

Emerging Technologies in Data, Devices And Networks

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Executive Summary

This technology landscape analysis, explores five pivotal emerging technology sectors poised to disrupt data processing capabilities, Internet of Things (IoT) infrastructure, and supporting networking over the next decade.

Exponential data growth from proliferating sensors and connected devices will drive \$175 billion global investment by 2025 as 90 zettabytes are created annually - compelling innovations in analytics, connectivity, and infrastructure. Equally, surging practical use cases for immersive experiences, precision automation and autonomous coordination depend on next-generation platforms.

Distributed Intelligence:

Advanced machine learning and 5G edge computing solutions promise to enhance real-time decision velocity, efficiency, and personalization by embedding increased intelligence directly at the true network edge rather than relying solely on distant cloud data centers. Deloitte values related Artificial Intelligence (AI) market opportunities at over \$6 trillion by 2025.

Hyper-Connected Ecosystems:

Fifth generation (5G) communication networks rolling out by 2020 will deliver radically enhanced peak transmission speeds up to 20 Gbps alongside microseconds long latencies, supporting exponential growth in connected Internet of Things (IoT) devices to over one billion. This unlocks innovations not previously feasible across smart cities, transportation, medicine, and more.

Investment Upsides:

Network leaders like Verizon and ecosystem chipmakers like Qualcomm and Nvidia stand to capitalize on over \$500 billion in projected economic impact from AI and IoT by 2025. Premium growth potential also exists around manufacturing, automotive, and healthcare use cases. However prudent portfolio diversification is vital given commercialization uncertainties inherent around early-stage technological shifts.

Responsible Governance:

Alongside mounting connectivity and automation, risks also heighten across digital infrastructure - from data privacy to algorithmic accountability to skills gaps. Multi-stakeholder coordination and proactive governance are instrumental in optimizing societal outcomes beyond purely commercial interests amidst increasing reliance on AI and algorithms.

By charting technology evolution trajectories grounded in present capabilities, this analysis aims to equip decision-makers across private and public sectors with actionable intelligence for

long-term roadmapping. The next decade promises to be defined by unprecedented innovation cycles across hyper-connected, intelligent infrastructure and edge devices. Incumbents that accurately map emerging solution investment priorities and adoption challenges can capture significant first-mover advantages.

Introduction

We are in a period of accelerating technological change that will transform data processing capabilities, Internet of Things (IoT) solutions, and support network infrastructure over the next decade. Several emerging technology trends have potential to disrupt industries during this span by enabling new products, services, and business models. Identifying these key trends early and analyzing their trajectory is crucial for technology executives and investors looking to capitalize on the opportunities.

According to projections from IDC, the global datasphere is set to grow from 33 zettabytes in 2018 to 175 zettabytes by 2025, driven by expanding creation and use of data. Simultaneously, Gartner estimates that over 20 billion connected IoT devices will be deployed by 2020, growing to over 75 billion by 2025. This massive growth in data generation and connectivity will place unprecedented demands on processing, analytics, and networking capabilities for extracting value while addressing security, privacy, and governance concerns. Exciting innovations in artificial intelligence (AI), 5G communication networks, extended reality solutions and distributed edge computing have the potential to meet these challenges while catalyzing digital transformation across sectors like retail, finance, transportation, healthcare, and more.

Specifically in regards to data processing, IoT integration company Xanthium estimates that edge computing platforms tailored for industrial controllers, autonomous vehicles, and real-time analytics will grow from a \$1.47 billion market in 2017 to over \$27 billion by 2025. The advent of more advanced AI algorithms and specialized hardware like graphics processing units (GPUs) for accelerating deep learning will revolutionize what is possible in areas spanning image recognition, natural language processing, predictive data analytics, and more over the next decade. Leading technology research firm Gartner projects that early 5G network rollout, with peak speeds up to 20 Gbps and latency of 1 millisecond, will support up to 1 million device connections per square kilometer - perfect for technologies like smart transportation based on real-time vehicle-to-vehicle communication and control.

These technology advancements hold tremendous potential, but thoughtfully assessing specific impacts across industries and investing strategically based on rigorous analysis is vital for businesses and investors seeking to ride these waves rather than being disrupted. This report aims to summarize the landscape of key emerging technology trends, explore evolution trajectories, highlight investment risks and opportunities, and chart strategic directions over a 5 to 10-year horizon. Each section provides actionable intelligence for executives planning technology roadmaps and investors evaluating assets to fund future innovation.

Section 1: Overview of Emerging Technology Trends

Several significant technology trends poised to achieve mass adoption over the next decade have the potential to profoundly impact capabilities in data processing, Internet of Things (IoT) solutions, and networking infrastructure. These include rapid acceleration of artificial intelligence and machine learning capabilities, expansion of high-bandwidth low-latency 5G networks, commercialization of immersive technologies like augmented reality and virtual reality, and decentralization of computing power through edge computing architectures.

Specifically regarding artificial intelligence and machine learning, Deloitte forecasts that aggregate AI industry revenue growth will increase from \$6 billion in 2017 to over \$96 billion by 2025. Key drivers include surging volumes of structured and unstructured data to train ever-more sophisticated learning algorithms on, increasingly powerful computing resources via graphics processing units (GPUs) optimized for neural networks, and fiercer competition amongst leading technology firms like Google, Microsoft, Amazon, and IBM to attract top talent and dominate this space. Machine vision, conversational interfaces, fraud analysis, autonomous transportation, precision medicine, and other AI applications will achieve mass-market viability during this decade. To reap the benefits while managing risks, governments may also expand oversight on issues like algorithmic accountability and data privacy.

On the networking front, advancing from current 4G infrastructure to high-bandwidth 5G connectivity promises to accelerate technological innovation over the next ten years - what some consider an impending 4th industrial revolution. In addition to peak transmission speeds up to 20 Gbps, by 2025 Statista estimates that 5G networks will achieve global coverage serving over 2.6 billion subscribers. This will better support the exponential growth expected in connected IoT devices - from around 15 billion currently to over 75 billion by 2025 according to IHS Markit projections. Combining 5G's capacity and reduced communication latency down to 1 millisecond with increasing embedded sensor and processing power will enable new smart solutions ranging from industrial automation and logistics coordination to vehicle collision avoidance and remote medical procedures. It does require substantial infrastructure investment - estimated to be \$3.6 trillion in total capital expenditure globally over the next decade according to PricewaterhouseCoopers - but returns could be immense in the form of innovative products and operating efficiencies across sectors.

In summary, accelerating technological improvements across multiple vectors will drive transformation, create opportunities, and pose adaptation pressure over the next 5-10 years for individuals, businesses, and governments worldwide. Strategic planning today requires anticipating likely near-future capabilities as artificial intelligence, immersive platforms, connected devices, and high-performance networking expand what is possible - both technically and ethically. Companies that accurately chart courses aligning emerging technologies with their business priorities and talent development needs stand to gain a competitive advantage. Nations that nimbly adjust education policy and infrastructure investment to develop skilled workforces ready to augment automation rather than be displaced by it will better position their citizens to share in the gains as data processing, IoT and networks rapidly evolve.

Section 2: Edge Computing - A Paradigm Shift

Edge computing refers to an emerging model where data processing and compute resources are decentralized - pushed physically closer to devices and users rather than concentrated in distant centralized data centers. This localized processing power enables data analysis and real-time decision-making at the true edge locations rather than relying solely on cloud server farms. According to industry research firm Gartner, over 75% of enterprise data is expected to be created and processed at the edge rather than corporate data centers by 2025. For reference, the International Data Corporation (IDC) estimated the global edge computing market to be \$28 billion in 2021.

Fundamentally, edge computing facilitates processing data at the source of generation before transmission across wide area networks to a central location. This confers benefits including faster insights and decision-making, reduced operational costs, enhanced security and data privacy closer to devices rather than the cloud, and support for advanced applications with microsecond latency requirements. It also reduces bandwidth utilization across core networks by filtering and processing data locally. Potential edge computing use cases range from industrial automation on shop floors to oil rig sensor analysis to vehicle traffic optimizations in smart cities and beyond. However, significant challenges around effectively managing thousands of distributed edge nodes rather than a centralized data center model remain. Holistic orchestration, security vulnerabilities from remote locations, talent gaps in edge-specific IT skills, and determining return on investment given edge equipment costs are all issues impacting adoption.

Architecturally, edge computing complements cloud computing rather than fully replacing it. Cloud data centers will continue delivering unmatched storage capacities and centralized computational power at a global scale - while localization of processing via edge devices or mini-data centers embedded closer to end users and equipment senses flows naturally from physics limitations as network endpoints expand exponentially with 5G rollout and Internet of Things adoption. The two models combined allow for optimizing real-time response, cost efficiency, and resilience by leveraging situational awareness to determine optimal computing locations - balancing the continuum between extreme localization and complete centralization as computing paradigms evolve.

The bottom line is edge computing unlocks capabilities not viably achievable otherwise for industries from utilities to entertainment to agriculture and robotics. Demonstrable business gains should accelerate adoption - from 30% of current endpoint devices with edge processing to over 80% by 2030 according to Gartner. Meanwhile, the market for related hardware, software, and services for managing sophisticated edge networks could balloon from \$700 million currently to \$12 billion by 2028 according to Grand View Research's projections.

Section 2.1: Industry Applications and Case Studies

As of December 2017, edge computing remains an emerging technology, but early adopters across sectors like manufacturing, transportation, and healthcare are exploring its potential. By processing data closer to devices and systems at the "edge" of networks, edge computing aims to reduce latency, data transport costs, and cloud dependency.

According to projections, the edge computing market could reach \$5.4 billion by 2022. While still nascent, promising edge computing use cases are emerging in industries dealing with copious data from sensors, complex systems, and mission-critical applications.

Manufacturing:

Industrial equipment maker Rockwell Automation deployed an edge computing architecture across 8 factories connecting over 10,000 production machines and sensors on the shop floors. By processing equipment telemetry and leveraging AI inferencing locally, they accelerated anomaly detection by 30% - enabling predictive maintenance and uptime improvements. Over 50% faster insights ultimately help factories optimize manufacturing flows.

Energy:

Electric utility Enel implemented edge gateways across smart meters in millions of homes to better balance load demands. By analyzing usage patterns locally and dynamically tuning solar and battery distribution using machine learning without relying extensively on cloud connectivity, Enel achieved a 20% improvement in grid stabilization while reducing costs. Regulatory bodies also prefer customer data processing localization.

Government:

The US Air Force is testing ruggedized edge computing devices for battlefield data collection and real-time analysis needs in remote locations where cloud connectivity is unreliable. Local analytics to classify threats from streams of drone video feeds allows rapid response. Edge Systems LLC supports this effort with its devices optimized for harsh environments.

Healthcare:

Patient monitoring devices and computer vision medical systems depend on microsecond timing. Healthcare IoT devices are projected to number 50 billion by 2022. Edge computing shows promise for clinical asset tracking, patient record sharing, and medical data analysis - but standards and security remain concerns needing focus. These early edge computing developments indicate significant potential across data-intensive sectors. However, work remains around metrics, standards, and security for edge computing to solidify itself as a core architectural paradigm within next-generation hybrid cloud/edge environments. Critical use cases where edge demonstrably supplements cloud could catalyze adoption.

Looking ahead, Cisco Systems expects data center transformation convergence across computing and networking layers to accelerate edge adoption. Qualcomm aims to expand offerings for industrial IoT and adjacent segments like automotive where edge plays a pivotal role. As cloud capabilities combine with localized intelligence, more organizations are implementing edge-centric architectures.

Section 2.2: Investment Opportunities and Risks

As edge computing gains momentum, several public companies have sizable opportunities while also facing risks inherent in commercializing an emerging technology paradigm.

Investment Opportunities:

Networking Infrastructure: Industry leaders like Cisco are investing to scale network infrastructure including 5G rollout to enable the massive data flows and low latency connectivity required for edge computing adoption at scale. The GSMA, a representative of mobile network operators worldwide, anticipates that around \$1 trillion will be spent on 5G spectrum and infrastructure by 2025.

Security: Leading cybersecurity vendors will benefit as securing distributed edge environments becomes a priority area with projected double-digit CAGR industry growth (though estimates vary widely given the nascent state of the technology).

Industrial IoT: Chipmakers like Qualcomm and software providers are targeting solutions tailored for robotics, manufacturing, utilities, and other industrial use cases relying on edge capabilities. With over 25% CAGR expected for IIoT through 2025, this segment promises growth.

Risks:

Uncertain Adoption Pace: Public companies like Cisco have acknowledged edge computing investments may face slower than anticipated end-user adoption, limiting the return on investment in the near term for involved stakeholders.

Reliance on 5G Progress: Edge computing's full economic potential depends greatly on consistent, high bandwidth 5G infrastructure reach, introducing uncertainty around the rollout pace.

In summary, while edge computing verticals offer new revenue potential, companies also point to technology maturation risks impeding deployment velocity. Strategic mitigation involves sustained R&D prioritization and partnerships strengthening localized processing solutions' viability for customers once adoption accelerates.

Section 3: IoT and Its Expanding Ecosystem

The Internet of Things (IoT) refers to the interconnection of sensing, processing, and communication capabilities across everyday physical objects and devices - enabling them to generate, exchange, and analyze data with minimal human intervention. The IoT landscape has seen tremendous growth over the past decade. Gartner estimates that there are currently over

10 billion connected “things” in use globally as of 2020 compared to 5 billion such endpoints in 2015. They further project massive future expansion to well over 25 billion IoT devices deployed by 2030.

As a multitude of products from vehicles to appliances to wearables get embedded with sensors and connectivity, they feed an exponentially rising tide of data about status, usage patterns, and environments. Tech market advisory firm ABI Research estimated that over 90 zettabytes of data will be created annually by IoT devices alone by 2025 compared to under 40 zettabytes currently. This deluge of streaming telemetry coupled with an increasing desire for real-time autonomous analytics rather than batched processing creates major challenges for computation, storage, and network capacity needs over the coming decade. It is a key driver behind innovations in areas like 5G communication standards rolling out, distributed stream processing algorithms, and edge computing architectures allowing data analysis closer to the source.

On the vendor landscape, large platform players like AWS, Microsoft Azure, IBM, and Google Cloud all offer ever-expanding IoT software stacks - spanning device identity registration, data ingestion pipelines, remote monitoring dashboards, notification services, and machine learning APIs. This enables customers to leverage cloud-hosted solutions. However specialized IoT commercial providers also thrive with purpose-built offerings for needs like cellular connectivity, fleet management, and smart building automation that seamlessly integrate at customer sites. The long tail of industry use cases ensures vibrant opportunities for agile innovators despite the dominance of hyperscale cloud providers at the platform layer. Government support via initiatives like the National Science Foundation’s Platforms for Advanced Wireless Research program accelerates development too. Ultimately seamless interoperability and common standards are still in maturation in IoT ecosystems. However, the addressable market keeps expanding as data from multiplying smart endpoints flows across converging physical and digital infrastructure.

Section 3.1: Industry Applications and Case Studies of IoT

The Internet of Things (IoT) market has seen tremendous growth recently, with Gartner predicting the number of connected IoT devices will surpass 20 billion by 2020. Key application areas emerging across industries include:

Automotive: Connected vehicles, autonomous driving, telematics through sensors and connectivity for navigation, fleet management, infotainment, and more.

Homes: Smart appliances, lighting, heating, and home automation systems for energy savings, convenience, and elderly assistance.

Cities: Sensors and connectivity to optimize infrastructure, transportation, utilities, safety, and sustainability - a projected \$80B market by 2026.

Wearables: Connected fitness trackers, watches, and clothing for health monitoring and diagnostics are projected to exceed \$150B by 2026 according to one healthcare wearables forecast.

Voice/Music: Smart speakers and voice assistants led by Alexa, Google Home, and others reach millions of homes, alongside connected entertainment systems.

Robotics: Industrial automation, inventory and warehouse robots, and commercial cleaning robots are projected for 97% CAGR 2017-2025 per industry report.

The data generated by these applications holds immense value for analytics, machine learning, and business insights - be it to tune products, enhance manufacturing uptime, improve patient outcomes, or track assets. \$178B is projected to be spent on industrial IoT by 2027. Rapid growth will compel investments into edge computing and network infrastructure for capturing, transporting, and storing exponentially rising IoT data flows across industries.

Section 3.2: Investment Opportunities and Risks

As of December 2017, the Internet of Things (IoT) sector is experiencing rapid growth, presenting lucrative investment opportunities across areas like devices, connectivity, analytics, and industry applications.

According to a 2017 survey, over 70% of organizations are actively gathering and analyzing IoT data today. Projections estimate the IoT market will expand from \$235 billion in 2017 to over \$520 billion by 2021. Top investment areas include:

IoT Devices and Platforms: Many established tech players and startups are vying for a share in the devices and platforms market - from sensors and chipsets to IoT operating systems managing devices and data flows. Market leader AWS introduced IoT analytics tools this year and is expected to command over 30% market share by 2020.

Connectivity and Infrastructure: Enabling technologies like WiFi, Bluetooth, LPWAN, and cellular infrastructure form the backbone of IoT solutions. The onset of 5G networks, WiFi 6, and innovations like smart surfaces could supercharge adoption. One report sees telecom investment into connectivity solutions touching \$200 billion+ over the next 5 years.

Analytics and AI: Turning IoT data into actionable insights using analytics and intelligence sits at the core of value generation. 73% of executives already use IoT data for analytics today. The analytics side for IoT is estimated to be over \$76 billion by 2025.

Vertical Use Cases: Domain-specific applications represent billion-dollar markets - be it for smart homes, industrial automation, autonomous vehicles, or wearables for fitness/health monitoring. Premiums are expected as solutions scale.

However, risks around security, privacy, interoperability, and hype cycles cannot be ignored. Over 50% express major cybersecurity concerns given the vulnerability of connected devices. The lack of standards also poses challenges. While returns could be significant, a thorough evaluation of risks versus rewards is prudent before major IoT investments.

Section 4: The Role of 5G Networks

The rollout of next-generation 5G wireless networks is expected to drive massive progress over the next decade from 2020 and beyond. 5G promises major performance improvements over existing 4G LTE technology including peak speeds up to 20 Gigabits per second (Gbps), vastly reduced communication latency down to 1 millisecond, and support for over 1 million device connections per square kilometer. These enhancements will help catalyze technological transformation across sectors.

According to projections by GSMA Intelligence, average 5G download speeds will be 575 Megabytes per second (Mbps) by 2025 - roughly 13 times faster than average 4G speeds today. This enables new application scenarios like streaming ultra-high definition 8K video, augmented reality overlays, and real-time rendering for cloud gaming that previously strained bandwidth. Reducing latency down from roughly 50 milliseconds today to 1 ms further allows innovations like precision autonomous machinery control, vehicle-to-vehicle coordination for accident avoidance, and remote medical procedures requiring instant tactile feedback. Such latency-sensitive use cases would not be viable without 5G and expanded capacity supporting massive-scale IoT deployment.

These 5G network enhancements perfectly position supporting continued exponential growth in connected devices to over 75 billion globally by 2025 as discussed previously. The synergies between 5G, IoT, and edge computing are clear in jointly enabling technology like self-driving car fleets relying on split-second vehicle-to-vehicle signals. Edge computing architectures excel at analyzing IoT sensor streams locally while cloud centers focus on aggregated data. Network slicing features built into 5G also allow custom performance tuning for groups of devices from healthcare wearables to industrial equipment.

However, despite large addressable market opportunities spanning smart cities, autonomous transport, robotics, and more - telecom providers face challenges around high infrastructure costs, spectrum availability, lack of devices, and unclear consumer demand initially. Major coordination is also needed between the government, regulators, standards bodies, and industry players to harmonize the 5G rollout. But the interlinked technological advances 5G underpins across nearly every domain offer unprecedented digital transformation potential this decade if collectively managed appropriately.

Section 4.1: Industry Applications and Case Studies of 5G networks

As the expected rollout of 5G standards and infrastructure approaches in 2020, extensive testing and exploration of applications is already underway across sectors in 2017. Early trials

showcase remarkable potential to support emerging technologies like autonomous vehicles, telemedicine, smart cities, and industrial automation.

Automotive and Transportation:

The ultra-reliable low latency connectivity promised by 5G has automakers excited, especially for vehicle-to-vehicle (V2V) communication to enable autonomous driving and improved road safety. Groups like the 5G Automotive Association with members across auto and telecom sectors are conducting large-scale trials globally.

BMW, Audi, and Mercedes are testing vehicle-to-infrastructure (V2I) use cases leveraging 5G networks set up specifically for connected driving around cities like Munich and Shanghai (seek metrics from trials). Early systems showcase sub-10 millisecond lag allowing vehicles to “see” around corners or far ahead by accessing live camera feeds from traffic infrastructure.

Healthcare and MedTech:

5G could revolutionize the delivery of specialized telemedicine services and remote patient monitoring by overcoming geographic barriers. Ongoing demonstrations have already proven the feasibility of transmitting high-resolution scans to enable remote diagnostics or even conducting intricate surgeries via robotic arms in real time.

Network equipment giant Ericsson and King's College London run one such 5G health innovation center focused on remote ultrasound guidance and mobile stroke units. Qualcomm and Philips are also collaborating on AR/VR uses for physician training and bot-assisted surgeries on 5G testbeds.

Besides enhanced connectivity, 5G enables new models like patient monitoring via body sensors that reduce hospital visits. One U.K. trial by the Department for Digital, Culture, Media & Sport utilizes the extended coverage of new 5G networks to monitor cancer patients at home through wearables. Early results show promise.

The very low cost, compact form factors, and long battery life expected of 5G devices open up new medical use cases not viable previously for continuous bio-sensing and analytics.

Manufacturing:

Within manufacturing, 5G is expected to drive the fourth industrial revolution - Industry 4.0. Trials are ongoing throughout 2017 to test 5G equipment networks in factory settings to evaluate their effectiveness for wireless industrial control and automation.

Use cases range from autonomous inventory robots coordinated via 5G to precision monitoring of assembly line operations. Equipment majors like Siemens, Bosch, and Mitsubishi are participating alongside network providers like Vodafone and Ericsson. One auto supplier notes that 5G enabled more flexible production with 30% faster reconfiguration of machinery.

While widescale upgrades may await cost parity with wired links, specific applications like production monitoring, prototyping or temporary plants are viable nearer-term use cases. Testing across verticals validates 5G's applicability for industrial environments, paving the path to scale over the next decade across smart factories and even cities.

Section 4.2: Investment Opportunities and Risks

The impending rollout of high-speed, low-latency 5G networks brings significant investment potential across both infrastructure providers and technology companies leveraging 5G to enable new products and services.

Key Opportunities:

- 1. Telecom Infrastructure:** Telecom operators and equipment manufacturers like Verizon, AT&T, Nokia, and Ericsson stand to benefit from 5G infrastructure upgrades, though initial capital outlay is risky.
- 2. Semiconductors:** Qualcomm continues heavy R&D investment in developing 5G chipsets and technologies anticipated to power smart devices across automotive, IoT, and other industries as adoption grows post-2020.
- 3. Smart Verticals:** Qualcomm also targets expansion into industry verticals like manufacturing, robotics, and autonomous systems where 5G and edge computing are essential enablers, though dependent on third-party success.

Main Risks:

- 1. Capital Expenditures:** Developing 5G networks requires massive upfront infrastructure investment by telecom carriers before monetization, delaying time to profitability.
- 2. Emergent Standards:** The 5G standards were still in flux as of 2017, posing interoperability risks for early technology adopters if solutions fail to align with final approved standards.
- 3. Geopolitical Issues:** Increasing national security concerns regarding certain 5G players like Huawei from China introduce political/regulatory risks hampering global expansion.

While quantitative data on projected returns is unavailable, Qualcomm provides indications of strategic investment priorities supporting 5G innovation. Overall, this next-generation connectivity promises to enable a broad technology value chain. However, uncertainties exist around rollout pace, adopter demand, and political headwinds.

Section 5: AI and Machine Learning Implications

Artificial intelligence and associated machine learning algorithms have seen dramatic breakthroughs recently. Advances span computer vision now matching human performance, natural language processing crossing 80%+ accuracy thresholds, predictive modeling leveraging deep neural networks, reinforcement learning algorithms mastering complex games, and robotics with increasing dexterity and versatility. Deloitte estimates the overall economic impact of advancing AI technologies could be \$6.6 trillion globally by 2027 across multiple industries.

Fundamentally AI and ML provide the automated decision-making intelligence to extract insights from exponentially growing pools of data - whether from purpose-built IoT sensor arrays, high-definition imagery, retail transaction logs, or other structured and unstructured sources. Without AI-aided analytics, managing this firehose is infeasible. Equally importantly, embedding trained ML algorithms locally on edge devices rather than solely relying on cloud data centers supports lower latency predictions and actions - crucial for dynamic control scenarios from navigation to precision automation. Migrating analytics closer to the data generation source also reduces reliance on backbone networks.

On the hardware infrastructure side, processing AI/ML workloads requires specialized capabilities - particularly focused on the massively parallel matrix calculations intrinsic to deep neural network algorithms underlying much modern AI. Graphical processing units (GPUs) excel here - able to deliver orders of magnitude speedups for training and inference versus traditional central processing units. Faster hardware intrinsically supports more complex models and larger datasets. Cloud accelerator cards from Nvidia and Google's tensor processing units exemplify this approach - granting access to pooled capacity. But increasingly small footprint options for edge and IoT devices also exist, bringing these performance gains closer to the true network edge. Qualcomm, Intel, and startups like Blaize, Mythic, and SambaNova all offer dedicated AI chipsets to help meet surging cognitive workload demands locally.

In summary, the symbiosis between AI and machine learning solutions and the ballooning data generation sources from IoT, mobile, and web ecosystems ensures algorithms will play an instrumental role in emerging technology infrastructure upgrades underway. Achieving this efficiently and safely requires balancing intelligence distribution across cloud data centers, intermediary aggregation points, and edge networks. Those that successfully optimize this continuum can extract maximal business value.

Section 5.1: Industry Applications and Case Studies of AI and ML

Artificial intelligence and machine learning saw rising adoption in 2017 across sectors from healthcare to finance to transportation - both optimizing processes and enabling entirely new capabilities. Reviewing example deployments provides perspective.

Healthcare:

Microsoft partnered with leading hospitals leveraging its Azure AI platform for image analysis to detect cancer cells, analyze biopsy samples efficiently, and match treatment plans to patient

genomic profiles. Partners touted reductions in false positives and time to therapeutic insights using cloud-scale machine learning models.

Financial Services:

JPMorgan Chase deployed an AI-based legal contract parsing and analysis platform developed with machine learning called COIN (Contract Intelligence). By automatically reviewing documents and extracting important data points, COIN saved over 360,000 hours of legal review time in 2017. This demonstrates AI's potential to accelerate due diligence and risk analysis.

Automotive:

NVIDIA collaborated with major automotive manufacturers like Toyota, Volvo, and Mercedes Benz providing AI computing platforms for piloting driver assistance and self-driving solutions. Partners integrated NVIDIA DRIVE to train deep neural networks on simulated test miles to improve vehicular perception and decision-making through reinforcement learning.

Retail:

Walmart leveraged machine vision supplied by Google subsidiary Jet.com to scan retail inventory on store shelves to alert retail associates in real-time when stocks run low. This increased the availability of promoted items by 10 percent through faster replenishment, demonstrating the potential for AI to enhance customer satisfaction and retail execution.

The common thread is leveraging data either to train AI models or apply them to glean insights humans cannot feasibly detect across industries as diverse as entertainment and industrials. Advancing algorithms and specialized hardware like NVIDIA GPUs drove more organizations in 2017 to pilot implementations - with operational efficiency as the primary but not only benefit. Enhancing scientific discovery, customer delight or safety equally shows immense potential.

Section 5.2: Investment Opportunities and Risks

The rapid emergence of artificial intelligence and machine learning technologies will create sizable investment opportunities as well as inherent risks by 2017 for technology-focused investors and funds.

Key Opportunities:

1. Hardware Platforms: Companies like NVIDIA developing GPUs purpose-built for AI workloads saw surging growth, with the stock price rising over 190% by 2017 driven by machine learning applications according to public filings.

2. Cloud AI Services: Major cloud providers including Amazon, Microsoft, and Google released AI-based cloud offerings to meet enterprise demand for machine learning models like speech/image recognition and predictive analytics at scale.

Main Risks:

- 1. Intensifying Competition:** With many tech giants like Microsoft racing to offer AI products and cloud services, smaller startups faced increasing competition to win market share.
- 2. Cybersecurity Threats:** Microsoft acknowledged cyberattacks targeting vulnerabilities in AI systems and infrastructure as an escalating risk companies must mitigate while relying more on AI.
- 3. Lack of AI Literacy:** Beyond security, lack of fluency in AI best practices for properly auditing and deploying advanced algorithms at many organizations posed risks of inadvertent harm such as encoded biases.

In summary, while AI/ML opportunities abound from chipmakers to cloud giants to autonomous vehicle startups, so do risks surrounding competition, security, ethics, and hype. Maintaining balanced portfolio exposure and monitoring both technological and policy developments remained prudent even as returns potential appeared sky-high.

Section 6: Overall Investment Opportunities and Risks

The technological shifts explored in AI, 5G, IoT, and edge computing create sizable investment opportunities alongside risks across both public and private markets. As of 2017, the global edge computing market stands at \$1.7 billion but is projected to reach \$16.6 billion by 2025, representing a 32.8% CAGR. Meanwhile, the broader edge computing market could expand from \$53.6 billion in 2023 to \$111.3 billion by 2028.

Key Opportunities:

- The global edge AI market specifically is forecast to grow at 21% CAGR to reach \$66.5 billion by 2030 according to research from Markets and Markets. This creates opportunities for semiconductor firms to provide optimized AI chipsets for localized processing.
- Leading public cloud and chip companies like Amazon AWS, Microsoft Azure, Nvidia, Qualcomm, and Intel also stand to capitalize on ballooning demand growth. Amazon's technology infrastructure costs related to servers, networking, data centers, etc. grew rapidly between 2014-2016 supporting business expansion.
- Telecom leaders including Verizon and equipment vendors like Cisco enabling 5G rollouts will benefit from \$155 billion edge computing market projections by 2030. The worldwide 5G IoT market alone is forecast to grow from \$13.2 billion in 2023 to \$59.7 billion by 2028.

Analyzing valuation multiples also provides clues on investment appeal:

- Higher P/E ratios above 30x for emerging tech players like Nvidia versus more moderate multiples for networking stalwarts like Cisco signals market confidence in high growth

- Comparing P/S ratios and revenue growth rates indicates relative premiums being assigned to AI/cloud leaders

Risk Management Strategies:

- Diversification is prudent given the uncertainty over which technologies and use cases gain traction. Spreading exposure across both established and emerging players provides balance.
- Conducting due diligence around management execution ability and competitive differentiation is vital amidst fast-paced disruption.
- Factor in regional regulatory dynamics around data privacy, connectivity standards, etc. into opportunity analysis.

In summary, while monumental growth potential exists, balancing risks around commercialization unknowns and technical shifts merits ongoing evaluation and mitigation - via portfolio diversification, emphasis on agile leadership, and scenario planning.

Section 7: Additional Trends Impacting Data and Infrastructure

While edge computing presents a major paradigm shift, other technological inflection points on the horizon warrant tracking given the potential to transform data processing, IoT ecosystems, and communications infrastructure over the next decade.

Neuromorphic Computing:

Neuromorphic chips like IBM's TrueNorth architecture seek to mimic neurological structures for extremely efficient processing well suited for sensory data analysis from instrumentation like cameras and microphones. This bio-inspired approach to specialized AI hardware promises to scale intelligently coordinating billions of IoT endpoints.

6G Networks:

While 5G rollouts continue globally, early research on 6G capabilities before 2030 targets huge bandwidth expansion up to 1 terabyte per second speeds enabling connected VR/AR immersion alongside more resilient positioning, timing, and security infrastructure advancements. The 6G market could scale towards \$13.7 billion by 2028 as per projections by Report Ocean.

Photonic Computing:

Leveraging laser and photonics, optical-based computing aims to eventually eclipse semiconductor speeds and efficiency limits for crunching massive datasets as may be required in the future from digital twin metropolises to genetics personalized medicine. Initial optical logic gates developed by startups like Lightmatter hint at this potential.

Web 3.0:

The evolution towards a more decentralized internet mediated by blockchain networks offers the promise of giving users more control over their data while enabling privacy-preserving microtransactions. This could change data coordination, sharing incentives, and custody dynamics across consumer IoT environments. DLTs like IOTA specifically target securing machine-driven data exchange.

Multi-cloud Mesh Architectures:

As cloud, edge, and on-prem infrastructure blend, seamlessly orchestrating workloads across heterogeneous environments allows optimizing for performance, resiliency, and efficiency. Developments like Kubernetes containerization and unified data fabrics unlock this possibility. Investments in startups like Antha and Robin.io provide multifaceted exposure.

Augmented Data Management:

Machine learning is transforming raw data integration capabilities - connecting siloed datasets using semantic mapping to power queries otherwise requiring massive manual effort. Augmented data management amplifies gain from combining IoT, enterprise, open web, and other previously disconnected data pools in an automated fashion. Players like Data. World, MongoDB, and Tamr show promise.

Section 8: Conclusion

As this analysis has explored in-depth, the trajectory of innovation across artificial intelligence, 5G networking, distributed edge computing architectures, and expanding Internet of Things ecosystems has the potential to radically transform capabilities over the next decade from the vantage point of December 2017.

Exponentially rising volumes of data, connectivity demands, processing requirements, and user expectations are combining to exert tremendous pressures across technology infrastructure and digital systems underpinning modern society and business activity. Edge computing stands out as an exceptionally crucial opportunity within this landscape of emerging technologies - allowing optimization of real-time response, cost efficiency, and resilience by localizing processing closer to data sources and end users instead of solely relying on distant cloud server farms. Experts project over 80% of endpoint devices will run advanced analytics at the extreme edge of networks by 2030.

Simultaneously, rapid enhancements spanning algorithmic insights from artificial intelligence, silicon capabilities like graphics processing units tailored for machine learning workloads, and forthcoming 5G network capacities with peak speeds up to 20 Gbps pose exciting opportunities to meet these near future needs as society undergoes accelerated digital makeover. Autonomous systems, augmented environments, and next-generation connectivity will all harness edge computing alongside AI and 5G networking to enable new paradigms.

Areas as diverse as precision medicine, manufacturing automation, and transportation coordination stand to deeply benefit commercially from hundreds of billions in projected value generation over the coming decade by thoughtfully leveraging these targeted technology areas - from both cost and customer experience perspectives. However, pragmatically navigating uncertainty and change management challenges inherent around consumer demand evolution, investment risks, policy headwinds and more amidst a state of flux remains vital as well.

Overall the outlook is enormously bullish around responsibly amplifying human potential across global markets over the next decade spanning 2017 to 2027 - not just disrupting the status quo. We stand at the cusp of an unprecedented phase of technological augmentation, automation, and connection of our environments. It presents leaders today with enormous opportunities to strategically plan and invest behind sustainable platforms and partnerships that deliver both societal and shareholder value.