Masterplan for Telecommunications 1994

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Masterplan for Telecommunications

Development in TREDA

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INTRODUCTION
TELECOMMUNICATIONS AND ECONOMIC DEVELOPMENT
At the end of the 20th century most economic activities have acquired a global dimension.
Telecommunications play an increasingly important role in optimizing those activities.

The role of telecommunications is visible in the classic fields of activity (agriculture, manufacturing) where they have a supporting role of increasing importance (e.g. Just-in-time delivery). Especially in the development of the tertiary sector, the so-called service industries, their role is crucial. In this field, telecommunications can be considered as the transportation system allowing the routing of the raw material (information) between producers and consumers of this information. Modern networks, with their increasing basis of intelligent subsystems, contribute in adding value to the information.

For a global quantification of this importance, reference can be made to the developments in the European Community. Here, an extensive process of community-wide sector restructuring was initiated to optimize the supply of telecommunications services on the basic assumption that in the first decades of the 21st century, 10-20% of combined GDP would be directly linked to the use of telecommunications services.

It is clear that the development of TREDA, which wants to attract foreign investors on a large scale, cannot neglect these considerations.The development of up to date facilities within the region and the global interconnection with other centres of economic activities is a priority. This masterplan addresses the technical issues related to this development.

Telecommunications can also be used to provide a competitive edge to information intensive users that would locate within the area by the creation of a specially designed regulatory environment.

In the specific context of telecommunications, TREDA can obtain a competitive advantage in regard to other zones. This potential advantage stems from 3 factors:

- the proximity of the global high capacity cable system connecting major economic centres throughout the world;
- the low penetration of telecommunications services in the area under consideration, allowing the newest technologies to be brought in under innovative tariff structures;
- the presence of technical knowledge permitting rapid deployment.

As well as providing a technical blueprint, enabling this development, this document also addresses the non technical issues which are pertinent to this vision. Measures are proposed that intend to create a business environment encouraging the commercial development of telecommunication facilities and services. Even

more important is
the intention to provide those services to the end users under a system of cost based tariffs.
As a consequence TREDA could provide a major interest for global companies active in the
services sector. The combination of high tech facilities, cost-based tariffs, well trained staff and
moderate wage levels, can be the basis for the development of service sector activities with
high added value in TREDA.
Proposals in this field of regulatory issues will be made to organize the supply of teleco-
mmunications services along the following lines:

- supply of services by large operators, allowing scale advantages to be obtained;
- supply of those services under a tariff system based on economic cost, avoiding cross
subsidies between user groups;
- creation of a dynamic environment encouraging the development and the use of the
most recent technologies.

This document first addresses the technical development issues and then covers various
regulatory aspects of telecommunications.

A TECHNICAL BLUEPRINT

OBJECTIVES

The objective of this document is to provide a technical blueprint for equipping TREDA with
adequate facilities supporting economic development.
Rather than proposing a new network isolated from existing facilities, the emphasis of this
blueprint will be on coordinating the approach of the individual TREDA countries. The following
observations support this approach.

- Although TREDA will certainly attract foreign investment from non riparian countries, it
is to be expected that, even in the initial phases, relations with the surrounding regions
will also develop. The riparian countries will not only be taking part in this investment
but will of course be the main suppliers of workforce and can be expected to deliver an
important share of the raw materials, the energy and an increasing part of subcon-
tracted services of all kinds. Telecommunication systems should follow an architecture
supporting a development of those relations right from the beginning.
- At this stage TREDA is only in part covered by telecommunications networks and part
of this coverage is provided by outdated equipment which has to be replaced.

Each of the riparian countries however, has one, or, in the case of the Russian Federation, a number of competing, telecommunications development plans, directly relevant to TREDA. Especially in the People's Republic of China, implementation of those plans is impressive and continuing at a fast pace.

The provision of long distance inter-connectivity of TREDA, within the riparian countries as well as on an international scale, can to a large degree use links and equipment which are presently available or on order, and on which spare capacity is available.

Although the costs of telecommunications are low compared to other types of infra-structure, they are not insignificant. If commercial investors should finance part of the development, a sound business plan must be provided. In this respect it is important to note that the development of TREDA will probably be investment driven and far larger than can be expected on basis of existing activities developing normally. Telecomm-unications equipment, which by nature should be in place before other investors will come to the region, will be a high risk investment.

Connecting TREDA to existing networks will decrease this risk and postpone large scale investments to a stage where a better view is available on the development of TREDA and the investment risk is correspondingly lower.

The emphasis of the present plan is on improving the interconnection between TREDA and other regions. A detailed and comprehensive proposal regarding the size, technology and placing of the nodes of the local networks is postponed until a more detailed view on location and type of zones of economic activity in TREDA is available. A preliminary approach, allowing small scale development, is however included under the short term implementation plan.

STRUCTURE OF THE STUDY

In the following chapters an overview of present facilities is given; the overview looks at the sector structure in each of the TREDA countries and the general situation regarding local and national long distance networks and international gateways. International cable links, relevant for the interconnection of TREDA are given separately. Information regarding planned de-

velopments is also included.
A scenario covering long term telecommunications demand is given. It provides the necessary
background for defining the required number of connection points and for the capacity of the
traffic carrying links.
A technical masterplan is provided covering the development of telecommunications in TREDA
in conformity with the long term demand forecast.
A short term implementation plan is proposed. Different steps are provided in the establish-
ment of an infrastructure providing an immediate minimal coverage and allowing for extension
coherent to the long term plan.

CURRENT FACILITIES
SUMMARY DESCRIPTION
Democratic People's Republic of Korea (DPRK):
Telecommunications are provided under a monopoly by the Ministry for Telecommun-
ications. There is no formal distinction between regulation and operations; the Ministry
is also responsible for the industrial policy aspects regarding telecommunications
provision (e.g. production of optical fibre).
People's Republic of China (PRC):
As in DPRK a state monopoly is responsible for telecommunications provision. Within
the monopoly the provinces, prefectures and individual cities have a degree of
operational autonomy within strategic guidelines defined at central level by the Ministry
for Post and Telecommunications.
Mongolia:
In Mongolia a formal distinction has been introduced between regulatory and opera-
tional matter, similar to EC guidelines. Regulatory responsibility is vested in the
Mongolian Telecommunications Ministry; the Mongolian Telecommunications Company
is responsible for operations and has a high degree of autonomy. Limited competition
exists at the level of data services provision.
Russian Federation (RF):
The public network, formerly operated by the Ministry of Telecommunications is still
operated as a monopoly but is increasingly under competitive pressure from dedicated
and overlay networks. Licensing of those networks is subject to a complicated pro-
cedure involving central as well as regional approval.

CURRENT NETWORKS

Democratic People's Republic of Korea (DPRK)

Local networks

The overview is limited to the Rajin-Sonbong area that will be included in TREDA.

In the area under consideration telecommunication facilities are problematic; connection of subscribers in the Rajin area is manual; subscriber lines are of open wire type, long distance connections are over open wire connections. No exact figure as to the number of subscribers could be obtained. A large number of lines are out of service.

Plans call for the installation of a communications centre in Rajin, housing a digital switch of 30.000 lines capacity. In a second phase digital switches will be installed in:

Huchang (20,000 lines)

Sonbong (30,000 lines)

Ungsang (20,000 lines)

Total capacity within the Rajin-Sonbong area will thus increase to 100,000 lines. All exchanges will be linked by optical fibre.

National long distance networks

The major backbone link in DPRK, relevant to the interconnection of the TREDA, consists of a 300 channel analogue radio link between Pyongyang and Vladivostok. The link has repeater stations situated in Chongjing and Rajin. The repeater station in Rajin does not provide local access to the link, however.

The DPRK Ministry for Telecommunications plans to reuse this link and to upgrade its performance in a number of steps.

The first step would consist in providing access to the link in Rajin, where a 30,000 lines switch would be installed (see local distribution networks), and linking Rajin to Hunchun (PRC) by addition of a 3 hop digital radio link of 300-900 channel capacity.

In a second phase the link would be increased in capacity to 1920 channels and still later it would be digitized.

An alternative plan would provide in the connection of all major cities by an optical fibre connection, similar to the architecture adopted by PRC. The connection Pyongyang-Hungnam-Chongjin-Rajin is of particular importance to TREDA.

International gateways and links

An Intelsat A station and a Intersputnik earthstation are available at Pyongyang for international communications.

Limited capacity is also available on a RF cable connection between Pyongyang

and Beijing
(PRC).
Limited capacity is available between Pyongyang and Vladivostok on openwire (12 channels)
and on the radio link between Pyongyang and Vladivostok (300 channels).
Mongolia
Local networks
76,000 subscribers (34,000 in Ulaanbaatar) on a total population of 2.5 million are connected
to the network. Local networks are by cable in cities, by open wire in rural areas. Connections
are up to 10-15 km in length, and established in 0.5 mm wire. Loading is used extensively;
long connections have high loss (no special amplifying equipment provided). Some subscribers
are connected by radio.
Total waiting list is above 50,000 (40,000 in Ulaanbaatar); average traffic by line is at 0.06
Erlang/subscriber (Ulaanbaatar); call completion rate is at 35%; tone dial delay attains 2-10
sec (exceptional 20 sec).
Switching equipment consists of step-by-step and crossbar equipment of USSR origin. Many
switches are old (30% would need to be replaced); spares are unavailable.
Switches do not provide billing information: as a consequence DDD cannot be introduced (op-
erator must issue a ticket) and fax is impossible. Only local calls are automatic and are not
metered.
An Alcatel E-10 switch has recently been installed in Ulaanbaatar (commissioned Sept./1992).
It combines the functions of local switch (30,000 lines), national transit switch and international
switch.
A grant was accorded by Japan to acquire an international toll switch scheduled to be opera-
tional 8/93 and providing connection to the 2 idr systems on the new Intelsat earthstation. This
international toll switch will be extended and the E10 will be reassigned to national transit and
local traffic.
National long distance networks
The main cities are linked by a microwave system (analog, 1920 channels total capacity, 60
channels per city maximum, USSR made) and open wire systems (12 channels between
cities) Both systems are problematic in operation and maintenance.
MTC plans to replace the present systems by digital radio links and to operate a VSAT system
on the Asiasat system in the medium term.
International gateways and links

A new Intelsat A station in Ulaanbaatar, commissioned in 1993, is designed to carry 2 idr
systems (2 Mbit/s) with DCME (total 120 channels). Due to occupation of Intelsat 6, 60E only
512 kbit/s is available and will provide 8 channels to Japan. Full capacity will be used when
Intelsat 6, 66 E becomes available in the second part of 1994.
An Asiasat earthstation now provides 30 channels capacity on Asiasat1 between Ulaanbaatar
and Beijing. In future it will use Asiasat2 and function as hub for a VSAT service.
Small capacity links exist with PRC (12 channels over openwire) and RF (analogue radio links
providing 12 channels to Ulan Ude). The line to Russia via Ulan Ude will be digitized shortly;
connection to the trans-siberian optical fibre is under study.
People's Republic of China
Local networks
The overview is limited to the Jenji prefecture in general and the Hunchun telecommunication
centre in particular.
Local distribution networks use underground cable to the main distribution points and open
wire for the end distribution.
Within Jenji prefecture all switching equipment is to be digital within the near future (before
end 1995).
Capacities are planned as follows:
Jenji (30,000 lines)
Longjin (8,000 lines)
Helong (4,000 lines, 8,000 lines in 1995)
Dunghua (10,000 lines)
Tumen (3,000 lines, 8,000 lines in 1993)
Antu (3,000 lines, 6,000 lines in 1993)
Wantchun (4,000 lines, 10,000 lines in 1995)
Hunchun (3,000 lines replaced and extended to 6,000 lines in 1992, with further
extension to 10,000 lines in 1993 and 20,000 lines in 1994).
Maintenance of MDF, switching equipment and outside plant is good.
National long distance networks
The Ministry for Telecommunications of PRC plans to connect all provincial centres with an
optical fibre network of 140 Mbits/s capacity (equivalent to 1920 voice channels). Completion
of the whole network is scheduled for 1995.
For TREDA this means that high capacity access to this network would be available at
Changchun, itself connected to Beijing (and the international gateways) and Harbin. Harbin will
be connected by fibre over Jiamiusi with Khabarovsk where a new international gateway will

be installed by Rostelecom in 1995 and where the trans-Siberian connection, linking Moscow
to Nakhodka will be accessed.
Hunchun, which can be considered the local access point in PRC for TREDA, is linked by a 8
Mbits digital radio link (120 channels) to Tumen. 2 Mbits (30 channels) are through connected
to Jenji which is itself connected to Changchun by 34 Mbit link (480 ch).
International gateways and links
Main gateways are Shanghai and Beijing where Intelsat-A earthstations as well as connections
to the international cable networks are available.
Of particular importance to TREDA is the international gateway in Beijing (accessible through
the optical fibre network) and the plan to interconnect the national backbone to the RF
(Chanchun-Jiamiusi-Khabarovsk).
Russian Federation
Local networks
In Vladivostok 68,000 lines (analog) are available, serving a population of 700,000. No figures
could be obtained concerning local distribution networks outside the city. It is clear however
that all outside plant is of open wire type. Maintenance level seems low in the rural areas.
Automatic switching is only available at the local level. Communications between local
exchanges and long distance calls require operator intervention. At present the public network
operated by "Rossvyazyinform" (Former Ministry responsible for telecommunications) is
antiquated and totally inadequate for business communications (under-sized and totally
manual). Due to tariff constraints (tariffs have increased but are still far below economic costs),
Rossvyazyinform lacks the financial resources required to maintain and expand the public net-
work in a proper fashion but is looking at supplier credits and BOT agreements with foreign
operators as potential solutions.
A number of new telecommunication operators, operating dedicated networks, have plans to
introduce fully automatic switching based on digital equipment supplied by NEC, Alcatel and
ATT.
National long distance networks and international gateways
(a) Public network operated by Rostelecom
The public RF telecommunications network has a 4 level hierarchy.
At present 5 international gateway switches are operating in Moscow and St. Petersburg. In
1995 international gateways will be installed in Khabarovsk, Novosibirsk,

Yekaterinenburg,
Samara, Rostov-on-Don (Khabarovsk will be connected by Jiamiusi-Harbin to Beijing on fibre
which will be ready in 1995).
Transit exchanges are provided in 7 regions. There are 86 trunk exchanges: mostly one,
sometimes more, for each administrative centre.
The existing capacity on the public network is very limited at present: 40 channels are available
on a coaxial cable linking Vladivostok and Slavyanka. Between Slavyanka-Kraskino, and
Kraskino-Khasan, respectively 24 and 12 channels are available on openwire. The path
continues to Pyongyang on 12 channels. Some connection to Japan is available on cable and
satellite; capacity was considered to be a "commercial secret" but probably low anyway.
Apart from some low capacity links with DPRK and Japan, all international traffic goes by cable
or by satellite (Intersputnik) to the gateway of Novosibirsk. Problems exist with capacity and
quality of these links.
Some capacity is available on a number of large scale, private networks, operated by shipping
companies, railways, fisheries, energy providers, mining industries.
For the purpose of the interconnection of TREDA to the international network and the long dis-
tance network within the RF, the following plans are the most relevant. At this moment the
project "50-50" looks into the provision of 50 digital trunk exchanges and the digitization of 50
transmission links in a cooperation between Rostelecom, Rosvyazinform, USwest, ATT,
Siemens, France Telecom, Deutsche Telecom (other partners are still sought).
Digitalization of the radio link Moscow-Khabarovsk is planned for 1994; in 1996 it is expected
to implement an optical fibre link between Moscow and Khabarovsk; the cable will be solely
owned by Rostelecom and rights of use will sold to other operators. Financing will be on basis
of supplier credit. Connection between Kabarovsk and Nakhodka is scheduled for completion
in 1995. An undersea link between Nakhodka and Japan is presently being discussed.
The whole connection will use SDH transmission so that capacity can be extended. It will
probably carry most of the traffic between western Europe and Japan. The links Copenhagen -
St Petersburg (fibre) and St-Petersburg - Moscow (micro-wave) are already operational.
Other new projects concern a link between RF and Ukraine and a link RF-

Turkey-Italy.
(b) The company "Vostoktelecom" operates a parallel network.
The network consists of:
an earthstation of Intelsat-A type (16 m antenna) in Vladivostok with an initial capacity
of 30 channels at start of operations (1993) and extended to 60 channels in 1995 (IDR
system linked to KDD-Japan for further transit);
an international switch in Vladivostok;
local switches in Vladivostok, Khabarovsk, Jakutsk, Irkoetsk, Nakhodka, Sakhalinsk.
The network configuration is a star on Vladivostok using fixed links rented from the railways
operator covering FE Russian Federation. At each of those sites a switch will be installed
accessible for local subscribers and providing long distance and international traffic. The
Vladivostok switch will provide long distance transit and international connectivity. In
compliance with the status of "dedicated network", the network operated by Vostok-telecom is
not connected to the public network operated by Rossvyazyinform.
TABLE 1

The company intends to provide from 1996 a link extending to the Kraskino peninsula
(recreational centre) as follows: Kraskino-Andrejevka (8 Mb/s,120 channels), Andrejevka-
Slavyanka (8 MB/s, 120 channels), Slavyanka-Vladivostok (4 Mb/s, 60 channels) and
connection of the Interdaltelecom hub to the state owned communications centre.
(c) The company Techexposoviaz plans to install a large scale network.
The network will provide an alternative to the existing public system. It will be used for ad-
ministration and business and would afterwards be extended and tied in with the public
system. The program must still be submitted to and approved by the administration of
Primorsky Krai.
The proposed configuration consists of an optical fibre connection (140 Mbit/ 1920 channels
capacity) between Vladivostok and Kraskino (hung on electrical power masts between
Vladivostok and Slavyanka, buried under railway track between Slavyanka and Kraskino),
digital radio link Kraskino-Hunchun (8 Mbit/120 channels) and optical fibre cable on electrical
power masts from Kraskino to Khasan (Tumen delta).
Other projects at present under consideration include:
the construction of the link Vladivostok-Nakhodka (140 MB/s optical

fibre cable hung on
power masts) linking into cable St Petersburg-Tokyo at Nakhodka (use of 565 Mb/s on
section Khabarovsk-Nakhodka still to be cleared by Cocom);
establishing a link Nakhodka-Port Vostochny (symmetrical cable 120 ch + radio link 120
channels digital);
connection of Vladivostok to Ussiriysk and Khabarovsk.

Existing Telecommunication Networks: Overview and Summary

Local distribution networks

Only PRC is able to deliver up to date communications at this moment; penetration rates are
still very low and below 5% (e.g. Hunchun 6,000 lines serving a population of 200,000) but
scheduled to increase to 10% in 1994.

The other countries have totally inadequate facilities. The fact that interconnection of
exchanges has to be done by operator, means that fax is very difficult, if not impossible. The
use of open wire lines reduces investment cost but provides only medium quality at best. The
extensive maintenance required by this technology seems often lacking.

National long distance links

Also in this field only PRC has adequate facilities available.

DPRK has a clear plan on required developments. Implementation of an interim solution
(reestablishing analogue radio link with minor modifications) should be possible in the short
run.

Mongolia has a operational system consisting of analogue radio links. The system is however
suffering from maintenance and operational problems inherent to the technology. Although the
upgrading is examined, the planned VSAT system will probably provide the quickest interim
solution.

An encompassing plan is now emerging and is solidly based on the public network operated by
Rostelecom.

A number of important issues are still to be solved (financing being the most important one in
the RF).

Full implementation of those plans can be expected in 1996-1997 at the earliest. The parallel
network operated by Vostok-telecom is available as a short term solution and provides limited
local and international connectivity.

International links and gateways

International links and gateways relevant to the eventual connection of the TREDA area with
the major zones of economic activity, consist of high capacity earth stations

for satellite
transmission and high bit rate cable connections. Location of relevant facilities is represented
on the following map.

Intelsat-A earth stations for satellite communications providing global communications;

Presently available stations are situated in DPRK (Pyongyang), PRC (Beijing,
Shanghai), ROK (Seoul), Japan;

In Mongolia (Ulaanbaatar) a new station was commissioned spring 1993 and is
operated by the Mongolian Telecommunications Company;

In Vladivostok a station operated by Vostoktelecom was available from the first half of
1993;

Spare capacity is available at both Beijing and Pyongyang whereas the new stations in
Vladivostok and Ulaanbaatar will allow for future extensions.

Other satellite networks of regional importance available within the region;

The first one is the system using the Asiasat1 satellite. In the present context this
system provides some links between Ulaanbaatar and Beijing and is currently upgraded. From September 1992 it will provide a total of 30 channels between Ulaanbaatar and Beijing. When Asiasat2 becomes available, the system will also be
used to provide VSAT service within Mongolia and within PRC;

A second satellite network is available, mainly for connections within the former
Comecon zone: it consists of Intersputnik earthstations available in Pyongyang and
Ulaanbaatar. The system is presently upgraded for digital transmission (also the station
in Ulaanbaatar is being digitized).

International cable networks

A high capacity link, consisting in part of high bit rate optical fibre presently links ROK (Seoul),
Japan (Tokyo), USA, western Europe.

Additional links Copenhagen (Denmark) - St Petersburg - Moscow and Moscow - Tokyo (the
link will pass through Khabarovsk and Nakhodka) are presently under study and will probably
have a capacity of 565 Mb/s. After completion of this link (planned by 1995), a path spanning
the northern hemisphere will exist and pass just North of the region under consideration.

A project of linking Beijing to Tokyo by optical fibre is in execution.

The construction of an international link Beijing - Changchun - Harbin - Khabarovsk (optical
fibre of at least 140 Mb/s capacity) has been agreed upon by PRC and RF.

An overview of facilities is provided on the following map.

FIGURE 1

Conclusion for international connectivity of TREDA area
Clearly TREDA is extremely well located in relation to the high capacity cable links that will become available in the next few years. In the short term existing capacity on nearby earth stations systems can be considered sufficient. If connection to those cables/stations can be obtained by the national backbone networks in the 3 riparian countries, TREDA can obtain first class interconnection with other economic centres without investing in its own satellite earth station.
Rather than providing more capacity to this network by creating a separate earthstation in TREDA, it is advised to connect this area to the existing and planned gateways and to develop the national backbone networks accordingly. As an extra advantage to the riparian countries this approach could tie into the communications networks some parts of the national territories situated along the links between TREDA and the international gateway at relatively low cost.
This aspect could be of particular interest to DPRK on the link between Rajin and Pyongyang.

LONG TERM DEMAND FORECAST
INTRODUCTION
The objective of this chapter is to provide a reasonable upper level estimate of requirements imposed upon a future telecommunications network serving the TREDA area. Two main topics are addressed by this forecast.
1. The number of connections to the network is important in proposing the number of steps in the switching hierarchy and is of course a determining factor in addressing the numbering plan and the allocation of numbering capacity to be set aside for TREDA.
2. The forecast will also provide an estimate for telecommunications traffic
within TREDA;
between TREDA and the riparian countries;
between TREDA and non-riparian countries.
The traffic forecast is important for the riparian countries in allowing them to plan for the necessary capacity on their national networks. This is of particular importance in providing links between TREDA and the international gateways and the dimensioning of those gateways. If

traffic forecasts support the view that TREDA can use those gateways, it is clear that tele-
communications development can follow a gradual implementation plan. Investments in the
initial phase can be fairly limited because the provision of a specific international gateway for
TREDA can be postponed.

SCENARIO FOR ECONOMIC EXPANSION

Population and GDP are separately forecasted; both follow a growth pattern which shows 4
distinctive periods.

- GDP grows moderately at first (4-5% p.a. for the period up to 2002);
- In the following period, annual growth increases to attain a maximum value of 15% in
2002;
- After that, growth remains high (above 10%) until 2013;
- From then on it declines slowly to values around 2% in 2039.

FIGURE 2

According to this scenario GDP increases from an initial value of US$ 8.5 billion in 1993, to
US$ 158 billion in 2033 (average compound growth of 7% p.a.)

FIGURE 3

Population is also growing, mainly through immigration into TREDA. The scenario provides for
a growth of 3-4% p.a. up to 2005, further increasing to 4.7% in 2011. From 2016 population
growth decreases to a value of 0.7% in 2033.

FIGURE 4

According to this scenario population increases from an initial value of approximately 3 million
in 1993 to 10 million in 2039.

FIGURE 5

Maximum population growth is situated later than maximum GDP growth, simulating the
attraction of the economic expansion on the population in surrounding regions.
The relation between GDP growth and population growth is shown in the following figure.

FIGURE 6

The resulting evolution in GDP/capita is shown in the following diagram. Based on an initial
value of $ 2,800/capita in 1993 a value of appr. $ 16,000/capita is attained in 2033.
Overall, this growth pattern is comparable to the one attained in some fast growing economies
based on a free trade zone concept. According to this development scenario,

in 2032 TREDA
would be similar to Hongkong and Singapore at present (see following table).
TABLE 2

FIGURE 7

Although the scenario is realistic in itself (it is essentially the scenario followed by Singapore
spread out over 40 years instead of 30), it is probably a fast growth scenario as far as TREDA
is concerned; the absence of a strong tradition of extensive cross border trade can be ex-
pected to slow down the development at least in the initial phase. The forecasts will
accordingly represent a maximum scenario as far as telecommunications demand is
concerned.

TELECOMMUNICATIONS REQUIREMENTS

For the purpose of forecasting telecommunications demand, following specific assumptions
are made.

For the sake of simplicity it is assumed that TREDA is distributed equally over DPRK,
PRC and RF and that the initial situation is the same in each of those countries. The
important differences which are currently in effect are supposed to vanish at some point
in the development of TREDA; they will be taken care off when proposing the short
term implementation plan.

The number of connections within TREDA will grow in proportion to the population;
penetration itself will increase in proportion to GNP/capita. According to available ITU
statistics linking penetration to GNP/capita, initial penetration would be at 4%, which is
somewhat below the value corresponding with a GNP/capita of $ 2,800. The
penetration would increase to 35% at the end of the period (corresponding with
GNP/capita of $ 16,500).
The following graph shows this evolution over the period 1993-2032.
FIGURE 8

TREDA will develop relations with other regions as a consequence of incoming
investment; in accordance with other developments (e.g. trade patterns within EC), it is
admitted that those relations will mainly be established between TREDA and its
immediate surroundings. In practical terms it is supposed that 70% of TREDA's external

relations will be oriented towards PRC, RF, DPRK, ROK and will be shared in equal
amounts between PRC, RF and the Korean peninsula.

Telecommunications traffic between TREDA and other regions is supposed to be
symmetrical (equilibrium between incoming and outgoing traffic) and put at a total value
of 7 minutes per $ 1000 GNP (annual total of incoming and outgoing traffic).

The traffic within the region is related to the interregional traffic: it is put at 200% in the
initial stages and increases to 600% at the end of the period.

The following graph gives a summary of evolution of number of subscribers (in 1000's)
and of international and regional traffic (in 1000's min/year).
FIGURE 9

The following graph illustrates how as a consequence of increasing penetration, and
the corresponding connection to the network of users with a lower traffic profile, total
traffic/subscriber first decreases with increasing penetration and then rises again as
local traffic develops in conjunction with growing intercompany relations within the
TREDA area.
FIGURE 10

Required transmission capacity is obtained from traffic forecasts allowing 50,000
minutes annual traffic/channel. The obtained capacities can be translated to physical
link capacities for the traffic with other regions. For the traffic within TREDA a detailed
traffic pattern, itself depending on location of economic activity, is required before links
can be planned and dimensioned.
LONG AND MEDIUM TERM REQUIREMENTS
On basis of the calculations in Table 3, it is clear that the masterplan for telecommunications
should take into account a long term demand of:

3.4 million connections to the network;

1000 million minutes of international traffic ("international" is to be understood as "non-
TREDA" in the present context);

5400 million minutes of local traffic ("local" to be understood as "internal to TREDA").

Those figures are transposed to network requirements as follows:

the numbering plan should allow for 7 positions to be available within TREDA;

the connection of TREDA to the surrounding countries should allow for a long term re-

quirement of 20,000 channels corresponding to a theoretical capacity of 1280 Mbit/s.
This requirement can be implemented by the creation of 10 links of 140 Mbit/s each,
between TREDA and PRC, RF and DPRK-ROK. 30% of this total capacity would be used for communications between TREDA and other countries, requiring the use of
existing gateways, and/or a separate international gateway (satellite station) in TREDA;

the long term requirement for connectivity within TREDA can be put at 6 times the
requirement for international traffic. Link dimensioning has to be based on a more
precise layout of the zone;

a medium term plan for TREDA would be based on requirements in 2000. At that date:
360,000 network connections are projected, with a total volume of 90 million minutes of
international traffic requiring 2000 channels.
TABLE 3

TECHNICAL MASTERPLAN
INTRODUCTION
Priority to international and interregional communications
A masterplan for telecommunications should address the following items:

the establishment of local distribution networks allowing the connection of individual
subscribers to the network nodes (exchanges);

the interconnection of those nodes allowing traffic to occur within the region;

the interconnection of one or more of those nodes (pending their hierarchy) to the
international network providing for international connectivity for the region under
consideration.
In this edition of the masterplan for TREDA the establishment of local distribution networks is
addressed in a summary way. The establishment of local networks will be studied in more
detail when a more precise view on the exact siting of infrastructure and facilities is available.
A minimal number of nodes will however be provided in the immediate future and allow for the
interconnection of users to those nodes without delay.
Linking those nodes to one another and providing international connectivity to those nodes is
of course essential, and must be realized before potential investors can be located in TREDA.
The issue will be addressed by the establishment of a ring structure in TREDA allowing the in-

terconnection of local distribution points (exchanges for fixed and mobile connections) situated
within TREDA. This ring will be interconnected to the national backbone networks of the 3
riparian countries and with access also to the international gateways in those countries.
In this approach, priority is given to the interregional and international connectivity of TREDA.
This approach is justified taking into account the peculiar development scenario to be followed
by TREDA which will be largely based on an inflow of foreign investment. As a consequence,
initial traffic patterns will be significantly different from patterns to be expected when TREDA
achieves maturity.
More precisely it can be expected that:

- In an initial phase traffic will mainly link individual locations in TREDA with locations in
non-riparian countries;
- In a second phase, when investment of riparian countries builds up and when economic
relations develop between TREDA and its hinterland, traffic between TREDA and the
riparian countries will surpass traffic between TREDA and other countries;
- Finally, in a maturity phase characterized by the development of a network of inde-
pendent business in TREDA and orientated towards the activities in TREDA, local
traffic will develop and will surpass in volume the traffic between TREDA and other
regions.

These assumptions have been incorporated in the long term demand forecast where the
proportion of local to total traffic increases continuously over the forecasting period.
For the elaboration of the technical masterplan the scenario implies that a stable network
structure for the traffic within TREDA, can only be developed over time.
A masterplan should propose following fundamental plans:

- numbering plan;
- signalling plan;
- routing plan;
- transmission and synchronization plan;
- switching plan and charging principles.

Of these fundamental plans the transmission plan is omitted. As the long distance connections
which are the subject of the present plan are all digital, the transmission plan is of special
relevance to the local networks which are to be designed at a later date.
Charging principles will be detailed under separate cover addressing regulatory issues.

For the sake of simplicity the masterplan is based on a demand forecast covering only "tele-
phony", which of course incorporates also fax and data over voice. Due to the complete
digitalization of the network, it will however easily provide bulk transmission capacity (fixed
links) and accommodate other services possibly developed outside the network itself (e.g.
PSDN) or using the concept of ISDN.
The masterplan covers only the Tumen Delta area. The interconnection of Mongolia, participat-
ing in the TRADP project, and an important hinterland for TREDA, is seen as follows:

The developments undertaken by MTC will provide a reasonable degree of penetration
of the terrestrial network in Ulaanbaatar and vicinity. The new international exchange
and Intelsat earthstation will provide international connectivity to other TRADP countries
and thus to TREDA;

The VSAT service on Asiasat will provide remote locations in Mongolia with the same
service;

In the long run Mongolia can have a second path of international connectivity by in-
stalling a digital radio link (by upgrading present one) or optical fibre connection to Ulan
Ude where the Trans-Siberian fibre can be accessed;

One issue needing consideration is the development of a tariff structure allowing
cheap rates for traffic between TREDA and parts of Mongolia considered to be exten-
sions of TREDA.

NUMBERING PLAN

The numbering plan intends to provide a guideline for the assignment of telephone numbers
over the entire forecasting period (40 years). The plan must meet the following constraints:

it must be easily understood by the user located in or outside TREDA;

it must be compatible with international practice;

it should be possible to implement without imposing exaggerated requirements on
technical equipment.

The numbering plan for TREDA is proposed as follows:

Uniform numbering system

TREDA will have a uniform numbering system. This means all subscriber numbers in TREDA
will have the same number of digits.

Homogeneous numbering system

TREDA will be a homogeneous numbering zone meaning that for every call within TREDA the

complete number has to be dialled.
Capacity of numbering system
According to the demand forecast, given 3,5 million subscribers in TREDA in 2032, the sub-
scriber numbers will have 7 digits. The first 2 digits will indicate the subregion, the exchange
and possibly the RSU.
At this moment (1993) the numbering system in PRC allows for a total of 12 digits divided into
2 for international service (00),2 for the country code (86), 1-3 for area code, 5-7 for subscriber
number. The number of digits excluding the international service is 10 and has to be compared
with the maximum of 12 recommended by CCITT Rec. E.163.
The PRC numbering system is non-uniform; subscriber numbers are variable in length,
according to place.
Examples (area code - subscriber number)

Beijing:	1-123456
Changchun:	123-123456
Hunchun:	1234-123456

Incorporating the TREDA 7 digit number into the PRC system would require changing the
numbering in the Hunchun area, now consisting of a 4 digit area code and a 6 digit subscriber
number, to a 3 digit area code and a 7 digit subscriber number.
The existing situation of a 6 digit subscriber number is however sufficient in the medium term.
It is recommended to allocate at this moment digits to each of the subregions as follows:

- TREDA-DPRK: 2.3
- TREDA-PRC: 4.5
- TREDA-RF: 6.7

This will allow 5 digits available for subscriber numbering in each of the subregions (appr.
10,000 subscribers in each of up to 8 subregions).
Incoming regional calls (riparian countries)
For incoming calls from riparian countries (or assimilated e.g; Mongolia), the entire TREDA
area will be considered as being part of the national network and as such will comply with the
individual national numbering plans.
As a consequence:

- In each of the riparian countries, the region within TREDA receives a new area code;
- Seen from each of the riparian countries, this new area code is valid for the whole of
TREDA, including the areas situated in the other riparian countries;
- The area code allocated to TREDA in each of the riparian countries can be different in
each of those countries.

Outgoing regional calls (riparian countries)
Outgoing calls to the riparian countries will be considered as outgoing international calls (this
does not preclude a procedure for cross border traffic between TREDA and bordering regions
involving reduced tariff to be installed).
Incoming international calls (non-riparian countries)
Incoming international traffic will be routed through any of the riparian countries (using the
appropriate country code) using the area code allocated to TREDA within the selected country.
If, at a later stage, TREDA were to have its own international prefix, traffic would be routed
directly to TREDA if a international gateway were available, or in transit by one of the riparian
countries according to existing procedures. Addressing TREDA through the international prefix
of one of the riparian countries means that the calling party in fact chooses the transit path.
Outgoing international calls (non-riparian countries)
Outgoing international calls will be automatically routed through the international gateways of
the riparian countries or, at a later stage, through a gateway within TREDA.
It is recommended to use the generally accepted prefix (00) to address the international ser-
vice and to provide automatic routing with overflow to the different gateways as soon as
possible.
Examples:

Local call (within TREDA)	1234567
Riparian Country to TREDA	XXX 1234567
TREDA to Riparian Country or International	00 CC AAA 1234567
International call to TREDA	00 RR XXX 1234567 or 00 TTT 1234567

where:

XXX	Area code for TREDA (can be different in each Riparian Country)
CC(C)	Country Code. (Riparian or other International. Can be three digits)
AAA	Area Code in the country being called)
RR	Riparian Country Code.
TTT	TREDA Country Code. (Assumed it will be three digits)

SIGNALLING PLAN
CCITT-7 will be used as a signalling system over the long term and will be actively introduced
and used. If short term problems inhibit the use of CCITT-7, interim solutions will be based in

using:

- CCITT R2 for terrestrial national and cross border traffic;
- CCITT no 5 for international long distance links and satellite links.

ROUTING AND SWITCHING PLAN

Introduction

The present routing and switching plan is limited to a general view on the hierarchy of switches serving TREDA and the interconnection of those switches at the primary level.

The plan must be completed in 2 steps.

The first step will cover the placing and interconnection of network nodes based on a more detailed infrastructure plan for TREDA.

The second step will cover a more precise dimensioning of the links after initial traffic data have become available.

General Hierarchy of the Network

The required numbering capacity will be provided by switches at the local level (CCITT "local exchange") in a combination between 100 switches of average capacity of 35,000 lines (2 digit switch identification, 5 digit subscriber identification) or 1000 switches of average capacity of 3,500 lines (3 digit switch identification, 4 digit subscriber identification).

These local exchanges will be connected to 3 primary switching centres, located in Rajin (DPRK), Hunchun (PRC) and Slavyanka (RF), switching traffic from local exchanges to:

- directly connected exchanges (local and primary) in riparian countries;
- national toll centre in each of the riparian countries;
- international gateways in riparian countries and/or gateway in TREDA.

Traffic Requirements

According to the demand forecast TREDA would develop 5,500 million minutes of local traffic and 1,000 million minutes of international traffic in 2032.

A partial traffic matrix is developed based on the following assumptions:

- total traffic between TREDA and other regions is put at 1000 million minutes.
- all traffic to or from any node is equally divided over incoming and outgoing directions;
- international traffic between TREDA and non-riparian countries is put at 30% of total TREDA/non-TREDA traffic;
- the 3 subregions of TREDA are assumed to be identical;
- all non-TREDA traffic to and from a TREDA subregion is routed via the international gateway of the riparian country in which the subregion is located;
- traffic between a TREDA subregion and one of the other two riparian countries is routed via the primary node of the relevant TREDA subregion;

traffic between any primary node to the international gateway in the same riparian
country is put at:
1,000 * 0.3/3 million minutes = 100 million minutes
(30% of total traffic divided equally over the 3 subregions)
and divided equally in incoming and outgoing traffic (50 Mmin in each direction);
traffic between TREDA and riparian countries is routed via national toll for the same
country, or via the primary node and national toll for other countries. The traffic volume
is put at:
1000 * 0.7 * 1/3 * 1/3 million minutes = 78 million minutes
(70% of total traffic divided in 3 subregions and again divided in 3 destinations)
Incoming traffic is again equal to outgoing (39 million minutes).
The traffic matrix becomes:
TABLE 4

For dimensioning the links it is assumed that the links between the primary nodes will carry
traffic as shown in Table 4A (only links to node A, other links similar).
TABLE 4A

FIGURE 11

Link Capacities
Link capacities are determined in the following table as follows:
At this stage of initial planning, link capacity is determined on the simplified assumption
that 1 channel is adequate for a traffic of 50,000 minutes/year. To take care of local
TREDA traffic on the links between the primary nodes, the required capacities on the
links between primary nodes, are increased by 400%. This increase corresponds to a
total amount of 39 * 4 * 2* 3 = 936 million min of traffic: traffic between the subregions
of TREDA but remaining within TREDA is thus put at 20% of total local traffic (traffic
remaining within TREDA);
Total bandwidth is calculated assuming 64 kbits/s per channel. On trunk routes,
compression techniques could reduce required capacity by 75%).
The last column gives the rounded number of 34 Mbits/s systems required for each link
to carry all traffic (one direction only).
TABLE 5

SYNCHRONIZATION PLAN
Synchronization in bit timing and framing is required for switching and

transmission systems.
A slip is a loss or a repetition of information (8bits) which occurs when clocks at sending and
receiving sides are different.
The network synchronization system has to be conceived in such a way that the encountered
slip rates are negligible (maximum 1 in 72 days according to CCITT).
In plesiochronous operation, each equipment has its own very precise clock (Cesium clock or
similar, with long term frequency departure better than 10-11 according to Recommendation
G.811) and needs to be duplicated.
To avoid the problem of expense (the clocks are very expensive and need replacement every
5 years) two other methods have been proposed:

1. In the master-slave mode one master clock synchronizes all other (slave) clocks;
2. In the mutual single ended mode, all network nodes exchange frequency references
and establish a common network clock frequency. Each nodes averages the incoming
references and synchronizes its own clock.

In TREDA 1 of options 1. or 2. is proposed.

SHORT TERM IMPLEMENTATION PLAN
INTRODUCTION
The short term implementation plan has as objective to implement facilities in TREDA, in line
with the masterplan but limited to the most urgent needs.
The implementation plan relates to:

Provision of communication facilities to support existing economic activity; the most
urgent being connections between Hunchun (PRC) and Kraskino-Vladivostok (RF) and
between Hunchun (PRC) and Rajin-Sonbong (DPRK).

Provision of communication facilities of a minimal level in the whole TREDA region so
that investment can proceed. This step will require the installation of a minimal number
of network nodes and amount of switching capacity and will also address the issue of
providing international connectivity.

COMPATIBILITY WITH LONG TERM MASTERPLAN
In general the structure of the network proposed for short term implementation agrees with the
proposal for the long term. As far as numbering plan and routing plans are concerned, the
following interim measures are proposed.
In the immediate future, all exchanges to be created are to be considered as local exchanges,
part of the respective national networks. The links between the Hunchun,

Slavyanka and Rajin
exchanges would be implemented as direct links between local exchanges. Only at a later
stage the hierarchical level of those exchanges would be increased to "primary centres". The
digital technology which is used would make this change relatively easy to perform. This
modification would still allow a combined exchange configuration (combination of local and
primary levels).

IDENTIFICATION OF SHORT TERM DEMAND

Trade Between PRC and RF

In 1992, total trade between Hunchun and RF amounted to US$ 0.15 billion. Total trade between Jilin and RF amounts to US$ 0.4 billion. It is expected that a growing
proportion of this trade will use the Hunchun-Kraskino axis for following reasons:

- a new road connecting Hunchun with Kraskino was finished in 1992.;
- from 93.06.01 on, the border post between Hunchun and Kraskino will also allow
persons to pass the border;
- in 1993 PRC and RF came to an agreement allowing PRC to use Zarubino as a main
port;
- a new railway between Tumen and Hunchun is nearly finished, an extension
connecting Hunchun to Kraskino is planned and will be operational towards 1995. As a
consequence, transport capacity between Hunchun and Primorsky Krai will more than
double to 10 million tonnes/year;
- in the last few months, trade has increased in a significant way. On an annual basis the
increase amounts to 50%.

As a preliminary hypothesis, annual value of trade between Hunchun and RF can be put at a
minimal value of US$ 0.3 billion (1993).
Assuming that $ 1,000 of trade generate three minutes of telecommunications traffic, annual
traffic would amount to appr. 1 million minutes between Hunchun and RF(Kraskino), requiring
20 channels).
Even in the absence of TREDA, growth will easily exceed 15% p.a.. requiring twice the
mentioned capacities in 5 years time.

Trade Between PRC and DPRK

Up to 1993, trade between PRC and DPRK is probably lower in volume than the trade
between PRC and RF. Also this trade is increasing. The development of the Rajin-Sonbong
zone will accentuate this increase.

Industrial activities (export processing) as well as trade related activities (transport) are the
main component for short term development of the Rajin-Sonbong free economic zone.
At this moment (May 1994) it seems clear that transport is the main driving factor for the
immediate development. This observation is based upon a number of interviews stating:

the urgent requirements from Jilin province (PRC) regarding access to a seaport and
the practical difficulties regarding the use of Zarubino-Kraskino in the RF for this
purpose;

the general requirements from potential investors in the area regarding personal
transport, requiring at least a small airport in the area.

Trade Between DPRK and RF

Although no precise figures are available, the 1993 value of this trade would seem to be
between the figures for PRC-RF and PRC-DPRK.
Contrary to the trade flows Hunchun-RF and Hunchun-DPRK, trade between DPRK and RF
seems to be stable or growing rather slowly. Under the assumption that traffic occurring
between DPRK and RF points will be routed through Hunchun, this slower growth permits the
traffic volume between DPRK and RF to be considered as marginal compared to the direct
traffic between DPRK-Hunchun and Hunchun-RF and without explicit impact on the capacity
requirements of those links. Future traffic measurements must verify this situation and future
direct link between DPRK and RF must remain a part of the long term plan.

Existing Infrastructure

The following map indicates existing infrastructure and planned upgrades.
FIGURE 12

TECHNICAL PLAN FOR TELECOMMUNICATIONS DEVELOPMENT

Local Telecommunications Networks

General

Considering the professional orientation of the services to be provided, it is recommended that
a potential requirement for medium or high speed services within the zone be taken into
account. Accordingly the development of a terrestrial network which will allow deployment of
those services is a first priority.
This approach uses at the same time to the largest extent possible, the technology which is
available within the riparian countries and reduces to some extent the constraints on hard

currency required for imported equipment.
The local distribution network will use the concept of "Local distribution centre" (LDC).
According to this concept, the distribution networks are limited in size to a maximum radius of
appr. 1.5 km, allowing the provision of high speed digital connections (up to 2 Mbits/s) over a
copper pair without requiring repeaters in the links connecting user premises to the LDC.
The LDC itself is connected to the main exchange serving the larger area by optical fibre,
carrying high speed links on which the traffic from individual subscribers is multiplexed.
This architecture provides the following advantages:
- using "remote switching units" (RSU's), the telephone service can be implemented economically. The architecture allows the combination of cost and operational advantages of large switches with the cost advantages of small networks (shorter cable connections);
- the architecture allows the provision of 2 Mbits/s service to subscribers that were initially connected on copper pairs, without major modifications to the network;
- when optical fibre connections have to be provided to the customer's premises (at this point rather the exception), the architecture allows limiting the intervention to the short path between the customer and the LDC;
- the architecture prepares the fully optical fibre local network, to be expected in the next few years.

DPRK
Medium term
In the medium term, the network would be defined as follows:
In Rajin a site will be defined for the installation of a digital switch with large end capacity (at least 40,000 lines) and connected to 9 RSU's of 512 lines capacity. In a first phase the switches would be only partially equipped (appr. 1000 lines for the whole zone). The building in Rajin will be of sufficient capacity to allow future large scale extension of the equipment. The Business Centre planned in Rajin will be connected to the Rajin main exchange.
Implementation of a Centrex facility will be examined.
Sites will be selected for the LDC's in each of the target zones for industrial and commercial development.
The following plan gives the general layout of the connections to be established between the

LDC's and Rajin centre. In the implementation, optical fibre connections will be used from the
start.
FIGURE 13

At each occasion where major public works are executed (road or railway work), a sufficient
number of HDPE tubes will be installed to allow the subsequent installation of optical fibre links
between Rajin centre and the LDC's, and between the LDC's and the end users.
The LDC to be established in Sonbong will take into account the future development of this
LDC into a autonomous local exchange; accordingly the connections between the LDC's to be
established in Ungsang, Hongui and Tumangang will be physically routed over the Sonbong
LDC.
Sites for LDC's serving residential/commercial zones at later dates will be defined. Also for
these sites HDPE tubes will be installed.
In the immediate future it might be necessary to connect users by semi-fixed radio links (2
MBit/s) to the main exchanges, as an interim measure pending the full development of the ca-
ble/fibre network.
Short term
The number of connections is defined according to the demand which can be expected within
a period of 2-3 years. In practice at least half of this capacity can be expected to be taken up
when the network becomes operational (at the beginning of 1995 at the earliest).
Connections are inventoried as follows:
Rajin
Business centre: 200 lines
These 200 lines will probably be equipped to some extent by key systems, increasing
the number of terminals having access to those lines to 600-800. Financing of this
small scale equipment is left open (possibly users will buy the equipment themselves).
Hotel: 25 lines
These lines will support the 100 planned rooms, many of which will probably be used
as temporary offices. Installation of the required switchboard is to be left to the hotel
operator.
Harbour area:
Official services (harbour authority, railway, police, etc.): 100 lines
Commercial services (road transport, shipping agencies, etc.): 100

lines
Industrial zones: 250 lines
Residential and business area (east of harbour): 100 lines
Sonbong
100 lines on remote switching unit (RSU) serving harbour, city and industrial zones
Unsang
100 lines on remote switching unit (RSU) serving the airport site
Table 6 gives the location of each site, together with the average traffic profile of the lines to
be installed (expressed in Erlang). Traffic is tentatively separated in a local component, traffic
to Chongjin, traffic to Hunchun, traffic to Pyongyang.
TABLE 6

Traffic figures represent total amounts of traffic (sum of outgoing and incoming).
From the table it is apparent that to take care of incoming and outgoing traffic, the main switch
has to be equipped with an additional number of 150 ports serving traffic needs as follows:

Hunchun	60 channels
Pyongyang	60 channels
Chongjin	30 channels

Total capacity of the main switch in Rajin then becomes 925 lines, rounded to 1000 lines. 2
RSU's of 100 lines each, are planned for installation in Sonbong and at the Ungsang airport
site respectively.
PRC
The existing extension plan for Hunchun exchange would be followed but could be advanced
in time if demand develops suddenly.
RF
A switch of 2000 lines is proposed in Slavyanka, further linked to Andrejevka, Kraskino and
Khasan where concentrators or RLU's could be installed in a first phase.
Links Between Primary Exchanges and Gateways
DPRK
The following map shows the optical fibre links between Rajin and the international gateway in
Pyongyang, which are presently installed and the extension of this link to Hunchun.
FIGURE 14

Pyongyang is the site of:
national toll and international switch (E10B);
Intelsat-A earth station for satellite communications.
Pyongyang-Hungnam:
275 km, 12-fibre optical link: cable laying finished April 1994; UNDP-funded

transmission equipment will be installed May-June 1994.
Hungnam-Chongjin:
375 km, 12-fibre optical link will be established before December 1994. Cable laying is
30% completed (May 1994).
Chongjin-Rajin:
93 km, 12-fibre optical link is under planning but will be established before December
1994.
Provision of suitable housing for the equipment to be installed in Rajin (switch and
transmission) as part of the telecommunications centre, as well as in Sonbong and Ungsang is
to be planned urgently and to be executed in the fall of 1994.
PRC
Planned network extensions are progressing well. Using Chanchun as a transit point, Jilin will
obtain excellent international access to Beijing gateway and Khabarovsk.
RF
International connectivity is now available (May 1994) through the Intelsat-A station in
Vladivostok, but is limited to subscribers in the Vostoktelecom network (dedicated network, not
connected to public network). In-dialling connectivity is limited.
Full connectivity will become available from 1995 on when the new international exchange in
Khabarovsk will come on line and when the links between this exchange and Moscow, Beijing
and Tokyo will be established. However, on September 1993 no financing arrangement was in
place to build the link between Vladivostok and the main connection between Nakhodka and
Khabarovsk.
Regional Cross Border Links
General Approach
Although the long term plan proposes the establishment of a loop connecting the primary
nodes in Slavyanka, Hunchun and Rajin, the short term implementation will be limited to a non-
redundant link between those three centres. In this configuration one of those centres will
function as a transit point for traffic between the other two.
The configurations which are examined below, indicate the use of Hunchun as a provisional
hub. Traffic between DPRK and RF would transit via Hunchun until at a later stage, a direct
link is established between Rajin and Slavyanka.
Options
Increase in use of multiplexing over open wire links between Jilin and DPRK
The connection between Yanji-Chongjin (3 channels) and Hunchun-Saebyol (1 channel) can

be increased to 12 and 3 channels respectively. This work could be performed at short notice.
The improved capacity will of course need further increase to support the development of
TREDA.
Connection between Hunchun and Kraskino-Vladivostok
In bilateral discussions between PRC and RF it was agreed that a digital radio link (800 MHZ, 2
Mbits/s) would be established between Hunchun and Kraskino, further linking to the cable
connection Kraskino-Zarubino and Zarubino-Vladivostok (30 channels FDM). A total of 30
channels would become available between Hunchun and RF.
At this stage (September 1993) the necessary equipment is installed at the PRC side. The link
between Kraskino and the border has to be installed.
FIGURE 15

An analogue radio link exists between Chongjin, Rajin, Sosura, Zarubino, Slavyanka,
Vladivostok. The link, with a total capacity of 120 channels, could be used to provide
connection between Rajin and Vladivostok, and, Rajin-Zarubino-Hunchun.
FIGURE 16

For the connection between Rajin and Hunchun to be established, an increase in capacity on
the link Hunchun-Zarubino (see 4.2) is required and analogue to digital conversion must be
arranged in Zarubino.
Although the realization of this step may seem attractive, a number of factors complicate the
issue:
The link now carries traffic from Pyongyang to Vladivostok: this traffic will continue to use the
link; reallocating capacity to the relation Rajin-Hunchun-Yanji is not possible and a link Rajin-
Hunchun will probably need to be implemented separately anyway (although using the same
masts).
It is proposed not to implement this step.
The next step in increasing capacity would provide for digital radio equipment on the existing
radio masts between Rajin, Sosura, Zarubino, Slavyank and Vladivostok.
A 34 Mbits connection would allow the following configuration to be established. Initially the
capacity would only be partially installed allowing later extension in relation to increasing
demand.
When this step is implemented, the FDM cable will be taken out of service.
Initial capacities would be: Hunchun-Vladivostok 8 Mb (120 ch), Rajin-

Vladivostok 2Mb (30 ch),
Rajin-Hunchun 2Mb (30 ch), Rajin-Yenchi-Beijing 4Mb (60 ch). Capacities by hop are initially:
Hunchun-Kraskino-Zarubino 16 Mb, Rajin-Zarubino 8 Mb, Zarubino-Vladivostok 10 Mb.
FIGURE 17

Problems to be examined relate to the technicalities of digitalization of the analogue link with
re-use of masts, antennas, feeders and power supplies, possibly with increase in transmit
power.
Although this option is cheap to implement, it would install the transmission hub for tele-
communications traffic in RF and would seem in contradiction to location of the economic hub
in Hunchun.
Optical Fibre Connection Between PRC and RF
When the railway between Hunchun and Kraskino is established, and when the national PRC
program of interconnecting the provincial capitals by optical fibre is completed, establishing an
optical fibre connection (140 Mbit/fibre) between Hunchun-Kraskino-Zarubi-o-Vladivostok
would be possible. The link mentioned in the paragraph before would at this moment be
increased in capacity on the section Rajin-Zarubino, where it would link into the optical fibre.
FIGURE 18

The section Hunchun-Zarubino-Vladivostok would provide a second path to the optical fibre
connection, increasing overall security of the network.
The loop structure provided in the masterplan, and linking Hunchun-Raji--Slavyanka, could be
completed by installing 2 new radio towers between Rajin and Hunchun (including buildings,
energy supply) and/or the installation of an optical fibre between Rajin and Hunchun.
FIGURE 19

Short Term Proposal
The use of Hunchun as a hub and transit point for traffic between Rajin and Slavyanka is
recommended.
As a consequence the problem of regional cross border connection is reformulated as the
provision of the links Hunchun - Kraskino/Zarubino on the one hand and Hunchun -
Rajin/Sonbong on the other.
Hunchun - Kraskino/Zarubino

The technical proposal consisting in the establishment of a 2Mbit link between Hunchun and
Kraskino (2 hop) and further continuation of this link on cable to Zarubino and Vladivostok is
supported for urgent implementation.
The following actions are recommended for immediate execution:

- installation of one radio tower in Kraskino completing the radio link Hunchun - Kraskino;
- installation of D/A conversion 2Mbit/30 channel in Kraskino and establishing connection
to Zarubino - Vladivostok (FDM cable).

Hunchun - Rajin/Sonbong
At the time of the road works connecting Hunchun to the area east of Wonjon Bridge, Jilin will
provide a 12 fibre, optical fibre link along the road. One pair of fibres will connect Rajin with
Hunchun. Under this agreement DPRK and PRC-Jilin will install all necessary equipment on
their respective territory with Wonjon Bridge as interconnection point.
DPRK will install a 63 km, 12-fibre optical link between Rajin-Sonbong-Wonjon Bridge
(planned to be installed before December 1994). This cable will connect to the link between
Rajin and Pyongyang and will carry the traffic between Chongjin-Hunchun and Rajin-Hunchun.
The same link will be used to connect the DPRK cities near the Tumen River, but outside the
Rajin-Sonbong FEZ, to Chongjin.
The following diagram proposes the transmission equipment to be used on the cable between
Chongjin-Rajin-Sonbong-Wonjon Bridge.
A spur connecting Sonbong to Ungsang and further to the airport site can be extended to
Khasan (RF), at a later date.
To standardize the equipment, all links will operate at 34 Mbit/s in PDH technology. At this
stage traffic expectations do not justify the use of more sophisticated SDH equipment which is
presently more expensive than PDH.
Equipment capacity assumes that traffic between Chongjin and Hunchun is equal to the traffic
between Rajin and Hunchun.
It is assumed that repeaters will need to be installed at distances above 50 km. Two repeaters
are to be provided, one on the link between Chongjin and Rajin, one between Sonbong and
Wonjon Bridge. This second one could be installed at Yang Yong, where a fibre will later
connect Undok and Saebyol to Chongjin.
FIGURE 20

REGULATORY ISSUES

THE CONCEPT OF PUBLIC SERVICE

In most countries telecommunications are supplied under a concept of "public service". No exact definition is available for this concept but in many cases the following characteristics are present:

The service is offered as "universal service": the operator must supply the service to any potential user over the whole region under his responsibility, and do so under a uniform tariff system.

The service is supplied under a monopoly which is initially justified on a cost basis. As the marginal cost related to the supply of a network continues to decrease, a monopoly supply is cheaper than any other arrangement; the monopoly is in fact a "natural monopoly". To avoid abuse of monopoly power, operations are executed under the supervision of the public authority, as part of a Ministry for telecommunications or a closely controlled government company.

The monopoly allows significant deviation between revenue structure (tariffs) and cost structure. As a result a cross subsidizing mechanism is created between regions (from urban to rural), between types of service (from international and long distance to local traffic) and between user groups (from business user to residential user); in practice also the first two mechanisms do create subsidizing flows between business and residential users).

All subsidizing is in fact internal to the sector and has even been extended in some cases by providing for subsidies to other activities related to the sector (e.g. the tele-communications equipment industry) and even unrelated to the sector (general monopoly rents payable to the government, postal service, etc.).

As far as the business users are concerned these subsidizing flows are similar to a taxation imposed on their use of telecommunication services.

Implications for TREDA

In many cases the situation has become politically irreversible. A new region like TREDA, where the constraints related to a large community of residential subscribers are not present, has the possibility to offer telecommunication services without imposing this kind of tax on the business community. The consequence would be especially important for large

users of tele-
communication services, where telecommunication costs represent a large proportion of total
production costs. An approach where telecommunication services would be offered under a
system of cost related tariffs would support the orientation of TREDA to become a zone
providing special attractiveness to the services industry.

PROFIT OPTIMIZATION VS COST RECOVERY

Profit optimization creates an important incentive for efficient resource allocation and provides
a powerful mechanism for continued renewal and development of products and services being
supplied.

Profit optimization can only be allowed however, in a situation where competition is real and
reasonably efficient. In a situation of a monopoly or oligopoly, there is a risk that profit
optimization will in fact result in high tariffs and profit levels in excess of those consistent with
recovery of economic costs.

As TREDA will use the quality and the price of its telecommunications resources as one of its
crucial advantages, operator activities should be based on profit optimization wherever this is
possible, to guarantee a continued development. As a consequence, a competitive market
structure will have to be created for the activities under consideration. Due care must be taken
however, to avoid the dangers of collusion between suppliers.

CONSIDERATIONS ON DEVELOPMENT COSTS

For a network of fixed layout (cable or fixed radio links), development costs increase less
rapidly than the capacity of the network. This observation explains why the monopolistic
market structure is often considered a "natural monopoly". In this situation important cost
reductions can result if competition is not allowed.

Clearly this conclusion goes again the result of the preceding paragraph. It is clear that
decisions about market structure must be taken in a pragmatic way, paying due attention to a
trade-off between the potential efficiencies of a natural monopoly. The most important
conclusion at this point is undoubtedly that decisions on market structure should not be taken
for the sector as a whole, but should be optimized for specific market segments.

INTERFACING WITH THE RIPARIAN COUNTRIES

It has been indicated that due to the relatively virgin state of the TREDA area, the regulatory

system for telecommunications can be designed in an optimal way and is relatively free from
constraints.
The situation is different in the surrounding areas of the riparian countries where sector
structures are different from one country to another and where existing systems are only
partially applicable to the specific situation of TREDA.
The creation of a specific regulatory environment for TREDA is clearly advised. On the other
hand this specific environment must be created in close coordination with the regulating
authorities in the riparian countries. Many services offered in TREDA will indeed connect to the
bordering regions. A "least cost development" will require the use of existing infrastructure,
situated in the riparian countries, to provide connectivity to TREDA. The conditions attached to
this service will have to be developed in common understanding between the riparian countries
and TREDA.

SECTOR ORGANIZATION
SECTOR STRUCTURE ALTERNATIVES
Introduction
Throughout the world, the classic approach, consisting in the provision of all tele-
communication services by the public authority, is increasingly replaced by an organization in
which regulation of the sector on the one hand, and provision of the services on the other, are
separated.
Objectives of this organizational specialization are mainly related to the introduction of
competition in providing telecommunication services to obtain more dynamic services
development, lower tariffs, and easier access to external (private) finance.
Creation of a distinct regulating authority allows the government to retain control of the sector
without tying up scarce financial resources in state owned facilities. When competition is only
partial, this control is required to avoid excessive tariffs and profits.
Alternatives
The following diagram divides the sector of telecommunications in three levels as follows.
Regulation
At this level a strategy is developed for the development of the telecommunications sector
where not only the sector itself is taken into account but also external effects (e.g. the role of
telecommunications in the economic development of a country).

Due to its global character, regulation can only be the responsibility of the public authority.

Long Term Business Strategy

At this level the long term development of the telecommunication sector is planned without consideration for the external effects (effects on other sectors). It is clear that strategic development of the sector as part of a global development (subject of regulation) or for its own sake (subject of business strategy) will not necessarily produce similar outcomes. The level of long term business strategy is closely linked to the financing of the sector.

Operational Management

At this level the strategy is implemented. It is this level that determines the efficiency of resource allocation.

As far as combination of the different levels of responsibility into one or more entities is concerned, the diagram provides four scenarios.

Scenario 1, summarised as "ministry", represents the combination of the 3 levels of responsibility into one entity which, due to its responsibility for regulation, can only be a public entity working under close supervision of the political authorities. Drawbacks of this structure are its slow decision making, its low response to markets and a tendency to sacrify the tele-communications sector to externalities.

Scenario 2, called "state company", would isolate the operational level from the other two. Operational decisions will be taken at a lower level and can be expected to be more efficient and be more diligent. In structures according to this diagram, externalities have a tendency to acquire more weight over time. This structure is unstable and as a consequence has a tendency to evolve towards the structure of a "Ministry".

Scenario 3, called "operating company", restricts the role of the authorities to the regulatory level. Business strategy and operational management are now located in an independent entity. This entity can be privately financed. This structure allows the public authorities to retain the essential controls of the sector. At the same time this structure provides a possibility for attracting private finance to the sector and can free public resources for other developments.

Clear arrangements (concession) on the operational autonomy of the operator are a prerequisite to make this structure function.

Scenario 4, "competitive structure", builds on scenario 3 where regulation and operations were separated. The possibilities of this structure are now taken one step further in that the independence of the operational level can now be used to allow more operators to work in competition with each other, in some or in all of the service segments. The diagram shows how it is possible within this structure to retain a monopoly in certain segments and to create competition in others. As in the preceding structure, clear arrangements between the regulator and the operators are required (concession for exclusive arrangements, licence for competitive arrangements).

FIGURE 21

EXISTING SITUATION IN TREDA COUNTRIES

As to the general organisation of the telecommunications sector, important differences apply in the four countries under consideration.

Present solutions range from complete state control including ownership of facilities (DPRK) to almost complete deregulation combined with private ownership of part the basic network (RF) (though this situation is perhaps only provisional). PRC and Mongolia occupy a middle position comparable to EC countries, allowing competition on non-basic services and the provision of customer premises' equipment (CPE).

The situation by country can be summarized as follows:

DPRK

Telecommunications are provided under a monopoly by the Ministry for Telecommunications.

There is no formal distinction between regulation and operations; the Ministry is also responsible for the industrial policy aspects regarding telecommunications provision (e.g. production of optical fibre).

PRC

As in DPRK a state monopoly is responsible for telecommunications provision. Within the monopoly the provinces, prefectures and individual cities have a degree of operational autonomy within strategic guidelines defined at central level.

At present (May 1994) foreign investment in network operations is not possible. The concept of "special zones" and "border zones" could be used to allow specific regulations within TREDA.

Mongolia

In Mongolia a formal distinction has been introduced between regulatory and

operational
matters, similar to EC guidelines. Regulatory responsibility is vested in the Mongolian Tele-
communications Ministry; the Mongolian Telecommunications Company is responsible for
operations and has a high degree of autonomy. Limited competition exists at the level of data
services provision.
RF
The public network, formerly operated by the Ministry of Telecommunications is still operated
as a monopoly but is to the same extent under competitive pressure from overlay networks
and dedicated networks. Licensing of those networks is subject to a complicated procedure
involving central approval as well as regional.
A temporary decree (approved by the president of the RF on 92.07.25) covers all tele-
communication activities in R.F.
All operator activities need to be covered by licenses delivered by the Ministry of Posts and
Telecommunications.
Operators can be implemented as private companies, state companies, mixed companies and
100% foreign held companies.
Public Operators
At this moment the main operator is Rostelecom who is alone licensed for carrying
public long distance and international traffic but who is also licensed to operate
telegraph service , data services, mobile services and local networks.
Rostelecom is a mixed joint stock company (shareholders: state, staff, the local
operators). Increase in private shareholders is planned but state will have to retain a
20% holding; the issue on foreign holdings is not resolved.
Rostelecom is the only operator licensed to engage in hard currency dealings and
settlements with foreign operators and employs 45,000 staff over the entire RF.
The local public operators are regional companies originating from the existing state
enterprises "Rossvyazinform".
The present Ministry, Rostelecom and the local Rosvyazinform companies were
formerly grouped in the Ministry.
Private Operators
Presently private operators fall into two groups:
Dedicated Networks
Those operators own switches, have their own customers, set their own tariffs. They can

provide no access to customers of the public network. These networks are usually connected
by satellite links to transit gateways in US or UK. Their licenses normally cover a 3-5 year
period.

Overlay Networks

Those networks must provide access to the public network using a public gateway.
International and long distance traffic will only be provided by the public network. For using
facilities they must pay usage fees to Rostelecom. Their tariffs are defined by the Ministry.
It is possible that at the expiration of the operating licenses, dedicated networks will be
relicensed as overlay networks and at a later date these overlay networks will be integrated in
the public local networks.

LONG TERM OPTIONS REGARDING SECTOR STRUCTURE

Introduction

The situation in TREDA can be summarized as follows:

- The area is only sparsely populated, allowing a regulatory system encouraging cost
based tariffs;
- Innovation in offered telecommunication services is highly important if TREDA wants to
build up and retain a competitive advantage based on telecommunication services. A
mixed market combining monopoly and competitive structures is indicated;
- For traffic between TREDA and other regions, existing operators in the riparian
countries can play an important role. For reasons of cost effectiveness, it is indicated
that all long distance traffic is transported by those operators under conditions however,
that transfer payments between TREDA and those operators do not endanger the attractiveness of TREDA;
- Finally TREDA cannot be kept under the national telecommunication regulations of the
riparian countries. The existing systems are different and would preclude uniformity
within TREDA.

It is proposed to create a sector structure based on following principles:

- Regulation and operations would be separated: this solution allows the governments of
the riparian countries to retain control of policy setting and gives maximum freedom for
organizing the operations;
- Operations themselves will be organized taking into account different services
segments and their characteristics (capital requirements, cost structure, development

dynamics).
In further paragraphs options will be proposed relating to:
- the coordination of regulation within TREDA and the relations between TREDA and the riparian countries regarding regulations;
- the number and the respective tasks of the operators active in TREDA, the role of the different operators presently existing in each of the riparian countries and the relations between those different operators.

Options Regarding the Creation of a Regulating Authority
Regarding the creation of a regulating body, two options can be identified.

(a) Under the first option the regulation remains national. Divergences within TREDA are avoided by the creation of a system of consultation between the Ministries for Tele-communications of DPRK, PRC, RF responsible for regulation within the national territory;

(b) The second option would create an autonomous regulating body responsible for the entire TREDA area. Authority of this body would be obtained by delegating national authority within the area of TREDA and within limits to be specified and possibly different from one country to another.

Options Regarding Telecommunication Operators
The following distinct sub-activities are proposed:
- network infrastructure: backbone network;
- network infrastructure and basic services (telephone, fax, basic data): terrestrial distribution network within TREDA;
- network infrastructure and basic services: radio distribution network within TREDA;
- value added network services (all services except "basic");
- customer premises equipment (including VSAT).

Options as to the organization of operations relate to:
- the market structure (monopoly, full or limited competition);
- ownership (public, private, mixed);
- operator area within TREDA (national, transnational).

LONG TERM PROPOSALS
Regulating Authority
The creation of a specific regulating body covering TREDA is advised (option (b)) for following reasons:
- the need to locate a proactive telecommunication body that is distinct from the operators within the area. This separate regulating body will be able to take into account the specific nature of TREDA and can promote cost based offering of tele-

communication services to a community initially composed of business users;

the slowness inherent in obtaining international consensus implied by option (a) would create important delays in the provision of new services and endanger the advantage of the region. Regulation of the sector would probably be rather weak under this option.

This weakness could be the source of important differences in the telecommunication sector within TREDA, and endanger the basic concept of a unified approach.

Option (b) avoids this danger if a sufficient level of delegation is provided to the TREDA regulator.

Operator Activities

Network Infrastructure: Backbone Network

In general this infrastructure concerns the links between the distribution points (switches) and encompasses high capacity radio links and cables linking those distribution points with other distribution points within TREDA and with the national networks outside TREDA. A more detailed picture of this network is provided in the chapter describing the technical outline.

Capital requirements for this service are high. Cost structures justify a monopolistic approach.

Consequently it is advised that this network be established under the existing national arrangements and that it uses the different public networks in each country to link TREDA to the international and national networks. Regulatory as well as market constraints, (limited competition will exist between the different national operators) will impose quality and financial conditions on the supply of services by the national operators.

The following conditions will need to be met:

The access points must be totally identified and specified.

National networks must be interconnected within TREDA so that the area is in fact interconnected into each of the bordering national networks and can access the international network by each of those three networks.

The backbone structure must provide sufficient capacity. The mutual interconnection of the national networks within TREDA will create the possibility of overflow for the international traffic from one network into another as a guarantee towards delayed investment in one of the national networks.

The financial conditions of accessing the national networks have to be specified and should be cost based. At a later stage competitive bidding for the handling

of the
international traffic to and from TREDA by the surrounding operators should be
allowed and encouraged and could provide a solution to this problem. TREDA
operators should be able to operate under conditions comparable to those obtained by
operators owning facilities or enjoying a right of use.
Taking into account the capacity that is at present available and that which will shortly come on
line, the creation of an international gateway facility within TREDA is not envisaged for the time
being. This position should be open to review by the regulating body however, and could be
changed if one of the aforementioned conditions is not met.
Network Infrastructure: Terrestrial Distribution Network
It is advised to create a unique operator, enjoying a monopoly within TREDA, but operating
under the obligation to connect all users to this infrastructure. Ownership structure could be
mixed with possible participation of the different national operators.
This operator would be allowed to provide all communication services between access points
on the backbone network and the user, and would be allowed to use all available technologies
to this extent with the exception of the use of radio techniques for low capacity connections of
final user sites.
It can be expected that as a consequence of those restrictions, the operator would specialize
in:

- switched telephone service, including fax, within dense user areas where distribution
can be done by cable or fibre;
- high capacity data services with connection by cable/fibre in dense areas, by digital
radio link for remote sites.

Network Infrastructure and Basic Services: Radio Distribution Network
It is advised to create an operator covering all of TREDA and enjoying a monopoly (and an
obligation to connect) within this area. The monopoly would be valid for a limited period of
time; at a future stage provision of this service would be open to competition. Ownership of this
operator should be mixed but should have a different majority compared to the terrestrial
network operator allowing effective competition between the two operators. Also this operator
would be allowed to provide all services but would be restricted to the use of radio links of low
capacity in the end distribution.
According to these restrictions this operator will specialize in:

telephony including fax and low binary rate data to remote fixed locations provide by
cellular or other radio techniques (Multiple access radio systems);
true mobile application of same services in the whole region (including densely
populated areas).

Provision of Value Added Network Services (VANS)

In this field capital requirements are moderate. Cost structure is to a large extent variable and
does not justify a monopoly. On the other hand this field of activity is the subject of many new
developments. As a consequence it is proposed to allow full competition in this field (EM
systems, Data verification, etc.).
Any ownership structure and full coverage of the area by any operator would be allowed.
Excluded from these operations would be the provision of network infrastructure. Infrastructure
and basic services required for the operations of VANS services, would be obtained from
operators under separate contracting arrangements.

Provision of Customer Premises Equipment (CPE), Including VSAT Systems

It is proposed to allow full competition in this area on condition of technical conformity to
published standards. Single user VSAT systems would be allowed without restriction. This
arrangement will provide potential competition and an efficiency check on efficiency on
operators of the backbone network and the local distribution networks. Connecting to VSAT
stations by multiple users would in any case imply the use of connections provided by
operators of local distribution networks, except where deviation from cost would be significant
(e.g. stemming from the use of inappropriate technology).

Summary

The global proposal regarding sector organization can be schematically represented as
follows.
FIGURE 22

FINANCIAL REGULATION OF THE SECTOR

INTRODUCTION

From the proposed sector organization it is clear that different agents will work together in a
coordinated way to provide telecommunication services in the area under consideration.
According to this proposal, the backbone network is provided for by the operators operating at
this moment in the respective countries. The establishment of the

distribution network on the other hand, including the billing of services to the final users, is conferred on two new operators working in an environment that is only partially competitive. This limitation requires some form of price regulation to be applied. Such a regulation can be used to manage the financial performance of the sector.

OPTIONS

Broadly speaking, two fundamentally different approaches are possible:

The first option would consider telecommunications as a business in itself taking only minimal account of externalities. Under this option a classic tariff structure, comparable to that prevailing in other regions, would be used and essentially be based on value pricing of traffic. Taking into account the user profile and the use of newest technologies in TREDA, substantial profits could be made. Price regulation under this structure would consist of applying some form of price capping, supplemented with an overall analysis of return on investment, to avoid exaggerate profits. Part of the profit expected by potential investors could flow back to the public authority if concessions would be awarded on the basis of a bid.

The second option would impose the supply of telecommunication facilities at minimal tariffs consistent with recovery of economic costs. Taking into account the special situation regarding customer base (only professional users) and user profile (relatively high traffic volume), a tariff structure based on high fixed cost and low traffic cost could be developed, creating a cost advantage for communication intensive industries in the area under consideration. Allowing a tariff structure similar to cost structure would also decrease the risk borne by investors and lower the cost of capital.

Under this option a system of price regulation should provide an incentive to minimal tariffs compatible with recovery of economic costs. A system could be installed giving complete tax relief if return on investment is below a certain threshold and imposing significant taxes above this level. An issue to be addressed concerns the possible over investment to lower the return under the threshold value.

PROPOSAL

It is advised to apply price regulation to the telecommunication sector

according to the second
option. The consequence would be that tariffs for telecommunication services would closely
follow costs, both in structure and in level. A detailed analysis should be performed to confirm
that due to this approach the area could present a telecommunication related cost advantage
to potential investors and that this approach could contribute to attracting communication
intensive users to this area.
Two remarks are to be made regarding this approach:

(a) This approach does not provide for cross subsidizing between large (professional) and
small (residential) users. If the latter increase in number, a minimal service for cheaper
residential telecommunications (which could be expensive under the proposed layout),
would consist of the provision of public phone booths at a number of locations.

(b) The regulation should also be applied to the services that are bought from the
operators supplying the backbone network. It is essential that the facilities used can be
obtained under a price structure reflecting the real cost of the facilities (fixed prices
linked to capacity rather than prices linked to actual volume). This aspect is of crucial
importance in the area of international telecommunications (cfr. 1.2.3).

SIMULATION

Objectives

The present simulation has following objectives:

- quantification of transfer payments and consequent transfer prices between TREDA
and national operators of the riparian countries for use by TREDA of the national
network for outgoing calls, the national backbone network linking TREDA to the
national toll switch and the international gateway;
- resulting tariff structure for telecommunications services in TREDA;
- resulting tariff advantages for TREDA.

Configuration (for Technical Details See Masterplan)

TREDA will be covered by two local distribution networks (not represented on following
diagram).
Those distribution networks will provide local communication within subareas of TREDA and
link those subareas to one of three main distribution points (one in each of the riparian
countries).
A ring structure will connect the three main distribution points between them and provide:

communications between subareas of TREDA;
the communications from TREDA to the riparian country corresponding to the
distribution point.
The main distribution points are connected to the national toll switch of the corresponding
riparian country and to the international gateway of the same country (admitted to be co-
located).
For tariff purposes the following charges are envisaged:
connection charge (covering investment in local distribution network);
subscription charge (covering non-traffic related operational costs);
traffic charges, subdivided according to following types of traffic:
local traffic (ring not used)
TREDA traffic (ring used)
traffic to riparian country
international traffic to non-riparian country.

Cost and Cost Allocation Scenario

Local Distribution Networks

The investment value is put at 1000 SDR/connection. (SDRs are "Special Drawing Rights" of
the International Monetary Fund. 1 SDR equals US$ 1.46, (October, 1994))
Annual operational cost is put at 10% of investment value.

Ring Structure

Investment values are put at:
750 SDR/junction for switching equipment
8000 SDR/km for links (140 MBits/s corresponding to 3840 channels)
links are estimated at 70 km each (average length);
Operational costs: 2% of investment value.

Links to National Toll Switches and International Gateways

Investment values:
750 SDR/junction for switching equipment
8000 SDR/km for links (140 MBits/s corresponding to 3840 channels)
links are estimated at 800 km each (average length);
Operational costs: 2% of investment value.

Use of National Network of Riparian Country from National Toll to Subscriber

Traffic volume related transfer charge of 0.05 SDR/min.

Use of International Links

Investment values:
Earthstation: 25 million SDR (capacity: 240 channels in + out);
Operational charges:
transponder use: 1.5 million SDR/year for 120 channels outgoing
maintenance: 0.2 Million SDR/yr
use of foreign network: 0.7 SDR /min.

TABLE 7

TABLE 8

Conclusions

The transfer prices for use of the network of the riparian countries between

TREDA and the
national toll switches/international gateways, have been calculated taking a discounting factor
of 25-35% into account. As a consequence the proposed tariffs cover economic costs more
than adequately.
For use of the national and international networks between those gateways and the
destination transfer prices have been set at 0,7 SDR/min for international calls and 0,05
SDR/min for national calls.
The transfer price for international links could be further lowered by negotiation and/or use of
cable links.
Resulting Tariff Structure
In the following tables resulting tariffs are calculated on a basis of discounting rates from 25-
35%. The resulting tariffs are:
connection charge (covers the amount of the initial investment):
        1000 SDR/connection
subscription charge
        100 SDR/ yr
traffic charges
        TREDA traffic: 0.006 SDR/min
        traffic to riparian country: 0.07 SDR/min
        international traffic: 0,9 SDR/min (collection rate).
Comparison with Tariffs in Other Regions
TABLE 9

Comparison of Telecommunications Costs Between TREDA and Other Regions
Figure 23 shows the annual cost of communications as a function of increasing traffic volume
(a constant mix of 20% 500 km and 80% intercontinental traffic is assumed).
The graph shows how intensive users obtain a cost advantage of 20-60% on communication
costs compared to users in other regions. For intensive use (32000 min/yr corresponds to ca. 2
h /day) the advantage compared to a site in western Europe amounts to 60,000 SDR/yr and
per line.
FIGURE 23

Remarks
It is obvious that the present calculations are approximate and that results have only an
indicative value. Their main interest is in illustrating the feasibility of creating a cost advantage
in TREDA, and to provide an illustration of the required mechanisms.
The reasoning which is followed in the present paragraph would also be used as an initial
model by the authority to be responsible for financial regulation of the

sector for:

- controlling the transfer prices between TREDA operator(s) and operators in the riparian countries;
- controlling the tariffs within TREDA.

In the present reasoning the main controlling factors are investment values, direct operational costs and rate of return. In practice the model will need to be extended with controls on the underlying cost efficiency.

FINANCING OPTIONS FOR SECTOR DEVELOPMENT

IDENTIFICATION OF OPTIONS

A large array of financing means are available for the financing of telecommunications networks. They can be inventoried as follows:

Grants

The amount of grants available for telecommunications is very limited; grants are mostly reserved for infrastructure development where revenue generation is difficult to arrange (roads, bridges, etc.).

Auto-financing

Telecommunication networks should generate substantial amounts of profit. Cash flow from operations can be use to finance the extension of an initial network. Limits on tariffs and characteristics of the customer base would limit the level of expansion to be financed from operations, to approximately 10% (e.g. in the case of a large scale public network).

External Financing

External financing involves the intervention of a partner who will want to make a profit on the financing provided.

External financing options can be classified according to the extent of involvement of the financing party in the subsequent operations.

Loans

Loans can be obtained from multilateral lending institutions and commercial institutions.

Supplier credit is an increasingly important possibility. The loan requires adherence to a payback schedule, and a schedule for paying interests. This schedule is fixed and cannot be adapted to changing economic circumstances.

For this reason lenders limit the amount of loans whereas recipients also want to avoid exaggerated exposure. A reasonable upper limit on loans is an amount equal to the amount of the "owners' equity" or 50% of total long term liabilities.

Revenue Sharing
Under a revenue sharing agreement an operator or a supplier will obtain part of the revenue
generated by the equipment they supplied during a limited period of time. After that time the
equipment is fully operated by the recipient.
A participant in a revenue sharing agreement is normally not involved in the operation of the
company (operating costs are not of his concern).
The total expense of a revenue sharing agreement to the recipient is higher than for a loan
because of the higher risk.
Build Operator Transfer Agreement (BOT)
Under a BOT agreement a partner (supplier, operator) provides the necessary finance and
recoups investment and financing costs by participating in the operation.
Apart from financing, the transfer of management know-how is an important aspect.
A BOT agreement is limited in time (5-15 years).
Joint Venture
A joint venture is normally concluded for an unspecified time. It is similar to a BOT agreement
except that the undefined time makes it possible to provide for a continued investment.
EXAMPLE FOR FINANCIAL STRUCTURE
Introduction
The following paragraph presents a financing scheme for TREDA which draws to a large
extent on the existence of TRADCO, the TREDA operating company.
Although the example could be put into practice for the initial development of the networks in
DPRK and in RF, its major importance is to identify possibilities and issues which need to be
addressed for the longer term expansion of the network.
Preliminary Assumptions
Development of infrastructure in TREDA requires a large amount of capital investment. Private
investment can be obtained if sufficient financial return is generated.
For telecommunications networks the international and the long distance networks are most
obvious targets for commercial investment. Both allow high profit margins to be obtained and
are not easy to finance by the users themselves.
For local networks the situation is different. Although in TREDA the emphasis will be on
commercial users, local networks mostly generate lower profit margins and require a large
amount of pre-financing. As the cost of local network establishment can be more easily
allocated to each individual user, user financing is an alternative.
For TREDA the following financing preliminaries are assumed.

As the existing international networks will be used, no specific financing mechanism is
proposed for those networks. Network extensions which might be required will be taken care
off by existing operators.
For the development of the long distance network interconnecting Hunchun-Rajin-Slavyanka a
financing mechanism is developed, including each of the three public operators of the riparian
countries, TRADCO and a foreign investor.
For the development of local cable networks no specific financing structure is proposed
(mobile service is to be examined at a later stage). A small initial investment in local networks
in DPRK and RF is however required and is proposed as a side effect of the establishment of
the long distance structure.
Structure
The company responsible for operating the long distance network between Hunchun-Rajin-
Slavyanka, the Tumen River Economic Development Area Telecommunication Operator
(TREDATO), will be owned by the following parties:

- The public network operators of the riparian countries: 5% each;
- TRADCO: 40%;
- A foreign investment group: 45%.

In this structure all new cashflow is provided by the foreign investor.
Local control and coordination by existing public network operators (local networks and
international networks) is provided for by:

- direct participation (5%) in the capital of TREDATO;
- indirect participation through TRADCO (all TREDA countries); TRADCO will be
represented in TREDATO by telecommunication experts.

The TRADCO countries also control TREDATO through the operating license delivered by
TRIT, which will be based on a policy approved by each of the member countries.
FIGURE 24

Points for Further Elaboration
Operating License
The operating license will address following issues; some obligations may be taken care off in
the company charter or constitution and should not be contradicted by the license:

- Time duration;
- Reinvestment of profits and expansion plans;
- Conditions at termination of concession (liquidation at book value/economic value,
valuation);

Conditions on concession renewal;
Exclusivity on traffic;
Obligation to carry all traffic;
Accounting and audit;
Procedure for financial regulation (open books);
Technical interconnecting interface definition;
Financial interface: transfer price to TREDATO for use of network by subscribers,
transfer price to PTO's for use of equipment (mast, power supplies, buildings), transfer
price to TRADCO for services.

Relations with TRADCO

The relations between TRADCO and TREDATO are twofold:
As a shareholder, TRADCO is co-responsible for managing TREDATO and has a decisive
voice in the allocation of profits generated by TREDATO.
TRADCO will also operate as a subcontractor for TREDATO in a number of fields, e.g.
accounting, financial and legal services;
customer relations including revenue collection;
non telecommunication specific maintenance;
local representation in TREDA of other shareholders.

Relations with PTO's in Riparian Countries

Relations with riparian PTO's have a technical as well as a financial dimension.
Technical constraints:
technical interfaces between local networks and TREDATO network and between
TREDATO network and national long distance networks and international gateways.
Financial constraints:
transfer price to TREDATO for use of network by subscribers;
transfer price to PTO's for use of equipment (masts, power supplies, buildings);
transfer price to TRADCO for services.
A special issue concerns the provision of equipment allowing the establishment of local
networks in Rajin-Sonbong and Kraskino-Zarubino areas.
When operations are fully established, financing of local network equipment will to a large
extent be provided by reinvestment of profits generated by TREDATO according to the
decisions by the TREDATO board and conforming to the company constitution.
At the start of operations a limited amount of equipment will be provided in the form of a down
payment compensating for the use in common of existing equipment, owned by the PTO's.
The following table provides an example of this set-up.

TREDATO	
Capital:	$ 1,000,000
Investment:	

```
                radio equipment:        700,000
                        to loc. DPRK:          30,000
                        to loc. PRC:           30,000
                        to loc. RF:            60,000
        LOCAL OPERATORS
        DPRK: loc. switch 200 lines            70,000
        RF: loc. switch 200 lines             70,000
        *        $ 15,000/mast
        **        $ 350/line
```

PROPOSAL FOR REGULATORY INSTITUTE

TASK DESCRIPTION

Regulation of the telecommunication sector covers following fields.

Sector Structure

This field addresses the market structure (monopoly/competition) under which tele-
communication services will be supplied, taking into account entry costs, advantages of scale,
and innovation dynamics of the specific sub-sector.

Regulation of the sector structure in TREDA should also pay attention to the multinational
character of the region; a strict coordination between the different riparian countries is
essential.

Initial proposals for TREDA have already been prepared and can be used as a basis for
discussion.

Ownership Issues

To relieve the capital requirements on the public authorities in TREDA, it is proposed to
finance network development by using private capital wherever possible. Contrary to many
other infrastructure developments (e.g. roads), the fact that costs as well as revenues are
easily allocated to a given user allows for commercial financing of operations in the tele-
communication sector.

Even with private finance, the public authorities remain involved in the long term strategy of
network developments. This control can be applied exclusively through the regulatory function
(licensing, etc.), or through a combination of licensing and participating in the capital of the
operators. The multinational dimension of TREDA is again an important and specific issue in
the establishment of operators covering the whole area. The possible participation of foreign
capital suppliers will equally be addressed.

The example regarding sector structure and finance discussed in former chapters can be used
as a basis for discussion.

Conditions on Market Access by Different Operators

The regulatory authority will define the conditions to which the operating license will be subject.

Those conditions will address:

- duration of the concession or license, procedures for termination and renewal;
- technical standards, including those dominating the interconnection with customers and/or other operators;
- the quality and performance requirements which the operator has to satisfy; those parameters, target values, measurement procedures will be defined as well as the rules which will apply in the case of non respect of those conditions;
- network expansion plans (technologies used, quantities, location);
- financial conditions (tariffs to users, interconnect charges);
- information to be supplied to the regulator and to the public;
- audit procedures;
- respect of privacy of communications;
- responsibility and liability limitation.

It will be examined to what extent the licensing regime can be made specific by service categories (concession, license, class license, publication, etc.).

Financial Regulation

The regulatory body will audit financial performance of the operators in TREDA with following objectives:

- obtain cost based tariff for each service group;
- generate adequate return on investment;
- guaranteed sizeable reinvestment of operating cashflow in the telecommunication network development within TREDA.

The regulator will have a right of enforcement on tariffs between operators mutually and between operators and users. Procedures for information provision, decision, appeal and enforcement will be defined.

Institutions

It is recommended that a specific regulating body be created for TREDA. This body should have extended autonomy within limits imposed by each of the national authorities.

The status of this body and its functions need to be defined within each of the national laws.

Its relation with each of the national bodies will be defined and will take into account the different national telecommunication related structures (ministry, standardization body, etc.) as well as other government authorities (other branches of the executive power, legislative and judicial bodies).

STRUCTURE
The "Telecommunications Regulatory Institute for TREDA (TRIT)" will be organized according
to a three tier structure as follows.
Board
Composition:
The institute will function under the responsibility of a Board of Directors, composed of
six voting members and four members with advisory capacity.
Each of the TREDA countries will have two members, one drawn from the TREDA
commission and one drawn from the regulating body in the member country.
The riparian countries will be represented by two voting members each.
Task description:
The Board will be responsible for policy approval and will discuss proposals with the
relevant national authorities if necessary, and for activity evaluation of the TRIT
administration.
Core Staff
Composition:
The core staff will consist of three experts respectively in the financial, legal and
technical fields. They will be permanently appointed but part-time assigned. They will
preferentially be obtained from Regulating Authorities within each of the riparian
countries.
Task description:
The core staff will be responsible for all work regarding policy proposal and execution
of approved policy.
Permanent Secretariat and Auxiliary Staff
Composition:
as required.
Task description:
permanent contact point for operators and users in TREDA; administrative support to
core staff.

IMPLEMENTATION PLAN
Implementation of the proposal will proceed in a number of steps:
1. The first step will be to discuss with the relevant authorities, the politically very sensitive
issues that have been raised in this proposal.
Up to now those authorities (the Ministries of Communication) have only been marginally
involved.
2. Pending the outcome of those discussions and assuming the trust towards a unified

regulatory regime will be supported, the second step would consist of institutional
development, leading to the establishment of an autonomous regulatory institute for TREDA.
The creation of the "Tumen Regulatory Institute for Telecommunications" (TRIT) will be
preceded by a intermediate phase during which a specialized work group of permanently
appointed members will provide the link between the actual subgroup for telecommunications
and PMC (or the commission) on the one hand, and the central regulatory authorities on the
other. Members will be sufficiently near to the central authorities to obtain rapid decisions on
present regulatory issues.
The evolution of the regulatory institute is schematically given in following figure.
3. As a third step the regulatory institute will have to detail its working procedures,
examine the different issues and decide how it will formalize its decisions towards the users
and suppliers of telecommunications services in TREDA.
A proposal regarding those matters will be established by the regulatory institute itself at the
start of its operation.
FIGURE 25

TABLE 1

Location
Type of Exchange
Number of
Channels
Number of
Subscriber Lines
Vladivostok
Khabarovsk
Sakhalinsk
Nakhodka
Yakutsk
Irkoetsk
international
local switch
local switch
PBX
PBX
PBX
42
8

10
8
8
8
100 + 50 + 44
50
116
20
34
117

TABLE 2

Hong Kong (1990)
Singapore (1991)
TREDA (2032)
Population
(million)

5.8

2.8

4.1
GDP
(billion US$)

83

40

59
GDP/cap
($ 1,000)

14.3

14.3

14

TABLE 3
Y
POP
GDP
GDP/C

Pen
subscr
intal
traffic
loc traff
loc traff
traff/s

* 1000
* $ bill
* $1000
%
* 1000
mill min
multiplr
mill min
min/yr
1993
3000
8.5
2.8
4.0
120
60
2
119
1488
1994
3105
8.9
2.9
4.8
148
62
2
127
1286
1995
3215
9.3
2.9
5.5
177
65
2
137
1143
1996
3329
9.8
2.9

6.3
208
69
2
147
1037
1997
3447
10.3
3.0
7.0
242
72
2
159
956
1998
3570
11.0
3.1
7.8
278
77
2
173
900
1999
3698
11.8
3.2
8.5
316
83
2
191
865
2000
3831
12.9
3.4
9.3
357
90
2
213
850
2001
3969
14.4
3.6
10.1

402
101
2
244
858
2002
4113
16.6
4.0
11.0
451
116
2
287
894
2003
4265
19.0
4.4
11.8
502
133
3
336
934
2004
4428
21.6
4.9
12.6
558
151
3
393
977
2005
4602
24.6
5.3
13.4
617
172
3
458
1022
2006
4787
27.9
5.8
14.2
680

195
3
532
1068
2007
4985
31.5
6.3
15.0
749
221
3
615
1117
2008
5198
35.5
6.8
15.8
822
249
3
710
1166
2009
5426
40.0
7.4
16.6
902
280
3
817
1216
2010
5671
44.8
7.9
17.4
988
313
3
938
1267
2011
5935
50.1
8.4
18.2
1081
350

3
1074
1318
2012
6211
55.8
9.0
19.0
1180
391
3
1226
1370
2013
6500
62.1
9.6
19.8
1287
435
3
1397
1423
2014
6803
68.3
10.0
20.6
1400
478
3
1572
1465
2015
7120
74.3
10.4
21.3
1520
520
3
1753
1495
2016
7418
80.2
10.8
22.1
1641
561
3

1937
1523
2017
7698
86.0
11.2
22.9
1762
602
4
2126
1549
2018
7959
91.5
11.5
23.6
1882
641
4
2319
1572
2019
8202
96.9
11.8
24.4
2002
679
4
2515
1595
2020
8427
102.2
12.1
25.2
2122
715
4
2714
1617
2021
8636
107.3
12.4
25.9
2240
751
4
2918

1638
2022
8828
112.2
12.7
26.7
2357
785
4
3125
1659
2023
9005
117.0
13.0
27.5
2472
819
4
3336
1680
2024
9168
121.6
13.3
28.2
2587
851
4
3551
1702
2025
9316
126.1
13.5
29.0
2699
883
4
3771
1724
2026
9452
130.5
13.8
29.7
2810
913
4
3995
1746

2027
9577
134.7
14.1
30.5
2920
943
4
4224
1770
2028
9690
138.8
14.3
31.2
3028
972
5
4457
1793
2029
9793
142.8
14.6
32.0
3134
1000
5
4697
1818
2030
9887
146.8
14.8
32.8
3239
1027
5
4942
1843
2031
9972
150.6
15.1
33.5
3342
1054
5
5192
1869
2032

10050
154.4
15.4
34.3
3444
1081
5
5449
1896

TABLE 4

	A	B	C	A'	B'	C'	Xa	Xb	Xc	T
A	(*)	(*)	(*)	39	39	39	50	-	-	167
B	(*)	(*)	(*)	39	39	39	-	50	-	167
C	(*)	(*)	(*)	39	39	39	-	-	50	167
A'	39	39	39	n	n	n	n	n	n	117
B'	39	39	39	n	n	n	n	n	n	117
C'	39	39	39	n	n	n	n	n	n	117
Xa	50	-	-	n	n	n	n	n	n	50
Xb	-	50	-	n	n	n	n	n	n	50
Xc	-	-	50	n	n	n	n	n	n	50
T	167	167	167	117	117	117	50	50	50	1002

(*): local traffic data not available
n: not subject to TREDA development
numbers give traffic volumes between origin (vertical) and destination (horizontal) in million minutes.
A, B, C: primary nodes; A', B', C': national toll centres; Xa, Xb, Xc: international gateways; T: totals

TABLE 4A

link	traffic	total link traffic (Mm) (one direction only)
AB	AB (*), AB'	39 (*)
AC	AC(*), AC'	39 (*)

AA'	AA', BA', CA'	117
AXa	AXa	50

(*) local traffic not included

TABLE 5

Link	Unidirectional Traffic (Mmin)	Bidirectional Traffic (Mmin)	Number of Channels Required	Badnwidth Mo. of 140 MBit/s systems
AB	185	370	234	100
AC	185	370	234	100
AA'	117	234	148	63
AXa	50	100	64	27
	7400	7400	4680	2000
	7400	7400	4680	2000
	4680	4680	2960	1264
	2000	2000	1264	540
	474	474	300	128
	474	474	300	128
	300	300	190	81
	128	128	81	35
	4	4	3	2
	4	4	3	2
	3	3	2	1
	1	1	1	1

TABLE 6

Rajin-Sonbong: traffic estimate

subscriber lines

traffic (av)
local

Chongjin

Pyongyang

Hunchun

localization
number
(Erl)
%
Erl
%
Erl
%
Erl
%
Erl

1 business centre

200
0,2
50%
20
10%
4
15%
6
25%
10

2 Hotel

25
0,1
40%
1
10%
0,25
25%
0,625
30%
0,75

3 Harbour

official use
100
0,1
50%
5
10%
1
15%
1,5
25%
2,5
commercial use
100
0,1
40%
4
10%
1
20%
2
30%
3

4 Industrial zones

250
0,1
20%
5
0%
0
40%
10
40%
10

5 Residential & business

100
0,1
20%
2
10%
1
35%
3,5
35%
3,5

6 Sonbong (RSU)

100
0,1
20%
2
10%
1
30%
3
40%
4

7 Unsang-airport (RSU)

100
0,1
20%
2
10%
1

30%
3
40%
4

Totals

975

41

9,25

29,63

37,75

TABLE 7

Scenario 1: discounting @ 25%

TREDA Tariff simulation
(financial unit: SDR)

end capacity of channels
1000'/y
80

growth factor
%/y
10

discounting factor
%
25

earth
ldd link
ldd
ring
ring
local

station
link
switch
link
switch
switch
investment (million SDR)
2,50
6,40
0,00
0,60
0,00
0,00
service period
5,00
10,00
10,00
10,00
10,00
10,00
no of channels
120,00
3840
1,00
3840
1,00
1,00
final traffic (million '/y)
9,60
307,20
0,08
307,20
0,08
0,08
initial traffic (million'/y)
5,96
307,20
0,08
307,20
0,08
0,08

operational costs(M SDR)
0,20
0,01

0,00
0,00
0,00
0,00
transponder costs(M SDR)
0,15

investment cost/'
0,10
0,01
0,00
0,00
0,00
0,00
operational cost/'
0,03
0,00
0,00
0,00
0,00
0,00
transponder cost/1'
0,03

COST SUMMARY

use of earth station
0,16

use of ldd link&switch
0,01

use of ring link&switch
0,01

use of foreign network
0,70

use of national network
0,05

TARIFFS

connection charge
1,00

subscription
0,10

TREDA traffic
0,01

traffic to riparian country
0,07

international traffic
0,87

TABLE 8

Scenario 2: discounting @ 35%

TREDA Tariff simulation

(financial unit: SDR)

end capacity of channels
1000'/y
80

growth factor
%/y
10

discounting factor
%
35

earth
ldd link
ldd
ring
ring
local

stat
link
switch
link
switch
switch
investment (million SDR)
2,50
6,40
0,00
0,60
0,00
0,00
service period5,00
10,00

10,00
10,00
10,00
10,00

no of channels
120,00
3840
1,00
3840
1,00
1,00
final traffic (million '/y)
9,60
307,20
0,08
307,20
0,08
0,08
initial traffic (million'/y)
5,96
307,20
0,08
307,20
0,08
0,08

operational costs(M SDR)
0,20
0,01
0,00
0,00
0,00
0,00
transponder costs(M SDR)
0,15

investment cost/'
0,11
0,01
0,01
0,00
0,01
0,01
operational cost/'
0,03
0,00
0,00
0,00
0,00
0,00
transponder cost/1'
0,03

COST SUMMARY

use of earth station
0,17

use of ldd link&switch
0,02

use of ring link&switch
0,01

use of foreign network
0,70

use of national network
0,05

TARIFFS

connection charge
1,00

subscription
0,10

TREDA traffic
0,01

traffic to riparian country
0,07

international traffic
0,89

TABLE 9

Connection
Charge
Subscription
Charge
Traffic
(500 km)
Traffic
(Interncontinental)

SDR
SDR/yr
SDR/1'
SDR/1'
W-Europe
100
100
0.7
3
USA
100
100
0.8
1.2
F-East
100
100

1
2
TREDA
1000
100
0.07
0.9

TABLE 1

TABLE 1

Location	Type of Exchange	Number of Channels	Number of Subscriber Lines
VladivostokKhabarovsk Sakhalinsk Nakhodka Yakutsk Irkoetsk	internationallocal switchlocal switchPBXPBXPBX	42810888	100 + 50 + 44501162034117

TABLE 2

	Hong Kong (1990)	Singapore (1991)	TREDA (2032)
Population(million)	5.8	2.8	4.1
GDP(billion US$)	83	40	59
GDP/cap($ 1,000)	14.3	14.3	14

TABLE 3

Y	POP	GDP	GDP/C	Pen	subscr	intal traffic	loc traff	loc traff	traff/s
	* 1000	* $ bill	* $1000	%	* 1000	mill min	multiplr	mill min	min/yr
1993	3000	8.5	2.8	4.0	120	60	2	119	1488
1994	3105	8.9	2.9	4.8	148	62	2	127	1286
1995	3215	9.3	2.9	5.5	177	65	2	137	1143
1996	3329	9.8	2.9	6.3	208	69	2	147	1037
1997	3447	10.3	3.0	7.0	242	72	2	159	956
1998	3570	11.0	3.1	7.8	278	77	2	173	900
1999	3698	11.8	3.2	8.5	316	83	2	191	865
2000	3831	12.9	3.4	9.3	357	90	2	213	850
2001	3969	14.4	3.6	10.1	402	101	2	244	858
2002	4113	16.6	4.0	11.0	451	116	2	287	894
2003	4265	19.0	4.4	11.8	502	133	3	336	934
2004	4428	21.6	4.9	12.6	558	151	3	393	977
2005	4602	24.6	5.3	13.4	617	172	3	458	1022
2006	4787	27.9	5.8	14.2	680	195	3	532	1068
2007	4985	31.5	6.3	15.0	749	221	3	615	1117
2008	5198	35.5	6.8	15.8	822	249	3	710	1166
2009	5426	40.0	7.4	16.6	902	280	3	817	1216

2010	5671	44.8	7.9	17.4	988	313	3	938	1267
2011	5935	50.1	8.4	18.2	1081	350	3	1074	1318
2012	6211	55.8	9.0	19.0	1180	391	3	1226	1370
2013	6500	62.1	9.6	19.8	1287	435	3	1397	1423
2014	6803	68.3	10.0	20.6	1400	478	3	1572	1465
2015	7120	74.3	10.4	21.3	1520	520	3	1753	1495
2016	7418	80.2	10.8	22.1	1641	561	3	1937	1523
2017	7698	86.0	11.2	22.9	1762	602	4	2126	1549
2018	7959	91.5	11.5	23.6	1882	641	4	2319	1572
2019	8202	96.9	11.8	24.4	2002	679	4	2515	1595
2020	8427	102.2	12.1	25.2	2122	715	4	2714	1617
2021	8636	107.3	12.4	25.9	2240	751	4	2918	1638
2022	8828	112.2	12.7	26.7	2357	785	4	3125	1659
2023	9005	117.0	13.0	27.5	2472	819	4	3336	1680
2024	9168	121.6	13.3	28.2	2587	851	4	3551	1702
2025	9316	126.1	13.5	29.0	2699	883	4	3771	1724
2026	9452	130.5	13.8	29.7	2810	913	4	3995	1746
2027	9577	134.7	14.1	30.5	2920	943	4	4224	1770
2028	9690	138.8	14.3	31.2	3028	972	5	4457	1793
2029	9793	142.8	14.6	32.0	3134	1000	5	4697	1818
2030	9887	146.8	14.8	32.8	3239	1027	5	4942	1843
2031	9972	150.6	15.1	33.5	3342	1054	5	5192	1869
2032	10050	154.4	15.4	34.3	3444	1081	5	5449	1896

TABLE 4

A B C A' B' C' X_a X_b X_c T

A (*) (*) (*) 39 39 39 50 - - 167

B (*) (*) (*) 39 39 39 - 50 - 167

C (*) (*) (*) 39 39 39 - - 50 167

A' 39 39 39 n n n n n n 117

B' 39 39 39 n n n n n n 117

C' 39 39 39 n n n n n n 117

X_a 50 - - n n n n n 50

X_b - 50 - n n n n n 50

X_c - - 50 n n n n n 50

T 167 167 167 117 117 117 50 50 50 1002

(*): local traffic data not available

n: not subject to TREDA development

numbers give traffic volumes between origin (vertical) and destination (horizontal) in million minutes.

A, B, C: primary nodes; A', B', C': national toll centres; X_a, X_b, X_c: international gateways; T: totals

TABLE 4A

link traffic total link traffic (Mm)

(one direction only)

AB AB (*), AB' 39 (*)

AC AC(*), AC' 39 (*)

AA' AA', BA', CA' 117

AX_a AX_a 50

(*) local traffic not included

TABLE 5

Link	Unidirectional Traffic (Mmin)	Bidirectional Traffic (Mmin)	Number ofChannels	Required Badnwidth	Mo. of 140MBit/s systems
ABACAA'AXa	18518511750	370370234100	740074004680 2000	474474300 128	4431

TABLE 6

Rajin-Sonbong: traffic estimate

subscriber lines		**traffic (av)**	**local**		**Chongjin**		**Pyongyang**		**Hunchun**	
localization	**number**	**(Erl)**	**%**	**Erl**	**%**	**Erl**	**%**	**Erl**	**%**	**Erl**
1 business centre										
	200	**0,2**	**50%**	**20**	**10%**	**4**	**15%**	**6**	**25%**	**10**
2 Hotel										
	25	**0,1**	**40%**	**1**	**10%**	**0,25**	**25%**	**0,625**	**30%**	**0,75**
3 Harbour										
official use	**100**	**0,1**	**50%**	**5**	**10%**	**1**	**15%**	**1,5**	**25%**	**2,5**
commercial use	**100**	**0,1**	**40%**	**4**	**10%**	**1**	**20%**	**2**	**30%**	**3**
4 Industrial zones										
	250	**0,1**	**20%**	**5**	**0%**	**0**	**40%**	**10**	**40%**	**10**
5 Residential & business										
	100	**0,1**	**20%**	**2**	**10%**	**1**	**35%**	**3,5**	**35%**	**3,5**
6 Sonbong (RSU)										
	100	**0,1**	**20%**	**2**	**10%**	**1**	**30%**	**3**	**40%**	**4**
7 Unsang-airport (RSU)										
	100	**0,1**	**20%**	**2**	**10%**	**1**	**30%**	**3**	**40%**	**4**
Totals										
	975			**41**		**9,25**		**29,63**		**37,75**

TABLE 7

Scenario 1: discounting @ 25%

TREDA Tariff simulation (financial unit: SDR)

end capacity of channels	1000'/y	80				
growth factor	%/y	10				
discounting factor	%	25				
	earth station	ldd link link	ldd switch	ring link	ring switch	local switch
investment (million SDR)	2,50	6,40	0,00	0,60	0,00	0,00
service period	5,00	10,00	10,00	10,00	10,00	10,00
no of channels	120,00	3840	1,00	3840	1,00	1,00
final traffic (million '/y)	9,60	307,20	0,08	307,20	0,08	0,08
initial traffic (million'/y)	5,96	307,20	0,08	307,20	0,08	0,08
operational costs(M SDR)	0,20	0,01	0,00	0,00	0,00	0,00
transponder costs(M SDR)	0,15					
investment cost/'	0,10	0,01	0,00	0,00	0,00	0,00
operational cost/'	0,03	0,00	0,00	0,00	0,00	0,00
transponder cost/1'	0,03					
COST SUMMARY						
use of earth station	0,16					
use of ldd link&switch	0,01					
use of ring link&switch	0,01					
use of foreign network	0,70					
use of national network	0,05					
TARIFFS						
connection charge	1,00					
subscription	0,10					
TREDA traffic	0,01					
traffic to riparian country	0,07					
international traffic	0,87					

TABLE 8

Scenario 2: discounting @ 35%

TREDA Tariff simulation		(financial unit: SDR)				
end capacity of channels	1000'/y	80				
growth factor	%/y	10				
discounting factor	%	35				
	earth stat	ldd link link	ldd switch	ring link	ring switch	local switch
investment (million SDR)	2,50	6,40	0,00	0,60	0,00	0,00
service period5,00	10,00	10,00	10,00	10,00	10,00	
no of channels	120,00	3840	1,00	3840	1,00	1,00
final traffic (million '/y)	9,60	307,20	0,08	307,20	0,08	0,08
initial traffic (million'/y)	5,96	307,20	0,08	307,20	0,08	0,08
operational costs(M SDR)	0,20	0,01	0,00	0,00	0,00	0,00
transponder costs(M SDR)	0,15					
investment cost/'	0,11	0,01	0,01	0,00	0,01	0,01
operational cost/'	0,03	0,00	0,00	0,00	0,00	0,00

transponder cost/1'	0,03
COST SUMMARY	
use of earth station	0,17
use of ldd link&switch	0,02
use of ring link&switch	0,01
use of foreign network	0,70
use of national network	0,05
TARIFFS	
connection charge	1,00
subscription	0,10
TREDA traffic	0,01
traffic to riparian country	0,07
international traffic	0,89

TABLE 9

	ConnectionCharge	Subscription Charge	Traffic(500 km)	Traffic (Interncontinental)
	SDR	SDR/yr	SDR/1'	SDR/1'
W-Europe	100	100	0.7	3
USA	100	100	0.8	1.2
F-East	100	100	1	2
TREDA	1000	100	0.07	0.9
