Healthcare Provider's Unique IoT Challenges Demand a Platform Strategy

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By Analysts Gregg Pessin

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Internet of Things device proliferation in the healthcare provider environment creates both opportunity and vulnerabilities. Healthcare provider CIOs require a platform strategy that manages the complexity and risks of this expanding universe of smart things.

Overview

Key Findings

- Hospitals are full of smart things, from thermostats to medical devices, with the number of smart devices growing and extending year over year. Healthcare delivery organizations (HDOs) typically acquire, implement, manage and operate these Internet of Things (IoT) devices at the department vs. enterprise level, creating unnecessary complexity and risk.
- The departmental approach to managing smart devices within an HDO hides the potential enterprisewide benefits of developing an IoT platform approach and implementing a strategy.
- Initial IoT platform solutions for HDOs are often nothing more than enhanced versions of existing IoT management systems, such as medical device connectivity systems. These preliminary IoT platforms are limited in scope, but provide a foundation for developing a platform approach.

Recommendations

CIOs seeking healthcare EHR and digital care delivery optimization by using IoT as efficiently as possible should:

- Stay focused on IoT's capability to enable better decision making to create consensus on an IoT vision to drive improvements for care delivery and HDO operations. Illustrate clearly why and how IoT is an essential capability for digital care delivery that drives organizational efficiency and improved patient engagement and experience.
- Assemble an IoT task force, and charge them with creating the IoT platform strategy for the HDO that will lift the conversation from department-level functional constraints to an enterprisewide strategy that facilitates digital care delivery.

- Create small wins for the HDO by initially applying IoT platform principles to a limited group of IoT. Leverage the small wins to initiate the IoT platform maturation process for the organization, delivering accumulative value with each addition to the platform.

Strategic Planning Assumption

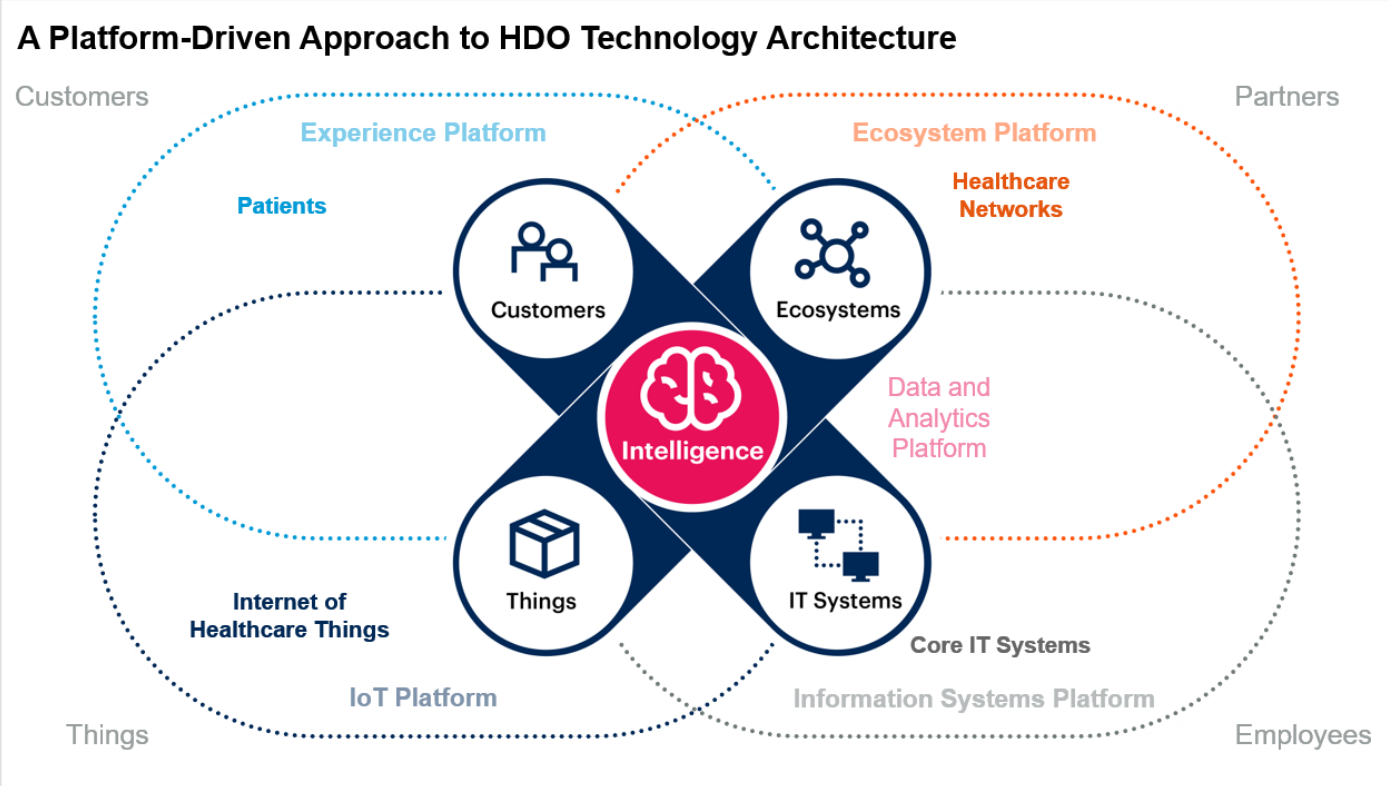
By 2022, IoT technology will be in 60% of new healthcare endpoint product designs, including medical devices.

Analysis

Introduction

IoT platforms are a core technology for the real-time health system (RTHS) and its capability to support clinical operations and digital care delivery. With digital technology involved in every aspect of an HDO's management and operations, it is vital for CIOs to understand IoT's role and its supporting platforms, as it is the mechanism used to connect the real world to the digital. A recent Gartner IoT survey focused on implementations worldwide indicated that 90% of HDOs will have production IoT solutions in place by the end of next year. [1] Seventy percent of the HDOs responding to the survey reported that they have IoT implementation in place or underway, with another 20% reporting implementation plans in the next fiscal year. CIOs lacking an IoT platform strategy run the risk of perpetuating a disjointed, costly and overly complex environment that will impede digital innovation. The IoT platform is a member of the larger collection of technology platforms supporting the HDO that combine to enable the digitalization of administration, clinical operations and care delivery (see Figure 1).

Figure 1. A Platform-Driven Approach to HDO Technology Architecture



Source: Gartner (June 2019)
ID: 386858

Today, HDOs have many smart devices that are classified as IoT. Due to history and diverse functionality, the need for a consolidated platform solution to address data collection, analysis and storage of the generated data is elusive to CIOs. IoT enters the HDO by way of justified departmental need to solve a specific data collection or system control issue. With budget, vendor selection and implementation outside the purview of the CIO, IT is left in a reactive state, eroding the potential benefits of an enterprise approach.

Another serious consequence is the disjointed approach, leaving the HDO vulnerable from a cybersecurity position. Without a platform methodology and strategy, HDO CIOs will not be able to take advantage of the efficiencies available nor the full potential combined value of the collected data. Over time, as smart device solutions enter the HDO as point solutions at an accelerated rate, the overall day-to-day load — from contracts and vendor management through to network and systems operations — will exceed IT's current staffing level's available capacity. To get ahead of this, HDO CIOs should define and establish a vision for what IoT and IoT platforms mean to the organization. Then, use that vision as a foundation to determine where the organization currently stands from an IoT inventory perspective, as well as a platform maturity level. Armed with this information, perform a gap analysis between the current state and the envisioned IoT end state, and create a roadmap that will guide the organization through the journey to full IoT maturity.

The Drivers Behind IoT Platforms in Healthcare

IoT is part of a larger group of technologies in the healthcare ecosystem that support several of the overarching goals for HDOs. The primary goal is to deliver quality care and services, manage the financial viability of the organization, and secure data and technology assets. IoT is also an enabler for the secondary drivers for HDOs, including transforming orientation and operations around the patient, transforming the practice of care delivery, and building core digital health and analytics capabilities.

IoT is the sensing mechanism of the enterprise. It provides the technology to digitally capture observations and events that occur in the healthcare environment. The aggregation of these various data sources creates the situational awareness that decision makers require to fulfill their missions for the HDO (see Note 1). In doing so, this data enables individuals within the organization to help meet the enterprise goals (for example, using patient location data to inform patient throughput and capacity management efforts). IoT platforms provide the hardware and software infrastructure to collect data from the multitude of IoT sources in an efficient, centralized manner.

Functional Model for IoT Platforms for Healthcare

Typically, IoT solutions are full-stack implementations where a single vendor provides the IoT sensing endpoints, gateways, data collection, and normalization software and analytics, plus dashboard/reporting software (see Note 2). As an HDO acquires more and more IoT solutions, the full stack of IoT functions are duplicated. This fragmented approach to IoT leads to many isolated

pockets of IoT in the organization creating integration difficulties and increased cyber risks due to the complexity.

IoT platforms offer an alternative approach to this by providing capabilities that satisfy many of the IoT requirements in the stack, including device management, communication, integration, data management, application enablement, as well as analytics. They provide a centralized platform for these functions, giving the HDO a cohesive IoT solution for data ingestion and processing, while allowing for vendor independence at the device edge. They also provide the capabilities to take advantage of strategic opportunities to use and reuse gathered data in a broader context.

In providing this centralized foundation, IoT platforms provide a way to address the problems of the prevailing state and capture the opportunities ahead to leverage the value of IoT in clinical and care delivery operations. They advance the enterprise's RTHS capability through implementation of the sensing layer of the architecture, which enables situational awareness, intelligent operations and real-time analytics.

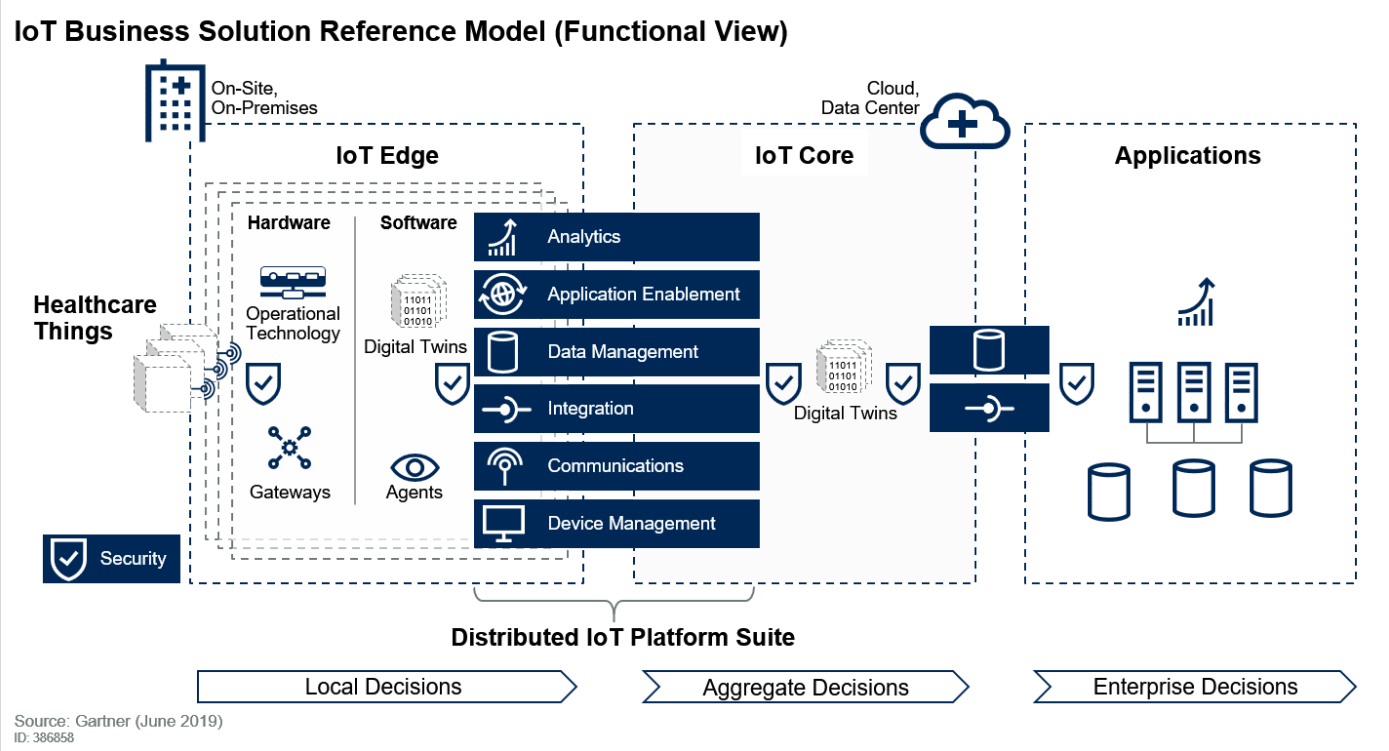
IoT platforms are part of a larger group of IoT functional components that provide most of the data collection required by the RTHS sensing layer. They include:

- **Internet of Healthcare Things (IoHT):** These can range from clinical, to facilities, to back-end office devices that possess the intelligence and technology to connect, communicate and interoperate. They sense and monitor the state or performance of a patient, environment or other real-world objects.
- **Distributed IoT platform suite:** A distributed, comprehensive set of services used to provision, monitor and analyze healthcare things. IoT platforms perform seven essential middleware functional capabilities (see Figure 2), which can be deployed either on the IoT edge, IoT core or both, depending on the business or clinical needs. While conceptually the IoT edge and IoT core share many functional capabilities, they have distinct roles:
  - **IoT edge:** The part of IoT platforms (optionally bundled with hardware) deployed inside, on or near things to support local decisions (such as initial threshold breach detection for vitals). Typically, but not always, the IoT edge runs a resource-constrained version of the IoT platform middleware stack. Hardware to run the IoT edge can vary widely, depending on performance and cost factors, and includes microcontrollers, gateways and edge servers.
  - **IoT core:** The part of IoT platforms deployed in a cloud or data center to provide aggregated decisions (such as process optimization across many assets). It typically, but not always, runs a highly scalable version of the IoT platform middleware stack. Hardware to run IoT core includes edge servers and micro data centers.
  - **Platform suite services:**
    - **Analytics —** Processing of data streams using rules and algorithms to provide insights.

- **Application enablement** — Software that enables business and clinical applications in any deployment model to analyze data and accomplish IoT-related business/clinical functions.
- **Data management** — Spans many competencies from data ingestion, to persistence, to organization, to governance.
- **Integration** — Includes high quality of service messaging, data normalization and transformation, and adapters for various applications.
- **Communications** — Includes communication protocols, and network technologies and services (private and public) for the transport of IoT data and management messages.
- **Device management** — Software to facilitate service and operations management processes for IoT endpoints.
- **Security** — The software, tools and processes used to audit and ensure security, governance and regulatory compliance.

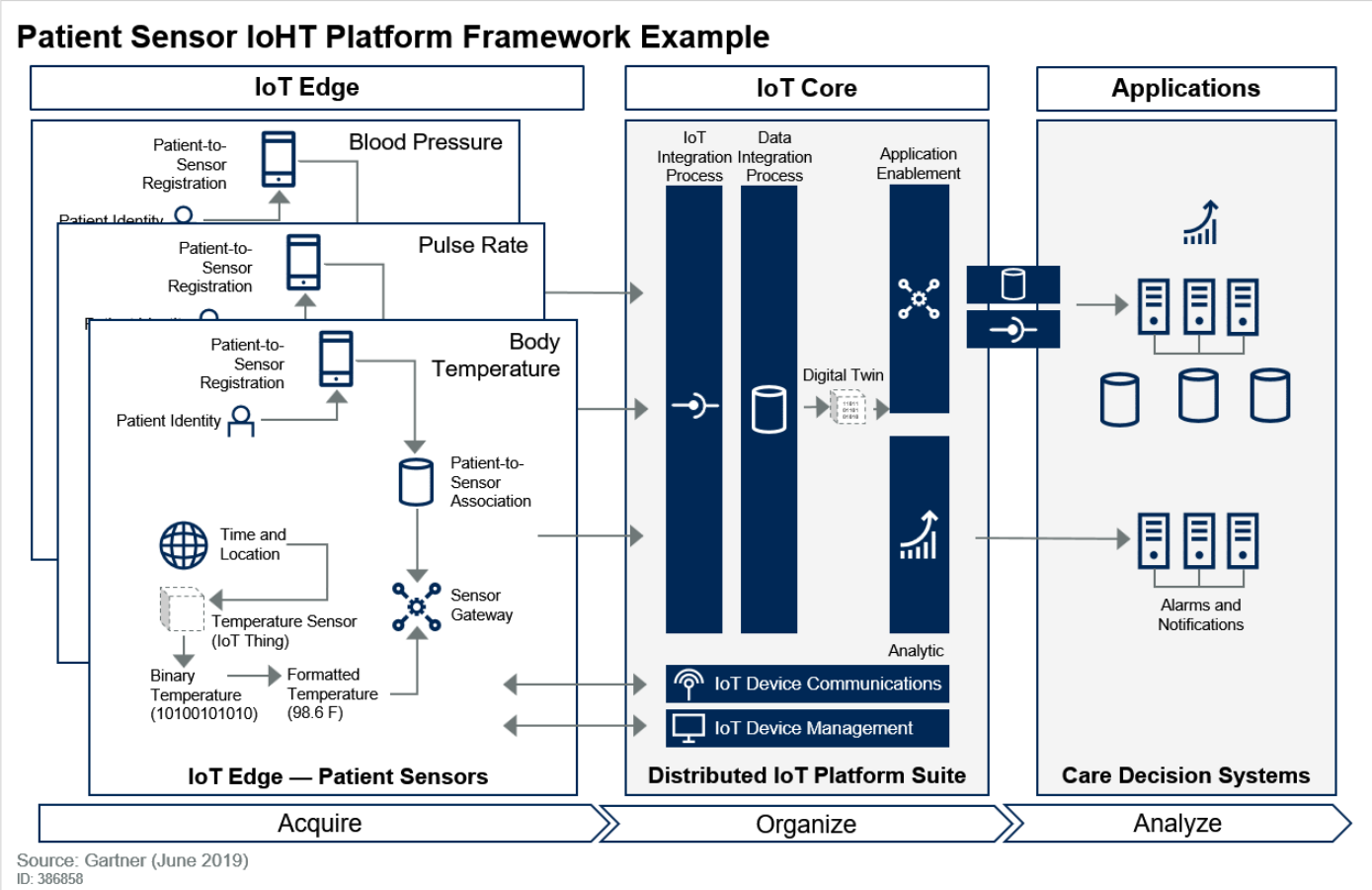
- **Applications:** IoT technologies are often integrated with one or more applications to provide a specific function, such as clinical patient monitoring for inpatients. Many other applications exist in the healthcare enterprise, including HVAC control, blood and tissue bank condition monitoring, and materials management/central supply inventory control.

Figure 2. IoT Healthcare Platform Solution Reference Model (Functional View)



A clinically specific example of the framework in practice is shown in Figure 3. Here, multiple patient sensors at the IoT edge provide their raw data, which must first be associated with a patient, for upstream processing by the IoT core. This is where the raw data is grouped together and stored, creating the framework for the patient's digital twin. This digital twin or data-oriented model of the current state of the patient is used by applications to update the EHR and provide data to other clinical and business applications. Alarms and notification systems are an example of applications that can directly use the IoT core's analytics to communicate critical patient information to the care team when sensed data escalates beyond accepted thresholds. This framework supports Gartner's data and analytics architectural concepts of acquire, organize and analyze.

Figure 3. Patient Sensor IoHT Platform Framework Example



The Value of IoT Platforms for HDOs

HDO CIOs have had IoT inside their organizations for years (networked connected devices) without being formally recognized as such. Currently, most of the medical devices in use have data connectivity, including serial ports for the oldest in the environment. The imaging technologies in medical radiology departments are a type of IoT. Up until this most recent era in healthcare, this older generation of IoT has fulfilled the intended purpose for which it was purchased. In today's environment, however, more is needed. Additional data integration requirements to complete the build of patient digital twins and create real-time operations are pushing the limits of the traditional

fragmented approach to IoT. This is true for other HDO aspects of IoT, including facilities and the back office.

The push to capture the needed data exists today, because the right technology has surfaced to satisfy that need for more information. This enables digital twins (models of patients and other HDO entities) that, when combined with appropriate analytics, can make a significant difference in the real world. HDO CIOs need to take advantage of this. There is a proliferation of sensing technologies available to help meet these new requirements; however, this abundance is a double-edged sword. Without a holistic approach to IoT, the HDO CIO will create a complex cacophony of devices, vendors, analytics and reporting tools, and miss strategic opportunities to use IoT information in a broader context. This will only add work to an already overburdened set of teams managing technology life cycles, such as vendor/contract management, IT operational management, application support team and others. These challenges that exist in the current state can be overcome by creating and applying a vision and strategy for IoT platforms.

As an example of situational awareness driven by IoT platforms, consider a nursing wing that is having an HVAC control issue. Without an IoT platform, the staff must rely on their own senses that the ward is too warm. Individual caregivers notice that the vitals for certain patients are indicating negative trends, but cannot see that this is happening across the ward without communicating with others. With an IoT platform that brings together patient data, as well as HVAC data, analysis can be run that shows a strong correlation between the temperature fluctuations in the hospital wing and patient condition changes. The facilities team in charge of fixing the issue is aware, through the analysis, that their system failure will affect patients negatively. Nursing staff are notified of the trend ahead of critical patient impact and take steps to proactively mitigate the situation until the facilities team corrects the root cause.

This is just one simple example, and there are many undiscovered correlations out there waiting to be found. By implementing IoT platforms, HDO CIOs are taking one of the first steps to create an environment where new relationships between datasets can be uncovered and put to immediate use to improve operational efficiencies and care delivery.

Getting Started on an IoT Platform Strategy

The world of IoT inside an HDO is quickly becoming its most intricate system of technology. This is expected, as the HDO environment itself is extremely complex, and IoT devices are designed to collect data to create digital twins of the environment. As IoT infiltrates all areas of operation of the HDO, and the complexity grows, it is incumbent on leadership to put the organization in the best position to not only manage IoT, but also to take the greatest advantage possible. This task can only be accomplished by leveraging an IoT platform that coexists with the other recognized healthcare delivery technology platforms: the information systems, experience, ecosystem, and the data and analytics platforms.

Stay Focused on IoT's Capability to Enable Better Decision Making to Drive Improvements for Care Delivery and HDO Operations

The digitalization of healthcare is not a “one and done” effort. At the root of this modernization of healthcare is data collection, which must be performed accurately and efficiently to serve the HDO. The defining capability of IoT is its ability to provide a clearer view of what is happening in patient care delivery, including the clinical state of the patient, the HDO resources aligned to deliver care, and facility and resource status. This data is core to any efforts to improve HDO processes. The organization cannot know what to correct if it cannot recognize the root cause of the issue. The business and clinical goals of the organization will be met (or not met) based on how well the enterprise executes on IoT. The era of intuitive, easy corrections for inefficiencies in healthcare delivery is coming to an end — they have been or are being solved today. As these “low-hanging fruit” opportunities are solved, they expose issues with higher complexities that are much more difficult to address. These issues need to be solved to gain the next level of efficiency for an HDO to take patient care delivery to the next level.

The first step in achieving this goal is to create a level of awareness of IoT, starting with board-level executives and working through the organization. Demonstrating how IoT supports and fulfills the business drivers of the HDO will help connect this advanced set of technologies to the HDO’s goals and mission. For the business and clinical employees, educate and build awareness for how IoT will enhance their efficiencies in their workflows and how the technology will augment their personal abilities to perform their role. For the technical teams, ensure that the responsible parties for IT and operational technology that touch IoT understand and are ready to incorporate the technology across existing full-stack solutions and begin to plan and architect for the platform-based approach. Remember that this new influx of data will also have a positive impact on teams responsible for data analytics and business intelligence solutions.

Assemble an IoT Task Force to Create the IoT Platform Strategy for the HDO

With any new technology such as IoT, there will be a set of employees with the supporting skill set, but gaps will still exist that must be addressed. List and rate the critical skills required within the organization across all stakeholders that will lead to successful IoT platform implementations (see Note 3). Use this list to plan and invest in skills and technology supportive of IoT platform and IoT software integration, data and analytics, as well as managed security solutions. The skills needed for success are not limited to just IT. Build a cross-functional roadmap for knowledge acquisition and resource development tied to IoT development projects and time scales. Any IoT platform effort will most likely be multidepartmental and require a diverse set of skills. A center-of-excellence approach or IoT task force style approach should be used to make sure these cross-functional efforts have cross-functional skill set and leadership support.

Charge the task force with creating the IoT platform strategy for the HDO.

The technical strategy for the organization’s IoT platform will encompass specific strategies for the technical subcomponents of the platform. For the IoT edge, the strategy must address the full-stack siloed solutions in place where integration with services “outside the stack” is imperative. There are also many edge devices in an HDO that have IoT capability with that functionality, but not currently utilized.

The platform itself needs an architecture and strategy that supports the flexibility and scalability required to ingest and process the data produced by the IoT edge. Where the edge strategy mostly deals with integration of existing capability or overcoming device limitations, the platform strategy is innovative and new, not shackled by legacy limitation. The platform strategy will not only ensure the edge integration, data integration, application enablement and analytics functions are agile and frictionless, but also provide for future innovations, such as artificial intelligence and machine learning.

The IoT platform will be a major component in the organization's integration strategy. Like the IoT edge strategy, integration must:

- Address the diversity of devices and device types at the edge
- Define how to handle legacy devices with limited communication capabilities
- Help hone the platform strategy to allow for that wide mix of interconnection abilities or lack thereof at the IoT edge

As the intermediary between the organization and the IoT edge, the platform strategy also must encompass integration with enterprise IT services and external third-party IT services.

The last subcomponent strategy supports the organization's analytics requirements. As HDOs mature into RTHSs, the IoT strategy must include an iterative process improvement relationship between how data is used and how it is collected. The end goal is to use data to create proactive response to situations and events that occur (or are about to occur). This evolution from reactive to proactive can only happen if the organization's analytics strategy is in harmony with the IoT platform strategy.

As always, there is a security and compliance risk component that must be part of any IoT platform effort. Strategic consideration for current best practices in preventing and mitigating the risk introduced by the complex technologies IoT brings to the HDO must be in place across the entire IoT footprint.

Create Small Wins for the HDO by Initially Applying IoT Platform Principles to a Limited Group of IoT

When shifting from a traditional IT solution approach to an innovative methodology, there are many barriers to overcome, and not all will be with the technology itself. In healthcare, the approach to IoT implementations has been one of isolated departmental installations, tightly focused on specific outcomes and value delivery. Under the guise of specific medical device functionality, imaging systems and facilities management — to name a few — IoT has become part of the working day at most HDOs. This is evident in the survey stats that found, by next year, 90% of HDOs will have IoT in production. These systems, once identified independently, are now

being grouped together under the IoT banner. Healthcare has, in fact, been using IoT under different names for years.

With this embedded use of IoT technologies, how data flows, how the devices participate in caregiver/employee workflows and how they are managed are embedded in the care delivery culture. IoT platforms will have an impact on these work patterns that will create resistance. In addition, the introduction of an IoT platform approach to utilize and manage IoT devices can be deemed as foreign and unnecessary to HDO leadership, as was centralized PC management 20 years ago or mobile device management 15 years ago. To overcome these impediments, HDO CIOs need to find areas of the organization where improvements to care delivery or HDO administration are easily correlated to the addition of IoT.

For example, providing a platform approach for the management and maintenance of temperature control systems across the HDO will provide cross-discipline benefit for labs, pharmacies, and tissue and blood banks, as well as facilities management. The ability to bring platform services to bear on this set of data:

- Provides a common platform to analyze the temperature data streams
- Provides application access to that data
- Enables centralized management of the IoT edge devices, including applying security and compliance governance (where there may have been none in the past)

By creating this quick win for the organization, the HDO CIO can demonstrate the real, tactical value of the IoT platform and transition that success into continued maturation of the organization toward digitalization.

Evidence

[1] P-18034 SRS IoT Solutions Survey from 2018.

Note 1
HDO IoT Device Categories and Examples

- Facilities
  - Security
    - Video surveillance, door locks/entry systems, fire alarms
  - Building management
    - Power monitoring, power distribution, energy consumption/management, elevators

- Environmental controls
  - HVAC, lighting, room control, water quality, humidity monitoring, tissue/blood refrigerators

- Patient monitoring
  - Medical devices
    - Smart medical devices, infusion pumps, ventilators, incubators, telemetry, smart stethoscopes, medical imaging
  - Clinical monitors
    - Electrocardiogram (ECG), heart rate, pulse oximetry, ventilators, capnography monitors, depth of consciousness monitors, regional oximetry, biopatch technology, respiratory rate
  - Smart patient room
    - Smart beds, hand hygiene, fall detection
  - Virtual care
    - Remote ICU telemetry
    - Teleology

- Remote wellness/chronic disease management
  - Implantable device monitoring
    - Pacemakers, defibrillators, neurostimulators
  - Wearables
    - Wristbands, biopatches, smartwatches, ear buds
  - Remote clinical monitors
    - Spirometer, pulse oximeter, ECG, glucometer, fall detection

- Real-time location services
  - Asset tracking

- Wheelchairs, infusion pumps, smart cabinets, medication carts, par-level management, rental management

- Employee
  - Physician, nursing, ancillary staff

- Patients
  - Infant abduction, flight risk, wandering systems

- Visitors
  - Wayfinding, digital signage

Note 2
Examples of Vendors Providing Platform Functionality

Table 1 highlights some sample vendors that provide some component of platform functionality. The list is not exhaustive, and reflects no evaluation or comparison of capability. Those listed are shown to provide examples of the kind of vendors that may exist in an IoT platform approach.

Table 1: Examples of Vendors With Platform Functionality

Vendor Name ↓	IoT Platform Function ↓
Atrius Health	Facility IoT
ALTEN Calsoft Labs	Healthcare IoT
Connexall	Medical device platform
KaaIoT	Healthcare IoT
Rigado	Healthcare IoT
STANLEY Healthcare	Healthcare IoT

Source: Gartner (June 2019)

Note 3

IoT Platform Skill Sets

Architecture/design practices

- API design
- Event-driven architecture
- Streaming analytics

Architecture/design technologies

- Full cycle API management
- Cloud integration
- Distributed computing

Execution/implementation practices

- Security and privacy
- Data literacy
- Agile integration

Execution/implementation technologies

- Process automation
- Communication and interoperability protocols/standards

Recommended by the Author

The Real-Time Health System Architecture for Health Delivery Organizations

Maturity Model for the Real-Time Health System

Drive a New Data and Analytics Architecture to Match Your Digital Healthcare Provider Needs

Top 10 Strategic Technology Trends for 2019: Digital Twins

Use the IoT Platform Solution Reference Model to Help Design Your End-to-End IoT Business Solutions

Essential Skills for Modern Integration Architecture

Recommended For You

Survey Analysis: Healthcare Provider IoT Adoption Is Becoming Mainstream

The Promises and Pitfalls of People Tracking Within Healthcare Providers

Survey Analysis: Healthcare Providers Must Modernize to Transform

Hype Cycle for Healthcare Providers, 2019

7 Critical Domains of a Successful Healthcare Provider Interoperability Strategy