JOLATA

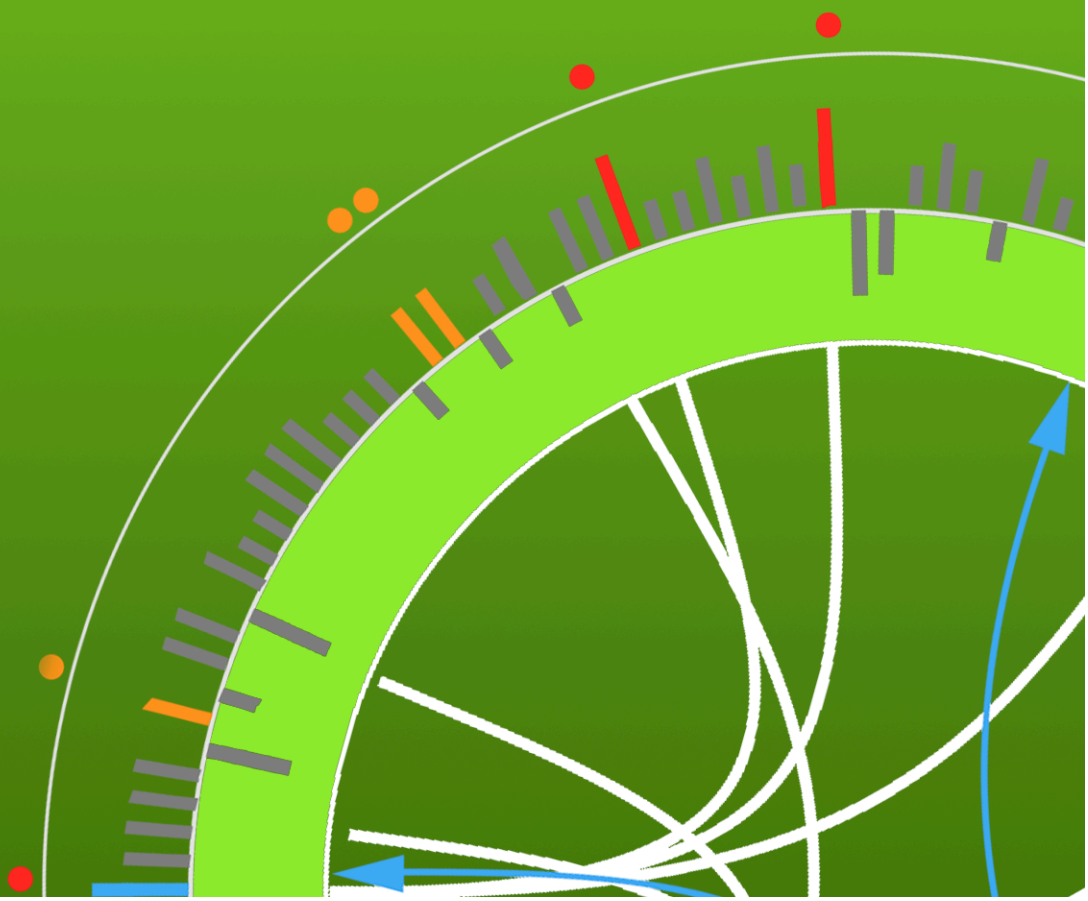
Making the network for you

WHITE PAPER

Jolata Overview:

If You Can't See It, You Can't Diagnose or Optimize It

2014



Jolata Overview

The Jolata Platform is a big data solution providing **real-time** and **precise** network intelligence, by aggregating, analyzing and visualizing millisecond-precision performance statistics for any flow and anywhere on the network.

By providing end-to-end and hop-by-hop precise performance metrics, customers are empowered to efficiently improve network performance, quickly identify root causes of network problems and accurately configuring the SDN/NFV-enabled networks.

Jolata Overview

Companies with mission-critical networks are losing millions of dollars because they are unable to accurately assess the quality of their networks, quickly determine the root causes of problems, and intelligently optimize their infrastructure. Mobile operators depend on the quality of their mobile networks to attract and retain subscribers, and financial exchanges rely on the network to quickly and fairly deliver market data to their most important customers.

These mission-critical networks will have to scale to transmit terabits per second, or more, across a nationwide network. The quality of these networks will determine whether the data is delivered correctly to customers and partners. Quality problems within the network, and the inability to quickly diagnose and fix these problems, will lead to lost revenue and customers.

Current monitoring standards like TWAMP/RFC2544 do a good job at detecting when things fail. More subtle issues, like QoS misconfiguration, bad performance by last mile providers and others however, are much more difficult to track, and fix. This can be a serious problem, especially in the Enterprise Business Market, where end-to-end SLAs are usually offered, but the operator rarely owns the whole network.

The advent of Software-Defined Networking (SDN) and Network Functions Virtualization (NFV) gives the network owner the promise of cost-effective, flexible and agile service-oriented data networks. SDN requires complete, precise and real-time network visibility in order to make intelligent and optimized decisions. The lack of such visibility today has hindered the service provider's ability to centralize networking policies, and thus they continue to suffer heavy operations overhead.

Jolata provides complete, precise and real-time network visibility to these customers with mission-critical networks so operators can improve service quality, reduce mean time to repair, and exceed service level agreements (SLAs).

Platform Overview

The Jolata Precision Platform is built based on two fundamental concepts: **accurate timing and complete data**.

First, accurate and precise network timing is the foundation to understanding and optimizing network performance. If you can't see the network with precise accuracy, then you can't measure it. If you can't measure it, then you can't diagnose it, optimize it, or manage it. For example, most traditional network monitoring tools provide measurements at intervals of every one to five minutes. However, at such low time resolution, a whole class of network problems, such as network congestion due to traffic microbursts, are missed.

Second, complete network information enables accurate assessment of network qualities and quick determination of root causes when problems arise. The Jolata solution captures and tracks every single packet as it traverses the network, and constructs multi-point flows in real-time with precise measurements of throughput, loss, latency, jitter and other metrics. Traditional network monitoring tools are incapable of providing such a complete set of information for the network operators.

For example, traditional network monitoring tools usually give operators a single number that represents round-trip network latency. However, a **single number is insufficient,** as it cannot tell the operator where the slowness happens if the network is congested, nor can this single latency number convey to the network operator how slow the network is at the trouble spots.

Precision

Measure **live** traffic with **microsecond** granularity, and **millisecond** intervals

Real-Time

Analyze and visualize results, and be alerted on problems **within seconds**

Scalability

Monitor **every packet, every flow,** and **any location** on a global network

Jolata's solution provides a complete set of metrics at different segments of the network, enabling them to hone into the trouble spots on the network thereby rapidly accelerating root cause analysis and helping resolve issues in far less time and with fewer resources.

Traditional Methods: RFC2544 and TWAMP

Addressing today's needs with traditional technologies (like RFC2544/Y.1731/TWAMP) implies setting up thousands of probes/responders and then collating and analyzing those results. Although RFC2544/Y.1731/TWAMP protocols specify the servers and responders in a standard way, they do not specify the means to synchronize their systems, coordinate nor schedule the measurements, nor do they specify the analysis of the measurements. The service provider must do all of the additional high-level integration work on their own, or use closed proprietary third party tools for the high level operation/management of these protocols.

RFC2544 and TWAMP protocols are "active" in that they insert packets onto the network. The operator must specify synthetic flows of packets (sizes, sources, destinations, types, class

of service) to emulate the traffic that is being monitored. This presupposes that the operator has prior and nearly perfect knowledge of all of the traffic flows on their network. Unless run continuously, they do not offer a real-time measurement of the link properties and if run continuously, there is a sustained impact to network performance due to the overhead of the synthetic traffic. Further, these protocols specify nothing about databases or the ability to access the metrics in an open API. And although built into most network equipment, these protocols did not contemplate the advent of SDN or NFV and are not well suited to either.

In contrast, Jolata's integrated approach provides a software probe solution, perfectly tuned to SDN/NFV, with a high-speed, scalable database for metrics that is easily accessible through a published REST API that is used for Jolata's real-time analytics and visualization, as well as open to the operator's or 3rd party analytics tools.

Life of a Packet in a Backhaul Network

By analyzing all the packets and flows in the network, the Jolata solution is able to give the operator accurate view of the performance of key traffic in his network, namely for a mobile network:

- LTE user plane and signaling plane traffic (S1-U, S1-C)
- 3G Iub (Over IP) and Iu-PS
- Gi and SGi (with full correlation to the eNodeB GTP encapsulated traffic)

This ability to look at the **"life-of-a-packet" across the network** is key to allow the operator to:

- Perform true end-to-end monitoring across multiple network segments and platforms
- Understand network events and accurately correlate the information available across multiple systems to quickly reach the root cause
- Improve quality of experience from real-time network performance monitoring by being able to accurately characterize end-to-end flows of their network

Case Study

Recently, Jolata deployed at one of the world's top 5 wireless operators, with the goal of helping them analyze its current network performance, evaluate various equipment vendors and optimize its network infrastructure.

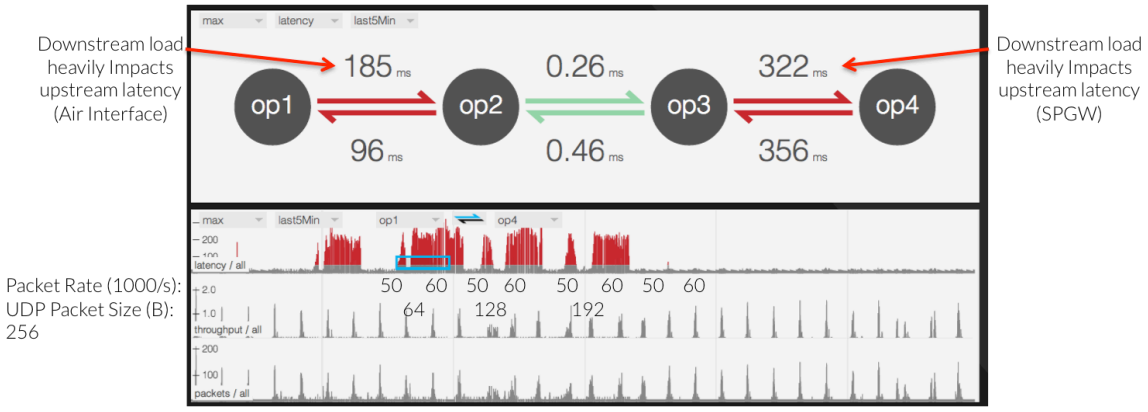
By looking at the end-to-end lifetime of a packet, from the UE to the Internet, we were able to identify bottlenecks in certain Gi LAN platforms and EPC core nodes that were, until then, unseen, but nevertheless causing quality of experience degradation. All that was known until then was that the round trip latency had increased substantially (via a RFC2544 probe) but no clues to the root cause were available.

Specifically, we identified the following areas where Jolata could immediately provide complete, precise and real-time visibility:

- First, the customer was experiencing unusually high round-trip latency (700ms peak) in its mobile network. However, due to the lack of precise visibility into its network, it was difficult to pinpoint the source of the latency. Jolata helped the customer determine the precise latency numbers, segment-by-segment, in real-time.
- Second, the customer was evaluating several radio and microwave equipment vendors, as part of the strategic initiative to differentiate its network performance. To meet this strategic goal, the customer wanted to ensure the equipment selected would meet the current and future traffic load. Using Jolata, they evaluated the performance of each type of equipment.
- Third, the customer expected that the traffic mix on their network to change over time, from being dominated by large video packets, to a healthy mix of small messaging packets due to the popularity of applications such as WhatsApp, WeChat and Line, and, as they deploy Voice over LTE (VoLTE). The customer suspected that its current network infrastructure may not meet subscriber expectations in this type of environment. It was hoping Jolata's precise visibility into the network would help it understand that.

Deployment Architecture

For this engagement, Jolata deployed its unique metering technology to observe traffic at different locations, or Observation Points (OPs), shown in Jolata's User Interface (UI) below:



The first OP (OP1) sits in front of a customer premise equipment (CPE) device. It observes traffic before it hits the air interface. The second OP (OP2) sits between the eNodeB and the cell site router, observing traffic coming off of the air interface. Between OP1 and OP2, Jolata can precisely monitor and analyze traffic on the Radio Network (RAN).

A third observation point (OP3) is deployed before the S/PGW (Service/PDN Gateway), and a fourth observation point (OP4) is deployed after the S/PGW. Between OP3 and OP4, Jolata can precisely monitor and analyze the behavior of the S/PGW.

In this architecture, we define the network segment between OP1 and OP2 to be the Air interface, the network segment between OP2 and OP3 to be the Access network, and the network segment between OP3 and OP4 to be the Core network.

Observations on Network Performance

The figure above is a screen shot showing Jolata's ability to pinpoint and diagnose a severe network performance issue. *In less than 5 minutes*, Jolata helped the customer to investigate the impact of packet rate on S/PGW performance and pinpoint the root cause. We observed as little as 30 Mbps of UDP traffic introduced at the Gi interface in the downstream direction only, caused an S/PGW rated at many Gbps to produce unexpectedly large peak latency, exceeding 700ms in the downstream *and* the upstream directions. This very surprising result is pinpointed to the S/PGW in between OP3 and OP4. Further, Jolata determined that the issue does not depend in packet size or throughput, but solely on packet rate.

Armed with this critical information, the customer worked with the vendor to tune its equipment for the traffic mix they expect to see. The observed improvement, verified by Jolata, was approximately 30%, going to 66,000 packets per second before latency starts to spike. As new releases are available, the Jolata solution can again be used to independently measure any performance changes.

Prior to the deployment of Jolata, the customer thought that the issue was primarily in the Access network between OP2 and OP3. The customer was able to get an updated software release for it's S/PGW and saw a 30% improvement in its performance. This example highlights the benefits of the Jolata solution 1) ability to quickly pinpoint the issue to a specific area or device (the S/PGW), 2) ability to determine the root cause within minutes (UDP packet rate), and 3) see where the problem is not (in the Access network). This is only made possible by the fine precision and resolution of the Jolata solution and in the real-time analysis and visualization.

Without the precise visibility and prediction into how its network will likely perform under a different traffic mix, the customer would have either lost customer confidence – the reverse of its strategic intent – or it would waste millions of dollars in acquiring new hardware, believing that the network is slow due to lack of capacity.

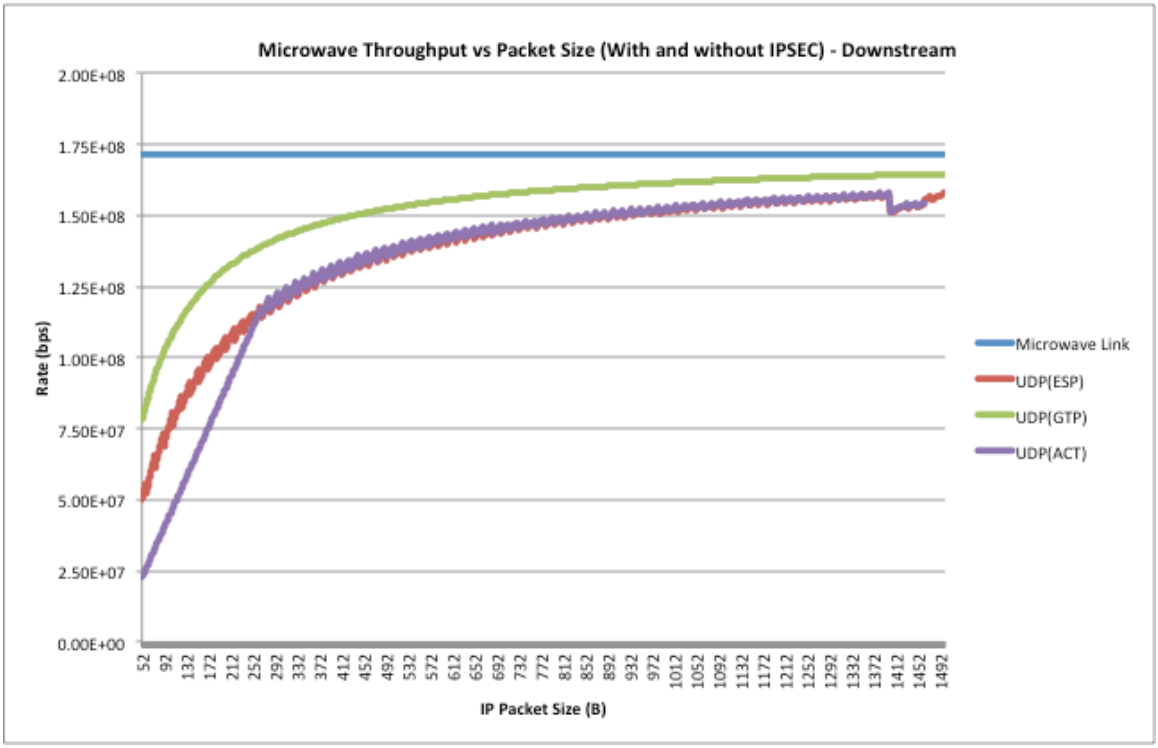
Jolata's solution enables the customer to continuously monitor their network for changing patterns, and test different scenarios to ensure their network is optimized for the new traffic mix and to be used to continuously evaluate equipment, software release and network configuration. Gathering, analyzing and reporting/visualizing network intelligence is an on-going, continuous requirement, for all traffic, and across the entire network.

By preventing bad customer experience, thus reducing churn, and preventing purchase of unnecessary equipment, Jolata can help the customer save millions of dollars.

Observations on Microwave Evaluation

In many cases, the backhaul from the cell site to the fiber access network is over point to point microwave, in fact, microwave backhaul is estimated to as much as 80% of the cell sites in countries like India. The performance of these links is a critical factor in the overall customer experience.

Microwave backhaul is subject to a large number of impairments with signal degradation to weather, location, installation, and interference from trees, buildings and other line of sight issues. There are many different implementations from many vendors and a variety of spectra to choose from, with widely varying performance from vendor to vendor.



The customer requested Jolata to measure the performance of their two primary microwave vendors and to evaluate the impact of packet size on the data throughput efficiency of the microwave link. Tests were carried out by connecting a UE to the Internet over an eNodeB that was connected to the access network over a symmetric point-to-point microwave link and then through the core, and the to the Internet. Actual, live UDP/IP traffic was observed on the links with results sorted by payload size varying from small to large.

In the past, when traffic was mainly video streams (primarily downstream from internet to the UE) and data, the packet sizes were generally large. However, going forward, we have seen the advent of machine-to-machine (M2M), Internet of Things (IoT), Twitter, Skype, VoLTE, WhatsApp and other applications and services. As these protocols and services predominate, the packet sizes are becoming smaller and smaller.

Testing was done in real time, producing metrics for latency, jitter, throughput and loss. The figure above shows the IP throughput of the microwave link versus IP payload size. The Blue line at 172Mbps is the data rate of the microwave link. The green line shows the impact of the overhead of the GPRS Tunneling Protocol (GTP) showing it's severe impact on small packets, reducing throughput to about 75Mbps.

During the testing the customer was able to assess the impact of IPSec encryption on the throughput by running the tests with and then without IP SEC. The red line shows the additional penalty due to IPSec, with performance dropping to 50Mbps. The purple line shows the total end-to-end throughput achieved not just over the microwave link, but overall from UE to Internet. Here we see the aforementioned packet rate limitation of the S/PGW imposing an even more burdensome penalty than GTP and IPSec resulting in just 24Mbps IP throughput over a 172Mbps link. The clearest result from the testing is that new services, especially VoLTE, M2M, IoT, Skype, etc., are going to require microwave systems and architectures that are more well suited to small packets.

Certain microwave systems, technologies and architectures may be better suited to small packets than others. Jolata's solution can evaluate these options for the operator, not just once, but on a continuous basis and as new updates are released, and as new more optimal configurations become available. Traditional monitoring tools cannot do this, since they must re-create the packet size and bandwidth distributions. However, this requires the use of the very link that is being impacted and that needs optimization. Jolata's solution observes and gets it results from the actually traffic with no need to synthesize or guess. In summary, the Jolata solution was used by the operator to perform real-time and off-line analytics on microwave link performance, and used this information to evaluate specific vendors, architectures and to optimize configuration. This has obvious benefits to any operator with a large proportion of microwave, to purchase the right product, the right amount of bandwidth and spectrum, reducing CAPEX, OPEX and Total Cost of Ownership (TCO).

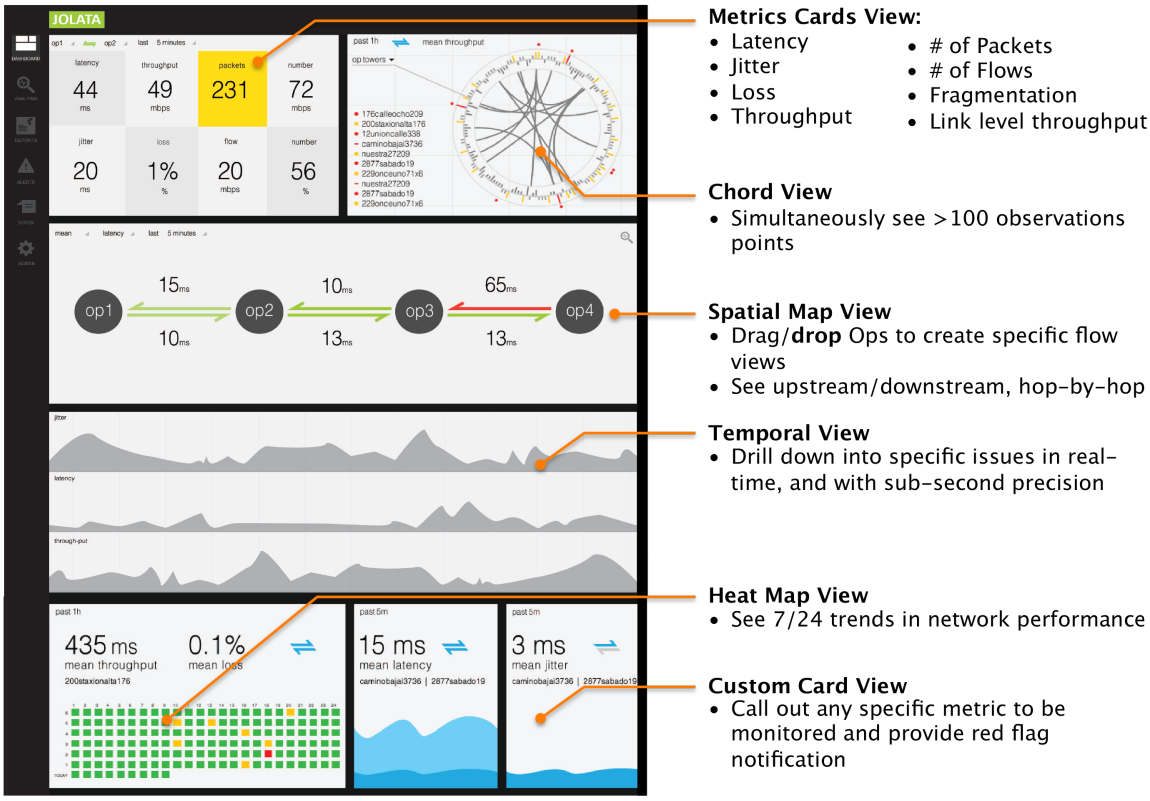
Product Overview

The Jolata Platform consists of three tiers:

- The Dashboard Application is responsible for presenting and visualizing the results of the analysis within seconds
- The Analytics Platform is responsible for aggregating the data sent by the Jolata meters and analyzing billions of metrics per minute
- The Data Plane consists of Jolata Meters is responsible for capturing, time-stamping, and fingerprinting hundreds of gigabits of data per second on the network

Jolata meters are deployed at different network locations, or observation points (OPs), including the edge (e.g., cell site routers or servers), aggregation points (e.g., access network or metro area network or Top Of Rack switches (TORs)) and core network locations (e.g., mobile switch center, data center or exchange). The Jolata meters are responsible for

capturing, time stamping, fingerprinting, and correlating packets across multiple observation points. In general, the more locations that are monitored, the more accurate and complete the information will be to the end user. These meters can be external devices (Linux-Intel servers) that process the packets, or better still, embedded agents running in the network elements themselves (e.g., in the eNodeB, cell site router, TOR, or in smart SFPs – small form factor pluggable transceivers).



The Jolata analytics platform can be deployed regionally or globally running on standard Linux servers. The analytics platform is responsible for aggregating and analyzing all the information generated by the Jolata meters. The Jolata analytics platform contains two components. The first is a stream-processing engine that automatically analyzes data as they come in to compute KPI's, and in real-time generate alerts and visualizations to inform users of the current network status.

The second component is a batch-processing engine that performs machine-learning algorithms on large set of data in order to build accurate models of the network. The database behind the analytics platform is a scalable, distributed, in-memory columnar data store that is built to ingest billions of metrics per minute with a query latency of less than half a second. The disk store provides an 8:1 compression ratio that enables customer to store vast amounts of data for historical purposes.

The Jolata web services layer exposes a REST API that can be consumed by any external process. The response is a well-defined JSON representation that can be easily consumed by

any client. The web services layer is scalable and distributed across multiple servers for high availability.

Lastly, Jolata's unique, patent-pending dashboard UI enables customers to focus on the most critical key performance indicators (KPIs), including network latency and jitter, throughput at IP and link levels, loss, fragmentation, packet count and flow count. These appear as "Metric Cards" in the upper left hand corner of the dashboard (see diagram on the previous page). Each metric is updated in real-time to ensure network status information is always current.

The Chord diagram (top right) provides a holistic view of up to 150 individual network locations or observation points, each OP represented by a "compass point" on the circumference of the chord. The Chord diagram shows qualitatively which parts of the network are over- or under-utilized.

If higher resolution information about a specific network segment is required, it is possible to simply drag-and-drop the nodes or chords of interest into the Spatial Map (below the Chord diagram) to build a linear, end-to-end view representation of the relevant network path. This Spatial Map visualizes the network, segment-by-segment, giving additional detail of how the network is behaving.

It is also possible to drag-and-drop individual nodes or segments from the Chord diagram or Spatial Map into the Temporal view. The Temporal View is updated with the most precise data within seconds of its occurrence, delivering sub-second details of the most critical metrics.

Critical trends are easily viewed using the red/yellow/green coded 7x24 Heat Map in the bottom left corner which shows data for the last 7 days, 24 hours per day, on an hourly basis.

From anywhere on the intuitive dashboard, it is possible to filter, highlight, drilldown, and analyze any part of the network end-to-end, quickly and precisely.

Summary

In today's high performance and time-sensitive networks, the need to improve incident response time and dramatically reduce the time to determine root cause becomes increasingly important. In addition, as companies start implementing their SDN and NFV strategies, complete and precise real-time network visibility becomes essential to the success of these efforts. Traditional solutions that exist in the market today cannot scale as the networks grow in size, become more distributed and virtualized, and are increasingly sensitive to latency problems.

Jolata is a software solution that focuses on precise monitoring of network delay, jitter, throughput and loss in real-time. The Jolata solution allows network operators to **see and measure every packet and every flow on the network**. By leveraging patent-pending technologies to fingerprint, analyze and visualize the complete network in real-time, the

Jolata solution enables network operators to meet or exceed the SLAs they have with existing customers and services, and develop new services over their access and backhaul network.

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