

UNIVERSITY *TRANSILVANIA* OF BRAȘOV
FACULTY OF ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

DEPARTMENT OF AUTOMATION, ELECTRONICS AND COMPUTER SCIENCE

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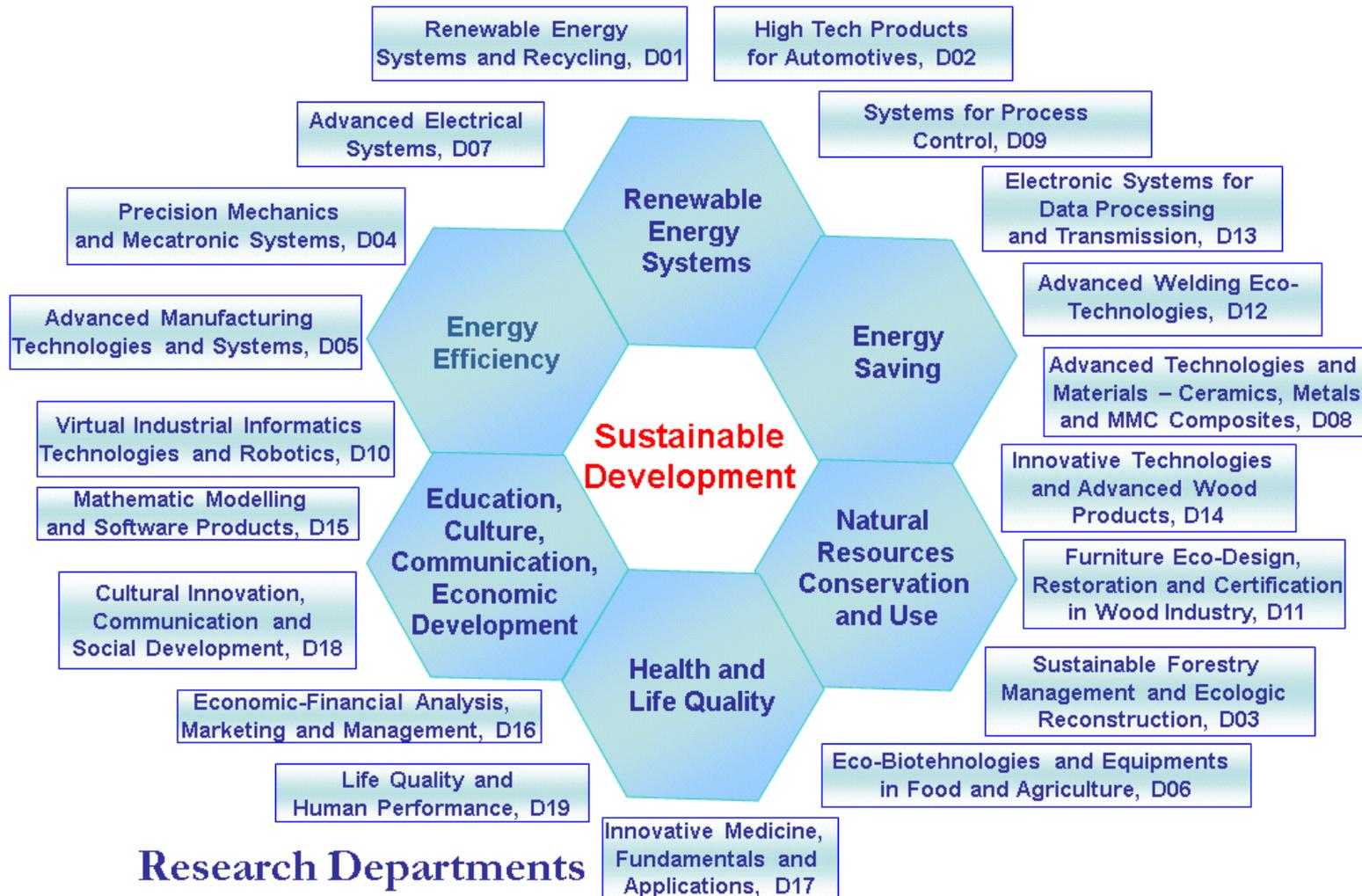
Smart Campus Management with Cloud Services

INSEED Cloud Burst and Blade Centre in the
PRO DD Green Data Centre

Annual Scientific and Technical Meeting of the
PRODD Research Institute, University
“Transilvania” of Brasov, November 13, 2012



R&D Institute of the University *Transilvania* of Brasov



The GENIUS Campus

- The R&D Institute: High-Tech products for Sustainable Development: PRO-DD
- A novel structure for advanced research on Sustainable Energy:
- The Green, Energy Independent University Campus GENIUS

Phase 1

RTD Institute
(Structural Funds)

Phase 2

Education Area
(Regional Funds)

Phase 2

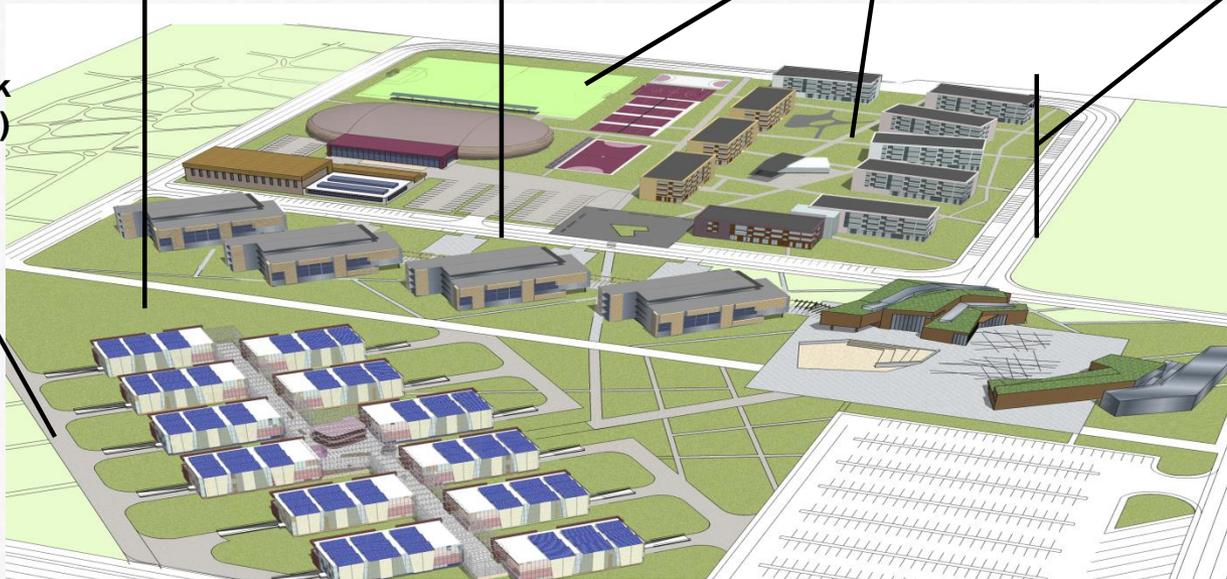
Students Facilities
(Governmental &
Regional Funds)

Phase 3

Business Center
(Structural Funds)
Clusters research
providers + research
direct and indirect
beneficiaries
Technology Transfer

Phase 1

The Solar Park
(RTD Projects)



1. Research
2. Education
3. Technology Transfer



The GENIUS Campus – PRO-DD Institute

- The R&D Institute: High-Tech products for Sustainable Development:
PRO-DD

The Solar Park

- PV Platforms
- 2MWp PV
- Residential buildings testing optimised solutions for integrating renewables



The PRO-DD Institute

- 12 Laboratories (3 floors) - Smart Buildings:
 - Renewables: solar thermal, PVs and heat pumps
 - Monitoring and data acquisition

Outdoor: testing stands for optimising complex sustainable energy solutions

Indoor: advanced research centre on Sustainable Energy

Financing: 2009 – 2012 (Structural Funds)



The GENIUS Campus – PRO-DD Institute



The partners

- High-Tech companies
- The Chamber of Commerce
- Sustainable development bodies
- Authorities



The PRO-DD Institute and the Students facilities

- R&D staff
- Post-doc
- Ph.D. students
- M.Sc. students



The GENIUS Campus – PRO-DD Institute

September 2009



April 2010



May 2010



March 2012



June 2011



The R&D Institute: High-Tech products for Sustainable Development: PRO-DD



The GENIUS Campus – PRO-DD Institute



The R&D Institute: High-Tech products for Sustainable Development: PRO-DD



The GENIUS Campus – PRO-DD Data Center

The PRO-DD Data Center

-Based on Green Technologies:

-Hardware:

- Low energy consumption
- Efficient cooling solutions

-Software:

- Optimal process management

July 2010:

Pilot project - MiniData Center
Collaborative environment for
content and flow management
of documents

-Functions:

- Data acquisition, monitoring and management
- Communication (internal, external, multimedia, video-conference)
- Complex data processing and storage
- Remote applications
- Security (data, buildings)
- Safety (fire, CO2)
- Habitat comfort
- Advanced training tool
- **Services delivery to the entire university and 3rd party**

May-September 2012:

Data Center
Cloud Burst platform
Multimedia infrastructure
Telecommunications trunks



The GENIUS Campus – PRO-DD Data Center

- Design Principles taken into account:
 - Centralize computing resources
 - Reduce electricity consumption
 - Reduce operating costs



BladeCenter Servers



The GENIUS Campus – PRO-DD Data Center

- Centralize computing resources
- Control over software used
- Providing increased computing power, the same for all users
- Reducing the number of licenses
- Using on the client side a very simple and inexpensive computing systems that requires only one monitor, keyboard, mouse and a modest software product for communication with servers
- Improved data security through: backups of all existing data; store data in the data center not on each computer
- Allows use of virtualization technology that leads to: increasing computational power provided to each user; reducing total cost of operations; reducing the number of servers (consolidation)
- Remote access to data and resources
- Conditions for effective collaboration between users (the data is all in one place)



The GENIUS Campus – PRO-DD Data Center

- Reduce electricity consumption
- Reducing physical space needed for data center servers to decrease the maximum volume of air to be cooled
- Reducing number of servers to reduce power consumption for cooling
- Every W on server leads to consumption of another 2 W for cooling and UPS
- BladeCenter technology consumes only 80 W / CPU
- Multi-core processors increase performance computing at the same energy
- BladeCenter technology and multi-core processors lead to a 35-100% increase in performance and power reduction of up to 40-50%
- Power consumption may drop by up to 25% using power management tools
- Virtualization leads to additional reduction of energy consumption between 20 and 50%



The GENIUS Campus – PRO-DD Data Center

- Reduce operating costs
- Using of BladeCenter servers:
 - Reducing energy consumption (14 Blade servers consume about. 3.5 kW, while 14 regular servers consume approximately. 9.8 kW)
 - Reduction of occupied space (42U handles 56 Blade servers instead of 21 regular servers)
 - Each regular server has its own network connections while BladeCenter servers have a single connection (via chassis)
 - Reducing the number of servers using virtualization (consolidation) leads to a decrease of: *Administration cost, Software cost, Cost of electricity* (by shutting down the unused servers); *Reduce the time for networking configuration* for 1.5 hours per server; *Increase availability* by 80% (moving virtual machines from one server to another in case of detection of failures)
 - According to consulting firms, the cost for a data center server is approx. 10.000 USD / year (7535 euros)
 - By virtualization costs go down to 7,000 USD / year (5274 euros)



The GENIUS Campus – PRO-DD Data Center

- PRO-DD Data Center Hardware Equipment characteristics
 - Number of processors: 29
 - Number of processor cores: 174
 - RAM Memory: 1440 GB
 - Video Memory: 6 GB GDDR5
 - Storing capacity: 28TB
 - Computing power: approx. 1TFlops
 - Extension Cloud Burst



The GENIUS Campus – PRO-DD Data Center

- CONCEPTS
 - Virtualization
 - Cluster
 - Cloud computing
 - Consolidation
 - Grid computing



The GENIUS Campus – PRO-DD Data Center

- Cloud Computing and Virtualization Architecture
- The resources administration system is designed as an efficient integrated solution for all of the hardware and software resources available. It allows complex hardware and software product integration.
- The system is designed to use all available hardware and software resources in order to solve complex problems that require extreme hardware performance (eg. Design of complex models needed for very large matrix operations). Using **virtualization** and **cloud computing** techniques eliminates the need to purchase very expensive equipment like *supercomputers* or *mainframe* computers.
- On the infrastructure built on **virtualization** different platforms can implemented:
 - Platforms for different services (search, payment, etc.)
 - Stacks for Java, .Net, PHP, etc.
 - Platforms for structured storage (database and file systems)
 - Platforms for high performance computing applications, etc.
 - Platforms for remote laboratories with Cloud Burst integration from INSEED



The GENIUS Campus – PRO-DD Data Center

- Cloud Computing and Virtualization Architecture
- Cloud computing allows the build of a virtual desktops infrastructure and even to replace the normal desktop computers with *thin client* devices (netbooks, tablet PCs and smartphones) that have access to the resources stored in the cloud.
- Cloud computing application services:
 - Provide the entire computing infrastructure as services.
 - Provide the solutions stacks as services.
 - Provide the applications as services using the Internet with no need to install and configure them on the clients' computers.
- Cloud computing infrastructure services:
 - Computing services: on real machines, on virtual machines, at the level of the operating system.
 - Network services.
 - Storing services.



The GENIUS Campus – PRO-DD Data Center

- Cloud Computing and Virtualization Architecture
- To access an application as a service using the Internet the system has the following main components:
 - Web based GUI (Graphical User Interface).
 - Resource administrator that distributes the available resources in the cloud, makes sure that the security rules are respected, monitors the system's performance, manages the virtual network.
 - Virtual machines library.
 - Active network equipment.
 - Advanced security module.
- One instance of the application can be used by more users (in this case students) in the same time.



The GENIUS Campus – PRO-DD Data Center

- Information system components
- Large computing infrastructure (High Performance Computing).
- Mathematical libraries for analysis and modeling.
- Management software for parallel or sequential processing of tasks.
- Specific software for application development.
- Project Management Software.
- Databases (history and simulation).
- Subsystem for presentation and reporting based on an application portal for communication.
- Virtual library component required for academia.
- Specific applications of different research areas.



The GENIUS Campus – PRO-DD Data Center

- Expected features and performance
- Improving access to scientific information and increasing the scientific research.
- Improved understanding of very large and complex mathematical models at higher resolutions, and the development of new scientific applications.
- Lower times for solving simulation problems.
- Decreased response time to complex problems and simulations.
- Access to the scientific community who provide some free computer applications in certain areas.
- Stimulate electronic exchange of information.
- Accelerate the exchange of information between the partners and reduce administrative activities in scientific collaboration.
- Ability to participate in national and European projects.



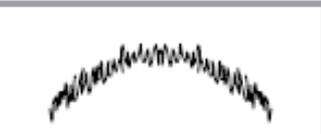
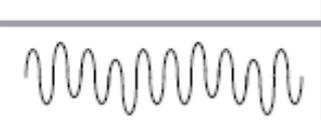
The GENIUS Campus – PRO-DD Data Center

- Incidents occurring in the power supply

| Disturbance category | Wave form | Effects | Possible causes | Possible solutions |
|-------------------------------|---|--|---|--|
| 1. Transient | | | | |
| Impulsive |  | Loss of data, possible damage, system halts | Lightning, ESD, switching impulses, utility fault clearing | TVSS, maintain humidity between 35 – 50% |
| Oscillatory |  | Loss of data, possible damage | Switching of inductive/capacitive loads | TVSS, UPS, reactors/ chokes, zero crossing switch |
| 2. Interruptions | | | | |
| Interruption |  | Loss of data possible, damage shutdown | Switching, utility faults, circuit breaker tripping, component failures | UPS |
| 3. Sag / undervoltage | | | | |
| Sag |  | System halts, loss of data, shutdown | Startup loads, faults | Power conditioner, UPS |
| Undervoltage |  | System halts, loss of data, shutdown | Utility faults, load changes | Power conditioner, UPS |
| 4. Swell / overvoltage | | | | |
| Swell |  | Nuisance tripping, equipment damage/reduced life | Load changes, utility faults | Power conditioner, UPS, ferroresonant "control" transformers |
| Overtvoltage |  | Equipment damage/reduced life | Load changes, utility faults | Power conditioner, UPS, ferroresonant "control" transformers |



The GENIUS Campus – PRO-DD Data Center

| 5. Waveform distortion | | | | |
|----------------------------|---|--|--|--|
| DC offset |  | Transformers heated, ground fault current, nuisance tripping | Faulty rectifiers, power supplies | Troubleshoot and replace defective equipment |
| Harmonics |  | Transformers heated, system halts | Electronic loads (non-linear loads) | Reconfigure distribution, install k-factor transformers, use PFC power supplies |
| Interharmonics |  | Light flicker, heating, communication interference | Control signals, faulty equipment, cycloconverters, frequency converters, induction motors, arcing devices | Power conditioner, filters, UPS |
| Notching |  | System halts, data loss | Variable speed drives, arc welders, light dimmers | Reconfigure distribution, relocate sensitive loads, install filters, UPS |
| Noise |  | System halts, data loss | Transmitters (radio), faulty equipment, ineffective grounding, proximity to EMI/RFI source | Remove transmitters, reconfigure grounding, moving away from EMI/RFI source, increase shielding filters, isolation transformer |
| Voltage fluctuations |  | System halts, data loss | Transmitters (radio), faulty equipment, ineffective grounding, proximity to EMI/RFI source | Reconfigure distribution, relocate sensitive loads, power conditioner, UPS |
| Power frequency variations |  | System halts, light flicker | Intermittent operation of load equipment | Reconfigure distribution, relocate sensitive loads, power conditioner, UPS |

- Required to be used at least one UPS, an air filter and a power distribution unit



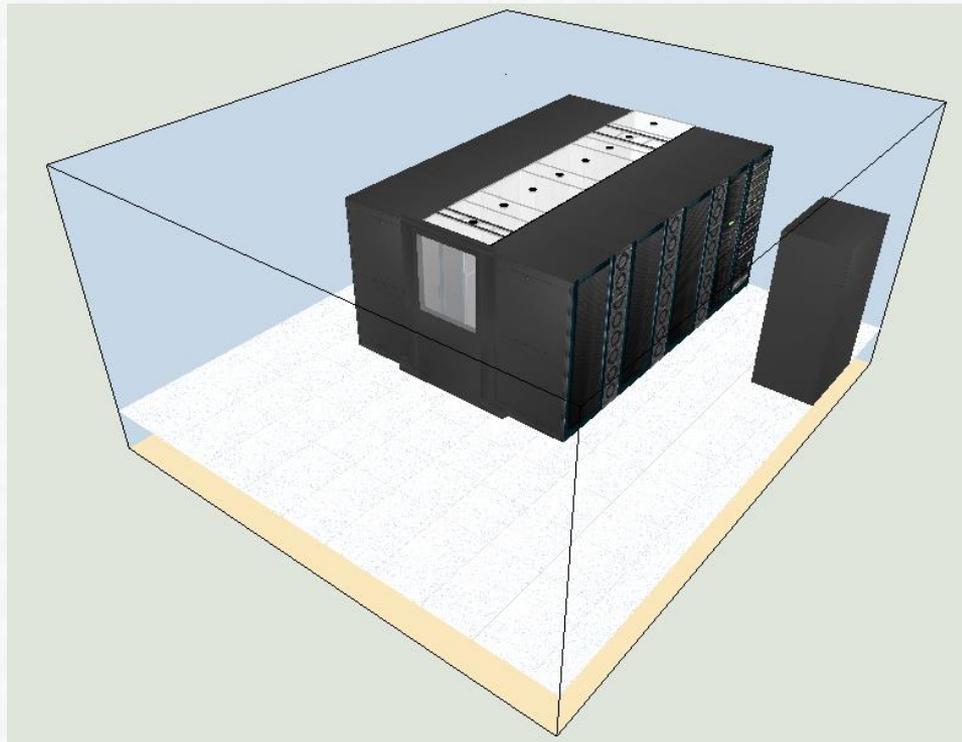
The GENIUS Campus – PRO-DD Data Center

- Incidents that occur due to the environment
- Optimum temperature: 22-24°C. If too low, too high or temperature variations occur:
 - Data corruption
 - System shutting down
- Optimum relative humidity: 30-50% (R.H.). To keep humidity between these limits is necessary a continuous air humidification (can not do this with a comfort system), which leads to a higher energy consumption
 - If it is too large: corrosion, condensation, gold, silver migration
 - If it is too small: electrostatic discharge
- The volume of air flow into the room: > 160 CFM per kW to maintain a uniform temperature into the room (at lower rates, as is the case with comfort systems, in the room appear warmer areas, and air is not clean enough).
- Required to be used at least one precision cooling unit (not enough a comfort system type)



The GENIUS Campus – PRO-DD Data Center

- Server room cooling solution:
- Solution is based on Hot Air Containment System (HACS).
- It involves closing the hot air passage between two rows of racks with a transparent ceiling and a door access to hot aisle.
- In this way you can install racks with high power, up to 20 KW / rack.



The GENIUS Campus – PRO-DD Data Center

- Data center location (yellow rectangle in the picture)



The GENIUS Campus – Technology Transfer

- Developing new education and training courses: M.Sc. programs
- Developing novel infrastructure in partnership with companies
- Applied research
- Joint research in Ph.D. programs

