Iridium Communication System for Data Telemetry of Renewable Distributed Generation System

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ABSTRACT

Distributed Generation (DG) is formulated using small, modular electricity generator sites close to the customer load. Often based on renewable technologies, the aggregate operation capabilities of these power generators are monitored by an Energy Control Center (ECC) using telemetric information from the individual sources. This forms the basis of DG dispatchability. This necessitates the design of a low-cost communication system for the required telemetry. The Iridium satellite system is able to provide global communications at a reasonable cost and thus can provide flexible communication links where alternative technologies are not available. This paper discusses the development of an Iridium Satellite System, which has a Low Earth Orbit (LEO) satellites, with 9601 Short Burst Data (SBD) transceiver, for data telemetry functions.

1. INTRODUCTION

To form a viable alternative to central generation of electricity, it is important that the Distributed Generation (DG) sources are integrated and dispatchable requiring DG sources to be monitored and controlled using a communications infrastructure that is both cost-effective and reliable [1]. The specifications of a DG communication system (DGCS) often depends on factors such as cost, telemetry requirements, control functions and feasibility of various communication technologies.

The remoteness of some DG sites makes it impractical for common communication technologies based on broadband copper and wireless to satisfy the DGCS requirements in a cost-effective manner. More specifically, the availability of high speed networking depends on the installation infrastructure when the DG generator is installed. When not available, alternative communication strategies such as point-to-point wireless radio modems [1] or cellular modems or satellite modems (or combination thereof) should be considered; For low data volumes, the Iridium-based systems may be less expensive than the alternatives.

In extremely remote situations, or when a redundant system is required, a satellite modem with low hardware cost and global coverage complements the requirement of remote access of DG sites. Hence, Iridium communication system with global access from pole to pole competes well for the low cost redundant system for data telemetry for low data volumes. Although comparatively expensive in terms of data transmission, the initial focus of this work will be to test the capability of the Iridium satellite modem and then to develop a smart software application to limit data transmission to a “need to know” basis. To manage the smart application requirements, a programmable interface controller (PIC) microcontroller will be used to control the satellite modem.

Some parameters to be monitored at the ECC from the DG sites include: voltage, current, real and reactive power, power quality, harmonics, transients, flicker and connection/fault status [2]. Hence, to meet the telemetry and control functions for the DG sites, a data acquisition system at the DG site with an Iridium Satellite system would provide sufficient link contingencies at times of a failure or when it is the only viable communication link. For redundancy, the envisaged communication system link for the DG site to the ECC is in Fig. 1.

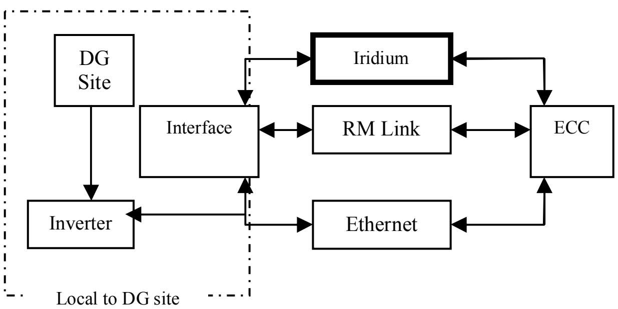


Figure 1. Overall system communication link

2. BACKGROUND

The Iridium SBD transceivers were launched, by Iridium Satellite LLC, a privately held company based in Bethesda, Maryland, U.S.A, targeting mainly for application development in the areas of field force automation and remote asset tracking [3]. Iridium constellation consists of 66 Low Earth Orbiting (LEO) satellites at about 780 km from the earth surface in 6 polar orbits.

The 9601 transceiver (ISU) is designed to support packet mode SBD service. It employs a Time Domain Duplex (TDD) approach, transmitting and receiving in an allotted time window of 90 ms frame structure at the frequency range of 1616 to 1626.5 MHz. The L-band frequency is used for communication between the ISU and satellite and Ka-band frequency for inter-satellite communication. FDMA/TDMA is used as the channel access scheme and the system uses a 50 kbps data rate and QPSK modulation format on an eight 8.28 ms time slot and 41.66 wide FDM channels [5].

The various elements of the SBD architecture consists of the remote Field Application (FA), the Iridium Subscriber Unit (ISU), the Iridium Satellite Constellation, Earth Terminal Controller SBD Subsystem (ESS) located at the Iridium gateway, the internet and the Vendor Application (VA). The ESS is responsible for storing and forwarding messages from the ISU to the VA and storing messages from the VA to forward to the ISU. The ISU communicates with the ESS via the Iridium satellite constellation. The interface between the VA and the ESS uses standard Internet mail protocols to send and receive messages. Mobile Terminated (MT) messages are sent to the ESS using a common email address, identifying the specific ISU by encoding the unique ISU International Mobile Equipment Identity (IMEI) in the subject line of the email. The data message is transmitted as binary attachment with the email. The Mobile Originated (MO) messages are delivered to a specific email address that is configured when the IMEI is provisioned. It is only possible to configure one type of delivery system i.e. either ISU-ISU or ISU-email [6]. Here the communication system developed is with the later delivery type.

3. SYSTEM IMPLEMENTATION

The FA was simulated using the Windows hyper-terminal program and the e-mail addresses as the VA were configured for the MO messages to be delivered. The communication with the transceiver, the sending of MO message and receiving of MT message were done with appropriate AT commands at the FA. The block diagram of the overall system design with the Iridium 9601 Transceiver is shown in Fig. 2.

The ISU supports a maximum of 205 bytes of MO messages and a maximum of 135 bytes of MT messages per SBD session. Hence, depending on the criticality of the frequency at which certain data needs to be transmitted for monitoring purposes of DG, the optimization on the data bytes on the MO message can be done so that the optimal capacity of the SBD frame is utilized per SBD session.

The transceiver was powered up with a regulated power supply of 5 volts dc and was connected to a fixed mast helical antenna with a 8 m cable. The 9601 transceiver was connected via a RS-232 serial cable to the PC. The loss on the cables, connectors and lightning arrestor was checked so that it does not exceed 3 dB which is the requirement as per the specifications.

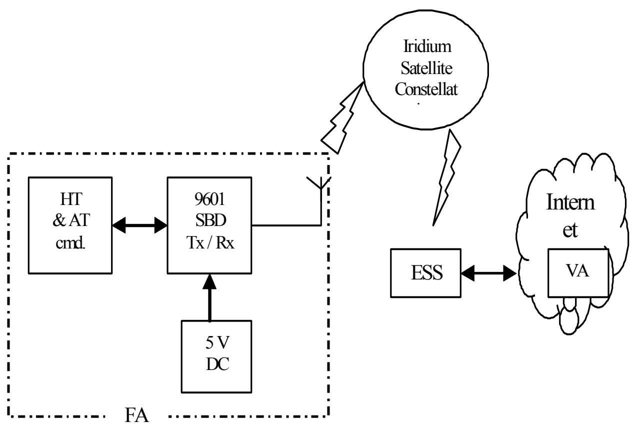


Figure 2. SBD System implemented with 9601

4. SYSTEM TESTING

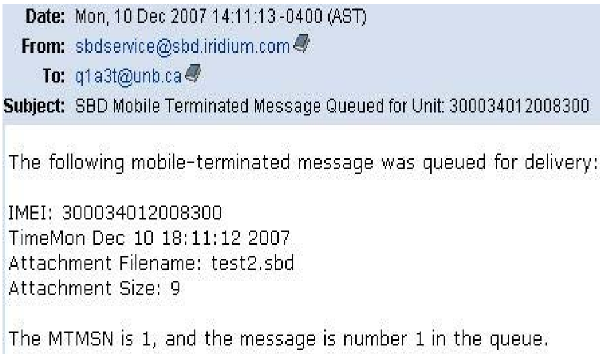
The system in Fig. 1 was tested with MO message generated at the FA. The message was received in an e-mail attachment at the VA as in Fig.3, with the time stamps of the session, MO Message Sequence Number (MOMSN), session status, message size and the ISU specific geo-location information. The geo-location information, if not required can be disabled to optimize the data frame.

With the timing information retrieved and analyzed it was found that it took 18 seconds for the MO message to reach the VA from the FA, which corroborates well with the study done by [4]. The calculation of the various components of the delays associated here from the FA to the VA shows that about 98% of the delay time is attributed due to the e-mail delays.

Figure 3. MO e-mail message received at VA

For testing the MT message, an e-mail with attachment content “Hello UNB” was sent to the ESS from the VA. The conformation message of its storage in the ESS for polling by the ISU was received as in Fig. 4. The same message was retrieved at the FA with appropriate AT commands as shown in Fig. 5. Various information including count of MT message queued at ESS can be obtained as indicated by the last digit returned by the SBDI command.

As the Iridium Gateway has an inherent process running once only every 30 seconds [4] to collect the MT SBD message to queue it for the individual mobile device, the worst case latency for the MT message to reach the ISU could be 30 seconds plus the other associated delays of about 1 second. The other associated delays could be due to the message size, uplink and downlink delays, the inter satellite handoffs delays and the delays due to the queuing algorithm implemented. Hence, critical control applications like anti-islanding of the DG sites may not be possible as the responses that are required at the field for such operations are in the order of milliseconds or less.


Date: Mon, 10 Dec 2007 14:11:13 -0400 (AST)
From: sbdservice@sbd.iridium.com
To: q1a3t@unb.ca
Subject: SBD Mobile Terminated Message Queued for Unit: 300034012008300

The following mobile-terminated message was queued for delivery:

IMEI: 300034012008300
TimeMon Dec 10 18:11:12 2007
Attachment Filename: test2.sbd
Attachment Size: 9

The MTMSN is 1, and the message is number 1 in the queue.

Figure 4. Conformation of MT message queued at ESS

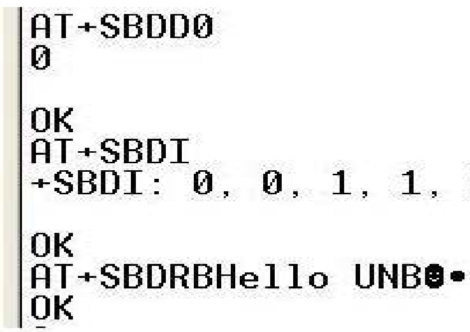


Figure 5. MT message received at FA

5. CONCLUSION

The Iridium 9601 SBD transceiver was tested successfully for sending the data from the remote FA to the VA (MO message) and VA to FA (MT message). These preliminary results illustrate the functionality of the SBD service of the Iridium system to provide rudimentary telemetric capabilities as required by the DG communication system.

The latency of this system, however, would limit the control capabilities of the ECC, although such a system would most likely be utilized as a redundant backup system. This system of communication would prove to be especially important for DG telemetry, considering its service availability at all locations on the globe and also due to the low cost of the hardware and its implementation. Hence, this low cost hardware investment communication system could be customized for data telemetry function for the DG sites as envisaged in Fig 1.

6. ACKNOWLEDGEMENTS

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7. REFERENCES

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