Service Measurement Tool for Internet Service Provider

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Abstract

In this paper, we propose a new service measurement tool that ISPs can be used to assure their clients of the quality of service in different areas. Our tool uses PHP API of RouterOS to control MikroTik devices. The RouterOS allows us to verify network performance and control the network's service measurement both in manual mode and scheduled mode. In the latter mode, we can specify the data size, the network we want to measure or the interval to repeat the same operation then save the result to the database, our tool will send the notification to the ISP via SMS. We also use the Fullcalendar2 framework to visualize the result in a calendar depending on the selected date. The result is shown in form of the bandwidth graph, average upload-download speed and percentage of measurable data that obtained from Canvas.js. The result presents the connection map of devices made from Google Map. Our tool is divided into 3 parts: 1) MikroTik router management, 2) service measurement and 3) user management that we separate users into 3 levels: 1) Maintenance officer, 2) District chief and 3) central authorities.

The result indicates that 1) users at every level can use our tool over the internet 2) the district chief can manage users and verify devices' performance in every area 3) maintenance officer can install and register devices via our tool 4) the management and measurement the performance of the network in each area are centralized and controlled by central authorities. Our tool has the flexibility to measure the performance of the network and the results are reliable that we can use to improve the service and more than that we can apply our tool to the various organizations for a low-cost software package.

Keywords: Service Measurement, MikroTik, RouterOS, Network Probe, Software API

1. Introduction

The internet service provider (ISP) is the company we pay a fee to get the access to the internet. All internet connected devices send a service request through their ISP to access to servers, those servers themselves have to send a response to the request via their own ISP. To maintain the stability and availability of services, the ISPs have to measure frequently the performance of their service and they can use that information to improve the quality of service and manage their system. There are several criteria for measuring the network such as performance, reliability and security[1]. The main objective of service management is 1) to monitor and detect anomalies in the system 2) to collect service's statistics that can be used to upgrade management and organization of the system. In general, ISP uses the Active Monitoring to collect all statistics and use them to analyze and organize the network management, for example, the Multi Router Traffic Grapher (MRTG)[2] is used on large networks. It is required both software and hardware with high capabilities, that means we need to pay at a high cost to measure the performance of the whole system, in order to increase service quality.

The use of technology in the measurement and testing of telecommunications systems, the administrators must focus on the assurance of services qualities as follows:

1) We must measure and test the telecommunication system by verifying different performance aspects such as availability of the service, network congestion and time of errors detection, etc.
2) The measurement and testing of telecommunications systems should not perturb the performance of the system.
3) The maintenance of telecommunication devices must be always in place in order to make sure that the service will always available.

Moreover, the management of complex and numerous networks drives the many difficulties to the manager to verify the operation of their devices, that why we need a tool that helps us to understand the problems and how to solve them correctly and quickly. Since the system is in the failure state for a long time

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that can make a significant impact on their business. So that, the main objective of our research is to study and develop a service measurement tool for telecommunication networks using MikroTik devices. Plus, reduce the testing cost and add expressivity of service measurement tool by adding users and devices management.

In this research, we propose a new system that can measure the service performance based on the standard RFC2554[3] for the testing of Ethernet Service in Telecom Networks that the management is the Centralized Network Monitoring[4] using MikroTik[5] in each area in order to verify and measure the operation of the network. Our approach can reduce the cost of hardware that needs for the service measurement, and the mobility of measurement devices is easier. We can use our tool to verify the failure of the main communication devices without the interruption of service. Further details are presented in the following sections. Section 2 explains materials and methods used in this research, focusing on MikroTik devices and RouterOS, mechanism and architecture of our tool and the development of the system. Section 3 presents results and discussion on our work and Section 4 draw conclusions and suggestion for future works.

2. Materials and methods

2.1 State of the art

The monitoring of Quality of Service (QoS) in telecommunication infrastructure can be done via various methods such as 1) Using software agent to track and collect the information we need sometimes it can work with the Artificial Intelligence. The software Agent approach has a constraint that both monitoring software and the operating system must be compatible and we need to verify if the agent still active. The well-known software is ManageEngine OpManager, PRTG Network Monitor, Site24x7, SysAid and Spiceworks IT Desktop. 2) Sending a small program to the target device and waiting for the occurred anomalies signals for example, when the system is down. The program is customized to specific devices and specific proposes.

In our research, we use the second approach that named Action Packed that combines detailed network topology, device, and flow visualizations with direct interactive monitoring and configuration of QoS, NetFlow, LAN, Routing, IP SLA, Medianet and AVC features.

2.2 MikroTik and RouterOS

MikroTik[5] is a Latvian company which was founded in 1996 to develop router and wireless ISP systems. It provides hardware and software for internet connectivity from around the world. The well-known MikroTik's software, RouterOS, is a system that provides extensive stability, controls, and flexibility for all kinds of data interfaces and routing.

We can control MikroTik router using RouterOS via PHP API [6,7] named PHP_PEAR that we must install it on the server to use PEAR2_Net_RouterOS which is a package for sending a command via IP Address of the devices in the network. We can download the package from http://pear2.github.io/Net_RouterOS/ then enable API service for the devices.

2.3 System overview

We use GNS3[8] along with RouterOS to simulate the operation of the system that uses MikroTik devices before the application in the real environment as shown in figure 1.

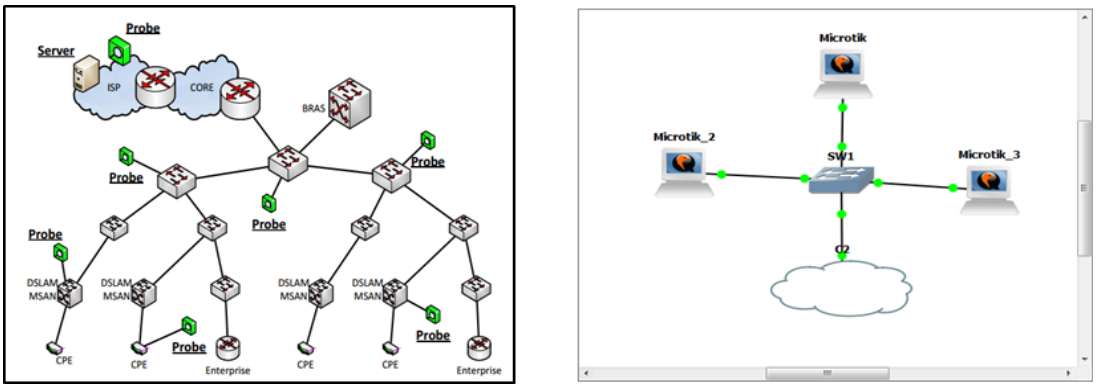

Figure 1 Simulation of MikroTik devices' connections

In the classic service measurement system[9] to measure a service performance, we need to write a script then send it to the device that we want to measure via FTP protocol then waiting for the result file sent to the server to display the result in the system as shown in figure 2. When we want to edit the script, we need to

resend a new script to the target device that can drive us to the connection problem and we need more time to operate.

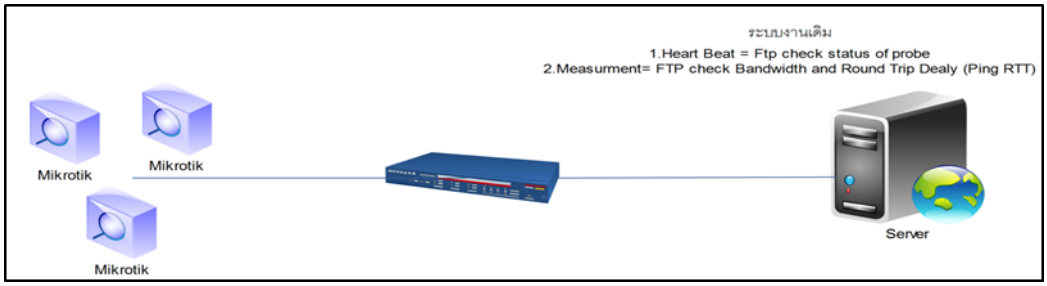

Figure 2 Classic service measurement system

In our method, the system is developed based on distributed approach. We distribute the control from central server to the core unit of each area (figure 3) to share the workload with the server. Moreover, we can easily control and manage devices in each sub-area.

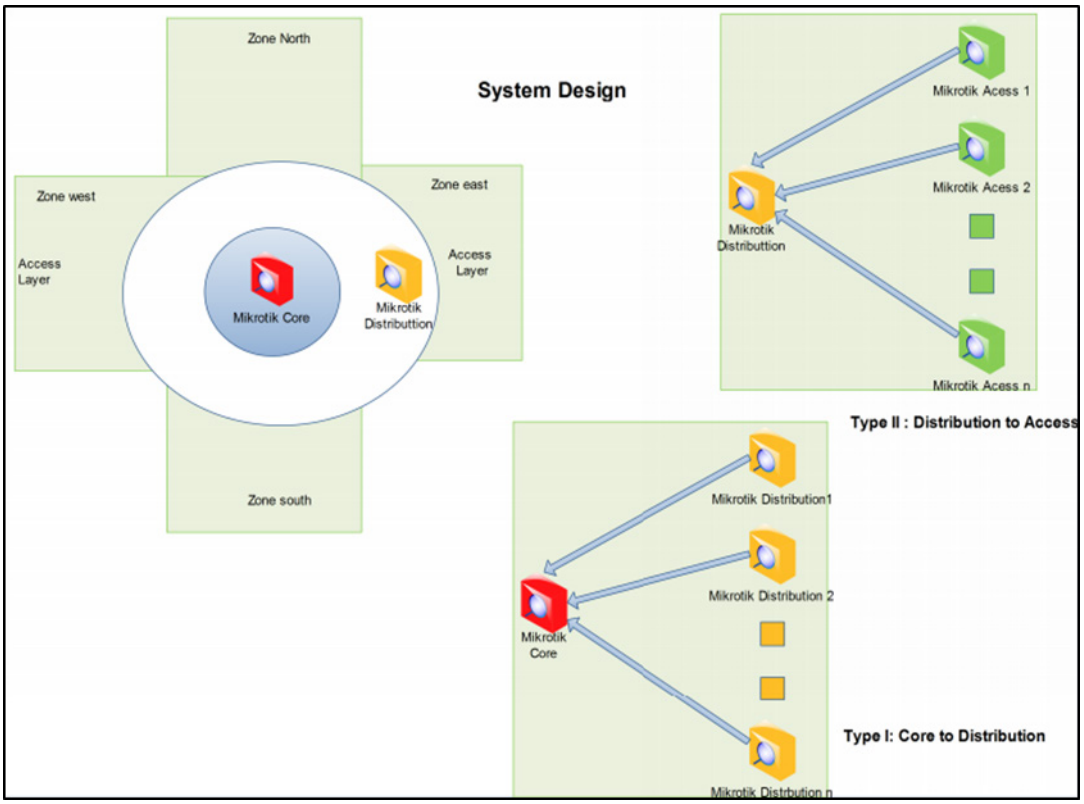

Figure 3 New service measurement System Overview

2.4 System's workflow

The operation flow of our system (figure 4) can be divided into 3 sections as follow:

1) User Management: we separate users into 3 levels, each has different right to control devices:
   a. Maintenance officer can do a Probe's test within his zone
   b. District chief can do a Probe's test across different zones
   c. Central authorities can do which Maintenance officer and District chief can do

2) Probe Management: we can register every device and fix its IP Address to check its performance later, we can verify devices' status and set device's working time and point device's location on Google Map.

3) Performance measurement: we can measure various aspects such as Ping, Bandwidth and show the result in form of graph and we can set measurement timer and the interval of auto-testing.

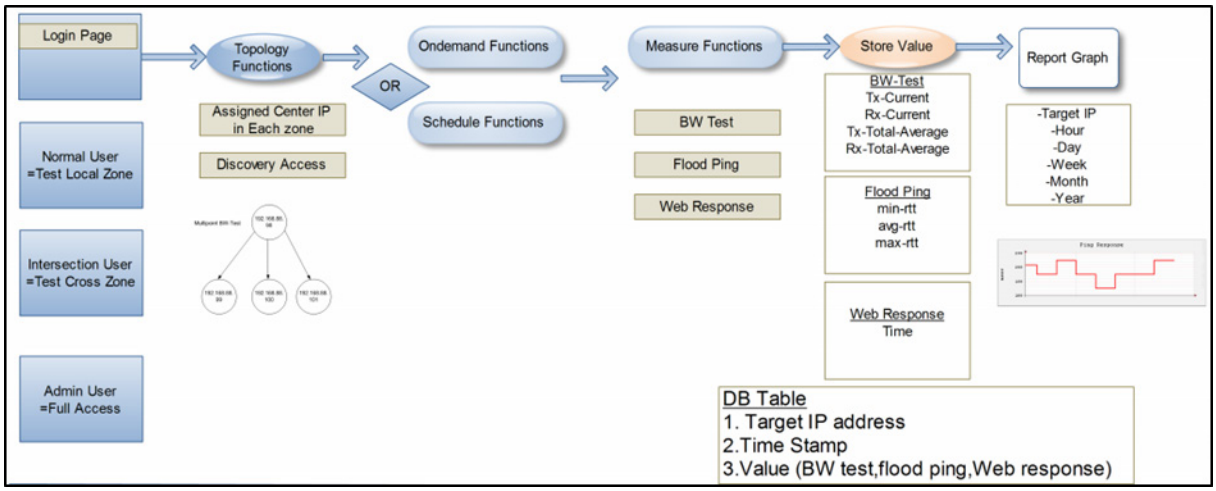

Figure 4 System's workflow

2.5 System development

```php
<?php
$sla_no=$_POST["sla_no"];
//$sla_no="sla01";
$comm=sprintf("php canvas_json_db_sh.php %s",$sla_no);
passthru($comm);
?>
```

Figure 5 Remote Code Execution

```php
 $probe_ip=mysql_result($rs1,0,2);
 $probe_user=mysql_result($rs1,0,3);
 $probe_pw=mysql_result($rs1,0,4);
$client = new RouterOS\Client($probe_ip, $probe_user,$probe_pw);
$responses= $client->sendSync(new RouterOS\Request('/tool/netwatch/print'));
$p1=count($responses)-1;
$sql4="select * from probe";
$rs4=mysql_query($sql4,$netview) or die ("x");
$p2=mysql_num_rows($rs4);
$sql2="Select probe.probe_ip from probe left outer join probe_ch_status on probe.probe_ip =
 probe_ch_status.status_ip where probe_ch_status.status_ip is NULL";
$rs2=mysql_query($sql2,$netview) or die ("x");
    while($row = mysql_fetch_array($rs2)){
    $com=sprintf('/tool/netwatch/add host="%s"',$row["probe_ip"]);
    $client->sendSync(new RouterOS\Request($com));
    }
$responses2= $client->sendSync(new RouterOS\Request('/tool/netwatch/print'));
foreach ($responses2->getAllOfType(RouterOS\Response::TYPE_DATA) as $response) {
```

Figure 6 PHP API for RouterOS

Figure 5 and 6 are code fragments of our system that shows how to use PHP_API to communicate with RouterOS installed in MikroTik devices. To communicate with RouterOS, we first create an object Client to send a command to the target device via its IP Address using function **sendSync()** with the syntax **"new RouterOS\Request('command that we want to send for example: /tool/netwatch/print')".** The waiting for the response. Then, the application will send the object of measurement in order to be stored in the database.

We can use function **time_sleep_until()** (figure 7) to make the system repeat the service measurement in specific interval then save the test in system's database in instance test mode or timer test mode and we can use the function curl() to send testing's notification via an SMS.

```
15 if($t=="Now"){
16     $t="+5 seconds";
17 }
18 //repeat
19     while($rep!="")
20     {
21      $timestamp = strtotime($t);
22      $time_go=date('Y-m-d H:i',$timestamp+($rep*60));
23      if(time_sleep_until($timestamp)){
24      $sql2="UPDATE  `netview`.`service_schedule_logs` SET `sv_time_start` =  '$time_go'
   WHERE  `service_schedule_logs`.`sv_sla` = '$sla'";
25     $rs2=mysql_query($sql2,$netview) or die ("x");
26     $comm=sprintf("php canvas_json_db_sh.php %s",$sla);
27     passthru($comm);
28     $sql3="select * from service_schedule_logs where sv_sla='$sla'";
29     $rs3=mysql_query($sql3,$netview) or die ("x");
30     $t=mysql_result($rs3,0,7);
31     $sla=mysql_result($rs3,0,2);
32     $rep=mysql_result($rs3,0,11);
33      }
34     }
35 }
36 else{
37     if($t=="Now"){
38     $t="+5 seconds";
39 }
40     //in time
41      $timestamp = strtotime($t);
42      if(time_sleep_until($timestamp)){
43     $comm=sprintf("php canvas_json_db_sh.php %s",$sla);
44     passthru($comm);
45     }
46 }
47   $sql3="select * from sms_message where sms_type ='2'";
48     $rs3=mysql_query($sql3,$netview) or die (mysql_error());
49     $sms_into=mysql_result($rs3,0,1);
50
51    $sql4="select * from user where `user_login` = '$user_send'";
52     $rs4=mysql_query($sql4,$netview) or die (mysql_error());
53     $user_tel=mysql_result($rs4,0,7);
54 $sms=sprintf("[netview]%s[%s]successful",$sms_into,$sla);
55 //send sms
56 if($user_tel!="" and $sms!="")
57 {
58 $smsdata=sprintf(
   "http://203.113.6.37/user=totpayphone&password=pathumthani&phonenumber=%s&sender=0893005740
   &text=%s",$user_tel,$sms);
59  $ch = curl_init();
60         curl_setopt($ch, CURLOPT_URL, $smsdata);
61         //return the transfer as a string
62         curl_setopt($ch, CURLOPT_RETURNTRANSFER, 1);
63         // $output contains the output string
64         $output = curl_exec($ch);
65         // close curl resource to free up system resources
66         curl_close($ch);
67 }
68 ?>
```

Figure 7 Service Measurement Control and testing's notification

3. Results and discussion

3.1 Dashboard

The dashboard (figure 8) is design based on Kaplan & Norton's concept[7] that allows the user to explore and follow the result of service measurement. Our dashboard is divided into 5 sections:

1) Area Management: show Probe devices in different areas and their information such as IP Address, name and location

2) User Management: manage users in system, show list of all users, specify their access right and modify users' attributes

3) Probe Management: manage Probe devices, show list of devices that user has a right to access and specific information about devices

4) Service Measurement: measure the performance of service, and test network performance
5) Report: export the testing report into the calendar format.

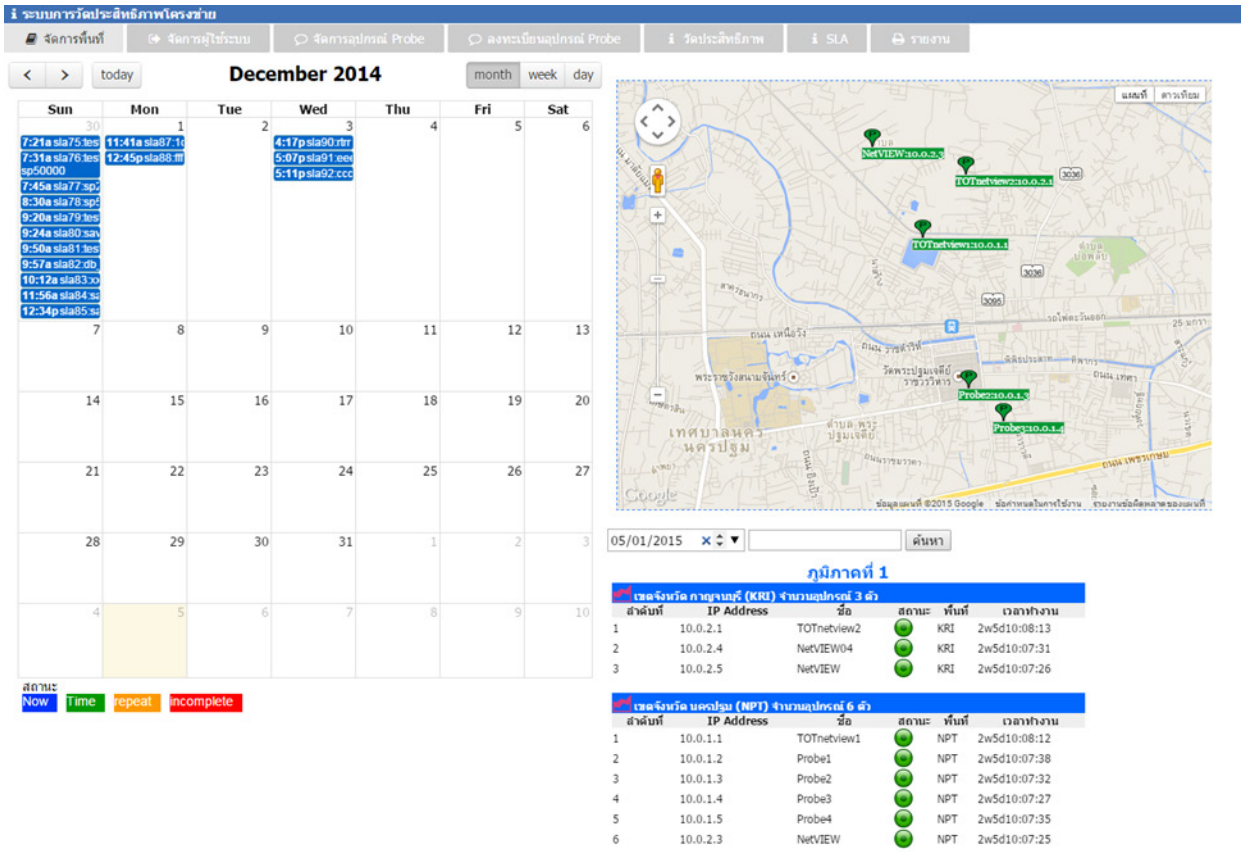

Figure 8 System Dashboard

3.2 Service measurement result

A Service Level Agreement (SLA)[10,11] is a contract between Service Providers and Customers that specifies what services the Service Provider will furnish, what transmission rate the Service Provider guarantee and what penalties the Service Provider will pay if he cannot meet the committed goals. The SLA will drive Service Provider to contribute to their customer's trust in terms of managed reliability and monitoring capabilities. To assure the availability and quality of their service, the Service Provider should verify in various aspect as shown in table 1.

Table 1 Service Measurement Testing aspects

Testing aspects	Result		Remark
	Correct	Incorrect	
Measurement in the same area	X		Depend on area
Measurement across areas	X		Depend on access right
Measurement with specific bandwidth	X		0.5-5 Mbps
Measurement with scheduled test	X		1-30 mins
Continuous measurement in different period	X		Starting from 1 mins
Repeat the measurement	X		every 5 mins
Measurement with many devices in the same time	X		More than 1 device

From Table 1, we implement our system as shown Figure 9 we have tested many times from 3 users in different areas with different access right as follows:

1) tko user at Nakhon Pathom (NPT) area as a maintenance officer
2) aue user at Kanchanaburi (KRI) area as a district chief
3) ana user at Bangkok (BKK) area as a central authority

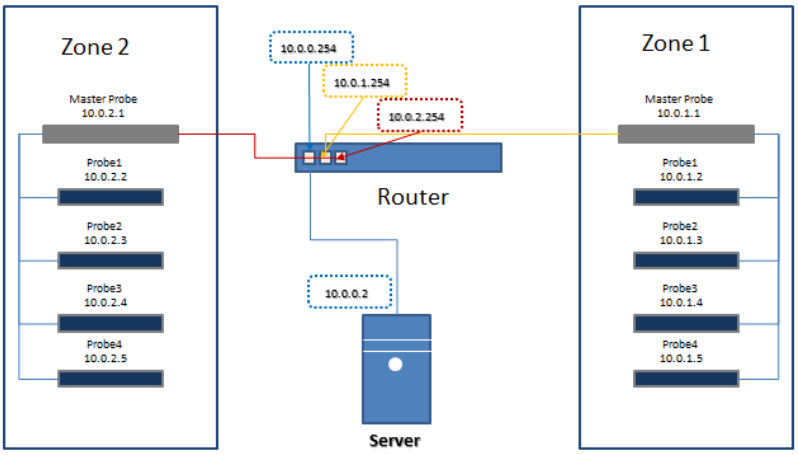

Figure 9 Overview of the network

The service measurement result is presented in the Table 1 that can show the correctness of different testing aspects.as shown in Figure 9. The result is presented in the Table 2 that show the service performance with different parameters.

Table 2 Service Measurement Result with specific bandwidth

Order	Source	Destination	Time	User	Area	Bandwidth	TX (Kbps)	RX (Kbps)
1	10.0.2.3	10.0.2.5,10.0.1.1	1 min	anan	BKK	1 Mbps	1019.53	1019.53
2	10.0.1.1	10.0.2.5	1 min	anan	BKK	1 Mbps	1019.33	1019.53
3	10.0.2.3	10.0.1.4	1 min	anan	BKK	1 Mbps	1019.33	1019.33
4	10.0.2.3	10.0.2.5	1 min	anan	BKK	1 Mbps	1019.73	1019.73
5	10.0.1.1	10.0.1.3	1 min	aue	KRI	5 Mbps	5110.99	5110.39
6	10.0.1.1	10.0.1.4	1 min	aue	KRI	6 Mbps	6142.04	6141.83
7	**10.0.1.1**	**10.0.1.4**	**1 min**	**aue**	**KRI**	**1 Mbps**	**1019.53**	**1019.53**
8	10.0.1.1	10.0.1.4,10.0.2.3	1 min	tko	NPT	1 Mbps	1019.33	1019.53
9	10.0.2.3	10.0.1.4	1 min	tko	NPT	2.5 Mbps	2554.48	2554.87

Figure 10 is the detail of the order 7 in Table 2. The source is 10.0.1.1 and the destination is 10.0.1.4. The output is shown in graph and in map location. In one minute of testing and bandwidth is 1 Mbps, the average value of Transmit Rate (Tx) is 1019.53 Kbps or 99.56%. The average value of Receive Rate (Rx) is 1019.53 Kbps or 99.56%.

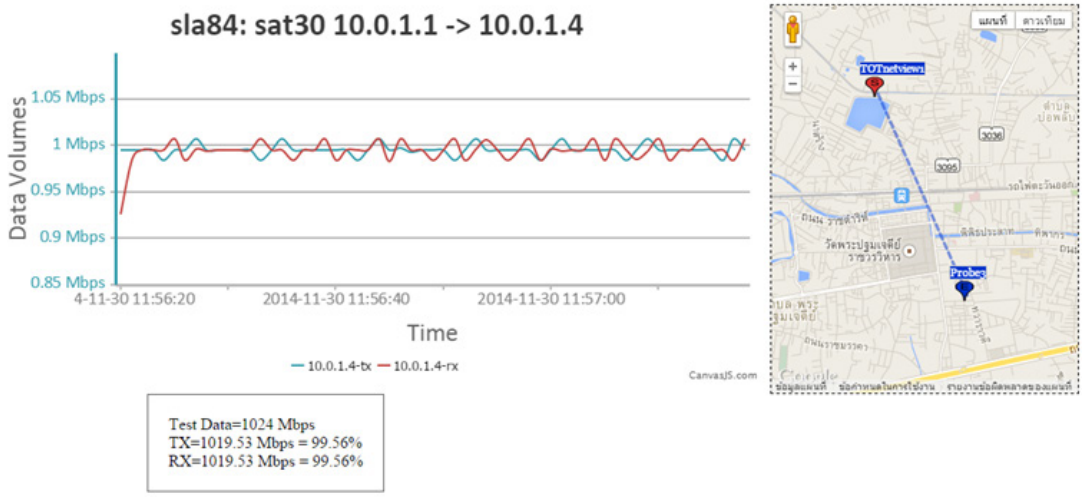

Figure 10 Measurement result Service Level Agreement

In order to evaluate tool, we have TOT Public Company Limited. TOT is a ISP, a Thai state-owned telecommunications company. TOT has applied our tool with TOT Netview within one year, the result has been shown that our tool can save the cost 133,261 baht per set of Probe and 13,0000,000 baht for the server needed for their own classic monitoring[9].

4. Conclusions & Future works

In this research, we develop a new service measurement tool for telecommunication networks using MikroTik devices and RouterOS and control these devices via PHP API that allows the user to manage the system, user, networks devices and allow users to measure the performance of the system.

In the future works, we can extend the expressivity of our tool by distributing the control to local control unit instead of using centralized control unit to share the workload and diffuse the risk of script working failures. We will try to use every functionality that came with the network device to improve the management of the system.

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