

Telecom Reference Architecture, Part 2

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Enterprise Reference Architecture

The Enterprise Reference Architecture (RA) fills the gap between the concepts and vocabulary defined by the reference model and the implementation.

Reference architecture provides detailed architectural information in a common format such that solutions can be repeatedly designed and deployed in a consistent, high-quality, supportable fashion. This paper attempts to describe the Reference Architecture for the Telecom Application Usage and how to achieve the Enterprise Level Reference Architecture using SOA.

- Telecom Reference Architecture
- Enterprise SOA based Reference Architecture

Telecom Reference Architecture

Tele Management Forum's New Generation Operations Systems and Software (NGOSS) is an architectural framework for organizing, integrating, and implementing telecom systems. NGOSS is a component-based framework consisting of the following elements:

- The enhanced Telecom Operations Map (eTOM) is a business process framework.
- The Shared Information Data (SID) model provides a comprehensive information framework that may be specialized for the needs of a particular organization.
- The Telecom Application Map (TAM) is an application framework to depict the functional footprint of applications, relative to the horizontal processes within eTOM.
- The Technology Neutral Architecture (TNA) is an integrated framework. TNA is an architecture that is sustainable through technology changes.

NGOSS Architecture Standards are

- Centralized data
- Loosely coupled distributed systems
- Application components/re-use
- A technology-neutral system framework with technology specific implementations
- Interoperability to service provider data/processes
- Allows more re-use of business components across multiple business scenarios
- Workflow automation

The traditional operator systems architecture consists of four layers,

- Business Support System (BSS) layer, with focus toward customers and business partners. Manages order, subscriber, pricing, rating, and billing information.
- Operations Support System (OSS) layer, built around product, service, and resource inventories.
- Networks layer – consists of Network elements and 3rd Party Systems.
- Integration Layer – to maximize application communication and overall solution flexibility.

Reference architecture for telecom enterprises is depicted below.

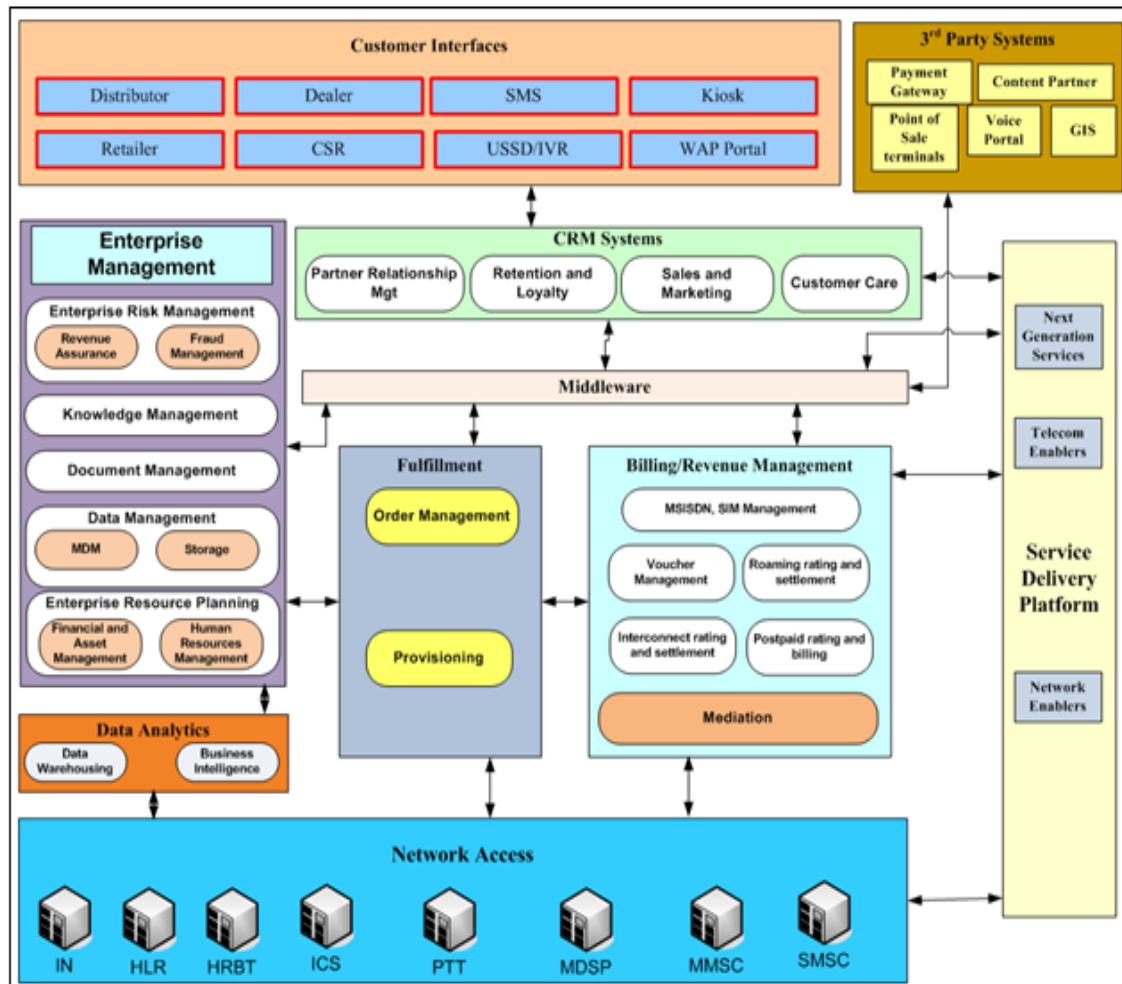


Figure 1. Telecom Reference Architecture

The major building blocks of any Telecom Service Provider architecture are as follows:

1. Customer Relationship Management

CRM encompasses the end-to-end lifecycle of the customer: customer initiation/acquisition, sales, ordering, and service activation, customer care and support, proactive campaigns, cross sell/up sell, and retention/loyalty.

CRM also includes the collection of customer information and its application to personalize, customize, and integrate delivery of service to a customer, as well as to identify opportunities for increasing the value of the customer to the enterprise.

The key functionalities related to Customer Relationship Management are

- Manage the end-to-end lifecycle of a customer request for products.
- Create and manage customer profiles.
- Manage all interactions with customers – inquiries, requests, and responses.
- Provide updates to Billing and other south bound systems on customer/account related updates such as customer/ account creation, deletion, modification, request bills, final bill, duplicate bills, credit limits through Middleware.

- Work with Order Management System, Product, and Service Management components within CRM.
- Manage customer preferences – Involve all the touch points and channels to the customer, including contact center, retail stores, dealers, self service, and field service, as well as via any media (phone, face to face, web, mobile device, chat, email, SMS, mail, the customer's bill, etc.).
- Support single interface for customer contact details, preferences, account details, offers, customer premise equipment, bill details, bill cycle details, and customer interactions.

CRM applications interact with customers through customer touch points like portals, point-of-sale terminals, interactive voice response systems, etc. The requests by customers are sent via fulfillment/provisioning to billing system for ordering processing.

2. Billing and Revenue Management

Billing and Revenue Management handles the collection of appropriate usage records and production of timely and accurate bills – for providing pre-bill usage information and billing to customers; for processing their payments; and for performing payment collections. In addition, it handles customer inquiries about bills, provides billing inquiry status, and is responsible for resolving billing problems to the customer's satisfaction in a timely manner. This process grouping also supports prepayment for services.

The key functionalities provided by these applications are

- To ensure that enterprise revenue is billed and invoices delivered appropriately to customers.
- To manage customers' billing accounts, process their payments, perform payment collections, and monitor the status of the account balance.
- To ensure the timely and effective fulfillment of all customer bill inquiries and complaints.
- Collect the usage records from mediation and ensure appropriate rating and discounting of all usage and pricing.
- Support revenue sharing; split charging where usage is guided to an account different from the service consumer.
- Support prepaid and post-paid rating.
- Send notification on approach / exceeding the usage thresholds as enforced by the subscribed offer, and / or as setup by the customer.
- Support prepaid, post paid, and hybrid (where some services are prepaid and the rest of the services post paid) customers and conversion from post paid to prepaid, and vice versa.
- Support different billing function requirements like charge prorating, promotion, discount, adjustment, waiver, write-off, account receivable, GL Interface, late payment fee, credit control, dunning, account or service suspension, re-activation, expiry, termination, contract violation penalty, etc.
- Initiate direct debit to collect payment against an invoice outstanding.
- Send notification to Middleware on different events; for example, payment receipt, pre-suspension, threshold exceed, etc.

Billing systems typically get usage data from mediation systems for rating and billing. They get provisioning requests from order management systems and inquiries from CRM systems. Convergent and real-time billing systems can directly get usage details from network elements.

3. Mediation

Mediation systems transform/translate the Raw or Native Usage Data Records into a general format that is acceptable to billing for their rating purposes.

The following lists the high-level roles and responsibilities executed by the Mediation system in the end-to-end solution.

- Collect Usage Data Records from different data sources – like network elements, routers, servers – via different protocol and interfaces.
- Process Usage Data Records – Mediation will process Usage Data Records as per the source format.
- Validate Usage Data Records from each source.
- Segregates Usage Data Records coming from each source to multiple, based on the segregation requirement of end Application.
- Aggregates Usage Data Records based on the aggregation rule if any from different sources.
- Consolidates multiple Usage Data Records from each source.
- Delivers formatted Usage Data Records to different end application like Billing, Interconnect, Fraud Management, etc.
- Generates audit trail for incoming Usage Data Records and keeps track of all the Usage Data Records at various stages of mediation process.
- Checks duplicate Usage Data Records across files for a given time window.

4. Fulfillment

This area is responsible for providing customers with their requested products in a timely and correct manner. It translates the customer's business or personal need into a solution that can be delivered using the specific products in the enterprise's portfolio. This process informs the customers of the status of their purchase order, and ensures completion on time, as well as ensuring a delighted customer. These processes are responsible for accepting and issuing orders. They deal with pre-order feasibility determination, credit authorization, order issuance, order status and tracking, customer update on customer order activities, and customer notification on order completion. Order management and provisioning applications fall into this category.

The key functionalities provided by these applications are

- Issuing new customer orders, modifying open customer orders, or canceling open customer orders;
- Verifying whether specific non-standard offerings sought by customers are feasible and supportable;
- Checking the credit worthiness of customers as part of the customer order process;
- Testing the completed offering to ensure it is working correctly;
- Updating of the Customer Inventory Database to reflect that the specific product offering has been allocated, modified, or cancelled;
- Assigning and tracking customer provisioning activities;
- Managing customer provisioning jeopardy conditions; and
- Reporting progress on customer orders and other processes to customer.

These applications typically get orders from CRM systems. They interact with network elements and billing systems for fulfillment of orders.

5. Enterprise Management

This process area includes those processes that manage enterprise-wide activities and needs, or have application within the enterprise as a whole. They encompass all business management processes that

- Are necessary to support the whole of the enterprise, including processes for financial management, legal management, regulatory management, process, cost, and quality management, etc.;

- Are responsible for setting corporate policies, strategies, and directions, and for providing guidelines and targets for the whole of the business, including strategy development and planning for areas, such as Enterprise Architecture, that are integral to the direction and development of the business;
- Occur throughout the enterprise, including processes for project management, performance assessments, cost assessments, etc.

(i) Enterprise Risk Management:

Enterprise Risk Management focuses on assuring that risks and threats to the enterprise value and/or reputation are identified, and appropriate controls are in place to minimize or eliminate the identified risks. The identified risks may be physical or logical/virtual. Successful risk management ensures that the enterprise can support its mission critical operations, processes, applications, and communications in the face of serious incidents such as security threats/violations and fraud attempts. Two key areas covered in Risk Management by telecom operators are

- **Revenue Assurance:** Revenue assurance system will be responsible for identifying revenue loss scenarios across components/systems, and will help in rectifying the problems. The following lists the high-level roles and responsibilities executed by the Revenue Assurance system in the end-to-end solution.
 - Identify all usage information dropped when networks are being upgraded.
 - Interconnect bill verification.
 - Identify where services are routinely provisioned but never billed.
 - Identify poor sales policies that are intensifying collections problems.
 - Find leakage where usage is sent to error bucket and never billed for.
 - Find leakage where field service, CRM, and network build-out are not optimized.
- **Fraud Management:** Involves collecting data from different systems to identify abnormalities in traffic patterns, usage patterns, and subscription patterns to report suspicious activity that might suggest fraudulent usage of resources, resulting in revenue losses to the operator.

The key roles and responsibilities of the system component are as follows:

- Fraud management system will capture and monitor high usage (over a certain threshold) in terms of duration, value, and number of calls for each subscriber. The threshold for each subscriber is decided by the system and fixed automatically.
- Fraud management will be able to detect the unauthorized access to services for certain subscribers. These subscribers may have been provided unauthorized services by employees. The component will raise the alert to the operator the very first time of such illegal calls or calls which are not billed.
- The solution will be to have an alarm management system that will deliver alarms to the operator/provider whenever it detects a fraud, thus minimizing fraud by catching it the first time it occurs.
- The Fraud Management system will be capable of interfacing with switches, mediation systems, and billing systems

(ii) Knowledge Management

This process focuses on knowledge management, technology research within the enterprise, and the evaluation of potential technology acquisitions.

Key responsibilities of knowledge base management are to

- Maintain knowledge base – Creation and updating of knowledge base on ongoing basis.
- Search knowledge base – Search of knowledge base on keywords or category browse.
- Maintain metadata – Management of metadata on knowledge base to ensure effective management and search.
- Run report generator.
- Provide content – Add content to the knowledge base, e.g., user guides, operational manual, etc.

(iii) Document Management

It focuses on maintaining a repository of all electronic documents or images of paper documents relevant to the enterprise using a system.

(iv) Data Management

It manages data as a valuable resource for any enterprise. For telecom enterprises, the typical areas covered are Master Data Management, Data Warehousing, and Business Intelligence. It is also responsible for data governance, security, quality, and database management.

Key responsibilities of Data Management are

- Using ETL, extract the data from CRM, Billing, web content, ERP, campaign management, financial, network operations, asset management info, customer contact data, customer measures, benchmarks, process data, e.g., process inputs, outputs, and measures, into Enterprise Data Warehouse.
- Management of data traceability with source, data related business rules/decisions, data quality, data cleansing data reconciliation, competitors data – storage for all the enterprise data (customer profiles, products, offers, revenues, etc.)
- Get online update through night time replication or physical backup process at regular frequency.
- Provide the data access to business intelligence and other systems for their analysis, report generation, and use.

(v) Business Intelligence

It uses the Enterprise Data to provide the various analysis and reports that contain prospects and analytics for customer retention, acquisition of new customers due to the offers, and SLAs. It will generate right and optimized plans – bolt-ons for the customers.

The following lists the high-level roles and responsibilities executed by the Business Intelligence system at the Enterprise Level:

- It will do Pattern analysis and reports problem.
- It will do Data Analysis – Statistical analysis, data profiling, affinity analysis of data, customer segment wise usage patterns on offers, products, service and revenue generation against services and customer segments.
- It will do Performance (business, system, and forecast) analysis, churn propensity, response time, and SLAs analysis.
- It will support for online and offline analysis, and report drill down capability.
- It will collect, store, and report various SLA data.
- It will provide the necessary intelligence for marketing and working on campaigns, etc., with cost benefit analysis and predictions.

- It will advise on customer promotions with additional services based on loyalty and credit history of customer
- It will Interface with Enterprise Data Management system for data to run reports and analysis tasks. It will interface with the campaign schedules, based on historical success evidence.

(vi) Stakeholder and External Relations Management

It manages the enterprise's relationship with stakeholders and outside entities. Stakeholders include shareholders, employee organizations, etc. Outside entities include regulators, local community, and unions. Some of the processes within this grouping are Shareholder Relations, External Affairs, Labor Relations, and Public Relations.

(vii) Enterprise Resource Planning

It is used to manage internal and external resources, including tangible assets, financial resources, materials, and human resources. Its purpose is to facilitate the flow of information between all business functions inside the boundaries of the enterprise and manage the connections to outside stakeholders. ERP systems consolidate all business operations into a uniform and enterprise wide system environment.

The key roles and responsibilities for Enterprise System are given below:

- It will handle responsibilities such as core accounting, financial, and management reporting.
- It will interface with CRM for capturing customer account and details.
- It will interface with billing to capture the billing revenue and other financial data.
- It will be responsible for executing the dunning process. Billing will send the required feed to ERP for execution of dunning.
- It will interface with the CRM and Billing through batch interfaces.

Enterprise management systems are like horizontals in the enterprise and typically interact with all major telecom systems. E.g., an ERP system interacts with CRM, Fulfillment, and Billing systems for different kinds of data exchanges.

6. External Interfaces/Touch Points

The typical external parties are customers, suppliers/partners, employees, shareholders, and other stakeholders. External interactions from/to a Service Provider to other parties can be achieved by a variety of mechanisms, including

- Exchange of emails or faxes
- Call Centers
- Web Portals
- Business-to-Business (B2B) automated transactions

These applications provide an internet technology driven interface to external parties to undertake a variety of business functions directly for themselves. These can provide fully or partially automated service to external parties through various touch points.

Typical characteristics of these touch points are

- Pre-integrated self-service system, including stand-alone web framework or integration front end with a portal engine
- Self services layer exposing atomic web services/APIs for reuse by multiple systems across the architectural environment
- Portlets driven connectivity exposing data and services interoperability through a portal engine or web application

These touch points mostly interact with the CRM systems for requests, inquiries, and responses.

7. Middleware

The component will be primarily responsible for integrating the different systems components under a common platform. It should provide a Standards-Based Platform for building Service Oriented Architecture and Composite Applications. The following lists the high-level roles and responsibilities executed by the Middleware component in the end-to-end solution.

- As an integration framework, covering to and fro interfaces
- Provide a web service framework with service registry.
- Support SOA framework with SOA service registry.
- Each of the interfaces from / to Middleware to other components would handle data transformation, translation, and mapping of data points.
- Receive data from the caller / activate and/or forward the data to the recipient system in XML format.
- Use standard XML for data exchange.
- Provide the response back to the service/call initiator.
- Provide a tracking until the response completion.
- Keep a store transitional data against each call/transaction.
- Interface through Middleware to get any information that is possible and allowed from the existing systems to enterprise systems; e.g., customer profile and customer history, etc.
- Provide the data in a common unified format to the SOA calls across systems, and follow the Enterprise Architecture directive.
- Provide an audit trail for all transactions being handled by the component.

8. Network Elements

The term Network Element means a facility or equipment used in the provision of a telecommunications service. Such terms also includes features, functions, and capabilities that are provided by means of such facility or equipment, including subscriber numbers, databases, signaling systems, and information sufficient for billing and collection or used in the transmission, routing, or other provision of a telecommunications service.

Typical network elements in a GSM network are Home Location Register (HLR), Intelligent Network (IN), Mobile Switching Center (MSC), SMS Center (SMSC), and network elements for other value added services like Push-to-talk (PTT), Ring Back Tone (RBT), etc.

Network elements are invoked when subscribers use their telecom devices for any kind of usage. These elements generate usage data and pass it on to downstream systems like mediation and billing system for rating and billing. They also integrate with provisioning systems for order/service fulfillment.

9. 3rd Party Applications

3rd Party systems are applications like content providers, payment gateways, point of sale terminals, and databases/applications maintained by the Government.

Depending on applicability and the type of functionality provided by 3rd party applications, the integration with different telecom systems like CRM, provisioning, and billing will be done.

10. Service Delivery Platform

A service delivery platform (SDP) provides the architecture for the rapid deployment, provisioning, execution, management, and billing of value added telecom services. SDPs are based on the concept of SOA and layered architecture. They support the delivery of voice, data services, and content in network and device-independent fashion. They allow application developers to aggregate network capabilities, services, and sources of content. SDPs typically contain layers for web services exposure, service application development, and network abstraction.

SOA Reference Architecture

SOA concept is based on the principle of developing reusable business service and building applications by composing those services, instead of building monolithic applications in silos.

It's about bridging the gap between business and IT through a set of business-aligned IT services, using a set of design principles, patterns, and techniques.

In an SOA, resources are made available to participants in a value net, enterprise, line of business (typically spanning multiple applications within an enterprise or across multiple enterprises). It consists of a set of business-aligned IT services that collectively fulfill an organization's business processes and goals. We can choreograph these services into composite applications and invoke them through standard protocols.

SOA, apart from agility and reusability, enables

- The business to specify processes as orchestrations of reusable services
- Technology agnostic business design, with technology hidden behind service interfaces
- A contractual-like interaction between business and IT, based on service SLAs
- Accountability and governance, better aligned to business services
- Applications interconnections untangling by allowing access only through service interfaces, reducing the daunting side effects of change
- Reduced pressure to replace legacy and extended lifetime for legacy applications, through encapsulation in services
- A Cloud Computing paradigm, using web services technologies, that makes possible service outsourcing on an on-demand, utility-like, pay-per-usage basis

The following section represents the Reference Architecture of logical view for the Telecom Solution. The new custom built application needs to align with this logical architecture in the long run to achieve EA benefits.

Packaged implementation applications, such as ERP billing applications, need to expose their functions as service providers (as other applications consume) and interact with other applications as service consumers.

COT applications need to expose services through wrappers such as adapters to utilize existing resources and at the same time achieve Enterprise Architecture goal and objectives.

The following are the various layers for Enterprise level deployment of SOA. This diagram captures the abstract view of Enterprise SOA layers and important components of each layer. Layered architecture means decomposition of services such that most interactions occur between adjacent layers. However, there is no strict rule that top layers should not directly communicate with bottom layers.

The diagram below represents the important logical pieces that would result from overall SOA transformation.

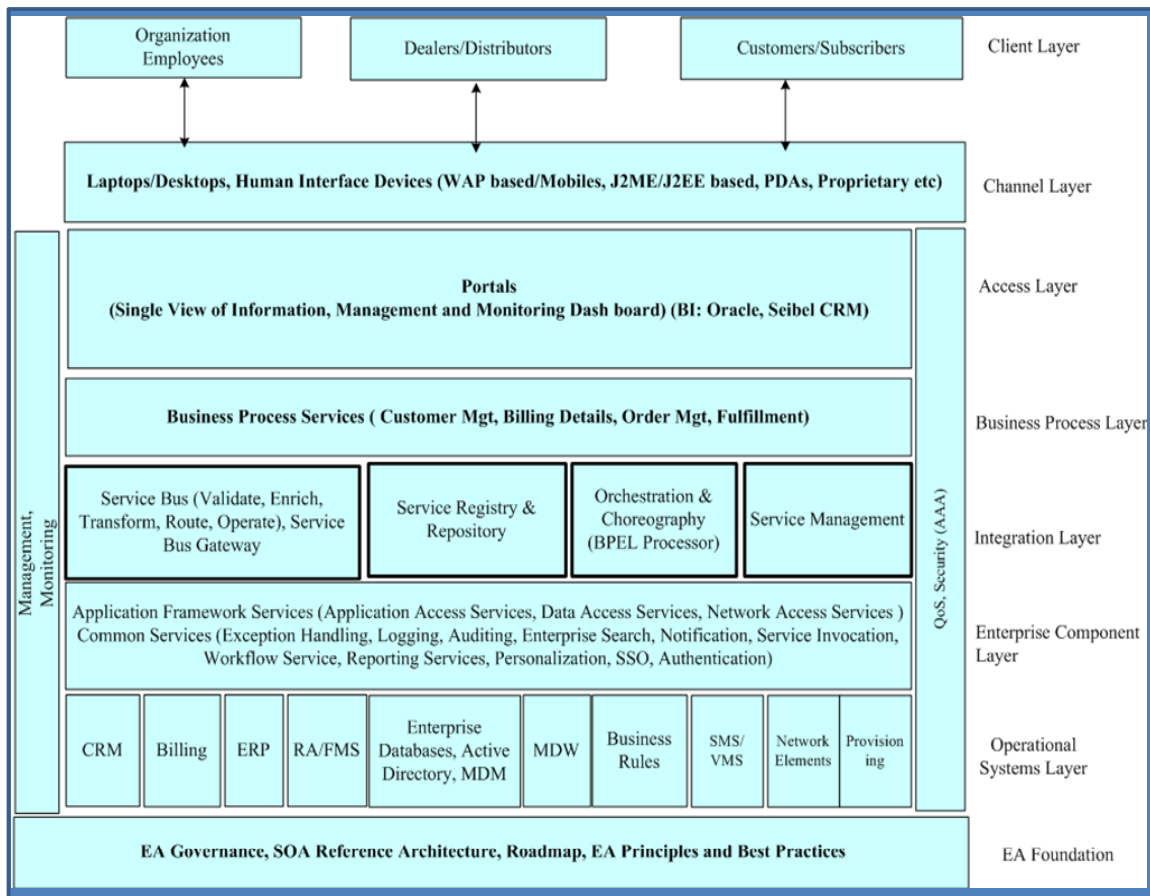


Figure 2. Enterprise SOA Reference Architecture

- Operational System Layer:** This layer consists of all packaged applications like CRM, ERP, custom built applications, COTS based applications like Billing, Revenue Management, Fulfillment, and the Enterprise databases that are essential and contribute directly or indirectly to the Enterprise OSS/BSS Transformation.

ERP holds the data of Asset Lifecycle Management, Supply Chain, and Advanced Procurement and Human Capital Management, etc.

CRM holds the data related to Order, Sales, and Marketing, Customer Care, Partner Relationship Management, Loyalty, etc.

Content Management handles Enterprise Search and Query.

Billing application consists of the following components:

- Collections Management, Customer Billing Management, Invoices, Real-Time Rating, Discounting, and Applying of Charges
-

Enterprise databases will hold both the application and service data, whether structured or unstructured.

MDM - Master data majorly consists of Customer, Order, Product, and Service Data.

2. Enterprise Component Layer:

This layer consists of the Application Services and Common Services that are responsible for realizing the functionality and maintaining the QoS of the exposed services. This layer uses container-based technologies such as application servers to implement the components, workload management, high availability, and load balancing.

Application Services: This Service Layer enables application, technology, and database abstraction so that the complex accessing logic is hidden from the other service layers. This is a basic service layer, which exposes application functionalities and data as reusable services. The three types of the Application access services are

Application Access Service: This Service Layer exposes application level functionalities as a reusable service between BSS to BSS and BSS to OSS integration. This layer is enabled using disparate technology such as Web Service, Integration Servers, and Adaptors, etc.

Data Access Service: This Service Layer exposes application data services as a reusable reference data service. This is done via direct interaction with application data. and provides the federated query.

Network Access Service: This Service Layer exposes provisioning layer as a reusable service from OSS to OSS integration. This integration service emphasizes the need for high performance, stateless process flows, and distributed design.

Common Services encompasses management of structured, semi-structured, and unstructured data such as information services, portal services, interaction services, infrastructure services, and security services, etc.

3. Integration Layer:

This consists of service infrastructure components like service bus, service gateway for partner integration, service registry, service repository, and BPEL processor. Service bus will carry the service invocation payloads/messages between consumers and providers. The other important functions expected from it are itinerary based routing, distributed caching of routing information, transformations, and all qualities of service for messaging-like reliability, scalability, and availability, etc. Service registry will hold all contracts (wsdl) of services, and it helps developers to locate or discover service during design time or runtime.

- BPEL processor would be useful in orchestrating the services to compose a complex business scenario or process.
- Workflow and business rules management are also required to support manual triggering of certain activities within business process. based on the rules setup and also the state machine information.

Application, data, and service mediation layer typically forms the overall composite application development framework or SOA Framework.

4. Business Process Layer: These are typically the intermediate services layer and represent Shared Business Process Services. At Enterprise Level, these services are from Customer Management, Order Management, Billing, Finance, and Asset Management application domains.

5. Access Layer: This layer consists of portals for Enterprise and provides a single view of Enterprise information management and dashboard services.

6. Channel Layer: This consists of various devices; applications that form part of extended enterprise; browsers through which users access the applications.

7. **Client Layer:** This designates the different types of users accessing the enterprise applications. The type of user typically would be an important factor in determining the level of access to applications.
8. Vertical pieces like management, monitoring, security, and development cut across all horizontal layers

Management and monitoring involves all aspects of SOA-like services, SLAs, and other QoS lifecycle processes for both applications and services surrounding SOA governance.

9. EA Governance, Reference Architecture, Roadmap, Principles, and Best Practices:

EA Governance is important in terms of providing the overall direction to SOA implementation within the enterprise. This involves board-level involvement, in addition to business and IT executives. At a high level, this involves managing the SOA projects implementation, managing SOA infrastructure, and controlling the entire effort through all fine-tuned IT processes in accordance with COBIT (Control Objectives for Information Technology).

Devising tools and techniques to promote reuse culture, and the SOA way of doing things needs competency centers to be established in addition to training the workforce to take up new roles that are suited to SOA journey.

Conclusions

Reference Architectures can serve as the basis for disparate architecture efforts throughout the organization, even if they use different tools and technologies. Reference architectures provide best practices and approaches in the independent way a vendor deals with technology and standards. Reference Architectures model the abstract architectural elements for an enterprise independent of the technologies, protocols, and products that are used to implement an SOA. Telecom enterprises today are facing significant business and technology challenges due to growing competition, a multitude of services, and convergence. Adopting architectural best practices could go a long way in meeting these challenges. The use of SOA-based architecture for communication to each of the external systems like Billing, CRM, etc., in OSS/BSS system has made the architecture very loosely coupled, with greater flexibility. Any change in the external systems would be absorbed at the Integration Layer without affecting the rest of the ecosystem. The use of a Business Process Management (BPM) tool makes the management and maintenance of the business processes easy, with better performance in terms of lead time, quality, and cost. Since the Architecture is based on standards, it will lower the cost of deploying and managing OSS/BSS applications over their lifecycles.

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Glossary of Terms

Acronym/Abbreviation	Definition
BPM	Business Process Management
BI	Business Intelligence
BPEL	Business Process Execution Language
BRM	Billing and Revenue Management
BSS	Business Support System
CDR	Call Detail Record
COBIT	Control Objectives for Information and Related Technology
COTS	Commercial Off the Shelf
EA	Enterprise Architecture
eTOM	enhanced Telecom Operations Map
ERP	Enterprise Resource Planning
ETL	Extract, Transform, Load
FMS	Fraud Management System
HTTP	Hyper Text Transfer Protocol
HTTPS	Hypertext Transfer Protocol Secure
HLR	Home Location Register
HOP	Hand Over Point
IMS	IP Multimedia Service
IN	Intelligent Network
IP	Internet Protocol
IT	Information Technology
MDM	Master Data Management
NGOSS	New Generation Operations Systems and Software
ODS	Operational Data Store
QOS	Quality of Service
RA	Revenue Assurance
RBAC	Role-Based Access Control
RBT	Ring-Back Tone
SDP	Service Delivery Platform

SID	Shared Information Data Model
SMS	Short Messaging Service
SMSC	Short Messaging Service Center
SOA	Service Oriented Architecture
SOAP	Simple Object Access Protocol
SP	Service Provider
TAM	Telecom Application Map
TOM	Telecom Operations Map
TMF	Telecom Management Forum
TNA	Technology Neutral Architecture
XML	Extensible Markup language
SOAP	Simple Object Access Protocol
USSD	Unstructured Supplementary Service Data
VAS	Value Added Services
WSDL	Web Service Definition Language

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