

# Architecting Intelligent Cyber Physical Systems

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# Artificial Intelligence

## 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

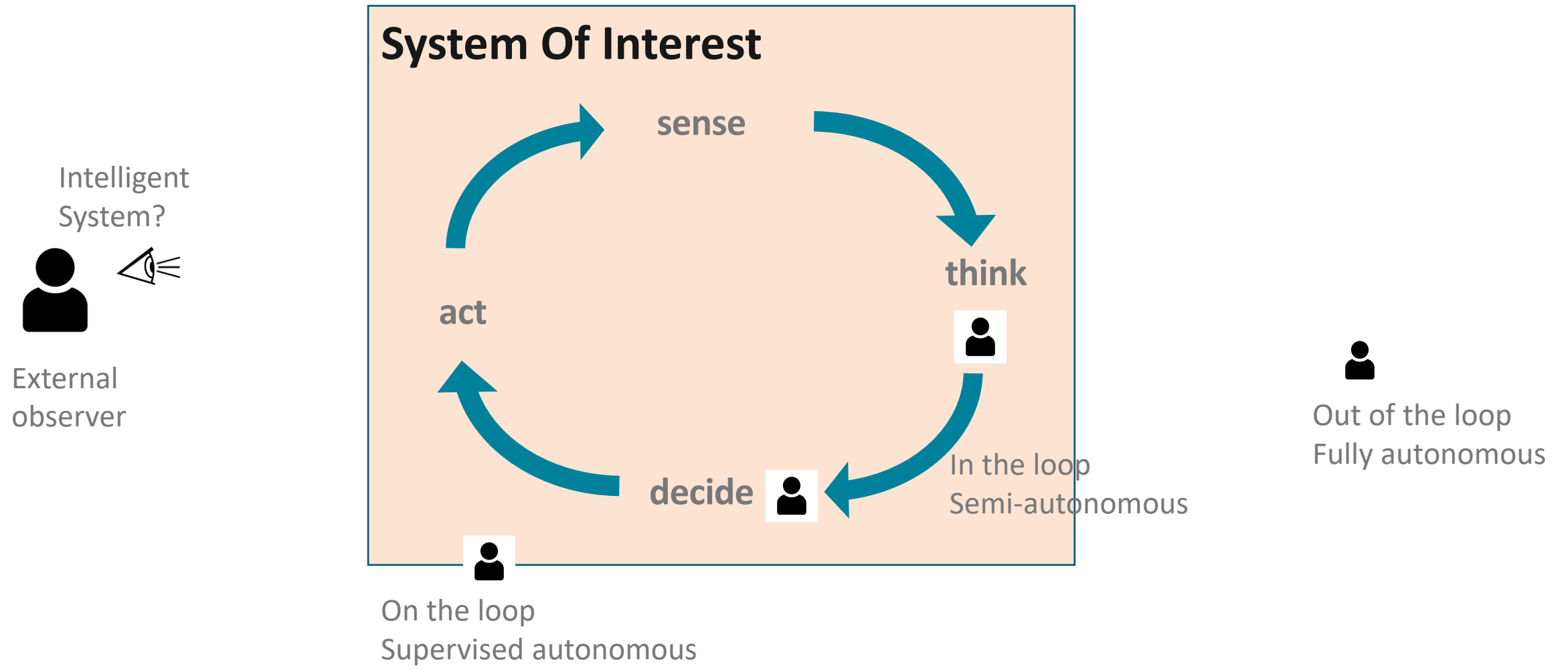
- software that can train itself to perform certain tasks
- get better at those tasks over time

**Considering a system as intelligent is a matter of personal judgement.**



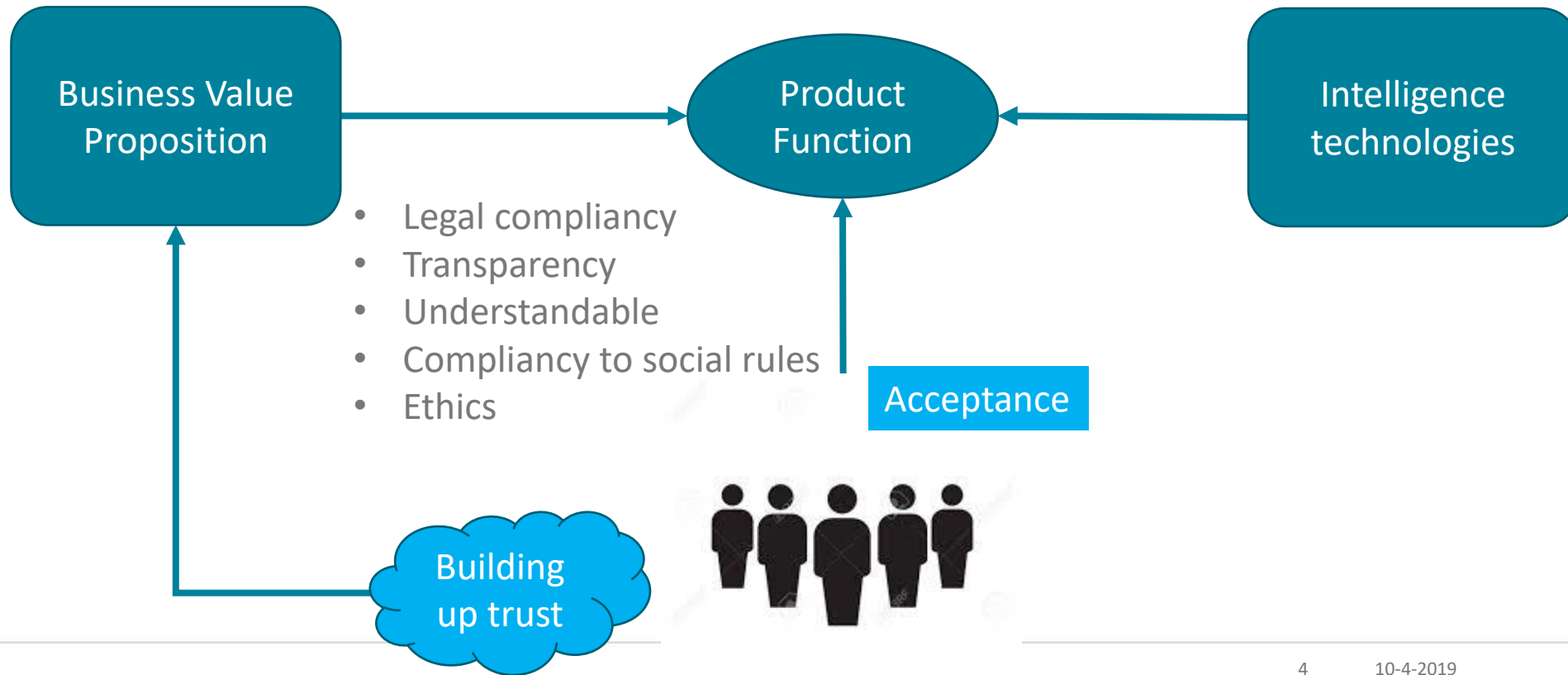
GM Firebird II having an "electronic brain" that allowed it to follow a lane

# The human and the decision loop



# The System Architect and Intelligent Systems

- Learning ability
- System autonomy
- Sophistication of decision making



# 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



Assist physician, driver



Target recognition

## Unburden humans

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



Improve warehouse efficiency



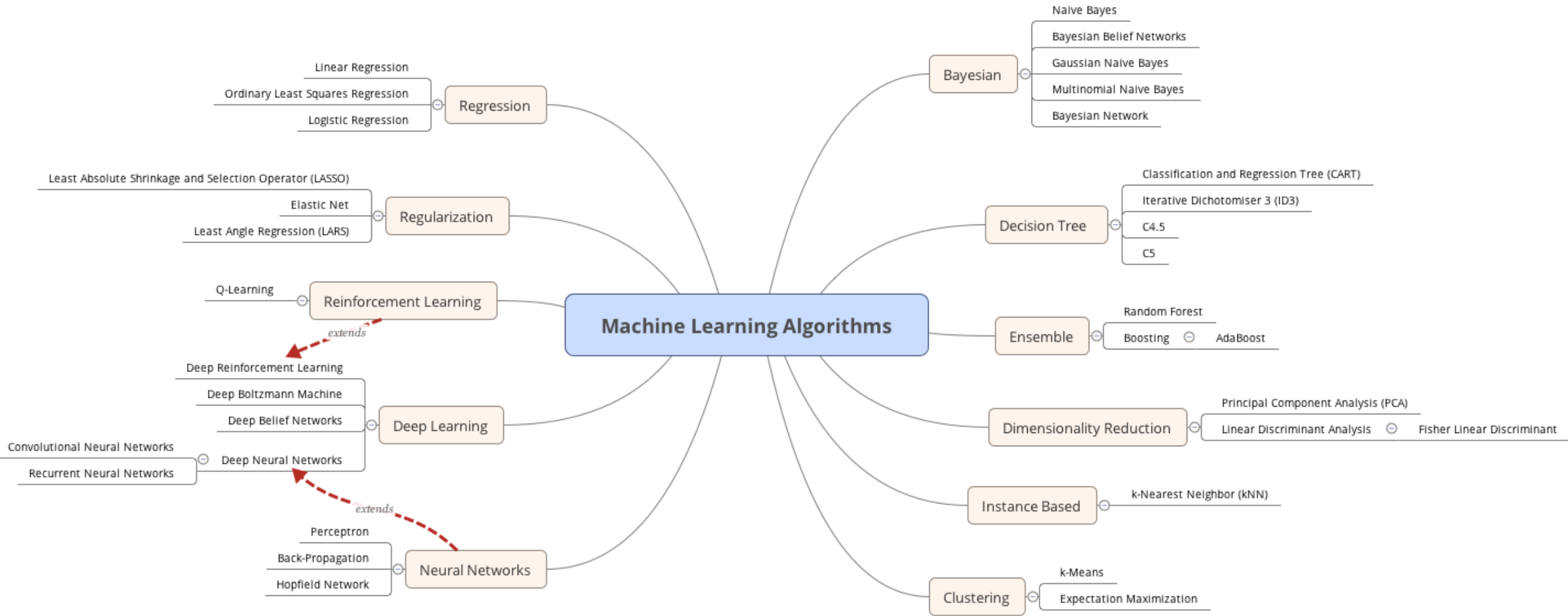
Improve printing quality

## Enable new uses

- Complexity
- Reaction time
- Dangerous tasks

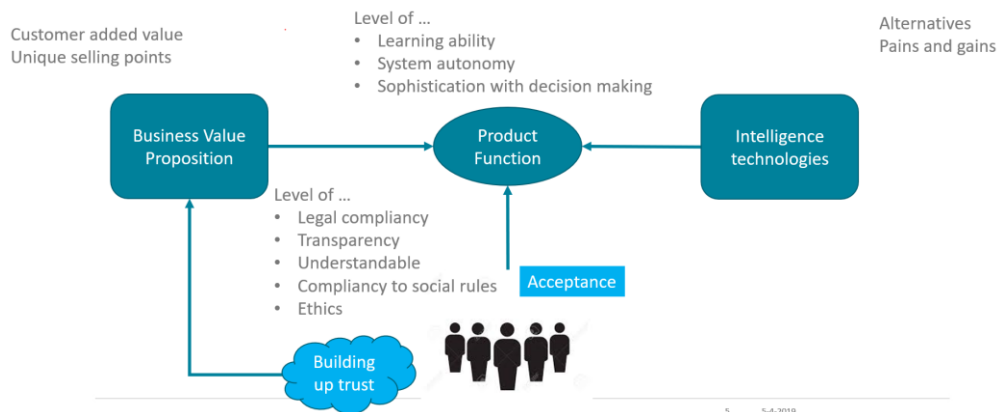


Improve availability

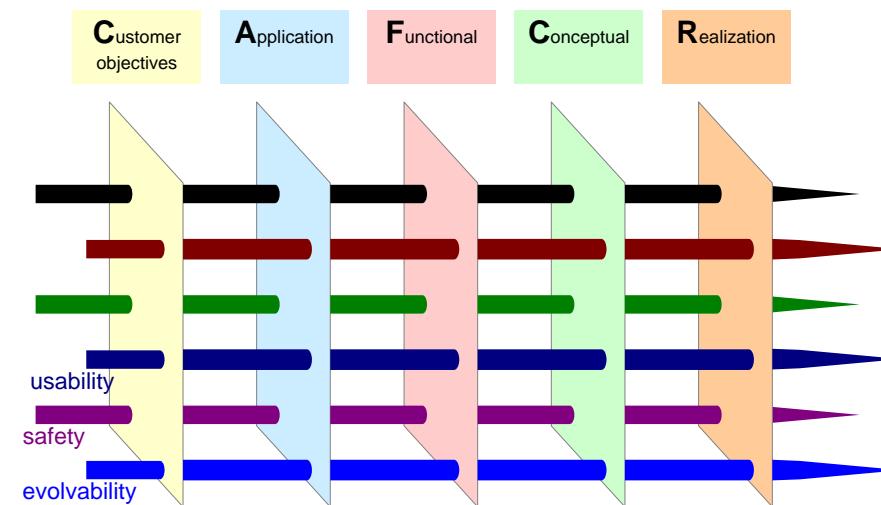
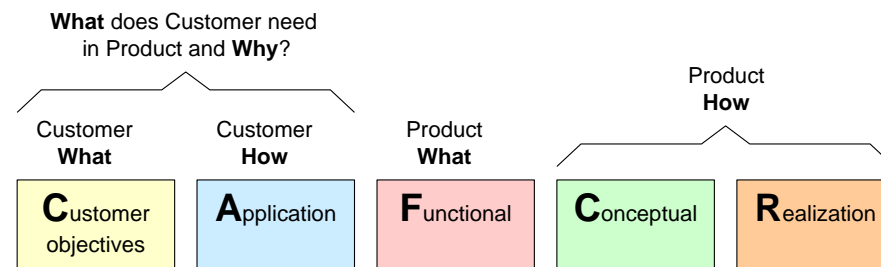
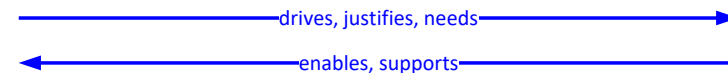


Understand capabilities and limitations

# A reasoning framework



ISO 25010  
Quality Characteristics





# Example 'intelligent' warehouse



Order fulfillment time



Learning ability

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

Understandability



Planners  
Operators  
Maintenance Engineers

# 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

Satisfaction
Usefulness
Trust
Pleasure
Comfort

ISO 25010 Qualities In Use

