# Big Data Analytics in 5G

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## Abstract

The convergence of 5G cellular, IoT and Advanced Data Analytics is going to disrupt the Information and Communications Technology (ICT) ecosystem. The combined effect of these technologies will pave the path for new business models, technology innovation and myriad opportunities for applications across all industry verticals that rely on Telecom and IT services. 5G promises to enable intelligent network and application services with connectivity to remote sensors, massive amounts of IoT data and low-latency data transmissions. Big Data analytics will no longer be an afterthought, and it will play a significant role in the evolution of 5G standards enabling the intelligence across network, applications and business.  This paper explores the role of analytics in the context of 5G, key technology trends and business drivers that shape the path to 5G applications and services, technical impediments in that path and finally a proposed maturity model of 5G analytics and networks transforming from being context-aware to being cognitive and intuitive.

## 1. Introduction

Unlike 4G/LTE, 5G will be more than just a pipe and it represents a purpose-built technology, designed and engineered to facilitate connected devices as well as automation systems. In many ways, 5G will be a facilitator and an accelerator of the next industrial revolution, often referred to as Industry 4.0. 5G promises to deliver high data rates (in the range of Gbps) with ultra-low latency (less than millisecond delay) for applications in Industrial Automation, Tactile Internet, Robotics and AR/VR applications etc.,

**Data Analytics** is at the sweet-spot taking full advantage of 5G network characteristics such as high-bandwidth, low-latency and mobile edge computing (MEC). 5G's ability to support massive connectivity across diverse devices (sensors/gateways/controllers), backed by the distributed compute architectures, creates the ability to translate the big data-at-rest and the data-in-motion into real-time insights with actionable intelligence.

Data Analytics will play a dual-role in the context of 5G.  On one side, analytics will continue to support various business applications/use-cases over 5G networks, but on the other side, analytics will play a critical role in the roll-out of 5G and network operations.

| | | |
|---|---|---|
| **Application Intelligence** *Data Plane* | Business and Technology Specific Applications **(IoT/IIoT)** | |
| | Network roll-out, Planning, Operations and Optimization **(SDN/NFV, OSS/BSS)** | **Network Intelligence** *Control Plane* |

*Figure 1 Dual-Faceted Role of Data Analytics in 5G*

**Application Intelligence:** 5G application use-case spectrum is very broad including wearables, smart home, smart cities, autonomous cars and industry automation. IoT and Industry 4.0 are going to be the biggest drivers for 5G applications. Hence, Context Aware Engine (**CAE**) will become an integral part of 5G to make networks aware of the underlying context and cognitive enough to provide smart experiences for an individual subscriber on the network with better flow management decisions.

**Network Intelligence:** 5G networks are inherently complex with multiple layers of virtual functions, virtual and physical RAN assets, spectrum usage, distributed computing nodes and based on SDN/NFV concepts [5]. Network analytics hence will become very critical to build a flexible 5G network where roll-out and operational complexity is simplified. Network planning and optimization (NPO) to decide where to scale specific network functions and application services will be based on machine learning algorithms that analyze network utilization and traffic data patterns more closely. In short, Operations and Business Support Systems (OSS/BSS) will have analytics integrated and embedded into their toolset unlike the traditional systems where analytics has been an afterthought until today.

## 2. Key Technology and Business Drivers

Big Data Analytics is inherently synergistic with other 5G technology trends such as SDN/NFV and MEC. Following are the key trends and business drivers that will shape the roadmap of data analytics in 5G:

- **Mobile Cloud/Edge Computing:** Mobile Cloud Sensing, Big Data, and 5G Network make an Intelligent and Smart World. Mission critical applications such as public safety and healthcare domain would need analytics in real-time. Thanks to slicing-based traffic prioritization, MEC-based local analytics or the latency improvements promised by new 5G air interface, 5G lays a foundation for supporting mission-critical edge analytics and tactile internet applications. 5G makes it possible to not just sense and analyse at the edge, but also trigger actuators to trigger response actions within fraction of seconds and all data seamlessly travels from cloud to a plethora of end points [1] and vice-versa.
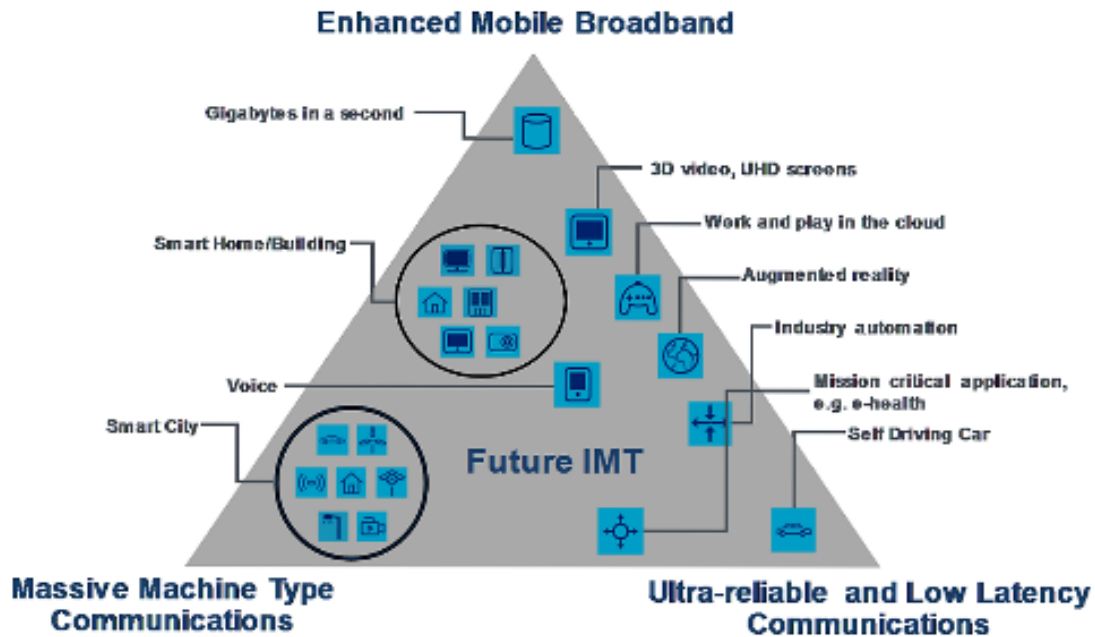
*Figure 2 5G Application Use-Cases / Drivers*

*(Image source: ETRI graphic, from ITU-R IMT 2020 requirements)*

- **IoT over 5G (Industrial IoT):** The mass amount of information being created by the IoT has the power to revolutionize everything from manufacturing to healthcare to the layout and functioning of smart cities — allowing them to work more efficiently and profitably than ever before. A fleet management company for instance found that it was able to reduce the cost of managing its fleet of 180,000 trucks from 15 cents per mile to just 3 cents[8].

- **Data Monetization:** Telco's until 4G/LTE have been only using data to improve service quality and customer experience. However, with the many possibilities of 5G network services combined with IoT & AI, they will explore new business models of monetization such as intelligent enterprise application services. For Telco's, business opportunities not just lie in monetizing data but the value delivered to enterprises through application and network intelligence layers.

- **Predictive Maintenance:** Predictive Maintenance is the leading use-case of Industry 4.0. As per a market research report [7], predictive maintenance is a $11B market opportunity in next 5 years. Predictive maintenance helps in predicting failures before they occur by leveraging AI. AI is anticipated to have an increasing role in ICT and is rapidly becoming integrated into many aspects of communication, applications, content, and commerce. Gartner's hype cycle [6] of emerging technologies in 2017 adds 5G and Deep Learning for the first time.

- **Cognitive Analytics:** Analytics in 5G will morph itself into Machine /Deep Learning instead of traditional descriptive analytics with basic BI reporting. Analytics in 5G will evolve to an extent that learns from the context, predicts what will happen next, prescribes the next best action or step, learns from the past behavioural patterns for taking the most optimal decision, and for fully autonomous applications, automates the next action. Analytics-generated insights can increasingly drive decision making, and with the speed of 5G, more information will be collected and processed, faster than ever before leading to cognitive intelligence applications.
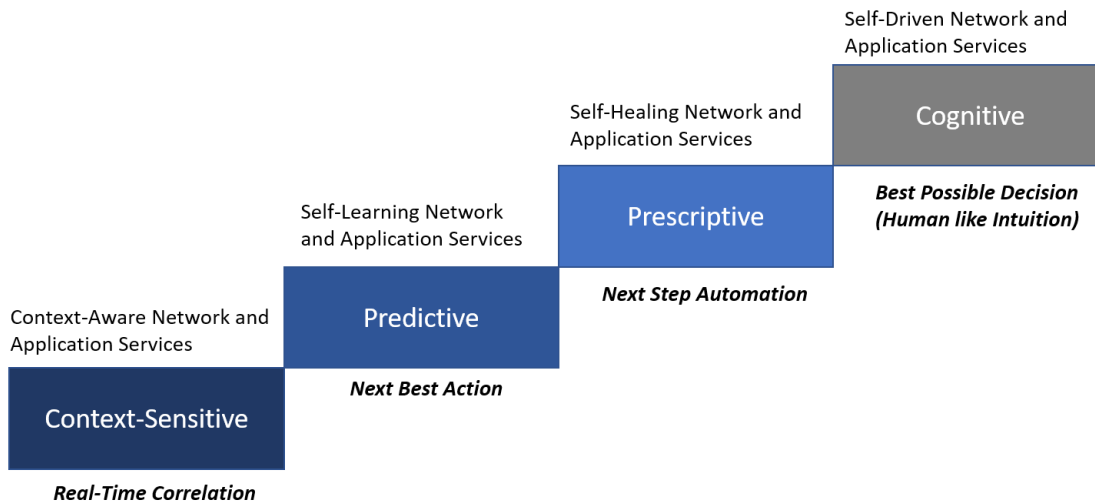
*Figure 3 Data Analytics Maturity Model for 5G Applications and Services*

## 3. 5G Use-Cases by Analytics Maturity Model

*IoT based analytics will be a big part of 5G use-cases and as explained in the previous section, analytics will evolve beyond basic intelligence and reporting. Here are the top use-cases by maturity model across key verticals.*

|  | Smart City | Smart Healthcare | Connected Automobile | Industry 4.0 |
|---|---|---|---|---|
| Context-Sensitive | Digital Shopping Experiences, Mobile Broadband, City Transportation | Wearables, Digital Medical History | Driver Behavior, On-board Diagnostics Service Reminders , Tiretronics | Asset Management |
| Predictive | Traffic Management Waste Management Banking/Insurance | Advanced Diagnostics Predictive Alerts | Insurance Premium Estimation Predictive OBD Alerts | Predictive Maintenance, Output Forecasting, Revenue Forecasting |
| Prescriptive | Public Safety, Home Safety / Surveillance | Preventive HealthCare | Breakdown Fix, Intelligent Routing Fleet Management | Energy Efficiency Supply Chain Optimization Job Scheduling |
| Cognitive | Urban Infrastructure Planning Emergency Response Systems City upkeep Bots | Remote Trauma Care | Autonomous/Driverless Cars | Control & Automation |

*Figure 4-Key 5G Analytics Use-cases by Verticals*

## 4. Technical challenges and path to 5G

- **High Speed Data-In-Motion:** Large-scale Industrial IoT, Smart Cities and Autonomous cars can pump petabytes of data in just few minutes. 5G's connectivity and low-latency transmission will add to this data throughput. Advanced fog/cloud infrastructure support will be needed to support lightning fast read/writes with low-latency compute and storage architectures on cloud.
- **Support for Application and Network Intelligence: The** 5G network must be much more than a pipe for big data. 5G architectures need to be defined and built in such a way that big data is intertwined into the fabric and analytics support that exists for distributed network and application intelligence use-cases.
- **End-to-End Security:** Big data raises numerous security questions as with any applications today. So, it is important to safeguard user's privacy or enterprise data without any compromise. Building a robust secure infrastructure from systems to applications is going to be critical in 5G design and architecture.

- **Real-Time Actionable Insights:** While low-latency is a characteristic of 5G networks, it becomes a very critical requirement for 5G to support fast data transfers into the cloud, analytics at the edge and in real-time, and persist the data at ultra-low-latencies to take real-time actions in mission-critical applications viz., public safety, emergency care and security surveillance.

**Conclusion**

In a simple network with limited capabilities, data analytics is of marginal importance: the network can only carry so much data, and there's not that much network data to collect or act on.  5G networks look to be anything but limited or simple, making analytics key to delivering on the 5G promise and making the full use of 5G resources. Gartner predicts that by 2020, 3% of network-based mobile communications service providers (CSPs) will launch 5G networks commercially.  The Hype Cycle report mentions that from 2018 through 2022 organizations will most often utilize 5G to support IoT communications. Gartner believes that 5G will be key platform enabling technology for artificial intelligence everywhere. [6]

**References**

[1] [Mobile Cloud Computing in 5G: Emerging Trends, Issues and Challenges](#)

[2] [GSA (Global Mobile Suppliers Association)'s article on Building 5G](#)

[3[] MarketResearch.com blog on 5G and analytics](#)

[4] [Ericsson's 5G and cloudification](#)

[5] [Role of Big Data Analytics in SDN/NFV](#)

[6] [Gartner's Hype Cycle of Emerging Technologies 2017](#)

[7[] IOT Analytics Market Research](#)

[8] [Information Age](#)

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