EXECUTIVE SUMMARY

GOVERNING DIGITAL TRANSFORMATION AND EMERGING TECHNOLOGIES

A PRACTICAL GUIDE

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INTRODUCTION

COMPETING IN THE DIGITAL ERA

A convergence of global trends over the last 20 years, including the boom in global data traffic, online users, connected objects, and access to cloud computing has laid the groundwork for the digital era. This era is predicted to bring tremendous value for business and societies alike. Armed with access to new technologies such as artificial intelligence (AI), blockchain, internet of things, and robotics process automation (RPA), traditional firms across industries are pursuing digital transformation to reimagine solutions to existing business challenges and create exponential value for their customers and partners.

Businesses globally have a right to be optimistic. According to the World Economic Forum, the combined value of the digitalization already occurring in every industry could generate upwards of $100 trillion over the next six years. That’s a massive increase, representing more than a doubling of the entire global gross domestic product (GDP) today.

However, traditional firms, regardless of size, recognize the potential for disruption from technology giants and digital startups and the resulting threat of value migration. Disruptors like Uber, Amazon, and Tesla have found ways to meet rising customer expectations, and in doing so have set the standards for what “good” looks like. These technology companies are signaling that they intend to insert themselves wherever they can remove friction, capture customer attention, drive out market inefficiencies, or strip away information to fuel their data and insight engines.

To compete in the digital era, traditional firms are increasingly asking more fundamental questions: How does our company stay relevant? How do we change our strategy to more effectively capture and retain customers’ attention? How fast can we move? Does our company have time to shift from low-growth to high-growth businesses before disruptors steal our customers? Where do we have assets that can become the basis of information-powered new businesses?

But traditional firms face very different circumstances than new digital businesses. They have advantages—established brands, markets, know-how, customers, suppliers, organizations, and cash flow. However, they rely on decades-old approaches, legacy systems, deeply embedded processes and capabilities, and deliberate execution and decision-making cultures to deliver profitable core businesses. This makes competing on customer experience, speed, agility, and lower cost a major challenge. As a result, digital transformation is often a complex and costly endeavor.

BOARDS PLAY A CRITICAL ROLE IN GUIDING FIRMS TOWARD SUCCESSFUL TRANSFORMATION

Across industries, directors recognize the near-term disruptive potential of new business models enabled by emerging technologies. As a result, boards are actively reassessing their oversight role in governing digital transformation initiatives, given that they play a critical role in guiding firms toward successful transformation to not only remain relevant but also thrive in the digital era.

According to the Report of the NACD Blue Ribbon Commission on Adaptive Governance: Board Oversight of Disruptive Risks, boards are eager to “find ways to tap into fresh, unconventional thinking to improve oversight of the risks and opportunities posed by disruptive forces and events, including... the seismic shifts in the way we live and work that are being accelerated by new and emerging technologies.”

Boards also realize that their current state of governance is no longer enough to fulfill their fiduciary duty to shareholders. Multiple challenges exist in enabling board readiness in this area, including but not limited to a lack of clarity on digital transformation and adequate metrics to track progress; challenges in separating hype from reality with emerging technologies; insufficient technology expertise; ingrained habits about board composition; and a prevailing and largely protective bias driven by recent attention to cyber and data privacy risk.

**Exhibit 1: Boards across industries expect near-term disruption from emerging technologies**

My company is vulnerable to the impact of disruption from emerging technologies within the next 12 months

![Bar chart showing the percentage of boards across industries that expect disruption within the next 12 months](chart)

**Source:** NACD 2019 Digital Governance Pulse Survey

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INTRODUCING A PRACTICAL GUIDE TO GOVERNANCE OF DIGITAL TRANSFORMATION

To help boards address this challenge, this report introduces a flexible and practical guide to prepare directors to navigate the complexities of digital transformation and emerging technologies, and guide their organizations to become more digital and data-driven.

The guide outlined in this report has been created as a result of a partnership between the NACD and Marsh & McLennan Companies. The findings presented in this report draw from primary research conducted through interviews with company directors, as well as a survey of 200 NACD members on the opportunities and challenges they face in addressing digital transformation. Accounting for differences in digital maturity across companies and even industries, our research outlines five fundamental principles to advance board oversight of digital transformation and emerging technologies.

**Principle 1:** Approach emerging technology as a strategic imperative, not just an operational issue.

**Principle 2:** Develop collective, continuous technology-specific learning and development goals.

**Principle 3:** (Re)align board structure and composition to reflect the growing significance of technology as a driver of both growth and risk.

**Principle 4:** Demand frequent and forward-looking reporting on technology-related initiatives.

**Principle 5:** Periodically assess the organization’s leadership, talent, and culture readiness for technological change.

In the following section, we break down each principle to help boards formulate and adopt a more cohesive oversight approach. The principles comprise oversight pitfalls, potential red flags, and detailed recommendations to enhance oversight. These principles are broadly applicable to and important for all directors, including those on the boards of public, private, and nonprofit organizations. Please access the report at [www.nacdonline.org](http://www.nacdonline.org) for a full discussion of each principle and their application.
## PRINCIPLE 1

Approach emerging technology as a strategic imperative, not just an operational issue.

<table>
<thead>
<tr>
<th>OVERSIGHT PITFALLS</th>
<th>RED FLAGS</th>
<th>RECOMMENDATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Fixation on the technology, not the value to the customer</td>
<td>Management presentations largely focused on technology adoption and deployment, much less on what business or customer problem it solves</td>
<td>Focus oversight on customer needs and business model change.</td>
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<tr>
<td></td>
<td>Uneven board-level understanding on the impact of new disruptive technology on the business strategy</td>
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<tr>
<td>2. Working with an incoherent vision</td>
<td>Lack of a common vocabulary and shared digital vision</td>
<td>Ensure a common understanding with management about what “going digital” means.</td>
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<tr>
<td></td>
<td>Excessive use of acronyms and technical jargon in management presentations</td>
<td></td>
</tr>
<tr>
<td>3. Technology governance equals risk governance</td>
<td>Majority of board-level technology discussions centered on preservation of corporate assets/value</td>
<td>Ensure that critical technology-related risk and strategy reviews are integrated and happen at the full-board level.</td>
</tr>
<tr>
<td></td>
<td>A very risk-averse board mindset around emerging technologies</td>
<td></td>
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<tr>
<td>4. Random acts of digital innovation</td>
<td>Management and boardroom buzz about the promise of shiny, new technologies</td>
<td>Assess whether management is building the necessary conditions to drive successful and ongoing digital transformation.</td>
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<tr>
<td></td>
<td>Focus on realizing immediate returns and easy innovation wins</td>
<td></td>
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<tr>
<td>5. The existing capabilities trap</td>
<td>Management either too eager or too reluctant to abandon existing capabilities or legacy business</td>
<td>Pressure-test management’s rationale for abandoning or protecting core businesses and capabilities.</td>
</tr>
</tbody>
</table>

## PRINCIPLE 2

Develop collective, continuous technology-specific learning and development goals.

<table>
<thead>
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</thead>
<tbody>
<tr>
<td>1. A board mindset that does not value continuous education or takes a one-size-fits-all approach to learning about technology</td>
<td>Learning that focuses on only the hype technologies or technologies that have yet to showcase practical applications</td>
<td>Assess collective and individual technology knowledge and skills gaps to inform both learning objectives and ultimately future recruitment needs.</td>
</tr>
<tr>
<td></td>
<td>A board approach to director learning about technology that is mostly reactive and ad hoc</td>
<td>Develop a multifaceted technology learning plan for both the full board and individual board members.</td>
</tr>
<tr>
<td></td>
<td>Individual director learnings about technology that are rarely shared and used in the boardroom</td>
<td>Ensure directors present back new information to the full board to distribute their knowledge.</td>
</tr>
</tbody>
</table>
**PRINCIPLE 3**

(Re)align board structure and composition to reflect the growing significance of technology as a driver of both growth and risk.

<table>
<thead>
<tr>
<th>OVERSIGHT PITFALLS</th>
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<th>RECOMMENDATIONS</th>
</tr>
</thead>
</table>
| 1. Limiting recruitment of digital directors solely to technology experts | • Search criteria for a digital director not clearly aligned with the future strategic needs of the business  
• Search criteria that fixates on specific technology know-how but doesn’t include proven experience in commercializing new innovations  
• Relying entirely on a token digital director to oversee technology or challenge management’s approach | Ensure the recruitment of a tech-savvy director focuses on both technical expertise and governance ability. |
| 2. Fragmented board oversight of technology-related matters | • Audit committee that has become the “kitchen junk drawer” for all new risk areas  
• Committee charters that do not mention technology as an area of oversight | Carefully weigh the merits of establishing a dedicated board-level technology committee, an ad hoc committee, or a technology advisory board. |

**PRINCIPLE 4**

Demand frequent and forward-looking reporting on technology-related initiatives.

<table>
<thead>
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<th>RED FLAGS</th>
<th>RECOMMENDATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Reporting that is static, focused on the past and present</td>
<td>• Dashboards that focus on traditional, well-known risks and much less focus on the unknowns or how the nature of risk of disruption may change</td>
<td>Improve forward-looking visibility about technological disruptors in board-management discussions.</td>
</tr>
<tr>
<td>2. Too much information, too little insight</td>
<td>• Lengthy slide decks that feel disjointed and many data charts that are difficult to interpret</td>
<td>Collaborate with senior management to establish appropriate board reporting guidelines.</td>
</tr>
</tbody>
</table>
| 3. Fixation on short-term return on investment (ROI) metrics | • Focusing on only financial performance metrics  
• Pressure applied to constant reporting | Focus on early leading indicators of digital transformation success or failure. |
PRINCIPLE 5

Periodically assess the organization’s leadership, talent, and culture readiness for technological change.

<table>
<thead>
<tr>
<th>OVERSIGHT PITFALLS</th>
<th>RED FLAGS</th>
<th>RECOMMENDATIONS</th>
</tr>
</thead>
</table>
| 1. Failure to embed digital fluency and track record into the recruitment, succession planning, and evaluation of the chief executive officer (CEO) and the executive team | • Senior leadership beliefs about digital that are fixed, and limited curiosity to learn and be exposed to different perspectives  
• Senior leaders who delegate digital initiatives to middle management  
• The CEO spending limited time on understanding how new technologies can disrupt the business or industry | Ensure both C-suite evaluations and succession planning formally assess current performance and future ability as a digital leader. |
| 2. Underestimating the importance of a change-ready culture that is open to innovation | • A misalignment of incentives throughout the organization  
• Organizational culture that values the status quo or actively resists change  
• Fixation on transforming process and structure, but little attention paid to the importance of culture | Ensure the company has an organizational culture that embraces change and promotes innovation and experimentation. |
| 3. Talent oversight focused mostly on present needs and past problems | • Human capital strategies centered around how the business operates and creates value today and in the near-term future  
• Use of mostly lagging indicators in management presentations | Ask management for forward-looking assessments of talent, aligning these metrics with the broader company strategy. |
Board members largely recognize the near-term disruptive potential of new business models enabled by emerging technologies. As a result, many are actively reassessing their oversight responsibilities in governing digital transformation initiatives and expect to play a critical role in guiding their firms to thrive in today’s digital era.

This report introduces a flexible and practical guide, based on five foundational principles, to help directors navigate the complexities of digital transformation and advance oversight of this area. To succeed, boards won’t need to become experts on every technology trend, but they will need to understand how new technologies can threaten existing business models or drive business model innovation. Those who rise to the challenge are likely to push their companies to reap the commercial benefits of these emerging technologies, while those who fail may doom their firms to obsolescence.
SUPPLEMENTAL MATERIALS
The 2019 Digital Governance Pulse Survey is a joint survey between the NACD and Marsh & McLennan Companies. The survey aimed to collect data and insights from NACD members on the opportunities and challenges they face in addressing digital transformation.

### Exhibit 2: Survey demographics

**Industry N=192**

<table>
<thead>
<tr>
<th>Industry</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financial</td>
<td>27.2%</td>
</tr>
<tr>
<td>Information Tech.</td>
<td>14.1%</td>
</tr>
<tr>
<td>Industrial</td>
<td>14.1%</td>
</tr>
<tr>
<td>Consumer Discretionary</td>
<td>10.5%</td>
</tr>
<tr>
<td>Health Care</td>
<td>8.4%</td>
</tr>
<tr>
<td>Energy</td>
<td>8.4%</td>
</tr>
<tr>
<td>Materials</td>
<td>6.8%</td>
</tr>
<tr>
<td>Consumer staples</td>
<td>4.7%</td>
</tr>
<tr>
<td>Telecommunication services</td>
<td>3.7%</td>
</tr>
<tr>
<td>Utilities</td>
<td>2.1%</td>
</tr>
</tbody>
</table>

**Organizational roles N=192**

<table>
<thead>
<tr>
<th>Role</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Independent director</td>
<td>63.2%</td>
</tr>
<tr>
<td>Independent chair</td>
<td>11.6%</td>
</tr>
<tr>
<td>CEO/Chair</td>
<td>7.4%</td>
</tr>
<tr>
<td>Lead director</td>
<td>6.3%</td>
</tr>
<tr>
<td>Non-independent director</td>
<td>5.8%</td>
</tr>
<tr>
<td>General counsel/Corporate secretary</td>
<td>5.8%</td>
</tr>
</tbody>
</table>
Demystifying AI

AI is the use of computers and algorithms to simulate human intelligence. AI amplifies cognitive abilities, providing solutions to problems where the complexity is too great, the information is incomplete, or the details are too subtle and require expert training. Learning from data—a computer version of life experience—is how AI evolves.

AI ENABLERS

**Explosion of Data**
The explosion of native and structured data has provided neural networks with the massive volume of training sets they need to function. 90 percent of global data was created in the last two years.

**Smarter Algorithms**
Maturation and increasing sophistication of algorithms to create innovative AI solutions. Better tools and readily available data processors exist today to manipulate and analyze data, allowing more experimentation and greater collaboration.

**Cheaper/Computing Resources**
Cloud computing and storage provide cheap access to more storage and computing capacity. Improved computer infrastructure such as advance graphical processing units (GPUs) have dramatically increased computers’ processing power.

TYPES OF AI

**SEE:** Detect, identify, and understand the context of objects in pictures, videos, and real life. This includes the ability to translate or interpret text, written language, and symbols—Computer vision and Optical Character Recognition (OCR)

**HEAR:** Capture, catalog and interpret spoken commands as well as speech, sounds, and auditory signals within the ambient environment or from video—Speech Recognition and Virtual Assistants

**COMMUNICATE:** Send insights, directions, or responses verbally or in writing using natural language. This includes the ability to apply appropriate dialects or slang or mimic individual speech patterns—Natural Language Processing (NLP) and Written Chatbots

**SENSE:** Ingest diverse inputs such as environmental conditions or biometrics utilizing sensors and other devices often associated with the internet of things (IoT) – Supervised Learning for prediction and decisions

**THINK:** Apply machine learning and other analytic techniques to integrate, analyze and generate insight from input information and signals – Deep Learning for simple questions with complex answers and Supervised Learning

Example of Simplified Ai Model

1. **Recognition (input to algorithm)**
   Examples:
   - Identify things in a picture or video
   - Translate speech verbatim

2. **Comprehension**
   Examples:
   - Gain and apply insights based on context
   - Relate things to each other

3. **Abstraction (output of algorithm)**
   Examples:
   - Evaluate and predict future performance
   - Post a positive or negative response

BENEFITS

- Reduced manual tasks and likely a leaner workforce
- Faster insights derived from data
- Lower operating costs and more efficient operations
- Enhanced product quality and customer experience
- Higher productivity and more effective performance
- Improved and more informed decision making

CHALLENGES

**Governance issue over AI for safety, accountability, and transparency**
There is a growing systemic risk due to the failure of these models further complicated by limited and unstandardized standards.

**Rise of cyber threats/risks**
Increasing surface area of attack is driven by the growth in pace of AI innovation, tech complexity, data sharing and interchange, and attack actors’ sophistication i.e. social engineering on social media platforms.

**Labor market disruption**
The advent of AI puts a premium on high order value activities, deeming the skills that people have to potentially be irrelevant soon.
### WHAT’S HOLDING AI PROGRESS BACK?

| Ensuring that AI systems are trustworthy | Training current employees to work with AI systems | Managing convergence of AI with other technologies (e.g., IoT, drones) | Building buy-in due to existing stakeholders’ mistrust and discomfort | Recruiting workers who are already trained to work with AI systems |

### AI APPLICATIONS

#### Most used AI solutions

- **Autonomous systems** can be an automation performing a more complex task or an AI-augmented machine operating without human.
- **Agents** use text or voice to communicate with users in natural language.
- **Decision automation** uses AI to automate tasks or optimize business processes.
- **Smart products** have AI embedded in them and are able to learn, hyper-personalize, and drive engagement with users.
- **Decision support/augmentation** make recommendations, produce insights, provide personalization, and predict events.

#### Differentiated business value with AI (Industry examples)

- **Automotive**
  - **Improving transportation efficiency** with autonomous fleets for ride sharing
  - **Enhancing driver experience** with semi-autonomous features, autonomous maintenance, and engine monitoring/predictive

- **Energy**
  - **Saving costs** with smart metering (real-time information on energy usage)
  - **Minimizing business disruption** with predictive infrastructure maintenance
  - **Increasing efficiency** of grid operation and storage

- **Telecommunications**
  - **Enhancing customer experiences** with virtual assistants, optimized networks and personalized services
  - **Saving costs** with more accurate “churn risk” predictions, reducing false positives by 75x

- **Manufacturing**
  - **Saving costs** with on-demand production and optimization of supply chain and production
  - **Minimizing business disruption** with enhanced monitoring and auto-correction of manufacturing processes
  - **Increasing the value of work** by human-robot collaboration

- **Retail**
  - **Exceeding customer expectations** with personalized design and production
  - **Increasing revenue** through optimized price, profitability, and anticipation of customer demand
  - **Improved inventory and delivery management** with smart logistics operations

- **Financial Institutions**
  - **Enhancing banking client experiences** with personalized (or new) services and products
  - **Increasing revenue** with more accurate microtargeting, segmentation, and marketing
  - **Improving risk management** with more efficient fraud detection/anti-money laundering

- **Health Care**
  - **Improving diagnosis** in imaging and areas such as detecting small variations from the baseline
  - **Earlier identification** of potential pandemics and tracking incidence of the disease to help prevent/contain spread
  - **Relieving workforce shortage** and **reducing costs** with humanoid robot as an admin role/caregiver
On the simpler end of the spectrum, screen-scraping technologies can take data from websites or legacy applications, manipulate the data, and key into another system for use in other processes.

On the more complex end of the spectrum, robots can be combined with more unstructured data and algorithms to manage more complex tasks and become more independent and intelligent over time. This approaches the characteristics of artificial intelligence.
## BENEFITS

<table>
<thead>
<tr>
<th><strong>Cost-Savings</strong></th>
<th><strong>Non-invasive</strong></th>
<th><strong>Optimized Analytics</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Replaces high-cost human labor by low-cost robots (up to 60%-80% cost-savings).</td>
<td>Reduced investment requirement due to direct integration into existing infrastructure</td>
<td>Gives a complete mapping and detailed documentation of processes</td>
</tr>
<tr>
<td>Virtual 24/7 workforce that emulates humans, repetitive processes</td>
<td>No invasive actions to underlying systems</td>
<td>Provides insights through high-quality data gathering, organization, and analytics</td>
</tr>
</tbody>
</table>

### Easy to Implement
- Typical implementation time for simple processes is measured in weeks
- Rapid prototypic technique applicable

### Faster ROI
- Simple process automation that can have a positive ROI in less than three months
- Effects of scale applicable from day 1 after launch

### Improved Productivity and Quality
- Guaranteed 24/7 availability of service and faster processing
- Ensures processes are 100 percent compliant with regulations

## CHALLENGES

### Strategy and Approach
Many firms do not set a clear vision, governance, or performance objectives in using RPA to scale up their operations.

Misunderstood or overestimated RPA capabilities often result in any efficiency, savings, and productivity gains falling short of expectations.

### Transition and Change Management
RPA programs and efforts are sometimes perceived as a loss of power and control.

This results in varying degrees of resistance from managers to give up their resources.

### System Integration Roadblocks
Many companies deal with the inherent challenge of ensuring that their applications can connect and share information—an expensive and time-consuming process that is often overlooked and circumvented with manual workarounds.

RPA can only provide a temporary relief to this.

### Managing Human Error
Human error in the initial short-term programming or in the medium-term adjustment of RPA can lead to catastrophic repercussions. A lack of sufficient knowledge from human to RPA is usually a cause for this.

Errors in one area of the program can trigger across other linked systems.

## CRITICAL SUCCESS FACTORS FOR RPA IMPLEMENTATION

<table>
<thead>
<tr>
<th>Pick the right processes.</th>
<th>Identify and tackle organization constraints.</th>
<th>Identify, assess, and test the data for any anomalies.</th>
<th>Engage and involve the right team at all phases.</th>
<th>Anticipate and address resistance as early as possible.</th>
<th>Document the process to establish proper-use protocols.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assess the tasks performed manually and require users to perform repeatedly</td>
<td>Address possible logistical/procedural/structural challenges to adopt RPA</td>
<td>Identify internal/external data sources data cleansing requirements and initial testing with a subset of data</td>
<td>Includes business leaders, operations analysts, project management, development and ongoing maintenance</td>
<td>Determine tactics to establish RPA benefits and alleviate concerns of job loss</td>
<td>With adequate design documents, and solution design guides</td>
</tr>
</tbody>
</table>
FAST FACTS: INTERNET OF THINGS (IoT)

Demystifying IoT

IoT is a network of physical objects, through which data and information—condition, movement, and position—of the object are collected or exchanged, linkable to the internet.

IoT is machine-to-machine communication.

IoT is composed of three independent components: things with networked sensors, data stores, and analytics engines.

COMPONENTS IN AN IoT ECOSYSTEM

<table>
<thead>
<tr>
<th>Hardware</th>
<th>Networks</th>
<th>Remotes</th>
<th>Platforms</th>
<th>Security Protocols</th>
</tr>
</thead>
<tbody>
<tr>
<td>IoT end devices within the IoT solution; chipsets or sensors add connectivity to non-connected devices.</td>
<td>Connect the IoT solution to the user; popular networking protocols include Wi-Fi/ethernet, cellular, mesh networks, bluetooth, 4G, and more.</td>
<td>Smartphones, tablets, computers, smartwatches, and smart speakers; provide users with interface to interact with an IoT solution.</td>
<td>The middleware, that transmits messages between devices and data storage. It includes analytics, data storage (i.e., cloud), and sometimes data communication and visualization.</td>
<td>Device authentication, data encryption, secure device management—that ensure the IoT solution remains protected.</td>
</tr>
</tbody>
</table>

IoT ENABLERS

**Better, Faster, and Cheaper Devices**

Costs of hardware procurement, and the sizes of components needed to implement many parts of digitization processes across different industrial sectors, have been steadily decreasing.

**Increasing Network Access and Speed**

Expanding wireless options and the advent of 5G will fuel IoT growth, enabling the expansion on IoT features, products, and quality (and risks).

IoT will account for one-fourth of the global 41 million 5G connections in 2024.

**Expanding Commercial Implementations**

With more balanced expectations of broader adoption, more proof of concept pilots will be planned and executed. This also extends beyond expected ROI for IoT that had often been tied to savings on utilities and maintenance bills.

IoT APPLICATIONS

**MOST-USED IoT SOLUTIONS**

- **Remote and Real-time Monitoring**
  Controlled through an app, voice command, built-in computing systems, and even AI-powered observed patterns

- **Asset-tracking Systems**
  For visibility throughout supply chains and to enable better tracking of shipped goods

- **Wearables**
  Including personnel trackers and augmented reality headsets

- **Smart Facility Management**
  Including connected lightings and smart HVAC (heating, ventilation, and air conditioning)

**BUSINESS OUTCOMES/VALUE**

- **Smart Agriculture**: Enabling farmers to monitor field conditions without physical presence and make strategic decisions for whole farm or a single plant/livestock

- **Smart Health Care**: More collaboration among colleagues and with patients; cost-savings from more streamlined processes; improving quality of medical treatment with smarter diagnostic tools

- **Smart Cities**: Enhancing security; reducing wastage with improved waste/water management; time-savings from optimized travel and transportation; increasing awareness to infrastructure and traffic issues; minimizing disruption

- **IoT in Financial Services**: Improved risk management with real-time data feedback; strengthening safety and security with simultaneous activities tracking; enhancing customer experience

- **Smart Manufacturing**: Allowing more informed decision-making; cost-savings from reduced machine downtime/energy wastage; optimizing material usage and work processes; increasing productivity
The data collected by IoT devices is where both the value and privacy risk of IoT lie; this is further complicated by having to address evolving data privacy regulations across borders. Firms that combine IoT telemetry with customer data need to protect it or face trust issues with stakeholders.

Infonomics and data broking to monetize the data collected by IoT products and services will increasingly become an IoT business outcome.

Marrying the application of AI to a wide range of IoT information (e.g., still images, videos, speech, network traffic activity, and sensor data to exploit AI in an IoT strategy).

Blockchain’s promising role in IoT allows users to encrypt data at its source, protect it through its life cycle, manage access, and thus address data privacy concerns.

IoT’s shift from centralized and cloud to edge computing architecture is underway. An edge architecture will eventually evolve into a more dynamic mesh that can enable more intelligent, flexible, and responsive IoT systems.

Legislation or regulatory activity will continue to be driven by security concerns—the most significant area of technical concern for organizations deploying IoT systems.

On the flipside, the IoT security market is expected to expand, with a CAGR of 27.8 percent (2018-2023). The deployment of software and hardware combinations can create more trusted and secure IoT systems.

Evolving technologies to boost power of IoT (e.g., new wireless network [5G] and silicon chip innovation [a new special-purpose chip]).

Amplifying Cyber Threats
A deployment of IoT devices could exponentially increase the surface area of attacks. IoT devices that are secure by design could become an entry point for an attacker or tool to launch an attack (e.g., distributed denial-of-service attack).

Labor Market Disruption
The advent of IoT puts a premium on data analytical skills, such as of data scientists and digital strategists. While digital skills are in short supply, skills of existing non-IT workers also need to be redressed with relevant learning opportunities.

About The Authors

NACD

Friso van der Oord is director of research, responsible for all NACD content development. He focuses on creating actionable insights on key corporate governance challenges and emerging risks and on raising the leadership profile of boards in areas such as strategy setting and long-term value creation. Prior to joining NACD, he was the global head of research for the Audit and Risk Management practices at the Corporate Executive Board (CEB). He also was a senior director of CEB’s Compliance and Ethics Leadership Council and worked for LRN where he ran the company’s ethics & compliance solutions. He is a member of the International Professional Practices Framework Oversight Council of the Institute of Internal Auditors. He holds an MA in international relations from Johns Hopkins University’s SAIS Program.

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MARSH & MCLENNAN INSIGHTS

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ABOUT NACD

NACD empowers more than 20,000 directors to lead with confidence in the boardroom. As the recognized authority on leading boardroom practices, NACD helps boards strengthen investor trust and public confidence by ensuring that today’s directors are well prepared for tomorrow’s challenges.

World-class boards join NACD to elevate performance, gain foresight, and instill confidence. Fostering collaboration among directors, investors, and governance stakeholders, NACD has been setting the standard for responsible board leadership for more than 40 years.