TECHNOLOGY BRIEF
Intel DVC Education

Deploying a Flexible School Infrastructure for the Digital Age

EXECUTIVE SUMMARY

Today's IT managers are tasked with supporting computing for a K-12 population amidst a multitude of devices, widely varying deployment and accessibility standards, and a large spectrum of usage scenarios. Principals and teachers are looking for an anytime, anywhere, any-device service that supports in-school, mobile, and home use across a breadth of evolving learning and teaching methodologies. How can educational institutions—from the single independent school to the city- or state-wide school system—develop an architecture that delivers a consistent, customizable, secure, manageable, and reliable experience that is device-agnostic? How and when do we perform the compute cycles necessary to equip students with the skills necessary for 21st century success?

In order to understand the possibilities and trade-offs, this paper looks at an achievable, cost-effective "good, better, best" model for education infrastructures, all based on common configurations in today's schools. The model recommended by Intel is designed to help schools adapt, serve, and scale without having to reinvest in new infrastructure each time the device or learning landscape changes. It is an evolutionary model, allowing schools to start where they are and move as budget and resources allow, toward systematic, planned, short- and long-term growth.

Problem Analysis

Technology is now an integral part of most U.S. school systems—ranging from servers and networks supporting administrative services to classroom PCs from kindergarten through high school. Administrators, IT managers, teachers, and students are in a continual process of adaptation and discovery as they balance new learning paradigms, operational and management costs, and an expanding array of devices. Security compliance adds another layer of complexity for IT managers meeting stringent demands.

With the number of school computing systems increasing and 1-to-1 eLearning (where each and every student and teacher has a dedicated laptop) proliferating, schools are resembling businesses in the complexity of their technology requirements. School IT managers must now consider supporting technology-based activities both within school and without, as students, teachers, administrators, and parents expect to use school-owned equipment remotely or access school applications on their own devices and systems.

Cloud computing, both internal and external, SOA, SOE, Web 2.0 and 3.0, SaaS, 3D Internet, WiMAX*, virtualization, mobility, 1-to-1 computing—these and a host of other technologies and services are now impacting today's education landscape. What will be available or necessary tomorrow is uncertain at best. Many IT professionals in school systems are finding that creating and maintaining a sustainable infrastructure amidst the dizzying array of choices and compliance requirements is complex and difficult. What's needed is a stable, solid plan centered on technology fundamentals, one that is inherently flexible no matter what lies ahead.

The core of the long-term solution—whether for cloud computing or any of the other available technologies— is simple: a rich, full-featured PC, most often a notebook. Rich PCs offer the safest and best choice for educational institution deployments. There is a phased, sustainable infrastructure "good, better, best" model based on rich clients for delivering the necessary applications, digital content and content creation, administrative services, and support that schools and school systems require.

INFRASTRUCTURE RECOMMENDATIONS

Good

Foundation:

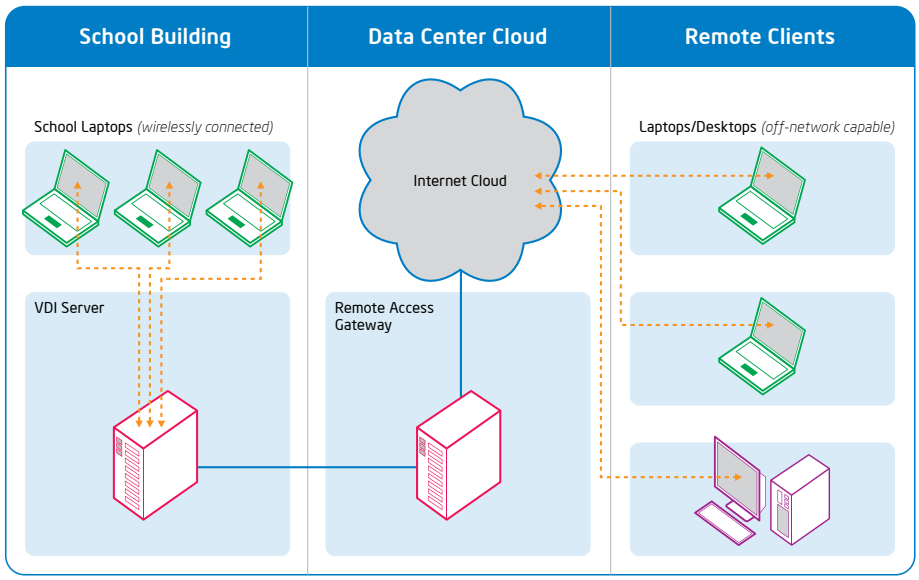
Schools support classroom computing and Internet access, but frequently lack remote service and centralized management. The server footprint is light, focusing on basic file and print functions.

- Standard client images are built and managed at the local device level
- Applications are installed locally on laptops or desktops
- May use classroom and/or school server(s)
- Internet connectivity

Recommended:

In order to add capabilities for remote and home users, Intel recommends client virtualization technology, along with remote access gateways. Because of cost and bandwidth limitations (which can be significant in large school districts), virtual client desktops are used specifically for remote users, enabled by a Virtual Desktop Infrastructure (VDI) server at the school site. Access gateways add security and central control for inbound VDI sessions, as well as outbound Internet traffic.

Good School Infrastructure



Better

Foundation:

Schools support streaming applications, as well as remote access. A streaming server provides application streaming and VDI sessions to traditional clients, as well as VDI sessions. One or more VDI servers support remote client sessions.

- Standard client images are built and managed at the local device level, including remote management capabilities
- Applications delivery is a mix of client-side and streaming
- Streaming server provides application streaming; VDI servers supports remote client sessions

- Management server(s) and remote access gateway provide access to VDI from outside the school, as well as Internet within school and for remote clients

Recommended:

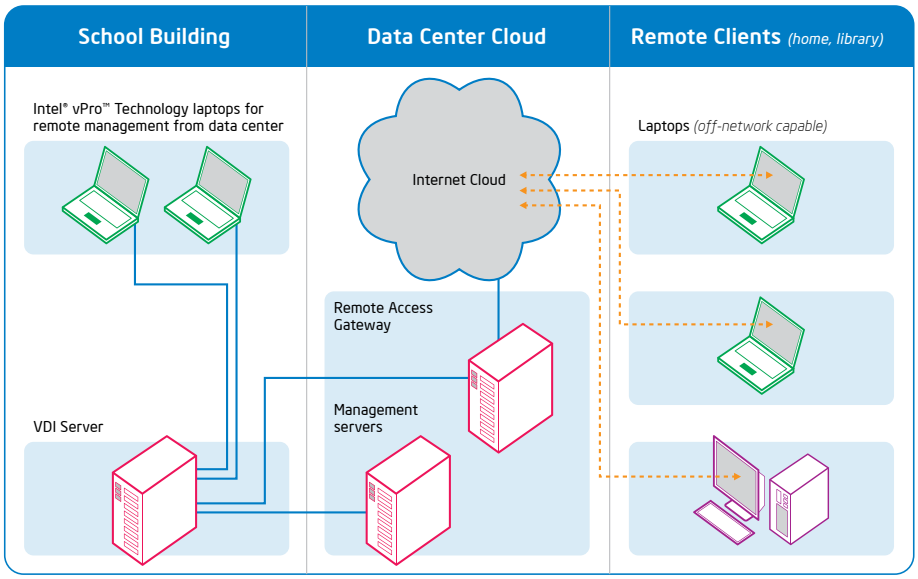
Here the goal is to centralize application control, licensing, and delivery, while providing greater autonomy to educators. Existing desktops and laptops enabled with Intel® vPro™ Technology become intelligent clients that support remote management capabilities. Installing VDI servers enables remote "school" desktops. VDI servers can also serve as a stepping stone, allowing legacy systems to run the school desktop prior to receiving replacement upgrade PCs.

Large school systems can use dedicated facilities to house dedicated management servers, while in smaller schools the school itself serves as the data center, with servers housed within the school building. Streaming servers can serve many users with a small footprint. Application streaming can be added to clients within the school building, reducing the need to install, maintain, and upgrade applications locally.

This model can have a significant impact on controlling software licensing management and costs. Streaming allows applications to be installed and run only when needed, rather than installing and maintaining applications on every system or image in case of future need.

For school administrators and teachers, the end result delivers greater efficiency and meets individualized learning goals. Principals and teachers can choose (and change) the applications that best suit their pedagogy and curriculum requirements at each grade level from the system-wide application pool. Because of the increased management and virtualization capabilities at this stage, schools are able to adopt new devices without necessitating an infrastructure overhaul.

Better School Infrastructure



Best

Foundation:

Schools support streaming operating systems and applications both in school and remotely. Server requirements increase to support virtualization and remote management.

- Client hypervisor provides virtualization at the client level
- Standard device images begin to be "device independent," and are managed and located in the infrastructure
- All applications are delivered in a streaming model; virtual containers are established to provide application isolation and independence
- Operating systems become a virtual layer or container, centrally managed and controlled, and dynamically delivered to the client
- VDI servers provide access to external users needing to run school applications
- All management and control is centralized, minimizing deskside service requirements
- Management and VDI server(s) also provide access to Internet within school and for remote clients
- Remote access gateways provide access and security for VDI sessions and Internet access

Recommended:

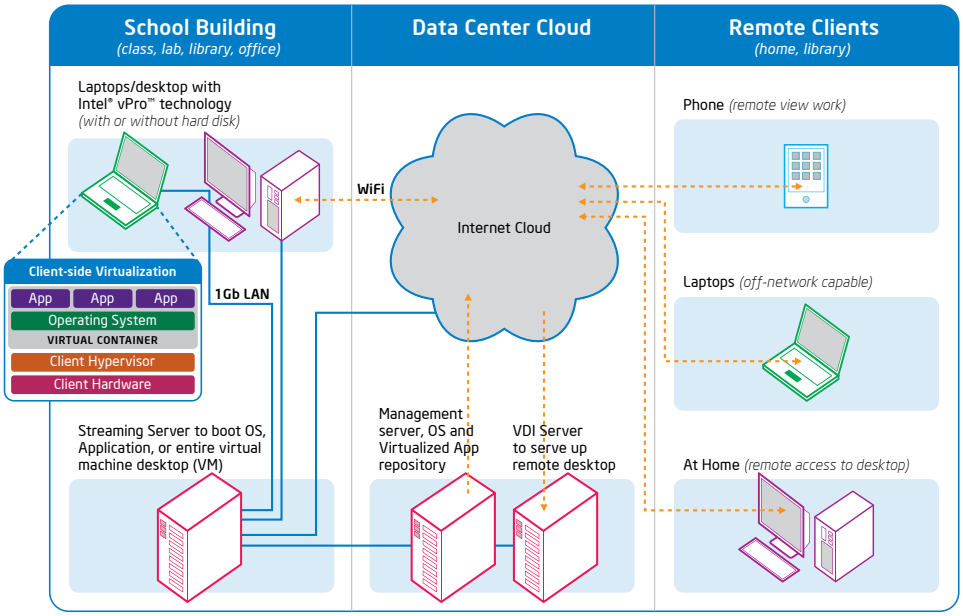
At this stage, rich clients are supported by a thin-client infrastructure and configuration, providing optimal user experience, performance, and flexibility. Combining the capabilities of rich and thin clients takes advantage of their respective benefits, while offering the best computing platform to students.

This combined approach offers the PC flexibility to run any education application now or into the future, with the central control and administration advantages that are experienced in thin and virtualized installs. Rich PCs allow computation and processing to occur on client machines—keeping server and infrastructure requirements to a minimum—yet enable the manageability and control of a thin client solution. Student and teacher information is stored in the data center cloud on management servers, along with the operating system and application repository.

In offline mode, when the data center is unavailable, bandwidth and local applications specific to each device are still operable, and can be quickly synced once back online (In contrast to the heavier bandwidth requirements of a multisession remote model). Fault tolerance is increased, as devices can operate if central servers or the data center are unavailable. Bandwidth requirements can be reduced as client devices will only update and sync applications; operating systems and software update requirements operate in a "sync and go" model.

A consistent user experience is provided to students and teachers in school and remotely on every desktop and device based on their login profile. Administration is simplified for teachers at the class level as technology management occurs at the district or school level. The ever-changing device mix is no longer critical, and more devices can easily be added over time.

Best School Infrastructure



SOLUTION COMPONENTS

Dynamic Virtual Clients (DVC)

Dynamic Virtual Clients are a family of application delivery methods that centralize management and data security, but provide the rich user experience and mobility of client-side execution. Intel's DVC model is based on the thin, rich client architectures possible in the "best" model. DVC allows a combination of best-of-breed solutions for rich clients coupled with thin client architecture. In this model, rich clients offer the full performance and experience of a traditional client, while gaining the centralized control, management, and standardization of a thin or virtualized client. Application and OS streaming, VDI servers, and remote management work together to provide a flexible, scalable infrastructure capable of responding cost-effectively to change. Technology investment and maintenance costs are reduced as schools increase their ability to centralize and consolidate IT management, licensing, and delivery.

Rich Clients That Act Thin

A traditional, rich PC provides the best performance and solution for schools moving into DVC's thin client architecture. It offers the local processing power and resources teacher and student clients need in order to adapt to an ever-changing software and classroom footprint.

Updating traditional rich client deployment methods through cost-effective planning will support adoption of the DVC model. This transformation supplies the benefits of a thin client solution, while maintaining the performance, flexibility, and capability provided in a traditional PC architecture.

- Deliver applications and operating systems to the full spectrum of today's and tomorrow's devices
- Same client can be used by multiple user groups with OS and application streaming based on login
- Solid state design extends client life up to 5 years and reduces maintenance

- Data and application security increases because little or no data is stored locally
- Repower for fixes, changes, or updates
- Students cannot corrupt the PC system
- Teachers and students gain all the performance of a traditional PC

Virtual Desktop Infrastructure (VD) Servers
VDI serves applications and/or operating systems to clients. On a thin client, VDI can be used to provide 100 percent of the desktop image; on a rich client it can provide some or all of the applications on-demand based on user profile. VDI serving allows client device independence, providing a consistent experience across all devices. All data is automatically housed within the data center, increasing data security. Centralized serving also centralizes and simplifies management.

Server Capacity
The actual number of laptops and desktops that a specific configuration of servers can support varies depending on such hardware characteristics as the processor type, the amount of memory installed, the storage configuration, the network configuration, the remote protocol used, and the demands of individual users (e.g., typing speed, applications used, frequency of access).

As DVC solutions evolve within a school system, the server footprint at schools can be reduced and servers repurposed to a central site to provide a centralized "cloud-like" solution. The addition of application streaming for both short- and long-term solutions is recommended to offset the workload requirement of VDI. Being able to execute some applications at the local level can significantly reduce data center compute requirements.

Cloud Services
Cloud services, whether internal or external, can be used to augment classroom or data center servers to provide Internet-based applications, operating systems, and CPU resources. A consistent virtual address accesses the application, enabling seamless roaming. Before choosing an external cloud vendor, it is important to weigh restrictions, such as licensing and pricing models, against the benefits. One strong advantage is that finding a cloud vendor who offers guaranteed server compliance with regulatory requirements as part of their package can significantly reduce the time spent by internal IT staff.

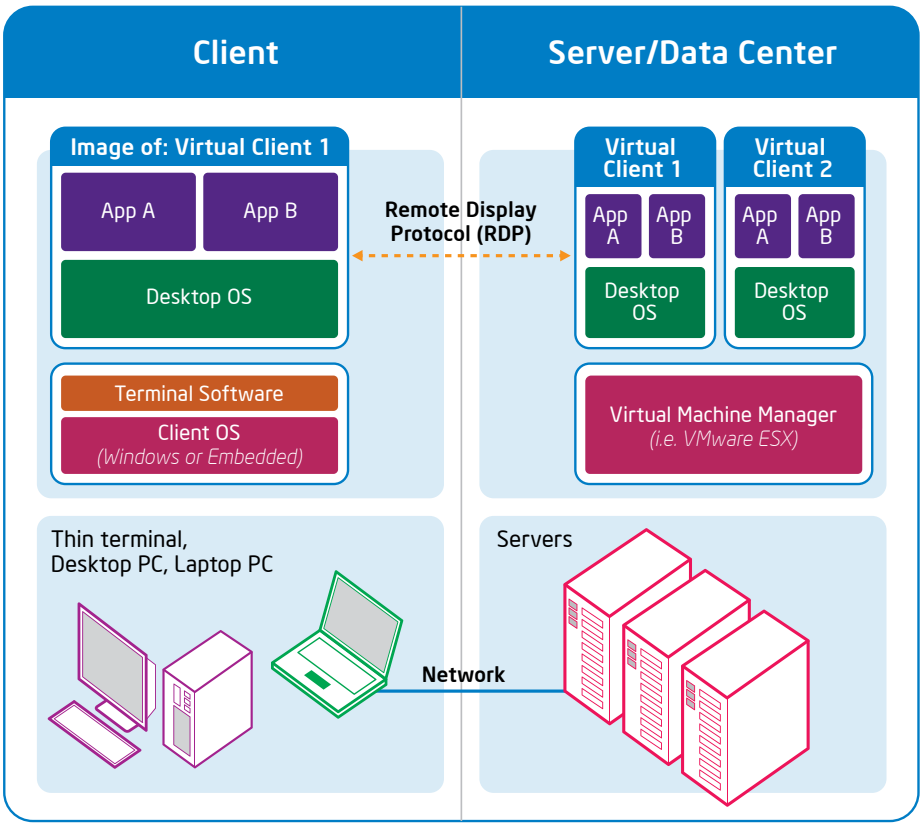
"Good, Better, Best" Solution Components

GOOD	BETTER	BEST
School laptops and desktops	Intel® vPro™ technology laptops	Intel® vPro™ Technology laptops and desktops
VDI server	VDI server	Client hypervisor
Remote access gateway	Management servers	LAN
Remote clients	Streaming servers	Management servers
Off-network capable laptops and desktops	Remote access gateway	Streaming servers
	Remote clients	OS and virtualized application repository
	Off-network capable laptops	VDI server
		Remote clients (phones, off-network capable laptops, desktops, etc.)

CONFIGURATION MODELS

Hybrid solutions are not only possible, they are recommended. They allow schools to evolve a mature software stack, as well as to control server costs. A look at three sample configurations shows some of the possible deployment options and benefits.

Virtual Hosted Desktop Model



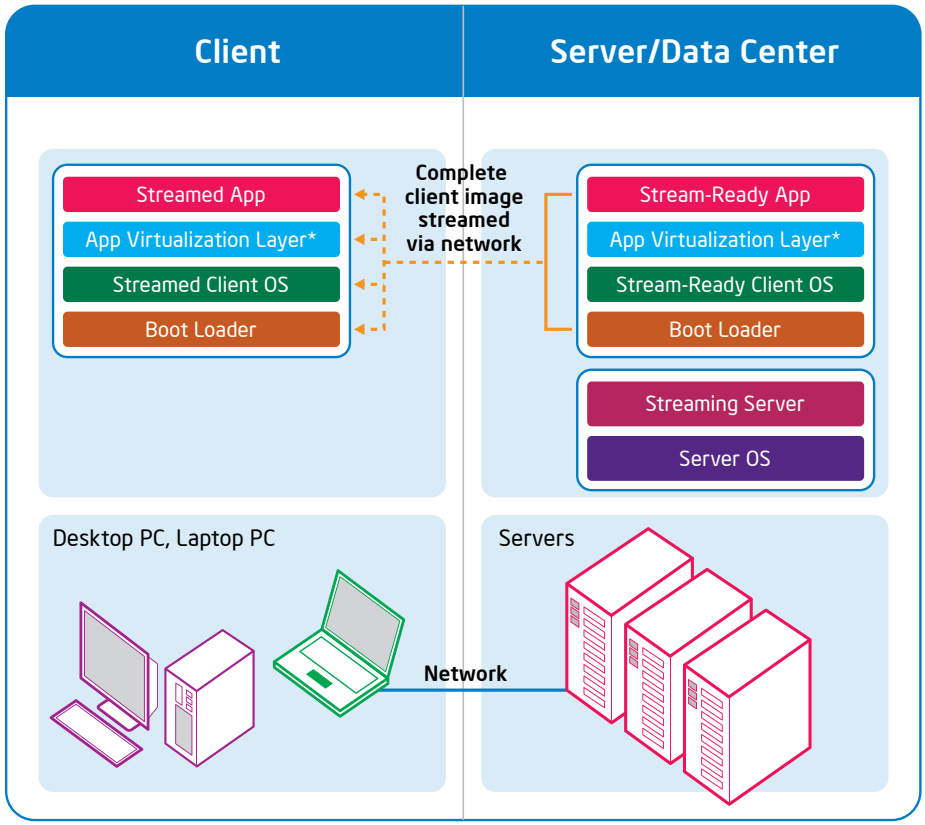
Benefits

- Centralized management and security
- Familiar PC interface with user customization
- Access from any Internet-connected PC
- "Stateless" client
- Disaster recovery

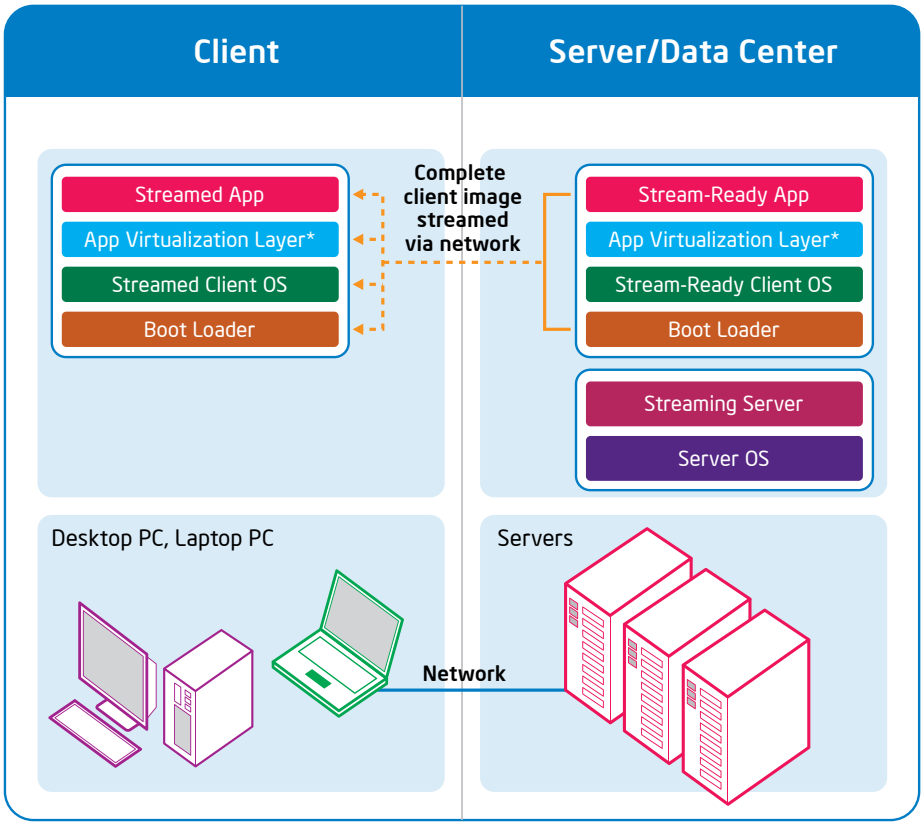
Benefits

- Centralized management and security
- Single OS and application image serves many clients
- Application virtualization eases OS compatibility issues and increases security through isolation
- Lower data center and network requirements than server-side models
- Familiar PC interface with user customization
- "Stateless" client
- Disaster recovery

OS and Application Streaming Model



Application Streaming Model



Benefits

- Centralized management and security
- Streamed applications can be the latest versions with all patches
- Responsive compute and graphics due to local execution
- Application virtualization eases OS compatibility issues and increases security through isolation
- Lower data center and network requirements than server-side models
- Familiar PC interface with user customization
- Disaster recovery for applications and data
- Off-network mobility with local caching

CONCLUSION

As schools strive to ensure every student has the skills to participate in the 21st century, technology is playing a central role. Supporting the evolving technology landscape cost-effectively, including an ever-changing mix of applications, while providing a high level of customization and service is a challenge faced by district-wide school systems and single schools alike. As shown here, a DVC model centered on cloud computing and rich PCs can be implemented in stages to meet the requirements, facility constraints, and budget limitations of schools. Rich clients based on Intel platforms combined with Intel vPro technology deliver optimal platform security and manageability. With the Intel Dynamic Virtual Client model, schools can meet the demands of the present, while effectively planning and scaling for the future.

APPENDIX

Intel® vPro™ Technology

Intel vPro technology provides security and manageability on the chip. Notebook and desktop PCs with Intel vPro technology bring hardware-assisted security and manageability capabilities that enhance their ability to maintain, manage, and protect PCs. Notebooks can be managed over a wired or wireless network through a wired LAN connection. Intel vPro is important when considering education solutions because it enables key security capabilities for virtualization on the client platform.

When Intel vPro technology is integrated into Dynamic Virtual Client models, the advantages are significant:

- **Security**: Hardware-based capabilities improve network traffic filtering and isolate clients under attack. Automatic security agents' verification and immediate remote restoration enhance preventive security efforts.
- **Manageability**: PCs with Intel vPro technology can help IT professionals diagnose and repair both wired and wireless systems remotely, cut downtime, and reduce the average in-person IT support time.
- **Energy-efficient performance**: As the multicore engine in Intel vPro technology, 45nm hafnium-based Intel® Core™2 Duo processors can provide over 90% faster performance when multitasking and over 90% faster performance on compute-intensive apps[1]. At the same time, their great energy efficiency enables smaller, quieter systems, and delivers great battery life for mobile PCs.

Intel vPro encompasses a set of Intel technologies that work together to enable key security capabilities for virtualization on the client platform from the processor to the network. These include Intel® Active Management Technology (Intel® AMT), Intel® Virtualization Technology (Intel® VT), Intel® Trusted Execution Technology (Intel® TXT), Intel® Anti-Theft Technology (Intel® AT), and the Intel® Advanced Encryption Standard instructions set (Intel AES-NI). Intel® Core™ processor-powered systems and Intel graphics provide a responsive experience even on demanding applications.

Intel® Active Management Technology (Intel® AMT)

- Provides hardware and software inventories on Dynamic Virtual Clients
- Provides remote diagnosis or repair for client hardware or software problems
- Keeps software agents active and contains malicious software

Intel® Virtualization Technology (Intel® VT) and Intel® Trusted Execution Technology (Intel® TXT)

- Help protect the integrity of virtual applications, operating systems, and containers in client hypervisor solutions
- Increase integrity and isolation of virtual containers
- Help protect data in memory

Intel® Anti-Theft Technology (Intel® AT)[2]

- Allows laptops to be disabled if they are lost or stolen
- Can be used with or without a connection to a school network or the Internet
- Hardware-based feature disables stolen laptops and detects suspicious behavior
- Blocks OS loading, and access to hard drive data or encryption keys
- Quickly and easily restores data and assets

Intel® Advanced Encryption Standard Instructions Set (Intel AES-NI)

- Enables fast, secure encryption and decryption using the Advanced Encryption Standard (AES)
- Offers a significant performance increase (compared to pure software implementations)

For more information visit www.intel.com or contact the technology solution provider of your choice.

1. (Desktop) Pre-production Intel® Core™2 Duo processor E8200 (6MB L2, 2.66GHz, 1333MHz FSB) and Pre-Production Intel Core™2 Quad processor Q9450 (6MBx2 L2, 2.66GHz, 1333MHz FSB) on Intel® DQ35JOE board, Intel® chipset Software Installation File 8. 30.1013, 2x1GB Dual Channel Micron* PC2-6400 DDR2 800 5-5-5-15. Intel® Pentium® 4 processor 530 (1MB L2, 3.00GHz, 800MHz FSB) on Intel® D945GCL board, Intel® GMA950 Express chipset, Intel chipset Software Installation File 8.1.1.1010, 2x1GB Dual Channel Micron PC2-6400 DDR2 667 5-5-5-15. Common to all platforms: Seagate* 320GB Barracuda 7200.10 NCQ Serial ATA 7200 RPM, Microsoft Windows Vista* Ultimate 32bit. Performance tests and ratings are measured using specific computer systems and / or components and reflect the approximate performance of Intel® products as measured by those tests. Any difference in system hardware or software design or configuration may affect actual performance. Buyers should consult other sources of information to evaluate the performance of systems or components they are considering purchasing. For more information on performance tests and on the performance of Intel products, visit www.intel.com/performance.

2. No computer system can provide absolute security under all conditions. Intel® Anti-Theft Technology (Intel® AT) (also referred to as the 'poison pill' in some documents) 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. Intel AT performs the encrypted data access disable by preventing access to or deleting cryptographic material (e.g. encryption keys) required to access previously encrypted data. ISV-provided Intel AT-capable encryption software may store this cryptographic material in the PC's chipset. In order to restore access to data when the system is recovered, this cryptographic material must be escrowed/backed up in advance in a separate device or server provided by the security ISV/service provider. The detection (triggers), response (actions), and recovery mechanisms only work after the Intel AT functionality has been activated and configured. The activation process requires an enrollment procedure in order to obtain a license from an authorized security vendor/service provider for each PC or batch of PCs. Activation also requires setup and configuration by the purchaser or service provider and may require scripting with the console. Certain functionality may not be offered by some ISVs or service providers. Certain functionality 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.

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