



Courtesy:
NAMRIA

Operational Aspects of GNSS CORS

What is a GNSS CORS system used for ?

Neil Ashcroft, Asia GNSS Reference Station Manager



- when it has to be right

Leica
Geosystems

What is a GNSS CORS system used for ?

Basics...

What are Global Navigation Satellite Systems used for ?

- Positioning
- Navigation
- Timing

What about a Continuous Operating Reference Station ?

- **Characteristics**
 - Fixed location – Permanent power, remote communications
 - Taking observations every epoch (20Hz – 30 Second)
 - Complete Skyview (0 degrees – 15 degrees – 90 degrees)



- when it has to be **right**

Leica
Geosystems

What is a GNSS CORS system used for ?

Primary Purpose ?

Will be based upon most urgent need...

...and will be application specific.

Enabling a **Digital Reality** to support informed decisions



So, define the **primary purpose** of your CORS infrastructure.



- when it has to be **right**

Leica
Geosystems

What is a GNSS CORS system used for ?

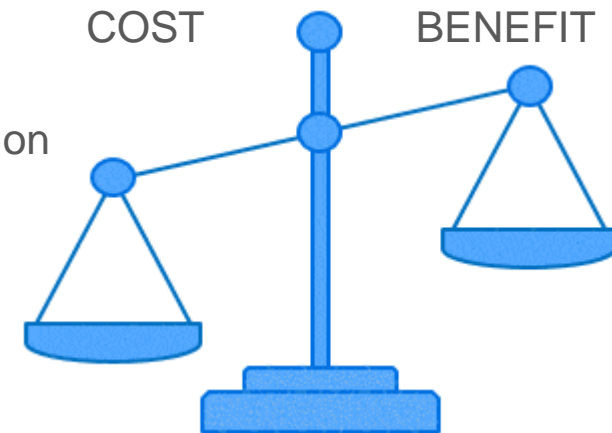
Applications

Science

- Geodynamics – Plate Tectonics
- Atmospheric – Weather
- Geodesy – Earth Shape, Reference Frame
- Climate Change – Sea Level Rise
- ...

Positioning

- Mapping
- Cadastral – Land Management, Boundary determination
- Construction & Engineering, Machine Control
- Navigation
- Asset Collection
- Intelligent Transportation



- when it has to be **right**

Leica
Geosystems



What is a GNSS CORS system used for ?

CORS Data Products



Real Time

- RTCM Formats, v2.x, v3.x, MSM
- Messages, Single Base, Network Solution (VRS, FKP,MAC)



Post-Processing

- RINEX Formats



Content

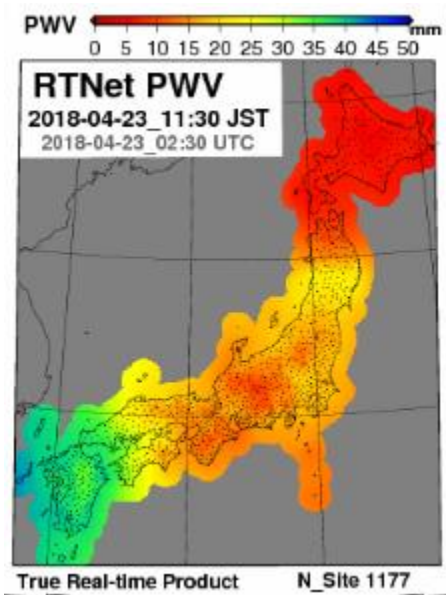
- Epoch Rates
- Elevation Mask
- Signals
- Auxiliary Sensors (Meteo, Tilt)



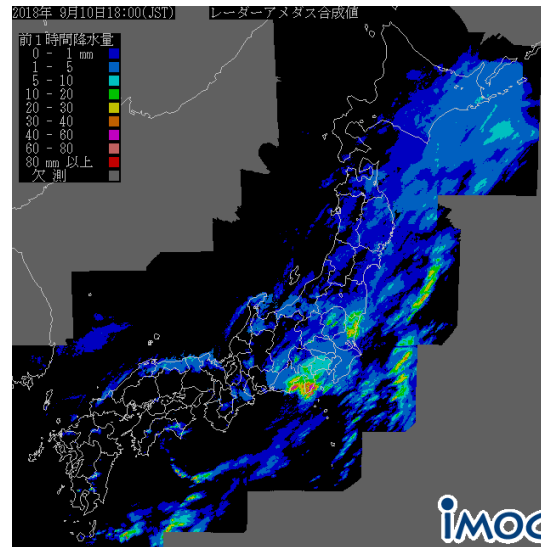
- when it has to be right



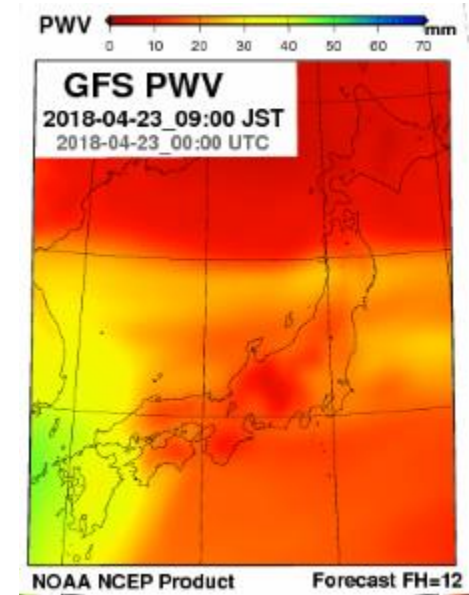
GNSS Meteorology



The real-time PWV (with latency of 1~2 minutes) product is used for multiple organizations for weather forecast service.



Shows analysis rainfall from https://www.imocwx.com/rdam/rd0_jp.htm

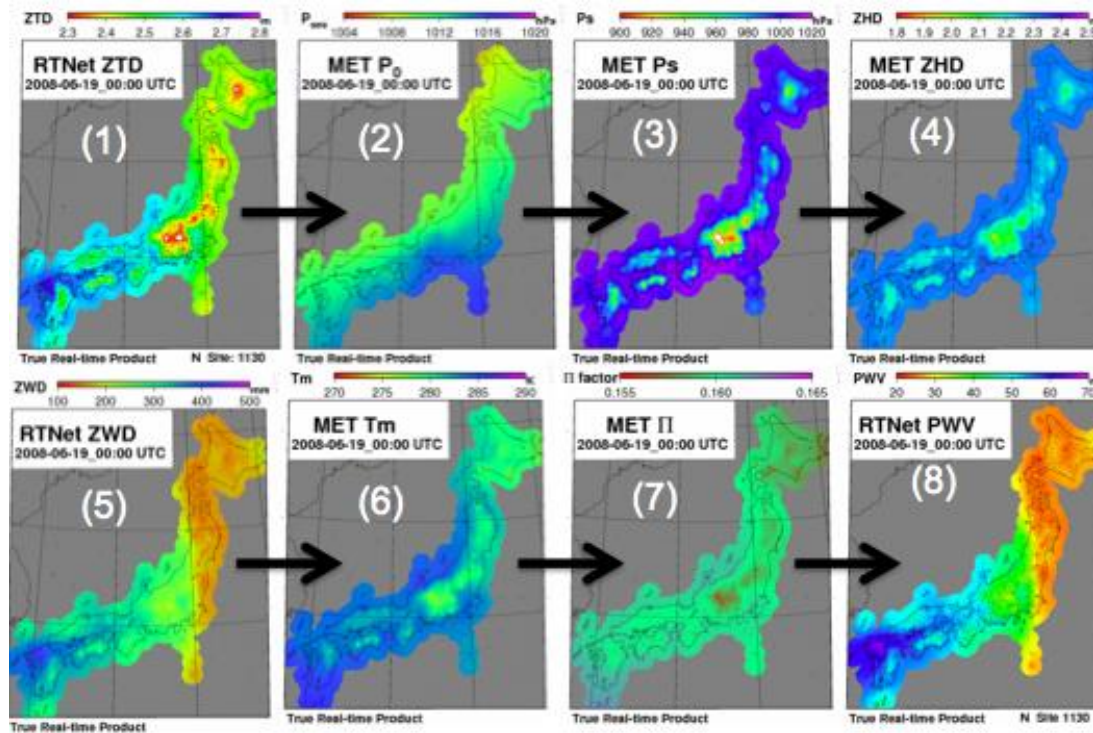


GNSS PWV products are compared with analysis/forecast field of PWV in numerical weather prediction system (NOAA NCEP GFS)

NOAA : National Oceanic and Atmospheric Administration
NCEP : National Centre for Environmental Prediction
GFS : Global Forecast System



GNSS Meteorology

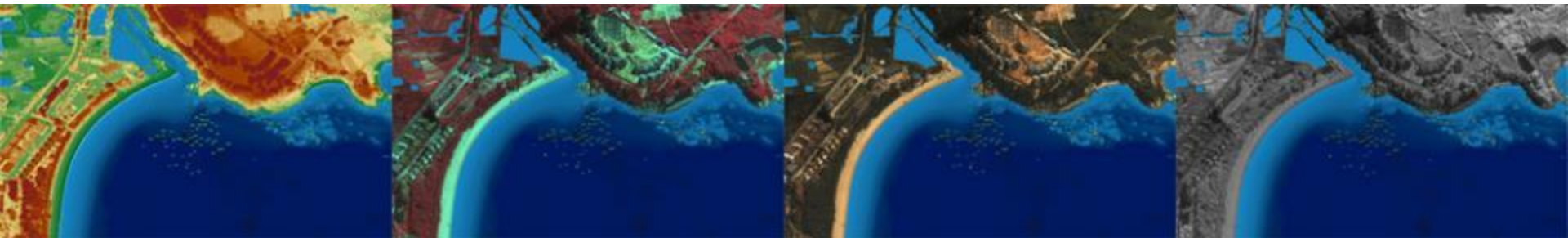
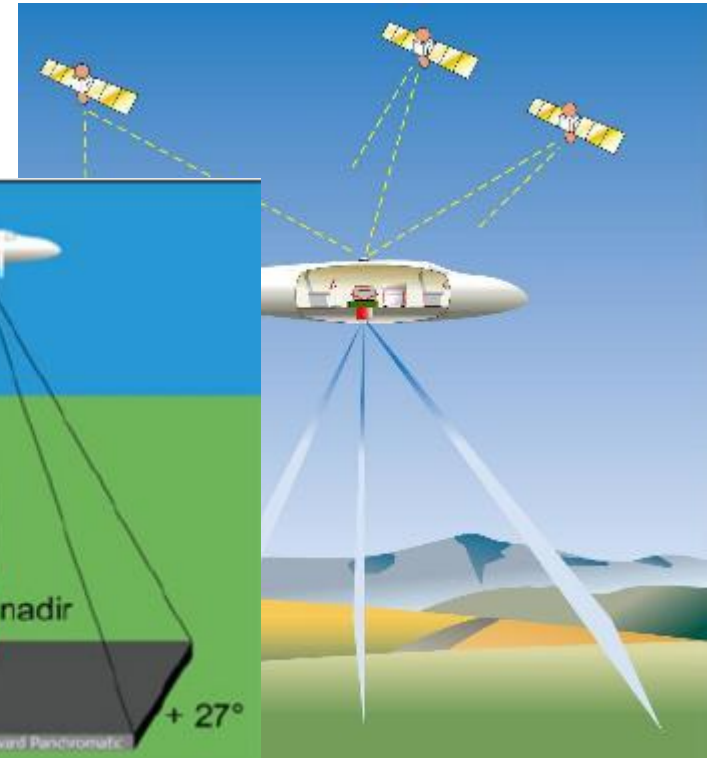
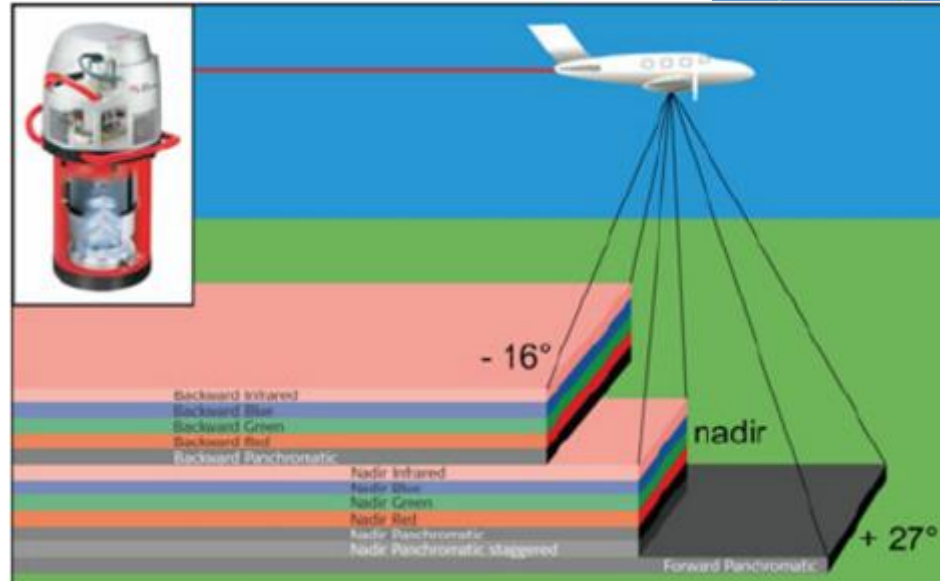


The maps show flow of conversion from GNSS ZTD (zenith tropospheric delay) to PWV (precipitable water vapor). ZTD has contribution from pressure and thus the map (1) has strong constrain with topography, while PWV map (8) has much less effect of altitude and has information on water vapor distribution.

Positioning

From the air...Fixed wing

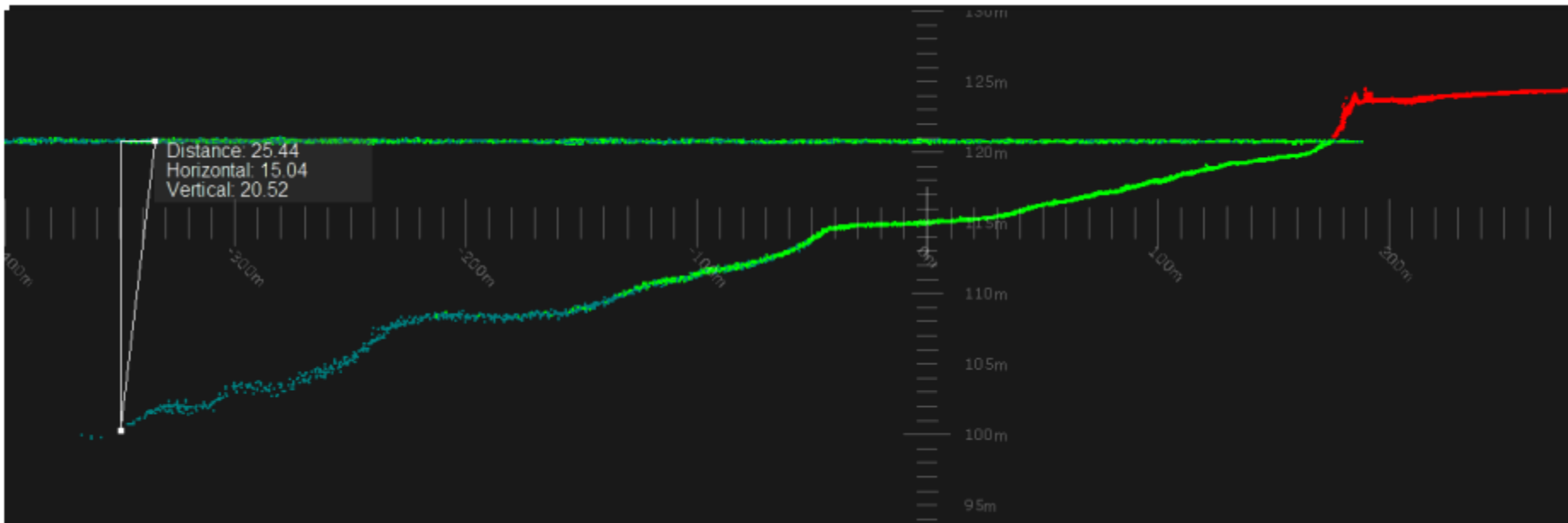
- Digital
- Lidar
- Bathymetric
- Hybrid



- when it has to be **right**

Leica
Geosystems

Positioning Bathymetric Data

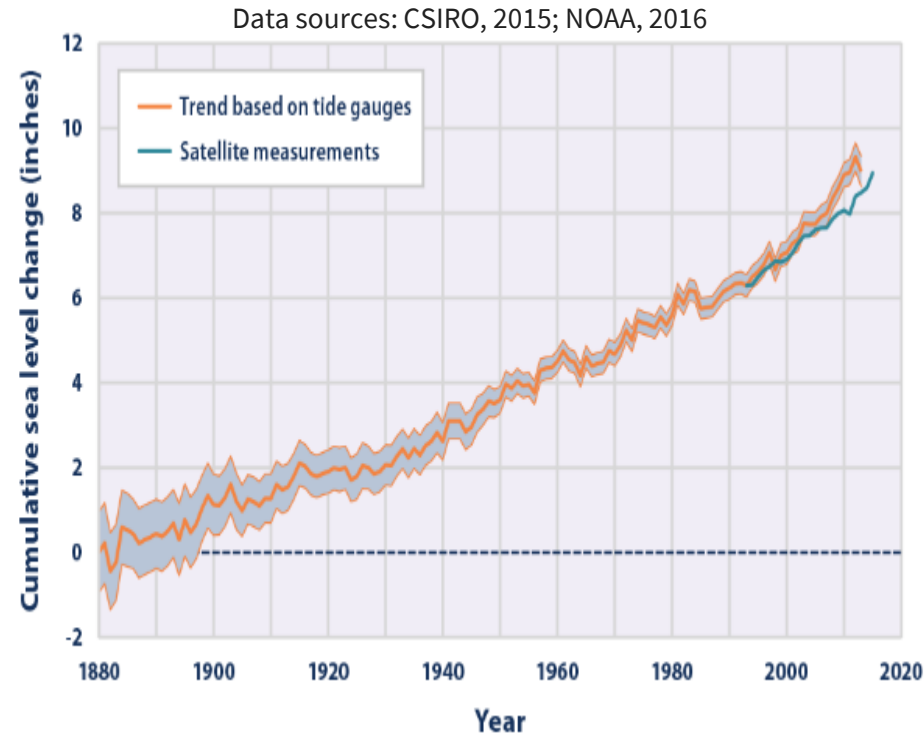


- when it has to be **right** *Leica*
Geosystems

Positioning

Drivers (Benefits) - Sea Level rise & Coastal Change

- Global warming and sea-level rise
 - Average 2,3 cm annually
- Precipitation increases
- More and more intensive weather phenomena's
- Ground-water levels change (water supply, irrigation and salinity changes)
- National borders and territorial waters change as the sea-level rises



Need to continuously monitor land and environmental change in the coastal areas



- when it has to be right

Leica
Geosystems

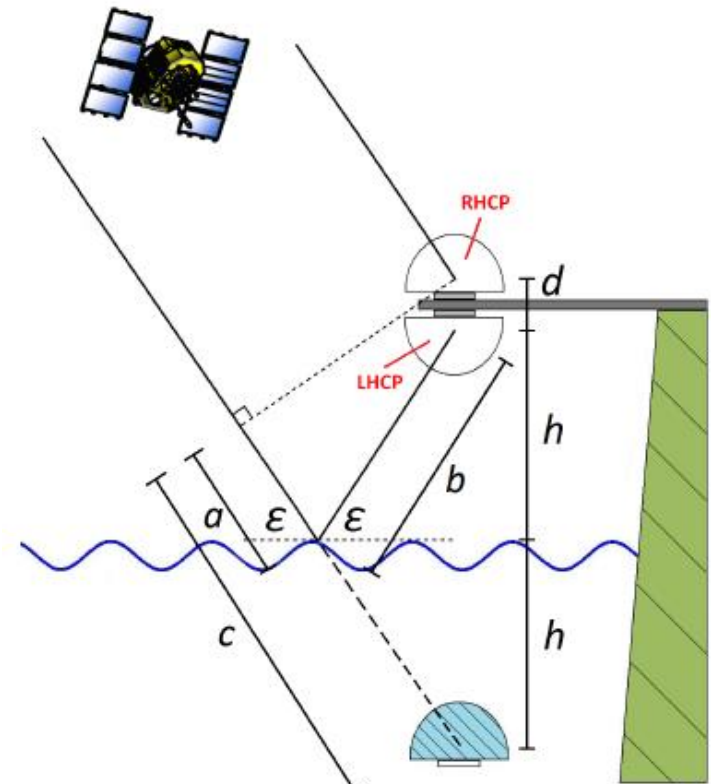
Reference Station Antennae

LHCP AR20

The “left-handed“ antenna → LHCP (left-hand-circular-polarised)

- The idea*:

- Measurement of reflected signal
- Determination of distance to reflective surface



* Reference: Monitoring Coastal Sea Level Using Reflected GNSS Signals; Johan S. Lofgren, Rüdiger Haas, Jan M. Johansson (2008 – 2011)



- when it has to be right



Positioning From the air...UAV's

- Digital
- Lidar



- when it has to be **right** *Leica*
Geosystems

Positioning

Mobile Mapping



Leica P20



Z+F 9012



Velodyne



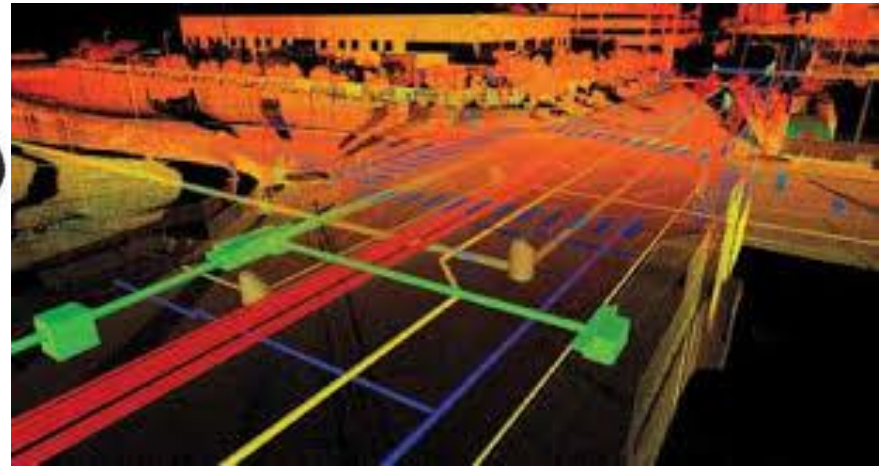
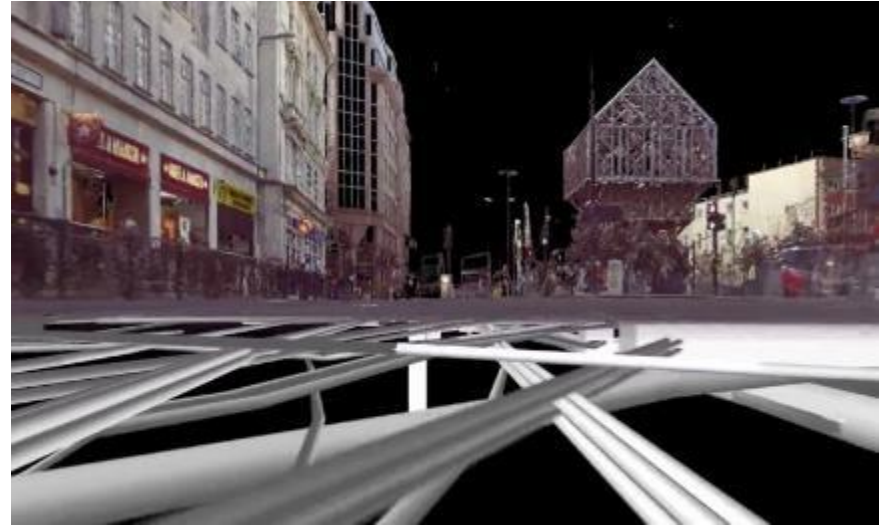
Imagery



- when it has to be right



Positioning Mobile Mapping



- when it has to be **right** *Leica*
Geosystems

Positioning

Mobile Mapping



- when it has to be **right**



Positioning Machine Control



Excavators



Dozers



Graders



Drill Rigs



Paving



- when it has to be **right** *Leica*
Geosystems

Positioning Precision Agriculture



FARMING ACCURACY

PRECISION VALUE:

GNSS L1 - GPS/Glonass
28 cm (post-to-post, 15 min)

GNSS L1/L2 - GPS/Glonass
15 cm (post-to-post, 15 min)

GNSS L1/L2 - GPS/Glonass/TerraStar
(4 cm absolute)

RTK - 2 cm
(absolute)



- when it has to be **right**



Positioning

Traditional Surveying



- when it has to be **right**

Leica
Geosystems

TECHNOLOGY



SMART
Lighting

SMART
Parking

SMART
Charging

SMART
Waste

SMART
Services

SMART
Water

SMART
Roads

Intelligent Transport Connected Vehicles

GNSS only ONE sensor in solution.

Provides overall Positional integrity



Image Source: USDOT



- when it has to be **right** *Leica*
Geosystems

Cost Benefits

Economic Report by Allen Consulting



Key Findings:

The report estimates that in 2012, augmented GNSS had delivered cost savings to the surveying and land management sector of between \$30 million and \$45 million.

These savings are projected to increase to between \$100 million to \$150 million by 2020. These estimates are based on conservative assumptions on the rate of development of CORS networks.

An estimate of the economic and social benefits of augmented positioning services in the surveying and land management sector

[Link](#)



- when it has to be right

Leica
Geosystems

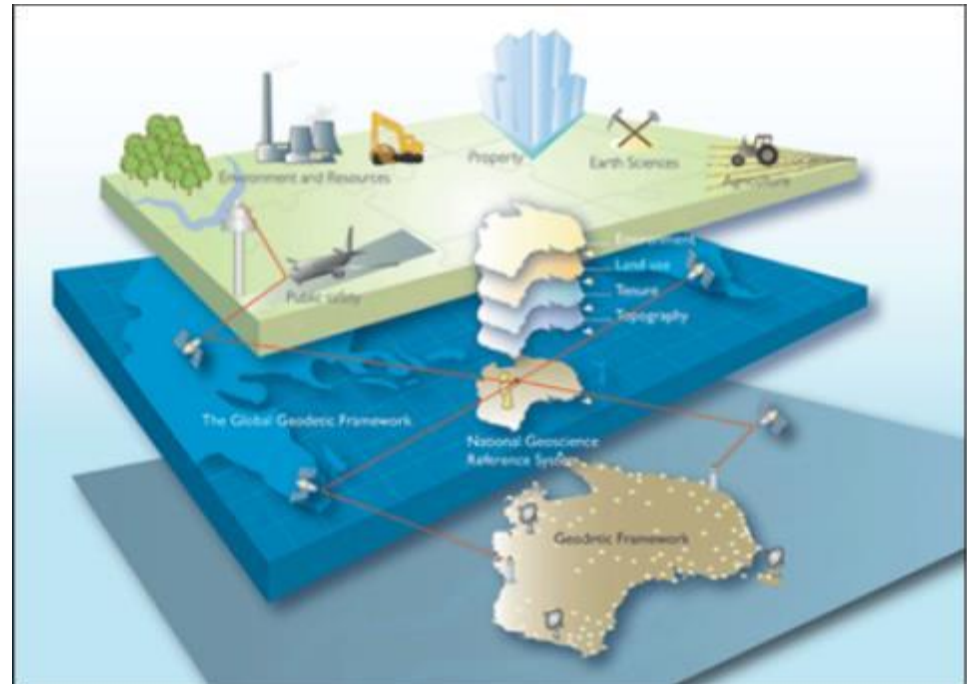
What is a GNSS CORS system used for ?

Summary...

A CORS system defines and monitors the National Reference Frame.

By accessing the derived products, realization of true National coordinates can be transferred into the field.

Everything is therefore positioned relative to a single reference.



Thank You

Any Questions ?



- when it has to be **right**



Leica
Geosystems