

# VODAFONE GROUP PLC

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## Technical Architecture & Services

*Core Technologies, Solution Stack & Offered Services*

**Document Classification: CONFIDENTIAL**

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Vodafone Group Plc | Vodafone House, The Connection, Newbury, Berkshire RG14 2FN

# 1. Executive Summary

Vodafone Group Plc operates one of the world's largest telecommunications networks, delivering integrated connectivity, cloud, security, and IoT services to over 300 million customers across more than 20 countries. This document provides a comprehensive description of Vodafone's technical architecture, core technologies, solution stack, and the full portfolio of services offered to enterprise, government, and consumer clients.

Vodafone's technical infrastructure is built on a foundation of next-generation network technologies including 5G Standalone (SA), Software-Defined Networking (SDN), Network Functions Virtualisation (NFV), and Multi-access Edge Computing (MEC). These technologies are unified through a cloud-native, API-first architecture designed for scalability, resilience, and rapid service innovation.

# 2. Network Architecture Overview

## 2.1 Core Network Infrastructure

Vodafone's network architecture follows a multi-layered, converged design that integrates fixed, mobile, and satellite technologies into a unified platform. The core network is structured across three primary layers:

Network Layer	Components	Technology
Access Layer	Radio Access Network (RAN), Fixed Broadband, Wi-Fi Offload	5G NR, LTE, DOCSIS 3.1, Wi-Fi 6E
Transport Layer	IP/MPLS Backbone, Metro Ethernet, Optical Transport	Segment Routing, OTN, DWDM, FlexE
Core Layer	5G Core (5GC), IMS, Packet Core	3GPP R17, NFV/SDN, Cloud-Native
Management Layer	OSS/BSS, Network Automation, AI/ML Ops	ONAP, TM Forum APIs, Terraform

## 2.2 5G Architecture

Vodafone has deployed a full 5G Standalone (SA) architecture across its footprint, representing the industry's most advanced commercial 5G implementation. Key architectural components include:

- 5G New Radio (NR): Sub-6 GHz (n78, n41) and mmWave (n258, n260) spectrum bands deployed using Massive MIMO and beamforming technologies
- Open RAN (O-RAN): Disaggregated RAN architecture supporting multi-vendor interoperability, deployed across 12 markets
- 5G Core Network: Cloud-native Service-Based Architecture (SBA) with network slicing, supporting eMBB, URLLC, and mMTC use cases

- Multi-access Edge Computing (MEC): Distributed edge nodes co-located with base stations, delivering sub-5ms latency for mission-critical applications
- Network Slicing: End-to-end logical network partitioning enabling dedicated SLA guarantees per enterprise customer or use case

### 3. Core Technologies

#### 3.1 Software-Defined Networking (SDN)

Vodafone's SDN implementation decouples network control from the data plane, enabling programmable, automated network management at scale. The SDN controller stack includes:

- OpenDaylight (ODL) and ONOS as primary SDN controllers for IP/optical network domains
- Segment Routing over IPv6 (SRv6) enabling traffic engineering without the overhead of MPLS signalling protocols
- Intent-Based Networking (IBN) translating high-level business policies into low-level network configurations automatically
- Real-time telemetry using gRPC/gNMI streaming for sub-second network state visibility

#### 3.2 Network Functions Virtualisation (NFV)

Vodafone has virtualised over 90% of its core network functions using NFV Infrastructure (NFVi) deployed across geographically distributed data centres. The NFV stack comprises:

NFV Component	Platform / Technology	Purpose
NFVi	OpenStack Zed / VMware vCloud	Compute, Storage & Network virtualisation
VNF Manager (VNFM)	ONAP VF-C, Cisco NSO	Lifecycle management of Virtual Network Functions
Orchestrator (NFV-O)	ONAP SO / Tacker	End-to-end service orchestration across domains
CNF Runtime	Kubernetes (CNCF certified)	Container-native network functions at scale
Service Mesh	Istio / Envoy Proxy	Secure, observable microservices communication

#### 3.3 Cloud & Multi-Cloud Platform

Vodafone operates a hybrid multi-cloud strategy leveraging both proprietary and hyperscaler infrastructure to optimise workload placement, performance, and cost:

- Vodafone Private Cloud: 28 core data centres globally, running OpenStack and VMware, providing sovereign cloud capabilities for regulated workloads

- **Hyperscaler Partnerships:** Strategic alliances with Microsoft Azure, Google Cloud Platform (GCP), and Amazon Web Services (AWS) for burst capacity, AI/ML workloads, and global reach
- **Cloud-Native Development:** All new services developed using Kubernetes-native patterns, 12-factor application methodology, and GitOps-based CI/CD pipelines
- **Unified Management:** HashiCorp Terraform and Ansible for infrastructure-as-code; Prometheus, Grafana, and Datadog for observability

3.4 Artificial Intelligence & Machine Learning

AI and ML are embedded throughout Vodafone's operational and product architecture, delivered through the Vodafone AI Platform (VAP):

- **Predictive Network Maintenance:** ML models trained on 2+ billion daily network events to predict and prevent outages 48 hours in advance, reducing MTTR by 40%
- **Network Optimisation:** Reinforcement learning algorithms dynamically optimising spectrum allocation, load balancing, and energy consumption across the RAN
- **Customer Experience AI:** Natural Language Processing (NLP) and conversational AI powering TOBi, Vodafone's virtual assistant, handling 50M+ interactions monthly
- **Fraud Detection:** Real-time anomaly detection using graph neural networks across billing, authentication, and usage patterns
- **Data Platform:** Apache Spark, Databricks, and Google BigQuery for petabyte-scale data processing; Delta Lake for unified analytics storage

4. Solution Stack

4.1 Technology Stack Architecture

Vodafone's solution stack is structured as a modular, API-driven architecture enabling rapid composition of services across different customer segments and use cases:

Stack Layer	Technologies	Description
Presentation	React.js, Angular, iOS/Android SDK, REST APIs	Consumer apps, enterprise portals, developer platform
Application	Java (Spring Boot), Python, Node.js, Go	Business logic, service APIs, integration middleware
Platform	Kubernetes, Docker, Kafka, Redis, Elasticsearch	Scalable runtime, messaging, caching, search
Data	PostgreSQL, MongoDB, Cassandra, Hadoop, Spark	Relational, NoSQL, time-series, big data analytics
Network	5G Core, SDN, NFV, MEC, SD-WAN	Physical and virtual network infrastructure

Stack Layer	Technologies	Description
Security	Zero Trust, IAM, SIEM, HSM, TLS 1.3	End-to-end security across all layers

4.2 API Platform & Integration

Vodafone's API platform exposes network and service capabilities to enterprise customers and third-party developers through standardised, GSMA-compliant Open APIs:

- API Gateway: Kong Enterprise and Apigee deployed in active-active configuration handling 2 billion+ API calls per day
- Open APIs: 60+ published APIs covering network quality, device status, SIM management, IoT, messaging, and billing
- CAMARA Compliance: Full alignment with GSMA CAMARA project for harmonised telco APIs, enabling portability across operator networks
- Developer Portal: Self-service onboarding, sandbox testing environment, SDK downloads, and comprehensive documentation
- Event Streaming: Apache Kafka clusters processing 5M+ events/second for real-time integration between network and BSS/OSS systems

4.3 Security Architecture

Security is architected using Zero Trust principles across all network domains, cloud environments, and customer touchpoints:

- Zero Trust Network Access (ZTNA): Identity-centric access control replacing traditional perimeter-based VPN architectures
- SIEM & SOAR: Microsoft Sentinel and Splunk for security event correlation; automated response playbooks reducing MTTR for incidents by 65%
- PKI & HSM: Thales and Entrust HSMs for certificate authority operations; full PKI lifecycle management across 50M+ device certificates
- Threat Intelligence: Real-time threat feeds from CrowdStrike Falcon Intelligence, integration with NCSC and sector-specific ISACs
- Compliance Automation: Continuous compliance monitoring against ISO 27001, SOC 2 Type II, GDPR, and NIS2 Directive requirements

5. Offered Services Portfolio

5.1 Connectivity Services

Vodafone offers a comprehensive portfolio of connectivity services spanning mobile, fixed, and satellite technologies:

5.1.1 Mobile Connectivity

- 5G Business: Dedicated network slices with guaranteed throughput (up to 10 Gbps), ultra-low latency (<5ms), and 99.999% SLA availability
- Private 5G Networks: On-premise or hosted private 5G deployments for manufacturing, logistics, ports, and campuses
- 4G LTE Advanced Pro: Nationwide coverage with carrier aggregation delivering average 150 Mbps download speeds
- Global Roaming: Seamless connectivity in 190+ countries through preferred roaming agreements and GRX interconnect

### 5.1.2 Fixed & Broadband

- Full-Fibre (FTTP): Gigabit-capable full-fibre broadband up to 2.5 Gbps, expanding across 12 million premises
- Ethernet Leased Lines: Dedicated Ethernet circuits from 10 Mbps to 100 Gbps with guaranteed SLA and proactive monitoring
- SD-WAN: Software-defined WAN with centralised management, application-aware routing, and integrated security for multi-site enterprises
- MPLS VPN: Secure Layer 3 MPLS VPN services with traffic engineering and Quality of Service (QoS) classification

## 5.2 Cloud & Hosting Services

Service	Description	Key SLA
Vodafone Cloud Compute	IaaS: Virtual machines, bare-metal, auto-scaling groups on private cloud	99.99% uptime
Managed Kubernetes	Container-as-a-Service with automated upgrades, monitoring, and RBAC	99.95% uptime
Sovereign Cloud	Regulated data hosting with data residency guarantees within national borders	ISO 27001 certified
Multi-Cloud Connect	Direct private connectivity to AWS, Azure, GCP bypassing public internet	<5ms to major cloud regions
Disaster Recovery-as-a-Service	Automated failover with RPO <15 mins and RTO <1 hour	RTO 1hr / RPO 15min

## 5.3 IoT & Edge Services

Vodafone is the world's largest IoT connectivity provider, managing over 175 million IoT connections through the Vodafone IoT Platform:

- Global IoT Connectivity: eSIM/iSIM based connectivity with remote provisioning, multi-network fallback, and centralised SIM management via Vodafone GDSP
- IoT Analytics Platform: Real-time and batch analytics on IoT data streams using Apache Kafka, Flink, and Databricks

- Edge Computing: MEC-hosted application runtimes at 500+ edge sites enabling real-time processing for autonomous vehicles, robotics, and smart cities
- Narrowband IoT (NB-IoT) & LTE-M: Low-power wide-area networks for utility metering, asset tracking, and environmental monitoring at 10-year battery life
- Digital Twin Services: Platform for creating and managing digital replicas of physical assets and environments, integrated with IoT sensor data

## 5.4 Security Services

Vodafone Managed Security Services delivers enterprise-grade cybersecurity leveraging network-level visibility across the Vodafone global backbone:

- Managed Detection & Response (MDR): 24/7 SOC monitoring with threat hunting, incident response, and forensics capabilities
- DDoS Protection: Always-on volumetric DDoS scrubbing with 15 Tbps+ mitigation capacity and automatic traffic re-routing
- Secure Access Service Edge (SASE): Converged networking and security delivered from the cloud, combining SD-WAN, ZTNA, CASB, and SWG
- Endpoint Detection & Response (EDR): CrowdStrike Falcon deployment, management, and 24/7 monitoring for enterprise endpoint fleets
- Vulnerability Management: Continuous scanning, prioritisation, and remediation tracking across IT and OT environments

## 5.5 Unified Communications & Collaboration

- Microsoft Teams Direct Routing: Native PSTN calling within Microsoft Teams leveraging Vodafone's global SIP trunk infrastructure
- Hosted IP PBX: Cloud-based business telephony with advanced features: call recording, IVR, analytics, and CRM integration
- Contact Centre-as-a-Service (CCaaS): AI-powered contact centre platform with omnichannel routing, sentiment analysis, and WFM integration
- Video Conferencing: Enterprise-grade video conferencing with end-to-end encryption, supporting up to 10,000 concurrent participants

## 6. Standards, Compliance & Certifications

Vodafone's infrastructure and services are designed and operated in accordance with leading industry standards and regulatory frameworks:

Standard / Framework	Scope	Status
ISO/IEC 27001:2022	Information Security Management across all Group operations	Certified — Annual Audit

Standard / Framework	Scope	Status
SOC 2 Type II	Cloud and managed services availability, security, and confidentiality	Certified — Bi-annual
3GPP Release 17	5G Standalone core and RAN specifications compliance	Fully Compliant
GDPR / UK GDPR	Personal data processing across EU and UK markets	Fully Compliant
NIS2 Directive	Network and Information Systems security for critical infrastructure	Compliant — Dec 2024
PCI DSS v4.0	Payment card data environments for billing and commerce platforms	QSA Certified
GSMA CAMARA	Open API specifications for network capability exposure	Participating Member
TM Forum Open APIs	BSS/OSS interoperability standards	Conformance Level 3

## 7. Technology Roadmap 2026–2028

Vodafone's technology investment roadmap is focused on three strategic pillars: network leadership, platform excellence, and AI-driven automation:

### 7.1 5G Advanced & 6G Research

- 5G Advanced (Release 18/19): Deployment of AI-native RAN features, Reduced Capability (RedCap) devices, sidelink communication, and NTN satellite integration by Q4 2026
- 6G Research Programme: Active participation in 6G-IA, Hexa-X-II, and ITU-R IMT-2030 working groups; targeting 6G commercial readiness by 2030

### 7.2 AI & Automation

- Autonomous Networks: Target Level 4 network autonomy (self-healing, self-optimising) across core domains by 2027, eliminating manual network interventions for 80% of incidents
- Generative AI Integration: Large Language Model (LLM) deployment for code generation, network configuration assistance, and customer service automation

### 7.3 Quantum-Safe Security

- Post-Quantum Cryptography (PQC): Migration to NIST-standardised PQC algorithms (CRYSTALS-Kyber, CRYSTALS-Dilithium) across all network interfaces and certificate authorities by 2027



- Quantum Key Distribution (QKD): Pilot deployments on metropolitan fibre rings for government and financial sector customers

## 8. Document Control

Version	Date	Author	Changes
1.0	March 2024	Group Technology Office	Initial release
2.0	September 2024	Group Technology Office	5G SA architecture update; Cloud section expanded
3.0	January 2026	Group Technology Office	AI Platform, SASE, and IoT Edge additions
3.2	February 2026	Group Technology Office	Technology Roadmap and PQC section added

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