Iridium Satellite Data Services White Paper

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Purpose:

This document describes Iridium Satellite's current data services. The objective is to provide an overview of the Iridium satellite network, hardware and data services to aid in the selection of an appropriate data service for a particular integrated data application. This document does not contain detailed technical information.

Scope:

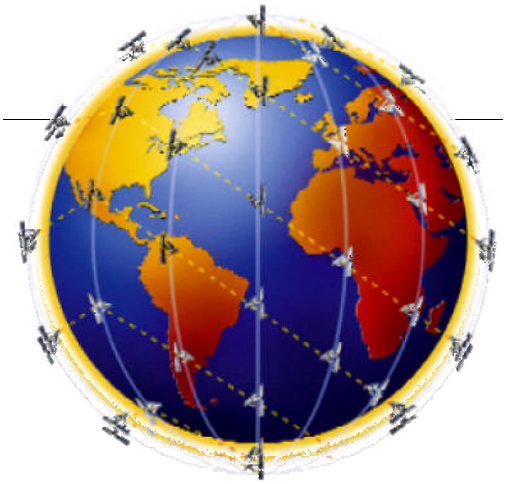
This white paper covers the following areas

- Iridium Satellite Network
- Iridium Hardware
- Iridium Dial-Up Data
- Iridium Direct Internet
- Iridium Router Based UDI Connectivity Solution [RUDICS]
- Iridium Short Burst Data (SBD)
- Iridium Short Message Service (SMS)

This paper provides basic system information and parameters; it does not contain a detailed technical description of each service. This paper assumes a reasonable knowledge of data, telephony and satellite communications.

Iridium Satellite Network Overview

The Iridium System is a satellite-based, wireless communications network providing a robust suite of data services to virtually any destination anywhere on earth. The Iridium system comprises three principal components: the satellite network, the ground network and the Iridium subscriber products including phones and pagers. The design of the Iridium network allows data to be routed virtually anywhere in the world. Data calls are relayed from one satellite to another until they reach the satellite above the Iridium Subscriber Unit and the signal is relayed back to Earth.



The on-orbit Iridium constellation consists of 66 operational satellites and spares in a constellation of six polar planes. Each plane has 11 mission satellites performing as nodes in the telephony network. The spare satellites are on orbit ready to replace any unserviceable satellite. This constellation ensures that every region on the globe is covered by at least one satellite at all times. 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 miles per hour. Each satellite is cross-linked to four other satellites; two satellites in the same orbital plane and two in an adjacent plane. The satellite constellation is expected to provide continuous global coverage until 2014 without any additional launches of satellites.

The ground network is comprised of the System Control Segment and gateways used to connect into the terrestrial data networks. The System Control Segment is the central management component for the Iridium system. It provides global operational support and control services for the satellite constellation and delivers satellite tracking data to the gateways. The System Control Segment consists of three main components: Four Telemetry 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.

Gateways are the terrestrial infrastructure that provides interconnection to the terrestrial data networks. Gateways also provide network management functions for their own network elements and links.

Iridium Satellite LLC Distribution Channels

Iridium has established a number of distribution channels for its services and products. The intent with each channel is to maximize either the distribution of existing products and services or to enable products and services to be integrated into specific vertical market applications. Specific descriptions of each channel are included below. Information on how to contact a distribution partner of the Iridium can be found on the Iridium web site at http://www.iridium.com.

Iridium Service Partner (SP)

SPs typically sell Iridium products and services through a distribution channel that encompasses both regional and vertical market attributes. SPs typically sell handsets or specific vertical market implementations of handsets (e.g. a maritime or aviation version) along with voice and basic circuit switched data services.

Iridium Value Added Reseller (VAR)

VARs incorporate a specific Iridium Subscriber Unit and service into a complete end to end solution for a particular customer or vertical market. A VAR is a company that provides a total wireless data solution for an end customer. They integrate all hardware and software for both the remote device as well as the back office/host computer system. VARs also directly sell Iridium Satellite Data Services with their solution. Iridium directly supports Iridium VARs with technical information. Iridium VARs are selected based upon experience, a repeatable business case and other factors.

Iridium Value Added Manufacturer (VAM)

A VAM is a company that has particular expertise in a vertical market and wishes to integrate an Iridium voice or data module into a finished or OEM product. VAMs do not resell voice or data services directly from Iridium. Iridium directly supports VAMs with technical information.

Iridium Value Added Developer (VAD)

A VAD is a company that has particular expertise in a vertical market such as back office systems for processing data from remote Iridium units and needs to work more closely with Iridium to integrate their back office system. VADs do not resell voice, data services or equipment directly from Iridium. Iridium directly supports VAMs with technical information.

Note that Iridium uses many criteria in selecting business partners and also utilizes a multi-tiered distribution structure.

Iridium Hardware

9522A L-Band Transceiver

The 9522A L-Band Transceiver (LBT) is intended for incorporation into an integrated voice and/or data solution or product. The LBT is simply the core transceiver module that is required in order to communicate over the Iridium network. Additional components are required such as power supply, antenna, environmental protection and the serial based interface between the LBT and the customer's application.

The LBT provides two interfaces for data applications. A TNC connector is provided for the RF connection to the antenna. A DB25 connector is provided for power, on/off control and a RS232 serial data.

Basic Specifications:

Dimensions	Value
Length (including antenna connector)	216.1 mm (8.51")
Length (excluding antenna connector)	196.4 mm (7.73")
Width	82.6 mm (3.25")
Depth	39.0 mm (1.54")
Weight (approximate)	610 g

DC Power Input Specifications	Value
Main Input Voltage - Range	+4.0 VDC to +4.8 VDC
Main Input Voltage - Nominal	4.4 VDC
Main Input Voltage - Ripple	40 mVpp
Peak Input Current (maximum)	2.5 A @ 4.4 VDC
Main Input Active Power (average)	2200 mW
Main Input Standby Power (average)	570 mW

Service Capabilities:

Circuit Switched Data (CSD)
Voice Telephony
Short Burst Data (SBD)
Short Message Service (SMS)

9601 SBD Transceiver

The 9601 SBD Transceiver is intended for incorporation into an integrated data only solution or product. The 9601 is simply the core transceiver module that is required in order to communicate via the Short Burst Data Service over the Iridium network. Additional components are required such as power supply, antenna, environmental protection and the serial based interface between the 9601 and the end user application.

The 9601 has two connectors, a SMA for the antenna and a header connector for power, on/off control, RS232 interface, and a network available output. Applications can readily drive the transceiver using an extended AT Command Set. Due to the use of L-Band as the operating frequency for Iridium, small antennas can be used.

Basic Specifications:

Parameter	Value
Length	106 mm
Width	56.2 mm
Depth	13 mm
Weight (approximate)	117g

Parameter	Value
Main Input Voltage Range	+4.5 VDC to +5.5 VDC
Main Input Voltage Nominal	5.0VDC
Main Input Voltage – Ripple	40 mV pp
Consumption at +5.0 VDC	*Value*
Input Standby Current (average)	66mA
Peak Transient Current – Transmit	1.5 A
Current Average – when SBD message transfer in process	<= 350 mA
Average Power consumption – when SBD message transfer in process	<= 1.75 W

Service Capabilities

Short Burst Data (SBD)

Iridium Dial-Up Data Service

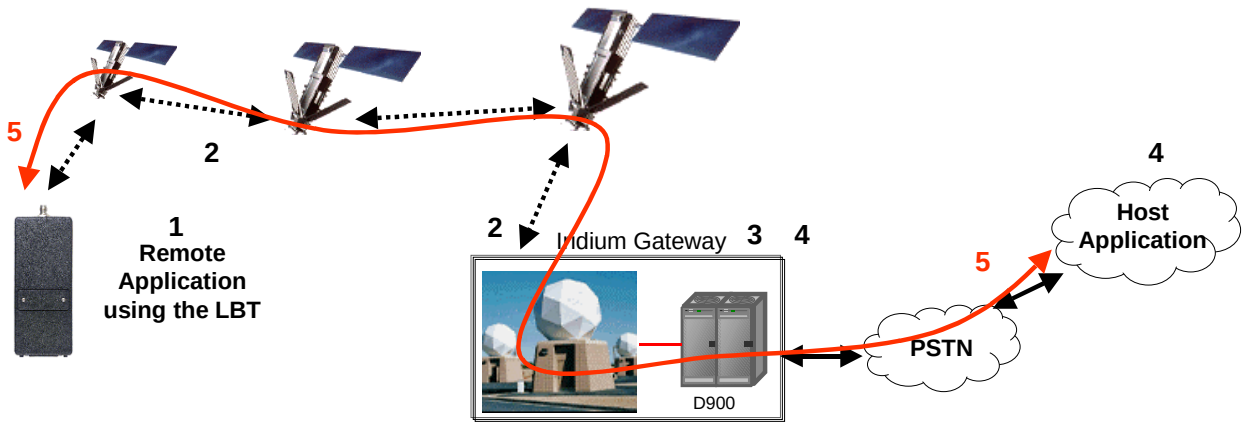
Service Description

Iridium Dial-Up Data Service is an asynchronous, circuit switched, 2400 bits per second, bi-directional service. Data calls can be originated:

- From an Iridium Subscriber Unit (ISU) to the Public Switched Telephone Network (PSTN) as shown in Figure 1
- From the PSTN to an ISU as shown in Figure 1
- From one ISU to another ISU as shown in Figure 2

An RS232C interface with AT Commands is used for making a data call. Data connections to the PSTN operate at 2400 bits per second. Terminating PSTN modems should be configured to start negotiating at 4800bps in order to minimize modem negotiation time. A document detailing the AT Commands is available to authorized developers.

Figure 1
A Circuit Switched Data Call from a remote application (ISU) to the PSTN.

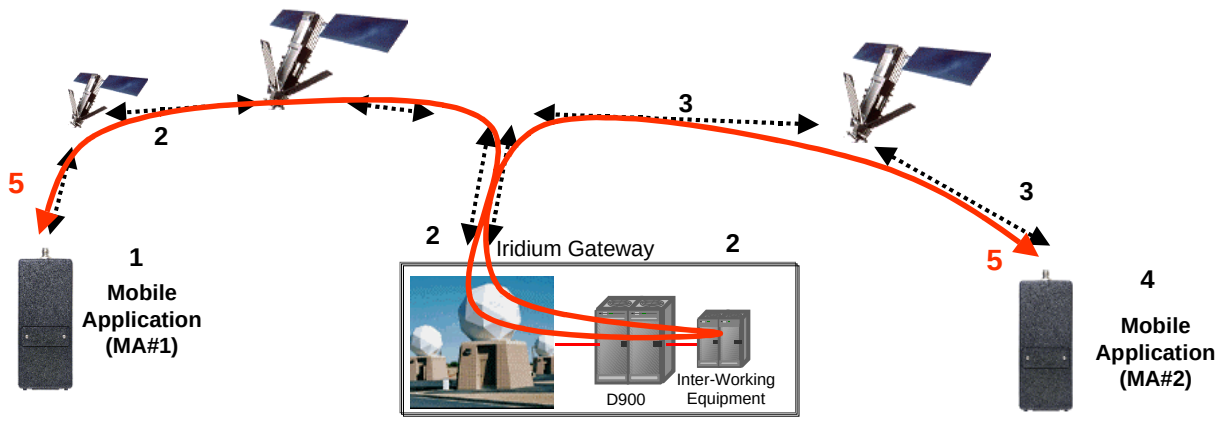


Sequence of Events:

1. Application dials number on PSTN using AT Commands (e.g. 0044171……)
2. Call request is routed over the constellation for user authentication and call set-up (~5 sec)
3. Switch makes connection to dialed number (~5 sec)
4. Analog modem in gateway and analog modem in host application synchronize (~30 sec).
5. End-to-End connection established, over the constellation, between the Host Application and Mobile Application

Note that it is also possible to for the Host Application to initiate the call to the remote application by dialing the MSISDN-C of the remote application beginning with the International dialing prefix followed by the Iridium Country code number (8816) and the eight digit number.

Figure 2
A Circuit Switched Data Call between two ISUs.



Sequence of Events:

1. Mobile Application #1 dials MSISDN or MSISDN-C of MA#2
2. MA#1 call is set-up and connected to inter-working equipment
3. Ring alert and call set-up issued by gateway to MA#2
4. MA#2 answers incoming call request (total set-up ~25 sec)
5. End-to-End connection established between MA#1 & MA#2

Dial-Up Data Applications

Dial-up data is suitable for applications that require direct computer-to-computer or device-to-device connections. Each device or computer should be connected to a PSTN modem or an ISU.

Sample applications for this type of service include:

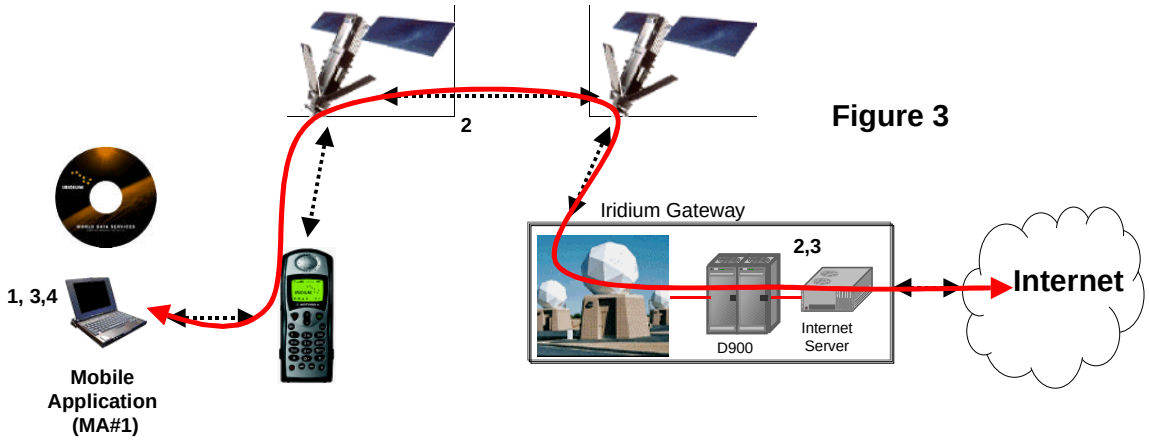
- Connecting Remote Terminal Units (RTUs) to central control and monitoring systems.
- Connecting monitoring equipment to central data collection systems.
- Continuous real time transfer of data.
- Dialing into an Internet Service Provider.
- Dialing into a LAN (Local Area Network.)

Iridium Direct Internet Service

Service Description

Direct Internet is a service that allows a subscriber with a Windows-based computer to access the Internet over the Iridium network using an optimized circuit switched data channel. If the destination computer is a computer connected to the Internet and has an Internet Protocol (IP) address then the Iridium Direct Internet Service is usually the best option if the remote user is using a standard Windows based operating system.

Figure 3
A Direct Internet Data Call from a remote application (ISU) to the Internet.



Sequence of Events:

1. MA#1 client Direct Internet Software dials the number for the Direct Internet Server
2. MA#1 call is set-up and connected to the Direct Internet Server
3. MA#1 negotiates connection protocol and authenticates with Direct Internet Server (~ 12 seconds)
4. Standard Internet applications software can then access the Internet

Direct Internet uses “on-the-fly” data compression to increase the effective data throughput. The compression ratio depends on the type of data being sent or received; text is highly compressible whereas JPEG graphics files are not compressible. Although the underlying channel rate is 2400bps, the effective throughput is typically higher. Direct Internet connections can only be originated from an ISU. Connections to an ISU cannot be originated from the Internet. Figure 3 illustrates the call path. The compression in Direct Internet works on email (SMTP and POP), web (http) and FTP. Currently supported Windows versions include Windows 95, 98, NT4.0, Me, 2000 and XP.

Direct Internet Service Applications

Typical applications include:

- Email – Send and receive email using Outlook, Eudora or other email client
- FTP (File Transfer Protocol) for transferring data files.
- Web browsing – primarily on text based sites.
- Telnet sessions

Iridium Point-to-Point Protocol (PPP) Service

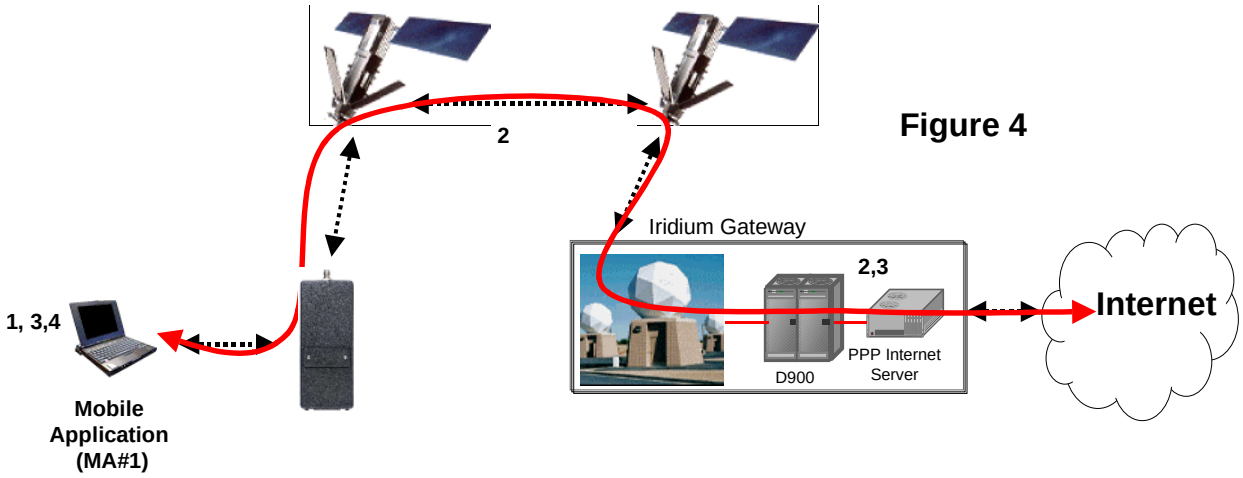
Service Description

PPP is essentially a hybrid between the Direct Internet Data service and the Dial-Up Data service. The user sets up a standard Dial-Up Networking connection that dials directly into the Direct Internet server, thus eliminating the analog modems required in a PSTN connection. Since PPP does not utilize the Direct Internet software, it does not provide the enhancements of compression. The advantage of this service is that you have the stability of a Direct Internet call without having to load the Direct Internet software on the client side. Set-up times of calls are reduced and the percentage of established calls is significantly higher than using the PSTN to connect to an ISP.

This service only works when a call is originated by an ISU to the PPP server in the gateway. The PPP server cannot call the ISU. The ISU is not assigned an IP address. Figure 4 illustrates the call path.

PPP service is designed for use in applications where a computing device needs to connect to a computer via to the Internet. Direct Internet relies on software that only supports Windows operating systems. Third party PPP protocol software is available from other sources for many computing platforms and devices. Note that Iridium only provides limited support for use of the PPP Service.

Figure 4
A PPP Data Call from a remote application (ISU) to the Internet.



Sequence of Events:

1. MA#1 dials the number for the PPP Server
2. MA#1 call is set-up and connected to the PPP Server
3. MA#1 negotiates the PPP connection protocol
4. Standard Internet applications software can then access the Internet via the TCP/IP stack

PPP Service Applications

Iridium PPP service is designed to serve two types of applications:

1) Direct connection to the Internet for non-Windows based computing platforms. Linux, Apple, Palm and other operating systems can be configured to use a PPP client for communication to the Internet. [Windows based applications should use Iridium Direct Internet Service.]
2) Application specific data communications for telemetry, remote monitoring or tracking of field based assets.

Non-Windows based systems, with typical applications utilizing the Internet, include email, file transfer, telnet and other terminal sessions. PPP service allows connection to any publicly available IP address on the Internet.

For specific applications, this service could be used with an Iridium 9522A L-Band Transceiver in an integrated application. An applications developer could integrate the service and hardware to provide data connectivity from a remote or mobile application to an IP address over the Iridium network.

Iridium Router based Unrestricted Digital Interworking Connectivity Solution [RUDICS]

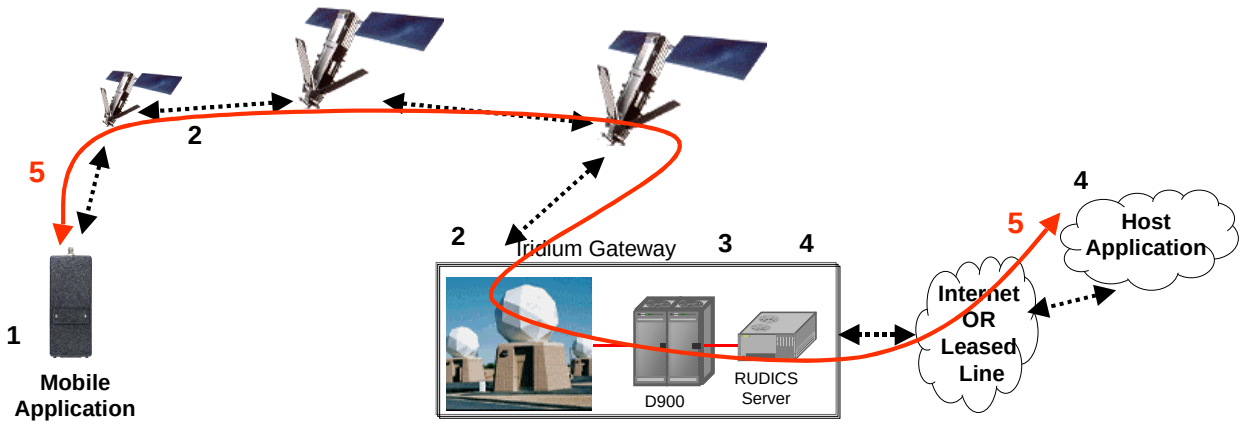
Service Description

RUDICS is a circuit switched data service designed to be incorporated into an integrated data solution. Integrated data solutions are applications such as remote asset monitoring, control, and data file transfer. Often these applications are designed to support hundreds or thousands of remote units. The other circuit switched data services mentioned in this paper are sometimes sub-optimal for such applications. RUDICS is designed to take advantage of the global nature of the Iridium communications system and combine that with a modern digital connection between the Iridium Gateway and the Value Added Resellers centralized application server or Host Application.

RUDICS uses the same circuit switched data service that is described in the sections on “Dial-Up Data” and Direct Internet. The difference and key benefit comes in the equipment used to terminate or originate the call in the Iridium Gateway.

Figure 5 illustrates the call path for a Mobile Originated call.

Figure 5
A RUDICS Data Call from a remote application (ISU) to the central Host Application

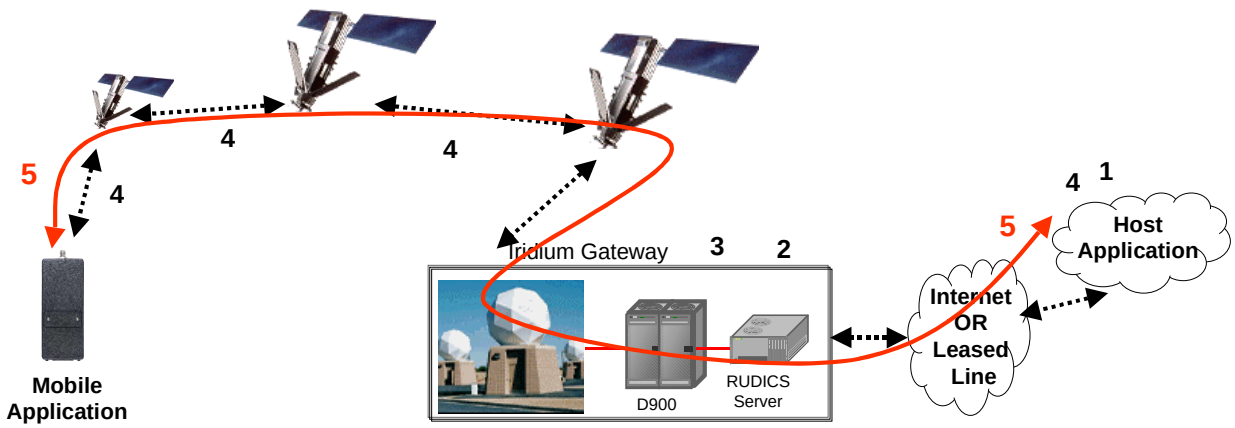


Sequence of Events:

1. Mobile application places call to a custom RUDICS Server Number
2. Call request is routed over the constellation for user authentication and call set-up.
3. Switch connects to RUDICS Server, secondary authentication conducted
4. RUDICS Server terminates call to pre-configured IP Address
5. End-to-End IP connection established, over the constellation, between the Host Application and Mobile Application

Figure 6 illustrates the call path for a Mobile Terminated call.

Figure 6
A RUDICS Data Call from a central Host Application to the remote application (ISU).



Sequence of Events:

1. Host application places telnet call to RUDICS Server
2. RUDICS Server Authenticates Host
3. Call request is routed to the switch for call set-up
4. Call request is routed over the constellation for user authentication and call set-up.
5. Mobile Application answers call. End-to-End IP connection established, over the constellation, between the Host Application and Mobile Application

RUDICS uses routers to allow termination and origination of circuit switched data calls to and from a specific IP address via a Telnet protocol. The capability is designed to support applications that have many field devices and one central host application. The service allows field devices to directly call the host application and the host application is able to directly call the field devices.

Connectivity between the Iridium Gateway and the Host Application can be by a variety of methods, including Internet, Virtual Private Network and Leased Line

RUDICS has a number of advantages over other methods of originating and terminating Circuit Switched Data calls on Iridium. The following table describes some of these advantages:

Service Type	Limitation	RUDICS Advantage
Dial Up Data	Analog modem training time	No modem training time and therefore lower cost per call
Dial Up Data	PSTN origination fee set by long distance or international carrier	Service rates are identical for Mobile Originated or Mobile Terminated calls
Direct Internet	Remote unit must initiate session. Unit cannot be called directly from an IP Address	Calls can be Mobile Originated and Mobile Terminated
Direct Internet	Requires Windows Operating System	No Operating System requirement
Direct Internet	Remote unit IP address is non-routable	Routable IP addresses.
Direct Internet	TCP/IP Stack negotiation uses billable airtime	Application vendor can select appropriate protocol
PPP Service	Requires TCP/IP Stack	No TCP/IP Stack Required
PPP Service	Remote unit must initiate session. Unit cannot be called directly from an IP Address	Calls can be Mobile Originated and Mobile Terminated
PPP Service	Remote unit IP address is non-routable	Routable IP addresses.
PPP Service	TCP/IP Stack negotiation uses billable airtime	Application vendor can select appropriate protocol

RUDICS Service Applications

Typical applications include:

- Email – Sending and receiving of email using custom applications software
- FTP (File Transfer Protocol) for transferring data files.
- Periodic data reporting by remote sensors
- Polling of remote units to collect data
- Control of remote equipment

Note that RUDICS is typically best suited for applications that deploy more than 500 units, which report to a central host application.

Iridium Short Burst Data (SBD) Service

Service Description

Iridium Short Burst Data (SBD) Service is an efficient network protocol designed for shorter sized data messages than can be economically sent via Iridium Circuit Switched Data Services. SBD uses a proprietary network protocol to transfer data messages to and from the remote terminal. An overview is shown in Figure 7.

It is possible to send Mobile Originated (MO-SBD) and Mobile Terminated (MT-SBD) messages. Message size for MO-SBD is between 1 and 1960 bytes. (0 byte messages are referred to as “mailbox checks.”) Message size for MT-SBD is between 1 and 1890 bytes. The maximum message size depends on whether a 9601 or 9522A transceiver is used. (The 9601 has shorter message lengths, but the hardware costs less, it supports up to 340 bytes MO-SBD and 270 bytes MT-SBD)

The target vertical markets for SBD are Logistics, Oil, Gas, Rail, Maritime, Aeronautical, and Utility industries as well as applications in the Government and Military sectors. Iridium itself does not provide complete end-to-end solutions. However, it looks to selectively partner with skilled Value Added Resellers (VARs) to integrate the required hardware, software, and SBD service that ultimately forms the complete packaged solution for the end customer.

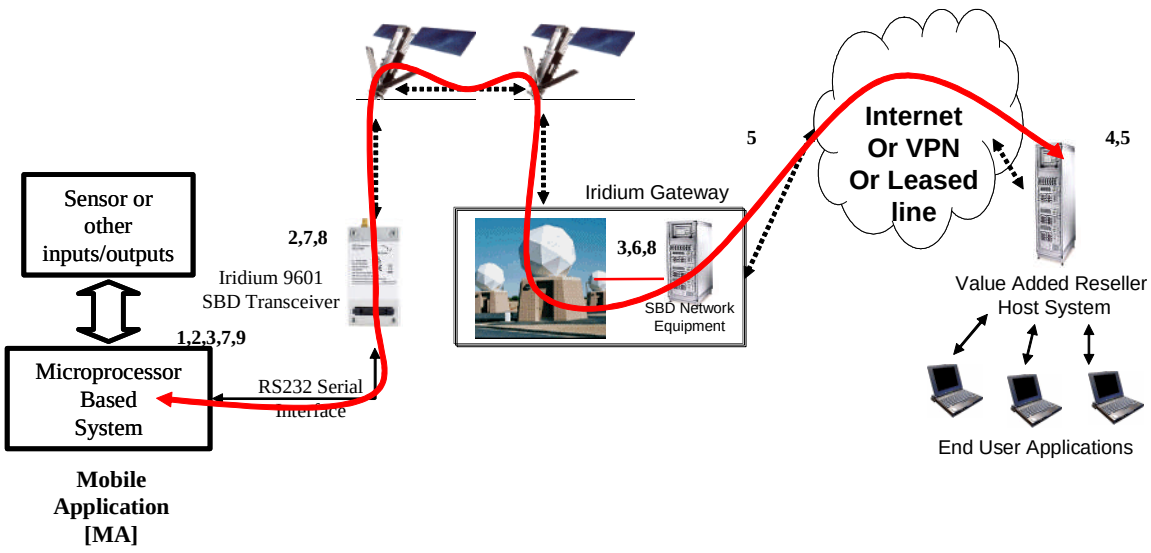
Remote Applications send Mobile Originated SBD (MO-SBD) data messages via an Iridium Transceiver. The application microcontroller or microprocessor communicates with the Transceiver using AT commands over an RS232 serial port. The application loads the data message into the Transceiver and instructs it to send the data message. The data message is transmitted across the Iridium satellite network utilizing inter-satellite links to reach the Iridium Gateway. From there the data message is transferred via e-mail or an IP Socket to the VARs host computer system. Here the message is stored in a database for further data processing.

Mobile Terminated SBD (MT-SBD) messages are sent to the Iridium Gateway via e-mail or IP Socket from the VARs host computer system. Providing that the Transceiver has been appropriately configured and provisioned, the Iridium Gateway will send a “Ring Alert” to the transceiver when a MT-SBD message has been queued. The Mobile Application can then decide whether to retrieve the MT-SBD data message at that time or later.

Global network transmit latency for delivery of messages ranges from approximately 5 seconds for short messages to approximately 20 seconds for maximum length messages. This latency is the elapsed time during the actual transmission of the data message between the Transceiver and the Iridium Gateway. Additional latency introduced by the Internet, remote application, private IP network connection or the customer’s host system is not in Iridium’s control and is not included in the latency times mentioned.

Due to the nature of the Iridium system architecture, SBD operates uniformly at all latitudes and longitudes. It is not affected directly by precipitation.

Figure 7
A SBD Data Call from a remote application (ISU) to the Internet.



Sequence of Events: MO-SBD
1) MA loads the MO-SBD data message into the L-Band Transceiver.
2) MA instructs the L-Band Transceiver to send the SBD Message to the Iridium Gateway
3) Iridium Gateway SBD Equipment receives the SBD Message; sends an acknowledgement to the MA and creates an email IP message with the SBD data message as an attachment to the email OR the data is transmitted via an IP Socket
4) MO-SBD message is sent to the destination email or IP Socket server hosted by the Value Added Reseller for processing of the data message.

Sequence of Events: MT-SBD
5) Data message is sent via email or IP socket to the Iridium Gateway server by the Value Added Reseller's Host Server.
6) Iridium Gateway SBD Equipment receives the MT-SBD Message and stores it in a database.
6) Iridium Gateway issues a "Ring Alert" to the transceiver that notifies it of a waiting message(s).
7) The MA initiates a "Mailbox Check" and the MT-SBD Message is downloaded to the L-Band Transceiver.
8) The L-Band Transceiver sends an acknowledgement to the Iridium Gateway that the MT-SBD Message has been delivered.
9) MA extracts the MT-SBD Message from the L-Band Transceiver and processes the message.

Iridium SBD Service Applications

Iridium SBD Service is designed to serve a range of applications that need to send data messages that on average are typically less than 300 bytes.

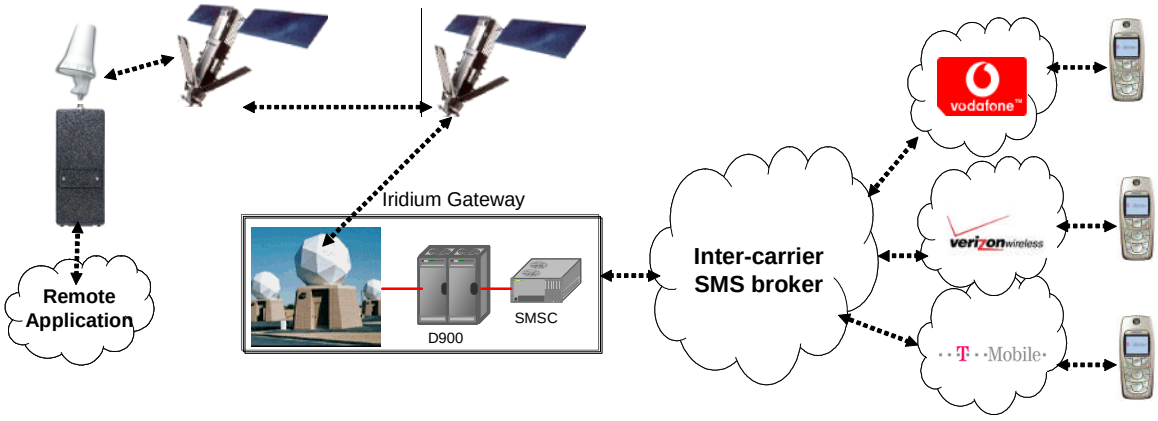
Specific applications may include:

- Flight following for aircraft and helicopters
- Tracking and messaging for maritime vessels
- Tracking of mobile land based assets such as containers, trucks and heavy equipment
- Monitoring of equipment on oil and gas pipelines
- Monitoring of equipment of water, gas and electric utility distribution networks

Iridium Short Message Service (SMS)

Service Description

Short Message Service is a GSM based system capability designed for both Mobile Origination (MO) and Mobile Termination (MT) of short text messages. There are numerous GSM-SMS applications developed for terrestrial GSM networks. It should be possible to adapt existing terrestrial based applications and also develop new applications using the Iridium SMS service.



The Iridium SMS service offers the following capabilities:

- Two-way global text messaging.
- Send to and receive from other Iridium SMS subscribers.
- Send to and receive from email addresses. Iridium subscribers are able to receive SMS messages via <MSISDN>@msg.iridium.com, where <MSISDN> is the Iridium phone number.
- Send to and receive from cellular subscribers (when available.)
- 160 characters per message.
- Messages will be stored until delivered (up to 8 days.)
- Supported on 9505 handsets and 9522 LBTs with SMS capable firmware.
    - SMS messages can be entered into the phone in one of two ways:
        - Via the phone's keypad
        - Via the phone's data port, using standard AT commands

Iridium SMS Service Applications

The Iridium SMS Service can be used to serve a range of applications that can send useful information within the 160-character limit of each message.

Specific applications may include:

- Weather information & alerts
- Schedule information
- News & Sports information
- Personal messaging
- Basic email messaging
- Monitoring of remote applications

- ## Choosing A Data Service

There are many reasons that a particular data service may be chosen. The purpose of the table below is to assist in narrowing down the choices and is not an exhaustive selection matrix. In addition to technical details, commercial information such as the usage profile and service pricing is also required in order to determine the most appropriate data service.

Service Name	Typical Use	Transfer Type
Direct Internet	Remote access to Internet based personal email service using a Windows based computer	Human to Machine
Dial-Up Data	Remote access to a corporate email service not connected to the Internet	Human to Machine
PPP Service	Access to the Internet by a computer without a Windows Operating System	Human to Machine
RUDICS Short Burst Data	Large scale monitoring of fixed or mobile assets beyond typical terrestrial coverage	Machine to Machine
Direct Internet Dial-Up Data RUDICS	File transfers that typically are 500 bytes or more per transfer	Machine to Machine
Short Burst Data	File transfers that typically are less than 500 bytes per transfer	Machine to Machine
Short Burst Data	Frequent short file transfers [Less than 500 bytes]	Machine to Machine
RUDICS Short Burst Data	Integrated data applications	Machine to Machine
Direct Internet Dial-Up Data PPP	General ad-hoc file transfer [Human to Machine]	Human to Machine
Short Message Service	Send or receive short email (text message)	Human to Human

List of Abbreviations

ISU – Iridium Subscriber Unit
ISP – Internet Service Provider
LBT – L-Band Transceiver
MO – Mobile Originated
MT – Mobile Terminated
PPP – Point to Point Protocol
PSTN – Public Switched Telephone Network
RF – Radio Frequency
RUDICS – Router based Unrestricted Digital Interworking Connectivity Solution
SBD – Short Burst Data
SIM – Subscriber Identity Module
VAM – Value Added Manufacturer
VAR – Value Added Reseller

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