# NETLAKE Guidelines for automated monitoring system development

# 007 Communication Options

## Objective

The purpose of this fact sheet is to provide some advice on the available methods to communicate with and retrieve data from your automated monitoring system.

## Considerations

Automated monitoring systems used for lake studies can measure a variety of parameters both above and below water and record these at high frequency. Consequently, large amounts of data can be collected and stored. An important consideration when designing an automated monitoring system is how you will collect and evaluate these data. At the most basic level there is one fundamental choice you will need to make:

- Will you collect your data by physically visiting the monitoring station and manually downloading the data to a computer or memory storage device?
- Or should you develop a method of communicating with your monitoring station that will allow you to collect your data remotely without physically visiting your station?

***On-site communication.***

The greatest advantage to on-site communication is its simplicity. Furthermore, in the case of standalone submersible logger/sensor systems, this may be the only option available. Depending on the ease of access, the number of loggers, the amount of data to be processed, and other factors, researchers commonly download the data directly in the field without moving the monitoring system, or remove the loggers, download on land, and then later re-deploy the system.

There are various options for downloading data loggers in the field. In the case of stand-alone loggers (i.e. Onset underwater loggers, or RBR solo loggers) data can be transmitted through the water proof housing as light pulses, or in other cases the data is transferred using custom cable that attach to the logger by RS232 or USB connections. Most generic data logging systems such as those produced by Campbell Scientific usually offer the ability to communicate by an RS232 connection which can be made in the field to a laptop computer. Downloading on site can require opening the instrument shelter that contains the data logger in order to make a connection to the logger itself. This can be problematic during rain or rough water conditions. One solution is to use water proof military or oceanographic style connectors so that the RS232 connection can be made through the wall of the instrument shelter/housing (Fig. 1A).

***Remote communication***

Remote connections allow data collection and monitoring without having to be physically at the site. There are many possible methods of developing a remote connection (see below), all of which are more complex and costly than the direct connection options described above. Despite the issues of cost and complexity there are many advantages to remote communications.

- They allow data to be downloaded more frequently, which in turn allows operators to visually inspect and quality control data, and more rapidly repair failing or fouled sensors

(Fig. 1B).

- They provide the possibility to update data logger programs i.e. to add new measurement intervals or logger processing functions.

- They provide the possibility to interact with the data logger, so that for example the user can switch on high frequency sampling in response to an ongoing event. Or the user can limit the time that power intensive sensors are used in response to reduced battery voltages.

- Finally by collecting the data more frequently data are automatically saved and backed up at a separate location. This can be of great advantage, especially for remote sites which cannot be visited often, or logger deployments, in inherently unstable conditions (i.e. on decaying lake ice).

***Options for remote communication***

There are many options for remote communication, the one chosen will depend on many factors including station location, power supply options, required communication frequency and cost. While we do not endorse any specific data logger manufacturer, Campbell Scientific does offer a wide variety of data communication options and we therefore, recommend visiting their website to get an overview of what is available. Below is a list of remote communication options.

- ***Short haul modem*** - Use of short haul modems allows a direct RS232 connection using an electrical cable connection over longer distances (up to several km) than would not normally be possible. This can be a reasonable option for loggers located near a lab or field station, and once installed there are no additional communication costs. The disadvantage is the cost and effort of stringing out long communication cables.

- ***Telephone modem*** – If a land line telephone service is available at the data logger sites and a telephone connection can be installed, it is possible that data communication can occur over the telephone network using modems at both the data logger and connecting computer. This is not really an option for buoy systems, but is commonly used for stream side monitoring stations.

- ***GSM (Global System for Mobile Communications) modem*** - Similar to the above option except that logger modem is connected to the GSM mobile phone network. The connecting computer still uses a standard telephone modem. This allows for much greater flexibility since a physical connection between the data logger and telephone network is no longer required. Of course for this to work there must be GSM coverage in the area of deployment, and this can require the use of a high gain antenna pointed in the correct direction. The disadvantage of this option is the costs associated with maintaining a GSM account and for the connection time needed to download the data.

- ***GPRS (General Packet Radio Service) modem*** – This is a mobile communication option that operates on the commercial wireless communications network. It is similar in many ways to the GSM option above, data transfer occurs over different frequencies but often to the same cell tower. A special modem is required for the data logger, however unlike the GSM connection no modem is needed at the receiving computer. Instead the computer connection occurs to an internet address associated with the GPRS account. The advantage of GPRS over GSM is that there are no connection costs and often GPRS provides a faster

connection. Communication is possible from any internet connected computer. When purchasing a GPRS account look into the options of obtaining a fixed IP address, rather than a dynamically assigned IP address. The fixed IP address will simplify data communications.

- ***Internet TCP IP connection***. - In cases where a local internet connection is available data loggers can be directly connected to the network using TCP IP protocol. As with any internet connection you will need to assign an IP address, IP gateway and subnet mask to the data logger or its TCP IP interface. And as above, we recommend using a fixed IP address if possible. This is not really an option for buoy based monitoring systems, although it is possible to combine this with a cable based fiber optic or short haul modem connection to a water based logger. The largest advantage to this option is a very high speed connection and low operating cost. For example, at Lake Erken an underwater fiber optic cable has been installed to provide high speed internet access to an island monitoring station from the mainland.

- ***Internet WiFi connection*** – Similar to the above except that TCP IP communications occur over wireless WiFi frequencies, in much the same way as a laptop connects to a WiFi network. This requires a WiFi router that is connected to the data logger, and as above one needs to assign an IP address, IP gateway and subnet mask to the data logger or the router interface. Use of high gain directional antennas can allow reliable WiFi connections over several hundred meter distances. The Lake Erken monitoring system has established a WiFi hot spot on an Island based station that provides WiFi coverage to much of the lake.

- ***Radio Link***. There are a wide variety of options, the choice of which will depend on government regulations, licensing requirements, power requirements and the needed transmission distance. In general radio based solutions transmit data over radio frequencies using transmitters and receivers especially designed for data communications. Transmission occurs over line of sight distances, which can be considerable over water. It is also possible to link stations into a network so that data can be relayed from one monitoring station to another thereby increasing the data transmission distance. Radio linked data transmission is best suited for locations that lack good GSM or GPRS coverage. The disadvantage to radio based communications can be greater power consumption and slower communication speeds.

- ***Satellite link*** – this is an option that can be used for remote locations where none of the above communication methods can be used. Satellite communications are also sometime used over large geographical areas in order to provide a consistent communication protocol that can be applied to the entire region. There are at least four different satellite systems that can be used for data communication. Each will require a specialized communication device, and each will offer different advantages and disadvantages in regards to cost data transmission speed and geographic coverage.

Finally one should also consider the software needed to initiate communication and download the data. When purchasing a data logger system, be sure the logger manufacture provides software that will allows commination using the method that best fits your needs. In the case of power intensive communications such as radio links or cellular modems one may also need to develop logger programs that shuts down the communication device over certain times of the day or in response to declining battery levels.

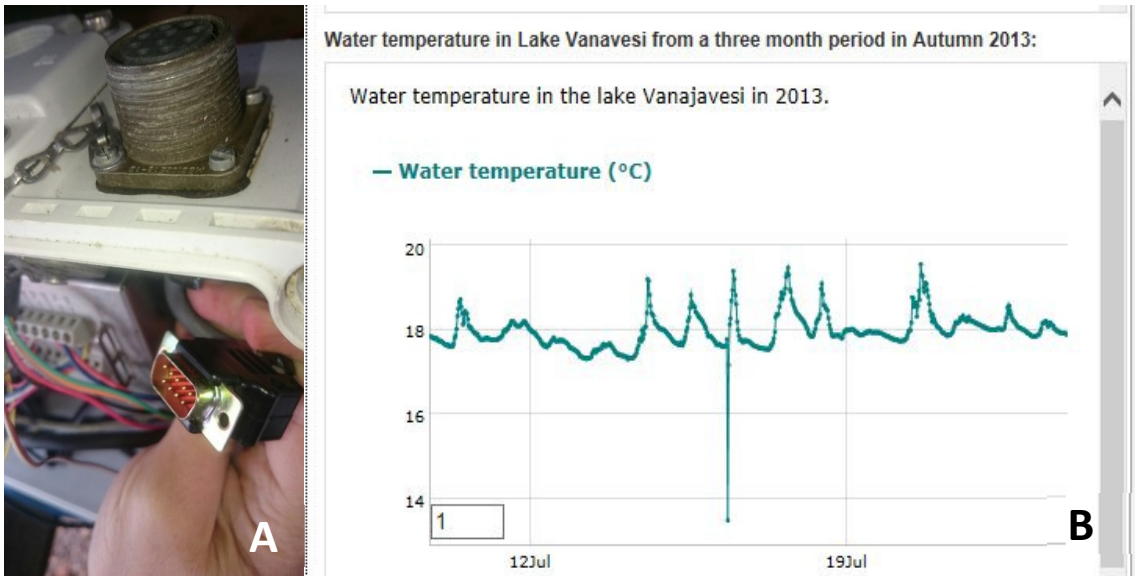


Figure 1. A) Example of using military style connectors to make RS 232 connection through the wall of monitoring system enclosure. B) example of visual quality control system that updated daily following remote communications and data collection. Bad data point can be easily detected.

## *Likely Problems*

- Unreliable communication due to weak radio or cellular signals. This can be improved using high gain omnidirectional or directional antennas

- Complexity in connecting communication equipment and establishing communications. We strongly recommend that you start testing your communication system long before the field season starts. It can take time and many customer support calls to learn how to make the correct electrical connections and set the correct software options needed to establish reliable communications.

- Loss of communications due to power loss. Some communication devices require significant power, in some cases more than the monitoring system itself. If there is a mismatch between the communications power requirements and battery storage and charging rate, the communication system can run down the station power so that the entire system fails. There are several solutions to this: carefully match your power supply to your power needs (AMSD 006); Develop data logger software that will shut down the communication devices over fixed periods of the day or in response to low battery power; use a separate power supply for the communication device.

***More information***

http://www.onsetcomp.com/
https://rbr-global.com/
https://s.campbellsci.com/documents/us/product-brochures/b_data_retrieval.pdf

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