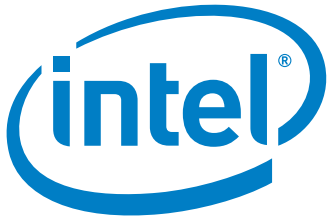

White Paper

Intel Information Technology

Computer Manufacturing

Client Management

Optimizing PC Performance with Simple Benchmarking Processes

Intel IT has developed a PC platform performance benchmarking process that enables us to measure, manage, and optimize our client PC builds from the user perspective, resulting in improved platform performance and more realistic user expectations. Although each generation of PCs is faster than its predecessor, the application loads we place on them increase as well, preventing users from taking full advantage of hardware performance increases. As part of an integrated planning and release process, platform benchmarking helps solve this problem, increasing IT efficiency, productivity, and employee satisfaction, as well as proactive communication with suppliers.

Phil Tierney and Tauben Tenty, Intel Corporation

November 2008

IT@Intel

Executive Summary

Intel IT has developed a PC platform performance benchmarking process that enables us to measure, manage, and optimize our client PC builds from the user perspective, resulting in enhanced platform performance and more realistic user expectations.

We realized it made good business sense to measure results and use those results to set and manage customer and supplier expectations.

Each new generation of PCs is faster than its predecessor; however, steadily increasing core application loads often prevent users from taking full advantage of improved hardware performance. As part of an integrated planning and release process, platform benchmarking helps solve this problem, increasing IT efficiency, productivity, and employee satisfaction.

Employees complained that with the IT build installed, their notebook PCs were very slow. We realized that it made good business sense to measure results and use those results to set and manage customer and supplier expectations.

Using a combination of off-the-shelf benchmarking tools and in-house scripts, our benchmarking suite allowed us to measure the holistic performance of our IT build in the user's environment.

This novel benchmarking approach is significantly different than the typical IT approach to benchmarking, which measures only technical performance components such as floating-point operation speed or graphic performance. Our unique benchmarking suite combines technical performance measures with functional workloads that users regularly invoke.

We have used the data generated by our benchmarking tools to:

- Provide comparable metrics for new build and application generations.
- Create a process for consistently improving application and platform performance, thereby optimizing user productivity.
- Enable clear internal decision making.
- Generate hard data to facilitate communication with third-party application suppliers.
- Quantify and influence user performance perception.

We believe that other IT organizations can similarly benefit by developing a mature integrated planning and release process that actively measures and manages overall platform performance from the user perspective.

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Business Challenge

Intel employees form a diverse group of users but they had a common complaint: New notebook PCs were just as slow as those they replaced, and battery life wasn't improved either. Intel IT responded to these concerns, which resulted from a combination of increasing application load, unrealistic user expectations, and immature build processes.

- **Increasing application load.** PCs get faster with every generation, but IT clients may not fully benefit from these improvements because application loads are increasing as well, as illustrated in Figure 1. We needed a way to optimize our custom IT builds that took into account these increasing application loads.
- **Unrealistic user expectations.** Users' expectations about corporate notebook PC performance are often affected by their experiences with a home system. Without the enterprise overhead, home PCs invariably run faster than work PCs. Users are generally not aware of performance impacts from security software, backup processes, and more; they simply consider their work PC "slow" in comparison. We needed to measure and increase the visibility of the performance impact of various applications to help moderate user expectations, improve

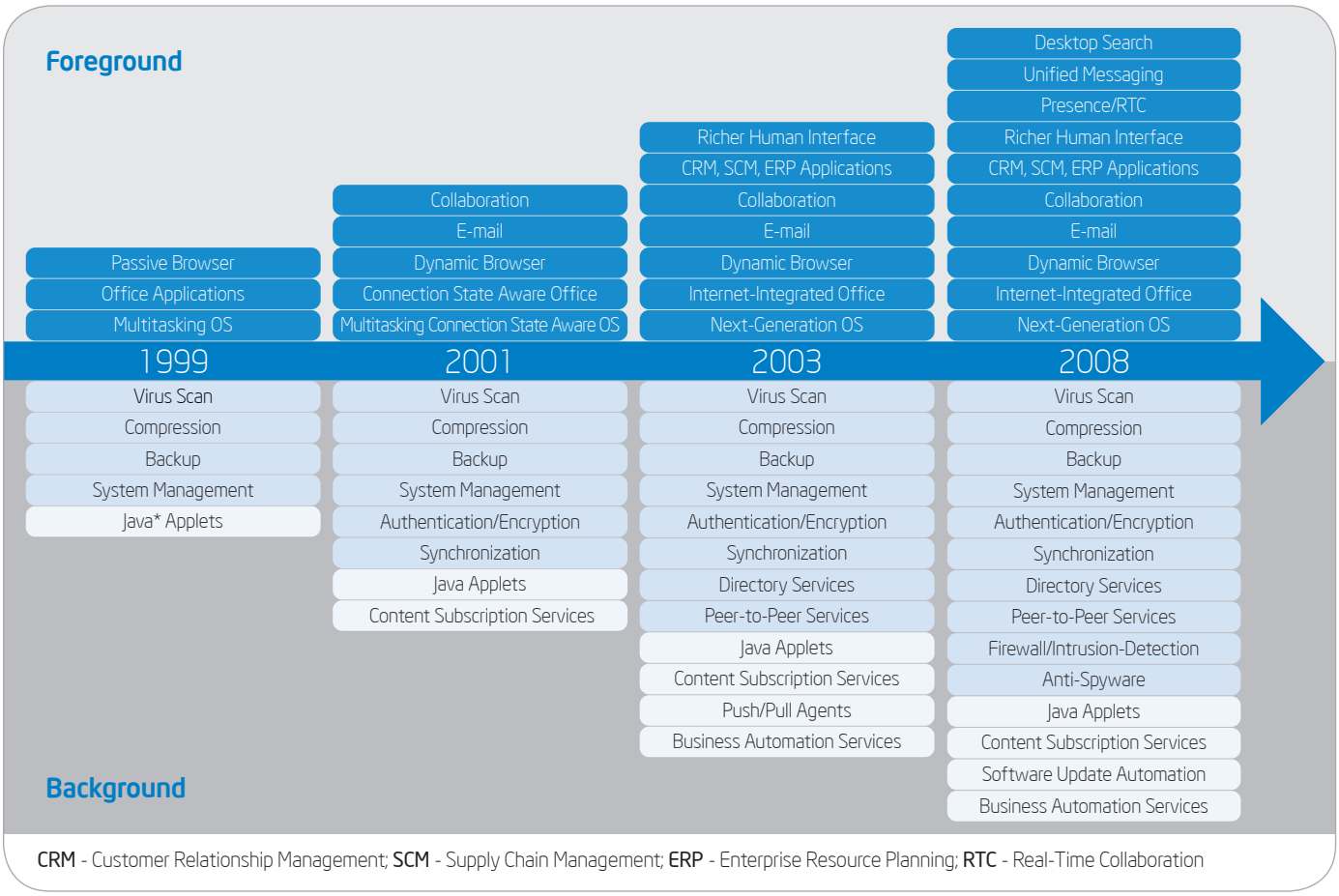


Figure 1. Steadily increasing application loads can significantly offset hardware performance improvements.

their choice of platforms, as well as help us optimize platform performance.

- **Immature build processes.** Historically, we had used a build process driven by events such as adding a new platform to our fleet, rather than putting the build process on a predictable cycle. In response to a platform addition, we would add branching logic to the build that installed required drivers for the new platform. Sometimes we also added patches that needed to be deployed to the build at the same time. We needed a more proactive, synchronized build process that minimized user disruption and increased platform performance.

To improve our fairly random build process, we began releasing builds to Intel users on a ten-week cycle, outlined in the sidebar on page 7. This cycle provided a managed process for testing and validation of released components such as new and updated applications, and gave us an opportunity to release an updated client build, which could include OS, drivers, security and manageability updates, and so on.

Although the new build release process was an improvement, our QA concentrated on the performance of individual applications and didn't measure total platform performance as experienced by our users. To address our users' performance concerns, we needed an integrated planning and release strategy that addressed total workspace performance—performance overhead as well as quality and stability.

Solution

To manage platform performance, we needed a way to consistently measure it from the users perspective. We created a benchmarking process to measure baseline performance, inform our optimization efforts, and manage customer expectations and perceptions. Our benchmarking suite helps ensure that when new or upgraded applications are released, we fully understand any client performance impacts.

Developing a Platform Performance Measuring Process

Our first step was to decide what to measure. Isolated lab tests weren't going to tell us what we needed to know. Instead, we needed to test our builds in the user's environment, with a typical full application load in place. Once we knew what to measure, we could turn our attention to developing a suite of benchmarking tests that would produce informative data. This data, in turn, would help us improve platform performance, make better internal decisions, and educate users about performance tradeoffs.

Defining the Client Experience

We wanted to focus on our users' experience, testing what they considered important from a performance perspective. We analyzed what our users do on a daily basis, and came up with the following performance criteria:

- System responsiveness
- Processing capability
- Stability
- Battery life

Our users' activities fell into three main groups:

- **Office productivity software** including word processing, spreadsheets, presentation, Internet browser, and so on

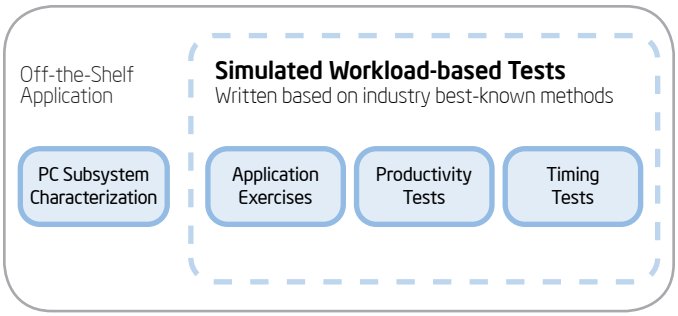


Figure 2. The benchmarking suite is a combination of off-the-shelf applications and scripts developed in-house.

- **Background processes** such as a host-based intrusion prevention system (HIPS) and upgrade/patch software
- **PC power activities** such as turning the PC on and off and going into standby or hibernate modes

Defining the Client Benchmarking Suite

To measure platform performance, we decided on a combination of off-the-shelf performance testing software and internally developed scripts, as shown in Figure 2.

We developed a four-part process that would provide a measure of platform performance including:

1. **Preparation** (manual operation)
   - Connect client to network.
   - Ensure system meets minimum security requirements and install a standard OS and application payload package. On a second pass, add new software, remove software, or change some system configuration to test performance impact against benchmark.
   - Open and synchronize e-mail application.
   - Disconnect client from network.
2. **Technical characterization** (uses industry-standard benchmarking software to record the configuration information of the PC being tested)
   - CPU
   - Hard disk
   - Memory
   - Graphics processing unit (GPU)
3. **Productivity tests** (uses automatic scripts, with an average of six runs)
   - Word processor crunch test
   - Spreadsheet crunch test
   - Presentation software load test
   - Internet browser load test
4. **Timing tests** (uses a combination of automatic and manual scripts)
   - PC startup
   - Hibernate
   - Standby
   - PC shutdown

To simplify comparison of various platforms, we calculated an overall Performance Specification score, which is a composite of the technical characterization, productivity tests, and timing tests.

Benchmark results were automatically uploaded once the tester had reconnected the machine to the Intel network. We manually compiled results into spreadsheets for evaluation.

In addition to the variety of in-house and third-party scripts and applications, the benchmarking suite also had the capability of running engineer-developed scripts, which can be included in result outputs. Furthermore, by connecting to a database that hosts shared scripts, engineers could share their scripts with one another.

Testing Methodology

In our initial testing, we chose several key applications based on their ease of evaluation and Intel's current corporate focus. We tested these applications in the standard Intel IT build on about a dozen different notebook models and on several different Intel® architecture-based platforms. We also tested them in an OEM build environment that included a suite of typical productivity software plus antivirus software, along with the latest patching from autoupdate services.

To determine the performance impact of a particular application, the tester removed the application from the client during Step 1 (Preparation) of the benchmarking process, after the network had been disconnected. Only the application under evaluation was removed. The benchmarking process then continued. At the end of the test, the platform was rebuilt or restored.

Due to differences in tester speed during manual test operations and other factors, the data we collected had an error margin of +/- 5 percent.

Intel IT's 10-Week Build Process

Benchmarking is just one part of a more rigorous integrated planning and release process intended to manage impact on users, help ensure quality, improve decision making, and reduce IT operation total cost of ownership (TCO). As part of the QA portion of pre-release, benchmarking enables us to quantify impacts on platform performance, providing genuine "performance management by design."

Our synchronized 10-week build process, detailed in Figure 3, allows us to:

- Reduce communication e-mails to our users by 30 percent.
- Find and fix more defects in less time.
- Deploy each build release to mesh with the 87 enterprise products now in production.
- Integrate users into the release, where their feedback drives product, training, and communication changes.
- Generate useful data that can drive internal and external product changes.

Controlled releases backed by communication and training, along with customer sponsorship, have resulted in improved adoption levels and productivity benefits.

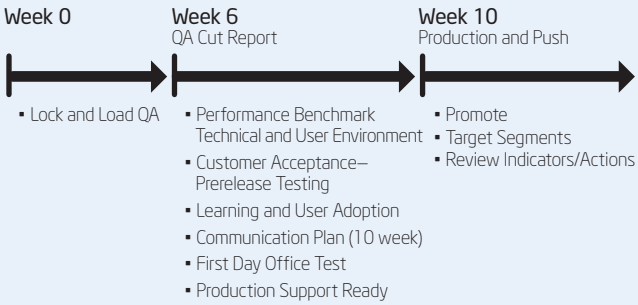


Figure 3. An organized, 10-week build cycle provides a controlled environment for our platform benchmarking efforts.

Analyzing Performance Data

Our benchmarking process allowed us to measure our performance overhead as well as pinpoint where much of this overhead was coming from.

User complaints about the slowness of systems with the IT build turned out to be right on target: The systems we gave them were on average greater than or equal to 33 percent slower than the same systems without our IT build, as shown in Figure 4.

Benchmark tests also revealed:

- HIPS was responsible for an average 11 percent negative performance impact.
- The patching/update application negatively affected platform performance by an average of 9 percent.
- A popular digital media player decreased battery life by 20 percent and negatively affected platform performance as well.

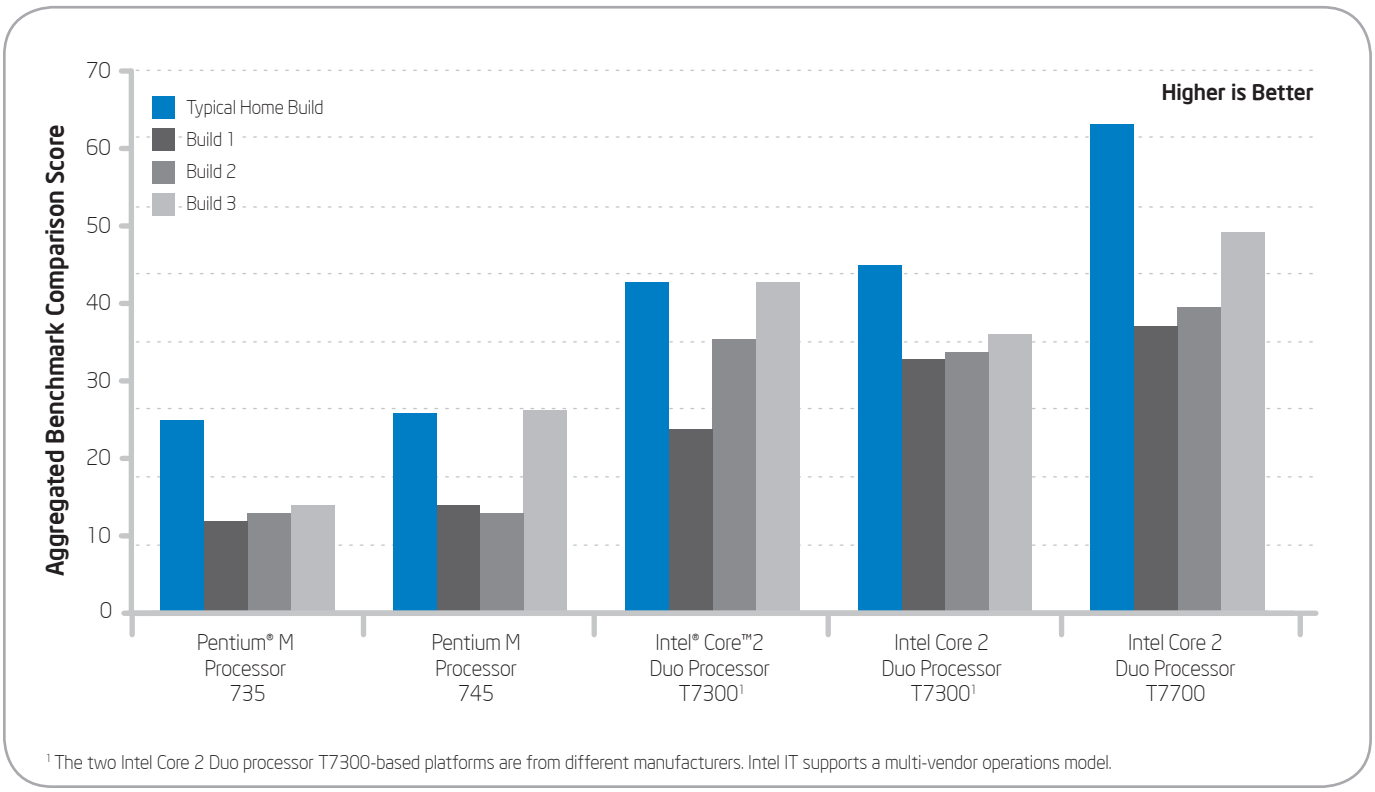
We also noted that as a platform build ages, performance decreases. For example, on one notebook, we saw a negative 7.6 percent difference between the build's performance when new and after it had been in use for three months.

Improving Platform Performance

This type of data suggests that it is imperative that IT organizations begin not only to understand the performance impact of build components but also make mid-life platform maintenance a priority.

To this end, we have implemented a three-phase plan to reduce IT build performance overhead to 10 percent by completing the following steps:

- Inventory all application overhead.
- Fix the easiest problems first.



[1] The two Intel Core 2 Duo processor T7300-based platforms are from different manufacturers. Intel IT supports a multi-vendor operations model.

Figure 4. Benchmark analysis showed that the enterprise build added significant performance overhead compared to a typical home build.

- Test the network effect—our current data is gathered while the client is disconnected from the network.
- Test aged builds.
- Push the use of our benchmark tools earlier in the development process so they are in use six to eight months before software is released to users.
- Qualitatively work with independent software vendors (ISVs) to resolve identified application performance issues.
- Use benchmarking results to better evaluate and compare new corporate application solutions before purchase.
- Share and compare our findings with the industry with a focus on how we can become more efficient.

Table 1 details the first two phases, along with their realized performance overhead impact. Optimization Pack (OP) 1 resulted in an average 8 to 12 percent reduction in IT build performance overhead, and OP2 delivered an average 12 to 15 percent reduction.

In the third phase of our benchmarking plan—OP3—we will implement supplier recommendations and enterprise monitoring as well as fine-tune builds based on OP1 and OP2 results. We expect to reduce IT build performance overhead by another 5 to 10 percent.

Table 1. Overhead Reduction Strategy

Optimization Pack (OP)	Tasks	Impact on Performance
OP1	▪ Client network tune up ▪ Cleanup ▪ Shutdown optimization ▪ Page file defragmentation ▪ Anti-virus tune up ▪ OS tune up ▪ Reconfiguring or removing services ▪ Power profile optimization—adaptive optimized ▪ Patch and update tune up ▪ Internet browser tune up ▪ Client exception and performance monitoring	Average 8 to 12 percent reduction in IT build performance overhead
OP2	▪ Client routine maintenance tasks ▪ Client disk defragmentation ▪ Productivity software suite tune up ▪ Boot process sequencing ▪ Disk file location optimization ▪ Host-based intrusion prevention system (HIPS) tune up ▪ Manageability cleanup—removal of superseded patch uninstall files	Average 12 to 15 percent reduction in IT build performance overhead

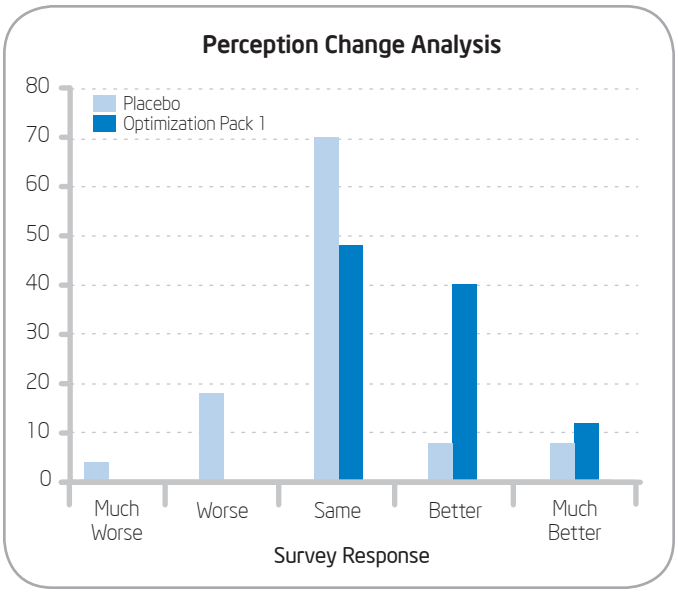


Figure 5. Perception change analyses allow us to measure the effect of performance optimizations. "Placebo" represents the original, unimproved build. Users were told they had received a performance pack update when, in fact, they hadn't. "Optimization Pack 1" represents the build with a performance pack update.

Business Benefits

Our benchmarking data had several business benefits.

Managing User Expectations

We shared the data we collected with users and showed them where performance tradeoffs could be made. We used perception change analyses to monitor client satisfaction. Figure 5 shows the results of one such analysis.

We also engage in dialogue with users through Intel IT social media blogs. By the nature of their job roles, segments of our user base are very knowledgeable on topics such as code optimization, power state optimization, and more. Using the blogs, we are able to converse with these experts and other interested parties. Inevitably, we found common areas of concern, which in turn became focus areas.

Blogs transform what was once anecdotal feedback about PC performance into positive discussions that help us reach conclusions on the root causes of problems more quickly. Blogs also involve users in early release software appraisal and perception surveying to support our benchmarking and performance analysis—all of which help users feel IT is actively working with them to improve performance.

Enhancing Supplier Dialogue

We also used our data to encourage ISVs to fix performance issues with their software. For example, we worked with one leading vendor to make their software more power-state aware, lowering the number of CPU spikes that cause increased battery drain.

Improving Internal Decision Making Process

Another benefit of gathering platform performance data is that it enables us to make more-informed decisions. For example, we can benchmark new solutions against each other and choose the one that offers the best combination of performance and functionality.

Using benchmark data also helps users make better, more knowledgeable decisions about which PC format and configuration will work best for them.

Conclusion

We must run Intel IT like any other business: measure results and use those results to set and manage customer and supplier expectations and improve service levels. A holistic approach to platform performance benchmarking and optimization has resulted in the following benefits:

- Enables better, more informed decision making for client management.
- Optimizes user productivity by implementing improved, measurable client system optimizations—resulting in enhanced stability, responsiveness, and battery life.
- Provides a discussion point for third-party software, helping to differentiate third-party solutions, drive improvement from ISVs, and identify conflicting or poorly interacting applications.
- Provides a clear performance differential to help manage customer expectations and help users select an appropriate platform.
- Allows us to track fleet performance as a platform ages in environment.
- Provides an opportunity to benchmark with other IT organizations.

We believe that other IT organizations can similarly benefit by developing a mature, integrated planning and release process that actively measures and manages overall platform performance—not just isolated aspects of performance—from the user perspective.

Author

Phil Tierney is an enterprise architect and client benchmark program manager with Intel Information Technology.

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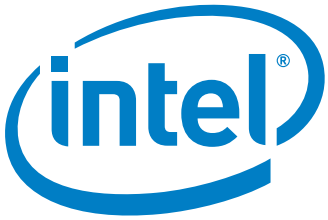
Acronyms

GPU	graphics processing unit
ISV	independent software vendor
OP	Optimization Pack
HIPS	host-based intrusion prevention system
TCO	total cost of ownership



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