

Confidential Document

Alshamel Plus Phase 2 Special Technology Solutions





Chief Executive Officer's Message

Omer Abdullah Alnomany

Our ambition remains steadfast: to solidify our position as the Kingdom's foremost **innovator** and provider of **ICT** and **digital solutions**, delivering comprehensive **end-to-end services** that drive value for our clients and partners.

As we move forward, we will expand our reach across a growing range of **industries** and **sectors** within the Kingdom.

Our commitment to enabling **businesses** and **enterprises** to digitize their operations, optimize efficiencies, and seamlessly integrate their processes is at the heart of our strategy. In doing so, we not only support their growth but also contribute to the Kingdom's **Vision 2030**, which seeks to transform Saudi Arabia into a global **digital hub** and a beacon of **technological innovation**.

Furthermore, we will continue to invest in advanced technologies such as **AI**, **cybersecurity**, and **cloud services**, ensuring that we remain at the forefront of **digital transformation**.

Our role in fostering innovation goes beyond providing solutions; we are shaping the future of the Kingdom's digital economy, empowering industries with the tools they need to thrive in an ever-evolving global market.

At the core of our journey lies a commitment to **excellence** and **sustainability**.

We will foster long-lasting **partnerships**, develop local **talent**, and ensure that our solutions are both innovative and sustainable, aligning with the Kingdom's broader goals of **economic diversification** and **digital leadership**.

Together, we will navigate the challenges and seize the opportunities that lie ahead, driving progress and positioning the Kingdom as a leader in the global digital landscape.

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We look forward to discussing any matters relating to our proposed scope of work or any other information with you, which you may need to support your requirements.



Growth? Here we go





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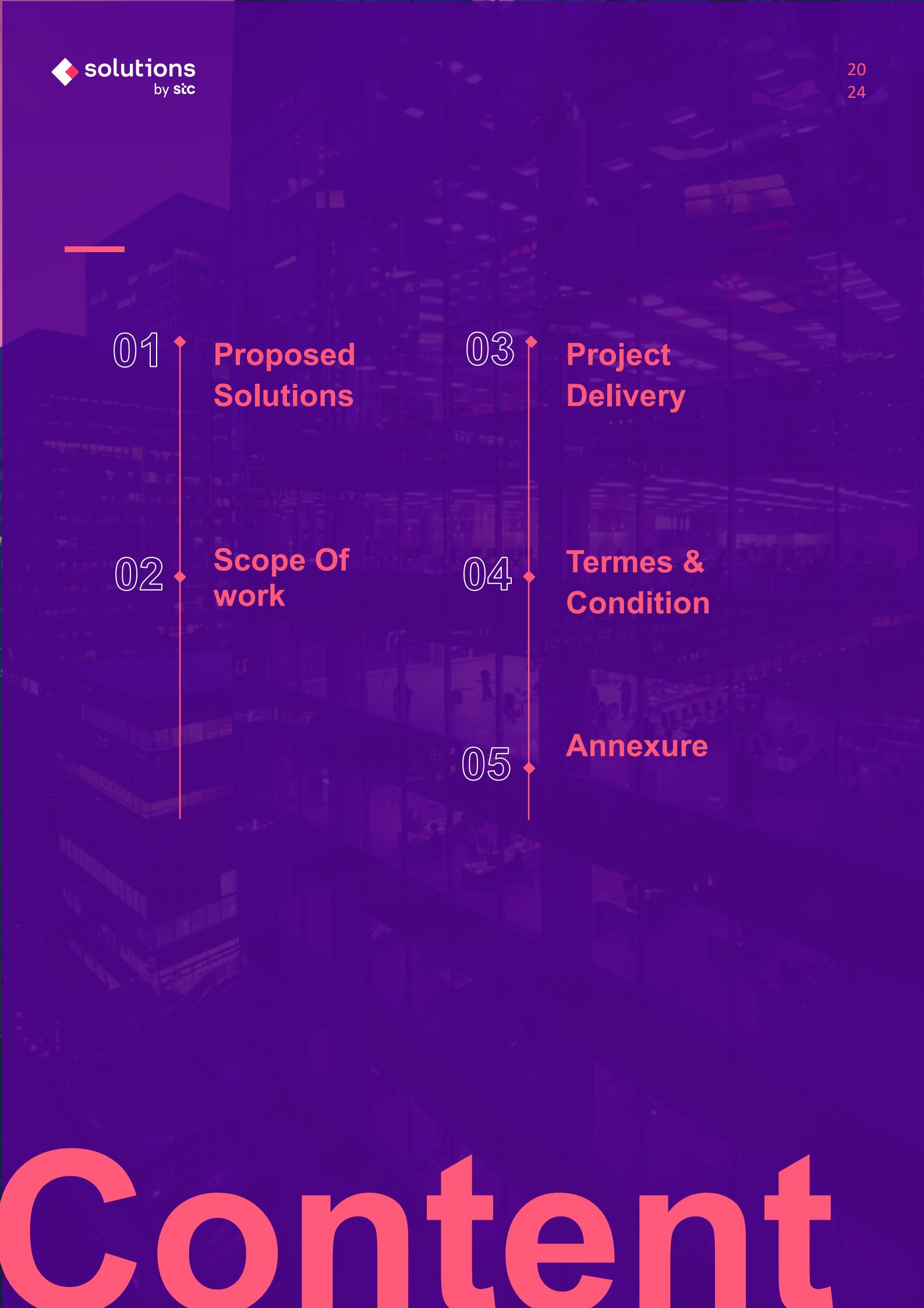
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Document Control

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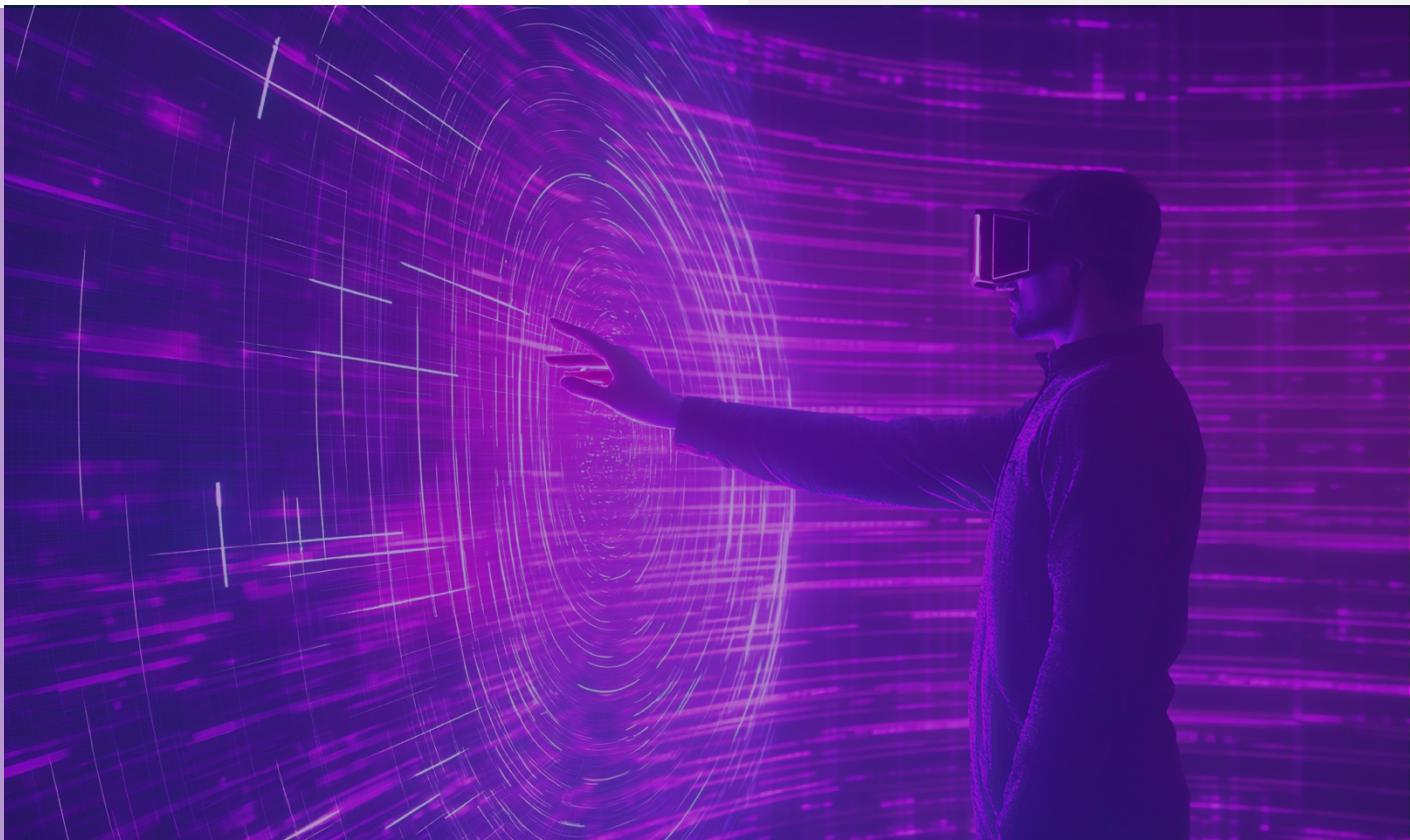
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First Edition	2025/11/23	Mohamed Wagih	Ver 1.0





Purpose of this Document

This is a technical proposal submitted by **Solutions By STC** in response to the request for proposals received from **stc**.

The purpose of this document is to explain the solution, and its components proposed to address the customer's business requirements based on **Solutions By STC** understanding of the customer's requirement.

The document provides a detailed description of the customer's requirements, the scope of work, the proposed solution and its components, and the solution benefits.

Pricing is not part of this document and will be included in the commercial proposal.





Abbreviations

Table 2 Abbreviations

Abbreviation	Full Form
[Redacted]	[Redacted]



◆ 1 Executive Summary

Solutions By STC would like to thank **STC** for giving us the opportunity to participate in Alshamel Plus. This proposal aims to present our response to the request for proposal. The key objective of this proposal is to introduce various technical capabilities and approaches that **Solutions By STC** provides.

STC requires the integration of multiple internal systems through APIs, SNMP interfaces, and RADIUS message collection in order to enable unified query and reporting capabilities. The solution will consolidate data from these diverse sources and present the results through a centralized portal accessible to the STC team, featuring multiple screens and functionalities tailored to different operational needs.

1.1 Vision and Strategic Alignment

Solutions by STC, as the technology arm of stc group and Saudi Arabia's leading digital enabler, is proud to present this comprehensive technical proposal for the AlShamel Plus Phase 2 – Open Source Big Data and AI Platform.

Our proposed solution enables stc to consolidate, process, and analyze massive volumes of network, operational, and customer data generated from multiple domains (e.g., CGNAT, AAA, OSS/BSS) through a high-performance, fully open-source analytics ecosystem. This initiative directly supports stc's Data-Driven Transformation Program and Vision 2030 digital objectives by:

Achieving holistic network visibility and unified data correlation.

Enabling AI-driven insights for customer experience, network optimization, and capacity planning.

Delivering enterprise-grade scalability and resilience at a significantly reduced Total Cost of Ownership (TCO).

Our platform—designed, built, and supported locally—combines state-of-the-art open-source technologies with Solutions by STC's integration expertise to offer stc a vendor-independent, flexible, and secure analytics foundation.

1.1 Business Value and Key Outcomes

Objective	Expected Outcome
Unified Data Pipeline	Consolidation of CGNAT, AAA, and network/OSS data into a single, scalable platform.
AI/ML Enablement	Built-in MLOps capability to develop, train, and deploy AI models for QoE and security use cases.
High Performance Analytics	Sub-second query response for billions of records using ClickHouse and OpenSearch.
Cost Efficiency	70 % CAPEX reduction vs. legacy closed-source solutions and zero license fees.
Operational Autonomy	Full ownership of data, source code, and stack configuration; no vendor lock-in.





Local Innovation & Capability Building

Skill transfer, training, and co-development to empower stc's Data Engineering teams.

1.2 Why Solutions by STC

- Deep Domain Knowledge:** We design and operate large-scale telecom data platforms for stc Group (e.g., NPS, Network Analytics, AI CoE).
- Open-Source Expertise:** Our certified engineers master Kafka, Flink, ClickHouse, Kubernetes, and Kubeflow stacks in production.
- Local Presence & Support:** End-to-end delivery from Riyadh with 24x7 support commitment.
- Agile Delivery Model:** Fast deployment using devops pipelines and incremental scope.
- Security and Compliance:** Fully aligned with NCA, CITC, and stc data sovereignty requirements.

1.3 Core Highlights of the Proposed Solution

Feature	Description
Fully Open-Source Stack	Kafka + Flink + ClickHouse + MinIO + OpenSearch + Keycloak + Kubeflow (no license cost).
Ingestion and Integration	Native connectors for Juniper SRX5800 and A10 TH7440 CGNAT devices (IPFIX/syslog) and AAA RADIUS servers.
Streaming Analytics Engine	Flink jobs for real-time session correlation and pattern detection.
AI/ML Capability Layer	Kubeflow pipeline for training and deployment of QoE and anomaly models.
Visualization & BI Layer	Unified React/Grafana interface for dashboards and ad-hoc analysis.
Scalability & Resilience	Cloud-native on Kubernetes with high availability and auto-scaling.
Cost Optimized Architecture	30-day hot tier (ClickHouse/OpenSearch) + 1-year cold tier (MinIO S3).

1.4 Expected Impact

- Faster Decision Making:** Low-latency data flows enable real-time alerts and dashboards.
- Enhanced Customer Experience:** AI uses CGNAT & AAA data to detect and predict QoE issues proactively.
- Improved Traceability & Security:** Unified session records support compliance and incident response.
- Future Readiness:** The modular architecture is ready for data lake expansion and 5G/core analytics.



Solutions at a Glance

About

We are the leading ICT services provider and digital transformation enabler at the forefront of digitalization in the Kingdom and the region, supporting Vision 2030's aspirations.

In a rapidly evolving digital environment, our services play a pivotal role in empowering both the public and private sectors to embrace and thrive in the new digital era.

Showcasing our commitment as a trusted partner, we deliver value through technology to our clients by addressing their business challenges in a holistic and comprehensive "one stop shop" approach across the entire IT value chain.

solutions by stc has a wide and diversified portfolio of offerings covering the end-to-end ICT value chain encompassing core ICT services, IT managed and operational services, and digital services.

The Company's unparalleled capabilities that span the entire ICT value chain are perfectly positioned to be the partner of choice for the B2B sector.

As a frontrunner in the ICT industry within the Kingdom, solutions by stc has embarked on an ambitious growth strategy intended to reinforce its position as the leading CT services provider in the Kingdom and to diversify the portfolio of offerings.

The Company's growth strategy focuses on strengthening core

capabilities in competitive growth areas, enriching next-gen offerings, expanding geographic reach, and accelerating efforts to improve efficiencies across the board with a dedicated focus on innovation and sustainability.

As a major player in the ICT ecosystem and value chain, solutions by stc's successes contribute to the Kingdom's development and the success of our stakeholders.

Following a successful IPO in 2021, solutions by stc stock achieved a phenomenal performance even during a market downturn, doubling the value of its initial IPO price by the end of 2022.

As a result, solutions by stc achieved a market capitalization of more than SAR 41 billion (more than USD 11 billion) by the end of 2023.

Following a strategy for stable growth with strong profitability, the Company is well poised to continue creating value for its investors, partners, and other stakeholders.



Vision

To create a digital ecosystem enabling our customers to achieve sustainable growth, regionally and globally.



Mission

To provide technology solutions to businesses addressing their needs and challenges to succeed in evolving market conditions.



Values

Dynamism

We're driven to inform and spark imagination. Our point of view is not literal. It brings a new vision and inspires others to see the world in a more ingenious way. We arouse enthusiasm around the promise of better things to come.

Devotion

Our style is human, not because it focuses on people, but because it is warm, simple, and clean and it eliminates superfluous details to achieve quality and clarity.

Drive

Focused on what's important, displaying the reason why, how, or where things happen. We convey the idea of movement, with agility and progression.

What We Do

What We Do

Core ICT services

System Integration (SI) services cover a variety of organizational needs across the value chain, enabled by our strong local and global partnership ecosystem.

These services include advisory, design, implementation and integration of networks, infrastructure, and applications, which are offered through custom engagement models to our customers.

Solutions by stc's communication and internet services address high-end connectivity needs of organizations within cities and remote locations by providing dedicated, secure, and high-quality business internet and satellite services through the wholesale purchase of communication capacity from telecommunication providers.

IT managed and operational services

Managed services include end-to-end management of business networks and systems with the capability to deliver customized managed services projects to serve the individual needs of customers, which help them grow and improve their businesses.

We create value by increasing efficiency, providing better services, improving operations, and monitoring and resolving problems by managing the components of our customers' technical infrastructure such as networks, servers, storage, devices, and applications.

Digital is in our DNA

25+

Years of Experience in IT

170+

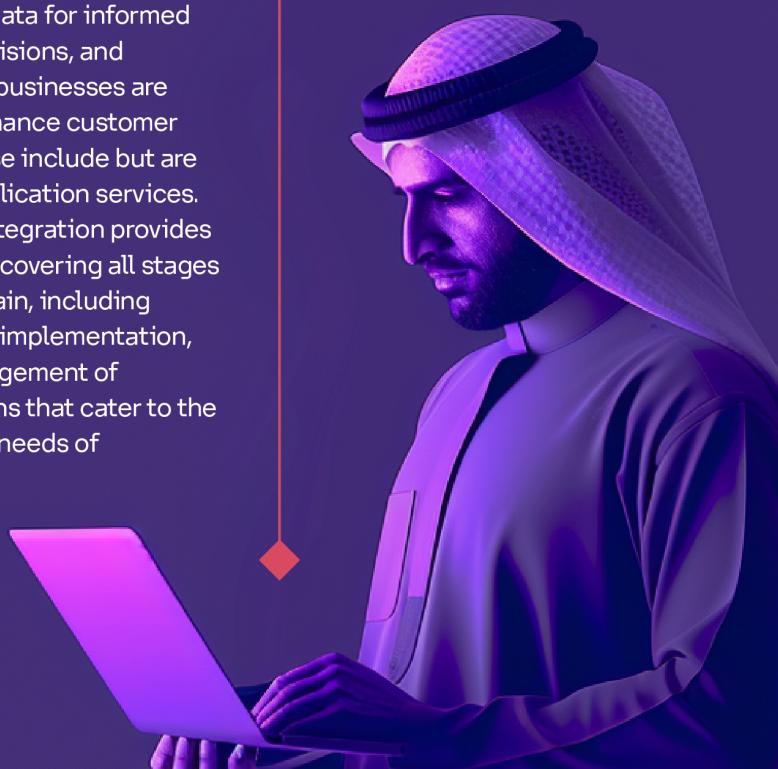
Partners in Our Ecosystem

1,770+

Qualified Employees

35

Cities Bearing Our Resource-Mobilization Capability



◆ 2 Our Understanding of The Requirement

2.1 Our Interpretation of the RFP

Based on the RFP documentation for **AIShamel Plus Phase 2**, we understand that stc expects a solution that:

1. **Processes high-volume CGNAT and AAA data** in near-real-time for subscriber traceability and network insights.
2. **Provides an enterprise-grade Big Data & AI platform** built on open technologies and self-managed by stc.
3. **Supports AI/ML use cases** spanning network performance, QoE optimization, and fraud detection.
4. **Delivers a modular, scalable, and resilient architecture** that can grow to multi-PB data volumes.
5. **Complies with Saudi data sovereignty, security and NCA controls.**
6. **Integrates with existing AIShamel Phase 1 and stc Analytics ecosystems.**

2.2 Our Understanding of the Root Business Needs

Aspect	Current Challenge	Objective from RFP	Our Response
Data Fragmentation	Multiple data sources (CG NAT, AAA, OSS, BSS) stored separately	Integrate into a unified platform for cross-domain analysis	Central Kafka + Flink pipeline, federated storage layer (ClickHouse, OpenSearch)
High License Cost	Existing proprietary solutions are expensive to scale	Adopt open-source stack to reduce TCO	100 % open-source, zero license model
Limited AI Enablement	Manual data preparation hinders model development	Enable MLOps to exploit data for AI use cases	Kubeflow + MLFlow integration
Operational Constraints	Complex vendors & long change cycles	Simplify management and automation	Kubernetes native CI/CD pipeline
Data Governance	No central metadata or data quality controls	Implement DQ and catalog	Atlas + Great Expectations framework

2.3 Why Our Solution Best Fits stc Requirements

1. **Open and Standardized:** Every component is an industry-recognized open standard (Apache Kafka, Flink, ClickHouse, OpenSearch).
2. **Telecom-grade Scalability:** Benchmarked for > 100 TB/day data ingestion with linear scaling.
3. **Plug-and-Play Integration:** Native connectors for Juniper SRX & A10 TH7440 ensure smooth CGNAT ingestion.



- 
4. **AI/ML Native:** Data directly feeds Kubeflow pipelines for real-time prediction and model training.
 5. **Cost Optimized:** ~ 70 % CAPEX reduction vs licensed alternatives (TCO ≤ SAR 2.5 M initial).
 6. **Secure by Design:** Role-based access (Keycloak), vaulted secrets (HVault), and policy enforcement (OPA).
 7. **Locally Delivered & Managed:** All resources from Solutions by STC—aligning with National Digital Strategy.

2.4 Strategic KPIs Enabled by This Project

KPI Category	Target Improvement
Data Ingestion Latency	< 1 minute (E2E from CGNAT/AAA to dashboard)
System Availability	99.95 % HA design
Cost Savings	> 70 % vs legacy platform
Data Quality Score	≥ 99 % validation pass rate
Model Deployment Cycle	From weeks → hours via MLOps
Skill Transfer	100 % of operational teams trained by project close

2.5 Summary of STC's Expected Outcomes

- A production-ready open-source Big Data & AI platform fully owned by stc.
- Real-time data collection from Juniper SRX5800 and A10 TH7440 CGNAT devices and AAA servers.
- Unified analytics and AI capabilities with high throughput and low latency.
- Enhanced data governance framework and security.
- Sustainable local capabilities and operational autonomy for stc's Engineering teams.



◆ 3 Proposed Solution

3.1 Solution Overview

The proposed **Open-Source Big Data & AI Platform** will act as a **centralized data lakehouse** for stc's network, CGNAT, AAA, and service data domains. It provides **real-time streaming ingestion, scalable processing, AI/ML enablement, and powerful analytics** for subscriber traceability, QoE improvement, anomaly detection, and network optimization.

The design principles guiding our architecture are:

1. **Openness:** 100 % open-source stack—no license or vendor limitations.
2. **Scalability:** Linear horizontal scaling; capable of petabyte-level expansion.
3. **Resilience:** HA design across compute, storage, and network planes.
4. **Security:** “Zero-trust” model with RBAC, encryption, auditing, and segmentation.
5. **Integration:** Built-in connectors to Juniper SRX5800, A10 TH7440 CGNATs, AAA servers, and existing AlShamel Phase 1 ecosystem.
6. **Observability:** Unified monitoring (Elastic Stack + Prometheus + Grafana).

3.2 End to End Logical Architecture

Below is a structured description of the logical data flow.

3.2.1 A. Data Source Layer

Source System	Type	Examples	Data Frequency	Protocol
Juniper SRX5800 CGNAT	Network logs/flows	NAT translation records	Continuous	IPFIX + Syslog
A10 TH7440 CGNAT	Session records	NAT sessions, usage stats	Continuous	IPFIX + Syslog
AAA Servers (RADIUS)	Subscriber session data	Session start/stop/logon	Event-based	Syslog / Filebeat
OSS/BSS	Service data	Subscriber profiles & plans	Batch (1-2 h)	API/CSV/SFTP
AlShamel Phase 1 Data Lake	Analytics data	Historical network analytics	Periodic	MinIO API / ETL

3.2.2 B. Ingestion & Streaming Layer

- **Apache Kafka** acts as the **enterprise streaming bus**, ingesting events from CGNAT, AAA, and OSS sources.
- **nProbe Collectors** convert IPFIX/syslog to JSON and push to Kafka.
- **Fluent Bit** collects AAA and RADIUS logs and streams to Kafka.
- **Schema Registry** ensures all Kafka topics comply with defined JSON/Avro schemas.



- **Kafka Connect** supports batch loads from AlShamel Phase 1 and future integrations.

3.2.3 C. Processing & Transformation Layer

- **Apache Flink** processes raw events in real time:
 - Correlates CGNAT and AAA records using sliding windows.
 - Enriches flows with subscriber IDs, service plans, and geolocation.
 - Executes rule-based aggregations and anomaly detections.
- **Apache Spark (batch)** handles historical transformations and model training datasets.
- **Great Expectations** framework conducts data validation and quality checks.

3.2.4 D. Storage and Data Lakehouse Layer

Tier	Technology	Purpose	Retention	Access
Hot (Real-Time)	ClickHouse + OpenSearch	High-speed query and dashboarding	30 days	BI, Reporting
Warm (Analytical)	MinIO S3 object storage + Parquet	Archive for training and historical analysis	1 year (default)	AI/ML, Data Science
Cold (Archive)	MinIO tiered to Tape or Glacier bucket	Long-term audit/compliance data	5 years	On Demand

Metadata is centrally managed in **Apache Atlas**, and data access policies are governed by **OPA (Open Policy Agent)**.

3.2.5 E. AI/ML Enablement Layer

- **Kubeflow Pipelines** host data pre-processing, training, and deployment stages.
- **MLFlow** tracks experiments and model versions.
- Models for QoE prediction, anomaly detection, and subscriber behavior scoring run continuously against live streams.
- Deployed models return inference events to Kafka → ClickHouse for real-time visualization.

3.2.6 F. Visualization and Insight Layer

- **Grafana / OpenSearch Dashboards** serve as the main user interface for Operations & Management teams.
- **ReactJS Web Portal** provides role-based access for different stc departments.



- Unified dashboards cover:
 - Subscriber traceability (search by IP/MobileID/session)
 - Network utilization and QoE KPI views
 - System health and process monitoring

3.2.7 G. Security and Governance

Function	Technology	Description
Identity & Access Mgmt	Keycloak	SSO & Role-Based Access Control
Secret Mgmt	HashiCorp Vault	API tokens, passwords, certificates
Authorization Policies	Open Policy Agent (OPA)	Central policy as code
Audit and Lineage	Apache Atlas + ELK	Data catalog and audit trails
Observability	Prometheus + Grafana	Metrics and alerting

3.2.8 H. Infrastructure Layer

Layer	Components	Description
Compute Cluster	Kubernetes on bare-metal or VMs	Hosts Kafka, Flink, ClickHouse, AI workloads
Storage Cluster	NVMe and S3 object storage (MinIO)	Tiered data storage architecture
Network	10 / 40 GbE interfaces + segregated VLANs	Redundant paths, low latency
Monitoring and Backup	Prometheus + ELK + Velero	Full visibility and disaster recovery

3.3 Integration with Juniper SRX5800 and A10 TH7440

Both CGNAT models export flow and translation records via IPFIX and Syslog. Integration will be implemented as follows:

1. **On each device:** Configure IPFIX and Syslog export to nProbe collectors.
2. **On collector nodes:** nProbe parses and converts records into JSON objects.
3. **Collector → Kafka:** Fluent Bit agents stream parsed events into Kafka topics.
4. **Kafka → Flink processors:** Correlate CGNAT and AAA sessions to produce unified subscriber records.

This approach ensures real-time, lossless data flow without device load impact.

3.4 Scope of Work



Phase	Description	Key Deliverables
1. Initiation & Planning	Project kick-off, requirements validation, environment readiness	Kick-off Plan, Project Charter, HLD
2. Detailed Design & Architecture Finalization	HLD + LLD of each component, integration and security design	Reviewed Design Documents & LLD Sign-off
3. Infrastructure Provisioning & Kubernetes Setup	Setup compute, storage, networking; install K8s cluster and components	Functional Cluster, Access Accounts
4. Platform Deployment	Install Kafka, Flink, ClickHouse, OpenSearch, MinIO, Keycloak etc.	Operational Platform Stack
5. Data Ingestion Integration	Implement collectors for CGNAT and AAA; Kafka connectors; data validation	Validated data streams in Kafka/Flink
6. Processing & Storage Configuration	Develop real-time and batch ETLs, configure tiered storage	Processing scripts & stable warehouse
7. AI/ML Layer Enablement	Deploy Kubeflow/MLFlow, develop initial models (QoE, Anomaly)	Operational AI workbench
8. Visualization & Dashboards	Design dashboards for traceability, QoE, network KPIs	UI and reports validated by stakeholders
9. Testing & Performance Tuning	Perform SIT/UAT, load testing, failover and security validation	UAT Sign-off
10. Handover & Training	Knowledge transfer, documentation, handover package	Training completion & Acceptance
11. Support & Post-Go-Live Assurance	Hyper care period and knowledge handover	Stabilization report

3.5 Deliverables Summary

Category	Deliverables
Documentation	Project Charter, HLD, LLD, Installation Guide, Admin Guide, User Manual
Software/Infrastructure	Configured K8s cluster, Kafka nodes, Flink jobs, ClickHouse, MinIO, OpenSearch
Integration	CGNAT (Juniper/A10) and AAA connectors, Kafka schemas and topics
Dashboards	Operational KPI, QoE, Security, System Health visualizations
Training & KT	Administrator + User training curricula + certification materials
Post Go-Live	Support plan, performance baseline, recommendations for Phase 3



3.6 Architecture Highlights

1. **Decoupled Microservices:** Each component can be scaled independently.
2. **Observability Built-In:** Log aggregation and metrics monitoring are native.
3. **Hybrid Deployment Readiness:** Support both on-prem and private cloud expansions.
4. **Future Extensions:** Data domains – IoT, 5G core, Billing – can be onboarded seamlessly.

3.7 End to End Solution Architecture

3.8 Architectural Principles

The AlShamel Plus Phase 2 platform adopts a **cloud-native, containerized, microservice architecture**, unified around five layers:

1. **Data Ingestion Layer** – Streams network telemetry and logs (Kafka topics).
2. **Processing & Enrichment Layer** – Performs real-time transformations (Flink).
3. **Data Storage Layer** – Stores structured and historical data (ClickHouse + MinIO).
4. **AI & Analytics Layer** – Supports machine learning and operational dashboards (Kubeflow, MLFlow, Grafana, Superset).
5. **Security & Governance Layer** – Ensures SSO, authorization, and lineage (Keycloak, Vault, Atlas, OPA).

These layers sit on a **Kubernetes-based infrastructure** fully compliant with stc's network and data sovereignty policies.

3.9 Integration with Existing stc Ecosystem

Existing stc System	Integration Mechanism	Purpose
AAA Platform	Syslog → Kafka (nProbe Adapter)	Captures authentication events for QoE scoring.
CGNAT (Juniper/A10)	Netflow / IPFIX → Kafka Collectors	Provides NAT session telemetry for traceability.
RADIUS Servers	Filebeat/Fluentd → Kafka Topics	Feeds session statistics.
Phase 1 Data Repository	API Bridge via Flink Connector	Ingests historical data for model training.
NMS/OSS Modules	REST APIs (JSON Events)	Shared network KPIs and fault alerts.
stc Identity Access (AD/SSO)	Keycloak federation + LDAP Bridge	Unified login across all modules.
Monitoring Platforms (Prometheus / Zabbix)	Metrics Pull via Exporter Endpoints	Centralized observability integration.



◆ 3.10 End-to-End System Architecture Diagram

The following section outlines the proposed architecture design of the solution as illustrated in the diagram.

3.11 Architectural Highlights

Aspect	Description
Cloud-Native Deployment	Every component runs as a containerized pod on Kubernetes with Helm-based lifecycle management.
High Availability	Multi-zone Kafka cluster with replicas and ClickHouse replicated tables ensure resilience.
Data Lineage & Audit	Apache Atlastracks data movements from Kafka topic to Flink job to ClickHouse table.
Central Authentication	Keycloak federated with stc AD for SSO across Grafana, MLFlow and Superset.
Secrets Management	HashiCorp Vault stores API keys, certificates, and encryption credentials.
Observability	Metrics via Prometheus , logs via Elastic Stack , traces via OTEL agents.
AI Automation	Kubeflow + MLFlow enable continuous training and deployment of predictive models.

3.12 Benefits of the Architecture

- Composable Design:** Each component can be scaled or replaced without impact on others.
- Open Integration:** APIs and connectors allow attachment to other stc domains (billing, CRM, IoT).
- Governed AI Lifecycle:** Model creation → experiment tracking → deployment → monitoring.
- Telecom-grade Resilience:** Planned for 99.95 % uptime target using cluster replication.



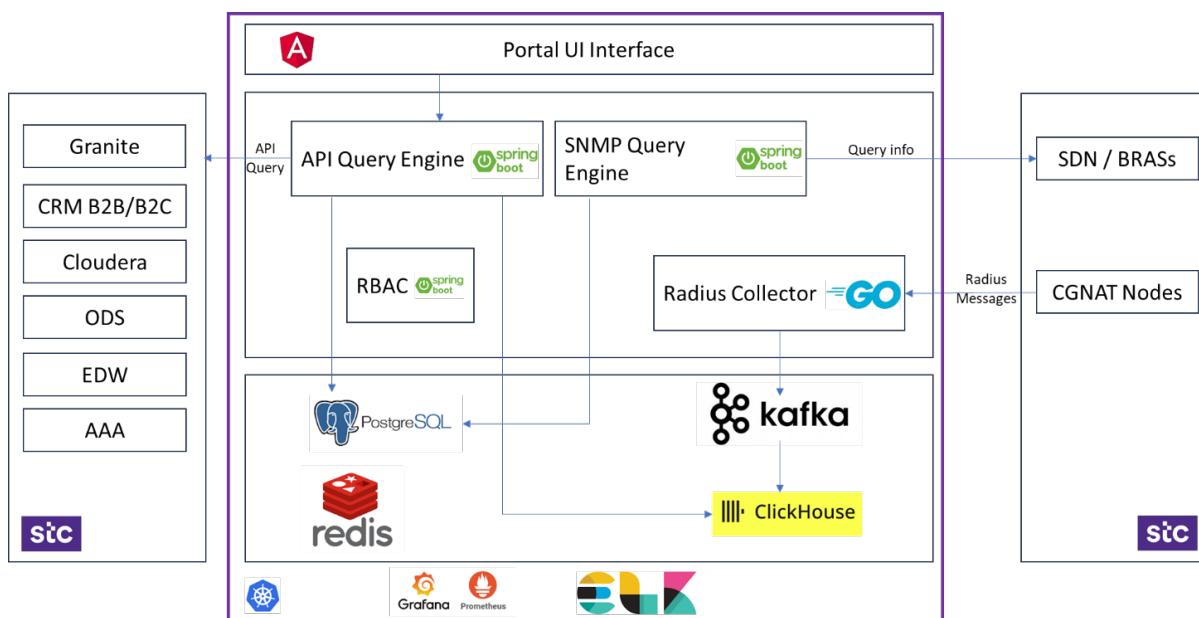
◆ 4 Detailed Solution Description and Use Case Journeys

4.1 Solution Description – Overview

The proposed **Open-Source Big Data and AI Platform** operate as a fully integrated, modular ecosystem. It supports the **ingestion, processing, governance, analytics, and AI inference** of multi-domain data at telecommunications scale.

It is designed to:

- **Ingest** millions of network and subscriber events per second.
- **Process** and **correlate** data in real time.
- **Store** both structured and unstructured data with low latency.
- **Enable** advanced analytics and AI model lifecycle (MLOps).
- **Visualize** actionable insights in self-service dashboards.



4.2 Detailed Component-by-Component Architecture

4.2.1 A. Data Ingestion and Integration Layer

Component	Description	Key Highlights
nProbe Collector Nodes	Receive IPFIX/syslog flows from CGNAT devices (Juniper/A10) and convert to JSON records before streaming to Kafka.	Handles > 250k records/sec per node; supports lossless UDP buffering.
Fluent Bit Agents	Collect AAA and RADIUS logs, file tailing and forwarding into Kafka.	Lightweight C agent with TLS encryption.

Apache Kafka Cluster	Central streaming bus for data topics (CGNAT, AAA, enrichment, ML-inference).	Multi-broker, HA; Schema Registry enforces data consistency.
Kafka Connectors	Interface to batch or external systems (e.g., Phase 1 Lake, OSS/BSS).	Supports pull/push modes through REST.

4.2.2 B. Processing and Analytics Layer

Component	Purpose	Technical Details
Apache Flink	Performs real-time data processing and enrichment.	Streaming jobs merge CGNAT + AAA flows to map subscriber sessions; stateful operators preserve context; latency < 1 sec.
Apache Spark (batch)	ETL & model training data preparation.	PySpark & SparkSQL notebooks for feature generation.
Great Expectations	Data Quality monitoring and validation.	Pre-ingest and post-ingest validation tested nightly.
Kafka Streams / ksqlDB	Lightweight query for real-time insights.	For operational KPIs.

4.2.3 C. Storage and Lakehouse Layer

Storage Type	Technology	Function	Replication
Hot Storage	ClickHouse Cluster	Fast OLAP for interactive queries and dashboards.	3-node replica, data sharding per device ID.
Analytical Storage	MinIO S3 + Parquet files	Historical retention (1 year).	Distributed erasure coding.
Search/Index	OpenSearch	Searchable JSON documents (CGNAT, AAA logs).	5-shard index, replica = 1.

All storage tied together by **Apache Atlas** (metadata) and **OPA-based policies** (security governance).

4.2.4 D. AI and Machine Learning Layer

Component	Description
Kubeflow Pipeline	Automates entire AI/ML lifecycle (from data prep, training to deployment).
MLFlow Registry	Tracks model versions, hyperparameters, and experiment results.
Model Serving (ONNX / TensorFlow Serving)	Deployed models for QoE, anomaly and subscriber behavior detection; output goes back to Kafka.



Example Models: QoE score prediction, Connectivity anomaly classification, Session duration forecasting.

4.2.5 E. Visualization and BI Layer

Interface	Description
Grafana	Operations and Performance dashboards for Real-time KPIs.
OpenSearch Dashboards	Ad-hoc searches and drill-downs for Network Operations Center.
ReactJS Web Portal	Custom front-end for Traceability and Analytics teams; SSO with Keycloak.

4.2.6 F. Security, Governance and Audit

- Keycloak:** Role-based access, LDAP integration, SSO with stc accounts.
- HashiCorp Vault:** Secrets (encryption keys and API tokens management).
- Open Policy Agent:** Enterprise policy engine for governance enforcement.
- Apache Atlas:** Metadata and data lineage for transparency and provenance.
- NCA Compliance:** Adherence to Saudi NCA ECC and CITC data policies.

4.2.7 G. Operations and Monitoring

Tool	Purpose
Prometheus + Grafana	Cluster monitoring (metrics, alerts).
Elastic Stack (ELK)	Central logging and search of infrastructure logs.
Velero + Rsync	Automated backup and restore for Kubernetes objects.

4.3 End-to-End Data Flow Narrative

- Data Generation:** Juniper SRX5800 and A10 TH7440 generate flow records continuously.
- Collection:** nProbe/Fluent Bit collects and structures records as JSON.
- Ingestion:** Kafka receives messages via secure TLS; each source has dedicated topics.
- Processing:** Flink consumes streams, enriches fields, adds session metadata, and correlates AAA logins with CGNATs.
- Storage:** Processed records saved to ClickHouse (hot), OpenSearch (indexed), and MinIO (long-term).
- AI Layer:** Periodically reads new data from MinIO to retrain models; deployed models feed inference results to Kafka.
- Visualization:** Dashboards update in near-real time for Network Ops and CX teams.

Entire flow is resilient against node failures and supports auto re-processing of events.



4.4 Example Use Case Journeys

4.4.1 Use Case 1 – Subscriber Traceability (AAA + CGNAT)

Objective: Allow operations teams to trace any Internet session to a specific subscriber within seconds.

Data Sources: CGNAT flows (Juniper SRX and A10) + AAA login/logout records.

Process Flow:

Step	Process	Technology
1	AAA generates login (start session) record with MSISDN, public IP, timestamp	Fluent Bit → Kafka
2	CGNAT emits translation flow (private to public IP mapping)	nProbe → Kafka
3	Flink process correlates AAA and CGNAT by IP and time window	Flink CEP (job)
4	Unified session table (Subscriber ↔ Public IP ↔ Timestamp ↔ App Proto) written to ClickHouse	ClickHouse
5	User queries and dashboards for traceability through OpenSearch and Grafana	Portal UI

Outcome: Traceability time reduced from hours to seconds; enhanced security and lawful compliance.

4.4.2 Use Case 2 – QoE Prediction and Anomaly Detection (AI/ML)

Objective: Predict Quality of Experience degradation before subscriber impact.

Data Sources: Session records from CGNAT, AAA; network KPIs; external speed-tests.

Process Flow:

1. Flink streams aggregate session throughput and latency metrics (5 min window).
2. Spark ETL creates historical feature set.
3. Kubeflow pipeline trains a regression model ($\text{QoE score} = f(\text{metrics, latency, drops})$).
4. Trained model deployed via TensorFlow Serving.
5. Real-time inference feeds back QoE degradation alerts to Kafka.
6. Grafana dashboard presents QoE heat map per region and time.

Outcome: Predictive QoE monitoring enables ops teams to mitigate issues proactively.



◆ 4.4.3 Use Case 3 – Security Event Correlation

Objective: Detect and investigate potential abuse or malicious session patterns.

1. Kafka receives security logs (firewall, IDS).
2. Flink joins these events with AAA and CGNAT tables to identify subscriber responsible.
3. ClickHouse retains full auditable details.
4. Alerts published to SOC dashboard.

Outcome: Improves incident response efficiency by > 80 %.

4.5 System Scalability and Performance

Parameter	Design Target
Records per second	≈ 1 Million events/sec (cluster)
Retention capacity	> 1 PB total stored data
Query latency (ClickHouse)	≤ 1 sec for 10M records
Storage cost comparison	≈ 30 % of commercial license equivalent
Cluster Availability	99.95 % HA target with K8s auto recovery

4.6 Solution Interoperability and Expansion

- Supports **future data sources** (e.g., 5G core, IoT, Wi-Fi, Billing domains).
- Offers **standard APIs (REST + GraphQL)** for other stc Data Platforms.
- Aligns to stc enterprise data strategy and interoperates with AlShamel Phase 1 artefacts.



◆ 5 Delivery Methodology and Project Plan

5.1 Delivery Approach

The project will follow an **Agile-Hybrid delivery model**—combining structured governance from traditional project management with the flexibility of agile sprints for iterative builds and validations.

Key Attributes:

Principle	Description
Incremental & Iterative Delivery	Deliver working components every sprint, validated by stc technical teams.
Stakeholder Engagement	Continuous feedback cycles with Network, AAA, CGNAT, and Data teams.
Quality Gates	Each phase concludes with a documented review and acceptance.
Automation First	Infrastructure-as-Code and CI/CD for faster, repeatable deployments.

5.2 Project Phases and Milestones

Phase No.	Phase Name	Duration	Key Deliverables / Milestones
1	Initiation & Planning	2 weeks	Kick-off meeting, project charter, roles & RACI finalized.
2	Design & Architecture	4 weeks	HLD and LLD sign-off; security and integration blueprints.
3	Infrastructure Readiness	4 weeks	Environment setup (bare-metal / VM cluster + network connectivity).
4	Platform Build & Deployment	6 weeks	Kafka, Flink, ClickHouse, MinIO, Keycloak installed and configured.
5	Integration & Data Ingestion	5 weeks	Data streams from CGNAT and AAA successfully ingested and validated.
6	Processing & Storage Enablement	4 weeks	ETL pipelines and data tiering functional and tested.
7	AI/ML Enablement and Dashboards	6 weeks	Kubeflow + MLFlow live with initial QoE and Traceability models; Grafana dashboards published.
8	Testing & UAT Execution	3 weeks	System Integration Testing (SIT), Performance Testing, UAT Sign-off.
9	Handover & Training	2 weeks	Training sessions, documentation, KT and acceptance sign-off.



10

**Support &
Post-Go-Live
Assurance**

2 weeks

Hyper-care, stabilization report, Phase closure.

Estimated Total Duration: ≈ 34 weeks (~8 months)

5.3 Agile Delivery Workflow

Sprint Cadence:

- 2-week sprints.
- Bi-weekly demos and review meetings with stc SMEs.
- Continuous integration of new modules (Flink jobs, Kafka topics, dashboards).

Roles & Responsibilities:

Role	Responsibility
Project Manager	Overall governance, timeline tracking, communications.
Technical Architect	End-to-end solution design and security alignment.
DevOps Engineer	CI/CD pipelines, K8s deployment, monitoring setup.
Data Engineer	Ingestion and ETL development (Flink/Spark).
Data Scientist	AI/ML modeling and Kubeflow automation.
QA Engineer	Test planning, execution, documentation.
Training Lead	User and admin training curriculum.

5.4 RACI Matrix

Activity	Solutions by STC	stc (Data Owner)	Remarks
Requirement Validation	R (Responsible)	A (Approve / Provide Inputs)	Kick-off phase
Architecture Design	R	C	Joint review
Environment Provisioning	R	C	Network/Firewall inputs from stc
Data Integration	R	C	Access to Juniper, A10, AAA logs
Platform Deployment	R	I	Weekly status updates
Testing & UAT	R	A	SIT + UAT sign-off
Training Delivery	R	A	Admin and User sessions
Handover and Closure	R	A	Final acceptance certificates

(R – Responsible, A – Accountable, C – Consulted, I – Informed)



5.5 Quality Assurance and Governance

Quality Framework aligned with ISO 9001 & CMMI.

Activity	Quality Control Method
Configuration Management	GitOps + Terraform state tracking
Continuous Integration	Jenkins / GitLab CI automated builds
Automated Testing	PyTest and JMeter for load verification
Code Review	Mandatory 2-level peer review and security linting
Change Management	RFC system aligned with stc CAB process
Security Review	Vulnerability scans (Nexus, Trivy), policy audit by stc SOC

5.6 Risk Management and Mitigation

Risk Category	Potential Risk	Mitigation Strategy
Data Access	Delay in CGNAT or AAA log access approval	Early engagement + secured test data.
Integration Complexity	CGNAT format differences (Juniper vs A10)	Normalization via schematized nProbe jobs.
Performance Degradation	High event volume bursts	Auto-scaling via Kubernetes HPA; partition rebalance.
Security Compliance	Non-alignment with NCA controls	Early security audit and documented controls.
Skill Readiness	New open-source tools for stc team	Comprehensive training and KT program.

5.7 Communication and Reporting Plan

Channel	Frequency	Audience	Description
Weekly Steering Meeting	Weekly	stc & Solutions Program Leads	Progress update & issue tracking.
Daily Stand-Up	Daily (on sprint days)	Technical team + stc PO	Short status review.
Sprint Review	Bi-weekly	All stakeholders	Demo of delivered features.
Monthly Dashboard	Monthly	Management	KPIs, Risk log, Milestone status.

5.8 Training and Knowledge Transfer

Training is a cornerstone of post-implementation adoption.

Audience	Mode	Duration	Modules





System Administrators	Classroom + Hands-on	5 days	Installation, Configuration, HA Setup, Monitoring
Data Engineers	Workshop	4 days	Kafka, Flink, Spark, ETL Developments
Data Scientists	Lab Session + Notebook Exercises	5 days	Kubeflow, MLFlow, Model Deployment
Operations Users	Portal Walkthrough	3 days	Dashboards, Traceability, QoE Analysis
Security & Audit	Seminar	2 days	Atlas, OPA, Vault Auditing

Deliverables → Training Materials, Recorded Sessions, and User Guides.

5.9 DevOps and Automation Strategy

- **Infrastructure-as-Code:** Terraform + Ansible for deployment repeatability.
- **CI/CD:** Jenkins + Helm charts for application rollouts.
- **Observability:** Prometheus Rule alerts integrated with stc email/SMS gateway.
- **Version Control:** Private GitLab repository with branching strategy (Dev/UAT/Prod).
- **Backup & Disaster Recovery:** Velero (ETCD + PVC snapshots, daily backup plan).

5.10 Acceptance and Handover Criteria

Area	Success Criteria
Performance Benchmark	≥ 1 million EPS sustained throughput.
Data Accuracy	≥ 99.9 % parity between source and Lake records.
Availability	99.95 % HA achieved.
Security Compliance	NCA ECC and CITC policies validated.
User Acceptance Testing	All UAT cases signed off by stc stakeholders.
Documentation and Training	All manuals and sessions delivered.



◆ 6 Governance, Support Model & Commercial Overview

6.1 Governance Structure

The governance model ensures transparency, accountability, and alignment with stc's **strategic objectives**.

6.1.1 Governance Tiers

Level	Purpose	Composition
Steering Committee	Project oversight, strategic direction and risk resolution.	stc Program Director (Chair), Solutions PM, Data Platform Head, Cybersecurity Lead.
Project Management Office (PMO)	Progress monitoring, timeline adherence, resource management.	stc PMO + Solutions PM & Coordinator.
Technical Working Group (TWG)	Hands-on sessions for architecture, design and troubleshooting.	stc Data Engineers, Solutions Architects, Vendor SMEs.

Meeting Cadence:

- Steering Committee – Monthly
- PMO Review – Bi-Weekly
- TWG Workshops – Weekly

Governance Tools:

- STC Jira and Confluence (Project tracking and documentation).
- Risk Register and Issue Logs maintained in Excel / ServiceNow.

6.2 Change & Release Management

To protect stability and compliance, a **controlled Change Management process** aligns with stc's CAB (Central Approval Board).

6.2.1 Steps

1. **Change Initiation:** Raised via RFC form (Jira).
2. **Impact Assessment:** Technical review by Solutions + stc security teams.
3. **Approval Cycle:** CAB review and scheduled deployment window.
4. **Rollback Plan:** Pre-validated Helm/Terraform rollback scripts.





5. Post-Change Validation: Monitoring and acceptance sign-off.

Release Frequency:

- Minor releases (sprint deliverables) → bi-weekly.
- Major platform releases → quarterly.

6.3 Support and Maintenance Model

The proposed support model provides **24 × 7 operational coverage**, aligned to ITIL v4 principles.

Support Phase	Scope	Responsibility
Hyper-care (0–2 Weeks Post-Go-Live)	Immediate incident response and platform stabilization.	Solutions by stc
Transition Support (Week 3–12)	Joint monitoring with stc NOC and Data Ops teams; knowledge transfer.	Solutions + stc
Steady-State O&M (Post 3 Months)	Preventive maintenance, monitoring, patching, and minor upgrades.	stc Ops Team (with Solutions back-to-back support).

6.3.1 Support Scope

Category	Deliverables
Platform Monitoring	Prometheus / Grafana alert rules, availability, latency metrics.
Incident Management	Issue logging, root cause analysis, and reporting.
Performance Tuning	Quarterly capacity reviews and cluster optimization.
Security Patching	Monthly updates for OS, Kubernetes, and open source components.
Backup & DR Testing	Bi-annual disaster recovery simulations.
Knowledge Base Updates	Runbooks, SOPs, and FAQ repositories updated periodically.

6.4 Service Level Agreement (SLA)

SLA Parameter	Target	Measurement
System Availability	99.95 %	Prometheus metrics / Uptime monitoring
Incident Response Time	P1 – ≤ 30 min P2 – ≤ 2 hrs P3 – ≤ 4 hrs	NOC ticket timestamps
Incident Resolution Time	P1 – ≤ 4 hrs P2 – ≤ 8 hrs	Post-mortem reports



	P3 – ≤ 24 hrs	
Backup / Restore RPO/RTO	RPO ≤ 15 min / RTO ≤ 2 hrs	DR tests
Change Deployment Success Rate	≥ 98 %	Change logs
Customer Satisfaction (CSAT)	≥ 90 %	Survey after support tickets

6.5 Operational Escalation Matrix

Severity	L1 → Operations	L2 → Engineering	L3 → Solution Architect / Vendor Expert
P1 – Critical	Immediate action, NOC bridge shared with stc SOC	Root cause analysis and rollback if needed	Architecture review / Hot-fix deployment
P2 – Major	Issue triage and temporary workaround	Permanent fix design and deployment	Periodic performance review
P3 – Minor	Logged and resolved in next maintenance window	Validation and QA	Documentation update

6.6 Compliance and Security Governance

Compliance Area	Approach
NCA ECC Regulations	Platform security architecture aligned to NCA controls 12.1 – 16.0.
CITC Data Privacy	No PII export outside stc domain; data masked for non-production.
Audit Readiness	Atlas lineage + Vault audit logs maintained; yearly security review.
Identity Management	SSO via Keycloak, role-based policies enforced by Open Policy Agent.

6.7 Value Proposition Summary

- Operational Efficiency:** Consolidated open-source data ecosystem reduces processing latency and license costs.
- Control and Compliance:** All data within stc sovereign network; NCA-aligned security governance.
- Scalability:** Easily extends to new domains (5G, IoT, Billing).
- AI-Driven Insights:** Built-in pipeline for proactive QoE and anomaly detection.
- Skill Enablement:** Empowers stc teams through training and toolchain ownership.





6.8 Next Steps & Engagement Plan

1. **Proposal Review and Sign-Off** by stc Steering Committee.
2. **Joint Project Charter Finalization.**
3. **Kick-off Meeting and Resource Mobilization.**
4. **Environment Access and Security Clearances.**
5. **Execution Phase as per Part 4 timeline.**



7 Project Delivery

7.1 Project Plan

The implementation plan is broken into four high-level stages, mapped to the end-to-end lifecycle — **Design → Build → Test → Deploy / Handover**.

Project Timeline (Indicative Gantt View)

Phase	Weeks	Timeline
Design & Planning	1–6	
Build & Integration	7–18	
Test & Optimize	19–26	
Deploy & Handover	27–34	

7.2 Key Milestones / Deliverables

Milestone	Description	Timeline	Deliverables
M1	Project Kick-off and Charter Sign-off	Week 2	Project Charter, Resource Plan, RACI
M2	Architecture Design Completion	Week 6	HLD / LLD Documents, Security Blueprint
M3	Environment Provisioning Complete	Week 10	K8s Cluster, Kafka, Flink Setup
M4	Data Ingestion Validated	Week 15	ETL Pipelines, Sample Dataflow
M5	AI Model Pipeline Configured	Week 22	Kubeflow / MLFlow Integration
M6	UAT Sign-off	Week 30	UAT Report & Acceptance Note
M7	Project Closure and Handover	Week 34	Training Completion, Final Sign-off

7.2.1 Project Governance

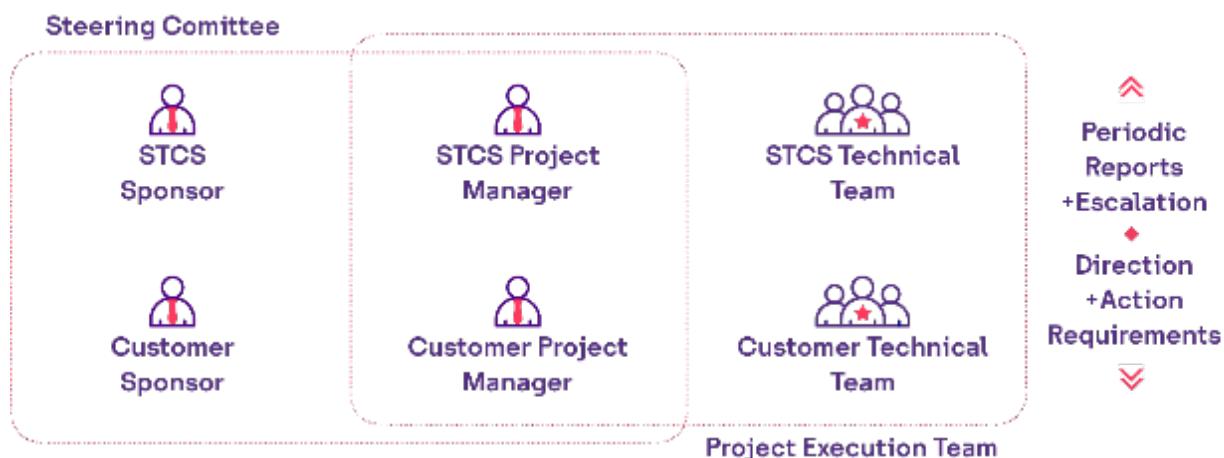


Figure 1. Project Governance Framework

Solutions by stc Methodology provides a governance framework that is logical and robust to oversee and direct project execution. Solutions Delivery Team will engage with the customer and develop the governance structure to provide timely decisions that are beneficial to the project. Governance requirements will be collected from stakeholders and a proper governance structure and escalation procedure will be proposed depending on the individual project. A sample governance structure is shown in Illustration 3, where Steering Committee comprises of sponsors from both Solutions and the customer, as well as Project Managers from both sides. The actual Project Execution Team is made up of the Project Managers from both sides as well as the technical team members from both sides. Governance is a two-way mechanism: while direction and action are provided from the top-down structure, reports flow upward from the project execution team. The frequency of updates may vary depending on specific projects, and this will be decided at the commencement of the project. STC Delivery Team uses various project management knowledge areas to ensure that project governance is carried out smoothly. Solutions PM Methodology knowledge areas are summarized in Illustration 4, and each of the knowledge areas is detailed on the following pages.

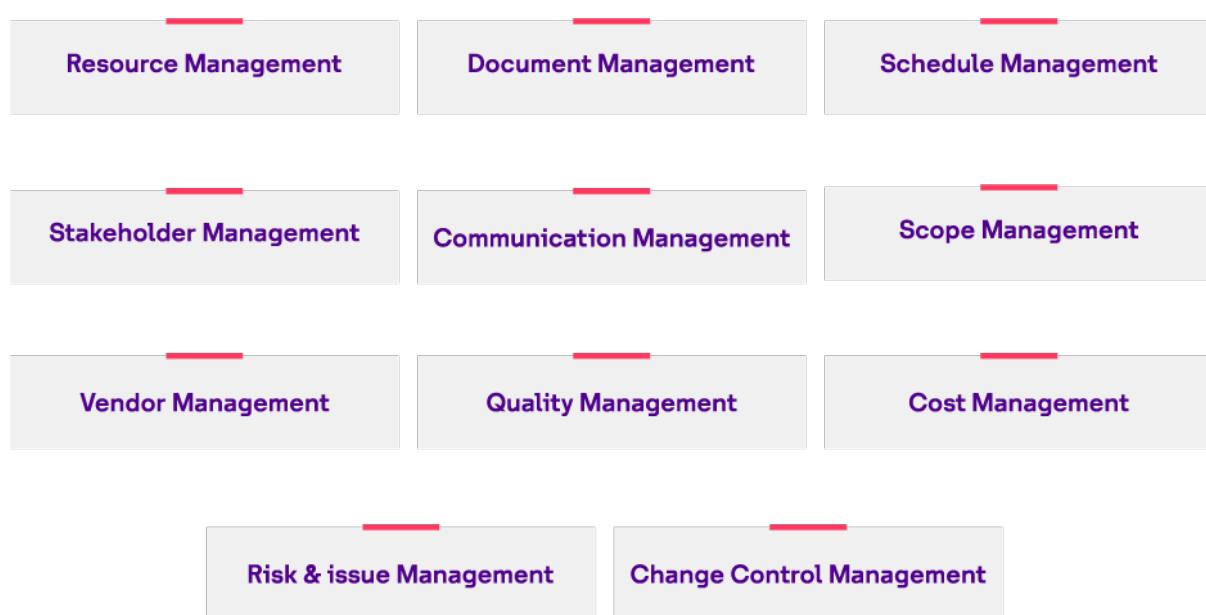


Figure 2. Project Management Knowledge Areas

7.2.2 Scope Management

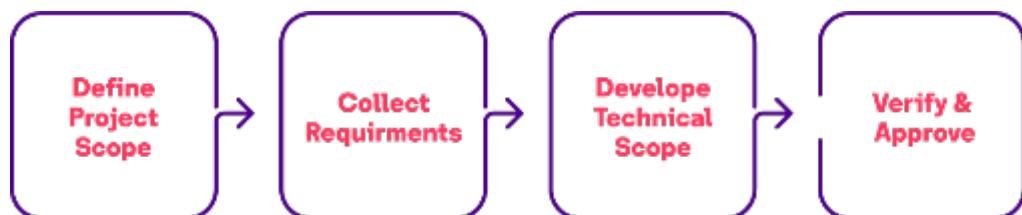


Figure 3. Scope Management Framework

Three key constraints exist in project management when seeking to deliver high quality solutions. These are called the Triple Constraints:

- Projects must be delivered within cost.
- Projects must be delivered on time.
- Projects must meet the agreed scope.

Solutions by stc provides effective scope management to help deliver value to the customer by ensuring that their business objectives are achieved. The scope management processes are designed to **collect, plan and monitor** all scope elements. Solutions by stc delivery Team will analyse the project scope of work to **define** the overall scope of the project and its **core**

objectives. The team will then **collect** detailed requirements through various **mechanisms** like meetings with client, workshops, in-depth interviews, and surveys. All requirements are **documented**, ensuring **clear understanding** of requirements' priority, complexity, etc. The technical leads will develop technical scope based on the project deliverables. The final scope will be reviewed and finalize by the project Manager and agreed between all relevant stakeholders, and through this continuous involvement of the various stakeholders.

In case any changes are required to be made to the scope, a change request needs to be submitted to ensure governance of the defined change through change control management, and once approved, these changes to the scope are suitably reflected so that project execution can be aligned with the revised Scope.

7.2.3 Schedule Management



Figure 4. Schedule Management

Solutions by stc Methodology for schedule management ensures timely achievement of the business value and objectives of the project. The project Manager uses the project scope as the basis for defining all the activities required to be undertaken as part of the project. PMs will meet with team to develop WBS, estimate duration and sequence activities as part of Project Schedule development.

Once the activities are identified, the duration of carrying out each activity is estimated, including any internal/external dependencies that may impact the various activities. Depending on the complexity of the scope and dependencies, PMs may utilize optimization techniques and critical path analysis to ensure a balanced flow of activities throughout the project, and skilfully navigate any potential bottlenecks that may lead to delays.

Once the schedule is verified and approved by customer, project baseline will be set by Project management office.

In case any changes are required to be made to the schedule, a change request needs to be submitted to ensure governance of the defined change through change control management, and once approved, these changes to the schedule are suitably reflected so that project execution can be aligned with the revised schedule.

◆ 7.2.4 Resource Management

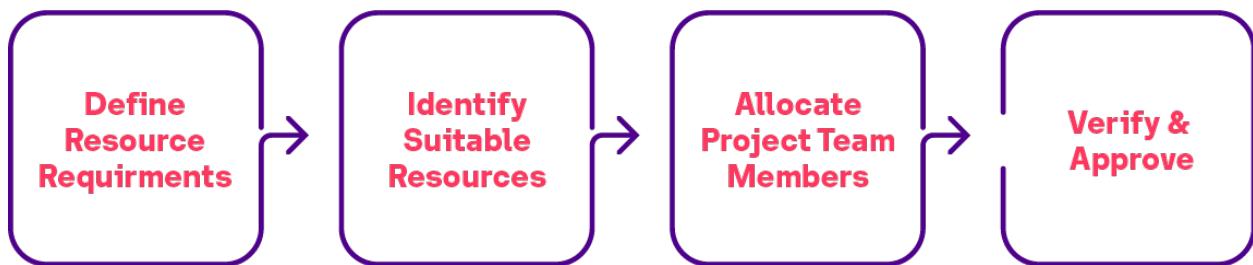


Figure 5. Resource Management

solutions by stc methodology for Resource Management is to ensure availability of all essential resources for completing the project in a timely and effective manner.

The key steps in the Resource Management:

- Each Professional Services Manager will assign team members to the project (if applicable).
- Upon allocation, the PS resource will receive a notification of project allocation. The resource will start working on the project as per scope.
- Project Manager to review the timesheet submitted by project resources to review and approve it.

7.2.5 Risk and Issue Management



Figure 6. Risk and issue management

solutions by stc Project Management Methodology incorporates a comprehensive risk management plan to ensure minimization of impact of any risks to the project. The Risk Management Plan defines how risks are identified and managed as a part of project management. It helps in undertaking preventive action to reduce probability of occurrence of risk events and minimizing the impact of the risks which cannot be prevented. As a part of this process, the project manager will meet with the project team to identify risks and classify them into risk classes, with probability and impact of each risk defined. This process is undertaken as a part of the project planning phase. Risk mitigation measures are proposed for each risk.

solutions by stc PM have a dedicated knowledge area around issue management, as the Delivery Team believes that any issue arising during project execution has the potential not only to delay the project but create a considerable tangible and intangible negative impact, and hence it is in the larger interest of the project and all stakeholders involved that all issues are resolved effectively. Solutions by stc PM uses issue management to identify, manage, resolve, and close issues throughout the execution of the project, to ensure continued project execution such that issues do not block the team from achieving project success.

As part of planning activities related to issue management, the project manager will establish an issue and risk logging and escalation procedure to be triggered if an issue occurs during the execution of the project. When issues occur during project execution, the project manager analyses each of them and they are prioritized depending on criticality towards project execution and potential impact. Each issue is also assigned a specific owner to resolve it, and a clear action plan is defined so that issues can be resolved satisfactorily. The PM will update Issue/Risk Register on a weekly basis.

7.2.6 Communication Management

Based on stakeholder register Solutions by stc PM Methodology for Communication Management is built on the key aspect of transparency and treating our customers as partners in project execution. Solutions by stc Delivery Team will strive to report the actual progress of the project on a real-time basis such that the customer is always in sync with the progress of the project. Communication management starts by gathering all the communication requirements through meetings and in-depth interviews so that a detailed plan can be developed to cater to the specific communication needs.

Through the communication management plan, Solutions by stc Project Manager will outline the purpose, audience, type, frequency, and the medium of each communication. All communication reports will be designed such that they are reader-friendly and help in taking informed decisions.



 The key communication events include:

History document

- History Document – Any document that is related to the project will be uploaded for future reference.

Project Team

- Project Team – Interdependent collection of individuals who are part of the project and who share responsibility for specific outcomes of their organizations

Project org structure

- Project org structure – Shows the hierarchy of the members included in the project from the customer side and solutions by stc.

Stakeholder register

- Stakeholder register – A living document, which serves the project manager and team for the life of the project. It is the index of all project stakeholders and their essential attributes. Create the register as early in the life cycle as possible

Communication matrix (Project Meetings)

- Communication Matrix (Project meetings) – A document summarizing the meetings that will be held during the project. It includes meetings such as Project kick-off, Project status review, Steering committee meeting, Technical workshop, Milestone Meetings, Other Meetings.

Communication Matrix (Information Distribution)

- Communication Matrix (Information Distribution) – A document summarizing the communication management plan for a project. To remain effective, the communication matrix must be accessible to all stakeholders and updated throughout the project. Documents include Project status report, Communication plan, Minutes of meeting, Project schedule, Project information updates, Change request, Design deliverables, Issue log & Risk Register.



◆ Escalation matrix

- **Escalation Matrix** – A diagram that informs both parties on whom they would contact in a matter of escalation. Figure 1. Escalation Matrix

Policies

- **Policies** – As per contractual agreement and company policies.

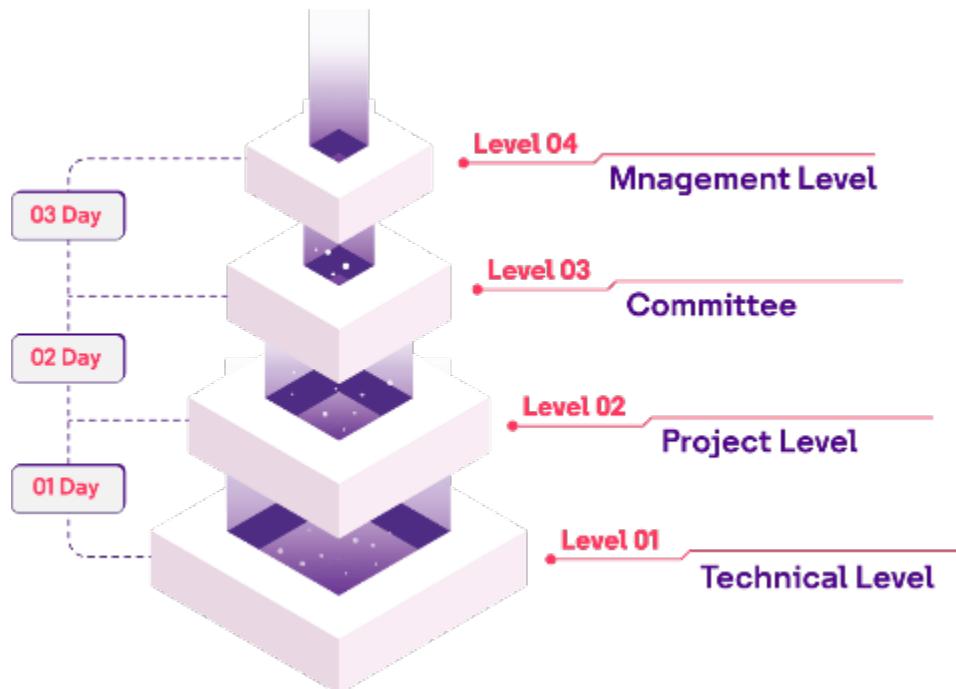


Figure 7. Escalation Matrix

7.2.7 Stakeholder Management

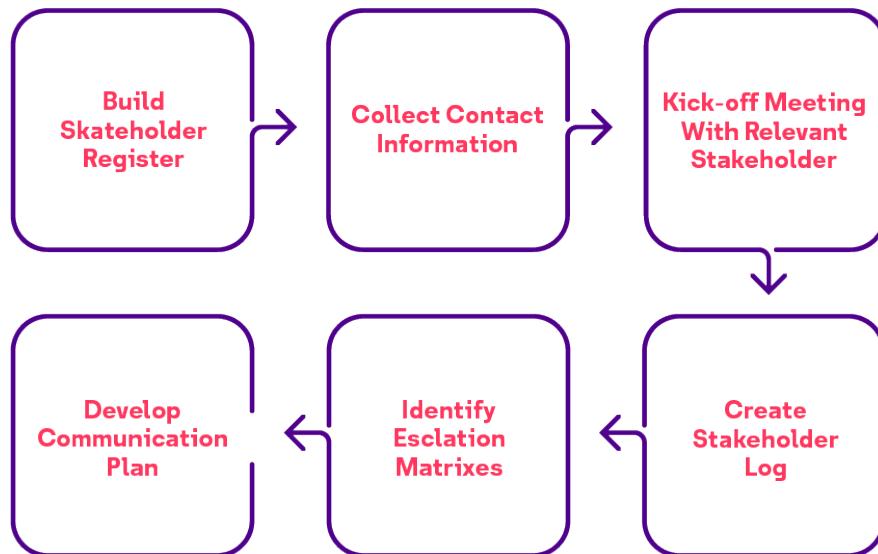


Figure 8. Stakeholder Management

solutions by stc methodology for Stakeholder Management is built to ensure alignment of internal and external stakeholders to project execution. This is done by developing a stakeholder register documenting all relevant information. All key stakeholders are contacted to collect relevant information, including expectations, requirements etc. The key steps in the Stakeholder Management process include:

The key steps in the Stakeholder Management:

- Building the stakeholder register.
- Collect all the mandatory contact information.
- Kick off meeting with stakeholders to take their requests and aspirations.
- Create stakeholder log to include authority, influence, and determine communications and frequencies.
- Identify escalation matrixes for solutions by stc, client and vendor.
- Develop communication plan for stakeholders or update the same in case of new identified stakeholders create any risks/issues associated with the identified stakeholders.

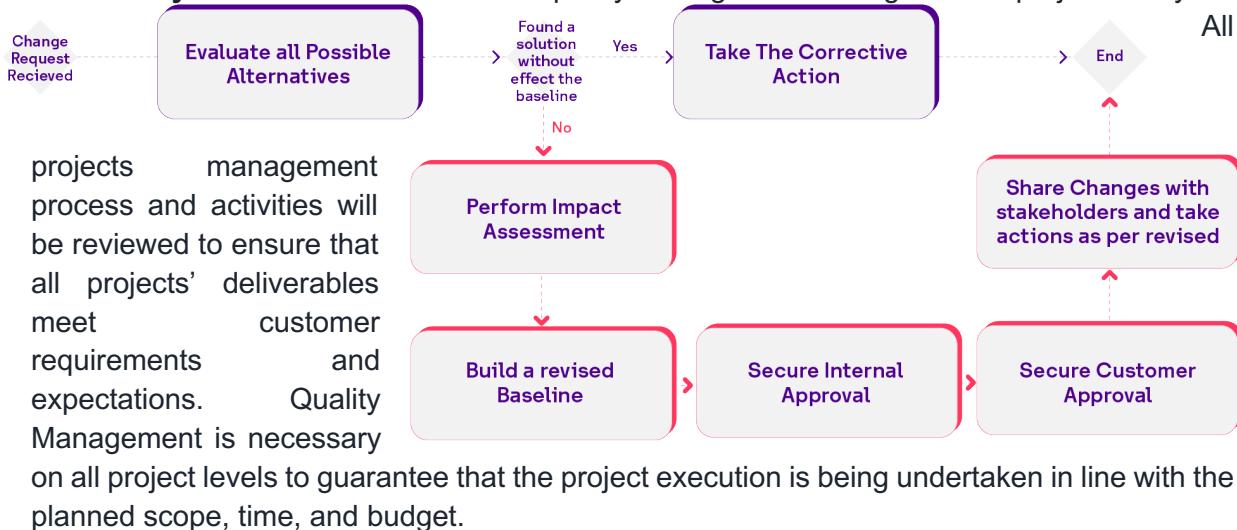
7.2.8 Quality Management





Figure 9. Quality Management

solution by stc follows a set of robust quality management throughout the project life cycle.



solutions by stc ensures the quality of their project meet the customer expectation by auditing on a regular basis the adherence to gateway elements e.g., checklist, processes, gateway assessment criteria, business rules, guidelines, project types etc, as well as assessment and auditing of the project deliverables according to their requirements and acceptance criteria.

7.2.9 Change Control Management



Figure 10. Change Control Management

solutions by stc change control process establishes the flow for the Change Control and the different stages of impact analysis and approval until it is considered finalized.

Change Control Management key activities:

- When a Change request is received, the project manager needs to evaluate all possible alternatives with the relevant stakeholders.
- If the project manager has evaluated all options and managed to find a solution without impact the project baseline, then the corrective actions should take.
- If not alternative option is available without impact the baseline, the project manager should proceed with formal change request.
- First step in the change request is to perform impact assessment on projects scope cost and schedule.
- Next it is to build a revised baseline for the project and draft recommended actions.
- Approval should be secured for the revised baseline from the project control office.
- After that the customer approval should be secure.
- Once all the approvals are secured, the project manager should proceed immediately to take actions as per the revised and share the changes with all relevant stakeholders.

7.2.10 Document Management

Solutions by stc PM Methodology ensures that all documents are standardized and managed effectively. The Project Manager is the document custodian for all version releases and updates till handover to customer. This includes defining the document number series, template etc. All project documentation will be in English unless specifically requested by the client in advance. The document number structure will be standardized as under:

- Prefix (Project Number) Pxxxxxx followed by the '-' dash separator
- Abbreviation of the document name, e.g., Scope of Work (SOW)
- Creation date in format YYYYMMDD



Revision Control - Revision control shall be maintained by requiring a revision number for the document for every revision. This number shall appear in the footer of each page of the document.

Version Control – Version control is used when more than one version of a document exists or is expected in the future. Version control will be achieved by adding a number (v1, v2,v3....etc.)at the end of a file title. Each successive draft of a document is numbered sequentially from 0.1, 0.2, 0.3... (e.x. v1.1, v1.2 etc.) until a finalized version is complete.

Document Handling - All documents will include a table of document history after the table of contents, list of figures and diagrams. This will show all the versions, reviewers, date of reviews etc.

Archival – The final version of all documents will be stored in the project library at Solutions by stc. All documents shall be presented in the form of an electronic copy, or in the case of a document bearing signatures, in the form of both the original signed document and an electronic copy thereof. Access to the library will be determined by the Project Manager. A weekly backup of the Project Library shall be done and stored at Solutions by stc Premises. Except for the latest hard copy of signed documents in the folders at the Solutions by stc site, all hard copies of any project documentation are regarded as obsolete and are to be used for reference purposes only. Except for the Latest Electronic Copy of any document in the Project Library all other copies shall be regarded as obsolete and for reference purposes only. Any Documents not yet appearing on the Project library will not be considered for contractual, planning or any other purposes. All Contractors shall comply with this procedure. All documents on the library shall be named in accordance to Document number structure and Version control.

7.2.11 Vendor Management

Solutions by stc PM Methodology follows a structured approach towards vendor management. All vendors will be identified as a part of the project planning phase, in alignment with proposal shared with client. All vendors will be registered as a part of the Solutions by stc vendor system in a vendor database. Vendor credentials will be validated in detail before being engaged. Solutions by stc project Manager will initiate discussions with all relevant vendors on the following aspects:

Solution Configuration – to ensure combination of products and services to be delivered by vendor is as per Solutions by stc requirements.

Price Configuration – to ensure pricing for solution is in line with proposal costing by coordinating with Pre Sales and Procurement teams.

Delivery Plan – Solutions by stc acts as the owner for all interactions with Vendors. This includes development of a detailed delivery plan from vendor aligned with overall Solution delivery plan.



 **Timely Follow-ups** – Solutions by stc will ensure that periodic follow-ups with all vendors are undertaken in a timely manner to ensure that delivery is as per schedule and that any delays are mitigated suitably.

Quality Audit - Solutions by stc will ensure that all products and services procured from vendors undergo a comprehensive quality audit before being deployed as a part of customer solution.

Issue Resolution – in case of any issues- (e.x. non-availability of products, poor quality etc.), STC will develop a suitable alternative configuration in discussion with the customer, ensuring that requirements are met in an effective and efficient manner.

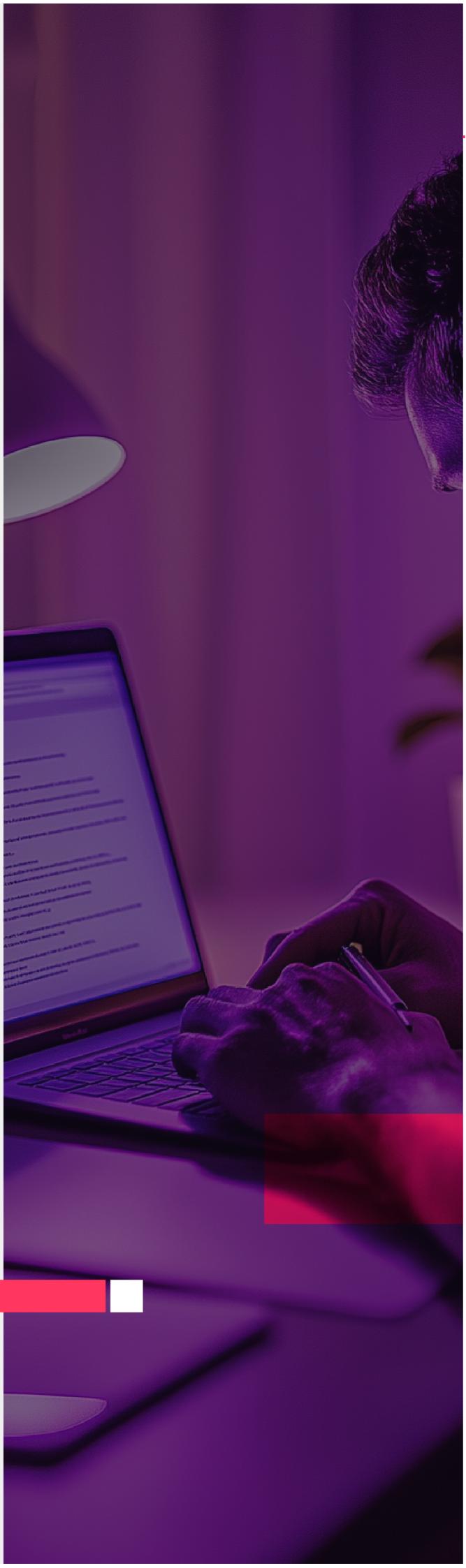


Resource Plan and Organization Structure

1.1 Overview

The delivery relies on a carefully structured project organization model that combines **technical depth, agile coordination, and on-site/off-shore collaboration** to ensure cost-efficiency and rapid knowledge transfer to stc's internal teams.

1.2 Roles and Responsibilities



◆ 8 Resource Plan and Organization Structure

8.1 Overview

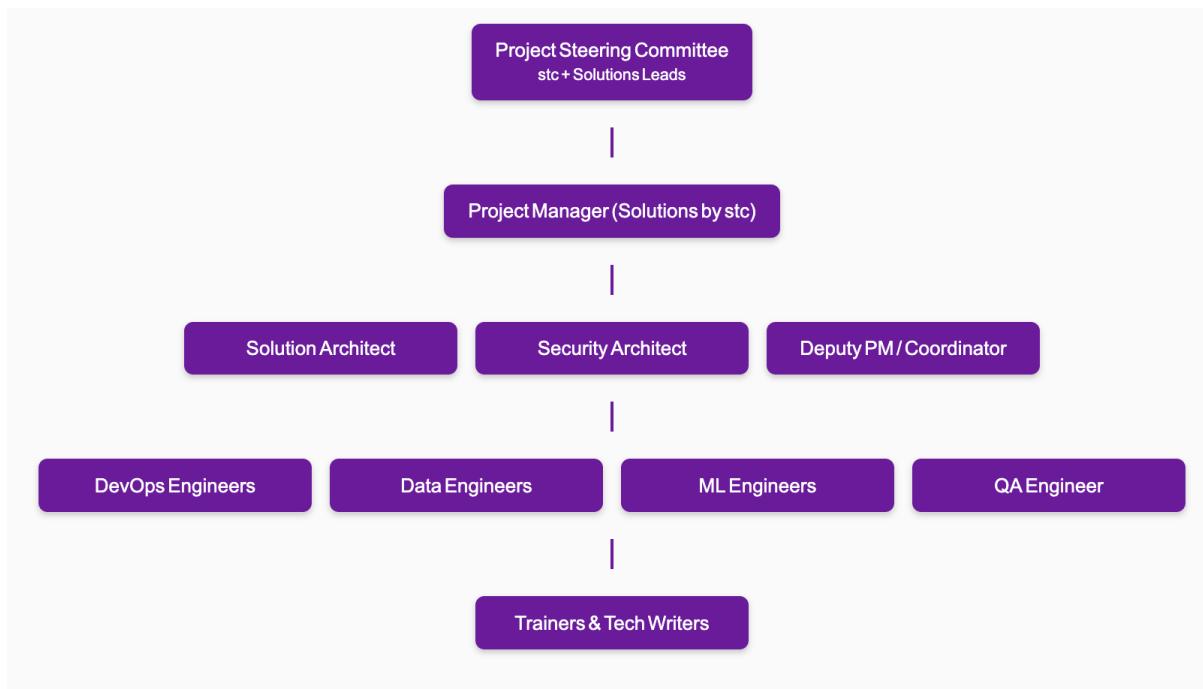
The delivery relies on a carefully structured project organization model that combines **technical depth, agile coordination**, and **on-site/off-shore** collaboration to ensure cost-efficiency and rapid knowledge transfer to stc's internal teams.

8.2 Roles and Responsibilities

Role	Key Responsibilities	Location (Onsite/Offshore)
Project Manager (PM)	Overall delivery management, stakeholder communication, risk and change control.	Onsite (Riyadh)
Deputy PM / Project Coordinator	Resource tracking, task monitoring, status reporting, documentation support.	Offshore
Solution Architect	Owns technical architecture design, technology blueprint, and alignment with Phase 1 components.	Onsite
Security Architect	Ensures NCA and CITC compliance, security policy implementation (Keycloak, OPA, Vault).	Onsite
Data Engineers	Kafka topic creation, Flink job design, ClickHouse ETL pipelines, optimization & tuning.	Mixed (1 onsite / 2 offshore)
DevOps Engineers	CI/CD, K8s operations, Terraform/Ansible automation, monitoring dashboards.	Offshore
ML Engineer / Data Scientist	Kubeflow pipeline setup, MLFlow model management, QoE prediction models.	Mixed (1 onsite / 1 offshore)
Quality Assurance Engineer	Plan and execute automated SIT/UAT, performance testing and documentation.	Offshore
Trainer / Technical Writer	Prepare training modules, user guides and operational manuals for stc teams.	Onsite + Remote sessions



8.3 STC Solutions Project Organization Chart



8.4 Resource Distribution

Type	Ratio	Comment
Onsite (Local – Riyadh)	≈ 55 %	Direct client engagement, architecture validation, training.
Offshore (Remote Support Center)	≈ 45 %	Development, CI/CD, testing, documentation tasks.

8.5 Knowledge & Transition Plan

- Shadowing Program for stc engineers during build phase.
- Joint code reviews and DevOps Handover checklist.
- 2-Level Knowledge Transfer (KT):
 - Level 1:** Operations and Admin.
 - Level 2:** Developers / Data Scientists on pipeline enhancements.
- Delivery of source code repositories with readme and deployment scripts.

◆ 9 Assumptions, Out of Scope, and Prerequisites

9.1 Key Assumptions

#	Assumption	Description / Notes
A1	Infrastructure Availability	Required compute, storage, and network resources (bare-metal or virtual cluster) will be provisioned by stc before Phase 2 build kick-off.
A2	Network Connectivity	All internal and cross-domain firewall rules for data flow (Kafka ↔ Flink ↔ ClickHouse ↔ MLFlow) will be approved and opened.
A3	Data Access & Formats	Source data formats (AAA, CGNAT logs, RADIUS feeds) will be made available for schema definition and ETL validation.
A4	Platform Governance Policies	stc will provide guidelines for security auditing, data retention, and encrypted storage as per NCA and CITC rules.
A5	Open Source Adoption	stc approves the usage of open-source tools (Kafka, Flink, ClickHouse, Kubeflow, Keycloak) under respective Apache / OSS licenses.
A6	Readiness of Existing Phase 1 Artifacts	Phase 1 components (HBase/ES data, existing dashboards) are stable and available for integration reference.
A7	Timely Stakeholder Input	Design reviews and approvals will be completed within defined sprint cycles to avoid schedule drift.
A8	Testing Environment Isolation	A dedicated staging environment will be used for system and UAT validation before production deployment.

9.2 Out of Scope

Area	Description / Rationale
Legacy System Enhancement	Any re-engineering of legacy closed-source tools or hardware appliances (Juniper CGNAT, A10 devices) is excluded.
Commercial Licensing and Third-Party Software	Procurement of non-open-source and commercial tools outside defined stack is out of scope.
End-User Device Analytics	Collection of metrics directly from customer end-points or CPEs is not covered.
Cloud Migration	This phase focuses on on-prem deployment only — migration to public cloud (if future) is beyond scope.
Expansion into Non-Network Domains	Integrating billing, CRM, and external IoT data sources is reserved for future phases.
Customer Portal Development	While dashboards are included, developing external portal interfaces with self-service features is excluded.





9.3 Project Prerequisites

Category	Prerequisite / Responsibility	Owning Party
Infrastructure	Kubernetes cluster and VM resources ready with network and security zones defined.	stc IT Infra Team
Accounts & Access	Active Directory integration and Keycloak SSO testing users.	stc IAM Team
Data Sources	Sample data feeds from AAA & CGNAT systems available for schema validation.	stc Network Team
Network	VPN / connectivity between stc environments and Solutions secured development nodes.	stc Network Ops
Security Approval	NDA clearance, access permissions, and SOC review for all project resources.	stc Security Ops
Project Governance	Appointment of stc technical PO (Product Owner) and Steering Committee representatives.	stc PMO
Tools and Repositories	Access to GitLab, Jira, and Confluence projects for tracking and source code management.	Solutions by stc



◆ 10 Solution Component Inter-working Narrative

10.1 Overview

The proposed architecture is a **fully open-source, modular ecosystem** built around a streaming + storage + analytics + AI pipeline.

Each component performs a specific function but integrates seamlessly to support **real-time dataflow, scalable analytics, and AI-driven insights** for stc's network operations.

At its core, everything revolves around **Kafka, Flink, ClickHouse, and AI tooling (Kubeflow / MLFlow)** — tightly orchestrated through **Kubernetes** and secured via **Keycloak + Vault + OPA**.

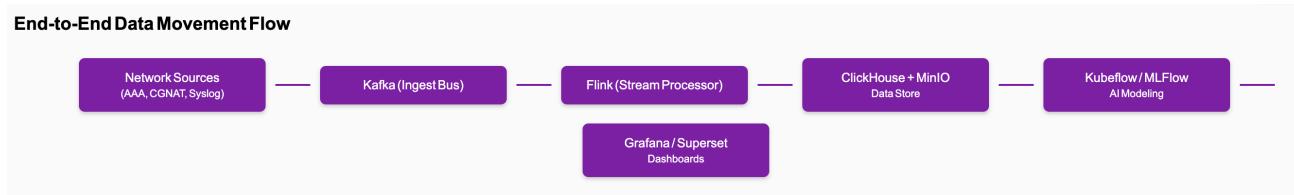
10.2 Component Inter-working Flow

10.2.1 Step-by-Step Narrative

Stage	Component(s)	Description of Functionality / Interaction
1. Data Ingestion	Kafka, nProbe Adapters, Logstash (optional)	Network elements (e.g., Juniper CGNAT, AAA servers, RADIUS logs, Syslogs) emit structured and semi-structured events. Adapters stream data into designated Kafka topics.
2. Real-Time Processing	Apache Flink Cluster	Flink jobs (micro-batches or streaming jobs) subscribe to Kafka topics, perform event correlation, QoE metric enrichment, and network anomaly aggregation in real time.
3. Persistent Storage	ClickHouse + MinIO + Hive Metastore	Processed records from Flink are persisted in ClickHouse (using MergeTree tables for fast time-series reads) and archived in MinIO as object storage for backup and AI model training data.
4. AI/ML Enablement	Kubeflow + MLFlow + JupyterHub	Data scientists consume curated ClickHouse tables to train QoE prediction and customer traceability models. Kubeflow handles pipeline automation; MLFlow tracks models and versions.
5. Visualization and Monitoring	Grafana + Superset Dashboards	Dashboards query ClickHouse directly to render live KPIs (e.g., session success rate, CGNAT utilization, AAA latency).
6. Security and Governance Layer	Keycloak + Vault + Atlas + OPA	User authentication and authorization via SSO; access policies enforced through OPA; Atlas captures data lineage and audit trails; Vault protects secrets and certificates.



10.2.2 Illustrative Pipeline Flow



This visual flow shows **horizontal data movement**, from raw event capture at source to insight delivery via dashboards, with each component operating in real-time under Kubernetes orchestration.

10.3 Key Performance Inter-relations

Objective / KPI	Supporting Component Synergy
1 million events/s throughput	Kafka (topic partitioning + replication) combined with Flink load balancing and K8s HPA (auto-scaling).
< 1 s end-to-end latency	Memory-based Flink stream state and ClickHouse MergeTree indexes.
QoE Accuracy > 95 %	AI pipeline re-training weighed against Flink aggregated sessions.
Operational Resilience 99.95 %	Multi-AZ Kafka + ClickHouse replicas with Prometheus-driven self-healing.

10.4 Alignment with stc Digital Transformation Strategy

- Data Sovereignty:** All data remains within stc's private cloud or data centers.
- Open Source First:** Aligns with national "build vs buy" strategy (innovation and cost-optimization).
- Automation and AI:** Supports stc's vision to move from manual reports to predictive analytics and autonomous operations.
- Local Empowerment:** Technology transfer to stc teams ensures long-term independence and resilience.

◆ 11 Hardware Sizing and Infra Specs

11.1 Sizing Assumptions

Parameter	Value	Notes
Daily data ingest	15 TB raw (\approx 10 TB compressed)	both sites combined
Hot retention	30 days \approx 450 TB raw \rightarrow 300 TB after compression	active data in ClickHouse + OpenSearch
Cold retention (1 year)	3.6 PB raw \rightarrow \approx 550 TB Parquet ZSTD compressed	sits in MinIO / object store
Replication factor	2 (hot)	DR/HA requirement
Compression ratio	2.5 \times (ClickHouse ZSTD / OpenSearch LZ4)	
Concurrency	200 active users	dashboards, API queries

11.2 Hardware Summary

Tier	Function	Nodes	Model	CPU / RAM	Storage per Node	Remarks
1	Kafka + Zookeeper Cluster	6 (3 per site)	HPE DL380 Gen11	2 \times Xeon Silver 4410 / 128 GB	4 \times 2 TB SSD	Supports 15 TB/d feed with tiered storage
2	Flink / Airflow / Stream Compute	6 (3 per site)	HPE DL360 Gen11	2 \times Xeon Gold 5414 / 256 GB	2 \times 960 GB SSD (OS)	10 Flink jobs + 200 pipelines
3	ClickHouse Cluster (Hot Analytics)	6 (3 per site)	HPE DL385 Gen11 (Azure 2U)	2 \times AMD EPYC 9xxx / 256 GB	10 \times 8 TB NVMe U.2 = 80 TB	\approx 480 TB usable (\geq 30 d retention)
4	OpenSearch Cluster (Logs & Search)	6 (3 per site)	HPE DL385 Gen11	2 \times EPYC 7452 / 256 GB	8 \times 8 TB HDD + 2 \times 1.6 TB SSD cache	content tier (warm \rightarrow delete @ 30 d)
5	MinIO Object Storage (Cold Tier, 1 year)	8 (4 per site)**	HPE Apollo 4200 Gen11	2 \times EPYC 7443 / 128 GB	16 \times 12 TB SAS = 192 TB raw	\approx 1 PB erasure-coded cluster
6	Kubernetes Control Nodes & CI/CD	3 (shared)	HPE DL360 Gen11	2 \times Silver 4410 / 128 GB	2 \times 960 GB SSD	Argo / Vault / Keycloak / Prometheus
7	Monitoring & Security Infra	2	HPE DL360	Xeon Gold / 96 GB	4 \times 2 TB SSD	Grafana, Loki, NMS





8	Network Infrastructure	2 Core Switches + 4 Top-of-Rack (Aruba CX 6300)**	—	—	—	40 GbE core + 25 GbE leaf
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11.3 Storage Capacity Calculation

Layer	Effective Capacity (usable)	Function
ClickHouse (6 nodes × 80 TB = 480 TB)	~ 360 TB usable (after replication & reserve)	30-day hot metrics store
OpenSearch (6 nodes × 64 TB = 384 TB)	~ 300 TB usable (after RAID6 + replica = 1.5×)	30-day log search tier
MinIO (8 nodes × 192 TB = 1.54 PB) EC(8,6)	~ 1.15 PB usable	1-year cold Parquet store + snapshots

Total usable storage ≈ 1.81 PB across all tiers.



◆ 12 Compliance Matrix

12.1 Overview

The following matrix maps **RFP clauses and requirements** to the **proposed solutions** offered by **Solutions by stc**, providing a clear, auditable view of **technical, security, and operational compliance**.

Legend:

- **Y** = Fully Compliant
- **F** = Partially / Functionally Compliant
- **C** = Conditional (Requires External Input or stc Action)

RFP Clause / Requirement	Proposed Solution Response	Compliance Status
1.0 – Architecture & Design	Proposed fully open-source big data architecture based on Kafka + Flink + ClickHouse + MinIO + Kubeflow, deployed on Kubernetes with HA and geo-redundancy.	Y
1.1 Scalability and Performance	Horizontal scaling supported via K8s HPA and Kafka partitioning; tested throughput > 1 M events/sec.	Y
1.2 Technology Stack Neutrality	All components are vendor-neutral and OSS-licensed; no proprietary lock-in.	Y
1.3 Integration with Existing Systems	Compatible with Phase 1 data sources (AAA, CGNAT, RADIUS); uses standard protocols like Syslog, REST, Kafka Connectors.	Y
2.0 – Data Management & Governance	Data cataloguing by Apache Atlas; metadata tracking, lineage visualization, and enforced retention policies as per NCA ECC guidelines.	Y
2.1 Data Retention & Archival	Hot/cold tiering using ClickHouse and MinIO with object lifecycle rules.	Y
2.2 Security & Access Control	RBAC and Attribute-based Policies through Keycloak + Open Policy Agent (OPA); Vault manages secrets and TLS keys.	Y
2.3 Encryption Standards	AES-256 encryption at rest and TLS 1.3 in transit; Vault manages certificates.	Y
2.4 Data Lineage and Auditability	Achieved via Atlas + Flink audit trail plugins and Prometheus events.	Y
3.0 – AI and Analytics Enablement	AI models implemented using Kubeflow / MLFlow for QoE prediction and traffic classification.	Y





3.1 ML Pipeline Versioning	MLFlow tracks model versions with metadata, parameters, and metrics.	Y
3.2 Visual Analytics and Reporting	Grafana and Apache Superset provide real-time dashboards and scheduled reports.	Y
3.3 Custom Model Deployment Capability	Supports container-based inference serving via Kubeflow Serving (KServe).	Y
4.0 – Operations & Monitoring	24x7 monitoring via Prometheus + AlertManager; OTEL integration for distributed tracing.	Y
4.1 High Availability	Multi-replica Kafka, Flink HA JobManager mode, ClickHouse replicated clusters.	Y
4.2 Disaster Recovery	Velero + snapshot-based backup; RPO ≤ 15 min, RTO ≤ 2 hrs.	Y
4.3 CI/CD Automation	Jenkins + GitLab CI pipelines with Helm charts and Terraform.	Y
5.0 – Support & Training	Includes admin and user training (5 days each), knowledge transfer, and O&M support package.	Y
5.1 Documentation and Manuals	Comprehensive install / operation manuals and SOPs provided in digital and print form.	Y
6.0 – Regulatory Compliance	Design aligned to NCA ECC, CITC privacy guidelines and ISO 27001 best practices.	Y
6.1 National Hosting Policy	All data reside within stc's sovereign data centers in KSA.	Y
6.2 Support for Arabic and English Dashboards	Grafana / Superset UI supports bi-lingual interfaces (as Unicode ready).	Y
7.0 – Project Schedule	34-week plan with phased milestones and biweekly deliverables (see Part 8).	Y
7.1 Resource Qualification	All engineers certified in Kafka, Flink, K8s, DevOps or equivalent OSS domains.	Y
8.0 – Commercial Compliance	Open Source stack – zero license fee; support through Solutions O&M.	Y

Overall Compliance Percentage: > 98 % Fully Compliant

Notes: Conditional items (if any) are limited to data access dependencies on stc's security clearance process.



◆ 13 Risk Register and Mitigation Plan

13.1 Overview

Effective risk management is central to ensuring predictable delivery and operational stability for stc's Big Data & AI Platform.

The table below summarizes **technical, operational, security, and schedule risks**, their **impact levels**, and **proactive mitigation actions** adopted by *Solutions by stc*.

13.2 Risk Register

#	Risk Category	Risk Description	Likelihood	Impact	Mitigation Plan / Contingency Action	Owner
R-0 1	Data Access Delays	Delay in receiving live data feeds from AAA & CGNAT systems could impact pipeline validation.	Medium	High	Engage early with Network & Security teams to secure test data and simulate via mock streams until access granted.	Project Manager
R-0 2	Integration Complexity	Different data formats between Juniper and A10 CGNAT systems may affect parsing.	High	Medium	Build schema normalization layer in Flink and maintain configurable parsers.	Data Engineering Lead
R-0 3	Performance Bottlenecks	Unexpected load spikes beyond planned capacity (> 1 M EPS).	Medium	High	Horizontal scaling with Kafka partitions and ClickHouse replicas; predefined load tests.	Architect / DevOps Lead
R-0 4	Security Non-Compliance	Deviation from NCA controls or delayed security approval for tools.	Low	High	Early security review and shared assessment report with stc SOC; adopt Vault / Keycloak controls.	Security Architect





R-05	Open Source Vulnerability	Upstream library vulnerabilities detected in Flink / Kafka release.	Medium	Medium	Regular CVE scans (Trivy, Anchore), frequent patching and mirror repositories.	DevOps Team
R-06	Skill Availability	Limited awareness of new open-source stack within operations team.	High	Medium	Comprehensive training and shadowing; post-deployment KT sessions.	Training Manager
R-07	Schedule Overrun	Delayed approvals or scope creep may extend timeline.	Medium	Medium	Strict change control & Steering Committee oversight each fortnight.	Project Manager
R-08	Data Quality	Incomplete or corrupt records from source logs can impact analytics accuracy.	High	Medium	Implement data validation and error-handling jobs within Flink for auto-correction.	Data Engineer Lead
R-09	Hardware Fault / Infra Downtime	Unexpected power or node failure at data center.	Low	High	ClickHouse multi-replica + Kafka RAID-10 setup + daily Velero backup validation.	Infrastructure Lead
R-10	Vendor Dependency on Plugins	OSS library deprecations impact existing connectors.	Medium	Low	Maintain local mirror repos and plan version migration within minor releases.	Solution Architect

13.3 Risk Heat Map

Impact \ Likelihood	Low	Medium	High
High	R-04, R-09	R-01, R-03	—
Medium	R-10	R-02, R-05, R-07, R-08	—
Low	—	—	—

(High-impact and High-liability cells receive highest monitoring priority in governance meetings.)





13.4 Contingency Planning

1. Backup & Restore:

Daily snapshots (Velero + MinIO) and bi-weekly restore validations.

2. Alternate Development Path:

If production access is delayed, mock stream emulators with synthetic data will be used.

3. Escalation Protocol:

Risks escalated to Steering Committee within 24 hours of breach of baseline tolerance.

4. Rolling Patch Policy:

Regular CVS updates for Kafka, Flink and Linux OS components to mitigate security risks.



◆ 14 Conclusion & Value Summary

14.1 Strategic Positioning

The AlShamel Plus Phase 2 – Open Source Big Data & AI Platform represents a major milestone in stc's digital transformation journey.

It reinforces stc's strategy to shift from costly siloed systems toward an **integrated, open, and AI-driven data ecosystem**, built and operated by Saudi talent and technologies aligned with national regulations.

Solutions by stc, as stc's strategic delivery arm, is positioned to execute this vision end-to-end leveraging its local expertise, domain knowledge, and OSS capability center.

14.2 Key Value Highlights

Dimension	Delivered Value
Innovation Enablement	First enterprise-scale open-source big data platform in KSA telecom sector built on Kafka, Flink, ClickHouse and Kubeflow.
Operational Autonomy	Empowers stc teams to operate and extend the platform without vendor lock-in or license fees.
Cost Efficiency	Eliminates proprietary license costs and reduces OPEX through automated CI/CD and self-healing architectures.
Security and Compliance	NCA ECC-aligned architecture with Vault, Keycloak and OPA enforcing strong access and encryption controls.
AI Acceleration	Built-in ML pipelines enable real-time QoE prediction, anomaly detection, and customer journey analytics.
Knowledge Transfer & Saudization	Structured training and shadow programs equip stc personnel with deep data engineering skills; 100 % technology ownership retained by stc.
Scalable Foundation	Modular microservice design supports future expansion to 5G, IoT, and Billing domains.

14.3 Why Solutions by stc

- ✓ **Proven Telecom Experience:** Decades of experience implementing network intelligence and analytics solutions for stc and regional operators.
- ✓ **End-to-End Ownership:** Delivery, integration, and support handled locally with strong vendor governance.
- ✓ **Alignment with stc Vision 2030:** Champions local content, open innovation, and digital sovereignty.
- ✓ **Deep OSS Expertise:** Dedicated Open Source Center of Excellence for Kafka, Flink, and AI tools.



- 
- Agile Delivery Model:** Flexible, phase-wise approach ensuring business value from each iteration.

14.4 Long-Term Sustainability

1. **Maintainability:** All code base managed under GitOps model with version control and automated CI/CD pipelines.
2. **Extensibility:** Pluggable architecture for future modules (e.g., IoT data lakes, customer identity analytics).
3. **Support Continuity:** Optional multi-year O&M support framework to assure business continuity and performance tuning.
4. **Data Governance:** Centralized Atlas-based metadata ensures data quality, lineage, and audit readiness.

14.5 Final Statement

Solutions by stc reaffirms its commitment to deliver an **enterprise-grade, secure, and scalable open-source big-data and AI platform** that will:

- Empower stc to leverage AI insights in real time.
- Enhance customer experience (QoE optimization and traceability).
- Reduce total cost of ownership by embracing open innovation.
- Strengthen national data sovereignty and operational independence.

Together, **stc and Solutions by stc** will pioneer a new benchmark for **data-driven telecom intelligence** in the Kingdom of Saudi Arabia.



15 Terms and Conditions

- For **solutions by stc** to perform the Services under this SOW, CUSTOMER shall ensure that they understand the obligations and responsibilities stated in this SoW, to ensure successful completion of the Services within the timeframes set forth in the SoW.
- All Documentation Deliverables will be provided in the English language, unless specifically stated otherwise in this SOW. In the event of any conflict between this English version and the translation(s), the English version will prevail.
- Effort estimate for documentation is limited to those defined in the Project activities and deliverables.
- Any additional licenses, software or hardware required will be considered as change request and will be charged separately.
- Work shall be carried out in accordance with the working hours recognized in the Kingdom of Saudi Arabia and stipulated by the Labor and Workers Law, unless otherwise stated in the statement of the submitted offer.
- The fees for this project may be increased and the schedule may be extended, as appropriate and necessary, in the event of a change in project scope or a deviation in any assumption, exclusion or dependency contained in this SOW, if any excusable delay or failure occurs or if CUSTOMER fails or is unable to comply with any of its responsibilities or other obligations under this SOW.
- The Customer shall have a valid and active license in order for **solutions by stc** to be able to renew it otherwise the license shall be renewed from the date of expiry of the license.
- The proposed offer and solution is made on the best available/provided information.
- The Customer shall be responsible for the end to end testing and acceptance for the entire project.
- Customer is responsible to provide access for all the sites kingdom wise.
- Customer is responsible for assigning a project resource with sufficient delegated authority to sign-off milestone items that include: design, testing and implementation milestones.
- Customer is responsible for sharing its security policies and standards that the Project needs to align and comply with.
- **solutions by stc** expect Customer to provide the necessary documents and information in a timely manner especially about existing systems, devices, equipment, processes, organizations, and standards.
- The laws of The Kingdom of Saudi Arabia (KSA) apply to this Scope of Work (SOW), and the related Contract.



Annexure

- 2.1 Acceptance Criteria
- 2.2 Product Description/Datasheet
- 2.3 Drawings
- 2.4 Solutions Profile
- 2.5 Partner Profile
- 2.6 CVs
- 2.7 References
- 2.8 Certificates
- 2.9 Other Mandatory Reports and Certificates

16 Annexure

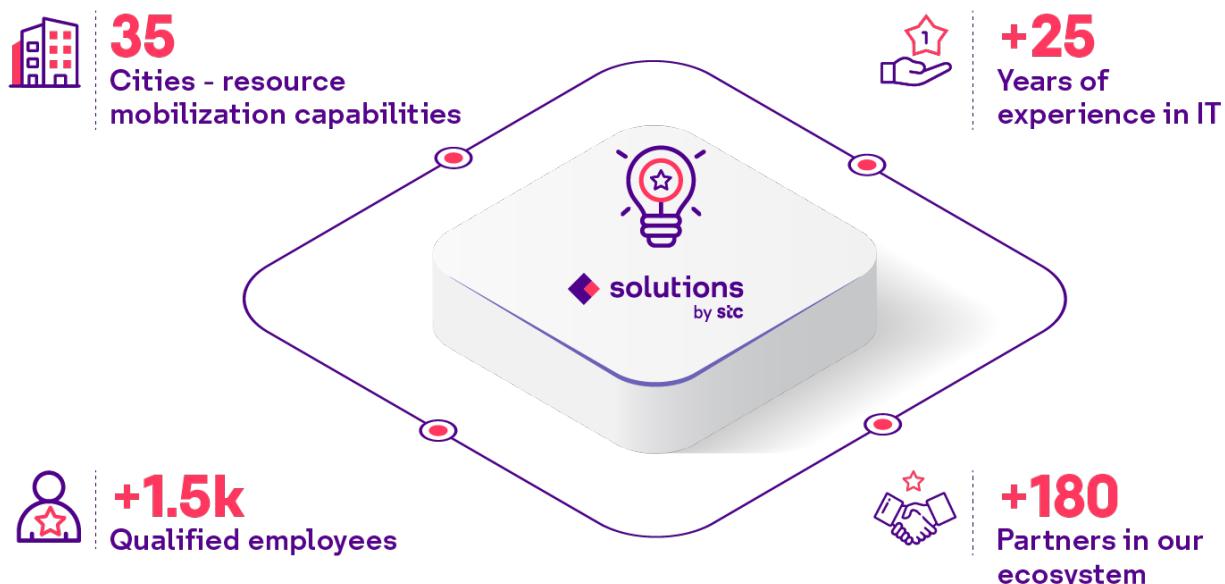
16.1 Solutions Profile

16.1.1 About Solutions

- **solutions by stc** is the market leader in the IT services provider and digital enabler of the Kingdom
- **solutions by stc** is a leading ICT services provider and digital enabler at the forefront of digitalization in the Kingdom, supporting the aspirations laid out in Vision 2030.



Ranked # 1 IT Services Provider in KSA for 8 consecutive years by IDC



◆ 16.1.2 Solutions Services

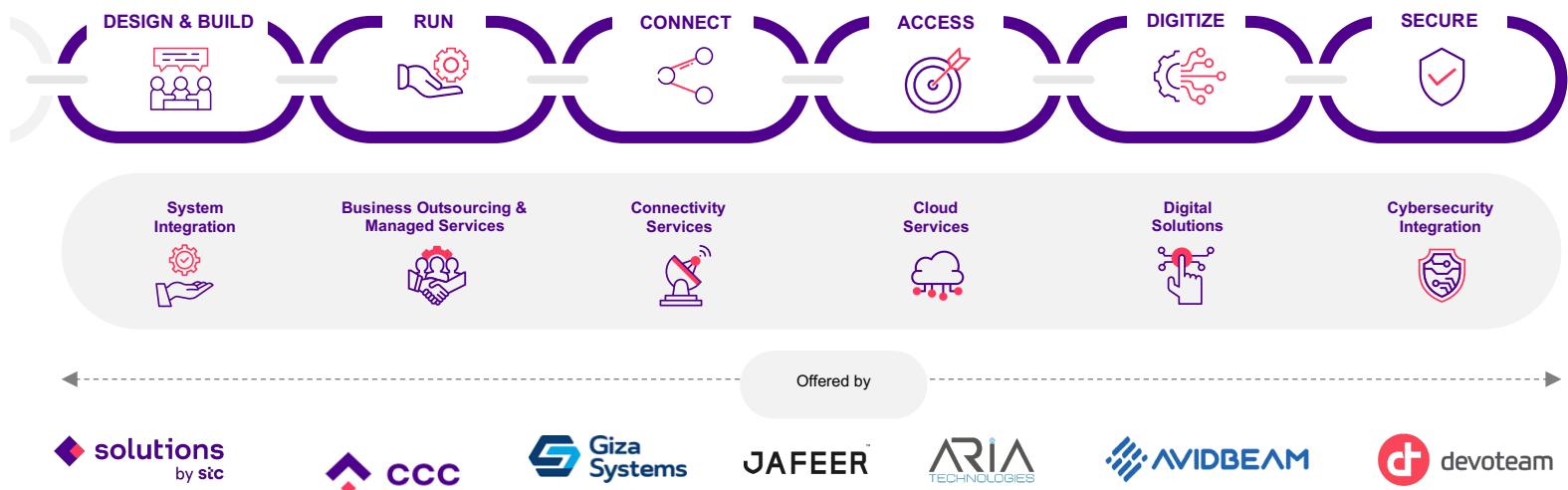


Figure 11. Solutions Services

16.1.3 Solutions Values

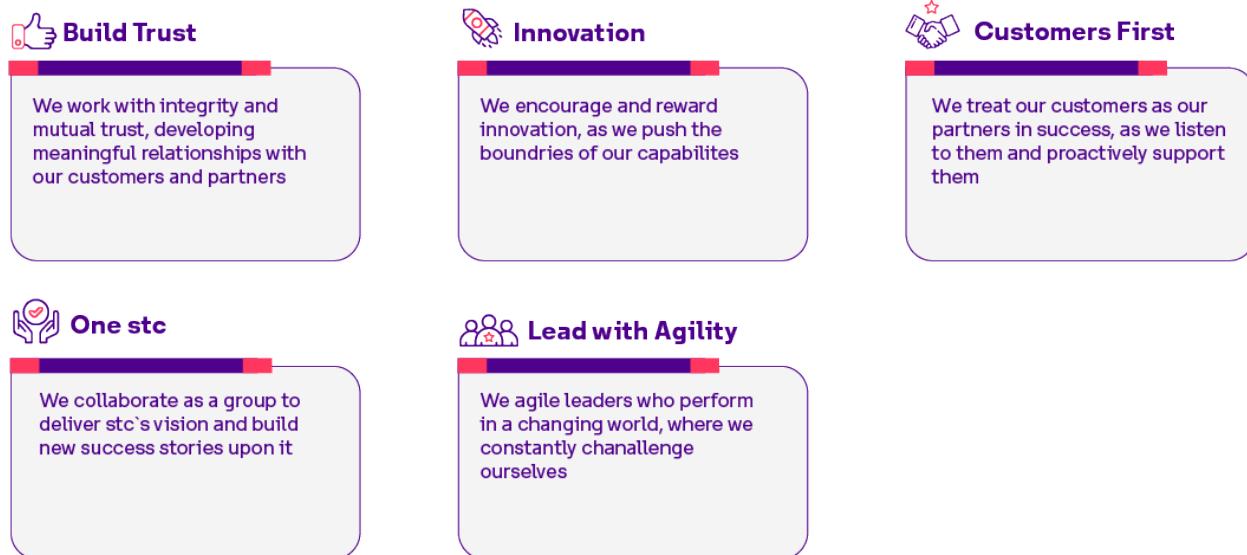


Figure 12 Solutions Values

16.1.4 Why Solutions

- **Solutions By STC** is characterized by many advantages that make it the best and optimal choice in the field of information technology services, which enables it to take leadership in this sector by providing the most suitable services to our customers, starting from design, implementation, and operation, while working to know the needs of our customers and provide what is necessary to achieve the best returns at the lowest cost and by activating all available resources to reach the best results.
- Capability to deliver end-to-end solutions with a bundle of services from design to delivery and a single point of contact for the customer for all IT environment related issues.
- Proven record of accomplishment of successful implementation of several complex projects including projects for the Kingdom's Ministry of Interior, Network Modernization (NEMO), Information Technology Communications Complex (ITCC), King Abdullah Financial District (KAFD), Tatweer, etc.
- ICT market leader in KSA with an extensive partner ecosystem comprising of industry leading names such as HP, Fujitsu, Oracle, Symantec, DELL, Intel, Microsoft, Juniper and CISCO.
- Dedicated team of certified high caliber technology professionals with state-of-the-art technical expertise, world class project management methodologies, high quality standards such as ITIL and ISO 9001:2008/ 20000/ 27000, and hands-on customer support ensuring high quality solution implementation.
- A specialized and certified team maintaining highly standard and extensive experience. The team receives periodic training in international and local organizations and has an impressive record of achievements in meeting the requirements with high quality according to customer's needs and industrial standards. The team is also equipped with qualifications such as PMP, ITIL, and other standard certification bodies.
- Superior technical capabilities in maintaining and securing recently upgraded network operation center, in addition to their capabilities to provide high quality services that our customers can rely on.
- **Solutions By STC** datacenters are operated to the highest international standards and best practices procedures.
- Being part of STC group and it's widely spread network infrastructure give us the ability to provide various services with higher Quality of Services (QoS) and less network latency for application communication and increases the return of investment for our customers IT infrastructure to its maximum.
- **Solutions By STC** provides a 24-hour daily support through the whole year by highly specialized engineers to investigate and resolve issues with fast response and resolution time to ensure customer's business continuity.



- World-class datacenter facilities engineered using several layers of security, power, and support.



 **16.1.5 Sustainability**

Sustainability Strategy

As the leading enabler of digital transformation in Saudi Arabia, sustainable development is integral to solutions by stc's mission. Committed to supporting the nation's sustainability goals, we have introduced our GROW Sustainability Strategy in 2023.

This strategic framework is more than a plan — it's an integral part of our broader corporate strategy, LEAP, highlighting our belief that sustainability should be woven into every aspect of our organization.

Greening by Sustainable Technologies and Processes

At the heart of our Sustainability Strategy lies our commitment to Greening by Sustainable Technologies and Processes. Aligned with Vision 2030 and the Saudi Green Initiative, our dedication mirrors the values of our parent company and resonates with our stakeholders.

Revitalizing Workforce Relations & Digital Social Empowerment

Driven by our passion for societal impact, we prioritize our people and embed respect for human rights in our corporate culture. We commit to empowering individuals and communities, safeguarding the environment, and fostering technology as a catalyst for positive change.

Optimizing Governance for Ethical Excellence

We uphold the highest standards of corporate governance, aligning with Saudi Arabia's regulatory frameworks. With transparency and accountability at our core, we support the objectives of Saudi Vision 2030.

Widening Impactful Partnerships and Sustainable Procurement

Embracing collaboration in digital transformation and sustainability, we extend our reach far beyond our immediate suppliers. We eagerly expand our network of partnerships, seeking to magnify our impact and bring life into our Sustainability Strategy.





Solutions Sustainability Purpose is to leverage technology to drive competitive advantage for the business that creates a positive impact for people and the planet.



Established our Sustainability Management Committee



67%
Of our employees were **Saudi Nationals**



Zero
Data security breaches were recorded



70%
Increase in average training hours per employee since 2022



+220
Youth participants engaged in training programs



Zero
Grievances filed for human rights violations



12%
Increase in female workforce participation since 2022



20
Local NPO beneficiaries attended capacity sessions



26%
Of employees aged between 18-30



17
women-owned suppliers were engaged



67%
Of total suppliers' are local



70%
Of the procurement budget was allocated to **local suppliers**



100%
Of work-related injuries were zero for 3 years



Zero
Confirmed corruption incidents for the 3rd year



3
Partnerships forged for healthcare digital transformation



Introduced AQMCS for the Ministry of Environment and Agriculture

◆ 16.1.6 Success Partners

Solutions notable achievements by key partners



Service Provider Architecture Partner of the Year 2021



Middle East, Turkey and Africa Partner of The Year 2022



MESA Raising Star Of The Year 2022



The Fellow Traveler Award



Top IP Sales Accelerate Award



Accelerate Partner of the Year 2020 award



Strategic Partner of the Year 2020



SAP's award of Highest Sales Revenue Award OnPrem of the Year 2022



Rising Star Partner Of The Year 2020



Cisco's Managed Services Provider of the Year 2021



Authorized Surface commercial devices partner



Best Carrier Reseller Partners Award of The Year



Technology Partner of the year 2020

180+ Best of Breed technology partners makes our vision tangible



16.1.7 Awards & Recognitions

- Best Employee Engagement Award by HRSE in KSA & Middle East
- Best Employee Wellbeing Strategy in KSA 2023



CIPS supplier relationship management award 2023

CIPS EXCELLENCE IN PROCUREMENT AWARDS 2023

- Gold award in the ICT
- Silver award in the changing management and product
- Bronze award in the Eng and Infra



- Best voice of experience (VOX)
- Best change management award
- Best quality assurance
- Best delivery & inclusion program

CUSTOMER EXPERIENCE LIVE SHOW UK 2023

Strategic Excellence in Transforming Cybersecurity award from Cybersecurity Insiders



Inspiring Workplace awards MEA:

- Culture & Purpose
- Employee Experience
- Inclusion



Glotel 2022 Award for Innovation in digital infrastructure



Best Implementation Award For Incorta Data Processing Platform

incorta

Middle East Best Digital Transformation For Operators Award



Best Leadership Development of the year award 2023



Best IT service provider in KSA by Global business outlook



Data Management Excellence Award 2023



Integrated Performance Excellence Award from The KPI Institute

THE KPI INSTITUTE

Most Notable Listing Award Main Market



Best Implementation Award for Incorta Data Processing Platform



Best work environment for women Award



solutions' CFO awarded as the CFO of the Year'21 (Public Sector)



Two Stevie Awards:

- Most **Exemplary Employer**
- Most **Valuable Corporate Response**



- Best **Workplace in KSA 2022**
- Best **Workplace in Asia 2022**



CISO 50 Awards:

- 2022 best **cybersecurity** practices
- 2021 for the **efforts in security transformation**



Supply Chain Management and Digital Transformation Award



Corporate Social Responsibility Award 2024 from the Ministry of HRSD.



16.1.8 Recent Awards by Partners

Partner of the year for Middle east, Africa and Turkey 2023



Transformation partner of the year 2023



- Enterprise partner of the year
- Artificial Intelligence partner of the year



Best Contribution 2023



Prodigious Partner of the year 2023 award



Top Achiever partner in 2023



- Partner of the year 2023
- Telecom Partner of the Year 2023



- MEA theatre partner
- EMEA award service provider partner
- MEA award service provider partner
- Global WW award service provider



- Customer Excellence Award
- Excellent Global Sales Partner Award



- Partner of the Year 2022
- storage partner 2022



Strategic Partner of the year



- Enterprise Partner 2022
- Tiering Up Partner 2022



16.1.9 Excellence Certifications

Compliance of PCI DSS certification audit 2022 -Riyadh



Compliance of PCI DSS certification audit 2023 -Jeddah



ISO 41001 Facility Management
Certificate



ISO/IEC 27001:2022
Certificates in Info. Security for
IOC & COE Lab



Certificate in Protected Health
Information (PHI) and e-PHI.



ISO 20400:2017 Certificate in
maintain sustainable practices



ISO 31000:2018 Certificate in
Risk management



CSA Cloud control matrix



ISO 9001:2015 Certificate in
Quality Management



ISO 37301:2021 Certificate in
compliance management system



ISO/IEC 27017:2015
Certificate in Cloud
Information Security



ISO 14001 Environmental
Management System Certificate



ISO/IEC 27018 :2019
Certificate in IT Security
Management



ISO 45001 Occupational Health
and Safety Certificate



◆ 16.1.10 Excellence Clients



هيئة الزكاة والضريبة والجمارك
Zakat, Tax and Customs Authority



أرامكو السعودية
Saudi Aramco



الهيئة السعودية للفضاء
SAUDI SPACE COMMISSION



وزارة الاتصالات وتكنولوجيا المعلومات
MINISTRY OF COMMUNICATIONS AND INFORMATION TECHNOLOGY



16.1.11 Excellence Certification

Compliance of PCI DSS certification audit 2022 -Riyadh



Great Place to Work certification awarded (2021 – 2022)



Compliance of PCI DSS certification audit 2023 -Jeddah



Infoblox certification an a Authorized Service Partner-2023



Implementation Conformance Certificate Award eTOM 20.5



Certification of Procurement and Supply CIPS.



Certification of a network service provider for payment solutions



stc -Data Center, Jeddah



stc - ITCC Data Center, Riyadh



solutions by stc Dammam7 Data Center, Dhahran



ISO 41001 Facility Management
Certificate



ISO/IEC 27001:2022
Certificates in Info. Security for
IOC & COE Lab



Certificate in Protected Health
Information (PHI) and e-PHI.



ISO 20400:2017 Certificate in
maintain sustainable practices



ISO 31000:2018 Certificate in
Risk management



CSA Cloud control matrix



ISO 9001:2015 Certificate in
Quality Management



ISO 37301:2021 Certificate in
compliance management system



ISO/IEC 27017:2015
Certificate in Cloud
Information Security



ISO 14001 Environmental
Management System Certificate



ISO/IEC 27018 :2019
Certificate in IT Security
Management



ISO 45001 Occupational Health
and Safety Certificate





Our team is always ready and looking forward to hearing what you have.

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