Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

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FCC MAIL BRANCH

In re Application of	)	
	)	File Nos.
SATELLITE CD RADIO, INC.	)	49/50-DSS-P/LA-90
	)	58/59-DSS-AMEND-90
For Authority to Construct,	)	44/45-DSS-AMEND-92
Launch and Operate a Digital	)	
Audio Radio Service	)	

COMMENTS OF RADIO SATELLITE CORPORATION

Radio Satellite Corporation ("RSC") hereby submits its Comments on the above-referenced application of Satellite CD Radio, Inc. ("SCR"), pursuant to the Commission's Report No. DS-1244, DA 92-1408, released October 13, 1992.

RSC believes that all DAR systems should be capable of operating at variable data rates and should provide for return (mobile-to-ground station) links.

RSC designed the RadioSat system in 1989 to provide a wide array of integrated communications and navigation services to consumers[1] through MSAT.[2] RSC first publicly described the RadioSat system on May 7, 1990.[3] and filed a RadioSat ground station application on May 22, 1990.

The RadioSat application showed how MSAT, the mobile satellite system under construction by Telesat Mobile, Inc. ("TMI") in Canada and the American Mobile Satellite Corporation ("AMSC") in the U.S., could provide DAR services. It showed how multiple data rates could be

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1 See attached flier, "Car Radio of the Future." Also, see the attached article from Microwave Journal, "Mobile Satellite Communications for Consumers," November 1991.

Radio Satellite Corporation will send its *Car Radio of the Future* video describing the RadioSat system free to anyone requesting it.

2 Zuliani, Michael J. and Gary K. Noreen, "Mobile Satellite Service: A North American Perspective," 39th IAF, Bangalore, India, October 1988.

3 Noreen, Gary K., "Mobile Satellite Broadcast System Design," pp. 233-236, Proceedings of the 40th IEEE Vehicular Technology Conference, May 6-9, 1990, Orlando, Florida.

accommodated - a key development, since talk channels require less than a quarter the data rate of stereo music channels.

The RadioSat application was highly innovative in several key ways:

1) It was an application for a Mobile Satellite Service in an existing band using an authorized satellite, so it required neither a new allocation nor the processing of mutually exclusive applications.
2) It would provide a wide array of integrated services of much greater value to consumers than just a few more radio channels.
3) It would use satellites already under construction that should be in service at least 6 years before any new DAR satellite system.

The original SCR application lacked these features. Instead, it was limited to audio entertainment distribution only - just a small subset of mobile satellite services - and to a single data rate. It required an investment of hundreds of millions of dollars and the launch of a new geostationary satellite limited to digital audio broadcasting. It required a new allocation, thus a new rulemaking by the FCC. It would require the FCC to process mutually exclusive applications.

In its notable limitations, the SCR proposal was remarkably similar to that of Geostar. This was not surprising, since many of SCR's principals and attorneys played the same roles for Geostar: the Chairman of SCR, Martin Rothblatt, was formerly President of now-defunct Geostar Corporation, and Robert Briskman, President of SCR, was also from Geostar.

Like SCR, Geostar proposed to launch a network of satellites to provide an artificially limited set of services to mobiles - in the case of Geostar, it was position determination; with SCR, it was digital audio broadcasting. Both Geostar and SCR requested enormous amounts of spectrum for their limited services. Both Geostar and SCR characterized their services as "new" ones requiring special action from the Commission, but in both cases, the services were subsets of geostationary Mobile Satellite Service.

Both Geostar and SCR were represented by Richard Wiley. Not surprisingly, the Commission rushed in near-record time to award a license to Geostar,[4] and now appears about to do the same to SCR.

Geostar went bankrupt last year. After racking up a debt of $100 million, and going through $80 million of equity financing, its assets were sold in auction for $397,000, and its license was "sold" for $100,000.[5]

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4 The Commission's rulings on Geostar were characterized by hallucinatory statements about the "advanced state" of Geostar's proposal and by an extreme aversion to consider any rational alternatives.

5 Mobile Satellite News, January 1992.

The Geostar fiasco scared potential investors away from the mobile satellite industry, making it difficult for legitimate ventures to raise money. It was entirely avoidable. The severe deficiencies of Geostar's approach were well documented early in the Commission's proceedings on Geostar.[6]

SCR limited the services it proposed to provide so that it could claim a Pioneer's Preference. This is an approach that defies logic outside the FCC, but a similar strategy worked for Geostar. Geostar managed to define itself as something other than MSS, and managed to get the Commission to process its application separately in spite of the obvious fallacy of the claim. SCR is taking the same approach, and apparently getting away with it.

By artificially limiting the services it will provide, SCR is limiting its potential market. A similar artificial limitation in the current DOMSAT industry would have prevented most operators from shifting their operations from long distance telephony to video distribution when they were preempted by fiber optic networks. It would have destroyed the DOMSAT industry. This approach is also contrary to everything the Commission did in the geostationary MSS proceeding, where it said it wanted to encourage innovative use of the spectrum. It appears to have been taken simply to qualify SCR for Pioneer's Preference.

SCR has amended its application to include some of the data broadcast services originally proposed by RSC. However, it is now limited to just satellite-to-mobile transmissions at one data rate - a severe handicap in the marketplace.

To avoid another fiasco, RSC recommends that DAR systems have two key additional features:

1) Variable data rates. If a talk channel requires just 16 kbps while stereo music requires 64 kbps, it would be quite wasteful to force voice channels to use 64 kbps channels. Similarly, if 64 kbps channels prove adequate for many stations, it would be foolish to force all users into 256 kbps "CD quality" channels.
2) A return link (from mobiles to a network center) allows many useful new services. Given the Commission's plan for a one-way DAR service, this deficiency will be more difficult to correct. The return link could be provided by an "MSS" operator, though in a different frequency band.

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6 Comments of Transit Communications, Inc., Gen. Docket No. 84-689, RM-4426, December 17, 1984. TCI noted that the services proposed by Geostar could be provided through a single satellite mobile satellite system with integrated GPS receivers, while using just 3% of the spectrum required by Geostar. This is, in fact, how TMI, Inmarsat and AMSC are now providing all the services Geostar promised.

RSC believes that DAR systems incapable of operating at variable data rates would be highly wasteful of spectrum (as well as of satellite power) and should not be permitted.

It is understandable that neither SCR nor the Commission want to include return links in DAR because that would remove any remaining facade over the fiction that DAR is a new service. RSC believes additional geostationary MSS operators are desperately needed in any event[7] - even if it means giving SCR an undeserved Pioneer's Preference.

Respectfully Submitted,

RADIO SATELLITE CORPORATION

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November 12, 1992

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7 TMI and Inmarsat have been supportive of the RadioSat proposal. Unfortunately, AMSC - the monopoly geostationary MSS operator licensed by the FCC - blocked RSC from developing the RadioSat system. As a result, RSC was forced to suspend operations at the end of 1991. RSC filed a lawsuit against AMSC in Federal court in the District of Columbia in February 1992 charging numerous violations of communications and antitrust law; the suit is currently in mediation. Gary Noreen, the founder of RSC, was forced to leave the mobile satellite industry and now leads telecommunications design and development for an advanced mission to Mars at the Jet Propulsion Laboratory.

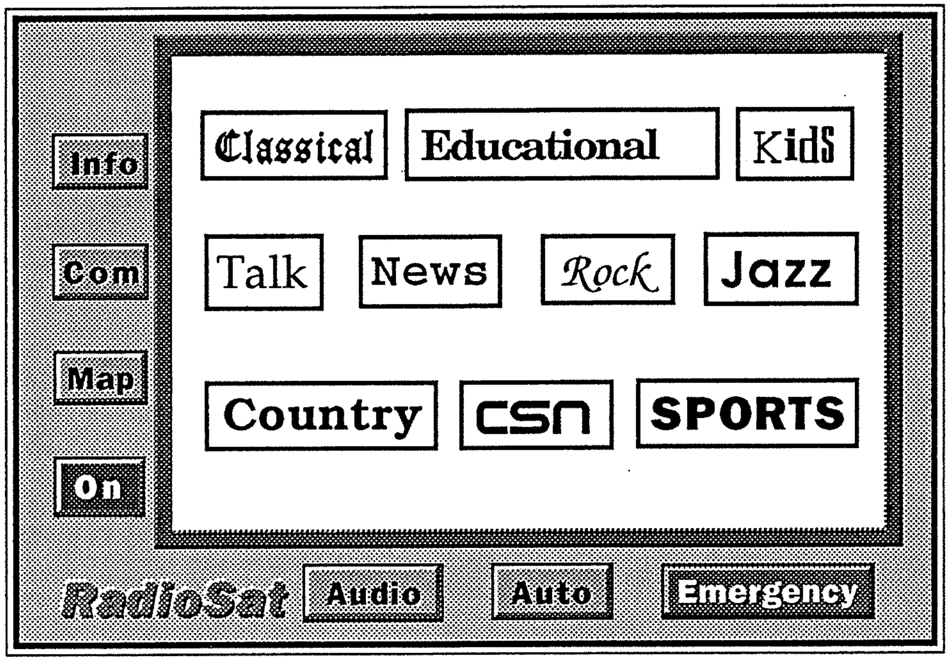
RadioSat

Car Radio of the Future

Radio Satellite Corporation designed the RadioSat system to provide integrated communications and navigation services to consumers, including:

- nationwide interactive digital audio entertainment;
- data broadcasts, including traffic advisories, weather reports, travel databases, and stock and sport updates;
- precision navigation; and
- two-way voice and data communications.

The RadioSat system requires an MSAT satellite, to be launched in 1994, and GPS, the satellite-based navigation system used in Desert Storm.



By integrating complementary services into low-cost car radios, the RadioSat system provides utility far beyond the simple addition of functions.

- Integration of two-way data communications with audio broadcasting enables direct response to broadcast solicitations, permitting consumers to order advertised products and services or to respond to polls simply by pushing a button.
- Integration of precision navigation with data broadcasting enables the display of vehicle location and current traffic hazards and congestion on a digital map, which the driver can use to optimize travel plans.
- Integration of precision navigation with two-way communications permits users to request emergency assistance from their vehicles and to automatically inform emergency agencies precisely where their vehicles are located.
- Integration of two-way data and voice communications permits transmission of voice pages to and from mobiles, along with positive acknowledgments.

With its highly flexible design, the RadioSat system can easily accommodate new services conceived and developed in the future.

For more information about the RadioSat system and a free video showing a computer simulation of the car radio of the future, call Radio Satellite Corporation at (818) 791-3951 or write us at 1167 N. Holliston Ave., Pasadena, CA 91104.

COMMERCIAL APPLICATIONS SERIES

Mobile Satellite Communications for Consumers

Gary K. Noreen
Radio Satellite Corp.
Long Beach, CA

Introduction

This paper reviews the capabilities of MSAT and describes the RadioSat† system. The RadioSat system, which is currently under development, will provide integrated communications and navigation services to consumers, including nationwide digital audio broadcasts; data broadcasts, such as traffic advisories, weather reports, travel databases, and stock and sports updates; precision navigation; and two-way voice and data communications. Low cost mobile satellite radios will be designed to replace existing car radios and are expected to become a popular mass market product. The RadioSat system will use MSAT satellites,[1] shown in Figure 1 and scheduled for launch in 1994, and the global positioning system (GPS), which is a US government satellite-based navigation system. It will provide the smart car of the future with extensive, flexible communication capabilities.

RadioSat services are provided with a single, low cost user-friendly mobile radio at a cost far below that of providing each service independently and with utility far beyond the simple addition of functions. For example, integration of two-way data communications with audio broadcasting will enable direct response to broadcast solicitations, permitting consumers to order advertised products and services or to respond to polls simply by pushing a button. Also, integration of precision navigation and data broadcasting will enable the display of vehicle location and current traffic hazards and congestion on a digital map, which the driver can use to optimize travel plans. Integration of two-way communications with precision navigation will permit users to request emergency assistance from their vehicles and will allow them to inform emergency agencies automatically of the precise location of their vehicles. Integration of two-way data and voice communications will permit transmission of voice pages to and from mobiles, along with positive acknowledgements.

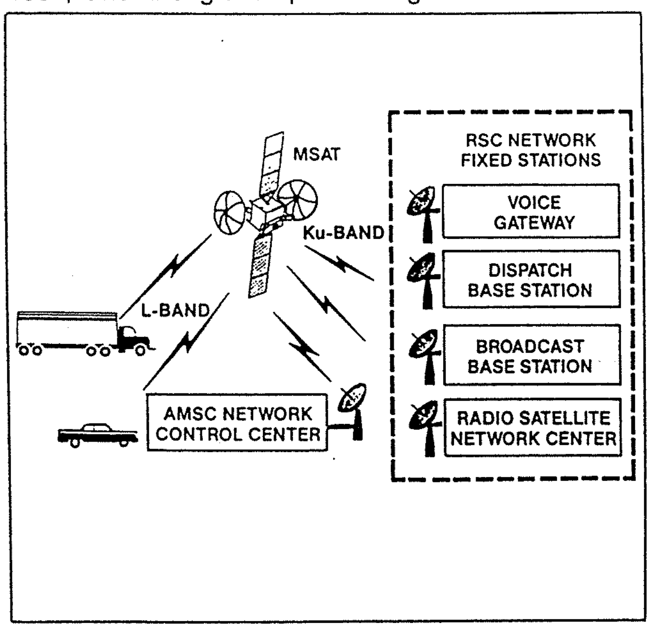


Fig. 1 The RadioSat system.

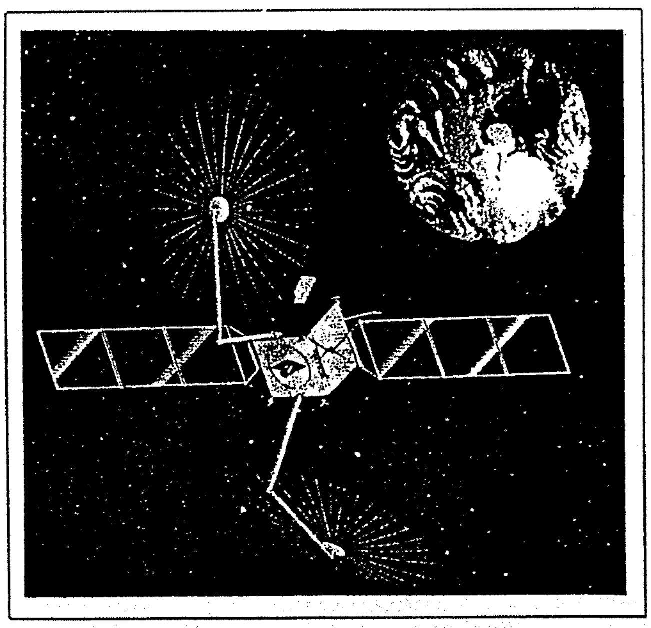


Fig. 2 The MSAT satellite.

†RadioSat is a trademark of Radio Satellite Corp.

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MSAT

The MSAT satellite system will relay communications between mobiles throughout North America and fixed earth stations. One MSAT satellite is under construction for Telesat Mobile, Inc., which will operate MSAT in Canada. A second satellite is under construction for the American Mobile Satellite Corporation, the US MSAT operator. Each MSAT satellite can provide coverage throughout North America. They will back up each other.

Each MSAT satellite employs a pair of 6 by 5 m elliptical reflectors to concentrate coverage over North America, as shown in Figure 2. Separate transmit and receive antennas are used to minimize passive intermodulation, a frequent problem with this class of satellite. Each satellite uses a Hughes 601 three-axis stabilized bus with a design life of 15 years.

All communications between satellites and mobiles are at L-band. All communications to mobiles are sent through fixed Ku-band earth stations to the satellites, which transpond the signals to L-band, amplify them and retransmit them to mobiles. Similarly, all mobiles transmit at L-band to the satellite, which transponds L-band signals to Ku-band, amplifies them and retransmits them for reception by fixed Ku-band earth stations. Table 1 lists the MSAT frequencies.

Four beams cover the contiguous US and Canada, corresponding roughly to one beam per time zone, as shown in Figure 3. A separate beam covers Mexico and the Caribbean. Other beams cover Alaska and Hawaii.

The radiated power of a satellite system is expressed as Effective Isotropic Radiated Power (EIRP). The aggregate EIRP of each MSAT satellite is 500 kW, as shown in Figure 4, three orders of magnitude higher than Marisat, the first commercial satellite designed for mobile communications.

MSAT has the unique ability to broadcast commercial audio programming through satellites directly to mobiles with small, inexpensive antennas. This requires an EIRP of 5 kW per channel. The entire capacity of an Inmarsat II could support only a single such channel; each MSAT satellite is capable of supporting 100 channels.

MSAT receive system performance also is much better than previous satellites, permitting additional new services. Receive system performance of commercial L-band satellites, expressed as mobile antenna gain (G) divided by receive system temperature (T), is shown in Figure 5. The high receive system performance of MSAT permits the transmission of voice using an omnidirectional mobile antenna and a two W amplifier.

Each MSAT satellite can send dozens of audio broadcasts using only a fraction of its total capacity. It can also support a wide array of other new mobile satellite services. Which services ultimately come to fruition depends largely on their relative economic merits.

TABLE I
MSAT FREQUENCIES

Satellite-to-Mobile	1530.0-1559.0 MHz
Mobile-to-Satellite	1631.5-1660.5 MHz
Satellite-to-Fixed	10.75-10.95 GHz
Fixed-to-Satellite	13.0-13.15 and 13.2-13.25 GHz

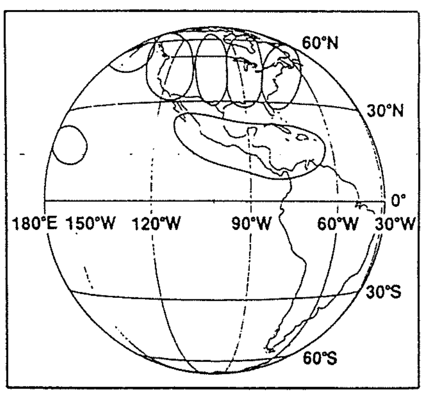

Fig. 3 MSAT L-band coverage.

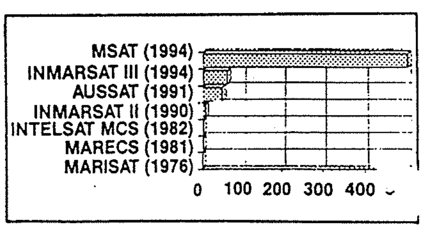

Fig. 4 Effective isotropic radiated power (kW).

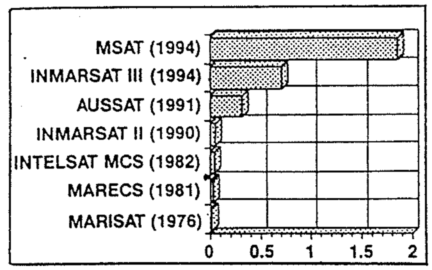

Fig. 5 MSAT Receive System performance (G/T) (1/K).

Mobile Satellite Economics

The economics of MSAT can be best understood by considering each MSAT satellite as a repeater 22,300 miles high. The extreme height of MSAT satellites has two key economic consequences. First, it is much more expensive to construct and operate a repeater 22,300 miles high, than a repeater 100 ft high, a typical terrestrial tower height. Thus, the cost per channel of MSAT is far greater than the cost per channel of a typical terrestrial repeater. Each MSAT service must earn much higher revenue per channel than that required to pay for terrestrial repeaters. Secondly, a repeater 22,300 miles high can cover hundreds or thousands of times the area of a repeater 100 ft high. This attribute of MSAT provides the means for generating the high revenue per channel required for mobile satellite communications.

To justify the high cost of MSAT channels, it is necessary either to charge a higher price per mobile or to support far more mobiles per channel than terrestrial systems.

Two-way voice services require the first of these approaches. Such services support a relatively small number of users, typically 100 or less, on each channel. Therefore, users of two-way MSAT voice services must pay much more per unit airtime for the use of MSAT than for terrestrial-based systems, except in areas with low population densities.

The second of these approaches can result in the creation of mass-market consumer products and services. Point-to-multipoint services and point-to-point data communications exemplify this approach.

Point-to-multipoint mobile services, such as audio and data broadcasts, are effectively provided

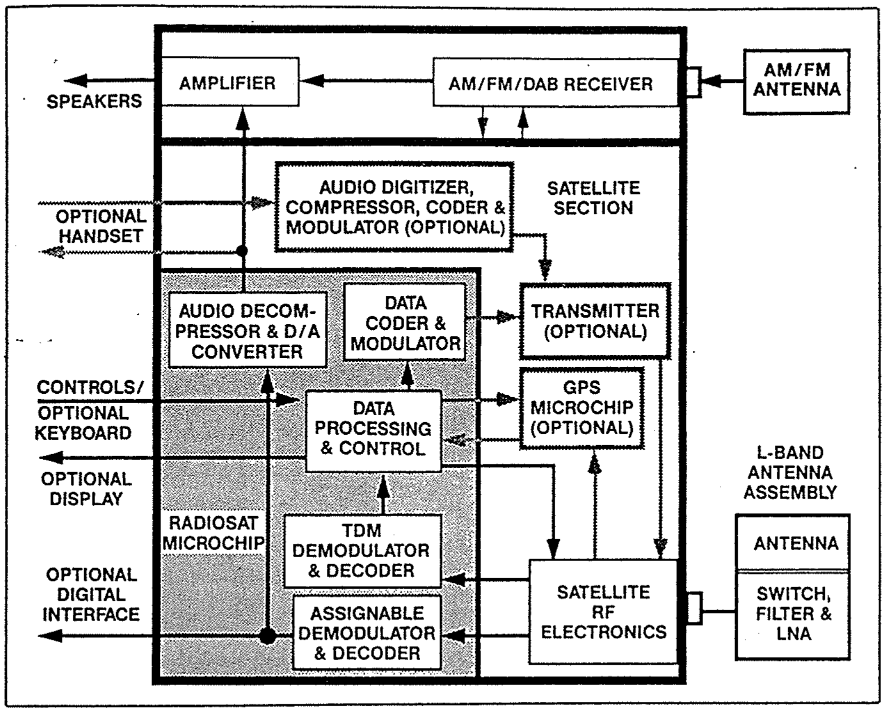

Fig. 6 A schematic diagram of RadioSat's mobile radio.

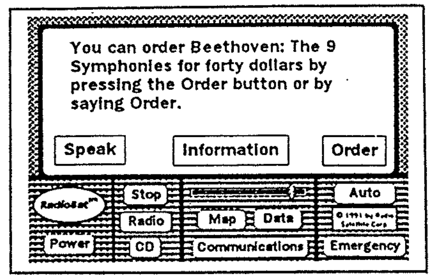

Fig. 8 Interactive radio.

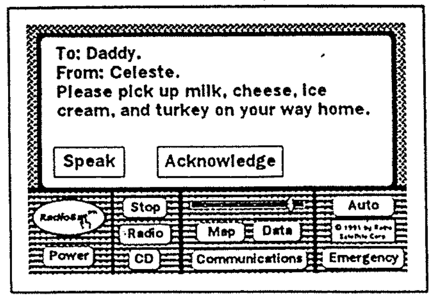

Fig. 9 Alphanumeric paging with positive acknowledgment.

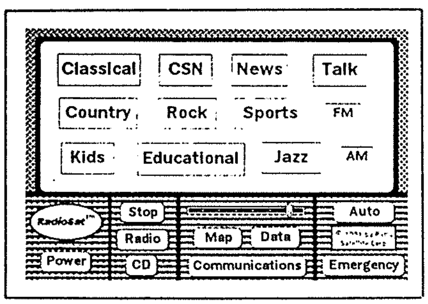

Fig. 7 User interface radio display.

through MSAT. Since MSAT covers an area hundreds of times larger than terrestrial broadcast systems, tens of millions of mobiles in hundreds of markets can potentially receive each channel. Thus, the much larger potential audience of MSAT offsets its relatively high cost per channel.

MSAT can also provide point-to-point data communications at a lower cost than terrestrial networks. Alphanumeric paging and two-way messaging services support very large numbers of mobiles on each channel. Terrestrial systems cannot take advantage of this efficiency; the limited range of terrestrial repeaters limits the number of mobiles reached by each repeater. Thus, the high cost of supporting large numbers of repeater sites dominates the cost of terrestrial mobile data systems, rather than the incremental cost of adding channels to individual sites.

The RadioSat System

The RadioSat system was optimized for services that support enormous numbers of mobiles on each MSAT channel.[2] This system exemplifies how the capabilities of MSAT can be used to produce new consumer services and products.

The design objective was to integrate all mobile satellite services with consumer potential into one low cost mobile radio. Low cost is achieved by integrating all the required electronics into a few integrated circuits, permitting mass production. By providing many integrated services to consumers in one radio, the attractiveness of the radio to consumers is maximized, resulting in large potential market size. With a large market, production costs are minimized.

RadioSat Mobile Radios

In addition to the AM/FM receiver sections of a conventional radio, each satellite radio incorporates an L-band satellite RF section and a custom RadioSat microchip (RSM), as shown in Figure 6. The RSM includes demodulators and decoders for both channels and an audio decompressor, and provides data processing and control functions. The RSM also includes a data coder and modulator for use with an optional transmitter.

A global positioning system microchip (GPSM) can be added to the radio for precision navigation. This chip uses GPS broadcasts and navigation information sent through the company's TDM channel to estimate mobile position with 5 m accuracy. The GPS frequency at 1575.42 MHz is between the MSAT satellite-to-mobile and mobile-to-satellite frequency bands. This proximity makes it possible for a GPS receiver to share the antenna and front end with a RadioSat mobile radio.

User Interface

The capabilities of the RadioSat system are best understood by considering how it will operate in a typical car. A computer model is shown that simulates a satellite radio installed into a double-height dashboard slot. The model features a set of fixed buttons on the bottom and a touch screen on top. The model can be operated on a hands-and-eyes-off basis. It accepts voice commands in place of pressing buttons and can speak through voice synthesis to convey messages received.

Figure 7 shows the model display after pushing the radio button.

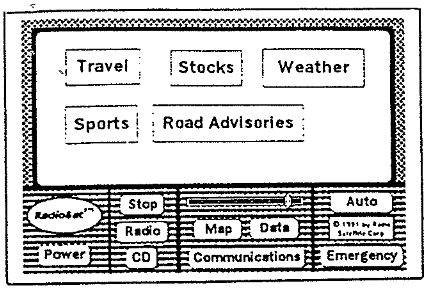

Fig. 10 Data broadcast options.

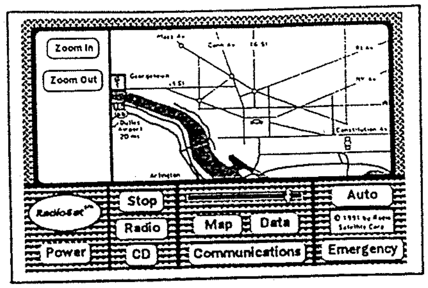

Fig. 11 Tornado alert showing car and tornado on map.

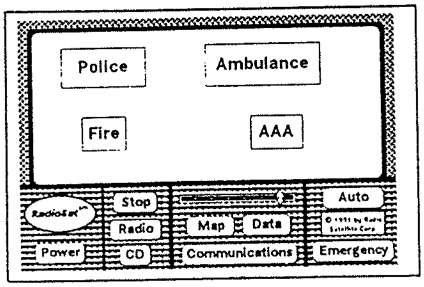

Fig. 12 Emergency communications.

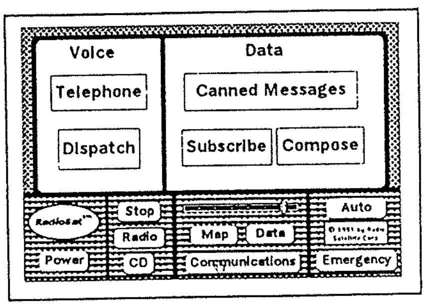

Fig. 13 Two-way communications options.

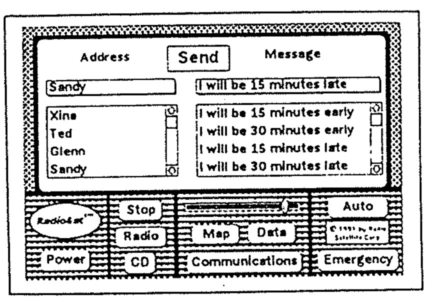

Fig. 14 Canned message screen.

Channels broadcast over the satellite system are identified by format rather than call letters. Selecting AM or FM results in a screen with tuning controls.

The two-way RadioSat system allows users to respond directly to broadcast solicitations. For example, after playing a piece of music, the announcer can state that a CD containing that music can be purchased by pressing the order button on the radio. A data transmission accompanying the statement would generate the display shown in Figure 8. By simply pressing the button, the driver sends a short data signal back through the satellite to the ground facilities, which provides information identifying the driver and the advertisement that promoted the response. This feature can be used to order products, services, information and samples; contribute funds to public radio programmers or other organizations; and to respond to listener polls.

All radios are individually addressable, so alphanumeric paging messages can be sent to drivers, as shown in Figure 9. Pages sent over the RadioSat system can be acknowledged, unlike any other paging system.

Satellite radios can receive a variety of data broadcasts, some integrated into the navigation or emergency alert systems. Some simply provide information that may be of interest, such as selected stock quotations or sports scores, as shown in Figure 10.

The data broadcast capabilities of the RadioSat system enhance GPS receivers in two distinct ways. First, by using GPS differential corrections sent through the RadioSat system, each radio can determine its position to within a couple of meters, as opposed to 100 m uncertainty with uncorrected GPS. Second, the RadioSat system can broadcast warnings of natural disasters, chemical spills and traffic accidents to motorists. Each radio can alert the driver if the warning concerns something in the driver's area. The warning can be displayed on a map, as shown in Figure 11, similar to those provided today in car navigation systems, so that the driver can consider alternative routes to avoid hazards. In the event of trouble, the driver can send a request for assistance that includes precise location information as shown in Figure 12. Acknowledgments can be sent back to the driver, advising that the message has been received and telling how long it will take for assistance to arrive.

The RadioSat system is designed to enable easy use of data communications because data is much less expensive than voice through the satellite. Voice, cellular telephone through the satellite, can be provided with add-on equipment, as shown in Figure 13. Drivers will have the ability to send short canned data messages, as shown in Figure 14, or with an attached computer keyboard, will have the ability to send more complicated messages.

Conclusion

The launch of the first MSAT satellite in 1994 will open dramatic new opportunities to communications equipment manufacturers. The RadioSat system will use MSAT to provide a low cost, highly flexible two-way communications capability for consumers that can be adapted to many new applications. ■

References

1. Gary K. Noreen, "MSAT: Mobile Communications Throughout North America," 39th IEEE Vehicular Technology Conference, San Francisco, CA, May, 1989.
2. Gary K. Noreen, "Mobile Satellite Broadcast System Design," 40th IEEE Vehicular Technology Conference, Orlando, May 7 to 10, 1990. Also, see Gary K. Noreen, "An Integrated Mobile Satellite Broadcast, Paging, Communications and Navigation System," 40th IEEE Broadcast Symposium, September 7, 1990.

Gary K. Noreen *received his BS and MS degrees in electrical engineering from the University of Washington and Carnegie-Mellon University, respectively. In 1989 he organized Radio Satellite Corp. and currently he is chairman and CEO. Radio Satellite Corp. provides integrated mobile satellite communications services to consumers. Since 1983, Noreen has been president of Transit Communications Inc. (TCI). Prior to forming TCI, Noreen designed communications systems for advanced interplanetary space missions and for MSS at NASA's Jet Propulsion Laboratory, where he was leader of the land mobile satellite service study team. He is an AMSC board member and a member of Tau Beta Pi, IEEE and AIAA.*