بسم الله الرحمن الرحيم

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College of Computer Science and Information Technology

Proposing Template for Service level Agreements of the Fixed Internet Service Providers in Sudan

أقتراح قالب لأتفاقيات مستوى الخدمة لمقدمي الانترنت الثابت في السودان

A Thesis Submitted to the College of Graduate Studies in Partial Fulfillment of the Requirements for the Degree of Master of Computer Science

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الآيـــــة

(قُلْ هَلْ يَسْتَوِي الَّذِينَ يَعْلَمُونَ وَالَّذِينَ لَا يَعْلَمُونَ)

سورة الزمر(9)

Dedication

This thesis is dedicated to:

In the name of God, my Creator, Master of My Master, and my great messenger Muhammad (May God bless him and grant him peace) who taught us the purpose of life,

I dedicate this research to:

To whom was her prayer the secret of my success and surgical balm

To my beloved mom

To those who taught me without waiting, and I carry his name with pride

To my beloved father

To those who carry in their eyes the memories of my childhood

To my sisters

To my professors,

Companions for the trail,

To all the people in my life who have touched my heart,

To the nation's martyrs,

Acknowledgements

In the Name of Allah, the Most Merciful, the Most Compassionate All praise be to Allah, the Lord of the worlds; and prayers and peace be upon Mohamed His servant and messenger.

First and foremost, I must acknowledge my limitless thanks to Allah, the Ever-Magnificent; the Ever-Thankful, for His help and blessings. I am totally sure that this work would not have been accomplished, without His guidance.

I owe great debt of gratitude to our university for giving me the opportunity to complete this work.

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I would also like to express my wholehearted thanks to my family for their generous support provided to me throughout my entire academic life and particularly through the process of pursuing the master degree. Because of their unconditional love and prayers, I have managed to complete this thesis.

Abstract

The provision of telecommunications sector services includes important components related to business accuracy and performance provided, which directly reflect on the quality of service and thus on the customer's satisfaction. Contractual relation between customers and telecommunication service providers are becoming increasingly complex, largely due to changes in the marketplace and growth in the number and complexity of offered services. Therefore, Service Level Agreements (SLA) are essential and play a key role to manage the provided services among the network entities. they refer to the service contracts between providers of telecommunications service and their customers, is used to specify what the customer could expect from the provider, the obligations of the customer as well as the provider, performance, availability, security objectives of the service, in addition the procedures to be followed to ensure compliance with the SLA. Hence to comprehensive definition of SLA templates is to provide the structures and the organizational methodology for the SLA content. In this research, a general study on the concept and components of the SLA is presented, the study proposes template that represent these components. The study also highlights, the importance of SLA in the telecommunications sector, comparing the existing templates in Sudanese telecommunications sector with the global templates for communications. The aim of this research is to propose a new template to improve the quality of services in Sudanese telecom companies.

المستخلص

يتضمن تقديم خدمات قطاع الاتصالات مكونات مهمة تتعلق بدقة الأعمال والأداء المقدم ، والتي تنعكس بشكل مباشر على جودة الخدمة وبالتالي على رضا العميل. أصبحت العلاقة التعاقدية بين العملاء ومقدمي خدمات الاتصالات معقدة بشكل متزايد ، ويرجع ذلك إلى حد كبير إلى التغيرات في السوق والنمو في عدد وتعقيد الخدمات المعروضة. لذلك ، تعد اتفاقيات مستوى الخدمة (SLA) ضرورية وتلعب دورًا رئيسيًا في إدارة الخدمات المقدمة بين كيانات الشبكة. تشير إلى عقود الخدمة بين مزودي خدمة الاتصالات وعملائهم ، وتستخدم لتحديد ما يمكن أن يتوقعه العميل من المزود ، والتزامات العميل وكذلك المزود ، والأداء ، والتوافر ، والأهداف الأمنية للخدمة ، في إضافة الإجراءات الواجب اتباعها لضمان الامتثال لاتفاقية مستوى الخدمة. ومن ثم ، فإن التعريف الشامل لقوالب SLA يوفر الهياكل والمنهجية التنظيمية لمحتوى SLA. في هذا البحث ، يتم تقديم دراسة عامة حول مفهوم ومكونات اتفاقية مستوى الخدمة ، وتقترح الدراسة نموذجًا يمثل هذه المكونات. كما تسلط الدراسة الضوء على أهمية اتفاقية مستوى الخدمة في قطاع الاتصالات ، ومقارنة النماذج الموجودة في قطاع الاتصالات السوداني مع النماذج العالمية للاتصالات. الهدف من هذا البحث هو اقتراح نهج جديد لتحسين جودة الخدمات في شركات الاتصالات السودانية.

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List of Abbreviations

Abbreviations	Full Form
ITU-T	International Telecommunication Union – Telecommunication Standardization Sector
ETSI	European Telecommunications Standards Institute
SLA	Service Level Agreement
SLO	Service Level Objective
SP	Service Provider
SC	Service Customer
ISP	Internet Service Provider
QoS	Quality of Service
NP	Network Performance
KQI	Key Quality Indicator
KPI	Key Performance Indicator
UA	Unavailability
SA	Service Availability
SAP	Service Access Point
OGF	open grid forum

Chapter 1: Introduction

1.1 Background of the Research

Over the years, it has been of great concern to service providers and their consumers to provide and evaluate service quality for network end-users[1]. in order to guarantee a certain quality of the provided service and in response to customer needs, some mechanisms of service level management must be implemented [2]. Service Level Agreement (SLA) is a formal definition of the relationship that exists between a service provider and its customer. An SLA can be specified and used in any industry and is used to determine what the customer can expect from the provider, the customer's and the provider's obligations, the service's performance, availability and security goals, as well as the procedures to be followed to ensure compliance with the SLA[3].

SLA templates are, thus, the canonical system and format of a SLA, they provide the mechanisms and method of organization for the content of the SLA. When the SLA models are filled in with unique details for a particular service, they become a realistic example of SLA[4]. In order to ensure a certain quality of the service provided, some service level management mechanisms must be applied. In spite of the application of these agreements in Sudan, there is no standard SLA template during the service negotiations and the service quality assurance phase.

1.2 Problem Statement

There is no standardized SLA templates to manage quality of service (QoS) and service guarantee of telecommunication services effectively. The absence of a standard template means that there is no structure and method for organizing the SLA contents there is no mapping scheme between the SLAs and QoS parameters, there is no comprehensive definition of the components of the service providers and customers that proper the SLA, this conflicts with the primary goal of the SLA which aim to create a healthy relationship between the service

provider (SP) and the service customer(SC), and to protect the legal rights of both the SP and the SC.

1.3 Questions of the Research

- Does the current SLA in Sudan meet the International standards?
- How to improve the current SLA in Sudan?
- How to evaluate the proposed SLA Template?

1.4 Objectives of the Research

- To evaluate the current Service Level Agreement (SLA) which is existing in Sudan.
- To propose an SLA Templates for telecom services to manage QoS and guarantee telecommunication services effectively.
- To compare the proposed standardize template with the existing SLA in Sudan and find the gap between them.

1.5 Significance of the Research

The research plays and important role for the telecommunications sector in Sudan. Although SLA are currently applied at the local level of institutions yet there is no real commitment to SLA. It is necessary to adhere to the telecommunications law enforcement in Sudan that concerns the quality of fixed internet service providers, in addition to the customer's awareness to obtain standardized services followed by international characteristics and standardized templates to commensurate customer's needs.

1.6 Scope of the Research

The scope of this research is to provide designed SLA template meeting the requirements for different services that can be adapted to any telecommunication service in Sudan, especially Fixed Internet Service Providers (ISP) Companies of Sudan.

1.7 Methodology of the Research

This Research consists of many phases: First, studying of Service Level Agreement (SLA) and the standards bodies of the SLAs. Second, evaluating the current Service Level Agreement (SLA) Existing in Sudan. Third, designing SLA Templates to manage QoS to guarantee the implementation of the telecommunication services effectively. Fourth, finding gap between the existing agreements in Sudan and the proposed template.

1.8 Thesis Organization

Chapter one is a background about SLA and it includes also description of the problem statement, questions, objectives, scope and methodology of study. Chapter two Literature review and a general definition of a SLA, quality of service and a study of the standards bodies of the SLAs. Chapter three describes the research methodology, evaluates existing SLAs in Sudan, then design SLA template, and finally the comparison proposed standardized template to the existing SLA in Sudan and fine the gap between them. Chapter four is the conclusion and recommendation of the study.

Chapter 2: Literature Review

This chapter introduces SLA and their components, defines the QoS and service life cycle, in addition to the discussion of the international standards bodies to create SLA template. The chapter also discussion the importance and function of their role in promoting and improving the work of telecommunications institutions by presenting the institution's work according to levels determined by the company in line with its objectives and strategy.

2.1 A General Overview of Service Level Agreement (SLA)

2.1.1 Definition of Service Level Agreement (SLA)

A Service Level Agreement (SLA) is a contract between a network service provider and a customer that specifies, usually in measurable terms, what services the network service provider will furnish and what penalties will assess if the service provider cannot meet the established goals [5][6][7].

Researchers defined “Service Level Agreement” as a format that contains an explanation of the agreed service, parameters of the level of service, the guarantees regarding the Quality of Service, and arrangements for all cases of violations [8].

The manner in which these interactions are carried out the contracting parties’ involvement is specified by electronic contracts, the collection of QoS assurances and the commitments of the different parties are an essential feature of an IT services contract. This is usually called a Service Level Agreement (SLA) [9][10].

2.1.2 Service Provider and Service Customer Definitions

SP refers to firms who offer business such as communications and/or data services. **SC** exploit the SLA to reach the stage of quality of service they require and to keep appropriate business models for a long period [1][11][8].

2.1.3 SLA Components

An ideal SLA should include the following components as shown in below figure 2.1 [12][3]:

- Purpose – mentions why SLA is formed.
- Parties – mentions the parties included in the SLA and their jobs.
- Validity Period- states the time period covered by the SLA. This is defined by both the start time and the final time of the period.
- Scope – describes the services mentioned in the SLA; SLA structure should illustrate the service so that the consumer can simply recognize the services procedure.
- Restrictions – states the essential steps to be done in order to supply the required service levels.
- Service-level objectives – the service levels that are approved by the customer and the providers.
- Service-level indicators – those indicators are used to measure these levels of service.
- Penalties – describes what is to be done when the provider cannot achieve the goals in the SLA.
- Optional services – services that are not ordinarily needed by the customer, but might be needed as exclusion.
- Administration – defines the procedures formed in the SLA to achieve and measure its goals.
- Exclusions – states what is not included in the SLA.

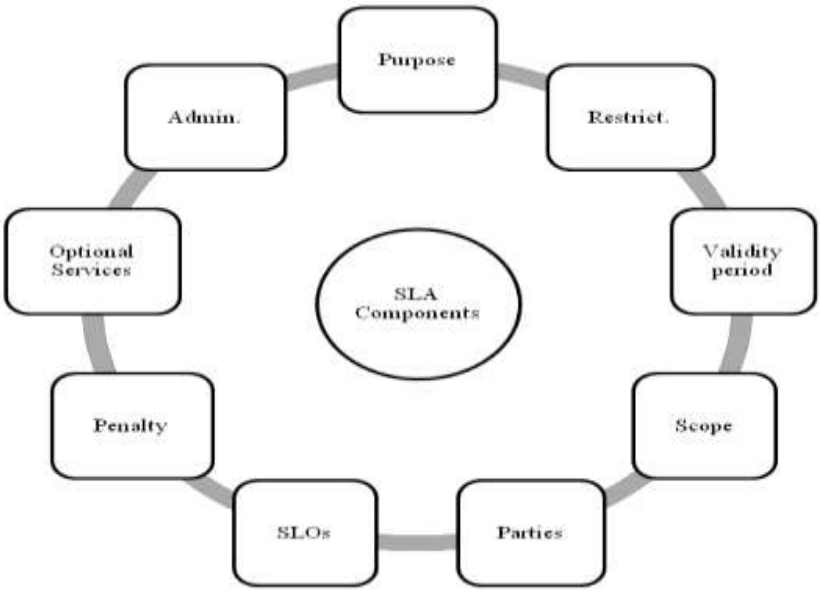

Figure 2. 1: SLA Components

2.1.4 Qualities That Can Be Determined in an SLA

There are two groups of qualities that can be identified in SLAs: **Measurable Qualities** can be measured automatically using metrics; for example, the percentage of time a system is available, accuracy and capacity. **Unmeasurable Qualities** are those that cannot be measured automatically from a given viewpoint; for example, determining the cost of changing a service (modifiability) is difficult to automate and interoperability [12][8].

2.1.5 SLA Parameters and Metrics

Metrics are used in process control, software process improvement, business strategy implementation, and basically any field where data has to be collected in order to verify whether goals are being met [10][12].Or Value calculated from observed attribute/s of a measure[13].SLA parameters are a quantifiable characteristic of a service with specified scope and boundaries. parameters should be: achievable, enforceable and quantifiable [12][8].

2.1.6 Standards

There are two standard formats for SLA documents[12]:

I. Web Service language Agreement WSLA

The WSLA framework was proposed by IBM in 2001, its language is based on XML and defined as an XML schema. Primarily, the WSLA allows the creation of machine-readable SLAs for services implemented using web services technology that defines service interfaces in the WSDL[10][14]. The WSLA Language Specification defines a type system for the various SLA artifacts. WSLA is designed to accommodate this structure in three sections[10][15][14]:

- All the contractual parties are listed in the Parties section.
- The Service Definition portion of the SLA defines the service features and measurable parameters of the service. The goal of the definition of the service is to explain four issues: What are the parameters of the SLA? What service do they pertain to? How SLA parameters are determined or measured? How can we access the metrics of a managed resource? This is the information needed by the measurement service in order to perform its tasks.
- Obligations, the last part of an SLA, describe different guarantees and restrictions that may be imposed on the parameters of the SLA.

II. WS-Agreement

The WS-Agreement specification, developed by the OGF, defines an XML-based language for agreements as well as a protocol for advertising the capabilities of service providers, creating agreements between service consumers and providers, and monitoring agreement compliance [9][16][17].

2.1.7 SLA Life Cycle

It define the SLA life cycle in three phases (Figure 2.2). Firstly, the **Creation Phase**, in which the customers find service provider who matches their service requirements. Secondly, the **Operation Phase**, in which a customer has read-only access to the SLA. Thirdly, the **Removal Phase**, in which SLA is terminated and all associated configuration information is removed from the service systems[6][8].

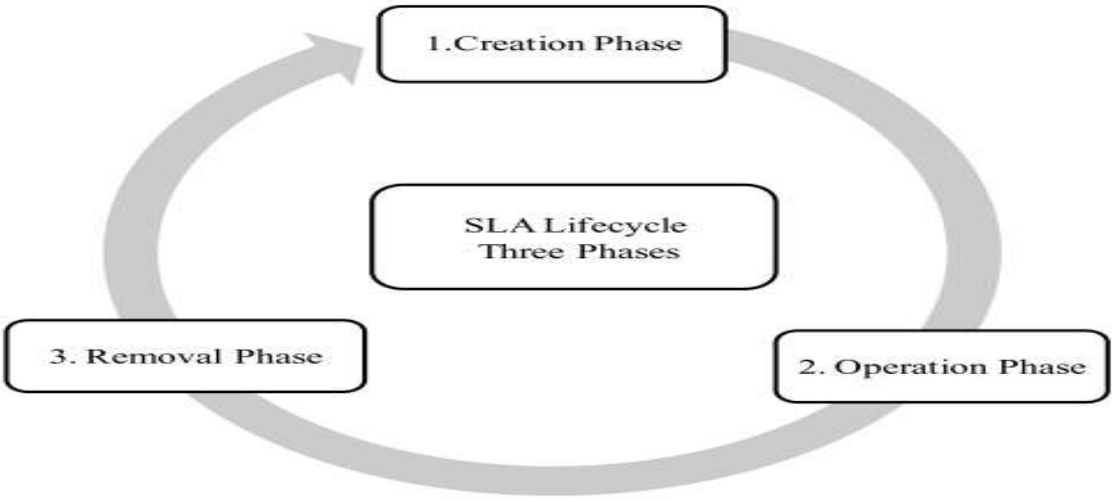

Figure 2. 2: SLA Life Cycle SLA

Table 2. 1: Mapping Between Types of SLA Life Cycle

Three Phases	Three Phases Six Steps	Description
Creation Phase	Development of Service and SLA Templates	This stage involves the identification of customer needs and requirements, the capacities of the network, the identification of acceptable service features and criteria, the levels of service, the execution of service, and the implementation of SLA standard models[12][6].
	Discovery and Negotiation of an SLA	The stage of discovery consists of the negotiation of the SLA with the customer to select the values of the SLA parameters related to specific services, the costs incurred by the service customer after signing the SLA, the costs incurred by the service provider when the SLA is infringed, the definition and, at last, the periodicity of the reports

		related to the service to be provided to the service customer[6][12].
	Service Provisioning and Deployment	This stage involves the resource provisioning of the service, where the service is activated and prepared for the use of the service shopper, network configuration that may be to meet particular service requirements, or to support the overall service network, and service activation[6][12].
Operation Phase	Execution of the Service	This step is the service's actual evaluation. It consists of three main stages, the first being the execution and control of the service, then the actual reporting time and finally the QOS validation that refers to the quality of service. SLA violation processing is the final step of this level[6][12].
Removal Phase	Assessment and Corrective Actions during Execution	The evaluation stage of SLA consists of two sections, the individual customer assessment and the overall service evaluation. For each SLA, the customer's SLA evaluation involves assessing the level of customer service (QoS), customer satisfaction, achieving future changes, and evolving requirements and assessment of the overall service [6][12].
	Termination and Decommission of the Service	Termination and decommissioning of the process of the service which is in charge of terminating the service. This termination may be the product of multiple reasons; it may be a contract issue, expiration or breach. The decommissioning of the discontinued services which result in the SLA being terminated[6][12].

2.1.8 Benefits of SLA

The actual SLA an integral part of the service provider's product offerings - depicts exact details of the service construct, quality expectations, and delivery. There are many benefits of the SLA [22]**:**

- Help companies understand Customer and SP requirements for SLAs.
- Help equipment suppliers agree on the mapping of technology-specific parameters and measurement methods into service-specific parameters and measurement methods.
- Help software companies agree on common interface definitions for SLA management.
- Help prioritize service improvement opportunities.

- Help create common SLA/QoS goals across multiple technology domains.
- Help Customers define the end-to-end QoS metrics for multimedia telecommunication services, especially those carried over IP-based networks.
- Help Customers compare services and service quality levels offered by different SPs.

2.2 Service Quality

The term service quality is an association of two different words, service and quality. A **service** is an action performed by an entity (the provider) on behalf of another one (the requester), through the interaction between these two entities, which is called service provisioning and involves various phases, there is a transfer of value from the provider to the requester or recipient. The service is a mixture of several features: intangibility, heterogeneity, perishability, and production and consumption simultaneously [18]. **A quality** has come to be recognized as a strategic tool for attaining operational efficiency and better performance of business[19]. Also Recommendation ITU define both **a service** a set of functions offered to a user by an organization constitutes a service, **Quality** the totality of an entity's characteristics that bear on its ability to meet stated and implied requirements [13].

The **service quality** as a multi-item scale developed to measure the quality of service, described as the degree and direction of discrepancy between the perceptions and expectations of customer’s service. it distinguishes two kinds of quality of service: technological related to what the customer gets from a service and functional related to the delivery of the service[20].

2.2.1 Quality of Service

Quality of service (QoS) Complete characteristics of a telecommunications service which bear on its responsibility to satisfy the service user's specified and implied needs[13].Service Level Agreements (SLAs) specifying quality attributes (QoS -Quality of Service) and ensuring the quality of service needed[21].

It is important to differentiate between types of QoS parameters that are independent of the infrastructure and service-supporting network technology, those that are service-related and those that are specific to network technology[22]:

- Technology-specific Parameters: Technology-specific QoS parameters are those related to the network technology supporting the service, particularly where the service offered is a network bearer service.
- Service-specific Parameters: Service-specific QoS parameters are those typically related to the application carried by the network and, service-specific or application-specific technology parameters such as reliability.
- Technology/Service-independent Parameters: Service/technology-independent QoS parameters are those which are often (if not always) specified in a SLA. Examples such as percentage of the availability.

2.2.1.1 Service Life Cycle and QoS

In fact, service quality can play a significance role during several phases of the service life-cycle shown in below Figure 2.3 [23]:

I. Service product planning and development

When planning and developing a service product, consideration must be given to a number of QoS and SLA aspects.

II. Negotiation and sales

During this phase, the service provider must negotiate and agree with the customer technical details of specific instances of the service product offered.

III. Implementation

Service implementation is the phase when the service is configured, activated (commissioned or brought into service) and operation begins.

IV. Execution

This phase covers all normal operations of the services and service instances covered by the SLA. It includes normal in-service monitoring and operation, real-time QoS reporting and service quality validation, and real-time SLA violation handling.

V. Assessment

Assessment of QoS and SLA is scheduled during a single customer SLA contract period where the assessment is related to the delivered QoS against the SLA parameter values and limits, and the levels of customer satisfaction with the service product.

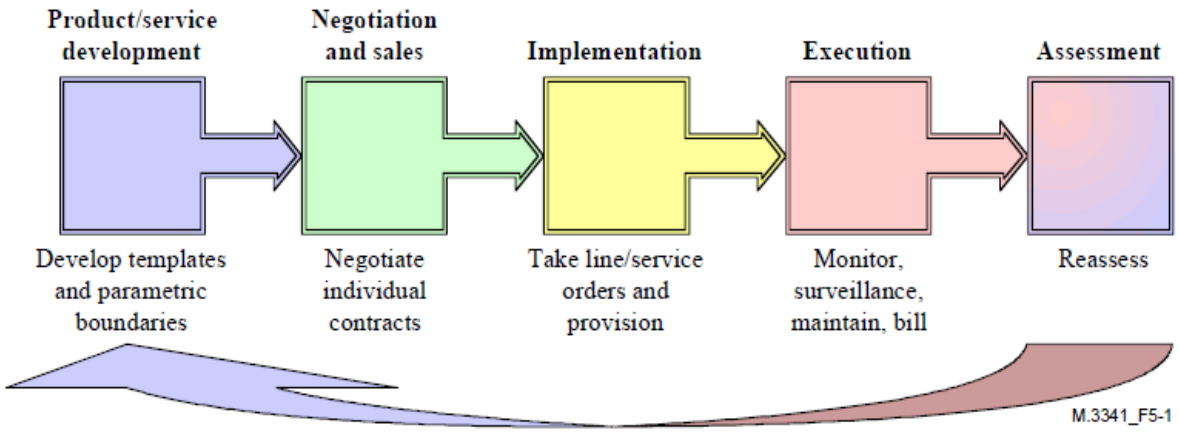

Figure 2. 3: Service Life Cycle and QoS

2.2.2 Network Performance (NP)

The ability of a network or network portion to provide the functions related to communications between users[13]. NP relies on the planning, growth, operation and maintenance of the service-supporting network by an SP and can be considered the center of the technical part of QoS [22]. It is important therefore to distinguish between NP and QoS events and parameters[22]:

Table 2. 2: Distinction between QoS and NP

QoS	NP
User-oriented	Provider-oriented
Service attribute	Connection element
Focus on user-observable effects	Focus on planning, design and development, operations an d maintenance of network
Between Service Access Points	End-to-end or network connection element capabilities

In the view of customers, the overall quality of a telecommunication service is affected by several factors linked to network efficiency parameters shown below (figure 2.4). The critical element of estimating a service is the perception of the client, and therefore its degree of satisfaction with the provider, which is the only organization with which it communicates directly. This level of satisfaction comes from the perception of the various service aspects (support, operability, serviceability, security), which are influenced by network characteristics[21].

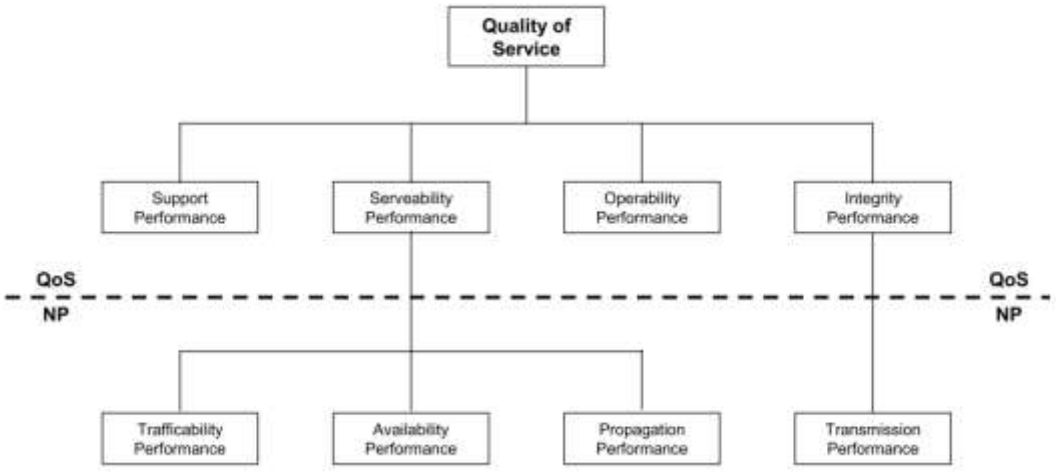

Figure 2. 4: Relation between QoS and NP

Four main factors contribute collectively to the overall QoS perceived by the user of a telecommunication service (see Figure2.4). These are severability, operability, integrity and support, each of which should be considered as a concept characterized by many measures or parameters. Serveability includes both accessibility performance and retainability performance. These in turn can be broken down in terms of trafficability, availability, reliability and propagation performance, all of which can be considered Network Performance (NP) that delivers QoS. Service integrity depends on transmission (information transfer) NP[22]

2.3 Standards Bodies of the SLAs

Telecommunication networks in every country use formal communication standards for physical interconnection. Without signed agreements and telecommunications standards, large-scale voice and data communications would not be possible. There are many international standards that provide guidelines and instructions for defining and configuring SLA templates in order to effectively manage service quality and ensure the service of telecommunications services. However there are many standards and guidelines for creating SLAs:

2.3.1 ITU

The international telecommunications union is an alliance organization of the United Nations which has members in each country. As an organization of governments, the ITU also has the most formal telecommunications standards for organizations, and provides recommendations for creating standard templates for SLA content.

2.3.2 ETSI

The European Telecommunications Standards Institute (ETSI) is the commission of the European communities to assist the process of technical procedure in telecommunications, broadcasting and office information technology, also developing recommendations for creating standard templates for SLA content.

2.3.3 Tele Management Forum

Tele Management Forum is an international consortium of communications service providers. Its mission is to help service providers and network operators automate their business processes in a cost and time-effective way.

Table 2. 3: Summary of standard bodies of SLA component

Standard	SLA component	SLA content
ITU	Business part, service part, technology part, and QoS report.	Points of Contact; Services Provided; System Design Information; Supporting Equipment; Level and Quality of Service; Monitoring and Reporting; Service Center; SP Backup and Disaster Recovery

Standard	SLA component	SLA content
		Mechanisms; Terms and Conditions; Network and Delivery Upgrades; Change Procedures; Service Violations and Remedies; Tariffs and Billing; Service Termination[4].
ETSI	Service covered, QoS commitments, customer support, report, charging and billing, revision procedure.	Content, feature, Connection establishment, Service life cycle, Duration of the agreement, Setting up, Operation, Service break up, Outage process, Indicators, Means to ensure quality, Quality features, Help Desk, Outage management, Consumption reports, Outage reports, QoS reports, Costs, Penalties, Validation of bills before recovery, Modes of payment.
Tele Manage ment	Several contents	Introduction, Customer Requirements, Overview of Service , Term, Responsibilities, Details of Service Exceptions, Sampling and Reporting, Penalties , Dispute Resolution and Escalation, Change Requests, Termination, Relevant Law, Confidentiality, Warranties, Indemnities and Limitations of Liability, Signatories.

In the above table (2.3) indications for preparing a standard template for SLA for international standards bodies, the first is the ITU which describes the detailed classification of SLA content, it provides the guidelines for the definition of SLA templates in detail and introduces the overview and characteristics of SLA templates. The second is the European standards institute which indicates for the content of the SLA and provides useful guidance on the users expectations about the QoS parameters, their agreed level, and monitoring. The third standard which is TeleManagement forum introduces the major components and relationships that comprise a SLA between a SP and SC. There for this research will look in to the first tow standards (ITU & ETSI) to come up with mix parameters form the tow that suites Sudanese telecom companies.

2.3.4 SLA Templates

SLA Templates are the official representation method and format of the SLA for any specific service. It provides the structures and the organization method for the SLA content. templates should be at least as acceptable: Accordant with the current criteria, extensible, realizable, and comprehensible[4].

In this section we will discuss building SLA template for the recommendations of the ITU and ETSI because they are the most comprehensive: they include the SLA contents and the basic composition of SLA templates and extended composition of SLA templates depending on what was stated in the reference[4].

2.3.4.1 The Significance of SLA Templates

Service level agreements are the product of responding to this new competitive environment, thus structuring and organizing its components**,** Assist in arranging and organizing the content of the agreement [22] , which leads to:

- Help SPs and SC to identify the components of SLAs and the role of these components within a SP offering services to customers.
- Identify different aspects of SLAs at each link within the supply chain.
- Help SPs find a mapping scheme between SLAs and QoS parameters.
- Provide inputs for evaluating impacts and requirements in different operational process areas when a new service offering and SLA is designed.

2.3.4.2 SLA contents

According to the guidelines and recommendations of the ITU and ETSI that any agreement should include the following contents:

- Points of Contact
- Services Provided
- Supporting Equipment
- Level and Quality of Service

- Monitoring and Reporting
- Service Center
- SP Backup and Disaster Recovery Mechanisms
- Terms and Conditions
- Change Procedures
- Service Violations and Remedies
- Tariffs and Billing

2.5 Related Works

We have made literature review related to networks and services performance evaluation with respect to SLA behavior-based QoS.

Ayyoub Akbari, Jose Roberto, German Satos and josep sole (2019) purposed of this survey is to identify existing research gaps in utilizing SLA elements to develop a generic methodology, considering all quality parameters beyond the Quality of Service (QoS) and what must or can be taken into account to define, establish and deploy an SLA[1].

Daniel Puka, Manoel Camillo and Prodocimo introduced a service level management system, which can be applied to different Telecommunication systems, an architecture for service level management is including many aspects, from the creation of the service level contract, up to monitoring the service level. And presented a complete service level management system for ATM Networks, including contractual management and information gathering[2].

Dinesh C. Verma provided an overview of the different techniques and approaches that can be used to support the notion of service level agreements in IP networks[3].

Linlin Wu and Rajkumar Buyya presented a comprehensive survey of how SLAs are created, managed and used in utility computing environment , Cloud computing, Grid computing[6].

Waheed Aslam Ghumman M.Sc.(2016) presented a distributed monitoring approach for the cloud SLAs for reduces the number of communications of SLA violations to a monitoring coordinator by eliminating the unnecessary communications[7].

A. Prakash and R.P. Mohanty(2015) presented the various perspectives of an important element in service management called service quality, and criticism of these perspectives. A clarification plan was also proposed. The proposed classifications are not intended to be conclusive, but intended to contribute to the ongoing debate over service classification and service quality. The resulting classification brought new ways of developing strategies and improvements in the service delivery process [20]

V. Binu and N. D. Gangadhar (2016)purposed an SLA Framework which incorporates negotiation and secure monitoring mechanism involving a third-party is developed in cloud computing [24]. Jacek Kosiński and all (2008) proposed SLA monitoring and management framework for telecommunication services [25].

M. Maurer, V. Emeakarohaa, I. Brandica and J. Altmannb, investigated the cost depending on the use of different public SLA template adaptation methods and present the novel approach of adaptive SLA matching. This approach adapts SLA templates based on SLA mappings by allowing Cloud users to define mappings between public SLA templates, which are available in the Cloud market, and their private SLA templates, which are used for various in-house business processes of the Cloud user[26].

M. Antonio , F. Frota and all(2018) proposed a framework to orchestrate the management of cloud services and security mechanisms based on the security requirements defined by a SLA, in an automated manner, throughout their lifecycles, and the integration of the framework with a cloud computing solution, in order to demonstrate and validate the framework support throughout SLAs lifecycle phases[27].

Philipp Wieder, Ramin Yahyapour and All (2008) presented a survey of use in resource management and scheduling that SLAs will play a stronger role in the Grid RMS domain. A WS Agreement is now an OGF Recommendation proposed for expressing and establishing SLAs. We expect that more network-level regulators or intermediaries will now rely on the use of SLAs for two reasons: (i) interoperability with other regulators and intermediaries at the network level and (ii) use of a unified interface to negotiate quality of service between users and service providers[28].

Ludwig, heiko (2014) provided a new WSLA framework for defining and monitoring SLAs for web services. The drive for this work is the need to enable service customers and service providers to unambiguously define a wide range of SLAs, and to define SLA parameters and how to measure them[29].

Ismail, Bukhary and all (2014) presented a policy-based automated negotiation approach to an SLA for web services that applies a mathematical policy mapping model, an adaptive algorithm, and an intelligent negotiation strategy selection algorithm to implement agent-based negotiation within a trusted negotiation mediator framework [30].

Dr.Sarmad Al-Aloussi (2013) provided a theoretical model for evaluating SOA's SLA. The model is based on two main features; the first is the formalization of the Service Level Agreement (SLA) through the use of a standard policy while the

second is the formalization of the "Qualifying Service Levels" against which we can measure the SLA .It also contributed to the service level agreement model and the system of interaction between the user and the provider. Service to reduce the time and cost of providing the service[30]. In the table below (table 2.4) is a summary of the recommendations of international organizations

Table 2. 4: Related Work

Year/Author	Title	Description
2006/ITU-T	Guidelines for the definition of SLA templates ITU-T	This Recommendation primarily addresses the SLA impersonation templates used for service customers and service providers. Provides an overview and characteristics of SLA impersonation templates, describes detailed classification of SLA content, and provides instructions for defining SLA impersonation templates in detail, including instructions for completing SLA templates[4].
2002/REG/USER	ETSI Template for Service Level Agreements (SLA)	In this paper, the ETSI User Group provided useful guidance on user expectations about service quality of standard-setters, regulators, and service providers. It also provided a framework for the proposed service-specific service quality standards for assessing service quality, and guidelines for identifying parameters relevant to users[31].
2001/TeleManagement Forum	SLA Management Handbook	This paper aims to create a complete guide to assist two parties in developing a Service Level Agreement (SLA). The end customer develops the telecommunications service quality requirements necessary to operate his business, then the two parties begin to compile the optimal set of parameters and values to build a service level agreement (SLA) that includes all requirements. Two tools are the basis for clarifying management roles, processes, responsibilities and expectations: the service life cycle and the SLA parameter framework[22].

Most of the relevant work above has addressed the concept and the implementation of the SLA, but this work did not consider the instructions of any of the international standards organizations to build a standard template for structuring and organizing the content of the service level agreement, Therefore the related work did not give certain blueprint or describe the roles and relations of all the entities that participate in providing the service, and determine the responsibilities of each service provider to ensure service quality to customer satisfaction.

Chapter 3: Research methodology

This chapter will focus manly in the methodology which is going to be adopted in this research as well as the research design and procedure. The chapter will also describe the operational framework, in addition to the explanation of the development and implementation.

3.1 Research Design and Procedure

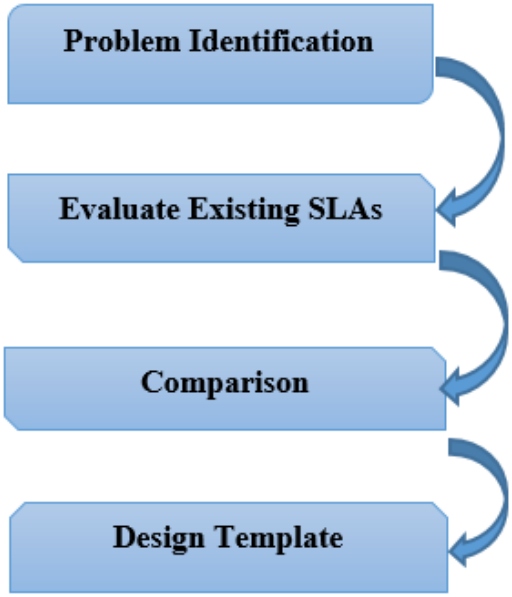

Figure 3. 1: Research Design and Procedure

3.1.1 Problem Identification

After the research and study of the literature on the concept of service level agreements and the standards bodies of the SLAs, the study proves that there is no standardized SLA templates to manage quality of service (QoS) and service guarantee of telecommunication services effectively in Sudan which was mentioned through the literature review in Chapter 1.

3.1.2 Evaluate Existing SLAs

This section, will describe the concept of service level agreement that used in Sudan, and how these agreements are formed and their standards. There were

sample of the agreements of four popular Sundaneses internet service companies were taken to compare them with standard bodies to find gap between them in Chapter 3.

3.1.3 Comparison

This part will compare the existing SLA in Sudan with the proposed template to find the gap between them, then to apply the proposed template in the internet service providers in Chapter 3.

3.1.4 Design of SLA Templates

This is done to develop a standardized telecom services template to effectively manage QoS and guarantee telecommunication services based on the ITU and ETSI guidelines in Chapter 4.

3.2 operational framework

Table 3. 1: Operational Framework Table

No	Research question	Objective	Activity(s)	Deliverable(s)
I.	Is the current SLA is Sudan meets the International standards?	To evaluate the current Service Level Agreement (SLA. Existing in Sudan.	Literature study	Gaps on the current SLAs in Sudan.
II.	How to improve the current SLAs in Sudan?	To propose an SLA Templates for telecom services to manage QoS and guarantee telecommunication services effectively.	Design standard SLA template	Criteria and the guidelines specifications
III.	How to evaluate the proposed SLA Template?	To compare the proposed standardized template to the existing SLA in Sudan and find the gaps.	Comparison of the SLAs of the ISPs and the proposed template	The develop Template

3.3 Evaluation of the Existing SLAs

The Telecommunications and Post Regulatory Authority was visited, as a responsible authority for the quality and licenses of companies providing services: fixed, mobile, voice, data and internet access. After reviewing the telecommunications services Quality Regulations for the year 2020 which was issued in Sudan pursuant to the provisions of Clause 88, many articles of the law were discovered which are concerned with the QoS and its levels of provision, with the aim of providing a fair competition between operators and SP related to the field of the telecommunications. However, the protection of users and beneficiaries of telecommunications services stressed the following:

- Evaluate and monitor the compliance of service providers with service quality obligations, including periodic review of their performance.
- Define the minimum acceptable levels of the service levels provided are specified in the text of the license granted to networks, services and communications, and so that the provision of services below these levels is prohibited, whatever the reasons.

Even though the implementation of SLA in Sudan is practiced by couple of companies ISPs, yet was not easy to talk about service level agreements, due to the fact that this concept is not clear to a large number of them. Also, obtaining samples of service level agreements from some of the institutions was not easy. As they considered these documents to be confidential documents related to the work of the institution, especially those documents which are related to the service provision and performance standards which are part of the agreement. However, due to the limited number of these institutions only four popular ISPs companies were chosen to evaluate their service level agreement.

3.3.1 Internet Service Providers (ISPs)

ISPs are organizations that offers variety of services to allow access use or participate in the Internet. They operate in a semi-competitive environment, in which they deliver services such as: accessing the internet service, online hosting, email services, web hosting or online storage services. In addition to the Wireless Internet Service Provider (WISP) which is define as an Internet service provider with a network based on wireless networking. Therefor this is section will discuss in detail four leading companies in the of telecom service as follow:

a. **Company (A)**

Company (A) Wireless Broadband Services is a privately owned company that owns radio frequency license from Sudan national telecommunication corporation to provide nationwide fixed wireless broadband services. The company currently is operating in tow cities in Sudan. Company (A) is a leading fixed wireless broadband service provider in Sudan with aggressive plans to expand in more cities in 2015. Services provided by Company (A):

- Data Connectivity for Wide Area Network (WAN): Seamlessly extend your local area network into a wide area network (WAN) for multi-site businesses, establish clearer connections and reduced telco bills for voice or video communications, mirror data for brilliant business continuity and more.
- High Speed Internet: Connect to the world with business-grade, high-availability, high-speed Internet access with symmetrical upload and download speeds. This is a key benefit of the Company (A), Fixed Wireless Broadband network.

- Wide Range of Business Applications: Company (A) enables enterprises to enhance their main business. It provides a better way to connect teams to the internet and each other.

After reviewing Company A's SLA contract, it is found that content of the agreement in the following points:

- Objective.
- Service provided.
- Customer support contacts.
- Escalation procedure.
- Response and restoration.
- Fault report communications procedure.
- Fault complain categories.
- Planned service outages.
- Service availability.
- Signatories.

b. **Company (B)**

Company (B) is one of the largest telecommunications companies in the region. It came to meet the needs of customers in Sudan and Africa. Company (B) has taken steady steps to move from local markets to global markets, setting an example for the state’s approach to privatization policy. Company (B) is generally considered a competitive carrier that serves local, regional and international operators via: marine and terrestrial cables.

After reviewing Company B's SLA contract, it is found that content of the agreement in the following points:

- Signatories.

- Terms and Conditions.
- Service level.
- Violations and Remedies procedures.
- Indemnities and Limitations of Liability.
- Claim procedures.

c. **Company (C)**

Company (C) for development is a telecommunication company specialized in WiMAX internet, connectivity, and surveillance.

After reviewing Company C's SLA contract, , it is found that content of the agreement in the following points:

- Signatories.
- Service level.
- Escalation procedure.
- Indemnities and Limitations of Liability.
- Violations and Remedies procedures.
- Fault Report Communications procedures.
- Claim procedures.

d. **Company (D)**

Company (D) is a well-established provider of communications services. It uses cutting edge technologies such as Next Generation Network (NGN) and Wireless Loop (WLL), its products and services include voice, data, internet and multimedia services. Company (D) is in the forefront of operators being one of the few to

deploy NGN as the base of the network and is one of the first to do so in Africa. Company (D) is a telecommunication company that provides hi-end telecom technology with a friendly touch at affordable prices.

After reviewing Company D's SLA contract, it is found that content of the agreement in the following points:

- Signatories.
- Terms and Conditions.
- Service level.
- Violations and Remedies procedures.
- Indemnities and Limitations of Liability.
- Claim procedures.

3.3.2 Comparison of the SLAs of the ISPs and the proposed template

After evaluating the content of the existing SLAs in Sudan, they will be compared according to the recommendations of the ITU as well as ETSI in the table below. At first, the comparison of the general part which all ISPs companies were interested in defining the general details such as the signatories' identification and contact information. However they do not tend to describe clearly the responsibility, terms and conditions that should be met by both the SP and the SC during the SLA lifecycle.

Secondly, based on ISP's SLA, companies give more attention to the service detail in second part in of SLA. Those details include the definition and description of the service such as offer service, service name, service description …etc.

Thirdly, in the customer support part, Sudanese companies do not give much attention. However they partially mention it in SLA yet only tow companies out of the chosen for talk about it such as help desk and schedule availability, but not interested on activities associated with the technical evolution e.g. supporting equipment, backup and recovery mechanisms.

Fourthly, Sudanese companies give less attention to the part of QoS commitments. On other hand the QoS parameters are not mentioned clearly in there SLA.

Finally, the Sudanese companies are not interested on the activities associated with the charging and billing for the service such as tariffs, penalties, format and billing frequency, validation and modes of payment, to possibly avoid any misunderstanding between the provider and the customer.

Table 3. 2: Comparison between Existing SLA in Sudan and proposed template

SLA content	Company (A)	Company (B)	Company (C)	Company (D)
Signatories Identification	✓	✓	✓	✓
Points of Contact	✓	✓	✓	✓
Terms and Conditions	✓	✓	✓	✓
Service Center	✓		✓	✓
Change Procedures				
Service Violations and Remedies	✓	✓	✓	✓
Tariffs and Billing				
Service Termination				
Services Provided	✓	✓	✓	✓
Service level	✓	✓	✓	✓
QoS commitments		✓		✓
Supporting Equipment				

SP Backup and Disaster Recovery Mechanisms				
Monitoring and Reporting	✓	✓	✓	✓

Chapter 4: Development and Designing

This section is to define standardized and generic guidelines of SLA templates in telecom services which are developed to improve service quality and the service provider works within precisely defined responsibilities and tasks.

4.1 Design SLA Templates

The aim of the proposed standardized SLA templates is to be applicable to other service organizations. Based on the recommendations of the ITU and ETSI providing the guidelines and instructions for the definition and composition of SLA representation templates in order to manage QoS and service guarantee of telecommunication services effectively:

4.1.1 General detail

In this section the general details content the signatories' identification, contact information, and terms and conditions which should be met by both the SP and the SC during the SLA lifecycle. However this should include signatories' name , service full name, responsibility, name of contact and job title**.**

4.1.2 Services covered

this part should be assigned for the provider to detail the range of services that is offer and the definition and description of the service such as service provided, service name, service description , ready for service date , service class. This is to guarantee both parties can fully identify their needs and expectations and agree on which services will be provided.

4.1.3 Customer Support

This part deals with all activities associated with the support of a telecommunication service to enable the customer's use of the service. In this section customer support should be detailed and include the help desk availability schedule and information exchanges for the outage process, customers' complaint

management, resolution process of problems, priority levels and escalation process.

In addition to the technical support which deals with all activities associated with the technical evolution of any component of the service at the provider's initiative. As this should specify the procedure and conditions for a technical upgrade by the provider of the equipment used to provide the service at the provider's as well as at the customer's premises e.g. supporting equipment, backup and recovery mechanisms.

4.1.4 QoS commitments

At this part of the SLA, the providers' commitments on the QoS parameters level should be specific. In addition to the designing of the content and frequency of the reports. The questions below could be followed to measure and determine how specific the QoS parameter are:

What are the QoS indicators and parameters that are pertinent to the particular service?

• What is the acceptable range of performance for the user and the provider?

• How are these to be measured?

• Who will measure it?

4.1.5 Charging /Billing

This part should mention in details all relevant activities associated with the charging and billing for the service such as tariffs, penalties, format and billing frequency, validation and modes of payment, to avoid any misunderstanding between the provider and the customer.

4.2 SLA - Components and Guide for its Preparation

A Service Level Agreement is a formal agreement between two or more entities that is reached after a negotiating activity with the scope to assess service characteristics, responsibilities and priorities of every part. A SLA may include statements about performance, billing, service delivery but also legal and economic issues. During the following paragraphs, the components of the service level agreement will be defined, and a guide to preparing them in the form optimum:

4.2.1 General provisions

4.2.1.1 Signatories Identification

The structure of the "**Signatories Identification**" proforma is shown in below

Table 4. 1: Signatories Identification

	SC	**SP**
Full Name		
ID		
Service Full Name		
Service Identifier		
Service Instance ID		
Service Start Time		
Service Termination Time		

Where:

- **Signatories Name**: This field contains the full name of the SC or SP in the corresponding column.
- **ID**: The assigned identifier specified for the SC or the SP. It can be used as a reference in order to search the corresponding information about the SC or the SP.
- **Service Full Name**: The full name of the service provided to the SC. An abbreviation can also be specified in this field.
- **Service Identifier**: The service number assigned by the SP.

- **Type of Request**:
- **Service Start Time**: This field is used to indicate when the service will be provided to the SC.
- **Service Termination Time**: This field is used to indicate when the service provided to the SC will be terminated.

4.2.1.2 Points of Contact:

The structure of the "**Points of Contact**" proforma is shown in below

Table 4. 2: Points of Contact

	Responsibility	**Name of Contact**	**job Title**	**Description**	**Telephone Number**	**Fax Number**	**Email Address**	**Additional Information**
SC								
SP								

Where:

- **Responsibility**: This field is used to specify what the contact person is responsible for, and the possible values to be filled in this field are "Technical matter" and "Administrative matter". Based on the contact person's actually responsibility, the allowed values can also be extended.
- **Name of Contact**: The full name of the contact person for this Service.
- **Job Title**: The work title for the contact person.
- **Description**: The short description of the scope or the responsibility of the contact person.
- **Telephone Numbers(s)**: The contact telephone number of the contact person. At least one number is specified. It is recommended that both the

office telephone number and the mobile numbers be filled in this field, in case of an emergency.

- **Fax Number(s)**: The contact fax number of the contact person. If there are more than one fax number, e.g., one for backup purpose, they can also be filled in this field. This field can also be left empty if there are no contact fax numbers.
- **Email Address**: The contact e-mail address of the contact person. If there is more than one e-mail address, e.g., one for backup purpose, they can also be filled in this field. This field can also be left empty if there are no contact e-mail addresses for this person.
- **Additional Information**: This field is reserved for extensions, and can be used to specify any other additional information that is related to this contact person.

4.2.1.3 Terms and Conditions:

The structure of the "**Terms and Conditions**" proforma is shown in *below*

Table 4. 3: Terms and Conditions

Subjection Indication	
SC's Indemnify Description	
SP Ownership Declaration	
SC Information Ownership Declaration	
Responsibility for Software Licensing/Ownership	
SP's Indemnify Description	
Dissemination Declaration	
Additional information	

Where:

- **Subjection Indication**: The indication of the fact that the SLA is subject to "Terms and Conditions" of other agreements between the SP and SC.

- **SC's Indemnify Description**: A specification of the extent, if any, to which the SC will indemnify the SP for third-party claims against the SP as a result of the SP's activities.
- **SP Ownership Declaration**: Descriptions of the SP's ownership or interest in patents trademarks, trade names, inventions, copyrights and trade secrets related to SP offerings.
- **SC Information Ownership Declaration**: Description of the SC's information data ownership.
- **Responsibility for Software Licensing/Ownership**: Specification of the responsibility for software licensing and/or ownership.
- **SP's Indemnify Description**: A specification of the extent, if any, to which the SP will indemnify the SC for claims that services infringe upon the Intellectual Property of others.
- **Dissemination Declaration**: Description of the information that may be disseminated openly.
- **Additional Information**: This field is reserved for extensions, and can be used to specify any other additional information that is related to the terms and conditions.

4.2.2 Services covered

4.2.2.1 Service Provided:

The structure of the "**Service provided** "proforma is shown in below

Table 4. 4: Service provided

Service Identifier	
Service Name	
Service Description	
Service Interfaces Requirements	
Ready-for-Service Date(s)	

SC Notification Process	
Additional Information	

Where:

- **Service Identifier**: An identifier assigned by the SP for identification of the specific service; the identifier can be used as a reference for searching the detailed information about the service. This field can be left empty if SP does not use Service Identifiers.
- **Service Name**: The full name of the service. It is a user-friendly name of the service and can be used as a nickname for the Service Identifier.
- **Service Description**: A description of the service in terms meaningful to the SC and the SP.
- **Service Interfaces Requirements**: A specification of the service interfaces requirements, e.g., electrical and mechanical specifications, data link layer protocols, etc.
- **Ready-for-Service Date(s)**: A specification of the Ready-for-Service (RFS) dates and, if appropriate, the lead times required for service provisioning. It is expected that the service will be available on or before the date specified, at the cost agreed, and performing to the specifications contained within the SLA.
- **SC Notification Process**: A description of the process for SC notification in the event that the agreed RFS date cannot be met. Lead times for such notification may also be specified.
- **Additional Information**: This field is reserved for extensions, and can be used to specify any other additional information that is related to the provided services.

4.2.2.2 Service Level:

The structure of the "Service Level" proforma is shown in *below*

Table 4. 5: Service level

Service Class	
Out-of-Service Times	
Force Majeure	
SC-Caused Outages	
Restoration Priority	
Restoration Times	
Planned Outage Notification	
Procedures	
Additional Information	

Where:

- **Service Class**: This field is used to specify the overall class of the service level. SPs usually use "Platinum", "Gold" or "Silver", etc. to categorize their provided service levels. Also, a number can be used in this field. This field can be left empty if there is no classification assigned for this SC.
- **Out-of-Service Times**: Out-of-service times such as the time required for routine maintenance. The process used to communicate changes in scheduled maintenance outages.
- **Force Majeure**: Description of force majeure and other events beyond the SP's control when service may not be provided.
- **SC-Caused Outages**: Description of customer-caused outages that may impact the service. This field can be left empty
- **Restoration Priority**: Specification of the priority/precedence for restoration of service.
- **Restoration Times**: Specification of restoration times.
- **Planned Outage Notification Procedures**: Description of the notification procedures for planned outages.

- **Additional Information**: This field is reserved for extensions, and can be used to specify any other additional information that is related to the Service Level.

4.2.2.3 Service Violations and Remedies:

The structure of the "**Service Violations and Remedies** "proforma is shown in below

Table 4. 6: Service Violations and Remedies

Violation	
Performance Bonuses	
Disputes Resolution Procedures	
Additional Information	

Where:

- **Violation**: Description of the performance penalties in the event that SP fails to execute agreed service levels. Performance penalties could be administrative actions by the SP, monthly percentage fee rebates, correlated to the degree of underperformance, specific fee reductions or rebates, or contract termination if the underperformance is chronic. Violations can be described in different rows for different details or aspects if needed.
- **Performance Bonuses**: Description of the performance bonuses in the event that the SP exceeds the agreed service levels.
- **Disputes Resolution Procedures**: Description of the procedures to resolve disputes, e.g., arbitration procedures.
- **Additional Information**: This field is reserved for extensions, and can be used to specify any other additional information that is related to Service Violations and Remedies.

4.2.3 Customer Support

4.2.3.1 Service Center:

The structure of the "**Service Center** "proforma is shown in *below*

Table 4. 7: Service Center

Services Scope	
Authorized SC Staff	
Service Periods	
Contact Means	
Resolution Notifications	
SC's responsibility for Resolution	
Training	
Systematic Errors Identifying	
Additional Information	

Where:

- **Services Scope**: Description of the scope of services offered by the SP's Service Center.
- **Authorized SC Staff**: Identification of the SC staff members that are authorized to use the Service Center. Usually, this field should be filled with the list of staff members of SC. In the case where anyone from SC is authorized staff to ask the Service Center, this field should be filled with "Anybody".
- **Service Periods**: Specification of the periods when the service center is accessible to SC, including evening, week-end, and holiday coverage.
- **Contact Means**: Description of the means of contacting the service center, e.g., telephone, e-mail, etc. The contact telephone number or e-mail address should also be filled in this field.
- **Resolution Notifications**: Description of how the SC will be notified of the problem resolution.

- **SC's responsibility for Resolution**: Description of SC's responsibilities resolving reported problems.
- **Training**: Description of training required by SC staff.
- **Systematic Errors Identifying**: Description of the mechanisms and/or procedures for identifying systematic errors based on help desk analysis.
- **Additional Information**: This field is reserved for extensions, and can be used to specify any other additional information that is related to the Service Center.

4.2.3.2 Outage management requirements

Table 4. 8: Outage management requirements

Request Leveling/ Priority levels	**Response/Resolution Times**	**Escalation Process timescale**	**Acting people**	**Repair time report**
Critical				
Medium				
Simple				
Emergency service				

Where:

- **Request Leveling/ Priority levels**: Description of the mechanisms for assigning severity levels to customer help requests or problem reports.
- **Response/Resolution Times**: Description of response times and resolutions times.
- **Escalation Process**: Description of the escalation process to be followed to change severity levels.
- **Acting people**: the responsible party to which the problem is escalated in case service center fails to resolve a solution**.**

- **Repair time report:** report on the causes of the malfunction and the time of repair.

4.2.4 Technical support

4.2.4.1 Change Procedures:

The structure of the "**Change Procedures** "proforma is shown in below

Table 4. 9: Change Procedures

Permitted Changes	
Specifying Method	
Change Time	
Additional Information	

Where:

- **Permitted Changes**: Description of any changes that the SC is permitted to make such as additional software.
- **Specifying Method**: Description of the method for specifying changes to requirements.
- **Change Time**: Description of the time required to change user requirements, such as notice and response times.
- **Additional Information**: This field is reserved for extensions, and can be used to specify any other additional information that is related to the Change Procedures.

4.2.4.2 Supporting Equipments:

The structure of the "**Supporting Equipments** "proforma is shown in *below*

Table 4. 10: Supporting Equipments

Equipment Identifier	
Equipment Name	
Equipment Description	
Space Requirements	

Power Requirements	
Environment Control Requirements	
Maintenance Access Procedures	
Additional information	

Where:

- **Equipment Identifier**: The identifier of the SP equipment to be located on SC premises.
- **Equipment Name**: The user-friendly name of the SP equipment to be located on SC premises.
- **Equipment Description**: The description of the SP equipment to be located on SC premises.
- **Space Requirements**: The space requirements for this equipment.
- **Power Requirements**: The power requirements for this equipment.
- **Environment Control Requirements**: The environmental control requirements for this equipment.
- **Maintenance Access Procedures**: The access procedures for SP maintenance and installation staff.
- **Additional Information**: This field is reserved for extensions, and can be used to specify any other additional information that is related to this supporting equipment.

4.2.4.3 Backup and Recovery Mechanisms:

The structure of the "SP Backup and Recovery Mechanisms" proforma is shown in

Table 4. 11: Backup and Recovery Mechanisms

Backup Procedures	
System Redundancy	
Recovery Parameters	
SP Disaster Recovery Priority	
SC Support	
Additional Information	

Where:

- **Backup Procedures**: Description of the procedures for data and application backups.
- **System Redundancy**: Description of the service delivery system redundancy.
- **Recovery Parameters**: Description of recovery parameters, i.e., how quickly can data be restored.
- **SP Disaster Recovery Priority**: Description of the priority and process for SP disaster recovery.
- **SC Support**: Description of the SC support required to assist with disaster recovery.
- **Additional Information**: This field is reserved for extensions, and can be used to specify any other additional information that is related to the backup and recovery mechanisms.

4.2.5 QoS commitments

4.2.5.1 QoS Parameters

The structure of the "SP Backup and Recovery Mechanisms" proforma is shown in

Table 4. 12: QoS Parameters

Parameter ID	Parameter Name	Value Range	Value Units	Qualifier

Where:

- **Technology Dependency**: This indicates whether the QoS metrics in this table is technology dependent or independent.

- **QoS Parameter Area**: This indicates which area this QoS Parameter is dealing with. The possible categories to be filled in this field can be "Network Performance Metrics", "Traffic Metrics" and "Service Metrics".
- **Parameter ID**: It is assigned for each Parameter for reference and identification purpose.
- **Parameter Name**: This is field is used to specify the full name and the abbreviation of the specified QoS Parameter.
- **Value Range**: This field can be filled with the agreed value range (it can be negotiated between the SC and the SP, or the SC can select the value range from a list that SP provides), indicating the possible values that the QoS parameter should be in the range in order to be conformed to the agreed service level.
- **Value Units**: This indicates the units that are used by this parameter. When no units are used for this QoS parameter (such as a ratio), this field is filled with "--", indicating "not applicable".
- **Qualifier**: This indicates whether this QoS Parameter is mandatory, optional or conditional for this service.

4.2.5.2 QoS Report

The structure of the "QoS Report" proforma is shown in *below*

Table 4. 13: QoS Report

Content of Reports	
Reporting Frequency	
Report Delivery Mechanism	
Time Points and Intervals	
Report Presentation	
Monitoring Approach	
Detecting Mechanisms	
SC Auditing Process	
Performance Assessment	
Additional Information	

Where:

- **Content of Reports**: Specifications of the content of performance reports.
- **Reporting Frequency**: Specifications of the frequency of performance reports.
- **Report Delivery Mechanism**: Specification of the performance report delivery mechanism, e.g., e-mail, postal delivery, electronic retrieval, report distribution lists, and the number of copies.
- **Time Points and Intervals**: Definitions of the time points or intervals associated with performance events, and data aggregation intervals.
- **Report Presentation**: Specifications of the method for performance report data presentation, e.g., table's histograms, charts, etc.
- **Monitoring Approach**: Specification of the approach and extent to which the SP will monitor all necessary services e.g., network devices, circuits, services and applications, to prevent service unavailability. This field can be left empty.
- **Detecting Mechanisms**: Description of the mechanisms and processes the SP will use to detect and track downtime. This field can be left empty.
- **SC Auditing Process**: Description of the process that the SC may use to audit the SP's tracking and reporting mechanisms. This field can be left empty.
- **Performance Assessment**: Specification of when and how SC service monitoring data will be used to assess service performance. This field can be left empty.

- **Additional Information**: This field is reserved for extensions, and can be used to specify any other additional information that is related to QoS reporting. This field can be left empty.

4.2.6 Charging/Billing

4.2.6.1 Tariffs and Billing:

The structure of the "**Tariffs and Billing** "proforma is shown in *below*

Table 4. 14: Tariffs and Billing

Billing Details	
Billing Frequency	
Bill Delivery	
Additional Information	

Where:

- **Billing Details**: Description of the level of detail included in the bills. Billing details can be described in different rows for different aspects if needed.
- **Billing Frequency**: Description of the frequency of billing.
- **Bill Delivery**: Description of the media used to deliver the bill, e.g., suitable for use with software applications.
- **Additional Information**: This field is reserved for extensions, and can be used to specify any other additional information that is related to Tariffs and Billing.

4.2.6.2 Penalties

4.2.6.2.1 Penalties on delay on delivery

The amount of the penalties related to the disrespect of the delivery date should be computed depending on the delay and on the service importance for the company on a case by case basis

Table 4. 15: Penalties on delay on delivery

Delay on Delivery	**Penalty**

4.2.6.2.2 Penalties on GTTR

This amount is a percentage on the monthly price of each connection concerned percentage depends on the actual time to repair and on the commitment agreed between the parties.
Table 4. 16: Penalties on GTTR

Actual repair time for commitment	**Penalty**

4.2.6.2.3 Penalties on GSAR

This amount is a percentage on the monthly price of each connection depends on the difference between the committed availability rates
Table 4. 17: Penalties on GSAR

Difference between the target and the actual availability rate	**Penalty**

Chapter 5: Conclusions and Recommendations

5.1 Conclusions

In the current competitive world, Quality of Service (QoS) is becoming, a key parameter in selling and buying telecommunications services. This why achieving a SLA is more and more often perceived as the best means to ensure the optimal quality to the perspective customer and the provider. It is important that we follow international standard bodies that provide guidance on how to structure, define and get the users expectations on QoS, for establishing an SLA they are intended to provide additional support.

The realization of implementing SLAs in Sudan in this research was conducted on both public and private instutions that are offering ISPs in Sudan. Although SLAs content exist in Sudan yet it varies with the proposed template content in accordance with ITU and ETSI guidelines in the structure and organization. The researcher proposed a standard template for preparing SLA that helps in managing QoS and service guarantee of telecommunication services effectively. The proposed template covered service provided, general information about describing QoS measurements, monitoring and reporting.

5.2 Recommendations

In this section, and after what has been reviewed with regard to SLA and their preparation at the local level, this present a set of recommendations and proposals to the government represented by the regulatory authority for the telecommunications sector:

a. Using the proposed template for preparing SLA that helps in order to manage QoS and service guarantee of telecommunication services effectively.
b. All contracts, agreements and licenses carried out by the institution most express to follow SLA and the penalties who when its abandoned.

c. When obtaining a service, the customer should always make sure of the quality of service and the guarantee at the levels of service that. This will enhance the interest of service providers in the levels and quality of service, and the result will always be in favor of the user of the service, especially with the expansion of the communications market and the multiplicity of competitors in this market.

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