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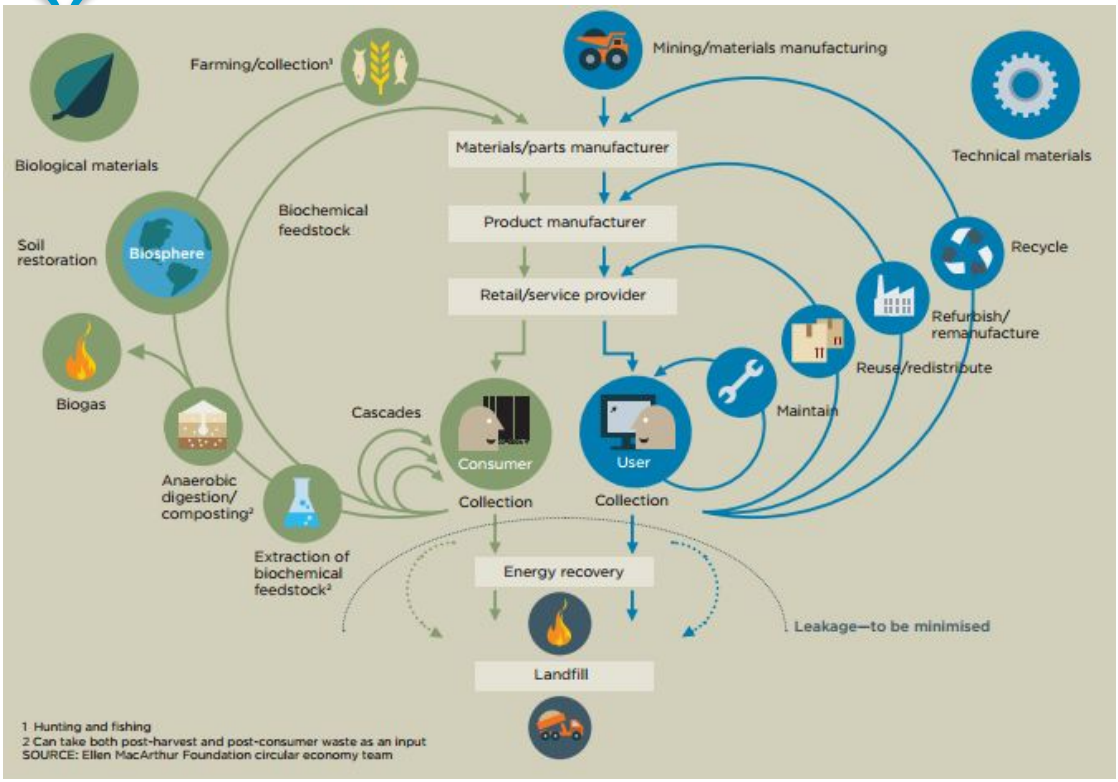
PLM and SLM Joined Digitally for the Connected World

People matter, results count.

Agenda

- Why connected assets / products
  - The circular economy
  - Outcome-based business models
  - Digital Thread
- Configuration management requirements in a connected world
- Adding structured data to product configuration
- Using Aras for maintaining product configuration

The necessity for a circular economy is one of primary reasons for connected products.



The Ellen Macarthur Foundation. Towards the Circular Economy. @2013

Evolving Strategies

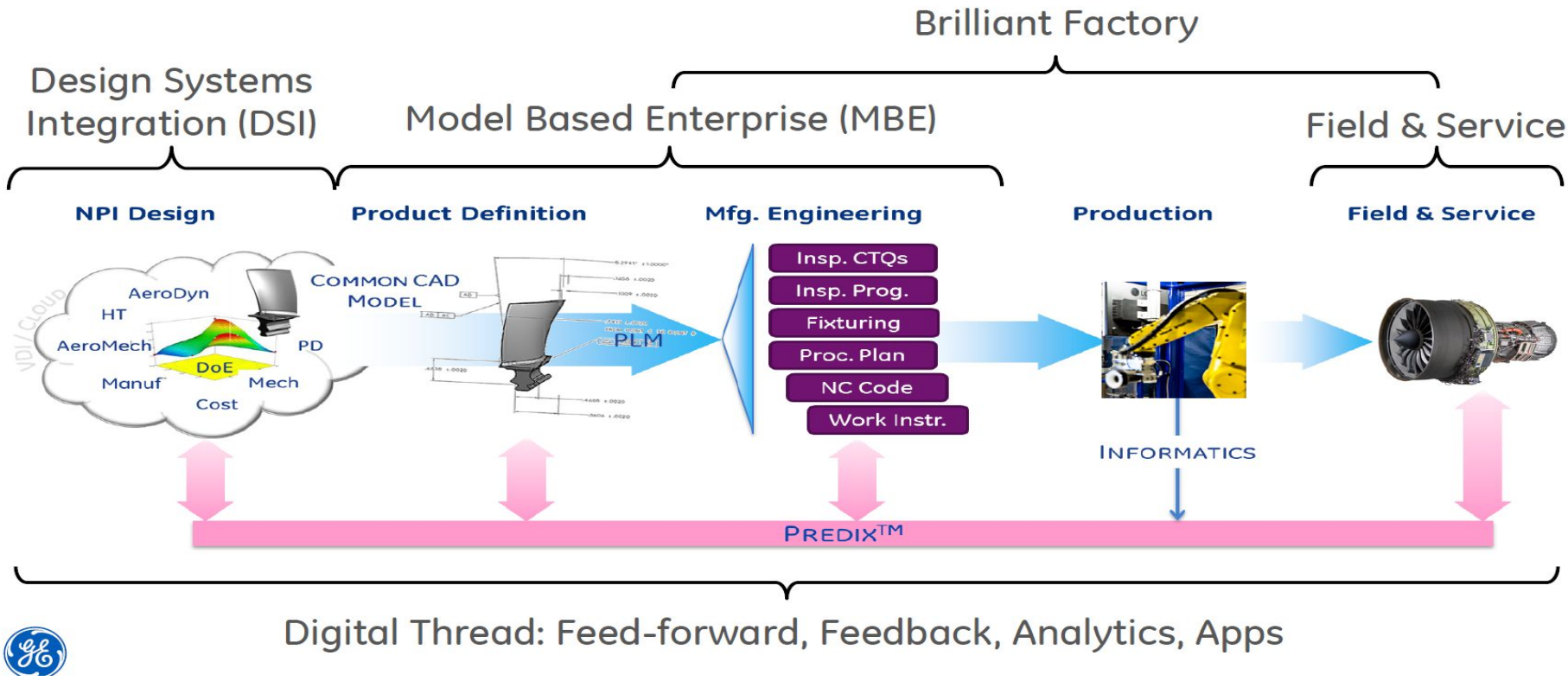
- Product reuse
- Part reuse
- Refurbishment
- Outcome based pricing (buy by the hour)
- Different product ownership models

Circular Economy Continuum

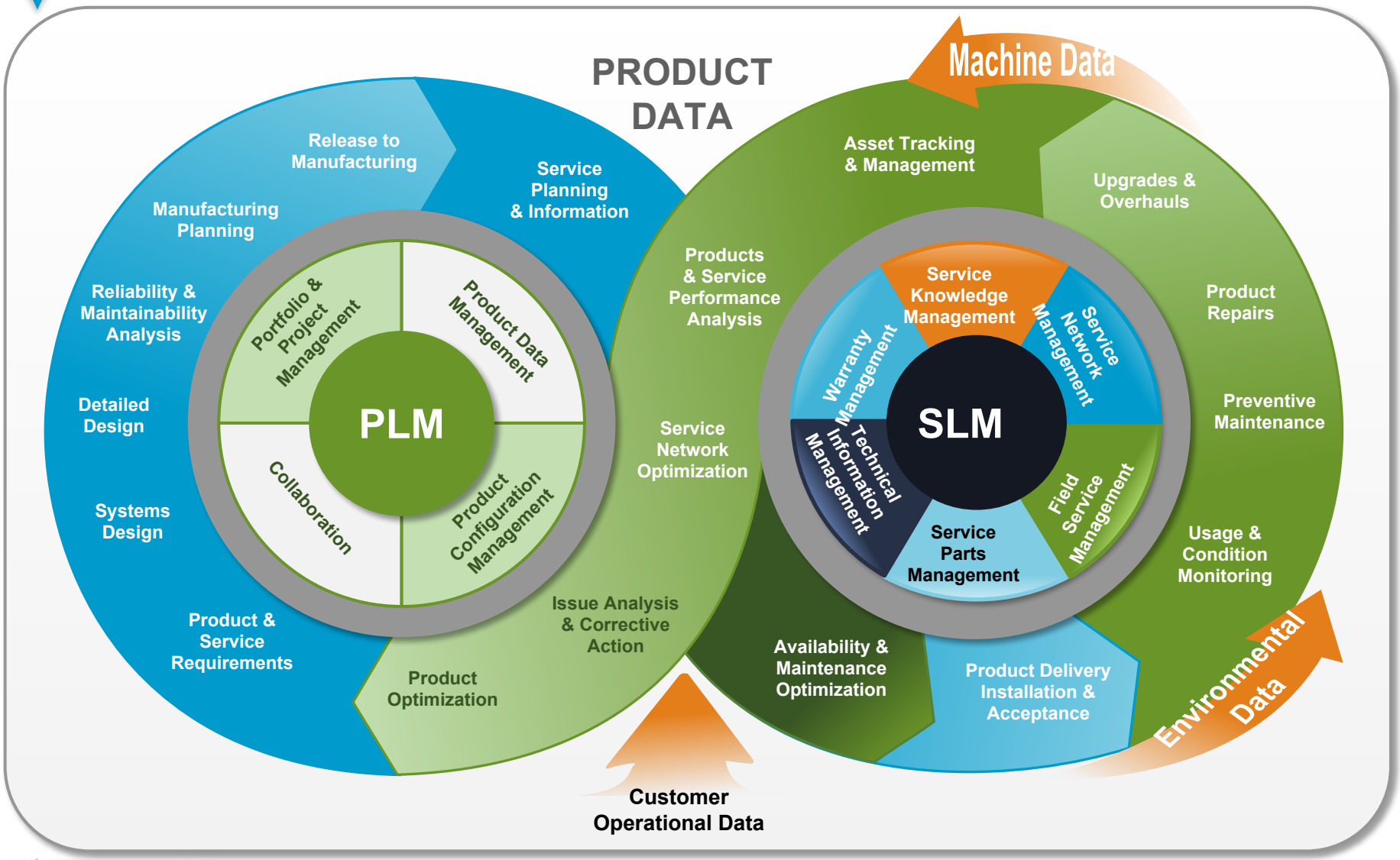
Lagging	Formative	Moderate	Advanced	Best in Class
Product Model	Service Parts	Field / Service	Service Contracts	Outcomes-Based

An Outcomes-Based business model requires a Digital Thread.

GE's Model of the Digital Thread



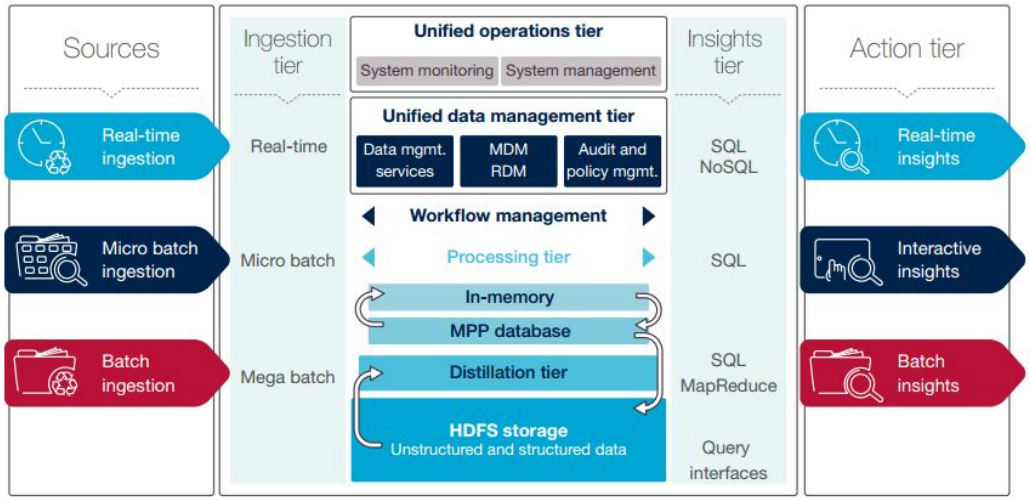
A connected PLM / SLM architecture enables the Digital Thread.



Connected products and analytics adds more data and complexity to configuration management.

Connected Assets

Data Lake Used to Collect Data From Assets and Enable Advanced Analytics and Machine Learning



By 2020, over 40% of all data will result from machines talking to one another

From the dawn of civilization to 2003: we produced 5 Exabytes of data

Now we produce 5 Exabytes of data EVERY TWO DAYS!

Yet, standard PLM / SLM configuration BOMs are not set up for connected products and analytics.

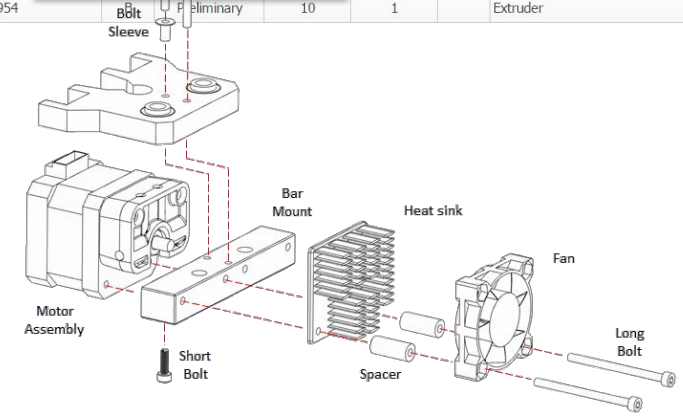
Insufficient for Analysis

BOM | BOM Structure | Alternates | AML | Documents | CAD Documents | Goals | Changes | Part Submission Warrants

Attributes but not in machine readable format

What are the performance characteristics and where are they found?

Part Number				Quantity	Lock...	Name
MP2942				1		Body
MP26				1		Spacer Black 5-16 in length .14in ID .25in OD
MP23				1		RGB LED Strip Common Anode
MP2660	B	Released	15	2		Spacer Black 1-2 in length .14in ID .25in OD
MP2939	A	Released	20	1		Body Fan Assembly
MP2347	B	Released	5	1		Fan 24V 40x40x10 1m leads
				2		Spacer Black 16.5mm length 3.2mm ID 7mm OD
MP29				1		Body Hardware
MP29				1		Body Panels
MP29				1		Stepper Motor Assembly
MP24				4		Thing-O-Matic 2 Radial Ball Bearings
MP29				1		Cable Hardware
MP09				2		Mechanical Endstop
MP2954		Preliminary	10	1		Extruder



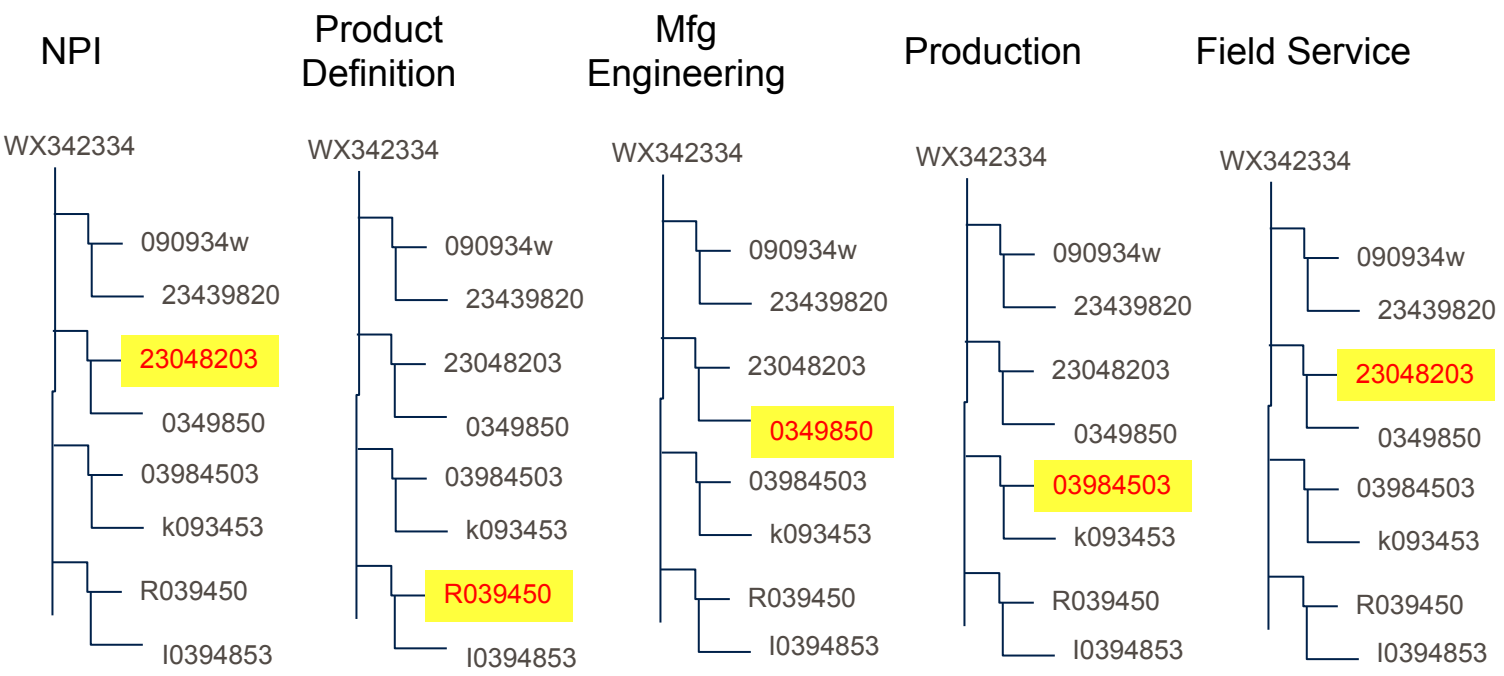
Structured Performance Data

- Describes the performance characteristics of the product
  - Pressures, temperatures, etc.
  - Maximums, minimums
  - Voltages, amperes, etc.
  - MTF, time in service, etc.
- Defines the performance characteristics of the parts and the system as a whole
- Enables comparative analysis to the operation of the parts and products collected via IoT

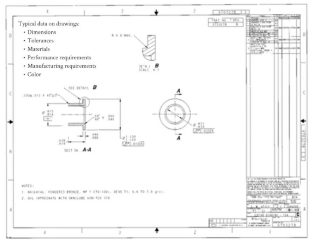
The PLM / SLM architecture must enable product data and product configuration management over time and states.

Product / Asset Configuration

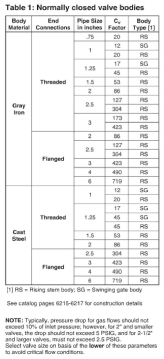
- Hardware
- Software
- Electronics
- Revisions
- Traciblity
- Audit Trail



3d CAD model



Drawings



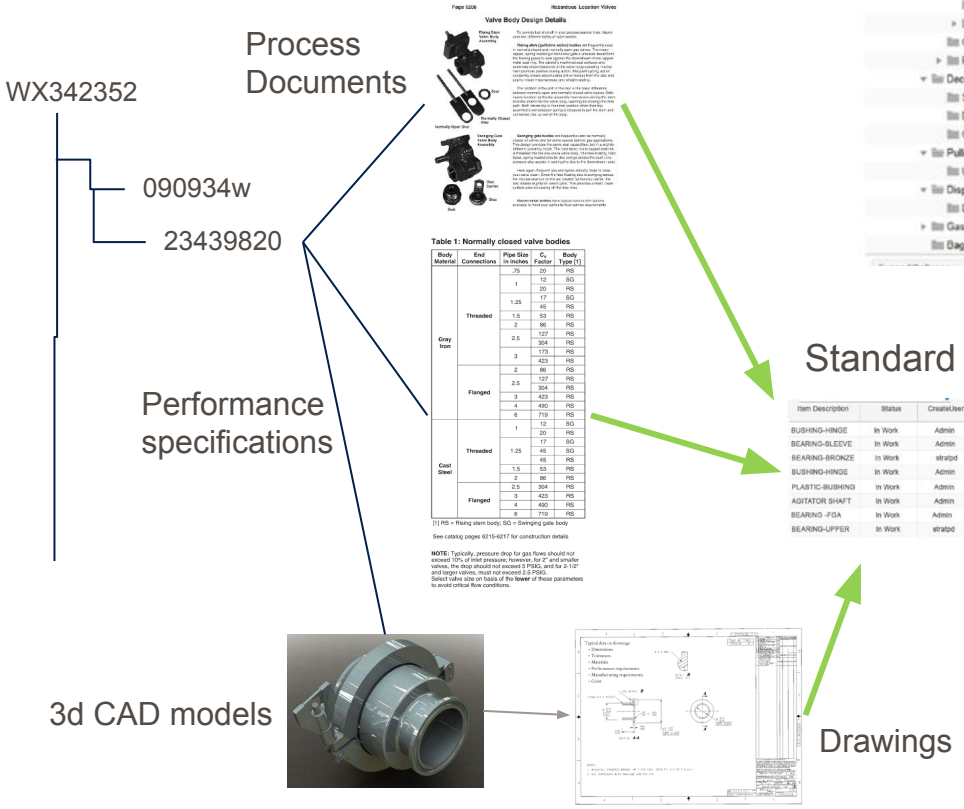
Specifications

Process Documents

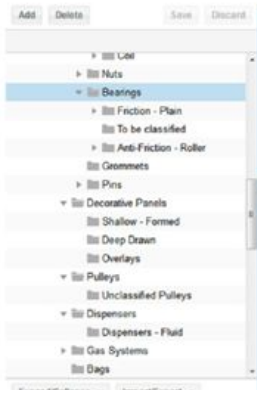
Structuring data is a way to manage the data onslaught and enable outcomes-based business models.

PLM Bill of Information

- Files are stored in PLM
- Data in files is unstructured



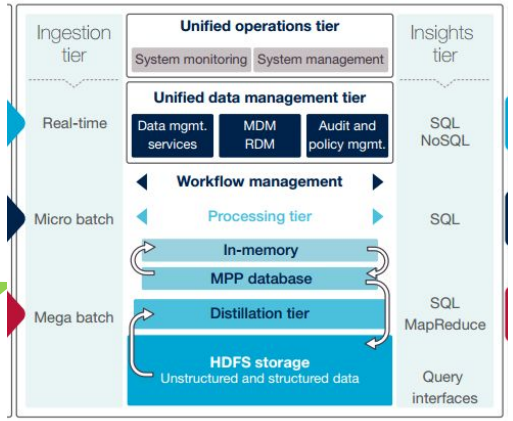
Standard Data Model



Standard Data Structure

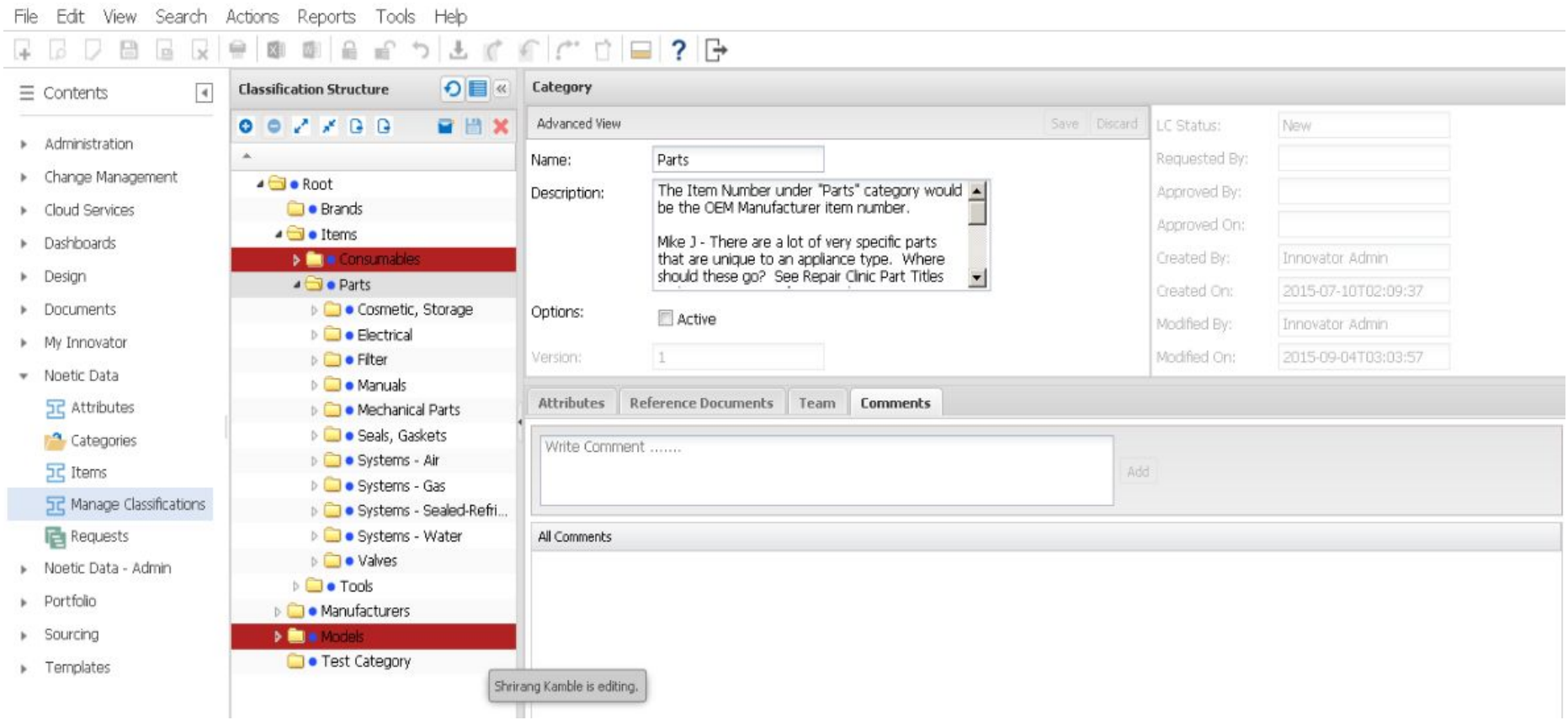
Data Lake

- Standardized data
- Consistent data format
- Algorithms used to identify issues
- Available for analytics



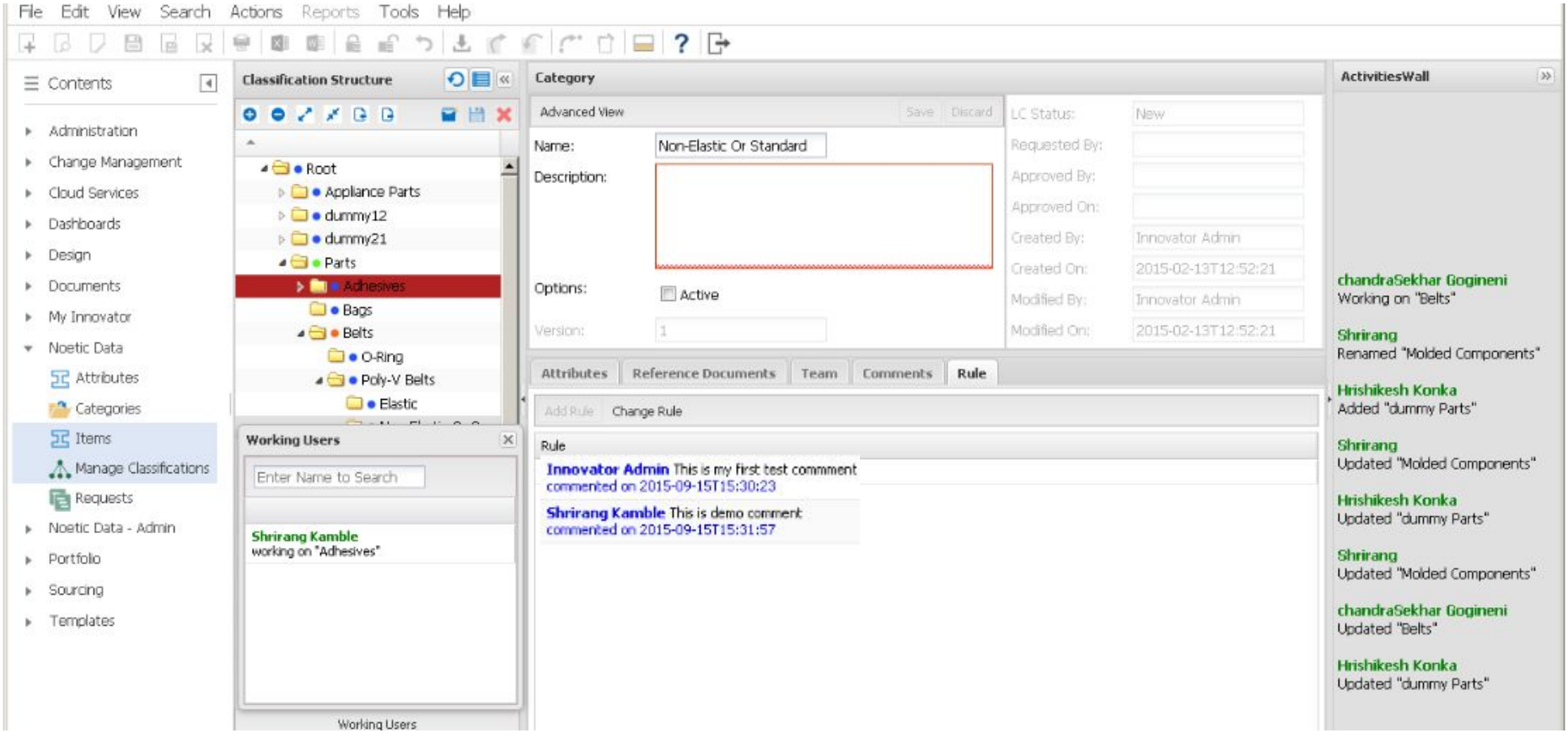
Aras Innovator with additional collaboration functions is a good tool for structuring data.

Data Structure Collaboration

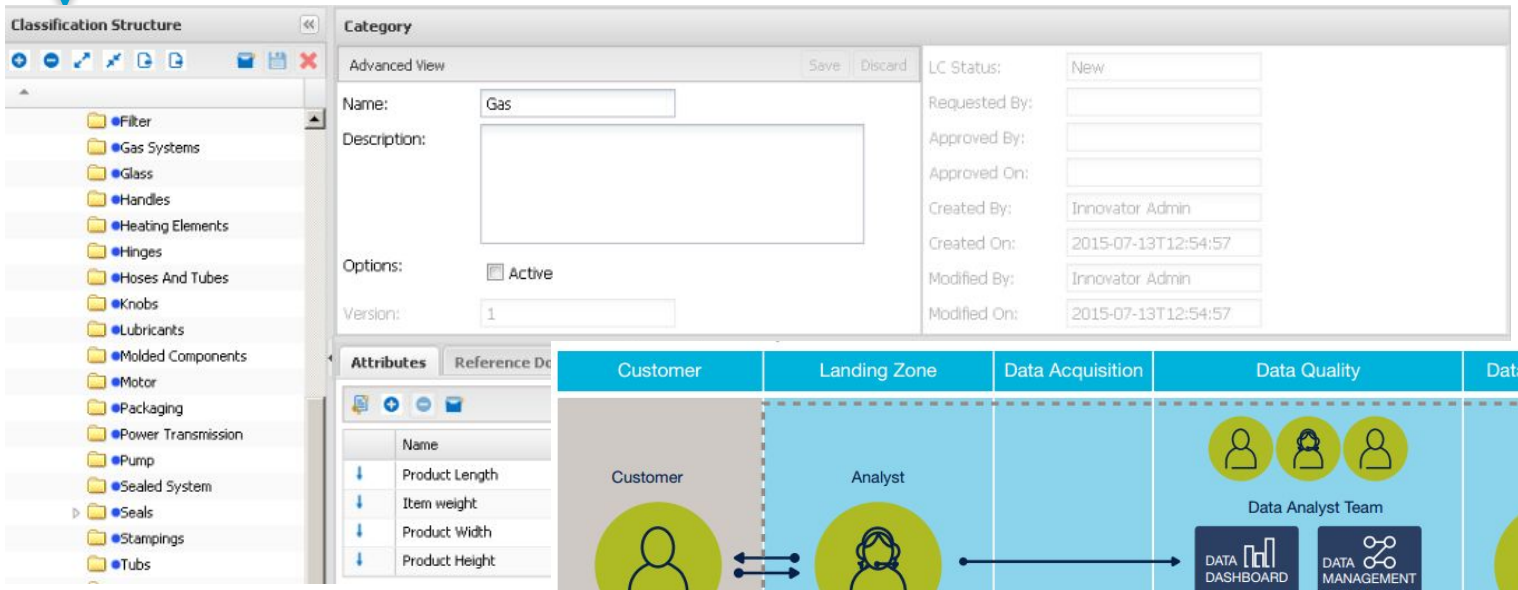


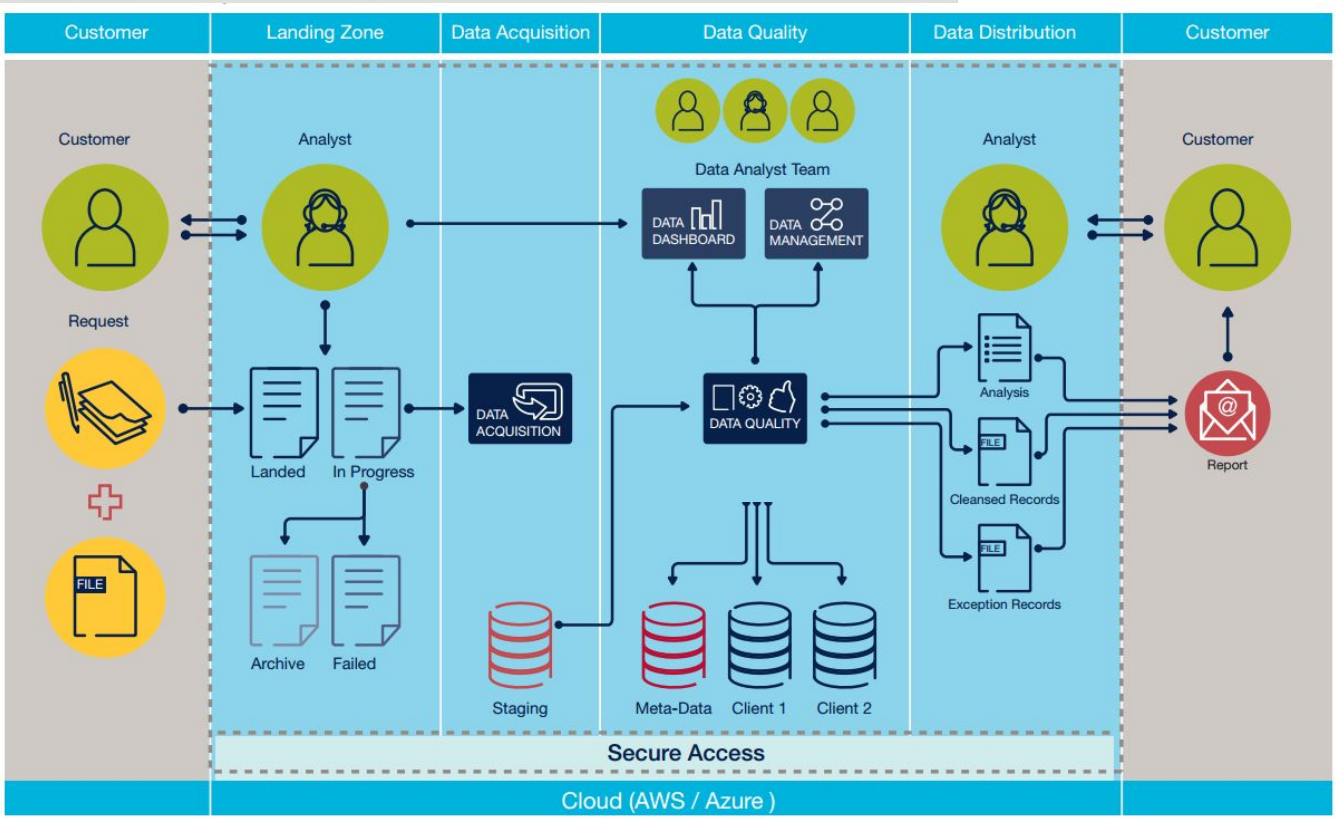
Aras Innovator with additional collaboration functions is a good tool for structuring data (cont.)

Capturing Knowledge For Future Reference



Once the structure and attributes are defined, “Data Quality as a Service” can populate the attributes.



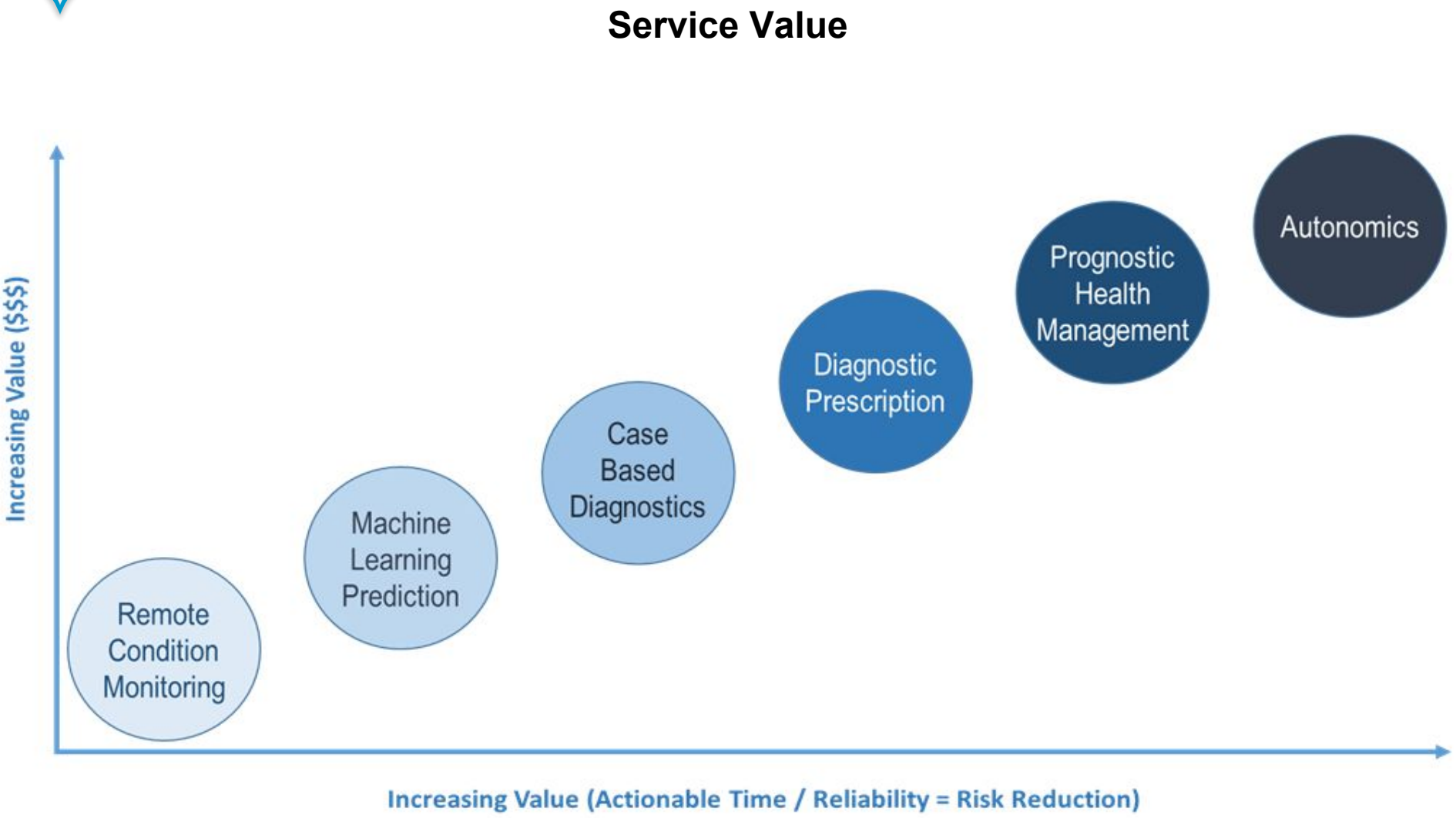


After PLM / SLM integration and structured data, maintenance can change dramatically.

Asset Maintenance Use Case

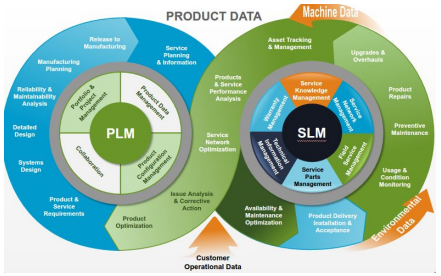
- A manufacturing defect is identified in a wheel bearing
- There are two bearing types installed on a family of locomotives: “oil lubricated” or “sealed / greased”
- Simply search the attribute “bearing lubrication” for the value “oil”
- The result is all the bearings that are subject to the recall and the serial number locomotive and the bearing location

Better data results in more service value.



Increasing the accessibility of structured engineering data enables value from outcome-based business models.

Value Areas



- Reduced supply chain costs
  - Reduction in duplicate parts in inventory
  - Reducing supplier base to the most reliable cost effective part
  - Accurate BOM's and better obsolescence control
  - More information for customers and purchasing on part attributes
- Improving the ability to manage as-maintained configurations at the Serial # Level
  - Flexible BOM structure with a robust Engineering Change Management Process
  - Feeding operational quality, safety and reliability data back to Engineering
  - Improving the ability to plan and manage product recalls and modifications
- Enabling more accurate diagnostic tools with accurate parts data and asset configuration
- Providing sales and engineering more information on fielded assets to identify new reliability enhancements, new product options and new product design ideas.

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