



Research Agenda, Q1 2017

Internet of Things

Covering the technologies required to enable the virtualization of the physical world and the new avenues of enterprise value creation made possible by turning IoT data into actionable business insight.

The Internet of Things (IoT) Channel focuses on the emerging technology paradigm in which sensors, 'connected' machines and other smart devices create and then disseminate data over the internet and private enterprise networks. It provides an enterprise-centric perspective on the early adoption and demonstrable benefit of IoT, incorporating insights from throughout 451 Research including enterprise platforms, data and analytics, mobility, security, datacenter and cloud technologies.

ABOUT 451 RESEARCH

451 Research is a preeminent information technology research and advisory company. With a core focus on technology innovation and market disruption, we provide essential insight for leaders of the digital economy. More than 100 analysts and consultants deliver that insight via syndicated research, advisory services and live events to more than 1,000 client organizations in North America, Europe and around the world. Founded in 2000 and headquartered in New York, 451 Research is a division of The 451 Group.

Analysts



Christian Renaud
Research Director,
Internet of Things



Kevin Burden
Vice President,
Mobility Research &
Data Strategy



Patrick Daly
Senior Research
Associate



Laura DiDio
Research Director,
VotE: IoT



Andy Golub
Managing Director,
VoCUL



Eric Hanselman
Chief Analyst



Ian Hughes
Analyst, Internet of
Things



David Immerman
Senior Research
Associate



Brian Partridge
Vice President,
Mobility, Telecom
and Internet of
Things



Ken Rehbehn
Principal Analyst

Overview

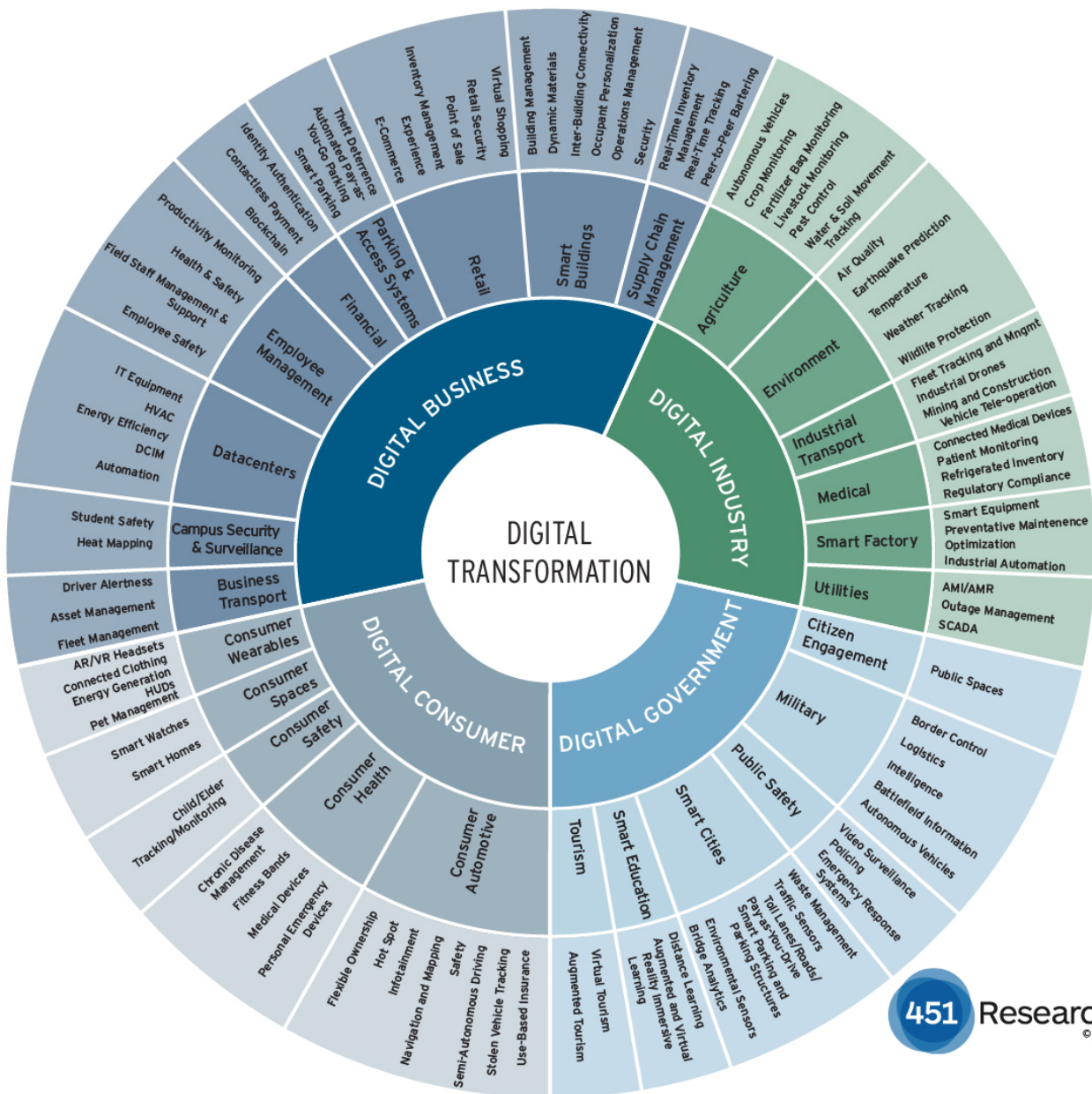
451 Research's coverage of the Internet of Things (IoT) spans the market across a variety of segments, from infrastructure and devices required to enable physical-world 'things' communicating data to the internet-centric infrastructure required to network, process, store, share and take action based on IoT data insights.

Over the past decade, machine-to-machine (M2M) communications has steadily evolved from a niche technology used mostly in industrial applications to a mature and must-have capability in several major vertical industries including retail, healthcare and transportation. We are now entering a new IoT era in which anything that can be connected to the internet will be as the marginal costs of adding connectivity nears zero. We view the markets for M2M and IoT as distinct but related and overlapping. M2M is a mature market segment; IoT is in its infancy.

Fueling IoT market growth, segment speculation and c-level interest are falling connected device costs, advances in connected device management and application tools and platforms, ubiquitous and affordable data connectivity, and a marked increase in overall enterprise awareness on the positive return on investment (ROI) characteristics of connected device solutions in the context of their business operations.

IoT Market Development

Source: 451 Research, 2017



Methodology

The 451 Research IoT research channel integrates both qualitative and quantitative research to triangulate on the early development of the IoT market. Qualitatively, the research team works with early adopter customers, IoT technology vendors, ecosystem players (funding sources, professional services) and the broader market to uncover where the real value is being realized in IoT, return on investment of early deployments, nascent standardization efforts and future indicators of market development.

451 Research divides the market into 10 related categories: edge computing, IoT operating systems, gateways/aggregation, wearables, modules and connectivity, bandwidth providers, middleware and applications, big data, cloud and professional services. We work with companies in each of these categories to track these areas as they mature their offerings based on real-world deployments. These are initial categories that we anticipate will evolve as the IoT market develops and clear use cases and technology 'winners' emerge.

451 Research brings unique quantitative insight to the IoT market, from both the supply side and the demand side. Through market sizing and forecasting of the myriad device types and radios driving the IoT revolution, we can monitor the growth and volume of endpoints producing data. We also conduct quarterly IT decision-maker and consumer demand surveys to keep the pulse of the reality of enterprise IoT adoption and the real value it is generating today, as well as expectations for the future.

Edge Computing

Microcontrollers, systems on a chip (SOCs) and sensors are critical enablers to the IoT ecosystem; they make 'things' smart or provide contextual information from the physical environment. 451 Research covers innovations in edge devices as they integrate legacy systems into IoT, as well as new edge connectivity paradigms.

IoT Operating Systems

IoT operating systems are software that directs the edge hardware function, program scheduling, storage management, I/O and communication resources within an IoT system. Similar to the role of an OS on a computer or mobile OS on a smartphone, the IoT OS provides the critical platform glue between edge-computing resources and sensors and IoT applications. 451 Research follows the development of the nascent IoT operating system segment as it matures to include proprietary and new protocols as well as policy and security requirements from enterprises.

Gateways and Aggregation

IoT edge gateways and aggregation provide a critical networking layer that can aggregate sensor and smart object data streams for delivery to the cloud or datacenters, or, increasingly, provide intelligent edge-computing capabilities. Advanced gateway designs provide rugged aggregation points for sensor data, which can also provide proxy security services for downstream things with limited on-device countermeasures. 451 Research coverage of IoT gateways and aggregation devices follows the different methods incumbent and challenger vendors will use to solve the unique scale and bandwidth needs of billions of connected things.

Wearable Technologies

Wearable technology devices represent a rapidly growing point of ingress for IoT data, sensing data directly from the humans that wear them or from their surrounding environment. 451 Research coverage includes fitness bands, smart watches and heads-up displays (HUDs) in its current forecast and will expand tracking to include connected clothing, body-worn cameras, wearable medical technologies, smart jewelry, etc., as volumes warrant it. There are a number of companies focused on bringing both technology categories into the industrial setting.

Modules and Connectivity

IoT connectivity modules provide the RF wireless capabilities for connected things to transmit data over very short, medium or long distances. The IoT connectivity module segment provides the basic plumbing for IoT by providing the data transmission from things to either an aggregation point or directly to a remote datacenter or cloud resource. We research innovations in edge devices as they integrate legacy systems into IoT, as well as new edge connectivity paradigms.

Bandwidth

IoT bandwidth providers offer the managed fixed and mobile connectivity on-ramps that connect things to datacenter/cloud and back-end systems. In the past five years, the pricing for 2/3/4G cellular connectivity has fallen drastically due to hypercompetitive market conditions and strong motivation on the part of MNOs and MVNOs to win M2M/IoT business around the globe. 451 Research covers how IoT presents new opportunities and challenges to traditional bandwidth providers, as well as new standards and challengers such as ultra-narrow band (UNB) alternatives.

Middleware and Applications

IoT middleware and application platforms have emerged to take on higher-order IoT device management, application development, data handling and management, data visualization and middleware-driven integration to enterprise IT systems and API management. This category includes horizontal platforms such as SIM management and operations, middleware, API management, device management and data management. This category also includes vertical-specific IoT platforms such as those sold into the connected car ecosystem, e.g., BlackBerry/QNX. 451 Research covers companies with IoT middleware and applications as well as pre-standard and industry consortia attempting to standardize on common data formats.

Big Data

Databases and analytics are where the key value of IoT is realized, in the actionable insights provided by the large quantities of data being aggregated. IoT's many use cases and applications eschew a single database model, and the market is already awash with multiple distributed and centralized database and analytics models. In addition, many mission-critical IoT applications require rapid analysis closer to the data 'surface,' and will require a combination of both distributed and centralized approaches. We cover innovative database approaches to the IoT market as well as the various approaches vendors are taking to analyze the unprecedented amount of data IoT creates.

Cloud

The cloud has a critical enabling role as the execution venue of choice for many IoT applications and the tools that will drive the insights to deliver ROI. The availability of high-quality, virtualized, on-demand compute, storage and network resources in public, private or hybrid configurations has forever altered the enterprise IT infrastructure model for deploying and supporting enterprise application workloads. The game-changing economic and scale advantages of the cloud model align perfectly with the requirements of IoT, and they could be argued as the most critical enabler for its long-term viability as the execution venue of choice. 451 Research covers the many companies that have staked out IoT as the next growth market for new or existing cloud offerings and big data services.

Professional Services

This segment includes professional consulting and integration services related to IoT strategy, business process design, application design, systems integration and security. Despite the hype, IoT is still nascent and rapidly developing. Embracing IoT for any enterprise will introduce untold complexity and disruption to both existing IT systems and business processes. Global and regional systems integrators and consultants will be called on to play their normal roles from beginning to end of any IoT strategy lifecycle as well, either on their own or as part of even larger enterprise digitization efforts. As IoT develops and matures, 451 Research will cover the large population of professional services firms that will assist enterprises in developing and deploying their own IoT strategies.

Note

In addition to the market dynamics listed above, the IoT Channel will continue to collaborate with fellow 451 Research analysts across other channels as we assess the wider implications of the increased industry focus on IoT. Numerous vendors overlap areas of our research, and some have multiple products in different technology domains.

Upcoming Research on the Internet of Things

Voice of the Enterprise

Combining 451 Research's industry-leading analysis with an extensive network of more than 50,000 senior IT professionals, Voice of the Enterprise: IoT tracks the adoption of IoT across thousands of organizations and exposes the major opportunities for enterprises, IT vendors, suppliers and investors.

Delivered quarterly, this unique study combines comprehensive, survey-driven analyst reports and statistically significant data to uncover the effect innovative IoT initiatives are having on the adoption of IT infrastructure, cloud, professional services and more at enterprises of different sizes across many industries. This research tracks the real opportunity for IoT today as well as what to expect for the future through ongoing trending questions in conjunction with quarterly themes, as outlined below.

	Workloads and Key Projects	Organizational Dynamics	Vendor Evaluations	Budgets & Outlook
Internet of Things	Q1	Q2	Q3	Q4

Voice of the Connected User Landscape (VoCUL)

In addition to its network of 50,000 senior IT professionals, 451 Research also leverages its Leading Indicator panel of 25,000 business and technology professionals, who are vetted through an application process that admits those with the lifestyle and professional attributes that provide a forward-looking view of technologies, companies and the macro economy well in advance of other sources. These insights are analyzed against companion results from quarterly, population representative surveys of US consumers based on Census Bureau statistics, which confirm how the leading indicator trends are unfolding in the mass market. Together, they provide a multidimensional and comprehensive package of survey insights that is unique in the marketplace.

Among other areas, VoCUL focuses on IoT adoption trends including wearable devices, smart homes and connected cars.

	Leading Indicator	Representative	Advisory
Wireless Service Provider Trends	Quarterly	Quarterly	
TV Service Provider and Alternative TV Trends	Quarterly	Quarterly	
Smart Home and ISP Trends	Q2, Q4	Quarterly	
Wearable Device Trends	Quarterly	Quarterly	
Wireless Service Providers			Quarterly
Endpoints and IoT			Quarterly

Supply-Side Research

IoT represents a growing market opportunity for new devices, solutions, connections and services beyond traditional voice and data. Understanding the pace of growth and identifying the segments and industries driving value in the market is the focus of 451 Research's market tracking and forecasting methodologies. Through quarterly updates, 451 Research delivers its tracking and forecasting of the supply of key IoT market indicators by region and country.

Market Forecast	IoT/M2M Cellular Connections Forecast
Updated and Published Quarterly	Annual cellular connections, ARPU, revenue By 15 unique vertical application markets By 7 regions By 65 countries
Market Forecast	Mobile Data Traffic Forecast
Updated and Published Quarterly	Data traffic by network generation and device type By 7 regions
Market Monitor	IoT/M2M Module Tracking and Forecast
Updated and Published Quarterly	Global OEM annual unit market share

Technology & Business Insight Reports

M&A Outlook 2017: Mobility and the Internet of Things

Analysts: Brian Partridge, Christian Renaud, Chris Marsh, Declan Lonergan, Brenon Daly

Publication Date: Q1 2017

Even after a recent record tech M&A run, dealmakers still had ambitious shopping plans in 2016. Across the globe, tech acquirers announced \$500bn worth of transactions in the just-completed year, ranking 2016 as the second-highest annual total since the internet bubble burst. More than any other year, 2016 saw an expansion of buyers beyond the 'usual suspects,' as old-line companies got caught up in transforming their businesses through M&A.

Data Management of Things 2017

Analysts: Jason Stamper, Ian Hughes

Publication Date: Q1 2017

IoT is placing new demands on data storage, networking, processing and analytics. For end users, vendors and investors, it represents both a challenge and an opportunity. This report, the successor to the 2015 report of the same name, looks at the changing speed and nature of data in the era of IoT, asks why traditional systems can no longer cope, and identifies 10 technologies that might just help.

IoT in Transportation

Analysts: Christian Renaud, David Immerman

Publication Date: Q1 2017

Telematics and fleet management are not new markets, but they face new, innovative technology that can potentially disrupt the transportation industry as a whole. This report outlines these technologies and their role in the current telematics market, as well as IoT technology that we see having a substantial impact on telematics in the near future. We will provide vendor profiles to illustrate the innovative technologies being optimized by both large and small telematics players. The report also broadly outlines the future potential impacts of autonomous vehicles on the transportation sector and IoT.

Industrial IoT

Analyst: Ian Hughes

Publication Date: Q2 2017

The Industrial Internet of Things (IIoT) is the most mature use case for instrumentation and actuation of devices. With a mixture of critical legacy brownfield systems and aspirations to new, more complex plans, there are significant challenges and opportunities for companies to expand and move into this space. This report looks at the areas of IIoT that are evolving and the new opportunities for more traditional IT companies to provide value across the stack. It will include looking at the significant trends, companies and collaborations including the output of influential IIoT consortia.

War of the (Internet of Things) Radios 2017

Analyst: Ken Rehbehn

Publication Date: Q2 2017

The transformative potential of IoT continues to raise expectations with investors, enterprises, equipment suppliers and network operators. But getting the most out of IoT technology means securing cost-effective wide area network access for low-power, low-data-rate devices. This report, the successor to the 2016 report of the same name, looks at progress and changes in the radio networks that will enable emerging IoT applications.

Platforms & Applications: The Role of Edge, Aggregation and Cloud in IoT

Analyst: Christian Renaud

Publication Date: Q3 2017

IoT platforms transform biological, environmental, and machine data into actionable insights. Platform capabilities vary, however, causing customer confusion as to what constitutes a 'platform,' and how platforms differ from the applications they enable. This report surveys the broad landscape of IoT platforms and offers a taxonomy for how they should be categorized and compared to one another, as well as identifying where platform capability currently resides to service the diverse use cases within IoT.

IoT Security in the Industrial Sector

Analyst: Patrick Daly

Publication Date: Q3 2017

OT networks, including ICS and SCADA systems, were originally air-gapped from the IT network and as such were built without even the most basic security features. As those networks have increasingly been connected to IT systems, the air-gap has shrunk while the need for security has increased. This report examines the major vulnerabilities within OT networks today and provides a guide for maintaining an adequate level of security, complete with a description of available technologies and active vendors to help IT and OT decision-makers navigate the market.

Augmented and Virtual Reality: User Interfaces Into the Internet of Things

Analyst: Ian Hughes

Publication Date: Q4 2017

IoT applications generate an unprecedented amount of data, challenging traditional visualization and analytics tools. This TBI looks at augmented and virtual reality systems as emerging user interfaces for viewing and interacting with the things and data of IoT.

Preview: 2018 Trends in the Internet of Things

Analyst: Christian Renaud

Publication Date: Q4 2017

This report provides a view of the key trends that will affect the market in 2018. It details the top trends, likely impact and recommendations for each. We look specifically at innovative and disruptive technologies emerging to pull together a dynamic supply chain as well as the resurgence of digital commerce and the challenges of embracing cloud options for business applications.