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BigDataStack

Holistic stack for big data applications and operations

A seafarers tale: Real-time Ship Monitoring

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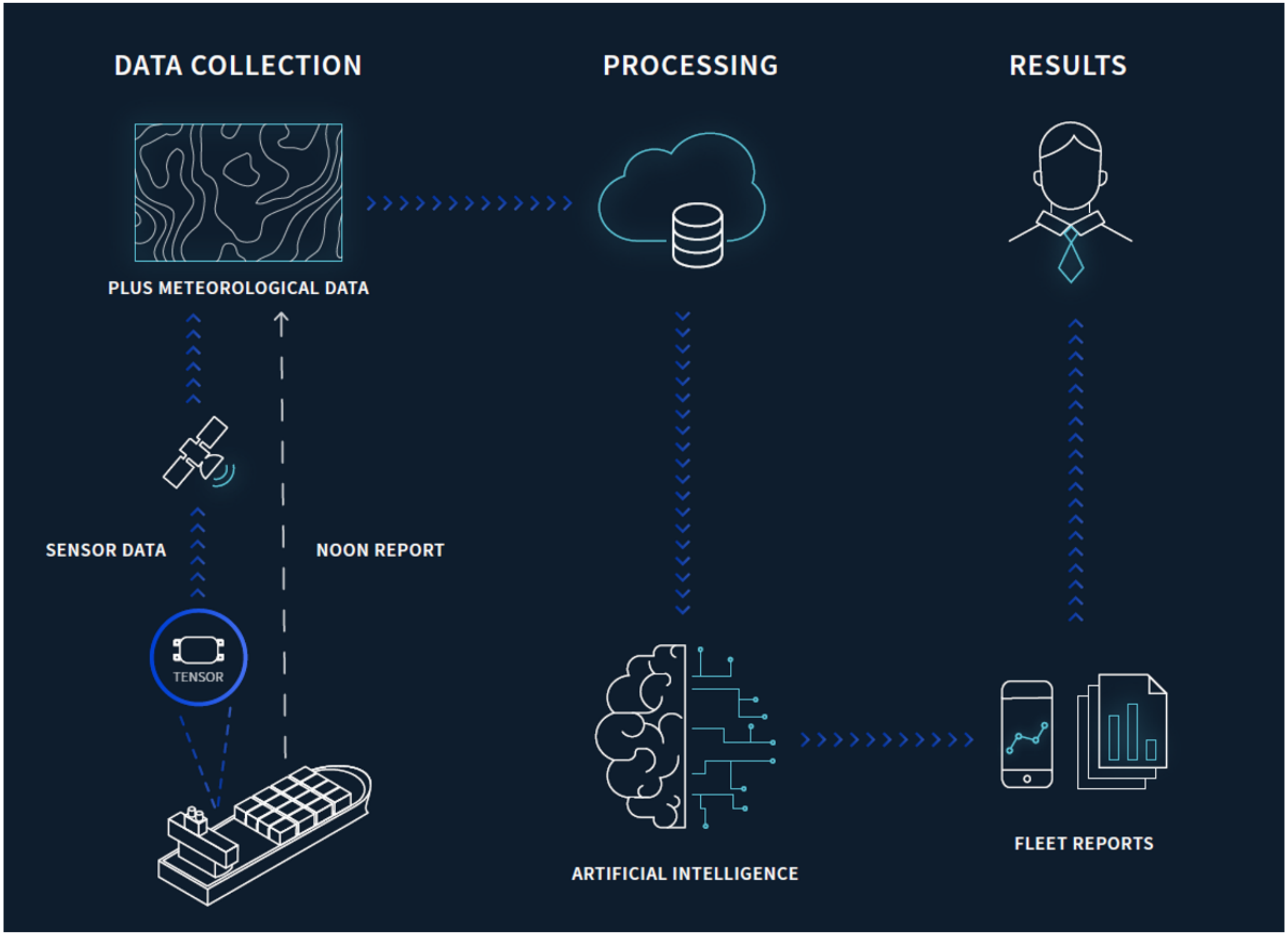
European Commission

Danaos Corporation

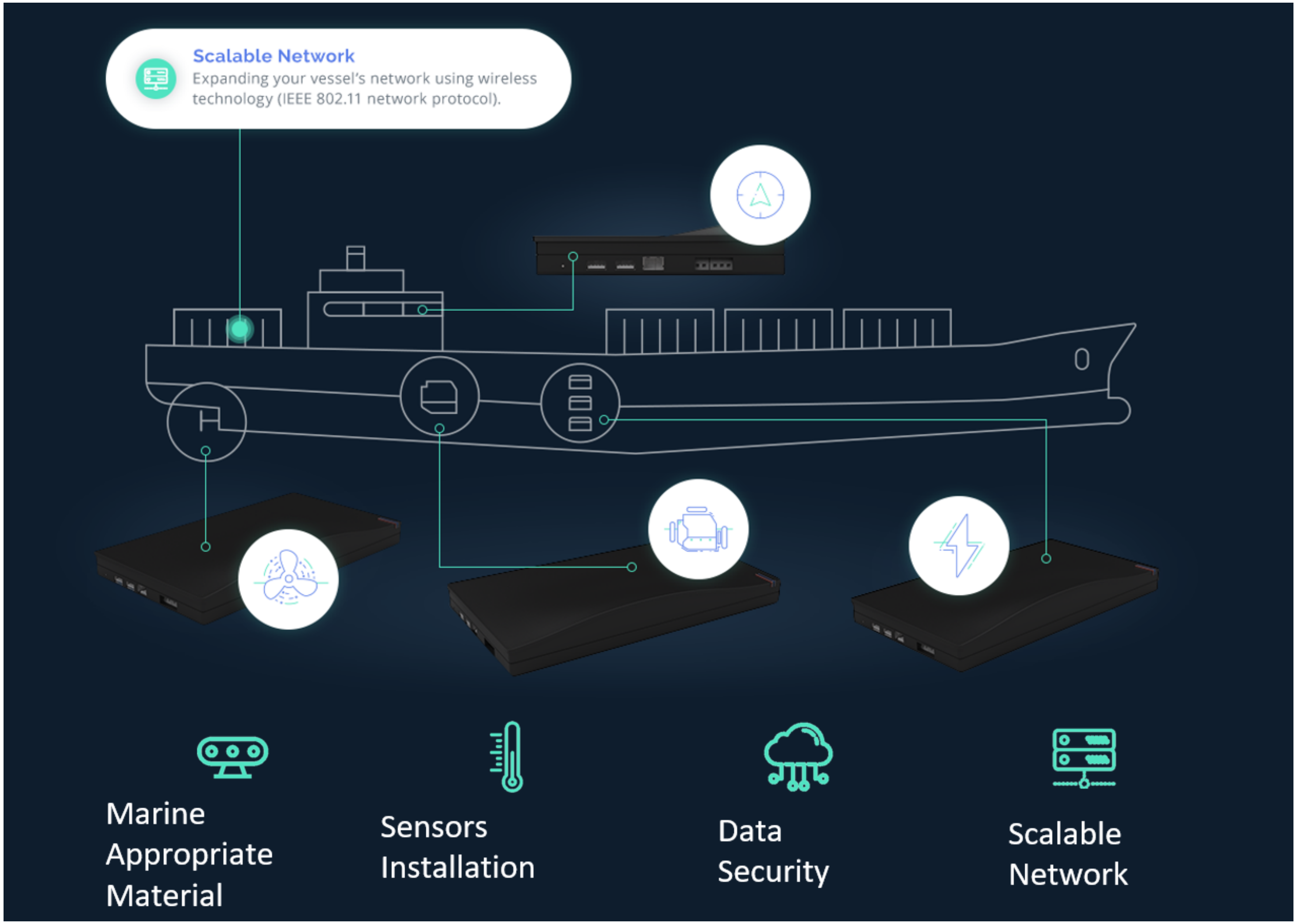
- One of the largest, independent owners of modern large-size container-ships.
- A proven track record of operational excellence and technological leadership.
- Our distinct edge in advanced shipping technology and long track record of
  - safety,
  - efficiency and
  - environmental responsibility,
- Helped us forge lasting relationships with our customers
- Our deep understanding of the shipping do[illegible]d us to get involved quite early (1980s) into software for shipping as well.

Real-Time Ship Management Objectives

How we do it


DATA COLLECTION
PROCESSING
RESULTS
PLUS METEOROLOGICAL DATA
SENSOR DATA
NOON REPORT
TENSOR
ARTIFICIAL INTELLIGENCE
FLEET REPORTS

On-board installations



Market needs

- Simple data logging is not a solution anymore
- Ignorance and over-information are the two sides of the same coin
- Actionable Information is required from the end-user
- Analytics over big data is mandatory

Storyboard - scenario (1/5)

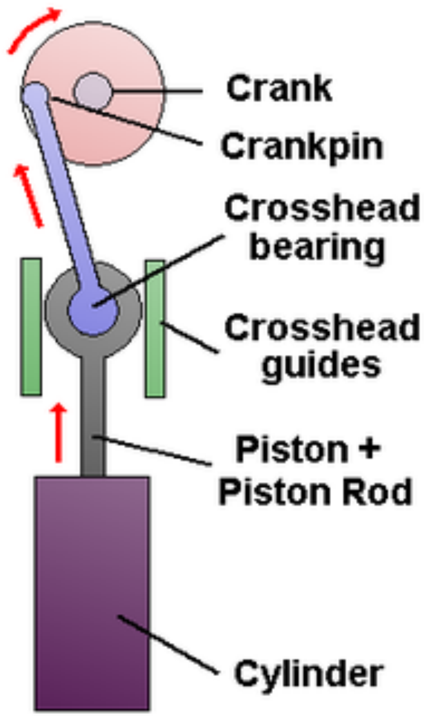
- Vessels have time-constrained routes
- When a main engine part fails unexpectedly
  - The vessel may go off-hire
    - Chartering revenues decrease
    - Urgent part replacement increases cost
    - Bad company image
- Finding potential failures allows
  - Timely ordering of spare parts
  - Replacement of parts before failure

Storyboard - scenario (2/5)

- Main-engine malfunctions is a vast problem
- We focus on Cross-head Bearings malfunctions
  - Evolve gradually
  - Can only be detected with on-board inspecti
  - No known correlation of metrics to predict it

- Slow Steaming
  - Common practice imposed by charte
  - Used to save fuel but
  - Causes bad lubrication of the cylinder
- We wish to predict these breakages
- This physical phenomenon is hidden in the data

Storyboard - scenario (3/5)



Seatrade Maritime News

The economics of slow steaming

Slow steaming is no longer a new concept to shipping. The practice of deliberately slowing down the speed of a ship is in fact a common operating feature of today's shipping market as a way to lower costs by reducing fuel consumption. And with shipping lines trying to stay profitable in the present weak freight market, slow steaming has proven a good way to trim operating expenditures so as to boost the bottomline.

Storyboard - scenario (4/5)

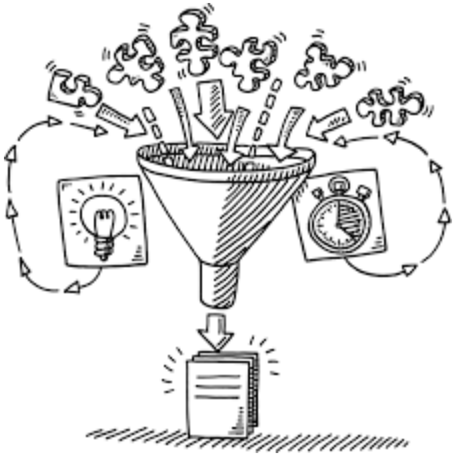
- Technical Challenges
  - Many parameters are related to the malfunction
  - Difficult to accurately predict failures
  - Data-loss may occur (due to broken sensors onboard)
  - Malfunction pattern identification seems to be data intensive and computationally demanding

Storyboard - scenario (5/5)

- Operational Challenges
  - Premature Alarms
    - Increase the operating costs
    - Cause ordering of unnecessary parts
  - Part replacement price depends on
    - Where?
    - When?
    - Who?

Used Data

- Operational Data: Telegrams
  - 47K records
  - Every 12 hours or upon arrival/departure
  - Updated when an error is identified (rarely)
- General-purpose sensor data
  - 21 different sensors
  - 64M records
  - Per-minute basis
- Main Engine sensor data
  - 100 different sensors
  - 64M records
  - Per-minute basis
- Given our customer contracts, we expect a big rise in the number of monitored vessel, thus, this volume will increase dramatically.



BigDataStack added-value

- Real-time stream processing by distributed **CEP** to identify
  - Sensor malfunctions
  - Business rules violations
- **Preventive maintenance**
  - Taps on the **Data Quality Assessment** service
  - Efficient
  - Considers all available data-sets by the deployment configurations
- **Seamless Data movement and Data Analytics** to handle data sets distributed both at LXS and Object Store
- Enhanced SQL query performance against (even remote) Object Stores made possible by the **data-s** **technologies**

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Thank you!

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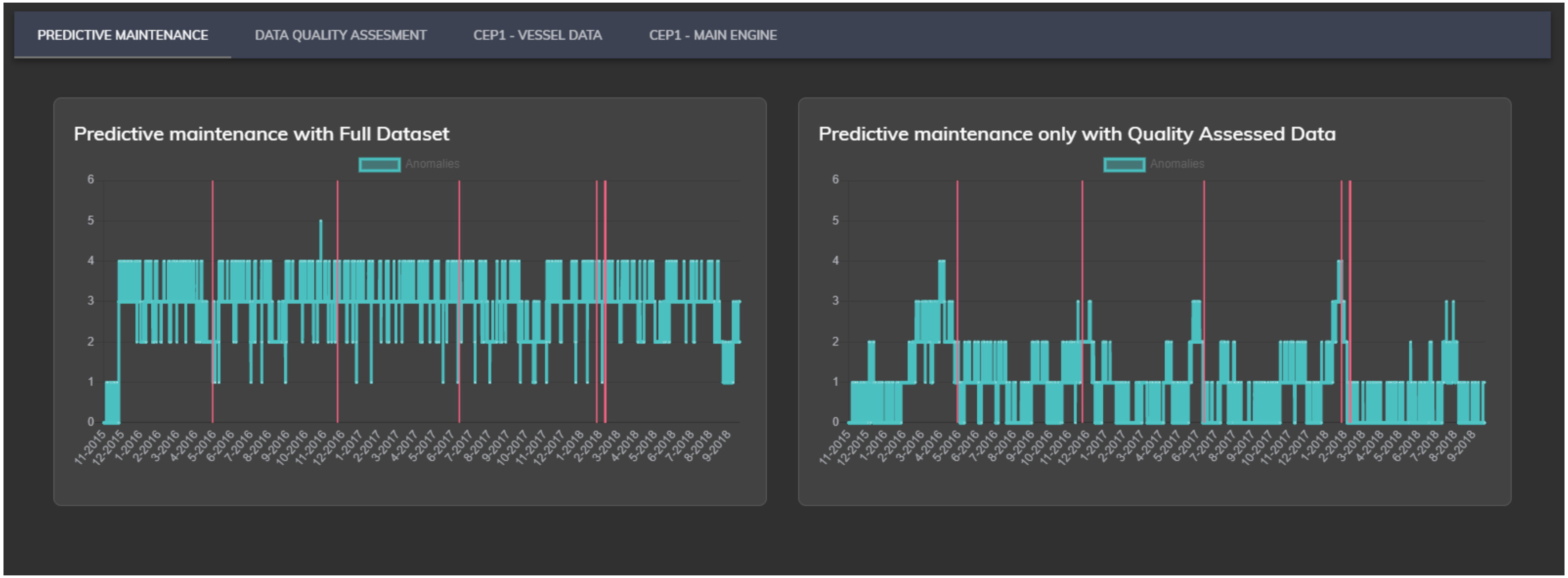
Data Quality Assessment Tool

- A data quality assessment component
- Performs domain-agnostic, probabilistic error detection
- Following a supervised learning approach
- Deep neural networks as a likelihood model
- Given a data set , compute a model
- Output: A probability for each record that is valid

Predictive Maintenance and Data Quality Assessment



Predictive Maintenance

- Combination of different algorithms
  - Supervised Learning
  - Semi-supervised Learning
  - Unsupervised Learning
- XC Boost
  - Labeled data with a static window of 30 days prior to defect
- One-Class Support Vector Machine (SVM)
  - Trained on data with no history of defects
- Multivariate Long short-term memory (LSTM)
  - Trained on data with no history of defects
- Rolling Weighted Permutation Entropy
  - Higher values of entropy (more information) indicates abnormal operation