Unleashing the Power of IoT with 5G: A Paradigm Shift in Connectivity Services

1. Introduction

The IoT & 5G together presents a remarkable opportunity of disrupting the data-based service markets. In a world where the produced data is growing exponentially (United Nations, 2023), a question emerges:

> "how to handle this enormous amount of ever fast growing data into something useful without any doubt, to deliver real benefits to citizens and consumers, in a timely but financially viable way?"

The convergence of IoT (Internet of Things), AI (Artificial Intelligence), and big data technologies are reshaping industries, business and, ultimately, our way of living. They are already transforming our cities into a more smart and connected ecosystem. By harnessing the potential of IoT, AI, and big data analytics with the evolutionary 5G, it is possible to create a future where data-driven decisions and insights can enhance efficiency, deliver better services and ultimately improve the quality of life for individuals and communities – at much cheaper price tags.

The "unexpected" integration of AI with IoT (Transforma Insights, 2022) seems to emerge as a natural approach to handle and benefit out of the accelerated rates of data consumption (Statista.com, 2022) and the need of highly innovative solutions demanded to handle all this data from across all sectors of human activity.

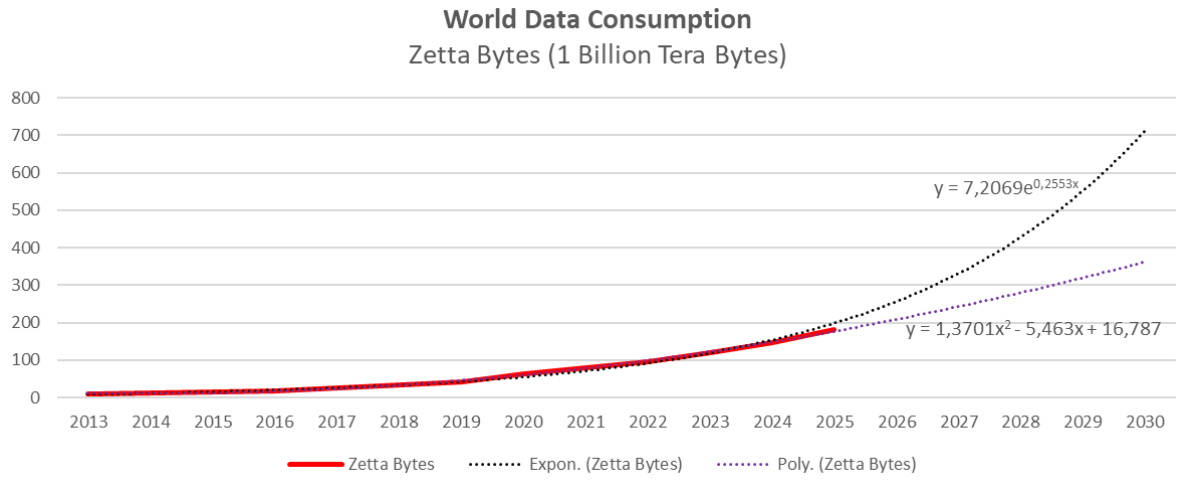
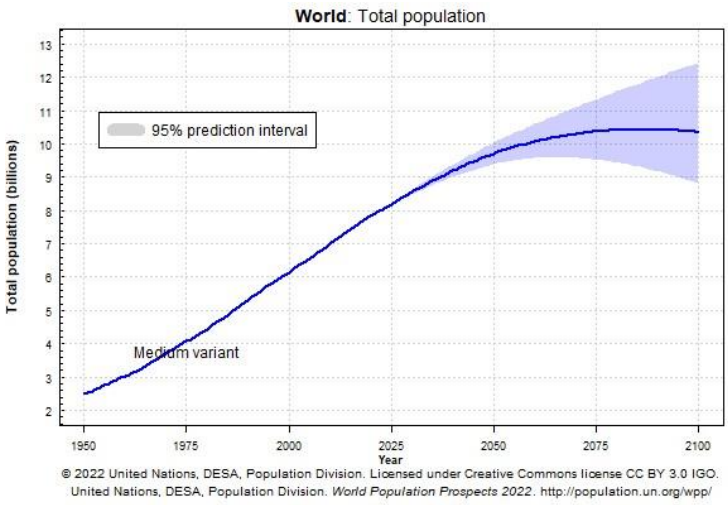


Figure 1 - World Data Consumption compared trends (exponential x polynomial growth), in Zetta Bytes (Statista.com, 2022)

Key activity sectors such as smart cities, smart grids, connected mobility[1] or even healthcare become very data-craving applications. A remarkable case is the healthcare sector – where IoT-enabled

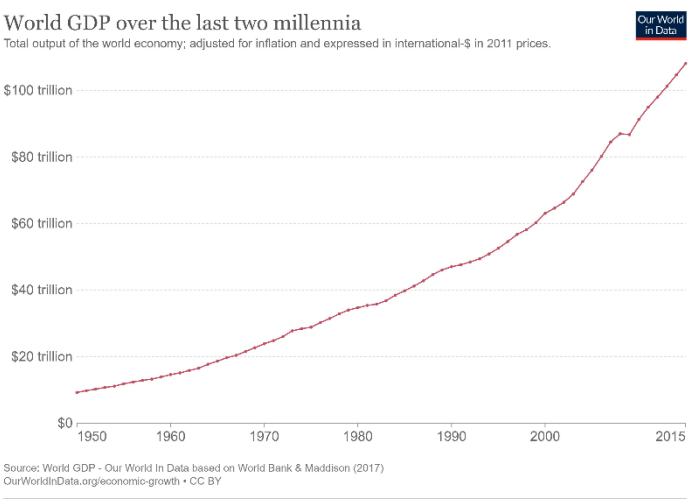
[1] Connected mobility, as connected means of transport.

"individualized healthcare" allied with AIoT sensors and digital twins – promise to revolutionize patient monitoring and personalized treatments while aiming to face the challenge of delivering quality of life and healthcare to about 8 billion (and counting) people in the world (United Nations, 2022).



The promise of big data & AI-based analytics is to extract insights from vast amounts of data (particularly IoT-generated data) coming from a multitude of databases and from distinct or even incompatible systems, to produce or enable proactive, predictive and split-second data-driven decisions, to healthcare, connected mobility, manufacturing, agriculture, environment and beyond, in a way it could likely not be manageable otherwise.

An AI-powered digital twins (PwC China, 2020) and advanced analytics (McKinsey Co., 2016) are transforming industries by displaying simulating real-world scenarios and views while predicting outcomes, and optimizing operations. Taking for instance an extremely complex system as a Smart City: the digital twin promise to "leap frogging" the city management – from "in the 90´s-stuck software" dashboard interfaces handing incomprehensible amount of dials & charts from a myriad of non-collaborative systems – into a more friendly and intuitive visual simulation (eventually using xR[2]) that harness all that real world data into a real-time digital replica, to deliver ultimate human interface with rich visualization added with prescriptive, predictive, diagnostic and reactive analytics, to public management and citizens (PwC China, 2020).



The role of the telecom companies is, as before, to provide essential connectivity services for IoT, supporting the IoT ecosystem, and facilitating the integration of AI and analytics capabilities. However, the telecom companies´ IoT marketplaces can offer platforms for developers and businesses to develop, buy, sell, explore and access a wide range of AIoT solutions, APIs[3], and data-driven services.

Challenges related to data privacy, security, and standardization must be addressed. Organizations must adopt robust security measures and ethical data practices to build trust and ensure the responsible use of IoT and AI technologies. With quantum computing at the horizon, leading

[2] xR, or "extended reality" uses AR, augmented reality, VR, virtual reality, or MR, mixed reality) technologies as User interface to data (Autodesk, 2023).
[3] API, Application Programming Interface (IBM, 2023).

innovation in cybersecurity is utterly important to keep the technology safe and viable. Investment in cybersecurity for IoT and AIoT, as well as on Quantum-based cybersecurity, is urgently strategic.

2. Background and Market Overview

Intended to give a glimpse of the changes and effects the IoT + AI + 5G convergence could bring, let´s take an analogue and imagine a world without the internet during the COVID-19 pandemic. The internet has played a crucial role in facilitating communication, collaboration, access to information, and essential services during this period.

Here is a highly hypothetical scenario about how the non-existence of the internet and its main enablers (the telecom companies) could have impacted the world during the COVID-19 years:

> Communication and remote work: The internet has enabled remote work and virtual communication platforms, allowing businesses, organizations, and individuals to continue their operations and stay connected. Without the internet, work would have to rely on wired telephone calls, rendering home-based or remote work nearly impossible, leading to disruptions in productivity and economic activity.
>
> Access to information: The internet has been instrumental in providing real-time updates, news, and resources related to the pandemic. It has facilitated access to vital information, guidelines, and health advisories from authorities and experts. Without the internet, disseminating and accessing accurate and timely information would have been much more challenging.
>
> Education and e-learning: The internet has been crucial in enabling online education and e-learning platforms during the pandemic. Schools, colleges, and universities have shifted to remote learning, allowing students to continue their studies. Without the internet, the education sector would have faced significant disruptions, impacting the learning and progress of students.
>
> Telehealth and remote healthcare: The internet has facilitated telehealth services, allowing individuals to consult doctors remotely and access healthcare resources. It has played a vital role in monitoring patients, providing medical advice, and delivering healthcare services. Without the internet, accessing healthcare remotely would have been limited, putting additional strain on healthcare systems.
>
> E-commerce (with door-to-door delivery) and essential services: The internet has been instrumental in facilitating online shopping and the delivery of essential goods and services. It has allowed people to purchase groceries, medications, and other necessities while minimizing physical contact. Without the internet, individuals would have had limited access to essential goods and services, leading to further challenges during lockdowns and restrictions.
>
> Social connections and mental well-being: The internet has provided a platform for social interactions, virtual gatherings, and support networks. It has helped people stay connected with friends, family, and communities, mitigating the feelings of isolation and loneliness. Without the internet, maintaining social connections and supporting mental well-being would have been more challenging.
>
> Crisis response and coordination: The internet has facilitated efficient coordination and response efforts by governments, organizations, and communities during the pandemic. It has enabled the dissemination of emergency alerts, contact tracing, and resource allocation. Without the internet, the ability to respond swiftly and coordinate efforts would have been hindered.

While it is difficult to precisely predict the full consequences of living without the internet during the COVID-19 years, it is clear that would have significantly impeded communication, access to

information, remote work, education, healthcare, and essential services, not to mention the inconceivable absence of the selfies, the twitter hashtags, the going-viral youtubers.

Strategic enablers, the telecommunication companies play a critical role in providing the infrastructure and services necessary for the internet and its by-products, IoT and AIoT.

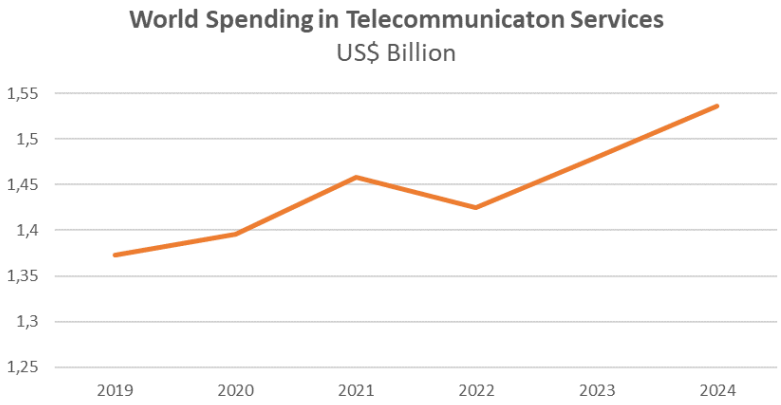


Figure 2 - World Spending in Telecommunication Services (Statista.com, 2023)

Here are some key roles of telecommunication companies in IoT and AIoT:

1. Internet Connectivity: Telecommunication companies provide the networks and connectivity services that enable individuals and organizations to access the internet. They build and maintain the physical infrastructure, such as fiber optic cables, cellular towers, and satellite systems, that form the backbone of internet connectivity.
2. Broadband Services: Telecommunication companies offer broadband services that provide high-speed internet access to homes, businesses, and public institutions. These services are essential for enabling fast and reliable internet connections, allowing users to access online content, engage in video conferencing, stream media, and perform various online activities.
3. Mobile Internet: Telecommunication companies provide mobile network services, allowing users to access the internet on their smartphones and other mobile devices. Mobile internet has played a significant role in increasing internet access and connectivity, especially in regions with limited fixed-line infrastructure.
4. Internet Service Provision: Telecommunication companies often function as internet service providers (ISPs), offering internet plans and packages to individual consumers and businesses. They manage the provision of internet services, including billing, technical support, and customer service.
5. Network Infrastructure Development: Telecommunication companies invest in the development and expansion of network infrastructure to meet the growing demand for internet connectivity. They continuously upgrade their networks, deploy new technologies (such as 5G), and expand coverage areas to improve internet access and quality.
6. Innovation and Technology Advancement: Telecommunication companies drive innovation and technological advancements in internet-related services and technologies. They invest in research and development to enhance network performance, develop new internet-related products and services, and explore emerging technologies like IoT, AI, and cloud computing.
7. Data Transmission and Security: Telecommunication companies are responsible for securely transmitting data over their networks. They implement measures to protect user data and privacy, including encryption, firewall systems, and network security protocols.
8. Internet Affordability and Accessibility: Telecommunication companies play a role in making the internet more affordable and accessible to a broader population. They offer various internet plans, pricing options, and initiatives to bridge the digital divide and ensure that individuals from different socio-economic backgrounds can access the internet.

Overall, telecommunication companies have been doing a remarkable job, serving as the backbone of internet connectivity, providing the necessary infrastructure, services, and technological advancements that enable individuals and organizations to benefit from the internet's impacts on their lives and lifestyles.

Looking into the markets, the global GDP ratio for each economic sector can vary based on factors such as country-specific characteristics, economic development, and technological advancements. However, here is a rough estimate of the global GDP distribution across the sectors that will feel the impact of IoT, AIoT and 5G:

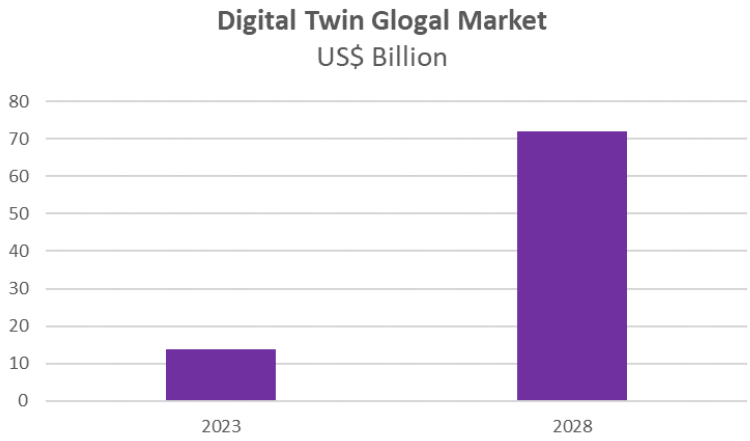
Primary Sector, which includes agriculture, forestry, fishing, and mining, generally contributes around 5-10% of the global GDP.

Secondary Sector, encompassing manufacturing, construction, and utilities, typically contributes around 20-30% of the global GDP.

Tertiary Sector, which includes services such as retail, transportation, finance, healthcare, and tourism, tends to be the largest contributor to global GDP. It generally accounts for around 50-70% or more of the global GDP. The dominance of the services sector is driven by factors such as urbanization, consumer spending, technological advancements, and the growing importance of knowledge-based, data-driven services.

Quaternary (knowledge-based) and and Quinary Sectors (decision-making) to the global GDP is more challenging to quantify directly, as they often overlap with the tertiary sector. However, these sectors are gaining increasing importance in the global economy due to technological advancements, innovation, and the growth of knowledge-intensive industries.

For instance, the digital twin global market is foreseen to growth from US$ 13.8 Billion in 2023, to US$ 71.8 Billion in 2028, a growth ratio of about 30% CAGR (Market Data Forecast, 2023).



Connected mobility encompasses various components, products, and solutions that integrate technology and transportation to enhance the overall mobility experience.

Strategic market for IoT and AIoT, the connected mobility encompasses various components, products, and solutions that integrate technology and transportation. Here are some of its key areas:

1. Connected Vehicles:

- Connected Car Technologies: Vehicles equipped with advanced sensors, telematics, and connectivity features that enable real-time data exchange.
- Vehicle-to-Vehicle (V2V) Communication: Enables vehicles to communicate with each other, sharing information about road conditions, traffic, and potential hazards.
- Vehicle-to-Infrastructure (V2I) Communication: Connects vehicles with roadside infrastructure, traffic signals, and smart city systems to optimize traffic flow and safety.

2. Intelligent Transportation Systems (ITS):

- Traffic Management Solutions: Utilize real-time data and analytics to manage traffic congestion, optimize signal timings, and improve overall traffic flow.

- Smart Parking Systems: Enable drivers to find available parking spaces through real-time information, reducing congestion and enhancing convenience.
- Adaptive Traffic Control Systems: Use sensors and algorithms to dynamically adjust traffic signal timings based on real-time traffic conditions.

3. Mobility Services:

- Ride-Hailing and Carsharing Platforms: Connect users with transportation options such as ride-hailing services (e.g., Uber, Lyft) or carsharing services (e.g., Zipcar, Car2Go).
- Mobility-as-a-Service (MaaS): Integrated platforms that offer a range of transportation services (public transit, ridesharing, bike-sharing, etc.) through a single app or subscription.
- Personal Mobility Devices: Electric scooters, bicycles, and other micro-mobility solutions that are connected and share data with users and service providers.

4. Data and Analytics:

- Big Data Analytics: Processing and analysis of large volumes of data from connected vehicles, infrastructure, and mobility services to derive meaningful insights.
- Predictive Analytics: Leveraging historical and real-time data to anticipate traffic patterns, demand for transportation services, and optimize routing and resource allocation.
- Intelligent Transportation Management Systems: Centralized platforms that collect and analyze data from various sources to monitor and manage transportation networks efficiently.

5. Autonomous and Electric Vehicles:

- Autonomous Driving: Integration of connected technologies, sensors, and AI to enable self-driving vehicles, which can communicate with each other and the surrounding infrastructure.
- Electric Mobility: Electric vehicles (EVs) and the associated charging infrastructure, supported by connectivity to provide real-time charging station information and optimize charging patterns.
- Looking ahead, the future of connected mobility is expected to bring further advancements and innovations. Some potential developments include:
- Continued growth of electric and autonomous vehicles, with improved connectivity and expanded capabilities.
- Increased integration of artificial intelligence (AI) and machine learning (ML) algorithms for advanced traffic management, predictive maintenance, and personalized mobility solutions.
- Expansion of smart city initiatives, with connected infrastructure and transportation systems working in synergy to create more efficient and sustainable urban environments.
- Integration of emerging technologies for secure data exchange and decentralized mobility platforms.
- Advancements in vehicle-to-everything (CV2X) communication, enabling vehicles to communicate not only with each other and infrastructure but also with pedestrians, cyclists, and other road users for enhanced safety and cooperation.

9. Conclusion

In conclusion, the convergence of IoT, AI, and 5G presents a remarkable opportunity to disrupt data-based service markets and reshape industries. With the exponential growth of data, there is a need to handle this vast amount of information in a useful and financially viable way. By harnessing the potential of IoT, AI, big data analytics, and 5G, it is possible to create a future where data-driven decisions and insights enhance efficiency, deliver better services, and improve the quality of life.

The integration of AI with IoT emerges as a natural approach to handle the accelerated rates of data consumption and provide innovative solutions across various sectors. Sectors such as smart cities, smart grids, connected mobility, and healthcare benefit greatly from IoT-enabled technologies, AIoT sensors, and digital twins. These advancements have the potential to revolutionize patient monitoring, personalized treatments, and address global healthcare challenges.

Big data and AI-based analytics enable the extraction of insights from vast amounts of data, particularly IoT-generated data, to drive proactive, predictive, and data-driven decisions across sectors like healthcare, connected mobility, manufacturing, agriculture, and the environment. AI-powered digital twins and advanced analytics transform industries by simulating real-world scenarios, predicting outcomes, and optimizing operations.

Telecommunication companies play a critical role in providing essential connectivity services for IoT, supporting the IoT ecosystem, and facilitating the integration of AI and analytics capabilities. However, challenges related to data privacy, security, and standardization must be addressed through robust security measures and ethical data practices.

The impact of IoT, AIoT, and 5G is not limited to the connectivity sector alone. It extends to various economic sectors, with the services sector being the largest contributor to global GDP. The adoption of IoT, AIoT, and 5G in sectors such as connected mobility is driving advancements in connected vehicles, intelligent transportation systems, mobility services, data analytics, and autonomous and electric vehicles. The future of connected mobility holds further developments in electric and autonomous vehicles, AI integration, smart city initiatives, and advancements in secure data exchange and decentralized mobility platforms.

10. About the Author

Marcelo is a seasoned professional with extensive experience in the telecommunications industry, specializing in IoT products and services.

With a distinguished career spanning across renowned companies such as Vodafone, Huawei, and other telecom organizations, Marcelo has a proven track record of successfully selling and deploying IoT solutions on a global scale. His deep industry knowledge, combined with his expertise in understanding customer needs, enables him and his team to deliver IoT solutions that drive business value and unlock new opportunities for clients.

Driven by a passion for innovation and a commitment to delivering exceptional customer experiences, Marcelo is dedicated to harnessing the power of IoT to transform industries and drive digital transformation. Marcelo can be found on LinkedIn.

Table of Figures

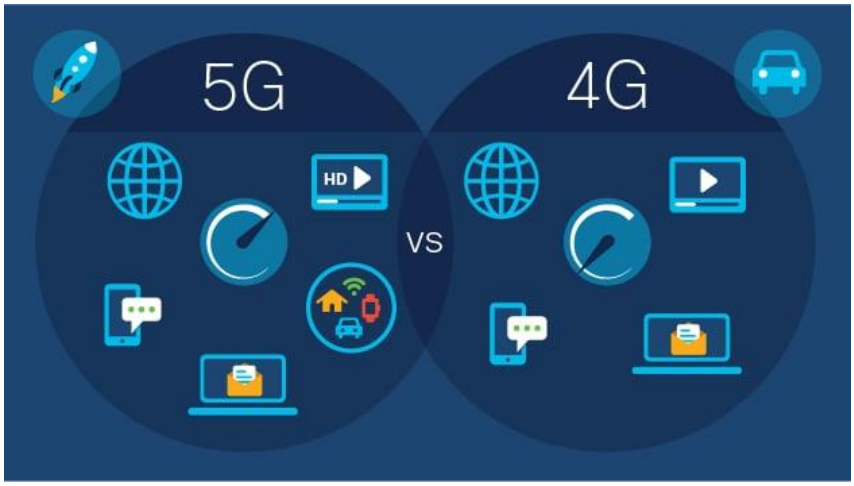


Figure 3 - 5G x 4G diagram (Cisco, 2023)

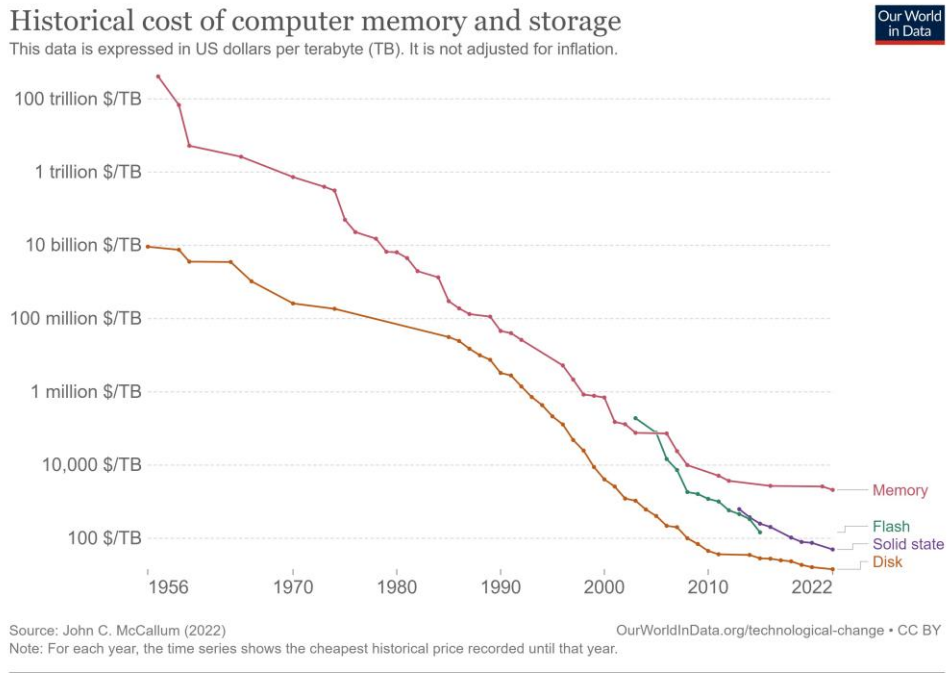


Figure 4 - Cost of Tera Byte Storage over time (McCallum, 2022)

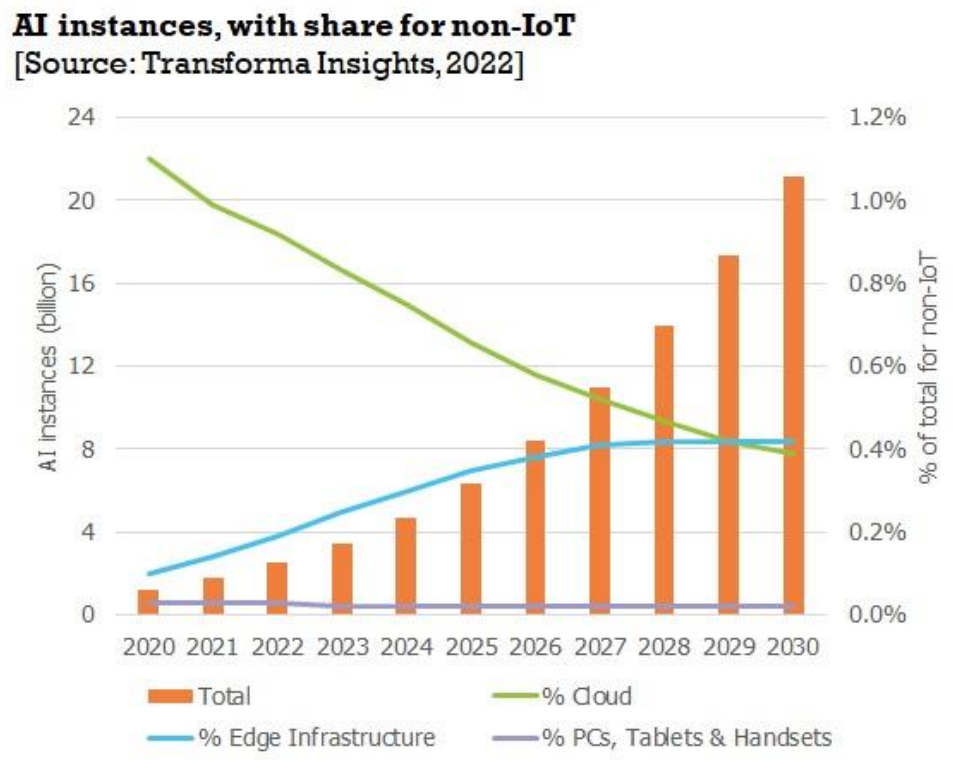


Figure 5 - AI & IoT (Transforma Insights, 2022)

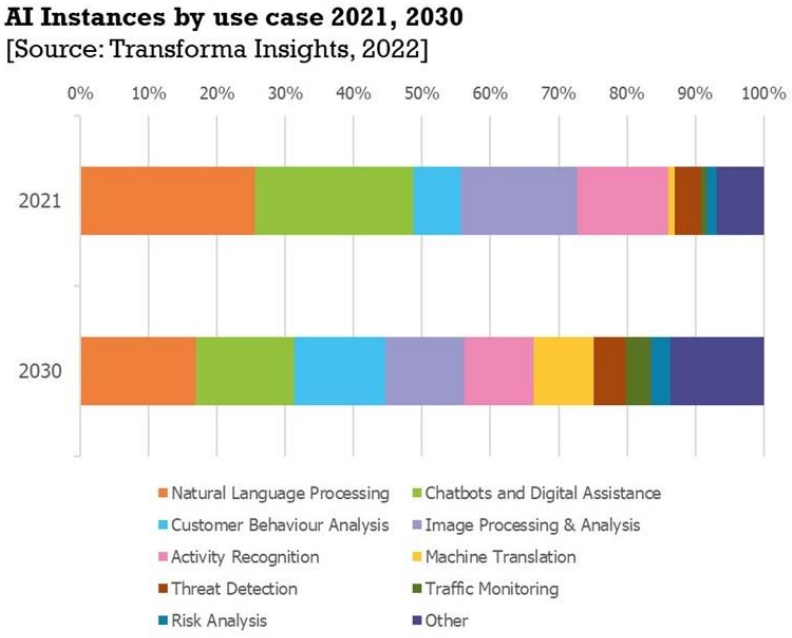


Figure 6 - AI Instances, by Use Cases (Transforma Insights, 2022)

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