An EC´s FP7 funded R&D project
(EC Contract 212966)

- RELIAWIND
- November 2008

- RELIAWIND Objectives
- NREL

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PROJECT RATIONALE

The first-ever European wide project that brings together major stakeholders of the complete Wind Energy value chain in order to jointly develop tools, models and design guidelines that will set the grounds for an upcoming new generation of highly cost effective onshore and offshore Wind Turbine Generators (WTG).

- 10 partners representing the full span of value chain, ranging from Academy to Industry.
- 10 partners associated to achieve European technological leadership by increasing knowledge that will allow to master the design, operation & maintenance of WTG.
- A fast track (36-months) project: start date 15/03/2008.
- Strongly results oriented (81 deliverables).
- A budget of 7,7 million euros.
- A proposed EC contribution of a maximum of 5,1 million euros.

TECHNOLOGICAL BACKGROUND

The future evolution path of wind power sector is offshore wind farms. From an Operations & Maintenance (O&M) point of view, the key success factors for offshore wind power are:

- ✓ Wind turbine designs for reduced maintenance. This implies:
  - ✓ **Use of high reliability components**
  - ✓ **Reduction of overall number of components and simplicity of design**
  - ✓ **Modular design of wind turbines which facilitates the interchange of faulty modules**
  - ✓ **Development of effective condition monitoring and remote control systems**
  - ✓ Re-siting of electrical units into an environmentally controlled section of the turbine
  - ✓ Implementation of offshore corrosion protection technology
- ✓ **Development of appropriate maintenance strategies for service and repair actions**
- ✓ **Reduction of time required for offshore working**
- ✓ Improvement of access methods, less sensitive to wind/wave conditions
- ✓ Development of an innovative holistic design of a multi-megawatt offshore WTG, where the design is not just incremental innovations or the mere up-scaling of current conventional onshore designs.

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PROJECT OBJECTIVES

- Objective 1: Identify Critical Failures and Components

- Identify Critical Items define as:
  - High valued components
  - Reliability sensitive pars (i.e. high failure rates from historical experience)
  - New technology or process apply to the component
  - Single failure points (failures that cause the total loss of the WTG)
  - Single source components
- Define failure causes, modes, and effects at component, sub-system and system level based on the analysis of available operational data.
- Define Reliability Allocations at system and sub-system level based on historical data.

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PROJECT OBJECTIVES

➢ Objective 2: Understand Failures and Their Mechanisms

- Identify, evaluate and document component failures, the potential impact of each functional or hardware failure on sub-system and system level and eliminate or mitigate the unacceptable effects.
- Perform Weibull analysis of population of components, determine when wearout begins and effectiveness of repair/discard actions.
- To identify, design and develop possible fault tolerance mechanisms, such as redundancies and back up systems at component and sub-component level, to ensure that failure propagation is contained at part, sub-component or component level and that the end effects are not impacting the operational availability of the WTG.
- Try to match component failure rate to schedule inspections, provide failure indicators identifying the parameters and measurements associated with the condition of impending failure and their evolution over time so that failures may be anticipated before the actual failure propagation is triggered, reduce the risk of maintenance induced failures and facilitate required inspections with minimal tools.

PROJECT OBJECTIVES

- Objective 3: Define the Logical Architecture
  - To identify and select the best sensing technology for each critical failure mode, or develop new sensing devices, appropriate for the parameters and measurements required and define the best signal treatment, conditioning and transmission for the different sensors utilized.
  - To define the expert system architecture that best fits the needs of supervisory control, diagnostics and prognostics of the WTG (neural networks, fuzzy logic, unsupervised supervisory system, etc.).
  - To define and develop a predictive supervisory WTG control system, that optimize power production and loads imposed on WTG critical components to maximize reliability, component lives and WTG availability.
  - To develop an advanced remote diagnose system with a high rate of both defect detection and location and a extremely low rate of false alarms.
  - To develop a set of predictive tools that will enable maintenance planners to accurately predict future evolution of WTG condition to plan maintenance needs and to produce highly optimized maintenance resources.

PROJECT OBJECTIVES

- Objective 4: Demonstrate the Principles of the Project Findings
  - To define a common set of protocols and standards that would guarantee interoperability among different manufacturers and customers.
  - To integrate technologies, methods and applications in a consistent set of remote control and monitoring tools.
  - To develop a consistent set of applications that would enable to optimize the operation and maintenance concept, by maximizing WTG availability and optimizing CoE (cost of energy) for both onshore and offshore wind farms.

- Objective 5: Train partners and other Wind Energy sector stakeholders
  - To provide training to the partners and other stakeholders about the reliability, modelling and information tools needed to enable a more reliability-minded approach to be applied in the future to these activities

- Objective 6: Disseminate the achieved new knowledge.
  - The aim is to disseminate the findings to the Wind Energy Sector Community in the European Union. This will be achieved through Conferences, Workshops, web site and media initiatives.

PROJECT OBJECTIVES vs. WORK PACKAGES

Objectives and associated work plan		WP-1	WP-2	WP-3	WP-4	WP-5	WP-6
Objective 1	To identify Critical Failures and Components	Field Reliability Analysis					
Objective 2	To understand Failures and Their Mechanisms		Design for Reliability				
Objective 3	To define the Architecture of a Health Monitoring System			Algorithms			
Objective 4	To demonstrate the Principles of the Project Findings				Applications		
Objective 5	To train internal and external partners					Training	
Objective 6	To disseminate the new knowledge through Conferences, Workshops, Web Site and Media						Dissemination

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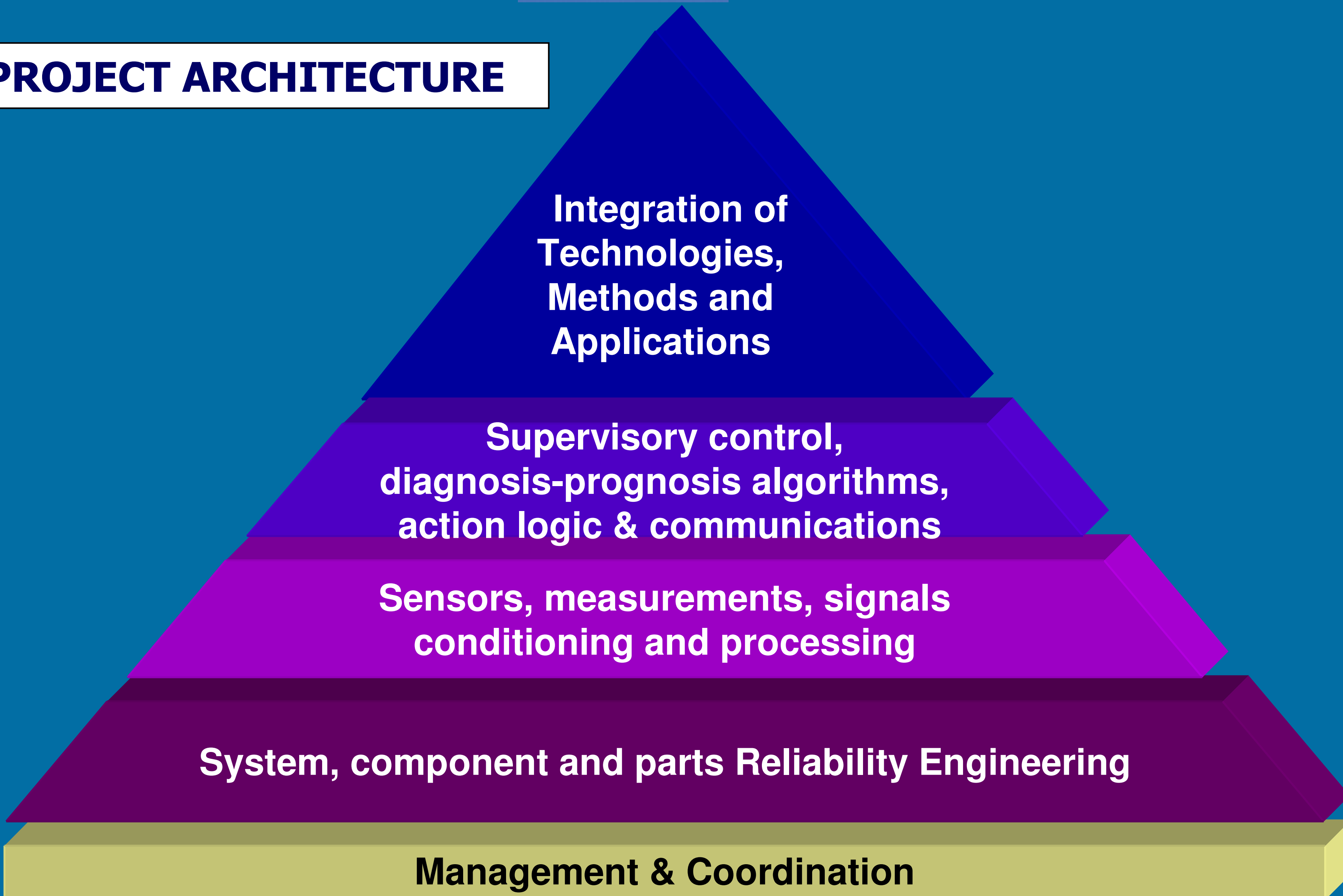
PROJECT ARCHITECTURE



QUANTITATIVE OBJECTIVES

- Mean Time Between Failures (MTBF):
  - Offshore: 20% increase
  - Onshore: 10% increase
- Mean Time to Repair (MTTR)
  - Offshore: 50% reduction
  - Onshore: 20% reduction
- Operational Availability (%)
  - Offshore availability: 97-98%, (currently 85-90%)
  - Onshore availability: 98-99% (currently 97-98%)
- Cost of Energy (CoE): < 0.04 €/kWh

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PROJECT CONSORTIUM

Partner's integration in Value Chain

Research Institutions:
SZTAKI
Durham University

Components Manufacturers:
LM Glasfiber
Hansen
ABB
SKF
Garrad Hassan

WTG Manufacturers:
Ecotecnia
Gamesa

Wind Farm Owners:
TBD

Reliability Specialize Firm
Relex

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SYSTEM/COMPONENT PARTNER RESPONSABILITY

System / Component	Responsible Partner
Pitch System (Electrical & Hydraulic)	Ecotecnia – Gamesa
Blades	LM Glassfiber
Blade Bearings	SKF
Gearbox	Hansen & SKF
Hub, Main shaft, Main frame, Rear structure, Cover, Tower, Foundation, Yaw system	Ecotecnia
Converter, Transformer, Switch Gear, Generator	ABB
Control	Garrad Hassan - Gamesa
Auxiliary Equipment	Gamesa
Wind Farm Systems	Gamesa