VIEW POINT

TELECOM NETWORK OPERATION CENTER AND MANAGEMENT SYSTEMS: NEW TRENDS

Abstract

Telecom operations are undergoing a major shift driven by 5G/6G, cloud-native network functions, Open RAN, edge computing, and AI/ML. This evolution renders legacy TMN-based models insufficient, requiring software-defined, intent-driven, and increasingly autonomous operations. TM Forum's Open Digital Architecture (ODA) and Open Digital Framework (ODF) now serve as the industry blueprint, enabling modular, cloud-native, API-first, and AI-orchestrated operations. Infosys believes that a zero-touch, AI-native NOC is essential to achieving lower MTTR, reduced OPEx, faster concept-to-cash, and superior B2B/B2C service experiences.

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Introduction

As networks grow more complex and service expectations rise, NOCs and NMS must ensure real-time visibility, automation, and proactive assurance across heterogeneous wireline and wireless domains. Operators are moving from network-centric to service-centric models with stringent SLA and KPI requirements, demanding precise and autonomous 24×7 monitoring. This transition is reinforced by rapid growth in the EMS/NMS market, expected to expand from USD 11.04 B in 2025 to USD 26 B by 2034, further accelerating the adoption of NOC-as-a-service models.

New technological drivers

- **5G and 6G:** Higher bandwidth, low latency, massive device density, and emerging AInative 6G architectures demand advanced management for network slicing, edge workloads, and stringent QoS.
- **Open RAN (ORAN):** Multivendor interoperability requires centralized orchestration and assurance across heterogeneous RAN components.
- **AI/ML:** Enables predictive maintenance, automated optimization, anomaly detection, and emerging gen AIbased functions such as automated reporting and network design assistance.
- **Mobile edge computing (MEC):** Distributed edge resources require coordinated management to ensure lowlatency performance and seamless data flow.
- **Cloudnative network functions (CNFs):** Cloudbased deployment of network functions increases scalability and agility, necessitating integration with cloud orchestration platforms.
- **SDN/NFV:** Decoupled, softwaredefined control improves flexibility and automation, requiring centralized orchestration of virtualized functions.
- **Cybersecurity:** Rising threats and expanded device ecosystems elevate the need for integrated, realtime security management with approaches like SASE.
- **Private 5G:** Enterprisespecific deployments demand localized control, high reliability, and strong security, adding new operational requirements for NMS/NOC systems.

TELECOM MANAGEMENT NETWORK(TMN) FRAMEWORK

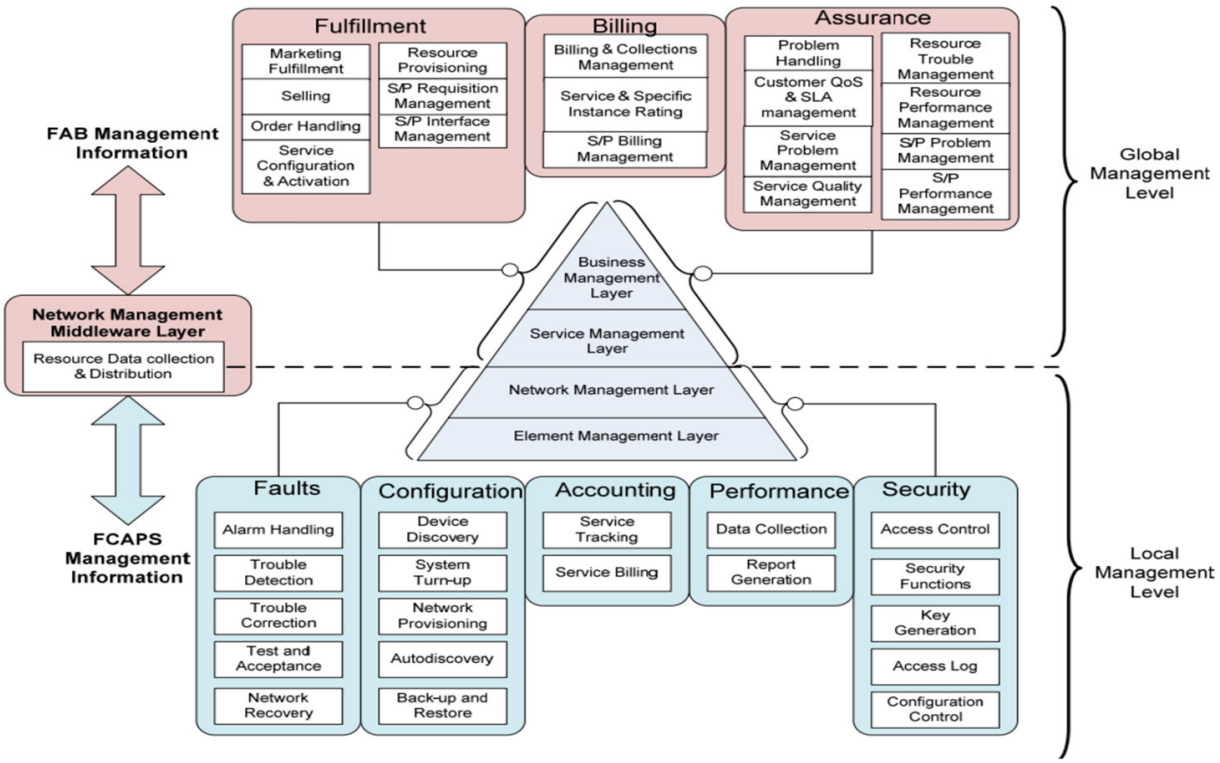


Figure1: Telecom network management framework

INTEGRATED NOC services

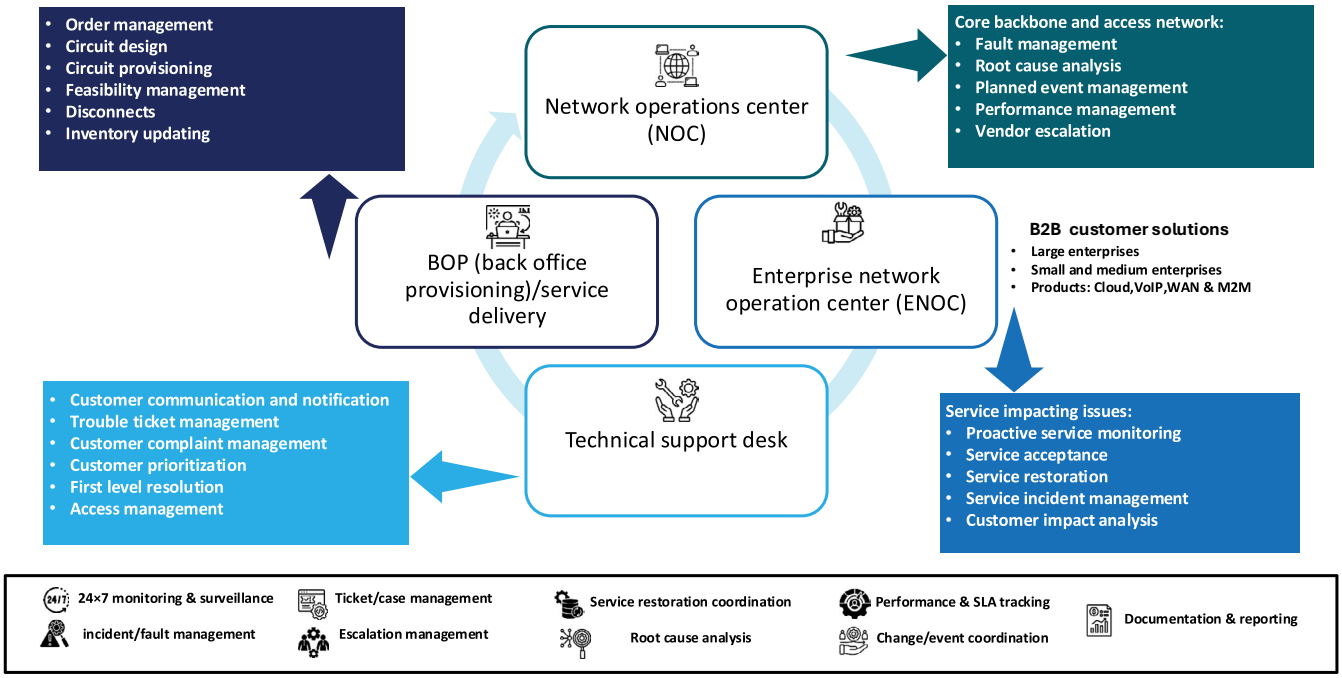


Figure 2: Integrated NOC (Network Operations Center) services

Impact on network management systems

These technological advances are pushing the evolution of network management systems towards the following.

- Increased automation and orchestration
- Real-time monitoring and analytics
- AI-driven optimization and predictive maintenance
- Enhanced security and reliability
- Greater flexibility and scalability

New trend aspects of telecom network management

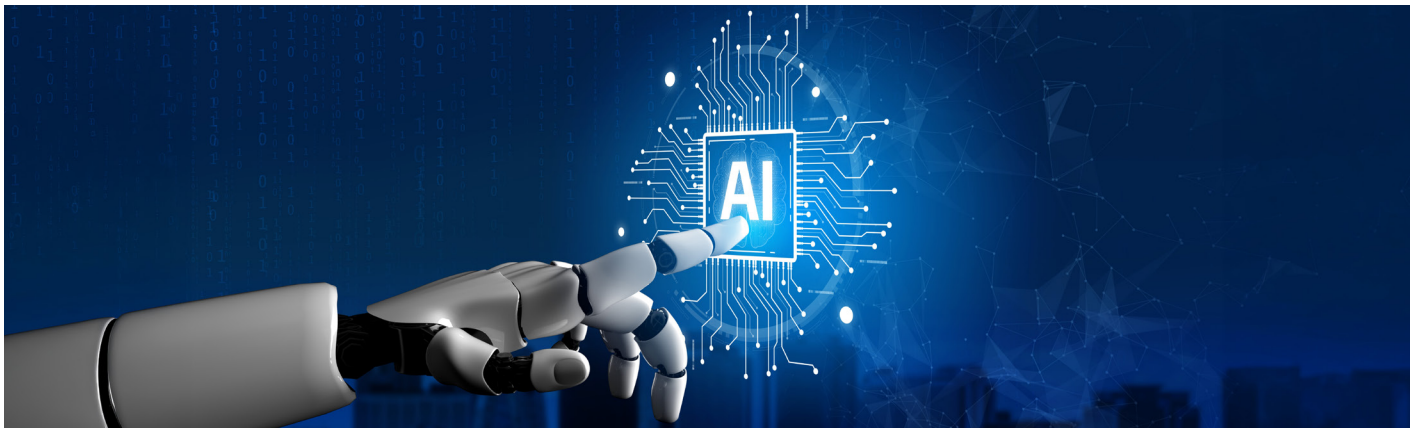
- **Network visibility and monitoring:** Real-time monitoring of network performance metrics like latency, throughput, signal strength, and resource utilization across all network elements to identify potential bottlenecks and proactively address issues.
- **Automation and orchestration:** Utilizing automated tools to streamline network configuration, provisioning, and troubleshooting tasks, reducing manual intervention and improving operational efficiency.
- **Data analytics and predictive maintenance:** Leveraging machine learning algorithms to analyze network data, predict potential failures, and optimize network resource allocation based on usage patterns.
- **Multi-vendor management:** Managing diverse network equipment from multiple vendors through a unified platform to ensure seamless integration and consistent performance.
- **Security and compliance:** Implementing robust security measures to protect the network from cyber threats and ensuring adherence to industry regulations.
- **Cloud-based network management:** Utilizing cloud infrastructure to scale network management capabilities, enable flexible deployment, and facilitate data analysis.

Challenges in telecom network management

- **Network complexity:** Increasing network complexity due to new technologies like 5G, edge computing, and IoT devices.
- **Data volume:** Managing large volumes of network performance data efficiently.
- **Integration challenges:** Integrating diverse network elements and management systems from different vendors.
- **Rapid technological change:** Staying updated with emerging technologies and adapting network management practices accordingly.

Focus areas for the future

- **AI and machine learning:** Using AI to revolutionize customer experience management in telecom. Implementing AI-powered network optimization, anomaly detection, and predictive maintenance.
- **Network slicing:** Dynamically provisioning network slices tailored to specific application requirements.
- **Zero-touch automation:** Automating network provisioning and configuration with minimal human intervention.
- **Edge Computing:** Managing distributed edge computing infrastructure to bring processing power closer to data sources.



Key business challenges

- **Data management and analysis:**
  - **Complex data sets:** Telecom networks generate vast amounts of data from various sources, making it difficult to analyze and extract meaningful insights effectively.
  - **Real-time analytics:** The need to analyze data in real-time to react quickly to network issues and customer demands.
- **Customer experience and retention:**
  - **Poor digital experience:** Providing a seamless digital customer experience across various channels is crucial but can be challenging due to complex systems.
  - **Churn prediction**: Identifying customers at risk of leaving the service and taking proactive measures to retain them.
- **Cost Optimization:**
  - **High operational costs:** Maintaining and managing large telecom networks can be expensive, requiring efficient operations.
  - **Infrastructure investment:** Upgrading networks to support new technologies like 5G requires significant capital investment.
- **Security and compliance:**
  - **Cybersecurity threats:** Protecting sensitive customer data from cyberattacks is a major concern in the telecom industry.
  - **Regulatory compliance:** Navigating complex regulatory landscapes across different regions.
- **Network performance and scalability:**
  - **Network congestion:** Managing network traffic during peak usage periods to ensure smooth service.
  - **Scalability for future demands:** Designing networks that can adapt to growing data needs and emerging technologies.
  - **Fraud prevention of advanced fraud schemes:** Detecting and preventing sophisticated fraud activities like SIM swapping and account hijacking.
- **Operational complexity:**
  - **Complex network management systems**: Integrating various network management tools and systems can be challenging.
  - **Proactive issue resolution:** Identifying and addressing potential network issues before they impact customers.

Key strategies to address these challenges

- **Advanced analytics and AI:** Utilize machine learning and big data analytics to gain insights from network data, predict customer behavior, and optimize network operations.
- **Cloud-based solutions:** Leverage cloud computing to improve scalability, flexibility, and cost efficiency in network management.
- **Customer-centric design:** Focus on creating a seamless digital customer experience through user-friendly interfaces and personalized services.
- **Cybersecurity investments:** Implement robust security measures to protect network infrastructure and customer data.
- **Automation and orchestration:** Automate routine network management tasks to reduce operational costs and improve efficiency.
- **Collaboration with vendors:** Partner with technology providers to stay updated on the latest advancements and solutions.

Impact on NOC operations

- NOC operations will become more automated and initiative-taking, with a focus on predictive maintenance and self-healing networks.
- NOC engineers will need to develop new skills in areas such as AI, automation, and cloud computing apart from native technologies developed in OSI and TMN model till date.
- NOCs will play a more strategic role in network optimization and service delivery.
- Shift from network centric to service and business centric approach of operations.

Core functions of NOC

- **Fault management:** Detecting and resolving network issues.
- **Performance management:** Monitoring and optimizing network performance.
- **Configuration management:** Managing network device settings.
- **Security management:** Protecting the network from threats.

Key EMS/NMS and NOC coverage

- **Vendor-specific EMS/NMS:**
  - Providers like Cisco, Huawei, Ciena, Ericsson, Nokia, NEC, COMSAT, Satconnect, SES etc. offer comprehensive NMS solutions tailored to their equipment for their proprietary wireline and wireless line of services.
- **Covered transmission technologies:**
  - **Wireline:** Fiber optics, Ethernet, IP/MPLS, SDH/SONET, DWDM, xDSL, FTTx, OTN
  - **Wireless:** 5G (NR),4G LTE, Wi-Fi, WiMAX, FSO, Microwave, Satellite

Legacy TMN based NMS systems are still in use for previous generation legacy SDH/SONET and similar technologies, but migration to cope up with stringent data driven roll outs of NGN network is seriously required a robust framework compatible to accommodate digital transformation and fill the gap of era(2G -> 6G), approach(Network Centric to Business Centric),Technology and flexibility.TM Forum has designed ODF framework to enable digital transformation in the telecommunications industry.

- **6G (tentative):**
  - AI-native network management: Deep integration of AI for autonomous network operation.
  - Terahertz (THz) spectrum management: Handling the complexities of very high-frequency spectrum.
  - Integrated sensing and communication (ISAC) management: Managing networks that combine communication and sensing capabilities.
  - Digital twin network management: Using digital twins to simulate and optimize network performance.
  - 6G is still in early stages of development, and tentative commercial launching dates are expected in the 2030's.

Key considerations:

- The shift is towards software-defined, automated, and AI-powered NMS.
- Open APIs and interoperability are becoming increasingly important.
- Cybersecurity is a critical focus area.

TM Forum has significantly evolved its frameworks to address the modern telecommunications landscape. Here's a breakdown of how TM Forum is addressing the evolution of network management:

Key TM Forum frameworks

- **Open digital architecture (ODA):**
  - This is TM Forum's key initiative for enabling digital transformation in the telecommunications industry.
  - ODA promotes a cloud-native, software-defined approach to network and IT operations.
  - It emphasizes the use of open APIs, modular components, and automation to achieve greater agility and efficiency.
  - Essentially, ODA is designed to help telecom operators move away from monolithic legacy systems and towards a more flexible and adaptable architecture.
- **eTOM (Enhanced Telecom Operations Map):**
  - eTOM provides a business process framework for telecommunications service providers.
  - It defines the end-to-end business processes involved in delivering and managing telecommunications services.
  - While the underlying concepts of TMN's layered approach are still relevant, eTOM provides a more business-oriented view of network management.
- **Information framework (SID - Shared Information/Data Model):**
  - SID provides a standardized data model for the telecommunications industry.
  - It enables the exchange of information between different systems and organizations.
  - This is crucial for ensuring interoperability and facilitating the integration of new technologies.
- **TM Forum Open APIs:**
  - TM Forum is heavily involved in developing and promoting open APIs.
  - These APIs enable seamless integration between different systems and components, fostering a more open and collaborative ecosystem.

How these frameworks relate to TMN

- While the traditional TMN model provided a layered architectural approach, TM Forum's frameworks build upon those concepts and adapt them to the modern digital era.

- ODA, in particular, addresses the need for a more dynamic and agile approach to network management, which is essential for 5G, cloud, and other emerging technologies.
- The focus has shifted from a strictly hierarchical management structure to a more distributed and API-driven approach.

Key takeaways:

- TM Forum's frameworks are designed to help telecom operators transform their operations and embrace digital technologies.
- ODA is a critical initiative for enabling cloud-native network management.
- Open APIs and standardized data models are essential for ensuring interoperability.

A shift to modern NOC

The role of the Network Operations Center (NOC) is expanding rapidly as telecom networks evolve toward 5G/6G, cloud-native architectures, Open RAN, edge computing, private networks, and AI-driven automation. Modern networks are becoming highly distributed, software-defined, and service-centric—requiring NOCs to shift from traditional monitoring to real-time assurance, predictive analytics, cyber-resilience, and autonomous operations. At the same time, the cost and complexity of maintaining in-house operational teams continue to rise, making NOC outsourcing and NOC-as-a-Service (NOCaaS) an attractive option for service providers seeking scalability, 24×7 availability, expert skillsets, and lower operational risk.

Why NOC services matter more than ever

A modern NOC ensures continuous, secure, and efficient network operations with robust business continuity (BCP). With networks transitioning to multi-vendor, multi-cloud, and highly virtualized environments, operators need NOCs that can support:

- **5G standalone (SA) operations**, dynamic network slicing, and ultra-low-latency services
- **Cloud-native network functions (CNFs)** and Kubernetes-based telco cloud
- **Open RAN architectures**, requiring centralized policy control and RIC/xApp/rApp-driven optimization.
- **Edge and distributed computing**, where workloads move closer to users.
- **Massive IoT expansion**, demanding scalable, AI-assisted monitoring.
- **Advanced cybersecurity frameworks** such as SASE, zero-trust, and automated threat detection

The accelerated rise of **NOCaaS** is strongly correlated with growth, as operators seek operational resiliency, faster transformation, and cost predictability.

Why investing in modern NOC services delivers strategic value

- **Reduced MTTR through predictive & preventive operations**
  A next-gen NOC leverages AIOps, real-time telemetry, anomaly detection, and predictive maintenance to identify and resolve issues before they impact end users—lowering MTTR, enhancing uptime, and stabilizing service performance.
- **Enhanced cybersecurity posture**
  With expanding attack surfaces across edge, cloud, IoT, and distributed RAN, continuous 24×7 monitoring is essential. Integrated threat intelligence, automated correlation, and SASE-based enforcement ensure rapid detection and mitigation of cyber threats.
- **Lower total cost of operations (OPEx)**
  Outsourcing NOC operations provides:
  - Reduced staffing and training overhead
  - Access to specialized 5G/Cloud/AI/O-RAN talent
  - Scalable operating models aligned with traffic and service growth
  - Lower toolchain maintenance cost through shared platforms

  This shifts operators from fixed cost models to flexible, consumption-based operational spending.
- **Readiness for future networks (6G, autonomous networks, digital services)**
  As the industry heads toward:
  - 6G AI-native networking,
  - autonomous, intent-driven networks,
  - hyper-connected enterprise ecosystems, and
  - digital service marketplaces,

  NOCs must evolve into Service Operations Centers (SOCs) capable of managing digital experience, cloud orchestration, cross-domain assurance, and automated closed-loop control.

How Infosys strengthens the NOC journey

Leverages advanced automation minimizing manual interventions and reducing operational costs. Our globally distributed teams provide access to top-tier expertise at competitive rates, ensuring that you receive world-class service without the high expense of maintaining an in-house team.

Infosys delivers next-gen NOC services by combining:

- Cloud-native toolchains and observability platforms
- AIOps and GenAI copilots for automated insights and RCA
- TM Forum ODA-aligned architecture for modular and open operations.
- Full-stack automation pipelines across RAN, core, transport, edge, and cloud
- Security-integrated operations to ensure resilience.
- Flexible engagement models, including NOCaaS and hybrid operations.

This ensures operators achieve:

- Consistent 24×7 operations
- Faster service rollouts and restorations.
- Predictable OPEx
- Superior customer and enterprise experience

Telecom Network Operation Centre : Line of services

- **NOC as a Managed Service : A centralized first line of defense for telecom wireline and wireless network operations, providing multi-layer monitoring, incident lifecycle management, automation and analytics driven assurance to ensure network and service availability, performance, customer experience and resiliency.**
- **Shift from reactive fault handling to predictive and experience driven operations.Key drivers – Service Experience, Automation & AIOps adoption, Multi-vendor ecosystem management and OPEX efficiency.**
- **NOC Set Up as a service : For greenfield network and captive operations, services will be provided at consulting level only.NOC Infrastructure and device set up to be owned by CSP.**

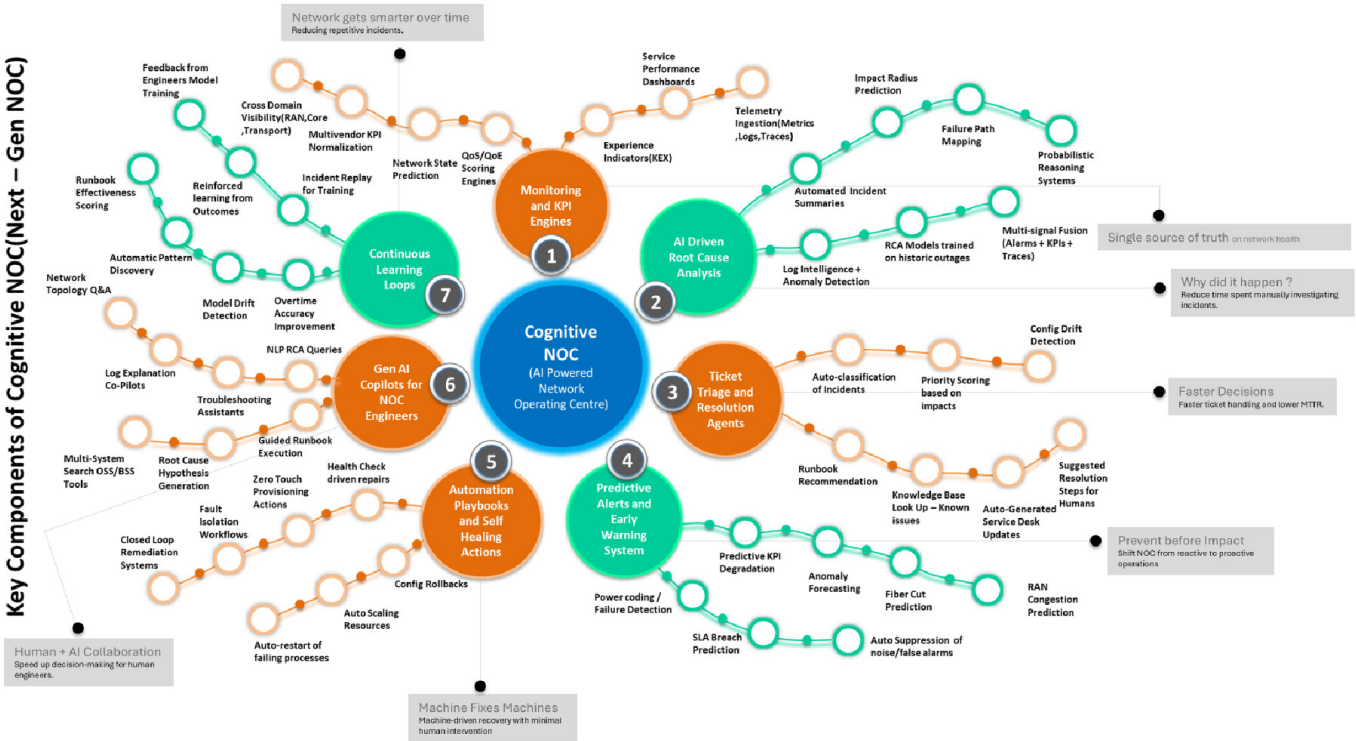
Business Domains : In House ,Outsourced and Hybrid Model

NOC Line of Services :TM Forum /ITUT/ITSM & PMI Approach

1 NOC Set UP	2 L0 – L1.5 Support	3 L2 to L3 Support	4 NOC by Domain & Technology	5 NOC Process Re-Engineering	6 Service Assurance (B2B/B2C)	7 Network Audit & Optimization
Facility / Infra /Cloud NOC Enablement	Network Monitoring Faults, Degradation	Advanced Troubleshooting and Isolation	Infrastructure (Fiber/Copper/HFC,MW and Satellite)	Process Assessment	High Revenue Customer Management	DART Methodology (Discover, Analyze ,Recommend and Transform)
Toolchain Integrations (Monitoring/ITSM/Analytics)	Fault/Incident Mgmt. Configuration Mgmt. Security Monitoring	Problem Management Chronic and repeat faults	Transmission,IP,MPLS	Process Automation & Optimization	Proactive Incident Prevention	Performance Transformation Roadmap
Security, Process and Communication(UCC)	Ticket Management Reports, Dashboard and Analytics	SLA & KPI Risk Mitigation Vendor, Field Coordination	Customer Centric (B2B/B2C)	Six Sigma and SIPOC Methodology	Experience Analytics Service Improvement	CAPEX and OPEX Optimization

Performance Measurement Criteria :

Availability and Reliability Metrics	MTTR & Incident Reduction	Prevented Outages Predictive Accuracy Reduced Truck Rolls	Network & Service Performance KPI & KQI	Reduced Men hours Saved and ESAT Score	CSAT and NPS	Reduced OPEx and Performance Improvements



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Avnish is principal consultant in Infosys BPM industry solution team. He is holding more than 20+ years of leading experience in telecom network operations, Fiber and Transmission network rollout, Network O&M, Consultancy and FTTx Predictive analysis projects. Indulged actively in managed services of network operating Centre (ISP & OSP) in wireline and wireless technical subdomains. Led onshore and offshore projects of various telecom operators and CSP. As a telecom professional, he plays the role of solution architect and network consulting with common objective of expanding the Infosys business horizons and enhancing customer delight.

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