



GUIDELINES

FOR

NETWORK REDUNDANCY, RESILIENCE
AND DIVERSITY

ON

INFORMATION AND COMMUNICATION
NETWORKS

IN

KENYA

1st July 2017

Table of Contents

1. Introduction	3
1.1. Purpose of the Network Redundancy, Resilience and Diversity (NRRD) Guidelines	3
1.2. Phase-in Monitoring Period	3
1.3. Scope of the Network Redundancy, Resilience and Diversity (NRRD) Guidelines	3
2. Definitions and Abbreviations	4
2.1. Definitions	4
2.2. Abbreviations	5
3. NRRD Parameters	6
3.1. Service Availability	6
3.2. Network Element Availability	6
3.3. Link Availability	6
TABLE 1: NRRD METRICS IDENTIFIED FOR KENYA	7
4. NRRD Guidelines for Mobile Network Operators (MNO)	10
4.1. Service Availability	10
4.2. Network Element Availability	10
4.3. Link Availability	11
5. NRRD Guidelines for Internet Service Providers (ISP)	11
5.1. Service Availability	11
5.2. Network Element Availability	11
5.3. Link Availability	12
6. NRRD Guidelines for Fixed Wireless Access Network	12
6.1. Service Availability	12
6.2. Network Element Availability	12
6.3. Link Availability	13
7. NRRD Guidelines for International Gateway (IGW) Operators	13
7.1. Service Availability	13
7.2. Network Element Availability	13
7.3. Link Availability	13
8. NRRD Guidelines for Submarine Cable Network (SCN) Operators	14
8.1. Service Availability	14
8.2. Network Element Availability	14
8.3. Link Availability	14
9. NRRD Guidelines for Internet Exchange Point (IXP) Operators	14
9.1. Service Availability	14
9.2. Network Element Availability	15
9.3. Link Availability	15
10. NRRD Guidelines for Fixed Networks	15
10.1. Service Availability	15
10.2. Network Element Availability	15
10.3. Link Availability	16
11. Submission of Quarterly Reports	16
12. Record-Keeping and Retention	16
13. Promulgation of the NRRD Guidelines	17
13.1. Effective Date of the NRRD Guidelines	17
13.2. Review of the NRRD Guidelines	17
ANNEX 1: AVAILABILITY MEASURES	18
ANNEX 2: COMPLIANCE RETURN FORM	19
GENERAL INFORMATION	19
REPORTING SECTION	21
INCIDENT REPORTING	28
AVAILABILITY MEASURES	31
EXAMPLES OF HOW TO CALCULATE THE METRICS	34
COMMENTS/ SUGGESTIONS	35

1. Introduction

The Communications Authority of Kenya (hereinafter referred to as the Authority) was established under the Kenya Communications Act, 1998, as Amended (hereinafter referred to as The Act), to licence and regulate telecommunications, radio communications, postal and broadcasting services in Kenya. The Authority is also responsible for ensuring consumers enjoy quality communications services at all times.

These Network Redundancy, Resilience and Diversity (NRRD) Guidelines are issued pursuant to Section 23 of the Act.

1.1. Purpose of the Network Redundancy, Resilience and Diversity (NRRD) Guidelines

The Network Redundancy, Resilience and Diversity (NRRD) Guidelines are intended to collect information on the status of NRRD by Authority licensees and provide the empirical basis of potentially necessary regulatory interventions and appropriate procedures for use by network operators in support of sustained reliable and available Information and Communications Technology (ICT) networks in Kenya.

The NRRD guidelines will monitor the following network aspects:

- i) Redundancy to improve the availability and fault tolerance of a system or service by duplicating one or more components of the system.
- ii) Resilience to enable a network to provide and maintain an acceptable level of service in the face of various faults and challenges to normal operation by providing a set of defences against failure and reducing the impact of an adverse event on network service delivery.
- iii) Diversity to ensure that alternatives are available when challenges impact particular elements or processes. This will prevent network degradation from normal operational parameters.

1.2. Phase-in Monitoring Period

The Authority intends to implement these NRRD Guidelines with an initial phase-in period of three (3) years from the effective date, during which no penalties will be levied. During this period:

- i) The Authority will work with industry to collect information and consider further refinements of these NRRD Guidelines, including the thresholds for all the metrics. Following this phase-in period, the NRRD guidelines shall be revised;
- ii) The Authority may publish the NRRD performance for the industry without showing the performance of the individual licensees, and
- iii) Licensees will be non-compliant with their license conditions if they do not submit returns but their performance levels will not result into non-compliance.

1.3. Scope of the Network Redundancy, Resilience and Diversity (NRRD) Guidelines

These NRRD Guidelines apply to the following networks:

- i) Mobile Network Operators (MNO);
- ii) Internet Service Provider (ISP) Networks;
- iii) Fixed Wireless Access (FWA) Networks;
- iv) International Gateway (IGW) Networks;
- v) Submarine Cable Networks (SCN);

- vi) Internet Exchange Point (IXP), and
- vii) Fixed Network Operators (FNO).

2. Definitions and Abbreviations

2.1. Definitions

In these Guidelines, unless otherwise stated the following definitions apply:

“Authority” means the Communications Authority of Kenya;

“Critical Network Elements” are those, the failure of which would cause severe disruption over a very large area or entire network. This categorization including specific named elements thereunder, covers a highest level of criticality for purposes of NRRD Target setting in these Guidelines.

“Diversity” is a technique used so that the same fate is unlikely to be shared by parts of the system undergoing correlated failures.

Diversity is closely related to redundancy, but has the key goal to avoid fate sharing. It consists of providing alternatives so that even when challenges impact particular elements or processes, other alternatives prevent degradation from normal operational parameters. These diverse alternatives can either be simultaneously operational or available “as needed” to remediate failures as they occur;

“Major Network Elements” are those, failure of which would cause significant disruption to services over a large area. This categorization including specific named elements thereunder, covers a middle level of criticality for purposes of NRRD Target setting in these Guidelines.

“Metric” is a system of related measuring that enables quantification of some characteristic of a system, component or process. A metric is composed of two or more measures;

“Minor Network Elements” are those the failure of which would cause disruption of services over a localized area. This categorization, including specific named elements thereunder, cover the lowest of three levels of criticality for purposes of NRRD Target setting in these Guidelines.

“Redundancy” means improving the availability and fault tolerance of a system or service by duplicating one or more components of the system.

Redundancy is a technique to compensate for random uncorrelated failure of components. In the event that a fault occurs and results in an error, redundant components are able to operate and prevent a service failure;

“Resilience” means the ability of the network to provide and maintain an acceptable level of service in the face of various faults and challenges to normal operation.

Resilience is provided by having a set of defences that reduce the probability of a fault leading to a failure and reduce the impact of an adverse event on network service delivery.

“Service” Means the description of a given telecommunications services as set out in the license of a given operator; and

“Target” means an aspirational standard for a given metric and network type developed with reference to best practices, industry and other standards and guidelines which are intended to act as a reference against which to compare the reportable achievements of network operators with regard to NRRD.

2.2. Abbreviations

In these Guidelines, unless otherwise stated the following abbreviations apply:

AAA	Authentication, Authorization and Accounting	MNO	Mobile Network Operator
ASN	Access Service Network Gateway	MSC	Mobile Switching Centre
BSC	Base Station Controller	MUX/DMUX	Multiplexer/ Demultiplexer
BSF	Backhaul From Interconnect to SCLS	NMS	Network Management System
BTS	Base Transceiver Station	NPE	Network Protection Equipment
CS	Circuit Switched	NTP	Network Time Protocol
CSN	Connectivity Service Network	OCS	Online Charging System
CS MGW	Circuit Switched Media Gateway	PCRF	Policy and Charging Rules Function
CSP	Content Service Provider	PDN-GW	Packet Data Network Gateway
DHCP	Dynamic Host Configuration Protocol Servers	PE	Provider Edge Routers
DNS	Dynamic Name Server	PFE	Power Feed Equipment
eNodeB	Evolved Node B	PoP	Point of Presence
FNO	Fixed Network Operator	PS	Packet Switched
FWA	Fixed Wireless Access	PSTN	Public Switched Telephone Network
GGSN	Gateway Gprs Support Node	PSU	SCLS Power Supply Unit
GMSC	Gateway Mobile Services Switching Centre	RNC	Radio Network Controller
GPRS	General Packet Radio Service	S-GW	Serving Gateway
HLR-AuC	Home Location Register – Authentication Centre	SBC	Session Border Controller
HSP	Hosting Service Provider	SCLS	Submarine Cable Landing Station
HSS	Home Subscriber Server	SCN	Submarine Cable Networks

ICT	Information and Communications Technology	SGSN	Serving GPRS Support Node
IGW	Internet Gateway Network	SIP	Session Initiation Protocol Servers
IMS	IP Multimedia Sub System	SLTE	Submarine Line Terminating Equipment
IXP	Internet Exchange Point	SMTP	Simple Mail Transfer Protocol
IPS	Intrusion Prevention System	STP	Signal Transfer Point
ISP	Internet Service Provider	TDM	Time Division Multiplexing Switches (Exchange)
ITP	Internet Transfer Point	UPS	Uninterruptable Power Supply
MME	Mobile Management Entity	www	World Wide Web

3. NRRD Parameters

In order to determine the levels of NRRD of ICT networks in Kenya, the Authority has identified the metrics shown in Table 1 below against which licensed networks will be monitored. The following definitions apply:

3.1. Service Availability

Service Availability is the state of Licensees' Services being available to a customer, including both on-net and necessary off-net components, where off-net means service availability from other ICT networks interfaced with licensee network and providing up- or downstream connectivity. Service unavailability may also be caused by external events. Service availability calculation shall include all of the above.

3.2. Network Element Availability

Network Element Availability is the state of one or more network elements within an operator network functioning as designed. Network element availability may be impacted by external events. Network element availability calculation shall include all of the above.

3.3. Link Availability

Link Availability is the state of one or more external links from an operator network to another network functioning as designed. Link availability may be impacted by external events. Link availability calculation shall include all of the above.

TABLE 1: NRRD METRICS IDENTIFIED FOR KENYA

Metric Name	Description and Objective
(a) Service Availability	<p>This metric represents the availability measure in a prescribed monitoring period and its cumulative representation over consecutive monitoring periods. This metric is measured independently of the number of users impacted.</p> <p>Calculation Method:</p> $\text{Service availability (Monitoring Period (M)) \%} = \left[1 - \frac{\sum_i^N \text{service downtime}(i)}{\text{Monitoring Period (M)}} \right] * 100$ <p>Where: M = The monitoring period. N = number of times the service is down.</p> <p>Note: 1) Downtime and Monitoring period in seconds 2) Monitoring period should exclude downtime due to planned maintenance 3) Monitoring period should exclude downtime due to natural causes, acts of terrorism, and malicious damage</p> <p>Cumulative Service availability (for K number of Monitoring Periods) (%)</p> $= \left[1 - \frac{\sum_1^K \sum_i^N \text{service downtime}(i)}{\sum_1^K \text{Monitoring period (M)}} \right] * 100$ <p>Where: K = the number of monitoring periods.</p>
(b) Network Element Availability	<p>This metric represents Network Element availability measured in a prescribed monitoring period and its cumulative representations over consecutive monitoring periods. Here, Network Elements refer to the elements in the core network, access and internal links (links between network elements entirely within an operator's network).</p> <p>Calculation Method: Shall be calculated separately for each network element type</p> <p>Network Element X availability (Monitoring Period (M))%</p> $= \left[1 - \frac{\sum_i^N \text{Network Element (X) downtime}(i)}{\text{Monitoring Period (M)}} \right] * 100$ <p>Where: N = number of times a network element type is down resulting in loss or impairment of its functionality as a result</p>

of the loss of that network element.

X = Represents a specific network element type. In a network, where there is a population of a network element type, the downtime of each element shall contribute to the overall downtime (e.g. failure of any transport links between core network and various elements up to the access nodes shall contribute to the overall downtime, where appropriate)

M = The monitoring period.

Note:

- 1) Downtime and Monitoring period in seconds
- 2) Monitoring period should exclude downtime due to planned maintenance
- 3) Monitoring period should exclude downtime due to natural causes, acts of terrorism, and malicious damage
- 4) If there are redundant elements/nodes deployed in active-standby mode, then availability should be considered for the combined system as one unit.
- 5) If the redundant nodes are deployed in load-sharing mode and dimensioning is applied in such a way that where there is failure of one node, all the traffic is automatically moved to the second available node, then availability should be considered for the combined system as one unit.
- 6) If the redundancy nodes require manual switchover and there is a potential loss of service during the switching period, then availability should be considered separately for these individual nodes.

Cumulative Network Element X availability (for K number of Monitoring Periods) (%)

$$= \left[1 - \frac{\sum_1^K \sum_i^N \text{Network Element (X) downtime}(i)}{\sum_1^K \text{Monitoring period (M)}} \right] * 100$$

Where:

K = the number of monitoring periods.

(c) Link Availability	<p>This metric represents Link availability measured in a prescribed monitoring period and its cumulative representations over consecutive monitoring periods. Here, Link refers to connectivity between one ICT network and another ICT network.</p> <p>Calculation Method: Shall be calculated separately for each external network it is connected to</p> <p><i>External Transport Link availability to Network Z (Monitoring Period M)%</i></p> $= \left[1 - \frac{\sum_i^N \text{External Transport Link Availability to Network Z downtime}(i)}{\text{Monitoring Period}} \right] * 100$ <p>Where: <i>N</i> = number of times a link is down. <i>M</i> = The monitoring period.</p> <p><i>Cumulative External Transport Link availability to Network (Z) (for K number of Monitoring</i></p> $= \left[1 - \frac{\sum_1^K \sum_i^N \text{External Transport Link Availability to Network Z downtime}(i)}{\sum_1^K \text{Monitoring period (M)}} \right] * 100$ <p>Where: <i>M</i> = The monitoring period. <i>K</i> = the number of monitoring periods.</p> <p>Note:</p> <ol style="list-style-type: none"> 1) Downtime and Monitoring period in seconds. 2) Monitoring period should exclude downtime due to planned maintenance. 3) Monitoring period should exclude downtime due to natural causes, acts of terrorism, and malicious damage 4) If there are redundant links deployed in active-standby mode, then availability should be considered for the combined link as one unit. 5) If the redundant links are deployed in load-sharing mode and dimensioning is applied in such a way that where there is failure of one link, all the traffic is automatically moved to the second available link, then availability should be considered for the combined system as one unit. 6) If the redundant links require manual switchover and there is a potential loss of service during the switching period, then availability should be considered separately for these individual links.
-----------------------	---

The Targets set for these Availability Measures are as used in these NRRD Guidelines and are outlined at Annex 1 below.

4. NRRD Guidelines for Mobile Network Operators (MNO)

The Authority shall monitor the following as the minimum thresholds of the NRRD metrics for mobile networks:

4.1. Service Availability

The Authority shall evaluate Service Availability at the Radio Access Nodes of the mobile network system and will require licensees to achieve **99.900% availability**. Service Availability shall be calculated using the equation at Table 1(a).

4.2. Network Element Availability

The Authority shall evaluate Network Element Availability for Critical Elements and for Major Elements in a mobile network.

a) Monitoring of Availability of Critical Network Elements

Licensees will be required to achieve **99.999% availability** for each type of Critical Network Elements as computed under the formula given in Table 1b) above. The Authority identifies the following as Critical Network Elements:

- i) Signal Transfer Point /IP Transfer Point (STP / ITP);
- ii) Mobile Switching Centre (MSC);
- iii) MSC-Servers;
- iv) Circuit Switched Media Gateway (CS MGW);
- v) Serving GPRS Support Node (SGSN);
- vi) Gateway GPRS Support Node (GGSN);
- vii) Mobile Management Entity (MME);
- viii) Serving Gateway (S-GW);
- ix) Packet Data Network Gateway (PDN-GW);
- x) Home Location Register –Authentication Centre (HLR-AuC);
- xi) Home Subscriber Server (HSS);
- xii) Core Network Power Supply;
- xiii) Gateway Mobile Services Switching Centre (GMSC);
- xiv) GMSC-Server;
- xv) Policy and Charging Rules Function (PCRF);
- xvi) Online Charging System (OCS), and
- xvii) Link between Core Network and first Aggregation Layer.

b) Monitoring of Availability of Major Network Elements

Licensees will be required to achieve **99.99% availability** for each type of Major Network Elements as computed under the formula given in Table 1b) above. The Authority identifies the following as Major Network Elements:

- i) Radio Network Controller (RNC), and
- ii) Link between first Aggregation Layer and the second Aggregation Layer.

c) Monitoring of Availability of Minor Network Elements

Licensees will be required to achieve **99.9% availability** for each type of Minor Network Elements as computed under the formula given in Table 1b) above. The Authority identifies the following as Minor Network Elements:

- i) Base Transceiver Station (BTS) or its functional equivalent (NodeB or eNodeB), and
- ii) Links to BTS' and functional equivalents.

4.3. Link Availability

The Authority shall evaluate Link Availability for each type of link as computed under the formula given in Table 1(c) and require licensees to achieve **99.99% availability**. Link availability is to be reported for the following links:

- i) Links between the MNO and other MNOs;
- ii) Links between the MNO and other public switched telephone network (PSTN) Operators;
- iii) Links between the MNO and Internet Service Provider (ISP)/Internet Exchange Point (IXP);
- iv) Links between the MNO and International Gateway (IGW) Operators, and
- v) Links between the MNO and Roaming Links.

5. NRRD Guidelines for Internet Service Providers (ISP)

The Authority shall monitor the following as the minimum thresholds of the NRRD metrics for Internet Service Provider (ISP) Networks.

5.1. Service Availability

The Authority shall evaluate Service Availability measured at the Access Nodes of the Internet Service Provider and will require licensees to achieve **99.900% availability**. Service Availability shall be calculated using the equation in Table 1(a).

5.2. Network Element Availability

The Authority shall evaluate Network Element Availability for Critical Elements and for Major Elements in an Internet Service Provider (ISP) Network.

a) Monitoring of Availability of Critical Network Elements

Licensees will be required to achieve **99.99% availability** for each type of Critical Network Elements as computed under the formula given in Table 1(b) above. The Authority identifies the following as Critical Network Elements:

- i) Provider (P) / Provider Edge (PE)/Aggregation/Access Routers;
- ii) Switches;
- iii) AAA;
- iv) DHCP servers, and
- v) Link between Core Network and first Aggregation Layer.

b) Monitoring of Availability of Major Network Elements

Licensees will be required to achieve **99.9% availability** for each type of Major Network Elements as computed under the formula given in Table 1b) above. The Authority identifies the following as Major Network Elements:

- i) World Wide Web (www) server;
- ii) Policy server;
- iii) Links between Aggregation Point and Provider Edge (PE);
- iv) Links within the P core network;
- v) Links between Provider (P) and Provider Edge (PE) routers, and
- vi) Links between P/PE routers and Aggregation Layer.

c) Monitoring of Availability of Minor Network Elements

Licensees will be required to achieve **99.9% availability** for each type of Minor Network Elements as computed under the formula given in Table 1b) above. The Authority identifies the following as Minor Network Elements:

- i) Access Node and its functional equivalents, and
- ii) Links between Aggregation Layer and Access Nodes and their functional equivalent.

5.3. Link Availability

The Authority shall evaluate Link Availability for each type of link as computed under the formula given in Table 1c) and require licensees to achieve **99.9% availability**. Link availability is to be reported for the following links:

- i) Links between ISP and ISP networks;
- ii) Links between the ISP network and the Internet Exchange Point (IXP), and
- iii) Links between the ISP network and the Fixed Network (FN).

6. NRRD Guidelines for Fixed Wireless Access Network

The Authority shall monitor the following as the minimum thresholds of the NRRD metrics for Fixed Wireless Access Network Operators.

6.1. Service Availability

The Authority shall evaluate Service Availability measured at the Radio Access Nodes of the Fixed Wireless Access Network Operator and will require licensees to achieve **99.0% availability**. Service Availability shall be calculated using the equation in Table 1(a).

6.2. Network Element Availability

The Authority shall evaluate Network Element Availability for Critical, Major and Minor Elements in a Fixed Wireless Access Network.

a) Monitoring of Availability of Critical Network Elements

Licensees will be required to achieve **99.99% availability** for each type of Critical Network Elements as computed under the formula given in Table 1b) above. The Authority identifies the following as Critical Network Elements:

- i) Voice Gateways;
- ii) AAA Servers, and
- iii) Link between Connectivity Service Network (CSN) and Access Service Network Gateway (ASN).

b) Monitoring of Availability of Major Network Elements

Licensees will be required to achieve **99.9% availability** for each type of Major Network Elements as computed under the formula given in Table 1b) above. The Authority identifies the following as Major Network Elements:

- i) Domain Name System (DNS) Servers;
- ii) Dynamic Host Configuration Protocol (DHCP) Servers;
- iii) Access Service Network (ASN)-Gateway, and
- iv) Link between Access Service Network Gateway (ASN) and Access Network.

c) Monitoring of Availability of Minor Network Elements

Licensees will be required to achieve **99.0% availability** for each type of Minor Network Elements as computed under the formula given in Table 1(b) above. The Authority identifies the following as Minor Network Elements:

- i) Radio Access Nodes, and
- ii) Links between Access Network and Radio Access Nodes.

6.3. Link Availability.

The Authority shall evaluate Link Availability for each type of link as computed under the formula given in Table 1c) and require licensees to achieve **99.9% availability**. Link availability is to be reported for the following links:

- i) Links between the Fixed Wireless Network and Other Fixed Wireless Networks;
- ii) Links between the Fixed Wireless Network and other Public Switched Telephone Network (PSTN) Operators;
- iii) Links between the Fixed Wireless Network and Mobile Network Operators (MNOs);
- iv) Links between the Fixed Wireless Network and Internet Service Provider (ISP)/Internet Exchange Point (IXP);
- v) Links between the Fixed Wireless Network and International Gateway (IGW) Operators, and
- vi) Links between Internet Service Provider (ISP) and Submarine Cable Networks (SCN) operators.

7. NRRD Guidelines for International Gateway (IGW) Operators

The Authority shall monitor the following as the minimum thresholds of the NRRD metrics for Internet Gateway Network (IGW) Operators.

7.1. Service Availability

The Authority shall evaluate Service Availability on international traffic destinations and will require licensees to achieve the following availability measures:

- i) Voice calls to specific, major traffic destination (referring here to the top 10 jurisdictions for the reporting period) destinations shall be reachable **99.990%** of time, and
- ii) Voice calls to all other international destinations shall be reachable **99.9%** of time.

Service Availability shall be calculated using the equation in Table 1(a).

7.2. Network Element Availability

The Authority shall evaluate network element availability for critical elements in an Internet Gateway Network.

Licensees will be required to achieve **99.9% availability** for Critical Network Elements as computed under the formula given in Table 1(b) above. The Authority identifies the following as Critical Network Elements:

- i) Time Division Multiplexing (TDM) Switches (Exchange);
- ii) Signal Transfer point (STP)-Internet Transfer point (ITP) mated pairs;
- iii) Session Border Controller (SBC);
- iv) Gateway power supply;
- v) Firewalls, and
- vi) Session Initiation Protocol (SIP) servers.

7.3. Link Availability

The Authority shall evaluate Link Availability for each type of link as computed under the formula given in Table 1(c) and require licensees to achieve **99.999% availability**. Link availability is to be reported for the following links:

- i) Links between the International Gateway Network (IGW) and Interconnect points of Submarine Cable Networks;

- ii) Links between the International Gateway Network (IGW) and international destinations through fibre lease circuits, and
- iii) Links between the International Gateway Network (IGW) and International destinations through satellite.

8. NRRD Guidelines for Submarine Cable Network (SCN) Operators

The Authority shall monitor the following as the minimum thresholds of the NRRD metrics for Submarine Cable Network Operators.

8.1. Service Availability

The Authority shall evaluate Service Availability to and from the remote Submarine Cable System Terminal Station(s) situated outside Kenya and will require licensees to achieve **99.99% availability** of connectivity to and from international destinations. Service Availability shall be calculated using the equation in Table 1(a).

8.2. Network Element Availability

The Authority shall evaluate Network Element Availability for Critical Elements and for Major Elements in a Submarine Cable System.

a) Monitoring of Availability of Critical Network Elements-Dry Section

Licensees will be required to achieve **99.999% availability** for each type of Critical Network Elements (Dry Section) as computed under the formula given in Table 1(b) above. The Authority identifies the following as Critical Network Elements (Dry Section):

- i) Network Protection Equipment (NPE);
- ii) Submarine Line Terminating Equipment (SLTE);
- iii) Power Feed Equipment (PFE);
- iv) SCLS Power Supply Unit (PSU);
- v) Link to the Interconnect PoP, and
- vi) Link between dry and wet section.

b) Monitoring of Availability of Critical Network Elements-Wet Section

Licensees will be required to achieve **99.999% availability** for each type of Critical Network Elements (Wet Section) as computed under the formula given in Table 1b) above. The Authority identifies the following as Critical Network Elements (Wet Section):

- i) Repeaters, and
- ii) Branching Units.

8.3. Link Availability

The Authority shall evaluate Link Availability between the interconnect point where all other service providers connect to the SCN and will require licensees to achieve **99.999% availability** under the formula given in Table 1(c).

9. NRRD Guidelines for Internet Exchange Point (IXP) Operators

The Authority shall monitor the following as the minimum thresholds of the NRRD metrics for Internet Exchange Point (IXP) Operators.

9.1. Service Availability

The Authority shall evaluate Service Availability of Internet data traffic and will require licensee's customers to be able to receive acceptable level of service for **99.99%** of time. Service Availability shall be calculated using the equation in Table 1(a).

9.2. Network Element Availability

The Authority shall evaluate Network Element Availability for Critical and Major Elements in an Internet Exchange Point Network.

a) Monitoring of Availability of Critical Network Elements

Licensees will be required to achieve **99.999% availability** for Critical Network Elements as computed under the formula given in Table 1b). The Authority identifies the following as Critical Network Elements:

- i) High speed Switching Fabric;
- ii) Authentication, authorization, and accounting (AAA);
- iii) Firewall;
- iv) IXP Route server;
- v) Multiplexer/Demultiplexer (MUX/DMUX);
- vi) Dynamic Name Server (DNS);
- vii) Exchange Power Supply;
- viii) Switching Fabrics;
- ix) Caching servers, and
- x) Routers.

b) Monitoring of Availability of Major Network Elements

Licensees will be required to achieve **99.990% availability** for Major Network Elements as computed under the formula given in Table 1b). The Authority identifies the following as Major Network Elements:

- i) World Wide Web Server;
- ii) Network Time Protocol (NTP);
- iii) Link between ISP/CSP/HSP and Switching Fabric, and
- iv) Link between Aggregation Point and MUX/DMUX.

9.3. Link Availability

For Internet Exchange Provider (IXP), the Authority shall evaluate Link Availability for the link between the IXP and each Submarine Cable Network (SCN) operator as computed under the formula given in Table 1(c) and require licensees to achieve 99.999% availability.

10. NRRD Guidelines for Fixed Networks

The Authority shall monitor the following as the minimum thresholds of the NRRD metrics for Fixed Network Operators.

10.1. Service Availability

The Authority shall evaluate Service Availability at the Access Nodes of the fixed network operator. Access nodes are either interconnect points (other network operators) or interface points to provide services to public/private users (cabinets). Licensees will be required to achieve **99.9% availability**. Service Availability shall be calculated using equation in Table 1(a).

10.2. Network Element Availability

The Authority shall evaluate Network Element Availability for Critical, Major and Minor Elements in a Fixed Network.

a) Monitoring of Availability of Critical Network Elements

Licensees will be required to achieve **99.99% availability** for Critical Network Elements as computed under the formula given in Table 1b). The Authority identifies the following as Critical Network Elements:

- i) Local Exchange;
- ii) Tandem or Trunk Exchange;
- iii) Toll Exchange;
- iv) STP;
- v) Link between Toll Exchange and Local Exchange, and
- vi) Link between Toll Exchange and Tandem Exchange.

b) Monitoring of Availability of Major Network Elements

Licensees will be required to achieve **99.9% availability** for Major Network Elements as computed under the formula given in Table 1b). The Authority identifies the following as Major Network Elements:

- i) Remote Concentrator, and
- ii) Links between Local Exchange and Remote Concentrators.

c) Monitoring of Availability of Minor Network Elements

Licensees will be required to achieve **99.0% availability** for Minor Network Elements as computed under the formula give in Table 1b). The Authority identifies the following as Minor Network Elements:

- i) Cabinets, and
- ii) Links between Remote Concentrators and Cabinets.

10.3. Link Availability

The Authority shall evaluate Link Availability for each type of link as computed under the formula given in Table 1c) and require licensees to achieve **99.9% availability**. Link availability is to be reported for the following links:

- i) Links between Fixed Network Operator (FNO) and other FNOs;
- ii) Links between Fixed Network Operator (FNO) and IXP;
- iii) Links between Fixed Network Operator (FNO) and IGW, and
- iv) Links between Fixed Network Operator (FNO) and SCN.

11. Submission of Quarterly Reports

Licensee shall submit quarterly reports in the format provided at Annex 2 below or as may be further prescribed by the Authority from time to time. Where availability has been impaired by external factors, the licensee shall detail such incidence at the Incident Reporting section of the quarterly reports for Service, Network Element and/or Link Availability as appropriate.

12. Record-Keeping and Retention

Licensees required to report under these NRRD Guidelines shall maintain a soft-copy database record of all data necessary to compute the target values for the required metrics using the formulas provided in these Guidelines at Table 1 in disaggregated form. Licensees will be required to retain and make available for inspection by the Authority these records for a period of no less than 3 years.

13. Promulgation of the NRRD Guidelines

13.1. Effective Date of the NRRD Guidelines

These NRRD Guidelines shall become effective from 1st July 2017.

13.2. Review of the NRRD Guidelines

The Authority may review these NRRD Guidelines from time to time in consultation with stakeholders.

Issued by the Communications Authority of Kenya

Director General
Communications Authority of Kenya

Date

ANNEX 1: AVAILABILITY MEASURES

Availability Measures	
Uptime %	Downtime / Unavailability in time
99.999 (Five Nines)	Yearly: 5 minutes 15.36 seconds Monthly: 26.2 seconds Weekly: 6 seconds
99.99 (Four Nines)	Yearly: 52 minutes 35.7 seconds Monthly: 4 minutes 23 seconds Weekly: 1 minute 0.5 second
99.9 (Three Nines)	Yearly: 8 hours, 45 minutes, 57 seconds Monthly: 43 minutes 49.7 seconds Weekly: 10 minutes 4.8 seconds
99.0 (Two Nines)	Yearly: 3 days, 15 hours, 39 minutes, 29.5 seconds Monthly: 7 hours, 18 minutes, 17.5 seconds Weekly: 1 hour, 40 minutes, 48 seconds.
98.0	Yearly: 7 days, 7 hours, 18 minutes, 59 seconds Monthly: 14 hours, 36 minutes, 34.9 seconds Weekly: 3 hours, 21 minutes, 36 seconds
95.0	Yearly: 18 days, 6 hours, 17 minutes, 27 seconds Monthly: 1 day, 12 hours, 31 minutes, 27 seconds Weekly: 8 hours, 24 minutes

ANNEX 2: COMPLIANCE RETURN FORM

NETWORK REDUNDANCY, RESILIENCE AND DIVERSITY (NRRD) COMPLIANCE RETURN FORM

PURSUANT TO THE PROVISIONS OF KICA 1998 AS AMENDED, THE KENYA INFORMATION AND COMMUNICATIONS REGULATIONS AND THE LICENSE CONDITIONS

Please note that the latest version of this form is the one on the Authority's website

1. GENERAL INFORMATION

1.1 Licensee Details

Name of Licensee _____

License No _____

Other Licenses held _____

1.2 Period under review (Tick against appropriate quarter)

FINANCIAL YEAR _____ (based on Government of Kenya Financial year)

Quarter 1
(1st Jul-30th Sep)
☐

Quarter 2
(1st Oct -31st Dec)
☐

Quarter 3
(1st Jan -31st Mar)
☐

Quarter 2
(1st Apr-30th Jun)
☐

1.3 Address

1. Physical Address:

Town _____ Street/Road _____

L.R. No. _____ Floor No. _____ Room No. _____

2. Postal Address:

P. O. Box _____ Postal Code _____

Post Office Town _____

3. Phone Contact:

Tel. No. _____ Mobile No _____ Other Tel. Nos _____

1.4. Email and Web Address:

Email address: _____

Web Address: _____

Did any of the address information change during the quarter? (Tick as appropriate) Yes No

(If Yes, attach a notification letter on the same)

Please note that all the address information requested must be provided above whether or not there were changes during the quarter.

1.4 Contact details

Name of Head of Organization _____

Title of Head of Organization _____

Name of contact person _____

Title _____

Telephone _____

Email _____

Signature _____

1.5 Instructions

1. Please provide information in the space provided, you may insert additional rows and pages as required.
2. Please refer to Appendix A for calculations of the required metrics. Appendix B provides worked examples on how to calculate a metric. Please note that:
 - (a) where the reporting network does not have specific element/link types, please mark the corresponding Availability metric as “not applicable;”
 - (b) the network/link descriptions given are intended to be generic. If a particular network uses different naming conventions and/or network architectural components other than those specified, please report Availability for a given network element based on the appropriate functionally analogous category. Please annotate your answer if you believe additional information concerning the equipment/configuration reported on is required.

REPORTING SECTION

[please complete the appropriate section/s in relation to your license category/ies]

(Information should be submitted within 15 days after the end of each Quarter)

2.0 NRRD Metrics for Mobile Network Operators (MNO)**2.1 Service Availability**Target: **99.900% availability**

	Service Availability	Availability (%)

2.2 Network Element Availability -**a) Availability of Critical Network Elements**Target: **99.999% availability**

	Network Element	Availability (%)
i).	Signal Transfer Point /IP Transfer Point (STP / ITP)	
ii).	Mobile Switching Centre (MSC)	
iii).	MSC-Servers	
iv).	Circuit Switched Media Gateway (CS MGW)	
v).	Serving GPRS Support Node (SGSN)	
vi).	Gateway GPRS Support Node (GGSN)	
vii).	Mobile Management Entity (MME)	
viii).	Serving Gateway (S-GW)	
ix).	Packet Data Network Gateway (PDN-GW)	
x).	Home Location Register –Authentication Centre (HLR-AuC)	
xi).	Home Subscriber Server (HSS)	
xii).	Core Network Power Supply	
xiii).	Gateway Mobile Services Switching Centre (GMSC)	
xiv).	GMSC-Server	
xv).	Policy and Charging Rules Function (PCRF)	
xvi).	Online Charging System (OCS)	
xvii).	Link between Core Network and first Aggregation Layer	

b) Availability of Major Network ElementsTarget: **99.990% availability**

	Network Element	Availability (%)
i).	Radio Network Controller (RNC)	
ii).	Link between first Aggregation Layer and the second Aggregation Layer.	

c) Availability of Minor Network ElementsTarget: **99.9% availability**

	Network Element	Availability (%)
i).	Base Transceiver Station (BTS) or its functional equivalent (NodeB or eNodeB)	
ii).	Links to BTS' and functional equivalents	

2.3 Link AvailabilityTarget: **99.990% availability**

	Links	Availability (%)
i).	Links between the MNO and other MNOs	
ii).	Links between the MNO and other Public switched telephone network (PSTN) Operators;	
iii).	Links between the MNO and Internet Service Providers (ISP)/Internet Exchange Point (IXP);	
iv).	Links between the MNO and International Gateway (IGW) Operators	
v).	Links between the MNO and Roaming Links.	

3.0 NRRD Metrics for Internet Service Providers (ISP)**3.1 Service Availability**Target: **99.900% availability**

	Service Availability	Availability (%)

3.2 Network Element Availability**a) Availability of Critical Network Elements**Target: **99.99% availability**

	Network Element	Availability (%)
i).	Provider (P)/Provider Edge (PE)/Aggregation/Access Routers	
ii).	Switches	
iii).	AAA	
iv).	DHCP servers	
v).	Link between Core Network and first Aggregation Layer	

b) Availability of Major Network ElementsTarget: **99.9% availability**

	Network Element	Availability (%)
i).	World Wide Web (www) server	
ii).	Policy server	
iii).	Links between Aggregation Point and Provider Edge (PE)	
iv).	Links within the P core network	

v).	Links between Provider (P) and Provider Edge (PE) routers	
vi).	Links between P/PE routers and Aggregation Layer	

c) Availability of Minor Network Elements

Target: **99.9% availability**

	Network Element	Availability (%)
i).	Access Node and its functional equivalents	
ii).	Links between Aggregation Layer and Access Nodes and their functional equivalent	

3.3 Link Availability

Target: **99.900% availability**

	Links	Availability (%)
i).	Links between ISP and ISP networks	
ii).	Links between the ISP network and the Internet Exchange Point (IXP)	
iii).	Links between the ISP network and the Fixed Network (FN)	

4.0 NRRD Metrics for Fixed Wireless Access Network

4.1 Service Availability

Target: **99.0% availability**

	Service Availability	Availability (%)

4.2 Network Element Availability

a) Availability of Critical Network Elements

Target: **99.99% availability**

	Network Element	Availability (%)
i).	Voice Gateways	
ii).	AAA Servers	
iii).	Link between Connectivity Service Network (CSN) and Access Service Network Gateway (ASN)	

b) Availability of Major Network Elements

Target: **99.900% availability**

	Network Element	Availability (%)
i).	Domain Name System (DNS) Servers	
ii).	Dynamic Host Configuration Protocol (DHCP) Servers	
iii).	Access Service Network (ASN)-Gateway	
iv).	Link between Access Service Network Gateway (ASN) and Access Network	

c) Availability of Minor Network ElementsTarget: **99.0 % availability**

	Network Element	Availability (%)
i).	Radio Access Nodes	
ii).	Links between Access Network and Radio Access Nodes	

4.3 Link AvailabilityTarget: **99.9% availability**

	Links	Availability (%)
i).	Links between the Fixed Wireless Network and Other Fixed Wireless Networks	
ii).	Links between the Fixed Wireless Network and other public switched telephone network (PSTN) Operators	
iii).	Links between the Fixed Wireless Network and Mobile Network Operators (MNO's)	
iv).	Links between the Fixed Wireless Network and Internet Service Provider (ISP)/Internet Exchange Point (IXP)	
v).	Links between the Fixed Wireless Network and International Gateway (IGW) Operators	
vi).	Links between Internet Service Provider (ISP) and Submarine Cable Networks (SCN) operators	

5.0 NRRD Metrics for Internet Gateway Network (IGW) Operators**5.1 Service Availability**

Target:

- i). Voice calls to specific, major traffic destinations (referring here to the top 10 jurisdictions for the reporting period) shall be reachable 99.990% of time and
- ii). Voice calls to all other international destinations shall be reachable 99.9% of time.

	Service Availability	Availability (%)
i).		
ii).		

5.2 Network Element Availability-Availability of Critical Network ElementsTarget: **99.9% availability**

	Network Element	Availability (%)
i).	Time Division Multiplexing (TDM) Switches (Exchange);	
ii).	Signal Transfer point (STP)-Internet Transfer point (ITP) mated pairs	
iii).	Session Border Controller (SBC);	
iv).	Gateway power supply	
v).	Firewalls	
vi).	Session Initiation Protocol (SIP) servers	

5.3 Link AvailabilityTarget: **99.999% availability**

	Links	Availability (%)
i).	Links between the International Gateway Network (IGW) and Interconnect points of Submarine Cable Network (SCN) Interconnect Points	
ii).	Links between the International Gateway Network (IGW) and international destinations through fibre leased circuits	
iii).	Links between the International Gateway Network (IGW) and International destinations through satellite	
iv).		

6.0 NRRD Metrics for Submarine Cable Network (SCN) Operators**6.1 Service Availability**Target: **99.99% availability**

	Service Availability	Availability (%)

6.2 Network Element Availability**a) Availability of Critical Network Elements-Dry Section**Target: **99.999% availability**

	Network Element	Availability (%)
i).	Network Protection Equipment (NPE)	
ii).	Submarine Line Terminating Equipment (SLTE)	
iii).	Power Feed Equipment (PFE)	
iv).	SCLS Power Supply Unit (PSU)	
v).	Link to the Interconnect PoP	
vi).	Link between dry and wet section	

b) Availability of Critical Network Elements-Wet SectionTarget: **99.999% availability**

	Network Element	Availability (%)
i).	Repeaters	
ii).	Branching Units	

6.3 Link AvailabilityTarget: **99.999% availability**

	Links	Availability (%)
i).	Link between the interconnect point where all other service providers connect to the SCN	

7.0 NRRD Metrics for Internet Exchange Point (IXP) Operator

7.1 Service Availability

Target: **99.99% availability**

	Service Availability	Availability (%)

7.2 Network Element Availability

a) Availability of Critical Network Elements

Target: **99.999% availability**

	Network Element	Availability (%)
i).	High speed Switching Fabric	
ii).	Authentication, authorization, and accounting (AAA)	
iii).	Firewall	
iv).	IX Route server	
v).	Multiplexer/ De-multiplexer (MUX/DMUX);	
vi).	Dynamic Name Server (DNS)	
vii).	Exchange Power Supply	
viii).	Switching Fabrics	
ix).	Caching servers	
x).	Routers	

b) Availability of Major Network Elements

Target: **99.990% availability**

	Network Element	Availability (%)
i).	World Wide Web Server	
ii).	Network Time Protocol (NTP)	
iii).	Link between ISP/CSP/HSP and Switching Fabric	
iv).	Link between Aggregation Point and MUX/DMUX	

7.3 Link Availability

Target: **99.999% availability**

	Links	Availability (%)
	Link between Internet Exchange Point (IXP) and Submarine Cable Network (SCN) operators	

8.0 NRRD Metrics for Fixed Network Operator

8.1 Service Availability

Target: **99.9% availability**

	Service Availability	Availability (%)

8.2 Network Element Availability

a) Availability of Critical Network Elements

Target: **99.99% availability**

	Network Element	Availability (%)
i).	Local Exchange	
ii).	Tandem or Trunk Exchange	
iii).	Toll Exchange	
iv).	STP	
v).	Link between Toll Exchange and Local Exchange	
vi).	Link between Toll Exchange and Tandem Exchange	

b) Availability of Major Network Elements

Target: **99.9% availability**

	Network Element	Availability (%)
i).	Remote Concentrator	
ii).	Links between Local Exchange and Remote Concentrators	

c) Availability of Minor Network Elements

Target: **99.0% availability**

	Network Element	Availability (%)
i).	Cabinets	
ii).	Links between Remote Concentrators and Cabinets	

8.3 Link Availability

Target: **99.900% availability**

	Links	Availability (%)
i).	Links between Fixed Network Operator (FNO) and other FNOs	
ii).	Links between Fixed Network Operator (FNO)	
iii).	Links between Fixed Network Operator (FNO) and IGW	
iv).	Links between Fixed Network Operator (FNO) and SCN	

9.0 INCIDENT REPORTING

This section should be completed only where a licensee has reported Service and/or Network Element/Link Availability below the Targets set by the Authority for the current reporting period. If this is the case, please complete the below tables, adding rows as necessary.

9.1 Service Unavailability Incidents for Reporting Period

Please complete the below table, adding lines as necessary if your Service Availability for the current reporting period is below the appropriate Target set by the Authority. Please list each separate Service unavailability incident in a separate row.

ID	Service Unavailability Incident Reporting					
	FROM Date/Time	TO Date/Time	Service(s) Affected	Failure Description	Maximum Geographic Area Impacted	Estimated No. of customers impacted
	00/00/2010/00:00	00/00/2010/00:00	e.g. voice, data, SMS etc.	Causation, equipment/ links affected, sequence of events, restoration efforts required etc.	Counties or Sub counties	Class of customers (e.g. consumer, enterprise, carrier – if so, identify) and numbers)
S.1.						
S.2.						
S.3.						
S.4.						
S.5.						

9.2. Network Element Unavailability Incidents for Reporting Period

Please complete the below table, adding lines as necessary for any category of Network Element and Link for which availability in the current reporting period is below the applicable Target(s) set by the Authority. Please list each separate unavailability incident in a separate row.

ID	Network Element Unavailability Incident Reporting					
	FROM Date/Time	TO Date/Time	Network Elements(s) Affected	Failure Description	Maximum Geographic Area Impacted	Estimated No. of customers impacted
	00/00/2010/00:00	00/00/2010/00:00	Network element/internal link description	Causation, equipment/links affected, sequence of events, restoration efforts required etc.	Counties or Sub counties	Class of customers (e.g. consumer, enterprise, carrier – if so, identify) and numbers)
NE.1.						
NE.2.						
NE.3.						
NE.4.						
NE.5.						

9.2. Link Unavailability Incidents for Reporting Period

Please complete the below table, adding lines as necessary for any category of Network Element and Link for which availability in the current reporting period is below the applicable Target(s) set by the Authority. Please list each separate unavailability incident in a separate row.

ID	Network Element Unavailability Incident Reporting					
	FROM Date/Time	TO Date/Time	Link(s) Affected	Failure Description	Maximum Geographic Area Impacted	Estimated No. of customers impacted
	00/00/2010/00:00	00/00/2010/00:00	Link to other operator (specify)	Causation, equipment/ links affected, sequence of events, restoration efforts required etc.	Counties or Sub counties	Class of customers (e.g. consumer, enterprise, carrier – if so, identify) and numbers)
L.1.						
L.2.						
L.3.						
L.4.						
L.5.						

APPENDIX A: AVAILABILITY MEASURES

Metric Name	Description and Objective
(a) Service Availability	<p>This metric represents the availability measure in a prescribed monitoring period and its cumulative representation over consecutive monitoring periods. This metric is measured independently of the number of users impacted.</p> <p>Calculation Method:</p> $\text{Service availability (Monitoring Period (M)) \%} = \left[1 - \frac{\sum_i^N \text{service downtime}(i)}{\text{Monitoring Period (M)}} \right] * 100$ <p>Where: M = The monitoring period. N = number of times the service is down.</p> <p>Note:</p> <ol style="list-style-type: none"> 1) Downtime and Monitoring period in seconds 2) Monitoring period should exclude downtime due to planned maintenance 3) Monitoring period should exclude downtime due to natural causes, acts of terrorism, and malicious damage $\text{Cumulative Service availability (for K number of Monitoring Periods) (\%)} = \left[1 - \frac{\sum_1^K \sum_i^N \text{service downtime}(i)}{\sum_1^K \text{Monitoring period (M)}} \right] * 100$ <p>Where: K = the number of monitoring periods.</p>
(b) Network Element Availability	<p>This metric represents Network Element availability measured in a prescribed monitoring period and its cumulative representations over consecutive monitoring periods. Here, Network Elements refer to the elements in the core network, access and internal links (links between network elements entirely within an operator's network).</p> <p>Calculation Method: Shall be calculated separately for each network element type</p> $\text{Network Element X availability (Monitoring Period (M)) \%} = \left[1 - \frac{\sum_i^N \text{Network Element (X) downtime}(i)}{\text{Monitoring Period (M)}} \right] * 100$ <p>Where:</p>

N = number of times a network element type is down resulting in loss or impairment of its functionality as a result of the loss of that network element.

X = Represents a specific network element type. In a network, where there is a population of a network element type, the downtime of each element shall contribute to the overall downtime (e.g. failure of any transport links between core network and various elements up to the access nodes shall contribute to the overall downtime, where appropriate)

M = The monitoring period.

Note:

- 1) Downtime and Monitoring period in seconds
- 2) Monitoring period should exclude downtime due to planned maintenance
- 3) Monitoring period should exclude downtime due to natural causes, acts of terrorism, and malicious damage
- 4) If there are redundant elements/nodes deployed in active-standby mode, then availability should be considered for the combined system as one unit.
- 5) If the redundant nodes are deployed in load-sharing mode and dimensioning is applied in such a way that where there is failure of one node, all the traffic is automatically moved to the second available node, then availability should be considered for the combined system as one unit.
- 6) If the redundancy nodes require manual switchover and there is a potential loss of service during the switching period, then availability should be considered separately for these individual nodes.

Cumulative Network Element X availability (for K number of Monitoring Periods) (%)

$$= \left[1 - \frac{\sum_1^K \sum_i^N \text{Network Element (X) downtime}(i)}{\sum_1^K \text{Monitoring period (M)}} \right] * 100$$

Where:

K = the number of monitoring periods.

(c) Link Availability	<p>This metric represents Link availability measured in a prescribed monitoring period and its cumulative representations over consecutive monitoring periods. Here, Link refers to connectivity between one ICT network and another ICT network.</p> <p>Calculation Method: Shall be calculated separately for each external network it is connected to</p> <p><i>External Transport Link availability to Network Z (Monitoring Period M)%</i></p> $= \left[1 - \frac{\sum_i^N \text{External Transport Link Availability to Network Z downtime}(i)}{\text{Monitoring Period}} \right] * 100$ <p>Where: <i>N</i> = number of times a link is down. <i>M</i> = The monitoring period.</p> <p><i>Cumulative External Transport Link availability to Network (Z) (for K number of Monitoring</i></p> $= \left[1 - \frac{\sum_1^K \sum_i^N \text{External Transport Link Availability to Network Z downtime}(i)}{\sum_1^K \text{Monitoring period (M)}} \right] * 100$ <p>Where: <i>M</i> = The monitoring period. <i>K</i> = the number of monitoring periods.</p> <p>Note:</p> <ol style="list-style-type: none"> 1) Downtime and Monitoring period in seconds. 2) Monitoring period should exclude downtime due to planned maintenance. 3) Monitoring period should exclude downtime due to natural causes, acts of terrorism, and malicious damage 4) If there are redundant links deployed in active-standby mode, then availability should be considered for the combined link as one unit. 5) If the redundant links are deployed in load-sharing mode and dimensioning is applied in such a way that where there is failure of one link, all the traffic is automatically moved to the second available link, then availability should be considered for the combined system as one unit. 6) If the redundant links require manual switchover and there is a potential loss of service during the switching period, then availability should be considered separately for these individual links.
-----------------------	---

APPENDIX B: EXAMPLES OF HOW TO CALCULATE THE METRICS

These calculation examples apply to service availability, network availability and link availability

Notes:

1. Monitoring periods will vary due to different days in a month over a calendar year.
2. Cumulative availability is an integration of the current and previous downtimes for each reporting period.
3. In the examples below, example 1 is the start of monitoring NRRD metrics.
4. Two calculations shall be carried out for each monitoring period: one specific to the monitoring period and one considering the previous monitoring availability (cumulative)

Examples

Monitoring period (MP) = 3 Months

$MP = 3 * 31 * 24 * 60 * 60 = 8035230 \text{ Seconds}$

Example 1: Two downtimes during the monitoring period -> MP1-DT1 and MP1-DT2

$MP1-DT1 = 30 \text{ minutes} = 1800 \text{ seconds}$

$MP1-DT2 = 15 \text{ minutes} = 900 \text{ seconds}$

$MP1 \text{ Availability} = \{1 - [(1800+900)/8035230]\} * 100$

$MP1 \text{ Availability} = 99.966\%$

Example 2: One downtime during the monitoring period -> MP2-DT1

$MP2-DT1 = 60 \text{ minutes} = 3600 \text{ seconds}$

$MP2 \text{ Availability} = \{1 - [(3600)/8035230]\} * 100$

$MP2 \text{ Availability} = 99.955\%$

Cumulative availability (over 2 the monitoring periods) -> Integrate over MP1 and MP2

$\text{Cumulative availability (6 months)} = \{1 - [(1800+900+3600)/(8035230+8035230)]\} * 100$

$\text{Cumulative availability (6 months)} = 99.960\%$

Example 3: No downtime during the monitoring period

$MP3-DT = 0 \text{ seconds}$

$MP3\text{-Availability} = \{1 - [(0)/8035230]\} * 100$

$MP3\text{-Availability} = 100\%$

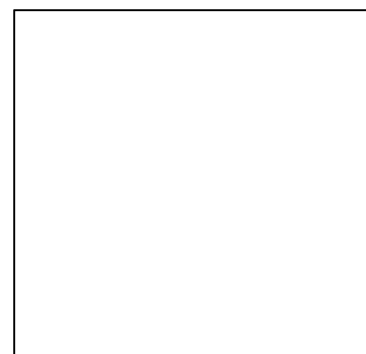
Cumulative availability (over the 3 monitoring periods) -> Integrate over MP1, MP2 and MP3

$\text{Cumulative availability (9 months)} = \{1 - [(1800+900+3600+0)/(8035230+8035230+8035230)]\} * 100$

$\text{Cumulative availability (9 months)} = 99.974\%$

10.0 COMMENTS/ SUGGESTIONS

Please share any challenges faced and/or make suggestions to improve the regulatory environment.



Signed.....
Name.....
Title.....
Date

Company Stamp above

*(NB: Where nil returns are submitted, an explanation **MUST** be provided under the Comments/Suggestions section of this form)*

THANK YOU FOR COMPLETING THIS FORM

FOR OFFICIAL USE ONLY – DO NOT FILL BELOW THIS LINE

These returns have been:

	Checked By:	Verified by:	Approved/Rejected (Tick as appropriate)
Name			
Title			
Signature			
Date			

**ISSUANCE OF COMPLIANCE CERTIFICATE MAY BE WITHHELD IF A
LICENSEE HAS NOT COMPLETED AND SUBMITTED THIS RETURNS FORM
TO THE SATISFACTION OF THE AUTHORITY**