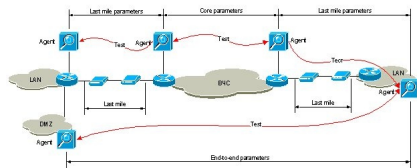


# Overview of the IP Quality Monitor (IQM) solution

IP Quality Monitor (IQM) is a hardware-software system intended for measurement, monitoring and management of the end-to-end IP quality parameters. IQM takes into account different classes of service and zone structure of IP network. In addition it is possible to deploy distributed monitoring with number of remote management domains.

In automatic mode IQM system performs IP quality parameters measurement and control. Communication service provider (CSP) can use IQM to deploy SLA as value added service to IP VPN. SLA control could be carried out on any directions of customer's networks, last miles, access, distribution and core levels. Meanwhile, any network topology could be used for measuring. Using IQMM system CSP can provide its customers (IP VPN, L2VPN) with reliable information about network quality parameters.



The traditional approach is applied to the quality parameters measurement: specialized network devices (probes) are placed on the key network nodes. Program IQM agents (IQMA) are running on the probes.

Any x86 or ARM- platform running Linux can be a hardware platform for IQMA. Requirements to the hardware are minimal: memory from 512 MB, free disk space - from 1GB. Fanless "thin client" with flash memory, Desktop PC, plug- computers can be used as the hardware platform for IQMA. Also you can use IQM agents deployed in NSG router.

There are two methods available for agents connecting: T-connection, in-line connection. It is recommended to use T-connection mode, due to its higher reliability. Agents can initiate the test session (active mode) or accept requests for tests (passive mode). Besides, it is possible to use various network devices (such as routers, switches, servers) with UDP Echo service running as the passive agents.

In the automatic mode (scheduled) or on demand agents send a number of test packets to peer agents and measure parameters of their delivery: loss, delay, variations of delay (jitter). There are special tests to measure channel capacity. The received information is processed and stored in text files, and then passed to the higher level — to the core system for statistics processing and analysis. This system is named IQM Manager (IQMM).

Using the probes at the IP network key nodes will allow to measure not only the end-to-end parameters, but also at the certain part of the network. It facilitates further process of a network problems troubleshooting. Thus, for example, it is possible to carry out quality management on one of the most problematic divisions of a network — on the last miles.

The IQM system could monitor the number of networks with various requirements for quality parameters. Control policies can be applied individually to each test, or to zone-to-zone directions.

IQM system can be integrated with other monitoring systems by different vendors.

### □ □ □ □ □ □ □ □ □ □ **Managed parameters**

Quality assurance includes the analysis of following parameters: IP packet loss, round-trip delay time, one-way delay time, jitter (packet delay variations), available bandwidth (channel capacity) and number of remarked packets. Measurement of these parameters can be made in different classes of service, for example: standard, premium and real-time. It is possible to take into account the zone structure of an IP network. This approach permits quality management in zone-to-zone directions instead of point-to-point.

## Overview of the IP Quality Monitor (IQM) solution v3

Written by Максим

Wednesday, 18 April 2012 10:54 - Last Updated Thursday, 19 April 2012 12:45

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**Packet loss** can be influenced by a number of factors, including signal degradation over the network medium, overloaded network links, corrupted packets rejected in-transit, faulty networking hardware, faulty network drivers or normal routing routines. Packet loss is calculated as a ratio of lost packets to the total number of packets sent over the IP network in specified direction.

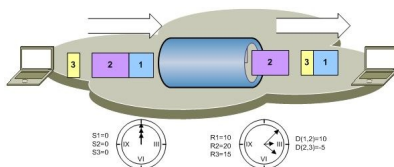
**Round-trip delay time** (RTD — round-trip delay time, RTT — round-trip time, RTL — round-trip latency) is the time required for a packet to travel from a specific source to a specific destination and back again.

**One-Way Delay time** (OWD) — the time that a packet spends in travelling across the IP network from source to destination. OWD (as opposite to RTD) can assure that the go and back paths are the same (or not) in terms of congestion, number of hops, or Quality of Service (QoS).

**Jitter** (Jitter, IPDV — IP Packet Delay Variation, PDV — packet delay variation). In IP networks, jitter is the variation in the delay of the packets. IP Packet Delay Variation is defined in RFC 3393 as a difference of the one way delays of selected packets. Let's designate R as time when packet was sent, and S as delivery time. Then PDV value for i-packet and j-packet could be calculated as:

$$D_{i,j} = (R_j - R_i) - (S_j - S_i) = (R_j - S_j) - (R_i - S_i).$$

The figure illustrates how the PDV occurs due to irregularity of IP packets delivery:



RFC 3550 defines incremental approach for calculation of PDV:

Wednesday, 18 April 2012 10:54 - Last Updated Thursday, 19 April 2012 12:45

This method is used by IQM agents for jitter measurement.

**Number of remarked packets** – a number of packets (in %) delivered with changed value of class of service.

From the technical point of view, IP Quality Monitor consists of two basic elements: quality parameters measurement agents (IQMA) and management system (IQMM)

The diagram illustrates the IQM Manager architecture. It features a central IP network cloud connecting three separate LANs. Each LAN contains an IQM-Agent (represented by a server icon) and a router. The IQM-Agents are connected to a central IQM-Alarms server and an IQM-Reporter server. The IQM-Alarms server is connected to an Administrator (person icon) via HTTP. The IQM-Reporter is connected to an Operator (person icon) via HTTP. A legend at the bottom explains the symbols used in the diagram:

- Red wavy arrows: Tests
- Blue wavy arrows: Statistics gathering
- Green wavy arrows: Management
- Yellow rounded rectangles: Network nodes
- Yellow rounded rectangle with server icon: IQM Manager infrastructure

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4 / 16

## Overview of the IP Quality Monitor (IQM) solution v3

Written by Максим

Wednesday, 18 April 2012 10:54 - Last Updated Thursday, 19 April 2012 12:45

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IQMM system is program complex with sole GUI front-end, performing following functions:

- Management of IQM Systems:

  - IP quality control policy configuration

  - Policy violation actions configuration

  - Management of agents deployed in the network

  - Tests configuration

  - On-demand tests initiation

- Agents state monitoring

- Automatic statistical data processing:

  - Export of data delivered from agents to SQL database

  - Data pre-processing and consolidation

## Overview of the IP Quality Monitor (IQM) solution v3

Written by Максим

Wednesday, 18 April 2012 10:54 - Last Updated Thursday, 19 April 2012 12:45

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Data storage

Data analysis

- IP quality policy violation alarming
- Display of statistics in various forms

Tabular representation

Graphical

Representation of agent's state and controlled channels on the geographical map

Monitoring results reporting

Display alarms about the detected violations of the control policy

- Interactive map functions. Interactive map represents performance characteristics of network and network devices on geographical map with network topology applied

Total bandwidth used on network links.

Errors occurred on network links.

## Overview of the IP Quality Monitor (IQM) solution v3

Written by Максим

Wednesday, 18 April 2012 10:54 - Last Updated Thursday, 19 April 2012 12:45

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Network devices performance parameters: CPU load, memory usage etc.

Colored indication of network links utilization.

- Administration:

User authorization and system access control

User and role profiles management

Subordinate IQMM (distributed setup) systems access control

Customer's accounts management (Requires additional software module "IQM: Users Personal Area")

In the presence of the additional software module IQMM-CISCO-SAA, IQMM supports functional work with SAA (Service Assurance Agent) – built-in network devices manufactured by Cisco Systems:

- Managing Cisco SAA,
- Data collection from Cisco SAA,
- Analysis and presentation of statistical information is fully realized in IQMM system

# Overview of the IP Quality Monitor (IQM) solution v3

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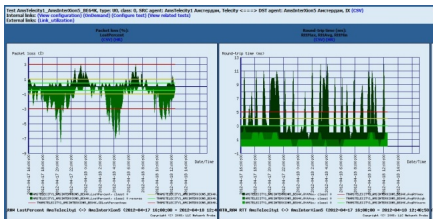
Wednesday, 18 April 2012 10:54 - Last Updated Thursday, 19 April 2012 12:45

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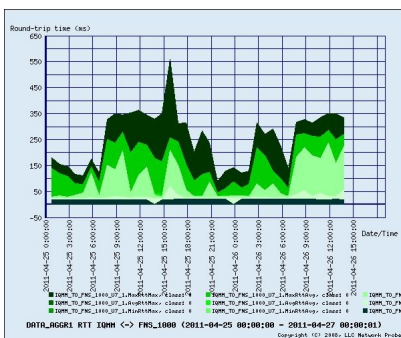
functional, described in this document

## Statistics of measurements

Statistics can be represented in the graphical form as well as in tabular form. To obtain the necessary reports a user can use a filter to restrict the query by a group of criteria: source zone, target zone, active (source) agent, passive (destination) agent, test ID, customer ID, class of service, type of controlled parameter.



Average data is also available: system provides hourly and daily aggregated historical reports of controlled parameters. The averaging period can be changed. The illustrations below are reports with hourly and daily aggregation.





Wednesday, 18 April 2012 10:54 - Last Updated Thursday, 19 April 2012 12:45



- Representation of agent's state and controlled channels on the geographical map
- Alarms list represents violations occurred,
- Dashboards – table-view of alarms,
- Additional notification means are: e-mail, syslog, SNMP Trap.

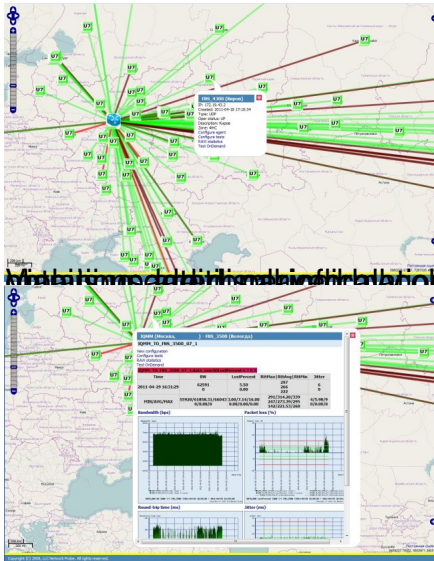
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9 / 16

## Overview of the IP Quality Monitor (IQM) solution v3

Written by Максим

Wednesday, 18 April 2012 10:54 - Last Updated Thursday, 19 April 2012 12:45



With this solution, the operator can see the location of the problem areas on the map. The possibility of the

### Alarms list

Alarms list provides the operator with access to a list of violation signals, allows to analyze the problem, change the status of the signal, add a comment, remove the signal. The importance of the signal is determined by the color.



### Dashboards

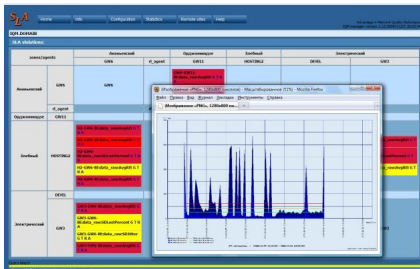
The dashboard presents signals in the summary table “source-zone – destination-zone”. This approach to the visualization allows locating the problem areas in the zonal level.

## Overview of the IP Quality Monitor (IQM) solution v3

Written by Максим

Wednesday, 18 April 2012 10:54 - Last Updated Thursday, 19 April 2012 12:45

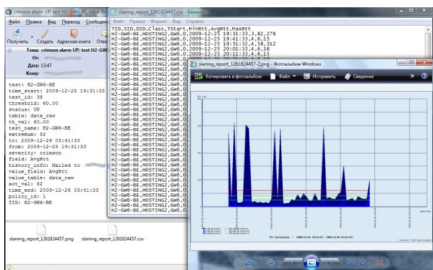
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### Notifications

When violation is discovered IQM can use the following means for operator notification:

- Sending e-mail with the appropriate report,
- Sending syslog,
- Sending SNMP-Trap,
- Logging to the database.

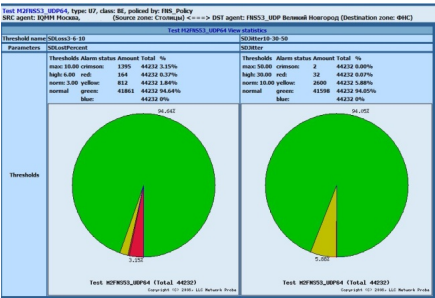


The e-mail notification contains a summary about the violation, graph and table.

Reports

SLA - reports

SLA reports provide information about controlled parameters availability according to used policy. The reports are substituted in the form of slices for each parameter for each test. The shares corresponds to the proportion of time that controlled parameter was within the threshold of certain control policy.



QoS reports

The QoS reports provides information about the minimum, average and maximum values of monitored parameters over a specified period.

# Overview of the IP Quality Monitor (IQM) solution v3

Written by Максим

Wednesday, 18 April 2012 10:54 - Last Updated Thursday, 19 April 2012 12:45

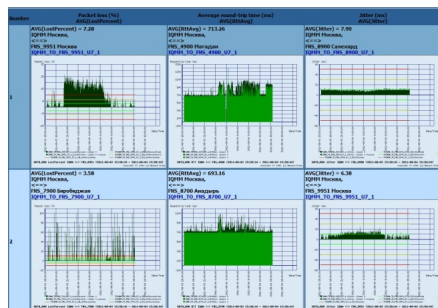
Number	SRC agent	DST agent	Test name	Parameters	Minimum	Average	Maximum
1	IQM1	FISH_UDP_FISK1	FISH_FISK1_U7	Packet loss (%)	0.00	0.00	0.00
				Average round-trip time (ms)	2	2.27	5
				Jitter (ms)	0	0.05	0
				Packet loss (%)	0.00	0.01	0.50
2	IQM1	FISH_UDP_FISK2	FISH_FISK2_U7	Average round-trip time (ms)	3	3.01	4
				Jitter (ms)	0	0.00	0
				Packet loss (%)	0.00	0.00	0.00
				Average round-trip time (ms)	30	35.49	60
3	IQM1	FISH_UDP_FUR11	FISH_FUR11_U7	Jitter (ms)	0	0.19	1.2
				Packet loss (%)	0.00	0.05	5.50
				Average round-trip time (ms)	137	142.48	175
				Jitter (ms)	0	0.00	0
4	IQM1	FISH_UDP_VVK1	FISH_VVK1_U7	Average round-trip time (ms)	137	142.48	175
				Jitter (ms)	0	0.00	0
				Packet loss (%)	0.00	0.05	5.50
				Average round-trip time (ms)	137	142.48	175

Query time 0

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## TopX QoS reports

TopX QoS reports provides information about TopX worst directions from the quality parameters monitoring point of view.



## Interactive network map

Interactive map functionality designed for network links and devices utilization monitoring. Interactive map represents performance characteristics of network and network devices on geographical map with network topology depicted:

Total bandwidth used on network links.

Errors occurred on network links.

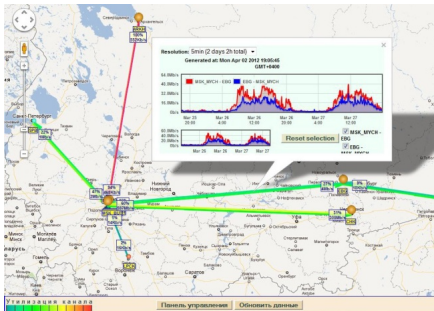
Network devices performance parameters: CPU load, memory usage etc.

## Overview of the IP Quality Monitor (IQM) solution v3

Written by Максим

Wednesday, 18 April 2012 10:54 - Last Updated Thursday, 19 April 2012 12:45

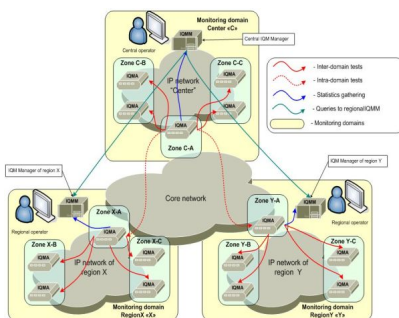
Colored indication of network links utilization.



## □□□□□□□□□□ Distributed monitoring

Distributed monitoring is possible by means of managing remote monitoring domains.

In case of monitored network has regional-distributed structure with number of traffic concentration points and regional networks it make sense to deploy distributed multilayer monitoring system by dividing the whole network into a number of monitoring domains. Each monitoring domain will consist of number of IQM agents and local IQM manager. Local IQM manager will gather intra-domain quality measurements from its own agents, perform analysis of data received, and provide reports and alarms for regional operators. Central IQM manager will manage all local IQM managers and all agents. If needed, it could be possible to access the local IQM manager data from central IQM manager.

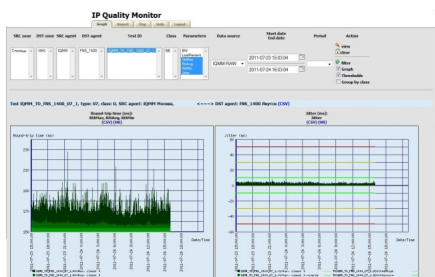


The figure depicted an example of deploying of distributed SLA monitoring system. Regional operators use their own IQM management systems for the local goals of monitoring and agents management. Intra-domain measurements will be gathered by local IQM management systems. If needed, the rights for management could be delegated to the center leaving view-only rights to regional operators.

### □ □ □ □ □ □ □ □ □ □ □ □ **Personal Area**

IQM Personal Area - additional software that implements the function of limited customer's access to IQMM reports and maps. Using a Personal Area is recommended to provide end users of a network with information of the quality parameters status. It is also possible to use the Personal Area by the territorial divisions of large telecom operators in the case of delimitation of responsibility areas.

Personal area's users have access to the following IQM-information depending on user's role access profile:

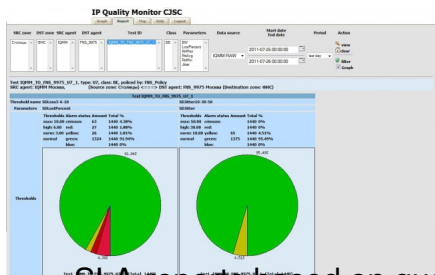


- Graphical and table reports with quality parameters measured on customer's networks.

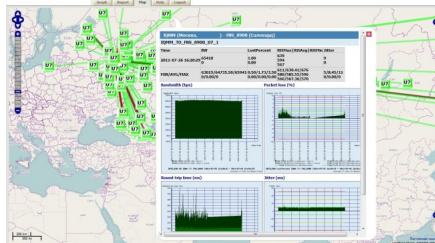
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Written by Максим

Wednesday, 18 April 2012 10:54 - Last Updated Thursday, 19 April 2012 12:45



SLA reports based on quality parameters measured on customer's networks.



Monitoring map with customer's network.