WHITE PAPER
mHealth
Healthcare

Using mHealth to Work Smarter: Increasing Efficiency for Clinicians and Health Workers

EXECUTIVE SUMMARY

mHealth is a widely used term in the rapidly changing world of mobile technologies for healthcare. Initial use of the term often focused on the use of mobile phones and handheld devices to deliver health information and services to consumers in mature nations and to rural citizens in developing nations. In order to address critical global challenges, mHealth should instead be viewed as an umbrella term that covers a wide range of mobile solutions which can help enable governments and health organizations to deliver higher-quality, more efficient healthcare.

Successful mHealth deployment should include matching the right mobile device to the user's tasks and workflow requirements. Suitable mHealth devices may be feature phones, smart phones, PDAs, tablets, netbooks, purpose-built platforms, laptops, or workstations on wheels. mHealth solutions should align with organizational objectives and be embedded within a comprehensive information architecture that provides necessary levels of connectivity, security, and privacy while aligning with end users' workflow and ergonomic needs. When the confidentiality of protected health information (PHI) must be maintained, devices with hardware-assisted security technologies can provide added insurance.

"There's no ideal device. They all have trade-offs. Smart phones are a great tool for physicians to see what lab results are coming in, but you wouldn't want to use them to view radiology images or do a lot of data entry."

– Judy Murphy, RN, FACMI, FHIMSS
Vice President of Information Services, Aurora Health Care

Introduction: A Broad Definition of mHealth

mHealth is an umbrella term that applies to the rapidly growing use of mobile technologies to deliver health-related information and services. The mHealth Alliance defines mHealth broadly, writing, "mHealth stands for mobile-based or mobile-enhanced solutions that deliver health."[1]

The demand for mobile health technologies has never been greater. mHealth solutions, integrated into well-designed workflows, can help governments and healthcare organizations:

- Provide higher-quality, more coordinated care
- Improve the productivity of health professionals
- Reduce errors in treatment
- Deliver information and services to rural and underserved regions
- Act as an enabler for health workers to deliver information and services to rural and underserved regions

Table of Contents

As healthcare organizations escalate their use of electronic health records (EHRs) and other e-health solutions, mobile access to data becomes increasingly valuable.

- For treatment teams, mHealth can support high-level care coordination such as that required by Accountable Care Organizations.[2] Mobile solutions can enable all authorized members of the treatment team to access up-to-date information and software applications when and where they need to.
- For visiting nurses and rural or community health workers (such as midwives who are focused on Millennium Development Goals 4 and 5 around information mortality and maternal health), mHealth can transform paper-based workflows. This transformation can help improve workers' productivity, enhance quality by bringing data into the healthcare system more rapidly, and provide a better experience for patients and citizens.

This paper shares perspectives and practices that can help organizations use mHealth to improve healthcare delivery, with an emphasis on device selection.

Aligning mHealth with Organizational Objectives

Intel's experiences suggest that the most effective mHealth deployments are comprehensive, data-driven projects that align with strategic healthcare and enterprise goals related to the quality, cost, accessibility, and efficiency of healthcare. mHealth can also help enhance employee retention, train remote workers, and extend services outside the walls of the hospital, clinic, or community care center to patients at home or in underserved areas.

mHealth planning should begin by assessing information flows and identifying points where better access to information and tools can help reduce administrative overheads, avoid duplication of effort, allow health workers to more efficiently collect, access, or enter information, and meet other organizational objectives. Intel has worked with healthcare leaders worldwide to develop practical value models that can help with this process.[3]

CLINICIAN PERSPECTIVE

**Barbara Stuttle, CBE, MHM, DN, RGN,
Deputy Chief Executive and Chief Nurse,
NHS South West Essex,
and National Clinical Lead for Nursing**

We can't deliver care like Florence Nightingale did. We have to work smarter to meet the growing demand, and we have to enable more of a partnership with our patients. Computers and mobile technologies can help us do that. Once you've started using them, it's like booking an airline reservation or withdrawing money from an ATM. You would never go back, because it's so much more efficient, and it makes the whole process safer.

Devices need to be designed for what the user's going to use them for. You need different capabilities for different settings.

All nurses should have mobile phones, but to take adequate and efficient notes and access information, you need a laptop or a mobile clinical assistant (MCA). With those devices, you can graph the patient's results and show them the trends. When they see it graphically, it starts to makes sense and it builds motivation. And your care is all documented and audited.

People express concerns around confidentiality, but they forget we used to lose paper records—it's always been an issue. We've gone a long ways to securing the information on a laptop and mitigating the damage if anything happens. Now you can program the laptops so that if they're lost or stolen, they become unusable.

We've come a long way, and we will continue to evolve and develop. The more we can tie the information with telehealth and telecare, and start to integrate with health and social care services, and give the patient access, the more we can do. The possibilities are endless.

Condensed from an interview conducted April 15, 2011.

Considerations for mHealth Information Architecture

To deliver the greatest value, mHealth solutions should be architected for consistency with the organization's overall information architecture. Rather than being driven by a point solution, mHealth should be integrated with the IT architecture and be able to support large-scale deployment and the breadth of tasks health workers perform. As in any area where technologies are advancing rapidly, it's important to preserve flexibility—to avoid being locked into a single type of device, or into infrastructure that can accept data from only a specific class of devices.

Privacy and security requirements are a critical consideration and are influenced by the regulatory environment and the type of information users will be accessing. Privacy and security should be planned from the outset and not tacked on as an afterthought. Data should be protected from end to end: when it is stored, in use, or in transit. (See sidebar, Intel® Technologies to Enhance Security.)

Many organizations are exploring cloud-based services and new methods of delivering applications and services to client devices.[4] The choice of how software is delivered to the wide variety of mobile devices must balance privacy and security concerns with ease of use, version management, offline data access, and network capacity. For some usage models, users will benefit from desktop virtualization methods such as application streaming and virtual containers running on rich clients. Rich clients are especially important when:

- Network bandwidth is limited or access is not consistently available (a particularly critical issue for first responders)
- Users work with large data sets such as medical images
- Latency limits application performance, for example, when using latency-sensitive data entry modalities such as voice command and control or handwriting recognition
- Users need to run multimedia and text applications simultaneously, for example, conducting a videoconference, looking up text and image data simultaneously, or running decision-support applications

The choice of application delivery method and client type will also influence the total solution cost. The cost savings achieved by choosing inexpensive, thin-client devices can be more than offset by increases in data center costs for servers, centralized storage, and network build-out.

Mapping Devices to Users, Tasks, and Environments

There is no single, universal mHealth device. Depending on the users and their tasks and workflows, the most suitable mHealth device may be a feature phone, smart phone, PDA, tablet, netbook, laptop, purpose-built platform such as a mobile clinical assistant (tablet computers designed for healthcare usage models, see sidebar, Mobile Clinical Assistants on page 7), or laptops mounted on lightweight carts (Figure 1 on page 4).

To select devices, begin by considering the worker's role, education level, and skill set. Hospital physicians will have different information needs from emergency medical services (EMS) personnel, rural survey workers, or village midwives.

Conduct a detailed assessment of the user's workflow, the type of information users will work with, and how they will access it. For example, if users are documenting their interaction with a patient or capturing health survey data, will they fill in forms or take detailed narrative notes? Will the device enable a good interaction with the patient/citizen or will it get in the way?

INTEL® TECHNOLOGIES TO ENHANCE SECURITY[5]

Intel offers a range of technologies designed to enhance security and safeguard confidential data from the PC to the cloud:

- **Intel® AES-NI** is a set of new instructions that have been added to certain Intel® processors; these instructions accelerate the execution of the Advanced Encryption Standard (AES) encryption and decryption algorithms thereby helping remove one of the main objections to using encryption to protect data: the performance penalty[i]
- **Intel® Anti-Theft Technology (Intel® AT)** can remotely disable or delete data from a lost or stolen laptop[ii]
- **Intel® Identity Protection Technology (Intel® IPT),** available in select 2nd generation Intel® Core™ processor-based PCs, supports strong authentication to protect access to sensitive information[iii]
- **Intel® vPro™ Technology** enables secure remote management of PCs and more efficient patch management[iv]
- **Intel® Virtualization Technology (Intel® VT)** assists with high-performance, secure virtual computing in data centers or on desktops and laptops[v]
- **Intel® Trusted Execution Technology (Intel® TXT)** is a hardware solution that validates the behavior of key components within a server or PC at startup; known as the "root of trust," the system checks the consistency in behaviors and launch time configurations against a "known good" sequence[vi]

Consider the totality of the user's workflow. Will users have multiple forms on the screen at once? Will they run interactive training programs, or share educational videos and charts with patients/citizens? Will they view medical images or incorporate them into reports? Complex workflows require more capable devices.

How much data will users enter, and how time-sensitive is the information? Acute situations demand more real-time and immediate communication that might be supported by text messaging on a mobile phone. Data collection for population health, or other environments where users may not have constant and reliable network connectivity, could be better suited to locally running applications with store and forward later to a central data base.

Users who work with PHI or other sensitive information will benefit from devices with hardware-assisted security technologies.

The work environment may impose additional requirements. In clinical settings, sealed-case designs can help reduce infections by being easy to wipe with disinfectants. In field hospitals, rural areas, and outdoor settings, ruggedized devices can extend product life.

Many health workers will use a mobile phone for voice and SMS messages as well as a more powerful device for the bulk of their workflow. Consultant-physicians may want to check lab result on their smart phones, but chart their work and view medical images on a laptop, purpose-built platform, or workstation on wheels while conducting rounds and examining patients. Rural midwives ideally need a netbook or laptop to document their clinical notes and consult reference information, but need to contact their patients through both data and voice communications.

Table 1 on page 5 summarizes some issues to consider as you assess specific device capabilities, match them to your intended users and uses, and conduct user tests. Note that many of these issues also apply to mHealth solutions targeted at patients, citizens, and consumers. For example, information delivery to a population of elderly patients must ensure that displays are easy to read and keyboards or other means of data entry are practical for people with arthritis.

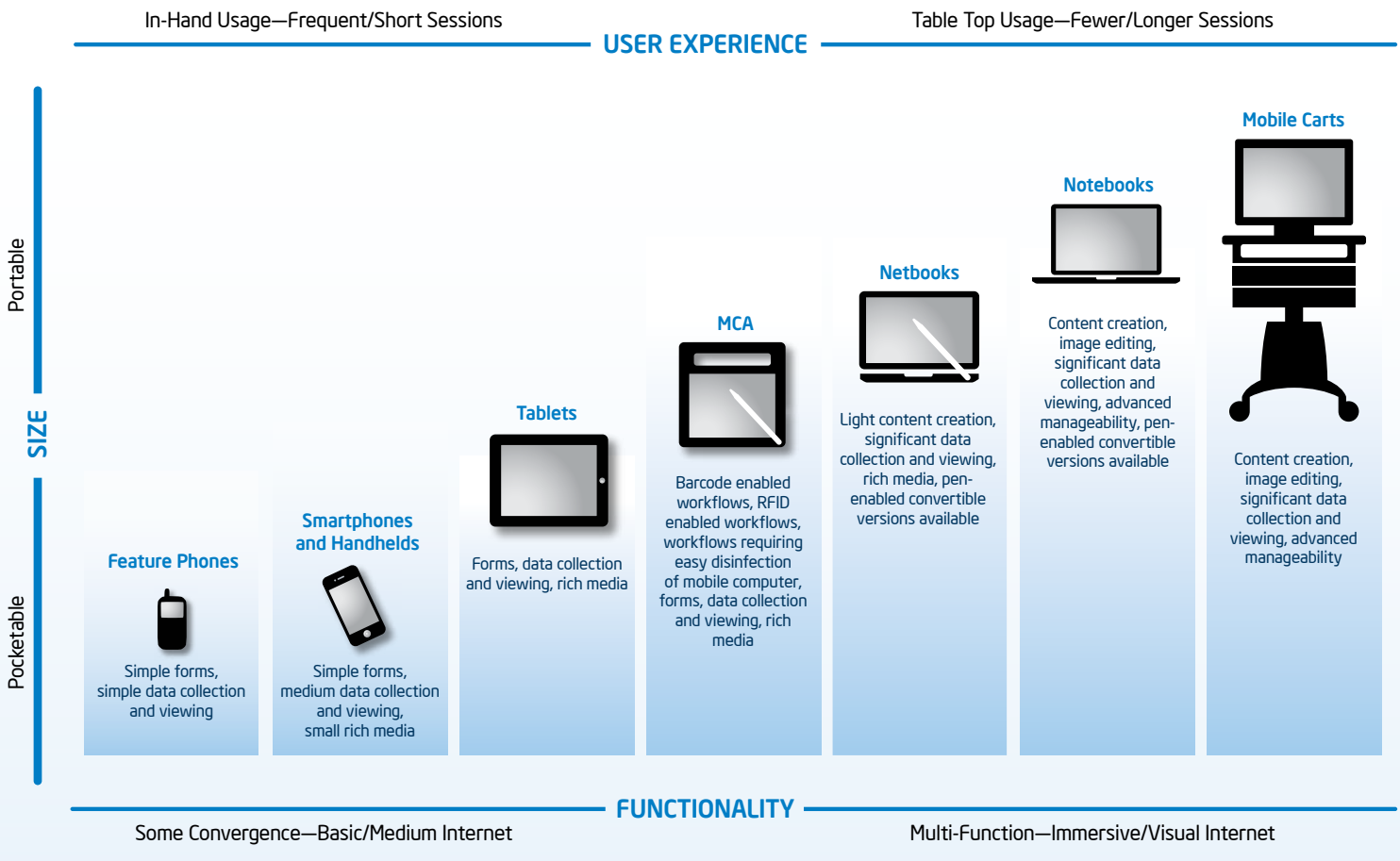

Figure 1. Devices for Users, Tasks, and Environments.

Table 1. Matching Devices to Usage Models and Users	
DEVICE CAPABILITIES	**QUESTIONS AND CONSIDERATIONS**
Processing Power, Memory, Graphics Capabilities	▪ Does the device provide a responsive experience while running the targeted applications, including media-rich files? ▪ Can it run software-based security solutions while maintaining response times? ▪ Does it support multitasking?
Communications, Connectivity and Collaboration	▪ Does the device support Bluetooth, 3G, 4G, USB? ▪ Does it provide a local soft phone for VoIP communications without overtaxing the network? ▪ Can users send SMS messages? Conduct videoconferences? ▪ Can users work offline and synchronize when they connect to the network? ▪ How easy is it to integrate the device with health devices?
Software	▪ What operating system(s) are available and how widely supported are they? Is the OS consistent with the rest of the organization or will it require a new learning curve? Is there a full set of development tools? ▪ Are relevant applications available and optimized for the device category?
Readability	▪ Is the screen large enough? ▪ Is it viewable in bright sunlight and dim lighting? ▪ Are displays readable by an aging workforce?
Data Entry	▪ Do data entry options match the user's requirements? ▪ Can users choose from a variety of data entry methods—keyboard, touch screen, handwriting, speech recognition?
Usability and Portability	▪ Are the device's size and weight suitable for the usage model? ▪ Will the battery last through the user's workday? ▪ Is it easy to swap batteries or dock and recharge the device? ▪ Does the device include a digital camera, barcode reader, or other value-added capabilities? ▪ Can the device hibernate and does it have instant-on capability to save on battery life while being quickly available to users?
Security/Privacy	▪ Can data be encrypted? Does the device provide hardware and/or software assistance to speed encryption? Does it have enough performance to support software security solutions? ▪ Can you remotely disable the device if it is lost or stolen? ▪ Does the device provide built-in technologies such as fingerprint readers or barcode/RFID readers that can assist with authentication?
Environmental Characteristics	▪ Does the device provide a sealed case design? Can the device be easily disinfected? ▪ Are ruggedized versions available? ▪ Is the device shock resistant?
Price	▪ What is the total solution cost, including device acquisition, connectivity, software development costs, service, and support?

mHealth in Action

Deployments and pilots around the world demonstrate mHealth's value in a variety of usage models and a range of devices. Here are a few examples.

Mobile Clinicians within the Hospital in the U.K.

NHS Lothian piloted an mHealth solution designed to improve workflow and patient care at St. John's Hospital in Scotland. MCAs were used by ward nurses, physicians, and pharmacists for ward rounds, pharmacy work, and discharge summaries. NHS Lothian found that the solution produced significant improvements in staff productivity, quality of patient care, patient and clinician satisfaction, patient safety, and cost of care.[6]

Visiting Nurses in Japan

Nagasaki University School of Medicine is using MCAs and regular tablets in an mHealth field trial that runs through 2011. Visiting nurses use the mobile technologies as they call on patients in remote villages in the Nagasaki Prefecture. Connected to the tablets and MCAs are devices for measuring blood pressure, ECG, oxygen saturation, glucose, heart rate, and digital camera. Most of the health devices connect wirelessly via Bluetooth, and a number are Continua-compliant. (See sidebar, Continua Health Alliance.) Data is integrated into the EHR and transmitted via WiFi* or 3G networks. The field test is enhancing the visiting care system's ability to provide high-quality care for elderly people in remote villages.

Emergency Medical Services in the U.S.

Valley Health, which serves the residents in Virginia, West Virginia, and Maryland, deployed an mHealth solution that equipped ambulances with Intel® processor-based laptops, tablets, and netbooks from Dell. EMS workers transmitted EKG results and other patient data to the hospital, which helped eliminate a 30-minute wait to activate the catheterization lab and improved the treatment of heart attack patients.[7]

Continua HEALTH ALLIANCE

CONTINUA HEALTH ALLIANCE

The Continua Health Alliance is an open, international organization of more than 230 healthcare and technology companies. Continua Alliance members have collaborated to establish interoperability guidelines for connected healthcare products for fitness, disease management, and elder care (products such as blood pressure cuffs, weight scales, glucose meters, thermometers, pedometers, and others).[8]

CLINICIAN PERSPECTIVE

**Judy Murphy, RN, FACMI, FHIMSS,
Vice President of Information Services,
Aurora Health Care, Milwaukee, Wisconsin,
and Board of Directors, HIMSS**

Decision support is the app that's really pushing mobile right now. If you can use mobile devices within the context of care delivery and get the decision support system firing while you're making the decisions and delivering the care, you have a great opportunity to hard-wire the best practices and really follow the protocols.

There's no ideal device. They all have trade-offs. Smart phones are a great tool for physicians to see what lab results are coming in, but you wouldn't want to use them to view radiology images or do a lot of data entry.

Space is a huge issue in the hospital. If you carry a laptop, there's nowhere to set it down. We're using lightweight mini-carts with a full-fledged laptop and a barcode reader connected via USB. It doesn't take up wall space or bed space, and you have the flexibility to move it wherever you want in the room. Laptops have come down in cost and the battery life is decent, so it's very practical.

All our visiting nurses carry laptops and have for 10 years. They need the full functionality of a laptop, because they need to retrieve and enter a good amount of documentation and there's a lot they have to keep track of. It takes a lot of data entry to document the patient encounter, even more than in the hospital.

Mobile phone apps for consumers? The real value will come when those apps are tethered to a true EMR.

Condensed from an interview conducted on April 18, 2011.

Health Surveys in Bangladesh

In Bangladesh, mobile healthcare workers are using feature phones and Intel®-powered netbooks to improve maternal and child health. In the field, health workers use a feature phone to gather simple survey data from pregnant women. This data is transmitted to a database that is accessed by doctors in a local clinic through a web browser on a low-cost netbook computer. From the browser, doctors can send follow-up care notifications and appointment reminders to the mobile health workers via SMS.

Rural Mobile Clinics in Nigeria

Mobile medical teams in Nigeria are using Intel-powered netbook PCs to gather comprehensive patient information that is forwarded to a health information database and used to improve delivery of healthcare services, optimize allocation of resources in remote communities, and track health trends. The project team has reported a 270 percent increase in healthcare delivery to underserved populations and a 900 percent increase in disease reporting rates for the first six months of the project.[9]

Crisis Field Hospital in Haiti

Following the January 2010 earthquake in Haiti, Israeli Defence Forces (IDF) Medical Corp established an emergency field hospital that used an MCA for triage and data capture. The team created EHRs for each patient, and used the platform to access them at the point of care. This process helped the team reduce transcription errors, streamline workflow, and deliver faster, safer care under difficult circumstances.[10]

Summary

mHealth can enhance the productivity of mobile health workers and improve the quality, cost, and efficiency of care both inside and outside the hospital. Organizations can build success by aligning mHealth deployments with organizational objectives, developing comprehensive infrastructure, and matching mobile devices to the requirement of healthcare workers and their workflows.

Intel® technologies deliver energy-efficient performance for a broad range of mHealth platforms, including tablets, netbooks, notebooks, and purpose-built platforms like the MCA. Intel healthcare IT experts can help you plan innovative mHealth deployments.

MOBILE CLINICAL ASSISTANTS

Mobile Clinical Assistants (MCAs) are purpose-built platforms for health professionals. Intel developed the initial MCA reference design based on research and workflow studies, interviews with clinicians worldwide, and usability studies. MCAs are ergonomic tablets that can be wiped clean with disinfectant and can include integrated peripherals such as a bar-code reader, RFID reader, smart card reader, fingerprint scanner, and/or digital camera. MCAs are available from vendors including Advantech, Barco, Gammatech Computers, Motion Computing, Panasonic, TabletKiosk, and Twinhead.[11]

To learn more, talk to your Intel representative or visit Intel's Healthcare IT sites:

www.intel.com/healthcare

premierit.intel.com/healthcare

"We have to work smarter to meet the growing demand, and we have to enable more of a partnership with our patients. Computers and mobile technologies can help us do that."

– Barbara Stuttle, CBE, MHN, DN, RGN,Deputy Chief Executive and Chief Nurse, NHS South West Essex and National Clinical Lead of Nursing

[1] http://www.mhealthalliance.org/about/frequently-asked-questions

[2] Read a whitepaper about how healthcare IT can support ACOs: http://www.intel.com/Assets/PDF/whitepaper/325069.pdf

[3] Learn about the mobile point of care value model: http://www.intel.com/Assets/PDF/whitepaper/Intel_MPOC_Value_Model_Whitepaper.pdf

[4] Read a whitepaper about application delivery methods for healthcare: http://emea.himss.org/docs/Healthcare%20Thin%20Client.pdf

[5] Join the Intel Healthcare IT Professionals Community at http://premierit.intel.com/healthcare and download a whitepaper by Intel healthcare security expert David Houlding at http://premierit.intel.com/docs/DOC-6242. To learn more about the secure healthcare cloud, see http://premierit.intel.com/docs/DOC-6130

[6] Read more: http://premierit.intel.com/docs/DOC-5834

[7] Read more: http://www.intel.com/references/pdfs/valleyhealth.pdf

[8] For more information, see http://www.continuaalliance.org/index.html

[9] Read more: ftp://download.intel.com/education/PMO/NigeriaMailafiya.pdf

[10] Read more at: http://www.toughbook.eu/sites/default/files/casestudy_pdf/Haiti%20WP_FieldHospitalHaiti.pdf

[11] For more information, visit http://www.intel.com/about/companyinfo/healthcare/products/mca/index.htm

[i] AES-NI is a set of instructions that consolidates mathematical operations used in the Advanced Encryption Standard (AES) algorithm. Enabling AES-NI requires a computer system with an AES-NI-enabled processor as well as non-Intel software to execute the instructions in the correct sequence. AES-NI is available on Intel® Core™ i5-600 Desktop Processor Series, Intel® Core™ i7-600 Mobile Processor Series, and Intel® Core™ i5-500 Mobile Processor Series. For further availability of AES-NI enabled processors or systems, check with your reseller or system manufacturer. For more information, see http://www.intel.com/technology/dataprotection/index.htm

[ii] No computer system can provide absolute security under all conditions. Intel® Anti-Theft Technology (Intel® AT) requires the computer system to have an Intel AT-enabled chipset, BIOS, firmware release, software, and an Intel AT-capable service provider/ISV application and service subscription. The detection (triggers), response (actions), and recovery mechanisms only work after the Intel AT functionality has been activated and configured. Certain functionality may not be offered by some ISVs or service providers and may not be available in all countries. Intel assumes no liability for lost or stolen data and/or systems or any other damages resulting thereof. For more information, see http://www.intel.com/technology/anti-theft/index.htm

[iii] No computer system can provide absolute security under all conditions. Intel IPT requires an enabled chipset, BIOS, firmware and software and a website that uses an Intel® IPT Service Provider's Intel IPT solution. Consult your system manufacturer and Service Provider for availability and functionality. Intel assumes no liability for lost or stolen data and/or or any other damages resulting thereof. For more information, see http://www.intel.com/technology/identityprotectiontechnology/index.htm

[iv] Intel® vPro™ Technology is sophisticated and requires setup and activation. Availability of features and results will depend upon the setup and configuration of your hardware, software and IT environment. To learn more visit: http://www.intel.com/technology/vpro

[v] Intel® Virtualization Technology requires a computer system with an enabled Intel® processor, BIOS, virtual machine monitor (VMM) and, for some uses, certain computer system software enabled for it. Functionality, performance, or other benefits will vary depending on hardware and software configurations and may require a BIOS update. Software applications may not be compatible with all operating systems. Please check with your application vendor.

[vi] No computer system can provide absolute security under all conditions. Intel Trusted Execution Technology (TXT) is a security technology that requires for operation a computer system with Intel® Virtualization Technology, an Intel Trusted Execution Technology-enabled Intel processor, chipset, BIOS, Authenticated Code Modules, and an Intel or other Intel® Trusted Execution Technology compatible measured virtual machine monitor. In addition, Intel Trusted Execution Technology requires the system to contain a TPM v1.2 as defined by the Trusted Computing Group and specific software for some uses. For more information, see http://www.intel.com/technology/malwarereduction/index.htm

Printed in USA 0511/JDU/HBD/PDF Please Recycle 325517-001US