



White Paper
Intel Information Technology
Computer Manufacturing
VoIP/SolP

The Business Case for Enterprise VoIP

Intel recently conducted a pilot program that integrated voice over Internet protocol (VoIP) into the production enterprise environment, giving a group of employees the opportunity to experience the benefits that VoIP and unified messaging bring to the workplace. The pilot demonstrated cost savings and user productivity benefits using a session initiation protocol (SIP)-based Internet protocol (IP) private branch exchange (PBX), VoIP desk phones, VoIP softphones, digital-to-IP phones and wireless fidelity (Wi-Fi*) SIP mobile handsets.

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Executive Summary

Intel IT collaborated with one of the company's business units to conduct a pilot deployment of an open standards, session initiation protocol (SIP)-based voice over Internet protocol (VoIP) solution at one of its medium-size corporate sites in Parsippany, New Jersey. More than 50 Intel employees migrated from their existing digital phones to a combination of VoIP softphones and desk phones to service their telephony and voice messaging needs. Over a six-month period, the pilot captured data on technology integration, cost savings, and user productivity.

Participants using the new VoIP solution performed tasks faster and more efficiently than with the traditional phone system.

We used several Intel building blocks and technologies in the pilot, including Intel NetStructure® Host Media Processing Software, Intel NetStructure® PBX-IP Media Gateways, Intel® Xeon® processor-based servers, and Intel® Centrino® mobile technology-based laptops.

The VoIP pilot demonstrated interoperability between endpoints and tight integration with the production backend messaging system. We also tested an infrastructure migration path during the move from the existing circuit-based telephony system to an open architecture, packet-based implementation.

The pilot was a success, both in terms of the technology and productivity. Participants using the new VoIP solution performed tasks faster and more efficiently than with the traditional phone system. Benefits of an open standards-based VoIP solution include:

- Measurable, real-world user productivity benefits
- Greater voice messaging accessibility and efficiency
- Lower total cost of ownership (TCO)
- Immediate and long-term hard cost savings
- Reduced expense of telecom administrator moves, adds, and changes (MACs)
- Simplified management of servers, systems, endpoints, and network
- Greater flexibility of component selection

Industry-wide interest in VoIP deployment is substantial and growing. This paper documents how an open standards VoIP solution can reduce costs and increase user productivity.

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Business Challenge

Like many enterprises, Intel considered deploying VoIP to service our telephony needs. While we conducted many successful lab trials, VoIP business models based on hard costs alone consistently came up short. Over the course of many years, we highly optimized our existing voice infrastructure for cost. A combination of factors (including low cost-per-minute, a self-maintained bridging system, high compression over a voice over frame relay network, and fully depreciated hardware) made moving to a VoIP solution a financial challenge.

Industry Landscape

In the last couple of years, the landscape and the analysis have changed. The industry is moving away from circuit-based voice solutions. End of life and end of support notices for time-division multiplexing (TDM) private branch exchanges (PBXs) and spare parts availability are prompting enterprises to re-evaluate their voice solutions.

The Radicati Group, a telecommunications market research firm, predicts that 74 percent of all corporate telephony lines will be IP-based by 2009¹. Reasons companies give for implementing VoIP include ease of integration, cost savings, flexibility, productivity, consolidated network management, and the robust features that VoIP offers to both users and IT operational staff.

Enterprises realize that rapid acceptance of VoIP standards and applications are making installations far easier than traditional voice installations. International market research firm Infonetics Research projects that worldwide revenue from IP-capable PBX equipment will reach \$10.2B in 2008, up from \$3.6B in 2003.²

Because companies see their fully depreciated PBX systems as roadblocks to the cost savings and enhanced applications that IP telephony provide, some vendors are offering hybrid systems and upgrade paths that combine the capability of a traditional PBX and the enhanced feature

set of an Internet protocol (IP) PBX. As Figure 1 shows, over the next several years, VoIP adoption will continue to flourish, as installation of hybrid VoIP systems continue to grow faster than either traditional TDM or pure IP systems. However, a concern of some IT departments is that they are simply replacing one vertical telephony system with a newer vertical voice solution based on IP.

User Benefits

The maturation of VoIP brings greater benefits to users. VoIP products enable more features and tighter integration with backend infrastructure. Tighter integration with our messaging system, for example, allows for voicemail delivery to e-mail inboxes.

New usage models not possible with traditional voice systems compelled us to revisit the return on investment (ROI). As hard costs for VoIP systems decrease, soft cost benefits and increased productivity become an important element of the business value equation that ultimately influences the decision to move to a new VoIP deployment.

Additionally, our earlier trials were isolated and we needed to better understand the full impact of how converged communications affects users. We needed a broader and richer deployment of a fully integrated VoIP solution, and determined that a pilot that captured data on technology integration, cost savings, and user productivity would help us determine the feasibility of adopting VoIP across the enterprise.

¹ The Radicati Group. "IP Telephony to Make Up 74% of All Corporate Telephony in 2009." (December 21, 2005)

² Infonetics Research. "Enterprise Telephony Market Share 3Q05." (November 28, 2005)

Developing a Pilot

In our VoIP pilot, we wanted to achieve several high-level objectives that the typical enterprise needs to understand before committing to a new voice technology. Exploring our business goals and the new usage models made possible by VoIP would allow us to thoroughly evaluate the impact of changing such a critical business capability. Our objectives included:

- Introducing a variety of converged communications devices into the enterprise
- Understanding the benefits of an open standards based VoIP solution
- Evaluating a phased migration plan from a traditional circuit-based PBX to a packet-based PBX voice system
- Measuring the cost savings and productivity impact of using VoIP, converged communications devices, and unified messaging

Converged Communications Devices

VoIP enables converged communications and unified messaging, which in turn improve employee productivity. The pilot brought together a number of different devices that typically comprise a complete VoIP solution. The devices included:

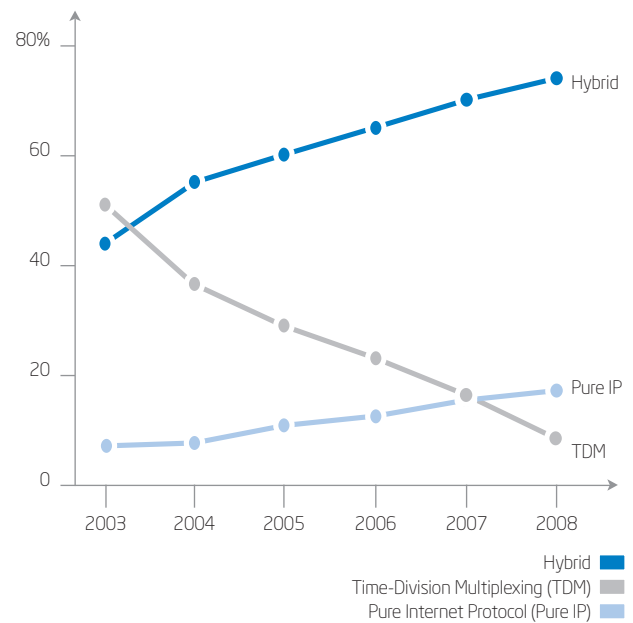
- VoIP desk phones
- VoIP softphones
- Pre-existing digital phones converted to VoIP
- Mobile wireless fidelity (Wi-Fi*) handsets

Use of individual devices depended upon the user group and usage model. The pilot presented an opportunity to understand how to maximize the benefits of particular devices based on user needs. It also allowed us to evaluate the planning and infrastructure requirements necessary to support each converged communications device within the solution.

Open Standards Benefits

The migration from circuit-based voice to packet-based voice is an inflection point in the industry. Rather than deploy a single vendor solution, we chose to define a new voice architecture based on open standards. SIP, in particular, enabled us to design a modular voice architecture using off-the-shelf components. We validated that this architecture was robust enough to operate in a production enterprise. The promise of multi-vendor compatibility and low-cost, swappable units was an appealing proposal. At the same time, tight integration with the messaging back-end was essential.

Figure 1. Projected PBX shipments by platform type



Source: Infonetics Research. "Enterprise Telephony Market Share 3Q05." (November 28, 2005)

Intel NetStructure® Host Media Processing Software

Intel NetStructure® Host Media Processing Software provides the media processing component of the IP PBX. The IP PBX is a software application that runs on a standard off-the-shelf Intel architecture server. The IP PBX uses SIP signaling for setting up and tearing down voice, video and other media sessions.

Intel NetStructure® PBX-IP Media Gateway

Intel NetStructure® PBX-IP Media Gateway is an open-standards-based, purpose-built device that provides a cost-effective bridge between legacy telecom equipment and a managed packet network. It works by converting signals from existing digital telecom equipment to SIP, an industry-standard IP protocol. Using the Intel NetStructure® PBX-IP Media Gateway allows enterprises to keep their existing installed base of desk phones. These appliance gateways allow the new IP PBX to communicate with legacy, circuit-based desk phones, granting users the ability to manage voice remotely from their personal computers.

SIP, in particular, enabled us to design a modular voice architecture using off-the-shelf components.

The pilot utilized many components employing Intel building blocks that were SIP-compliant:

- Intel® Centrino® mobile technology-based laptops
- Intel NetStructure® PBX-IP Media Gateways
- Intel NetStructure® Host Media Processing Software
- Intel® Xeon® processor-based servers

To further test SIP interoperability, the pilot selected multiple VoIP endpoints from five different vendors. At the end of the pilot, we maintained the environment as an ongoing proving ground and showcase for new Intel building blocks and SIP-based endpoints.

Phased Migration

We wanted to demonstrate an enterprise migration strategy from a legacy PBX to an IP PBX. To do this, we maintained the existing TDM PBX within the call path and relegated it to a simple gateway function. This allowed the IP PBX to handle the call processing and SIP routing. Further, users could revert back to their original digital desk phones as backup devices.

Cost Savings and Productivity

We measured hard cost savings and user productivity gains to identify and quantify the

cost benefits of deploying VoIP. Hard costs included hardware, software, head count, and expenses.

We identified soft cost savings by comparing common tasks performed using the existing digital telephony system to the VoIP solution.

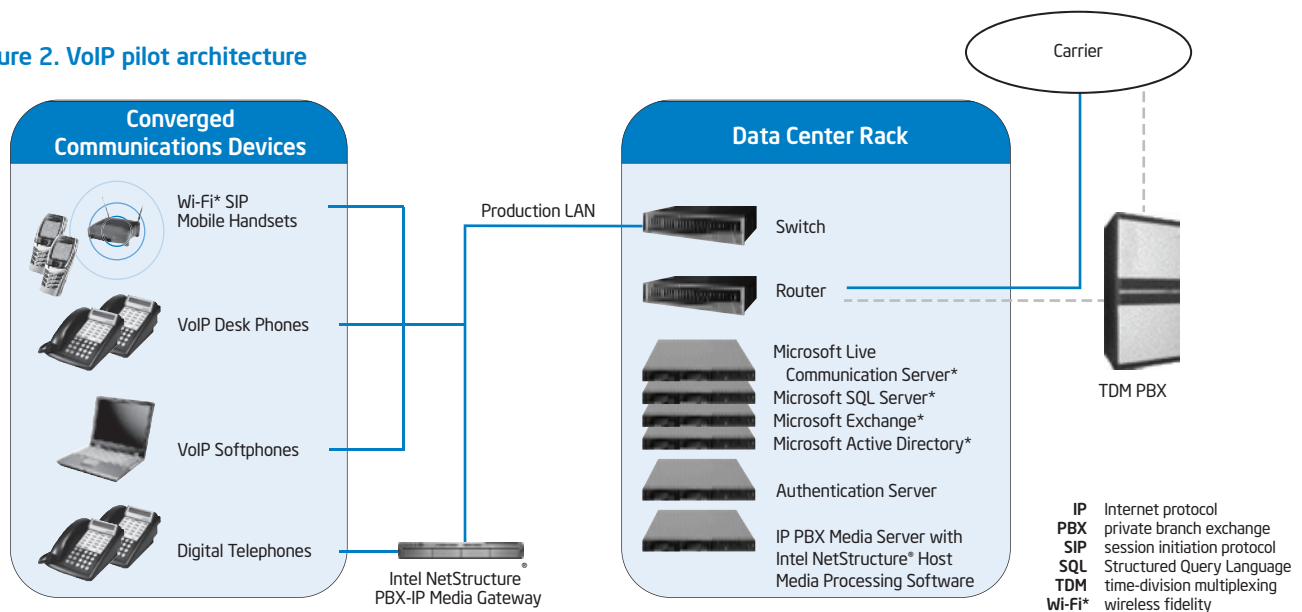
We then calculated a five-year ROI for an enterprise site consisting of 650 users using the hard and soft cost data.

VoIP Architecture

The pilot architecture used open-standards-based components that employed Intel communication building blocks. Intel NetStructure® Host Media Processing Software provided the media processing component of the IP PBX, and the Intel NetStructure® PBX-IP Media Gateways translated existing circuit-based telephony to packet-based telephony, thereby allowing communication over an Ethernet network. Intel NetStructure® PBX-IP Media Gateways helped us achieve considerable cost savings by allowing us to continue using existing digital desk phones.

Figure 2 shows a network diagram of the VoIP pilot implementation. The IP PBX provided all the standard telephone services and was also tightly integrated into the messaging infrastructure. This provided users with additional, enhanced VoIP applications like unified messaging. Voice traffic

Figure 2. VoIP pilot architecture



was prioritized and converged onto the standard production local area network (LAN) with the data traffic. Voice trunks remained connected to the public telephone network through a traditional PBX, which acted as a gateway to the carrier. This approach allowed us to conduct the pilot with minimal disruption to the existing telecom and network infrastructure. We did not require expensive upgrades to existing PBX software or hardware and we did not need to replace users' existing phones.

VoIP endpoints ultimately connected to the LAN. Existing digital desk phones connected to the LAN through the Intel NetStructure® PBX-IP Media Gateways. We implemented Wi-Fi handsets on our wireless network and will fully test them at a later date.

The pilot provided the traditional telephony feature sets in addition to new features made possible by VoIP and a SIP-based IP PBX with Intel NetStructure® Host Media Processing Software, as shown in Table 1.

The deployment plan included Quality of Service (QoS), which tagged the VoIP endpoint packets so that the network gave higher priority to voice traffic than data packets.

Study Methodology

More than fifty people representing various user groups and job functions participated in the VoIP pilot over a six-month period. In order to measure productivity, a human factors engineer (HFE) conducted timed studies of participants in a lab that duplicated an office environment. Testing occurred using the different types of VoIP endpoints listed earlier. With user profile information, we calculated productivity savings using VoIP and then compared this with the legacy voice solution. Savings were then extrapolated over a 650 user site.

User Profile

We conducted the pilot at an Intel facility in Parsippany, New Jersey. As shown in Figure 3, the study included participants from front-line, middle, and senior management, engineering, marketing, operations, IT, and business development.

Within these categories, we chose users from five market segments, as shown in Figure 4, which describe different types of Intel workers:

- **Nomads.** Heavy travelers and senior managers with strong remote access needs
- **Cube Captains.** Mainstream users who are satisfied with the technology they use

Table 1. Features

Traditional Features	VoIP-enabled Features
Hold	Fax
Transfer	Follow me
Mute	Unified messaging
Conference	Remote call management
Redial	Inbox voicemail
Forward	Automated attendant
	Presence information
	Directory access
	Click to call
	Click to conference
	Screen pop

Figure 3. Pilot participants by job function

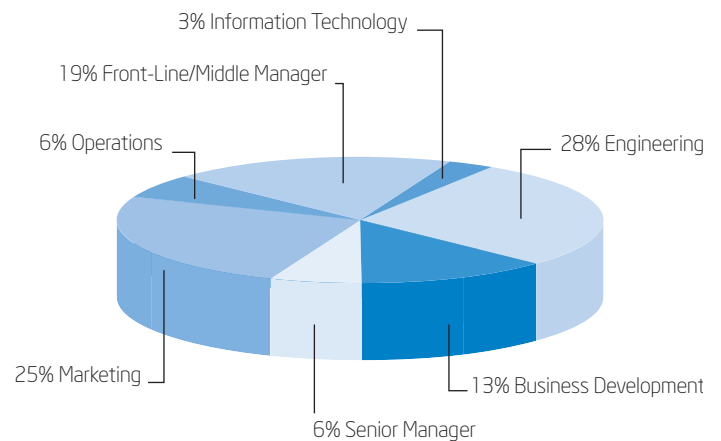
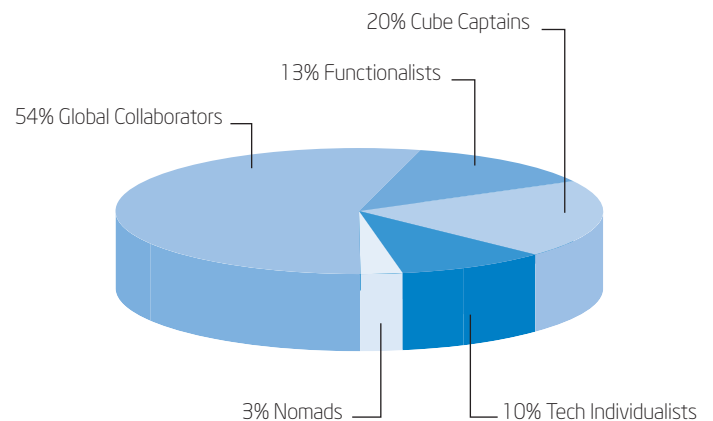


Figure 4. Pilot participants by segmentation



- **Functionalists.** Workers who are frustrated with and have a low reliance on office technology in general
- **Global Collaborators.** Geographically dispersed team workers and travelers who are heavy users of asynchronous and synchronous collaboration tools
- **Tech Individualists.** The most technically savvy group, often seen as technology opinion leaders

Procedure

Pilot users received basic training on the VoIP systems prior to the study. Their level of expertise varied. Some users were expert, while others were only somewhat familiar with VoIP.

To document telephony behaviors, human factors engineering observed users. We identified and documented specific voice tasks that are typical in the work environment. The tasks included various phone scenarios:

- Recording and activating an out of office greeting
- Looking up a phone number and placing a call to a specified phone number
- Putting a call on hold
- Transferring a call to a specified phone number
- Setting up a three-way conference call (ad hoc conference)
- Retrieving a voicemail
- Forwarding a voicemail to a specified contact
- Faxing a document to a specified phone number
- Configuring a notification when a contact becomes available (camping)
- Automatically forwarding an incoming call to another number (find me/follow me)
- Scheduling an audio bridge for a conference call

We timed each scenario from the first action taken (mouse click, button press, or handset pick up) to the last action taken to complete the task (mouse click, button press or handset hang up). Users alternated between VoIP and legacy phone

tasks in order to minimize the effect of task sequence on the results.

To allow for the fact that all users had many more years of experience with a standard telephone than with a VoIP system, productivity times included only those actions that led to successful task completion. We captured data on incorrect user actions on tasks to provide usability design recommendations and to improve help files and training materials.

Voice Endpoints

During the six-month pilot period, we assigned users one of four configurations:

- **VoIP desk phone.** Four different models of SIP-based VoIP phones from three different manufacturers
- **Legacy digital desk phone.** The user's original desk phone transparently converted to VoIP using the Intel NetStructure® PBX-IP Media Gateway
- **VoIP softphone client and headset.** A voice application running on the user's laptop and experienced through a headset. The client application mirrored typical telephone functions.
- **VoIP combo package.** A VoIP desk phone, VoIP softphone client, and headset

Fifty-eight percent of pilot participants received a VoIP hard phone or legacy phone, 28 percent received a soft phone, and 14 percent received the VoIP combo package. All users received the laptop client application to access the unified messaging features of the IP PBX. The client application allowed users to:

- Manage desk phone and messaging rules
- Send and receive faxes from their personal computers
- Tune the find me/follow me feature
- Drag and drop, ad hoc conferencing
- Manage voicemails in their inboxes
- Configure optional voice utilities
- Track incoming and outgoing calls

Productivity results were captured across all phones and features.

Data Analysis

We used a single factor analysis of variance in analyzing the results of each timed task, meaning we only looked at the difference in task times between solutions. We used an accepted significance level of 0.05 in the research, reducing to five percent the likelihood that any differences we measured were due to chance. A set of 29 users took part in the scenario testing portion of the study.

Financial Analysis

We calculated a five-year financial analysis using two components: hard costs and productivity gains. For the purpose of the analysis, we used a medium-size enterprise site of 650 users where an existing circuit-based telephony infrastructure already existed.

Hard Cost Savings

To determine whether moving to VoIP could deliver significant enterprise savings on hard costs, we identified categories on an IT financial balance sheet where VoIP had an effect. We listed recurring costs, with most new investment occurring in the first year of VoIP deployment.

Telephony Hardware, Software, and Licensing

A new PBX installation requires an initial investment to move to an open-standards-based IP PBX. Under the same circumstances as our study, a medium-size enterprise site can expect to save 55% by implementing an IP PBX instead of installing the latest TDM PBX. We based this calculation on the costs of the IP PBX, hardware, software, and licensing compared with equivalent capability on the TDM side.

Move/Add/Change Costs

With a legacy PBX system, the costs of MAC orders on individual phones can be significant. Each MAC requires at least one telephony technician to complete each of these tasks. With a VoIP solution, users simply carry their IP phones

to a new location and plug them in. Moves and changes are all handled in software, and in some cases a telephony technician is not involved in the process at all.

Based on MACs in a medium size-site, we concluded that VoIP provided a 52 percent savings per year over a standard, circuit-based PBX system. In a larger enterprise site, the savings increase due to the logistics of a larger campus and the number of technicians involved in the MAC process.

Data Center Footprint Reduction

The data center footprint shrinks significantly when moving to a VoIP solution. We documented a 3-to-1 (67%) reduction in total data center area for a 650-user site. The study indicated we could achieve a \$20,000 per year savings by replacing the racks of hardware that supported a traditional PBX on a standard phone system with less than one rack of Intel architecture servers supporting the VoIP IP PBX system. We also calculated savings from reduced maintenance costs and power and air conditioning consumption. More important than the dollar savings is real space savings within the data center. Building a new data center or expanding existing space is extremely time consuming and costly. It is not unusual for an IT department to contract this function at significant cost.

Audio Conferencing

Using a VoIP solution for audio conferencing also produces significant savings. Intel uses close to half a billion minutes of conferencing time worldwide annually. We expect to save on small conference calls, defined as those involving six or fewer people. Sixty-six percent of Intel's conference calls are small. With the VoIP solution, we avoid costly conference bridge lines, as each user simply calls the conference host directly. This saves both bridge setup time and provider costs. Faster setup time is a productivity gain, and the reduction of provider costs is a hard cost savings.

Cabling and Wiring

Because VoIP uses the same network cable as a personal computer, there is no need to run a separate phone cable to each desk. This offers tremendous savings in new buildings without

More important than the dollar savings is real space savings within the data center.

pre-existing cable runs. Cost savings can occur on contractor costs and on the materials needed to wire a separate voice network such as wire, phone jacks, outlets, spare parts, and crash kits. We conducted our VoIP pilot at an existing wired site, therefore we did not itemize these costs in the financial analysis.

Monthly Usage Costs

We expect to reduce the costs of local and international calling by moving to VoIP. International call savings will be significant, especially if calls from the site are not routed over a private voice network or heavily compressed. Long distance savings will probably be negligible

because of recent competition in the marketplace that has already lowered cost per minute.

Calling card savings will also be significant. For example, Nomads can reduce charges by using a softphone from a hotel, airport, or public Wi-Fi hotspot. They can also attend lengthy meetings on an audio bridge while on the road. This usage model provides inherent cost savings from remote IP calling. Home office workers have a similar work profile.

Productivity Gains

The human factors engineering study of specific voice tasks documented significant user

Figure 5. VoIP task performance vs. traditional voice solution per employee

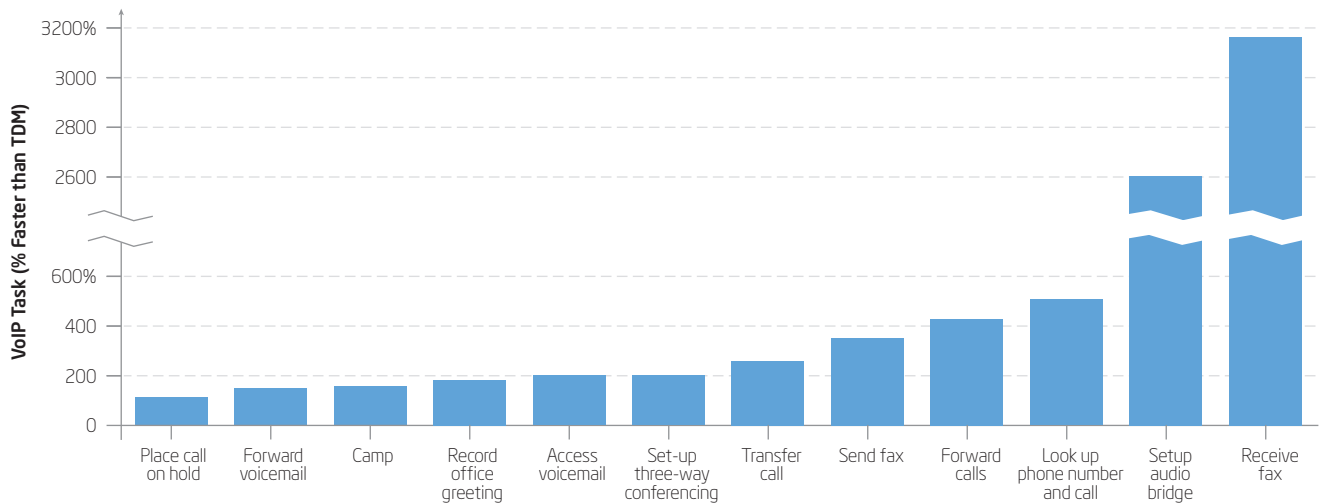
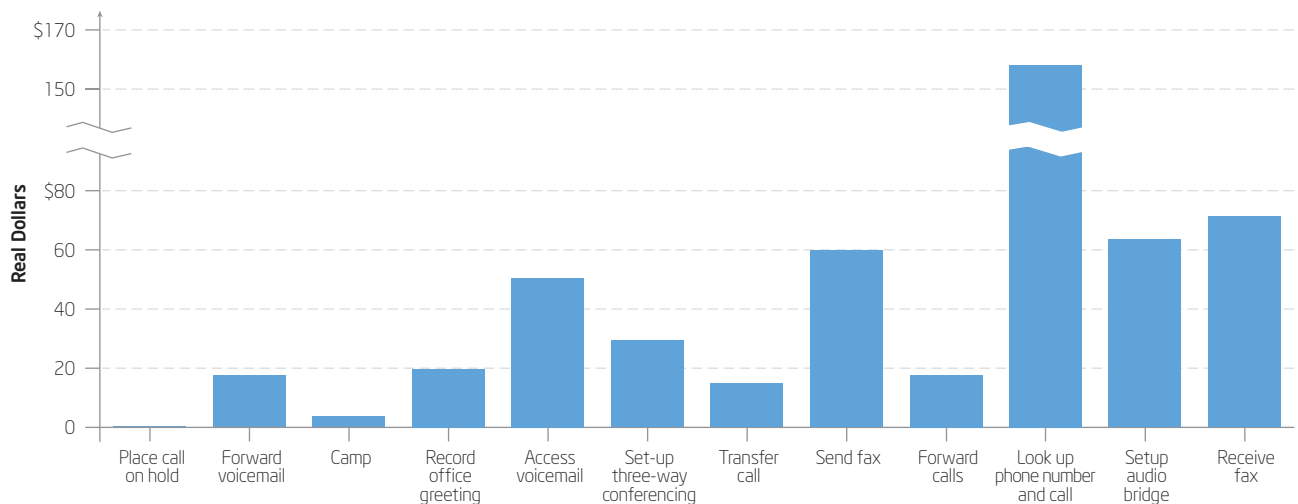


Figure 6. Annual productivity savings per task per employee



productivity gains for a typical employee (see Figure 5). Performance generally increased between 134 to 500 percent using the VoIP and unified messaging solution. We saw significant time savings over the legacy phone system on two tasks: scheduling a conference bridge at 27 times faster and receiving a fax at 31 times faster. While these two time savings are remarkable, the overall productivity savings were more in line with the other tasks due to the low frequency of these two events (see Figure 6). Repetitive tasks, like accessing voicemail or looking up a contact's phone number and then placing a call were two and four times faster, respectively, than using the non-VoIP solution. Users achieved the most substantial productivity benefits from these tasks.

We calculated time saved on the full range of repetitive voice tasks for each user across a medium-size 650 user site. We applied a 50 percent discount on the time savings to obtain the productivity calculation.

Net productivity gains using VoIP and unified messaging added up to significant cost savings, as shown in Table 2.

Data gathered in the pilot highlights a VoIP benefit that is often under-represented: VoIP systems greatly enhance user productivity. We found that the advanced features of unified messaging make regular voice tasks far more efficient in comparison to TDM systems available today.

Conclusion

Our VoIP pilot showed that we can achieve significant cost savings through migrating from an existing TDM PBX solution to an open-standards-based IP PBX. By analyzing both hard and soft cost savings, we can demonstrate a positive ROI after two years. In addition to hard costs savings, user productivity gains on frequent voice tasks can also show a dramatic benefit to both the enterprise user and the IT department. VoIP continues to drive productivity through new telephony features and unified messaging and thus makes a compelling argument for enterprises considering the move to VoIP.

Explore www.intel.com to find additional information about VoIP in the enterprise, including white papers, a virtual tour, and discussions of VoIP technologies and standards.

Authors

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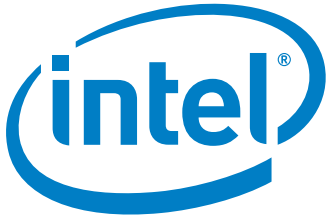
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Table 2. Estimated annual productivity gains

Productivity Metric	Gains
Time gain per user	2.7 days per year
Productivity gain per user	\$480
Productivity gain at a 650-user site	\$312,000

Acronyms

HFE	human factors engineer
IP	Internet protocol
LAN	local area network
MAC	move, add, and change
PBX	private branch exchange
QoS	quality of service
ROI	return on investment
SIP	session initiation protocol
TCO	total cost of ownership
TDM	time-division multiplexing
VoIP	voice over Internet protocol
Wi-Fi*	wireless fidelity



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