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PARIS

St. Lawrence Seaway's journey into PI System with advanced analytics for vessel ETA forecasting at bridges and locks

Presented by Jamie Andrews & Remi Duquette

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Your Presenters

Remi Duquette

Vice-President Industrial AI+IIoT

Maya HTT

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- **My curriculum in numbers**…
- ✓ **5** spacecrafts in orbit
- ✓ **150+** industrial & engineering services engagements
- ✓ **5,000+** hours on AI-ML-DL
- ✓ **10,000+** hours on skates
- ✓ **1** short-track speed skating champion
- → **Your industrial AI+IIoT partner of choice!**

Jamie Andrews

Manager Information Systems

The St. Lawrence Seaway Management Corporation — Corporation de Gestion de la Voie Maritime du Saint-Laurent

jandrews@seaway.ca

- → 25+ years in Pulp & Paper and Marine Transportation
- → Knowledgeable in almost every facet of Business
- → PI System techy since 2000
- → **Key Seaway digital transformation & AI leader!**

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Agenda

- ✓ Introduction to St. Lawrence Seaway
- ✓ One Image to Explain St. Lawrence Seaway
- ✓ Economic Impact of St. Lawrence Seaway
- ✓ Societal Changes & Timeline
- ✓ Introduction to Maya HTT
- ✓ AVEVA PI System History at Seaway
- ✓ BIS Vessel ETA Forecasting at Bridges & Locks
- ✓ Future Avenues at St. Lawrence Seaway with Maya HTT

Maya HTT

The St. Lawrence Seaway Management Corporation

Corporation de Gestion de la Voie Maritime du Saint-Laurent

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The Seaway

The Great Lakes – St. Lawrence Seaway System extends 3,700 kilometres from the Atlantic Ocean to the head of Lake Superior.

⚓ Major Ports

🍁 Administered by the St. Lawrence Seaway Management Corporation

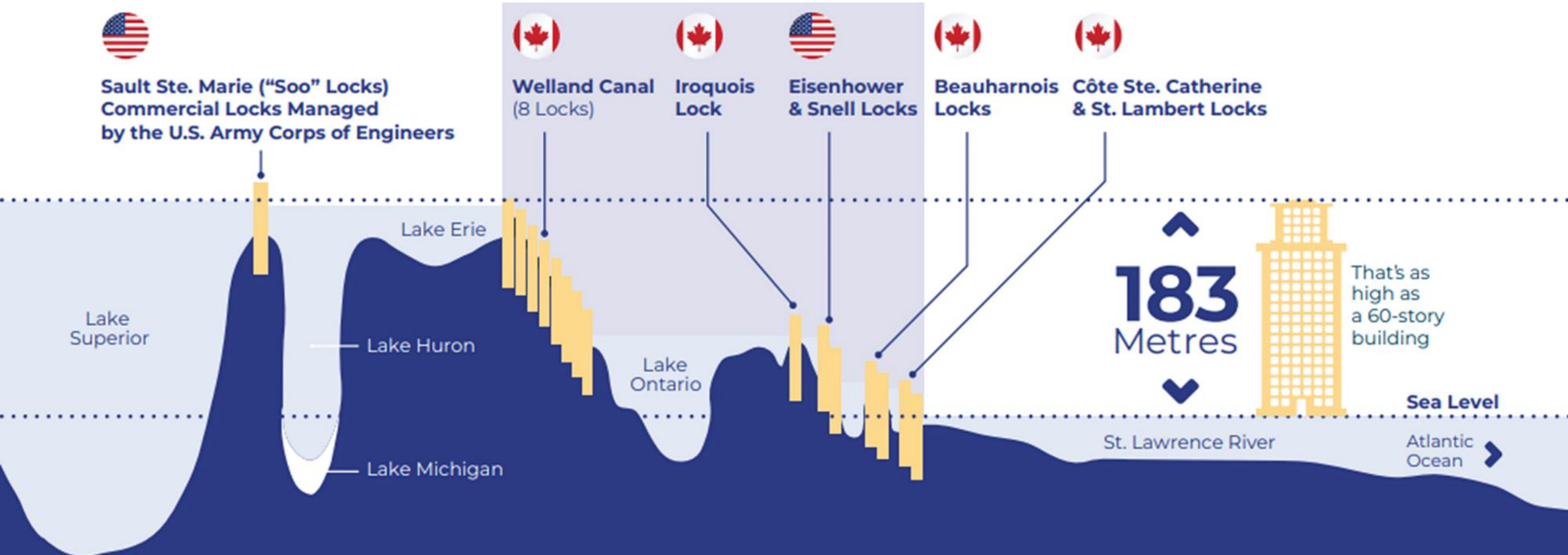🇺🇸 Administered by The Great Lakes St. Lawrence Seaway Development Corporation

Beauharnois (2 LOCKS)

St. Lambert and Côte Ste. Catherine (2 LOCKS)

Iroquois (1 LOCK)

Eisenhower and Snell (2 LOCKS)

Welland Canal (8 LOCKS)

The Seaway

Sault Ste. Marie ("Soo" Locks) Commercial Locks Managed by the U.S. Army Corps of Engineers

Welland Canal (8 Locks)

Iroquois Lock

Eisenhower & Snell Locks

Beauharnois Locks

Côte Ste. Catherine & St. Lambert Locks

Lake Superior

Lake Erie

Lake Huron

Lake Michigan

Lake Ontario

183 Metres

That's as high as a 60-story building

Sea Level

St. Lawrence River

Atlantic Ocean

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Economic Impact

EXECUTIVE SUMMARY

ECONOMIC IMPACTS OF MARITIME SHIPPING IN THE GREAT LAKES – ST. LAWRENCE REGION

MARTIN ASSOCIATES - LANCASTER, PA   JULY 2023

$51 billion USD
$66 billion CAD

in economic activity

357,000

jobs supported
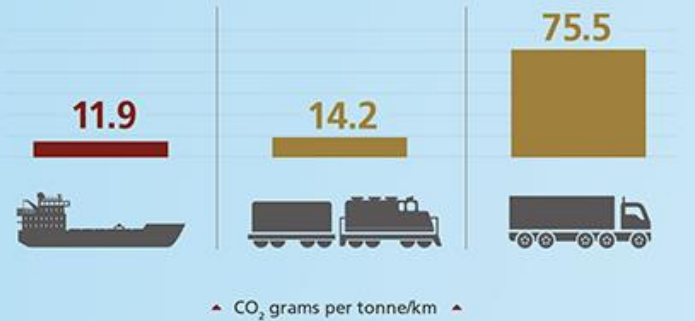
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The St. Lawrence Seaway Management Corporation

Corporation de Gestion de la Voie Maritime du Saint-Laurent
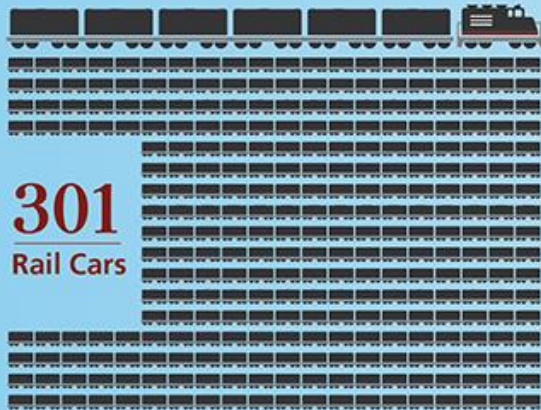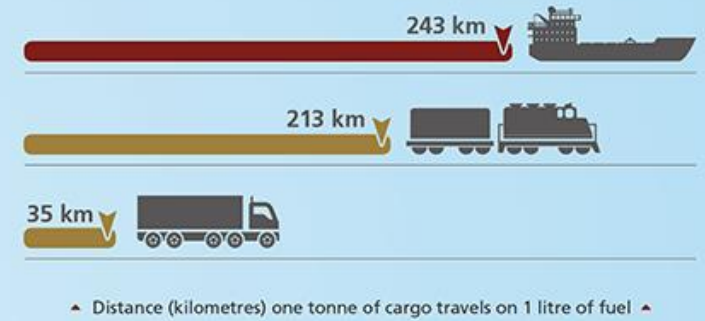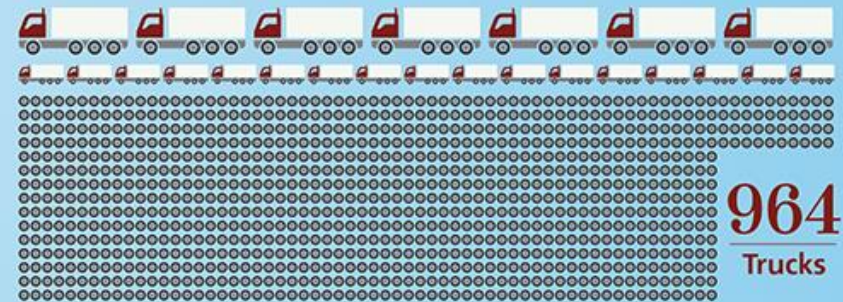
# St. Lawrence Seaway Social Responsibility

Mission:

We serve our customers by passing ships through a safe, secure and reliable waterway system in a cost effective, efficient, environmentally and socially responsible manner to deliver value to the North American economy.

Commitment to Our Communities:

As stewards of the St. Lawrence Seaway, we interact with numerous stakeholders. We recognize the interests of the municipalities that border the Seaway and the thousands of local residents and recreational boaters who enjoy the beauty and nature of our waters. We value open communication with the communities along our waterway in contributing to the understanding of what we do and how we do it.

Moving toward the Future:

- Historical Speaking ships travelling the Seaway have the right of way, that is any traffic crossing a moveable bridge is stopped so the ship can pass
- Today we are in constant communication with the communities and providing tools such as the Bridge Information System to help the public navigate our moveable bridges and keep traffic flowing
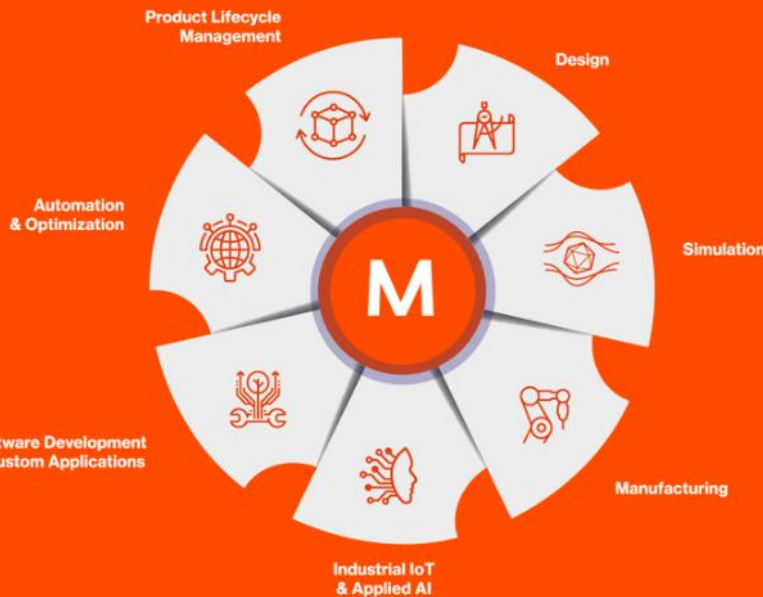
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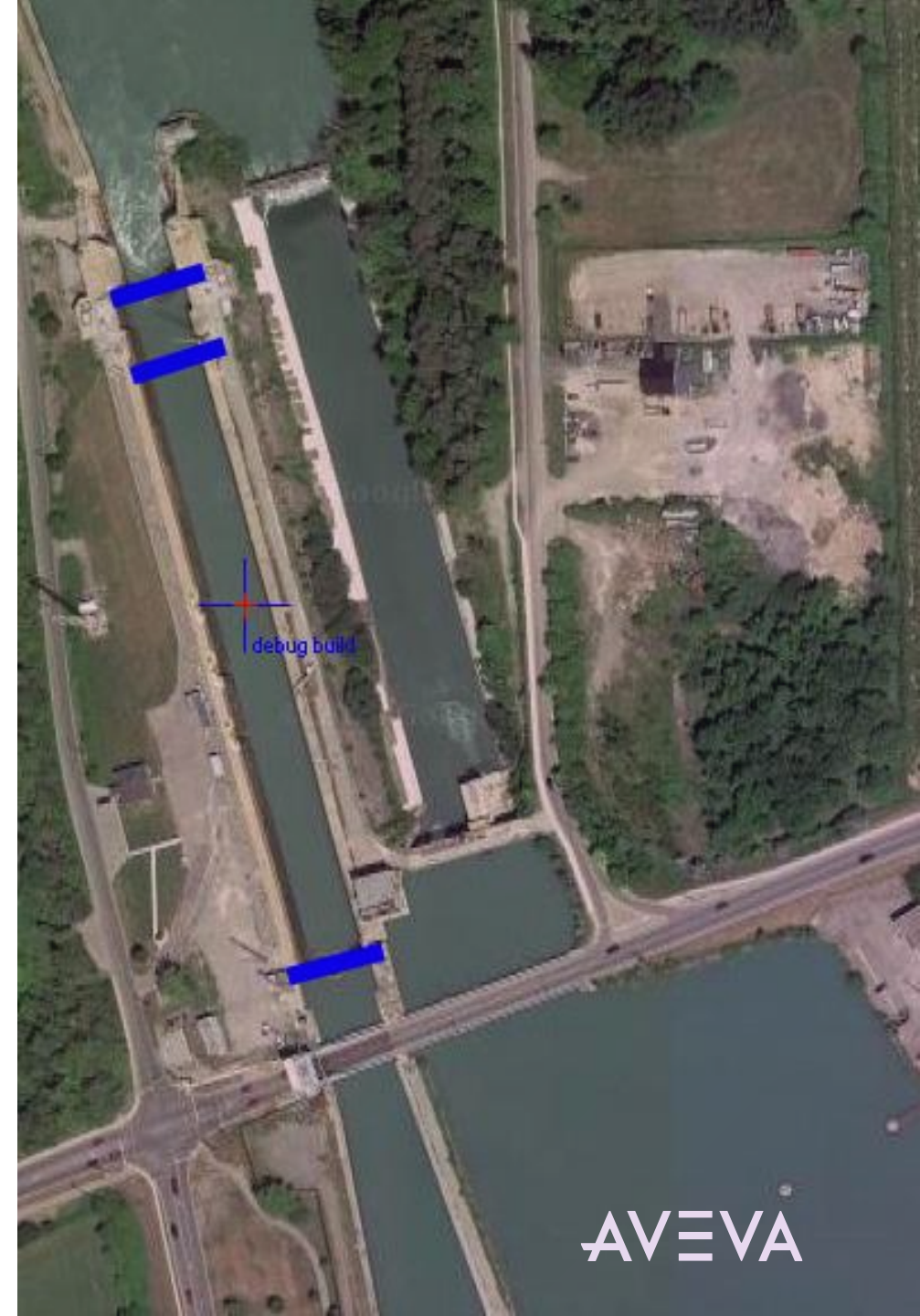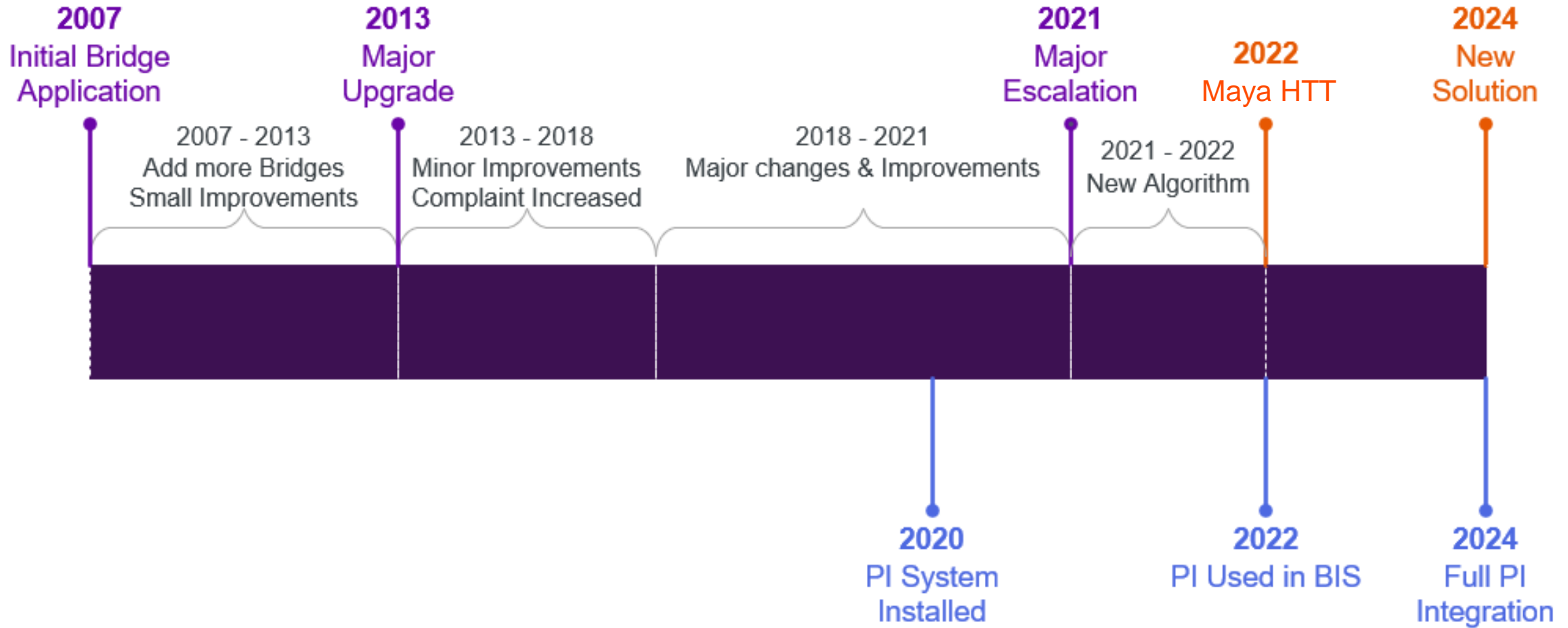
Premium AVEVA PI System SI Partner & CIMSOFT Partner

- **12+ years of experience working with the PI System**
- **5.9M+ PI Tags deployed at 150+ sites worldwide**
- Your PI System Integrator with deep bench for…
  - PI Core + PI Edge + PI Cloud
  - Timeseries & 3rd-party data integration
  - Data pipeline engineering & AI & machine learning
- Your digital transformation partner for…
  - Executable data-driven & physics-based digital twins
  - ML-Ops on industrial edge devices
- Domain expertise across many industries
- Staff consisting of 75% Engineers & Scientists
  - 22% have PhD's, 30% have Master's Degrees

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PI System at the Seaway

Overview

- Migrated from iHistorian/Proficy in Summer 2020
- 100,000 tags High Availability Corporate wide AVEVA PI System (90% Used)
- Unlimited Connectors (Various Scada Systems, AIS, RDBMS)
- 50 PI Vision and 30 Datalink licenses…and growing
- PI Data access using PI SQL, Asset Framework SDK, and OPC Server
- **PI Culture is on the rise!**

** AVEVA™ PI System Customer for 4 years **

Advanced Analytics & AI-Forecasting on top of PI System Improving Bridge Condition ETAs by 20%

Challenge

- List of vessels is dynamic and changes overtime;
- Relationship between bridges & vessels is dynamic. Any vessel (out of 10,000+) can be present at any bridge at any given time;
- Bridges and vessels datasets are distinctly separate;
- Need to provide accurate ETA for open/close status to bridge stakeholders (cities, etc.) and other infrastructure users.

Solution

- Consolidation into the AVEVA PI System of existing functionality in the Bridge Information System (BIS) custom application, TMS, and PI System.

Results

- **20% Improved BIS-based Bridges & Locks Condition Change ETA Forecasting**
- **More accurate messaging for drivers &pedestrians who use SLSMC managed bridges**
- **Built a future-proof architecture – ready for all bridges to use AIS data as a next step**
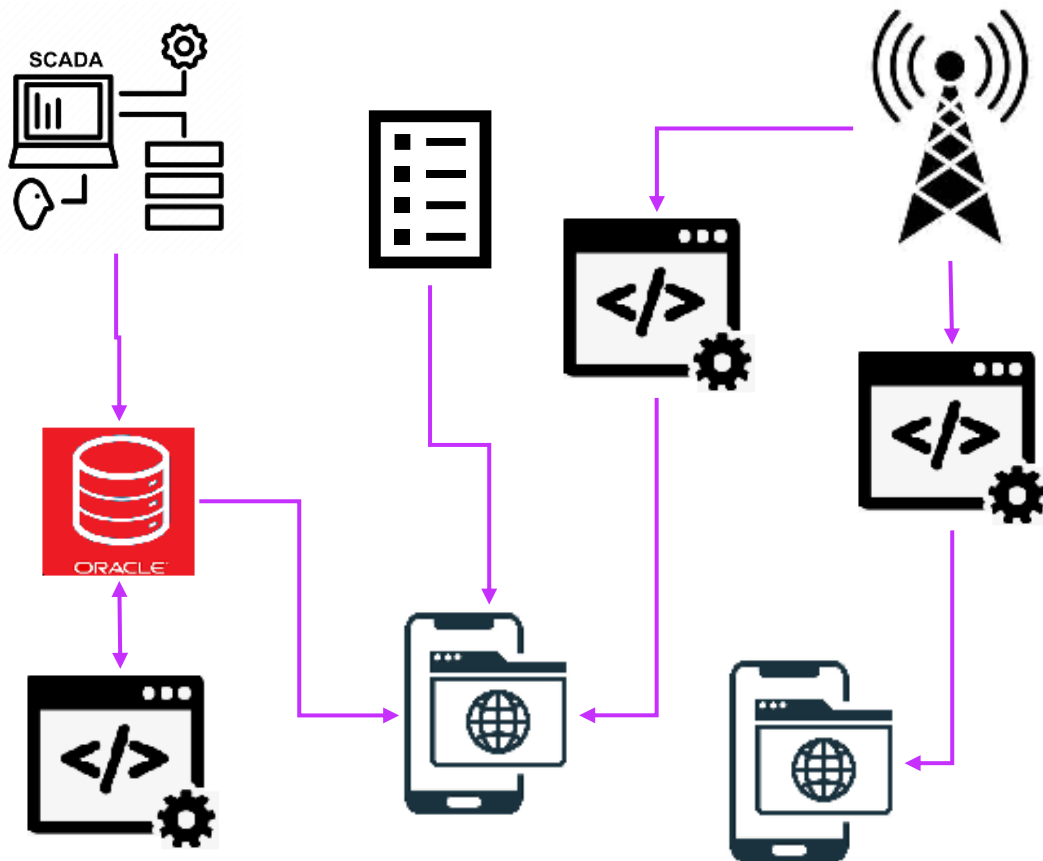
Design Strategy

- Combination of a custom PI AF SDK application running alongside the PI System was chosen
- AIS-based bridge design
  - Custom application parses the ship data to see if any ships are within the bridge geofence region.
  - Relays the information back to PI
  - ETA & messaging are calculated in PI
- TMS/SCADA based bridges
  - All logic is handled in PI without AIS data
- Solution can easily work with & without AIS data
- Solution is expandable for other assets, such as locks
- Low-impact, high-performance analytics in PI
- Relational datasets managed in TMS, referenced in PI using PI AF Tables

Maya HTT

The St. Lawrence Seaway Management Corporation

Corporation de Gestion de la Voie Maritime du Saint-Laurent

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Standardize Seaway Back-End Components in PI System

Initial Architecture

New PI System Architecture

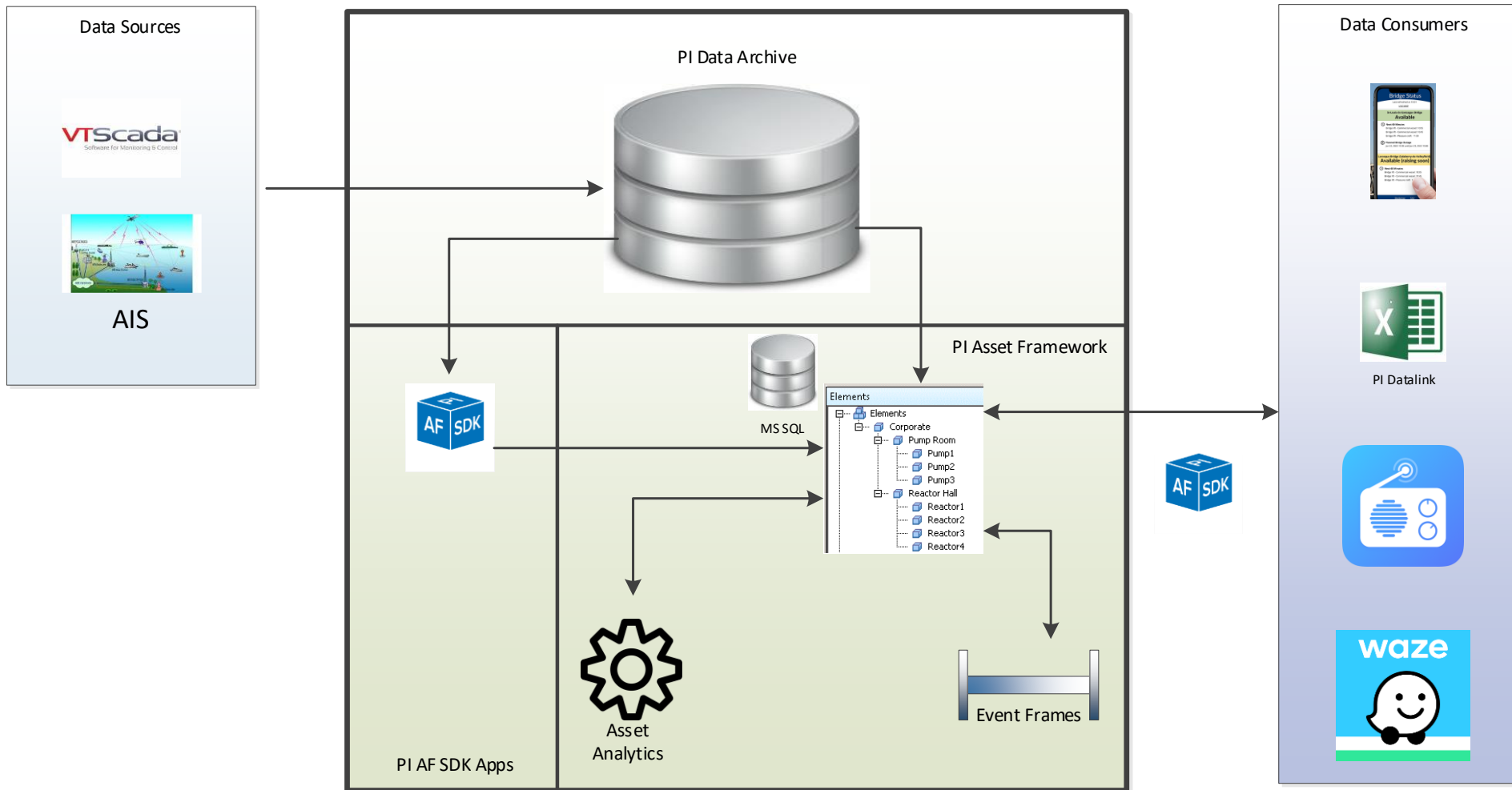Maya HTT | The St. Lawrence Seaway Management Corporation | Corporation de Gestion de la Voie Maritime du Saint-Laurent | AVEVA
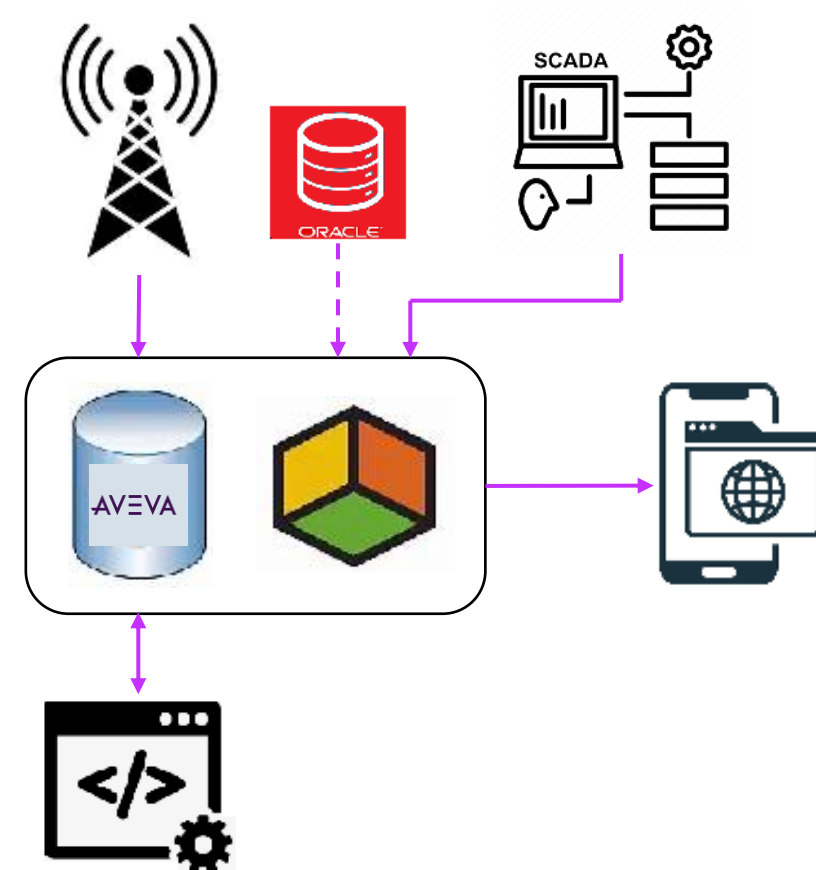
Future Design

Vessel of Interest (VIS) Application
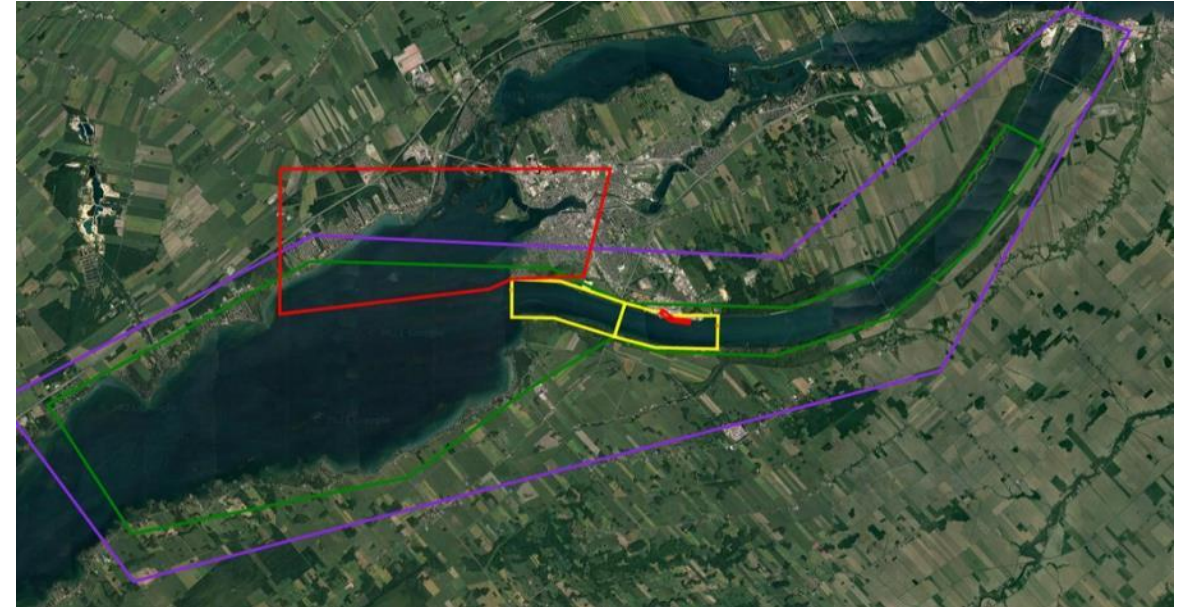
Solution Foundation
- A .NET Framework Windows Service was created in C# which utilizes PI AF SDK for AVEVA PI System integration

Real-Time Data Flow
- Bulk requests enable data queries, rankings, and writing to PI tags to occur on sub 15s timescales with minimal server impact

Filters and Ranking
- After retrieving information about each vessel, each vessel transit plans, and each bridge, filters out and ranks vessels per bridge based on position, data quality, and ETA

Maisonneuve Bridge 10
Bridge Status AIS Tracking Zones

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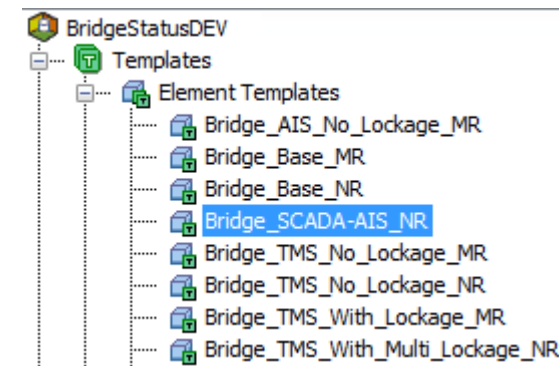
Asset Framework (AF) Standardization

- Standardization was implemented across tag naming, AF hierarchies, and AF templates
- Standardization allows for easy additions and updates in the AVEVA PI System

Selected(x)	Name	ObjectType
x	CWL_APPS_BRIDGE-STATUS_MR-B10_Forecast-Status.AF	PIPoint
x	CWL_APPS_BRIDGE-STATUS_MR-B2_Forecast-Status.AF	PIPoint
x	CWL_APPS_BRIDGE-STATUS_MR-B3_Forecast-Status.AF	PIPoint
x	CWL_APPS_BRIDGE-STATUS_MR-B5_Forecast-Status.AF	PIPoint
x	CWL_APPS_BRIDGE-STATUS_MR-B7A_Forecast-Status.AF	PIPoint
x	CWL_APPS_BRIDGE-STATUS_MR-B7B_Forecast-Status.AF	PIPoint
x	CWL_APPS_BRIDGE-STATUS_MR-B9_Forecast-Status.AF	PIPoint
x	CWL_APPS_BRIDGE-STATUS_NR-B11_Forecast-Status.AF	PIPoint
x	CWL_APPS_BRIDGE-STATUS_NR-B19A_Forecast-Status.AF	PIPoint
x	CWL_APPS_BRIDGE-STATUS_NR-B19_Forecast-Status.AF	PIPoint
x	CWL_APPS_BRIDGE-STATUS_NR-B1_Forecast-Status.AF	PIPoint
x	CWL_APPS_BRIDGE-STATUS_NR-B21_Forecast-Status.AF	PIPoint
x	CWL_APPS_BRIDGE-STATUS_NR-B3A_Forecast-Status.AF	PIPoint
x	CWL_APPS_BRIDGE-STATUS_NR-B4_Forecast-Status.AF	PIPoint
x	CWL_APPS_BRIDGE-STATUS_NR-B5_Forecast-Status.AF	PIPoint

Bridge_SCADA-AIS_NR

General | Attribute Templates | Ports | Analysis Templates | Notification Rule Templates

Filter

	Name	Description	Default Value
	Category: AF Calc		
	Forecast-Status		0
	Status-Colour		0
	Category: AF Table		
	Lock-Location		0
	Lock-Offset		0
	Category: PI Data		
	EMS-Override		0
	EMS-Override-Available		0
	EMS-Status		0
	Estimated-Lift-Time		0
	Fully-Closed		0
	Red-Light		0
	Status		0

BridgeStatusDEV
- Templates
  - Element Templates
    - Bridge_AIS_No_Lockage_MR
    - Bridge_Base_MR
    - Bridge_Base_NR
    - Bridge_SCADA-AIS_NR
    - Bridge_TMS_No_Lockage_MR
    - Bridge_TMS_No_Lockage_NR
    - Bridge_TMS_With_Lockage_MR
    - Bridge_TMS_With_Multi_Lockage_NR

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AF Analytics & Outputs

- Logic for the analytics follows what was provided by SLSMC
- PI AF Advanced Analytics was implemented
- Output to be used by notification system that presents information on the web
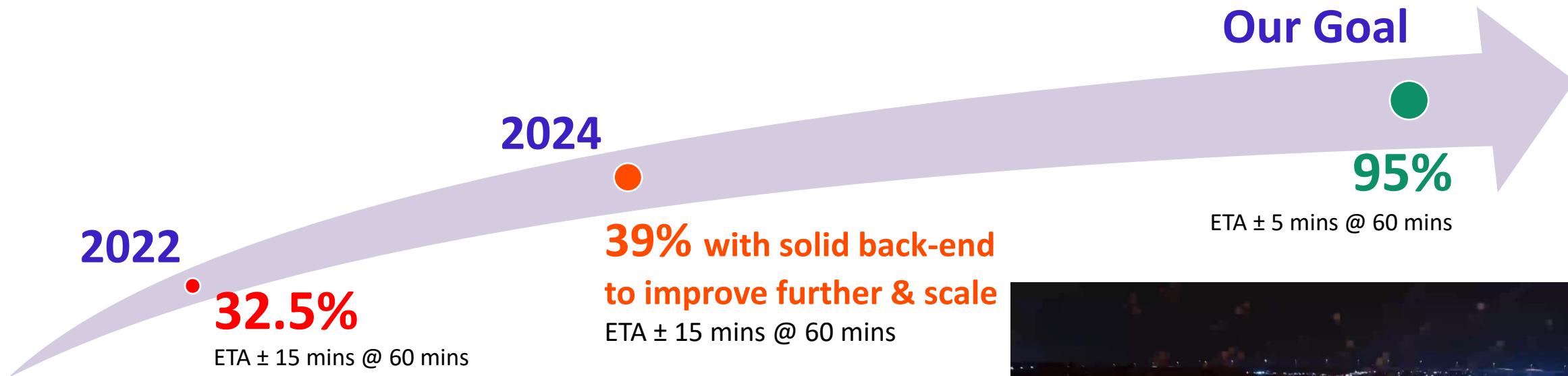
Time Stamp	Value
2023-08-14 7:10:00 AM	Available
2023-08-14 8:01:00 AM	Available, Raising Soon
2023-08-14 8:53:00 AM	Unavailable, Raising
2023-08-14 8:55:20 AM	Unavailable, Raised
2023-08-14 9:20:40 AM	Unavailable, Lowering
2023-08-14 9:22:40 AM	Available

NR Bridge 1

General | Child Elements | Attributes | Ports | Analyses | Notification Rules | Version

Filter

	Name	Value
Category: AF Calc		
	Forecast-Status	Unavailable, Raised
	OPC_Interface_Health	0
	Status-Colour	Red
Category: AF Table		
	Lock-Location	D
	Lock-Offset	15
Category: PI Data		
	EMS-Override	NORMAL
	EMS-Override-Available	NORMAL
	EMS-Status	CLOSE
	Estimated-Lift-Time	-1
	Fully-Closed	OPEN
	Red-Light	Excluded
	Status	1
Category: Reference Data		
	Bridge-Name	B1
	Region	NR
	TMS-Location-ID	7390
Category: TMS Data		
	Description-E	Lakeshore Rd (St. Catharines)
	Description-F	Ch. Lakeshore (St. Catharines)
	Dummy-ETA	No Data
	Dummy-Type	No Data
	Maintenance-Description-E	No Data
	Maintenance-End	No Data
	Maintenance-Start	No Data
	Override-Status	0
	Pleasure-Craft-ETA	No Data
	Pleasure-Craft-Type	No Data

Future Avenues at St. Lawrence Seaway with Maya HTT

IIoT, AI & Big Data

Our Goal

2024

2022

39% with solid back-end to improve further & scale
ETA ± 15 mins @ 60 mins

32.5%
ETA ± 15 mins @ 60 mins

95%
ETA ± 5 mins @ 60 mins

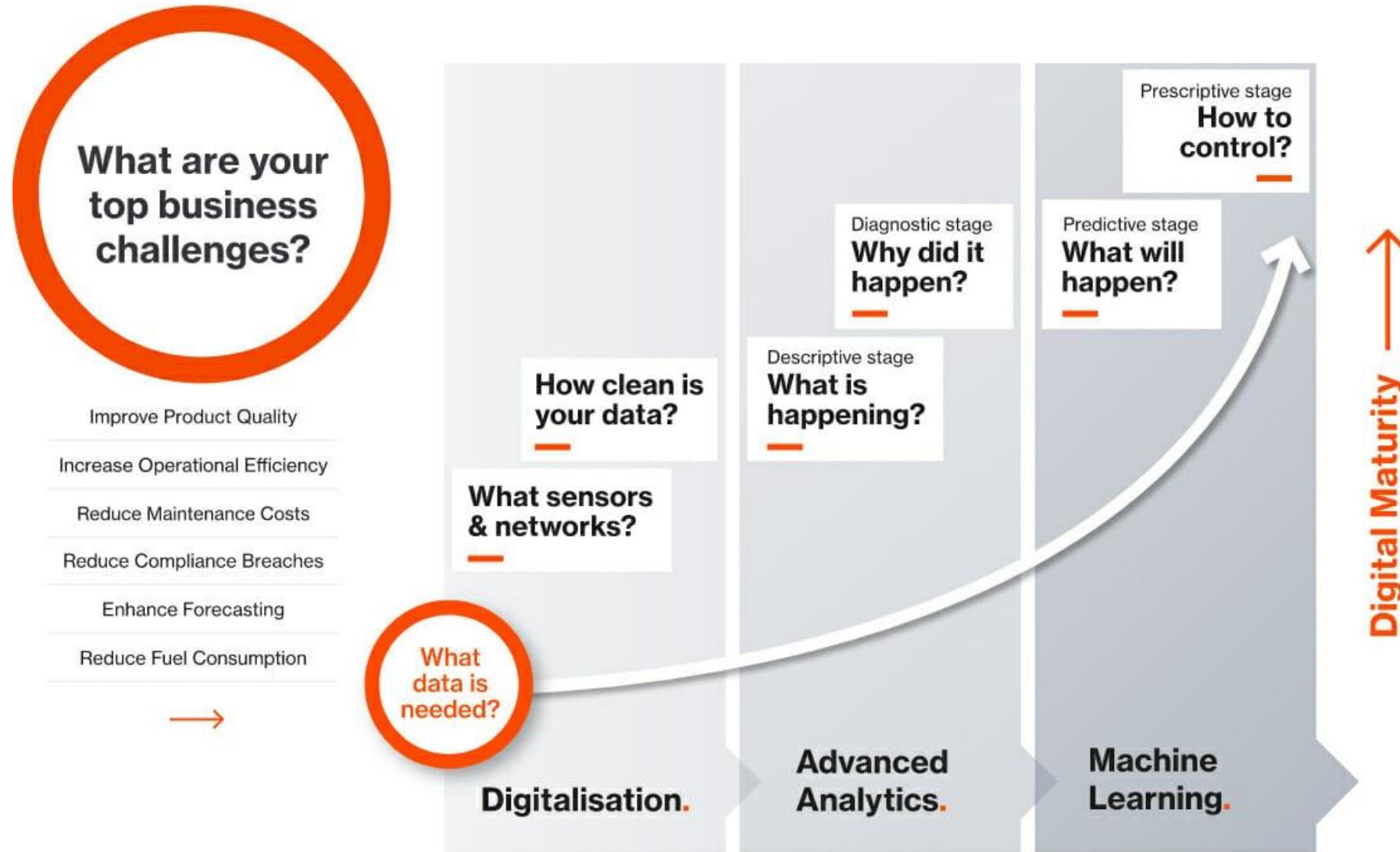**Next steps to achieve the 95% goal**:
- Model physical world (locks, canal, etc.) and key influential variables
- Update templates to account for this new physical model
- Train machine learning and AI model(s) to improve accuracy further using what we learned in the physical modeling
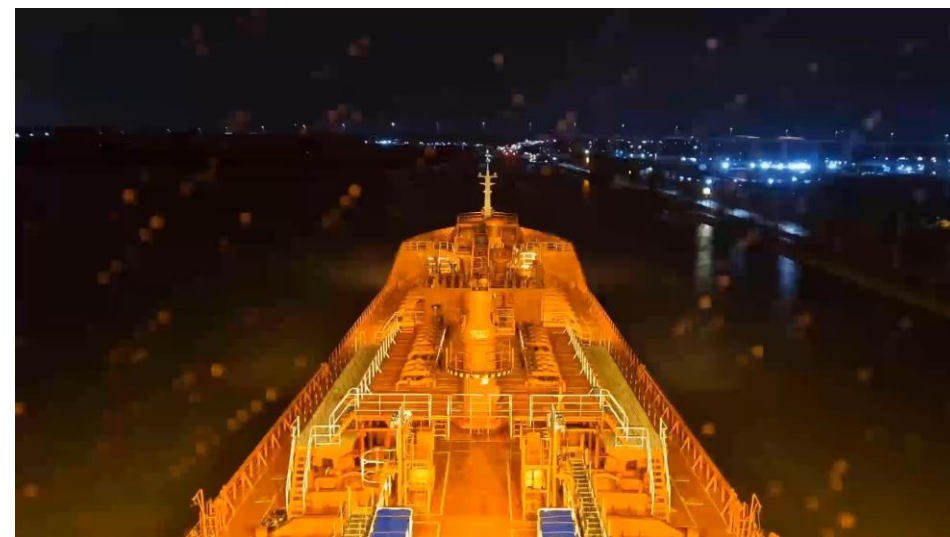
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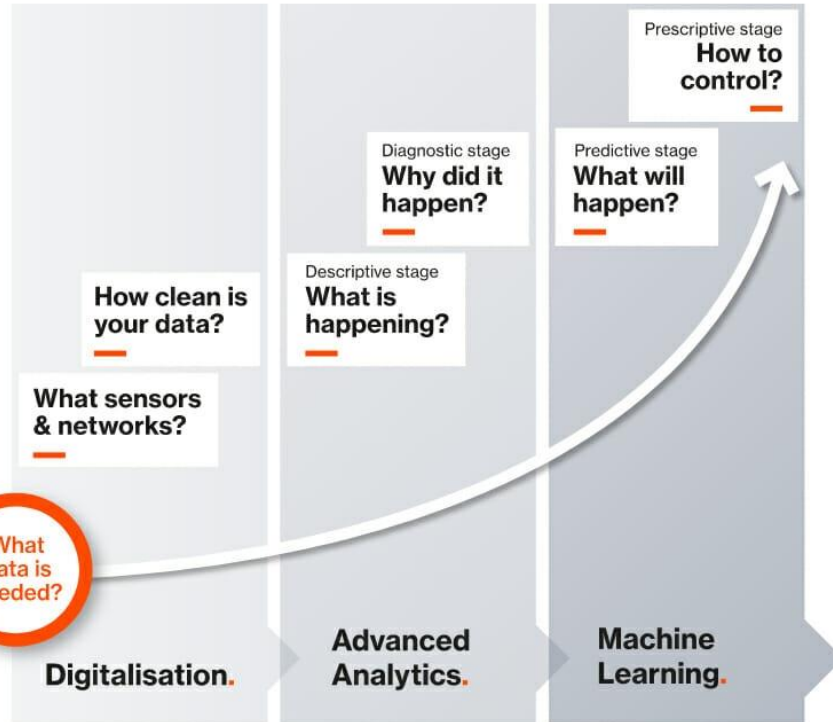
Digital Transformation Journey in the Industrial World

What are your top business challenges?

Improve Product Quality

Increase Operational Efficiency

Reduce Maintenance Costs

Reduce Compliance Breaches

Enhance Forecasting

Reduce Fuel Consumption

What data is needed?

How clean is your data?

What sensors & networks?

Descriptive stage
What is happening?

Diagnostic stage
Why did it happen?

Predictive stage
What will happen?

Prescriptive stage
How to control?

Digitalisation.

Advanced Analytics.

Machine Learning.

Digital Maturity

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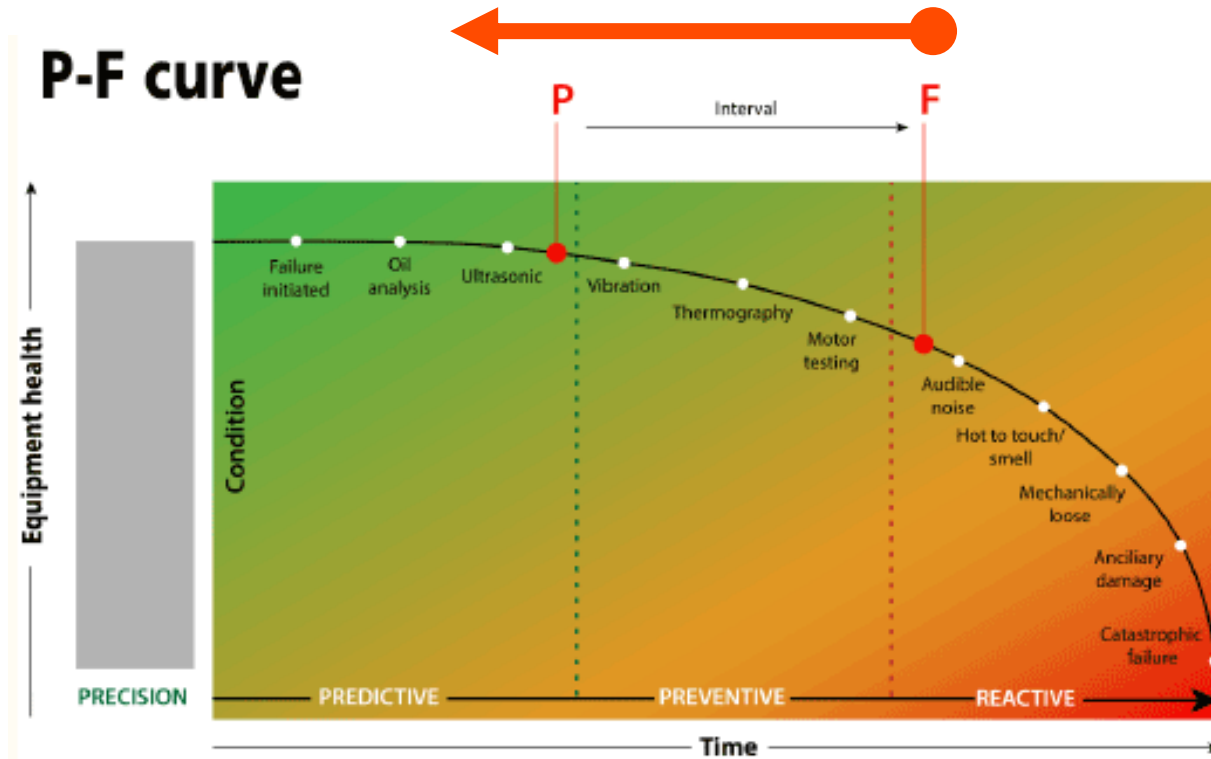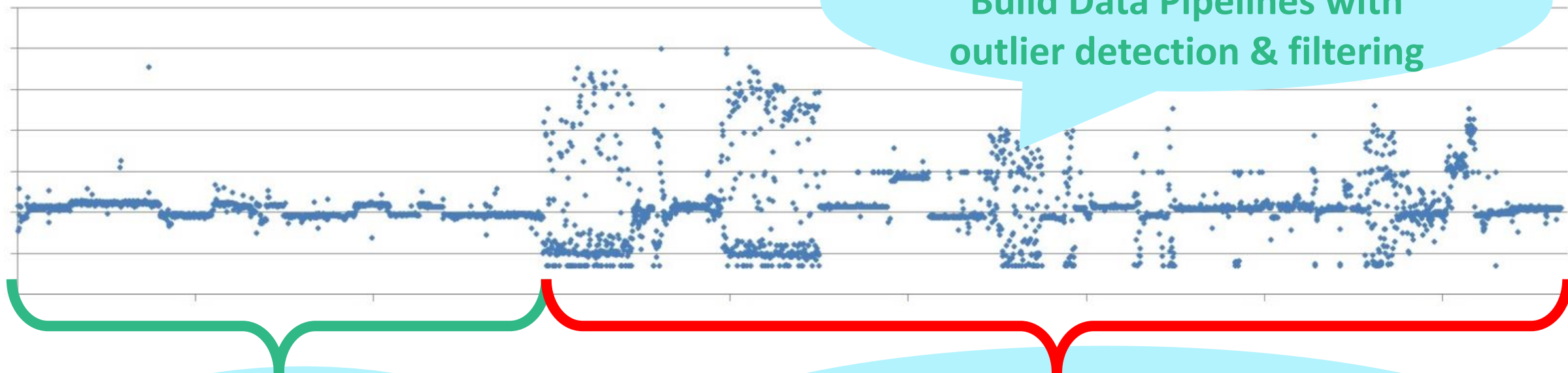# Digital Transformation Journey in the Industrial World

Figure: P-F curve from www.isa.org

Data Governance is Paramount in all Digital Transformation
Assume your data is dirty until proven "reliably" clean

Thanks for Listening! Any Questions?

Speaker Info

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🐦 @avevagroup

ABOUT AVEVA

AVEVA is a world leader in industrial software, providing engineering and operational solutions across multiple industries, including oil and gas, chemical, pharmaceutical, power and utilities, marine, renewables, and food and beverage. Our agnostic and open architecture helps organizations design, build, operate, maintain and optimize the complete lifecycle of complex industrial assets, from production plants and offshore platforms to manufactured consumer goods.

Over 20,000 enterprises in over 100 countries rely on AVEVA to help them deliver life's essentials: safe and reliable energy, food, medicines, infrastructure and more. By connecting people with trusted information and AI-enriched insights, AVEVA enables teams to engineer efficiently and optimize operations, driving growth and sustainability.

Named as one of the world's most innovative companies, AVEVA supports customers with open solutions and the expertise of more than 6,400 employees, 5,000 partners and 5,700 certified developers. The company is headquartered in Cambridge, UK.

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