IT@Intel White Paper
Intel Information Technology
Mobility
November 2009

Enabling Device-Independent Mobility with Dynamic Virtual Clients

DIM would enable us to deliver the information users need in the environment they need it, independent of what device they are using—giving mobile workers more choice, flexibility, access, and performance.

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Executive Overview

To enable device-independent mobility (DIM) at Intel, Intel IT is considering implementing dynamic virtual client (DVC) technology, which uses containerized software appliances to abstract the OS; applications; corporate and personal data and workspaces; and user-specific settings. In this model, users can access their applications and information from any device, anywhere, anytime.

As new client devices and technologies emerge, client mobility—once thought of as disconnecting a laptop from the wired network to carry around—is evolving to include:

- Delivering IT services to devices that cannot sustain a full IT build, such as netbooks and smart phones.
- Providing on-site mobility, where users can move between their offices, labs, and homes, and access their IT environment from a variety of devices.
- Separating corporate data from personal data and making both accessible from multiple device platforms.

DIM would enable us to deliver the information users need in the environment they need it, independent of which device they are using—giving mobile workers more choice, flexibility, access, and performance. For IT, the benefits of DIM include centralized application and data policy management, cost savings by reducing integration for individual hardware platforms, and improved delivery of IT services to users.

Initial testing of technologies underlying DIM and evaluation of platform and support costs during proofs of concept and pilot studies indicate that we can realize a per-platform cost savings of USD 100. Additional cost savings are possible as platform configurations evolve and infrastructure services are changed to accommodate new platform provisioning and information storage concepts.

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BUSINESS CHALLENGE

As mobile devices and technologies proliferate in the marketplace, an increasing number of employees at Intel want to use their personal devices within the enterprise, choosing the best platforms, applications, and services to accomplish their jobs and manage their lives. This trend is often referred to as the "consumerization of IT."

For example, an employee might prefer a desktop or notebook PC to access the Intel network locally and remotely; a lightweight netbook for meetings and long-distance travel; and a smart phone for quick access to e-mail, calendar, contacts, and some corporate or personal content provided by cloud storage. This combination of devices gives employees access to applications and information anytime, anywhere.

Intel IT anticipates the need to support employees who carry not just one or two devices as they do today, such as a notebook and a cell phone, but employees who roam among devices depending on their physical location. This situation raises many challenges:

- Keeping business and personal information separate on each device an employee uses, whether that device is owned by Intel or by the employee.
- Keeping corporate data and application context synchronized and secured across a user's many devices.
- Maintaining security, manageability, and functionality across disparate devices.
- Helping ensure that new technology solutions co-exist with legacy technology and applications.
- Achieving the best return on investment (ROI) for the technology choices we make.

In addressing these challenges, we realized that we needed to find a solution that supports users' desire for device independence while also benefiting Intel.

After researching technologies over a period of 18 months, we concluded that abstracting the traditional corporate build environment from the underlying hardware platform into layers—OS, applications, user data, and user-specific settings—would provide many benefits to users and to IT. This delivers a stateless computing model, regardless of the device accessing it.

Tying applications and services to one single platform and excluding them from others limits users' mobility and forces them to think about which device they are using at any given time. Device-independent mobility (DIM) allows employees the freedom to use any device at any given time to access the

Enabling Employee Productivity with Device Independence and Rich Client PCs

Employee productivity improves with device independence because employees can choose the device with the best performance and usability for a particular task without worrying about whether the applications and data they need will be available on that device. For example, using virtual containers on a notebook PC with hardware-assisted virtualization capabilities, employees can have access to multiple environments (corporate and personal) on a single PC—something that is not possible on a mobile Internet device. However, employees may also want to carry companion devices for travel or home use for light computing tasks, such as access to the Internet, contacts, or schedules. Device independence gives employees the flexibility to use the best device for each circumstance.

corporate information that they require in a format that is tailored specifically to the platform they are using.

DIM provides users with greater choice, flexibility, access, and performance, while providing Intel IT with centralized application and data policy management, cost savings by reducing integration for individual hardware platforms, and improved delivery of IT services to users.

SOLUTION

To implement DIM, we are considering using dynamic virtual client (DVC) technology to abstract the OS, applications, user data, and user-specific settings so we can deliver them independently to a wide variety of devices.

Abstraction of components, such as the OS and applications, into virtual containers enables faster turnaround time on upgrades and new capability introduction, and provides greater flexibility and faster solution development at lower cost.

Our planned solution consists of three steps: evaluating existing DVC technologies, building an IT architecture that supports DIM, and implementing DIM in segmented communities rather than waiting for a solution that meets the needs of all users.

Evaluating Existing DVC Technologies

We have evaluated several of the available DVC technologies that support various aspects of DIM.

- **OS streaming.** OS streaming allows IT to step away from platform engineering; instead, we would use platforms as delivered from the OEM. The OEM is then responsible for supporting the native OS, drivers, and so on for these platforms.
- **Application streaming.** Similar to OS streaming, isolating applications into their own virtual containers simplifies application maintenance and allows users to access the applications they need from the device they choose.
- **Cloud storage.** Secure cloud storage enables removal of user data from client endpoints. This lets the user access files anywhere, anytime, and eliminates the need for IT to back up this data. Cloud storage also provides an opportunity for IT to create and manage file retention policies, leverage efficient file storage and archival technologies, and enable more effective legal discovery practices.
- **Client virtualization.** Client virtualization is an important building block for services abstraction. It allows us to separate the hardware, OS, application, and user-specific settings layers, making it possible to change one without affecting the others.

Building an Architecture that Supports DIM

Our evaluation of existing DVC technologies made it clear that virtual containers are the key component to building an architecture that supports DIM. As shown in Figure 1, the overall DIM architecture is based on extensive use of internal and external cloud storage and services, which in turn provide data and applications to a broad range of devices.

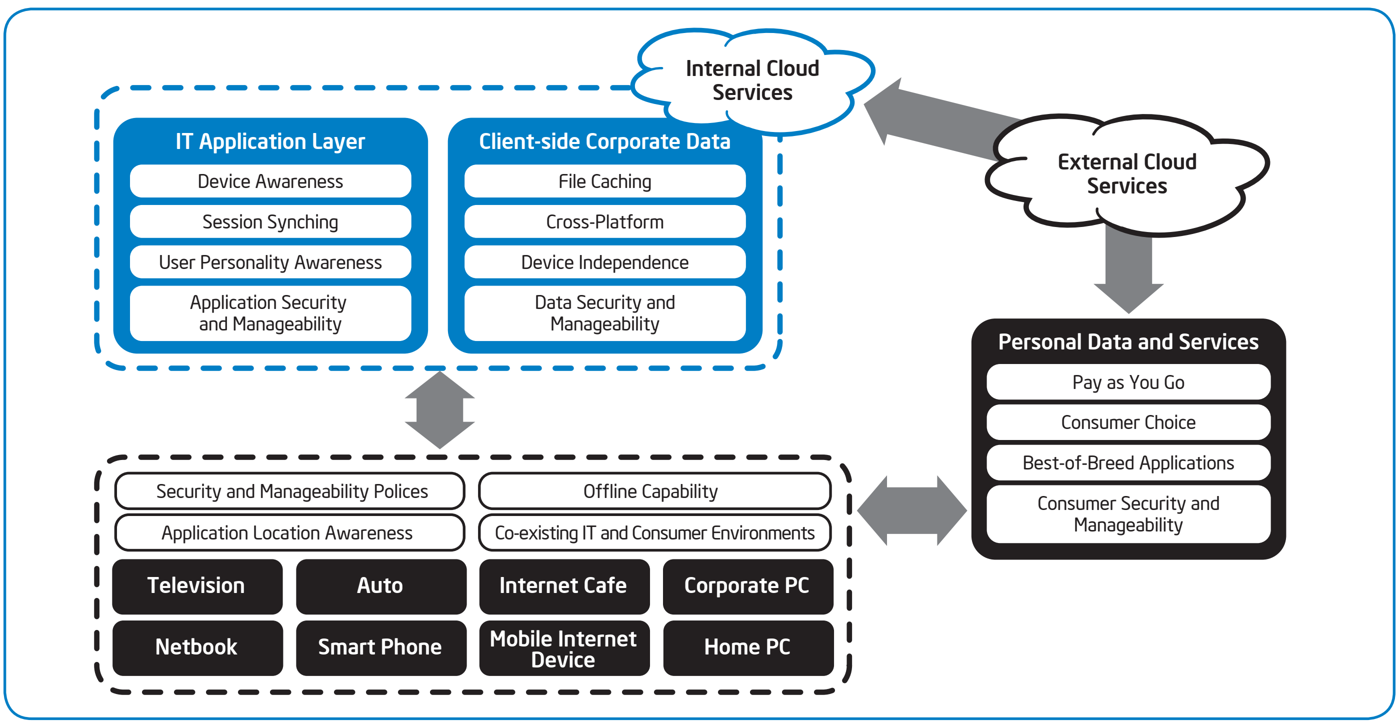

Figure 1. Device-independent mobility (DIM) involves a broad mix of capabilities and services, consumed by a wide range of devices.

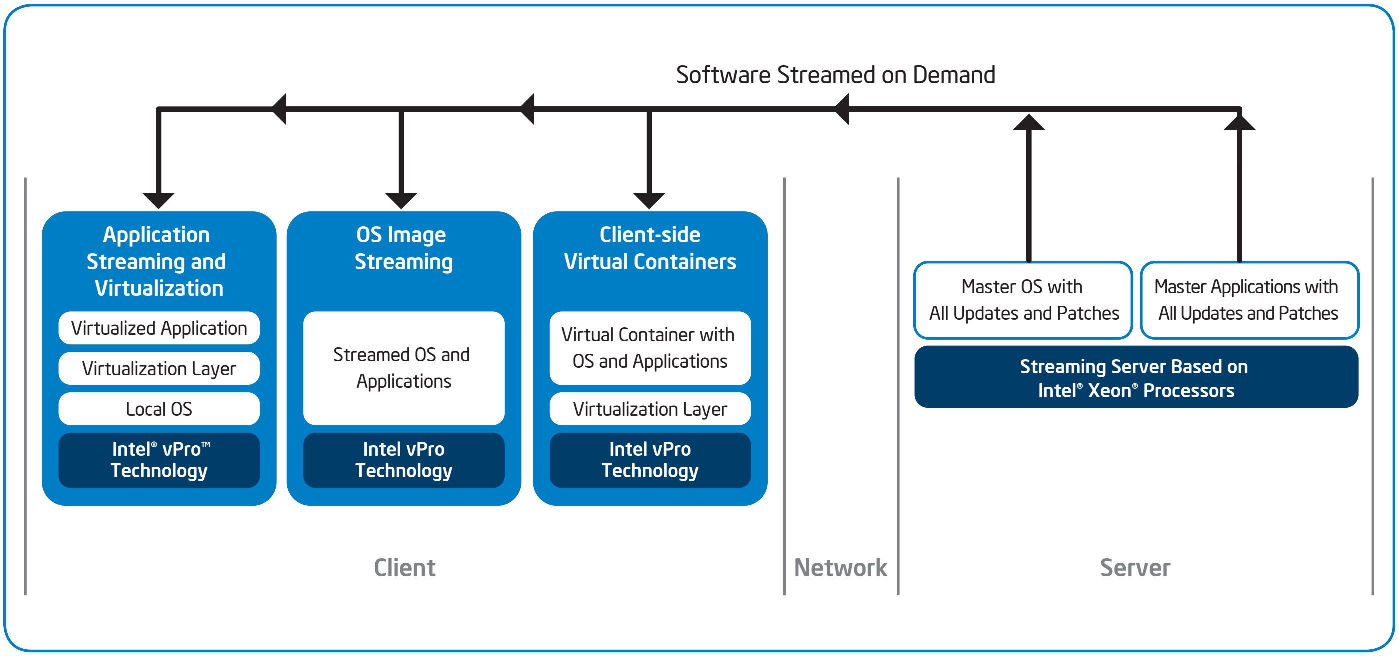

Figure 2. Dynamic virtual client (DVC) technology enables device-independent mobility (DIM).

USING CONTAINERIZED SOFTWARE APPLIANCES

The abstraction of the OS, applications, data, and user-specific settings into containerized software appliances, also referred to as layers, is central to the DIM concept. This abstraction is accomplished using DVC technology.

By encapsulating the dependencies of an application or data set into a self-contained unit, containerized software appliances can dramatically simplify software deployment by freeing users from having to worry about resolving potentially complex OS compatibility issues, file dependencies, or undesirable interactions with other applications. Additionally, containerization improves security by isolating one application from another. If the security of one appliance is compromised, or if the appliance crashes, other isolated appliances are not affected.

Containerization also simplifies IT's task of configuring and deploying security patches, because only a small number of client endpoints, which now exist as a back-end service, need to be patched. The next time a client connects, it will synchronize and be updated.

Once we have built a DIM architecture in which all the layers are truly abstracted, we will have achieved a stateless computing model, where many clients share a single base OS image and base application layer. These layers are identical across each platform, which greatly simplifies IT's management environment because we can patch a centrally managed component on the back end instead of in tens of thousands of unique footprints.

Figure 2 illustrates how DVC technology supports DIM. On PCs with Intel® vPro™ technology, application streaming, containers, and virtualization provide flexibility in which applications and data are provided on a particular device. When connected to the server, the appropriate applications and data can be synchronized.

SEPARATING PERSONAL AND CORPORATE WORKSPACES AND DATA

As shown in Figure 3, the DIM model stores personal and corporate data in separate virtual containers. The end user stores personal information in a personal container, either on the device itself or in a personal cloud, and it is the end user's responsibility to manage this data, including running backups. Corporate data is stored securely in a corporate container and is managed in accordance with corporate policies.

Data separation offers two important benefits:

- **Improved data security and stability.** Hardware-assisted virtualization, such as Intel vPro technology, not only improves performance, but enables secure separation of the personal environment from the corporate environment. In this manner, negative events in the personal space, such as computer viruses or application corruption, have no effect on corporate data and applications.

- **Reduced liability.** DIM provides content separation at the client level by design, which means less personal content will end up in the corporate infrastructure. It may also be possible to limit the passing of company content back to the personal file system, or at least have the system detect when this occurs. As we implement DIM, we need to address information storage and flow to protect both the company and the individual from information loss and misuse.

Using an internal cloud for storing work-related documents helps improve document retention management and protection of corporate intellectual property. In addition, implementation of an internal cloud eliminates the need to back up clients using a connected network backup system and enables new data archive and legal discovery processes, which have significant cost savings potential.

Once there is widespread use of cloud storage services, IT can implement a tiered storage strategy that offers several benefits:

- Minimizes the cost of archival storage.
- Enforces data retention policies, thereby reducing the amount of information being stored and managing the legal liability of information being kept longer than it needs to be.
- Provides content index and search services for legal discovery and information reuse.

We can start to realize the many benefits of properly managed information with thoughtful management of corporate content within the DIM framework.

IMPLEMENTING VIRTUALIZATION

Virtualization provides portability of workloads across devices and is important for legacy application compatibility and coexistence of multiple workloads.

During our technology evaluation, we considered several technologies that support OS and application streaming and virtualization, including:

- Type 2 hypervisor or hosted virtualization
- Directed I/O-based hardware virtualization, offered on PCs with Intel vPro technology
- Type 1 or client native hypervisor-based virtualization
- Virtual container security, manageability, and mobility

We evaluated these technologies within existing user segments throughout Intel, including a proof of concept (PoC) for the Intel call center in Costa Rica. We also assisted with an evaluation of these technologies in one of Intel's main business groups and ran a PoC in our IT training rooms for which we're now in the process of deploying a permanent solution.

IMPLEMENTING INTERNAL CLOUD INFRASTRUCTURE AND EXTERNAL CLOUD SERVICES

Cloud computing is an important enabling technology for DIM, as it provides the ability to store corporate data in the cloud and to access and synchronize this data between devices. In general, cloud computing provides services and data that reside in shared resources, and any authenticated device can access those services and data over the Internet.

We envision a mix of internal and external cloud services. We define an internal cloud as an internal IT environment with cloud computing characteristics, whereas external clouds are provided by suppliers.

Internal clouds can have most of the features of external clouds. They can use similar technologies to host cloud-aware applications and to provide a dynamic infrastructure that responds to demand and fault signals.

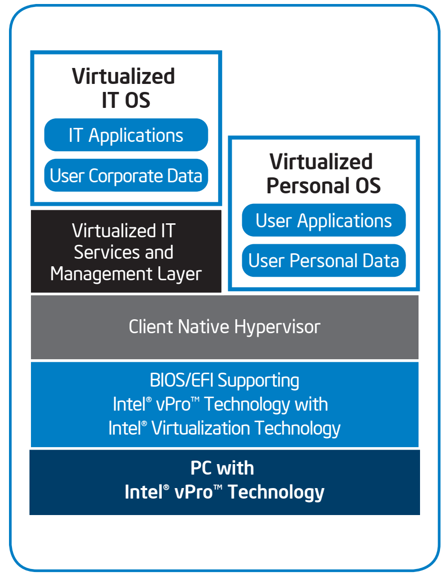

Figure 3. Intel® vPro™ technology enables separate virtual containers for personal and corporate use.

As was shown in Figure 1, the internal cloud would provide the IT application layer and corporate data for DIM, while an external cloud would provide personal data and services.

Focusing on Segmented Communities

To realize a maximum ROI while implementing DIM, we need to identify solutions that address existing and emerging requirements rather than waiting for a solution that meets the needs of all users. This approach allows us to implement new solutions more quickly, obtain a more immediate ROI, and collect crucial feedback we can share with suppliers, architects, and engineers.

We have identified three DIM use cases that could be implemented in the short term:

- Delivering IT services to devices that cannot sustain a full IT build, such as netbook, mobile Internet device (MID), or smart phone.
- Providing on-site-mobility; users can move freely between office, lab, and home, and access their IT environment from a variety of devices.
- Separating corporate data from personal data and making it accessible from multiple platforms.

Each of these use cases exercises a slightly different aspect of DIM and will enable us to gain valuable experience and information that we can use as we continue to build our DIM architecture.

Results

Two current projects are helping us explore the practicality of DIM. One involves providing e-mail, calendar, and contact information on smart phones; the other explores the practicality of using netbooks in the enterprise environment.

SMART PHONE PILOT PROJECT

With the advent of encryption on smart phones, we have been able to proceed with a pilot project that will explore the feasibility of providing corporate e-mail, calendar, and contact information services on users' personal smart phones.

Previously, we provided these services only on smart phones purchased by Intel for employees. Now, for the first time, we will be providing services by enabling native applications on different devices that employees purchase themselves.

Our pilot project started in February 2009 with 300 participants; we anticipate that it will last about one year. During this period, we hope to answer the following questions:

- Can we move away from the model of buying personal devices for users while still benefitting from the productivity gains such devices offer?
- Does DIM provide a significant reduction in IT support costs?
- Is it possible to provide IT services in a secure manner on personal devices, and is this viable in the enterprise environment?
- Can personal devices support IT services, or are they more appropriate only for personal applications?

NETBOOK PROOF OF CONCEPT

Netbooks and other small form factor devices such as MIDs are becoming more popular with employees, who want to purchase them and bring them into the workplace. We needed to investigate what the impact on IT would be if we allowed this:

- Would the security risk be acceptable?
- Would netbooks increase IT support costs?
- Would netbooks negatively affect user productivity?

To answer these questions, we developed a PoC to test using netbooks in the workplace. We tested three brands of netbooks and three separate scenarios, with the following results:

- Locally installed IT build. This was secure but expensive.
- IT build run as a virtual machine. This can be costly and unsecured, and degrades performance.
- Locally installed OEM-provided OS with an enterprise workspace provided by a virtual hosted desktop (VHD) interface. This adequately addresses the value proposition for using netbooks in the enterprise as complementary devices to users' primary workspaces.

Our PoC results indicated that netbooks, when used as companion devices, can improve employee productivity through better mobility, connectivity, and access to corporate data without increasing platform provisioning and support costs, or appreciably increasing security risks due to platform mobility.

Figure 4 shows the aspects of DIM that our netbook PoC supports.

The VHD usage model reduces the commingling of corporate and personal information assets. This data separation reduces the burden on IT to back-up non-corporate information. It also reduces legal exposure by limiting the amount of personal information that's stored on PC platforms and back-up storage systems.

BENEFITS

As shown in Table 1, DIM offers many benefits—both to users and to IT. During our PoCs, for example, testing of technologies underlying DIM and evaluation of platform and support total cost of ownership (TCO) indicated a per-platform cost savings of USD 100.

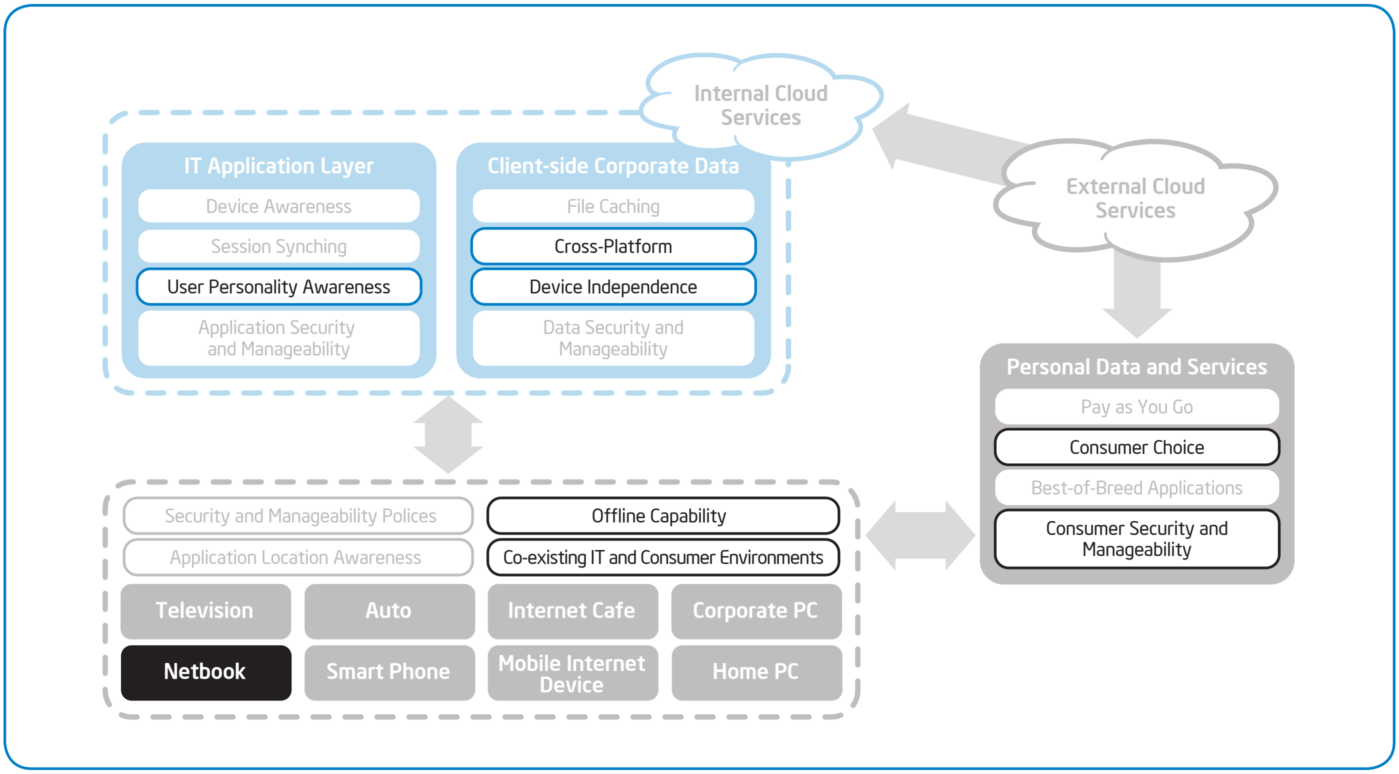

Figure 4. A proof of concept (PoC) determined that our netbook use case meets a number of criteria for device-independent mobility (DIM).

NEXT STEPS

DIM presents a major challenge for IT: We must change the way operate. Today, IT-provided data, application, OS, and hardware layers are tightly integrated and device-specific. To implement DIM, we need to think about these components as services. We also need to understand and resolve security issues as we land IT services on each new device. While e-mail, calendar, and contact information are obvious choices for consumable IT services, we need to determine which other applications to enable for DIM.

As DVC technologies evolve, we will continue to implement new infrastructure services that support the DIM model; champion improvements to Intel vPro technology; collaborate with hypervisor ISVs to bolster application virtualization and streaming; and continue moving forward with server virtualization. We will also look for additional DIM use cases and complete more PoCs.

There are also industry-wide opportunities to develop products and tools that enable DIM. For example, although server virtualization has matured over the past 10 years, viable client virtualization technologies on PCs with Intel vPro technology are just now beginning to emerge, and supporting industry standards are still in their infancy.

Table 1. IT and User Benefits

IT Benefits	User Benefits
Focus on supporting services rather than devices	More platform choice
Centralized manageability and security of corporate information assets	Built-in device-awareness presents applications and data that are appropriate for a given device
Lower total cost of ownership for IT	Enhanced mobility for applications and user data
Reduction in required IT resources	Cross-platform support

CONCLUSION

With the consumerization of IT, managing clients in an enterprise environment is becoming more complex and costly. Users are demanding access to corporate applications and data from multiple devices, some of which IT does not own or manage. DIM, based on DVC technology, enables user choice and flexibility while allowing IT to focus on delivering services rather than managing hardware platforms.

DIM lets IT manage the thing that's most important to the enterprise—its information assets—and better control its platform provisioning expense by delivering applications on demand, supporting offline usages as necessary, and by supplying virtual work environments where they make sense. Users also benefit by being able to choose the most appropriate device for their task and location.

ACRONYMS

DIM	device-independent mobility
DVC	dynamic virtual client
MID	mobile Internet device
POC	proof of concept
ROI	return on investment
TCO	total cost of ownership
VHD	virtual hosted desktop

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