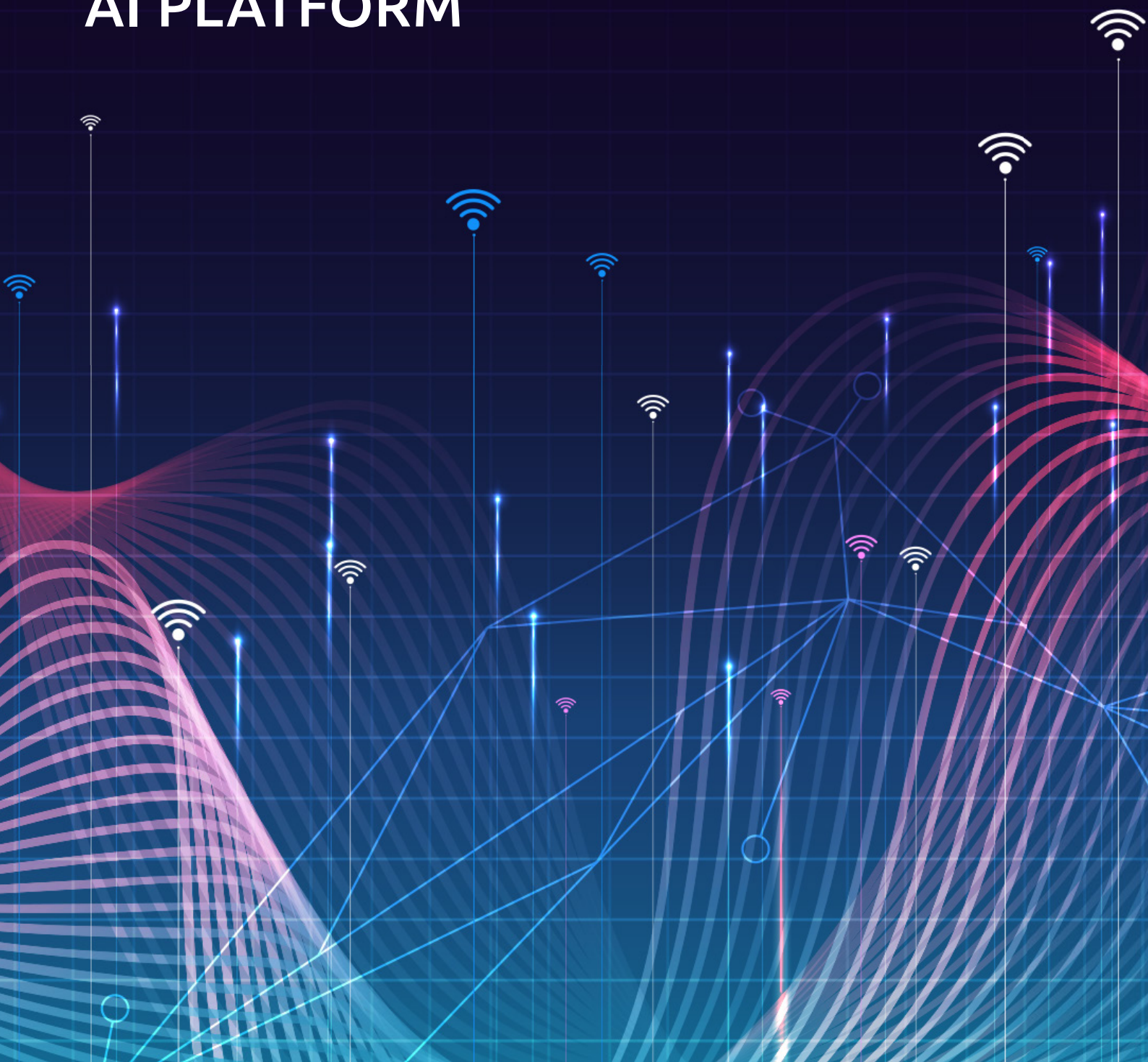
Capgemini engineering

NETANTICIPATE: THE ULTIMATE NETWORK AI PLATFORM



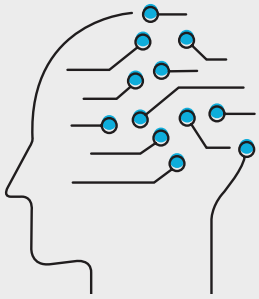
Background & Motivation

As the telecommunications industry advances, it will bring new generations of cellular technology to market – from 5G, to 6G, and beyond - with ever higher data rates. These networks will involve more connected devices, supporting more advanced use cases, and generating larger amounts of data on network traffic patterns, user behavior, and device performance.

It would be extremely difficult for a human workforce to analyze exabytes of network data within seconds and make real-time decisions. Telco service providers would therefore like to build a brain for the network so that it can think and take care of itself. Network AI can provide this network brain, allowing it to self-configure, monitor, manage, correct, defend, and analyze with zero human intervention.

Network AI can improve network performance and efficiency and optimize mobile networks across a Radio Access Network (RAN), transport and core, to improve the end-user's quality of experience.

3GPP, the world's leading standards organization for mobile networks, has already started laying the foundation for AI/ML features for all future releases of mobile networks, including 6G, for realizing a truly data-driven network.



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An autonomous feedback loop ensures the network self-learns to improve the actions it takes over time.

Solution Overview

Capgemini has developed the state-of-the-art NetAnticipate framework to seamlessly introduce Network AI use cases in telecommunication networks.

NetAnticipate is a cloud-native, highly scalable, self-learning AI platform for realizing autonomous 5G network operation, and is fully compliant with 3GPP and O-RAN industry standards.

It analyzes a substantial number of hidden and hierarchical influencers to predict potential network anomalies, make autonomous decisions, and take preventive actions. An autonomous feedback loop ensures the network self-learns to improve the actions it takes over time.

NetAnticipate uses best-in-breed AI algorithms to create self-learning closed loop automation. It orchestrates various deep-learning algorithms to identify network anomalies in real-time, forecast anomalies in the future using multi-variate timeseries analytics, and prescribe preventive actions to fix those anomalies before they can affect the network. Actions taken are improved through deep reinforcement learning techniques. Reinforcement learning uses paradigms for sequential decision-making under uncertainty, solely by rewards and penalties, based on previous actions performed in the network.

Figure 1 gives an overview of various blocks in NetAnticipate:

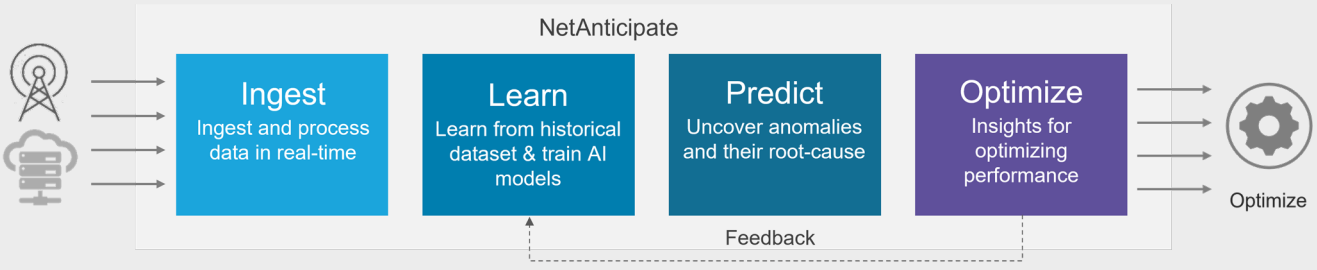

Figure 1: NetAnticipate Overview

The key components of NetAnticipate are –

1. Ingest: This module ingests and pre-processes data in real time from various data sources in different formats.

2. Learn: This module is responsible for large scale machine learning (ML) model training and a comprehensive model lifecycle management capability.

3. Predict: This module provides high-speed ML inference to accurately predict network performance degradation and identifies any anomalies to flag. It also finds the root cause of any abnormal behavior in the network.

4. Optimize: This module takes decisions based on the prediction and triggers appropriate action to continuously optimize the network performance.

Figure 2 illustrates the high-level architecture of NetAnticipate. NetAnticipate core automates data ingestion through DataOps pipelines. ML model training and inference are automated through MLOps pipelines.

NetAnticipate core enables easy introduction of new use cases as playbooks in the network using a no-code or low-code approach through SDKs.

NetAnticipate core enables data ingestion from a variety of data sources, including directly from network elements, OSS, NMS, EMS, fault ticket DBs, external data lakes, and analytics engines.

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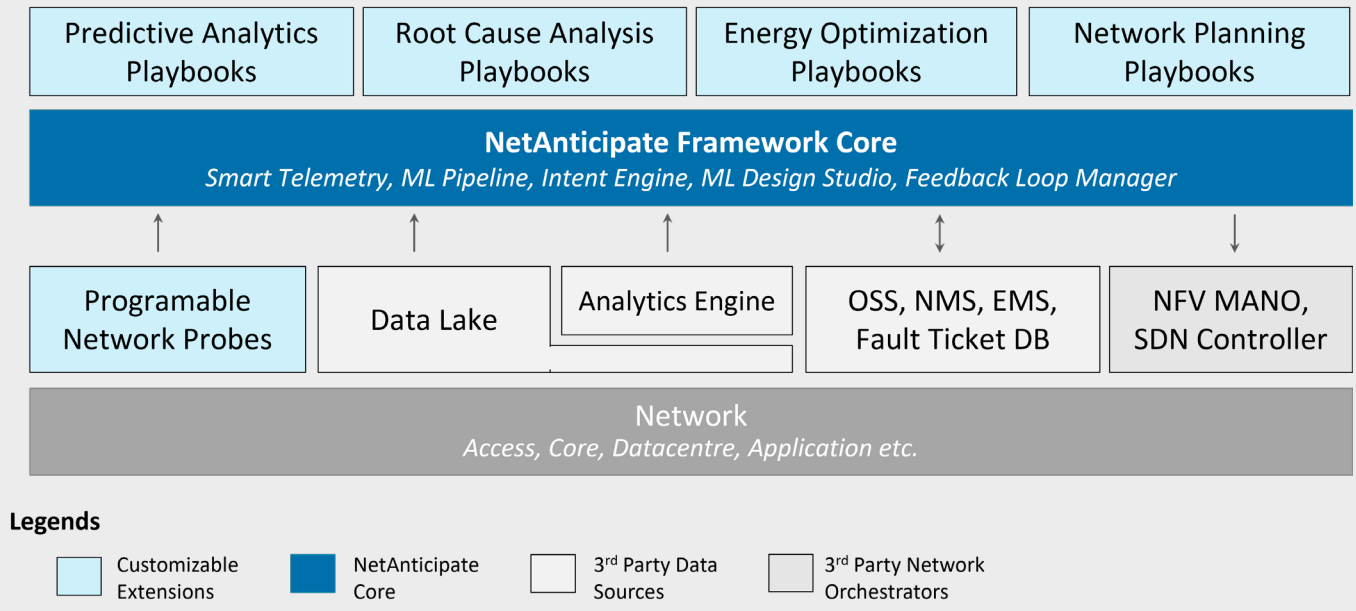

Figure 2: NetAnticipate Architecture

Centralized core components take care of data ingestion, processing, and ML lifecycle management.

NetAnticipate offers disaggregated architecture with the capability for centralized model training, and high-speed inference at the edge. This type of deployment is most suitable where low latency inference is required. Figure 3 shows a disaggregated architecture view of NetAnticipate.

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The edge component is deployed at the edge site to collect and process real-time telemetry data, for inference processing, and to take actions and monitor the real-time behavior of the system. This deployment is preferred where low latency results are expected in URLLC use cases in 5G.

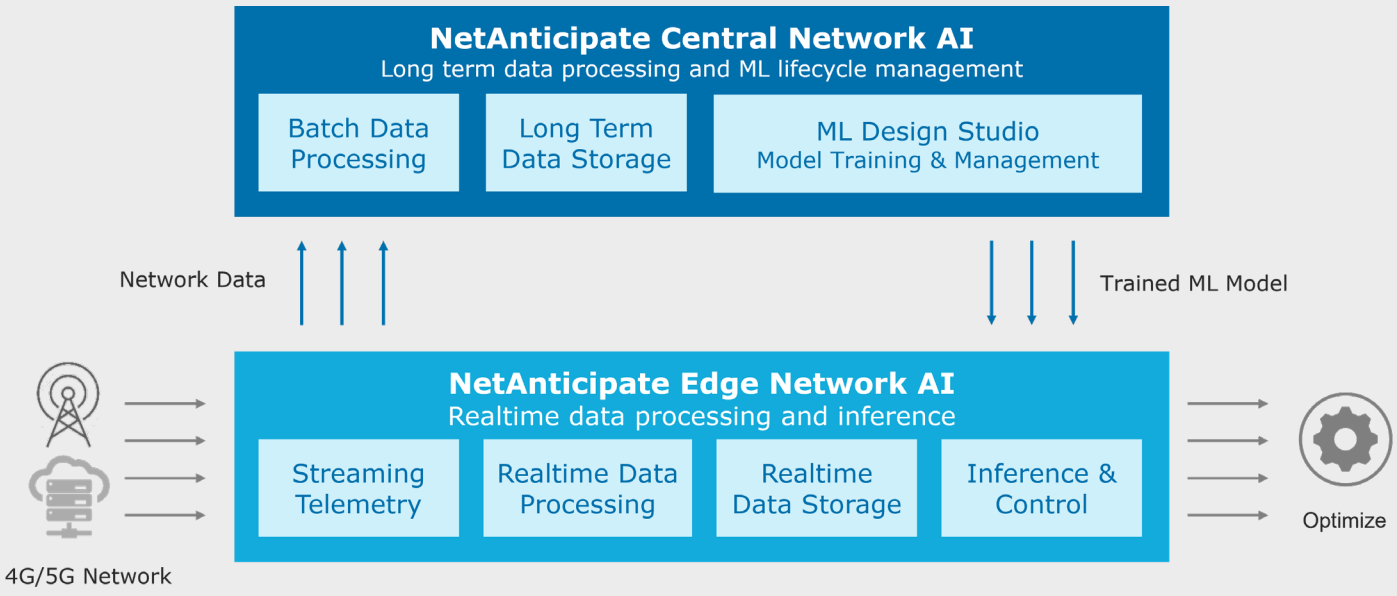
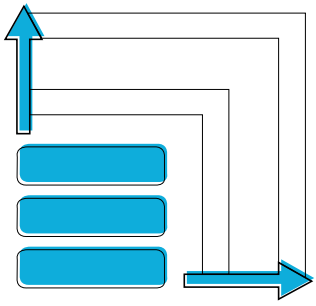


Figure 3: NetAnticipate Disaggregated Architecture

NetAnticipate uses federated learning to collaboratively learn a shared prediction model while keeping all the training data at the edge, thus addressing concerns of data privacy and time lag in model updates in the traditional ML techniques described in previous section. With NetAnticipate, a federated learning solution can be deployed in a highly disaggregated architecture that scales both horizontally and vertically, as shown in figure 4 below.



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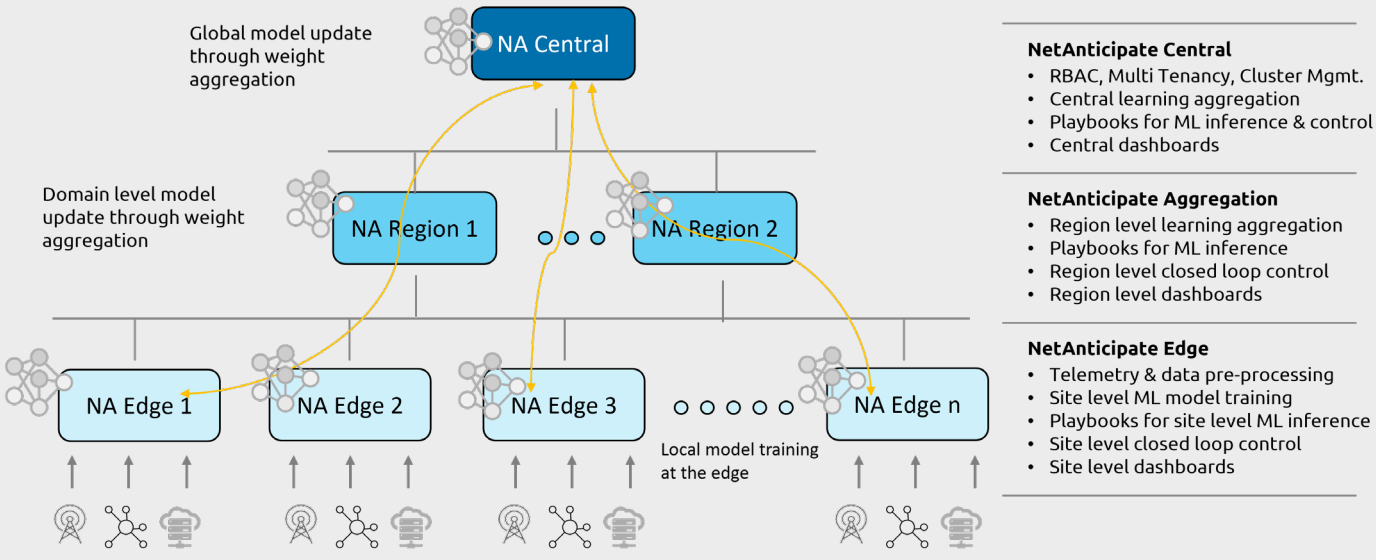


Figure 4: NetAnticipate enables disaggregated and scalable edge AI with federated learning

Top Customer Benefits

NetAnticipate has several key benefits that make it a unique Network AI framework.

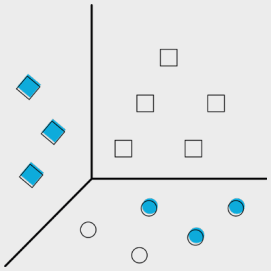
1. It is a vertical platform created specifically for telecom use cases (4G, 5G and beyond) and is very easy for network administrators to use, for creating their own customized workflows without the help of data scientists. It is fully compliant with 3GPP and O-RAN industry standards.

2. It is a cloud-native platform based on Kubernetes and leverages micro-services architecture, so it can be easily deployed across bare metal, private, and public cloud infrastructures.

3. It orchestrates various deep learning algorithms to find network anomalies in real-time (Autoencoders & MLP), forecast anomalies in the future using multi-variate timeseries (e.g., RNN/LSTM & CNN/TCN), and prescribe preventive actions to fix these anomalies before they can affect the network. It uses deep learning to prescribe preventive actions, and improves the prescribed action taken over time using deep reinforcement learning like Deep Q Network (DQN) and Deep Q Network (DQN). NetAnticipate uses semi-supervised learning techniques like cluster assumption for auto-labelling of historical data.

4. It provides a "ML Design Studio" to manage the lifecycle of deep learning models. These reusable models are pre-trained on large datasets and may be retrained to meet the user's specific needs.

5. NetAnticipate allows prediction models to run on low cost hardware with minimal computational resource, at the edge of network or directly in network devices.



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Key Features

Feature Name	Feature Description	Technical Details
Input Telemetry Interfaces	NetAnticipate supports a variety of interfaces for data ingestion from network elements, OSS, EMS, NMS etc.	The supported data interfaces are – AMQP, Azure Event Hub, File/CSV, FTP, gRPC/gNMI, Kafka, Log/Syslog, MQTT, REST/HTTP(S), SFTP/FTP, SNMP v2 & v3 and WebSocket.
Input Data Lakes	NetAnticipate supports data ingestion from a variety of databases/data lakes.	The supported data lakes are – Elastic Search, Hadoop/HBASE, Hadoop/HDFS, Hadoop/HIVE, Timescale DB, Influx DB, MongoDB, and S3.
ML Frameworks	NetAnticipate supports a variety of ML frameworks to bring in the best-in-breed algorithms for ML model training.	The supported ML framework are – BigDL/Chronos, H2O, Keras/TensorFlow, PyTorch, scikit-learn, tslearn.
AutoML Frameworks	NetAnticipate supports a variety of AutoML frameworks to automate the time-consuming and iterative tasks involved in the ML model training process. It enables developers with limited ML expertise to train high-quality models specific to their business needs.	The supported AutoML frameworks are – auto-sklearn, BigDL/Chronos, H2O AutoML, AutoKeras.
ML Algorithms	NetAnticipate supports unique ML and deep learning algorithms for supporting a variety of Network AI use cases ranging from radio, core, transport, and apps.	The supported ML algorithms are: 1. **Supervised/Classification** – AdaBoost, Convolutional Neural Network (CNN), Decision Tree, Generalized Linear Model (GLM), K-Nearest Neighbors (KNN), Logistic Regression, Multi-layer Perceptron (MLP), Naive Bayes, Random Forest, Recurrent Neural Network (RNN), Support Vector Regression (SVM), XGBoost. 2. **Supervised/Regression** – AdaBoost, Convolutional Neural Network (CNN), Decision Tree, Generalized Linear Model (GLM), K-Nearest Neighbors (KNN), Linear Regression, Multi-layer Perceptron (MLP), Naive Bayes, Random Forest, Recurrent Neural Network (RNN), Support Vector Regression (SVM), XGBoost. 3. **Timeseries/Forecast** – Autoregressive Integrated Moving Average (ARIMA), Long Short-Term Memory (LSTM), Prophet, Seq2Seq, Temporal Convolutional Networks (TCN), NBeats, Autoformer, TCMF. 4. **Timeseries/Anomaly** – Autoencoder, DBSCAN, Elliptic Envelope, Isolation Forest, K-Means, One-Class SVM.
ML Design Studio	ML Design Studio is NetAnticipate's data science SDK. It provides a development environment to easily manage the lifecycle of ML models and playbooks through MLOps pipelines. NetAnticipate provides catalogues to publish, store, search, and consume trained ML models and playbooks in a distributed telecom network.	
Intelligent Services	Using ML models and playbooks, NetAnticipate provides several intelligent services that make it easier for end-users to consume AI services.	The intelligent services provided by NetAnticipate are – Real time analytics, predictive analytics, and root cause analytics (RCA).
Intelligent Alerts & Notifications	NetAnticipate alerts external systems based on current or predicted conditions and uses a deduplication mechanism to avoid redundant alerts. Additionally, email notifications can also be sent to a person or group of people to intimate the alert condition.	NetAnticipate's alert condition can be configured based on a real-time static threshold, dynamic threshold, ML-based anomalies detected or forecast behaviors.
Cognitive Closed Loop	NetAnticipate's closed loop automation (CLA) engine continuously assesses real-time network conditions, predicts anomalies, finds the most likely root-cause for predicted incidents, and recommends changes to be made to the orchestration layer. The orchestrator implements the changes, according to operator-defined policies.	NetAnticipate's closed loop automation (CLA) enables self-learning and auto-healing advances using AI/ML-based prediction, recommendation, and policy-based actions.
Infrastructure agnostic	NetAnticipate can seamlessly run on bare-metal, private and public clouds.	NetAnticipate can run on private clouds, OpenStack and VMWare. It also can run on public clouds, Amazon AWS, MS Azure & Google's GCP.

Use Cases

NetAnticipate solves customer problems in several areas ranging from telecom, satellite, datacenters, and many more. The key use cases are listed below.

Area	Potential improvements	Use Cases
Radio Network	Improvement of up to 30-40% throughput.	• Intelligent O-RAN – traffic steering, QoE optimization, energy optimization • RAN features - link adaptation, handover, SON & RRM optimization • RAN slice optimization and SLA assurance
Core Network	Improvement of up to 20-30% throughput.	• Core interwork intelligent orchestration & predictive maintenance • Intelligent policy management in core network • Core network slice optimization and SLA assurance
Transport xHaul Network	Improvement of up to 30% throughput.	• xHaul network predictive analytics • Network failure prediction in multi-layer SDN • Intelligent SD-WAN orchestration
Satellite & Non-Terrestrial Networks	Improvement of up to 20-30% throughput.	• QoS assurance in space-air-ground network • Intelligent & adaptive modulation in LEO • Intelligent beam hopping
Subscriber Churn	Reduction of up to 50% throughput.	• Subscriber churn prediction • User satisfaction level prediction
Datacenter Operation	Improvement of 40%+ throughput.	• Datacenter power usage prediction and optimization • Cognitive workload management • Capacity planning
NOC / SOC	Improvement of up to 40-50% throughput.	• Predictive maintenance • Autocorrelation and root cause analysis (RCA) • Guided diagnostics

Industry Recognition & Awards

NetAnticipate has won several top awards, recognizing the cutting-edge innovation the framework has introduced for 5G and beyond.

1. In 2022, it won the prestigious ”Glotel Award” – known as the Oscars of telecom - in the “Advancing Artificial Intelligence” category.
2. In 2021, it won the “Pipeline Innovation Award” in the “Innovation in Data Analytics” category.
3. In 2021, it was a finalist in the “Leading Lights Award”.
4. In 2018, it won the “Network Transformation Award“ for the “Best AI/ML Application in Innovation and Technology”.

Conclusion

NetAnticipate brings immense value add for the telco industry, as shown in figure 5 below. It is very easy to use with automated data and ML pipelines and pluggable playbooks. It offers faster anomaly detection to reduce mean time to detect, while offering faster mitigation through advanced timeseries forecasting, and supports scalable distributed edge architecture for very large networks or data sets across geographies. The framework comes with comprehensive SDKs and APIs for third-party vendors to integrate new data sources, analytics and use cases. It supports microservice-based architecture and follows cloud-native principles. It offers a rich and user-friendly GUI interface to configure, monitor, and visualize various model training, inference, and analytic insights.

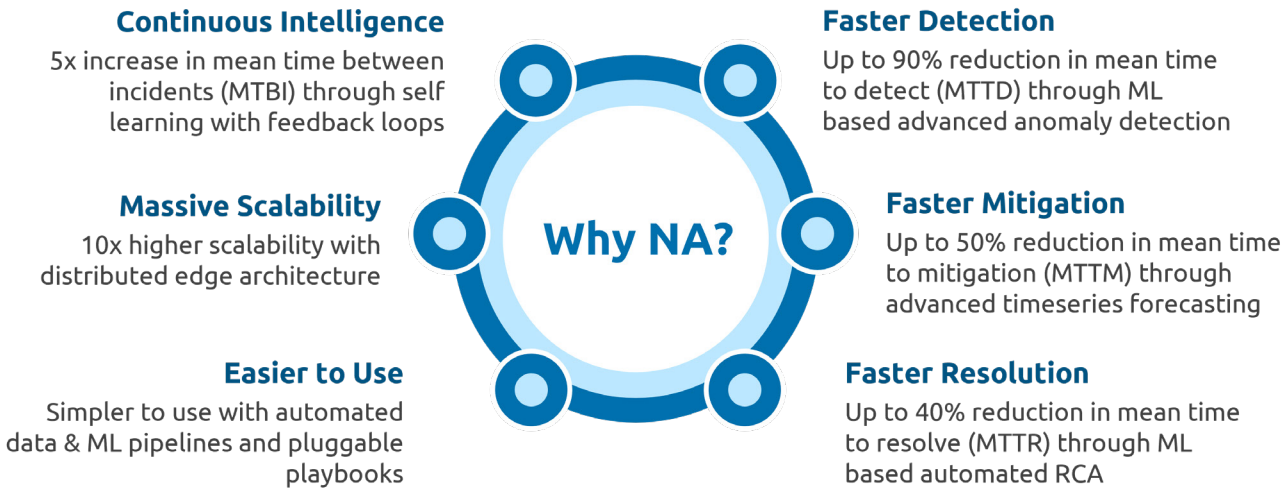

Figure 5: NetAnticipate Value Adds

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