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Computer Network Performance management using a Simple Network ManagementProtocol

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Abstract

Performance management is understanding the behavior of network and its elements in response to traffic demands, measuring and reporting on network performance so that performance can be maintained at an acceptable level no real-time or near real-time for some applications. Measurement example (link utilization, link error rate, network throughput, Network throughput for quality of service, user response times).

Users are care about response time for interactive transactions, throughput for file transfers and print jobs, high availability, ease of use, convenience. But don't care about network backbone utilization, percent error rate, percent packet loss, ping round trip time.
For any performance tools used to measure link utilization like IBM proviso, Cacti or HP Network Node Manager there are steps for performance management (data collection, process and analyze data then determine threshold for acceptance performance).
For any performance measuring tool of the above it is suggested to use SNMP protocol with a suggested polling time. But Sampling too quickly may cause some network devices to overload and will certainly increase network management traffic. But also long sample intervals miss all the useful variation in the performance metrics. We have to measure performance according to scope and from user or network perspective. So Heisenberg uncertainty principle of quantum physics can be stretched to explain why excessive SNMP prodding of the network can limit and how accurately it can be measured. [19and20]

Keywords: Simple Network Management Protocol, Network Node Manager, i Smart Plugins, Hewlett-Packard, International Business Machines, Quality of Service, Class of Service

1. Introduction

Performance management is understanding the behavior of network and its elements in response to traffic demands, measuring and reporting on network performance so that performance can be maintained at an acceptable level no real-time or near real-time for some applications.
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performance metrics. We have to measure performance according to scope and from user or network perspective [1, 2, and 3].

2.Network Performance Management

Network performance management is the collective techniques that enable, manage and ensure optimal performance levels of a computer network.
Network performance management generally requires the performance and quality service level of each network device and component to be routinely monitored.
Network performance management typically takes performance metrics from all across the network at a granular level. It reviews performance of the router to measure performance for each port.
Network performance monitoring processes help in identifying performance bottlenecks, whereas network performance management ensures that problems are mitigated and the network is restored back to the required performance level. In addition to internal metrics, network performance management also reviews, analyzes, maintains and manages performance from a user perspective [1, 2, 3, 15 and 16].

3. Performance Management

3.1Performance Management Identifies

- Normal baseline network performance for comparing perceived 'bad'network behavior
- Current or potential utilization problems
- Slow response time
- Application, server, and network availability
- Optimum data transfer times
- Violation of SLAs, QOS policies or COS guarantees[13 and 14]
- Reality of Monitoring QOS Networks
- QOS makes networks more complex to manage[13]
- Requires performance management/capacity
- Planning for each class of service [5]

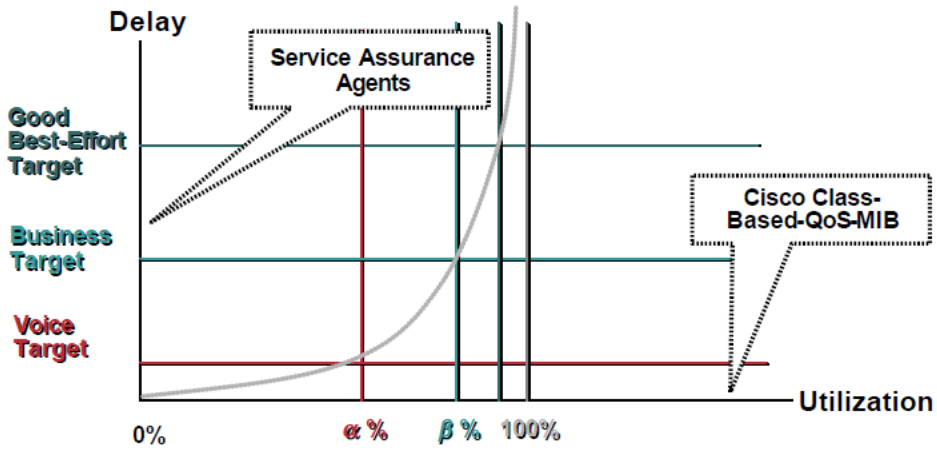

Fig. 3.1 Class of service Delay/Utilization Trade-Off theoretical

If I can keep Voice traffic < a %, I will keep Voice delayunder M1 ms
If I can keep Business traffic < b %, I will keep Business delay under M2 ms

3.2Management Domain

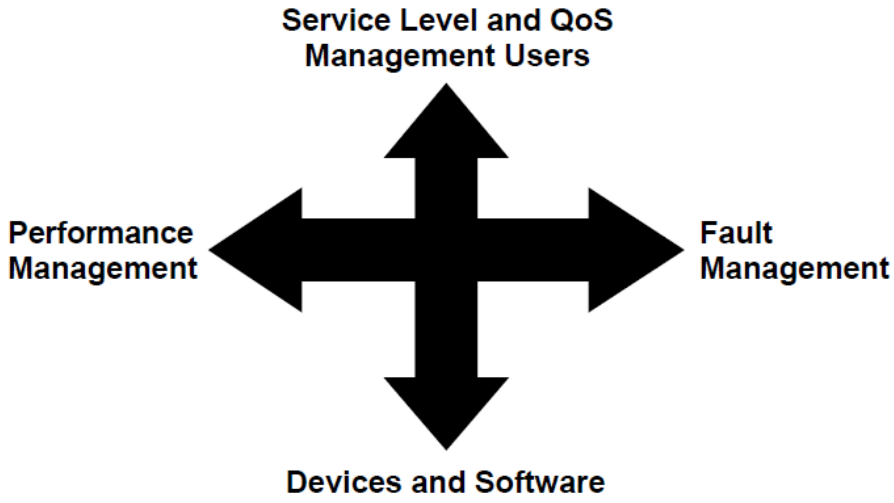

Fig. 3.2 Domain of fault, network performance management

Everything could use the same data source then Processed and presented differently, Interaction between all three.
Performance management sends events to fault management, notifying it of performance related faults.
Performance management can send events to accounting notifying it of SLA violations, Collection of performance, fault and accounting data can impact network performance and trigger faults
The Most Key factors in network performance management include:

- Network delays
- Packet losses
- Throughput
- Packet transmission
- Error rate [4,5 and 6]

3.3How Performance and Fault Management Intersect

Proactive fault analysis is the conceptual areathat ties together fault, performance and change management in an ideal network management system.
Processing performance data may uncover network faultsthis may lead you to add event thresholds to more quickly report these issuesExcessive or repeated faults may lead you tochange what is being monitored for performance.[17 and 18]
It providesreal-time, as soon as a notification is generated

3.4 Importance of performance management

- Network troubleshooters need real-time utilization and error data.
- Help desk needs to view performance data in relation to a user complaint

- Network engineering staff needs performance data for capacity planning.
- IT group needs data to present at the monthly service level agreement (SLA) meetings[3,5 and 6]

4. SNMP operational Theory

Wide range of network device parameters like system uptime, interface status, interface packet statistics, routing protocol statistics etc. are treated as different objects by SNMP. These objects are maintained by the server portion of SNMP software, known as SNMP agent, running on network devices like routers and switches. SNMP client program known as the SNMP manager, runs on a remote machine and queries these objects, through SNMP Get requests, to know the status of the network device. Similarly, the manager can control some of the network device parameters by doing an SNMP Set request which is equivalent to a write operation. Apart from the manager sending SNMP GET/SET requests to the agent, the agent too can proactively notify the manager of critical/significant events on the network devices through SNMP trap messages. SNMP manages the device by reading and writing values to different SNMP objects, with each object representing a specific network parameters [4, 7, 8 and 9].

5. HP Network Node Manager

HP Network Node Manager is a tool which can help us to manage the network performance. It is keep an eye on our network, find issues, recognize outages related to network, and help us improve our network availability and performance.

- Discovers and documents network topology
- Monitors network traps and events to create actionable incidents
- Provides tool interface to repair outages as quickly as possible

NNM is the tool we used in our thesis to measure the link utilization of links , as per below figure NNM discover the nodes by SNMP and recognize all its configuration with its interfaces , and as per below NNM discover the layer 2 topology as it facilitate the troubleshooters to view the link utilization or whatever metric you want to view using the iSPI performance for metrics.[10]

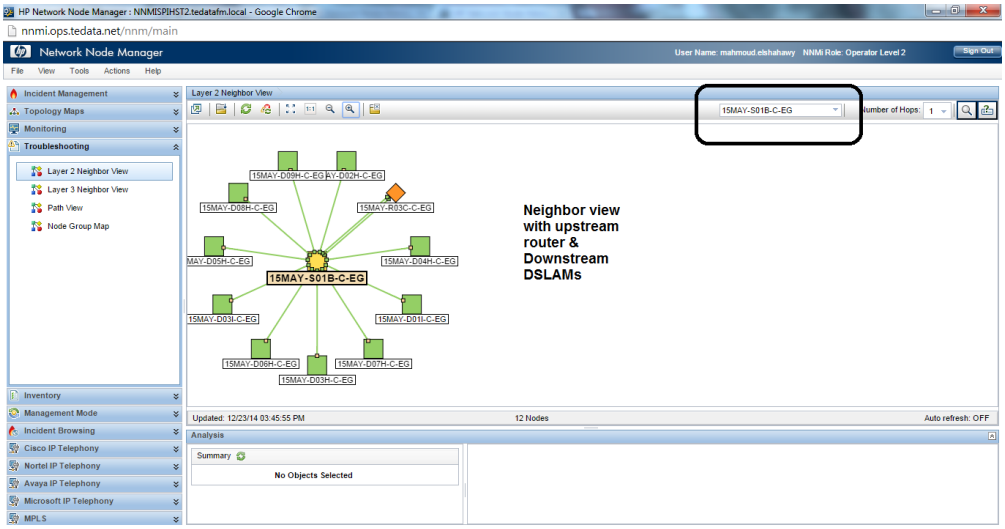

Fig. 5 NNM discover and document the network topology

6. iSPI performance for metrics

6.1 iSPI performance for metrics overview

The NNM iSPI for Performance adds sixteen performance reports to NNM. These reports give the operator 50 additional ways to measure the behavior of nodes and interfaces in a network. The additional measures (utilization, availability, packet discards, packet errors, and many variations on those themes) will speed problem diagnosis and allow the operator to detect problems that fault monitoring alone cannot detect. The ability to investigate a situation using performance metrics means that the operator can catch little problems early, before they develop into big problems.
With the resiliency of today's IP networks, fault and availability management is not enough Network performance problems are just as likely to affect a business. Therefore, an effective management solution should incorporate network performance management, encompassing device, interface, and link performance. As important as including performance management is, how you incorporate it into your solution is equally critical. Management solutions must drive increased productivity and efficiency. Disparate fault and performance solutions or loosely integrated point tools require that operators toggle back and forth between separate systems.[10]

6.2 Why choose the NNM iSPI for Performance to measure the metric with recommended interval retrieval?

- Simple add-on to NNMi
- Need limited network reporting and have a limited budget
- Want a solution that will allow me to grow to a data warehouse; easy upgrade to Performance Insight
- Need fine granularity
- Confirm the Heisenberg uncertainty principle of quantum physics which can be stretched to explain why excessive SNMP prodding of the network can limit and how accurately it can be measured[11 and 12]

7. Monitoring configuration

After discovery the network nodes you have to configure the monitoring as per belowFigure.
You can configure the performance polling interval per node group or per group interfaces.
The default interval is 5 minutes, but you have to take in your consideration the link type regarding the SNMP bit counter.

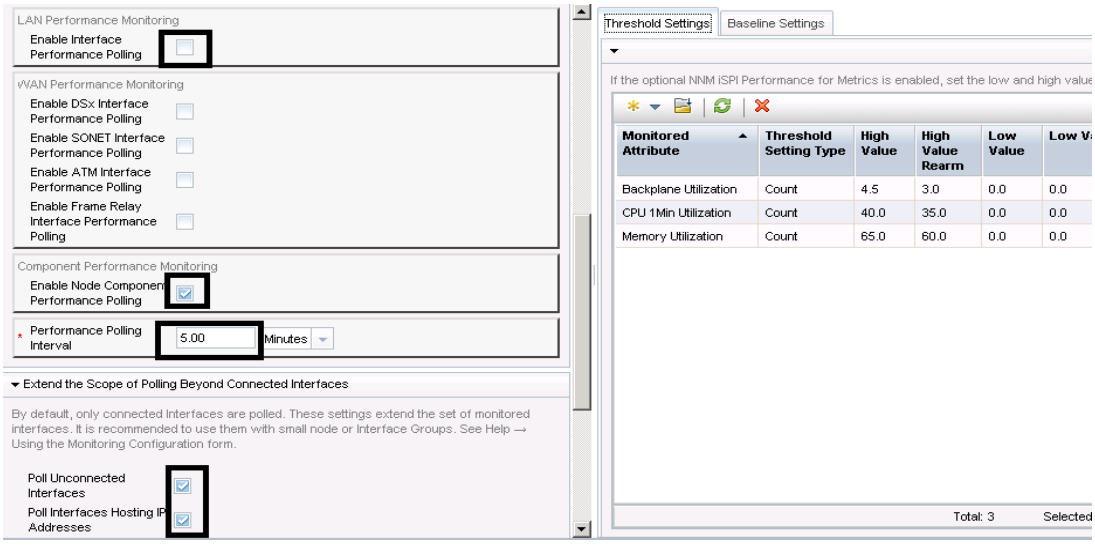

Fig.7 NNM Monitoring configuration

8. Comparison between Links from Type perspective "SNMP Counters"

Allow you to compare apples to apples, Counters have standard definitions
As defined by IETF, IEEE, other vendors
32 bit counter link Sample:
100 mbit/sec = 100,000,000 bits/sec = 12,500,000 bytes/sec
2^32 bytes = 4,294,967,296
2^32 / 12,500,000 = 343 seconds = 5.72 minutes between counter flips

So as per this sample , if measure the link utilization and choose the polling interval 5 minutes , you will lose the accuracy as the SNMP counter will be flip every 5.72 minutes , so if we need to calculate the performance of a link 32 bit counter you have to choose a very small polling intervals.
As the speed network media increase , the minimum time in which a 32bit counter wrapping will be decreased.
For this type if the counter wraps occurred between SNMP samples definitely the result will not be accurate. So 32bit counter is not useful for high speed interfaces and also for historical data. You may use it for row data only. As its count will be wrapped in small time intervals.

64 bit counter link sample:
2^64 bytes = 18,446,744,073,709,551,616
2^64 / 12,500,000 = 1,475,739,525,896 seconds = 46,763 years

So as per equation above, now we can choose polling interval 5 minutes and it should be very accurate as the counter will be flip after 46,763 years.
You have to know in advance how utilized a link, all of them have to be sampled by five minutes intervals. But if you use 64 bit counters, you can tolerate a large sample interval for SNMP historical data collection.

9. The measuring mechanism of link utilization in NNM

How you calculate use depends on how data is presented for what you want to measure. Interface use is the primary measure used for network use. Use this formula based on whether the connection you measure is half-duplex or full-duplex. Shared LAN connections tend to be half-duplex, mainly because contention detection requires that a device listen before it transmits. WAN connections are full-duplex because the connection is point-to-point; both devices can transmit and receive at the same time because they know there is only one other device that shares the connection. Because MIB-II variables are stored as counters, you must take two poll cycles and figure the difference between the two (hence, the delta used in the equation).

$$\text{Input utilization} = \frac{\Delta \text{ifInOctets} \times 8 \times 100}{(\text{number of seconds in } \Delta) \times \text{ifSpeed}} \qquad \text{Eq.1}$$

$$\text{Output utilization} = \frac{\Delta \text{ifOutOctets} \times 8 \times 100}{(\text{number of seconds in } \Delta) \times \text{ifSpeed}} \qquad \text{Eq.2}$$

Eq.1, 2 the in/out link utilization

- ΔifInOctets: The Δ (or difference) between two poll cycles of collecting the snmp ifInOctets object, which represents the count of inbound octets of traffic.
- ΔifOutOctets: The Δ between two poll cycles of collecting the snmp ifOutOctets object, which represents the count of outbound octets of traffic.
- IfSpeed: the speed of the interface, as reported in the snmpifSpeed object.

These formulas are simplified because they do not consider overhead associated with the protocol

10. Measuring performance data online

The simplest way to look at historical SNMP data is to select the device you're interested in and choose the Performance: Display SNMP data: For Selected Nodes menu. This brings up the xnmgraph GUI which displays the device performance data found in the database, if any.
Below are samples of link utilization, measured by NNM, polling interval five minutes.

Measuring online:

When we discovered the node, SNMP using by the Network Node Manager NNM detect automatic the layer 2 topology and the below showing the link utilization online between two interfaces, this is needed usually for troubleshooters.

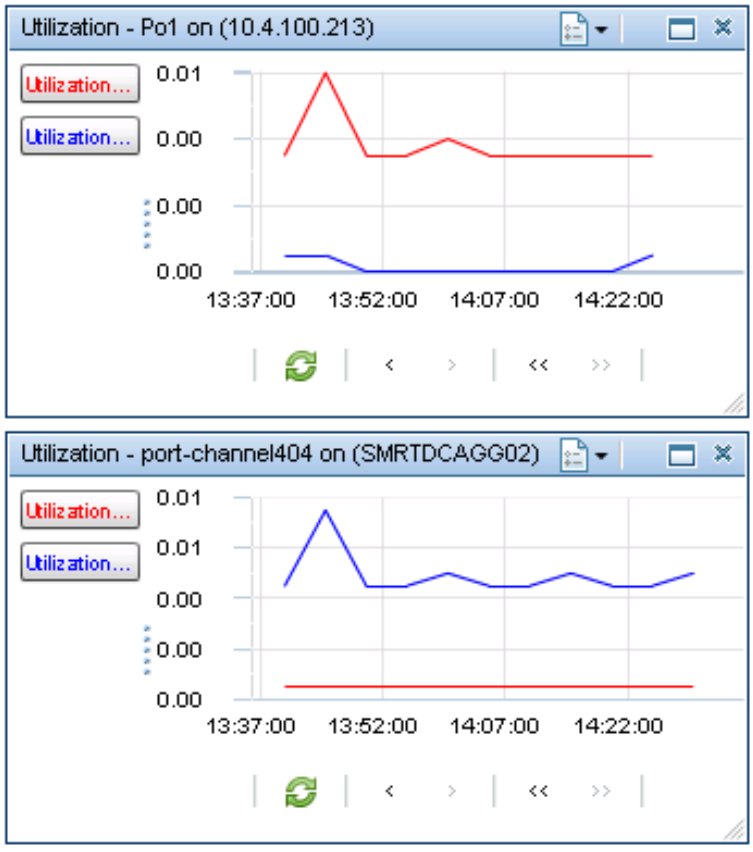

Fig.10 online in/out utilization of two interfaces

11. Comparison between Performance Monitoring Applications

11.1 Cacti "open source"

Cacti is a complete network graphing solution, Cacti provides a fast poller advanced graph templating, multiple data acquisition methods, and user management features out of the box. All of this is wrapped in an intuitive, easy to use interface.
Cacti use the same delta equation in measuring the link utilization

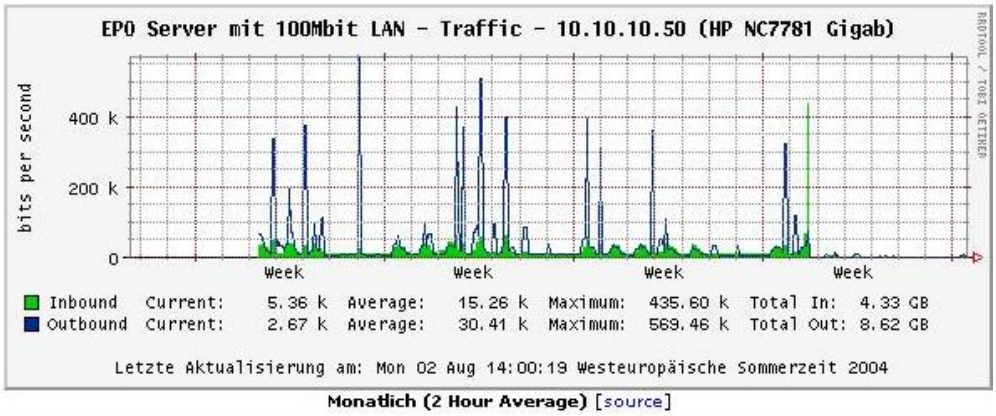

Fig.11.1 the utilization of 100Mbit link by cacti

But it have a big issue, in cases of 32bit counter we can noticed that we have spikes. Which mean the inaccuracy data we detected.

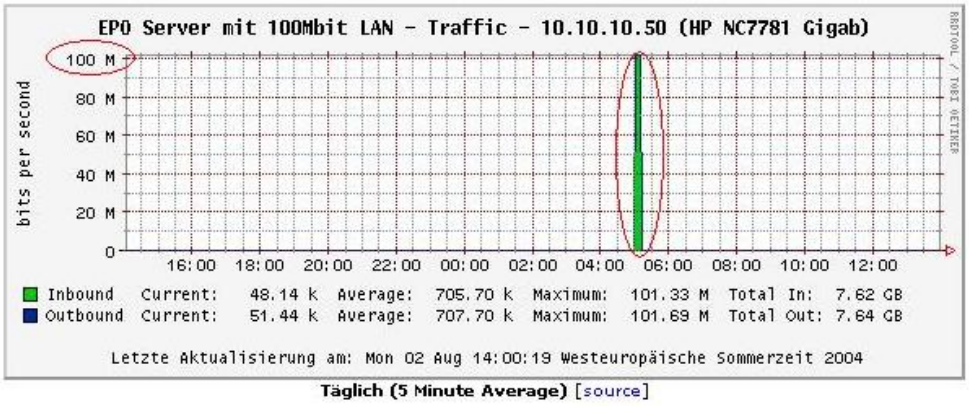

Fig.11.1i Spike of 100Mbit link utilization by cacti

This inaccuracy data is related to the wrapping of the link counter as when cacti calculate the delta between the two samples of SNMP polling the result will be negative as sample2 will be greater than sample2 if the link counter wrapped
Delta = (sample2-sample1)/ delta time in sec

Remark (1): Cacti neglect the minus in the result, so the cacti present a wrong data at this time.

To avoid spikes in measurement during the link counters, performance tools should detect the wrapping and calculate the delta as per below:
Delta= (max utilization-sample2)/delta time in sec
Which HP NNM & IBM Proviso do for this

12. Conclusion

The need for Quality of Service (QoS) guarantees is a growing trend through the public broadband network operators as well in the Internet community.
The research study the performance management for the network and how to measure performance metrics . Performance management refers to the methodology of understanding the behavior of network and its elements in response to traffic demands, measuring and reporting on the network to maintain the network performance at an acceptable level. We propose to use SNMP protocol for network performance evaluation with a given polling time considering all tradeoffs.

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