PI Enabled Data Pipelines for Cloud Analytics

October 8th 2019

Agenda

- **Introduction – Occidental Overview**

- **PI, Applications & Data Pipeline**

- **Twin Talk**

- **Highlights, Best Practices & Lessons Learned**

- **Future Plans**

Who We Are – Occidental Overview

Oil & Gas
Focused in world class basins with a history of maximizing recovery

OxyChem
Leading manufacturer of basic chemicals and significant cash generator

Midstream
Integrated infrastructure and marketing provides access to global markets

1.3 MMboed[1] Combined Oxy Production

- Permian — 533
- Rockies — 334
- Gulf of Mexico — 142
- South America
- Middle East — 259
- Domestic — 78%
- International — 22%

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Permian Unconventional
- 1.6 MM net acres including premier Delaware Basin position
- Strategic infrastructure and logistics hub in place
- EOR advancements

Gulf of Mexico
- 10 Active operated platforms
- Significant free cash flow generation
- Sizeable inventory of remaining tie-back opportunities

Rockies
- Leading position in the DJ Basin
  > 0.4 MM net acres including vast minerals position
  > Largest producer in Colorado with significant free cash flow
- Emerging Powder River Basin
- Largest producer in Uinta Basin

Permian Conventional
- 1.4 MM net acres
- Significant scale, technical capability, and low-decline production
- CCUS potential for economic growth and carbon reduction strategy
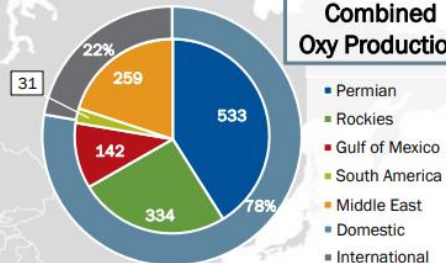
South America
- Premium position in Colombia
  > TECA steamflood development
  > Six new exploration blocks
  > ~2 MM total gross acres
- South American deepwater exploration opportunities

Middle East
- High return opportunities in Oman
  > 6 MM gross acres
  > 17 identified horizons
- Developing ON-3 in U.A.E.
  > 1.5 MM acres
  > Between Al Hosn and Oman developments
- Al Hosn and Dolphin provide steady cash flow with low sustaining capex

[1]4Q18 Net MMboed excluding Africa

Occidental Petroleum Corporation, Aug. 2019

OSIsoft.

Occidental: Premier, Complementary Global Asset Portfolio

- ☑ #1 producer in the **Permian Basin** of West Texas and southeast New Mexico

- ☑ #1 in carbon dioxide enhanced oil recovery projects **(CO2 EOR)**

- ☑ #1 producer in the **Denver-Julesburg Basin** of Colorado

- ☑ #1 producer in the **Uinta Basin** of Utah

- ☑ #1 independent producer in **Oman**

- ☑ #4 producer in the **Gulf of Mexico**

- ☑ Leading position in **Colombia**

- ☑ Top 3 producer of polyvinyl chloride (PVC), chlorine and caustic soda

- ☑ Leading international midstream assets and master limited partnership (MLP)

Production Surveillance Applications

Development and Exploration Predictor Map & Advanced Process Analytics

IPSO ONSHORE

Intelligent Production Surveillance and Optimization (IPSO) Onshore

IPSO OFFSHORE

Intelligent Production Surveillance and Optimization (IPSO) Offshore

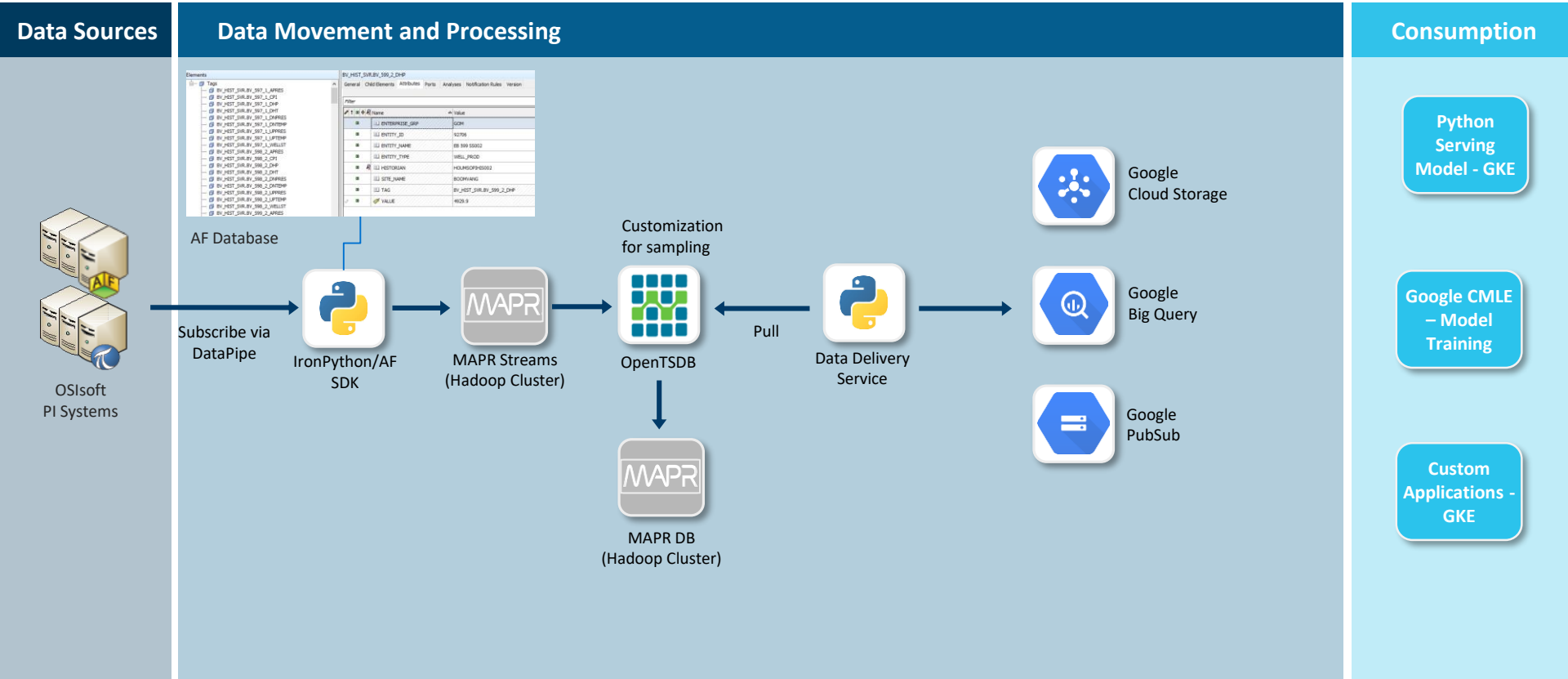Optimize well performance analysis and calculate diagnostics through real-time surveillance and automated algorithms

Developed by Advanced Analytics and Emerging Technologies Team

APA - Anomaly Detection System

- Goal: provide assistance in performing root cause analysis (RCA) after equipment outages, and lay the foundation to enable preventive measures
  - Increase uptime via lessening unplanned outages
  - Shorter maintenance cycles

- Applied to high value operational assets
  - Offshore Platforms - e.g. pipeline pumps, compressors

- Consumable to all applications, e.g. Onshore, Offshore, etc

- ML training (weekly, daily, hourly)
  - hyperparameter tuning
  - automated threshold calculation

- AF - Equipment/Asset Tag structure

APA Data Pipeline - Current Approach

Data Sources

Data Movement and Processing

Consumption

AF Database

OSIsoft
PI Systems

Subscribe via
DataPipe

IronPython/AF
SDK

MAPR Streams
(Hadoop Cluster)

Customization
for sampling

OpenTSDB

Pull

Data Delivery
Service

MAPR DB
(Hadoop Cluster)

Google
Cloud Storage

Google
Big Query

Google
PubSub

Python
Serving
Model - GKE

Google CMLE
– Model
Training

Custom
Applications -
GKE

APA Data Pipeline - Challenges to Address

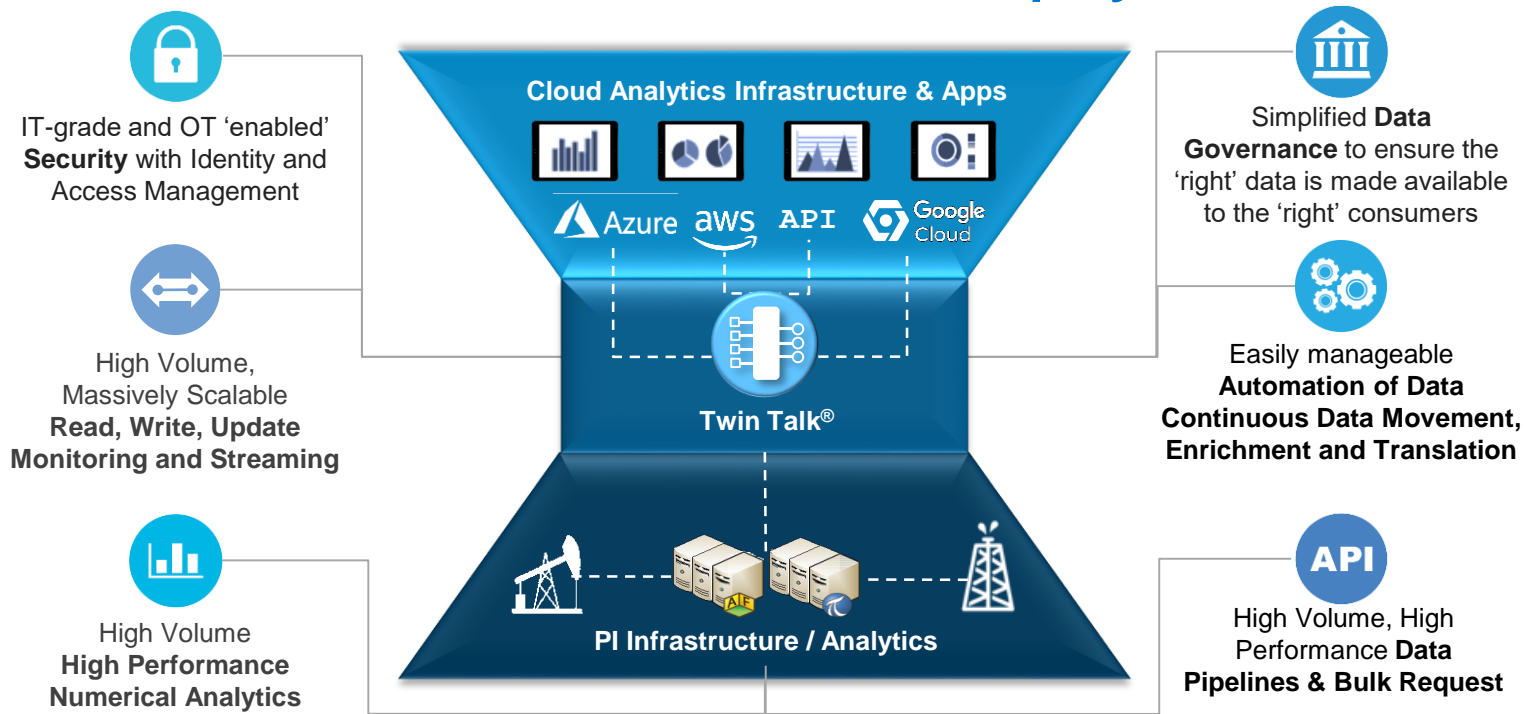**Initial Data Pipeline from PI to Cloud**

- Custom developed code, non-HA

- Unique, non-redundant skills

- Manual touch Backfill process

- Increased Technical debt
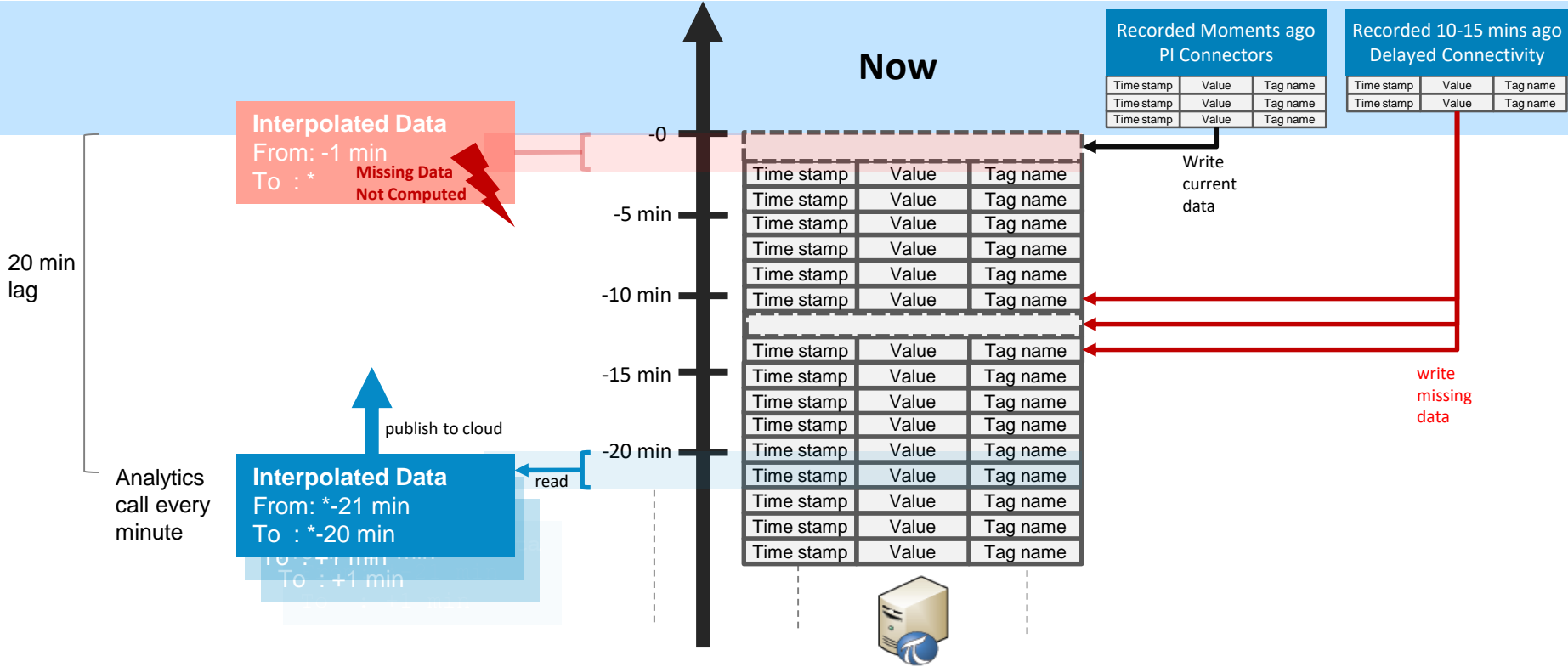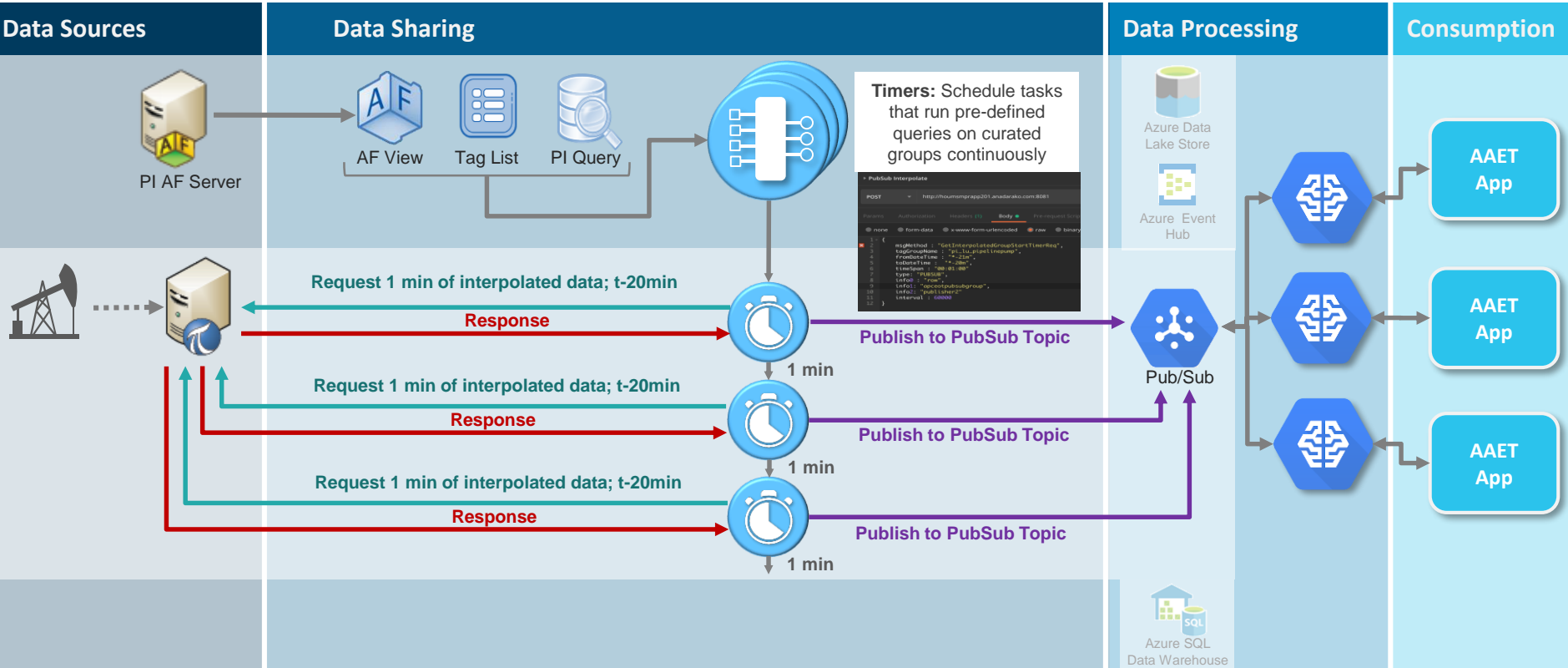
- More Operational monitoring points

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Data Integrity Challenge: Last Minute Interpolated Data Operation Computed Before Data is Stored in PI System
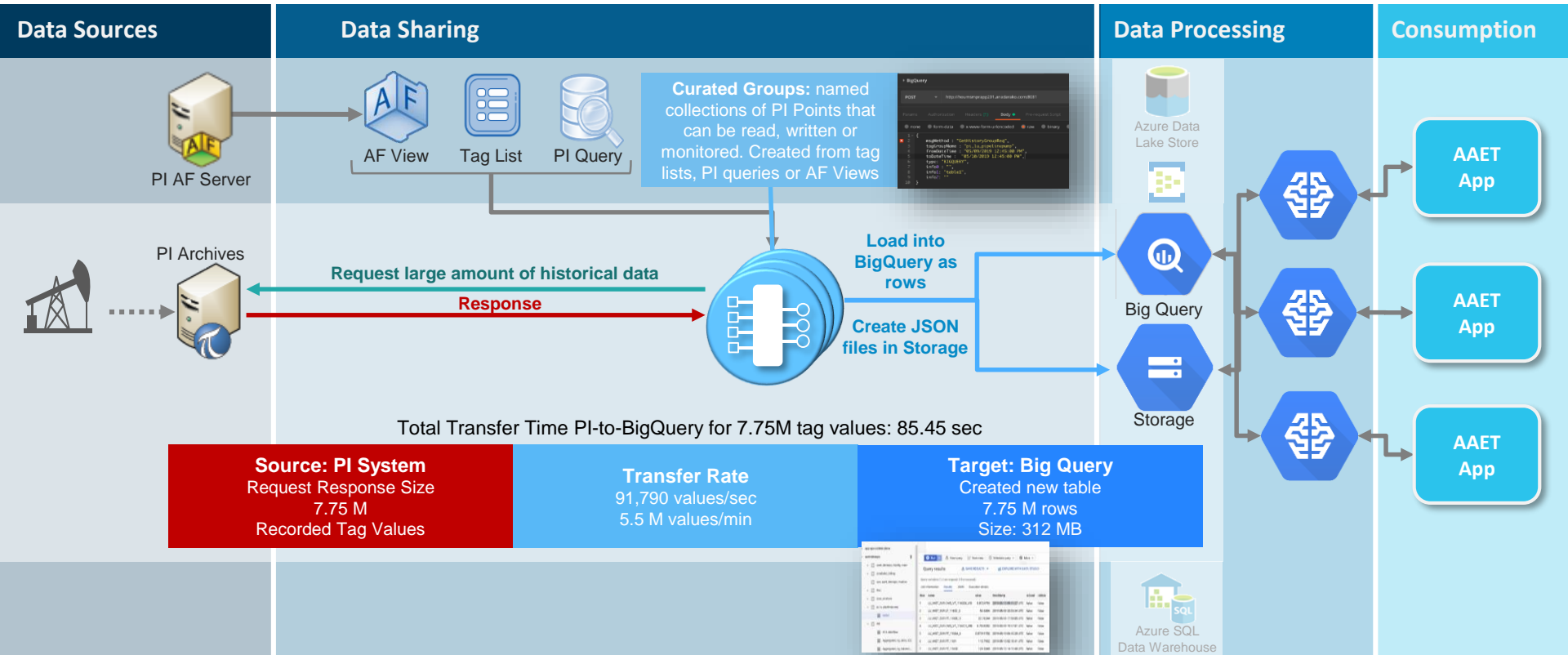
Results: Publish Interpolated Data from PI - Google PubSub Continuously Setup: 20 min Lagging / 1 Min Time Windows

Results - Load Large Amount of Recorded Values into BigQuery
Setup: Transfer 7.75M Values from PI System into BQ Table

Data Sources

PI AF Server

PI Archives

Data Sharing

AF View

Tag List

PI Query

Curated Groups: named collections of PI Points that can be read, written or monitored. Created from tag lists, PI queries or AF Views

Request large amount of historical data

Response

Load into BigQuery as rows

Create JSON files in Storage

Total Transfer Time PI-to-BigQuery for 7.75M tag values: 85.45 sec

Source: PI System
Request Response Size
7.75 M
Recorded Tag Values

Transfer Rate
91,790 values/sec
5.5 M values/min

Target: Big Query
Created new table
7.75 M rows
Size: 312 MB

Data Processing

Azure Data Lake Store

Big Query

Storage

Azure SQL Data Warehouse

Consumption
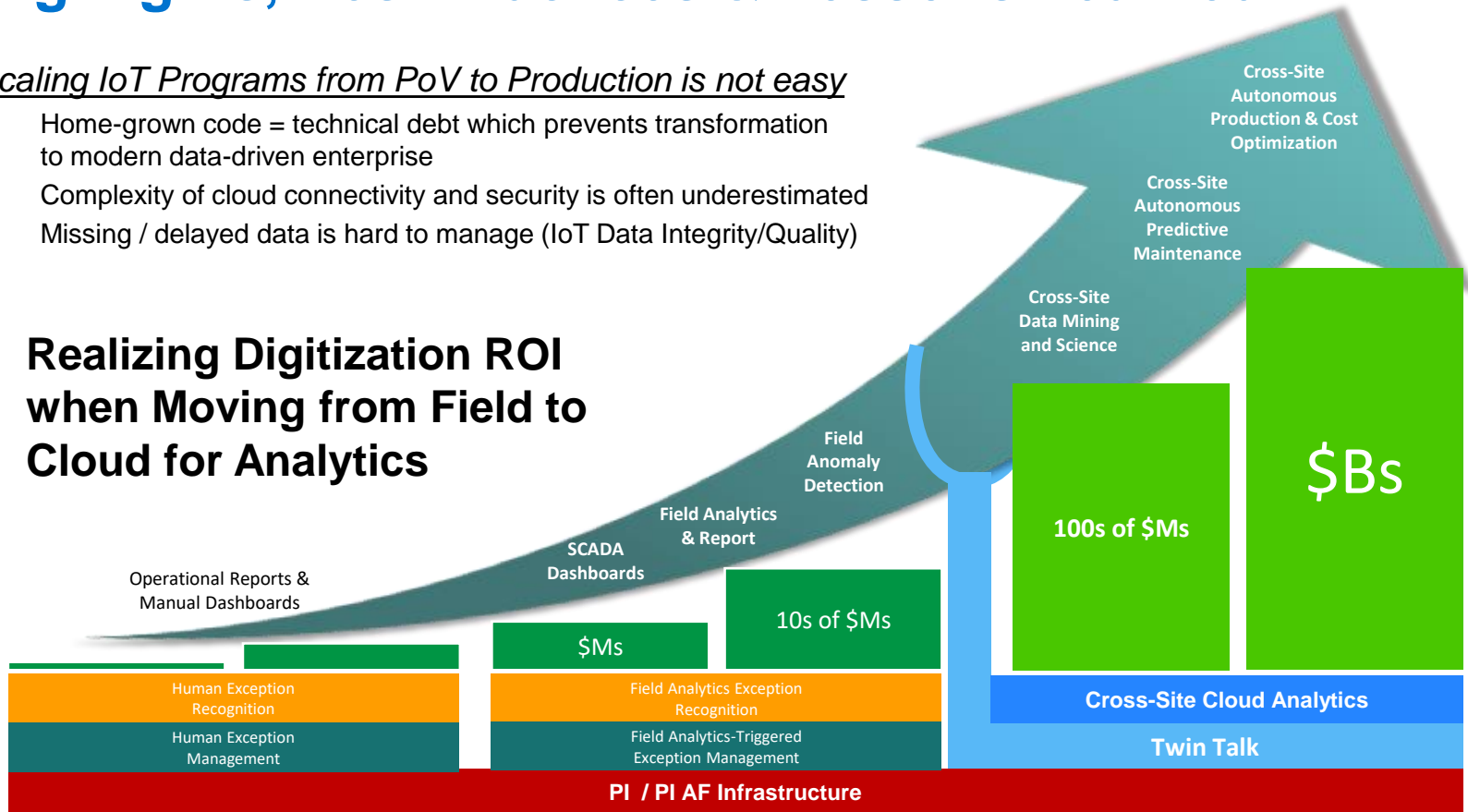
AAET App

AAET App

AAET App

Highlights, Best Practices & Lessons Learned

Scaling IoT Programs from PoV to Production is not easy

- Home-grown code = technical debt which prevents transformation to modern data-driven enterprise
- Complexity of cloud connectivity and security is often underestimated
- Missing / delayed data is hard to manage (IoT Data Integrity/Quality)

Realizing Digitization ROI when Moving from Field to Cloud for Analytics

Cross-Site Autonomous Production & Cost Optimization

Cross-Site Autonomous Predictive Maintenance

Cross-Site Data Mining and Science

Field Anomaly Detection

Field Analytics & Report

SCADA Dashboards

Operational Reports & Manual Dashboards

$Bs

100s of $Ms

10s of $Ms

$Ms

Human Exception Recognition

Field Analytics Exception Recognition

Cross-Site Cloud Analytics

Human Exception Management

Field Analytics-Triggered Exception Management

Twin Talk

PI / PI AF Infrastructure

Future Plans

- Continue to get more value from PI ecosystem and Cloud capabilities

- Further testing with Azure Destinations

- Enable Data Self Service

- Continued Asset Framework Build out

- Writeback of results to PI, PI Vision

Speakers

- **Eric Garcia**

  – Cloud Engineering Manager at Occidental

- **Matt Oberdorfer**

  – CEO at Embassy of Things Inc.

Thank You