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OMSPA

OPTIONS FOR
REMOTE MONITORING AND CONTROL
IN MAPLE SYRUP OPERATIONS

January 2015

Growing Forward 2

AAC agricultural adaptation council

Ontario

Canada

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INTRODUCTION

Advancements in technology have had a profound effect upon the efficiency and productivity of maple syrup operations. The implementation of remote monitoring and control is one of the more interesting and increasingly popular innovations that has emerged and continued to develop in recent years. Many producers already have technology in the form of computers, smart phones, cellular service and Internet access. This greatly increases the ease of which remote monitoring and control can be adopted and integrated into maple syrup operations.

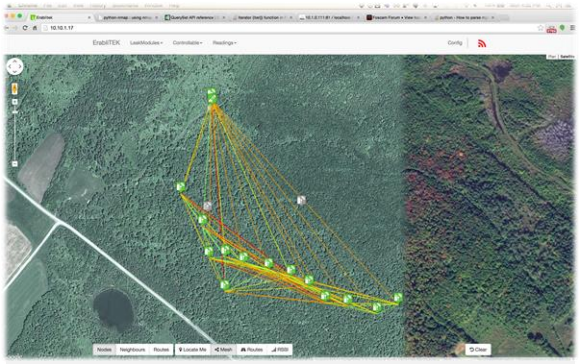
The potential applications for remote monitoring and control are as numerous as the imagination allows. Video monitoring of pump houses, sap tank level sensors, control switches for pumps, and vacuum monitoring systems for sap lines are just a few examples of areas where this technology can be of value to an operation. Anything that increases efficiency and decreases labour in a maple operation has the capacity to improve the quality of life of the producer and the profitability of the business.

Foscam – Internet protocol (IP) camera options

Implementations of remote monitoring and control systems in Ontario have been minimal to-date but have been increasing. Producers have been installing equipment on their own or with the help of private security companies or other professionals. A number of businesses have started up in recent years, specifically to provide monitoring and control solutions for maple syrup operations. In addition, well-established maple equipment manufacturers have been developing their own line of products and complete monitoring and control systems to add to their overall offerings.

Every maple operation is unique. Factors such as location, size, topography and availability of labour have a great influence on the requirements of a given operation. A system of monitoring and control will require customization to fit the needs, lifestyle and technical abilities of the producer, while working within the confines of the operation. A producer can easily start out small with one or several monitoring and control devices and build upon that as their knowledge and comfort levels increase.

The use of this technology may help a producer manage variables that are out of their control such as equipment failures, changing weather conditions and damage to tubing. By monitoring video feeds, air temperatures and vacuum levels it is easier to deal quickly and effectively to changing situations and conditions.



ErabliTEK remote monitoring equipment map

The intention of this report is to improve awareness of the available products and solutions and to increase the general technical understanding of these types of systems and the associated communication methods. With an increasing number of options available, some may be more feasible, cost effective, or appropriate for a given operation.

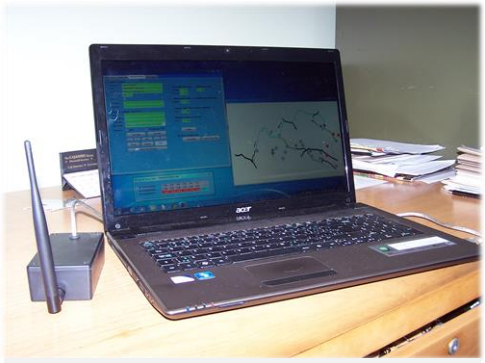
A glossary of terms with definitions is included in the appendix of this report for quick reference to some of the common technical terminology.

Benefits

Many benefits can be realized through the implementation of remote monitoring and control into a maple syrup operation. Most producers will have specific benefits in mind that they hope to achieve when deciding to implement a system, the most common being to save time and labour and to increase profits.

Benefits of remote monitoring and control may include:

- Increased yields and profits
- Improved quality of life for the producer
- Enhanced food safety and security
- Greater ability to monitor and archive trends
- Identification of areas that are efficient or in need of improvement


TapTrack Coordinator and PC Interface

Early detection of issues, such as immediate notification of vacuum loss on a sap line or a sap tank reaching capacity, makes it possible to immediately respond with targeted maintenance or appropriate action to prevent sap losses. This, in addition to the ability to remotely control equipment, can have a direct effect on the yield and profit of an operation by increasing production and reducing overall labour requirements. Saving time may also mean more sleep and less stress for the producer.

Depending on factors such as elevation and aspect, various sections of a sugar bush may start running or freeze up at different times. This can easily be monitored by means of strategically placed air temperature sensors. Swift and appropriate actions can then be taken based on the readings.

Producers with other commitments can also maintain a level of involvement through a monitoring and control system while they are away from the sugar bush. The ability to monitor and receive alerts 24/7 keeps a producer aware and involved in all aspects of their operation.

Greater efficiency may also mean more time to focus on food safety and quality control to ensure the production of the highest quality of maple syrup. A more efficient operation should run more smoothly, with fewer mistakes and greater care for detail. Food safety and general security of the premises is also increased by the addition of devices such as door sensors and video surveillance, helping to prevent any potential tampering or theft.


Remote Pump House with Video Monitoring

An added benefit is increased safety for the producer. Lessened requirements for driving to pumping stations, walking lines in the sugar bush, climbing ladders to check sap levels in tanks, etc. may result in fewer accidents.

Most of the maple specific solutions record all of the sensor data. This wealth of stored information makes it easier to monitor, archive and evaluate all production data in relation to the parameters measured. Although sugar bush monitoring and the ability to collect large amounts of related data is relatively new, there is great potential for data analysis that will reveal useful trends and areas for improvement that can impact current and future seasons.

Drawbacks

Regardless of the many benefits that may exist, there are always a number of potential drawbacks to consider when implementing something new. Some of the drawbacks of installing a remote monitoring and control system, may include:

- Costs
- Additional maintenance
- Technical requirements
- Potential periodic failure of the system

Initial costs and efforts are a drawback in setting up a system of remote monitoring and control, but, if effective, these costs should be more than returned over a period of time through increased efficiency and/or productivity. Time and effort is required to determine the best options, source out the appropriate equipment and have it installed and functioning properly. Initial costs are involved with the purchase of any equipment. Installation costs will also apply if services are required from the manufacturer or another professional service for installation of a system. Depending on the situation, additional costs may come in the form of the addition of a power source and/or Internet connection for a system to function to its full potential. Annual or monthly fees may also apply in some cases (Internet, satellite, or subscription fees).

Varying levels of technical knowledge will be required. Some systems, particularly those that are not connected to any sort of network such as a basic indicator, are the simplest, requiring minimal technical skills. The more integrated systems are more complex but most are designed so that they can be self-installed with minimal technical knowledge. Once a system is up and running, it theoretically should run smoothly but even basic upkeep and management requires some technical understanding. It is encouraged that a producer be involved in the planning and installation of their monitoring and control system to become familiar with it and develop a technical understanding of their network and products. Troubleshooting issues in any system is difficult when knowledge and understanding are limited.

A false sense of security that everything is functioning properly can be a problem when relying on monitoring equipment, if at times the equipment fails. If, for example, the Internet stops working and a video feed freezes or if a sensor malfunctions and does not send a notification, a producer may miss important information. A producer must be aware of potential issues and physically check if a problem is suspected. Fortunately, most solutions have a notification system to indicate if any of the devices on the network are not working.

A minor drawback is the decreased freedom and exercise that a producer will experience due to the diminishing need to leave the sugar camp to visit pump houses and check tubing for leaks.

Return on Investment

In addition to the range of benefits that can be expected by implementing remote monitoring and control technologies into a maple operation, a large factor is what it will actually mean in terms of dollar amounts and return on investment (ROI). A number of the companies that provide vacuum monitoring systems for the sugar bush predict an average annual ROI of 5%. This could be higher or lower depending on a variety of factors, including geographical size of the operation, number of taps, number of mainlines and availability of a person to remedy issues based on the monitoring feedback (e.g. address vacuum loss on a particular mainline). For an average 2,500 tap operation, an ROI of 5% could mean an increase in value of the crop of $1,938 per year. This is based on an increase of 5% from an average production of 1 L/tap and the Ontario average price of $62/4L (OMSPA Production and Pricing Survey, 2014).

Factors that help make the most use of a sugar bush vacuum remote monitoring and control system and promote an optimal ROI, are to have:

- Excellent tapping techniques and well planned, tight, leak free tubing installations
- Personnel available to respond in a timely fashion to a notifications of an issue
- A monitoring system that is maintained in order to function smoothly and consistently

CDL's Vacuum monitoring device

It is more difficult to assign a direct ROI value to the additional monitoring and control products since their benefit is not directly related to higher crop yields. In spite of this, video monitoring, tank sensors and power control undoubtedly have high potential to provide returns by increasing efficiency, reducing labour, and preventing losses through greater management of an operation.

From a business standpoint, the expected return on investment is an important consideration when making decisions about changes to an operation. On the other hand, decisions may be made regardless of cost, simply because a producer wants to increase their enjoyment or ease of making maple syrup.

IMPORTANT CONSIDERATIONS AND DECIDING FACTORS

Each operation is unique and will require a somewhat customized solution to meet the specific needs and objectives set forth by the producer. When making decisions concerning which devices may provide the most benefit to an operation and how best to implement and operate them, consider the following:

- Define and prioritize objectives.
  - What are the most important things you hope to achieve?
  - What areas would benefit the most from monitoring or control that tend to be an issue and have required a great deal of time and attention in the past?
- List current operation attributes that may be relevant.
  - Power availability.
  - Building layout.
  - Communication methods available.
  - Distance to furthest points to be monitored.
  - Topography (in terms of line of sight).
  - Number and location of pumping stations and sap tanks.
  - Other obligations of the producer and availability and cost of additional labour.
  - Level of producer technical expertise or availability of other technical expertise.
- The initial capital investment required.
  - Funds that are available for investment.
  - Costs of various systems and how quickly a return on the investment is predicted to be realized.
  - Cost and ease of installation.
  - Self-installation or hired installation.
- The user interface that will be used.
  - Whether the user interface is set up on a dedicated computer, over the Internet, with an app, or in another manner, the producer must have the appropriate device and level of comfort to interact with it.
- Potential for future expansion (scalability).
  - Ease of adding to the monitoring and control system within the existing operation.
  - Ease of expanding with the operation if it becomes larger in the future.
- Maintenance and support.
  - What is required in terms of maintenance and support for the various systems?
  - Will it be possible to manage the technical aspects and fix any problems that may arise “within house” or will help be readily available when needed from the manufacturer or another professional?
  - Annual fees or subscriptions (service, Internet connections, power, etc.).

Consider topography and distance to remote pump houses

Consider site characteristics

TYPES OF COMMUNICATION FOR MONITORING SYSTEMS

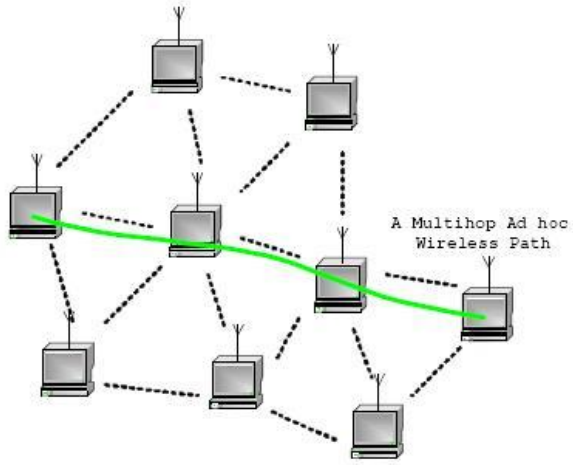
There are a number of communication methods (protocols) available for transmitting data within a maple operation and beyond to the outside world. Each method operates on its own set of rules and limitations but has the ability to be translated into a common format and sent over additional communication systems. Many monitoring systems will incorporate multiple communication methods to maximize the benefits of each. The most common and versatile of

these communication systems is Internet Protocol (IP), the method by which data is sent from one computer or device to another over the Internet.

Types of communication methods commonly used for monitoring and control systems include wireless mesh, local area network (LAN), wireless local area network (WLAN) and satellite. Most of these options can be used independently or incorporated with other communication methods. For any of these to be monitored and controlled from an off-site location they must be connected to the Internet.

Wireless Mesh

Wireless Mesh is the communication method commonly used in maple specific monitoring and control products to easily create a wireless network. Most implementations make each device (node) in the network able to send its own information, whether related to sensor data or control, along to the next node and by this means to the gateway or coordinator. These nodes also re-transmit all information they receive from other nodes, not intended for itself, to further extend the range and ability of the network. This architecture brings many benefits as it is easily scalable to add to the network and is relatively manageable. Each node has an individual identity, but is treated equally within the network. With a mesh layout, the system is able to continue operating in the event that one node fails due to the high probability that most nodes will still have a number of other nodes within range to communicate with. Most available systems are battery operated with low power requirements and, depending on the device, will operate from 3 weeks to 7 years using standard batteries. Some of the equipment providers have a solar option to keep the batteries charged.



Wireless Mesh Example – All nodes equally connected; information passes along easiest path.

All of the equipment provider's solutions incorporate a gateway (coordinator, controller, etc.) to manage all of the nodes and corresponding data and to provide an interface between the mesh network and a device used to manage the system and monitor the data. Most commonly, this gateway is connected directly to a computer or Local Area Network device for local management and extension of the Internet. Most of the equipment providers are using similar standards and protocols in their networks, but for the most part the equipment from one company will not directly integrate and communicate with the equipment from another. Each network has its own identifiers and security that limits their ability to communicate with each other.

The technical limitations with most electronics and communications generally involves trade-offs and balancing the benefits and drawbacks of variations in features. Wireless distance between nodes is one of the most important balances, as higher wireless power (increasing range) will negatively impact battery life. Due to battery life constraints, along with Industry Canada guidelines on output power, most equipment providers experience 250-500 m range between nodes in the sugar bush, depending on the line of sight (LOS) between them. In open LOS conditions, the range increases dramatically, and most systems can communicate up to 7 km. To extend a mesh network, most equipment providers recommend installing an additional node or basic repeater, using larger or directional antennas or incorporating another communication method.

Wired

Wired communication is the simplest and most dependable method of communication as it relies on the direct use of cables and wiring to transmit data. It results in a single connection between two end-points. Wired connections avoid the potential issues that present with wireless, but the limitations minimize its use. Some of these limitations include:

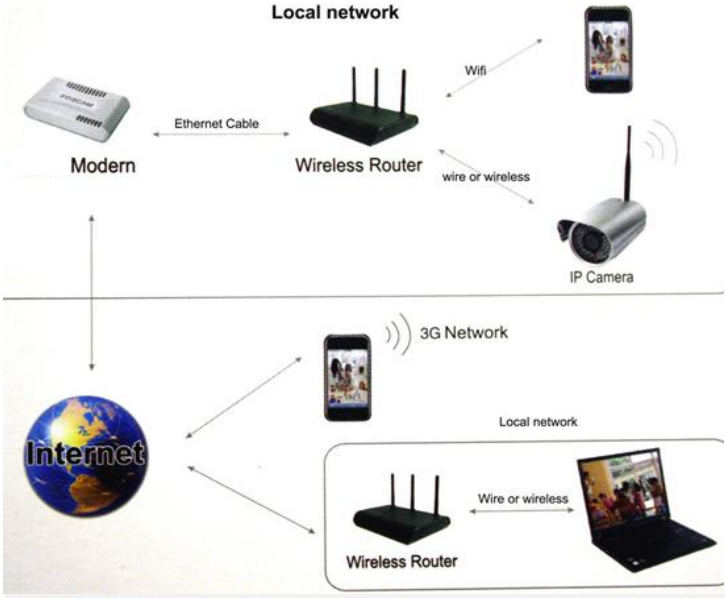
- Cost – most cable is copper based, making it pricey if long lengths of cable are required.
- Deployment time – installing cable can be time consuming.
- Range – most copper communication is limited to 100 m.

In a maple syrup operation, items that are monitored or controlled by wired communication will generally be limited to those that are close in proximity. There are a few basic monitoring solutions that fall under wired-only communication, but the majority of cost effective and feature-rich solutions now integrate a local area network (LAN) due to the increased ability to manage many devices over the same system.

Category-5 Ethernet Cable for IP Communication

Local Area Network

A local area network (LAN) is a computer network that carries data between devices and can connect to the Internet through a local Internet service provider's connection. Adding a LAN to a wireless mesh based monitoring and control system can extend the usability of the system to multiple computers on the same network (generally in the same building or property). By connecting that LAN to an Internet connection, the same functionality can also be extended to any computer or mobile phone anywhere in the world. A notification will be sent to you if there is an issue and you have the ability to check in on your monitoring at any time. Most operations have a feasible option for installing Internet access, whether through a local wireless Internet service provider, satellite Internet or a cellular hotspot. Category 5 and 6 Ethernet cable are the most common cable used to connect a LAN. Because it uses wires, it is also subject to the benefits and limitations of a wired communication system.



Example of a LAN (Local Area Network) and extension to the outside world through Internet

A further extension of a LAN is to add a wireless router or access point, making it a wireless LAN (WLAN) or Wi-Fi. (In this report WLAN and Wi-Fi are used interchangeably as they refer to the same communication system.) This can increase the value of the system as it can extend the availability of monitoring, control and connection to the Internet to Wi-Fi Laptops, smartphones and tablets. Wi-Fi is the communication method that laptops, tablets and smartphones use to connect to a home, office or public Internet router or 'hotspot'. Outdoor WLAN access points often have a 1-3 km range and theoretically can go 30+ km under the right conditions. A WLAN also allows for more monitoring and control options as there are many devices in the generic monitoring, security and automation market.

Satellite

The greatest benefit of satellite communication is that it is available virtually anywhere as long as there is a clear view of the sky (generally the south-west sky from Ontario). There are solutions that offer a remote monitoring and control system with integrated satellite connection and solar power. The use of satellite communication involves an annual fee, but is very convenient when monitoring a remote bush that does not have existing power or communication (Internet or cellular reception). All notification, monitoring and control of this type of system could be done remotely with a laptop, smartphone or tablet connected to the Internet.

Marcland satellite station

Where no other form of Internet is feasible, a satellite Internet connection can be used in conjunction with a Local Area Network and/or Wireless Mesh network to effectively make the networks accessible remotely.

OVERVIEW OF TYPES OF MONITORING

Video Monitoring

Video Monitoring is an extremely valuable tool that allows a producer to visually monitor equipment from a remote location, saving a great deal of time and effort. A few applications for video monitoring are:

- Monitoring pump houses (tanks, extractors, etc.)
- Monitoring gauges (vacuum, pressure, temperature, etc.)
- Security

Foscam Wi-Fi IP Camera with Pan and Tilt

The limitation of video monitoring, as compared to most sensors, is that cameras are not designed to notify the producer if something goes wrong. Because of this, some producers install a monitor or television screen in their boiling area to allow for easy viewing of the video streams. A live video feed is only valuable if someone is able to monitor it. The exception to this is cameras that have a motion detection feature that enables them to take a snapshot, record a video or send a notification to the producer. This adds some security value, but the motion detection and notification aspects are not necessarily valuable in a maple syrup production respect.

When choosing a video monitoring solution, it is important to find a camera that best serves your operation in function, reliability and interaction. There are many functional differences between camera models that are worth considering:

- Operating range: temperature, indoor/outdoor, etc.
- Video quality (VGA, 720p, 1080p, etc.)
- Ability to zoom in
- Pan/tilt function to view multiple directions
- Infrared sensor for visibility in the dark
- Motion detection
- Audio support
- Remote viewing ability – monitor, computer, smartphone app

By evaluating the site where a camera is to be installed, the value of a camera will be maximized if it is able to accomplish multiple tasks. For example, a single camera that can pan and tilt and has infrared capability and audio support could be very useful installed in a pump house. Positioned in a key location and programmed with preset positions, the camera could show a view of the sap tank level, extractor, vacuum gauge, pumps, door and wall thermometer as well as listen to the activity using audio. By selecting a camera solution with the most functionality you are able to maximize its ROI to your operation.


Video Monitor in Boiling Area

There are three common communication formats available to monitor a remote video. The most basic option is a small independent security kit, available from stores such as Costco or Staples, that is easy to self-install and comes with multiple cameras. The benefits of these systems are the low cost and easy installation. Drawbacks are the relatively limited range (generally one building) and the difficulty to view remotely. The other two options are to purchase cameras that are manufactured to be part of either a wireless mesh or wireless local area network. There is more flexibility with these systems to extend the range of the monitored area to reach more remote pump houses or even separate properties.

Sensors

Sensors can be used in many ways to measure and record a reading and then to notify the user if the reading increases or decreases past a predetermined value. Sensors in maple syrup operations can be used for many applications, including to monitor:

- Vacuum levels – various locations in tubing installations
- Sap levels in storage tanks
- Sap temperature in storage tanks
- BRIX of sap at the R.O.
- Temperature of syrup for automatic draw-off
- Air temperature
- Door sensors (notification or alarm when certain doors open to protect against tampering)
- Current/voltage meters
- Sap flow meters
- Levels of fuel storage for evaporators or generators

Magika Technologies Vacuum Sensor

Many sensors currently in use in maple syrup production provide simple feedback or automation (i.e. vacuum gauges, automatic draw-off, etc.) but are not part of a connected and integrated system. There are many local area network sensor solutions on the market, but they are not specifically designed for the maple industry and require more effort to set up and integrate. Currently, the most functional sensors in maple production are those designed specifically for the maple industry and connect via a wireless mesh network. Each sensor has the ability to connect into the type of network and equipment it was designed to communicate with (wireless mesh, LAN, WLAN, satellite, etc.). From there, it can then be extended via a LAN and/or Internet connection.

Smartrek's tank level sensor

The distance between a sensor controller and the monitoring point can greatly affect the reliability and quality of information provided. It can be beneficial to have multiple inputs, but the usefulness is based on the relative distance between the end point and the sensor. General rules are that sensor wires should be less than 100 m in length (best if less than 10 m) and tubing for vacuum sensors should ideally be kept less than 60 m for optimal performance.

When evaluating systems for your operation, it is important to discuss your needs with the product manufacturers as they are often capable and willing to build custom sensors as required. This is because the controller is a key part of the sensor unit and functions to interpret the sensor information and report it back to the coordinator through the network. The main difference between sensor units is the sensor portion which can incorporate whatever probe is required to measure the parameter in question.

Power Controls

Remote control and automation is a valuable addition to an operation, particularly if it is in conjunction with a monitoring system. The ability to make a physical change remotely, in response to a notification from a sensor or an observation from a video feed greatly increases the producer's ability to maximize their efforts. A few examples of how this technology may be used, includes:

- Turning vacuum pumps or other equipment on and off remotely based on information such as temperature, vacuum readings, or observations from video surveillance of an extractor.
- Turning lights on and off remotely (may be useful for video feed).
- Switches automatically controlled by specific sensor readings (e.g. vacuum turns on when outside temperature is >2°C and off when temperature drops to 0°C or pump engages when a tank level sensor indicates that a tank is full).

- Adjustment of R.O. remotely based on BRIX reading.

There are a few remote control options available through wireless mesh, local area network and satellite systems. Most of the solutions utilize low-power switching to a relay for higher voltage. There are a few 120vac power-bar options available in a local area network solution that are simple 'plug-and-play'. Each switch needs to connect into the type of network and equipment it was designed to communicate with (wireless mesh, LAN, WLAN, satellite, etc.) and then can be extended via a LAN and/or Internet connection as previously explained.

A factor to consider when comparing options for power control is how many devices one power control unit can operate. Most of the maple specific options can operate one or two devices, but some can operate as many as eight. The LAN/WLAN options vary from one input up to eight for power control.

Ubiquiti's 120v Web-Power Control Bar

MONITORING AND CONTROL SOLUTIONS

There are an increasing number of monitoring and control devices and systems on the market. For the most part, they fall within three main categories; maple specific monitoring and control, generic monitoring and control and basic indicators. Maple specific products refer to those that have been developed to specifically serve the maple syrup producer. Generic products are those that have been developed for the general market but have some application in a maple operation. Basic indicators are general market products and solutions that are not necessarily connected to a network and are generally simpler but can provide a useful function and a high value to cost ratio in some instances. All three categories may be utilized together in an overall solution for a producer, but the initial purpose, communication type and technical complexity of the solution will vary. Each operation is unique with its own set of deciding factors, resulting in the ideal solution being specifically tailored. In order to maximize overall value, the chosen solution must balance the benefits it is capable of providing with its ease of implementation and use.

ÉrabliTEK PC and Mobile Interface

To help compare the commercially available remote monitoring and control options, each maple specific company summary, where possible, includes a cost estimate for implementation of a full system for an average 2,500 tap operation with a single pump house. The system is assumed to include a gateway, one tank level sensor, one video camera, one relay power control unit and vacuum sensors for five mainlines, as available by each company. These numbers are to give a general idea for costs but a major discrepancy for comparison purposes is that not all companies offer the same monitoring and control options so prices will not include a device that is not available or account for variations in quality or number of inputs/outputs. Specifics of costs, where available, are included in a chart at the bottom of each summary. It is also useful to review the costs of individual items in order to consider how well a solution will scale for your particular operation.

Maple Production Specific Monitoring and Control

There are nine companies that have available products or are developing products for remote monitoring and control specifically for use in maple syrup production. Four of the main maple sugaring equipment manufacturers, CDL,


Smartrek's maple specific devices

Dominion & Grimm, Lapierre and Marcland, are in various stages of developing or revealing their own solutions. At the time of writing, Marcland has had a solution on the market for a few years, CDL has announced their initial products and announcements are expected from Dominion and Grimm and Lapierre in 2015. It is expected that all types of production equipment will increasingly be designed to integrate into overall monitoring and control systems (e.g. CDL's Intelligent R.O.).

Over the past several years a number of entrepreneurs have launched their own monitoring and control products specific to the maple production market, with a focus on sap line vacuum monitoring. These companies are: ÉrabliTEK, Magika, Smartrek, Sugarbush Electronics and TapTrack. With the exception of Marcland, all of the maple production specific solutions operate a Wireless Mesh network. Technically speaking, since the communication methods are similar, operating on the same type of network, the implementation and requirements will also be similar. All of these companies have products on the market and operations equipped with their solution. Some of them are already booked through the next season or have a waiting list.

The deciding factors between the companies will depend on available and future features, sales, support and availability. Since the components of each company's systems create their own private wireless mesh network, the components are not interchangeable. Because of this, it is recommended for the wireless mesh options, to engage a single company's solution per operation.

Marcland's Unit Multi Mini Station

Marcland's solution is unique when compared to the other currently available options in that their single device can provide remote monitoring and control without requiring external power, LAN or Internet connection. Their Unit Multi Mini Station is an all-in-one unit that provides up to 8 analogue inputs, 3 digital inputs and 2 output control ports that can be used to monitor or control a remote operation. The Unit comes equipped to transmit and receive information via a satellite connection and has the option of solar power. The satellite communication option does have annual and monthly fees but these may be offset by the minimal setup and simplicity of the system. This option may be a practical solution for a producer that does not have supporting infrastructure at their sugar bush.

Generic Monitoring and Control Products

The generic monitoring and control market has many options available, including high end security, "the smart connected home" and simple do-it-yourself equipment. A "smart connected home" refers to the recent trend of incorporating a range of sensors and automation into a home to be controlled by the homeowner, often by means of an app on a smartphone. The most common products today in this category are video monitoring, smart thermostats, smart fire detectors, connected door locks, light & power control, and general security sensors.

For the purposes of this report we will discuss LAN/WLAN communication based equipment, commonly available to the consumer market. These can be self-installed and configured by the savvy producer or, if assistance is preferred, many local computer shops and security companies can assist in design and installation.

Generic Wi-Fi Camera Interface

Since these products are all LAN based, they can be configured to be managed remotely with an Internet connection in the same way as the maple specific solutions.

The most commonly available products are video cameras, power control, and basic alarms. Most alarm sensors are a generic receiver with a specific sensor attached to it. Common sensors are door/window alarms, temperature sensors, motion alarms, and float-balls. Most of these options come with built in Wi-Fi, making them easy to add and connect to a WLAN. There are also many options available to extend a WLAN outdoors, increasing the coverage for monitoring and control devices, while also extending the available Wi-Fi coverage for laptops and other mobile devices for yourself and your customers.

Ubiquiti Outdoor Wi-Fi Access Point

Another option available to consumers is to enlist a local security company's services. Although this may come with a subscription fee, the required effort is minimal and most security services should be able to incorporate video monitoring and security sensors. The most difficult function to replicate with either a LAN or services from a local security company is vacuum monitoring because it is specific to maple syrup production.

A summary page of options that are available in the generic monitoring and control category can be found in the following section of this report.

Basic Indicators and Control

In some operations, the added complexity and management of a "connected" system will not add enough value to justify the capital investment and learning curve. And sometimes simpler is just better. There are quite a few independent, non-connected options that can bring value and benefit to an operation in a simple, budget friendly way. Most of these are not connected and do not offer any options for monitoring or control remotely.

Some basic monitoring and control options are:

- Basic video monitoring kit. Offering 1-10 cameras for local monitoring.
- Audible sump-pump alarms for sap tanks to signal when a certain level is reached.
- Light bulb controlled by a float-ball to indicate when sap tanks are almost full.
- Cellular based bush-camera (used commonly by hunters).
- AC switches to control vacuum and other pumps from the boiling area.

Generic video monitoring system

Basic indicators and control options are fairly limited in their use and scalability, but may provide a simple low cost solution or be used effectively for local monitoring or in conjunction with other "connected" options.

SUMMARY OF COMPANIES WITH COMMERCIALLY AVAILABLE OPTIONS

This section is comprised of summary pages for the companies that have remote monitoring and control equipment either currently available or in the development stages. The first pages eight pages represent brief summaries of the companies that provide maple production specific monitoring and control offerings, followed by a page each for generic products and basic indicators. Where possible, prices have been included as well as a cost estimate for an average 2,500 tap operation. The prices included are those at the time of writing and are subject to change. Prices may also be affected by volume or package discounts. These summaries are for informational purposes only as product offerings, features, and prices may change.

Summary Chart of Companies and their Product Offerings

COMPANY	PRODUCT OFFERINGS					
	Sensors			Video	Power Control	Additional Information
	Vacuum	Tank Level	Door/ Security			
Maple Equipment Manufacturers						
CDL	✓	✓		✓	✓	New products launched December 2014.
Dominion and Grimm						New products coming 2015.
Lapierre						New products coming 2015.
Maple Monitoring						
ÉrabliTEK	✓	✓		✓	✓	Small company - installations fully booked for 2015 season.
Magika Technologies	✓	✓			✓	
Marcland Instruments	✓	✓			✓	Offers a range of automation equipment.
Smartrek Technologies	✓	✓			✓	
Sugarbush Electronics	✓					Small company currently supplying only to New Hampshire and Vermont. May be able to expand into Canada by 2016.
Taptrack Technologies Inc.	✓					Vacuum sensors are the main product but other sensors are in development. Software has traceability and productivity program.
General Monitoring Solutions						
Local Security Companies or Local Computer Shop		✓	✓	✓		Local private security companies or computer shops can provide general monitoring services.
Self-Installation Options						
Wi-Fi Based		✓	✓	✓	✓	Many products are available, including those made by Foscam and Ubiquiti.
Off-the-shelf		✓	✓	✓	✓	Many products are available from hardware and department stores.

Example: Implementing Remote Monitoring

Considerable benefit can be received from strategic implementation of remote monitoring and control devices in any size of operation, whether starting out with a single device or a complete range of products. The following outlines recommendations for a simple initial installation that could easily be built upon.

Video monitoring is a versatile tool, making it a good choice to incorporate in an initial installation. A WLAN based camera with a pan/tilt function can be easily positioned in a pump house to monitor the extractor, gauges and pumps. Additional cameras can be added either initially or at any point to monitor other aspects of the operation.

Since video cameras can be used as a tool to monitor sap tank levels but do not provide any notification, a tank level sensor is useful to consider in an initial installation. A tank level sensor is easy to install and is particularly useful because of the constant monitoring of tanks that is required during periods of sap flow. A sensor will lessen the time required for continual physical monitoring as well as the probability of sap loss or flooding damage if tanks were to overflow. Most of the sensors can provide an instant read-out of sap level and can be configured to text or email the producer in the event that the tank is nearing capacity. Additional sensors for any other areas of concern can easily be added as desired once the framework is in place.

A rough estimate for installing a single camera in a pump house and a tank level sensor in a main sap tank is $1,000-$1,200, plus an Internet connection. This includes $700-$900 for a maple specific tank level sensor and gateway and $300 for generic Wi-Fi parts (Wi-Fi router and Foscam Pan/Tilt Camera). An Internet connection would be required to allow for remote viewing and notification.

Rural Internet is available for approximately $600/year and some companies may allow 'suspension' of an account for part of the off season. If your residence is on the same property it is possible to share your Internet connection between your house and sugar camp (i.e. with some Ubiquiti WLAN equipment) to eliminate the cost of an additional Internet connection.

Adding any subsequent cameras, sensors or power control devices to the system would require less cost and effort as the Internet, gateway and Wi-Fi router would already be in place.

CONCLUSIONS AND RECOMMENDATIONS

This report represents a point in time for a rapidly changing intersection of technology and maple syrup production. The nature of technology is to advance and evolve, with new ideas constantly shaping the development of newer and better products. Technology, in the form of remote monitoring and control systems, is relatively new to the maple industry so can be expected to see rapid changes in terms of the product offerings and the companies that provide them. More companies may see the demand that exists and establish their own product lines, adding to the options available. At the same time, other companies may dissolve or become acquired by other businesses due to the nature of the competitive market.

Each solution has benefits and limitations which need to be evaluated as they relate to your operation, keeping in mind the items discussed in the considerations and deciding factors section. Initial implementation of individual devices or an entire system requires a close look at the characteristics of the current operation and where monitoring can bring the most value.

A complete system with sugar bush vacuum monitoring, video cameras, tank level sensors, power control and a variety of other custom sensors may be most cost effective for medium to larger operations but there are viable and cost effective options for any size of operation. The simple benefit of savings in travel time to multiple pump houses in a large operation can be significant. For a small producer, especially one with outside employment or obligations, a monitoring and control system can bring value and peace-of-mind in knowing that things are running smoothly in their absence and sap is being collected for the next boil.

Most of the maple specific solutions provide offerings for sugar bush vacuum monitoring but there are differences in features. Quantity of input ports, battery life, solar panels, and unit housing as well as differences in additional devices that are available within the product lines may vary. Marcland's satellite communication option brings a unique solution to remote locations that do not have a power source or Internet communication. In comparison, wireless

Smartrek's Mobile App Interfaces

mesh and LAN solutions do require a little more infrastructure in regards to power and Internet for remote access, but both of these may already be available in an operation. A large benefit of is that they are very easy to add devices to for a large or expanding operation.

Using a LAN/WLAN based option of generic products has the advantages of being simple to expand and useful for adding Wi-Fi service around your property. This is particularly valuable in areas that do not have cellular phone service. There are many generic products available that are Wi-Fi/WLAN compatible but may lack some of the functions that come with maple specific solutions. Basic monitoring options such as basic wired indicators are also self-installation friendly and readily available.

All solutions are modular in that they can be built upon, making it perfectly reasonable to start out small and see how well something serves your operation. You may also find that in some cases combining a maple specific solution with some generic products could be a good option.

Particularly if considering a complete and integrated system, it is best to have a consultation with prospective companies to get a complete picture of their products and pricing. A major factor will be whether you are interested in a complete turn-key solution tailored to your operation or are interested in pursuing an installation of generic products that you source out and install yourself. It is advisable to be mindful of expansion in terms of future products or geography when installing a system because once the basic communication back-bone is in place, expansion costs are generally substantially less than the original implementation.

Remote monitoring and control devices are relatively new to the maple industry but, as tools for maximizing the efficiency of maple operations and the effectiveness of producers, are rapidly advancing. Many of the products referenced in this report are initial product offerings and undoubtedly the next few years will see further expansion and integration of this technology into modern maple syrup operations.

Photo courtesy of ÉrabliTEK

APPENDIX

COMPANY CONTACT INFORMATION

COMPANY	WEBSITE	CONTACT INFORMATION
CDL	en.cdlinc.ca	Local CDL store or dealer, or Martin Bérubé Phone: 418-572-0978 Email: martin.berube@cdlinc.ca Head Office - Saint-Lazare, Quebec
ControlByWeb.com	www.controlbyweb.com	Phone: 435-750-5999 Email: sales@ControlByWeb.com Utah, United States
Dominion and Grimm	www.dominiongrimm.ca	Mario Lemire, Sales and service Phone: 518-651-7792 or 450-370-6121 Email: mlemire@dominiongrimm.ca Head Office - Anjou, Quebec
ÉrabliTEK	www.erablitek.com	Phone: 855-537-2253 Email: info@erablitek.com Sherbrooke, Quebec
Foscam	www.foscamcanada.com	Phone: 416-800-4563 Email: sales@foscamcanada.com 3550 Victoria Park Ave., Suite 201, Toronto, Ontario
GHC Safety and Security Solutions	www.ghcsafetyandsecurity.com	Jamie Couper Cell: 519-766-8086 Email: jamiec@ghcsafetyandsecurity.com Arthur, Ontario
Lapierre	www.elapierre.com	Bev Campbell Phone: 705-279-8349 Cell: 705-279-8349 Head Office - St-Ludger, Beauce, Quebec
Magika Technologies Inc.	www.magika.ca	Sylvain Létourneau Cell: 581-990-3287 Email: sylvain.letourneau@magika.ca St-Sylvestre, Quebec
Marcland Instruments	www.marcland-usa.com	Robert Crooks Phone: 518-532-7922 Email: sales@marcland-usa.com 220 River Rd., Schroon Lake, New York
Smartrek Technologies	www.smartrektechnologies.com	Phone: 581-701-3075 Email: service@smartrektechnologies.com St-Honore-de-Shenley, Quebec
Sugarbush Electronics	www.sugarbushelectronics.com	Rolf Zuk Phone: 603-638-4191 Email: rolf@sugarbushelectronics.com 967 Woodsville Road, Monroe, NH 03771
Taptrack Technologies Inc.	www.taptrack.ca	Phone: 705-759-4857 Email: sales@taptrack.ca Sault Ste. Marie, Ontario
Ubiquiti Networks	www.ubnt.ca	Phone: 519-935-3362 Email: admin@ubnt.ca 1004 Allenford Rd., South Bruce Peninsula, Ontario

GLOSSARY OF TERMS

Ad hoc – A communication mode that allows computers or devices to directly communicate with each other without a router. Often used to describe solutions that are developed for temporary use for a specific purpose.

Analogue – Describes a device or system that represents changing values as continuously variable physical quantities. Computers require modems to turn signals from a digital to analogue format before they can be transmitted over communication lines that carry only analogue signals (i.e. telephone lines). The signals are then turned back into digital form (demodulated) at the receiving end so that the computer can process the data in a digital format.

App (Application) – A self-contained program or piece of software designed to fulfill a particular purpose; an application, downloaded by a user to a mobile device.

Controller – A hardware device that manages the transfer of data from a computer to a peripheral device and vice versa. Often referred to as a coordinator or gateway with maple specific monitoring and control systems.

Cellular Communication – Utilizing the cellular mobile network, through mobile phone or 3G/4G hotspot, to connect to the Internet.

Data – Digital Information stored on a computer or transmitted over a network or the Internet.

Gateway – Hardware or software that acts as a bridge between two networks so that data can be transferred between computers or devices. In maple specific monitoring and control systems this can also be referred to as a controller or coordinator.

Integrated – Two or more components merged together into a single cohesive system that is designed to function as a unit.

Interface – A device or program enabling a user to communicate with a computer or system.

Internet Protocol (IP) – The principal communications protocol by which data is sent from one computer or device to another on the Internet or a Local Area Network (LAN). A code used to label packets of data sent across the Internet, identifying both the sending and receiving computers.

Local Area Network (LAN) – A computer network that interconnects computers and other devices within a limited area, such as a building or home, using network media. Most LANs are connected by Ethernet cable, or wirelessly through WLAN/Wi-Fi, and are capable of transmitting data at very fast rates.

Line of Sight (LOS) – An unobstructed path between sending and receiving antennas for the transmission of a signal.

Mesh network – A communications network made up of radio nodes organized in a mesh topology in which each node relays data for the network. All nodes cooperate in the distribution of data in the network. Wireless mesh networks often consist of mesh clients, mesh routers and gateways.

Node – Any device connected to a network, each having a unique network address that identifies it. Generally each device in a mesh network, except for the gateway, is considered a node.

Radio – Radio frequencies are used to communicate between nodes in a mesh network, between devices in a WLAN network and in satellite communication.

Relay – An electrical device, typically incorporating an electromagnet, that is activated by a current or signal in one circuit to open or close another circuit.

Repeater – An electronic device that relays a transmitted signal, by receiving and then amplifying and rebroadcasting it. By amplifying the signal, a repeater increases the transmission range of the original signal.

Router – A hardware device that routes data from a local area network to another network connection, allowing only authorized devices to connect to the network.

Satellite Communication – The use of artificial satellites that have been stationed in space for the purpose of providing telecommunications. Used for facilitating radio, television and telephone transmissions by means of the reflection or amplification and retransmission of signals between stations on earth or in space.

Sensor – A device that detects or measures a physical property such as light, motion, temperature or vacuum level and indicates, records, or otherwise responds to it.

Wi-Fi – A trademarked term. Any wireless local area network (WLAN) products that are based on the Institute of Electrical and Electronics Engineers' 802.11 standards. Refers to wireless networking technology that uses radio waves to provide wireless high-speed Internet and network connections.

Wireless Local Area Network (WLAN) – A type of wireless computer network that uses high frequency radio waves rather than wires to communicate between two or more devices or nodes within a limited area such as a building. Term used interchangeably with Wi-Fi in this report.