

OSPF Path Cost Mapping

User's Manual

OSPF Pathing

An application from SBRConsulting, LLC

OSPFPathing is a set of programs that allows mapping of network routes base on OSPF interface costs. OSPFPathing collects OSPF information from Mikrotik routers into a database and creates all of the connecting paths. It can then draw a map of the network, including showing the shortest path between any 2 selected routers.

Requirements

OSPFPathing is built using PHP 5.6. It requires a MySQL or MariaDB database. The graphing is done using Image_Graphviz and AT&T's GraphViz. Collection of the Mikrotik data is done using Net_RouterOS. All development and testing have been done on a CentOS LAMP platform.

General Operation

OSPFPathing operates by logging into each Mikrotik router via the API. This means that UserIDs and Passwords must be known and routers must have the API service enabled. After configuring the UserIDs and Passwords (a default can be specified) the user requests that the Database be generated. The system will start with the designated router and follow all OSPF paths from that router to find the neighbors. Each neighbor will be logged into and the OSPF data collected. This is repeated until all discoverable (neighbor) routers are in the database.

Once the database is built, the user may request the map be displayed. The user can choose to have "start" and "end" routers marked and the shortest path between them highlighted. The sections below describe operation in greater detail.

License Levels

This is preliminary and subject to change.

There are four levels of paid licensing for OSPFPathing beyond the free version. The chart below outlines the features each offers:

Application	License Item	Free Version	Basic Paid	Intermediate	Large	Super
OSPFPathing	SaveMap	FALSE	TRUE	TRUE	TRUE	TRUE
	MaxDepth	5	5	20	Unlimited	Unlimited

WhatIf	FALSE	FALSE	TRUE	TRUE	TRUE
SetColors	FALSE	TRUE	TRUE	TRUE	TRUE
MaxNetworks	1	2	5	10	Unlimited
MaxRouters	10	100	250	500	Unlimited
MaxMaps	1	5	20	50	Unlimited
WhatIfChanges	0	0	1	10	Unlimited

The License Items are:

- SaveMap : The user can have the map saved as a PNG file. This file can be downloaded with the Download Map button on the map display page. This process involves a conversion from the SVG file that is display to PNG. This conversion is done by third party cloud-based software. The software requires an API key that can be obtained from <https://cloudconvert.com>.
- MaxDepth : The maximum number of levels that will be traversed by the program. All routers connected to starting router are at level 1. All routers connected to level 1 routers are level 2.
- WhatIf : allows changing path costs and re-displaying the map to see what the changes will do to the way data is routed.
- SetColors : The user may select colors to be used for various elements of the map.
- MaxNetworks : The maximum number of networks that can be stored at one time. When this limit is reach, adding a new network will require deleting or overwriting an old network.
- MaxRouters : The maximum number of routers that can be displayed in one map.
- MaxMaps :
- WhatIfChanges : The maximum number of path cost changes that can be made at one time.

Getting Started

Installation

The install package automatically installs everything that is required. Download the package from www.sbrconsulting-llc.com/OSPFPathing to your LAMP server. Unzip the file :

```
Tar xvzf OSPFPathing.tgz
```

Using sudo or as root run

```
make install
```

While the installer is running it will ask several questions. It will require the database host, database name, database root user password, database user id and database user password. It will create the database and add the required tables and required default data. It will put some files in /usr/local/sbr (the common directory for SBRConsulting, LLC applications), after creating it if needed. It will create

<document root>/sbrc/OSPFPathing for the web pages, etc. The installer creates 2 databases, if they do not exist. One is sbrconsulting_llc which is common to all applications from SBRConsulting, LLC. The second is the one for OSPFPath, normally call sbrcOSPF, but can be renamed during installation. Two database users are also create, if they do not exist. "sbrc" is the database user for common SBRConsulting application databases. "sbrcOSPF" is the database user for the database specific to the OSPFPathing application.

Once the script is finished, you may run

```
make clean
```

to remove the temporary files that the installer used.

After the installer completes, point a browser to <your server>/OSPFPathing/Config.php. This will bring up the application configuration page where you can set your default values, for colors and a few other things. Once the configuration values are satisfactory, you are ready to setup the Router Logins. Choose Manage Router Logins from the top menu and create some logins.

Once all required logins are entered, you must generate the database. Click on Generate Database in the top menu. Select a starting point in the network and click Generate. While the generation is in progress a window shows the progress being made. When the generation is complete (this may take several minutes) you can display the map of what routers were found.

The installer installs

Net_RouterOS: https://github.com/pear2/Net_RouterOS

Graphviz: <http://www.graphviz.org/>

Image_Graphviz: https://pear.php.net/package/Image_GraphViz/docs/latest/li_Image_GraphViz.html

Depending on the configuration and OS version of your server you may need to set selinux permissions to allow httpd to write to the /var/www/html/sbrc/OSPFPathing/images directory as this is where the files are created for displaying the map. Also, especially on newer releases of CentOS, you may need to change httpd.service to PrivateDir=false so that the files are written to the proper location.

Manage Router Logins

The Manage Router Logins page creates one or more database entries for each router. The user enters an IP address and the UserID and Password used to access each router. Because the program may connect to a router multiple times, usually to different IP addresses, based on the network topology, it must know the UserID and Password for each address. To make this easier for the user, there is a checkbox that allows the program to collect all of the IP addresses from the router and store the same UserID and Password for each IP address.

Manage Router Logins

Router Address:

Router UserID:

Router Password:

Off Add all addresses from router

Illustration 1: Config

There is also a mechanism for storing a “default” UserID and Password pair. The default is used if the system cannot find a UserID and Password pair for a router as it traverses the network. Entering UserID and Password for the IP address 0.0.0.0 sets the default UserID and Password. Multiple UserIDs and Passwords are supported for the network. The password can be null, though this is not a recommended practice.

Typical usage would be to enter the address of an edge router, the UserID and Password for that router and select “Add all addresses from router.” Click save and a list of the addresses added to the database will be displayed. Then enter 0.0.0.0 as the Router address and enter the default UserID and Password for the routers in your network. Click save. If there are additional routers that do not use the default password, enter an address for each, the UserID and Password to use and click Save. Once all the router UserIDs and Passwords have been identified, you are ready to generate the database.

The password is made visible when the mouse hovers over the “eye” button.

Generate the Database

The next step is to collect all of the data from the routers. This is done on the Generate Database page. If the database has been generated before, the user can select a router from the drop down to regenerate the database. If no routers are in the database, the user must enter an address as the starting router.

It does not matter what router is used as the starting router. However, the router that is used here is the one that shows at the top of the map, if the database is cleared.

As networks are fairly static this should not need to be done often. When network changes occur, it is necessary to re-run the database generation. There are three modes of operation for this process. If the toggle button “Clear Database” is checked, the system will clear all the routers and links for the selected

Network. If the toggle button “Add” is selected, all routers discovered will be added to the database. This means that any previously discovered routers will be duplicated in the database. If the toggle button “Overwrite DB” is selected, as it traverses the network, the system will update existing links between existing routers. It will also add any missing routers. It will not delete missing or unused routers, routers that do not have connections to other routers. If a router is deleted from the network, it will still show on the map, and will still show old connections.

It is possible to regenerate the database so that missing routers no longer show on the map. Selecting the “Clear Database” toggle will delete all the routers and the connections. Then, as the system traverses the network, it will add any router it finds via OSPF neighbors.

In either case, when the database generation is complete, it will display the number of routers added and the number of connections added.

There is an option to use a loopback IP Address. Without this the first IP Address identified for a router is the one that is used for subsequent communication. This is not always the most effect as not every device is available to all other devices on the network. Once the program finds an address in the specified range (at this time only one range is supported) it makes that the primary address for communicating with the device. Click the “Use Loopback Address” button to display the “Loopback Address Range” field. Enter the network address in CIDR notation, e.g., 192.168.100.0/25.

Display the Map

Displaying the map allows choosing a network and then a “start” and “end” router. If start and end routers are chosen these routers will be highlighted with colors in the resulting graphic and the path from one to the other will be highlighted. The various colors and styles all have default values that are set on the Config page. They be changed on this page for the current session. The items that can be changed are shown in Table 1.

Node Colors	
Start	The node at the beginning of the path being analyzed.
End	The node at the end of the path being analyzed.
Normal	Nodes that are not part of the path being analyzed.
Path	Nodes on the path being analyzed
Down	Nodes that have been discovered but cannot be contacted now. (Not yet implemented.)
Disabled	Nodes that have been disabled in the application.
Node Shapes	
Start	The node at the beginning of the path being analyzed.
End	The node at the beginning of the path being analyzed.
Normal	Nodes that are not part of the path being analyzed.
Path	Nodes on the path being analyzed.
Down	Nodes that have been discovered but cannot be contacted now. (Not yet implemented.)
Disabled	Nodes that have been disabled in the application.
Link Colors	
Forward	Links going from the Start node toward the End node.

Reverse	Links going from the End node toward the Start node.
Asymmetrical	Links that do not have the same forward and reverse cost.
Link Line Styles	
Down	Links that have one or both end nodes down.
Disabled	Links that have one or both end nodes disabled.
Asymmetrical	Links that do not have the same forward and reverse cost.

Table 1- Node and Link Settings

The Colors and Shapes values are hidden by default to conserve screen space. Clicking on the the title will expand the area so colors and/or shapes may be set. Clicking the header again hides the selections. The page starts with the colors set in the Set Defaults page. Each field may be cleared by clicking the 'X' next to the field. The user may enter color names typing the name or select from the list by clicking on the down arrow. A list of valid names that match the entered value(s) may be clicked to choose a value. A list of the names can be found at <http://www.graphviz.org/doc/info/colors.html>. Color names must be entered as a single word. No spaces or other punctuation is allowed.

The Start Node and End Node colors are only used if a Starting Router and Ending Router have been selected. Likewise the Forward and Reverse Link colors only apply when a Starting and Ending Router have been selected. When a Starting and Ending Node are selected, they and all the nodes in the path between them are optionally put into a box on the map. There is a toggle button, “Show Path in Box” at the bottom of the page to turn on the box. The links between them are colored Forward and Reverse Link colors. The nodes between them have the Path Node shape and color. Any nodes and links not on the selected Path will have the Normal path shape and colors. Colors or shapes may be returned to the default values with the “Reset Default Colors/Shapes” button at the bottom of the section.

It is possible to save the image created as a PNG. Turn on the Save as PNG toggle to enable this. The time to render the page will be longer as a third party, cloud-based system is used to create the image. Once the page is rendered, a button will appear to download the image.

If the user desires to only see the path in question the Only Show Path toggle should be turned on. This will generate a map that only contains the Start node, the End node, and the nodes in between that are on the shortest path.

Whether the entire map or only the path in question is display, turning on the Show Path in Box button will rearrange the map so that the path is “linear” and bounded by a box. If this selector is turned off, no bounding box will be drawn.

The map shows both the forward and reverse path between the routers. Because the paths are based on the interface costs and both forward and reverse paths are shown, this can be a very helpful tool. It is fairly simple to see when the paths are not the same. This would be an indication that interface costs are different on the 2 ends of the link. This may be by design, but often it is a mistake and can cause some performance degradation in some networks. In addition, to the colors, the cost of each link and the OSPF Area the link is a part of are show as the link's label.

If costs have been modified, see Modify Path Cost, the paths are shown as specified in the Asymmetrical Link setting under Shapes. The current cost of the link is shown and the original cost of the link is in parenthesis.

The label of each link shows the Area the link is associated with.

The map is generated as an SVG. You can select to have the map downloaded as a PNG.

Clicking on any of the routers will open a new tab/window with the WebFig page of that device.

Modify Path Costs

There are several ways to modify the costs and thereby see what effect the changes will have on network operation. The page comes up with the current setting for the network selected. Node names are black if they are active, grey if they have been disabled from this page, or red if the device is down (future). The sliders allow enabling and disabling nodes. When a node is disabled it does not get included in the path calculations.. This is the way the user can emulate a network outage and see how the network will respond. The toggles to set nodes up or down act immediately. There is no need to use the Update button.

Disabled nodes are displayed on the map as determined by the Display the Map page color, shape and linestyle settings.

The forward and reverse cost of each link can be modified. The page will display the original setting in parenthesis to the right of the current cost and change the current cost to red to indicate it is not the original value. Changing a cost to a very high number will effectively disable the link in that direction.

After link costs have been changed, click the Update button to save the changes.

To restore all links their original value, click the Revert button.

Set Defaults

There are several items that can be set on the Set Defaults (Configuration) page. First is the Cloud Convert Key. This is the key that is used to make the PNG files from the SVG image the application draws.

All of the color, shapes and linestyles can be set here.

The database connection information is here. It is originally populated with the values provided during installation. If the database login has changed, the information can be changed here.

The license key is also shown. Along with the key are the items the key allows. While the items cannot be changed, the key can be updated here. Contact SBRConsulting to obtain a new key.

Possible Future Enhancements

The following are planned for future release:

- Use SNMP to acquire OSPF data thus allowing more than just Mikrotik routers to be displayed.
- Delete an entire network
- RESTful API connections
- Find the longest path in the network
- Link cost report.

Alphabetical Index

Area.....	7
Clear Database.....	5
Color.....	7
Color names.....	6
Database.....	
Sbrconsulting_llc.....	4
SbrcOSPF.....	4
Device is down.....	7
Disabled.....	7
Display the Map.....	5
Emualte a network outage.....	7
Generate the Database.....	5
Graphviz.....	4
Https://cloudconvert.com.....	3
Image_Graphvix.....	4
Link Colors.....	6
Link Line Styles.....	6
Loopback IP Address.	5
Manage Router Logins.....	4
MariaDB.....	2
MaxDepth.....	3
MaxMaps.....	3
MaxNetworks.....	3
MaxRouters.....	3
Mikrotik	2
Modify Path Cost.....	7
MySQL.....	2
Net_RouterOS.....	4
Node Colors.....	5
Node Shapes.....	6
Only Show Path.....	6
Pages.....	
Display the Map.....	5
Generate the Database.....	5
Manage Router Logins.....	4
Modify Path Costs.....	7
Set Defaults.....	7
PNG.....	6
PNG file.....	3

Save as PNG.....	6
SaveMap.....	3
Selinux permissions.....	7
SetColor.....	3
Shape.....	7
Show Path in Box.....	6
SVG.....	7
Whatif.....	3
WhatifChanges.....	3
“eye” button.....	4