Enabling Healthcare Innovation at the Edge

Intel® Health Application Platform

Executive summary

The health industry is complex, vast, and experiencing profound transformation. It faces both challenges and opportunities as it strives to meet the needs of diverse stakeholders, including solution developers, hospitals and care providers, medical and pharma researchers, insurers, government, and perhaps most important of all, patients. The challenges range from ensuring effective, affordable, and timely care delivery for an aging and chronically ill population to managing stringent government regulations and data security risks. As new technologies and connected infrastructure provide access to critical and more comprehensive data, there is enormous potential to help save lives and lower costs through more proactive intervention.

To address these challenges and enable these opportunities, Intel created the Intel® Health Application Platform—an innovative application software platform. When coupled with an Intel® architecture-based design specification first offered in the Flex IoT Compute Engine*, the Intel Health Application Platform can enable healthcare solution providers to securely deliver distributed healthcare services across an always-connected and ever-expanding healthcare edge and to any cloud.

The Intel Health Application Platform software and Flex IoT Compute Engine can help boost robustness, ease of use, and capability of end-to-end healthcare provider solutions that leverage a smart computing edge. These provider solutions allow care providers to connect with the data they rely on to deliver their most innovative products and services.

Challenges

Against a persistent backdrop of trying to improve quality and access while lowering costs, the health industry is also in transition as it faces new challenges—from an increasingly aging population and a shift from infectious to chronic disease management, to a shortage of trained personnel and resources, outdated infrastructure, and incompatible technologies and protocols. Today, while general-purpose smartphones and tablets are often used for healthcare provision and monitoring, even connected devices that are created for specific healthcare usage can become unstable or unreliable when operating systems or applications are updated. Furthermore, these current solutions may also present data ownership, security, and access issues. Solution deployment can bring risks, as the ecosystem grapples with functionality interruptions on critical health monitoring devices and systems, asset management, data transmission across firewalls and networks, and storage on public or private clouds. Finally, regulations are increasing in both number and stringency, and penalties can be costly.
Solution

The Intel Health Application Platform is an innovative application software platform for use by healthcare solution providers to enable a variety of exciting remote care usage models. The Intel Health Application Platform and Flex IoT Compute Engine bring the performance, security, and certified connectivity healthcare solution providers need to enable new categories of devices with the flexible edge application deployment benefits of consumer tablets and phones. Plus, the solution brings the enterprise-grade stability, security, and longevity that can reduce system-wide TCO and improve the user experience.

Solutions based on the software platform allow customers to retain data ownership to address privacy, IP protection, and other data issues and, when coupled with the Flex IoT Compute Engine, offer a tuned hardware specification that facilitates customization without sacrificing predictability. Remote care solution providers benefit from load-and-go capabilities that allow value-add differentiation, faster time to market, and better resource management to deliver tailored solutions covering a wide spectrum of potential usage models including post-acute care transitions and monitoring of aging populations.

Such solutions can work with healthcare-compliant environments to help ensure data privacy and feature Wi-Fi, 3G connectivity certifications and data services, a growing range of verified peripherals, enhanced standards support, rapid onboarding services, device provisioning/management options, logistics services, and full technical support. The Intel Health Application Platform is updated with new features on a regular basis.

With the Intel Health Application Platform software powering multiple hardware designs offered by Flex, the remote care solution provider ecosystem now has a unique platform and business model to build a new category of edge devices that can enable the secure delivery of distributed data and services across an always-connected and ever-expanding healthcare edge and to any cloud.

- **Designed for smart healthcare edge:** The Intel Health Application Platform is an innovative application software platform that leverages the growing intelligence at the edge, enabling healthcare solution provider designs that provide the robustness and reliability needed to support a variety of novel and exciting remote care usage models.

- **Seamless and secure end-customer experience:** Solutions built using the Intel Health Application Platform and Flex IoT Compute Engine provide a predictable and secure application deployment and data management environment, with true data ownership and hardware-based security to help ensure IP protection and patient privacy.

- **Vibrant, robust ecosystem:** In concert with global hardware solution provider Flex, healthcare ecosystem partners using the Intel Health Application Platform gain faster, more flexible deployment through integrated hardware, software, and certified communications services that help lower costs and technical barriers and speed time to market.

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**Figure 1:** Intel® Health Application Platform overview

<table>
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<tr>
<th>More verified peripherals</th>
<th>Enhanced standard support</th>
<th>Services and support</th>
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<tbody>
<tr>
<td>• Support for hundreds of new devices with third-party peripheral drivers</td>
<td>• Continua Bluetooth Low Energy* (BLE*) and Bluetooth Classic* for sensor data transfer</td>
<td>• Data services</td>
</tr>
<tr>
<td>• Add new drivers with SDK</td>
<td>• Continua Design Guidelines (CDGs) HL7 FHIR for data transfer to the cloud (available in early 2019)</td>
<td>• Rapid onboarding services</td>
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<tr>
<td>• Connect a mobile device via Wi-Fi or Bluetooth* in a controlled, secure manner</td>
<td></td>
<td>• Service provisioning/management</td>
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**Healthcare ecosystem**

- OEMs
- Application developers
- Solution providers
- Peripheral manufacturers
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What’s New

The Intel Health Application Platform is continually expanding its feature set and capabilities—all available via simple software upgrades on existing devices. New features include:

Support for companion mobile devices with the added ability for the software stack to integrate and work with mobile devices, tablets, or phones. This gives both the solution provider and healthcare provider increased flexibility and control. Companion application features include:
- Data syncing from the IoT Compute Engine to the tablet
- Access point with whitelisted device support
- Peripheral pairing from tablet to the IoT Compute Engine (near-field communication [NFC] independence)
- Wi-Fi setup on the IoT Compute Engine using a tablet
- Reading confirmation
- Authentication on app (extensible to a multiuser scenario)

Enhanced standard support to help ensure compatibility and compliance for the health industry.
- Continua Bluetooth Low Energy* (BLE*) and Continua Bluetooth Classic* for sensor data transfer via BLE peripherals (that follow the standards).
- Continua Design Guidelines (CDGs) HL7 FHIR for data transfer to the cloud (available in early 2019). This standard outlines how to send data from a Continua IoT Compute Engine with the Intel Health Application Platform to a Continua FHIR receiver (i.e., cloud). Upon implementing the Continua FHIR receiver, providers and users can easily receive data from Intel HAP.

Growing set of devices and peripherals and support for more than 200 protocols, made possible by integration with a third-party provider.
- ECG blood pressure monitor (excluding arrhythmia and mean value)
- Blood glucose monitor (excluding tags, such as before meal or after meal)
- Blood oxygen monitor (excluding SpO2/hour streams and pulse waveform)
- Thermometer (excluding streams)
- Weight scale (excluding body composition)
- Heart rate monitor
- Spirometry monitor
- Fetal Doppler
- Activity, sleep, and respiration rate monitor

Automatic upgrades and continually expanding features on a future-proofed platform.

Growing set of devices and peripherals and support for more than 200 protocols, made possible by integration with a third-party provider.

Healthcare challenges are significant and multilayered

<table>
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<tr>
<th>Aging population</th>
<th>More chronic disease</th>
<th>High readmission rates</th>
<th>Doctor and nurse shortage</th>
<th>Rising costs</th>
<th>Disparate data</th>
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<tr>
<td>2 billion people—22% of the world’s population—will be 60 years or older in 2050, with two-thirds in developing countries²</td>
<td>Approximately 860 million people worldwide have more than one chronic condition²</td>
<td>Hospital readmission rates are at 21%, with an average cost of $26 billion annually²</td>
<td>The world faces a shortage of 4.3 million health workers³</td>
<td>Up to 20% of US GDP is spent on healthcare⁴</td>
<td>Nonclinical devices are capturing more data from humans than medical providers⁵</td>
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Features and benefits
The Intel Health Application Platform helps enable solution providers to take advantage of a smart computing edge to better connect patients and caregivers and capture and deliver the data they rely on for more personalized, data-driven healthcare.

| SEAMLESS UPDATES AND CONNECTIVITY | Helps eliminate system updates that can create disruption when connected to peripherals and data or increase maintenance requirements.  
|                                  | Supports robust connectivity from the sensor-based peripheral to the cloud.  |
| TRUE DATA OWNERSHIP              | Allows healthcare providers to maintain total control of their data at every step.  
|                                  | Encrypts and stores data only until it can be forwarded to the back-end location designated by the solution owner and/or solution provider. Intel does not own patient and other medical data.  |
| ADVANCED SECURITY                | Provides a known methodology for security to ensure robustness and help protect trusted data at the edge.  
|                                  | OpenSSL and Bouncy Castle* support transport layer security (TLS) and multiplexed transport layer security (MTLS) implementations for security.  
|                                  | Increases resiliency with Intel® SoC hardware root of trust.  
|                                  | Verifies a hardware root of trust and allows the use of certificates to validate the ICE with Intel® Secure Boot.  
|                                  | Secure virtual machine (VM) helps ensure medical data on the ICE utilizes secure storage of the embedded multimedia controller (eMMC).  |
| VERIFIED PERIPHERALS             | Support a growing selection of interoperable peripherals, including a blood pressure monitor, weight scale, and pulse oximeter.  
|                                  | Support for hundreds of new devices with third-party peripheral drivers.  
|                                  | OEMs can add new drivers with the SDK.  
|                                  | Scale across many remote monitoring use cases for end customers to help reduce spending on R&D resources.  |
| ENHANCED STANDARDS SUPPORT       | Continua Bluetooth Low Energy* (BLE*) and Continua Bluetooth Classic* for sensor data transfer.  
|                                  | Continua Design Guidelines (CDGs) HL7 FHIR for data transfer to the cloud.  |
| HIGHLY EXTENSIBLE AND CUSTOMIZABLE | Allows solution providers to focus on innovation, get to market faster with low R&D, and leave logistics handling to Flex.  
|                                  | Ability to interface with companion devices through a mobile application.  |
| FLEXIBLE APPLICATION DEVELOPMENT | Enables solution providers to layer their own or relevant Android*-based value-add applications.  
|                                  | Android sample application to accelerate development of mobile solutions for data visualization and peripheral onboarding.  
|                                  | Take advantage of the 3G connectivity (included) by using a wireless access point securely connected with a tablet device.  |
| FAST, FLEXIBLE DEPLOYMENT        | Offers hardware, software, and communications services, as well as logistics, through global ecosystem partner Flex.  
|                                  | Integrates easily into solution provider’s existing back end.  |
The foundation for IoT

Intel works closely with the ecosystem to deliver smart IoT solutions based on standardized, scalable, reliable Intel® architecture. These solutions range from sensors and gateways to server and cloud technologies to data analytics algorithms and applications. Intel provides essential end-to-end capabilities—performance, manageability, connectivity, analytics, and advanced security—to help accelerate innovation and increase revenue for enterprises, service providers, and key industries like healthcare. Intel can help organizations use data to monitor, control, optimize, and benchmark, as well as to share historical and current information to improve decision-making.

intel.com/iot

Ecosystem-read innovation

By kitting the Flex IoT Compute Engine with their solution, the healthcare ecosystem solution providers can then deliver directly to the healthcare provider. In a remote monitoring scenario, doctors could recommend the remote care treatment to patients, who then receive the kit through a commercial delivery service.

Solution developers can focus on innovation and speed time to market with design, development, and logistics handled by Flex. Flex offers product customization, high-volume manufacturing, fulfillment, and customer support.

Conclusion

IoT technologies can be a catalyst for change—creating efficiencies and offering the potential for improved patient outcomes. The value of remote care has been widely researched and documented in the industry. The Intel Health Application Platform and Flex IoT Compute Engine can help enable solution providers to develop a variety of new and exciting usage models that can enhance remote care delivery.

Learn more

Discover the Intel Health Application Platform at intel.com/hap.

Find out about Intel IoT innovation for healthcare ›

To learn more about Flex, visit flex.com/expertise/cloud, or to contact a Flex representative, go to flex.com/connect.

Why remote care?

Remote care occurs outside of a clinical setting such as a hospital or physician’s office, allowing clinicians and caregivers to manage chronic and/or acute disease states at home or other remote locations. This approach can relieve the healthcare system of many unnecessary hospitalizations and time spent in a clinical setting while providing patients with care and attention on an as-needed basis in a more familiar and comfortable environment.

Numerous research studies have shown the efficacy of remote patient monitoring. A 2015 study found a 50 percent reduction in 30-day readmission and up to a 19 percent decrease in 180-day readmission among patients who received a remote care—based intervention. According to Berg Insights, over 7 million health care consumers utilize remote patient monitoring technology as a part of their everyday care plan. The use of remote monitoring is expected to continue its growth at a compound annual growth rate (CAGR) of 47.9 percent to reach 50.2 million by 2021.

Innovation in the remote patient monitoring world and increased utilization among patients has resulted in a rapidly developing RPM policy landscape. Thus far in 2018 alone, we’ve seen a number of milestone policy decisions that address RPM and telehealth reimbursement in Medicare, aim to invest in 5G broadband infrastructure and update the regulatory landscape, and include RPM as a basic benefit in Medicare Advantage.

1. The Intel® Health Application Platform (IHAP) is a general purpose information technology platform. The IHAP is intended to transfer, store, display and convert data from one format to another in accordance with a preset specification. The IHAP is not intended to initiate control or alter the functions or parameters of any connected medical devices. The IHAP does not diagnose, cure, mitigate, treat, or prevent disease or medical conditions and is not intended for use in real-time patient monitoring or urgent patient care.
8. New peripherals are currently being validated and will be enabled at a later date.
9. Intel technologies’ features and benefits depend on system configuration and may require enabled hardware, software or service activation. Performance varies depending on system configuration. No computer system can be absolutely secure. Check with your system manufacturer or retailer or learn more at intel.com.
10. Cost reduction scenarios described are intended as examples of how a given Intel-based product, in the specified circumstances and configurations, may affect future costs and provide cost savings. Circumstances will vary. Intel does not guarantee any costs or cost reduction.
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