



“An internet of things infrastructure”

Cagri Balkesen

20 March, 2008

Success story: Wal-Mart

According to studies by University of Arkansas, RFID Research Center

- RFID Out-of-stocks reduced (%26)
- RFID Outperformed control stores
- RFID Tagged-items outperformed

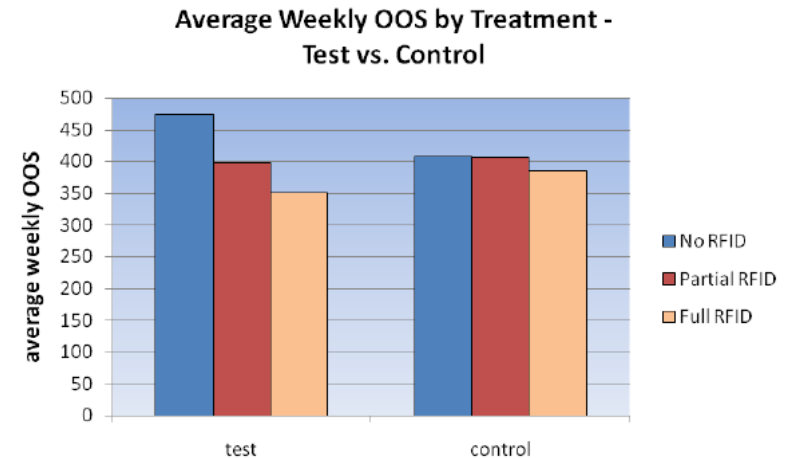


Figure 3. Average Weekly OOS by Treatment

Changes in Understated PI

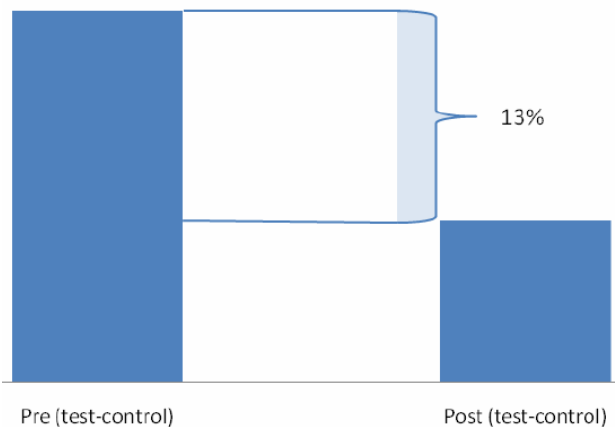


Figure 3. PI Improvement (Decrease in Inaccuracy)

Another study:

- RFID %13 decrease in inventory accuracy

“Does RFID Reduce Out of Stocks? A Preliminary Analysis”,
 “Does RFID Improve Inventory Accuracy? A Preliminary Analysis”,
 RFID Research Center, University of Arkansas



Motivation

“5 billion bar codes are scanned world-wide every day. If the sponsors of the AutoID-Center were to decide today to place tags on every item they manufacture, demand for IC’s among sponsors alone could run to several hundred million tags a day”
-Sanjay Sarma, Auto-ID Labs

- 5 ¢ tag vision
- minimum functionality and data
- everything in network
- high-volume, low-margin approach
- wide-spread adoption



Background - EAN, UCC, GS1

- European Article Numbering Association
- Uniform Code Council
- GS1: Global standards (esp. for SCM)

+ } GS1



EPC - Electronic Product Code

- Identify all objects uniquely at item level
- Hierarchical, extensible and open standard
- Minimum data, just pointer to product information
- Analogy: “License Plate”



Electronic Product Code

ELECTRONIC PRODUCT CODE (96 BIT FORMAT, GID-96)

01.0006A74.00098F.001532DAC

Header
8 bits

EPC Manager
28 bits

Object Class
24 bits

Serial Number
36 bits

e.g., Manufacturer
(>268 million)

e.g., Product
(> 16 million)

e.g., Serial Number
(> 68 *billion*)

Tag Data Standard, EPCglobal Inc.

- 🌱 EPC Formats: Binary and URI (tag-encoding, pure-identity)
- 🌱 Different headers -> different schemes, integrate existing



Today's Agenda

- Introduction ✓
- Electronic Product Code (EPC) ✓
- EPCglobal** ←
- EPC Network Architecture
- Conclusion



EPCglobal



Partnership between 100 global firms:

- GS1 (UCC+EAN)
- Proctor and Gamble
- Gillette
- ...



Global:

- Standards Development and Adoption
- Brand management and marketing
- Policies (Privacy, Intellectual Property)



Local:

Member Organizations

- 101 countries worldwide
- Member communication, support
- Training and Education



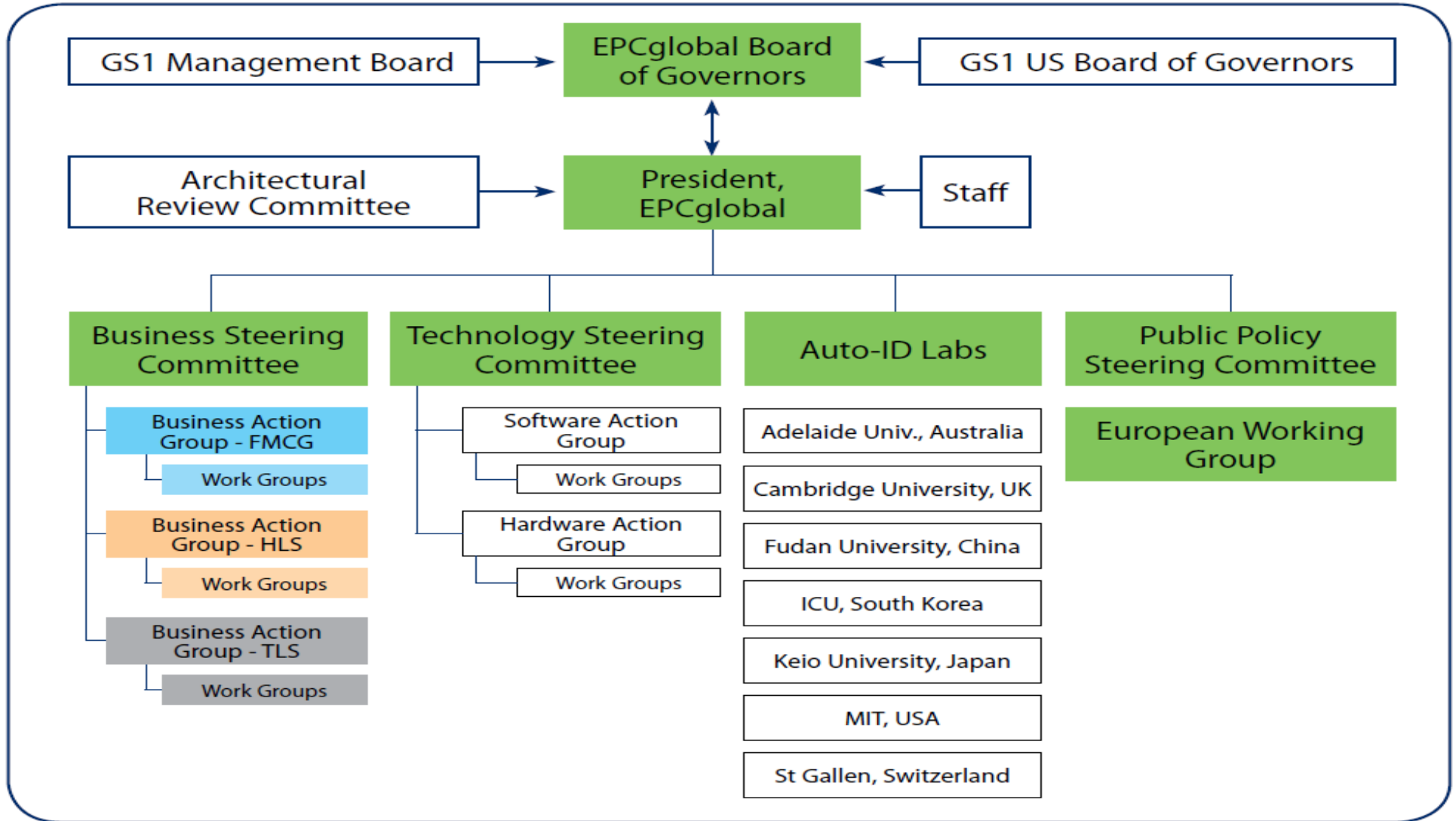
Continued Research

Research (Auto-ID) → Commercialization (EPCGlobal)

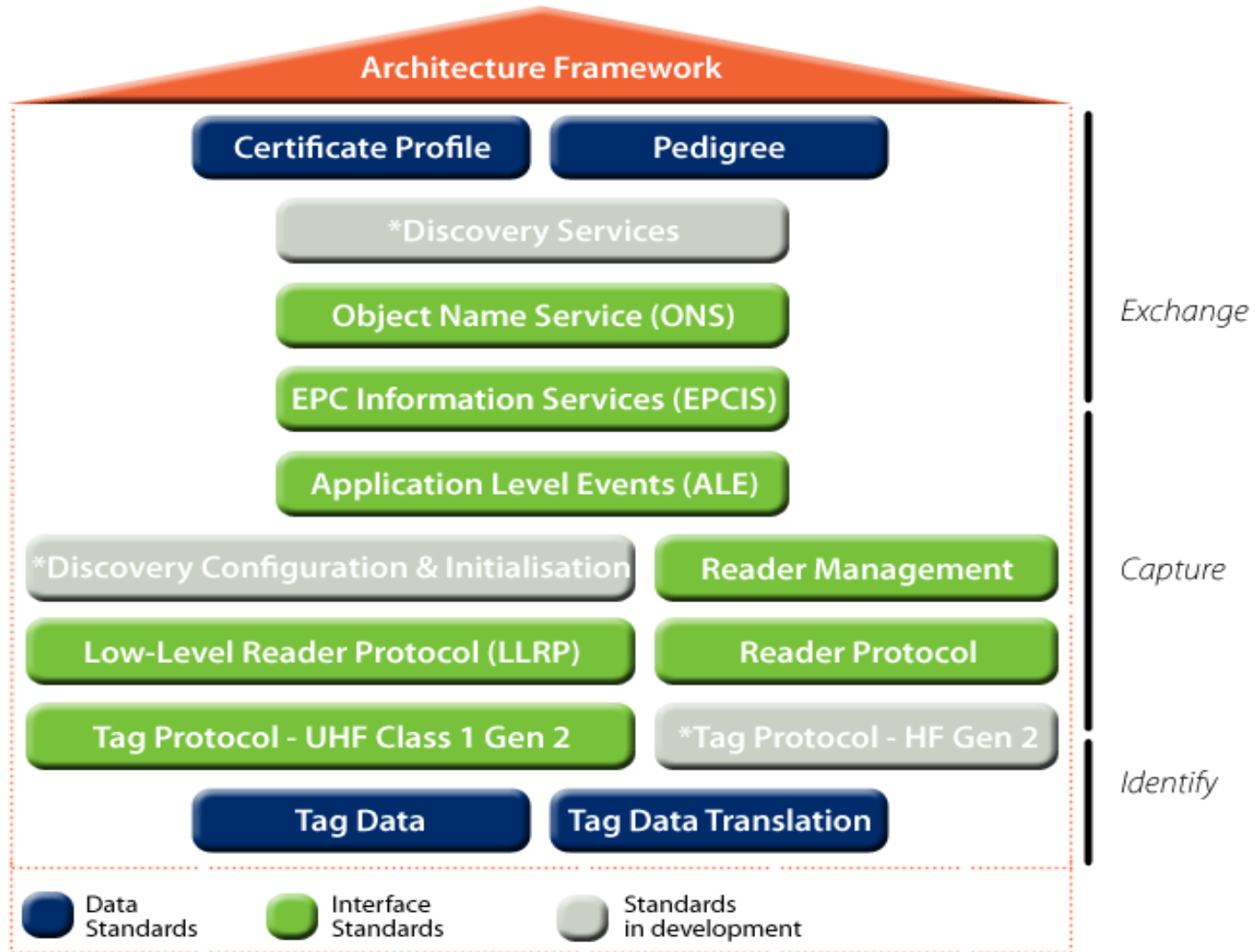
Jim Petragani, "EAN.UCC System Update," PowerPoint Presentation, Aftermarket Council on Electronic Commerce, August `2, 2004.



EPCglobal Organisation



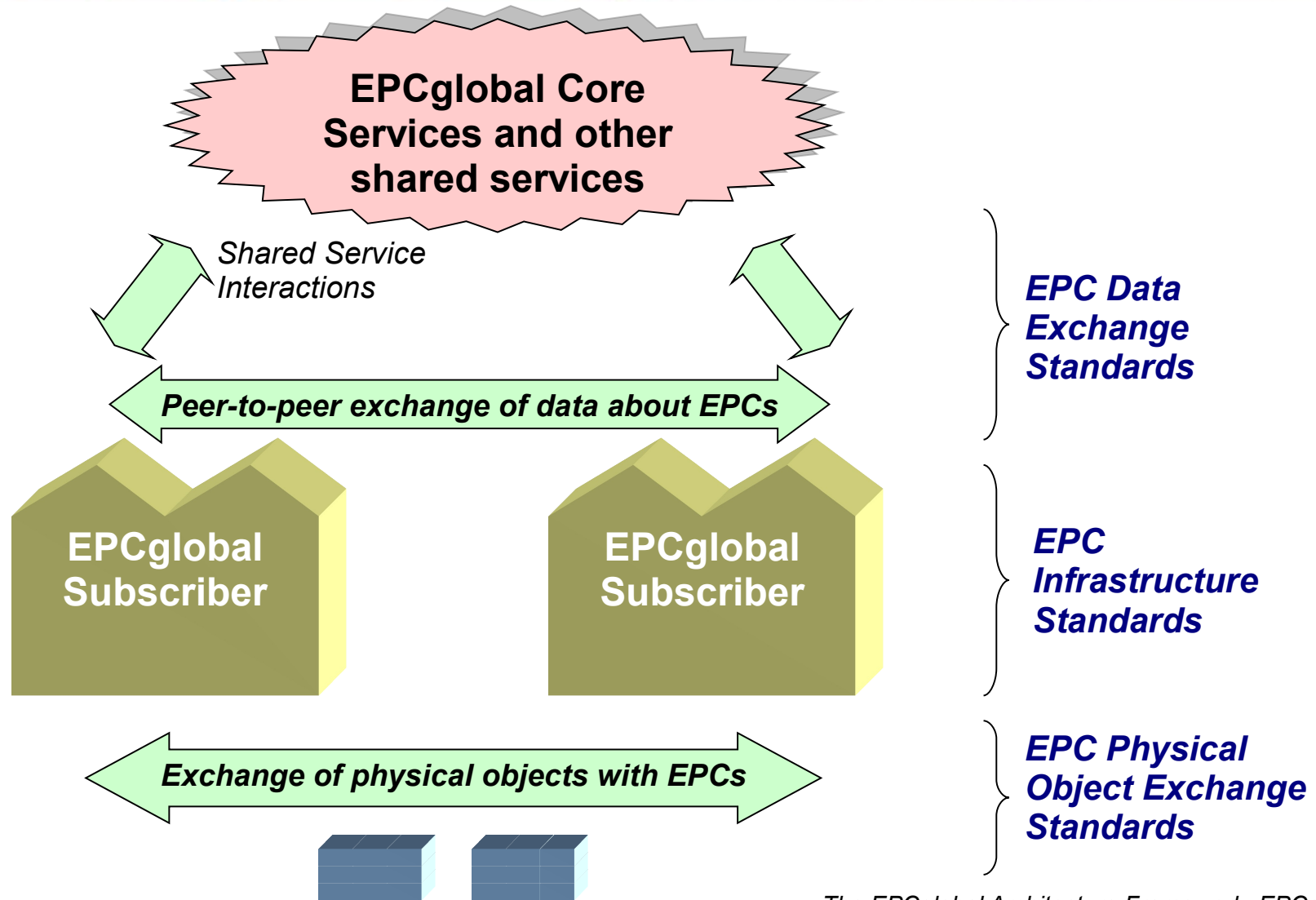
Overview of Standards



EPCglobal Inc., www.epcglobal.com/standards



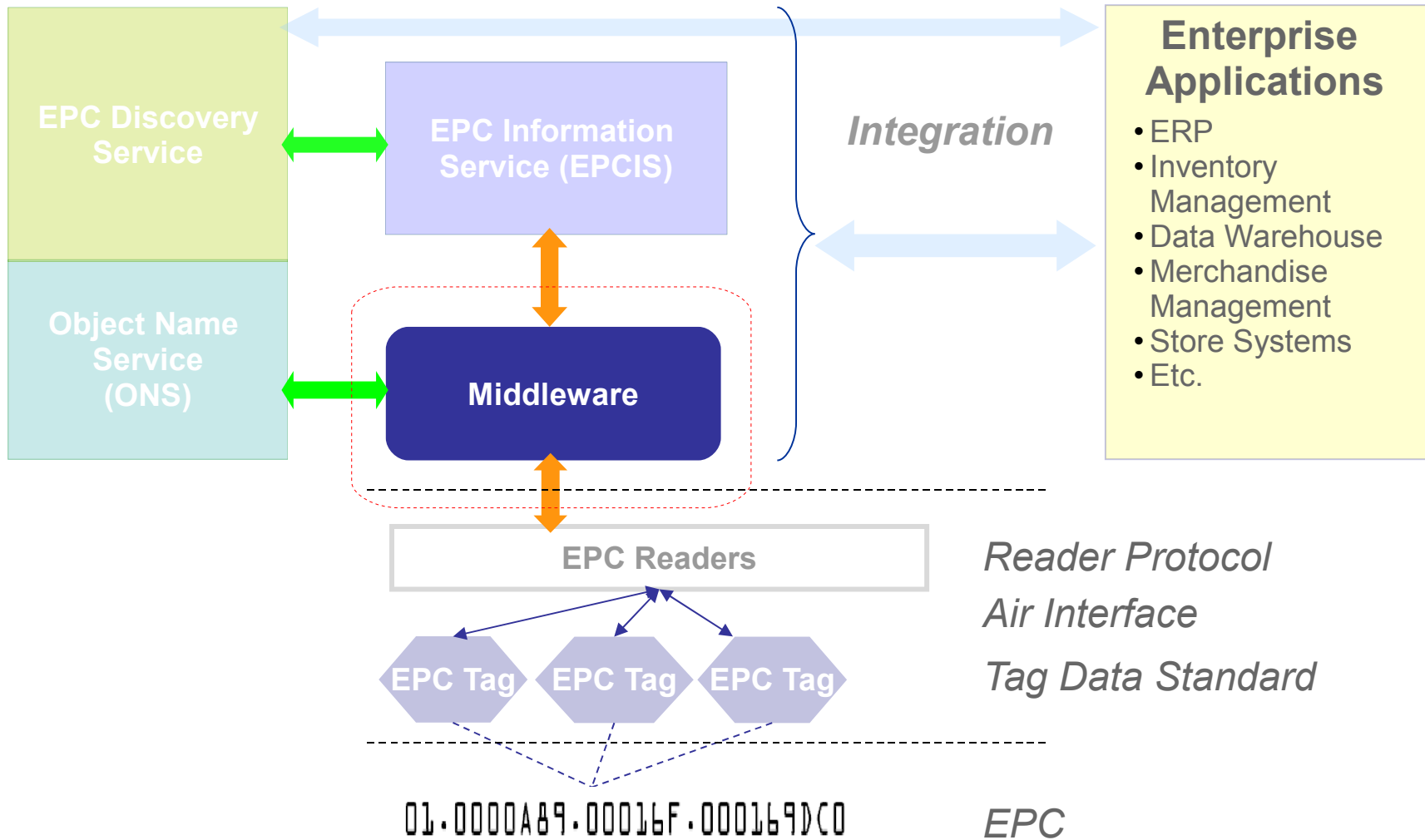
Architecture Layers



The EPCglobal Architecture Framework, EPCglobal Inc.



Middleware - ALE



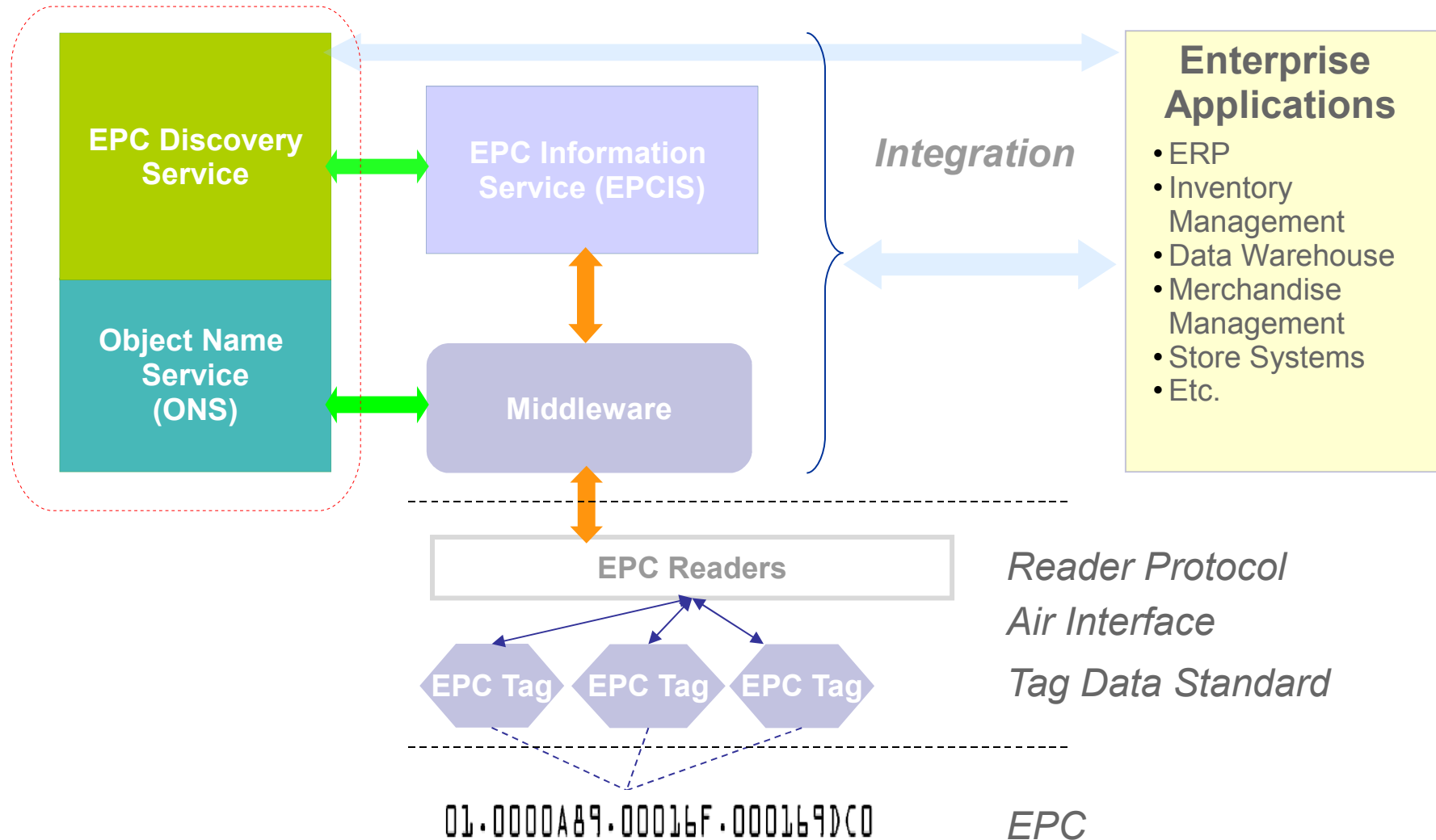
EPC Middleware - ALE

“**EPC Middleware** - Software to process and filter streams of tag data from multiple devices prior to sending to ERP systems”

- 📡 Data collection, filtering, aggregation, transformation ...
- 📡 Event management based on application requirements
- 📡 Acts as an information router



Object Name Service

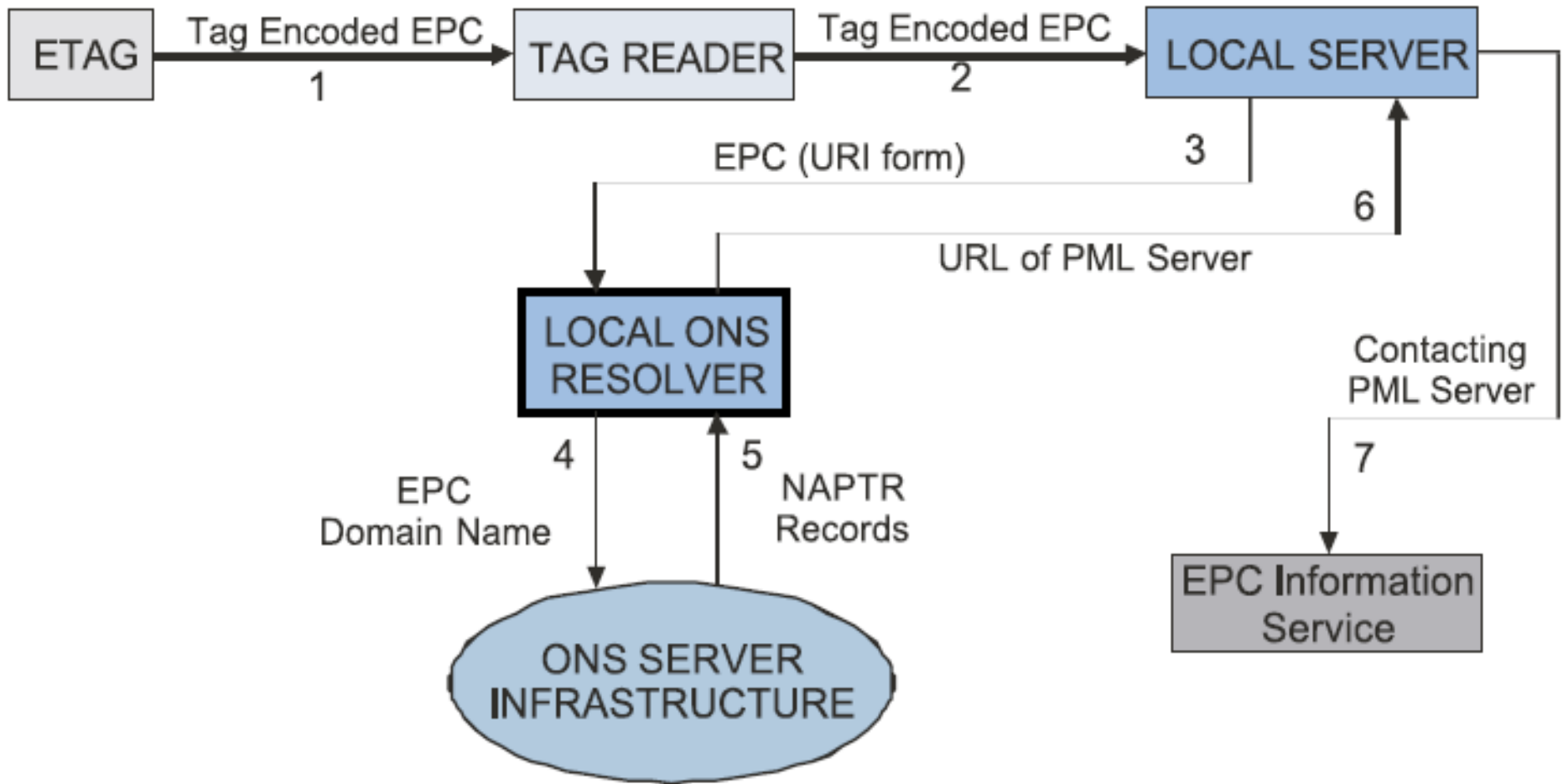


Object Name Service

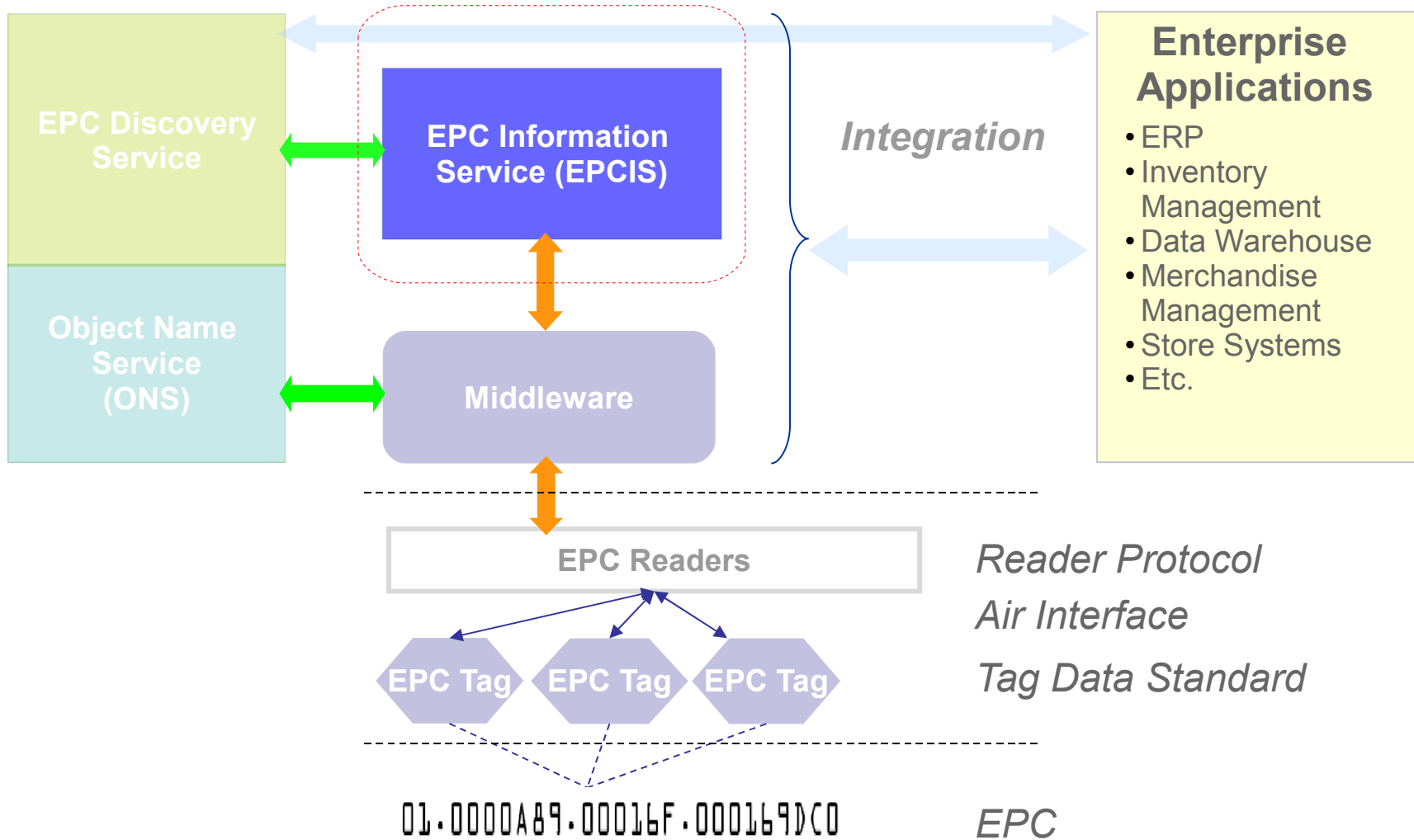
- Services to find and request data related to an EPC
- Identifies network location of the information for an object
 - analogy: reverse phone directory
 - lookup(EPC) => URL
- Based on DNS technology and infrastructure



How ONS Works?



EPC Information Systems



EPC Information Systems (EPCIS)

- ❖ Primary vehicle for data exchange between subscribers
- ❖ Encapsulates all access to underlying RFID infrastructure
- ❖ Facilitates capturing, securing and access to EPC-related data through a uniform interface
 - ❖ Interface for exchange of data and specifications of the data








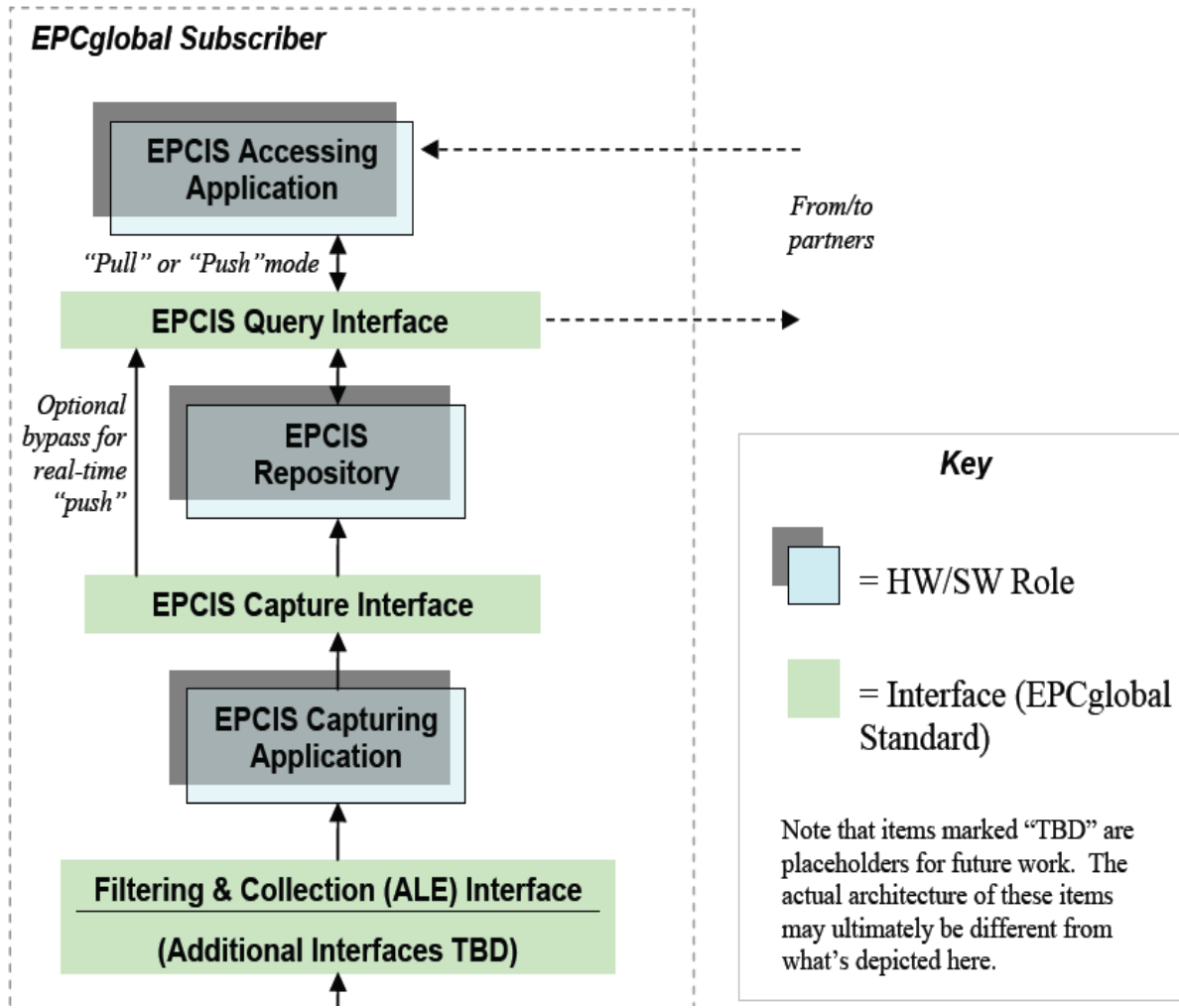
EPC Information Systems (EPCIS)

- ❏ Static vs. transactional data
 - ❏ *Static*: does not change, from manufacturer
 - ❏ Class-level and instance-level static data
 - ❏ *Trans.* : can grow and change, by many distinct enterprises
 - ❏ Instance Observations
 - ❏ Quantity Observations
 - ❏ Business Transaction Observations
- ❏ Vocabulary types (urn:...:receiving, urn:...:shipping ...)
- ❏ Platform independent messaging via SOAP with outside world



EPC Information Systems (EPCIS)

-  EPCIS Capturing Application
-  EPCIS Capture Interface
-  EPCIS Repository
-  EPCIS Query Interface
-  EPCIS Accessing Application



Application Scenarios

🌱 Fighting product counterfeiting and e-pedigree in pharmaceutical industry

🌱 Pfizer, in viagra product line



🌱 RFID baggage tracking in Airports

🌱 Hong Kong, Las Vegas, ...



🌱 Supply chain management

🌱 Less out-of-stocks, shrinkage and better inventory



Discussion

🏠 Challenges

- 🏠 Adoption: feasibility and acceptance
- 🏠 Privacy and confidentiality, Air Interface and ONS
- 🏠 Why and how should organizations work together?
- 🏠 What to share with whom?



Concluding Remarks

- Discovery Service (under development)
 - Google of internet of things
- Problems to tackle
 - Underlying technology (RFID) reliability
 - Price barrier
 - Technology acceptance and risk perception



