SELECTING DATALOGGERS IN AN INFORMATION AGE

Speaker / Author: Guy Snelling

InterCal
PO Box 10907, Vorna Valley, 1686, South Africa
e-mail: guy@intercal.co.za
Phone: 011 315 4321 Fax: 086 515 2344

Abstract

The collection of physical data is becoming more and more important as companies strive to save energy and to comply with various regulations. To this end data loggers are being used in many applications to measure and collect data from a variety of parameters such as the temperatures in a medical warehouse to the temperature, humidity, electrical power and CO levels required to improve the energy efficiency of buildings. One of the difficulties encountered when setting up such a project is choosing the right system for the application. This paper hopes to guide the reader into the types of data loggers that are available, and sets out guidelines to assist with selecting the correct system for the project.

1. Introduction

Over the past 40 years or so, data loggers have evolved from large, bulky, heavy machines to units about the size of a finger nail. The storage media has also evolved from simple paper rolls and cassette tape to solid state memory that can hold years worth of data. Programming these machines has gone from large push button keyboards, to programming via PC or a remote unit.

Data loggers have also been able to measure an abundance of parameters, from basic voltage and current, to pressure, temperature, humidity, light levels, speed, flow, ….well let's just say that if it can be measured, a data logger can measure it.

As the size of data loggers has reduced, and the complexity and capability has increased, it should be realised that all data loggers, both ancient and modern, still do a very simple job. They receive an analogue signal, convert it to a voltage, measure that voltage, save it in a digital format with a time stamp and then wait a set period of time before doing it all over again. The differences generally come with regard to the accuracy of the measurements, the speed at which they can be taken, and the way in which that data is made available to the user.

Once the data has been collected, there have been, and still are, varying methods of retrieving the stored data, from physically reading the values on a paper strip through tape and disc readers to data stored on flash disk. More recently it has become possible to retrieve the data from the logger without even being near the logger itself.

This abundance of available data loggers and the methods by which they work, can make the job of choosing a suitable system for your application a hard, and sometimes a costly one. Buying a data logging system based purely on price, can end up in frustration due to a lack of

features or ergonomics while a high end system may be too complex and expensive for what is really needed.

In this paper I hope to throw a little light on the subject so that the reader can make an informed decision about which type of logging system to purchase, or at least so that they can understand the terminology and characteristics of the various systems should they choose to call in a consultant.

2. Type of Dataloggers

Even though there are many data loggers on the market, they fall into three main types although there are often overlaps in certain models.

2.1 Mini-logger

The first of these types is the so-called 'mini-logger'. These are small, self-contained, battery operated units with a fixed amount of data memory. As a rule, they are programmed and 'launched' using a Personal Computer, and then installed to where they are to log the data. After a period of time they are then retrieved and the data is downloaded.

These mini-loggers are usually relatively cheap and are often used in situations where the loss of a the logger may occur, such as when accompanying a product in a cold-chain transport exercise. Since the data is only downloaded after a period of time however, the data is not available in real-time and so any alarm conditions will only be noted 'after the event'. Some loggers do have alarm condition displays on them, but they must still be viewed manually.

Mini-loggers are also often also used for environmental mapping exercises where the temperature and other environmental conditions needs to be monitored over a set period of time and then a report issued. This typically occurs in warehouses and other storage facilities where it is required to investigate temperature gradients throughout the facility. These loggers would not normally be used for continuous monitoring however, due to the labour requirement of regular launch and downloading of the data as well as the fact that real-time alarming is not possible.

Once a temperature map of a facility has been obtained, another type of logging system would be installed in the critical locations on a more permanent basis. This moves us on to our next logger type.

Figure 1. Examples of mini-loggers

2.2 Centralised logger

A centralised logging system would often be in the form of a single, multi-channel data logger with probe wires and sensor cables spread throughout the facility. These data loggers are often capable of measuring multi-parameters and are thus useful in a facility where a variety of measurements need to be made. There are substantial cost implications with this type of system since the unit itself may be expensive and the labour component to install the probes is also relatively high. Also, once the system is in place it is not easily relocated as all the probes would need to be re-installed to the new location.

Another disadvantage of such a wired system is one of 'putting all your eggs in one basket'. In the case of mini-loggers, if one should fail only those measurements would be lost and also a failed logger could be quickly and easily replaced. If a central logger fails however, the logging of all measurements would stop until such time as the central logger could be repaired or replaced, usually at a substantial cost of time and money.

Where these loggers are often used though is for the validation of protocols, processes and equipment in the pharmaceutical industry

Figure 2. Examples of centralised logging systems

2.3 Wireless loggers

Wireless logging systems have come to the forefront of logging systems in recent years because they tend to have the advantages of both mini-loggers and central loggers but with very few of the disadvantages of either.

These usually consist of units not dissimilar to mini-loggers in that they are small and self-contained, relatively in-expensive and they collect data into their own on-board memory. The stored data is then transmitted via radio to a central logging point where it is permanently stored and can also be displayed.

Obviously these data loggers can each be easily moved to different locations, as long as they stay within range of communications with the central receiver, and the central receiver itself can be re-located with minimal disruption. Some of these loggers are designed for outdoor use and can thus be located many hundreds of meters from the receiver.

Should any of these data loggers fail, again it is only those particular measurements that would be lost as in the case of the mini-loggers, and being in-expensive a failed logger can be replaced quickly without too much cost implication. In addition, as each of these units is a self-contained data logger, it also follows that should the receiver itself fail, data would

continue to be collected by the data loggers until such time as the receiver can be replaced. Or at least until their memories are full.

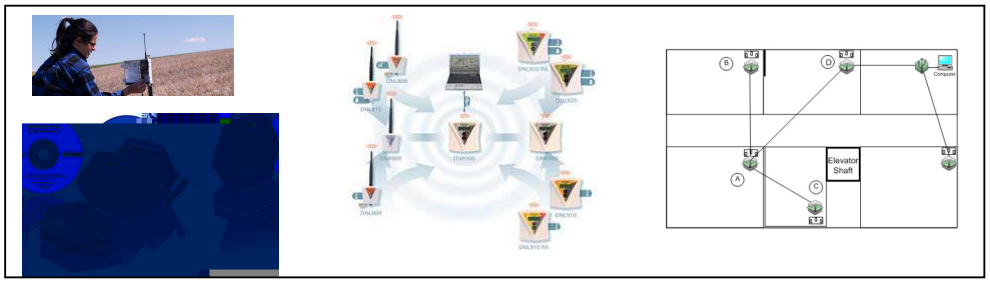

Figure 3. Examples of wireless logging systems

2.4 Cloud loggers

As with all logging systems, the data must be retrieved from the logger and then stored somewhere. This would usually be on an associated personal computer, either one used by the person manually downloading mini-loggers or the PC that automatically receives data from centralised and wireless systems. Once the data is stored, it should then be distributed, mainly so that it can be used and analysed by interested parties but also as form of security since if something happens to the PC or hard-drive then the data may be lost. Distributing the data can be performed manually or automatically and via file transfer or possibly via email.

A more recent innovation that streamlines this process is what I will term 'Cloud loggers'. These loggers generally take a similar form to Wireless loggers or are sometimes similar to Central loggers, but they transmit their data to an external server usually via an internet connection. This server could be located anywhere in the world and is usually maintained, and the data backed-up, by a service provider. This method has several advantages and solves several problems associated with local data storage as, due to the nature of the data-store being on the internet, the data is readily available to anyone in the world with the credentials to access it with no interaction by a local operator and since the data is stored on a maintained-server the data is regularly backed-up and should always be available.

Problems that may arise with this type of system are usually a result of problems with the connection the internet. Some loggers of this type use a SIM card to connect to the internet via the local GSM network. Local problems here would prevent the data from reaching the server. Other loggers connect to the internet via the LAN or WLAN in the building. This requires that the internet connection be authorised and maintained by the local IT department.

However, once the data is on the server, local software can display data on any device connected to the internet and can also send out alarm notifications via email.

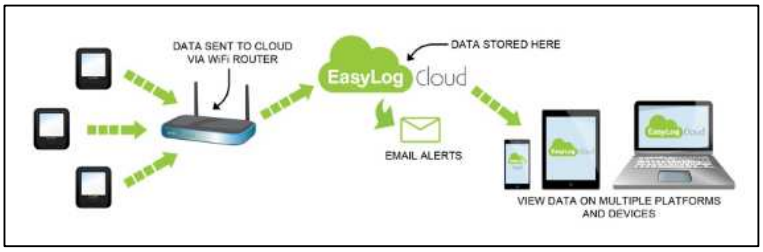

Figure 4. Diagram of a typical cloud-based logging system

3. Software

All modern data loggers measure and collect data electronically and generally they all work in the same way and have very similar specifications. Once you have selected a type then it is very tempting to choose the cheapest range in that type. However, while the measurement specifications may be similar between brands, one place in which different brands of data logger will differ substantially is in the software that is used to access the data.

Many of the cheaper mini-loggers are supplied with free software either on a disk or which can be downloaded from the manufacturer's website. This software is often very simple and just allows the user to launch the logger and then to later download the data into a text file. Simple graphs may also be available, but beyond that this software is often very limited.

The more 'upmarket' data loggers are often also supplied with free basic software, but then there may be a more complex version of the software that can be purchased separately. In addition to the basic functions, there may be additional functions such as statistical analysis, the ability to combine data from multiple loggers into one graph or dataset, export of data directly in Excel, secure locking of the data, compliance with standards such as 21 CFR and so on.

So even though a range of data loggers may appeal to you on price and performance, it is always a good idea to have a look at the supplied software to ensure that it will also meet your needs.

4. Applications

It follows that since there are different types of loggers then there are different applications for each type. When selecting a logging it is ther

too would require temperature controlled storage. In a small facility it would be possible to use mini-loggers in each of the storage area. These could have the data downloaded regularly and the resulting records or graphs could be stored with the batch records of the raw materials.

During manufacture, certain areas of the production environment would need to be monitored and mini-loggers would also suffice for a small facility, again with the data being downloaded and stored with the batch records of the product.

As we can see it would be possible to use mini-loggers in such an environment and smaller facilities often do so due to the low initial cost. They also have the advantage in that individual loggers may be moved around in a dynamic production environment to where they are most needed for specific products. One of the drawbacks however is having one person responsible for visiting each logger regularly in order to download the data. This is both time consuming and open to human error and in a large facility the labour cost alone may be substantial. Another problem is that if the temperature range is exceeded at any point, this may only be noticed when the data is reviewed and this could be sometime after the event resulting in complete batches of product having to be recalled and destroyed.

A more permanent and sophisticated logging system would be one that continuously monitors the environment and generates an alert when the temperature extremes are approached so that action can be taken before the limits are exceeded.

A central logging system with multiple probes installed around the facility is an option here. While the initial cost of the logger maybe substantial, when the system needs to be expanded each additional measurement point may be relatively low cost as only a probe has to be installed. Such a system would be able to collect data in real time and be able to generate 'live' reports and alarm conditions. However, as previously mentioned, should such a logger fail for some reason, all data collection would cease until the logger could be repaired or replaced. This may cause problems with maintaining cold chain records of production runs and material and product storage.

A wireless logging system, while operating in a similar fashion, has redundancy built-in by its very nature. Should one particular logger fail, the other loggers will continue to collect data. Should the receiver fail, the loggers will collect data until the receiver is restored. Such a system also has the advantage that particular measurement areas can easily be relocated when changes are made to the facility.

So much for storage and production, but what about transport? Again mini-loggers are the cheap option here. One or more loggers are installed in each refrigerated truck before a trip commences, and the data is downloaded at the end of the journey. In some cases, it is also possible to install mini-loggers in the product boxes themselves so that the product is monitored throughout the entire transport process.

However, again we have the problem that temperatures that exceed the set limits are only noted at the end of the journey and the product may be ruined along the way.

One type of logging system that encompasses many of the cold chain requirements is one that sends and stores data in an internet server i.e. a Cloud based system.

Loggers in both production and storage could be sending their data off-site to an external server and this data would be readily available to generate alarms, or to be analysed in real-time by anyone in the world with the authority to do so – very useful for multi-national companies.

A big advantage of cloud based logging is that it can also be applied to the transport sector by the use of GPS-based trackers with temperature measurement capabilities. Temperatures and location data are continually sent to a central server, and alarms can be generated when limits are approached. With the location of the truck being available, it would be possible to reroute the truck to the nearest refrigerated storage area or even to send another truck to meet the first and to transfer the product.

4.2 Laboratories

The cold chain is specific to the food and drug industry, but there are many other industries that require data to be logged, but usually only in a fixed location. One of these is in research and testing laboratories.

Laboratories such as these will often have equipment that must be maintained at certain temperatures, such as incubators and water-baths and therefore require a suitable logging system in order to maintain records. These facilities are often autonomous and would require only that the data be available locally.

Again, mini-loggers can be used but again the manual downloading of data is both time consuming and open to human error.

As in the case of drug production and storage, it would also be possible to use a central logger with wired probed installed throughout the facility, but this once again has the risk of putting all your eggs in one basket. Also, laboratories such as these go through growth and expansion phases, which would require relocation of probes in the system.

Once again wireless logging systems come to the fore as these have both the advantages of the mini-loggers with their isolation from system failure and the ease of relocation, and the advantage of the central system with its automatic retrieval and analysis of the data.

Cloud based systems here may have their use, particularly with the security of the data on external servers, but this may tend to overkill in some situations.

4.3 Pharmaceutical validations

In the pharmaceutical industry in particular, there is the requirement to validate processes and equipment. Typical examples included the validation of autoclave cycles to ensure that product is being correctly sterilised, as well as the validation of ovens and freezers to ensure that product stored in them is not exposed to temperatures outside of set limits.

In these cases it would be most useful to use either mini-loggers or a centralised logging system.

Mini-loggers would possibly be used for large walk-in chambers, and also for infrequent testing. Their main disadvantage is that a real-time readout is not usually possible and so a

failure of the process may only be noticed at the end of the validation cycle. In the case of a 30-day temperature mapping of a warehouse, this could prove to be a waste of money.

It is also possible to use a centralised logging system, but since the logger itself would usually be outside the equipment or process it is necessary to provide a way for the probes to enter the equipment without jeopardising the integrity of the process. In the case of autoclaves for example, a special port may be included in the chamber or indeed the probes themselves may be permanently installed.

Once the loggers or probes are installed, either permanently or temporarily into such equipment the process would then be allowed to run according to the relevant protocol and the parameters would be measured and logged. At the end of the process time, the resultant data would be analysed to see if the protocol limits were met.

4.4 Large industries

Typically large industries that have huge plants and require multiple parameters to be measured. These may include temperature, but probably at more extreme values than the cold chain and laboratory environments, as well as pressure, flow, conductivity and so on. While these can be measured by many logging systems, due to the production environment it would unusual to find mini-loggers in such situations. Wireless loggers could be an option, but many large industries may produce interference to the wireless signals and the amount of steel typically found in the plant would also affect the viability of using such loggers.

In such a situation it would be normal to use a series of central loggers, each with multiple inputs for measuring the parameter of a certain area of the plant, and with the data being observed in that area's control room. The advantage here is that the logger itself could be located away from the extreme environments found in the plant, with only the probes exposed to potential risk. It may also be possible for the all the data from all the loggers to be routed to a single location in the plant. In the case of logger failure, only one area of the plant would be affected and with suitable stock of spares, it may be possible to have the system running again in a short space of time.

5. Conclusions

As can be seen, a variety of data logging systems exist and are available. The situations where the use of one type of system over another may overlap and the requirements of the logging system should be carefully analysed before a choice is made. Questions that should be considered may include 'Can I spare or even trust someone to download the data manually?', 'How often do I need to record measurements?', 'What must happen to the data once it has been retrieved?',' Do I need real time alarms?', 'What will be the implications if we decide to relocate some of the measurement points?', 'Can we afford to be without the entire logging system in the case of failure?', 'Do I need to make the data available to our overseas or national holding company?'. Also, since all measurement equipment should be regularly calibrated, it is also worth considering how easy is it for a calibration laboratory to calibrate each type of system.

While this paper has endeavoured to introduce the reader to the type of logging systems available, as well as to highlight the pros and cons of each system, it does not try to be the complete guide to selecting a logging system. The author suggests that, armed with the

information gleaned from this paper, the reader should approach companies that supply candidate logging systems and consult with them regarding a final system suitable for the application.

6. References

No documents were referenced in this paper. The views and opinions are based purely on the authors experience in the subject. Images were obtained from various internet sites and are used under 'fair-use' license.