MSAT: A Booster for Land Based Mobile Radiocommunication Networks?

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ABSTRACT

This paper intends to demonstrate that the foreseen phenomenal growth of mobilesat services will impact positively existing terrestrial mobile radio services. Mobilesat systems will not displace the existing terrestrial market in the near future, partly due to the high cost of their terminal units and associated airtime, but also due to some technical limitations, such as lack of spectrum efficiency and high susceptibility to shadowing. However the ubiquity of mobilesat services will open new markets to terrestrial radio technologies: the latter is expected to be the most economical way of extending locally mobilesat services to many users. Conversely, Mobilesat systems will be used to extend the capabilities of terrestrial radio systems in areas where the former cannot be implemented cost efficiently. It is believed that terrestrial mobile networks operators using these service extension capabilities will have a competitive advantage over those who do not.

Overall, it is expected that emerging mobilesat services, far from being a threat to terrestrial radio systems, will rather provide these with numerous opportunities of incrementing their base market.

FOREWORD

This paper reflects the opinion of a Canadian operator of terrestrial mobile networks (cellular, paging, mobile data and private networks) regarding the potential impact of the North American MSAT system on the land based mobile radio industry. This operator is also involved in the distribution of mobilesat products and services.

INTRODUCTION

Between now and 1994, 12 satellites dedicated to mobile satellite communications will be launched world-wide. The associated investments are in the order of $US 5,000,000,000 [1]. Forecasts indicate that the actual level of 20,000 satellite mobile units in service at the end of 1989 will increase to 80,000 units in 1993, and to 2,000,000 units in 1995, over the entire globe [2]. By then, the full range of mobilesat voice and data services will be available, namely via the North American MSAT system. The highly flexible architecture of such a system will allow it to emulate virtually any type of terrestrial mobile service: cellular, paging, mobile data, two-way radio, etc. Unlike these services, MSAT provides a complete and seamless North American coverage, even in the most remote areas. What will be the net effect of this definite advantage over the apparently limited land based networks?

Rather than displacing a significant share of the existing market, mobilesat communications are likely to impact positively the penetration of their terrestrial counterparts. Hence, this paper proposes to demonstrate the anticipated impact of the mobilesat systems on the existing terrestrial mobile radio services..

A COMPARISON BETWEEN MOBILESAT AND LAND BASED SYSTEMS

Terminal Costs. Any new technology or system is generally more expensive at its introduction, largely because it lacks the economy of scale associated to mass production. The Mobilesat technology will not be any different. Moreover, the lack of world-wide standardization amongst mobilesat systems will further delay any savings for close to a decade, as a universal mobilesat standard is not foreseen in the near future. Each family of fairly complex mobilesat terminals is and will be produced in much smaller quantities than their terrestrial equivalents. For instance,

close to 7 million cellular terminals will be put in service between now and the end of 1993 in the United States alone [3,4]. This is much more than the total of all types of mobilesat terminals that will be sold in the entire world during the same period of time. Similar relative order of magnitudes would hold true for SMR's and private systems.

Airtime Costs. In addition to the retail price of the terminal, the tariff associated with mobilesat airtime is likely to remain higher than the terrestrial systems. This is partly due again to the lack of world-wide standards, causing each system to incur large up-front non-recurring development expenses. The high price is mainly occasioned by the very high start-up costs inherent to any satellite system.

$CDN 3,000 to $4,000 is a typical projected figure used for planning purposes of a voice mobilesat terminal. In comparison, many cellular phones sell already for less than $CDN 500. Typical planning figures for airtime mentioned by mobilesat operators vary from $CDN 1.00 to $2.00 a minute for voice, compared to about $CDN 0.50 for cellular usage in Canada. Similar comparisons also hold true for data services.

Susceptibility to Shadowing. Land based mobile systems generally benefit from a more generous link budget margin than mobilesat systems. Satellite power is expensive and limited: for a fixed total satellite power, doubling the power per channel (3 dB increase) implies that the total satellite capacity (and airtime revenues) would be reduced by a factor of two. For instance, a satellite that could provide service to 100,000 mobile users with a fade margin of 3 dB could service only 50,000 users with a fade margin of 6 dB. That is why these systems are designed for relatively low fade margins (typically 3-10 dB). In addition, mobilesats generally operate in the 1.5 GHz band, and are thereby more affected by the shadowing effect of nearby objects than mobiles operating in terrestrial bands (150 to 900 MHz). These two factors are responsible for the expected high susceptibility of mobilesat to shadowing. This could actually force a mobile unit to remain stationary during voice communications in shadowed areas (roads with adjacent trees, downtown and suburban areas, hilly areas, etc.). Similarly, mobile data users would experience a non-negligible reduction of their throughput when moving in the same areas.

Spectrum Efficiency. Despite the very narrow 5 kHz channel spacing planned for the North American MSAT, satellite systems are far less spectrum efficient than their terrestrial counterparts: even with a spot-beam technology, a specific frequency can barely be reused once over the North American continent, at L band. On the other hand, cellular systems can reuse a specific frequency hundreds of times over that same area, as can other terrestrial systems, although not as efficiently as cellular. RF spectrum is a limited resource: the system able to carry more calls per MHz for a specific territory is technically capable of achieving a larger market share. This definite advantage of land based systems over mobilesat is proportional to the global call carrying capacity of each system over a defined territory. A similar rationale applies to data transmission.

Propagation Delay. Satellite delay, well known to those who call frequently overseas, is likely to incite some mobile users to use voice terrestrial systems, where available. Data transmission is not affected by satellite delay, except for some rare real time remote control applications.

Mobilesat and Their Terrestrial Counterparts: Two Distinct Markets

We believe that the higher retail prices of mobilesat communications and some of the inherent technical constraints described above are likely to keep most of these terminals in areas where there are no terrestrial alternatives. The net impact of mobilesat on existing land based mobile networks is thus likely to be minimal.

One noticeable exception to this statement is the niche market of long haul vehicles (trucks, trains, airplanes): these users need continuous coverage, and seamless operation, which terrestrial systems cannot adequately provide at the moment. It is mainly in this niche market that the non-maritime mobilesat operations are actually growing. However, the continuous expansion of land based systems and their eventual mutual interconnections is likely to generate serious competition to mobilesat systems in this specific area, in the near future.

SYNERGY BETWEEN TERRESTRIAL AND SATELLITE SERVICES

Despite the constraints and limitations mentioned above, the growth of mobilesat communi-

cations is predicted to be phenomenal by many observers: mobilesat terminals will be found all over the world within the decade. Person to person communication will be possible anywhere in the world.

The phenomenal growth of cellular systems in the recent years caused a positive impact on private mobile systems and SMR's: cellular systems taught people that they could stay in touch at any time. Many users then chose non-cellular systems to fill this recently discovered need of communications.. Similarly, the new non-geographically limited mobilesat communications services will reenforce the image of "keep in touch everywhere". This is likely to impact positively the existing terrestrial mobile radio systems, as it becomes more commonplace to remain in contact with the office, the residence, etc.

Mobilesat is a key ingredient in implementing the concept of the universal personal communicator, this telephone-like unit that will be used anywhere in the world, accessing networks (including mobilesat) on a least cost and optimal performance basis. The ubiquity of mobilesat terminals will shortly be the best promoter of that concept, which will benefit both land based and satellite systems.

New Terrestrial Markets Opened by Mobilesat

Mobilesat services will bring communications capabilities to areas that could not be reached before. In these areas, terrestrial services will permit a local extension of satellite services to numerous users needing to occasionally reach remote individuals out of their local coverage The following paragraphs outline a few examples.

Remote Mobilesat Telephone Systems. Like a cellular system, Mobilesat services will allow users to access directly the Public Switched Telephone Network (PSTN). Many remote users (small communities, fishing and hunting camps, mines installations, etc.) could share a fixed mobilesat link(s) by using terrestrial wireless technology. Fig. 1 suggests a possible mix of a few services for this application: VHF links, "CT-2" like telephones and a wireless PBX (CT-2 is the new generation of intelligent Cordless Telephones (CT)). A mini cellular switch could also be used locally to provide service to cellular telephones in the area.(Fig. 2).

These two mobilesat service extensions have the following advantages over the traditional wired solutions: the end users would get a completely *mobile* local and toll telephone service, within the local coverage area. All they need to carry is their wireless handset (or portable cellular phone).

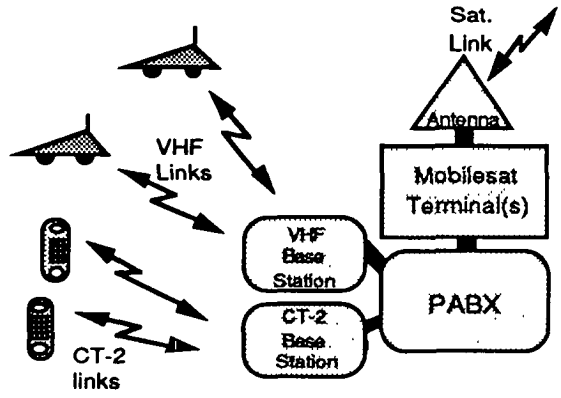

Fig. 1. Remote Mobile Telephone Configuration A

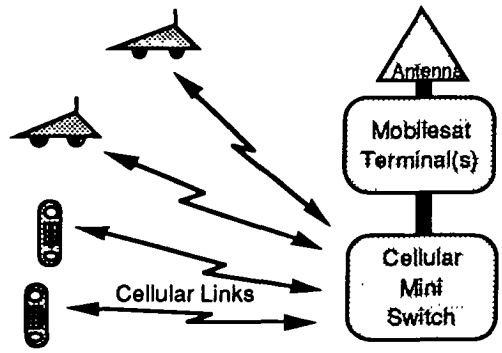

Fig. 2 Remote Mobile Telephone Configuration B

Furthermore, the portability of mobilesat terminals and their low cost (in comparison to other types of satellite communication) make them very well suited for temporary services (seasonal hunting and fishing, large construction projects, etc.)

Remote Mobilesat Radio Systems. Remote mobile radio systems can be interconnected to a remote dispatcher via a mobilesat link (Fig. 3), thus giving each vehicle a link with its head office, in addition to its existing link with other vehicles. Economics are likely to prove that it is less expensive to provide local coverage with a terrestrial system, rather than equipping each mobile with a mobilesat terminal.

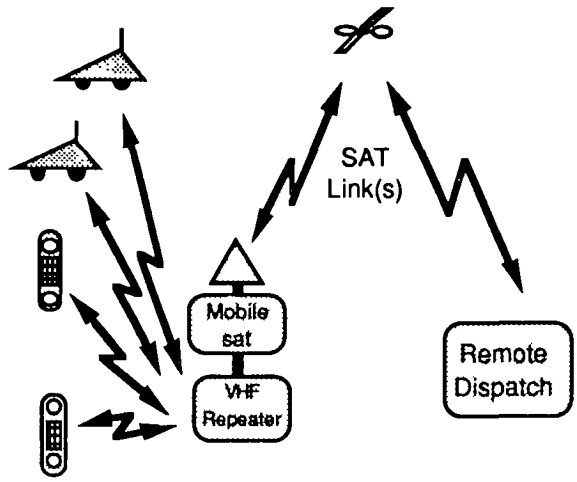

Fig. 3 Remote Dispatch using Mobilesat Terminal

The local range of mobilesat units can be extended by using vehicular repeaters, thereby allowing the mobile user to access his system when away from the vehicle.

Remote Mobilesat Data Systems. Data transmission is one of the most promising areas of mobilesat. The portable and inexpensive mobilesat terminal will start a new era in gathering data from countless locations and in controlling them remotely. Here again, a terrestrial mobile data system might prove a more economical alternative in linking locally various points to a mobilesat terminal (Fig. 4)

Using Mobilesat for Extending Existing Terrestrial Networks

So far, we have shown how terrestrial radio systems can extend remote mobilesat systems. But mobilesat terminals can also be used to extend terrestrial radio systems in areas where the latter cannot be implemented cost efficiently .

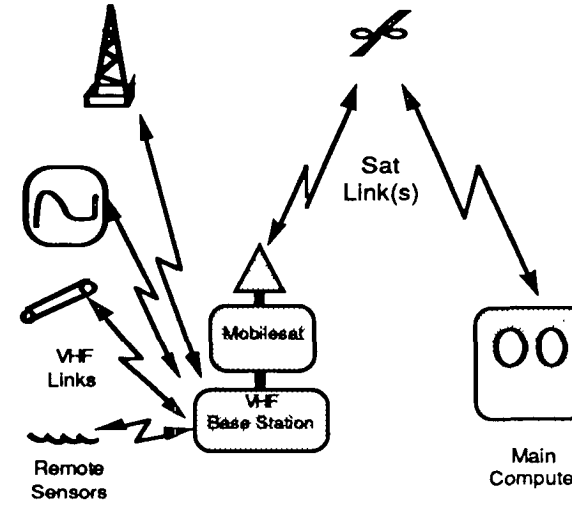

Fig. 4 Remote Sensing using Mobilesat Data Terminal

Extending Cellular Systems. Mobilesat Telephone Service will essentially provide the same capabilities as a cellular system. This service can be used to extend the coverage provided by actual cellular operators. The two systems will be technically incompatible, at least initially, and the competitive advantage of this extension will reside in the marketing strategy used to jointly market these services: one stop shopping, unique billing for both services, etc. Then, eventually, some mobile units will be capable of accessing both systems, and the respective network controller of each system will allow these units to hand off from satellite to terrestrial coverage, and vice-versa, on a least cost and optimal performance basis. From the user viewpoint, this will translate into a truly North American mobile telephone coverage, with the operational benefits of both systems: excellent communications in downtown and shadowed areas, at a lower price, in cellular areas; service everywhere else within satellite coverage.

Extending Land Based Mobile Systems. SMR's and private radio systems address the needs of the multiuser type of communica-

tions: taxi fleets, law enforcement agencies, public utilities, etc. Because mobilesat systems will have the capacity of emulating current terrestrial systems, they will be capable of extending SMR's and private radio systems in a way that is virtually transparent to both the mobile user and to the dispatcher. For example: with his land based mobile system, a dispatcher could reach a national fleet of mobile users, split into sub-fleets on a regional basis (on a provincial basis, for instance, in Canada). Within each region mobilesat units could be configured to be integrated to the sub-fleet, where it becomes uneconomical to provide the service with the landmobile system (in less densely populated areas). Both mobilesat and land mobile units of the same sub-fleet would then be accessed simultaneously by the dispatcher. From an operational viewpoint, there would be no difference between the units, except for the coverage areas.

Another interesting application is the combined use of both satellite and terrestrial mobile services to provide emergency communications. Terrestrial systems can be seriously affected by major disasters (fallen towers, damaged landlines, etc.). However, there are generally sufficient mobile units that survive the event to maintain good communications, if they had access to a repeater... For these eventualities, frequency agile repeaters, teamed with mobilesat links, could be mounted in emergency vehicles or in mini-shelters that can be carried by helicopter. A mobilesat link could be established between this repeater and the rest of the world, thus allowing the emergency rescue team to be coordinated by a central coordinator. (Fig. 5).

Extending Mobile Data Systems. Along the same line of thought, terrestrial mobile systems can be used to provide coverage where they can be cost efficient; mobilesat could provide coverage elsewhere. The mobile units would all be interconnected together at the application level, making possible transparent exchanges of data between any given mobile and/or fixed point in the system.

Eventually, some mobile units will be integrated at the system level: they will be able to access their destination using either land or satellite based systems, on a least cost and performance basis.

Mobile data services will boom within the next few years; we believe that terrestrial operators who will provide extended coverage by using a mobilesat system will definitely have a competitive advantage over other service providers.

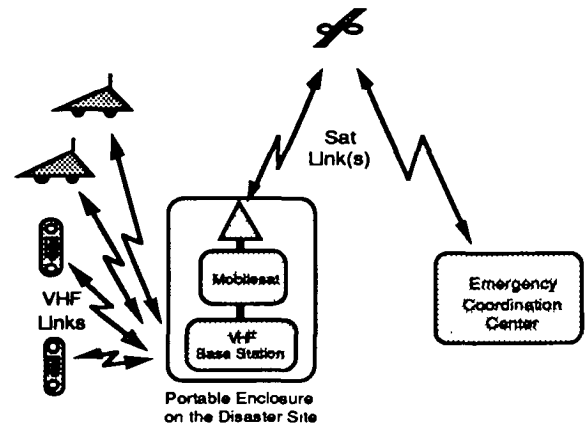

Fig. 5 Emergency Communications with an MSAT Link

CONCLUSION

As illustrated in the previous sections, we believe that mobilesat services are unlikely to displace a significant share of the existing land based mobile services. They will rather generate new market opportunities, either by making possible new applications, or by extending the capabilities of terrestrial systems on a continent wide basis.

Both mobilesat and land based radio systems must be coupled to realize the full level of global service that neither can achieve unilaterally. This needed cooperation is the first step towards the "Universal Communicator" described above.

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