UNITED REPUBLIC OF TANZANIA

**MINISTRY OF COMMUNICATIONS AND TRANSPORT**

# TECHNICAL REPORT
# ON FEASIBILITY STUDY FOR IMPLEMENTATION OF THE NATIONAL ICT BACKBONE INFRASTRUCTURE

(United Republic of Tanzania)

Presented by:

**Joint Team of Tanzania, CITCC and WorldTel**

***June, 2005***

## Acknowledgement

The Government of the United Republic of Tanzania through the Ministry of Communications and Transport (MoCT, in exercising her mandate formed a National Steering Committee (see Appendix C) under the chairmanship of the Permanent Secretary MoCT to assess the current national ICT Backbone status with the aim of implementing a capacity rich, efficient and ubiquitous national broadband backbone infrastructure.

An assignment like this could not have been accomplished without help of others, whom we would like to publicly acknowledge here. Firstly, The Steering Committee Members are indebted to the Technical Working Group (see Appendix D) who did excellent work in facts gathering, analysing and finally drafting this report. Similarly, the government on her side owes appreciation and is grateful to all individuals (see Appendix E) who travelled all-over the country for the purpose of verifying practicability of the National ICT backbone infrastructure.

Secondly, the Steering Committee appreciates the time afforded by the Technical Working Group and its Report Writing Group Members for their invaluable commitment, time and constructive contributions in the course of conducting successful field survey for the OFC backbone infrastructure and consequently preparing this report.

Thirdly, without reservations, the Steering Committee would also like to recognize valuable contributions and commitments extended by TCRA, TRC, TANESCO, TTCL, TAZARA, TPC, SONGAS and TISPA to the successful conductance of feasibility study and hence preparation of this report. Particularly, the tireless efforts and valuable skills rendered by their experts in making this exercise a success.

Finally and most important, the Steering Committee expresses sincere thanks and special recognition to the Government of Tanzania through Ministry of Communications and Transport (MOCT), Chinese Government, CITCC and WorldTel for their immeasurable commitment and facilitation of successful performance of this undertaking.

# Table of Contents

# EXECUTIVE SUMMARY

Resulting from the Government and Private sector authorities' endorsement of the National "Ideal" ICT Backbone Network provided in the Report on Status of the National ICT Backbone Infrastructure (see Appendix G), the Ministry of Communication and Transportation (MOCT) through the National ICT Backbone Steering Committee in collaboration with WorlTel of Geneva, Switzerland and CITCC of China formed a Technical Working Group (TWG) to perform a feasibility study on implementation of the National ICT Backbone Infrastructure.

As guided by Steering Committee, the duty of the Technical Working Group were to study the proposed "Ideal" backbone network (see Figure 1), for feasibility on its practical implementation and advise the Government through the national ICT Backbone Steering Committee accordingly. As a result of this study, the TWG has determined and herewith avails the resultant (practical) national backbone network that covers all 21 regions of Tanzania Mainland as shown in Figure 2 and future study will be carried out to establish similar capacity connectivity for the five regions in Zanzibar. The backbone network will provide ubiquitous capacity and future-proof resources to enable unrestricted provision of broadband rich ICT services down to the remote and rural areas. It will provide large bandwidth capacity for cross-border links to all neighbouring countries and connect to the EASSY submarine cable, COM-7 and other regional Optic Fibre Cable projects for improved inter-regional and international ICT based services including internet bandwidth.

The feasible National backbone network architecture mainly follows the proposed national "Ideal" backbone and will be built on three main Optic Fibre Cable (OFC) rings namely, the Northern ring, the Western ring and the Southern ring. Formation of these rings will be accomplished by consolidation of segments of the existing and planned OFC networks already on the ground from different national institutions like TANESCO, TRC, Songas and TAZARA; and bridging the eminent gaps between them for a full-fledged unified OFC national backbone network.

In the initial design of the National OFC backbone network, use of the latest bandwidth-rich transmission technologies such as Dense Wavelength Division Multiplexing (DWDM) and Synchronous Digital Hierarchy (SDH) have taken precedence in order to guarantee ubiquitous capacity, quality performance and unconstrained ride in the ICT marathon to the far future. This national OFC backbone would form a "Carrier of Carriers" network providing bandwidth capacity to all ICT service providers (fixed, mobile, voice, data, audio/ video broadcasting, multimedia) including the Public Services Telecommunications Network (PSTN) operators.

The TWG in considering implementation of this backbone network took into cognisance the need for the backbone to support provision of Universal ICT Services Access to the country by various service providers, competitively, in technology neutral environment and providing various ICT services.

The total cost for implementation of the National ICT OFC backbone network is estimated at **US$ 170m** of which US$ 107m would be required for construction of Optic Fibre Cable routes, US$ 36m for provision of transmission equipment, US$ 12m for power supply equipment and US$ 15m for civil and other related works. Table 0-1 gives a summary of the cost breakdown.

**Table 0-1: Summary of Cost Breakdown for the National ICT OFC Backbone**

| | | | | |
|---|---|---|---|---|
| **No.** | **Description** | **Cost of Eq. & Materials (USD)** | **Cost of Service (USD)** | **Sub total (USD)** |
| 1 | Optical Fiber Cable Installation | 34,835,348.91 | 71,632,310.00 | 106,467,658.91 |
| 2 | Transmission Equipment Installation | 23,696,035.00 | 12,046,100.00 | 35,742,135.00 |
| 3 | Power Supply System Installation | 9,266,913.00 | 2,988,150.00 | 12,255,063.00 |
| 4 | Civil Work And Others | - | - | 15,067,000.00 |
| **5** | **Grand Total (USD)** | **67,798,296.91** | **86,666,560.00** | **169,531,856.91** |

Depending on availability of funds, the network can be implemented within a period of 24 months done simultaneously for efficiency and effectiveness achievement.

Based on the above, the Report recommends the following to the Government of the United Republic of Tanzania:

(1) Consider and approve the report;

(2) Facilitate availability of the necessary funds and other resources for immediate implementation of the National ICT Backbone Network as shown in Figure 2; and

(3) Facilitate sustainable institutional arrangements for management of the National OFC Backbone network.

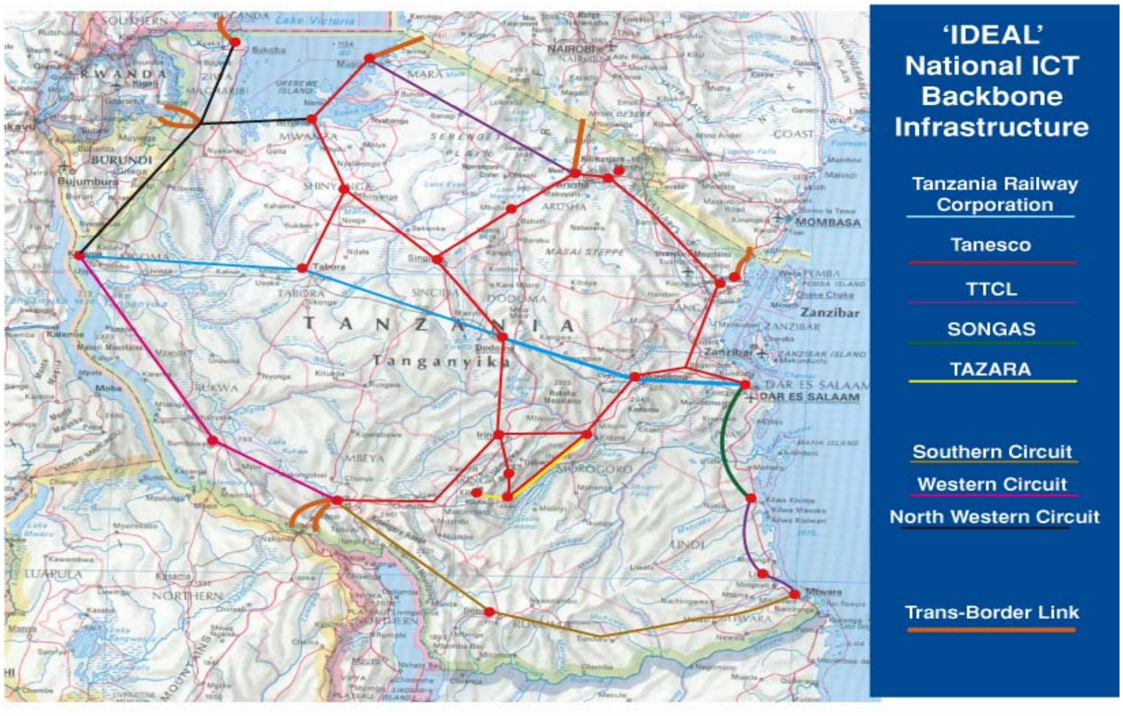



Figure 1: The National "Ideal" ICT Broadband Backbone (Source Nov 2004 Report –Appendix G)

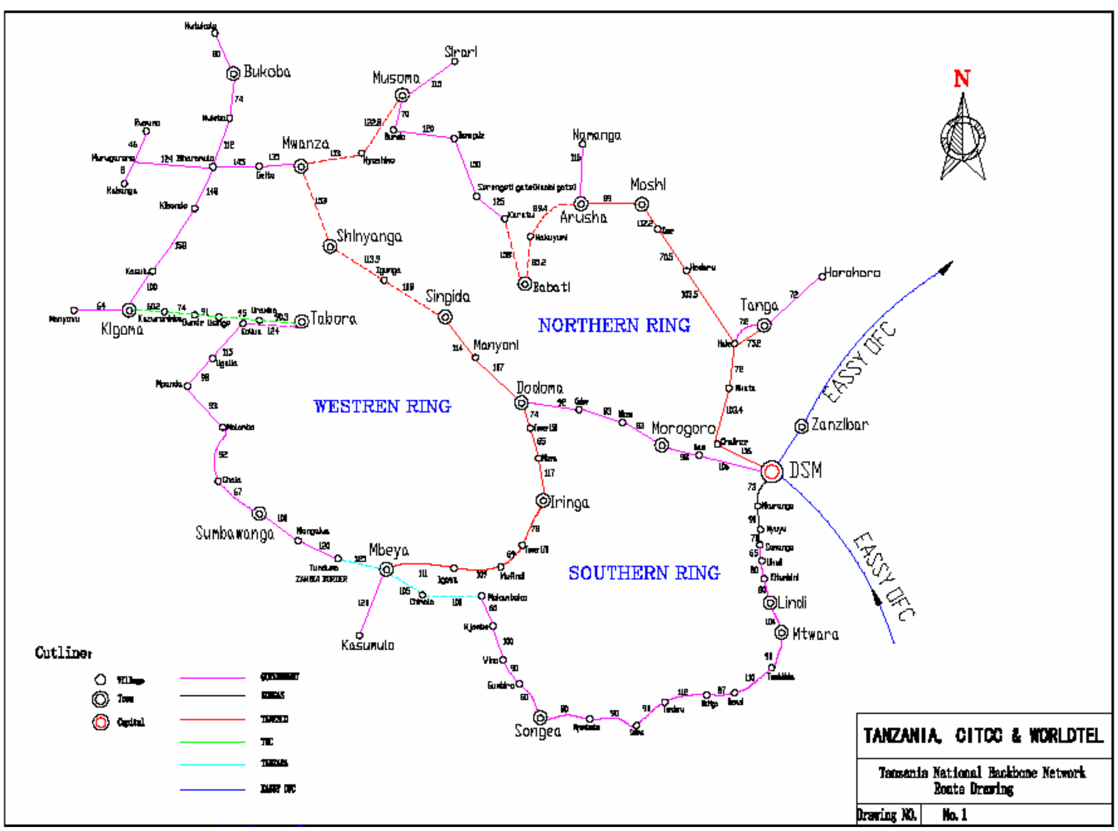



Figure 2: The National ICT OFC Backbone

## List of Abbreviations and Acronyms

| | | |
|---|---|---|
| BOQ | - | Bill of Quantities |
| CITCC | - | China International Telecommunications Construction Corporation |
| COMTEL | - | COMESA Telecommunications Company |
| DDF | - | Digital Distribution Frame |
| DWDM | - | Dense Wavelength Division Multiplexing |
| EASSy | - | East African Sub-marine Cable System |
| GDP | - | Gross Domestic Product |
| HDPE | - | High-Density Polyethylene |
| ICTs | - | Information and Communications Technologies |
| IP | - | Internet Protocols |
| ISPs | - | Internet Service Providers |
| MKUKUTA | - | Mkakati wa Kukuza Uchumi na Kuondoa Umaskini Tanzania |
| MOAT | - | Mobile Operators Association of Tanzania |
| MoCT | - | Ministry of Communications and Transport |
| OA | - | Optical Amplifier |
| OADM | - | Optical add/drop Multiplexer |
| ODF | - | Optical Distribution Frame |
| OFC | - | Optic Fibre Cable |
| OTM | - | Optical Terminal Multiplexer |
| SDH | - | Synchronous Digital Hierarch |
| SONGAS | - | Songosongo Gas Supply |
| TANESCO | - | Tanzania Electric Supply Company |
| TAZARA | - | Tanzania Zambia Railway Authority |
| TCRA | - | Tanzania Communications Regulatory Authority |
| TISPA | - | Tanzania Internet Service Providers Association |
| TPC | - | Tanzania Posts Corporation |
| TRC | - | Tanzania Railway Corporation |
| TTCL | - | Tanzania Telecommunications Company Limited |
| UNMDGs | - | United Nations Millennium Development Goals |
| USD | - | United States Dollar |
| WDM | - | Wavelength Division Multiplexing |
| ZANTEL | - | Zanzibar Telecommunication Limited |

## List of Tables

# List of Figures

# 1 INTRODUCTION

## 1.1 Scope of the Report

This report is prepared based on the preliminary investigation of the current situation of Tanzania existing national OFC backbone transmission networks. From the existing and planned networks belonging to the individual public institutions, a unified National ICT OFC Backbone Network is conceived and the overall implementation requirements resources are put forward. In summary the report addresses the following objectives:

(1) Present result of the field investigation on the existing operational OFC networks and existing OFC network development plans;

(2) Based on the result of the investigation, provide feasible backbone network architecture by consolidating some parts of the existing networks and plans, and bridging the network gaps for a unified National Backbone infrastructure.

(3) Identifying the technical and financial requirements for implementation of the National ICT backbone infrastructure

(4) Provide recommendation for implementation and operations of the National ICT backbone infrastructure.

## 1.2 Country Profile

### 1.2.1 General Information

Tanzania is a union of two countries namely, Tanganyika (Tanzania Mainland) and Zanzibar (Unguja & Pemba). The country is located in East Africa, sharing a boarder with Kenya and Uganda (North), Rwanda, Burundi and Republic of Congo (West), Zambia, Malawi and Mozambique (South) and Indian Ocean (East).

The country covers an area of **945,087km$^2$** (continental-mainland **942,430km$^2$**, Islands **2657km$^2$** including Zanzibar and Pemba Islands).The total population of Tanzania, according to 2000 census is **32** Million with a growth rate of **2.8%.**

Administratively, the United Republic of Tanzania has 25 Regions (Mainland 20 and Islands 5) and 114 Districts. The **25** regions are Arusha, Coast, Dodoma, Iringa, Kigoma, Mbeya, Mara, Kilimanjaro, Morogoro, Mtwara, Mwanza, Lindi, Ruvuma, Shinyanga, Singida, Tabora, Tanga, Kagera, Rukwa, Dar es salaam, Zanzibar Town/West, Zanzibar north, Zanzibar south, Pemba north, Pemba south.

The majority of Tanzanians (75%) dwell in rural areas while only 25% live in urban areas. However, in recent years the rate of urbanization has been increasing tremendously. The country is 45% forestry.

The country is blessed with natural resources like Diamond, Gold, Coal, Iron and Natural Gas while staple food for the population include Corn, Wheat, Rice and Green bananas. Coffee, Cotton, Sisal, Cashew and Clove serve as main economic crops in the United Republic of Tanzania. The GDP (in 2002) stood at 8400 Billion Tanzanian Shilling (about 865.9 Billion USD) at a growth rate of 6.2% (in 2002).

### 1.2.2 The State of Telecommunications

Since telecommunications sector liberalisation started, there has been growth in subscriber numbers as summarised in the table below:

**Table 1.2-1: Tanzania Subscriber Growth Stastics**

| Year | Fixed phones | Mobile phones | Total |
|---|---|---|---|
| 1995 | 88,000 | 2,198 | 90,198 |
| 1996 | 101,000 | 3,200 | 104,200 |
| 1997 | 114,600 | 20,045 | 134,645 |
| 1998 | 121,769 | 36,143 | 157,912 |
| 1999 | 150,220 | 50,100 | 200,320 |
| 2000 | 173,591 | 126,646 | 300,237 |
| 2001 | 177,802 | 285,970 | 463,772 |
| 2002 | 150,504 | 515,355 | 665,859 |
| 2003 | 199,110 | 815,000 | 1,014,110 |
| 2004 | 148,360 | 1,942,000 | 2,090,360 |

Source: TCRA

The graphical representation of the above tabulations is shown hereunder:

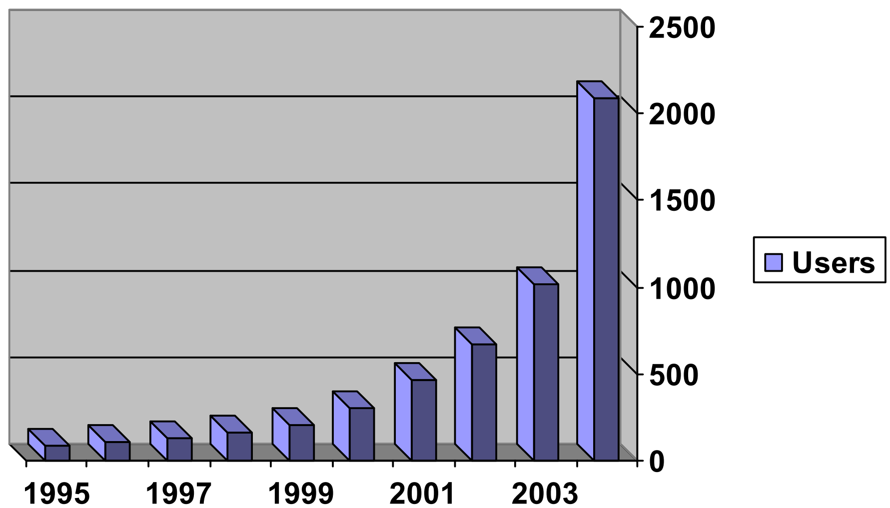



**Figure 3: Graphical presentation of Subscriber statistics**

In 1998, the capabilities of Tanzanian Telephone switching were 185,885 lines, increased 2% compared with preceding year. The fixed Telephone lines are 121,769, increased a little compared with past year. It was about 2% of the families installed the telephone in 1999.

There is only one Internet Exchange Point (IXP) in Tanzania managed by TISPA. Only eight (8) ISPs and three (3) non-ISPs are connected to the IXP.

Currently, the existing Optic Fibre Cable (OFC) transmission networks are privately operated by TRC, TAZARA, TANESCO and SONGAS. While the Microwave radio systems are mainly operated by TTCL and mobile cellular companies like MIC (T) Ltd, Vodacom (T) Ltd, Celtel (T) Ltd and Zantel.

Tanzanian electronic media is operating in free market principles. Private individuals are allowed to own Television and Radio Stations. Private entrepreneurs own newspapers as well as magazines and journals. By end 2004 there were 15 private Television Stations, one national TV station, 28 private Radio stations and only one national Radio station. Small TV operators like communities were also active and there were 20 of them. On the other hand 15 cable TV operators were operational. There are a number of private newspapers and magazines. On this regard therefore adequate transmission capacities are very much needed.

### 1.3 The Importance of the Backbone OFC Project

Tanzania has a vision with relation to the development of ICT, that's "Tanzania to have a universally accessible broadband infrastructure and ICT solutions that enhance sustainable socio-economic development and accelerated poverty reduction nationally; become a hub of ICT Infrastructure regionally and be a full participant in the global Information Society." It is a well known phenomenon that telecommunication plays a vital role in facilitating the social-economic development thus well positioned to contribute significantly to the achievement of the objectives of the National strategy for Economic Growth and Poverty Reduction in Tanzania (MKUKUTA), National Development Vision 2005, and objectives of the United Nations Millennium Development Goals (UNMDGs) 2015 for poverty reduction.

#### (a) Facilitation of National Economic Development

Communication is an important component of social fertility; Information industry is basic for sound and strong national economy. The higher demands from the communication industry are asked to facilitate rapid acceleration in the development of the national economy. ICT is the key part of communication and the basic of industry development and realization of sound rural economy. For developing country like Tanzania, ICT backbone infrastructure is at the cross-roads, the impaired developments of national communication system has caused unbalanced developments between urban and rural economies. Therefore, for the long term benefits, the government intension is to pioneer investments flow for support the economy developments of balanced economies of scale. With this avail, the government intends to construct the nationwide OFC backbone transmission network, to increase the long distance circuit capacity. In her endeavours to take the ICT services further, the Government has listed all potential remote and rural areas to be considered for ICT services provision. The national ICT backbone infrastructure aims at achieving this endeavor for facilitation of rapid economic development.

**(b) To Fulfil the Increasing Demands to Information Services**

Communication network is the principal part of information infrastructure, the carrier of information exchanging and transmission. A long with the tremendous increase of the new services and the market competition intensification, Tanzania is facing a new challenge and chance. The needs of varies social fields to the multi-layer and diversification of information transmission also grow tremendously. For fulfilling the increasing demands to information services, expending the market shares and developing the fields of new services, the construction of a long distance transmission network is imperative under the cornered situation.

**(c) To Strengthen the Competitive Abilities of the Domestic Operators**

The field of ICT in Tanzania has been in an effective competition marketing structure. A long with the foreign telecommunication operators participating in, the competition on the market of Tanzanian telecom operation must be very intensity. So that, as soon as possible to construct and improve a national backbone transmission network, and then to provide the reliable circuits, optical fibers or communication ductworks for hire to domestic telecom operators, to fulfill their needs on various new services and the potential needs of network operation enterprises are strictly needed for strengthen the Tanzania national competitive abilities. Strategically, the construction of Tanzania National Backbone Network shall make Tanzania as one of the transmission centers in its region. Realizing resources sharing of the National Backbone Infrastructure and promoting the concept of a converged and interconnected network that would allow stakeholders to ‘invest’ their networks to a grid of interconnectivity are very important. Thus, the returns of their investments are sought from a broader perspective than that of a point to point connection.

**(d) Necessary to Develop the High Speed Broadband Transmission**

The developments of telecommunication technologies are changing quickly. The terms for updating the frameworks of telecom products are shorter and shorter again. The data flux on the telecom network must exceed the voice one. It pushes the traditional fixed telephone networks turn its development direction to the data services, especially to that of centralized on IP services. Finally, the ICT must support the new generation of Telecom Network that converged all of the confluent services including voice over IP. Therefore, towards the new services, leading ahead properly, to construct and improve the Tanzania national OFC Backbone as soon as possible, adopting the advanced and successful network organization technologies and in lower cost, Tanzania could rapidly and smoothly transit to an exceeding capacity, flexible and high efficient, safe and reliable, economical and applicable and wide bandwidth and high speed information network.

**(e) To efficiently exploit the benefits from the EASSy Project**

The EASSy project aims at providing high quality capacity optic fibre international connectivity from Tanzania, to within Africa and the rest of the world and reducing out payments to satellite telecommunications facility providers. In broad perspectives, the objectives of the project are:

i. To improve high capacity optic fibre connectivity within East Africa and provide a gateway for the region to the rest of the world;

ii. To bring the power of high speed and bandwidth connectivity to African countries and the rest of world;

iii. To reduce unit costs (capital & operational) for global connectivity leading to increased profits, lower tariffs and charges for end users;

iv. To provide direct routes through own infrastructure, obviating the need for transits through third parties hence, reduced out payments;

v. To meet growing demand for Broadband (high bandwidth) Connectivity by users such as Internet Service Providers, Data service providers, Broadcasters and voice Service Providers; and

vi. To facilitate the expansion of inter-Africa trade through provision of better and affordable communications in the region.

Countries in the Northern, Western and the Southern part of Africa currently are connected by various undersea optical fibre cable systems which not only provide intra-regional access for the countries connected to these systems, but also access to other international submarine optical fibre cable systems to the rest of continents.

The East African seaboard and landlocked countries do not have such systems in operation, nor plans to implement them in the near future. The only way for these countries to gain access internationally is via satellites.

A broadband service via satellites in comparison with similar access via optical fibre cables is very expensive. Satellite technology has technical constraints in terms of limited available bandwidth / capacity, transient transmission delays, quality and related prohibitive high bandwidth cost.

The EASSy project intends to implement a 9,900 Km under sea optical fibre cable system that will link the whole of the Eastern Africa Seaboard starting at Mtunzini near Durban in South Africa, the proposed submarine fibre cable will continue on Northwards, branching out to Maputo in Mozambique, Mahajanga in Madagascar, Dar Es Salaam and Zanzibar in Tanzania, Mombassa in Kenya and terminating at Djibouti and at Port Sudan. Provision is also made for the cable to provide branching to Mogadishu in Somalia.

Eastern Africa hinterlands and land-locked countries will be able to access the proposed EASSy System at the cable's appropriate shore landing stations at Mtunzini, Maputo, Mahajanga, Dar Es Salaam, Mombassa, Mogadishu, Djibouti and Port Sudan.

The current signatories of the EASSy project MoU in Tanzania are TTCL, ZANTEL Ltd, and SATCOM AFRICA NETWORKS (T) Ltd.

## 1.4 Composition of the Working Teams

### 1.4.1 The Steering Committee

The Steering Committee under the chairmanship of the Permanent Secretary, MoCT is made up of the Ministry of Communications and Transport, TCRA, Community representatives and ICT stakeholders in the country.

### 1.4.2 The Technical Working Group and its Terms of Reference

Out of the Steering Committee members (Appendix C), a Technical Working Group comprising of local Engineers and the CITCC (China) experts (Appendix D), was formed. This Working Group was given the following Terms of References:-

(i) To study the proposed Ideal backbone as presented in the November, 2004 Report and based on it, conduct field survey and advice the Government on practical realization of the Ideal National ICT Backbone Infrastructure;

(ii) To establish the required estimated costs to construct the national backbone;

(iii) To jointly work and present a report by 9$^{th}$ June 2005

### 1.4.3 The Report Writing Group

The Report Writing Group Members (**Appendix*:* E**) comprises both Tanzanians and Chinese and was charged with putting in order the collected data and drafting of the final Report.

# 2 BACKGROUNG INFORMATION

## 2.1 Demand Forecast

According to the Tanzanian vision on the National ICT OFC Infrastructure Backbone, the main objective of this project is to form a telecom backbone transmission network to satisfy domestic and global ICT requirements in the long term. It intends to provide long-distance telephone networks, data backbone networks and extend Internet bandwidth countrywide by offering sufficient capacities, network resiliency and guaranteed quality of service provision to meet the needs of voice, data, mobile, internet, leased circuit and more.

For the purpose of this investigation, the forecasted service demands are considered within a period of 3 to 5 years. The following factors have been considered in formulation of the service demand forecast: transmission requirements of different operators including fixed, mobile and data communications, the ever increasing requirement for transmission of high speed data, the development trend in telecommunications sector including the potential development of future ICT services and applications.

Detailed information on the forecasted 2Mb/s and 155Mb/s circuitries between different areas is provided in Table 2.1-1 and Table 2.1-2 respectively. From the tables it is evident that there is huge requirement of line capacity to transport ICT services and applications between cities and thus need for putting in pace a high capacity ICT backbone infrastructure.

**Table 2.1-1: 2Mbit/s Circuit matrix（63*E1）**

| No. | Region Name | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | DSM | | | | | | | | | | | | | | | | | | | | |
| 2 | LINDI | 3 | | | | | | | | | | | | | | | | | | | |
| 3 | MTWARA | 3 | 3 | | | | | | | | | | | | | | | | | | |
| 4 | MOROGORO | 3 | | 3 | | | | | | | | | | | | | | | | | |
| 5 | DODOMA | 5 | | | | | | | | | | | | | | | | | | | |
| 6 | SINGIDA | | | | | 3 | | | | | | | | | | | | | | | |
| 7 | TABORA | | | | | 3 | 3 | | | | | | | | | | | | | | |
| 8 | IRINGA | | | | | 3 | | 3 | | | | | | | | | | | | | |
| 9 | ARUSHA | 5 | | | | | | | | | | | | | | | | | | | |
| 10 | MOSHI | | | | | | | | | 3 | | | | | | | | | | | |
| 11 | TANGA | | | | | | | | | 4 | 3 | | | | | | | | | | |
| 12 | BABATI | | | | | | | | | 3 | | 3 | | | | | | | | | |
| 13 | MWANZA | 5 | | | | 3 | | | | 5 | | | | | | | | | | | |
| 14 | SHINYANGA | | | | | | | | | | | | | 3 | | | | | | | |
| 15 | KIGOMA | | | | | | | | | | | | | 3 | 3 | | | | | | |
| 16 | BUKOBA ( BIHARAMULO) | | | | | | | | | | | | | 5 | | 3 | | | | | |
| 17 | MUSOMA | | | | | | | | | | | | | 3 | | | 3 | | | | |
| 18 | MBEYA | 4 | | | | 5 | | | | | | | | | | | | | | | |
| 19 | SUMBAWANGA | | | | | | | | | | | | | | | | | | 2 | | |
| 20 | SONGEA | | | | | | | | | | | | | | | | | | 2 | 1 | |
| | Total | 28 | 6 | 9 | 6 | 22 | 6 | 9 | 6 | 20 | 6 | 10 | 6 | 27 | 6 | 9 | 11 | 6 | 13 | 3 | 3 |

**Table 2.1-2: 155Mb/s Circuit Matrix**

| No. | Region Name | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | DSM | | | | | | | | | | | | | | | | | | | | |
| 2 | Lindi | 1 | | | | | | | | | | | | | | | | | | | |
| 3 | Mtwara | 1 | 1 | | | | | | | | | | | | | | | | | | |
| 4 | Morogoro | 1 | | 1 | | | | | | | | | | | | | | | | | |
| 5 | Dodoma | 1 | | | | | | | | | | | | | | | | | | | |
| 6 | Singida | | | | | 1 | | | | | | | | | | | | | | | |
| 7 | Tabora | | | | | 1 | 1 | | | | | | | | | | | | | | |
| 8 | Iringa | | | | | 1 | | 1 | | | | | | | | | | | | | |
| 9 | Arusha | 1 | | | | | | | | | | | | | | | | | | | |
| 10 | Moshi | | | | | | | | | 1 | | | | | | | | | | | |
| 11 | Tanga | | | | | | | | | 1 | 1 | | | | | | | | | | |
| 12 | Babati | | | | | | | | | 1 | | 1 | | | | | | | | | |
| 13 | Mwanza | 1 | | | | 1 | | | | 1 | | | | | | | | | | | |
| 14 | Shinyanga | | | | | | | | | | | | | 1 | | | | | | | |
| 15 | Kigoma | | | | | | | | | | | | | 1 | 1 | | | | | | |
| 16 | Bukoba (Biharamulo) | | | | | | | | | | | | | 1 | | 1 | | | | | |
| 17 | Musoma | | | | | | | | | | | | | 1 | | | 1 | | | | |
| 18 | Mbeya | 1 | | | | 1 | | | | | | | | | | | | | | | |
| 19 | Sumbawanga | | | | | | | | | | | | | | | | | | 1 | | |
| 20 | Songea | | | | | | | | | | | | | | | | | | 1 | 1 | |
| 21 | Total | 7 | 2 | 3 | 2 | 6 | 2 | 3 | 2 | 5 | 2 | 3 | 2 | 7 | 2 | 3 | 3 | 2 | 4 | 2 | 2 |

## 2.2 Existing Networks and Plans for OFC Infrastructure

The existing OFC network and development plans in Tanzania are highly uncoordinated due to the fact that each institution holds own network and development plans. As per the assessment made on the existing and planned OFC infrastructures, the basic OFC networks suitable for the National backbone applications are separately owned by the following institutions TANESCO, TAZARA, TRC and SONGAS. The details of ownership are provided in table 2.2-1 and Figure 4 below.

**Table 2.2-1: Status of OFC Lines**

| No. | Section | Distance (km) | Fibre core | Laying Method | Status | Remark |
|---|---|---|---|---|---|---|
| 1 | **Iringa– Dodoma** | 237 | 1x24 | Over Pylons | Phase 1- in Construction | TANESCO to use 8 cores |
| 2 | **Iringa- Singida** | 210 | 1x24 | Over Pylons | Phase 1- in Construction | TANESCO to use 8 cores |
| 3 | **DSM-Tanga-Arusha Singida-Babati** | 885 | 1x24 | Over Pylons | Phase 1- in Construction | TANESCO to use 8 cores |
| 4 | **Mbeya –Iringa** | 357 | 1x24 | Over Pylons | Phase 2 – Planned | TANESCO to use 8 cores |
| 5 | **Arusha-Babati Musoma-Tabora Shinyanga- Singida** | 1264 | 1x24 | Over Pylons | Phase 2- Planned | TANESCO to use 8 cores |
| 6 | **Kihansi-Chita** | 4 | 1x24 | Over Pylons | existing | TANESCO used 8 cores |
| 7 | **Chita –Mangula** | 156 | 1x24 | Over Pylons | existing | TANESCO used 12cores TAZARA used 12cores |
| 8 | **Mangula –Kidatu** | 2.1 | 1x24 | Over Pylons | existing | TANESCO used 8 cores |
| 9 | **Tunduma-Mbeya-Makambako** | 200 | 1x24 | buried | existing | TAZARA |
| **10** | **Mlimba –Chita** | 23.5 | 1x12 | buried | existing | TAZARA used 2 cores |
| **11** | **DSM-Somanga** | 220 | 1x24 | buried | existing | SONGAS used 2 cores |
| **12** | **DSM-Morogoro** | 202 | 1x6 | buried | existing | TRC used 2 cores |
| **13** | **Morogoro-Dodoma** | 254 | 1x8 | buried | existing | TRC used 2 cores |
| **14** | **Kigoma-Tabora-Dodoma** | 792 | 1x12 | buried | planned | TRC |

**Note: The existing OFC lines indicated as phase 1 is already under construction.**

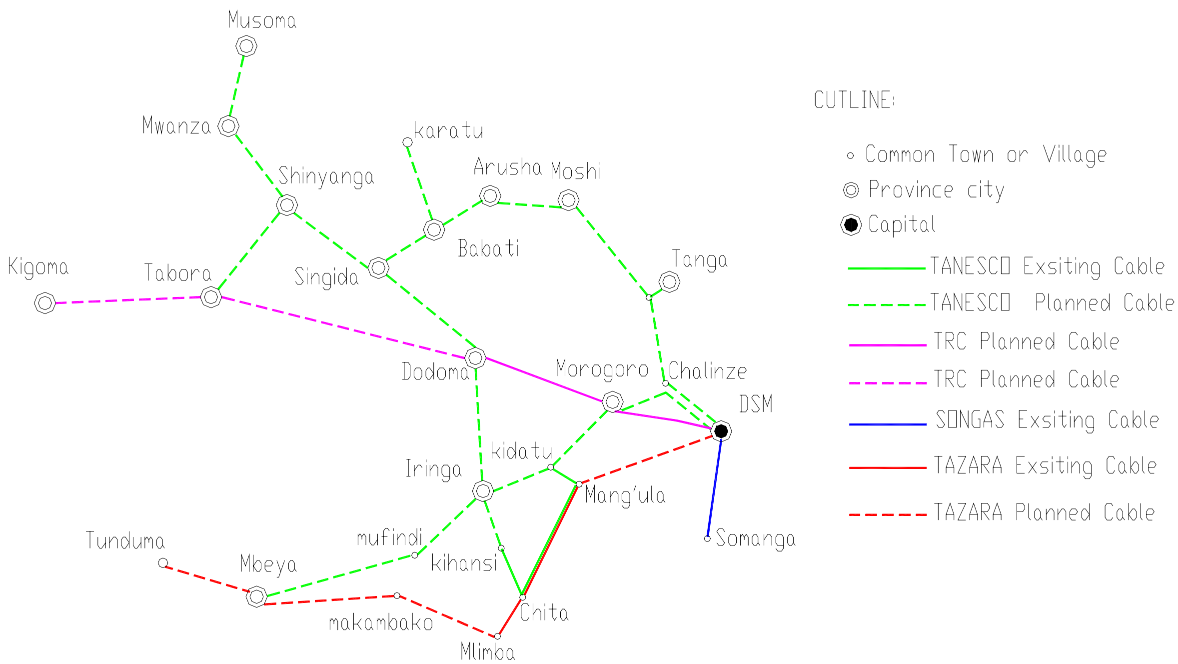



**Figure 4: Layout of existing and planned OFC Lines**

The above existing and planned individual OFC links does not provide balanced coverage to suit provisioning of quality ICT services nationwide and thus need to be integrated and improved for the formation of a unified National ICT Backbone Infrastructure.

## 2.3 Project Scope

The major need for construction of the network comes from massive growth in data and Internet traffic due to huge demands for communications. Main drive in this capacity growth is attributed to:-

- Requirement for formation of neutral National ICT backbone infrastructure for all operators
- Requirement to satisfy bandwidth needs of new broadband services including multimedia applications whose bandwidth requirements can not be fully met by the existing networks
- Increased demand for regional and global connectivity

It is intended that after implementation of the project, the system would be able to provide high capacity, network resiliency and quality performance for delivery of voice, data, IP based and image services and applications, and will also provide fibre capacity for lease and use by different operators. The system under this project is therefore geared to provide one of the key vehicles for achievement of sound socio-economic and industrial developments.

In this project, a total of about 6997 km OFC lines will be constructed. The newly-built OFC lines are 3,522 km, including 2,653 km of 48 cores and 869 km of 24 cores. For the rebuilt OFC links a total of 3,475km will be constructed, including 3,430 km of 48 cores and 45 km of 24 cores. About 160km of two HDPE pipe duct system would be constructed.

On the transmission equipments a total number of 93 DWDM and 39 SDH equipments and their respective network management systems will be provided.

Apart from provision of the proposed OFC and transmission systems, the project will provide power systems and equipment shelters.

# 3 THE PROPOSED OFC BACKBONE INFRASTRUCTURE PROJECT

## 3.1 Design Considerations

The following factors have been considered for design of the transmission backbone network to be implemented:

(1) Provision of abundant capacity

(2) Guarantee high level of network resiliency and redundancy

(3) Guarantee high quality of performance of transmission systems

(4) Provide nationwide geographical coverage

## 3.2 Transmission Systems

Figure 5 below provide routing details of the proposed National OFC backbone transmission system. Three rings are planned to cover all 21 regional HQs in Tanzania mainland and one interconnection point at DSM for linking of Tanzania Island to the National backbone network through the EASSy network.

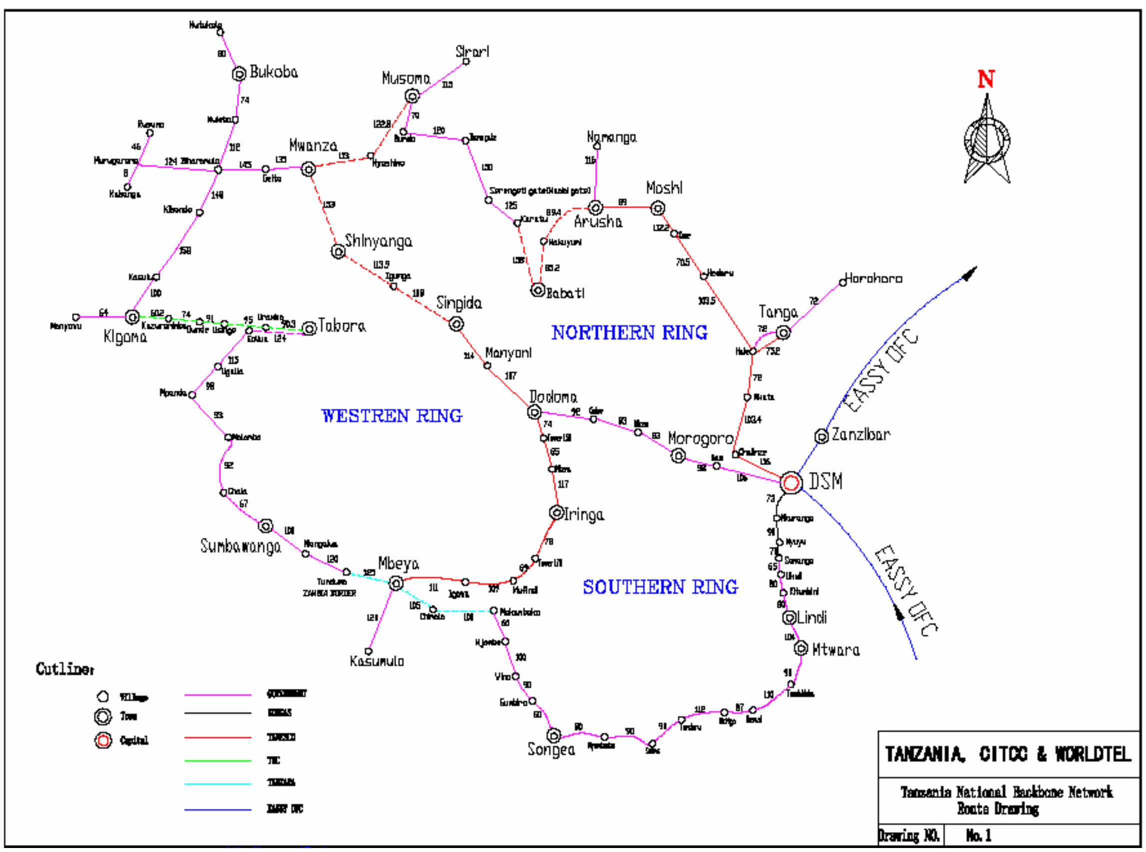



**Figure 5: Routes of the Backbone Transmission Network**

### 3.2.1 Network Architecture of Transmission Systems

Considering factors such as market competition, use of existing network resources， geographical location of different cities to be served，environment condition，development trend and speed of different areas，status of national economy，population density and service demands; the proposed architecture of the backbone transmission network is based on two layers; the DWDM and SDH layers as described below:

#### a) Architecture of DWDM layer

The DWDM layer will provide upper transmission layer of the backbone network. The DWDM will use ring framework. The rings will not only connect all regional centers and major centers but will also provide abundant transmission capacity through the DWDM equipment. By this way larger transmission capacities will be available throughout the country to satisfy demands of different users using limited OFC resources. Three transmission rings are proposed in the architecture namely: the Southern Ring, the Northern and the Western Ring. Also the DWDM layer includes one (1) spur. The individual parts of the DWDM layer are explained below as follows:

**(i) The Northern ring**

**Route:** DSM- The Dodoma – Singida- Shinyanga- Mwanza- Musoma- Babati –Arusha- Moshi- Tanga- DSM,

**Length:** 2905km of OFC,

**Stations:** 28 stations including 14 OADM and 14 OA stations

**(ii) The Southern ring**

**Route**: DSM-Lindi- Mtwara- Songea- Mbeya—Iringa- Dodoma- Morogoro- DSM,

**Length**: 2299km of OFC

**Stations**: 32 stations including 0 OADM and 22 OA stations

**(iii) The Western ring**

**Route**: Dodoma - Singida - Shinyanga - Mwanza - Biharamulo - Kigoma - Tabora - Sumbawanga - Mbeya - Iringa – Dodoma.

**Length**: 3253km of OFC,

**Stations:** 31 stations including 14 OADM and 17 OA stations

**(iv) Spur link**

Biharamulo- Bukoba- Mutukula（UGANDA Border.

The spur link is based on DWDM for inclusion of Bukoba region and take care of the international cross border traffic with Uganda.

The above DWDM network layer is presented in figure 6 below.

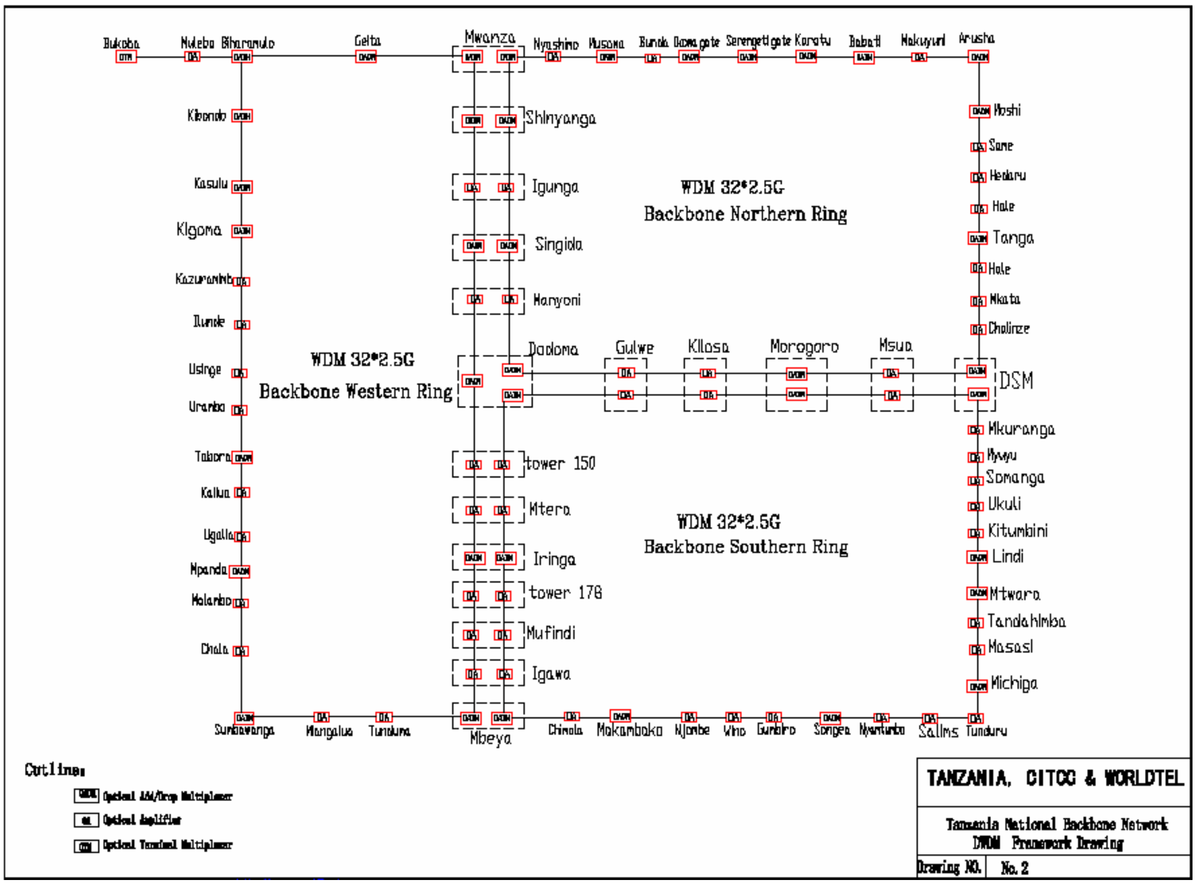



**Figure 6: DWDM transmission network layer**

### b) Architecture of SDH Layer

The SDH layer is based on DWDM layer. According to direction and traffic forecasts, the function of the SDH layer is mainly to provide bandwidth interfaces for traffic dropping and insertion to/from the different stations and to/from interconnecting international networks along the transmission. For this project, eight (8) rings and eight (8) links in total are proposed for the SDH layer. The rings are: three (3) Northern rings, two (2) Southern rings, and three (3) Western rings. The details are as follows:

### *c) Northern Circuit*

(i) Northern Ring No.1

DSM- Dodoma - Mwanza – Arusha. To take care of regional traffic routing between Dodoma Mwanza and Arusha areas. There are four (4) stations in the SDH ring.

(ii) Northern Ring No.2

Arusha- Moshi - Tanga - Babati –Arusha. To take care of regional traffic routing between Arusha Moshi Tanga and Babati regions. There are four (4) stations in the ring.

(iii) Northern Ring No.3

Mwanza - Musoma - Shinyanga - Mwanza. To take care of regional traffic routing between Mwanza Musoma and Shinyanga. There are three (3) stations in the ring.

### *d) Southern Circuit*

(i) Southern Ring No.1

DSM - Dodoma - Mbeya - Songea –DSM. To take care of regional traffic routing between DSM Dodoma and Mbeya.There are four (4) in the ring.

(ii) Southern Ring No.2

DSM-Lindi- Mtwara - Morogo-DSM. To take care of regional traffic routing between DSM Lindi Mtwara and Morogo. There are four (4) stations in the ring.

### *e) Western Circuit*

(i) Western Ring No.1

Mwanza - Biharamulo - Kingoma - Mwanza. To take care of regional traffic routing between Mwanza, Bukoba and Kingoma. There are three (3) stations in the ring.

(ii) Western Ring No.2

Dodoma - Singida - Tabora - Dodoma. To take care of regional traffic routing between Dodoma Singita and Tabora. There are three (3) stations in the ring.

(iii) Western Ring No.3 of SDH backbone transmission network

Dodoma - Sumbawanga - Mbeya - Iringa - Dodoma. To take care of regional traffic routing between Dodoma Sumbawanga Mbeya and Iringa. There are four (4) stations in the ring.

*f) Spur links*

The SDH spur links are provided for international interconnect with bordering countries: KENYA, ZAMBIA, MALAWI, UGANDA, RWANDA and BURUNDI. The total number of station for the spur links is ten (10). The details of the SDH network is given in figure 7 below.

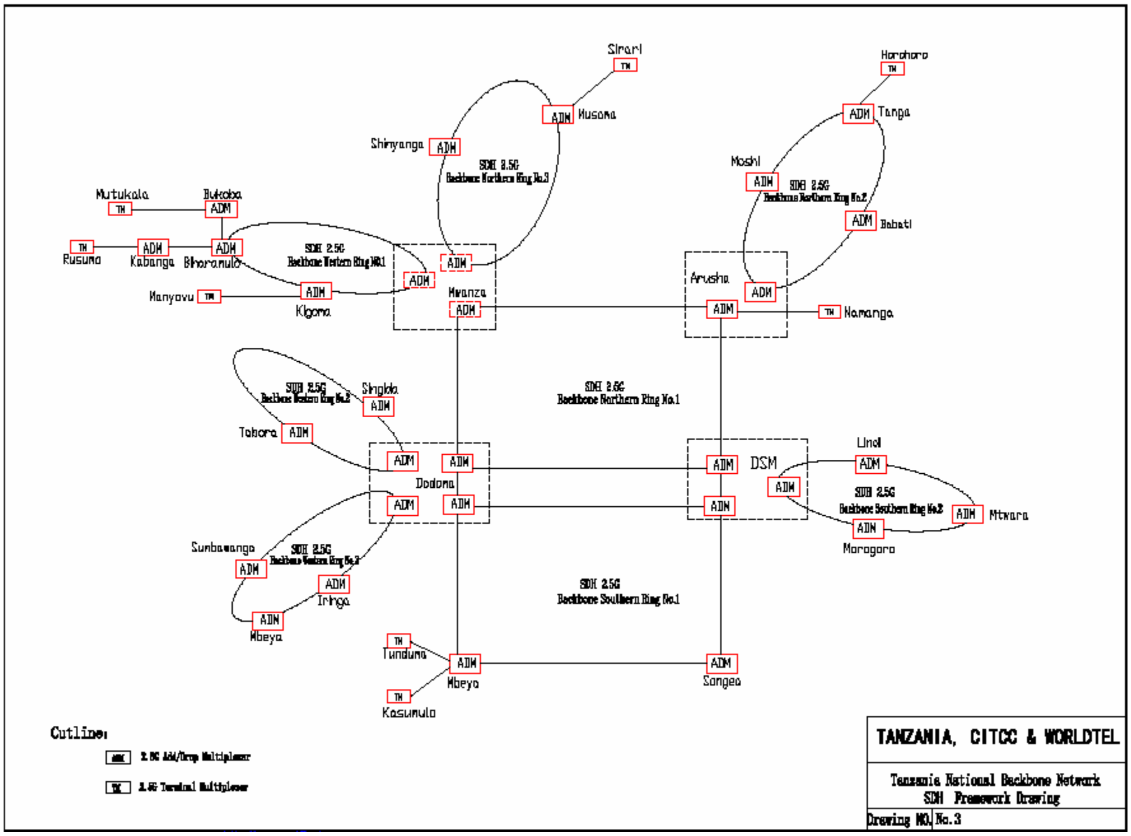



**Figure 7: SDH network layer**

### 3.2.2 Configuration of Transmission Line Capacity

All three OFC rings are provided with WDM-32 system based on SDH 2.5Gb/s line speed. As per the traffic forecast, the Northern WDM ring is provided with 4x2.5Gb/s SDH configuration, the Southern WDM ring with one 3x2.5Gb/s SDH configuration and the Western WDM ring with one SDH 4x2.5Gb/s SDH configuration. The only Biharamulo – Bukoba-Mtukula DWM link is provided with one (1+1)x2.5Gb/s SDH configuration.

### 3.2.3 Protection Method

#### a) WDM system protection

The WDM system can provide 1+1 optical layer line protection, 1+1 optical channel protection and 1:N channel protection.

**(i) 1+1 Optical line protection mode**

The 1+1 Optical layer line protection involves protection at optical physical line level as such two different physical OFC pairs are required to achieve protected line operation. Such configuration is generally applied in chain networks.

**(ii) 1+1 Optical channel protection mode**

1+1 optical channel protection mode involves protection at card level can be used in ring network but would still require use of two different optical cable pairs, one as working line, and another as standby line. If one link fails, the system rearranges automatically itself to secure uninterruptible communication services.

**(iii) 1:N (N≤8）Wavelength protection mode**

In the 1:N (N≤8）protection configuration, the standby wavelength channel is shared by all N active channels. If either of the working wavelength channel fails, the protection channel will take operation automatically according to the decision priority setup in place.

Under this project, 1:N (N<8) Wavelength Protection mode is employed.

#### b) SDH Network protection

Two kinds of protection modes are employed in the SDH layer: MSP in 1+1 / 1: N protection and MS-SPRing protection (using two or four fibre core ring).

The MSP (1+1) protection method is employed in Optical SDH links and in this case, TTCL’s SDH microwave links can provide protection if the SDH OFC network fails.

The MS-SPRing protection is employed in SDH rings and it uses two optical fibre cores.

#### c) Equipment board protection mode

For the main equipment board of DWDM and SDH, It adopts 1+1 protection, one board working and another board standby. For branch board of SDH, it adopts 1: N protection.

### 3.2.4 Network Management System

According to the multi-layer structure of network management and operation system, two layers of network management systems are employed for this backbone project: Sub-network management (SNM) and Element management system (EMS) for separate management of both WDM and SDH networks. The main SNM center will be in DSM and will supervise the entire transmission network. The SNM center will manage two EMS centers, one in DSM responsible for management of north and south ring; and another in DODOMA responsible for management of West ring. The scope of supervision includes fault management, control management, configuration management and security management. For maintenance convenience reasons, local maintenance terminals are provided for to each local maintenance centers for supervision of OADM station in the WDM system. The local terminal can be used to configure new installations as well to perform local maintenance operations.

### 3.2.5 Service Communication System

A communication system is require facilitate maintenance services in WDM system by enabling voice communication among stations using E1 Octet of optical supervision circuit (OSC). The system is provided with two calling methods: selective and conference telephone calling.

### 3.2.6 Synchronisation System

Synchronisation system is used to provide synchronization signal to the transmission network. It will be used to synchronize equipment in all stations using external timing system (BITS) to be provided in this project. The ADM stations will achieve synchronization by receiving satellite timing signal in initial stages. The timing signal will bypass the SDH repeater stations (or SDH relay station). The external timing signal is 2Mb/s (framed) or 2MHz (unframed).

### 3.2.7 Equipment Selection

#### a) Selection Criteria

The transmission Equipments in this project should be in accordance with ITU-T relevant recommendations.  DWDM system equipments will be selected and for interfacing with SDH equipment wave length converter will be adopted. The optical interface should be in accordance with ITU G. 957 standard. The SDH transmission equipment should be in accordance with ITU G.813 standard. The protection between rings should be in compliance to with ITU G.842 standard. The Working power supply to be employed is -48v positive pole grounding. Equipment Cabinet height is 2.6, 2.2 or 2.0 meters.

**b) Equipment Configuration**

According to the network architecture under this project, the following quantities of transmission equipment are provided in table 3.2-1 below:

**Table 3.2-1: Equipment Requirement**

| N0. | Equipments name | Unit | Qty. | Remark |
|---|---|---|---|---|
| 1 | Optical Add/Drop Multiplexer Equipments (OADM) | set | **38** | |
| **2** | Optical Terminal Multiplexer Equipments( OTM) | set | **1** | |
| **3** | Optical Amplifier Equipments (OA) | set | **54** | |
| **4** | SDH 2.5G Add/Drop Multiplexer Equipments ( ADM) | set | **31** | |
| **5** | SDH 2.5G Terminal Multiplexer Equipments( TM) | set | **8** | |
| **6** | DWDM Sub-network Management System （SNM） | set | **1** | |
| 7 | DWDM Element Management System （EMS） | set | **1** | |
| 8 | SDH Sub-network Management System （SNM） | set | **1** | |
| 9 | SDH Element Management System （EMS） | set | **1** | |
| 10 | Local Craft Terminal | set | **20** | |

### 3.2.8 Allocation of Transmission Equipment

The following criteria have been used for identifying and selecting locations at each station for installation of the transmission equipments

(i) Making most use of the available existing resources like equipment rooms and power supply systems belonging to TTCL, TANESCO, TRC, TPC or other operators. For selection of repeater stations (OA stations), selection is should be left for the best among available equipment rooms.  In case there have no existing equipment room or the existing room does not have enough space, then the only viable solution is to construct new equipment room or refurbish the existing one.

(ii) Availability of space (about 10-18 $M^2$ for an OA and 35-70 $M^2$ for Optical Terminal Station) for construction of new sites.

(iii) Provision for extra space for future network expansions.

(iv) Requirement for interconnection to the existing PSTN operators centers.

(v) Suitability of stations in the design of the transmission nodes i.e distant between stations is within the specified range.

According to different functions and applications, the transmission stations are categorized as: ADM station, OTM station, OA station, TM station and Optical Jumper Station (OJ). The total number of all stations is 150. Table 3.2-8 provide schedule of the equipment placement.

Table 3.2-2: Schedule of transmission equipment allocation

| No. | Station Name | Station Owner | Station Type | Commercial Power availability | Battery & Power Supply | Diesel generator | Remark |
|---|---|---|---|---|---|---|---|
| 1 | **Mkuranga** | SONGAS equipment room | OA | NO | YES | NO | NEW |
| 2 | **Myuyu** | SONGAS equipment room | OA | NO | YES | NO | NEW |
| 3 | **Somanga** | SONGAS equipment room | OA | NO | YES | NO | NEW |
| 4 | **Ukuli** | New equipment room | OA | NO | NO | NO | NEW |
| 5 | **Kitumbini** | New equipment room | OA | NO | NO | NO | NEW |
| 6 | **Lindi** | TTCL equipment room | OADM | YES | YES | YES | Existing |
| 7 | **Mtwara** | TTCL equipment room | OADM | YES | YES | YES | Existing |
| 8 | **Tandahimba** | TTCL equipment room | OA | YES | YES | YES | Existing |
| 9 | **Masasi** | TTCL equipment room | OA | YES | YES | YES | Existing |
| 10 | **Michiga** | New equipment room | OADM | NO | NO | NO | NEW |
| 11 | **Tundura** | TTCL equipment room | OA | YES | YES | YES | Existing |
| 12 | **Salims** | New equipment room | OA | NO | NO | NO | NEW |
| 13 | **Nyamtumbo** | New equipment room | OA | NO | NO | NO | NEW |
| 14 | **Songea** | TTCL equipment room | OADM | YES | YES | YES | Existing |
| 15 | **Gumbiro** | TTCL equipment room | OA | YES | YES | YES | Existing |
| 16 | **Wino** | TTCL equipment room | OA | YES | YES | YES | Existing |
| 17 | **Njombe** | TTCL equipment room | OA | YES | YES | YES | Existing |
| 18 | **Makambako** | TAZARA equipment room | OADM | YES | YES | YES | Existing |
| 19 | **Chimala** | TAZARA equipment room | OA | YES | YES | YES | Existing |
| 20 | **Mbeya TTCL** | TTCL equipment room | OADM | YES | YES | YES | Existing |
| 21 | **Mbeya(TANESCO Office)** | TANESCO equipment room | OJ | YES | NO | NO | Existing |
| 22 | **Mbeya(TAZARA Station)** | TAZARA equipment room | OJ | YES | NO | NO | Existing |
| 23 | **Tunduma** | TAZARA equipment room | OA、TM | YES | YES | YES | Existing |
| 24 | **Miangalua** | New equipment room | OA | NO | NO | NO | NEW |

| No. | Station Name | Station Owner | Station Type | Commercial Power availability | Battery & Power Supply | Diesel generator | Remark |
|---|---|---|---|---|---|---|---|
| 25 | **Sumbawanga** | TTCL equipment room | OADM | YES | YES | YES | Existing |
| 26 | **Igawa** | New equipment room | OA | NO | NO | NO | NEW |
| 27 | **Mufindi** | TANESCO equipment room | OA | NO | NO | NO | NEW |
| 28 | **Tower NO.178** | New equipment room | OA | NO | NO | NO | NEW |
| 29 | **Iringa TTCL** | TTCL equipment room | OADM | YES | YES | YES | Existing |
| 30 | **Iringa(TANESCO Office)** | TANESCO equipment room | OJ | YES | NO | NO | Existing |
| 31 | **Iringa substation** | TANESCO equipment room | OJ | YES | NO | NO | Existing |
| 32 | **Mtera** | TANESCO equipment room | OA | YES | NO | NO | NEW |
| 33 | **Tower NO.150** | New equipment room | OA | NO | NO | NO | NEW |
| 34 | **Dodoma** | TTCL equipment room | OADM | YES | YES | YES | Existing |
| 35 | **Dodoma(TANESCO Office)** | TANESCO equipment room | OJ | YES | NO | NO | Existing |
| 36 | **Dodoma substation** | TANESCO equipment room | OJ | YES | NO | NO | Existing |
| 37 | **Manyoni** | TTCL equipment room | OA | YES | YES | YES | Existing |
| 38 | **Singida** | TTCL equipment room | OADM | YES | YES | YES | Existing |
| 39 | **Singida(TANESCO Office)** | TANESCO equipment room | OJ | YES | NO | NO | Existing |
| 40 | **Singida substation** | TANESCO equipment room | OJ | YES | NO | NO | Existing |
| 41 | **Gulwe** | TRC equipment room | OA | YES | YES | YES | Existing |
| 42 | **Kilosa** | TRC equipment room | OA | YES | YES | YES | Existing |
| 43 | **Morogororo** | TTCL equipment room | OADM | YES | YES | YES | Existing |
| 44 | **Msua** | TRC equipment room | OA | YES | YES | YES | Existing |
| 45 | **Chalinze** | TANESCO equipment room | OA | YES | NO | NO | NEW |
| 46 | **Mkata** | New equipment room | OA | NO | NO | NO | NEW |
| 47 | **Hale** | TANESCO equipment room | OA | YES | YES | NO | Existing |
| 48 | **Tanga (TANESCO Office)** | TANESCO equipment room | OJ | YES | NO | NO | Existing |
| 49 | **Tanga (TTCL Office)** | TTCL equipment room | OADM | YES | YES | YES | Existing |

| No. | Station Name | Station Owner | Station Type | Commercial Power availability | Battery & Power Supply | Diesel generator | Remark |
|---|---|---|---|---|---|---|---|
| 50 | **Hedaru** | New equipment room | OA | NO | NO | NO | NEW |
| 51 | **Same** | TANESCO equipment room | OA | YES | YES | NO | Existing |
| 52 | **Moshi (TANESCO Office)** | TANESCO equipment room | OJ | YES | NO | NO | Existing |
| 53 | **Moshi (TANESCO substation)** | TANESCO equipment room | OJ | YES | NO | NO | Existing |
| 54 | **Moshi (TTCL Office)** | TTCL equipment room | OADM | YES | YES | YES | Existing |
| 55 | **Kiyungi** | TANESCO equipment room | OJ | YES | NO | NO | Existing |
| 56 | **Arusha(TANESCO Office)** | TANESCO equipment room | OJ | YES | NO | NO | Existing |
| 57 | **Arusha (TTCL Office)** | TTCL equipment room | OADM | YES | YES | YES | Existing |
| 58 | **Njiro(TANESCO substation)** | TANESCO equipment room | OJ | YES | NO | NO | Existing |
| 59 | **Makuyuni** | TTCL equipment room | OA | NO | YES | NO | Existing |
| 60 | **Babati (TANESCO Office)** | TANESCO equipment room | OJ | YES | NO | NO | Existing |
| 61 | **Babati (TTCL Office)** | TTCL equipment room | OADM | YES | YES | NO | Existing |
| 62 | **Babati Substation** | TANESCO equipment room | OJ | YES | NO | NO | Existing |
| 63 | **Karatu Substation** | TANESCO equipment room | OJ | YES | NO | NO | Existing |
| 64 | **Karatu TTCL** | TTCL equipment room | OADM | YES | YES | NO | NEW |
| 65 | **Serengeti gate(Naabi gate)** | New equipment room | OADM | NO | NO | NO | NEW |
| 66 | **Ikoma gate** | New equipment room | OADM | NO | NO | NO | NEW |
| 67 | **Bunda** | TTCL equipment room | OA | NO | NO | NO | NEW |
| 68 | **Musoma TTCL** | TTCL equipment room | OADM | YES | YES | YES | Existing |
| 69 | **Musoma(TANESCO Office)** | TANESCO equipment room | OJ | YES | NO | NO | Existing |
| 70 | **Nyashimo (Nasa)** | TTCL equipment room | OA | YES | YES | NO | Existing |
| 71 | **Mwanza(TANESCO Office)** | TANESCO equipment room | OJ | YES | NO | NO | Existing |
| 72 | **Mwanza(TANESCO Substation)** | TANESCO equipment room | OJ | YES | NO | NO | Existing |
| 73 | **Mwanza (TTCL Office)** | TTCL equipment room | OADM | YES | YES | YES | Existing |

| No. | Station Name | Station Owner | Station Type | Commercial Power availability | Battery & Power Supply | Diesel generator | Remark |
|---|---|---|---|---|---|---|---|
| 74 | **Geita** | TTCL equipment room | OADM | YES | YES | NO | Existing |
| 75 | **Biharamulo** | TTCL equipment room | OADM | YES | YES | YES | Existing |
| 76 | **Muleba** | TTCL equipment room | OA | YES | NO | NO | NEW |
| 77 | **Bukoba TTCL** | TTCL equipment room | OTM | YES | YES | YES | Existing |
| 78 | **Kibondo** | TTCL equipment room | OADM | YES | YES | NO | NEW |
| 79 | **Kasulu** | TTCL equipment room | OADM | NO | NO | NO | NEW |
| 80 | **Kigoma TTCL** | TTCL equipment room | OADM | YES | YES | YES | Existing |
| 81 | **Kigoma TRC** | TRC equipment room | OJ | YES | NO | NO | Existing |
| 82 | **Kazuramimba** | TRC equipment room | OA | YES | YES | YES | Existing |
| 83 | **Ilunde** | TRC equipment room | OA | YES | YES | YES | Existing |
| 84 | **Usinge** | TRC equipment room | OA | YES | YES | YES | Existing |
| 85 | **Kaliua** | TRC equipment room | OA | YES | YES | YES | Existing |
| 86 | **Urambo** | TRC equipment room | OA | YES | YES | YES | Existing |
| 87 | **Tabora TTCL** | TTCL equipment room | OADM | YES | YES | YES | Existing |
| 88 | **Tabora TRC** | TRC equipment room | OJ | YES | NO | NO | Existing |
| 89 | **Ugalla** | New equipment room | OA | NO | NO | NO | NEW |
| 90 | **Mpanda** | TTCL equipment room | OADM | YES | YES | YES | Existing |
| 91 | **Malambo** | New equipment room | OA | NO | NO | NO | NEW |
| 92 | **Chala** | New equipment room | OA | NO | NO | NO | NEW |
| 93 | **Shinyanga TTCL** | TTCL equipment room | OADM | YES | YES | YES | Existing |
| 94 | **Shinyanga (TANESCO Office)** | TANESCO equipment room | OJ | YES | NO | NO | Existing |
| 95 | **Shinyanga (TANESCO Substation)** | TANESCO equipment room | OJ | YES | NO | NO | Existing |
| 96 | **Igunga** | TTCL equipment room | OA | NO | NO | NO | NEW |
| 97 | **DSM TTCL** | TTCL equipment room | OADM | YES | YES | YES | Existing |
| 98 | **DSM SONGAS** | SONGAS equipment room | OJ | YES | NO | NO | Existing |

| No. | Station Name | Station Owner | Station Type | Commercial Power availability | Battery & Power Supply | Diesel generator | Remark |
|---|---|---|---|---|---|---|---|
| **99** | **DSM TANESCO** | TANESCO equipment room | OJ | YES | NO | NO | Existing |
| **100** | **Rusumo（Rwanda）** | TTCL equipment room | TM | NO | YES | NO | Existing |
| **101** | **Mutukala（Uganda）** | New equipment room | TM | NO | NO | NO | NEW |
| **102** | **Sirari（Kenya）** | New equipment room | TM | NO | NO | NO | NEW |
| **103** | **Namanga（Kenya）** | TTCL equipment room | TM | NO | YES | NO | Existing |
| **104** | **Horohoro（Kenya）** | New equipment room | TM | NO | NO | NO | NEW |
| **105** | **Kasumulo（Malawi）** | New equipment room | TM | NO | NO | NO | NEW |
| **106** | **Manyovu（Burundi）** | New equipment room | TM | NO | NO | NO | NEW |
| **107** | **Kabanga（Burundi）** | New equipment room | TM | NO | NO | NO | NEW |

## 3.3 OFC Line Plant

### 3.3.1 OFC Route Selection Criteria

Routing of the OFC lines have been selected based on the following:

(1) To satisfy requirement to reach all regional HQ and major centers

(2) To allow easy and cost effective extension of tail links to small towns and rural areas

(3) Existence of OFC along electricity high tension pylons and railways

(4) To follow major roads for easy of accessibility

(5) To maximize utilization of existing resources such as equipment rooms, power supply

(6) Realization of easy interconnection to the existing telecom centers

Roads and Railway lines reach to many areas of the country so they have greatly influenced routing of the optical cable. Optical fibre cable is generally constructed along the highway and railway in the many circumstances due to availability of way leaves and easy of accessibility to sites.

### 3.3.2 OFC Capacity

The capacity and quantity of the OFC proposed under this project have been arrived at by considering the following factors:

(1) Based on the forecasted demand

(2) To satisfy requirements of all users in Tanzania

(3) To provide spare capacity for future uses and take care of emerging new services such as data and image and multimedia

(4) To allow smooth upgrades of the transmission systems.

(5) To provide adequate capacity for domestic and international applications.

(6) To provide high level of network resiliency, redundancy and reliability for offering quality services.

(7) On construction and maintenance consideration aspects, requirement for quick repair during breakdown, fast development in the optical fibre technology, OFC structure, and cost aspects; it is recommended that the number of cores in a single cable need not be too large.

With regard to the above factors, it is recommended that the planned OFC network should have 48 cores while the links to borders with neighboring countries should be of 24 cores. Wherever the existing OFC line laid with 24 cores, then line will not be rebuilt, but when the existing OFC line is less than 24 cores, then the line will be needed to be rebuilt or upgraded.

### 3.3.3 Scope of OFC Proposed Backbone OFC

According the structure of backbone network, the entire OFC network is made by two parts, part one is the *Rebuilt part* along the way leave owned by TANESCO, TRC, TAZARA, SONGAS (existing or planned) and part two is the *Newly-built part*, that closes the "gap parts" for rings formation.

The newly-Built part will provide 48 core cable of about 2653km in length, and 24 core cable of about 869 km in length. The Rebuild part will construct 48 core cable of about 3430 km and 24 core cable of about 45 km. The whole project will construct 48 core cable of about 6083 km and 24 core cable of about 914 km length in total.

The details of the OFC routing are indicated in the Figure 8 below:

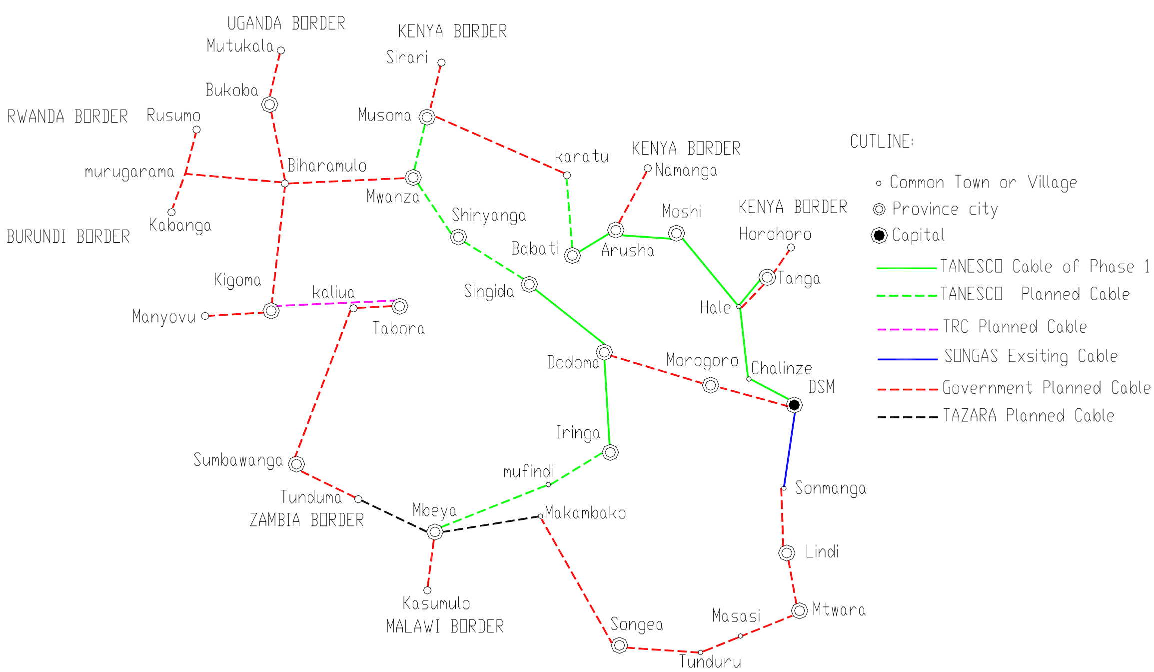



**Figure 8: The Proposed National ICT OFC Backbone**

### a) The re-build Part

The rebuilt part deals with two categories of OFC construction works:

#### (i) Category 1

Categories 1will have three situations of OFC construction works:

**Situation 1:**

Construction of OFC closing links (tie links) on the existing OFC links with 24 cores for extention to backbone network – newly built (TANESCO phase-1, SONGAS Somanga-Mtwara, Karatu-Musoma links).

**Situation 2:**

Construction of 48 cores cable on the existing OFC with insufficient cores - 6 cores DSM – Morogoro link and 8 cores Morogoro-Dodoma link both belonging to TRC

**Situation 3:**

Construction of 48 cores on links originally planned with 24 cores (TANESCO phase 2, TRC planned, TAZARA planned). Ref Table 3.3.1.

**Table 3.3-1: OFC Links for Rebuild Portion**

| No. | Section | distance(km) | cores | Status | Remark |
|---|---|---|---|---|---|
| 1 | Kigoma-Tabora | 410 | 1x48 | TRC | Rebuilt |
| 2 | Mbeya –Iringa | 357 | 1x48 | TANESCO | Rebuilt |
| 3 | Babati – Karatu | 158 | 1x48 | TANESCO | Rebuilt |
| 4 | Arusha – Babati | 166 | 1x48 | TANESCO | Rebuilt |
| 5 | Singida – Shinyanga - Mwanza | 375 | 1x48 | TANESCO | rebuilt |
| 6 | Mwanza-Musoma | 236 | 1x48 | TANESCO | rebuilt |
| 7 | Mbeya –Chimala- Makambako | 120 | **1x48** | TAZARA | rebuilt |
| 8 | Mbeya –Tunduma | 200 | **1x48** | TAZARA | rebuilt |
| 9 | Karatu – Musoma | 465 | **1x48** | | Newly built |
| 10 | Somanga - Lindi- Mtwara | **327** | **1x48** | | Newly built |
| 11 | Dodoma—Morogoro—DSM | **462** | **1x48** | TRC | Rebuilt |
| 12 | **Hale-Tanga** | 72 | 1x48 | | Newly built |
| **13** | **Total** | **3348** | **1x48** | | |

### b) OFC Extension links

All central stations will use TTCL stations in the regional HQs and major towns, and when the existing OFC line is available, it will be used to connect to the central stations. The details of extension cable works are shown as follows:

ODFs installations will be done at the places where jumper cable will be employed for termination of the backbone OFC link at TTCL offices. For the purpose of line diversity and protection, station's lead-in and lead-out lines will be run through separate physical routes. For instance, In the case of TANESCO office is a terminal one, only one lead-in route will run from the office, but if the office is a central (multi-directions), then two separate route will be run to TTCL's offices for inclusion in the rings. The details are provided in Table 3.3-2 and the Figure 9 below.

**Table 3.3-2: OFC Extension links**

| No. | Station name | Section | length (km) | Fiber core | Laying way |
|---|---|---|---|---|---|
| 1 | Mbeya | TANESCO office-TTCL | 0.5 | 48 | ducting |
| 2 | Mbeya | TAZARA station –TTCL | 10 | 48 | Ducting, Direct burying |
| 3 | Iringa | TANESCO station –TTCL | 9 | 48 | ducting |
| 4 | Tower 178 | TANESCO OFC--OA station | 0.5 | 48 | Direct burying |
| 5 | DSM | SONGSA station-TTCL | 13 | 48 | ducting |
| 6 | Arusha | TANESCO station--TTCL | 9 | 48 | Direct burying |
| 7 | Makuyuni | TANESCO OFC—TTCL | 0.8 | 48 | Direct burying |
| 8 | Karatu | TANESCO OFFICE--TTCL | 0.5 | 48 | ducting |
| 9 | Nyashimo | TANESCO OFC--OA station | 1 | 48 | Direct burying |
| 10 | Igunga | TANESCO OFC--OA station | 0.2 | 48 | Direct burying |
| 11 | Babati | TANESCO office --TTCL | 0.8 | 48 | ducting |
| 12 | Babati | TANESCO station—TTCL | 4 | 48 | Direct burying |
| 13 | Musoma | TANESCO station—TTCL | 3 | 48 | Direct burying |
| 14 | Mwanza | TANESCO office –TTCL | 0.5 | 48 | ducting |
| 15 | Mwanza | TANESCO station—TTCL | 9 | 48 | Direct burying |
| 16 | Shinyanga | TANESCO office –TTCL | 0.7 | 48 | ducting |
| 17 | Shinyanga | TANESCO station—TTCL | 15 | 48 | Direct burying |
| 18 | Singida | TANESCO office –TTCL | 0.8 | 48 | ducting |
| 19 | Tabora | TANESCO office—TTCL | 0.7 | 48 | ducting |
| 20 | Tabora | TRC station –TTCL | 1.3 | 48 | ducting |
| 21 | Kigoma | TRC station—TTCL | 0.4 | 48 | ducting |
| 22 | Makambako | TAZARA station—TTCL | 1 | 48 | ducting |
| 23 | Iringa | TANESCO office-TTCL | 1 | 24 | ducting |
| 24 | Dodoma | TANESCO office-TTCL | 1 | 24 | ducting |
| 25 | Dodoma | TANESCO station –TTCL | 9 | 24 | Direct burying |
| 26 | Singida | TANESCO station –TTCL | 8 | 24 | Direct burying |
| 27 | Tower 150 | TANESCO OFC--OA station | 0.5 | 24 | Direct burying |
| 28 | DSM | TANESCO station—TTCL | 13 | 24 | ducting |
| 29 | Mkata | TANESCO office—OA station | 0.8 | 24 | Direct burying |
| 30 | Tanga | TANESCO office --TTCL | 0.2 | 24 | ducting |
| 31 | Hedaru | TANESCO OFC--OA station | 1 | 24 | Direct burying |

| No. | Station name | Section | length (km) | Fiber core | Laying way |
|---|---|---|---|---|---|
| 32 | Moshi | TANESCO office --TTCL | 0.2 | 24 | ducting |
| 33 | Moshi | TANESCO station—TTCL | 10 | 24 | Direct burying |
| 34 | Arusha | TANESCO office --TTCL | 0.3 | 24 | ducting |
| **35** | **Subtotal 1** | | **82** | **48** | |
| **36** | **Subtotal 2** | | **45** | **24** | |

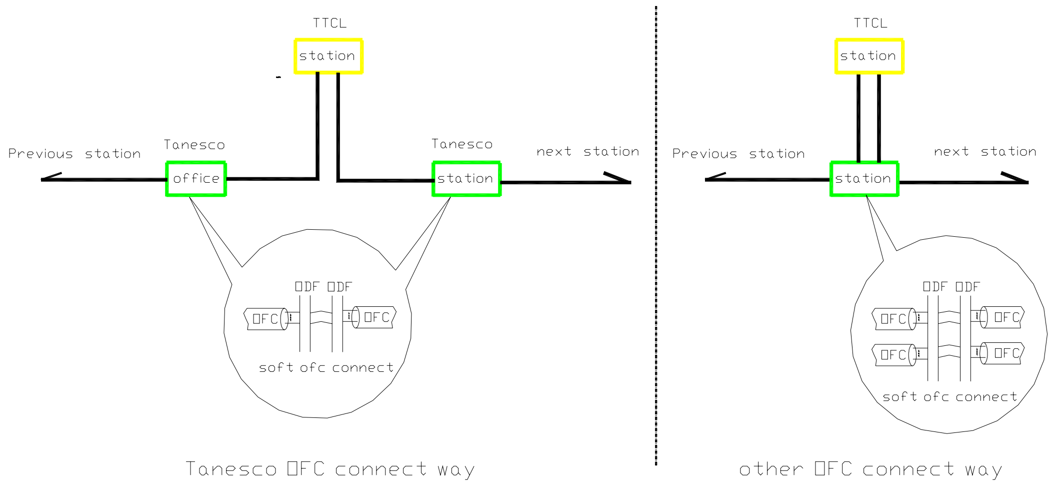



**Figure 9: OFC Connection method**

### c) Newly-Built Part

The newly-built part of OFC constructions include four portions: the Southern Circuit, the Western Circuit, the North-Western and the international links to bordering countries:

**Southern Circuit**

This comprise of 48 core cable for closing of the Southern ring. The cable will start at Mtwara leading east to Masasi, Tunduru, Songea and terminating in Makambako. The route from Makambako to Mbeya will use the TAZARA fiber optic cable. This will provide a ring that will increase resilience and redundancy for TANESCO, TAZARA and TTCL networks for southern bound traffic. It would also have the potential of carrying across the trans-border traffic from neighboring countries. The total length of the route is 969 km.

**Western Circuit**

This comprise of 48 core cable for closing of the Western ring. The cable will start at Tunduma leadng to Tabora via Sumbawanga. This would create another major ring spanning from Mbeya, Tabora, Dodoma and Iringa. This route is 809 km in length.

**North-western Circuit**

A 48 core link from Kigoma to Biharamulo and Mwanza with a spur to Bukoba, would complete the western ring spanning from Kigoma, Biharamuro, Mwanza, Shinyanga, and Tabora. The route is 875 km in length.

**Cross-border links**

The cross-border OFC route under this project will comprise the following links:

(i) 24 core cable from Mbeya to Kasumulo for linking to MALAWI. The route is 120 km long.

(ii) 24 core cable from Bukoba to Mutukula for linking to UGANDA. The route is 80 km long.

(iii) 24 core cable from Biharamulo to Rusumo for linking to RWANDA. The route is 170 km long.

(iv) 24 core cable from Biharamulo to Kabanga for linking to BURUNDI. The route is 132 km long.

(v) 24 core cable from Kigoma to Manyovu for linking to BURUNDI. The route is 64 km long.

(vi) 24 core cable from Tanga to Horohoro for linking to KENYA (lower border). The route is 72 km long.

(vii)24 core cable from Arusha to Namanga for linking to KENYA (central border). The route is 116 km long.

(viii) 24 core cable from Musoma to Sirari for linking to KENYA (upper border). The route is 115km long.

(ix) 24 core cable from Mbeya to Tunduma will use TAZARA fiber optic cable for linking to ZAMBIA.

The total length of the cross-border cable is 869 km. Details are provided in Table 3.3-3 below.

**Table 3.3-3: New Built OFC routes**

| No. | Section | length (km) | Fiber core | Laying way |
|---|---|---|---|---|
| 1 | Mtwara-Songea-Makambako | 969 | 1x48 | Direct burying 、Ducting |
| 2 | Tunduma—Sumbawanga | 220 | 1x48 | Direct burying 、Ducting |
| 3 | Sumbawanga—Tabora | 589 | 1x48 | Direct burying 、Ducting |
| 4 | Mwanza—Biharamulo | 280 | 1x48 | Direct burying 、Ducting |
| 5 | Biharamulo—Bukoba | 186 | 1x48 | Direct burying 、Ducting |
| 6 | Biharamulo—Kigoma | 409 | 1x48 | Direct burying 、Ducting |
| 7 | Mbeya—Kasumulo | 120 | 1x24 | Direct burying 、Ducting |
| 8 | Bukoba—Mutukala | 80 | 1x24 | Direct burying 、Ducting |
| 9 | Biharamulo—Rusumo | 170 | 1x24 | Direct burying 、Ducting |
| 10 | Biharamulo—Kabanga | 132 | 1x24 | Direct burying 、Ducting |
| 11 | Kigoma—Manyovu | 64 | 1x24 | Direct burying 、Ducting |
| 12 | Tanga—Horohoro | 72 | 1x24 | Direct burying 、Ducting |
| 13 | Arusha—Namanga | 116 | 1x24 | Direct burying 、Ducting |
| 14 | Musoma—Sirari | 115 | 1x24 | Direct burying 、Ducting |
| **15** | **Subtotal 1** | **2653** | **1x48** | |
| **16** | **Subtota 2** | **869** | **1x24** | |

### 3.3.4 OFC Laying and Installations

#### a) Choice of OFC Laying Method

There are three methods for installation of the OFC: direct buried, aerial and ducting. Normally, the life time of OFC line usage is for 30 years. The aerial OFC line appears to be less secure due to its vulnerability to animal and human activities thus only recommended for short term and medium term solutions. The direct buried OFC line is more secure, but entails higher costs due to large scope of civil works, compensation for farm crossing, crossing roads etc; like the direct buried cable, the ducted cable is secure and additionally can provide multi-ducts thus gives allowance for future use or expansion, however, it is the most expensive option.

According to the route conditions that we have seen during the preliminary survey, some sections of the routes are located in a highland and mountainous areas. In areas where it is thought the that mountainous condition will provide difficulties in the construction works, TANESCO power pylons will be used for carrying the OFC and this case it means adoption to aerial method through high-tension transmission.

Direct buried cable method is suggested for adoption in areas where the land is relatively flat and of average soil condition. The direct buried routes are selected to follow the main roads, through villages and are negotiated carefully to easy accessibility & construction works across the woodland, forest and rock mountainous areas. In average buried cable route is placed at about 100-200m in length away from the roads. In case of odd soil conditions sections like hard rock or difficult mountains, the aerial method is opted for the cable construction.

In the urban areas, ductwork system will be adopted for laying the OFC lines and has been noted that TTCL has existing duct systems in almost every urban ship therefore it is better to make the most use of it for installation of the OFC backbone. Wherever the existing ducts will need modifications or expansion, then PVC plastic pipes may be adopted. For OFC going through small villages or small townships, it is recommended to use direct buried cable method.

#### b) PVC Pipe Line Capacity and Construction Scope

Due to diversified possible use of the OFC lines i.e , there leased dark fibre or wave length for private / corporate use and possible future cable upgrades, there is need to allow for provision of atleast spare PVC plastic pipe duct capacity along the backbone duct sections. In this project, 20km of 4 PVC pipe duct system is recommended for DSM area. Likewise for the other four (4) zonal cities of MWANZA, ARUSHA, MBEYA and DODOMA, 10km of 4 PVC pipe duct system is recommended. And for other remaining municipalities and towns, 6km of 4 PVC pipe duct system is proposed. In small towns, 2km of 2 PVC pipe duct system will be adequate. In total 700 km of PVC duct system will be constructed under this project. The exactly scope of the duct construction works and the relative technical requirements will be discussed in the detail during detail design phase.

#### c) Optical Cable Line Protection

Some protection measures will have to be employed in order to cancel effects of any undesirable induction due to electrical and electromagnetic fields. In this case though the cable will have no metal conductors/pairs, some metal components are inherent in the cable mechanics and thus the following protection measures will be employed in the design stage in order to cancel the effect of the electromagnetic inductions:

**(i) Anti- lightning strike**

Besides suffering from direct effect of lightning strike hit, the cable line is also vulnerable to the effect of electric arc and ground potential difference caused by the strike. When the strike current exceeds the designed intensity destructive damage to the cable and equipment can be sustained. The anti-strike measures can be applied under such situations to mitigate its destructive effect. Detail information on the strike protection method will be provided in the detail design stage

**(ii) Damp proof**

Fiber optical cable is generally vulnerable to wear and erosion if subject for a long time to damp or water-logged condition. In effect the cable performance will degrade progressively with time by increased transmission attenuation and hence reduced its designed lifetime significantly. As protection to such effects, damp proof layer or shield and jelly-filler measures are employed.

**d) Optical Cable Specifications**

**(i) G.652 optical fibre**

a. Single-mode optical fibre recommended by ITU-T

b. Mode field diameter (wavelength of 1310nm，defined by Peterman)

- Standard value：getting one between 8.6 and 9.5μm
- Difference：not exceeding ±0.7μm

c. Cladding diameter

1. Standard value：125.0μm
2. Difference：not exceeding ±1μm

d. Concentric difference based on the wavelength of 1310nm：

- not more than 0.8μm

e. Non-concentric extent of fiber cladding：less than 2.0%

f. Fibre curl extent: curvature radius of 4.0m

g. Fiber cutoff wavelength fiber cutoff wavelength should meet the requirement of the λcc as below:

- λcc（test with 20 meter optical cable plus 2 meter fibre）：≤1260nm

h. Fiber attenuation coefficient

- Largest fiber attenuation coefficient based on wavelength of 1310nm 0.36dB/km

  By comparison, the difference of the attenuation coefficient based on the wavelength of 1310nm and any other wavelength which is between 1285-1330nm should not exceed 0.03dB/km.
- Maximal attenuation value of the wavelength of 1550nm is 0.22dB/km.

  By comparison, the difference of the attenuation coefficient based on the wavelength of 1550nm and any other wavelength which is between 1480-1580nm should not exceed 0.05dB/km.
- Fiber attenuation curve should be of good linearity and have no distinct step. The attenuation value of any 500-meter-long fiber tested by OTDR based on the wavelength of 1310nm and 1550nm should not exceed ($\alpha$ mean +0.10dB)/2，$\alpha$ mean is the average attenuation coefficient of fiber.

i. Curve attenuation characteristic of the fibre based on the wavelength of 1550nm and 1625nm. The maximal attenuation value of fiber G.652A at the window of 1550nm is 0.50dB when coiled loosely by 100 circles with the bending radius of 30 mm，Maximal attenuation value of fiber G.652B and G.652C at the window of 1625nm is also 0.50dB. Maximal attenuation value of G.652D fiber at the window of 1625nm is 0.50dB.

j. Dispersion

The range of zero dispersion wavelength is 1300-1324nm；

The slope of maximal zero dispersion should not exceed 0.093ps/（nm2.km）.

k. Polarization Mode Dispersion

Polarization Mode Dispersion coefficient of one reel of cable at the window of 1550nｍshould not exceed 0.20ps/√km；Polarization Mode Dispersion of optical cable line （≥20 reel）should not exceed 0.15ps/√km。

l. Tensile filtering experiment

All of the one-off coating fiber must be tested by tensile filtering experiment before being made into optical cable. The pull should not be less than 8.2N （about 0.69GPa、100kPsi， strain of fiber is about 1.0%），and the experimental time is about 1 s.

**(ii) Cable**

- Cable structure

  The structure of optical cable core is loose tube layer wound type, and the number of cable core is 48 in this project.

- Type of optical cable outer sheath structure and occasions for use.

  Pipe cable is laid in downtown pipes or in bridges between pipes. Direct buried cable (type I) is laid along highway or bridges in the middle of the segment.

- Mechanical Characteristics

  Optical cable mechanical characteristics should comply with the index in Table 3.3-4. When optical cable suffers from permitted pull and stress in a short time, the additional attenuation should be less than 0.1dB and the strain should be less than 0.1%. When the pull and stress is released, there should be no distinct residual additional attenuation and strain in optical fiber, and optical cable has no distinct residual strain also, and there should be no visual split in sheath. When cable suffers from permitted pull and stress in a long time, there should be no distinct residual additional attenuation and strain in optical fiber.

**Table 3.3-4: Right pull and Stress for the Cable**

| **Type** | **Right pull（N）** | | **Right stress（N/100mm）** | |
|---|---|---|---|---|
| | **Short time** | **Long time** | **Short time** | **Long time** |
| Pipe cable | 1500 | 600 | 1000 | 300 |
| Direct buried cable | 3000 | 1000 | 3000 | 1000 |

- Requirements of environmental temperature

  Operation: －３０℃～＋７０℃

  Laying： －n１５□～＋６０□

  Transportation and Storage：－５０□～＋７０□

- Reel length of optical cable

  Optical cable standard length of one reel is 3000m and 2000m.
- Standard thickness of outer plastic sheath of optical cable is more than 2.0mm.
- Optical cable PE sheath insulation resistance

  Tested after having dipped in water for 24 hours, the insulation resistance of optical cable sheath should not be less than 2000MΩ.km (tested by 500v direct current)
- Dielectric strength

  After dipped in water for 24 hours, dielectric strength of the outer sheath which is between steel tape and earth will not be less than 15KV 2minute in direct current. And dielectric strength which is between steel tape and the metal strong core will not be less than 20KV 5second in direct current.
- Other

  For reconstruct part of TENESCO, it depends on the status of different using, to choice OPGW or ADSS.

## 3.4 Associated Construction Works Requirement

### 3.4.1 Requirement of Telecom Station

#### a) Equipment Room Condition

**(i) Indoor requirements:**

Permanently air conditioned maintained to the following conditions:

a. Temperature: 25±2℃;

b. Relative Humidity: 45%～65%;

c. Variation Rate of Temperature: <5℃/h， without the dew coming into being;

d. Anti-dust: the quantities of dust specks in the air tested on the static state should be less than 18000 speck per litre.

**(ii) Outdoor requirements**:

Resistible to burning, non-explosive items, non-volatile gas, non-susceptible to strong electromagnetism field, strong to vibrations or strong noises pollutions with source near the equipment room and any factor which will harm the normal operation of the system should be found and avoided.

**(iii) Floor Height:**

The height of the floor of the house should comply with the standard on which the machine with a height of 2200mm or 2000mm can be installed; the practicable height of the room should be no less than 3meters.

**(iv) Floor Load Bearing Capacity:**

The floor should be capable handling load of at least 600 Kg/m$^2$ with the machine installed in the house arranged by the mode of face to back or back to back; the loading of the floor should be at least 800Kg/ m$^2$ with the accumulator installed in;

**(v) Inside Fitness:**

The fitments inside the room should conform to the requirement for installation of communication equipments, and it is recommended to use durable materials, anti-dust, anti-slide and non-burning materials. Not allowed to use the materials such as wood floor and suspended ceiling and plastics. Some measure should be taken on hole be well sealed: anti-fire, anti-wet or anti-bugs;

**(vi) Safety & Fire Control:**

Safety and Fire control measures should conform to the Safety Regulations & provisions in place for buildings;

**(vii) Grounding Requirement:**

Common grounding for building and equipment is recommended for proper protection against lightning. The grounding resistance should be less than 1 ohm.

### 3.4.2 Requirement for Power Supply System

A power supply system for telecom equipments must be safe and reliable. Power supply is the key component on operation of telecommunication equipments. The power supply quality will directly influence performance of the communication network, thus in order to ensure availability of communication services the power supply must work prudently within the specified limits and with high level of availability.

For this project, detailed information of status of all surveyed stations is provided as follows:

(i) All TTCL's major stations have Commercial power, standby diesel generators and Rectifier and backup batteries. For the remote microwave station where there is no commercial power, TTLL have adopted use of solar power systems.

(ii) TANESCO uses Commercial power supply for equipment in all stations. TRC and TAZARA employ solar power system for their remote stations.

Under this project, use of existing power systems is opted wherever the power system has adequate spare capacity. In case the existing power supply system in not adequate there is need add separate power equipment however, the capacity of the new power supply equipment is dimensioned for equipment under this project only.

**a) Types of Power Supply system**

There three kinds of power supply works considered for this project depending on situation of each station:

**(i) Integrating to existing Power supply system**

In case of availability of commercial power and existing standby generator, new power installation will cover provision of new Rectifier & Batteries. The new power equipment will be integrated to the existing AC power sources. This scenario is typical of many TTCL stations.

**(ii) Provision of Mini-type Power Supply System**

The scope of power equipment provision for new stations will include connection to commercial power if available, new generator, new rectifier & batteries, such type of power system is typical of TTCL and TANESCO stations.

**(iii) Provision of Solar Power Supply System**

For solar power stations, the scope of power supply equipment will entail provision of complete new solar power supply system, consisting of solar panels, batteries and regulator. The scenario is typical for remote stations belonging to TTCL, TRC and TAZARA. Detailed requirement for power supply installations under this project is given in table 3.4-1 below:

Table 3.4-1: Power Supply System Installation of All Stations

| No. | Name of station | Position of station | Type of station | integration Power | minitype Power | solar Power | Remark |
|---|---|---|---|---|---|---|---|
| 1 | Mkuranga | Near SONGAS station | OA | | | 1 | |
| 2 | Myuyu | Near SONGAS station | OA | | | 1 | |
| 3 | Somanga | Near SONGAS station | OA | | | 1 | |
| 4 | Ukuli | New | OA | | | 1 | |
| 5 | Kitumbini | New | OA | | | 1 | |
| 6 | Lindi | TTCL room | OADM | 1 | | | |
| 7 | Mtwara | TTCL room | OADM | 1 | | | |
| 8 | Tandahimba | TTCL room | OA | | 1 | | |
| 9 | Masasi | TTCL room | OA | | 1 | | |
| 10 | Michiga | New | OADM | | | 1 | |
| 11 | Tundura | TTCL room | OA | | 1 | | |
| 12 | Salims | New | OA | | | 1 | |
| 13 | Nyamtumbo | New | OA | | | 1 | |
| 14 | Songea | TTCL room | OADM | 1 | | | |
| 15 | Gumbiro | TTCL room | OA | | | 1 | |
| 16 | Wino | TTCL room | OA | | 1 | | |
| 17 | Njombe | TTCL room | OA | | 1 | | |
| 18 | Makambako | TTCL room | OADM | | 1 | | |
| 19 | Chimala | TAZARA station | OA | | | 1 | |
| 20 | Mbeya | TTCL room | OADM | 1 | | | |
| 21 | Tunduma | TAZARA station | OA | | | 1 | |
| 22 | Miangalua | New | OA | | | 1 | |
| 23 | Sumbawanga | TTCL | OADM | 1 | | | |
| 24 | Igawa | New | OA | | | 1 | |
| 25 | Mufindi | TANESCO station | OA | | 1 | | |
| 26 | Tower 178 | New | OA | | | 1 | |
| 27 | Iringa TTCL | TTCL | OADM | 1 | | | |
| 28 | Mtera | TANESCO station | OA | | 1 | | |
| 29 | Tower 150 | New | OA | | | 1 | |
| 30 | Dodoma | TTCL room | OADM | 1 | | | |

| No. | Name of station | Position of station | Type of station | integration Power | minitype Power | solar Power | Remark |
|---|---|---|---|---|---|---|---|
| 31 | Manyoni | TTCL room | OA | | | 1 | |
| 32 | Singida | TTCL room | OADM | 1 | | | |
| 33 | Gulwe | TRC room | OA | | | 1 | |
| 34 | Kilosa | TRC room | OA | | | 1 | |
| 35 | Morogoro | TTCL room | OADM | 1 | | | |
| 36 | Msua | TRC room | OA | | | 1 | |
| 37 | Chlinze | TANESCO room | OA | | 1 | | |
| 38 | Mkata | New | OA | | | 1 | |
| 39 | Hale | TANESCO room | OA | | 1 | | |
| 40 | Tanga | TTCL room | OADM | 1 | | | |
| 41 | Hedaru | New | OA | | 1 | | |
| 42 | Same | TANESCO room | OA | | 1 | | |
| 43 | Moshi | TTCL room | OADM | 1 | | | |
| 44 | Arusha | TTCL room | OADM | 1 | | | |
| 45 | Makuyuni | TTCL room | OA | | | 1 | |
| 46 | Babati | TTCL room | OADM | 1 | | | |
| 47 | Karatu | TTCL room | OADM | | 1 | | |
| 48 | Serengeti gate | New | OADM | | | 1 | |
| 49 | Ikoma gate | New | OADM | | | 1 | |
| 50 | Bunda | TTCL room | OA | | | 1 | |
| 51 | Msoma | TTCL room | OADM | 1 | | | |
| 52 | Nyashimo | TTCL room | OA | | | 1 | |
| 53 | Mwanza | TTCL room | OADM | 1 | | | |
| 54 | Geita | TTCL room | OADM | | 1 | | |
| 55 | Biharamulo | TTCL room | OADM | | 1 | | |
| 56 | Muleba | TTCL room | OA | | | 1 | |
| 57 | Bukoba | TTCLroom | OADM | 1 | | | |
| 58 | Kibondo | TTCLroom | OADM | | 1 | | |
| 59 | Kasulu | TTCL room | OADM | | | 1 | |
| 60 | Kigoma | TTCL room | OADM | 1 | | | |
| 61 | Kazuramimba | TRC room | OA | | 1 | | |
| 62 | Ilunde | TRC room | OA | | 1 | | |

| No. | Name of station | Position of station | Type of station | integration Power | minitype Power | solar Power | Remark |
|---|---|---|---|---|---|---|---|
| 63 | Usinge | TRC room | OA | | 1 | | |
| 64 | Kaliua | TRC room | OA | | 1 | | |
| 65 | Urambo | TRC room | OA | | 1 | | |
| 66 | Tabora | TTCL room | OADM | 1 | | | |
| 67 | Ugalla | New | OA | | | 1 | |
| 68 | Mpanda | TTCL room | OADM | | 1 | | |
| 69 | Malambo | New | OA | | | 1 | |
| 70 | Chala | New | OA | | | 1 | |
| 71 | Shinyanga | TTCL room | OADM | 1 | | | |
| 72 | Igunga | New | OA | | | 1 | |
| 73 | DSM | TTCL room | OADM | 1 | | | |
| 74 | Rusumo | TTCL room | TM | | | 1 | |
| 75 | Mutukala | New | TM | | | 1 | |
| 76 | Sirari | New | TM | | | 1 | |
| 77 | Namanga | TTCL room | TM | | | 1 | |
| 78 | Horohoro | New | TM | | | 1 | |
| 79 | Kasumulo | New | TM | | | 1 | |
| 80 | Manyovu | New | TM | | | 1 | |
| 81 | Kabanga | New | TM | | | 1 | |
| 82 | Total | | | 20 | 22 | 39 | |

### 3.4.3 Power Supply Supervision System

All power supply equipments need to be supervised remotely from the central monitoring station. Under this project, alarm signals of different power equipment (solar batteries, rectifiers, batteries and so on) and other house keeping alarm signals will be relayed to the maintenance centre through supervision system for monitoring purpose.

### 3.4.4 Construction of OFC Duct System

#### a) Requirement of Ductwork Routes

(i) Duct routes should avoid to be constructed along temporary road, along roads under construction, or along soft (non-compacted) road.

(ii) Duct pipes should be constructed away from contaminated canal with erosive chemicals.

(iii) Clear streets with few barriers (underground and above ground) could be the better choice for the construction.

(iv) Precautions should be made when constructing duct routes on the same side of the road with combustible gas-pipes and high voltage power lines, and if that can not be avoided then they should keep a fair distance with one another.

#### b) Locations of Ductwork Routes

(i) The ductwork systems should be constructed within pavement of town streets, and if it is impossible for them to be constructed within the pavement, they may be put under the slow driveway and not under the fast driveway.

(ii) If ductworks are done along highways, then ducts should be constructed within the isolation zone.

(iii) The center line along pipes routes should be parallel with the center line of roads.

(iv) Communication duct pipes lines should not be constructed near each other, if necessitate be in same route then they should be separated by reasonable difference in depth.

## 3.5 Estimation of Investment Cost

### 3.5.1 Explanation of BOQ

This BOQ is prepared based on data collected from different institutions and data obtained during preliminary survey carried out by the joint team of Tanzania and CITCC.
The price provided in the BOQ CIP based. The BOQ includes OFC materials, transmission equipment, and project services.

The estimated costs for main equipment & materials and services are based on China industry of purchase, transportations and project implementations cost. Not accounted for in the cost schedules are:

a) Customs taxes for imported goods and customs clearance fee.
b) Taxes applicable to foreign contractor i.e withholding taxes, neither taxes applicable to local contractors i.e VAT, etc
c) The expenses to be incurred for connecting to the EASSy OFC line

### 3.5.2 BOQ and Price Schedules

The Summary of project prices is provided in Table 3.5-1 below. The detailed BOQ schedules are given in Appendix B.

**Table 3.5-1: Summary of BOQ**

| No. | Description | Cost of Eq. & Materials (USD) | Cost of Service (USD) | Sub total (USD) |
|---|---|---|---|---|
| 1 | Optical Fiber Cable Installation | 34,835,348.91 | 71,632,310.00 | 106,467,658.91 |
| 2 | Transmission Equipment Installation | 23,696,035.00 | 12,046,100.00 | 35,742,135.00 |
| 3 | Power Supply System Installation | 9,266,913.00 | 2,988,150.00 | 12,255,063.00 |
| 4 | Civil Work And Others | | | 15,067,000.00 |
| **5** | **Grand Total (USD)** | **67,798,296.91** | **86,666,560.00** | **169,531,856.91** |

### 3.6 Proposed Implementation Schedule

This project is proposed for implementation in two logical stages done simultaneously for the formation of fully functioning OFC backbone network. The total period for the whole project is 24 months from the confirmation of funding.

**Logical Stage 1:**

Stage One will involve construction of major sections of Northern, Central and Southern Routes. The details are shown in Table 3.6-1 and Table 3.6-2 below and Appendix A (4) at the end of the report.

**Logical Stage 2:**

Stage Two will involve closing the Southern and Western OFC rings and shall cover routes in Tables 3.6-3 & Table 3.6-4 and drawing No.5 of the Appendix A (5) in the end of the report.

**Table 3.6-1: Routes Details for Logical Stage One**

| | |
|---|---|
| Northern Routes | DSM-HALE-TANGA-HOROHORO,TANGA-HALE-MOSHI-ARUSHA-NAMANGA,ARUSHA-BABATI-MUSOMA-SIRALI, MUSOMA-MWANZA-BIHALAMULO-BUKOBA-MUTUKALA,BIHALAMULO-MURUGARAMA-RUSUMO, MURUGARAMA-KABANGA |
| Central Routes | DSM-MOROGORO-DODOMA-SINGIDA-SHINYANGA-MWANZA |
| Southern Routes | DODOMA-IRINGA-MBEYA-TUNDUMA,MBEYA-KASUMULO |

**Table 3.6-2: Implementation Schedule of Logical Stage One**

| Phase One Project | (Months) | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Phase One | OFC Line | Km | 3840 | | | | | | | | | | | | | | | | | | | | | | | | |
| | Trans. Equip. & Power Supply | station | 46 | | | | | | | | | | | | | | | | | | | | | | | | |

| Detailed Survey & Design | Approval | Manufacture & Delivery | Factory check | Prepara-tion | CONSTRUCTION | ACCEPTANCE |
|---|---|---|---|---|---|---|

**Table 3.6-3: OFC Routes in Logical Stage Two**

| | |
|---|---|
| Southern Routes | DSM-Lindi- Mtwara- Songea- Mbeya |
| S-Western Routes | Biharamulo - Kigoma - Tabora - Sumbawanga - TUNDUMA |

**Table 3.6-4: Implementation Schedule for Logical Stage Two**

| Phase Two (Months) | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Phase Two | OFC Line | Km | 3157 | | | | | | | | | | | | | | | | | | | | | | | | |
| | Equip. & Power | station | 35 | | | | | | | | | | | | | | | | | | | | | | | | |

| Detailed Survey & Design | Approval | Manufacture & Delivery | Factory check | Prepara-tion | CONSTRUCTION | ACCEPTANCE |
|---|---|---|---|---|---|---|

# 4 CONCLUSION AND RECOMMENDATIONS

By considering the status of the existing national OFC networks and other required resources, the Steering Committee has determined that practical implementation of the National Backbone network is highly feasible. It is seen possible to achieve a fully fledged, bandwidth rich national OFC network in the country by consolidating some segments of the existing individual OFC networks belonging to the public institutions (TANESCO, TRC, TAZARA, and SONGAS) and bridging the gaps to form the unified National OFC backbone infrastructure. The national OFC backbone will be built on three main Optic Fibre Cable (OFC) rings namely, the Northern ring, the Western ring and the Southern ring.

In the initial design of the backbone network, use of the latest bandwidth-rich transmission technologies such as Dense Wavelength Division Multiplexing (DWDM) and Synchronous Digital Hierarchy (SDH) have been proposed in order to guarantee ubiquitous capacity, quality performance and unconstrained bandwidth for future use. This national OFC backbone would form a "Carrier of Carriers" network providing bandwidth capacity to all ICT service providers (fixed, mobile, voice, data, audio/ video broadcasting, multimedia) including the Public Services Telecommunications Network (PSTN) operators. The backbone network would support provision of Universal ICT Services Access to the whole country by various service providers, competitively, in technology neutral environment and providing various ICT services.

The total cost of the National ICT OFC backbone project is estimated at **US$ 170m** of which US$ 107m are required for the Optic Fibre Cable portion, US$ 36m for provision of transmission equipment, US$ 12m for power supply equipment and US$ 15m for civil and other related works. The project can be implemented and completed within 24months period from funding confirmation.

Based on these avails, Steering Committee have the following recommendations to the Government of Tanzania:

(1) to consider and approve this report;

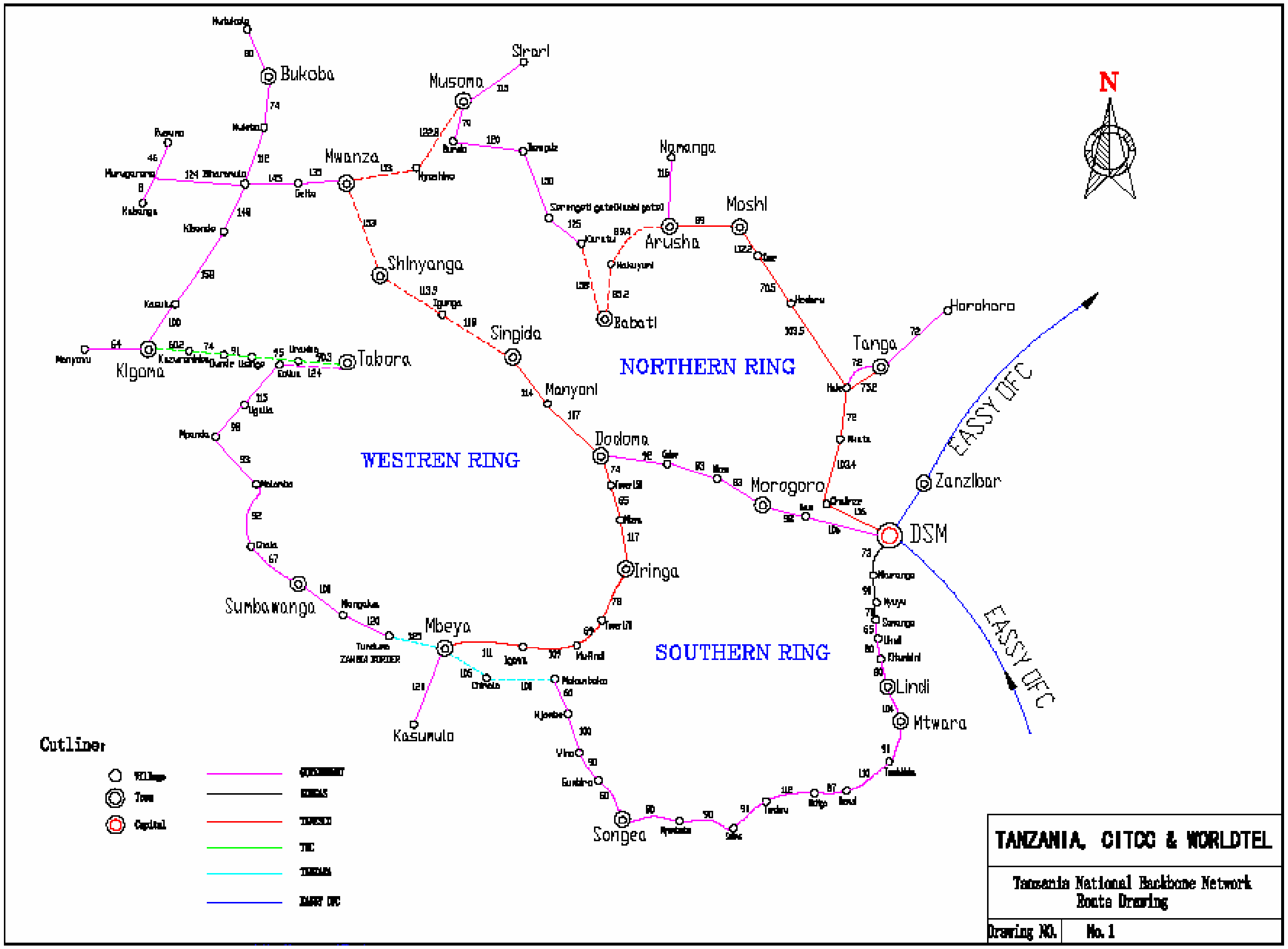
(2) to facilitate availability of the necessary funds and other resources for immediate implementation of the National ICT Backbone Network; and

(3) To determine and mandate sustainable institutional arrangements for management, operation and maintenance of the National OFC Backbone network.

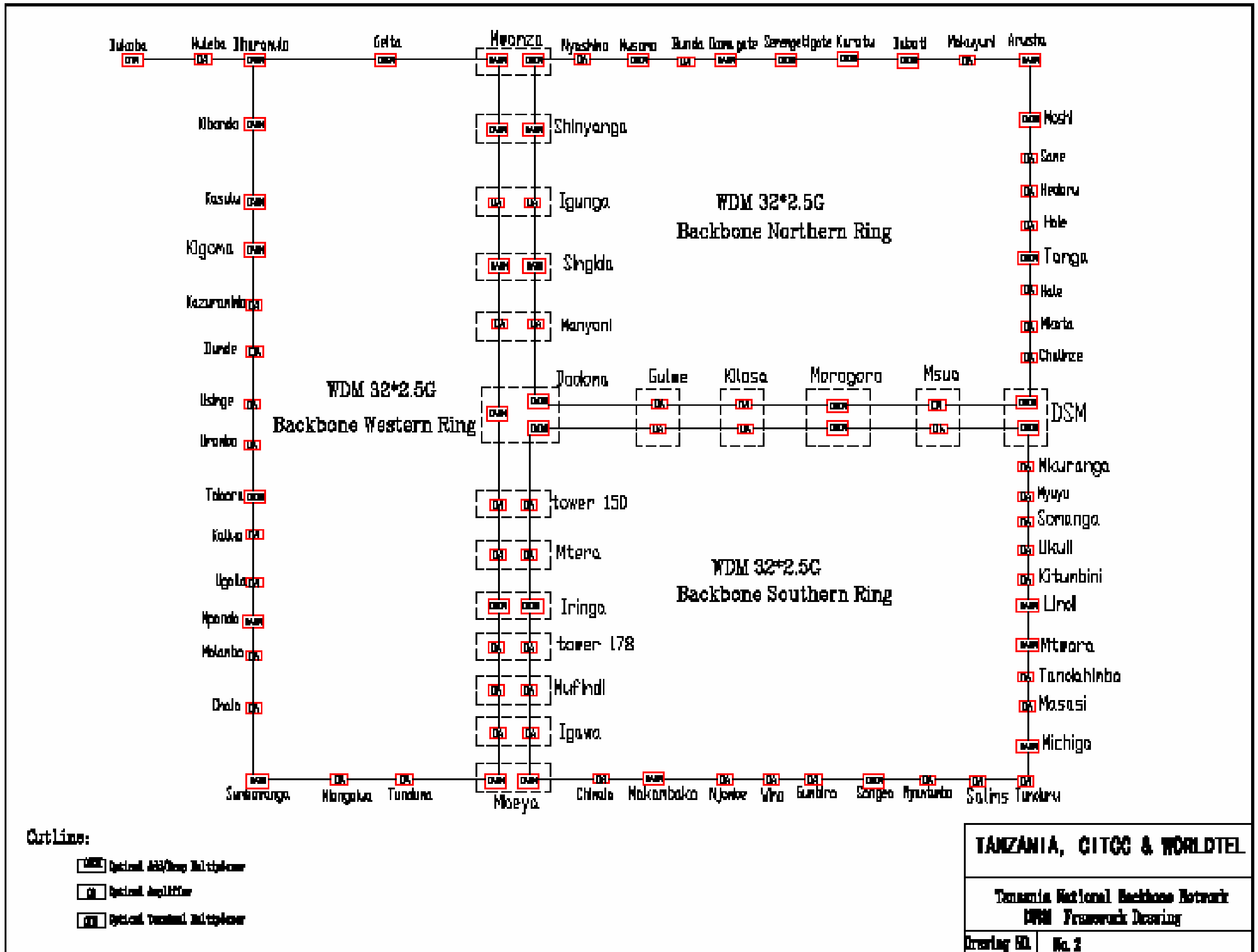
# 5 APPENDICES

## Appendix A: Network Drawings:

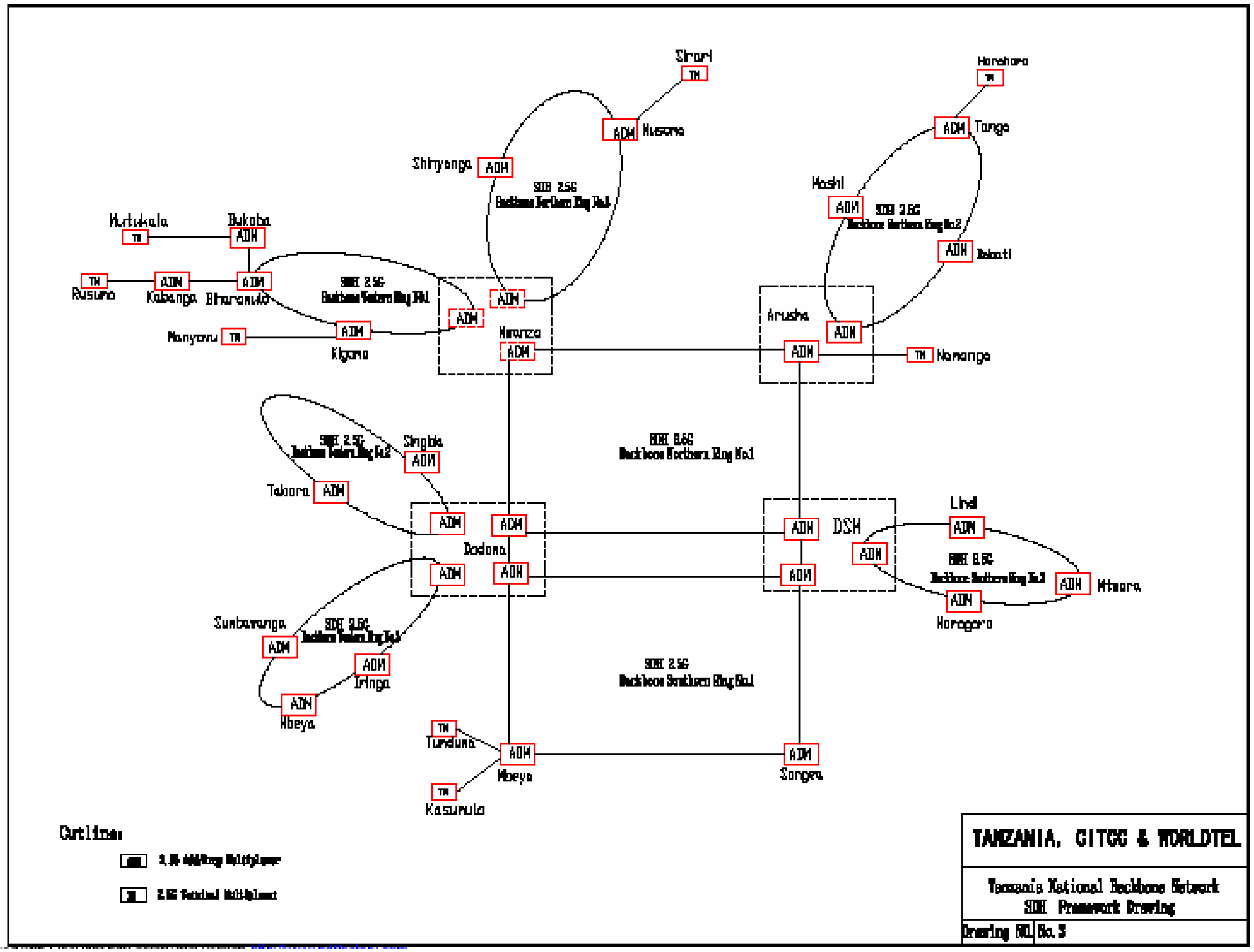
1. Drawing No.1 --- Tanzania National Backbone Routes



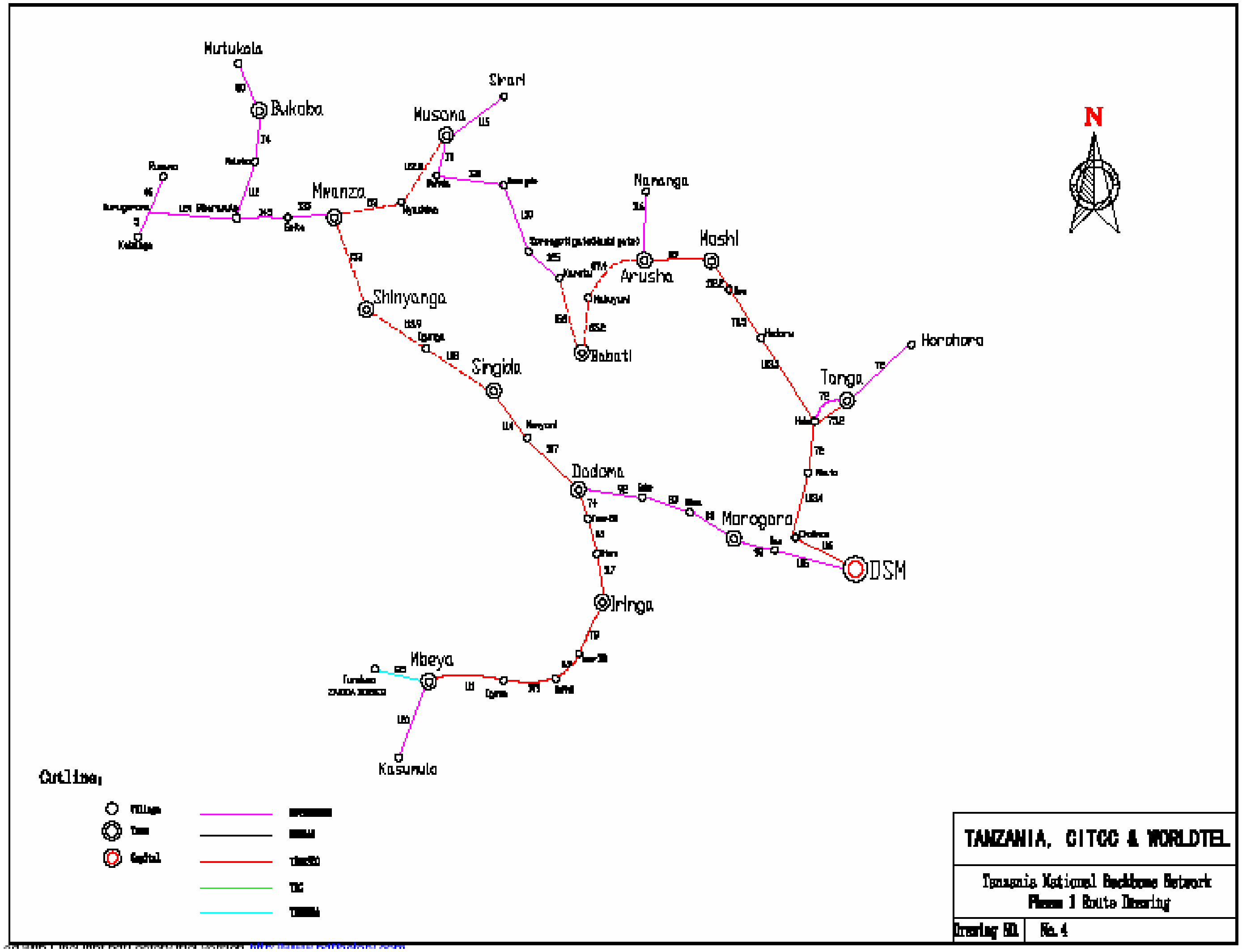
2. Drawing No.2 --- Tanzania National Backbone Network DWDM Layer



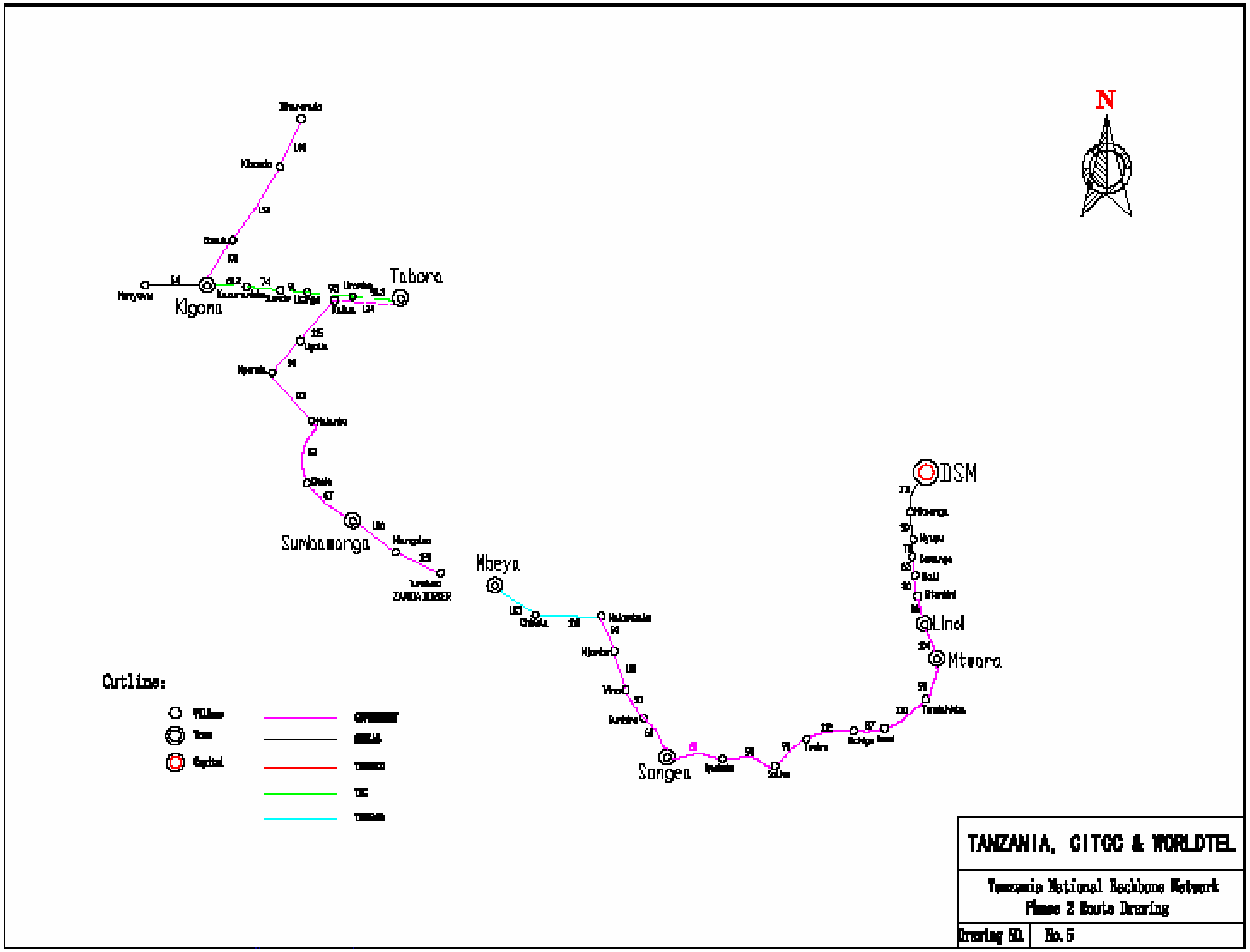
3. Drawing No.3 --- Tanzania National Backbone Network SDH Layer



4. Drawing No.4 --- Tanzania National Backbone Network - Stage 1 Implementation



5. Drawing No.5 --- Tanzania National Backbone Network - Stage 2 Implementation



## Appendix B: Schedules of Bill of Quantities

### Summary of BOQ

### OFC Network Project in Tanzania

| No. | Description | Cost of Eq. & Materials (USD) | Cost of Service (USD) | Sub total (USD) |
|---|---|---|---|---|
| 1 | **Optical Fiber Cable Installation** | **34,835,348.91** | **71,632,310.00** | **106,467,658.91** |
| 2 | **Transmission Equipment Installation** | **23,696,035.00** | **12,046,100.00** | **35,742,135.00** |
| 3 | **Power Supply System Installation** | **9,266,913.00** | **2,988,150.00** | **12,255,063.00** |
| 4 | **Civil Work And Others** | | | **15,067,000.00** |
| 5 | **Grand Total (USD)** | **67,798,296.91** | **86,666,560.00** | **169,531,856.91** |

## Detailed Summary For OFC of BOQ

| No. | Description | Unit | Qty. | Unit Price of Eq. & Materials (USD) | Cost of Eq. & Materials (USD) | Unit Price of Service (USD) | Cost of Service (USD) | Sub total (USD) |
|---|---|---|---|---|---|---|---|---|
| | **Optical Fiber Cable Project Newly Build** | | | | | | | |
| 1 | HDPE(Φ40/33mm) constrution(2way) | km | 160 | 16,400 | 2, 624, 000 | 14,800 | 2, 368, 000 | 4, 992, 000 |
| 2 | Buried Optical Fiber Cable(48D) | km | 2, 513 | 2, 200 | 5, 528, 600 | 10, 150 | 25, 506, 950 | 31, 035, 550 |
| 3 | Buried Optical Fiber Cable(24) | km | 849 | 1, 969 | 1, 671, 681 | 9, 950 | 8, 447, 550 | 10, 119, 231 |
| 4 | Underwater Optical Fiber Cable(48D) | km | 5 | 15, 000 | 75, 000 | 20, 000 | 100, 000 | 175, 000 |
| 5 | Duct Optical Fiber Cable(48D) | km | 140 | 2, 020 | 282, 744 | 2, 900 | 406, 000 | 688, 744 |
| 6 | Duct Optical Fiber Cable(24D) | km | 20 | 1, 627 | 32, 538 | 2, 800 | 56, 000 | 88, 538 |
| 9 | Jointing Closure(24D) | pcs | 290 | 220 | 63, 800 | 1, 350 | 391, 500 | 455, 300 |
| 10 | Jointing Closure(48D) | pcs | 885 | 250 | 221, 250 | 2, 600 | 2, 301, 000 | 2, 522, 250 |
| 12 | ODF | set | 110 | 3, 750 | 412, 500 | 4, 860 | 534, 600 | 947, 100 |
| 13 | Protection Pipe and other Materials | km | 3, 362 | 600 | 2, 017, 200 | 180 | 605, 160 | 2, 622, 360 |
| | | | | | | | | |
| **14** | **Sub total 1 (USD)** | | | | 12, 929, 313 | | 40, 716, 760 | 53, 646, 073 |
| | | | | | | | | |
| 15 | Factory Inspection of OFC and Terminal Box | 1 persons in 2 | 8 | – | – | 5, 000 | 40, 000 | 40, 000 |

| No. | Description | Unit | Qty. | Unit Price of Eq. & Materials (USD) | Cost of Eq. & Materials (USD) | Unit Price of Service (USD) | Cost of Service (USD) | Sub total (USD) |
|---|---|---|---|---|---|---|---|---|
| | | weeks | | | | | | |
| 16 | Training | 1 persons in 3 weeks | 20 | – | – | 6, 000 | 120, 000 | 120, 000 |
| 17 | OFC and Jointing Closure for maintenance (5%) | lot | 1 | 414, 406 | 414, 406 | | | 414, 406 |
| | | | | | | | | |
| **18** | **Sub total 2 (USD)** | | | | 414, 406 | | 160, 000 | 574, 406 |
| | | | | | | | | |
| 19 | Maintenance Instruments | | | | | | | |
| 20 | OTDR | set | 8 | 23, 000 | 184, 000 | | | 184, 000 |
| 21 | Splicing Machine | set | 8 | 18, 000 | 144, 000 | | | 144, 000 |
| 22 | Optical Phone | set | 8 | 6, 200 | 49, 600 | | | 49, 600 |
| 23 | Optical Source and Optical Power Meter | set | 8 | 9, 000 | 72, 000 | | | 72, 000 |
| | | | | | | | | |
| **24** | **Sub total 3 (USD)** | | | | 449, 600 | | | 449, 600 |
| | | | | | | | | |
| **25** | **Sub total 4 (Sub total 1 + 2 + 3) (USD)** | | | | 13, 793, 319 | | 40, 876, 760 | 54, 670, 079 |
| | | | | | | | | |
| | **Optical Fiber Cable Project Re-Build** | | | | | | | |
| 26 | Buried Optical Fiber Cable(48D) | km | | | 4, 488, 000 | | 20, 706, 000 | |

| No. | Description | Unit | Qty. | Unit Price of Eq. & Materials (USD) | Cost of Eq. & Materials (USD) | Unit Price of Service (USD) | Cost of Service (USD) | Sub total (USD) |
|---|---|---|---|---|---|---|---|---|
| | | | 2, 040 | 2, 200 | | 10, 150 | | 25, 194, 000 |
| 27 | Buried Optical Fiber Cable(24) | km | 30 | 1, 969 | 59, 070 | 9, 950 | 298, 500 | 357, 570 |
| 28 | Duct Optical Fiber Cable(48D) | km | 98 | 2, 020 | 197, 921 | 2, 900 | 284, 200 | 482, 121 |
| 29 | Duct Optical Fiber Cable(24D) | km | 16 | 1, 627 | 26, 030 | 2, 800 | 44, 800 | 70, 830 |
| 30 | ADSS or OPGW Optical Fiber Cable(48D) | km | 1, 292 | 10, 230 | 13, 217, 160 | 4, 400 | 5, 684, 800 | 18, 901, 960 |
| 31 | Jointing Closure(24D) | pcs | 15 | 220 | 3, 300 | 1, 350 | 20, 250 | 23, 550 |
| 32 | Jointing Closure(48D) | pcs | 1, 150 | 250 | 287, 500 | 2, 600 | 2, 990, 000 | 3, 277, 500 |
| 33 | ODF | set | 40 | 3, 750 | 150, 000 | 4, 860 | 194, 400 | 344, 400 |
| 34 | Protection Pipe and other Materials | km | 2, 070 | 600 | 1, 242, 000 | 180 | 372, 600 | 1, 614, 600 |
| | | | | | | | | |
| 35 | Sub total 5 (USD) | | | | 19, 670, 981 | | 30, 595, 550 | 50, 266, 531 |
| | | | | | | | | |
| 36 | Factory Inspection of OFC and Terminal Box | 1 persons in 2 weeks | 8 | – | – | 5, 000 | 40, 000 | 40, 000 |
| 37 | Training | 1 persons in 3 weeks | 20 | – | – | 6, 000 | 120, 000 | 120, 000 |
| 38 | OFC and Jointing Closure for maintenance | lot | 1 | 921, 449 | 921, 449 | | | 921, 449 |

| No. | Description | Unit | Qty. | Unit Price of Eq. & Materials (USD) | Cost of Eq. & Materials (USD) | Unit Price of Service (USD) | Cost of Service (USD) | Sub total (USD) |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| 39 | Sub total 6 (USD) | | | | 921, 449 | | 160, 000 | 1, 081, 449 |
| | | | | | | | | |
| 40 | Maintenance Instruments | | | | | | | |
| 41 | OTDR | set | 8 | 23, 000 | 184, 000 | | | 184, 000 |
| 42 | Splicing Machine | set | 8 | 18, 000 | 144, 000 | | | 144, 000 |
| 43 | Optical Phone | set | 8 | 6, 200 | 49, 600 | | | 49, 600 |
| 44 | Optical Source and Optical Power Meter | set | 8 | 9, 000 | 72, 000 | | | 72, 000 |
| | | | | | | | | |
| 45 | Sub total 7 (USD) | | | | 449, 600 | | | 449, 600 |
| | | | | | | | | |
| 46 | Sub total 8 (Sub total 5 + 6 + 7) (USD) | | | | 21, 042, 030 | | 30, 755, 550 | 51, 797, 580 |
| | | | | | | | | |
| | | | | | | | | |
| 47 | **Grand total (USD)** | | | | 34, 835, 349 | | 71, 632, 310 | 106, 467, 659 |

Note1: The newly-built part of the OFC backbone includes parts which have not been planned by any operators, international links and HDPE duct lines in the urban areas.

Note 2: The rebuilt parts of the OFC backbone consist of planned lines (but no funding available) and leading-in lines (tie links).

# Detailed Summary for Transmission Equipment of BOQ

| No. | Description | Unit | Qty. | Unit Price of Eq. & Materials (USD) | Cost of Eq. & Materials (USD) | Unit Price of Service (USD) | Cost of Service (USD) | Sub total (USD) |
|---|---|---|---|---|---|---|---|---|
| | **Optical Fibre Transmission Equipment With Accessories** | | | | | | | |
| 26 | SDH 2.5Gb/s ADM | set | 31 | 74, 500 | 2, 309, 500 | 40, 500 | 1, 255, 500 | 3, 565, 000 |
| 27 | SDH 2.5Gb/s TM | set | 8 | 65, 600 | 524, 800 | 35, 700 | 285, 600 | 810, 400 |
| 28 | DWDM OADM | set | 38 | 328, 000 | 12, 464, 000 | 192, 300 | 7, 307, 400 | 19, 771, 400 |
| 29 | DWDM OA | set | 54 | 72, 000 | 3, 888, 000 | 40, 000 | 2, 160, 000 | 6, 048, 000 |
| 30 | DWDM OTM | set | 1 | 149, 000 | 149, 000 | 84, 200 | 84, 200 | 233, 200 |
| 31 | Element Management System（EMS） | set | 2 | 60, 300 | 120, 600 | 34, 100 | 68, 200 | 188, 800 |
| 32 | Sub-network Management System（SNM） | set | 2 | 96, 400 | 192, 800 | 54, 500 | 109, 000 | 301, 800 |
| 33 | Lcoal Craft Terminal(LCT) | station | 20 | 14, 500 | 290, 000 | 8, 200 | 164, 000 | 454, 000 |
| 34 | DDF with Cable&Connectors | lot | 73 | 3, 550 | 259, 150 | 1, 400 | 102, 200 | 361, 350 |
| | | | | | | | | |
| 35 | Sub total 1 (USD) | | | | 20, 197, 850 | | 11, 536, 100 | 31, 733, 950 |
| | | | | | | | | |
| 36 | Factory Inspection | 1 persons in 2 | 6. 00 | | | 5, 000 | 30, 000 | 30, 000 |

| No. | Description | Unit | Qty. | Unit Price of Eq. & Materials (USD) | Cost of Eq. & Materials (USD) | Unit Price of Service (USD) | Cost of Service (USD) | Sub total (USD) |
|---|---|---|---|---|---|---|---|---|
| | | weeks | | | | | | |
| 37 | Training | 1 persons in 4 weeks | 48. 00 | | | 10, 000 | 480, 000 | 480, 000 |
| 38 | Spare Parts(Cost of Eq.x10%) | lot | 1 | 2, 019, 785 | 2, 019, 785 | | | 2, 019, 785 |
| | | | | | | | | |
| 39 | Sub total 2 (USD) | | | | 2, 019, 785 | | 510, 000 | 2, 529, 785 |
| | | | | | | | | |
| 40 | Maintenance Instruments | | | | | | | |
| 41 | Multi-Wave Length Anylazer | set | 2 | 50, 000 | 100, 000 | | | 100, 000 |
| 42 | Spectrum Anylazer | set | 2 | 35, 000 | 70, 000 | | | 70, 000 |
| 43 | 2.5Gb/s Anylazer | set | 2 | 241, 000 | 482, 000 | | | 482, 000 |
| 44 | 155Mb/s Anylazer | set | 20 | 36, 200 | 724, 000 | | | |
| 45 | Optical Power Meter | set | 20 | 1, 500 | 30, 000 | | | |
| 46 | 2Mb/s Error Code Detector | set | 20 | 3, 620 | 72, 400 | | | |
| | | | | | | | | |
| 47 | Sub total 3 (USD) | | | | 1, 478, 400 | | | 1, 478, 400 |
| | | | | | | | | |
| 48 | **Grand total (Sub total 1 + 2 + 3) (USD)** | | | | 23, 696, 035 | | 12, 046, 100 | 35, 742, 135 |

# Detailed Summary for Power Supply Equipment of BOQ

| No. | Description | Unit | Qty. | Unit Price of Eq. & Materials (USD) | Cost of Eq. & Materials (USD) | Unit Price of Service (USD) | Cost of Service (USD) | Sub total (USD) |
|---|---|---|---|---|---|---|---|---|
| | **Power Supply System Equipment** | | | | | | | |
| 1 | 1).Solar Power Station | | | | | | | |
| 2 | Rectifier | set | 39 | 9, 960 | 388, 440 | 7, 000 | 273, 000 | 661, 440 |
| 3 | Batteries | group | 78 | 11, 000 | 858, 000 | 5, 500 | 429, 000 | 1, 287, 000 |
| 4 | Solar Battery & Controller | set | 39 | 82, 500 | 3, 217, 500 | 15, 000 | 585, 000 | 3, 802, 500 |
| 5 | Generators | set | 39 | 45, 000 | 1, 755, 000 | 9, 000 | 351, 000 | 2, 106, 000 |
| 6 | Power Supply System Distrbution Panel | pcs | 39 | 400 | 15, 600 | 250 | 9, 750 | 25, 350 |
| 7 | Surge Protection | pcs | 39 | 1, 500 | 58, 500 | 500 | 19, 500 | 78, 000 |
| 8 | Grounding System | station | 39 | 2, 500 | 97, 500 | 3, 500 | 136, 500 | 234, 000 |
| 9 | Spare Parts | lot | 1 | 22, 929 | 22, 929 | | | 22, 929 |
| 10 | 2）.Commercial Power Station | | | | | | | |
| 11 | Rectifier | set | 42 | 9, 960 | 418, 320 | 7, 000 | 294, 000 | 712, 320 |
| 12 | Batteries | group | 84 | 11, 000 | 924, 000 | 5, 500 | 462, 000 | 1, 386, 000 |
| 13 | Generators | set | 22 | 45, 000 | 990, 000 | 9, 000 | 198, 000 | 1, 188, 000 |
| 14 | Air Conditioner | set | 22 | 3, 800 | 83, 600 | 800 | 17, 600 | 101, 200 |
| 15 | Power Supply System Distribution Panel | pcs | 42 | 400 | 16, 800 | 250 | 10, 500 | 27, 300 |
| 16 | Surge Protection | pcs | 22 | 1, 500 | 33, 000 | 500 | 11, 000 | 44, 000 |
| 17 | Grounding System | station | 22 | 2, 500 | 55, 000 | 3, 500 | 77, 000 | 132, 000 |
| 18 | Spare Parts | lot | 1 | 11, 124 | 11, 124 | | | 11, 124 |
| 19 | 3). Power network management | set | 2 | 15, 000 | 30, 000 | 12, 000 | 24, 000 | 54, 000 |
| 20 | 4). installation materials | station | 81 | 2, 600 | 210, 600 | 300 | 24, 300 | 234, 900 |
| | | | | | | | | |
| 21 | Sub total 1 (USD) | | | | 9, 185, 913 | | 2, 922, 150 | 12, 108, 063 |
| | | | | | | | | |

| No. | Description | Unit | Qty. | Unit Price of Eq. & Materials (USD) | Cost of Eq. & Materials (USD) | Unit Price of Service (USD) | Cost of Service (USD) | Sub total (USD) |
|---|---|---|---|---|---|---|---|---|
| 22 | Factory Inspection | 1 persons in 1 week | 4. 00 | | | 4, 000 | 16, 000 | 16, 000 |
| 23 | Training | 1 persons in 2 weeks | 10. 00 | | | 5, 000 | 50, 000 | 50, 000 |
| | | | | | | | | |
| 24 | Sub total 2 (USD) | | | | | | 66, 000 | 66, 000 |
| 25 | Maintenance Tools | station | 81 | 1, 000 | 81, 000 | | | 81, 000 |
| | | | | | | | | |
| 26 | Sub total 3 (USD) | | | | 81, 000 | | | 81, 000 |
| | | | | | | | | |
| 27 | **Grand total (Sub total 1 + 2 + 3) (USD)** | | | | 9, 266, 913 | | 2, 988, 150 | 12, 255, 063 |

## Detailed Summary for Civil Work and Others of BOQ

| No. | Description | Unit | Qty. | Unit Price (USD) | Sub total (USD) |
|---|---|---|---|---|---|
| | **Civil Work and Others** | | | | |
| 1 | Newly Build For Equipment Room(Container) | station | 34 | 25000.00 | 850,000.00 |
| 2 | Rebuild For Equipment Room | station | 73 | 1000.00 | 73,000.00 |
| 3 | Compensation For OFC Project | km | 6997 | 2000.00 | 13,994,000.00 |
| 4 | The Connection Of Commercial Electricity And Transformer Installation | station | 10 | 15000.00 | 150,000.00 |
| | **Grand Total (USD)** | | | | 15,067,000.00 |

## Appendix C: Members of the Steering Committee

| | | | |
|---|---|---|---|
| 1. | Salim H. Msoma | MoCT | Chairman |
| 2. | Eng. E. OleKambainei | MoCT | Moderator |
| 3. | Eng. A.B. Kowero | MoCT | Member |
| 4. | Ali A Mufuruki | IRT/ WG | Member |
| 5. | A. S. Mbeo | TUT | Member |
| 6. | Mohamed Mussa | ZANTEL | Member |
| 7. | Sunil Vedd | SONGAS | Member |
| 8. | Col. A. N. Nalingigwa | MoDANS | Member |
| 9. | Peter Ngota | TTCL | Member |
| 10. | Prof. J. S. Nkoma | TCRA | Member |
| 11. | Suhail Sherrif | TISPA | Member |
| 12. | Benhadard M. Tito | TRC | Member |
| 13. | Mr. L. A. Gewe | TPC | Member |
| 13. | Mr. O. Mzee | UNDP | Member |
| 14. | Pearson Lubumbe | TAZARA | Member |
| 15. | Dr. J. S. Kilongola (DICT) | TCRA | Member |
| 16. | M. Kamulika | MoCT | Member |
| 17. | Samson Mwela | MoCT | Member |
| **19.** | Eng. J. Kilaba | TCRA | Member |
| 20 | Eng. M. A. Saleh | TANESCO | Member |
| 21 | Mr. F. Tabaro | MOAT | Member |

## Appendix D: Members of the Technical Working Group

| | | | |
|---|---|---|---|
| 1. | Eng. E. N. Ole-Kambainei | MoCT | Co-ordinator |
| 2. | Eng. A.B. Kowero | MoCT | Chairman |
| 3 | Eng. J. Kilaba | TCRA | Member |
| 4. | Eng. M. S. Madulu | TANESCO | Co-opted Member |
| 5. | Eng. E. Nagunwa | TTCL | Member |
| 6. | Suhail Sherrif | TISPA | Member |
| 7. | Maj. Y.H. Mohamed | MoDNS | Co-opted Member |
| 8. | Mr. L. A. Gewe | TPC | Co-opted Member |
| 9. | Eng. C. Nkwabi | TAZARA | Member |
| 10. | Mr. M. Kamulika | MoCT | Secretariat |
| 11. | Eng. E. Obeid | TANESCO | Co-opted Member |
| 12. | Eng. A. S. Mbeo | TUT | Member |
| 13. | Eng. L. Hemela | TTCL | Co-opted Member |
| 14. | Mr. Li Hui | CITCC | Member |
| 15. | Mr. Gao Xingping | CITCC | Member |
| 16. | Qu xin | CITCC | Member |
| 17. | Yin wei Xing | CITCC | Member |
| 18. | Ye jianjun | CITCC | Member |
| 19. | Tang XiaoHao | CITCC | Member |
| 20. | Shen Wangping | CITCC | Member |

## Appendix E: Members of Survey Teams

**Northern Group:**

| | | | |
|---|---|---|---|
| 1. | Maj. Y. Mohamed | MoDANS | Group Leader (local) |
| 2. | Eng. Emmanuel Nagunwa | TTCL | Member |
| 3. | Eng. Obedi Elirehema | TANESCO | Member |
| 4. | Shen Wangping | CITCC | Member |
| 5. | Mr. Li Hui | CITCC | Member |
| 6. | Mr. Gao Xingping | CITCC | Group Leader (CITCC) |

**Southern Group:**

| | | | |
|---|---|---|---|
| 1. | Shija Madulu | TANESCO | Group Leader (local) |
| 2. | Eng. Leonard Hemela | TTCL | Member |
| 3. | Eng. C. Nkwabi | TAZARA | Member |
| 4. | Ye jianjun | CITCC | Group Leader (CITCC) |
| 5. | Qu xin | CITCC | Member |

## Appendix F: Members of the Report Drafting Group

| | | | |
|---|---|---|---|
| 1. | Eng. Emmanuel Nagunwa | TTCL | Coordinator |
| 2. | Eng. James M. Kilaba | TCRA | Member |
| 3. | Eng. Elirehema Obedi | TANESCO | Member |
| 4. | Mr. Masegese Kamulika | MoCT | Secretariat |
| 5. | Ye jianjun | CITCC | Member |
| 6. | Qu xin | CITCC | Member |
| 7. | Mr. Gao Xingping | CITCC | Member |
| 8. | Mr. Li Hui | CITCC | Member |
| 9. | Shen Wangping | CITCC | Interpreter |

## Appendix G: Report on Status of the National ICT Backbone Infrastructure