FUTURE NETWORK-ENABLED MARKETPLACE

Setting a compass for the next decade of ICT market innovation and collaboration.

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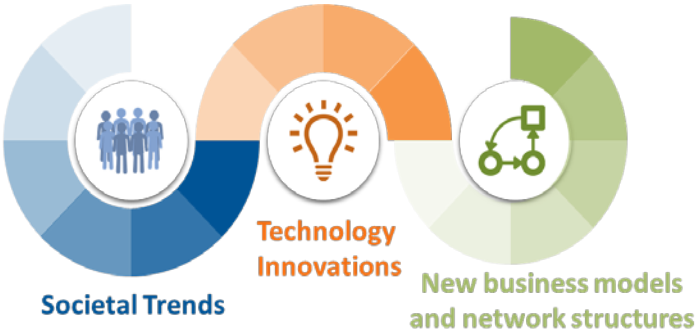
1. Introduction – *The Evolving Market*

The journey to the future marketplace will be shaped by many factors. For the Information and Communications Technology (ICT) industry, these factors are no longer confined to technology developments within this core market sector, as services and applications are increasingly intersecting with many vertical industries, and consumer expectations are becoming extremely customizable in focus. The industry's collective challenge is to lay the groundwork for a future set of services and business models that can be enabled through advanced network capabilities and forward-thinking collaboration. This vision is the basis for the *future network-enabled marketplace*.

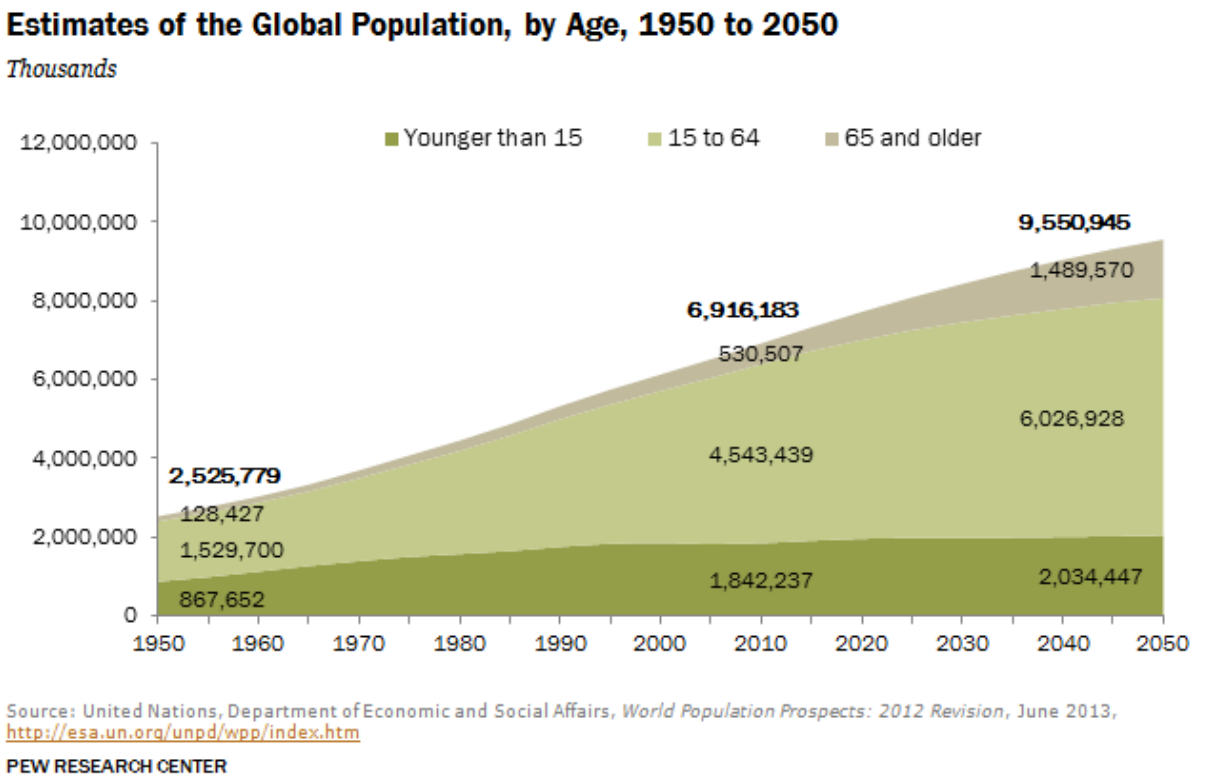
At a fundamental level, the future marketplace will be realized through a combination of three factors: societal trends, technology innovations and new business models. In fact, each of these factors can create an amplifying effect on the other factors. For example, technological innovations can often act as a catalyst for changing societal trends, while new business models can create an entry point for new technology introduction to the market.



Societal trends are often dominated by factors such as changing demographics and population movement trends. Upon closer examination, there are always sub-trends that collectively contribute to societal impacts on technology developments, business shifts and customer expectations.

Over the next 5-10 years, it is expected that demographic changes will continue to compound and create an evolving set of customer expectations regarding new products and services. One of the most significant factors is represented by the

relationship of the population growth by age groups. Recent research indicates that the fastest-growing population will be in the 65-and-over age group as a result of historical birth patterns and improvements in health care and medicine. This is followed by the 15-64 age group.



The shifting demographics will affect a broad range of market factors, including workforce characteristics, new economic models and the way customers consume media and adopt innovative applications. New services such as eHealth and remote diagnostics will create opportunities for virtual delivery of services, which incorporate rich content, high reliability and enforceable security and privacy measures.

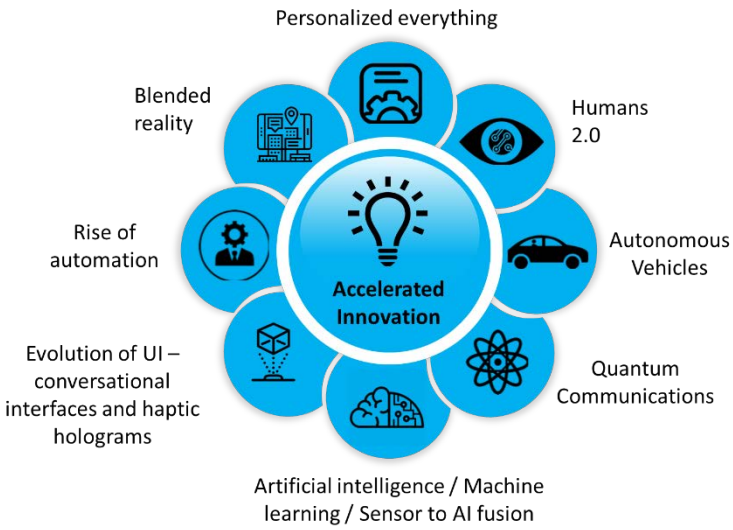
The second major societal trend is expected to be rapid urbanization, as populations shift to urban centers and geographically coupled cities evolve into smart regions, with cities becoming vibrant markets in themselves. As a result of the continued urbanization of the consumer base, factors such as transportation, energy, clean water and health will become even more critical.

"With more than 80% of global GDP generated in cities, urbanization can contribute to sustainable growth if managed well by increasing productivity, allowing innovation and new ideas to emerge." - *World Bank*

Urbanization will also impact the development of new applications, as factors such as proximity and rapidly configurable social groups lead to new applications that reflect these trends. Similarly, megaregional trends will create new consumer perceptions, as cities are increasingly able to leverage market power. The evolution to a smarter set of city services will be supported by the exponential growth of data collection and analytics.

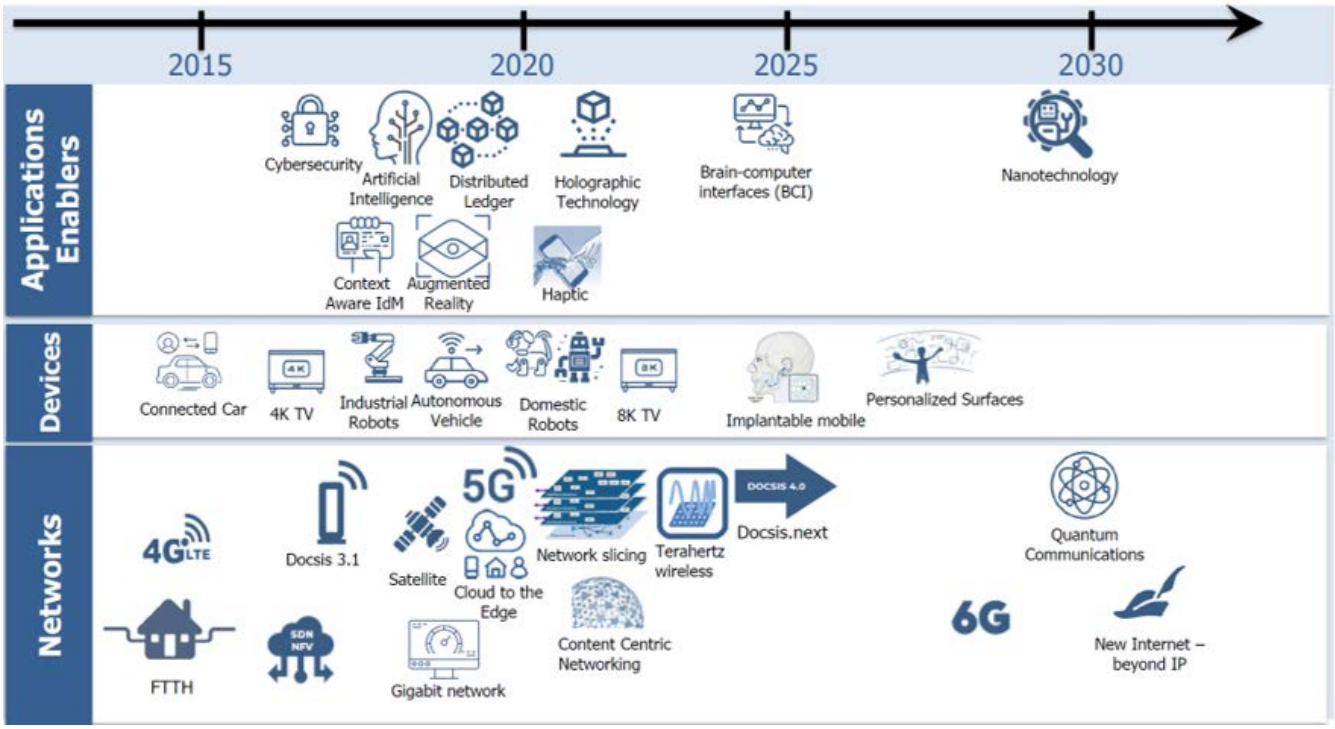
Historically, societal trends have been a major contributor to the emergence of **technology innovation**. Over the past few decades, the transformation to the "digital age" has been shaped by both *digital natives* and *digital immigrants*. The digital natives grew up in a time of rapid digitalization of both technology and the economy. On the other hand, digital immigrants were brought into an era where their skills and proficiencies were transformed into a new era of online commerce, social media interactions and massive mobility. In this respect, societal appetite and demand for a market that relied upon instantaneous connectivity to other people, things, services and products created a fertile environment for rapid technology innovation and application development.

Accelerated innovation is a product of rapid technology advancement coupled with new processes such as automation and artificial intelligence (AI). Over the next decade, market innovators will discover new ways to harness capabilities such as AI and advanced analytics and move them from process improvements to actual drivers for new services and applications.

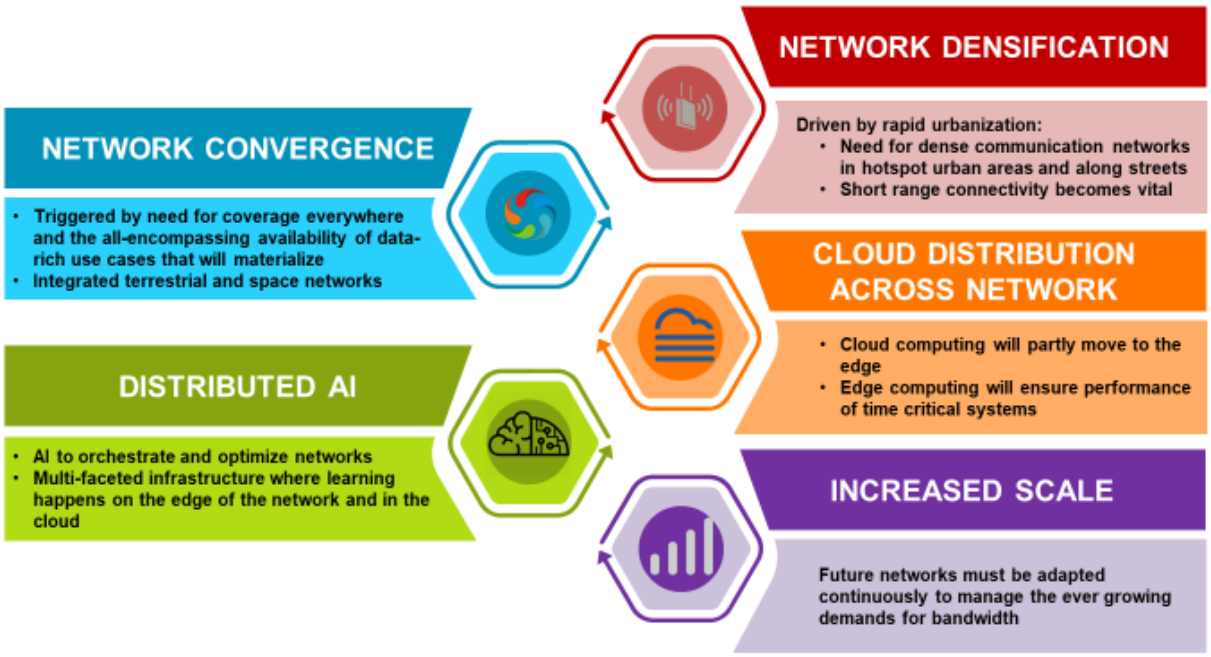


In addition to the societal and business drivers, there is a broad range of emerging technologies that are expected to impact the market across the network, device and application levels, which are illustrated below:

Emerging Technologies



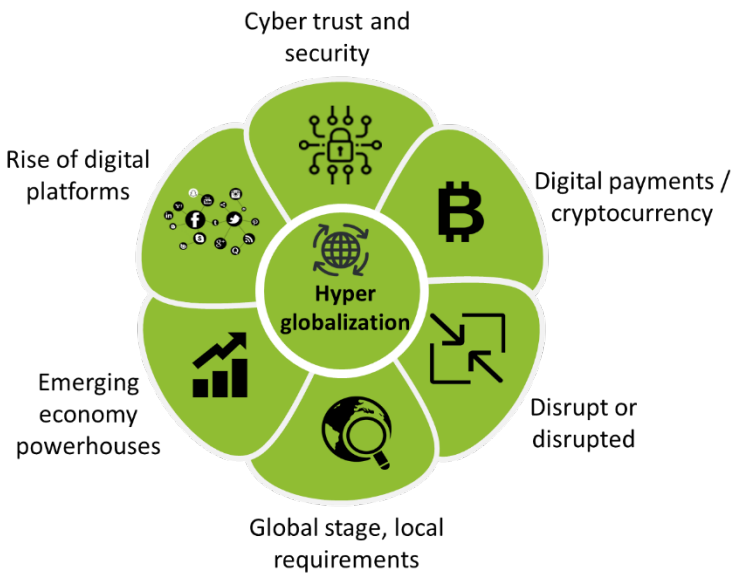
Of particular note is the emergence of innovative vertical applications and new consumer devices and their impact on 5G as an enabler across service and industry sector domains. Further, there is a future level of network convergence that will traverse the time period of 5G introduction and maturity, and create a roadmap for eventual 6G services and applications.



The following is a summary of key **network trends**:

A thorough assessment of these trends shows that networks will need to increase densification levels to meet 5G and beyond application and service needs. At the same time, computing and storage will more heavily move to the edge. This evolution will depend on capabilities such as AI to be applied in a more distributed manner, where learning happens at the edge and in the cloud. All these factors infer that networks will become more converged and more pervasive, in terms of scale and adaptability to changing customer needs.

The next step in the progression to a network-enabled marketplace is defined as **new business models and network structures**. Business models in the consumer and enterprise markets are often driven by the changing societal needs environment coupled with technology innovations that will bring new services to market.



It is expected that hyper-globalization will play a major role in disrupting current business models and transactional frameworks. While driven by a higher global awareness and product acceptance, globalization will also impact the manner in which payments and transactions are conducted in the future marketplace. These disruptive approaches will gain more traction in the market if consumers and businesses can establish a higher degree of trust and security, without sacrificing simplicity of use. This infers that a secure and private trust framework can actually act as the gateway to new transactional and payment models.

In this future marketplace, the goal of new business models will be enabling companies to produce and provide products and services ever closer to the moment of demand. The four characteristics that will drive these new business models are sharing, personalization, pay per use and platforms.

Sharing will result from the rapid technological breakthroughs, increasing urbanization, demographic shifts and the rise of millennial buying habits.

New systems that facilitate the sharing of underused assets will be driven by real-time

data and mobile access. It is expected that business models will increasingly emphasize access to products and services over their outright ownership.

Personalization will emerge out of growing individualization of demand and profit from exploiting heterogeneities across customers' needs. For enterprise services, this will drive more customized, SLA-based services. One of the key questions surrounding personalized data is whether consumers will be willing to sell their data to gain more access and influence in the marketplace.

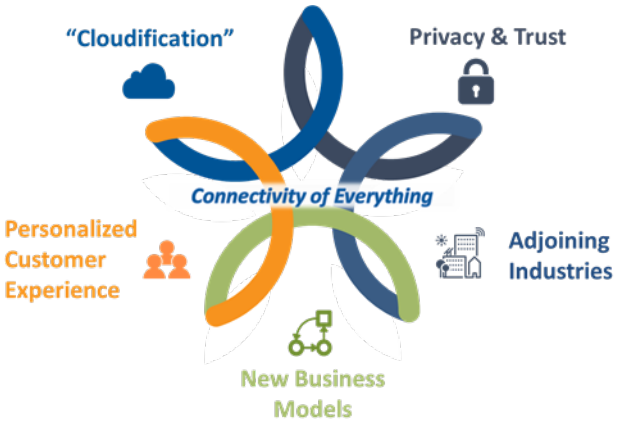
Pay-per-use business models will rely on a billing model based on how you use services. Although this variation on the subscription model means the seller's revenues fluctuate from month to month, it is offset by a perception of greater fairness, which in turn will breed greater customer loyalty. A seller can gain an advantage by optimizing the use of its facilities and resources. Similarly, micropayments become more feasible when there is significant volume, but only if the cost of billing is minimized.

New ***platforms*** will utilize technology to connect people, organizations and resources within an ecosystem that creates value. Online platforms will continue to expand where work can be transacted. In addition, new platform models will become more prevalent where the platform pays users for what they create.

In reality, the collective impact of all three of these factors (i.e., societal trends, accelerated innovation and new business models) will define the future vision of the network-enabled marketplace. While articulation of this vision will provide an insightful view of the market of the next 5-10 years, it is really the set of pathways to this future marketplace model that will yield a *collaborative roadmap* for the future. The realization of this collaborative roadmap will position ATIS and the industry to take full advantage of the evolving business opportunities of the next decade. This roadmap also will enable ATIS and the industry to meet the challenges across domains and sectors, which will define success in this future marketplace.

2. Pathways to the Future

The future marketplace can be best viewed from a series of business and technology pathways that are enabled by a hyper-connected ecosystem of applications and devices. It is the *connectivity of everything* coupled with a broad range of network-enabled attributes and data that will define the critical pathways to the future. The following is a brief description of each of the marketplace pathways, which will be further defined in subsequent sections:



Cloudification – This is the largest change in the network ecosystem right now. Cloud native is a growing priority for communications networks.

Privacy & Trust – Exchange of data, security, trust, privacy and the role of trusted intermediaries are common themes across the industry.

Personalized Customer Experience – Leveraging AI, network data and contextual information will enable increasingly personalized customer experiences.

Adjoining Industries – Exploring opportunities to collaborate with adjoining industries is critical to expansion.

New Business Models – These create new revenue streams and payment models to monetize bandwidth, services and value propositions.

2.1 Cloudification

The concept of cloud computing was developed to meet the need for server resources that could deliver massive scale and global accessibility at low cost. The cloud concept has proved to have compelling technical and economic advantages, which are why cloud technology will dominate future networks. Almost all future services will have a cloud component. **Networks will be designed and optimized to meet the communication needs of cloud computers and to connect users to cloud services.**

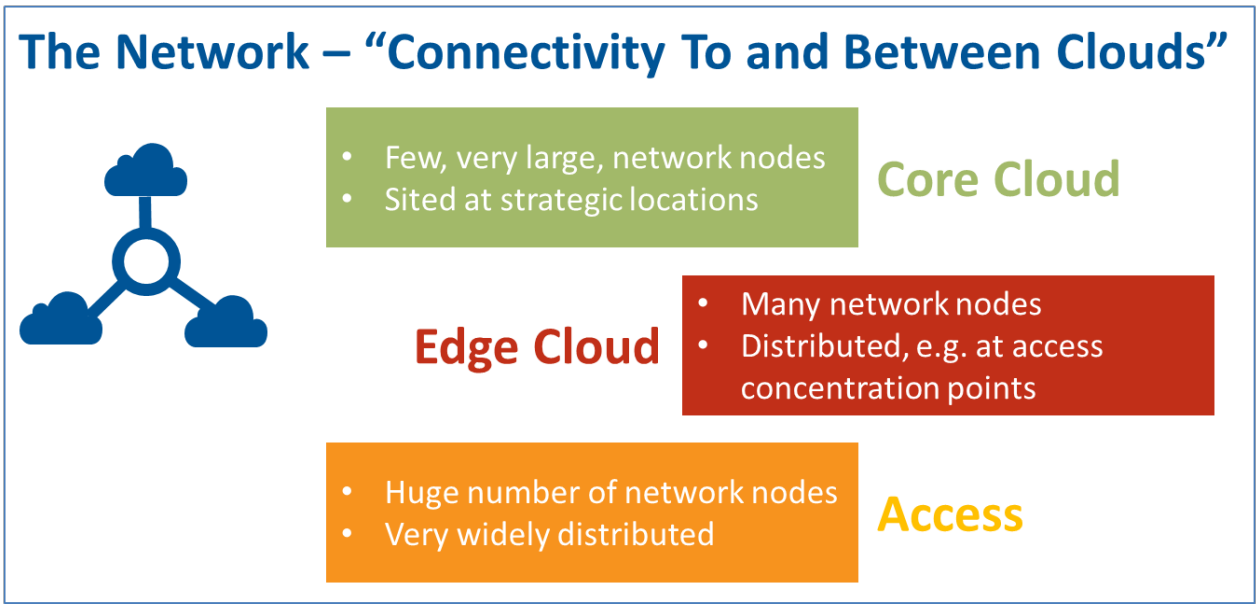
Cloud computing is the preferred technology of large web properties. It is also the key service delivery technology for future communications networks. Compared to conventional nodal implementations, **cloud computer services offer more flexibility and can deliver much improved operational expenses (opex)**. Future communications networks will be built around a cloud architecture, which could include a combination of "cloud-native" approaches and Network Function Virtualization (NFV). **Automation for the operational management and deployment of services built on clouds will be essential to meeting OPEX goals**.

Moving service logic from specialized platforms tied to specific network locations to a flexible cloud environment will **enable network operators to dramatically increase their service velocity**. Leveraging the flexibility of the cloud, coupled with automation of deployment and testing, can reduce the time needed to deploy a new service or feature from months to days.

The use of a cloud environment is associated with the exposure of system capabilities using Application Programming Interfaces (APIs). These APIs can help fulfill a dual

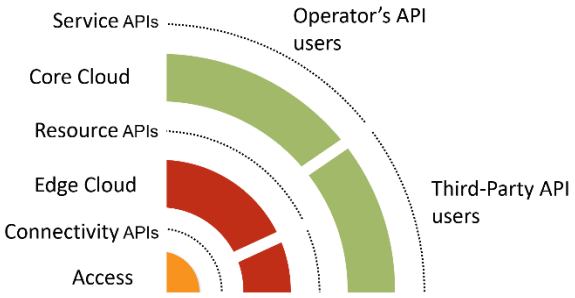
purpose. Within the network operator, the APIs allow services to be rapidly deployed to the cloud and to support elastic computing. However, the use of APIs to give access to system capabilities can also deliver value in external relationships. **The twin trends of cloudification and increased use of APIs will better position network operators to collaborate with verticals and other partners.**

The term "cloud" can suggest a uniform distribution of resources throughout the network. But the reality is that clouds are deployed in a structured way, while the location of resources is dictated by economic and technical performance considerations. The diagram below illustrates this emerging cloud structure.



The **core cloud, which is concentrated in a few, very large, data centers,** is responsible for compute-intensive functions and high-level service functions. These nodes will be sited at strategic locations to provide regional/global resource distribution. Resource elasticity and the ability to quickly switch a load between sites will provide geographic redundancy. The network will be optimized to provide the massive data connectivity between core cloud nodes. Traffic must be rapidly rerouted between nodes in fail-over situations.

A variety of deployment models for the network core cloud are emerging. Some networks are building their own core cloud, and even selling cloud capacity. Other networks are purchasing cloud capacity from established Internet cloud providers. Overall, **a complex picture of "coopertition" is emerging between communications networks and cloud providers**.



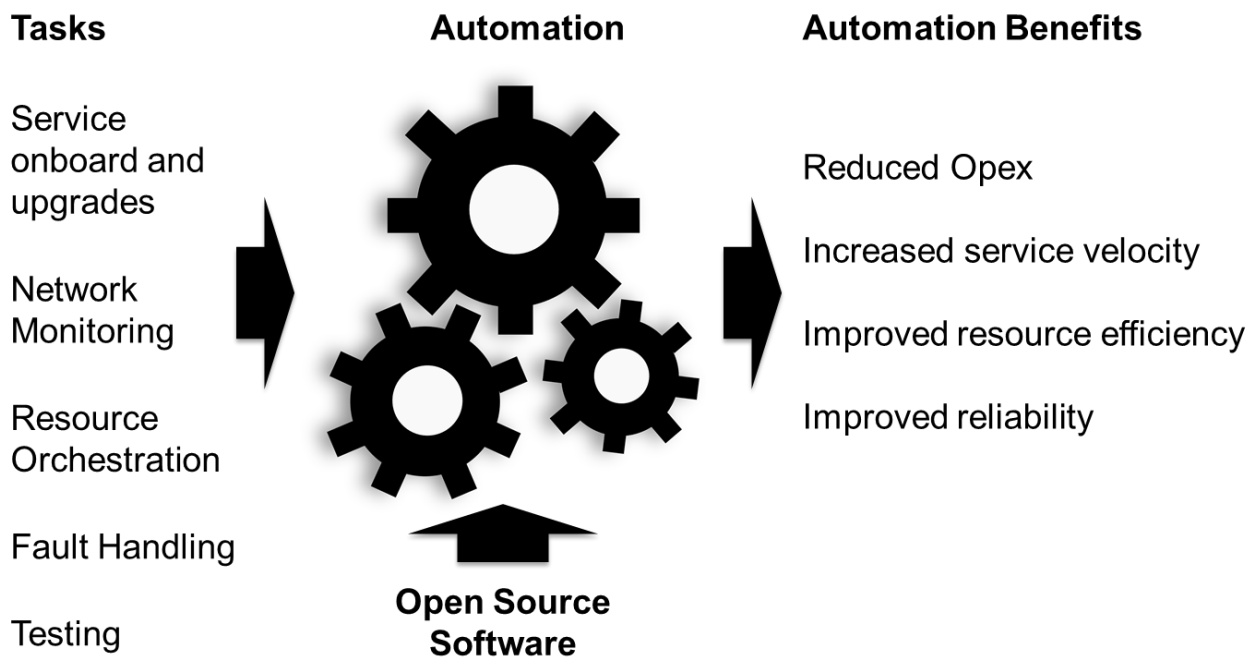
The development of interactive Virtual Reality (VR) and Augmented Reality (AR) services requires compute and media resources that are accessible with very low latency, and hence must by physically close to users. The **edge cloud is a layer of emerging importance tha**t allows resources to be located at the network edge while retaining the cloud model's flexibility and elasticity. Wireless access networks will be part of the trend towards cloudification. **One function of the edge cloud will be to support distributed Radio Access Network (RAN) functions**. It has been estimated that the value of the equipment market for the edge cloud will grow by nearly a factor of 10 by 2024[1].

The **development of the edge cloud is an important opportunity for network operators** to increase their role as providers of cloud infrastructure and cloud hosting. Edge cloud services will be physically close to the edge of the network, an architecture that often means on operator premises, where incoming network access is concentrated. The growth of the edge cloud will be facilitated by standards for exposing of generic, reusable capabilities.

The network's lowest level provides network access to the full, geographically distributed range of fixed and mobile users. The challenge in the access layer is to deliver massive bandwidth and low latency between end users and cloud nodes. High-capacity metro networks and 5G wireless will be instrumental in access networks.

[1] https://www.prnewswire.com/news-releases/edge-computing-market-to-grow-ten-fold-by-2024-300892936.html

A key aspect of realizing the technical and commercial advantages of cloudification will be to maximize the use of software automation to support network operations. The cloud and cloud services are fully efficient only if they are operated using automated tools and engineered processes. Traditional manual approaches to network operation must evolve to reduce opex and ensure that highly dynamic, cloud-based networks are robust and reliable.



A critical enabler in supporting cloud networks, and particularly the automation of cloud network operations, is the use of open source software platforms and tooling. **Adopting open source technology and equipping teams with suitable structures and skills to use the technology will be an important part of transforming today's networks towards a cloud-based model**. Making good use of automation will create new networks economics and open up new markets. But automation will also require structuring and planning because ad-hoc or manual processes can nullify the benefits. Distributed AI will be an important part of developing automation solutions that address market needs.

Cloudification creates shared platforms that are available to many independent applications and user groups. This sharing helps create resource elasticity, but it also

brings risks in terms of information leakage or conflicts over resource prioritization. To address these problems, **network slicing complements cloudification** by giving different slices virtual independence. The use of slices provides different user groups with security and protects their resource commitments from disruption by other parties. Network slicing and cloudification will evolve in conjunction to deliver networks that combine flexibility with the ability to deliver separate virtual networks to meet different needs.

In summary, cloudification will be an important technology to meet the technical and commercial objectives of future networks. By opening APIs and creating coopertition relationships around cloud capabilities, networks will enter new markets and have the opportunity to reduce their opex costs.

The core cloud is already a feature of many networks. In future, the edge cloud will also be widely deployed and will become a critical portion of the infrastructure – both to support distributed RANs and to offer a range of local, low-latency service resources.

Network cloudification requires organizational practices to evolve to make the best use of new capabilities and to address new challenges. Widespread automation, often using open source tools, of management and deployment tasks will be essential.

2.2 Privacy and Trust

Privacy and trust are essential to the health of the online digital economy. For online transactions, consumers trust that the entity they are transacting with will keep their personal information private. However, personal information comes in many different forms and, particularly with new, AI-based technologies, can be derived from information sets that may not otherwise be viewed as personal.

Generally, we find no single common definition of "personal information." For example:

- National Institute of Standards and Technology (NIST) Special Publication 800-122 provides a definition of personally identifying information (commonly known as PII).

- The Federal Trade Commission (FTC) has made additional statements to further clarify the definition of personal information.

- The European Union has separately addressed the definition of personal information in its General Data Protection Regulations (GDPR).

- The industry-led Network Advertising Initiative (NAI) has published a code of conduct relative to the handling of personal information.

- Individual U.S. states have passed legislation addressing privacy and personal information.

NIST has separated personally identifying information (PII) into two categories:

- Linked information is any piece of personal information that can be used to identify an individual.

- Linkable information by itself may not be enough to identify a person, but when combined with another piece of information, it could identify, trace or locate that person.

For example, a user's IP address is not classed as PII on its own, but as linked PII.

The FTC has gone a step further by clarifying that PII is any information that can be reasonably linked to a particular person, computer or device and thus warranting privacy protections. This definition includes persistent identifiers such as device identifiers, including processor/device serial numbers, MAC addresses, static IP addresses and HTTP cookies.

The European equivalent of PII is defined by the EU GDPR as:

- Any information relating to an identified or identifiable natural person ("data subject").

- An identifiable natural person is one who can be identified, directly or indirectly, with name, identification number, location data, online identifier or to one or more factors specific to the physical, physiological, genetic, mental, economic, cultural or social identity of that natural person.

The GDPR states that even cookies can be considered personal data. This definition does not completely correspond to the PII definition popular in the U.S. For example, a user's IP address is not classed as PII in the U.S. by NIST, but is classified as linked PII. In the EU, it is classified as personal data.

One of the more pervasive uses of personal information is in advertising. The FTC and consumer groups have expressed concerns that online advertising may harm user privacy. In response, the advertising industry created the NAI trade group to develop self-regulatory standards for online advertising. The NAI Code of Conduct[2] provides a

[2]NAI Advertising Principles: https://www.networkadvertising.org/2013_Principles.pdf

set of self-regulatory principles that require NAI member companies to provide notice and choice with respect to a variety of online advertising activities. The code addresses the types of data that member companies can use for advertising purposes and imposes a host of substantive restrictions on member companies' collection, use and transfer of data used for personalized advertising. In addition, the NAI Code mandates that member companies provide users a means to opt out of personalized advertising. To help ensure that members abide by the NAI Code, the NAI has a robust compliance program, including sanctions mechanisms.

Finally, multiple U.S. states have passed legislation that further “define” personal information, albit not necessarily consistently with NIST, FTC or EU definitions. Furthermore, it is important to note that PII is a legal concept, not a technical concept. As such, there is a great deal of uncertainty and confusion relating to the technical treatment of information that is directly or indirectly linkable to a specific person. This is further complicated by the fact that many new technologies (often AI-enabled) can utilize broad sets of “non-identifying” information to infer personal information.

This overall uncertainty related to online privacy is both confusing and concerning to consumers, as well as online businesses. There is no general federal or state law that requires an online business to have a publicly viewable privacy policy in all cases. However, several laws require privacy policies for specific situations such as health care and finance, and to help protect children’s privacy online. In addition, businesses with an interest in transparency will also publish an online privacy policy. Nevertheless, these policies are generally not read or understood by consumers. Fundamentally, the consumer must trust that the online business will “do the right thing” with any personal information collected.

However, consumers are often in a poor position to verify the trust they must place in online businesses. Ideally, consumers should understand what kind of personal data is being collected, exactly who is collecting it and what legal rights, responsibilities and regulations might be associated with the collected data’s protection and distribution.

An online application/platform may collect a variety of types of personal information from the consumer. For example:

- Users may provide data for the purpose of establishing a secure identity for gaining online access. Data collected in this process includes identifiers, passwords and biometrics for the purpose of authentication, as well as profile data (e.g., physical address and phone numbers) and security questions (e.g., mother's maiden name).

- Users may provide data to a community, such as via social media. This data may include a user profile, personal images, textual comments and other documentation of life events.

- Behavioral data may be collected by the application itself. This data may include location and location history, purchasing/shopping choices and history, browsing history and keystroke/mouse timing.

- Data may be available online that is collected by third-parties via public records and made available (generally for a fee) to the public. Public data could include information derived from public video cameras, such as those deployed for security purposes.

- In addition, other non-identifying data might be used in combination to infer personal information.

Data can be collected by a variety of parties. For example, in addition to the data collected by the online application itself, the network may capture data associated with a user's interaction with that online application. This data may include domain name information acquired based on the user's DNS query, IP addresses and user location information at the time of the user/online application interaction. In addition, the online application may contract separately with third-party advertisers, which may collect user information directly, without the direct intervention of the online application provider or network. This information, typically from HTTP cookies and/or

IP address information, can be used by the advertiser to track shopping behaviors to better target advertisements.

Most personal information collected online has positive/valuable uses, but release of this information can also lead to identity theft, financial loss and personal harm such as cyberstalking.

With all of these variables in play, consumers are often unaware which, and how much, personal information is being collected, as well who is collecting it. As such, consumers must not only trust the application provider, but also the networks used and the third-party providers associated with the application provider.

There are several options for enabling consumers to better manage and protect their personal data. For example:

- Tracking-mitigation technologies can be applied to enable consumers to expose and limit tracking behaviors.

- Trust mediators and personal agents/avatars can be used to manage online transactions on the user's behalf. An intelligent mediator/agent can hide or randomize many aspects of user information while also alerting users about who is receiving their personal information.

- "Cloaking" technologies and solutions may also be used.

Distributed Ledger Technology (DLT) and its cryptographic principles can be applied to provide digital identities that enable individuals to have greater control over their own personal identity and the value derived from their personal data. These DLT-based identity management solutions enable users to manage their identity data themselves and disclose it directly to businesses on a need-to-know basis.

As the technologies, applications and user preferences evolve, it is likely that trust and privacy will continue to be key concerns. As such, they will intersect with many different aspects of the network and marketplace evolution.

2.3 Personalized Customer Experience

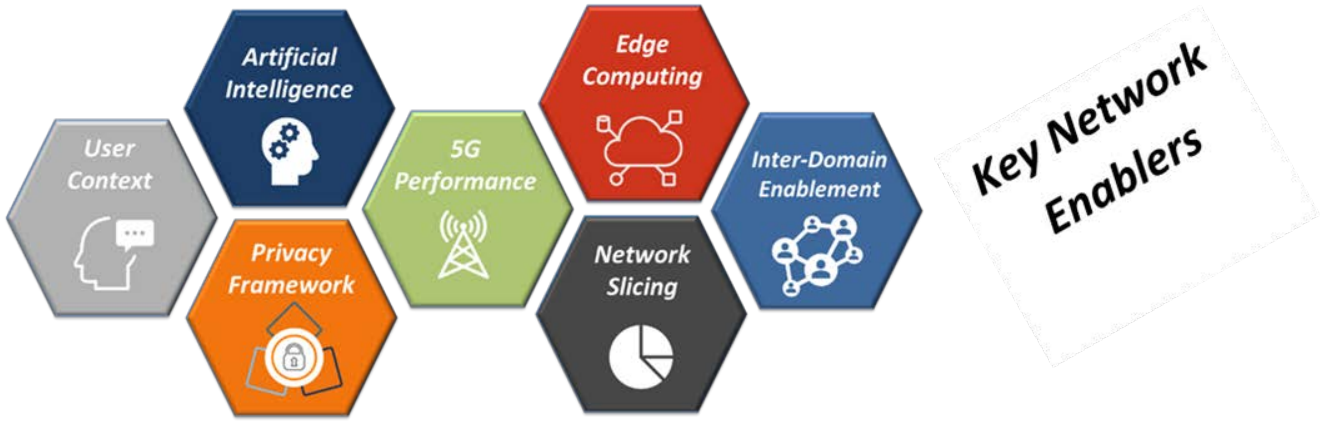
Customer experience, sometimes synonymous with user experience (UX), will continue to be important factor. In the future, it will be largely perceived as a measurement of value in the consumer and business sectors. The massive amount of network and application layer data that is increasingly available, coupled with new capabilities such as AI, will open new opportunities for optimizing customer experience.

Over the last few decades, customer experience and content consumption have evolved from a passive model, where users ingest some level of pre-determined content and applications, to a participatory ecosystem, where customers derive value through a set of experiences. More recently, the market has evolved to an immersive experience. This is represented by the increasing use of advanced applications using VR and AR to immerse customers into a content-rich environment that they can control and shape. What will be the next evolutionary step of customer experience?

The forward-looking concept of a **personalized customer experience** is one where the network becomes the fundamental UX enabler in a way that transcends current technology and business capabilities. Although application-level data could offer an enhanced customer experience, the network has the scope and connectivity across domains to deliver a customized UX that is dynamic and predictive to a consumer's needs.

Integrating advanced network capabilities to deliver a perceived personalized experience to a consumer or enterprise customer.

The first step in defining a personalized UX, driven by advanced network capabilities, is to define the key *network-enablers*. From a perceptive aspect, these enablers should operate in a transparent environment surrounding the customer. They also should deliver an experience that is tailored to a consumer's needs, behaviors, contextual environment and desired level of simplicity.



Over the next 5-10 years, there will be a number of key enablers to personalized UX that are driven by next-generation networks and emerging capabilities:

User context provides a means to collect and apply contextual information about the user's environment (with proper consent) to personalize how a customer wishes to consume content and interact with groups, applications, services, etc.

Artificial Intelligence enables dynamic, real-time analysis of large amounts of collected data to shape a simplified UX that otherwise would not be possible with current analytics or human oversight.

Privacy Framework disseminates a customer's desired level of privacy across multiple applications and domains. It relies on a user-defined set of privacy levels and trust relationships that may vary across applications and transaction types.

5G Performance leverages the high bandwidth and ultra-low latency capabilities of 5G networks to deliver a real-time UX that enables applications to deliver a rich experience in a ubiquitous mobile world.

Edge Computing moves compute and storage to the edge. This shift allows users to achieve new and powerful application-execution environments and enable distributed processing of transactions near the customer and the application space.

Network Slicing builds a defined set of end-to-end slices across networks and domains that align with specific application classes and user needs. This architecture avoids complex provisioning and positioning of network assets.

Inter-Domain Enablement creates a set of inter-domain frameworks and relationships between networks and vertical sectors to promote advanced applications and deliver a simplified process for discovering.

In addition to assessing the network-enabling factors, it is important to consider the major societal trends and shifts that will drive the consumer appetite for a personalized UX. Three major demographic trends are expected to shape this environment:

Aging Population - As the remaining members of the baby boomer generation, and early Gen X, turn 65, there will be even more opportunities for remote-delivered healthcare (telemedicine) and virtual services that will increase the quality of life and independent living.

Millennials – Over the next decade, there will be an increasing set of business trends that will continue to keep pace with millennial buying habits and financial needs. Examples include expanding online financial and mobile wallet services, and greater dependence on crowdsourcing solutions. All these trends will be based on higher privacy and security expectations.

Gen Z – Will become a growing percentage of both the workforce and the prime consumer market, two trends that will promote a new and different application space.

For example, recent studies show that 49 percent of Gen Z get their news from social media versus 17 percent of all older adults[3]. In addition, this report suggests that Gen Z will be "widely distrustful of institutions and powerful interests" and have a significantly greater global view of geopolitics and products.

Ultimately, the intersection of new network-enabling capabilities and the evolving generational trends will create a powerful environment for the introduction of the *personalized customer experience*. Success will be driven by the ability of the market to first create this experience, then for the network to leverage this dynamic environment to deliver products and services in a way that creates new relationships and business models.

It is expected that brand loyalty will be less based on factors such as product bundling and end-to-end service models. Consumers will pursue relationships based on instantaneously connecting their needs to the product or service of their choice, in any given environment.	***New customer loyalty and relationship models for the future***
Data value will not necessarily be proportional to data volume or velocity. In the future, data lifecycles will be increasingly constrained, but the value of real-time data that is relevant to a customer's real-time needs will be critical to the growth of the marketplace and deemed as having greater value.	***Data treatment that recognizes the relevancy and real-time value to the customer***

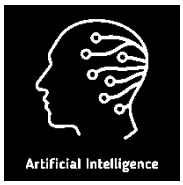
[3] *Understanding Gen Z* by Morning Consult – 2019

Consumers and businesses will expect a more elastic set of privacy and security boundaries, where the user has greater control to calibrate the perimeter based on social or business groups, types of services, trust levels and the context of their environment.	***Privacy and security solutions conforming to customer's social and business ecosystem***
One of the most significant factors in delivering a personalized UX is the pre-positioned availability of network resources, data assets and user-preferred content. Although some of this information can be obtained at the application level, networks are uniquely positioned to act on context, mobility, proximity and user patterns.	***Knowledge base to predict customer's needs and pre-position resources***
As the number and diversity of content sources continue to grow, and the application space between verticals and service domains expand, simplicity (as defined by the customer) will be a major driver in creating new revenue models. Users will increasingly seek out solutions that deliver a secure but simplistic set of service interactions.	***Simplicity of consuming content and executing applications across domains***
The future environment of pervasive content and the Internet of Everything will inevitably lead to new business relationships. Emerging subscriptionless services and microservices will alter traditional service relationships. Markets will evolve to where some consumers of data and services are indirect users but create new opportunities.	***Defining the difference between the "customer" and the "user"***

Summary

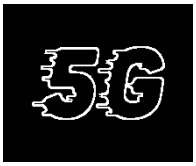
When considering the evolution to a **personalized customer experience** in the future marketplace, there are several compelling needs requiring industry collaboration and technology innovation:

1. ***AI at network scale*** *will need to be applied in creating real-time and predictive assessment of user needs, behaviors and future actions to deliver a holistic UX.*

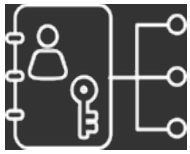


2. *Networks will need to significantly increase the level of* ***context acquisition*** *and leverage* ***context managers*** *to collect, analyze and apply context (with user consent) to create a customized UX.*

3. ***5G performance*** *at the network and application layers will need to be coupled with* ***new network architecture approaches*** *to discover and pre-position content essential to delivering personalized UX.*



4. ***Adaptable privacy and security frameworks*** *will be needed to enable application execution and smart transactions across domains and verticals, with user-selected perimeters and boundaries.*



2.4 Adjoining Industries

The sphere of industries adjoining ICT is rapidly expanding as verticals and new industry sectors are increasingly leveraging communications networks and information services.

Applications such as smart transportation and smart health have rapidly evolved to leverage and integrate with networks and communications systems to meet intelligent connectivity and data collection needs. Although connectivity services for IoT and smart devices represent an ongoing opportunity, it is expected that value with move up the stack to the higher layers because applications will need to cross verticals, industry sectors and service domains. This value creation is often manifested by differentiating an application beyond basic connectivity or data delivery. Ultimately, moving up the stack will require a higher level of collaboration and partnering between the ICT sector and the verticals and enterprises that develop and deliver the applications.

As more verticals intersect with the traditional ICT environment, value will move up the stack, and Service Providers will need to evolve to capture value at higher layers

Network operators could explore opportunities with verticals who have critical infrastructure needs as an alternative to DIY solutions

One of the significant trends associated with vertical markets becoming more mobile and connected is the reliance on underlying critical infrastructure. In many verticals and industry segments, alternatives for meeting critical infrastructure needs will include building the infrastructure or partnering with network operators. To be best positioned for this opportunity, network operators will need to pursue more customized solutions while leveraging common assets across verticals where needs intersect within the market. On this basis, critical infrastructure for adjoining markets represents a significant area of collaboration for factors such as security, resilience and reliable network delivery of critical services.

From an infrastructure point of view, IoT represents both a new revenue opportunity for service providers and a challenge in terms of multi-use platforms. IoT applications are diverse by nature, with different levels of performance, reliability, security and physical requirements. At the same time, IoT platforms can serve as a valuable service enabler for vertical markets.

IoT presents additional opportunities for providing platforms as a service, reselling IoT or offering end-to-end solutions for vertical markets

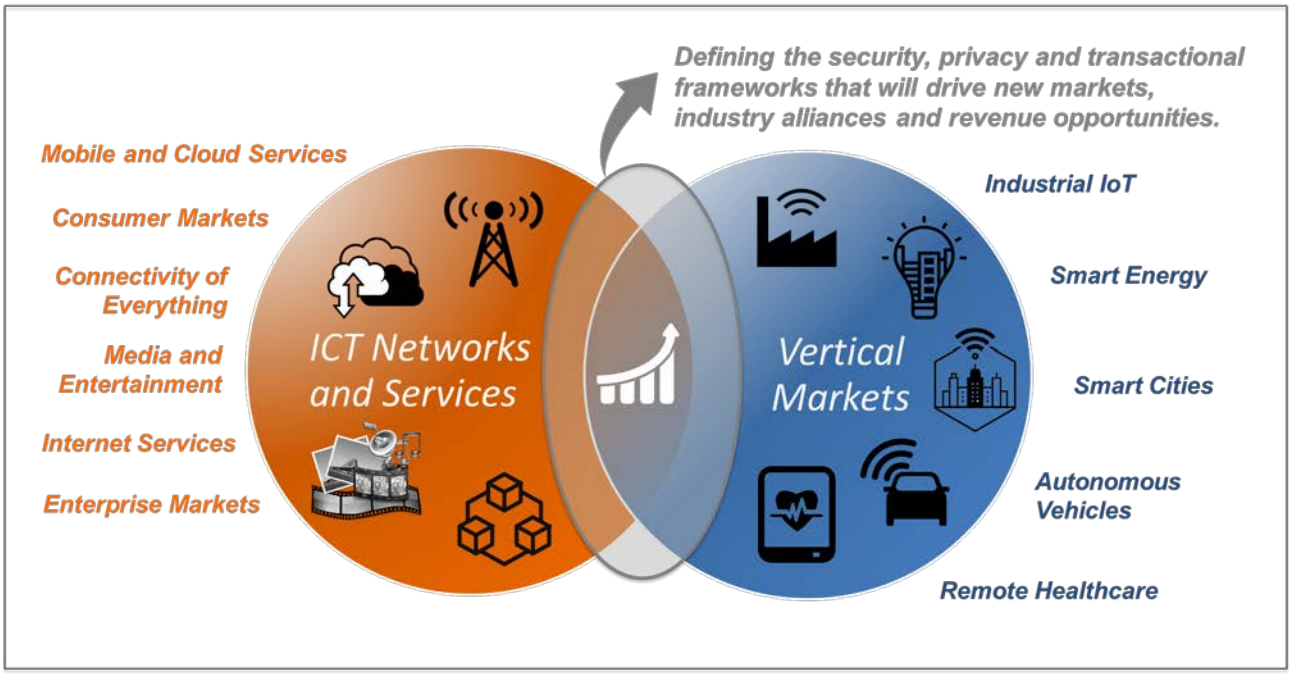
As IoT continues to penetrate the market, verticals and enterprises are expected to explore new business models, such as network operators reselling services or shared IoT platforms. In addition, the need for end-to-end service architectures will invariably cross verticals and ICT domains, representing new opportunities for operators to create scale and offer platform-based solutions.

Collaboration with satellite providers for mobile infrastructure backhaul and underserved-area connectivity

In addition to vertical market segments, adjoining industry service providers such as satellite operators offer significant opportunities for natural partnerships. Satellite operators are already exploring 5G integration needs. In many cases, adjoining service providers could find it strategically important to partner on needs such as connectivity, infrastructure backhaul and support for rural or underserved communities.

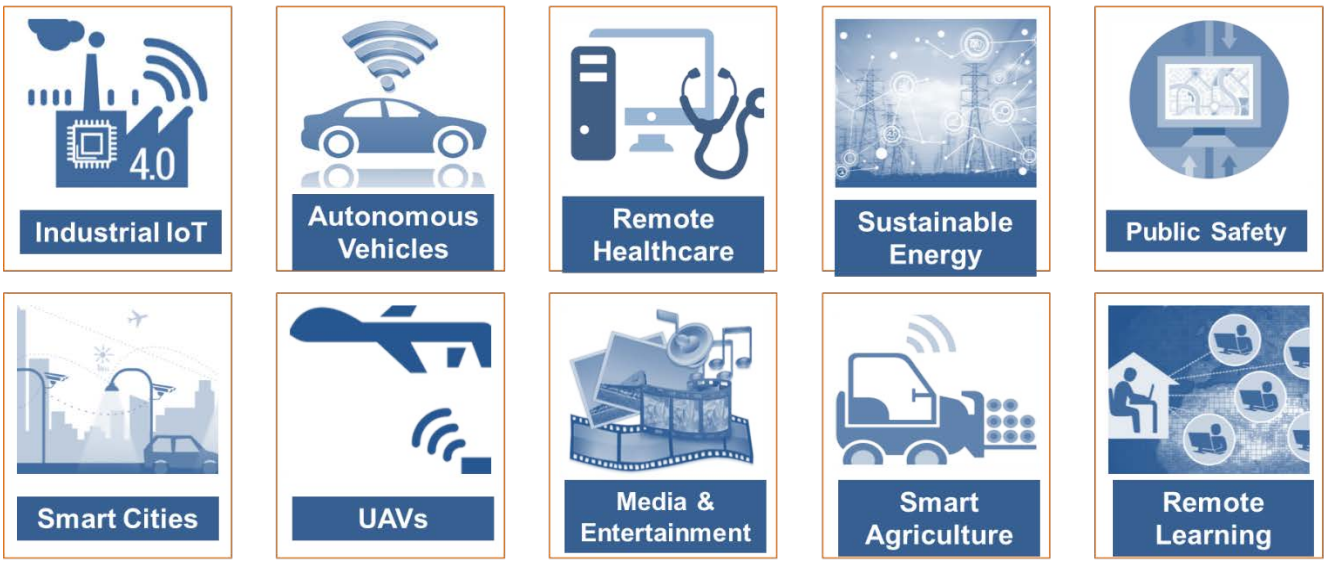
It is expected in the future that bandwidth needs, latency requirements and other performance factors will drive the need for multipath delivery of services, which will need to operate in a manner that is transparent to end users. Similarly, as more compute, storage and processing take place on the network edge, the need for mobile, fiber, satellite and unmanned aerial vehicle (UAV) delivery platforms will be characterized by different edge and core infrastructure in many cases.

In the future, the value proposition ICT industry partnerships with vertical markets will be the intersection space between network-enabled capabilities and vertical enhancers that bring additional value to services and applications.



Exploring this dynamic, ICT networks and service platforms can deliver nearly ubiquitous connectivity, backbone efficiencies, embedded AI, contextual awareness and access to other networks and enterprises. Vertical markets will be primarily focused on the application space that represents their consumers of services. However, there will exist a common set of needs that traverse each vertical market. Those needs will require segment-centric development or a shared framework approach across industries. Frameworks addressing common needs such as privacy, security, connectivity, discovery and inter-domain transactions are examples of potential opportunities for the ICT sector to drive collaborative solutions and create value for both the vertical markets and the adjoining ICT sector.

A forward-looking assessment of vertical markets offers the potential of many partners within the adjoining industry markets. Understanding that the ICT sector is uniquely positioned at this intersection, there is significant value in identifying which vertical markets offer the greatest potential for collaborative frameworks and platforms.


4.0
Industrial IoT
Autonomous Vehicles
Remote Healthcare
Sustainable Energy
Public Safety
Smart Cities
UAVs
Media & Entertainment
Smart Agriculture
Remote Learning

2.5 New Business Models

As technology evolves and the industry rapidly adapts to an ever-changing ecosystem, it will be key to assess new business models designed to leverage new opportunities and collaborations. It will be important to examine varying methods for identifying value outside of traditional subscription models and enable companies to produce and provide products and services ever closer to the moment of demand. These new business models will be enabled by progress in AI, DLT and IoT, all of which will improve data sharing, personalization, payment models and the underlaying platforms.

Distributed ledger technology solutions enables trading of assets and optimizing resources.

Innovative DLT-based solutions can help businesses create new revenue streams. In the energy sector, for instance, without the interference of a central authority, DLT platforms can enable consumer peer-to-peer trading of renewable energy from their domestic premises, where excess energy stores can be traded autonomously and in near real time over the grid. By enabling real-time coordination of renewable and grid electricity supply with demand data, energy suppliers also can use DLT to improve demand-side energy efficiency. This same DLT mechanism can be used to trade telecom services and infrastructure resources across consumers, enterprises and carriers.

In examining network slice as a service for verticals, the business model is focused on achieving a required level of performance, availability, reliability and other key factors. Network slicing enables the network to apply different requirements for functionality – such as charging, policy control, security, mobility, speed and availability – to different network

Network "slice as a service" creates a market for new applications.

segments or slices serving different groups of devices with similar service/traffic characteristics.

For example, subscriptionless services may require application-specific charging and policy control. Meanwhile, other data transport use cases can efficiently be handled with standard charging or policies. In order to handle the multitude of segments and verticals in a robust way, there is a need to isolate the different segments from each other. The network slice model is well-suited to subscriptionless services where the services of a network slice may be tuned and aligned with the large number of vertical applications or segments. The specifications for service access may then be aligned at the service level and micro-segmentation of services at a slice or sub-slice level to achieve the required objectives.

Data-as-a-service (DaaS) business models enable customers to derive useful intelligence to deliver new products/services.

Data-as-a-service (DaaS) models provide users with high-quality data on-demand that can be quickly and easily accessed from a centralized repository. A vast amount of data is being produced every day. As more IoT devices launch, and more smart cities deploy sensor-heavy infrastructures and date-exchange platforms, it is critical to have an expedient method to sort, access and leverage those mountains of information.

The *as-a-service* markets are critical for allowing network operators to expand their services into enterprise markets and addressing user demand for an ever-increasing level of customization delivered using 5G, IoT, cloud networking and AI. These, and the other new models mentioned above, are just a few of the opportunities emerging in the future network-enabled marketplace. Some additional examples include collaboration models with vertical industries allowing for revenue sharing and value-sharing oriented ecosystems growing from the rapid deployment of IoT devices.

3. Future Marketplace Vision

A critical step in defining the collective opportunities for the industry over the next decade is to converge on a vision of the future marketplace. As previously discussed in this document, there will be a number of steering factors that are expected to emerge related to societal, technology and business trends. These key considerations for the future include:

- Networks will create additive value by building intelligent connectivity as part of 5G and IoT investments.

- AI will further leverage device integration by applying network scale to create new capabilities that are not possible today.

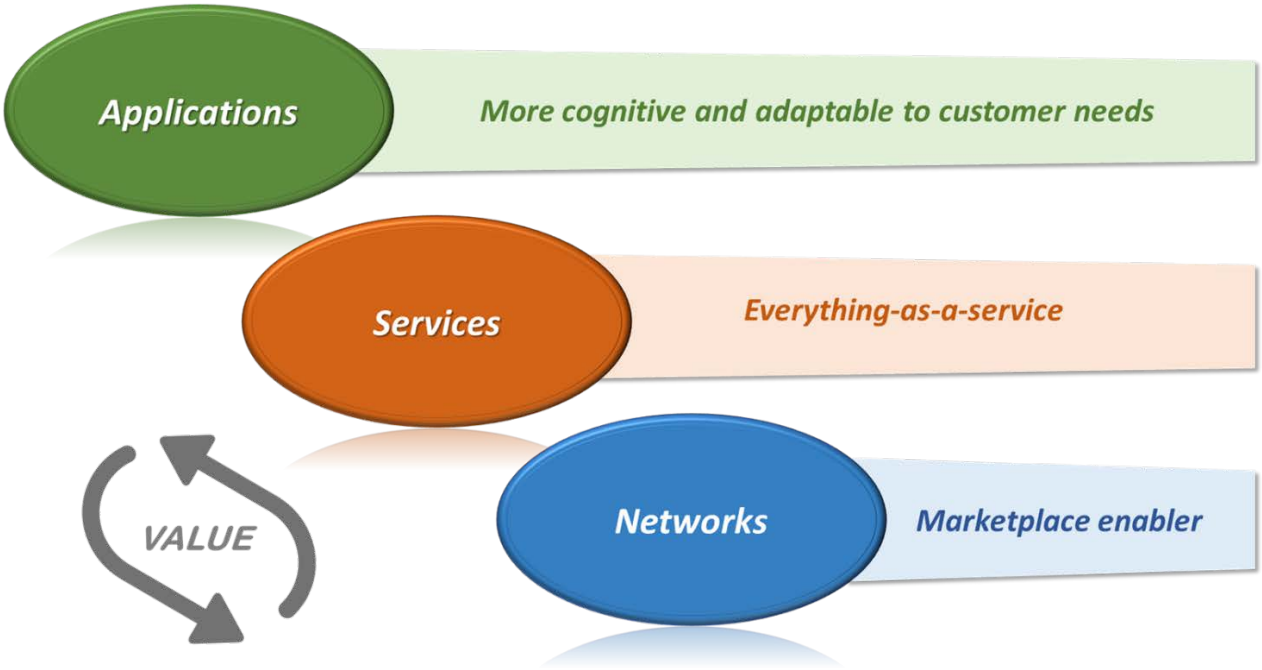
- Significant advancements at the network edge will create massive new opportunities for edge-enabled services and microservices.

- Personalization and customization will be driving forces in the future consumer and enterprise markets.

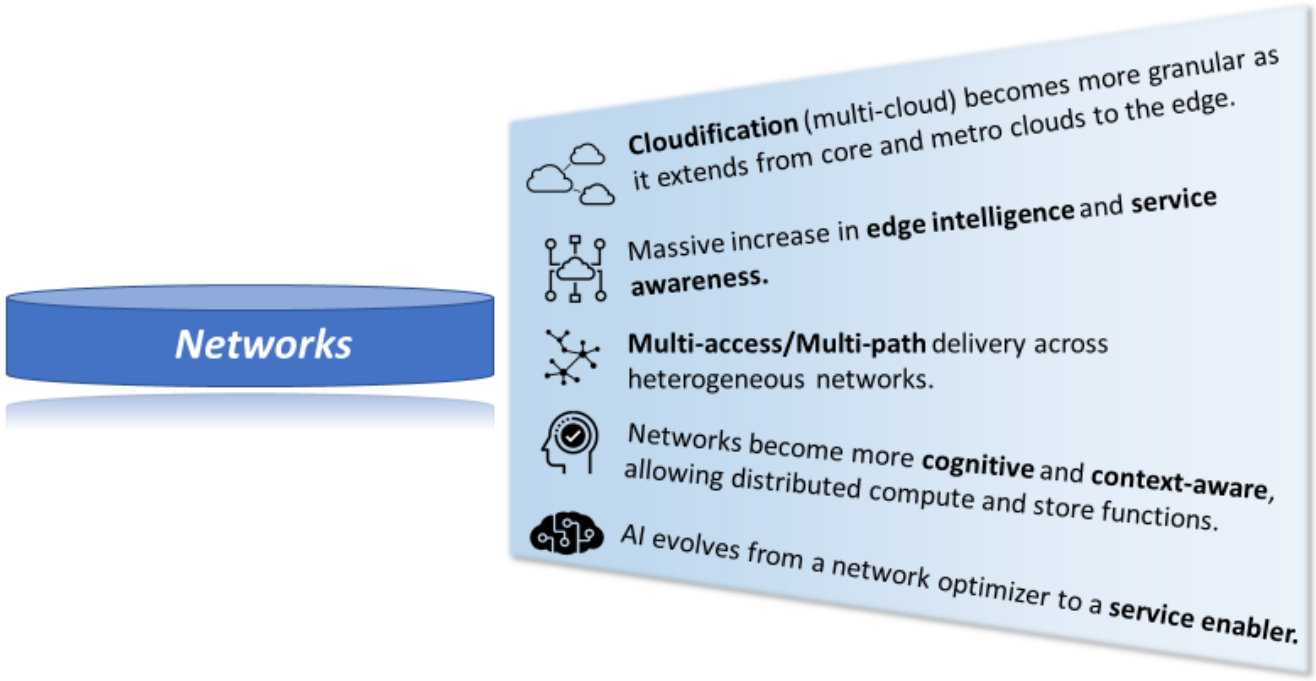
- Trust and privacy will exist at a layer above network security and will become increasingly more user-defined and contextually aware.

In assessing the future market and the related business opportunities, one of the key elements will be the future model for value creation. Although many in the industry view value as moving up the stack, another, more holistic market view is that value can be created and amplified across each of the three layers: networks, services and applications. For example, investments in network performance, coupled with service-enabling capabilities such as AI and edge intelligence, can promote new applications that create market appetite in new vertical and enterprise markets and consumer applications. This in turn creates more value at a service-delivery level, driving new

network investments. Therefore, it will become increasingly important for network operators to collaborate with the ecosystem participants, which will leverage the network-enabled marketplace to support new applications and create new markets.

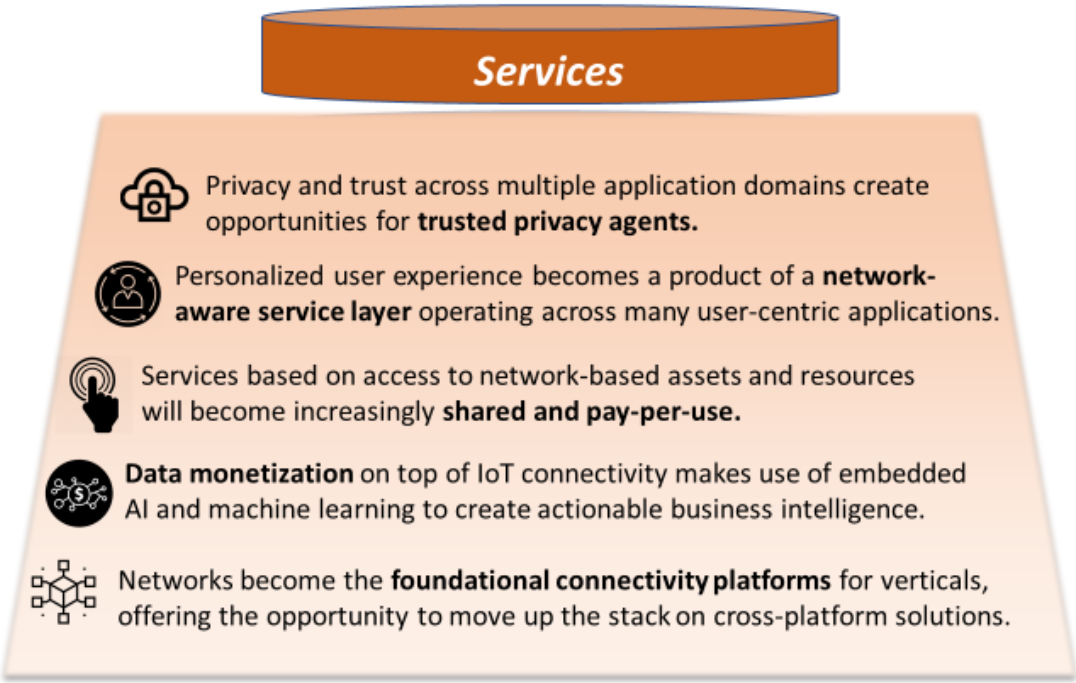


The key components of the future marketplace can be best understood by considering market-driving factors across networks, service and applications. Beginning with **networks**, we observe a compilation of network-derived factors that can be combined to deliver increased market value:



Network operators may choose to organically extend their cloud infrastructure and/or work with cloud provider partners to support domestic and international markets. As cloudification increasingly extends toward the edge, network intelligence will become more distributed and service-aware. In some cases, these services may exist entirely at the network edge to meet communications and performance requirements. Multi-access/multi-path delivery will rely on service awareness to meet more stringent performance and reliability needs. Networks will leverage contextual and cognitive data, coupled with AI, to create services that are adaptive to the customer's environment.

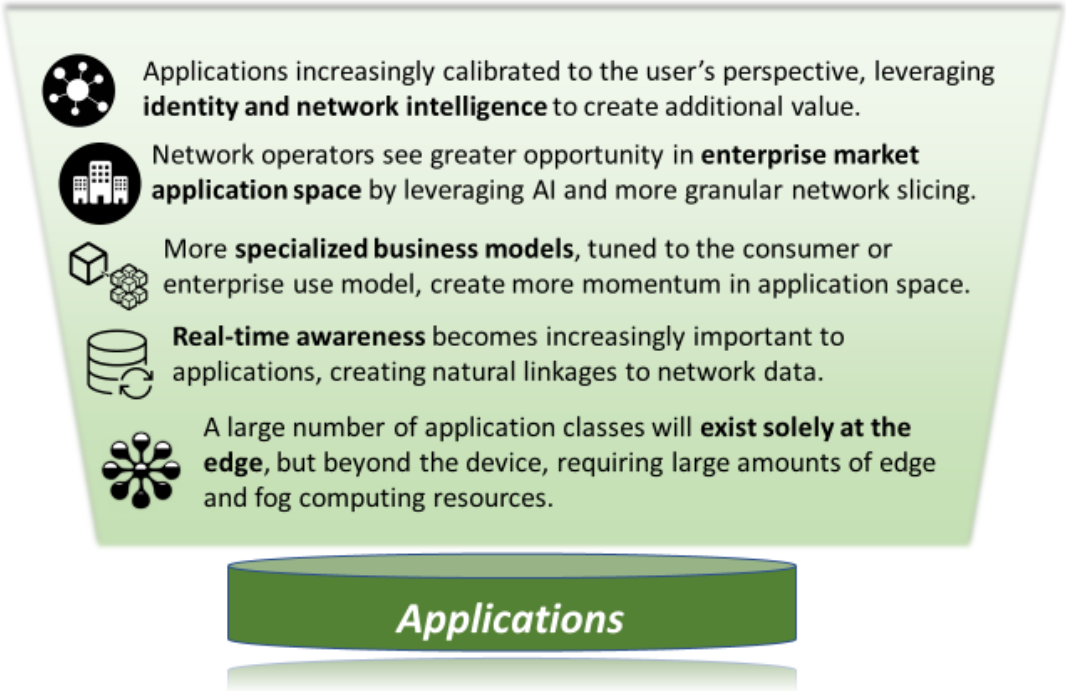
The benefits gained from these new network capabilities can then be applied to creation of new **services** domains:



Services will become more personalized and customizable by taking advantage of new user-defined attributes. The ethical and security aspects of trust and privacy will be translated into new business opportunities, creating new opportunities for trust and privacy agents across service domains. Personalized UX will become possible by the existence of a network-aware service layer that can operate across both communications networks and vertical applications in order to deliver performance.

Attributes based on user-specific needs. Furthermore, it is expected that the use of shared and pay-per-use services will increase, relying on network assets to discover data and execute transactions. For enterprises, actionable business intelligence that leverages network resources will significantly help to monetize data. As a result, services will become increasingly multi-domain across adjoining markets, supported by foundational connectivity platforms.

As a result of the developments at the network and service layers, **applications** will be able to increasingly leverage these advanced capabilities:



Applications that may have relied on customer profiles or device-level data can increasingly make use of actionable network intelligence to create rich customer experiences. Enterprise markets will recognize greater opportunities for customization through the use of AI and optimized network delivery. In turn, the use of specialized business models and transaction environments will be made possible by combining various elements of network intelligence and an abundance of data. Applications can now rely on real-time awareness attributes to understand the customer's dynamic environment. Edge-enabled applications that utilize edge and fog computing resources may solely exist at the edge compute/storage level, making use of instantaneous processing of data to deliver real-time applications.

Advancements in each of these three domains – network, service and application – will combine to create a marketplace that is increasingly tuned to real-time performance and a customer's personalized needs. Ultimately, this synergy will deliver new market capabilities that will change how customers perceive their environment and interactions.

The following is a summary of some of the market-impacting applications that will be made possible over the next decade:

Ultra-Enhanced 3D Visual Communications deliver super-high-resolution 3D imagery in real-time, 360° applications, including dynamic holographic imagery. Applications include smart factories, 3D-assisted surgery, remote healthcare, electronic contact lenses, tele-positioned UX, immersive shopping malls, virtual museum and hyper-precise 3D positioning.

Multi-Sensory Applications and Haptic Communications combine information from multiple sensory sources to allow humans and machines to interact with their environment on a real-time basis. Applications include the tactile internet, advanced multimedia experiences, remote robotic healthcare, exoskeleton-based artificial limbs, telesurgery, robotics and manufacturing.

Ultra-High Definition Positioning collectively utilizes space, air and ground communications to deliver ultra-high-definition positioning and imagery. Applications include precision navigation, public safety, accurate positioning in complex environments (underwater/underground), imagery sent to electronic glasses/contact lenses and smart agriculture.

Context-Aware Applications collect information from large numbers of contextual sources and apply it in real time to applications that leverage the environment surrounding a human or machine. Applications include transaction validation, digital identity, enhanced multimedia applications, retail merchandising, remote healthcare, IT environments and personalized multimedia warning alerts.

Intelligence–Enabled Connectivity utilize AI, hyper-connectivity and massive data to support the next generation of IoT-enabled intelligent applications. These include edge-enabled applications, privacy and security perimeters established around devices based on AI-assisted assessments and event-driven connectivity to the network.

Content Optimized Networks align mobile network content networks with the benefits of named content architectures to meet the future demands of rapid content discovery and delivery using ICN-based solutions. Applications include AR, linear video delivery, anchorless mobility, multi-access conferencing and smart mobility.

4. A Collaborative Roadmap for the Future

Creating a vision for the network-enabled marketplace provides a basis for developing a collaborative roadmap for the future. Companies and industry sectors will vigorously compete, but it is understood that foundational platforms and capabilities have traditionally acted as a catalyst for massive adoption of new applications across network and service domains.

In assessing the collaborative framework for the future, it is important to consider the directional changes that are impacting the industry. Although many of these changes are specific to industry sectors, there are several evolutionary (and common) challenges that will impact the industry, setting a compass for the future:

1. *Intersection of adjoining industry segments and vertical markets around a communications and information core.*

   Acknowledging this critical need of evolving markets, ATIS is playing an important role in bringing together industries and verticals to solve common platform and interoperability needs.

Alignment

2. *Network operators and service providers are assessing a growing set of standards, open source codes, point solutions and deployment options associated with new technologies.*

   There is an increasing need for industry organizations such as ATIS to support the integration of commonly beneficial solutions that synchronize requirements and promote interworking.

Integration

3. *Geopolitical events and challenges associated with protecting national interests are driving greater government engagement and ownership in securing critical infrastructure and services.*

Global Leadership

ATIS is promoting an environment where industry, government and academia can strengthen global leadership in the development of secure solutions and networks and advance North American interests.

A collaborative roadmap for the future must encompass both a marketplace vision and the evolutionary changes that are shaping the industry. Plotting this path to the future must promote innovation and competition, while at the same time identifying the foundational needs that will advance the industry and the surrounding marketplace.

Near-term opportunities for collaboration will focus on promoting the use of 5G and IoT solutions across vertical markets and industry sectors. In addition, enterprise

markets will realize the benefits of multi-cloud solutions and multi-access technologies that can deliver improved performance and reliability, resulting in a significantly greater suite of intelligent services and applications to this market.

Network operators are uniquely positioned to translate the emerging ethical and legal requirements for trust and privacy to business solutions, utilizing common platforms across vertical markets and industry sectors. Likewise, network-enabled AI can deliver additive value if applied across an application space that may span service domains.

In the longer term, collaboration on platform needs that fully leverage the massive increase in edge intelligence (e.g., computing and storage) can enable services and applications to take advantage of ultra-low latency and distributed processing. Ultimately, the early identification of North American needs and requirements for 6G development will promote global leadership and advance new services and applications for the North American marketplace.

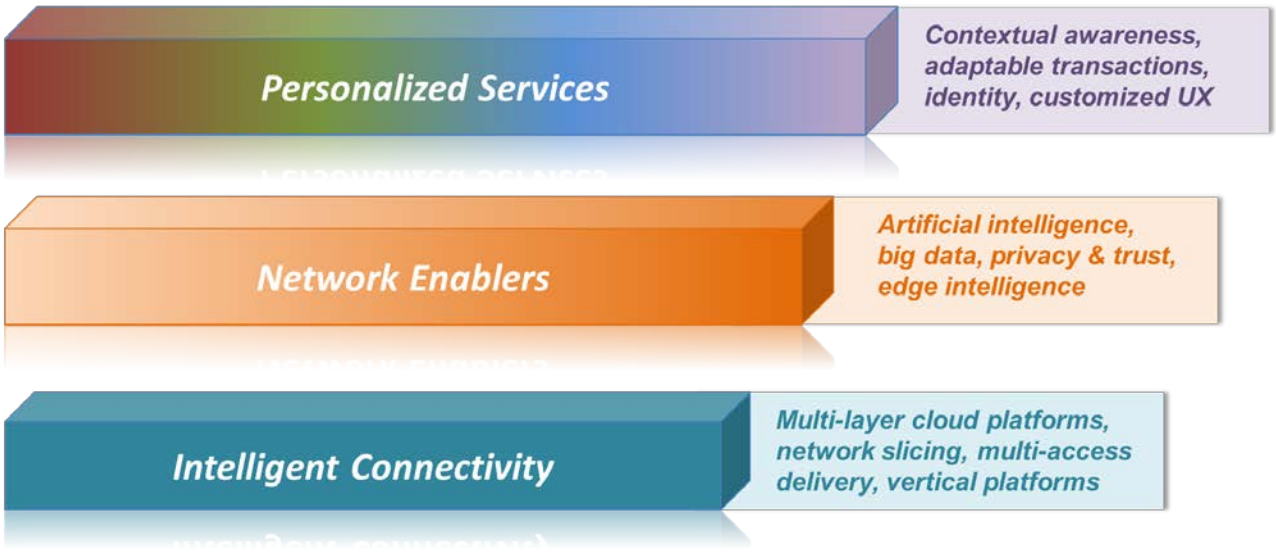
5. Conclusions

This report provides an assessment of the emerging societal, technology and business trends that are shaping the future marketplace and the critical role that network-based capabilities will play in addressing these future opportunities. Arriving at a collective vision for the network-enabled future marketplace provides the foundation for a collaborative roadmap for the industry. Although innovation and free market principles will always guide the industry, collaborative frameworks, platforms and requirements can address many of the challenges that exist across industry sectors, vertical markets and service domains.

The "Pathways to the Future" included in this document are not intended to be exclusive of other factors that may impact the future marketplace. However, when considered collectively, these factors will contribute to a robust set of services and applications that will define the next decade of development and innovation, leveraging the value that networks will bring to the market. In this respect, networks will continue to expand beyond connectivity and service delivery, leveraging network investments in value-added capabilities. Networks will have the scale to take full advantage of service enablement capabilities such as AI, massive data intelligence, privacy enforcement and flexible business transactions, shaping the future of how we communicate and use information and data.

This document also synergizes the critical trends impacting the marketplace with the pathways discussed above to develop a vision of the future market. This vision is built upon three layers – networks, services and applications – providing a collective view of

a destination point for the industry over the next decade. In considering this vision, it is important to acknowledge that those in the industry will independently leverage their core capabilities and business strategies to deliver value to their customers across many business models. Consequently, the industry will adopt strategies that operate across one or more of the layers described below:



At the **intelligent connectivity** layer, participants gain value from providing intelligent transport and data collection solutions, optimized service delivery, core and edge cloud networks and platforms that meet vertical market needs. 5G and IoT solutions are rapidly emerging to meet intelligent connectivity needs today and into the future.

The layering of **network-enablers** allows network providers to leverage investments in software-defined infrastructure, automation, AI, DaaS, trust and privacy platforms and emerging network edge intelligence. These capabilities deliver additive value on top of intelligent connectivity and leverage network scale to provide cost-effective features to consumers, enterprises and vertical markets.

Finally, the **personalized services** layer represents the future vision for service-aware and application-aware capabilities that are encompassed by contextual attributes, cognitive functions, next-generation identity management, user-defined transactions

and preferences, and adaptable privacy and trust perimeters. In essence, this layer of future network capabilities will allow network operators to deliver a personalized customer experience within networks and across domains and application space.

Ultimately, the development of this report is intended to guide the industry in realizing a collective vision and identifying the key collaborative steps that will position the industry for the next decade. Although collaboration approaches and frameworks will evolve, it is critical for the industry to converge on a set of foundational needs that will promote speed to market and customer adoption in the future marketplace.

ATIS acknowledges the key insights, market perspectives and technology guidance that were provided by its members in developing this report. The future marketplace will be shaped by a robust set of new capabilities that will change how we communicate and use information. The industry is positioned to lead this transformation and take advantage of collaboration to advance these opportunities to the marketplace.