Architecting Intelligent Cyber Physical Systems

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Intelligence (Wikipedia)

Intelligence has been defined in many ways, including: the capacity for logic, understanding, self-awareness, learning, emotional knowledge, reasoning, planning, creativity, critical thinking, and problem solving.

The term Artificial Intelligence is understood as

• software that can train itself to perform certain tasks
• get better at those tasks over time

Considering a system as intelligent is a matter of personal judgement.
The human and the decision loop

System Of Interest

sense → think → decide → act → sense

Intelligent System?

External observer

On the loop
Supervised autonomous

In the loop
Semi-autonomous

Out of the loop
Fully autonomous
The System Architect and Intelligent Systems

- Learning ability
- System autonomy
- Sophistication of decision making

Business Value Proposition

Product Function

Intelligence technologies

- Legal compliance
- Transparency
- Understandable
- Compliancy to social rules
- Ethics

Acceptance

Building up trust
Example: Trusting driverless vehicles

AGV transporting cargo
Restricted environment
No direct human interaction

Car transporting humans
Public environment
Operating in the human consumer space
Customer Value, why making a CPS intelligent?

Assist humans
- Dealing with information overload
- Taking decisions
- Act remotely

Unburden humans
- Of being alert
- Save labor
- Technology disappear in the background

Enable new uses
- Complexity
- Reaction time
- Dangerous tasks

Assist physician, driver
Unburden humans
Target recognition
Enable new uses
Improve printing quality
Improve warehouse efficiency
Improve availability
Understand capabilities and limitations
A reasoning framework

Stakeholder Concerns

ISO 25010
Quality Characteristics

What does Customer need in Product and Why?

Customer What
Customer How
Product What
Product How

Customer objectives
Application
Functional
Conceptual
Realization

drives, justifies, needs:
enables, supports:

Stakeholder Concerns

Customer added value
Unique selling points

Business Value Proposition

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Level of ...
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Points and gains

Alternatives

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Example ‘intelligent’ warehouse

Order fulfillment time

Customer WHAT
Customer Objectives
Being market leader in food retail

Customer HOW
Customer Application
Deliver within a hour

Product WHAT
Functional
Adaptive warehouse logistics

Product HOW
Conceptual
Order prediction based on customer data analysis

Product HOW
Realization
Stock Management based on Deep Neural Networks

Learning ability

Understandability

Planners
Operators
Maintenance Engineers

Building up trust
Cyber Physical Systems become ‘intelligent’

Slowly start, but now fast emerging
• Product business value
• Trust, understandability in the Human – Machine interaction

System Architecting methodology
• Be aware of the system aspects, related to intelligence
• No change in the System Architects role
• Current frameworks and tools can be used

Be open for new approaches