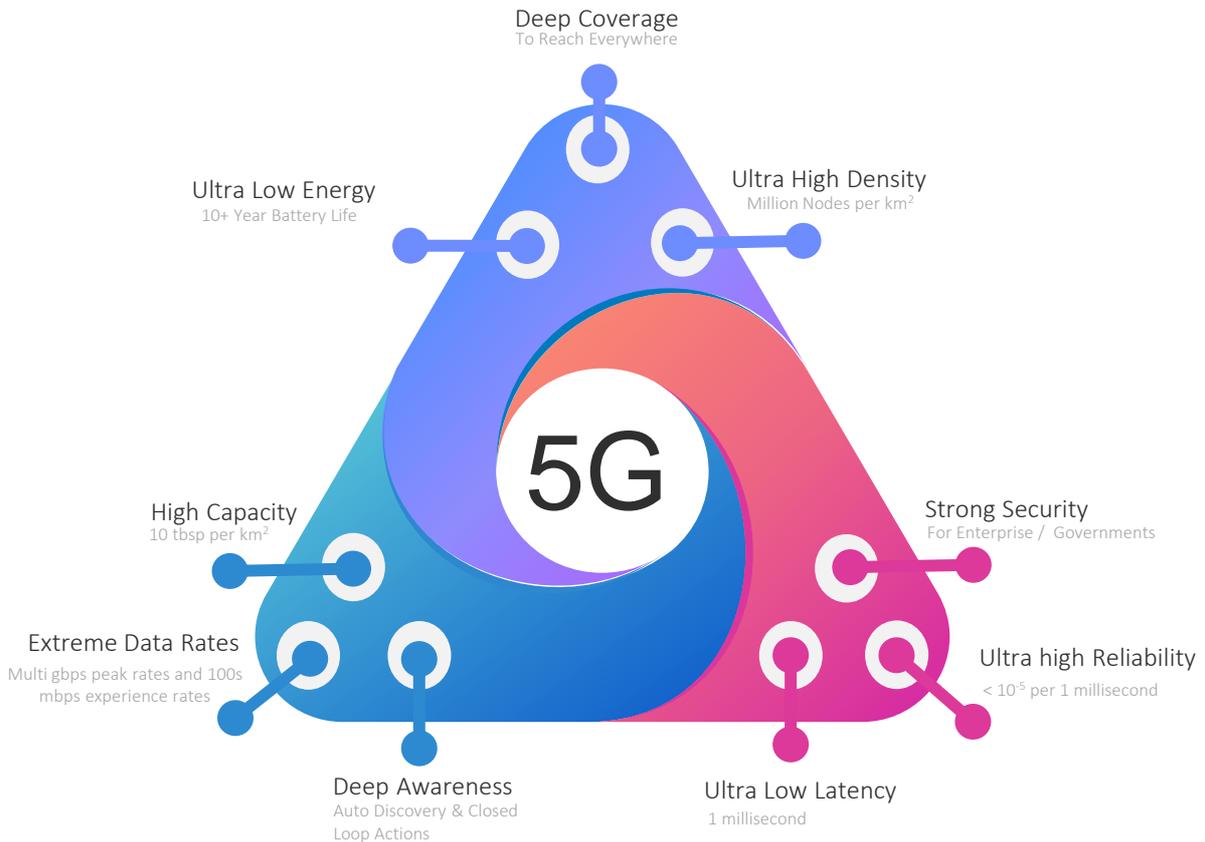# Cloud Native 5G Core

WHITEPAPER

Jio's 5G Core – A Digital Platform for the Future

The transition to 5G networks will lead to a radical transformation in the business model of telecom operators. Until recently, mobile networks were designed for the end-users to consume voice, SMS, web browsing, and video streaming. The transition to 5G requires moving from 'Consumer/End-User Centric' approach to an 'Industry Centric' approach. Operators readiness of providing secure Enterprise 5G networks is driving industrial innovations

The new era of 5G networks will provide technology and operational innovations that will result in intelligent devices and applications consuming & generating data like never before. Equipped with the capability to provide higher bandwidth, lower latency, greater capacity and security, 5G requires a state-of-art architecture, which leverages software centric modular approach, along with smart cloud infrastructural capabilities.

Deep Coverage
To Reach Everywhere

Ultra Low Energy
10+ Year Battery Life

Ultra High Density
Million Nodes per km^2

High Capacity
10 tbsp per km^2

Strong Security
For Enterprise / Governments

Extreme Data Rates
Multi gbps peak rates and 100s mbps experience rates

Ultra high Reliability
< 10^{-5} per 1 millisecond

Deep Awareness
Auto Discovery & Closed Loop Actions
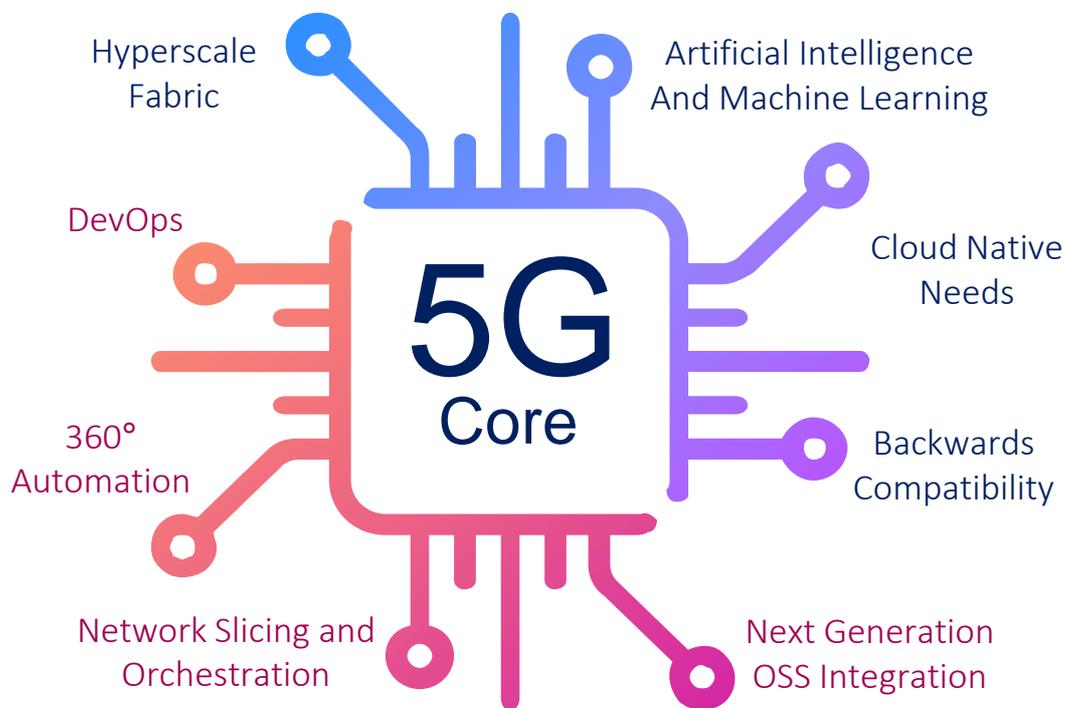
Ultra Low Latency
1 millisecond

The prime transformation is within the core network, which delivers the necessary performance for the new use cases. The 5G core needs to be flexible, programmable and distributed in nature, so that it provides the necessary agility to shorten time-to-market and provides the utmost performance and efficiency gains.

Objective

The objective of this whitepaper is to provide deep insights into the transformation of telecom networks as they embrace the 5G Core Network. Best practices through cloud native adoption are also outlined and explained in the paper. Through this two-pronged approach, we aim to explain to business professionals, network architects as well as enterprises – how 5G adoption will serve as a catalyst to business transformation. It also discusses various approaches to keep processing latency in line with 5G requirements while providing the required robust implementation essential for service provider deployment.

The key platforms acting as the support systems of the 5G Core are explained along with the recommendations for a solution deployment blueprint.

Hyperscale Fabric

Artificial Intelligence And Machine Learning

DevOps

Cloud Native Needs

5G Core

Backwards Compatibility

360° Automation

Network Slicing and Orchestration

Next Generation OSS Integration

Contents

☐ Evolution to the Core Network in 5G

☐ Being Cloud Native is key to the Hyperscale Architecture of Jio's 5G Core

☐ Bringing Cloud Agility to the Network

☐ A Uniform Data Management Services Layer

☐ Network Slicing in the Core – Making Enterprise 5G Possible

☐ Enabling a Mix of Centralized and Distributed Cloud Deployments

☐ Where and How DevOps Meets 5G

☐ Key Platforms Forming the Support System of 5G Core

Evolution to the 5G Core Network

The impending 5G transition will enable a new wave of services including Enhanced Mobile Broadband (eMBB), Ultra Reliable Low Latency Communication (uRLLC) and massive Machine Type Communications (mMTC).   Network Operations will be fully driven by Automation Platforms and Data. While the need to capture, process and react to network data in real-time will give rise to machine learning, platforms must also evolve to fully automate the network lifecycle.
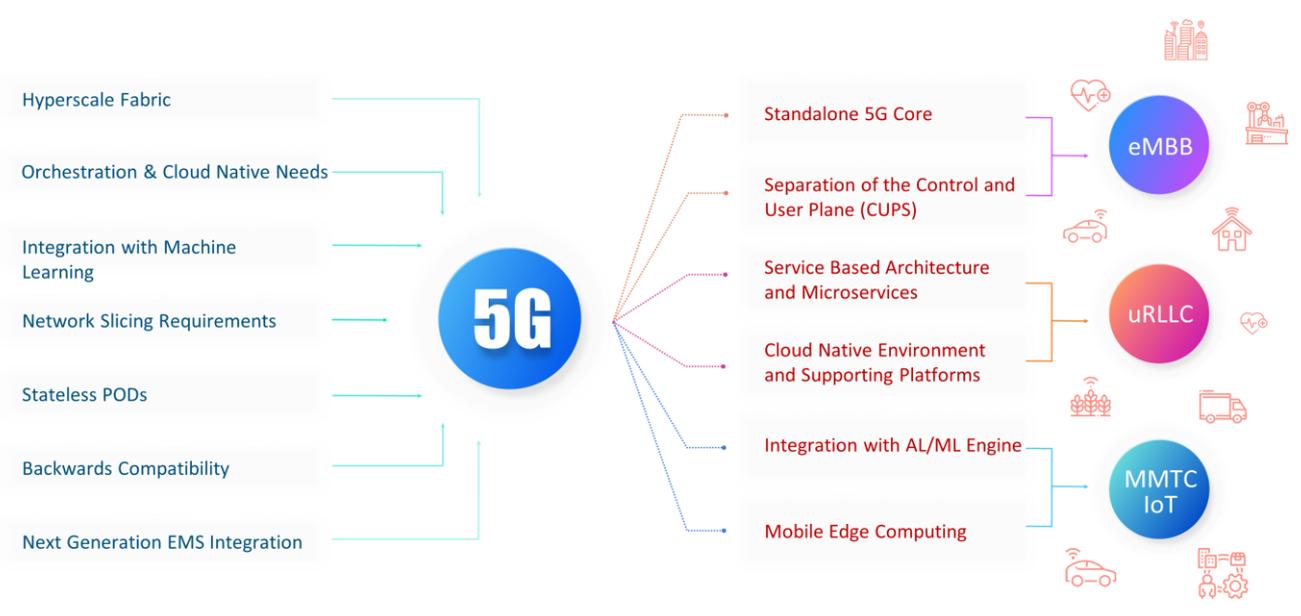
To accommodate various use-cases proposed in 5G, it is important that the core network should be architected with inherent flexibility and efficiency. This can be accomplished by designing systems where control plane and user plane are segregated as cloud native functions integrated with cross domain, data agnostic AI / ML engines. All functions should also be stitched together using Automation platforms for Planning, Deploying, Maintaining and Operating next generation Networks.
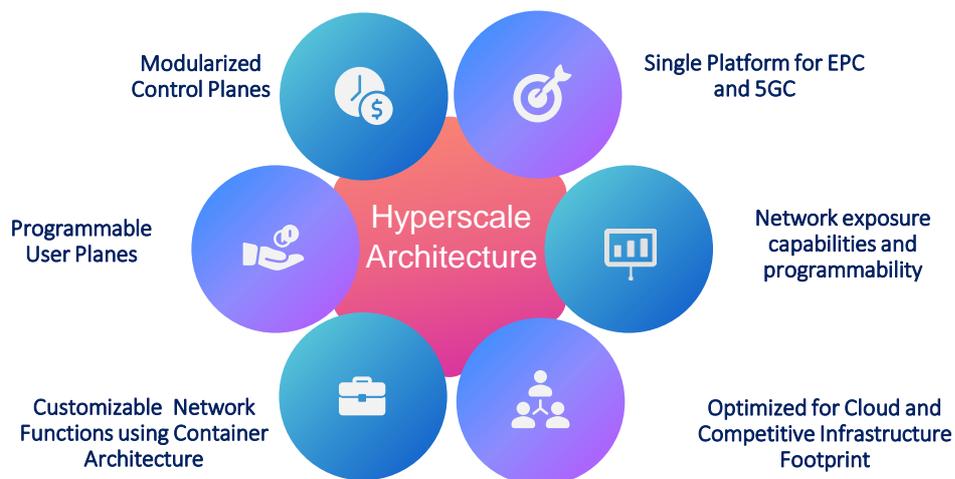
Being Cloud Native is key to the Hyperscale Architecture of Jio's 5G Core

Cloud native architectures are the foundation of 5G innovation. Jio's 5 G core network consists of a component based control plane, programmable user plane, and a disaggregated information plane to simplify signalling interaction.

Containerised network functions allow 5G networks to programmatically deploy network functions and network slices. This enables both carrier and enterprise 5G networks. These cloud native network functions and slices are deployed on a private cloud infrastructure with an option to deploy on a public cloud platform as well. The cloud native approach eliminates expensive proprietary hardware appliances, long upgrade cycles, and customization of software for meeting different customer needs.

Jio's 5G core solution comes in two flavours – 5G Hyperscale for carriers, and 5G Hyperlite for Enterprise/Private 5G deployments. As a result, CSPs can experience the benefits of a scalable system that can grow as their deployments and use cases expand.

Flavours of Jio's 5G Core stacks are ready to support large variety of 5G Use Cases for every consumer, enterprise and industrial applications.

Modularized Control Planes

Single Platform for EPC and 5GC

Programmable User Planes

Hyperscale Architecture

Network exposure capabilities and programmability

Customizable Network Functions using Container Architecture

Optimized for Cloud and Competitive Infrastructure Footprint

Jio's 5G Core solution is fully based on these cloud native principles, with software architecture based on microservices, this allows operators to quickly migrate to standalone 5G Network using a true 5G Core Network. It is built upon the 3rd Generation Partnership Project (3GPP) defined Service Based Architecture (SBA), supporting a programmable data path that handles massive throughput with a reduced hardware footprint. It ensures capacity, elasticity to any underlying cloud infrastructure, and high levels of orchestration and automation for operational efficiency.

Bringing Cloud Agility to the Network

The 5G Core solution is based on agile design principles, a flexible combination of NFs and a multi-access core solution that includes support for 5G NR (NSA and SA modes). Moreover, the 5G Core is a combo solution which also supports 4G network functions such as the HSS/HLR along with the UDM, the PCRF and PCF combination as well as VoLTE/VoNR extensions to the IMS core. The components are designed as individual micro services so that each of the services are individually scalable and maintainable.
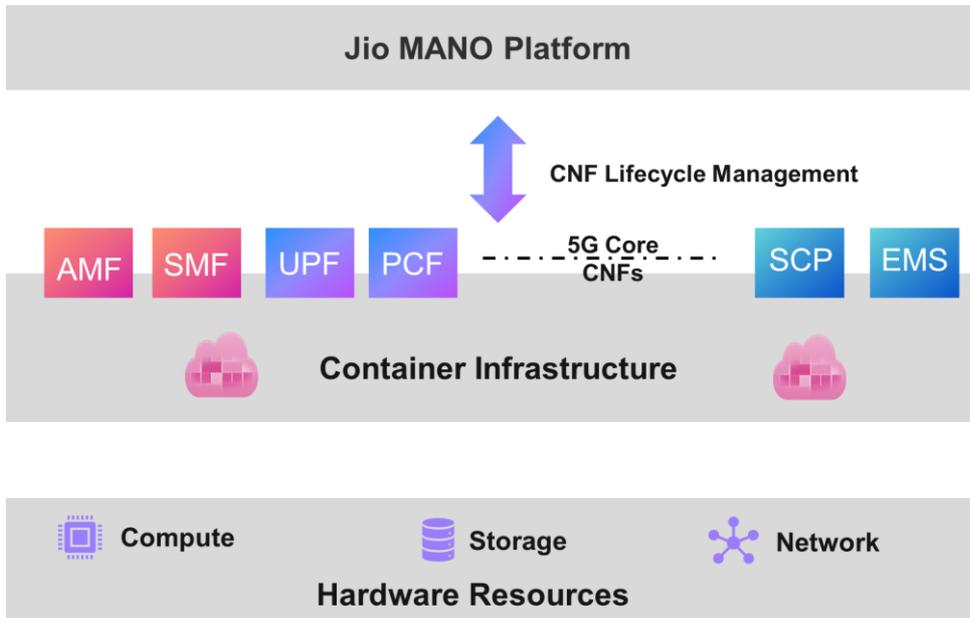
This ensures inline upgrades with zero downtime and gives the whole solution great resilience. The network functions fit in a modular software architecture for both centralized and distributed deployments. Applications are delivered and executed as a set of containers and designed to run on a Container as a Service (CaaS) platform. The modularity of the solution facilitates a short time to market.

Jio's 5G Core embraces the following Cloud Native principles

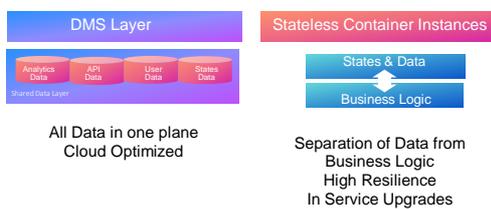|	
Decomposed Solutions	Container based microservices architecture is common across the entire Jio 5G Core portfolio.
Infrastructure Agnostic	The ability to run applications in any cloud infrastructure, regardless of the CaaS and Infrastructure as a Service (IaaS) combination. The cloud native applications must be able to run in any modern kernel without requiring any proprietary additions.
State Optimized Design	A state-optimized design considers the impact severity of a state/data loss to application, impact on the user, and also the cost/benefit considerations pending frequency of changing states.
Highly Available & Fault Tolerant	Fault tolerance in applications and services, supporting the combination of failures at any time, without full restart and loss of service. If one instance of each required microservice is alive, the service will be provided.

# A Uniform Data Management Services Layer

Jio's cloud native core implements a layered architecture in which not only are the user and control planes separated, but cloud native network functions. It splits the data storage from the service logic to introduce a fully virtualized, distributed, highly available Data Management Services Layer. The data held by the Data Management Services Layer enables high throughput access to transient data as well as persistent data. It stores subscriber and session information, creating a very flexible network in which any CNF has access to all the data whenever required.

All Data in one plane
Cloud Optimized

Separation of Data from
Business Logic
High Resilience
In Service Upgrades

The network also becomes more robust because in case of a failure, it easy to switch to another CNF that has instant access to the same data to provide continuity of service. This simplified arrangement not only enables massive scaling, but it also significantly reduces signaling traffic with a simplified architecture.

Jio's DMS Layer offers a wide range of capabilities:
- **Data resiliency:** Real-time data availability and reduced signaling
- **Flexibility:** Unified data privacy, unified approach to security, data zoning and data sharing
- **SLA-based service:** High availability of data, simple automated operation and capacity usage/prediction
- **Multivendor interface:** Common cloud storage, seamless Integration and reduced time to market
- **Real-time, low latency:** Ready for session data and subscriber data with proven, real-time geo-redundancy robustness
- **CNF efficiency and scalability:** Simplified CNF operations, simplified scalability, faster time to market and reduced signaling
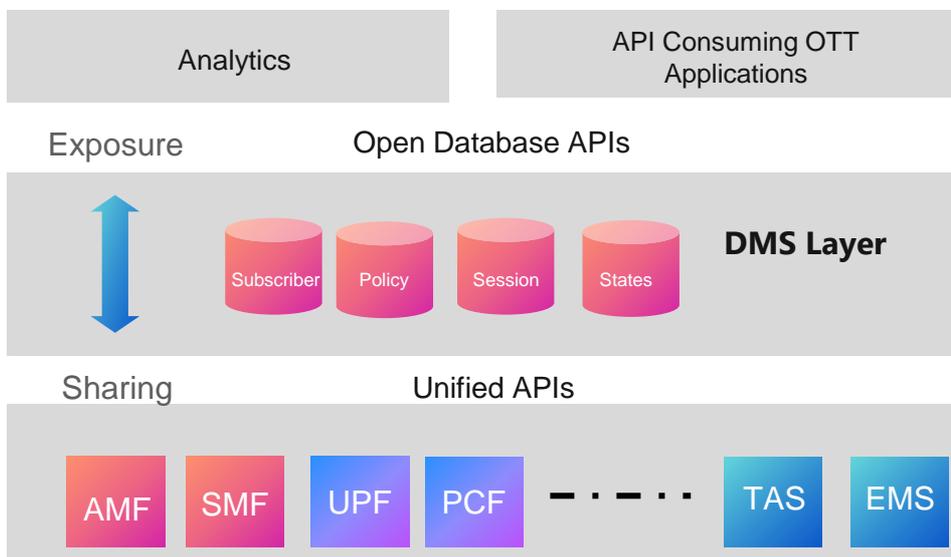
Network Slicing in the Core – Making Enterprise 5G Possible

Network slicing is one of the fundamental building blocks of core networks. It enables service providers to rapidly create custom services by segregating traffic and delivering specific sets of KPIs for each of them.

Each network slice (Mobile broadband slice, Massive IoT slice, Mission critical IoT slice & Other slices) is an isolated end-to-end network tailored to fulfil diverse requirements in different Industry verticals requested by a particular application. The salient feature of network slicing is the ability to customize the capabilities and functionality that a mobile network offers to its business customers.

Being a key technology included in 5G, networks will need to be sliced to ensure sufficient isolation and security between public and private application instances. These independent network instances enable service-specific Service Level Agreements (SLAs) for connectivity, mobility, capacity, security, redundancy and QoS/QoE.
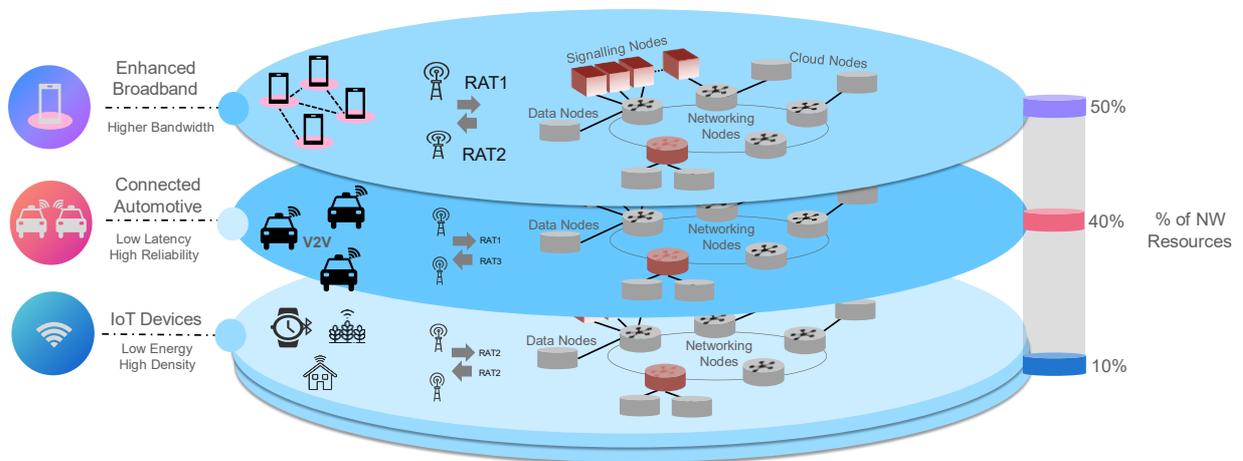
Being a key technology included in 5G, networks will need to be sliced to ensure sufficient isolation and security between public and private application instances. These independent network instances enable service-specific Service Level Agreements (SLAs) for connectivity, mobility, capacity, security, redundancy and QoS/QoE.

Enabling a Mix of Centralized and Distributed Cloud Deployments

With the overwhelming growth of mobile data consumption, distributed cloud is emerging as a paradigm along with the centralized one, to enable elegant scaling.

Far Edge in enterprise 5G context, is the edge computing infrastructure which is deployed in the enterprise premises, farthest from the cloud data center(s) and closest to the users. **Network Edge** is the edge computing infrastructure which is deployed in a location between the far edge and the cloud data centers**. Cloud Data Centers** are the Carrier's Private data centers hosting the complete set of core network nodes as well as Automation Platforms for Network Lifecycle Management.
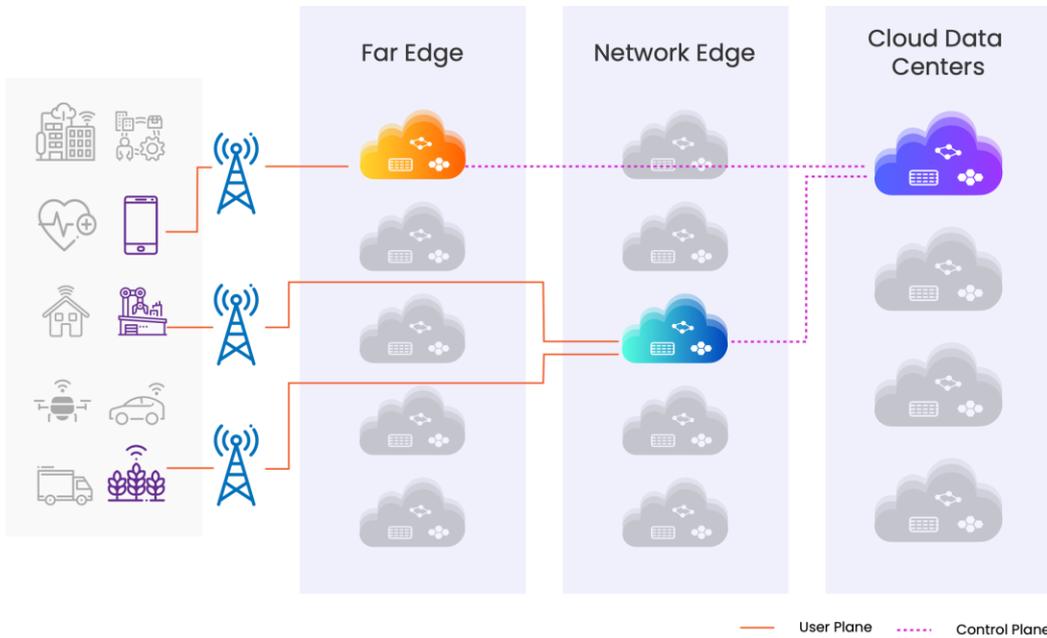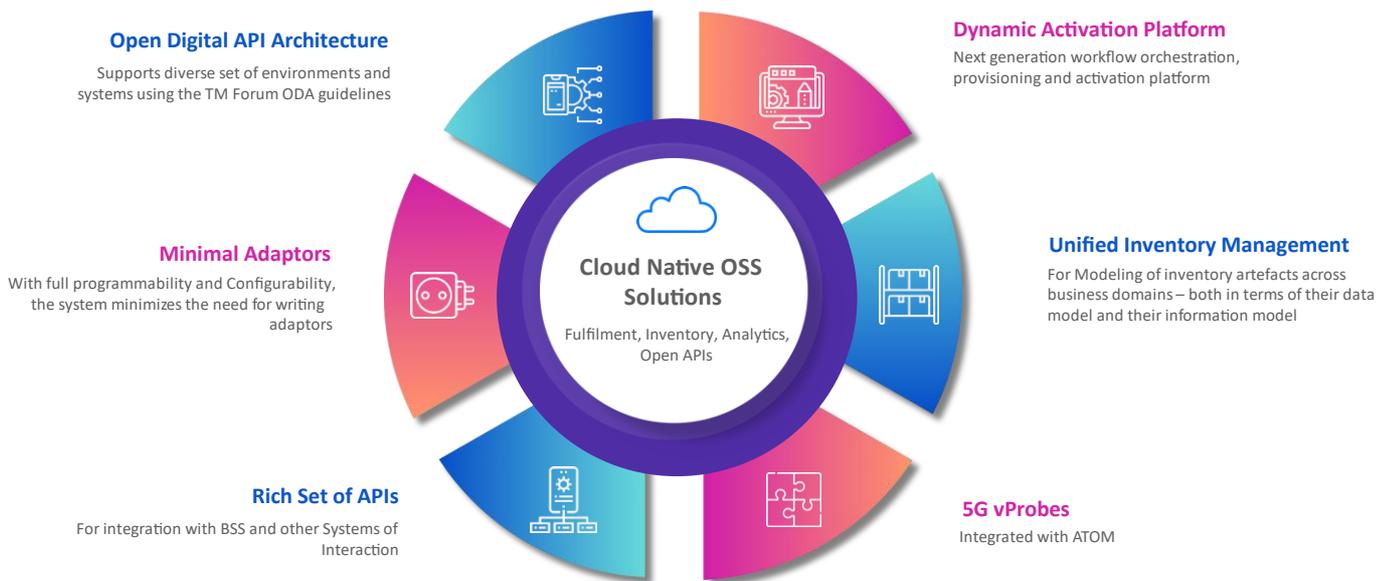

The new class of 5G applications demand that compute resources for user traffic be deployed at the network edge, closer to users and things so they can provide lower latency to enable industrial use cases.
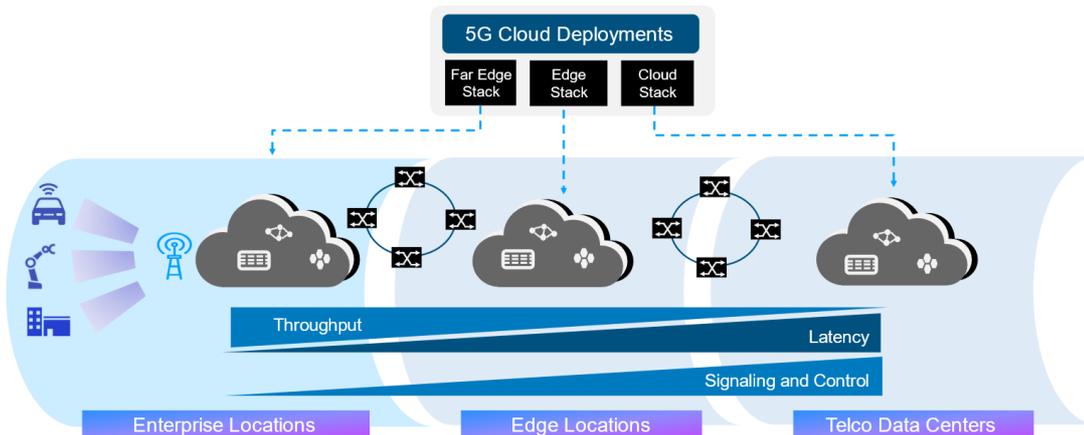
Cloud Native OSS Fulfilment System

In order to deliver on the promise of 5G services, it is required that we are able to provision and activate services on the fly. 5G use cases are diverse, and hence a platform is required which is not only catering to telco provisioning needs, but also integrates with 3rd party platforms if needed. The Jio 5G OSS Fulfilment Management System is a next generation workflow orchestration, provisioning and activation platform. The platform also includes Unified Inventory Management. The Jio OSS FMS Platform simplifies operations by replacing a traditional, high touch management model with a next generation, programmable and virtualized model

Open Digital API Architecture
Supports diverse set of environments and systems using the TM Forum ODA guidelines

Minimal Adaptors
With full programmability and Configurability, the system minimizes the need for writing adaptors

Rich Set of APIs
For integration with BSS and other Systems of Interaction

Cloud Native OSS Solutions
Fulfilment, Inventory, Analytics, Open APIs

Dynamic Activation Platform
Next generation workflow orchestration, provisioning and activation platform

Unified Inventory Management
For Modeling of inventory artefacts across business domains – both in terms of their data model and their information model
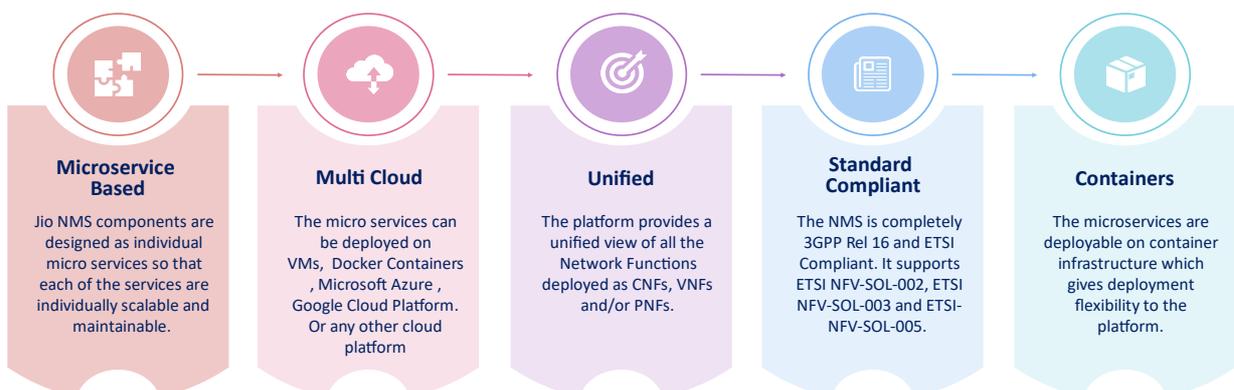
5G vProbes
Integrated with ATOM

The system is capable of integrating with all other elements of the network as well as application servers. The Jio OSS FMS solution supports creation of custom workflows using the interactive user interface. The Cloud Native OSS FMS also enables the provisioning of services at the Edge for Enterprise Use.

Service Assurance Through a Converged Network Management System

Networks are changing and so is the way we manage them. Jio's Network Management System is a critical piece in the overall cloud assurance solution as it is the sole mediator for monitoring and managing the cloud native functions and services. It provides a single pane of glass for the Network Operations Centre. It is fully integrated with AI and ML capabilities, leading to "light touch" operations.
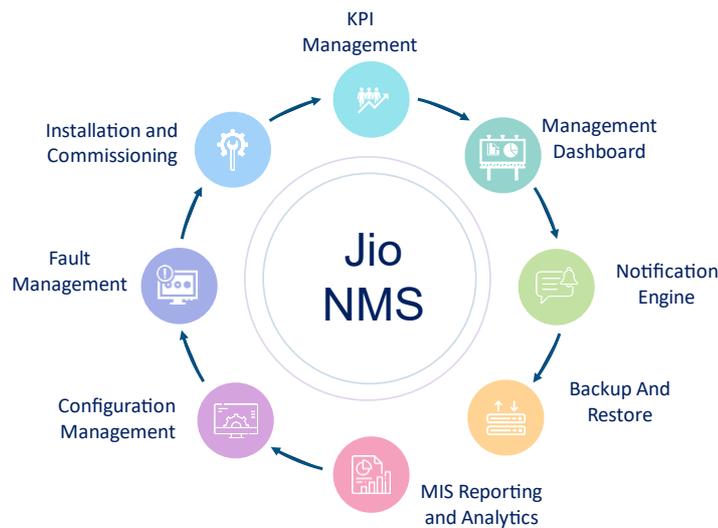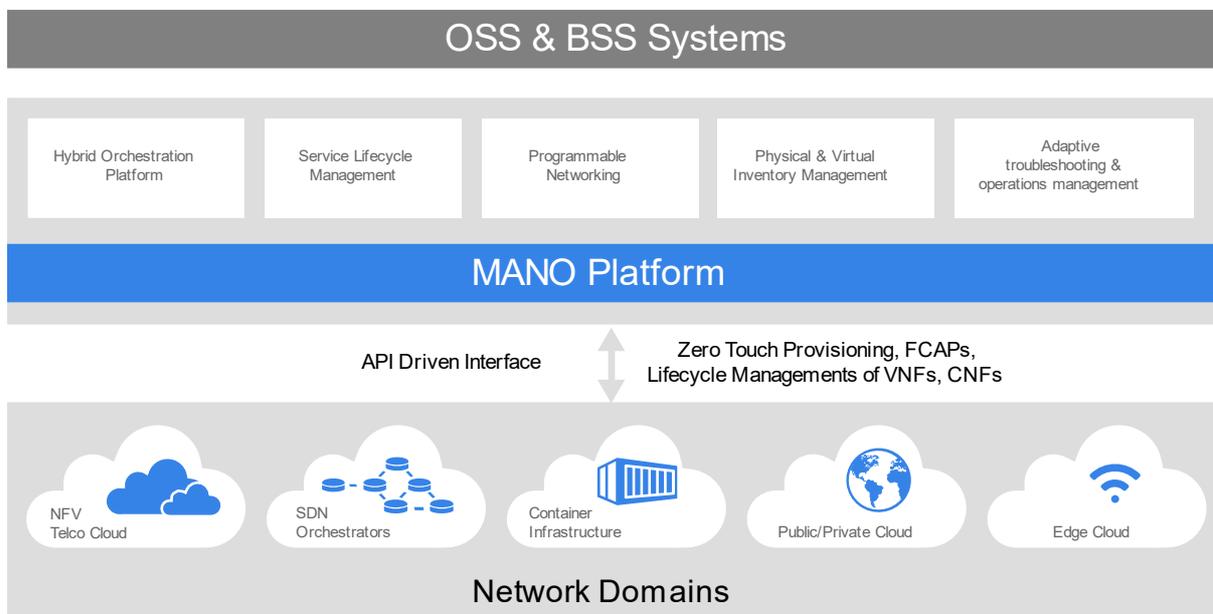

A carrier grade management solution capable of scaling as the network grows, maintaining high performance levels as the number of network elements increases, and providing simplified integration with third-party systems. The solution abstracts relevant aspects of the network elements it is managing, into an information model. The abstracted information is further communicated to next level of management systems with easy northbound integrations. It manages network elements both in the form of virtualized network functions (VNFs) , cloud native functions (CNFs) and physical network functions (PNFs). In addition, it supports a broad array of features to ease the operations and management of the nodes. The platform also provides a foundation to implement Operations Support System (OSS) architectures that enable service providers to meet stringent quality of service (QoS) requirements and meet customer needs for rapid deployment of new services

Microservice Based

Jio NMS components are designed as individual micro services so that each of the services are individually scalable and maintainable.

Multi Cloud

The micro services can be deployed on VMs, Docker Containers , Microsoft Azure , Google Cloud Platform. Or any other cloud platform

Unified

The platform provides a unified view of all the Network Functions deployed as CNFs, VNFs and/or PNFs.

Standard Compliant

The NMS is completely 3GPP Rel 16 and ETSI Compliant. It supports ETSI NFV-SOL-002, ETSI NFV-SOL-003 and ETSI-NFV-SOL-005.

Containers

The microservices are deployable on container infrastructure which gives deployment flexibility to the platform.

Converged Orchestration & Life Cycle Management

The unified orchestration framework supports service and resource management through their lifecycle – from planning to fulfilment to closed-loop assurance. The Jio MANO platform has been natively designed from its very inception to plan for a distributed "cloud" operation to support the emerging need for distributed 5G core infrastructure. It has the potential to transform the future of virtualized infrastructure and services enabling the evolution of 5G networks. It simplifies operations by replacing a traditional, high-touch management model with a next generation, programmable and virtualised model which works on the concepts of zero-touch operations. This enables provisioning of fast, on-demand services over hybrid networks - making sure traditional networks are "NFV Ready."

OSS & BSS Systems				
Hybrid Orchestration Platform	Service Lifecycle Management	Programmable Networking	Physical & Virtual Inventory Management	Adaptive troubleshooting & operations management

MANO Platform

API Driven Interface ⇅ Zero Touch Provisioning, FCAPs, Lifecycle Managements of VNFs, CNFs

NFV Telco Cloud   SDN Orchestrators   Container Infrastructure   Public/Private Cloud   Edge Cloud

Network Domains

Knowing that the future Networks need to be more adaptive, intelligent, self-organizing, self-healing and self-operating, the platform leverages machine learning to find anomalous network patterns and supports closed loop automations through auto healing and auto scaling use cases. Apart from the standard VNF/CNF lifecycle management, slicing and chaining use cases – the platform delivers carrier-grade features which can cut across VIMs. This supports multi-VIM deployments at scale. The platform embraces the maturity model for network transformation from PNFs to VNFs/CNFs across the complete lifecycle of the network and services. It also supports various features like Resource Orchestration, VNF Life Cycle Management , Dynamic Policy Execution and End-to-end Service Orchestration for both Telco and Enterprise environments.

SDN & SD-WAN Automation

The SDN and SD-WAN Automation is a unified solution for programmable networking across domains. It seamlessly integrates with domain controllers for managing the IP/MPLS, Transport and Edge Networks. As 5G and edge deployments roll out, making network slicing a requirement, service providers will likely want to extend SD-WAN networks into an end-to-end network fabric. The vision of Software Defined Networking (SDN) is to have a programmable and open API driven routing & switching infrastructure which can be provisioned, managed, monitored and upgraded through automated processes in operations.

Orchestration benefits include:
- Simplified management for a multi-vendor environment
- Agility to deploy enterprise services
- Revenue growth with a full suite of enterprise services
- Automation from ordering to assurance
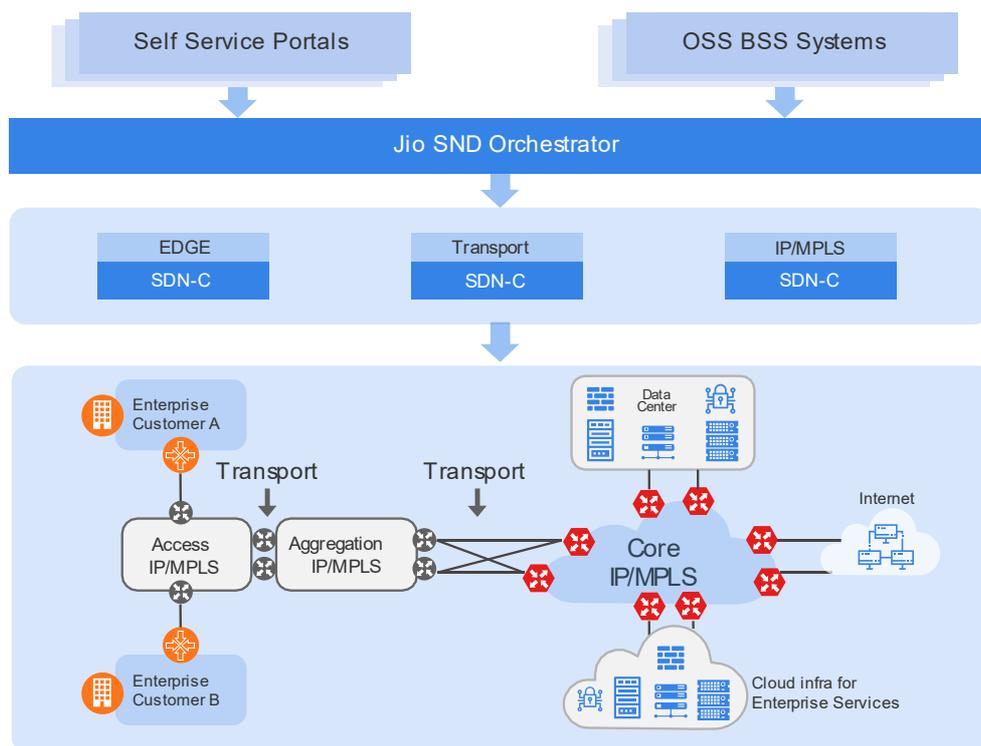
The Jio SDN Orchestrator is a unified solution for programmable networking across domains. It seamlessly integrates with domain controllers for managing the IP/MPLS, Transport and Edge Networks. Since the IP and Transport networks are evolving, the platform provides an approach to manage such networks with agility, automation, ease of use, minimal human intervention and reduced error rates. The Jio SDN Orchestrator enables zero touch service provisioning, where by a customer could go to a web portal and order services that can be automatically configured and delivered without requiring human intervention.

Real Time Network Intelligence using AI/ML

Jio ATOM (**A**daptive **T**roubleshooting, **O**perations and **M**anagement) Platform is a disaggregated & Cloud Native data lake platform tailored for the operators to enable smarter operations through ML as a Service (MLaaS). It leverages machine learning to detect anomalous network patterns and create reports and alerts based on these patterns for proactive root cause analysis and resolution before the network symptoms start affecting operations. The platform provides operational insights, data binding and correlation without writing any code as well as various ways to conduct automated analysis using AI / ML algorithms to bring organizational transparency with Automated SLA management capabilities in the workflow engine, orchestrating the operational tasks between the systems.
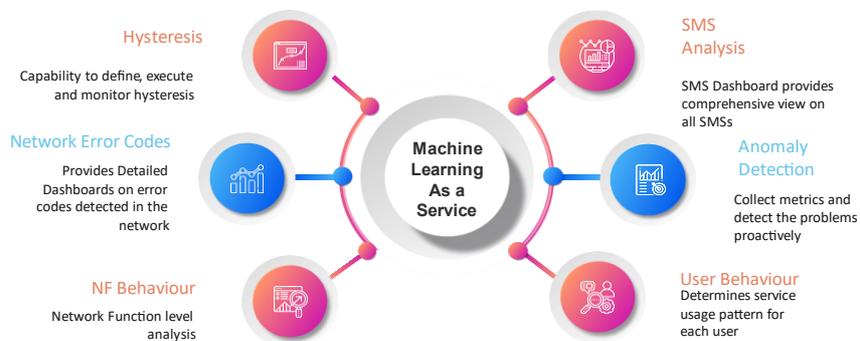
AI/ML is being used for 5G network planning, automation of network operations (e.g., provisioning, optimization, fault prediction, security, and fraud detection), network slicing, reducing operating costs, and improving both the quality of service and customer experience based on chatbots, recommender systems, and techniques such as robotic process automation (RPA).

Custom KPI Analytics Reports obtained from the Platform. **Thousands** of such reports can be retrieved from the platform for advanced analytics.

5G ML Probes - Real-time 5G CN Analysis

An Integrated Virtual Probe and Real-Time Intelligence solution will provide telecom operators with unprecedented insight into network performance and customer behaviour. With this solution, MNOs can dramatically reduce hardware costs, network complexity and the performance issues typically associated with probe solutions while providing real-time network intelligence. The solution has the capability to deploy vProbes embedded in the virtual network functions. This makes it possible to probe geographically distributed Virtualized Network Functions (VNFs)/Cloud Native Functions (CNFs) in a scalable and cost-effective manner. vProbe is a probing agent which collects probing data (Streaming Data Record-SDR) from 4G/5G Network nodes. It is not feasible to perform manual routing and cabling to manage such diverse use cases using traditional probing solutions. Hence, there is a need for a "FullStack5G" solution, which builds network probing as part of the 5G Cloud Native solutions and delivers an integrated experience for network operations without the need for systems integration.
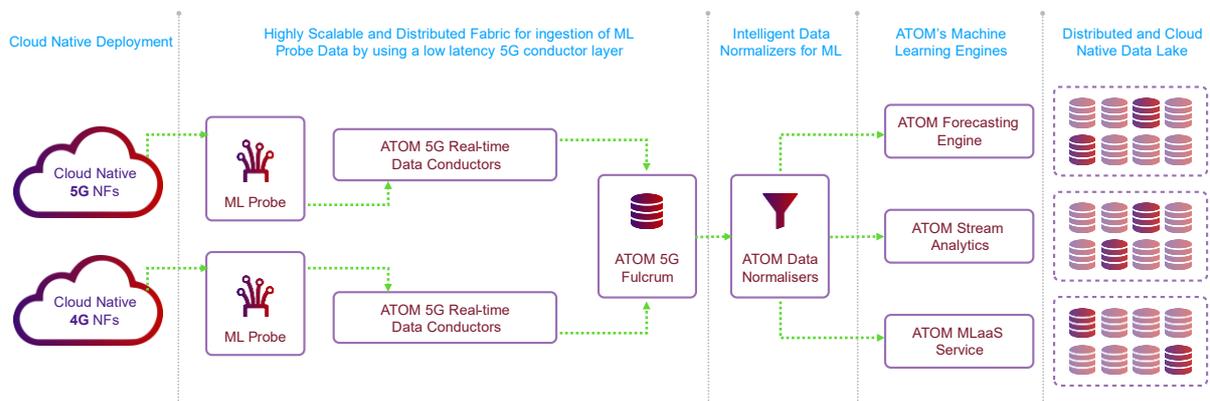

The ATOM platform enables the use of virtual probes in the 5G network which are connected through a real-time conductor fabric &leverages the existing machine learning engines of the platform. The platform provides operational insights, data binding and correlation without writing any special code. It brings organizational transparency with Automated SLA management capabilities in the workflow engine orchestrating the operational tasks between the systems. The data records collected from Virtual Probes used by the ATOM 5G Real-Time Data Conductors enrich the incoming data. The data records collected by different NFs can be used by the platform to perform anomaly detection on the collected data based on the historical models, perform forecasting on the available data or normalize it to use it for different debugging, reporting and correlation purposes.
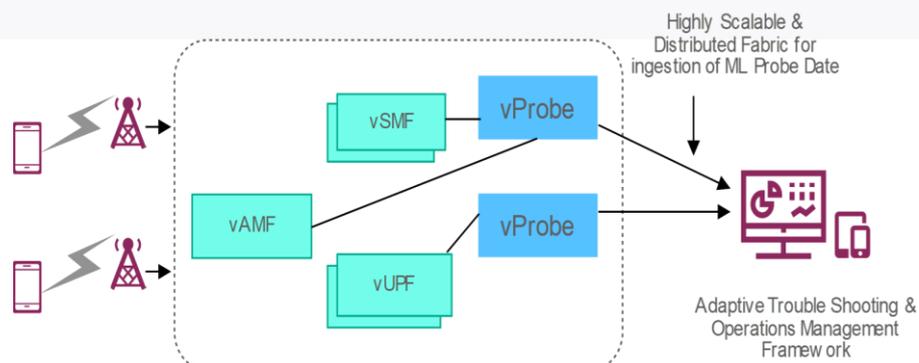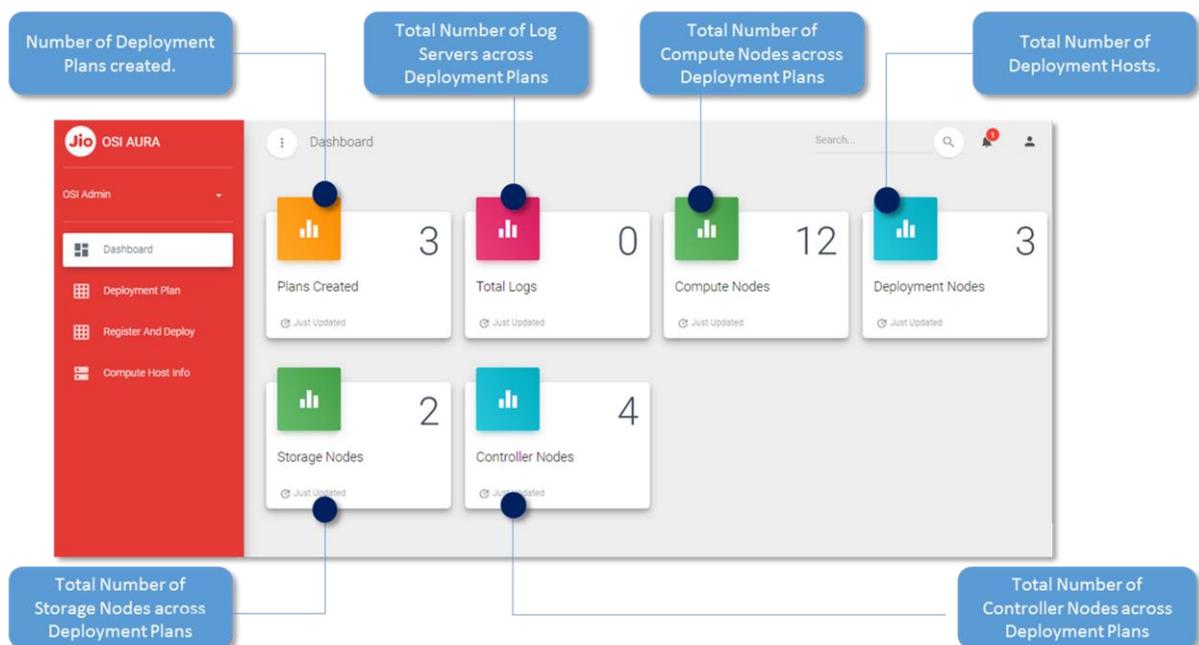
Automated Cloud Deployments

The Jio Automated Cloud Installer (ACI) aims to deploy hybrid production grade environments in a way that makes them simple to operate, upgrade and scale. With its comprehensive and easy to use graphical user interface, a user can easily plan and deploy a fully automated Openstack or Docker clouds across deployment sites. This leads to a significant reduction in the time taken for their installation and commissioning. The Jio ACI makes it easy to provision instances, networks and the production ready cloud infrastructure. The solution provides the flexibility to plan the deployment on several geographic locations with a single click from its interactive user interface. without the need for systems integration.
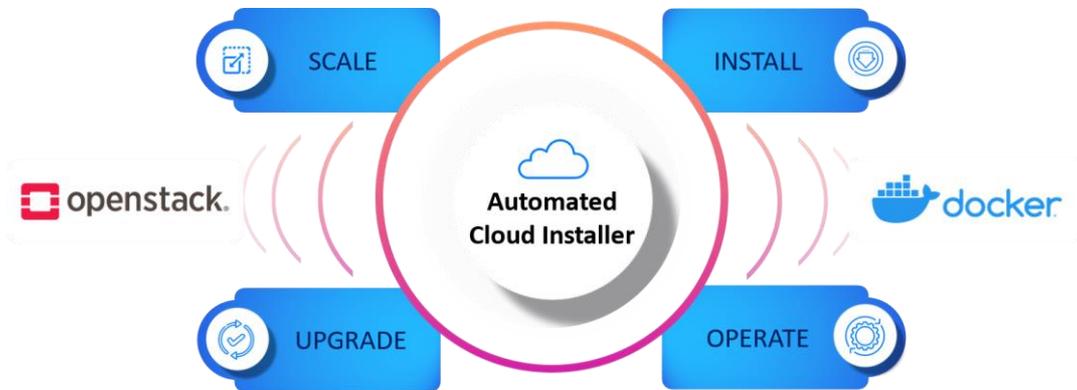
The Jio ACI comes with an interactive graphical user interface for easy design of deployment plans consisting of sites spread across geographies, automated installation and horizontal scale in/ scale out of hardware resources. Coupled with the Jio C-MANO platform, the ACI platform ensures end to end automation in the modern 4G/ 5G carrier network.

Production Deployments at Telco Scale

*The largest 5G SA Core network supporting **120 Mn** Customers and **90 Tbps** of traffic, for ongoing 5G PAN India Trials. Jio's Cloud Native 5G SA Core combined with the automation platforms enabled such a large scale rollout in **less than 50 days** – despite the Covid situation in India.*

Jio MANO

500 Cloud Native PODs deployed for Jio's 5G Core Network

100K
CPEs Capacity deployed across 4 Zones in India

50K
NF Instances Supported per cluster of platform

110+
Multi-Cloud VIM Sites Live in the network

5K+
Sites provisioned using Zero Touch Provisioning

15+
Flavors of Vendor Products Integrated with MANO

620+
Serving 620+ Enterprise offices across the country

Jio NMS

All 5G Nodes are pre integrated and 80+ 4G Nodes are integrated in the production network.

300+
NF Instances Supported

5K+
Sites provisioned with Zero Touch

100%
FCAPs Integration

110+
Serves 110+ different types of 4G/5G nodes

90%
AMC Cost reduction

Jio ATOM

Providing insights on 200+ Billion Data Points every day

500+
Bn Records Processing Per Day Capacity

10K+
Bn Records Capacity Cluster Deployed

100
PBs Storage Support

3000+
Data Source Instances

50Mn
Real time Analysis for 50 Mn Records Every Second

40+
Number of Instances deployed

1K+
Connected Network Element Instances

Jio ACI

*Automated Deployment of 5G Core Network on **8 Data Centers and 42 MEC Sites***

100+
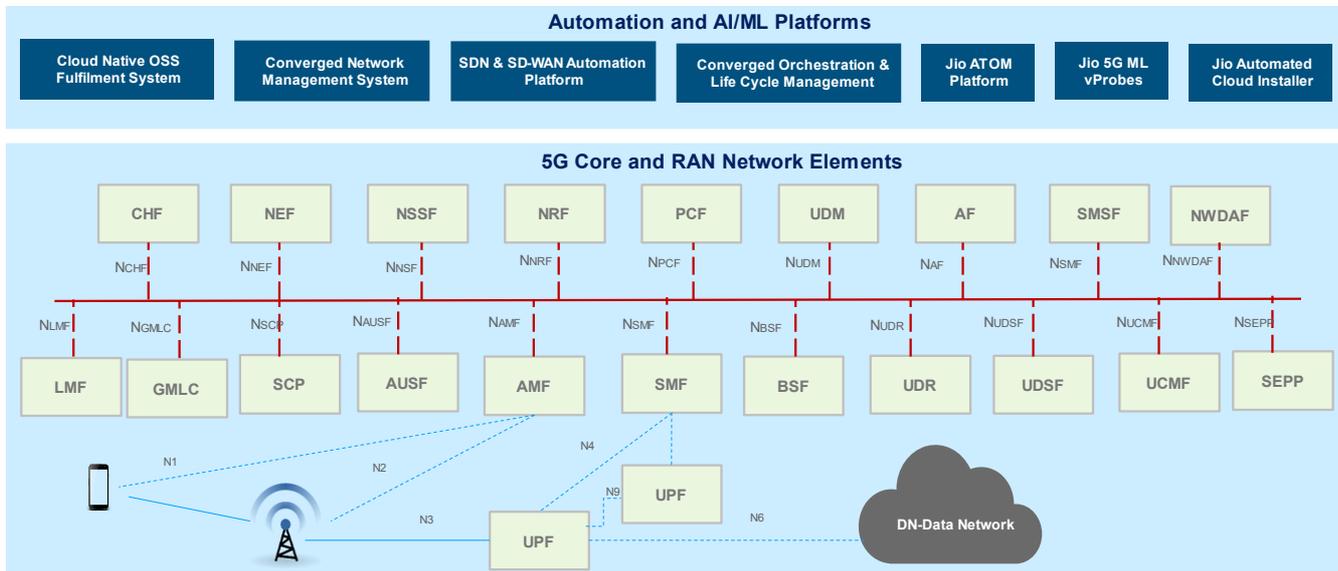Capacity to deploy 100+ MEC Sites

20K+
Compute nodes capacity per cluster

Jio OSS FMS

All 5G Nodes are pre integrated and 80+ 4G Nodes are integrated in production for provisioning and configurations.

Solution Summary

Simple, Smart and Secure Transition to 5G

Jio being one of the largest LTE network in the world, with 425+ million customers and carrying traffic volume of over 140 million GB/day; deeply understands the design and operational challenges faced by telecom operators. With a strong and robust 5G product portfolio, Jio aims to be the global technology pioneer in 5G product and ecosystem development.

Jio's True 5G Core Network, which is 3GPP Release 16 compliant, provides a world class experience across a variety of service scenarios, including the cases of ultra-high traffic volume density, connection density and mobility. Jio supports SA and NSA 5GC deployments, which gives the highest return on investment for telecom operators and avoids all wasteful integration efforts. Further, Jio Platforms promises to deliver world-class engineering and professional support services, to digitally transform an operator's network and further enabling consumer and enterprise businesses.

Team Members

#	Name	Role
1	Aayush Bhatnagar	Lead Architect with deep knowledge in the areas of Cloud Solutions, AI/ML applications, Blockchain and Telecom Industry.
2	Mohit Vaish, Bhavin Patel, Neha Nayyar, Nitin Khurana, Ashish Bhatnagar, Sony Sankar.	Experienced product management professional with in-depth knowledge of conceptualizing next generation telecom networks.