

# Advanced automated navigation solutions for container terminals based on security- enhanced anti-spoofing GNSS and sensors onboard SC vehicles

Juan Andrade Cetto

Instituto de Robótica e Informática Industrial, CSIC-UPC

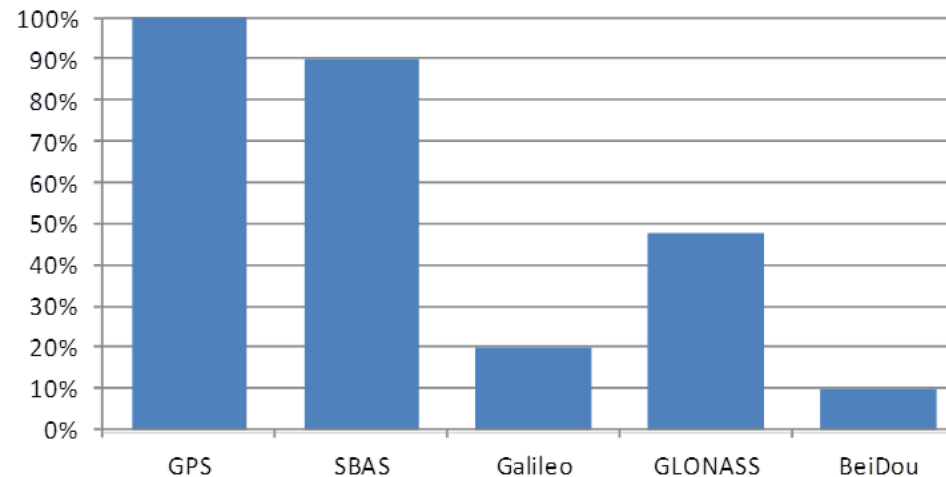
Robótica y sistemas no tripulados para aplicaciones de seguridad

Madrid, 2 de Diciembre de 2016

# Current status of the EGNSS adoption in Maritime applications



GNSS capability of Maritime devices\*



- **EGNOS trials** conducted by EC confirmed IMO performance requirements for coastal navigation, port approaches and inland waterways.
- **Galileo** uptake will likely increase rapidly, once it is recognized by IMO as part of the WWRNS

**Multi-constellation GNSS receiver is key for the IMO E-Navigation concept, providing better availability and accuracy**

# EGNSS opportunities for the maritime industry

**EGNOS and Galileo, can contribute to a safer and more efficient navigation**

## Examples of applications:

- ✓ General navigation
- ✓ Automatic collision avoidance
- ✓ Track control
- ✓ Traffic management
- ✓ Port operations
- ✓ Fisheries monitoring



**Galileo will contribute to international SAR operations**

# EGNOS and Galileo added value to maritime applications

<div>E-GNSS Services</div> <div>Applications<sup>1</sup></div>		EGNOS			GALILEO			
		OS	EDAS	SOL	OS	High Precision	Authentication	SAR
General Navigation	Ocean waters							
	Coastal waters							
	Harbour entrances and approaches							
	Inland waterways							
	Restricted waters <sup>2</sup>							
	Port							
	Manoeuvring operations in ports							
	Traffic Management							
	Homeland security							
	Search and Rescue							
	Recreation and Leisure							

Regulated

Unregulated

Relevant

Not relevant

Long term relevance

1Applications defined in IMO resolution A.815(23)

Juan Andrade Cetto, IRI (CSIC-UPC)

Robótica y sistemas no tripulados para aplicaciones de seguridad  
 Madrid, 2 de Diciembre de 2016

# LOGIMATIC: Tight integration of EGNSS and onboard vehicles for port vehicle automation

- The project will develop an innovative navigation unit (hardware and software) for the automation of the operations of straddle carriers in container terminals.
- Objectives
  - Improve productivity by increasing operational efficiency
  - Reduce labour and operational costs
  - Increase task accuracy and reduce errors
  - Reduce worker strain and fewer safety incidents
  - Improve cycle times

# LOGIMATIC: Tight integration of EGNSS and onboard vehicles for port vehicle automation

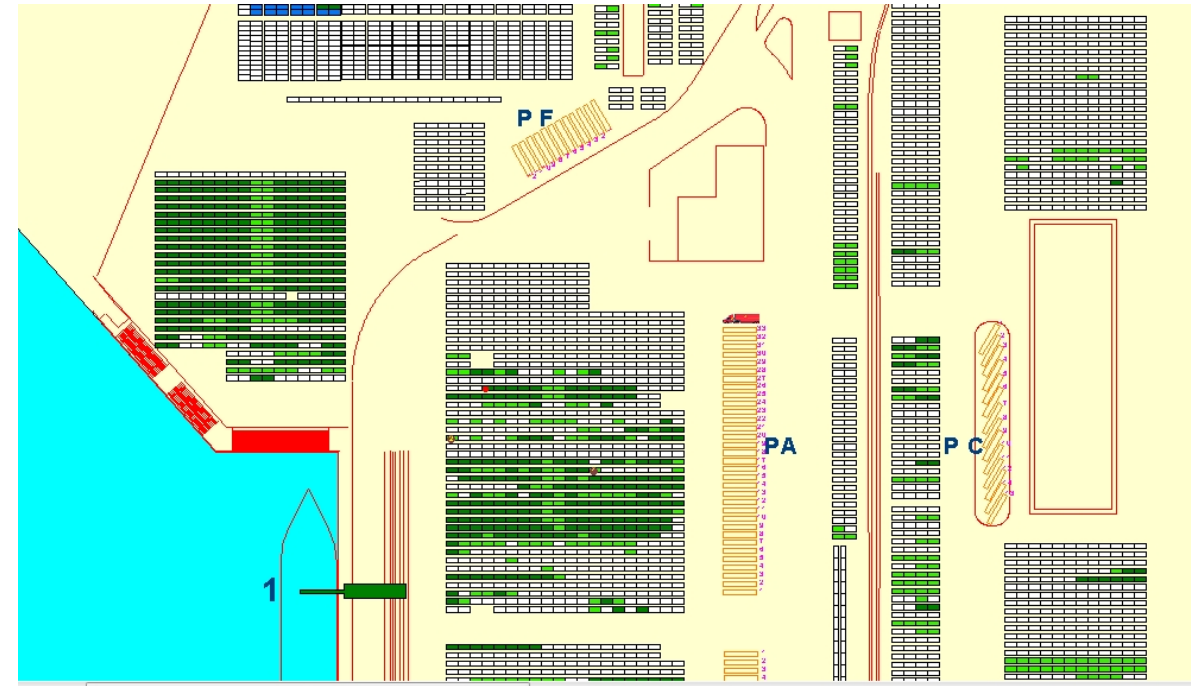
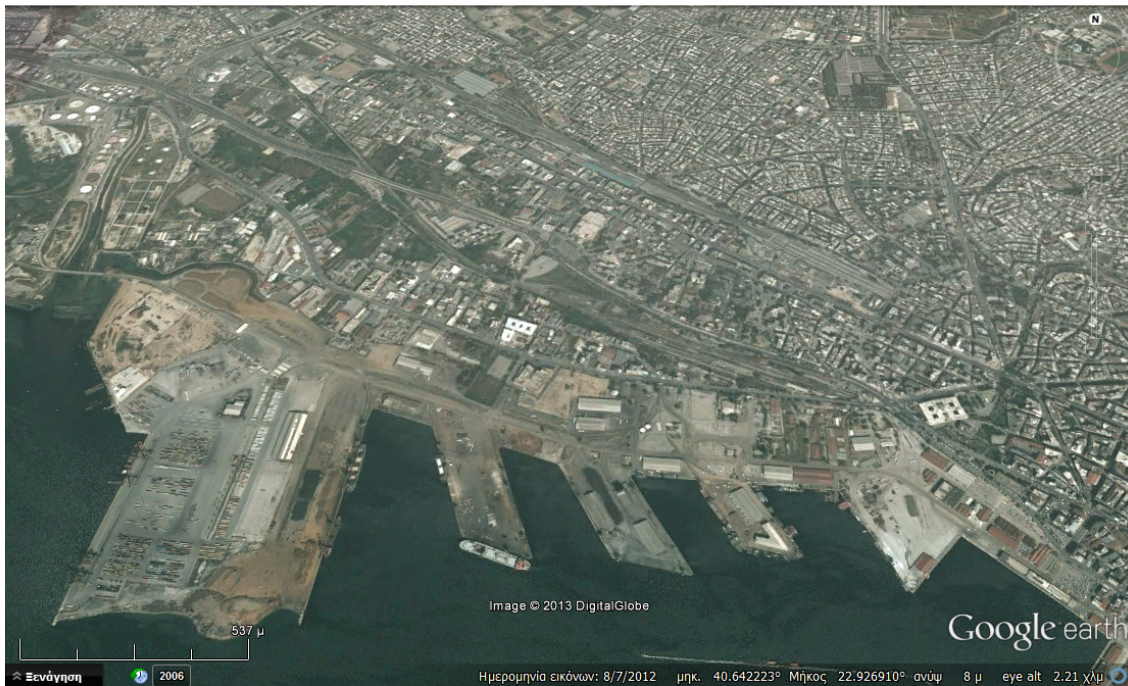
- The unit will be composed by
  - (1) a position and navigation module,
  - (2) an automatic driving control,
  - (3) a container operations module and
  - (4) a mission planning module.
- The unit will communicate with the Terminal Operating System TOS for task allocation and reporting.
- **The unit will include security mechanisms to detect and avoid spoofing and or jamming attacks.**

# LOGIMATIC Consortia





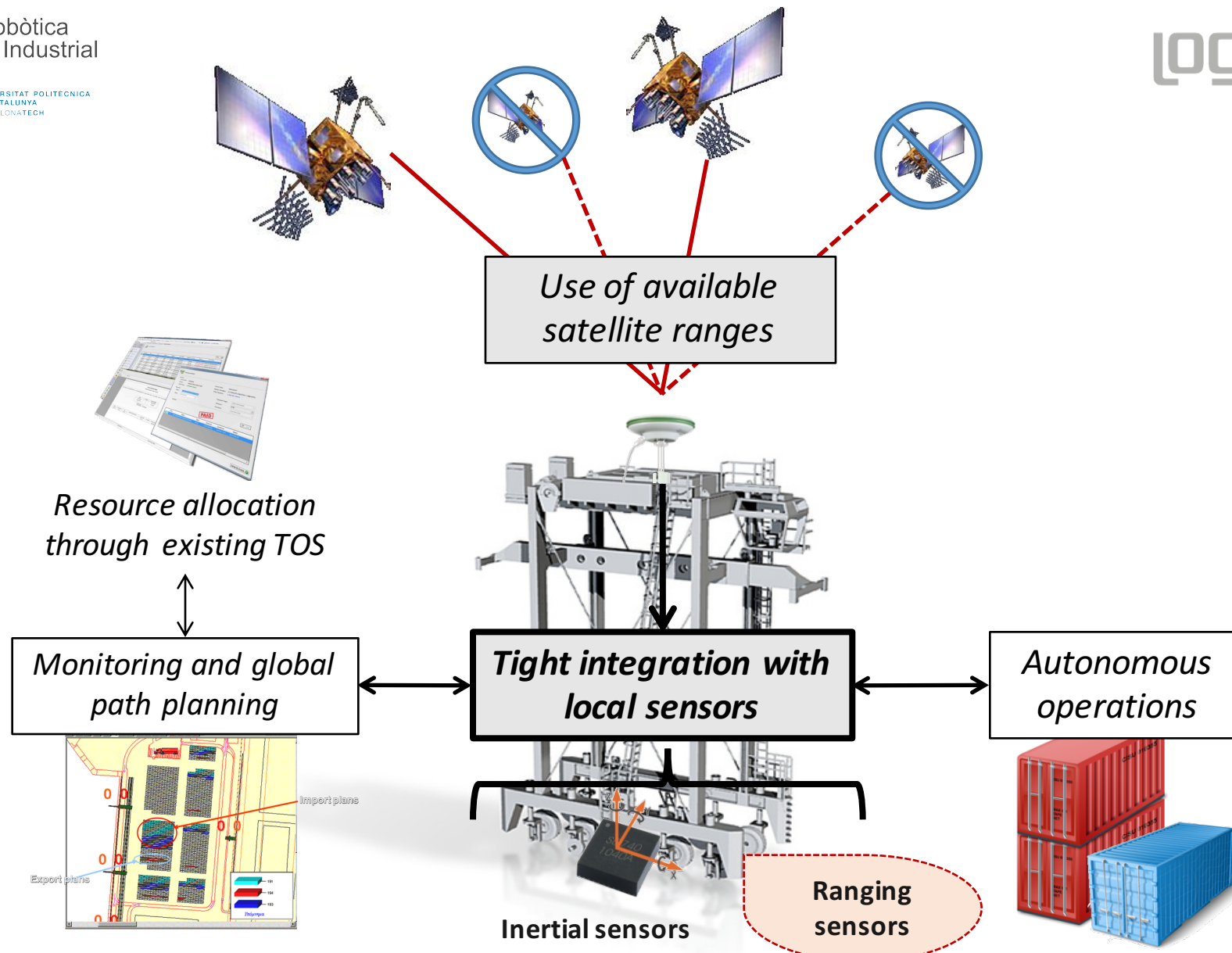
# ThPA Container terminal





# Straddle Carrier automation



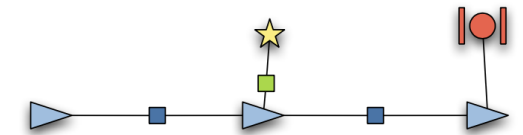
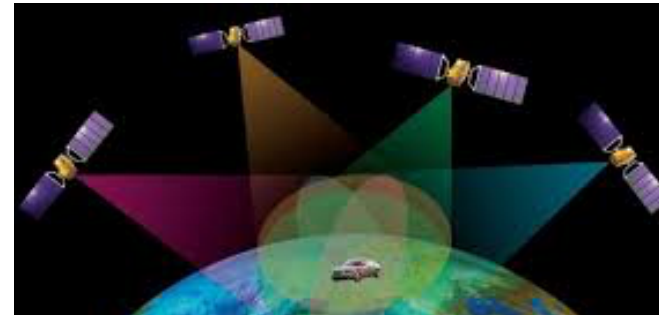
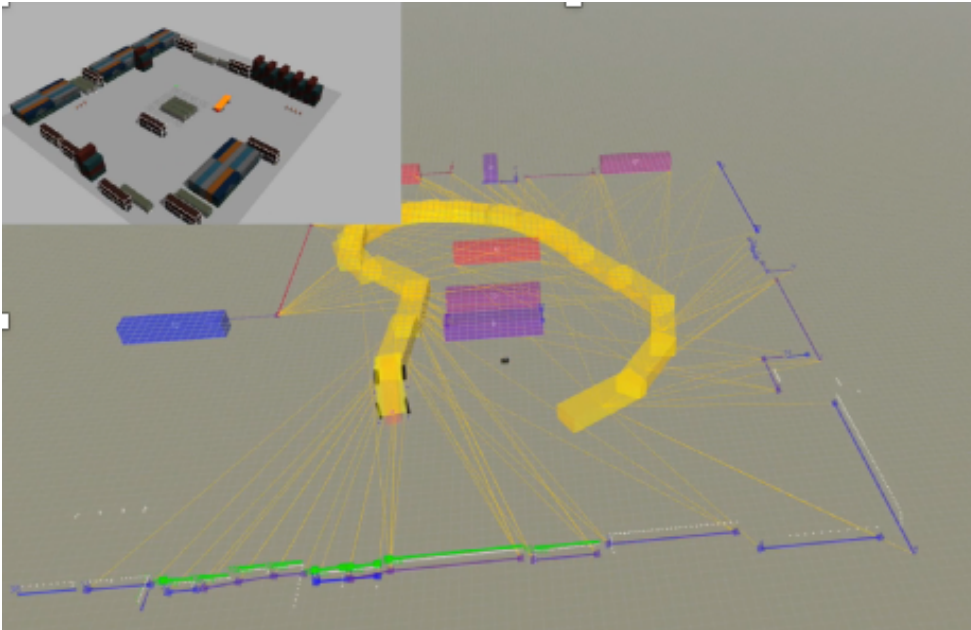


Juan Andrade Cetto, IRI (CSIC-UPC)

Robótica y sistemas no tripulados para aplicaciones de seguridad  
 Madrid, 2 de Diciembre de 2016

# Robust positioning solution

Add pseudorange and Doppler shift to local sensor-based localization and mapping solution



pseudorange

$$\rho^{[i]} = \sqrt{(r_x - s_x^{[i]})^2 + (r_y - s_y^{[i]})^2 + (r_z - s_z^{[i]})^2} + c\delta t$$

Doppler shift

$$d^{[i]} = \frac{s^{[i]} - r}{|s^{[i]} - r|} \cdot (\dot{s}^{[i]} - \dot{r}) + v$$

# GALILEO Security advantages for antispoofing/amtihacking

- Authentication
- Commercial service
- Two ciphered communication channels
- Private data communication
  - Precise transmission of timing data
  - Ionospheric models
  - Local differential correction signals

