

Case Studies with Intel[®] vPro[™] processor technology

An Analysis of Early Testing of Intel[®] vPro[™] processor technology in Large IT Departments

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Abstract

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We reviewed, compiled, and discussed the results from ten pilot implementations of the new Intel vPro processor technology based PCs at leading companies in a number of industries including: Energy, Financial Services, Forrester Products, Health Care, and News Media. Our observations and data came from pilot deployments conducted by EDS (Electronic Data Systems), a large IT services provider supporting millions of PCs worldwide.

Through our observations, discussions, and review of the pilots we were able to quantify a number of key benefits enabled by this new technology. The Appendix summarizes the improvements in key performance areas enabled by the technology. We captured significant statements made by current clients and non clients of EDS involved in the pilot deployments. This report helps provide a better understanding of the impact Intel vPro processor technology can contribute to the enterprise.

Throughout the pilots we saw time and again enthusiasm born of the realization that Intel vPro processor technology will provide real value in cost reductions through significant improvement in PC availability for inventory and updates, reduced PC downtime increasing user productivity, and greatly improved techniques for diagnosing and repairing hardware and software problems. The ability to access and remotely turn the PC on at any time for management tasks in itself opens opportunities to solve many problems – as you will see. Although we did not specifically measure benefits in reduced power consumption, everyone recognized the problem of whether to turn off the PC at the end of the work day is now solved along with the many other issues resulting from PCs being unavailable during off hours and/or applying updates during working hours. The quote below from an EDS technician on the project sums up the experience.

“Customers who see Intel® vPro™ processor technology demonstrated during the pilots are routinely experiencing what we call ‘wow moments.’ That’s the point at which they realize just how much they will benefit from the capabilities enabled by these new business PCs.”

EDS Pilot Test Team

March 2007

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Executive Summary

EDS piloted the new Intel vPro processor technology for the PC platform, with hardware-level security and management features, to evaluate its capabilities in large enterprise IT environments. The companies where the testing was performed had an average installed base of 40,000 PCs.

We reviewed the results of these pilots and talked with people involved in the pilot process. One thing came out in all our discussions: IT support personnel as well as the people using the PCs are looking for solutions to reduce desk-side support or recovery visits and reduce the amount of time PC users are down.

More importantly, we heard many comments about how this technology can reduce costs in many ways. Businesses everywhere are looking for the advantages of reduced costs and improved reliability. The challenge has been how to have one without impairing the other.

A previous project we did with Intel and The Institute of Internal Auditors addressed the factors that make up the total cost of ownership (TCO) of the PC fleet. The importance of effective management practices and compliance must not be diminished through the efforts to reduce costs, so it is encouraging to see a new technology deployed that shows immediate promise for cost reduction and improved reliability and availability. Here is what a company with a large PC fleet said during their pilot.

“vPro represents the only solution we’ve evaluated that will assist us in lowering our TCO. We concluded by not adopting this technology we would continue to see our support costs rise.”

This report provides examples of how Intel vPro processor technology can impact employee productivity and reduce support personnel time. Unlike some new technologies that have been disruptive in nature, PCs with Intel vPro processor technology can be added to the PC fleet gradually, as part of a standard PC refresh process. This will enable IT to take advantage of new capabilities as soon as the systems management tools and supporting technology infrastructure are in place.

While we found every IT environment to be unique, data from each of the pilots reviewed consistently demonstrated that each organization participating in a pilot will benefit from the capabilities enabled by Intel vPro processor technology. As an example, pilot results showed Intel vPro processor technology will improve security by increasing the speed and effectiveness of critical patch saturation. As demonstrated during the pilots, IT organizations

“I was very skeptical going into the meeting on the new [Intel] vPro technology as I had heard a lot of discussion on how different this was and how this will change the way we support the desktop. Then they showed some of the remote capabilities and took control of a PC, diagnosed a hardware problem remotely, and then diagnosed a software problem on another PC, and booted the PC from a remote management console. This technology immediately demonstrated it has the functionality to improve management of the machines and decrease desk-side visits.

“My staff wanted us to order new machines immediately to improve our client support as the PC is critical to our business units and any downtime costs us hard dollars.”

IT Manager

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said they would reduce software related desktop visits 91% and reduce hardware related desk-side visits by 60%.

The hardware based capabilities of Intel vPro processor technology enable solutions that are not available with software alone. As a result, IT has new tools to resolve persistent problems while improving IT resource utilization and reducing overall cost of ownership. Advantages highlighted during the pilots included: improved asset management, reduced power consumption, improved security, reduced downtime, and reduced desk-side visits. This report can serve as a model to identify projected benefits of Intel vPro processor technology.

It isn't just the cost of user downtime, but the business impact that varies from user to user. It is difficult to assess the actual cost to a particular business unit, and can range from no impact to millions of dollars in the case of a trader, or someone's life in the case of nursing stations. Timely resolution of PC downtime issues increases user productivity, improves overall business performance and reliability, reduces costs, and frees IT resources to focus on other pressing issues.

It came through loud and clear that large enterprises have difficulty even knowing how many PCs are supported on the network. Some organizations indicated their PC inventory could be off as much as 20% from an actual manual inventory count. Accurate PC inventory becomes critical when you consider the harm that can be caused by a rogue machine that is not current on virus updates or patch management.

The consensus among IT managers in the pilots was that Intel vPro technology and supporting infrastructure can produce a PC inventory with 99.9% accuracy. They agreed knowing what equipment you have and where it is constitutes one of the greatest challenges in managing large enterprise networks.

Readers are encouraged to view the summary of test results in Appendix A to see the categories of tests that were performed and the magnitude of the results.

What is different about Intel® vPro™ processor technology?

PCs with Intel vPro processor technology provide a new set of capabilities that allow seamless support for the PC fleet with the ability to solve root cause issues while lowering the overall cost of enterprise desktop computing. These architectural enhancements to core PC building blocks provide the ability to remotely manage assets, diagnose, remediate, and secure the PC environment even if the PCs are turned off or the operating system (OS) is inoperable.

Just being able to diagnose problem PCs on the network and take them off line in a timely manner if they have out of date patches and virus updates can prevent a complete network outage. As one IT Manager said, "One rogue PC connected to the network can wreak havoc for the entire enterprise." Knowing exactly what equipment is connected to an enterprise network not only promotes prompt user support, but allows timely identification of small problems before they become a large problem. Intel vPro processor technology addresses problem resolution for many of the PC software and hardware issues resulting in significant reduction in desk side visits along with reduced user downtime. With PCs and users in far remote areas, the significance of the savings can be even greater.

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Intel® vPro™ processor technology Pilot Implementations:

EDS conducted a series of pilots on the implementation of Intel vPro processor technology in companies across a range of industries including Energy, Financial Services, Forrest Products, Health Care, and News Media. As expected, there were variations in the level and types of benefits. This report summarizes experiences from the pilot implementations, and can serve as a template for identifying and estimating the value of benefits Intel vPro processor technology can provide.

What is Intel® vPro™ processor technology?

Intel vPro processor technology is a new platform brand (like Intel® Centrino® processor technology) enabling business-class PCs with new capabilities to help address the needs and requirements faced by business today. Intel vPro processor technology comprises a processor, chipset, networking, and other components working together to enable enhanced remote management capabilities for PCs. With Intel vPro processor technology, IT personnel can use a third-party manageability and/or security software controller (e.g., Microsoft SMS, Altiris, LANDesk...) to collect inventory information, remotely diagnose problems, and provide many types of service remotely even to PCs that are turned off or have an inoperable OS. Administrators can also better protect individual PCs and the network from threats.

Intel vPro processor technology makes use of a small manageability engine and persistent nonvolatile flash memory at the chipset level, where critical system information can be safely stored, plus a remote communication channel that is always available to authorized IT personnel. As long as the PC is plugged into a power source and connected to the network, administrators can access the computer and collect information, even if the computer is powered down, reconfigured, or inoperative.

Business Needs:

Interviews with IT and executive management in the companies visited identified key business needs to be considered when assessing potential benefits of Intel vPro processor technology. Then as the experience with Intel vPro processor technology was seen in live business environments, we were able to extrapolate potential benefits across the different types and sizes of companies and different industries. The tables throughout this report show experiential data, and these experiences are described in narrative form.

Top Issues from Institute of Internal Auditors International (IIA) PC Management Best Practices-2003

- PC Asset Management
- Security Awareness
- Automatic Backup
- Automated Compliance Monitoring
- Automated Software License Monitoring
- Intrusion Protection
- Desktop Standardization
- Enforcement of Standards

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The business needs most consistently identified across all industries included managing costs and improving efficiency for:

- Cost Reduction
- Worker Productivity
- System Availability
- Problem Resolution
- Reducing Desk-side visits
- Asset Inventories
- Software Upgrades
- Security
- Change Management
- Energy Efficiency

Cost Reduction

One of the largest PC pilot companies with over 200,000 enterprise PCs said, **“vPro represents the only solution we’ve evaluated that will assist us in lowering our TCO. We concluded that by not adopting this technology we would continue to see our support costs rise.”** We felt this observation was significant in that traditional processes to support PCs can now change dramatically to shift most problem resolution to level 1 support. That customer was also excited about the opportunity to perform critical updates and patches without being dependent on the current OS, the PC being turned on, or the user having the option to allow or defer an update.

Hardware Enabled Solution

The ability with Intel vPro processor technology to at any time remotely access PCs that are attached to the network and a power source is the starting point for better addressing key business needs. Each organization will see the opportunities differently as each has different priorities. For example, we heard one company say “energy savings

An EDS technician present at most of the pilot sessions summarized the customer experience as follows:

“Customers who see Intel vPro processor technology demonstrated during the pilots are routinely experiencing what we call ‘wow moments.’ That’s the point at which they realize just how much they will benefit from the capabilities enabled by these new business PCs.”

alone more than covered the small incremental cost” of Intel vPro processor technology. Another felt the improved security, ability to remotely resolve most PC problems, and/or ability to inventory and manage hardware and software were the most important advantages.

Another issue raised in a different pilot was the ability to avoid buying various software agents at the client PC. “That will save \$20K to \$30K annually. In addition, the agent software increases complexity in the environment, and you could not always guarantee it was not removed.”

Worker Productivity

Greater network stability, faster PC diagnosis and repair, off-hours deployment of updates and patches, and reduced desk-side visits all contribute to improving worker productivity through significantly improved up-time of the PCs. In a number of industries where PCs in remote locations are common we noted managers making a point that it may take 4 hours to a day to get to a remote machine.

Customers who see Intel vPro processor technology demonstrated during the pilots rave about being able to remotely image dead machines to their corporate approved image or being able to redirect the machine to an image that permits them to use Microsoft’s RDP or attach to a Citrix server while the tech orders parts or are waiting for resolution to their problem. Keeping workers productive, even while their machine may be inoperable.

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Issues regarding access to remote PCs were found to be more common in the manufacturing, retail, health care, and transportation industries. Participants in these industries believe savings in reduced desk-side visits will be significant. As discussed with pilot participants, many software issues typically require a desk-side visit today. But with Intel vPro processor technology participants could actually see most software issues resolved from a central console – with no desk-side visits.

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What Organizations Said are the Business Needs to be Met in PC Management

- **Cost Reduction:** There is no substitute for continuously seeking maximum efficiency and continuous cost reduction for the overall PC fleet – particularly as the fleet size increases. The objective is to manage costs without negatively impacting other business needs.
- **Worker Productivity:** All the elements here work together to maximize the value of the PC in improving worker productivity.
- **System Availability:** Availability of the PC is clearly important to the PC users, but is also essential to the IT personnel responsible for maintaining a reliable, functional, and secure PC fleet with known configurations and software.
- **Problem Resolution:** Problem resolution often can start before the PC user is aware of a problem. A PC behaving outside normal parameters can be detected by monitoring agents. Variations in temperature, voltage, fan operation, network traffic, and OS activity can signal a problem and alert the helpdesk to initiate analysis, protection, or recovery.
- **Reducing Desk-side Visits:** The timeliness and efficiency of PC problem resolution can be significantly improved by simply reducing the need for desk-side visits. Simplifying problem resolution can also be accomplished by taking the user out of the process and improving the tools available for remote diagnosis and repair.
- **Asset Inventories:** Maintaining an accurate and timely inventory of PC hardware and software is a perennial problem, and can be greatly simplified if all PCs are readily available for remote access and inventories can be accomplished at times when network traffic and user workloads are at their lowest levels.
- **Software Upgrades and Patch Deployment:** Software updates arrive at regular and irregular intervals, and their importance can range from normal to urgent. Sometimes it is so important to apply patches that the entire PC fleet must be updated within a narrow time window, and any PC not updated may have to be quarantined and patched before it is allowed to rejoin the trusted network. The management objective is timely, efficient, verified patch management.
- **Security:** Significant efforts are expended in maintaining a secure PC fleet. Essential elements of security include timely application of security updates and patches, protection against intrusion and unauthorized access, and monitoring for evidence of malware. It is also useful to maintain persistent logs of sensitive activities on PCs and to protect such logs against user access and overrides. Remote access to PCs also requires robust security.
- **Change Management:** Change is constant. Hardware, software, configurations, user privileges, communication and usage patterns, and data kept on PCs are all subject to change management and, of course, they change continuously. Management seeks to be aware of “all” changes potentially impacting confidentiality, integrity, and availability (security) of the information and infrastructure.
- **Energy Efficiency:** With a relatively small PC fleet the amount of energy consumed by leaving them on at all times is comparatively minor. As the numbers reach the thousands or tens and hundreds of thousands the incremental cost of energy to power the fleet increases significantly for each additional hour the PCs remain powered. But when turning off the PC puts it out of reach for problem resolution, inventory, scanning, patching and other updates, the organization may make an unfortunate trade to sacrifice energy efficiency for protection.

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System Availability

Availability of the PC to the user means the IT processes remotely accessing the PC for inventory, software upgrades, patching, virus scanning, etc. are best performed at those times when the PCs are not in use.

Intel vPro processor technology essentially makes the PC available to the management control console any time it is plugged into a power source and connected to the network. Access to the PC independent of the health of the OS or the presence or absence of an agent allows a technician, via an encrypted connection, to power-up the PC at any time for any purpose. This also allows communication with the PC in a manner that is completely separate from ordinary network communications. So, for example, you can make the machine available for diagnostics, repair, or update but at the same time make it unavailable to spread malware across the network. (More about this later).

Availability

Our studies showed 25% or more of a company's PCs may not be available at a given time for inventory, update, or patching. In cases of urgency, like stopping the spread of malware, this can be a real and costly problem. But even for a seemingly mundane operation like inventory, the costs of unavailability can be measured in terms of overpaying for software or service agreements, personnel physically tracking down PCs, and never quite knowing how many PCs you really have or where they are.

Because the PC with Intel vPro processor technology can be simultaneously available to the user and the remote console, the problem of the user having to find something else to do while the PC is occupied by a technician virtually goes away. Even when the PC is in use, a remote operator can gather information and run diagnostics in a priority subservient to the user's tasks – thus minimizing impacts on performance. Then in cases where remote technicians must communicate with the user, the communication can be precise and specifically oriented to the issues addressed. In one case we saw the remote technician power down the PC and explain to the user how to remove the cover and reseal the expansion memory chips. While not every user can be expected to apply even such rudimentary hardware solutions, in this case the problem was solved without a technician visit.

Problem Resolution

Problem resolution is complex and expensive. Sometimes it can be a challenge to identify or recreate a software problem, and hardware problems typically require a second visit with the needed part(s). The objective is to reduce complexity and expense. Often this can occur through removal of the most expensive tasks in problem resolution – desk-side visits (see below). But with PC's based on Intel vPro processor technology, many other complexities can be avoided because the PC's behavior can be recorded in persistent log

Problem Solved!

PC repairs can be accelerated with Intel vPro processor technology. Working remotely, a technician can boot up an ailing PC from another device or CD, then establish a remote console session and troubleshoot the problem. If an application is corrupted, the technician can re-image the hard drive and restore user data from clean files. Use of vPro technology can reduce software repair times from 1.5 hours to less than half an hour per incident – with no travel time or costs.

For a 40,000 enterprise PC environment with an average of one software problem per year an estimated 40,000 hours of technician time could be saved annually for software issues.

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information that is always available to a command console to simplify diagnostics – whether or not the PC is turned on and operational.

With Intel vPro processor technology a PC's configuration can be remotely compared to configuration data maintained in a centralized inventory, so it is easy to know how much memory is functioning versus the amount supposed to be installed, what software is installed on the PC (or not, in some cases), and whether the PC is exhibiting symptoms of a problem caused by malware. Other components can also be checked even if the hard drive is not working at all.

Our studies showed most of the PC problems encountered can be resolved remotely if the command console has access to the device and can run diagnostics outside of the machine's operating system control. PC problem resolution makes up a significant portion of the overall IT budget, so the costs saved by Intel vPro processor technology simplifying and shortening the repair and recovery cycle means those funds can be applied to growth and for more innovative projects.

Desk-side Visits – Current Situation

Desk-side visits consume large amounts of IT time and resources and result in greater end user down time, especially when the technician must get to remote locations. A technician visiting a PC displaces the user's access to their PC while the technician is working on it. Typically the placement of the PC in the work area also prevents the user from accessing other items in that space for the duration of the visit. So reducing the need for desk-side visits is an important objective. Reasons most frequently cited by companies participating in the pilot as driving the need for desk-side visits include:

- Diagnose problems and plan/perform repairs
- Power-up the PC and establish network connectivity
- Perform asset verification
- Conduct patch management and security analysis
- Verify information such as an alert or message reported to a remote console

One company discussed significant downtime issues related to hardware problems, with up to four visits required in some cases to resolve problems. If the diagnosis could be performed remotely, the timeliness of problem resolution could be significantly improved.

A common theme among several of the pilot participants was the amount of time required for the technicians to support remote locations. One pilot company said they fly technicians to some remote locations to resolve hardware issues, and most of the diagnosis can be done remotely with Intel vPro processor technology and reduce the amount of time required for hardware problem resolution. They also had a two hour response requirement in the Service Level Agreement that made it even more critical to respond to hardware problems through remote diagnosis versus transporting technicians to diagnose the problem.

Pilot companies frequently commented on the lack of technicians available after the defined coverage 6 x12 and having to pay overtime to provide coverage outside those times.

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Desk-side Visits: Pilot Results

Metric	Current process	Average With Intel vPro processor technology
Number of desk side visits typically required to fix a software problem	1 to 3	0.14
Number of desk side visits typically required to fix a hardware problem	1 to 3	1

Actual numbers from the pilot tests varied for different companies and different industries. On average, companies participating in the pilot said they required an average of 1.8 desk-side visits to fix a software problem. After testing with Intel vPro processor technology, all companies felt they could diagnose and fix most software related problems remotely. On average they believed they would dispatch a technician for a desk side visit 16% of the time. Said differently, they would need to dispatch a technician for one in six trouble tickets, representing a 91% reduction in desk side visits for software problems.

Resolving hardware problems requires on average 2.5 visits per event. With Intel vPro processor technology, participating companies believe they can remotely diagnose and positively identify the correct replacement part. Respondents felt they would need on average one desk side visit to resolve a hardware problem, representing a 60% reduction in desk-side visits for hardware problems.

The authors noted the enthusiasm of pilot participants upon seeing the features of Intel vPro technology. However, the examples provided in this section illustrate only partial estimates of the potential value of improvements available with the new capabilities. This is understandable because the technology will not be implemented all at once, and people have a tendency to focus on the most immediate issues in their environments.

Even with these moderate examples it is easy to extrapolate significant value from reducing desk-side visits in any environment.

Technicians participating in the pilots definitely believed remote access capabilities will reduce dependence on the users and on less skilled personnel at remote locations. As noted by one pilot test team, they “could diagnose a hard drive failure and order a replacement and start a re-image without having to visit the workstation.” The only desk-side visit would be to replace the hard drive. Another pilot company said they currently use a CD to physically boot the system and then connect to a network to load the OS. They said with Intel vPro processor technology they could send the image remotely and kick off the installation that way instead.

A large healthcare provider noted they are in the middle of a migration from one OS to another. Their comments included, “use of the IDE-Redirect feature of vPro would have been a time and cost saver for us. In addition we are incurring extra charges for additional desk side visits that are outside our normal services.”

Unusual Desk-side Visit Reductions

One IT manager in the pilots noted that when a technician went to visit a PC they usually got stopped by at least three or four other individuals with some type of problem. These typically were not logged, and no problem ticket was opened for “Drive-By” visits. They also took a considerable amount of additional time. So it isn’t just a saving of the original call, but also those drive-by customer oriented stops that can be reduced and eliminated. The savings with Intel vPro processor technology can be much greater than just the time reported to visit the original problem ticket. As end users become trained to have remote diagnosis first and receive more rapid response to corrective action they will turn around and use the help desk more appropriately.

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Another IT manager said “the ability to remotely power off/on the system makes vPro worthy by itself, and everything else is gravy.” He has to spend at least 30 minutes just to find someone on site to locate and power off the system. This is time consuming and frustrating.

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Capabilities demonstrated that help reduce the need for desk-side visits

A communications channel that runs “below” the OS improves control by enabling IT to probe non-responsive PCs. The most frequent reason for a PC to be non-responsive is simply that it is turned off. But it may also be non-responsive for other reasons such as hardware or software dysfunction. So the ability to remotely start up a PC that is turned off is the first step toward reducing the need for desk-side visits. (Note the ability to remotely turn on the PC is different from the existing “wake on LAN. It uses a much more secure encrypted connection.) The next step is to boot the PC to a secure and operable status. A PC may fail to boot because of a failed drive or other device, or because the OS is corrupted, or from other software failure.

Intel vPro processor technology provides the ability to remotely boot the PC from a standard image on a secure management server and redirect the console to the system administrator. Intel vPro processor technology also takes the user out of the problem solving process, sparing them a potentially lengthy and awkward task of explaining the problems they encountered. Persistent event logs maintained in an area not accessible to the user improve IT’s ability to more effectively identify and diagnose problems, including replacing corrupt files or software and rebooting a PC – all without ever leaving the management console.

Typical Pilot Testing Comments

In discussions with pilot participants, they were enthusiastic about the capabilities of PCs based on Intel vPro processor technology. A number of IT managers stated it was extremely helpful to have the on-site demonstration as it is difficult to fully appreciate without seeing it in action. “It also helped seeing it run in our own environment.”

An IT operations manager said his most significant “take away” was the ability to remotely power manage the systems. He felt that alone was enough to warrant the “small” increase in cost. Everything beyond that is a bonus in his mind.

“Being able to reboot a system from the console versus having to hunt down someone on site, to hunt down the system, to recycle the power would save at least 30 minutes of time and frustration for each occurrence.”

Asset Inventories: Current Situation

Maintaining an accurate inventory of PC assets – including hardware and software elements is a universal challenge. As noted when one of the co-authors was at Bank of America, the manual inventory became out of date as soon as it was completed. PCs that are powered off, failed, or have lost their system ID due to re-imaging, being rebuilt, etc., present problems for the remote inventory process. Participating companies reported as many as 30% of PCs may fail to respond to remote inventory polling at any given time, and it could take two weeks or longer to complete the inventory via multiple attempts and onsite visits.

One IT manager noted his inventory in one area “showed significantly more machines than personnel” and he could not understand how that could be since there was not a business need to have that many PCs. Knowing he had an accurate PC and software inventory was very important to him. He said “we pay on a per PC basis.”

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One pilot participant commented that his company’s current inventory process involves “managing a 5 column spreadsheet, which requires lots of time and effort to maintain and yet the inventory is still not accurate.”

Difficulties in maintaining accurate inventories result in several types of problems including:

- Inventories are conducted less frequently than desired
- Accuracy of PC inventories is less than desired (typically ranging from 70% to 85%)
- Costs of conducting inventories are higher than desired due to manual effort
- Negative impacts on end of lease issues
- Negative impacts on management of recalls
- Negative impacts on life cycle planning
- Negative impacts on the ability to identify unauthorized components on the network

In summary, feedback from participating customers indicated existing automated tools are often limited in their effectiveness. As a result, companies who wanted a complete picture spend additional time in manual inventory efforts. The result is that software and hardware inventory processes are relatively labor and time intensive with only partially accuracy.

Asset Inventories: Pilot Results

Metric	Average with Current process	Average With Intel vPro processor technology
What percentage of PCs respond to a typical polling process at a given time?	85%	98%
What is typical accuracy of a hardware asset inventory for 5000 PCs, including manual and automatic polls?	84% with desk-side visits to between 250-500 PCs	98% with no desk-side visits
Time required to perform a manual hardware-asset inventory per PC?	28 min – plus travel time	<1 min, remotely, even if PC is powered off
What percentage of hardware-asset inventories can typically be automated?	81%	99%
What percentage of hardware-asset inventories can be performed off-hours?	51%	99%

By directly accessing any PCs at any given time, and communicating via a secure channel below the OS, inventory process time can be reduced to a small fraction of the time previously required – to as little as 30 minutes to inventory 1000 PCs.

One pilot IT Manager noted how Intel vPro processor technology could assist them in standardizing their hardware deployment strategy. “Right now,” he said, “each department runs itself. We don’t have a central control over configurations. But with this technology we can cut across departmental lines by communicating directly with the PCs

EDS Observations on the Pilots

Customers who see Intel vPro processor technology demonstrated during the pilots like the ability to finally close the door on the last 20 percent of PCs in their environments that are out of compliance with corporate policy because the machines were either not turned on or couldn’t be accessed and thus could not be updated by automated means. This technology gives IT the ability, without desk-side visits, to achieve a 98% penetration rates when deploying a critical security patch.

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regardless of where they are.” Customers overall were interested in collecting more key information like asset tag, warranty end date, purchase order, owning department, and purchase date; and tying it back to the specific PC in the data base. This becomes much more practical at little or no additional cost.

Benefits of Improving Asset Inventory

Regulations and legislation require consistent and reliable management of sensitive information assets. Company policies and controls are only as good as their enforcement. Software licensing requirements add to the need for assurance of compliance across all areas.

Accurate PC inventories allow accurate cost estimating for services provided to system users, improved control of licensed software, compliance with regulations and legislation such as the Sarbanes-Oxley act, and much more. Accurate PC inventories improve life cycle planning, managing lease agreements, knowing what replacement parts to stock, recall management, problem resolution, identification of unauthorized components, awareness of unauthorized changes in hardware configurations, and enterprise modeling.

With Intel vPro processor technology, hardware inventories can be performed remotely as needed, perhaps monthly, across the entire network. If 5% of a fleet of 40,000 PCs require even 15 minutes of manual intervention and user downtime per inventory item, that translates into 1000 hours of technician and user downtime. Over the course of a year (assuming quarterly inventories), that is about 2 person-years.

Software Upgrades and Patch Deployment – Current Situation

As a general rule, most customers participating in the pilots could only patch a PC when it was on. Either the PC must be left on all the time or the patches are deployed when the user turns on the system. One pilot participant has systems that are seldom used turn on via BIOS settings and off via scheduled events.

Another pilot participant commented that with current patching processes they were able to successfully deploy patches out to PCs on average 70% of the time. Those that could not be reached were either turned off or were experiencing a problem such as the OS being down.

Another frequent observation was that users often deferred patches to minimize interruptions, leaving their systems vulnerable. In one case, the patching processes generated calls to the help desk with complaints about user interruption or causing system slow down.

EDS Observations on the Pilots

"Participants consistently commented that patching can only occur when the PC is on. As a result, either the PC must be left on all the time, or the patches must be deployed when the user turns on the system. All participants felt that the ability to schedule the time to power up systems and boot them during off-peak hours would make coverage more complete. People will not be around to "defer" update nor will they see the system slow down because of patching during work hours."

While wake on LAN provides a method to wake remote systems for patch deployment, multiple customers commented they purposely were not using this capability. Others who follow a predefined schedule for patch distribution said if a PC is not available to be patched at a given time it will wait until the next round of patch deployments.

Case Studies with Intel® vPro™ processor technology

Software Upgrades and Patch Deployment: Pilot Results

Metric	Average with Current process	Average With Intel vPro processor technology
Average time to update a typical software application for 5000 PCs?	253 hours	11.65 hours
Success rate for automated software application upgrades?	80%	97%

Results from the Pilot show that based on current processes, automated software upgrades were successful on average 81% of the time. Based on the capabilities enabled by Intel vPro processor technology companies felt automated software upgrades would be successful 98% of the time, representing a 21% improvement. In addition, with current processes, performing an upgrade on an installed base of 5000 PCs would take days or weeks. Customers who participated in the pilot believed deploying the same upgrade or patch to an equivalent number of PCs could be accomplished in a matter of hours.

Generally, all participants thought the ability to securely power up a PC and apply software patches and upgrades during off hours would improve the success rate for deployments. People will not be around to "defer" updates nor will they see system slow down because of patching during work hours. The ability to patch more machines for the same effort and have better success on patching is an important feature, and has a measurable benefit. One customer estimated that PCs requiring a desk-side visit to deploy a patch or upgrade would drop from approximately 10% down to 2%.

Security

Companies face many challenges to securing the PC fleet including the inability to:

- Perform update if PC is powered off or security / management agent is disabled or removed
- Manage or remediate PCs due to malicious attack
- Discover all PCs to update if some do not respond to poll
- Acquire system information for update when the PC does not respond to poll
- Update all systems at once (so the window of vulnerability is not extended)
- Remotely shut down compromised systems fast enough to slow/halt the spread of a virus/worm
- Prevent vulnerability of PCs powered up by user before update is installed.

A manager in one of the pilot companies identified a benefit that affects all large corporations going through down-sizing of personnel. They stated, "Use of the remote bios feature can be used when Human Resources calls and requests the immediately disabling of an account. A technician could remote into the machine and place another password on the system when, for example, an employee is terminated."

The nature of personal computing is great flexibility and access to information. Consequently, techniques to exploit PC security vulnerabilities increase daily. When a security update is released, it is often to counteract a new and immediate threat. The security administrator for the PC fleet employs lots of tools and techniques, but these are ineffective if the target PC is turned off or otherwise not reachable via the normal communication channel.

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In addition to firewalls, intrusion protection, monitoring, anti-virus and anti-spam controls, PCs must be frequently scanned for evidence of malware and properly handled when infections are found. It is also useful to maintain persistent logs of sensitive activities on individual PCs, to protect such logging against user access and overrides, and to send alerts to the management console in the event of selected sensitive events. This gives an IT technician policy-based visibility of fan speeds, temperatures, case intrusions, hardware failures, OS lock-ups, and other critical events as they occur.

Another large enterprise saw Intel vPro processor technology as a better way to remotely manage their environment. Since they are always looking for ways to improve security along with meeting regulatory requirements, that increases the need for best practices in security. With the enterprise mode of Intel vPro processor technology security features such as TLS/PKi, Kerberos along with digital certificates can all be integrated into the environment.

Remote access to a PC must be subject to aggressive security measures. Because a key Intel vPro processor technology feature is remote access to the PC in a manner that bypasses normal communication channels, it is important to understand how Intel vPro technology improves rather than decreases security.

The remote communication channel is based in hardware and firmware, not on the software stack in the OS. Because of this it works even if the OS is compromised or inoperative, and even if PC power is off. The channel is secured through HTTP authentication and Transport Layer Security (TLS). TLS is a cryptographic protocol that provides endpoint authentication to ensure secure communications across a network to prevent

How PCs with Intel® vPro™ processor technology improve security

Always available communications enable IT to deliver remote updates and patches to all PCs connected to power and network, thus accelerating saturation and reducing vulnerability. Enterprise-wide actions like mass shutdown can be performed during off hours as an automatic process. Improved automation of remote access allows an organization to reduce technician time required to support deployment of critical updates and patches.

Security Advantages of Intel® vPro™ processor technology

Intel vPro processor technology enables better inbound protection by decreasing the number of virus attacks, malware, etc. that successfully infect the platform. The environment achieves that goal by means of 64 programmable hardware filters that detect and stop known malware from affecting the platform, regardless of operating system health or virus-protection-agent state.

Likewise, Intel vPro processor technology enables better outbound protection, because fewer virus attacks, malware, etc. propagate to the network from an infected platform. It achieves that goal by means of programmable hardware filters that detect and stop known malware from being transmitted and infecting other network connected platforms, regardless of virus-protection-agent state.

Improved inbound and outbound protection reduces the number of support calls (desk-side and all other forms) to repair systems infected by malware; fewer systems get infected, and those that do get infected are easier to remediate remotely. In a related benefit, end-user productivity is increased by requiring less time to be spent recovering from malware and allowing users to continue to operate (connected to the network) while only the malware is blocked (and other traffic is

Case Studies with Intel® vPro™ processor technology

Accurate and timely security updates and patching help maintain compliance with internal and third-party (e.g., government) security policies, improve security assessment and tracking, and provide system stability. Systems are more secure when patches are delivered in a timely manner, lowering downtime and desk-side visits due to unpatched systems.

Increasing User Uptime by Improving Security

IT organizations must provide users with security services that quickly detect vulnerabilities, update security software, and remediate all PCs during a brief interval after a threat is identified. In particular, IT organizations must be able to reach the “last 10%” of PCs more quickly and effectively. Those are the systems traditionally out of reach of the management console because power is off, the OS is not working, or security or management agents have been disabled.

If a help-desk technician suspects a PC’s problems are related to a virus, the technician usually tells the user to disconnect the PC from the network. A technician is then dispatched desk-side to reboot the PC, run a secure version of a virus scan on the system, clean the virus from the system, update the agent and apply a patch. In today’s business environment, this process typically takes 1 to 2 hours on site. With Intel vPro processor technology, this entire process can be completed remotely from the management console. The master console has access to the PC even if its OS is down and standard network communication through the OS software stack is unavailable. In this case, no desk-side visit is required, IT labor costs are reduced, corporate policies can be enforced more completely, the PCs can be quickly returned to the user network, and productivity losses are minimized. This is a significant improvement over traditional patch management.

“Locked-Down” versus Open Build

To simplify management tasks and improve user uptime, the PCs in many business environments are “locked down.” That is, users cannot install applications and may have limited or no ability to store data locally. This can be effective for task workers who are constantly connected to the corporate network, and who do not need to install their own applications. Although a locked-down build makes it easier for IT technicians to manage and secure PCs, it greatly reduces user flexibility. In the typical business environment, 10% to 50% of users may require “open” builds because they must install software or maintain data locally. However, it is more difficult to inventory, maintain, repair, and remediate PCs with an open build.

Change Management

Managing changes to the PC environment is tricky because some changes require immediate attention, but may arrive just when a user is performing an important task and does not wish to endure processing delays. Software updates are best administered centrally because of the expectable wide range of results if such processes are left to user discretion. Even allowing the user to postpone the install and/or the subsequent required reboot can cause problems across the network.

As noted throughout this document, the preferred time to apply updates to a PC is when it is not in use. However, regardless of whether there is a policy of leaving the PC turned on at all times, some users will turn their PCs off. Problems resulting from new installs, re-imaging, or hardware and software failure can also render PCs inaccessible.

Case Studies with Intel® vPro™ processor technology

Changes and patch management are greatly simplified with the addition of Intel vPro processor technology, which allows systems to be powered on, if they are turned off, and to receive and install mandatory advertisements. This allows for 99+% of Intel vPro processor technology PCs to be remotely patched within hours instead of days or weeks. It also greatly reduces the number of desk side visits. One of the large healthcare service providers involved in the testing noted a less than 70% success rate in patch management due to systems being turned off or the OS being down.

Another health care IT manager noted they were very interested in the ability to take a specific machine off-line since quarantining a machine versus a specific port would provide better controls. They had occurrences where machines that were infected could be plugged into the network and posed a threat to the network.

The amount of time to deploy patches to the environment can be critical in preventing a network outage. One participant noted the estimated time to perform a critical patch update for 1,000 PCs takes at least 3 days and would drop to less than 4 hours with Intel vPro processor technology. In addition the % of PCs requiring a desk side visit will drop from approximately 10% to 2%.

The quarantine of a non-compliant machine was noted as a feature by one pilot group that would be extremely beneficial. They noted the System Defense policy would compel the user to allow a patch to apply since their system would be locked out from the network unless they were current.

Overall pilot user discussions on the patch capabilities relating to timeliness, handling patches in off hours, and scheduling during off peak work hours were key in reducing network exposure to the enterprise. One pilot participant made the comment that the PC must be left on all the time or the patches are deployed when the end user initiates the system shut-down process. This also increased the risk in that users many times shut the machines off prior to receiving the entire patch.

Notes from the Pilot

Their number one pain point is off-hours management, especially patching and updating systems. ... Bob's ideal is to be able specify SMS functions to occur during specific, recurring times, such as the second Saturday, at 2:00-6:00 a.m., configurable to the system level. Even the ability to configure it at the collection level would be beneficial so he can have less impact on the end users.

"Wake on advertisement" to deploy patches after hours is definitely a strong satisfaction point for this company. Many calls are received to the help desk with complaints about patches interrupting their work or causing system slow down. They "Hate the Balloon" that indicates a new application or update is available.

Worse yet, we heard from health care professionals with updates being made on shared work stations during a period of time when patient care was critical. Intel vPro technology demonstrated an advantage in being able to schedule those updates when non-critical functions were being performed.

Energy Efficiency

Some companies were excited about the energy savings they expect from having the ability to power the systems off in off-hours, then remotely turn them on when it is necessary to deploy a patch. A couple of clients had scenarios where a requirement of the service agreement is to leave machines on 24X7 to keep patches and virus definitions up to date. One pilot company said it wasn't just the ability to perform patch updates in off-times, but the ability to use energy more efficiently.

Case Studies with Intel® vPro™ processor technology

A variety of exhaustive studies have been performed on the power consumption required to run PCs. One conservative study showed it costs approximately \$36 a year to run a PC around the clock 24X7. So if the machines are turned off 16 hours daily (and longer on the weekends), a savings of two thirds per machine, approximately \$24 annually per PC could be achieved. In this example, of a fleet of 40,000 machines would save approximately \$960,000 on utility costs per year. A simple procedural change of every user turning off the PC could present significant savings to the bottom line.

Another company with over 150,000 PCs in place and another 150,000 PCs coming online said, "Corporate policy is to leave PCs on 24X7." At the time of our report they had not fully completed the math, but were estimating savings of \$6 million in energy costs.

Deploying Intel® vPro™ processor technology—How to Proceed

Organizations vary in their level of maturity with regard to management and security practices, but all of them must do some work to prepare to take full advantage of the new capabilities of Intel vPro processor technology . Many IT shops have a mix of management and security applications – remote management tools, asset management tools, patch audit and distribution, etc. Often this list of tools will even include some custom internally-developed applications. So it is important to consolidate. Most companies have determined that the hardware based management and security features of PCs based on Intel vPro processor technology provide a set of de facto standards which they can build on. These capabilities are embedded in the base hardware (Intel puts them there), so they are available from any OEM (in desktop PCs now, and laptop PCs soon), meaning they are not proprietary (i.e. only available from a single OEM). This provides a nice set of base capabilities for the ISVs to build on. So now the IT shop only has to consolidate on the ISV products built on Intel vPro processor technology

Processes and Training

The IT department will have to change many of their processes to take full advantage of the new capabilities. The typical level 1, 2, 3 escalation process will change as more can be done remotely. The IT organization has lots of opportunities to focus on standardization and automation of the PC support infrastructure. The technology provided to the first level of support will change the way that everyone handles PC problems and issues in the future. The authors believe this will make life much easier for the business user of the PC and provide for improved continuous operations of the desktop environment.

Steps to Take in Preparation for Intel® vPro™ processor technology

1. Define a deployment plan to take advantage of Intel® vPro™ processor technology through normal PC hardware migration.

Every enterprise should have a PC replacement strategy. Based on the results of this testing, we believe that strategy should include a plan to migrate to PCs with Intel vPro processor technology as soon as possible. From discussions during pilots, IT managers agreed the additional cost for a PC with Intel vPro processor technology is small compared to the benefits, and every manager said "It only makes sense as we do our PC refresh to replace each old machine with a system equipped with Intel vPro processor technology."

Case Studies with Intel® vPro™ processor technology

The authors believe it is advantageous for enterprises to standardize on PCs with Intel vPro processor technology, and to manage the migration with a planned and systematic approach that fits the normal refresh cycle. We understand these plans will have to be adjusted to fit with the upgrade of your environment to Microsoft Vista. Most environments will have a mixture of machine types with Intel vPro processor technology and non-Intel vPro processor technology, but this environment integrates well and provides no changes to the process for those machines not equipped with Intel vPro processor technology. An aggressive migration plan to this technology is in the best interest to streamline operations, reduce end user downtime, and provide improved overall PC performance and compliance.

2. Determine necessary systems management infrastructure to take full advantage of Intel® vPro™ processor technology at the desktop PC.

Leading ISVs are adding support for Intel vPro processor technology to their products. We found during the pilots most companies have many different system automation tools and are working to standardize the processes surrounding system management. If you don't have the necessary systems management tools already in place to take advantage of Intel vPro processor technology, you should begin putting the appropriate architecture in place.

As soon as a base level of Intel vPro processor technology equipped PCs are in place within the organization you can begin experiencing the benefits of full-time remote access and monitoring capability. The network monitoring and management tools and processes must also be in place to manage communications with Intel vPro processor technology - equipped machines, but you do not have to wait for the management tools before you begin deploying Intel vPro processor technology PCs to the desktops.

3. Determine process changes required when Intel® vPro™ processor technology is deployed in the enterprise, and how migration efforts will impact procedure changes.

Each organization must change the processes, procedures, and support team responsibilities to take advantage of improved service opportunities for the end user. Major changes will take place in how calls are handled at the help desk. In addition help desk technicians' jobs will change. More tasks will be handled by the first line help desk personnel while technicians will be called into the field to handle only the most difficult problems. Users must be educated on some of the capabilities that will seem foreign to them. They won't be used to the PC being turned on and off remotely. Also, they won't be used to having maintenance performed while they are not present at their desktop. With this new technology comes a different way of working with the PC. Some of the pilot teams called this technology the biggest change ever in simplifying user support.

a. Determine training needs, reassess staffing skill sets, and determine migration to new staffing model to support enterprise PC fleet.

Change brings the need for end user and technical training, and potentially a different staffing model for user support. We recommend a pilot of a small group first to assist in determining specific training needs and changes needed in the staffing model.

b. You must start in order to get there for PC Best Practices.

PC Best Practices are a combination of many factors. You must start soon with a road map for moving forward to improve security and compliance. Use factors from our guide

Case Studies with Intel® vPro™ processor technology

on PC Management Best Practices, and explore opportunities to begin using Intel vPro processor technology. A pilot environment is the best way to begin to ensure the technology infrastructure supports the features you want in the first rollouts of Intel vPro processor technology.

c. Refresh PCs with Intel® vPro™ processor technology.

As noted by a number of the pilot users, there really is no reason not to purchase all new PCs with the new Intel vPro processor technology. Incremental costs vary by configuration and vendor, but everyone commented that in the scheme of things the cost difference was not significant, and one less desk-side visit in the life of the PC easily pays for the difference.

Conclusion

In our study we learned an orderly transition to the Intel vPro processor technology requires putting in place a set of key components to take full advantage of the hardware and for problem resolution. Technology management can begin working on the technology infrastructure components that will be enable better diagnosis and repair when the first Intel vPro machine is plugged into the network.

As the PC continues to increase in importance to the enterprise, the need for better ways to decrease user downtime becomes more significant. From our observations and discussions during the pilots we noted Intel vPro processor technology provides the technology framework for improved protection, reliability, and availability of each individual PC, plus features that improve compliance with enterprise and regulated control standards. These features are stronger than ever before because Intel vPro processor technology provides a hardware-based solution, not just a software approach to managing PCs.

Although estimates of time savings must be determined individually by each organization, we know from the case studies that considerably fewer desk-side visits and reduced user downtime can be achieved. We observed significant time savings for user and PC service personnel when Intel vPro processor technology is deployed. Elimination of many desk-side visits with immediate resolution for the end user was observed in every category of problems including hardware and operating system issues. Although desk-side visits won't be completely eliminated, significant reductions are achievable by taking the steps outlined in this document.

The key to the successful deployment is an aggressive plan to improve processes, change procedures for help desk and PC maintenance personnel, and integration of Intel vPro processor technology with the systems management tools. The full efficiency and improvements in PC management cannot be achieved by just buying PCs with Intel vPro processor technology. But the sooner the PC fleet is enhanced with Intel vPro processor technology enabled machines, the more immediate the improvements will be when the supporting infrastructure is deployed.

As independent researchers working with technology security issues for a number of years we are greatly encouraged by the number of issues Intel vPro processor technology addresses through a hardware based solution. This is the first technology change at the PC

Case Studies with Intel® vPro™ processor technology

level that really addresses the major concerns from our study performed on PC Management Best Practices completed during 2003.¹

¹ *PC Management Best Practices – A Study of the Total Cost of Ownership, Risk, Security and Audit*, Institute of Internal Auditors Research Foundation, November, 2003.

Case Studies with Intel vPro Technology - Appendix

PC Management Improvement with Intel® vPro™ processor technology

	Without Intel vPro processor technology		With Intel vPro processor technology	
	Low to High	Average	Average	Improvement
System Availability				
% PCs responding to poll - hardware	70 to 95%	85%	98%	16.0%
Problem Resolution				
User downtime, software issue, onsite (minutes)	30 to 180	114	19	83.3%
User downtime, software issue, remote (minutes)	90 to 2160	982.5	18.75	98.1%
User downtime, hardware issue, onsite (minutes)	120 to 2160	1240	365	70.6%
User downtime, hardware issue, remote (minutes)	720 to 4320	2880	995	65.5%
Time to acquire & install new part, onsite (minutes)	23 to 2880	1273.13	190	85.1%
Time to acquire & install new part, remote (minutes)	45 to 4320	2415	967.5	59.9%
Time to diagnose a software problem (minutes)	12 to 720	195.7	22.6	88.5%
Reducing Desk-side visits				
Desk-side visits for software fix	1 to 3	1.64	0.14	91.4%
Desk-side visits for hardware fix	2 to 3	2.29	1	56.3%
Asset Inventories				
Time to discover 1000 PCs at a single site (minutes)	60 to 12240	4260	18	99.6%
Typical asset inventory accuracy for 5000 PCs	75% to 99%	84%	98%	16.7%
Minutes/PC to conduct a manual hardware inventory	15 to 37.5	27.5	0.47	98.3%
Minutes/PC to conduct a manual software inventory	37.5 to 60	48.75	2.54	94.8%
Success rate for automated hardware inventories	68 to 95%	81%	99%	22.2%
Hardware inventories that can be conducted after hours	45 to 90%	51%	99%	94.1%
Downtime for hardware asset inventory (minutes)	0 to 37.5	17.38%	0	100.0%
Software Updates				
Patch deploy time for 1000 PCs (minutes)	480 to 5040	3888	552	85.8%
% of PCs requiring desk-side patch	2 to 10%	7.5%	2%	73.3%
Saturation rate achieved for patching/updating PCs	75 to 98%	85%	97%	14.1%
Time to achieve Patch/update saturation (minutes)	2880 to 20160	16704	1008	94.0%
Change Management				
Time to load agents on new PC (minutes)	10 to 38	19.6	6.67	66.0%
User downtime for full build (minutes)	120 to 180	150	15	90.0%
Tech time for a full build (minutes)	40 to 210	125	17	86.4%
Tech time (per 2000 PCs) for onsite build (hours)	10 to 40	28.75	8.5	70.4%
Time to update software app for 5000 PCs (minutes)	2880 to 43200	15174	690	95.5%
Success rate for automated software app upgrades	40 to 98%	80%	97%	21.3%

Case Studies with Intel vPro Technology - Appendix

About the Authors

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Charlie has for many years addressed security, reliability, auditability, risk, compliance, governance, and assurance in information and technology. He served in management and IT roles from programmer/analyst, to IT auditor, to CIO, and managed many systems projects. A recognized author, he speaks on a range of IT topics. He produced board-level information security guidance for the Critical Infrastructure Assurance Office (now part of U.S. Homeland Security), and coordinated development of information security metrics for a subcommittee of the U.S. House of Representatives.

Le Grand directed the work of The Institute of Internal Auditors Research Foundation that produced the landmark Systems Auditability and Control (SAC) reports. He served as IIA's CIO to develop and implement a three-year project that migrated IIA systems and networks to the Internet, implemented its first two web sites and first email system, and the framework for a global communication network.

Charlie testified for the U.S. President's Commission on Critical Infrastructure Protection. He served on the board of directors of the Partnership for Critical Infrastructure Security, the Executive Committee of the Generally Accepted Information Security Principles Committee, the Advanced Technology Committee of The IIA, National Cyber Security Partnership, Center for Continuous Auditing, and American Bar Association's Information Security Committee. He was co-leader of a team that developed "Information Security Program Elements" and "Information Security Metrics" for the Corporate Information Security Working Group. He continues to serve on various working groups addressing security, control, auditability, standards and infrastructure protection.

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Mark served as the Research Project Leader for The IIA Research Foundation on the PC Management Best Practices project. He is Director of one of the top four Internal Auditing academic programs worldwide. The program has a significant emphasis on information technology, information security and business process design. He teaches "Information Technology Audit and Risk Management", "Internal Audit" and "Advanced Auditing". He also works as an Independent Risk and Audit Consultant.

He was previously with Bank of America for over twenty years – through the end of 2002. During his last two years at the bank he was Senior Vice President of Internet/Intranet Services. The group was responsible for all web hosting services and technology infrastructure for the bank. In that capacity he was responsible for establishing and chairing the process for all e-business architecture standards and products. Prior to that he served as Senior Vice President and Director of Information Technology Audit at Bank of America. He worked within the Internal Audit Group of the bank for eighteen years in technology, financial, and operational auditing. He was responsible for partnering and auditing technology, information security, and business continuity. Prior to joining Bank of America, he was a senior consultant of Accenture (Andersen Consulting).

He has worked in various capacities with The IIA including three Systems Auditability and Control (SAC) projects in 1990, 1993, and 2001. He is published in the areas of Internal Audit, Information Security, and Business Continuity. He received the 2005 IIA Educator of the Year award.