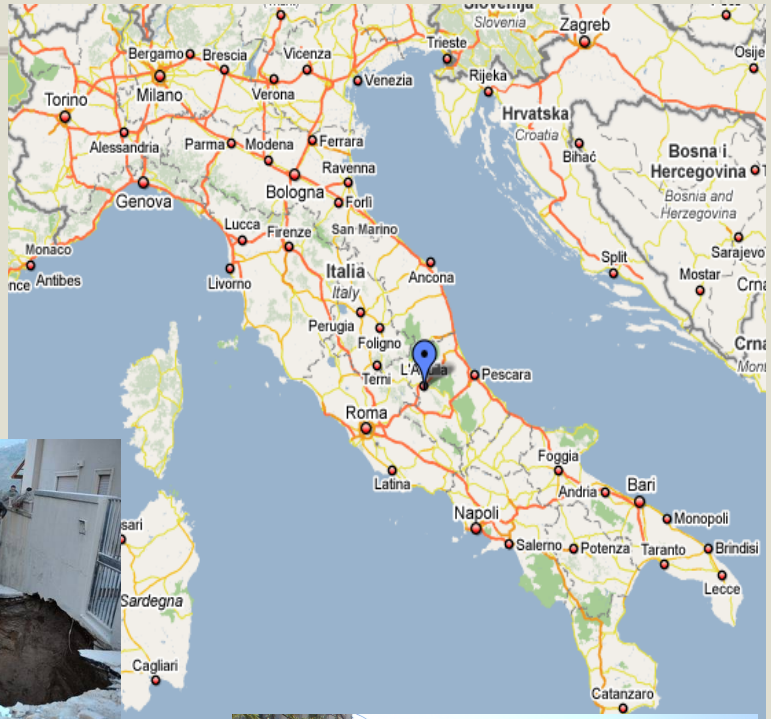
INCIPICT

INnovating CIty Planning through Information and Communication Technologies

From the April 6th 2009 earthquake to now

- More than 300 people killed
- Many historical buildings destroyed
- Six years later
- L'Aquila as an open area for experimental projects' test beds
- the INCIPICT project is only one of them
- INCIPICT, 5M€ fundings
- Constructuion of an experimental optical network for the city
- Design of an innovative communication network
- Implementation of advanced services



INCIPICT PA work package

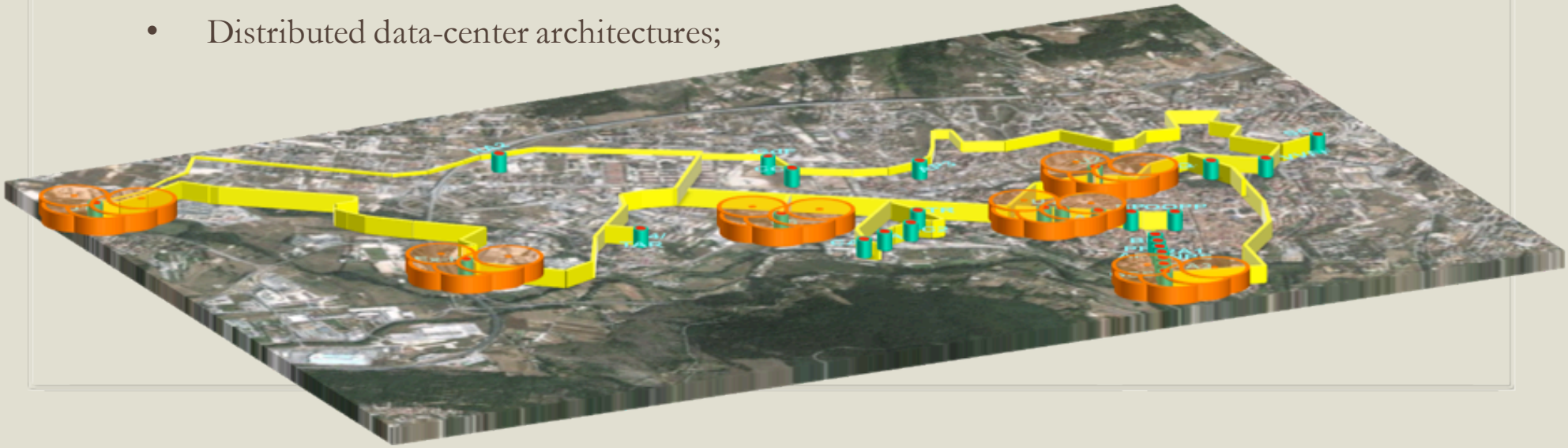
- **PA:** Development of a metropolitan area network and services for Public Administration
  - Optical ring deployment
  - Dematerialization of PA documents
  - Management and continuity of operations of PA in emergencies

INCIPICT ROS & WIR work packages

- **ROS:** Development of an experimental optical network
  - Energy efficiency of the access optical network
  - Innovative solutions for METRO networks
- **WIR:** Innovative pervasive wireless technologies
  - Energy efficiency and low complexity in physical layer techniques
  - QoE-based network coding techniques
  - Cognitive networks towards energy efficiency in next generation wireless networks
  - Distributed localization
  - Wide deployment of Wireless Sensor and Actuator Networks

INCIPICT ROS

- **Main research areas**
  - Fiber-optic propagation modeling (UnivAQ);
  - Photonics device modeling (UnivAQ);
  - Optical networking (CNIT, Pisa);
  - Optical Access (CNIT, Pisa);
- **The fiber-optic ring will serve as a test-bed for the implementation and/or analysis of:**
  - Software-defined-network schemes for flexible resource allocation and service provisioning;
  - Innovative optical access schemes;
  - Distributed data-center architectures;



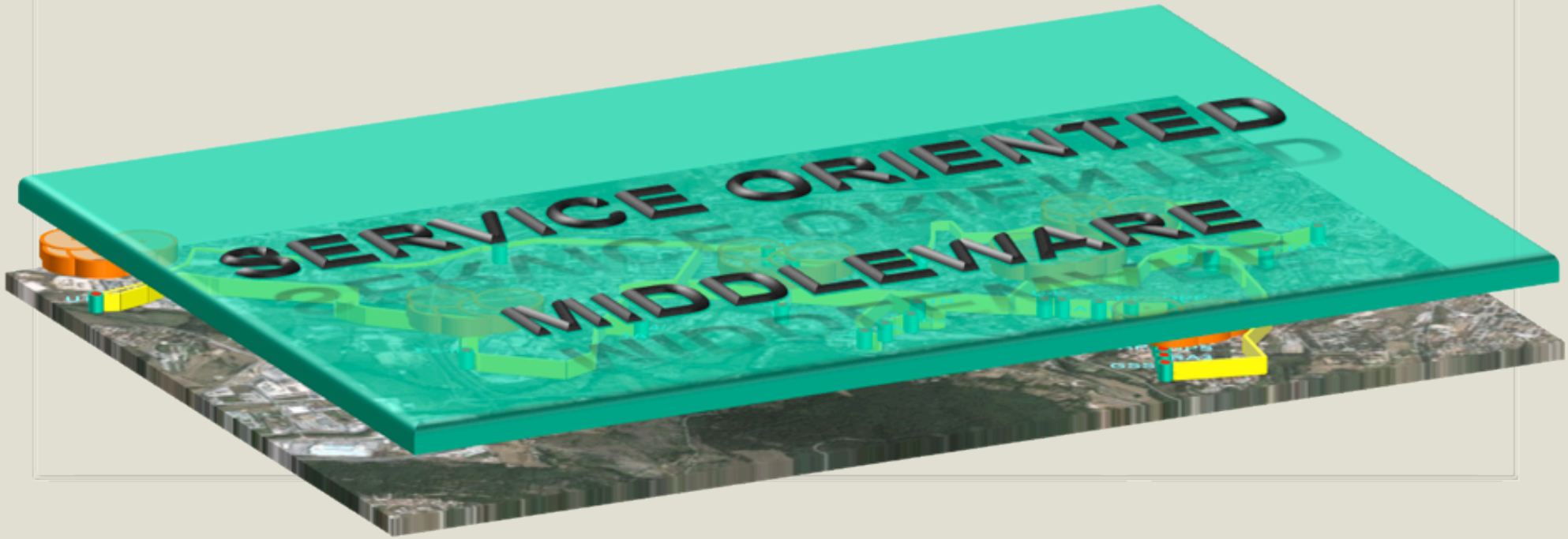
INCIPICT WIR

- **Space Modulation**
  - same data rate and end-to-end performances of MIMO schemes
  - reduction of transmission power and computational complexity
  - savings in energy (radio applications)
  - opportunistic schemes for the allocation of power (random behavior)

- **Network Coding**
  - mediation of incoming packets instead of simple retransmission (e.g., merge, reorder)
  - computational efficiency and robustness of the network dynamics
  - reduction of energy consumption of the wireless communication

INCIPICT MID work package

- **MID:** Middleware for dynamical coordination of heterogeneous software services
  - Design and coordination of dynamic software services (through a specific framework) by exploitation of the service choreography technique
  - Non-expert users (e.g. tourists) can indirectly specify the cooperation between services that can be necessary to satisfy their needs
  - Tools will be available in order to look for and access to services that will be used to create the choreography
  - In order to reach this objective a proper service oriented middleware must be defined



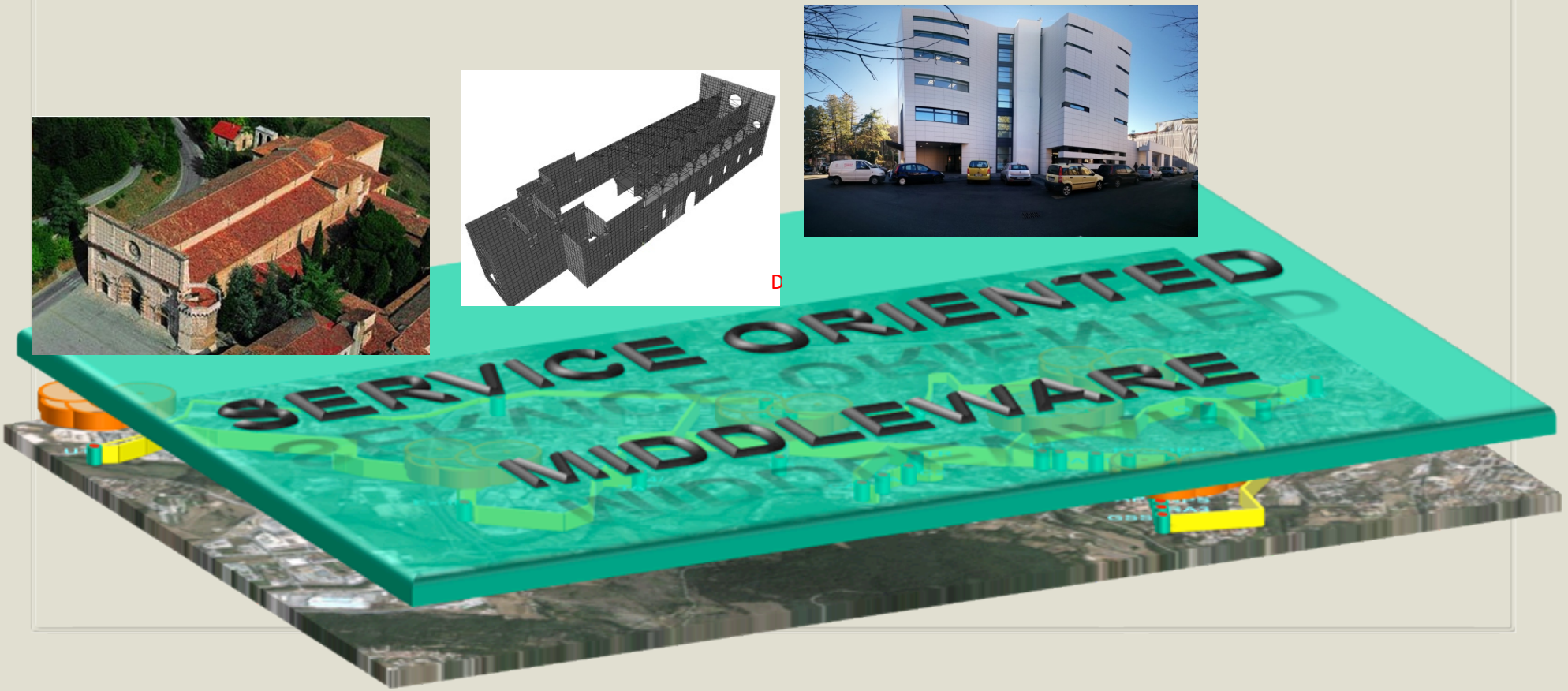
INCIPICT MID

- **Main research areas**
  - Software Engineering
  - Formal Methods
  - Distributed Systems
  - Context-oriented Programming
- **ICSLab: Integration Code Synthesis Laboratory**
  - Cloud Infrastructure as a Service (IaaS) for the provision of computational resources and virtual environments for the deployment of distributed software systems
  - Cloud Platform as a Service (PaaS) for distributed software systems simulation & analysis, and execution & monitoring
  - Cloud Software as a Service (SaaS) for the "on-demand" composition & coordination of distributed software applications through the automated synthesis of integration code

INCIPICT SER work package

SER: Innovative methods and services

- SER1: Structural health monitoring
- SER2: Disaster resilient and energy efficient building automation
- SER3: Cultural Heritage Enhancement



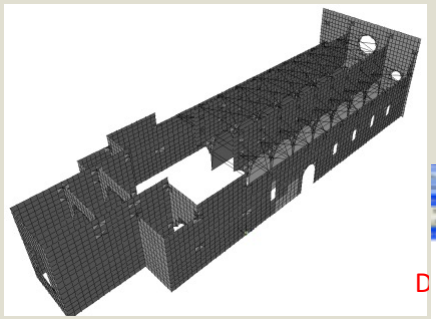
SER1: Structural Health Monitoring

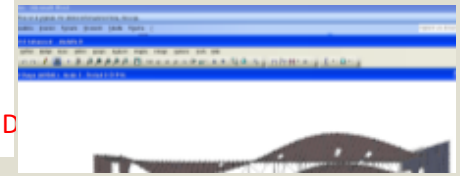
Development of a vibrational monitoring system by means of acceleration measurement

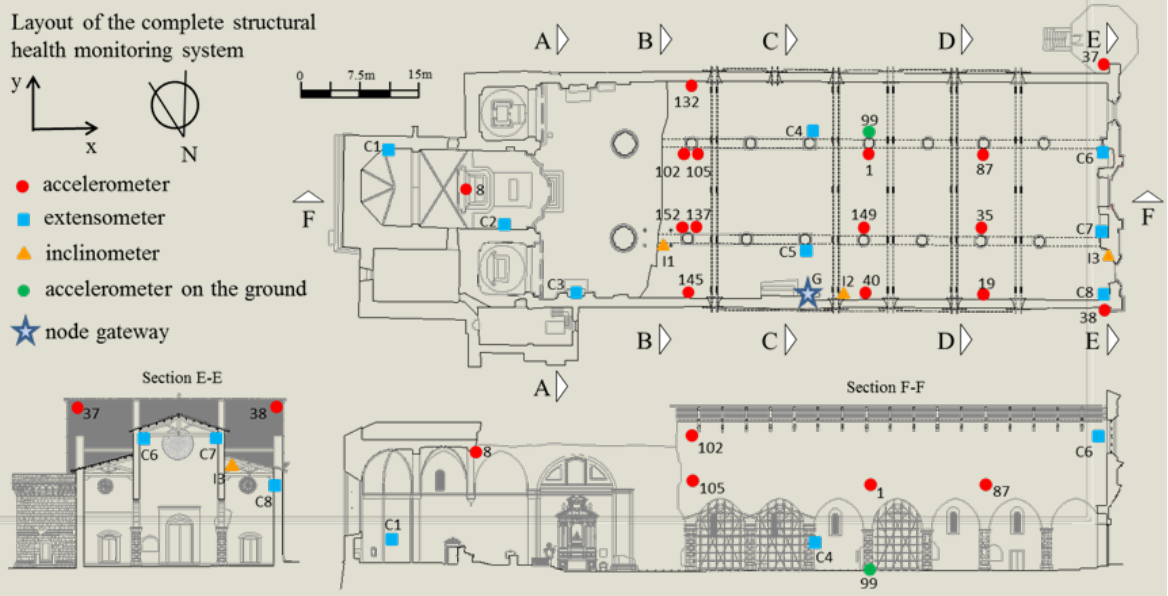
Structural analysis by numerical finite element models to spport the structural monitoring design

Modal identification through measurement of the dynamic response due to dfferent loading condition

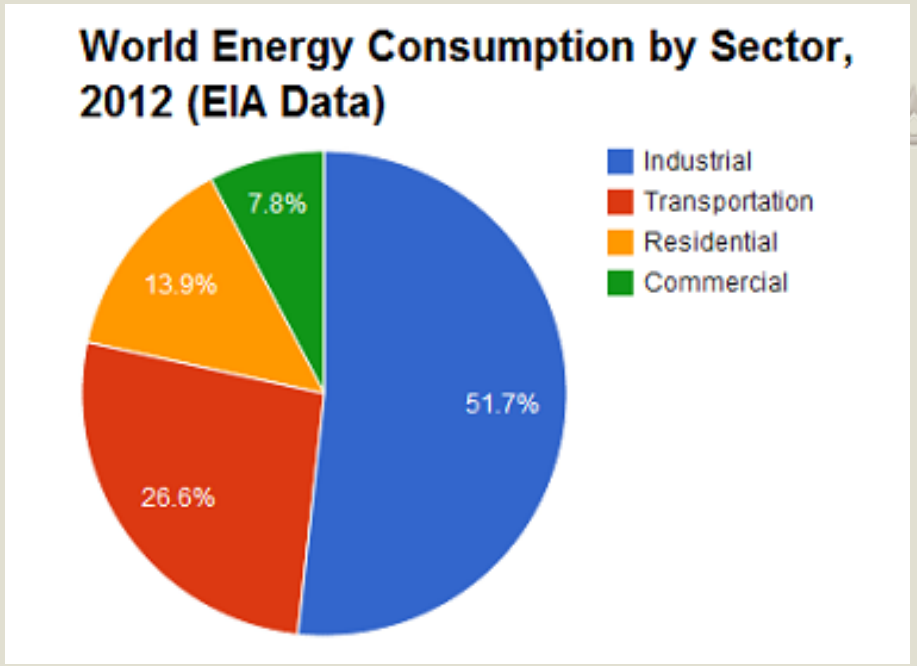
Potenza F., Federici F., Lepidi M., Gattulli V., Graziosi F., Colarieti A., "Long term structural monitoring of the damaged Basilica S. Maria di Collemaggio through a low-cost wireless sensor network", Journal of Civil Structural Health Monitoring, in press.





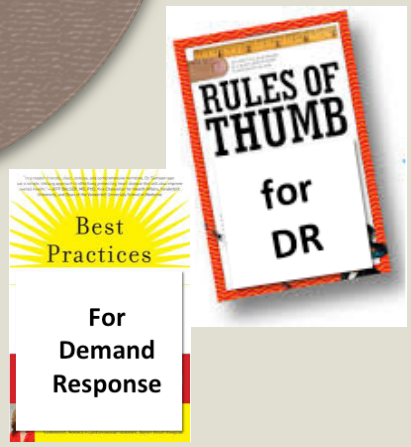


SER2: Building automation systems: Motivations



Physical modeling, automatic control, communication: Cyber-Physical Systems

Building automation systems: SoA



Courtesy of Madhur Behl

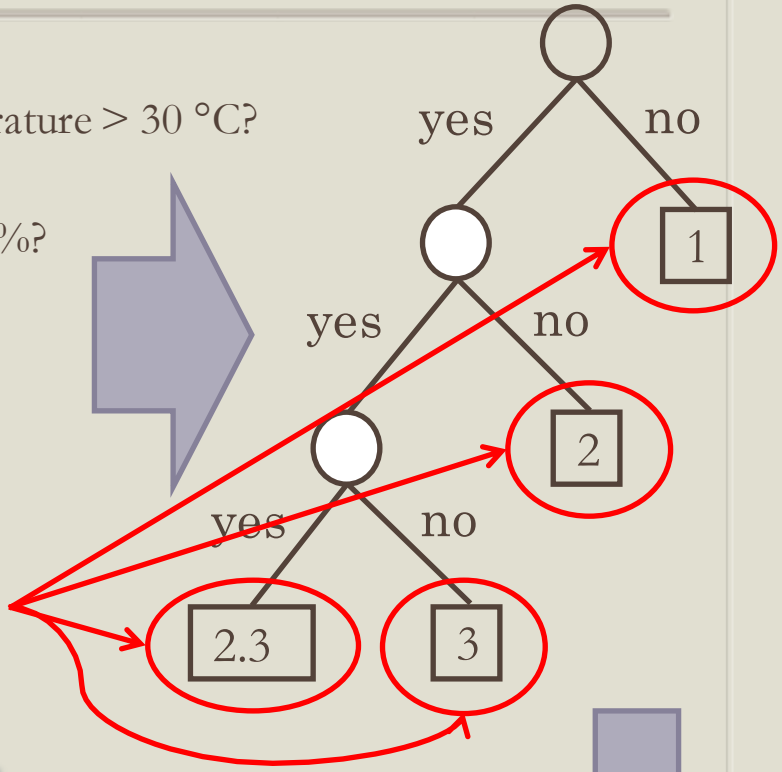
Human sciences building in L'Aquila: Research on Cyber-Physical Systems

DR-Advisor: A Data Driven Demand Response Recommender System.
Madhur Behl, Francesco Smarra, Rahul Mangharam. Applied energy, submitted for publication

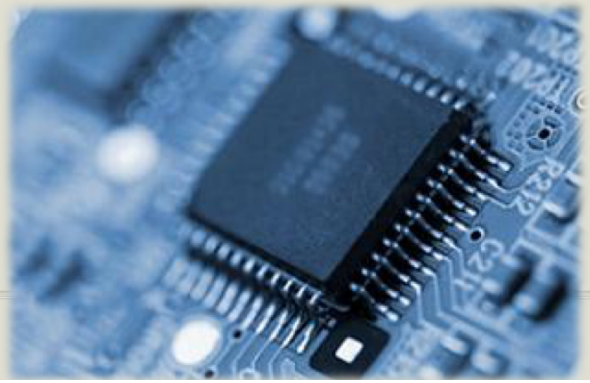
Is outside temperature > 30 °C?

Is humidity < 30%?

Is it cloudy?



POWER CONSUMPTION



Human sciences building in L'Aquila: a living lab

Weather

- Temperature
- Humidity
- Wind Speed
- Wind Direction

Schedule

- Time Of Day
- Day of Week
- Set Points

Building

- Chilled Water Temp
- Lighting Power
- Zone Temperature
- Power Consumption

Web

SER3: Cultural Heritage Enhancement

Roberto Scopigno, Marco Callieri, Paolo Cignoni, Massimiliano Corsini, Matteo Dellepiane, Federico Ponchio, Guido Ranzuglia, 3D models for Cultural Heritage: beyond plain visualization , IEEE Computer, Volume 44, Number 7, page 48-55 - July 2011

- Main research areas
  - Software Engineering
  - 3D scanning & Rendering
  - Interactive graphics and virtual reality

- Main research & development activities in these areas
  - Research and development of 3D modelling techniques accessible via mobile devices
  - Methodologies for customized and contextualized fruition of informative content via mobile devices

Conclusions

- L'Aquila as an open/living lab and test bed
- INCIPCT as a platform offering:
  - Support for innovation of the Public Sector
  - Experimental optical ring
  - Provides proper interfaces for applications (Smart City, IoT, etc.), with three pilot activities:
    - Pervasive Structural Health Monitoring (SHM)
    - Pervasive Building Energy management
    - Cultural Heritage promotion through ICT
- First achievement
  - "CHRoMOus – Cultural HeRitage MOnitoring Sensors" in the executive program between Italy and Sweden from 2014 to 2017, signed in Stockholm on the 12th of September 2014