The Road to Automation for the Canadian Maritime Industry

Steps to achieve Artificial Intelligence and Autonomous Ships in the Maritime Industry for the Green Voyage

CSL

April 2023

CSL IN BRIEF – 160 YEARS YOUNG

CANADIAN-BASED

Privately-owned, Montreal-based marine transportation company with operations throughout the Americas, Europe, Australia, Asia and Africa.

CARGO TRANSPORTED

Includes cement, iron ore, grain, bauxite salt, aggregates and sugar, among many others.

120	1,600
ship fleet	**employed**
worldwide	ship and shore (approx)

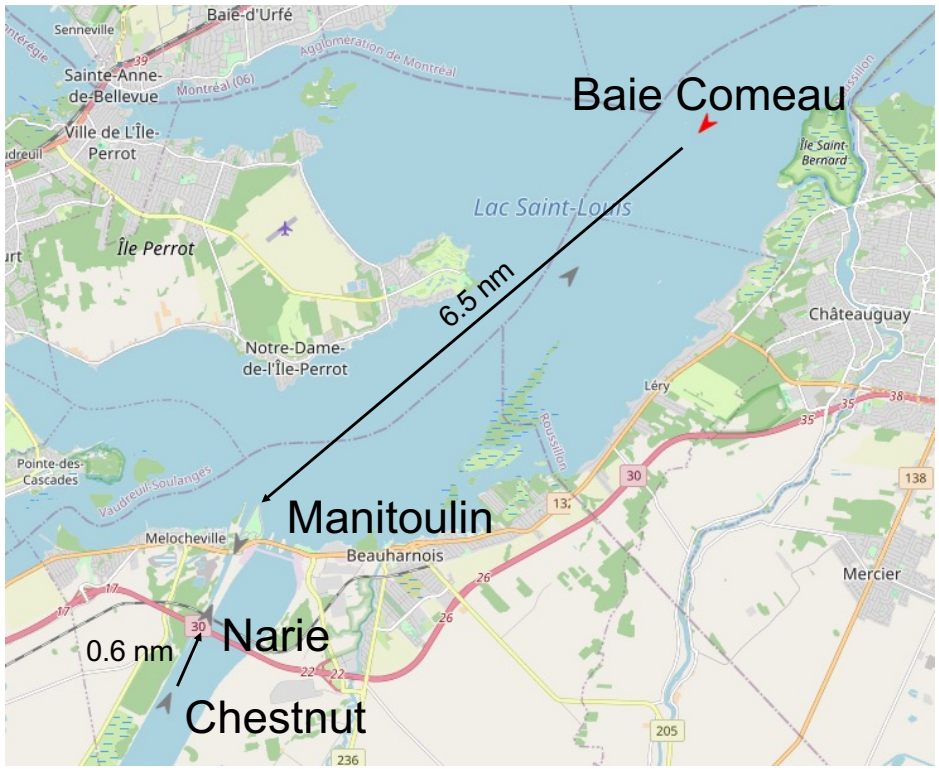
Leading provider of marine dry bulk cargo handling and delivery services.

World's largest owner and operator of self-unloading vessels.

World's third largest owner and operator of pneumatic and mechanical cement carriers.

Picture this…

OUR PROBLEM – Hurry up and WAIT



A real-world situation – November 3, 2022

The single largest systematic carbon inefficiency in our industry (imagine this in airports…)

Responsible for 20-25% of shipping's carbon footprint

MARITIME AI

AI benefits for shipping carriers

Increase **safety with predictive maintenance** and automated responses

Maximize the **usage of ship's capacity with computer-vision** fueled positioning systems

Adjust to the changing market realities, **fluctuating demand**, and unpredicted events **with dynamic pricing** algorithms

Calculate the **most efficient route forecasting in terms of fuel consumption**

Improve the cost-effectiveness and **productivity of their processes with advanced planning and scheduling tools**

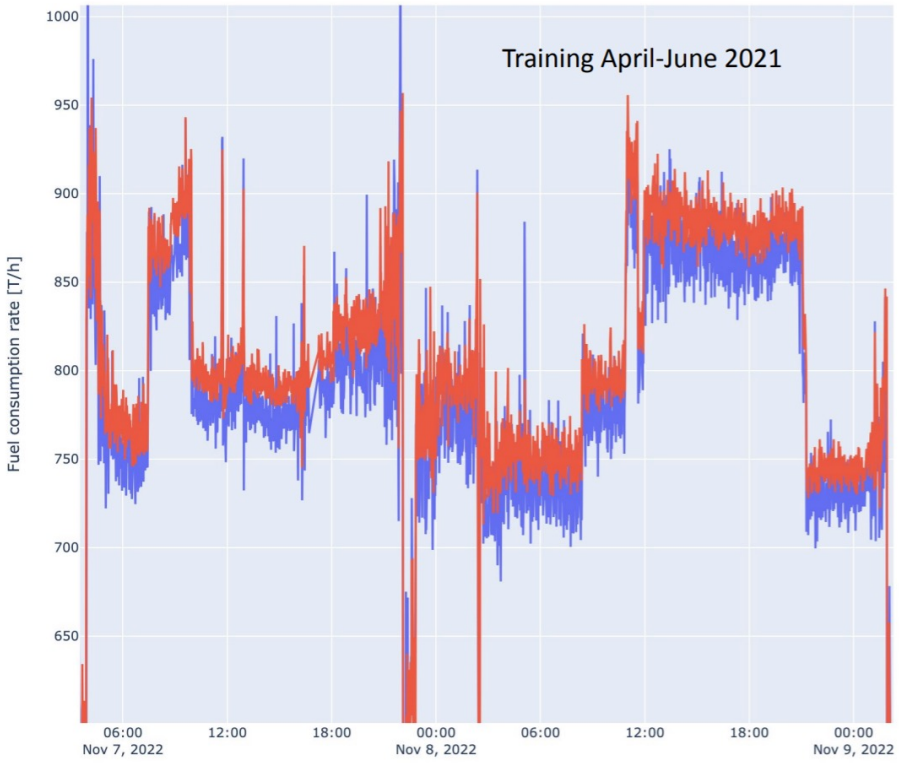
MARITIME INNOVATION ROADMAP

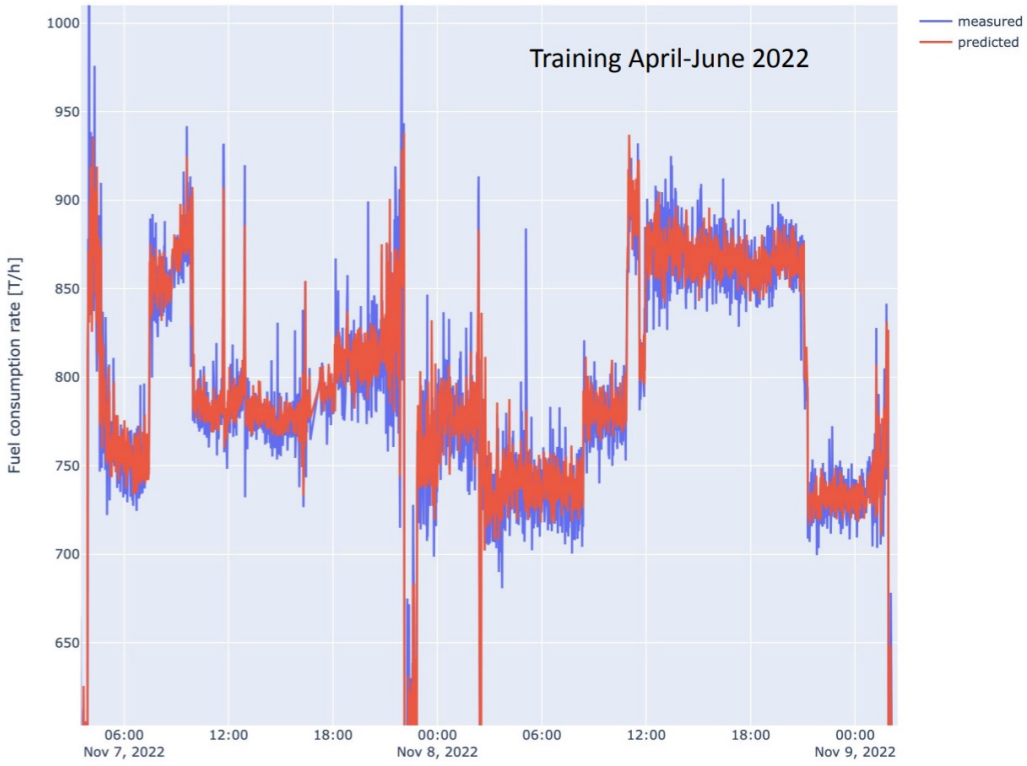
Business Case	Data Sources	Connectivity	Cloud Infra	Data Ingestion	Data Sharing	Reporting	Modeling	Automation
Use Cases Influencing Variables	3rd party sources / Open Data Business applications IoT sensors / Digital Twin Edge Computing	VSAT LEO LTE / 5G	Cloud Architecture Cyber Security	Data Architecture Data Governance	IMO Mapping APIs	Real-Time / "HMI" Analytics / Business Intelligence	Machine Learning Federated Machine Learning	Edge AI / Assisted Navigation Levels of ship autonomy AI - Ship - Fleet - Ecosystem / SaaS

Internal operational process optimizations

ML RESULT – Agreement over Full Range - 96% accuracy

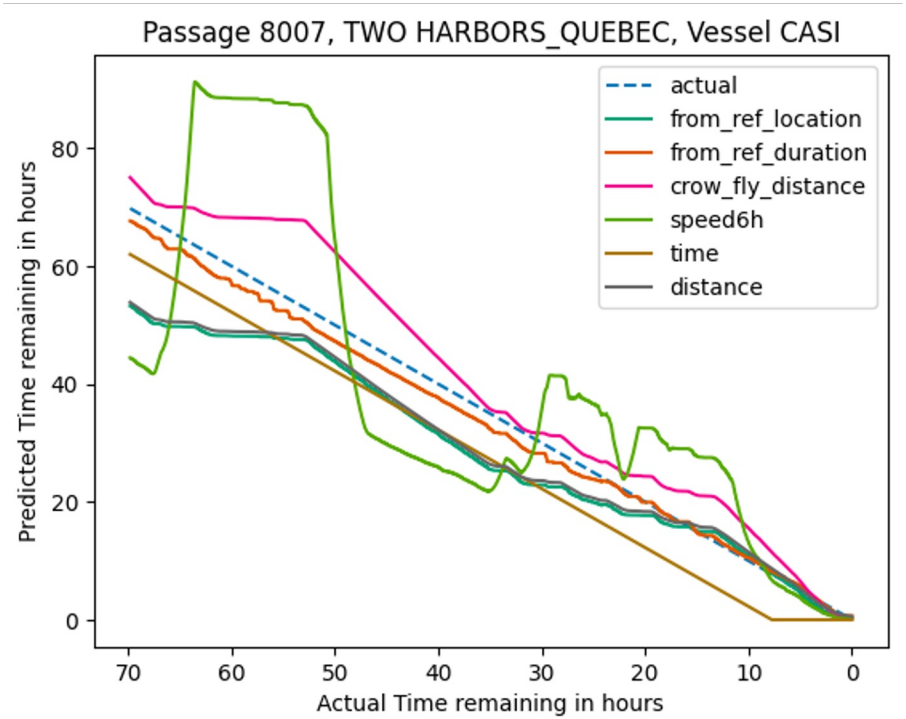
ML RESULT – Drift Compensation with Hull cleaning





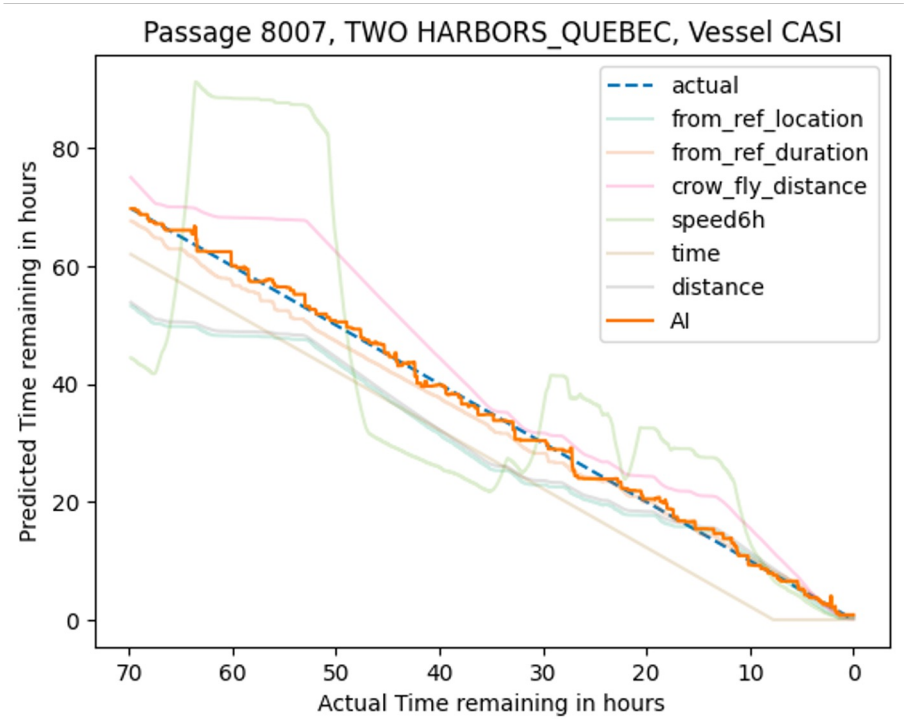
ML RESULT – Getting the Best Estimates?

1. With machine learning we can leverage previous travels the learn the best way to predict.



ML RESULT – Getting the Best Estimates?

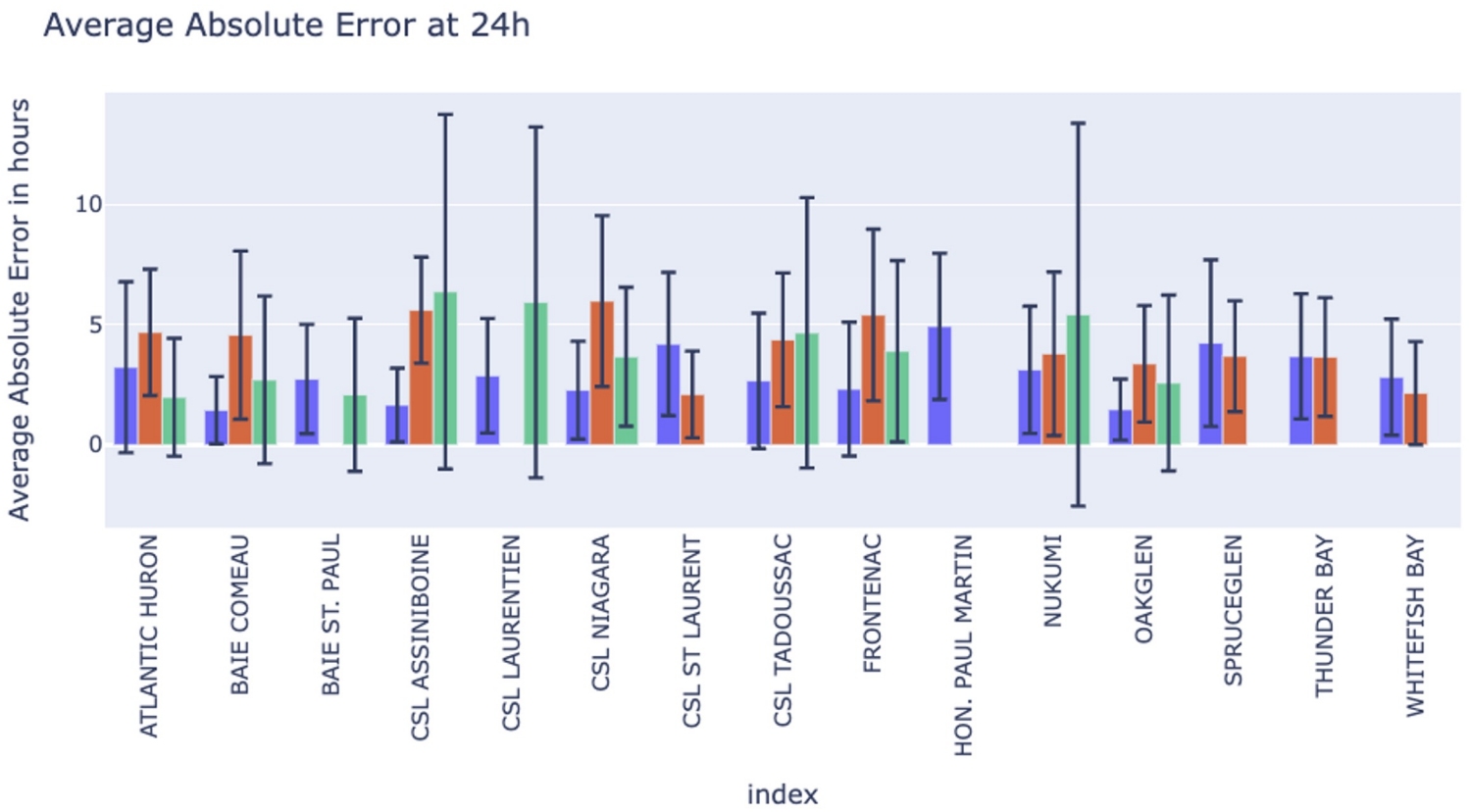
With machine learning we can leverage previous travels the learn the best way to predict.



Trained on 2021-01-01 through 2022-08-01

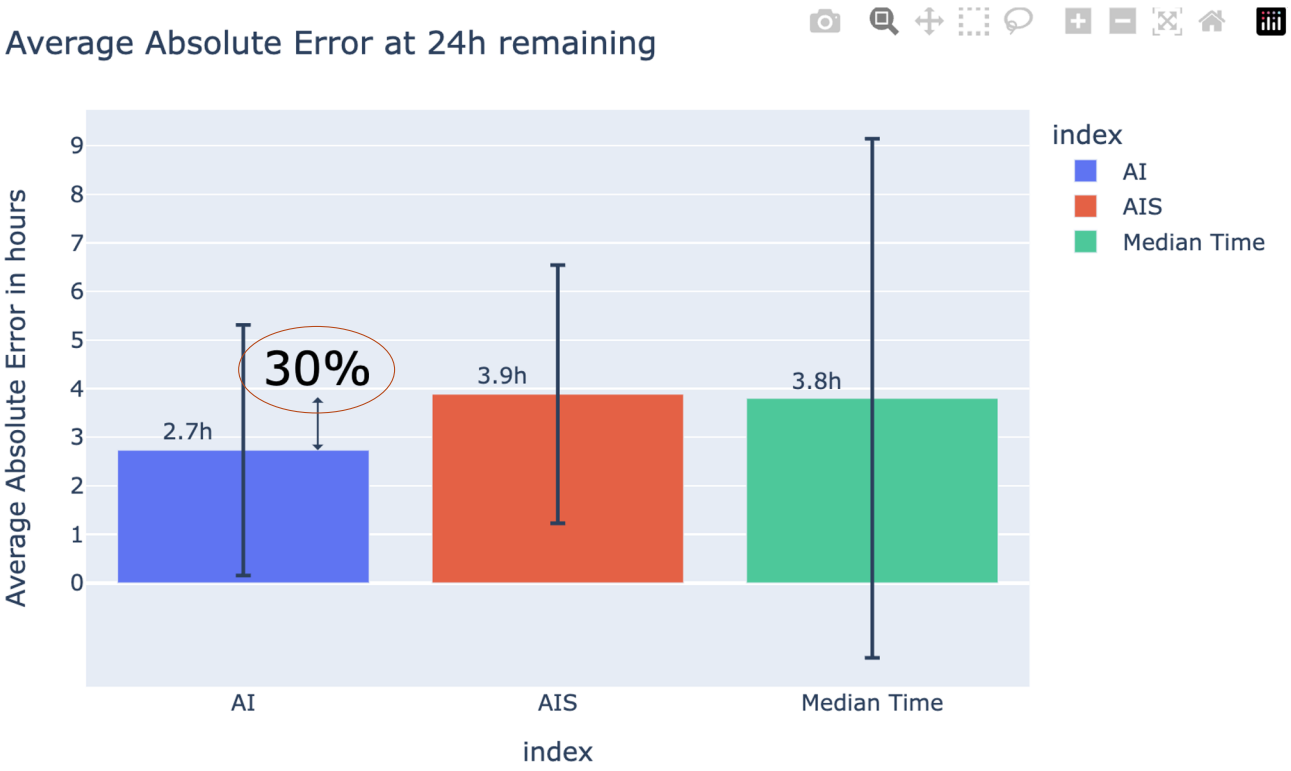
Tested on 2022-08-02 through 2022-12-31

ML RESULT – Measuring each ship (CAD)!



	mean	std
AI	2.7	2.6
AIS	3.9	2.7
Median Time	3.8	5.3

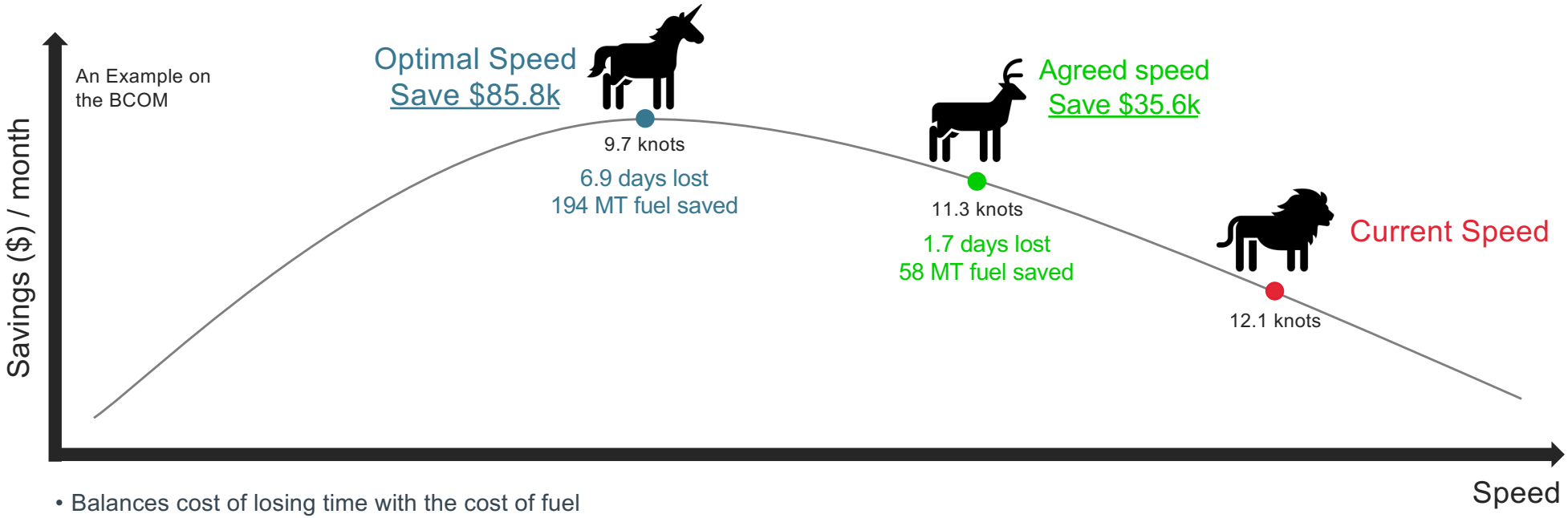
ML RESULT – a 30% Improvement!



	mean	std
AI	2.7	2.6
AIS	3.9	2.7
Median Time	3.8	5.3

SPEED MANAGEMENT

Recommended Speed for Sailing

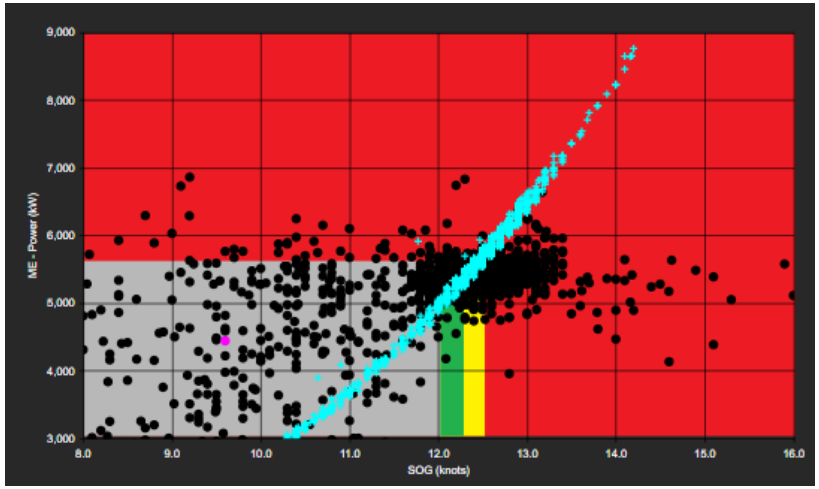


- Balances cost of losing time with the cost of fuel
- Considers the minimum safe operating speed of the vessel
- Jointly decided by Commercial & Technical

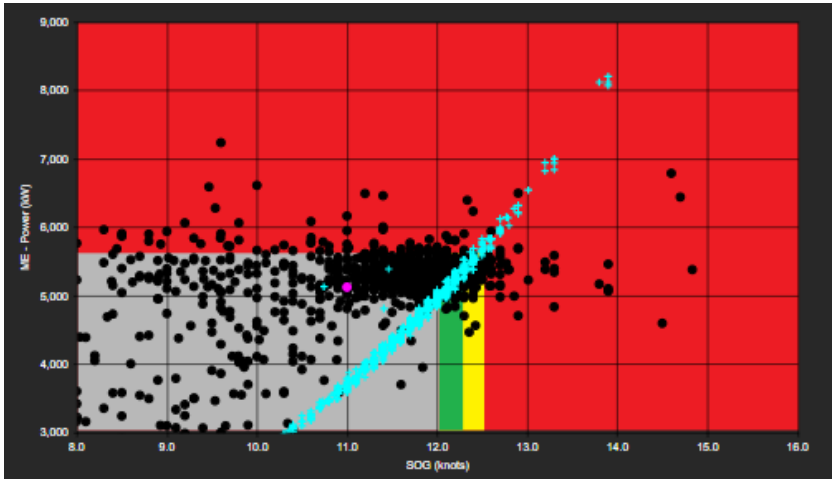
SPEED MANAGEMENT BENEFITS

Pilot project: 8 Canadian vessels cumulated 218 days in open water.
297 MT of fuel was saved, equivalent to 952 MT of CO_2 reduction.
No impact on the business.

Before O2 Speed Management



After O2 Speed Management



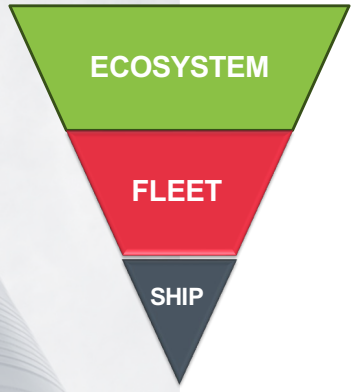
Red area is the inefficient power range for a desired speed. We can clearly see the impact of the crew reducing time spent in these areas

ALL THIS IS GOOD, and we even won awards for it

BUT…

IT'S NOT ENOUGH

BUT OUR BIGGEST COLLECTIVE PROBLEM IS…



WE ARE ALL WORKING IN ISOLATED SILOES

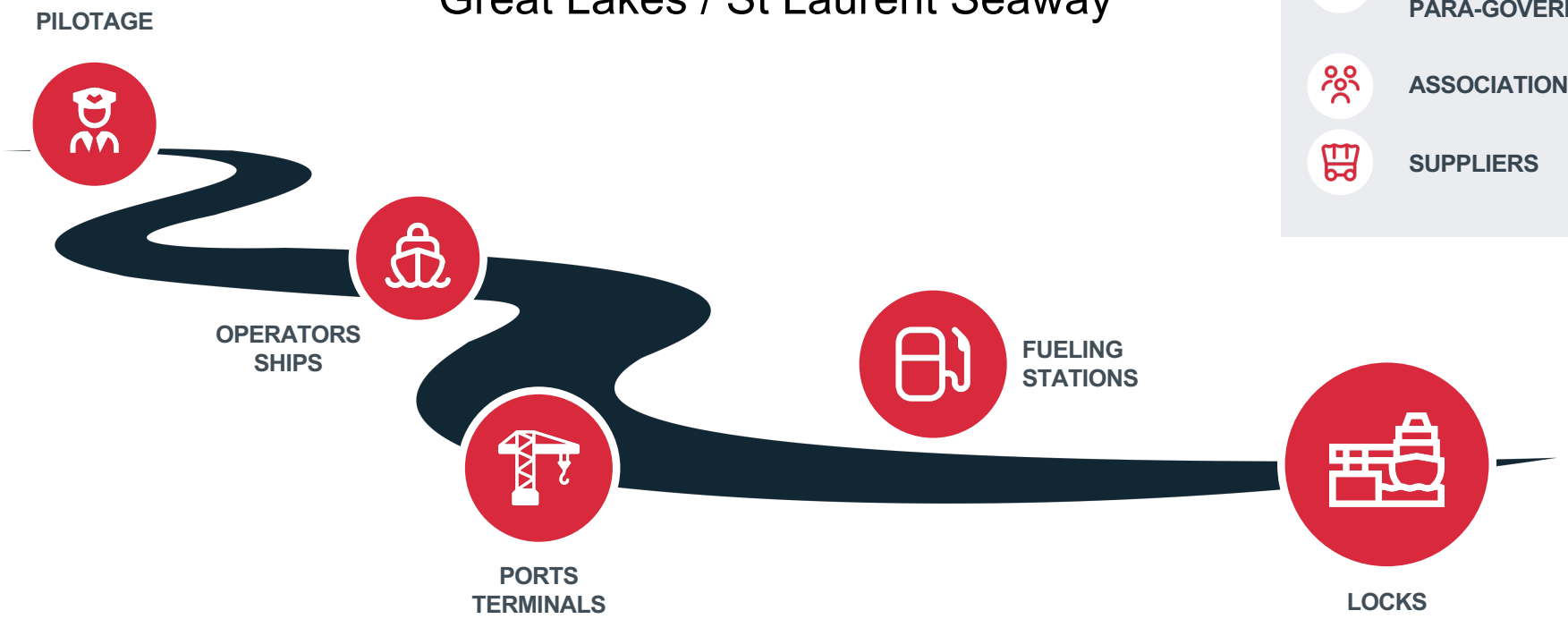
And we’re afraid of sharing our data…

Now picture this with…

200 ships
17 locks
120 ports

MARITIME STAKEHOLDERS

The scale of the problem in the Great Lakes / St Laurent Seaway



- GOVERNMENT / PARA-GOVERNMENT
- ASSOCIATIONS
- SUPPLIERS

SOLUTION: A COLLECTIVE MISSION STATEMENT

Let's call it the GREEN VOYAGE

The Road to Automation in the Great Lakes and St-Lawrence Seaway

- Industry players collaborate
- To optimize the schedule, time and fuel for each voyage
- By sharing relevant anonymized data and applications
- Through APIs
- On AI-powered maritime data aggregation platforms
- That create consistent and self-improving actionable patterns, insights and routes
- For the maritime regional ecosystem & to the benefit of all stakeholders.

SOLUTION = DATA + AI SOFTWARE

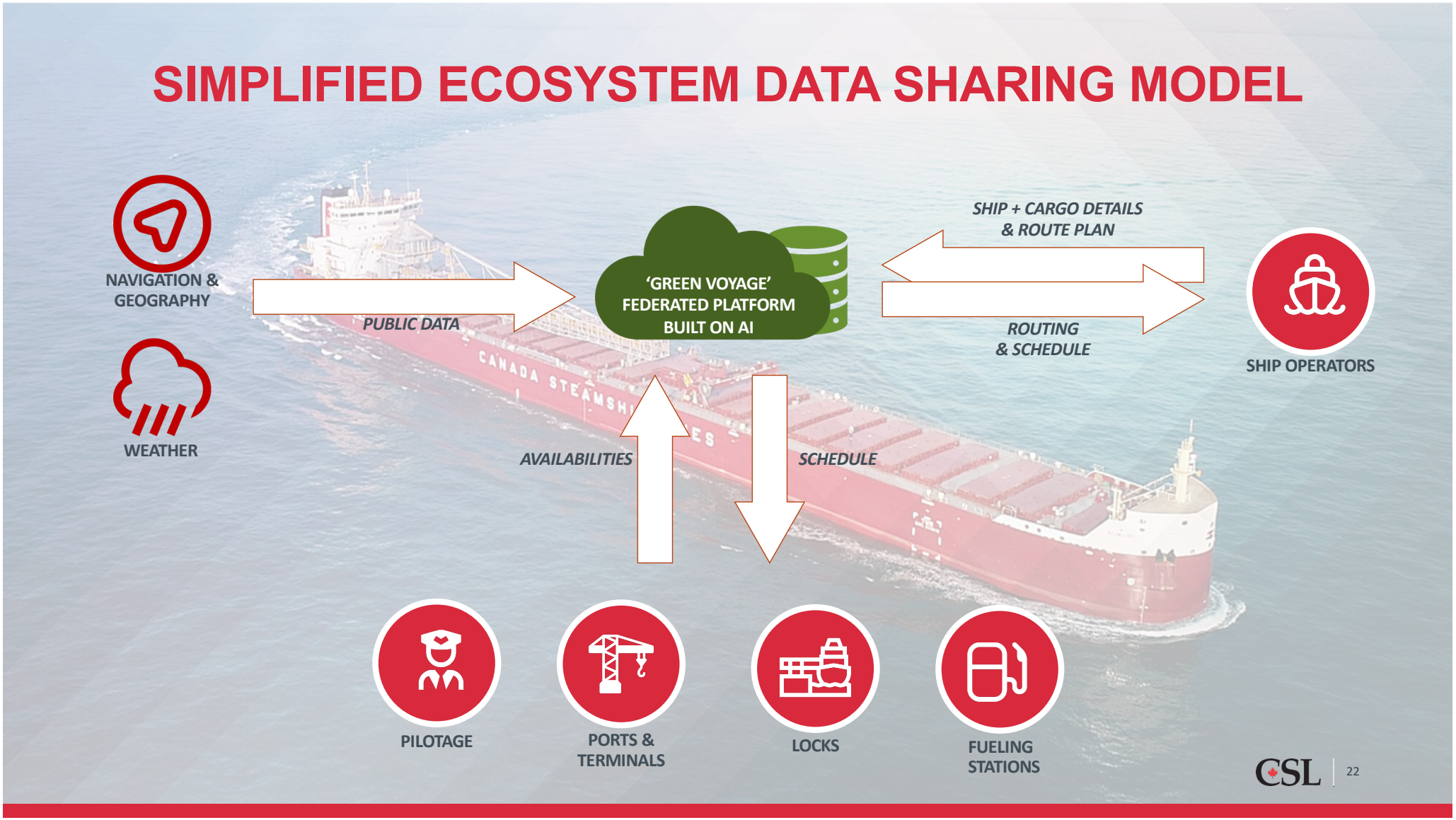
Data

- CSL has done a lot of the legwork
- Wrote an industry-setting Framework which proposes a way to securely and conveniently share data
- Focus on data privacy and the IP remains secure with the data provider
- No commercially sensitive data can be seen by others
  - For operators like us can: cargo type, cargo weight, exact draft, port berths)

SOLUTION = DATA + AI SOFTWARE

- Based on a recognized IMO FAL 48 standard
  - CSL is now a member of the IMO Expert Group on Data Normalisation
- Using Rest APIs as a sending protocol - low implementation cost and operation overhead
- Even mapped out the data fields necessary for Operators, Ports, Terminals, Pilotage, etc, supplying the formats, the ranges, etc.
- **Call to action: We just need to create our APIs to share our data**

SIMPLIFIED ECOSYSTEM DATA SHARING MODEL



MARITIME DATA INPUTS INFLUENCING THE GREEN VOYAGE

Data Assets influencing routes, fuel and scheduling for the Green Voyage

OPERATORS SHIPS

Inputs Data Sets

SHIP
- Ship type / model / Hullm and rudder loads / engine and propellor models / Windage / Service and fouling margins
- Ship owner
- Ship agent
- Speed over ground
- Speed over water
- Power
- Autopilot gain
- Turning radius
- Main RPM
- Auxiliary RPM
- Propeller pitch
- Dock power source : auxiliary engine or shore power

CARGO
- Type
- Electric equipment during loading usage
- Electric equipment during discharging usage
- Hotel load
- Cargo weight
- Deadweight

FUEL
- Bunker quantity
- Average consumption
- Price

Inputs Data Sets

NAVIGATION
- Voyage ID
- Direction / course
- Orientation / heading

GEOGRAPHY
- Position
- Navigation zone
- Fore Draft
- Aft Draft
- Environmental regulations

OUTSIDE FORCES
- Draft and trim
- Water levels
- Tides
- Wind
- Current
- Fouling
- Ice

PEOPLE
- Pilot
- Pilot availabilities
- Pilot schedule
- Crew availabilities

MARITIME DATA INPUTS INFLUENCING THE GREEN VOYAGE

Data Assets influencing routes, fuel and scheduling for the Green Voyage

PORTS TERMINALS

FUELING STATIONS

LOCKS

Inputs Data Sets

STOPS

- Origin activity
- Destination activity

- Port list with IDs
- Port availabilities

- Terminal list with Ids
- Terminal availabilities

- Locks list with Ids
- Locks availabilities

- Fueling stations list with Ids
- Fueling stations availabilities

- Unscheduled stops
- Network and canal availabilities
- Traffic and congestion
- Bridge passings

Inputs Data Sets

TIME

- Time arrival in Port
- Time in Port / Load / Unload
- Time departure Port

- Time arrival Terminal
- Time in Terminal
- Time departure

- Time arrival Lock
- Time in Lock
- Time departure Lock

- Time arrival Fueling station
- Time in Fueling station
- Time departure Fueling station

- Delayed time
- Time of position report
- Time for crew change
- Time for cleaning
- Time for repairs
- Anchored time
- End of sea passage

SOLUTION = DATA + AI SOFTWARE

- Send to a 3rd party that will crunch the ETAs and use multi-variante calculations to take into account everything that affects the voyage itself

- Let's look at a real life example with the Port of Montreal

Port of Montréal and GSTS Collaboration

4+ years of successful collaboration and partnership

Multiple industry initiatives resulting in several capabilities

Results from Digitization Projects

- **ETA Prediction** – accurately predict ETA of all vessels arriving at port up to 28 days in advance
- **Intelligent Geofences** – automatically receive alerts and updated ETA predictions when ships cross pre-defined checkpoints
- **Ice Management** – predict harsh ice conditions up to 7 days in advance
- **GHG Emissions Calculator** – calculate carbon footprint within port boundaries
- **Digitized Trade Routes** – tabulate emissions for all vessels globally; report on vessel voyages between two or more ports where Green Shipping Corridors are established
- **PMIS System Integration** – integrate ETA Predictions

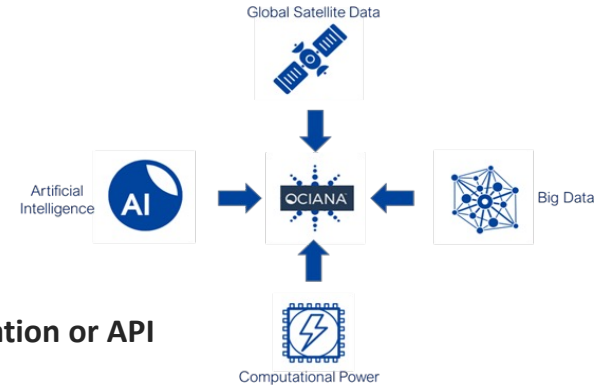
Port of Montréal and GSTS Collaboration (contd.)

Current Digitization Initiatives and Innovation Opportunities

- **World's First AI-Powered Predictive Collaborative Berth Scheduler**
  - **Supporting Port Operations**
    - Daily operations
    - Monthly planning
    - Long term planning
  - **Supporting collaboration with stakeholders**
    - Pilotage
    - Tug Companies
    - Terminal Operators
    - Shipping Lines
    - Government Agencies

OCIANA Platform

OCIANA™ incorporates the latest developments in **Artificial Intelligence** and **Big Data Analytics** to improve maritime situational awareness and provide real-time decision-making intelligence.



Multi-Source Data Analytics

- Designed to ingest a **wide range of data sources** including global AIS data, an array of satellite data, and weather data; OCIANA also ingests IoT data
- OCIANA spatially and temporally correlates the data and employs **AI algorithms**
- Output from the AI/ML trained models can be accessed through the **web-based application or API**

  -- Integration with existing systems (e.g., PMIS, shore-based coordination platforms)

Partner Communication

- An embedded communications channel enables **multiple users to share information** in real time
- Advanced **chat and collaboration tools** to facilitate coordinated response -- adherence to digitization standards

OCIANA Collaborative Berth Scheduler

Enabling Digital Planning and Operational Optimization

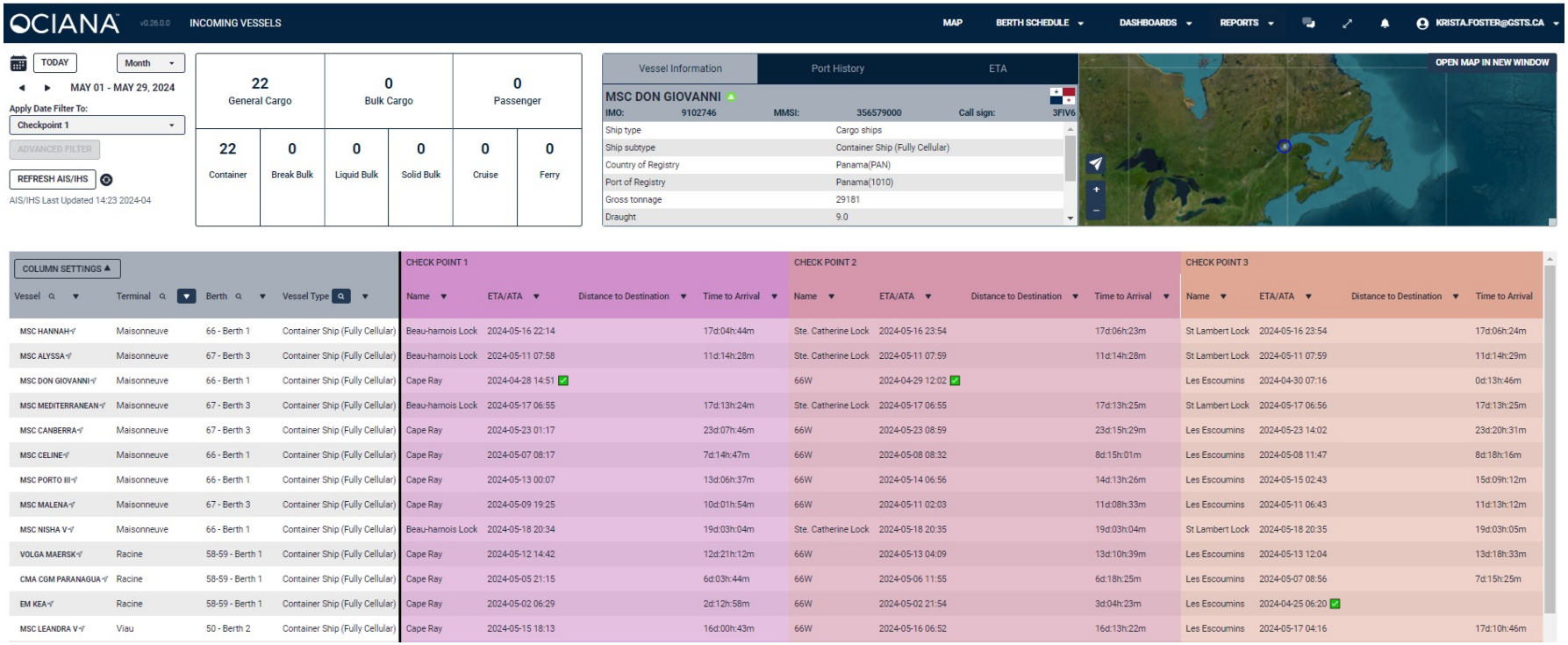
To allow ports, pilotage, and shipping lines **real-time data exchange**

Facilitating JIT Arrivals aimed at:

- minimizing time at anchorage and therefore **reducing congestion** in the port area
- enabling ships to **optimise steaming speed**, thereby lowering fuel consumption, and reducing emissions

Incoming Vessels Screen

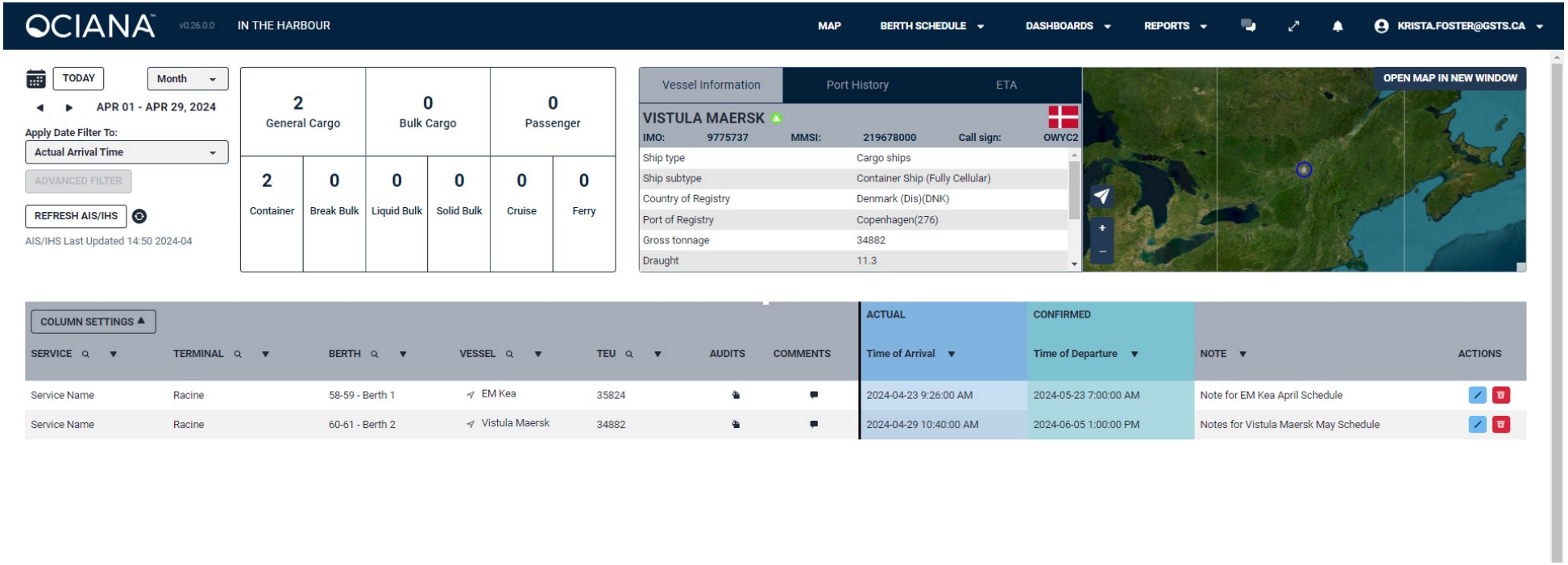
Leveraging OCIANA's ETA Prediction and Intelligent Geofences



Vessel	Terminal	Berth	Vessel Type	CP1 Name	CP1 ETA/ATA	CP1 Distance to Destination	CP1 Time to Arrival	CP2 Name	CP2 ETA/ATA	CP2 Distance to Destination	CP2 Time to Arrival	CP3 Name	CP3 ETA/ATA	CP3 Distance to Destination	CP3 Time to Arrival
MSC HANNAH	Maisonneuve	66 - Berth 1	Container Ship (Fully Cellular)	Beau-harnois Lock	2024-05-16 22:14		17d:04h:44m	Ste. Catherine Lock	2024-05-16 23:54		17d:06h:23m	St Lambert Lock	2024-05-16 23:54		17d:06h:24m
MSC ALYSSA	Maisonneuve	67 - Berth 3	Container Ship (Fully Cellular)	Beau-harnois Lock	2024-05-11 07:58		11d:14h:28m	Ste. Catherine Lock	2024-05-11 07:59		11d:14h:28m	St Lambert Lock	2024-05-11 07:59		11d:14h:29m
MSC DON GIOVANNI	Maisonneuve	66 - Berth 1	Container Ship (Fully Cellular)	Cape Ray	2024-04-28 14:51 ✓			66W	2024-04-29 12:02 ✓			Les Escoumins	2024-04-30 07:16		0d:13h:46m
MSC MEDITERRANEAN	Maisonneuve	67 - Berth 3	Container Ship (Fully Cellular)	Beau-harnois Lock	2024-05-17 06:55		17d:13h:24m	Ste. Catherine Lock	2024-05-17 06:55		17d:13h:25m	St Lambert Lock	2024-05-17 06:56		17d:13h:25m
MSC CANBERRA	Maisonneuve	67 - Berth 3	Container Ship (Fully Cellular)	Cape Ray	2024-05-23 01:17		23d:07h:46m	66W	2024-05-23 08:59		23d:15h:29m	Les Escoumins	2024-05-23 14:02		23d:20h:31m
MSC CELINE	Maisonneuve	66 - Berth 1	Container Ship (Fully Cellular)	Cape Ray	2024-05-07 08:17		7d:14h:47m	66W	2024-05-08 08:32		8d:15h:01m	Les Escoumins	2024-05-08 11:47		8d:18h:16m
MSC PORTO III	Maisonneuve	66 - Berth 1	Container Ship (Fully Cellular)	Cape Ray	2024-05-13 00:07		13d:06h:37m	66W	2024-05-14 06:56		14d:13h:26m	Les Escoumins	2024-05-15 02:43		15d:09h:12m
MSC MALENA	Maisonneuve	67 - Berth 3	Container Ship (Fully Cellular)	Cape Ray	2024-05-09 19:25		10d:01h:54m	66W	2024-05-11 02:03		11d:08h:33m	Les Escoumins	2024-05-11 06:43		11d:13h:12m
MSC NISHA V	Maisonneuve	66 - Berth 1	Container Ship (Fully Cellular)	Beau-harnois Lock	2024-05-18 20:34		19d:03h:04m	Ste. Catherine Lock	2024-05-18 20:35		19d:03h:04m	St Lambert Lock	2024-05-18 20:35		19d:03h:05m
VOLGA MAERSK	Racine	58-59 - Berth 1	Container Ship (Fully Cellular)	Cape Ray	2024-05-12 14:42		12d:21h:12m	66W	2024-05-13 04:09		13d:10h:39m	Les Escoumins	2024-05-13 12:04		13d:18h:33m
CMA CGM PARANAGUA	Racine	58-59 - Berth 1	Container Ship (Fully Cellular)	Cape Ray	2024-05-05 21:15		6d:03h:44m	66W	2024-05-06 11:55		6d:18h:25m	Les Escoumins	2024-05-07 08:56		7d:15h:25m
EM KEA	Racine	58-59 - Berth 1	Container Ship (Fully Cellular)	Cape Ray	2024-05-02 06:29		2d:12h:58m	66W	2024-05-02 21:54		3d:04h:23m	Les Escoumins	2024-04-25 06:20 ✓		
MSC LEANDRA V	Viau	50 - Berth 2	Container Ship (Fully Cellular)	Cape Ray	2024-05-15 18:13		16d:00h:43m	66W	2024-05-16 06:52		16d:13h:22m	Les Escoumins	2024-05-17 04:16		17d:10h:46m

In the Harbour Screen

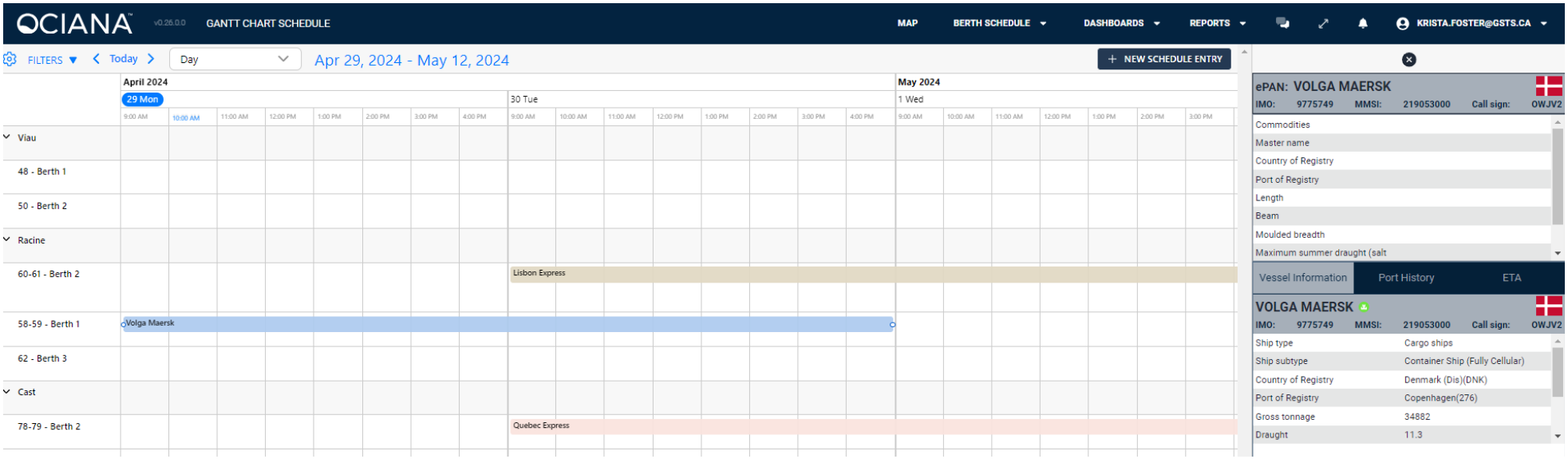
Leveraging OCIANA's Port Analytics



Gantt Chart View of the Collaborative Berth Schedule

Leveraging OCIANA's Predictive Analytics

- Display Pre-Arrival Notification (ePAN) and ship ETA
- Allow shipping lines to submit initial requests and port to confirm berth availability
- Enable collaboration with terminal operators, pilotages and tug operators
- Streamline communications for change requests and confirmation for revised BTW – eliminate calls and emails



THE ECONOMIC BENEFITS

An example from The Spire platform study – 100 Vessels

SPIRE VOYAGE OPTIMIZATION
Powered by Theyr

A STUDY COMPARING "US" VS "THEM" SHOWS …

- 15% Fuel Use Reduction
- 7.5% Voyage Time Improvement
- 8% TCE Improvement

FOR A 100 VESSEL FLEET …

- 7500 MT fuel used per year
- 5450M per year fuel cost
- Up to 70% of annual operational cost

REPRESENTS A POSSIBLE SAVINGS OF …

- $22.5M Fuel Savings
- $33.8M Savings on TCE
- $1.98M MTs Carbon Reduction

Voyage Optimization Solution
Available via API

A HUGE CULTURE SHIFT

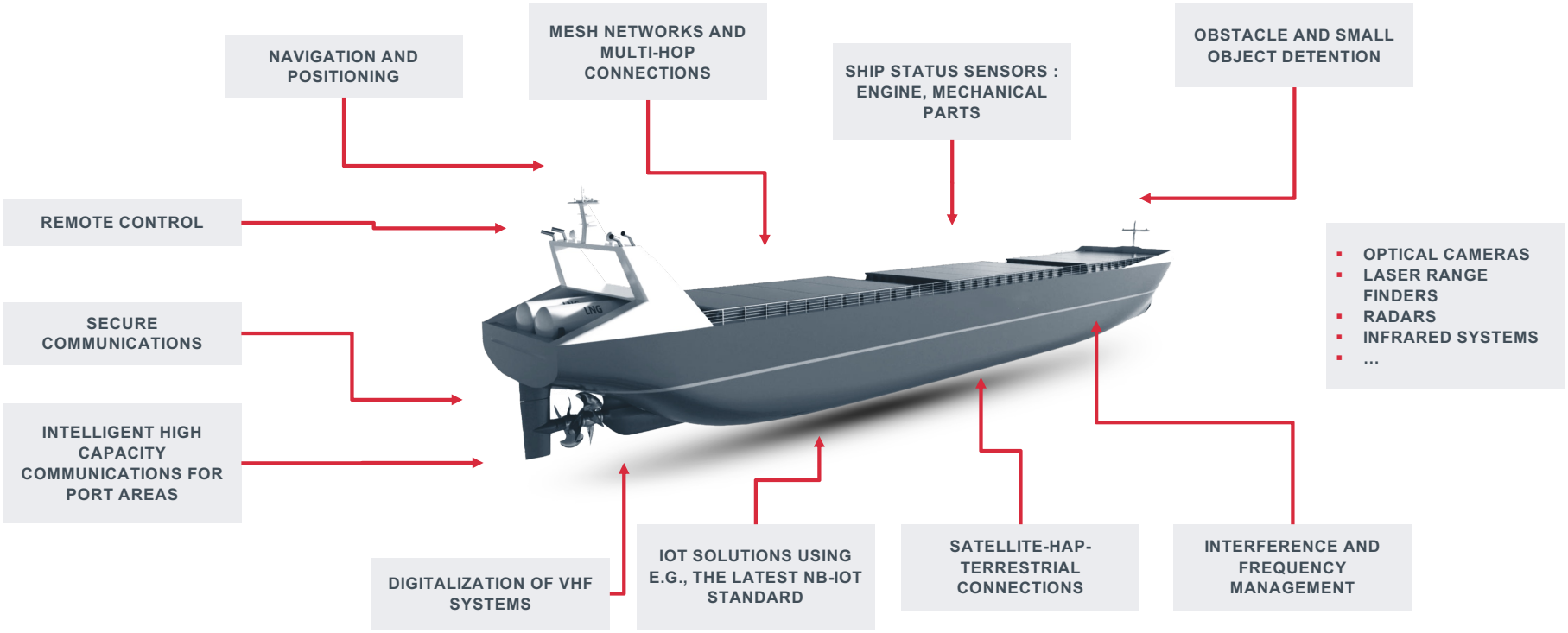
Change management is so important

- Captains reducing their speed and not racing

- ‘First come, first serve’ becomes ‘Here is your place in the line’

= THE FOUNDATION FOR SHIPPING AUTONOMY

What's everything that goes into levels of an autonomous ship?



SHOW ME THE MONEY

SHOW ME THE MONEY
DATA