9.4 Development Indicator of Access Network

There are several types of access networks, and access network may be developed according to the development/expansion of the services.
In this chapter, the development indicators for various access networks are mentioned.

9.4.1 Metallic Access Network

The conventional metallic access network in Vietnam has been constructed widely and will be still mainly expanded with the growth of the POTS demand.
In the near future, a metallic access network is expected to be utilized not only for POTS but also for new services of N-ISDN (Narrow-band ISDN) and xDSL (Digital Subscriber Line) which enable the access network to provide higher speed digital services.
Therefore, sufficient amount and quality of the networks are important. In the case of metallic access network utilization, the following should be considered.

(1) Subscriber Cable Network

As described in section 5.3.1 Figure 5.3.1-1, the metallic cable network shall consist of primary and secondary cable sections that shall be cross-connected in one Cabinet. Several steps of the cross-connecting points are not preferable in a maintenance aspect rather than effective usage of the cable pairs.
For the subscriber cable expansion/maintenance activities in Vietnam, the following design policies are recommended;

(a) Transmission Loss

The maximum transmission loss for subscriber cable; 7 dB

(b) Cable Loop Resistance

The maximum cable loop resistance ; 1,000 Ω.

(c) Provision periods for Planning

The provision periods for the facility planning minimizing the total costs shall be appropriately defined and authorized in Vietnam. The recommended provision periods are listed in the Table 9.4.1-1.

Table 9.4.1-1 Provision periods

(Years)

	Indonesia	Philippine	Japan	CCITT GAS2*	Vietnam
Primary Cable in Duct	5	5	5	5 to 10	5
Primary Direct Buried	10			10 to 20	
Secondary Cable	10	5	10	10 to 20 ≥ 20**	10
Duct System	15	15	15	20 to 40	15

Note : * CCITT GAS2 (1979) "Local Network Planning"
** for direct buried cables

(d) Primary Section

The primary cables shall be so designed as to meet the demands of the defined provision period. Along the primary cable route, the cable pair units distributed to the cabinets shall be gathered into a big size cable that is drawn to the local exchange building.

The cable shall be basically laid into the duct between MDF and a Cabinet and not have auxiliary intermediate cross-connection points other than at end Cabinet.

The cross-connection Cabinet can increase the flexibility of the primary cable network and furthermore, it splits up into primary and secondary parts with the different provision periods. The use of the Cabinet is not worthwhile in small subscriber line network or parts of the network where the subscriber fluctuation is small. The best location of the Cabinet in the area shall be where the number of secondary cable lines routed back in the direction of the exchange plus the primary cable lines is approximately equal to the number of remaining secondary cable lines.

(e) Secondary Section

The secondary cables shall be designed with capacities based on the provision period and buried directly or installed overhead, into the ducts in urban areas.

Since the load of a specific DP can not be predicted with any degree of accuracy, the DP planning should not be based on the full capacity of the DP, that is to say the planned utilization shall be maximum 80% of the capacity.

(f) Duct System

The duct system shall be designed with due consideration of the sufficient and minimum capacity based on the provision period in order to avoid the

difficulties of road excavation as mentioned in the Section 5.3.1. Furthermore, the future optical access network plan shall be taken into account. Since the optical fiber cables are much smaller than the metallic cables, one duct may be shared by several inner sub-ducts.

(2) N-ISDN (BRI) on Metallic Cable Network

The local subscriber network with the metallic cables has been providing the means for subscriber connection to the plain old telephone service (POTS), without encountering any major transmission problems at the voice frequency band of 300 to 3,400 Hz. Meanwhile, the current metallic cable networks can provide a new digital access service of N-ISDN (BRI) basic rate by utilizing as a bi-directional transmission medium.

As compared with POTS, the transmission frequency bands of N-ISDN (BRI) are occupied up to 80kHz or 320kHz (depending on the systems : echo-cancellor or Ping-Pong). Therefore, the transmitted signal will suffer impairment in the following electrical characteristics due to such a high frequency band;

- Crosstalk Noise

  Crosstalk noise is generally due to finite coupling loss between pairs sharing the same cable, especially those pairs that are physically adjacent. Near-End Crosstalk is assumed to be the dominant type of crosstalk, which coupled into a disturbed N-ISDN (BRI) line from a number of the other digital data lines. Far-End Crosstalk affects much more in case that the N-ISDN (BRI) system is of a Time Compression Multiplexing, so-called Ping Pong.

  A foamed PE insulated core cable is superior in terms of crosstalk noise to a paper insulated one.

- Impulsive Noise

  The impulsive noise is generated from the other systems, e.g. low speed analogue leased lines, sharing the same cables as well as from other sources, e.g. call generating signal/billing noises.

  SPC switch does not bring the billing noises.

- Non-linear Variation with Frequency of Digital Line

Considering above, the following minimum requirements for the current metallic cable network should be taken;

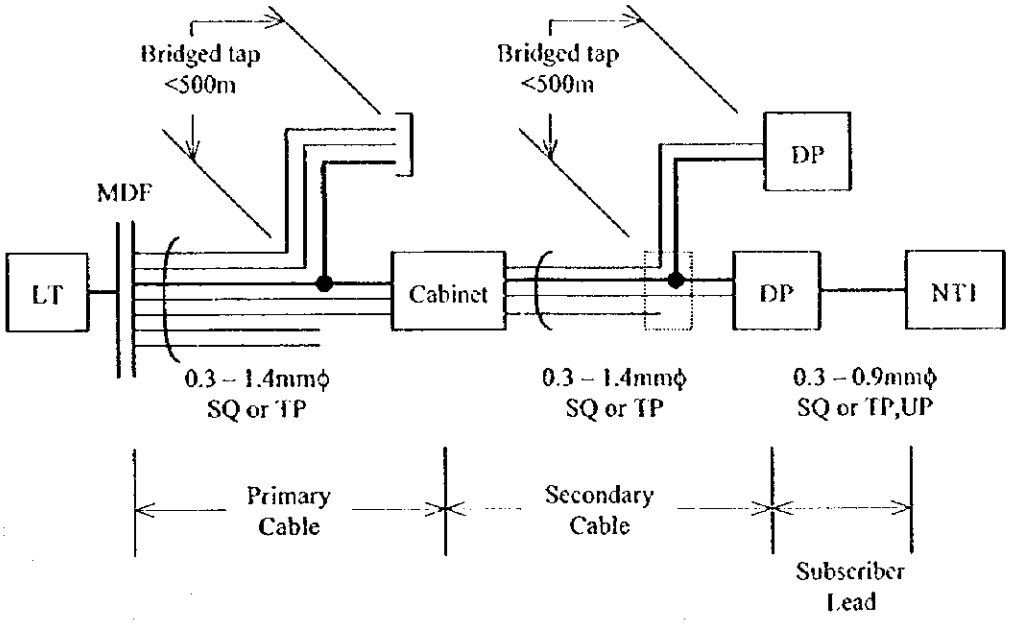
- No Loading Coils,
- No Open Wires,
- Bridged Taps : Maximum 2 bridge taps and 500m length are accepted.

The objective of the provision of N-ISDN (BRI) is to be capable of satisfactory operation of the metallic cable lines without special conditioning. The metallic cable network, which provides N-ISDN (BRI), consists of ;

- Primary cables
- Secondary cables
- Subscriber leads
- Interconnection points of MDF, Cabinets and DPs.

In the network, the following network characteristics can be included (see Figure 9.4.1-1);

- Bridged taps,
- Cable sections of difference diameters,
- Twisted pairs or Star quads, and Untwisted pairs in case of subscriber leads.



LT : Line Termination
NTI : Network Termination
MDF : Main Distribution Frame
DP : Distribution Point
SQ : Star Quads
TP : Twisted Pairs
UP : Untwisted Pairs

Source : ITU-T L.19

Figure 9.4.1-1 Network Structure for Digital Local Line

The current conditions of the metallic cable lines are not uniform in regional P&Ts. The conditions cover not only the cable line characteristics but also the peripheral

line conditions that are the number of data lines accommodated in and the type of the switch.

At the stage of the provision of N-ISDN (BRI) service, the regional P&Ts shall study their own current conditions and take necessary actions for the service in addition to the minimum requirement mentioned above.

In some cases, the removal of bridged taps and pair selection for use may be required in order to expand the applicable coverage of N-ISDN (BRI) service.

(3) xDSL on Metallic Cable Network

In upgrading the access network to be broadband-capable, re-use of existing infrastructure is one way to make the best use of existing assets.

Digital Subscriber Line (xDSL) technology can resolve it by utilizing the current metallic cable networks. From this point of view, xDSL will cover the future demand of high-speed service for the time being as a temporary step toward the FTTH establishment.

The xDSL has the following types of the systems (see Figure 9.4.1-2):

- HDSL : High-bit-rate Digital Subscriber Line,
- SDSL : Symmetric Digital Subscriber Line,
- ADSL : Asymmetric Digital Subscriber Line,
- VDSL : Very high-bit-rate Digital Subscriber Line.

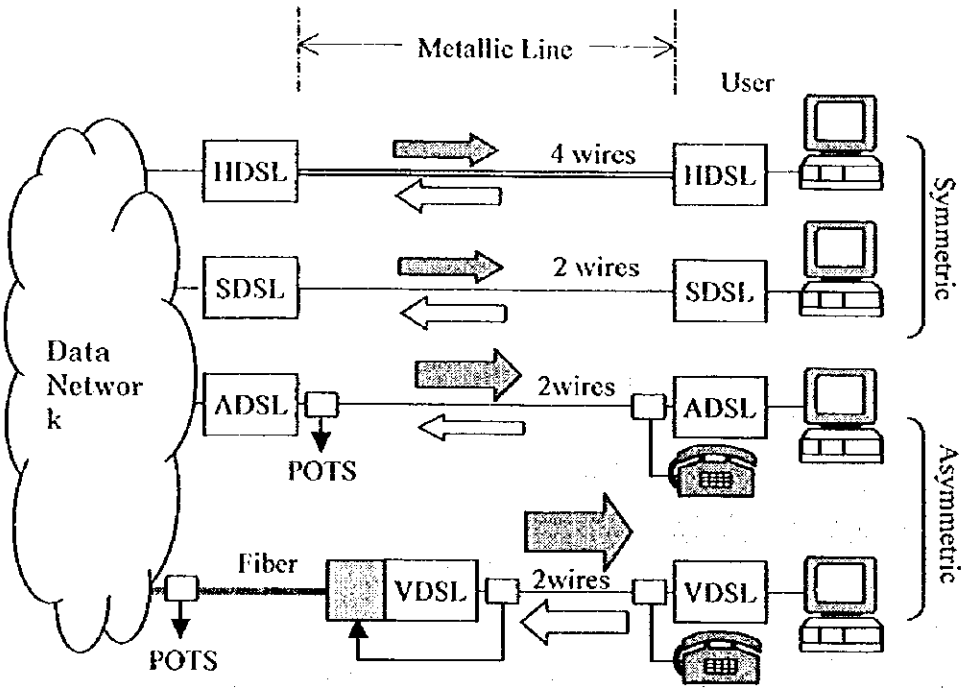


Figure 9.4.1-2 xDSL System Configurations

The service bit-rates and the applicable line distances of the xDSL are shown in the Table 9.4.1-2.

Table 9.4.1-2 xDSL Systems

	Bit Rate	Max. Distance in Metallic Line	Remarks
HDSL	1.5Mbps or 2Mbps (Symmetric up/down stream)	3.6km	4 wires
SDSL	160Kbps to 2Mbps (Symmetric up/down stream)	6.9km for 160K and 2.4km for 2M	2 wires
ADSL	Up stream :16 to 640Kbps Down stream :1.5 to 9Mbps	5.5km for 1.5M and 2.7km for 9M	2 wires
VDSL	Up stream :1.5 to 2Mbps Down stream :13 to 52Mbps	1.4km for 13M and 0.3km for 52M	2 wires

Note : The figures are based on the results experimented in USA.
The applicable maximum distances shall be studied and tested on the existing metallic cables in Vietnam.

While the xDSL realizes the high bit rate service on the metallic lines, the frequency band in transmission is expanded to Mega-Hertz order. It affects the applicable condition of the current metallic cable network in same as N-ISDN (BRI) technical considerations.

In advance of the service commencement on the current metallic networks, the following requirements should be studied technically and the applicable conditions should be standardized in Vietnam;

- Removal of Loading Coils,
- Number and length of Bridged Taps,
- Induced current by AM radio broadcasting wave,
- Interference with the other high bit-rate lines (e.g. N-ISDN (BRI) lines, high-bit-rate dedicated lines, other xDSL lines) sharing the same cable,
- Uneven quality and noise in cable core due to the cable aging/deterioration.

The applicable distances and bit-rates by the xDSL systems are illustrated in the Figure 9.4.1-3.

Considering the user needs, ADSL and VDSL are useful more than the other xDSL systems, especially ADSL and VDSL are being employed in combination with an Optical Access Network as a world-wide trend.

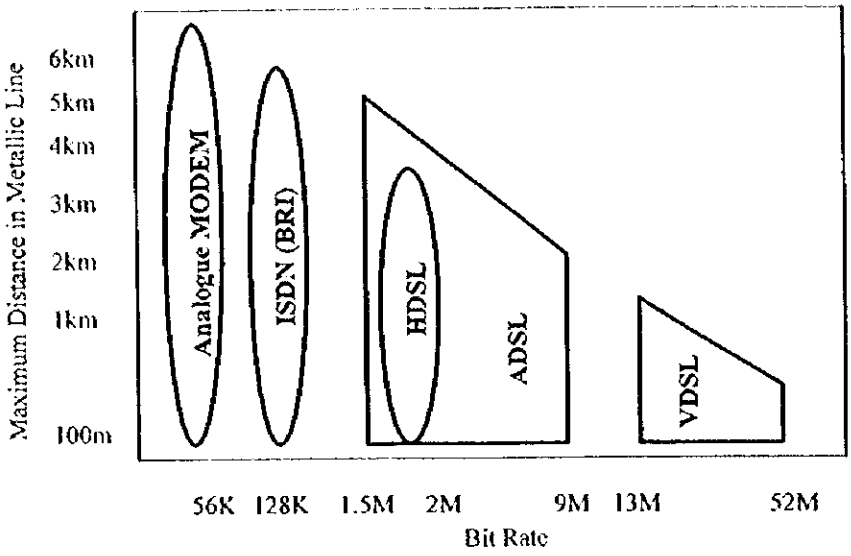


Figure 9.4.1-3 xDSL Coverage

<ADSL>

ADSL can provide asymmetric digital line with various speed ranges and capabilities. In general, an ADSL creates three information channels, i.e. a high-speed downstream channel, a medium speed duplex channel and a POTS channel. The minimum configuration provides 2Mbps downstream and 16Kbps duplex channels, and further more, downstream rates up to 9Mbps and duplex rates up to 640Kbps are available.

The system configuration of ADSL is illustrated in Figure 9.4.1-4.

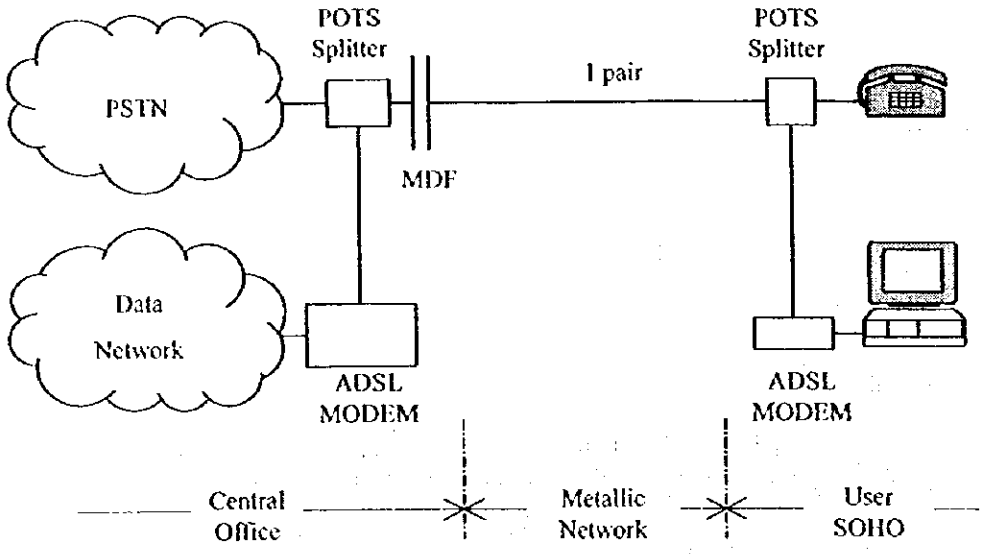


Figure 9.4.1-4 ADSL System Configuration

Unlike analogue modems put in point-to-point, a couple of ADSL modems are connected to the both ends of a metallic cable pair (2 wires), not through PSTN.
The POTS channel of a telephone or facsimile is split off from the digital ADSL modem by POTS splitter (passive filter), thus guaranteeing uninterrupted POTS, even if ADSL or the power fails.
ADSL modem provides a high-speed downstream channel and medium speed duplex channel, speeds depending on the products, and it can meet the requirement of Video On Demand (VOD) service for internet users. Presently, ADSL modems utilized widely are categorized in two types on the modulation systems and provided by numbers of manufacturers with their own specifications.

- CAP (Carrierless Amplitude / Phase modulation)
- DMT (Discrete Multi-Tone) : ANSI

Under study of the xDSL international standardization, such current ADSL environment brings the concerns of incompatibility among the different types or the difference manufactures into the service introduction. In other words, the ADSL modem type connected to one end of the metallic line must be same as the connected one to another end.

<VDSL>

VDSL provides higher speed downstream and upstream more than ADSL and it is targeted for the following business users ;

- Business offices intend to speed up their LAN system,
- Telecommuters intend to transfer their enormous file data,
- Video conference users,
- Tele-medicine system users,
- VPN (Virtual Private Network) providers.

Since the applicable distance of VDSL on the metallic line is very short (0.3km and 1.4km for 52Mbps and 13Mbps, respectively) due to the high frequency band, this system shall be utilized in a combination of OAN (Optical Access Network, described in Section 10.3.2) and the metallic cable network.
In accordance with the positioning of the ONU (Optical Network Unit) connected to OAN, FTTH, FTTB, FTTC and FTTCab configurations will be formed. In the hybrid fiber-metal architecture with the exception of HTTH, the VDSL system complements the high-speed metallic access technology for service delivery from the

ONU to the customer's premises.

Figure 9.4.1-5 shows the PON-VDSL network architectures, PON (Passive Optical Network) is a passive point-to-multipoint architecture of optical access networks. When the VDSL modems (including modem cards) are equipped at the cabinets or curbs, the setting space of the VDSL modems and the power supply shall be taken into account.

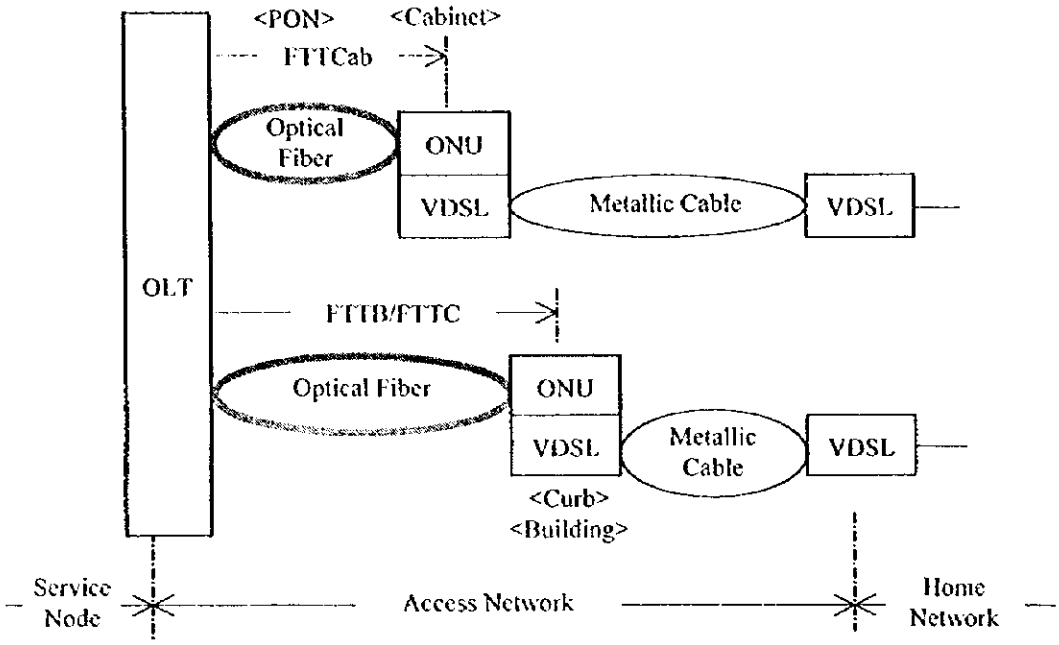


Figure 9.4.1-5 PON-VDSL Network Architectures

<xDSL Considerations>

In addition to the technical considerations on xDSL service on the current metallic networks, the following shall be taken into account:

- Incompatibility of the modems

  As described above, incompatibility among the different types or the different manufactures shall be considered in the service areas. For the successful xDSL introduction, all xDSL equipment has to be purchased from one supplier. Since it is not realistic, the standardization is indispensable. Table 9.4.1-3 shows the current status on ADSL and VDSL standardization activities.

Table 9.4.1-3 ADSL and VDSL Standardization Activity

	ITU-T	ETSI	ANSI
ADSL	Under study : SG15 (G992.1 and G992.2)*	TM6 DTR/TM-06001	T1E 1.4 T1.413
VDSL	Under study : SG15	TM6 DTR/TM-03068	T1E 1.4

Note : upper row (working group) / lower (standards)
*to be standardized, G992.1 and G992.2 for ADSL and G991.1 for HDSL

- Formation of the xDSL service operation

  When VNPT will provide xDSL service, the setting space of the xDSL modems shall be considered at the local exchanges or the cabinet/curb points. On the other hand, the new xDSL service providers may intend to provide it in conjunction with internet services. Since the providers do not have their own access networks, VNPT has to consider the access conditions to the service providers, i.e. lease conditions of the metallic lines between MDF and the service provider, see Figure 9.4.1-6.

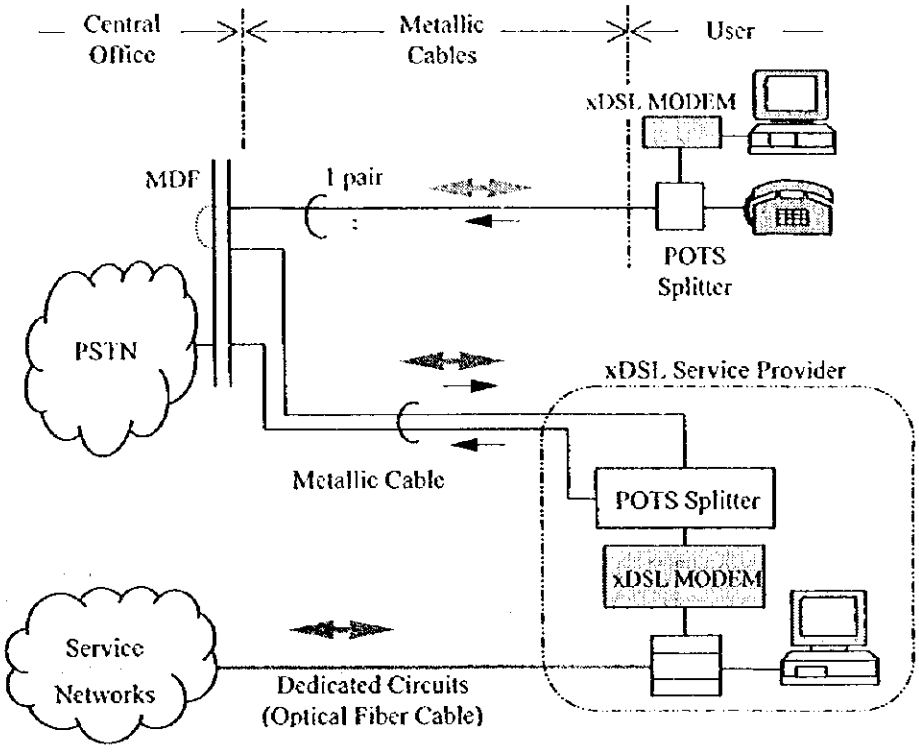


Figure 9.4.1-6 xDSL Service Provider

- Cost of the xDSL equipment

  Cost is a prominent issue for the introduction of the xDSL systems.

  Although the xDSL cost is presently still high, it is being decreased steadily. As shown in the Figure 9.4.1-7, the ADSL equipment cost per line is expected to go down to US$500/line in a few years.

  Accordingly, the xDSL system can be viable to meet the high-speed service demand by the time the optical access networks will be deployed.

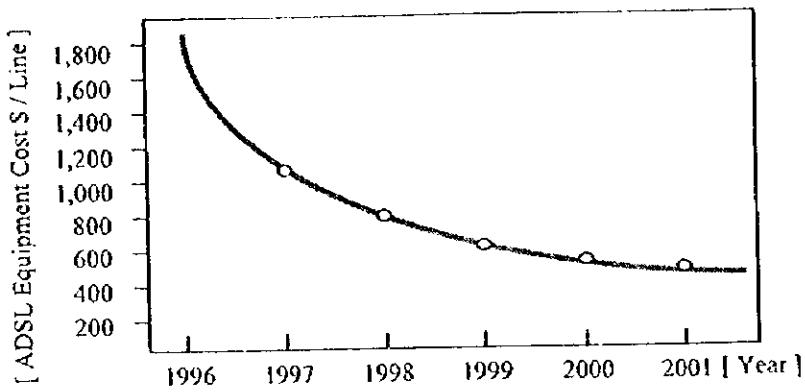


Figure 9.4.1-7 xDSL Cost Trend

9.4.2 Optical Access Network

In this section, a guide on the future Optical Access Network (OAN) is described.

(1) Optical Access Network Overview

In the future in Vietnam, the new service categories will be expanded from narrow-band services to the broadband services in parallel with the POTS growth.

(See Figure 9.4.2-1)

High speed internet services are seen as a major driver for middle-band to broad-band networks and the intranet and LAN access type services are seen as being a big driver. The peak bit rates in the 0.5 Mbps to 6 Mbps region are recognized as being appropriate to these services. Video-conferencing and Video-phone for residential market are deemed as important in Vietnamese future.

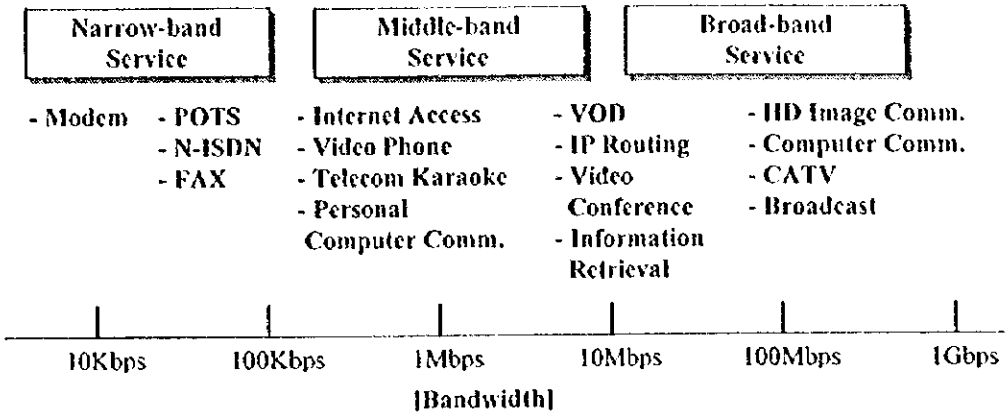


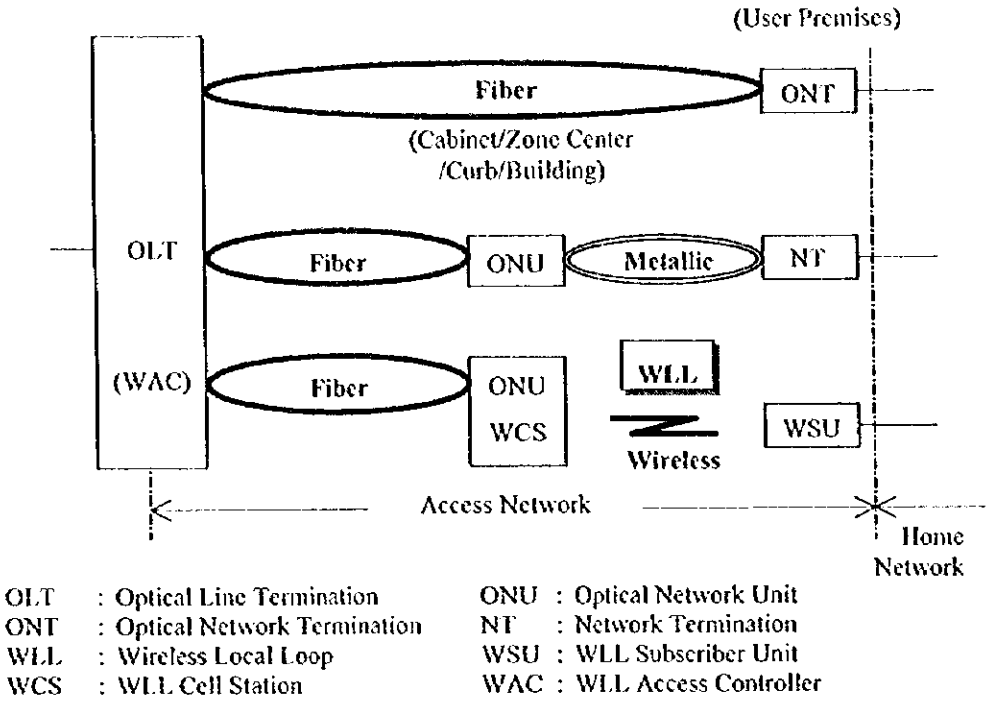
Figure 9.4.2-1 Service Evolution Forecast

The access networks will have to be designed and engineered on the basis of a service-driven approach. It is essential to take a long-term perspective in considering what kind of access networks should be put in place to match the demand for new services.

As compared with the conventional metallic cable network, the optical fiber cables have the following strong points;

- Higher band-width,
- Longer transmission distance,
- Induction free,
- Higher security,
- Lighter weight and smaller cable size.

These features produce not only to cover the high-speed services but also to expand the customer service area and to facilitate the construction and maintenance works. The OAN may or may not enter the customer's premises and the physical interface between ONU (Optical Network Unit) and customer terminals may be based on either fiber cable, metallic cable or radio, i.e. the OAN can be combined to the other access networks (see Figure 9.4.2-2). The ONU/ONT (Optical Network Termination) converts the optical signal to an electrical signal and the inverse, and it can be located at the cabinet/curb or at the customer's premises.



OLT : Optical Line Termination
ONT : Optical Network Termination
WLL : Wireless Local Loop
WCS : WLL Cell Station
ONU : Optical Network Unit
NT : Network Termination
WSU : WLL Subscriber Unit
WAC : WLL Access Controller

Figure 9.4.2-2 Optical Access Network Architecture

(2) OAN Roll-out Steps

The needs of the OAN in Vietnamese future are described above. However, the OAN is still more expensive network than the metallic network. In this context, the opticalization steps of the access network are suggested on the following aspects;

- Economical Approach to OAN for POTS demand,
- Strategic Approach to OAN for broadband and high-speed multimedia services.

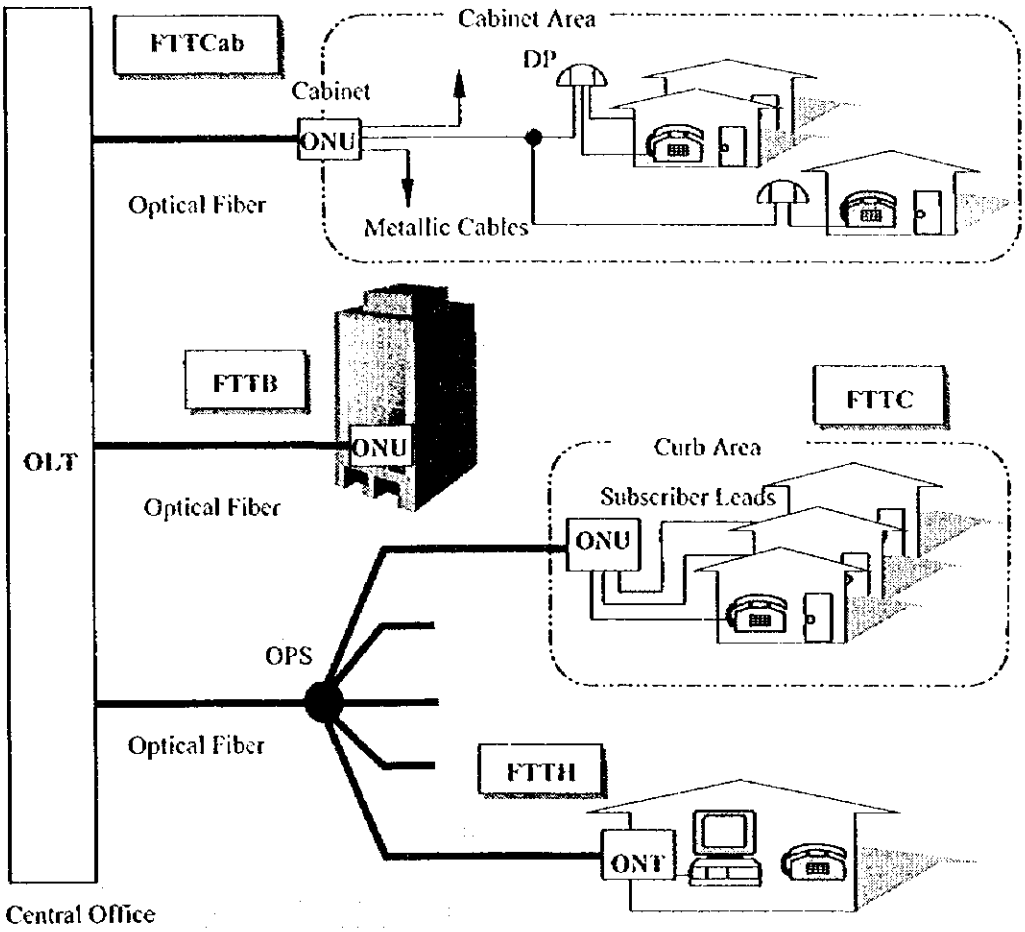
In connection with the OAN roll-out steps, possible applications of OAN are classified into the FTTx access network architectures (see Figure 9.4.2-3).

- FTTCab (Fiber To The Cabinet)
  The fiber part of the cable runs from an exchange to a cabinet, and then metallic cables run from the cabinet to the homes. At the fiber end, several hundreds of the subscribers are gathered.

- FTTB (Fiber To The Building)
  The fiber cable runs from an exchange into the building, and then inner-building cables run into the offices or rooms.

- FTTC (Fiber To The Curb)
  The fiber part of the cable runs from an exchange to within a few hundred meters of the home, and then metallic cables or drop wires run from a fiber end point to the homes. It is shared among dozens of subscribers).

- FTTH (Fiber To The Home)
  The FTTH is a final and long-term target.
  An optical fiber runs into a home and the customer is served by direct fiber connection in the access.



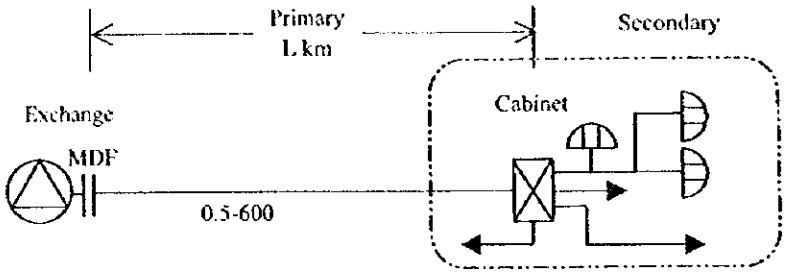
ONU : Optical Network Unit
OLT : Optical Line Termination
DP : Distribution Points
ONT : Optical Network Termination
OPS : Optical Power Splitter

Figure 9.4.2-3 Optical Access Network

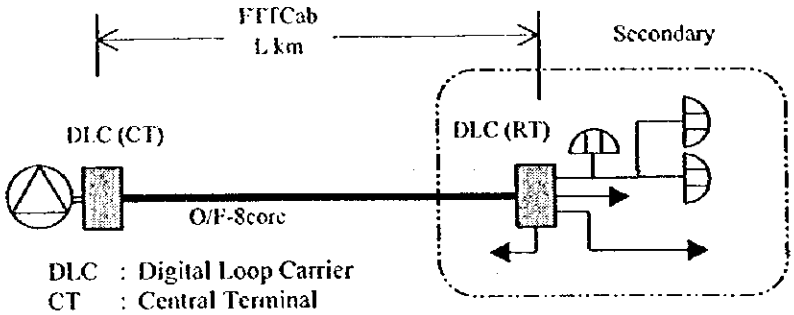
(3) Economical Approach to FTTCab

As an economical approach, the FTTCab may be introduced for remote cabinet areas where the metallic cable costs in the primary sections are higher than the optical systems' costs. In those areas, the optical systems initially may accommodate only narrow-band service users (mainly telephones and facsimiles).

As an example, the cost comparison between metallic network and optical fiber system is exemplified under the conditions as assumed in the Figure 9.4.2-4 and Table 9.4.2-1. In order to simplify the comparison, the operation and maintenance costs and the secondary portion are excluded.



(a) Metallic Network



DLC : Digital Loop Carrier
CT : Central Terminal
RT : Remote Terminal

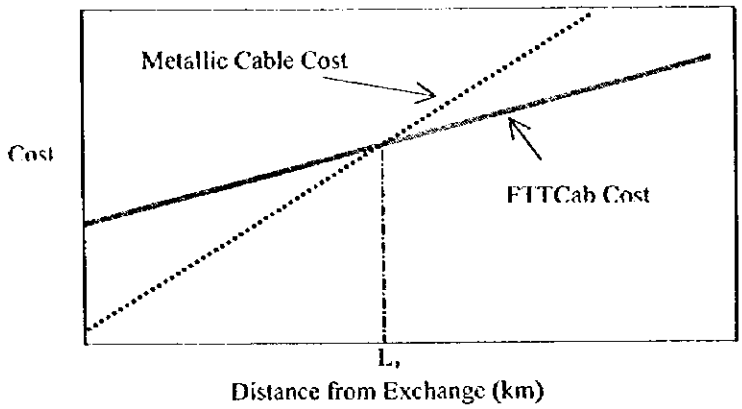
(b) DLC Optical Fiber System

Figure 9.4.2-4 Network Configuration for Cost Comparison

Table 9.4.2-1 Network Conditions for Cost Comparison

Metallic Network	Optical Fiber System
Cost component : - L km of the Metallic Cable 0.5mmϕ-600pairs - Ducts 100mmϕ PVC-4 pipes - Cabinet 1,800 type	Cost component : - L km of the Optical Fiber Cable 8 cores - Ducts and Inner Pipes 100PVC-2 and 3 inner pipes - A set of DLC Equipment (e.g. CT and RT) 480ch- POTS, Out-door type
Metallic Cable Costs : $(C_m + D_m) \times L + Cab$ C_m : Metallic cable cost per km D_m : Duct installation cost per km Cab : Cabinet cost L : Distance from exchange to the cabinet (km)	FTTCab Costs : $(C_f + D_f) \times L + DLC$ C_f : Optical fiber cable cost per km including inner pipes cost D_f : Duct installation cost per km DLC: DLC (CT and RT) cost L : Distance from exchange to the RT (km)

Based on the cost curves, the cost-equivalence distance, L_1 (km), between both systems is obtained in the following formula (see Figure 9.4.2-5).



$$L_1 = \frac{DLC - Cab}{(C_m + D_m) - (C_f + D_f)}$$

Figure 9.4.2-5 Cost-equivalence Distance

In case of cost parameters as given in the Table 9.4.2-2, the turning point L_1 is calculated.

Table 9.4.2-2 Cost Parameters (Examples)

Metallic Primary Cable			Optical Fiber Cable and DLC		
M. Cable Cm (per km)	Duct Dm (per km)	Cabinet Cab	OF Cable Cf (per km)	Duct Df (per km)	DLC DLC
165	215	10	70	120	550

L_1 =	2.8 (km)

Note : In this table, the relative costs (setting 10 for a cabinet cost) are used.

Where the cabinet location is greater than the distance of L_1 from the exchange, the optical system, FTTCab, is more economical in the primary section.
In addition to the above, the optical system can extend the service coverage areas.
From a transmission viewpoint, no additional loss has to be assigned to the optical section, so that, starting from the RT, the subscriber-line length can be the same as in the case of subscribers directly connected to the exchange. However, it should be recognized that the subscriber line loop resistance might be the limiting factor.
On the other hand, the optical line distance can be extended much further than the metallic primary line.
The economical application coverage of the DLC system is suggested generally as shown in the Figure 9.4.2-6 in comparison with the metallic feeder network or RSU (Remote Switching Unit) system.
The application suggests that;

- DLC system is cost-effective where the distance (CT to RT) is over L1 km and the demand of approx. 500 customers.
  Suitable for middle cluster of demand.

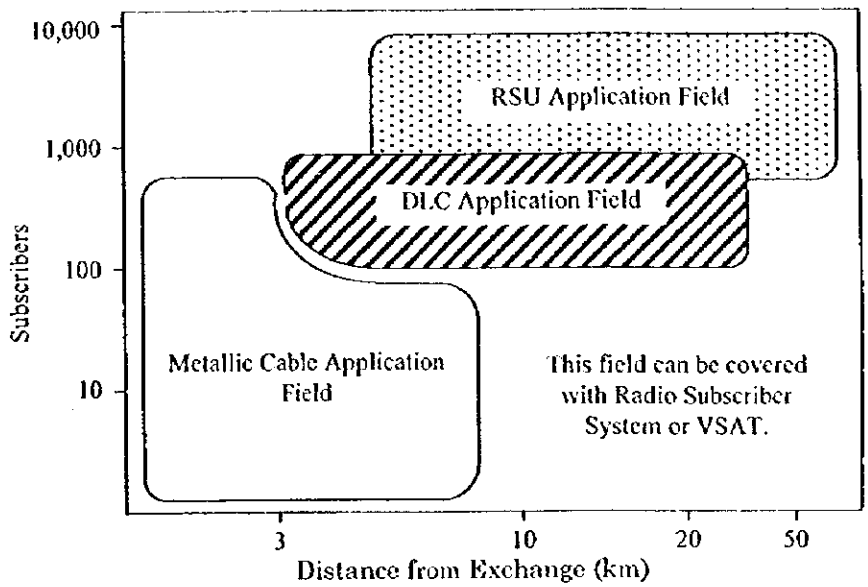
- RSU is applicable where the demand is over 1,000 lines. Generally, DLC and RSU can be located farther from the exchange (main switching unit) in line with SDH loop.
  Suitable for large cluster of demand.

- Where there is low demand density and far from the exchange, Radio Subscriber system or VSAT may be cost-effective.
  Suitable for remote and rural area.

These categories may change according to the actual network costs (metallic

networks, DLC systems and RSU systems costs) in Vietnam. It is expected that the cost of the DLC system will drop significantly as demand in the world market rises, and then the DLC application field will be expanded widely.
This figure supports only POTS demands (including N-ISDN service) and if the demand of the higher bit-rate services is emerging in the relevant area, these application fields are not applicable.

The actual cost comparison shall be studied taking into account Vietnamese conditions, i.e. the construction and maintenance/operation circumstances.
This approach is applicable anytime, anywhere in Vietnam. Optical fiber can be cost-effective in the local network, even if existing metallic lines are in place and in need of re-enforcement. Thus the future economical OAN structure shall be taken into account, in the conventional planning works.



Note : "Subscribers" and "Distance" are defined as the figures in/to a Primary Cabinet or a DLC Remote Terminal.

Figure 9.4.2-6 Application Field of DLC System

(4) Strategic Approach to OAN

For services requiring bit rates higher than those supported by POTS and N-ISDN, ADSL or HDSL technology may provide a very attractive solution. However, it is primarily concerned whether such systems could provide full service networks, where there is a requirement to be able to deliver several channels of good quality

entertainment video or equivalent bandwidth. ADSL or HDSL is not capable of this on a sufficiently large percentage of lines from the local exchange and so other options need to be considered.
The fully or partially fiber based (i.e. the FTTx architectures) outside plants shall better deliver the requirements.
Basically, the OAN provision is aimed to become cost-effective for the higher bit-rate services. This requires the access network to be flexible and easily upgradable. Therefore, the phased approach to the final target of FTTH shall be proceeded strategically for such a future demand.

Figure 9.4.2-7 shows the phased FTTH approach.

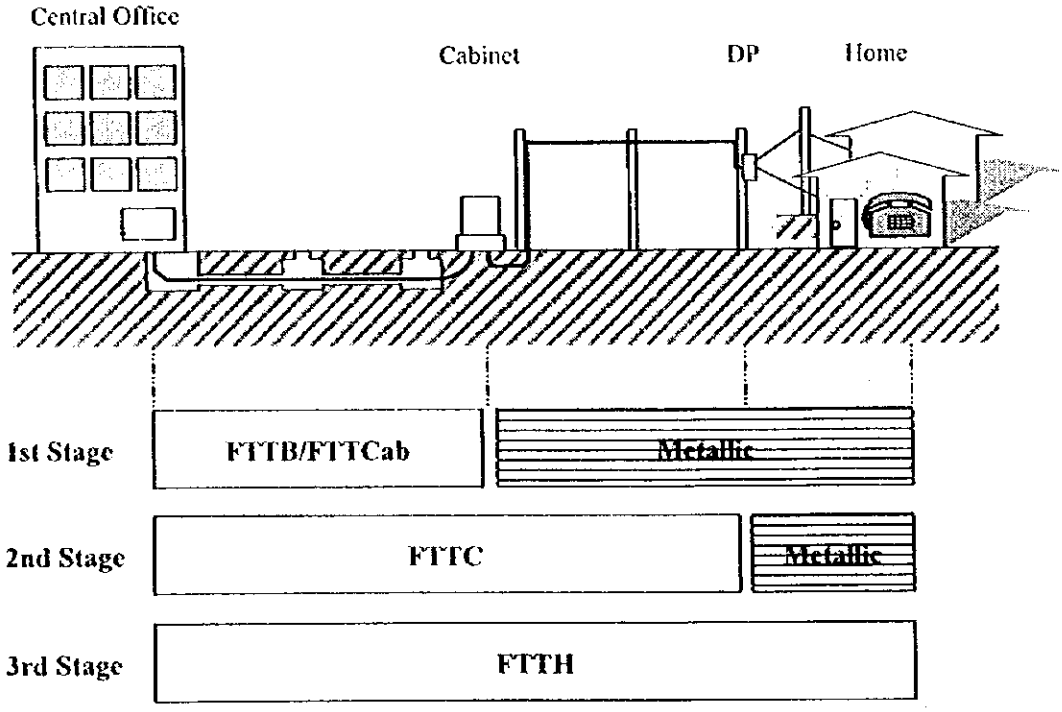


Figure 9.4.2-7 Phased FTTH Approach

<1st Stage>
At the initial stage toward the FTTH achievement, FTTB and FTTCab variations are extremely attractive from the economical point of view. It can minimize the risk of over capital investment. If the FTTCab has been deployed and the projected market turns out to be very much smaller than predicted, there has been a minimal waste of capital on this new network infrastructure. The FTTCab network architecture consists of the optical fiber section and metallic cable section. The network will

operate mainly POTS and a few broadband/multimedia services as a hybrid fiber-metal access system.

The hybrid fiber-metal access system with xDSL technology may meet some parts of the broadband/multimedia service demand, but it does not cover the over-all area due to the limit of the xDSL ability.

In any event, the FTTB/FTTCab deployment shall be proceeded strategically in order to respond quickly to the future demand. At the commercial and/or business areas where the demand is expected, the existing primary/direct feeder sections will be replaced with the optical fiber systems, or the new fiber network will be overlaid. When the demand including narrow and broad-band services is big (e.g. several hundreds order of telephone users) in the area/building, a DLC (Digital Loop Carrier) system may be used as an optical fiber transmission system.

Figure 9.4.2-8 shows the shifting step from the existing primary cables to FTTB or FTTCab (DLC system).

The FTTB/FTTCab provisions shall be considered for at least significant parts in Ha Noi, Ho Chi Minh City and Da Nang based on their proper deployment plans.

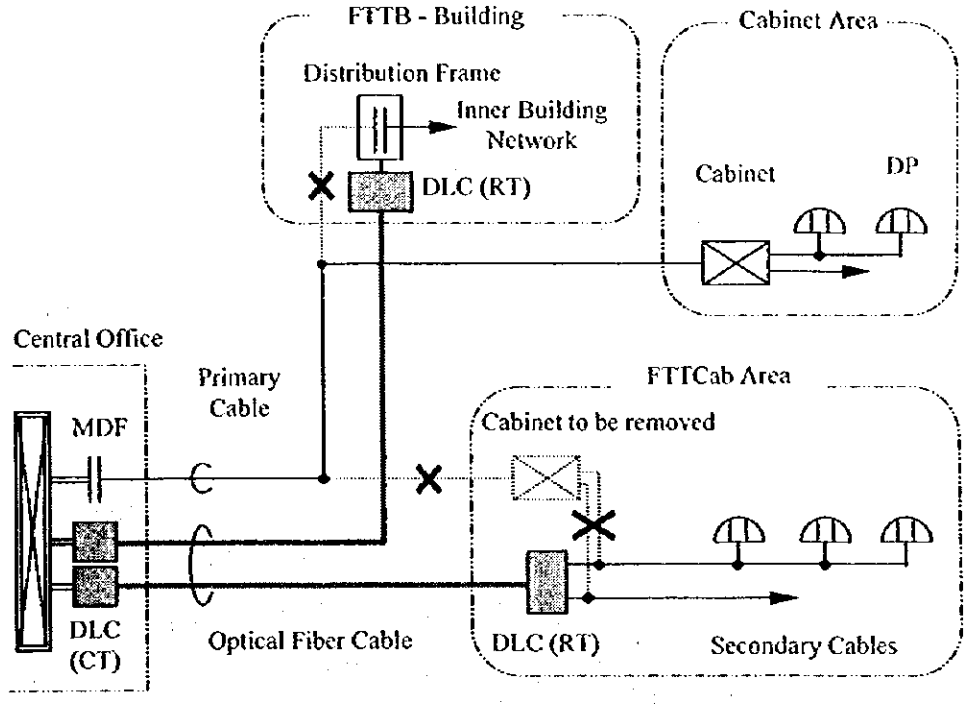


Figure 9.4.2-8 FTTB/FTTCab Shifting Step

<2nd Stage>

With the further growth of the broadband service demand, more flexible and economical OAN will be required. The OAN much closer to the home, FTTC with PON system (Passive Optical Network) can cover the requirements effectively more than the FTTCab (see Figure 9.4.2-9).

- Bringing fibers much closer to the homes,
- Upgradable architecture to HTTH, technically and cost-effectively.

Presently FTTH is a very expensive technology with every house requiring the devices to convert light signals to electronic signals. The FTTC shares this conversion process among 8 to several tens of homes (depending on the system specifications).

The FTTC will be able to be upgraded economically to FTTH for some customers, while continuing to serve other less-demanding customers over the FTTC.

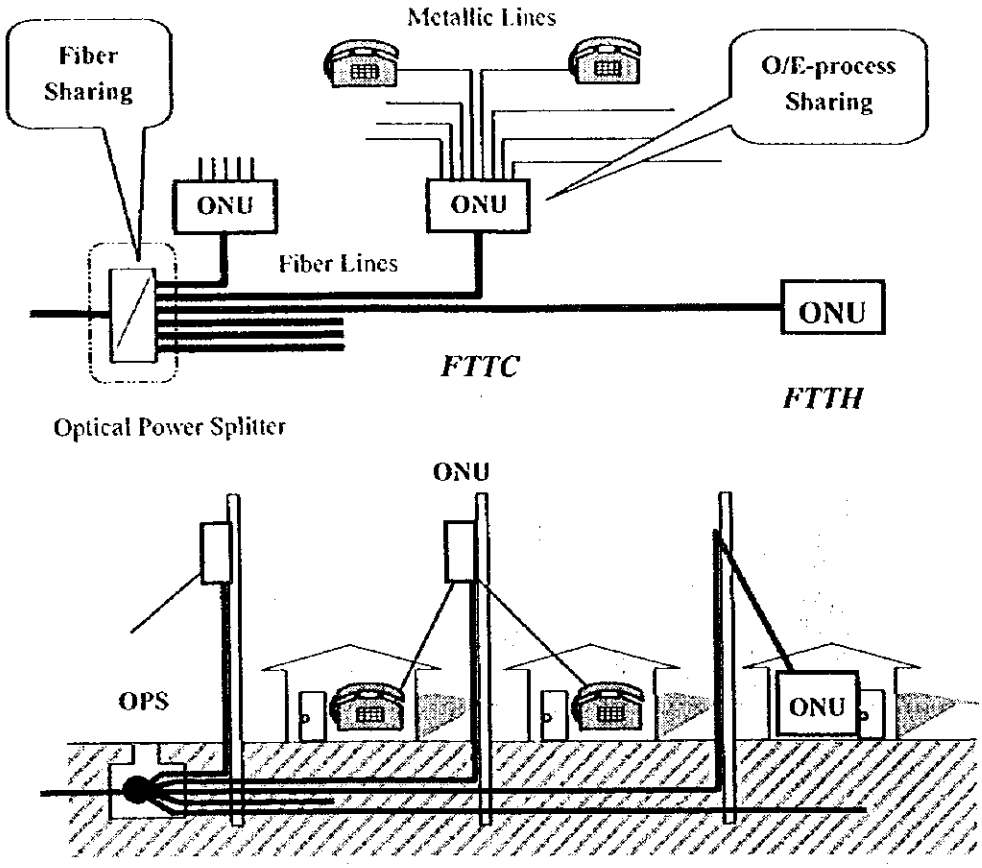


Figure 9.4.2-9 PON System for FTTC and FTTH

<3rd Stage>

The network evolution can take two forms: first, the first choice of the FTTH installation and, second, "upgrade" evolution in which an installed FTTx system is upgraded to FTTH wholly or in part.

Access network deployment decisions are mainly based on economics, e.g. revenue expectation, capital costs, and operations costs. The FTTH may not be deployed until it offers economic advantages over other network access alternatives. The main drivers for the FTTH are expected to be revenue enhancement and operations savings. Capital cost reduction is expected in the future so that the greater volume in production on optical modules will accelerate the cost reduction.

The HTTH is motivated by the following factors;

- The FTTH removes the bandwidth bottleneck of the VDSL link.
- In all-fiber, FTTH outside plant facility is less susceptible to lighting and corrosion than the hybrid fiber-metal of FTTC/FTTCab. Thus, more reliable and reducing maintenance costs associated with FTTH.
- Portions of the fiber plant should also be common and reusable in the evolution from FTTx to FTTH.
- FTTx ONUs will be powered from the network, either locally powered with battery backup or powered via twisted pairs from another network site. FTTH ONUs are associated with a single customer and are likely to be powered by the customers.

(5) Optical Local Access Networks

The optical local access networks that could be either a point-to-point (single star), active, or passive point-to-multi (double star), ring architecture shall be designed in line with the cost and the network security.

The network architectures are described in Appendix I-9-1.

Generally, in the metropolitan area, the high-rise buildings shall be linked in the fiber loop (see Figure 9.4.2-10).

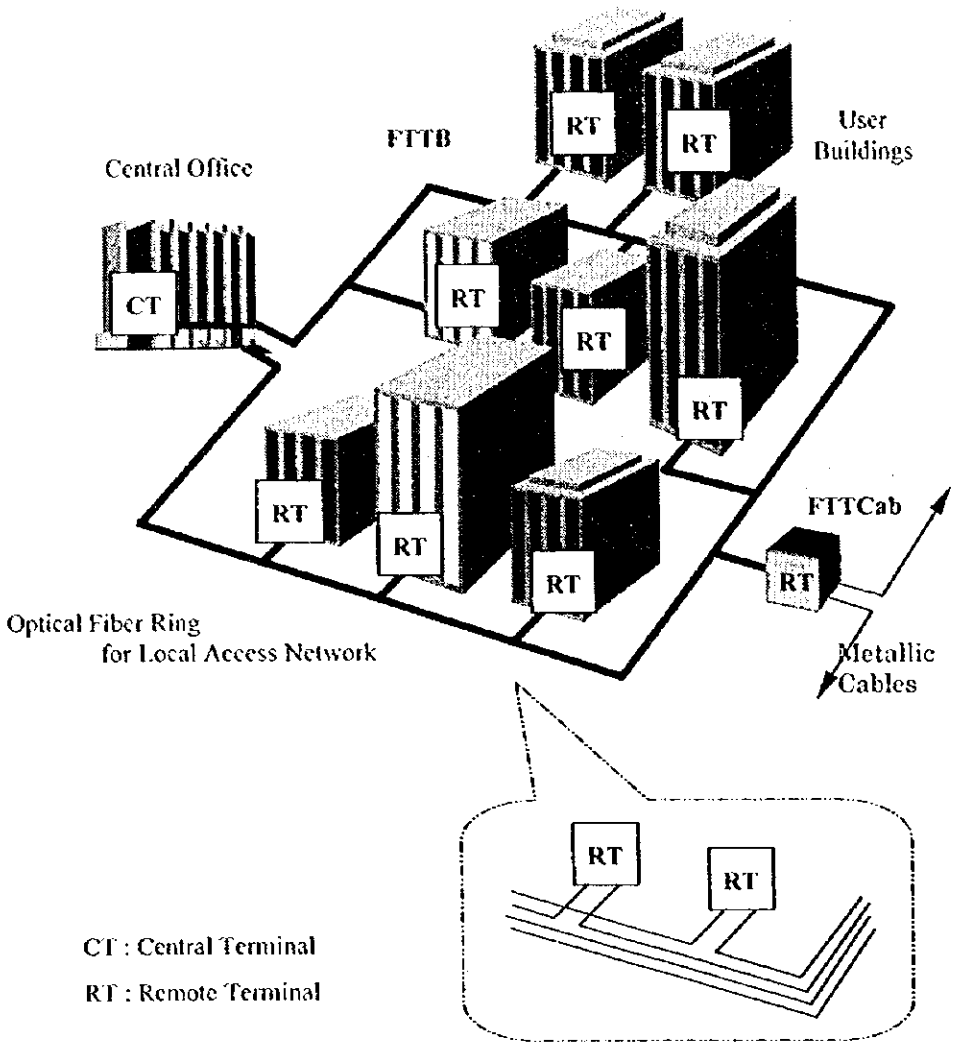


Figure 9.4.2-10 FTTB/FTTCab Fiber Ring

(6) OAN Systems

The optical fiber systems utilized in the OAN are described below.

(a) RSU

The RSU combines the functions of concentration by switching and multiplexing in transmission, resulting in a very great saving of lines.

The RSU is not autonomous, being dependent on the technology and the control of the parent exchange (Main Switching Unit), and consequently non-neutral with respect to the application. In this point, the RSU may be seen as a remote part of the parent exchange itself.

(b) DLC

DLC is regarded as an optical fiber transmission system that provides digital multiplexing without traffic concentration. Since the DLC is so designed as to be independent from the switching system, the interface at a digital local exchange should be V5.x -Interface (V5.1 : ITU-T G.964 or V5.2 : ITU-T G.965). Optionally a voice-channel interface is provided for an analogue switching system.

When utilized in the network architecture of Active Double Star, the O-E and E-O conversion equipment is necessary at the active splitting point.

This system comprises the following three components (see Figure 9.4.2-11);

- Optical fiber cable (ITU-T G.652),
- Optical line terminating unit,
- Digital multiplex unit.

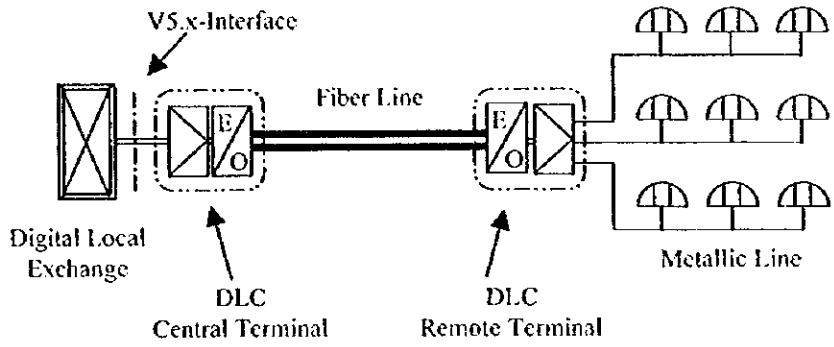


Figure 9.4.2-11 DLC System

(c) PON

PON (Passive Optical Network) system that consists of OLT (Optical Line Termination), ONU (Optical Network Unit), OPS (Optical Power Splitter) and fiber cables (cf. ITU-T G.652) is utilized in Passive Double Star network architecture. This system is suitable for gathering numbers of the small demand clusters (several tens of subscribers per a cluster). That is to provide "nearer fibers to be terminated to the customers".

In comparison with the DLC system for FTTCab, the PON system (FTTC) is ;

- Bringing fibers much closer to the homes,
- Higher bit-rate services capable,
- Higher quality of the networks,
- Cost per user is higher,

- To be considered on data security due to passive star architecture.

The system configuration is illustrated in the Figure 9.4.2-12.

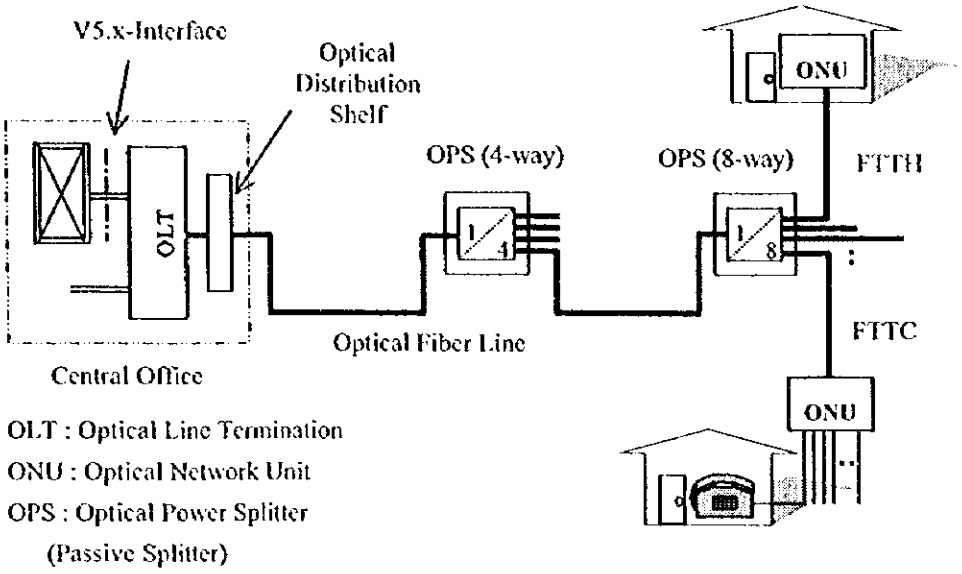


Figure 9.4.2-12 PON System

The recommended PON system and the studied bi-directional transmission systems are described in Appendix I-9-2.

The quoted fiber reach limitations in the PON are distinguished by system types and splitting ratios. All distances as quoted in Table 9.4.2-3 refer to fiber kilometers.

Table 9.4.2-3 Recommended Logical Reach Limitations

Distance	System Type (SDM and WDM)	System Type (TCM)
20 km	A split ratio of at least 16 way shall be supported	A split ratio of at least 8 way shall be supported
10 km	A split ratio of at least 32 way shall be supported	A split ratio of at least 16 way shall be supported

Source : ITU-T G.982

(7) OAN Time Target

The OAN in Vietnam shall be developed based on the strategic roll-out scheme. The telephone demand has been growing sharply over the past few years and it is expected to continue to increase for several more decades. Under such

circumstances, the economical FTTCab will be newly installed at many areas (middle demand density) in Vietnam which are located away from a local exchange. On the other hand, the strategic FTTB/FTTCab deployment will be planned in the metropolitan areas (e.g. central city areas in Ha Noi, Ho Chi Minh City and Da Nang) for new broadband/high-speed multimedia service demand.

The supply of optical components in the world market will increase sharply and consequently the reduction of component costs will be accelerated by more than half in a few years. Table 9.4.2-4 and Table 9.4.2-5 show the price targets on the optical modules/components forecast by leading suppliers in the world.

Table 9.4.2-4 Target Optical Module Prices

Module	Initial price (ECU) before year 2001	Target price (ECU) (million lines)
OLT core	180000	90000
OLT line card	4000	2000
ONU FTTB core (32 lines)	3000	2000
ONU FTTC/Cab core (128 lines)	9000	6000

Note: Average bit-rate of 3Mbps is assumed.
Source : FSAN

Table 9.4.2-5 Target Costs of Fibers and Passive Components

	Cost Status ($) $5X10^3$ pieces	Future ($) 10^6 pieces
Cabled Fiber (/m)	0.2	0.07 to 0.1
Fusion Splice	10 to 40	10
Terminated Connectors	8 to 25	5 to 10
Terminated Splitters (per port)	50	25

Note: The costs of the terminated connectors depending on the performances
Source : FSAN

The FTTCab (hybrid fiber-metal) will be provided in conjunction with the xDSL technology.

Notably, VNPT might introduce the ADSL technology on overall metallic network prior to the OAN provisions for the time being. It is an affordable choice for Vietnam, while it will retard the OAN achievement.

Past the year 2010 and towards the year 2020, the cost of optical network components will decrease throughout the world and the high-speed service demand will be countrywide in Vietnam as telephone demand spreads. By that time, the metallic cables will have exceeded their life spans and require upgrading. Hence, in view of the natural service evolution and the deterioration of the metallic cables, the OAN will be aggressively deployed.

As a whole, the percentage of the conventional metallic networks will be decreased.

The access network evolution in Vietnam is as illustrated in Figure 9.4.2-13 and described in Table 9.4.2-6.

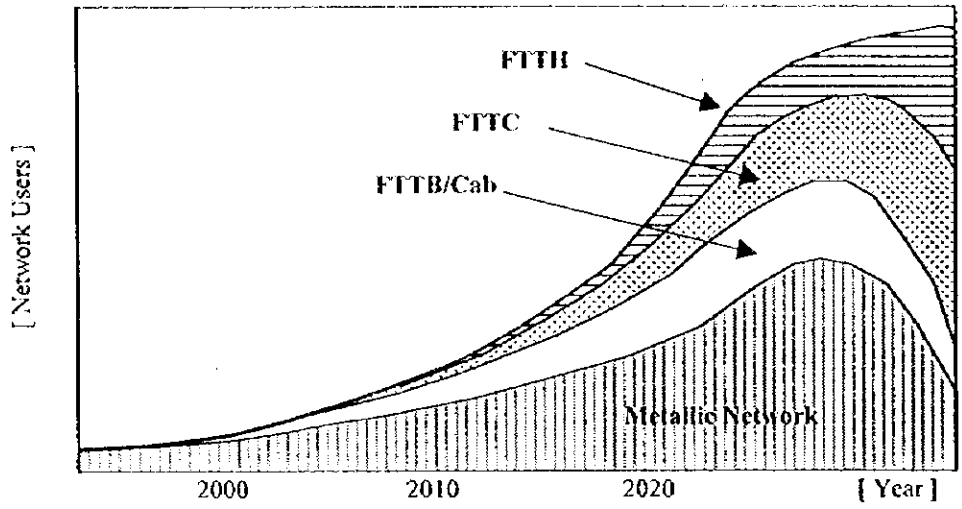


Figure 9.4.2-13 Trend of OAN in Vietnam

Table 9.4.2-6 OAN Evolution in Vietnam

Year	Optical Access Network Evolution	Associated Services
1998 to 2000	Conventional metallic networks will be expanded and numbers of optical fiber systems will be introduced in the forms of FTTB and/or FTTCab in Ha Noi and Ho Chi Minh City, but this will not be an aggressive expansion.	- POTS - Dedicated data line - Introduction of N-ISDN and xDSL - *FTTB/FTTCab* - *Study of FTTC*
2001 to 2010	The metallic network will continue to increase, while FTTB and FTTCab will be expanded in the leading cities and the industrial districts. FTTC will be introduced and strategically increases and at the same time FTTH will be required.	- POTS, ISDN - Mid-band Service - *FTTB and FTTCab (hybrid fiber-metal)* - *FTTC and FTTH*
2010 to 2020	The deteriorated metallic networks will be replaced with the OAN. The demand will increase still in POTS and mid to broad-band services that will be accommodated in the forms of FTTC and FTTH.	- POTS, ISDN - Mid-band Service - Broad-band Service - *FTTB, FTTC and FTTH*
Beyond 2020	A goal of all fiber networks is likely to be set as a final target. In the forms of FTTx, all the predicted services will be able to be provided for the customers anywhere.	- POTS - Mid-band Service - Broad-band Service - *Target of all-fiber network*

9.4.3 Radio Subscriber System

(1) General

Various types of radio subscriber systems have been utilized in the world. In addition new types of radio subscriber systems have recently been developed and introduced. Also, several types of radio subscriber systems are being utilized in Vietnam, and their expansions are planned nation-wide.

In general, these systems can be classified into the following types:

(a) Cellular based system (WLL)

Cellular based radio subscriber systems (WLLs) have been developed based on the cellular mobile systems such as AMPS, PDC, GSM and CDMA, and subscriber terminal generally accommodates one (1) telephone per subscriber.

In this report, a cellular based system includes a cordless based system, which has been developed based on cordless telephones such as PHS and DECT and its cell radius is generally smaller than that of cellular based system.

(b) TDMA (Time Division Multiple Access) system

TDMA systems have been developed based on the TDMA multi-channel access technology, and have generally a function of repeater, which work as an approach link (entrance) between a base station and distribution station (repeater station).

In general, a coverage area is larger than that by cellular based system, and a subscriber station can accommodate plural telephone lines per subscriber station.

The comparison between cellular based system and TDMA system is summarized in Table 9.4.3-1.

Table 9.4.3-1 Comparison between Cellular based System and TDMA System

Item	Cellular based System	TDMA System	Remarks
	Based on Cellular Mobile or Cordless Telephone Systems	Using TDMA technology	
Radio Frequency Band	800/900 MHz bands 1800/1900 MHz bands	1.4/1.5/2.4/3.5 GHz bands (generally)	
Coverage Area	Small (Smaller than approx. 15 km in radius)	Large (Smaller than approx. 30 km in radius)	
System Capacity	Large (Several tens of thousands lines)	Small (Approximately thousand lines)	
Capacity / Subscriber	1 line / subscriber (generally)	Plural lines / subscriber	
Repeater Function	Not included	Included	

(2) Cellular based System (WLL)

This type of system has been developed based on the cellular/cordless mobile systems such as AMPS, GSM, CDMA, DECT, PHS, etc.

(a) System Features

i) Service menu

This system can provide voice channels and/or low speed data communications channels (generally 9.6 kbps or 14.4 kbps and maximum lower than 64 kbps).

ii) Capacity

The system capacity is nearly same as the cellular mobile system (several tens of thousands per unit), so it is generally larger than that of TDMA system.

iii) Radio Frequency

These systems use the same frequency bands as the cellular mobile systems and PCS, PHS, PCN, so the careful frequency assignment is required.

iv) Functions

These systems have almost the same functions as cellular mobile systems, but several functions such as hand-over and location registration are left out.

v) Coverage area

A coverage area by a cell is generally smaller than that by TDMA systems, so service areas are configured by cluster of cells and can cover wider area by the cluster.

(b) System Configuration

The system requires an exchange, controller and transceiver in base station and subscriber unit, etc. as shown in Figure 9.4.3-1.

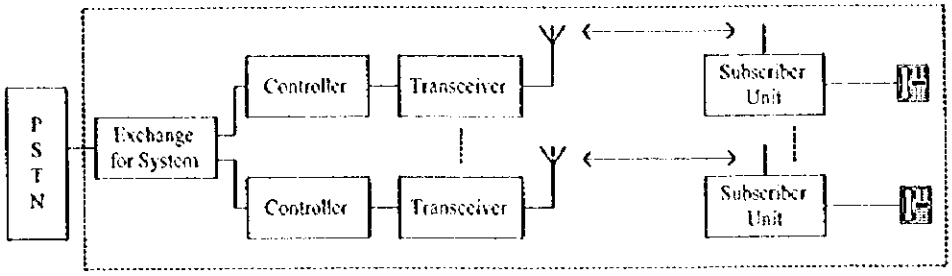


Figure 9.4.3-1 Typical System Configuration of Cellular based System (WLL)

(c) Future Trend of System

These types of systems will be developed in parallel with the development of the cellular mobile system. (refer to Section 9.5) Therefore, the transmission speed will be expanded to correspond to the multimedia services.

In addition, the cost of the system is expected to be reduced in order to compete with the cable system.

(3) TDMA System

This type of systems applies TDMA and has a point-to-multipoint configuration.

(a) System Features

i) Service menu

This system can provide voice channels and/or medium speed data communications channels (generally 32 kbps, 64 kbps or higher).

ii) Capacity

The system capacity is not so large (about several thousands), so it is generally used in low demand area.

iii) Radio frequency

The systems generally use the same frequency bands as microwave systems, so the frequency assignment should be carefully carried out.

iv) Functions

These systems have general functions as same as radio communication systems.

v) Coverage area

A coverage area is generally wider than that by cellular based systems, and can be expanded by adding repeater stations.

(b) System Configuration

The system configuration is shown in Figure 9.4.3-2.

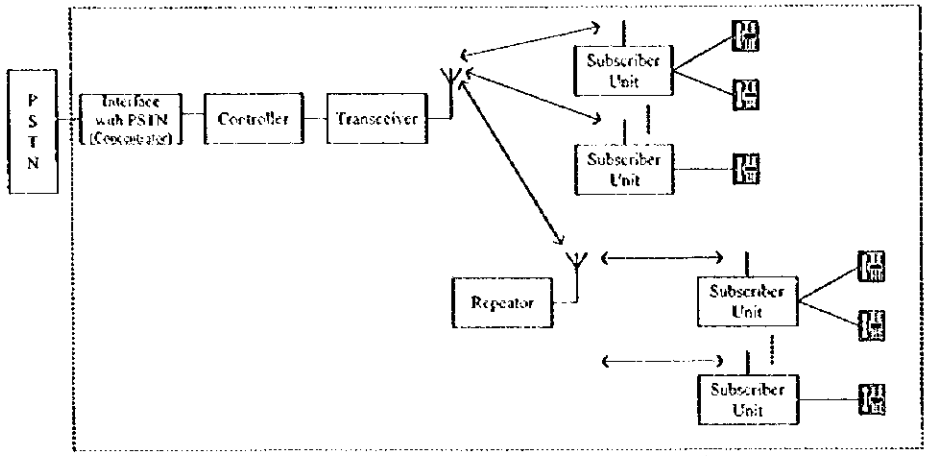


Figure 9.4.3-2 Typical System Configuration of TDMA System

The system applies a small capacity exchange or concentrator in order to reduce the cost, and subscriber unit can provide plural communications channels depending to the demand.

(c) Future Trend of System

This type of systems may co-exist with the cellular based systems due to its effectiveness in low demand areas. In addition, the system may be developed to correspond to higher data communications such as multimedia services.

9.4.4 VSAT System

(1) General

The VSAT system is technically suitable to apply in isolated areas, but the cost for earth stations and leased charge of transponders is critical point to decide the utilization. Therefore, the utilization of the VSAT system should be considered from the technical and economical viewpoints comparing with the terrestrial systems. In addition, low/medium earth orbit (LEO/MEO) systems may be utilized not only for mobile services, but also for fixed services, therefore, the VSAT system should be

utilized considering the system features comparing with these systems.

(2) System Features

(a) Service Menu

The VSAT system can provide not only voice channels but also data communications channels, therefore, the system can be used for multimedia services.

(b) Capacity

The system capacity can be easily expanded by adding earth stations and bandwidth of transponders to be utilized, but the expansion should be considered from the technical and economical viewpoints.

The capacity of a VSAT station (number of accommodated lines per VSAT station) affects to the system configuration.

(c) System Characteristics

The system has peculiar characteristics to satellite communications, i.e., transmission delay occurs through long path (earth station – satellite – earth station) and the cost of the system independent of the locations of earth station.

(3) System Configuration

The basic configuration of the VSAT system is almost the same as the existing system.

(4) Future Trend

(a) General

The trend of the VSAT system is to reduce its cost and to expand its transmission capacity by modifying its system parameters such as access scheme and modulation scheme.

The VSAT system will co-exist due to its peculiar features with the other satellite communications systems such as LEO/MEO systems.

(b) Trend in Vietnam

i) Satellite

It is important to consider whether Vietnam should invest in launching its own satellite or not. If Vietnam has its own satellite, the satellite should be used not only for telecommunications but also for broadcasting or other

purposes. If the satellite is to be used only for telecommunications purpose, the cost is not justifiable.

ii) Hub station

At present the hub station is located in Ho Chi Minh city, but it is better that a new hub station would be introduced in Ha Noi corresponding to the expansion of the earth stations (VSAT stations). Because the system would be utilized not only by DGPT but also by the other governmental organizations, whose headquarters is generally located in Ha Noi, so the easy and effective utilization of the system will be possible.

9.5 Development Indicator of Mobile Communications

9.5.1 Cellular Mobile Telephone Network

(1) General

There are many types of cellular mobile telephone systems in the world, i.e., GSM, PDC, digital AMPS, CDMA systems, etc. Other than cellular mobile systems, there are several mobile systems based on cordless telephone technologies such as PCN, PHS and PCN systems. In this report, cellular mobile systems include the cordless based systems.

These cellular mobile telephone systems can be defined as three (3) generations, i.e., the First generation such as AMPS and TACS, the Second generation such as GSM, PDC and D-AMPS and the Third generation such as IMT-2000.

At present second generation systems are mainly being used in the world, and the third generation systems (new systems) are under standardization.

In Vietnam, GSM systems, which belong to the second generation system, have been introduced and expanded nation-wide. To expand and improve the cellular mobile telephone network, the introduction of the following systems should be considered.

(a) PCS, PHS and PCN

The definitions of PCS (Personal Communications Service) and PCN (Personal Communications Network) are not clear, and these terms have been used in several ways. In general the following three meanings are usually used.

- Evolution of existing cellular systems
- Cordless voice telephone system, which lacks full ability to hand off calls from cell to cell.
- Cellular system at a higher frequency than the existing cellular

PCS is a general term for digital mobile communications services with 1.9 GHz radio frequency band in U.S.A. PCS includes the system using 1.9 GHz band such as GSM, cdmaOne, D-AMPS, etc.

Also, PHS (Personal Handyphone System) and PCN is being used for supplemental system to the cellular mobile systems in Japan and other countries due to its economical/technical features.

(b) IMT-2000

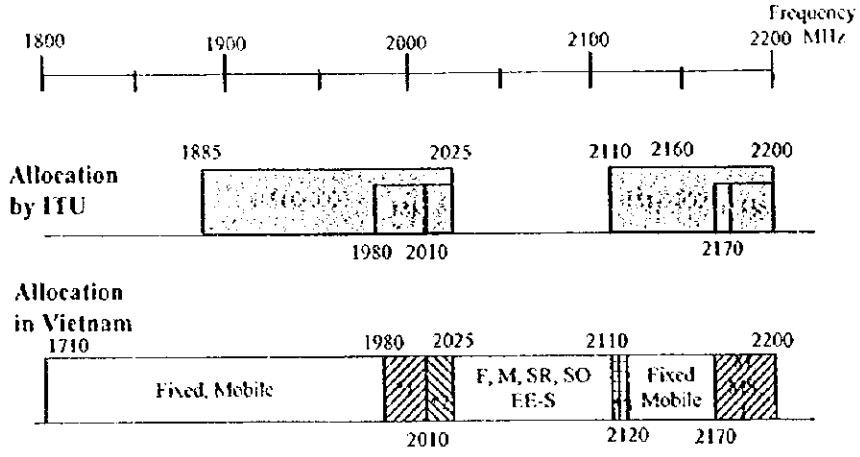
International Mobile Telecommunications 2000 (IMT-2000) is planned to have the following features and will enable to provide multimedia services.

i) High speed data communications
   144 kbps in mobile operation
   384 kbps at pedestrian speed
   2 Mbps for stationary terminals
ii) World-wide roaming
iii) Speech quality nearly same as that of fixed telephone

IMT-2000 is to be standardized by December 1999, and service is to be provided by the year 2000 (or 2001) at the earliest.

At present, W-CDMA and cdma2000 may be standardized as IMT-2000, and it is predicted that the system might co-exist with the second generation systems for the time being (about 10 years).

To introduce the IMT-2000, the radio frequency allocation should be ensured according to the radio frequency allocation around 2 GHz as shown in Figure 9.5.1-1.



F: Fixed, M: Mobile, MS: Mobile-Satellite, SR: Space Research, SO: Space Operation
EE-S:Earth Exploration-Satellite, MSS: Mobile Service Satellite
*1: Mobile, Mobile-Satellite, Fixed
*2: Fixed, Mobile, Space Research, Space Operation, Earth Exploration-Satellite
*3: Fixed, Mobile, Space Research

Figure 9.5.1-1 Radio Frequency Allocation for IMT-2000

(c) GMPCS

To supplement terrestrial cellular mobile services, global mobile personal

communications system by satellite (GMPCS) has been just introduced in the world. GMPCS is a system using plural satellites with low/medium earth orbit (LEO/MEO), and several types of GMPCS are developing in the world. Major GMPCS systems are summarized in Table 9.5.1-1.

Table 9.5.1-1 Major GMPCS Systems

	IRIDIUM	GLOBALSTAR	ICO
Commencement of Service	November 1998	3rd 1999	August 2000
Orbit	780 km LEO	1,414 km LEO	10,390 km MEO
No. of Satellites	66 (6 x 11 +spare 6)	48 (8 x 6 + spare 8)	10 (2 x 5 + spare 2)
No. of Earth Stations	15	38 (60)	12
Tariff	US$ 1.64/min	US$ 1 – 2/min + Terrestrial	US$ 2 – 3/min
Price of Terminal	US$ 3,000 – 4,000	US$ 750	US$ 1,500

(d) MMAC

Multimedia Mobile Access Communication system (MMAC) is a system with the following capability:

i) High speed wireless LAN
ii) High speed wireless access for public communications
iii) Hand-over function
iv) Broad band transmission capacity : 10 Mbps/user
v) Radio section: 5 GHz - 25 GHz, Cable section: ATM technology

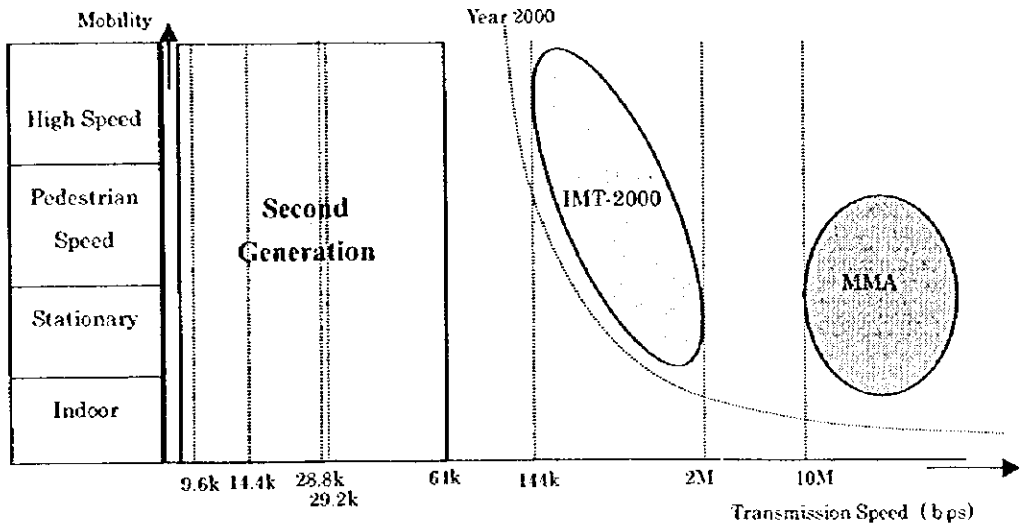


Figure 9.5.1-2 Mobility and Transmission Speed of Cellular System

(2) Comparison with Other Countries

The penetration ratio of cellular mobile services in Vietnam is still far behind compared with the other countries as shown in Table 9.5.1-2.

Table 9.5.1-2 Cellular Services in the Other Countries

Country	Population (x 1,000)	No. of Subscribers (x 1,000)	Penetration Ratio (%)	Remarks
Vietnam	75.18	68.9 (184.2)	0.09 (0.25)	( ) : as of June 1998
Australia	18.31	3,815	20.84	
China	1,232.08	6,850 (13,860,000)	0.56	( ): as of Sep. 1998
Hong Kong	6.31	1,361.9	21.58	
India	944.58	328,000	0.03	
Indonesia	196.81	513,000 (562,517)	0.26	( ): as of March 1998
Japan	125.76	26,906.5	21.40	
Malaysia	20.58	1,520,300	7.39	
New Zealand	3.57	493,000 (388,000)	13.81	( ): as of April 1998
Pakistan	134.15	65,000	0.05	
Philippines	71.90	959,000	1.33	
Singapore	3.04	430,000 (876,4000)	14.14 (28.2)	( ): as of May 1998
South Korea	45.55	3,181,000 (5,600,000)	6.98	( ): as of July 1998
Sri Lanka	18.30	71,000	0.39	
Taiwan	21.47	970,500 (1,170,000)	4.52	( ): as of June 1998
Thailand	60.00	924,400 (1,154,100)	1.54 (1.92)	( ): as of July 1998

Upper: ITU data as of 1996, Lower ( ) : Newest data
Source: ITU (as of 1996)

Considering the potential demand in Vietnam mentioned in Chapter 7, the growth of cellular mobile service can be expected, so the expansion plan of the existing system and the introduction plan of the new services should be established.

(3) Development Scenario of Cellular Mobile Telephone Network in Vietnam

The development scenario of cellular mobile telephone network is established from the following viewpoints:

(a) Expansion of existing Services

VMS and GPC have expansion plans of service areas nationwide, and their plans are to cover all provinces and major cities by 1998. At present, major provinces and cities have been covered by these providers, so the expansion of service

areas would be carried out in major other cities/towns considering the demand of cellular mobile service.

Also, the cellular mobile services shall be improved in quality and quantity, i.e., improvement of GOS (grade of service), protection against interference and expansion of coverage areas.

(b) Introduction of New Systems

In parallel with the improvement and expansion of the existing systems, the introduction of new systems should be considered for provision of new services. As new cellular mobile telephone systems, the following systems can be considered:

i) PCS, PHS and PCN

PCS using CDMA, PHS or PCN can supplement the cellular mobile services due to difference of their frequency bands.

In addition, these systems can provide short message services (SMS), so the systems can also supplement the paging services.

ii) CDMA

Not only for mobile service (PCS), but also for fixed service (WLL), CDMA is effective system in Vietnam. This technology is a fundamental one for the next generation system, i.e., IMT-2000.

iii) GMPCS

To supplement terrestrial cellular mobile systems, GMPCS is the most effective system. However, its tariff may be higher than the conventional cellular mobile systems, therefore, the application of the GMPCS should be limited to the specific purposes.

(c) Trend of Cellular Mobile Service in Vietnam

The trend of cellular mobile service in Vietnam is considered as shown in Figure 9.5.1-3.

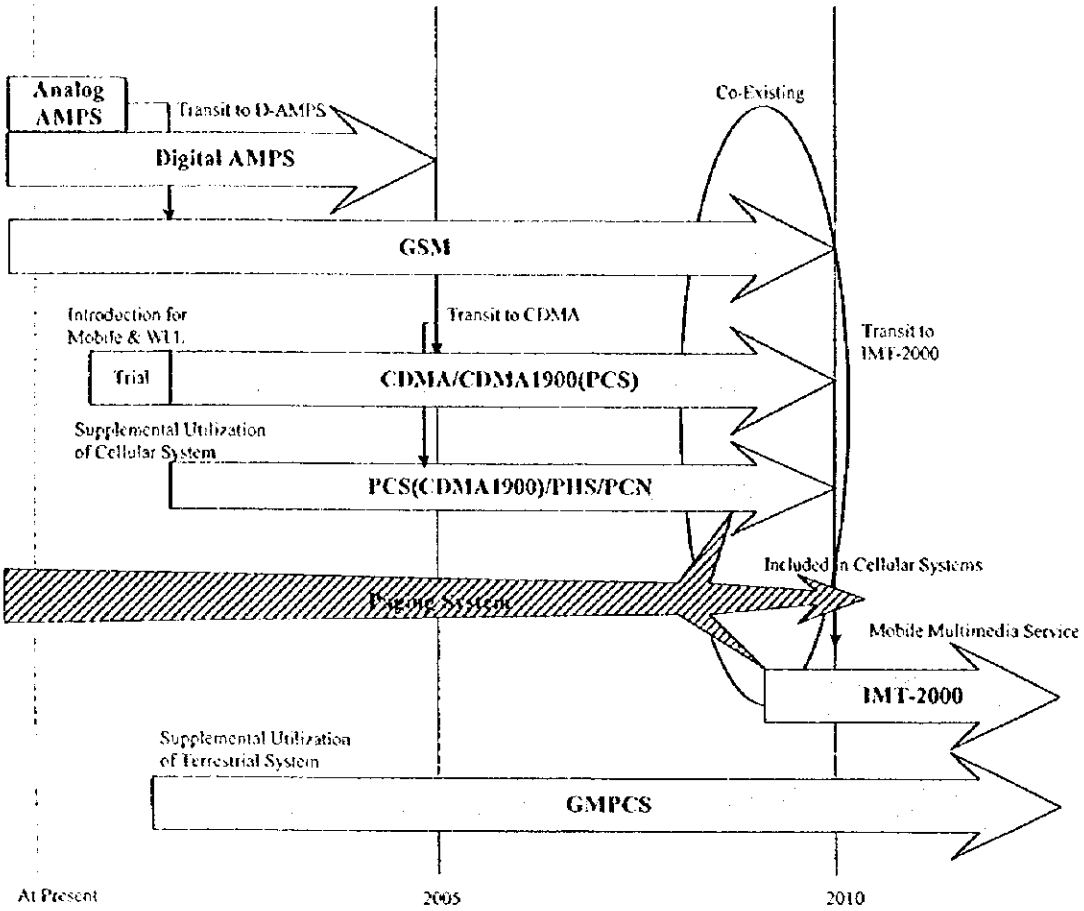


Figure 9.5.1-3 Cellular Mobile Systems to be applied

(a) Analog AMPS will be replaced/absorbed by D-AMPS or the other cellular systems such as GSM and CDMA.

(b) GSM may be utilized for the time being by the introduction of IMT-2000 due to its popularity in the world, but the major position in the cellular mobile service may be replaced by CDMA.

(c) CDMA may be introduced as trial in specific areas, and based on the result of the trial CDMA is expected to play a major role in cellular mobile service before the introduction of IMT-2000. At present, VIETEL and Saigon Postel have plans to introduce CDMA systems.

(d) PCS/PHS/PCN systems may be utilized in specific areas, especially in urban areas as supplemental systems to the cellular mobile systems due to their

technical and economical reasons.

(c) Cellular mobile systems have a function of paging/short message service, therefore, cellular mobile service may assimilate paging service if the fee of cellular mobile services is reduced as same as that of paging service.

9.5.2 Paging Network

(1) General

The paging networks in Vietnam have been developed by the several providers as mentioned in clause 3.2.3.

The major provinces and cities have been covered by paging services, so in future the service areas would be expanded to the other provinces/cities considering the demand conditions.

On the other hand, the introduction of new paging systems is proceeding in the world, but the introduction of paging system is far behind cellular mobile system.

(a) New Pager with Multi-function

The development of the paging systems is carried out regarding having multi-functions such as display of characteristics.

At present, the first generation's paging systems are utilized in Vietnam, but the second generation's paging systems are being utilized in the world.

The trend of the paging systems is shown in Figure 9.5.2-1.

The system parameters of the major paging systems are mentioned in Table 9.5.2-1.

Table 9.5.2-1 System Parameters of Major Systems

	POCSAG	ERMES	FLEX
System Bit Rate	512 – 1200 bps	3,125/ 6,250 bps	1,600/3,200/ 6,400 bps
Modulation	2 FSK	4 FSK	2/4 FSK
Carrier Spacing	25 KHz	25 KHz	25 KHz
Frequency Band	150, 280, 450, 900 MHz	160 MHz	900 MHz
Subscribers per Carrier	26,000/ 62,000	Max. 320,000	Max. 530,000

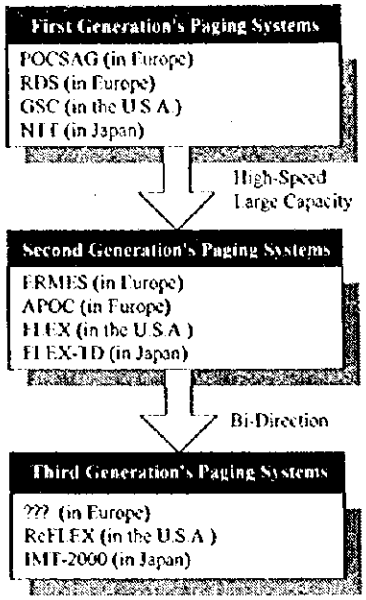


Figure 9.5.2-1 Trend of Paging Systems

(b) Paging System using GMPCS

GMPCS system is utilized not only for cellular system, but also for paging system by using satellite. However, the paging function of GMPCS is mainly used for complement of cellular function, because cellular function can be hard to catch call indoor, so paging function is used for detection of call indoor.

(c) Paging Function using PCS/PHS/PCN

Paging function can be provided by the PCS, PHS and/or PCN. In Japan, "P-Mail" short message service which can transmit either text characters or a hand-written bit map image has been provided as one of PHS service, and there is a definite trend to churn from pagers to PHS due to the growing popularity of the services.

(2) Comparison with Other Countries

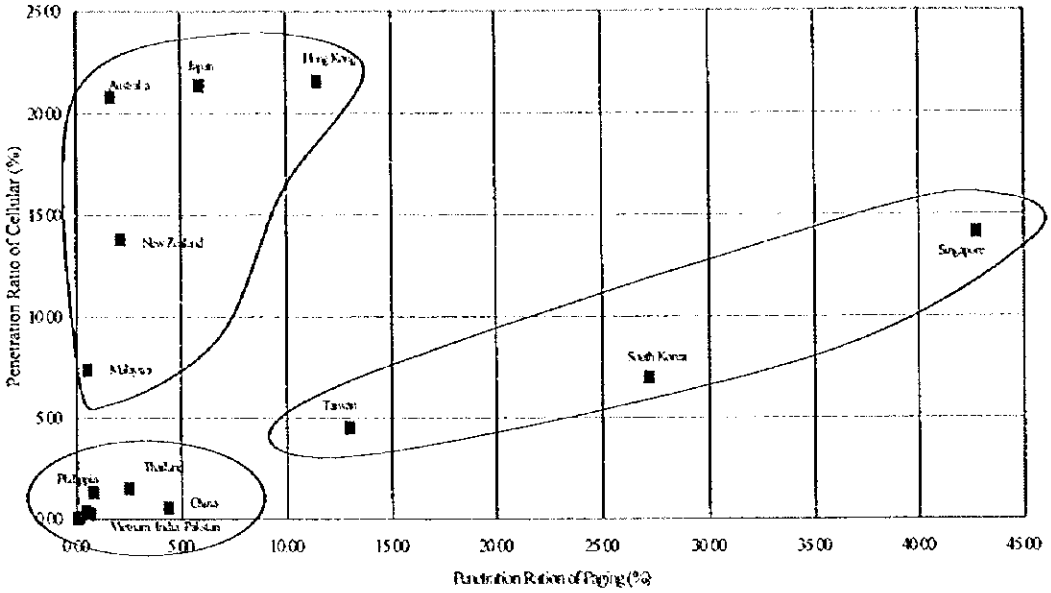
The paging service conditions in Vietnam are compared with the other countries as shown in Table 9.5.2-2.

Table 9.5.2-2 Comparison of Radio Paging

Country	Population (x 1,000)	No. of Operators	No. of Subscribers	Penetration Ratio (%)	Remarks
Vietnam	75.18	6	96,000 (126,874)	0.13 (0.17)	Excluding HCM ABC ( ): as of June 1998
Australia	18.31	4	300,000 (330,000)	1.64	Excluding 1 operator ( ): as of Aug. 1998
China	1,232.08	3 or more	54,000,000 (50,500,000)	4.38	Excluding 1 operator ( ): as of Sep. 1998
Hong Kong	6.31	4	720,000	11.41	
India	944.58	6	597,000	0.06	
Indonesia	196.81	5	1,335,000	0.68	
Japan	125.76	2	7,400,000	5.88	
Malaysia	20.58	6	108,000 (133,000)	0.52	( ): as of Feb. 1998
New Zealand	3.57	3	75,500 (51,000)	2.11	( ): as of April 1998
Pakistan	134.15	1	30,000	0.02	
Philippines	71.90	5	574,000	0.80	
Singapore	3.04	4	1,300,000 (1,361,800)	42.76 (44.80)	( ): as of May 1998
South Korea	45.55	12	12,400,000 (13,600,000)	27.22	Excluding 9 operators ( ): as of July 1998
Sri Lanka	18.30	3	82,000	0.45	
Taiwan	21.47	1	2,777,500 (2,700,000)	12.94	( ): as of July 1998
Thailand	60.00	6	1,495,000 (822,699)	2.49 (1.37)	( ): as of July 1998
Total	2,977.59	61	83,290,000	2.80	

Source: No. of Subscribers: Upper: mobile comms. Asia (October 1998), Lower: newest data
Population: ITU (as of 1996)

The paging subscribers have been recently overtaken in number by that of cellular mobile service in Vietnam. The relationship between the numbers of cellular and paging subscribers is indicated in Figure 9.5.2-2.



Source: ITU and others

Figure 9.5.2-2 Number of Subscribers of Paging vs Cellular Subscribers

The above figure in Asia Pacific region shows that there are three (3) tendencies, i.e., cellular-oriented group (cellular subscribers are larger than paging subscribers), paging-oriented group (paging subscribers are larger than cellular subscribers), developing group (cellular and paging penetrations are low and tendency is not clear).

Vietnam currently belongs to the developing group, but the recent trend may be towards the cellular-oriented group.

(3) Target of Paging Network in Vietnam

The target of paging service is established considering the above tendency and the forecasted demand as follows:

(a) Paging service should be improved mainly in quality such as upgrading system, because large growth of paging service can not be expected.

(b) Tariff of paging service should be considered in order to expand in quantity referring that of cellular service and ordinary telephone service, because the discrimination of services by paging and cellular systems might be reduced.

(c) The function of paging system can be included in those of the cellular mobile system, especially cordless based system, therefore, the paging service and system may be assimilated in cellular mobile service/system according to the reduction of utilization fee of the cellular mobile.

9.6 Development Indicator of Non-Voice Communications

The non-voice communications services such as data communications are to be expanded and improved considering the present situations in Vietnam and the other countries, especially in similar countries and neighboring countries.

9.6.1 General

(1) Communications Infrastructures

The infrastructures of communications such as telephone and non-voice communications are categorized by access rate and usage frequency as shown Figure 9.6.1-1.

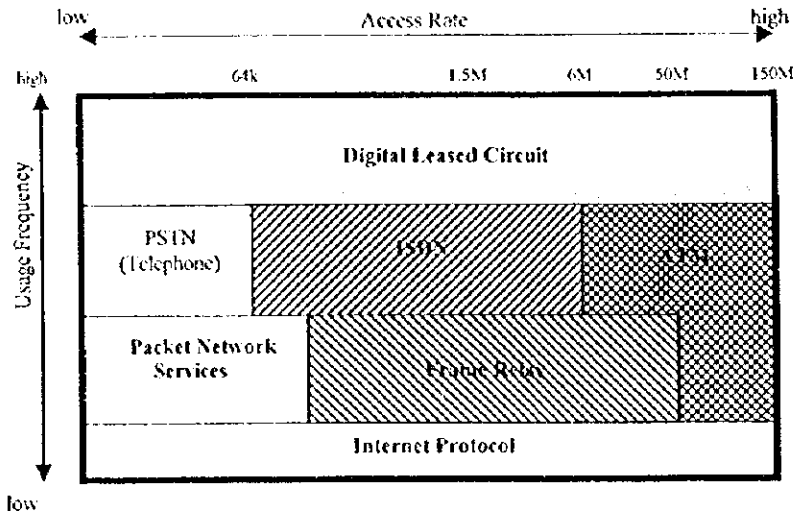


Figure 9.6.1-1 Access Rate and Usage Frequency

In this Study, the approach to non-voice communications is carried out from the viewpoint of infrastructures, because the applications can be used over several infrastructures, so the approach to non-voice communications from applications is extremely complicated.

(2) Application of Infrastructures

The relationship between service (application) and transmission speed is shown in Figure 9.6.1-2.

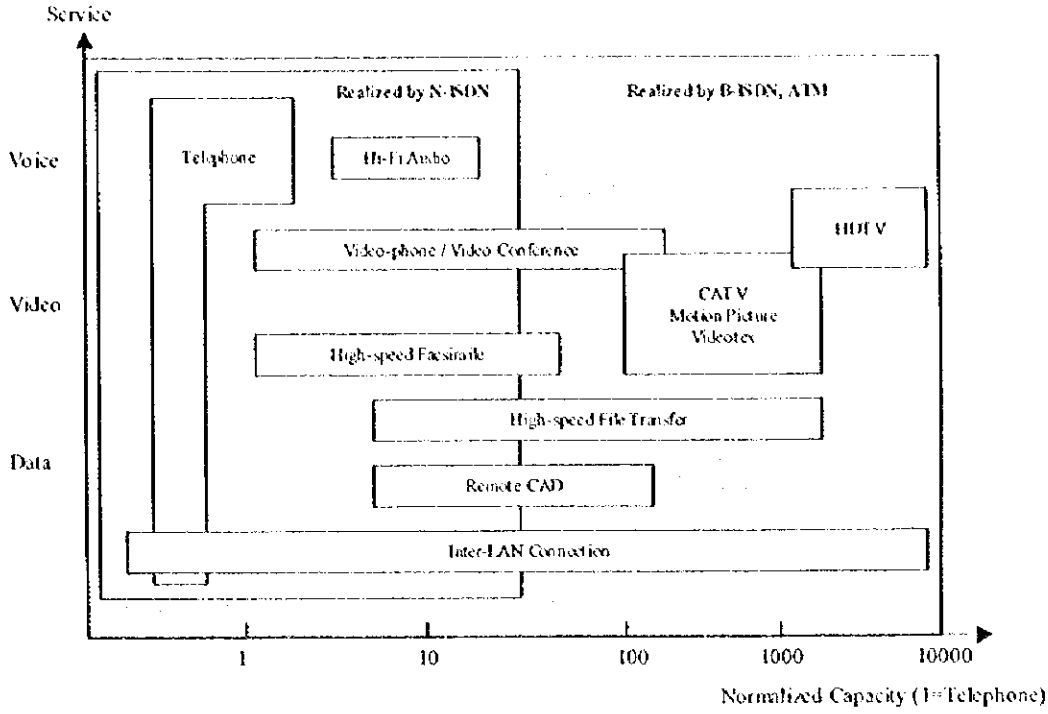


Figure 9.6.1-2 Service and Transmission Speed

Through the new development of infrastructures, new services and applications can be easily introduced in Vietnam.

(3) Transition to New Services

Non-voice communications services have been developed in proportion to the expansion of social/economic activities and development of communications technologies in the world. According to the development of non-voice communications, various new services are introducing in the world.

It is important to expand data communications network for performing effectively and smoothly social and economic activities in Vietnam. However, the data communications services in Vietnam are insufficient, so it is indispensable to upgrade and expand data communications services.

To improve and expand the data communications services, the following items are considered:

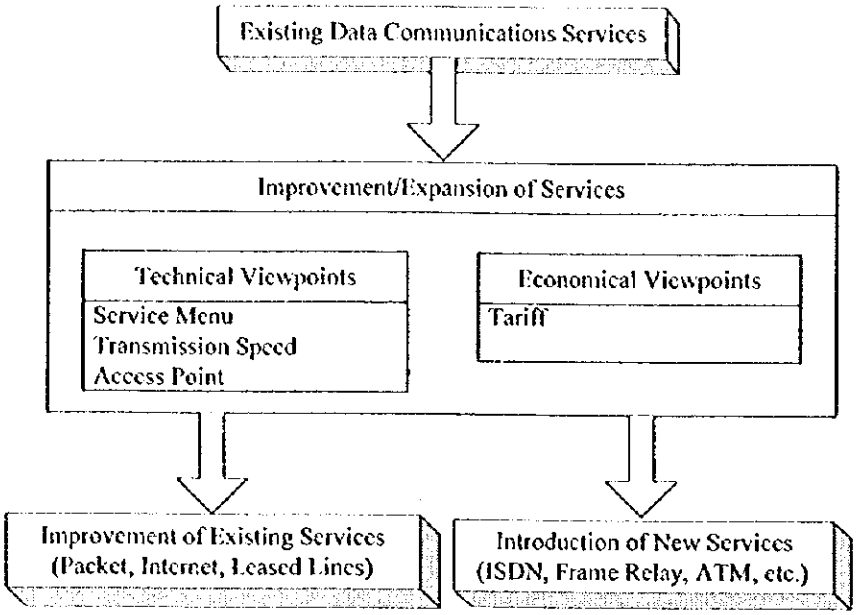


Figure 9.6.1-3 Factors for Transition to New Services

(a) Improvement Factors for Data Communications

To improve and expand the data communications in Vietnam, the following factors should be considered:

i) Expansion of Service Menu

Corresponding to demand and requirements by users, menu of the data communications services will be expanded.

ii) Increasing Transmission Speed

At present, the maximum transmission speed except for leased line services is 64 kbps by using packet network. It is indispensable to increase transmission speed of data communications corresponding to the demand and requirements.

iii) Expansion of Service Areas

At present, the data communications services are limited in the specific areas such as Hanoi, Ho Chi Minh City, Da Nang, etc. To expand the data communications and to transit to new services, the service areas/access points should be expanded nation-wide.

iv) Reasonable Tariff Structure

To promote utilization of data communications services, a reasonable tariff structure should be established.

(b) Transition to New Services

As one of improvement and expansion measures of data communications services, new services corresponding to the demand and requirements by users would be introduced in Vietnam.

It is predicted that the users will shift from existing services to new services as shown in Figure 9.6.1-4.

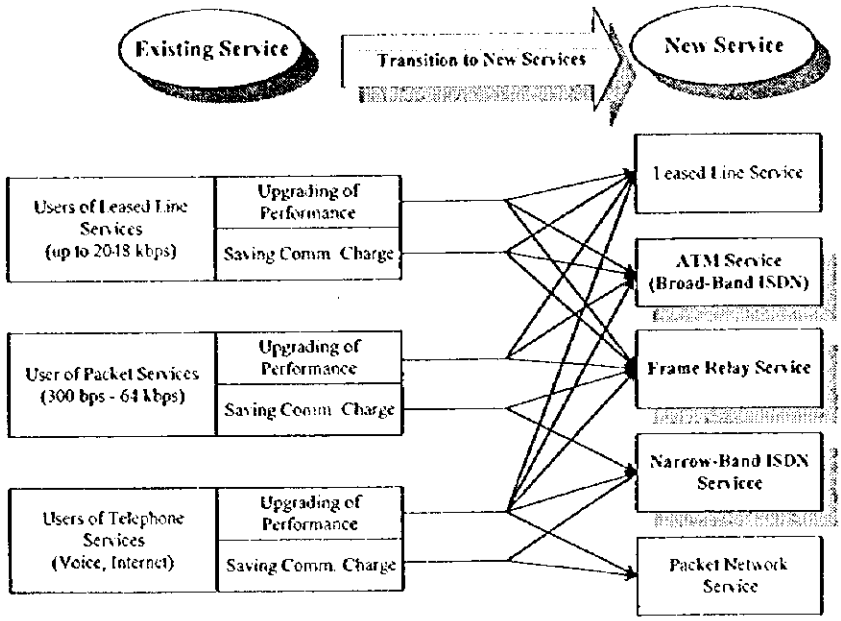


Figure 9.6.1-4 User Transition to New Services

(4) World Trend of Data Communications

(a) General

The trend of data communications in the world are summarized below based on the market survey data of ATM Forum and Frame Relay Forum, investigated by Distributed Networking Associates in 1998:

i) Offering Bandwidth

Based on the questionnaire survey performed, service providers would offer the following dedicated bandwidth services:

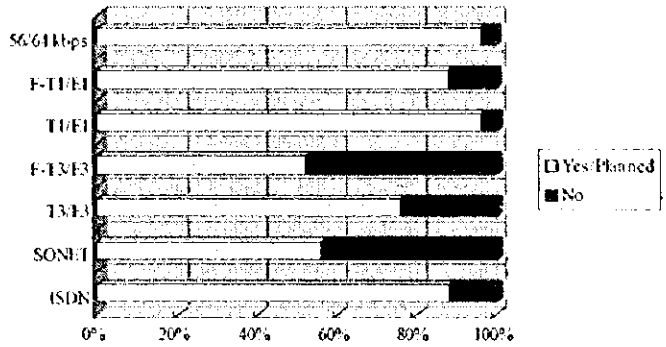


Figure 9.6.1-5 Related Dedicated Bandwidth Service Offering

According to the above figure, most service providers plan to offer 56/64 kbps, T1/E1 and ISDN for dedicated bandwidth, and high capacity system such as T3/E3 and SONET (Synchronous Optical NETwork, transmission speed: 51.84 Mbps – 13.22 Gbps) is not so much compared with lower capacity systems.

It means that the utilization of data communications is not only object to enlarge transmission capacity, but also object to realize efficient transmission by using new services.

ii) Port Speed

In addition, the following figure shows the port speed to be required:

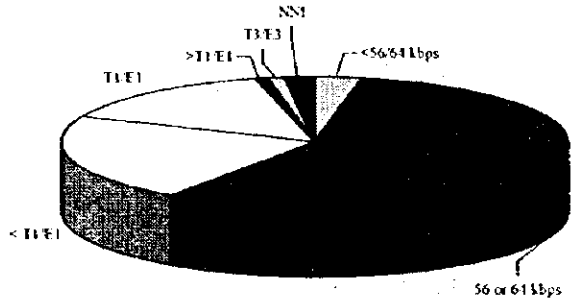


Figure 9.6.1-6 Port Speeds

Based on the result of market research, more than half of ports apply the 56/64 kbps port speed, and most of ports are utilized at the port speed of T1/E1 (1.5/2 Mbps) or lower.

iii) Integrated Access Service

The following figure shows the type of integrated access to services to be required.

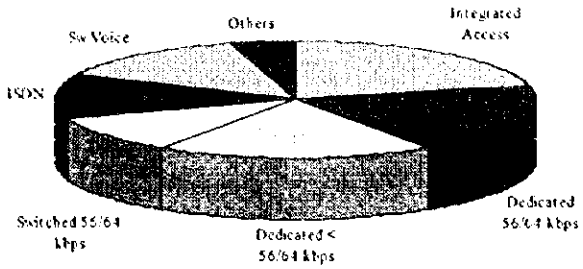


Figure 9.6.1-7 Integrated Access to Services (Dedicated Bandwidth)

The above figure shows that most of integrated access to service also utilizes bandwidth lower than 56/64 kbps through dedicated and switched lines.

(b) Trend in U.S. and Developed Countries

The data communications (non-voice communications) are being dramatically expanded in U.S. and the other developed countries, where the platforms for communications networks have been fully developed and the new services are being required. In these countries, the traffic of non-voice services are expected to be higher than that of voice services within 2 or 3 years.

(c) Trend in the South-East Asian Countries

Compared with the above countries, the non-voice communications are still smaller than voice communications. In these countries, the platforms for voice communications have not yet been fully developed. Therefore, the trend in developed countries can not be applied to these countries. Especially, the trend of new services such as IP and Electronic Commerce (EC) may be completely different from the developed countries. In addition, the detailed utilization conditions of data communications in these countries can not be obtained, and can not be predicted without enough data.

(5) Data Communications in Vietnam

The present situation of data communications in Vietnam is mentioned in Chapter 3, so the overall conditions and features of data communications in Vietnam are summarized in this section.

(a) Volume of Data Communications

The number of data communications users/lines is very small, and utilized sections/areas are limited in specific areas such as Ha Noi, Ho Chi Minh, Da Nang, etc.

(b) Services Menu of Data Communications

At present, the data communications are limited to the services of Packet and Leased Lines, and new services such as ISDN and Frame Relay services have not yet been provided in Vietnam.

The current share of data communications services in Vietnam is shown in Figure 9.6.1-8.

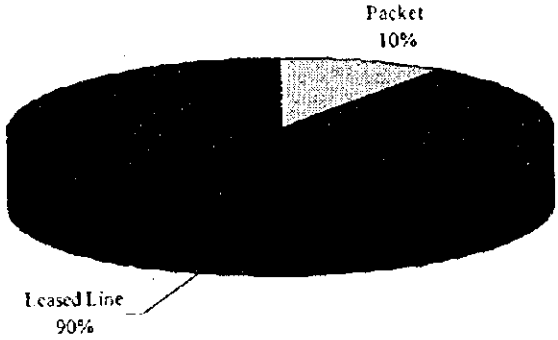


Figure 9.6.1-8 Share of Data Communications Services in Vietnam

The number of data communications lines is very small, and about 90 % of lines depends on leased line service. It means that the communications sections are limited to the specific locations/sections.

(6) Data Communications in Other Countries

The prediction of data communications is very difficult and basic data for prediction such as historical data of new services could not be obtained through the study. Therefore, the present situation and trend in the other countries, especially in Asia Pacific region, have been used for reference as the prediction of data communications in Vietnam.

(a) Data Communications in Asia Pacific Region

The present situations of data communications, i.e. Internet, Leased Line, ISDN, Frame Relay (FR) and Asynchronous Transfer Mode (ATM) in the Asia Pacific region are summarized in Table 9.6.1-1.

Table 9.6.1-1 Data Service Conditions in Asia Pacific

Country	Internet	Leased Lines	ISDN	FR	ATM	Remarks
Vietnam	○	○	×	×	×	
Australia	○	○	○	○	○	
Cambodia	○	○	×	×	×	
China	○	○	○	○	○	
Hong Kong	○	○	○	○	○	
India	○	○	×	×	×	
Indonesia	○	○	○	○	×	
Japan	○	○	○	○	○	
Laos	?	?	×	×	×	
Malaysia	○	○	○	○	×	
Myanmar	?	?	×	×	×	
New Zealand	○	○	○	○	?	
Pakistan	○	?	×	×	×	
Philippines	○	○	○	○	×	
Singapore	○	○	○	○	×	
South Korea	○	○	○	○	×	
Sri Lanka	○	○	×	×	×	
Taiwan	○	○	○	○	×	
Thailand	○	○	○	○	×	

Note: ○: in service, ×: not in service, ?: no information
Source: Data in Internet as of October 1998 and Asian Communications Jan. -- Sep. 1998

The detailed service conditions of data communications in Asia Pacific region are mentioned hereafter in each service menu.

(b) Data Communications in Japan

It is difficult to obtain the conditions such as annual trend of data communications in other countries. Therefore, the conditions of data communications conditions in Japan (NTT) are shown as reference in Figure 9.6.1-9.

The figure shows the commencement year by service menu and trend of number of users by category such as Leased line, ISDN and Packet/Frame relay/ATM. These categories include the following services:

i) Leased Line

Leased lines mean standard leased line (analog and low speed digital leased line), High Speed Digital Transmission Service (HSD) and ATM bearer service (branded as ATM Mega-link service).

ii) ISDN

ISDN lines mean Basic Rate Interface (BRI) and 1.5 Mbps Primary Rate Interface (PRI).

iii) Packet/Frame Relay/ATM

These lines mean switched Packet, Frame Relay and ATM lines (ATM bearer service is categorized in leased line service).

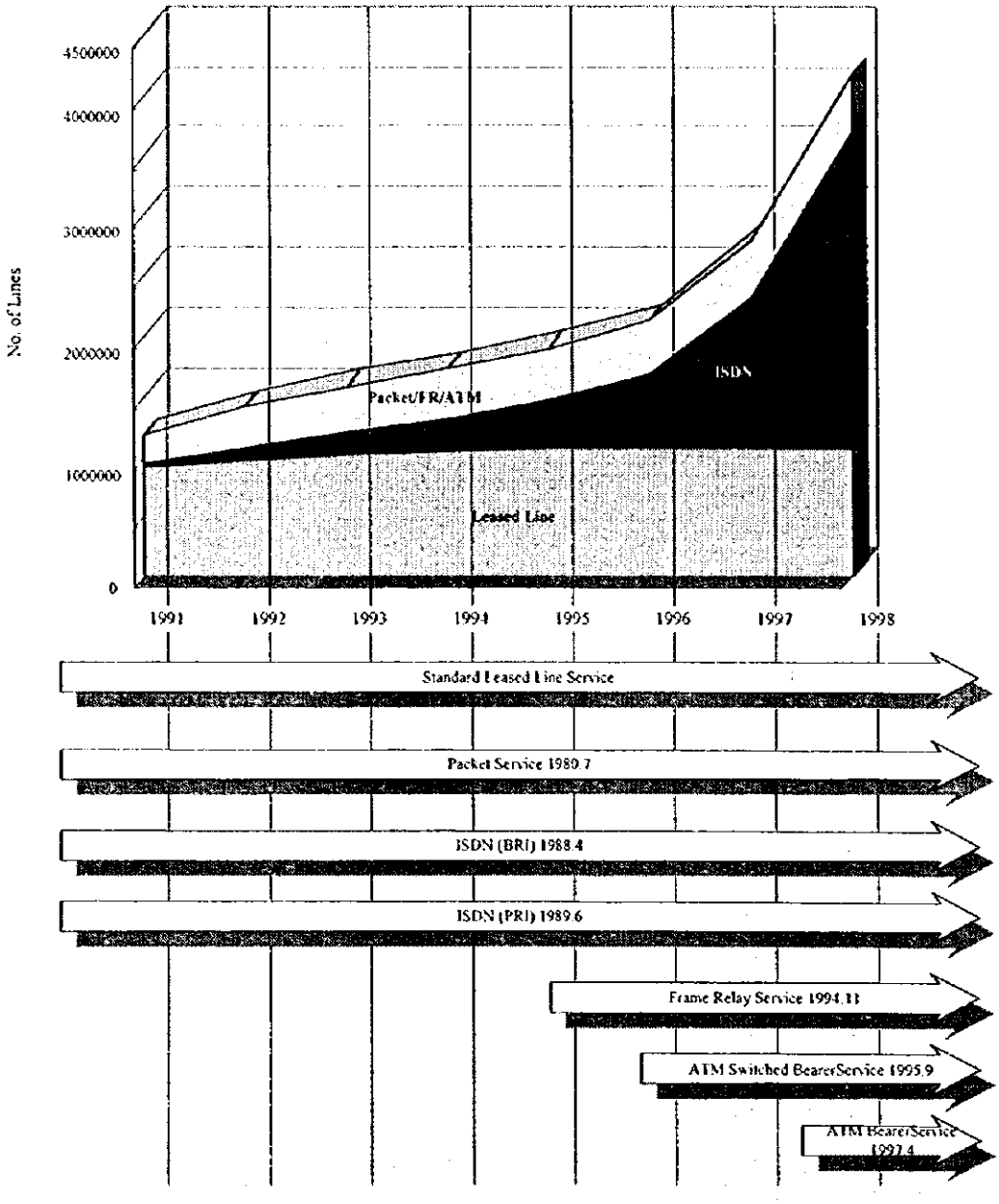


Table 9.6.1-9 Data Communications Trend in Japan

The above figure shows that the following trend of data communications in Japan:

i) Number of leased lines, especially analog and low speed digital, is gradually reducing year to year, and the bandwidth of leased line is being increased.
ii) Number of ISDN lines is rapidly increasing in recent year, i.e., in the five (5) years since the commencement of services, the users have dramatically increased.
iii) Numbers of Packet, Frame Relay and switched ATM lines are slightly increasing, but their bandwidths are being increased.

The share in data communications is shown category by category in Figure 9.6.1-10.

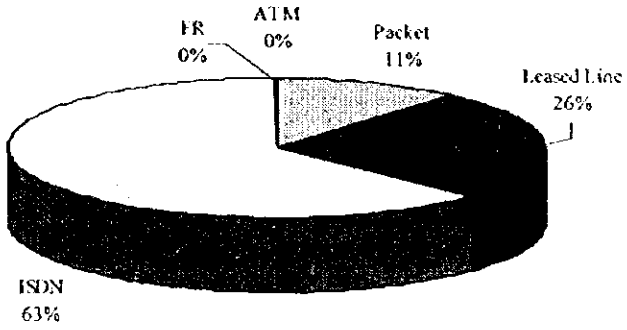


Figure 9.6.1-10 Share of Data Communications Services in Japan

For the data communications, two-third of lines utilizes the ISDN, and leased lines only occupies about 26 %. This conditions may result from usage cost of data lines (ISDN is cheaper than a leased line) and destinations of communications (ISDN can connect between ISDN users on demand, and destinations of communications are not permanent). High speed data transmission systems such as Frame Relay and ATM are only very small percentage.
Compared with the conditions in Vietnam as shown in Figure 9.6.1-8, the ratio of leased lines in Japan is small, and the ratio of ISDN is very large.

The detailed conditions of data communications in Japan are mentioned in each related section.

9.6.2 Internet Services

(1) Present Situation in Vietnam

The Internet services were provided from November 1997 by several providers in Vietnam as mentioned in Chapter 3, however, the number of users couldn't reach the expected level.

This condition might be caused by the following factors:

(a) Expensive Access Charge

The access charge of the Internet service is expensive comparing with ordinary telephone charge and the other countries.

(b) Lack of Computers

The number of computers, which has significant correlation with the number of Internet users, is still small in Vietnam.

(c) Lack of Access Points

The access points of the Internet service are limited in specific cities such as Ha Noi and Ho Chi Minh, so the telephone charge for remote users to the Internet access point is generally expensive.

(d) Restricted Access

All the Internet Web can not be freely accessed in Vietnam.

(2) Comparison with Other Countries

The conditions of Internet services are compared with the other countries from the various viewpoints as follow:

(a) Number of Users

The conditions of the Internet services in other countries are summarized as follows:

Table 9.6.2-1 Comparison with Other Countries

	Hosts Total	Hosts/10000 inhabitants	User Total	Users/10000 inhabitants	No. of PCs	Remarks
Vietnam	5	-	100 (8,082)	0.01	250,000	
Australia	514,760	281.11	2,000,000	1,092.18	5,700,000	
Cambodia	-	-	-	-	-	
China	19,739 (6,880)	0.16	150,000 (1,200,000)	1.22	3,700,000	
Hong Kong	49,162	77.90	300,000	475.36	950,000	
India	3,138	0.03	80,000	0.85	1,400,000	
Indonesia	9,591	0.49	80,000	4.06	940,000	
Japan	734,406	58.40	7,000,000	556.61	16,100,000	
Laos	-	-	-	-	5,000	
Malaysia	25,200 (4,200)	12.24	63,945	31.07	880,000	
New Zealand	84,532 (53,610)	236.78	300,000	840.34	950,000 (800,000)	
Pakistan	511	0.04	4,000	0.30	155,000	
Philippines	3,628	0.50	40,000	5.56	670,000	
Singapore	28,892	94.91	150,000 (316,700)	492.72	660,000	
South Korea	66,262	14.55	600,000	131.74	5,997,000	
Sri Lanka	349	0.19	2,500	1.37	60,000	
Taiwan	34,650	16.14	300,000	139.72	1,900,000	
Thailand	9,245	1.54	80,000 (67,000)	13.33	1,000,000 (1,000,000)	

Source: Upper: World Telecommunication Development Report (data: 1996)
Down: Others (newest data)

Compared with the other countries, the numbers of hosts/users are very small, and their ratios to inhabitants also very low in Vietnam.

(b) Access Charge

The access charge of the Internet service in Vietnam is more expensive than the other countries compared with ordinary call charge of telephone. Table 9.6.2-2 shows the comparison of Internet access charge and call charge of telephone in Vietnam and Japan.

Table 9.6.2-2 Comparison of Access Charge

	Vietnam	Japan
Ratio of Internet Access Charge to Telephone Call Charge	Approx. 0.1 - 6	Approx. 0.2 - 2
Remarks	Minimum: long distance call Maximum: local call	

The above table shows the following service features:

i) In Vietnam, the charge is relatively cheaper for long distance access to Internet access point but is expensive in a same area as access point.

ii) In addition, Internet access to access point in a same area is relatively expensive in Vietnam.

(c) Penetration of Computers

The number of computers and the penetration ratio of computers are shown in Table 9.6.2-2. These values are also very small compared with the other countries. It means that conditions for Internet are not yet favorable in Vietnam.

(d) Access Points

In Vietnam the access points for the Internet service are limited to several cities such as Ha Noi and Ho Chi Minh. In addition, the access charge is also expensive, so the access to Internet service is more expensive than the other countries, especially for the users far from access points.

(e) Restrictions for Internet Service

The Internet service in Vietnam has some restrictions regarding connection to any harmful Webs.

(3) Expansion Plan

(a) Requirements for Expansion

The number of users of Internet services in Vietnam is smaller than the expected number and those in the other countries mentioned above, so it is required to improve and expand the Internet services by the following measures:

i) Expansion of Access Points

Access points for Internet services should be expanded not only in major cities but also all provinces.

ii) Reducing Access Charge

The Internet services are very useful and effective for users, because the required data and information can be obtained easily and instantly by using computer network. However, the number of users of Internet services is smaller than expected one, and most of users are foreign companies or foreigners.

To break through these conditions, it is expected that reduction of access charge is most effective measures.

iii) Restrictions

By relaxation of the restrictions for access to Webs, the Internet service can be used more effectively and the users are expected to be increased.

(b) Prediction

The demand forecast of Internet users is mentioned in Chapter 7, and Internet users will be dramatically increased by improving the service conditions mentioned above. However, it is difficult to forecast the access speed of users for Internet services.

Responding to the introduction of new data communications services such ISDN services, the some parts of access to Internet would shift to dial-up/dedicated access through the new services such as ISDN.

As one of applications of the Internet, Voice over IP (VoIP) is mentioned in the section 9.6.9.

9.6.3 Packet Services

(1) Present Situation

The service conditions and facilities conditions are mentioned in Chapter 3 and Chapter 5, respectively. However, the detailed service conditions such as users by transmission speed could not be obtained through the Study.

The total users of Packet services is 229 as of 30 June 1998. This number is not so large (0.015 % of main telephone lines).

(2) Comparison with Other Countries

Most in Asia Pacific region provides Packet services, but only a few data is available as shown in Table 9.6.3-1.

Table 9.6.3-1 Packet Service Conditions in Asia Pacific

	No. of Users	Ratio to Main Telephone Lines	Remarks
Vietnam	229	0.015 %	Of 30 June 1998
China	65,700	0.093 %	X.25
Japan	160,000	0.265 %	
Malaysia			Up to 2 Mbps

Source: Asian Communications (Jan. – Sep. 1998)

Compared with the other countries, the number and ratio to main telephone lines are very lower than the other countries.

(3) Expansion Plan

The Packet services have not yet been penetrated in Vietnam compared with the other countries as shown in Table 9.6.3-1. To expand and promote the usage of the Packet services in Vietnam, it is required to improve the following items:

(a) Expansion of Access Points

Access points for packet services should be expanded not only in major cities such as Ha Noi, Ho Chi Minh, but also all provinces, especially Industrial Zones (IZs) and Export Processing Zones (EPZs).

(b) Reducing Access Charge

The packet services are very useful and effective for business users, therefore, to break through these conditions, reduction of access charge is most effective measures.

The demand forecast of Packet services is very difficult, even though enough data and information could be obtained. However, by improving the above issues the demand of Packet service will be increased until the introduction of the new services such as Frame Relay and ISDN.

It is predicted that users of Packet service might be **shift to new services** such as Frame Relay and ISDN after their introduction.

9.6.4 Leased Lines

(1) Present Situation in Vietnam

The number of leased lines is not so large, but here are only two (2) data communications services, i.e., leased line service and Packet network service, so the share of leased line service is large in Vietnam as shown in Chapter 3.

(2) Comparison with Other Countries

(a) Comparison with Asia Pacific Region

The conditions of leased lines in some other Asia Pacific region are shown in Table 9.6.4-1.

Table 9.6.4-1 Leased Line Conditions in Asia Pacific

	No. of Leased Lines	Ratio to Main Telephone Lines	Remarks
Vietnam	2,039	0.130 %	
China	303,810	0.432 %	X.25: 65,700
Japan	1,073,252	1.778 %	As of March 1998
Malaysia			Up to 2 Mbps

Source: Asian Communications (Jan. – Sep. 1998)

In Vietnam, the ratio of leased lines to data communications is very high, but the ratio to main telephone lines is still lower than the other countries. It means that the number of leased lines is absolutely small compared with the other countries.

(b) Trend of Leased Lines in Japan

As trend of leased lines in Japan, the service conditions by NTT, which is dominant provider, are mentioned below. The following three (3) types of leased line services are available in Japan.

i) Standard Leased Line Service

Standard leased line service provides analog leased lines with 3.4 kHz bandwidth and digital leased lines with 50 bps – 9,600 bps. NTT's share is about 98 %.

ii) High Speed Digital Transmission Service (HSD)

This service provides high speed digital leased lines with 64 kbps – 150 Mbps. NTT's share is about 80 %.

iii) ATM Leased Line Service

This service provides the ATM leased lines with 0.5 Mbps – 135 Mbps. Other than ATM leased line service, switched ATM service is also provided in Japan. At present, the number of users of ATM leased lines is far larger than that of switched ATM lines.

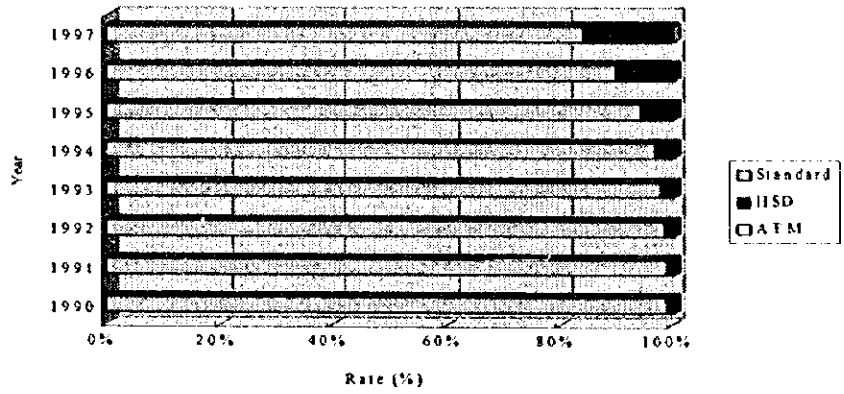


Figure 9.6.4-1 Trend of Leased Line Services in Japan

Table 9.6.4-2 Annual Trend of Leased Line Service in Japan

	1991.3	1992.3	1993.3	1994.3	1995.3	1996.3	1997.3	1998.3
Standard	901,000 (99.1 %)	962,000 (98.9 %)	997,000 (98.5 %)	1,018,000 (98.1 %)	1,025,000 (97.1 %)	1,001,000 (94.6 %)	967,000 (90.0 %)	902,000 (84.2 %)
HSD	8,000 (0.9 %)	11,000 (1.1 %)	15,000 (1.5 %)	20,000 (1.9 %)	31,000 (2.9 %)	57,000 (5.4 %)	107,000 (10.0 %)	169,000 (15.8 %)
ATM (Bearer)	-	-	-	-	-	-	-	255 (0.02 %)
Total	910,990	974,991	1,013,992	1,039,993	1,057,994	1,059,995	1,075,996	1,073,252

Source: NTT

The above figure shows that standard leased lines (analog and low speed digital lines) are gradually decreased and replaced by digital leased lines (HSD), however, the standard leased line service still has many users. In addition, ATM leased line service has only small share.

(3) Expansion Plan

Analog leased lines are being shifted to digital leased lines, and the transmission capacity (transmission speed) is being enlarged in recent year.

(a) Issues to be solved

To expand the utilization of leased lines, user demand and requirements should be assessed.

i) Expansion of Service Areas

Service areas for leased line services should be expanded not only in major cities but also specific areas such as Industrial Zones (IZs) and Export Processing Zones (EPZs) considering the social/economical development plan.

ii) Reducing Leased Charge

To promote the utilization of leased line services, it is essential to reduce leased charges.

(b) Prediction

By the limitation of data communications service menu in Vietnam, the share of leased line services are large, however, the introduction of the new services such as ISDN and Frame Relay might promote the **transition from leased line service to the new services**. Therefore, the utilization of leased line service might be limited in specific purposes from the economical and technical viewpoints, i.e., tariff, traffic and destinations, etc. The trend of leased line services in Vietnam is predicted as shown in Figure 9.6.4-2.

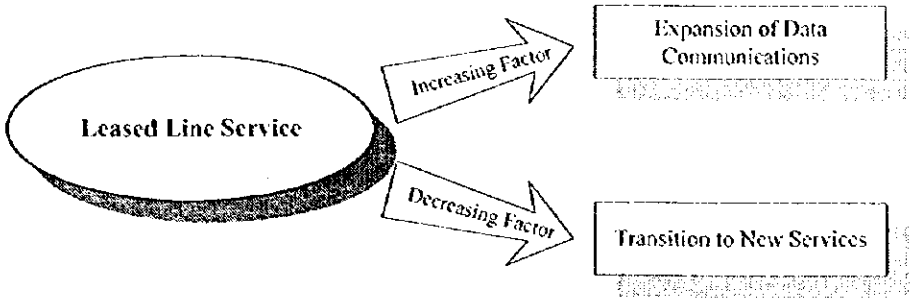


Figure 9.6.4-2 Trend of Leased Line Services in Vietnam

9.6.5 ISDN

(1) Conditions for Introduction of ISDN

ISDN service has not yet been provided in Vietnam, but it is likely to be introduced soon, i.e., the trial of ISDN is on-going in Vietnam.

The conditions for the introduction of ISDN service in Vietnam are as follows:

(a) Required Transmission Speed

Based on the existing data communications conditions, especially leased lines, the required transmission speed would not be high and most of users may require 64 kbps or less.

(b) Demand

Considering the conditions of the existing data communications in Vietnam, data communications are limited to using Packet service and leased line service. Therefore, it is required to expand service menu of data communications.

(c) Service Areas

Considering the existing data communications services in Vietnam, most of users may concentrate in Ha Noi and Ho Chi Minh City, and utilization of data communications are limited to specific areas, so service areas for data communications should be expanded.

(2) Trend of ISDN

ISDN enables high-speed access such as LAN and Internet, and have become business necessities in the world.

ISDN services continue to grow at a rapid pace throughout the world despite the emergence of the other high bandwidth technologies.

ISDN services can be classified into the two (2) categories, i.e., **narrow-band ISDN (N-ISDN)** and **broad-band ISDN (B-ISDN)**. At present, N-ISDN service is dominant in the world.

The N-ISDN service can also categorized into "**basic rate interface (BRI)**" and "**primary rate interface (PRI)**".

The application of ISDN would be decided on the following key criteria:

(a) Necessity of higher bandwidth
(b) Requirement of performance transparency
(c) Requirement of cost containment
(d) Realization of simplified access

ISDN will be enhanced and comfortably co-exist as a complementary of other high bandwidth technologies, so ISDN will be remained the most universal higher speed network of all those compete with.

(3) Conditions in Other Countries

(a) Conditions in Asia Pacific Region

The present situations in the other Asia Pacific region are summarized in Table 9.6.5-1.

Table 9.6.5-1 Present Situations in Other Countries

	ISDN Users	Basic Rate Users	Primary Rate Users	B-channel Equivalents	B-channel per 100 inhabitants	B-channel as % of Main Lines	Remarks
Australia	35,000 (37,000)	11,800	-	23,600	0.13	0.27	
Hong Kong	1,000	960	40	3,180	0.05	0.09	
Indonesia	- (700)	-	-	-	-	-	
Japan	530,050 (697.400)	337,150	6,490	823,530	0.66	1.37	BRI/PRI
Malaysia	320 (1,300)	320		650		0.02	
New Zealand	400	340	60	2.42	0.07	0.15	
Pakistan	60	-	-	-	-	-	
Singapore	5,370 (2,640)	5,370	-	10,730	0.35	0.69	BRI/PRI
South Korea	8,400 (5,000)	8,400	-	16,810	0.04	0.09	
Taiwan	2,570 (5,600)	2,570	-	5,130	0.02	0.05	
Thailand	590 (2,680)	590	1,170	-	-	0.03	

Note: No. of users includes both basic rate and primary rate interface users.
B-channel equivalents converts the number of ISDN user lines into their equivalent voice channels. The number of basic rate users is multiplied by two and the number of primary rate users is multiplied by 23 or 30 depending on the standard implemented.
Source: World Telecommunication Development Report, ( ): newest data

At present, ISDN has not yet penetrated in the world, and its ratio to main lines is still low. In addition, the provided service is mainly N-ISDN, BRI.

(b) Trend in Japan

As ISDN service trend in Japan, the NTT's annual trend is shown in Figure 9.6.5-1 and Table 9.6.5-2. ISDN service provides the following two (2) types of service in Japan:

i) INS 64

This service provides two (2) B-channels (64 kbps x 2) and one (1) D-channel (16 kbps), this service is BRI stipulated ITU-T. The service was provided in 1988.

ii) INS 1500

This service, which was started in 1989, provides 23 B-channels (64 kbps x 23) and one (1) D-channel (64 kbps), or 24 B-channels, this service is a PRI stipulated in ITU-T.

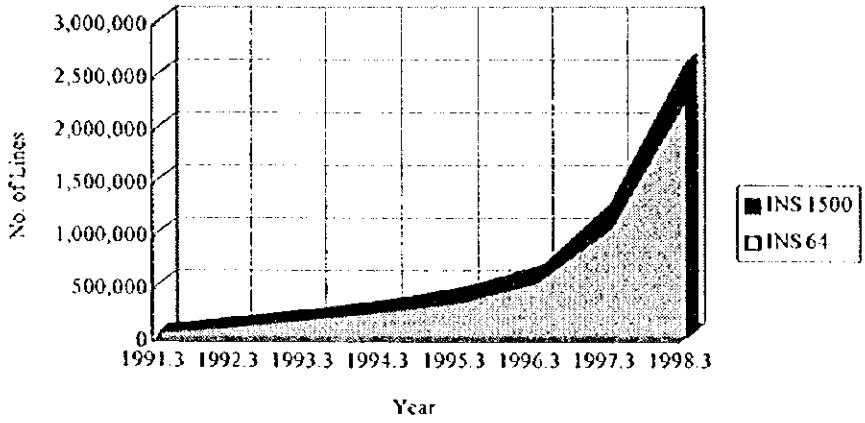


Figure 9.6.5-1 Annual Trend of ISDN Service in Japan

Table 9.6.5-2 Annual Trend of ISDN Service in Japan

	1991.3	1992.3	1993.3	1994.3	1995.3	1996.3	1997.3	1998.3
INS 64	27,000	84,000	157,000	235,000	337,000	510,000	1,037,000	2,286,000
	81.8 %	82.4 %	83.5 %	83.6 %	83.8 %	83.3 %	82.8 %	87.2 %
INS 1500	6,000	18,000	31,000	46,000	65,000	102,000	216,000	336,000
	18.2 %	17.6 %	16.5 %	16.4 %	16.2 %	16.7 %	17.2 %	12.8 %
Total	33,000	102,000	188,000	281,000	402,000	612,000	1,253,000	2,622,000

The number of ISDN users is rapidly increasing and BRI service is more sharply increased than PRI service after several years from service commencement.

(4) Introduction Plan of ISDN

By the introduction of ISDN service, data communications can be activated and expanded in Vietnam. Therefore, it is strongly requested to introduce ISDN in Vietnam as soon as possible.

Considering the present data communications conditions in Vietnam and trend in other countries, **Basic Rate Interface (BRI)** of **N-ISDN** is indispensable service in Vietnam. PRI service of N-ISDN may be introduced in the future considering the expansion conditions of BRI service.

It is expected that the demand of ISDN would not be large at first stage of ISDN service provision, however, the number of ISDN users would be dramatically increased and some users of the existing data communications services would shift to ISDN users after several years.

In addition, ISDN can accommodate voice channel(s), therefore, users who require data communications and/or plural voice channels are expected to use ISDN service.

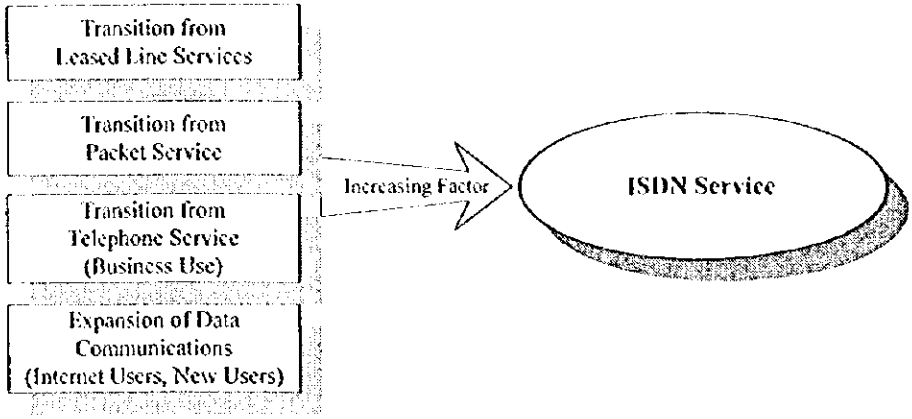


Figure 9.6.5-2 Trend of ISDN Service in Vietnam

9.6.6 Frame Relay

(1) Environmental Conditions for Introduction of Frame Relay

At present, Packet service is being provided in Vietnam, but its number of users is not so large as mentioned in Chapter 3. Packet-based voice and data network except Packet service has not yet been provided in Vietnam. By introducing Frame Relay, convergence of voice and data onto a common network infrastructure can be realized in Vietnam.

(2) Trend of Frame Relay

Frame Relay (FR) has the following features:

(a) Capability of handling 2 Mbps – 45 Mbps data rates
(b) Less expensive and more efficient than X.25 leased line offerings
(c) Very flexible (a part of ISDN development and fits into a WAN environment)
(d) Co-existing with ATM and can be upgraded to ATM

The number of FR users is 45,000 in the world in 1998, and its growth rate is about 45 % in 1997. Growth is strong, but a bit slower than in prior years (Overall customer growth: 46 %, Overall port growth: 63 %), absolute growth still exceeds prior years.

Frame Relay has no fast packet competitor other than Switched Megabit Data Service (SMDS), and is a replacement for low speed private lines due to primarily an economic decision. Initially, Frame Relay was targeted at the public leased line market where it could offer higher data rates at lower costs, but as data networking grew, corporate customers needed to connect their LANs together with higher network.

(3) Service Conditions in Other Countries

(a) Conditions in Asia Pacific Region

Frame Relay is a new technology, so the services have not yet penetrated in the Asia Pacific region. The present conditions are shown in Table 9.6.6-1.

Table 9.6.6-1 Frame Relay Service Conditions in Asia Pacific

	No. of Lines	Ratio to Main Telephone Lines	Remarks
China	10,730	0.015 %	
Japan	15,701	0.026 %	As of March 1998
Singapore			4k – 1984 kbps
South Korea	28,600	0.139 %	Including X.25
Taiwan	8,200	0.077 %	Including X.25

Source: Asia Communications

(b) Trend in Japan

Frame Relay service was launched in 1994 in Japan. This service is provided by several providers. The following data is annual trend of number of Frame Relay lines provided by NTT:

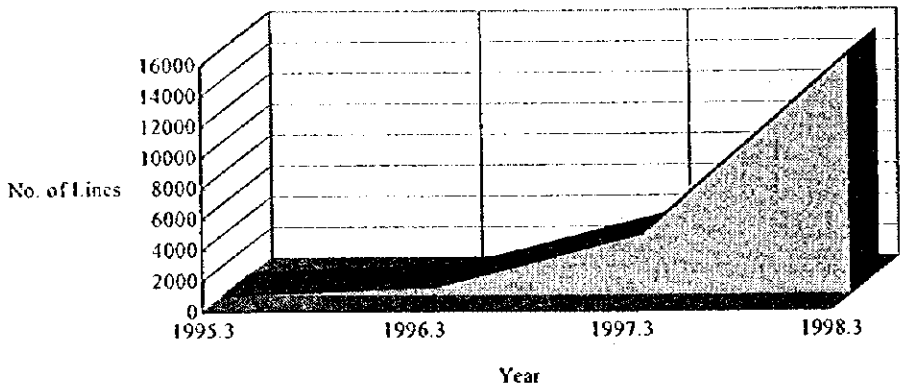


Figure 9.6.6-1 Annual Trend of Frame Relay Lines in Japan

Table 9.6.6-2 Annual Trend of Frame Relay Lines in Japan

	1995.3	1996.3	1997.3	1998.3
Number of Lines	28	565	3,942	15,701

(4) Introduction Plan of Frame Relay

Frame Relay service is a new service, so it is difficult to predict and establish its plan. Frame Relay service may be used instead of the existing leased lines and Packet service lines, and may include new users for data communications.

At first, Frame Relay will be mainly utilized in international leased lines.

However, it is predicted that ISDN service can cover Frame Relay service, so the introduction and expansion of Frame Relay service strongly depend on its tariff structure and its bandwidth (transmission speed) to be provided.

It is recommended that the ISDN service would be introduced prior to the introduction of Frame Relay service, so the study and investigation of Frame Relay should be carried out before the introduction.

9.6.7 ATM

(1) Conditions for Introduction of ATM

Asynchronous Transfer Mode (ATM) is a new technology and it is under development stage in the world. In addition, the present demand for data communications requires transmission speed lower than 2 Mbps, so the strong necessity of ATM does not exist now in Vietnam.

(2) Trend of ATM

ATM is designed to provide transportation of data, from 34 Mbps to 620 Mbps such for voice, video and data communications, so ATM is utilized as **multi-service platform.**

ATM has 2,000 users in 1998 and its growth rate was about 80 % in 1997 in the world. Growth rate of ATM is too small due to a small base, and several Frame Relay carriers do not offer ATM because the service is too young.

It is estimated that ATM has clearly fewer than 1,000 additional customers in the world, and will develop similar to Frame Relay with **lagging by four to five years.**

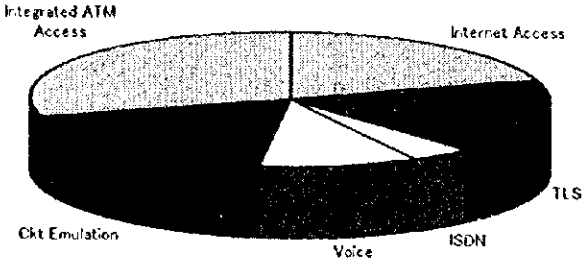


Figure 9.6.7-1 Integrated Access to Services via ATM

(3) Conditions in Other Countries

ATM service is a new service, so there is little reference for marketing, especially in Asia Pacific region.

In Japan, two (2) types of ATM service are provided, i.e., **ATM switched bearer service** and **ATM service by leased line (bearer service)** mentioned in the section of 9.6.4.

Both types of ATM services have small users though ATM service was launched in 1995 in Japan, and the first users appeared 3 years after the commencement of the service. ATM switched bearer service provides 6 Mbps speed in Japan, this speed is lower than the ATM maximum speed. Table 9.6.7-1 shows the number of ATM lines provided by NTT.

Table 9.6.7-1 Conditions of ATM Services in Japan

Year	1995.9	1996	1997	1998.3
No. of Lines	0	0	0	4

(4) Introduction Plan of ATM

ATM service is suitable for high speed data transmission, so ATM is not urgent technology on the conditions that there is few users who require high speed data transmission. However, the study and investigation of ATM should be continuously carried out considering the requirements of transmission speed, etc.

9.6.8 CATV

(1) Present Situation in Vietnam

In Vietnam the CATV service is provided only by Saigon Tourist Cable Company, and its number of users is estimated 700 foreign users and 80 local users. Also, this service restricted to provide foreign programming.

(2) Conditions in Other Countries

(a) U.S.A.

In the U.S.A. about two-third of households is using CATV system and its number of users is approximately 67,000,000.

About half of them are to be digitized in the year 1998, therefore, CATV systems can be easily utilized and fused with telecommunications such as Internet and E-mail.

On the other hand, the users of digital satellite TV services are rapidly increasing (about 6,000,000 users), so CATV services are in competition with these services.

(b) Japan

The number of CATV users is counted in 6,720,000 and penetrated in 14.8 % of households in March 1998. Its growth rate is 3.8 % per year. The present CATV systems are of analog type, so it is required to be digitized in order to compete with digitized satellite TV systems and terrestrial TV systems to be digitized.

(3) Fusion of CATV and Telecommunications

CATV is effective system for fusion of telecommunications and broadcasting. The approach to fusion of telecommunications and broadcasting is shown below:

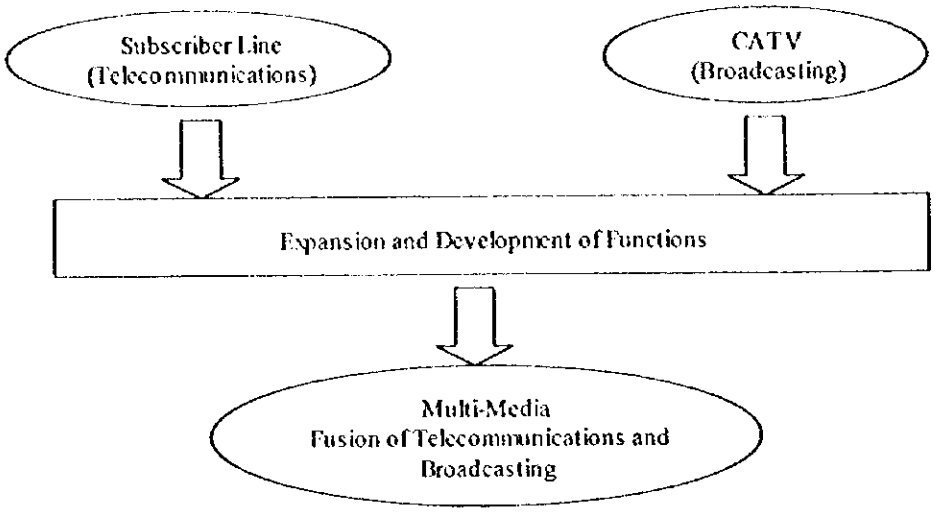


Figure 9.6.8-1 Fusion of Telecommunications and broadcasting

(a) Approach from CATV

In the case that number of CATV users is large, it is easy to approach to the fusion by expanding and developing the function of CATV.

This model is applied to the countries such as the U.S.A., where the number of CATV users is approximately 67 million (two-third of households).

(b) Approach from Telecommunications

In the case that number of CATV users is small, it is easy to approach to the fusion by expanding and developing the functions of the telecommunications systems such as applying FTTH (Fiber To The Home).

Considering the present situation of CATV in Vietnam, the approach from the telecommunications is more realistic, because the CATV is not popular in Vietnam. The realization of fusion will be considered from the viewpoint of expanding and developing the functions of the telecommunications systems. Considering the target of new service introduction, the fusion of telecommunications and broadcasting can be carried out easily at the stage of Step-3 mentioned below.

9.6.9 Overall Indicators for Non-Voice Communications Services

(1) General

The necessity and prediction of individual data communications service are mentioned in each section. However, the demand forecast of non-voice communications services is very difficult even though the sufficient data and information would be obtained. Because the non-voice communications is too young to forecast demand (historical data is not enough) and there are various types of services such as access types and transmission speeds, and services to be used would be often changed according to the technology development and requirements by users. Therefore, the general trend of non-voice communications services is qualitatively stated in this section.

(2) Scenario of New Service Introduction

It is tentatively considered that the introduction of new services for data communications should be carried out based on the following scenario by transition from the existing networks/services:

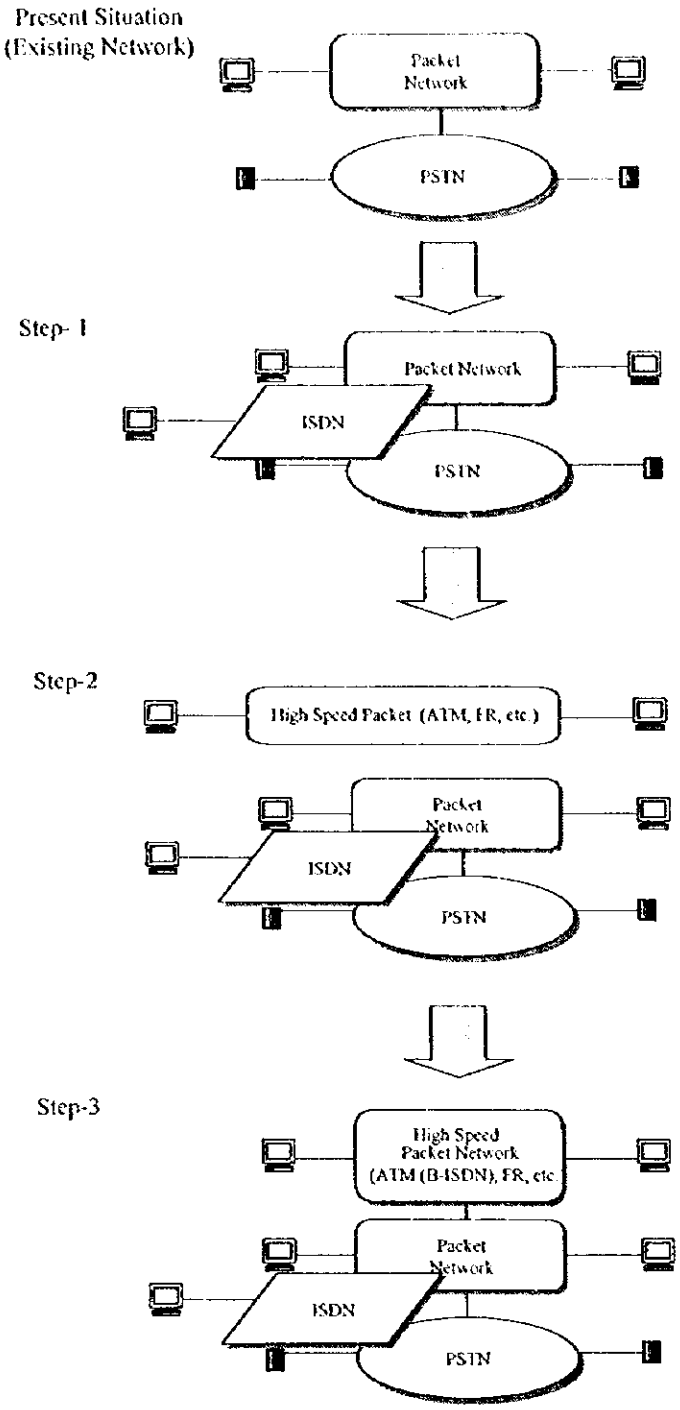


Figure 9.6.9-1 Scenario of New Service Introduction

(a) Step-1

In the stage of Step-1, **N-ISDN (mainly Basic Rate Interface)** services will be introduced corresponding to the demand of higher data transmission speed through PSDN (Public Switched Data Network). Also, the new data communications systems such as Frame Relay and ATM will be investigated

through trial in this stage.

(b) Step-2

Primary Rate Interface of N-ISDN will be expanded, and **ATM** and/or **Frame Relay (FR)** technology will be introduced corresponding to the demand of higher data transmission speed than the speed of N-ISDN. ATM/FR service will be applied to the special users, which number would be expected to be small. In this stage, ATM/FR will be applied as **bearer service**.

(c) Step-3

Corresponding to the need/demand of broad-band data transmission, **Broad-band ISDN (B-ISDN)** will be introduced together with ATM/FR. ATM/FR service will be provided as **switch bearer service**.

(3) Overall Qualitative Prediction

The demand forecast of data communications is very difficult even though the sufficient data and information would be obtained. In addition, sufficient data and information regarding data communications could not be obtained in quantity and in quality in Vietnam, therefore, only the prediction of data communications can be performed by intuition.

Based on the overall introduction plan mentioned above, the trend of data communications in Vietnam can be predicted as follows:

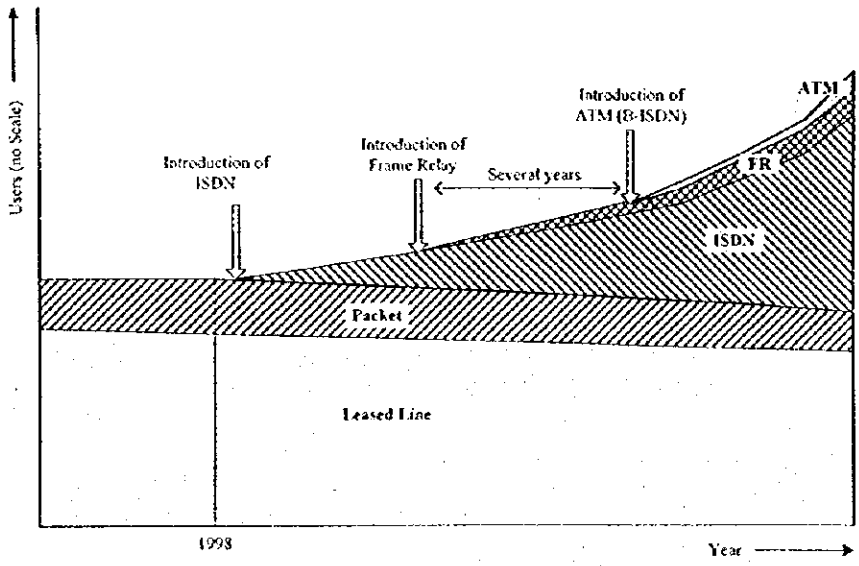


Figure 9.6.9-2 Trend of Data Communications in Vietnam

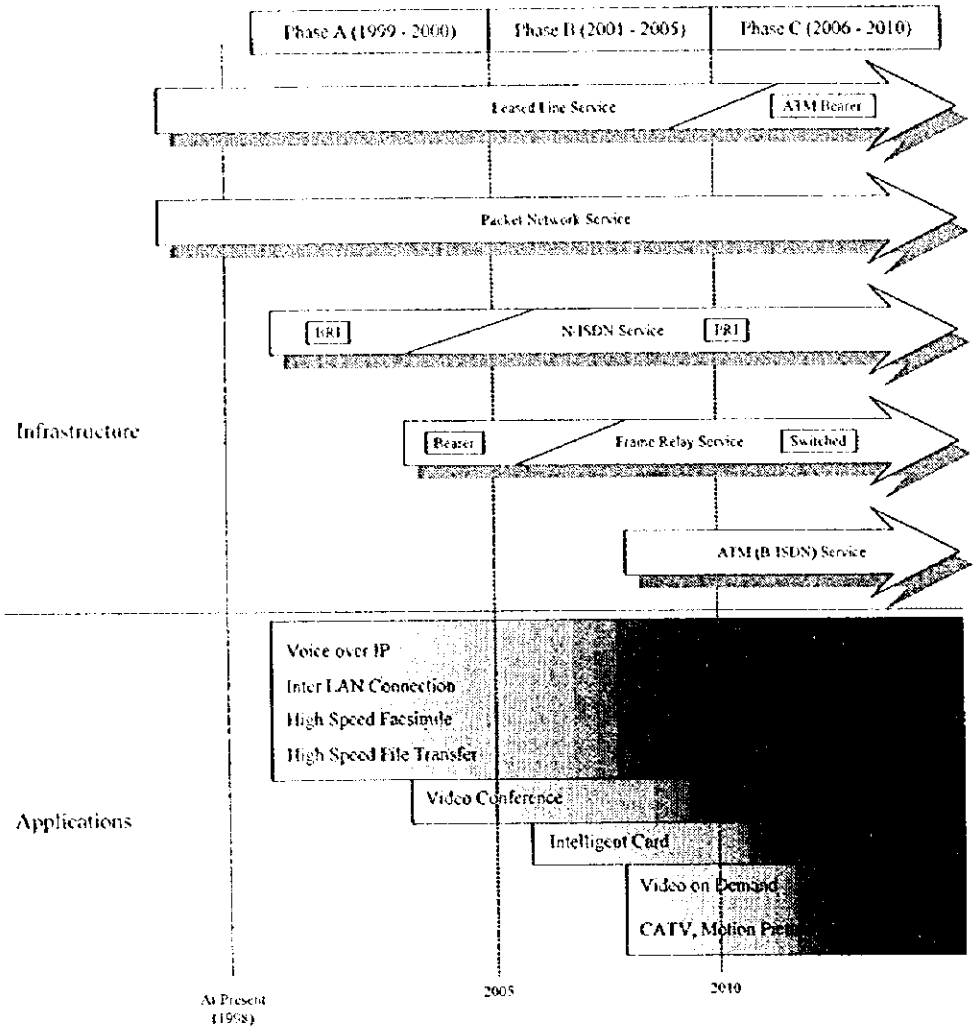


Figure 9.6.9-3 Introduction of Non-Voice Communications Services

The major new services and applications other than the existing services will be introduced in Vietnam as follows:

(a) Voice over IP

As an application of Internet, VoIP (Voice over IP) is developed and being utilized in U.S. and other countries. VoIP, which is expanded outside of the Internet, stands for technologies and services which realize conversation service by putting packetized voice signal through networks with IP interface in general. VoIP requires networks to carry low-latency isochronous traffic. The Internet transmits without discriminating any kind of traffic. By the introduction of VoIP,

the traffic of non-voice communications may be drastically increased.
However, VoIP still has the following technical issues to be overcome:

i) Delay is generated inside terminal/gateway equipment and through networks. In the South-east Asia, large delay occurs through networks because it is routed via US.

ii) Jitter and Packet Loss caused by Congestion
The Internet can be congested depending on time slots, and even slight congestion causes jitter and loss of packet. As a result, Internet telephony causes one-way communication where it is audible on one side and inaudible on the other. The possibility of audio packets lost in the Internet tends to increase when the number of routers (hop count) is large.

iii) Audio Quality
The audio quality of VoIP largely depends on algorithm of audio compression. The quality of VoIP products which use PC is not stable since there is no unified standard for adjusting audio system despite many kind of PCs actually exist in the world.

iv) Audio Volume
Gain adjustment between gateways is required.

v) Echo
In case of connecting gateway to analog lines, which convert 4-wire to 2-wire, occurrence of echo is not unique to VoIP (In case of connection through ISDN, echo is no problem.)

vi) Scalability
Numbers of VoIP products lack in scalability.

vii) Others
Voice packet is unable to pass firewall since it is send by UDP (User Data Protocol).

Several improvements of the above issues on capabilities and services of VoIP are being carried out as follows:

- Technological improvement based on network and equipment
- Improvement on CPU performances (Moore's law)
- Standard protocol for the sake of interoperability (ITU-T H.323 version 2)
The interoperability between gateways from various vendors was not realized due to proprietary protocol, but various vendors have started working on their

task on interoperability since the year 1999 based on the ITU-T recommendation H.323 version 2, which is guideline for interoperability of the Internet Telephony and published in 1998.

- High quality speech CODEC
- Cooperation of terminals and network functions
  Large-scale VoIP systems in cooperation with existing telephone networks have been under investigation. This is to control telephone switches from IP networks through Common Channel Signaling System No.7.

The network related problems will never be resolved even if technology of gateway and terminals are developed further.
The quality of VoIP through the Internet is largely influenced by the other traffic and it is not practical to use the Internet as the backbone of VoIP except for the case where good quality is maintained such as between Japan and US.

The introduction of VoIP technology could benefit the integration of voice and data systems, so the VoIP service will be also introduced in the near future in Vietnam as corporate network (also called an internetwork or a wide area network) as shown in Figure 9.6.9-4. Corporate network has the feature that there is much data traffic and ratio of voice is relatively small.

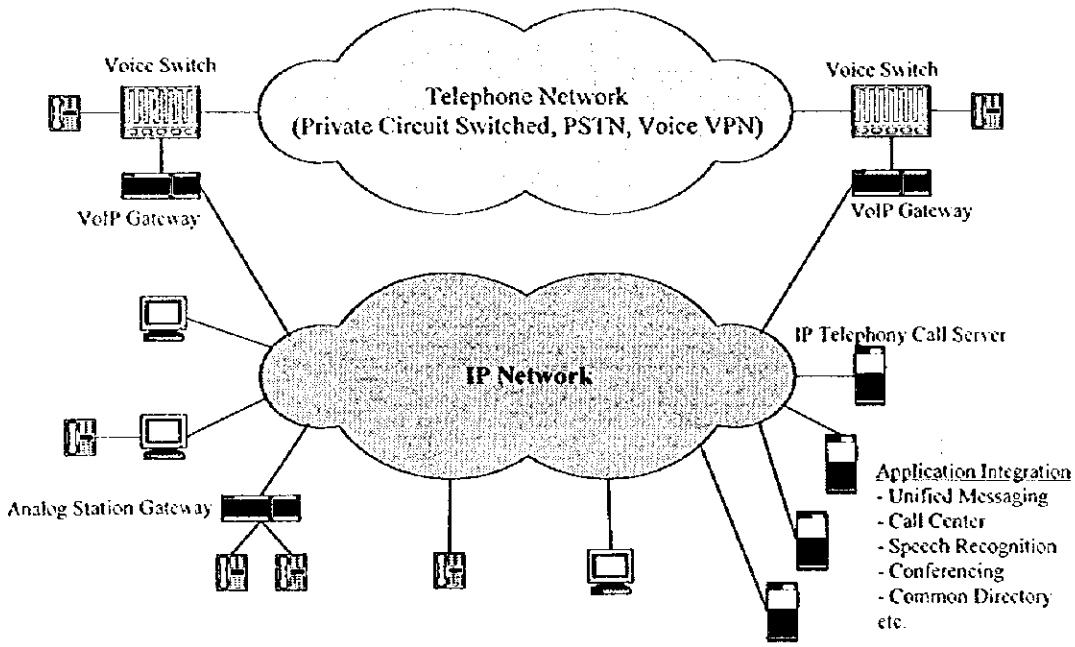


Figure 9.6.9-4 Corporate Network Configuration

VoIP is one of the key technologies for new value added services. However, use of the Internet for VoIP is not practical in general because of its quality problems, especially, in the case where network quality is not so good. Considering the above conditions it is better to expand VoIP service after the improvement of PSTN and introduction of ISDN network.

(b) High-speed Facsimile and File Transfer

The introduction of new data communications infrastructure makes high-speed facsimile/file transfer possible. These applications may be available during Phase A by the introduction of N-ISDN (BRI).

(c) Inter-LAN Connection

The high-speed transmission systems such as Frame Relay and ATM can provide the services of inter-LAN connection and so on. These applications may be available during Phase A by the introduction of N-ISDN (PRI), and expanded during Phase B by using Frame Relay and ATM.

(d) Video Conference

By introducing high-speed transmission systems such as ISDN, video conference can be available. Therefore, the high speed transmission systems should be introduced in order to provide the service in Vietnam.

Video conference can be available during Phase A in specific areas by using high speed leased lines, and full-scale introduction may be carried out during Phase B by using Frame Relay and ATM.

(e) Video on Demand

Video-on-demand service requires high-speed transmission system, therefore, the convergence between CATV and telecommunications can easily make provision of video-on-demand service possible. CATV service is mentioned in the section 9.6.8.

Video-on-demand may be available during Phase B by the introduction of Frame Relay and ATM.

(f) Intelligent Card

The trials of intelligent card have just been carried out in the world. To provide this service, the expansion and improvement of data communications network/infrastructure are indispensable, so expansion/improvement of the data

communications network/infrastructure should be carried out in order to easily introduce the service.

A limited service of Intelligent card may be available during Phase B corresponding to the improvement of the communications infrastructures.

In addition to the above applications, the following application will be available by combination and utilization of the new infrastructures, and will contribute to creation of better quality of life:

(g) Telemedicine

By linking health care institutions through high speed, high capacity networks, it will be possible for doctors to actively engage in the exchange of information and in cooperative work, especially at clinics located in isolated areas such as remote islands and isolated mountainous areas to eliminate the need to travel to the specialty hospitals located in distant locations.

Also, "Home treatment" and "Home nursing care" will be available.

These services can be possible by the introduction of high speed/capacity networks, and will be more efficient by combination of picture/video transmission functions, therefore, the services are expected to be introduced by the end of Phase A and will be expanded/improved during Phase B.

(h) Remote Education

By using high speed, high capacity networks, the remote education in isolated areas can be improved. Also libraries and museums will be available by putting into electronic format information regarding books and holdings of various facilities. These services will be possible by the end of Phase A as same as the telemedicine. The required infrastructure largely depends on the contents of the service, therefore, the contents and application shall be considered in detail by the users.

(i) Disaster Management

With widespread deployment of disaster information system, emergency information and other critical information can be transmitted instantaneously so that there can be timely response which will not only limit the scope of the damage but also self save lives.

These services also will be available by the introduction of high speed, high capacity networks and expansion of these networks by the end of Phase A.

(j) Electronic Commerce

Electronic commerce (EC) is a promising service by using non-voice communications, but this service requires fully developed digital network nation-wide from the technical viewpoint. In addition, the introduction of EC requires the establishment of policy, regulation and law in advance. Considering the conditions in Vietnam, the fundamental network should be expanded and improved nation-wide prior to the introduction of EC service.