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Introduction to inmarsat broadband global area network for mobile backbone networks

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Article Info	ABSTRACT
	In this paper is introduced the Inmarsat Global Area Network (GAN) as backbone to mobile networks. At the end of 2005 Inmarsat launched its BGAN service as the first high speed wireless data solutions with voice available on a global basis. The service is accessed through a portable, broadband satellite transceiver with antenna easy to carry as a laptop. The BGAN network consists constellation of Geostationary Earth Orbit (GEO) I-4 and I-5 satellites with an optimized ground network, which interconnects variety of terrestrial infrastructures at local BGAN users. This system employs bandwidth efficient modulation and coding techniques, capable of supporting variable bit-rate services and QoS depending on the needs of the application. The BGAN system is satellite component of 3G IMT-2000, specially the Universal Mobile Telecommunications Service (UMTS) standards. It will provide a near-global coverage overlay for the terrestrial networks, giving users service availability beyond the reach of terrestrial IMT-2000 networks. A range of supported terminals, personaldevices, portable and mobile units linked with onboard entertainment, communications systems to remote base stations for civilian and military applications and SCADA or M2M are discussed.

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1. INTRODUCTION

Inmarsat was the first international and nongovernmental Mobile Satellite Communications (MSC) operator and is still the only one to offer a mature range of modern communications services to maritime, land, aeronautical and other mobile or semi-fixed users. Founded in 1979, the keystone of the Inmarsat strategy is that since 2004 is supporting the Broadband Global Area Network (BGAN), which provides up to 492 Kb/s Voice, Data and Video (VDV) including Internet access for mobile, fixed and portable multimedia and many others advanced applications.

Inmarsat as a largest satellite communications provider for all mobile solutions has developed BGAN models for global business solutions known as an Inmarsat-M4 system. With the appropriate software and hardware M4 service supports all mobile data and Integrated Services Digital Network (ISDN) solutions up to 64 Kb/s and Internet Protocol (IP) up to 492 Kb/s including secure encryption (STU III/STE) system important for corporate and military communications, and extend fixed or mobile office such as a LAN, Internet and ISDN/PSTN in remote areas using multimedia semi-fixed GAN (Global Area Network) at first and BGAN (Broadband GAN) portable utilization later. The BGAN system provides a range of IP and VDV solutions covering almost all of the world land mass for civilian and military satellite communications,

telephone, newsgathering, videoconference, Internet, SCADA monitoring and broadcasting in all remote environments.

The BGAN service is ideally suited to the following types of organizations:

a. Those devices are operating in remote and rural regions, including onboard all mobiles and for SCADA solutions.
b. Those devices are designed rapidly to set up temporary urban or remote offices for corporate and government applications.
c. Those devices can be used by individuals and as well as organizations with employees that travel regularly countrywide or worldwide.
d. Those devices will serve organization requiring backup or additional capacity at any urban or suburban site globally.

Therefore, BGAN offers broadband type data rates and effectively enables staff to replicate their remote or mobile office environment out in the field. The BGAN service supports a number of applications, including all current Windows, Mac OS 10.1 onwards and Linux [1-4].

2. INMARSAT M4 SERVICE

Inmarsat M4 incorporates industry-standard ISDN and IP interfaces and offers users a choice of two ways of sending and receiving data: Mobile ISDN and Mobile Packet Data Service (MPDS). Each method has its own advantages, the high quality and speed of ISDN, the considerable cost-effectiveness and flexibility of IP, and the choice depends on what the user is aiming to achieve. The ISDN solution is the International Telecommunication Union (ITU) term for the digital public telecommunications network. The 64 Kb/s data service supports applications between ISDN terminals using ISDN protocols such as V.120 or X.75. It will support any 64 Kb/s data stream and is the service used for implementing ISDN mobile applications, such as videoconferencing, LAN routing, file transfer, broadcast-quality audio transmissions and secure telephony. However, the Mobile ISDN service provides full-time use online of a high-capacity channel capable of carrying a constant data stream.

The service is accessed primarily through the RJ-45 connector and therefore up to eight multiple ISDN devices can be attached to the BGAN. A Point-to-Point Protocol (PPP) modem data service, suitable for data file transfer, E-mail or Internet access, may also be available via an RS-232, USB or infrared port. Users are charged by the length of time this dedicated channel is allocated, so to provide connection ISDN call typically takes less than five seconds. Because of the global growth of ISDN, a whole range of telecommunications applications that were once the domain of large corporations has now become cost-effective and easily available to even the smallest of businesses in remote and mobile environments.

The MPDS enables terminal to become simply connected to the Internet and user is only charged by the amount of sent and received data, rather than by how long the application takes or how long they are connected. The mobile IP is a perfect solution for many applications such as Web browsing, E-mail sessions, E-solutions, database enquiries, IP/LAN connectivity, Intranet access, etc. The MPDS standard has been developed to provide transfer of packet data over Inmarsat networks, thereby giving users more efficient and flexible data transmission models. It operates on 64 Kb/s satellite channel, in both directions transferring High Speed Data (HSD) via the following configurations: 1. Videoconferencing; 2. Voice over Internet Protocols (IP); 3. PC and Local Area Network (LAN) Access; 4. Mobile Multimedia and Broadband; 5. Store-and-Forward Video; and 6. Voice and Audio Broadcast [5-8].

3. BROADBAND GAN (BGAN)

The BGAN solution is a near global Satellite Internet and Multimedia Network with telephony using portable or mobile terminals. The BGAN terminals are normally used to connect a laptop or palmtop PC to broadband Internet in remote locations, although as long as line-of-sight to the satellite exists, the terminal can be used anywhere. The value of BGAN terminals is that unlike other satellite Internet services which requires bulky and heavy satellite dishes to connect, a BGAN terminal is about the size of a laptop and thus can be carried easily in the beg or vehicle in the rural and remote environments.

The network is deployed by Inmarsat satellite operator and uses GEO I-4 and I-5 satellites to provide almost global coverage. The main two capabilities that apply to basic BGAN usage are the Standard Background IP and Voice, which data costs that offer BGAN service is about 7.50 US$ per Background Megabyte. Voice calling is on average 1 US$ per min and varies slightly based on the destination of the call using Land lines, Cell phones, other Satellite phones which are the most expensive. The BGAN network is currently the fastest global data link available via a portable terminal.

It can be easily set up by anyone, and has excellent voice calling quality. It works on the L-band, avoiding rain fade and other issues of traditional larger satellite systems.
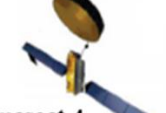
The BGAN standard IP service supports both Circuit Switched (CS) and Packet Switched (PS) voice and data service and depending on the BGAN terminal IP offers interactive (send and receive) data rates of up to 492 Kb/s (maximum bearer rate) over a best effort of shared connection. Streaming IP interactive rates are 32, 64, 128, 176 and 256 Kb/s, ISDN data rate is 64/56 Kb/s ISDN and Global Voice up to 4 Kb/s (Uses included 2-wire phone) or 3.1 KHz Audio, Data up to 64 Kb/s. The Supplementary Voice services is SMS with 160 characters, Voicemail, Call waiting, Call barring, Call hold and Call forward over 4 Kb/s circuit-switched Voice service and can be performed via a peripheral handset or headset.

This network is providing access via Inmarsat I-4/I-5 satellites on L-band frequency using Transmitter (Tx) at 1626.5-1660.5 MHz and Receiver (Rx) 1525-1559 MHz, full-duplex operation (send and receive with bearer bandwidth of 200 kHz. Power Options of BGAN are single BA-5590 style battery, 120/240 AC power supply and standard vehicle DC adapter. Otherwise, BGAN is able to access three models of the Radio Access Network-Core Network (RAN-CN) interface in IMT-2000 networks. The File Transfer Protocol (FTP) is used to transfer files between computers on a network. The FTP mode can be employed to exchange files between computer accounts, transfer files between an account and a desktop computer, or access online software archives. BGAN is completely secure and supports all major Virtual Private Networks (VPN) products and encryption standards. Mobile Broadband Internet, which is portable, compact and lightweight and can be carried as easily as a laptop. Terminals can be connected quickly and easily to multiple laptops via wired or wireless connections, including Bluetooth or WiFi, depending on the terminal. Terminals can be used indoors (via external antenna) and outdoors and are robust enough to withstand challenging environments and extremes of temperature [6, 9-11].

3.1. Space and ground segment of bgan network

The Inmarsat satellite network is providing service for mobile and semifixed users via GEO constellation and ground segment to the fixed of the Terestrial Telecommunication Network (TTN). The ooperational satellite look angle or elevation of BGAN equipment has to be at least 5° from the Horizon, which is fixing manually until 90°. In Table 1 is shown comparison of Inmarsat satellite main parameters for I-4/I-5 and previous ceased I-2 and I-3 constellations.

Table 1. Comparison of inmarsat satellites main parameters

Inmarsat Satellites	No. Satellite-Band	Coverage/Band	Mobile Link EIRP	Channellization	S/C Dry Mass	Solar Array Mass
Inmarsat-2	4 – L/ -band	1 Global Beam	39 dBW	4 Channels (4.5 to 7.3 MHz)	700 kg	14.5 m
Inmarsat-3	5 – L/C-band	7 Wide Spots 1 Global Beam	49 dBW	46 Channels (0.9 to 2.2 MHz)	1000 kg	20.7 m
Inmarsat-4	2 + 1 – L/C-band	228 Narrow Spots 19 Wide Spots 1 Global Bema	67 dBW	558 Channaels (EOL) (200 KHz)	3340 kg	45 m
Inmarsat-5	4 – Ka-band	69 Wide Bands 6 Stearable Spots 1 Global Beam	77 dBW	72 CH (Forward) 72 CH Return)	6100 kg	33.8 m

The Inmarsat BGAN Network currently is using GEO I-4 and I-5 satellite constellations as a Space Segment. Inmarsat-4 Global beam coverage is shown in Figure 1, and Spot beam coverage in Figure 2. The existing three global beams of Inmarsat I-4 and I-5 satellite constellations provide overlapping coverage of the whole surface of the Earth apart from the Poles and in this way it is possible to extend the reach of terrestrial wired and cellular networks to almost anywhere on Earth. However, Spot beams concentrate

extra power in small areas of high demand as well as making it possible to supply standard services to smaller and simpler terminals.

Operator can use the BGAN terminal signal quality indicator lights for pointing if is approximately known the direction to the GEO satellite. Otherwise, to provide detailed pointing instructions you can be used the BGAN LaunchPad pointing wizard. In addition, can be used the compass to pointing the terminal in the correct direction. However, as with all GEO satellite connections, latency is an issue. Common latency is 1–1.5 seconds round trip for the Background IP service. It is slightly better for the Streaming services at 800 ms – 1 second. This latency is mainly due to the great distance that has to be traveled before a packet can reach the Internet, but is slightly exacerbated by the back-end technology, as normal latency over a VSAT system is roughly 550ms. BGAN users frequently use PEP software or other TCP packet accelerators to improve performance [6, 12-15].
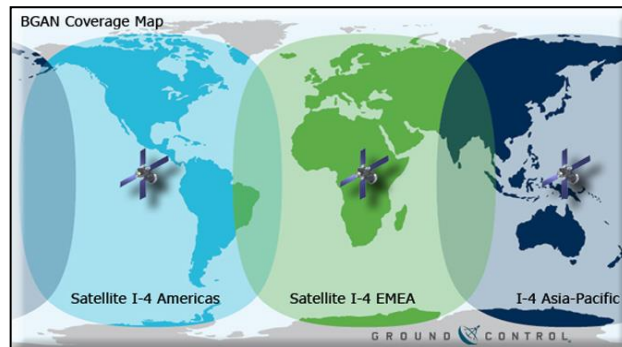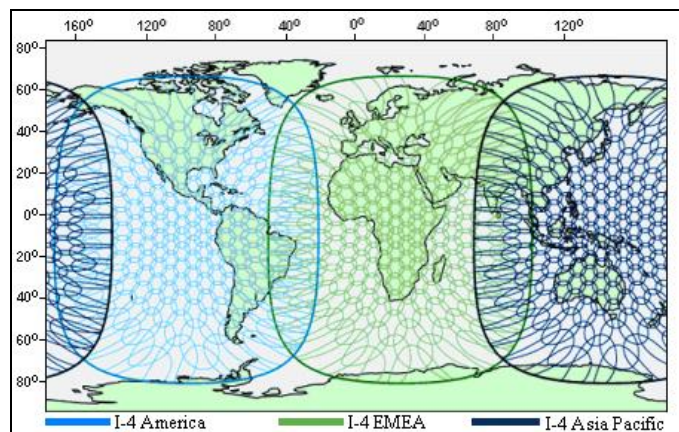

Figure 1. Inmarsat-4 global beam coverage

Figure 2. Inmarsat-4 spot beam coverage

The part of BGAN Ground Segment are illustrated in Figure 3, such as M4 Portable and Vehicular BGAN equipment linked to the Corded Videophone, Portable Videophone, Wireless Video Source and optional Encryption Device. The BGAN unit is connected via Inmarsat I-4/I-5 Spacecraft to the Ground Earth Station (GES), which is interfaced to the ISDN Telephone Network of TTN. The Portable BGAN can be linked in LAN via Bluetooth or WiFi with Handset, Videoset, Headset, Videocamera and Laptop or Palmtop, while can be connected with corded line with Laptop, Handset and optional Encryption device, shown in Figure 4.

The portable or vehicular BGAN equipment can be simultaneously connected in semi fixed or mobile LAN infrastructure to several hardware configurations such as: Voice solution (ISDN phone, Cordless phones and Voice over IP-VoIP); Remote corporate office or Rural household solution (Fax, PC Laptop and Cordless phones); Videoconferencing solution (Videophone over IP–VPoIP, Videoconference over IP-VCoIP and Web camera set); and Multimedia solution (PC, Video Camera and Cordless phone); so at this point, they are both TES multimedia solutions are compatible with the Inmarsat mini-M standard and service.

The BGAN equipment can be employed for the following solutions: tourism, agriculture, mining, surveying, oil and gas, construction, Asynchronous Transfer Mode (ATM) and banking, emergency and disaster response, news gathering, broadcasting, industry, exploration, mobile office, onboard all mobile applications, E-solutions, surveillance, distance monitoring and control, law enforcement, homeland security, defense and tactical management and so [6, 16-18].

Figure 3. Mobile BGAN ground segment

Figure 4. Portable BGAN LAN solution

3.2. Type of BGAN terminals and service

The Inmarsat BGAN is a new true revolutionary communications system that enables customer to make telephone calls, to surf the Web, send E-mail and transfer a host of data from anywhere within the satellite footprints. This is a go-anywhere wireless packet data service, based on the IP offering mobile and fixed high-speed access to the Internet, Web and computer networks, LAN via a small, lightweight portable satellite IP Modem, in size to a notebook PC. Because the service is based on IP, corporate it is particularly suited to applications where data is sent in short bursts, such as E-mail, browsing the Web, and connecting to corporate LAN and Intranets.

Other BGAN applications include File Transfer and File Transfer Protocol (FTP) for downloading files from the Internet, sharing files with colleagues, as well as Web E-commerce, for online ordering and procurement and secure end-to-end connectivity over a corporate VPN. In this sense, if is running as a secure and shared 144 Kb/s rate channel, BGAN operates at more than twice the speed of current ground General Packet Radio Service (GPRS) cellular phones. Thus, it is based on MPDS IP packet technology, so users only pay for the amounts of data they send and receive, and not for the amount of time spent online such as ISDN mode.

In fact, these Inmarsat solutions enable all users to stay always connected and stand-buy on the Internet Web using a valid SIM card inserted in the BGAN Satellite IP Modem. Hence this SIM card may be activated and used in other GPRS mobile devices for roaming between networks. The portable Football BGAN Satellite Terminal shown in Figure 5 is practical and easy to carry unit anywhere and anytime remotely. In Figure 6 are shown an optional solar panel to recharge the Football in a no-power location with its carrying bag. It can be used a variety of compact solar solutions from 35 to 55 watts, which will charge the BGAN unit in 6 hours of direct sunlight.

Figure 5. Transportable BGAN for rural areas

Figure 6. Solar panel set with carrying bag

In Figure 7 is depicted BGAN transportable terminal produced by Harris manufacturer that can be used in a vehicle applying own or its power supply, and in Figure 8 is illustrated the same model that can be deployed for military or enforcement applications [6, 14]. In Figure 9 is shown the same model of BGAN unit deployed onboard boats, small ships or in remote office, which provides simultaneous voice, broadband data access applications and make a phone call at the same time via a Bluetooth handset or standard desktop phone [6, 15].

Figure 7. Transportable BGAN for civilian applications

Figure 8. Transportable BGAN for military applications

Figure 9. Transportable BGAN for mobile applications

In Figure 10 is depicted BGAN vehicular terminal also produced by Harris manufacturer that can be installed in any car, truck and bus applying vehicle power supply. The same equipment can be installed in railway locomotives as well, to provide communication and signaling service. However, in Figure 11 is illustrated the same mobile BGAN model installed onboard vehicle and antenna on the roof. Composed of three units: a transceiver, an IP handset and an antenna, the Harris BGAN transceiver provides on the move high-speed Internet and phone networks access. The Inmarsat BGAN service supports the commonly used network and mobile Internet applications providing continuity to professionals' sites and working lives way beyond the boundaries of the urban office:

a. Instant Remote Access-Being able to access the corporate or military LAN infrastructure at any time and to maintain productivity or different information levels from anywhere within the satellite coverage area of BGAN.

b. VPN Connectivity-Connecting to a wide range of corporate or government Virtual Private Network (VPN) ensures end-to-end access to secure information at high speeds.

c. High-Speed Internet Access-The Regional BGAN service enables reliable and fast access to Internet Web content and resources at any time and any place inside of satellite coverage area. In reality, all mobile or fixed users can be connected to Internet roaming within remote and mobile environments.

d. Store and Forward Video-Fast and convenient, in the other words, no other mobile wireless service can deliver comparable speed and simplicity.

e. Remote IT Support-Perform all kind of PC software upgrades and runs different diagnostic tasks remotely.

f. Digital Image Transfer-With BGAN is possible to send and receive scanned images of documents and high-quality digital pictures.g). E-commerce-The recently developed Inmarsat mobile packet data service is ideal for exploiting much other opportunities provided by E-commerce to engage business transactions with total security in urban and rural environments.

g. E-mail-As a backbone of business and corporate multimedia satellite communication, E-mail solution in remote and rural industrial environments is crucial to the efficient functioning of business users, who can be in touch with all parties by sending or receiving information as required.

h. Database Queries – This very important corporate information is safely housed in corporate databases for immediate accesses to such data stores and is crucial to obtain promptly important business-critical information for planning, research and development and customers records, among other data.

Figure 10. Vehicular BGAN with Components

Figure 11. Mobile BGAN unit onboard vehicles

The Inmarsat BGAN will use very small, light portable Satellite IP Modem, which size is similar to notebook PC, measuring approximately 200x140 up to 350x300 mm, and with weighing about from 1 up to 3 kg. In fact, this revolutionary satellite transceiver was one of the first innovations from Inmarsat as a world leader in mobile wireless business communications via satellite. It is a wireless packet data service based on IP standard, which offers mobile, high-speed access to the Internet and corporate IT networks via a small, lightweight portable, transportable, fixed or vehicular Satellite IP Modem. Besides, fully autonomous tracking antenna acquires and tracks the BGAN satellite signal while on the move.

In Figure 12 is shown prototype of Inmarsat BGAN satellite terminal which components includes: (1) Integral antenna; (2) Compass; (3) SIM card; (4) Battery; (5) External power; (6) USB (Universal Serial Bus); and (7) Indicators. Besides, Figure 5 (B) shows control panel items such as: (1) Power switch on/off control button; (2) Interface control button; (3) Power indicator; (4) USB indicator; (5) Ethernet indicator;

(6) Bluetooth indicator; and (7) Battery indicator, while Figure 13 illustrates the Inmarsat BGAN IT satellite modem ready: "To take a way and use".

Figure 12. Components of the BGAN IP modem

Figure 13. Prototype of the BGAN Satellite IP modem

They turn simply on the power, open the lid of the device and point it at the GEO satellite. A high capacity battery and charging system will power the unit, while supply can also be used from an 110/220VAC 50/60Hz power source. The battery is designed to provide 1 hour of continuous communication operation at peak rate and 24 hours in standby mode. The IP Modem must be located so that it has unobstructed view of the satellite. It is supplied with an integrated GPS antenna and receiver to enable the user to position the Satellite IP Modem correctly.

This unit is connected to any standard PC or handheld Personal Digital Assistant (PDA). Users access the Internet and other network services in the usual way, through the familiar Microsoft Windows software interface or Macintosh v10.1, where they can run standard PC applications, such as E-mail packages and Web browsers. However, connection can be by USB, with a cable length up to 5 m, and by Ethernet, providing connectivity to LAN with cable lengths less than 100 metres, or by Bluetooth or WiFi access, simply offering state-of-the-art wireless connection within a 10-metre range. Otherwise, for USB and Bluetooth access, the PC software installation will create a Dial-up Network (DUN) access for device known as a mobile Inmarsat Satellite IP Modem [6, 19-21].

4.   SATELLITE SCADA OR M2M OVER BGAN

The BGAN terminal products of Harris, Hughes, Wideye or other manufacturers can be used for the direct point-to-multipoint broadcasting of satellite Machine-to-Machine (M2M) or Supervisory Control and Data Acquisition (SCADA), which automatic sensors may report regularly back to the control ground centres via satellite links, shown in Figure 14. All sensors of remote cites shown on the left side of this figure can be connected via BGAN, satellite, GES, Application Server and VPN Internet to the end users in some corporate or government control office.
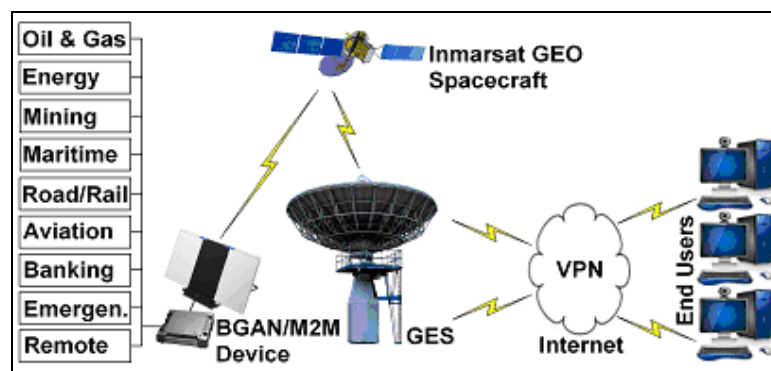

Figure 14. Implementation of BGAN for SCADA applications

There is a facility to send data messages of up to 2000 bits together with one of four alert signals may be sent as a single message. The technology for remote control and data acquisition extends to the remote and rural environments for efficiently, gathering management data and guarding against any kind of catastrophic failure, all without overspending on expensive technical labour and travel is a tougher challenge. These small terminals are very effective way of remotely collecting and broadcasting basic environmental industrial and corporate data such as for:

a. Radiation Leak Alerting-Nuclear power stations can use SCADA to monitor waste storage sites, shipments and provide an instant alert so that a potential leakage can be averted. A leak of radioactive material is very poisonous and long lasting the most feared forms of pollution.

b. Industrial Process Control-SCADA equipment allows controlling many important variables such as temperatures, liquid chemical flow rates and emission levels.

c. Pipeline Monitoring-Oil and gas pipelines (electricity power lines) can run for few hundreds of kilometers, crossing national frontiers as they go, which can be vulnerable to acts of nature and human malice. SCADA monitors of key operating data, transmission and confirmation of commands by remote control centres, wellheads and pumping stations in support of oil and gas distribution.

d. Water Resources Requirement-SCADA way control and monitoring installations at remote reservoirs and on pipelines can give early warning of new leaks, and allowing repair work to be started promptly at the right place and with the right resources. Hence result is minimum loss of water, an economical repair and less pressure to increase charges to water users.

e. Automatic Reporting for Ships and Vehicles-The transportation fleet generates a mass of data that ought to be reported and analyzed in the constant search for business advantage such as: positions, mileage and speeds; cargo condition; fuel and water tanks levels; main engine condition and maintenance information.

f. Lighthouses/Lighting Sea Buoys Control-It is determined for control of good and continuous working conditions of Lighthouses and Lighting Sea Buoys.

g. Power Stations Monitoring-Is designated for remote control of all power stations located far a way in rural areas, voltage controls, break downs of system and other monitoring for keeping them in good order.

h. Meteorological Stations Reporting-Is designed to conduct monitoring and reporting all necessary meteorological and hydrographic data of remote Meteorological station in rural areas.

i. Water Level Control-Monitoring service can perform a remote water levels control of rivers, lakes and water accumulation resources for agriculture use and hydroelectric generators.

The manufacturer of BGAN units Wideye has developed a small portable M2M enabler IOTA, to replace the Laptop or Desktop PC for use in conjunction with their Sabre BGAN terminal. Thus, IOTA is most suited for unmanned operations in a remote, hard-to-access or hazardous location. It controls the BGAN terminal and interfaces with the on-site monitoring equipment. The user can customize the software applications on the IOTA for command and control of their monitoring equipment and the BGAN terminal. The whole setup can be accessed remotely from the user's office via the Inmarsat BGAN satellite network for telemetry and data polling [22-25].

5.   CONCLUSION

At the end is necessary to conclude that Inmarsat BGAN devices are small very powerful tools for use in remote and rural environments for all mobile and ground-based civilian and military applications. For the corporate and personal use Inmarsat, Iridium, Globalstar, ACeS and other MSC operators will offer dual mode functions portable handsets for both satellite and cellular connections. The fixed or mobile BGAN handsets can be deployed onboard ships, land vehicles, aircraft and temporary accommodation at camps or bases.

The BGAN model of rural payphone for villages and remote communities will offer the ability to communicate with any location in the world using voice facilities and emergency numbers for access to medical, firefighting or security services. It is similar to the typical city payphone operated by phonecards, ruggedly constructed to protect withstand vandalism, simple-to-use and it will be powered using mains network supply or solar panels. Local authorities can use payphones for emergency calls using a special access card. The MSC model of in-door phone offers every remote household or business sites connection to TTN via a standard phone set connected to interface box and external out-door antenna mounted on the roof. Finally, Inmarsat, Iridium, Globalstar and other MSC operators have developed a special BGAN for military mobile, fixed and transportable tactical and defense communications systems for Navy, Ground and Air forces, which can be implemented in instant time.

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