EPC Global Architecture Network

{Adapted based on The EPCglobal Architecture Framework EPCglobal Final Version 1.2}

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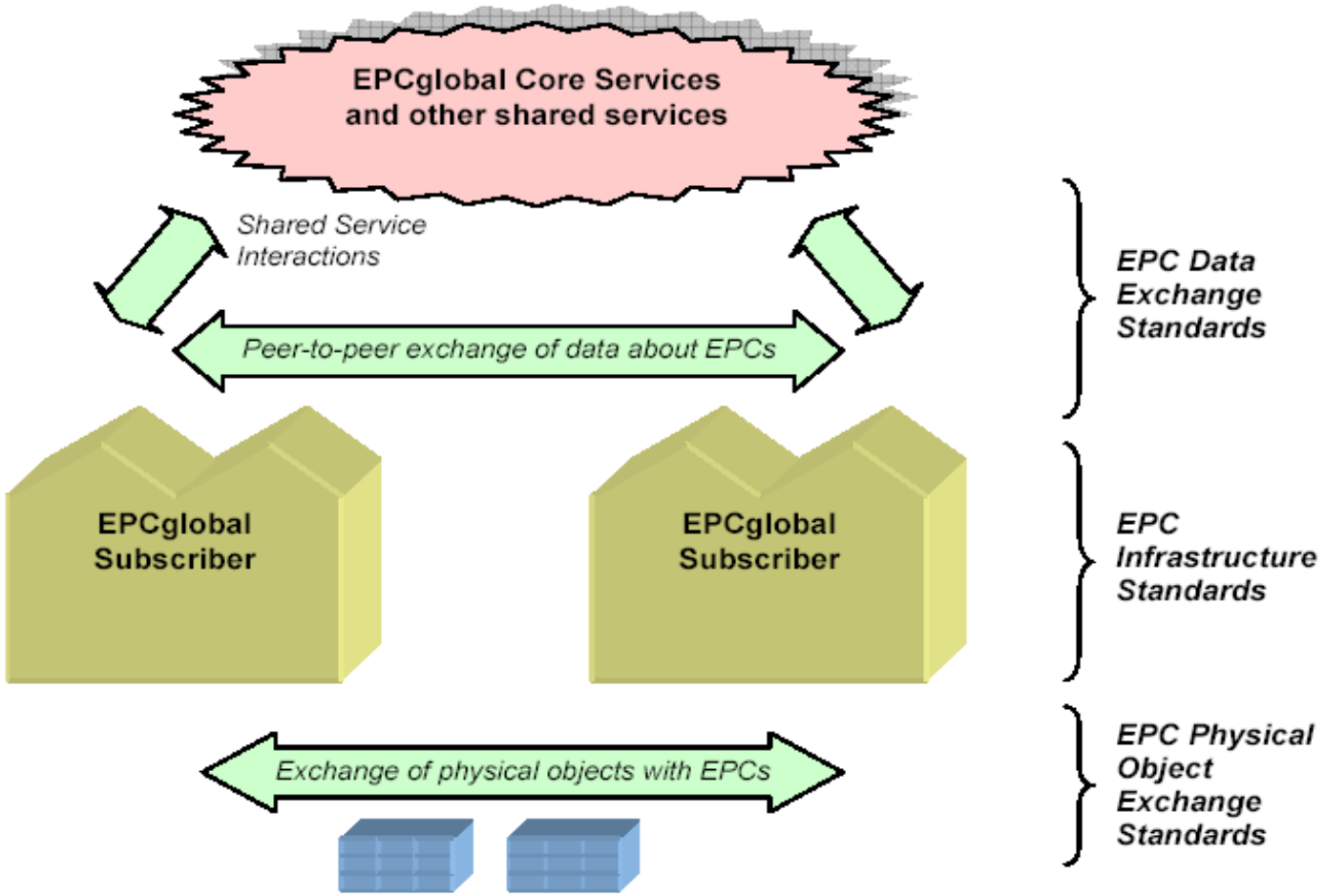
Agenda

- Enumerate each of the hardware, software, and data standards that are part of the EPCglobal Architecture Framework and show how they are related.
- Define the top level architecture of EPCglobal Core Services
- Explain the underlying principles that have guided the design of individual standards and Core Service components within the EPCglobal Network.
- Provide architectural guidance to end users and technology vendors seeking to implement EPCglobal Standards and to use EPCglobal Core Services
- More details:
  - http://www.epcglobalinc.org/standards/architecture/architecture_1_2-framework-20070910.pdf

Architecture Framework Overview



Architecture Framework Activities

- EPC Physical Object Exchange
- EPC Data Exchange
- EPC Infrastructure

EPC Physical Object Exchange

- Subscribers exchange physical objects that are identified with Electronic Product Codes (EPCs)
- Physical objects are trade goods
- Subscribers are parties in a supply chain for those goods

EPC Physical Object Exchange

- EPCglobal Architecture Framework defines EPC physical object exchange standards

- Ensure that when one subscriber delivers a physical object to another subscriber, the latter will be able to determine the EPC of the physical object and interpret it properly

EPC Data Exchange

- Subscribers increase the visibility of physical objects outside their four walls.
- The EPCglobal Architecture Framework defines EPC data exchange standards
- That provides a means for one subscriber to share data about EPCs with another through direct peer- to-peer interaction

EPC Infrastructure

- Follow the movements of objects by sensing their EPC codes, and gather that information into systems of record within the organization

- The EPCglobal Architecture Framework defines interface standards for the major infrastructure components required to gather and record EPC data

Architecture Framework Standards

Activity	Standard	Status	Reference
Object Exchange	UHF Class 0 Gen 1 RF Protocol	(Note 4, below)	[UHFC0]
	UHF Class 1 Gen 1 RF Protocol	(Note 4, below)	[UHFC1G1]
	HF Class 1 Gen 1 Tag Protocol	(Note 5, below)	[HFC1]
	UHF Class 1 Gen 2 Tag Protocol	Ratified	[UHFC1G2]
	EPC Tag Data Specification	Ratified	[TDS1.1]
Infrastructure	Reader Protocol	In development	[RP1.0]
	Reader Management	In development	[RM1.0]
	Tag Data Translation	In development	[TDT1.0]

Architecture Framework Standards

Activity	Standard	Status	Reference
Data Exchange	Application Level Events (ALE)	In development	[ALE1.0]
	EPCIS Capture Interface	In development	[EPCIS1.0]
	EPCIS Data Specification	In development	[EPCIS1.0]
	EPCIS Query Interface	In development	[EPCIS1.0]
	ONS	In development	[ONS1.0]
	EPCIS Discovery	TBD (Note 3)	(none)
	Subscriber Authentication	TBD (Note 3)	(none)

Goals for the EPCglobal Architecture Framework

- The Role of Standards
- Global Standards
- Open System
- Platform Independence
- Scalability and Extensibility
- Security
- Privacy
- Industry Architectures and Standards
- Open, Community Process

Role of Standards

- To facilitate the exchange of information and physical objects between trading partners
- To foster the existence of a competitive marketplace for system components.
- To encourage innovation

Global Standards

- EPCglobal is committed to the creation and use of global standards
- EPCglobal standards are developed for global use

Open System

- The Intellectual Property policy of EPCglobal is designed to secure free and open rights to implement EPCglobal Standards

Platform Independence

- EPCglobal Architecture Framework can be implemented on heterogeneous software and hardware platforms

- Specifications are platform independent meaning that the structure and semantics of data in an abstract sense is specified separately from the concrete details of data access services and bindings to particular interface protocols

Scalability and Extensibility

- EPCglobal Architecture Framework is designed to scale to meet the needs of each End-user e.g., :
  - Minimal pilot implementation conducted entirely within an End-user's four walls
  - Global implementation across entire supply chains

Security

- EPCglobal Architecture Framework is designed to promote a secure environment for operations inside and outside a company's four walls.

Privacy

- EPCglobal Architecture Framework is designed to accommodate the needs of both individuals and corporations to protect confidential and private information
  - EPCglobal Public Policy Steering Committee (PPSC) is responsible for creating and maintaining the EPCglobal Privacy Policy

Industry Architectures and Standards

- EPCglobal Architecture Framework is designed to work with and complement existing industry-wide architectures and standards.

Open, Community Process

- End user involvement in developing requirements through the Business Action Groups.
- Open process in which all EPCglobal subscribers having relevant expertise are encouraged to join working groups that create new standards.
- Several review milestones in which new standards are vetted by a wide community before final adoption.

Underlying Technical Principles

- Unique Identity
- Decentralized Implementation
- Layering of Data Standards – Verticalization
- Layering of Software Specifications – Technology Agnosticism
- Extensibility

Unique Identity

- Uniqueness
- Federation
- Representation independence
- Decentralized assignment
- Structure
- Light Weight

Decentralized Implementation

- The EPCglobal Architecture Framework is decentralized, meaning that logically centralized functions are distributed among one or more facilities serving individual EPCglobal Subscribers.

- The key elements of decentralization in the EPCglobal Architecture Framework are the assignment of EPC codes, and the ONS lookup service.

Layering of Data Standards – Verticalization (1)

- EPCglobal standards that govern data are designed in a layered fashion.
- Within each data standard, there is a framework layer that applies equally to all industries that use the EPCglobal Network.
- Layered on top of this are several vertical data standards that populate the general framework, each serving the needs of particular industry groups.

Layering of Data Standards – Verticalization (2)

- Two important data standards:
  - EPC Tag Data Specification (the framework elements include the structure of the “header bits” in the binary EPC representations and the general URI structure of of the text-based EPC representations)
  - EPCIS Data Specification (the framework elements include the abstract data model that lays out a general organization for master data and transactional event data)

Layering of Software Specifications

- EPCglobal Architecture Framework is primarily concerned with the exploitation of new data derived from the use of Electronic Product Codes and RFID technology within business processes.

Extensibility

- A general design principle for all EPCglobal Standards is openness to Extension.
- Extensions include both enhancements to the standards themselves
- Extensions made by a particular enterprise, group of cooperating enterprises, or industry vertical, to address specific needs that are not appropriate to address in an EPCglobal specification.

Architectural Foundations

- Electronic Product Code
- EPC Manager
- EPC Manager Number
- Embedding of Existing Codes
- Class Level Data versus Instance Level Data
- EPC Information Services (EPCIS)

Electronic Product Code

- Electronic Product Code:
  - Ties together all data that flows within the EPCglobal Network
  - Plays a central part in every role and interface within the EPCglobal Architecture Framework

EPC Manager

- EPC Manager responsible for:
  - Allocating new EPC from its assigned block
  - Associating it with a physical object or other entity
  - Maintaining the Object Name Service (ONS) records associated with blocks of EPCs it manages

EPC Manager Number

- Way an Issuing Agency grants a block of EPCs to an EPC Manager is by issuing the EPC Manager a single number
  - EPC Manager Number

- Having the EPC Manager Number as a distinct field within any given representation, allows any system to instantly identify the EPC Manager associated with a given EPC

Embedding of Existing Codes

- Most coding schemes currently defined with the EPC Tag Data Specification are based on existing industry coding schemes
-
- The “block” of EPC codes is a contiguous block within each EPC identity type to which the EPC Manager Number pertains

Class Level Data versus Instance Level Data

- In some cases, it is necessary to associate data with a class of object rather than a specific object itself

- Some kinds of Electronic Product Codes are used to identify things that do not have any meaningful grouping into object classes

EPC Information Services (EPCIS)

EPCIS data can be divided into five categories:

- Static Data
- Class-level Static Data
- Instance-level Static Data
- Transactional Data
- Instance Observations
- Quantity Observations
- Business Transaction Observations

Roles and Interfaces – General Considerations

- Architecture Framework vs. System Architecture
- Cross-Enterprise versus Intra-Enterprise

Architecture Framework vs. System Architecture (1)

- EPCglobal Architecture Framework :
  - Interrelated standards for hardware, software, and data interfaces (EPCglobal Standards)
  - Core services that are operated by EPCglobal and its delegates (EPCglobal Core Services)
  - Does not define a system architecture that end users must implement, nor does it dictate particular hardware or software components an end user must deploy.
  - End-user system architecture may only need to employ a subset of the EPCglobal Standards and Core Services

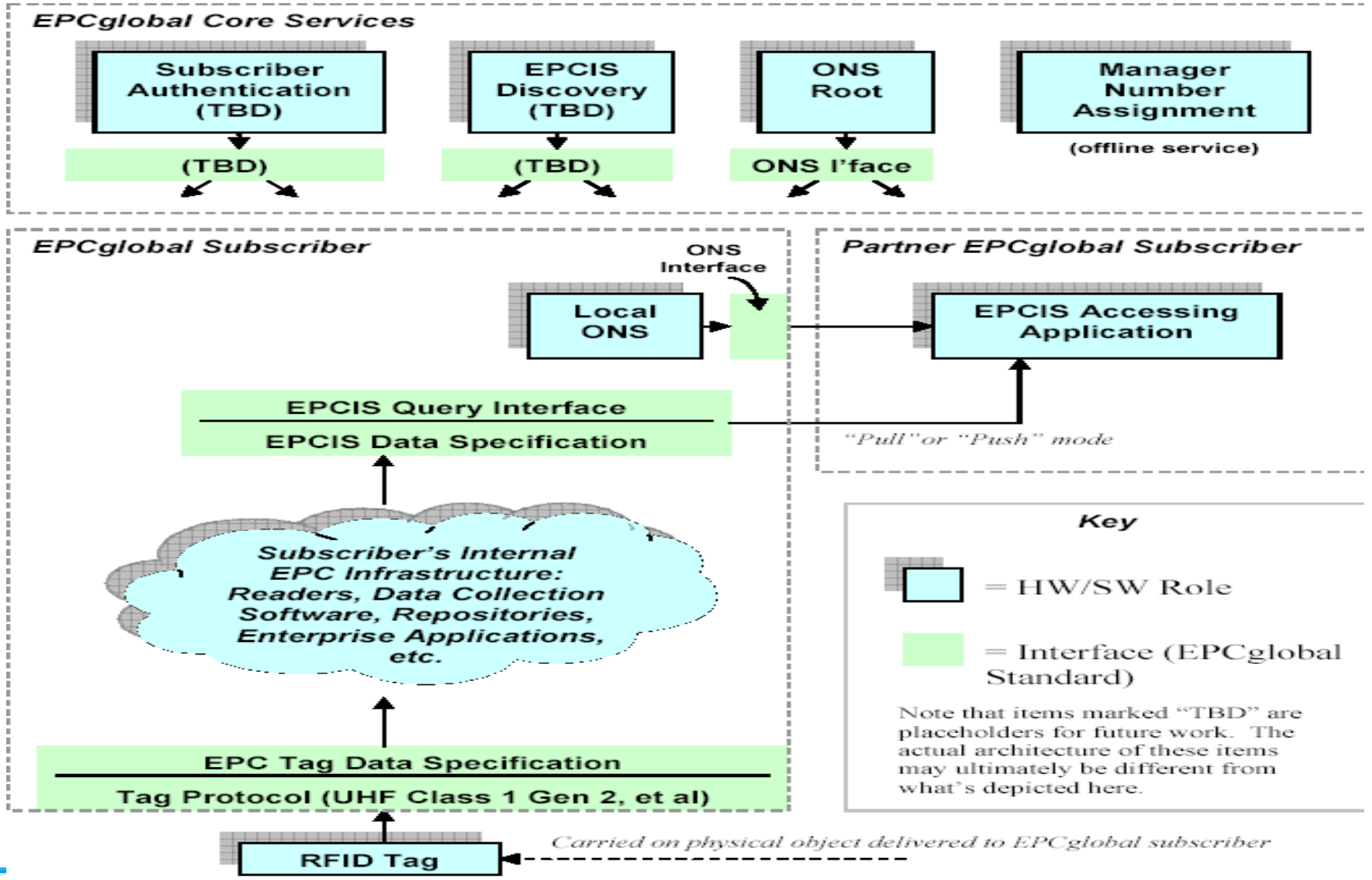
Architecture Framework vs. System Architecture (2)

- Mapping between hardware and software roles Actual hardware or software components deployed by an end-user may not necessarily be one-to-one
- Roles may be carried out by an end user's legacy system components
  - May have additional responsibilities outside the scope of the EPCglobal Architecture Framework

Cross-Enterprise vs. Intra-Enterprise

- Use of EPC Data Exchange between enterprises and EPC Object Exchange between enterprises, is necessary to interact with other subscribers
- Subscriber has much more latitude in its decisions surrounding adoption of the EPC Infrastructure standards as those standards do not affect parties outside the subscriber's own four walls

Data Flow Relationships – Cross-Enterprise (1)

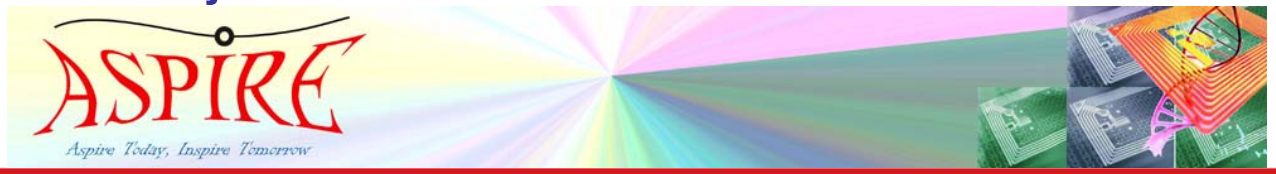


Data Flow Relationships – Cross-Enterprise (2)

- Data Exchange Interactions
- Object Exchange Interactions
- ONS Interactions
- Number Assignment

Data Exchange Interactions

- The EPCIS Accessing Application may:
  - Know in advance exactly where to find the information
  - Know where to find the information it seeks based on information obtained previously
  - Use the Object Name Service (ONS) to locate the EPCIS service of the EPCglobal Subscriber who is the EPC Manager of the object in question
  - Use EPCIS Discovery Services to locate the EPCIS services of all EPCglobal Subscribers that have information about the object in question, including EPCglobal Subscribers other than the EPC Manager of the object



Object Exchange Interactions

- A physical object is received by the EPCglobal Subscriber, bearing an RFID tag that contains an EPC code

- The EPCglobal Subscriber reads the tag using RFID Readers deployed as part of its internal EPC infrastructure

ONS Interactions (1)

- EPCglobal Subscriber wishes to locate an EPCIS service:
  - Consults the Root ONS service controlled by EPCglobal.
  - Root ONS service identifies the Local ONS service of the EPC Manager organization for that EPC
  - EPCglobal Subscriber then completes the lookup by consulting the Local ONS service, which provides the pointer to the EPCIS service in question

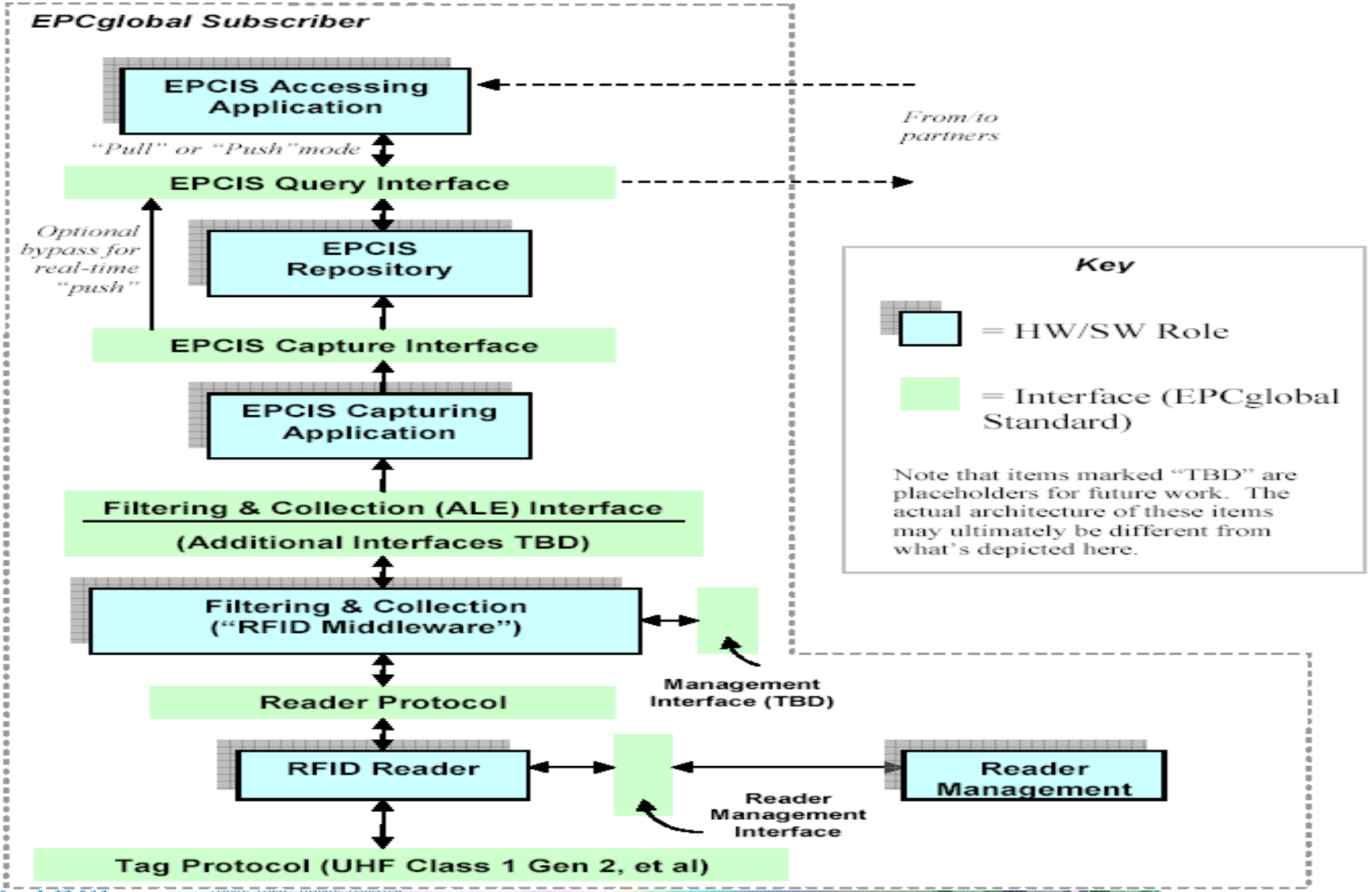
ONS Interactions (2)

- Implications:
  - "Root ONS service" and "Local ONS service" as used above may each be implemented by multiple independent servers
  - EPCglobal's Root ONS service is actually itself two levels down in a hierarchy of lookups, which has its true root in the worldwide DNS root service
  - ONS benefits from the DNS caching mechanism

Number Assignment

- EPCglobal's service of issuing unique EPC Manager Numbers to each EPC Manager organization that requests one, in its capacity as the Issuing Agency for the GS1 family of codes.

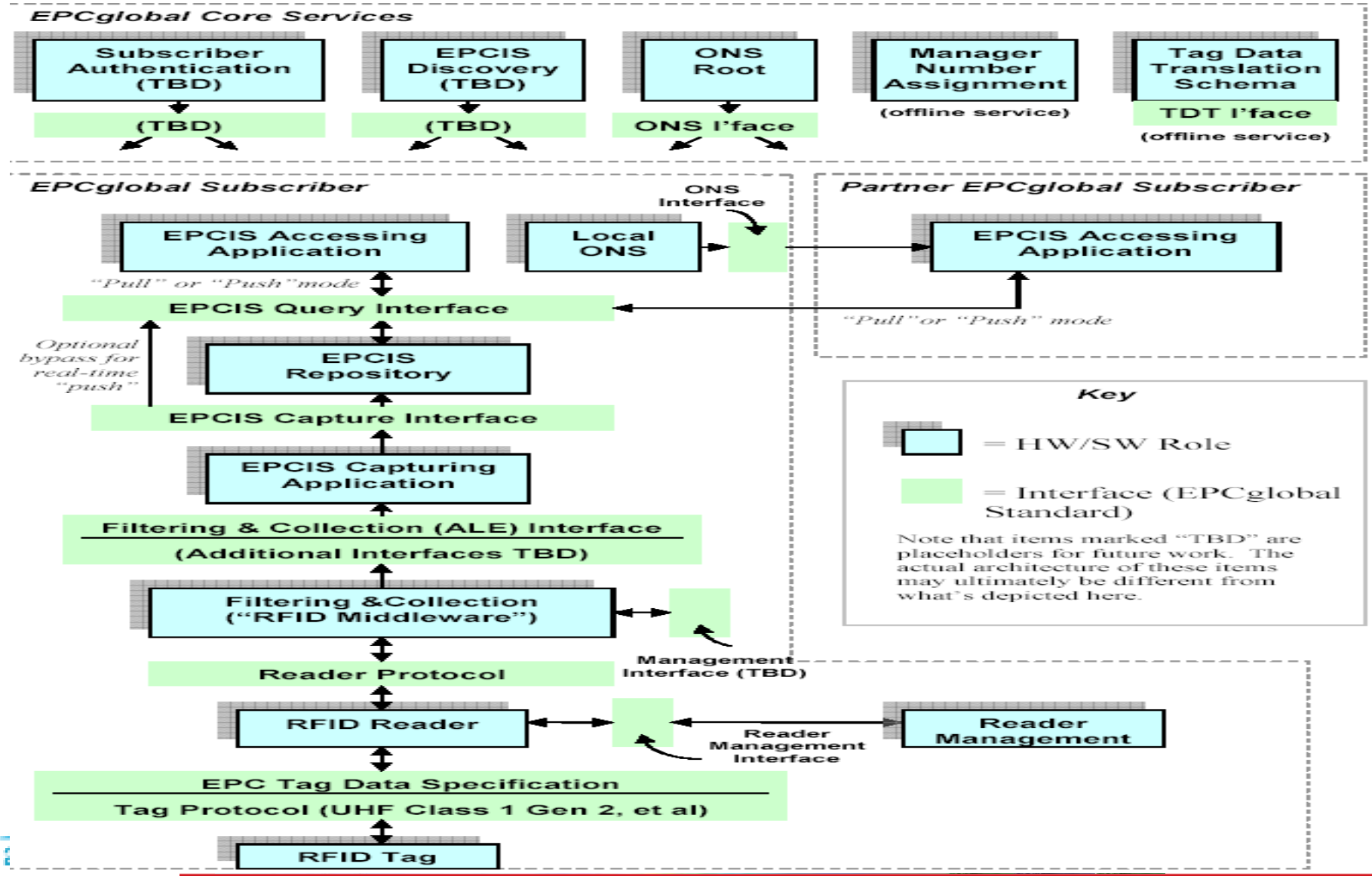
Data Flow Relationships – Intra-Enterprise (1)



Data Flow Relationships – Intra-Enterprise (2)

- The Reader Protocol Interface insulates the higher layers from knowing what reader makes/models have been chosen
- The Filtering & Collection Interface insulates the higher layers from the physical design choices made regarding how tags are sensed and accumulated, and how the time boundaries of events are triggered
- The EPCIS interfaces insulate enterprise applications from understanding the details of how individual steps in a business process are carried out at a detailed level

Roles and Interfaces – Reference



Roles and Interfaces – Responsibilities and Collaborations (1)

- RFID Tag (Role):
  - Holds an EPC code
  - May allow the EPC code to be changed post-manufacture.
  - May hold an immutable code that gives manufacture information, including the manufacturer identity, unique manufacture serial number, etc.
  - May have additional user data apart from the EPC code.
  - May have additional features such as lock, kill, access control, etc. These features may involve additional data stored on the tag such as a lock code, lock status, kill code, access password, etc.

Roles and Interfaces – Responsibilities and Collaborations (2)

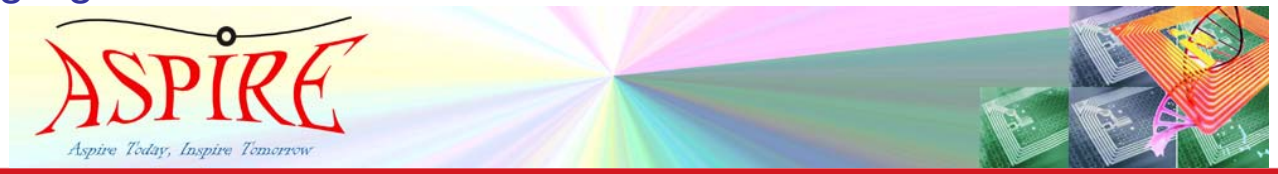
- EPC Tag Data Specification (Interface):
  - Normative references:
    - Ratified EPCglobal Standard (TDS1.0)
- **Responsibilities:**
  - Defines the overall structure of the Electronic Product Code, including the mechanism for federating different coding schemes.
  - Defines specific EPCglobal coding schemes.
  - For each EPCglobal coding scheme, defines binary representations for use on RFID tags, text representations for use within information systems, and rules for converting between one representation and another.

Roles and Interfaces – Responsibilities and Collaborations (3)

- Tag Protocol (Interface):
  - Normative references:
    - EPCglobal Specifications (from Auto-ID Center) (UHFC0), [UHFC1G1], [HFC1]
    - Ratified EPCglobal Standard (UHFC1G2)
  - Responsibilities:
    - Communicates a command to a tag from an RFID Reader.
    - Communicates a response from a tag to the RFID Reader that issued the command.
    - Provides means for a reader to singulate individual tags when more than one is within range of the RFID Reader.
    - Provides means for readers and tags to minimize interference with each other.

Roles and Interfaces – Responsibilities and Collaborations (4)

- RFID Reader (Role):
  - Reads the EPCs of RFID Tags within range of one or more antennas (via a Tag Protocol) and reports the EPCs to a host application (via the Reader Protocol)
  - When an RFID Tag allows the EPC code to be written post-manufacture, writes the EPC to a tag (via a Tag Protocol) as commanded by a host application (via the Reader Protocol)
  - When an RFID Tag provides additional user data apart from the EPC code, reads and writes user data (via a Tag Protocol) as directed by a host application (via the Reader Protocol)
  - When an RFID Tag provides additional features such as kill, lock, etc, operates those features (via a Tag Protocol) as directed by a host application (via the Reader Protocol)
  - May provide additional processing such as filtering of EPCs, aggregation of reads, and so forth



Roles and Interfaces – Responsibilities and Collaborations (5)

- Reader Protocol (Interface): Normative references:
  - EPCglobal Working Draft (RP)
- Responsibilities:
  - Provides means to command an RFID Reader to inventory tags, read tags, write tags, manipulate tag user and tag-identification data, and access other features such as kill, lock, etc.
  - May provide means to access RFID Reader management functions.
  - May provide means to control RF aspects of RFID Reader operation.
  - May provide means to control aspects of Tag Protocol operation.
  - May provide access to processing features. For features that require converting between different representations of EPCs, may use the Tag Data Translation Interface to obtain machine-readable rules for doing so.

Roles and Interfaces – Responsibilities and Collaborations (6)

- Reader Management Interface (Interface):
  - Normative references: EPCglobal Working Draft (RM)
- Responsibilities:
  - Provides means to query the configuration of an RFID Reader.
  - Provides means to monitor the operational status of an RFID Reader
  - Provides means to control configuration of an RFID Reader.
  - May provide means to access RFID Reader management functions.

Roles and Interfaces – Responsibilities and Collaborations (7)

- Reader Management (Role):
  - Monitors the operational status of one or more RFID Readers within a deployed infrastructure.
  - Manages the configuration of one or more RFID Readers.
  - Carries out other RFID Reader management functions.

Roles and Interfaces – Responsibilities and Collaborations (8)

- Filtering & Collection (Role):
  - Receives raw tag reads from one or more RFID Readers.
  - Carries out processing to reduce the volume of EPC data, transforming raw tag reads into streams of events more suitable for application logic than raw tag reads.
  - Determines which processing operations as described above may be delegated to the RFID Reader, and which must be performed by the Filtering & Collection role itself.
  - Decodes raw tag values into URI representations defined by the Tag Data Specification.
  - Maps between “logical reader names” and physical resources such as reader devices and/or specific antennas.

Roles and Interfaces – Responsibilities and Collaborations (9)

- Filtering & Collection (Role) (2):
  - When the Filtering & Collection role is accessed by more than one client application, mediates between multiple client application requests for data when those requests involve the same set or overlapping subsets of RFID Readers.
  - Sets and controls the strategy for finding tags employed by RFID Readers.
  - May coordinate the operation of many readers and antennas within a local region in which RFID Readers may affect each other's operation; e.g., to minimize interference.

Roles and Interfaces – Responsibilities and Collaborations (10)

- Filtering & Collection (Role) (3):
- The Filtering & Collection (ALE) Interface currently:
  - provides a standard interface that applies to a large collection of use cases in which RFID Tags are inventoried.
  - does not support use cases in which tags are written or killed, in which the kill or lock passwords are maintained, or in which "user data" or TID memory on the tags is read or written. These are expected to be addressed by future specifications, possibly new interfaces adjacent to the ALE Interface, or possibly by extending the ALE interface itself.
  - Management of the Filtering & Collection role is not yet addressed by any EPCglobal specification.

Roles and Interfaces – Responsibilities and Collaborations (11)

- Filtering & Collection (ALE) Interface (Interface) (1):
  - Normative references: EPCglobal Proposed Standard (ALE)
- Responsibilities:
  - Provides means for one or more client applications to request EPC data from one or more data sources.
  - Insulates client applications from knowing how many readers/antennas, and what makes and models of readers are deployed to constitute a single, logical data source.
  - Provides declarative means for client applications to specify what processing to perform on EPC data.

Roles and Interfaces – Responsibilities and Collaborations (12)

- Filtering & Collection (ALE) Interface (Interface) (2):
- Responsibilities:
  - Provides a means for client applications to request data on demand (synchronous delivery) or as a standing request (asynchronous delivery).
  - Provides means for multiple client applications to share data from the same reader or readers, without prior coordination between the applications.
  - Provides a standardized representation for client requests for EPC data, and a standardized representation for reporting filtered, collected EPC data.

Roles and Interfaces – Responsibilities and Collaborations (13)

- EPCIS Capturing Application (Role):
  - Recognizes the occurrence of EPC-related business events, and delivers these as EPCIS data.
  - May coordinate multiple sources of data in the course of recognizing an individual EPCIS event.
  - May control the carrying out of actions in the physical environment, including writing RFID tags and controlling other devices.

Roles and Interfaces – Responsibilities and Collaborations (14)

- EPCIS Capture Interface (Interface):
  - Normative references: EPCglobal Working Draft EPCIS
- Responsibilities:
  - Provides a path for communicating EPCIS events generated by EPCIS Capturing Applications to other roles that require them, including EPCIS Repositories, internal EPCIS Accessing Applications, and Partner EPCIS Accessing Applications