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RFID Networking, Standards, and Software a Decade Later: Where are We, Where do We Go From Here?

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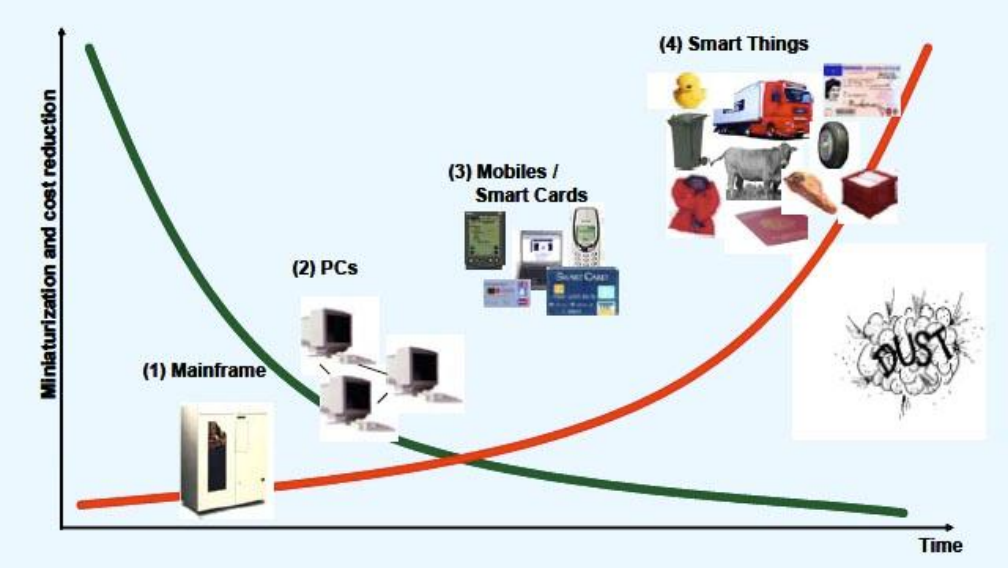
15 April 2010

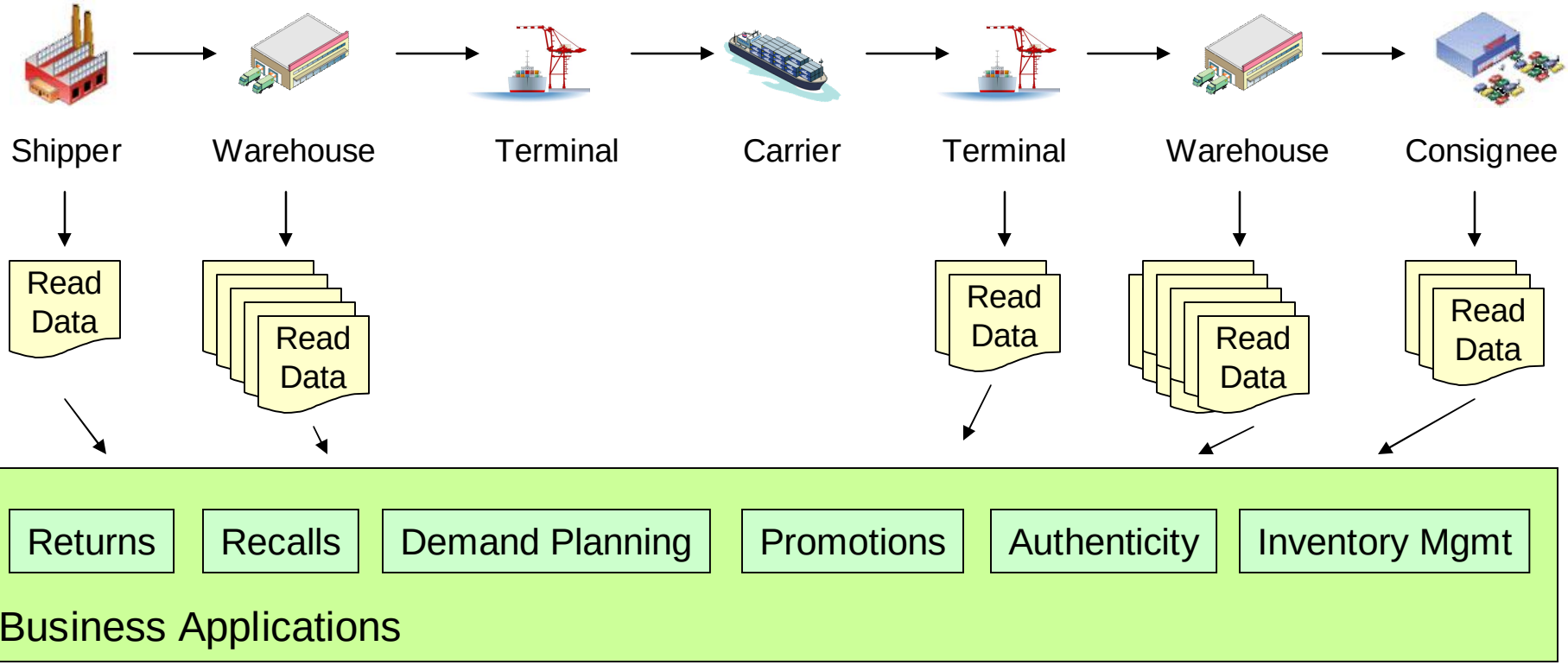
Original vision: Internet of Things

- What could we do if every physical object on the planet had a unique, machine-readable identity?



***Source*: ITU "Ubiquitous Network Societies and their impact on the telecommunication industry", April 2005, available at www.itu.int/ubiquitous**

Supply chain visibility



- Gather data as objects are observed moving through the supply chain, for business benefit

Consumer-facing applications

ñMilk will expire tomorrowò

ñJerry McGuire
Starring: Tom Cruise, Renee Zellwegerò

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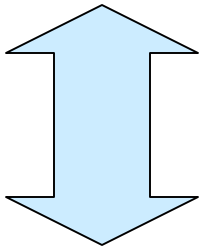
Bits and Atoms

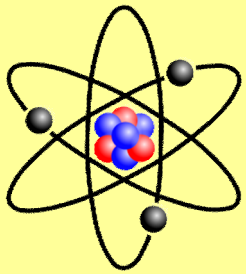
00110000
01110100
00100101
01111011

Bits:
Information
Systems

Business Applications

Consumer Applications



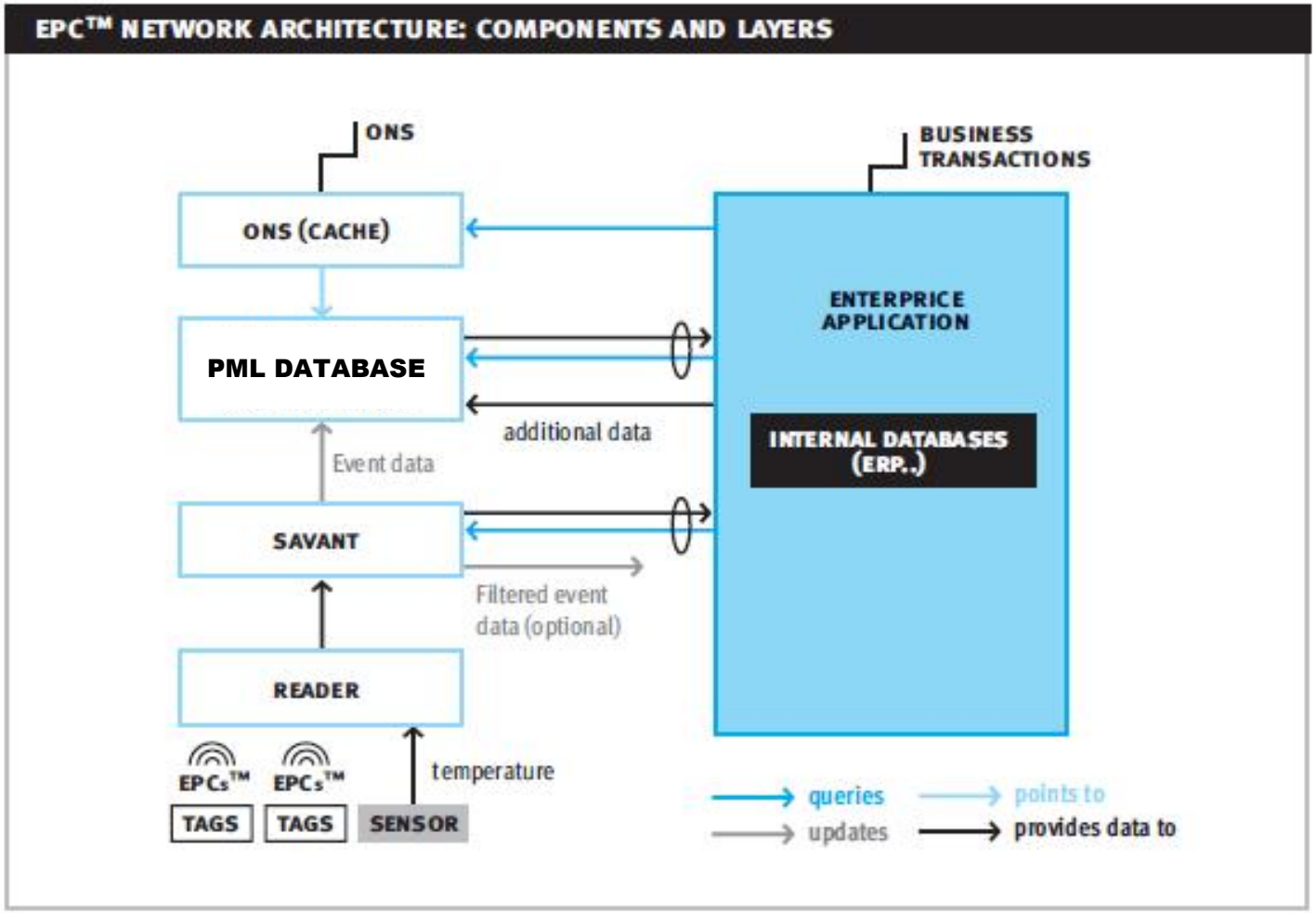


Atoms:
Stuff in the
Physical
World

Auto-ID Center Architecture Principles

- Give a globally unique identifier to everything
  - "Dumb number"
    - does not encode any business information
- "License plate" – data carrier
  - No data in the tag (except the identifier)
  - Use the identifier to look up data elsewhere
- Low-cost tag
- Standards

Auto-ID Architecture (1999 – 2002)



Auto-ID Center Proposed Standards (c. 2002)

00110000
01110100
00100101
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Bits:
Information
Systems

ONS

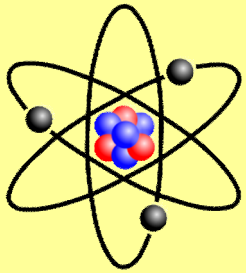
Applications

Physical Markup Language (PML)

In Between:
Data Capture

ñSavantò

Air Interface



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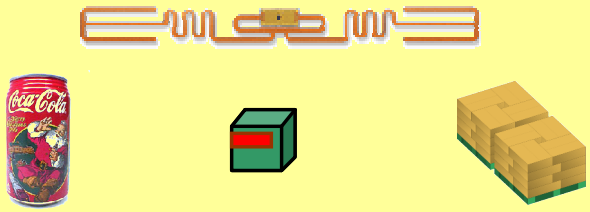
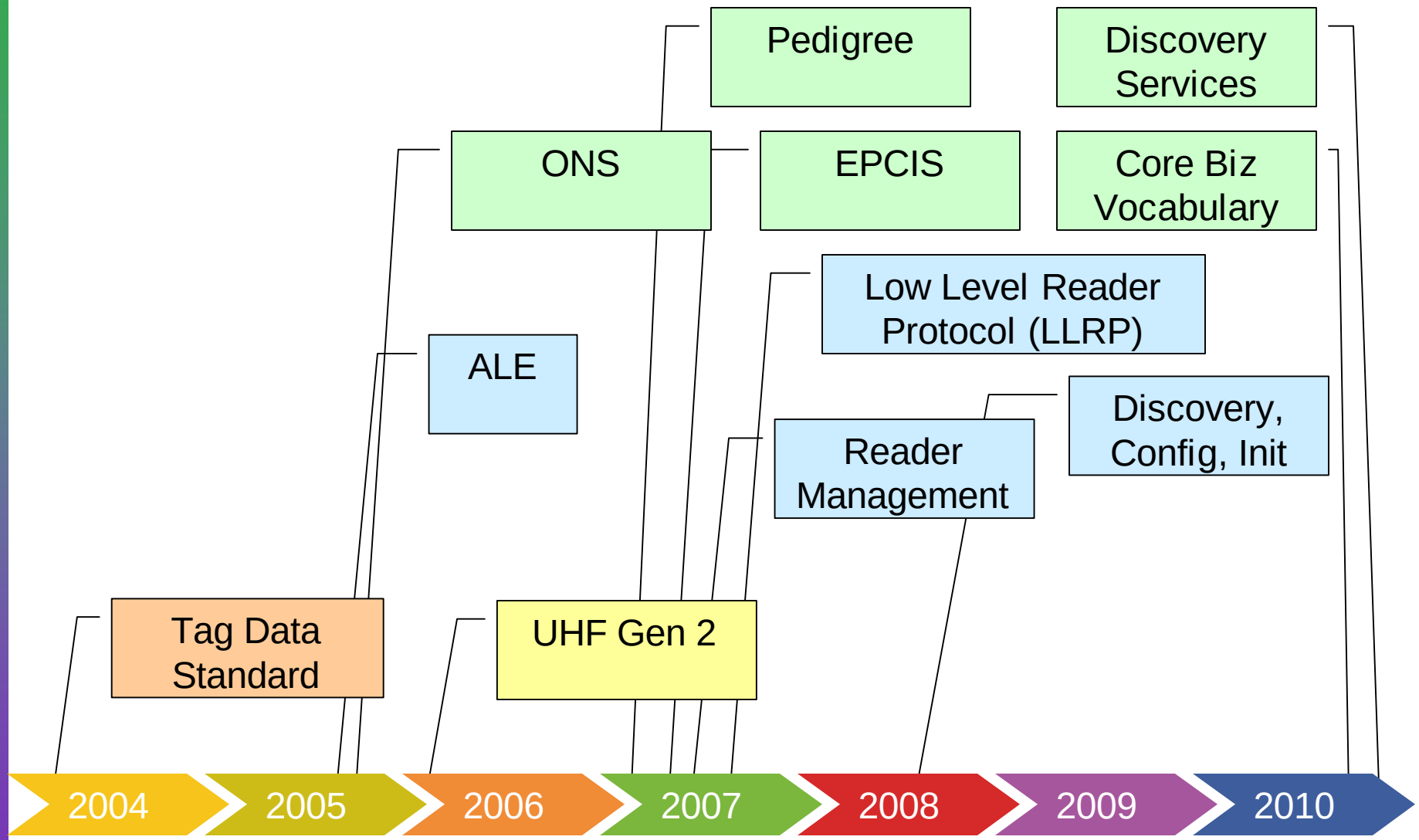


Identi-
fication:
Electronic
Product
Code
(EPC)

What Happened Next



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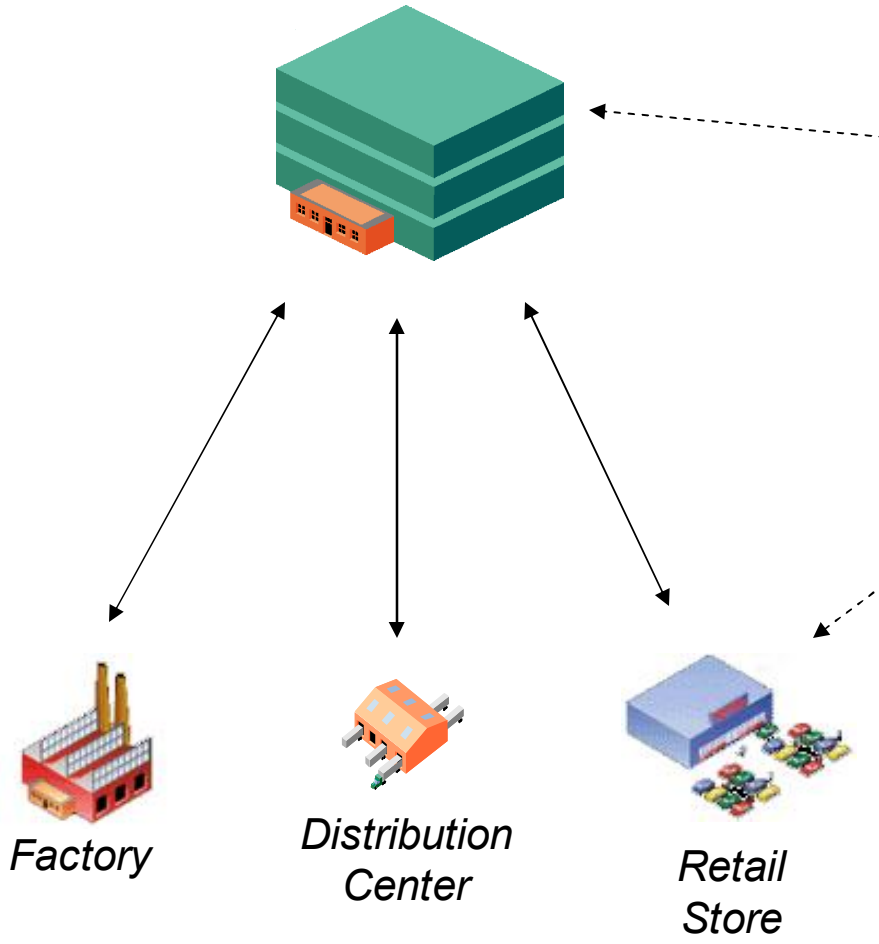
Learnings: It's Visibility, Not (just) RFID



- Business decisions are made here, in the company headquarters data center
- é but there's an awful lot of important action here, in the real world.

➔ Goal: bring awareness of the physical world (with or without RFID)

Learnings: EPC – no new IDs!

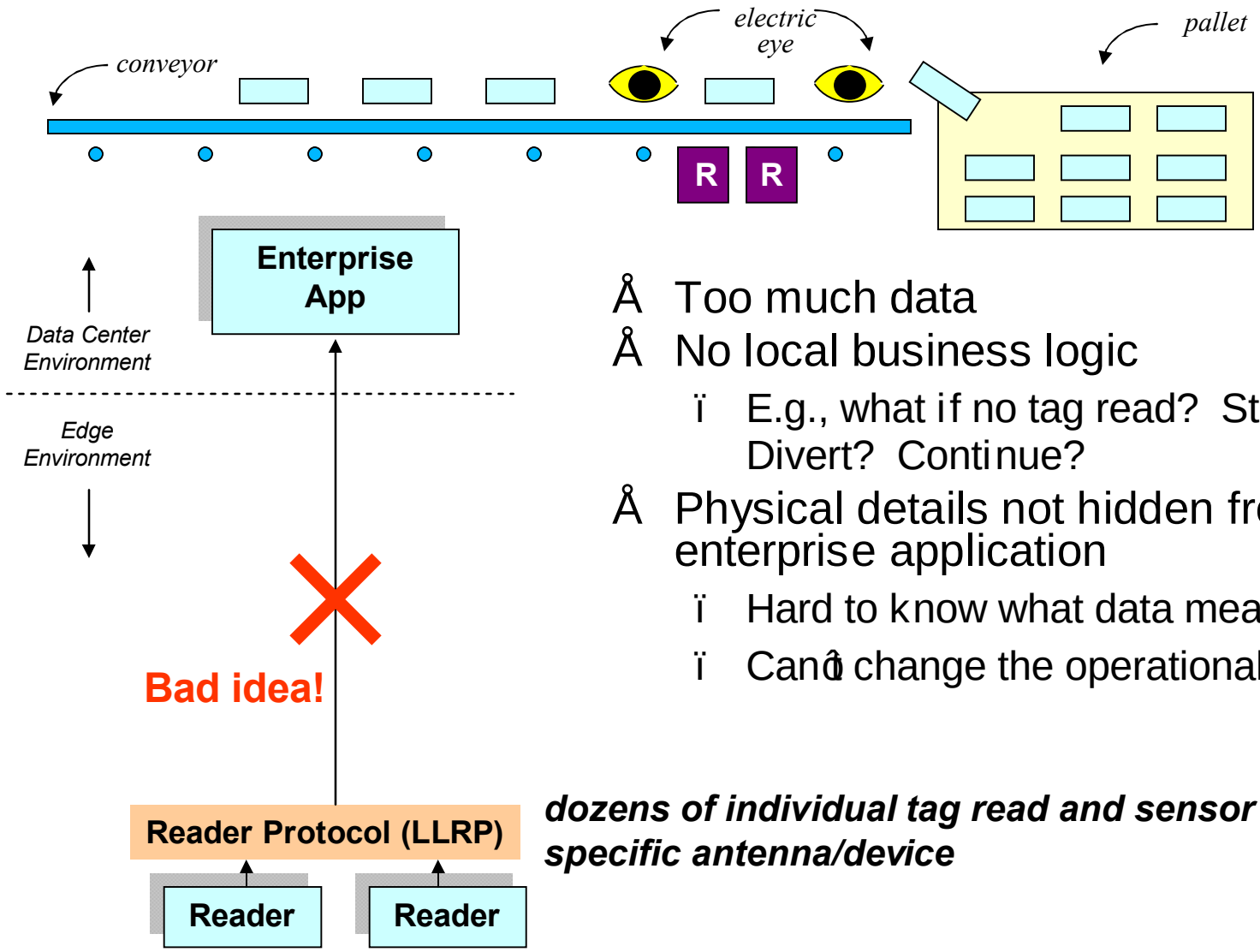
- Original EPC: entirely new identifier

- End users: "We will not renumber!"
- EPC Standard (2004): a federated identifier
  - Multiple "schemes" to federate existing identity systems

    urn:epc:id:sgtin:0614141.112345.400 ⟺ 

  - All GS1 bar code identifiers have EPC equivalent, plus others
  - EPC itself federated into Internet Uniform Resource Identifier (URI) universe

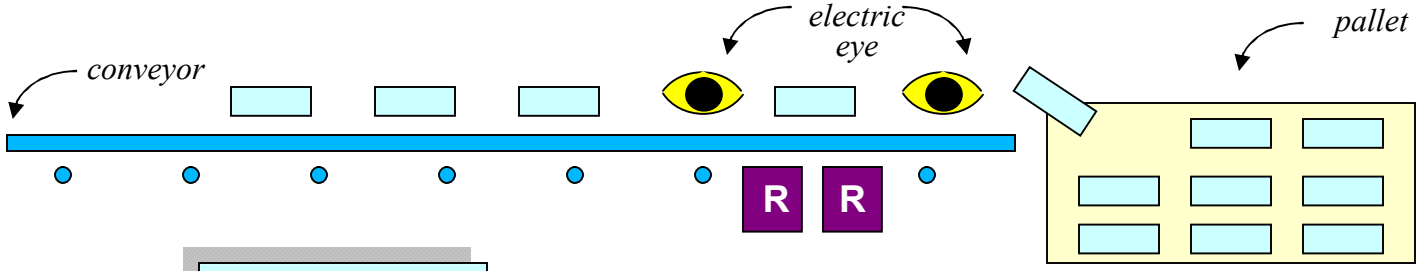
Learnings: Decouple Data Capture from Data Use

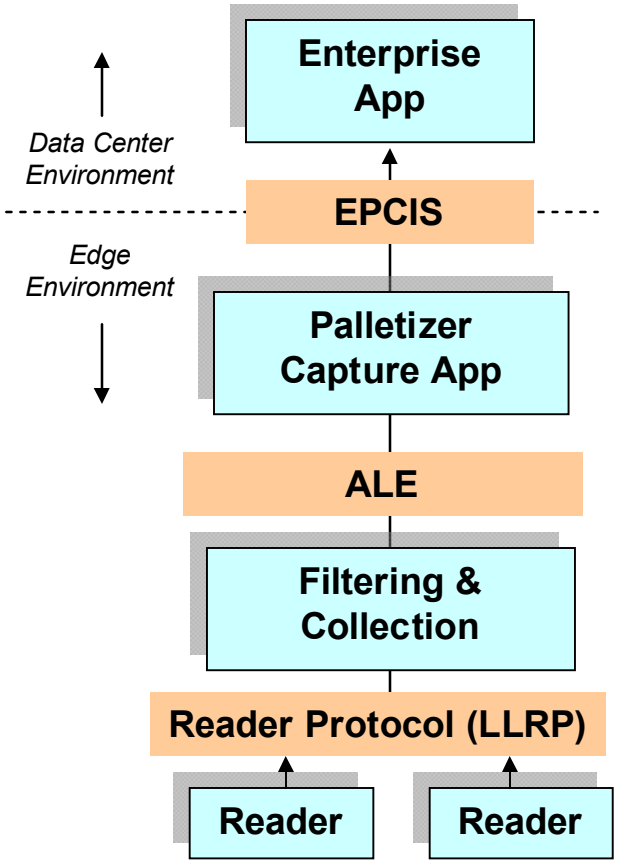


- Too much data
- No local business logic
  - E.g., what if no tag read? Stop? Divert? Continue?
- Physical details not hidden from enterprise application
  - Hard to know what data means
  - Can't change the operational process

dozens of individual tag read and sensor events from specific antenna/device

Learnings: Decouple Data Capture from Data Use





"at time T, the association of the following case tags to the following pallet tag was created at palletizer #3, to fulfill order #1234"

Service consumed by enterprise
-- operational details hidden

"between the time the case crossed the two beams at location L, the tag X was read"

Service consumed by local business logic
-- device details hidden

dozens of individual tag read and sensor events from specific antenna/device

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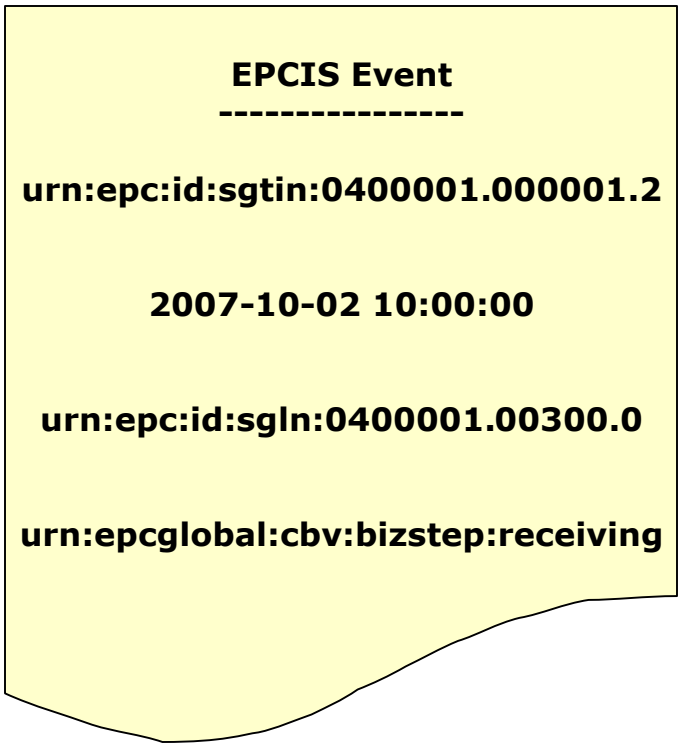
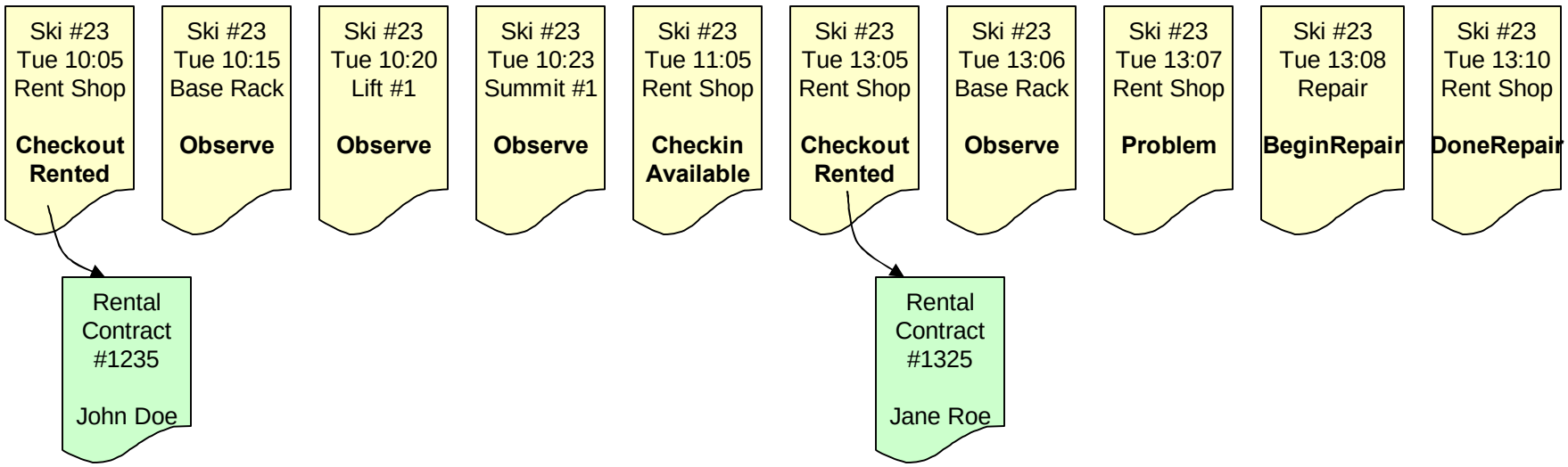
Learnings: What, When, and Where, but also Why

- An EPCIS event has four dimensions:
  - What: what physical objects were involved (EPC or other identifier)
  - When: when the event took place (timestamp)
  - Where: where the event took place (location identifier)
  - Why: what business process step was being carried out
- A record of something that happened in the physical world
- May or may not correspond to an RFID tag read

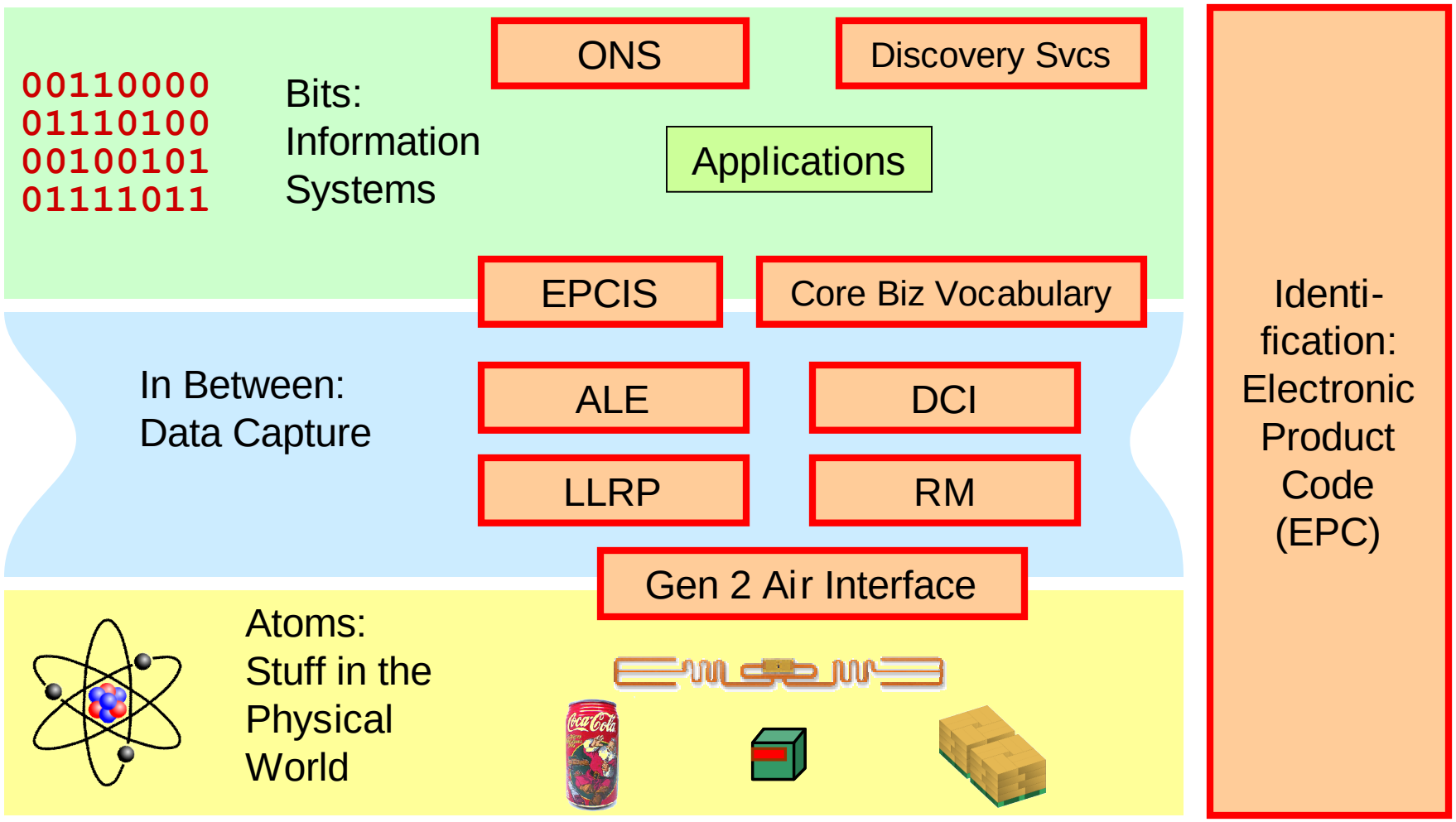


Learnings: What, When, and Where, but also Why

- Identify the business context of the visibility event:
  - What business step was taking place at the time of the event
  - What is true from a business perspective after the event
  - Any associated business transactions
    - Purchase Order, Invoice, BOL, etc



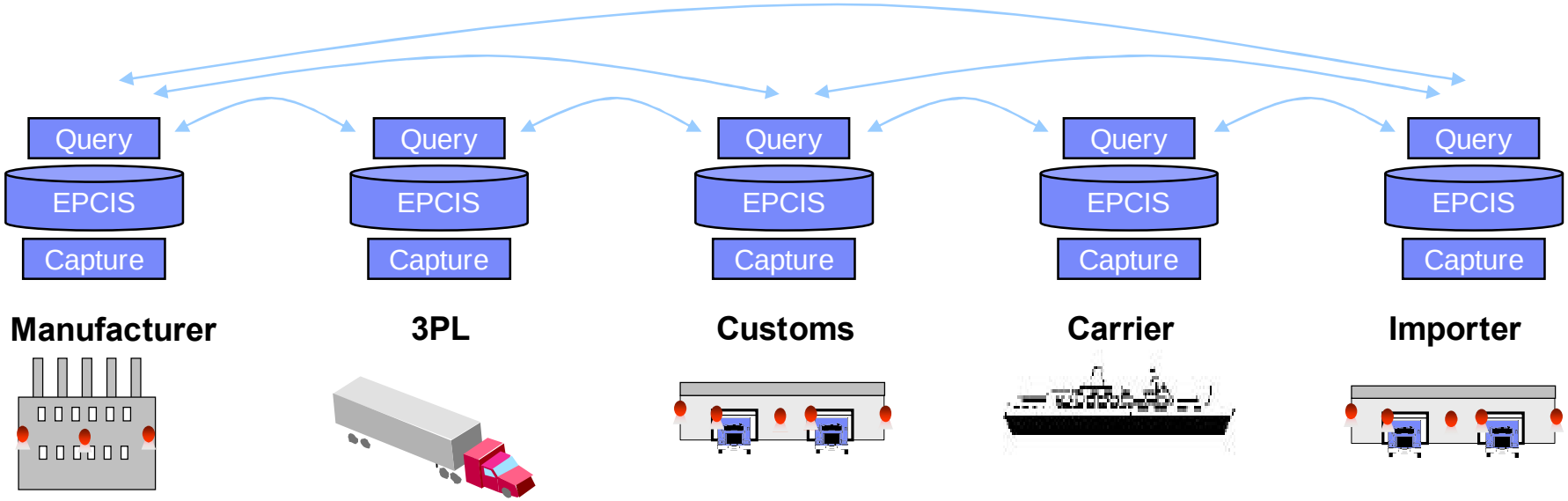
Where We Are Today (2010)



So What's Next?

- Large multi-party supply chains
- Beyond the 5-cent tag
  - More memory
  - Encryption, authentication, etc
  - Sensors and other gizmos
- Downstream serialization
- Business vocabularies and scenarios
- Security/privacy
- B2C

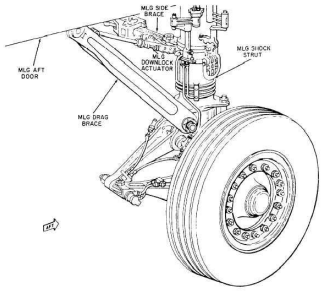
Large Multi-party Supply Chains



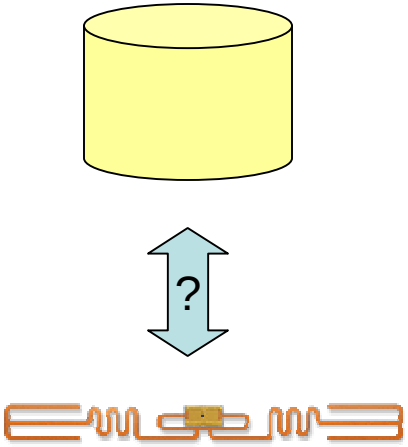
- Research questions:
  - How will "Discovery Services" *really* work?
  - The "introduction" problem
  - Authorized access to data across the supply chain that respects business agreements
  - Scale

Beyond the 5-cent Tag: Memory

- 512 bit, 1K bit, 64K *byte* tags now available
- Sample possible use case:
  - Aircraft part carries its repair history
  - Available even without a network
  - Can be updated in the field



- Research questions:
  - When (if ever) is this a good idea?
  - What should be the data architecture?
    - What goes on tag, what goes on DB?
  - Synchronization



Downstream Serialization

- Ideal case: unique serial number applied at origin, stays through life of product
- Not always possible:
  - Contract manufacture (same product, multiple origins)
  - Upstream party doesn't care, downstream party does (e.g., book industry)
  - Missing identification
- Question: how to manage this?

Business Vocabulary & Scenarios

- Data Capture Necessarily Decoupled from Data Use
  - One party generates visibility data
  - Another consumes it
    - Doesn't know much about how it was captured
- Questions:
  - What should "why" dimension contain for data to be intelligible?
  - How to account for different ways of doing business?
  - How to make data reusable for many applications?
  - How do we make it easy for users to create the right data?

Security, Privacy, and all that

- Business: protect my valuable data
- Consumer: protect my identity & privacy

- Questions:
  - What are the requirements?
  - What barriers to feasibility?
    - Expensive hardware (esp. on tag)
    - Key management
    - Unavoidable security/simplicity tradeoffs
  - How to overcome the barriers?

Business to Consumer

- Last decade focused on supply chain and other business-internal and B2B applications
- With dawn of mobile phone age, the time for consumer apps has finally arrived

- Questions:
  - What is the right architecture for B2C applications of RFID, visibility data?
  - What additional / new data needed for consumer applications?
  - How to approach context sensitivity?
  - Security, privacy, and all that

Summary

- A decade of amazing progress:
  - 1999 – Auto-ID Center founded
  - 2004 – Standards process launched
  - 2006 – 11 ratified standards
  - 2010 – Over 100 products certified as standards compliant
- → It's here to stay
- Yet, full-scale adoption barely begun
- What will the next decade bring?

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Thank You!

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