

WIRELESS COMMUNICATION

TOPIC: IRIDIUM SATELLITE SYSTEM (ISS)

-THE ULTIMATE WIRELESS NETWORK



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THE IRIDIUM SATELLITE SYSTEM (ISS)

ABSTRACT: -

The credential part of the paper lies in the applications part where the application (forthcoming) of ISS as an alert system for **EARTHQUAKE** and **TSUNAMI** like natural disasters with which the casualties can be reduced drastically.

Every year thousands of people die because an earthquake catches them in a dangerous place or during a defence-less sleep. Here's an alert system that could warn before an earthquake strikes, or **TSUNAMI** blows.

Iridium is a satellite based wireless personal communications network designed to permit a wide range of mobile telephone services including voice, data, networking, facsimile, geo location, fax capabilities and paging. The Iridium project, which even sounds like something out of star wars, has its main objective to allow handheld mobiles to be used from anywhere on the planet, with the call being routed directly from handset to handset via one or several of the satellites. The iridium mobile telephone system is undoubtedly the Cadillac of mobile telephone systems. With complete coverage of the Earth's oceans, airways and Polar Regions,

Iridium delivers essential services to users who need communications access to and from remote areas where no other form of communication is available. With this system caller can call to any person, anywhere at any time in the world.

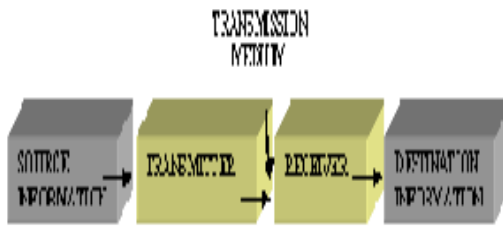
This paper unleashes the system facts such as the network coverage, satellite constellation of ISS system and its operation along with its advantages and applications. Last but not least the innovative application of ISS as **TSUNAMI**, **EARTHQUAKE** alert system is explained in brief.

INTRODUCTION: -

The fundamental purpose of an electronic communications system is to transfer information from one place to another. Thus, electronic communications can be summarized as the transmission, reception, and processing of information between two or more locations using electronic circuits.

TYPICAL COMMUNICATION MODEL:

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electronic devices or circuits that converts original source information to a signal that is more suitable for transmission over a given transmission medium. The transmission medium provides a means of transferring signals from a transmitter to a receiver. A receiver is a collection of one or more electronic devices or circuits that accept the transmitted signals from the transmission, medium and converts them back to the original form.

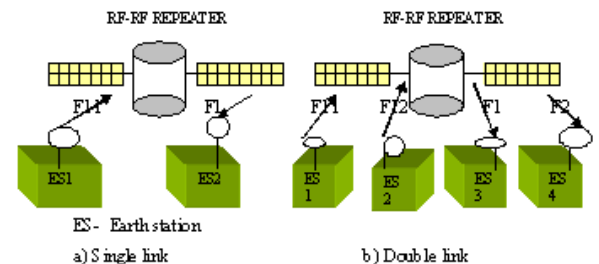
SATELLITE COMMUNICATION: -

A Satellite communication system consists of one or more satellite space vehicles (transponder), a ground based station to control the operation, and a user network of earth stations that provides the interface facilities for transmission and reception of terrestrial communications traffic through the satellite system. In essence, a communication

satellite is a microwave repeater in the sky that consists of a diverse combination of amplifier, receiver, transmitter, regenerator, filter, multiplexer, demultiplexer and so on.

A satellite communication system with single-channel satellite transponder can communicate with one transmitter and receiver i.e. each earth station can communicate with only one other earth station. To overcome this disadvantage multiple-channel satellite transponders are introduced. For multi-channel system, multiple carriers are used and to handle multiple channels and so multiple-accessing format should be established.

SATELLITE COMMUNICATION SYSTEM



PERSONAL COMMUNICATION

SATELLITE SYSTEM : -

Mobile satellite systems (MSS) provide the vehicle for a new generation of wireless telephone services called personal communications satellite systems (PCSS). The Personal Communication Satellite

System (PCSS) is the mother of the Iridium satellite system.

MSS satellites are, in essence, radio repeaters in the sky and their usefulness for mobile communications depends on several factors such as the space vehicle altitude, orbital pattern, transmit power, receiver sensitivity, modulation technique, antenna radiation pattern, and several other factors. Satellite communication systems have traditionally provided narrowband and wideband voice, data, video, facsimile, and net communicating via high altitude, geosynchronous earth_orbit (GEO), and satellites. Personal communications satellite services, however, use low earth_orbit (LEO) and medium earth_orbit (MEO) satellites that communicate directly with small, low power mobile telephone units. PCSS telephones will be able to make or receive calls at anytime, anywhere in the world.

HISTORY BEHIND ITS NAME:

The system is called iridium after the element on the periodic table with the atomic number 77, because iridium's original design called for 77 satellites. The final design, however, requires only 66 satellites.

OPERATION: -

The 66-vehicle LEO inter-linked satellite constellation can track the location of a subscriber's telephone handset, determine the best routing through a network of ground-based gateways and inter-satellite links, establish the best path for the telephone call, Initiate all the necessary connections, and terminate the call upon completion. The unique feature of iridium satellite system is its cross-links. With this two-way global communications is possible even when the destination subscriber's location is unknown to the caller.

The Iridium System is a satellite-based, wireless personal communications network to permit a wide range of mobile telephone services including voice, data, networking, facsimile, and paging, Virtually any destination anywhere on earth. allowing telecommunication anywhere, any time, and any place Each satellite is cross-linked to four other satellites; two satellites in the same orbital plane and two in an adjacent plane To relay digital information around the globe. The cross-link antennas point toward the closest spacecraft orbiting in the same plane and the two adjacent co-rotating planes. Feeder link antennas relay information to the

terrestrial gateways and the system control segment located at earth station.



IRIDIUM SATELLITE

CONSTELLATION: -

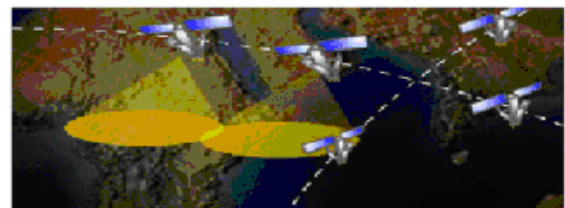
The Iridium system comprises three principal components: the satellite network, the ground network and the Iridium subscriber products including phones and pagers. Voice and data calls are relayed from one satellite to another until they reach the satellite above the Iridium Subscriber Unit (handset) and the signal is relayed back to Earth.

The Iridium constellation consists of 66 operational satellites and 14 spares orbiting in a constellation of six polar planes. Each plane has 11 mission satellites performing as nodes in the telephony network. The 14 additional satellites orbit as spares ready to replace any unserviceable satellite..

Iridium USES 66 operational satellites configured at a mean elevation of 420 miles above earth in six nearly polar orbital times of

100 min 28 sec. This allows iridium to cover the entire surface area of earth and whenever one satellite goes out of view of a subscriber a different one replaces it. The satellites are placed appropriately in north south directions forming co-rotating planes up one side of earth, across the poles, and down the other side. The first and last planes rotate in opposite directions, creating a virtual beam. The co-rotating planes are separated by 31.6 degrees and the beam planes are 22 degrees apart.

Iridium Satellite Cross-Links



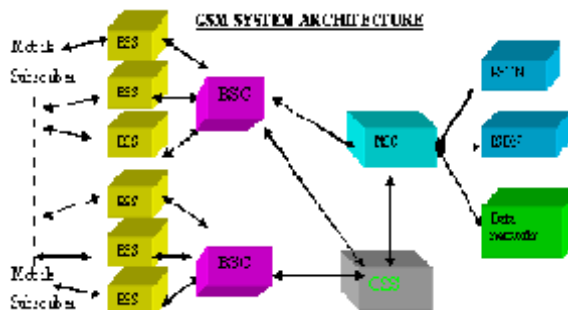
GLOBAL COVEARGE OF ISS: -

Each satellite is equipped with 3 L-band antennas forming a honeycomb pattern that consists of 48 individual spot beams with a total of 1628 cells aimed directly below the satellite. As the satellite moves in its orbit, the footprints move across earth's surface and subscriber signals are switched from one beam to the next or from one satellite to the next in a handoff process. When satellites approach the north or South Pole, their footprints converge and the beams overlap.

Outer beams are then turned off to eliminate this overlap and conserve power on the spacecraft. Each cell has 174 full duplex voice channels for a total of 283,272 channels worldwide. The satellites are in a near-polar orbit at an altitude of 485 miles (780 km). They circle the earth once every 100 minutes traveling at a rate of 16,832 mph. This constellation ensures that every region on the globe is covered by at least one satellite at all times

IRIDIUM SYSTEM ARCHITECTURE: -

The iridium uses GSM-based telephony architecture to provide a digitally switched telephone network and global roaming feature is designed in to the system. Each subscriber is assigned a personal phone number and will receive only one bill, no matter in what country or area they use the telephone.



SYSTEM LAYOUT: -

The ground network is comprised of the System Control Segment and telephony gateways used to connect into the terrestrial telephone system

It provides global operational support and control services for the satellite constellation, delivers satellite-tracking data to the gateways, and performs the termination control function of messaging services. The System Control Segment consists of three main components: 4Telemetry Tracking and Control sites, the Operational Support Network, and the Satellite Network Operation Center. The primary linkage between the System Control Segment, the satellites, and the gateways is via K-Band feeder links and cross-links throughout the satellite constellation. Subscriber telephone sets used in the iridium system transmit and receive L-band frequencies and utilize both frequency and time division multiplexing to make the most efficient use of a limited frequency spectrum. Other communications links used in iridium include EHF and SHF bands between satellites for telemetry, command, and control, as well as routing digital voice packets to and from gateways.

Iridium gateways are prime examples of advances in satellite infrastructures that are responsible for the

delivery of a host of new satellite services. The purpose of the gateways is to support and maintain roaming subscribers as well as to interconnect iridium subscribers to the public switched telephone network. Gateway functions include the following:

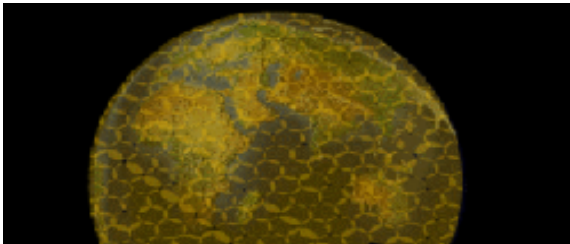
1. Set up and maintain basic and supplementary telephony services.
2. Provide an interface for two-way telephone communications between two iridium

Subscribers and iridium subscribers to subscribers of the public switched telephone Network.

3. Provide iridium subscribers with messaging, facsimile, and data services.
4. Facilitate the business activities of the iridium system through a set of cooperative mutual agreements.

IRIDIUM SATELLITE NETWORK COVERAGE:

IRIDIUM SYSTEM SPOT BEAM FOOTPRINT PATTERN



Each satellite is equipped with 3 L-band antennas forming a honeycomb pattern that consists of 48 individual spot beams, with a

total of 1628 cells aimed directly below the satellite as shown in above figure each of the spot beam approximately measuring around 30miles or 50k.m. As the satellite moves in its orbit, the footprints move across earth's surface and subscriber signals are switched from one beam to the next or from one satellite to the next in a handoff process. When satellites approach the North or South Pole, their footprints converge and the beams overlap. Outer beams are then turned off to eliminate this overlap and conserve power on the spacecraft. Each cell has 174 full-duplex voice channels for a total of 283,272 channels worldwide.

FREQUENCY PLAN AND MODULATION: -

All ka-band up-links and cross-links are packetized TDM/FDMA using quadrature phase shift keying and FEC1/2 rate convolutional coding with viterbi decoding. Coded data rates are 6.25 Mbps for gateways and satellite control facility links and 25 Mbps for satellite cross-links. Both up-link and downlink transmissions occupy 100MHZof bandwidth and inter-satellite links use 200MHZ of bandwidth. The frequency bands are as follows:

L-band subscriber to satellite voice links=1.616GHZ TO 1.6265GHZ

Ka-band gateway downlinks=19.4 GHZ to 19.6GHZ.

Ka-band gateway up-links=29.1GHZ to 29.3GHZ

Ka-band inter-satellite cross-links =23.18GHZ to 23.38GHZ

Comparison between iridium and traditional satellite systems: -

- ∅ Using satellite cross links is the unique key to the iridium system and the primary differentiation between iridium and the traditional satellite bent pipe system where all transmissions follow a path from earth to satellite to earth.
- ∅ Iridium is the first mobile satellite to incorporate sophisticated, onboard digital processing on each satellite.
- ∅ Entire global coverage by a single wireless network system.
- ∅ Only provider of truly global voice and data solutions.
- ∅ With this system the subscriber will never listen a message called "OUT OF COVERAGE AREA"

This list provides just a few of absolutely inexhaustible list of comparisons.

ADVANTAGES: -

Iridium Satellite Advantages and Benefits



Advantages

- * Satellite Cross-links
- * Digital Network
- * Signal Strength
- * GSM Platform Based
- * Global Paging

Benefits

- * Global Coverage
- * Consistent Quality
- * Reliability
- * Total communication system
- * Robust features and functionality
- * Always in touch

Iridium provides a total global communications solution!

- ∅ Less reliance on wire-line networks
- ∅ Continuous talk time
- ∅ Fewer outages
- ∅ Don't need to be in the in the same footprint as the gateway

DISADVANTAGES: -

- ∨ High risk associated with designing, building, and launching satellites.
- ∨ High cost for the terrestrial-based networking and interface infrastructure.
- ∨ low power, dual mode transceivers are more cumbersome and expensive

APPLICATIONS: -

- √ Fixed cellular telephone service
- √ Complementary and back up telephone service in fields of:
 - ∅ Retail
 - ∅ Manufacturing
 - ∅ Military
 - ∅ Government
 - ∅ Transportation
 - ∅ Insurance
 - ∅ Finance

FORTH COMING APPLICATION:
EARTHQUAKE and TSUNAMI ALERT THROUGH ISS:

Earthquakes and Tsunamis strike without warning. The resulting damage can be minimized and lives can be saved if the people living in the earth quake-prone area are already prepared to survive the strike. This requires a warning before the strong ground motion from the earthquake arrives. Such a warning system is possible because the energy wave released at the epicenter travels slower (at 3.5 to 8km/s) than light.

The warning signal from the earthquake or tsunami epicenter can be transmitted to different places using the satellite communication network, fiber-optics network, pager service, cell phone service or a combination of these. The satellite based

wireless network such as ISS is idle if system has to cover a large continent like ASIA.

For EARTHQUAKE, TSUNAMI-prone countries like Indonesia, Japan seismic alert system using the ISS network spread throughout the earth is proposed here. This system does not try to find the epicenter or the fault line caused by the earthquake.

PRINCIPLE:

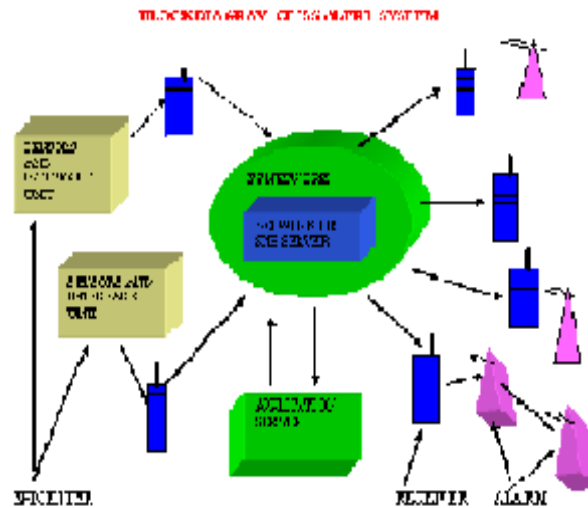
Energy waves released travel slower than light waves .It simply monitors the earth vibrations and generates alert signal when the level of earth vibrations crosses a threshold.



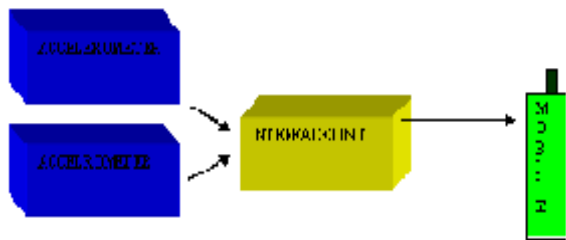
COMMUNICATING THE DANGER:

This GSM-based ISS alert system monitors the earth vibration using a strong motion accelerometer at the earthquake-prone area and broadcasts an alert message to towns and villages through the cell phone network existing throughout the state. Here wireless mobile phones (ISS phones) are used as transmitter and receivers.

The communication system for earthquake alert comprises an earthquake Sensor and interface unit, decision system and alert-dissemination network.



BLOCK DIAGRAM OF EARTHQUAKE ALERT SYSTEM



After receiving alert, a middle-aged person takes 30 to 40seconds to go down the stairs from fifth floor and 65 to 80 seconds from tenth floor. If it takes a minimum of 10 seconds to damage a poorly structured house, this 10 seconds too can be consider for going to safer place. If we consider these points, giving earthquake alert before the actual occurrence of earthquake can minimize casualties. Time to alert is critical. But in generating the alert quickly, there are

possibilities of false alarm. In the system proposed here, an attempt has been made to reduce the possibility of false alarm. Still, the system needs to be simulated and validated before putting into practice.

CONCLUSION: -

Commercial point of view:

Availability of services and early subscriber take-up will be the key to survival for operators. Lower infrastructure costs will further help in early break-even and profitability for network operators. Equipment vendors should therefore focus on making available cost effective solutions for providing a wide range of services to attract both business and non-business users. Evolution, not revolution is the only way to get to the market earl and with the lowest cost.

Economic point of view:

Since the satellites has already been launched it is important that this system is applied as much as possible. Innovative Applications like “seismic alert of earthquakes and tsunami” should be brought out which serves the real purpose of being an engineering application. Government should also play a major role to get these services close towards ordinary man and should play its part in providing its citizen the best possible communication system in the world.

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1. www.gmpcs-us.com
2. www.iridium.com

ANNEXURES:

Iridium Tools:

DATA KIT



MXU 2000



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