remote communication

The importance of selecting the right telemetry option...

OTT HydroMet

eBook

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Introduction

What is Telemetry?

Telemetry is a process of sending and receiving data, which is essential for remotely collecting measurements by transmitting them to receiving equipment for analysis and closer monitoring.

Throughout the environmental water cycle, including surface water, groundwater, coastal water, and everything in between, there are water quantity and quality measurements that need to be communicated at some type of regular interval.

The Importance

Telemetry is an important tool for near real time water resource monitoring as it enables **remote** data collection, as well as station access when two-way communication is possible. There are various telemetry options that can be used for monitoring in remote locations, so data can be accessed without an extra trip to the field.

Telemetry also provides the means to warn water professionals when specified field conditions go past a certain threshold.

For example, if water levels surpass 5 feet, alarms can go out as a warning. These thresholds are completely customizable. However, it's important to note that not all telemetry methods can provide real-time messages or data. These high-value benefits have led to the telemetry and telecom industries evolving at a faster pace than ever before.

What You'll Learn

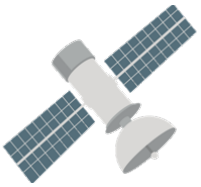
In this eBook, you'll learn about each major remote communication option available and the pros and cons associated with them based on different monitoring objectives and data needs. You will also see a deeper dive on newer telemetry options including Iridium satellites and cellular networks, and how two-way communication and alarm management can help you improve data quality and manage costs.

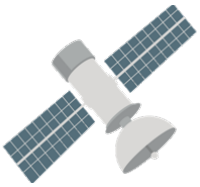
Telemetry Fundamentals

ENVIRONMENTAL SATELLITES

IRIDIUM® SATELLITES

CELLULAR NETWORKS





THE THREE MOST NOTABLE REMOTE COMMUNICATION METHODS

The Applications

Telemetry is used for gathering ground water, surface water, and precipitation measurements to inform:

- Water resource management
  - Water availability
  - Water use
- Meteorological research
- Environmental monitoring and climate data
- Weather forecasting
  - Natural disaster and episodic event predictions
  - Flood protection applications
  - Severe storm tracking

All over the world, many public agencies play key roles in water resource monitoring, from managing the quality and availability of water for public consumption to predicting water-related events that will affect the public. Telemetry provides the means to warn of rising water levels or high-intensity rain events to provide critical data for emergency response managers and the public through triggered alarm transmissions. This is important for flood warning especially.

These organizations, such as the US Geological Survey and the World Meteorological Organization, rely on data from thousands of monitoring applications in remote sites ranging from southern swamplands to streams in the mountains.

In addition to performing these tasks and providing photographic images, telemetry allows government organizations to perform remote data collection of hydro-metrological data from almost anywhere on the Earth.

Telemetry is valuable for anyone dealing with water quality (including nutrient monitoring, especially for nitrate and

phosphate within water) or water quantity (including water level, flow, and precipitation) collected from the field or in-situ monitors for the purpose of assessing current conditions or predicting long-term trends.

Advantages (& Disadvantages)

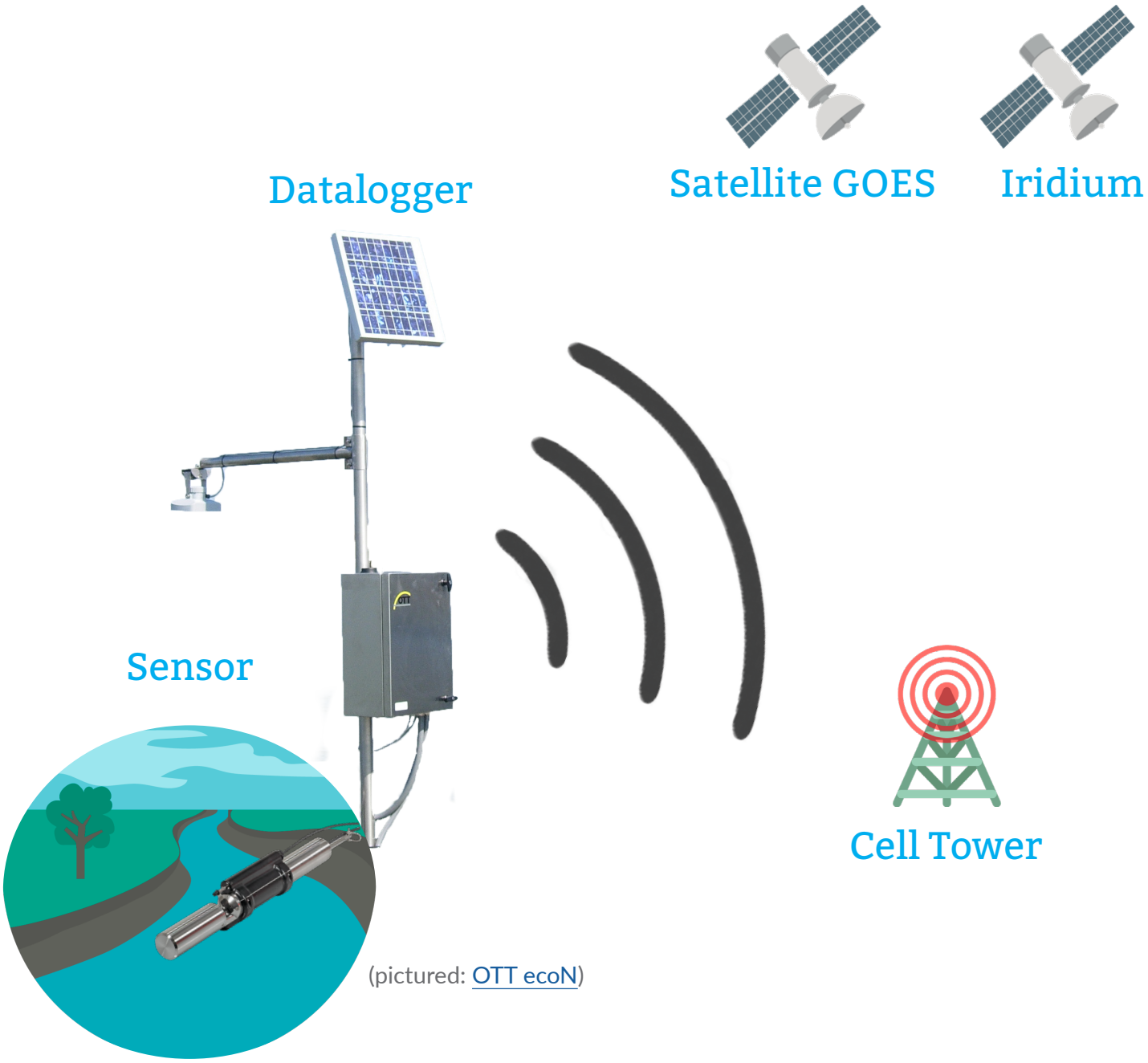
With telemetry, you gain the following advantages:

- Real-time or near-real-time data when you need it most
- A reduced amount of expensive field visits
- Better preparation for field visits to know what you need to bring to do the required job, e.g., to calibrate, maintain, or exchange sensors
- Remote network management
- Network health – current status of your monitoring status
- Change settings and use remote access to turn equipment on/off

It's important to note that there are a few associated downsides:

- Additional costs or time and effort to set-up the full system solution
- Needing the infrastructure (such as servers, data storage, cloud hosting, scripts in the background, and security) in place to manage the data

However, once a telemetry system is in place, the pay-off in data is immediate. There are also existing options to easily setup and manage new systems, including OTT HydroMet solutions.



Example: Remote communication of surface water monitoring data

Common options for remote collection of water quantity and water quality monitoring data include: GOES satellite, Iridium, and mobile/cellular communication.

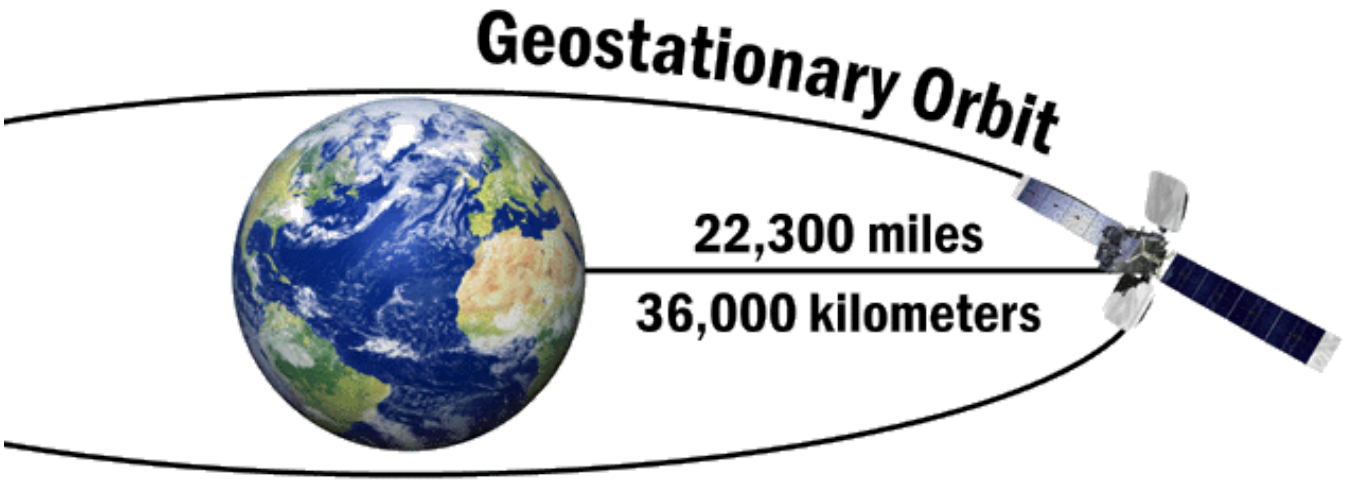
Telemetry Options

What are they?

Environmental satellites are high Earth orbiting geosynchronous satellites that follow a fixed geographic location on Earth, therefore appearing to remain in one place for observers. This means you only need to point receiving antennas at one location with no need for future adjustments.

There are many types of satellites around the world used for sending data collected from environmental monitoring systems and sensors: GOES, METEOSAT, HIMAWARI, FY, and INSAT. These are operated by different government or intergovernmental organizations, as well as public companies. The United States GOES system, the European METEOSAT system and the Indian INSAT system are examples of these systems. The GOES system is used by all US government agencies.

There are two primary GOES satellites located 22,300 miles above the Earth's surface, with one located over the Eastern US and one operating over the Western US. These two satellites cover Alaska, Hawaii, the entire continental United States, a majority of Canada and Latin America, and the Pacific and Atlantic Oceans. The GOES satellite system has been operating continuously since the 1970s by a division of the National Oceanic and Atmospheric Administration (NOAA) and this method of sending data via scheduled intervals has become a standard method of transmission.



How they work

GOES satellites transmit data only one-way via remote transmission, which can be any of:

- Scheduled data transmission
- Random data transmission
- Predefined intervals

One-way transmission means the system pushes data out but is unable to verify whether it was received by the satellite.

If you are part of a government agency or bureau, such as the USGS, you may automatically have access to the GOES satellite system for free. For outside cooperators, you should submit a request to The National Environmental Satellite, Data, and Information Service (NESDIS), which is an organization within NOAA created to manage US environmental satellite programs.

Channels are coordinated through NESDIS – they will assign you a transmission time and transmission channels. Time slots have limits and are typically 10-15 seconds long every hour and you'll only be able to transmit data through your system during this time slot. This system exists because the bandwidth of the network is relatively low and there is increasing pressure on the spectrum availability compared to what is available using other transmission technologies.

GPS time syncing is required for a transmitter to know the correct timing of data transmission, to

accurately ensure transmissions are sent at your proper assigned time slot. Sutron transmitters are equipped with highly accurate clocks, allowing around 30 days of accurate transmissions without the addition of GPS syncing.

GOES does support random transmissions through a separate channel assigned for alarms. This is also a one-way transmission, so you can't connect to the station and verify the data like you could with cellular. Additionally, there is a small chance of collision for alarm transmissions.

Did you know? GOES random transmissions sent through all Sutron transmitters are sent in sets of up to 3. This is to highly increase the likelihood of at least 1 going through.

Advantages

- Very reliable, even during major natural disasters
- A low annual cost
- Available anywhere within the coverage area
- Supports real-time alarms (but small chance of collision)
- Geostationary, for a fixed sky location
- Generally low power, as they only transmit during their time slot
- Use of GPS helps guarantee timing, transmission stability, and reliability

Geostationary satellite remote stations are generally very easy to setup, maintain and use because the satellites are at a fixed location in the sky requiring minimum antenna pointing efforts. They are also able to operate at low power, requiring only battery and solar panel charging for the majority of stations, but still consume higher amounts of power during transmission than other popular methods of telemetry in comparison.

Disadvantages

- No two-way communication
- All data is available for public consumption
- Does not have polar region coverage
- Requires approval from NESDIS
- May have higher hardware costs
- Low network bandwidth – limits amount of data transmitted
- Environmental data only
- Restricted transmission window, typically of 10 seconds at a defined time slot
- Random transmission scheme may have collisions with other transmissions

Having no two-way communication can especially be a hurdle depending on the location and importance of your station. If the station setup needs to be updated, or a minor issue needs to be addressed, someone has to go into the field to adjust it. This can eat up unnecessary time and money, especially if the site is remote or difficult to access.

Sutron dataloggers with an integrated GOES transmitter are commonly used for long-term continuous monitoring of key environmental parameters. For more information on a such solution view Sutron SatLink 3.

Key Takeaways

The GOES system is ideal for US government agencies that do not require immediate data. Although there is relatively low bandwidth for the network, with only 10-15 second time slots per hour to send data, for many hydrometric and meteorological applications this bandwidth is more than sufficient.

Overall, water resource professionals should turn to GOES satellites when they need highly reliable, low cost, one-way scheduled data and alarm transmissions.

Example: OTT HydroMet GOES Station featuring the OTT RLS Water Level Radar

Telemetry Options

2 Iridium Satellites

What are they?

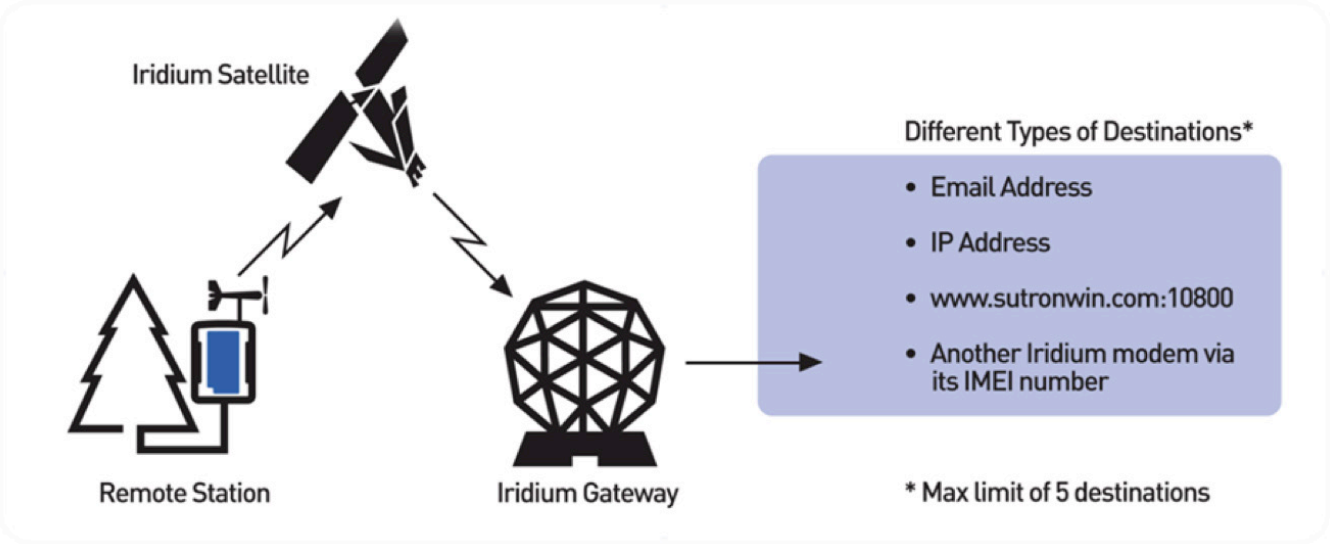
Iridium telemetry satellite technology uses a network of 66 active low-earth orbiting satellites managed by Iridium Communications to provide robust global communication services very reliably and with low latency. In contrast with the publicly owned GOES Satellite System, Iridium is privately owned and allows you to access your data as frequently as you'd like, but for a fee based on the amount of data being sent. Iridium also allows for two-way communication, allowing you to communicate with your dataloggers and change your configurations as desired.

Iridium is noted for its alarm transmission capabilities, allowing you to receive real-time data when certain thresholds have been reached or passed, without transmission collision concerns.

How they work

The network of Iridium satellites is low Earth orbiting and polar orbiting – at any point in time and any place on Earth, there is one satellite on the horizon you can use for your needed data. They form a fully meshed network that uses remote data transmission with short burst data, cyclical and threshold-based data transmission, user defined intervals, and two-way communication.

Your station will need an Iridium antenna with a clear view of the sky for this process to begin. Data starts from the nearest low orbiting satellite to your station and then travels satellite to satellite until it reaches the Iridium Gateway in Arizona, a process that typically takes 5-10 seconds.



Short burst data (SBD) is used to both send and receive data packages, which are between 10-340 bytes each.

Once your data reaches the Iridium Gateway, it is then provided to your server. Data notifications can be sent via email, direct IP, a Local Readout Ground Station (LRGS), or software solution like the Hydromet Cloud. You can create robust systems with multiple alarm, or siren, stations and a control center.

Certain Sutron devices such as the SatLink 3 and XLink 100 and 500 can send longer packages by separating them into multiple transmissions, allowing you to transmit up to 1,700 bytes.

With a data monitoring tool like Hydromet Cloud, you can monitor your data, view and set-up alarms. and receive support from the OTT HydroMet team.

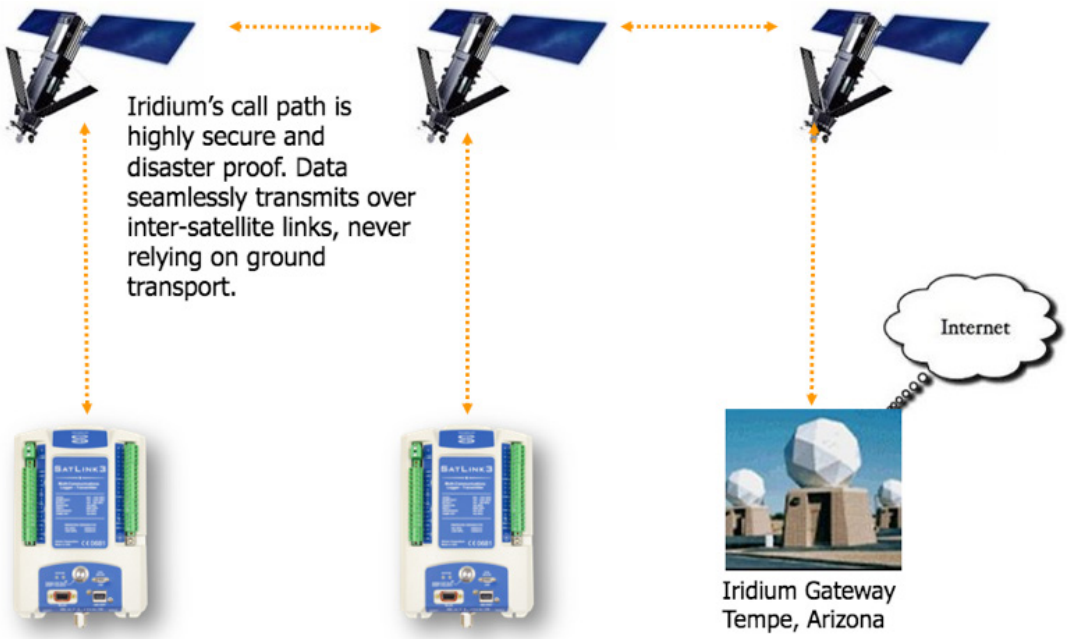
Advantages

- Extremely reliable
- Full global coverage
- Two-way communication
- High availability of data
  - Receive immediate alarm transmissions
- Well situated for underserved or remote locations (as long as there is a clear view of the sky)
- Relatively low power consumption
- Small footprint of modules
- No concern of transmissions colliding with each other – each station has its own unique IMEI ID number and communication handshakes to the satellite are handled in the background automatically

Iridium satellites are extremely reliable as there are 66 satellites in a fully meshed network, and each satellite can receive and forward data being received from origination stations. Two-way communication is especially valuable to save trips to your site and send updates/changes between a remote station and a back office or server.

Disadvantages

- Fee-based service based on how much data you send
  - Expensive for higher volumes of data, especially with pictures or time stamps
- Suited to transmit lower volumes of data with less frequent updates



Example showing Sutron SatLink 3 with integrated Iridium Modem

What is Two-Way Communication?

Two-way communication allows you to remotely make requests, send configurations, and more back to your station without having to make an additional field visit. You can ask the remote datalogger to send data, including diagnostic data that may not be regularly transmitted. In turn this data provides information about the site that can be obtained before going into the field to better prepare you for site visits and assess whether a visit is necessary or urgent.

Benefits include:

- Reduced number of site visits with remote site access:
  - Download data
  - View/access diagnostic data
  - Turn on/off instruments
  - Change measurement setups/configurations
  - Complete network management possible – move from single station management to network management
- Reduced maintenance cost with remote user access
- Improved data capture and prevented data gaps by asking for data that may be missing

The added value of remote communication is even higher during rare events – remote access to your station could help you collect more data and more often.

By considering the cost and time saved if you can reduce even one site field visit, you can often recover the added cost of selecting a telemetry option offering two-way communication.

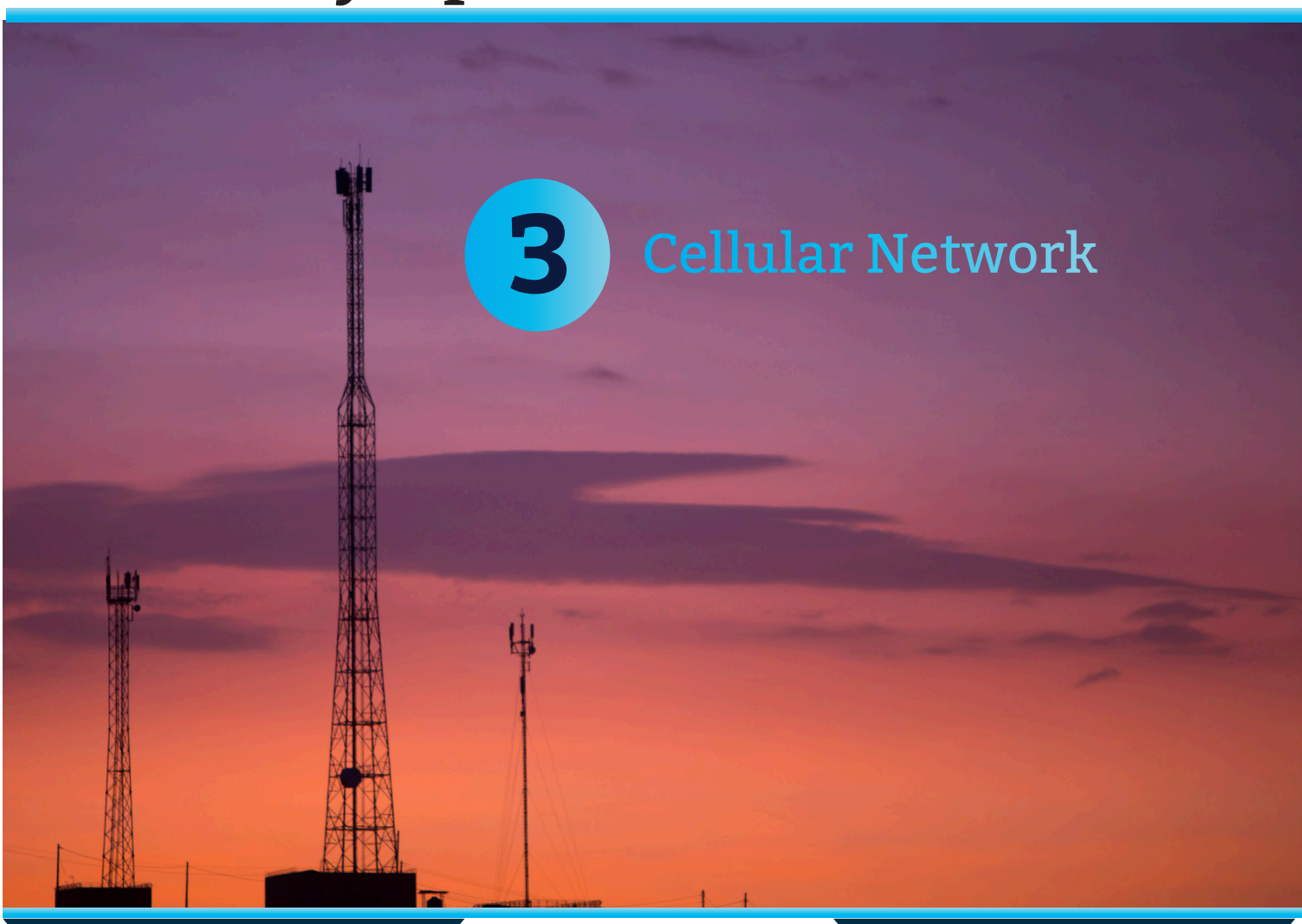
Key Takeaways

Overall, Iridium satellites provide the capability for a completely wireless end-to-end data solution. They are ideal for those who need two-way communication, private data, and/or highly remote station locations. Iridium is also suited for alarm transmissions for those who don't need very regular data updates but do need to know when a certain threshold has been passed.

Iridium is best for when there is a need for lower volumes of data but higher data availability.

OTT HydroMet logging transmitters such as the Sutron loggers support integrated Iridium modems. For more information on such solutions view Sutron SatLink 3 and Sutron XLink 100 and 500.

Telemetry Options



3 Cellular Network

What is it?

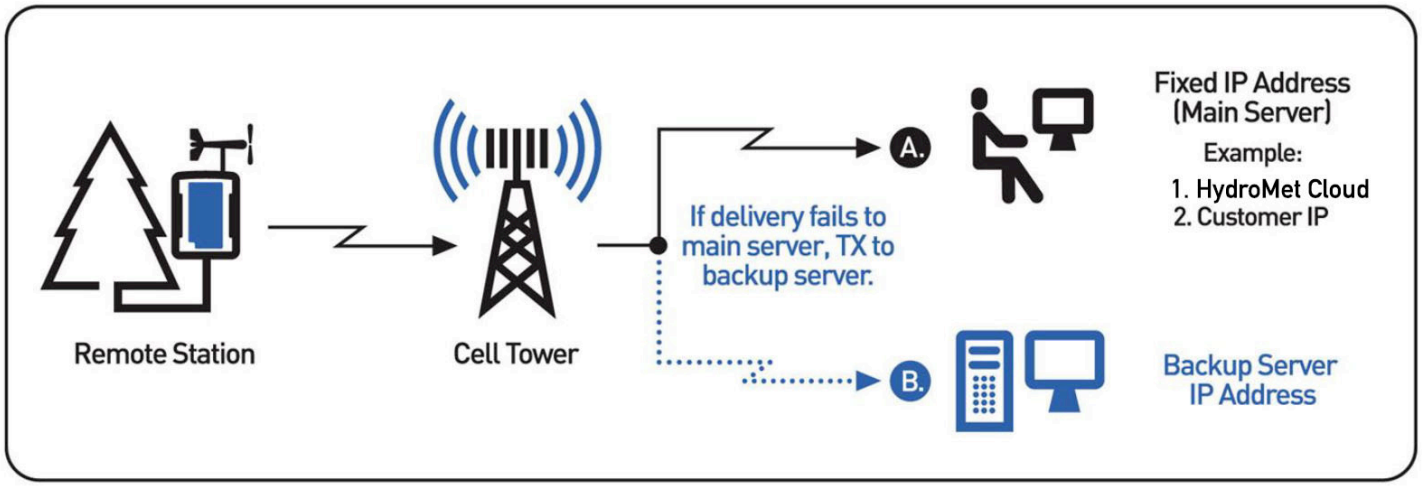
This method of remote data transmission relies on the cellular technology we use in our day to day lives. With the growth of digital cellular technologies, such as General Packet Radio Service (GRPS), Code Division Multiple Access (CDMA), 4G / LTE, and in the future 5G as well as IoT connectivity, the use of remote data collection and high-speed data transmission services using IP technology are becoming ever more popular.

How it works

You need cell access at the location of your station in order to use cellular networks. Networks are typically distributed over land areas, with multiple base stations to provide cells with coverage. Cellular transmission may not work for very remote locations, where cellular coverage is hard to access. If you are at a location with weak signal, you can install standard and high antennas to increase the signal for your site.

The various options available for cellular data transmission include:

- SMS
- GSM/GPRS(2G), CDMA, HSPA/ HSPA+(3G/3.5G), 4G / LTE, 5G, Cat-M1, NB-IoT



Environmental sensor and datalogger manufacturers have kept pace with recent trends to offer integrated hardware and software application solutions where the user only needs a data plan, SIM card, or appropriate account with a cellular provider to get data from the field to the desktop. Dataloggers now often have modems built into them to transmit data through IP technology.

Different regions globally use either 2G/3G, CDMA or 4G and in the future 5G, digital cellular. Various technologies are available depending on the country you are in. Generally speaking from a technology standpoint, the support for Internet protocol (IP) services are similar. The cellular network providers offer data plan products that target the increasing demand of machine-to-machine (M2M) communications and it is common to have a third-party company offer managed services and connectivity solutions that can be more competitive than the principle cellular service provider.

Other available options include enhanced security services by leveraging VPN technology, custom APN access, and Static IP addresses. Typically, users consider the network coverage, recurring fees, and application requirements when selecting the best cellular option.

Other options which are emerging are new standards published under 3GPP - release 13, which are called CAT-M1 and NB-IoT. These standards

are intended to provide the next generation of IoT connectivity. CAT-M1 is supported mainly in the US by major providers like Verizon and AT&T.

Outside the US, with focus on Europe, the NB-IoT technology is currently being pushed forward.

Advantages

- Available anywhere with cell access
- Much higher bandwidth for remote stations
- Two-way communication
  - Made possible with IP based methods: client/server architecture, network management
- Reasonable pricing
- Supports features of IP communication
- Scheduled and alarm data transmissions
- User defined intervals
- Lower cost option to send pictures taken by a camera on site

Depending on the needs and budget of the organization, modern cellular technology can be an attractive option for many, especially since the monthly fee for these services has decreased significantly in recent years. Furthermore, technological evolutions have also improved the speed and coverage. With these improvements there are older technologies that have or will sunset in the coming years. For example, in the US Verizon, a major service provider, will no longer support technologies < 4G after December of 2019. This includes CDMA.

Disadvantages

- Transmission costs
- Two-way communication relies on data plan
- Not suited for very remote locations, relies on cell service
- Not as reliable as satellite transmission
- Wireless signals can be weakened or prevented by interference
- Signal can be delayed if not prioritized by your data provider

With cell service, there's always a chance your transmission could be delayed. Physical objects or installation enclosures surrounding the antenna, as well as environmental factors, distance, and limited network bandwidth can all affect the strength of the signal. These are concerns when real-time data is crucial.

When deploying a new network or remote monitoring stations and building the infrastructure, it's important for the implementation team to consider the following factors: service providers & coverage, reoccurring costs, reliability, longevity of service or sustainability of mobile network, and need for IP based methods, such as client/server architecture or network management.

Sutron products continue to address changes within mobile communication by offering removeable and replaceable option cards. As new technologies are developed, customers only need to swap out the modem card rather than replace the entire unit. For more information on such solutions view Sutron SatLink 3 and Sutron XLink 100 and 500.

Key Takeaways

Cellular networks have become one of the most attractive remote transmission options due to the advancements made in recent years.

The price is steadily decreasing, they consume low amounts of power in comparison to satellite transmissions, and they can transmit high volumes of data close to real-time. It is only when a signal has the potential to be weak or nonexistent that it is wise to not consider cellular networks.

Example: Water Quality Monitoring Buoy featuring a Hydrolab Multiparameter Sonde and OTT HydroMet Datalogger with Cell Communication

The Data Transmission Journey

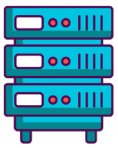
Once you have selected a method to transmit your data, how does your data from the station reach you in your office? There are numerous programs, cloud systems, and communication methods to take your data all the way to you. The typical journey can be charted as the following:

Sensor

(pictured: OTT ecoN)

Datalogger

(pictured: Sutron SatLink 3)



Server

Reaching the Server

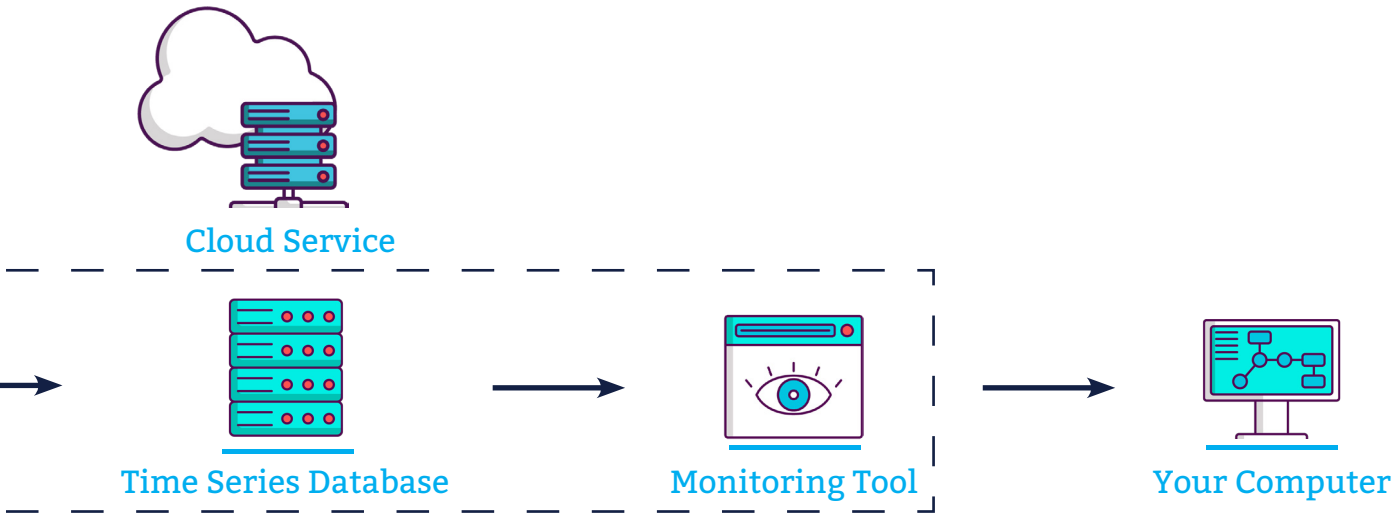
The data is first sent from the datalogger, through an established connection, to a server. Each data transmission contains a certain number of bytes, and some telemetry options can handle higher bandwidths than others.

These data transmissions are communicated from the source to the server via protocols. IP protocols are one of the most popular options because they are standardized, and the IP protocol family continues to grow, which includes:

- TCP/IP
  - Transmission Control Protocol/Internet Protocol is the term for internet protocols. It specifies how data is exchanged over the internet – TCP specifically defines the channels of communication and how a message is packaged, while IP defines how to address and route each packet. TCP/IP defines the network and the transport of the data.
- FTP
  - File Transfer Protocol is used for the purpose of transferring data. When data is sent to an FTP server, a data center can now download this data to use for desired applications. FTP is a good choice when you require a server located outside of the internal network, and when data needs to be downloaded on-demand.
- HTTP
  - Hypertext Transfer Protocol is used by the World Wide Web to manage communications between web browsers and servers. For data transmission, you'll need to send to an HTTP server. The HTTP protocol allows you to adjust datalogger settings remotely.

Having standardized protocols and formats allows for easy integration into existing IT infrastructures.

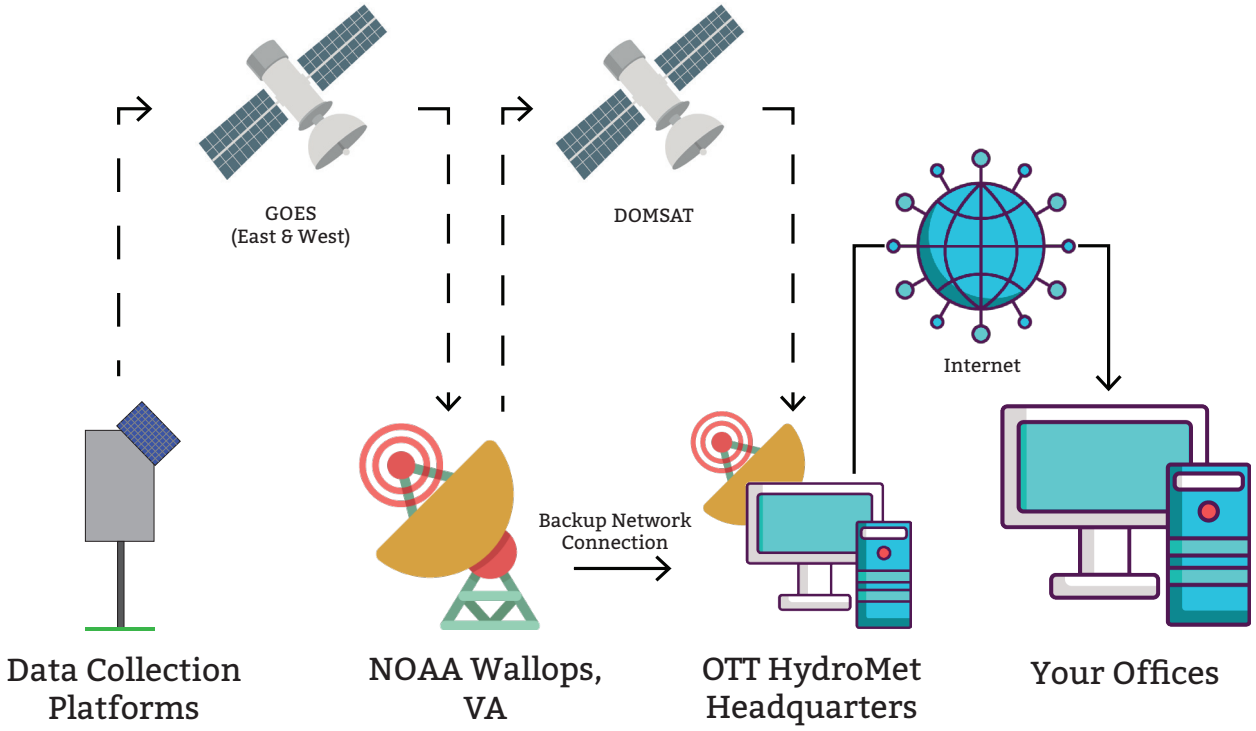
For the data to be sent via IP communication, an IP connection first needs to be established, and then a connection to the server with either a symbolic address or raw IP needs to occur. The data is then sent using the chosen protocol (such as HTTP(S) or FTP(S)) and chosen format.



GOES

All data going through the GOES system has an assigned station ID. Your data travels from your station's dataloggers to either the East or West geostationary satellites and then back to Earth to ground station receivers. If you have a Direct Readout Ground Station (DRGS), you can receive messages directly from GOES. Otherwise you can utilize one of the NOAA systems for transmitting data. One is the retransmitting of received data to a domestic communications satellite (DOMSAT) and receiving the data with receivers such as LRIT\HRIT or DOMSAT receivers. You can use various softwares such as LRGS to collect this data.

Another NOAA system supports direct transmission via internet, using a TCP socket protocol, where you can retrieve historical data or a real-time stream.



Iridium Vs Cell

There are some notable differences in how data can travel from a station to a server when comparing Iridium and cellular. The example below compares and contrasts the Sutron SatLink 3 logging transmitter capable of supporting Iridium or mobile communication.

	Iridium Satellite	Cellular Mobile Networks
Transmissions	**EMAIL or IP ADDRESS** -Send to an email or IP address as set up in the Iridium Registration Process. May select from 1 to 5 of the following type addresses: email and/or direct IP/port	**INTERNET IP** -Transmission to Internet IP (Server) address with failover to optional back-up server address **SMS** -SMS transmissions sent to up to 3 phone numbers
Reliability	High – due to availability of the highly reliable Iridium Satellite Network	Not as reliable, especially for emergency or alarm transmissions. Can encounter coverage issues, SIM compatibility issues, and high latency depending on whether the network has congestion or poor signal.

Starting with transmissions, cellular can transmit data via IP to one or more independent primary servers, can send data to cloud hosting services such as Hydromet Cloud via IP, and also send and receive messages via SMS transmissions. SMS is a way of sending data to your personal phone, which can be useful particularly for receiving alerts, and can be sent directly from your station or from a time series database. From the station, you can also send SMS to change any set-ups and configurations.

That said, Iridium can also do transmissions via IP. However, bandwidth can be a limitation as the transmissions need to be less than 340 bytes per transmission or multiple transmissions will be sent (up to 5 max). Iridium data can also be sent via email, into a server via DirectIP, or into an LRGS solution (LRGS allows a server to read data from multiple ports). If you are considering Iridium, ensure you are reviewing how the data can be received and what systems or infrastructure you need or need access to. Unlike cell, there are a limited number of cloud solutions that can ingest and decode Iridium data. One example of a Software as a Service (SaaS) solution that works seamlessly with Iridium data is Hydromet Cloud.

Cell is much faster of the main telemetry options, but it does require a fully functioning network with a carrier, SIM card, and more. Iridium allows you to bypass that level of infrastructure as it is a much simpler system, since it's global.

Two-way communication via cellular and Iridium also has a few notable differences.

- Cell:
  - Internet IP: command response via real-time interactive session using LinkComm, provides high bandwidth for remote station access
  - SMS: Command response only
- Iridium:
  - Command response only

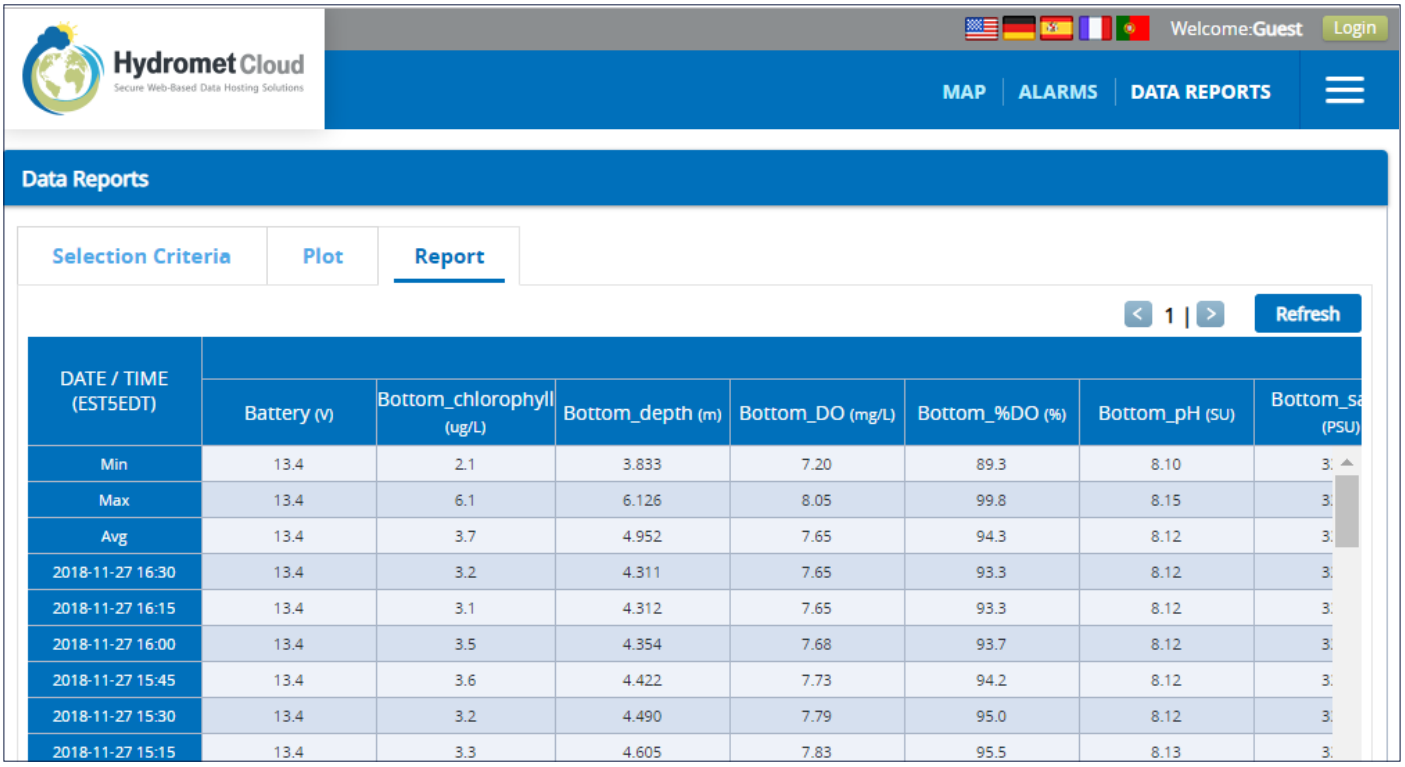
Cellular allows a user to not only receive data across an IP and SMS but will also allow a user to send commands to the station. It is basically a real-time two-way communication across both the internet IP and SMS. 2-way IP communication is by way of a static IP, redirector or VPN. If using a client/server architecture the measurement site is a client with no static IP address.

Iridium also allows a two-way communication, but the commands are via email. However, these email messages should still reach the station in very near real-time.

Viewing the Data

Once the data has reached a server and is then stored in a database, you need a way to view it. A monitoring tool can serve as the connector between your computer and the database. Monitoring tools give users their own accounts protected with usernames and passwords, to allow you to see the data from all of your stations in one place.

A cloud-service involves a third-party collecting the data on their servers on your behalf, creating a simpler and less time-consuming user experience. The alternative would be creating your own infrastructure for an On-Premise Solution, with servers that need to be installed and constantly maintained. A cloud service allows you to simply login to the website to view your data.



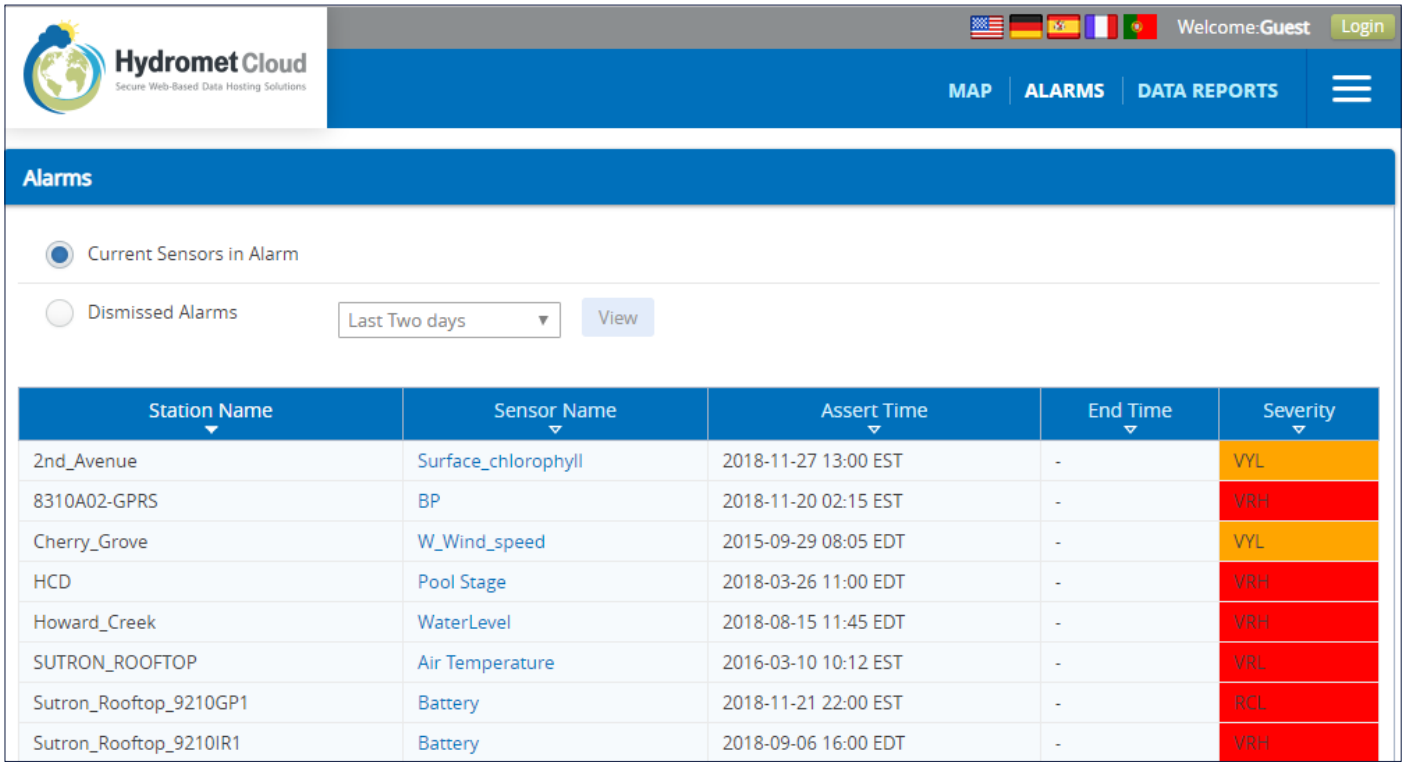
DATE / TIME (EST5EDT)	Battery (V)	Bottom_chlorophyll (ug/L)	Bottom_depth (m)	Bottom_DO (mg/L)	Bottom_%DO (%)	Bottom_pH (SU)	Bottom_sa (PSU)
Min	13.4	2.1	3.833	7.20	89.3	8.10	3.
Max	13.4	6.1	6.126	8.05	99.8	8.15	3.
Avg	13.4	3.7	4.952	7.65	94.3	8.12	3.
2018-11-27 16:30	13.4	3.2	4.311	7.65	93.3	8.12	3.
2018-11-27 16:15	13.4	3.1	4.312	7.65	93.3	8.12	3.
2018-11-27 16:00	13.4	3.5	4.354	7.68	93.7	8.12	3.
2018-11-27 15:45	13.4	3.6	4.422	7.73	94.2	8.12	3.
2018-11-27 15:30	13.4	3.2	4.490	7.79	95.0	8.12	3.
2018-11-27 15:15	13.4	3.3	4.605	7.83	95.5	8.13	3.

Example: Data hosting solution with report capabilities

A good example of a web/cloud system is Hydromet Cloud. Hydromet Cloud is a powerful tool for displaying your data as it is collected, and even plot or graph it sensor by sensor. You can find all your information in one central dashboard. You can set alarms on your data for thresholds, and the Cloud can even send email alerts to you based on your configurations.

Hydromet Cloud can also take data from multiple sources and put the data into a single format for users. This service is hosted by OTT HydroMet and is especially useful for organizations who need a monitoring network but don't have the IT infrastructure to build a backend network to support an in-house model.

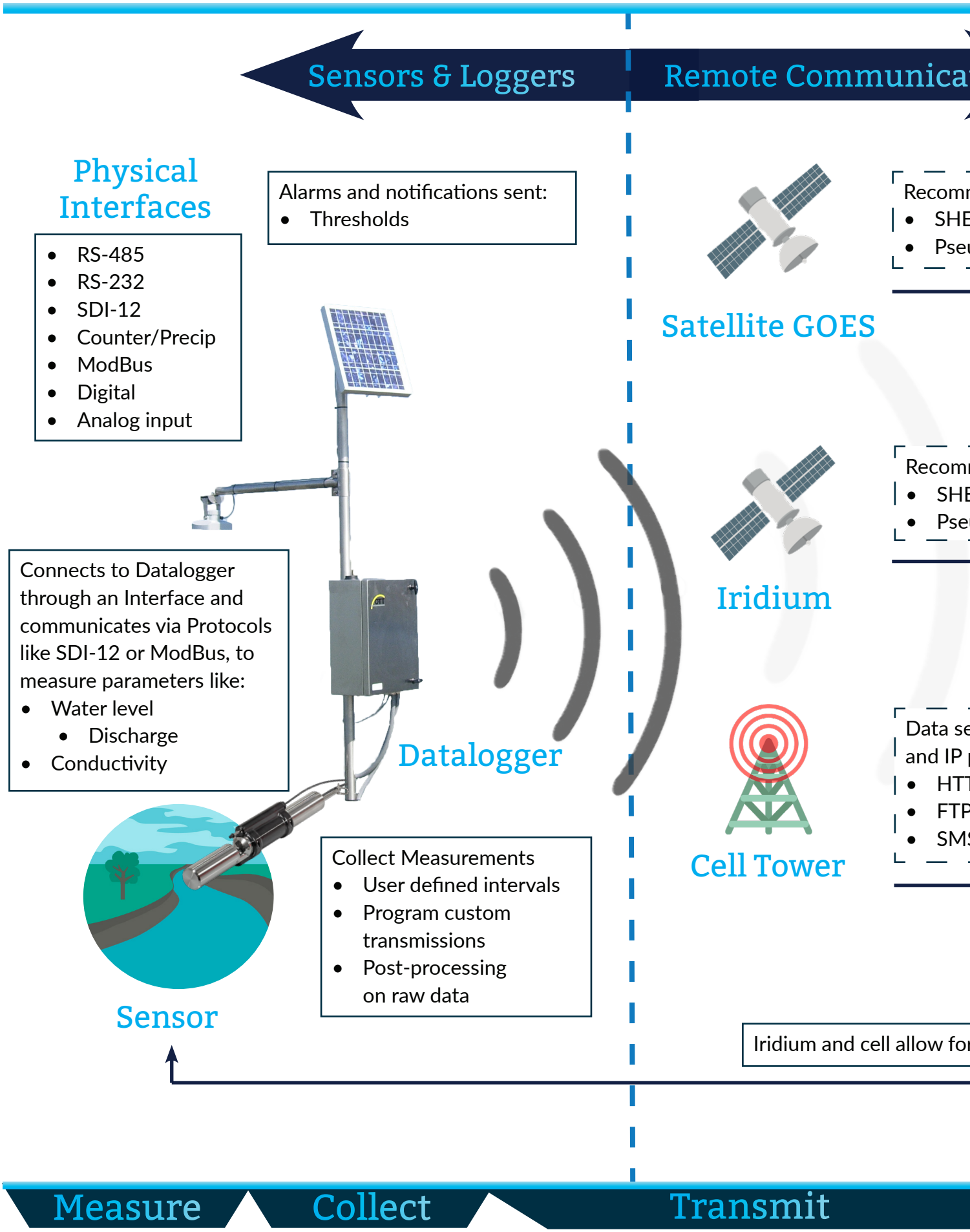
The back-end of Hydromet Cloud is Tempest, which is a universal receiver that can provide unlimited local storage for your raw station data. It also includes a toolkit with multiple capabilities including data retrieval between a LRGS and database, message decoding, database configuration, and more.



Station Name	Sensor Name	Assert Time	End Time	Severity
2nd_Avenue	Surface_chlorophyll	2018-11-27 13:00 EST	-	VYL
8310A02-GPRS	BP	2018-11-20 02:15 EST	-	VRH
Cherry_Grove	W_Wind_speed	2015-09-29 08:05 EDT	-	VYL
HCD	Pool Stage	2018-03-26 11:00 EDT	-	VRH
Howard_Creek	WaterLevel	2018-08-15 11:45 EDT	-	VRH
SUTRON_ROOFTOP	Air Temperature	2016-03-10 10:12 EST	-	VRL
Sutron_Rooftop_9210GP1	Battery	2018-11-21 22:00 EST	-	RCL
Sutron_Rooftop_9210IR1	Battery	2018-09-06 16:00 EDT	-	VRH

Example: Viewing sensors currently in alarm

The Data Value Chain



tion

mended Data Formats:
EF
udo Binary B

mended Data Format:
EF
udo Binary D

ent using modem
protocols:
TP(S)
P(S)
S

GOES data received by NOAA in Virginia --> LRGS --> Receive data via:

- LRGS
- Hydromet Cloud

Iridium data received by Gateway in Arizona --> Receive data via:

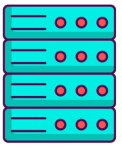
- Email
- Direct IP/Port
- Hydromet Cloud

Receive data via:

- Server
- Static IP address via FTP
- SMS
- Hydromet Cloud

Receive data using On-Premise servers and view using a monitoring tool like Tempest

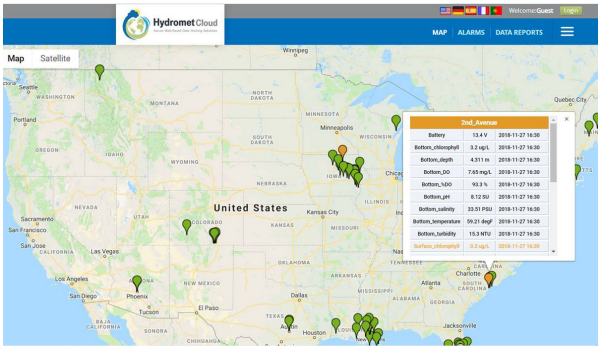
Server



Time Series Database

Monitoring Tool

View data using monitoring tools like Hydromet Cloud from your browser



r two-way communication between your station and your computer

Receive

View

Comparing Telemetry Options

When selecting a telemetry option, it is important to start with the problem or challenge that you are trying to solve. A helpful exercise is comparing the most popular options available based on your own needs.

Do you or will you require alarms, two-way communication, data more often during events, or data redundancy? By comparing the pros and cons of each option you can identify what type of telemetry best meets your needs.

Environmental satellites, Iridium satellites, and cellular mobile communications are generally the 3 most widely used telemetry options today. Historically, radio telemetry has also been a popular option since the 1960's, but it has since become outdated due to other options taking advantage of newer, faster technology.

Main Features

	Geostationary Satellite	Iridium Satellite	Cellular Mobile Networks
Reliability	High	High	Depends on load/ bandwidth
Two-way Communication	✗	✓ (latent)	✓
Data More Often	With Hybrid solution	✓	✓
Alarms	With Hybrid solution	✓	✓
Bandwidth	Limited	Limited	High - Depends on plan
Operational Cost	Typically none	Low to High - Depends on amount of data	Low to Medium - Depends on amount of data
Latency (Delay Receiving Data)	Medium/Low	Low	Low
Service Availability	Global - remote (no polar coverage)	Global - remote	Depends on service provider and coverage
Transmission Formats & Protocols	Most common - SHEF, Pseudo Binary B	Most common - SHEF, Pseudo Binary D	IP protocols: FTP(S), HTTP(S)

Main Benefits

Geostationary Satellite	Iridium Satellite	Cellular Mobile Networks
• **Reliable** data transmission during major events, e.g., hurricanes or floods • **Free** of charge for most government and local organizations • **Low power**	• **Reliable** data transmission during major events, e.g., hurricanes or floods • **Alarm messages** via email and TCP/IP • **Remote** station access	• **Very flexible** IP transmissions, and high bandwidth can transmit measured data as well as meta data • Data transmissions to **multiple servers** (redundant) w/ different IP protocols e.g. FTP, HTTP or HTTPS • **User defined** transmission intervals, from large to small intervals, with ability to adjust in alarm states

Main Applications

Geostationary Satellite	Iridium Satellite	Cellular Mobile Networks
• Remote transfer of hydro or meteorological data • Weather forecasting • Climate data • Severe storm tracking • Meteorological research • Environmental monitoring	• Remote transfer of hydro or meteorological data • Receive alarm messages and interact with station • Two-way communication permitting remote station access	• Used from urban hydrology to nutrient monitoring • For sites collecting more data, more often • For datasets with greater density, made up of measurements collected frequently or additional parameters such as meta data
Locations including: • Places with a clear view of the sky	Locations including: • Places with a clear view of the sky	Locations including: • Places with strong cell signal

Main Factors to Consider

Location/Availability • Remote with harder to reach signal, or city with easier access? • What is the service availability?	**Two-way communications** • Ability to remotely access a station datalogger or sensor	**Bandwidth** • How much data needs to be sent in a single transmission?
Cost • Cost of hardware and cost of data transmissions • Initial costs vs recurring costs	**Infrastructure** • How you access the data: is a third party needed, is a script for grabbing and parsing data involved, is data accessible on your mobile phone, via email, or through your data management/ analysis software	**Requirements** • Immediate need for episodic events, or long-term trends? • What is the data needed for, and how critical is it?
Ownership/Control • Intended audience, or who consumes and owns the data – your organization, third parties, or regulators?	**Frequency and Protocols** • How are you going to get your data? • What are your underlying restrictions? • Is redundant data of value? • Is data human readable or is a decoder needed?	**Reliability** • Ability to consistently relay data with as few missed transmissions as possible, for example susceptibility to bandwidth constraints (e.g., disaster events) • How sustainable is the system?

To develop the most efficient data measurement, collection and relay system, it is important to consider your requirements when choosing your potential telemetry technology.

Let's use an example to walk-through our options. If you have a high priority station set up to record over 2.5 megabytes of measurements per hour, which telemetry method should you select?

GOES satellites would not be ideal, as 10-15 seconds will not be enough time to transfer over 2.5 megabytes of data every hour, as that requires a large bandwidth.

Iridium uses low orbiting satellites, so they shouldn't receive any interference from a disaster, which is best for high priority data. But it will likely have a higher cost, as you have to pay for the amount of data you transfer.

In this case, cellular may be the best option because you can transmit more data, more often. The one thing to note is the site's location and whether there is high quality cell service available in the region. It's important to be in a good coverage area when any type of disaster hits, and if you haven't been granted a high priority status by your data plan provider, you may not receive your data as quickly as you need it.

If certain features of Iridium transmission are desired, such as data redundancy or alarm transmissions, a hybrid system is a good option.

Hybrid Systems

Current common telemetry methods are typically based on a single communication method. Sometimes, the telemetry method that best suits your application is an obvious choice, such as using a satellite-based method for a surface water monitoring application in a remote area of India or Brazil, but for some applications, there is not always a clear answer.

By combining two or more telemetry options, you can achieve a more frequent transmission schedule for remote event monitoring. This allows advantages associated with one telemetry method to offset disadvantages of others.

Some example scenarios include:

- When considering cellular, but you have a need for critically important data to be right on time, all the time, consider pairing with a satellite option like GOES or Iridium for redundancy
- When considering GOES, but you have a need for real-time data in alarm states, consider pairing with Iridium or cellular so it can switch in certain alarm conditions to collect and transmit more data more often
- When considering GOES, but you have a need to make changes to your system remotely, consider pairing with cellular or Iridium for two-way communication

The reasons to consider hybrid systems are simple:

- Ability to change its transmission method based on site conditions
- Gives you a dual-communication path backup option, which is ideal to have
- Access to the reliability of certain telemetry options with alarm and event monitoring capabilities added on top

In some cases, a hybrid telemetry approach is an excellent option, but this is not something that is commonly available from most vendors. Also, the type of datalogger or data collection platform plays a significant role in how the messages may be sent and thereby received. For example, not all loggers support voice and/or email or text alarm messages.

An excellent device that does allow for the flexibility required from hybrid systems is the

Sutron SatLink 3, a datalogger that supports GOES, Iridium, and cellular transmission options all at once. This gives you more versatility in your primary and supporting telemetry options, since the logging transmitter, SL3, can be programmed to transmit the data several ways:

- When the data logger goes into alarm
- Transmit when it goes in and then back out of alarm
- Transmit every reading while the station is in alarm

You have more control over which data and how much data you want to receive when a threshold is reached. For example, if you have a measurement interval of 2 minutes and logging interval of 1hr, and if the threshold is reached, an alarm transmission will be sent every 2 minutes while in alarm.

Solution Example: Sutron SatLink 3 featuring simultaneous telemetry options

Sutron's SatLink 3 provides a cost-effective way to measure, log, calculate and transmit data from remote locations around the world. The unit monitors 32 independent measurements of most hydrological, meteorological, environmental or related sensors. As a compact multi-communication logger, it has built-in SDI-12, Analog, Digital, RS485 and 4-20mA measurement circuitry. You can add optional modems for additional cellular or Iridium communications.

You can also customize any transmission process by using Python through the SatLink 3, a unique feature that allows you to do your own format for transmissions.

The Big Picture

Telemetry options are not one-size fits all. As the number of options available increase, it's more important than ever to understand their key differences to find one that best matches your data consumption needs.

Choosing the right telemetry method for your water monitoring application can offer many benefits including:

- ✓ Improved operational uptime and efficiency
- ✓ Improved water resource management
- ✓ Improved water allocation & planning
- ✓ Event notification and emergency management
- ✓ Extended life of your onsite systems
- ✓ Cost savings for both data transmission and system maintenance

While the telemetry method you select is important, it's also crucial to select the right technology to support the needs of your site and data.

The OTT HydroMet system is equipped to handle end-to-end remote data collection needs, from sensors and dataloggers to cloud services and monitoring tools.

OTT HydroMet offers dataloggers designed specifically for hydrological applications that are very low power and include a multitude of data transmission options to get data back to the office. Dataloggers with alarm capabilities, such as the Sutron or OTT dataloggers, provide options such as user definable value limits, rate of change limits, and alarm groups.

You can also collect and manage your data through the advanced data collection Web service, Hydromet Cloud, which delivers the acquired data via the Internet in a ready-to-use format. Users who are logged into the website can view, plot, download, and process the data as it's received as well as set-up alerts and alarms for their systems.

Our team can provide administration and support, by remotely accessing the same data you see and help with any issues we see.

OTT HydroMet - Insights for Experts

OTT HydroMet delivers valuable insights for experts in weather and water applications. Proudly formed from seven strong brands: OTT, Lufft, Kipp & Zonen, Sutron, ADCON, Meteo-Star and Hydrolab®, OTT HydroMet offers the combined strength and expertise of leaders in the water quality, quantity, surface weather, solar radiation measurement and telemetry fields with over 500 years of combined experience in environmental measurements.

OTT HydroMet offers advanced products and services that help monitor the world's water and weather to scientists and consultants seeking to protect the world's resources and lives.

Additional Resources

For more information, watch our 40-minute exclusive Telemetry on-demand webinar for water resource professionals:

Or read more about various telemetry options in our Telemetry Whitepaper focusing on the importance of location:

OTT Hydromet

SUTRON

Location, Location, Location: Choosing the Right Telemetry Method for Your Remote Water Monitoring Applications

Because of the remote locations and naturally harsh environments of many water resources, monitoring and communicating the resulting data is not always simple or straightforward. Telemetry is an automated process for performing measurements and collecting data back to receiving equipment for analysis. Remote or inaccessible locations require the use of different radio communication technologies integrated into the telemetry system to transmit the information. Therefore, a remote telemetry system is a necessary tool for many water resource monitoring professionals. This whitepaper will take an in depth look at using the most effective and efficient telemetry method to monitor and transmit water resource data based on the location of the application.

The Origins of Telemetry

The automated communication process for performing measurements and collecting data, what is commonly referred to as telemetry today, can be traced back to the early parts of the 20th century when power utility companies needed a method to understand the operational conditions of their supply networks. During the mid-1960s, computer technology with the ability to process real-time functions emerged, enabling the dawn of supervisory control and data acquisition systems (SCADAs). These industrial utility systems were hardwired to monitor the status of the equipment, trigger alarms for changes, and in some cases, log data. Over the decades, the markets and technologies developed rapidly to include network analysis functions to allow for energy management of the utilities network, and part of these systems included radio communications to substations. Separately, the 1950's also exhibited the beginnings of aerospace telemetry when the Soviet Union launched Sputnik 1 and that, in part, has led to a huge global satellite communications network.

Regardless of the application, the data communications from early telemetry systems had limitations. The data was being delivered to the control center, but the systems usually did not offer the capability to interact directly with the remote transmitter and sensors. Today, we are more inclined to refer to concepts such as machine-to-machine (M2M) communication or the Internet of Things (IoT) when discussing how to embrace the promise of data communications products and services to help solve problems. However, some of the legacy communications systems still have an important role in helping hydrological and meteorological professionals resolve complex issues.

In the following pages we will discuss:

- Environmental Satellites (GOES, INSAT, etc.)
- Iridium Satellites
- Cellular Communications

Satellite Data Transmission: Reliably Communicate Data from Even the Most Remote Areas

Geostationary Satellite systems

Today, there are a number of geostationary satellites operated by different government or intergovernmental organizations. Some of the services these satellite systems support include weather forecasting, climate data, severe storm tracking, meteorological research, and environmental monitoring. In addition to performing these tasks and providing photographic images, these satellite systems offer the option for government organizations to perform remote data transfer of hydro-metrological data from the Earth.

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Insights for Experts

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Written and designed by your OTT HydroMet experts