Healthcare has reached a tipping point. With the growing prevalence of chronic disease and an aging population, many healthcare providers are facing significant workforce and resource challenges. Patients want to be more involved in their care than ever before, expecting on-demand access to healthcare information and personalized treatment plans. And, as global healthcare shifts to value-based care, clinicians and payers need actionable data to make faster and better clinical and business decisions.

Against this backdrop, health IT leaders are working to transform their digital infrastructure, incorporating the Internet of Things (IoT) with the hope that it will enable clinicians to use robust data to improve care and operational outcomes. This white paper will explore the current impact of IoT in healthcare, analyze the path forward, and share recommendations to realize value today and plan for the future.
EXTENDING CARE

The healthcare industry is experiencing an explosion in the number of connected devices and Internet of Things platforms aimed at operational and clinical improvements, with the healthcare IoT market growing from more than $40 billion in 2017 to almost $160 billion in 2022.¹ These devices can be grouped into two primary categories: First, the Internet of Medical Things (IoMT), which are FDA approved and include patient monitors, medical implants, infusion pumps, and other devices that report data for clinician decision-making. Second, the Internet of Healthy Things (IoHT), which are devices that provide non-clinical data for context and wellness monitoring – mostly wearables.

Yet, devices form just one part of the IoT equation. To create a fully connected IoT ecosystem, healthcare organizations need to consider how to incorporate sensors, analytics, security tools, communication capabilities, and on and off-premise next-generation infrastructure to enable centralized device management and secure, seamless communication of actionable data.

Deploying an IoT ecosystem also requires stakeholder commitment from both IT and clinical leaders to formulate the business case and to define success metrics as organizations work to realize quantifiable value from IoT investments. And, in every industry – but particularly in healthcare – trust is key. As an example, healthcare organizations must protect data at every stage of the workflow to meet HIPAA/GDPR requirements while considering opportunities and standards for loosely coupled information sharing.

BE CAUTIOUS OF DATA SILOS

As healthcare organizations invest in IoT, leaders need to build their strategy to demonstrate “early wins” and incubate projects while building the supporting infrastructure to scale for the future. Large public clouds may initially make it easier to get an IoT project off the ground, but IT organizations also need to consider the benefits of an open, interoperable environment, particularly within the highly fragmented and regulated healthcare setting. In fact, sending data to a large public cloud may result in data actually being "locked" into new silos. It may also be cost prohibitive to retrieve the data to create new value, which is the ultimate goal of IoT.

To take full advantage of the IoT opportunity, organizations need to connect both the physical world with the digital, starting with real-time data collection, then adding analytics to create value, and eventually, automation. Each step builds confidence in the next. The IoT continuum spans the edge, distributed core, and cloud with zones of intelligence that can perform analytics when, how, and where it matters – optimizing value for your health system.

EXAMPLES OF HEALTHCARE IoT APPLICATIONS

- In-facility, point-of-care management and monitoring surveillance
- Chronic disease management
- Remote assisted living
- Wellness/preventative care
- Remote consult/intervention
- Materials/drug management
- In-facility operations and logistics

¹ Medtech and the Internet of Medical Things 2018
CARE AT THE EDGE

A typical U.S. hospital may employ as many as 15 different connected devices per bed to monitor an individual patient. There is an emerging opportunity to increase operational efficiencies by applying standards to create a common means of collecting, extracting, and then analyzing all the data. To fully leverage this opportunity, healthcare organizations need edge gateway technologies that can aggregate, cleanse, and compress data, and then act on the data while it matters, only sending summary data to the cloud for remote monitoring, EMR embedding, and research analytics purposes.

Edge gateways play an important role as healthcare providers deploy IoT infrastructure – allowing for localized processing as well as buffering and filtering data and applying security before transmitting the data to the cloud. By performing functions such as identification, encryption, segmentation, and threat analysis at the edge, these gateways can help address challenges with network latency, bandwidth, and security. Beyond the technical issues edge gateways resolve, they significantly reduce the total lifecycle cost of data.

AN OPEN, SYSTEM OF SYSTEMS APPROACH

The healthcare IoT ecosystem today is inherently fragmented. There are hundreds of purpose-built IoT platforms, with no common communication framework, which can create multiple silos of data across the care continuum. To minimize the impact of data silos, we recommend that healthcare organizations develop flexible and open methodologies to integrate applications and share data securely, across multiple domains. In short, healthcare providers need an open, multi-cloud, multi-edge strategy. They need modern cloud-native development (DevOps) that is platform-independent and breaks components into micro-services (individual services can be updated without taking down an entire system).

Open source development is ideal for IoT and digital transformation projects, promoting standardization and interoperability between platforms, delivering faster time to value through a common framework for data modeling, and providing added security through a global community of experts constantly evaluating and patching potential threats.

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DE-RISK YOUR IoT JOURNEY

Many organizations start their IoT journey with one application driven by a single business case, but the true potential of IoT is the ability to connect systems and provide even more valuable outcomes from the open, scalable “system of systems” and a data generation network effect.

When building the IoT architecture, best practices include developing a strategy to create not just an innovation loop, but rather a virtuous cycle where you have data coming in from your “things,” going through the edge, passing into the core, landing in a cloud, generating insights, and traveling back out to the edge. In healthcare, this might mean collaborating to find new treatment protocols or tracking drug effectiveness more quickly than possible in the past. Connecting disparate research efforts working on the same problem also offers another opportunity to find new ways to more efficiently deliver hyper-specialized care.

Regardless of the initial strategy, investments in underlying technology and infrastructure need to support the next generation of computational, storage, and communication capabilities required to meet the growing demand to collect, analyze, and secure healthcare IoT data at scale.

Healthcare systems will need to modernize legacy infrastructure to take advantage of IoT potential. This modernization will need to happen in conjunction with decoupling the following three areas:

1. **Decouple Infrastructure from Applications** – using open standards and ecosystem frameworks like the Linux Foundation’s EdgeX, and platform-independent device management solutions (like Pulse IoT Center from VMware for managing IoT edge devices) allows for the support of “things” and gateways with different hardware, operating systems, and communication protocols in a single IoT platform.

2. **Decouple the Edge from the Cloud** – using open, cloud-native principles (DevOps), as closely as possible to the point of data creation in the physical world, lets the organization control the data through any permeation/combination of public and private clouds.

3. **Blend Healthcare Domain Knowledge with Emerging Technologies** – collaborating with application and data generating vendors to enable agile development across industry technologies to address and build solutions for high-value challenges.

Healthcare providers and payers are already realizing value from IoT investments, including:

- **33%** report extensive medical cost savings from their remote patient monitoring
- **42%** achieve extensive medical cost savings from their wellness and prevention
- **31%** realize extensive administrative cost savings

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3 Accenture Internet of Health Things Survey
VALUE FROM IoT INVESTMENTS

Healthcare organizations are already seeing early impact from healthcare-specific applications. Wearable technologies and virtual patient observations enabled by IoT allow providers to improve patient engagement before, during, and after hospital visits – and dramatically transform the patient experience. Reducing inpatient stays using in-home monitoring (for example, heart monitors, glucose monitors, and spirometers) improves the patient experience and makes a direct impact on the bottom line by avoiding readmission penalties, as these devices notify clinicians of abnormalities or the need for intervention.

Another use case example is leveraging the power of edge computing to turn video monitoring into actionable intelligence (see sidebar).

According to a recent study presented at the American College of Cardiology’s (ACC) Cardiovascular Summit, a new smartphone application may help reduce the number of hospital readmissions in patients who have been treated for a heart attack. Early results show that, of the 60 participants using the application, only three percent were readmitted for any reason within 30 days, compared with 19 percent of all heart attack patients.4

MAKE YOUR IoT STRATEGY FUTURE-PROOF

No matter where you are in your healthcare IoT strategy, Dell EMC can help your organization get started and prepare for the future.

Our edge-to-core-to-cloud open IoT infrastructure includes the ability to simplify data collection, manage devices on the network, centralize data storage, provide on-demand analytics, and integrate networking. Our solutions help collect data generated by secure edge computing through Dell Embedded Box PCs and other end-user technologies, Dell Edge IoT Gateways powered by Intel, and VMware Pulse IoT device management. Dell Boomi ensures your organization can quickly integrate systems, providing the flexibility needed to react to regulatory compliance changes. In addition, Dell EMC provides capabilities to store and analyze this data with our on-premise scale out storage (Isilon) and compute (PowerEdge, Dell Edge

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Gateways) solutions. All organizational data can be shared seamlessly in a multi-cloud environment with extended archive into the cloud and application development on a common cloud platform.

We are also committed to leveraging our solutions portfolio and partner ecosystem to promote open, scalable platforms for healthcare. Together with Intel, Dell EMC has invested in the EdgeX Foundry, a vendor-neutral open source project hosted by the Linux Foundation. EdgeX creates an open ecosystem at the edge with the goal to forge a common reference framework built on open source components to avoid data silos and IoT vendor lock-in. EdgeX is key to driving interoperability across any sort of IoT platform, moving the industry towards a more interoperable, scalable, and flexible ecosystem.

The combination of the comprehensive Dell EMC IoT portfolio, partner capabilities, and domain expertise gives healthcare organizations the ability to unlock the complexity of healthcare IoT, so you can, in turn, realize value for you and your patients.

DELL TECHNOLOGIES: LEVERAGING CLOUD-NATIVE PRINCIPLES FOR MASSIVE SCALE AT THE EDGE

Dell Technologies continues the commitment to openness and standardization in IoT by participating in efforts such as EdgeX Foundry, the Industrial Internet Consortium (IIC), and the OpenFog Consortium. EdgeX Foundry is a vendor-neutral open source project building a common interoperability framework to facilitate an ecosystem for edge computing. Since launching in April 2017, EdgeX Foundry has grown to more than 60 member organizations. Learn more at www.edgexfoundry.org.