

# Application of Automatic Identification System (AIS) data for Port Performance Measurement Framework

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## Background

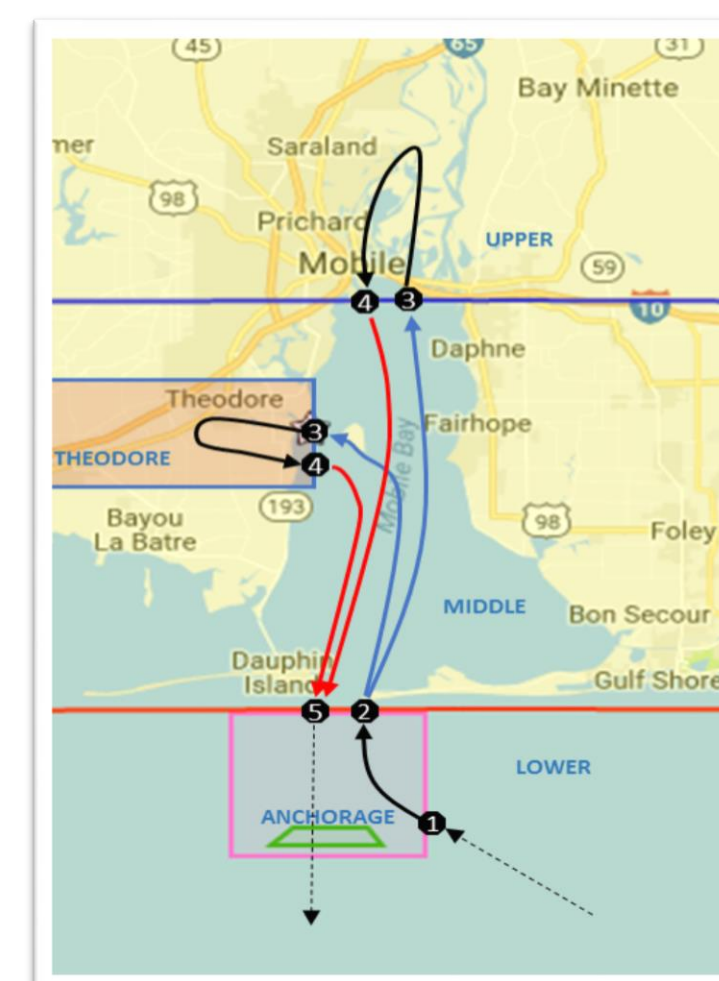
- The U.S. Army Corps of Engineers (USACE) is responsible for the maintenance of federally authorized navigation channels
- There is a need to develop objective performance measures for determining the current level of service of navigation projects
- Automatic Identification System (AIS) is a navigation safety radio communication tool that transmits key information about a vessel's ID, navigation status, location, time stamp, etc.
- The U.S. Coast Guard is responsible for recording and archiving all AIS transmissions pertaining to the United States

## Objective

- Primary objective is to use archival AIS data to develop and demonstrate measures to evaluate and compare the conditions of the navigation channels
- The measures focus on the following key performance attributes:
  - Transit time for vessels between trip points
  - Dwell time at the defined nodes
  - Impact of transit restrictions and other incidents
  - Performance changes over time

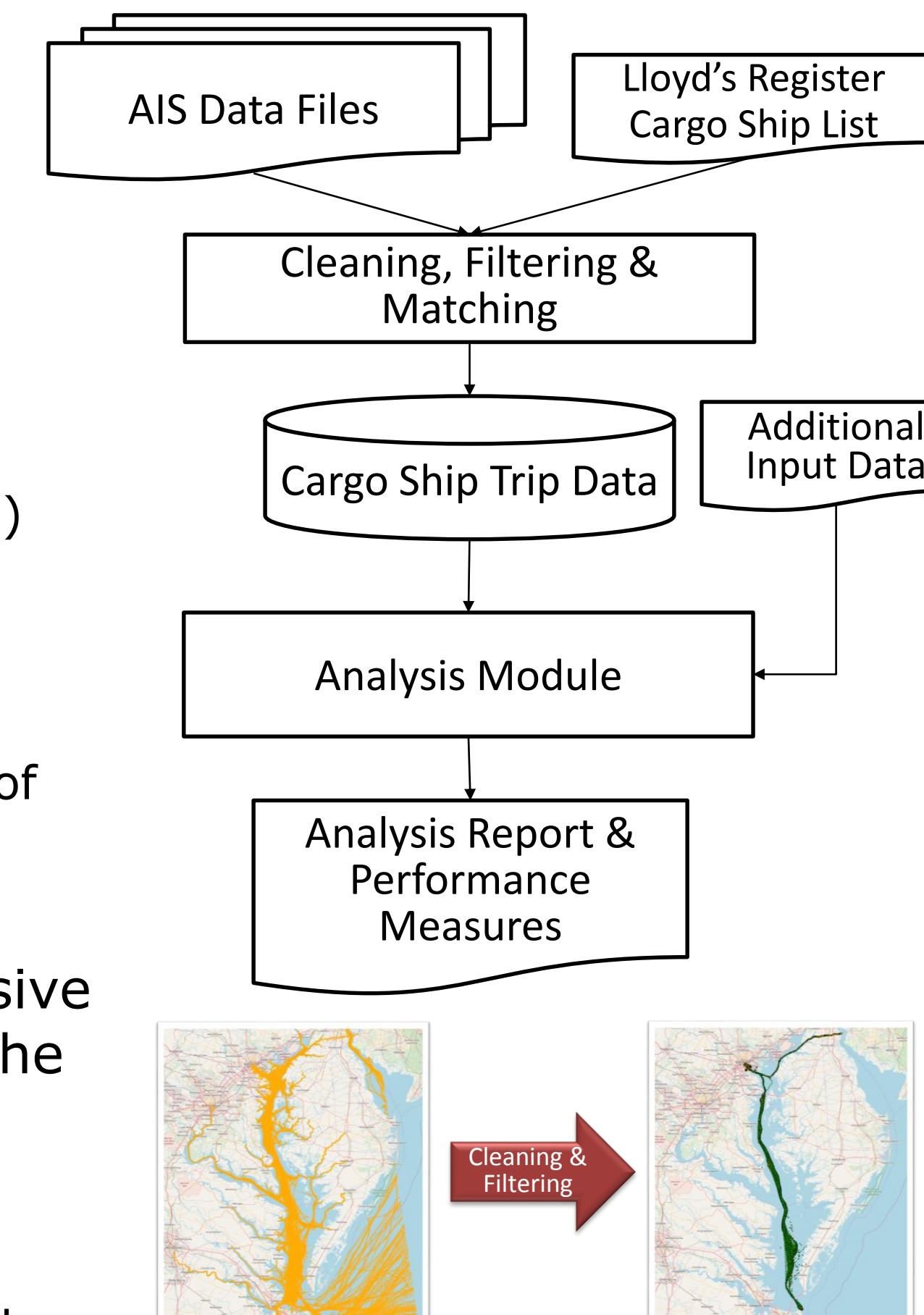
## Analysis Framework

- AIS records are reduced to vessel trips that pass predefined trip points along the channel
- Trip points represent the starting and ending points of a segment to be analyzed
- Transit and dwell time are calculated from elapsed times between the trip points
- For accurate identification of cargo vessels, and their characteristics, information from Lloyd's Register is merged



## Data Processing

- Key attributes of AIS data used in the analysis
  - MMSI: vessel unique ID
  - IMO\_Number: International Maritime Organization unique, permanent ID
  - TX\_DTTM: date-time stamp in coordinated universal time (UTC)
  - LAT: latitude coordinate
  - LON: longitude coordinate
  - NAME: vessel name
  - SHIP\_AND\_CARGO\_TYPE: type of vessel and cargo type
  - Vessel Dimensions
- Raw AIS data requires extensive preprocessing to be used in the analysis due to
  - Incomplete records.
  - Improper ship and cargo type.
  - Out of geographical boundary, etc.



## Variables & Performance Measures

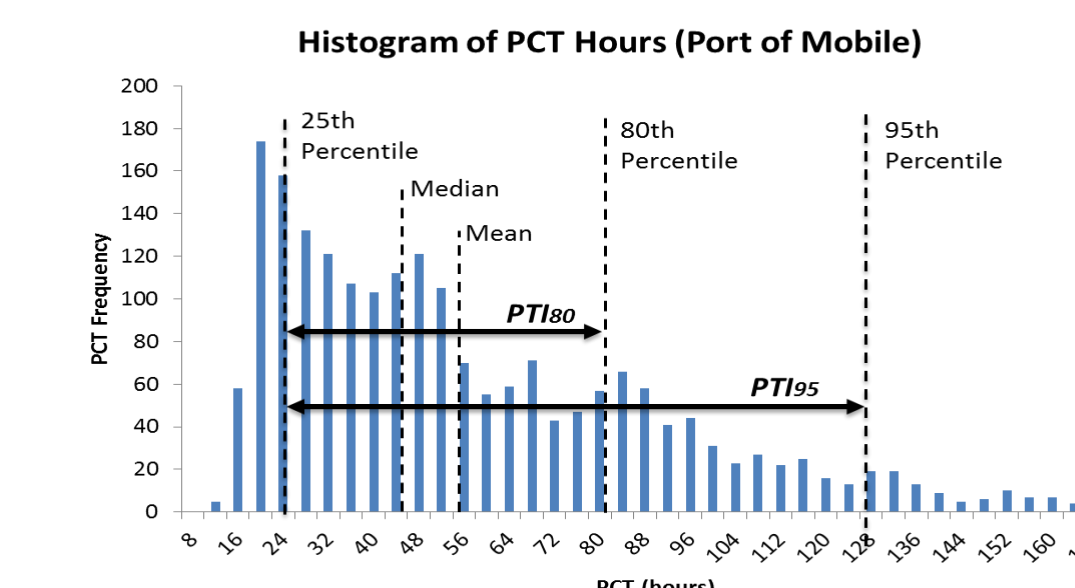
- Total Port System Time (TPST):** Total elapsed time from the moment the vessel approaches the outer anchorage area until it exits the port (e.g., ①→②→③→④→⑤)
- Port Cycle Time (PCT):** Total elapsed time from the moment the vessel enters the port until it exits the same point (e.g., ②→③→④→⑤)
- Transit Time Inbound (TTIB):** Travel time from the point the vessel enters the channel until it nears the dock area (e.g., ②→③)
- Transit Time Outbound (TTOB):** Travel time from the point the vessel enters the channel until it nears the dock area (e.g., ④→⑤)

- For each of the above variables travel time index (TTI) and planning time index (PTI) are calculated
  - TTI = median travel time / baseline travel time
  - PTI = 95<sup>th</sup> percentile travel time / baseline travel time

## Case Study Results

- Port of Mobile:** Two years with approximately 62 million AIS records were analyzed for performance measures

Measure	Baseline TT (hours)	Travel Time Index	Planning Time Index
TPST	32.6	1.70	5.72
PCT	27.6	1.67	4.50
TTIB	2.3	1.07	1.33

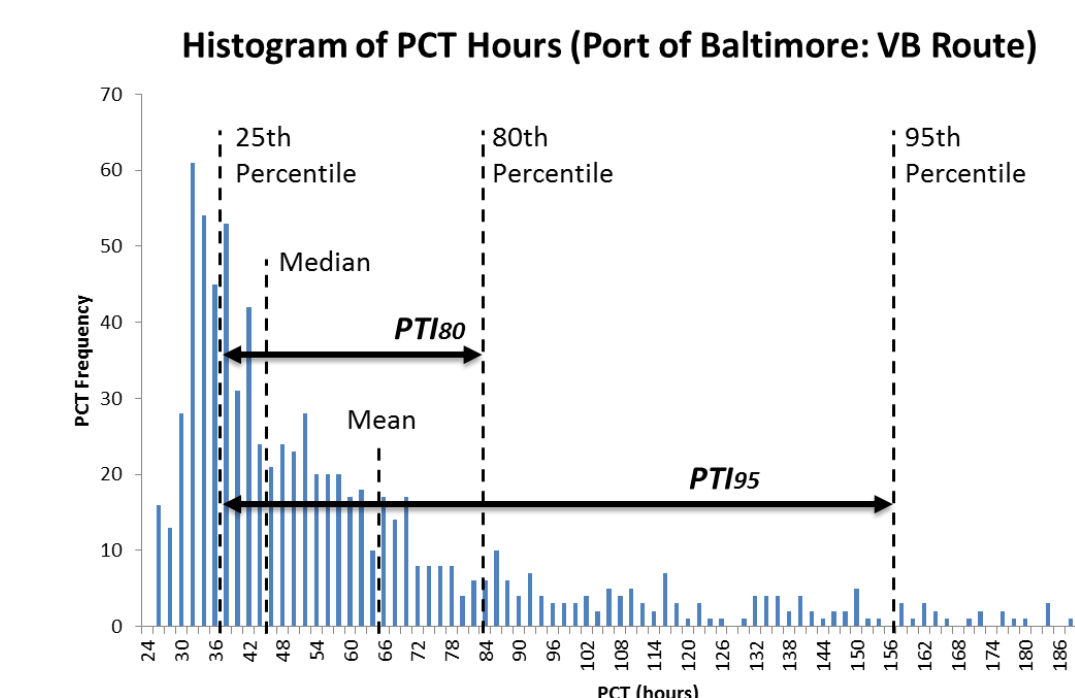


PCT by Ship Type	Baseline TT (hours)	Travel Time Index	Planning Time Index (95 <sup>th</sup> P)
Bulk	48.0	1.61	2.92
Chemical	28.7	1.15	2.73
Container Ship	17.3	1.19	1.79
General	39.6	1.48	2.97
Crude Oil	42.8	1.07	1.52
Other	27.2	1.57	4.48

PCT by Ship Size	Baseline TT (hours)	Travel Time Index	Planning Time Index (95 <sup>th</sup> P)
Under 500 FT.	33.2	1.45	3.59
500 – 699 FT.	31.3	1.55	4.07
700 – 899 FT.	40.4	1.47	3.18
Over 900 FT.	17.5	1.26	3.27

- Port of Baltimore:** One year with approximately 6.8 million AIS records were analyzed for performance measures

Measure	Baseline TT (hours)	TTI	PTI
PCT (VB route)	35.8	1.34	4.39
PCT (C&D canal)	24.8	1.51	6.61
TTIB (VB route)	8.9	1.06	2.38
TTIB (C&D canal)	5.3	1.05	1.22



PCT by Ship Type (VB route)	Baseline TT (hours)	Travel Time Index	Planning Time Index (95 <sup>th</sup> P)
Bulk	76.2	1.38	3.74
Chemical	41.3	1.28	3.79
Container Ship	32.0	1.14	1.98
General	60.3	1.23	3.03
Tanker	75.9	1.42	2.13
Vehicles Carrier	33.1	1.26	2.19
Other	36.9	1.25	2.31

PCT by Ship Size (VB route)	Baseline TT (hours)	Travel Time Index	Planning Time Index (95 <sup>th</sup> P)
Under 500 FT.	46.5	1.43	3.37
500 – 699 FT.	35.1	1.44	4.96
700 – 899 FT.	33.8	1.43	4.65
Over 900 FT.	36.1	1.12	2.97