Proactive Monitoring of Friction Management Systems Reduces Costs and Downtime

By: Nicholas Dryer and David Mintskovsky

Abstract

The latest research shows that friction management systems reduce friction and thus reduce the cost of fuel for railroads, and increase rail as well as OTM Life. Unfortunately, these systems are placed in remote locations and have minimal communication capability, and in many cases end up non-operational, which eliminates their benefit. A major railroad found a solution that utilizes the latest cellular and satellite technology along with a custom web interface that provides easy access and real-time monitoring of field equipment. The oil and gas pipeline companies have been taking advantage of a similar solution globally over the past ten plus years.

The product, defined as a remote monitor (often marketed as an M2M solution), and the user interface allows for fast information transfer and regular status updates of equipment in the field. It also allows for on-demand polling by individuals or companies responsible for maintaining that sector of the rail and equipment. Using report-by-exception, the remote monitor notifies an operator instantaneously when a problem occurs. Some of the common field related problems included power outage, low material level, non-operational pumps, trigger system malfunctions and potential vandalism. Additionally, remote monitoring will be able to generate consumption reports, which will allow for a more predictive approach for maintenance and service versus a reactive and delayed approach that greatly reduces the benefits of the systems.

This paper will discuss the ease of installation, simplicity in use, and other benefits of a remote monitor and how it helps reduce maintenance and services costs, improve production and know when equipment is non-operational for the railroads.

Introduction

Before any type of remote monitoring was available on the friction management systems, very little was known about the performance of the assets in the field. Many areas of railroad systems had significant amounts of non-operational time; it is not unheard of to have over eighty percent of friction management assets down at any given time. For example, a subdivision in Texas had an audit performed on ten systems that discovered that only two of them were actually working. Another subdivision in Alabama that has twelve systems, four were found to be non-operational.

The first generation remote monitors provided the ability to monitor material levels, while this was the first attempt, this system did not provide railways an indication on whether the system was even operational. The second generations of remote monitoring systems began to give railways a more in depth look at how the systems were operating, the additional functions of monitoring wheel counts, pump time, and system power became available, however, at a higher cost. The systems were not reliable as they consumed the site batteries with their high power communication radios. Additionally, these systems constantly sent out messages that overwhelmed field engineers and created constant information that ended up being ignored. If the power at the site was lost, the radios would stop responding requiring one to notice that the radios were no longer communicating, and would eventually require a field visit to verify if the battery was bad or if the solar panel had problems.
The new solutions for Rail Friction Management (RFM) available today provide proven field reliability and robust features not available with the previous generations. Manufactured by an M2M electronics and communications company, the systems can be installed on all friction management platforms available today and are not manufacturer specific. Using cellular and satellite networks these systems work throughout North America as well as all over the world. Some of the key features include the ability to shut off the friction modifier pump remotely, access the latest site data, receive instant notifications if problems occur in the field, and the ability to determine specific site problems such as a low battery voltage or low tank level.

Additional features include exception based reporting, over-the-air reprogramming of key parameters, ability to transmit alarm messages to specific operators and crews, and connectivity using any Internet enabled device. Most importantly, the new RFM remote monitors help reduce the overall cost of maintenance by ensuring that equipment is operational, reduce and possibly eliminate some of the travel time and visits to remote locations, as well as increase efficiency and fuel savings of maintenance crews.

For example, a maintainer currently covers a territory of roughly 285 miles and visits 48 units over the course of a five day work week performing a visual inspection. The visual inspection would not provide information on whether or not the wheel sensor is working properly. The travel time to each site could be as long as five hours depending on weather and road conditions. The time to inspect each site may only be ten minutes, which accounts for roughly 20% of value added work. The rest of the time is spent commuting from site to site.

Application of Technology

The RFM remote monitor is specifically designed to help maintain friction management systems with key features requested by several Class I railroads. These features are discussed in detail below, in no particular order.

- User defined parameters – the user can log into a secure website and set up specific parameters that they want monitored. These parameters can be door alarms, battery voltage, tank level, wheel/axle counter, AC power presence, solar panel voltage, and pump operation. A parameter such as battery voltage would have a high and low alarm level, a user can set 10V as the low level and 15V as the high level. If the voltage is found to be out of this set range, an alarm is generated and a message is sent to the user(s). The user can reprogram these parameters at any time from any internet connected device. Figure 1 shows configuration parameters for some of the channels.
Exception based reporting – the user set parameters are checked after every train event or at set time intervals (ex. Every 4 hours). If a parameter is found to be out of the pre-set range (ex. Tank level is too low), an alarm message is generated and sent out via email or SMS to a specified user or group of users. If all the parameters are within the pre-set range, the RFM remote monitor goes back into idle mode, which preserves battery life. Once a parameter returns to within pre-set range (ex. tank refilled), a return to normal message is sent out to the users and the remote monitor goes back into idle mode. Figures 2 and 3 show the alarm messages sent out via email and the same message can be seen on the secure website.
Figure 2: Alarm Message Sent by Email

```
09 Jul 2013 07:22  Alarm Notification

Sent To: [Redacted] (Nicholas Dryer), [Redacted] (Charlie Rudeen), [Redacted] (David Mintskovsky)

Message:
The MP Marceline Single Track site has received an alarm report. The following values were reported by the site:

Monitor Battery Voltage: 8.4 V
Total Wheel Count Track 1: 454,711
Dispensed Material Track 1: 19.3 US gal
Total Wheel Count Track 2: 0
Dispensed Material Track 2: 0.0 US gal
Tank Level (Controller): 177 US gal
Last Train Direction Track 1: West
Track Last Event: Track 1
Wheel Count Last Event: 296
Dispensed Material Last Event: 480.0 ml
Solar Panel Voltage: 8.7 V
Power Source Voltage: 12.0 V

To view the details of this alarm, visit https://secure.pipelinewatchdog.com.
```

Figure 3: Return to Normal Message Sent by Email

```
09 Jul 2013 08:03  RTN Notification

Sent To: [Redacted] (Nicholas Dryer), [Redacted] (Charlie Rudeen), [Redacted] (David Mintskovsky)

Message:
The MP Marceline Single Track site has returned to normal status. The following values were reported by the site:

Monitor Battery Voltage: 8.3 V
Total Wheel Count Track 1: 454,711
Dispensed Material Track 1: 19.3 US gal
Total Wheel Count Track 2: 0
Dispensed Material Track 2: 0.0 US gal
Tank Level (Controller): 178 US gal
Last Train Direction Track 1: West
Last Train Direction Track 2: C
Track Last Event: Track 1
Wheel Count Last Event: 296
Dispensed Material Last Event: 480.0 ml
Solar Panel Voltage: 12.9 V
Power Source Voltage: 12.9 V

To view site details, visit https://secure.pipelinewatchdog.com.
```
• Daily reports – a daily summary report is generated and stored on a cloud server that can be viewed using the secure website. The report is automatically generated at a user defined time of day and a summary of the last week, month, or year report can be sent directly to an email address of specified users. Figure 4 shows a channel history view that can be accessed through a link on the website.

![Figure 4: Ability to View History](image)

• Real-time data – a user can log into the secure website and “poll” the specific site or a group of sites to receive the latest site data. This feature is especially useful if maintenance is required and helps in troubleshooting issues such as site battery problem, a solar panel issue, or low fluid level.

• Levels of users – each site can have multiple users assigned to it. The users can have varying degrees of access ranging from Company Manager that can control all site information to Read Only Technician that can only read the data, but not change any parameters. The sites themselves can be assigned to specific subdivisions. A Company Manager can have access to all sites within an organization and can assign the Technicians to have access to only specific sites within a company or subdivision. Alarm messages can be sent to specific users who are responsible for that site or that subdivision or to an entire group of users. Figure 5 shows what a company manager sees when logging into the website. Figure 6 shows the view of what a technician who is assigned to specific subdivisions would see when logging into the website.
Figure 5: Company Manager Sees All Subdivisions
Backup battery – the RFM remote monitor has its own battery that ensures continuous operation even if site batteries are depleted. The internal battery allows the RFM remote monitor to continue transmitting alarm messages of parameters that are out of the pre-set range, such as low battery level at the site, door open, low tank level, etc… This internal battery is trickle charged off the main batteries and allows the remote monitor to operate more than six months on its own power.

Remote interrupt – a user can set specific times and dates to turn OFF and then back ON the pump inside the lubrication system as well as turn it ON/OFF on demand. One of the key benefits is the savings of lubricant when performing maintenance on the rail, such as rail grinding, or performing ultrasonic inspections when a system may need to be off for three days before the inspection. Additional cost savings are achieved when comparing remote interrupt to manually turning off every single unit before an inspection or maintenance activity. With remote interrupt, the controller is still operating and the remote monitor continues transmitting daily reports such as wheel/axle counts, door open/closed, battery voltage, tank level, power presence, etc… Figure 7 shows the user interface for instant and scheduled remote pump interrupt.
RS232 Serial – each RFM remote monitor is equipped with an RS232 serial port that can communicate with specific digital controllers that are provided with friction management systems today. The remote monitor reads the data and interprets the information which is then displayed on the secure website. New controllers are being added to the portfolio of controllers with which the remote monitor communicates upon request.

Data Storage – the RFM remote monitor is equipped with a memory card that can store site information for the last twenty (20) years. The data can be retrieved over-the-air if the unit has a cellular connection or by downloading the data to a computer using a USB cable. This is particularly helpful if performing specific tests on a section of rail.

Digital channels – four digital channels are available for use with magnetic door alarms, to count wheels/axles of a passing train or to detect the presence of AC power. Digital channels can help in troubleshooting site issues, such as the loss of AC power. When used with magnetic door alarms, they can help determine if a door is being opened for regular maintenance or if there could be another problem such as theft.

Analog channels – four analog channels are available for measuring items such as battery voltage, solar panel voltage, pump operation, and fluid level sensor (can be either a 0-10V or 4-20mA). All of these channels can have alarm thresholds configured remotely, using any internet connected device and can be programmed at any time.

The digital and analog channels provide instantaneous as well as periodic input checking. Instantaneous inputs monitor continuously and send out alarms when they occur. Periodic inputs have high and low level limits and report at the regularly scheduled intervals, such as after every train event. Should an out of limits alarm condition occur, a message is sent via email or SMS to the specified users. If the condition returns to within the pre-set limits, a new message is sent to the users. Table 1 below describes the different alarms and their configurable alarm conditions.
### Periodic Input Configurable Alarm Conditions

<table>
<thead>
<tr>
<th>Battery/Power Supply Voltage</th>
<th>Outside Alarm Threshold (High or Low Limits)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar Panel Voltage</td>
<td>Outside Alarm Threshold (High or Low Limits)</td>
</tr>
<tr>
<td>AC Power Detect Probe</td>
<td>Does Not Alarm, Only to aid in troubleshooting</td>
</tr>
<tr>
<td>Grease Tank Level Sensor</td>
<td>Below Alarm Threshold (in percentage)</td>
</tr>
</tbody>
</table>

### Instantaneous Input Configurable Alarm Conditions

<table>
<thead>
<tr>
<th>Pump On Time</th>
<th>Pump staying on longer than time threshold</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pump Current Sense</td>
<td>No current sensed or high current sensed</td>
</tr>
<tr>
<td>Wheel/Axle Count</td>
<td>No Counts for configurable amount of time</td>
</tr>
<tr>
<td>Tank Door Sensor</td>
<td>Door opened</td>
</tr>
<tr>
<td>Electrical Door Sensor</td>
<td>Door opened</td>
</tr>
<tr>
<td>Power Loss</td>
<td>Power was lost at site/AC Detect aids in determination of failure</td>
</tr>
</tbody>
</table>

**Table 1: Alarms and their conditions**

These new remote monitors offer easy field installation to work with existing friction management systems. They can be mounted inside or outside an existing system and connect with two wiring harnesses. A trained installer can complete the field installation of one remote monitor in less than one hour. The goal for future implementation is to have the monitors installed in the factory of the major friction modification system providers and thus eliminating the need for field-retrofit. A few pictures of the remote monitor installed in existing friction modification system manufactured by Loram-MOW and Lincoln.
Figure 8: Remote Monitor Actual Size 5.4x7.8x2.8 inches (135x200x72 mm)

Figure 9: Monitor Inside TOR unit
Figure 10: Monitor Inside TOR Unit

Figure 11: Close Up of Remote Monitor Connected
Figure 12: Monitor Inside GF Unit

Figure 13: Close Up of Monitor Inside GF Unit
Analysis

The first fifty (50) units were installed on existing friction management systems. The field retrofit installation required approximately one hour per system. Upon completion of the field installation, the remote monitor became operational and started transmitting messages.

The following is a sampling of the screens that can be viewed by logging into the secure website from any internet enabled device: Figure 14 shows a view of the entire subdivision with information about the main parameters such as operational status, site power, tank level and electrical door status.

<table>
<thead>
<tr>
<th>Status</th>
<th>Int</th>
<th>Site</th>
<th>Last Contact</th>
<th>Monitor Battery Voltage</th>
<th>Tank Level (Gallon)</th>
<th>Solar Panel Voltage</th>
<th>Power Source Voltage</th>
<th>Electrical Door Status (Controller)</th>
<th>Internet Site</th>
<th>Unit Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>OK</td>
<td>01</td>
<td>01</td>
<td>03 Aug 2013 13:30</td>
<td>7.5 V</td>
<td>198 US gal</td>
<td>13.0 V</td>
<td>13.0 V</td>
<td>Closed</td>
<td>PumpEnabled</td>
<td>RPM</td>
</tr>
<tr>
<td>OK</td>
<td>02</td>
<td>02</td>
<td>03 Aug 2013 13:30</td>
<td>7.5 V</td>
<td>186 US gal</td>
<td>13.0 V</td>
<td>13.0 V</td>
<td>Closed</td>
<td>PumpEnabled</td>
<td>RPM</td>
</tr>
<tr>
<td>OK</td>
<td>03</td>
<td>03</td>
<td>03 Aug 2013 13:30</td>
<td>7.5 V</td>
<td>156 US gal</td>
<td>13.0 V</td>
<td>13.0 V</td>
<td>Closed</td>
<td>PumpEnabled</td>
<td>RPM</td>
</tr>
<tr>
<td>OK</td>
<td>04</td>
<td>04</td>
<td>03 Aug 2013 13:30</td>
<td>7.5 V</td>
<td>156 US gal</td>
<td>13.0 V</td>
<td>13.0 V</td>
<td>Closed</td>
<td>PumpEnabled</td>
<td>RPM</td>
</tr>
<tr>
<td>OK</td>
<td>05</td>
<td>05</td>
<td>03 Aug 2013 13:30</td>
<td>7.5 V</td>
<td>156 US gal</td>
<td>13.0 V</td>
<td>13.0 V</td>
<td>Closed</td>
<td>PumpEnabled</td>
<td>RPM</td>
</tr>
<tr>
<td>OK</td>
<td>06</td>
<td>06</td>
<td>03 Aug 2013 13:30</td>
<td>7.5 V</td>
<td>156 US gal</td>
<td>13.0 V</td>
<td>13.0 V</td>
<td>Closed</td>
<td>PumpEnabled</td>
<td>RPM</td>
</tr>
<tr>
<td>OK</td>
<td>07</td>
<td>07</td>
<td>03 Aug 2013 13:30</td>
<td>7.5 V</td>
<td>156 US gal</td>
<td>13.0 V</td>
<td>13.0 V</td>
<td>Closed</td>
<td>PumpEnabled</td>
<td>RPM</td>
</tr>
<tr>
<td>OK</td>
<td>08</td>
<td>08</td>
<td>03 Aug 2013 13:30</td>
<td>7.5 V</td>
<td>156 US gal</td>
<td>13.0 V</td>
<td>13.0 V</td>
<td>Closed</td>
<td>PumpEnabled</td>
<td>RPM</td>
</tr>
<tr>
<td>OK</td>
<td>09</td>
<td>09</td>
<td>03 Aug 2013 13:30</td>
<td>7.5 V</td>
<td>156 US gal</td>
<td>13.0 V</td>
<td>13.0 V</td>
<td>Closed</td>
<td>PumpEnabled</td>
<td>RPM</td>
</tr>
</tbody>
</table>

Figure 14: Entire Subdivision View

Clicking on any of the sites shown in Figure 14, leads to the specific site and more detailed information such as wheel counts, graphs for tank levels, specific location of the unit, amount of dispensed material, pump status, and several others.
In the site specific view as shown in Figure 15, a user can select to view a graph for the values reported to the site for tank level, solar panel power, site power, dispensed material during the last track event as well as wheel counts. Graph of the tank level is shown in Figure 16 and can be modified to show several months, a year, or a custom date range.
Figure 16: Instant Graphing Capability

Quality control of service for filling and maintaining material level is now clearly visible and information is available with graphs and numbers. Figure 17 shows the graph of a when a tank was filled and returned to 100% full.
Figure 17: Tank Filling Graph

Ability to see the history of all the channels under the “View History” provides information about the state of the units and when alarms were reported as well as cleared, as shown in Figure 18.
Discussion of Advancements in Technology and Benefits

Before reliable remote monitoring became available, maintainers could spend as much as 80% of their time commuting from site to site. If a problem is noticed during one of the visits, the maintainer may not have all the right tools or equipment to correct the problem and would need to come back to the site the next day or another week. Additionally, before remote monitors, sites may be down and non-operational until a maintainer can come by and see the site not working. After a problem is noticed, it could take several more days to make the systems operational, reducing the benefits of having a friction management system on the rails.

With the first generation of remote monitors, the systems provided ability to see the tank levels, battery voltage, train events, wheel counts and pump time. Some of these legacy systems required high amounts of power and thus draining the site batteries and forcing the system to shut down. Additionally, the first generation included radios that are becoming obsolete and being phased out by the Class I railroads. These radios require a significant amount of maintenance of their infrastructure and this increases the cost of the entire system, although that cost may not always be associated with the friction management systems.

The new generation of remote monitors makes the maintainers much more efficient in planning site visits and knowing which materials and tools to bring with them to the specific sites. Using a previous example of a maintainer covering roughly 280 miles of track per week, with an average salary of $1000 per week, only $200 or roughly 20% is being used for actual maintenance work. The rest is being...
used for non-maintenance related work. The added benefit of having a monitor in the field is the ability for a maintainer to now cover their territory more efficiently. Additionally, the remote monitor is constantly checking the system compared to a maintainer that could only check it once a week and sometimes less frequently.

The monitors also provide instant notification if a problem occurs in the field and create an opportunity for faster service to be performed on the malfunctioning unit. This helps reduce the downtime and decreases other rail maintenance activities. Working units also improve overall performance and fuel efficiencies and reduce costs.

Conclusions

Having an effective remote monitoring solution could potentially pay for itself in less than six months and many times having faster return on investments (ROI).

During the initial launch of 50 units, we measured 94 percent of the systems being up and running and reporting every day. One of the 50 systems was shut down due to a derailment, which leads us to conclude that 96 percent of the systems were operational and visible. This is significantly better when compared to systems with no remote monitoring or poor monitors that are not fully functional. Additionally, having working remote monitors allows the maintainers to focus on problem areas/units and provides them with knowledge of what supplies to bring with them.

Proactive remote monitoring, using field proven equipment, saves time, reduces costs and makes the railroads more efficient. These remote monitors can and should be required for all future wayside equipment and may be useful in other applications.

Acknowledgments

BNSF
Elecsys Corporation
Lincoln, a SKF Group brand
Loram – MOW

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Costs and Downtime Systems Reduce Friction Management of Proactive Monitoring of Friction Management Systems Reduces Costs and Downtime

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Director of Sales
M2M Rep

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Abstract

- Friction Modifiers reduce fuel costs
- Friction Modifiers save rail
- Systems are placed in remote locations
- Minimal communication/visibility

Background

- Before remote monitoring
  - No information about systems
  - Were they working or not?
  - Costs saving?
  - Price of modifier systems not justifiable

- First Generation of Remote Monitors
  - Monitored material level
  - Did not provide any additional information
    - Was the unit functioning?
    - Was the pump working?
    - Was battery charged?
    - Wheel counts?
    - A lot of assumptions had to be made

- Second Generation of Remote Monitors
  - More information became available
    - Wheel counts
    - Pump “On” time
    - System power
  - Monitors were not reliable
    - Used repeater radios
    - Radios consumed all site power
    - No back-up batteries

- Second Generation of Remote Monitors
  - More Information Available
    - Constant messaging to field engineers
    - Information was not being read/utilized

    - Were the units functioning?
New RMU System Overview

Data Server

Client Devices

Two Way Data Transfer

Field Equipment

New RMU Features

User defined parameter setting
- Low and high level setting for alarms

Exception based reporting
- Parameters are checked after every train event and message is sent if outside pre-set range
- Return to normal messaging

New RMU
- Additional features
  - Remote pump shut off
  - Instant alarm notification of problems
  - Backup battery - receive alarms if power is lost
- Reduce cost of maintenance
- Help ensure up-time

Background

New RMU
- Reduce cost of maintenance
- Site visits are reduced
- Maintainer knows of specific site problems
- Right tools and equipment for repairs

New RMU can monitor
- Communication with controller
- Tank level
- Site power (if AC is present)
- Site battery and solar panel voltage
- Material tank door (Open or Closed)
- Electrical compartment door (Open or Closed)
- Pump status
- Wheel/axle counts

New RMU Features

Daily, weekly and monthly reporting
- Automatically generated
- Logged to a secure site
- Sent by email to specified users

Real time data access
- “Poll” site for latest information
- Ability to “Poll” multiple sites (entire Subdivision)
**New RMU Features**

**Different levels of users**
- Company Manager, Technician, Read-Only Technician
- Various access to parameters and ability to change them
- View multiple subdivision or specific sites assigned to specific user

**Backup Battery**
- Continues operating if site power is lost
- Transmits “Power Loss” message
- Repeats the message every few days
- Battery will last over 30 days with no site power
  - Sends alarm messages every 3 days

**Remote interrupt**
- Set dates and times to turn OFF the pump
- Turn pump ON/OFF on demand
- Save material during maintenance
- Eliminate manual labor to turn OFF every unit before inspection (detector cars)
- Daily reports continue

**RS232 Serial Port**
- Communicate with controllers used in friction management systems
- Read and interpret the data automatically
- Display data to a secure site

**Data Storage**
- Memory card to store site data
- Over-the-air data retrieval (Cellular)

**IP67 Enclosure**
- 5.4” (135mm) W
- 7.8” (200mm) T
- 2.8” (72mm) D

**Digital Channels**
- Door alarms
- Wheel/Axle counter
- Presence of AC

**Analog Channels (with Alarm thresholds)**
- Battery and solar panel voltage
- Material level sensor
- Pump operation
RMU Installed

Website Information
Remote Web Monitor

Subdivision List

Company Manager Sees All Subdivisions

Technician Sees a Specific Subdivision(s)

Map View
Remote Web Monitor

Sites Overview
Site Information

- Site Information
  - Configure Site
  - CH Mapping
  - Site Pictures

Description:
- Subdivision: BNSF, Friction Management Monitor
- Latitude/Longitude: 38.8051 N / 94.80395 W
- Time Zone: Central Standard Time

Map

Remote Pump Control

Configure Parameters for Alarms

Configure Parameters for Alarms

- General
- Schedule
- External Power Status
- Total Wheel Count Track 1
- Dispensed Material Track 1
- Total Wheel Count Track 2
- Dispensed Material Track 2
- Tank Level (Controller)

- Solar Panel Voltage (Monitor)
- Power Source Voltage (Monitor)
- High Alarm Limit (Volts)
- Low Alarm Limit (Volts)

Remote Pump Control

Remote Web Monitor

My Network
- Reports
- Users
- Administration
- Documentation
- Help
- My Information

Subsidiary >> Province Monitor >> Site ATRX Test - Cables >> Information

RPM-100 Pump Information Setup

Field Schedule
- Global schedule
- Special schedule

Pump Control
- Pump Enabled
- Start Hour / Stop Hour
- Interrupted Days
- First Day
- Last Day

Current Schedule

Initial Test Response Times

- Discuss initial subdivision deployment and response time by maintainers

Conclusions

- Proactive Remote Monitoring Saves Time and Costs
- Can be applied to other applications
- Should be required for all future wayside equipment
Acknowledgments

- BNSF Railway
- Elecsys
- LORAM Maintenance of Way
- Lincoln Industrial/SKF

Questions

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