

# Self-Optimizing Networks: Machine Learning from Real-Time Performance Visibility

Transforming the mobile customer experience for a 5G world



To be competitive as the market moves toward next-generation, virtualized networks, mobile operators (MNOs) must provide exceptional visibility into the performance of their networks. This is a critical for creating the automated, self-optimizing networks of the future, and delivering an outstanding customer experience.

## Self-Optimizing Networks: A Closed Loop

Self-optimizing networks depend on three interrelated systems: analytics & machine learning for decision-making, real-time visibility ('nervous system'), and software-defined networking (SDN) plus network functions virtualization (NFV) for responsive control. Accedian provides the virtualized network instrumentation which feeds the network brain and closes the network self-optimization loop.

## CLOSING THE LOOP ON BUILDING THE SELF-OPTIMIZING MOBILE NETWORK

## SELF-OPTIMIZATION

### The Three Pillars of MNO Network Automation

#### Brain: Decision-Making

Policy, Analytics & Machine Learning

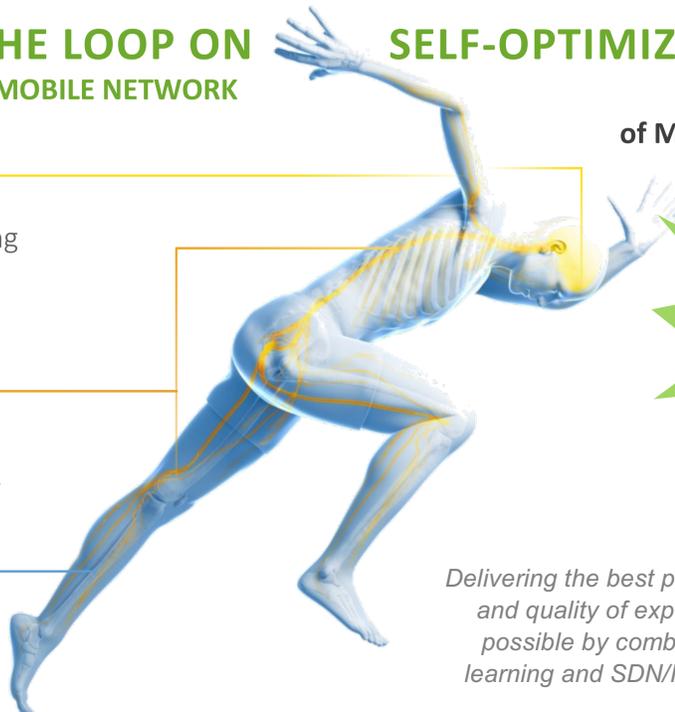


#### Nervous System: Instrumentation Feedback Loop

Real-Time Network State Visibility

#### Muscles: Responsive Control

SDN Controller/s



There is no  
automation  
without a  
feedback loop

*Delivering the best possible network performance and quality of experience in real time is only possible by combining analytics & machine learning and SDN/NFV with real-time visibility.*

Closed-loop automation systems requires hyper-scale virtualized instrumentation to deliver the real-time, multi-vendor network state. In the short-term, best-in-class 'network state' metrics and KPIs for continuous monitoring and analytics/machine learning deliver true network intelligence visibility. In the intermediate-term, such instrumentation crucially supplies the ubiquitous, real-time, accurate, precise, network intelligence required to realize true mobile network automation and control.

## The Role of Machine Learning

### Machine Learning: Essential for 5G

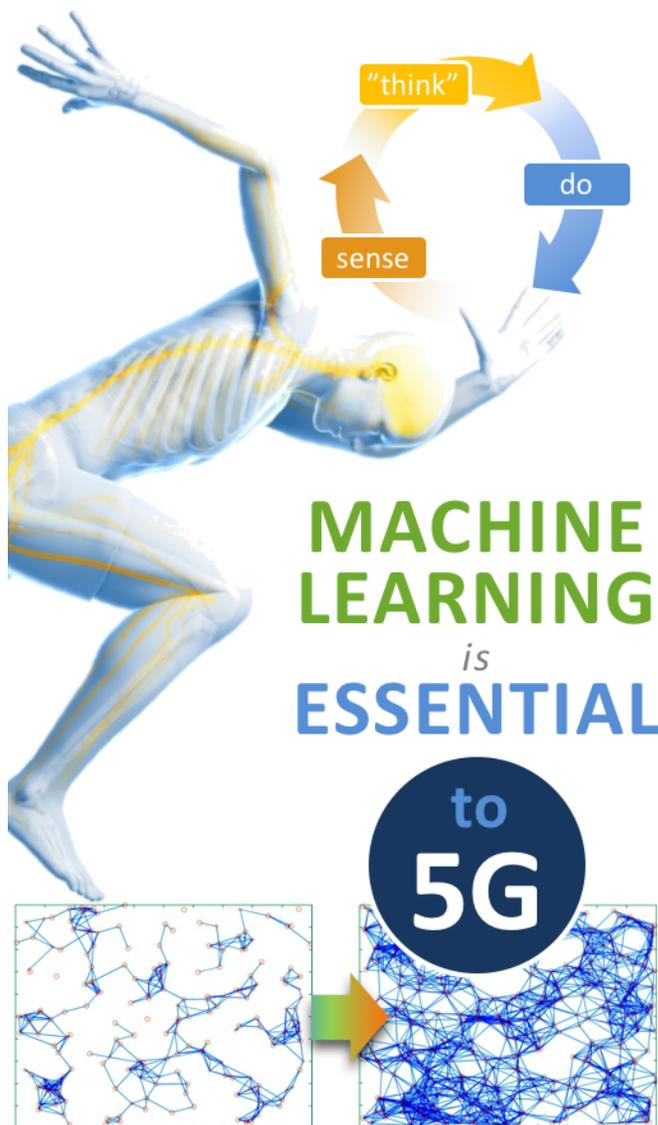
Compared with today's LTE networks, 5G networks will be highly virtualized with exponentially more moving parts. Network functions will reside in many more locations, and talk to each other like a living, breathing ecosystem. Billions of Internet of Things (IoT) devices, along with significantly more apps and traffic, add to the complexity. Result: 5G networks by their very nature will move beyond human control, necessitating machine learning for self-optimization. Operators without effective machine learning will be left far behind.

### Data Virtue: the Fourth 'V'

The 'learning' in machine learning is accelerated by the three Vs of big data

1. **Velocity** - real-time data; the faster the feedback, the faster the learning
2. **Volume** - broad geographic coverages
3. **Variety** - data from many sources, across all network layers

But, especially for 4G and 5G, these three Vs are not sufficient to ensure QoE through a closed self-optimization loop. For that, a fourth V is needed, Data Virtue: the quality of data, built from accuracy and granularity.

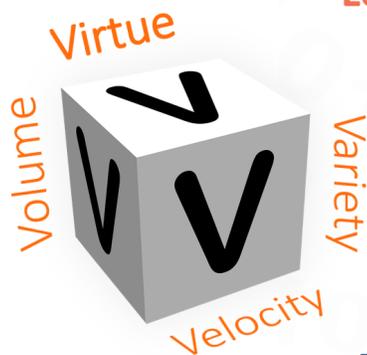


Machine learning enables self-optimization, an essential ingredient for 5G to work.

## CONTROL/MACHINE LEARNING NEEDS VISIBILITY



Learn Refine Accelerated by:



Not Sufficient Without the 4<sup>th</sup> "V"



Fueled by Good Data

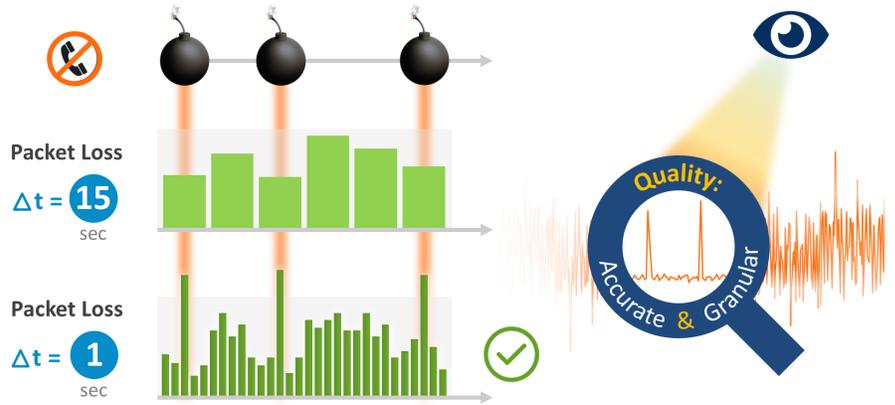
## The Invisible Becomes Visible

Highly accurate, granular data and ubiquitous visibility are the true catalysts for machine learning convergence; without these, it isn't possible to deliver actionable insights.

## Accuracy and Granularity: Essential for MNO-Grade Data Quality

For machine learning used by MNOs, the faster data arrives, the faster correlation can occur—but only if the data is sufficiently accurate. For example, an operator trying to diagnose call drops might look at packet loss to see if it correlates with those drops. But low resolution measurements hide these relationships; correlation can only be established if there's high enough granularity.

## MACHINE LEARNING NEEDS HIGH RESOLUTION



High resolution data is the only way to achieve meaningful correlations and closed-loop control using machine learning.

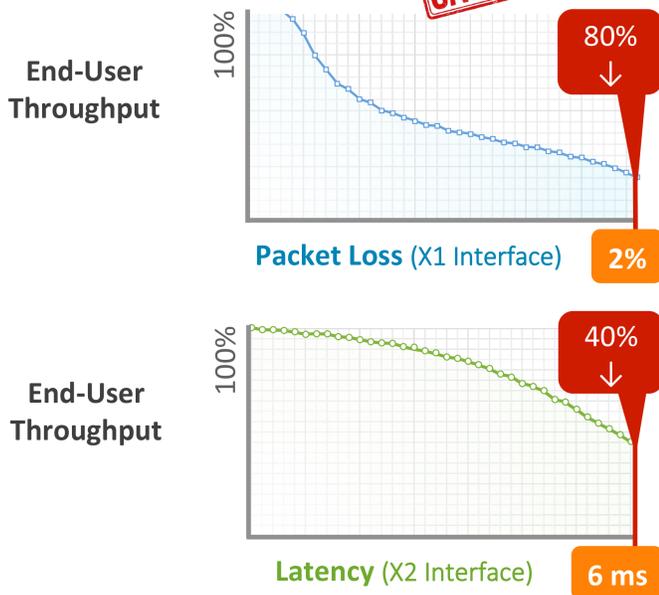
## Machine Learning Applications

### The Big Impact of Micro-Impairments

The next-generation network case study shown below reveals how micro-impairments of as little as 2% packet loss can cause as much as 80% drop in end-user throughput, or latency of as little as 6 milliseconds can cause end-user throughput to drop by as much as 40%.

The impact of these micro-impairments can be quite huge on their own, let alone if they add to each other. But it's not possible to discover these problems without accurate, granular data.

## MICRO-IMPAIRMENTS BIG IMPACT



It is not possible to see or react to micro-impairments without accurate, granular data.

### Beyond Proactive Troubleshooting

Accurate, granular data paired with machine learning has utility beyond revealing micro-impairments. In the case study shown below, the operator used virtualized instrumentation reaching 250,000 test points and national coverage generating 1 trillion data points per month to focus optimization around three main areas of improvement. This resulted in nearly 100% “more network” with no CapEx spent in network equipment whatsoever; it was all done with SDN-based infrastructure tuning.

## ACTIONABLE INSIGHTS DRAMATIC GAINS



Goal to Minimize	By Optimizing	End User Throughput Impact
X2 Latency	eNodeB Buffers	37% ↑
Micro Bursts	Network “Slicing”	27% ↑
Path Delay	Application-Layer Routing	33% ↑



Actionable insights and machine learning can be used to focus optimization efforts and get more out of the network.

## Solving Performance Impairment Mysteries

Doubling the capacity of the perfect network is great, but what about when things go *really* wrong? Can analytics help MNOs find the needle in the haystack?

To the right is the case of large scale VoLTE call drops happening every 14 minutes, impacting hundreds of thousands of users. This was happening while the network was supposedly behaving “normally” by any parameter taken individually: utilization was below 20%, and packet loss and delay were well within recommended specs. So what was happening?

This is an example of how actionable analytics, combined with Accedian's 4th V (Data Virtue)—delivering disruptive accuracy and granularity—can detect relationships otherwise invisible to the “naked eye” of traditional monitoring systems. Because the operator had *Voluminous*, high *Velocity*, and *Varied* data that was of high *Virtue*, (highly accurate and granular), they were able to correlate the call drops with micro-losses of 5 consecutive packets and nearly undetectable latency spikes in the order of microseconds.

But, and this is an important point, things like latency and packet loss are never the root cause—they originate from somewhere in the network. When fed with a wide variety of data from a broad geography, machine learning shines

## REVEALING THE INVISIBLE

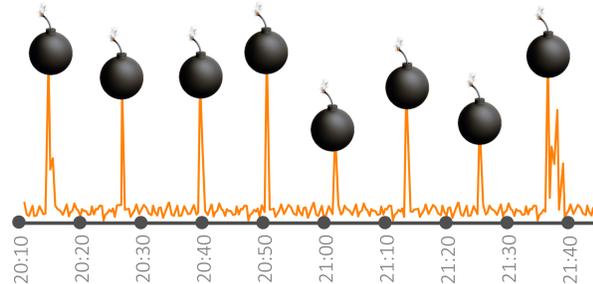


Metro-Wide  
VoLTE Call  
Drops



Every 14  
Minutes

“Network Behaving Normally”



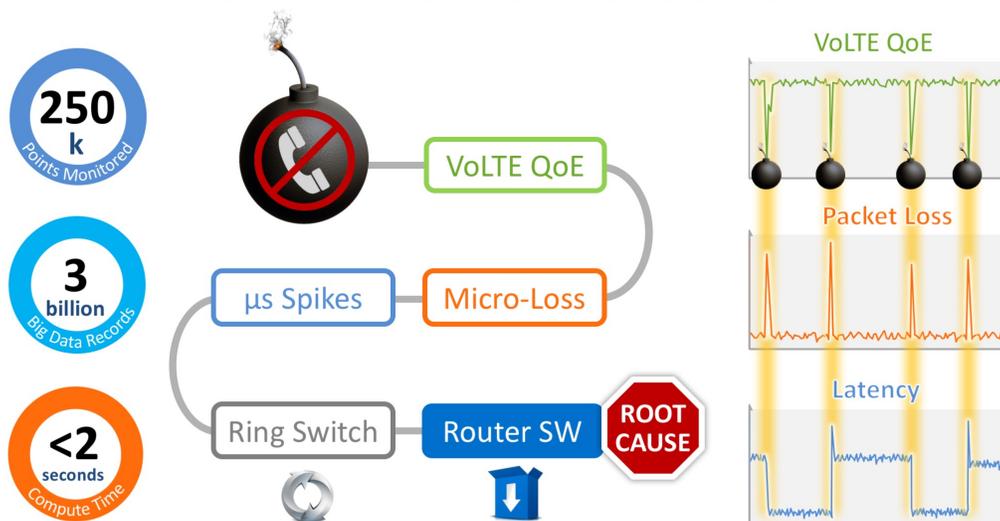
Call drops every 14 minutes when the network is operating “normally”?  
What’s happening?

because it can sift through billions of records. In this case, the culprit was found to be a faulty router firmware version in a key location.

Armed with this new level of insight, the operator quickly resolved the issue. Knowing where to look was instrumental, and intelligent analytics that made it possible. Without the granularity and accuracy required to see microscopic variations, neither humans nor machine learning could have found the root cause.

The speed and precision of root cause determination, and the real-time responsiveness that it provides, are what makes analytics and machine learning essential to closed-loop/self-optimized networks.

## REVEALING THE INVISIBLE



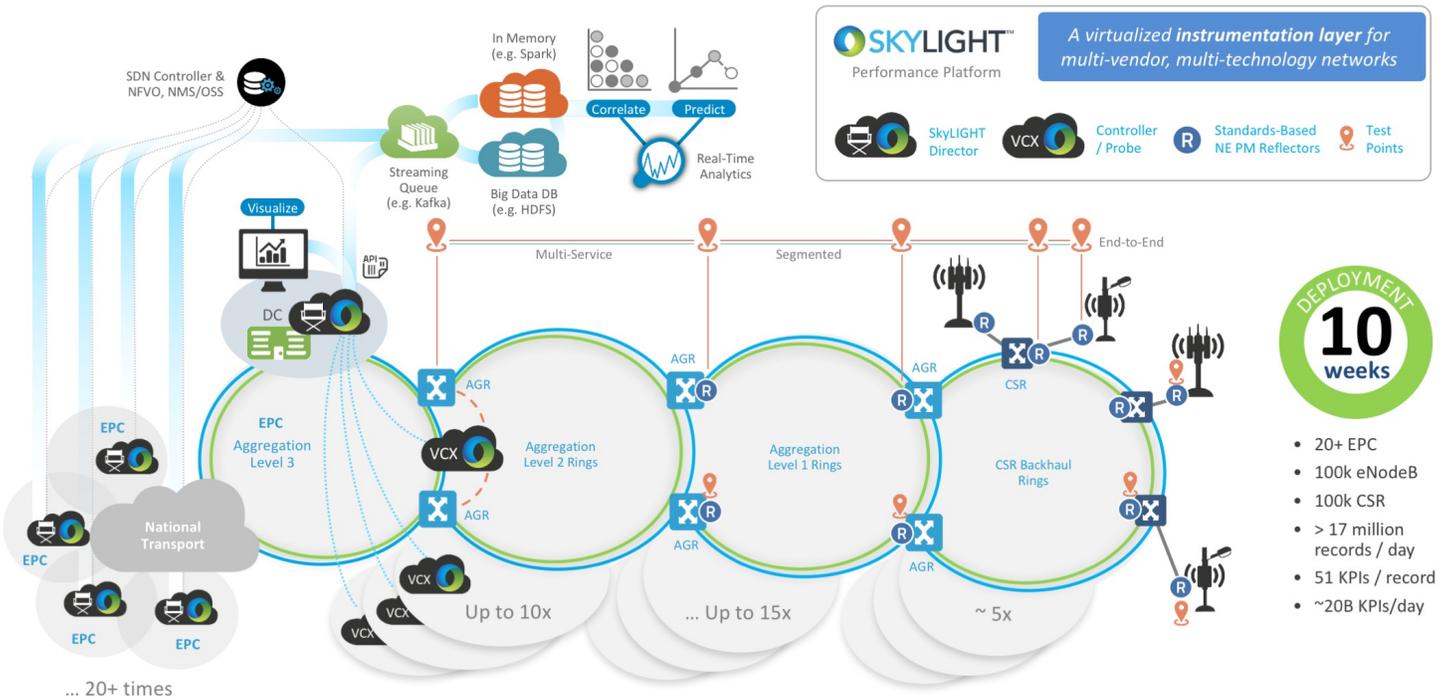
Resolving pernicious network performance issues is easy...  
when you know where to look.

## Virtualized Instrumentation: Tier-1 Mobile Network Operator Deployment Example

International-scale virtualized instrumentation deployments prove out the utility and necessity of a precise, dependable source of actionable analytics for next-generation mobile network performance optimization. Service providers like the one shown here use Accedian's solutions to monitor millions of services and sites within their networks, every

second, every day. Billions of monitoring sessions represent every vital sign, effortlessly captured for immediate and extended insight—enabling resolution of complex problems in seconds that would otherwise escape human detection, using closed-loop automation.

“Maintaining impeccable QoS & QoE at cloud-scale.”



*The value of ubiquitous, network-wide virtualized instrumentation is its ability to supply granular, high-quality data—helping service providers localize performance pinch-points, focus upgrades and optimization efforts, predict failures, and extract the most from their networks.*

## Machine Learning: Recipe for Success

Leveraging machine learning to enable self-optimizing networks is quite simple... when you know the recipe. Here it is, in 100 (binary) easy steps:

- 000 Deploy a real-time data lake
- 001 Fill it with **high accuracy/granularity, ubiquitous data**
- 010 Learn with fast analytics
- 011 Optimize user experience in **real-time**
- 100 Goto 001

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