Activities within ProcessIT.EU

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Advanced Research & Technology for Embedded Intelligence and Systems

ARTEMIS Joint Undertaking

The public private partnership for R&D actors in embedded systems

Roadmap

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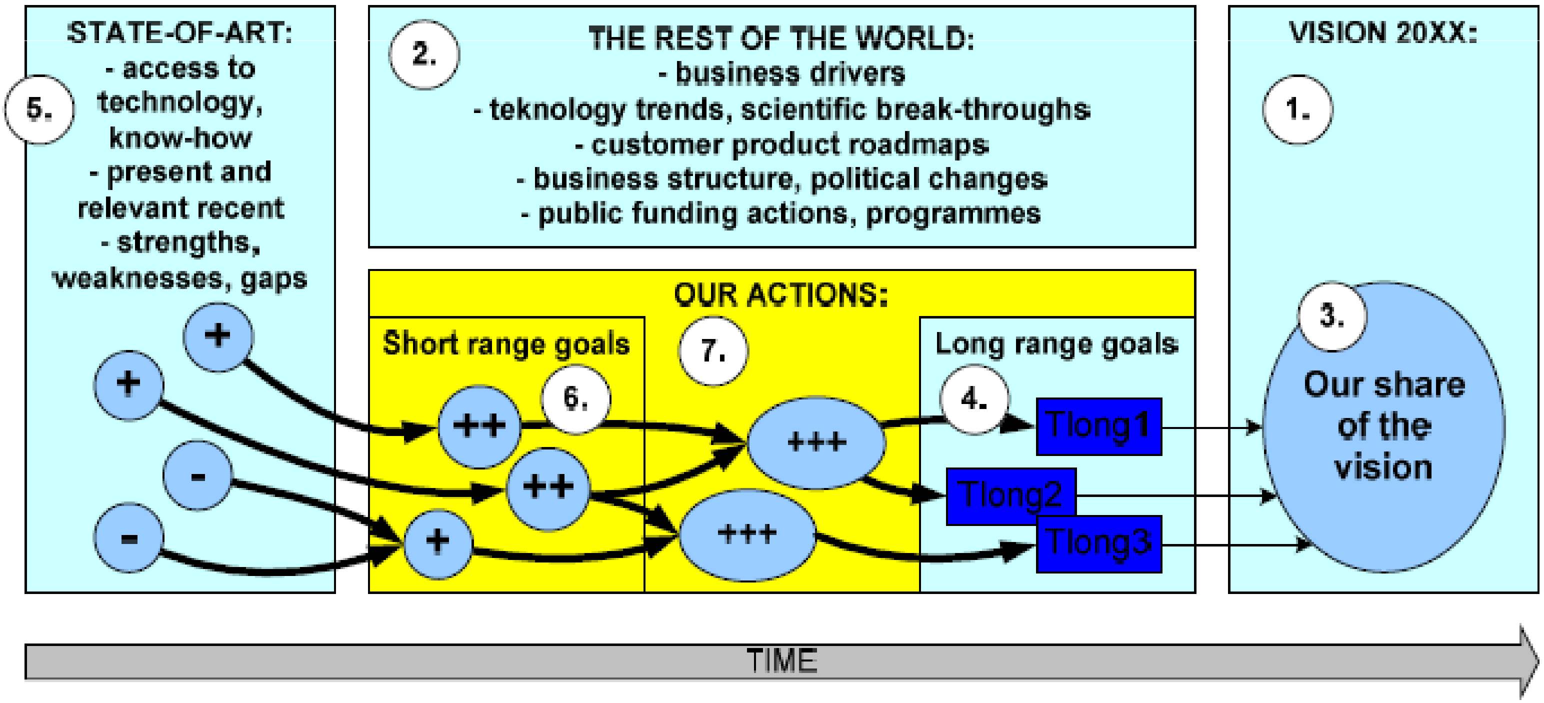
- Target
  - Document supported by presentation

Roadmap development overview

- Method
  - VTT developed process



Overview of work in progress...

Research areas and business environment - "The rest of the world"
Product efficiency | Products, platforms and services | Networking | Collaboration environment | Competence and quality of work | Managed safety and security | Distributed manufacturing

Ideal concepts
- Instant access to dynamic virtual factory
- Transparency between ERP and field
- Sensing and networking in rough environments
- Energy harvesting devices
- Simulator platform for tool integration
- Automatic code generation
- …

Our share of the vision

Dependence
Time line

Action 1
Action 2
Action .
Action .

State-of-the-art Technology availability

Long range goals
Virtual factory | Plug and play | Application store | Using big data | Recycling using internet of things | Integration of production and maintenance planning | IP convergence | Model based risk evaluation

Roadmap process

- Identified research areas/business env.
  1. Production efficiency
  2. Platforms Products and Services
  3. Sustainability
  4. Networking
  5. Competence and Quality of Work
  6. Safety and Security
  7. Distributed and Flexible Manufacturing
- Trends and Visions for each area

Roadmap process

- Example: **Identified trends** in ***Production efficiency & Platforms Products and Services***
  - Growth without new heavy investments.
  - Low capital intensive technologies.
  - Increased integration of production and business operations.
  - Cross layer (ISA-95 levels) optimization
  - Produce to order and not to stock (e.g. VMI)
  - Process industry as part of the smart energy grid (or system)
  - Mass customization and tailor made products. Agile plants which have the economics of a large single stream plant and the flexibility of a batch plant, which, within limits, is able to make almost any product required.
  - Competition of natural raw materials in almost all industry segments
  - Increased availability and uptime.
  - Integrated production and asset management
  - ...

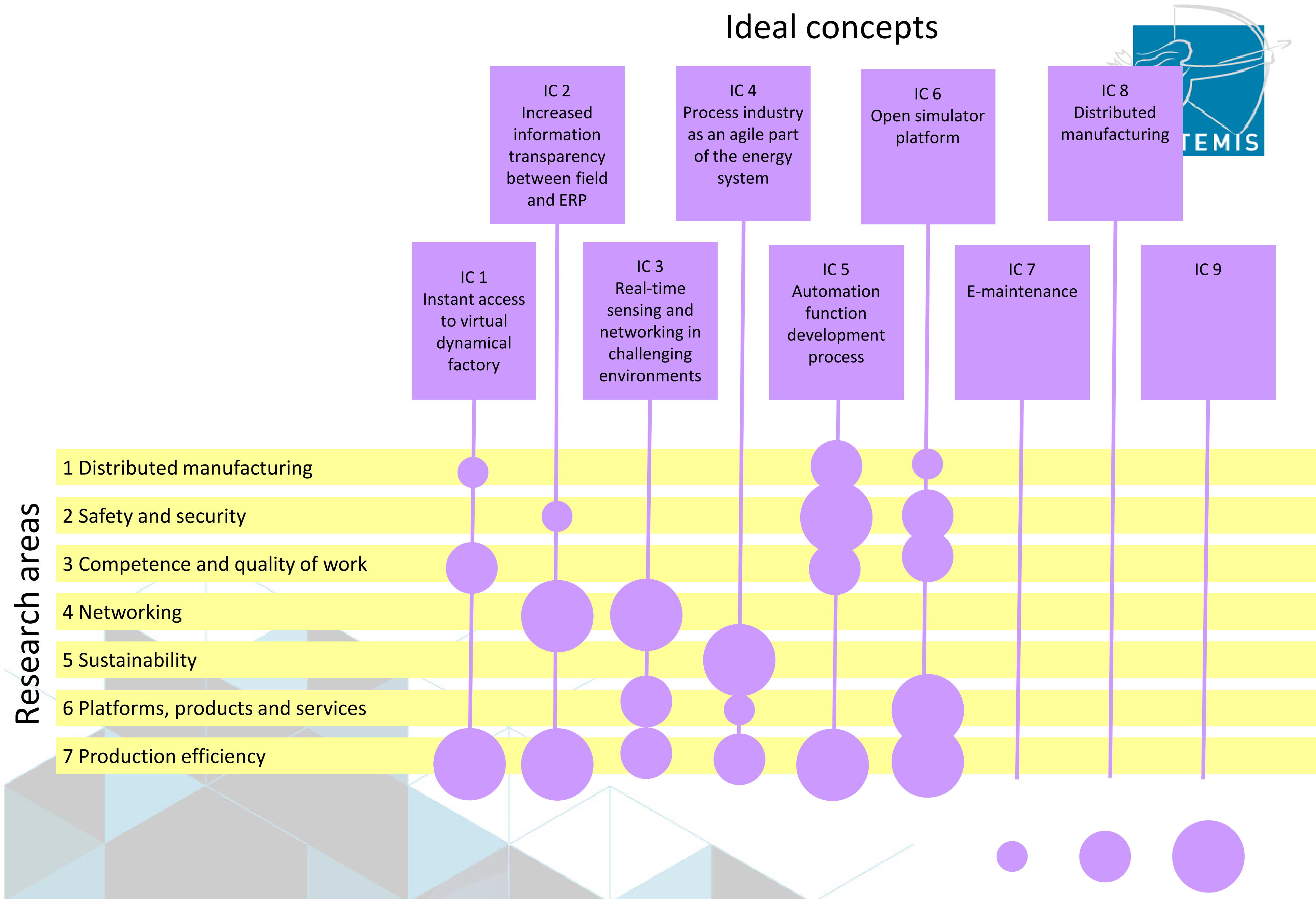
Roadmap process

▶ Example: **Goals and Visions** for ***Production efficiency & Platforms Products and Services***

- Well developed virtual factory
  - Meet the challenges of fast process adaptation due to e.g. mass customization, rapid technology adaptation and plant redesign.
  - Process understanding, operator training, safety analysis, optimization and performance prediction, investment planning.
  - Introduction of technology from consumer products. e.g. game industry.
  - Managing the virtual dual of real factories or processes is as crucial for competitiveness as managing real building or operating. Business & Societal Impact
  - All purposes and multi-technology simulators.
  - Integration platforms for computations, simulation and engineering data, e.g. adaptation of models directly from design data, adaptation of models from as-built.
  - New way of working for automation systems. Rapid prototyping, Soft-ware-in-the-loop, hardware-in-the-loop simulation.
- System integration by plug&play
  - Optimal production for low pollution, high productivity, material usage, system safety.
  - Compliance with standards.
- The platform application store
  - Sufficiently open architecture.
  - Supporting environment for development, distribution, support, marketing, and sales.
- …

Roadmap process

- Find ”ideal concepts” that is reachable within 202x and are supported by identified trends and vision
  - Instant access to virtual dynamic factory
  - Information transparency between field and ERP
  - Real-time Sensing & Networking in Challenging Environments
  - Process industry as an agile part of the energy system
  - E-Maintenance
  - Open simulator platform
  - …

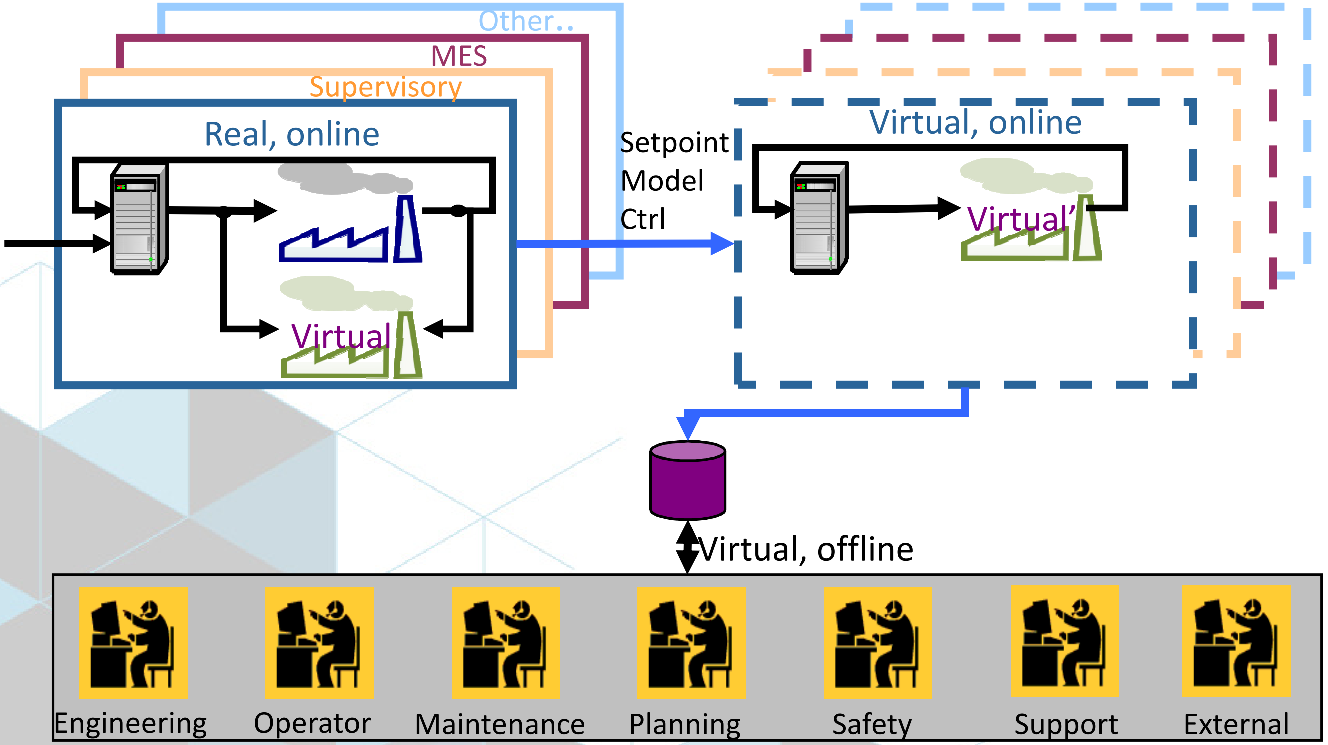


Ideal concepts
IC 1
Instant access to virtual dynamical factory
IC 2
Increased information transparency between field and ERP
IC 3
Real-time sensing and networking in challenging environments
IC 4
Process industry as an agile part of the energy system
IC 5
Automation function development process
IC 6
Open simulator platform
IC 7
E-maintenance
IC 8
Distributed manufacturing
IC 9
Research areas
1 Distributed manufacturing
2 Safety and security
3 Competence and quality of work
4 Networking
5 Sustainability
6 Platforms, products and services
7 Production efficiency
Impact
S
M
L

Example of ideal concept (4 slides)

Instant access to virtual dynamic factory
Ideal concept

To have instant and organisation wide access to the virtual real-time plant in order to provide the right services to the right persons in right time



Instant access to virtual dynamic factory
Business potential

- *Providing decision supporting tools at different organization levels and among a network of companies to increase the OEE.*

Some examples:

- Real-time access to training. Preferably in a consumer-oriented game inspired environment.
- Model-based reasoning at several ISA-95 levels by providing prediction and back-tracking possibilities.
- Usage of soft-sensors, where real sensing is impossible.
- Providing first-line rather than back-office simulation services, i.e. new methodology for "way of working".
- Enabling agile production by efficient support due to prediction possibilities.
- Enabling remote service providers (global). e.g. optimization, structural analysis, trouble solving services that requires virtual factory.
- More…

Instant access to virtual dynamic factory
State-of-the-art

- Within the area of process tracking on-line simulators two approaches have been found in the literature
  - Yokogawa electric corporation: A series of papers from 2006-2010 focusing on prediction based plant operations.
    - Online tracking simulator
    - Adjusts parameters to minimize output error
    - Driven by the need to maintain operator skills
    - Strong focus on prediction and estimation (MBR?)
    - Very simple process demonstrated (e.g. heat exchanger)
    - Not clear how the concepts uses the control system when in prediction mode.
  - Metso automation, One paper from 2012 on a method to online update the parameters based on real-time plant measurements.
    - New method on parameter and state estimation for a tracking simulator
    - Uses PI control and auto-tuning
    - States that there is a huge potential in bringing simulators on-line.

Instant access to virtual dynamic factory

Future enablers

- Numerically robust and fast parameter and state update mechanisms for complex dynamical models (parameters are not constant!).
- Mechanism to update the virtual on-line model and control system.
- Computational issues regarding simultaneous instances of virtual factories.
- Storage and access to data that enable backtracking (e.g. PMR).
- Technologies to handle big data.
- Platform to support several functional views: dynamical, topology, steady-state etc.
- Redefined development process and/or open simulator platform in order to secure that plant modifications are handled also for the virtual plant.

Automation function development process
Ideal concept

Process IT function development process meeting the challenges from globalization and technology trends.

- ***Internet of things***
- ***System of systems***
- ***Cloud computing***
- ***Security and IPR issues of cloud computing***
- ***Collaborative debugging eco systems***
- ***Increased need for virtualization***
- ***Big data***

Tools
V-process
Model based
Organisation
New roles
Requirements
Global distribution
Building trust
Responsibility

Process IT function: a technical solution (often only software) that improves the plants OEE

Automation function development process
Business potential

- *Using new technologies to provide trusted functionality on a global market demand a well designed development process.*

- Safety analysis for cloud computing.
- Redundancy issues for cloud computing.
- Verification and validation under “closed IPR” conditions.
- Process that supports and makes use of collaborative debugging, verification and validation.
- Providing functionality and services globally from a centralized hub.
- Making use of big data from maintenance in the development (improvement) process.
- Each part of the value chain requires an adapted systems engineering (SE) approach - correct level of SE will maximize the gain (performance, safety, integration, innovation).
- More components are sourced base on functionality rather than pure hardware, i.e. sourcing hardware is moving towards sourcing system of systems – the verification loop will play an even more important roll in the future.
- Model-based development process will speed-up the process to design new functionality by reusing models and requirements.
- Improve business and technical communication – avoid costly “after commissioning” discussions.

Automation function development process
State-of-the-art

- Telecom and defense have worked and developed systems engineering from mid ’90s (NCOSE). Automotive joined early 2000. (*Schlager, J., July 1956. "Systems engineering: key to modern development“)*

- There is a clear trend to use a model based framework for SE (perhaps not so strong in the process automation field, ABB, Metso, Siemens, Outotec?).

- Much is driven by the legislation around safe systems (e.g. cesar project) and the fact that you want to reuse the design requirements periodically.

- Not much seems to be done regarding the function development process and how it needs to be adapted to meet new technologies (e.g. mentioned aspects of cloud computing, IPR)

- In practice, there is probably a very varied usage of SE in the process IT value chain (more input?).

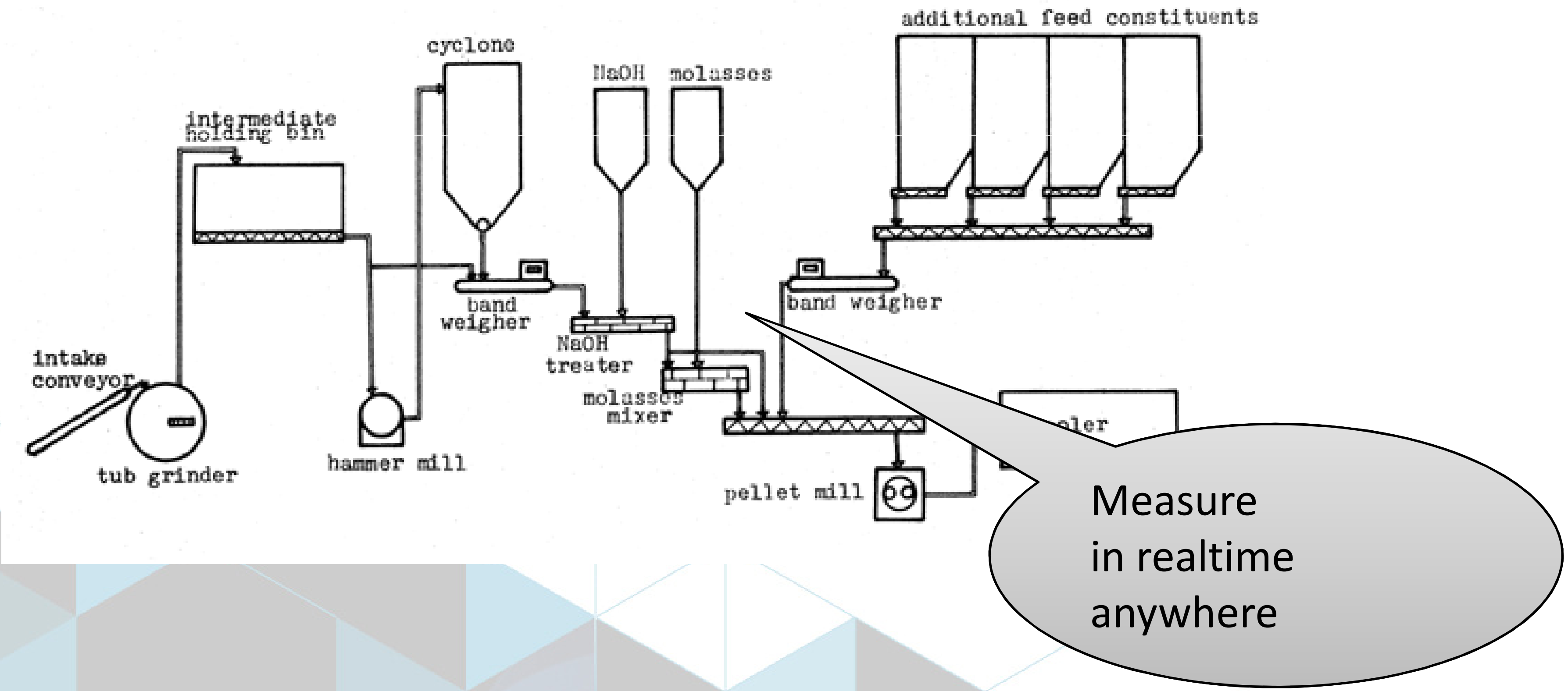
Automation function development process

Future enablers

- Shared vision within the value chain.
- Suitable level and methods for requirement formalization.
- Automatic target coding.
- Model platform for tool integration.
- Legislation
- Direct and easy access to data

Ideal concept

To measure any parameter of interest, anywhere in an operating industrial process in real-time.



Real-time Sensing & Networking in Challenging Environments

Business potential

- *By enabling real-time sensing throughout the process, control and maintenance system can be optimized to support increased production and uptime.*

Examples:

- Reduced un-planned stops caused by breaking devices, as the device can send an alarm if its condition is impaired (e.g. smart bearings).
- Control-loops can be optimized for minimum component wear and not only process performance, (e.g. valves).
- The use of disposable wireless sensors, will give a complete view of e.g. the process temperature profile, that not have been possible previously (pelletizing plant, or continuous casting).
- Better process understanding can improve process operation and planning.
- Support and feedback to virtual factory and simulation tools.

Real-time Sensing & Networking in Challenging Environments

State-of-the-art

- Real-time sensing today
  - Expensive
  - Proprietary solutions
  - Incompatible with other suppliers devices.
  - Wired
- Disposable sensors exists, but are typically expensive and does not communicate wirelessly.

Future enablers

- Large scale diagnostics
- E-maintenance
- Remote operation
- Energy management devices
- Internet of Things technology.
- Cheap embedded devices, small enough to embed in devices without affecting the performance.
- Disposable, wireless devices, cheap enough to send as a tracking device through an operational process at fixed intervals.
- Categorization for the recycling process (using ids on electronic devices)

Continuation

- Continue to work on the ideal consepts
  - Input welcome!
- Suggest actions and timeline

Thank you for your attention!

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