INTERFACE MANAGEMENT WITH MBSE – FROM THEORY TO MODELING

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AGENDA

1. Introduction
2. Interfaces
3. System of System Interfaces
4. System Interfaces
5. Through the development lifecycle
6. Conclusion

INTRODUCTION

- Interoperability is a key facet of a successful system, and essential to a system of systems.
- Interoperability is a property of a system, whose interfaces are completely understood, to work with other products or systems without any restricted access or implementation.
- Software interoperability is the capability of different programs to exchange data via a common set of exchange formats, (read/write) file formats using same protocols.
- DOD: The condition achieved among communications-electronics systems when information or services can be exchanged directly and satisfactorily.
- So, interoperability begins with interfaces: mechanical, electronic, hardware, software, people-ware, etc.

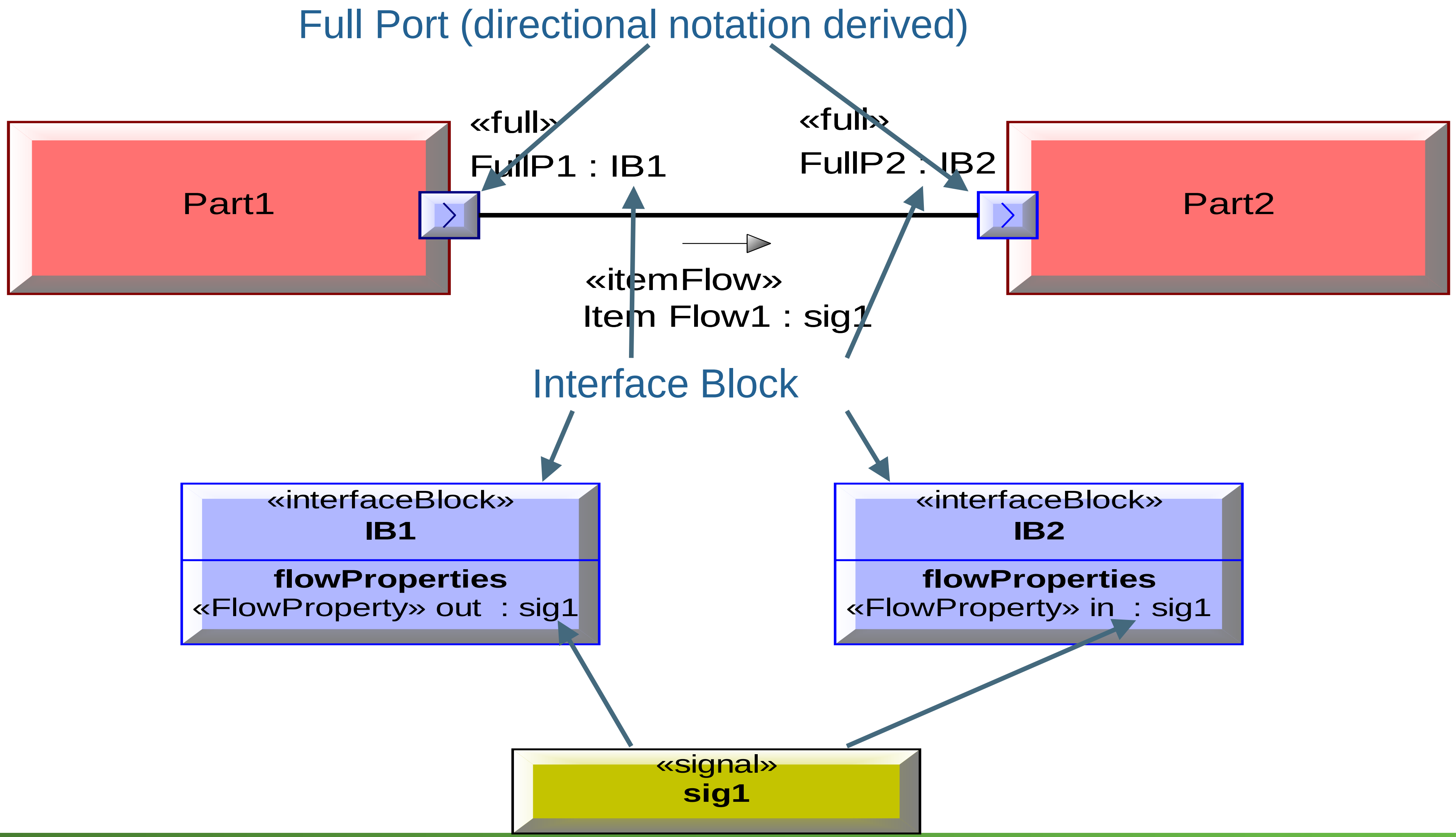
DESIGNING INTERFACES

- Starts with requirements and stakeholder needs

- System-to-System interfaces
  - Define the required behavior/functionality
  - Identify the Dependencies - interaction with other systems and within the subsystems
  - Identify the necessary interactions
    - Data, physical, logical, electrical, etc.
  - Define logical interface requirements
  - Define interaction performance characteristics
  - Allocate to physical interfaces

- Human Interfaces
  - Identify the characteristics of the (Human) users that will interact with the system.
  - Define the required tasks to be performed
  - Identify the Primary User Interface Elements
  - Define the Navigation Map

FULL PORT NOTATION

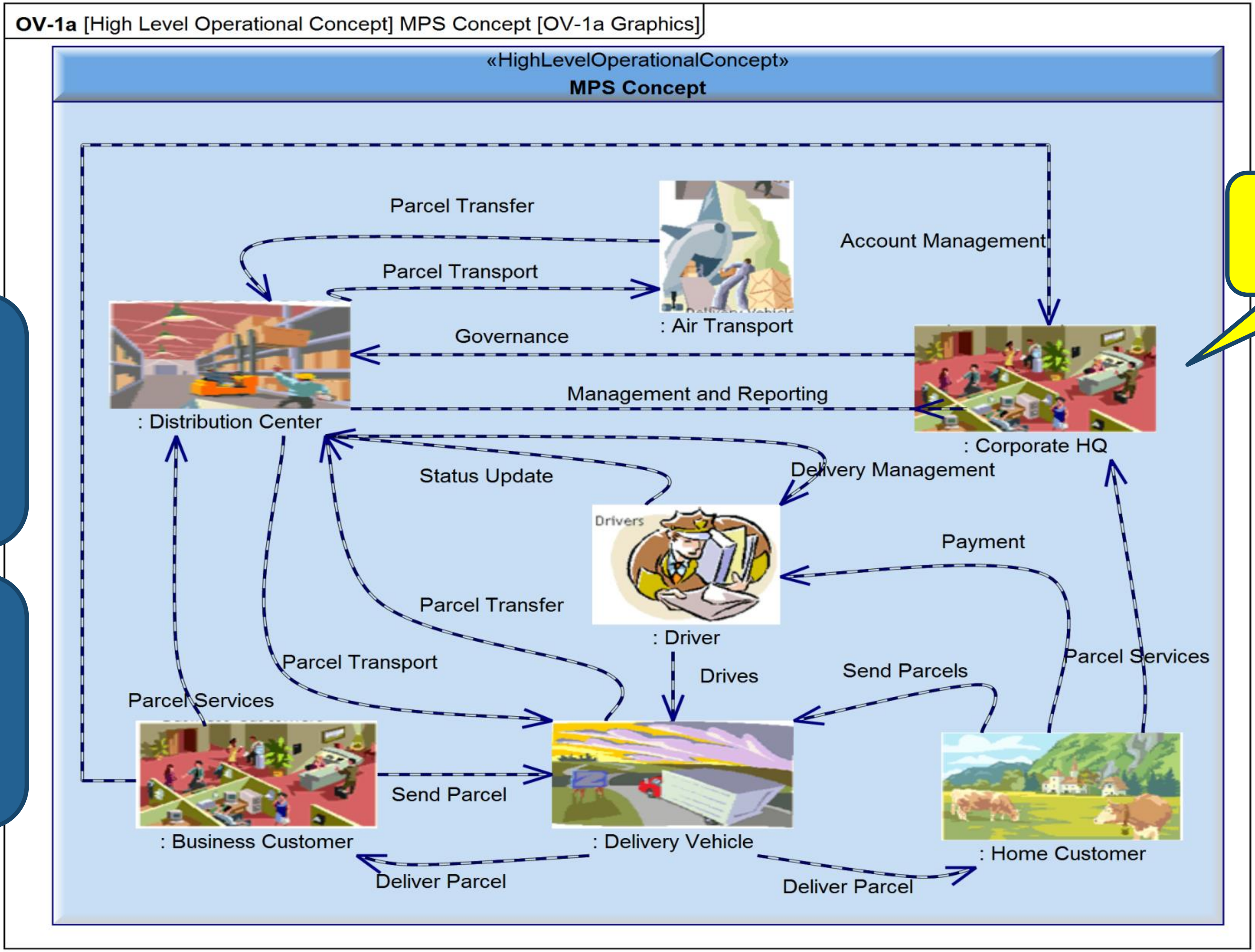


SYSTEMS OF SYSTEMS INTERFACES

OPERATIONAL CONCEPT GRAPHIC

Provides a means to communicate with non-technical stakeholders while maintaining model consistency

Defines nominal interfaces between conceptual entities in the context.



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CAPABILITY DEPENDENCIES

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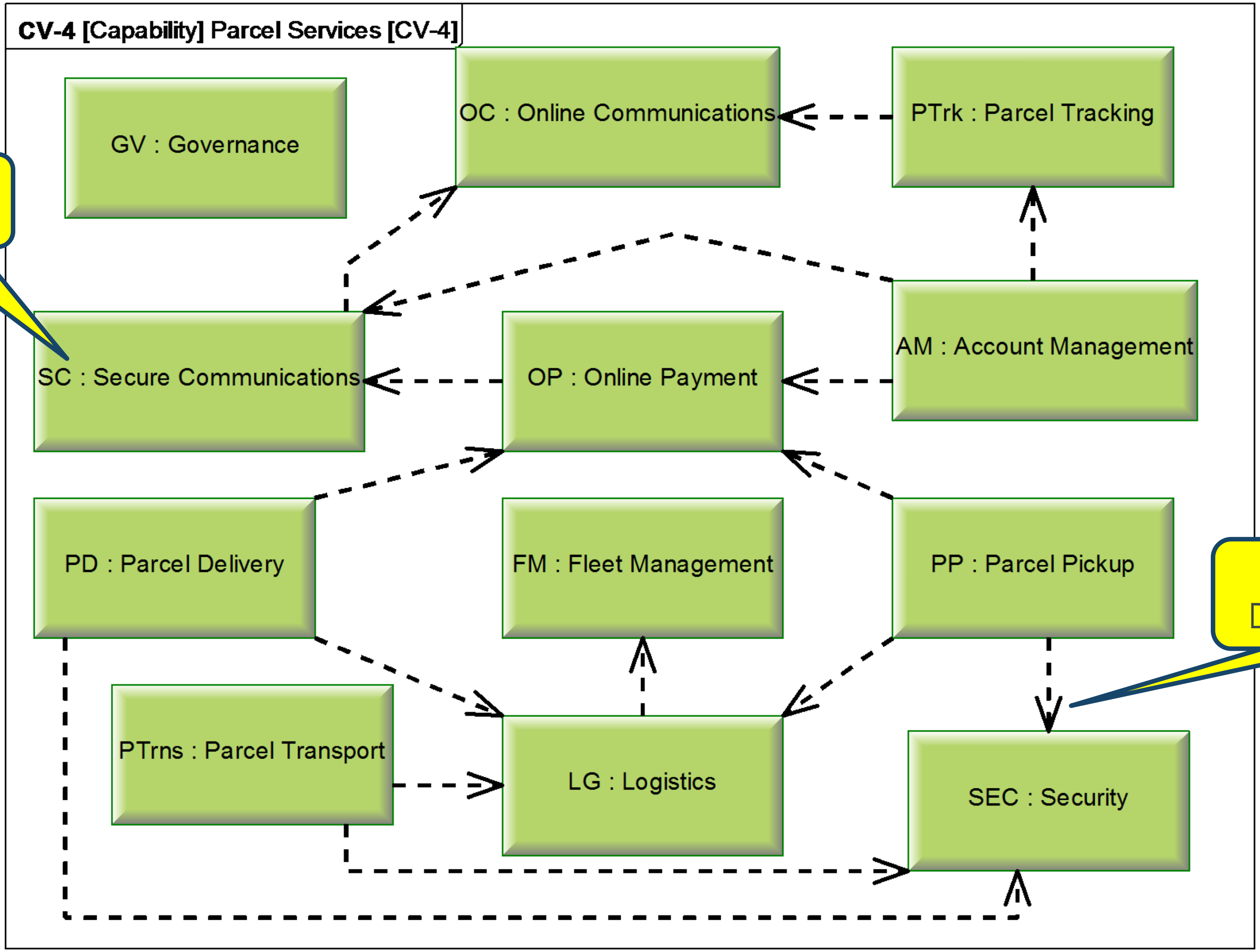


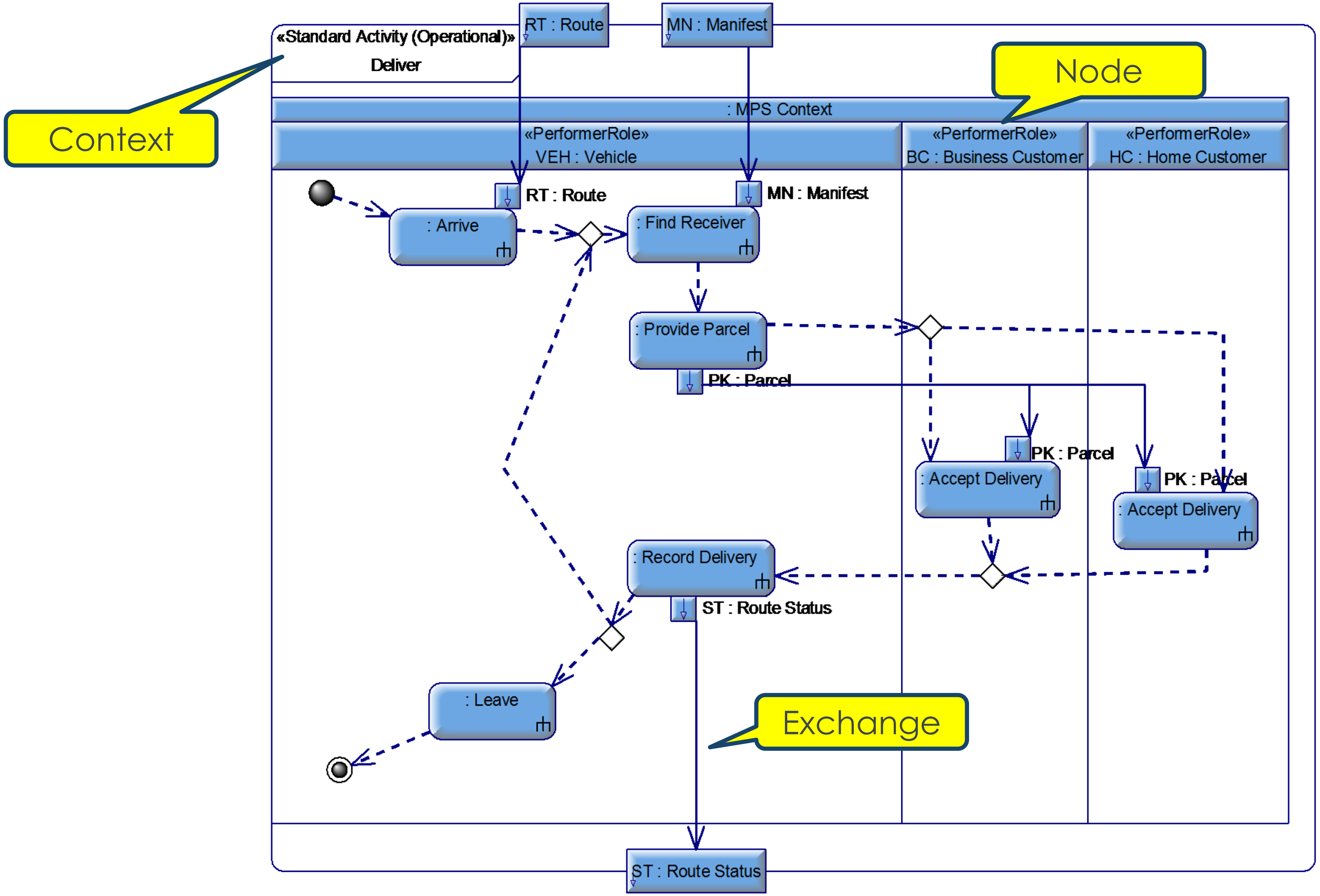
Required Capability

Capability Dependency

Capability dependencies provide context for capability phases and resource deployment

Dependencies between capabilities implies interfaces between implementing systems.

LOGICAL ARCHITECTURE INTERACTIONS



Interactions crossing swimlanes defines system interface characteristics

LOGICAL ARCHITECTURE ICD (FRAGMENT)

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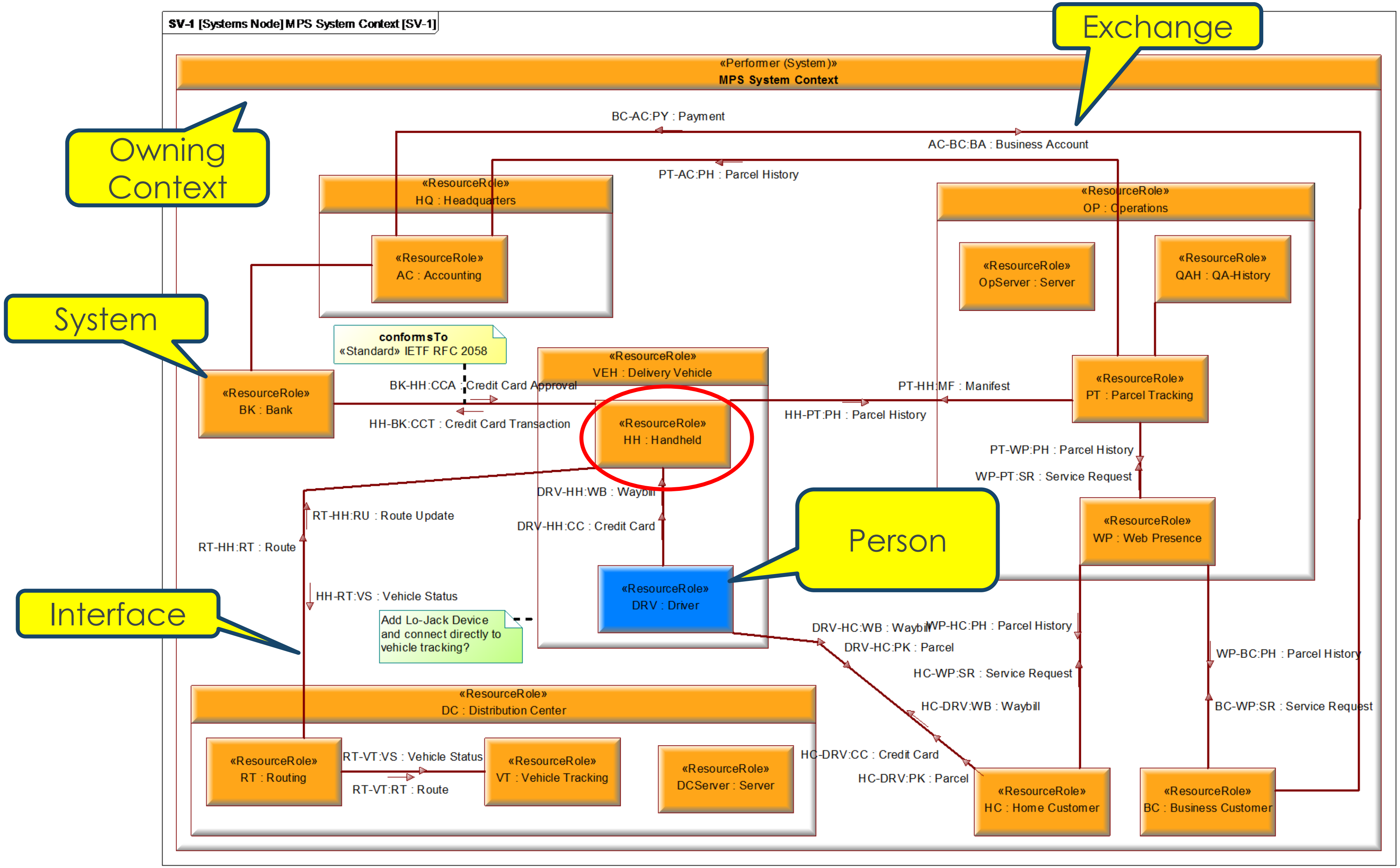
[Architectural Description] Structure [OV-3 Info Exchange]

Operational		Producer		Needline	Consumer	
Name	Conveyed	Performer (Operational)	Activity (Operational)	Name	Performer (Operational)	Activity (Operational)
CHQ-BC:BL	«Exchange Element» Bill	«Performer (Operational)» Corporate HQ		BC - CHQ	«Performer (Operational)» Business Customer	
BC-VEH:PK	«System» Parcel	«Performer (Operational)» Business Customer	«Activity (Operational)» Provide Waybill	BC - VEH	«Performer (Operational)» Vehicle	«Activity (Operational)» Verify Waybill and Payment
BC-VEH:PW	«Exchange Element» Parcel Waybill	«Performer (Operational)» Business Customer	«Activity (Operational)» Provide Waybill	BC - VEH	«Performer (Operational)» Vehicle	«Activity (Operational)» Verify Waybill and Payment
VEH-BC:PK	«System» Parcel	«Performer (Operational)» Vehicle	«Activity (Operational)» Provide Parcel	BC - VEH	«Performer (Operational)» Business Customer	«Activity (Operational)» Accept Delivery
SF-DC:PK	«System» Parcel	«Performer (Operational)» Storefront		SF - DC	«Performer (Operational)» Distribution Center	
DC-VEH:MN	«Exchange Element» Manifest	«Performer (Operational)» Distribution Center	«Activity (Operational)» Find and Record Outgoing Parcels	VEH - DC	«Performer (Operational)» Vehicle	«Activity (Operational)» Load Vehicle «Activity (Operational)» Find Receiver «Activity (Operational)» Find Sender
DC-VEH:PK	«System» Parcel	«Performer (Operational)» Distribution Center	«Activity (Operational)» Find and Record Outgoing Parcels	VEH - DC	«Performer (Operational)» Vehicle	«Activity (Operational)» Load Vehicle
DC-VEH:PW	«Exchange Element» Parcel Waybill	«Performer (Operational)» Distribution Center	«Activity (Operational)» Find and Record Outgoing Parcels	VEH - DC	«Performer (Operational)» Vehicle	«Activity (Operational)» Load Vehicle
DC-VEH:RT	«Exchange Element» Route	«Performer (Operational)» Distribution Center		VEH - DC	«Performer (Operational)» Vehicle	«Activity (Operational)» Arrive
VEH-DC:MN	«Exchange Element» Manifest	«Performer (Operational)» Vehicle	«Activity (Operational)» Unload Vehicle	VEH - DC	«Performer (Operational)» Distribution Center	«Activity (Operational)» Record and Store Incoming Parcels
VEH-DC:PK	«System» Parcel	«Performer (Operational)» Vehicle	«Activity (Operational)» Unload Vehicle	VEH - DC	«Performer (Operational)» Distribution Center	«Activity (Operational)» Record and Store Incoming Parcels
VEH-DC:PW	«Exchange Element» Parcel Waybill	«Performer (Operational)» Vehicle	«Activity (Operational)» Unload Vehicle	VEH - DC	«Performer (Operational)» Distribution Center	«Activity (Operational)» Record and Store Incoming Parcels
VEH-DC:ST	«Exchange Element» Route Status	«Performer (Operational)» Vehicle	«Activity (Operational)» Record Delivery «Activity (Operational)» Record Pickup	VEH - DC	«Performer (Operational)» Distribution Center	
HC-VEH:PK	«System» Parcel	«Performer (Operational)» Home Customer	«Activity (Operational)» Provide Waybill	VEH - HC	«Performer (Operational)» Vehicle	«Activity (Operational)» Verify Waybill and Payment
HC-VEH:PW	«Exchange Element» Parcel Waybill	«Performer (Operational)» Home Customer	«Activity (Operational)» Provide Waybill	VEH - HC	«Performer (Operational)» Vehicle	«Activity (Operational)» Verify Waybill and Payment
HC-VEH:PY	«Exchange Element» Payment	«Performer (Operational)» Home Customer	«Standard Activity (Operational)» Provide Payment	VEH - HC	«Performer (Operational)» Vehicle	«Activity (Operational)» Verify Waybill and Payment
VEH-HC:PK	«System» Parcel	«Performer (Operational)» Vehicle	«Activity (Operational)» Provide Parcel	VEH - HC	«Performer (Operational)» Home Customer	«Activity (Operational)» Accept Delivery

Generated automatically from the architecture

SYSTEM INTERCHANGE SPECIFICATION

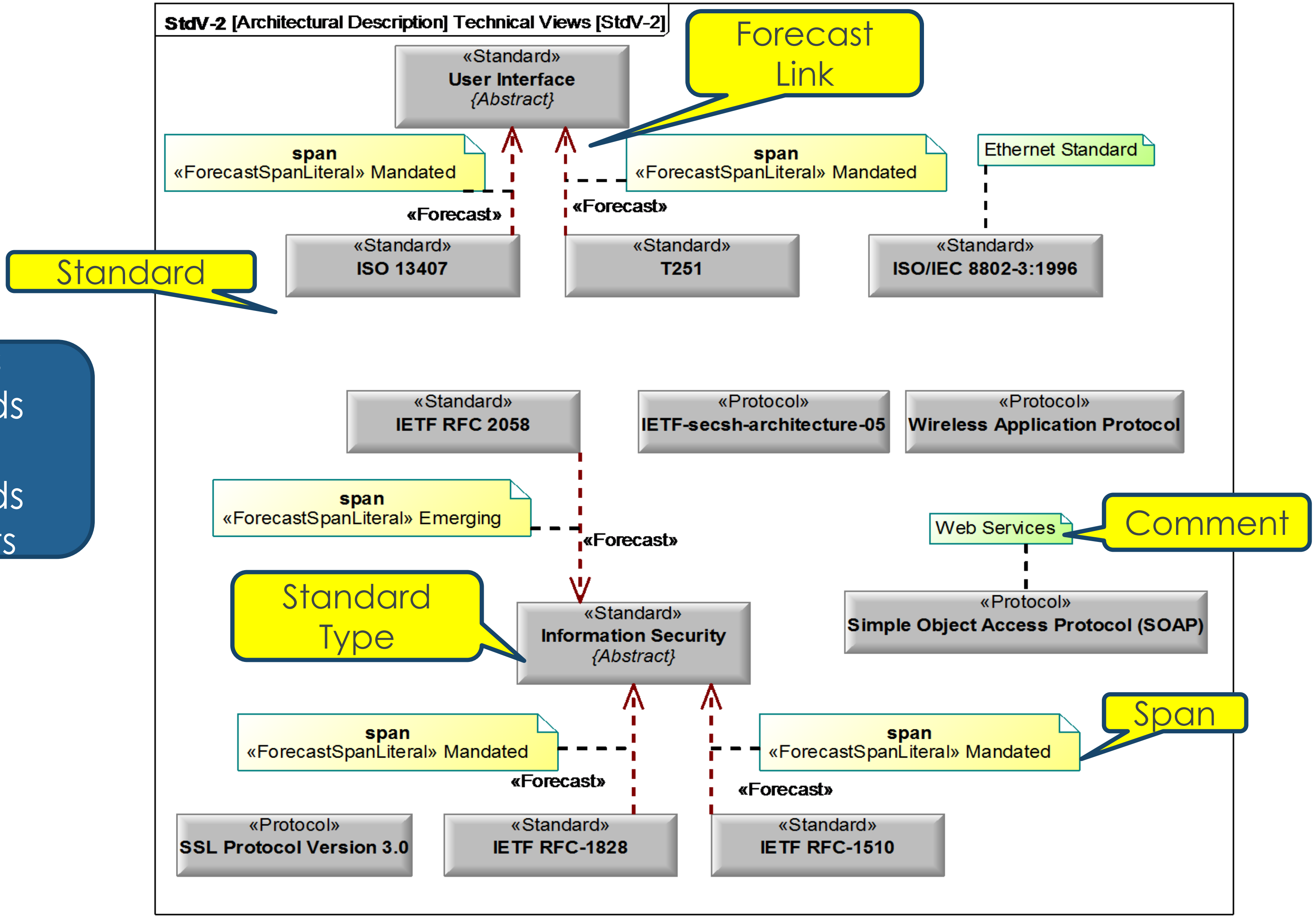


Systems can also be specified as services

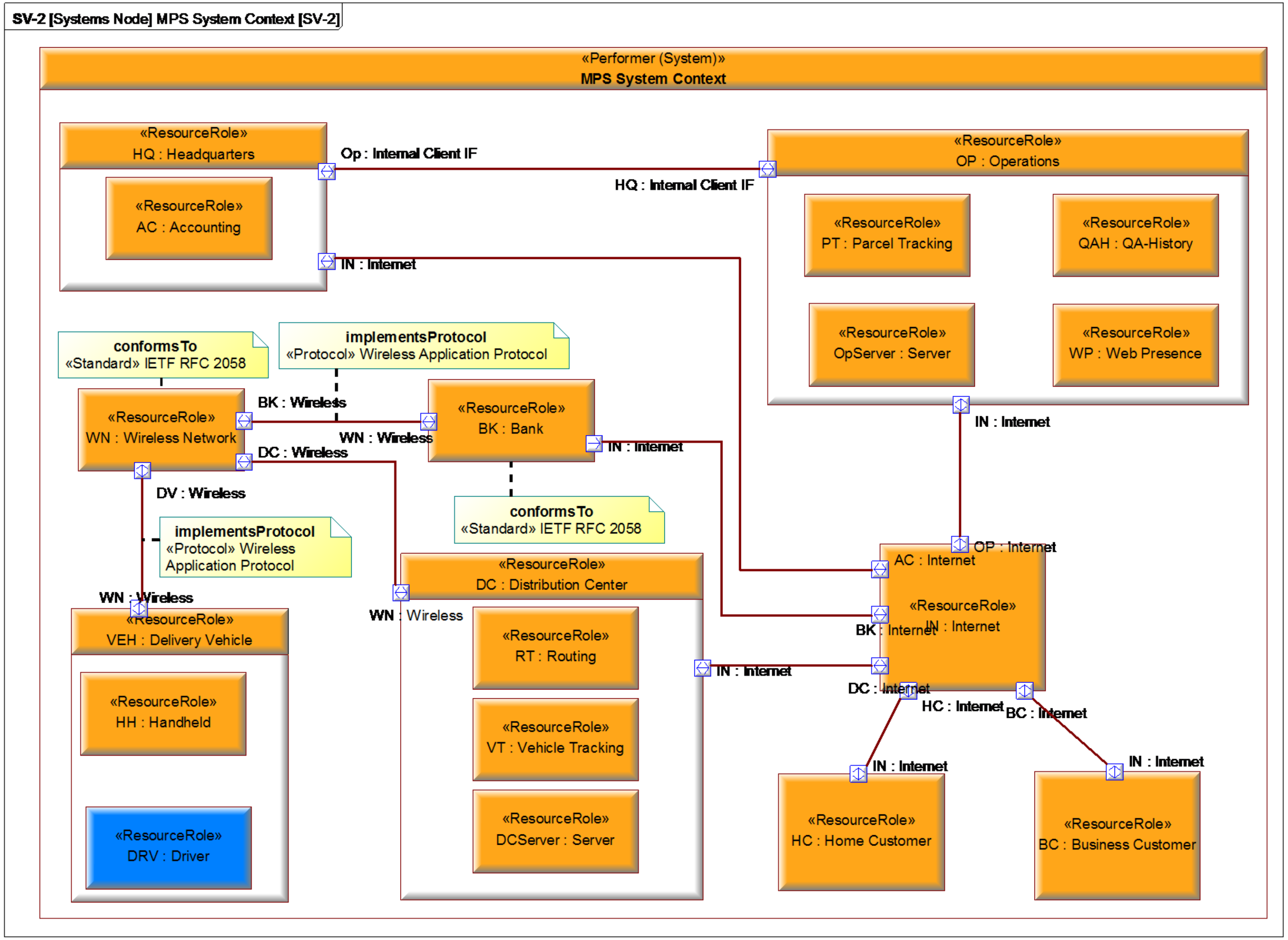
Defines system and human interface requirements and interactions

THE EVOLUTION OF STANDARDS OVER TIME

Defines standards and standards forecasts



SYSTEM INTERFACE SPECIFICATION



Defines how systems will interact to provide capabilities

STANDARDS COMPLIANCE MATRIX

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[Architectural Description] Technical Views [StdV-1 Matrix]

Standards

Standard

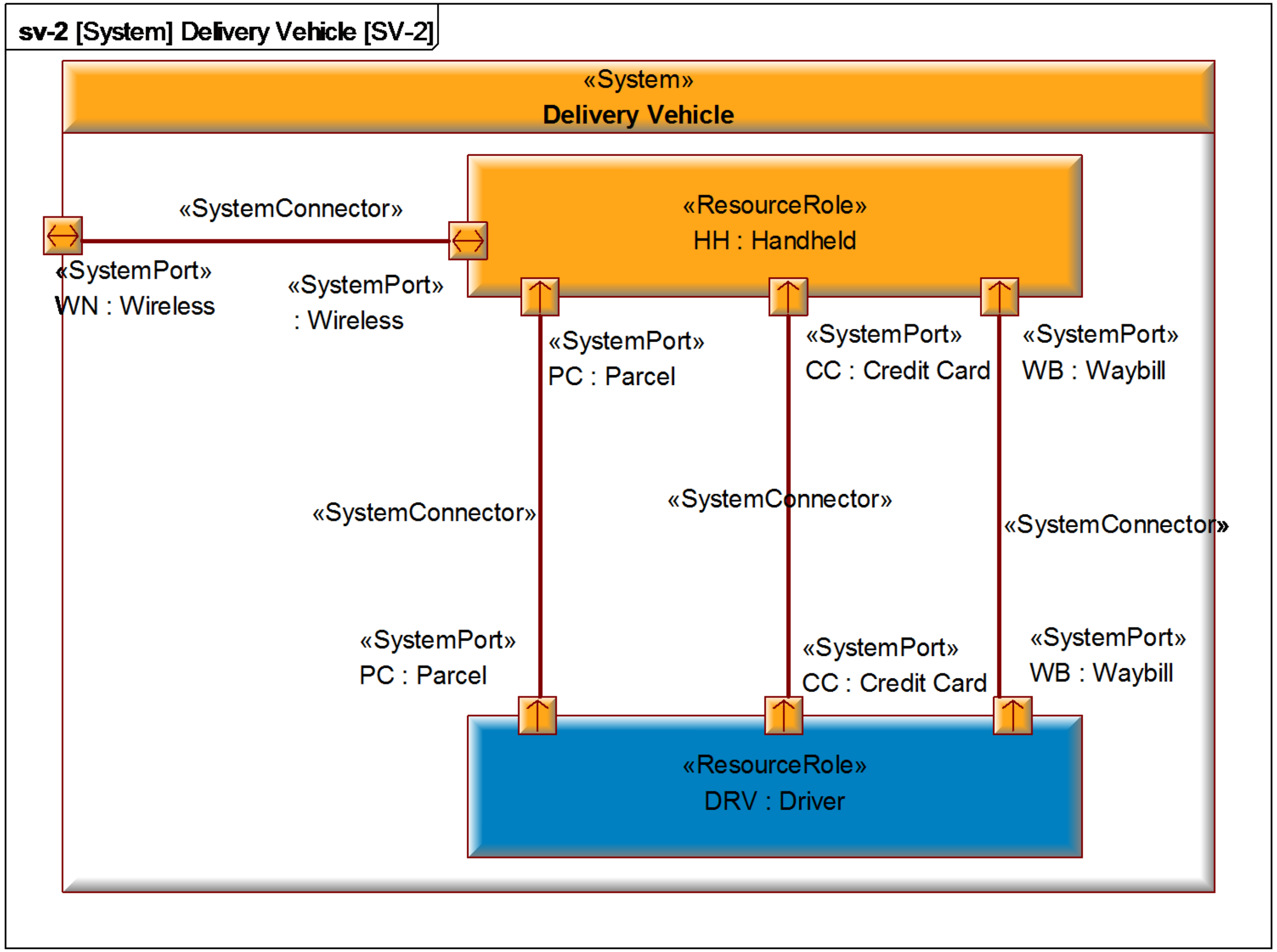
Model Elements

Conforming Elements	«Protocol» IETF-secsh-architecture-05	«Protocol» Simple Object Access Protocol (SOAP)	«Protocol» SSL Protocol Version 3.0	«Protocol» Wireless Application Protocol	«Standard» IETF RFC 2058	«Standard» IETF RFC-1510	«Standard» IETF RFC-1828	«Standard» Information Security	«Standard» ISO 13407	«Standard» ISO/IEC 8802-3:1996	«Standard» T251	«Standard» User Interface
«ResourceRole» BK					X							
«ResourceRole» HH					X							
«SystemInterface» HH - BK					X							
«Performer (System)» Wireless Network					X							
«ResourceRole» WN					X							
«ResourceRole» WP									X		X	

Generated automatically. Summarizes standards conformance

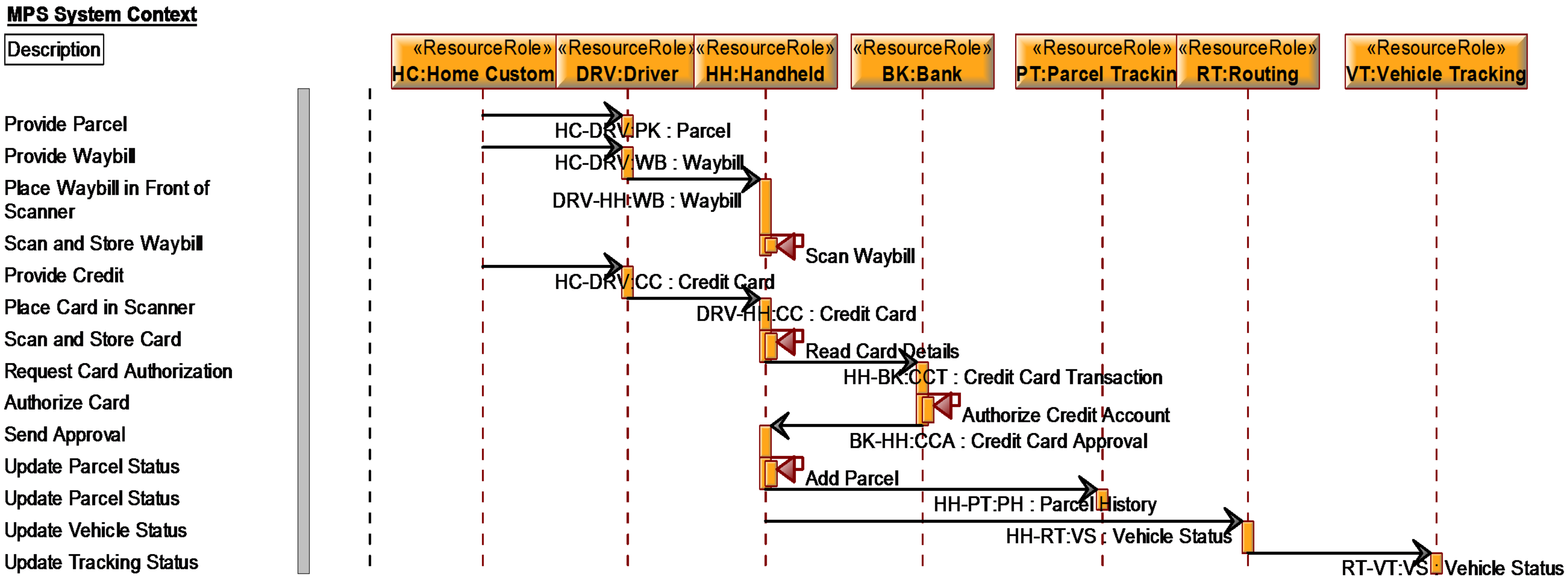
Conformance

DRIVER-HANDHELD MODULAR INTERFACES

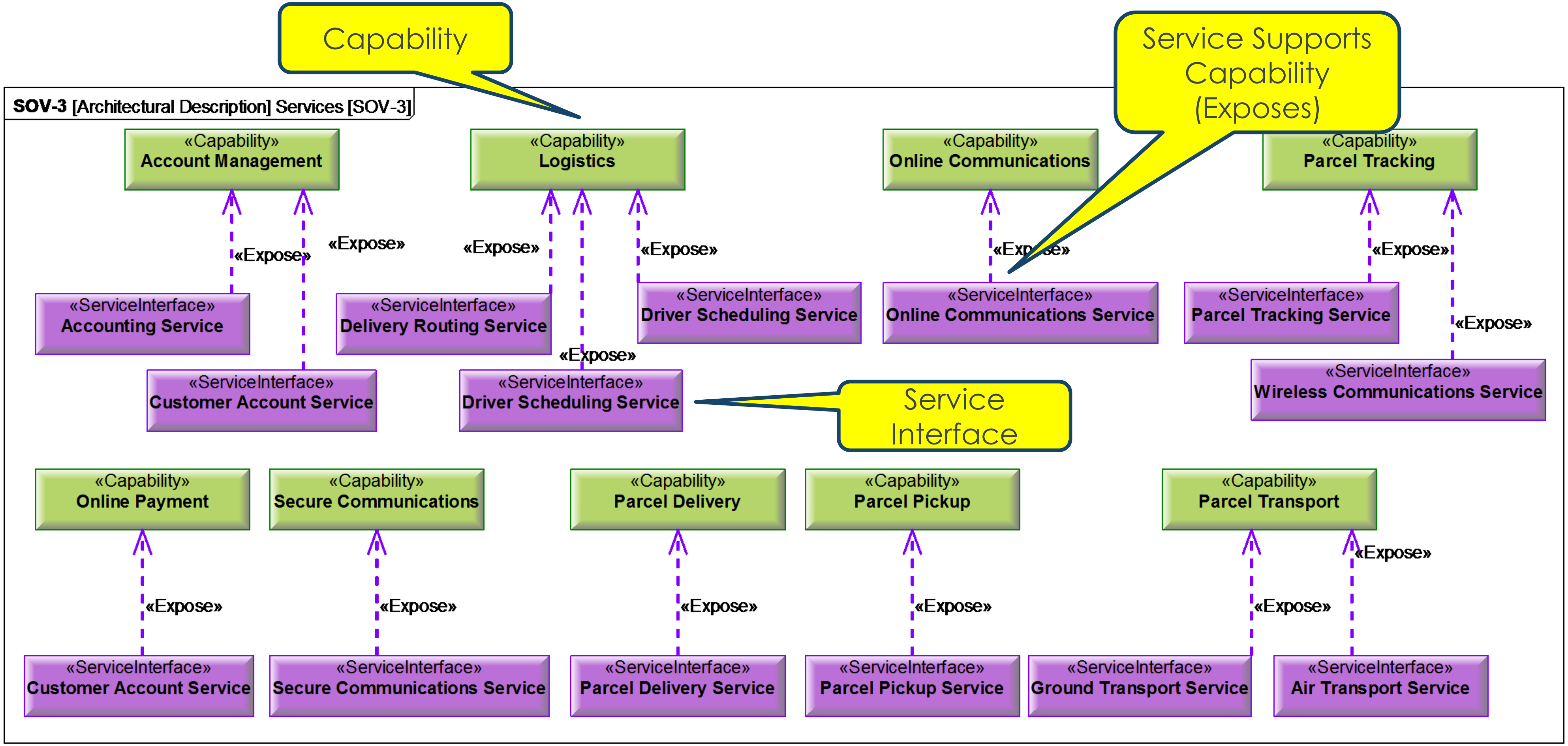


SYSTEM EVENT TRACE DESCRIPTION

- The order and timing of the interactions is just as critical as the interface definition itself: not just what happens, but when and why it happens.

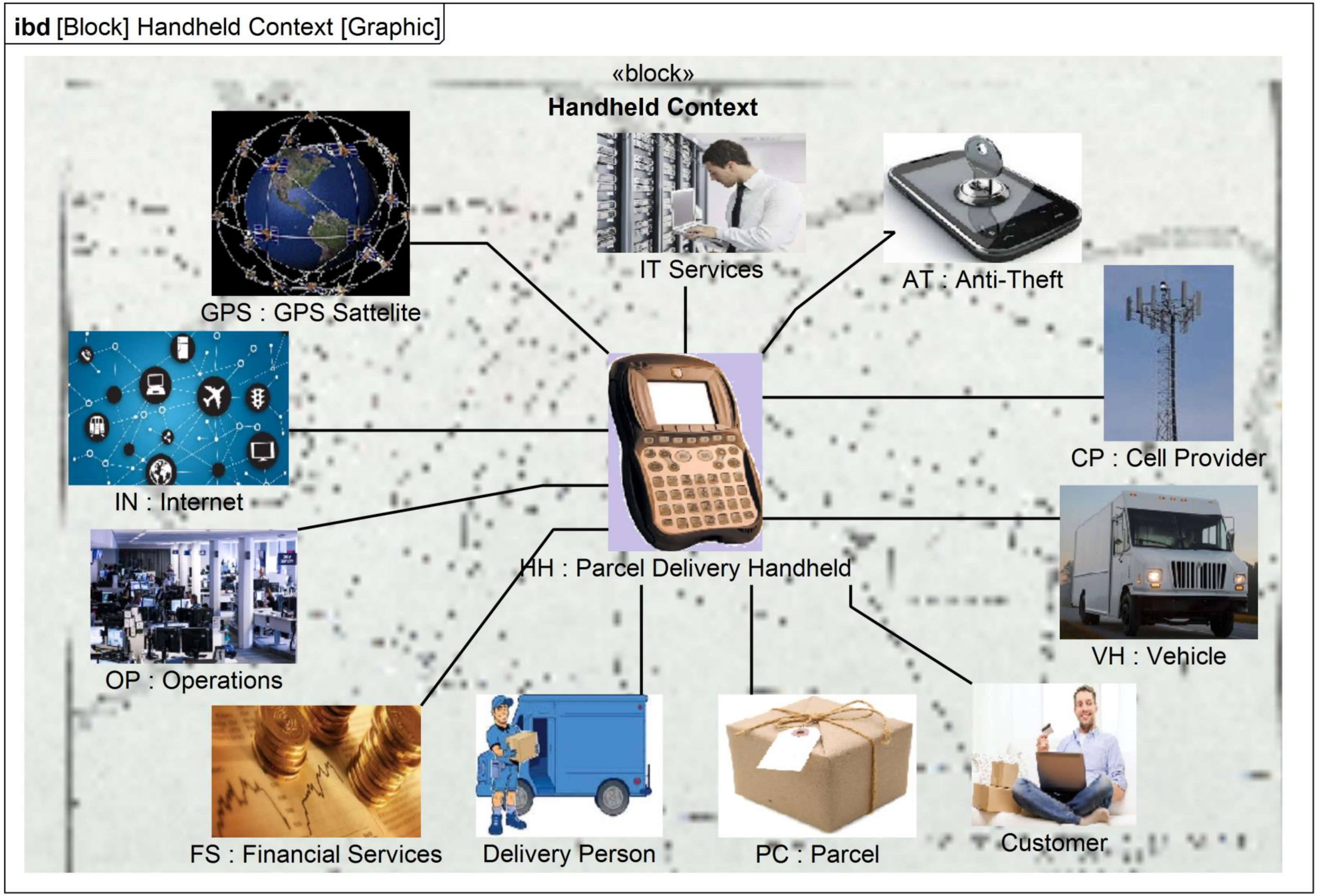


DERIVING SERVICES FROM CAPABILITIES

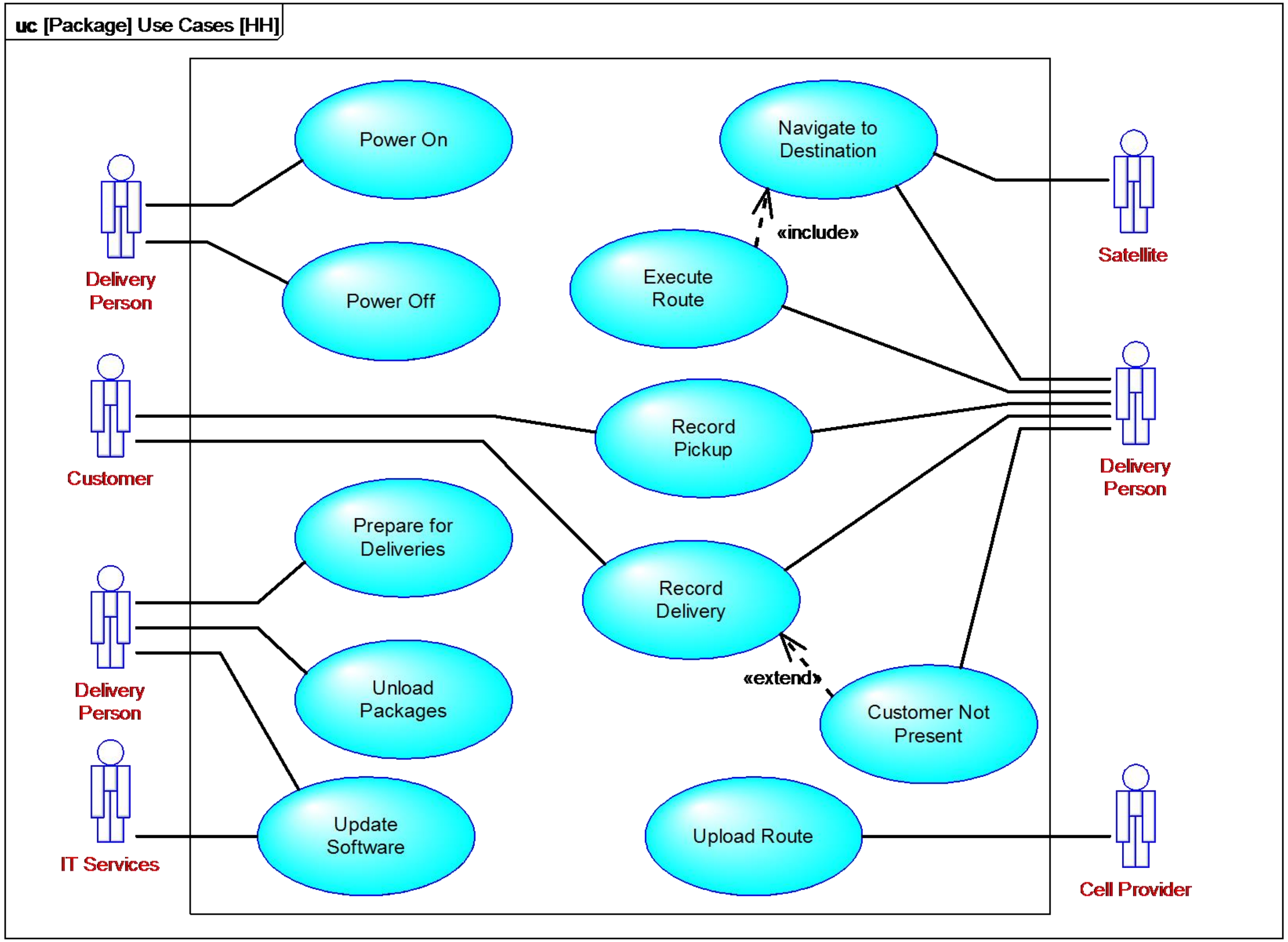


SYSTEMS INTERFACES

CONTEXT OF HANDHELD DEVICE



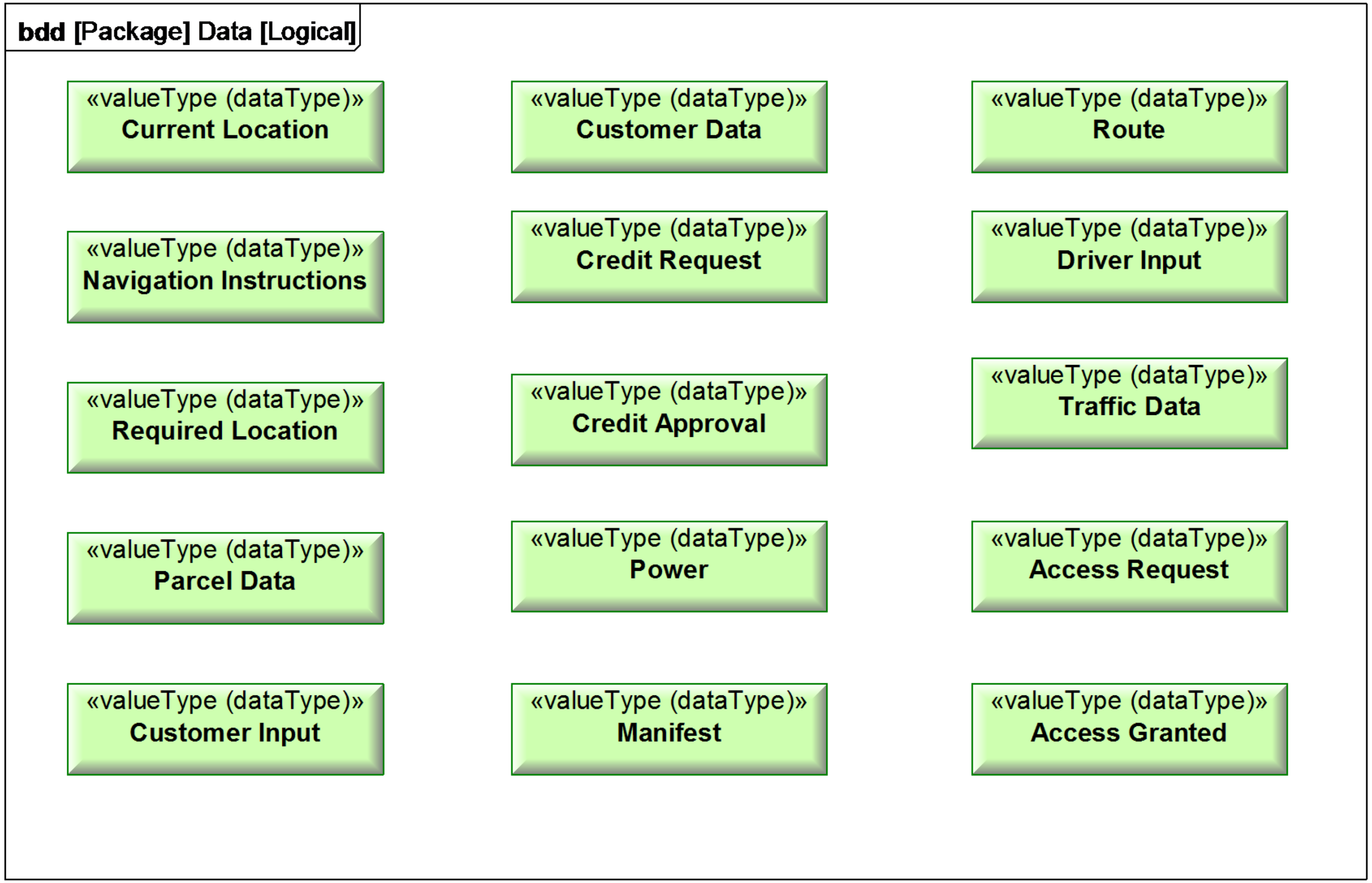
USE CASES DEFINE INTERACTIONS WITH ACTORS



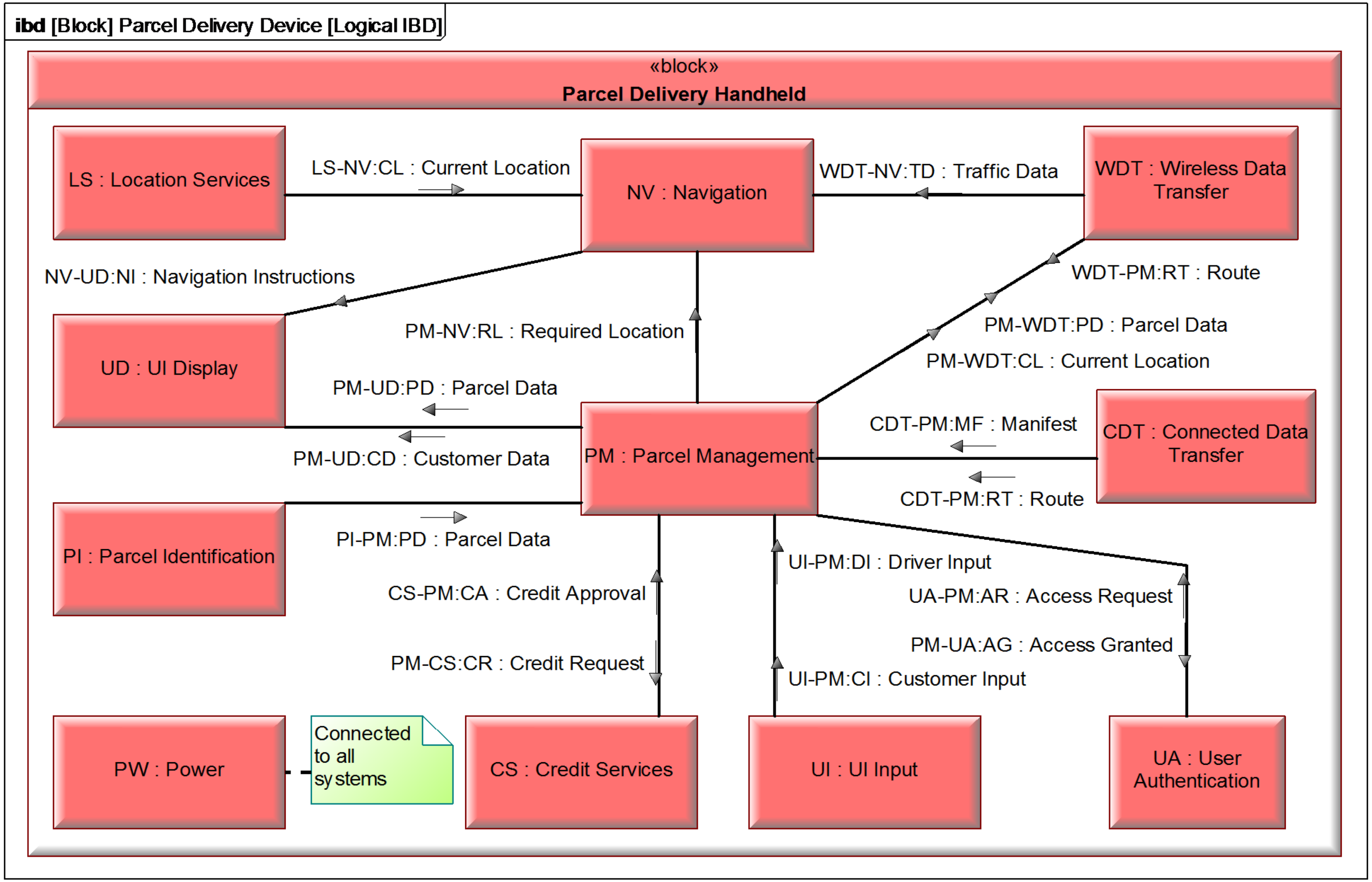
LOGICAL V. PHYSICAL MODELING WITH IBDS

- IBDs can be used to capture both a logical model of parts, connections and flows, and a physical model
- Logical model focuses on logical parts and flows and may not show ports or types (unless logical types defined)
  - Based on specification rather than implementation ('what' not 'how')
  - Abstract types (if any)
- Physical model focuses on physical parts and flows and normally shows ports and physical (implementation) types
  - Normally follows logical modeling
  - May be many physical models for one logical model
  - Real-world types
- May affect package structure
  - Logical package contains logical types
  - Physical package contains physical types
- Can link logical model items to physical model items via Allocation

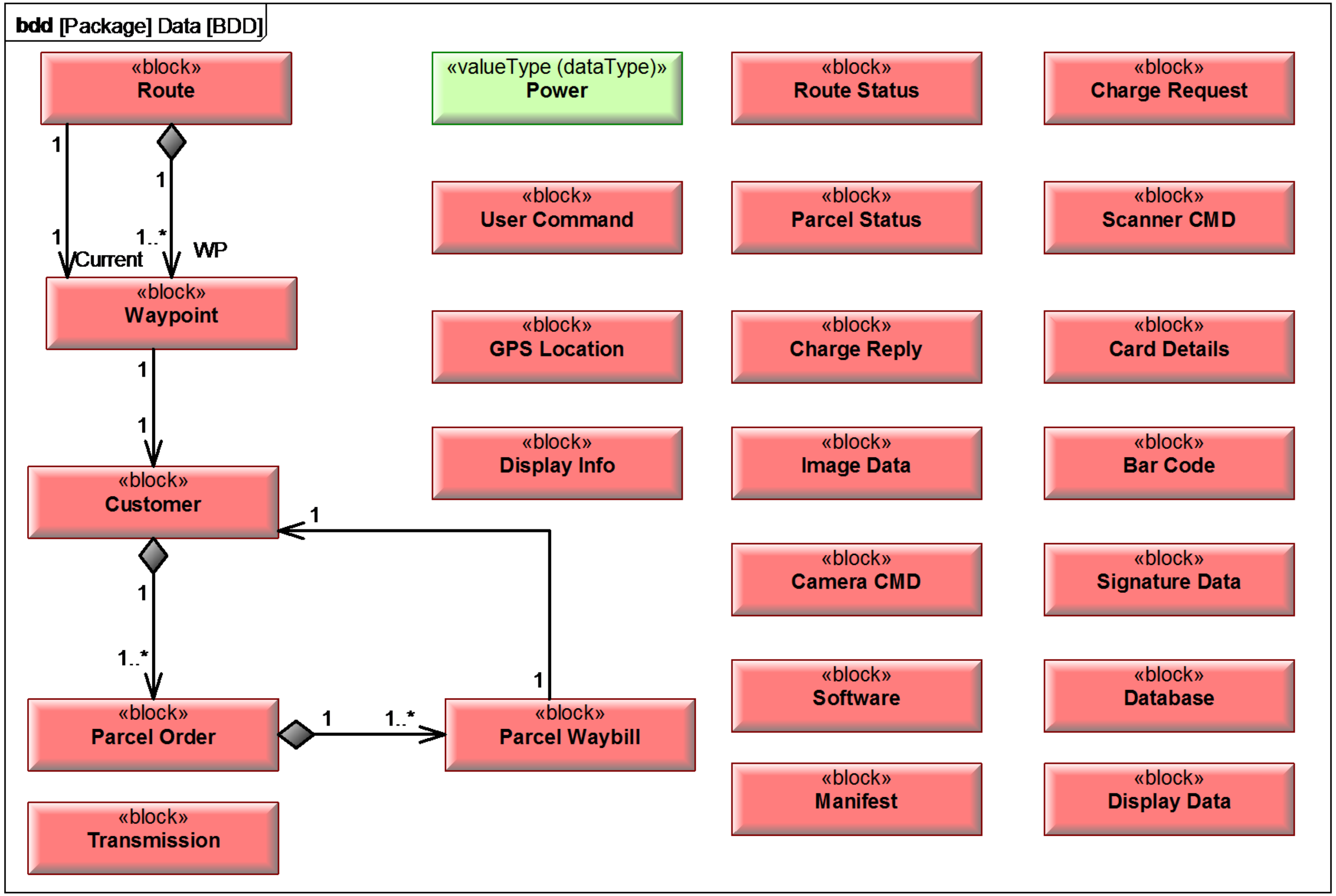
LOGICAL DATA



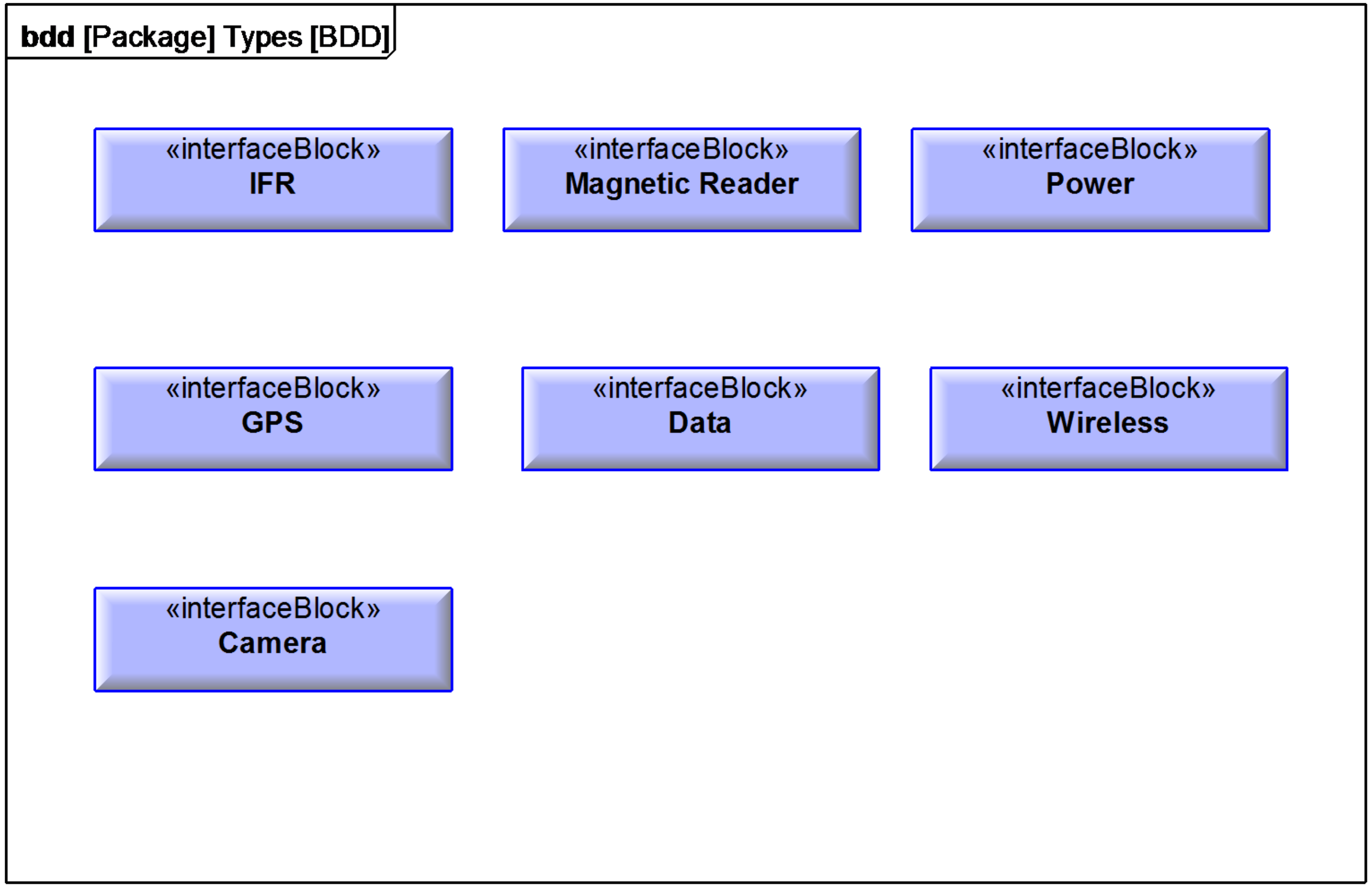
EXAMPLE IBD - LOGICAL MODEL



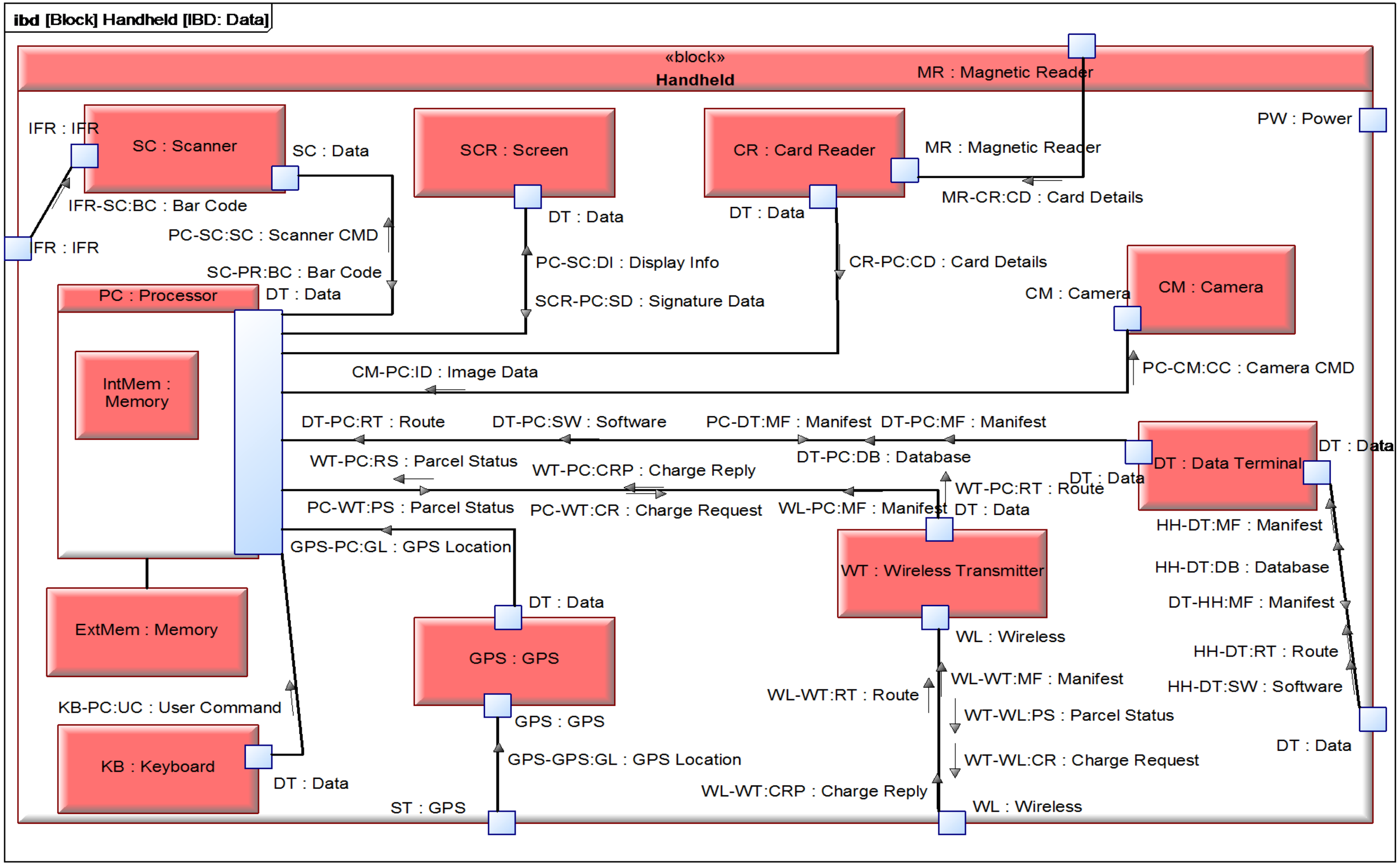
PHYSICAL DATA



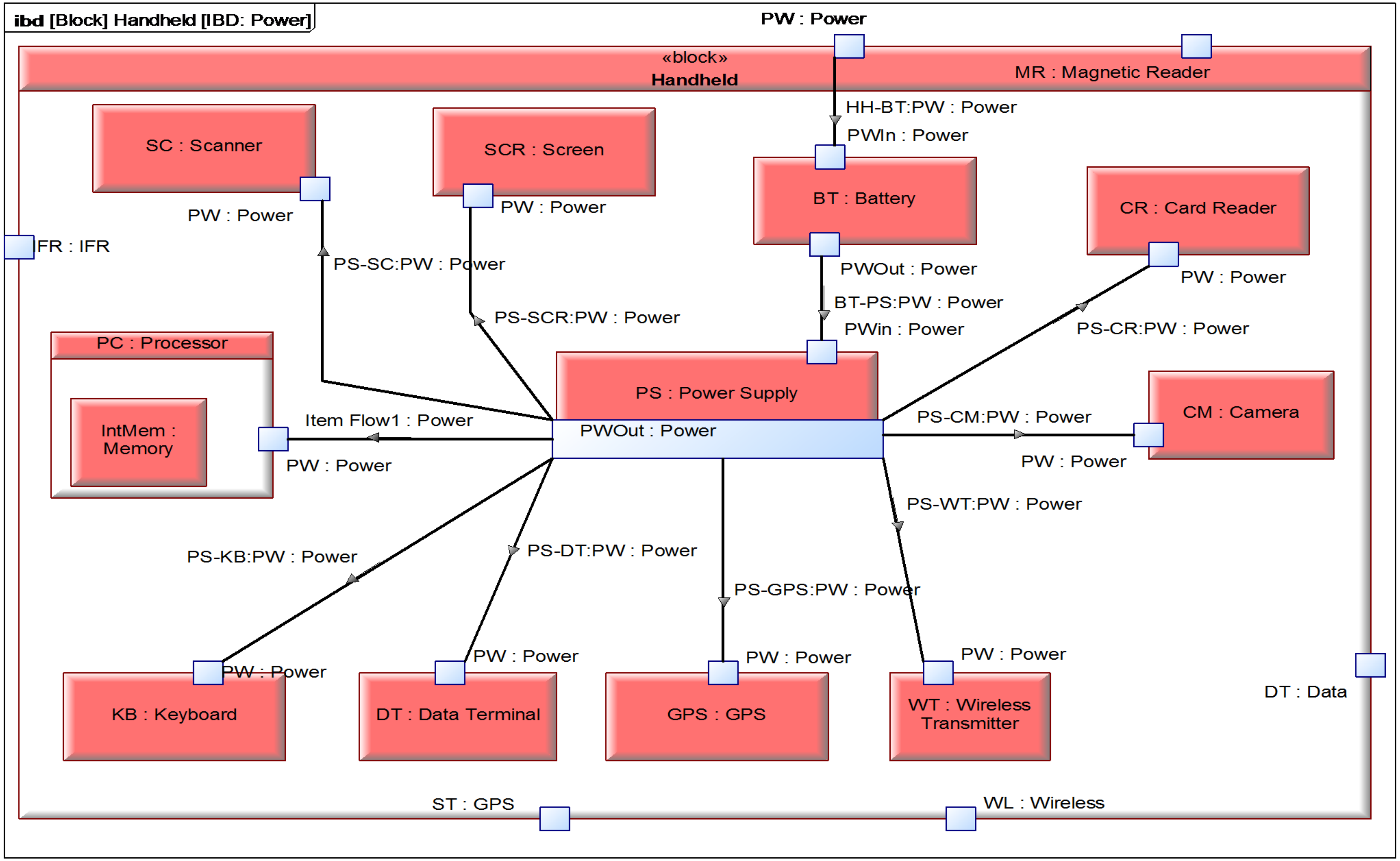
INTERFACES


bdd [Package] Types [BDD]
«interfaceBlock»
IFR
«interfaceBlock»
Magnetic Reader
«interfaceBlock»
Power
«interfaceBlock»
GPS
«interfaceBlock»
Data
«interfaceBlock»
Wireless
«interfaceBlock»
Camera

EXAMPLE IBD – PHYSICAL MODEL

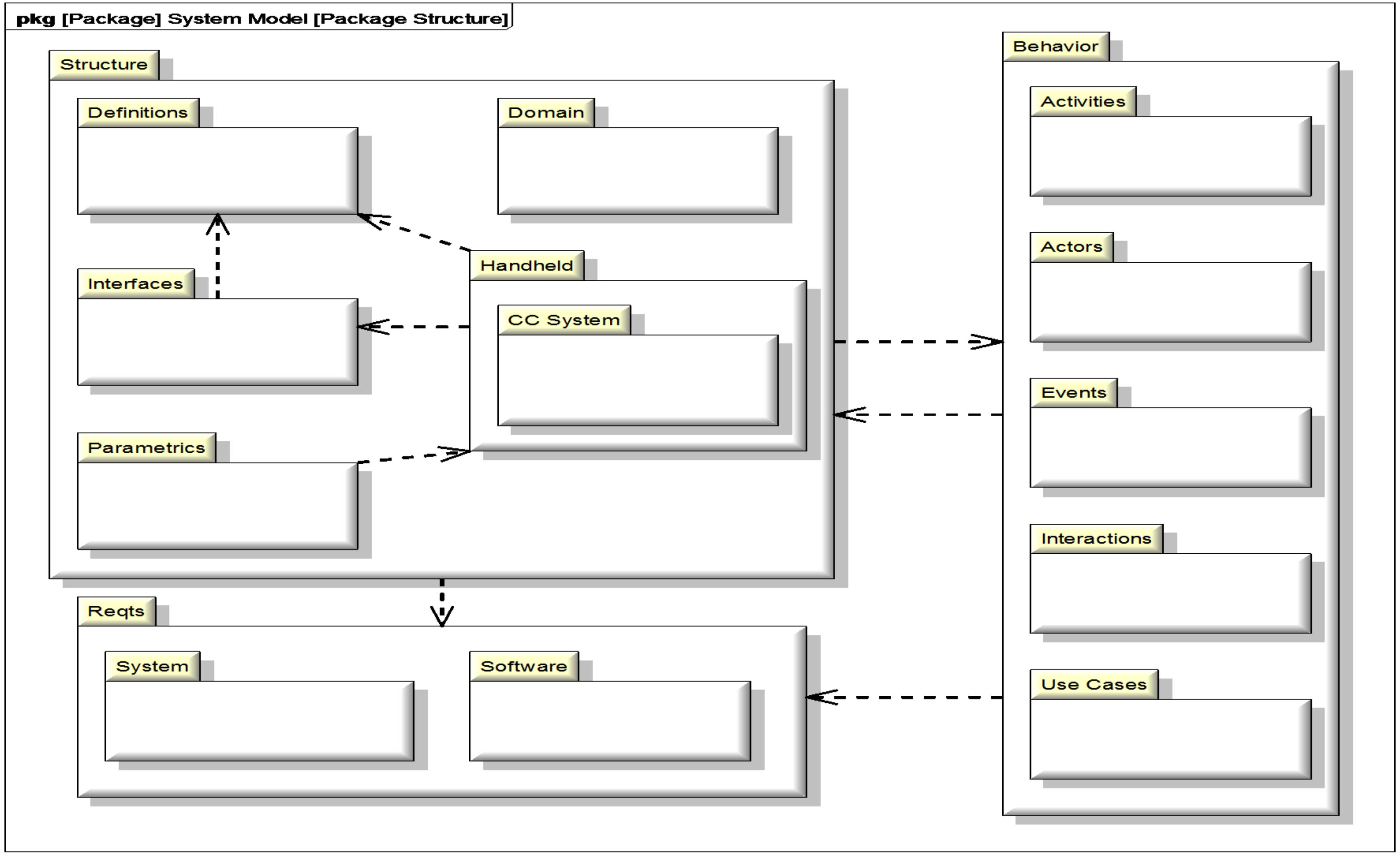


EXAMPLE IBD – PHYSICAL MODEL

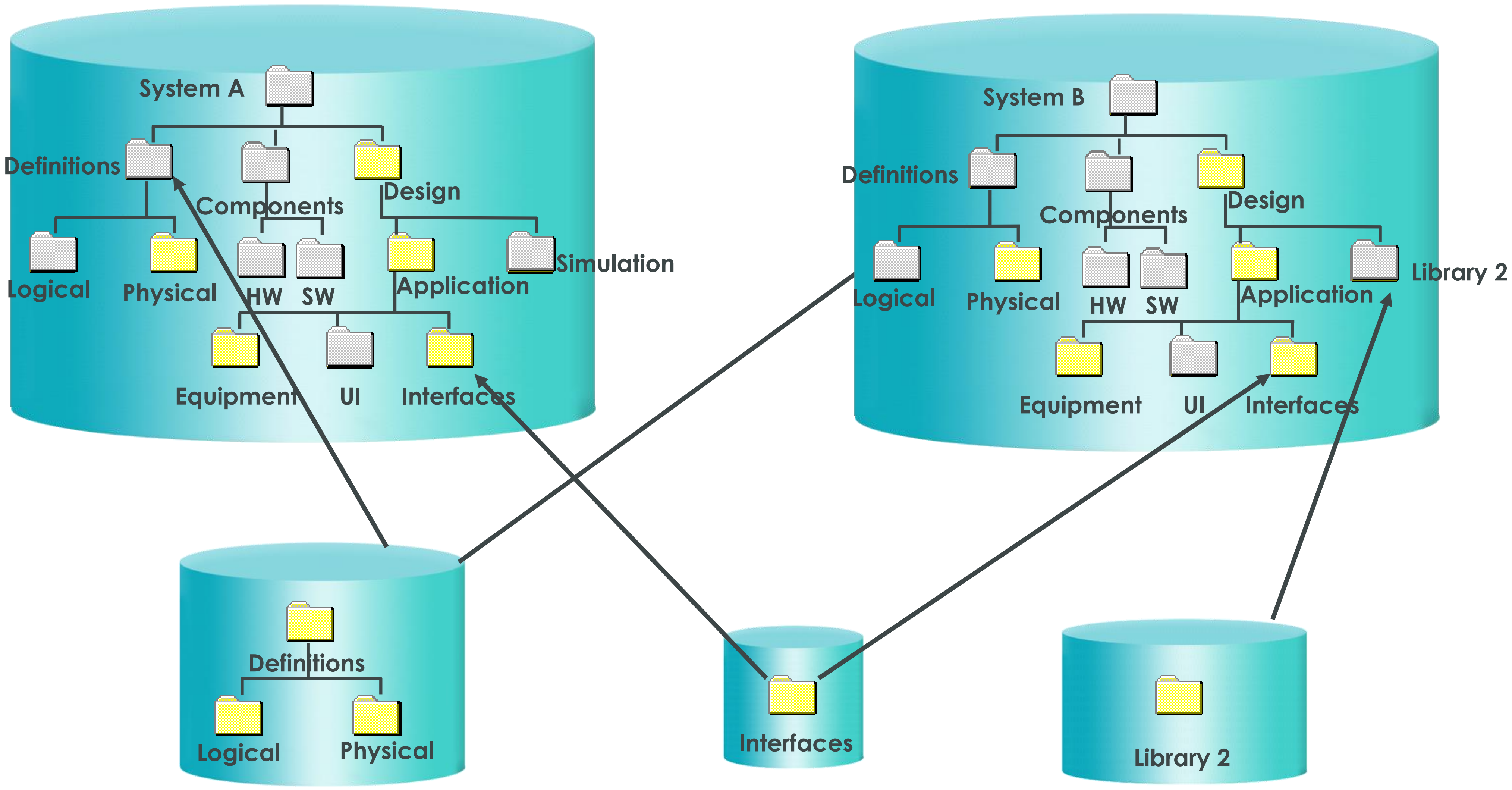


MODEL PACKAGE STRUCTURE

- Shows Dependencies within model to interfaces



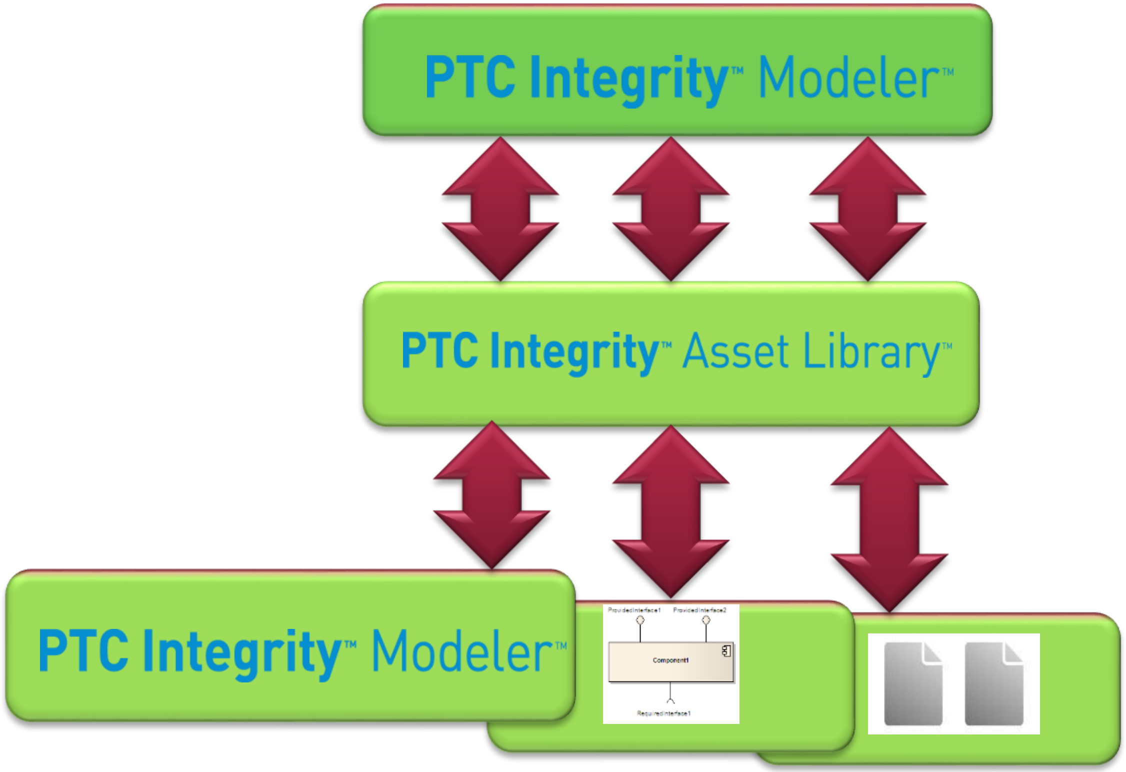
REUSING AND SHARING MODEL LIBRARIES



ASSET-BASED DESIGN ENABLES COLLABORATION AND VIRTUAL TEAMS

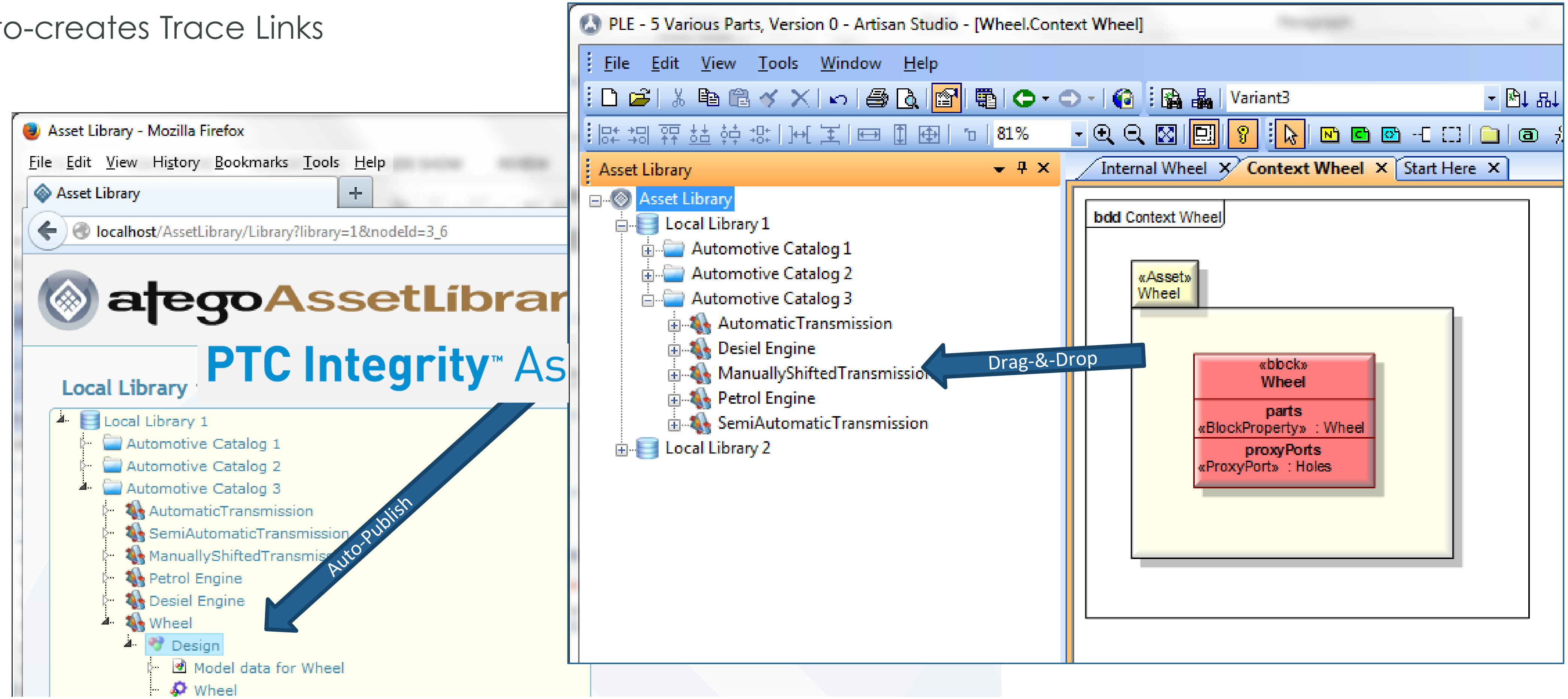
ASSET-BASED MODULAR DESIGN

- Design the same way you Build
  - Construct Systems of Sub-Systems (SoS)
  - Use Services to build your Application (SOA)
  - Plug Components together (CBD)
- Modular Design
  - Top-Down, Architected
    - Specification (& Requirements) Driven
    - Parallel Working
    - Separation of Concerns
  - Bottom-Up, Asset Mining
    - Un-modeled Assets
    - Other Modeling Tools
    - Legacy Integration
    - Published Interfaces (e.g. IDL, SysML)
  - Uses the Reusable Asset Specification (RAS) and OSLC



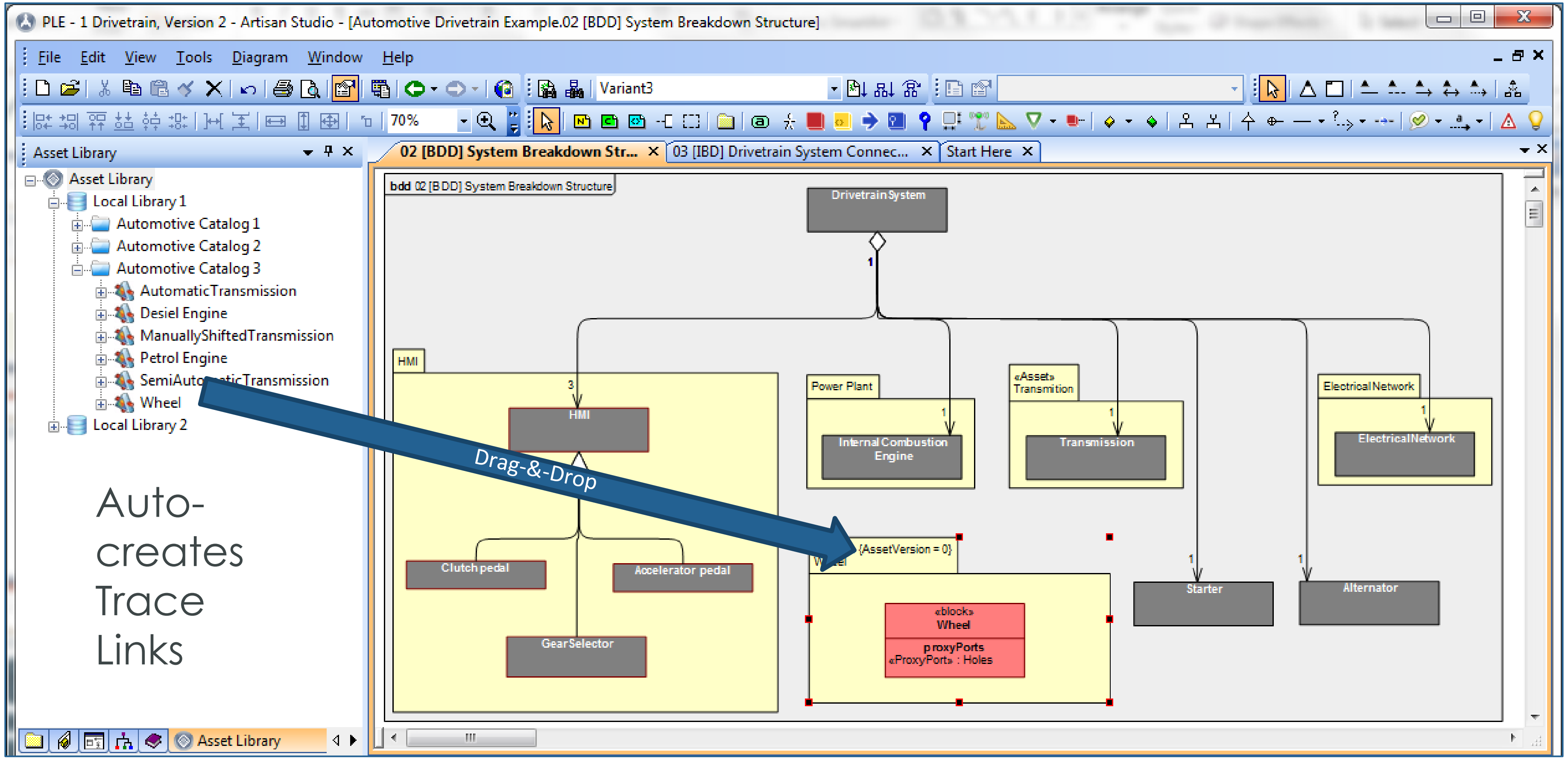
ASSET-BASED MODULAR DESIGN

- Publish from Sub-system model into PTC Integrity Asset Library
  - Publishes the asset as a black box
  - Enables reuse as opposed to clone and own
  - Auto-creates Trace Links



ASSET-BASED MODULAR DESIGN

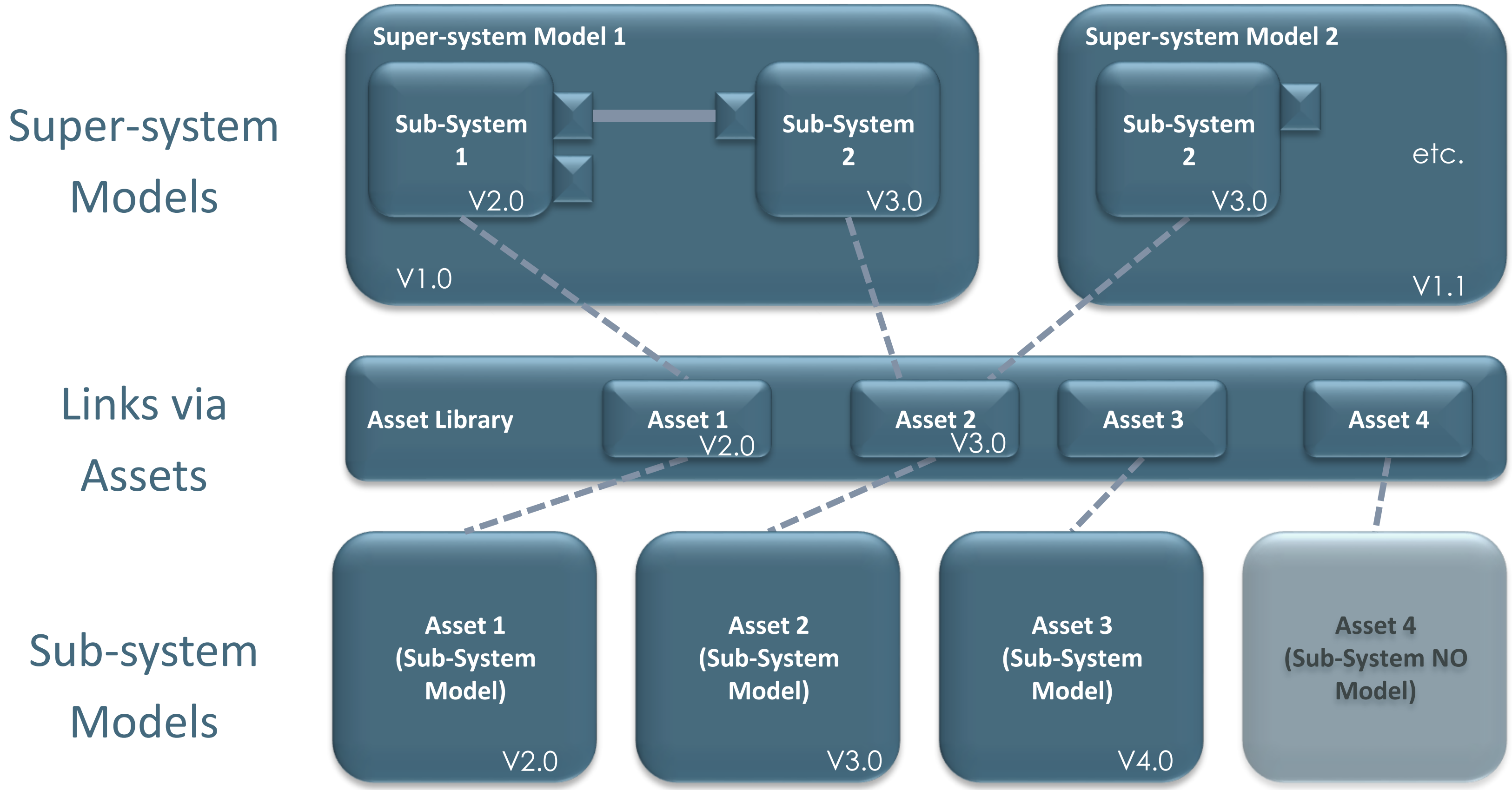
- Use Sub-system from PTC Integrity Asset Library in Super-system Model
  - Reuse interfaces, requirements, operations, parameters, constraints, etc.



Auto-creates Trace Links

ASSET-BASED MODULAR DESIGN

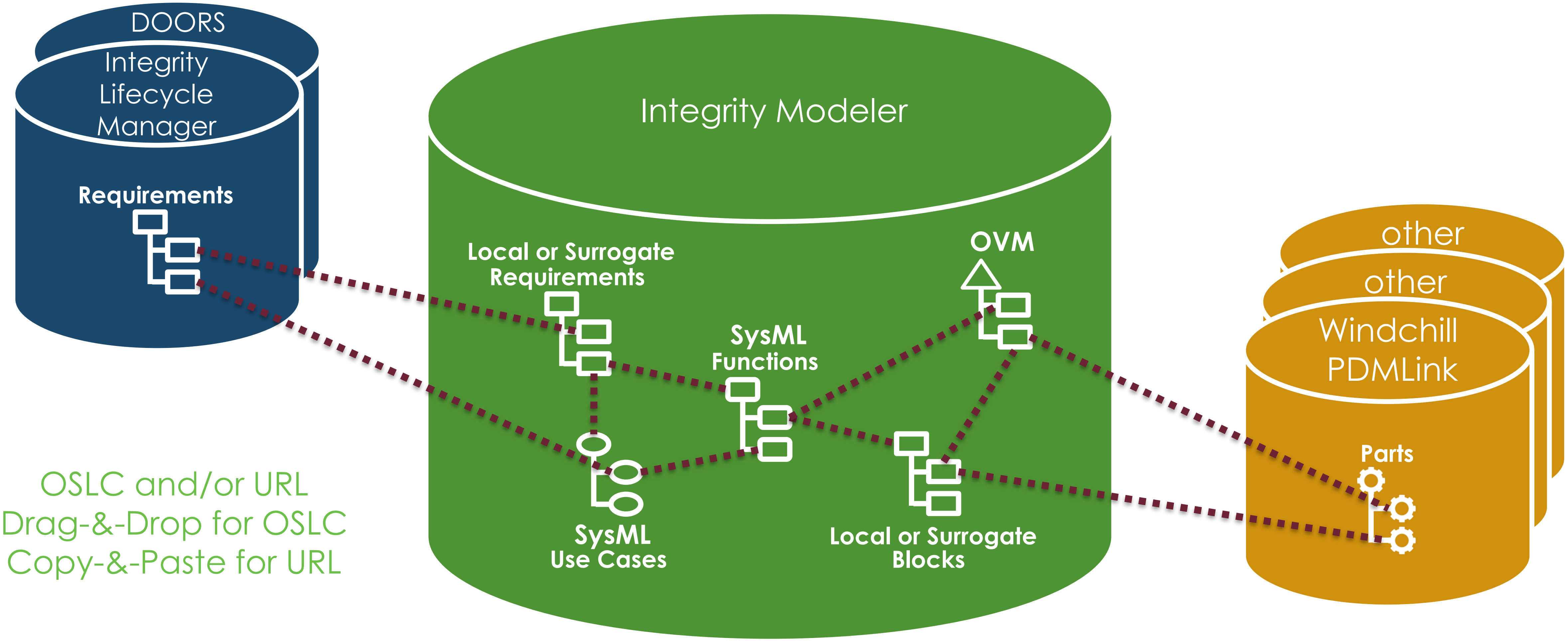
- Super-system Model = Configuration of Versioned Sub-systems



THROUGH THE DEVELOPMENT LIFECYCLE

LINKING FROM REQUIREMENTS TO MODELS TO PLM

External Traces & Model Surrogates with Visual Model Trace Links



OSLC and/or URL
Drag-&-Drop for OSLC
Copy-&-Paste for URL

TRACING FROM REQUIREMENTS TO SYSML TO CAD

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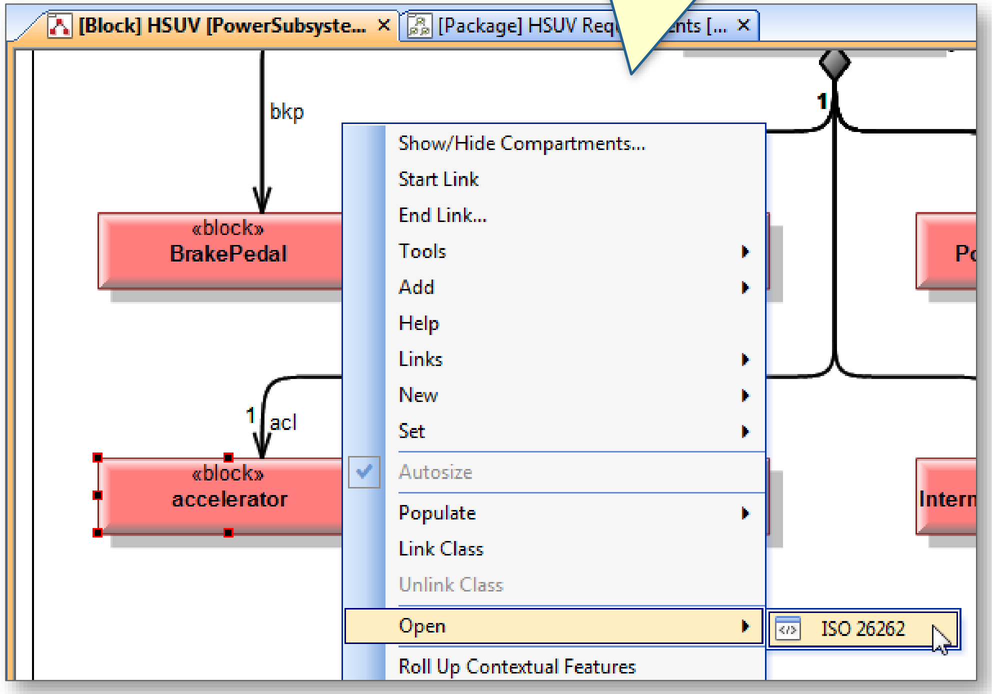
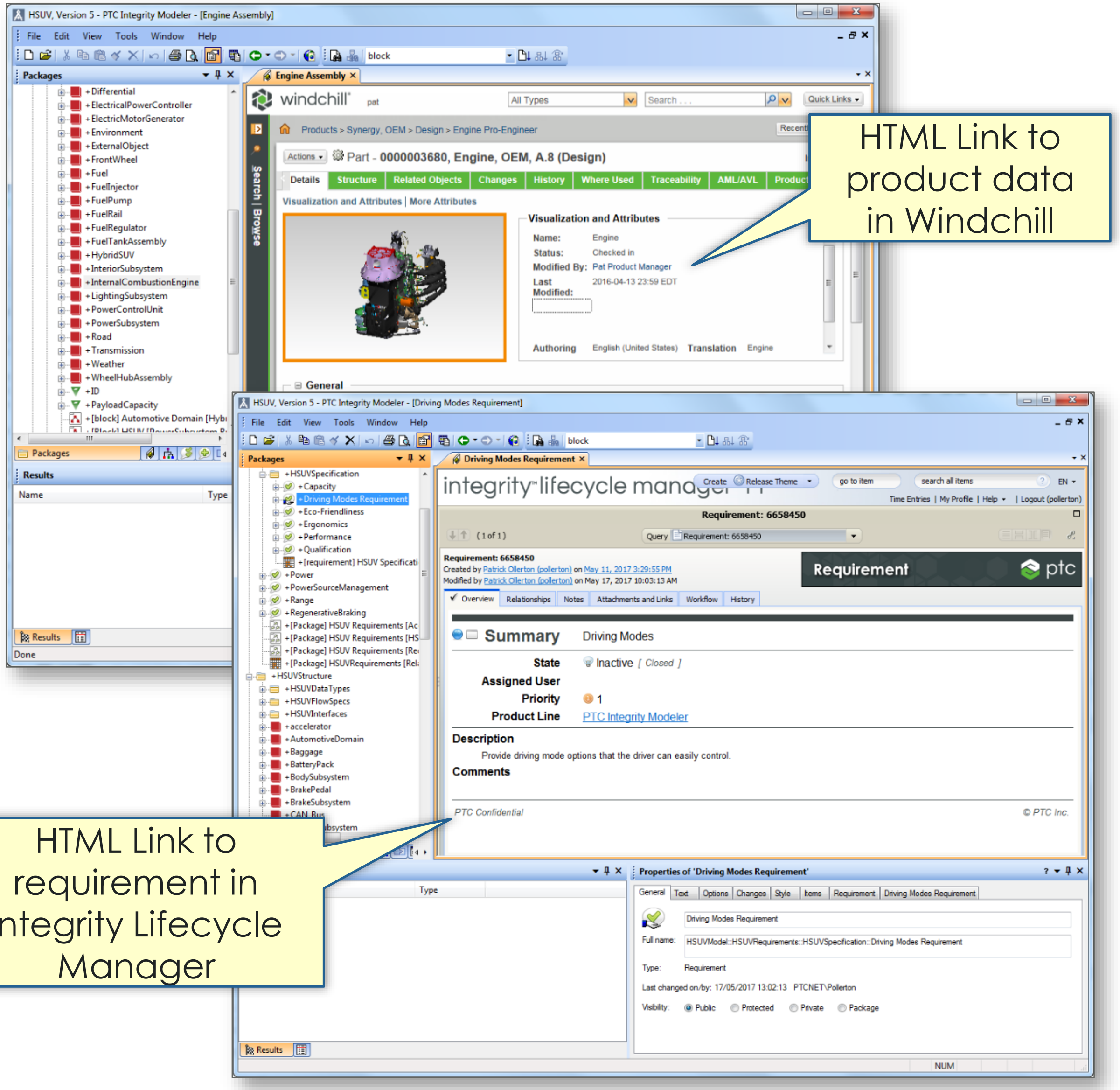
Right-click on items in browsers or on diagrams to open HTML Links and Surrogates

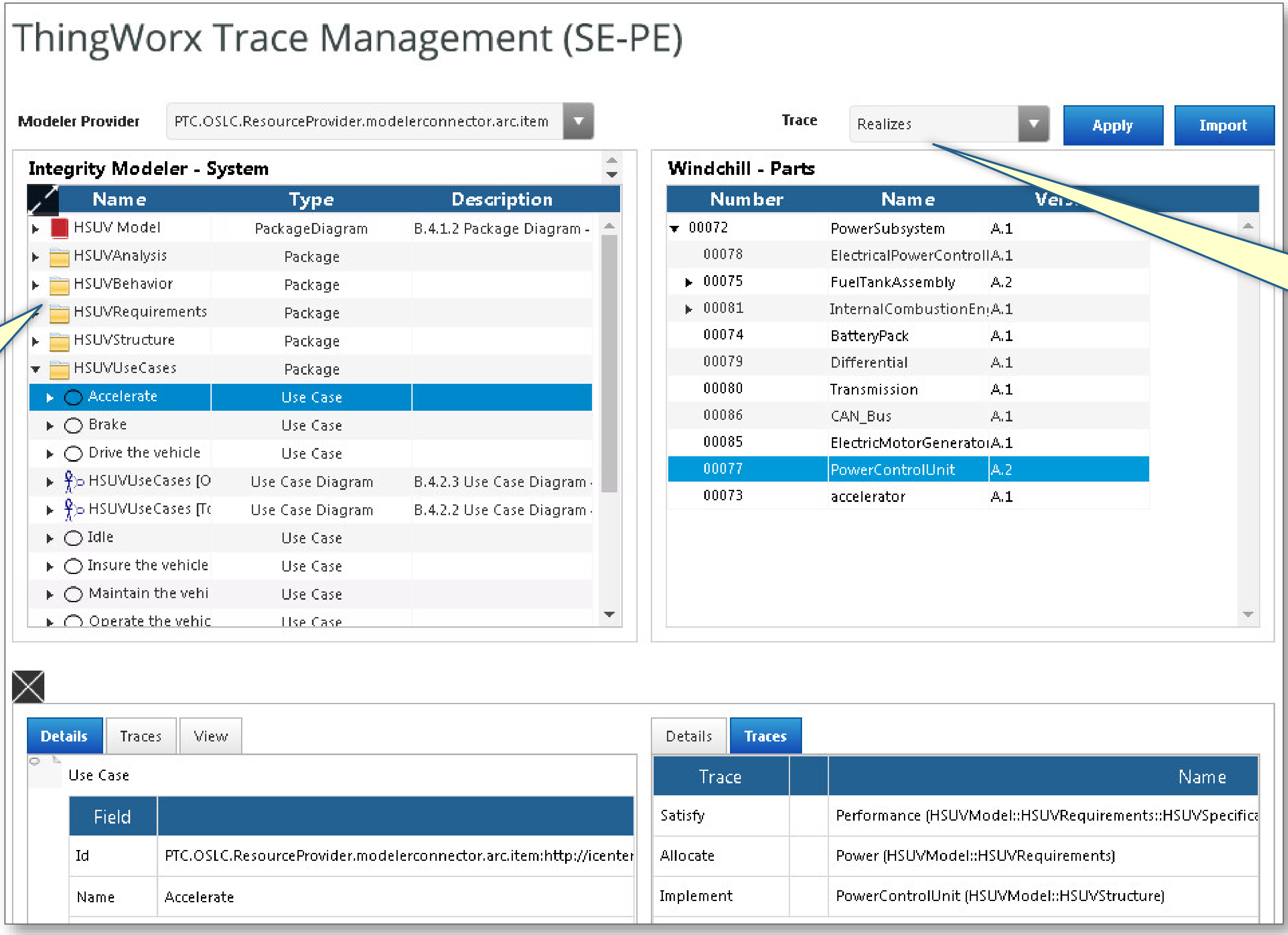




HTML Link to product data in Windchill

HTML Link to requirement in Integrity Lifecycle Manager

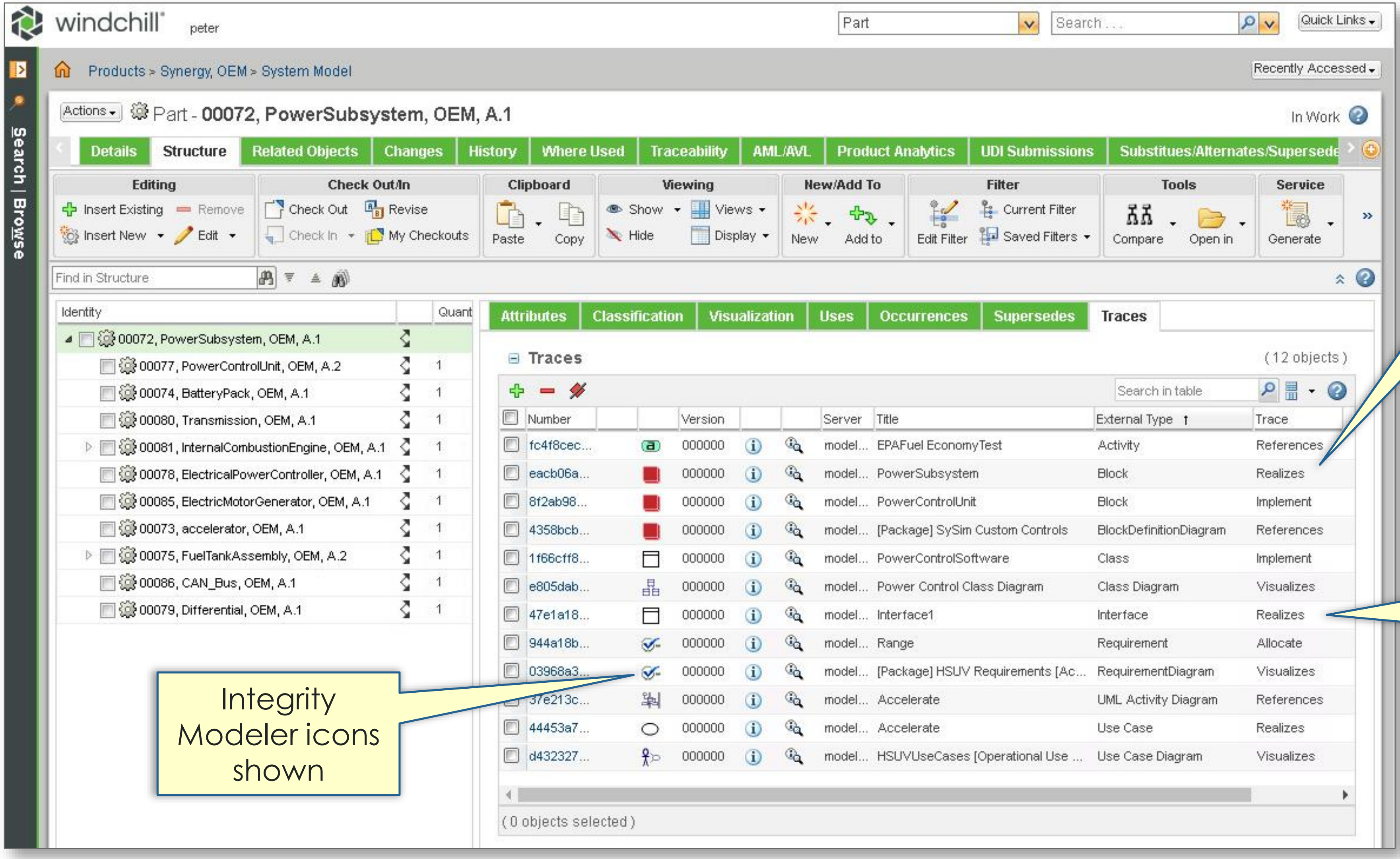
THINGWORX TRACE MANAGEMENT (SE-PE) DISPLAY



You define the Integrity Modeler types that are available in the ThingWorx Trace Management app

You define the valid link types for your organization

WINDCHILL LINKS TO INTEGRITY MODELER



Integrity Modeler icons shown

Trace links to all Integrity Modeler items are displayed in Windchill

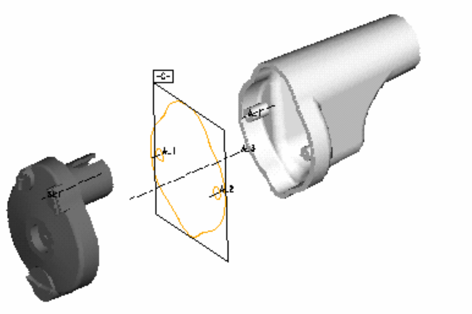
Integrity Modeler type and trace link type displayed

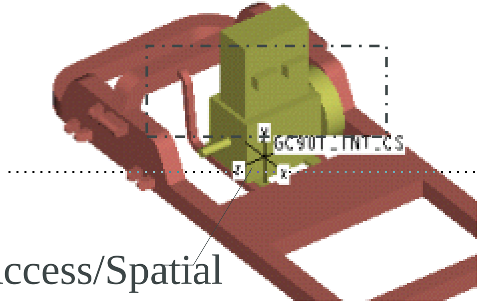
PHYSICAL INTERFACES

Interfaces are controlled boundaries between modules, components or parts

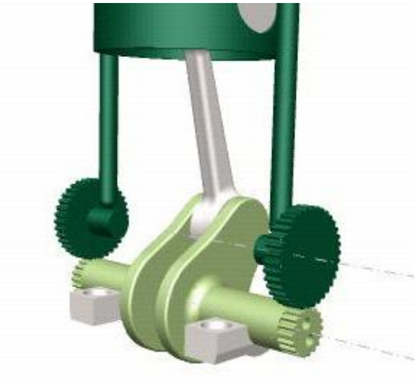
Types include:
- Attachment, Spatial (envelope)
- Transfer (e.g. power)
- Communication
- User Interface

Direct/Attachment





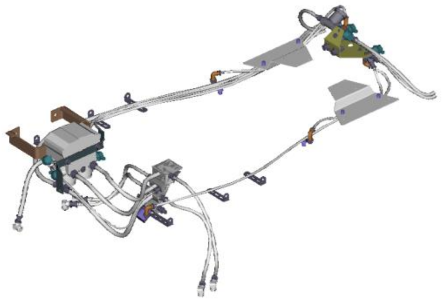
Access/Spatial



Transfer of Power

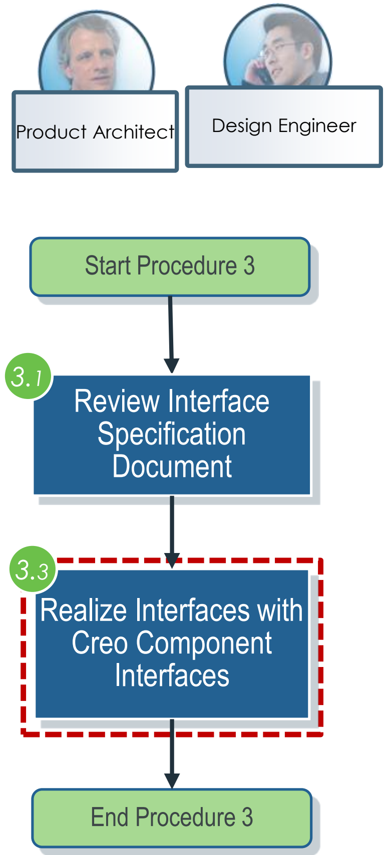
User Interface

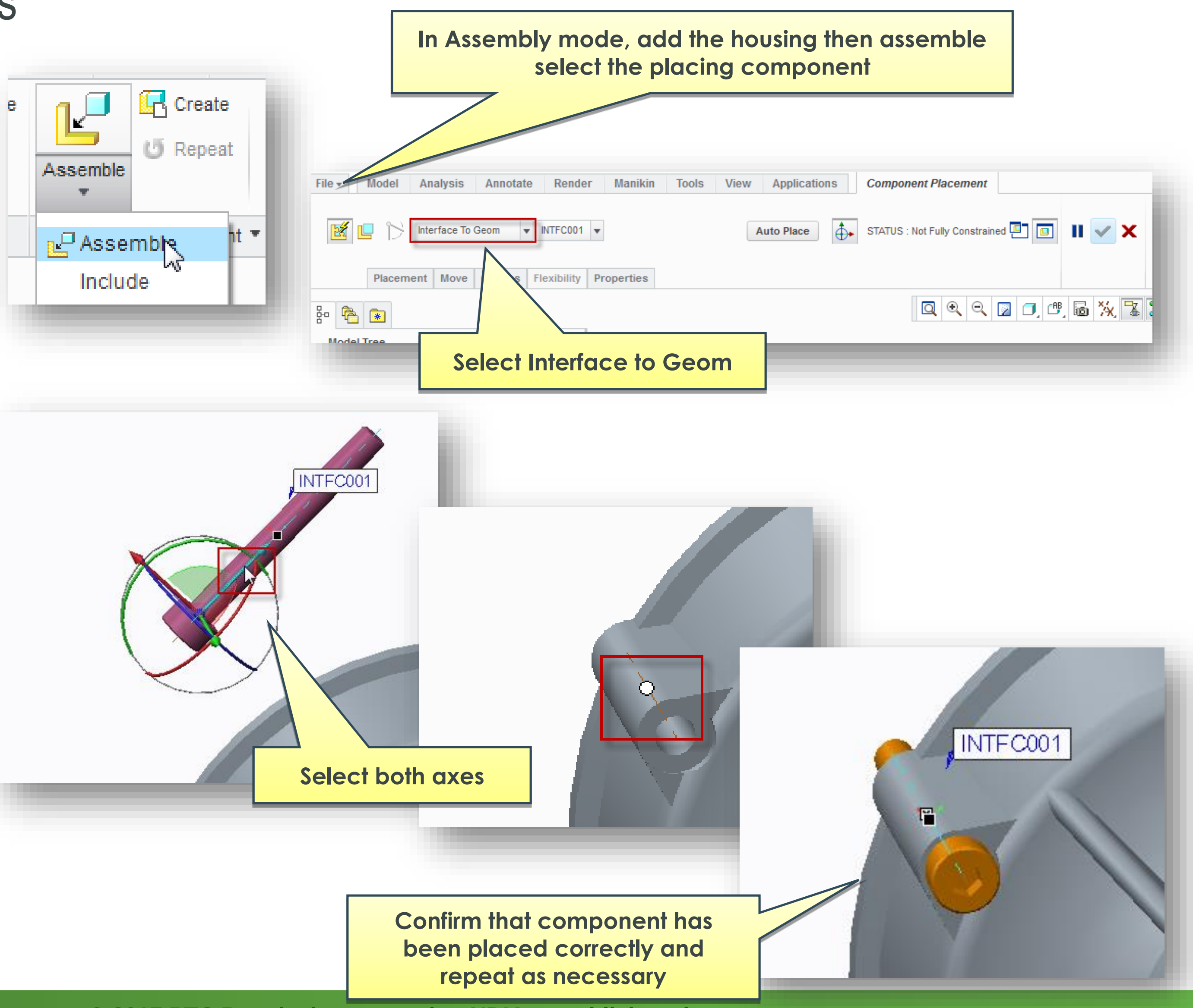
Communication



REALIZING INTERFACES

► Develop and Propagate Interfaces

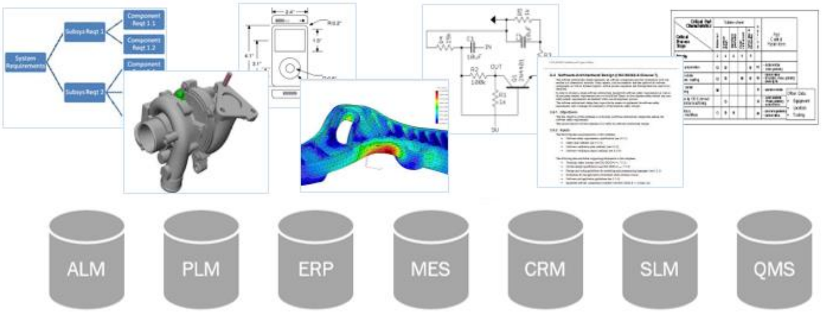




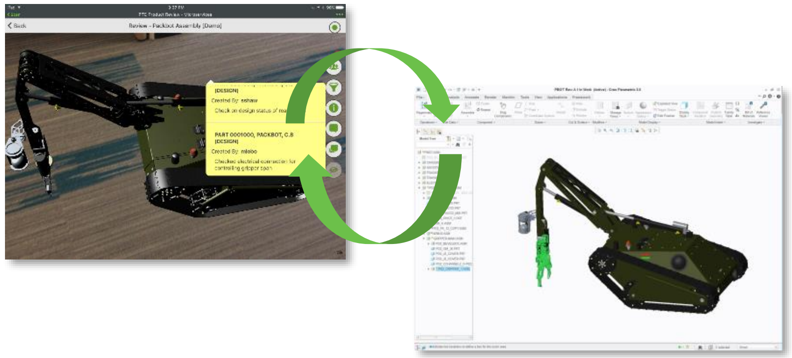
COLLABORATIVE AR/VR DESIGN

A Few Simple Steps from CAD to AR/VR

Collaborate Globally



Effortlessly Collect all Relevant Information



Closed-Loop Change Management

DIGITAL TWIN

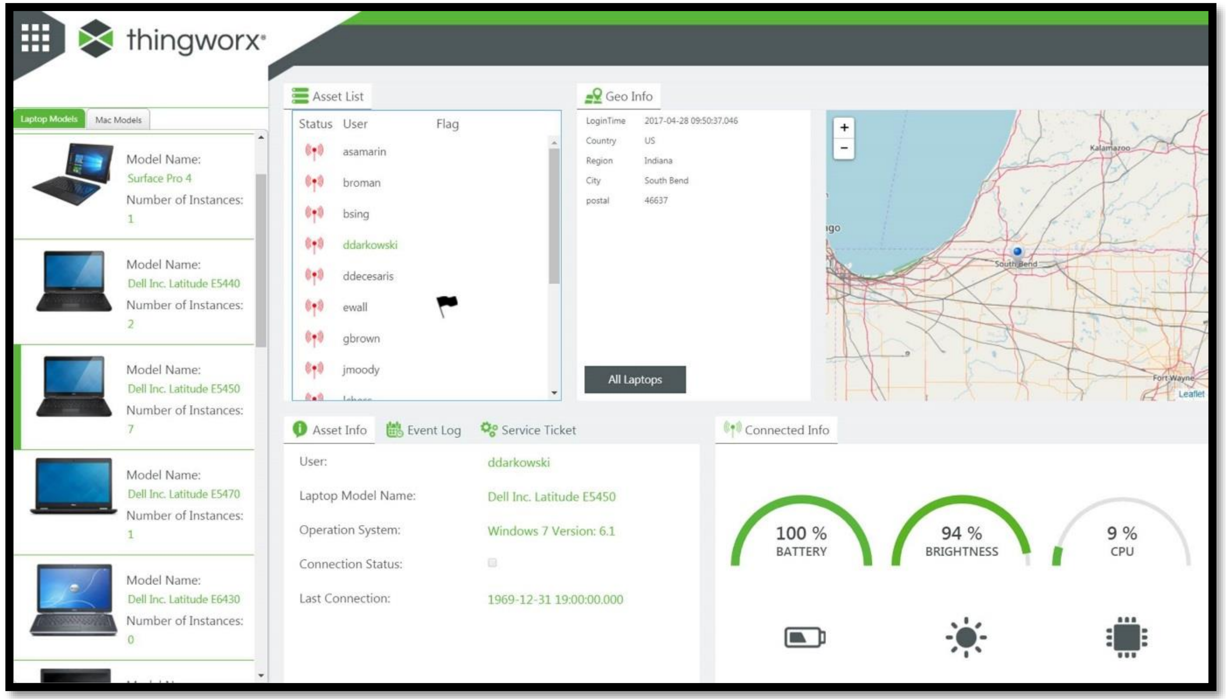
QA Engineer

Understand Your Product in the Field

Registry of Information

Identify Solutions

A digital record of each product's designed, manufactured, serviced and real-world state



- Improve profitability by analyzing the configurations of fleets of assets for future sales, recalls or update opportunities
- Improve decision making by analyzing individual assets again their real-world usage
- Ensure security, legal and regulatory compliance with hardware and software configuration traceability

CONCLUSION

- Interface requirements start at the very beginning of development
- They are many ways to define an interface. The best one depends on particular circumstances and will change over time
- Interfaces can be traced from requirements through to architecture through to design and physical implementation
- Define common interfaces first in a collaborative environment.
  - This means they will be available when people need them.
  - They will also only be defined once
- Interfaces are where things usually go wrong so it is best to get them right.

QUESTIONS AND ANSWERS