

# Smart Boxes & Container Seals

## Considerations on Vulnerabilities & Design

**Joint Research Centre of the European Commission**

Marco Sironi,

Institute for the Protection and Security of the Citizen

Via E. Fermi 1, 21020 ISPRA (VA), Italy

<http://silab.jrc.it/>

[marco.sironi@jrc.it](mailto:marco.sironi@jrc.it)

## JRC's Mission

... is to provide customer-driven scientific and technical support for the conception, development, implementation and monitoring of EU policies ...

...the JRC functions as a reference centre of science and technology for the EU, independent of private and national interests...



## 7 Institutes in 5 Member States



### IRMM – Geel, Belgium

- Institute for Reference Materials and Measurements

Staff:  $\cong$  250



### IE – Petten, The Netherlands

- Institute for Energy

Staff:  $\cong$  180



### ITU – Karlsruhe, Germany

- Institute for Transuranium elements

Staff:  $\cong$  250



### IPSC - IHCP - IES – Ispra, Italy

- Institute for the Protection and the Security of the Citizen

- Institute for Health and Consumer Protection

- Institute for Environment and Sustainability

Staff:  $\cong$  350, 250, 370

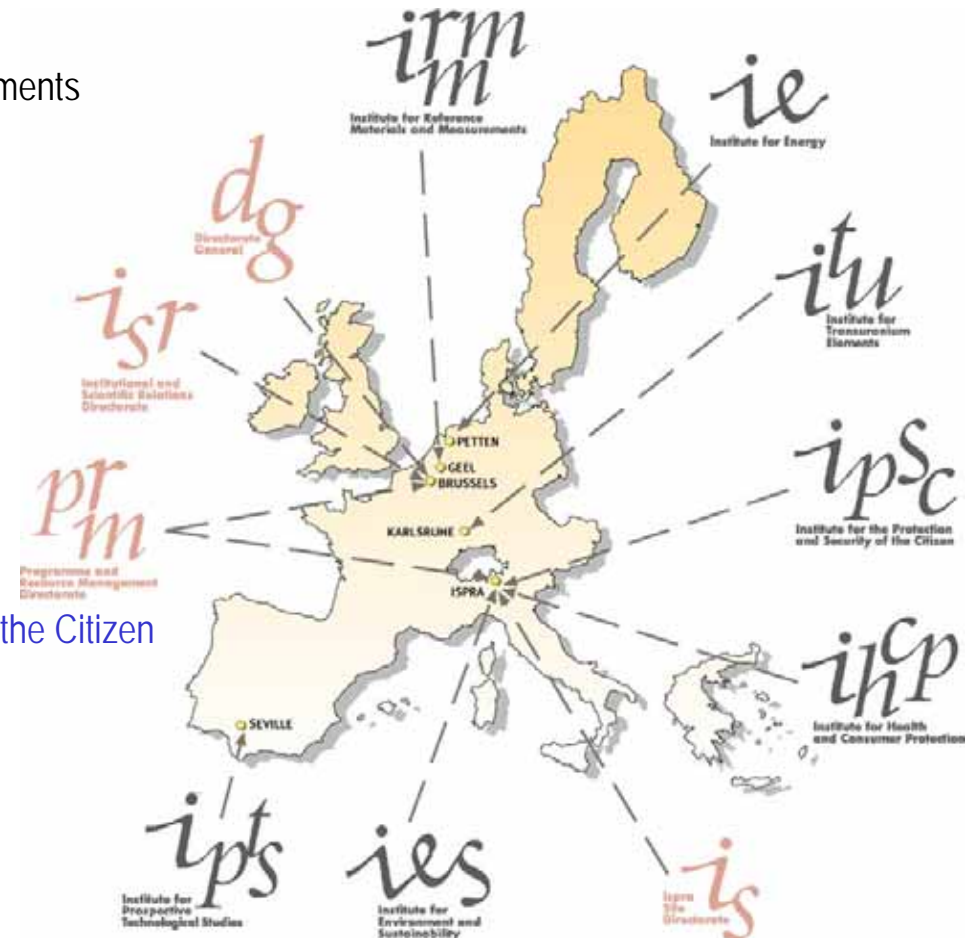


### IPTS – Seville, Spain

- Institute for Prospective Technological Studies

Staff:  $\cong$  100

**Total staff: ~ 2200 people**



## Joint Research Centre (JRC)

Institute for the Protection  
and Security of the Citizen  
(IPSC)

Traceability and  
Vulnerability Assessment  
Unit (TRVA)

**SILab**

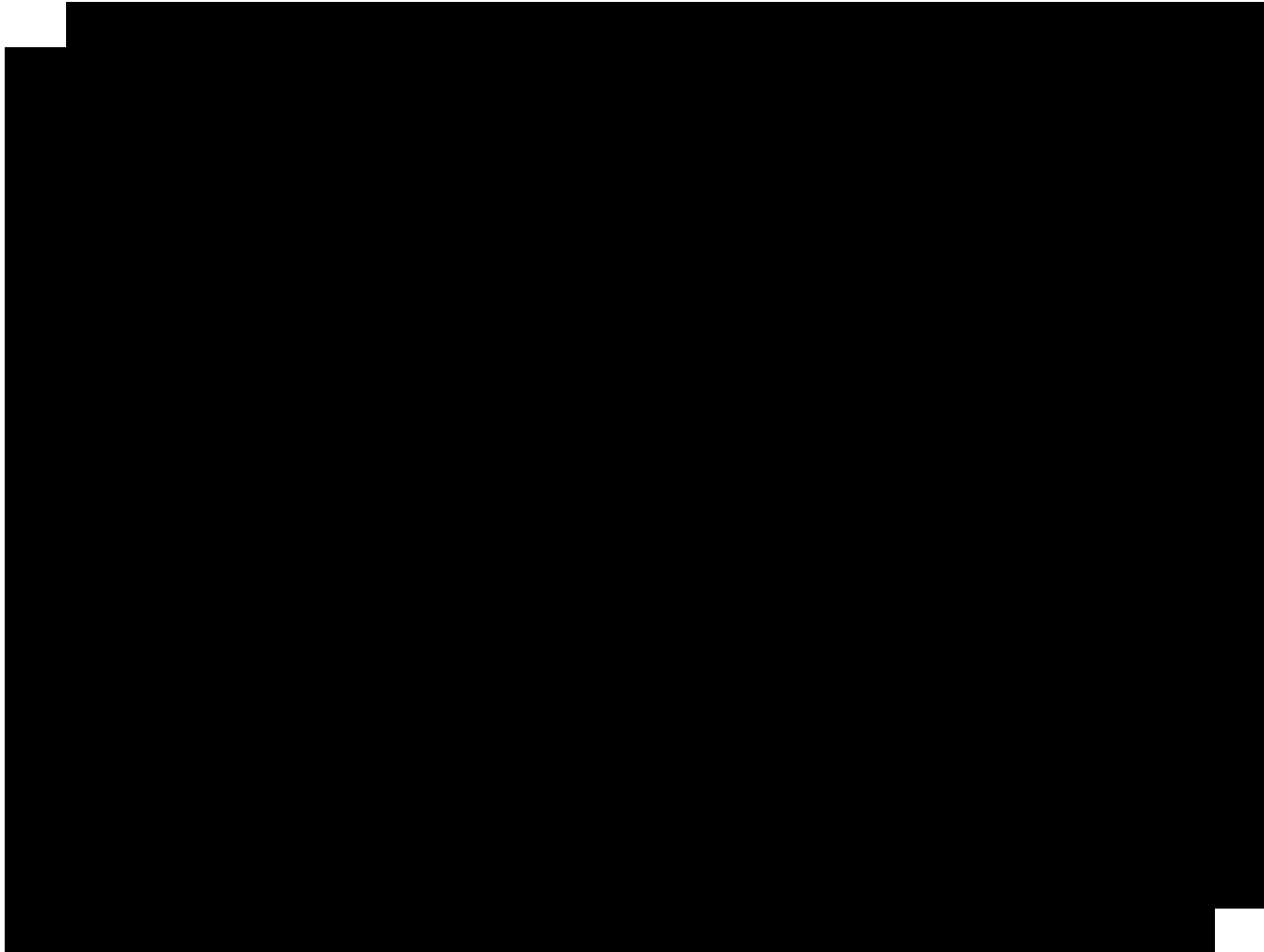
Seals and Identification Laboratory



## General considerations on vulnerability:

- Vulnerability of the container design
- Vulnerability of high security mechanical seals and e-seals

Opening of the main container left door leaving the seals in position



## Opening of the main container right door leaving the seal(s) in position



# Container design weaknesses

## Possible countermeasures:

With the existing containers:

- Apply the seal to the central bars
- Use an additional locking bar, in front of the four container bars, with two seals

Redesign the container:

- Design the doors to prevent easy opening of the left door leaving in place the right door
- Seal the doors not on the bracket but directly. For example connecting the two front part of the doors with a seal.
- Use high quality steel for the fabrication of rivets and container brackets and locks.

## Opening a container sealed with high security mechanical seal with no visible tampering of the seal



## Opening a container sealed with e-seal (active RFID based) without triggering an alarm



## Seal design weaknesses

### Possible countermeasures:

#### Mechanical seals:

- Avoid single pin seals
- Use cable seals with multiple wires
- Same number on pin and sleeve

#### E-seals:

- Use cable seals with a security inside the cable.
- Same number on pin and sleeve

- Passive eSeals
- Active eSeals
- Integrated Alarm System for container full protection (smart box)
- Supply Chain Security through secure container loading.

## Three passive transponders inside the seal:

- Permanent transponder for unique identification of each container and for keeping track of the container travel through intermediate reading stations
- Temporary transponder that breaks at the seal closure, giving feedback on the correct seal installation.
- Temporary transponder to detect illegal openings (transponder breaks when opening the seal). To be legally broken when the container is delivered.



Seals developed for the  
test trial in Lithuania

New seal design suitable for  
containers and trucks

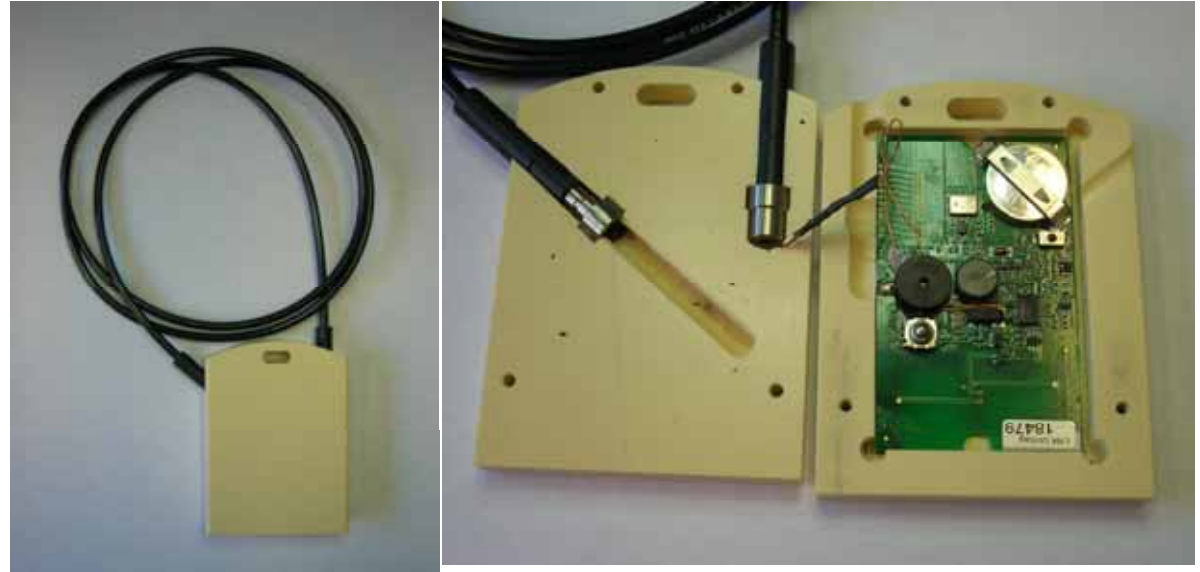


- Target cost: less than 5€
- Single use: no necessity to ship it back
- Reading in contact. OK when the container is already scheduled to stop for inspection
- Tampering detectable at reading
- Suitable for border to border checks
- Dedicated reading infrastructure required

- Two on going pilot projects to test the seals: in cooperation with Chinese Customs Authorities and with Italian Agenzia delle Dogane
- A reading system complete with software and database.
- Training courses for operators available in Ispra.



- A new smart seal, based on active transponder and able to transmit a signal in a range of 30 meters is under development
- This seal will also have the capability to communicate with our container Integrated Alarm System, to avoid seal reading infrastructure



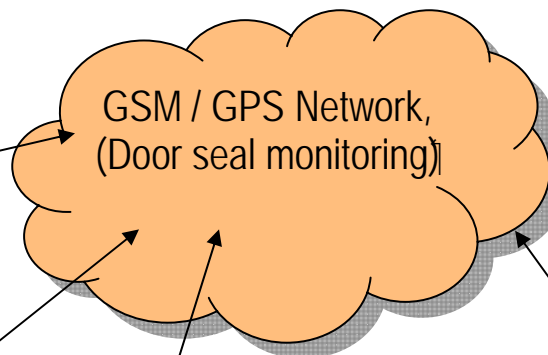
- Target cost: less than 25 euro
- Multiple use, necessity of shipping the it back
- Possibility to read the seal remotely while the container is moving.
- Tampering detectable at reading
- Dedicated reading infrastructure required.
- Infrastructure issues: standard, compatibility with different brand seals, technological aging

Ten RFID active seals with reading system ready to be delivered for the China pilot project

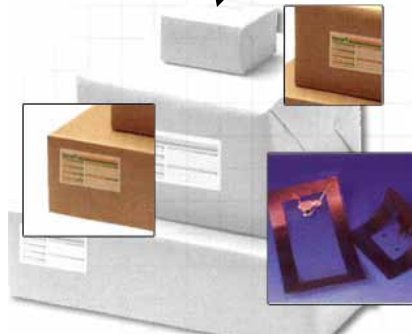


## A “Smart Box” System to increase transportation security

Container equipped with internal alarm system and sensors



Monitoring station  
(cell phone)



Control on stuffing operations



Monitoring station (PC)

## Integrated Internal Alarm for total coverage



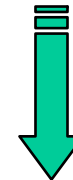
Container internal  
sensors



Data logger



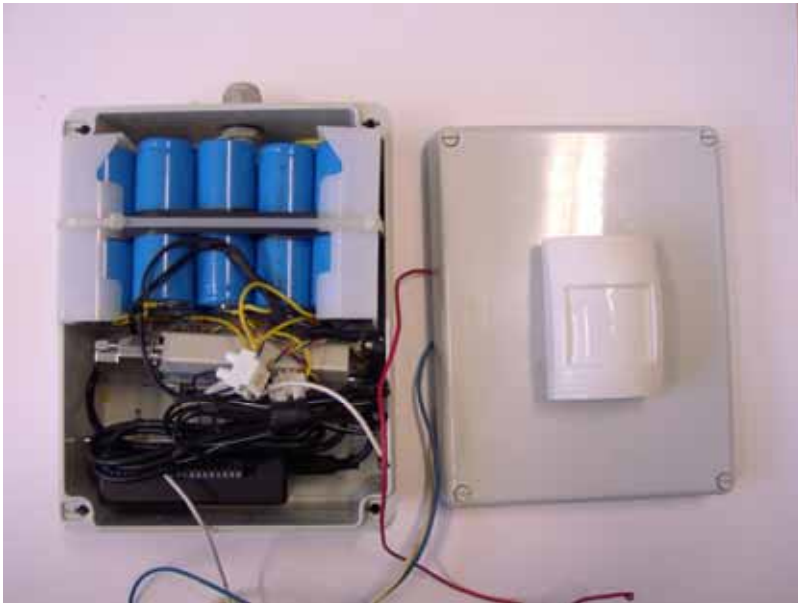
GSM Modem + GPS antenna



To GSM net

- Similar to a “home alarm”. It gives full protection to the internal volume
- When an intrusion occurs, an alarm is triggered and automatically sent through the GSM network
- The alarm is in real time, GPS gives the geographical position of the container when the alarm was triggered
- No dedicated infrastructure required, the system uses the GSM network
- A demo system developed and tested at JRC

Remote Monitoring System in the configuration designed and tested at JRC



A prototype of industrial  
product developed by Kymatics



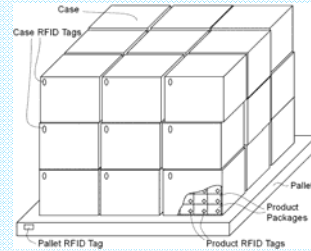
- Target cost: 100 euro
- Multiple use, necessity of shipping the system back
- Possibility of remote communication and positioning, alarm in real time.
- No dedicated reading infrastructure required, it relies on existing commercial standards (GSM, GPS).
- Infrastructure evolves driven by market with no cost for container shipping

# A Secure supply chain



Warehouse storage

1



Loading of goods

2



Loading of container equipped with eSeals...  
...and remote monitoring capabilities



3



Container shipping

6



Container intermediate storage

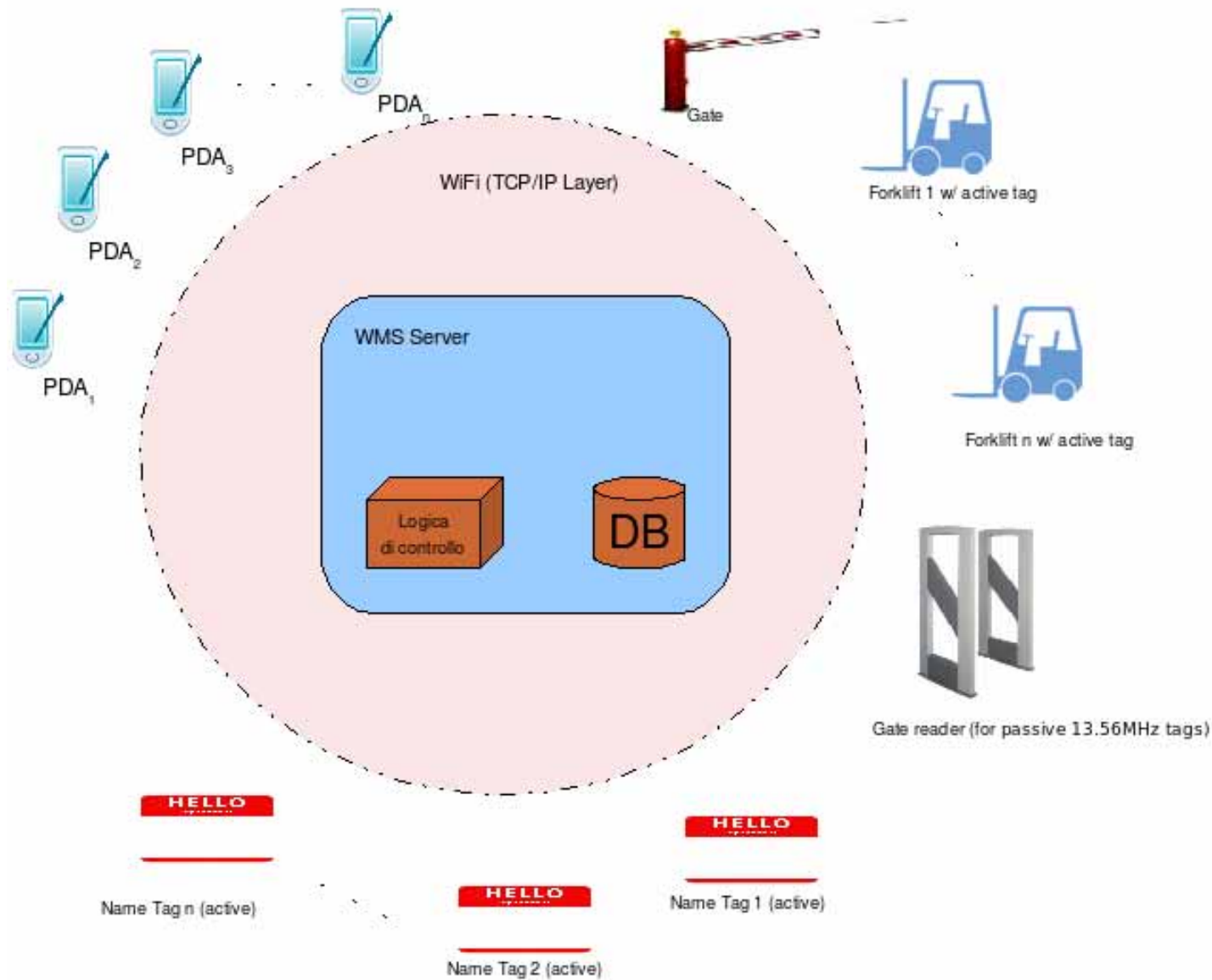
5



Container transport

4

# A Secure supply chain

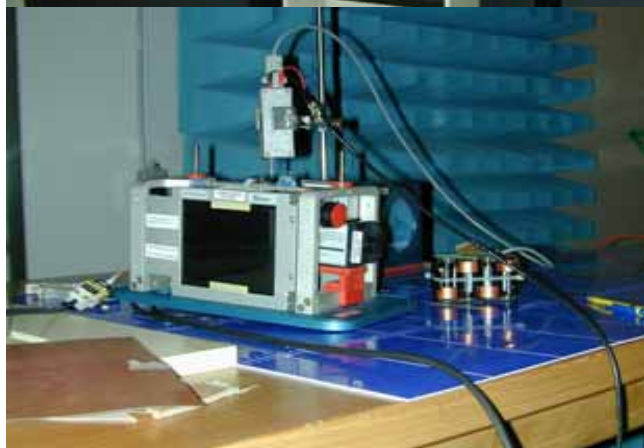


- A test trial is ready for demonstration at the JRC
- A gate opens the restricted secure area upon consensus when the forklift approaches
- A set of low, medium and high frequency antennas are set to read different combinations of tags on the goods



# Tests at TEMPEST laboratory

Performance, vulnerability, reliability, conformity and interoperability testing



- Vulnerability Assessment of the whole system (container + sealing system) is mandatory to pinpoint weaknesses.
- Design of seals and container to be optimized to take into account results of vulnerability study.
- Avoid “easy intrusions”. Impact on security will be very negative.
- Remote secure control of container loading reduces the risk of hiding unauthorized goods.
- JRC could act as as independent laboratory for testing, vulnerability assessment & technology development to increase the security of the Supply Chain.