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Executive Summary

The National Transmission Company of South African's (NTCSA) Telecommunications business unit provides operational and business telecommunications services to Eskom. Since these services are used in a real-time operational environment, the overall requirement of these services is that they are reliable and of high quality.

This document outlines the minimum access network configuration required to meet the performance requirements as stated in the Service Level Agreements (SLA).

1. Introduction

NTCSA Telecommunications provides operational and business telecommunications services to Eskom Holdings SOC Limited and its subsidiaries. The point-to-point circuits provided by NTCSA Telecommunications are used for operational services such as teleprotection, telecontrol and direct voice lines. These circuits are provided according to contractually defined service categories that have associated performance requirements. The offered circuits are denoted as five service level categories to the customers, namely Platinum+, Platinum, Gold, Silver, and Bronze services. Service categories per circuit/service are stated in Service Level Agreements (SLAs) with customers.

This document provides guidance for selecting the most appropriate network configuration to meet performance requirements as listed in the SLAs.

2. Supporting clauses

2.1 Scope

This document provides the minimum access network infrastructure requirements for meeting NTCSA Telecommunications' customer SLAs.

2.1.1 Purpose

The purpose of this document is to give NTCSA Telecommunications guidance on access network infrastructure configuration required to meet customer expected performance. The document will provide assurance to the customer that if the NTCSA Telecommunications access network infrastructure is configured as stipulated, their performance requirements will be met.

2.1.2 Applicability

This document shall apply throughout NTCSA and Eskom Holdings SOC Limited and its subsidiaries.

2.2 Normative/informative references

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

2.2.1 Normative

[1] ISO 9001, Quality Management Systems.

[2] 240-70783066, Telecommunications Transport Network Standard

[3] ITU-R Recommendation F.1703 (01/05): Availability objectives for real digital fixed wireless links used in 27500 km hypothetical reference paths and connections

[4] 32-729, System Operator Minimum Telecommunications Requirements

2.2.2 Informative

[5] 240-124193749, Service Level Agreement Between Transmission System Operator and Eskom Telecommunications

[6] 240-122845542, Service Level Agreement Between Transmission and Eskom Telecommunications

[7] ETAG 1933, Service Level Agreement Between Transmission (Eskom Telecommunications) and Generation (Power Stations)

[8] Service Level Agreement (Distribution),latest revision, Claude Solomon

[9] Service Level Agreement (Group IT),latest revision, Sharon Mokoena

[10] Service Level Agreement (External Customers),latest revision, Nolan Dominic

2.3 Definitions

2.3.1 General

Definition	Description
Availability	Refers to the percentage of time, measured over a predefined period (mostly one month), that the telecommunications system reliably transmits and receives information. Information is deemed to be reliably transmitted when predetermined error performance objectives, such as BER are exceeded. Mathematically, Availability can be expressed as $\frac{\text{Service uptime}}{\text{Reporting period}} \text{ x } 100\%$ or in terms of equipment MTBF: $Availability = \frac{MTBF}{MTTR + MTBF}$
Fault	Means any incident that does or is likely to impact on the functionality of the strategic telecommunications network as used by the electric utility.
Loss of Service	Means any period of time for which a network node is not available to NTCSA Telecommunications or for use by the electric utility due to either a critical fault or planned outage
Remedy	Means the action(s) required to resolve a fault by limiting its effects. The Remedy may cause restrictions in system performance.
Re-routing	Means the re-establishment of communication services after a fault on a network path, by means of a predetermined process of selecting alternative paths in a network along which to send network traffic.
Restoration	Means the action(s) required to repair the faulty system. When a restoration is implemented, the system is restored to the state it was in before the fault occurred.
Restoration Time	Means the time taken from the fault being reported, either by the customer or an element management system, to the fault being repaired, excluding any period(s) of time: 1) As a result of a Force Majeure event, 2) Where the customer has agreed in advance that the repair can be delayed, or 3) Where a fault has been cleared but is awaiting the customer's confirmation of the fault being repaired.
Risk Element	Means: 1) Any part of the operation of the strategic telecommunications network and/or network nodes, 2) any item of equipment or software, or 3) any customer asset which NTCSA Telecommunications has notified to and agreed with the customer as being a valid risk and placed in the customer's risk register as being unable to be maintained, repaired and/or replaced by NTCSA Telecommunications or whose maintenance, repair and/or replacement is restricted for any reason outside of NTCSA Telecommunications' control.

2.3.2 Disclosure classification

Controlled disclosure: controlled disclosure to external parties (either enforced by law, or discretionary).

2.4 Abbreviations

Abbreviation	Description
ADM	Add-Drop Multiplexer
BME	Bandwidth Management Equipment
CPE	Customer Premises Equipment
DRT	Design Review Team
IED	Intelligent Electronic Device
IP/MPLS	Internet Protocol/Multi-Protocol Label Switching
MSAP	Multi-Service Access Platform
MTBF	Mean Time Between Failures
MTTR	Mean Time to Repair
NCC	National Control Centre
NTCSA	National Transmission Company of South Africa
OEM	Original Equipment Manufacturer
OTN	Optical Transport Network
PTM&C	Protection, Telecommunications, Metering and Control
RT	Repair Time
RTU	Remote Terminal Unit
SCOT	Steering Committee of Technologies
SLA	Service Level Agreement
TDRT	Telecommunications Design Review Team
TT	Travel Time (to site)

2.5 Roles and Responsibilities

The following are the roles and responsibilities for the implementation of this document:

1) NTCSA Telecommunications – Responsible for the implementation, operation and maintenance of the voice and data networks. NTCSA Telecommunications shall participate in the standard reviews through SCOT.

2) NTCSA Telecommunications NPAE: Planners are responsible for implementing the recommendations of this standard, based on customer needs and service categories.

3) NTCSA Telecommunications Ops and Field: Maintenance teams to ensure compliance to recommended restoration times (Mean Time To Repair) and spare keeping philosophy.

4) TDRT – Responsible for ensuring that the Planners and Design Engineers design the voice and data networks in accordance with recommendations of this document.

5) PTM&C Telecoms – Responsible for establishing contracts, reviewing standards and testing of the new technologies with the assistance of customers and NTCSA Telecommunications.

6) Quality Assurance and standards implementation– Responsible for auditing the networks and ensure that the networks are installed according to the associated installation standards.

7) Customers – Responsible for providing the current and future requirements. Customers shall update the requirements whenever there are changes. Customers shall participate in the standards development through SCOT.

2.6 Process for monitoring

All detailed designs shall be reviewed on a per project basis by TDRT. Quality Assurance shall perform audits to ensure compliance with the approved design standards/guides.

2.7 Related/supporting documents

NA

3. Telecommunications service categories

NTCSA Telecommunications offers five categories of telecommunications services to its customers. The services are Platinum+, Platinum, Gold, Silver and Bronze services, as shown in Table 1. All other services with no SLA agreement will be considered Best Effort services.

Table 1: Service Categories

Service Category	Availability	Unavailable Minutes p.a
Platinum +	99.92%	420.48
Platinum	99.73%	1419.12
Gold	99.40%	3153.6
Silver	99.16%	4415.04
Bronze	98.33%	8777.52

3.1 Quantification of availability

Service Level Agreements (SLAs) between NTCSA Telecommunications and its customers are expressed in availability levels terms. Availability is approximated by the mean time between failures (MTBF) values of the equipment and the mean time to repair (MTTR) values as per Equation (1):

$$Availability = \frac{MTBF}{MTTR + MTBF} \quad \text{..... (1)}$$

3.1.1 MTBF

The MTBF value is generally provided by the manufacturer of the equipment being utilised. This value is taken as 150 000 hours in the 240-70783066, Telecommunications Transport Network Standard [2]. For the purposes of the Network Architecture Standard, the assumption is to take a tenth ($\frac{1}{10}$) of the manufacturers MTBF as indicated in Table 2 below. This decision is based on the experience that OEMs tend to exaggerate their equipment MTBF values; and the objective herewith is to design based on worst-case MTBF expectations.

Table 2: Manufacturer MTBF

Module	Year (from the manufacturer)	Hours	Years ($\frac{1}{10}$ of the OEM MTBF)	Hours
Control card	23	201618	2.3	20161.8
Data card (LEDS1/X21/RS232)	77	674982	7.7	67498.2
Ethernet	60	525960	6	52596
Voice card (FXS/FXO/LGS/LGE/E&M)	61	534726	6.1	53472.6
E1	121	1060686	12.1	106068.6
STM-1/4/16	47	412002	4.7	41200.2
Power Supply	142	1244772	14.2	124477.2

3.1.2 MTTR

Mathematically, MTTR is given by the following equation:

$$MTTR = RT + TT + (1 - P)TR$$

Where:

RT = the repair time on site,

TT = the travel time to the site,

P = the probability that a spare module is available when required, and

TR = the time to obtain the spare module.

In this document, the service availability calculations for each configuration will be at predefined MTTR intervals. Predefined MTTR consists of the following activities time to obtain spares (including shipping), the probability that the spare is working, time to travel to site, time to repair on site. The MTTR time intervals chosen cater for these activities.

3.2 Network architectures considered

The 240-70783066 Telecommunications Transport Network Standard [2] guarantees 99.991% availability by the Transport Network Equipment for a single route 1+0 configuration over a single hop, and also guarantees 99.999% availability by the Transport Network Equipment for a single route 1+1 configuration over a single hop. The backbone network shall as a minimum be dimensioned to guarantee an end-to-end availability of 99.96% (based on a maximum hop of 250km), in line with ITU-R Recommendation F.1703 (01/05): Availability objectives for real digital fixed wireless links used in 27500 km hypothetical reference paths and connections [3].

There are five service categories that telecoms services are defined according to, namely Platinum+, Platinum, Gold, Silver, and Bronze. Six different network topologies were investigated below for compliance to these service categories.

3.2.1 Zero redundancy access network (A)

A zero-redundancy access network configuration has a single service card, single control card, single power supply and a single uplink card provisioned per client equipment.

Figure 1: Zero redundancy access network configuration

Table 3 below shows services availability at different MTTR values with zero redundancy access and 1+0 transport configuration.

Table 3: Zero redundancy access network configuration

MTTR (hours)	Access Equipment (BME, MSAP & Router)	Transport Equipment (ADM) 1+0	Backbone	Availability	Service Availability
2	99.97982%	99.99100%	99.96000%	99.90167%	Plat
4	99.95964%	99.99100%	99.96000%	99.86136%	Plat
8	99.91931%	99.99100%	99.96000%	99.78079%	Plat
12	99.87900%	99.99100%	99.96000%	99.70029%	Gold
16	99.83871%	99.99100%	99.96000%	99.61987%	Gold
20	99.79844%	99.99100%	99.96000%	99.53953%	Gold
24	99.75819%	99.99100%	99.96000%	99.45926%	Gold
48	99.51717%	99.99100%	99.96000%	98.97923%	Bronze
72	99.27692%	99.99100%	99.96000%	98.50192%	Bronze

Platinum+ services are not supported by this configuration. Platinum services are achievable with this configuration up to the MTTR of 8 hours, however MTTR consist of time to travel to site, time to repair on site, time to obtain a spare module and the probability that the spare module is working.

Considering 8 hours to resolve the fault it is technically feasible but practically infeasible. This configuration is not applicable for platinum services, but it is applicable for other services like gold, silver and bronze.

3.2.2 Access network with control and power redundancy(B)

Figure 2 below depicts an access network configuration, where a single chassis is used with the dual control card; dual power supply, and a single service card are provisioned per client CPE.

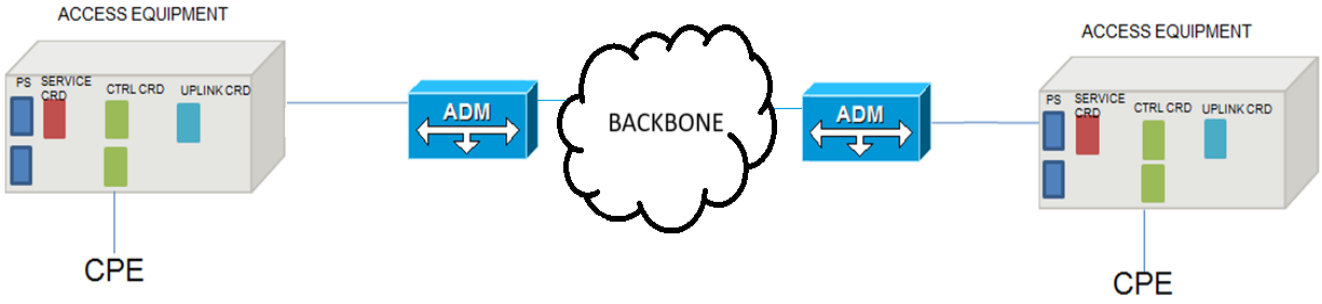

Figure 2: Access network configuration of a single service card, dual control card and dual power supply

Table 4 below shows service availability predictions at different MTTR values with 1+0 transport, for the above configuration.

Table 4: Access network configuration of a single service card, dual control card and dual power supply

MTTR (hours)	Access Equipment (BME, MSAP & Router)	Transport Equipment (ADM) 1+0	Backbone	Availability	Service Availability
2	99.99134%	99.99100%	99.96000%	99.92470%	Plat+
4	99.98268%	99.99100%	99.96000%	99.90740%	Plat
8	99.96537%	99.99100%	99.96000%	99.87279%	Plat
12	99.94804%	99.99100%	99.96000%	99.83818%	Plat
16	99.93072%	99.99100%	99.96000%	99.80357%	Plat
20	99.91339%	99.99100%	99.96000%	99.76896%	Plat
24	99.89605%	99.99100%	99.96000%	99.73434%	Plat
48	99.79198%	99.99100%	99.96000%	99.52664%	Gold
72	99.68779%	99.99100%	99.96000%	99.31892%	Silver

Platinum+ services are achievable with an MTTR value of 2 hours, this is practically infeasible considering time to travel to site, time to repair on site, time to obtain a spare module and the probability that a spare module is working. This configuration is not recommended for Platinum+ services.

Platinum services are achievable up to the MTTR value of 24 hours, this configuration is recommended for Platinum services considering the time it takes for the fault to be repaired, provided the spare module is available local to the service centre. It is also applicable for other services such as Gold, Silver and Bronze.

It is financially feasible to implement this configuration for Platinum, Gold, Silver, and Bronze services.

3.2.3 Access network with uplink and transport redundancy (C)

This configuration depicts transport (uplink) module-level redundancy, only transport (uplink) card have redundancy but in a single chassis. This configuration also shows redundancy in transport (ADM) network for path redundancy in case one route fails, there is an alternative route. ADM redundancy is provisioned through duplication of control cards, power supply units, service modules and uplink modules.

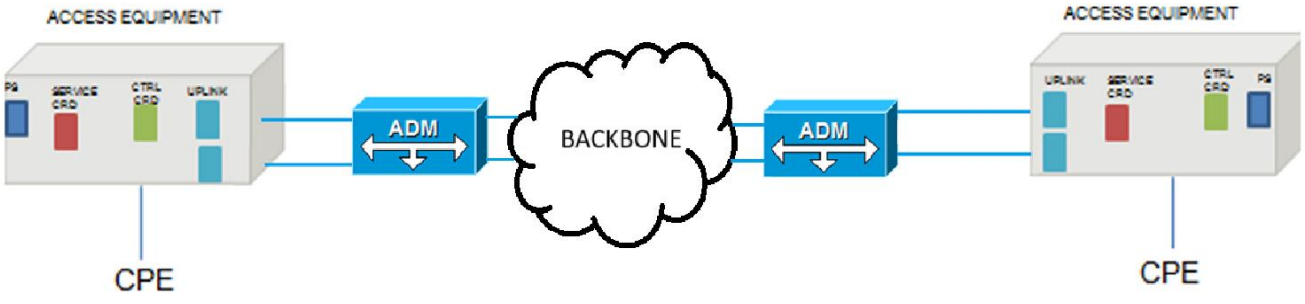

Figure 3: Access network with uplink redundancy and full ADM card-level redundancy

Table 5 below shows services availability at different MTTR values with path redundancy transport for the above configuration.

Table 5: Access network with uplink redundancy

MTTR (hours)	Access Equipment (BME,MSAP & Router)	Transport Equipment (ADM) path redundancy	Backbone	Availability	Service Availability
2	99.98467%	99.99900%	99.96000%	99.92736%	Plat+
4	99.96935%	99.99900%	99.96000%	99.89673%	Plat
8	99.93871%	99.99900%	99.96000%	99.83551%	Plat
12	99.90808%	99.99900%	99.96000%	99.77432%	Plat
16	99.87746%	99.99900%	99.96000%	99.71318%	Gold
20	99.84686%	99.99900%	99.96000%	99.65209%	Gold
24	99.81627%	99.99900%	99.96000%	99.59103%	Gold
48	99.63297%	99.99900%	99.96000%	99.22561%	Silver
72	99.45011%	99.99900%	99.96000%	98.86171%	Bronze

Platinum+ services are achievable with an MTTR value of 2 hours, this is practically infeasible considering time to travel to site, time to repair on site, time to obtain a spare module and the probability that a spare module is working.

Platinum services are achievable up to the MTTR value of 12 hours. This configuration is not recommended for Platinum+ and Platinum services. It is very expensive to implement, and it is practically infeasible that the fault will be resolved within 2 hours for Platinum+ services and 12 hours for Platinum services.

This configuration can be applied for other services (Gold, Silver, and Bronze), but it is not financially feasible to implement this configuration for such services, as it requires full redundancy of ADM cards, but provides inferior performance to configuration (B) for most services.

3.2.4 Access Network with power, control, uplink and transport redundancy (D)

The configuration below shows an access network of a single chassis with dual power supply, dual control card, dual uplink card and single service card. This configuration also has redundancy on the transport (ADM) network. ADM redundancy is provision through duplication of control cards, power supply units, service modules and uplink modules.

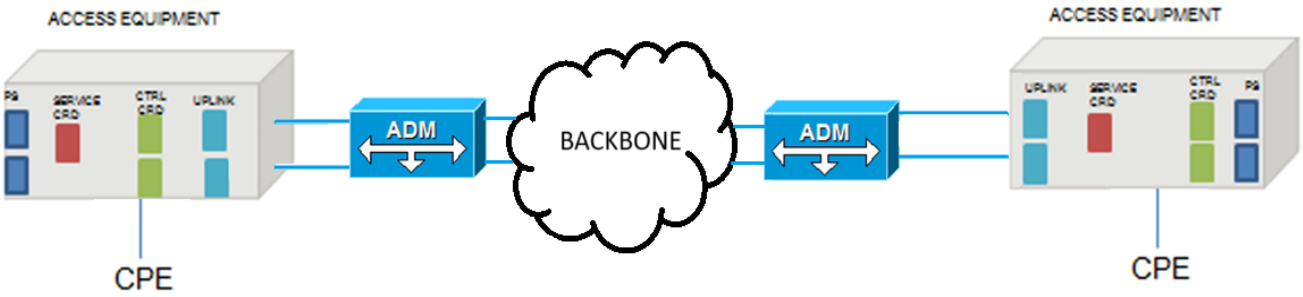

Figure 4: Access network with redundancy for uplink, power supply and control cards and full ADM card-level redundancy

Table 6 below shows services availability at different MTTR values with path redundancy transport for the above configuration.

Table 6: Access network with redundancy uplink, power supply and control cards

MTTR (hours)	Access Equipment (BME,MSAP & Router)	Transport Equipment (ADM) path redundancy	Backbone	Availability	Service Availability
2	99.99620%	99.99900%	99.96000%	99.95040%	Plat+
4	99.99239%	99.99900%	99.96000%	99.94279%	Plat+
8	99.98477%	99.99900%	99.96000%	99.92756%	Plat+
12	99.97715%	99.99900%	99.96000%	99.91232%	Plat
16	99.96951%	99.99900%	99.96000%	99.89705%	Plat
20	99.96186%	99.99900%	99.96000%	99.88178%	Plat
24	99.95421%	99.99900%	99.96000%	99.86648%	Plat
48	99.90811%	99.99900%	99.96000%	99.77438%	Plat
72	99.86169%	99.99900%	99.96000%	99.68169%	Gold

Platinum+ services are achievable up to MTTR value of 8 hours, Platinum+ services are of a high priority in the NTCSA network which means 8 hours of MTTR value is reasonable if spare modules are available, working and local to the service centre. Local service centre personnel need to be aware of Platinum+ circuits in their area, respond fast and ensure appropriate stock of spares.

This configuration is recommended for all the services, but with Platinum+ services there is a high risk, if the spare module is not available or not working, 8 hours will not be sufficient to resolve a fault.

3.2.5 Fully redundant access network (E)

Fully redundancy access network with no redundancy in a transport network - This configuration depicts an access network, where there is a redundancy in chassis level.

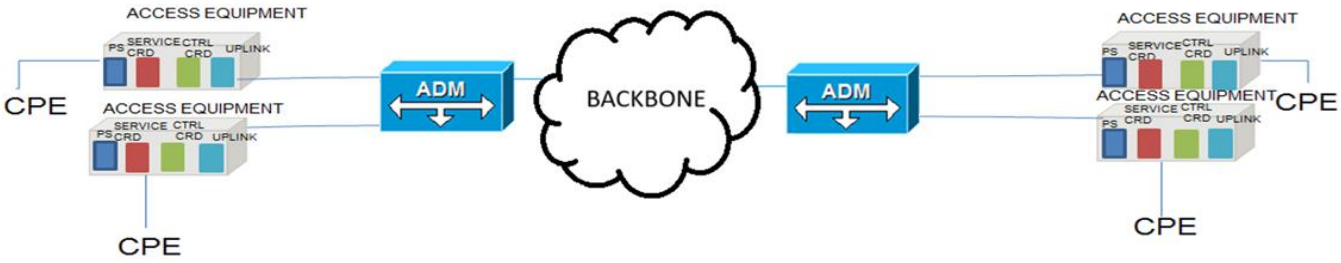

Figure 5: Fully redundancy access network configuration

Table 7 below shows service availability at different MTTR values with 1+0 transport for the above configuration.

Table 7: Fully redundancy access network with partially redundancy in a transport network

MTTR (hours)	Access Equipment(BME,MSAP & Router) 1+1	Transport Equipment (ADM) 1+0	Backbone	Availability	Service Availability
2	100.00000%	99.99100%	99.96000%	99.94201%	Plat+
4	100.00000%	99.99100%	99.96000%	99.94201%	Plat+
8	100.00000%	99.99100%	99.96000%	99.94200%	Plat+
12	99.99999%	99.99100%	99.96000%	99.94200%	Plat+

MTTR (hours)	Access Equipment(BME,MSAP & Router) 1+1	Transport Equipment (ADM) 1+0	Backbone	Availability	Service Availability
16	99.99999%	99.99100%	99.96000%	99.94199%	Plat+
20	99.99999%	99.99100%	99.96000%	99.94198%	Plat+
24	99.99998%	99.99100%	99.96000%	99.94197%	Plat+
48	99.99992%	99.99100%	99.96000%	99.94184%	Plat+
72	99.99981%	99.99100%	99.96000%	99.94163%	Plat+

This configuration makes it possible to achieve Platinum+ services throughout with 1+0 transport network configuration. This configuration is applicable for all services and is financially feasible. The disadvantages of this configuration is the lack of full redundancy at transport level.

3.2.6 Fully redundant access and transport network (F)

Full redundancy access network and transport network - This is a fully redundant configuration with a highly protected access network architecture. The customer equipment is provided with two separate hardware interfaces, each from a separate node. Moreover, assurance is made that the circuits travel diverse routes in the transport network. This is done to mitigate a single point of failure. This configuration also has redundancy on the transport (ADM) network. ADM redundancy is provision through duplication of control cards, power supply units, service modules and uplink modules.

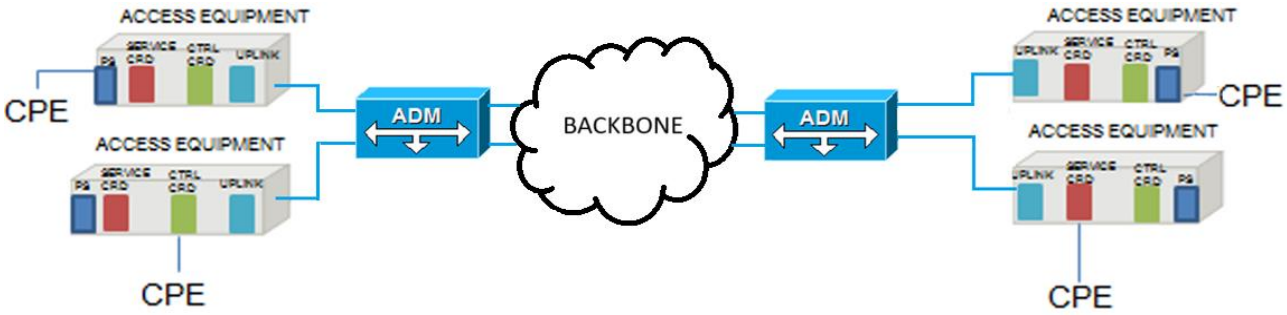

Figure 6: Fully redundancy access network and full ADM card redundancy

Table 8 below show services availability at different MTTR values with 1+1 transport for the above configuration.

Table 8: Fully redundancy access network and backbone network

MTTR (hours)	Access Equipment (BME, MSAP & Router) 1+1	Transport Equipment (ADM) 1+1	Backbone	Availability	Service Availability
2	100.00000%	99.99900%	99.96000%	99.95800%	Plat+
4	100.00000%	99.99900%	99.96000%	99.95800%	Plat+
8	100.00000%	99.99900%	99.96000%	99.95800%	Plat+
12	99.99999%	99.99900%	99.96000%	99.95799%	Plat+
16	99.99999%	99.99900%	99.96000%	99.95798%	Plat+
20	99.99999%	99.99900%	99.96000%	99.95797%	Plat+
24	99.99998%	99.99900%	99.96000%	99.95796%	Plat+
48	99.99992%	99.99900%	99.96000%	99.95783%	Plat+
72	99.99981%	99.99900%	99.96000%	99.95763%	Plat+

Platinum+ services are achievable up to the MTTR value of 72 hours with diverse routes in the transport network.

This is a high performing configuration for the NTCSA Telecommunications network, but it is financially infeasible to implement such a configuration for low priority services. It may be applicable for Platinum+ services in remote difficult to access areas, where access to the backbone network is many hops (far) away.

3.3 Feasible configurations per service category

3.3.1 Platinum+ services

The minimum investment required to meet Platinum+ availability requirement of 99.92% is from configuration B, which yields an Availability of 99.93% at an MTTR of 2 hours. However, this is practically infeasible, since the travel time (to site) could be over 2 hours, this means there will be not enough time for obtaining the spare and repairing on site.

The minimum feasible investment required to meet Platinum+ availability requirement of 99.92% is from configuration D, which yields an Availability of 99.93% at an MTTR of 8 hours. This is practically feasible, provided the spare module is available, working and is local to the service centre. This would ensure that MTTR is kept below 8 hours, since travel time to site is estimated at 2 hours, leaving 6 hours for obtaining the spare and repairing on site. Urgent response to faults is required for Configuration D to remain feasible.

The most feasible investment required to meet Platinum+ availability requirement of 99.92% is from configuration E, which yields an Availability of 99.94% at an MTTR of 72 hours. This is practically feasible, provided the spare module is available, working, and national to the service centre.

Due to criticality of Platinum+ services, its is important note the need for redundant DC supplies (dual chargers, dual DB boards and dual battery banks) on sites with Platinum+ services.

3.3.2 Platinum services

The minimum investment required to meet Platinum availability requirement of 99.73% is from configuration A, which yields an availability of 99.78% at an MTTR of 8 hours. Configuration A will require the same level of urgency as Platinum+ to restore a Platinum circuit, potentially adding a lot of strain on limited resources, and is thus not practical in most areas.

The most feasible investment required to meet Platinum availability requirement of 99.73% is from configuration B, which yields an availability of 99.73% at an MTTR of 24 hours. This is practically feasible, provided the spare module is available, working, and local to the service centre. Configuration D can also feasibly meet Platinum service requirements with an availability of 99.77% at an MTTR of 48 hours.

3.3.3 Gold services

The minimum investment required to meet Gold availability requirement of 99.40% is from configuration A, which yields an Availability of 99.46% at an MTTR of 24 hours. This is practically feasible, provided the spare module is available, working and local to the service centre.

The most feasible investment required to meet Gold availability requirement of 99.40% is from configuration B, which yields an Availability of 99.53% at an MTTR of 48 hours. This is practically feasible, provided the spare module is available, working and provincial to the service centre.

3.3.4 Silver services

The minimum investment required to meet Silver availability requirement of 99.16% is from configuration A, which yields an Availability of 99.22% at an MTTR of 36 hours. This is practically feasible, provided the spare module is available, working and local to the service centre.

The most feasible investment required to meet Silver availability of 99.16% is from configuration B, which yields an Availability of 99.32% at an MTTR of 72 hours. This is practically feasible, provided the spare module is available, working and national to the service centre.

3.3.5 Bronze services

The feasible investment required to meet Bronze availability requirement of 98.33% is from configuration A, which yields an Availability of 98.50% at an MTTR of 72 hours. This is practically feasible, provided the spare module is available, working and national to the service centre.

3.4 Recommendations

Table 9 below summarises the recommended configuration in terms of availability and financial feasibility to implement these configurations.

Table 9: Recommended configurations

Services	Availability	Possible Configurations	Recommended Configuration	Availability for Recommended Configurations	MTTR (Required for min. availability)	Comments
Platinum +	99.92%	D to F	D E	99.93% 99.94%	8 hours 72 hours	Config D is recommended provided the spares are available, working, and local to the service centre. Prioritize response time.
Platinum	99.73%	C to F	B D	99.73% 99.77%	24 hours 48 hours	Config B is recommended provided a working spare is available local to the service centre
Gold	99.4%	All	A B	99.46% 99.53%	24 hours 48 hours	Config A is recommended Provided a working spare is available local to the service centre
Silver	99.16%	All	A B	99.22% 99.32%	36 hours 72 hours	Config A is recommended provided a working spare is available local to the service centre
Bronze	98.33%	All	A	98.50%	72 hours	

3.4.1 Spares holding and distribution philosophy

For the recommended configuration, it is important that the spare module is working and available local, provincial (regional) and nationally to the service centre.

For the MTTR of 24 hours (1 day) or less it is strongly recommended that the spares holding shall always be within 150 km from site.

For the MTTR of 48 hours (2 days) it is recommended that the spares holding shall be within a region (province). This would ensure that MTTR is kept below 48 hours.

For the MTTR of 72 hours (3 days) the spares holding can be anywhere within the country as long as the time to transport a spare module would not exceed 24 hours (1 day) and MTTR is kept below 72 hours.

These recommended configurations would be more effective and guarantee the required availability, if and only if NTCSA Telecommunications adopts the above-mentioned spares holding philosophy and complies with recommended MTTR.

3.4.2 Minimum investment

The recommended configurations were chosen based on optimal investment for the chosen service category. Assumptions considered include unavailability probability of the chosen network configuration, compliance to proposed spares keeping philosophy, maintenance staff trained and capable of resolving faults, and fast response to faults. Implementation of a non-recommended and more expensive configurations to lessen MTTR requirements is not a recommended practice. Planning engineers need to make maintenance teams aware of service categories of new circuits, implemented configurations, as well as spares and MTTR implications.

4. Authorization

This document has been seen and accepted by:

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5. Revisions

Date	Rev	Compiler	Remarks
May 2025	3	M.Mpanza	Document due for revision. Added unavailability minutes and reference to best effort services. Updated network configuration drawings, recommended configurations, and Minimum Investment requirements
March 2019	2	N Ndlovu	Document due for review. Update the content of the document, update the assumptions, and also add drawing per configuration.
July 2014	1	P Motsoasele	First issue

6. Development team

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