FP6 – INTEGRAL – Integrated ICT framework for Distribution Network with Decentralized Energy Resources: Prototype, Design and Development
Self Healing ADA function

CAIRE Raphaël – RAISON Bertrand – LE Thanh Luong – LABONNE Antoine – TOURE Selle – THERMOZ-LIAUDY Damien – BRACONNIER Thierry – HAMM Philippe – BJORN Sthal – BACHA Seddik – VALEY Gilles – RICHARDOT Olivier – HACHANI Mohamed – VIALLE Julien – BLACHE Francois – DUMONT Raphael – DAVOINE Jacques – VALLA Gaylord – GUSTAVSSON Rune – HADJSAID Nouredine

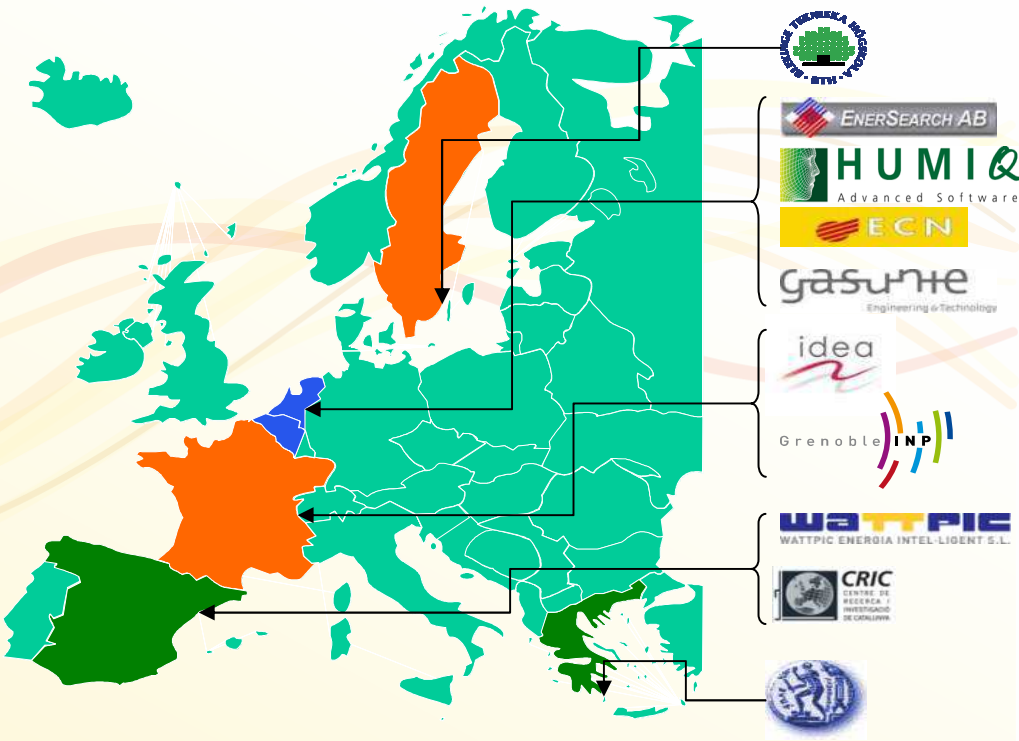
Call ID: FP6-2005-TREN-4
IEA workshop Oosterbeek, 25 April, the Netherlands

INTEGRAL European project

The INTEGRAL project aims to **build** and **demonstrate** an industry-quality reference solution for **DER aggregation-level control and coordination**, based on commonly available ICT components, standards, and platforms for every actors (DER owners, grid operators, etc…) of the Smart Grids.

→ Define **Integrated Distributed Control** as a unified and overarching concept for coordination and control for large-scale DER/RES aggregations and grid components **(all actors)**: **Bottom-Up approach (MAS)**

→ Show how this can be realized by **common industrial**, **cost-effective** and **standardized**, **state-of-the-art ICT platform solutions**



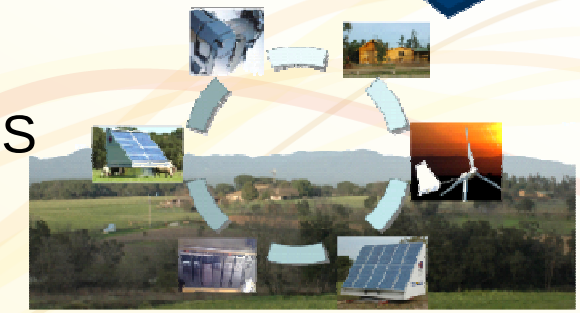
Call ID: FP6-2005-TREN-4
Integrated ICT-platform based Distributed Control (IIDC) in electricity grids with a large share of Distributed Energy Resources and Renewable Energy Sources

INTEGRAL European project

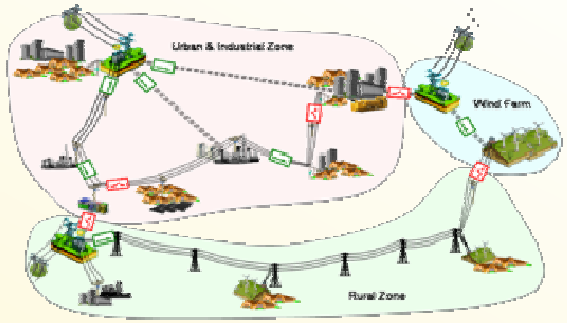
Demonstrate its practical validity via **three field demonstrations** covering the full range of **different operating conditions** including:

→ **normal operating conditions** of DER/RES aggregations, showing their potential to reduce grid power imbalances, optimize local power and energy management, minimize cost etc.

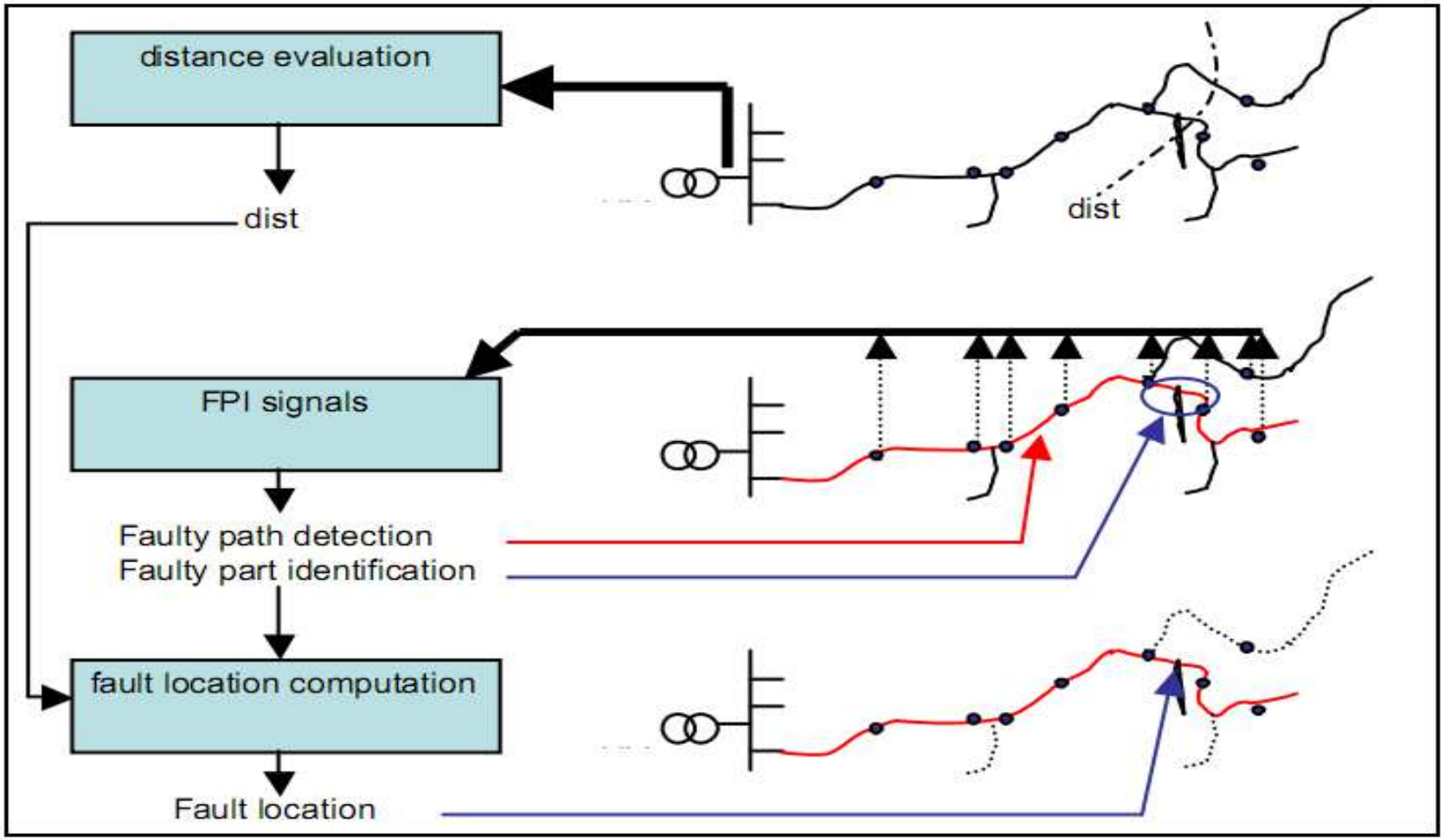
→ **critical operating conditions** of LV DER/RES aggregations MICROGRID, showing how DER can help for stability when grid-integrated.



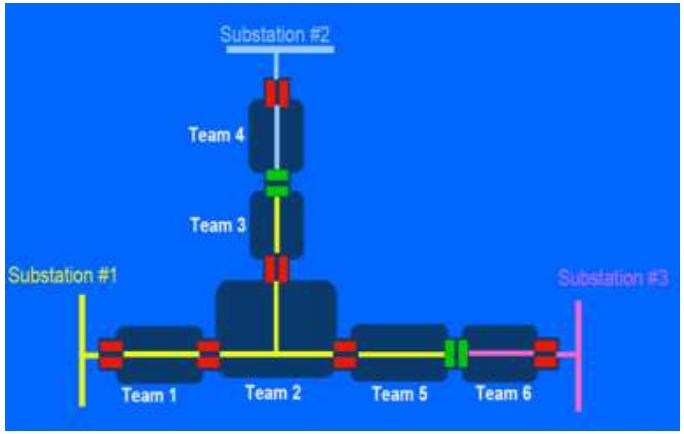
→ **emergency operating conditions**, showing **self-healing capabilities** of the grid components (**FLIR**) relying on DER/RES aggregations in case of congestion management.



Self Healing Functionalities



Embedded intelligence for self-healing function



Intelliteam (S&C)

Centralised
More than 100 substation operated

Demo C

Décentralised

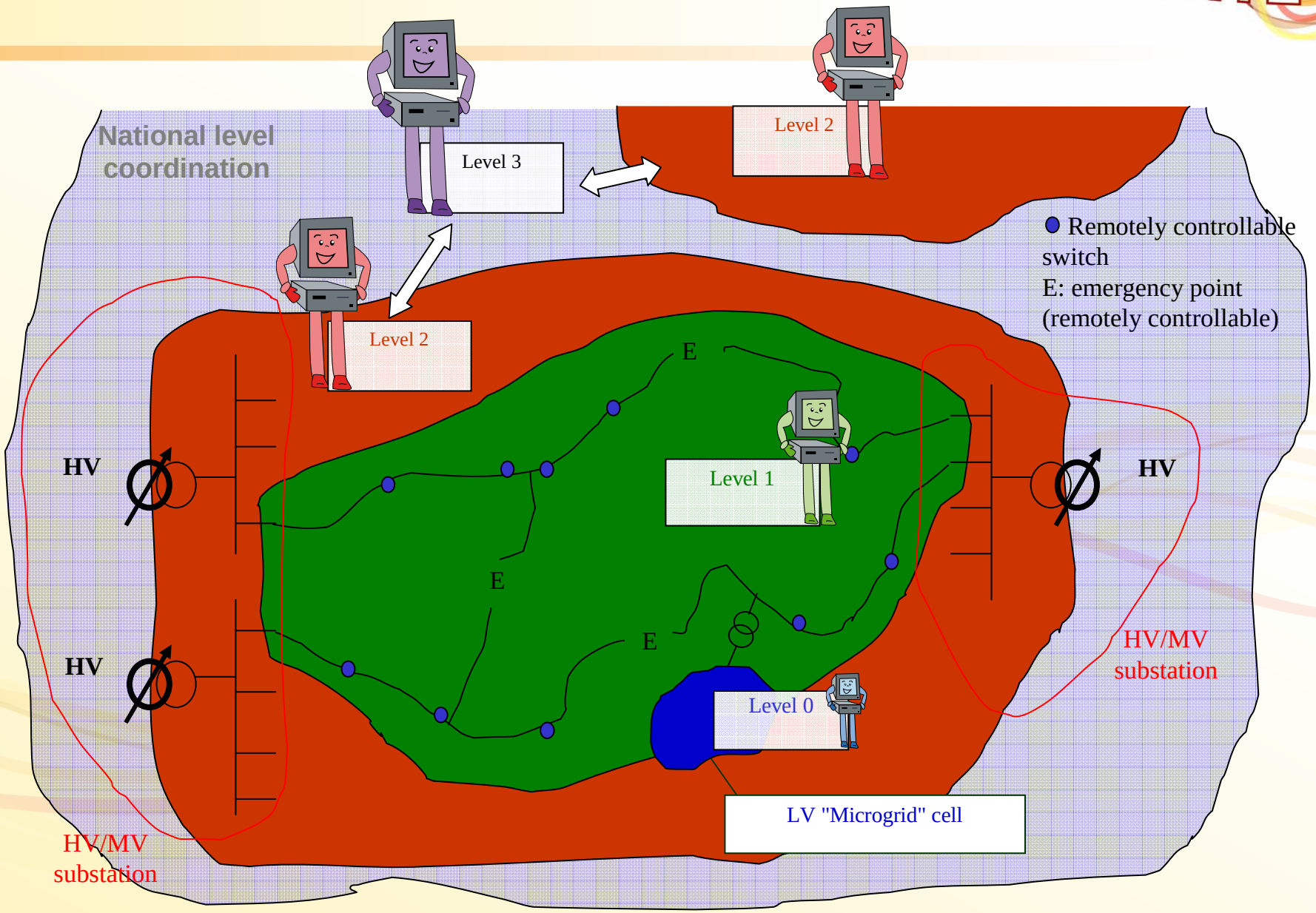
Centralised

Over 100 substations

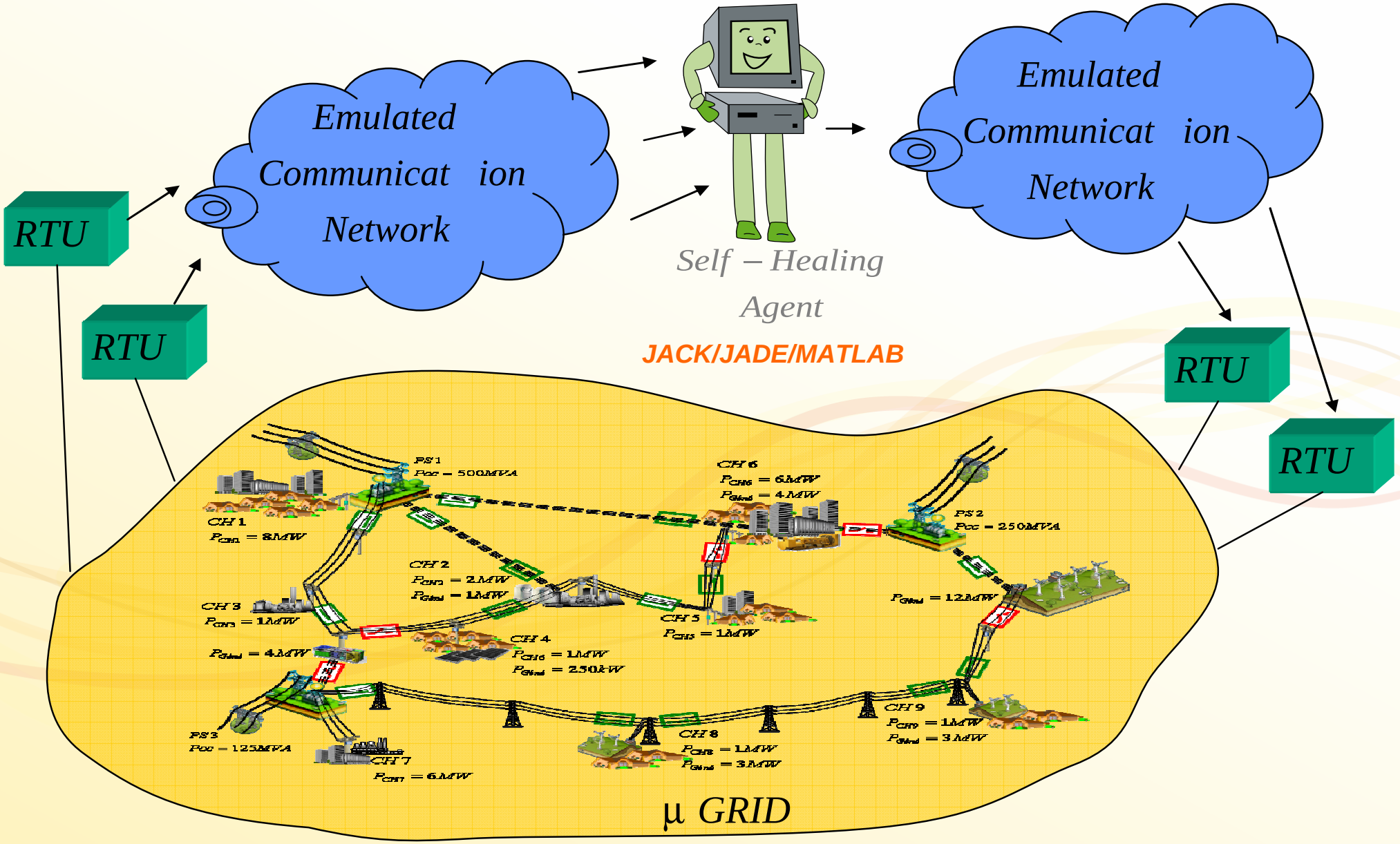
Geographic sizing taking into account electrotechnical constraints → Cell level 1

Completely decentralized

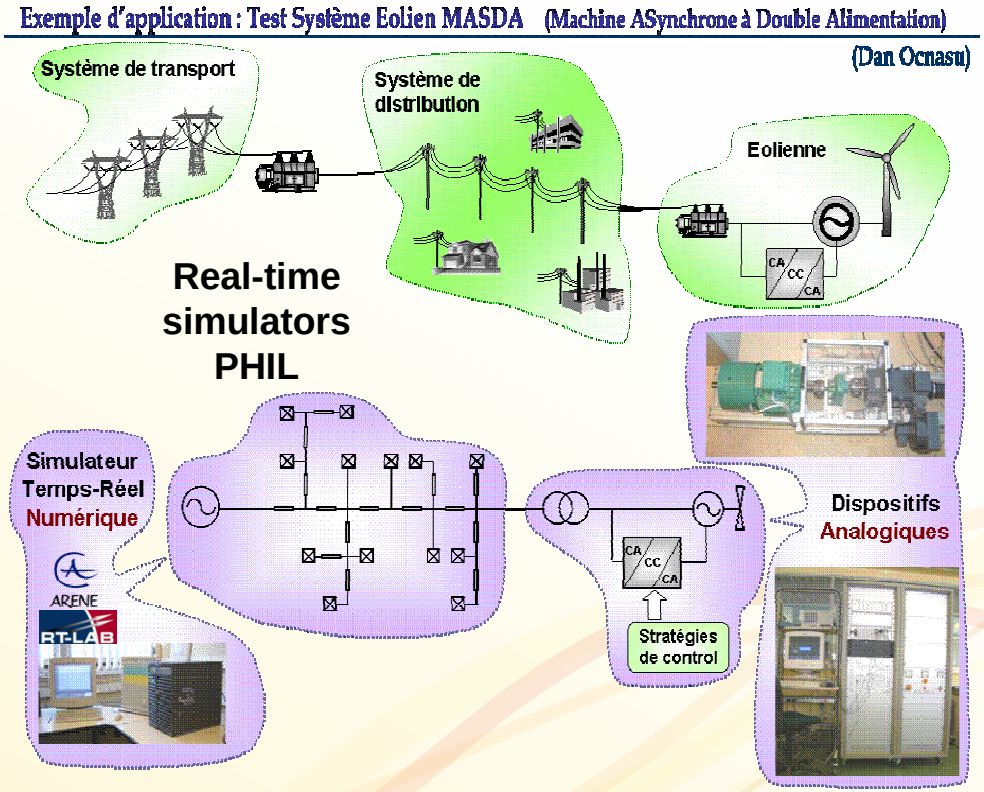
Multi-cell grid definition



Demonstration principle



PREDIS research center real time simulator



MGE UPS SYSTEMS

Schneider Electric

ENSE^3 : Masters Electric energy engineering
Energy systems and markets

idea

EDF

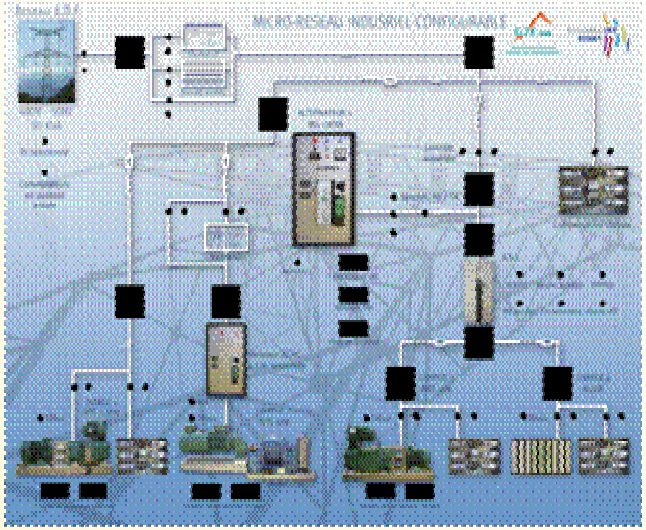
AREVA

Some research topics:

- Wind and hydro turbines control systems – variable speed
- DG connection to the grid - interface
- Enery quality

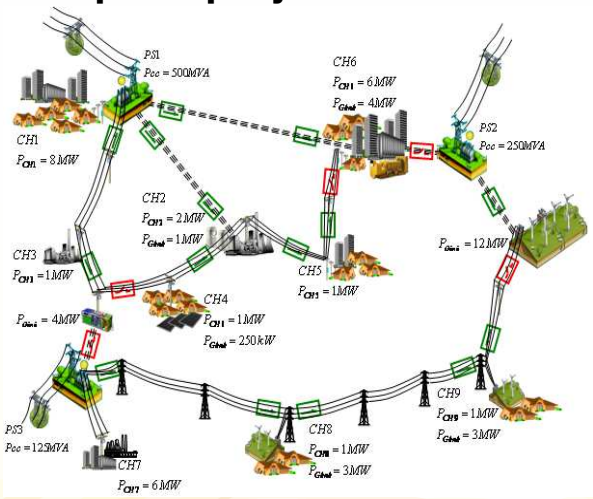
PREDIS research center power hardware in the loop

PREDIS research center analogical networks



Industry type network - Assigned power 200 kVA – scale ratio 1/10ème

European project INTEGRAL



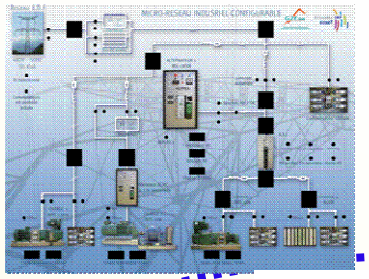
Distribution network
Assigned power 30 MW – scale ratio 1/1000

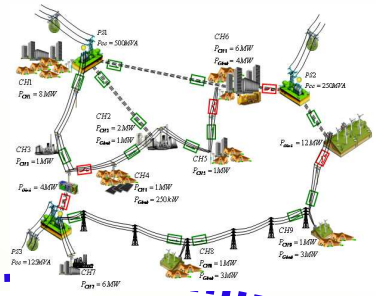
ENSE³ : Master Electric energy engineering

Some research topics:

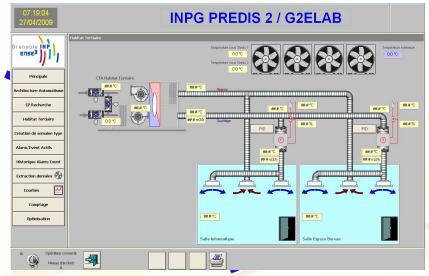
- **Renewable energy insertion (Virtual Power Plant, Volt Var Control, self-healing,…)**
- **Protections, instability, reconfiguration and reliability of flexible networks**

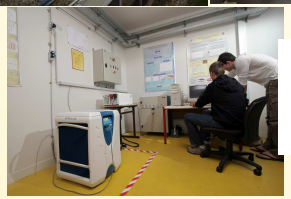
Test bench within the PREDIS center



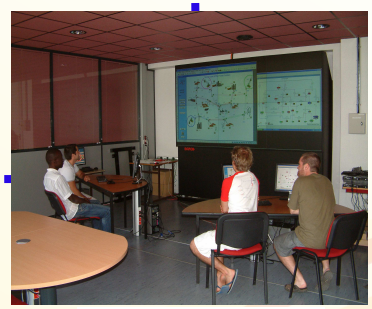


μ networks





Embedded generator



Control center

Smart Buildings

Pilotage et simulation temps réel hybrique

Electric Vehicules

Integrated ICT framework for Distribution Network with Decentralized Energy Resources: Prototype, Design and Development

Results

Scenarios to be tested

Use case1: Fast fault detection and isolation (location robustness)

Use case 2: Fast fault detection and isolation (fault type)

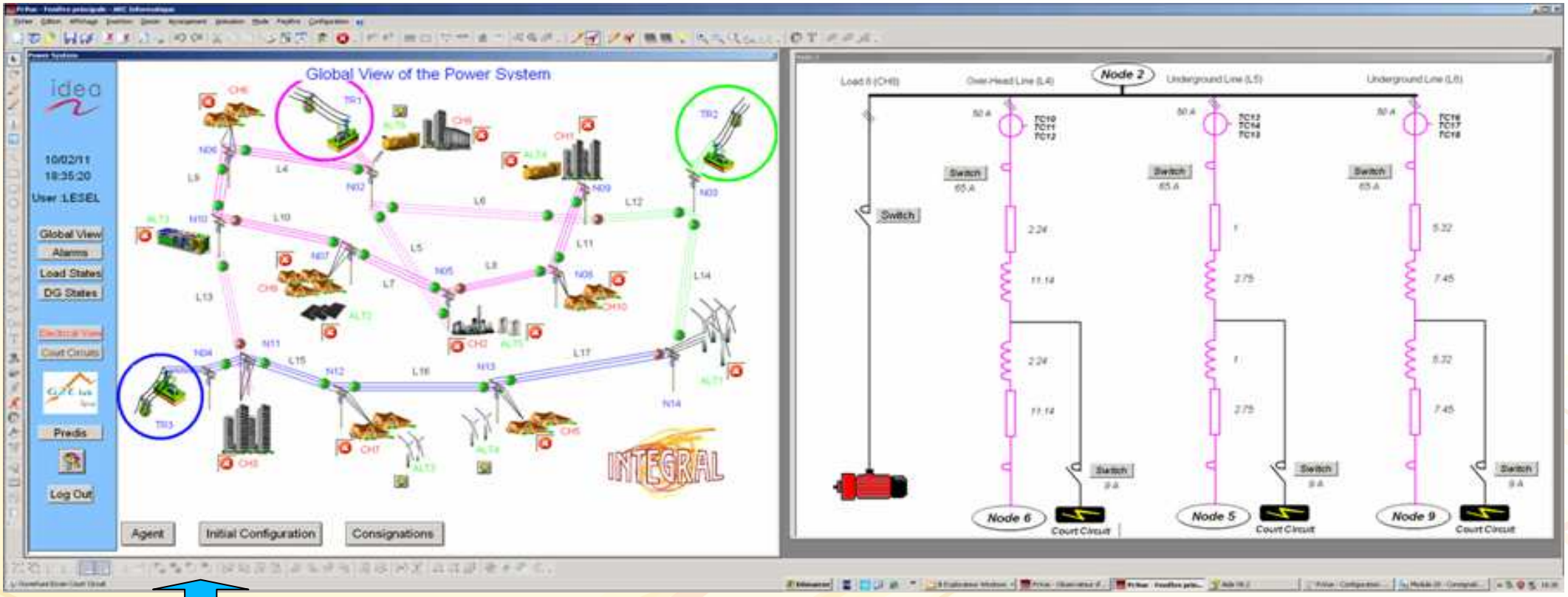
Use case 3: Fast fault detection and isolation in respect with the grounding of the substation

Use case 4: Fast service restoration processes and communication performances

Use case 5: Fast fault detection and isolation depending on the power flow inside the Distribution Network

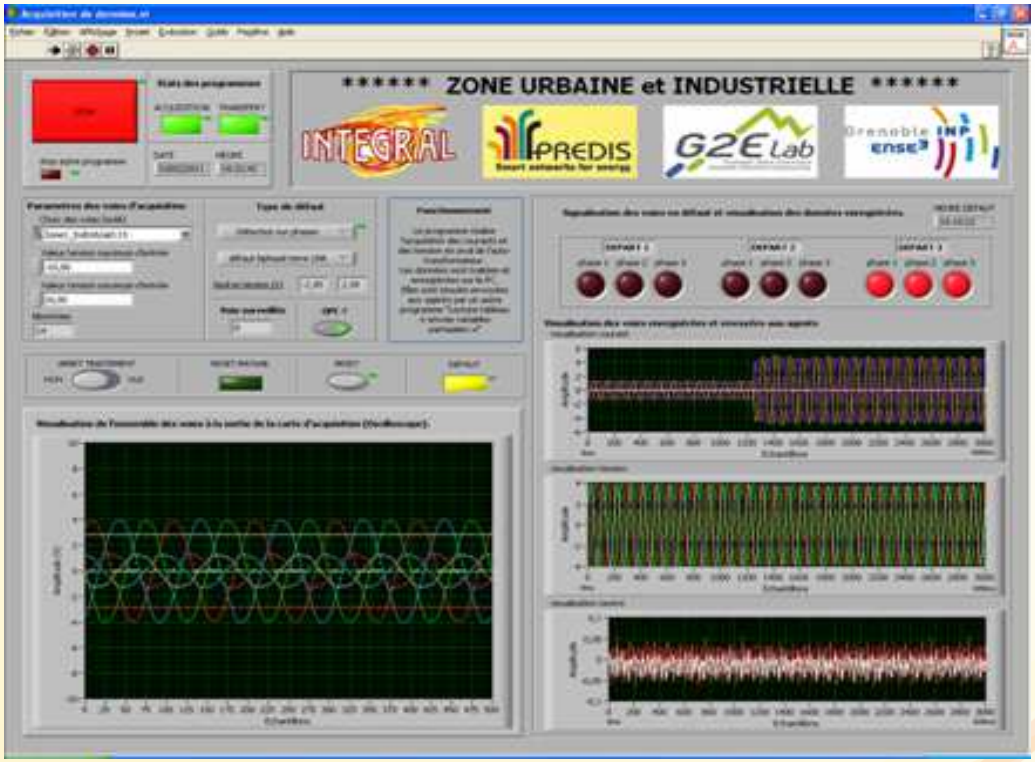
Use case 6: Fast fault detection and isolation depending on the Initial configuration

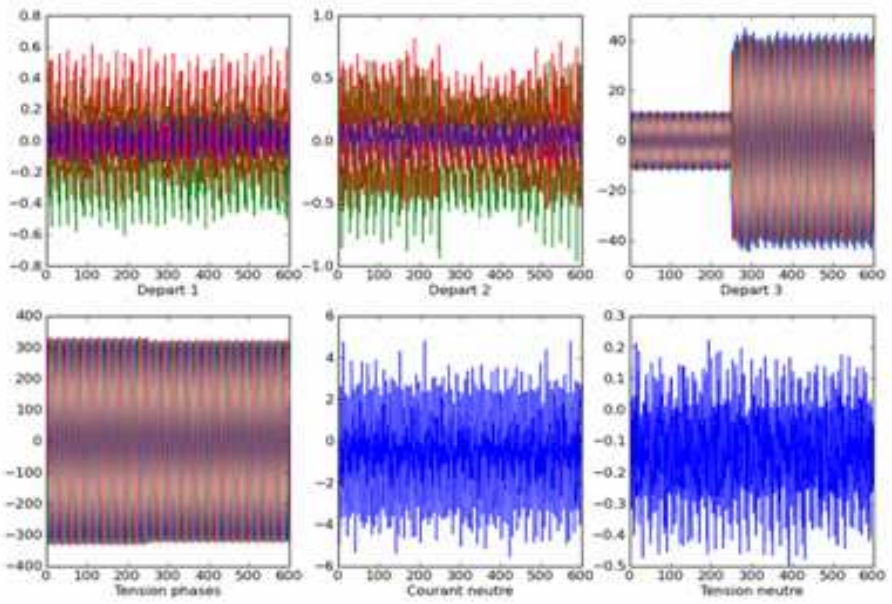
Latest developments – fault ignition



- **High level SCADA to control PREDIS µ network** (DSO/INTEGRAL operator)
  - **Load and sources (S5)**
  - **Topology and grounding (S2-6)**
  - **Faults (three-two-single phase [to ground] fault) (S1-2)**

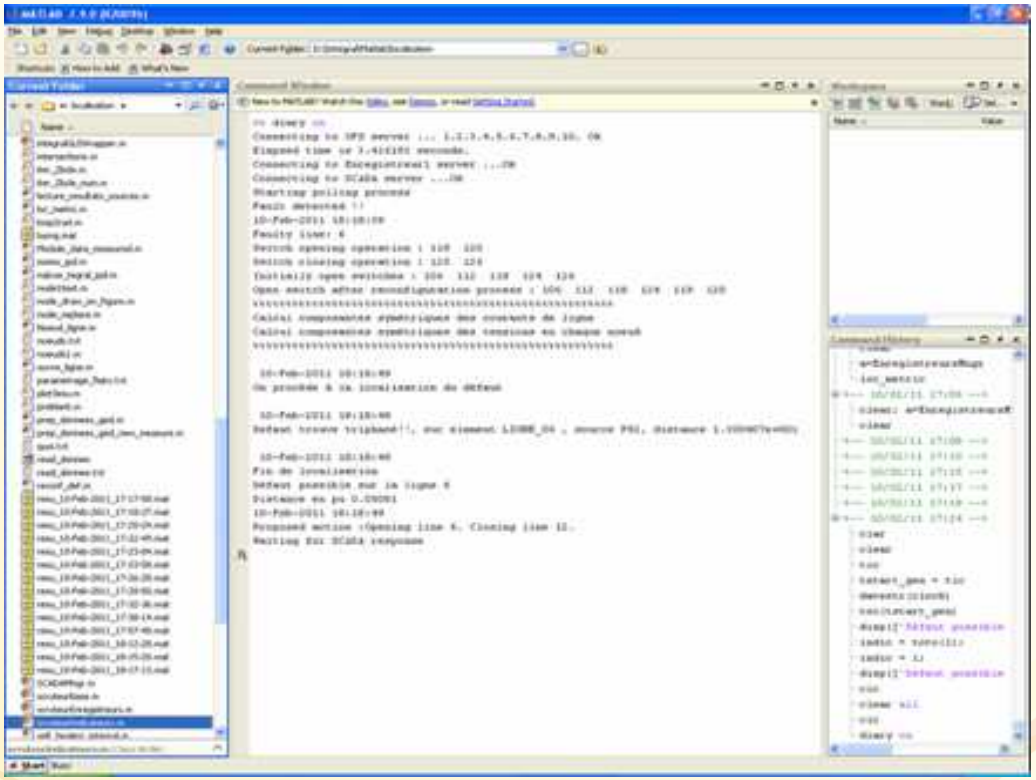
Latest developments – fault recorder

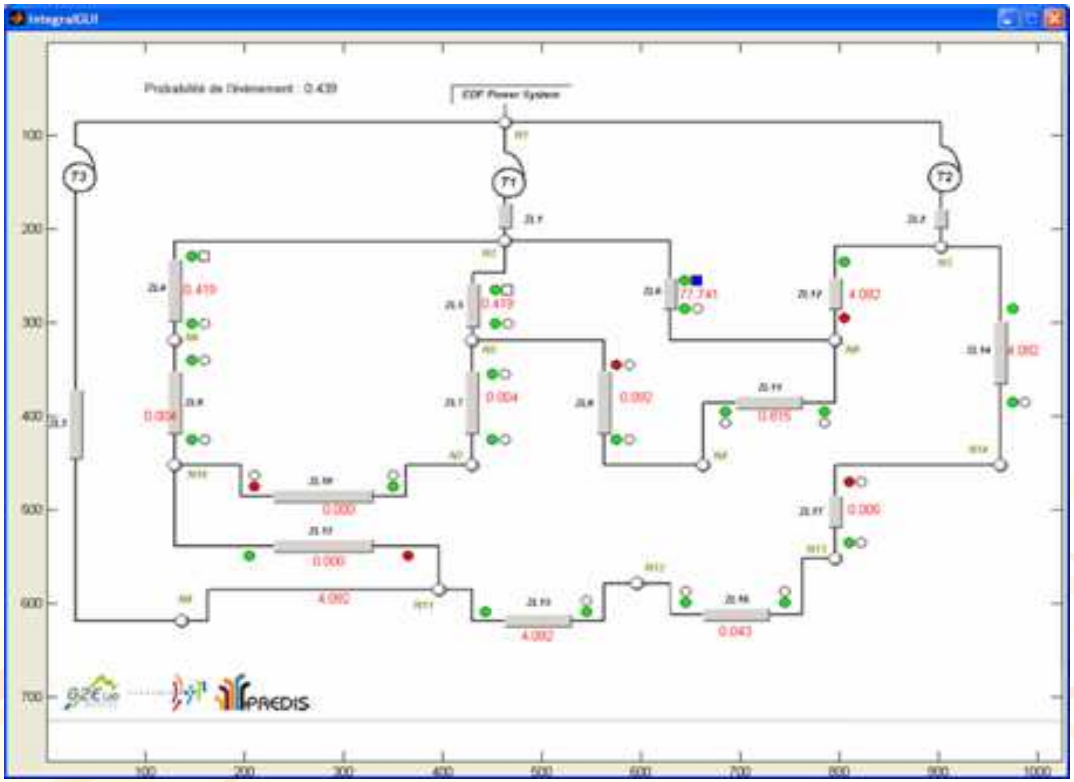




- **The fault is recorded in real time in Labview**
  - **Fault detection**
  - **500 ms recording**
  - **ability to propose the data to the agent with OPC server**

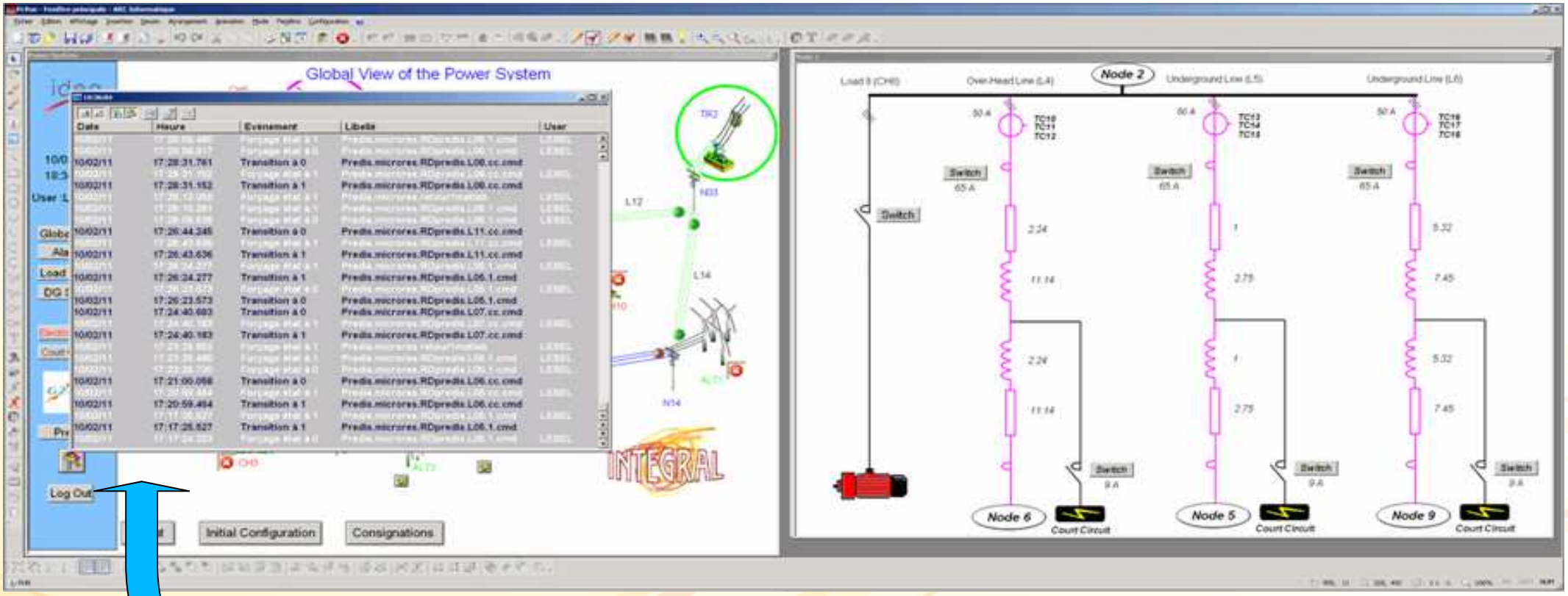
Latest developments – Agent





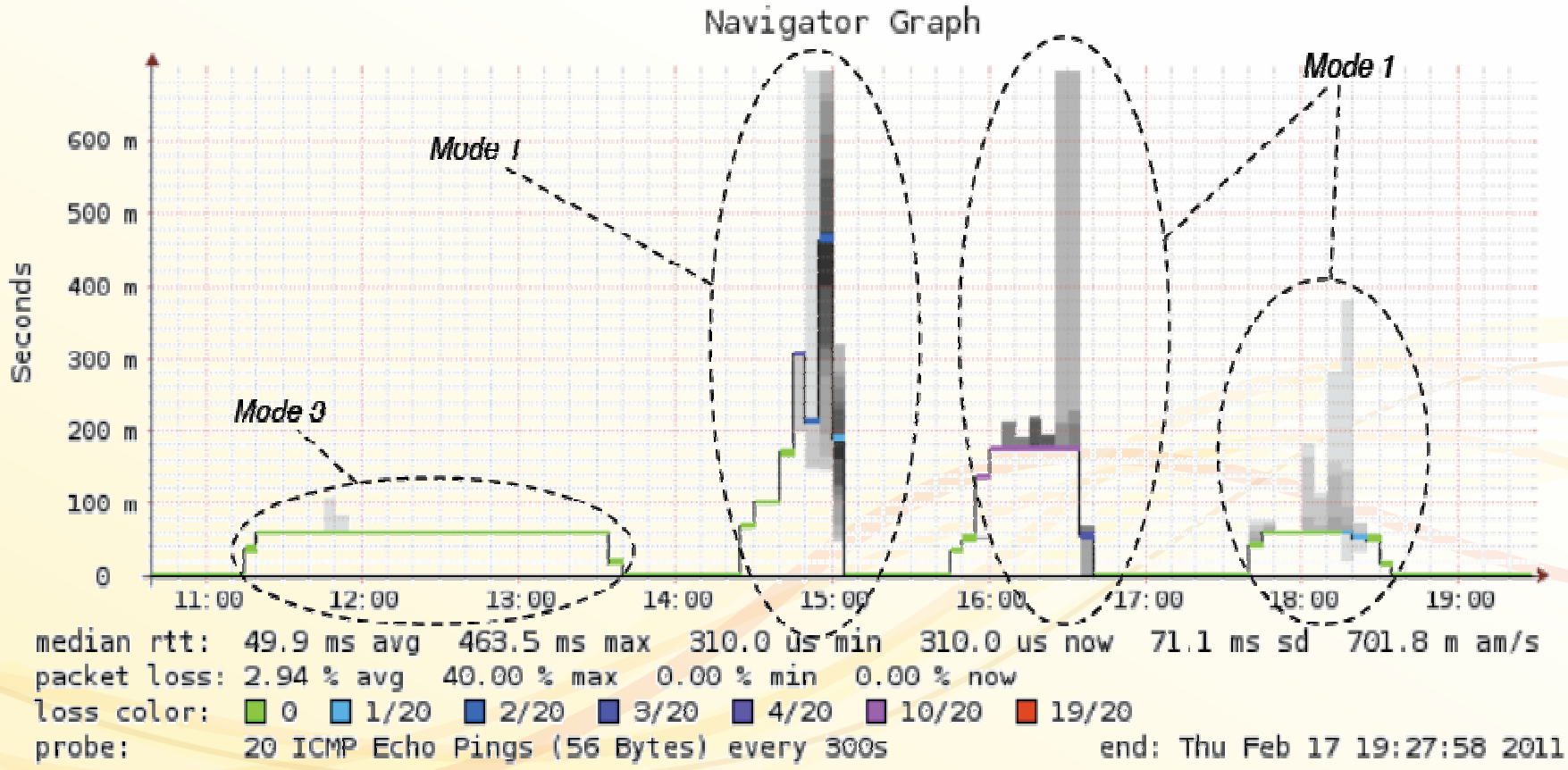
- **The agent detect the fault thanks to FPI and FR detection ability**
  - **Fault detection @ 18:18:39**
  - **Wait 4 seconds for RTU sync.**
  - **Gives the proposition to the SCADA @ 18:18:49**

Latest developments – SCADA



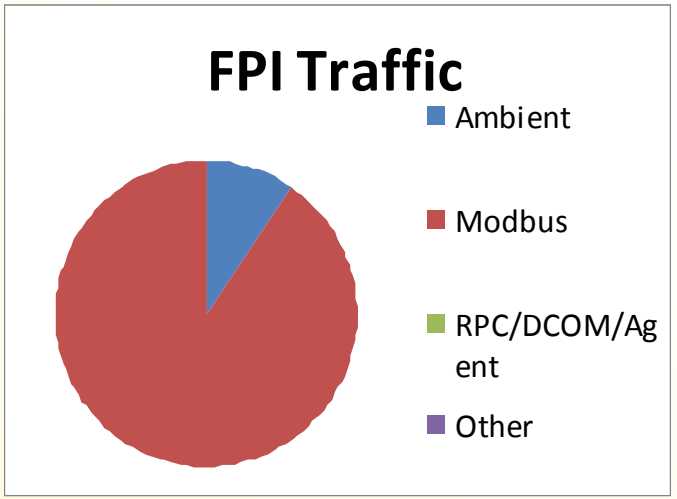
➢**The SCADA record the actions of the DSO operator and accept or not the reconfiguration proposition of the Agent**

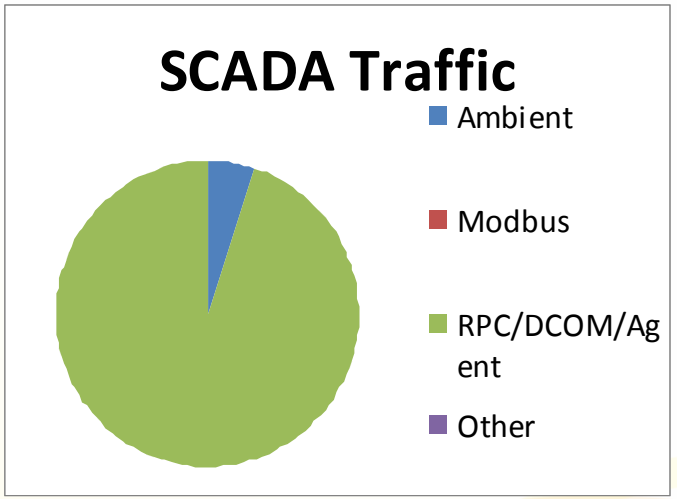
Latest developments – ICT emulation

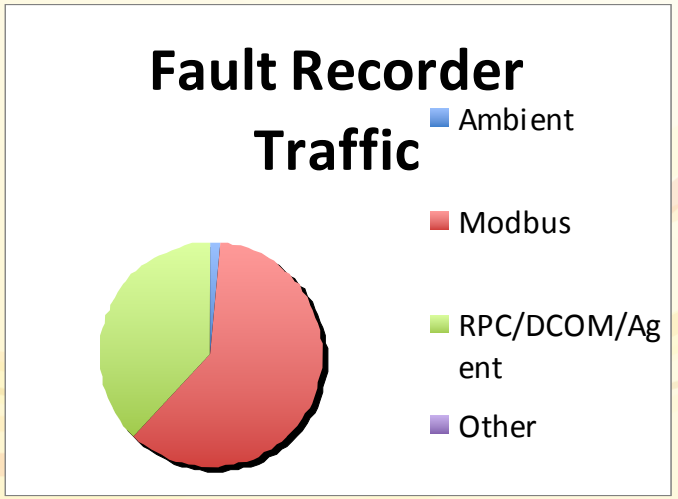


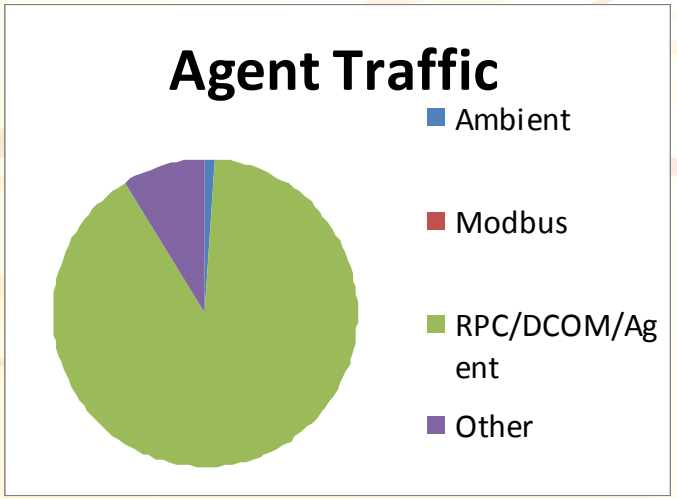
➢**The 4 nodes record data and allow the INTEGRAL operator to change communication performances (Scenario 4)**

Latest developments – ICT emulation latest results – protocol evaluation









- **Data stored in the nodes allow to check the protocols usage of the different VLAN bandwidth → sizing !!!**

Exemple of result table

Communication Performance			Faulty line L11		Fault type: two phase to ground					
	Node1		Node2		Node3		Node4		duration	Success
Test	setup	plr	setup	plr	setup	plr	setup	plr	Sec.	OK @ 59,1%
A01	0%	0%	0%	0%	0%	0%	0%	0%	8,8s	OK @ 59,1%
B02	0%	0%	0%	0%	1%	5%	0%	0%	10,67s	OK @ 59,1%
B03	0%	0%	0%	0%	2%	6,5-10%	0%	0%	16,64s	OK @ 59,1%
B04	0%	0%	0%	0%	3%	10,5-12%	0%	0%	23,52s	OK @ 59,1%
B05	0%	0%	0%	0%	4%	10,5-12%	0%	0%	32,7s	OK @ 59,1%
B06	0%	0%	0%	0%	5%	18-20%	0%	0%	36,94s	OK @ 59,1%
B07	0%	0%	0%	0%	6%	20,5-24%	0%	0%		NO

Integrated ICT framework for Distribution Network with Decentralized Energy Resources: Prototype, Design and Development

Conclusions and perspectives

Conclusions

Transition to **Smart Grids** while accommodating large amount of DER and keeping the desired level of quality and reliability **require investigations on decentralized operation** as well as on **adaptive architectures**.

Cell definition (with geographic definition has been achieved).

Our test bench is intended to validate the **MAS concepts** and to size correctly the needs in term of **communication and computerization performances**.

Master 2 Master protocols are mandatory for self healing function for instance.

Multi point fault location (coupled with FPI) better than single point.

Services Oriented Infrastructure with Service Layer Agreement was highlighted, for different ADA distributed functions.

Perspectives

New components will be added in the following demonstration development such as:

- **communicating protective relays** with fault recorder build in
- numerical substation control command emulator (PCCN/61850) with different PC/API communicating trough different links and managing the protection, the OLTC, the capacitor bank, etc…

ModBus Communication semantic replaced with real **61850 standards** (& CIM)

AMI for emulated MV/LV substation and Demand Side Integration will be implemented for grid services (and State Estimation purpose).

Others **D-ADA functions** (MAS) will be tested such as **VVC** coupled with **reconfiguration**, **distributed state estimation**, etc…

Integrated ICT framework for Distribution Network with Decentralized Energy Resources: Prototype, Design and Development

CAIRE Raphaël – RAISON Bertrand – LE Thanh Luong – LABONNE Antoine – TOURE Selle – THERMOZ-LIAUDY Damien – BRACONNIER Thierry – HAMM Philippe – BJORN Sthal – BACHA Seddik – VALEY Gilles – RICHARDOT Olivier – HACHANI Mohamed – VIALLE Julien – BLACHE Francois – DUMONT Raphael – DAVOINE Jacques – VALLA Gaylord – GUSTAVSSON Rune – HADJSAID Nouredine

Thank you for your kind attention!

Any questions?

More information :

http://www.integral-eu.com/