AQUARIUS

MANAGING FIELD DATA STEP BY STEP

GUIDE | From field sensors to data logger to software

Offered by OTT HydroMet

The big picture

Water security can be defined as the availability of a sufficient quantity and quality of water to sustain livelihoods, health, socio-economic development and ecosystems. To achieve this goal, water managers need timely access to reliable, insightful, defensible data.

Water resources are under increasing pressure from issues such as climate change, population growth, urbanisation, land use and agricultural demand. These changes can result in water scarcity (quantity and/or quality) and intensify competition for water resources, so monitoring activities need to adopt a more holistic approach; integrating meteorological, hydrologic and water quality data throughout an entire catchment for example.

Impact of technology

Enormous progress has been seen in both the hardware required to take reliable measurements, and the software required to get the best value from that data. Recent developments in sensors, dataloggers and telemetry have delivered intelligent monitoring systems that are able to operate remotely, running on very low levels of power and delivering reliable data in real-time. This has prompted dramatic growth in the implementation of high-intensity monitoring systems that generate enormous volumes of data. These systems also possess advanced alarm capability; issuing alert messages by SMS, email, etc. when pre-set conditions arise.

Water management policies must be sustainable and resilient, so it is vital that both strategic and operational decisions are based on sound data. However, if data are not managed correctly, users may become 'data-rich but information-poor', so some of the most important decisions in the organization of a monitoring program relate to the ways in which data will be managed.

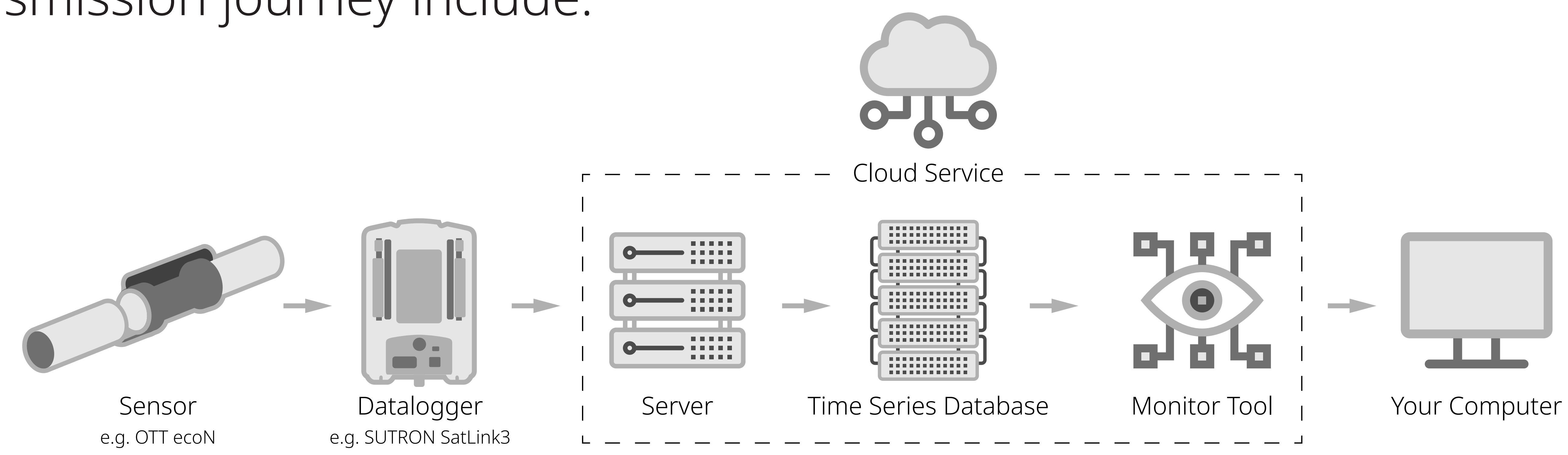
Today's water managers need data for more than just the monitoring of trends to inform policy; there are also increasing regulatory demands along with a requirement to provide timely warnings for the impacts of extreme weather. In addition, the demands of stakeholders are growing, with a requirement for customized access to relevant data.

With so many new requirements and stakeholders, the remainder of this document will focus on the key steps in the data journey; explaining how water managers can obtain the greatest value from their data – easily, quickly and reliably.

Data collection is used for applications including ground water, surface water, and precipitation 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

The steps of the data transmission journey include:



Visualizing a Hydrology Network — The Data Value Chain

1.

Sensor to Datalogger

Main Factors to Consider:

Requirements

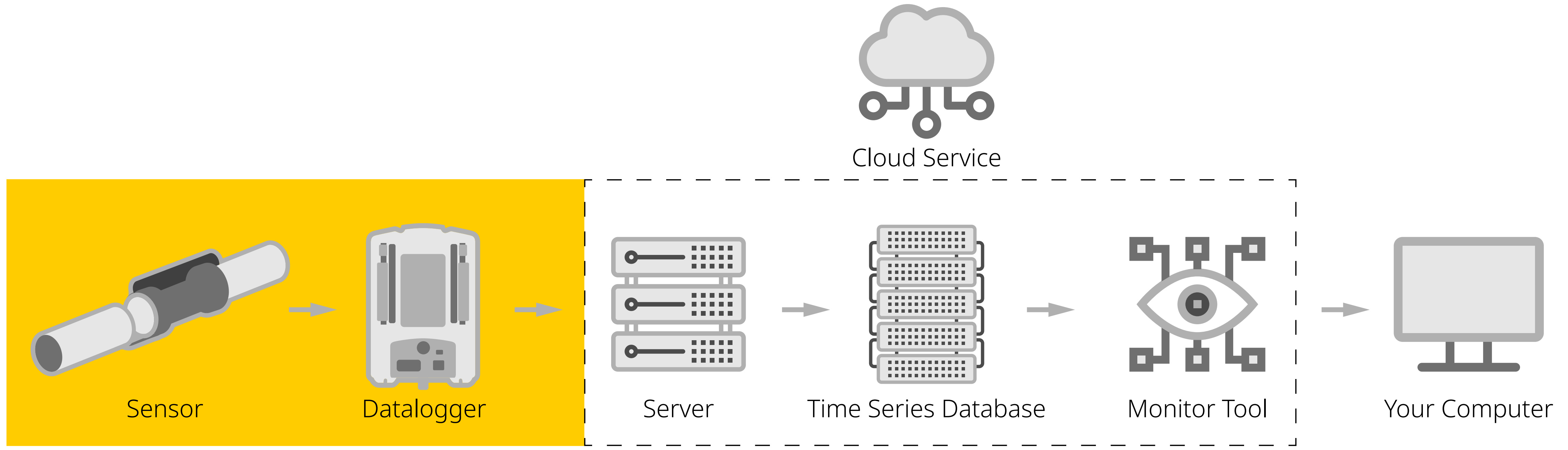
What parameters need to be measured? How many sensors? How much power will they require? Is the datalogger compatible?

Reliability

Environmental monitoring stations usually need to operate without mains power and in remote locations, so to minimize costs they need to operate reliably and independently for extended periods.

Location and Availability

To avoid the need for frequent site visits, there should be an extended period between service/calibration, with a low power requirement and with sensors that avoid drift and fouling.

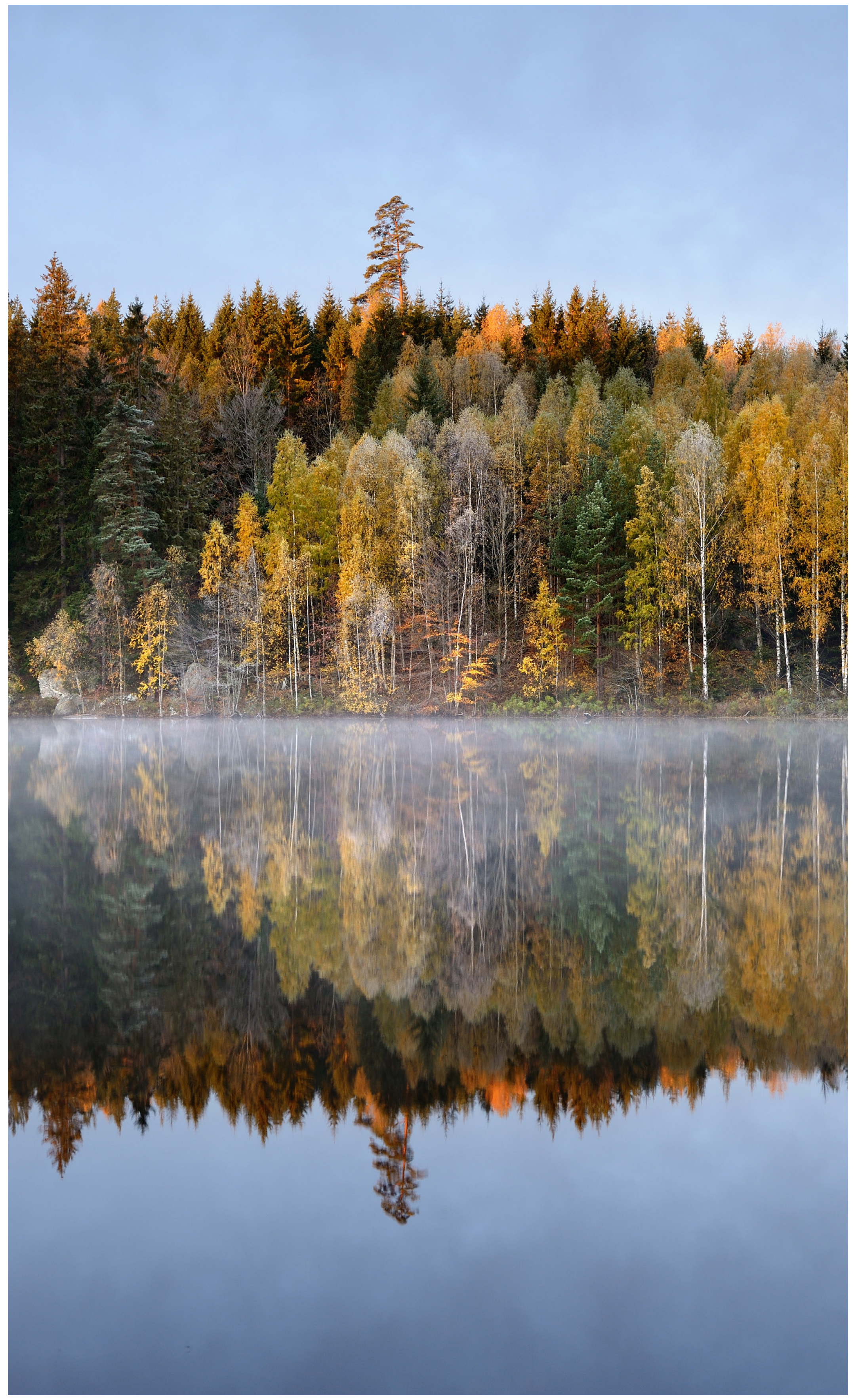


Measure and collect

It is important to ensure compatibility between sensors and a datalogger. In practice, most modern dataloggers are able to accommodate all of the more popular communication protocols. However, it will be necessary to check that the datalogger can provide power to those sensors that need it, and that the datalogger is able to translate the signal from the sensors (which may not be linear) into engineering units. The power requirement will depend on the datalogger, the type and number of sensors, and on the frequency of measurements. Ideally, the datalogger should also be able to process the data – to produce maxima, minima, averages and other mathematical formulae, and be able to automatically adjust monitoring frequency when pre-set conditions arise.

Dataloggers generally feature a fixed number of inputs for analog, digital and counter sensors, but protocols such as SDI-12 and Modbus facilitate a master and slave configuration that can expand input capacity considerably. SDI-12 sensors are frequently employed in environmental applications because they are low-power and feature integrated microprocessors which can perform complex internal correction, compensation and averaging algorithms that enhance the quality of the data.

Modbus is a communication protocol used for machine-to-machine data transfer in a wide variety of (mainly) industrial applications, but including remote monitoring and control. Modbus is often used to connect a plant/system supervisory computer with a remote terminal unit (RTU) in Supervisory Control and Data Acquisition (SCADA) systems.



2.

Datalogger to Software

Main Factors to Consider:

Location and Availability

Is a reliable cellular signal available?

Bandwidth

Does the telemetry method have the capacity for the anticipated volume of data?

Frequency and Protocols

Can the telemetry method operate with the dataloggers and with the transmission frequency required?

Software

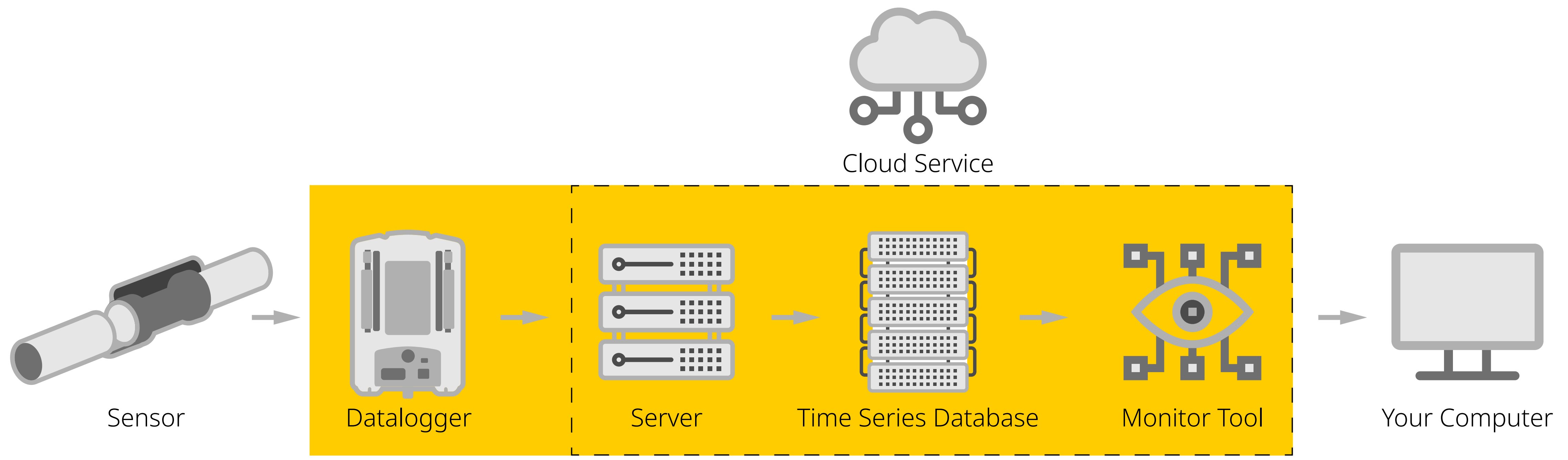
Does the data management program have the capability to accommodate the data formats and transmission protocols?

Costs

Set up and operational

Power Requirement

Datalogger Capability



Transmit and Receive

Environmental monitoring data is of no value until it is in the possession of those that need it. Furthermore, data is at its most valuable when it first created, so it is usually important for data to be transferred as soon as possible – ideally as 'live' data. Data management programs such as AQUARIUS can be deployed with many off-the-shelf telemetry systems as well as AQUARIUS EnviroSCADA. Alternatively, AQUARIUS can be integrated with a data acquisition system through the use of a comprehensive web services API.

There are three main telemetry options:

1. **Environmental Satellites —** high Earth orbiting geosynchronous satellites that follow a fixed geographic location on Earth. This means receiving antennas only need to point at one location. There are many types of satellite for transmitting environmental monitoring data, including: GOES, METEOSAT, HIMAWARI, FY, and INSAT.

Publically owned, these satellites are ideal (often free of charge) for government agencies that do not require immediate data. With short time slots, typically 10-15 second per hour to send data, they have a low power requirement and the bandwidth is sufficient for most hydrometric and meteorological applications. These geostationary satellites are suitable for those that require highly reliable, low-cost, one-way scheduled data and alarm transmissions.

2. **Iridium Telemetry —** uses a network of 66 active low-earth orbiting satellites. The cost of data transmission is priced according to the volume of data. Iridium provides two-way communication and enables almost immediate alerts. Data starts from the nearest low orbiting satellite to the transmitting station and then travels satellite-to-satellite until it reaches the Iridium Gateway in Arizona (takes 5-10 seconds). Data notifications can be sent via email, direct IP, a Local Readout Ground Station (LRGS), or a software solution such as AQUARIUS. Iridium provides a completely wireless end-to-end data solution and is ideal for highly remote stations where there is a need for lower volumes of data but higher data availability; especially if two-way communication and private data are pre-requisites.

3. **Cellular Telemetry —** with the growth of digital cellular technologies, such as GRPS, CDMA, 4G / LTE, 5G and IoT connectivity, the use of remote data collection and high-speed data transmission services using IP technology is growing in popularity. Cellular networks are typically distributed over land areas, so transmission may not work for very remote locations, and signal quality is prone to variability. However, network coverage continues to increase and improve, and the cost of data plans from service providers is decreasing. Cellular telemetry consumes low amounts of power in comparison with satellite, and cellular offers two-way communication with the ability to transmit high volumes of data in close to real-time. Cellular telemetry is not suitable when a signal has the potential to be weak or non-existent.

In some circumstances it may be necessary to combine two or more telemetry options (hybrid) for redundancy or to offset the disadvantages of one method with the advantages of another. For example, some users employ GOES for regular transmissions, but automatically switch to cellular for larger, more frequent transmissions during an alarm state.

3.

Software to You

Main Factors to Consider:

Requirement for two-way communication

Will it be necessary to remotely access live or stored data, initiate outputs or reconfigure the logger?

Requirement for immediate alerts

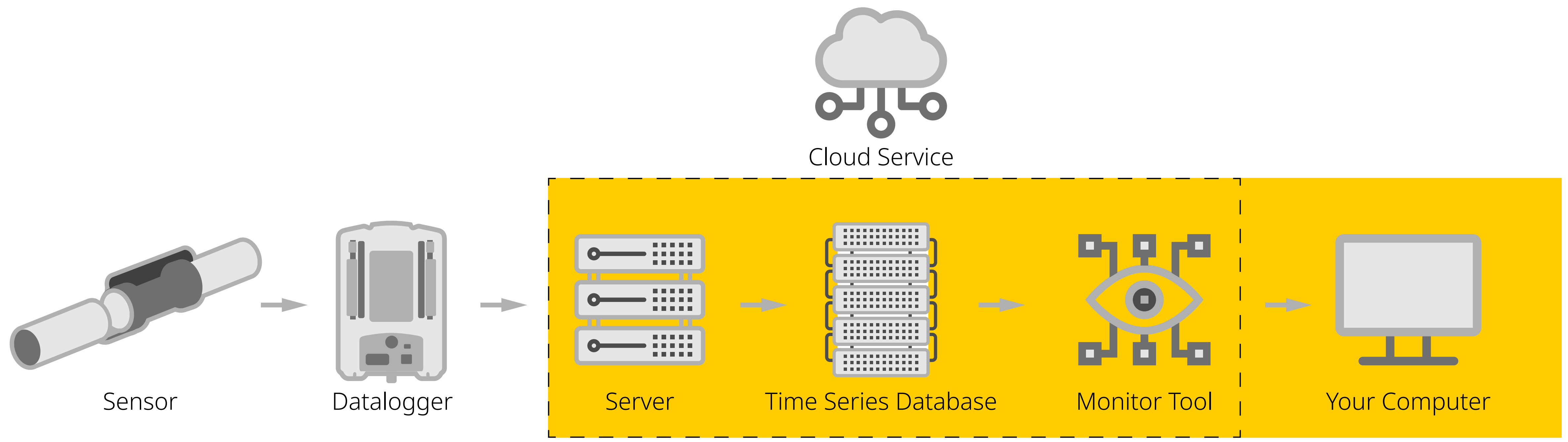
Such as flood or storm warnings?

Infrastructure

Ownership and Control

Frequency and Protocols

Reliability



Receive and View

With more monitoring points producing more data, the challenge for data management systems (software) is to be able to handle the volume of data whilst also providing insightful, actionable information for users and other stakeholders.

Organizations may have sufficient internal IT resources to achieve this, but commercial cloud-based solutions are now readily available, offering the backend infrastructure to receive, process, display, and store measurement data from almost any number of monitoring stations via a secure data hosting platform.

The essential features of good data management systems are:

- developed specifically for hydrometeorological applications
- can be implemented very quickly
- do not require extensive IT infrastructure and support
- do not involve capital expense
- provide easy access to highly secure remote servers
- are already proven world-wide
- contain standard templates but allow users to define their own dashboard
- are intuitive and require very little training
- deliver accurate, insightful, defensible data

Additional (advantageous) features include:

- integration of disparate data sources, including sample, time-series, and third party data
- facility to build sophisticated models of complex water resource systems
- provide timely stage and discharge data
- visualize and proactively forecast potential problems
- scripting capability to fully customize simulations
- automatic QA/QC of data with full traceability

In order to meet the challenge of water security, water managers need easy access to the big picture, which means they need an effective tool to capture all useful data, ideally with a cloud-based software service. The software should provide users with simple access to both stored and real-time data via PC, tablet or smartphone. This should include a customisable dashboard with graphical, mapping or tabular displays, enabling users to quickly and easily view and compare historical trends or drill down to live readings from an individual sensor.

Software should enable water managers to easily build better rating curves, derive statistics, and report in real-time to meet stakeholder expectations for timely, accurate water information. The software should also allow users to plan sampling and field work, and then monitor progress - if technicians can enter results and observations while on site, transcription errors will be reduced for better data accuracy and improved productivity. The deliver transparent, defensible data, the software should automatically build a data processing correction and editing audit log of all corrections, quality codes, and notes for time series data.

A good example of data management software with all of the features mentioned above is AQUARIUS – a software platform designed to integrate disparate hydrology, water quality and meteorological data to empower water managers to make data driven, smart decisions with timely insights. The platform can quickly pull historical statistics to compare, visualize and proactively forecast potential problems to provide alerts and notifications regarding rainfall and stage for example.

In the past, data were often created and stored in silos. Infrequent collection meant that data were less representative and therefore not suitable for alerts or direct comparison with other data sources. Jump forward to today and there has been an explosion in continuous monitoring, with high intensity data being collected from a much larger number of locations. This has enabled the development of forecasts with automatic alerts and created a demand for highly accessible data management systems that can be quickly and easily configured to deliver the timely, accurate, quality assured insights that are necessary to protect water security.

One of the main reasons for the international popularity of the AQUARIUS data management platform is that it does not just ingest information from a user's own network; it can also collect data from other sources, such as federal and state networks. This adds context and helps provide a deeper understanding of the big picture.

OTT HydroMet aims to provide expert knowledge in the journey from data to insights, and with leading edge products along the entire data chain from sensors to dataloggers, to telemetry and data management solutions. Our team has the experience, technology and expertise to ensure that water managers are able to quickly and easily transform complex data into knowledge.

Insights for Experts

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