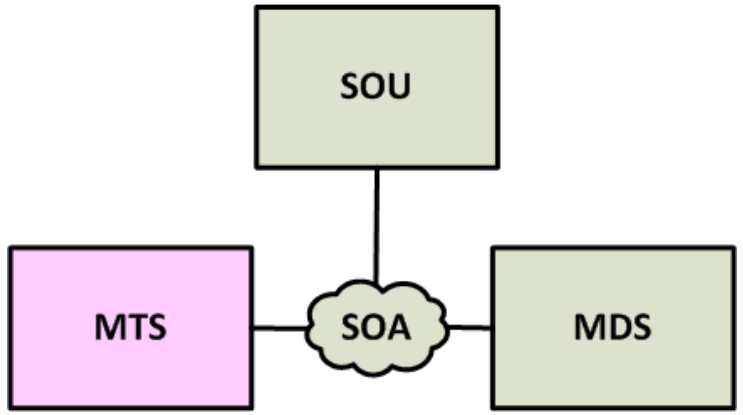
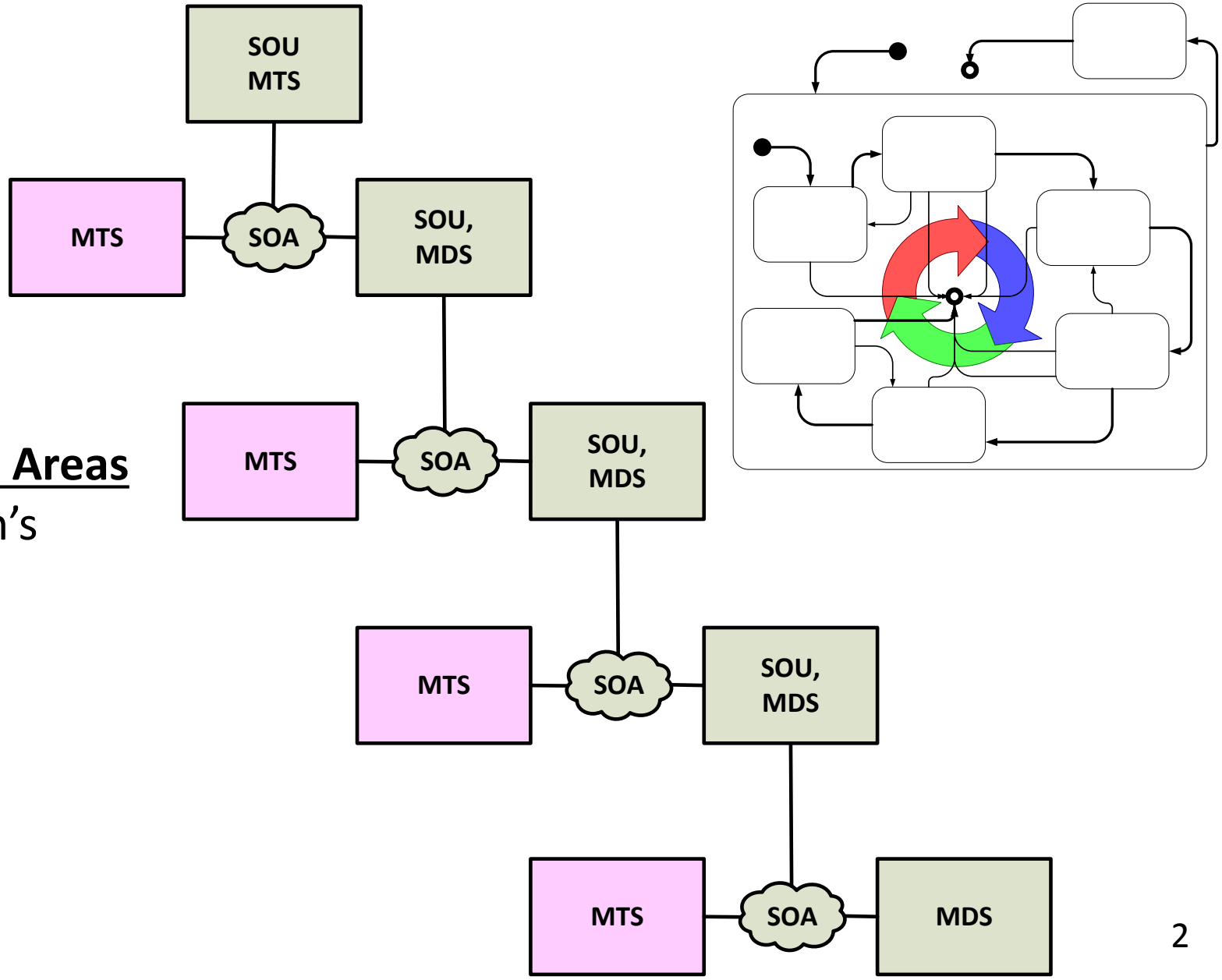
Sample S*Pattern Extracts

From Embedded Intelligence (EI) Pattern (AKA Management Pattern):

- Generic EI Functional Roles and Situation Management States
- Sample EI Stakeholder Features
- Sample EI Interactions
- Sample EI Requirements and Attribute Table References
- General Pattern Configuration Overview

Generic EI Functional Roles, SMFA Situation Management States

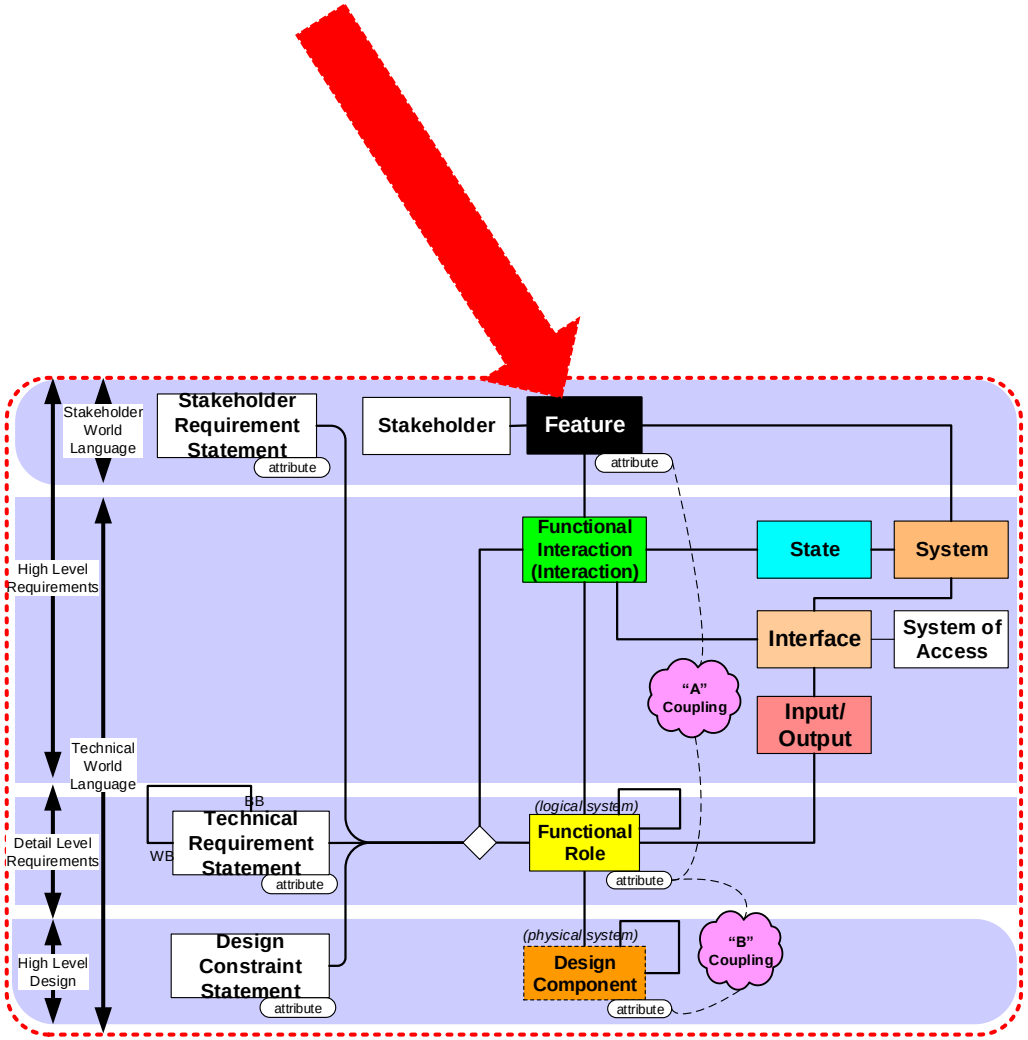




The **System Management Functional Areas (SMFAs)**: Manage aspects of a system's faults, configuration, accounting, performance, or security (FCAPS).

MDS: Managed System
MTS: Management System
SOA: System of Access
SOU: System of Users

Sample EI Stakeholder Features



System Performance Management

Performance Management Capability

System Configuration Management

Configuration Management Capability

System Security Management

Security Management Capability

System Accounting Management

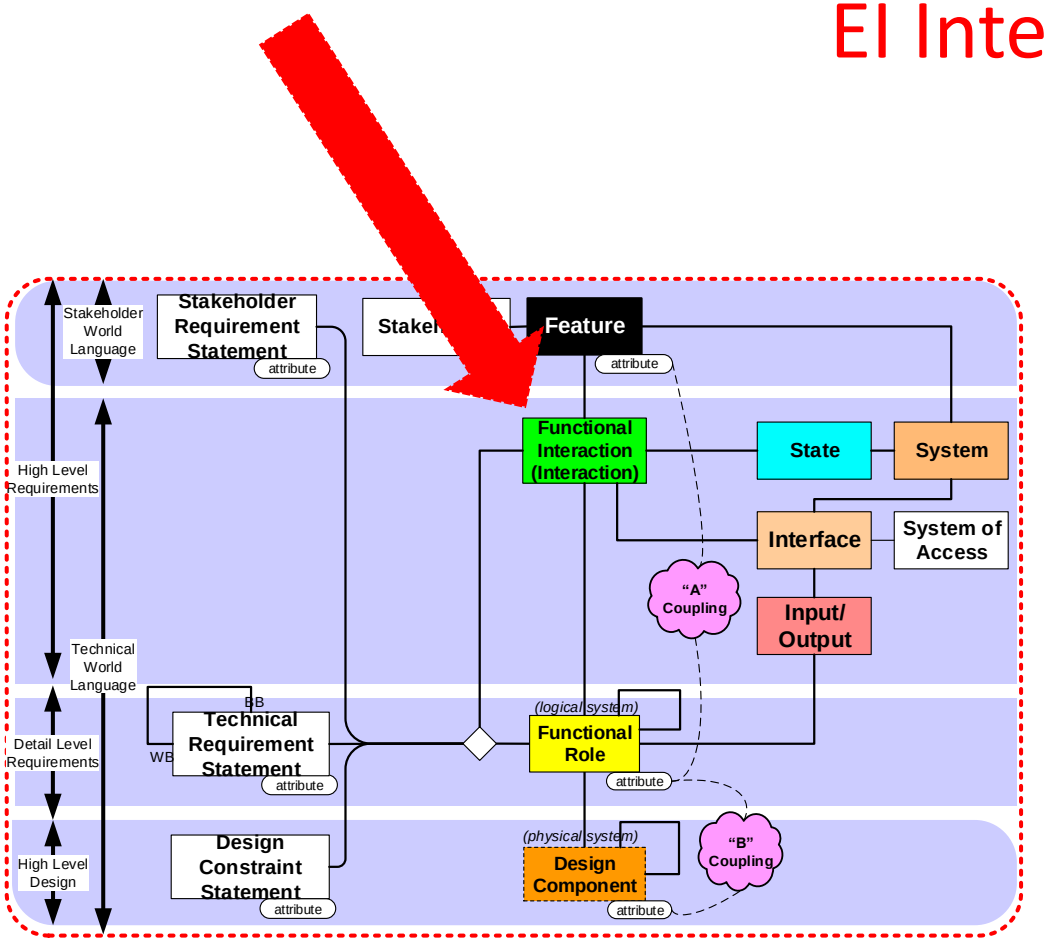
Accounting Management Capability

System Fault Management

Fault Management Capability

Sample EI Interactions

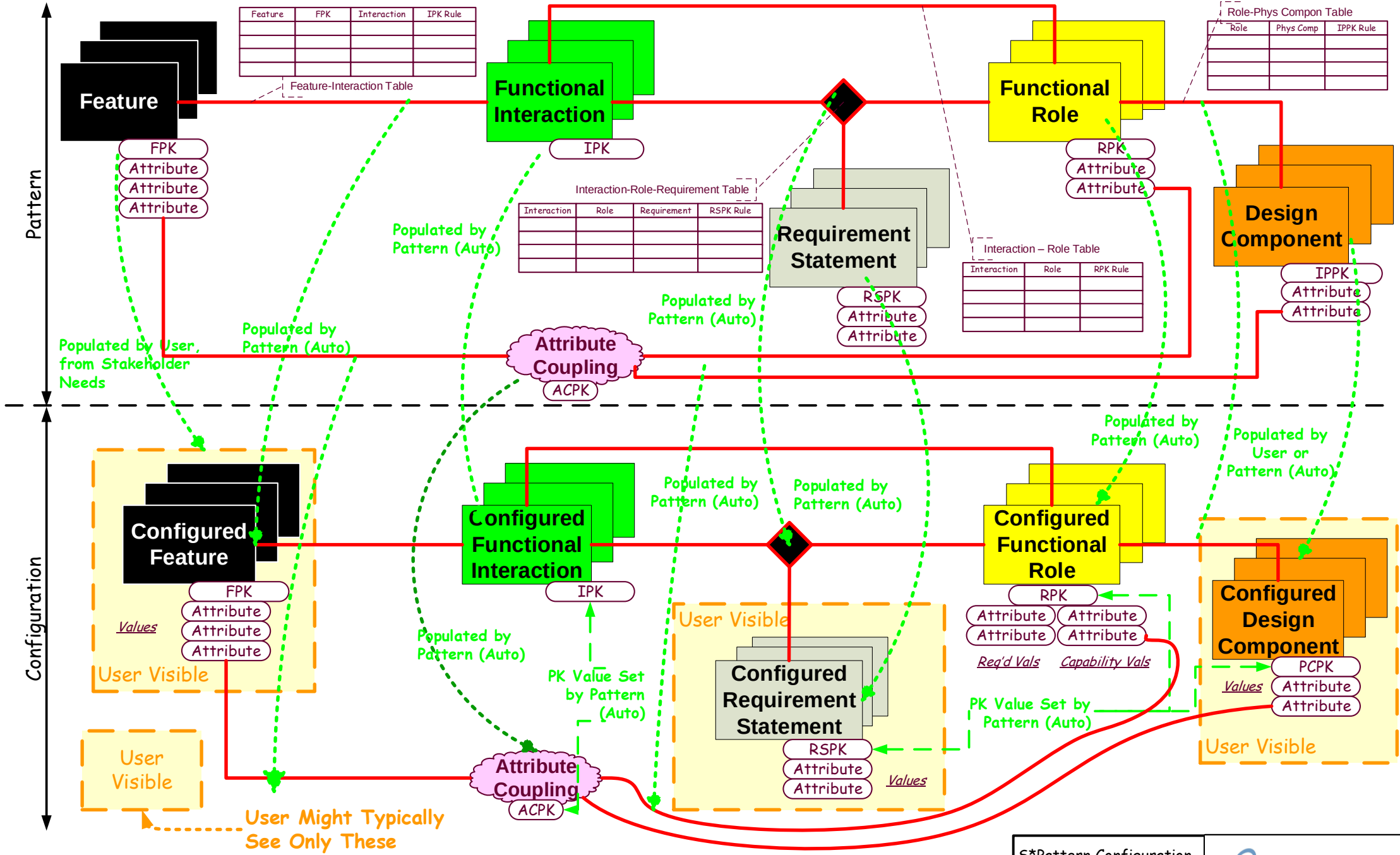
EI Interactions



- Operate System
- Maintain System
- Configure System
- Account For System
- Secure System
- Provide Access

Sample EI Requirements and Attribute Table References

	Functional Interaction	IPK Value	Functional Role	Req. ID	Requirement Statement	Requirement Status	T1--Managed System Measured Outputs Table	T2	T3	T4--Managed System Controlled Inputs Table	T5	T6--Human Outputs Table	T7--Human System Managers Table	TA--Alarms, Exceptions, and Notifications Table	TB--Regulatory Control Loops Table	TC--Discrete Control (Loops) Table	TD--Interlocks Table	TE--Recipe Capabilities Table	TF--Operational Sequence Table	TG--SOPs Table	TH--Logs and History Table	TI--Calculated Variable Table	TJ--Equipment Module Table	TK	TL--System Response Table	TM--Failure Sequence Table	TN--Reports Table	S1--Sensors Table	S2--Actuators Table
198	Maintain System	301.3 Automated Fault Data Analysis	Maintainer	AUTO 4012	The maintainer shall receive, understand, and act upon the fault data analysis reports listed in the Reports Table as routed to the maintainer and associated with Automated Fault Data Analysis.	Ready For Review																				X		
199	Maintain System	301.3 Automated Fault Data Analysis	Managed System (Level N)	AUTO 4011	The system shall automatically generate the fault data analysis reports listed in the Reports Table as associated with Automated Fault Data Analysis, upon the trigger events and for the report consumers listed there.	Ready For Review																				X		
200	Maintain System	301.3 Automated Fault Data Analysis	Management System (Level N+1)	AUTO 4013	The system shall receive and process the fault data analysis reports listed in the Reports Table as routed to the supervisory management system and associated with Automated Fault Data Analysis.	Ready For Review																				X		
201	Maintain System	301.4 Process Context Automatic Fault Data Logging	Maintainer	AUTO 4084	The maintainer shall receive and understand the historical fault data log views, displays, or reports of the types [Report Type], including process context data, listed in the Reports Table, when indicated in that table as maintainer directed by [Data Consumer], requesting these if so indicated in that table by [Triggering Event].	Ready For Review																				X		
202	Maintain System	301.4 Process Context Automatic Fault Data Logging	Managed System (Level N)	AUTO 4081	The system shall transmit fault data for faults found in the Alarms, Exceptions, and Notifications Table that are listed in the Logged Data Table, for capture by external management system log, including process context data.	Ready For Review								X							X							
203	Maintain System	301.4 Process Context Automatic Fault Data Logging	Management System (Level N)	AUTO 4081.1	The system shall transmit fault data for faults found in the Alarms, Exceptions, and Notifications Table that are listed in the Logged Data Table, including process context data, for capture by external management system log.	Ready For Review								X							X							
204	Maintain System	301.4 Process Context Automatic Fault Data Logging	Management System (Level N+1)	AUTO 4082	The system shall receive and record fault data for faults found in the Alarms, Exceptions, and Notifications Table that are listed in the Logged Data Table from the managed system, along with the [Additional Logged Context Data], for subsequent generation of log	Ready For Review								X							X							
	Maintain System	301.4 Process Context	Management System	AUTO	The system shall produce the historical logged fault data views,	Ready For																						

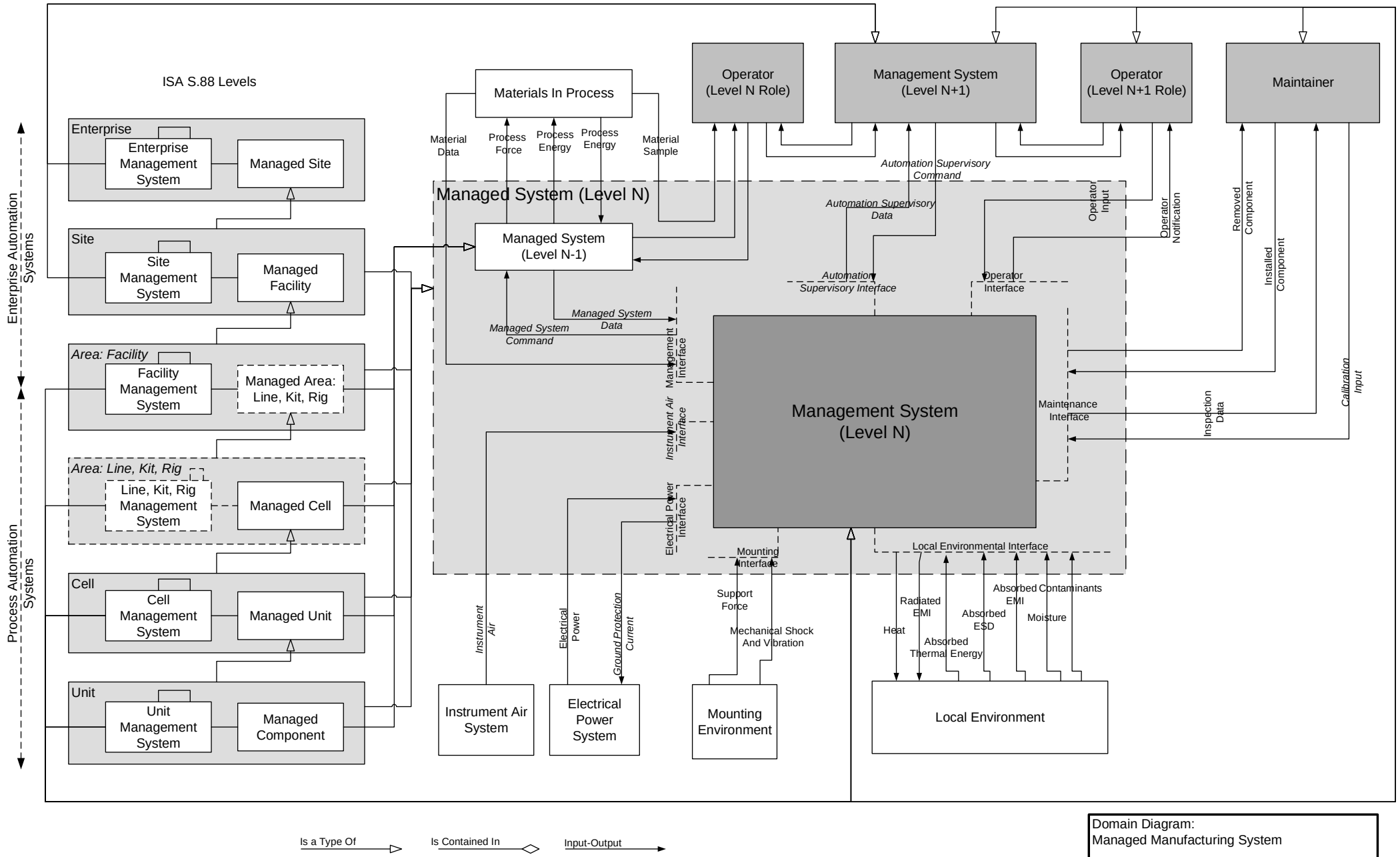

Pattern
Configuration
Feature
FPK
Attribute
Attribute
Attribute
Feature | FPK | Interaction | IPK Rule
Feature-Interaction Table
Functional Interaction
IPK
Interaction-Role-Requirement Table
Interaction | Role | Requirement | RSPK Rule
Requirement Statement
RSPK
Attribute
Attribute
Functional Role
RPK
Attribute
Attribute
Role-Phys Compon Table
Role | Phys Comp | IPPK Rule
Interaction – Role Table
Interaction | Role | RPK Rule
Design Component
IPPK
Attribute
Attribute
Populated by Pattern (Auto)
Populated by Pattern (Auto)
Populated by User, from Stakeholder Needs
Populated by Pattern (Auto)
Attribute Coupling
ACPK
Configured Feature
FPK
Attribute
Attribute
Attribute
Values
User Visible
Configured Functional Interaction
IPK
Populated by Pattern (Auto)
Populated by Pattern (Auto)
Populated by Pattern (Auto)
Populated by Pattern (Auto)
Configured Functional Role
RPK
Attribute
Attribute
Attribute
Attribute
Req'd Vals
Capability Vals
Populated by User or Pattern (Auto)
Configured Design Component
PCPK
Values
Attribute
Attribute
User Visible
User Visible
Configured Requirement Statement
RSPK
Attribute
Attribute
Values
PK Value Set by Pattern (Auto)
PK Value Set by Pattern (Auto)
Attribute Coupling
ACPK
User Visible
User Might Typically See Only These

Sample Pattern Extracts

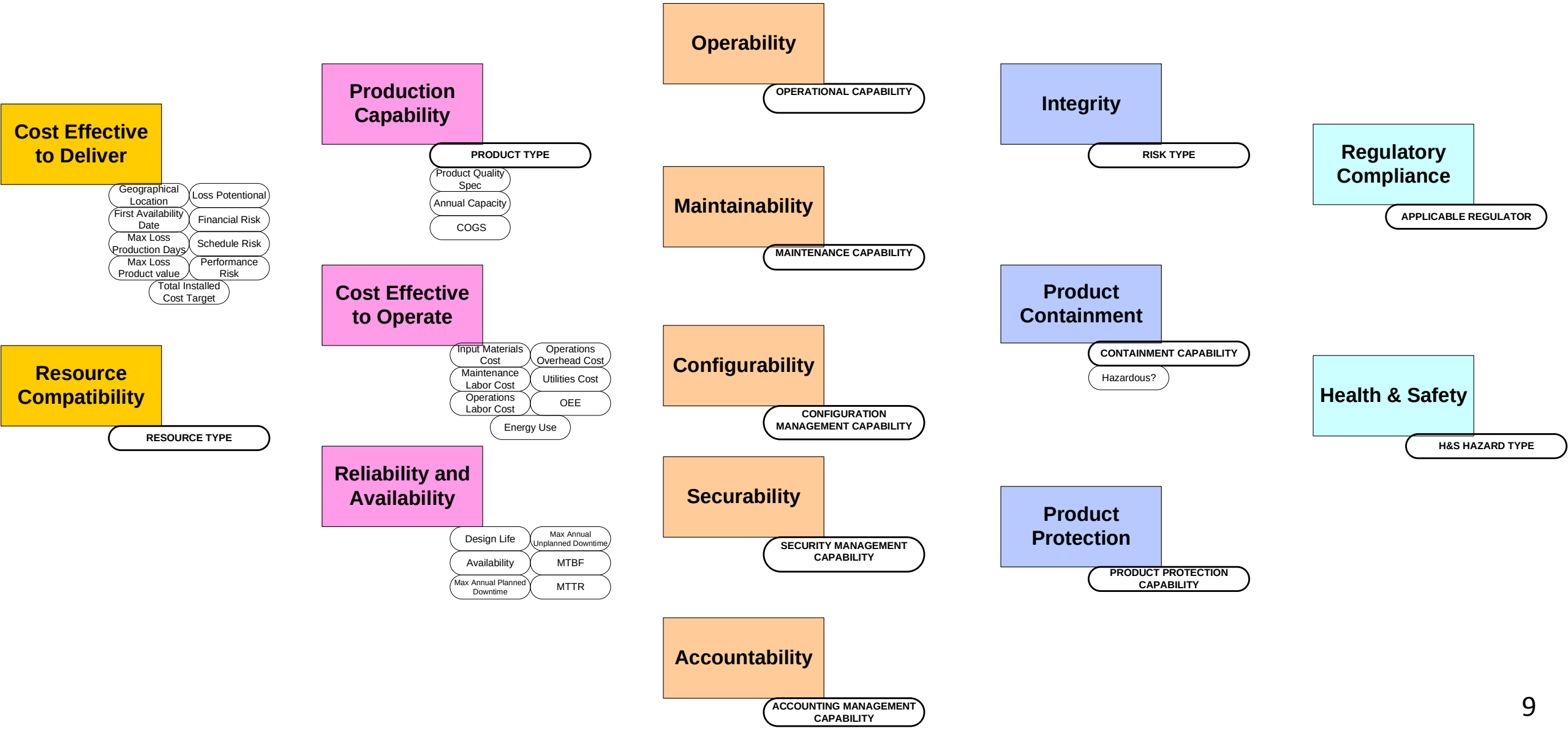
From Smart Manufacturing Pattern:

- Manufacturing Domain Model and Hierarchy
- Manufacturing Feature Model—Generic Level
- Sample Manufacturing Interaction Models
- Sample Manufacturing Systems of Access Models

Manufacturing Domain Model and Hierarchy

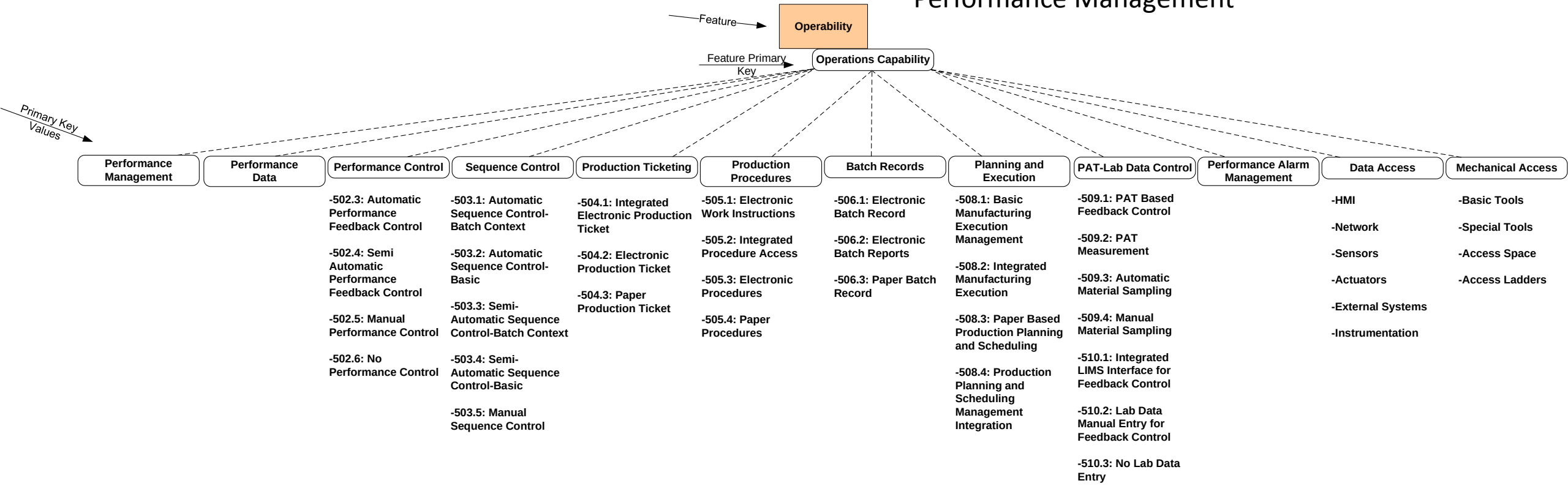


Manufacturing Feature Model—Generic Level



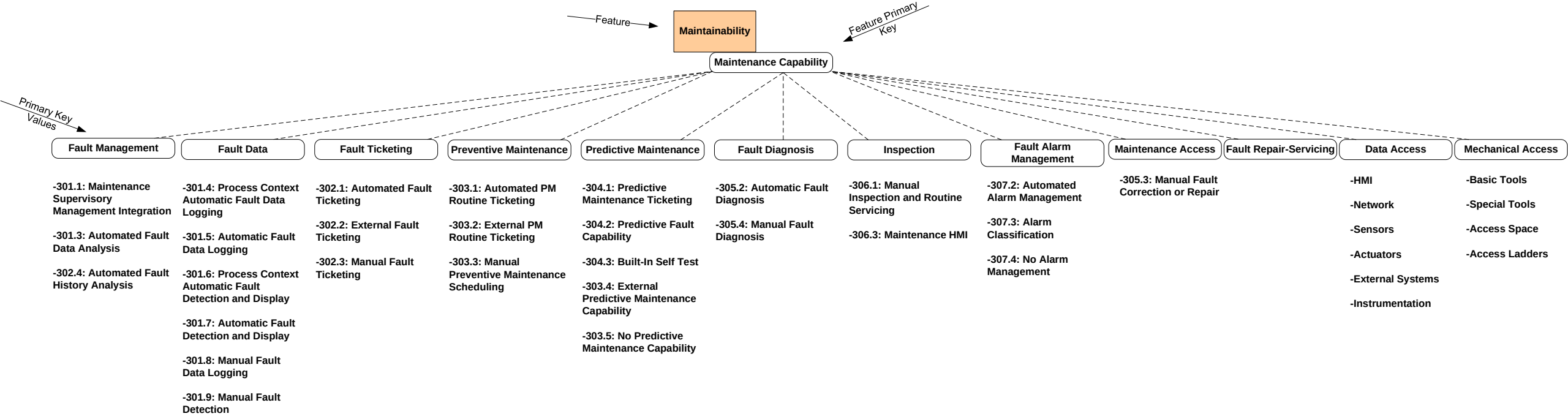
Manufacturing Feature Specialization by Feature Primary Keys

Operability, AKA
Performance Management

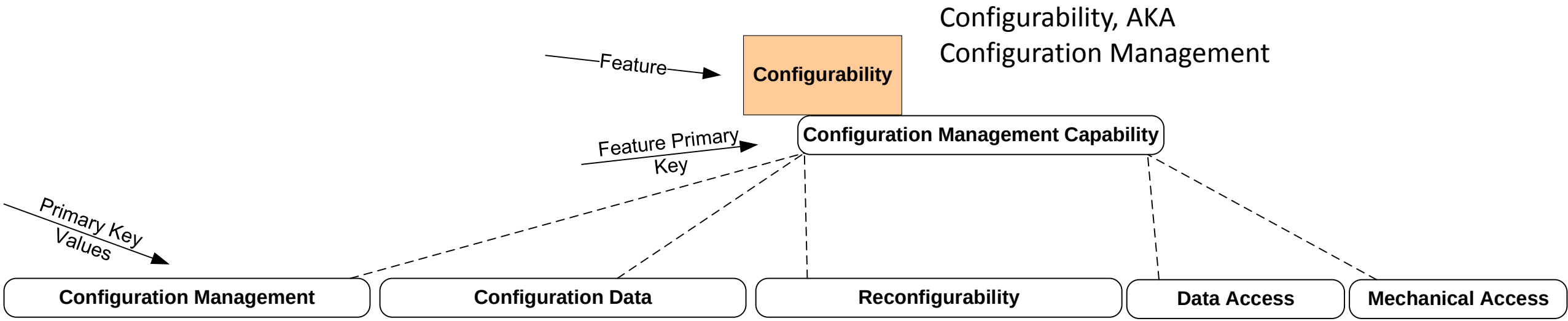


Manufacturing Feature Specialization by Feature Primary Keys

Maintainability, AKA
Fault Management



Manufacturing Feature Specialization by Feature Primary Keys



-201.1: Configuration Supervisory Management Integration

-202.1: Automatic Configuration Data Logging

-202.2: Process Context Automatic Configuration Data Logging

-202.3: Manual Configuration Data Logging

-203.1: Automatic Configuration Data Measurement and Display

-203.2: Process Context Automatic Configuration Data Measurement and Display

-203.3: Manual Configuration Data Measurement

-204.1: Automatic Reconfigurability

-204.2: Semi-Automatic Reconfigurability

-204.3: Manual Reconfigurability

-HMI

-Network

-Sensors

-Actuators

-External Systems

-Instrumentation

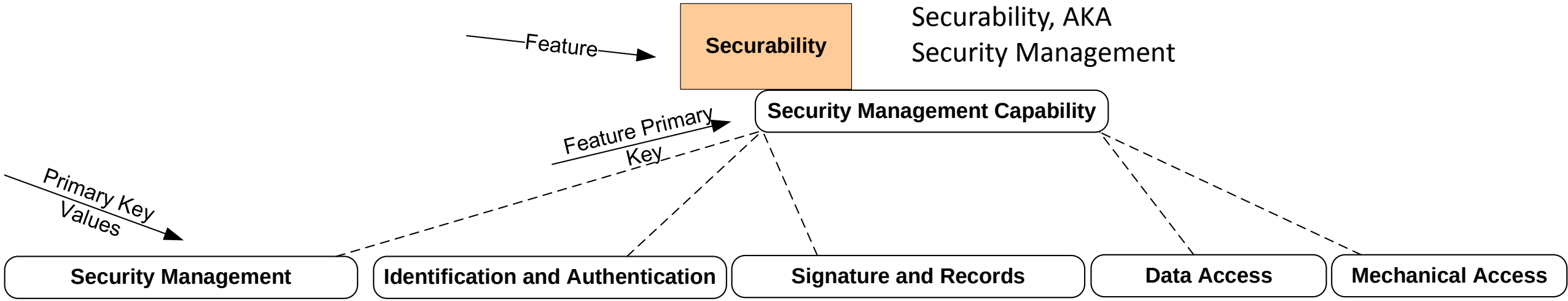
-Basic Tools

-Special Tools

-Access Space

-Access Ladders

Manufacturing Feature Specialization by Feature Primary Keys



-401.1: Security Supervisory Management Integration

-401.2: Automated Security History Analysis

-401.3: Internal Security Logging

-403.1: Automatic Operational Privileges Authorization

-403.2: Manual Operational Privileges Authorization

-402.1: Biometric Based Identification and Authentication

-402.2: Automatic Identification and Authentication

-402.3: Manual Security Identification and Authentication

-404.1: Electronic Signature Capability

-404.2: Electronic Record Capability

-404.3: Hybrid Electronic Records Capability

-404.4: Paper Records and Signatures

-HMI

-Network

-Sensors

-Actuators

-External Systems

-Instrumentation

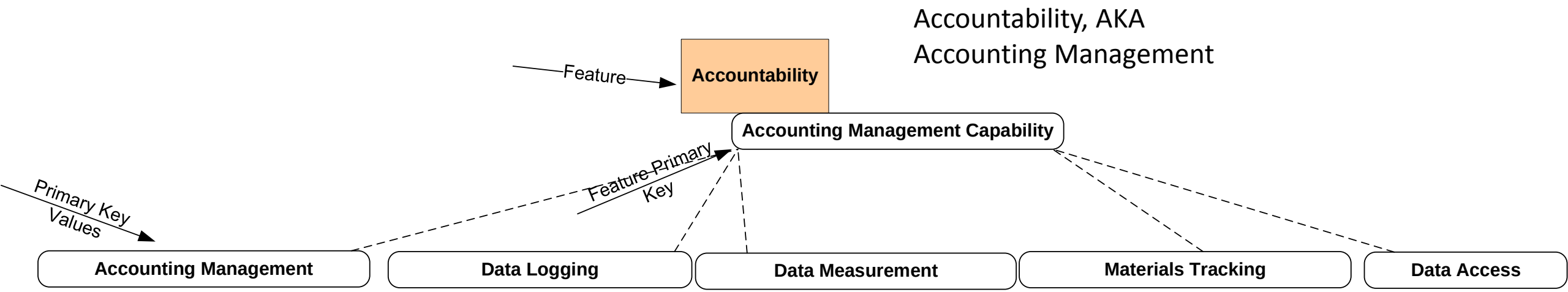
-Basic Tools

-Special Tools

-Access Space

-Access Ladders

Manufacturing Feature Specialization by Feature Primary Keys



-101.1: Accounting Supervisory Management Integration

-101.2: Automated Accounting Analysis

-102.1: Process Context Automatic Utilization Data Logging

-102.2: Automatic Utilization Data Logging

-102.5: Manual Utilization Data Logging

-102.3: Process Context Automatic Utilization Data Measurement and Display

-102.4: Automatic Utilization Data Measurement and Display

-102.6: Manual Utilization Data Measurement

-103.1: Automatic Materials Utilization Tracking Capability

-103.2: Manual Materials Utilization Tracking Capability

-HMI

-Network

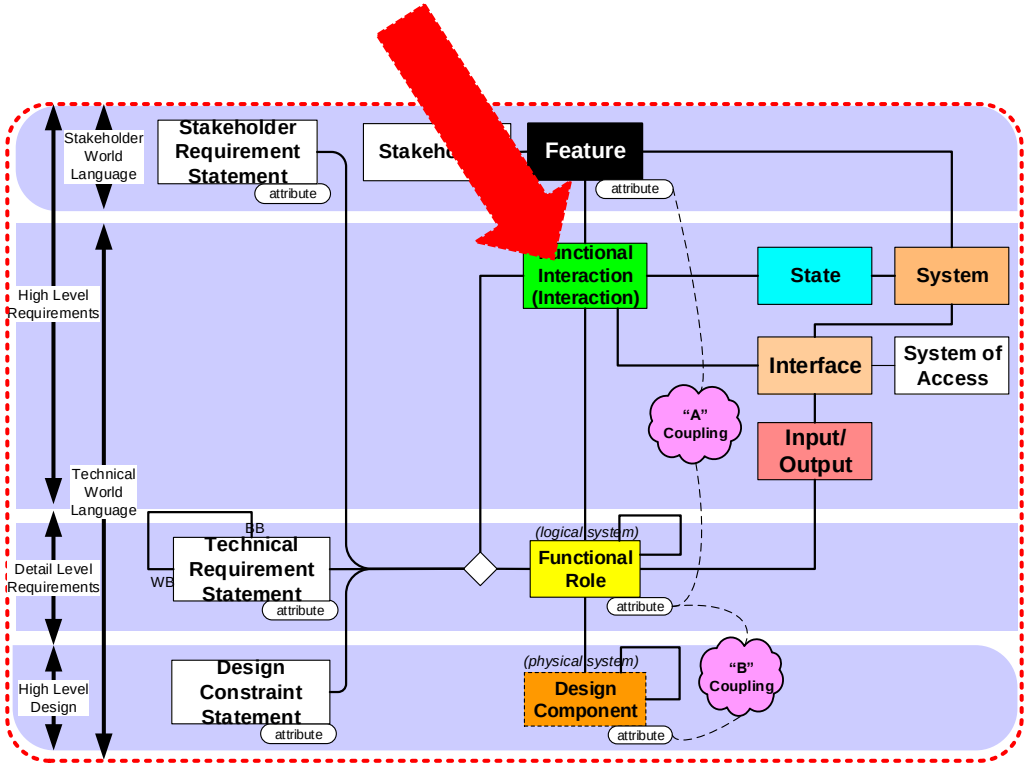
-Sensors

-Actuators

-External Systems

-Instrumentation

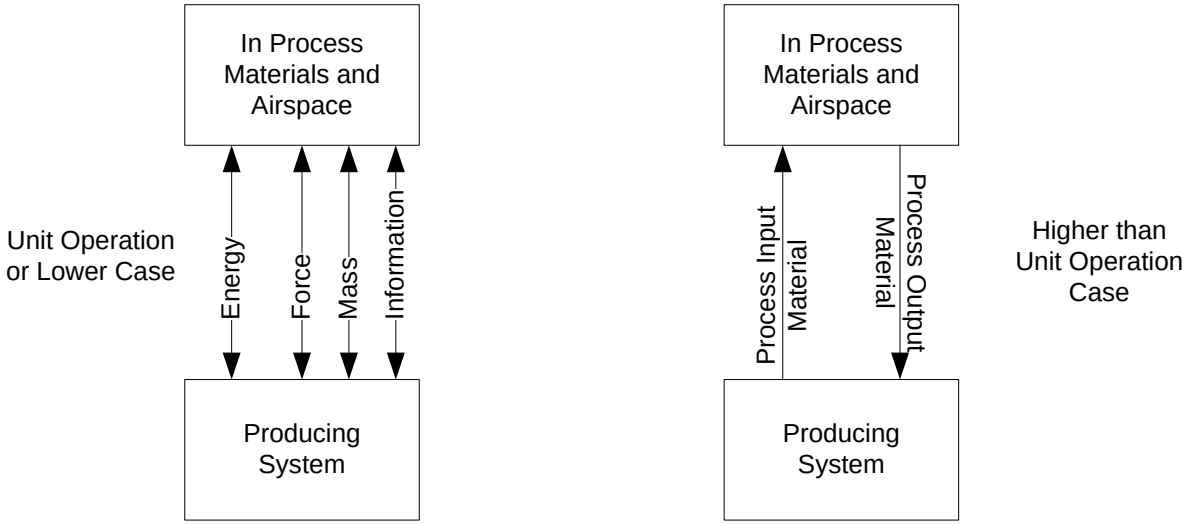
Manufacturing Interactions: Generic



- Operate System
- Maintain System
- Deliver System
- Transform Material
- Configure System
- Consume Utility
- Transport Material
- Account For System
- Protect
- Secure System
- Provide Access

Interaction: Transform Material

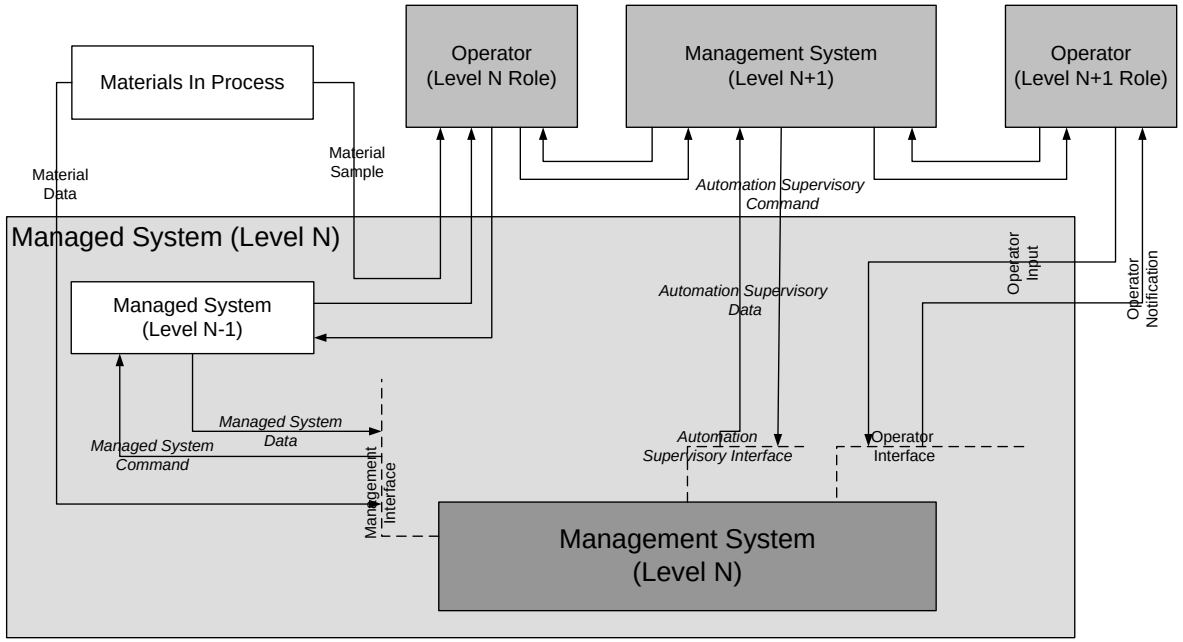
Definition:	The interaction between process equipment and materials in process in which the materials' structural, chemical, or other physical aspects are altered.
Model Information:	Only Unit Operation (or lower) level cases model material transformation forces, transformation energy, and transformation mass flows that occur during the transformation process, as seen by the material in process. Higher level cases model only the pre and post interaction materials. The attributes of the process and materials are modeled according to this same division.
Other related interactions:	Receiving and providing raw, in-process, or finished materials are part of the Transport Material interaction, not this interaction. The scope of this interaction does not include the management of transformation processes by human or automated means—for those aspects, refer to Operate System.



Interaction: Operate System

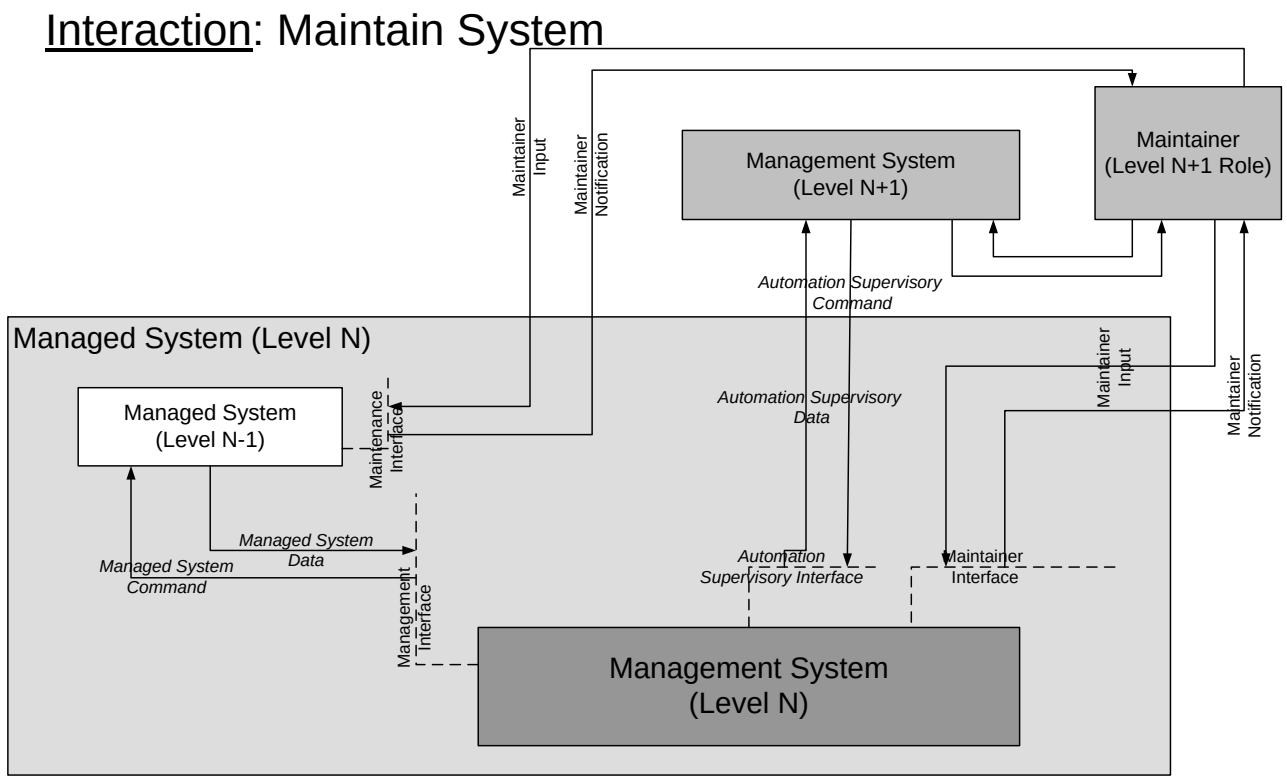
Definition:	The interaction of a managed system with a higher level management system and/or operators and managers acting in higher level management roles, through which the performance of the managed system in its basic mission is managed. The scope of this interaction does not include the actual production transformations of the managed system, but is focused on the management of their performance. It does not include management of faults, configuration, security, or accounting aspects.
Other Related Interactions:	Transform Material; Maintain System; Configure System, Secure System, Account for System.
Primary Key Values:	

Interaction: Operate System



Interaction: Maintain System

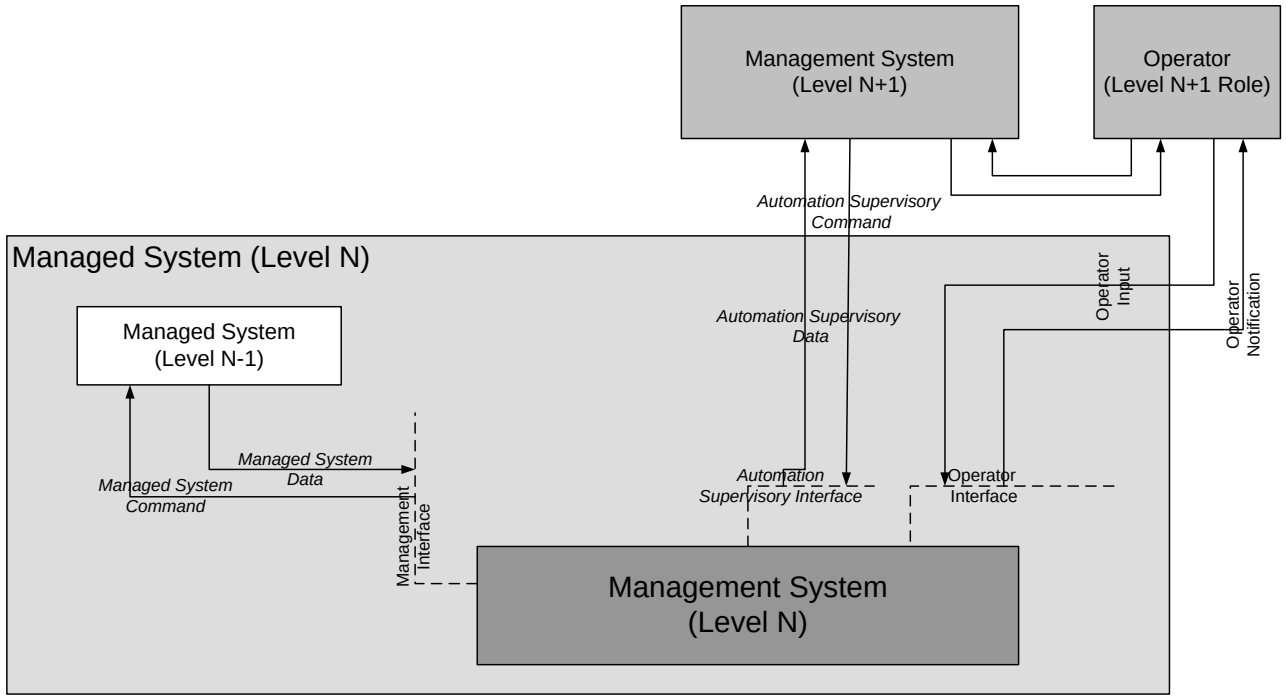
Definition:	The interaction of maintenance occupants and higher level management systems with a managed system, for purposes of maintaining that system in a qualified or appropriate state for its intended purpose. This includes all forms of maintenance -- the prevention of faults (preventive maintenance), as well the detection, diagnosis, recovery, and repair of faults (corrective maintenance).



Interaction: Configure System

Definition:	The interaction of a managed system with a higher level management system and/or operator acting in a higher level management role, through which the configuration of the managed system is managed.

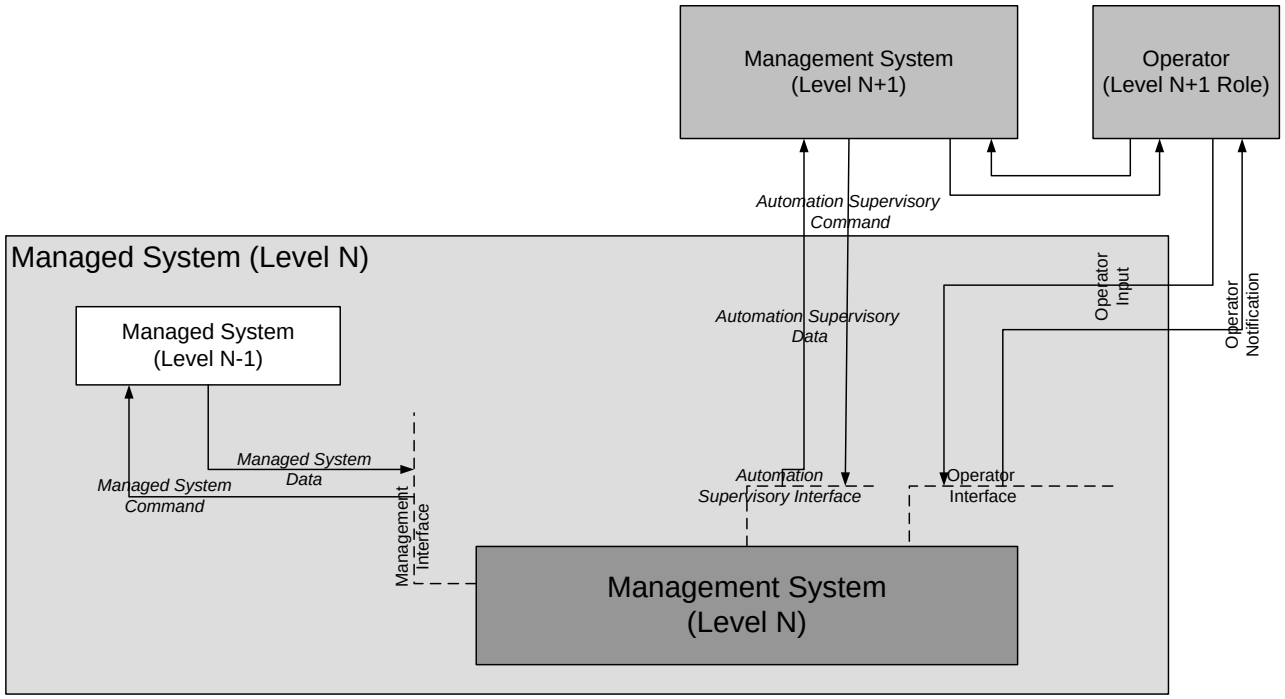
Interaction: Configure System



Interaction: Secure System

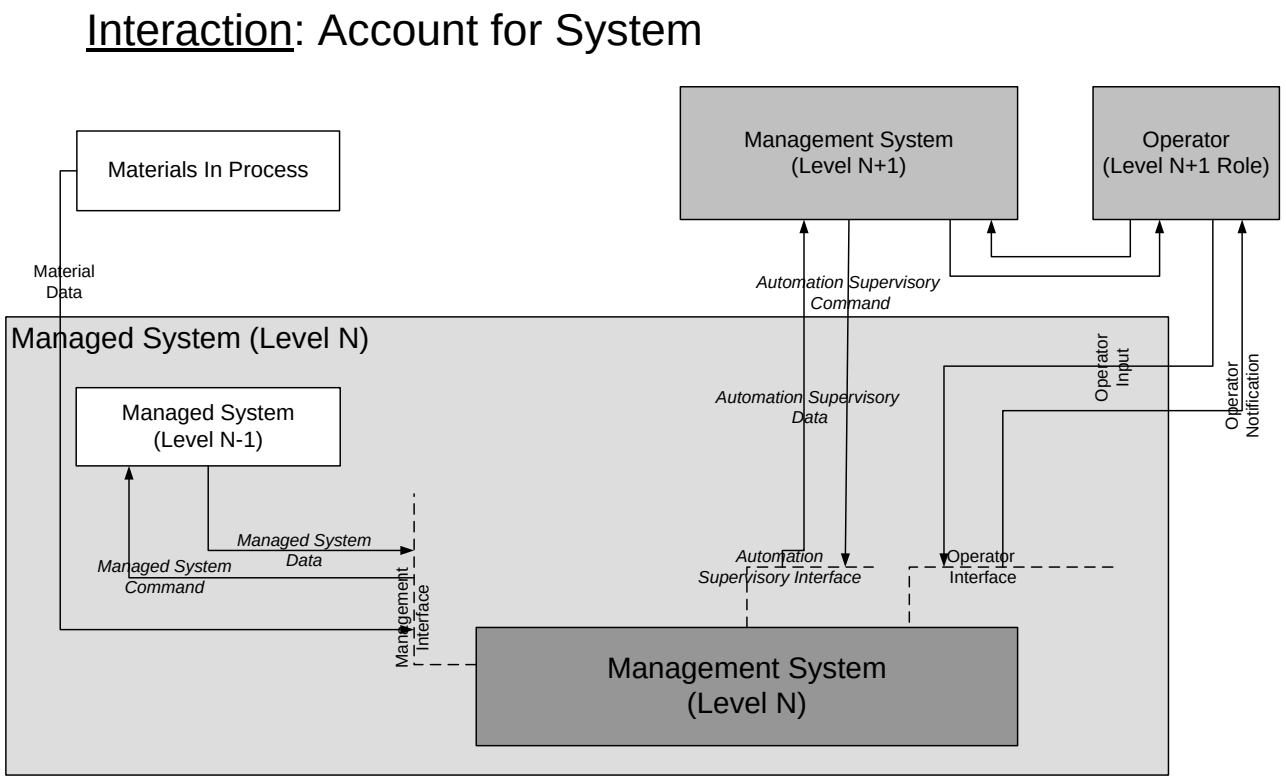
Definition:	The interaction of a managed system with a higher level management system and/or operators acting in a higher level management role, through which the security of the managed system assets and capabilities is managed.

Interaction: Secure System



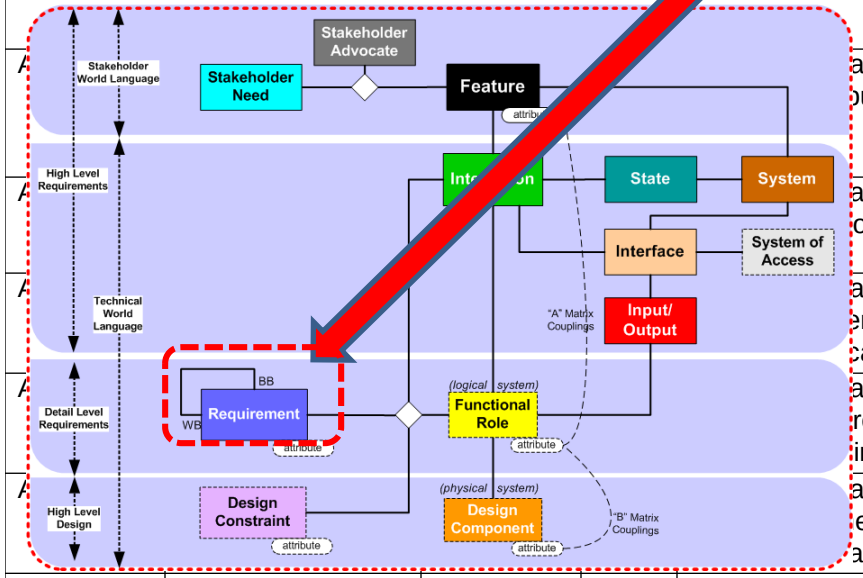
Interaction: Account for System

Definition:	The interaction of a managed system with a higher level management system and/or operator acting in a higher level management role, through which the utilization of the resources or capabilities of the managed system is accounted for.



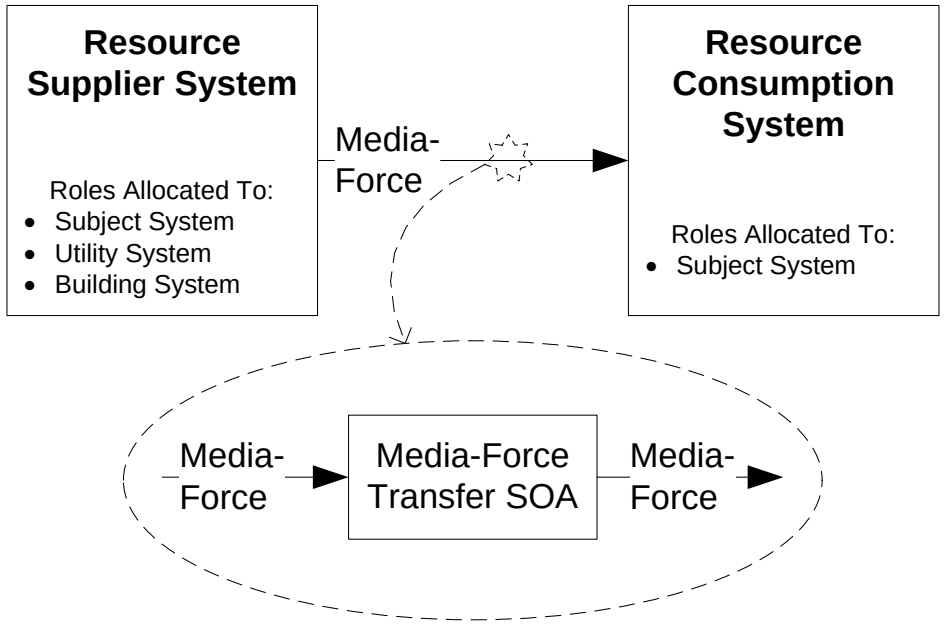
Account for System: Requirements

Interaction	Interaction Primary Key	Role	Req ID	Requirement
Account for System	101.2 Automated Accounting Analysis	Managed System (Level N)	AUTO 6001	The system shall produce the system accounting analysis outputs, views, displays, or reports as listed in the Reports Table.
Account for System	102.1 Process Context Automatic Utilization Data Logging	Managed System (Level N)	AUTO 6011	The system shall transmit [illegible]tem utilization data, as shown in the Logged Data Table, for capture by external manageme[illegible]ystem log, including process context data.
Account for System	102.2 Automatic Utilization Data Logging	Managed System (Level N)	AUTO 6021	The system sh[illegible]ransmit system utilization data, as shown in the Logged Data Table, for capture by external [illegible]agement system log.
Account for System	102.3 Process Context Automatic [illegible]	Managed System (Level N)	AUTO 6031	The sy[illegible]m shall measure and display system utilization data as listed in the Managed System Mea[illegible]ed Outputs Table, including process context data and including a status of data indicator.
A[illegible]				[illegible]all measure and display system utilization data as listed in the Managed System [illegible]uts Table, including a status of data indicator.
A[illegible]				[illegible]all display or report system utilization data as shown in the Logged Data Table, for [illegible]or logging of such data.
A[illegible]				[illegible]all all the operator to manually measure the system utilization data listed in the [illegible]m Measured Outputs Table, for those listed for the Manual Utilization Data [illegible]capability.
A[illegible]				[illegible]all display, indicate, or report the materials utilization data listed in the Managed [illegible]red Outputs Table, for those listed for the Automatic Materials Utilization Tracking [illegible]including a status of data indicator.
A[illegible]				[illegible]all depend upon external (Operator) capture and tracking of materials utilization [illegible]e Managed System Measured Outputs Table, for those listed for the Manual [illegible]ation Tracking capability, and including a status of data indicator.
Account for System	Accounting Management Regulations	Managed System (Level N)	GS_AM _AR_1	The system shall provide accounting management capabilities such that it complies with the regulations required by the regulators listed in the Applicable Regulators Table.



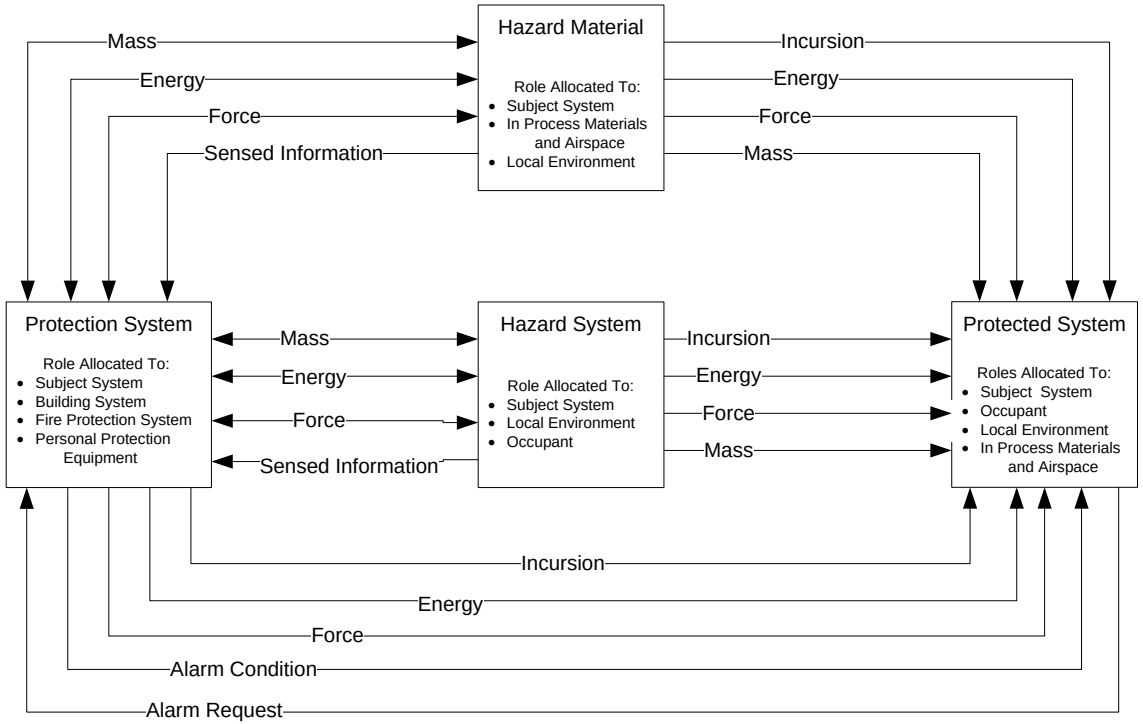
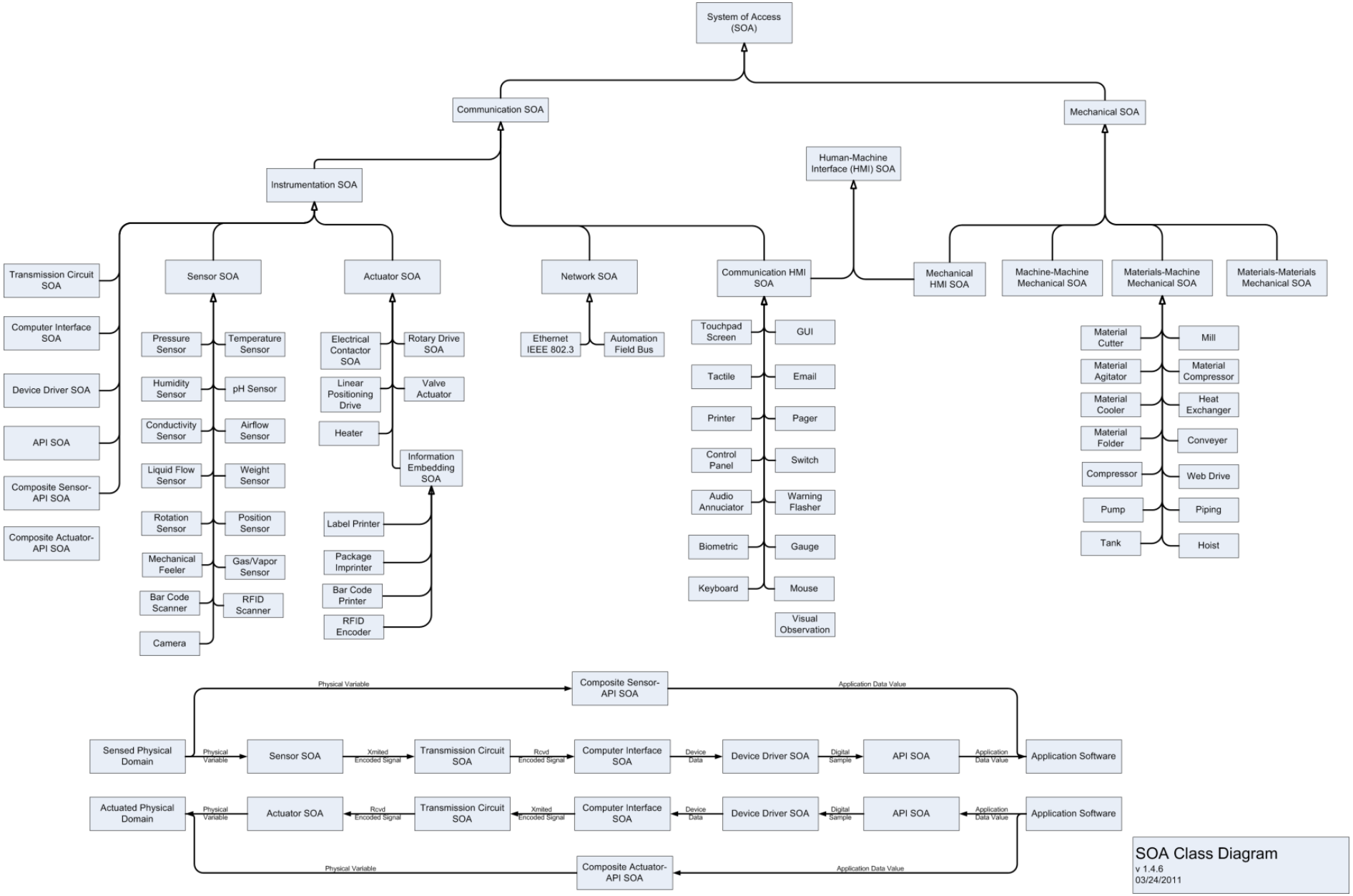
Interaction: Consume Utility

Definition:	The interaction whereby utilities are transferred between systems.
Model Information:	Instances of this interaction may involve production input and outputs, raw materials, utility media supplies and returns, exhaust, energy, mounting/support forces, vibrations, etc. A subject system may be a source (supplier) of one instance of media or force transfer and a sink (destination) to another. Media or force transfer interactions imply a hidden system of access (SOA) role that may be detailed in selected specialized patterns.



Interaction: Protect

Definition:	The interaction of a subject system with external actors (other systems, people, product and material, and the system's environment) such that the subject system itself, the external systems, people, product and material, and the subject system's environment are protected from hazards originating in each other. This includes maintaining structural integrity, along with distribution of and protection from static and dynamic forces.
Model Information:	A given instance of this interaction may have any of its four common roles allocated to either the Subject System or any of the External Actors interacting with the Subject System.



Example Systems of Access (SOA) Families in Manufacturing Systems Domain