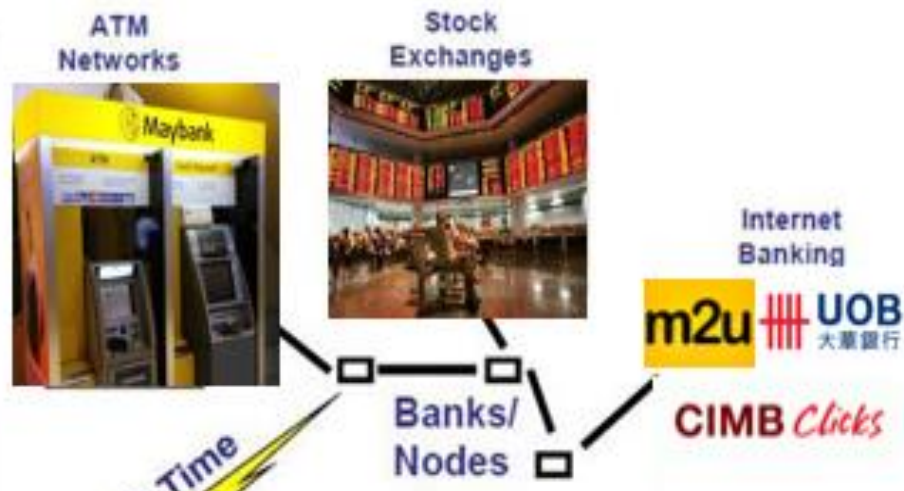
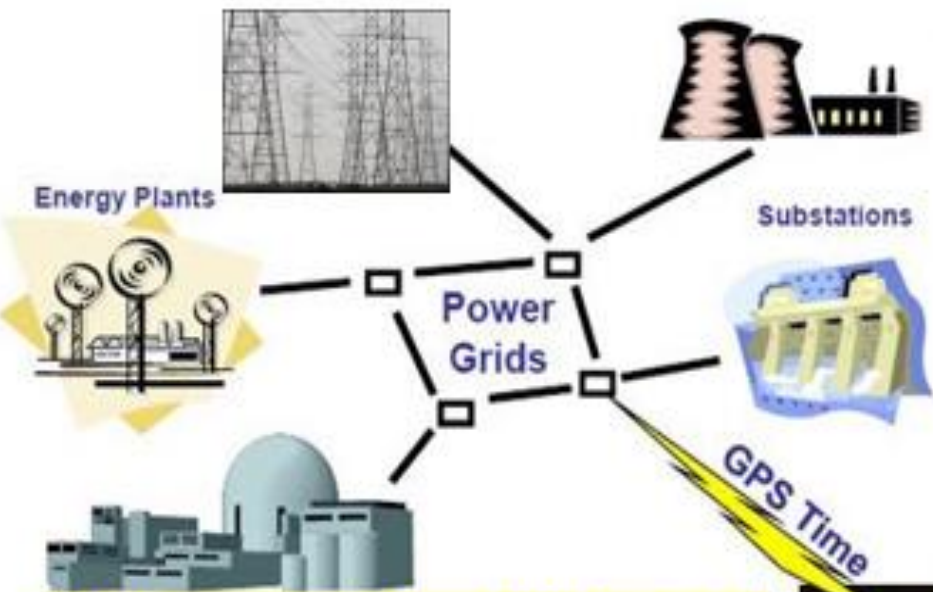
RECREATIONAL MARKET

Recreation

Light vehicles

Personal
communication





GPS Supporting Power Grid Systems

GPS Supporting Banking Operations



GPS Supporting Transportation Systems



GPS Supporting Communications Systems

GPS/GNSS Market

Billions...

Global GPS Market:
Products (Marine,
Aviation, Automotive,
Outdoor/fitness & GPS
Enabled Smart Phones),
Applications (Navigation,
Machine Control, &
Logistics Tracking) &
Geography (2011 - 2016).

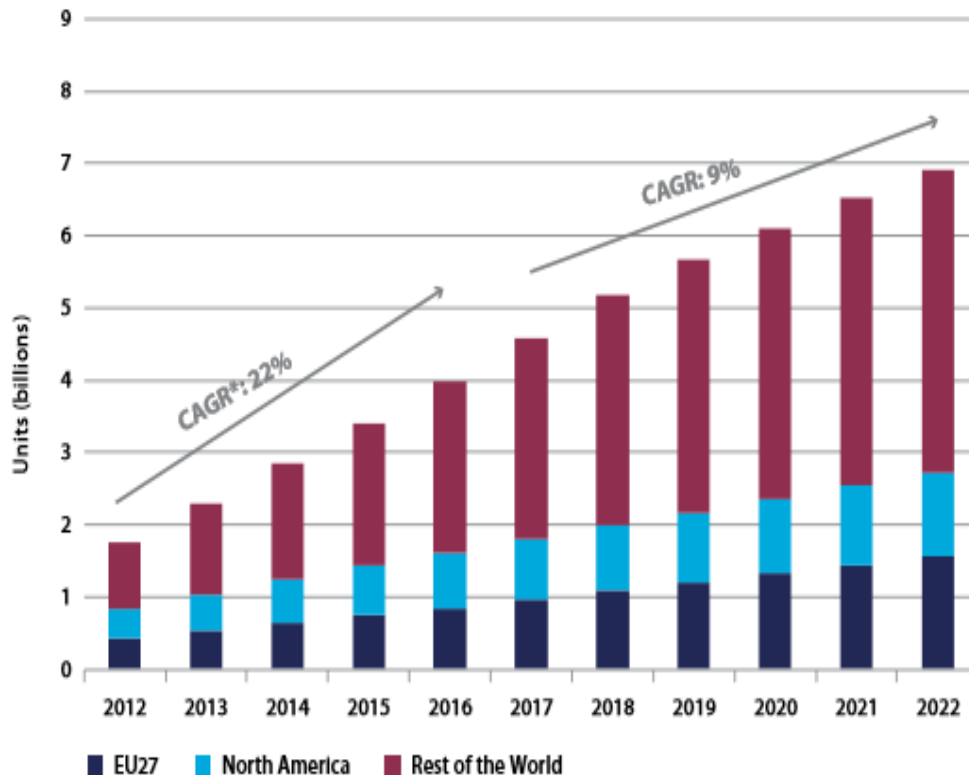
GPS Market (\$ Billion)

<http://www.marketsandmarkets.com/Market-Reports/global-GPS-market-and-its-applications-142.html>



Seven billion GNSS devices by 2022 – almost one for every person on the planet

Installed base of GNSS devices by region



- ▶ Over the coming decade, the installed base of GNSS devices will increase almost four-fold, largely driven by increased penetration in regions outside Europe and North America.
- ▶ Such a large number of devices, almost one GNSS receiver for every person on the planet, has the potential to deliver additional significant benefits, not measured in this report, especially in terms of time and fuel savings, as well as efficiency gains.
- ▶ It is expected that the number of GNSS devices will increase in Europe and North America from 1 to 3 per inhabitant over the coming decade.
- ▶ For the Rest of the World, rapid growth, albeit from a low initial starting point, will see an increase from 1 device per 10 inhabitants to 1 per 2 inhabitants over the coming decade.

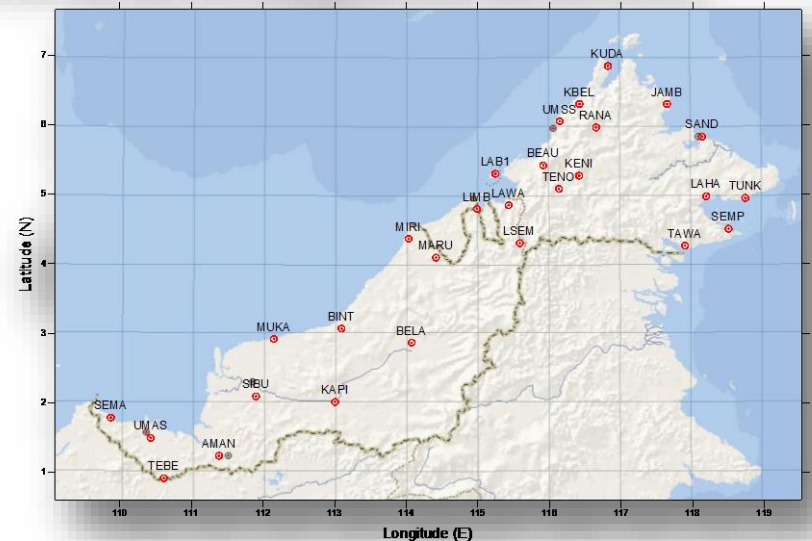
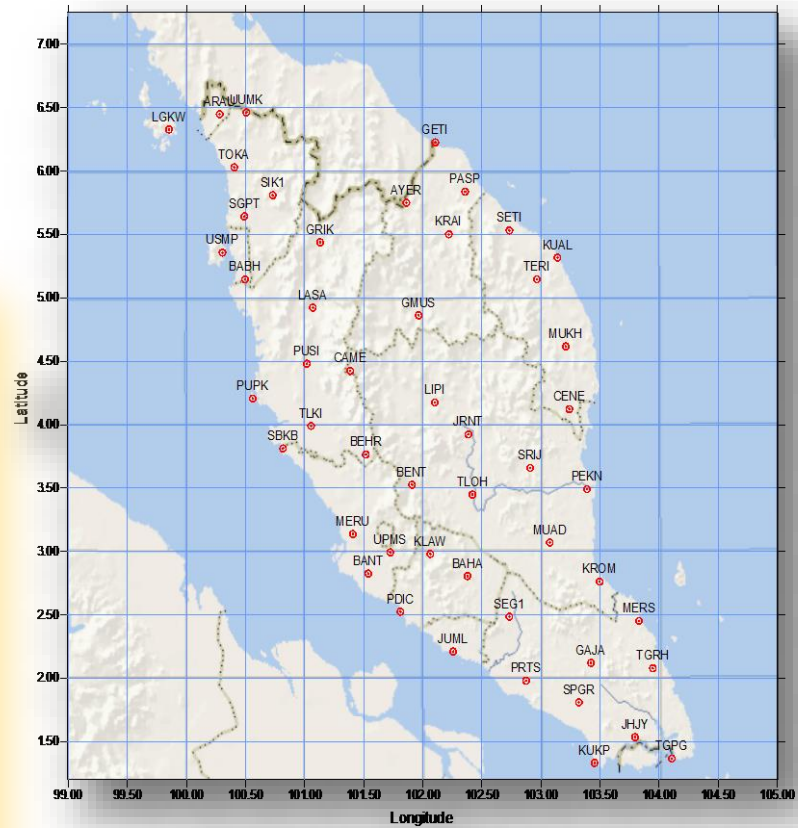
Source: GNSS market report 2013 by European GNSS Agency

GNSS ground infrastructure setup in Malaysia



MyRTKnet

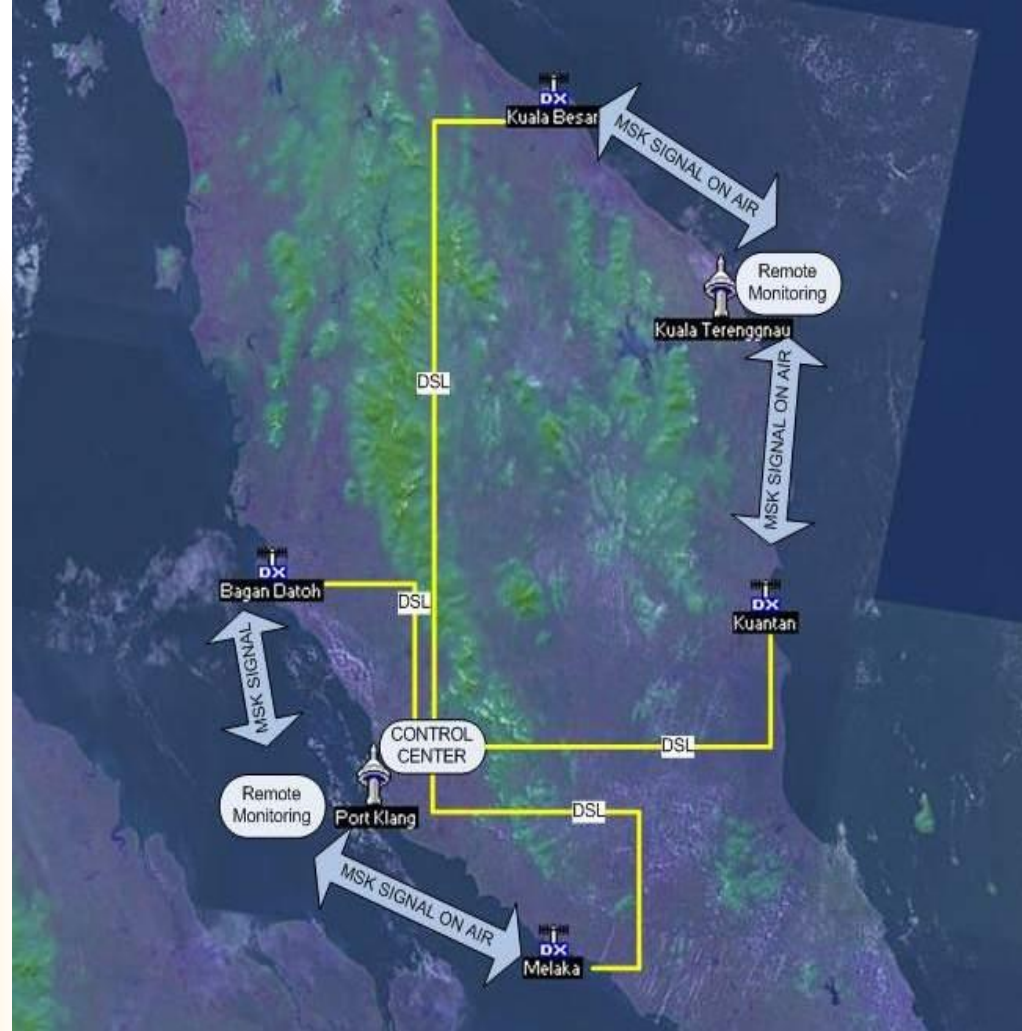
- Setup by Department of Surveying and Mapping Malaysia (JUPEM)
- Comprises of 78 GPS reference stations with spacing of between 30 to 120 km and providing real-time corrections.
- Support e-cadastre surveying activities; location-based activities; fleet tracking and management.





MSK-DGNSS

- Setup by Jabatan laut Semenanjung Malaysia
- Remote Monitoring Station in: Port Klang and K. Terengganu
- Reference Station in: Bagan Datoh, Melaka, Kuantan and Kuala Besar
- To improve accuracy and safety of maritime navigation
- Increased nominal accuracy from 10-15m to 1-3m. Reduced risk of maritime accidents
- Faster transit times for commercial shipping.





COSPAS-SARSAT: Search and Rescue

Apmm Perteingkatkan Sistem Sar Negara Dengan Cospas-Sarsat



Bernama

14/2/2015

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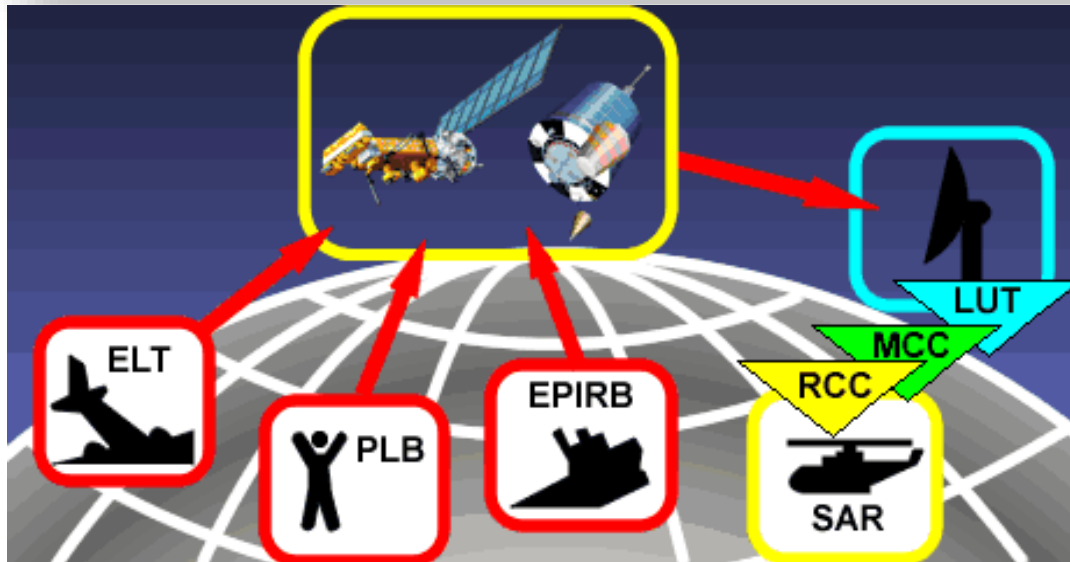
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EMAIL

KUANTAN, 14 Feb (Bernama) -- Agensi Penguatkuasaan Maritim Malaysia (APMM) mencipta satu lagi sejarah apabila menerima sistem bantuan berteknologi satelit iaitu Cospas-Sarsat sebagai usaha meningkatkan keupayaan negara dalam operasi mencari dan menyelamatkan (SAR). Menteri di Jabatan Perdana Menteri Datuk Seri Dr Shahidan Kassim berkatapenggunaan sistem itu juga akan menjadikan APMM setanding dengan Pasukan SAR negara maju yang mempunyai sistem berteknologi tinggi. "Sistem ini menggunakan satelit untuk menjejak isyarat dan lokasi dari beacon kecemasan seperti Emergency Locator Beacon (ELT), Emergency Position Indicator Radio Beacon (EPIRB) dan Personal Localtal Beacon (PLB) yang telah siap dipasang dan diuji 30 Jan lepas dan kini telah beroperasi sepenuhnya. "Melalui isyarat yang diperoleh, pengawasan isyarat kecemasan akan dapat dilakukan sepanjang masa dan penerimaan isyarat kecemasan didapati dalam waktu sebenar bersama maklumat yang berkaitan," katanya. Beliau berkata demikian kepada pemberita selepas majlis sambutan Hari Maritim Malaysia ke-10 di Akademi Maritim Sultan Ahmad Shah (AMSAS) di sini, hari ini. -- LAGI SHAHIDAN-APMM 2 (AKHIR) KUANTAN Dalam

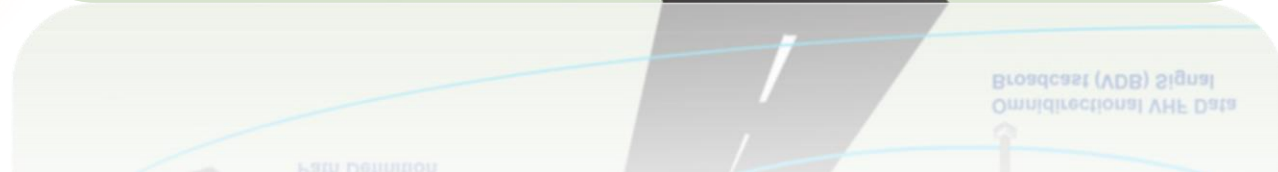
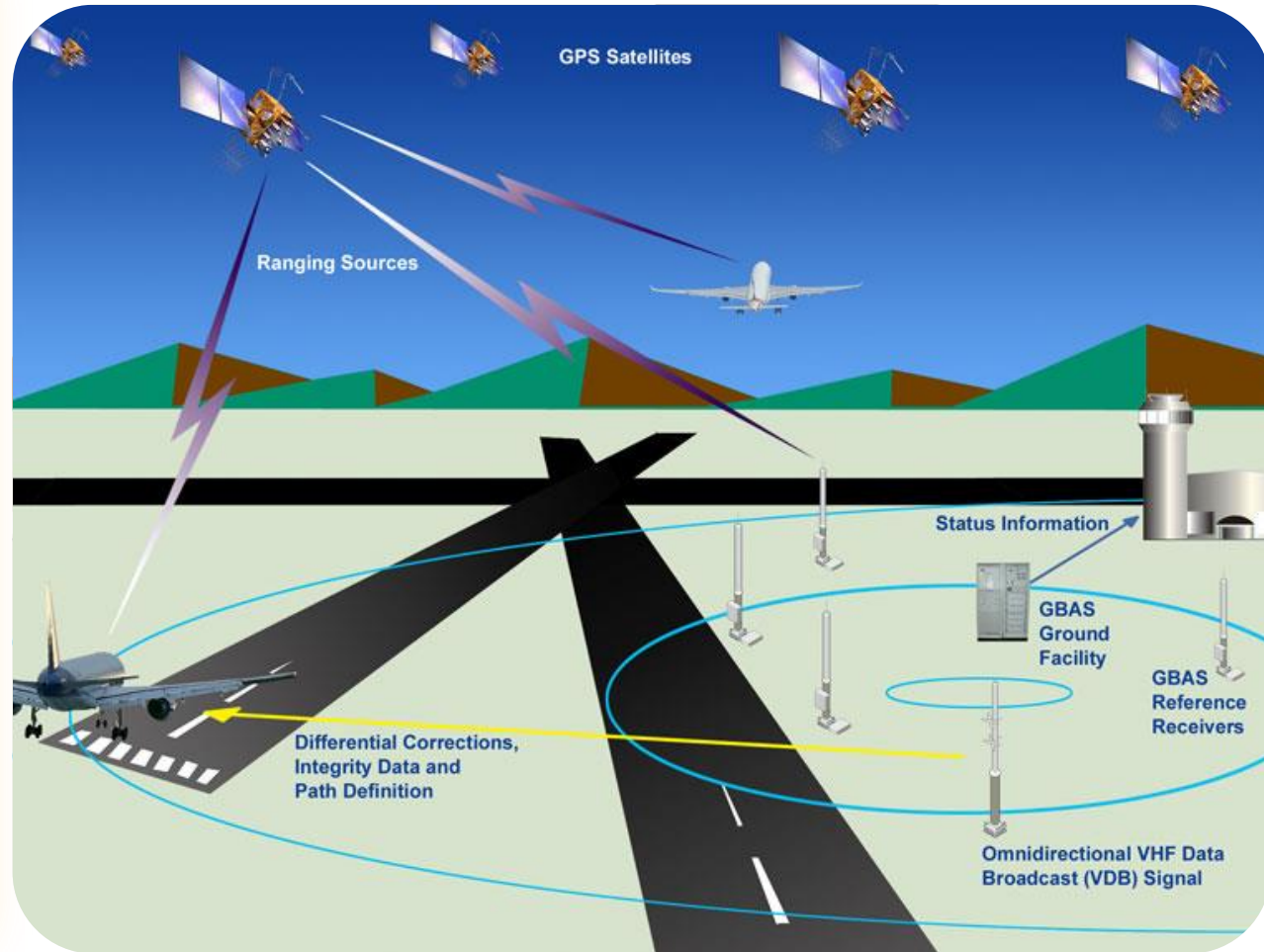
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MSN Sport >

MOST POPULAR



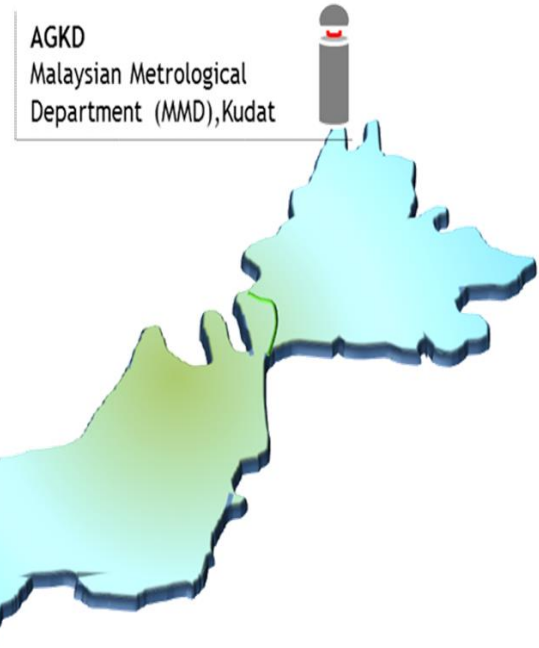
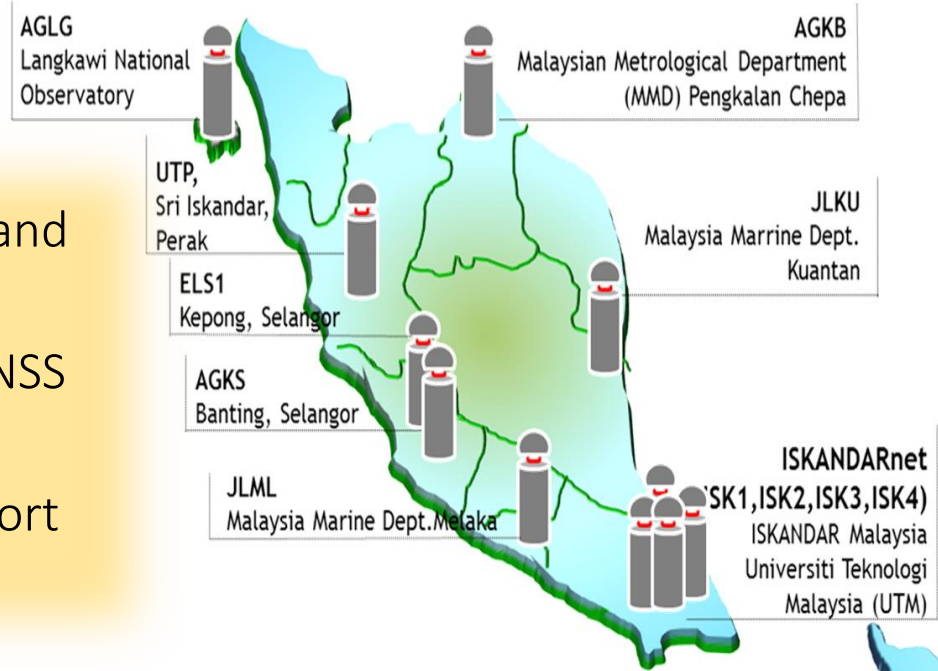
Ground Based Augmentation System

- Planned to setup Ground Based Augmentation System (GBAS)
- System determines differential corrections and integrity monitoring of GNSS.
- Provides navigation and precision approach service in the vicinity of the host airport



R&D CORS network

- Setup by multiple Research Institutes and University, led by ANGKASA
- Provide a precise and accurate GPS/GNSS satellite data correction services
- Become a research platform and support positioning activities



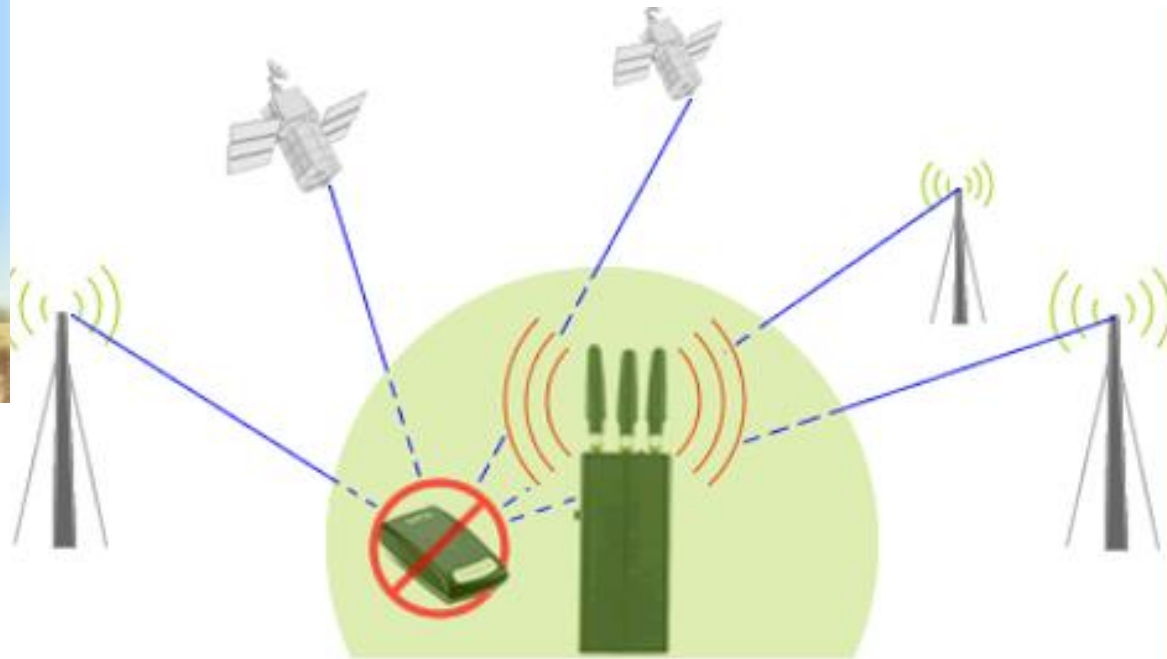
GNSS Vulnerabilities

- GPS signals are weak and easily be outpunched by poorly controlled signals from television towers or devices.
- Users not realise on vulnerable of devices to disruption and interference.
- Unintentional – *RFI, Multipath, signal errors, Ionospheric influence (solar max)...*
- Intentional – GPS Jammer, *Spoofing*



GNSS Jamming

- Jamming: Broadcasting of a strong signal that overrides or obscures the signal being jammed



GPSSignalsJammedDuringTankTrials

Lieutenant Colonel Lester W. Grau, US Army, Retired

Based on 6 August 2000 reports in The Sunday Times of London, Agence France-Presse and the 25 September 2000 Eleftheri Typi, Athens

The highly accurate Global Positioning System (GPS) supports modern ground forces as they move and shoot. Maps and compasses stay in cases as digitized forces quickly use GPS to determine their location and the enemy's. Although map-reading skills atrophy, few worry that GPS may suddenly provide erroneous information or cease working. Still, US Army equipment has already faced attacks on GPS functions—by allies.

In August 2000 the Greek government sponsored a tank competition at Litokhoro to determine the Greek army's next tank—a deal worth \$1.4 billion for 250 tanks. Competitors included the British Challenger 2E, the US M1A1 Abrams, the German Leopard 2A5 and the French Leclerc. During the trials, the British and US

tanks had navigation problems despite using multiple GPS satellites to determine their positions precisely. After the embarrassing performance, officials discovered that the GPS satellites were being jammed—by a French security agency. Less than a foot high, the jammers transmitted stronger signals than satellites on the same frequency. The jammers were reportedly hidden on the firing range and remotely activated as US and British tanks were tested.

Greek defense officials found the jamming episode rather amusing and discounted the associated technical problems. The threat remains: if an ally can create such havoc during a test, what effect could hostile GPS jamming have during combat?

Military jamming of GPS likely in Scotland during Joint Warrior exercise

By Steven McKenzie

BBC Scotland Highlands and Islands reporter

Jamming of GPS in parts of Scotland is likely during Europe's largest military exercise next month, the Ministry of Defence (MoD) has said.

Jamming during Joint Warrior last October was suspended after complaints from Western Isles fishermen.

The islands council, Comhairle nan Eilean Siar, also said satellite TV, mobile phones and internet connectivity were disrupted.

The MoD said prior warning would be given of any jamming.

Joint Warrior will run from 16-26 April.

The war games and counter terrorism training are held twice a year, in spring and autumn, and involve Nato armies, navies and air forces.

Much of the training takes place in Scotland.

The Royal Navy has already alerted fishermen to the possibility they will be challenged by helicopters and ships in radio communications as part



Fishermen have been warned to expect challenges from helicopters and warships

Related Stories

Military jamming of GPS suspended

Low flying before major exercise

Forces gather for Joint Warrior

N.Korea Jams GPS to Disrupt S.Korea-U.S. Drills

North Korean military units jammed Global Positioning System signals Friday in some parts of South Korea, the government believes.

A government source on Sunday said intermittent GPS failure occurred in northwestern base station coverage areas such as Seoul, Incheon and Paju last Friday. "We suspect the interference was caused by strong jamming signals sent by the North."

The North first attempted to jam GPS signals last August during joint South Korea-U.S. military exercises and the latest attack apparently targeted the current "Key Resolve" drills, intelligence agencies say.

U.S. Air Force Chief Warns against Over-Reliance on GPS

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January 20, 2010

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The Global Positioning System is vulnerable to threats such as jamming and anti-satellite weapons and the United States should reduce its dependence on the system while developing alternatives for precise positioning, navigation, and timing (PNT), the U.S. Air Force's top military leader said Wednesday (January 20).

Air Force Chief of Staff Gen. Norton Schwartz made the comments during his opening keynote address, "The United States as an Aerospace Nation: Challenges and Opportunities," at the Tuft University [Institute for Foreign Policy Analysis \(IFPA\) Fletcher Conference on National Security Strategy and Policy](#). The 2010 conference's theme is "Air, Space, and Cyberspace Power in the 21st Century."

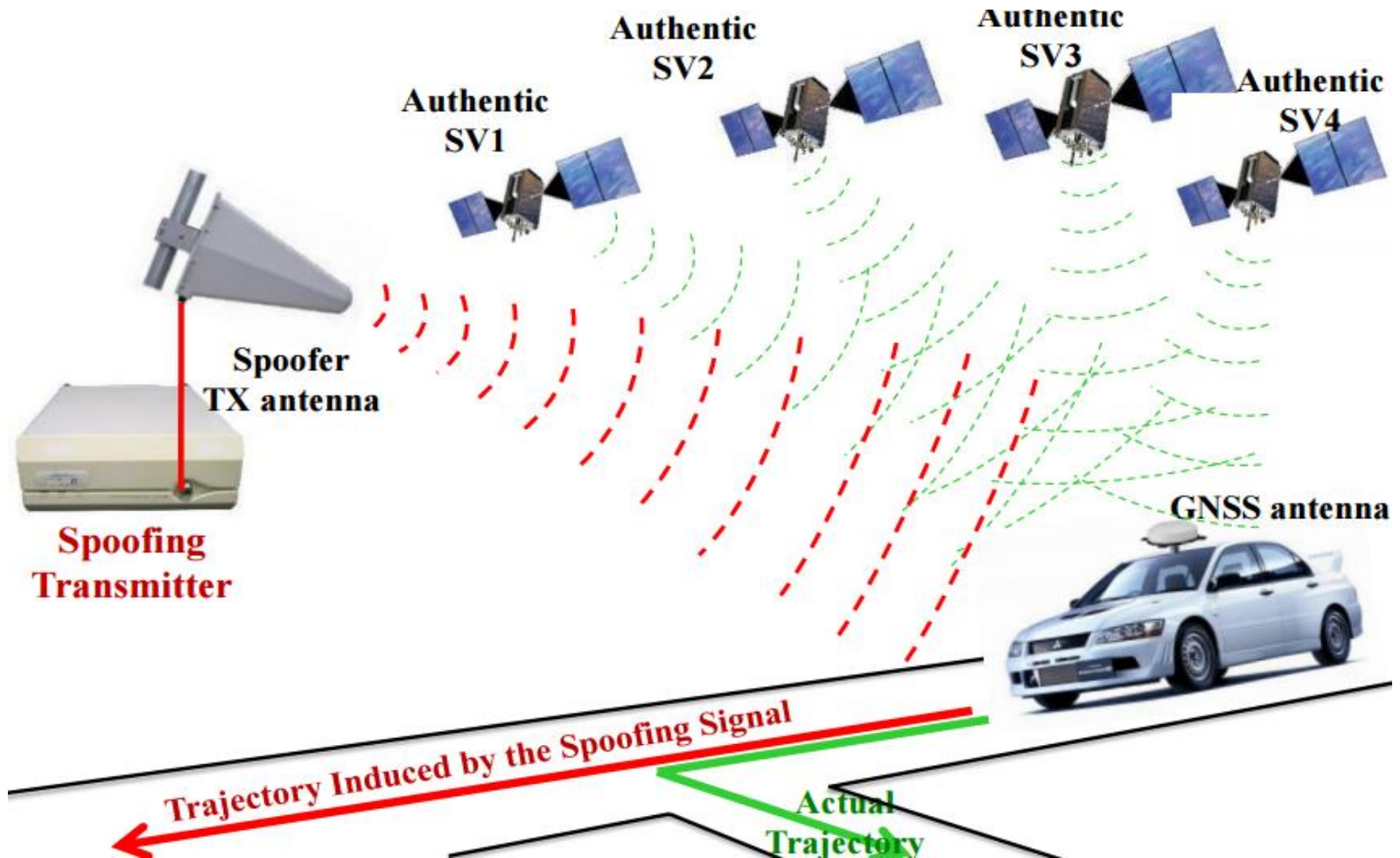
The Air Force is the Defense Department's executive agency charged with maintaining and operating GPS.



Gen. Norton Schwartz, USAF photo

GNSS Spoofing

- Deliberate interference that aims to mislead GNSS receivers into general false positioning solution



GPS 'spoofing' could threaten national security

'Average person doesn't realize how much infrastructure is based on GPS'

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Students hijack USS80m yacht with GPS spoofing

By Michelle Starr | July 30, 2013

Students from the University of Texas created a custom GPS spoofing device that allowed them to take over a superyacht's navigation system, changing its course.



GPS jammers and spoofers threaten infrastructure, say researchers

Widely used but illegal GPS jammers can cause problems with cell networks, ...

by Sean Gallagher - Feb 24, 2012 8:51am CST

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GPS 'spoofers' could be used for high-frequency financial trading fraud

TECHNOLOGY / 22 FEBRUARY 12 / by OLIVIA SOLON

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GPS "spoofers" -- devices that create false GPS signals to fool receivers into thinking that they are at a different location or different time -- could be used to defraud financial institutions, according to Todd Humphreys from the



GNSS Impact

Impact sector

Effects Description

Economy

Overreliance on GNSS signal is rampant for financial operations, inter-bank communications, transactions tracking, and etc.

Health Services

Disable search and rescue operations, prevent helping people who are in danger due to accident, crimes, etc

Communication

Failure of GNSS timing can provide desynchronization for internet and mobile networks.

Transportation

Affect air traffic control, highway navigation, monitoring of cargos traffic, etc.

Energy

Affect precision and real-time measurements for power grids

Environment

Disable alerts systems essential for natural disasters prevention.

Defence

Disable tracking emergency vehicles, tracking dangerous people wearing electronic bracelet, etc.

Agriculture

Yields become worst, etc.

GNSS as critical infrastructure : International Overview

- USA - Critical Infrastructure Protection Program
- EU – European Programme for Critical Infrastructure Protection (EPCIP)
 - Ongoing review of Directive 2008/114/EC on CNI
 - JRC 2010 study on GNSS
 - Dependencies and interdependencies of GNSS in CNI
- National level – Critical National Infrastructure (CNI)
- Norway-CNI
 - New law and regulation on protection of CNI is under implementation
 - Includes satellite navigation infrastructure
 - GNSS signals



Presidential Decree № 899 of July 7, 2011 (1)

“On Adoption of Priority Directions for Science, and Technology Development and of the list of the critical technologies”

states

- Priority directions for science and technology development
 - security and terrorism counteraction
 - nanosystem industry
 - **information and telecommunication systems**
 - life sciences
 - advanced weapons, military and special equipment
 - responsible nature management
 - **transport and space systems**
 - energy efficiency, energy saving and nuclear power engineering
- List of critical technologies of the Russian Federation
 - 27 critical technologies including:
 - ✓ Information, control and **navigation technologies** as a separate line
 - ✓ A number of technologies for which PNT technologies are vital at a minimum and are enablers at a maximum



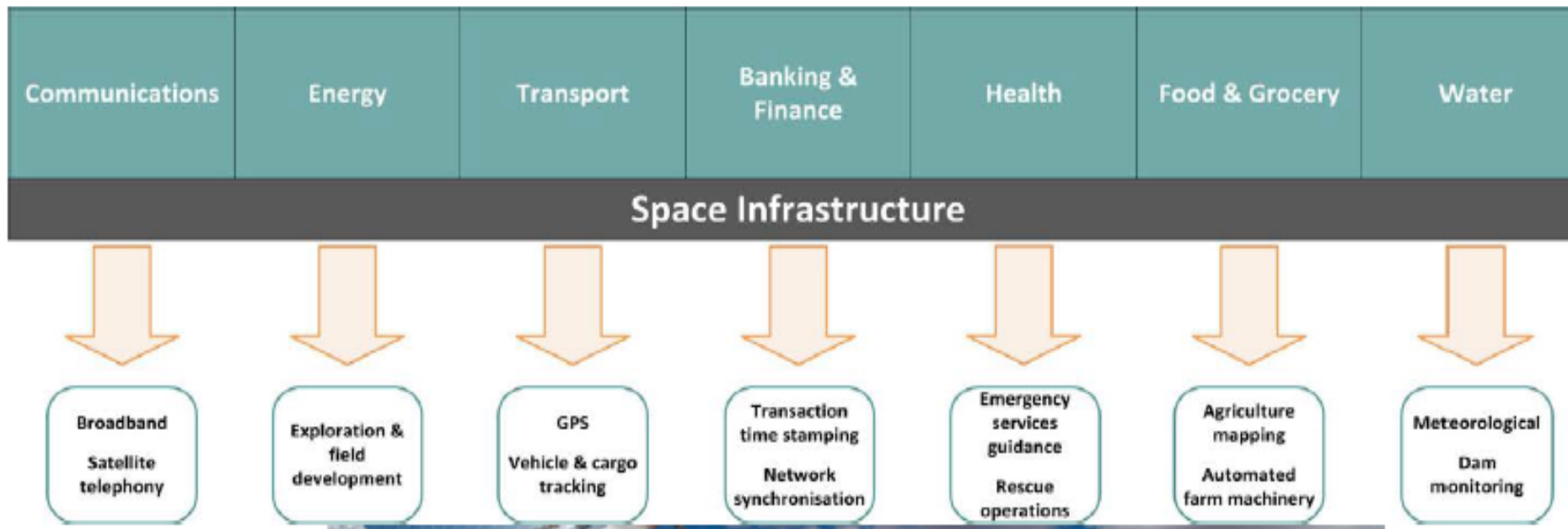
Navigation technologies are listed as critical technologies of the Russian Federation included into the priority directions of science and technology development

Space infrastructure – where does it fit in?

Space infrastructure is an important enabler of other critical infrastructure

– *“Space capabilities are increasingly important aspects of critical infrastructure assets, networks and supply chains.”* – *Australia’s Satellite Utilisation Policy*

- Global Positioning System (GPS); Global Navigation Satellite System (GNSS); Position, Navigation & Timing (PNT)
- Satellite communications
- Earth observation



The Way Forward ..

1. Recognize GNSS as critical infrastructure
2. Designate and empower a lead federal official
3. Protect the adjacent bands to GNSS as “Quiet” neighborhoods
4. Make ownership of jammers as an offence
5. Make use of jammers a felony
6. Make anti-jamming and anti-spoofing laws enforceable at all levels of government
7. Establish a national system to detect & rapidly locate jamming
8. Ensure sufficient enforcement personnel to detect, prevent, respond to and prosecute jamming



end



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<http://malaysia.ning.com>

