



AUTO-ID FOR INDUSTRIAL CONTROL

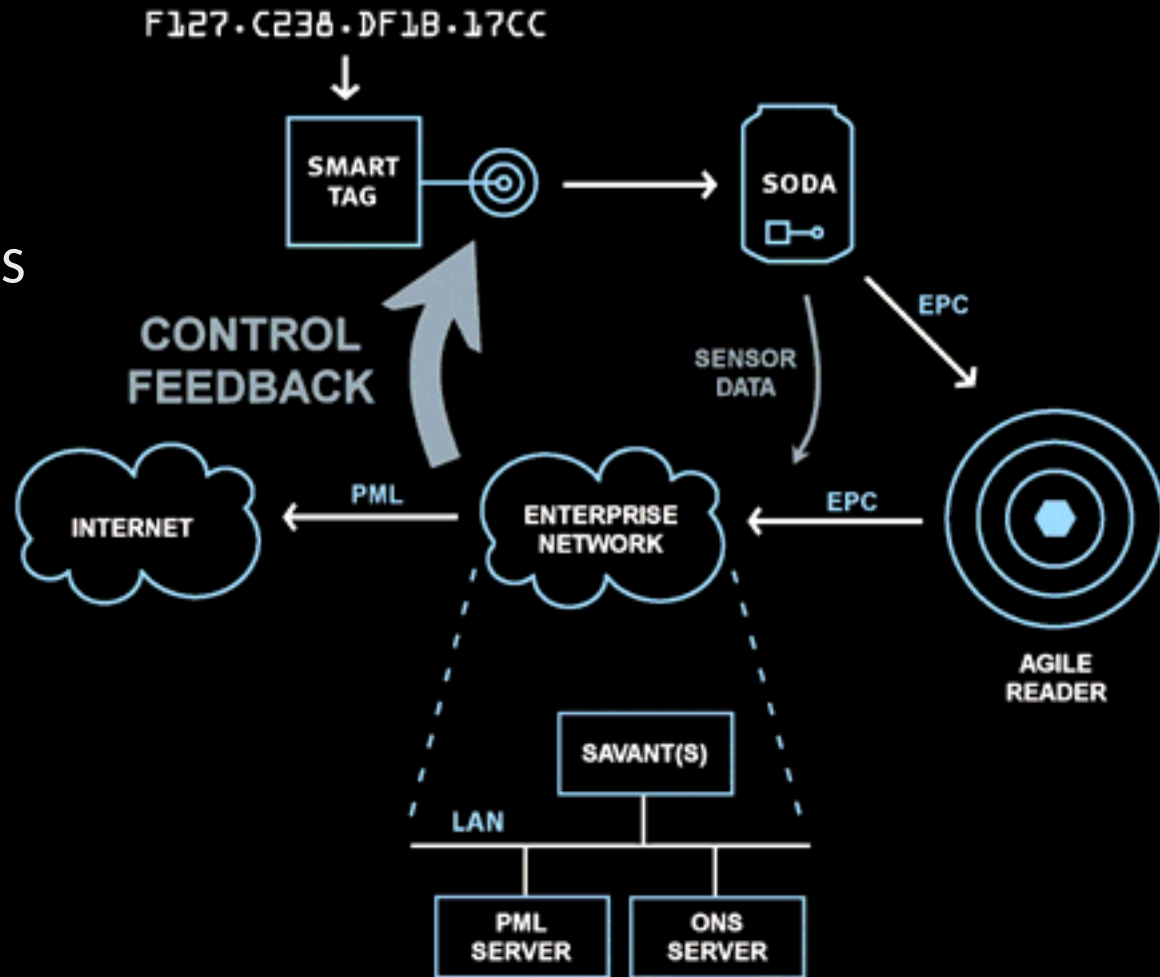
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AUTO-ID FOR CONTROL: CLOSING THE LOOP

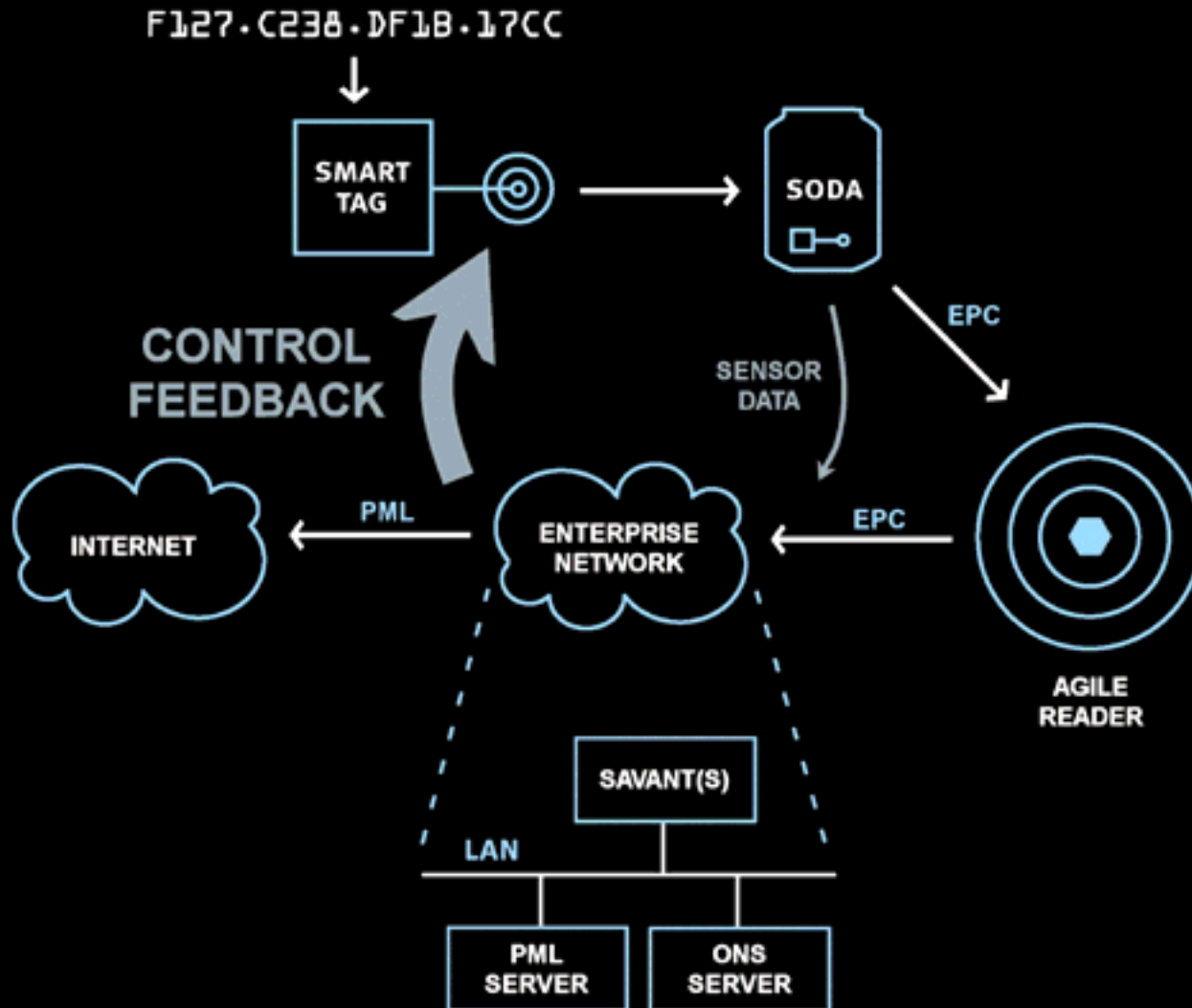
- Motivation
- Background
- Technology building blocks
- Auto-ID for manufacturing

- Questions





AUTO-ID FOR CONTROL: CLOSING THE LOOP



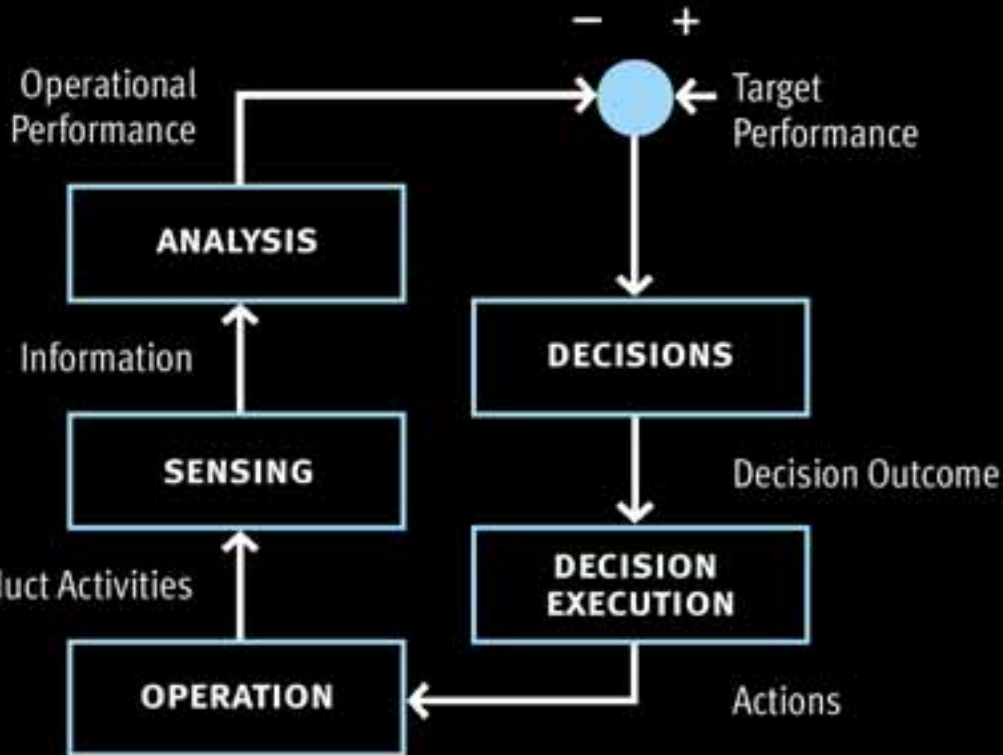


WHY DEVELOP AUTO-ID BASED CONTROL?

- Auto-ID data is:
 - Accurate
 - Fine-grained
 - Item-level
 - Complete
 - Automatic
 - Timely
 - Universal
- In control terms, this means:
 - Reliable operation
 - Good performance
 - Ability to capture item level preferences
 - Support for customised control
 - Reduced human intervention / human errors
 - Supports real-time / just-in-time operations
 - Interoperability



SIMPLE THERMOSTATIC HEATING CONTROL



- Operation – room heating
- Sensing – thermostat
- Analysis – calculate temperature, compare with thresholds
- Decision – out of range?
- Execution – adjust gas valve



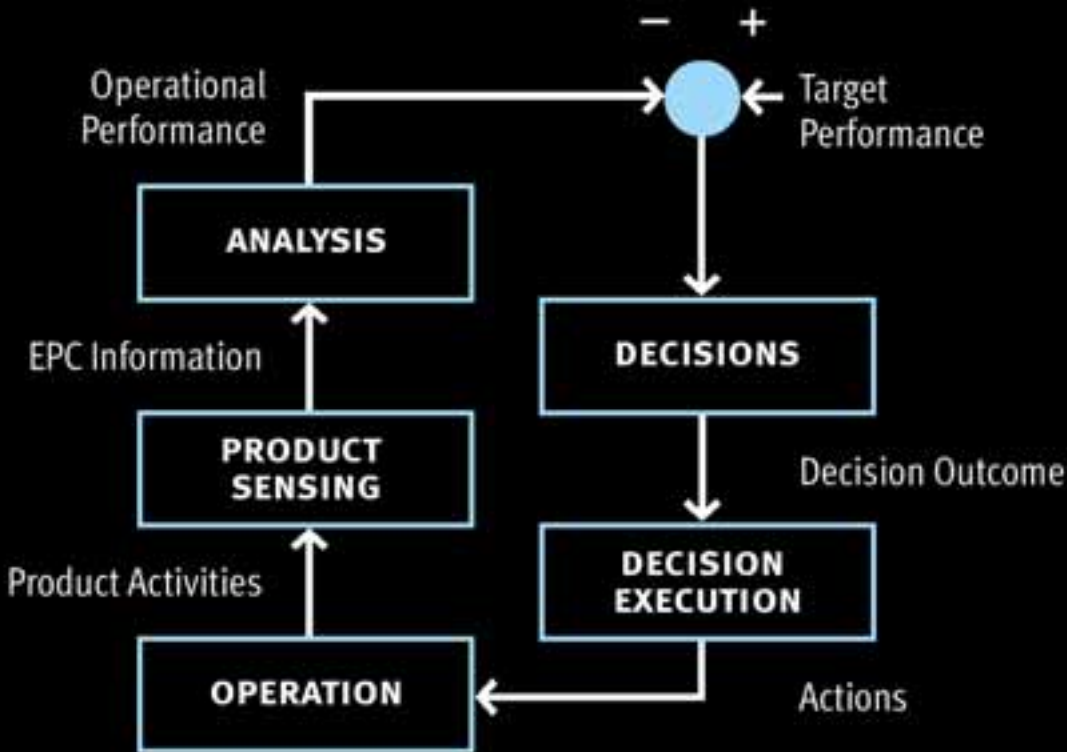
AUTOMATED RETAIL SHELF MANAGEMENT



- Operation – having products available on shelves
- Sensing – stock levels, removal rates, POS data
- Decision – replenishment & reordering planning, theft detection
- Execution – actioning replenishment & reordering, alerting security



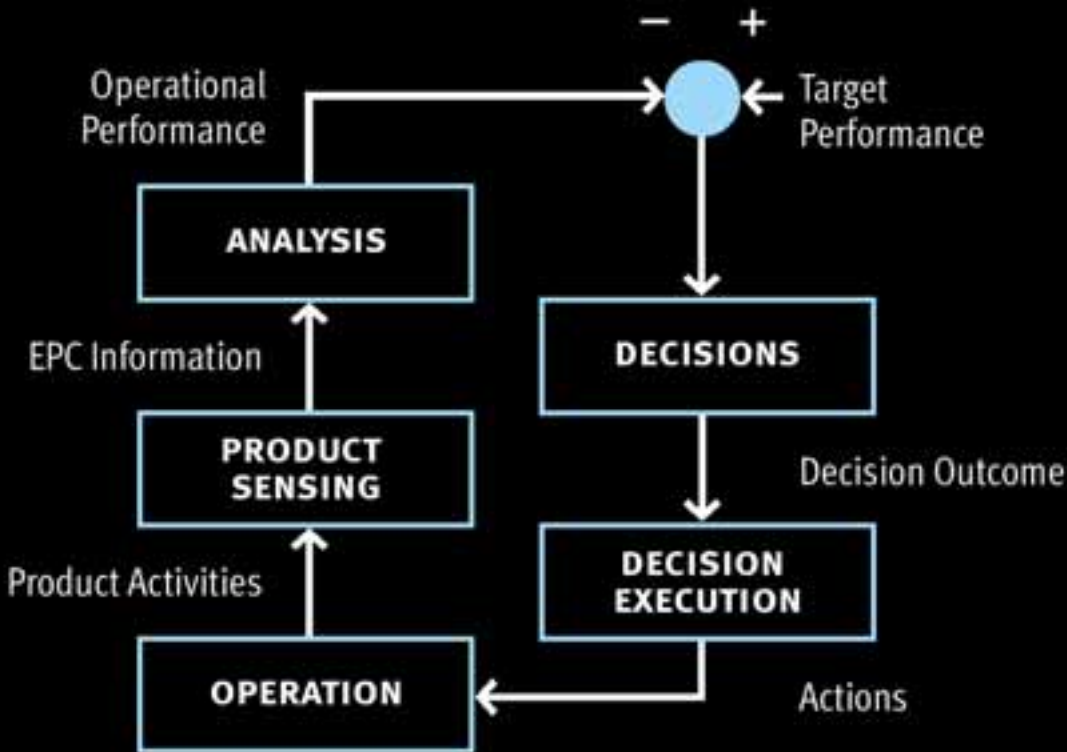
FLEXIBLE CONTROL OF A DISTRIBUTION FLEET



- Operation – delivering food products to retail outlets
- Sensing – product load & condition, truck location
- Decision – (re)scheduling, planning rerouting
- Execution – redirecting individual vehicles to new targets



MASS CUSTOMISATION IN MANUFACTURING



- Operation – gift box packing
- Sensing – item, box type and location
- Decision – customer order content, priorities, quality assurance
- Execution – adaptive automated materials handling



AUTO-ID AUTOMATION LABORATORY



Why?

**practical use of Auto-ID technology
in an industrial control environment**

learning tool for testing Auto-ID
technologies in manufacturing

item-level tracking via unique EPCs

- ▶▶ more flexible manufacturing
- ▶▶ late-stage mass customisation



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AUTO-ID AUTOMATION LABORATORY



We use

A robot
for packing/unpacking items



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A robot
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A conveyor system
to transport shuttles



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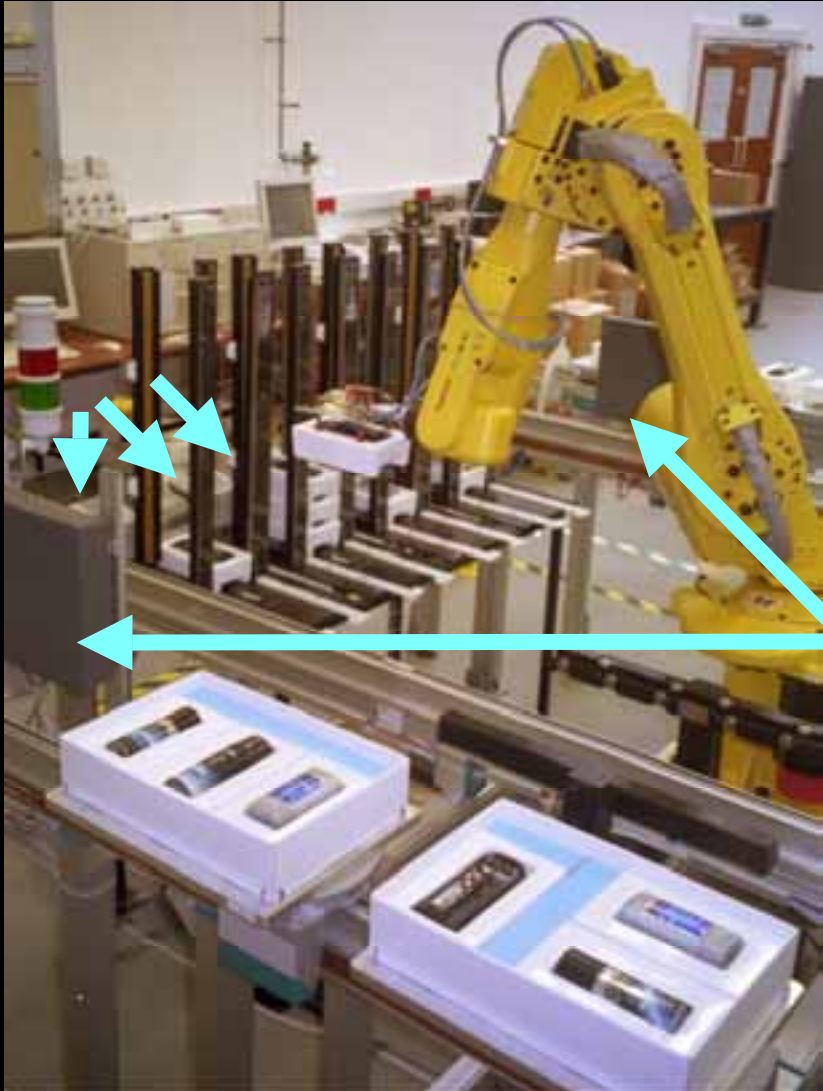
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RFID tags on items, boxes & shuttles





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A Savant
collects and filters RFID readings
generates software 'events'



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A PML Server

To store product data, batch orders

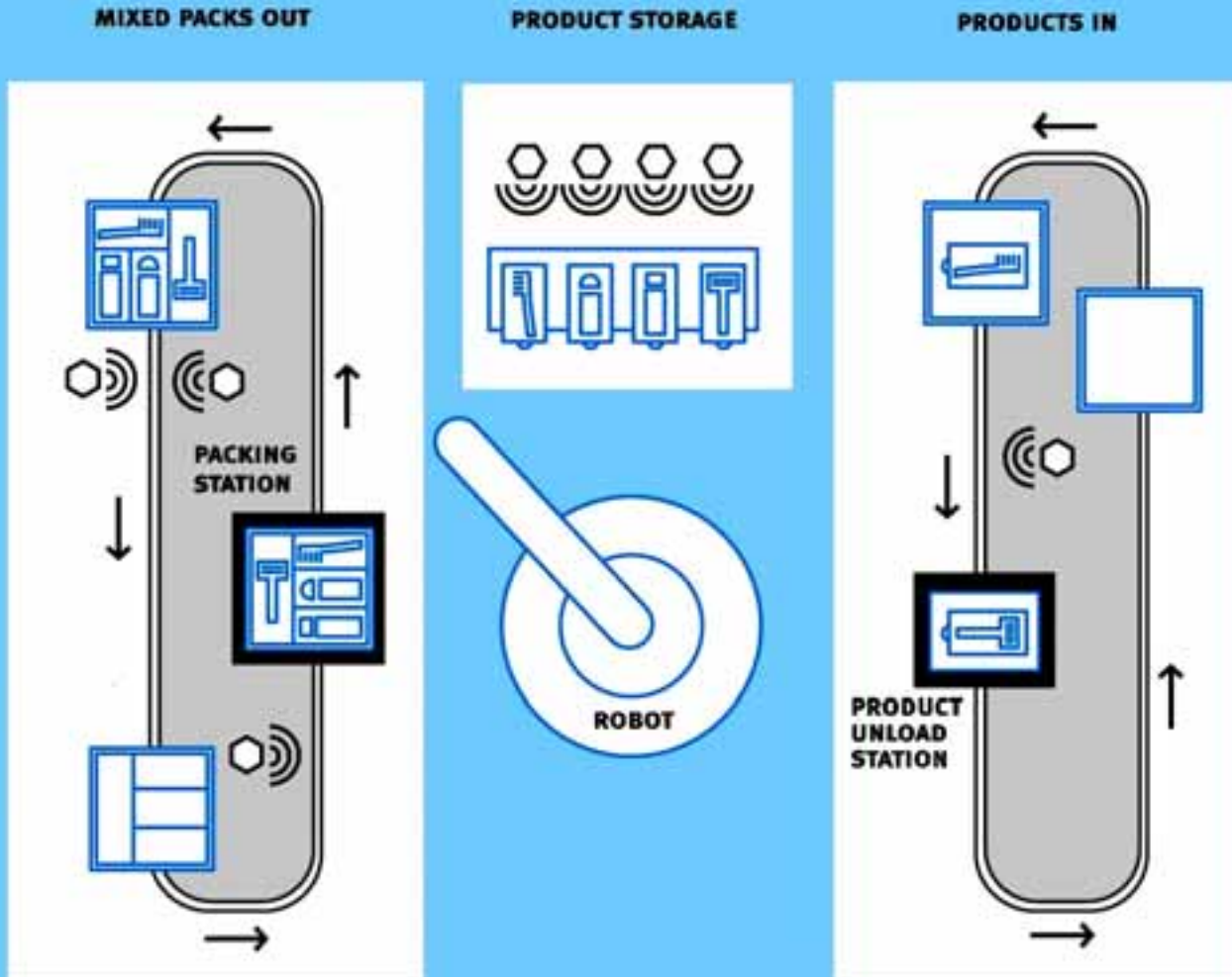


PHASE 1 DEMO (IMPLEMENTED JUNE 2002):

- Basic robot packing cell
- Traditional control system, augmented with Auto-ID data
- Demonstration of scenarios



PHASE 1 DEMO: HARDWARE SETUP



- Robotic packaging cell
- 2 types of gift box
- 4 types of Gillette items
- RFID tag readers
- Mini storage system
- Quality control station
- Specific example with general applicability



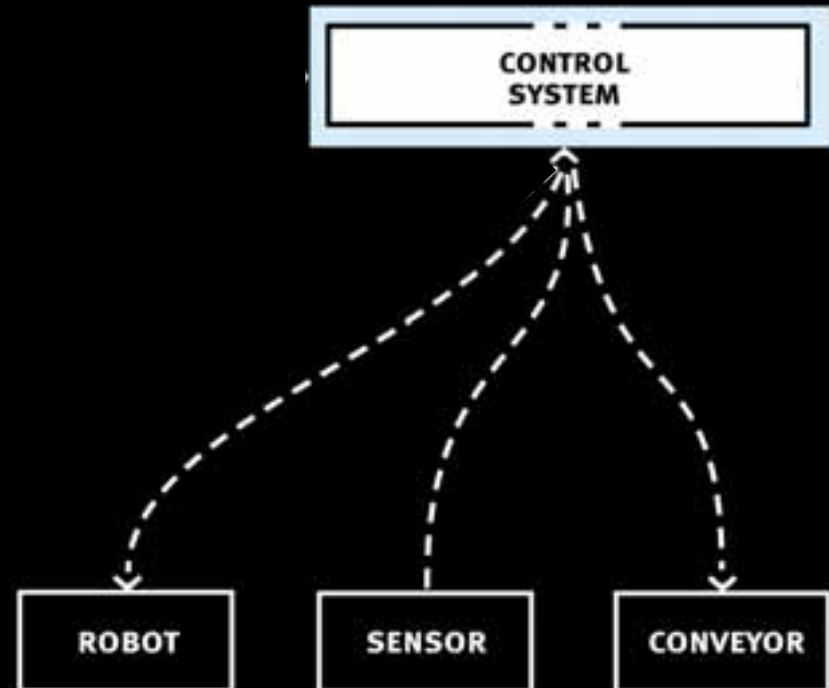
PHASE 1 DEMO: HARDWARE AND SOFTWARE SETUP

- Auto-ID data integrated with traditional control system
- Standard off-the-shelf RFID equipment (tags, tag readers)
- Use of EPC (electronic product code) for uniquely identifying items
- Implementation of the Savant (filtering of tag reads)
- Description of product status & build instructions with PML
- Prototype PML server implementation
- Custom 'Auto-ID enhancing' functions
 - Quality Control (check PML build instructions with QC tag reads)
 - Storage stacks (warehouse, product location)



PHASE 1 DEMO: HOW DOES IT WORK?

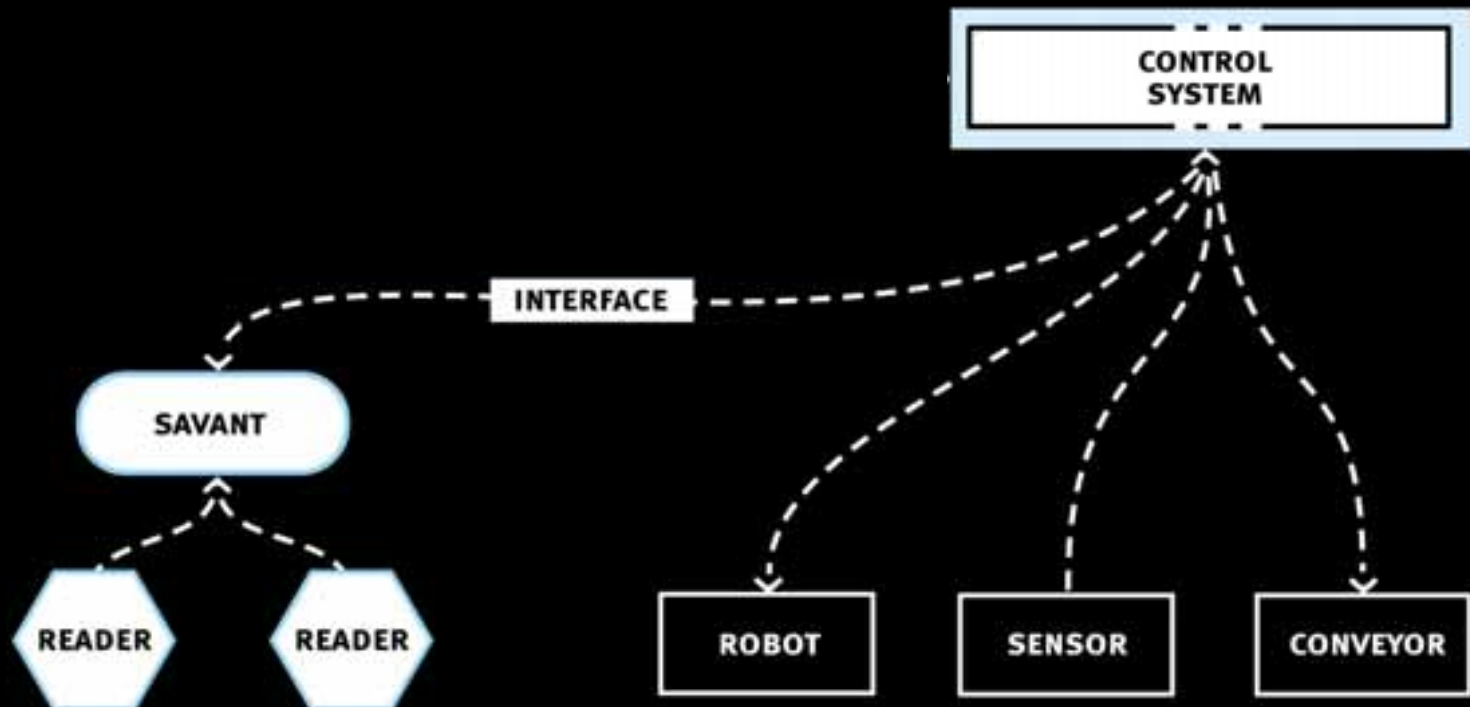
- Traditional, priority-based cell controller
dynamic, real-time selection of next operation with fixed
prioritisation of activities





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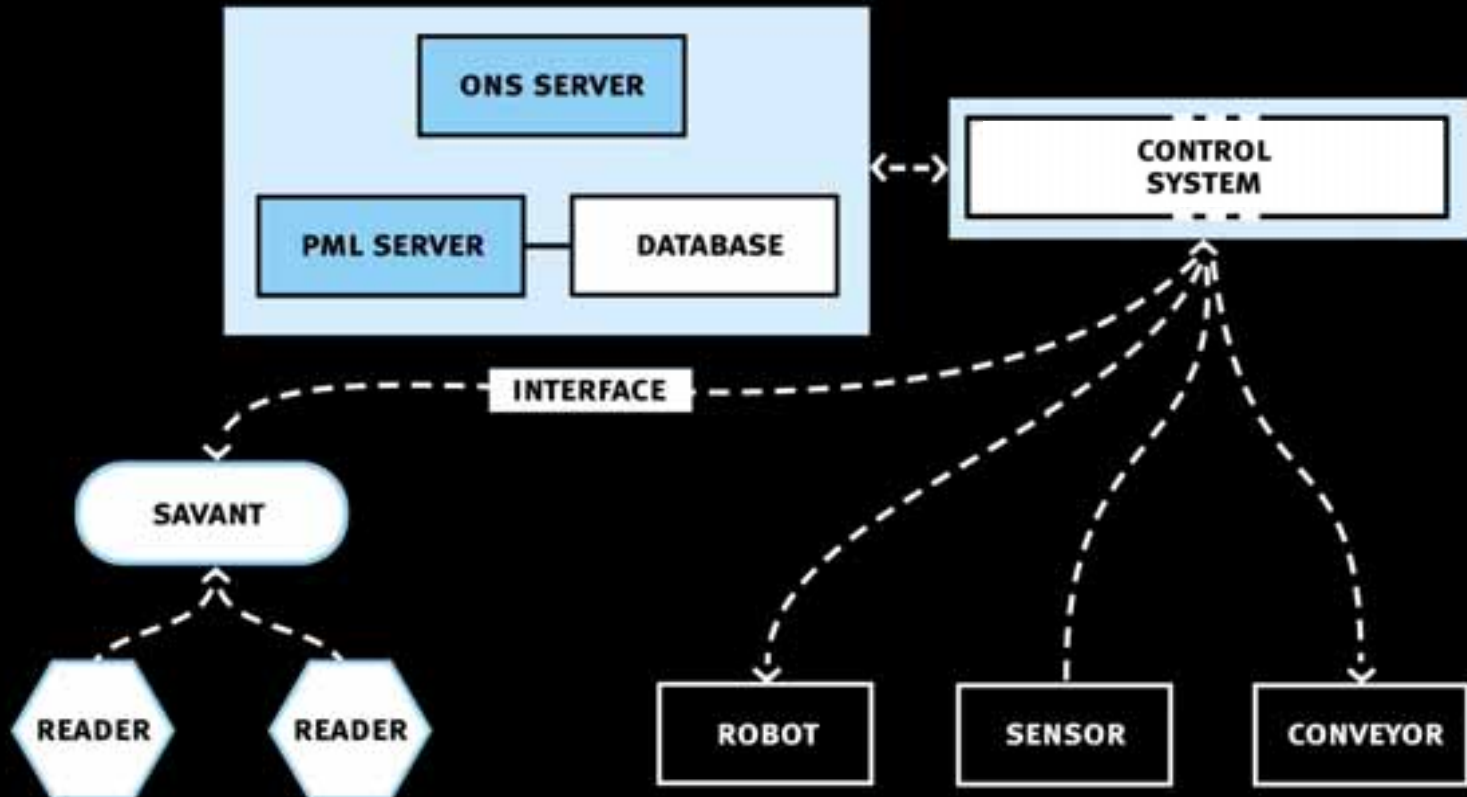
- Auto-ID provides additional sensor input to control system
provides part identification *and* timing at reader locations





PHASE 1 DEMO: HOW DOES IT WORK?

- Minimal PML server
 - provides detailed item information on demand
 - allows additional information to be recorded





PHASE 1 DEMO: SPECIFIC BENEFITS, GENERIC APPLICABILITY

- Unpacking of multiple streams of goods inwards
 - Inventory uncertainty reduced/removed
 - Sorting of any disturbances in storage
 - Packing of (different types of) gift boxes to match (different types of) orders
 - Late-stage mass customisation
 - Quality control of packed boxes
- Any kind of mixed-product packing
 - gift boxes
 - cases
 - pallets
 - containers
 - Other industrial operations
 - production systems
 - assembly
 - materials handling systems
 - warehouse management
 - distribution

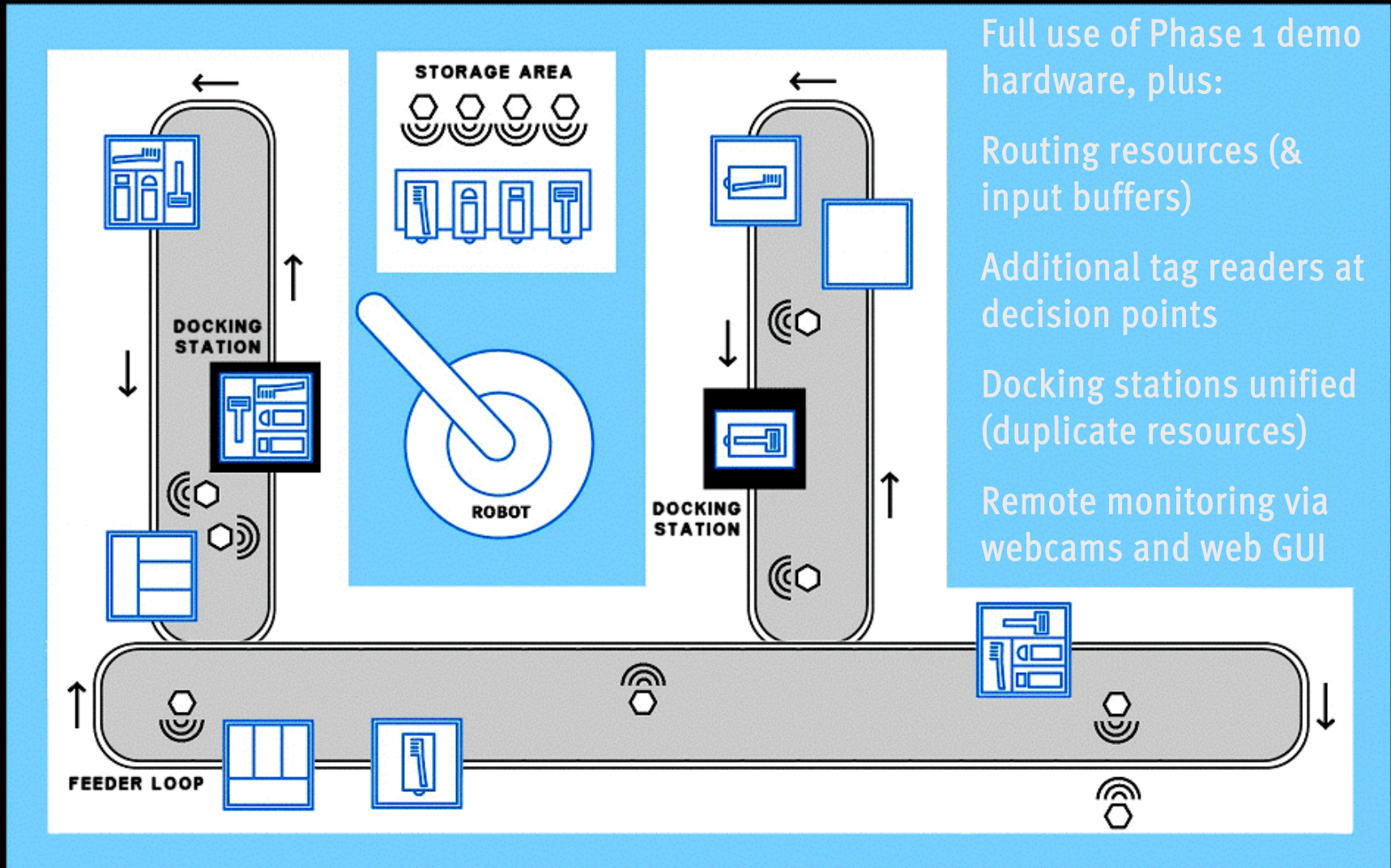


PHASE 2 DEMO (IMPLEMENTED FEB 2003)

- More hardware
- More scenarios
- Different architecture
 - using Auto-ID Data to enhance a distributed control system.

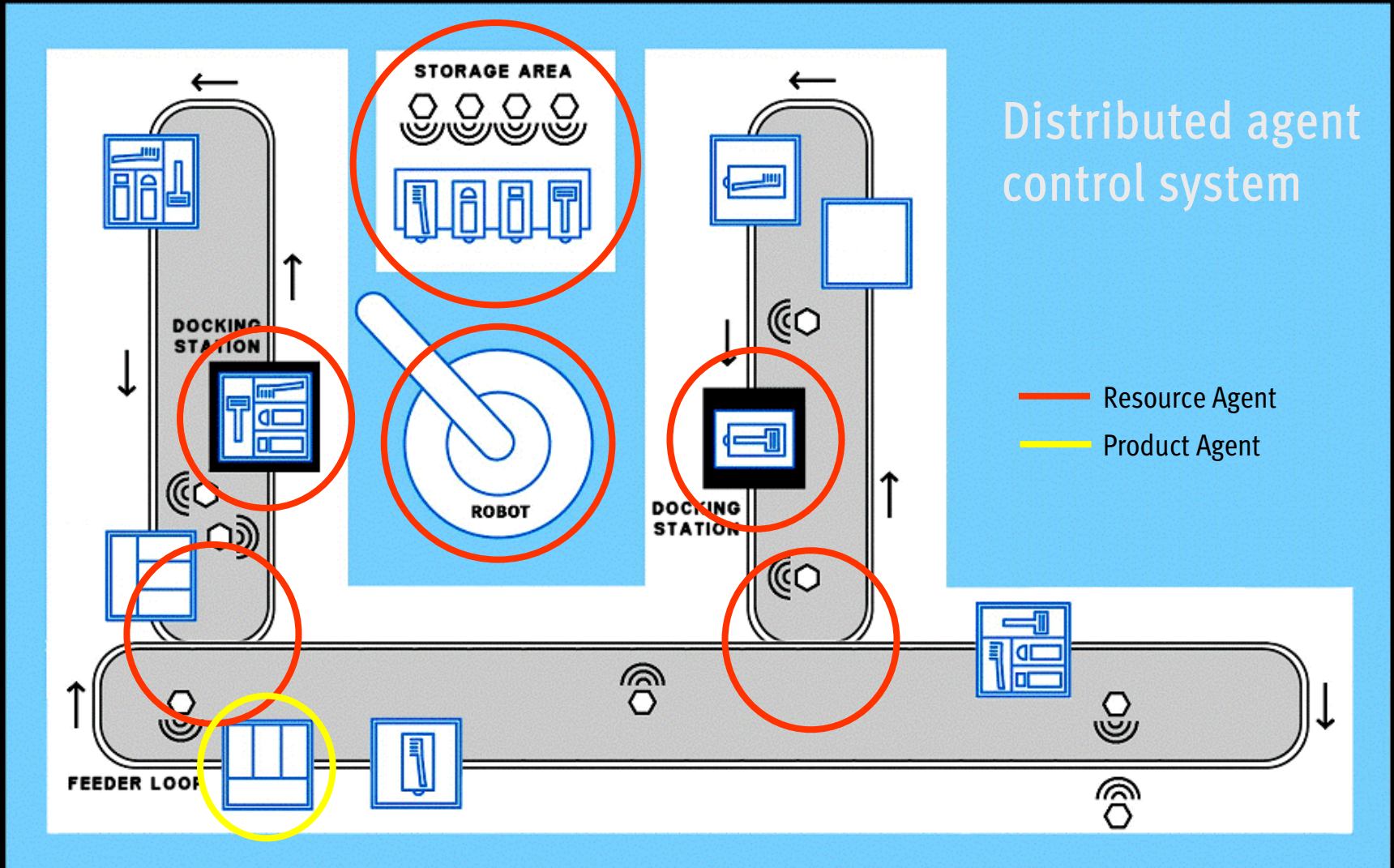


PHASE 2 DEMO: HARDWARE SETUP





PHASE 2 DEMO: HOW DOES IT WORK?





PHASE 2 DEMO: SPECIFIC BENEFITS, GENERIC APPLICABILITY

- All the benefits from the Phase 1 Demo
- Handling of batch and rush orders
 - rush order pushes to front of queue with no change-over time
- Handling resource failure
 - parts routed to duplicate/substitute resource
- Handling material shortage
 - order delayed for later processing
 - parts unpacked from a pre-packed low priority order
- Remote operations (Atlanta Board Meeting)
 - web order placement
 - remote monitoring and status information
- Enabling more robust, responsive & agile behaviours



AUTO-ID DEMO SUMMARY: BENEFITS OF BUILDING DEMO ENVIRONMENT

- Closed the Auto-ID loop
 - integrated Auto-ID data and infrastructure into a automated control system
 - take actions directly on the basis of Auto-ID information
- Provides a platform to build upon
 - increasingly sophisticated systems
 - further research into many areas
- Helps us with core Auto-ID objectives, namely:
 - develop the technology
 - prove the technology, prove the system
 - facilitate adoption