Using TCO to Determine PC Upgrade Cycles

When do rising support costs eclipse the savings from making the PC purchase last as long as possible? At Intel, we've developed a comprehensive methodology, based on total cost of ownership (TCO), that lets us calculate the real cost of operating more than 90,000 PCs. Using it, we can understand the real cost of deploying and maintaining PCs across varying time horizons.

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Executive Summary

Intel IT and Intel Finance have developed a comprehensive total cost of ownership (TCO) methodology that lets us calculate the real cost of operating more than 90,000 PCs.

We've been tempted to reduce expenditures in the short term by delaying PC upgrades to replace older models, also known as a "PC refresh." But we also realized that we didn't understand the full implications of such a move.

We needed to understand PC costs over time. Standard return on investment (ROI) analysis didn't help, because the question with PC refresh isn't if you should replace an aging PC but, instead, when should an aging PC be replaced?

We turned to an equivalent annual cost (EAC) method that let us account for the variable timing of modeled costs. We considered the costs associated with PC deployment, usage, and retirement. By calculating these costs across the specific life spans of PCs, we were able to arrive at an effective and valid comparison of refresh cycle options. Our analysis shows that our recommended PC refresh rate is about three-and-a-half years.

The new model provides several key benefits:

- Provides a holistic understanding of our PC costs, which improves our decision making.

- Allows us to explain the dynamics of PC costs in a clear and understandable way.

- Offers the flexibility necessary to perform "what-if" and sensitivity analyses. We can insert assumptions about costs and view their effects on overall TCO.

- Provides a solid baseline on which future cost metrics can be developed.

We continue to use and update the tool to improve our PC management practices and strategies.

"The Return on Investment for PC Refresh," featuring John Mahvi

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Business Challenge

Intel IT is a centralized, worldwide information technology organization, serving Intel's nearly 90,000 employees and contractors, and adding value to the overall business through the deployment and management of technology solutions. We manage thousands of desktop PCs, mobile PCs, and servers.

Our IT managers needed to find ways to trim spending while maintaining an effective operation. One suggestion: To delay the scheduled deployment (refresh) of new PCs in order to put off capital expenditures and other costs.

Yet at the same time, our chief financial officer had made it clear that long-term conservation of capital was a key objective. Any program we adopted must optimize cash flow over time.

Meeting those operational objectives led us to closely examine the true total cost of ownership (TCO) of PCs in the enterprise. And although delaying PC purchases would conserve cash in the short run, we suspected this move might actually be more expensive in the long term, producing a higher total cost of the life of a PC.

We knew that delaying a PC refresh would save money normally spent on acquisition and deployment, while increasing the costs for maintenance and support for the older systems. But we weren't sure when we'd reach the point of diminishing returns. When do rising support costs eclipse the savings from making the PC purchase last as long as possible?

A sound TCO analysis could help us justify and optimize our business decisions. This is especially critical during a rapidly shifting business climate.

Solution

If we were to gain a clear picture of how PC refresh cycles impact TCO, we needed a methodology that accounted for the variable costs of managing PCs over time. We believed that incorporating discounted cash flows within a TCO approach could help us find the perfect PC life cycle replacement timing, in which real costs are minimized.

Of course, the new system had to do more than simply add up static line-item costs. It needed to adjust costs based on the dynamics of two-, three-, four-, or five-year replacement cycles. Such a holistic, time-based TCO methodology would yield a true TCO figure based on the life cycle of the PC.

So we set out to define a new, comprehensive cost methodology that recognized the timing of costs and the trade-offs between different refresh options. The system we developed needed to incorporate three critical capabilities:

- Recognize and reflect the timing of cost elements.

- Enable comparisons among different refresh options.

- Involve key stakeholders in the process.

Which Costs to Consider

We mapped cost components into the PC life cycle by segmenting them into deployment, usage, and retirement stages, which helps uncover cost dynamics at each stage of the PC's life at Intel.

- **Deployment.** This segment includes the buy-and-build expenses associated with procuring the PC and deploying it into our environment. This includes the purchase price, procurement expenses, hardware configuration, software image engineering, software build, and initial end user training.

- **Usage.** We incorporate during-the-life-cycle costs associated with managing the PC and keeping the end user productive. Relevant components include help desk support, patch management, break-fix repairs (particularly out-of-warranty repairs), deskside support, asset management, and inventory.

- **Retirement.** As the system nears the end of its useful life, we incur additional costs connected to end-of-life, or the disposing of each PC in an environmentally responsible way. Note that this category can actually be a cost recovery, should the liquidation value of the PC exceed the expense of retiring it.

We consider the following life cycle cost components at Intel:

- **PC purchase price.** This includes delivery to the facility.

- **Training (per new PC).** The cost to train users on the new PC.

- **PC engineering (per new PC).** The cost to create any builds, patches, and images for the new PC, including the OS and standard software applications.

- **PC deployment and logistics (per new PC).** The cost to deliver PC hardware and all associated software to the end user's workspace; includes the cost of loading the software build onto the PC.

- **PC peripherals.** The cost to replace add-on devices, such as cords, monitors, keyboards, batteries, and docking stations.

- **Software and OS patch deployment.** The cost to create and deliver standard patches to the PC each year.

- **Support (first-level help desk and second-level deskside).** The average annual cost to support one PC user annually.

- **Out-of-warranty repair—years four and five.** The cost for break-fix repair after the standard three-year warranty period ends.

- **Retrieval and disposal costs (last year of life).** The cost to remove the PC from the user's workspace and dispose of it.

▪ Disposal cost recovery (last year of life). Funds received as a result of the residual value of the PC when it's disposed of.

Understanding and comparing the timing of costs was one of the most important objectives of this exercise. Many cost components in the usage stage tend to increase as the PC ages. For example, costs related to patch management, break-fix, and help desk usage generally increase significantly over time.

Planning Ahead For the Optimal PC Configuration

One of the most challenging impacts to productivity is an underpowered system that hasn't yet reached its refresh time. We've found that properly scaling the capabilities—such as memory, storage, CPU, and network connectivity—of the new PC system to meet our end users' needs until the next refresh cycle reduces our performance and productivity issues.

We look at the trends and try to think ahead to consider future needs, which help us make configuration decisions that keep productivity high and avoid expensive mid-cycle upgrades.

In order to reduce complexity, we deploy a limited number of PC hardware configurations into our installed PC base each year. For each PC configuration, we choose stable, industry-standard components that are available for a buying cycle of 12 to 15 months.

Considering Other Effects

Our TCO model focuses on specific hard operational costs, without taking into account soft costs that come from delaying PC refresh, such as increased user downtime, heightened security risks, and missed business opportunities.

However, an important component of PC refresh is to do a separate analysis of the possible business value from soft benefits that might affect our refresh decisions. These soft benefits might include:

▪ Higher worker productivity

▪ Faster response times

▪ Performance headroom for future applications

Other hard effects to consider that weren't part of our TCO model might include:

▪ Improved security (often tied to the upgrade of OSs or security applications)

▪ Simplified systems management

▪ Cost savings from energy-efficient processors and PCs that deliver improved power management capabilities

New technology may have a number of soft benefits compared to the technology it replaces. For example, our user surveys and observational studies have demonstrated that mobile and wireless technologies offer a greater than five-percent time savings in an employee's work week, which more than covers the increased hardware costs of notebook over desktop PCs. We applied the five-percent savings across 6,400 users and realized gains of USD 26 million in business value over a three-year period. This is approximately USD 4,000 per notebook over the life of the PC. Soft effects are significant and may be determining factors when making decisions on when to refresh a PC.

Collecting the Data

An effective TCO model requires solid data. But some costs can be hard to pin down, as our team discovered while collecting TCO data across Intel. We relied on a variety of methods to distill data points from available aggregate data.

Our model needed to support a five-year cycle, but we lacked any actual fifth-year cost experience from which to draw. We needed to find a way to extrapolate existing data to determine per-year costs over longer refresh cycles, so we developed models to project fifth-year costs in areas such as maintenance, support, and system disposal.

We took care when comparing different PC configurations, as some costs can vary significantly between different PC makes and models. We had to be careful not to confuse unusually high support issues for a particular defective PC model with the overall PC population's costs due to aging.

We also found that some expenses are better suited to top-down costing, while others lend themselves to bottom-up costing.

Building a Successful Business Case

Crafting a PC TCO program can be challenging unless participants are adequately prepared. While developing our program, we learned to identify important milestones:

▪ **Identify the stakeholders.** We had to correctly identify those who cared about and would be impacted by the analysis and its conclusions. Anyone with an interest in how PCs are paid for or used was potentially an important stakeholder. Our list of possible stakeholders included finance executives and decisions makers, line-of-business managers, horizontal service groups (for example, sales and customer service), functional groups (for example, manufacturing and engineering), and even internal PC user groups.

▪ **Assemble the team.** At a minimum, the team should include both the IT operations and finance groups. We spent a fair amount of time carefully deciding who would perform the actual analysis.

▪ **Provide a risk summary.** Any decision, including taking no action, carries its own risks. We considered and summarized as many of the operational and business risks of each option as possible.

Adjusting Optimal Refresh Rates

Our TCO model is dynamic. Different variables that affect the PC refresh cycle tend to lengthen or shorten the overall rate. Here are some examples of variables that may affect the optimal refresh rate.

These variables may lengthen the refresh cycle:

- **Acquisition and deployment costs.** Any increase in the purchase price, procurement costs, engineering cost for build, and other overhead.

- **Salvage value.** Increased price per unit for units sold in the aftermarket at the end of the cycle.

- **Disposal costs.** An increase in the cost to remove a PC from the user environment (clean, donate, scrap, or sell).

These variables may shorten the refresh cycle:

- **Support costs (baseline).** Increases in the cost of deskside and call-center support, security patches, and out-of-cycle warranty parts repair.

- **Support cost growth rates (%).** Growth in baseline support cost over time.

- **Out-of-warranty costs.** The out-of-warranty parts costs incurred after a warranty expires.

Top-down costing divides a cost activity across multiple recipients or beneficiaries. For example, our help desk serves many users beyond PC end users, such as server administrators and telecommunications users.

To discover what portion of help desk operations actually involved end users and their PCs, we analyzed call center logs to see how much time was spent on PC-related issues during the year. We then divided the portion of total help desk cost dedicated to PC support by the total number of PCs.

Bottom-up costing applies to the individual PC cost items that clearly belong only to one PC. For example, if a single PC requires an average of 1.5 hours of deskside build time from a technician, then that 1.5 hours of cost is applied directly to that PC. Other bottom-up costs include the cost of the PC itself, the cost to download a single software image, and any required end user training.

We found an unexpected side effect to developing a TCO model with this level of detail: It motivated Intel to prioritize the capture and tracking of cost data. Our forays into precise cost metrics helped uncover previously unseen cost-saving opportunities and further optimize our environment.

Designing the Model

There are a number of possible methodologies to analyze and compare cost structures. At Intel, our IT investment goal is to maximize cash flow over the long run. In this case, we were particularly interested in which refresh rate offered the optimal cash flow.

Typically, we rely on a net present value (NPV) analysis for investment decisions. However, we found that this approach becomes problematic when comparing different refresh cycles and time horizons. Typical IT investment decisions compare whether to invest in a new technology or not. With PC refresh, the question is not "if," but "how often."

We overcame that obstacle by converting the NPVs of each option into an equivalent annual cost (EAC), a common financial method used to compare capital investments with different lifetimes. An EAC is simply an annuity that has the same life and present value as the underlying cost stream. It allows us to take sets of uneven cash flows and convert them into smooth, regular cash flows that can be compared in a valid way.

To create our cost model, we first assembled a cross-functional team drawn from the IT and Finance groups at Intel (for more information, see the "Building a Successful Business Case" sidebar on page 5). Next, we needed to identify and agree on the cost components.

Table 1 shows the model into which we loaded our cost components, which are listed along the left side of the table. Each column represents the individual years of a PC's life cycle; the cost for

Table 1. Cash Flow (U.S. Dollars per PC per Year)

Cash Flow Description	Year 1	Year 2	Year 3	Year 4	Year 5
Notebook PC Acquisition Cost	(1,150)	0	0	0	0
Training	(25)	0	0	0	0
PC Engineering (Build)	(28)	0	0	0	0
PC Deployment and Logistics	(21)	0	0	0	0
Software and Patch Deployment	(15)	(20)	(24)	(30)	(38)
Help Desk Support (First Level)	(20)	(24)	(29)	(35)	(42)
Deskside Support (Second Level)	(67)	(89)	(111)	(139)	(173)
Out-of-warranty Repair	0	0	0	(76)	(132)
Additional Upgrades and Peripherals	0	0	0	(70)	(75)
Retrieval and Disposal Costs	(43)	(43)	(43)	(43)	(43)
Disposal Cost Recovery	778	552	392	278	198
TOTAL	USD (590)	USD 377	USD 184	USD (115)	USD (306)

Ongoing costs such as software and patch deployment increase each year that the PC is in service. Retrieval/disposal costs and disposal cost recovery are incurred only in the final year. Out-of-warranty repair costs emerge as the warranty expires, in the fourth year. (Note: Costs used here are only sample data; costs vary with each organization.)

a component appears in the appropriate year. For example, the PC acquisition cost (we've used a sample cost of USD 1,150) occurs only once, at the beginning of the first year of the PC's life cycle. Other costs, such as software and patch deployment, occur every year.

At Intel, we purchase rather than lease PCs, but the model applies equally well to a leasing scenario. Had we chosen to lease the PCs, our cash flow would have changed from a single instance at the beginning of the period to annual cash flows. The net would be roughly the same, depending on the terms of the lease.

Once we determine yearly costs, we can calculate the EAC for each cost component across specific life cycles. In Table 2, we show the EAC results for notebook PCs over life cycles ranging from one to five years. For example, a three-year life cycle EAC for help desk support is USD 24, calculated from help desk support costs of USD 20, USD 24, and USD 29 (figures drawn from Table 1) for years one, two, and three, respectively. The total EACs for each refresh rate, displayed in the bottom row, are an accurate measure of how much we can expect to spend—as an annual average—over the life of each PC.

Figure 1 offers a much clearer view, plotting the total EAC as a curve. From this analysis, we saw that the optimal refresh rate for notebook PCs at Intel is about a three-and-a-half year cycle.

Results

Our methodology and the resulting PC TCO cost model have significantly impacted systems planning and procurement at Intel. As a result, the way we approach our decision making has changed.

We've refined our insight into PC TCO. Previously, many stakeholders questioned the disposition of cost components in TCO reports, inquiring whether they were properly measured and presented in the model, and even whether some components should be included. By building a model with a clear methodology, and one that is visible to all stakeholders, we can offer an agreed-upon standard for driving PC cost analysis.

We can derive our optimal PC refresh cycle. Often, decision makers commit to a PC refresh cycle based on an intuitive sense of what interval provides the best value. Our cost model provides an agreed-upon basis for this important business decision.

Our analysis, based solely on hard operational costs, led Intel to return to a three-year refresh cycle from longer intervals imposed during the slow economy. The detailed cost model revealed that delaying PC deployments shifted costs into later periods and failed to optimize cash flow from a discounted cash flow perspective. The short-term gain in the current period was simply not enough to merit the prolonged lifecycle.

Table 2. Equivalent Annual Cost (U.S. Dollars, by Refresh Rate)

Cash Flow Description	Year 1	Year 2	Year 3	Year 4	Year 5
PC Acquisition Cost	1,150	589	402	309	253
Training	25	13	9	7	6
PC Engineering (Build)	28	14	10	8	6
PC Deployment and Logistics	21	11	7	6	5
Software and Patch Deployment	15	17	19	22	25
Help Desk Support (First Level)	20	22	24	27	30
Deskside Support (Second Level)	67	77	88	100	113
Out-of-warranty Repair	0	0	0	18	38
Additional Upgrades and Peripherals	0	0	0	16	27
Retrieval and Disposal Costs	43	21	14	10	7
Disposal Cost Recovery	(778)	(269)	(124)	(65)	(36)
TOTAL	**USD 591**	**USD 495**	**USD 449**	**USD 458**	**USD 474**

The equivalent annual cost chart provides a valid comparison for PCs held over different life cycles. (Note: Costs used here are only sample data; costs vary with each organization.)
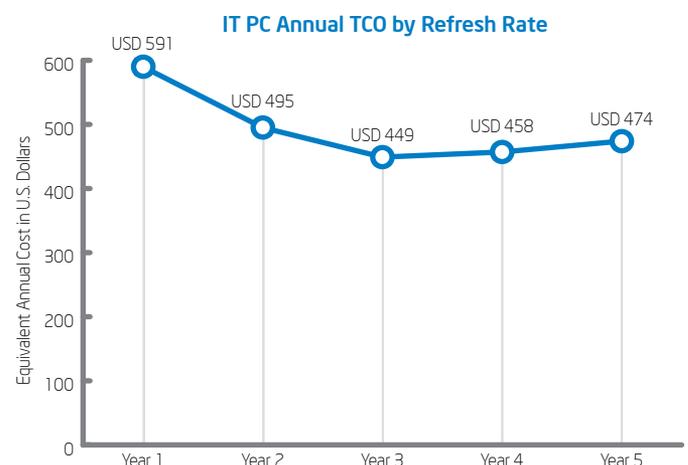

IT PC Annual TCO by Refresh Rate

USD 591 — Year 1
USD 495 — Year 2
USD 449 — Year 3
USD 458 — Year 4
USD 474 — Year 5

Equivalent Annual Cost in U.S. Dollars

Figure 1. At Intel, PCs deployed on a three-and-a-half-year cycle offer the lowest total equivalent annual cost. By delaying PC replacement until Year 4, for example, the equivalent cost for a PC over the course of four years rises to USD 458 per year. (Note: Costs used here are only sample data; costs vary with each organization.)

Dynamic cost inputs deliver flexible analysis. By changing cost component data points, our managers can easily perform "what-if" and sensitivity analysis. For example, lowering a PC's deployment cost shifts the cost curve (shown in Figure 1) to the left, and our cost methodology can show exactly how much money that will save.

Managers can also model trade-offs—such as bearing a higher procurement figure in order to obtain technologies that lower ongoing patching and help desk costs. The model can even examine the impact of outsourcing the PC help desk.

We now have a solid baseline to develop future cost metrics. Normally, technology improvements help reduce TCO. However, changes to our installed base—for instance, deploying wireless-enabled mobile PCs—may offset an increase in TCO with significant business value. Our PC TCO model provides an effective method of measuring the cost impact of the proposed change.

Conclusion

Developing the PC TCO model has yielded a number of benefits to Intel. It has also produced valuable insight for members of Intel's IT and executive management groups alike.

Benefits include:

- **A comprehensive cost model.** Decision makers appreciated that the cost model we developed accounts for all life cycle costs and their timings. The model has greatly increased management's confidence in our life cycle recommendations.

- **A simple way to compare EAC.** Our decision makers found this method to be very straightforward and quickly trusted the cost figures the model produced.

- **Improved cost tracking.** Developing our life cycle TCO model forced us to make the most comprehensive examination of cost components ever performed at Intel, helping us identify areas that needed improved tracking and analysis.

We've found that our PC TCO model gives us the information we need to evaluate the true cost of our PCs to determine their optimum refresh rates. We continue to use and update the tool to improve our PC management practices and strategies.

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Acronyms

EAC	equivalent annual cost	ROI	return on investment
HDD	hard disk drive	SSD	solid-state drive
NPV	net present value	TCO	total cost of ownership