

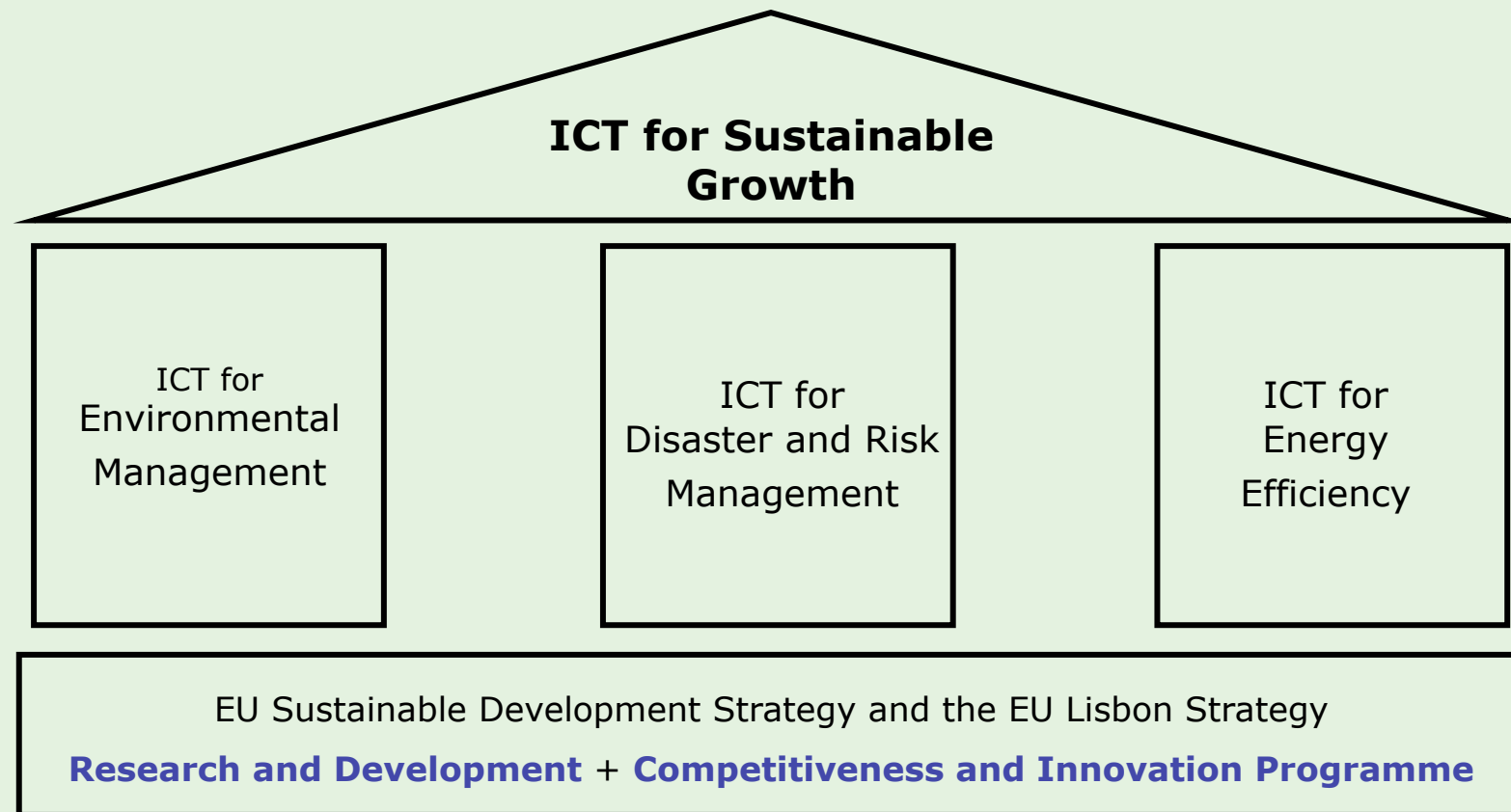
# Sensor networks for Disaster Management

## Ongoing Community Research

**Dr. Michel Schouppe**  
European Commission  
Information Society & Media Directorate-General  
Unit ICT for Sustainable Growth



# ICT for Sustainable Growth Unit



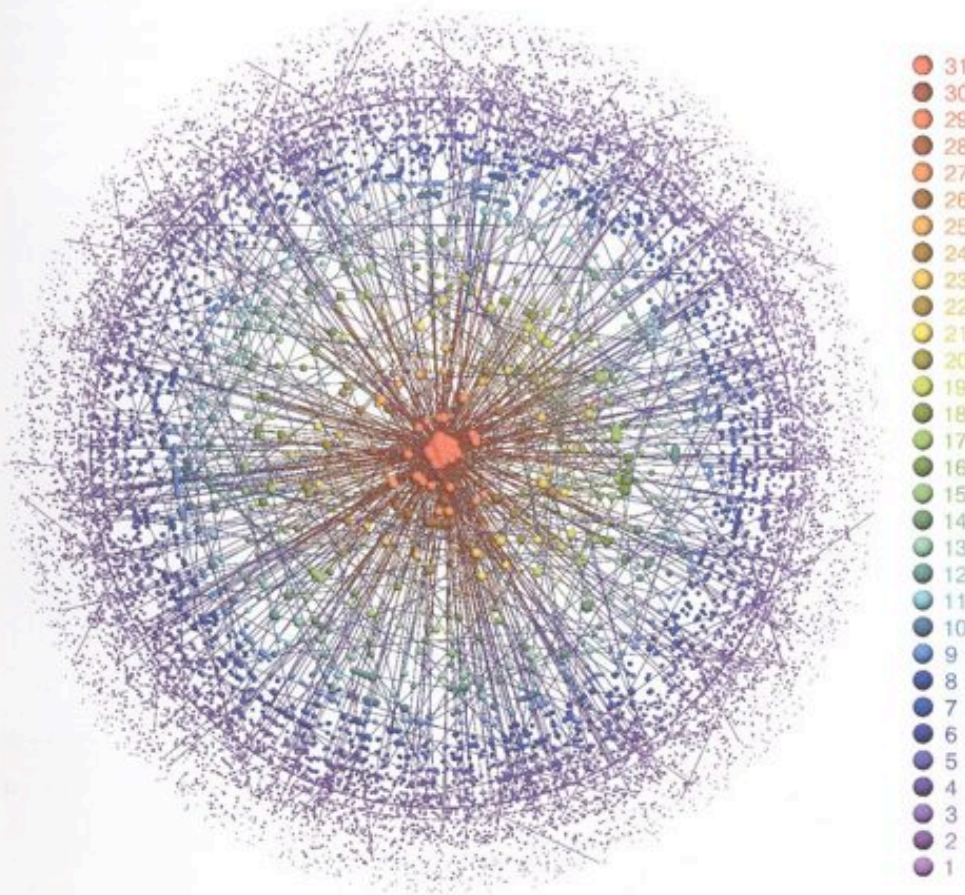
# Index

- **Motivation from a European perspective**
- **Monitoring trends & technological opportunities**
- **Ongoing EU research on sensor networks  
(including Web sensor technologies)**





# Sensors to support Complexity Management



Map of the Internet at coarse grained level  
[www.evergrow.org](http://www.evergrow.org), courtesy of Yuval Shavitt & Eran Shir

## Many real world systems are complex systems

- Holistic approaches
- Multidisciplinary research

## Need for an infrastructure to handle complexity

- Integration of knowledge and information
- Across disciplines, communities and actors

## New opportunities

- Collaboration culture
- Methodological advances
- Technological advances

# Sensors to support Environmental Legislation in Europe

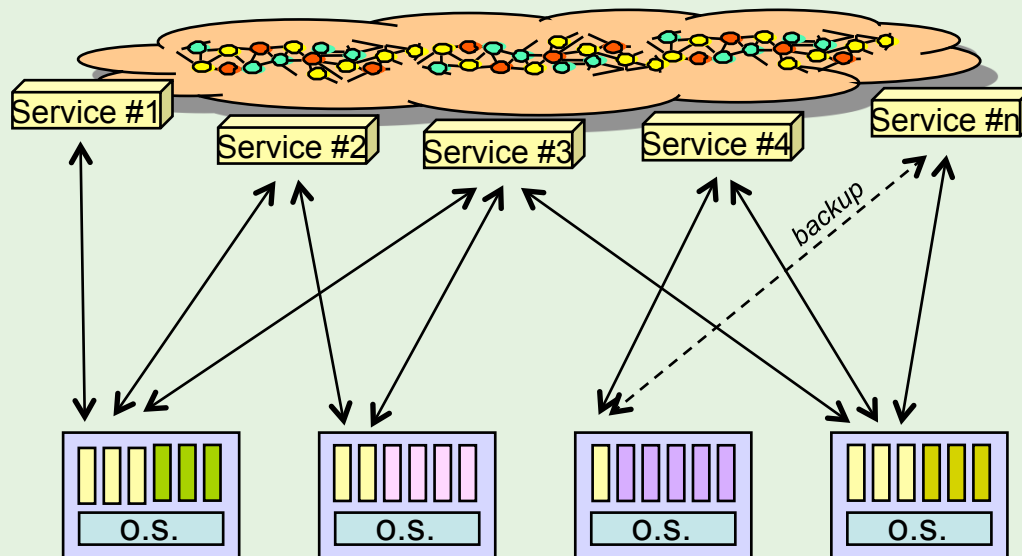
- Introduces **higher requirements** for common environmental monitoring and reporting:
  - More cohesive, streamlined **workflows**
  - Improved **comparability**, better **accountability**
  - **Data quality** is about relevance, timeliness, completeness, accuracy, accessibility, clarity, punctuality, consistency, cost efficiency, integrity, neutrality, robustness, security, soundness (EEA)
  - Aarhus convention, INSPIRE, WFD, CAFE, REACH, WEEE,...
- For a better formulation and successful implementation / assessment of the legislative context



# SISE – a Single Information Space in Europe for the Environment

## A collaborative “Information Space” on the Web

- Where users plug in their own use cases
- Requires a transparent backend system of systems
- More than measurements and data exchange
- Allowing ad hoc, on demand service chaining







# **SISE** **an actor centric** **“Information space”**

- For single users and virtual communities, with or without special ICT knowledge/training
- For scientific investigations and operational applications
- In synergy with models, forecasting and decision support systems
- Increasingly based on Web technologies

and Media





# Sensors and Data Foundations for a SISE

## Sustaining and integrating multi-source data





# Towards a GEOSS

(Global Earth Observation System of Systems)



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# Monitoring - Trends

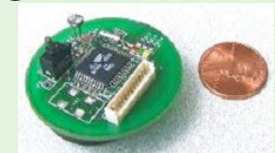
## Multiple data types & sources

- New sensors / platforms
  - Miniaturised, low cost, intelligent sensors -> massive use
  - Portable sensors -> random measurements
  - Soft sensors
- Smarter Networks (adaptive, flexible, autonomous)
  - Satellite constellations
- 3D/4D
- Real time
- Time series

**In a context of lower monitoring investments**



Mercator-1 prototype : ~16 m wingspan, ~2 kg payload (VITO)





# Technological opportunities

- Revolution in wireless communications
- Sensor miniaturisation
- Cheaper, higher computing capability
- Web technologies, participatory approaches
- GoogleEarth, Virtual Earth, ...
- Systems of systems open architectures
- Emerging interfaces and protocols, data & meta-information models

## **Impact at various levels:**

- Elementary sensor node
- Autonomous, self-healing & interconnected networks
- Strengthened use of sensor data (discovery, conversion, fusion, processing, presenting, broadcasting, ...)



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- Motivation from a European perspective
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- **EU research on sensor networks**



# Disaster Management Cycle

## Prevention and Mitigation

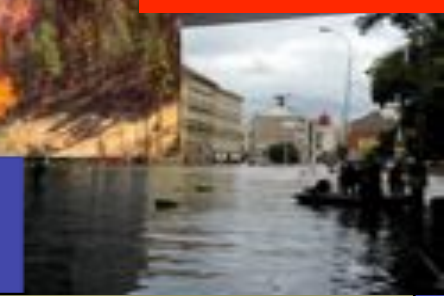
- Hazard prediction and modeling
- Risk assessment and mapping
- Spatial Planning
- Structural & non structural measures
- Public Awareness & Education..

## Preparedness

- Scenarios development
- Emergency Planning
- Training



Disasters



## Alert

- Real time monitoring & forecasting
- Early warning
- Secure & dependable telecom
- Scenario identification
- all media alarm

## Response

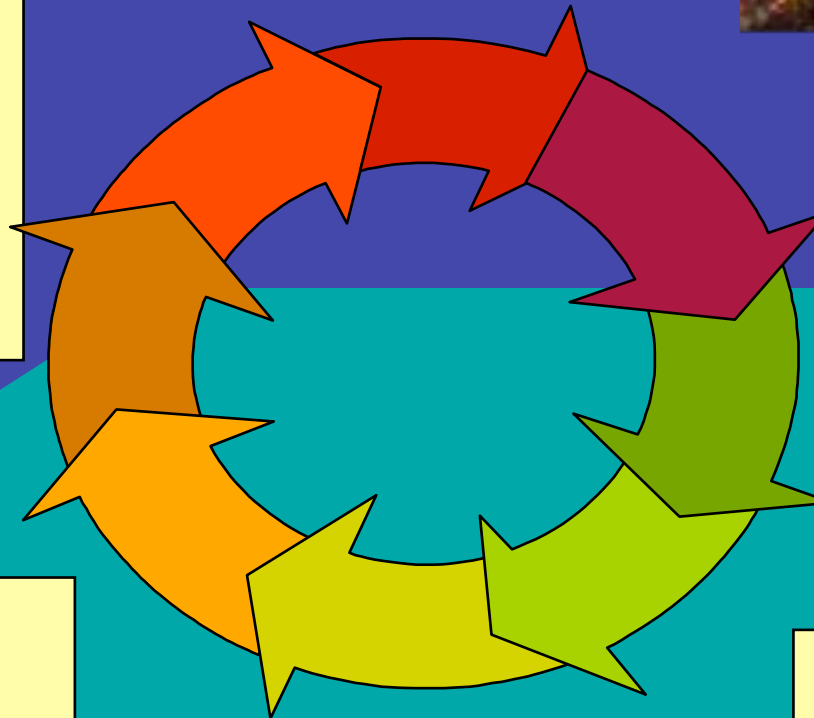
- Dispatching of resources
- Emergency telecom
- Situational awareness
- Command control coordination
- Information dissemination
- Emergency healthcare

## Recovery

- Early damage assessment
- Re-establishing life-lines transport & communication infrastructure

## Post Disaster

- Lessons learnt
- Scenario update
- Socio-economic and environmental impact assessment
- Spatial (re)planning







# ICT for the Environment Ongoing Research

## Collaborative research projects

- Risk information infrastructure and generic services
- Emergency management and rescue operations
- In-situ monitoring and smart sensor networks
- Public safety communication, alert systems and rapidly deployable emergency telecommunication systems
- Distributed tsunami early warning and alert system, relevant to Europe & Indian Ocean
- Humanitarian demining

Eight  
projects  
2006-2009  
~ 25 € Mio

## Specific Support and coordination actions

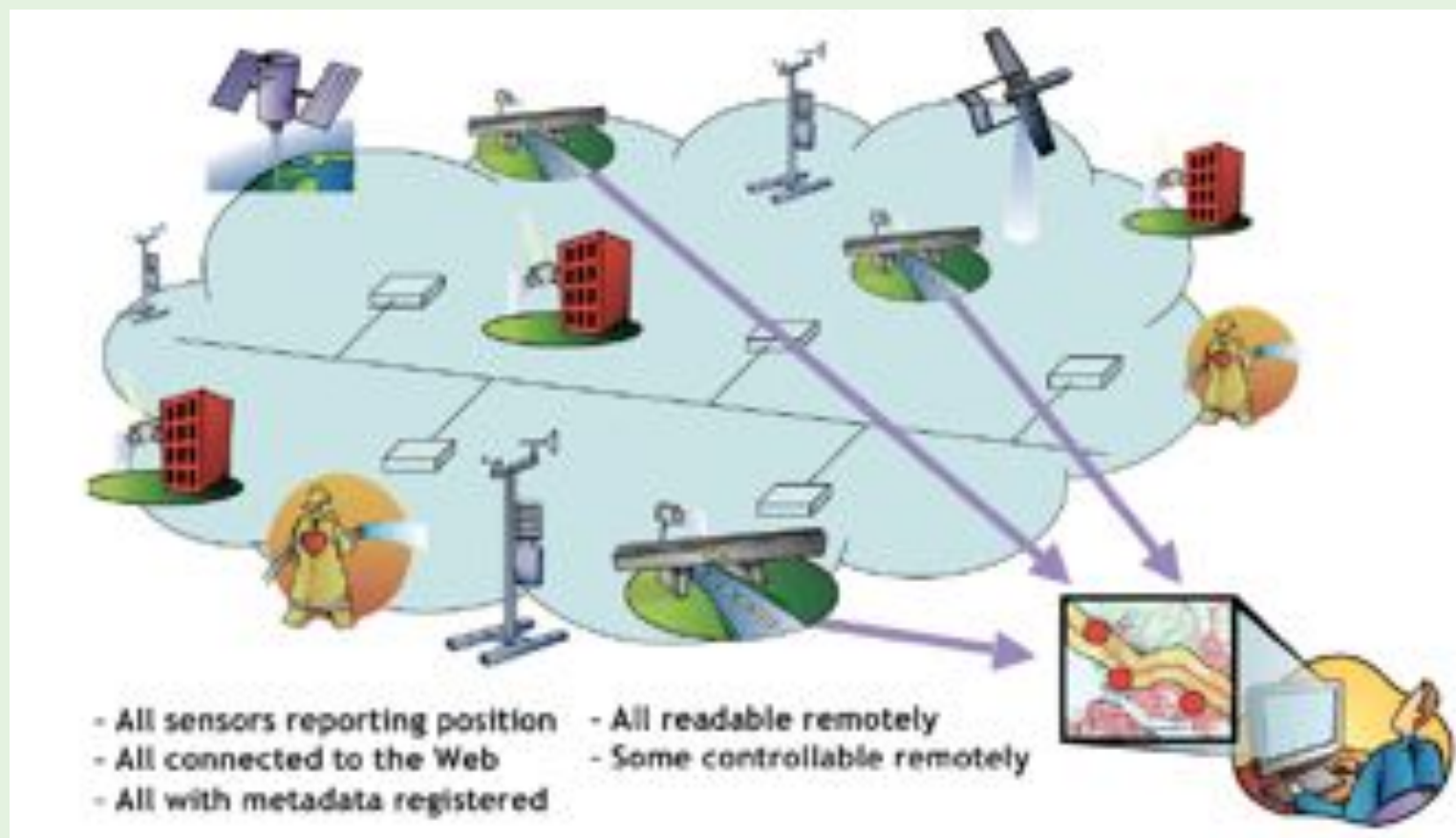
- to achieve full interoperability (telecom)



# ICT for Environmental Management

## Research vision – Smart Monitoring

Towards a dynamic management of heterogeneous sensor networks for full situation awareness



Sensor Web Concept (OpenGIS® White Paper)



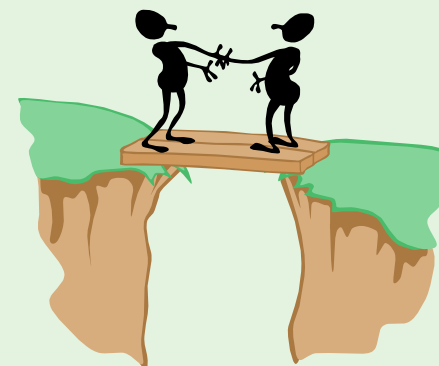
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# ICT for Environmental Management

## Research issues – Smart Monitoring

- Cooperation between multiple sensors
- Centralised and decentralised approaches (network control, data processing)
- Easy plug-in of new sensors
- Network customisation, re-tasking, (re-)deployment, self\*
- Appropriate architectures and services for middleware
- Integration and optimisation of existing monitoring networks
- Interfaces with Spatial Data Infrastructures and Web services







# Typical deliverables

- Sensor network **generic architecture frameworks**
- **Strategies** for:
  - sensor network reconfiguration, deployment and organisation
  - data communication, exchange, integration, fusion, interpolation, correlation, processing and visualisation
- Improvement and integration of innovative **sensing techniques**
- **Prototypes of sensor nodes and sensor networks**
- System level **simulators**
- Demonstration via **experimental validation** across Europe
- Contributions to **standards**

# **OGC Sensor Web Enablement (SWE) activity is establishing the interfaces and protocols that will enable a "Sensor Web"**

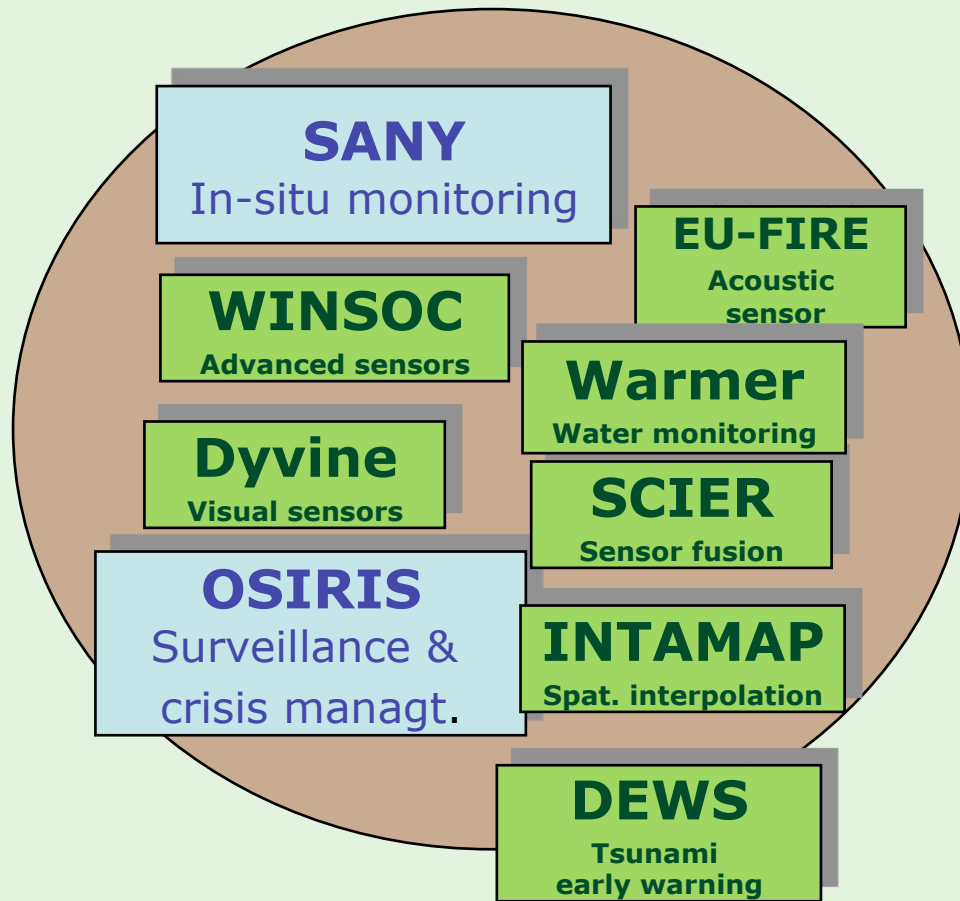
- Describe Sensors and Sensor Capabilities
- Discover Sensors
- Request Sensor Data
- Access Sensor Data
- Task Sensors
- Subscribe to Sensor Data
- Receive Alerts from Sensors

Foundation for "plug-and-play"  
web-based sensor networks



# ICT for the Environment

## Smart Monitoring Cluster



- **SANY** and **OSIRIS**: two large scale Integrated projects
- Both projects intend to contribute to GMES and GEOSS in the area of in-situ sensor integration





# SANY & OSIRIS Scope

User  
Domain

User Interface Support

Application  
Domain

Visualisation

Reporting

Sensor Applications e.g. DSS

Mediation &  
Processing  
Domain

Processing Services (e.g. fusion)

Model Management

Acquisition  
Domain

Sensor Services

Intermediate  
Sensor Services

Sensor  
Domain

SANY Sensor Service Architecture

SANY Implementation Architecture



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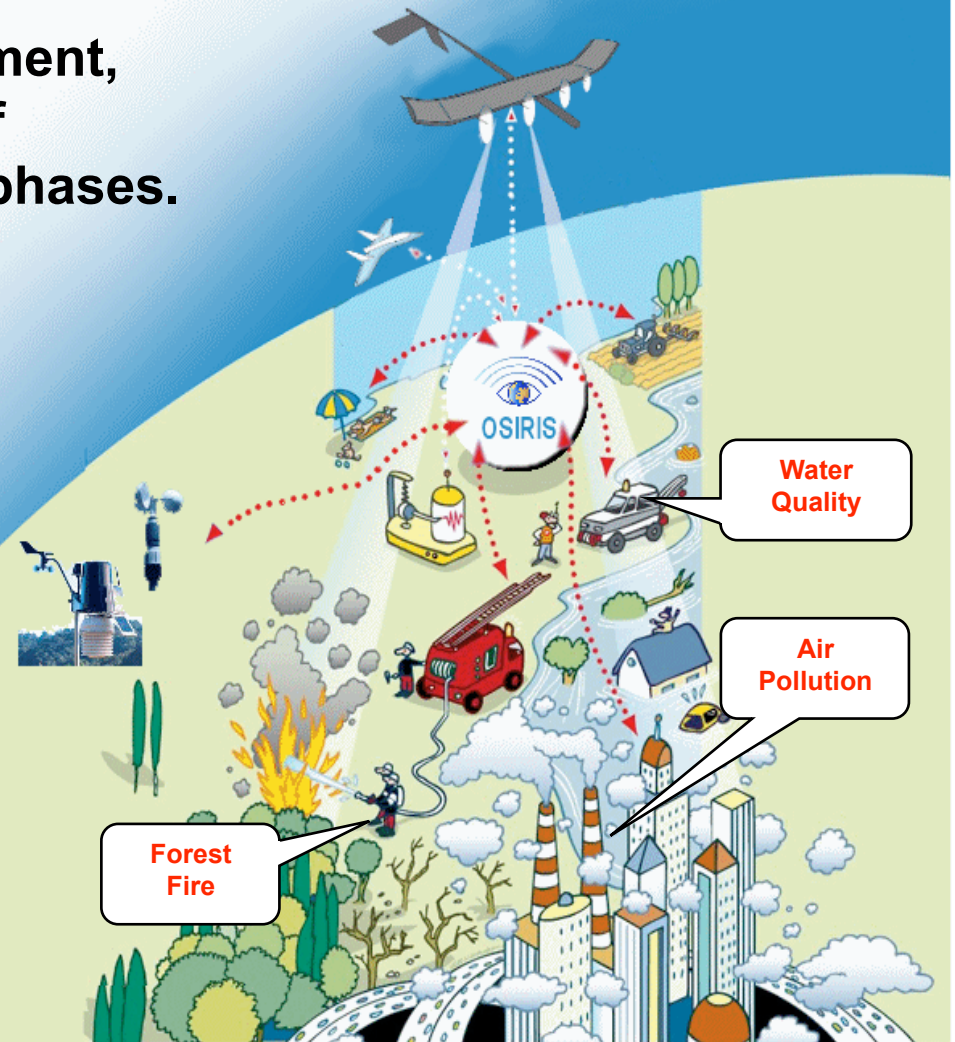
# OSIRIS

(<http://www.osiris-fp6.eu>)



. OSIRIS addresses the smart deployment, use and reconfiguration of network of sensors in the monitoring and crisis phases.

- **Service Oriented Architecture** for operation of sensors or sensors network
  - Enabling system reconfiguration and evolution
  - Sensor management, deployment, cooperation
  - Plug & play into a web service architecture
- **Live experiments** with end-users
  - **MONITORING** and **CRISIS** phases
    - Forest fire
    - Air pollution
    - Water quality

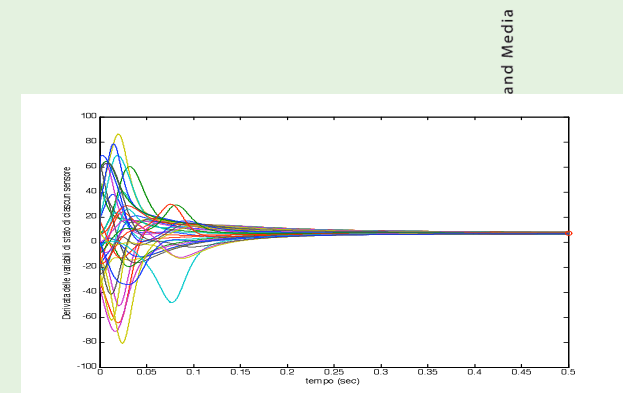


# WINSOC (<http://www.winsoc.org/>)



- **Innovative design methodology for wireless sensor networks**
  - Totally *decentralized architecture*
  - New techniques for the diffusion of information through the network
  - The entire network achieves a *global consensus* about a common observed phenomenon, through *local coupling* of nearby nodes
  - Greatly simplified protocol
  - High accuracy and reliability through proper coupling among adjacent sensors
  - Scalable, fault tolerant network
  - Ability to perform different tasks, e.g. parameter estimation, event detection, source localization, by simply changing the values of a few system parameters
- **Sensor Node prototype**
- **System level simulators**
  - Forest fires
  - Landslides

Time evolution of the estimation of the 36 sensors network in which each sensor is coupled with 4 adjacent sensors.





# Further Information & Contact

- **CDRom**
- **DG INFSO Unit “*ICT for Sustainable Growth*”**  
Email: [INFSO-ICTforSG@ec.europa.eu](mailto:INFSO-ICTforSG@ec.europa.eu)  
<http://ec.europa.eu/ictforsg>
- **Home page of the i2010 initiative:**  
<http://ec.europa.eu/information-society/eeurope/i2010/index-en.htm>
- **Research on ICT for the Environment**  
<http://cordis.europa.eu/ist/environment/projects.htm>
- **Registration as an expert:**  
<https://cordis.europa.eu/emmfp7/index.cfm?fuseaction=wel;welcome>

**Thank you for your attention!**



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