

REPORT ITU-R F.2060

Fixed service use in the IMT-2000 transport network

(Question ITU-R 221/9)

(2005)

1 Introduction

Recently, as traffic demands for mobile communications represented by IMT-2000 are increasing, fixed service (FS) use in the transport network in the mobile infrastructure is becoming an important application.

The IMT-2000 transport network supports the connections between the different base stations of the network, as well as the connections of one base station to other stations of the IMT-2000 infrastructure, in order to interconnect the IMT-2000 network to other telecommunication networks.

2 Scope

The aim of this Report is to show how the FS could be used at different hierarchical levels of the transport network of IMT-2000, in order to ensure the connections between base stations, and between base stations and higher-level stations within this transport network. This Report provides an example of the use of the FS in the transport network of IMT-2000.

FS use is necessary to support the operation of IMT-2000 networks in the transport network. Depending on the evolution of IMT-2000 and the required transmission capacities at different levels of the transport network, different FS frequency bands could be employed.

This Report gives possible structures of IMT-2000 transport networks including the outline of the needs of 3G cellular systems (IMT-2000). The Report also examines the possible use of already allocated FS spectrum. Regardless of the transmission network capacity, the choice of frequency bands depends on the local situation of the various countries (existing deployment of the frequency bands, number of mobile (IMT-2000) operators, etc.).

3 References

The reader will find additional guidance in the references listed below:

- | | |
|------------------------------|---|
| Recommendation ITU-R F.746: | Radio-frequency arrangements for fixed service systems |
| Recommendation ITU-R F.758: | Considerations in the development of criteria for sharing between the terrestrial fixed service and other services |
| Recommendation ITU-R F.1245: | Mathematical model of average radiation patterns for line-of-sight point-to-point radio-relay system antennas for use in certain coordination studies and interference assessment in the frequency range from 1 to about 70 GHz |
| Recommendation ITU-R F.1399: | Vocabulary of terms for wireless access |
| Recommendation ITU-R M.1224: | Vocabulary of terms for International Mobile Telecommunications-2000 (IMT-2000) |

Recommendation ITU-R M.1390:	Methodology for the calculation of IMT-2000 terrestrial spectrum requirements
Recommendation ITU-R P.530:	Propagation data and prediction methods required for the design of terrestrial line-of-sight systems
Recommendation ITU-R P.676:	Attenuation by atmospheric gases
Recommendation ITU-R P.837:	Characteristics of precipitation for propagation modelling
Handbook on Deployment of IMT-2000 systems:	http://www.itu.int/itudoc/qs/imt2000/84207.html
ECC Report 003:	Fixed service in Europe current use and future trends post-2002

4 List of acronyms

2G	2nd Generation Mobile System
3G	3rd Generation Mobile System (IMT-2000)
AAL	ATM adaptation layer (i.e. AAL 0, AAL 2, AAL 5,...)
ATM	Asynchronous transfer mode
ATPC	Automatic transmission power control
BER	Bit error ratio
BS	Base station
BSC	Base station controller
BTS	Base transceiver station
CBD	Central business district
CBR	Constant bit rate
CCDP	Co-channel dual polarized
CS	Central station (or Central base station)
C/I	Carrier-to-interference ratio
DSL	Digital subscriber line
FDCA	Fast dynamic capacity allocation
FL	Feeder loss
FM	Fade margin
FS	Fixed service
FSK	Frequency-shift keying
IMT-2000	International Mobile Telecommunication System-2000
IP	Internet protocol
LOS	Line-of-sight
MM	Multimedia
MSC	Mobile switching centre (2G or 3G)
OBQ	Offered bit quantity
PDH	Plesiosynchronous digital hierarchy

P-P	Point-to-point
P-MP	Point-to-multipoint
POP	Point of presence (of a fibre optical operator)
PSK	Phase shift keying
QAM	Quadrature amplitude modulation
RF	Radio frequency
RPE	Radiation pattern envelope (of an antenna)
SAP	Service access point
SDH	Synchronous digital hierarchy
STM	Synchronous transfer mode
Sub-CS	Sub-central station (or sub-central base station)
XPD	Cross-polarization discrimination
XPIC	Crosspolar interference canceller

5 Structure of IMT-2000 transport network

5.1 Example of the hierarchical levels in IMT-2000 transport network

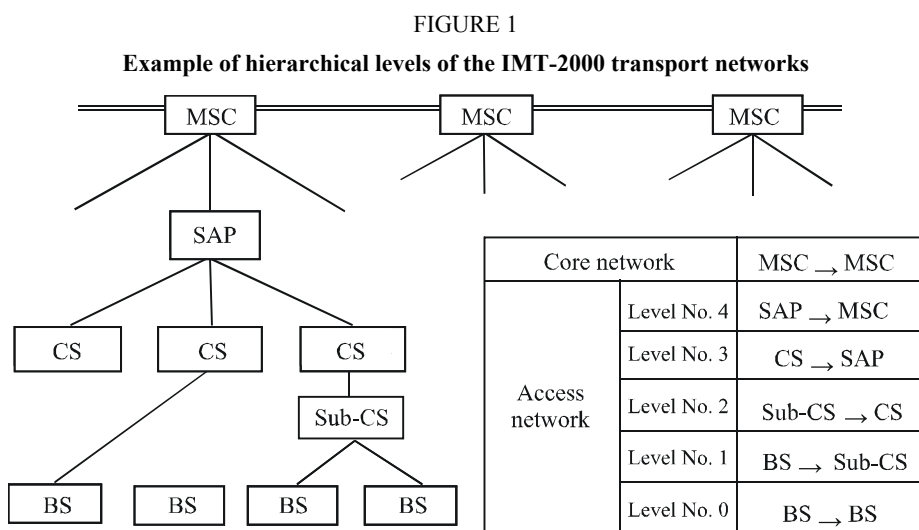
The transport network of IMT-2000 consists of different transport hierarchical levels to support the transmission interfaces of the IMT-2000 network.

In principle, the IMT-2000 network hierarchy consists of different hierarchical levels and network nodes. In this Report these nodes are defined as follows, using the terms given in Recommendations ITU-R M.1224 and ITU-R F.1399:

- MSC: mobile switching centres in the IMT-2000 network organizing the overall traffic flow as well as representing the interconnection to the fixed network;
- SAP: service access point – The basic node within the network with switching functions for the subordinate base stations in the IMT-2000;
- CS: central station (or central base station) – A base station where several or more links are converging in P-P or P-MP mode to connect the surrounding base stations;
- Sub-CS; sub-central station (or sub-central base station) – A base station having intermediate function of traffic transport between CS and other base stations, and
- BS: base station, except for those categorized as the above nodes, BS is a node forming an end of the transport network.

The general topology of the transport network in IMT-2000 is given in Fig. 1. The hierarchical levels each identifying the connection links used for several hierarchy in the transport network will be considered in the later sections from the viewpoint of use of the fixed service.

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In the start up phase, most of the connections are likely to be provided by fixed wireless links. As IMT-2000 networks mature other high capacity connections (i.e. fibre optics) may be substituted.

Examples of detailed topology of the IMT-2000 transport network hierarchical levels are described in Annex 1.

5.2 Capacity and hop length requirements in the transport network

A large variety of interconnections in terms of hop length and transport capacity are necessary to operate the IMT-2000 networks. In particular the transport capacity depends on the user's needs for mobile telecommunication services for which Recommendation ITU-R M.1390 provides a methodology for their estimation.

In Table 1 the expected transport capacities are given for the interconnections between the different layers. Detailed consideration on how to derive such expectations are provided in Annex 2. The evolution of the networks has been considered in that respect, expected capacities are given for both short term and long term.

Table 2 illustrates a variety of hop lengths in different operational environments (rural and urban) of the cellular network. Information on capacity and hop length leads to the media which would best serve the requirements of the different layers of the IMT-2000 networks.

TABLE 1
Expected link capacities for interconnecting the different hierarchical levels of IMT-2000 networks

Hierarchical level ⁽¹⁾	Short term	Long term
Hierarchical level No. 0	4-8 Mbit/s	4-34 Mbit/s
Hierarchical level No. 1	8-34 Mbit/s	8 Mbit/s – STM-1
Hierarchical level No. 2	34 Mbit/s – STM-1	$n \times 34 \text{ Mbit/s} - n \text{ STM-1}$
Hierarchical level No. 3	34 Mbit/s – 2 STM-1	$n \text{ STM-1} - n \text{ STM 16}$
Hierarchical level No. 4	$n \text{ STM-1}$	$n \text{ STM1} - n \text{ STM-16}$

⁽¹⁾ See Fig. 1 for definitions

TABLE 2

Hop lengths for interconnecting the different hierarchical levels of IMT-2000 networks

Hierarchical level⁽¹⁾	Urban (km)	Rural (km)
Hierarchical level No. 0	0.5-1.4	5-16
Hierarchical level No. 1	0.5-2.5	5-20
Hierarchical level No. 2	2.0-5.0	5.0-20
Hierarchical level No. 3	5-10	5.0-50
Hierarchical level No. 4	0-20	0-20

⁽¹⁾ See Fig. 1 for definitions

5.3 Transportation media used in the transport network

Not all of these connections within the IMT-2000 network are necessarily radio equipment, depending on:

- the network layer under consideration;
- technical facilities of a certain network operator; and
- economic framework.

A certain percentage of the interconnections within the IMT-2000 networks may be operated on cables (e.g. DSL systems) or fibre optics.

The different network levels have different requirements concerning telecommunication capacity and availability targets due to their function within the network. These levels will build a five hierarchical levels transport network, which may be accommodated by different transport media:

- hierarchical levels No. 0, No. 1 and No. 2 (connections between BSs, access from BS to Sub-CS and/or CS) operated mainly by P-P and/or P-MP fixed wireless links or cable;
- hierarchical level No. 3 (interconnection of CS and SAP) operated by P-P fixed wireless links and fibre optics;
- hierarchical level No. 4 (interconnection between SAPs, MSCs and possibly point of presence (PoP) to fibre optic networks) operated mainly by fibre optics; and
- core net (interconnection between MSC) operated mainly by fibre optics.

Scenarios where an interconnection of a certain hierarchical level within the transport network carries traffic of lower transport network layers are possible as well.

6 FS applications within IMT-2000 transport networks

In this section, the fixed service frequency bands and their appropriateness/usability for use in the IMT-2000 are reviewed. Included in this section are: technically and physically related band characteristics, possible link densities, requirements for systems today and in the future, as well as other factors which influence the appropriateness and usability of certain bands. In addition, a comparison of the topology and band specifics is provided.

6.1 Characteristics of FS bands

In general, all frequency bands available for the fixed service could be used in the IMT-2000 transport networks. In the following sections, technical characteristics of certain fixed service bands

such as appropriate transmission capacities, channel spacings, modulation levels, available number of channels and typical link lengths are examined.

6.1.1 Information on possible frequency bands for IMT-2000 transport networks

It should be noted that in some cases national usage can vary from the general characteristics described below. Furthermore, it has to be noted that apart from these technically and physically related characteristics as described in Tables 3 and 4 a number of other factors have to be taken into account that could have a significant impact on the usability of a number of bands. These factors are described in § 6.4 where the requirements for wireless links resulting from the IMT-2000 network topology are compared with the band specifics.

Since the structure and the density of the IMT-2000 transport network requires a large number of frequencies, especially for short hops in the range of a few kilometres up to some tens of kilometres, most of the frequency bands of interest, especially for densely populated areas, are located in the frequency range above 11 GHz, although bands below 11 GHz may also be used for certain links in more scarcely populated areas within the IMT-2000 infrastructure network. However, it should be recognized that fixed service bands below 3.4 GHz are required to serve more remote communities, where it is necessary to have long-hop lengths in order to minimize the number of sites. This is an important aspect in providing economical network access in remote areas.

TABLE 3

Characteristics of frequency bands above 3.4 GHz for P-P and P-MP systems

Band (GHz)	Recommendation ITU-R F.	Typical link length in temperate climatic areas (km)
3.6	1488	5-15 (P-MP)
4	382 635	20-80
5	746 1099	20-80
Lower 6	383	20-80
Upper 6	384	20-80
7	385	20-80
8	386	20-80
10	747	10-50
11	387	10-50
13	497	5-35
14	746	5-35
15	636	5-30
18	595	4-25

TABLE 3 (*end*)

Band (GHz)	Recommendation ITU-R F.	Typical link length in temperate climatic areas (km)
23	637	3-20
27	748	2-12
32	1520	1-10
38	749	1-6
52	1496	<2
57	1497	<2

More information on Table 3 can be found in Recommendation ITU-R F.746, which includes channel separation for each of these frequency bands.

TABLE 4

Capacity of fixed wireless links according to bandwidth and modulation

Bandwidth (MHz)	Capacity (Mbit/s)						
	2 × 2	8	2 × 8	34	51	155	2 x 155
3.5	4 states	16 states					
7		4 states	16 states				
13.75, 14			4 states	16 states	32 states		
27.5, 28, 29.65				4 states	16 states	128 states	128 states (CCDP)
40						64 states	64 states (CCDP)
55, 56						16 states	16 states (CCDP)

NOTE 1 – CCDP operation with cross-polarization cancellation is used up to 13 GHz and may also be used in the near future in higher bands. This mode of operation allows to double the capacity per channel by transmitting simultaneously on two orthogonal polarizations (H and V) within the same channel.

NOTE 2 – Modulations are referred by their number of digital states; for instance 4-PSK modulation is a 4 states modulation.

6.1.2 Impact of rain

The aim of this section is to provide some guidance on how climatic conditions could affect the choice of frequency bands for FS in the IMT-2000 transport network.

The choice of the most relevant band for mobile networks FS infrastructure depends on several parameters being either regulatory (e.g. bands opened or not for FS, licence of the operator limiting access to certain bands) or technical. As far as the latter is concerned, the impact of rain on these parameters, and thus on the choice of the band, should be considered.

It is obvious that this choice will be highly dependent of the geographic zone where the FS networks are deployed.

Therefore a comparison of the use of the 18, 23 and 38 GHz bands has been made with respect to their ability to comply with the requirements of capillary FS networks. In particular, studies on the maximum hop lengths for these frequency bands, according to some geographic rain zones, have been led. For the purpose of these studies, Recommendation ITU-R P.837-1 was used.

As a result of these studies, it appears that in rain climatic zones M, N, P and Q, which apply in several areas under tropical or equatorial climatic conditions, the characteristics of 18 GHz band in terms of maximum hop length are very similar to those of the bands 23 or 38 GHz in the rain climatic zone E, which applies to several other geographical areas with different climatic conditions, for instance in Europe. The distance values provided in Table 3 are no more valid for rain climatic zones M, N, P and Q.

The bands 23 GHz and 38 GHz, which in the climatic conditions of Europe are perfectly fitted for use in the transport network of mobile systems, may not present the same potential in other areas with increased rain precipitation characteristics. They may for instance be limited to very short links in densely populated areas.

Consequently, it is expected that in the areas belonging to rain climatic zones M, N, P and Q, the band 18 GHz could play an important role in the transport network of mobile systems, similar to the role of the bands 23 and 38 GHz in Europe.

More detailed information on the Mobile transport networks in Europe and the results of calculations for the bands 18 GHz, 23 GHz and 38 GHz are provided in Annex 3.

6.2 Technical requirements for P-P and P-MP systems

The technical requirements for either P-P systems or P-MP systems depend on which part of the IMT-2000 network structure and which link density is being considered.

6.2.1 Maximizing spectrum utilization

Both P-P and P-MP systems may be used for IMT-2000 transport network.

In some cases, due to economic reasons, only P-P systems may be deployed in rural areas. In urban and dense urban areas, both P-P and P-MP may be deployed. The choice between these two technologies in urban and dense urban areas may be driven by factors such as capacity requirements at access nodes, traffic management, hop length, availability target and urban limitations.

The efficient use of the spectrum is a basic requirement to allow all interested network operators to deploy their own network using the limited frequency bands.

It is important to note that the application of ATPC, XPIC (for SDH systems where practicable) and antennas with good RPE and improved XPD could improve the efficient use of the spectrum.

6.2.1.1 Benefits of using a combination of low and high modulation schemes in P-P networks

Both low level (e.g., 4 states) and high level (e.g., 16 states or higher) modulation systems are needed in a fixed wireless network.

A combination of low and high levels modulation systems optimises the trade-off between cost and spectrum efficiency, in a typical IMT-2000 network, as there is no definitive single solution satisfying each scenario:

- equipments using higher modulation systems are more costly and more sensitive to impairments (e.g. multipath propagation) than those with lower modulation systems;

- nevertheless the higher states modulation systems are most efficiently used in higher capacity systems (typically SDH systems) to reduce required spectrum or to fit into restricted channel bandwidths, or, for all types of systems, in parts of the network with existing or expected shortage of spectrum.

In addition, adaptive modulation schemes can optimize traffic throughput of P-MP systems by using the highest order modulation scheme supported at any instant depending on the link conditions (i.e. influence of propagation conditions) and traffic demands at the time of communication. When combined with other specific factors of P-MP systems, such as statistical multiplexing gains, useful increases in spectrum utilization can be realized. Adaptive modulation schemes are being considered as a standard feature in the fixed broadband wireless access air interface standards developed by some standards organizations. Interest in this technique is emerging for P-P systems also.

6.2.2 Traffic handling capability

For P-P systems, the interfaces necessary for the Transport equipment are defined by the transport capacity between BS and SAP: up to 4×2 Mbit/s or 34 Mbit/s, or between SAPs (requiring higher transport capacities): 34 Mbit/s, 2×34 Mbit/s or $n \times$ STM-1.

For P-MP systems the issue of capacity is complicated further by the area coverage considerations. Many P-MP hubs can transport up to 130 Mbit/s/28 MHz in any sectorized coverage area per channel of operation. Multiplexing gains would increase the potential to allocate this resource to a number of nodes within the coverage area.

Even if data traffic is increasing, having symmetrical and asymmetrical characteristics, the voice traffic will still be important. Thus the equipment has to transport different types of information efficiently by providing the possibility to transport the maximal capacity needed in time for the connection considered with the appropriate grade of service.

However, the nature of traffic will change during the course of the IMT-2000 development. A change from predominant voice services to data services is possible which may impact the nature of the traffic to be transported, for instance in terms of traffic asymmetry between uplink and downlink directions. P-MP systems should have the flexibility to cater for these changing requirements by either adapting the uplink/downlink modulation scheme or the ratio of the transmission time resource between uplink and downlink.

6.2.3 Transport mechanism

Some transport mechanisms are based on ATM. The transmission interfaces are mainly based on well-known PDH and SDH-Interfaces, such as 2 Mbit/s, 34 Mbit/s, STM-0 and STM-1, taking more or less the benefits from the ATM – Adaptation Layers (AAL 1 for CBR 2G traffic, AAL 2 and AAL 5).

With future IMT-2000 evolutions, other interfaces may become more prevalent.

6.2.4 Availability and quality

Traditionally, operators have deployed their mobile backhaul networks based on a combination of P-P fixed wireless and wired leased lines. The main deciding factor in the choice between fixed wireless links and leased lines is the individual operator's needs in terms of network control and transmission quality.

In networks with a high penetration of fixed wireless links, connections between the mobile base stations and the switch site are dimensioned for 99.95% availability or higher, corresponding to four unavailable hours per year. The use of efficient coding techniques could guarantee a quasi error-free operation during the periods of availability.

In these conditions, fixed wireless links are suitable for ATM and IP transport. In conclusion, the availability of a network based on fixed wireless links is very much a planning issue.

6.2.5 Protection

The end-users traffic is the most important asset for the operator. If the service delivered is not reliable, end-users will change their service provider. High quality equipment complemented with additional protection mechanisms provide the operator with the means necessary to deliver high-quality services.

A fixed wireless product includes facilities to implement as necessary protection towards equipment failure as well as towards radio propagation anomalies. A part of the hardware is duplicated to support the protected configurations on either or both of the two sides of the radio connection. The transmitting equipment can be configured either for hot stand-by transmission mode or as independent stand-by transmission mode: $(1 + 1)$ or $(N + 1)$ frequency diversity.

A smart aggregation node combined with an adequate architecture of the transport network adds yet another level of protection i.e. network protection. This functionality enables the operator to build reliable ring structures based on any fixed wireless capacity up to 155 Mbit/s. The ring protection mechanisms works on primary level, and it allows protection of all or pinpointed primary affluents within the total payload.

6.3 Density of P-P links in the IMT-2000 transport network

In general highly directional antennas should be used to increase the density of P-P links in the transport network. Therefore in dense networks, antenna pattern based on Recommendation ITU-R F.1245 should be favoured.

Making use of different polarizations significantly increases the density of terminals (taking into account the cross polarization of the antenna, but also that due to unequal atmospheric precipitations propagation losses, the use of the horizontal polarization at higher frequencies (for instance 38 GHz) is restricted to very short links.).

To derive more realistic results, other features such as ATPCs or parameters like influence of adjacent or nearby channels should be taken into account.

In some cases, in order to increase the density of terminals in dense network deployment, higher threshold degradation could be accepted (e.g. for dense network deployment), if performance and availability objectives can still be met and increased degradation can be compensated in the link budget.

6.4 Comparison of the topology and the band characteristics

This section highlights how the network topologies can be implemented taking into account the band characteristics as well as other influencing factors in order to allow for a dedication of frequency bands to specific parts of the IMT-2000 transport network.

Information on network topologies is available in § 5.2 and in Annex 1. The band characteristics and other influencing factors are described in § 6.1 and 6.4.2 respectively.

6.4.1 Comparison of the topology and band characteristics described in § 6.1 (without taking into account other factors)

Tables 5 and 6 provide lists of possible frequency bands for P-P and P-MP systems in relation to the network layers, respectively. This information only takes into account the band characteristics, the existence of Recommendations and standards for equipment for these bands. It does not take into

account any other factors (e.g. specific uses of the spectrum in a particular country) which could have significant impacts on the availability and appropriateness of the bands.

TABLE 5

Possible frequency bands for P-P systems in relation to different hierarchical levels of IMT-2000 network

Hierarchical level⁽¹⁾	Frequency bands (GHz)	Suitable frequency bands for shorter haul (GHz)	Suitable frequency bands for longer haul (GHz)
Hierarchical level No. 0	11-64	27-32-38-52-57	11-13-15-18-23-27-32
Hierarchical level No. 1	11-57	27-32-38-52-57	11-13-15-18-23-27-32
Hierarchical level No. 2	11-38	27-32-38	11-13-18-23-27-32
Hierarchical level No. 3	4-32	13-18-23-27-32	4-L6-U6-7.5-11-13-18
Hierarchical level No. 4	< 18	13-18	<18

⁽¹⁾ See Fig. 1 for definitions

TABLE 6

Possible frequency bands for P-MP systems in relation to different hierarchical levels of IMT-2000 network

Hierarchical level⁽¹⁾	Possible frequency bands (GHz)
Hierarchical level No. 0	26-28-32-38
Hierarchical level No. 1	26-28-32-38
Hierarchical level No. 2	3.5
Hierarchical level No. 3	3.5
Hierarchical level No. 4	Cannot be addressed by P-MP

⁽¹⁾ See Fig. 1 for definitions

6.4.2 Other factors to be taken into account when considering bands for the IMT-2000 infrastructure

When considering bands for the IMT-2000 infrastructure, many other factors have to be taken into account such as:

- sharing issues with other radio services;
- spectrum congestion due to existing national assignments; and
- national regulation issues.

6.5 Upgrade of existing 2G links into 3G links

The introduction of 3G is likely to be supported on existing networks when available. Therefore the increased capacity requirements as compared with 2G generation including advanced applications that is typically offered today within the 2G will necessitate an upgrade of current P-P links that support these networks.

Following the practical difficulties considered to upgrade existing PDH links to SDH with the associated increased propagation availability requirement (typically from 99.99% to 99.995%) , a possible way for upgrading is described in details with particular emphasis on the spectrum allocation requirements that could result.

6.5.1 Evolution of 3G networks

Current 2G networks have been heavily reliant on P-P radio infrastructure to link up the MSC – BSC – BTS. The vast majority of links are PDH with capacities of 2-34 Mbit/s and in many cases the frequency bands 23 and 38 GHz have been used. These bands support hop lengths between <1-20 km.

To support the services of 3G it is anticipated that the data traffic capacity will increase to the extent that cannot be carried by the current 2G infrastructure, particularly in the urban areas of the network. For PDH links that are currently carrying a capacity of 16-34 Mbit/s it is anticipated that a high proportion of these links will migrate up to SDH capacities, particularly STM-1. It should also be noted that PDH links deployed were planned with a propagation availability of 99.99%. For SDH links the availability will increase to a minimum of 99.995%.

The mobile traffic on which the above estimation is based includes high-quality speech, high-speed packet and medium/high multimedia signal transport. In 2010 it is assumed that required capacity to an individual station will increase about four times compared to that for the 2G system in terms of 90% cumulative value. A capacity of 30-50 Mbit/s may be necessary to meet most of the capacity demand for the 3G systems.

6.5.2 Technology limitations

Current technology limits the overall system gain of SDH STM-1 as compared to an existing PDH capacity. This will impact on the maximum achievable link length for a P-P link in a particular frequency band. Ideally the operator preference is to upgrade a PDH link to SDH in the same frequency band. However where the current PDH link has been deployed towards the maximum achievable link length for the band, it is sometimes not possible to remain in the same band for the upgraded SDH link.

6.5.3 System gain

The effect of “lost” system gain is detailed in Tables 7 and 8 by using parameters of state of the art fixed wireless systems operating in the frequency bands 23 GHz and 38 GHz.

TABLE 7
System gain at 23 GHz

Capacity/bandwidth	Typical O/P power (dBm)	System gain ⁽¹⁾ (dB)	“lost” system gain (dB)
16 Mbit/s/14 MHz	+17	94.5	–
34 Mbit/s/28 MHz	+17	91.5	–3
STM-1/28 MHz	+17	79	–15.5
STM-1/56 MHz	+18	84.5	–10

⁽¹⁾ Referenced to a BER of 10^{-6} , assuming non-protected systems

TABLE 8
System gain at 38 GHz

Capacity/bandwidth	Typical O/P power (dBm)	System gain ⁽¹⁾ (dB)	“lost” system gain (dB)
16 Mbit/s/14 MHz	+16	89.5	–
34 Mbit/s/28 MHz	+16	86.5	–3
STM-1/28 MHz	+15.5	74	–15.5
STM-1/56 MHz	+15	77.5	–12

⁽¹⁾ Referenced to a BER of 10^{-6} , assuming non-protected systems

The loss of system gain can be measured in terms of maximum distance achievable for a given capacity and a given frequency band. In the higher frequency bands the loss of system gain has a profound effect on the maximum hop length that can be achieved for higher capacity systems.

Increasing the antenna dish size is an engineering solution to recover some of the “lost” system gain, however there is an environmental impact to larger dish sizes that may not be tolerated by local planning committees. In addition, there is the possibility that current tower structures cannot support the additional antenna size due to wind loading constraints.

It should be noted that this measure could impact on other FS link assignments as well as on compatibility with other services sharing the same band, such as the passive services and would therefore have to be taken into account in link planning.

At the initial stage of the IMT-2000 deployment, it is efficient, economical and environmental to use the same site with the 2G system. This means that 3G base stations are overlaid to those of the 2G systems utilizing the same locations. Also in such cases, required capacity for radio access network will be notably increased by conversion from the 2G system to the 3G system.

It is apparent that, in order to allow existing PDH links to upgrade over the same path, other frequency bands need to be considered. 3G networks will evolve from existing 2G networks and so it is impractical to expect a total redesign of the network in the initial stages of development.

6.5.4 Location sharing

As higher layer links can transport lower network traffic, an MSC station can accommodate SAPs. The same relation could apply to SAP and CS. Location sharing by Node facilities with different layers brings about advantage of efficient maintenance and operation.

In a wide and high-density metropolitan area, several MSCs are needed, SAPs could also be concentrated to the same building as MSCs. Thus, on account of the reduced hierarchy, configuration of the networks will be simplified.

6.6 Infrastructure sharing between 3G operators

Where allowed or encouraged by the frequency management authorities, sharing of their infrastructure by mobile operators would be advantageous. Information on infrastructure sharing can be found in the Handbook on “Deployment of IMT-2000 systems”.