

FROM RESEARCH TO INDUSTRY

cea tech



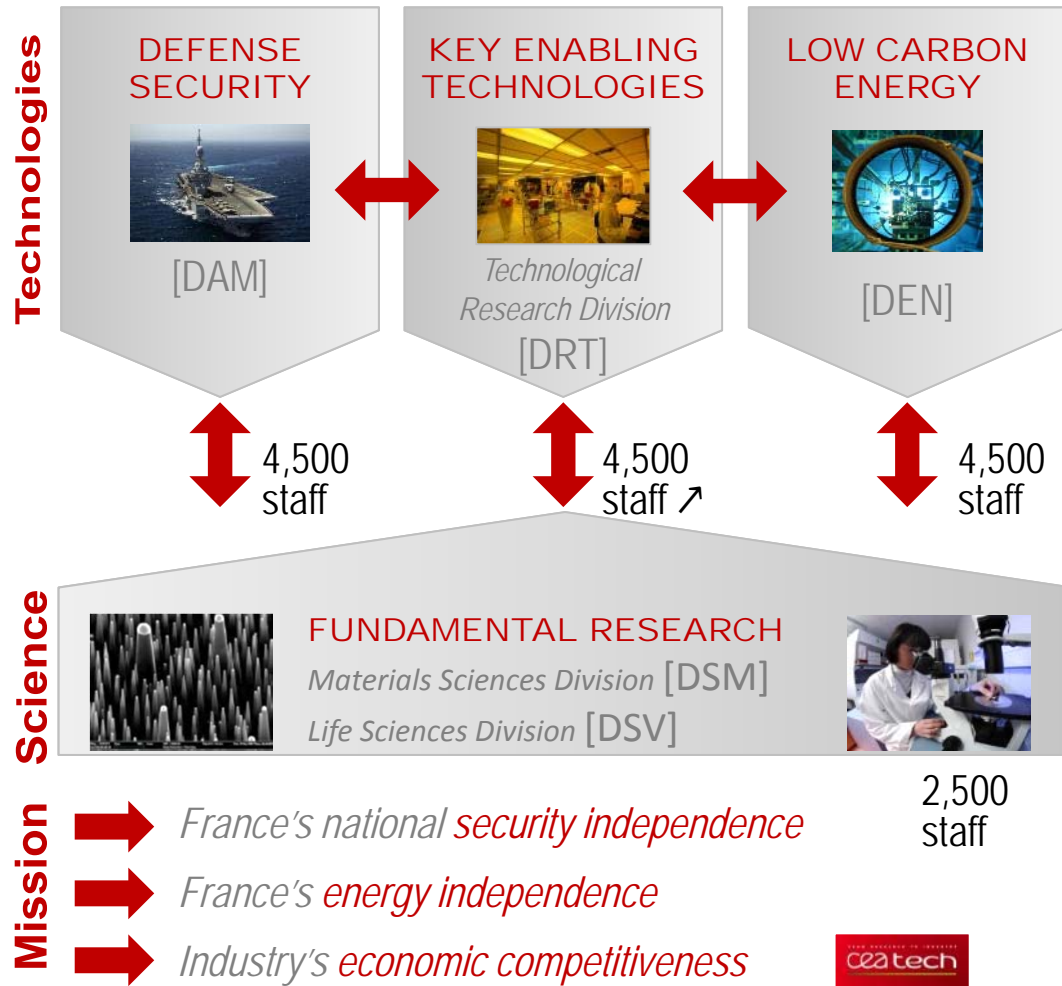
Your innovation partner for the digital transition



list



ALTERNATIVE ENERGIES AND ATOMIC ENERGY COMMISSION



- 16,000 staff
- 10 research centers
- €4,3 B budget
- 4,800 scientific publications
- 5,600 patent families in portfolio (2014)
- 750 priority patents delivered /year
- 115 innovative high-tech start-ups since 2000
- >500 direct R&D partnerships with industrial companies

3 ACTIVITY FIELDS | 3 INSTITUTES

leti

1967 - Grenoble

Laboratoire d'Electronique et des Technologies
de l'Information — **1800 people**



MICRONANOTECHNOLOGIES &
SYSTEMS INTEGRATION

liten

2005 - Grenoble / Chambéry

Laboratoire d'Innovation pour
les Technologies des Energies nouvelles
et les Nanomatériaux — **1100 people**



NEW ENERGY TECHNOLOGIES
/ NANOMATERIALS



list

2003 - Paris Sud

Laboratoire d'Intégration des Systèmes
et des Technologies — **700 people**



SMART DIGITAL SYSTEMS

SMART DIGITAL SYSTEMS



At the heart of
Campus Paris-Saclay



> **€80 M** annual operating budget

- **75%** external funding

710 employees

- 500 permanents
- >150 doctorants/post-doc

14 high-tech start-ups created

420 priority patents portfolio

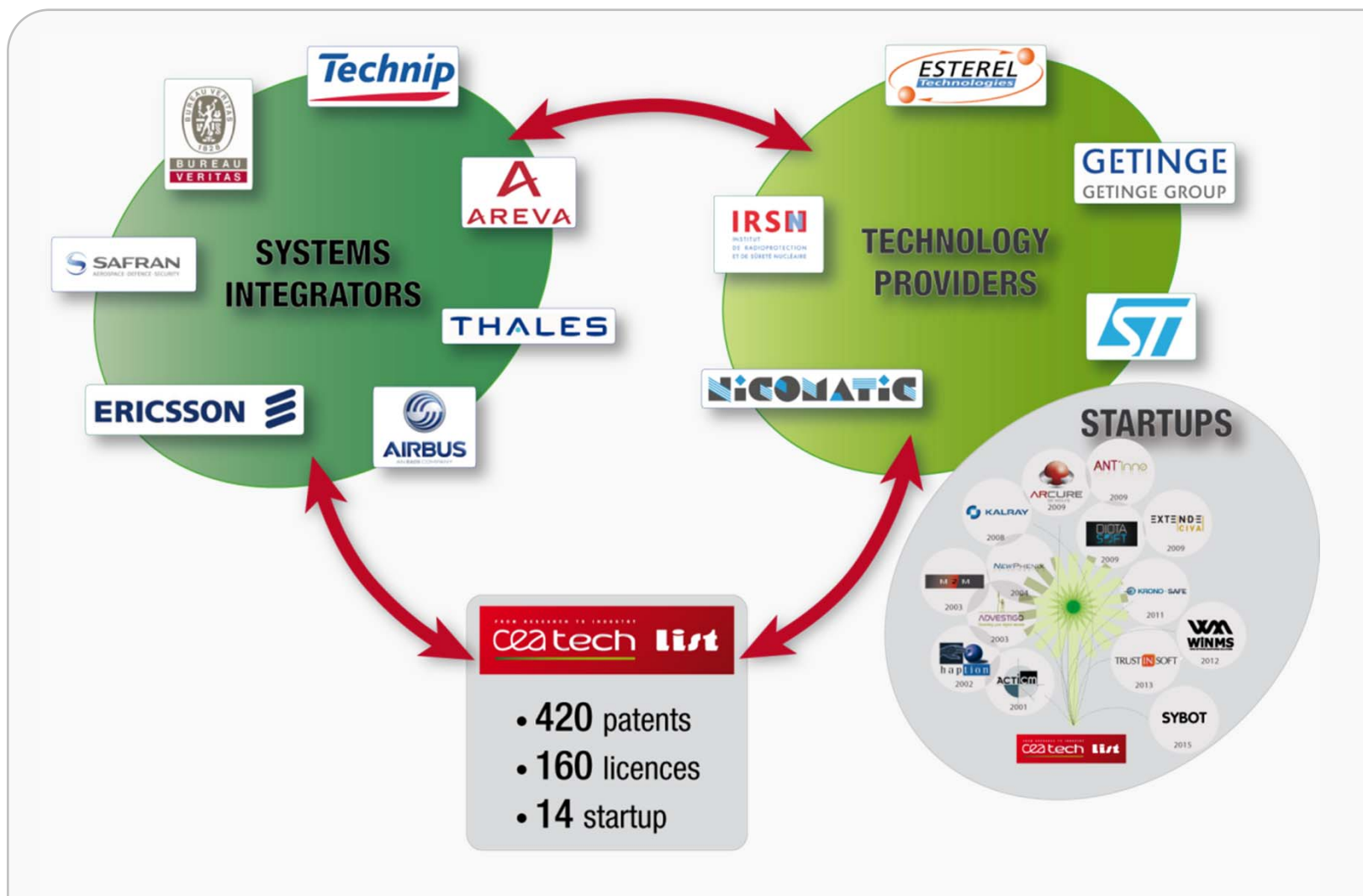
- 65 applications/year

160 active licences

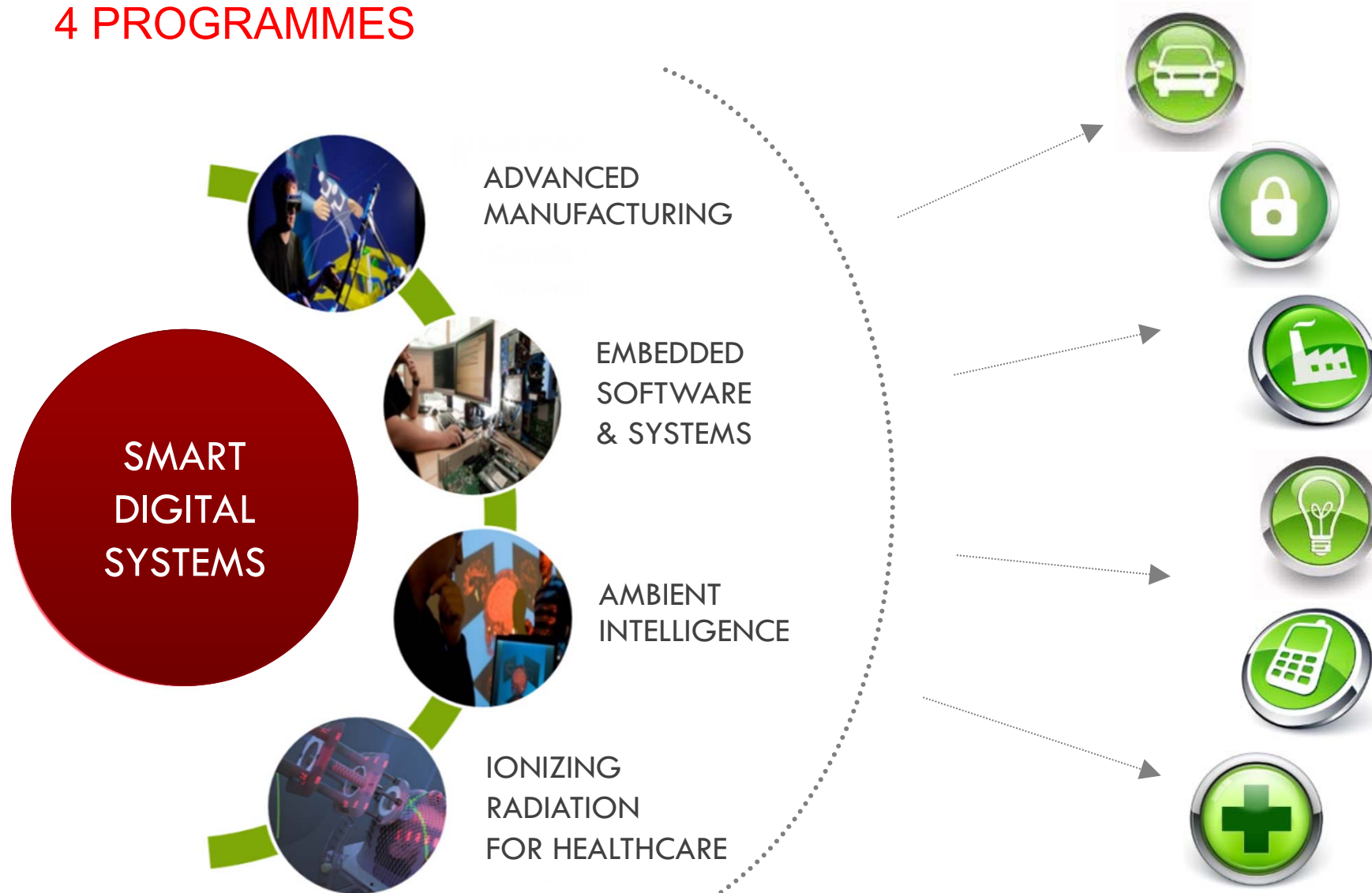
100 customers

- CAC 40 and SBF 120 (50%)
- SMBs and start-ups (40%)
- International (10%)

CEA LIST | AN ORIGINAL BUSINESS MODEL



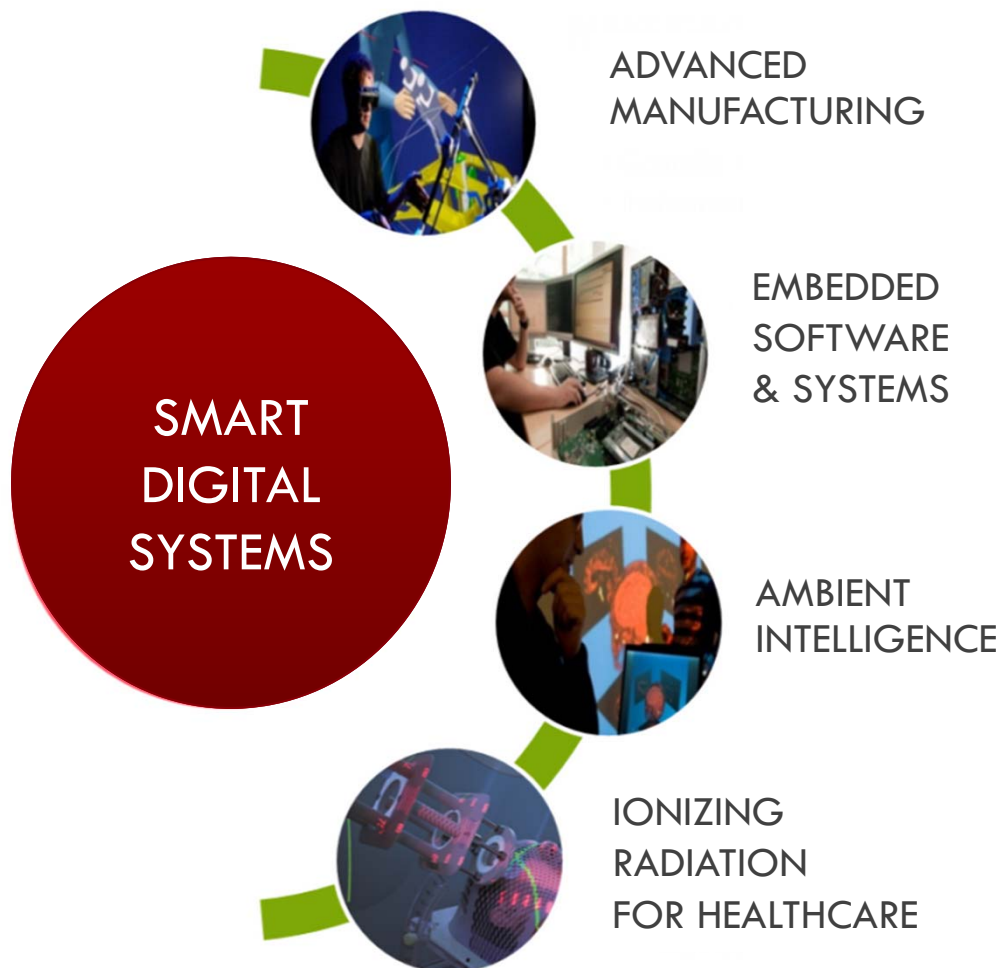
4 PROGRAMMES



4 PROGRAMMES



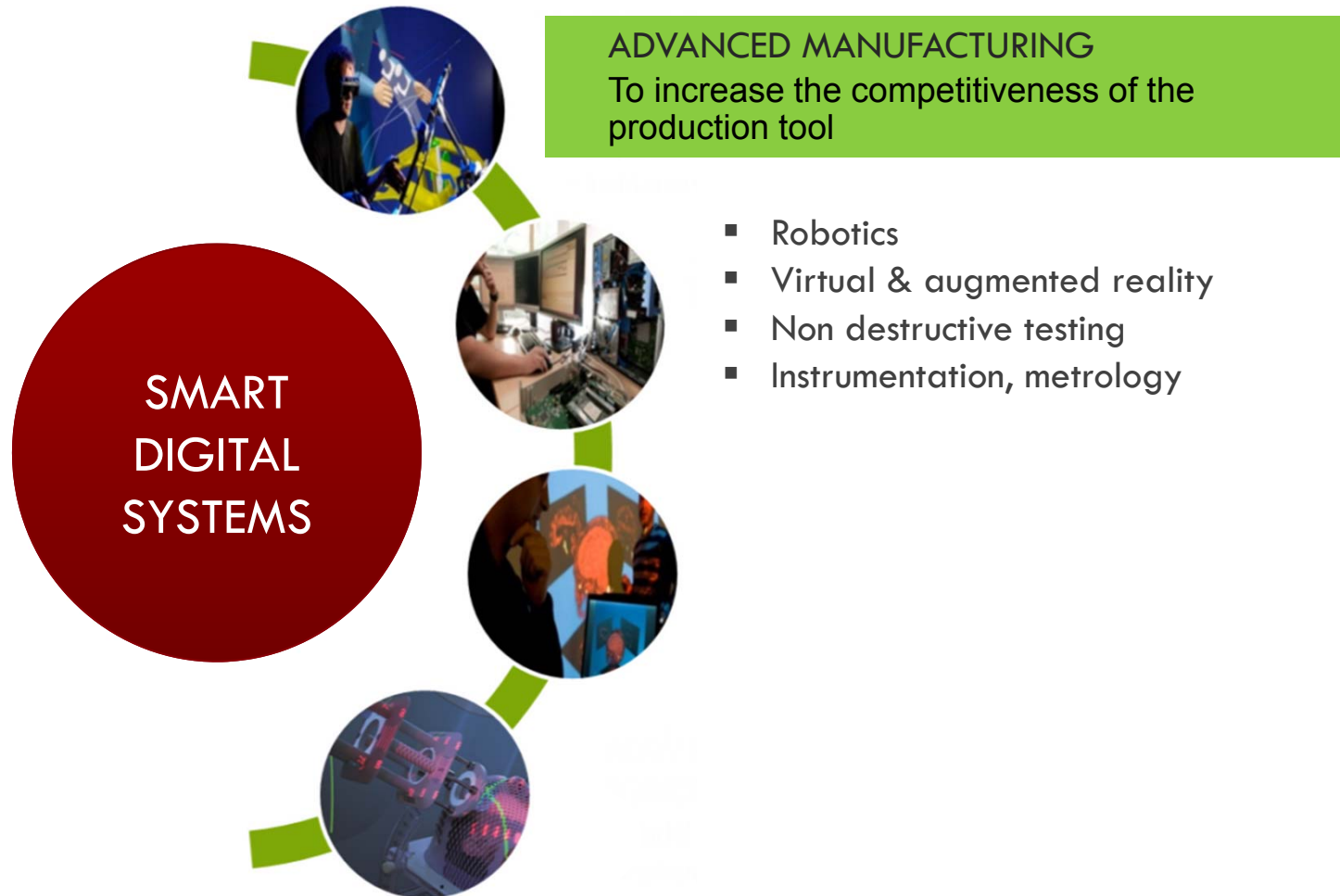
4 CHALLENGES



Digital transition →

- 1** To increase the competitiveness of production tool
- 2** Software tools to manage the digital complexity
- 3** To understand and interact with our environment
- 4** Towards personalized medicine

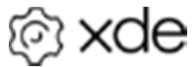
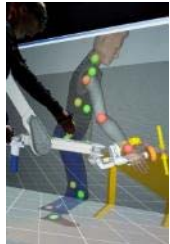
CEA LIST | YOUR INNOVATION PARTNER



ADVANCED MANUFACTURING

VIRTUAL REALITY

Training Interaction
Accessibility Ergonomy
Design



NON DESTRUCTIVE TESTING

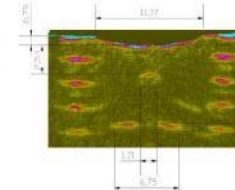


Sensors

Instrumentation



Diagnostic



Inspection process

Simulation

CIVA
NDEI

New process

Agile

Sustainable

ADVANCED MANUFACTURING

→ To increase the competitiveness of the production tool

Intelligent

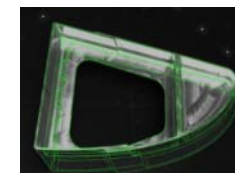
Human-centric

VISION

Assistance



Inspection



COLLABORATIVE ROBOTICS

Exoskeleton

Teleoperation

Collaborative Robot



Cobotics



Mobile handling

COBOTICS EXAMPLE | HERCULE EXOSKELETON

FEATURES

- Heavy loads carrying assistance (40-100 kg)
- 4 to 5 hours autonomy
- 20 km at 4km/h speed run and full charge
- Military and civil applications



RB 3D



CEA LIST | YOUR INNOVATION PARTNER



EMBEDDED SOFTWARE & SYSTEMS

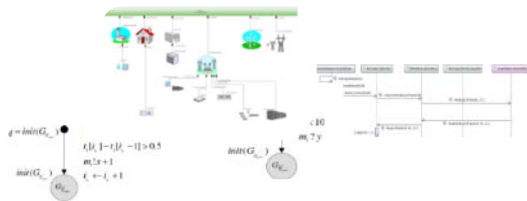
Software tools to manage the digital complexity

- Software & systems engineering
- HW/SW systems design
- Computing architectures
- Safety, security & reliability

EMBEDDED SYSTEMS & SOFTWARE | ENGINEERING TOOLS

MODEL-DRIVEN ENGINEERING

System and Component Design



Design Validation

Assisted code generation

```
#include <stdio.h>
#define MEM_SIZE 100
int tab[MEM_SIZE];
int tab_max[MEM_SIZE];

void genererTabEntiere partie()
{
    int i;
    for(i=0; i<MEM_SIZE; i++)
        tab[i] = rand() % 100;
    for(i=0; i<MEM_SIZE; i++)
        tab_max[i] = 0;
    while(1)
    {
        int i;
        for(i=0; i<MEM_SIZE; i++)
            if(tab[i] > tab_max[i])
                tab_max[i] = tab[i];
        printf("Max: ");
        for(i=0; i<MEM_SIZE; i++)
            printf("%d ", tab_max[i]);
        printf("\n");
    }
}
```



Tool suite

Reliability

Security

Interoperability

EMBEDDED SYSTEMS AND SOFTWARE

→ Software tools to manage the digital complexity

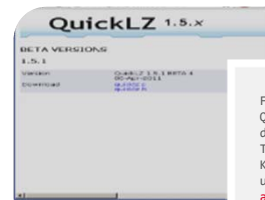
Standards conformance < Cyber-physical integration

Smart systems complexity factors :
autonomous, intertwined,
large-scale, mission critical



CODE ASSURANCE

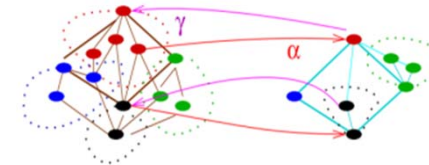
Coding standards conformity-check



Fixed a condition where QLZ_MEMORY_SAFE could fail detecting corrupted data. Thanks to Pascal Cuq and Kerstin Hartig who used **Frama-C's** **value analysis!**

Security Flaws Detection

Formal program verification



Tool suite

EXAMPLE | MODEL-DRIVEN ENGINEERING WITH PAPYRUS

Open-source Graphical Modeling Tool Suite

- Multi-purpose modeling (business, system, software, real-time)
- Interoperable with external tools
- Easy to build customized tool-chains for specific domains and needs (robotics, automotive, avionics, telecommunications, energy, cyber-security)



Wide adoption in industrial settings !

Testimonials and logos of companies using Papyrus:

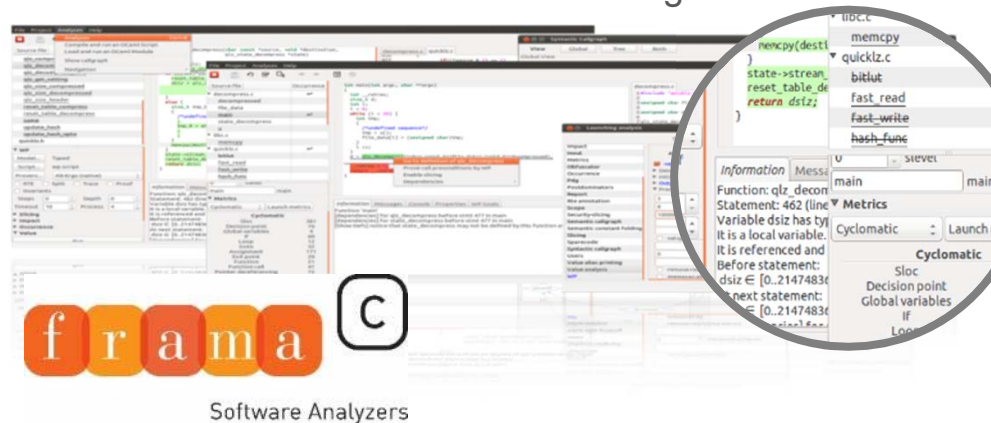
- ALDEBARAN**: "For the safety study of its computer-aided design (CAD) models, Aldebaran uses Papyrus as a computer-aided design (CAD) tool." - Research Director of Aldebaran
- ESTEREL**: "From mission schemas to space application design, there is one step: Papyrus! Designing the next generation of space systems will surely cross the path of Papyrus and Esterel. So, it's just a matter of time." - Software Engineer at Esterel
- ESTEREL**: "Esterel Technologies has chosen the Papyrus technology platform from CEA LIST as a core component of its SCADA System model-based systems engineering product offering and is currently pleased with its quality and efficiency as well as the common developments undertaken within our common ESTEREL Laboratory." - Jean-Michel Pons, Esterel Technologies
- STMicroelectronics**: "STMicroelectronics is using Papyrus to benefit from two main advantages: the standard aspect of UML for its communication capabilities to foster its use to directly get the benefits of existing edge cases or device-specific generation." - Jean-Michel Pons, Esterel Technologies
- ERICSSON**: "Open source is the only practical way to full MBE. Papyrus provides the seed for this vision. A vibrant and extensive community is key. Contributions from research/academia are essential. An outstanding opportunity to make a difference!" - Ericsson

Failure is not an option! There is no alternative!

EXAMPLE | SOURCE CODE ANALYSIS WITH FRAMA-C

Open-source Code Analysis Platform to guarantee absence of software vulnerabilities, conformity to safety and security coding-standards, conformity to specifications

- Modular via plug-ins
- Collaborative
- Combination of formal methods for better coverage



> 100+ kloc
> C source code
> Highest certification requirements
> 80% code coverage
> 200 alarms

> 500 9T9LW2
COA6L9B6
> 80% code

```
<weakness id="2958">
<name>invalid memory access</name>
POLARSSL
Straightforward, Secure Communication
<grade severity="4/7">
<output><textoutput><![CDATA[../ppc/share/lib/wcha
n.c:32:[kernel] warning: out
bounds write. assert \valid(tmp);
stack: smemset ::
tcases/CWE126_Buffer_Overread/s02/CWE126_Buffer_
rread_malloc_wchar_t_loop_03.c:70 <-
goodG2B1 ::
tcases/CWE126_Buffer_Overread/s02/CWE126_Buffer_
rread_malloc_wchar_t_loop_03.c:123 <-
126_Buffer_Overread_malloc_wchar_t_loop_03_good
]]></textoutput></output></weakness>
```

frama C
Software Analyzers

Wide adoption for critical domains & needs !



Safety –
A380 program



Nuclear power plant
software analysis

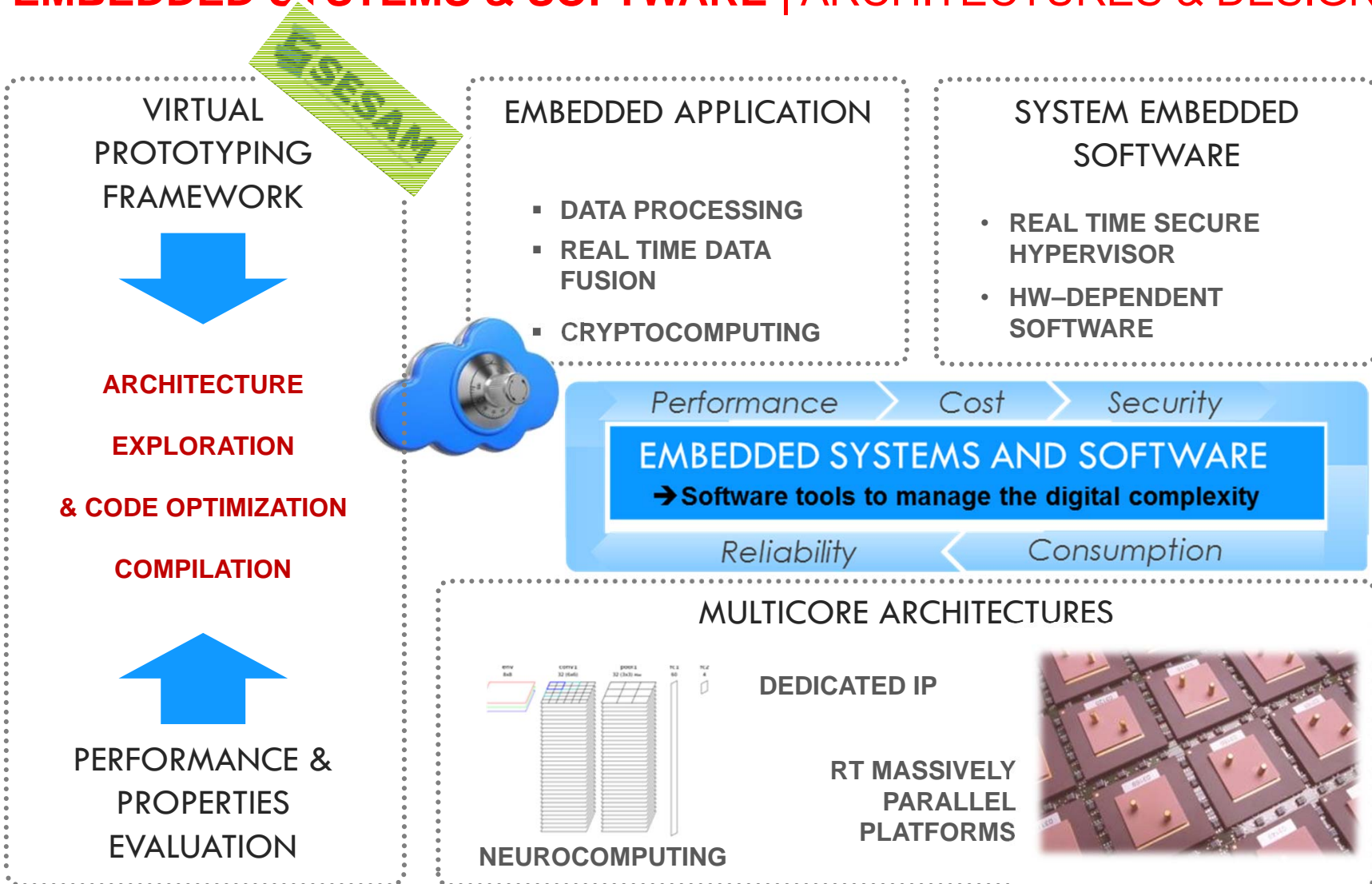


Certification –
Health robotics



Validation of COTS software (security protocols, compression libraries, etc.).
Awarded by NIST

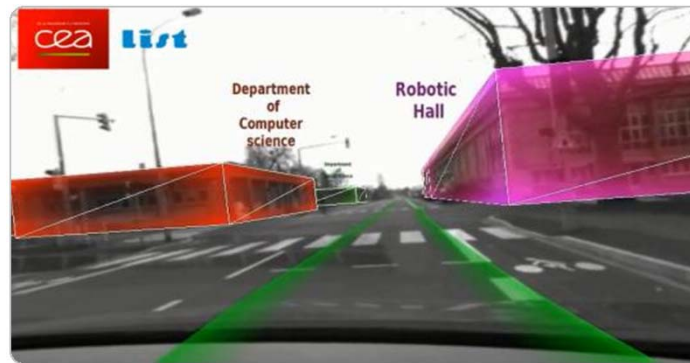
EMBEDDED SYSTEMS & SOFTWARE | ARCHITECTURES & DESIGN



EXAMPLE | VISION APPLICATION

LOCALIZATION « BY VISION »: ALGORITHMS

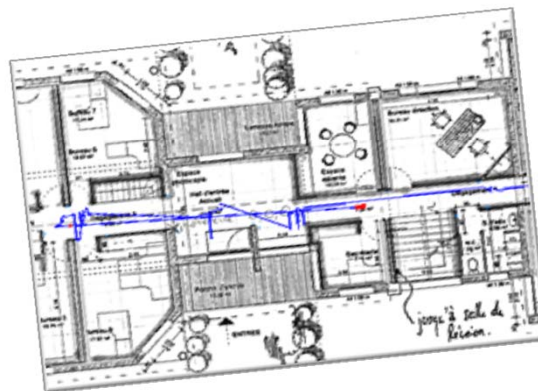
- Constrained Simultaneous localization and mapping (SLAM)
- Place recognition
- Multi Sensor Fusion :
Vision, GPS, IMU,
Odometer...



- ▶ Running indoor and outdoor
- ▶ High accuracy of localization and orientation
- ▶ Correction of GPS bias
- ▶ Robust to temporary lost of data from one sensor

RT LOCALIZATION « BY VISION » ON EMBEDDED HW

- Multi-CPU multi-FPGA circuit design using SESAM
- Simultaneous localization and mapping (SLAM) optimization



- ▶ 12 M gates equivalent complexity
- ▶ 75% reduction on CPU computation load wrt PC
- ▶ 10x acceleration
- ▶ Less than 20 ms latency

CEA LIST | YOUR INNOVATION PARTNER



AMBIENT INTELLIGENCE

➔ To understand and interact with our environment

- Sensors & signal processing
- Communication & interfaces
- Data processing & multimedia

AMBIENT INTELLIGENCE

MAN MACHINE INTERFACE



Tactile haptic interface



Augmented Reality

Activity analysis



VISION

Geolocation
Video protection



SENSORS

Scene analysis



3D & Mobility



NBRC
Diamond

Big data

IoT

Value

AMBIENT INTELLIGENCE

➔ To understand and interact with our environment

Intuitive

Understand

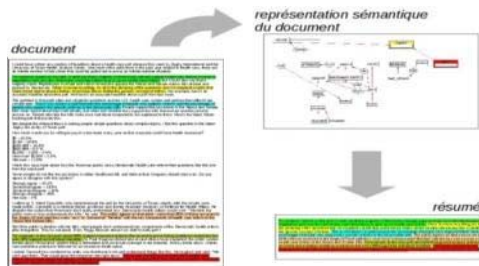
COMMUNICATION

Machine to machine communication



DATA STRUCTURE AND ANALYSIS

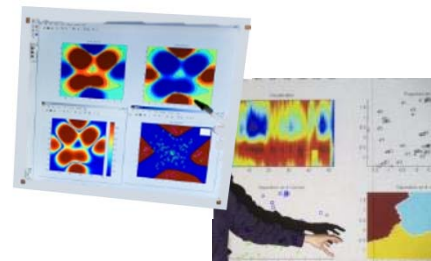
Multilingual text



Images / Videos



Data



EXAMPLE | AUGMENTED REALITY

FEATURES

- Markerless augmented reality system
- High registration accuracy on 3D complex objects and large environments
- Robustness to occlusion, viewpoint changes and lighting variations
- Mobile solutions
- Flexibility and ease of deployment



CEA LIST | YOUR INNOVATION PARTNER



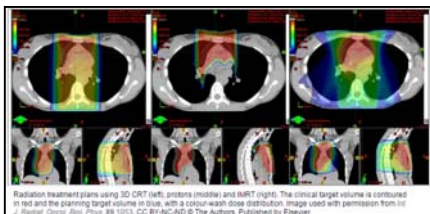
IONIZING RADIATION FOR HEALTHCARE
→ Towards personalized medicine

- Dose metrology
- Modelling and simulation

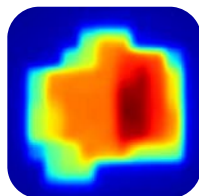
IONIZING RADIATION FOR HEALTHCARE

SIMULATION SOFTWARE

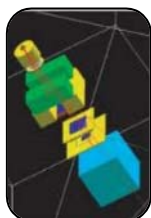
Decision support tools



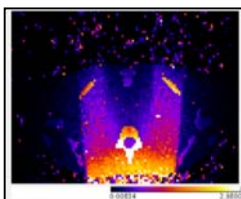
Treatment monitoring



Design assistance



Patient dosimetry and radiation dose optimisation in imaging



RADIOTHERAPY AND IMAGING INSTRUMENTS

Varian True Beam and Elekta VERSA HD accelerators



CT Scanner
GE Discovery



Brachytherapy



Detectors and phantoms

Radiotherapy > Modeling > Imaging

IONIZING RADIATION FOR HEALTHCARE
→ Towards personalized medicine

Dose < Security < Efficiency

TRAINING

Initial (DQPRM) + professional



Industrial dedicated courses

STANDARDISATION AND DOSE METROLOGY



Water and graphite calorimetry

New standard development



EXAMPLE | DOSEO PLATFORM

TECHNOLOGICAL SPACE

2,400m² dedicated to R&D and training

- Reception area [1,000 m²]
- Training space [400 m²]
- Technological platform [1,000 m²]



Two accelerators, a scanner, a technical brachytherapy platform [125I, 192Ir], a 60Co irradiator, laboratories and a computing server



* R&D partnership agreements

- 2 big players : **Elekta** and **Varian**



- 2 SMEs : **Esprimed** and **CIBIO**

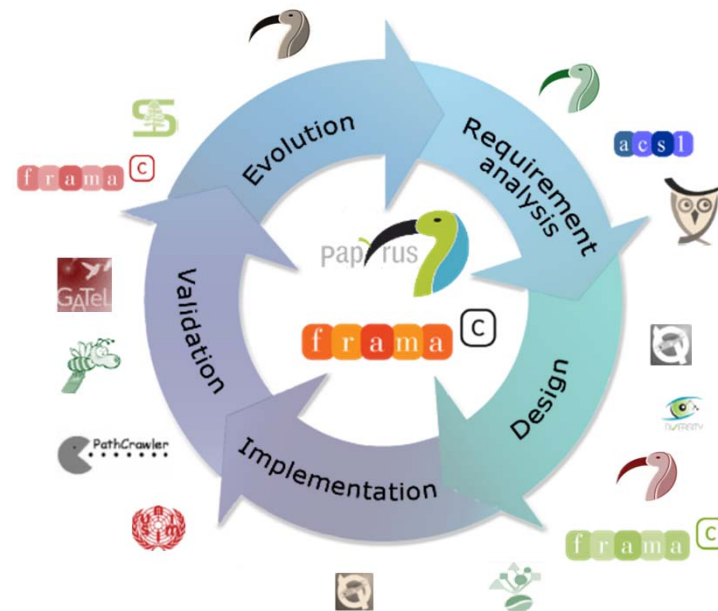




METHODS AND TOOLS FOR SOFTWARE & SYSTEM ENGINEERING

François TERRIER

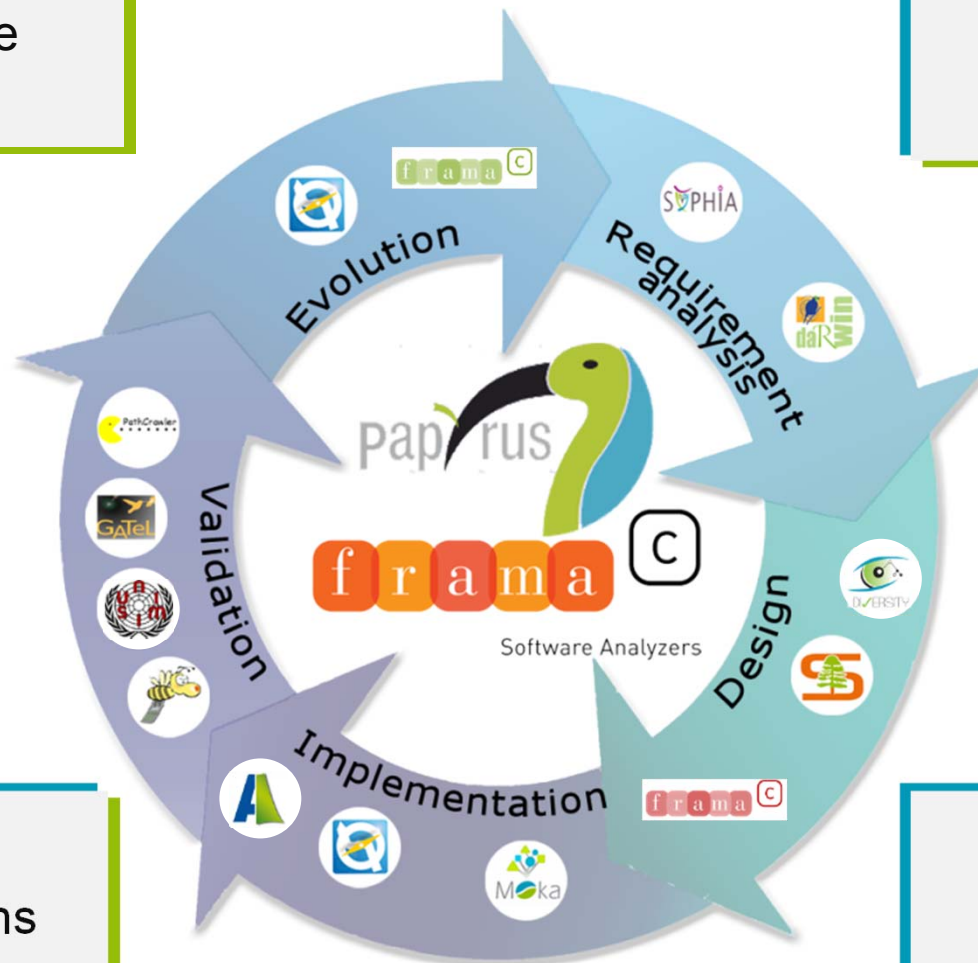
Département Ingénierie des Logiciels et des Systèmes



17/06/2015

Open source

Standards



Technologies

- Ing. SW & Syst
- Safety
- Security

Applications

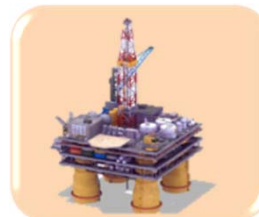
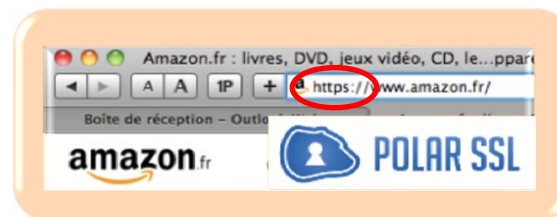
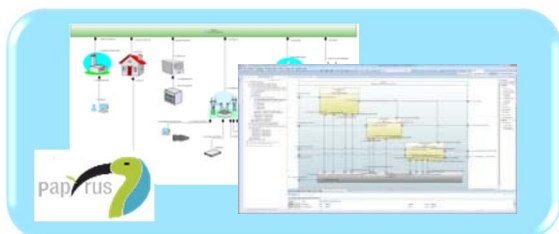
- Energy
- Avionics
- Railway
- Automotive
- Health
- IoT

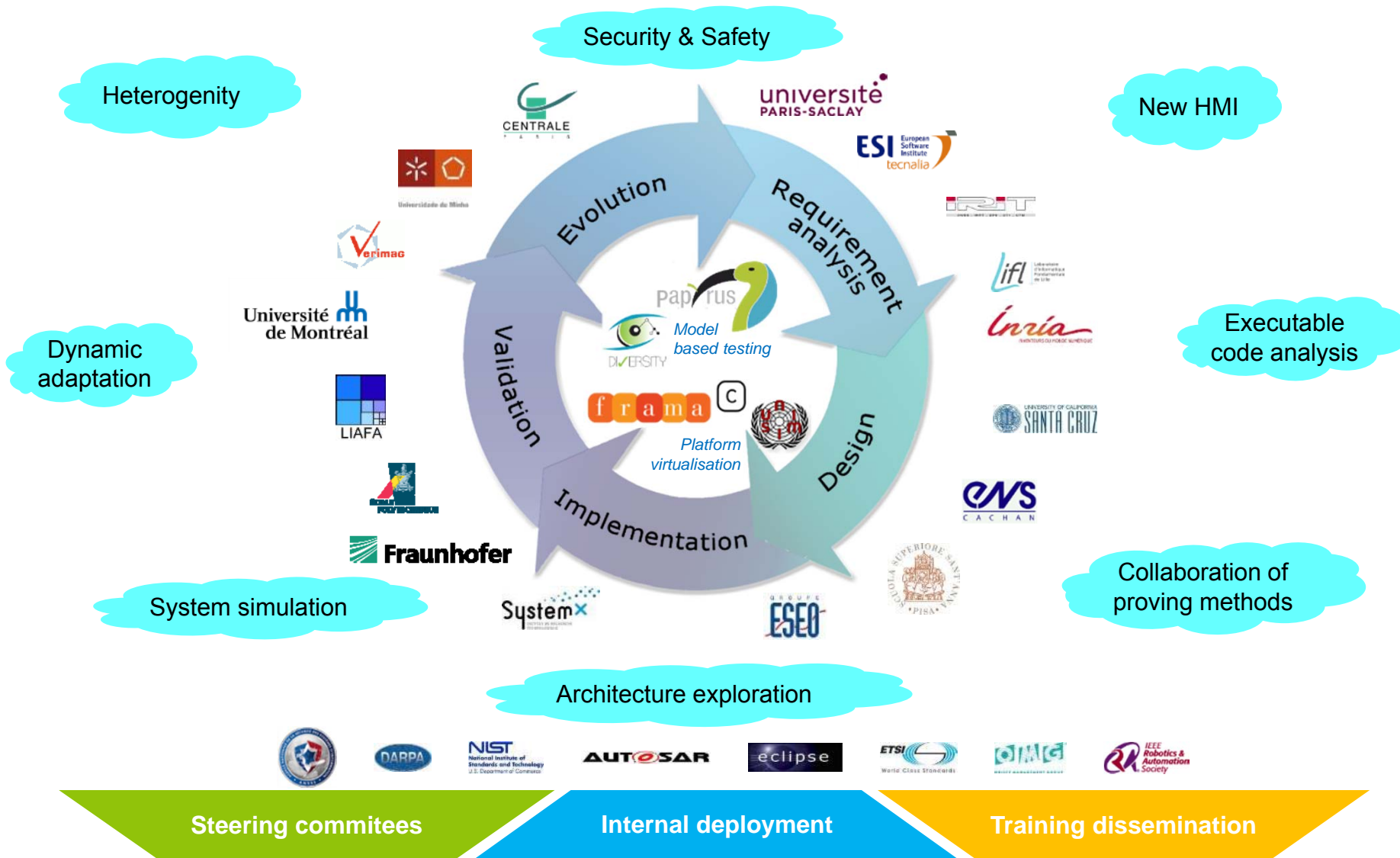
Global solutions

Dedicated tools

100 persons

- 65 permanent
- 1 Pr INSTN & DR CEA (F. Terrier)
- 1 DR CEA (S. Gérard)
- 45 Dr. - 17 Eng.
- 35 PostDoc/PhD Students





Industrial
application
expertises &
audits



Language,
process and
method
elaboration



Tool
design



Standard
organization
participation



Academic Research



Correct-by-construction design of safe CPS

A laboratory of 47 persons (+ 5 new permanent open positions for 2015... :-))

- 30 permanent members + 17 non-permanent members including PhD students, post-docs and CDDs

Main research concerns

- Modeling Language Engineering
- Model-based Formal Analysis (e.g., auto gen. of tests)
- Run-time Formal Verification and Monitoring
- Model-based Simulation
- Model-based Security & Safety Engineering
- Archi. Exploration, Configuration & Deployment
- Process, Requirement and Variant Engineering



TERRIER François
francois.terrier@cea.fr