

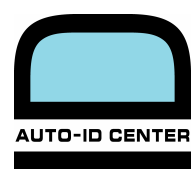
AUTO-ID: MERGING BITS AND ATOMS

C. Y. Wong

April 2003

Auto-ID Centre

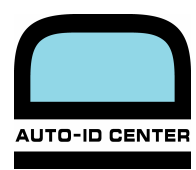
Institute for Manufacturing, Cambridge University



OVERVIEW

- About Auto-ID Centre
- Auto-ID – the supply chain perspective
- Auto-ID technology – building blocks
- New Supply Chain Models

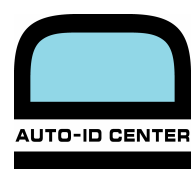
- Discussion



OVERVIEW

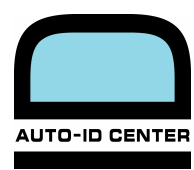
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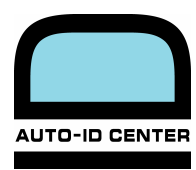
BACKGROUND OF AUTO-ID CENTRE

- Auto-ID Centre embedded within Institute for Manufacturing
- One of a number of research centres
- Variety of roles
 - Research – short-term and long-term
 - Specification and implementation
 - Collaboration with industry
 - Administration and communication



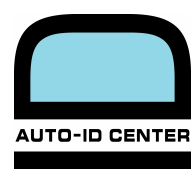
AUTO-ID UNIVERSITY RESEARCH CENTRE

- MIT, Cambridge USA
headquarters
core infrastructure – tags, readers, savant, PML
- Cambridge, UK
Auto-ID for control, savant/PML usage, BIS integration
- Adelaide, Australia
RFID systems and protocols
- Keio, Japan
Networking, ubiquitous computing
- Fudan, China
Fabrication of chips
- M Lab, Switzerland
PML, applications, business cases



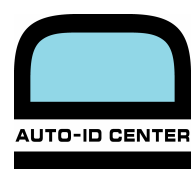
SOME OF THE AUTO-ID SPONSORS

- Gillette
- Wal-Mart
- P&G
- Unilever
- Kraft
- Philip Morris
- Nestle
- Best Buy
- Target
- Tesco
- Home Depot
- CVS
- Sun
- Philips
- Intel
- ST Micro
- Canon
- Alien
- BT
- NTT
- Metro
- Mitsui
- Pfizer
- Sara Lee
- USPS
- UPS
- DoD
- UCC/EAN
- Accenture
- IBM
- Coca-Cola
- Pepsi
- Kodak
- NCR
- SAP
- Symbol



AUTO-ID CENTRE

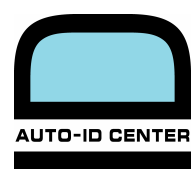
- Mission
 - Re-think the role and implementation of the barcode
 - Change the world by merging bits and atoms
- What do you need to do this?
 - Some way of automatic, reliable transfer and update of information based on physical operations
 - One single system for the whole supply chain
- Key functions of the Centre
 - Bring together appropriate technologies
 - Bring together interested parties
 - Generate open standards
 - Drive adoption



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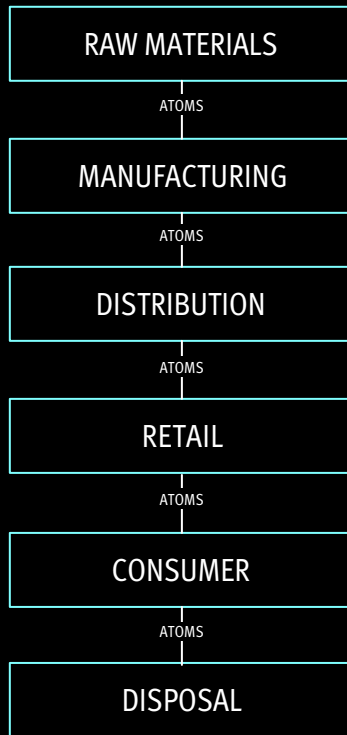


WHAT IS SUPPLY CHAIN?

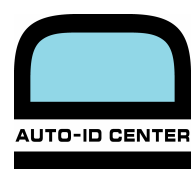
- Not just suppliers, not just a chain
- Supply Chain Management
 - Managing the complexity of bi-directional material and information flows
 - Integration of all the stages to ensure production and distribution of items to the right customer at the right time, place and price



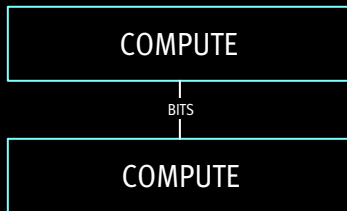
NETWORKS OF BITS AND ATOMS



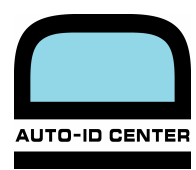
The supply chain is a network of atoms



NETWORKS OF BITS AND ATOMS

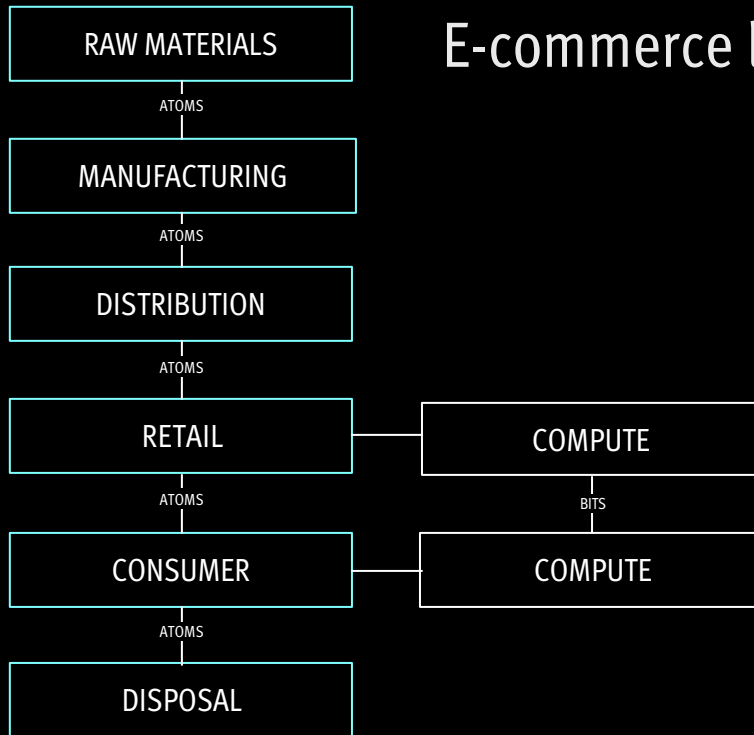


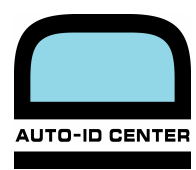
The Internet is a network of bits



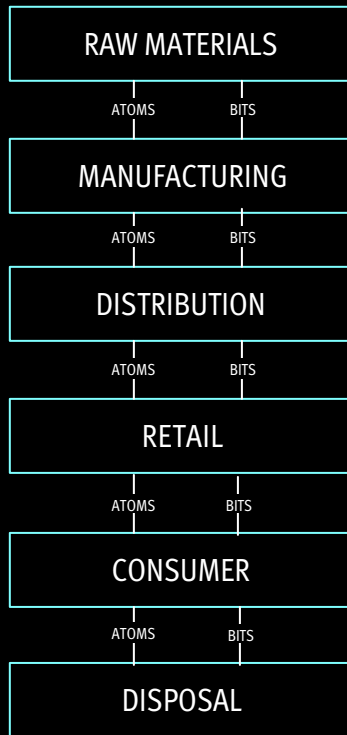
NETWORKS OF BITS AND ATOMS

E-commerce links the networks

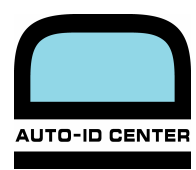




NETWORKS OF BITS AND ATOMS

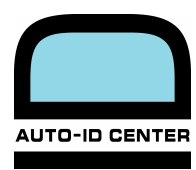


We aim to merge them



VISION

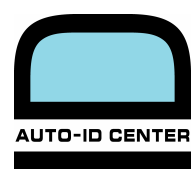
- A world where...
 - ...bits and atoms are merged
 - ...physical objects communicate in real time all the time
 - ...the Internet extends into everyday products
 - ...everything is connected



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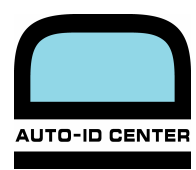
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AUTO-ID TECHNOLOGY

BUILDING BLOCKS

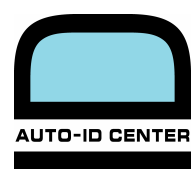
1. Uniquely identifying items
2. Detecting the presence and identity of items
3. Representing item characteristics and movements
4. Passing the information across the network
5. Interpreting and acting on the information



AUTO-ID TECHNOLOGY

BUILDING BLOCKS

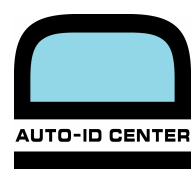
1. Uniquely identifying items
EPC – Electronic Product Code
2. Detecting the presence and identity of items
RFID tags & readers
3. Representing item characteristics and movements
PML – Physical Markup Language
ONS – Object Name Service
4. Passing the information across the network
Savant
5. Interpreting and acting on the information
Control



AUTO-ID TECHNOLOGY

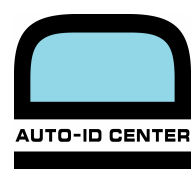
BUILDING BLOCKS: 1

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ELECTRONIC PRODUCT CODE: EPC

- EPC is a naming scheme for objects
 - Unique identifier for every object – includes serial number
 - Designed to be scaleable & extensible
- Decouple identity from data
 - Only store the EPC on an item
 - Additional information is held in a database and can be accessed using the EPC as a key
- Global, open standard
 - UCC/EAN support



EPC: 96-BIT VERSION

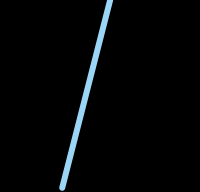
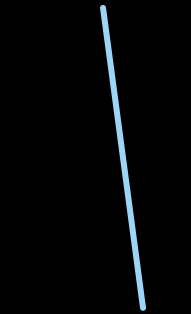
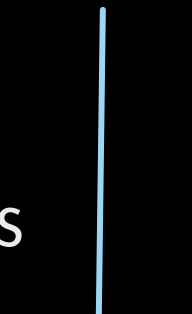
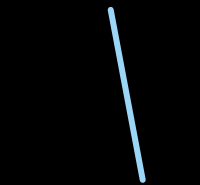
01.0000A89.00016F.000169D<0

Header
0-7 bits

EPC Manager
8-35 bits

Object Class
36-59 bits

Serial Number
60-95 bits

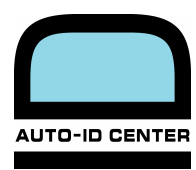


Version 8 bits

Manufacturer 28 bits
(> 268 Million)

Product 24 bits
(> 16 million)

Serial Number 36 bits
(> 68 billion)



AUTO-ID TECHNOLOGY

BUILDING BLOCKS: 2

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Control

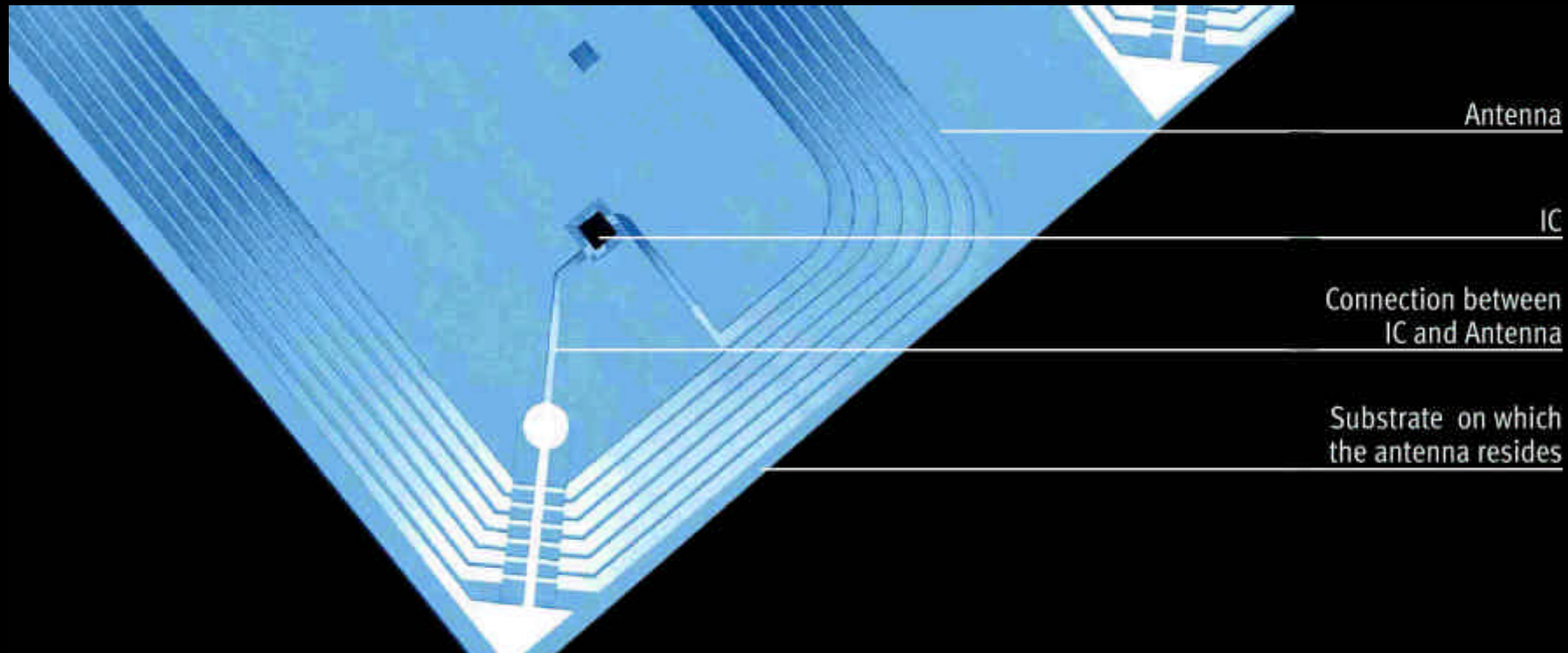
RFID TAGS AND READERS

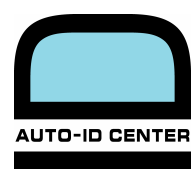
- Radio Frequency Identification - RFID

Chip + antennae = Tag

Readers

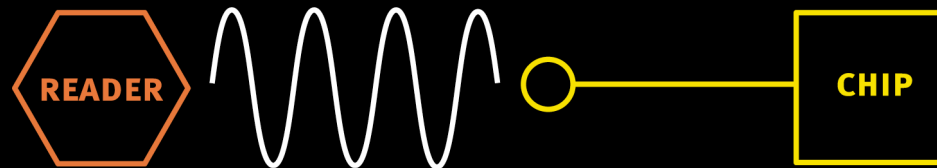
Uses radio waves – non line of sight technology





TAGS AND READERS

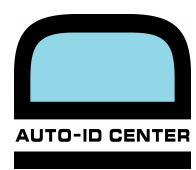
- The reader ‘zaps’ the chip with a radio wave



TAGS AND READERS

- The reader ‘zaps’ the chip with a radio wave,
the chip replies with its EPC,
Epc is the only thing stored on the chip
The chip is passive (no power)





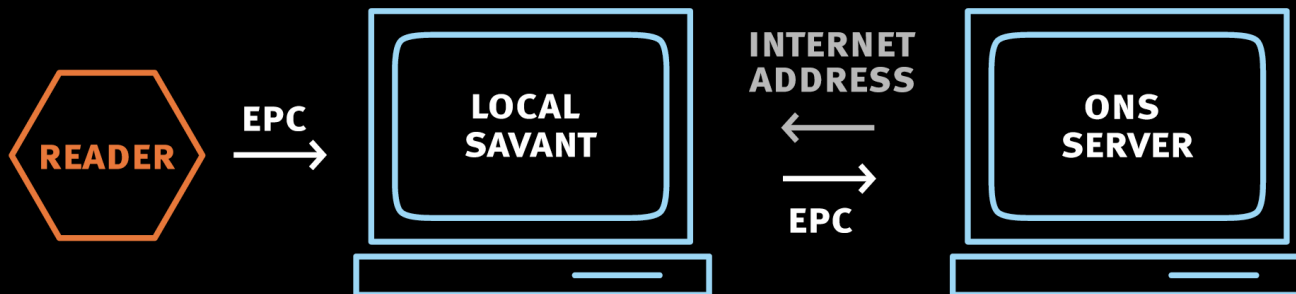
AUTO-ID TECHNOLOGY

BUILDING BLOCKS: 3

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Control

OBJECT NAME SERVICE: ONS

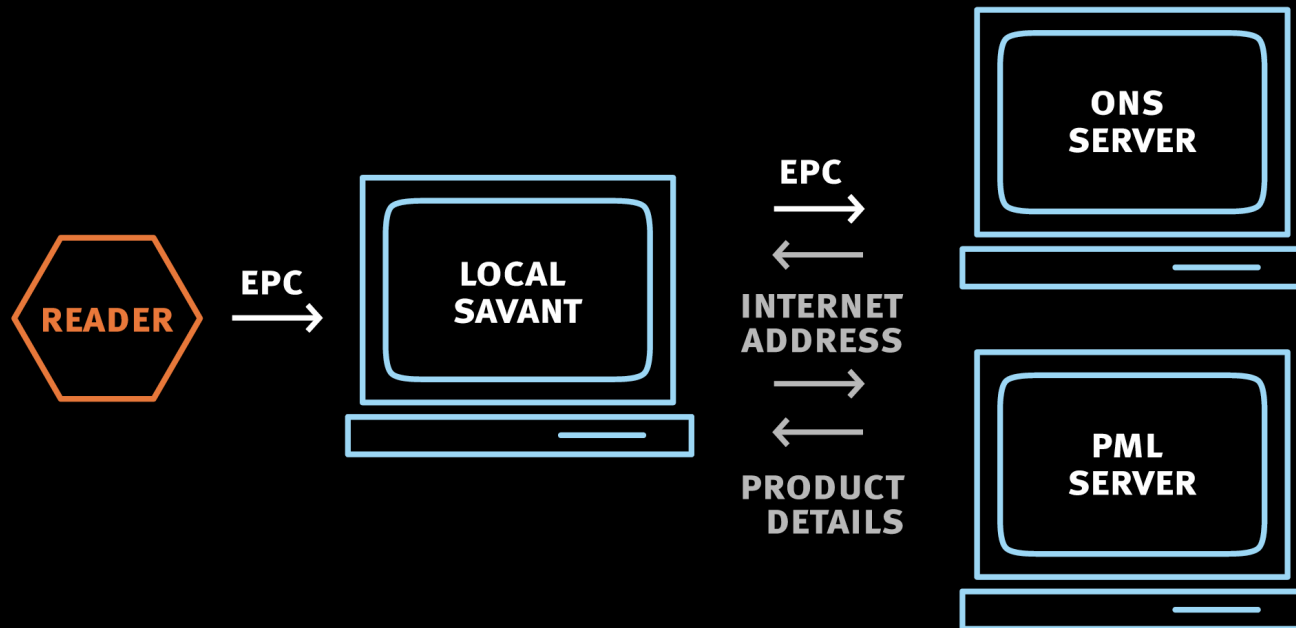
- Redirection Service
 - acts as telephone book in reverse
 - based upon Domain Name Service (DNS)

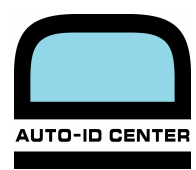


PHYSICAL MARKUP LANGUAGE: PML

- Language for describing physical objects

Network Database

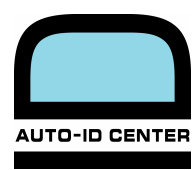




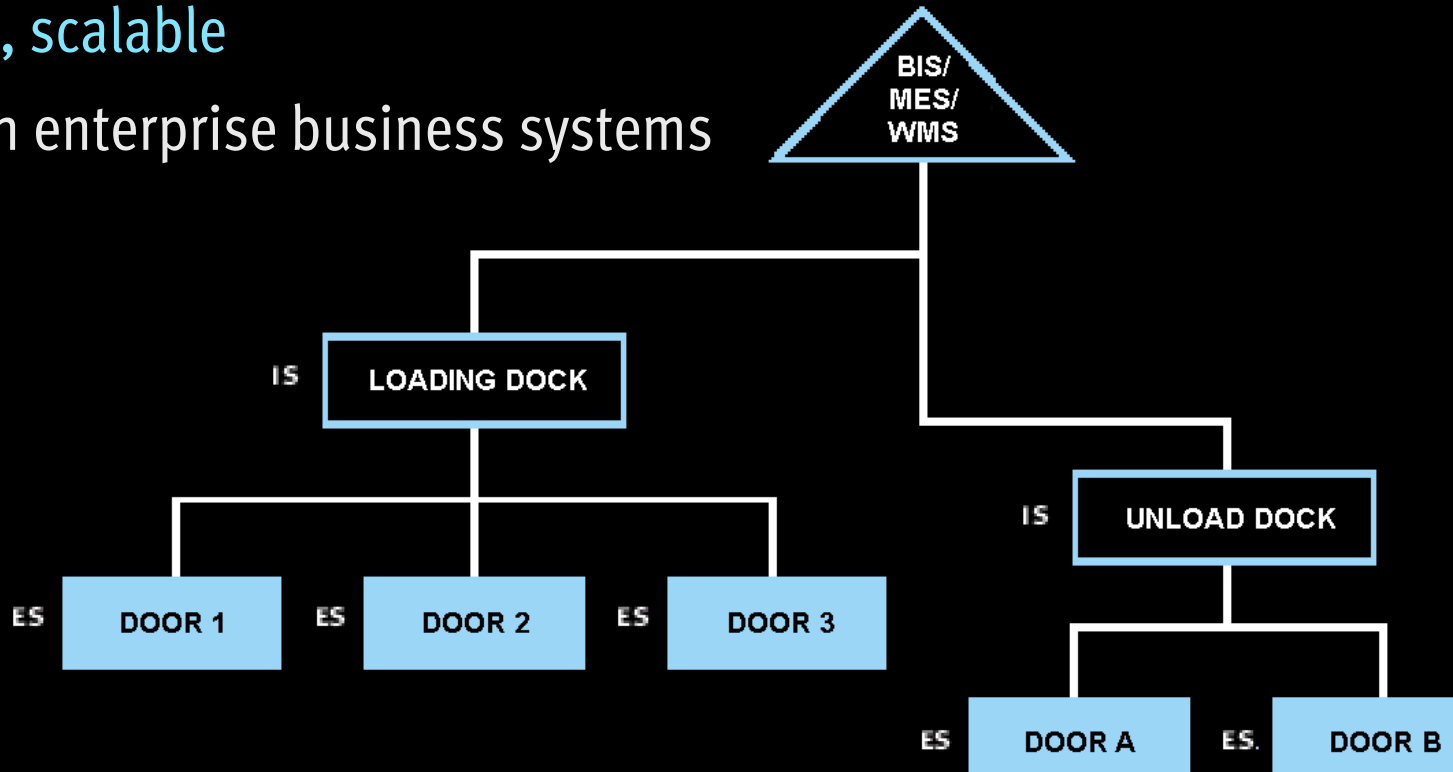
AUTO-ID TECHNOLOGY

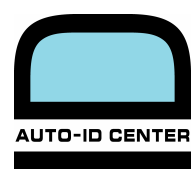
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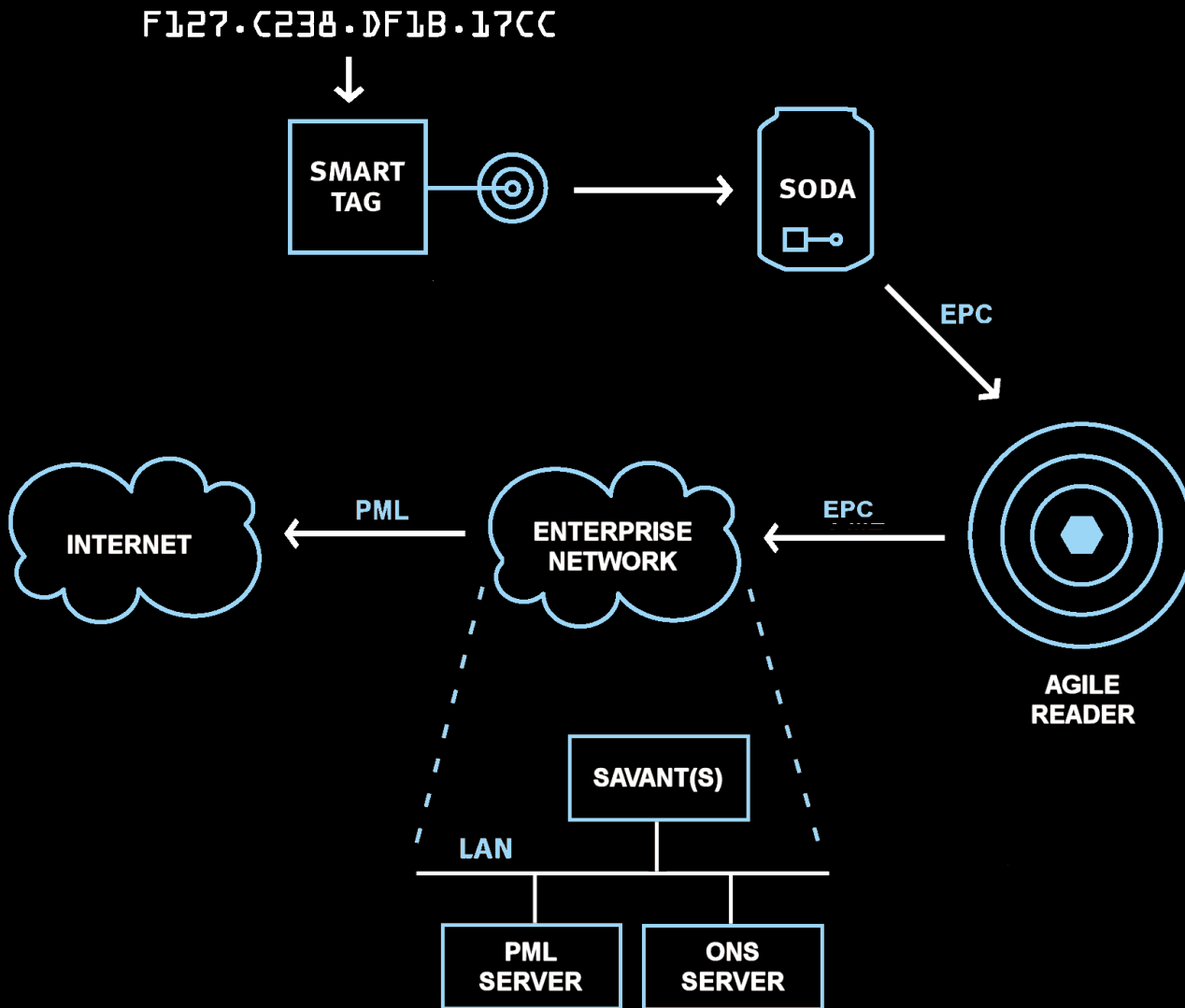


- System building block for data management designed to deal with large amounts of data performs local filtering/processing and caching/storage hierarchical, scalable
- Interface with enterprise business systems

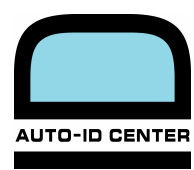




AUTO-ID TECHNOLOGY: SYSTEM BUILDING BLOCKS

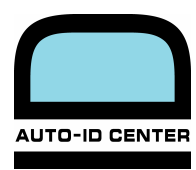


...smart, scalable
networking for the
physical world



WHAT DOES AUTO-ID TECHNOLOGY MEAN?

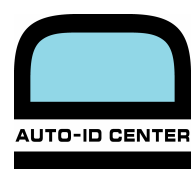
- Some way of automatic, reliable transfer and update of information based on physical operations
- One single system for the whole supply chain
- Auto-ID data characteristics:
 - Accurate
 - Fine-grained
 - Item Level
 - Complete
 - Automatic
 - Timely
 - Universal



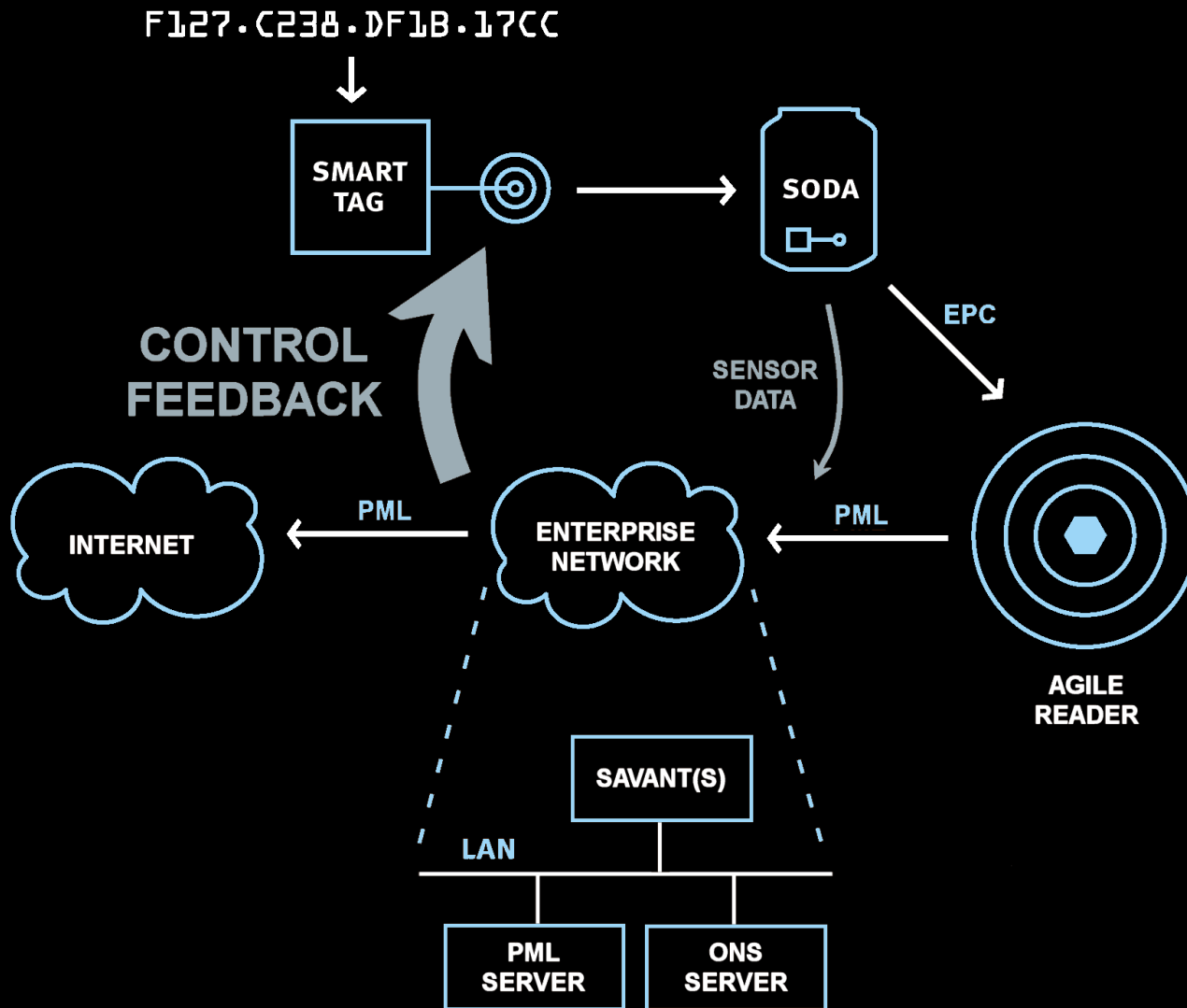
AUTO-ID TECHNOLOGY

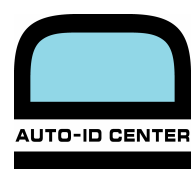
BUILDING BLOCKS: 5

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AUTO-ID FOR CONTROL

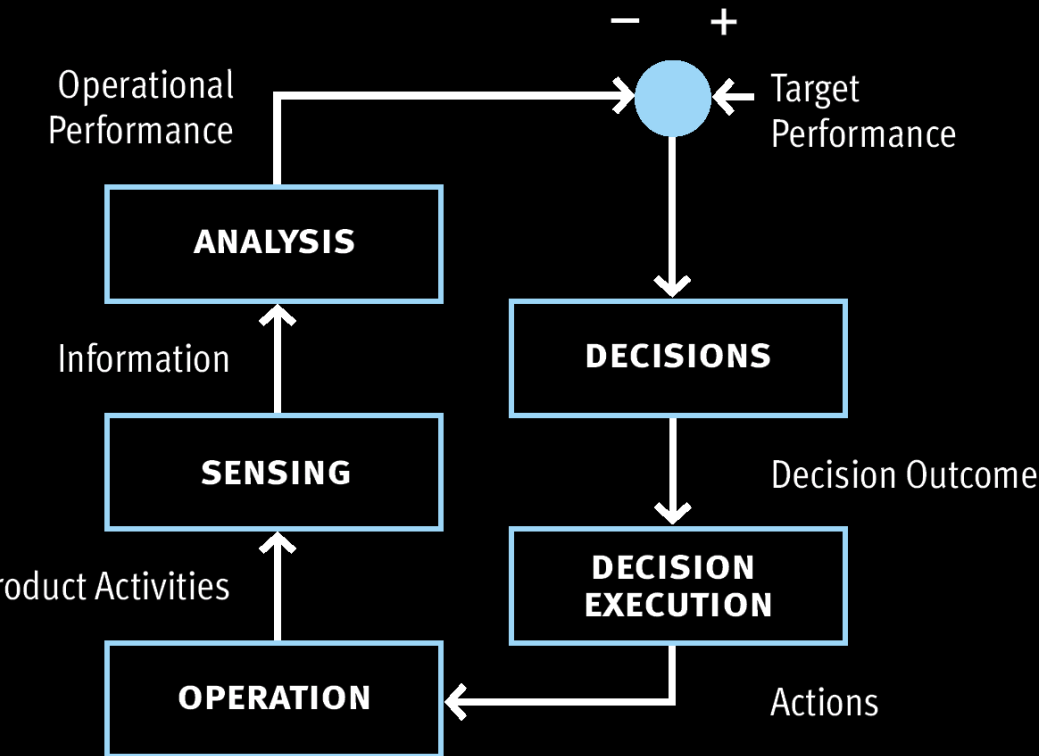




WHY DEVELOP AUTO-ID BASED CONTROL?

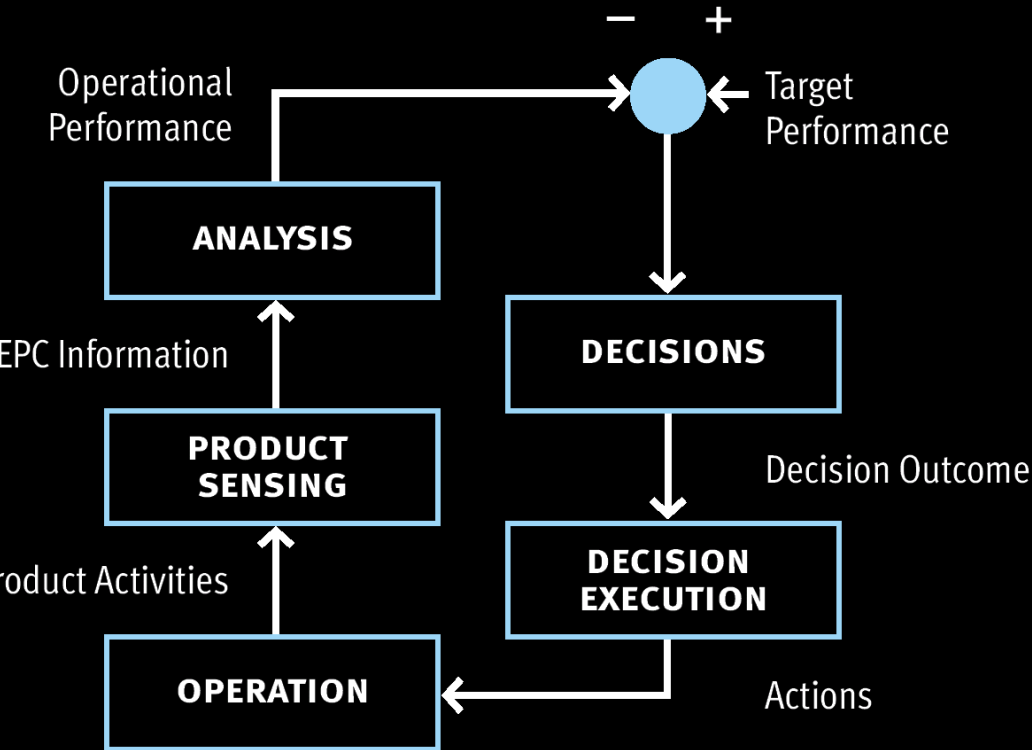
- Auto-ID data is:
 - Accurate
 - Fine-grained
 - Item-level
 - Complete
 - Automatic
 - Timely
 - Universal
- In control terms, this means:
 - Reliable operation
 - Good performance
 - Ability to capture item level preferences
 - Support for customised control
 - Interoperability

SIMPLE THERMOSTATIC HEATING CONTROL



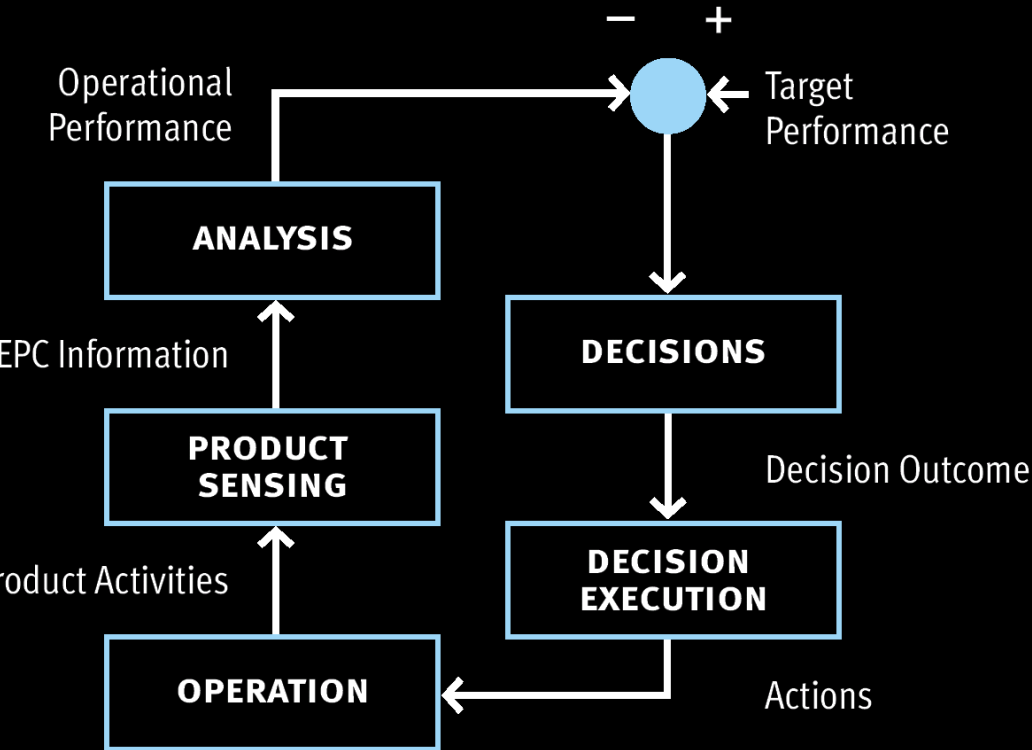
- Operation – room heating
- Sensing – thermostat
- Analysis – calculate temperature, compare with thresholds
- Decision – out of range?
- Execution – adjust gas valve

AUTOMATED RETAIL SHELF MANAGEMENT

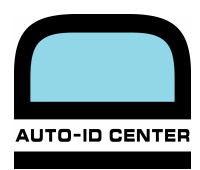


- Operation – having products available on shelves
- Sensing – stock levels, removal rates, POS data
- Decision – replenishment & reordering planning, theft detection
- Execution – replenishment & reordering, alerting security

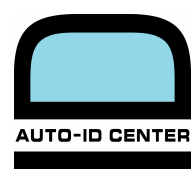
MASS CUSTOMISATION IN MANUFACTURING



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



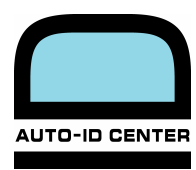
VIDEO



OVERVIEW

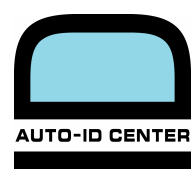
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IMPACT OF AUTO-ID BASED CONTROL ON SUPPLY CHAIN

- Auto-ID data is:
 - Accurate
 - Fine-grained
 - Item-level
 - Complete
 - Automatic
 - Timely
 - Universal
- In supply-chain terms, this means:
 - Accurate knowledge of what is where
 - Reduced safety stock levels
 - Increased on-shelf availability
 - Faster monitoring of demand
 - Quicker analysis of business operation
 - Better traceability for recalls
 - Less opportunity for theft
 - Reduced diversion of goods
 - Better traceability of black/grey markets
 - True interoperability



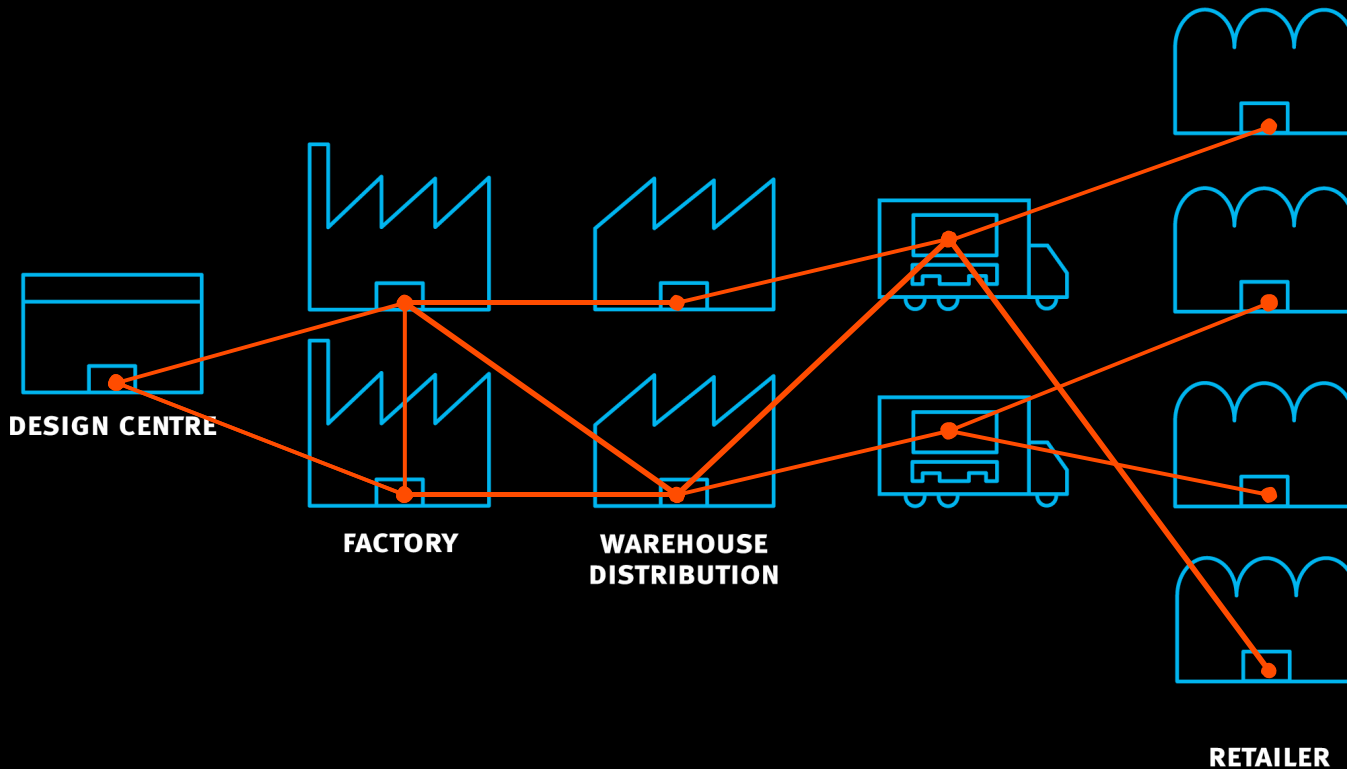
EXTENDING CURRENT SUPPLY CHAIN MODELS?

- Network of distributed intelligent products
- Products capable of making and executing decisions
- Find the best way through the entire supply chain

- This is called Product Driven Supply Chain

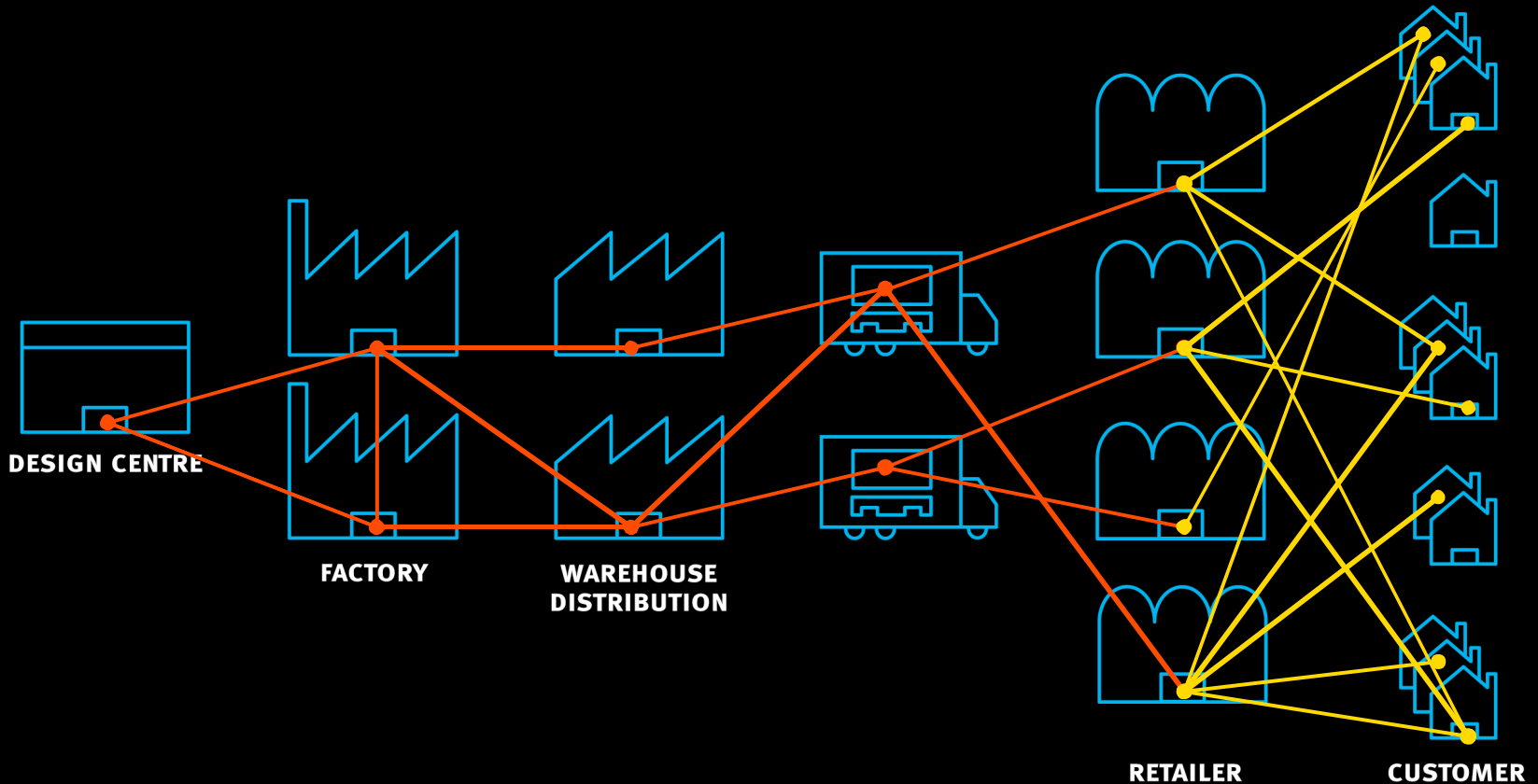
BENEFITS OF PRODUCT DRIVEN SUPPLY CHAIN

Product Driven Supply Threads



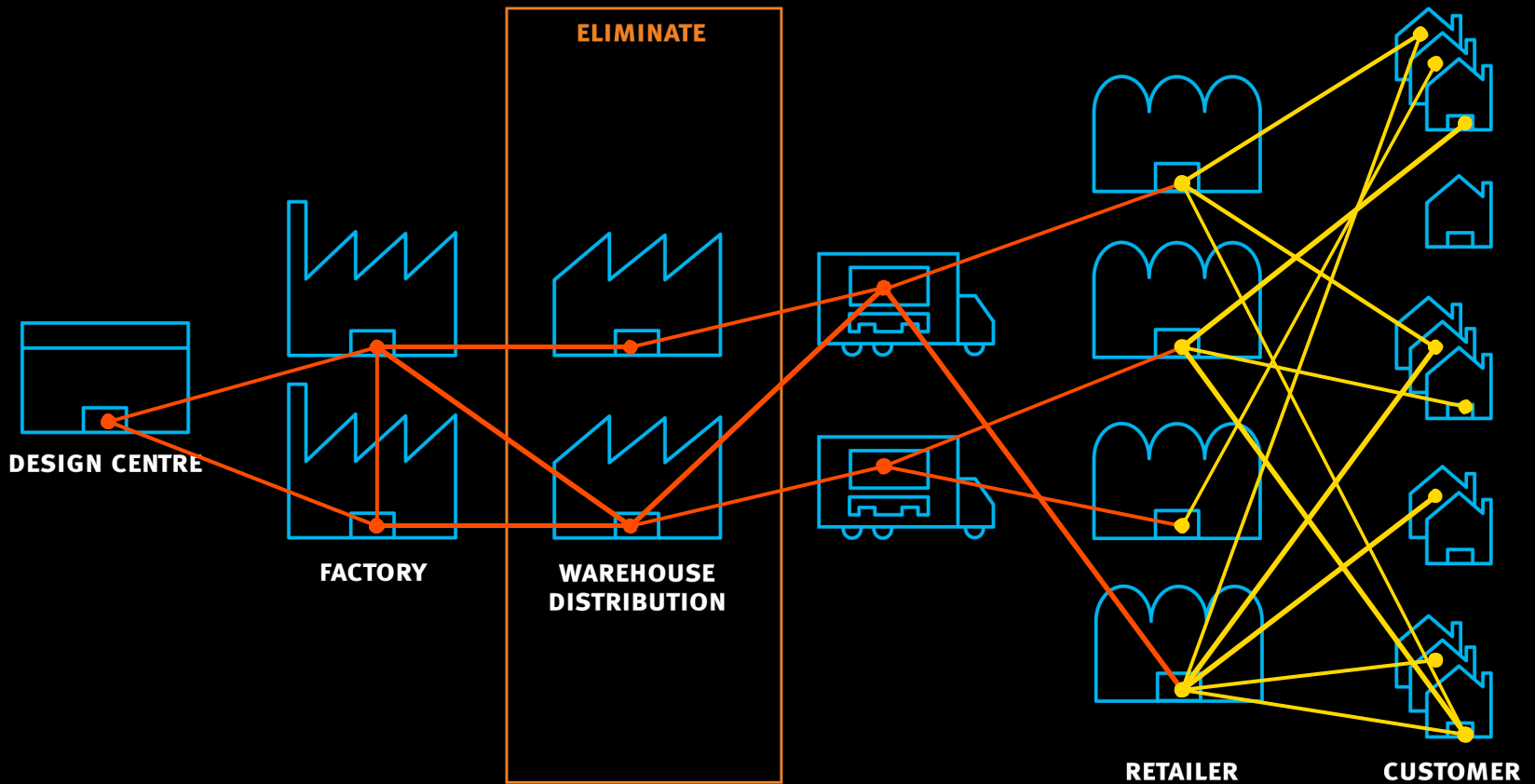
BENEFITS OF PRODUCT DRIVEN SUPPLY CHAIN

More consumer focused supply chain



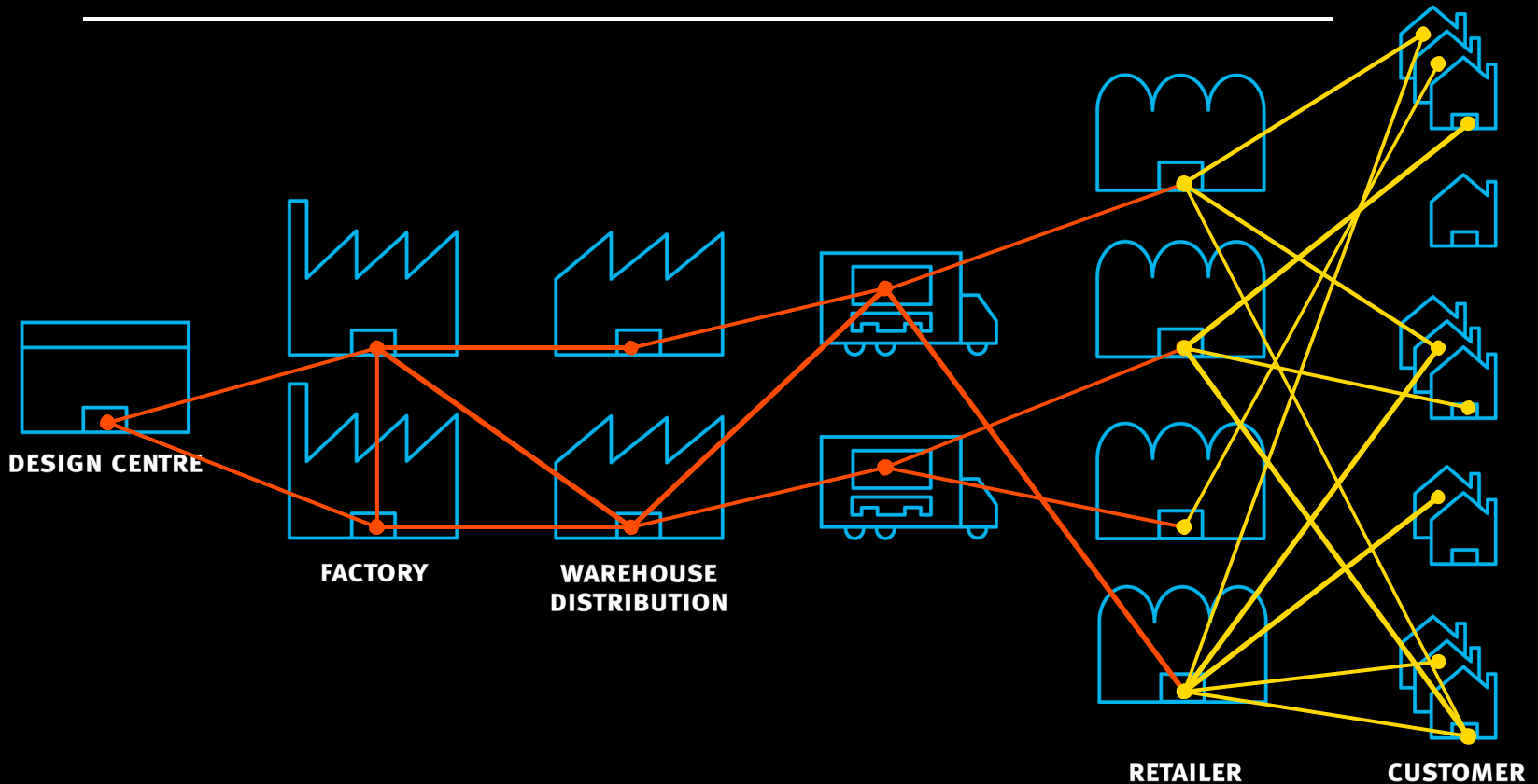
BENEFITS OF PRODUCT DRIVEN SUPPLY CHAIN

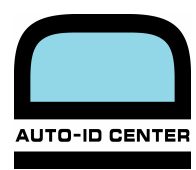
Virtual Warehouse



BENEFITS OF PRODUCT DRIVEN SUPPLY CHAIN

End-of-Lifecycle Management





DISCUSSION

AUTO-ID CENTER

www.autoidcenter.org

CENTRE FOR DISTRIBUTED AUTOMATION AND CONTROL

www-mmd.eng.cam.ac.uk/automation/