VITRO Virtualized dIstributed plaTfoRms of smart Objects

Project Coordinator

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Partners:

- Hellenic Aerospace Industry (GR)
- Thales Communications France (FR)
- Telefonica I+D (ES)
- Centre Tecnologic de Telecomunicacions de Catalunya (ES)
- Research and Academic Computer Technology Institute (GR)
- Technological Educational Institute of Chalkida (GR)
- Zodianet (FR)
- W-LAB (IT)
- Elsag-Datamat (IT)

Duration: *30 months*
Start: September 1st, 2010
Total Cost: *3.43 M€*
EC Contribution: *2.10 M€*
Contract Number: *INFSO-ICT-257245*

- ***"VITRO aims to extend the notion of virtual sensor networks and address innovative engineering/ research topics for the realization of VSN"***

Main Objectives

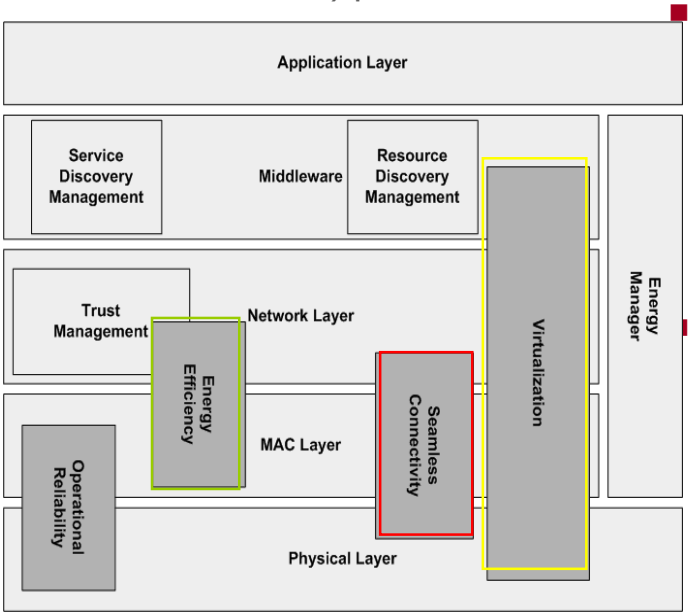
- **Provide a homogeneous abstract appearance** to enable federated collaboration with external entities and thereby extending the networking degree by several orders of magnitudes.
- **Simplify the discovery and management of the underlying hardware and software resources** of large collections of heterogeneous smart objects.
- **Achieve energy-efficiency, trust-awareness, seamless connectivity and communication** in large-scale heterogeneous WSN deployments and thereby enable dependable, virtualized, secure and scalable inter-objects collaboration.
- The **VITRO outcomes** will be packed in a **VITRO application toolbox**, consisting of middleware, advanced core communication components and a user-friendly management tool, which will enable easy configuration and instant support for deploying VSN applications.
- Although VITRO aims to be **application-neutral**, the proposed architecture and protocol toolbox will be validated through extensive simulation testing and implemented in a federated network of sensor nodes and smart objects in **smart home**, **building automation** and **industrial** application domains.

Project Management

- Project management is a quite important issue in a multinational project as VITRO. Thus, a workpackage (WP1) will be devoted to the project management and quality assurance of the project deliverables. Moreover, albeit being a STREP, exploitation and dissemination activities are core to VITRO and a prime driver for its activities.
- To give the VITRO approach sound industrial groundings, WP1 will commence by capturing latest market trends regarding sensor and actuator networking, as well as approaches for their virtualization. Such a market assessment and analysis concerns primarily wireless sensor and actuator networks for various application domains, but will mainly focus on smart home and building automation.
- Core to the industrial partners of VITRO, a significant effort will be spent in detailing exploitation plans of achieved results and insights. The aim here is to create a viable framework for successful exploitation of VITRO results and specify in minute details the exploitation plans of the project as a ***whole*** and for each partner ***individually***.
- Also, VITRO prime achievements will be disseminated in appropriate journals, workshops, conferences, etc. VITRO aims for large and lasting impact through participation in related standardisation bodies. ETSI M2M and IETF ROLL / 6LowApp are of pertinence and the membership of some of the project partners in these bodies ensures ***impact*** and ***visibility*** of VITRO commercially viable outcomes (WP7 tasks).

Technical Approach (1)

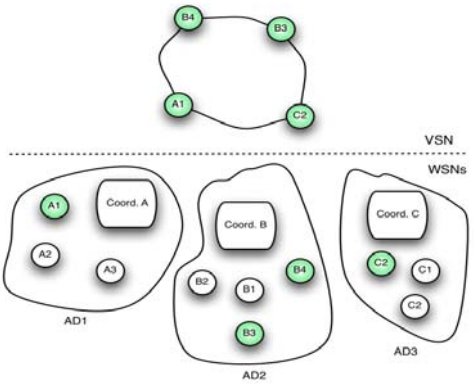
- ***WP2: Cross layer design*** for the adaptive VITRO protocol stack.
- ***WP2:*** System Requirements and specifications (sensors & communications) per ***Use Case.***



- ***WP3: Seamless Connectivity:*** VITRO will design an innovative, multichannel, flexible MAC solution, able to support VSN functionality through graph-colouring algorithms to minimize transmission collisions and guarantee the predefined hard-delay constraints.
- ***WP3: Energy Efficiency and Operational Reliability:*** VITRO aims at improving energy efficiency by the use of distributed network-channel coding and network coding division multiplexing, heavily tailored to the embedded system deployment.
- ***WP3: Verification through Population Protocol Model:*** A population protocol model will be used to model VSN networks and the interactions, as dictated by the VITRO protocol stack, in a formal yet minimalistic way.

Technical Approach (2)

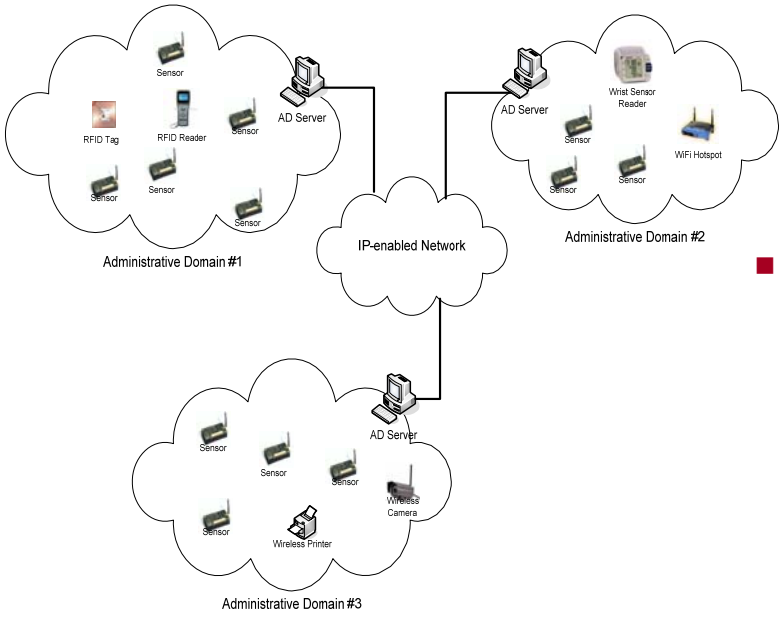
- ***WP4: Trust-Aware Routing Protocol for VSN:*** VITRO will work on open IETF ROLL RPL metrics for development in conjunction with the underlying IEEE 802.15.4e MAC specifications to provide an interoperable, trust-aware management scheme.
- ***WP5: Middleware Support for Dynamic Resource Discovery, Virtualization & Management*:** The VITRO middleware solution will be based on a multi-level approach that implements existing SOA standards on higher tiers, across with the appropriate modifications on the protocol stack, which brings the benefits of SOA to low capacity nodes.



- ***WP6: Interoperability of Multiple VSN's:*** not only to cover cases where one AD borrows resources from smart objects controlled by another AD but also provide engineering methods for direct inter-VSN communication without the need for centralised control. This will enable the development of more intelligent applications combining information gathered through different VSNs.

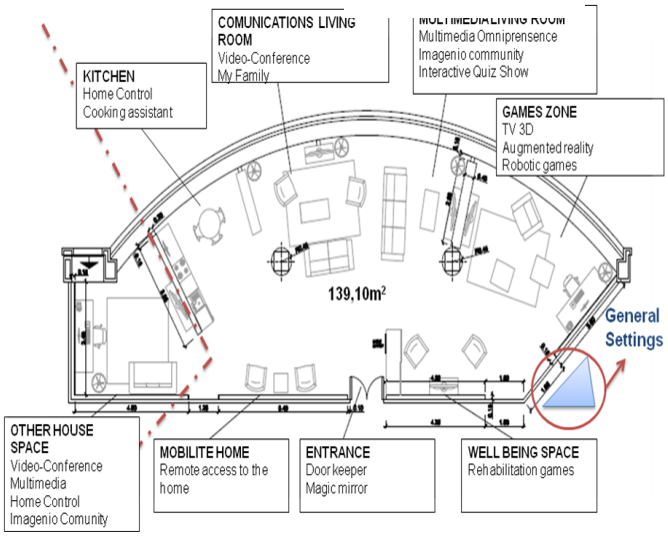
Technical Approach (3)

- ***WP6: A generic test-bed is proposed*** for integration trials: it needs to be explicitly detailed and specified, in terms of a ***single network*** vs a ***federated*** network (WISEBED, SENSLAB, TID, AWISSENET…).



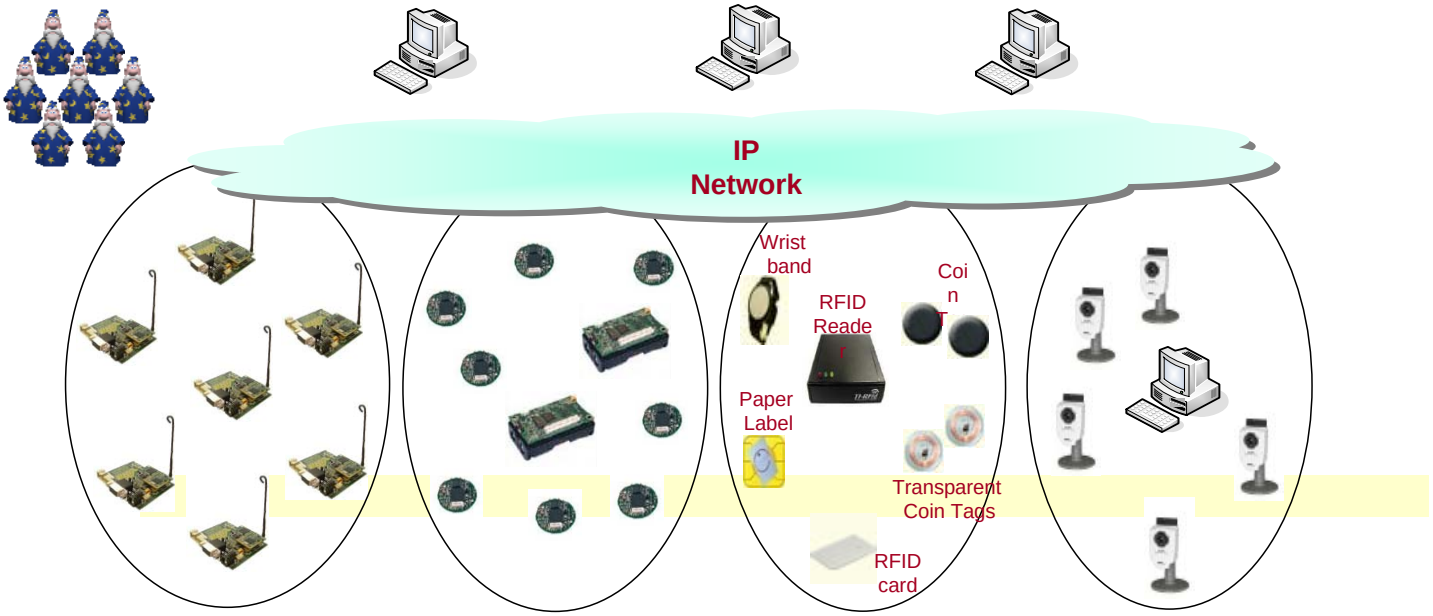
- ***WP6: User-Friendly Configuration, Commissioning, Self-Organization & Maintenance Tools:*** In order to be able to easily adopt the VITRO infrastructure in various WSN environments, both the initial configuration and the real-time reconfiguration of the VITRO nodes will be performed in a user friendly and fully automated way by a specially developed toolset which will take advantage of the developed middleware.
- ***WP6: Reduced Complexity of System Maintenance:*** Federating the above, an ultimate goal of VITRO is to ensure zero-outage, instant-response, green-operational and adaptive systems of lowest possible deployment, maintenance and troubleshooting complexity.

Federation of: TID test-beds



- Multimedia, Home Automation and Energy Management testbed
- Many differet technologies (including Zigbee and ZigBee pro sensors)
- 4 different sites in France

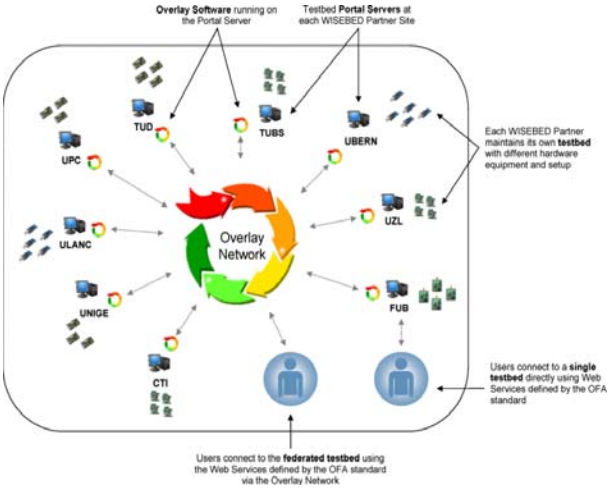
Federation of: AWISSENET Test-bed



- 100 stationary sensor nodes
- 10 multimedia nodes
- 30 RFID nodes

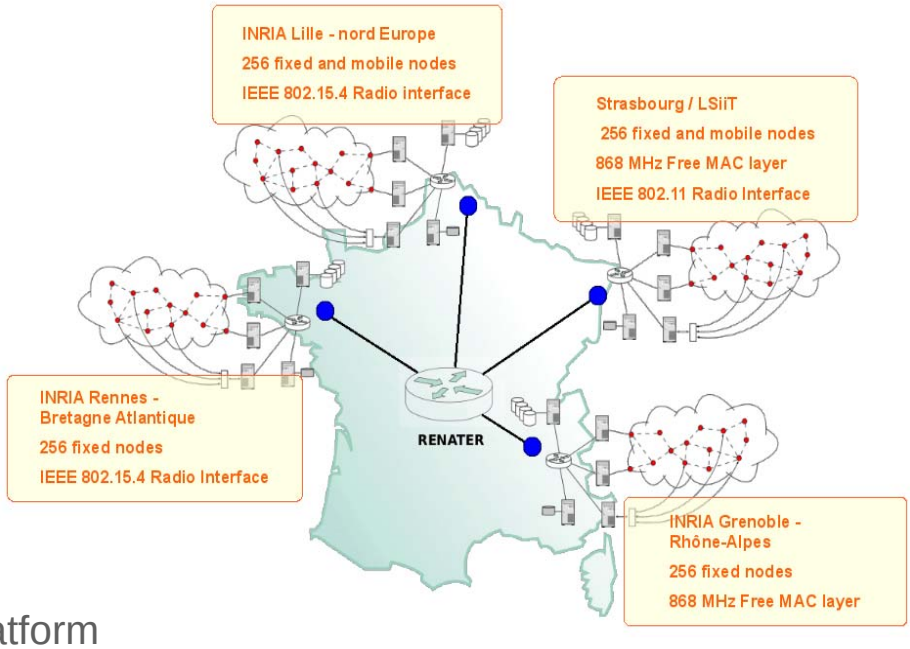
Federation of: WISEBED

- **A federation of independent sensor networks located at 9 locations throughout Europe**
  - **What can be tested?**
- all kinds of protocols, algorithms, middleware, and applications as long as they run on top of the MAC layer
- Those who want to test their own middleware can build on top of the MAC.
  - Those who want to create new algorithms or applications can use our own middleware and/or the library of sensor network algorithms, WISELIB.

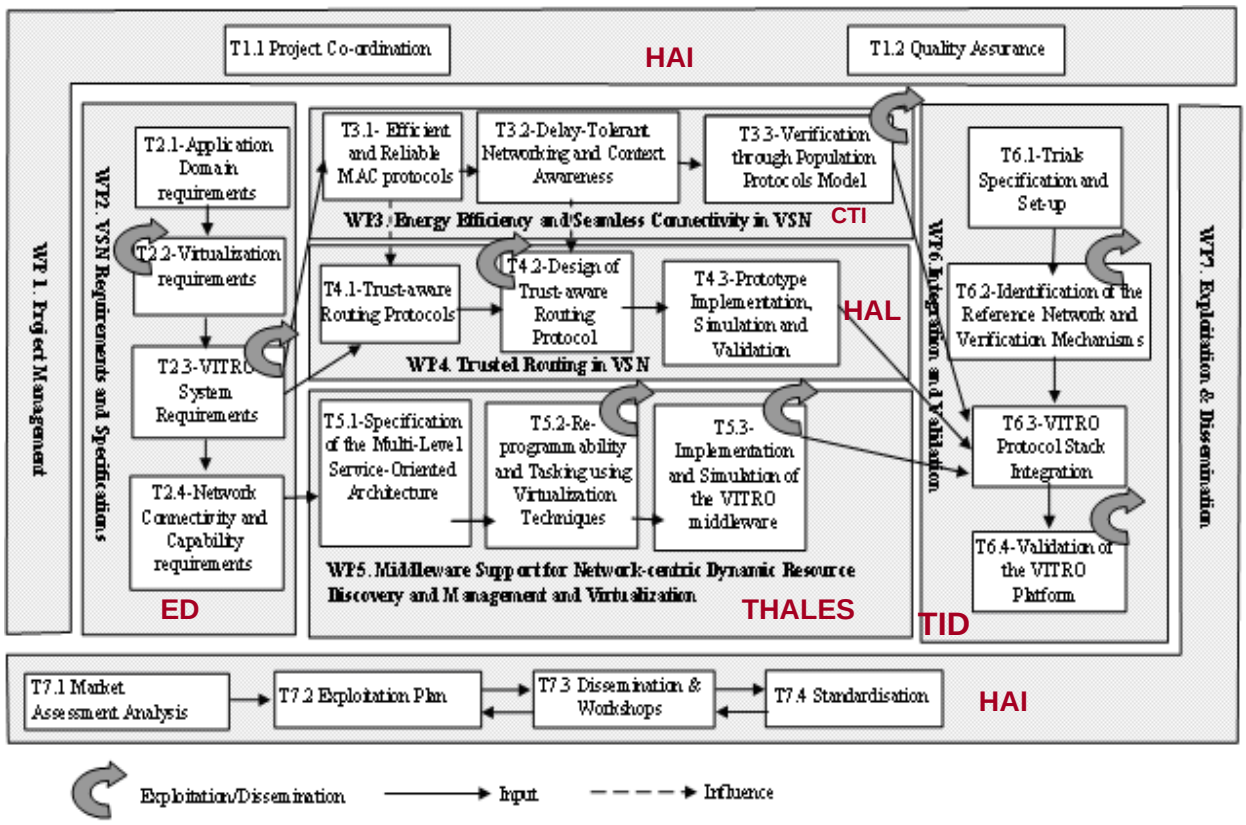


- Approx. 500 stationary sensor nodes (January, 2009)
- Approx. 40 mobile sensor nodes
- Outdoor sensor node deployment
- Wide range of sensor types is available

Federation of: SensLab Testbed

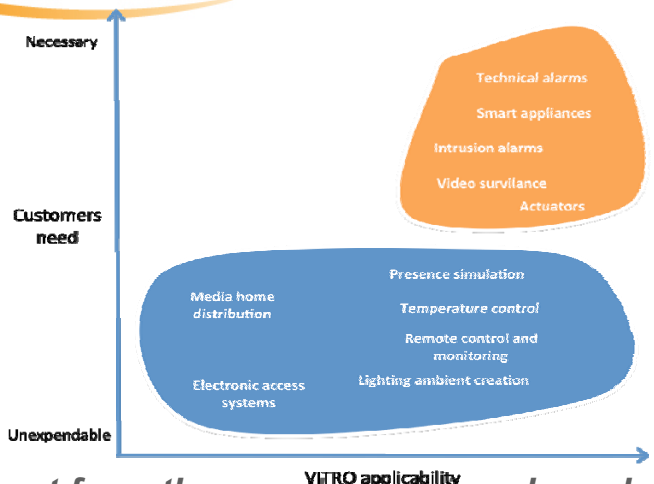


- Distributed WSN platform
  - 1,024 nodes over 4 interconnected sites
  - Wide spectrum of possibilities and heterogeneity
- Open for experiments
- TCF is partner of French national Senslab project



Expected Impact and Applicability

- *VITRO is expected to boost deployment of cooperative, reliable, virtualized smart communicating objects.*
- *The VITRO toolbox will enable user-friendly configuration, self-organization and maintenance of VSN, with low complexity and minimal effort.*
- *VITRO targets everyday applications such as smart homes/appliances, green buildings and integrated industrial control (WSN in industrial platforms and processes, surveillance and resources management)*
- *VITRO increases the diffusion of networks, software and services.*

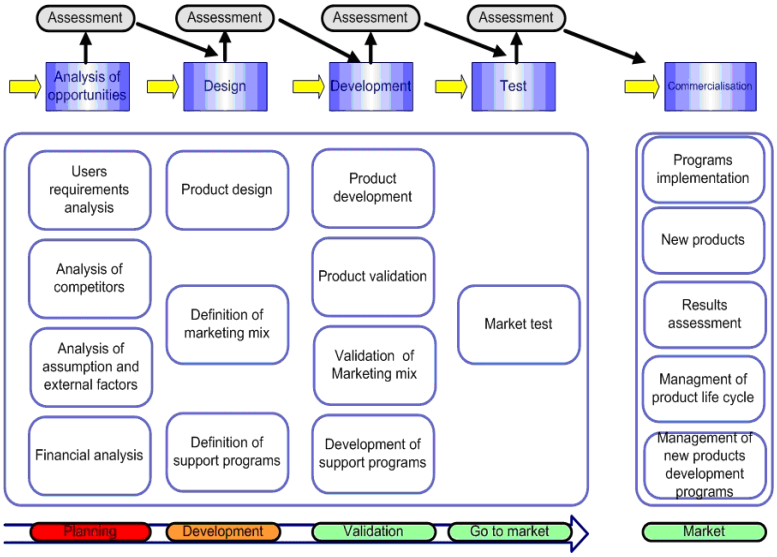


- *Apart from the popular services based on WSNs including outside temperature monitoring, temperature and weather conditions etc. there are advanced services exploiting the IEEE 802.15.4 area based positioning system. Such services include People Tracking Services and Dangerous Zone Alarm services.*
- *Several studies indicate the availability of a great number of applications within this area, which are currently applied not only as prototypes but as working systems.*

Exploitation Strategy

- ***Planning:*** **definition of the market framework and business models to be verified and validated in subsequent project phases. Off-line analysis through WP2-WP7.**

- ***Development:*** **In this phase, the exploitation strategy will be shaped in a form of preliminary business plan. The deployment of exploitation activities will be led in strong connection with the development of the VITRO platforms**



- ***Validation:*** **The final objective of exploitation-validation phase will be to support industrial companies in taking a "go-no go to the market" decision and use it accordingly. The validation of exploitation strategy will pursue the objectives to get immediate feedback from users and customer community.**

- HAI Profile
  - The largest aerospace, defense and security industry in Greece, founded in 1975 and active in military and civilian domains. Main activities include:
  - Development of Command Control systems including situational assessment systems.
  - Development of Dependable networks including wireless sensor networks and protocols.
  - Development of S/W and H/W for embedded systems, including
    - Autonomous and reconfigurable systems
    - Device & Network Security
- HAI: Role in the project
  - Coordinating VITRO, leading WP1 (Management) & WP7 (Exploitation, & Dissemination)
  - Participate at the requirements specification (WP2)
  - Development of trust aware routing protocol solution (WP4)
  - Participation in modeling, simulations, integration and testing, with a variety of (already possessed) sensor boards (WP6)
  - Expanding knowledge/technical skills in selected areas through dissemination /exploitation activities (WP7)
- HAI: Industrial exploitation activities
  - Deployment of communication platforms including wireless sensors and actuators which inter-connect to infrastructure networks
  - Enhancement of developing capabilities in the area of *homeland security* and ***border/coastal surveillance***
  - Heterogeneous sensor platforms for ***integrated industrial control*** (remote buildings and local networks' management)

No	Participant Name	Type	Country	Area of Activity/Expertise	Role in VITRO
1	HAI	Industry	Greece	•Embedded systems •Security systems •Sensors, data and systems integration •Testing, validation, qualification •RF design	•Project Management •Software Modelling •System integration, validation and optimization •WP1 and WP7 leader
2	THA	Industry	France	• Security Systems •WSN-SOA architectures •Middleware solution •Wireless Networking issues	•Lead WP5 effort •Provide innovative middleware solutions for WSN networks. •Active participation on system integration and validation
3	TID	Industry	Spain	•R&D arm of Telefónica, the leading telecom operator (193+ million customers) •R&D into the future of telecommunications, technologies and network innovation. •Services creation, related to the broadband intelligent networks and data communications.	•Study, design and implementation of middleware for network-centric resource discovery and management •Lead the Integration and trials validation (WP6) •Integrate the designed VITRO platform •Fine-tuning of toolkit and applications •Validate the service and user experience with real users.
4	CTTC	Research Institute	Spain	•embedded systems; wireless sensor networks •cooperative MIMO •low-power MAC •energy-optimized routing •cross-layer design; system optimization and synthesis	•network coded techniques for stable and reliable networking operations •enhancement of low-power MAC families based on .15.4e •ETX tuning and extension of RPL routing protocol •unprecedented cross-layer design for true end-to-end connectivity
5	CTI	Research Institute	Greece	•Middleware for sensor networks •Network control algorithms •Performance analysis •Modelling •Experimental evaluation	•Delay-tolerant communication mechanisms •Reliable protocols for seamless connectivity •Verification of VITRO protocols •Experimental evaluation using real hardware •WP3 Leader
6	TEIHAL	Research Institute	Greece	•Mobile/Wireless and Sensor Communications •Cross-layer design •Development of middleware	•Study virtualization requirements and propose an innovative solution •Extend RPL routing protocol through novel trust-aware and virtualization algorithms •Leader of WP4
7	ZNET	SME	France	•Sensors and actuators design and development •IP Platforms for WSAN interconnection •Middleware development	•Contribute to the user needs specifications •Provide several devices to be included in the test-bed •Develop middleware solutions for VITRO
8	WLAB	SME	Italy	•Wireless technologies prototyping •Pervasive and mobile computing	•VITRO use case requirements •Software modelling •Contribute to MAC protocol design and development
9	ED	Industry	Italy	•Design and production of systems, services and solutions in automation, security, transport, defence & space, and information technology	•Lead the WP2 related to the VSN Requirements and Specifications. •Design and implement solutions on Seamless Connectivity issue. •Contribute on design and implementation effort on network layer protocol.