"ASSET LIFECYCLE MANAGEMENT: ENABLING TECHNOLOGIES, SYSTEMS AND SERVICES»

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CERTH-ITI Research Seminar
9 Nov 2011

ATHENA Research Centre

Applied ICT

Industrial Systems Institute

Digital Curation Unit
Athena Research Centre

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Outline

- Engineering Asset Lifecycle Management
- Enabling Technologies
- Advanced e-Maintenance Services
- Skills & Competences
- Conclusion

Manufacturing

Mining - Metallurgy

Maritime & Shipping

Offshore Engineering

Transport

Power Generation

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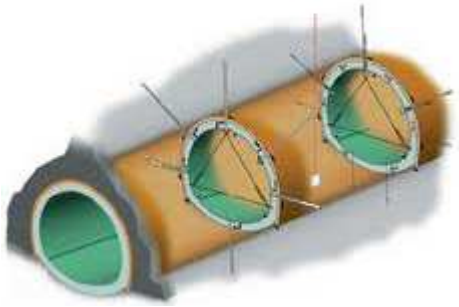
Facilities Management

Infrastructure

Highway Asset Management

Process Industry

Paper and Pulp Industry



Structural Integrity

Asset Lifecycle Management

Examine design options to meet business requirements

Evaluate decision options.

Manage procurement/construction/installation

Ensure quality, health, safety, responsiveness, dependability

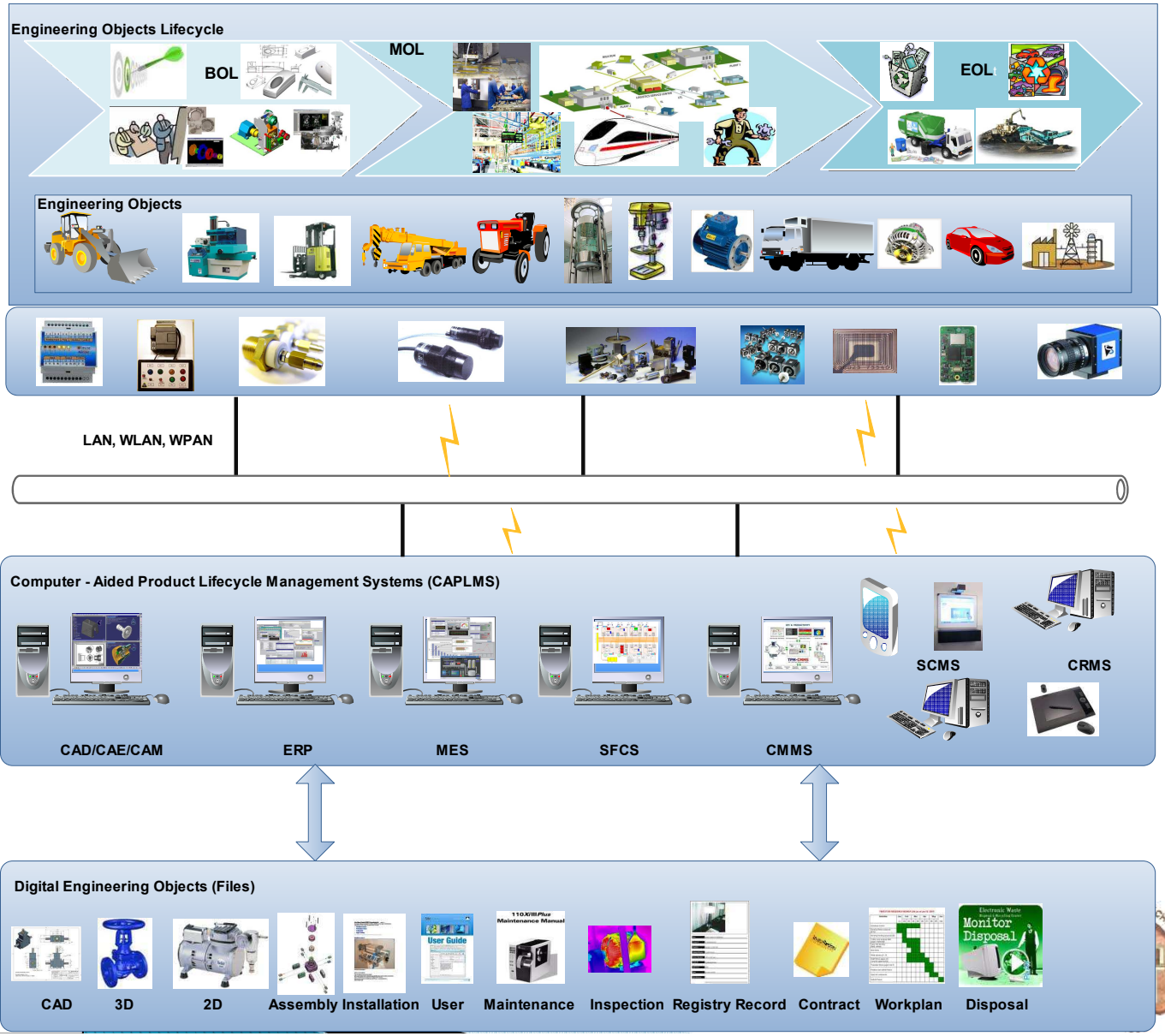
Manage Performance Indicators such as Total Cost of Ownership (TCO) and Overall Equipment Effectiveness (OEE), via adequate asset and maintenance strategies implementation & monitoring

Manage operational costs

Constantly evaluate current effectiveness against costs of investment in upgrades

Engage stakeholders, plan and execute disposal, recycling or remanufacturing

The Asset Lifecycle Management 'Ecosystem'



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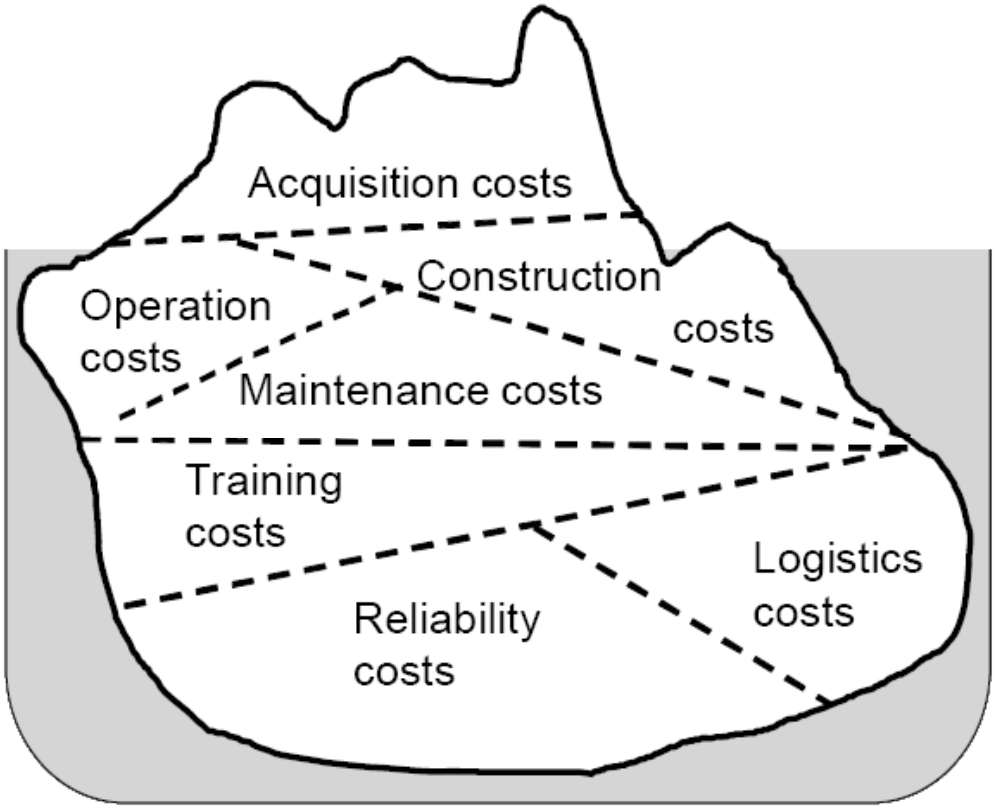
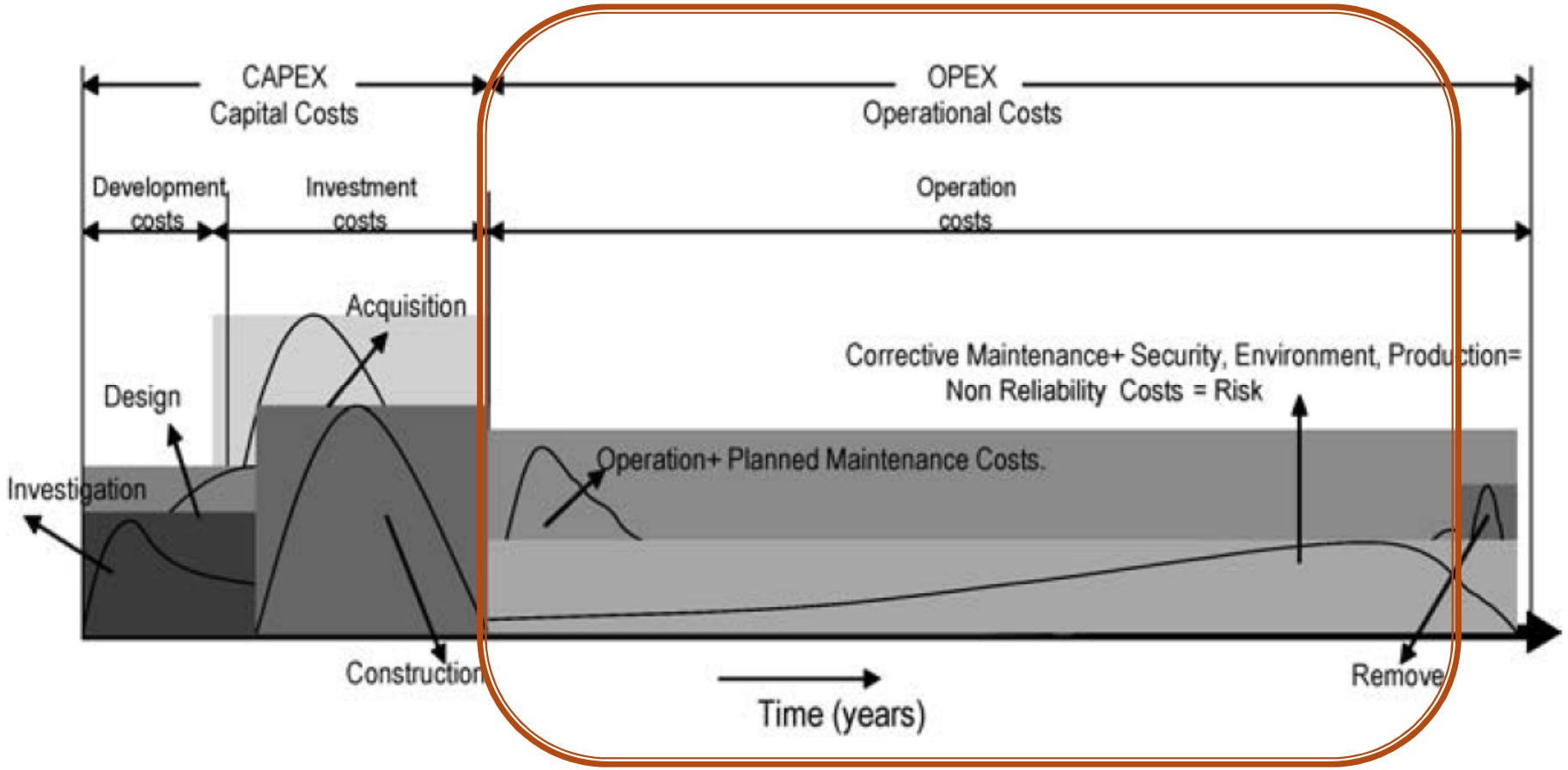
Show me the money: Asset Lifecycle Costing



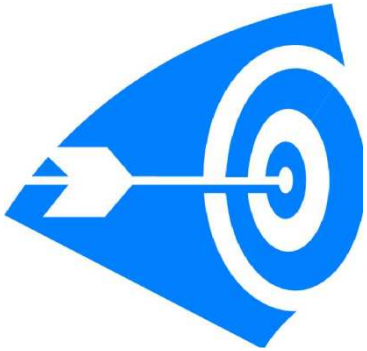
- Crespo-Marquez, A., (2007), The Maintenance Management Framework

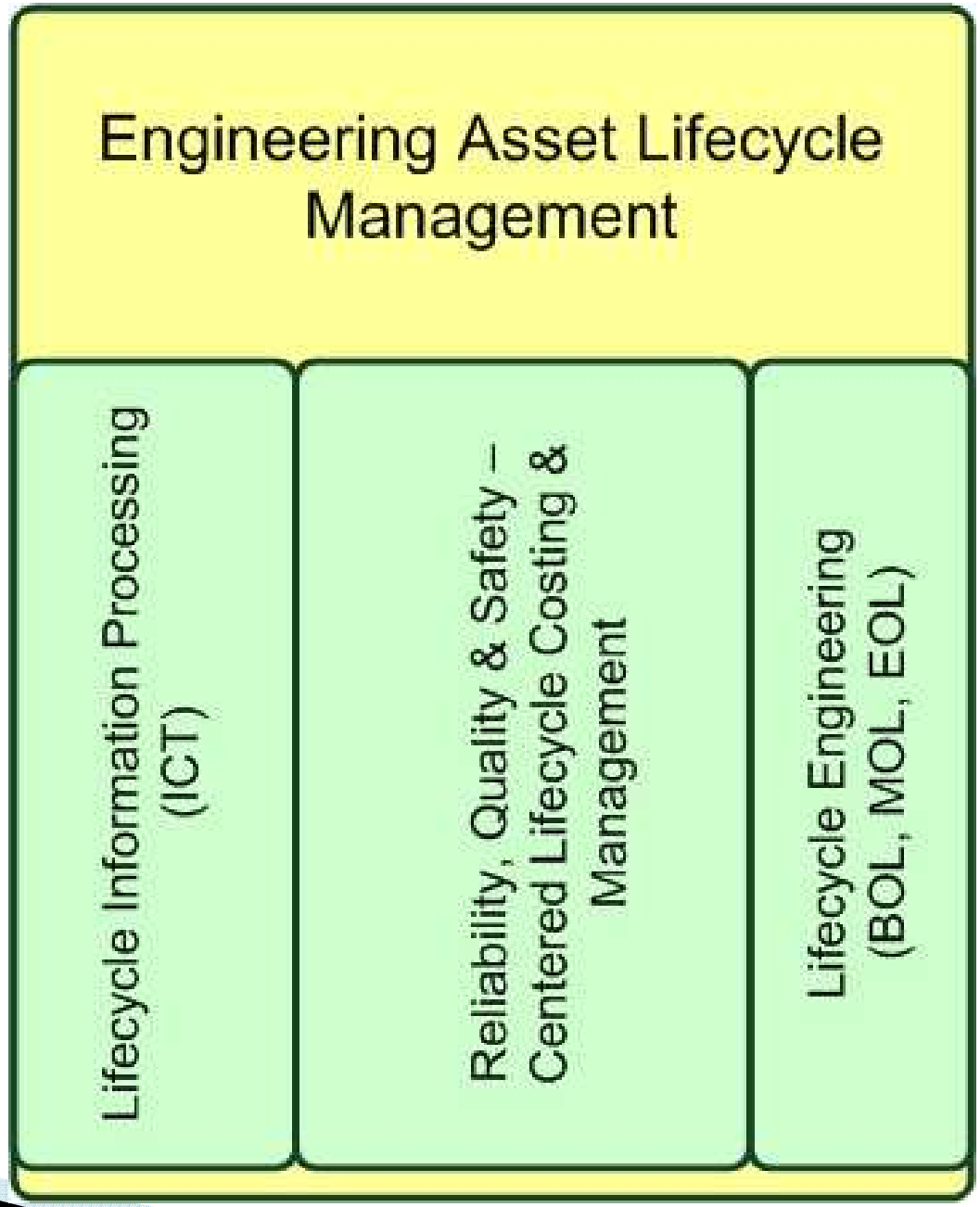
Asset Lifecycle Costing



- Crespo-Marquez, A., (2007), The Maintenance Management Framework

Is this motivating enough ?




Engineering Asset Lifecycle Management
Lifecycle Information Processing (ICT)
Reliability, Quality & Safety – Centered Lifecycle Costing & Management
Lifecycle Engineering (BOL, MOL, EOL)

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Key Enabling ICT Technologies

Web-based and semantic maintenance

Mobile and situated computing

Wireless sensing and identification

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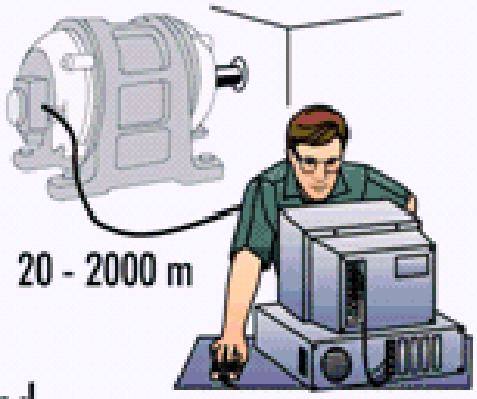
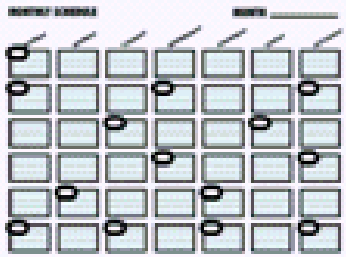
DYNAMAITE

TODAY

Condition Based Maintenance
~15%



Scheduled
Maintenance
~55%



Unplanned
Maintenance ~30%

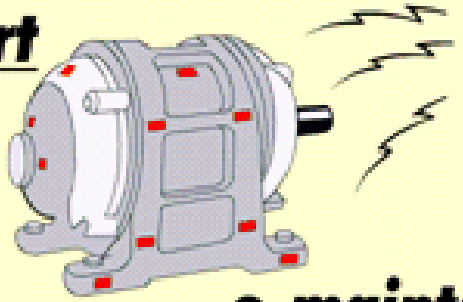
EU FUTURE

Dynamic Decision Based Maintenance

Wireless Communication

Smart PDA

Smart TAG



Lube Sensors

Micro Sensors

e-maintenance

Diagnostic Center

- History Data
- Modelbased Data
- Statistical Data

Strategies for Cost Effectiveness

Dynamite Book: e-Maintenance

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Challenges in EALM and e-Maintenance

- e-Maintenance makes related services and information ubiquitously available
- Facilitates seamless integration of data, services & actors
- Empowers enterprises to design, plan, execute and re-align their asset management activities
- Sustainability Efficiency assessed by KPIs
- Continuous measurement of operational and other data (Accuracy ? Timeliness ? Integrity ? Reliability ?)
- Maintaining asset condition, while meeting requirements is a fine balancing act with complex decision-making.

Web-based and semantic maintenance

Web-based maintenance changes the way maintenance ICT is employed:

- interconnects assets, devices and actors
- maintenance-support 'software creation' at the request of a user, device or event
- flow of maintenance-related services / not isolated SW
- distributed maintenance processes executed, right next to where maintenance activities take place.

Asset Lifecycle Data Management

Recording, processing and delivering data and orders providing decision support, via adequate HCI support

- Asset registry
- Low level controls & data
- Lifecycle asset data
- Asset operating state data
- Product or asset BOM (Bill of materials) data
- History records (tasks, operating & loading conditions, readings)
- Spare parts management
- Maintenance tasks management
- Human resources management
- Orders management
- Invoicing
- Key Performance Indicators (KPIs)

Maintenance Services Data Integration

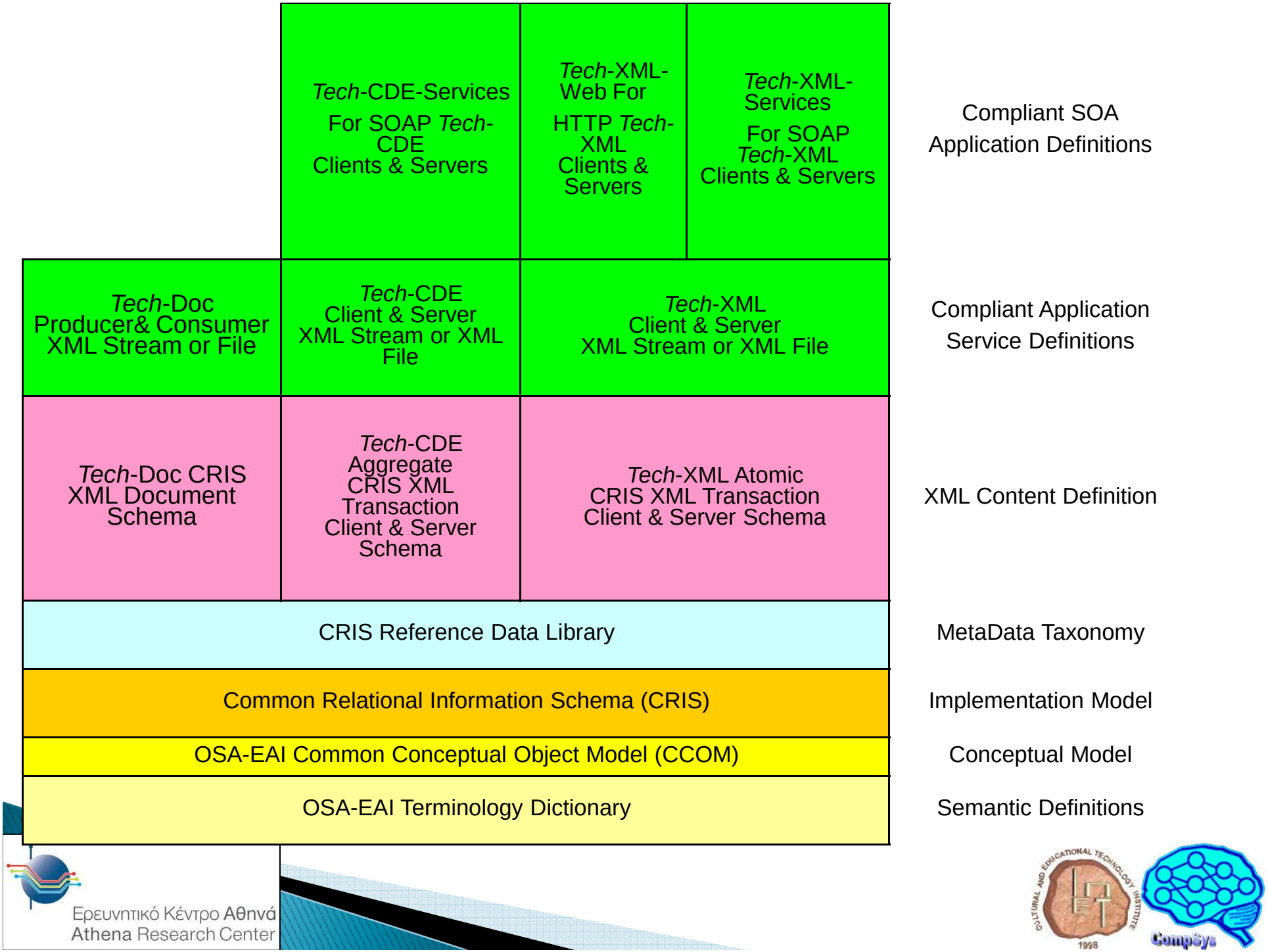
MIMOSA

- Non profit organization for the adoption of open standards for Maintenance & Engineering Asset Management

www.mimosa.org

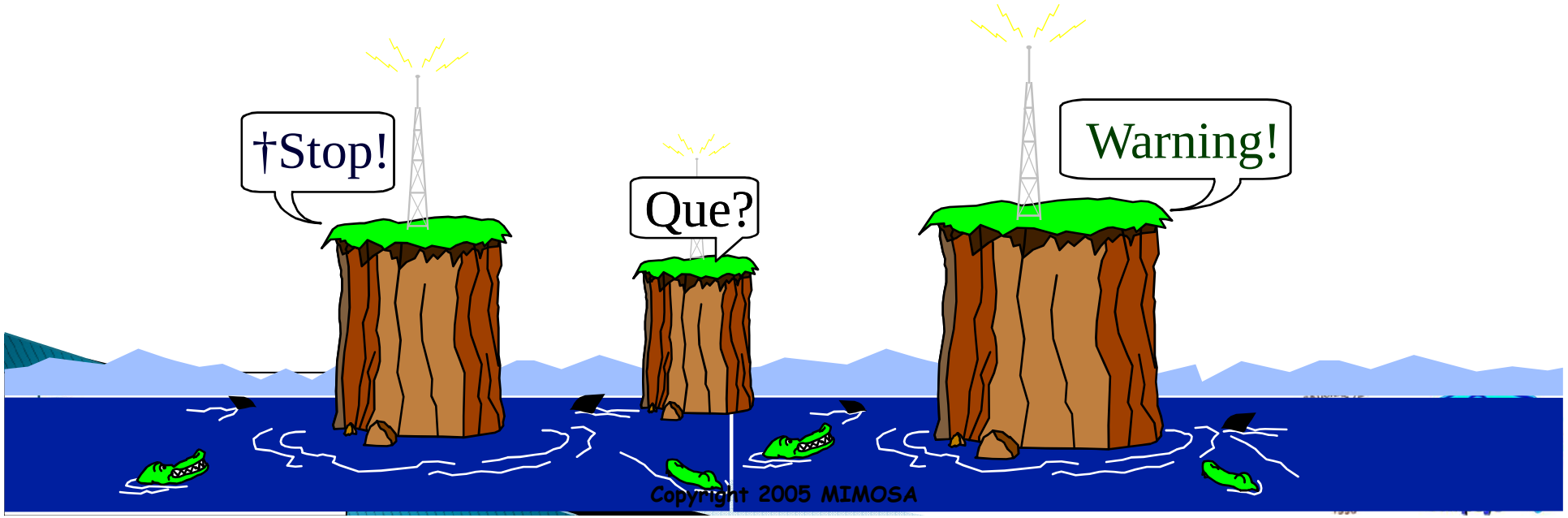
An Operations and Maintenance Information Open System Alliance

3e Technologies International, Inc.
ABB Automation
Agile Engineering Systems
Ahmed Elkhatib, Professor, Alexandria University
American Management Systems, Inc.
Andrew Ball, Maintenance Engineering, University of Manchester
AOC, Inc.
Aspen Technology
Assetricity, LLC
Association VAST, Ltd
Bently
Boeing Company
Bond Consultants
BP Refining
Brüel & Kjær Vibro
Cargill, Inc.
Citect Corporation
Clockwork Solutions
Control Point Corp.
CRC for Integrated Engineering Asset Management
Design Maintenance Systems, Inc.
ESRG, LLC
Foster-Miller Technologies, Inc.
Helsinki University of Technology
Honeywell
IDAX, Inc.
IDmicro, Inc.
Impact Technologies, LLC
Indra Systems
Invensys Systems Inc.
Ivara Corporation
Lloyd's Register of Shipping
Matrikon
MIMOSA Default
Modius, Inc.
MRO Software
Mtelligence Corporation
National Aeronautics and Space Administration (NASA)
Northrop Grumman Newport News
Oceana Sensor Technologies, Inc.
Open Roads Consulting
OSISoft
Pacific Northwest National Laboratory
PdMA, Inc.
Penn State University Applied Research Laboratory
Prüftechnik Condition Monitoring GmbH & Co. KG
Qualtech Systems
Richard M. Greenough, Mechanical Engineering, Cranfield University
RLW, Inc.
Scientific Monitoring, Inc.
Siemens AG
SKF Reliability Systems
SmartSignal Corporation
SPEC Corporation
Synergen
Teedro Limited
The PCB Group Companies
Timken Company
US Army Product Manager, Test, Measurement & Diagnostic Equipment
US Navy Total Open Ship Architecture Implementation Program Team
Vassilis Syrmos, Electrical Engineering, University of Hawaii-Manoa
Vibration Specialty Corporation
Virtual Convergence
Westar Aerospace & Defense Group
Wojciech Cholewa, Mechanical Engineering, Silesian Technical University
XtraOpen, LLC
Yamatake Corporation
Yokogawa Electric Corporation
Zeefax, Inc.

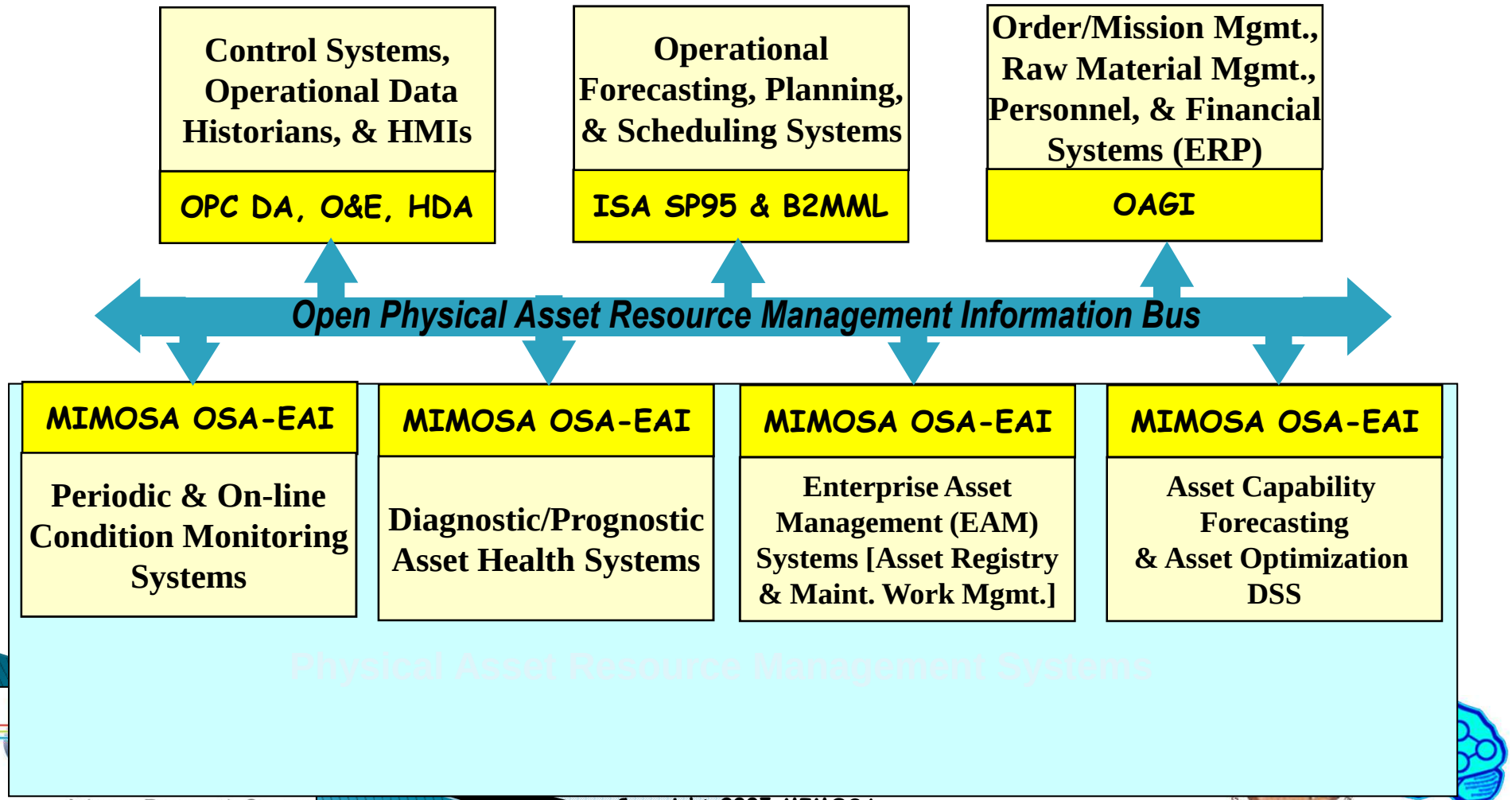

Tech-CDE-Services For SOAP *Tech*-CDE Clients & Servers
Tech-XML-Web For HTTP *Tech*-XML Clients & Servers
Tech-XML-Services For SOAP *Tech*-XML Clients & Servers
Compliant SOA Application Definitions
Tech-Doc Producer& Consumer XML Stream or File
Tech-CDE Client & Server XML Stream or XML File
Tech-XML Client & Server XML Stream or XML File
Compliant Application Service Definitions
Tech-Doc CRIS XML Document Schema
Tech-CDE Aggregate CRIS XML Transaction Client & Server Schema
Tech-XML Atomic CRIS XML Transaction Client & Server Schema
XML Content Definition
CRIS Reference Data Library
MetaData Taxonomy
Common Relational Information Schema (CRIS)
Implementation Model
OSA-EAI Common Conceptual Object Model (CCOM)
Conceptual Model
OSA-EAI Terminology Dictionary
Semantic Definitions

Before MIMOSA: Isolated 'Islands' of Information

- Task-specific islands of information
- Each island adopting a 'native' language'
- Hard to integrate

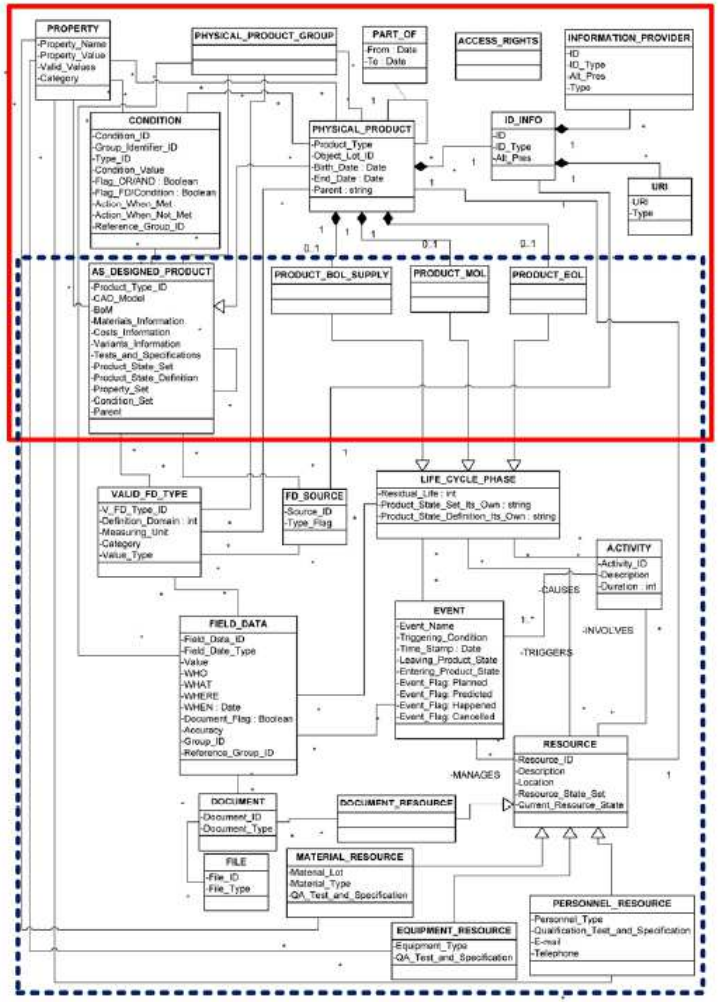


To data integration



Semantic data modelling

- MIMOSA covers issues related to data acquisition, condition monitoring, diagnosis, prognosis and management of maintenance work orders.
- Size of a fully-MIMOSA compliant database too complex
- Semantic data modelling by means of domain-specific asset management ontologies
- Employing asset management ontologies can facilitate data interoperability, knowledge processing & re-use and maintenance services delivery



- Example: [Matsokis 2010]

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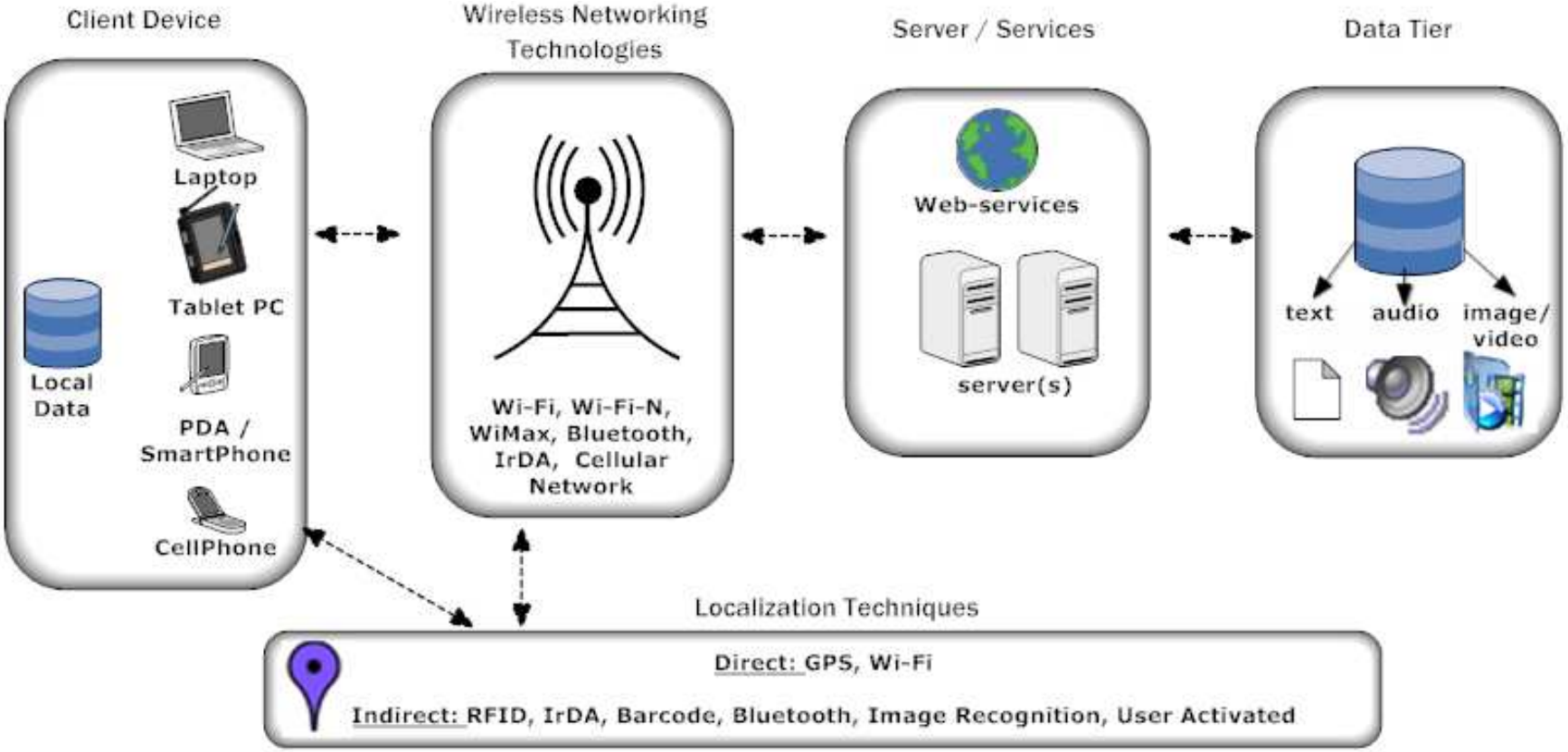
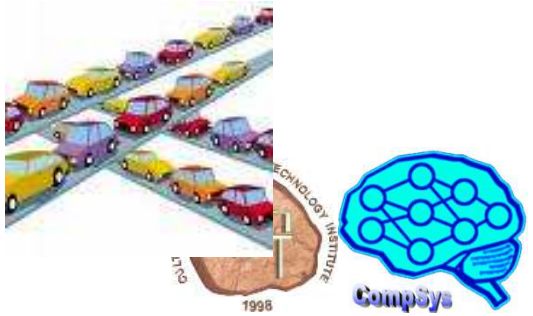
Mobile & Situated Computing Typical Architecture



Adaptive Service Systems

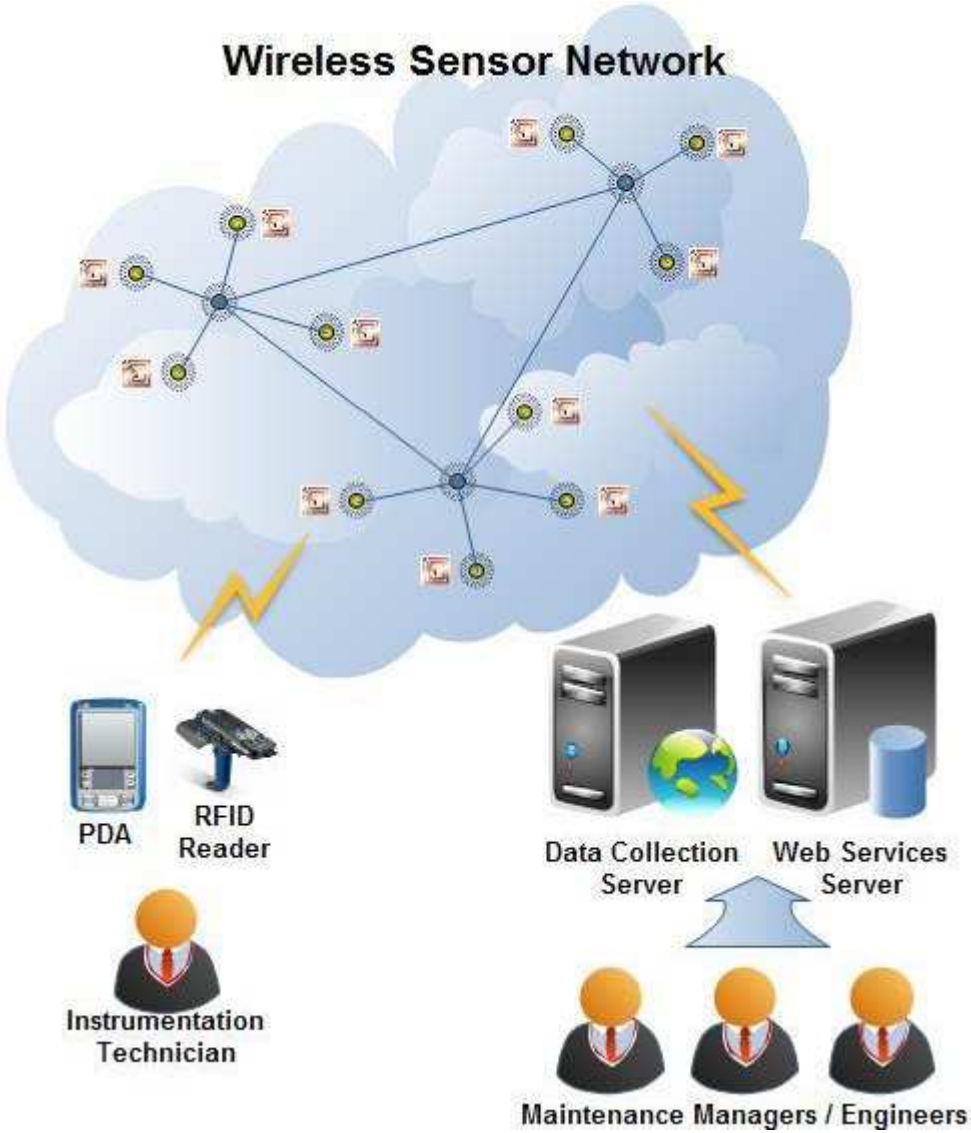
- A service request context is influenced by:
  - location awareness
  - time of the request
  - user profile / level of authorisation
  - device profile
  - usage scenario
  - monitored machinery
  - networking conditions



Wireless sensing & identification

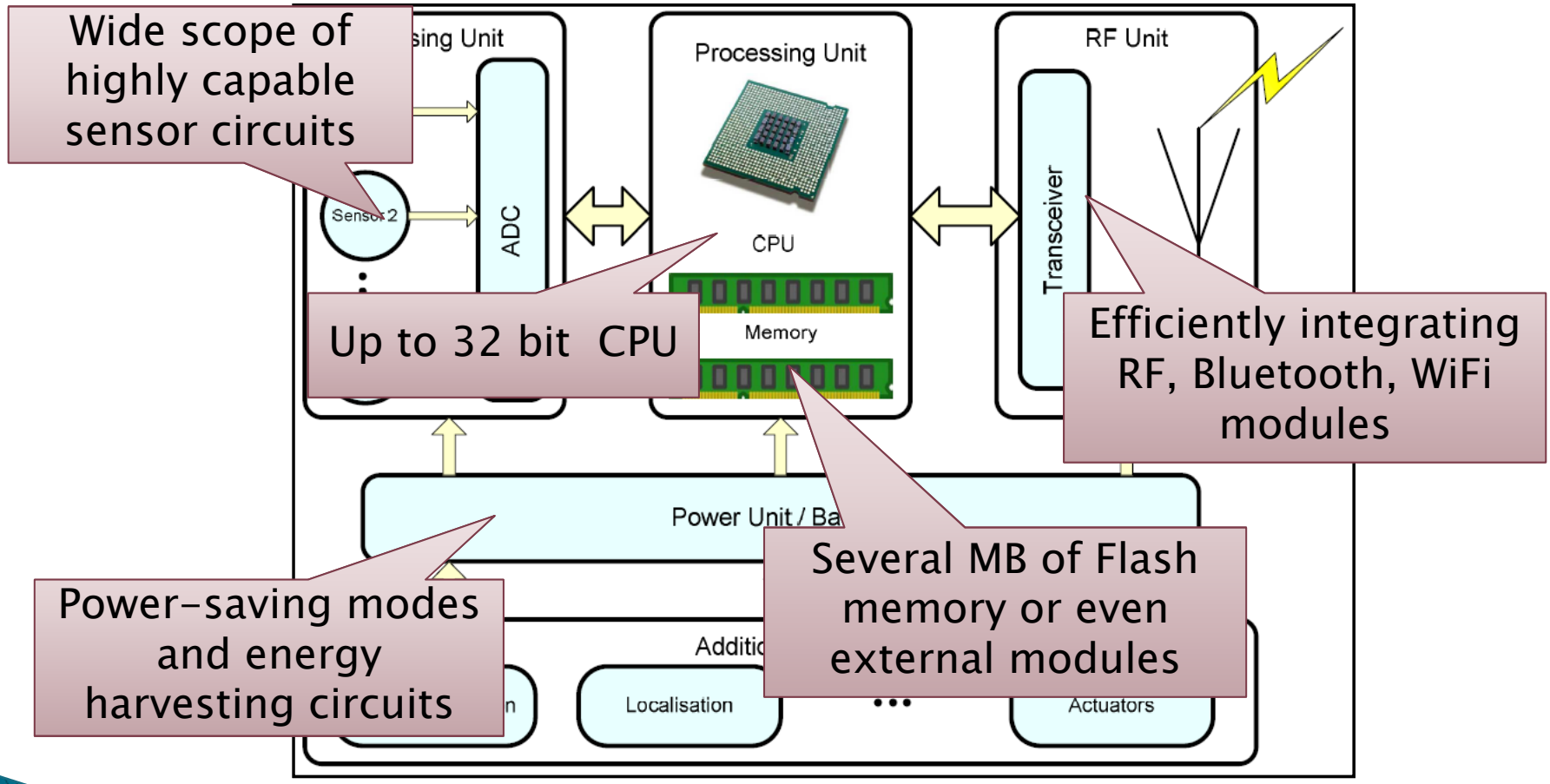
- Wireless sensing enables flexible condition monitoring to be implemented
- Auto-identification assigns context to service requests (localisation, asset identification, asset history record)
- The combination of wireless sensing and auto-identifications facilitates wireless asset monitoring to be implemented (enables mobile audits too!)

Wireless sensing and self-identification

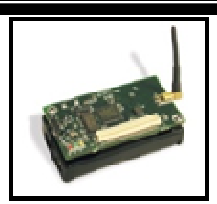
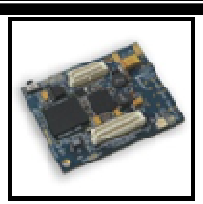
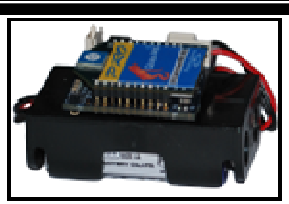


Wireless Sensor Networks

Sensor Module Hardware Architecture

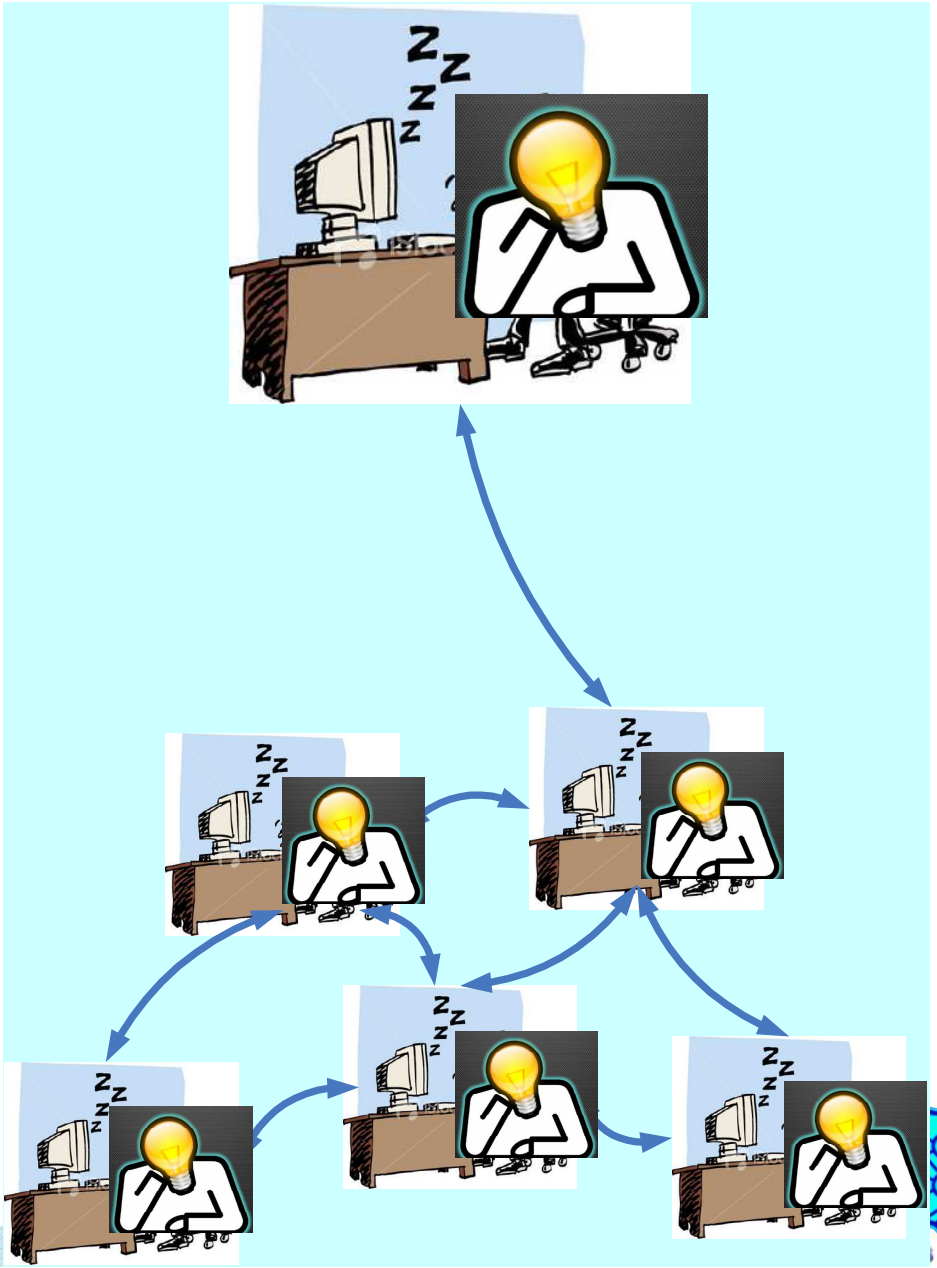


Wireless Sensor Module	Microcontroller	Memory Capacity	Wireless Connection	Operating System	API / Middleware
Crossbow (IRIS / MICAz)	ATmega1281 8-bit	8KB SRAM (IRIS), 512K (Ser.)FLASH, 128K (Prog.)FLASH,	2.4 GHz IEEE 802.15.4 / ZigBee compliant	TinyOS Based, Contiki (IRIS)	MoteWorks / TinyOS Nesc
Crossbow (Imote2)	Intel PXA271 32-bit	256KB SRAM, 32MB FLASH, 32MB SDRAM	2.4 GHz IEEE 802.15.4 / ZigBee compliant	TinyOS, Linux and SOS	MoteWorks / TinyOS Nesc, Microsoft .NET Micro Framework
Sun (SunSPOTs)	ARM920T 32-bit	512KB RAM, 4MB FLASH	2.4 GHz IEEE 802.15.4	Java Squawk	Java APIs
PrismaSense (Quax MS-Pro)	MSP430 16-bit	10KB RAM, 40KB FLASH	2.4 GHz IEEE 802.15.4 / ZigBee compliant	ISOS	Microsoft .NET Micro Framework
Shimmer	MSP430 16-bit	10KB RAM, 48 KB FLASH, Micro SD	2.4 GHz IEEE 802.15.4 and Bluetooth	TinyOS	TinyOS Nesc / Labview

Crossbow			Sun	Prisma	Shimmer-Research
					
IRIS	**MICAz**	**Imote2**	**SunSPOTs**	**Quax MS-Pro**	**SHIMMER Sensor**

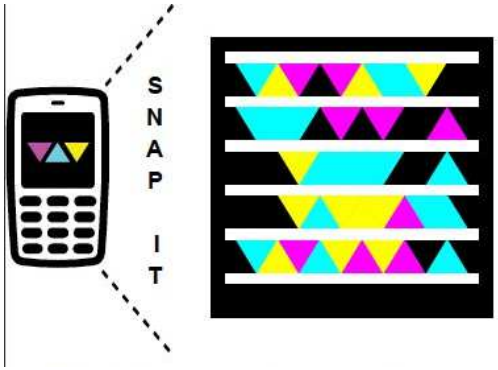
WSN Middleware

- data-centric mechanisms for data processing and querying within the network
  - process data locally
    - As many nodes as needed !
    - As little processing per node as necessary !
    - As little to transmit as possible

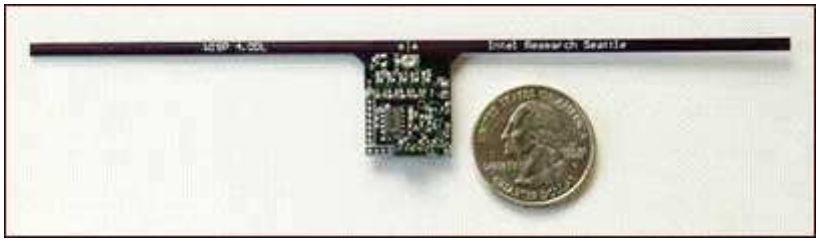


Asset self-identification technology

- a key enabler of context-adaptive data and services
- asset identification to tailor data and services to it (contextualized information mediation)
- self-identification technology includes:
  - Barcodes – Static information carriers
  - Image tags – Depend on camera image recognition capabilities
  - RFID tags
    - emerged as the practical way of linking physical assets with enterprise information systems
    - without the need for line-of-sight
    - can store limited information locally
    - facilitate on-site information and data storage and retrieval, particularly relevant for asset and maintenance management.



Linking RFIDs with WSN

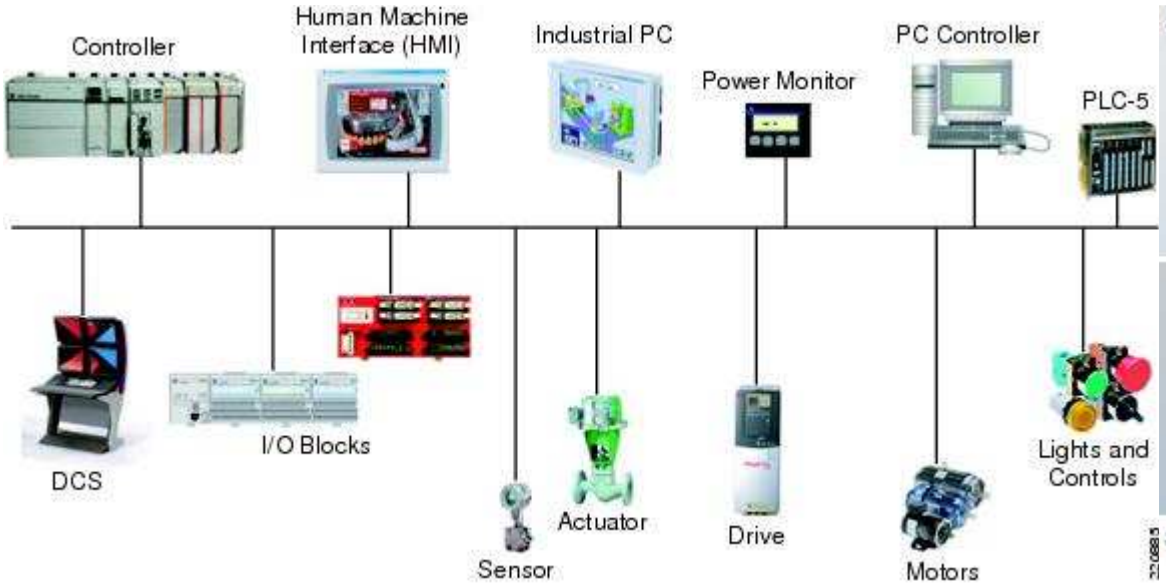


- Intel's WISP platform (http://www.seattle.intel-research.net/wisp).
- supports energy efficiency (self-powering technologies/energy harvesting)
- In the future: print your own tags (like inkjet printing)

ICT and OT

- Operational Technology (OT) rapidly converges with ICT

- OT comprises:
  - Sensors, measurement devices and setups, activators, as well as other devices and software employed for monitoring engineering assets and production systems


Controller
Human Machine Interface (HMI)
Industrial PC
Power Monitor
PC Controller
PLC-5
DCS
I/O Blocks
Sensor
Actuator
Drive
Motors
Lights and Controls


Auto Identification Systems

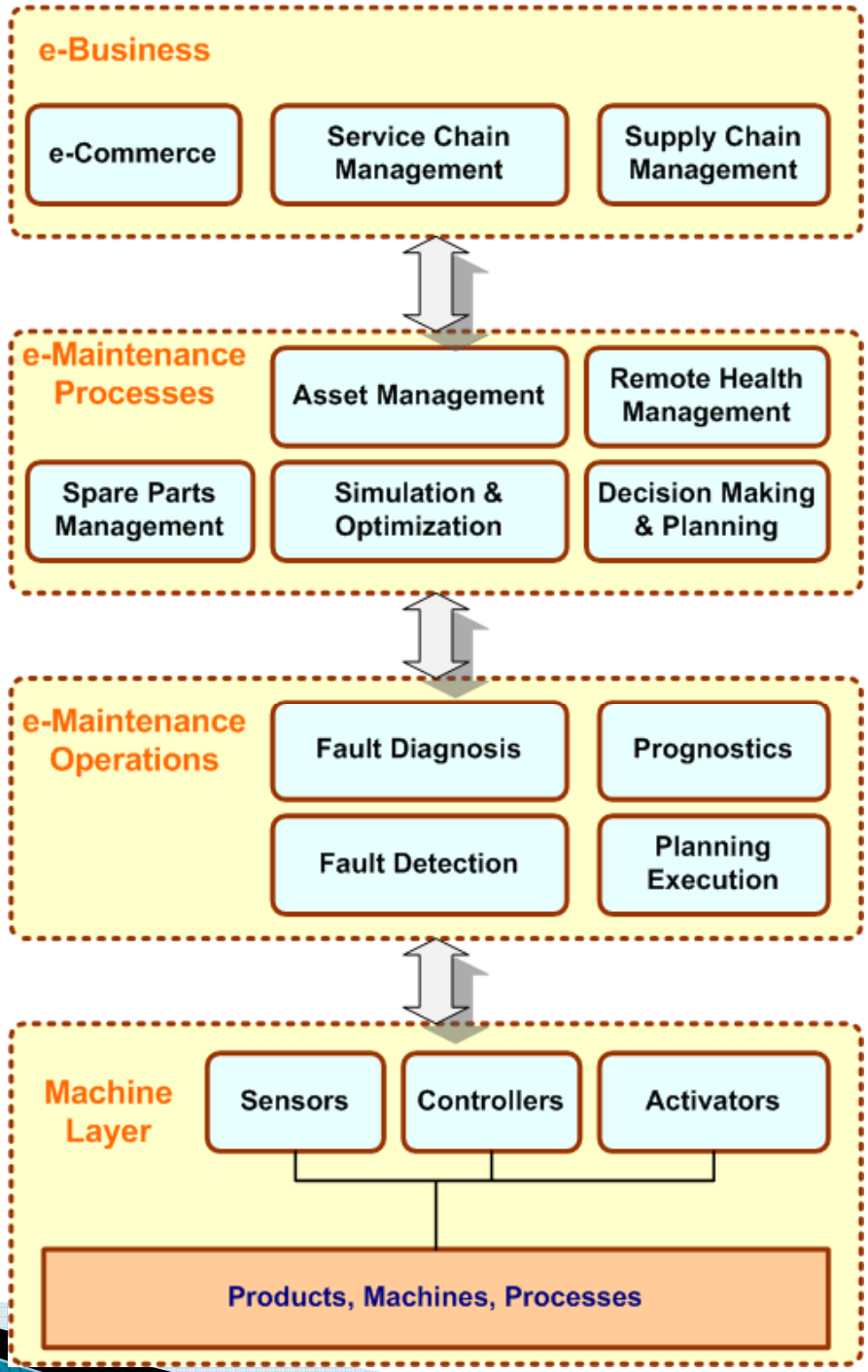

Safety Solutions


Automation Systems


Sensing Solutions


Industrial Components


3 PHASE MOTORISED VALVE CONTROL PANEL


e-Business
e-Commerce
Service Chain Management
Supply Chain Management
e-Maintenance Processes
Asset Management
Remote Health Management
Spare Parts Management
Simulation & Optimization
Decision Making & Planning
e-Maintenance Operations
Fault Diagnosis
Prognostics
Fault Detection
Planning Execution
Machine Layer
Sensors
Controllers
Activators
Products, Machines, Processes

IT & OT convergence

- Where does ICT end ? Where does OT start ?
- Dare you ask the CIO and the CTO ?

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- Engineering Asset Lifecycle Management
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- Skills & Competences
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Advanced Engineering Asset Management Services

- Maintenance Documentation
- Predictive Health Management -> Planning
- Performance Assessment
- Training & Knowledge Management

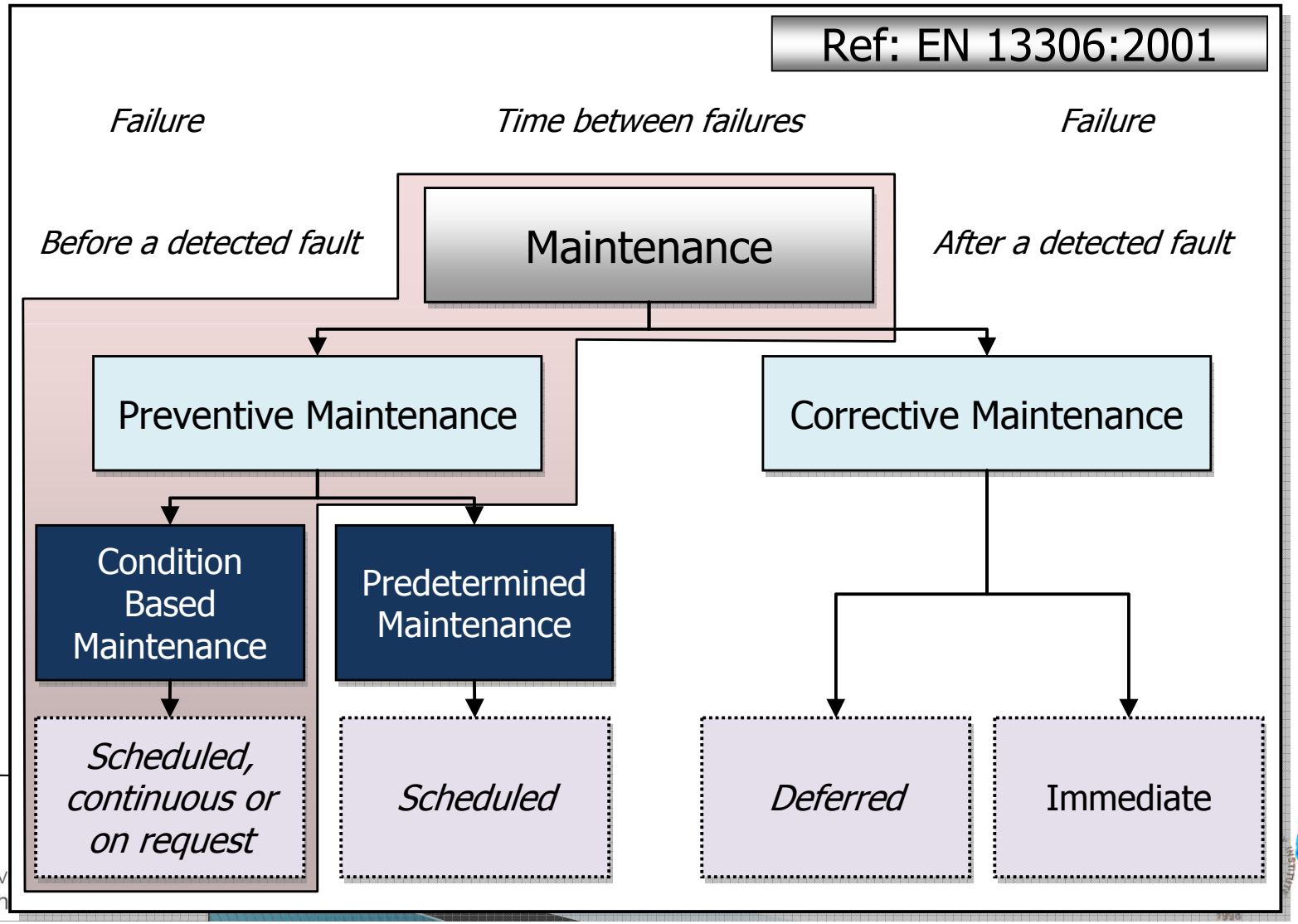
Asset Documentation

- Important part of asset management
- It involves the management of
  - procurement
  - Installation
  - operational phase information
  - technical documents
- What information ?
  - technical data
  - operation manuals
  - maintenance manuals
  - part lists
  - asset register
  - work orders
  - history records
  - scheduling information
  - work, inspection and repair instructions
  - contracts.
- ubiquitous availability of maintenance documentation

Asset Documentation

- augmented reality support with head-mounted displays.
- multi-modal & natural interfaces
- users are mobile actors, provided by contextually-relevant documentation.
- information retrieved by central repository or embedded in an RFID-

Maintenance Management



Predictive Health Management Steps

Sensing

- Monitoring entities
- Monitored parameters
- Sensor Definition
- Commissioning
- Set up
- DAQ

Data processing

- Conditioning
- Feature extraction
- Feature selection
- Data management

Detection

- Novelty detection
- Modelling normal behaviour
- Deviation from normal behaviour
- History data processing

Diagnosis

- History data processing
- Identification of faults and their causes
- Fault modeling
- Association of data / state to known conditions
- Confidence levels

Prognosis

- History data
- Future machinery usage estimation
- Estimation of future fault progression
- Residual life modeling
- Estimation of remaining life to failure
- Confidence levels

Results

- Post mortems
- Maintenance planning aid
- Feedback for BOL (Machinery usage recommendations, maintenance recommendations, machinery design recommendations)

Predictive Health Monitoring

Physical Assets	Networking	IT/OT	Maintenance Knowledge	Computational Model
System	MAN/WMAN, LAN/WLAN, 3G/4G	ERP, Servers	System class	State
Sub-system	LAN/WLAN	ERP, MES, CMMS, SFCS, Desktop/Server	Sub-system class	Sub-system-level Novelty Detection Diagnostics Prognostics
Unit	LAN/WLAN PAN/WPAN Gateways	Sensors, Actuators, Controllers, DAQ, RFID, PDA	Unit class Unit-level Fault modes Fault mechanisms Fault severity Fault criticality Asset relations Fault symptoms Fault features Measurement characteristics	Collective Models, Single Node Models Unit-level Novelty Detection Diagnostics Fault modelling Prognostics
Component	Serial/Bus PAN/WPAN	Sensors, Actuators, Controllers, DAQ, RFID, PDA	Component class Fault modes Fault mechanisms Fault severity Fault criticality Asset relations Fault symptoms Fault features Measurement characteristics	Single Node Models Novelty Detection Diagnostics Fault modelling Prognostics

Anomaly Detection

- What is anomaly detection (novelty detection, fault detection) ?

Wikipedia:

- *An anomaly is any occurrence or object that is strange, unusual, or unique. It can also mean a discrepancy or deviation from an established rule or trend.*

- In computer science, *anomaly detection refers to the process of detecting anomalies from the relevant data.*

- In Asset Lifecycle Management, Anomaly detection is the first level of Predictive Health Monitoring

Diagnosis

- Assignment of current condition to one or more known conditions, on the basis of
  - evidence (e.g. sensor readings, trending)
  - history record (e.g. maintenance record, fault history)
  - coded knowledge (e.g. Asset Category, Fault Tree, FMEA, etc)
  - human expert knowledge (expert decision)
- In Asset Lifecycle Management, Diagnosis is the second level of Predictive Health Monitoring

Prognosis

- Estimation / prediction of how the asset condition will evolve over time, given
  - current condition estimate
  - candidate future ‘loading’ conditions
  - candidate future operating condition
  - candidate future maintenance actions
- In Asset Lifecycle Management, Prognosis is the third level of Predictive Health Monitoring

Challenges for Prognostics

Dissimilar components suffer from diverse kinds of failures with different patterns of fault progression

In the simplest case the wear of a component can develop linearly as a function of time.

Unfortunately in the case of rotating machinery having tribological contacts between surfaces, often separated or partially separated by a lubricant, the situation is much more complex: the wear of surfaces usually follows an exponentially increasing model.

- Wear introduces changes to surfaces that can increase the loading, make surfaces weaker introducing particles between the surfaces which then cause accelerated wear.

Results: Asset Management Planning

On the basis of the current and projected asset condition, more informed choices can be made for Asset Management Planning, taking also into consideration:

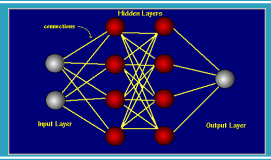
- Suppliers – Customers
- Market data (e.g. parts / products prices, etc)
- Own strategy (e.g. Setting availability / dependability targets, adjusting production, operation & maintenanace)
- Technical, health & safety, leagal and normative constratnts

Performance Assessment

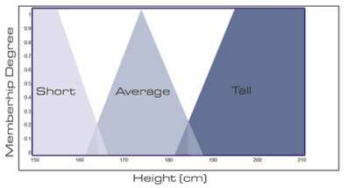
- e-Maintenance empowers personnel to engage in a Total Productive Maintenance (TPM) strategy, facilitating data collection, upon which to base performance assessment

Where can Computational Intelligence Help?

Numerical processing and sensor data



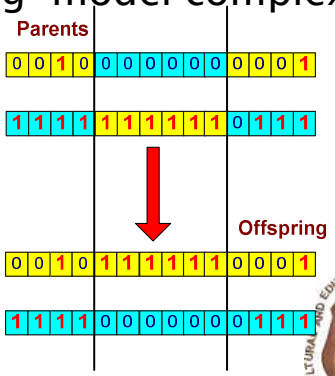
Associating symptoms with machine condition via fuzzy IF-THEN rules



- integration of numerical data and expert knowledge
- modelling uncertainty

Efficient searches in large spaces via simulated natural evolution

- Searches in model spaces (constructive algorithms: defining model complexity and topology)
- Searches in parameter spaces (optimisation)
- Searches in large feature spaces for best feature subsets



Computational Intelligence in Condition Monitoring

Neural networks & statistical learning

- data-driven diagnostic modelling
- time series models (NARMAX)

Fuzzy Rule Bases can be constructed to model uncertainty in:

- associations between signal features and machine or component condition
- perform fuzzy classification
  - *apart from cases of catastrophic failure, the occurrence of a fault is a gradual process*
- integrate heuristic or expert rules with data-derived rules

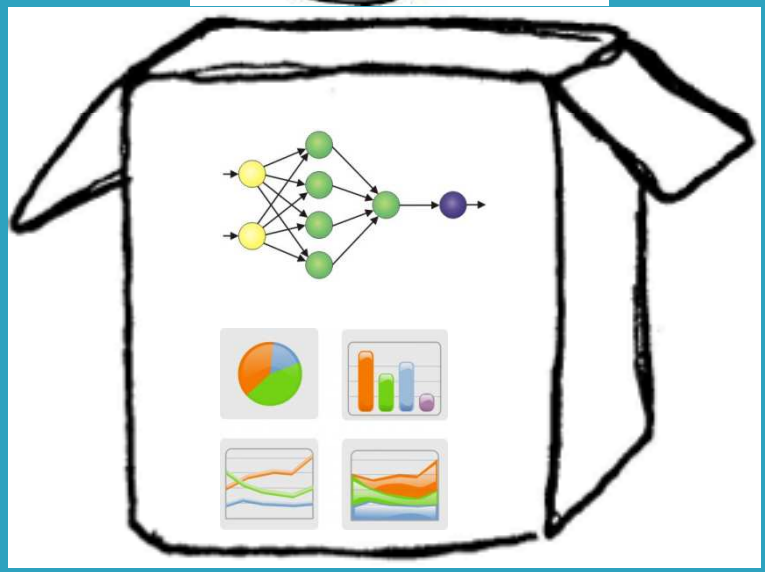
Fuzzy inference: flexible processing of knowledge contained in the rule bases & tuning of rule base based on data (fusion of knowledge + data)

Computational Intelligence in Condition Monitoring

- Evolutionary algorithms can have exploratory role :
  - among a large number of features , which are potential indicators of faults, find the most representative ones
  - search for adequate neural network topologies
  - aid the fuzzy system construction procedure

- Use Hybrid techniques to take advantage of individual merits of different signal processing and computational intelligence approaches

Doe k ?



Would this work ?

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- How to associate the readings from monitored machinery with the operating condition ?
  - Different techniques are appropriate for assessing the operating state of diverse engineering assets.
  - The combination of monitoring techniques may provide additional insight into the asset condition.
- But:
  - Different conditions manifest themselves in dissimilar ways, even for similar equipment
- Linking measurements to the machinery condition requires tailoring the detection, diagnosis and prognosis to each individual case

The learning steps

Initial data acquisition to capture a basic normal operating state.

Any deviation can be flagged out by a novelty detection mechanism

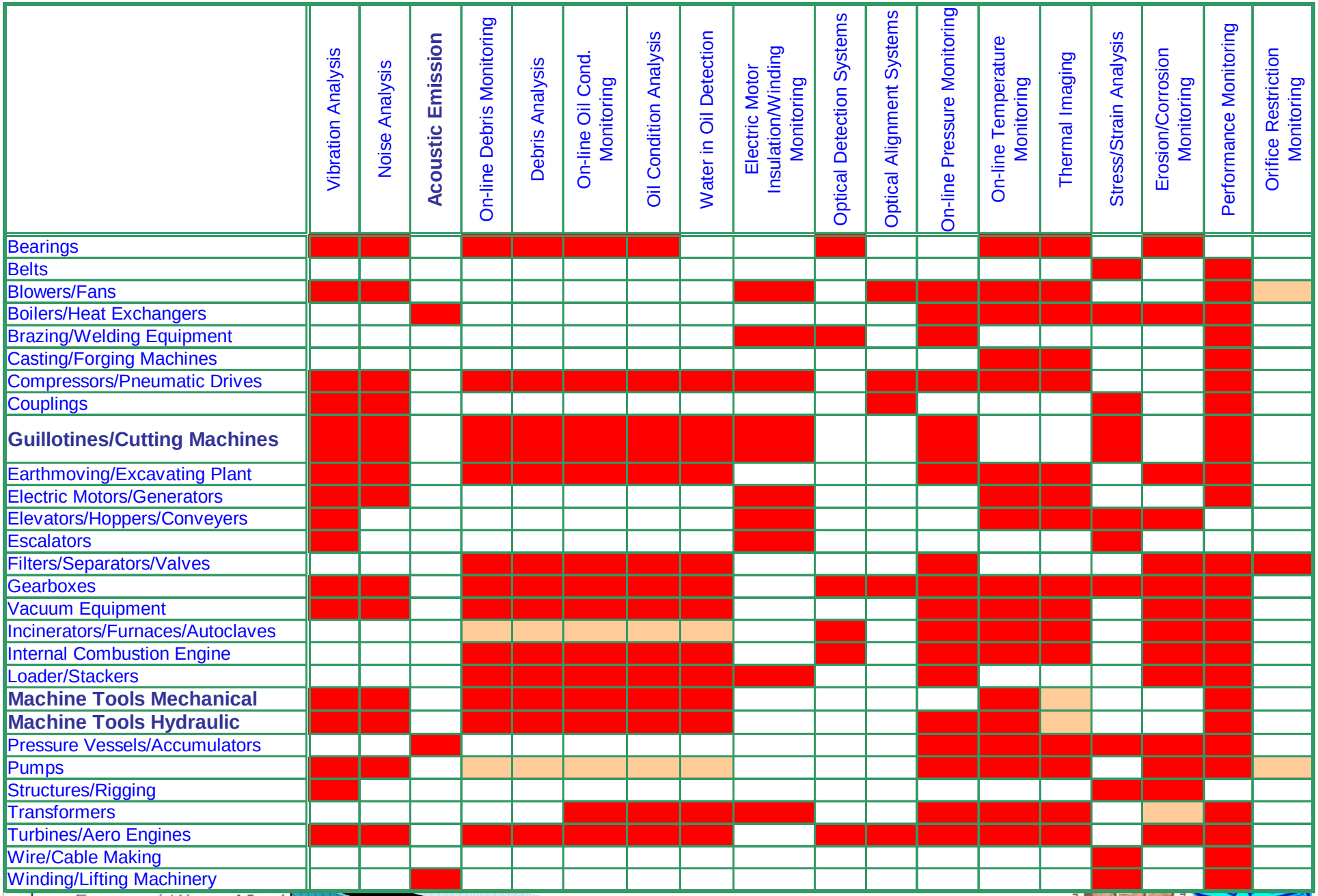
Readings from unknown states are assigned to known conditions

Conditions identified by the Failure Mode and Effects Analysis (FMEA)

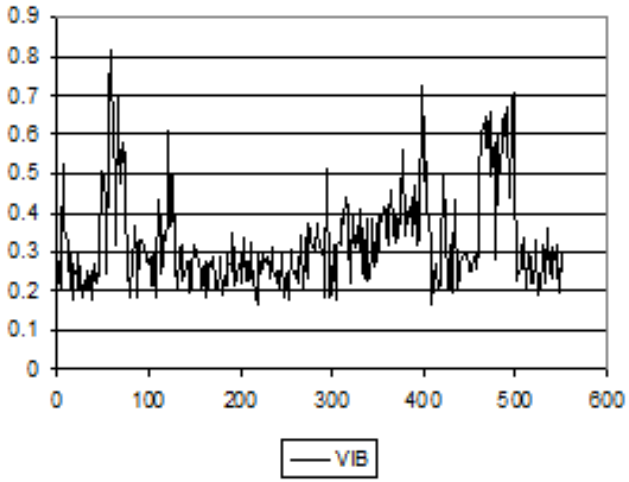
New readings included in the empirical diagnostic model

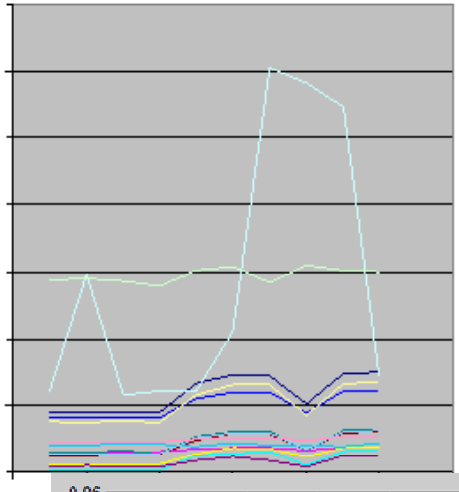
the model expands its applicability to previously unknown states

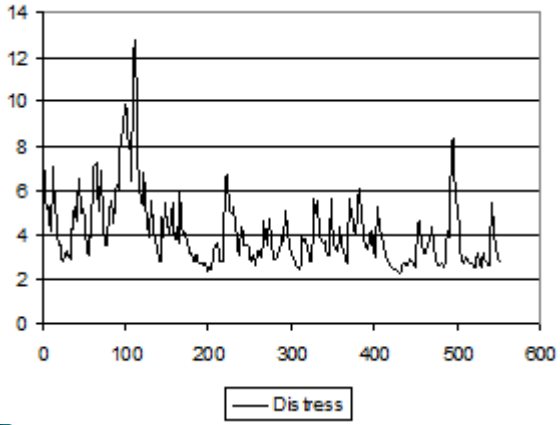
Any detection/diagnosis technique can be employed in this context

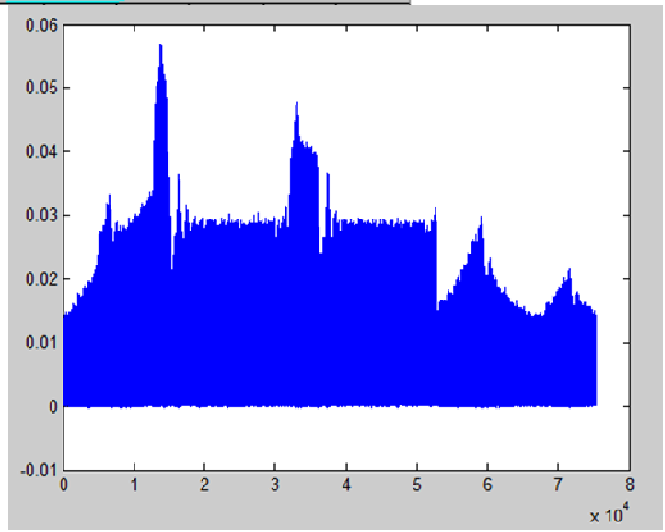

Vibration Analysis
Noise Analysis
Acoustic Emission
On-line Debris Monitoring
Debris Analysis
On-line Oil Cond. Monitoring
Oil Condition Analysis
Water in Oil Detection
Electric Motor Insulation/Winding Monitoring
Optical Detection Systems
Optical Alignment Systems
On-line Pressure Monitoring
On-line Temperature Monitoring
Thermal Imaging
Stress/Strain Analysis
Erosion/Corrosion Monitoring
Performance Monitoring
Orifice Restriction Monitoring
Bearings
Belts
Blowers/Fans
Boilers/Heat Exchangers
Brazing/Welding Equipment
Casting/Forging Machines
Compressors/Pneumatic Drives
Couplings
Guillotines/Cutting Machines
Earthmoving/Excavating Plant
Electric Motors/Generators
Elevators/Hoppers/Conveyers
Escalators
Filters/Separators/Valves
Gearboxes
Vacuum Equipment
Incinerators/Furnaces/Autoclaves
Internal Combustion Engine
Loader/Stackers
Machine Tools Mechanical
Machine Tools Hydraulic
Pressure Vessels/Accumulators
Pumps
Structures/Rigging
Transformers
Turbines/Aero Engines
Wire/Cable Making
Winding/Lifting Machinery

What do you make of it ?









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Feature Selection

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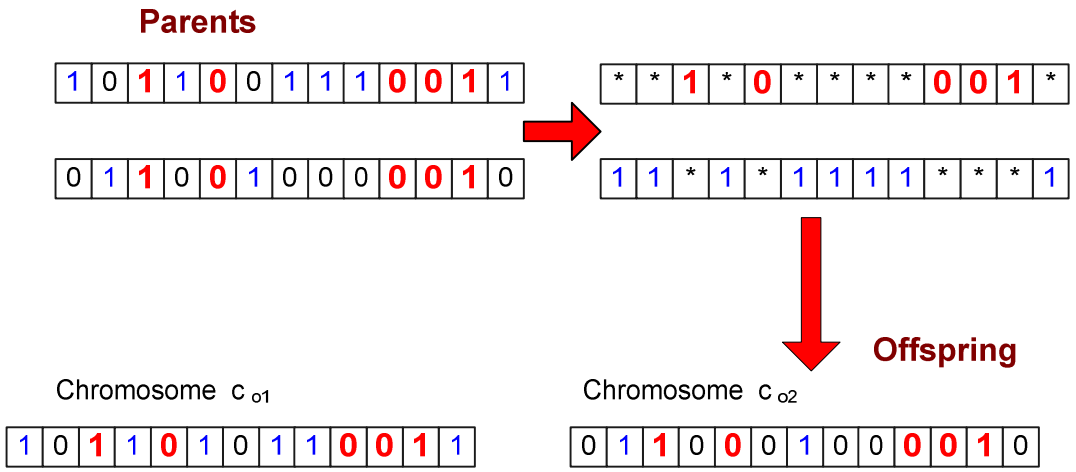
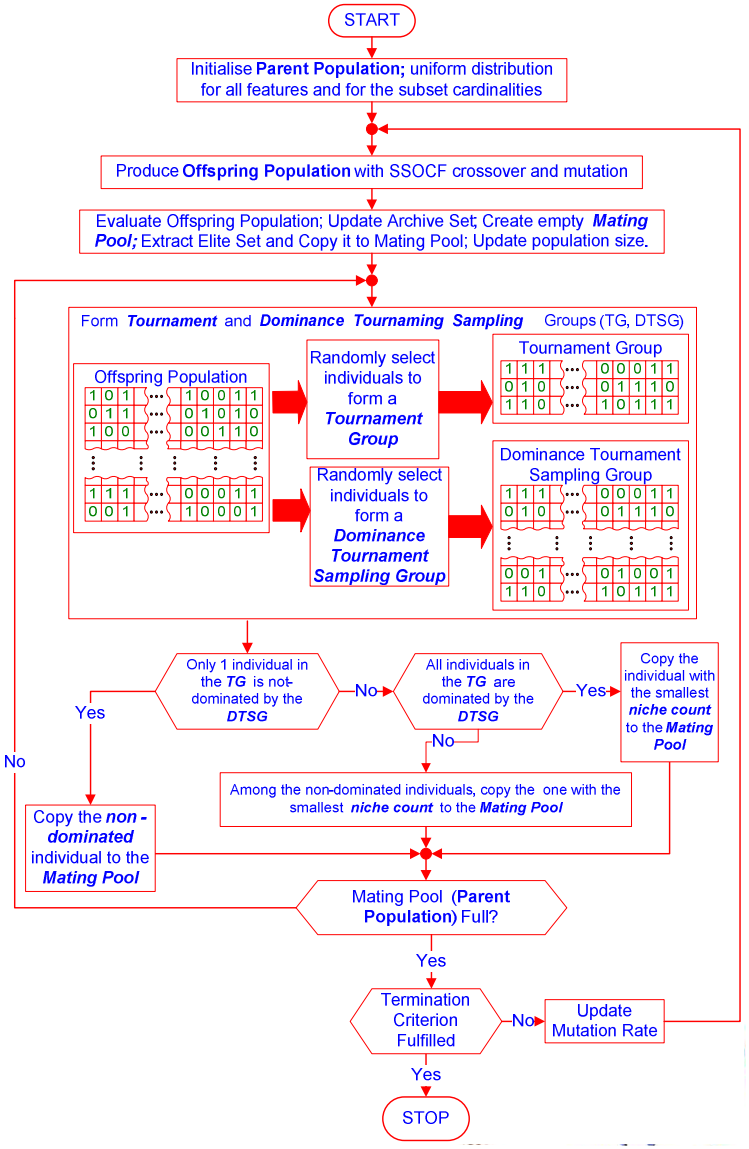
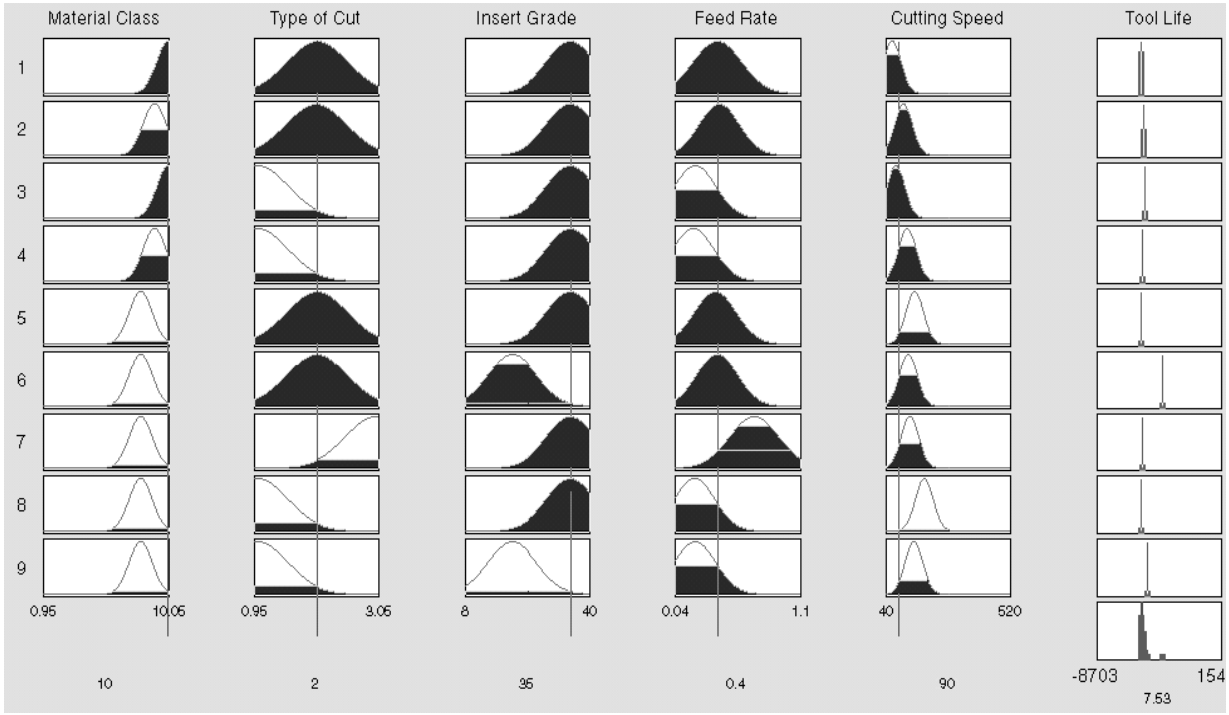
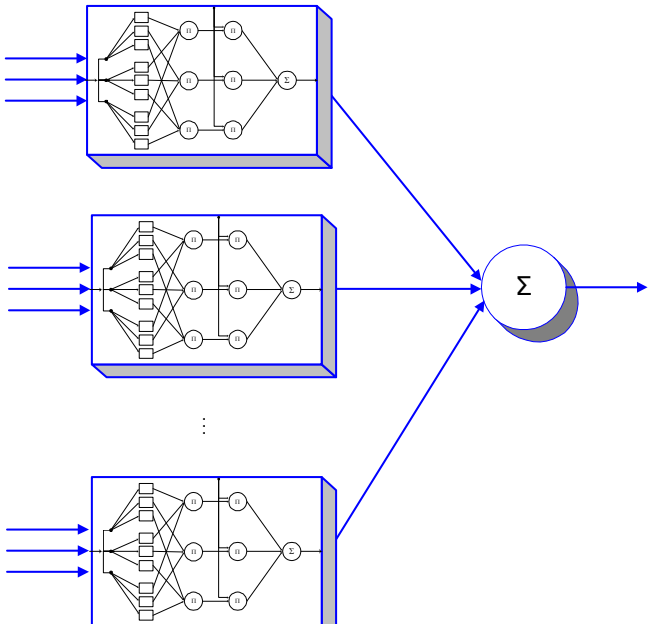
Evolutionary Multi-Objective Feature Selection for Diagnosis

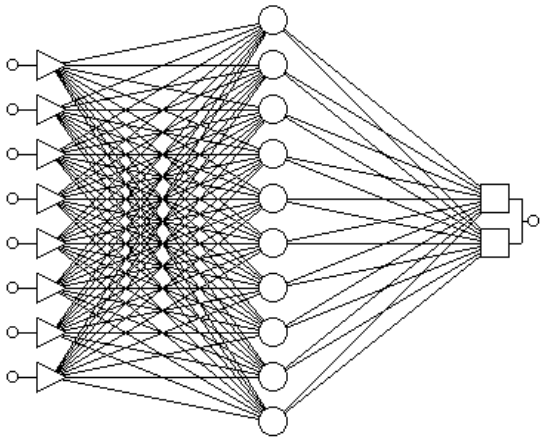




Diagnostic Tools







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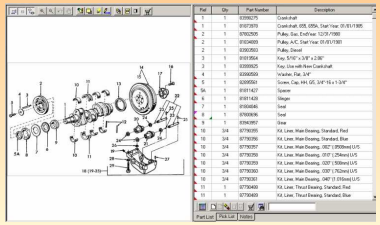
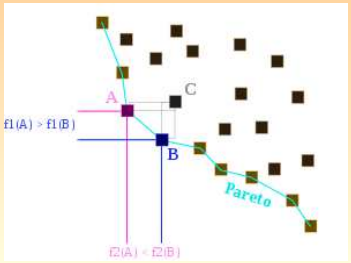
Other examples of Intelligence in Asset Lifecycle Management

- BOL
  - Exploit History, Lifecycle and Knowledge data for
    - Intelligent retrieval (e.g. for design components)
    - Multi-criteria intelligent design optimisation (e.g. to support sustainability)
    - Improve / correct design
    - Modelling of Lifecycle performance to come up with
      - different design options
      - service chain alternatives
      - warranty policy recommendations
    - Mining for data and knowledge in distributed repositories (knowledge extraction, transfer, exploitation, synthesis)
    - Deliver adaptive on-site knowledge support and training

Design Options / Trade-offs



Non-dominated design solutions



Optimisation

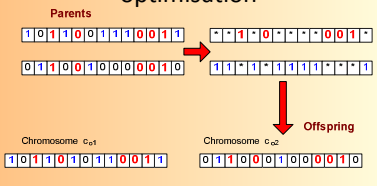
Optimisation

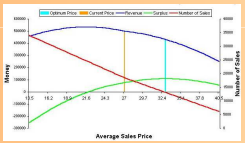
Evaluation

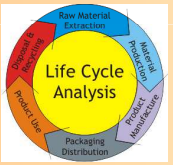
Knowledge

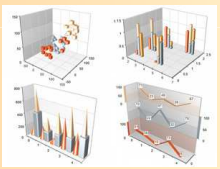
Analytical Hierarchy Process

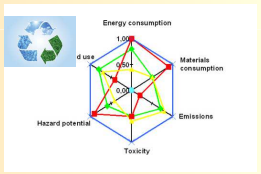
Evolutionay multiobjective optimisation



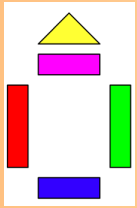


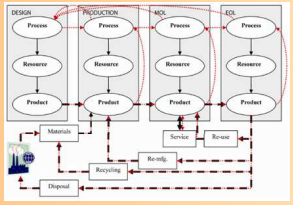


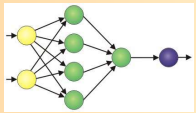


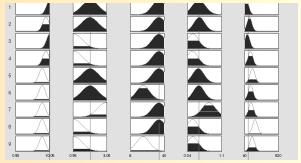


Evaluation Methodology (Eco-QFD, Lifecycle Simulation, Empirical Models)









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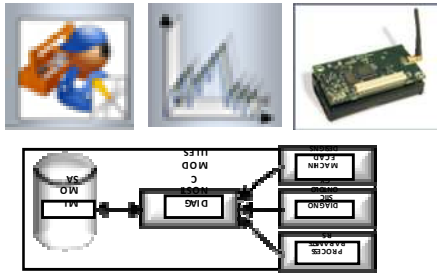
Other examples of Intelligence in Asset Lifecycle Management

- MOL
  - Embed asset identification & history keeping capabilities
  - Intelligent and adaptive monitoring and control of assets
  - Exploit History, Lifecycle and Knowledge data for building
    - Anomaly detection capabilities
    - Self diagnostics and prognostics
    - System level diagnostics and prognostics
    - Remaining life management
    - Intelligent Asset Care optimisation, planning and scheduling
    - Production planning decision support
  - Deliver adaptive on-site knowledge support and training



Other examples of Intelligence in Asset Lifecycle Management

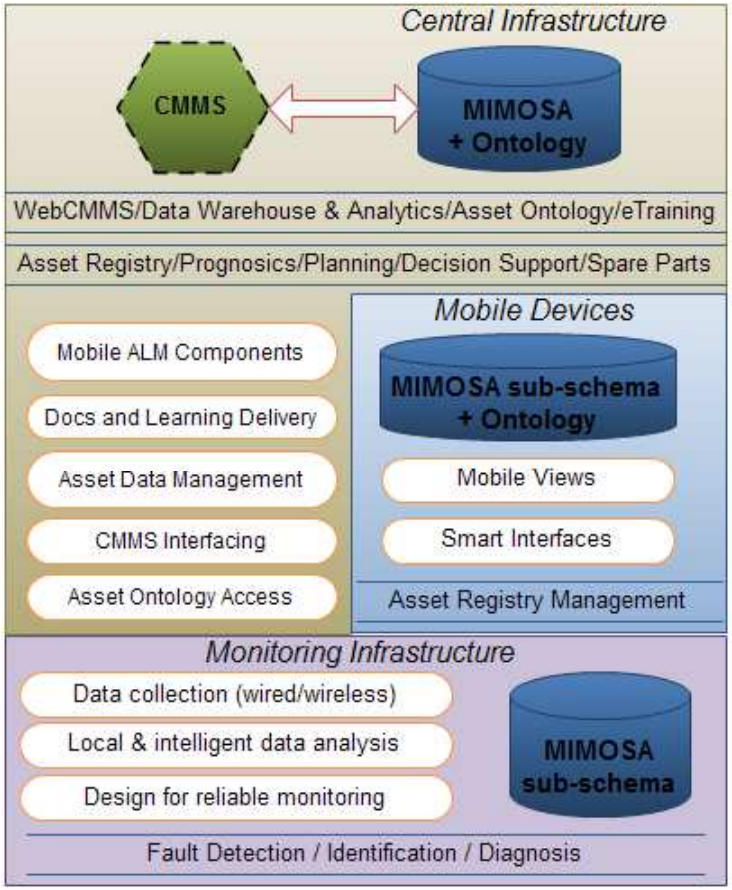
- EOL
  - Embed asset identification & history keeping capabilities
  - Intelligent support for EOL decision making
  - Smart components separation
  - Environmental hazard detection and decision support
  - Feedback to the BOL and MOL stages EOL data and knowledge, to improve EALM
  - Adaptively incorporate new guidelines and constraints (which may have not been in place at design time) in decision aid tools
  - Adaptive pricing support
  - Deliver adaptive on-site knowledge support and training

Wireless Condition Monitoring
Applications and Adoption Motivation

- Structural Health Monitoring
  - Infrastructure – Tunnels, Bridges, Railways
  - Cost of deploying and maintaining wired sensing
  - Need for 24/7 on-line structural integrity assessment

- Monitoring Industrial Machinery and Manufacturing Processes
  - Dedicated sensor subnets for each machinery unit
  - Flexibility to choose points of measurement
  - Portable installations easily refitted
  - (Smart) Sensor-embedded modeling and pre-processing

Example: WelCOM Project – Wireless Sensor Networks for Engineering Assets Lifecycle Optimal Management



welcom-project.ceti.gr

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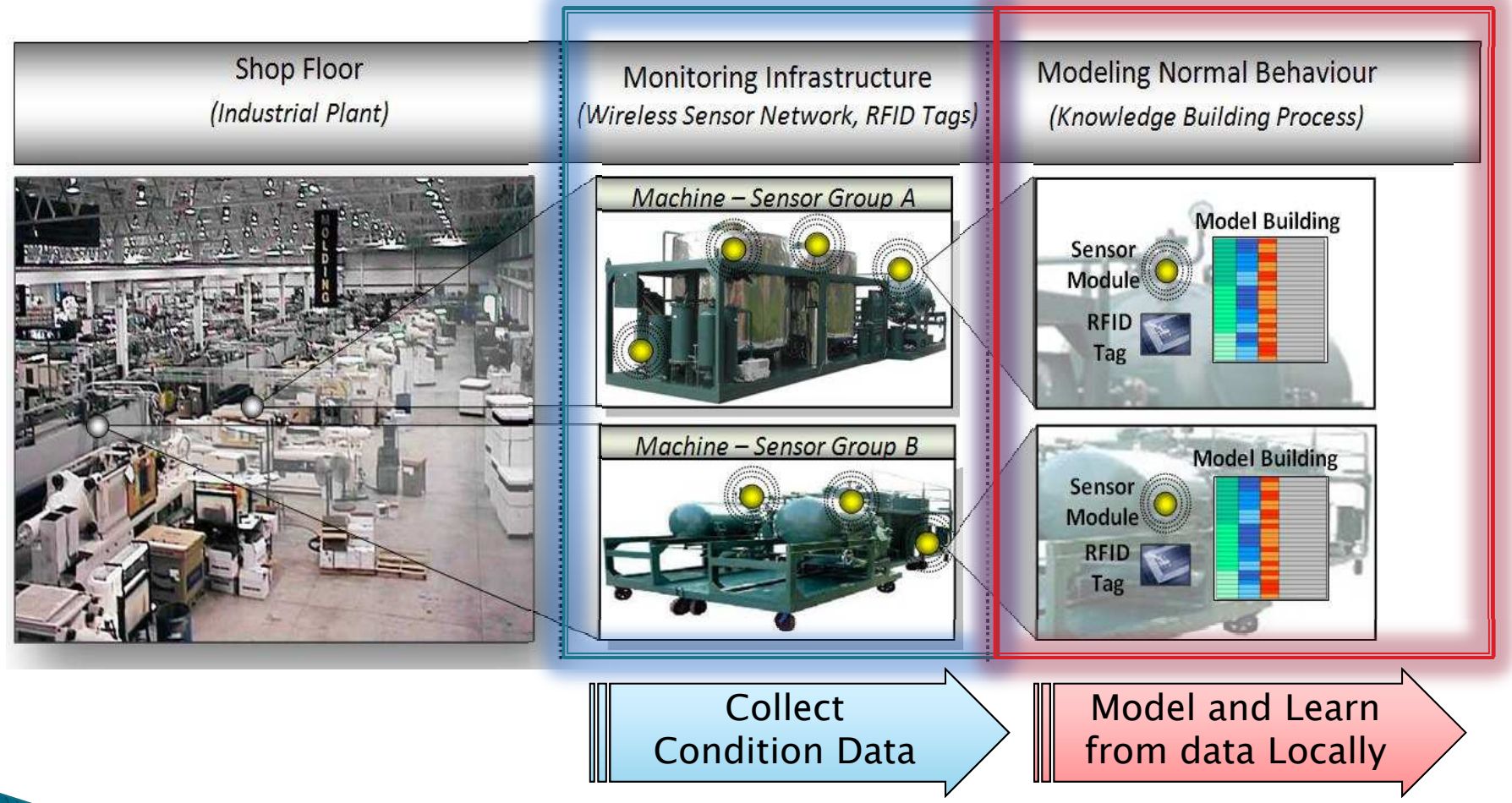
WSN Infrastructure / welcom-project.ceti.gr

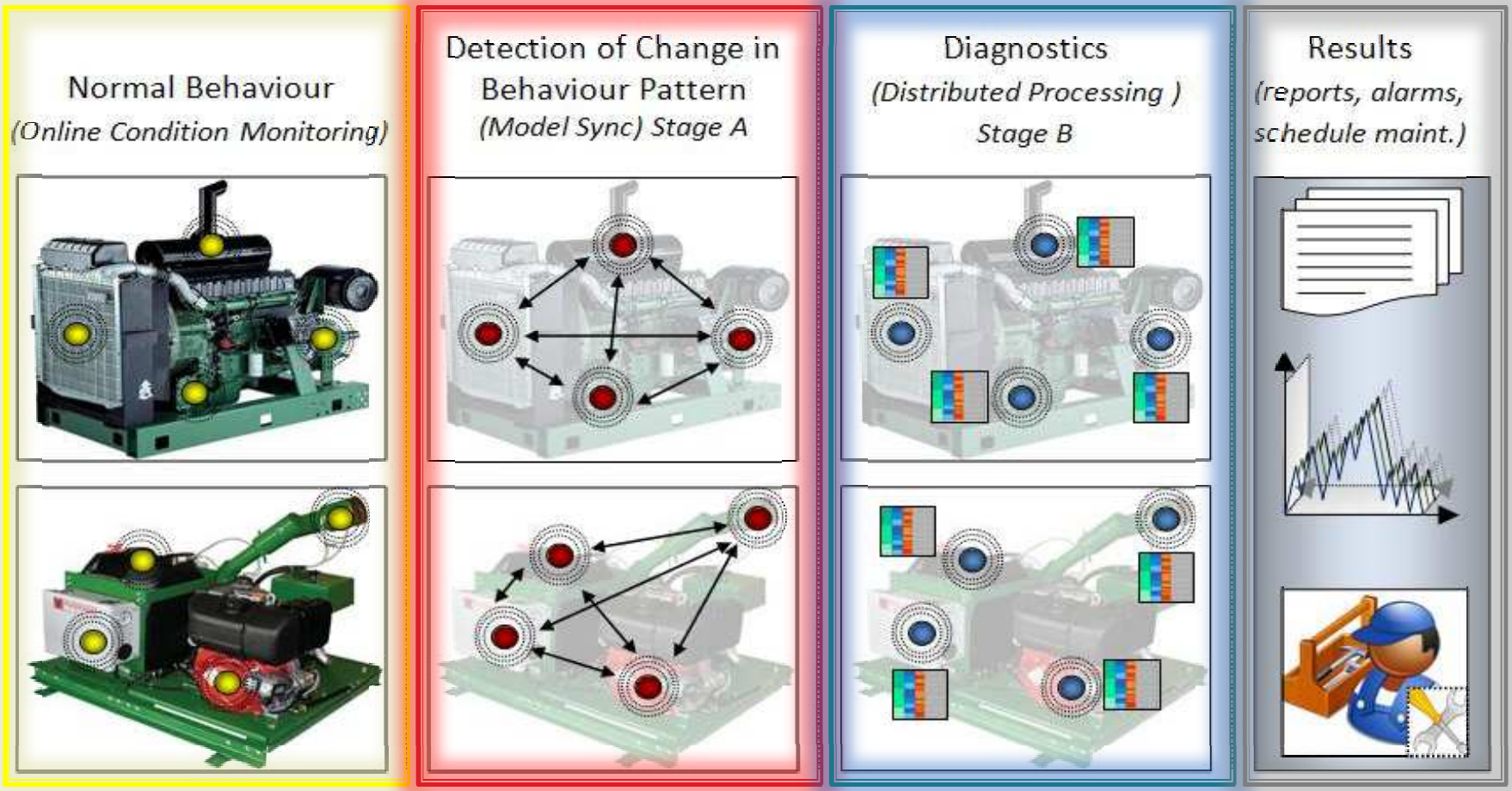
Sensor Embedded Intelligence

Learning Methods



Sensor Embedded Intelligence

Learning Methods



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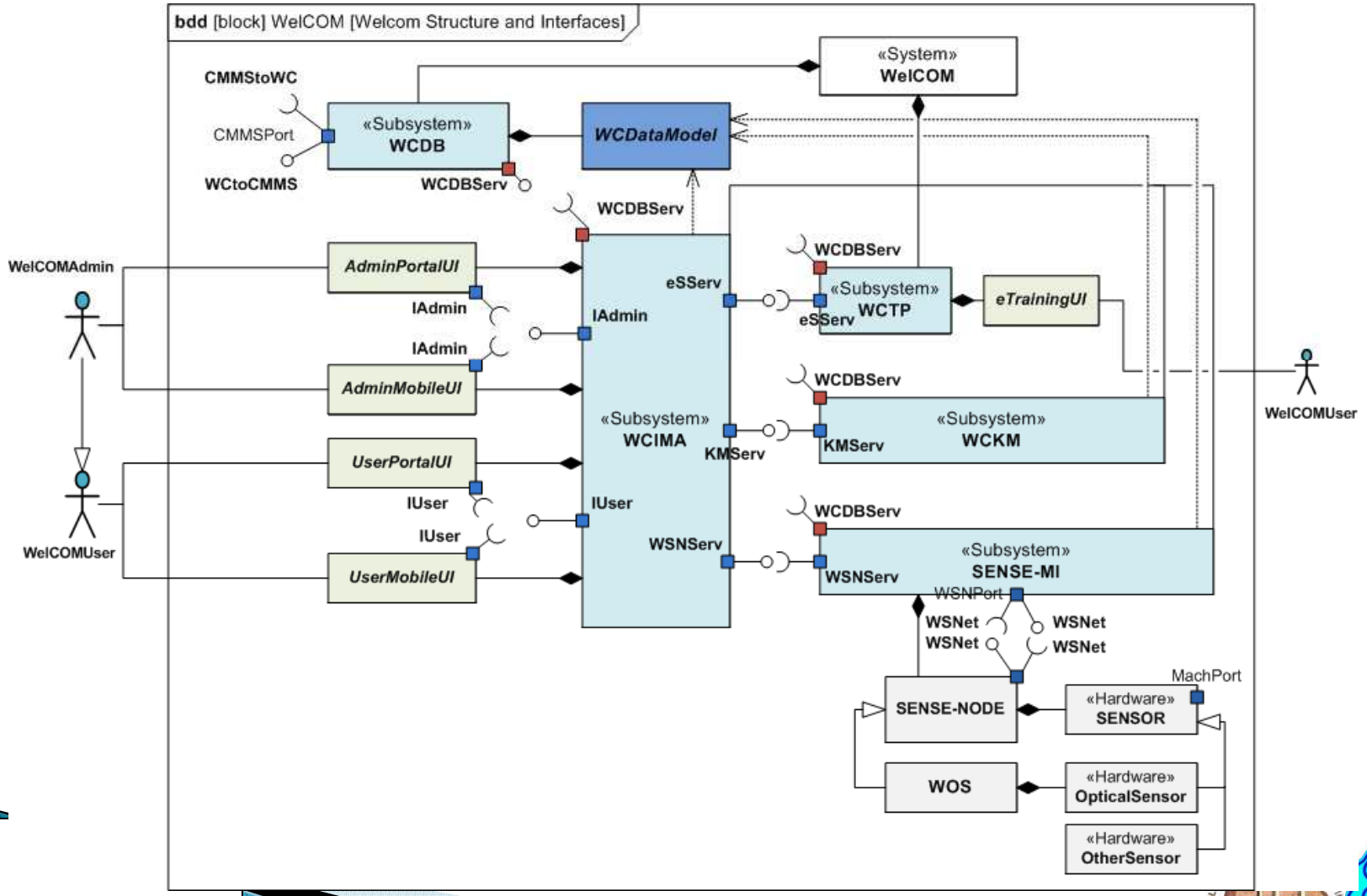
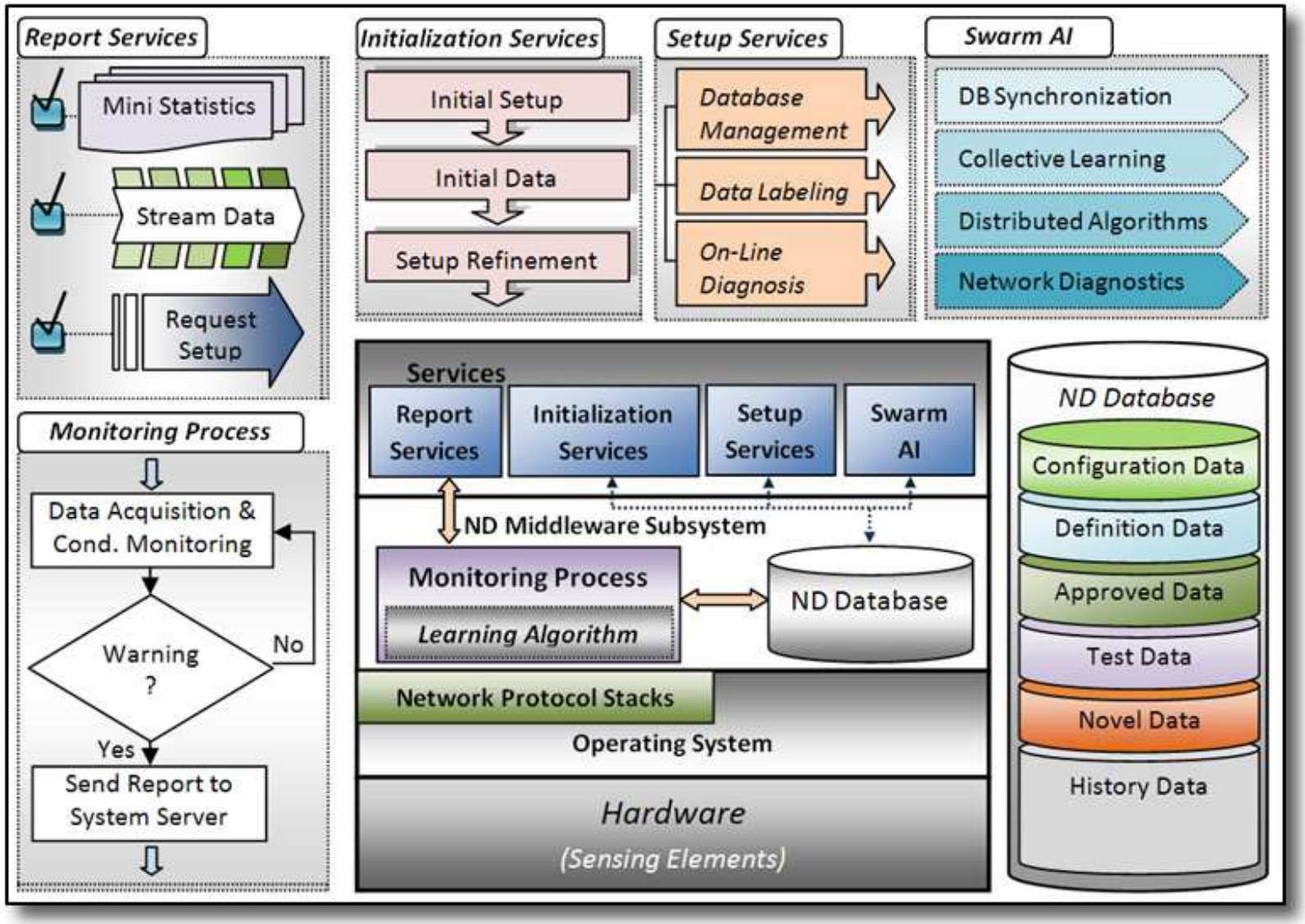
WelCOM Architecture

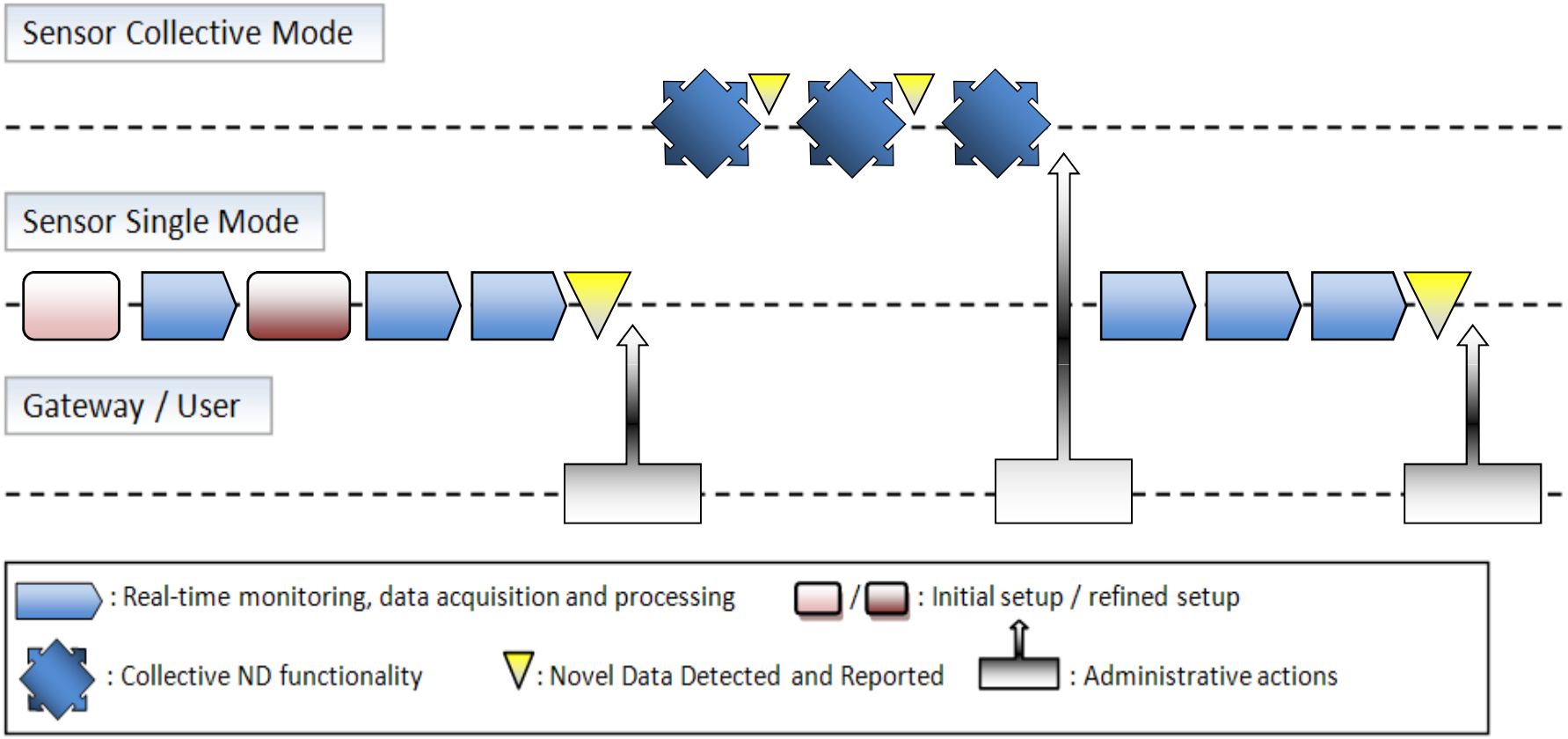


Detection and Diagnosis
Reference Architecture



Novelty Detection Subsystem

Example Diagram



Outline

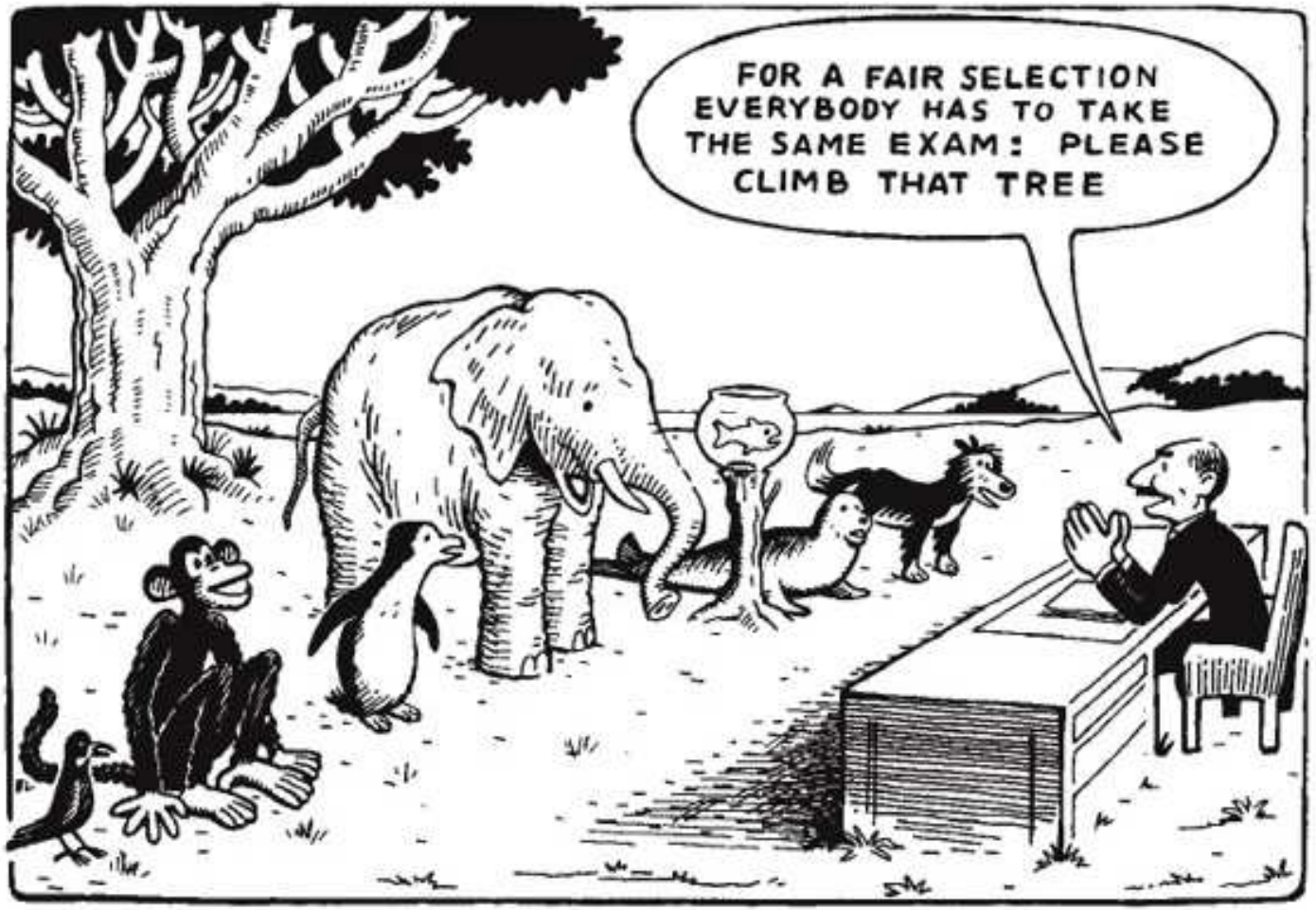
- Engineering Asset Lifecycle Management
- Enabling Technologies
- Advanced e-Maintenance Services
- Skills & Competences
- Conclusion

Maintenance Management Skills

- Maintenance Management increasingly recognized as important function supporting sustainability

- engineering, IT, finance, operations, business management and human resources management & development.
- Necessary body of knowledge in a single course?
  - higher education ?
  - postgraduate & vocational training courses
  - often target specialized aspects of Maintenance skills
- Most learners have already entered their working life

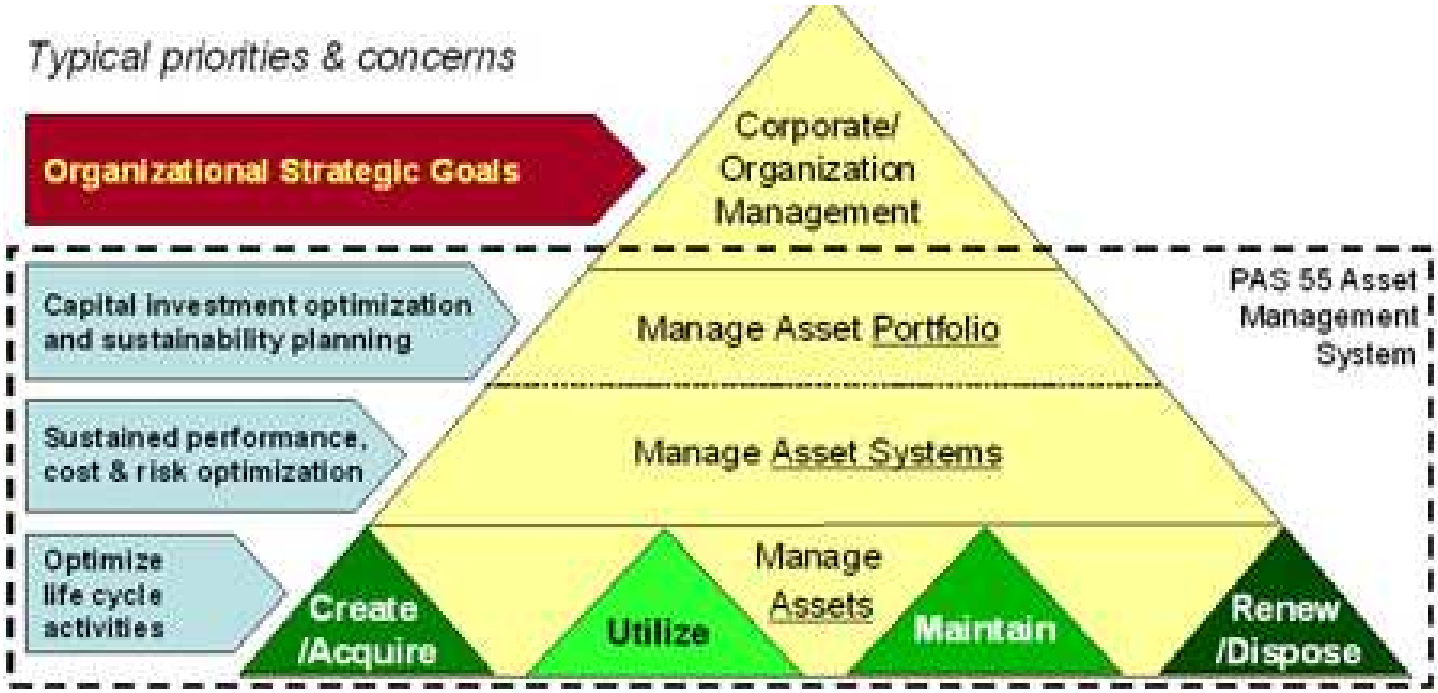
Personalised and role-directed training & competence assessment



Asset Management Roles & Skills Requirements

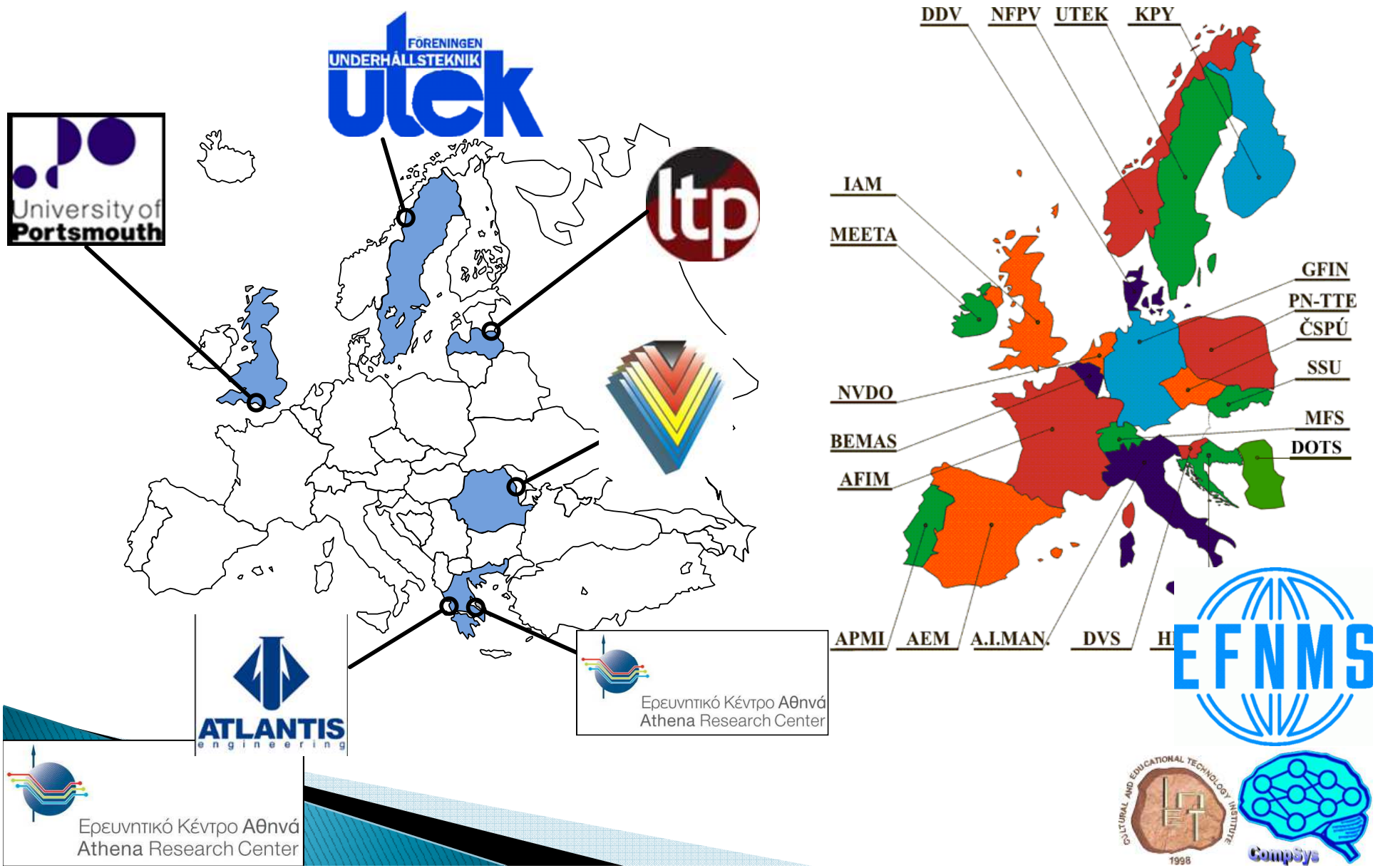
Source:
BSI PAS55, IAM, UK

How about the wider context ?



- PAS55 Framework for Asset Management, Institute of Asset Management, UK

www.ilearn2main.eu



Curriculum Design

1 Performed activities on the assets (Asset Care)

- 1.1 Maintenance involvement in design, procurement and operation of assets
- 1.2 Preventive and inspection activities
- 1.3 Repair techniques and methods
- 1.4 Goal, strategies, results

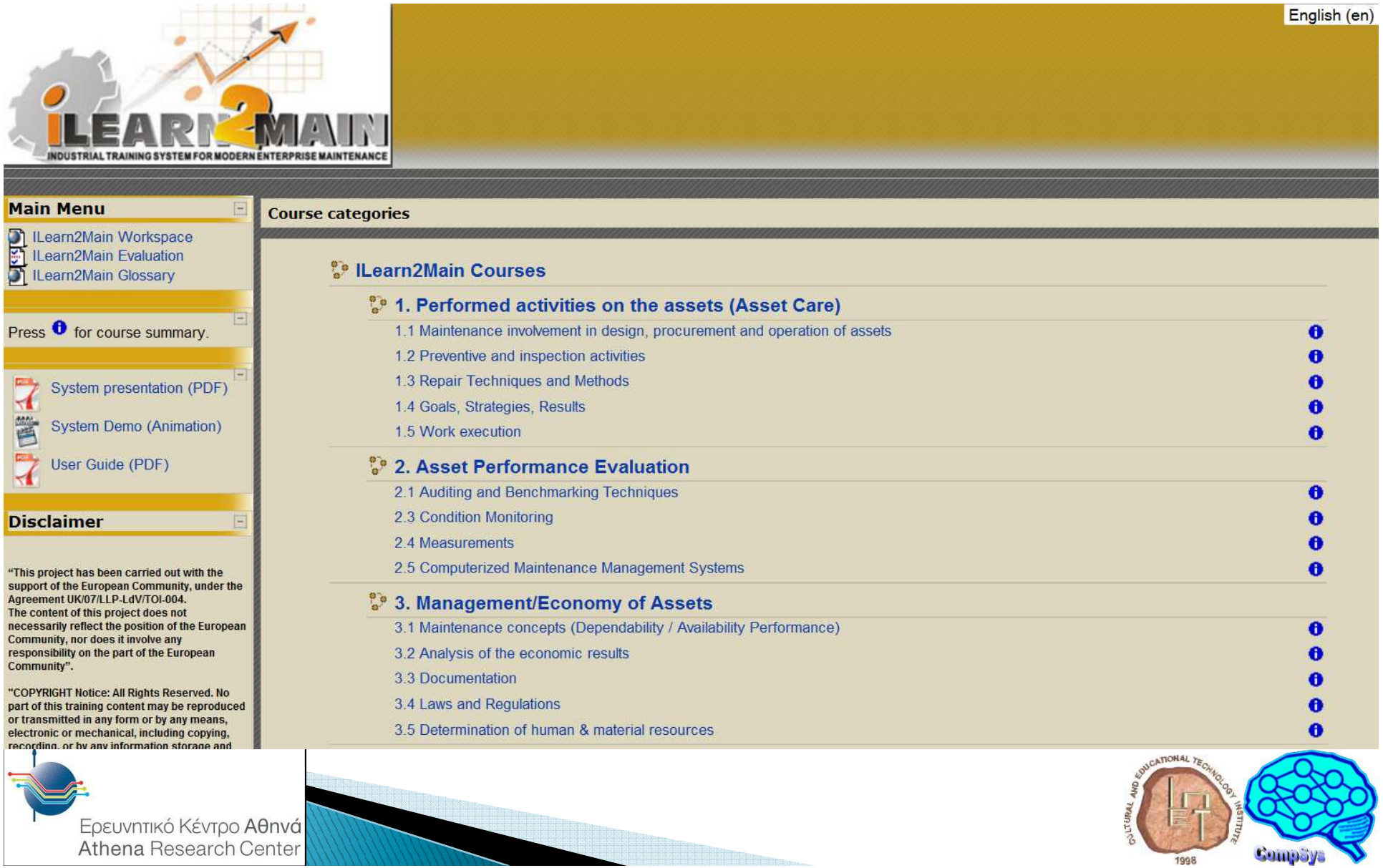
2 Asset Performance Evaluation

- 2.1 Analysis of the technical performance of the assets
- 2.2 Remote control
- 2.3 Condition monitoring
- 2.4 Measurements
- 2.5 Information systems

3 Management/Economy of Assets

- 3.1 Maintenance concepts (Dependability / Availability Performance)
- 3.2 Analysis of the economical results
- 3.3 Documentation
- 3.4 Laws and regulations
- 3.5 Determination of human & material resources

The iLearn2Main LMS



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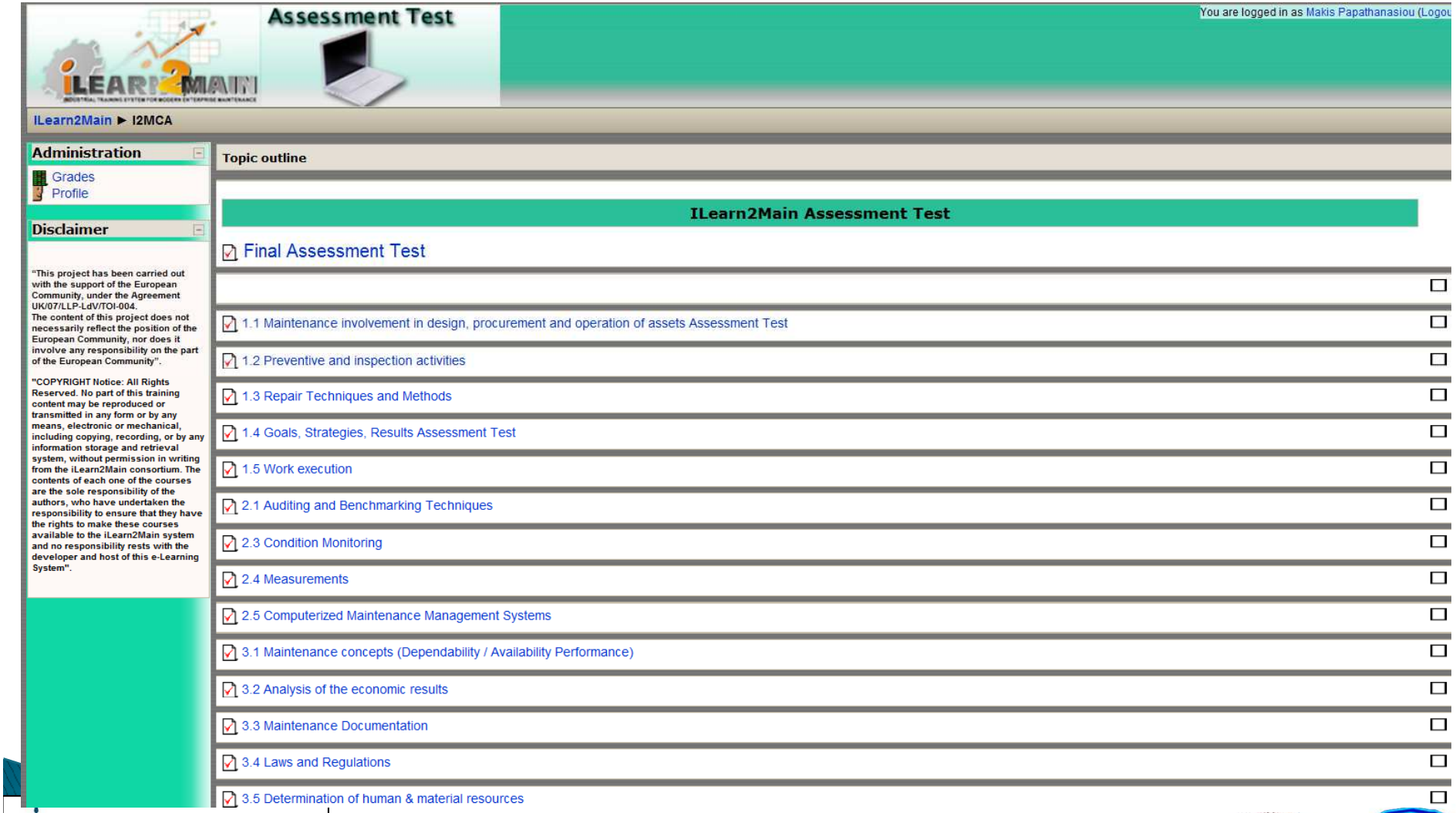
e-Assessment of Competences



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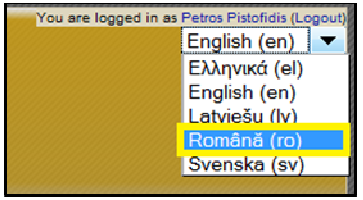
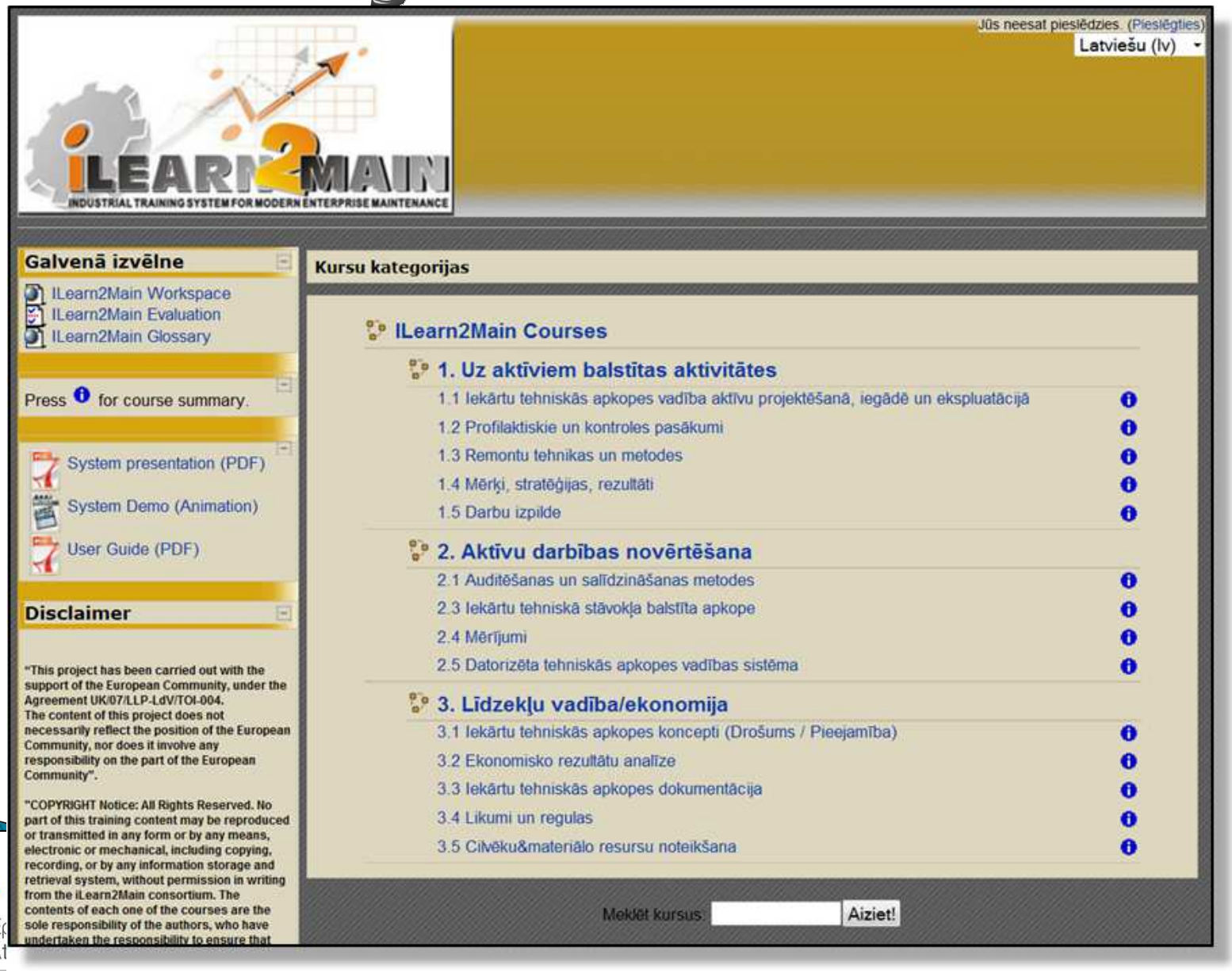
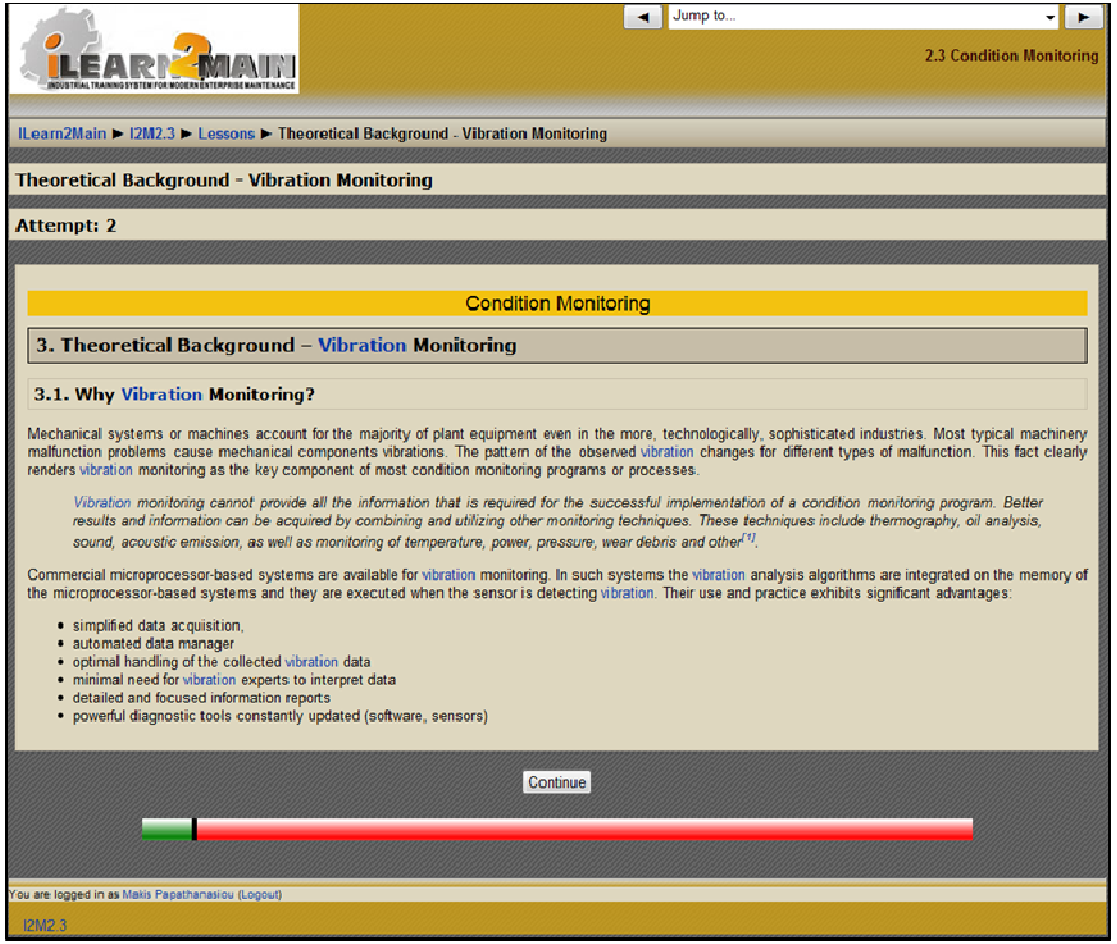
Multi-lingual content







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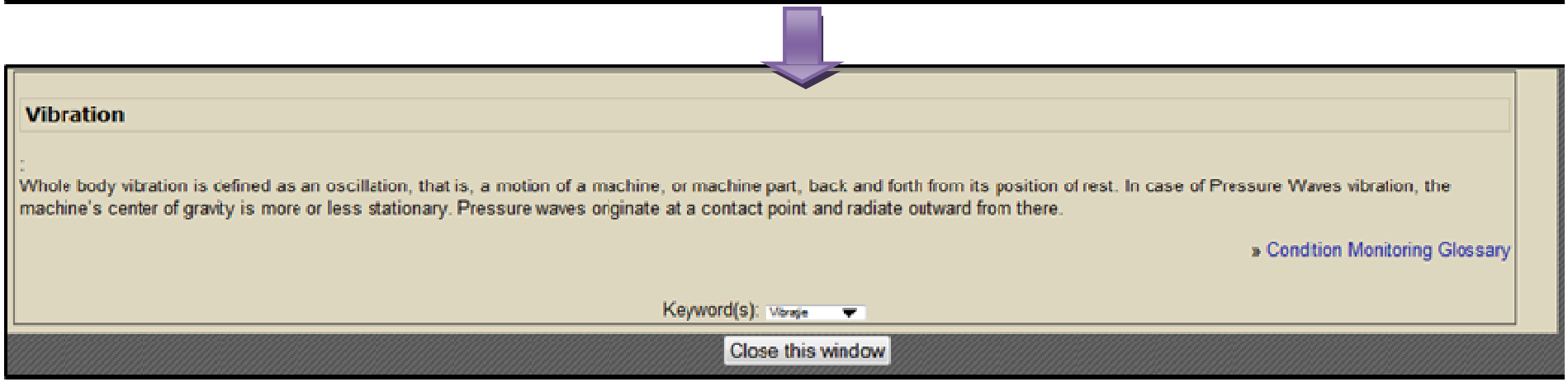
Glossary-integrated content

Whole body vibration is an oscillation, that is, a motion of a machine, or machine part, back and forth from its position of rest. The general definition of Vibration refers to mechanical oscillations about an equilibrium point. A force causes the initial movement and forces sustain the continued motion. Whenever a whole body vibration occurs, there are actually four forces involved that determine the characteristics of the vibration. These forces are [2]:

- The exciting force, such as unbalance or misalignment;
- The mass of the vibrating system;
- The stiffness of the vibrating system;
- The damping characteristics of the vibrating system;

The exciting force causes the vibration, whereas the stiffness, mass and damping forces oppose the exciting force to control or minimize the vibration.



Linked Bibliography

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Condition Monitoring

8. List of References

Publications & Books:

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[2]. D.W. Gardner, (1998), Review of fundamental vibration theory, in Handbook Handbook of Condition Monitoring, Edited by A. Davies (KLUWER Academic).

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[5]. David Stevens: Machinery Vibration Diagnostics, 07/05/2009, http://www.vibanalysis.co.uk/

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[9]. Corrosion Doctors, 29/05/2009, http://corrosion-doctors.org

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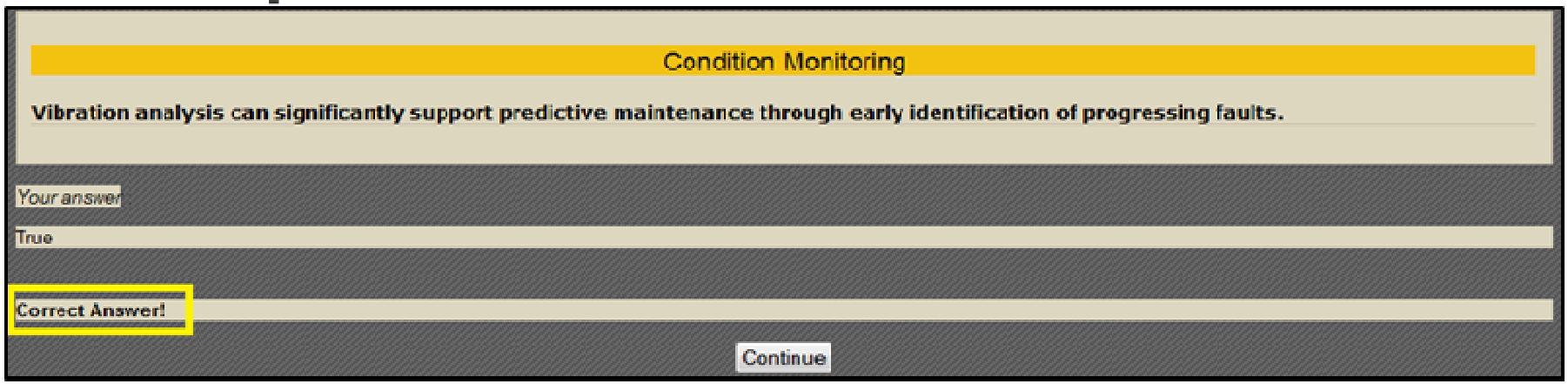
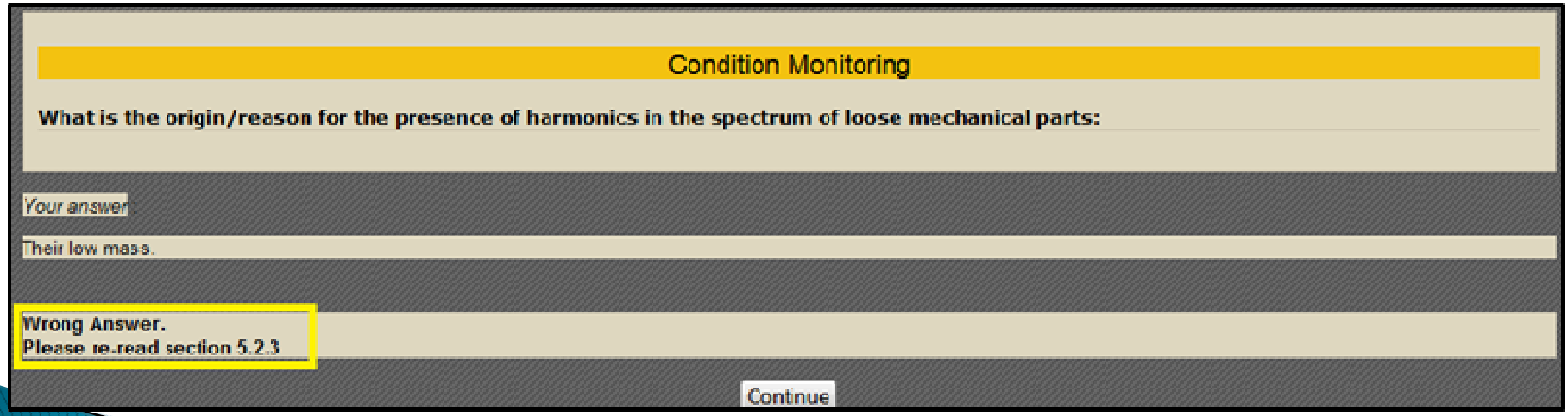
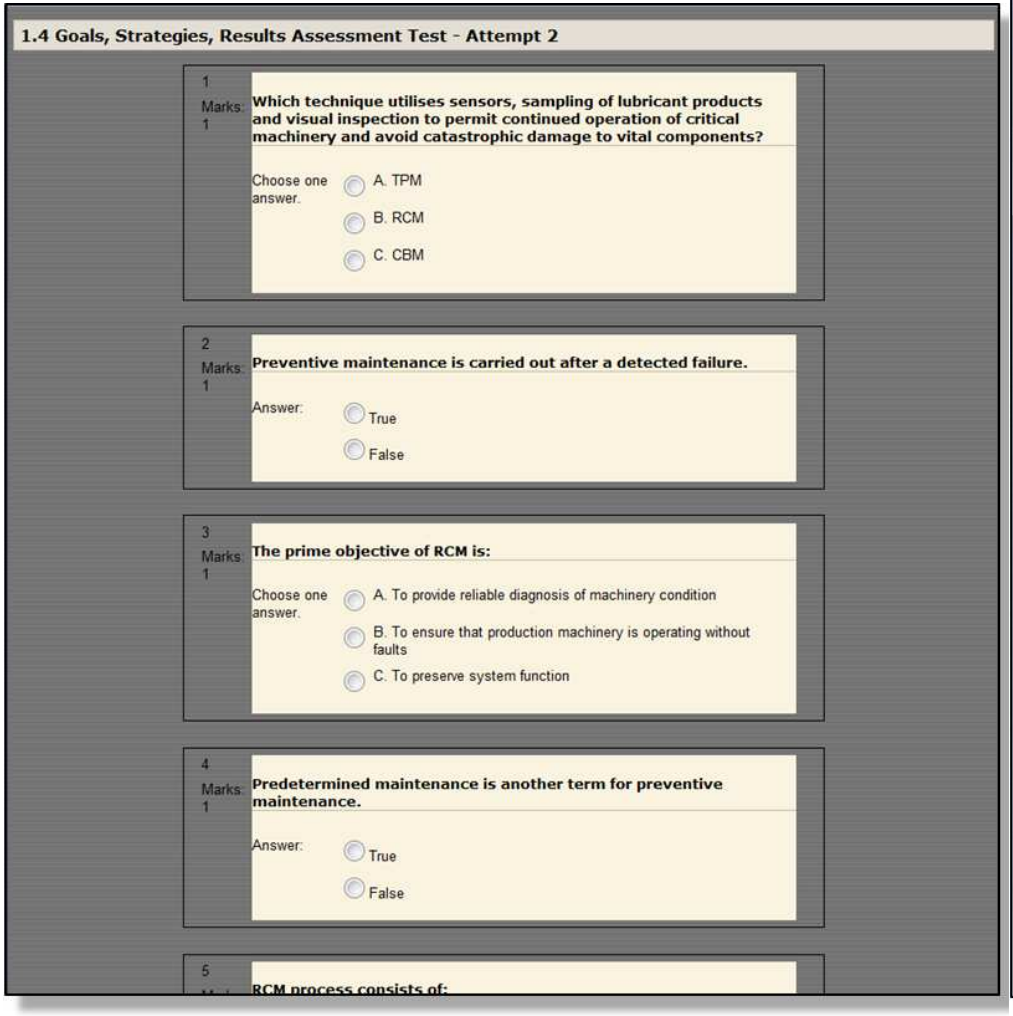
Assisted Learning & Comprehension Tests





Assessment Tests



1.4 Goals, Strategies, Results Assessment Test - Attempt 2

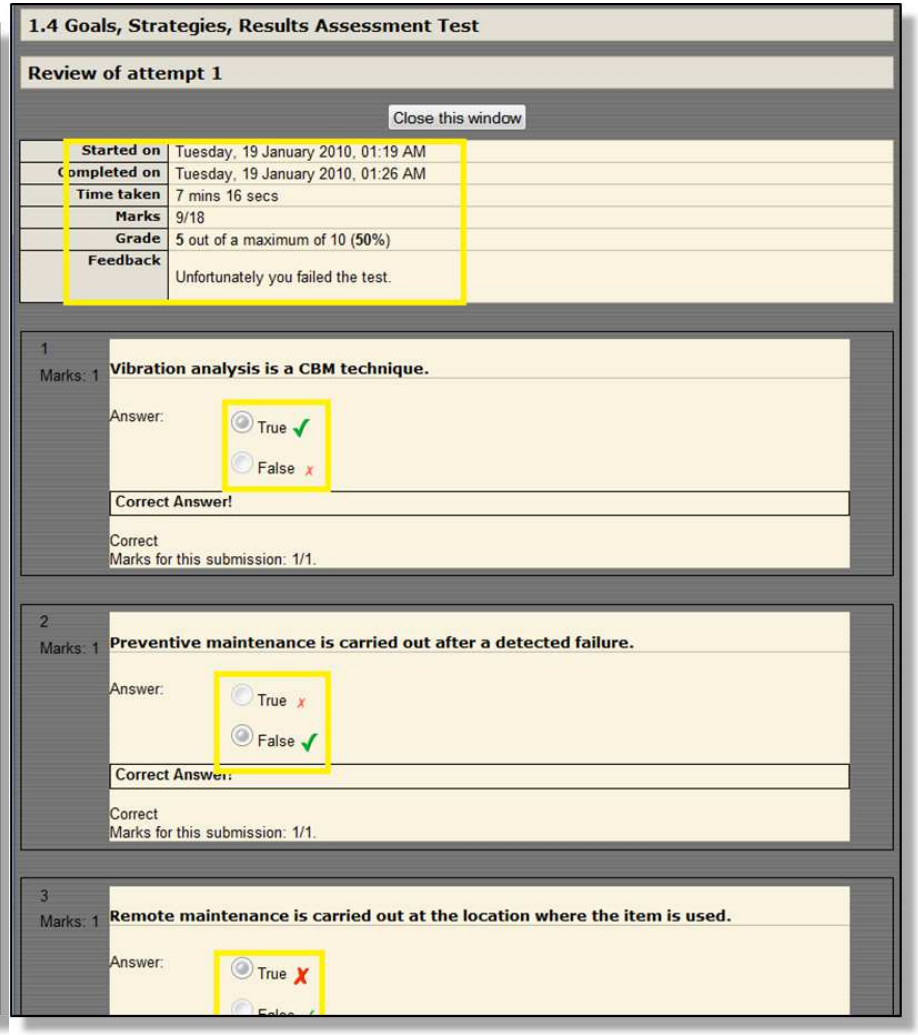
1
Marks: 1
Which technique utilises sensors, sampling of lubricant products and visual inspection to permit continued operation of critical machinery and avoid catastrophic damage to vital components?
Choose one answer.
A. TPM
B. RCM
C. CBM

2
Marks: 1
Preventive maintenance is carried out after a detected failure.
Answer:
True
False

3
Marks: 1
The prime objective of RCM is:
Choose one answer.
A. To provide reliable diagnosis of machinery condition
B. To ensure that production machinery is operating without faults
C. To preserve system function

4
Marks: 1
Predetermined maintenance is another term for preventive maintenance.
Answer:
True
False

5
RCM process consists of:



1.4 Goals, Strategies, Results Assessment Test

Review of attempt 1

Close this window

Started on	Tuesday, 19 January 2010, 01:19 AM
Completed on	Tuesday, 19 January 2010, 01:26 AM
Time taken	7 mins 16 secs
Marks	9/18
Grade	5 out of a maximum of 10 (50%)
Feedback	Unfortunately you failed the test.

1
Marks: 1
Vibration analysis is a CBM technique.
Answer:
True ✓
False ✗
Correct Answer!
Correct
Marks for this submission: 1/1.

2
Marks: 1
Preventive maintenance is carried out after a detected failure.
Answer:
True ✗
False ✓
Correct Answer!
Correct
Marks for this submission: 1/1.

3
Marks: 1
Remote maintenance is carried out at the location where the item is used.
Answer:
True ✗
False

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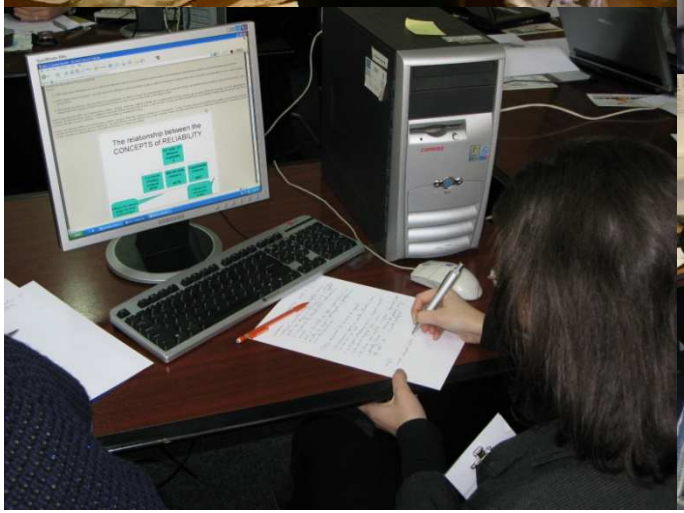
Athena Research Center

CULTURAL AND EDUCATIONAL TECHNOLOGY INSTITUTE
1998

CompSys


iLearn2Main


CONSILIUL NAȚIONAL
AL ÎNTREPRINDERILOR PRIVATE
MICI ȘI MIJLOCII DIN ROMÂNIA
Singura organizație patronală reprezentativă la nivel național pentru IMM-uri


The relationship between the
CONCEPTS of RELIABILITY

WelCOM e-training

E-Training Server

Mobile Apps

Web Services

Shop Floor
& Mobile
Training

Maintenance Staff

E-Training PCs

Maintenance Staff

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Athena Research Center

CULTURAL AND EDUCATIONAL TECHNOLOGY INSTITUTE
1998

CompSys

The future of Asset Management Training

Competencies framework (Asset Management & Beyond)

Personalised Learning

Groupware Learning

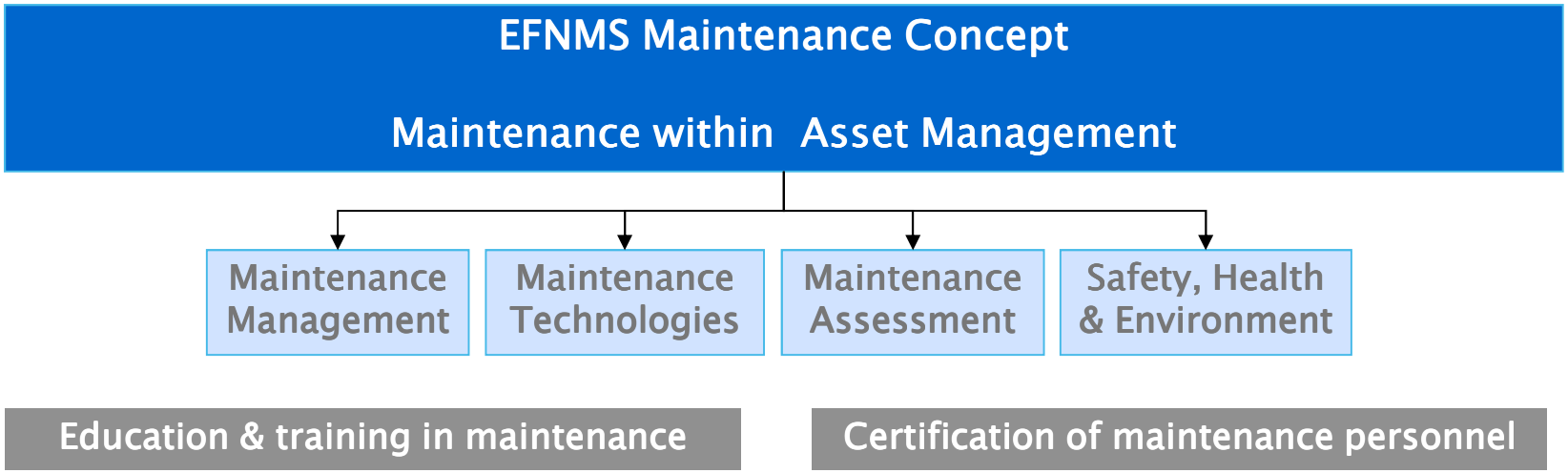
Skills development methodologies and tools

- 'Creative' approaches in place of On the Job Training (OJT)
  - E-Learning & 'Learning 2.0'
  - AR – Virtual Worlds
  - Virtual Learning & Personalised Learning Environment
  - Games & Simulation
  - Learning Labs

Outline

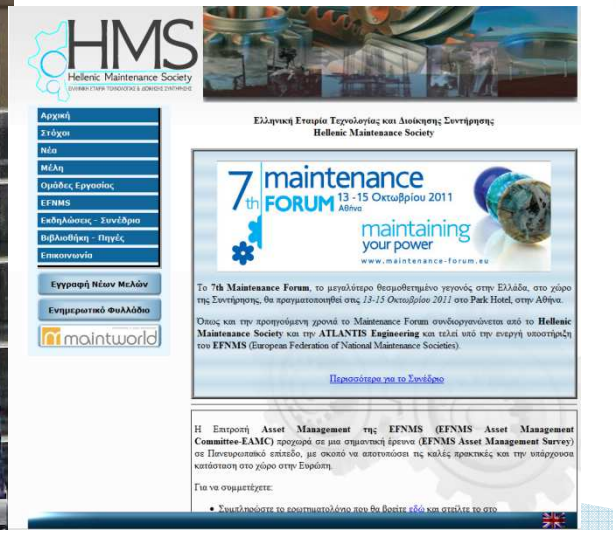
- Engineering Asset Lifecycle Management
- Enabling Technologies
- Advanced e-Maintenance Services
- Skills & Competences
- Conclusion

EFNMS Maintenance Management Concept



Source: www.efnms.org – The European Asset Management Committee of EFNMS

Hellenic Maintenance Society



Συμμετοχή σε Οργανισμούς – Working Groups και Δίκτυα

- IMS M4SM (Maintenance for Sustainable Manufacturing) Manufacturing Technology Platform (iLearn2Main participation) – www.ims.org
- International Society of Engineering Asset Management – www.iseam.org
- European Federation of National Maintenance Societies – www.efnms.org
- Hellenic Maintenance Society – www.hms-gr.eu
- IFAC TC 5.1 – Working Group http://tc.ifac-control.org/
- IFIP Working Group 5.7 http://www.dig.polimi.it/ifip-wg5-7/IFIP WG 5.7

Διοργάνωση 4th World Congress on Engineering Asset Management στην Αθήνα

WCEAM
World Congress on
Engineering Asset Management

Το στήγμα της Ελληνικής θέσης στην καινοτομία και τις καλές πρακτικές στο χώρο του EAM έδωσαν επίσης με κεντρικές ομιλίες τους ο κ. Πάνος Ζαχαριάδης, Τεχνικός Διευθυντής της Atlantic Bulk Carriers Ltd και ο κ. Παναγιώτης Παπανικόλας Τεχνικός Διευθυντής της Γέφυρα ΑΕ, η οποία έχει την ευθύνη της διαχείρισης και συντήρησης της γέφυρας Ρίου – Αντιρρίου.

Ο Co-Chair του συνεδρίου Δρ. Χρήστος Εμμανουηλίδης, μέλος του ΔΣ της HMS και Κύριος Ερευνητής στο Ερευνητικό Κέντρο 'Αθηνά', παρουσίασε το πρόγραμμα του συνεδρίου το οποίο περιέλαβε περισσότερες από 120 εισηγήσεις και επισήμανε ότι φέτος οργανώθηκαν ειδικές συνεδρίες για Stategic Engineering Asset Management από την EFNMS και το δίκτυο EUREN-SEAM, για πρακτικές που συμβάλουν στη βιώσιμη ανάπτυξη από την Τεχνολογική Πλατφόρμα 'Maintenance for Sustainable Manufacturing (M4SM)' του διεθνούς προγράμματος Intelligent Manufacturing Systems international (IMS), αλλά και για θέματα Condition Monitoring, Transport, Building & Structural Asset Management, Προηγμένες Στρατηγικές Συντήρησης κλπ. Ειδικότερο ενδιαφέρον είχε η συνεδρία για τις ανάγκες Εκπαίδευσης και Κατάρτισης στη Συντήρηση, καθώς και το διαδραστικό workshop στη χρήση εργαλείων e-Learning για το σκοπό αυτό, που οργανώθηκαν από το Ευρωπαϊκό έργο "iLearn2Main". Εξαιρετικό ενδιαφέρον είχε επίσης το ειδικό workshop σε θέματα "Ολοκλήρωσης και Διαλειτουργικότητας» που ανέδειξε την κρισιμότητα της ανάπτυξης και υιοθέτησης διεθνών προτύπων για την ολοκλήρωση της πληροφορίας και των υπηρεσιών σε συστήματα EAM.

Η σειρά συνεδρίων WCEAM ξεκίνησε στην Αυστραλία το 2006 από τον Καθηγητή Joseph Mathew, CEO του Cooperative Research Centre of Engineering Asset Management (CIEAM) και Co-Chair του φετινού συνεδρίου, με στόχο να φέρει κοντά την ερευνητική, ακαδημαϊκή και βιομηχανική κοινότητα από όλο των κόσμο, που δραστηριοποιείται στο χώρο του EAM. Το επόμενο WCEAM θα διεξαχθεί στο Brisbane της Αυστραλίας, 25-27 Οκτωβρίου 2010 και περισσότερες πληροφορίες για αυτό είναι διαθέσιμες στο www.wceam.com.

Η HMS συνεχίζει ενεργά την προώθηση των θεμάτων και εξελίξεων στο χώρο, προγραμματίζοντας τη διεξαγωγή του επόμενου Maintenance Forum στην Αθήνα το φθινόπωρο του 2010 και συμμετέχοντας στο EuroMaintenance που θα διεξαχθεί 12-14 Μαΐου 2010 στη Βερόνα της Ιταλίας. Περισσότερες πληροφορίες είναι διαθέσιμες στο www.hms-gr.eu.

WCEAM 2009 Ομιλητές

WCEAM
World Congress on
Engineering Asset Management

WCEAM 2009 ΟΡΓΑΝΩΤΕΣ

ISEAM CIEAM HMS Hellenic Maintenance Society

WCEAM 2009 ΧΟΡΗΓΟΙ

Bayer Technology Services

IMS INTELLIGENT MANUFACTURING SYSTEMS

CIEAM

Ερευνητικό Κέντρο Αθηνά Athena Research Center

GEFYRA

Prisma Electronics SA

Athentis Committed to Simplicity

sbc BUSINESS CHANNEL

PLANT management

Supply Chain & Logistics

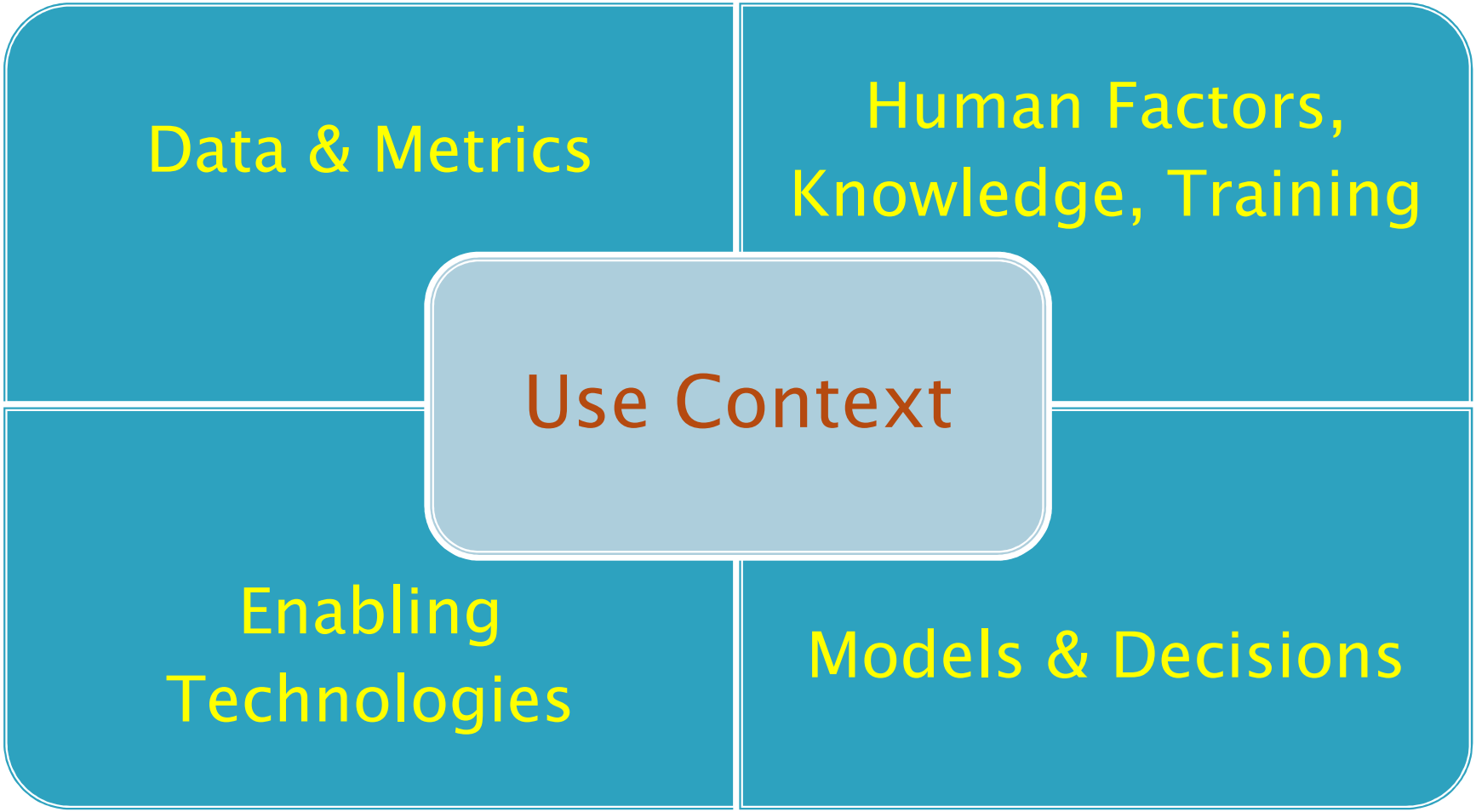
supplychain.gr NEWS

Advances in Production Management Systems

- International Federation of Information Processing – WG 5.7

- Annual Conference
- APMS 2012 – Athens, 24-26 September 2012
- www.apms-conference.org

M4SM Integration



"ASSET LIFECYCLE MANAGEMENT: ENABLING TECHNOLOGIES, SYSTEMS AND SERVICES»

Dr. Christos EMMANOUILIDIS

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CERTH-ITI Research Seminar
9 Nov 2011