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WP 8

VALIDATION & INTEGRATION

2ND YEAR REPORT

NOVEMBER 2003 OCTOBER 2004

EOLI SECOND YEAR PLENARY MEETING

NOVEMBER 2004



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INVOLVED PARTNERS

LABORATOIRE DE BIOTECHNOLOGIE DE L'ENVIRONNEMENT, INRA (2)

POLITECNICO DI MILANO (4)

SOCIETÀ DI PROGETTAZIONE ELETTRONICA E SOFTWARE (5)

UNIVERSIDAD NATIONAL AUTONÓMA DE MÉXICO (6)

UNIVRSIDAD DE LA REPÚBLICA ORIENTAL DEL URUGUAY (7)

IBTECH S.A. DE C.V. (8)

THE PARTNER 4 (POLIMI) IMPLEMENTED HIS ACTIVITY IN THE WP8 BY THE WAY OF A SUBCONTRACTOR.

THE SUBCONTARCTOR IS AN ITALIAN NATIONAL RESEARCH AGENCY: ENTE PER LE NUOVE TECNOLOGIE, L'ENERGIA E L'AMBIENTE (ENEA). IT DESIGNED AND BUILT UP THE SECOND PILOT PLANT OF THE PROJECT.

SCHEDULED TASKS

- 1. SEARCH FOR AN EFFICIENT DISTRIBUTION OF COMPUTATIONAL RESOURCES (VIZ. LOW COST SOLUTION); MINIMUM EXPERTISE REQUIRED TO PLANT WORKERS**
- 2. INTELLIGENCE DELOCALISATION AT SENSOR AND ACTUATOR LEVEL: OPTIMISE THE COST/PERFORMANCE RATIO**
- 3. INTEGRATE SW-HW SENSORS, CONTROLLERS, FDI, DSS IN COMPACT STANDARDIZED MODULES AS PLUG-AND-PLAY DEVICES**
- 4. PERFORMANCE EVALUATION OF INTEGRATED MONITORING AND CONTROLLERS**

OBJECTIVES

1. **DEVELOPMENT & IMPLEMENTATION OF THE INTEGRATION FRAMEWORK OF THE EOLI SUPERVISION SYSTEM ON MULTIPLE PLANTS (I.P. BOLOGNA AND THEN NARBONNE FOR EC FINAL EVALUATION)**
2. **INRA AND ENEA (WHICH IS SITED NEAR A FULL SCALE ONE) PLANTS WILL BE EQUIPPED WITH THE PROTOTYPAL VERSION OF EOLI HW-SW PLATFORM BY SPES. THE ENEA PILOT PLANT WILL BE USED FOR THE FIELD TEST; THEN THE SYSTEM WILL BE MOVED TO INRA PILOT FOR THE INTEGRATION OF MATLAB MODULES (CONTROL AND SUPERVISION) FOR THE VALIDATION**
3. **STRESS OUT THE DISSEMINATION & EXPLOITATION OF THE RESULTS OF EOLI PROJECT: THE SYSTEMS DEVELOPED BY UNAM AD UU TO CONTROL THEIR LAB PLANTS HELP US TO REACH THAT GOAL FOR EC REVIEW (SEE DERIVABLE D8.1)**
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Task & Objectives	Progress towards achieving objectives (Outputs)
WP 8 - TASK 8.2. SENSOR CONFIGURATION NETWORK SELECTION OBJECTIVES: SELECTION OF THE MOST SUITABLE HARDWARE + SOFTWARE SENSOR CONFIGURATIONS, STARTING FROM THE SIMPLEST ONE (PH + DO PROBES + SOFTWARE SENSORS) TO THE MOST COMPLEX (PH + DO + REDOX PROBES + UV NITRATE/COD SENSOR + TITRATION BIOSENSOR + SOFTWARE SENSORS)	EXPERIMENTS WERE RUNNING AT LAB (UNAM AND UU) AND PILOT (POLIMI_ENEA AND LBE) PLANTS TO INVESTIGATE THE BEST SENSOR NETWORK CONFIGURATION TWO APPROACHES ARE PROPOSED: THE FIRST ONE DEALS WITH THE IMPLEMENTATION OF A SYSTEM'S ARCHITECTURE USING COMMERCIAL GENERAL PURPOSE DEVICES AVAILABLE ON THE MARKET (UNAM IBTECH UU), THE SECOND ONE IS DEVOTED TO THE DEVELOPMENT OF AN EMBEDDED SOLUTION AND IS CONCERNING WITH AN ARCHITECTURE BASED ON EMBEDDED ELECTRONICS AND LOW COST COMPONENTS (SPES INRA-LBE). THE FIRST APPROACH IS NOW UNDER VALIDATION: DIFFERENT ARCHITECTURES BASED ON COMMERCIAL OFF THE SHELF COMPONENTS ARE RUNNING AT LAB PLANTS (UNAM AND UU) TO IMPLEMENT THE SECOND APPROACH, AN EMBEDDED DIGITAL PLATFORM WAS DESIGNED AND DEVELOPED (SPES): THE HARDWARE COMPONENTS WERE PRODUCED AND ARE READY FOR USE; THE SOFTWARE ENVIRONMENT IS GOING TO BE COMPLETED AND DEBUGGED. THE WHOLE SYSTEM WILL BE TESTED AND VALIDATED DURING THE THIRD YEAR AT THE TWO PILOT PLANT SITES (POLIMI-ENEA AND LBE)
WP 8 - TASK 8.3. HARDWARE AND SOFTWARE DESIGN OBJECTIVES: DESIGN THE HARDWARE AND FIRMWARE, BASED ON EMBEDDED TECHNOLOGY, OF THE ELECTRONIC BOARDS. DESIGN THE SOFTWARE MAIN FRAME OF THE SYSTEM BASED ON ERGONOMIC USER INTERFACES.	SEVERAL MATLAB MODULES WERE DESIGNED AND IMPLEMENTED FOR MONITORING, CONTROL AND SUPERVISION (UNAM, UU AND LBE). THEY ARE UNDER TEST AND VALIDATION AT THE LAB

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THE EFFORT WAS SPENT FOR THE MOST TO SET UP, TUNE AND MANAGE THE PILOT PLANT. A SET OF VARIABLES TO BE ACQUIRED ON-LINE WAS DEFINED (WP8.2) HARDWARE AND SOFTWARE TOOLS WERE IMPLEMENTED FOR THE AUTOMATION OF THE PLANT MANAGEMENT.

THE PLANT WILL BE USED FOR THE VALIDATION OF THE EOLI SYSTEM (THE HARDWARE AND SOFTWARE ARCHITECTURE AND THE SUPERVISION SYSTEM) AND FOR THE INTEGRATION ACTIVITY.

LBE

HARDWARE ARCHITECTURE



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MATERIAL:

- PC WITH ONE SERIAL PORT
- RS485 AND RS232
- ALIMENTATION 24V

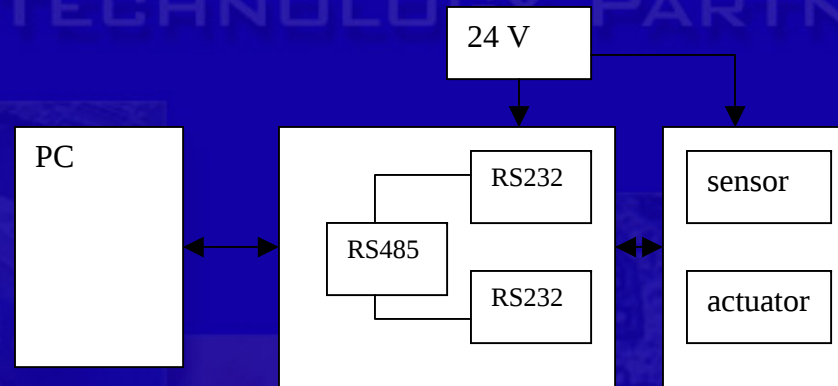
INPUT OUTPUT REQUIREMENT:

ANALOG INPUTS : 11

LOGIC INPUTS : 0

ANALOG OUTPUTS : 3

LOGIC OUTPUTS : 2



THIS I/O BUS IS USED WITH THE ACTUAL SENSORS AND ACTUATORS. MORE INPUTS OR OUTPUTS FOR ADDITIONAL MATERIAL (HARDWARE SENSORS TO BE DEVELOPED WITHIN THE PROJECT) CAN BE NEEDED.

LBE

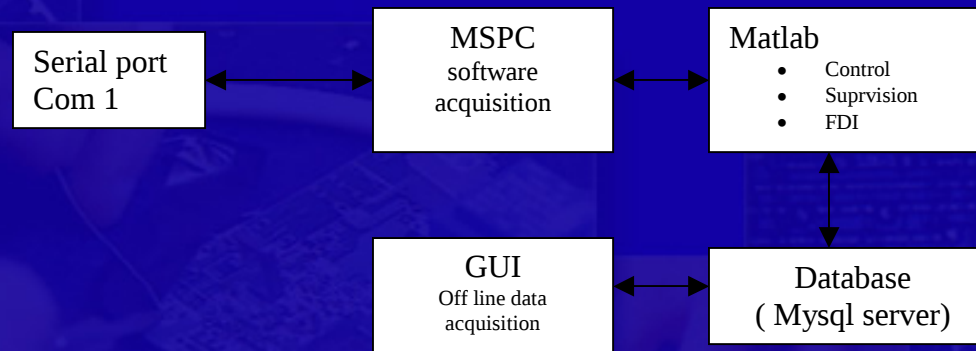


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SOFTWARE ARCHITECTURE

THE MSPC SOFTWARE ENVIRONMENT IS USED TO ACQUIRE DATA AND TO COMMUNICATE WITH THE SERIAL PORT CONNECTED TO RS485. EACH SAMPLING TIME, MSPC CALLS MATLAB'S MODULES (CONTROLLERS, FDI AND SUPERVISION SYSTEMS) TO EVALUATE THE OUTPUTS. ON LINE AND OFF LINE DATA ARE SAVED IN A DATABASE (WE USE MYSQL SERVER). DATA CAN BE UPLOADED OR DOWNLOADED FROM MATLAB'S MODULES FOR ANY ANALYSIS OR MONITORING NEEDS.



THE DATABASE STRUCTURE IS COMPLIANT WITH THE ONE DEFINED IN ANOTHER PROJECT (TELEMAC) FUNDED BY THE EC AND DEVOTED TO DEVELOP MONITORING AND CONTROL SYSTEMS FOR WWTP BASED ON ANAEROBIC DIGESTION.

THIS IS A SIGNIFICANT ISSUE IN ORDER OF POSSIBLE CLUSTERING.

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ENEA TAKES PART IN THE EOLI PROJECT AS SUBCONTRACTOR OF THE PARTNER 4 (POLIMI).

THE ROLE OF ENEA IS TO PROVIDE, SET UP AND MANAGE A PILOT PLANT TO BE USED FOR THE FIELD TEST BOTH OF THE ON LINE VERSION OF THE TITRATOR SENSOR AND OF THE EOLI HARDWARE AND SOFTWARE ARCHITECTURE.

TILL NOW THE ACTIVITY HAS BEEN FOCUSED TO BUILD UP AND START UP THE PILOT PLANT.

AT NOW IT IS LOCATED AT THE SITE OF A FULL SCALE MUNICIPAL WWTP. THE PILOT IS FED WITH WASTE WATER FROM THE FEEDING LINE OF THE FULL SCALE PLANT.

THE PLANT IS MOVABLE.

ENEA

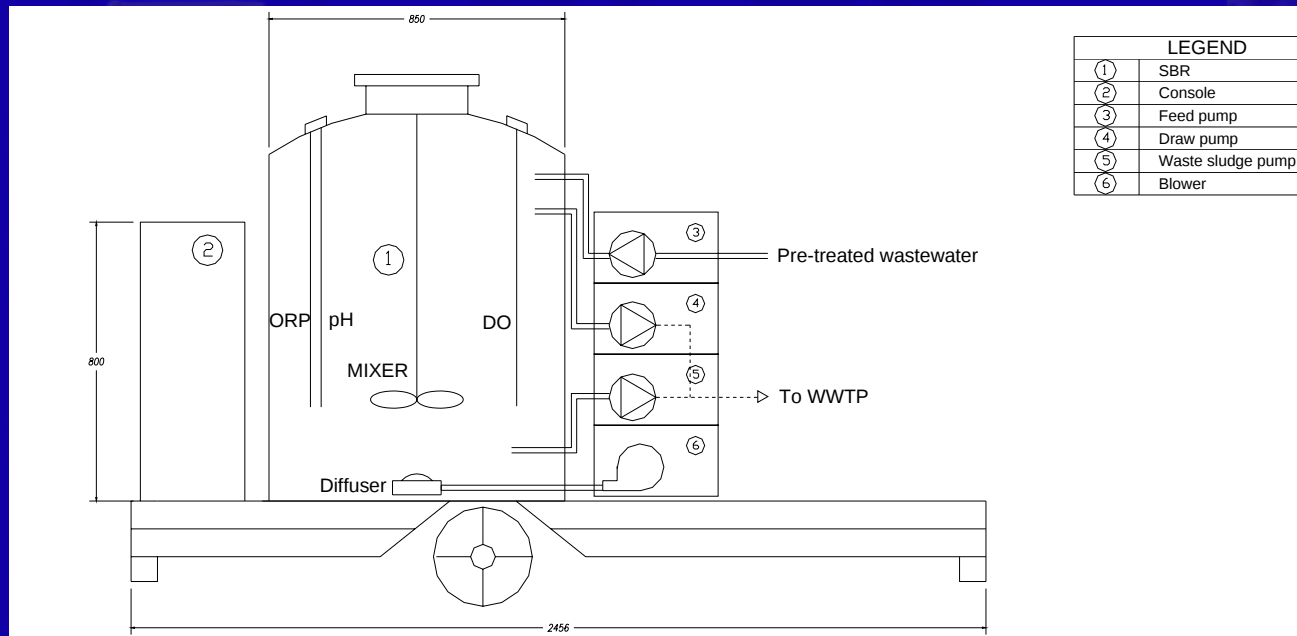


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THE PILOT PLANT HAS A VOLUME OF 500 LITRES, THE FEEDING VOLUME IS OF 100 LITRES FOR EACH CYCLE, FOR A DAILY TOTAL FEEDING VOLUME OF 400 LITERS ON FOUR CYCLES.

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- **PH**
- **ORP**
- **DO**

THE DATA ACQUISITION AND STORAGE IS IMPLEMENTED USING A PC EQUIPPED WITH A GENERAL PURPOSE DATA ACQUISITION BOARD (NI 6052E NATIONAL INSTRUMENTS) AND WITH A SOFTWARE ENVIRONMENT DEVELOPED IN LABVIEW (NATIONAL INSTRUMENTS).

THE I/O INTERFACE SPECIFICATION REQUIREMENTS ARE:

- **8 ANALOG INPUT (BIPOLAR, 16 BIT RESOLUTION)**
- **8 DIGITAL INPUT/OUTPUT**
- **2 ANALOG OUTPUT (12 BIT RESOLUTION)**

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THE MOST OF THE EFFORT WAS SPENT ON THE WP8.3.

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**THE FIRST RELEASE OF THE HARDWARE AND SOFTWARE PLATFORM
WAS DESIGNED AND REALIZED AND IS GOING TO BE TESTED AND
IMPLEMENTED AT THE ENEA PILOT PLANT.**

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JANUARY 2004

- **ELECTRIC SCHEMES DESIGN BEGINNING**

FEBRUARY 2004

- **FIRMWARE DESIGN BEGINNING**

MARCH 2004

- **ELECTRIC SCHEMES COMPLETION**

APRIL 2004

- **MANUFACTURING OF THE EMBEDDED ELECTRONIC BOARDS**
- **PC SOFTWARE DESIGN BEGINNING**

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MAY 2004

- **IN-CIRCUIT TEST AND DEBUG OF THE EMBEDDED ELECTRONIC BOARDS**
- **FIRMWARE DESIGN COMPLETION**

CHECK OF THE MILESTONE AT T0+18: POSITIVE.

JUNE 2004

- **SYSTEM SET UP**

JULY 2004

- **PLATFORM LAB TEST AND DEBUG BEGINNING**

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NOVEMBER 2004

• **LAB TEST AND DEBUG COMPLETION**

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THE HARDWARE BASIC COMPONENTS OF THE DIGITAL PLATFORM ARE NOW AVAILABLE:

- **THE ELECTRONIC SLAVE BOARD TO EQUIP EACH SENSOR: IT ACQUIRES AND PERFORMS A FIRST CONDITIONING OF THE SIGNAL AND, IF REQUIRED, PERIODICAL OPERATION OF DIAGNOSIS, SUCH AS DETECTION OF PROBE FAULTS, AND AUTO-CALIBRATION;**
- **THE ELECTRONIC MAIN BOARD OF THE PLANT IS ABLE TO COMMUNICATE USING A RF LINK (DECT STANDARD NETWORK) WITH THE SLAVE BOARDS TO GATHER THE DATA DIRECTLY ON A DIGITAL MEDIA AND TO STORE THEM; THIS BOARD HAS TWO SERIAL RS232 INTERFACES TO EXCHANGE DATA AND COMMAND WITH BOTH A PLC AND A PC.**

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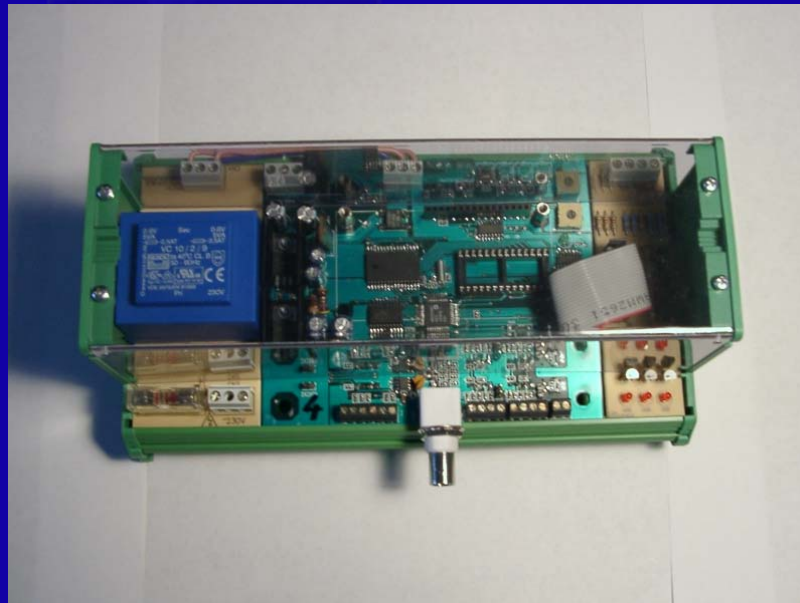


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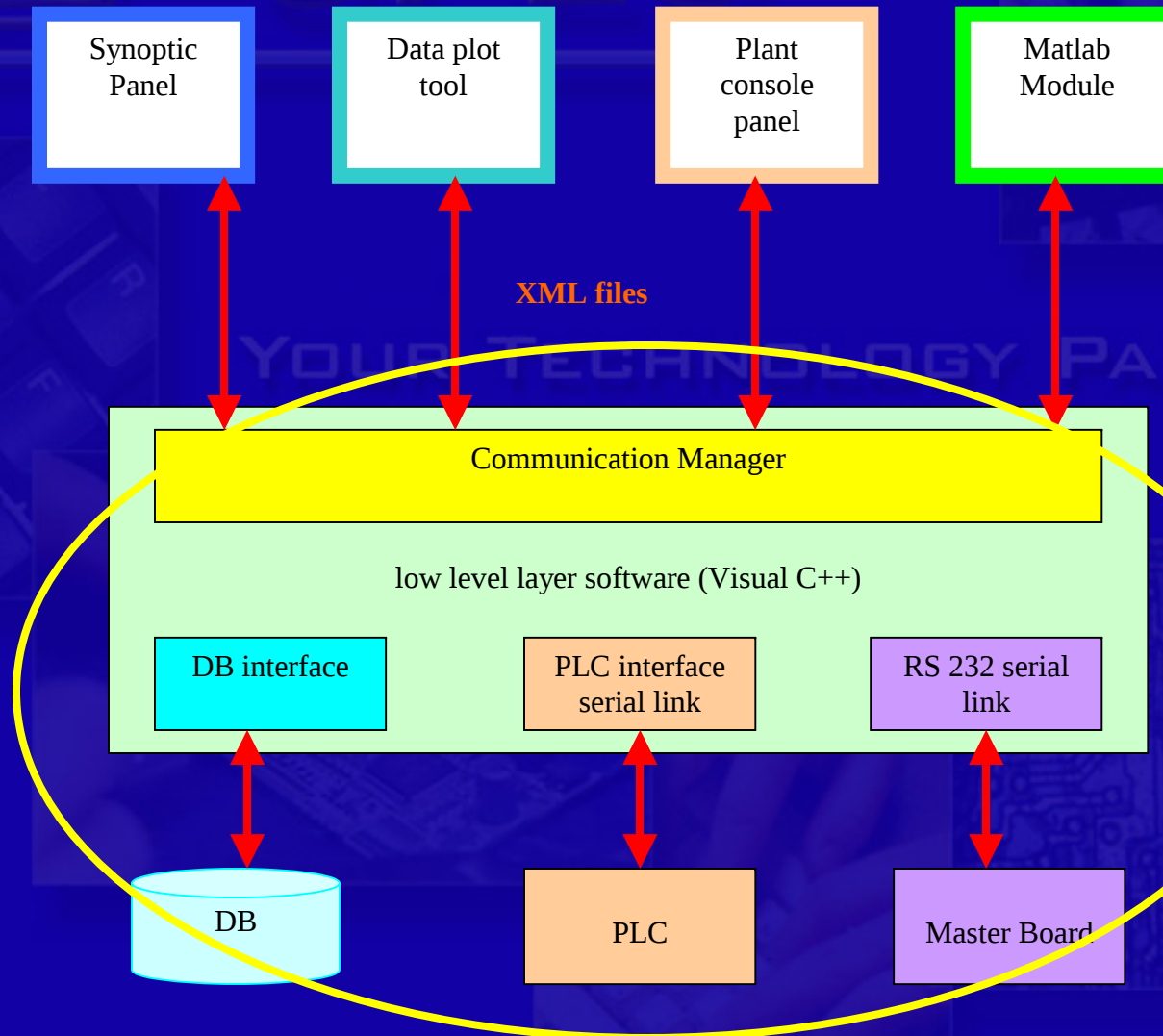
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THE EOLI SOFTWARE ENVIRONMENT HAS BEEN DESIGNED AND IMPLEMENTED ACCORDING WITH THE REQUIREMENT SPECIFICATIONS ASSESSED IN THE DELIVERABLE D8.1. IT PROVIDES ALL THE FUNCTIONALITIES NEEDED FOR MONITORING AND CONTROL.

THE CORE IS A DATABASE, IMPLEMENTED IN MYSQL TECHNOLOGY, USED TO STORE ALL THE DATA GATHERED (MEASUREMENTS), GENERATED (COMMANDS), TRANSFERRED AND MANAGED BY THE EOLI SYSTEM.

THIS SOFTWARE IS ORGANIZED IN MODULES.

SPES



SPES

THERE IS A LOW LEVEL LAYER, DEVELOPED IN MICROSOFT VISUAL C++, BASED ON A MULTITHREADING APPROACH, TO EMULATE PARALLEL RUN OF DIFFERENT TASKS ON THE SAME MACHINE, THAT SERVES THE BASIC TASKS OF THE SYSTEM:

- **INTERACTION WITH WINDOWS OS;**
- **COMMUNICATION VIA SERIAL RS232 LINKS WITH THE MASTER BOARD AND WITH THE PLC;**
- **MANAGEMENT OF THE DATABASE ACCESS;**
- **GATEWAY IMPLEMENTATION VIA LAN LINK;**
- **COMMUNICATION MANAGER IMPLEMENTATION.**

THE COMMUNICATION MANAGER IMPLEMENTS THE TASK OF DATA EXCHANGE BETWEEN THE DATABASE AND SEVERAL OTHER MODULES DEVELOPED FOR MONITORING AND CONTROL, IMPLEMENTED AS COMPILED MODULES. THE MEDIA FOR DATA EXCHANGE ARE TEXT FILES IN XML FORMAT.

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THE FORESEEN TIME TABLE FOR THE NEXT MONTHS

MARCH 2005

PC SOFTWARE DESIGN COMPLETION

FIELD TEST AT THE ENEA PILOT BEGINNING

MAY 2005

FIELD TEST AT THE LBE PILOT IN NARBONNE BEGINNING

OCTOBER 2005

END OF THE PROJECT

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DELIVERABLES TO BE PRODUCED

D8.2	HARDWARE SENSOR NETWORKS	T0+30
D8.3	SOFTWARE MAIN FRAME ABLE TO INTEGRATE AND MANAGE THE SYSTEM	T0+28
D8.4	REPORT ON THE EVALUATION AND VALIDATION OF THE WHOLE SYSTEM	T0+36

MILESTONES AND EXPECTED RESULT

- **FIELD TEST OF THE HARDWARE (ELECTRONIC) MAIN FRAME : T0+29**
- **VALIDATION TESTS OF THE HARDWARE AND SOFTWARE MAIN FRAME OF THE SYSTEM: T0+35**

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1. THE SENSOR NETWORK

**SELECTION OF THE MOST SUITABLE HARDWARE + SOFTWARE
SENSOR CONFIGURATIONS, STARTING FROM THE SIMPLEST ONE
(PH + DO PROBES + SOFTWARE SENSORS) TO THE MOST
COMPLEX (PH + DO + REDOX PROBES + UV NITRATE/COD SENSOR
+ TITRATION BIOSENSOR + SOFTWARE SENSORS)**

INTEGRATION ACTIVITY WITH

- WP1
- WP2
- WP3
- WP4

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2. THE DATABASE STRUCTURE

**SELECTION OF THE MOST SUITABLE STRUCTURE FOR THE MYSQL
DATABASE USED TO STORE THE DATA. POSSIBLE
CLUSTERISATION WITH THE TELEMATICS PROJECT
INTEGRATION ACTIVITY WITH**

•WP5

•WP6

•WP7

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3. THE MATLAB MODULES INTERFACE

SELECTION OF THE MOST SUITED FORMAT FOR THE TXT FILE USED TO TRANSFER DATA BETWEEN THE MATLAB COMPILED MODULES AND THE EOLI SOFTWARE ENVIRONMENT. A DTD DOCUMENT HAS TO BE PRODUCED AS REQUIREMENTS' SPECIFICATION.

INTEGRATION ACTIVITY WITH

- WP5
- WP6
- WP7

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4. FIELD TEST AND VALIDATION

VERIFY THE NUMBER AND THE TYPE OF COMPONENTS AND MODULES DEVELOPED TO BE INVOLVED IN THE VALIDATION AT THE PILOT SITES.

HARDWARE SENSORS VALIDATION MANAGEMENT – TIMETABLE.

MATLAB MODULES: HOW MANY AND THEIR PURPOSE - DEFINE A LIST AND A PRIORITY.

INTEGRATION ACTIVITY WITH

•ALL THE WPS

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TASK'S LIST FOR INTEGRATION - SUMMARY

JANUARY 2005

1. SENSORS' NETWORK – SELECTION OF THE MOST SUITABLE HARDWARE + SOFTWARE SENSOR CONFIGURATIONS

TASK LEADER?

2. DATABASE STRUCTURE – DEFINITION OF THE STRUCTURE AND TABLES OF THE MYSQL DATABASE; EDITING OF A REQUIREMENT SPECIFICATIONS DOCUMENT

TASK LEADER?

FEBRUARY 2005

3. MATLAB MODULES – DEFINITION AND EDITING OF A DTD FORMAT DOCUMENT

TASK LEADER?

4. FIELD TEST AND VALIDATION – LIST OF THE MATLAB MODULES TO BE VALIDATED AND DEFINITION OF A PRIORITY

TASK LEADER?

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CONCLUSION AND PROSPECTIVE

BOTH THE PILOT AND THE LAB PLANTS WERE BUILT UP AND STARTED UP ON TIME.

THE INTEGRATION ACTIVITY IS GOING TO BE STARTED AND IMPLEMENTED. THE ARCHITECTURE WAS DEFINED AND ASSESSED, THE HARDWARE AND SOFTWARE COMPONENTS ARE GOING TO BE TESTED.

THE INTEGRATION WILL BE FUNDAMENTAL FOR THE SUCCESS OF THE PROJECT.

THE GOAL IT IS TO CLEARLY DEFINE THE ROLE AND THE OBJECTIVES OF EACH PARTNER INVOLVED AND THE USE OF EACH PLANT (PILOT OR LAB PLANT) IN SUCH A WAY TO ENSURE AND FINALISE THE HIGHEST LEVEL AS POSSIBLE IN THE INTERACTION AND CO-OPERATION.



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