EMPOWER YOUR ANALYTICS WITH OPERATIONAL DATA

Enabling IT/OT Convergence: Operations Data and Advanced Analytics

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01/10/2019

Introduction

Intro into Operations

- Wants to drive and enable operations
- Deep expertise in engineering
- Wants trusted, purpose built and reliable

Intro to IT

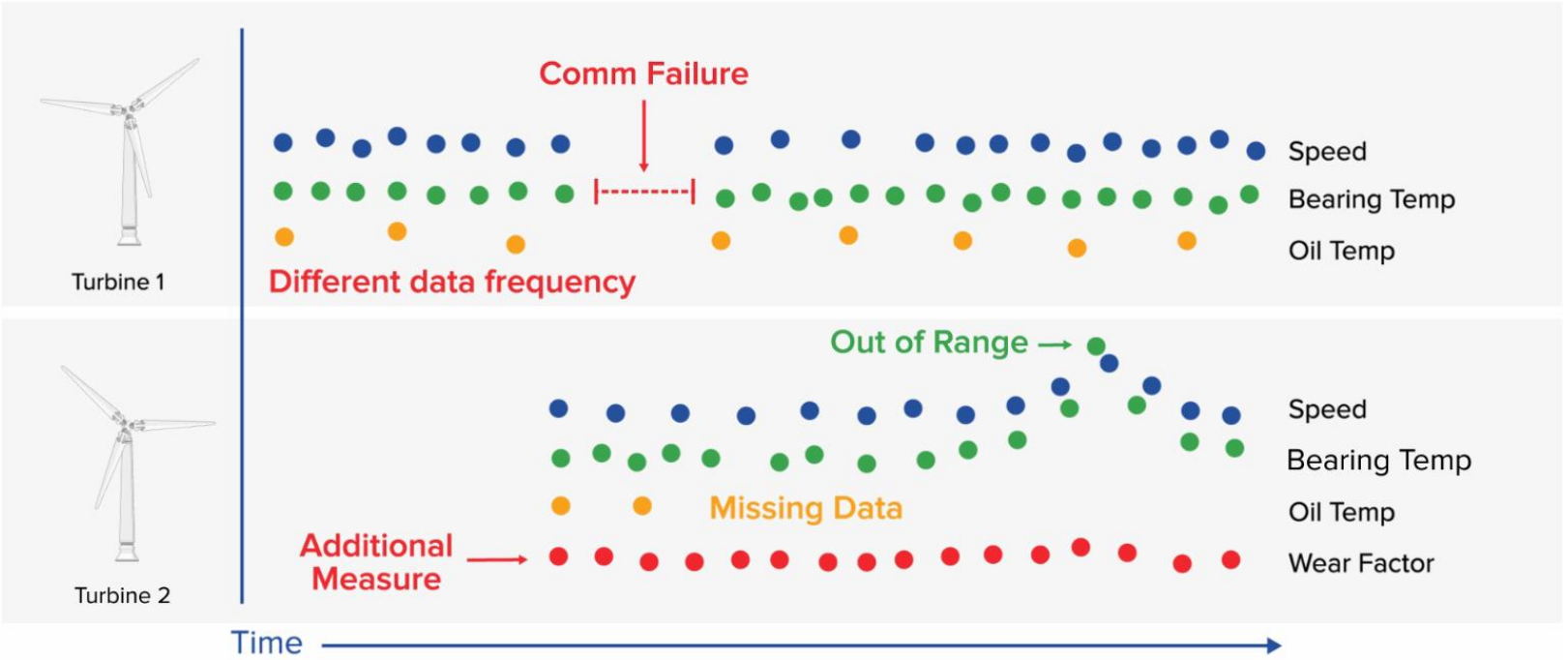
- Deep expertise in info systems
- Focused on digital transformation
- Early adopter of new technology

Challenges of Integrating OT & IT Data

Data Management & Integration

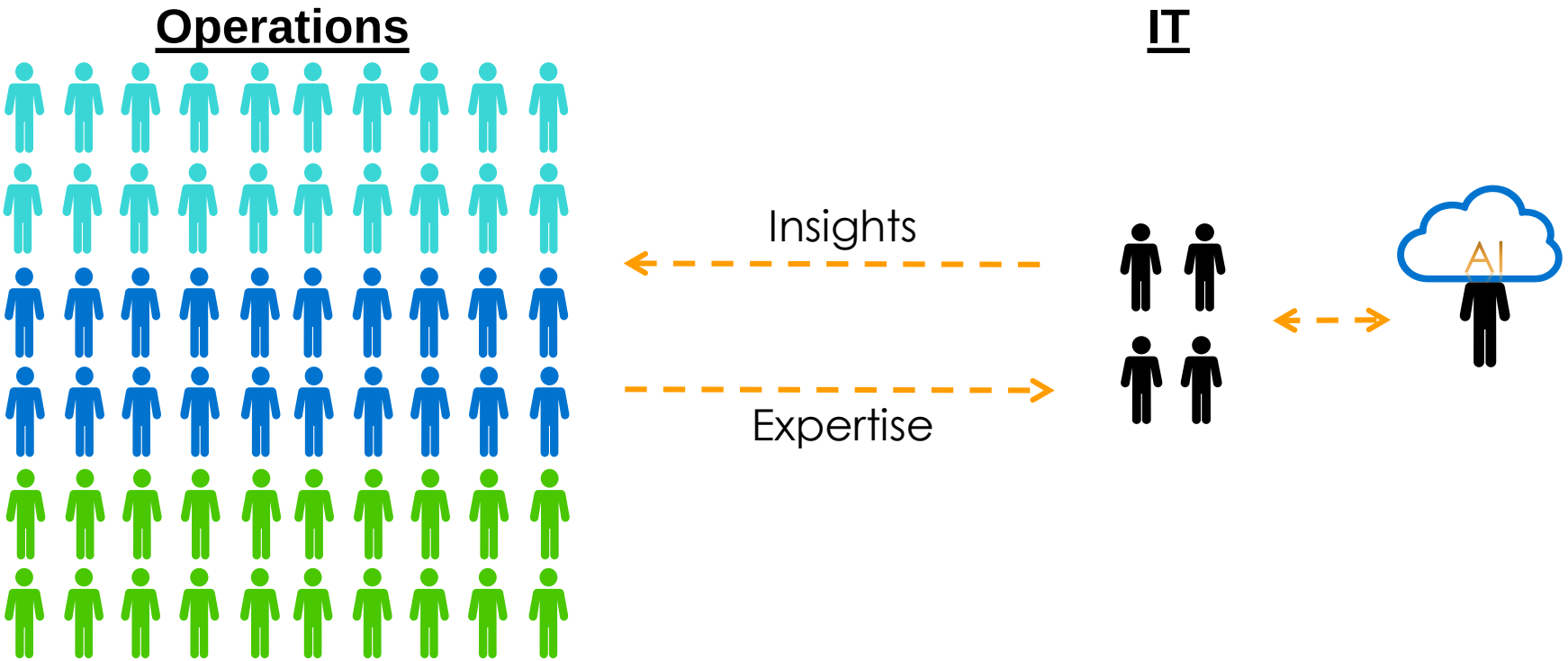
OT data is from a variety of dynamic sources	✓ The PI System standardizes & normalizes OT data
OT data is variable, continuous and time based	✓ Operations data needs to be prepared for use in IT tools
OT data requires context to compare fleets of assets	✓ Data Management with AF/EF & PI Integrator *reduces time & complexity* of analysis

Time-series Data is Not Naturally Aligned or Contextualized



Extending Your Opportunity

Bring Operations Insights to the Enterprise

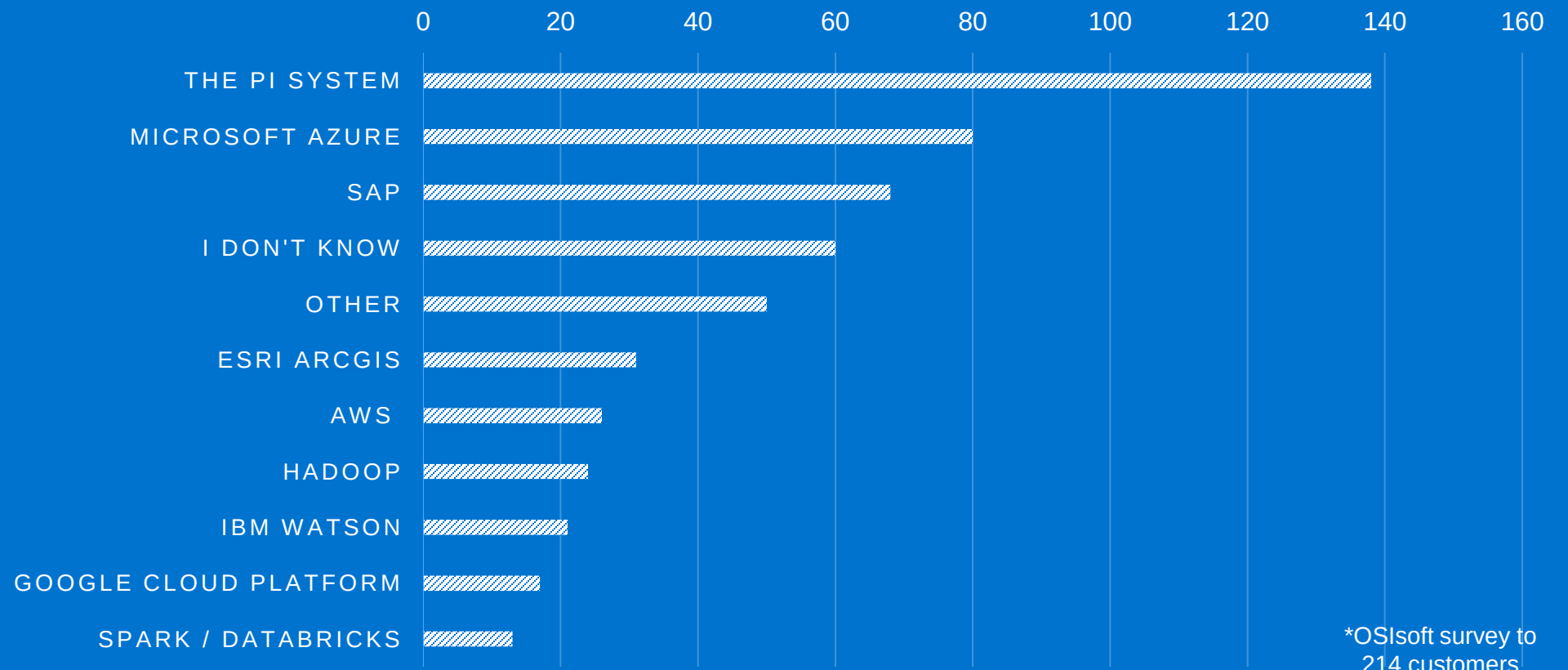


An ERP is not suited to operate your plant,
a PI System is not suited to be your ERP

It’s a better together story…

Cloud Strategy

What Technologies are Needed for Enterprise Analytics?



*OSIsoft survey to 214 customers

It’s a better together story…

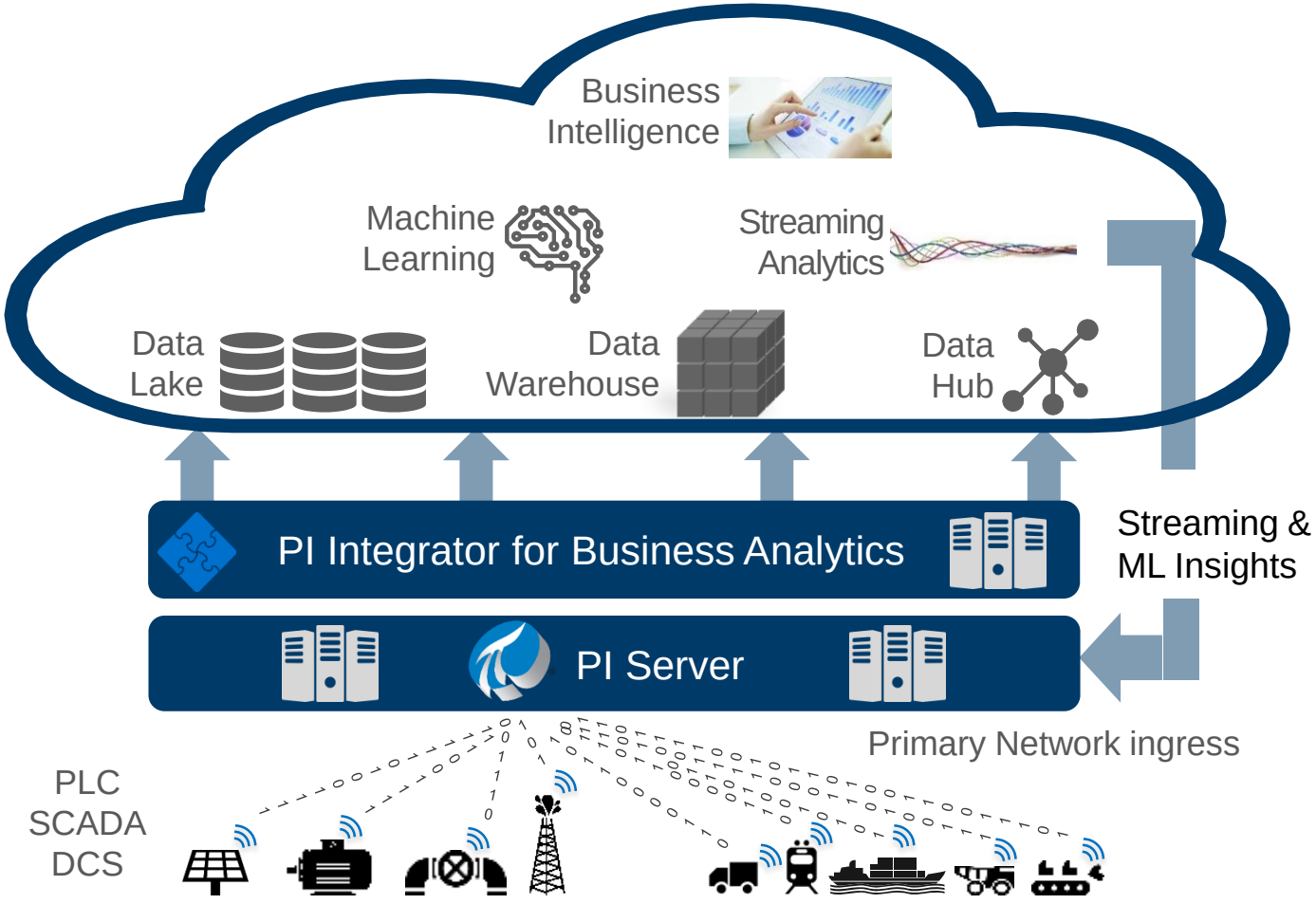
OSIsoft has a multi-cloud strategy designed for ***repeatable patterns*** with major cloud vendors

Google Cloud Platform

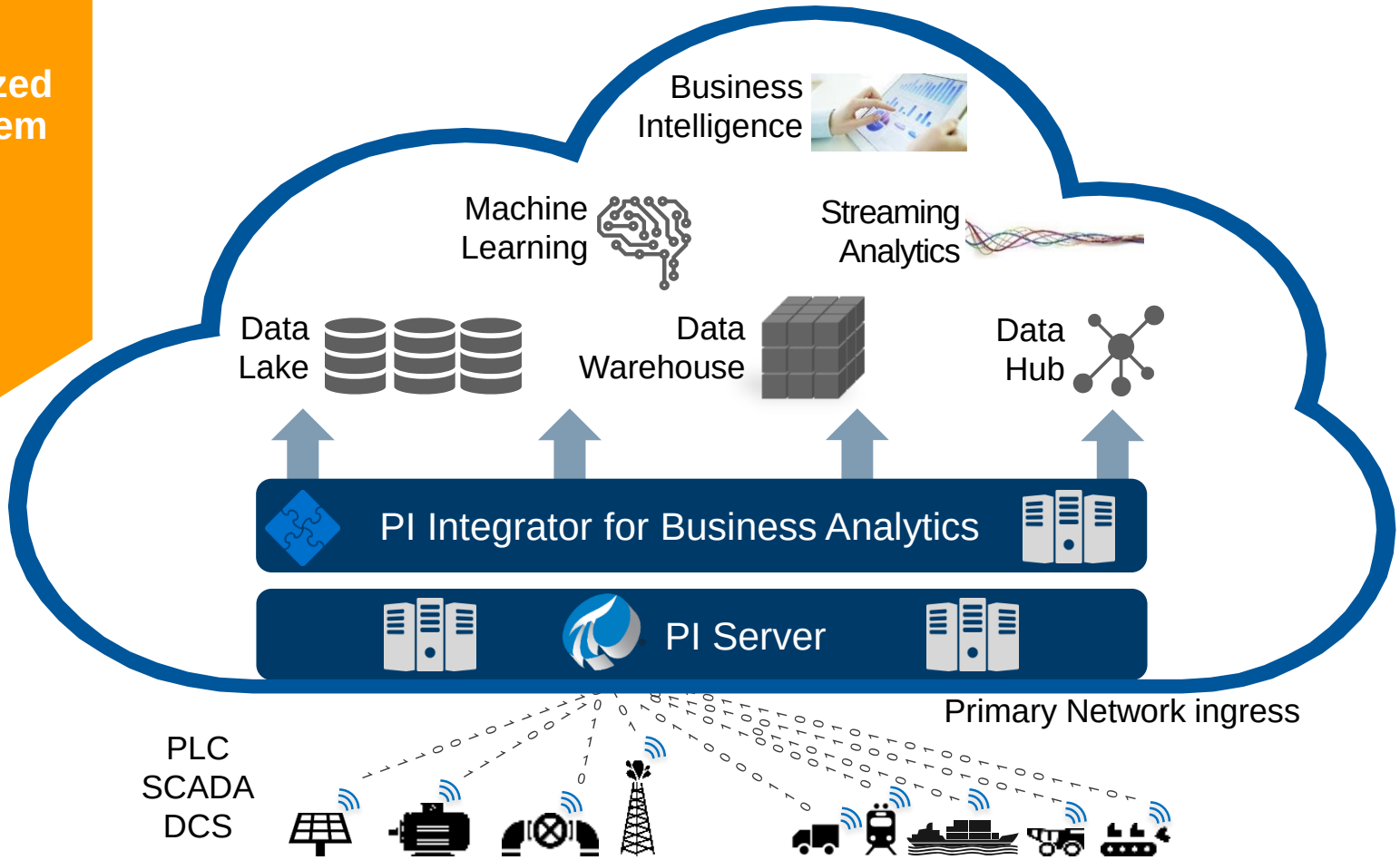
Repeatable Patterns for Extending into Cloud

An Enterprise Data Management & Integration strategy is necessary for success

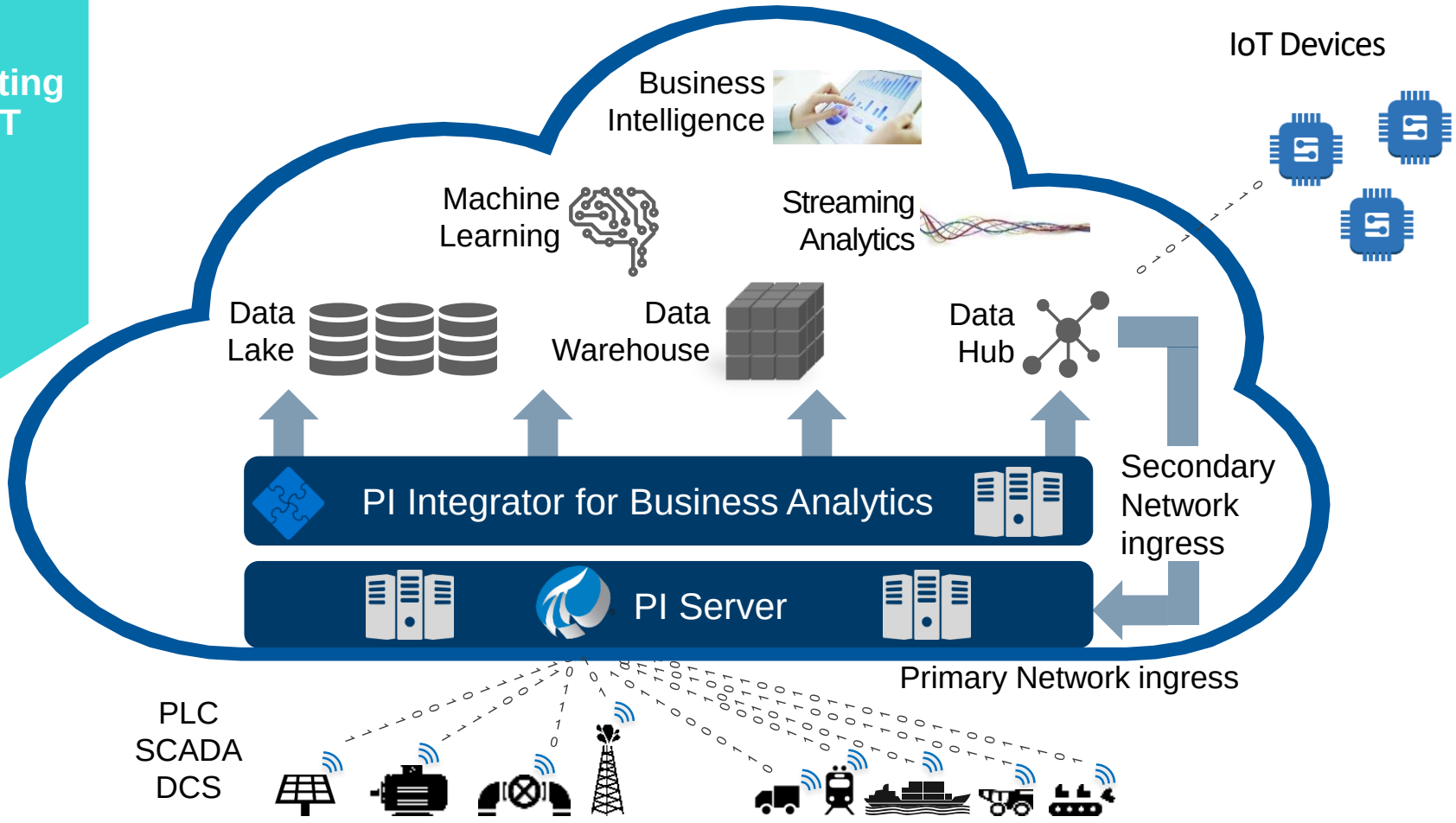
Data Science



Virtualized PI System



Architecting for IoT



Advanced Analytics

Success When Used to Augment Decisions

Greater Operational Efficiency

Henkel (with pmOne) **predict when a transition occurs** for an exothermic reaction, **saving 5% of process time**.

Enhanced Ability to Prevent Costly Failures

Invenergy (with SparkCognition) **predict catastrophic gearbox failures** at least **one month in advance**.

Better Environmental Protection

United Utilities proved an ability to accurately **predict combined sewer overflows 6 hours before an incident**.

Five Considerations Before Starting with Advanced Analytics

1. Gaps in data collection
2. Poor data quality
3. Low # of modes
4. Unknown relationships
5. Natural skepticism

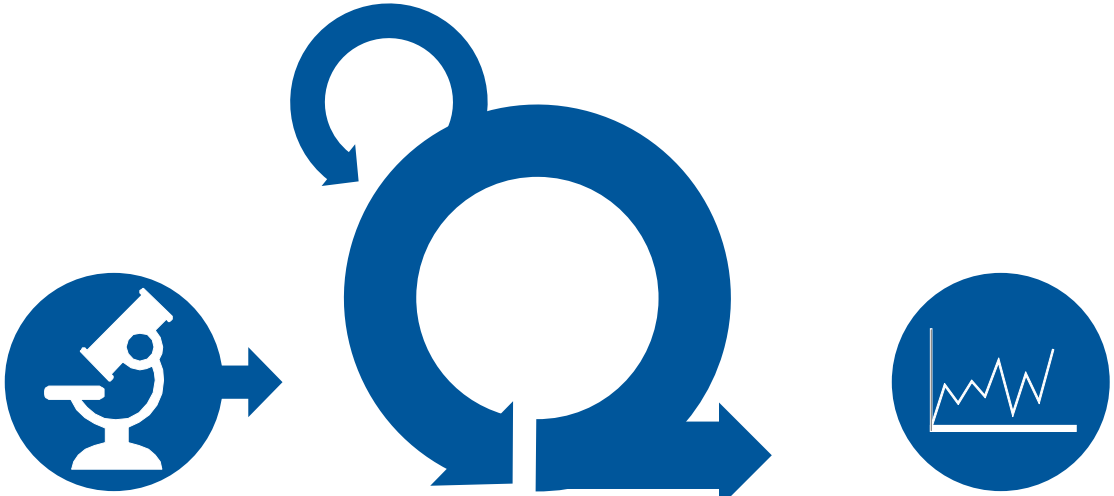
How does the PI Integrator help you with these obstacles?

1. Gaps in data collection – filter or interpolate
2. Poor data quality – filter unreasonable values
3. Low # of modes – determine modes by indexing on events
4. Unknown relationships – work with data experts, no code needed
5. Natural skepticism – involve SME in iterative training without requiring a lot of their time

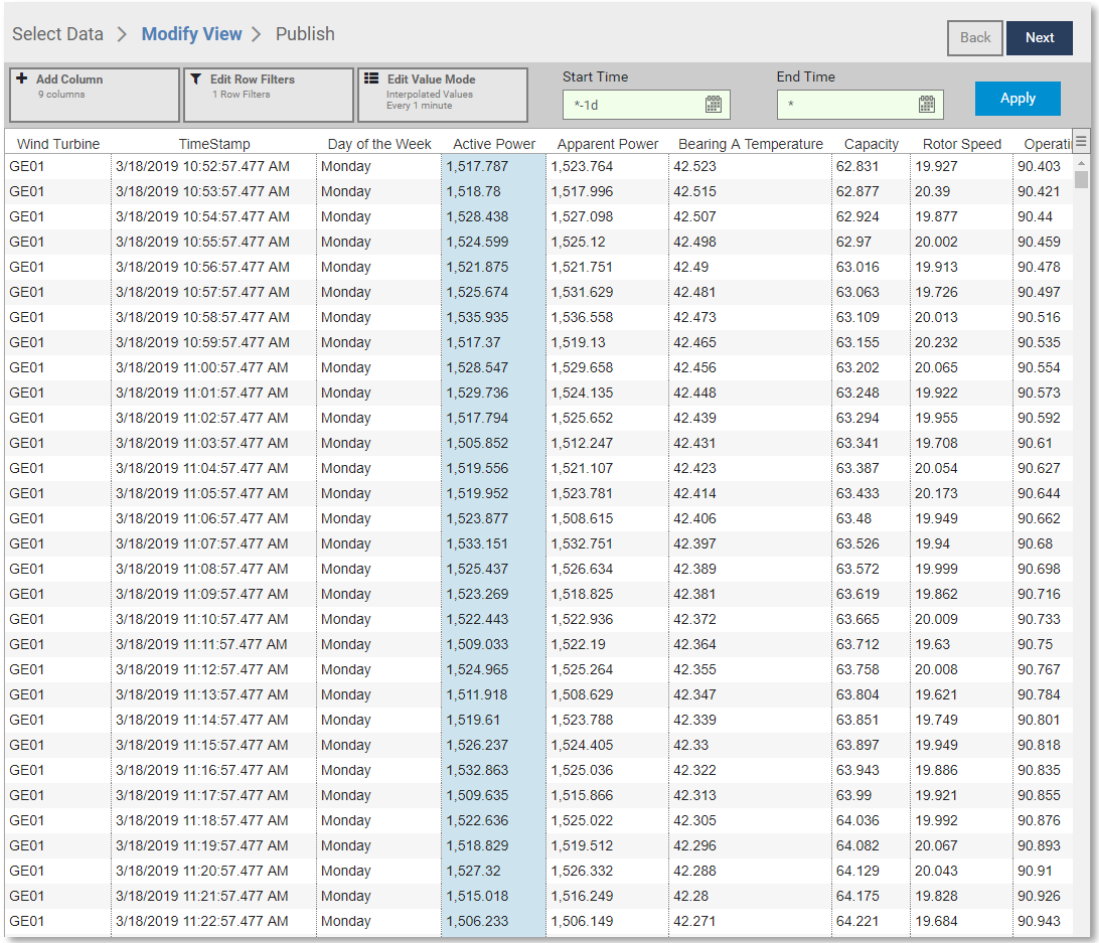
How do you reduce
the **uncertainty** of
what can be achieved
with **advanced analytics** ?

Adopt Iterative Workflows that Include SMEs

… and use technology that support these workflows



Discover

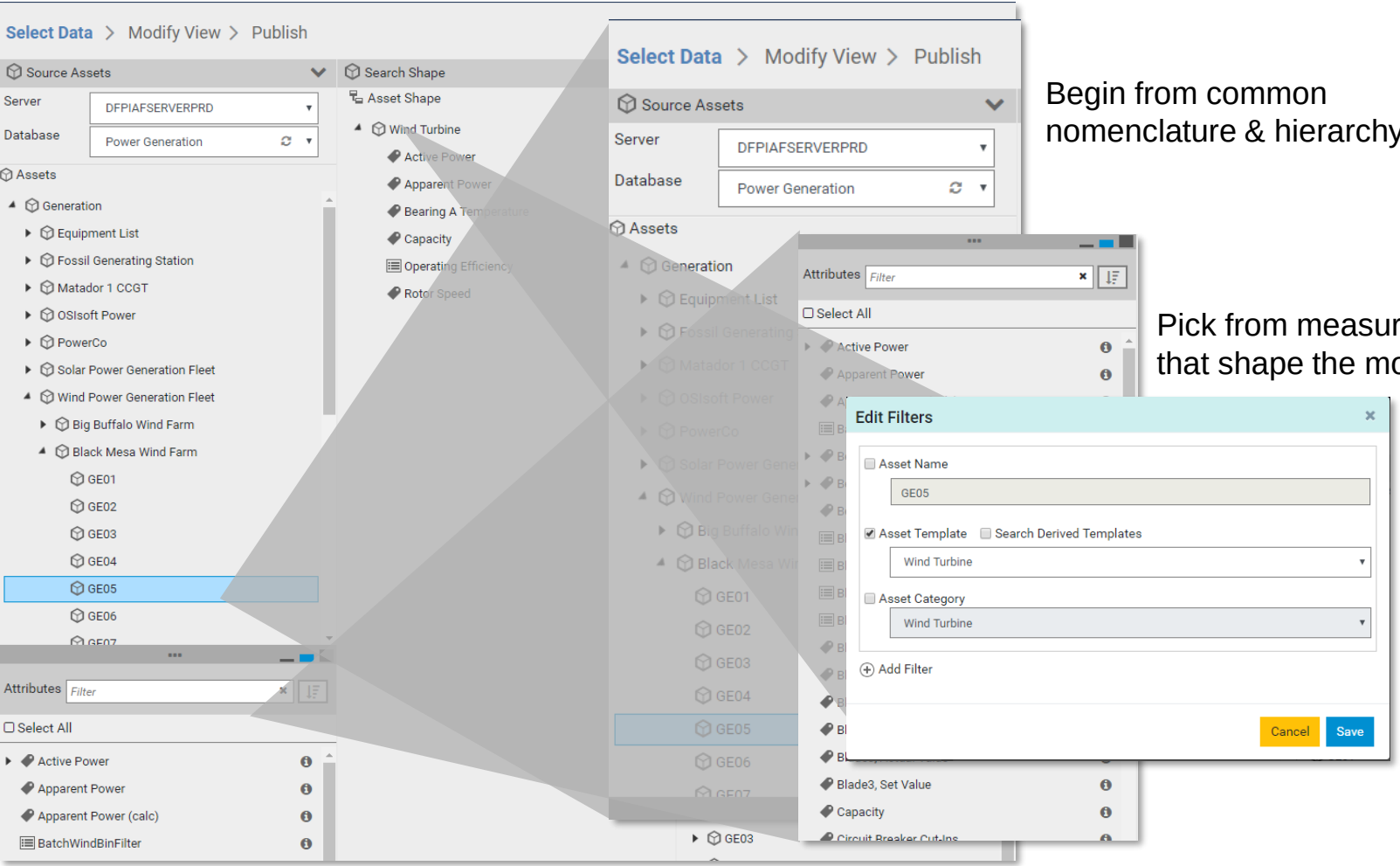


Wind Turbine	TimeStamp	Day of the Week	Active Power	Apparent Power	Bearing A Temperature	Capacity	Rotor Speed	Operati
GE01	3/18/2019 10:52:57.477 AM	Monday	1,517.787	1,523.764	42.523	62.831	19.927	90.403
GE01	3/18/2019 10:53:57.477 AM	Monday	1,518.78	1,517.996	42.515	62.877	20.39	90.421
GE01	3/18/2019 10:54:57.477 AM	Monday	1,528.438	1,527.098	42.507	62.924	19.877	90.44
GE01	3/18/2019 10:55:57.477 AM	Monday	1,524.599	1,525.12	42.498	62.97	20.002	90.459
GE01	3/18/2019 10:56:57.477 AM	Monday	1,521.875	1,521.751	42.49	63.016	19.913	90.478
GE01	3/18/2019 10:57:57.477 AM	Monday	1,525.674	1,531.629	42.481	63.063	19.726	90.497
GE01	3/18/2019 10:58:57.477 AM	Monday	1,535.935	1,536.558	42.473	63.109	20.013	90.516
GE01	3/18/2019 10:59:57.477 AM	Monday	1,517.37	1,519.13	42.465	63.155	20.232	90.535
GE01	3/18/2019 11:00:57.477 AM	Monday	1,528.547	1,529.658	42.456	63.202	20.065	90.554
GE01	3/18/2019 11:01:57.477 AM	Monday	1,529.736	1,524.135	42.448	63.248	19.922	90.573
GE01	3/18/2019 11:02:57.477 AM	Monday	1,517.794	1,525.652	42.439	63.294	19.955	90.592
GE01	3/18/2019 11:03:57.477 AM	Monday	1,505.852	1,512.247	42.431	63.341	19.708	90.61
GE01	3/18/2019 11:04:57.477 AM	Monday	1,519.556	1,521.107	42.423	63.387	20.054	90.627
GE01	3/18/2019 11:05:57.477 AM	Monday	1,519.952	1,523.781	42.414	63.433	20.173	90.644
GE01	3/18/2019 11:06:57.477 AM	Monday	1,523.877	1,508.615	42.406	63.48	19.949	90.662
GE01	3/18/2019 11:07:57.477 AM	Monday	1,533.151	1,532.751	42.397	63.526	19.94	90.68
GE01	3/18/2019 11:08:57.477 AM	Monday	1,525.437	1,526.634	42.389	63.572	19.999	90.698
GE01	3/18/2019 11:09:57.477 AM	Monday	1,523.269	1,518.825	42.381	63.619	19.862	90.716
GE01	3/18/2019 11:10:57.477 AM	Monday	1,522.443	1,522.936	42.372	63.665	20.009	90.733
GE01	3/18/2019 11:11:57.477 AM	Monday	1,509.033	1,522.19	42.364	63.712	19.63	90.75
GE01	3/18/2019 11:12:57.477 AM	Monday	1,524.965	1,525.264	42.355	63.758	20.008	90.767
GE01	3/18/2019 11:13:57.477 AM	Monday	1,511.918	1,508.629	42.347	63.804	19.621	90.784
GE01	3/18/2019 11:14:57.477 AM	Monday	1,519.61	1,523.788	42.339	63.851	19.749	90.801
GE01	3/18/2019 11:15:57.477 AM	Monday	1,526.237	1,524.405	42.33	63.897	19.949	90.818
GE01	3/18/2019 11:16:57.477 AM	Monday	1,532.863	1,525.036	42.322	63.943	19.886	90.835
GE01	3/18/2019 11:17:57.477 AM	Monday	1,509.635	1,515.866	42.313	63.99	19.921	90.855
GE01	3/18/2019 11:18:57.477 AM	Monday	1,522.636	1,525.022	42.305	64.036	19.992	90.876
GE01	3/18/2019 11:19:57.477 AM	Monday	1,518.829	1,519.512	42.296	64.082	20.067	90.893
GE01	3/18/2019 11:20:57.477 AM	Monday	1,527.32	1,526.332	42.288	64.129	20.043	90.91
GE01	3/18/2019 11:21:57.477 AM	Monday	1,515.018	1,516.249	42.28	64.175	19.828	90.926
GE01	3/18/2019 11:22:57.477 AM	Monday	1,506.233	1,506.149	42.271	64.221	19.684	90.943

Discover

Data preparation capabilities that accelerate training algorithms or creating views for BI Tools:

- Common nomenclature
- Aligned data
- Normalized measurements across assets
- Complex filtering by
  - Asset type
  - Event type

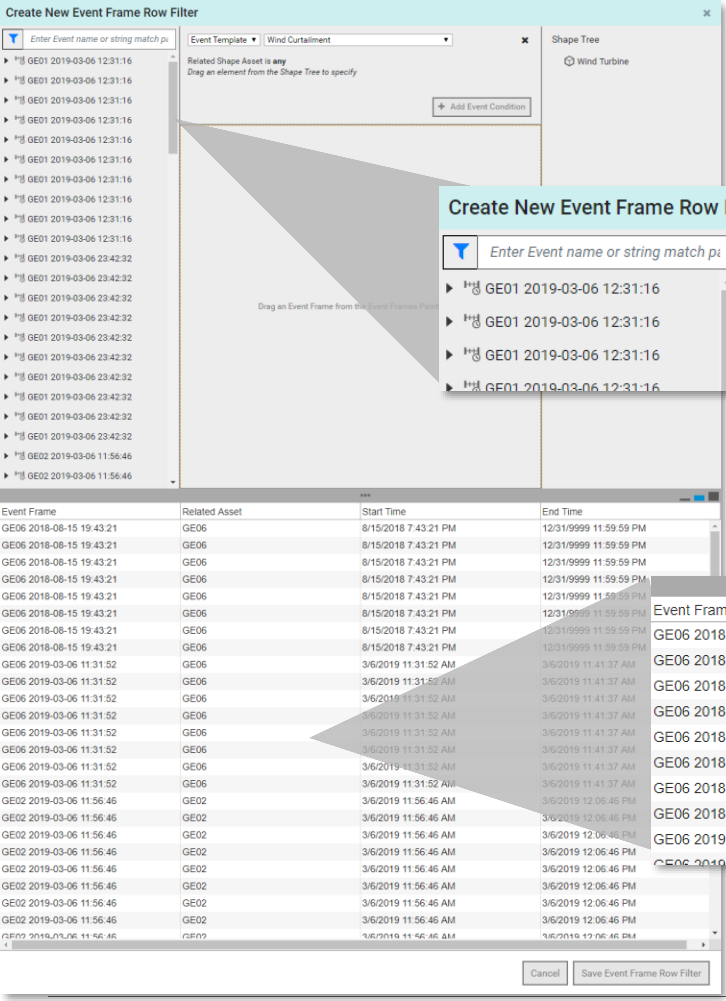


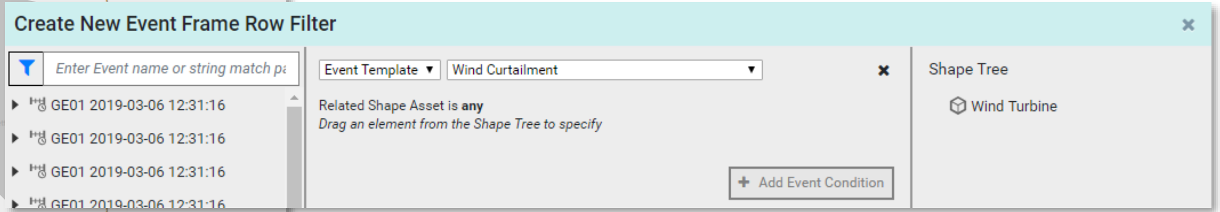
Begin from common nomenclature & hierarchy

Discover

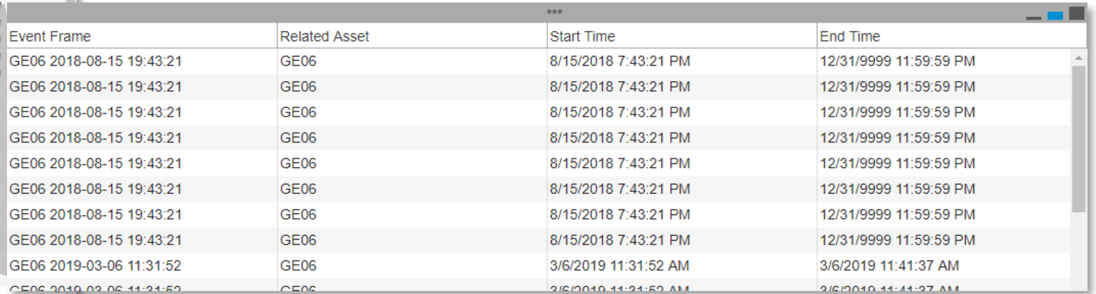
Pick from measurements that shape the model or view

Filter based on similar assets

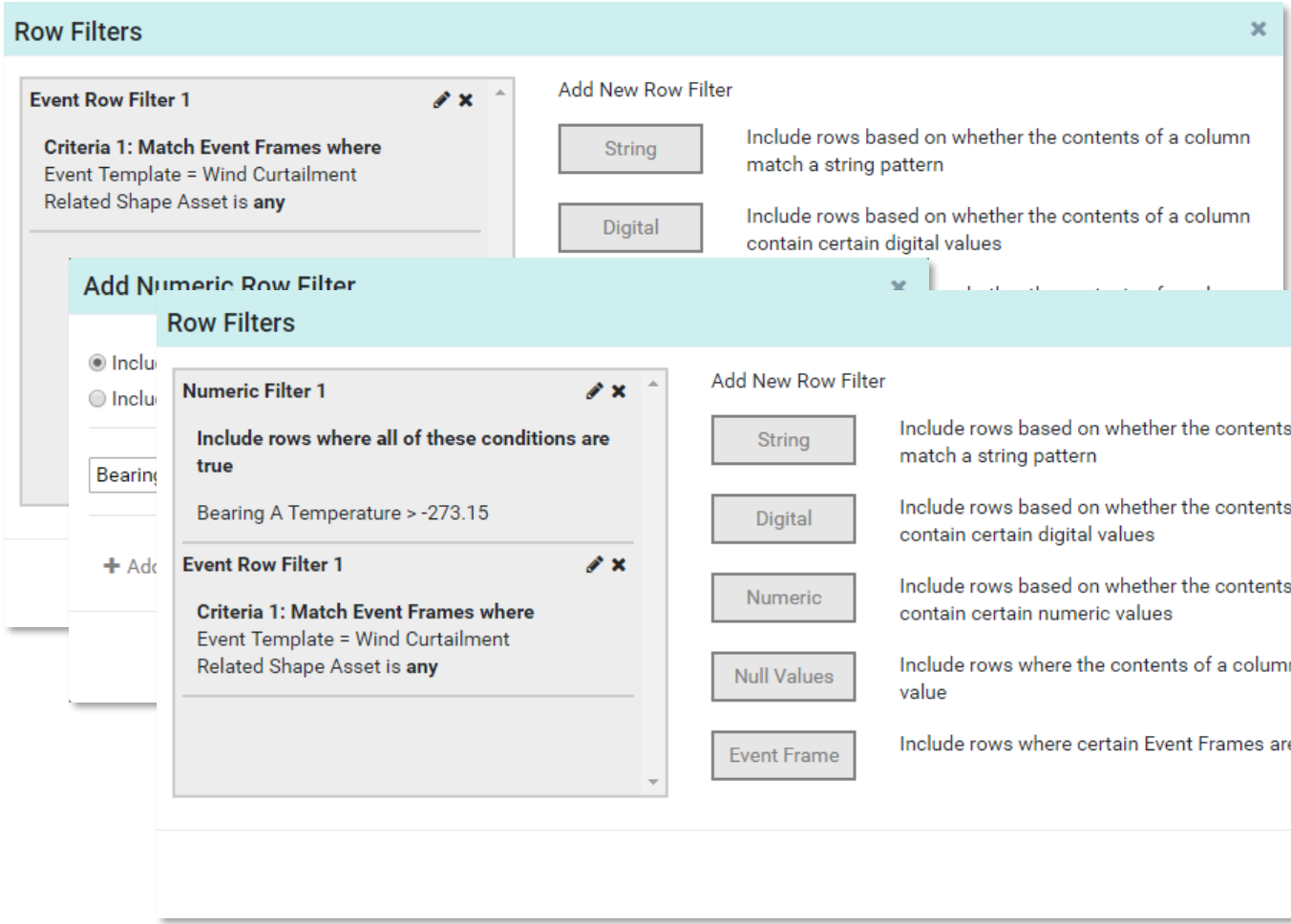




Select all data from a particular event type

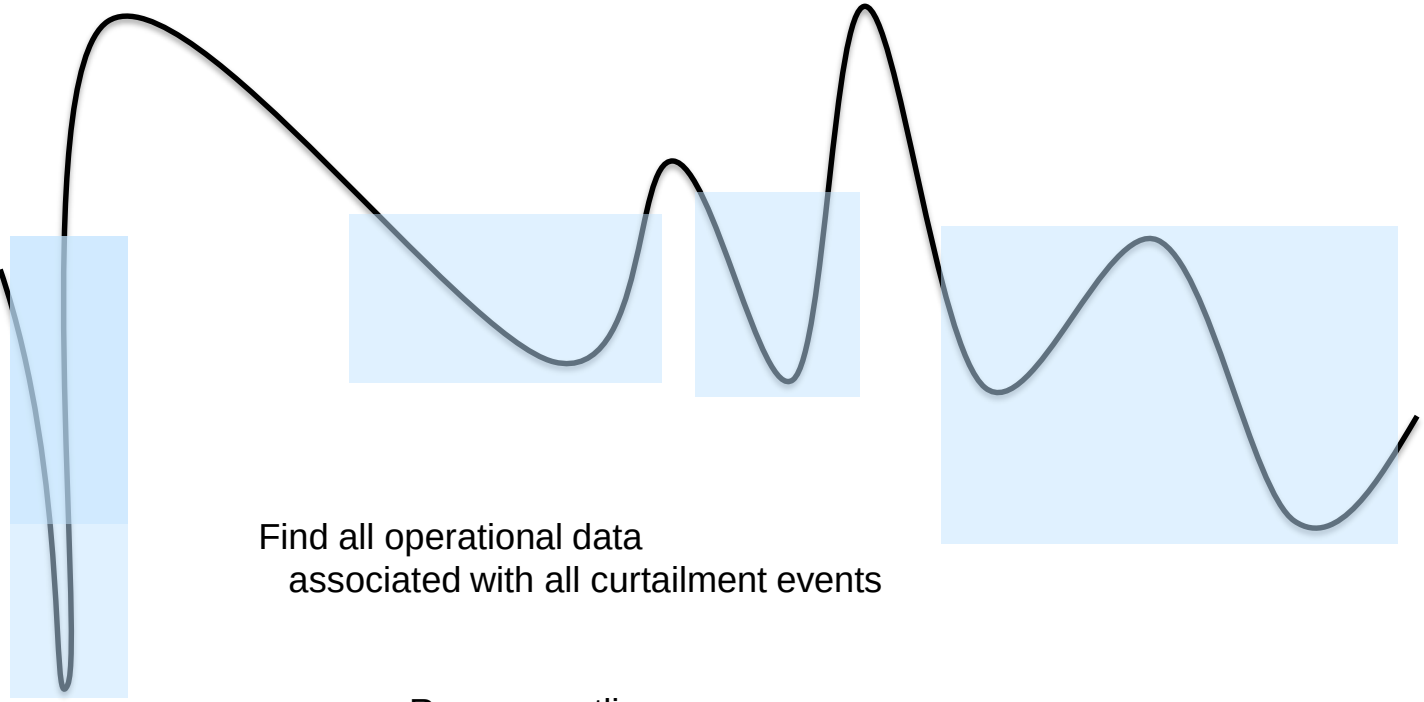


Quickly preview events after applying filter



Discover

Include multiple filters to clean data



Discover

Find all operational data
associated with all curtailment events

Remove outliers

Select Data > Modify View > Publish

Back | Next

Add Column (9 columns) | Edit Row Filters (1 Row Filters) | Edit Value Mode (Interpolated Values, Every 1 minute)

Start Time: *-1d | End Time: * | Apply

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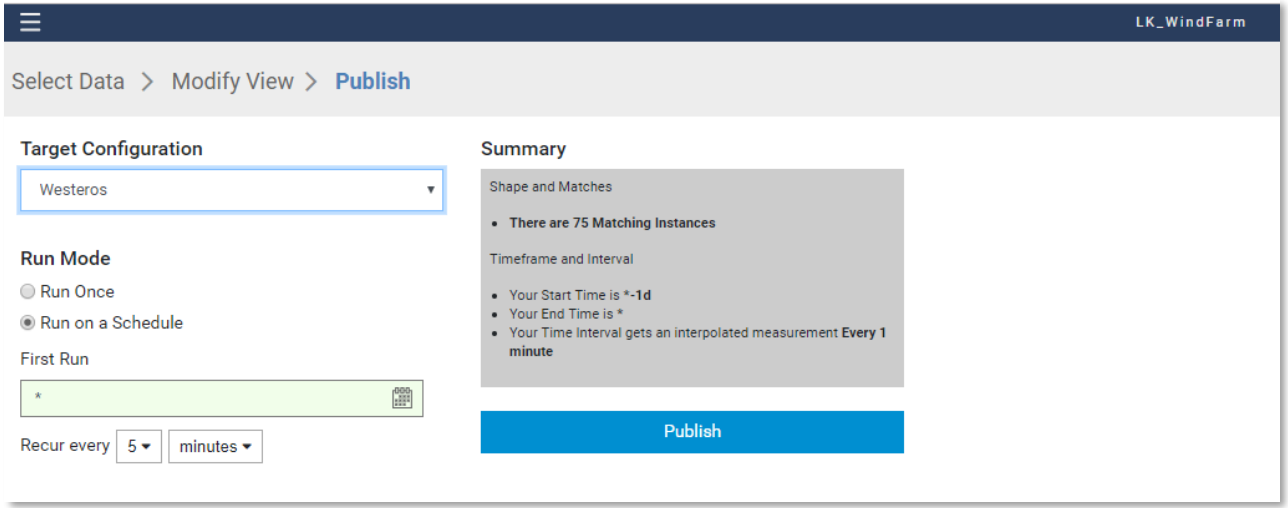
Discover

Operational data of an asset that is usable by algorithms or BI Tools!!

- Asset Context
- Data Alignment
- Asset Normalization
- Filtered on a Curtailment Event Type
- Filtered for T > -273.15 C

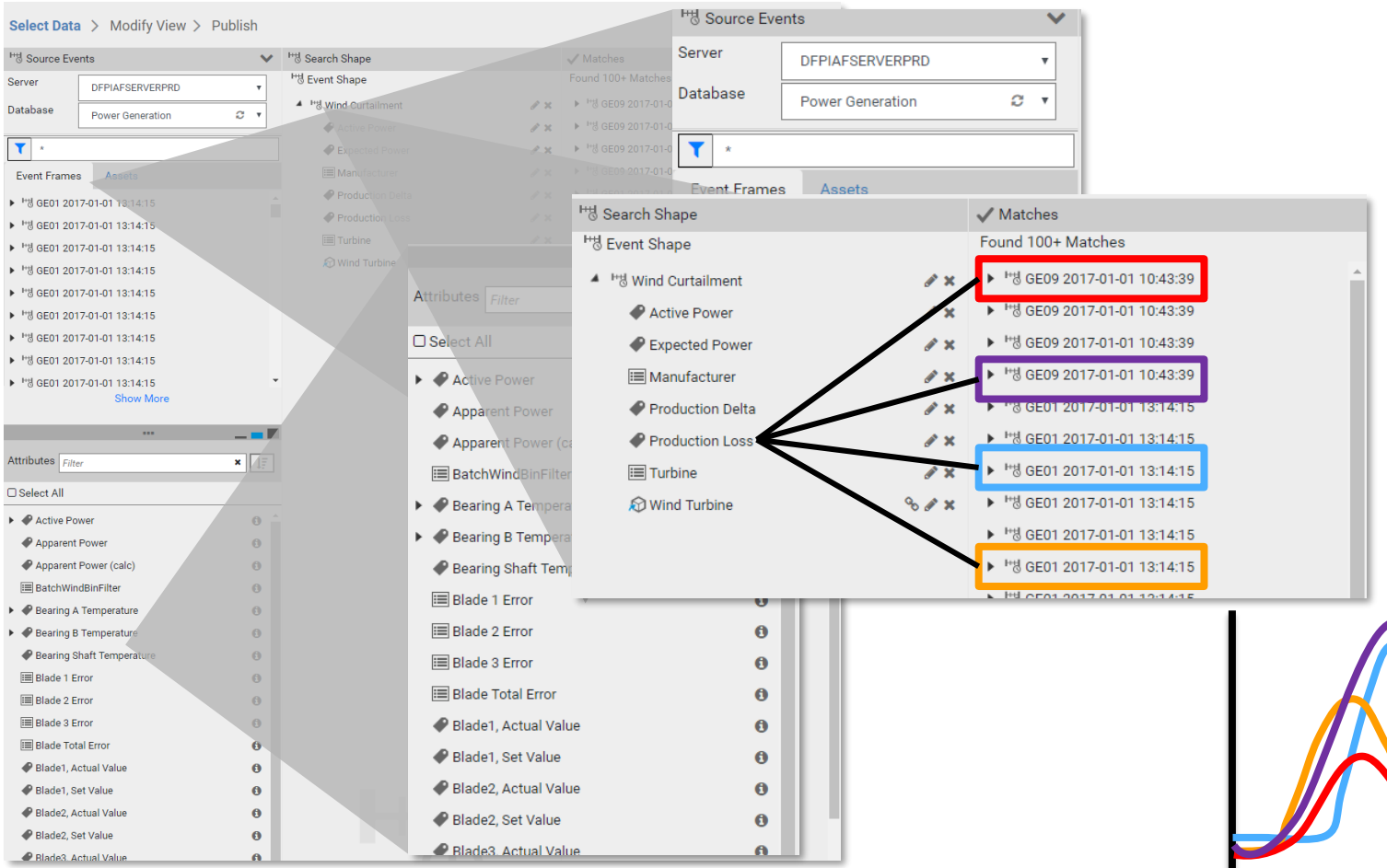
Discover



Select where you want to publish

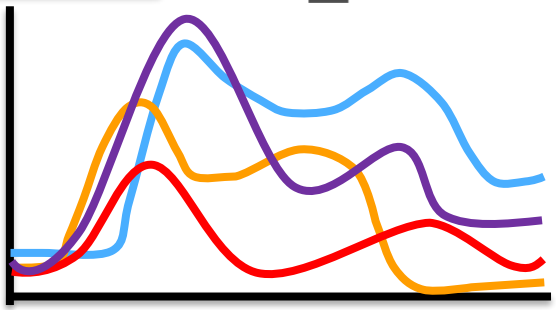
One-time bulk or incrementally push

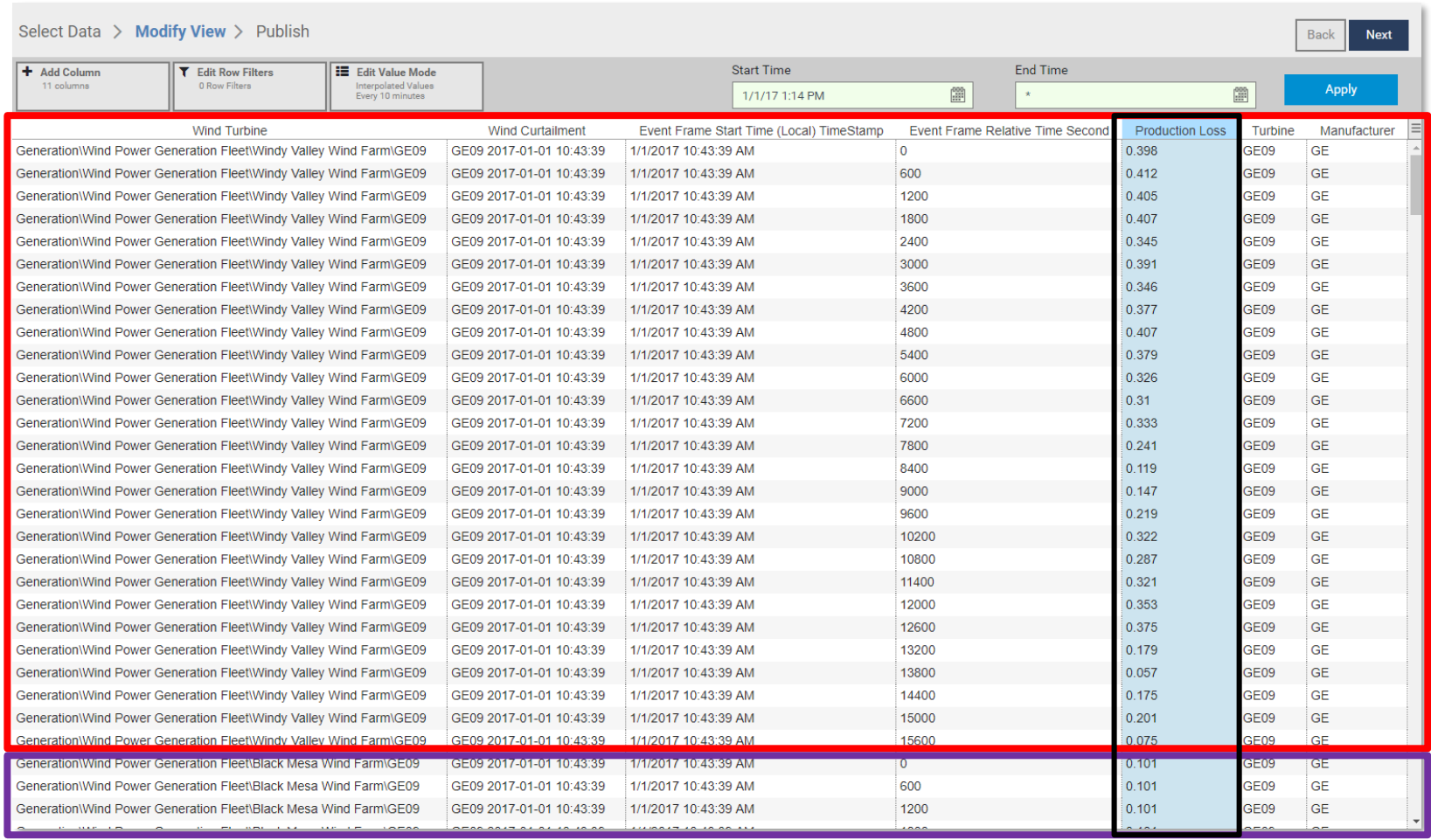
Benefit from native integration to AWS, Azure, Hadoop, and SAP HANA



Discover

What if you want to analyze events relative to each other?





Wind Turbine	Wind Curtailment	Event Frame Start Time (Local) TimeStamp	Event Frame Relative Time Second	Production Loss	Turbine	Manufacturer
Generation\Wind Power Generation Fleet\Windy Valley Wind Farm\GE09	GE09 2017-01-01 10:43:39	1/1/2017 10:43:39 AM	0	0.398	GE09	GE
Generation\Wind Power Generation Fleet\Windy Valley Wind Farm\GE09	GE09 2017-01-01 10:43:39	1/1/2017 10:43:39 AM	600	0.412	GE09	GE
Generation\Wind Power Generation Fleet\Windy Valley Wind Farm\GE09	GE09 2017-01-01 10:43:39	1/1/2017 10:43:39 AM	1200	0.405	GE09	GE
Generation\Wind Power Generation Fleet\Windy Valley Wind Farm\GE09	GE09 2017-01-01 10:43:39	1/1/2017 10:43:39 AM	1800	0.407	GE09	GE
Generation\Wind Power Generation Fleet\Windy Valley Wind Farm\GE09	GE09 2017-01-01 10:43:39	1/1/2017 10:43:39 AM	2400	0.345	GE09	GE
Generation\Wind Power Generation Fleet\Windy Valley Wind Farm\GE09	GE09 2017-01-01 10:43:39	1/1/2017 10:43:39 AM	3000	0.391	GE09	GE
Generation\Wind Power Generation Fleet\Windy Valley Wind Farm\GE09	GE09 2017-01-01 10:43:39	1/1/2017 10:43:39 AM	3600	0.346	GE09	GE
Generation\Wind Power Generation Fleet\Windy Valley Wind Farm\GE09	GE09 2017-01-01 10:43:39	1/1/2017 10:43:39 AM	4200	0.377	GE09	GE
Generation\Wind Power Generation Fleet\Windy Valley Wind Farm\GE09	GE09 2017-01-01 10:43:39	1/1/2017 10:43:39 AM	4800	0.407	GE09	GE
Generation\Wind Power Generation Fleet\Windy Valley Wind Farm\GE09	GE09 2017-01-01 10:43:39	1/1/2017 10:43:39 AM	5400	0.379	GE09	GE
Generation\Wind Power Generation Fleet\Windy Valley Wind Farm\GE09	GE09 2017-01-01 10:43:39	1/1/2017 10:43:39 AM	6000	0.326	GE09	GE
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Generation\Wind Power Generation Fleet\Windy Valley Wind Farm\GE09	GE09 2017-01-01 10:43:39	1/1/2017 10:43:39 AM	7800	0.241	GE09	GE
Generation\Wind Power Generation Fleet\Windy Valley Wind Farm\GE09	GE09 2017-01-01 10:43:39	1/1/2017 10:43:39 AM	8400	0.119	GE09	GE
Generation\Wind Power Generation Fleet\Windy Valley Wind Farm\GE09	GE09 2017-01-01 10:43:39	1/1/2017 10:43:39 AM	9000	0.147	GE09	GE
Generation\Wind Power Generation Fleet\Windy Valley Wind Farm\GE09	GE09 2017-01-01 10:43:39	1/1/2017 10:43:39 AM	9600	0.219	GE09	GE
Generation\Wind Power Generation Fleet\Windy Valley Wind Farm\GE09	GE09 2017-01-01 10:43:39	1/1/2017 10:43:39 AM	10200	0.322	GE09	GE
Generation\Wind Power Generation Fleet\Windy Valley Wind Farm\GE09	GE09 2017-01-01 10:43:39	1/1/2017 10:43:39 AM	10800	0.287	GE09	GE
Generation\Wind Power Generation Fleet\Windy Valley Wind Farm\GE09	GE09 2017-01-01 10:43:39	1/1/2017 10:43:39 AM	11400	0.321	GE09	GE
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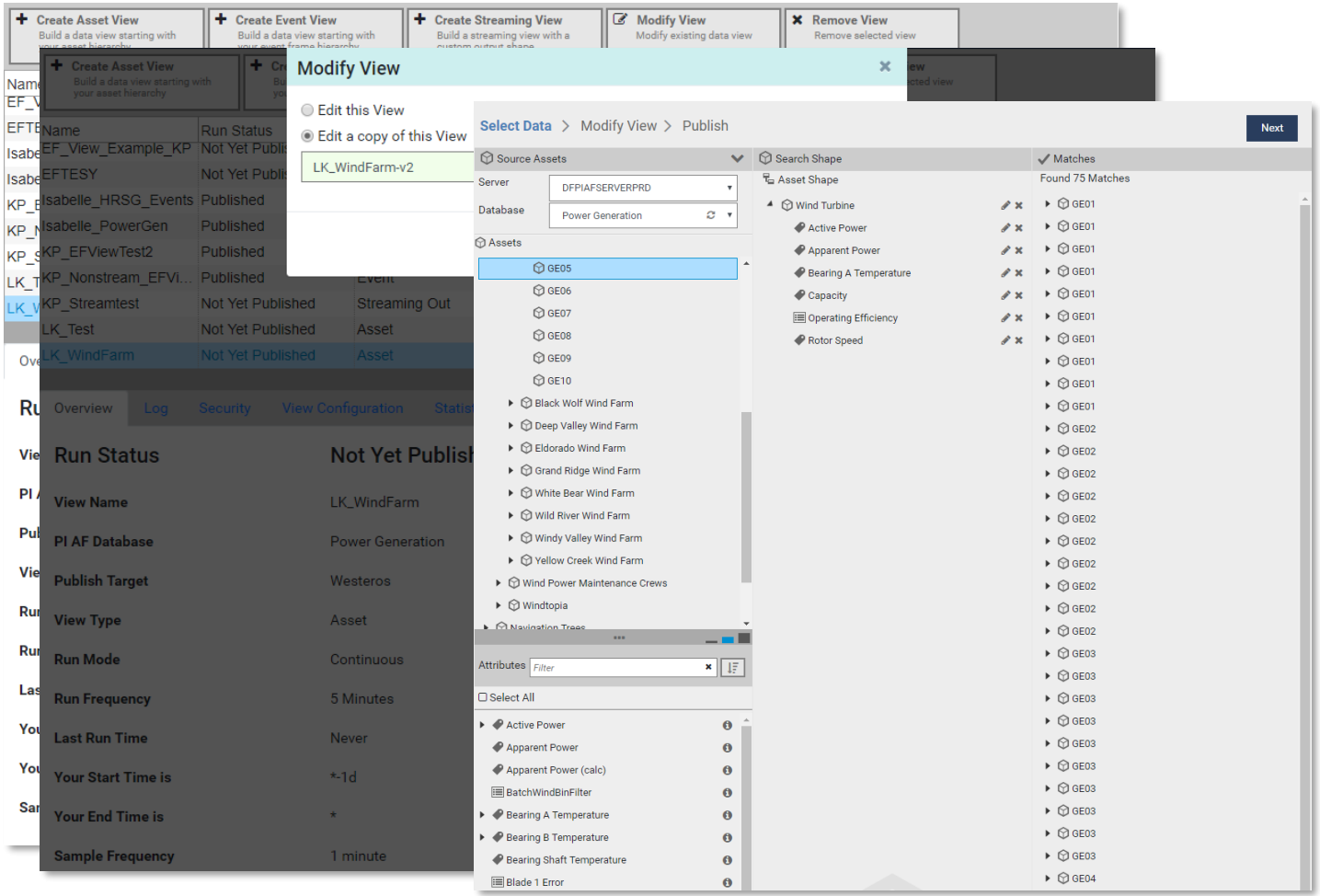
Generation\Wind Power Generation Fleet\Windy Valley Wind Farm\GE09	GE09 2017-01-01 10:43:39	1/1/2017 10:43:39 AM	12600	0.375	GE09	GE
Generation\Wind Power Generation Fleet\Windy Valley Wind Farm\GE09	GE09 2017-01-01 10:43:39	1/1/2017 10:43:39 AM	13200	0.179	GE09	GE
Generation\Wind Power Generation Fleet\Windy Valley Wind Farm\GE09	GE09 2017-01-01 10:43:39	1/1/2017 10:43:39 AM	13800	0.057	GE09	GE
Generation\Wind Power Generation Fleet\Windy Valley Wind Farm\GE09	GE09 2017-01-01 10:43:39	1/1/2017 10:43:39 AM	14400	0.175	GE09	GE
Generation\Wind Power Generation Fleet\Windy Valley Wind Farm\GE09	GE09 2017-01-01 10:43:39	1/1/2017 10:43:39 AM	15000	0.201	GE09	GE
Generation\Wind Power Generation Fleet\Windy Valley Wind Farm\GE09	GE09 2017-01-01 10:43:39	1/1/2017 10:43:39 AM	15600	0.075	GE09	GE
Generation\Wind Power Generation Fleet\Black Mesa Wind Farm\GE09	GE09 2017-01-01 10:43:39	1/1/2017 10:43:39 AM	0	0.101	GE09	GE
Generation\Wind Power Generation Fleet\Black Mesa Wind Farm\GE09	GE09 2017-01-01 10:43:39	1/1/2017 10:43:39 AM	600	0.101	GE09	GE
Generation\Wind Power Generation Fleet\Black Mesa Wind Farm\GE09	GE09 2017-01-01 10:43:39	1/1/2017 10:43:39 AM	1200	0.101	GE09	GE

Discover

Index views of operational data by events

Compare events on a timescale relative to start of the event

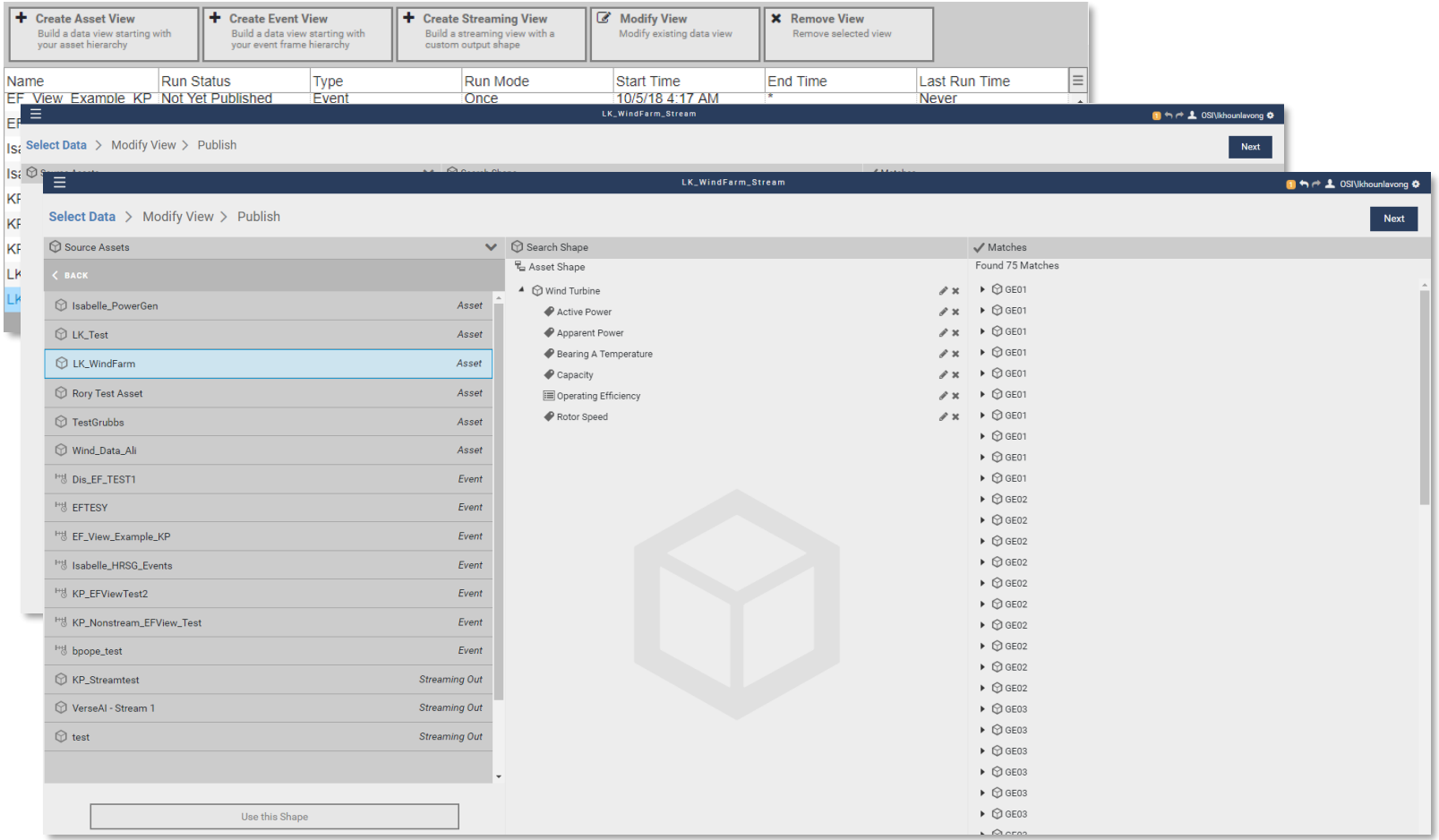
Explore



Explore

Adjust a new view starting from the previous view

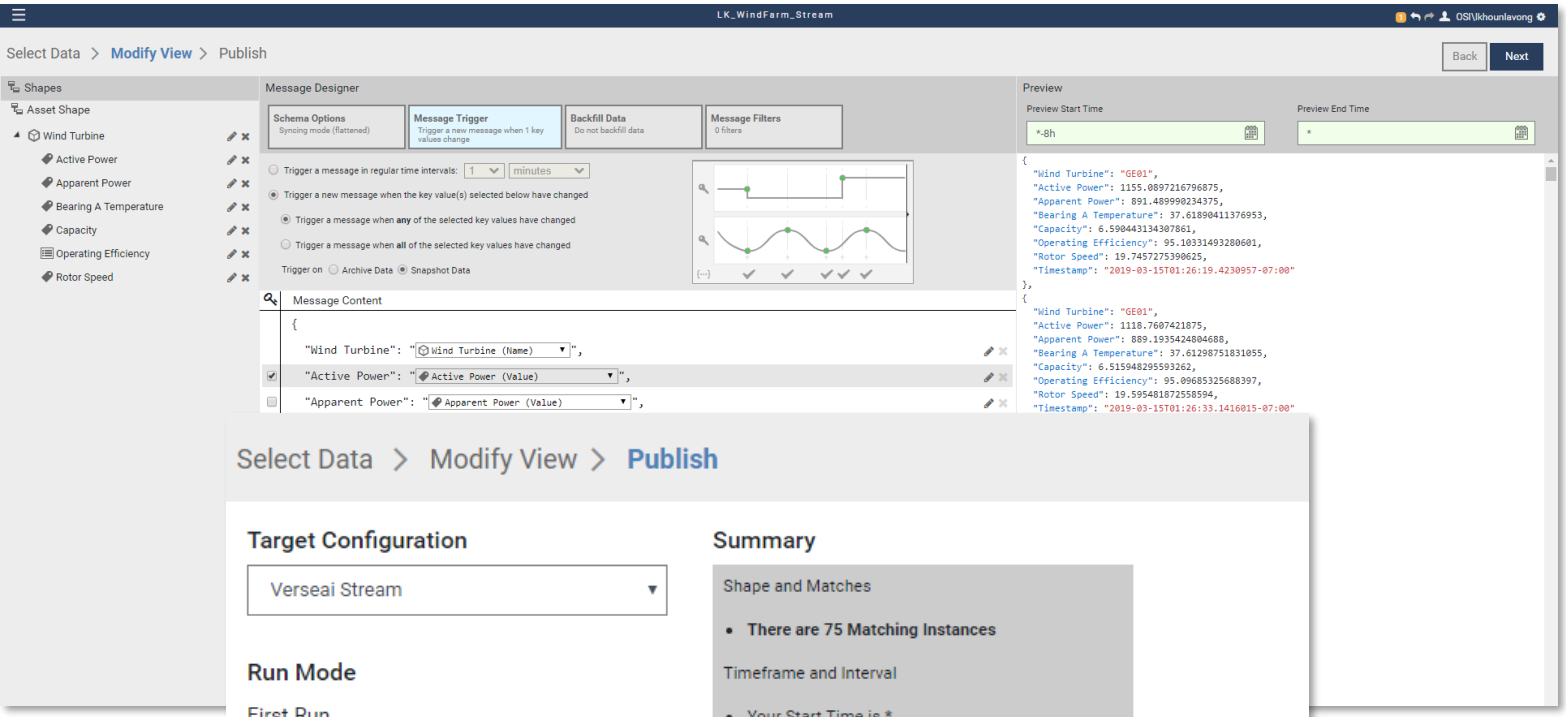
Implement



Implement

Create a stream of features for your algorithm

Begin from the shape of your training data



Implement

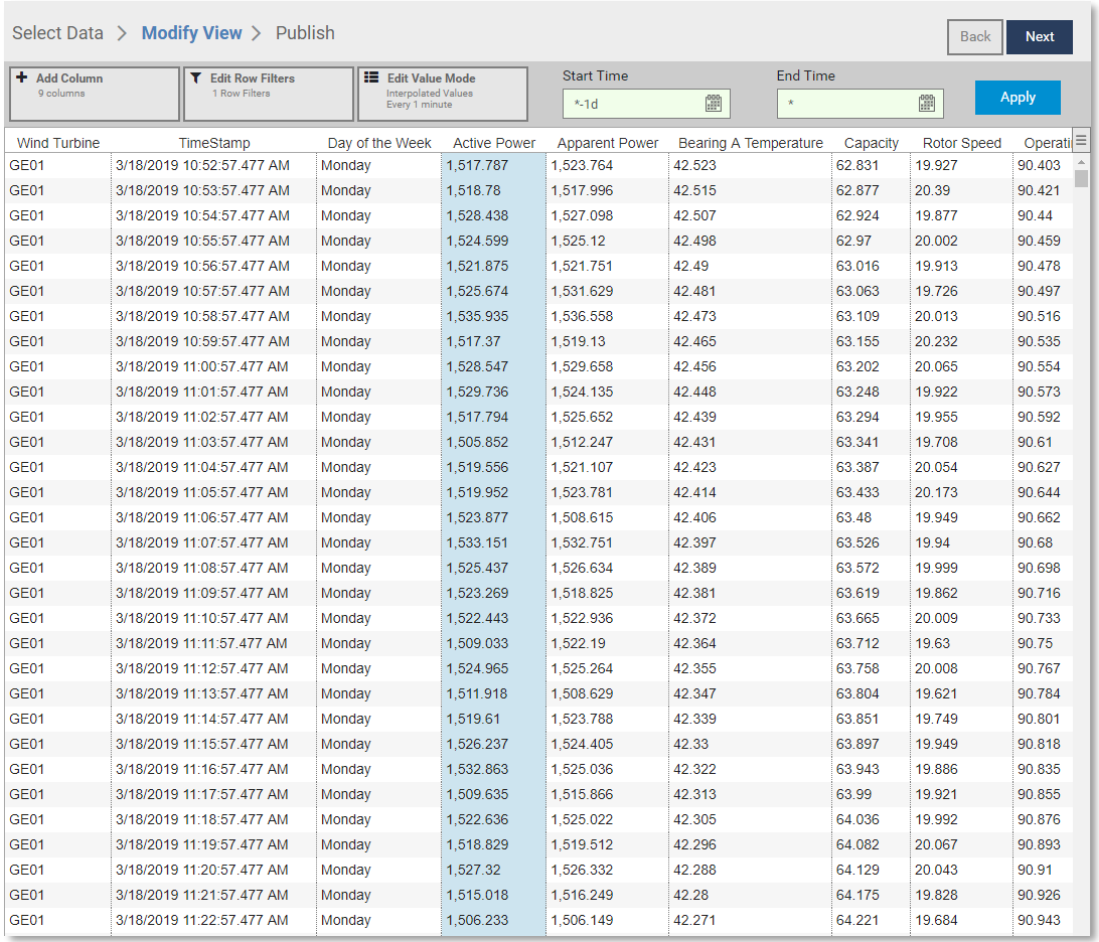
Adjust object if needed and determine how it updates

Pick a messaging hub to stream to

Summary

Capabilities That Streamline Advanced Analytics

- Context
- Normalization
- Event Marking
- Iterative Workflows
- Operationalization

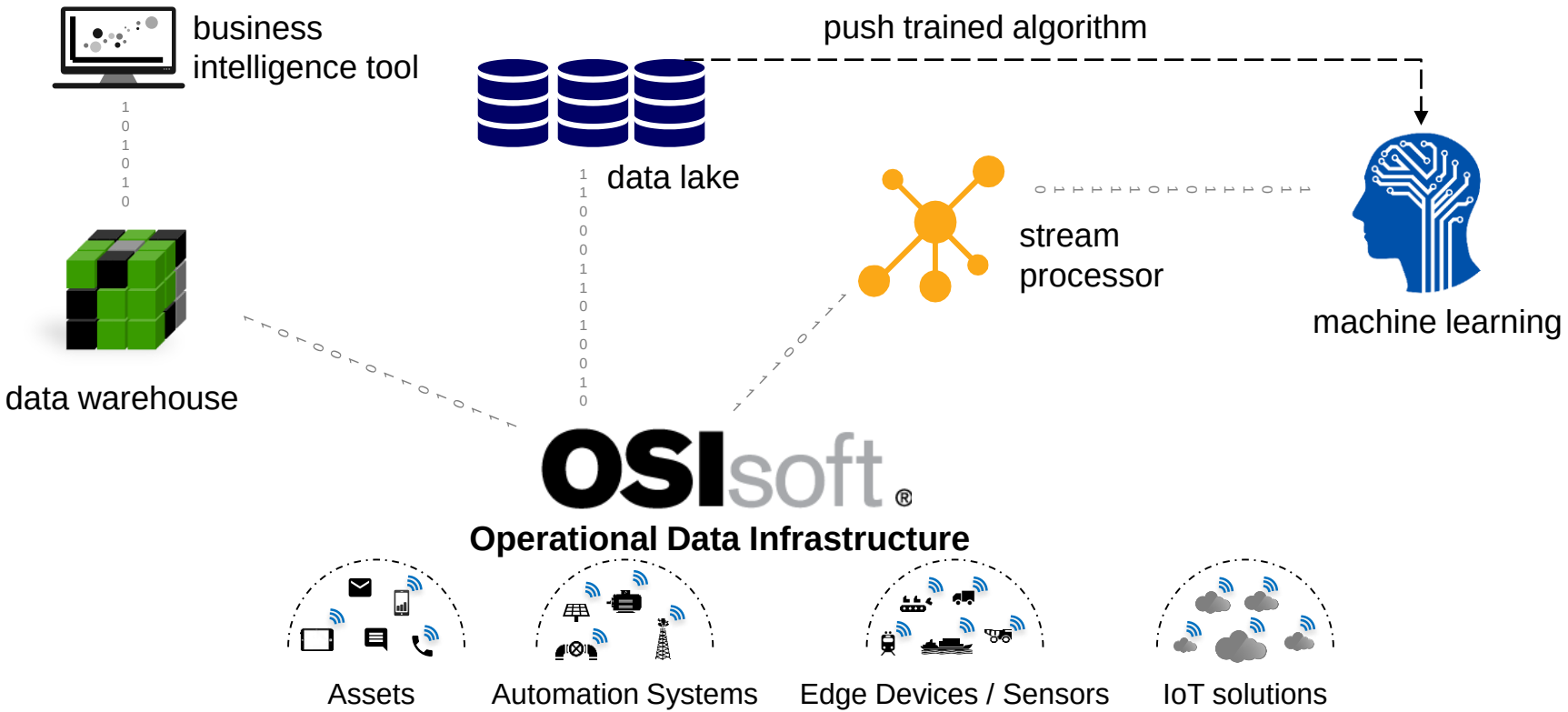


Wind Turbine	TimeStamp	Day of the Week	Active Power	Apparent Power	Bearing A Temperature	Capacity	Rotor Speed	Operati
GE01	3/18/2019 10:52:57.477 AM	Monday	1,517.787	1,523.764	42.523	62.831	19.927	90.403
GE01	3/18/2019 10:53:57.477 AM	Monday	1,518.78	1,517.996	42.515	62.877	20.39	90.421
GE01	3/18/2019 10:54:57.477 AM	Monday	1,528.438	1,527.098	42.507	62.924	19.877	90.44
GE01	3/18/2019 10:55:57.477 AM	Monday	1,524.599	1,525.12	42.498	62.97	20.002	90.459
GE01	3/18/2019 10:56:57.477 AM	Monday	1,521.875	1,521.751	42.49	63.016	19.913	90.478
GE01	3/18/2019 10:57:57.477 AM	Monday	1,525.674	1,531.629	42.481	63.063	19.726	90.497
GE01	3/18/2019 10:58:57.477 AM	Monday	1,535.935	1,536.558	42.473	63.109	20.013	90.516
GE01	3/18/2019 10:59:57.477 AM	Monday	1,517.37	1,519.13	42.465	63.155	20.232	90.535
GE01	3/18/2019 11:00:57.477 AM	Monday	1,528.547	1,529.658	42.456	63.202	20.065	90.554
GE01	3/18/2019 11:01:57.477 AM	Monday	1,529.736	1,524.135	42.448	63.248	19.922	90.573
GE01	3/18/2019 11:02:57.477 AM	Monday	1,517.794	1,525.652	42.439	63.294	19.955	90.592
GE01	3/18/2019 11:03:57.477 AM	Monday	1,505.852	1,512.247	42.431	63.341	19.708	90.61
GE01	3/18/2019 11:04:57.477 AM	Monday	1,519.556	1,521.107	42.423	63.387	20.054	90.627
GE01	3/18/2019 11:05:57.477 AM	Monday	1,519.952	1,523.781	42.414	63.433	20.173	90.644
GE01	3/18/2019 11:06:57.477 AM	Monday	1,523.877	1,508.615	42.406	63.48	19.949	90.662
GE01	3/18/2019 11:07:57.477 AM	Monday	1,533.151	1,532.751	42.397	63.526	19.94	90.68
GE01	3/18/2019 11:08:57.477 AM	Monday	1,525.437	1,526.634	42.389	63.572	19.999	90.698
GE01	3/18/2019 11:09:57.477 AM	Monday	1,523.269	1,518.825	42.381	63.619	19.862	90.716
GE01	3/18/2019 11:10:57.477 AM	Monday	1,522.443	1,522.936	42.372	63.665	20.009	90.733
GE01	3/18/2019 11:11:57.477 AM	Monday	1,509.033	1,522.19	42.364	63.712	19.63	90.75
GE01	3/18/2019 11:12:57.477 AM	Monday	1,524.965	1,525.264	42.355	63.758	20.008	90.767
GE01	3/18/2019 11:13:57.477 AM	Monday	1,511.918	1,508.629	42.347	63.804	19.621	90.784
GE01	3/18/2019 11:14:57.477 AM	Monday	1,519.61	1,523.788	42.339	63.851	19.749	90.801
GE01	3/18/2019 11:15:57.477 AM	Monday	1,526.237	1,524.405	42.33	63.897	19.949	90.818
GE01	3/18/2019 11:16:57.477 AM	Monday	1,532.863	1,525.036	42.322	63.943	19.886	90.835
GE01	3/18/2019 11:17:57.477 AM	Monday	1,509.635	1,515.866	42.313	63.99	19.921	90.855
GE01	3/18/2019 11:18:57.477 AM	Monday	1,522.636	1,525.022	42.305	64.036	19.992	90.876
GE01	3/18/2019 11:19:57.477 AM	Monday	1,518.829	1,519.512	42.296	64.082	20.067	90.893
GE01	3/18/2019 11:20:57.477 AM	Monday	1,527.32	1,526.332	42.288	64.129	20.043	90.91
GE01	3/18/2019 11:21:57.477 AM	Monday	1,515.018	1,516.249	42.28	64.175	19.828	90.926
GE01	3/18/2019 11:22:57.477 AM	Monday	1,506.233	1,506.149	42.271	64.221	19.684	90.943

Summary

- Advanced Analytics
  - Start with a small project that involves SMEs
  - Use an iterative approach to your projects
- PI Integrators
  - Support analytics workflows with **drag-and-drop data preparation** for SMEs
  - Provide **native integration** to a variety of advanced analytics platforms and BI Tools
  - Sends curated data via **bulk** and **incremental uploads** and **streams**

PI System Accelerates and Operationalises Advanced Analytics



New! Support for Amazon

Category	Destination	PI Integrator for Business Analytics 2018 R2		PI Integrator for SAP HANA 2017	PI Integrator for Esri ArcGIS 2017 SP1
		Standard	Advanced		
General	PI ODBC or Flat Files	✓	✓	✓	
Relational Database	SQL Server	✓	✓		
	Azure SQL Database	✓	✓		
	Oracle RDBMS	✓	✓		
Data Warehouse	SAP HANA Smart Data Integration			✓	
	Apache Hive	✓	✓		
	Azure SQL Data Warehouse	✓	✓		
	Amazon Redshift	✓	✓		
Data Lake	Hadoop HDFS	✓	✓		
	Azure Data Lake Store	✓	✓		
	Amazon S3	✓	✓		
Messaging Hub	SAP Streaming Analytics			✓	
	Apache Kafka		✓		
	Azure IoT Hub or Event Hubs		✓		
	Amazon Kinesis Data Streams		✓		
GIS	ArcGIS GeoEvent Server				✓