Title Develop a coordination mechanism for users and suppliers of satellite data collection systems (Satcom)

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## Introduction

This presentation first summarizes the users of remote data collection, their application and the devices available to them.

Then a range of sat comms services are described and their applicability. Some non-satellite based communications possibilities are also described.

Having provided an overview of the range of users and services, techniques are outlined where the information could be made available for the benefit of the user communities.

### Users of remote data collection

There are already well established users of remote data collection. The data is collected on a routine basis and is ingested into Metrological or Oceanographic models. The most prominent is the worldwide set of buoys, either moored or drifting. Even though these systems are relatively mature and the operators well experienced in their use, there are still important information that could be collected and shared :-

* The reliability of the data collection platforms
* Identification of mal-functioning equipment
* Comparative costing schemes between the satellite service operators

Just because different user communities are using the same data collection method (e.g. using buoys) does not mean that they are aware of each other and have a convenient way of exchanging experiences and techniques.

The range of users is wide. There is a broad spectrum of requirements for data collection devices for operational or research applications in areas such as –

* Agriculture
* Biodiversity
* Climate
* Disaster
* Ecosystems
* Energy
* Health
* Water
* Weather

The most challenging are data collection in remote locations where there is little or no existing infrastructure available. The issues are power availability and management and the size and weight of the data sensing device. In the case of animal migration studies it would be important to locate the changing locations of the data sensor.

Two main techniques are the inclusion of GPS capability in the sensor or doppler analysis of the uplink signal. In the first case the GPS information can be part of the data and be transparent to the satellite comms service. In the second case the location information would be provided as part of the satellite comms service.

Satellites in Geostationary orbits (GEO) have large footprints and fewer are necessary to provide global coverage. However because of the distance of the geostationary orbits more power is needed by the remote data collection transmitter. This can be mitigated with fixed position data collector equipment by using a high-gain directional antenna

Satellites in Low Earth Orbit (LEO) are closer and hence less power is needed, but they have much smaller footprints and large constellations of LEO satellites are needed to provide global coverage.

Both data sensor equipment manufacturers and satellite-based communication service providers are increasingly offering M2M (Machine to Machine) services alongside their traditional voice/fax/data services. The M2M services typically offer periodic or alert-based bi-directional transmission of low volume burst data. In some cases the satellite terminals have integrated programmable capabilities which can be customised to operate as simple tracker or as a more complex logger. Many of the devices include GSM capability as an alternative to satellite based data connectivity.

### Some examples of data sensing users and applications:

IO‐SAT and Skywave developed a solution to provide visibility of weather conditions for the mining industry in South America. The data collection platforms consist of a Campbell Scientific data-logger which captures the data and a SkyWave terminal which transmit the data from the data-logger to the Inmarsat satellite using the IsatData Pro service. The satellite transmits the data to the ground station and from there the data is distributed via the Internet. The data is the available to be viewed and downloaded through a browser. Alarms and events can be set up to generate emails and, if necessary, commands can be sent to the data-logger from the browser.

The Argos-3 downlink information contains orbital information of LEO satellites with an Argos-3 capability. This, for example, allows monitoring buoys to dive to depths of up to 2000 m and record data for up to ten days, before popping up to transmit all their data in a single pass, just as a satellite with Argos-3 capability flies over.

**Some examples of data sensing equipment:**



JouBeh 9602W SBD Controller Board

* Input Voltage: +4.5VDC to +32VDC
* Direct RS232 Communications via the standard DB15 connector
* Standard SMA connectors for both the Iridium antenna connector and the GPS RF passthrough
* Small size: 2.81”L x 1.90”W x 1.035”H



Skywave **IDP 600** series : Vehicle & Vessel Tracking and General Remote Asset Management

The IDP-600 series of terminals is designed for remotely tracking and managing fixed and mobile assets anywhere in the world, whether on land (IDP-680) or at sea (IDP-690).

**IDP-800**: Trailer & Container Tracking

The IDP-800 is a low profile, battery-operated series of terminals and is ideal for tracking unpowered equipment such as trailers, containers, railcars, vehicles and vessels.



**IDP-100**: Modems for System Integration

The IDP-100 series of modems is designed to be embedded into larger systems and provides a communications link to track, monitor and control industrial vehicles, vessels and equipment anywhere in the world



Skywave **IDP 700** series : Integrated Dual Satellite-Cellular Communication

IDP-780 satellite-cellular terminals allow fleet managers to realize increased flexibility and lower airtime costs for locating, communicating and remotely managing their mobile assets.

managing fixed and mobile assets anywhere in the world, whether on land (IDP-680) or at sea (IDP-690).





Typical buoy used with the Argos service (on NOAA and EUMETSAT satellites)

## Satellite Data Services Providers

### ARGOS

Argos has been used by biologists, marine scientists and the oceanographic community for nearly three decades, and is a dependable, true polar, operational data collection and platform location system. Argos-2 communication is one-way only, at 400 baud, with practicable data rates of the order of 1 kbyte per day. Transmissions by the mobile in this mode are unacknowledged by the system and therefore have to incorporate redundancy if data transfer is to be assured.

The latest Argos-3 service provides two-way communication which is used to provide additional energy efficient features and offers uplink data rates of up to 4.8 kbits/ s. The available data volume of the Argos-3 service is about 10 times the capacity of Argos-2

The system enjoys a particularly clean part of the spectrum (401.65 MHz), with minimal interference from other users

The downlink signal is processed by the Platform Messaging Transceivers (PMT) in the new generation of Argos platforms. With Argos-3, the downlink signal provides the capability for the satellite to indicate that the data has been received without error so the PMT can start sending its remaining messages. The downlink also provides orbit information which allows the PMT to calculate the exact time and duration of the next satellite with Argos capability. Consequently the data sensor’s transmitter need only transmit its data when there is a satellite in sight, reducing the transmission time and hence the energy requirements of the data sensor equipment and allowing for miniaturisation and attachment to smaller animals. The Argos system can then be used to track feeding, mating and migratory behaviour of animals in the wild.

A further feature of the service is that users of data sensing equipment can queue messages for their data sensors via Downlink Message Management Centre (DMMC), allowing maintenance operations like re-calibration or system reset to be performed.

The Argos service also provides the possibility of converting the collected data into a form suitable for transmission on the Global Telecommunication System (GTS).

The EUMETSAT Metop satellites, the NOAA polar orbiting satellites and the Saral satellite are equipped with Argos instruments. These satellites receive the uplink messages from the data collection equipment (4.8 kbit/s for 360 to 920 milliseconds) as they pass overhead and store the data on solid-state recorders. This data is subsequently dumped to the main receiving stations (4) once per orbit. The satellites also provide immediate re-transmission of the data in L-band suitable for reception by receiving stations within the satellite’s field of view (more than 65 stations). These receiving stations send the data to the two Argos processing centres for location determination, data processing and further distribution of the data products, allowing Argos users to get their data in near real-time (20 to 60 minutes) when the Argos platform is under antenna coverage. Users can receive their data via a dedicated user interface ([www.argos-system.org](http://www.argos-system.org)), telnet, FTP, Webservices.

Argos should be considered when the data volume is low and when size, power consumption and start-up time are important factors.

### DCP

Data Collection Systems (DCS) are operated by:

* **EUMETSAT** – Meteosat satellites with 1100 registered platforms
* **NOAA** – GOES satellites with 30,000 registered platforms
* **JMA**  – MTSAT
* **CMA** – Fen Yung
* **ISRO** – INSAT
* **Roshydromet** (Russia) – GOMS satellite Elektro L N1

[.....] Co-ordinated by Coordination Group for Meteorological Satellites (CGMS)

The DCS frequency range is 401 to 403 Mhz. The DCP platforms uplink the data in their assigned frequency channels. The received data is sent to and processed in the corresponding DCP center. In the case of the EUMETSAT DCP center, the DCP data can be distributed in several ways

* Satellite Multicast – EUMETCast in 3 footprints covering Europe, Africa and South America
* As Bulletins over the WMO Global Telecommunication System (GTS), with regional distribution points
* Internet (manual download and ftp push by request)
* Direct dissemination via the prime Meteosat Satellite (LRIT)

DCPs can be transmitted at regular intervals (pre-agreed) and/or as alerts (not exceeding 10 secs)

Standard Rate DCPs can be used up to100bps; High Rate DCPs can be used up to 1200 bps

Maximum number of messages per channel per day 960 for DCP, 8,640 for HRDCP

Maximum message size of single message 649 bytes for DCP, 65535 bytes for HRDCP

The target availability of the DCS is specified as better than 98%.

DCP platforms on moored buoys situated in the Indian Ocean acquire tide-level data from DCPs as part of tsunami warning networks.

DCP modems can use as much as 12W during transmissions.

### Globalstar

Globalstar is a US-based satellite phone service company and one of Iridium’s main competitor in the US market. Globalstar LEO satellites have an inclination of 52 degrees and therefore do not cover polar areas, due to the lower orbital inclination. For the simplex service most non-polar regions are covered, apart from the tip of South America and South Africa. The duplex service does not cover sub-Saharan Africa, or parts of South-East Asia.

Globalstar now has its complete 48 satellite constellation in space, but has fewer gateways than originally planned. But this is mitigated by the use of co-owned gateways or by the use of Independent Gateway Operators. The gateways provide connectivity from the satellites to the public switched telephone network and Internet.

The Company's products include mobile and fixed satellite telephones, simplex and duplex satellite data modems and satellite airtime packages.

Globalstar data solutions are used for a variety of asset and personal tracking, data monitoring and "Supervisory Control and Data Acquisition" or SCADA applications.

Services

* Voice Telephony
* One-way mobile-terminated SMS text messaging
* 9,600 bit/s circuit-switched datacalls
* 9,600 bit/s packet-switched Internet access
* One-way mobile originated short-burst messages (simplex devices only)
* Device geolocation within approximately 30 km

The Globalstar Simplex Modem STX-2 is designed to deliver reliable one-way digital data communications for remote sensing, tracking and monitoring applications. The STX-2 is a low cost, simplex module once integrated into a tracking or monitoring device, provides the ability to send packet-switched data automatically on a time or event driven basis. The STX-3 chip set has recently been launched which is a third of the size of the STX-2. Both cost and power have been reduced and the STX-3 is designed to be easily integrated into a broad range of M2M devices.

Proces start at $7.95/mo for 100 9-byte messages.

Globalstar satellites are simple "bent pipe" repeaters. The Globalstar service differs significantly from Iridium since a call has to be made the user in the same satellite footprint as a gateway station. There is no inter-satellite relay capability as in Iridium.

Globalstar have a range of SPOT products for satellite messaging that allows users to communicate from remote locations around the globe.  The SPOT product family uses Globalstar’s GPS satellite network to determine a customer's location and to transmit messages and GPS coordinates to others.

The Globalstar Europe ‘Home Zone’ currently includes all of Europe, North Africa and North America.  Customers do not pay roaming charges when travelling between these regions.

Globalstar provide a range of Postpaid Voice & Data plans from €0.15 per minute for up to 2,000 minutes.  Prepaid plans are available from €0.48 per minute for up to 1,000 minutes.

### Inmarsat

Inmarsat operate a fleet of geostationary satellites that cover the earth to around 70 degrees north and south. Originally a non-profit organisation providing distress communications for shipping, Inmarsat is now a commercial organization with products aimed at land-based users as well as those at sea. Inmarsat does not deal directly with customers - services to customers are handled by partners e.g. Skywave Mobile Communications.

Two services could be interesting to the data sensing community, IsatData Pro and BGAN.

#### IsatData Pro

IsatData Pro is the newest service in the Inmarsat family of services. It is specifically designed for remote telemetry and sensing applications where you need to send both alert and periodic information in real-time. It is a burst data service like Iridium SBD and Orbcomm.

IsatData Pro is an evolution from the IsatM2M, Inmarsat D+ and Inmarsat D services. It uses the Inmarsat 4 satellites and like its predecessors, it offers small terminals that require minimal power to operate. It has an availability of 99.9 per cent and expected lifespan into the 2020s. Unlike other satellite services, IsatData Pro permits greater flexibility in the amount of data that can be sent. Where previously you could only send 10s of bytes, with IsatData Pro you can send up to 6.4 kBytes of data and receive up to 10 kBytes of data (two-way service). Data can be sent at any time. The allocation of frequency/slot is automatically taken care of in the device.

IsatData Pro terminals (IDP brand) include GPS/GLONASS navigation for location information, integrated antenna for simplified installation, digital/analog/serial ports for connection to sensors, environmentally sealed enclosure for outside installation and an application processor for programming the behaviour of the terminal. IDP terminals are also ideal for low power applications, since the terminals are highly synchronized with the network and know when to wake-up and sleep to balance information transmission needs and power consumption. (9W in transmit mode, 1.2 W in sleep mode). The equipment has a 20 watt solar panel and battery. It is 12cm square and 5 cm high and includes antenna and GPS at the coat of approx 1000 US$.

Satellite-only and satellite-cellular versions of the IDP terminals are currently available. There are also versions that are used for ocean buoys.

The IDP series supports a wide range of security and location-based M2M services, from tracking and in-cab messaging for transportation fleets, transmitting telemetry information from oil & gas distribution equipment, to remote management and control of fixed assets.

#### BGAN

Broadband Global Area Network (BGAN) is Inmarsat’s “portable broadband” product. The

terminals are about the size of a laptop PC, and when pointed at the satellite will provide voice calls and IP data at speeds of up to 492 kbit/s. BGAN is sold as a landbased product only – the marine equivalent (which is physically larger, uses a stabilised antenna and has a top bit rate of 432kbit/s) is called FleetBroadband.

BGAN and FleetBroadband are priced differently. BGAN costs around $50/month in line rental, and then $7/megabyte. BGAN terminals cost between £1500 and £3000 depending on specification. BGAN terminals use around 0.5W in standby and 20W during transmission. Some

can operate from an internal lithium battery.

FleetBroadband has “free” line rental but charges $12/megabyte, subject to a minimum monthly amount of $30. FleetBroadband units require 150W – the extra power is needed to stabilise the antenna.

Both BGAN and FleetBroadband terminals are designed to operate from 12V or 24V supplies.

The Fleet 33/55/77 services are tailored to ship based usage. They offer voice, fax and dial-up data services. The Fleet terminals use stabilised antennas and consume up to 150W.

#### Global Xpress

Inmarsat are planning to introduce the Global Xpress (GX) service with the new generation of Inmarsat-5 satellites. The satellite network will deliver consistent high-performance download speeds of up to 50Mbps and up to 5Mbps over the uplink. The spacecraft will operate with a combination of fixed narrow spot beams that enable higher speeds through more compact terminals, plus steerable beams so that additional capacity can be directed in real-time to where it’s needed. It will be the first commercial operator to utilize Ka-band radio frequencies to deliver a global satellite service.

### Iridium

Iridium with 66 Low Earth Orbit satellites is the world's largest commercial satellite constellation. This global mobile satellite communications system, with voice and data solutions is owned by the Iridium Communications Inc. Company (McLean, VA, United States).

The Iridium System is a satellite-based, wireless communications network providing a robust suite of data services to virtually any destination anywhere on earth. Satellites are typically overhead for ten minutes at a time, but the system will hand-off calls automatically between satellites.

The Iridium system comprises three principal components: the satellite network, the ground network and the Iridium subscriber products including ocean platforms fitted with Iridium modems.

2 Iridium services are mainly used by in-situ Ocean and meteorological platforms:

* Short Burst Data (SBD)
* Circuit Switched Data / RUDICS

#### SBD

The SBD Service is designed for shorter sized data messages. SBD uses a proprietary network protocol to transfer data messages to and from the remote terminal.. Message size from the terminal can be between 1 and 1960 bytes. Message size to the terminal can be between 1 and 1890 bytes. Messages are delivered with a raw location (80% within 10 km) and data are received by email in attached file. Up to 5 different recipients email addresses are possible. Service is billed according to volume of data exchanged. Global network transmit latency for message delivery ranges from 5 seconds for messages of 70 bytes to approximately 20 seconds for maximum length messages. (Additional latency may occur across the Internet)

#### RUDICS

RUDICS is an Iridium data service that allows customers to send and receive data traffic over the Iridium network using an optimized circuit switched data channel. It utilizes circuit switching technology via a dial-up modem and ISDN for low-bandwidth data transfer for ISUs, enabling a host application to originate and terminate numerous connections simultaneously.

The service supports the transfer of relatively large data volumes (10’s of Kbytes and more) using the Iridium dial-up capability. The Iridium Data Module (IDM) places a call to the Public Switched Telephone Network (PSTN) or to another IDM then exchanges the data through that open circuit at approximately 2400 bits per second. The service is thus billed according to the length of the call which is in direct proportion to the volume of data being transferred. This service is bi-directional.

The RUDICS equipment supports the following service types: TCP/IP encapsulation, PPP, and MLPP. RUDICS also offers capability for multi-link Point-to-Point Protocol (PPP), in which multiple ISU’s can send data simultaneously across an N x 2400 bps PPP connection

#### Dialup

Iridium terminals can make or receive dial-up data calls just like a conventional

landline modem. The data rate is 2400bits/s. Calls are routed via a modem at the

Iridium gateway station, and can take up to 40 seconds to connect. Dialup costs in the

region of $1/min.

When dialling between Iridium phones the DAV feature can be used to reduce the latency on the connection. With DAV enabled, the call passes only via the satellites and not via Iridium’s gateway. Some airtime providers will give a discount for Iridium-to-Iridium calls.

#### Pilot

The Iridium service Pilot is replacing the OpenPort service. It offers an up to 134 kbps bidirectional broadband service. As a packet switched service, the costs are substantially reduced compared to circuit switched services.

#### Terminals

The standard Iridium module is the “9522”, which supports dial-up, RUDICS, and SBD. It runs on 4.4V DC and consumes 250mW in standby and 2500mW during a transmission. Each transmission burst (which is 8.2ms out of every 90ms) will draw a peak current of around 2.5A (=11W).

A smaller, lighter modem, the “9601” is available for use with the SBD service only.It runs on 5V DC and consumes 330mW in standby and 1750mW during transmission. Peak current requirement is 1.5A (=7.5W).

### Orbcomm

Orbcomm is a commercial satellite data service operator dedicated to M2M. Orbcomm operate a network of 25 satellites in low Earth orbit, offering a message based communication service. Orbcomm operates in the marine VHF band (138-148 MHz), and hops between frequencies to avoid interference. At this frequency Orbcomm can operate with lower power (compared with L-Band services), but it requires the use of a much larger antenna than other networks such as Iridium or Globalstar. Most antennas are basic "whip" antennas that can be several feet long. Smaller, more compact designs are available but with performance trade-offs

Orbcomm’s coverage is not continuous – holes in the coverage open and close as the satellites move – and they have only one polar-orbiting satellite, making polar coverage somewhat erratic.

16 Gateway Earth Stations (GESs) in 13 countries track and establish two-way communications with the Orbcomm satellites. The Gateway Control Centers (GCC) process the data and provide the interconnection to terrestrial communications networks. The Network Control Center (NCC), is located in Dulles, VA,

A M2M device is normally associated with just one gateway. Messages for the device are sent by to the associated gateway. If a satellite is in range, the messages are delivered in close to real-time. Otherwise, the satellite will store the message and attempt to forward it on when it next comes in range.

The uplink data rate is 2.4kbit/s and the downlink data rate is 4.8kbps. Messages are acknowledged by the system when correctly received and delivered to a user nominated mailbox. The platform position is determined, if required, using propagation delay data and doppler shift, or by an on-board GPS receiver. Position accuracy without GPS is similar to that offered by Argos, i.e. km-scale

As part of a $230 million expansion program, Orbcomm is launching 17 OG2 satellites on the new SpaceX Falcon 9 v1.1 launch vehicle in 2014. The OG2 satellites have advanced communications technologies and are significantly larger than the OG1 satellites. An OG2 satellite is the equivalent of six OG1 satellites, providing quicker service, enhancing coverage at higher latitudes and allowing for larger message sizes and increased data rates.

Orbcomm can offer:

* Two-way data communications throughout the globe
* A flexible, cost-effective combination of satellite and cellular data service (dual mode)
* A single source solution: Multiple networks, one agreement
* A robust portfolio of M2M solutions - from modems and chip sets to full systems solutions

**In 2013 Orbcomm reported** over 825,000 subscribers (M2M devices)

Orbcomm is best suited for users who send very small amounts of data. To avoid interference, terminals are not permitted to be active more than 1% of the time, and thus they may only execute a 450ms data burst twice every 15 minutes. The latency inherent in Orbcomm's network design prevents it from supporting certain safety-critical applications.

Message: 6 Byte Min to 8KByte Max Messaging Time: 5 to 45 minutes

Orbcomm has partner arrangements with other satellite providers including Inmarsat and Globalstar to extend the scope and range of its M2M products and services. That allows it to embed satellite partners' communication services into its devices. Some Orbcomm-compatible devices : -

Q1000 by QuakeGlobal Size : 64 mm x 64 mm x 16 mm Weight: 113.64 grams (smallest)

Q4000 by QuakeGlobal Size : : 99.3mm x 64mm x 15.9mm Weight:.170 grams

The Q4000 can be used with Orbcomm (Tx power: 5W min. - 10W max) or Iridium (Tx power 2W) or with GSM (850/900/1800/1900 MHz)

ORBCOMM services are much like email and messages can be easily integrated with business applications. Customer data can be retrieved or auto-forwarded via SMTP or HTTP/XML feed directly over the Internet or through a dedicated link

### Thuraya

Thuraya is primarily a satellite phone system which operates from two geostationary satellites covering Europe, the Middle East, most of Africa, central and south-east Asia and Australia. It covers all of European coastal waters and the Atlantic Ocean as far west as Iceland, the Azores and Cape Verde islands.

Thuraya offers dialup data at 9.6kbit/s, packet data (GmPRS8) at 60kbit/s downlink and 15kbit/s uplink, plus SMS messaging. A dialup subscription costs $35/mo and then $1-$2/min.

For packet data, the monthly fee rises to $55, including the first 5MB of data. Additional data is charged at $5.50/MB.

The ThurayaModule is a user terminal with a GPS receiver. It requires an external antenna, but the module itself is about the size of a pack of cards and weighs 60 grams. It offers the full range of Thuraya services. Some Thuraya modules are available with a 3W power consumption during transmit.

The ThurayaIP service offers internet access at around 450kbit/s, although this is a contended

channel shared between multiple Thuraya users. The terminal is A5 size and weighs 1.3kg. The terminal costs $4000, with airtime being priced at $550/mo for 138MB (=$4/MB). The flat rate price is $5000/month.

ThurayaMarine is a specialized phone designed for marine use. It uses around 36W in transmit mode.

## Some Non-satellite based Communications Possibilities.

### Project LOON

Project Loon is a research and development project being developed by Google with the mission of providing Internet access to rural and remote areas.

The project uses high-altitude balloons placed in the stratosphere at an altitude of about 32 km to create an aerial wireless network with up to 3G-like speeds.

The balloons are maneuvered by adjusting their altitude to float to a wind layer after identifying the wind layer with the desired speed and direction using wind data from NOAA.

Users of the service connect to the balloon network using a special Internet antenna attached to their building. The signal travels through the balloon network from balloon to balloon, then to a ground-based station connected to an Internet service provider, then onto the global Internet. The system aims to bring Internet access to remote and rural areas poorly served by existing provisions, and to improve communication during natural disasters to affected regions

The technology designed in the project could allow countries to avoid using expensive fiber cable that would have to be installed underground to allow users to connect to the Internet. Google feels this will greatly increase Internet usage in developing countries in regions such as Africa and Southeast Asia that can't afford to lay underground fiber cable

Solar panels about the size of a card table that are just below the free-flying balloons generate enough electricity in four hours to power the transmitter for a day and beam down the Internet signal to ground stations. These ground stations are spaced about 100 km (62 mi) apart, or two balloon hops, and bounce the signal to other relay balloons that send the signal back down. This makes Internet access available to anyone in the world who has a receiver and is within range of a balloon.

Each balloon provides Internet service in a 20 km radius covering an area of about 1,256 sq km

In full sun, the panels produce 100 watts of power, which is sufficient to keep the unit running while also charging a battery for use at night. A parachute attached to the top of the envelope allows for a controlled descent and landing when a balloon is ready to be taken out of service.

In the case of an unexpected failure, the parachute deploys automatically. The balloons typically have a maximum life of about 55 days, although Google claims that its tweaked design can enable them to stay aloft for more than 100 days

On 16 June 2013, Google began a pilot experiment in Christchurch New Zealand where about 30 balloons were launched.

### Solar-powered ultra-light unmanned aircraft

A proposed alternative to geostationary relay satellites is a special purpose solar-powered ultra-light aircraft (ULA), which would fly along a circular path above a fixed ground location, operating under autonomous computer control at a height of approximately 20,000 meters. Several implementations of this concept have been proposed in the past.

A prototype implementation was proposed in the United States DARPA Vulture project. The Vulture ULA would be capable of station-keeping over a fixed area for a period of up to five years and able to provide both continuous surveillance to ground assets as well as to provide extremely low latency communications networks.

Onboard batteries would be charged during daylight hours by solar panels covering the wings, and would provide power to the plane during night. Ground-based satellite dishes would relay signals to and from the aircraft, resulting in a greatly reduced round-trip signal latency of only 0.25 milliseconds. The planes could potentially run for long periods without refueling.

The initial US$89 million contract award was awarded to Boeing in September 2010. The Vulture ULA would be designed for a long endurance and high-altitude unmanned flight. The aerial vehicle would circle above any area that needs constant observation. It’s day and night cameras (each with a 600-mile swath) would send information back to ground bases. The drone would also be made of semi-flexible materials that would bend with the air instead of moving with it.

On April 2012, after more than 80% of the money had been spent, DARPA descoped the flight vehicle construction and flight test portion of the project.

However Boeing has continued with the concept and is developing the SolarEagle (Vulture II) as a High Altitude, Long Endurance (HALE) unmanned aerial vehicle solar-electric spy plane at its Boeing Phantom Works. It will remain airborne for five years at a time without needing to land and have a wingspan of 120m. SolarEagle will begin test flights in 2014.

Another company interested in ULA is AeroVironment (AV). The AV Global Observer is a high-altitude, long endurance unmanned aerial vehicle, designed by to operate as a stratospheric geosynchronous satellite system with regional coverage and using liquid hydrogen as fuel. Two Global Observer aircraft, each flying for up to a week at an altitude of 17,000 to 20,000 m, could alternate coverage over any area on the earth, providing a platform for communications relays, remote sensing, or long-term surveillance. In addition to flying above weather and above other conventional aircraft, operation at this altitude permits communications and sensor payloads on the aircraft to service an area on the surface of the earth up to 970 km in diameter, covering an area of 730,000 sq km.

Global Observer may offer greater flexibility than a satellite and longer duration than conventional manned and unmanned aircraft. The financial risk of a launch failure is much lower than with satellites.

Its first flight was in August 2010, The prototype crashed on its ninth test flight in 2011. AeroVironment recently signed an agreement with Lockheed Martin to seek opportunities together based on the Global Observer.

### GSM

Where coverage permits, GSM is a suitable option. The data rates that can be achieved are

GSM 9.6 kbps

GPRS 76kbps

UTMS 7mbps

Many of the M2M devices described above also include GSM capability. Although Inmarsat specialize in communication to ships they recognize the value of supporting GSM for use in the coastal regions.

Some satellite data service providers who offer dual mode devices, also support the capability of interworking with multiple Tier 1 cellular providers with a single billing arrangement. Others provide a single telephone number for the device which can be used for calls to the device whether by GSM or satellite. The support for dual mode may not continue, at least for handset equipment. Some vendors believe (because of the fast development in GSM features), it is unlikely that a user would carry a dual Sat/GSM handset as their only mobile phone.

For using GSM, typically there needs to be a base station within 35 Km. The transmission power in the handset is limited to a maximum of 2 watts for GSM 850/900 and 1 watt for GSM 1800/1900.

## A Coordination Mechanism for Users and Suppliers

### Guidelines

A coordination mechanism for users and suppliers could be established using a web site. The main aim of web site would be to make information available and to provide a forum for the exchange of knowledge and experience.

It is relatively easy to set up a website – there are many Open Source Content Management Systems available (e.g. wordpress). However it is very difficult to keep the web site from becoming lost among the millions of other web sites.

What is needed?

1. The web site must remain known (It needs to be found by Google)
2. It must be active
3. It must contain relevant information in a way that is easier to access than the alternatives

Less critical but important characteristics of the web site –

* It should be easy to use, navigate and participate
* It should provide fast access to relevant information
* It should minimize the maintenance activities that need to be done by the moderator
* It should encourage contributions
* The FAQ should contains substantial information
* It should contain links to the web sites of links to sat comms providers and manufacturers of data collection equipment – but how to prevent the links being stale?

The web site should not become a large repository of outdated information or long discussion chains.

FAQ and Discussions Boards are key ways to keep the web site active and useful. In practice it is often seen that the answers and comments into a discussion are very variable, and in many cases the responses are incorrect. This decreases the value of the FAQ and discussion board and makes it less interesting. This is looked at in more detail below.

### FAQ section

If a user of remote data collector equipment has a query, he/she can always use Google. The result however is often a long mixture of sales and advertising information.

It could be more efficient to be able to launch the query in a more focused forum, but to be useful the web site would need active participation of knowledgeable respondents.

How could that be achieved? The persons with the answers may not visit the web regularly.

But they may have other duties which could make the web site interesting to them –

* They may want to advertise new products/services
* They may want to notify the community of training events or conferences
* They may be promoting certain products with special discounts/tariffs
* They may want to advertise job opportunities
* They may be interested to find areas of demand which are not yet being covered by the products from other companies

Extending the web site to allow the above type of information to be posted may encourage the experts to visit the site on a regular basis.

But the expectations also should be realistic –

While allowing contributions to be made by data sensing manufacturers and sat comms service providers, it cannot be expected that they use the web site as the main way to provide information. After all they have their own company web site to do that.

However if they see large and active user communities using the site they will be interested in providing links and possibly answers to queries in discussion groups.

A specific question & answer site design has evolved in recent years, pioneered by [stackoverflow.com](http://stackoverflow.com) . It tries to combine the best of Wikis and discussion boards: users may ask a question, typically with a small write-up of context. Others can contribute and write answer articles.

The community can rate and comment questions and answers, so over time the most valuable stuff bubbles to the top, if sorted by rating levels. A frequently asked question with its canonical answer can be turned into a community owned question/answer.

→ Example site: [networkengineering.stackexchange.com](http://networkengineering.stackexchange.com)

Benefits : Users keep ownership of their question/answer articles   
Benefits : Quality of answers is gauged by the community to get a good relevancy sorting

Downside : Although tags and popularity ratings are available for navigating the information only google-style full text search is available for reporting

### Discussion boards

Although Discussions boards can be informative, in practice it is often seen that the comments into a discussion are very variable, and in many cases with the responses are incorrect. This decreases the value of the discussion board and makes it less interesting.

However the threshold for participation in bulletin boards is even lower than with wikis. Any user (with write access) can start a new formless thread on any topic. Typical discussion board software has no classification of any form except of offering separate boards per area of interest. For the given use-case no good criteria for splitting the board spring to mind.

But after more than a decade of stagnation, there is innovation in this software field. [discourse.org](http://discourse.org) adds a clever Web-2.0 style threading display and category tag feature. This makes reading a pleasure and offers some navigation by category.

→ Example sites: [discourse.ubuntu.com](http://discourse.ubuntu.com) or [bbs.boingboing.net](http://bbs.boingboing.net)

Benefits : Extremely low barrier to contribution   
Benefits : Good sense of how ideas evolve over time   
Benefits : Good integration for subscription and mobile notification

Downside : Moderator effort to watch, tag and (re-)classify discussion threads

### Information repository

A section of the web site should provide information on Data Collection equipment categorized according to power requirements/features

* Low power standby/transmitting
* Needs mains power
* Has integrated GPS receiver
* Supports multiple sat services
* Can use GSM

It should allow users to add comments on their experience with the equipment.

Some kind of tabular presentation would be convenient with a choice of ordering and a search capability for matching feature criteria. But it would be quite time consuming to keep the information up-to-date. In addition it would be necessary to prevent the information from being misused for marketing purposes.

### The hosting of the web site.

It may be important to have a neutral site for hosting the web site. This would lessen the risk that the site may be seen to have a bias in favor of the hosting organization.

Hosting the site with a WMO URL would be an advantage.

There are cloud services for hosting (e.g. Google sites), and many of them are free. But the hosting site should be stable with permanent (i.e. retrievable) storage of the information content of the web site.

### Users and Moderators

The Terms of Reference and operating principles of a Satcom Forum were discussed at a meeting in Paris on 3-4 October 2013. Within the Satcom Forum it is proposed that there would be specialist participants called FRUGs (Satcom Forum Representative of a User Group). While the FRUGs are expected to have detailed knowledge of the user community they represent, they will need a means to maintain contact and coordinate with their group and to exchange information with other FRUGs on common issues like data sensor equipment. The web site proposed above should cater for the needs of the FRUGs and the user groups that they represent. Indeed the FRUGs could be the best moderators of the information stored at the site concerning the group they represent and they could prime queries or provide answers in specialist discussion groups.

A rough order of magnitude of interesting items for such a site:

15 Satellite service providers

10 frequency bands and transmission technologies

40 vendors

100 Potentially interested research institutions

1000 individual users

10 moderators

### Summary

Given the problem solving mindset of the intended audience, minimum effort to contribution is a key requirement. Structured queries may be nice, but probably are not worth the deterrence of would be authors and the extra maintenance effort. A Question & Answer style site with pre-seeded questions and tags has the best chance of picking up interest. It must be accompanied by a small static web site for the very static information, like available providers, important technology background etc.

Users can explore questions by tags. The moderator's job would be mostly to deal with proper tagging and the occasional edit. To jumpstart the community, a moderator may also need to explicitly contact experts and ask them for input; ideally they may contribute directly. Probably some vendors will take the opportunity to contribute and answer questions as they come up - obviously from their point of view.

Hopefully the users who had their questions answered still check out the site from time to time and put in their opinion where they feel the vendor answer is biased.

## References

[1] Satellite communications systems buyers’ guideMichael Prior-Jones, British Antarctic Survey

[2] Developments in satellite communication systems David Meldrum 2008

## Recommended Text

The meeting noted the report of Mr Colum Grant (Doc03) and referred to the terms of reference provided in the Satcom report to EC-PORS (Inf08). The chair thanked Mr Grant for his extensive effort and research that was evident in this report, which provided essential background to the meeting. It reviewed the TOR for ET-CTS and agreed that, under the general OPAG-ISS and its ETs’ TORs, is the best placed group to support this activity.

It noted that only a few participants had direct experience in DCS issues and for those, the real expertise was with other colleagues in their organizations. It agreed that a sub team or task group could be established in ET-CTS but it would need to draw on these fellow experts who would need to be invited to be associate members of ET-CTS in order to be members of the task team. If it is agreed to establish the Satcom Forum, it will be necessary to define TORs for such a task team, and identify relevant experts to be members.

The TORs of such a Task Team should make it clear that ET-CTS will be providing technical expertise on issues related to DCS communications and technology. It would also include the requirement to escalate to other OPAG ISS teams issues that come from the Forum , such as data format changes, discovery metadata and so on. It is expected that at least one representative of ET-CTS task team would participate in the forum activities.

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