Satellite communication network

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Abstract

This paper describes a pioneering telecommunication satellite system (Iridium) based on a global digital satellite, which aims to provide portable telecommunication services through small common units, capable of using terrestrial mobile systems and digital communications. This operator has global quality and offers phone calls anywhere in the world. The result explains that based on the findings of this article and the statements of its researchers, this communication satellite system is the pioneer of personal communication based on global digital satellite. Its main mission is to provide portable telecommunication services through small shared units capable of using terrestrial cellular systems. It should be noted that these common units use low-power phones with low antennas. Calls are sent and received using L-band frequencies in an Fdma/Tdma universal access system. In addition, paging, fax and data services are also available through the Iridium constellation. Intersatellite links provide "switching in the sky" and transmit voice calls to Earth.

Keywords: Satellite, satellite network, communication network, satellite system

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Introduction

subject:

The subject of the article, the Iridium system is a satellite-based, wireless personal communications network designed to provide a wide range of telephony services such as voice, data, fax, paging to destinations almost anywhere on Earth The 66-satellite interconnected constellation system tracks the handset's location, determines routes through a network of ground gateways, establishes the call path, initiates connections, and tracks the call. Appropriate income terminates. This activity provides global communication even if the shared location is unknown to the caller. The global communications network provides revenue to all parties to each telephone call, including the originating or terminating country. Due to worldwide licensing agreements, there is no getting away from independent territory. Iridium system phones use L-band frequencies, with frequency division multiple access and time division multiple access (Fdmntdma) for optimal use of limited spectrum. Other communication links use the Ehf and Shfbands for intersatellite and telemetry communications, command and control of satellites, as well as routing of digital voice packets to/from gateways. The Iridium phone enables the subscriber to connect to the local cellular infrastructure or to a space constellation in a method called "dual mode". This interoperability gives the Iridium system subscriber the best of the worlds of telephony, space and land: it also enables communication anywhere, anytime.

In the following:

In the continuation of this article, it will be explained as follows. Overview, surveying aspects, system description, ground infrastructure, gates, services, Summary of findings, Conclusions and suggestions.

definitions

Motorola pioneered the development of one of the world's first commercial Low Earth Orbit (Leo) systems for worldwide telephone service, providing telephone calling anywhere, anytime. Between 1987 and 1990, Motorola's visionaries created a new industry that predicted the continuous telephone.

Worldwide The original concept, depicted in 1988, consisted of 77 satellites networked together [l]. Hence, the name "Iridium" was chosen because the element iridium has atomic number 77 in the periodic table. After further design and performance optimization deals, this constellation was increased to 66 satellites with system control systems, gateways, inter-satellite links and handsets [2]. The first set of satellites will be launched in 1996 with the full operation of this constellation. The Iridium program received full Federal Communications Commission (FCC) authorization in January 1995 for construction and operation in the United States. Contracts have been signed with three separate launch providers in China (Great Wall Industries), Russia (Khronichev) and the United States (Mcdonnell-Douglas). The construction of the satellite bus is underway by Lockheed Martin. The original L-Band antenna mission is being completed by Raytheon, while Scientific Atlanta has delivered the ground terminal test bed to Chandler, Arizona. Motorola is assembling the electronic load of microprocessors, modems and digital switch converters. The prime contractor, Motorola's Satellite Communications (Satcom) division, will operate a revolutionary production line to assemble the spacecraft with a planned payload of 4. satellites every 22 days [3,4,5]. This process will commence in the fall of 1995.

Overview

The Iridium system (see Figure 1) uses a GSM-based (Groupe Special Mobile) telephony architecture to provide a digitally switched telephone network and global dial tone to call-and receive calls-from any place in the world. This global roaming feature is designed into the system. A subscriber will be assigned a personal phone number. He will also receive only one bill, no matter what country he visits, whenever a subscriber places or receives a call. The Iridium system determines the user location and in turn the network charges the appropriate rate for that location [6]. Besides voice traffic, Iridium will,

provide other services such as paging, data messaging, and facsimile [7,8]. The key system design feature is a constellation of low earth orbiting spacecraft interconnected with four crosslinks per satellite. By using the lower altitude in this revolutionary manner, path delay is minimized. The Iridium phones-

called Subscriber Units-will operate directly with the satellites or through the terrestrial cellular system. This "dual mode" capability enables low-cost service [7,8].

The Iridium project will have a satellite and network control facility in Land sdowne, Virginia with a backup facility in Italy. A third engineering control complex is at Motorola's Satcom location in Chandler, Arizona. This site will handle the first40 satellites before transferring full operations to the Virginia Center. It will utilize the tremendous availability of new computational tools to reduce the workload of the operations center personnel in a nontraditional approach. The remote stations, called tracking, telemetry, and control (TTAC)stations, are located in northern Canada, with backup stations in Iceland. One facility will provide both operational support of the global network and satellite constellation. Sixty-six operational satellites are configured in six near-polar orbital planes, in which 11 satellites circle in one plane. This allows Iridium to cover [7,8].

all areas of the Earth. The satellites are phased appropriately in co-rotating planes up one side of the earth, across the poles, and down the other side of the earth. The first and last planes rotate in opposite direction, creating a "seam." Co-rotating planes are separated by 31.6 degrees, and these am planes are 22 degrees apart. The orbits have a mean altitude of 780Kms.Full Earth coverage is the enabling factor behind the Iridium system. Three L-Band antennas forma honeycomb pattern of 48 beams below each satellite. As the satellite beam footprint moves over the ground, the subscriber signal is switched from one beam to the next or from one satellite to the next in a hand-off process. As the satellites approach the poles, their footprints converge and the beams overlap. Outer beams are then turned off to eliminate this overlap and conserve spacecraft power

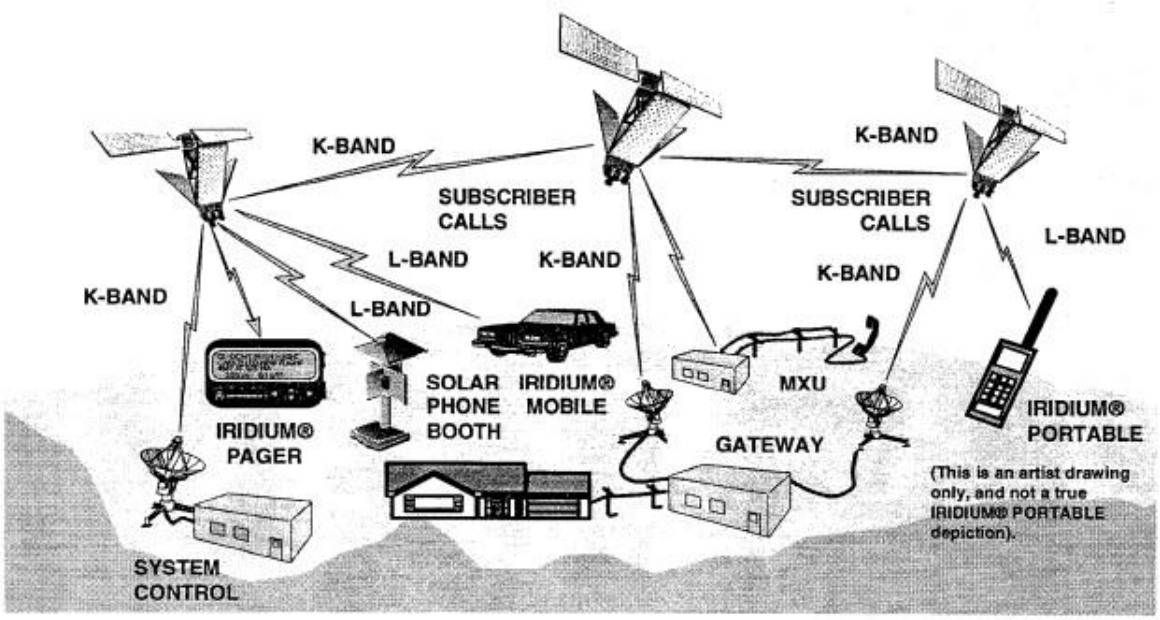

Figure 1. System Overview of Iridium

The telecommunication networking aspect using satellite crosslinks is the unique key to the Iridium system and is the primary differentiator from traditional transponder or "bent-pipe" systems (see Figure Iridium is the first mobile satellite system to incorporate sophisticated digital on-board processing on each satellite and the cross-link capability between satellites. The four-cross links, and the feeder links connecting satellites to gateways, operate at K-band frequencies. These intersatellite links, together with the gateway links, operate in packetized Time Division Multi plexing (Tdm) mode. The service links connecting subscriber units to the satellites operate in L-Band frequencies in the narrowband Tdmnfdm A mode [9].

Reaulatory Aspects

The U.S. Federal Communication Commission Band sharing in the 1,610 - 1,626.5 MHz bandMobile Satellite System spectrum cellular communications are assigned 5.15 MHz in the upper-end of this L-Band spectrum for Tdm/Fdma service band. Systems using the Code Division Multiple Access (CDMA) mode of access are assigned the remaining 11.35 Mhz of L-band spectrum for their service uplinks, and a proportionate amount of S-Band spectrum at2,483.5 to 2,500 Mhz for their downlinks. If on lyone Cdma system is put into operation, then the Cdma spectrum would be cut back to 8.25 Mhz. The remaining 3.1 Mhz of L-Band spectrum would then be assigned either to the Iridium system or to a new Tdmn/Fdma entry In January 1995, the Fcc issued a U.S. License to construct and operate a constellation of satellites called the Irid ium system, and two other systems in the Cdma mode. These two decisions have ensured that the global network can be launched and operated promptly with full operational capability during 1998[9].

Svstem Descrbtion

✓ Handsets. Subscriber units range from a portable phone to data modems or fax centers as well as pager units. They are similar to terrestrial models, with added features. For example, the telephone can be paged through the Iridium satellite system. The phone also works in dual mode, making it compatible with both local terrestrial cellular systems and the Iridium space system. When the terrestrial cellular system is not available, the Iridium dial tone is selected, since a satellite is overhead at all times. These phones will contain programmable features found in conventional portable phones such as storing phone numbers or call waiting. Furthermore, these units provide full-duplex voice and 2,400 baud operations, with direct ringing to the location of the phone.A vocoder is used for digital voice [10].

Spacecraft. Iridium satellites are long and slender, and triangular in shape, approximately two meters high, and weigh approximately 700 kg (see Figure 2). Three L-Band antenna panels provide the 48 beams of the footprint for subscriber communication (Figure 3). Each satellite has four,23 GHz satellite-to-satellite crosslinks to relay digital information around the globe. These crosslink antennas point to the nearest spacecraft in the same plane (fore and aft) and in the two adjacent co-rotating planes. "Feeder link antennas relay information to the terrestrial gateways and the System Control Segment earth stations. The spacecraft payload is the dominant element in the architecture, with high-speed digital switching handling complex telephony routing. Motorola's Satcom developed the payload, tested the routing of phone calls, and is producing payloads with the highest quality designed into the process [10].

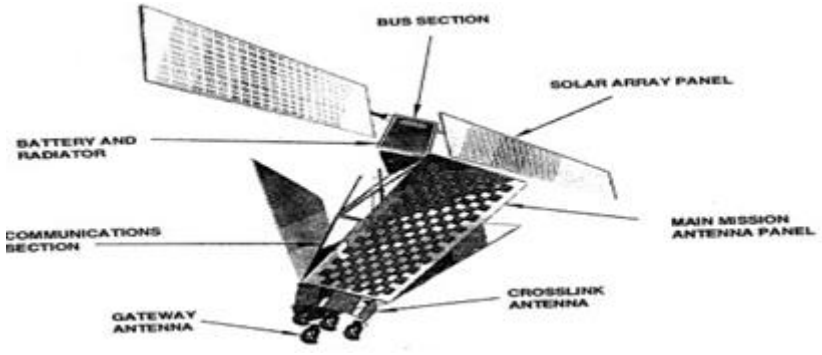

Figure 2. Satellite Subsystems

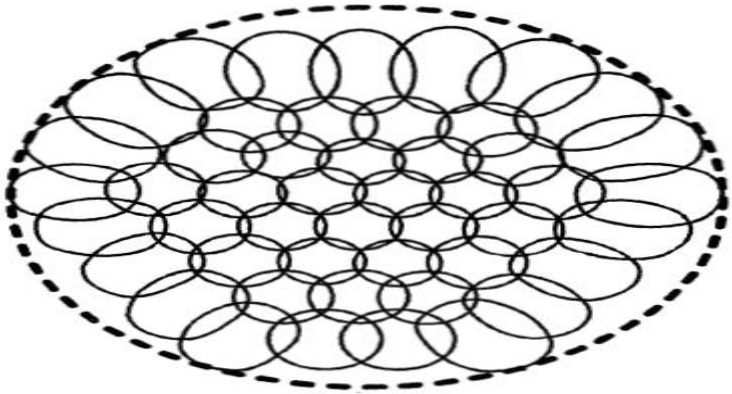

Figure 3. subscriber coverage

With 66 satellites in the constellation, there is a need for a high-quality production line assembly. Motorola, using key manu facturing technology with its partners, is establishing the first large-scale production line for satellite manufacturing. The commercially significant manu facturing appro aches, perfected in Motorola assembly plants around the world, will include quality in itiatives, continuous improvement processes, and cycle time reduction activities. This revolution in spacecraft manufacturing is being led by the innovators at Motorola's Samco Mproduction facility [10].

Communications Architecture

The L-Band communication service links operate in the 1,610 - 1,626.5 Mhz band. The to taloccupied bandwidth is 5.15 MHz. Modulation is quadrature phase shift key (QPSK). The maximum numbers of L-Band channels are 3,840, with right-hand circular polarization. Both uplinks and downlinks operate in the L-Band, using Time Division Duplexing (TDD)All K-B and links-uplink, downlink, and cross-links-are packetized Tdm/Fdma using QPSK modulation. These links use FEC rate1/2convolutional encoding with Viterbi decoding. Coded data rates are 6.25 Mbps for the gateways and satellite control facility links, with the cross links at a higher data rate of 25 Mbps. The frequency and s are listed below

- K-Band down-link 18.8 20.2 GHz
- K-Band up-link 27.5 30.0 GHz
- Crosslink 22.55 - 23.55 GHz

Both uplink and downlink occupy 100 Mhz bandwidths and use right-hand circular polarization. The intersatellite links use 200 MHz band width . with vertical polarization. Because cross links are used, the gateway Earth stations need only process the information designated to them. Crosslinks allow for reduced ground infrastructure requirements, enabling least cost routing, and permit full global coverage (in cluding the oceans) [10].

Ground Infrastructure

System Control Segment. The System Control Segment (SCS) manages the Iridiu Mcon stellation, in-cluding maintaining a telephony network infrastructure and as at ellitecon stellation (Figure 4). The primary function of the (SCS) is to manage the vast Iridium communications network. For example, one task is to reroute phone calls around a loaded crosslink. An addition a function of the System Control Facility is constellation maintenance, such as placing satellites in maintenance orbits, monitoring health and status, and maintaining and troubleshooting of malfunctioning satellites [10].

✓ Gateways. Figure 5showstheterrestrialgatewaysinterconnecting the Iridium constellation with the Public Switched Telephone Networks (PSTN). These gateways handle call setup and tear-down, posi-tion determination of the subscriber, and collect necessary data to support billing. Gateways use two to four 3.3meter antennas. Separation of the ground antenna terminals overcomes adverse effects of thun-derstorm cells that could interrupt service. At least two antenna terminals are needed with one always

acquiring the next spacecraft. Using the Groupe Special Mobile (GSM) telephone architecture and geographic-controlled system access, this total network permits [10].

Services

✓ Voice. Through the dual-mode telephones, the Iridium subscriber has use of both a localterre strial system (when available) and an Iridium spacecra ft overhead, 24 hours a day, to ring, page, or transmit calls. High-quality transmission provides quality digital voice service with lower time delays than found in geosynchronous satellite systems. Furthermore, the L-Band cellular links are designed for robust channels. Access to the Iridium satellite constellation is through Fdma/Tdma techniques, using a low-profile antenna. The subscriber unit itself is low-poweredas compared with current phones used in satellite-supported telecommunications. GSM protocol, combined with Iridium unique protocol, routes voice calls to the appropriate destinations [10].

✓ Paging. The Iridium system includes a global messaging service that delivers numeric or alphanumeric messages to paging units similar inform to the familiar pagers widely used today. The message delivery function uses Fdma/Tdma multi plexing to share the L-Band links with voice [10].

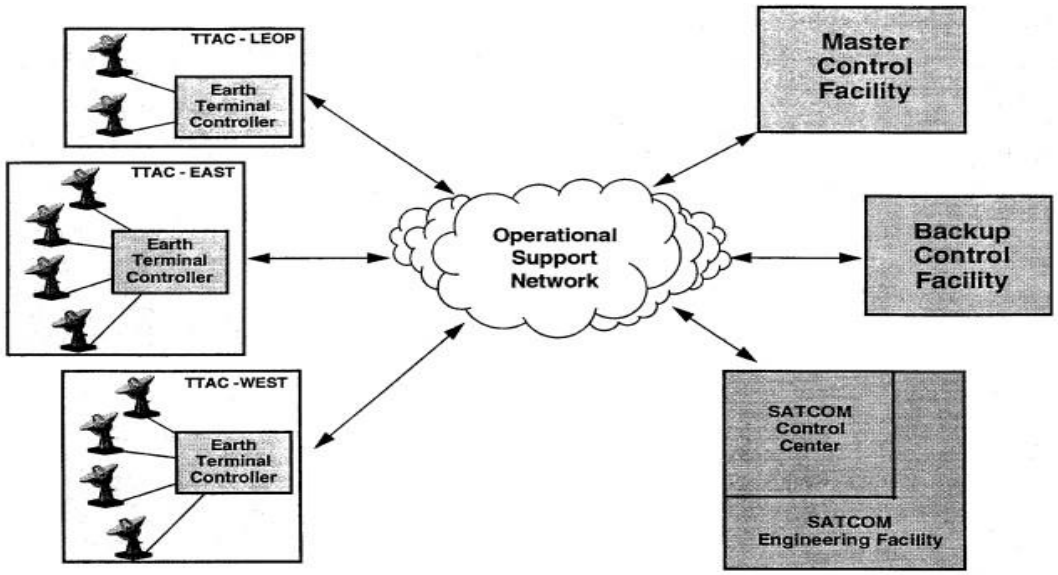

Figure 4. System Control Segment Infrastructure

and other Iridium services. For paging ransmission a spatial diversity is used to achieve high message character accuracy in the presence of fading and adverse pager unit orientation. The flexible message format accommodates variable-length messages as required by several different pager unit types. The messaging system infrastructure is used for certain supplementary functions, including notifying a subscriber that a voice-mail message is waiting. Other related supplementary services are message diversion, group messaging, and deferred mess a [10].

✓ Fax. The Iridium network can communicateGroup-3 facsimile messages. Faxes are for matted much like the digital voice packets using the same protocol and routing interfaces as the Iridium subscriber

units. Subscriber units will have a built-in data port for interface with an external fax unit. As an alternative, standard fax machines can bematched through Iridium hardware and protocol.

Ode ration Reliabilitv. Convenience And Flexibilitv's robust Iridium network design, along with global coverage and location determination, provides the convenience and functionality the user needs. The constellation of 66 satellites orbiting the Earth always provides a satellite in common view at any time of the day or night. Two-ground control facility with backup capability means reliability and integrity of thee tire Iridium system. With 48 beams per spacecraft, strong coverage is guaranteed. With a convenient worldwide voice and data service, subscribers can send faxes, data files and pages. A dial tone at any point in a land means intelligence, trust, communication. As an added incentive, all countries receive revenue from Iridium services used in their country. One concept that provides low-cost access to remote areas is the location of a solar-powered phone booth where electricity is not readily available. This very reliable phone service also helps dis aster relief with immediate, portable communication not dependent on local power or terrestrial telephony [10].

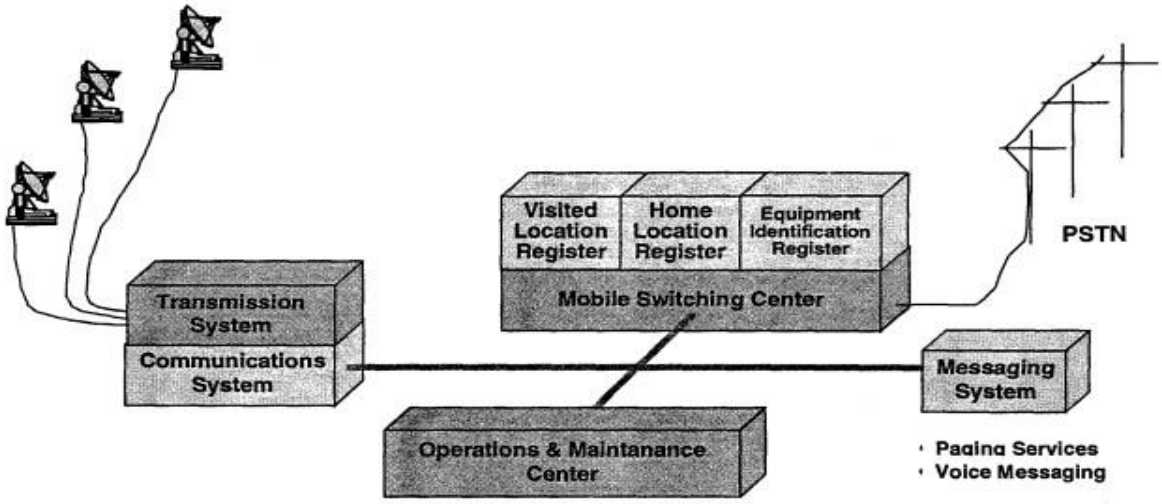

Figure 5. Gateway Subsystem Overview

Summary of findings

The Iridium communication satellite system is pioneering global digital satellite-based personal communications. Its principal mission is to provide portable telecommunications service through small subscriber units capable of working with either terrestrial cellular systems or the Iridium system. These subscriber units employ low-power phones with a low-profile antenna. Calls are transmitted and received throughout the world using L-Band frequencies in an Fdma/Tdma access system. Paging, fax, and data services are also available through the Iridium constellation. Intersatellite links provide "switching in the sky," relaying voice calls over the Earth. Most important is that the Iridium system is a vision of a portable, high-quality, worldwide digital communication system that will provide a dial tone anywhere on Earth.

The results

Conclusion and discussion

The result of this article shows that this communication satellite system is the pioneer of personal communication based on global digital satellite. Its main mission is to provide portable telecommunication services through small shared units capable of using terrestrial cellular systems. It should be noted that these common units use low-power phones with low antennas. Calls are sent and received using L-B and frequencies in an Fdma/Tdma universal access system. In addition, paging, fax and data services are also available through the Iridium constellation. Intersatellite links provide "change in the sky" and transmit voice calls to Earth. Most importantly, the content of this article explains that the Iridium system

is a portable, high-quality, universal digital communication system that provides telephone calls anywhere on the planet. Obviously this system can be useful, my findings agree with the findings of the researchers. And there is no difference.

Proposals

The use of personal communication satellite system based on digital satellite in the telecommunication center, the improvement of this system in providing portable telecommunication service sal learning.

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