2 The Role of the Mobile Satellite Systems

2.1 Lessons learned from the past

This section summarises some lessons which can be learned from past experience with mobile satellite systems, notably the so-called second generation "personal" satcom systems such as Iridium, Globalstar, ICO. All of the issues addressed here have at least some relevance to the planning of advanced mobile satellite systems.

2.1.1 General

♦ Alternative technologies will not stand still whilst a new satellite system is built and deployed.
♦ Forecasts of revenues and take-up in the first year of the project must be realistic, particularly when starting from a zero base.
♦ Do not design a satellite system around just one application.
♦ Long-term projects focused on a single, very specific objective tend to develop an unstoppable momentum with no break-points, and with little scope for re-orientation.
♦ The first to market is not necessarily the winner. The launch of service needs to be carefully managed, almost certainly with step-by-step roll-out. Committing to a "big-bang", high-profile service launch date is unwise. It is difficult to maintain credibility after launch if the product does not live up to the promise. Do not beta test your product on normal paying customers.
♦ User expectations, in terms of performance and service quality, need to be carefully managed. It is extremely dangerous to claim performance and characteristics equivalent to terrestrial services which can not in reality be delivered.
♦ Financing a start-up satellite system is now very hard – even for GEO technology. If possible, it is better to use an existing, cash-positive satellite operator as the vehicle for a new venture. If this is not possible, the founder investors - usually the industrial partners, plus possible a few strategic partners - must expect to fund the bulk of the capital costs.
♦ Bad news about one satellite project can be bad news for other competing satellite projects, particularly when they are listed.
♦ In many cases it will take the satellite manufacturer 20-40% longer to deliver the system than was planned at the start of the programme.

2.1.2 Market Assessment

♦ Do not be over-optimistic about mobile satellite market size: Iridium and Globalstar both estimated millions of users and expected new market segments to evolve. However, they ended up with a multiple of tens of thousands of users, mainly from the usual "desperate communicators" in the vertical markets. For S-UMTS, it is important that such misjudgements are not repeated. Market estimates should be based on historical data rather than futuristic dreams, and the system should be designed accordingly.
♦ A clear and realistic assessment of the time to market for the satellite product must be made and validated at the outset of the programme. In parallel, there must be an analysis of what will happen with alternative (terrestrial) technologies over the development/implementation/roll-out period.
♦ The market assessment for a satellite system must be broadly-based, across a range of user-types, applications and geographies. Some of the targeted markets will not materialise. The satellite system must have sufficient flexibility to deal with different demand characteristics. For advanced mobile services, the market assessment will need to cover the following, as a minimum:

Market segment analysis: International Business Travellers; regional users; local users; semi-fixed; transportable; specialist; remote industrial; remote operations;
news/media; true mobile (maritime, aeronautical, rail, trucks and other vehicles); government; military; disaster/emergency;

Geographical breakdown of demand: developed countries; developing countries; linkage to roll-out of UMTS; filling the gaps where there is no UMTS; where will 3G satellite service be bought, where will the service be used? What is the optimum coverage roll-out for satellite?

Applications: personal Internet access; public/group internet access; m-commerce and transactions; remote access to LAN or Intranet; content and software contribution and distribution; streaming video/audio; data broadcasting; remote expertise (e.g. telemedicine); SCADA; voice (very cheap or free); email;

Convergence and complementing: e.g. terrestrial services, satellite navigation and positioning, digital audio broadcasting, multicasting.

2.1.3 User Terminals

♦ Handheld is not the only way: Many of the new systems during recent years aimed at providing GSM-like handheld phones. However, the traditional mobile satellite users have, to a surprisingly large extent, stuck to existing systems (e.g. Inmarsat) providing services with larger, bulkier terminals. For the users in the traditional vertical markets, it seems to be equally (or more) important to get T-UMTS-like services rather than T-UMTS-like terminals.

♦ The supply of user terminals can be among the most difficult elements in a “mass-market” satellite project.

♦ The appearance and physical characteristics of the user terminal are important; including a satellite capability does not necessarily make a larger, heavier terminal more acceptable.

♦ For 3G satellite mobile serious consideration must be given to the user interface, and related closely to target market segments. Issues include: is there a place for dual mode terrestrial + satellite terminals, what is the market for satellite–only terminals, what is the potential for a simple satellite add-on to existing user equipment (enabled via a technology such as Bluetooth….)?

2.1.4 Pricing

♦ Even in situations where there is apparently no alternative (terrestrial) technology available to the user, it is not possible for satellite systems to charge whatever they like. Charges must appear to be reasonable.

♦ The premium for satellite service over equivalent terrestrial charges needs to be reasonable, and recognised as giving good value by the customer. Premiums higher than 2 times the equivalent terrestrial charge will be hard to justify.

2.1.5 Distribution

♦ Do not rely solely on the cellular industry: In recent years numerous mobile satellite initiatives have tried to attract the major players, manufacturers and operators, from the cellular world. So far the success has been limited. An important obstacle is that the cellular players tend to regard the mobile satellite market to be too small to be worth spending much time and effort on. (Maybe understandably so: even the most optimistic estimate of 8m S-UMTS users in this document, would equate to less than 1% of the global T-UMTS market.) The success stories of the past years have to a large extent been with smaller players who have focused on satellite and the relevant vertical markets.

♦ Distribution strategy must be coherent and focussed. Service provision/distribution channels must be aligned closely with the overall interests of the enterprise. They must get up to speed right at the start.
The investors are highly dependent on the performance of the distribution chain. Although at least some of the distributors will also be investors, they may still underperform. Even if some investor/distributors perform well, they are still very much at risk of poor performance by others, over whom they have no real control.

Motivating distributors to be effective in a relatively low volume (albeit higher margin) market such as satellite services is likely to be a continuing problem. Although terrestrial mobile service providers are an obvious channel to market for satellite services, they are unlikely to share the objectives and priorities of the satellite system operators. Specialist mobile satcom service providers may be better.

Satellite operators/owners are likely to have to be more active themselves in this area if the overall enterprise is to be successful.

N.B. Most of the above points apply also to user terminals and their manufacturers

2.1.6 Compatibility with UMTS

- There is a pressing need to obtain acceptance of satellite by terrestrial UMTS providers: at present most are not interested or actively hostile, and would like to use the satellite spectrum allocation for their own, non-satellite purposes.
- At what level will there be compatibility/interoperability between terrestrial and satellite UMTS – SIM card only, or something more? Will there be integrated common customer support and billing. Which sub-set of terrestrial facilities will be available on satellite? What data rates will satellite deliver? How many simultaneous users can satellite support in a given area?
- User co-operation issues: analysis is needed of the extent to which the lack of in-building performance is a problem; will users accept the need to point an antenna towards the satellite; to what extent can this process be simplified/automated?
- Is satellite the natural default for areas where there is no UMTS coverage, or will the normal default be GSM, GPRS etc.?
- In a mass-market, personal communications service, continuous service availability is very important. This is particularly applicable to a satellite service which claims to extend reach, fill gaps, and provide cover in remote locations. Thus much thought need to given to sparing/back-up arrangements for the satellite service, to deal with cases where the primary operational satellite is unavailable. It must be assumed that one-for-one sparing is financially unviable.

2.1.7 Market access

- Market access is crucial to business success – it is a key factor in obtaining user and partner confidence, and a successful financing. It is essential to identify up front the 10 or so key geographic markets and to ensure that access is confirmed in these as soon as possible before the start of service.
- It should be possible for 3G satellite mobile operators to benefit from market access already gained by narrowband mobile satcom operators such as Inmarsat, and from the ITU GMPCS MoU process. However, this is not necessarily guaranteed: there may well continue to be issues with developing countries centred on bypass, and in developed countries if the spectrum allocation is already being used for other purposes.

2.1.8 Spectrum

- Confirmed access to spectrum is vital; third party investment is very unlikely to be committed before spectrum is obtained.
- There is a pressing need for more spectrum to be allocated to mobile satellite services. Current L and S band allocations are insufficient to permit extensive delivery of broadband services. Realistically, it is hard to see how significant additional spectrum
will be made available in the L or S bands. Therefore the use of higher frequency bands for mobile services must be studied.

2.1.9 Technology issues

♦ Do not underestimate the complexity and costs associated with NGSO systems: So far, no mobile satellite communication system deploying other than geostationary satellites has been shown to be economically viable. The lower orbits require higher number of satellites, higher number of launches, and the satellites have shorter lifetimes - all drivers for the system's operational costs. Additionally, the complexity of required NGSO functionality such as handovers, have shown out to be difficult issues.

♦ Iridium experienced no launch failures, yet there were a significant number of failures in orbit. This raises the question of whether the mass production of satellites is feasible. It also demonstrates that launching is no longer the most significant barrier to successful operation.

♦ No LEO communications system has yet been able to demonstrate financial viability. Without significant technology development, it may be hard to show that such systems can be financially and commercially viable, because of system lead times, technical complexity and the front-loaded financial profile.

♦ The key advantage claimed for LEO systems is significantly reduced latency. However, latency is only an issue with certain applications – notably real time voice and highly interactive data exchanges. Thus for many satellite applications GEO technology should be perfectly acceptable.

2.2 Terrestrial Systems

2.2.1 Terrestrial Fixed Services

LMDS, ADSL broadband-like networks are outside the scope of this document because of the higher rate capability. However users will experience new services that should create new expectations that will drive the demand for this new type of services in a mobile environment.

2.2.2 Terrestrial Mobile Services in Europe

2.2.2.1 GSM, GPRS, EDGE, T-UMTS networks

In Europe it is assumed the wireless operators will not develop specific services on T-UMTS different from GPRS services in a first phase. Indeed, GPRS should be used in rural areas and T-UMTS should be the solution for traffic densification in urban areas, offering services at 144kbps rate; in this first phase it is thought T-UMTS will not be used for providing services requiring higher bit rates than GPRS. Data rates of 384kbps will be rolled out in a second phase.

2.2.2.2 Terrestrial broadcasting networks

DVB-T is expected to be the European solution for terrestrial broadcasting, even if it is possible some countries will not implement it, or will only implement partially the technology (fixed services, mobile services, 2k/8k, etc…).

The frame of development of DVB-T is heterogeneous in Europe today (politically, economically). Mobile DVB-T is potentially challenging high data rate multicast and also unicast markets.

2.2.3 Terrestrial Mobile Services elsewhere (not Europe)

2.2.3.1 MOBILE IN USA

TDMA AND WIN:

TDMA is the number one technology in the Americas in terms of operators, subscribers, and coverage area. The growth in worldwide TDMA subscribers was 74 percent during year-end
2000. TDMA will continue to be a vital source of revenue for TDMA operators as they expand their current networks. Together, the shared AMPS (Advanced Mobile Phone System) and TDMA network infrastructure currently supports over 61 million subscribers throughout the world. WIN stands for Wireless Intelligent Networks.

*TDMA and WIN are TIA (Telecommunications Industry Association) and ANSI (American National Standards Institute) approved standards and are recommended by the ITU (International Telecommunications Union)*

**EDGE:**
EDGE (Enhanced Data rates for Global Evolution), also known as Enhanced Data rates for GSM Evolution, is an enhanced radio modulation technique for TDMA and GSM (Global System for Mobile communications) systems. EDGE is a 3G (Third Generation) radio interface technology, which will support data and multimedia services and applications. EDGE is a 3G solution specifically designed to be incorporated into the existing spectrum of 850, 900, 1800, and 1900 MHz bands. It supports data rates up to an average of 384 Kbps and peak rates up to 490 Kbps in wide-area coverage.

EDGE is fully IMT-2000 compliant, as defined by the ITU-R Task Group 8 at the December 1999 meeting in Helsinki. EDGE has been approved by ITU as part of the Universal Wireless Communications (UWC-136) 3G technology options, specified by American National Standards Institute TIA/EIA-136.

EDGE is an integral part of the UWCC strategy to provide high-speed wireless data to the customer. EDGE and UMTS are both being developed within the 3GPP and thus provide opportunities for seamless transparency of services between the two technologies. Both EDGE and UMTS are built on the same core network.

**TDMA & GSM CONVERGENCE:**
TDMA and GSM have been developing together to provide high-speed data through EDGE. Recent global market dynamics and developments accelerate the efforts of TDMA operators’ evolutionary path to interoperability and convergence with GSM.

**DEPLOYMENT OF EDGE AND UMTS IN A TDMA NETWORK:**
This combination ensures a future-proof competitive service capability, highest network coverage and capacity, lowest rollout costs, and widest roaming capabilities. EDGE provides lower cost capacity delivery for voice and medium bit rate data services, as UMTS provides lower cost capacity for data intensive applications and higher theoretical maximum bit rate per subscriber. EDGE can be deployed in existing spectrum starting at the end of 2001 and these deployments can be complemented by UMTS.

**BENEFITS OF IMPLEMENTING EDGE IN A TDMA OR GSM NETWORK:**
Compared to the data services currently available from TDMA and GSM, EDGE provides significantly higher capacity and always on-line connectivity, EDGE will provide up to seven times more capacity than TDMA systems and up to three times more than GPRS (General Packet Radio Services).

For operators, EDGE offers the most cost-effective means for providing 3G services within existing spectrum. EDGE will provide the unique ability for operators to offer single terminal roaming between TDMA and GSM networks in all frequency bands worldwide. With EDGE, operators can realize their full revenue potential through incorporating international roaming more conveniently and more cost effectively than ever before possible.

**EDGE AND GPRS IN TDMA AND GSM NETWORKS:**
GPRS specifies a radio interface as well as a core access network. The GPRS core access network is a common standard used in GPRS, EDGE, and UMTS. EDGE is an improvement
of the GPRS radio interface, to increase the speeds for carrying information between the mobile device and the radio base station. EDGE can transfer three times more data per frequency band. EDGE is also a way to increase the capacity and data rates in an existing network.

A TDMA network is evolved directly to EDGE, but since GPRS is a subset of EDGE, GPRS will also be supported in TDMA networks. EDGE uses the GPRS network for data transport. EDGE adds higher data speeds and more capacity to GPRS networks.

A GSM network can offer GPRS as an interim step toward 3G to introduce packet data capabilities offering speed up to 115 Kbps.

GPRS requires network resources only when a subscriber sends or receives data. The “best effort” mode of working also smoothes out the traffic peaks. A new way of charging, for example per data volume instead of per connected time, opens up.

EDGE CAN MAXIMIZE EXISTING INVESTMENTS IN TDMA AND GSM:
EDGE is implemented in the existing frequency spectrum and thus requires no additional spectrum investment to enable operators to offer a wide range of new revenue generating services. There will be major economy of scale advantages from the convergence of TDMA and GSM technologies with EDGE, since the same core and radio access technology will be shared. Operators can also capitalize on many of their previous investments and reuse portions of their infrastructure.

EDGE DEPLOYMENT AND PRODUCTS:
EDGE is a common standard for TDMA and GSM, will leverage TDMA-GSM interoperability and convergence, and will be widely deployed in existing frequency bands (850, 900, 1800, and 1900 MHz). Collectively, TDMA and GSM have a market share of over 450 million users, as of late 2000, representing just over 85 percent of all mobile digital subscribers (excluding PDC). This figure continues to grow rapidly as penetration spreads to the rest of the world. With EDGE, operators have the opportunity to build on this subscriber base and to seize the new business opportunities this lucrative market offers.

EDGE system products will be available for both TDMA and GSM in Q4 2001. EDGE terminals will address three broad product categories: voice phones, smart phones, and communicators.

TDMA OPERATOR DEPLOYMENTS OF EDGE AND UMTS:
The UWCC’s endorsement of UMTS as a 3G option for TDMA operators has no implications for the actual deployments of the technology. Each of the UWCC operators will determine their own deployment plans, which depend on various factors including spectrum availability. The UWCC does expect some operators to deploy both EDGE and UMTS systems since both share the same core network.

ROAMING:
Compatibility between AMPS, TDMA, EDGE, and GSM, along with the deployment of dual-mode dual-band multiple technology wireless handsets, promotes network access for subscribers worldwide. Membership in the UWCC provides members with the exclusive access to the UWCC’s latest products defining common technical and operational specifications to implement international roaming. Members also gain the right to participate in future work advancing global roaming for TDMA customers.

SUMMARY
The picture shows the road-map to IMT-2000 for principal standards:
2.3 Satellite

2.3.1 Fixed satellite
Broadband satellite systems are under development for serving terminals with data rates above 2 Mbps. These types of services are outside the scope of the document. There is a potential market overlap in the range 500kbps to 2 Mbps between HDFSS services and ASMS.

2.3.2 Mobile satellite (N.B. The previous thought of differentiating Europe from other parts of the world has been dropped from this section)

For business users, satellite could have an opportunity for providing the same services and bit rates that T-UMTS but outside T-UMTS coverage areas. For mass-market users, this will not be the case as the provided services will not be necessarily the same as the ones provided by T-UMTS under the T-UMTS coverage. Satellite has the opportunity to propose high rate services on a broadcast or multicast mode.

Mobile Satellite Systems (MSSs) have been available to maritime users since the 70’s for voice and low-rate data services (Inmarsat). More recently the service offer was extended to land-mobile users and aeronautical users, while a number of competing operators started to appear on the market, mainly with the introduction of
systems based on non-geostationary orbits. Point-to-point services (e.g. voice, data, fax, access to the Internet, etc.) are those most commonly requested by users, though some multicast services are often used for fleet management purposes. At the same time, the system design was orientated to permit using smaller and smaller terminals, in line with terrestrial cellular developments. Bit-rates higher (e.g. 64 Kbits) than those supported by a normal 4-kbit/s voice channel are offered in some cases, but these services were mainly conceived for the vertical market due to their fairly high cost. At present, there are systems being implemented (e.g. Inmarsat IV, ICO, etc.) that can offer bit-rates high enough to support multimedia services similar to those offered by the cellular GPRS/T-UMTS users. Such systems, together with possible future satellite systems specifically designed and optimised for the support of high data rates, would implicitly constitute the so-called satellite component of UMTS (S-UMTS).

So far MSSs have mainly been used by business users because of their relative high cost. By the time S-UMTS will have been implemented, it may be expected that service cost may have decreased enough to also attract mass-market users.

For business users, S-UMTS will hopefully have an opportunity for providing services and bit rates similar to those of GPRS/T-UMTS but outside the GPRS/T-UMTS coverage areas. For mass-market users, this may not always be the case as the provided services will not be necessarily the same as the ones provided by GPRS/T-UMTS under the GPRS/T-UMTS coverage, mainly due to bit-rate limitations. Such opportunities are discussed in sect. 2.4.1 specifically dealing with the provision of high-rate point-to-point services via satellite.

In addition to the point-to-point services, satellites also have specific opportunities to provide high rate services on a broadcast or multicast mode (possibly also including a return channel for interactivity purposes), because of their cost-effectiveness in providing services for which the cost-per-bit is shared by many customers. It may be useful to further distinguish multicast / broadcast services into real-time services (such as the streaming ones), and non-real-time interactive services (i.e. those generally based on the transfer of a data file). Such opportunities are specifically dealt with in sect. 2.4.2.

2.4 Mobile Satellite Markets

2.4.1 Current Forecasts

One useful source of information for the next generation of MSS networks comes from OVUM, which conducted a study for ESA in the year 2000. OVUM presented a number of development scenarios, steady state, medium growth and high growth:

- **High growth**: based on UMTS Forum projections (See UMTS Forum Report 6), and supposing full alignment with 3G terrestrial mobile. This scenario would probably imply the timely deployment of an ad-hoc S-UMTS system, capable of supporting both point-to-point services. Such an S-UMTS system could possibly incorporate some of systems under implementation that can support wideband links.

- **Medium growth**: OVUM projections, by far lower than those of UMTS Forum, based on development starting to go outside vertical markets and partial alignment with evolving terrestrial mobile systems. This scenario could correspond to still paying coordinated efforts toward the implementation of an S-UMTS system, but with a delay for the multicast S-UMTS component, i.e. the
one that could more easily capture the mass-market because of its potentially higher cost-effectiveness.

- **Low growth**: Based on a “static-state”, continuing development of vertical markets. Such development is just based upon the expected technology advances (e.g. user terminal integration) and the economies of scale that the most modern MSSs can yield (e.g. increasing users base)

The medium growth scenario is one which represents an achievable target over the coming decade. It nevertheless requires significant and coordinated development programmes. The key issue is how far we can move beyond the medium projection, towards the market of 8m users in the high projection. This probably implies accelerating the deployment of the multicast / broadcast S-UMTS component, i.e. the one that can more easily attract a great users population.

The OVUM market projections are presented below.

![Figure 1: MSS User Projections (Source: OVUM)](image-url)
Figure 2: Breakdown of Medium Market Projections (Source: OVUM)

Figure 3: Breakdown of High Market Projections (Source: OVUM)
2.5 Positioning in the mobile communications infrastructure

2.5.1 Positioning for point-to-point satellite networks

2.5.1.1 Roles

Before going on to the role of S-UMTS, the roles of T-UMTS and GPRS will be briefly discussed. Arguably, T-UMTS and GPRS will together as complements serve the market need for UMTS/IMT2000 services. GPRS alone will not give sufficient capacity and the additional spectrum that is assigned for T-UMTS will therefore be needed, especially in densely-populated areas. It will be expensive to build coverage with T-UMTS but GPRS on the lower GSM band will be a perfect complement for this. Most of the terminals are expected to be dual mode GPRS/T-UMTS. The role of S-UMTS should therefore be studied in relation to the combination GPRS/T-UMTS/not only to one of them.

There are two main roles that S-UMTS can play with regard to point-to-point services:

1) Complementing Terrestrial bearer services - Extending the availability of a terrestrial bearer service in low density traffic areas where GPRS/T-UMTS deployment is non-adequate or unavailable.

2) Competing with Terrestrial bearer services - Offering mainly vertical services where outdoor coverage anywhere anytime is crucial but indoor coverage is not required.

In both cases S-UMTS is visioned as integrated with T-UMTS, and not as a stand alone system. Integration has several implications, the most important ones being those directly perceived by users (e.g. a common services subset, a unique mobile dialing number, the use of highly-integrated dual-mode terrestrial/satellite user terminal), but also those regarding operators can be significant (e.g. re-use of existing infrastructures). Integration issues are specifically dealt with in sect. 2.5.1.2

---

Figure 4: Breakdown of Market Projections (Source: OVUM)
The bearer service quality parameters of S-UMTS differ from those of T-UMTS and GPRS. Since S-UMTS will have availability difficulties in indoor environments, the S-UMTS as a competing service can only be considered in applications where Indoor coverage is unimportant. One such an application could be a bearer service for vehicles and various sorts of outdoor equipment. S-UMTS can in other words not be expected to be a competitor to T-GPRS/T-UMTS in general but maybe in some niche areas. Another case could be the provision of critical services at bit-rates higher than that offered by GPRS, in areas served by GPRS but not yet by T-UMTS.

Most of the users of GPRS/T-UMTS will probably be satisfied with the availability of these systems in the same way as they today are satisfied with the availability of cellular voice. Nevertheless, a proportion of the customers may require availability also in areas where GPRS does not offer any coverage. This is where the S-UMTS can fill a role as a complement to the terrestrial bearer services.

![Figure 5: Integration Concept of point-to-point S-UMTS and GPRS/T-UMTS services](image)

S-UMTS can complement T-UMTS in providing:

- Coverage completion/extension.
- Global roaming.
- Rapid deployment.
- Disaster-proof availability.
- Dynamic traffic management.

It should be noted that, in principle, all above roles can all be simultaneously undertaken by the same satellite system, which can well be designed such as to support diversified applications, with a great resources utilisation flexibility. As a consequence, possible traffic forecast errors for each individual role could well compensate with each other.

The above roles are individually addressed in the following:

**Coverage extension and completion**

S-UMTS can cover large areas, regardless of whether they are populated, with operating T-UMTS and other terrestrial services, or whether they are remote with no terrestrial telecommunications services. Consequently, S-UMTS can extend or complement T-UMTS services.
**Coverage extension**

S-UMTS can extend T-UMTS to locations not served by it. For instance, S-UMTS can provide the link to implement T-UMTS in villages and towns too poor or too remote to support wired connection. The services then offered can be the same as in populated areas and may include telephony, fax, messaging and Internet access, all in one system. The principal regions might be Africa, Latin America, India and some Pacific Rim countries, as well as remote regions such as islands, mountains or deserts, regardless of the rest of a country’s infrastructure. Deploying S-UMTS services in remote communities or in poorer areas of the world implies that some of them may not be strictly personal, but rather community-shared, with fixed, not mobile terminals.

S-UMTS can also extend T-UMTS to places it cannot serve when implemented by usual means, such as on board aircraft or ships. The utility of satellite communications at sea has been well proven, and Inmarsat was founded to serve the maritime communications market. One implementation scenario might be for larger ships, such as cruise ships, to be fitted with high gain antennas that compensate for the relatively low capacity per square kilometre of satellites. These in turn can offer communications to each cabin.

Capacity demand varies considerably with regions in the oceans. Today, Inmarsat satellites cover most of the global traffic demand, if not the global geographical coverage as LEO systems. A combined LEO and GEO system could provide global coverage as well as higher regional capacity. Future satellite systems could feature on-board switching to direct their beams on request (signalling calls) instead of inefficiently providing high capacity in wasting a lot of capacity in regions of the oceans where there is no demand for it.

Another possibility would be that of still using transparent satellites but with steerable beams serving those earth regions currently unserved by terrestrial facilities, Beams would be moved to other places when a region starts to be served by terrestrial infrastructures.

The principle of extension is illustrated in the simplified drawing in the following figure:

---

**Figure 6: Coverage extension.**
Coverage completion
S-UMTS may act as an umbrella cell in a hierarchical cell structure, covering gaps in the T-UMTS network. As shown below, a typical situation might be that part of an area has T-UMTS coverage, and S-UMTS is used to cover the complete area, including remote areas where T-UMTS is not financially viable. By using a local repeater, S-UMTS also could provide indoor coverage. A home network operator can therefore achieve a complete coverage of its regional market.

Global roaming
S-UMTS can extend T-UMTS operator coverage to areas not directly reached by the operator's facilities. This will permit the user to communicate in areas with incompatible systems. Even if the local network is compatible and roaming agreement are in force, S-UMTS can permit avoiding the roaming charges (provided these are lower than the additional cost of the via-satellite call). Traveller communications can be connected to a home T-UMTS cell or to other travellers. Such services may be important for international business travellers and for land, sea and air transport businesses, as central offices can then monitor the movements of fleet transportation units.

Rapid deployment
In areas where T-UMTS is anyway going to be deployed, S-UMTS can anticipate the service availability.

Since S-UMTS traffic is expected to decrease in these areas as the T-UMTS implementation progresses, it is important to have the S-UMTS system operative at an early stage compared to T-UMTS. The deployment concept is described below.
Figure 8: Rapid implementation of combined S/T-UMTS.
N.B. Clarification is needed as to what frequency band is used for the satellite RNC to RNC link in this figure.

Disaster-proof availability
Throughout the world, there are wars and other crisis zones that lack terrestrial communications because networks have been damaged or destroyed or, in some cases, have not been built. A political, military or humanitarian group can be interested in renting communications capacity segment to organise the logistics of their mission.

Even the best of terrestrial system (T-UMTS, GSM and others) can be disabled by natural or manmade disasters. Regardless of the reasons, S-UMTS can provide a back-up service.

Dynamic traffic management
S-UMTS can relieve permanent or temporary traffic congestion in T-UMTS. Communications traffic peaks at certain times of the day in some locations, such as city suburbs and public transport services during peak hours, or during certain seasons, such as in holiday resorts. There may also be more business-related communications during the day than in the evening or during the weekends, when it is likely to be more family-oriented. Since business and family communications have different services needs, the capacity and symmetry must be adjusted to the demand on an almost real-time basis. This also implies that dynamic capacity allocation must take into account location changes, for example due to daily commuting. Clearly S-UMTS can only help mitigating the T-UMTS congestion for users operating outdoor, or anyway having a good and constant visibility to the satellite.
2.5.1.2 Integration Aspects for Point-to-Point Services

As already mentioned in sect. 2.5.1.1., integration with T-UMTS is the adopted underlying assumption. This derives from the fact that S-UMTS can provide service in those areas covered by cellular systems (though indoor operation will most likely require a local repeater), as well as in areas not planned to be served by terrestrial systems. This is illustrated in the following figure reproduced from a UMTS Forum Report [6].

![Integration Aspects for Point-to-Point Services](image)

**Figure 9:** The role of S-UMTS as an integral part of the UMTS network (UMTS Forum)

Integration requires that mobile users be equipped with triple-mode terminals, supporting GPRS, T-UMTS and S-UMTS.

With regard to the network aspects of the integration between S-UMTS and GPRS/T-UMTS, it should firstly be remembered that a typical 3G cellular system will comprise a Core Network, to which both a GPS Radio Access Network and a UMTS Terrestrial Radio Access Network (UTRAN) are attached, the UTRAN including one ore more Radio Network Controllers (RNCs) and Node-Bs. In the satellite case the equivalent of the UTRAN is called the USRAN and the Node Bs are co-located with the Gateways. While the CN is radio-technology independent, the whole USRAN is dependent on the selected air interface.

That said, two are the main issues to be dealt with regard to S-UMTS integration:

- the USRAN
- the CN concept

As to the USRAN, this can be based on one of the six radio air interfaces endorsed by the ITU and described in more detail in sub-clause 8.1.1 of this report. Future RTTs, subject to the ITU evaluation process, may also be used. The closer the S-UMTS air interface is to that of T-UMTS, the higher are the possible synergies with regard to e.g. user terminal complexity, access system tune-up, operational experience commonality, etc.
As to the CN concept, two main approaches can be considered (the GPRS component is not here addressed for clarity reasons):

A first solution (resembling that adopted by Globalstar) is that of regarding S-UMTS as fully embedded within the overall UMTS, this meaning that S-UMTS would heavily rely upon the mobility functions of existing T-UMTS networks, and would then not need having an ad-hoc core network. In other words the satellite system would so interface with a pre-existing 3G networks.

According to this vision, an operator already having a T-UMTS network (i.e. a CN + a UTRAN) could attach a USRAN to his CN, thus immediately enjoy the advantages that via-satellite access can provide. Other operators may want to do the same thing, this leading to the existence of several independent USRANs, one per operator. The overall “S-UMTS system” may then be regarded as a set of independent USRANs, which will have to share the space segment resources in some way, e.g. on pre-assignment basis if each operator wants to have a guaranteed satellite capacity.

As to call routing, the mobile user will normally be registered (e.g. in the VLR) to one of the RNCs of the “home” UTRAN, or, when he travels outside of the home UTRAN reach, to the RNC of the home USRAN: this corresponds to the “complementary” scenario presented in sect. 2.5.1.1. Nevertheless, in such conditions the user should also be allowed to roam into the UTRAN of another operator instead of using the home USRAN, should the roaming charges be more favourable than the USRAN utilization charges. The adopted routing strategy shall also be compatible with the “competing” scenario (see again sect. 2.5.1.1), whereby a user registered to a home UTRAN may anyway want to use the home USRAN, if operating outdoor. The embedded integration concept is depicted below (the GPRS component is not shown).

An alternate integration approach (resembling that adopted by Iridium) is that of envisaging a self-standing S-UMTS system that includes all those CN functions
needed to support internal mobility. There would then be a single USRAN comprising all the satellite system GWs, and an ad-hoc satellite CN that would interface with the fixed terrestrial network. In other words, the satellite system would be totally independent of pre-existing T-UMTS networks.

A possible integration solution is to regard the S-UMTS system just as another UMTS network, into which the users of any T-UMTS network can roam when desired or needed. S-UMTS would so be a special network not having its own users, but just constituting a common communications resource that all T-UMTS users can utilise on roaming basis (S-UMTS may then not have its own HLR). According to this vision, S-UMTS would no longer be split into many “slices”, one per operator, and it could therefore be more appropriate to share its capacity among operators in a more efficient way, i.e. on a call-by-call basis.

Also in this case no difficulties are expected to comply with the requirements of both the complementary and the competitive scenarios. The self-standing integration concept is depicted below.

### 2.5.2 Positioning for broadcasting satellite networks

There are many scenarios that can be considered for the implementation of a broadcasting satellite network for mobile services. These range from the simple sharing of content, to the sharing of spectrum or to the co-ordinated use of several networks (satellite + terrestrial) for a service.

A basic assumption for the co-operation of mobile networks is that a terminal can interact with several networks (eg. satellite and IMT-2000) simultaneously. Such a co-operation of both networks (see below) can improve the capabilities and varieties of services, the economics for the user and, hopefully, the ease of handling. It combines the network service modes of both networks and thus enables new solutions for applications. Of course, there will still be services which need only one network. Some applications like interactive TV can use also separate terminals, eg. an IRD or a IMT-2000 mobile terminal.
Figure 10: Overview of Co-operating Networks

1. Integration at the terminal level, no co-ordination on the network level
2. IP services on co-ordinated satellite and IMT-2000 networks
3. IMT-2000 as a return channel for interactive broadcast services
4. Satellite as a technology in IMT-2000 networks

These scenarios will be briefly described and the technical elements required for their implementation will be identified.

Satellite can be envisaged in a global mobile offer, bundled with a pure bi-directional communication services offer (provided by wireless operators), in order to propose these broadcasting services 3rd Generation Mobile networks won’t be able to offer.

The mobile broadcasting satellite services can either be integrated with other networks (IMT-2000 or S-IMT-2000) or not. Broadcasting satellite mobile services could have to compete with DVB-T, the terrestrial broadcasting system from DVB specifically designed for mobile reception.

In the case satellite services are envisaged to be marketed in a bundled offer with mobile bi-directional services, the integration of networks would enable the joint provision of a full range of integrated services from peer-to-peer to broadcasting.
Individual requests can be satisfied through the IMT-2000 or S-IMT-2000 networks, whereas frequently accessed contents and broadcast transmissions are sent through the broadcasting satellite network to all users.

This integration also requires a unified subscriber care and billing system if we want to provide the subscriber with a unique bill.

![Figure 11: Services per network](image)

Satellite services can also be marketed in a stand-alone offer if sufficient number of subscribers can be ensured with services at a reasonable price for a sufficient park of terminals.
2.5.3 Geographical requirements

2.5.3.1 Regional needs for mobile services
The need for land-based mobile satellite services varies very significantly region by region, as do the requirements for particular applications, and the ability to pay. The opportunity for MSS is generally greater where the terrestrial infrastructure is weak or non-existent.

For aeronautical and maritime applications the requirement is generally for homogeneous global coverage, offering user terminals which will work in any region, global user support etc..

2.5.3.2 Regional positioning of the satellite infrastructure
The list of key issues for the planning of advanced mobile satellite systems includes:
- deciding in which regions the satellite coverage is needed;
- the extent to which the users move around within and outside their home region;
- catering for regional variations in user requirements and applications;
- interfacing with local terrestrial services;
- whether a multi-regional or global service is to be provided.

The satellite design will need to be flexible enough to cope with significant regional variations.

2.6 Users and Applications

Traditional markets for Mobile satellite systems are:
- Maritime.
- Trucking.
- Media/broadcasters.
- Government.
- Oil & gas.
- Corporate.
For the next generation of MSS market development, there is considerable interest in developing a service offer for a more mainstream market.

Two main user categories are identified:

? **Businesses and organisations**, with high demands regarding reliable and available services;

? **Private users** who will be more price sensitive than the first category.

Businesses and organisations can further be divided in two subgroups, depending on the type of usage. That is the remote or mobile office, where the main purpose is to provide the user with the same services as in his home office, i.e. a connection to the main office or intranet. The users own location is irrelevant to the information exchange. The other subgroup is logistics, where the location or position is an important part of the information transferred. Location based services are however also interesting to the private user, not only businesses.

As far as high bit rate services are concerned, the private user is likely to need more download and broadcast than businesses that need more symmetric services such as video-conferencing. Logistics demand is mostly data/video streaming for surveillance and tracking. Examples of location based services for the private user are broadcast of traffic information, download of maps either in a city or when driving between two cities.

In the UMTS Forum report No 9, a definition of applications is proposed:

**Applications are service enablers – deployed by service providers, manufacturers or users.**

Applications are invisible to the user. They do not appear on a user’s bill. A banking service, for example, would require a secure transaction application to be implemented by the services provider. A unified messaging service would require voice recognition and text-to-speech applications, deployed on the network or in the terminal device. Individual applications will often be enablers for a wide range of services.

Applications which will typically need to be implemented are:

<table>
<thead>
<tr>
<th>Market</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maritime</td>
<td>e-commerce</td>
</tr>
<tr>
<td>Trucking</td>
<td>Fleet management</td>
</tr>
<tr>
<td>Media</td>
<td>Video compression</td>
</tr>
<tr>
<td>Government</td>
<td>Encryption</td>
</tr>
<tr>
<td>Energy/Oil &amp; Gas</td>
<td>File transfer &amp; LAN access</td>
</tr>
<tr>
<td>Corporate</td>
<td>IP-based LAN/WAN extension</td>
</tr>
<tr>
<td></td>
<td>Security</td>
</tr>
<tr>
<td>Consumer</td>
<td>Billing</td>
</tr>
</tbody>
</table>

**Figure 13: Markets and applications mapping**