Peer-to-Peer Computing in the Enterprise:

Implications for IT and Business Decision Makers

Peer-to-Peer computing is moving into the mainstream business world, driven by a variety of new applications that target business needs. This powerful new computing model can help businesses improve productivity and collaboration, while greatly extending the capacity of their existing computing assets.

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Introduction: Peer-to-Peer Computing Moves into the Enterprise

> **"By 2004,** most large corporations and enterprises will have carried out large-scale deployments of P2P technologies."
>
> *– The Gartner Group*

There's nothing like finding another, more powerful use for a familiar tool. As desktop performance continues to increase, dozens of companies have discovered that Peer-to-Peer (P2P) applications can be used to harness that power, improving the functionality and efficiency of the entire computing environment. Today's P2P applications take advantage of desktop resources across the enterprise to bring work teams together more efficiently and seamlessly than ever before: to power virtual supercomputers for high-end computing applications; to optimize storage and network efficiency; and to reduce IT management costs.

The proven power of this computing model has set the stage for rapid adoption of P2P computing within the enterprise. For most businesses, the fundamental infrastructure is already in place:

- Networked computers are ubiquitous.
- Affordable desktops now have enough processing power and storage capacity to handle P2P computing requirements, while still delivering excellent performance for traditional workloads.
- Most corporate networks have sufficient bandwidth to support the rapid movement of large amounts of data and rich media content, especially since P2P applications can help to optimize bandwidth allocation.

A New Level of Computing Efficiency

Peer-to-Peer computing can be defined as any application or network solution that supports the direct exchange of resources between computers, without relying entirely on a common file server. Once P2P computing software is installed on employee desktops, every PC becomes a "peer" that can act as both a client and a server. Not only does this lay the foundation for a variety of new applications, it can also take a considerable load off the existing infrastructure, reducing the need for expensive and disruptive upgrades.

- Server Optimization – The shifting of the corporate workload onto desktops can greatly reduce processing and storage demands on centralized servers. It can also decrease capital expenditures moving forward, since the volume economics of desktop purchasing delivers more computing power per dollar spent. Businesses not only extend the capacity of their existing infrastructure, but can also add capacity more cost-effectively as their needs evolve.
- Network Optimization – Instead of automatically linking with a centralized server for network transactions, a P2P application searches for the nearest peer that can provide the necessary resources. As a result, the average distance for network interactions is significantly reduced. This lowers the total amount of traffic. It can also shift traffic away from Wide Area Networks and onto Local Area Networks, where the cost per megabit of data transmission is considerably less.
- Infrastructure Resilience – Under the traditional client server model, the failure of a single server or network pathway can impact hundreds or even thousands of end-users. With P2P computing, information is housed on many different clients, enabling extremely high levels of redundancy at very low costs. The potential for a serious disruption of service is greatly reduced, and there is less strain on high-availability servers.
- Desktop Manageability – P2P applications can be used to enhance the manageability of deployed desktops. Software distribution is a prime example. Many businesses currently fall behind in virus protection due to the difficult logistics of distributing updates to thousands of desktops. With an appropriate P2P application, virus signatures can be distributed by cascading the update from PC to PC. This accelerates deployment, and also reduces the load on centralized resources. P2P applications can also provide more coordinated virus protection, limiting the spread of a virus by quarantining infected clients.

In most cases, P2P applications are not designed to replace centralized solutions, but rather to complement them by taking advantage of unused resources at the edge of the network. As P2P enters the enterprise environment, the possibilities for new solutions and business benefits are far-reaching. The remainder of this paper discusses four key processes that are being transformed by the efficiencies of P2P computing technologies – collaboration, distributed processing, content distribution and knowledge management.

Collaboration

P2P collaborative applications create virtual workspaces where suppliers, customers, colleagues and business partners can make immediate and direct connections with each other and access common resources. These virtual workspaces provide efficient one-stop shops for voice conversations, shared files, joint planning documents, schedules and contacts. They have the potential to replace a good part of the random traffic of e-mails, conference calls, faxes, and other interactions that flood businesses today.

In comparison with dedicated Web sites and shared network solutions, secure P2P collaborative groups can be created quickly and flexibly, and with very little IT overhead. Collaborators can come together from both within and beyond the corporate network, and can typically access resources from their PC or from a variety of handheld devices. Because the application and data reside locally on users' PCs, processing and communication are handled primarily on the edge of the network. With this strategy, even very large groups can be supported without undue impact on corporate servers or core network bandwidth.

Distributed Processing

Complex computing tasks often require enormous amounts of processing power. Examples include financial modeling, engineering simulation, and computational chemistry, to name just a few. Solving such problems with centralized computing resources can require enormous capital expenditures, prolonged deployment efforts, and considerable IT support. P2P offers another approach. Companies can take advantage of desktop power to establish the equivalent of in-house supercomputers. Complex tasks can be solved much faster, with virtually no incremental capital expense and without impacting the productivity of other business applications.

Collaboration in Action – Groove

"If what is going on in IT over the past few years was the information age,
going forward it's going to be viewed more and more as the connection age."

– Ray Ozzie, CEO Groove,
Fortune, Winter 2002

Groove Networks was one of the first companies to develop Peer-to-Peer applications. Its Groove collaboration software has already been licensed to over 10,000 employees at GlaxoSmithKline PLC, in the U.K., and is currently being tested for deployment in the U.S. by Raytheon Company and Abbott Laboratories. Groove lets users from multiple companies initiate and maintain secure, shared workspaces where they can exchange messages, applications, voice and video in real time through a dedicated interface.

Key features include live voice over the Internet, instant messaging, text-based chat, threaded discussion and content distribution tools for sharing files, pictures and contacts. Users also have joint activity tools for simultaneous Web browsing and document editing, a white board for brainstorming, and a group calendar.

Groove uses XML coding to enable virtually seamless data synchronization between peers. If members work offline, all shared content is updated as soon as they reconnect to the shared environment. The latest release of Groove also offers improved control for IT organizations, including enhanced firewall support and configurable rules that limit the types of software that employees can install on their clients.

Distributed Processing in Action – An Affordable Supercomputer

"UTC's Peer-to-Peer installation will allow them to 'get a workload accomplished' that would [otherwise] take a supercomputer worth $20 million to perform."

– Dan Kusnetzky, IDC analyst
Quoted in InternetWeek, May 29, 2001

United Technologies Corporation is a $26 billion manufacturing conglomerate that makes everything from elevators to air conditioners. To accelerate their development cycle for turbine engines and other complex aircraft parts, the company is currently deploying an in-house P2P application on 100,000 Intel® Pentium® 4 processor-based desktops. This virtual supercomputer will enable design teams to crunch scientific calculations and solve complex modeling problems during off hours. The company expects to cut development times and related costs in half, mainly by eliminating multi-million-dollar prototypes.

UTC's Peer-to-Peer project is made possible, in part, by a corporate IT drive to standardize on Intel Pentium 4 processor-based PCs. The Intel Pentium 4 processor can execute billions of instructions per second. Paired with the Microsoft* Windows* 2000 or Microsoft* Windows* XP operating system, it offers a new level of power and stability for distributed processing applications. By standardizing on this client platform, UTC is increasing client manageability, reducing administrative costs, and improving the ability of distributed applications to run predictably across thousands of desktop PCs.

Source: InternetWeek, "PC as Supercomputer", May 29, 2001

Content Distribution

Even the largest servers can be overwhelmed or bogged down when thousands of employees or customers download large files simultaneously. P2P solves this problem by making use of the extra storage space on employees' local desktop drives. Messages, documents, videos, presentations and other data can be distributed from peer to peer throughout a supply chain. Content can be distributed in a cascading manner, so that changes made on one peer show up on the others' desktops almost simultaneously. Distribution is faster and server and network resources are freed for other tasks.

When real-time access is not an issue, files can also be delivered during 'off peak' hours to take advantage of unused bandwidth capacity. This further lowers the cost of distributing content over a network, and may soon become the method of choice for distributing software and other high-bandwidth information.

The value of such applications will continue to increase as large multimedia files and video presentations become more common in the corporate environment. By taking advantage of P2P content distribution, businesses will be able to make far better use of existing resources, reducing the need for infrastructure upgrades and easing the burden on support personnel.

Content Distribution in Action – Kontiki

Kontiki, a company in Mountain View, California, is testing an application that promises to harness the power of thousands of desktop computers to distribute TV-quality video, software and other digital content to employees and customers over the Internet. Kontiki's software allows each user's system to grab pieces of files simultaneously from many nearby computers, and can route transfers around any interruption without losing data. Each desktop uses Kontiki software to organize and search for digital files, to protect the machines from viruses and to enforce restrictions against unauthorized file sharing.

With a sufficient pool of connected clients, Kontiki will make it easy for users to find, schedule, download and play high-quality video, software applications, and other digital media. Businesses will also benefit from improved capacity for applications that require the delivery of rich content to employees, partners or customers, such as e-Learning, training and corporate broadcasts. By supporting efficient file sharing while protecting content rights, Kontiki is bringing the promise of Napster, Gnutella and similar applications into the business mainstream.

Intel's Share and Learn Software

"I couldn't afford to send big files over the wide area network (WAN). It didn't fit my budget. Now employees just look for the file on the PCs closest to theirs, which can be in the same office. It's cheaper. It's faster."

– Doug Busch, V.P. of Information Technology, Intel Corporation

Technology evolves rapidly at Intel, and keeping employees up to date is vital. Yet storing and delivering content to over 70,000 employees in more than 40 countries is a major expense. To address this concern, Intel recently developed Share and Learn Software (SLS), a P2P-based Web application that efficiently manages, distributes, and stores information on client machines. In addition to e-Learning, SLS can support knowledge management, corporate broadcasts,software distribution and network backup and restore procedures.

SLS provides an easily managed Web-based environment for content delivery over the company intranet. Operation is transparent to end-users, and information is tagged using XML to facilitate easy indexing and efficient searches. Results have been impressive in a pilot program that supported over 3,000 employees. Response times improved significantly for employees who downloaded materials and related WAN traffic has been reduced by an estimated 80%. Altogether, the total storage and delivery costs were reduced by a factor of ten.

Knowledge Management

E-mail has transformed business communication. Yet there is a serious downside as many employees struggle to process a hundred or more e-mails a day. P2P knowledge management applications can simplify this task, and also help employees make better use of all their digital resources. Intelligent agents sift through messages, Web sites, files and other data sources to track pertinent information based on the user's identity and informational needs. Extraneous items are deleted. Useful information is delivered directly to the desktop, and organized to optimize the work environment.

Knowledge Management in Action – WorldStreet.Net

Nowhere is the flood of electronic information greater than in the financial arena. As a result, dozens of financial companies have emerged as early adopters of knowledge management applications. One example is Oppenheimer Funds, Inc., which is using WorldStreet.Net, by WorldStreet of Boston. This collaborative application simplifies and filters the massive flow of financial information between money managers and the brokers and analysts who flood them with reports, deal offers and other communications.

WorldStreet.Net certifies users as financial professionals, and supports the sharing of relevant and structured information. It helps individuals and companies distribute and receive information more easily, while ensuring that recipients are both interested and entitled to receive it. It also provides filters that help users sort through the hundreds of e-mails they receive every day, prioritizing messages and eliminating unwanted communications.

Foundations of Peer-to-Peer Computing

Security in a Peer-to-Peer Environment

From the Internet, to e-mail, to mobile computing, every new distributed technology has presented IT organizations with unique security challenges. P2P is no exception, since it not only improves access to centralized resources, but may even distribute selected processes and information outside the corporate firewall. How can IT organizations protect the privacy and integrity of their computing assets, while still supporting efficient collaboration?

To start, businesses can deploy P2P applications that support standards-based security features, such as authentication, strong encryption and digital certificates. Such technologies have been well tested in the business environment, and offer excellent protection for distributed information and communications. Businesses may also consider instituting some level of centralized control over their P2P platform. For example, a centralized registration server can be used to authenticate all users before they enter a P2P community.

Many P2P application developers have already integrated advanced security features into their products. Intel is working to promote P2P security through its Peer-to-Peer Trusted Library, which provides open source security components that software developers can add to their P2P applications. Components are built upon the Open SSL (Secure Sockets Layer) Tool Kit, and support digital certificates, peer authentication, secure storage, public key encryption, digital signatures, and symmetric key encryption. Through these and other tools, the options for secure, standards-based P2P computing will continue to increase.

In addition, every business must look closely at the processes and communication channels that will be supported by new P2P applications. Existing security policies must be extended to support the particular nature of the interactions. This is really nothing new. Security solutions have never been completely technological, but have always required consistent and comprehensive policies to be effective. With a combination of advanced security technologies and effective policies, companies will be able to reap the considerable benefits of P2P applications without undue risk.

Extensible Markup Language (XML)

XML is a powerful programming language that allows software developers and content managers to create customized tags for data. Based on the ubiquitous Internet language of HTML, it offers an ideal mechanism for the transfer of short, structured messages between peers using today's Internet protocols. Since message data can be encrypted using current technologies, XML is an excellent protocol for secure communications.

XML programming can also facilitate the storage and retrieval of information. It enables data to be cached in multiple locations, and retrieved more easily and flexibly than with a custom or unstructured format.

XML is easily customized for specific P2P applications, so it's a flexible tool for software developers. It can also be used to add a higher level of intelligence to the environment, enabling P2P applications to recognize, disseminate and automatically install software patches and upgrades. This can be an important advantage for applications that may be deployed on thousands, or even millions, of desktops.

The Intel® Pentium® 4 Processor – the Optimal Platform for Peer-to-Peer Computing

The strength of a P2P environment depends not only on the number of PCs on the network, but also on the extra processing and storage capacity on each system. Powerful desktops are therefore important for supporting rich P2P functionality while maintaining high performance for traditional end-user applications.

The Intel® Pentium® 4 processor is a superb choice for P2P computing. The Intel® NetBurst™ microarchitecture of Intel's latest desktop microprocessor offers high clock frequencies, plenty of raw power, and more efficient execution of today's most demanding processing tasks. It performs P2P background tasks more efficiently, and significantly accelerates the execution of XML. A Pentium 4 processor 2.20 GHz, for example, executes XML instructions 298% faster and performs common collaboration tasks 343% faster than an Intel® Pentium® III processor 500 MHz (Figures 1 and 2).

A number of other Pentium 4 processor features contribute to outstanding PC performance:

- The 400 MHz system bus delivers data between the processor and main memory three times faster than a Pentium III processor's bus system.
- The new Rapid Execution Engine executes certain integer instructions in double time, enabling a Pentium 4 processor 2.20 GHz to perform these operations at a full 4.40 GHz. This speeds throughput and minimizes response times for a variety of applications, including security-related computations, which are typically integer intensive.
- Hyper-pipelined technology breaks operations into smaller parts, enabling today's industry-leading processor clock speeds of up to 2.20 GHz, and laying the foundation for higher frequencies in the future. Together with the Rapid Execution Engine and an Advanced Dynamic Execution unit, these high frequencies drive more operations through the system at a time.

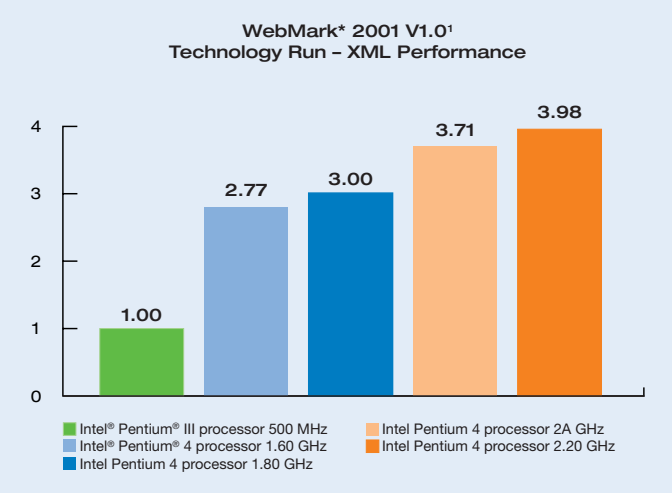

Figure 1: *The Intel® Pentium® 4 processor provides exceptional performance for XML, which lies at the heart of most P2P applications.*

Source: WebMark 2001 Technology Run

[1] Source: Intel Configuration: Intel® Pentium® III processor at 500 MHz – Intel® desktop board SE440BX-2, 128 MB PC100 CL2 SDRAM Intel® 440BX-2 Chipset Platform- Diamond Viper 550/nVidia TNT 2x AGP with 16 MB memory, nVidia reference driver 6.31 with MS DirectX 8.0, 1024x768 at 16-bit color, IBM DTTA-301010 10GB ATA-33 hard drive, DMA on, Microsoft* Windows* 98 SE and Intel® Pro/100+ PCI LAN. Intel® Pentium® 4 processor at 1.60 GHz, 1.80 GHz, 2A GHz, 2.20 GHz – Intel® desktop board D850MD, 256MB PC800 RDRAM –45; Intel® 850 Chipset Platform – IBM* 30GB ATA-100 DTLA-307030 hard drive, Intel® chipset INF file v3.200.1008, Intel® Application Accelerator Storage Driver v1.01, Leadtek* WinFast/nVidia* GeForce*3 4x AGP, nVidia Detonator* 4 v21.81 graphics driver, 1024x768 at 16-bit color, DirectX* 8.1, Microsoft* Windows* XP, 100 Mbps LAN; Intel® C & Fortran compilers 5.01 for SPEC; Intel Pro/100+ PCI LAN

Performance tests and ratings are measured using specific computer systems and/or components and reflect the approximate performance of Intel® products as measured by those tests. Any difference in system hardware or software design or configuration may affect actual performance.

For more information, please see www.intel.com/procs/perf/limits.htm

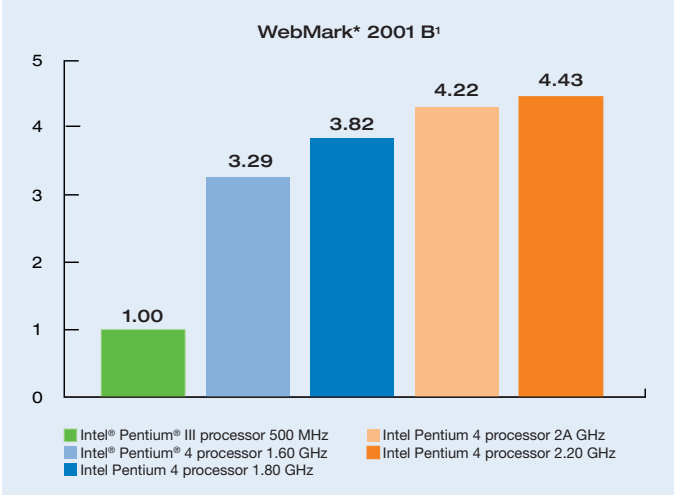

Figure 2: *The Intel® Pentium® 4 processor provides outstanding performance for business-to-business collaboration applications. WebMark* 2001 B models a collaborative environment for producing corporate presentations and documents.*

Source: WebMark 2001 B

Conclusion – Preparing for P2P

The P2P computing model will play an increasingly important role in business computing over the next few years. Applications targeting business customers have already emerged and early adopters are realizing significant benefits. As these applications mature, companies will be scrambling to utilize the enormous collective capacity that currently lies untapped on their employees' desktops.

To stay ahead of the curve, enterprise planners should begin now to assess the potential for P2P applications in their specific business environment. They should also consider the potential of P2P applications when making decisions about corporate desktop acquisitions. A powerful client base is a vital component of an effective P2P implementation. By taking advantage of the high-performance of the Intel® Pentium® 4 processor, companies can enhance employee productivity today, and establish a foundation for P2P applications that will serve them well in the coming years.

For more information on these and other P2P concepts, please visit Intel's Web site at www.intel.com/eBusiness/products/peertopeer/ Also, see *Peer-to-Peer Computing: Technologies for Sharing and Collaborating on the Net*, by David Barkai, available through Intel Press.

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