



USING THE ONLINE AHP TOOL FOR A FEATURE-BASED SELECTION OF SDN CONTROLLERS

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THE ONLINE TOOL: WWW.123AHP.COM

REGISTRATION

123AHP
my choice, my decision

home | new calculation | method | links

new user

Obligatory data

E-mail:

Password:

Confirm password:

Nickname:

Additional

Country:

City:

Year of birth:

sex:

☐ - newsletter

Register

login

The website provides a free online registration. It is recommended to register to gain unlimited use of the tool, especially when having a large number of criteria and/or alternatives to calculate. Without registration, the number of alternatives is limited to 5.

After finishing the registration and login process, you can start your AHP analysis by clicking on 'new calculation' as shown in this figure:

123AHP
my choice, my decision

home | new calculation | method | links

method

Choosing the best alternative solution by a decision making technique AHP (Analytic Hierarchy Process) (Analytical Hierarchy Process)

"I want to make a decision. Among several alternative solutions I want to choose the right one according to my own criteria. The one that is ideal for me, suitable for me and based on my own preferences. I want a simple selection process. I want to use a decision making method used by successful companies and institutions. I want a simple result image. I

What is
AHP
method of decision making

find out here

Examples

calculation library

examples

- Basic example
- Supplier selection
- College selection
- Cell phone selecting
- Cars
- SWOT and AHP

METHODOLOGY

In this page you will have to fill the alternatives your aiming to study and their corresponding criteria. In our case, alternatives are the set of open source controllers, as shown in the figure bellow. Therefore, the criteria are the set of most important features a SDN controller should have.

The screenshot shows a web interface titled 'calculation' with a navigation bar at the top containing links for 'HOME', 'NEW CALCULATION', 'METHOD', and 'LINKS'. The main heading is 'calculation' in red. Below it, instructions state: 'Enter the decision making title in the field. Enter all alternatives and criteria important for the decision you want to make.' and 'You can add more alternatives and/or criteria by clicking on plus.' There is a text input field labeled 'my title' containing 'Feature-based selection for Controllers'. Below this, there are two columns: 'my alternatives' and 'my criteria'. The 'my alternatives' column lists ten controllers in input fields: NOX, POX, Trema, Beacon, OpenMUL, RYU, Floodlight, OpenDaylight, ONOS, and OpenContrail. The 'my criteria' column lists ten features in input fields: Open source, First release, Language support, Platform support, Activity, REST API, Documentation, GUI, Clustered Deployment, OpenFlow support, and Openstack support. Both columns have plus and minus icons at the bottom for adding or removing items. At the bottom of the interface, there is a 'New calculation' button with a red circle icon and a 'next' button with a red circle icon.

To chose a given controller, we should conduct a matching process between the user requirements and the controller's provided features. Thus, different criteria are considered, AHP allows a comparison based on all these criteria using a relative prioritization.

We adapt AHP on our controller choosing as following:

- 1) Assigning pairwise priority of one criterion (feature) over another
- 2) Assigning pairwise priority of one controller over another for each one of the features

ASSIGNING PRIORITIES BETWEEN FEATURES

Feature-based selection for Controllers step 2 of 13

Previous step 1 2 3 4 5 6 7 8 9 10 11 12 13 Next step

criteria preferences

Use the scale to define importance of criteria.

In this step we compare each feature to another feature using a scale from one to nine:

- 1: Equally important
- 3: Moderately important
- 5: Strongly important
- 7: Very strongly important
- 9: Extremely important
- 2, 4, 6, 8: intermediate value

The main properties we are looking for in a SDN controller is to be somehow standard, replying to what SDN came for, which is allowing the open-source concept and programmability in networking.

In the following, we assign a level (from 1 to 9) to each feature compared to the other, based on our requirements detailed in page 5. Then in pages 6-12 of this report, we show screen-captures of how we filled the levels in this tool.

These assignments may vary depending on the use case.

The requirement matrix will be generated at the end by the tool with the results (presented in page 13).

ASSIGNING PRIORITIES BETWEEN FEATURES

Open source

- (9) extremely important than First release
- (7) very strongly important than Platform support and language support
- (5) strongly important than REST API, Documentation, GUI, and Clustered deployment
- (3) moderately important than Activity
- (1) equally important to OpenFlow support, and Openstack support

Language support

- (3) moderately important than First release
- (1) equally important to Platform support

Platform support

- (3) moderately important than First release
- (1) equally important to Language support

Activity

- (9) extremely important than First release
- (7) very strongly important than Platform support and language support
- (5) strongly important than REST API, Documentation, GUI, and Clustered deployment

REST API

- (7) very strongly important than First release
- (5) strongly important than Platform support and language support
- (1) equally important to Clustered deployment

Documentation

- (7) very strongly important than First release
- (5) strongly important than Platform support and language support
- (2) Quietly equally important than REST API, and Clustered deployment
- (1) equally important to GUI

GUI

- (7) very strongly important than First release
- (5) strongly important than Platform support and language support
- (2) Quietly equally important than REST API, and Clustered deployment
- (1) equally important to Documentation

Clustered Deployment

- (7) very strongly important than First release
- (5) strongly important than Platform support and language support
- (1) equally important to REST API

OpenFlow support

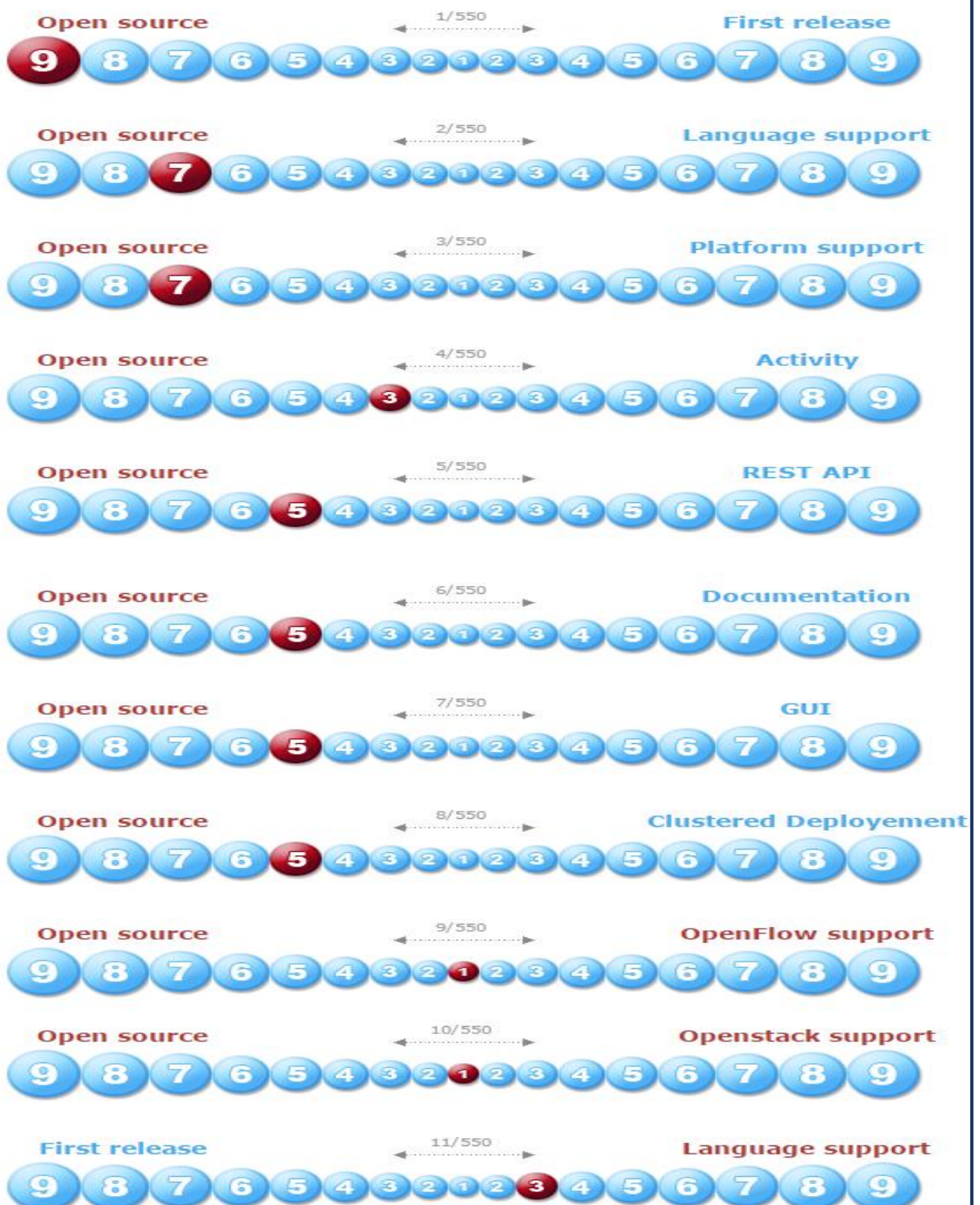
- (9) extremely important than First release
- (7) very strongly important than Platform support and language support
- (5) strongly important than REST API, Documentation, GUI, and Clustered deployment
- (3) moderately important than Activity
- (1) equally important to Openstack support, and OpenFlow support

Openstack support

- (9) extremely important than First release
- (7) very strongly important than Platform support and language support
- (5) strongly important than REST API, Documentation, GUI, and Clustered deployment
- (3) moderately important than Activity
- (1) equally important to Open source, and OpenFlow support

ASSIGNING PRIORITIES BETWEEN FEATURES

Open source



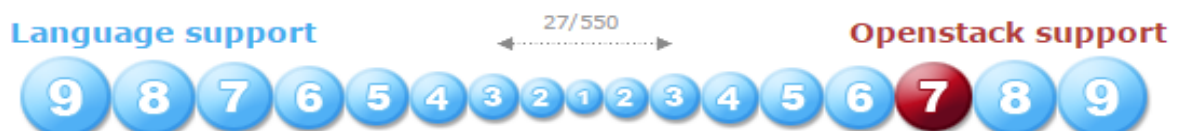
ASSIGNING PRIORITIES BETWEEN FEATURES

First Release



ASSIGNING PRIORITIES BETWEEN FEATURES

Language support



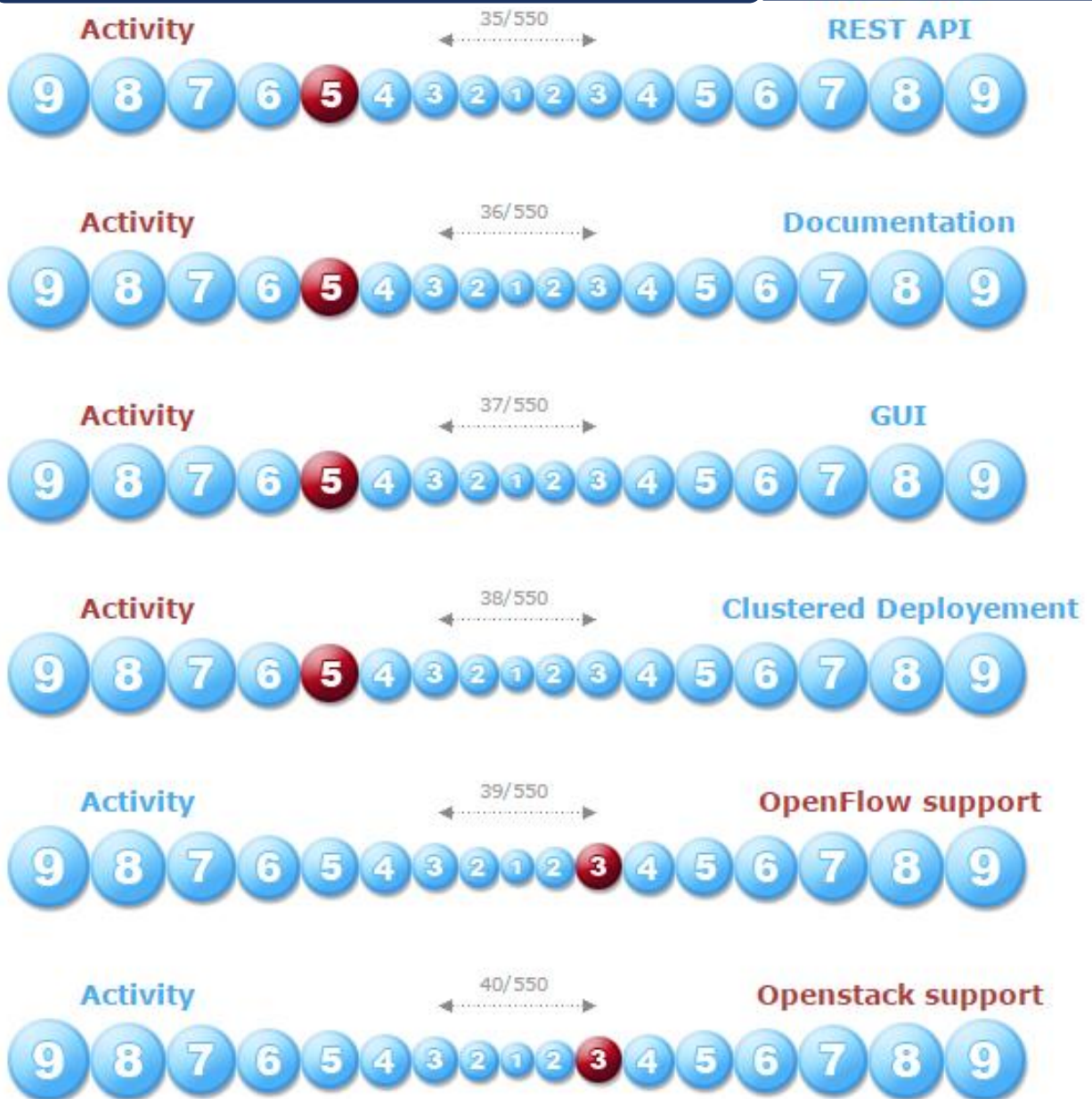
ASSIGNING PRIORITIES BETWEEN FEATURES

Platform support



ASSIGNING PRIORITIES BETWEEN FEATURES

Activity

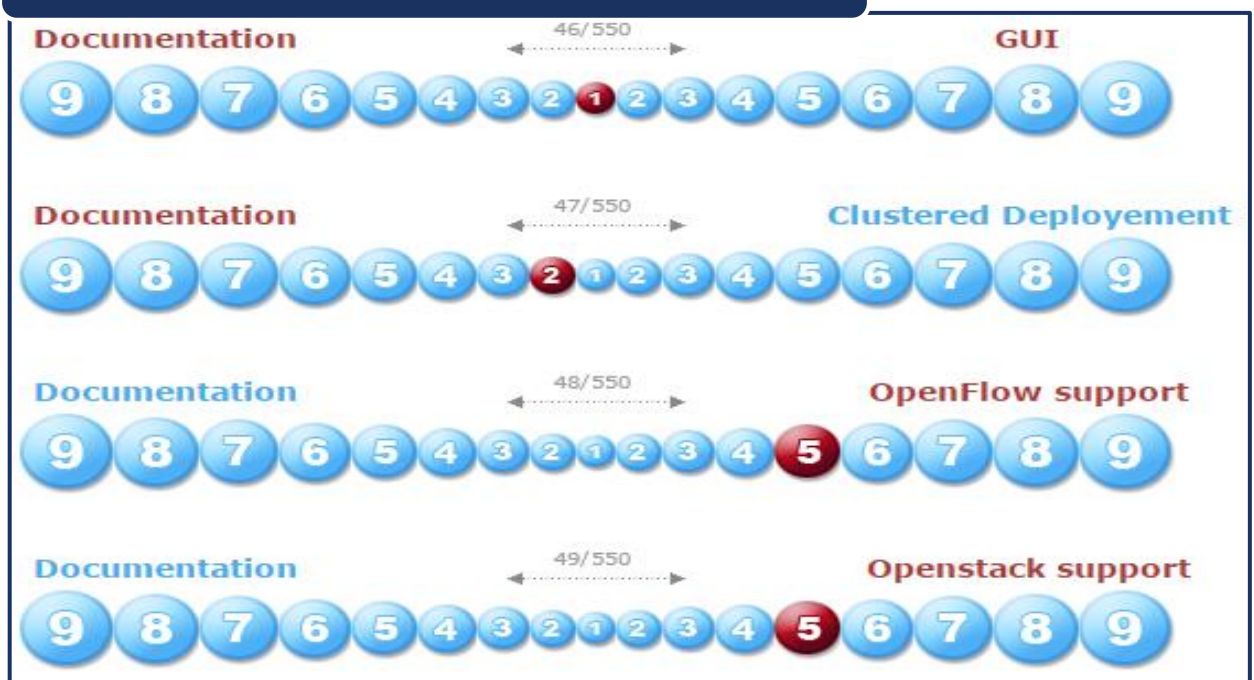


ASSIGNING PRIORITIES BETWEEN FEATURES

REST API



Documentation



ASSIGNING PRIORITIES BETWEEN FEATURES

GUI



Clustering Deployment



OpenFlow support



ASSIGNING PRIORITIES BETWEEN FEATURES

Bellow, the AHP's requirement matrix generated by the tool:

criteria preferences	Open source	First release	Language support	Platform support	Activity	REST API	Documentation	GUI	Clustered Deployment	OpenFlow support	Openstack support
Open source	1	9	7	7	3	5	5	5	5	1	1
First release	1/9	1	1/3	1/3	1/9	1/7	1/7	1/7	1/7	1/9	1/9
Language support	1/7	3	1	1	1/7	1/5	1/5	1/5	1/5	1/7	1/7
Platform support	1/7	3	1	1	1/7	1/5	1/5	1/5	1/5	1/7	1/7
Activity	1/3	9	7	7	1	5	5	5	5	1/3	1/3
REST API	1/5	7	5	5	1/5	1	1/2	1/2	1	1/5	1/5
Documentation	1/5	7	5	5	1/5	2	1	1	2	1/5	1/5
GUI	1/5	7	5	5	1/5	2	1	1	2	1/5	1/5
Clustered Deployment	1/5	7	5	5	1/5	1	1/2	1/2	1	1/5	1/5
OpenFlow support	1	9	7	7	3	5	5	5	5	1	1
Openstack support	1	9	7	7	3	5	5	5	5	1	1

ASSIGNING PRIORITIES BETWEEN CONTROLLERS

After the pairwise prioritization of features, we start the pairwise prioritization between controllers for each feature separately.

For example, we compare between controllers for the 'GUI' feature, if the controller has a GUI (yes) then it gets the higher level.

Feature [GUI]

yes

no

Alternatives

NOX

...

ONOS

Feature-based selection for Controllers

step 10 of 13

Previous step

1234567891011121314

Next step

criteria GUI

Use the scale to define importance of alternative by criteria GUI ,compared with the other alternative. Continue with comparisons.

NOX

371/550

POX

98765432123456789

NOX

372/550

Trema

98765432123456789

NOX

373/550

Beacon

98765432123456789

NOX doesn't have a GUI, while both of POX and Beacon do, for that we give them level (5). And since Trema also does not have a GUI, then the two controllers are equal: level (1).

The rest of comparison will follow this logic, using the information we collected in the table in page 15. The assigned levels in each feature comparison will be explained in the following.

ASSIGNING PRIORITIES BETWEEN CONTROLLERS

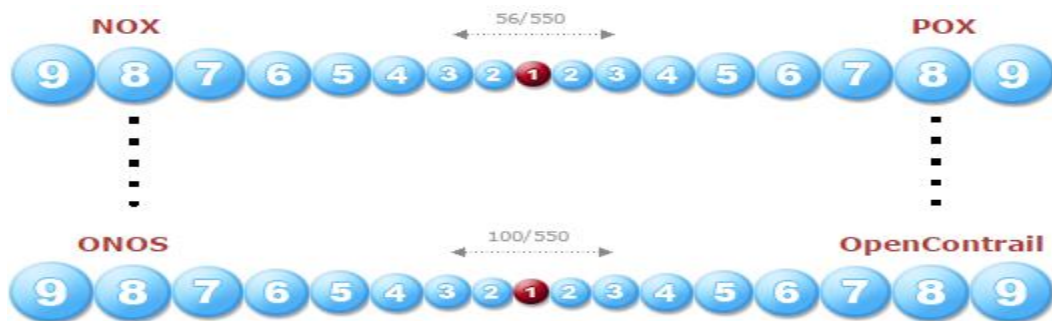
After the pairwise prioritization of features we start the comparison of controllers, for each feature separately. This part will be based on the information we collected in the table bellow

	Open source	First release	Language support	Platform support	Activity	Rest API	Documentation	GUI	Clustered Deployment	Open Flow supported version	OpenStack networking
<i>NOX</i>	Yes	2008	C/C++	Linux	Low	No	Low	No	Yes	1.0	No
<i>POX</i>	Yes	2012	Python	Linux, Mac, Win	Low	No	Low	Yes	No	1.0	No
<i>Trema</i>	Yes	2011	C/C++, Ruby	Linux	Medium	No	Medium	No	Yes	1.0	Yes
<i>Beacon</i>	Yes	2010	Java	Linux, Mac, Win	Low	No	Medium	Yes	Yes	1.0	No
<i>OpenMUL</i>	Yes	2012	C/C++	Linux	Low	No	High	Yes	Yes	1.0, 1.3, 1.4	Yes
<i>RYU</i>	Yes	2012	Python	Linux	Medium	No	Medium	Yes	Yes	1.0, 1.2, 1.3, 1.4, 1.5	Yes
<i>Floodlight</i>	Yes	2012	Java	Linux, Mac, Win	Medium	Yes	High	Yes	Yes	1.0	Yes
<i>OpenDaylight</i>	Yes	2013	Java	Linux, Mac, Win	High	Yes	High	Yes	Yes	1.0, 1.2, 1.3	Yes
<i>ONOS</i>	Yes	2014	Java	Linux, Mac	High	Yes	Medium	Yes	Yes	1.0, 1.2, 1.3	Yes
<i>OpenContrail</i>	Yes	2013	C/C++, Java, Python	Linux	High	Yes	High	Yes	Yes	Not supported	Yes

ASSIGNING PRIORITIES BETWEEN CONTROLLERS

Open source

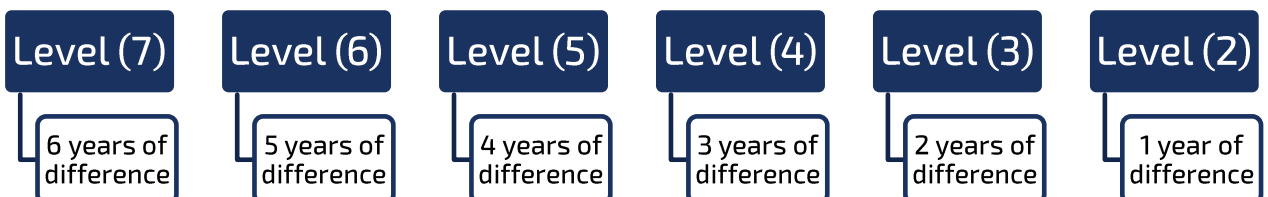
Since all the controllers are open source, the first feature will be equally important to all of them:



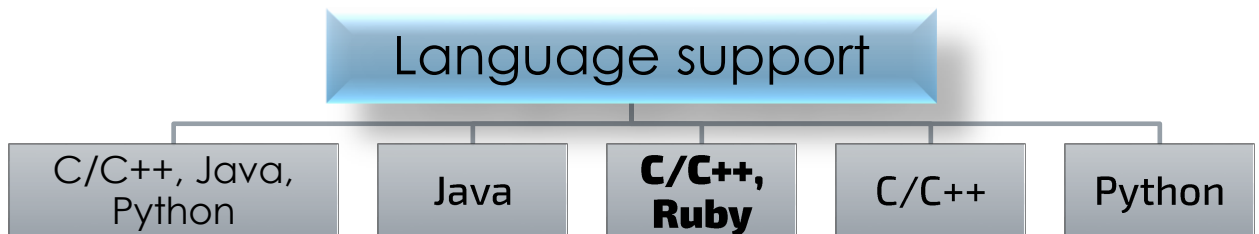
First release



As for this feature, we count the difference between the controllers' first release. The higher the difference, the higher is the level for the recent controller. For example, NOX was released in 2008, and Opendaylight was released in 2013, the difference is 5 years, so Opendaylight gets level (6) compared to NOX:

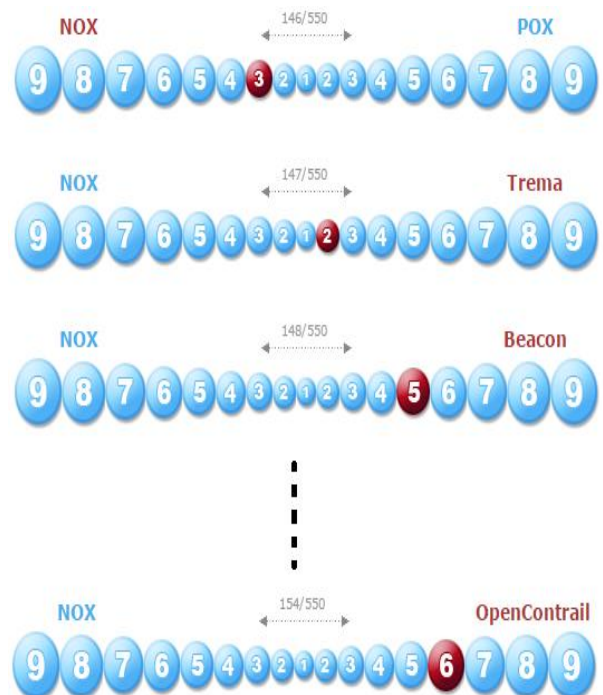


ASSIGNING PRIORITIES BETWEEN CONTROLLERS

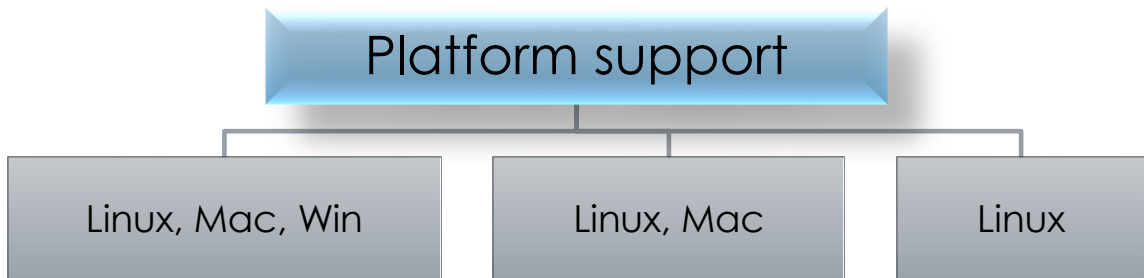


We made the prioritization based on the ranking of these programming languages, for that:

- [C/C++, Java, Python] is:
 - Level (8) compared to [Python]
 - Level (6) compared to [C/C++]
 - Level (5) compared to [C/C++, Ruby]
 - Level (4) compared to [Java]
- [Java] is:
 - Level (7) compared to [Python]
 - Level (6) compared to [C/C++, Ruby]
 - Level (5) Level (6) compared to [C/C++]
- [C/C++, Ruby] is:
 - Level (4) compared to [Python]
 - Level (2) compared to [C/C++]
- [C/C++] is:
 - Level (3) compared to [Python]



ASSIGNING PRIORITIES BETWEEN CONTROLLERS

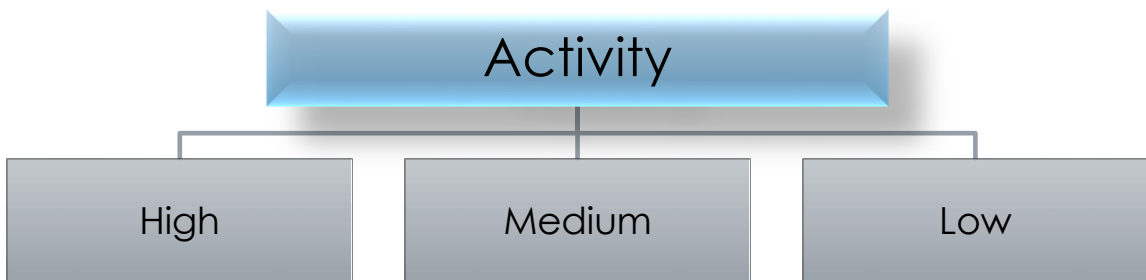


For this feature, it is obvious that a controller supporting all of the platforms will be having the highest level, as follow:

- Supporting [Linux, Mac, Win] is:
 - Level (7) compared to supporting only [Linux]
 - Level (5) compared to supporting [Linux, Mac]
- Supporting [Linux, Mac] is:
 - Level (3) compared to supporting only [Linux]

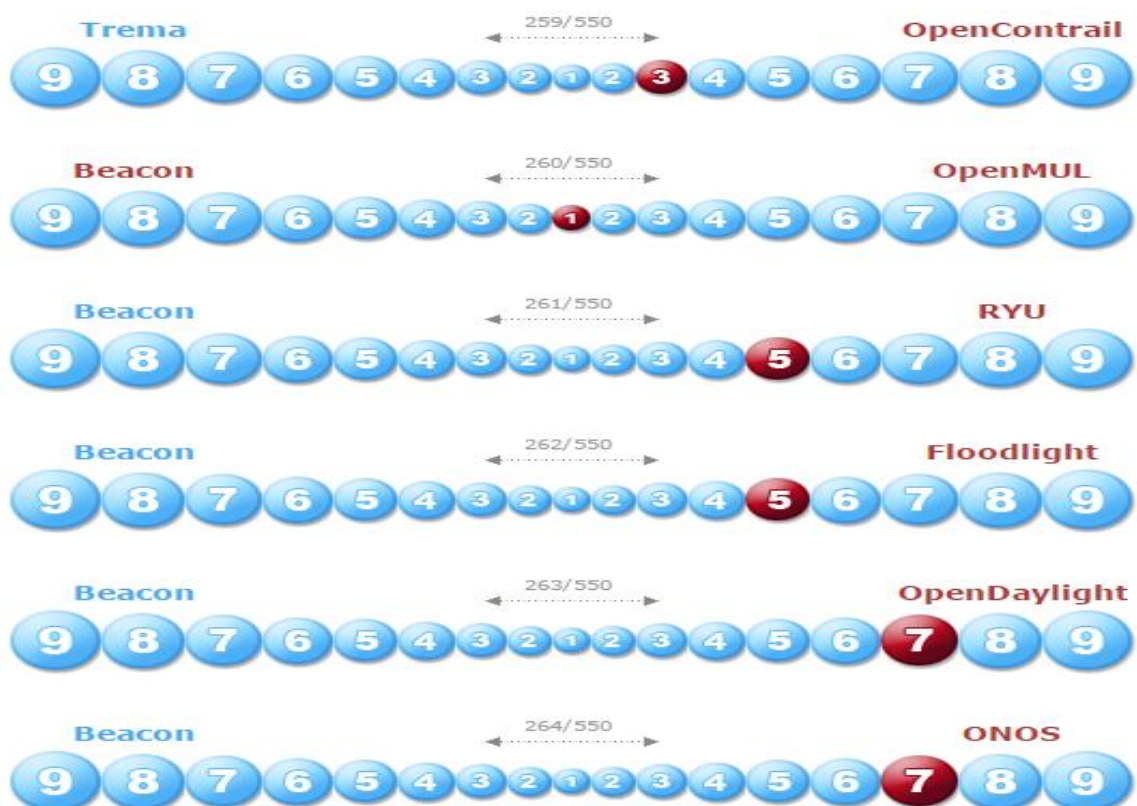


ASSIGNING PRIORITIES BETWEEN CONTROLLERS

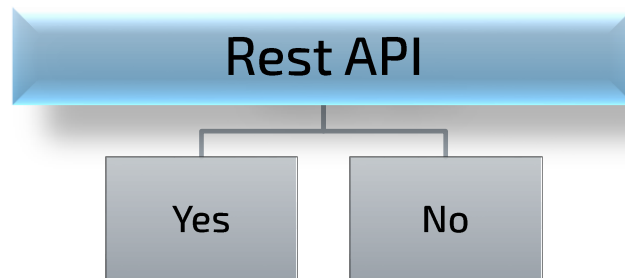


For this feature, it is obvious that a controller having a high activity will be having the highest level, as follow:

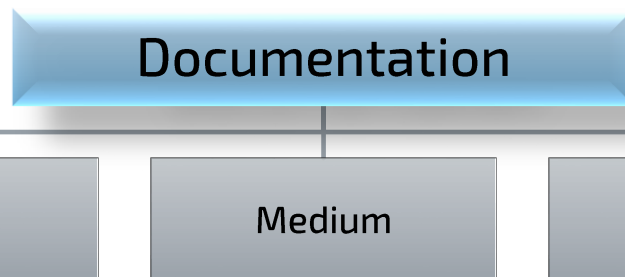
- [High] is:
 - Level (7) compared to [Low]
 - Level (5) compared to [Medium]
- [Medium] is:
 - Level (3) compared to [Low]



ASSIGNING PRIORITIES BETWEEN CONTROLLERS

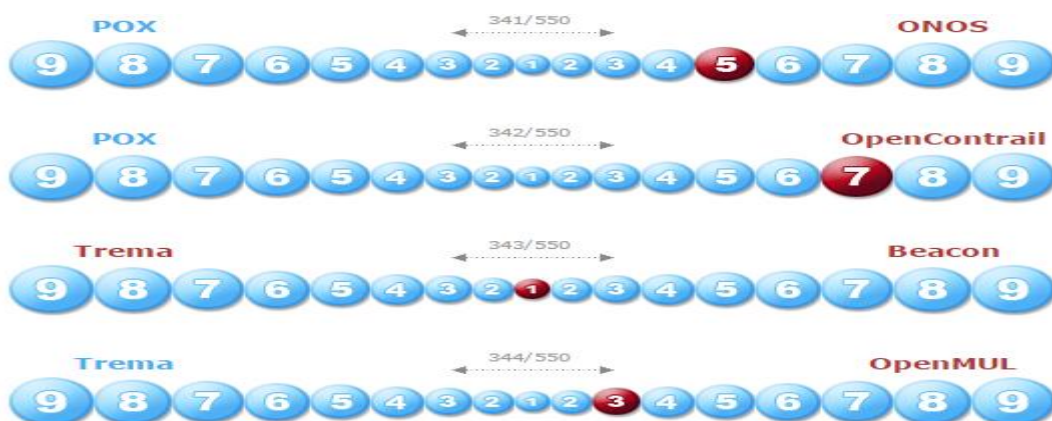


- [Yes] is:
 - Level (4) compared to [No]

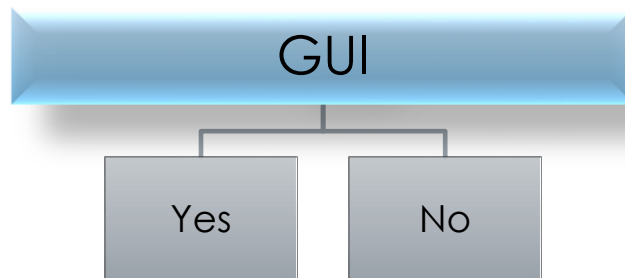


A controller having a richer documentation will be having the highest level, as follow:

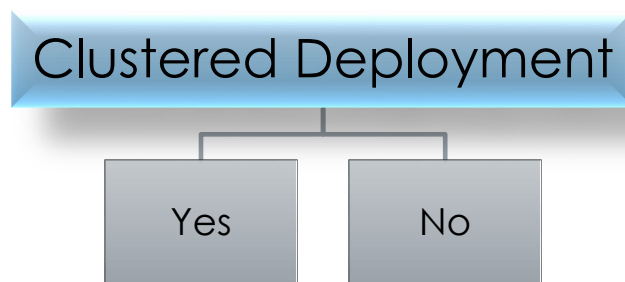
- [High] is:
 - Level (7) compared to [Low]
 - Level (5) compared to [Medium]
- [Medium] is:
 - Level (3) compared to [Low]



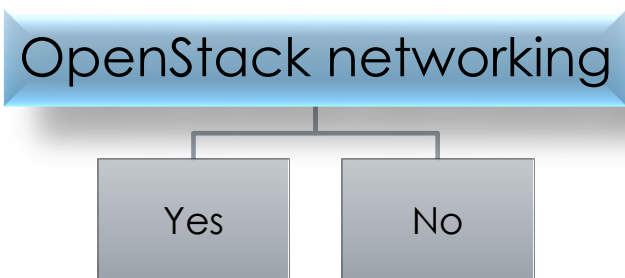
ASSIGNING PRIORITIES BETWEEN CONTROLLERS



- [Yes] is:
 - Level (5) compared to [No]



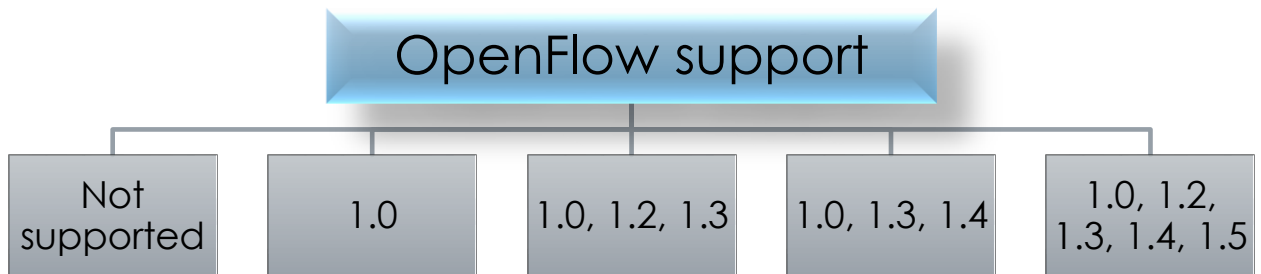
- [Yes] is:
 - Level (5) compared to [No]



- [Yes] is:
 - Level (7) compared to [No]

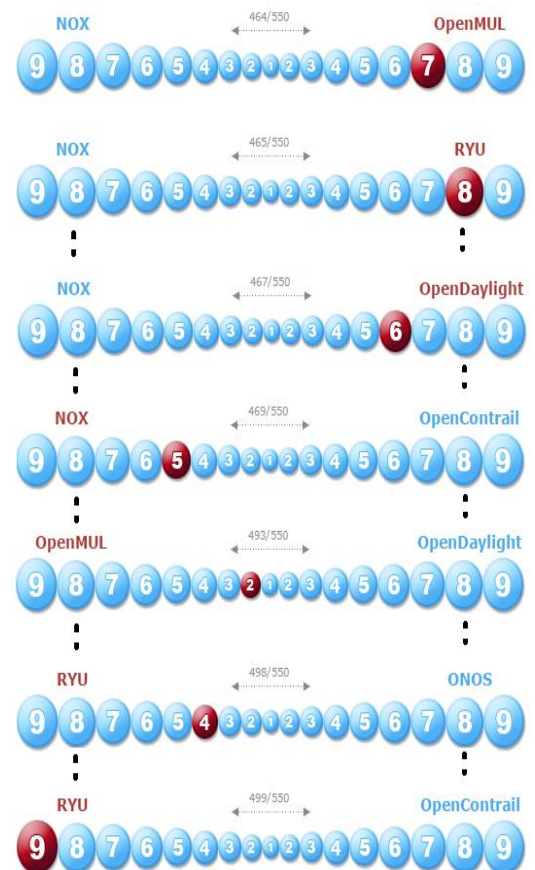


ASSIGNING PRIORITIES BETWEEN CONTROLLERS



A controller supporting most of OpenFlow versions gets the higher level,

- [1.0, 1.2, 1.3, 1.4, 1.5] is:
 - Level (4) compared to [1.0, 1.2, 1.3]
 - Level (5) compared to [1.0, 1.3, 1.4]
 - Level (8) compared to [1.0]
 - Level (9) compared to [Not Supported]
- [1.0, 1.3, 1.4] is :
 - Level (2) compared to [1.0, 1.2, 1.3]
 - Level (7) compared to [1.0]
 - Level (8) compared to [Not Supported]
- [1.0, 1.2, 1.3] is:
 - Level (6) compared to [1.0]
 - Level (7) compared to [Not Supported]
- [1.0] is:
 - Level (5) compared to [Not Supported]



ASSIGNING PRIORITIES BETWEEN CONTROLLERS

The Generated matrixes:

Open source	NOX	POX	Trema	Beacon	OpenMUL	RYU	Floodlight	OpenDaylight	ONOS	OpenContrail
NOX	1	1	1	1	1	1	1	1	1	1
POX	1	1	1	1	1	1	1	1	1	1
Trema	1	1	1	1	1	1	1	1	1	1
Beacon	1	1	1	1	1	1	1	1	1	1
OpenMUL	1	1	1	1	1	1	1	1	1	1
RYU	1	1	1	1	1	1	1	1	1	1
Floodlight	1	1	1	1	1	1	1	1	1	1
OpenDaylight	1	1	1	1	1	1	1	1	1	1
ONOS	1	1	1	1	1	1	1	1	1	1
OpenContrail	1	1	1	1	1	1	1	1	1	1

First release	NOX	POX	Trema	Beacon	OpenMUL	RYU	Floodlight	OpenDaylight	ONOS	OpenContrail
NOX	1	1/5	1/4	1/3	1/5	1/5	1/5	1/6	1/7	1/6
POX	5	1	2	3	1	1	1	1/2	1/3	1/2
Trema	4	1/2	1	2	1/2	1/2	1/2	1/3	1/4	1/3
Beacon	3	1/3	1/2	1	1/3	1/3	1/3	1/4	1/5	1/4
OpenMUL	5	1	2	3	1	1	1	1/2	1/3	1/2
RYU	5	1	2	3	1	1	1	1/2	1/3	1/2
Floodlight	5	1	2	3	1	1	1	1/2	1/3	1/2
OpenDaylight	6	2	3	4	2	2	2	1	1/2	1
ONOS	7	3	4	5	3	3	3	2	1	2
OpenContrail	6	2	3	4	2	2	2	1	1/2	1

Language support	NOX	POX	Trema	Beacon	OpenMUL	RYU	Floodlight	OpenDaylight	ONOS	OpenContrail
NOX	1	3	1/2	1/5	1	3	1/5	1/5	1/5	1/6
POX	1/3	1	1/4	1/7	1/3	1	1/7	1/7	1/7	1/8
Trema	2	4	1	1/6	2	4	1/6	1/6	1/6	1/5
Beacon	5	7	6	1	5	7	1	1	1	1/4
OpenMUL	1	3	1/2	1/5	1	3	1/5	1/5	1/5	1/6
RYU	1/3	1	1/4	1/7	1/3	1	1/7	1/7	1/7	1/8
Floodlight	5	7	6	1	5	7	1	1	1	1/4
OpenDaylight	5	7	6	1	5	7	1	1	1	1/4
ONOS	5	7	6	1	5	7	1	1	1	1/4
OpenContrail	6	8	5	4	6	8	4	4	4	1

Platform support	NOX	POX	Trema	Beacon	OpenMUL	RYU	Floodlight	OpenDaylight	ONOS	OpenContrail
NOX	1	1/7	1	1/7	1	1	1/7	1/7	1/5	1
POX	7	1	7	1	7	7	1	1	3	7
Trema	1	1/7	1	1/7	1	1	1/7	1/7	1/5	1
Beacon	7	1	7	1	7	7	1	1	3	7
OpenMUL	1	1/7	1	1/7	1	1	1/7	1/7	1/5	1
RYU	1	1/7	1	1/7	1	1	1/7	1/7	1/5	1
Floodlight	7	1	7	1	7	7	1	1	3	7
OpenDaylight	7	1	7	1	7	7	1	1	3	7
ONOS	5	1/3	5	1/3	5	5	1/3	1/3	1	5
OpenContrail	1	1/7	1	1/7	1	1	1/7	1/7	1/5	1

Activity	NOX	POX	Trema	Beacon	OpenMUL	RYU	Floodlight	OpenDaylight	ONOS	OpenContrail
NOX	1	1	1/5	1	1	1/5	1/5	1/7	1/7	1/7
POX	1	1	1/5	1	1	1/5	1/5	1/7	1/7	1/7
Trema	5	5	1	5	5	1	1	1/3	1/3	1/3
Beacon	1	1	1/5	1	1	1/5	1/5	1/7	1/7	1/7
OpenMUL	1	1	1/5	1	1	1/5	1/5	1/7	1/7	1/7
RYU	5	5	1	5	5	1	1	1/3	1/3	1/3
Floodlight	5	5	1	5	5	1	1	1/3	1/3	1/3
OpenDaylight	7	7	3	7	7	3	3	1	1	1
ONOS	7	7	3	7	7	3	3	1	1	1
OpenContrail	7	7	3	7	7	3	3	1	1	1

REST API	NOX	POX	Trema	Beacon	OpenMUL	RYU	Floodlight	OpenDaylight	ONOS	OpenContrail
NOX	1	1	1	1	1	1	1/4	1/4	1/4	1/4
POX	1	1	1	1	1	1	1/4	1/4	1/4	1/4
Trema	1	1	1	1	1	1	1/4	1/4	1/4	1/4
Beacon	1	1	1	1	1/4	1	1/4	1/4	1/4	1/4
OpenMUL	1	1	1	4	1	1	1/4	1/4	1/4	1/4
RYU	1	1	1	1	1	1	1/4	1/4	1/4	1/4
Floodlight	4	4	4	4	4	4	1	1	1	1
OpenDaylight	4	4	4	4	4	4	1	1	1	1
ONOS	4	4	4	4	4	4	1	1	1	1
OpenContrail	4	4	4	4	4	4	1	1	1	1

ASSIGNING PRIORITIES BETWEEN CONTROLLERS

The Generated matrixes:

Documentation	NOX	POX	Trema	Beacon	OpenMUL	RYU	Floodlight	OpenDaylight	ONOS	OpenContrail
NOX	1	1	1/5	1/5	1/7	1/5	1/7	1/7	1/5	1/7
POX	1	1	1/5	1/5	1/7	1/5	1/7	1/7	1/5	1/7
Trema	5	5	1	1	1/3	1	1/3	1/3	1	1/3
Beacon	5	5	1	1	1/3	1	1/3	1/3	1	1/3
OpenMUL	7	7	3	3	1	1	3	1	3	1
RYU	5	5	1	1	1	1	1/3	1	1/3	1
Floodlight	7	7	3	3	1/3	3	1	1	3	1
OpenDaylight	7	7	3	3	1	1	1	1	3	1
ONOS	5	5	1	1	1/3	3	1/3	1/3	1	1/3
OpenContrail	7	7	3	3	1	1	1	1	3	1

GUI	NOX	POX	Trema	Beacon	OpenMUL	RYU	Floodlight	OpenDaylight	ONOS	OpenContrail
NOX	1	1/5	1	1/5	1/5	1/5	1/5	1/5	1/5	1/5
POX	5	1	5	1	1	1	1	1	1	1
Trema	1	1/5	1	1/5	1/5	1/5	1/5	1/5	1/5	1/5
Beacon	5	1	5	1	1	1	1	1	1	1
OpenMUL	5	1	5	1	1	1	1	1	1	1
RYU	5	1	5	1	1	1	1	1	1	1
Floodlight	5	1	5	1	1	1	1	1	1	1
OpenDaylight	5	1	5	1	1	1	1	1	1	1
ONOS	5	1	5	1	1	1	1	1	1	1
OpenContrail	5	1	5	1	1	1	1	1	1	1

Clustered Deployment	NOX	POX	Trema	Beacon	OpenMUL	RYU	Floodlight	OpenDaylight	ONOS	OpenContrail
NOX	1	1	5	1	1	1	1	1	1	1
POX	1	1	1/5	1/5	1/5	1/5	1/5	1/5	1/5	1/5
Trema	1/5	5	1	1	1	1	1	1	1	1
Beacon	1	5	1	1	1	1	1	1	1	1
OpenMUL	1	5	1	1	1	1	1	1	1	1
RYU	1	5	1	1	1	1	1	1	1	1
Floodlight	1	5	1	1	1	1	1	1	1	1
OpenDaylight	1	5	1	1	1	1	1	1	1	1
ONOS	1	5	1	1	1	1	1	1	1	1
OpenContrail	1	5	1	1	1	1	1	1	1	1

OpenFlow support	NOX	POX	Trema	Beacon	OpenMUL	RYU	Floodlight	OpenDaylight	ONOS	OpenContrail
NOX	1	1	1	1	1/7	1/8	1	1/6	1/6	5
POX	1	1	1	1	1/7	1/8	1	1/6	1/6	5
Trema	1	1	1	1	1/7	1/8	1	1/6	1/6	5
Beacon	1	1	1	1	1/7	1/8	1	1/6	1/6	5
OpenMUL	7	7	7	7	1	1/5	7	2	2	8
RYU	8	8	8	8	5	1	8	4	4	9
Floodlight	1	1	1	1	1/7	1/8	1	1/6	1/6	5
OpenDaylight	6	6	6	6	1/2	1/4	6	1	1	7
ONOS	6	6	6	6	1/2	1/4	6	1	1	7
OpenContrail	1/5	1/5	1/5	1/5	1/8	1/9	1/5	1/7	1/7	1

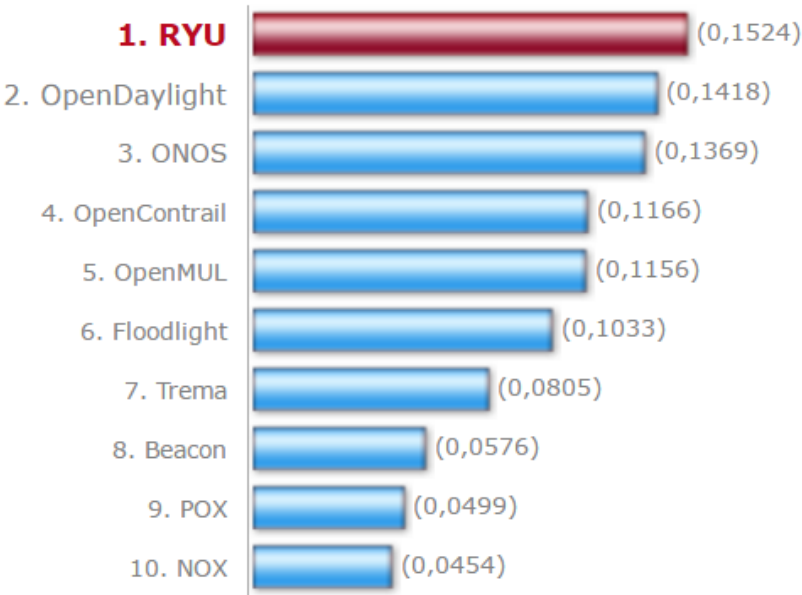
Openstack support	NOX	POX	Trema	Beacon	OpenMUL	RYU	Floodlight	OpenDaylight	ONOS	OpenContrail
NOX	1	1	1/7	1	1/7	1/7	1/7	1/7	1/7	1/7
POX	1	1	1/7	1	1/7	1/7	1/7	1/7	1/7	1/7
Trema	7	7	1	7	1	1	1	1	1	1
Beacon	1	1	1/7	1	1/7	1/7	1/7	1/7	1/7	1/7
OpenMUL	7	7	1	7	1	1	1	1	1	1
RYU	7	7	1	7	1	1	1	1	1	1
Floodlight	7	7	1	7	1	1	1	1	1	1
OpenDaylight	7	7	1	7	1	1	1	1	1	1
ONOS	7	7	1	7	1	1	1	1	1	1
OpenContrail	7	7	1	7	1	1	1	1	1	1

RESULTS

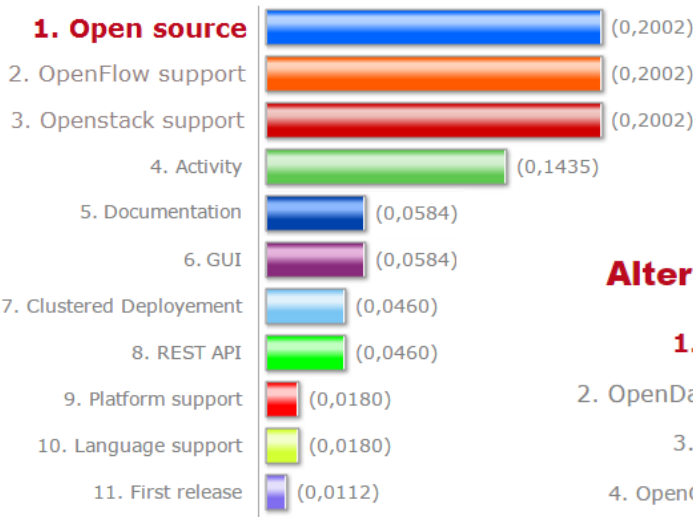
At the end, the tool generates the results of our and ranks them as following:

It shows that our top three controllers are RYU, OpenDaylight, and ONOS

my decision

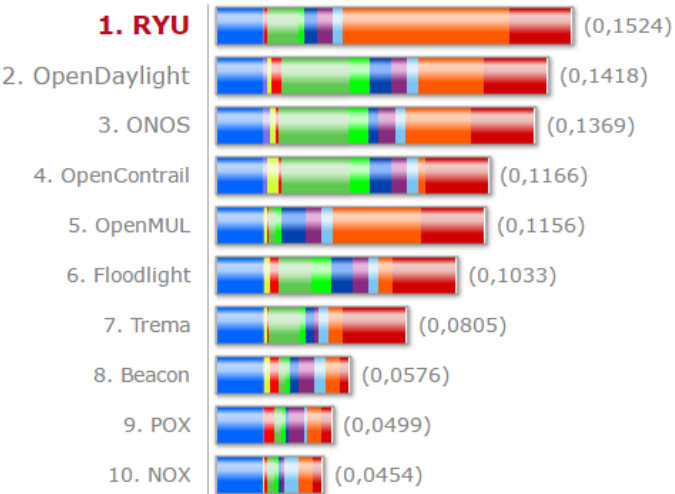


criteria importance



The tool also gives the ranking of the features and their ranking

Alternatives rankings with structure



Also gives the structure of these features in each controller: