## Tools and Technologies

### **🌊 1. Data Sources**

* **AIS (Automatic Identification System)** — real-time ship position data
* **NOAA, ECMWF, METAR** — weather and ocean data
* **Satellite data** — sea surface temperature, wind, waves
* **Port data APIs** — traffic, schedules

### **📦 2. Data Collection & Storage**

* **Apache Kafka** — real-time data streaming
* **Apache NiFi** — data ingestion pipelines
* **Amazon S3 / Google Cloud Storage / Azure Blob Storage** — scalable storage
* **PostgreSQL / TimescaleDB** — structured time-series data
* **MongoDB** — unstructured or semi-structured data

### **🧹 3. Data Processing & ETL**

* **Apache Spark / PySpark** — large-scale data processing
* **Apache Flink** — real-time stream processing
* **Airflow** — workflow orchestration
* **Kubernetes** — scaling containerized data pipelines

### **🔍 4. Big Data Analytics**

* **Hadoop / HDFS** — large dataset storage and processing
* **Presto / Hive** — distributed SQL querying
* **Elasticsearch** — fast data search and analytics
* **Dask / Vaex** — Python-based big data processing

### **🌦 5. Weather & Forecasting Models**

* **WRF (Weather Research and Forecasting Model)** — advanced weather predictions
* **ARIMA, LSTM, Prophet** — time-series forecasting models
* **XGBoost, LightGBM** — machine learning models
* **TensorFlow / PyTorch** — deep learning for complex pattern detection

### **📊 6. Visualization & Dashboard**

* **Grafana** — real-time monitoring dashboards
* **Tableau / Power BI** — business intelligence dashboards
* **Mapbox / Leaflet.js / CesiumJS** — interactive marine maps
* **D3.js / Plotly** — advanced data visualization

### **🚢 7. Deployment & Infrastructure**

* **Docker** — containerization
* **Kubernetes** — orchestration and scaling
* **AWS / Google Cloud / Azure** — cloud infrastructure
* **Edge computing devices** — on-ship data processing

### **📱 8. Mobile & Web App Development**

* **React / React Native / Flutter** — cross-platform app development
* **Node.js / Django / FastAPI** — backend services
* **GraphQL / REST API** — communication between frontend and backend