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APEC PHILIPPINES 2015

GNSS Activities in Chinese Taipei and Its Response to Preparedness of Natural Disaster

Institute of Transportation,
MOTC, Chinese Taipei

2015/5/27

Outlines

- GNSS Future Markets
- GNSS Activities in Chinese Taipei
  - Maritime Automatic Identification System (AIS)
  - National e-GNSS Service Modernization
  - GNSS in Next Generation ITS - V2X
    - DSRC-Based Transit signal priority
    - Vehicle to Infrastructure (V2I) Operations
- GNSS Tackle Natural Disasters and Climate Change
  - How FORMOSAT Contributes to Typhoon Path Forecast
  - Highway Bureau's Risk Management Coordination

GNSS Future Markets

- GNSS remains the main source of outdoor positioning information, and multi-constellation is becoming standard feature in today's user equipment.
- GNSS applications include
  - Location-based services (LBS)
    - Navigation, mapping and GIS, Geo marketing and advertising, safety and emergency, enterprise applications, sports, games ad augmented reality, social networking.
  - Road
    - Navigation, fleet management, satellite road traffic monitoring
    - Connected vehicles, dangerous goods tracking
    - Road user charging, insurance telematics
    - eCall, ERA-GLONASS, enhanced digital tachographs.

Complied from 2015/03, European GSA "GNSS Market Report" Issue 4

GNSS Applications

- Aviation
  - Regulated – Performance based navigation (PBN), emergency locator transmitter (ELM), automatic depended surveillance – broadcast (ADS-B)
  - Unregulated – Moving maps, infringement alarms, situational awareness, personal locator beacons (PLBs)
- Rail : High density command and control systems, low density line command and control systems, asset management, passenger information
- Maritime
  - Navigation - SOLAR vessels, Non-SOLAR vessels, inland waterway (IWW)
  - Positioning - Traffic management and surveillance (AIS, LRIT), search and rescue, fishing vessel control, port operations, marine engineering.
- Agriculture, Surveying, Timing and Synchronization.

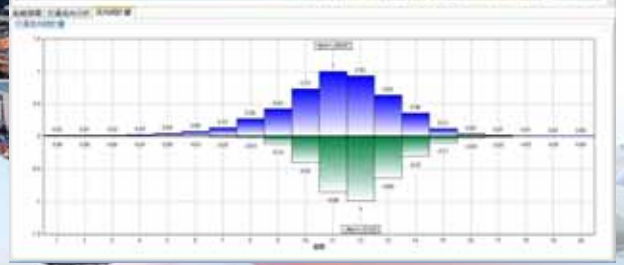
- In addition to GNSS PNT-based applications, GNSS signals can also serve as
- sources of Radio Occultation to reveal properties of the atmosphere
- and ionosphere, which is also called GNSS RO.
-

Complied from 2015/03, European GSA "GNSS Market Report" Issue 4

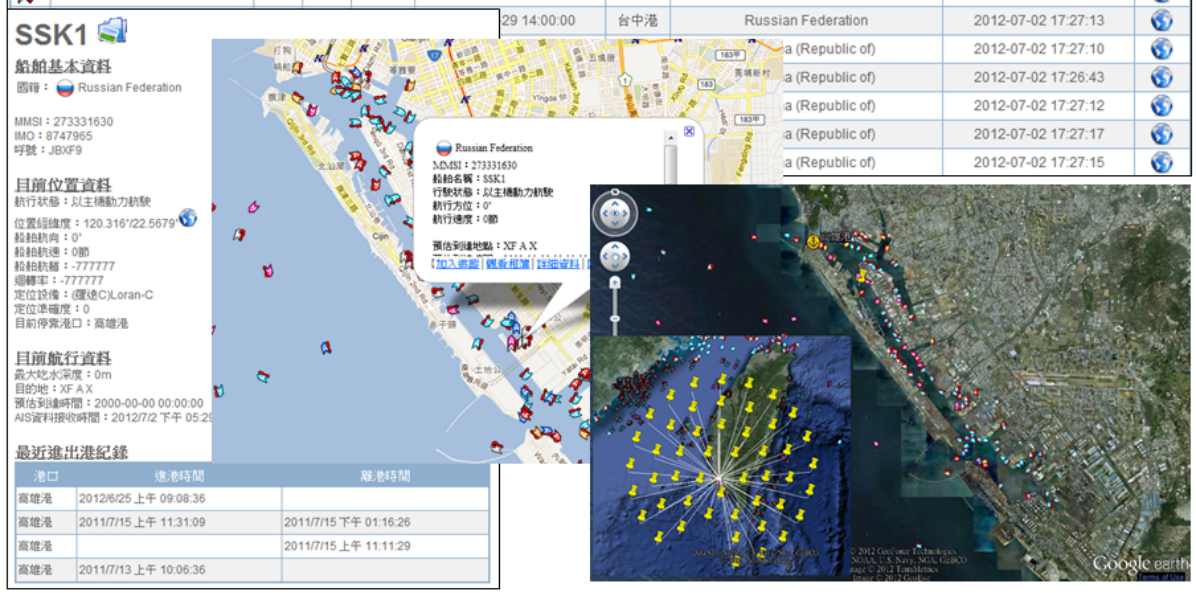
Automatic Identification System (AIS)

- Web based vessel dynamic information system has been developed since 2008.
- AIS base station number has increased from 13 (2012) to 17 (2014) in Chinese Taipei. And other 8 stations are expected to be installed in the near future.
- AIS automatically transmits the following messages using VHF communication on different transmitting frequency depending on vessel situations.
  - The vessel's Maritime Mobile Service Identity (MMSI), navigation status, rate of turn (ROT), speed over ground (SOG), positional accuracy, course over ground (COG), true heading, true bearing at own position, UTC seconds.

Vessel Tracking and Traffic Flow Analytical Model

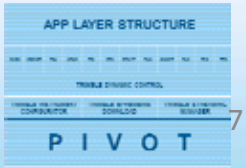


	船名	類別	速度	方位	ETA	港口	所屬國家	接收時間	MAP
	KAO NO.104		6.4	87.5°	2000-00-00 00:00:00	高雄港		2012-07-02 17:26:46	
	AZIZI	貨船	0	26°	2012-06-26 05:00:00	高雄港	Cyprus (Republic of)	2012-07-02 17:25:01	
	MARINA		11.3	269.8°	2012-07-04 08:00:00	高雄港	Malta	2012-07-02 17:27:07	
	ANNA K	貨船	0	209°	2012-07-01 18:00:00	高雄港	Denmark	2012-07-02 17:25:49	
	KING TAMATOA		0	267°	2012-06-27 15:30:00	基隆港	France	2012-07-02 17:27:18	
	ITAL UNICA	貨船	0	194°	2012-07-02 00:00:00	高雄港	Italy	2012-07-02 17:27:09	
	BERGANGER		0	231.1°	2012-07-02 08:00:00	高雄港	Norway	2012-07-02 17:25:51	
	SILS	貨船	0	28°	2012-07-02 08:00:00	高雄港	Switzerland (Confederation of)	2012-07-02 17:25:09	
	SSK1		0	0°	2000-00-00 00:00:00	高雄港	Russian Federation	2012-07-02 17:27:06	
					29 14:00:00	台中港	Russian Federation	2012-07-02 17:27:13	
							a (Republic of)	2012-07-02 17:27:10	
							a (Republic of)	2012-07-02 17:26:43	
							a (Republic of)	2012-07-02 17:27:12	
							a (Republic of)	2012-07-02 17:27:17	
							a (Republic of)	2012-07-02 17:27:15	

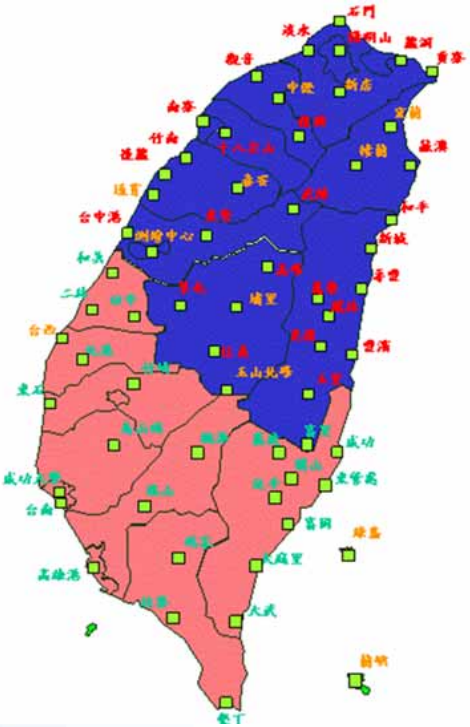


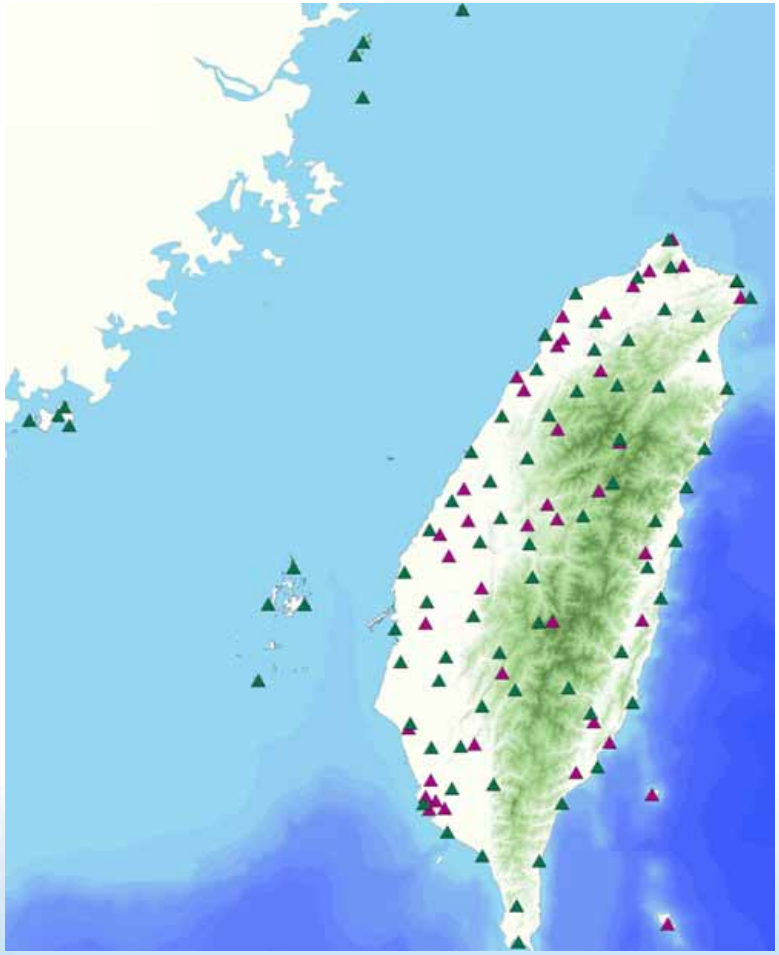
National e-GNSS Service Modernization

- Since 2012, national e-GPS service modernization (e-GNSS) has begun.
  - Hardware modernization of base GNSS stations with GPS and GLONASS GNSS receivers.
  - Due to crustal deformation, coordinates of all GNSS base stations have been recalibrated and revised.
- New e-GNSS service is officially announced to provide service starting from September 2014.
- This system use PIVOT software developed by Trimble Navigation, which includes Trimble Instrument Configurator (TIC), Trimble Ephemeris Download (TED), and Trimble Streaming Manager(TSM) to perform reference station remote control, data download, and DGNSS differential calculation and VBS-RTK (Virtual Base Station, Real Time Kinematic) real time positioning computing, respectively.

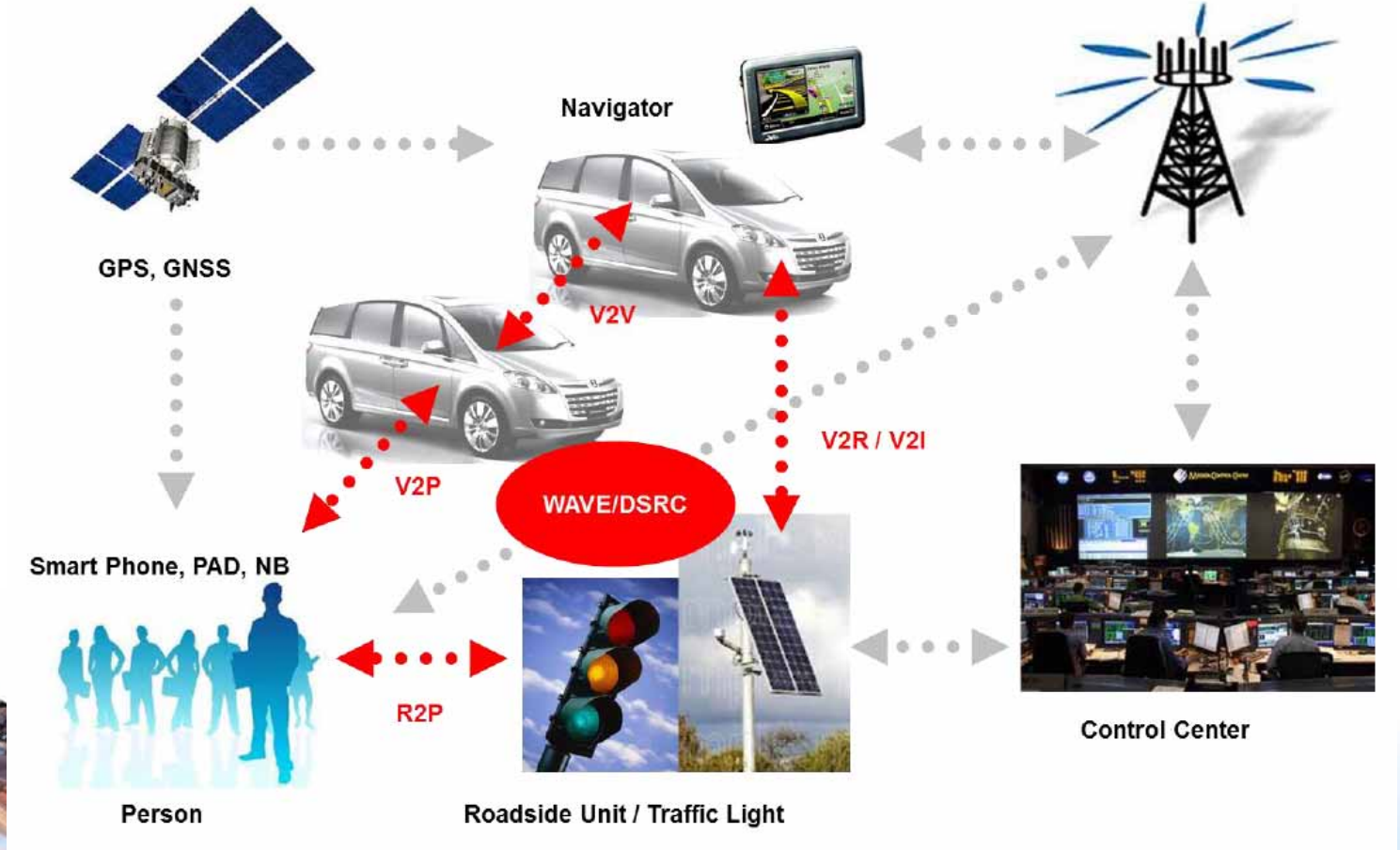


National Base Stations Network
e-GPS vs e-GNSS





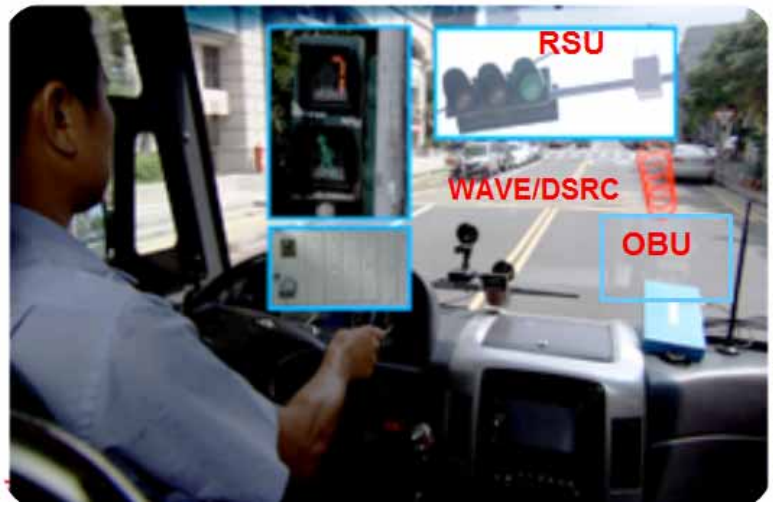
GNSS in Next Generation ITS - V2X



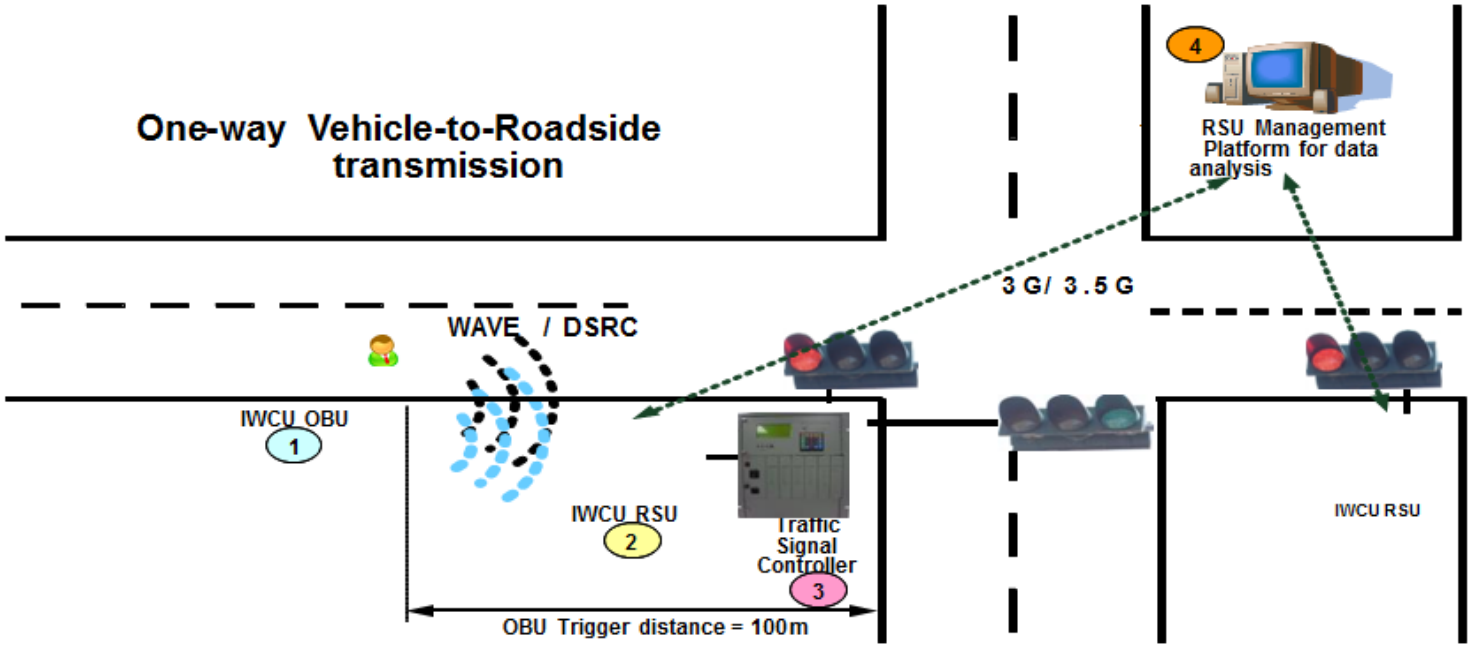
Source: 2014/3/11, ITRI, European Connected Vehicles Development and Deployment Status

DSRC-Based Transit signal priority

- WAVE/DSRC communication technology has been adopted in HsinChu city for transit signal priority operations. DSRC on-board-unit (OBUs) and road-side-unit (RSUs) developed by Industrial Technology Research Institute (ITRI), which called ITRI Wave Communication Unit (IWCU), are installed on buses and roadside near intersection for one-way communication. IWCU RSE is further connected to standard traffic signal controller (TSC) for traffic signal operation.
- Once buses approach the IWCU-OBU trigger distance to intersections which is around 100 meters, IWCU-RSU will send notification to TSC for its signal priority operations.
- Signal priority operation is based on green-time-extension, red-time-reduction, or do-nothing depending on current traffic signal phases. Each IWCU-RSU installed will use 3G or 3.5G wireless communication to report its operation status to RSE management platform for detailed data analysis.


RSU
WAVE/DSRC
OBU

RSU


One-way Vehicle-to-Roadside transmission
4
RSU Management Platform for data analysis
3 G/ 3.5 G
WAVE / DSRC
IWCU OBU
1
IWCU RSU
2
Traffic Signal Controller
3
IWCU RSU
OBU Trigger distance = 100m

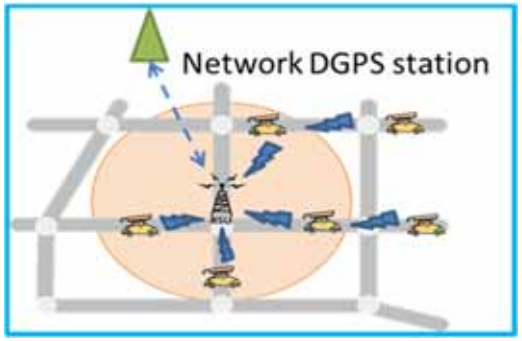
Vehicle to Infrastructure (V2I) Operations 1/2

- This project adopts device developed by ITRI which is IWCU also used in HsinChu city to install in high accident rate location in Keelung to provide safe-drive environment.
- This area is also suffered by traffic congestion during holidays. Two categories of information will be processed and generated for safety, comfort, and efficiency driving in this demonstration site, which are traffic-based information service and safety-based information service.
- Traffic-based information services include dynamic route guidance, travel time information, incident and accident information, CCTV video; while safety-based information service provides real time information of road construction, high accident road, traffic ahead, and traffic signal timing phase.

Vehicle to Infrastructure (V2I) Operations 2/2

- Benefits of adopting V2I technology to pedestrians and motorcycles are also considered and performed in this pilot project.
- These services is comprised of information collection and processing in multiple traffic control centers (C) and RSUs of infrastructure (I), information broadcasting via center to infrastructure (C2I) and infrastructure to vehicle (I2V).
- Basically C2I will provide more wide area information, while I2V provides local information.

Vehicle positioning using GNSS with correction from national e-GNSS service and QZSS.



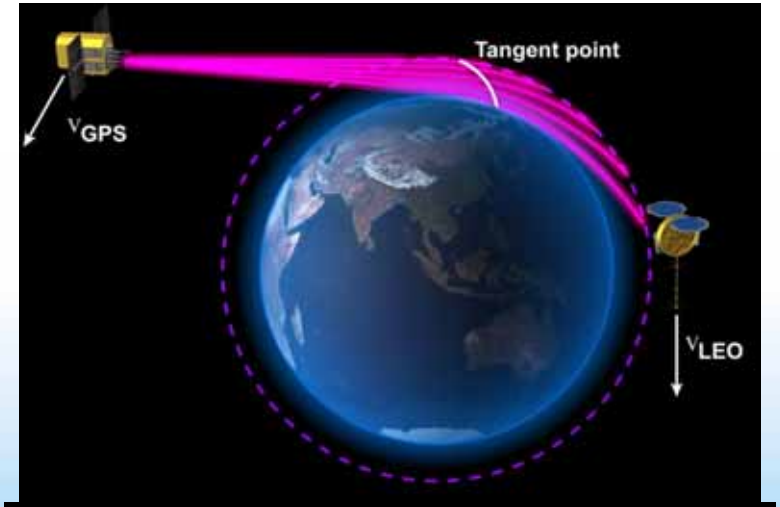
Why Needs GNSS to Tackle Natural Disasters and Climate Change

- 2014, The 22nd APEC Economic Leader's Declaration, Beijing, China
  - 45. We commit to jointly tackle pandemic diseases, terrorism, natural disasters, climate change and other global challenges.
- 2013, 8th APEC Transportation Ministerial Meeting (TMM8), Tokyo, Japan
  - 18. We reaffirm the importance of preparedness, resilience and response to natural disasters within the APEC region. We will continue to learn from past experiences and to share best practices to protect supply chains and transportation infrastructure.
- 2010, The 18th APEC Economic Leader's Meeting, Yokohama, Japan
  - Addressing the threat of global climate change is an urgent priority for all nations.

- FORMOSAT projects between Chinese Taipei and U.S. have demonstrated capabilities by using GNSS Radio Occultation (GNSS RO) technology to provide higher typhoon path prediction and accuracy of quantitative precipitation, where typhoon and flood are causes of natural disaster.

GNSS Radio Occultation (RO)

- GNSS Radio Occultation (GNSS RO) is an effective technique for measuring properties of the Earth's atmosphere from space, and one that has demonstrated significant improvements in weather forecasts, climate modeling and space weather prediction.
- A radio signal transmitted by a GNSS satellite in medium Earth Orbit is bent as it travels through the Earth's atmosphere, and is then received by a satellite in low Earth orbit (LEO) less than about 1,200 miles above the planet.

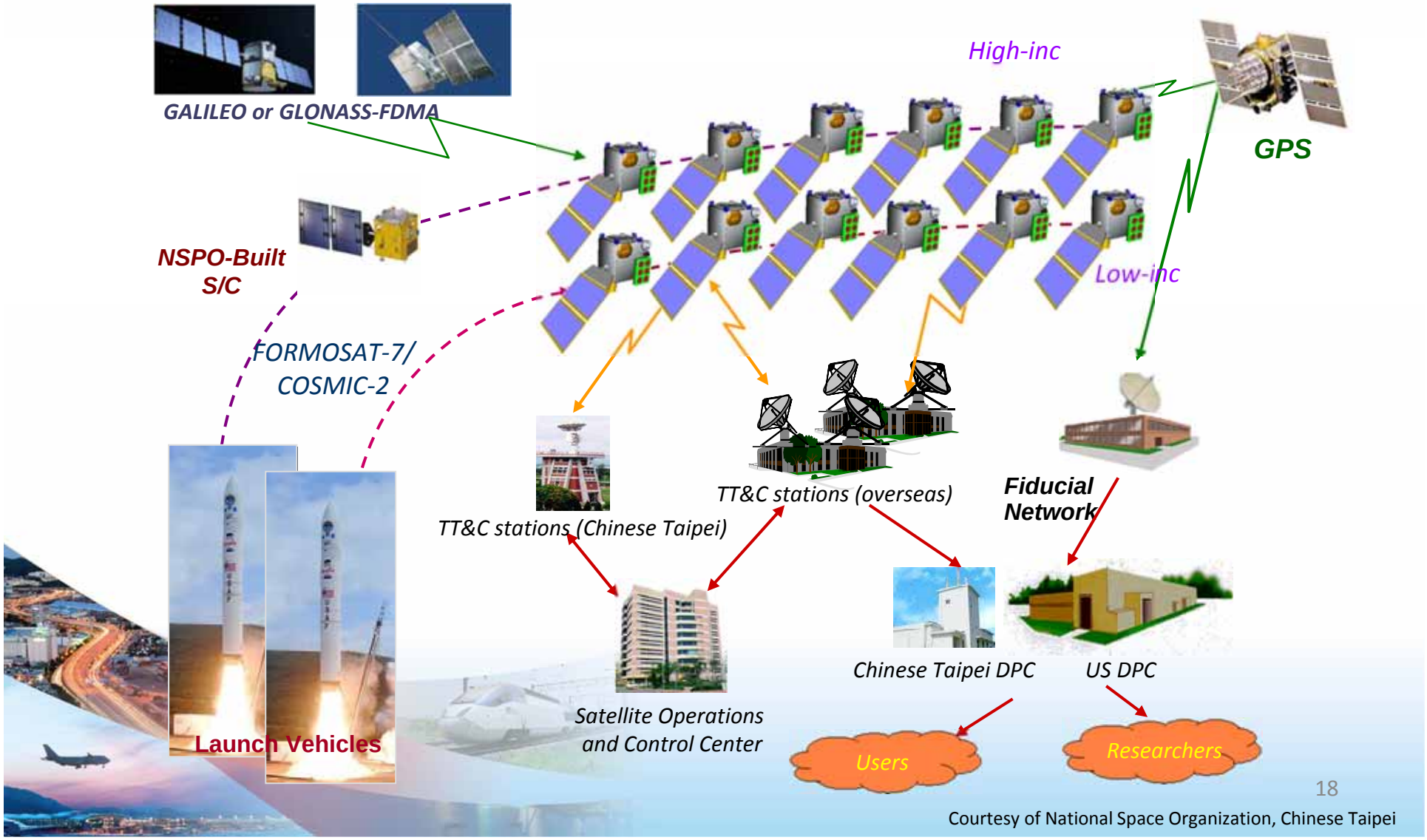


From http://www.cosmic.ucar.edu/launch/GPS_RO_cartoon.jpg

How FORMOSAT Contributes to Typhoon Applications

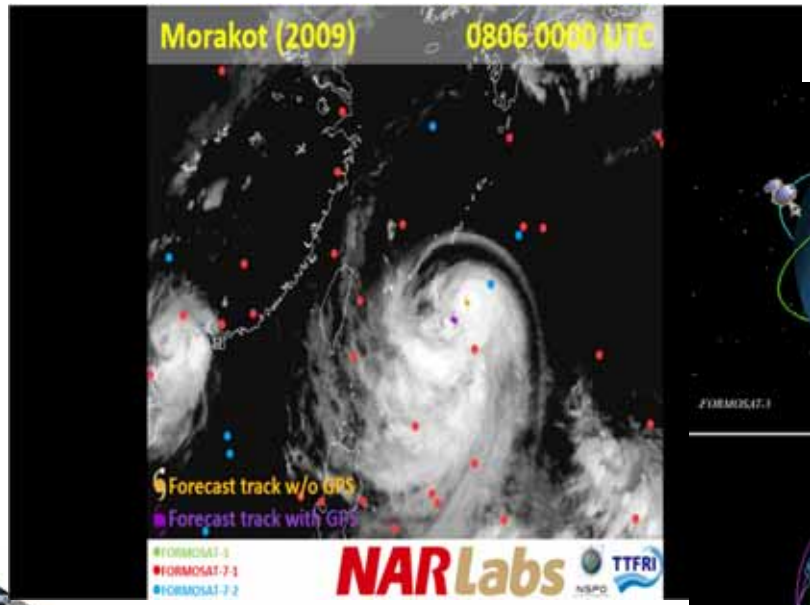
- In the typhoon path forecasting process, movement of typhoon or hurricane is mainly guided by large-scale steering flow. FORMOSAT-3 can provide the most updated vertical cross-section distribution of atmospheric temperature and humidity of the sea, which is lack in current weather observation process.
- With these unique information, the global numerical weather prediction model is improved, especially on typhoon path prediction and the accuracy of quantitative precipitation.
- With FORMOSAT's global observations, accurate cross-sectional atmospheric temperature data is provided which is almost not available. Based this valuable observation data, it not just can be used for weather model development and validation, not just for exploring global climate change phenomenon.

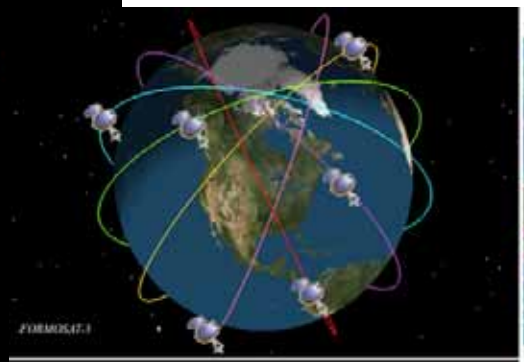
FORMOSAT-7 Mission Architecture

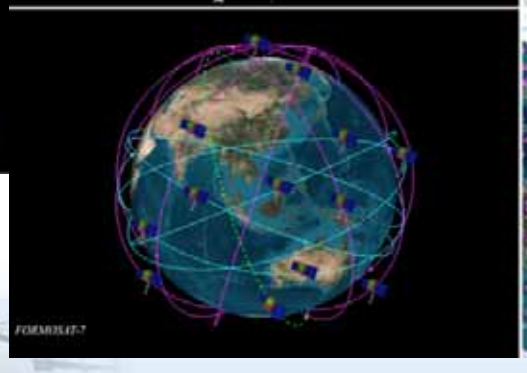


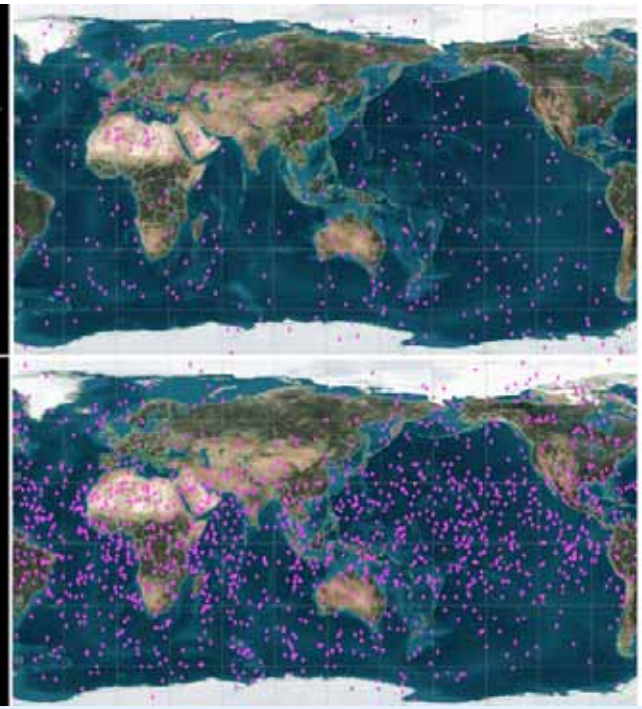
Courtesy of National Space Organization, Chinese Taipei

More Information, More Accuracy with FORMOSAT-7



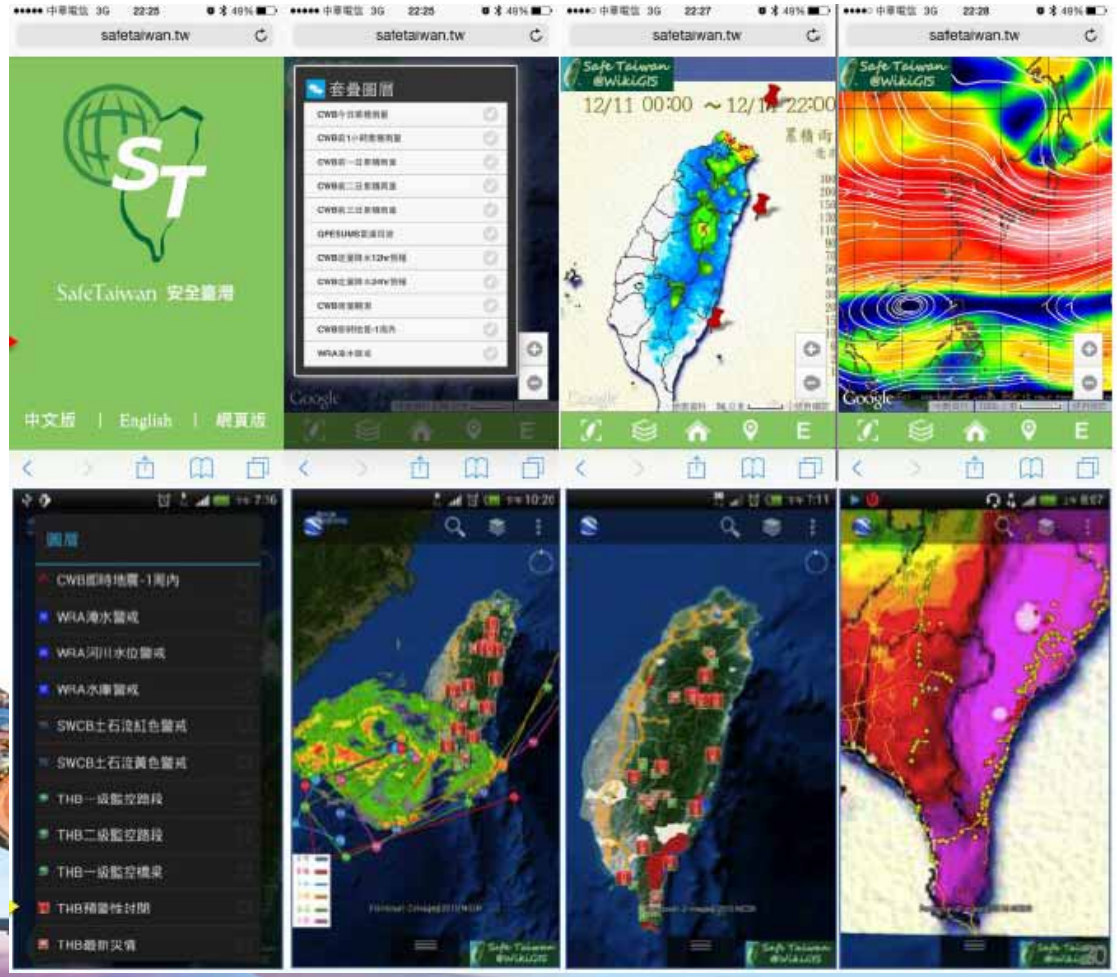


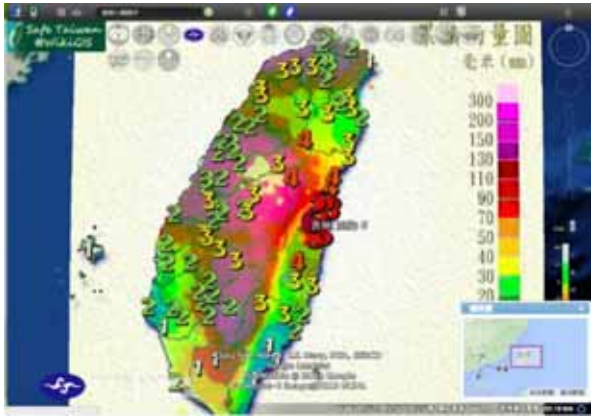




Courtesy of National Applied Research Lab, National Space Organization, Taiwan Typhoon and Flood Research Institute, Chinese Taipei

Highway Bureau's Risk Management Coordination





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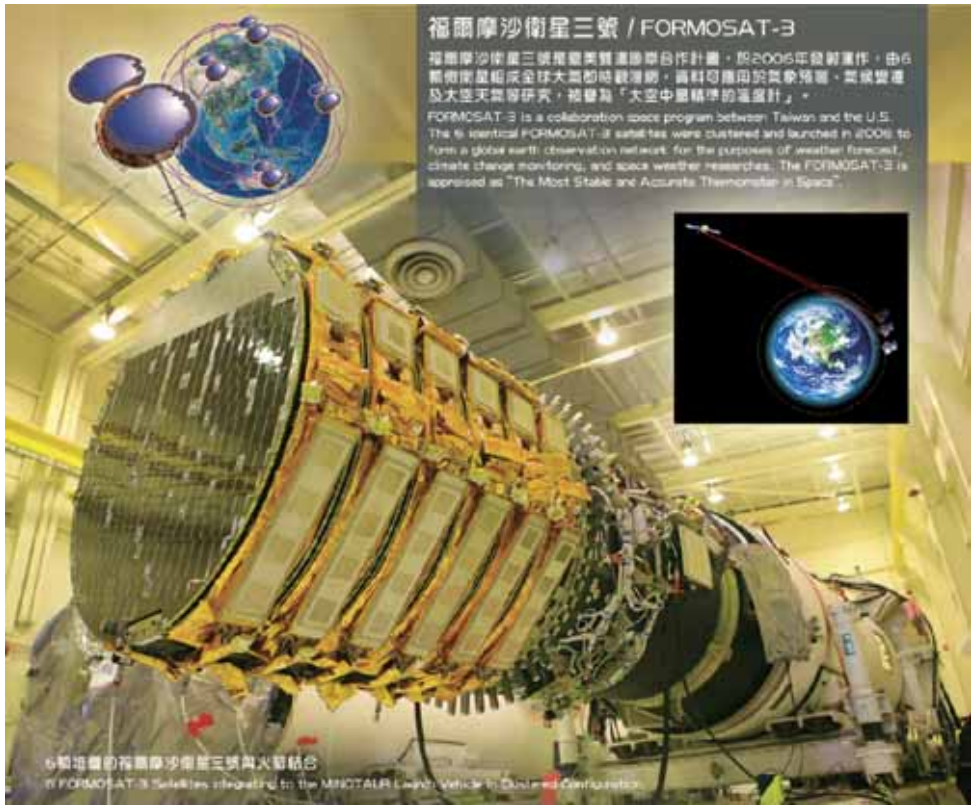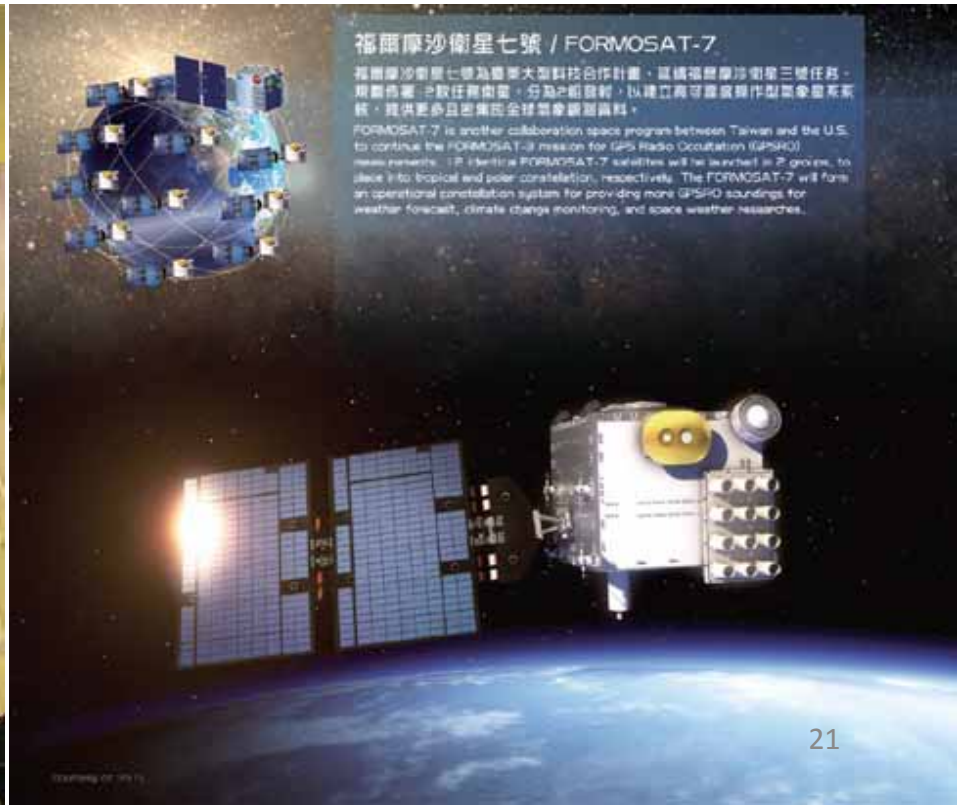
Thanks For Your Attention