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Mastering 5G Complexity with AI and ML

By:

Although 5G may be overhyped today, its future promise is real. So are the operational challenges it poses for communication service providers (CSPs). Delivering new mobile services for leading-edge applications and use cases will stress the ability of network operators to manage the range of enabling hardware and software technologies in their underlying infrastructure. Operations teams will face challenges in each 5G domain—subscriber, service, edge and core—and across domains.

This article examines the unique challenges in each domain, the best steps for applying machine intelligence (AI, ML and big data analytics) to address them, and the top usage scenarios and opportunities for you and your key business group stakeholders. As STL Partners points out in its 5G and telecoms data analytics research, AI and analytics are key enablers of 5G, but before operators can benefit from these technologies, telcos must lay the foundations of data analytics across their network and organization.

5G Poses Operational Challenges Across All Domains

Subscriber Domain Challenges

5G will inherit the billions of smartphone users on today's 4G networks, but gigabit connections will spawn high-speed applications driving a new generation of smartphones and consumer devices capable of utilizing the huge increase in bandwidth. User quality-of-experience (QoE) will depend on the ability of CSPs to ensure the reliability of these connections. It will also require that your network quality-of-service (QoS) meets the demands of each application. CSPs will need insight into the different types of applications subscribers are using, including time of day, location and duration in order to project future usage and provide sufficient network capacity.

5G will unleash a proliferation of embedded smart devices that will utilize ultra-reliable, low latency communications channels for real-time, machine-to-machine (M2M) control of vehicles, homes, buildings, public infrastructure and industrial processes. Mission-critical applications with stringent

performance constraints will require constant monitoring and rapid remediation of service-affecting problems. This will have to be performed automatically by machines instead of teams of human operators; people will be unable to respond quickly enough to satisfy service level agreements (SLAs) for M2M communication.

Service Domain Challenges

The diversity of 5G services and the underlying complexity creates service operations challenges for 5G that are far more daunting than in today's 4G networks. The next generation of 5G services will extend well beyond today's one-size-fits-all voice, text, video and multi-megabit data services, supporting an array of 5G applications and use cases.

For example, critical applications in healthcare, public safety and industrial automation will require ultra-reliable communications services with demanding SLAs. Service-aware network slicing will enable the creation of virtual, end-to-end networks tailored to specific application requirements, so that operators can deliver different types of services via a common physical infrastructure.

Mobile edge computing adds another layer of complexity. The edge data center infrastructure could be owned and operated by a 5G MNO, an MVNO, or by a third party that manages the service-enabling software. In this scenario, assuring demanding SLAs for real-time M2M communications services will involve coordination between service operations centers at different service providers.

Edge Domain Challenges

Compared to the 4G edge, the 5G edge will be highly dense, diverse and dynamic, combining new enabling technologies in 5G products to support high-performance connections for smartphone users and smart devices, and also high-density connections for IoT devices. Deploying 5G at scale will require mastering a level of operational complexity at the edge that goes well beyond the scope of 4G.

Multi-gigabit connections will drive the need for a massive increase in 5G backhaul bandwidth, which will be supplied by optical networks to support the increase in capacity. Shifting network demand and traffic patterns will require dynamic allocation of bandwidth for fronthaul/backhaul capacity, introducing another layer of complexity.

Core Domain Challenges

The 5G core will undergo a fundamental transformation as operators adopt software-defined networking (SDN) and network functions virtualization (NFV) for service-enabling infrastructure. Early adopters are gaining experience with SDN/NFV in limited-scale deployments, but for 5G to deliver on its promise, mainstream adopters will need to master the complexity of operating this new generation of core network infrastructure.

4G and 5G are expected to co-exist for 5 to 10 years, so interworking between 4G and 5G network functions in the core is a critical requirement that further complicates network and service operations. During the period of coexistence, the installed base of smartphone subscribers must be able to roam seamlessly between areas of 4G and 5G coverage. It will be challenging to operate a legacy 4G network in parallel with a new 5G network while maintaining subscriber QoE across both domains.

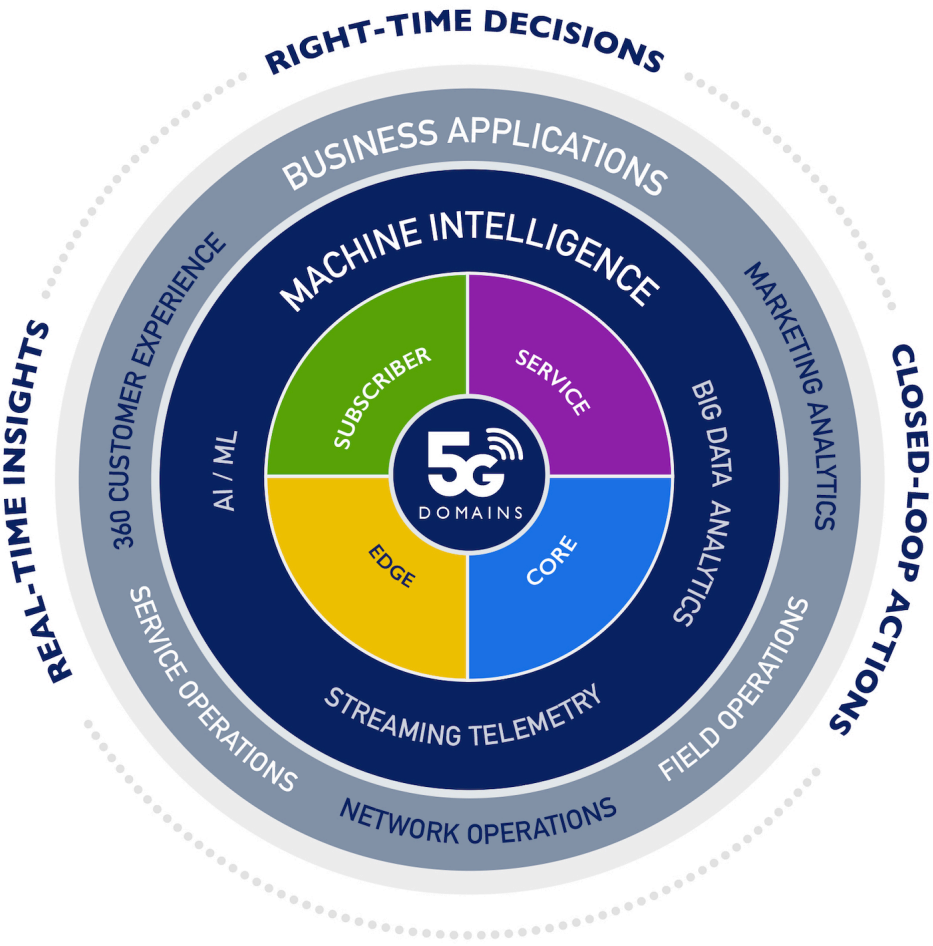

Figure 1: 5G Decisions Chart

Applying AI and Machine Learning to these 5G Challenges

Machine intelligence is needed for 5G networks to be self-optimizing and self-healing. Dense networks of small cells with advanced antenna technologies need to be continuously tuned based on the devices connected, application data flow, bandwidth utilization and RF signal analysis. Fronthaul and backhaul capacity needs to be managed dynamically based on varying bandwidth demand and network utilization. Network failures can be remediated automatically, applying machine intelligence to detect and isolate the root cause and then determine the appropriate fix or workaround, which may involve reallocating network resources or shifting network demand onto other resources in the underlying infrastructure.

Failure prediction for individual hardware or software components is a good example of an application of machine intelligence within a silo. Recently, I was involved in a trial which focused on prediction of failure in RAN networks. The trial showed that ML could identify the 1.2 percent of network RAN elements responsible for 75 percent of outages and within this group correctly predict 334 out of 337 actual incidents. Further, 50 percent of these incidents could be identified three hours or more in advance, which would be sufficient time to prevent them, most especially as approximately 74 percent of failures could be addressed remotely without a truck roll.

AI Across Multiple Domains

AI will play a critical role in enabling operations teams to rapidly detect, isolate and remediate

problems that are manifested by events triggered across multiple 5G domains. AI algorithms enable you to take insights gleaned from individual operational silos and correlate those data points across multiple domains.

For example, a group of subscribers report poor application performance while an alert indicates the backhaul network is experiencing a bottleneck, but the root cause is actually a malfunction in a small cell that is flooding the network with a stream of bad packets. Without machine intelligence, different operations teams might investigate the same incident by accessing multiple dashboards and examining various log files to determine what is happening within their silo. Only after sharing information between teams, investigating further and ruling out possible root causes will they arrive at a definitive explanation. The intent of applying machine intelligence is to remove human operators from this process as much as possible, leveraging operations tools that use ML and AI to perform the required data analysis and correlation of insights across multiple domains. The goal is not only to have machines figure out what is happening but to automatically take corrective action. While some operators may deem this to be too risky, for many scenarios in 5G networks this will be a necessity. Services for ultra-reliable machine-to-machine communication will depend on the ability of machines to fix machines.

Today, diagnosis of the root cause of a complex incident is the province of small teams of expensive experts. Machine intelligence multiplies the effectiveness of these teams of skilled people and allows a larger proportion of complex incidents to be handled by less-skilled teams augmented by machines. For example, augmenting traditional methods with ML enabled the same team mentioned above to eliminate 98 percent of previous alarm noise, reduce the average time to resolve an incident by almost an hour, and increase the number of incidents found per hour by 40 percent.

Key Usage Scenarios

5G Roaming

The advent of 5G places additional constraints on mobile operators when selecting a visited network. A smartphone user who frequently streams 4K video will have high expectations for the performance of an enhanced mobile broadband service, whether delivered on the subscriber’s home network or when roaming onto the network of another operator. Ultra-reliable, low-latency M2M communications will also have stringent QoS requirements that must be satisfied when a smart device roams onto a visited network.

It will be challenging to ensure QoE for roaming subscribers. Ensuring QoE in 5G roaming scenarios starts with monitoring network performance, reliability and capacity at the edge and in the core, so that you can maintain real-time visibility into network state spanning both domains. Roaming requires tracking subscriber usage and behavior, which involves analyzing data generated within silos in both the subscriber and service domains. When making a decision to select a visited network, a complete picture is needed of the subscriber’s profile, service-specific QoS requirements and the current state of the roaming network.

360-Degree Customer Experience

360-degree customer experience management goes beyond ensuring the performance, reliability and security of 5G services. The term "360-degree” implies that all aspects of a subscriber’s experience with your products and services are monitored and managed to ensure total customer satisfaction. This includes customer interactions with automated systems and personnel in sales and customer care.

Machine intelligence enables information to be correlated cross-domain with insights gained from monitoring subscriber usage of applications, devices, networks and services to ensure the highest quality, 360-degree customer experience. You'll be able to immediately recognize and rapidly respond to any issues that negatively impact customer experience, helping to reduce churn and steer subscribers into products and services that better serve their needs.

The Bottom Line

The benefits of AI-powered operational intelligence will contribute to significant OPEX savings. Reducing OPEX in 4G networks is already a major focus for all the leading operators. The urgency will be even greater for 5G, given the scale and complexity of the underlying infrastructure and the significant CAPEX investment required. Machine intelligence enables operations teams to streamline and automate operational workflows, leading to better outcomes while reducing the time expended in tedious and error-prone, manually intensive processes. Operations teams can't afford to consume the precious time of highly skilled contributors that can be better utilized elsewhere.

Machine intelligence can be leveraged to reduce the mean-time-to-detect and mean-time-to-repair faults and anomalies. Real-time performance monitoring combined with closed-loop network monitoring will ensure QoE for subscribers. Predictive analytics will help you head off potential problems by taking timely preventative action. The 5G edge domain will be highly complex and involve the continuous tuning and optimization of radio spectrum, small cell capacity, fronthaul/backhaul bandwidth and virtual RAN resources. AI and ML-based analytics can be applied in this domain to ensure quality of service for meeting SLAs and efficient utilization of the edge domain infrastructure.

Knowing what lies ahead, the challenge is to determine the right path to get there. Start by gaining an understanding of the operational complexities and then lay the groundwork to leverage the power of big data and AI/ML through analytics. This path will by no means be straight up the slope of enlightenment. No doubt it will be a tough climb, with several false peaks on the way, but eventually applying machine intelligence to master the complexity of 5G will enable you to satisfy your business stakeholders and deliver an improved customer experience.