

## WHITE PAPER

# Untethered Computing: Feasible, Economic, and Desirable

Sponsored by: Intel Corporation

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January 2003

### A VISION OF MOBILITY TAKES CONCRETE FORM

For a long time, road warriors and other mobile professionals have sought to liberate themselves from their dependence on connections in order to be more productive and have a truly mobile office that allows them to compute anywhere. Although these types of highly compensated workers have been the driving force behind the increasing demand for greater mobility, a much broader base of workers could benefit from it. The arrival this year of Intel's Centrino mobile technology with integrated wireless will enable a new level of computing utility that will help realize this dream of mobility.

The age of truly untethered computing is dawning. Users will be able to move around from place to place, unfettered by wires, computing when and where they want. The two umbilical cords — AC power and data communications — that have heretofore connected a computer to a particular location will finally be cut. With Centrino's better power management, which enables increased battery life, the system will offer more battery life per session, even with the embedded wireless connection operating. By implementing only features that meet a demanding combination of requirements for battery-saving technologies and greater performance, Intel has produced a platform designed for mobility. This design includes minimizing the overall physical and thermal envelope and adding the necessary security to protect wireless connections from intrusion.

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### MODELING THE COST SAVINGS AND BENEFITS

Although quantitative assessment turns up cost savings and benefits both large and small, the most important metric in terms of the design's relevance to the enterprise turns out to be extending worker productivity. While the benefit of increased productivity accrues most obviously to the elite cadres of highly compensated mobile professionals — top executives, road warriors, corridor cruisers, and sales and management personnel who manage many tasks and are highly mobile — everyone in the organization can derive a degree of value from the productivity benefit.

Centrino mobile technology has benefits along four vectors:

- Longer battery life — All processing functions are optimized for low power consumption.
- High performance — A balance is struck between platform performance and power consumption for every desirable feature.
- Wireless communications — The integrated wireless LAN component makes efficient use of power for this key mobility-enabling function.
- Smaller form factor — Lower power use also allows smaller envelopes, enhancing mobility across all form factors from mainstream notebooks to ultraportables and tablet designs.

## M E T H O D O L O G Y

Given these four vectors, we modeled some of the direct costs and benefits of Centrino-based PC clients with simple assumptions.

## F I N D I N G S

From this exercise, we concluded that Intel's Centrino mobile technology offers clear value to commercial organizations. Economic impact runs from minimal, such as energy cost savings, to maximal, such as the potential value of lost intellectual property. The most compelling economic argument, however, can be made in the productivity arena. The opportunity for savings for mobile professionals is most obvious, but similar benefits, albeit at a lower level, also accrue to ordinary office workers.

In addition to the quantifiable benefits, there are several other substantial qualitative benefits offered by the technology, including:

- The untethered lifestyle
- The ability to attract and retain skilled employees
- The opportunity to take advantage of the growing wireless ecosystem

### **MOBILE PROFESSIONAL PRODUCTIVITY MODEL**

We start off with a fully loaded salary of \$125,000, a compensation package expected for a highly mobile, productive individual. Included in this category are traditional top management and sales positions. Despite the perception that mobility allows you to work at all possible hours, the calculation is made conservatively, using an eight-hour, five-day basis, and an assumption of 22 workdays per month. Thus, standardizing on 2,112 hours per month yields a productivity potential of \$59.19 per hour.

One of Centrino's key advantages is its enabling of longer battery life without sacrificing performance. This ability to add hours to a computing session opens up the potential for measurable productivity increases, particularly on long airplane flights, the chief locale of sustained untethered computing today. The Centrino advantage is calculated at one additional hour per leg of the trip. A trip is assumed to have two legs (out and back), and thus the savings per trip is two hours. Using an assumption of four such trips per month would lead to eight hours total additional productivity per month, valued at \$473.48. This gain, although modest in some ways, easily justifies a \$2,000–3,000 purchase of a productivity tool such as a mainstream notebook or ultraportable.

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Although it is clear that initial form factors and adoption will be at the high end, mainstream adoption is not likely far behind.

## **MAINSTREAM WORKER PRODUCTIVITY MODEL**

As mobility becomes more of a requirement for many categories of workers (e.g., moving from place to place within a company while remaining connected as well as working at home), they will increasingly become candidates for Centrino-based systems.

Office workers are unlikely to travel as often as upper management or sales professionals, but some do have opportunities for increased productivity, typically moving from work area to work area within a campus. One of the interesting effects of increased mobility will be to extend work areas. As a result, office workers won't have to gather around a network cable or compete for the two available in the conference room. They can collaborate in any conference room, atrium, or hallway area, or even in the middle of the cafeteria. Using, then, the same assumptions about hours worked per month and a fully loaded salary of half that of an executive manager and an increased productivity of, again, half the number of hours of the mobile professionals, still yields additional productivity of \$118.37 per month or \$1,420.45 per year per employee.

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Now, the value proposition for mainstream adoption becomes one notch more convincing when you add the fact that there are more people in the lower part of the hierarchy. So, even if the per-worker savings isn't as great as it is for upper management and sales, there are more workers, adding up to a total pool that is in fact larger. If we assume that an organization has 10,000 seats and 10% are mobile professionals, then the annual value of additional productivity for the mobile professional group is \$5,681,818. The annual productivity value for the worker population is \$12,784,091, or more than twice as great. This benefit is substantial enough to warrant serious consideration when weighing Centrino-based systems for mainstream adoption.

Thus, based on modeling, productivity alone — up and down the management line — appears to justify the purchase of Centrino-based notebooks. In addition, mainstream workers are more likely to do some computing on their own time if they have an easy, convenient means of doing so.

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As another point of reference on worker productivity, Intel's IT department did some return-on-investment (ROI) studies on the deployment of wireless infrastructure throughout the company. Using a sample of 160 people, the IT department studied the changes in its behavior against known costs, using activity logs, usability testing, and formal interviews as input data. Using a discounted cash flow model and adjusting user perceptions about productivity downward for conservatism, Intel found that ROI increased with building size; that is, the larger the building, the more people could take advantage of the same wireless infrastructure. In the end, Intel calculated that the productivity savings were great enough to offset the cost of investment over a three-year period such that break-even was achieved with only 11 minutes per week of additional productivity per employee.

## **ENERGY COST MODEL**

Here, we start with the same assumption as the last model, taking as a given that unconnected time can be increased by up to eight hours per month. We estimate at \$2 the monthly electrical cost of running a notebook on a heavy schedule.

If the time savings is eight out of 176 working hours per month, then we can derive a proportional cost savings of 4.5%, which translates to \$0.09 per month or \$1.09 per year.

Thus, it seems that the electrical savings is really very small. Even if Centrino allows more untethered computing, the savings in electrical cost is too small to be significant in the decision process.

## ***COST OF SECURITY BREACH OF WIRELESS INFRASTRUCTURE MODEL***

At the other end of the spectrum lies the potential cost of lost intellectual property. If a malicious hacker is able to sniff the data going over an insecure wireless network, then the loss could be astronomical.

Let's assume a model in which the likelihood of the wrong information getting into the wrong hands is extremely low. The more likely scenario is that a hack would be by a random bad guy who might or might not destroy your software stack, but who was unlikely to be after your innermost secrets. Now, some hacks are highly targeted (e.g., those mounted by intelligence services against specific individuals), but most are crimes of opportunity, in which hacker and hackee are not matched for any particular reason. So, our model envisions high negative payoffs at low probabilities and gives the loss an "insurance" value, which is simply the product of the risk and the value of the loss.

For dramatic effect, we use as an example the value generated by the PC industry since its inception, assuming that the existing players might not have reaped this value had their trade secrets been stolen at the beginning. Measuring the future value of an industry as its total stream of present and future profits, discounted over time back to the present moment, we can get a rough estimate of what kind of value we're talking about.

Since its inception, the PC industry has generated revenue of around \$2 trillion, which, when discounted at 10% as a stream of future payments, was worth more than \$565 billion in 1981. At an average margin of 10%, that would be \$57 billion in profits over 20 years or so. Had that intellectual property been lost at the beginning, companies would have had to forego, let's say, half that stream, or \$28 billion.

The chances of losing \$28 billion are remote, but not infinitesimal. So, we assume 1%. Thus, a fast-moving, lucrative industry could expect the "insurance" value of protecting against this breach to be \$280 million. That figure is, of course, a theoretical maximum in an industry where all the profit is derived by a single company. A more realistic view would say that the loss to any given individual company in that industry would likely be one-hundredth that value, or \$2.8 million.

This exercise may be highly theoretical, but it is valuable in giving a first approximation of the potential value of lost intellectual property, which could be huge. Although the loss is fairly unlikely, targeted attacks against the wireless infrastructure could be successful against unprotected targets. Thus, a company should be willing to spend potentially hundreds of thousands of dollars to protect against this potential loss.

One of the key goals of Centrino mobile technology is to ensure that data cannot be intercepted over the airwaves. Clearly, if mobile professionals are going to be communicating more and more over wireless links, then a secure digital link is going to become increasingly important.

As a kind of end note on security, it is worth pointing out that there is also a potential business-continuity savings in deploying wireless notebooks. When users have notebooks instead of desktops, they tend to take them home. If some disaster happens at the corporate site, and the workers can't get to their workspaces, they still have their computing plants with them.

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### **CORPORATE SOFTWARE IMAGE STABILITY MODEL**

Because Centrino will be a long-lived platform that will enable organizations to forego some or their normal image qualification, there is a savings to be gained by moving to the new platform.

If we assume that the requalification process (a so-called "image break") costs \$6,500 per image and that a company has on average 80 images, then the cost of a break is \$520,000. The savings of even one less image break in a four-year life cycle would be one-fourth of that figure per year, or \$130,000.

Thus, Centrino can contribute substantially to image management savings.

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### **COST SAVINGS ON TECHNICAL SUPPORT CALLS MODEL**

Because of the robust integration of wireless elements in Centrino, corporations will be able to rely on the wireless stack as they roll out wireless to their populations. Wireless compatibility, stability, and interoperability, in both 802.11 and Bluetooth environments, will be achieved through validation of the whole stack, which Intel has undertaken as part of its development and deployment efforts.

At \$25 per service call in an organization of 10,000 seats, 15–25% of which need help with wireless in a given year, the annual savings from a more stable wireless stack would be \$37,500–62,500, or \$3.75–6.25 per seat overall and, of course, \$25 per seat for the calling population. Adding an hour of lost productivity to these figures yields low and high savings estimates of \$33.34–65.44.

While these savings are not all that substantial, they do represent one more reason to purchase Centrino-based systems.

### **PREINSTALLATION SAVINGS MODEL**

Another model assumes that companies will eventually go wireless, and if they have preinstalled the wireless clients, then they achieve a savings over the retrofitting scenario. As a company adds access points, the preinstalled clients become more valuable because they can be used in an increasing number of locations. Because wireless is built into Centrino, the cost is assumed to be zero for the preinstall alternative. Against this figure is weighed the \$60–80 street price of a wireless LAN card. The retrofit scenario includes the cost of the card plus a \$25 telephone service call or a \$100 onsite service call plus the loss of one hour of productivity during the service call. Calculating low and high values based on the cost of the card, the type of service call, and the productivity value of the worker yields a savings of between \$144 and \$210 per seat.

### **WIRELESS AS A RECRUITMENT HURDLE MODEL**

The new technology may even have personnel implications; that is, companies may be better able to attract and retain key personnel by providing Centrino-based systems.

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If professionals on the cutting edge begin to expect a mobile wireless notebook as a productivity tool, then the lack of such a tool could cause defections. To model the value of this potential loss, we assume the departure of two professionals per year for lack of wireless infrastructure. Costs involved include the direct loss of productivity plus the cost of replacement.

Recruitment via a headhunter costs on average 25% of the fully loaded, first-year salary. At \$125,000, the same cost used in prior models of mobile professional salaries, that fee would amount to \$31,250. The loss of two professionals per year would thus be \$62,500 per year. To that figure must be added the value of a half a month's productivity lost in transition, or \$5,208 per departure. At two departures per year, that figure would be \$10,416 per year. Together, these two costs add up to almost \$73,000 per year in lost productivity and recruitment.

A truly mobile platform helps employees balance their work and life and can lead to a reduction of stress and greater retention. People who are wedded to their personal hardware have a tendency to stay with their jobs.

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## QUALITATIVE BENEFITS

The rest of the models in this study do not fit easily into quantitative models, but their inclusion is nonetheless materially important because, over time, one of them may in fact overshadow the more concrete models as reasons to buy Centrino-based systems.

### **ECOSYSTEM ENABLING**

The value of Centrino and mobile platforms in general will increase as the wireless infrastructure gets built out. We are currently in the phase of industry development analogous to the period when gas stations first made long-distance travel in private automobiles possible. Although ultimately thousands of entrepreneurs invested in gas stations and other aspects of the transportation infrastructure, the oil, steel, rubber, and auto industries as well as various governments had to invest initially in order to make the infrastructure robust and ubiquitous. Once there were enough gas stations out there, people began to buy cars with the expectation that they could drive them pretty much anywhere.

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In the case of wireless, investing in hotspots and in the platform helps enable the ecosystem, which will drive the industry forward. As in the days of the early cell phone industry, large players are seeding the territory with devices, infrastructure, and services. The result will be that fairly soon hotspots — places where any subscriber with a legitimate account can hop on an 802.11 wireless connection and be on the Internet in a matter of seconds — will be sufficiently omnipresent so that users will be able to wander in and out of various LANs with ease. This planting of hotspots with increasing density will ultimately create a "warm fabric" of network connections so that users will rarely be out of touch.

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Two groups currently investing in this warm fabric are Cometa Networks and Toshiba America Information Systems.

Cometa is a partnership among venture firms 3i and Apax Partners and industry leaders AT&T, IBM, and Intel. Cometa has been set up to be a wholesaler of high-speed 802.11 wireless data services. The consortium plans to provide services to telecommunications companies, Internet service providers, cable operators, and wireless carriers, which will, in turn, sell access to their customers. Cometa is aiming to have hotspots set up in hotels, airports, retail chains, universities, and in other public high-population locations in the United States.

Toshiba America Information Systems has recently broadened its mission from being just a PC hardware company to taking up the wireless infrastructure development problem. The company is investing in hotspots and setting up partnerships with providers to stimulate mobile computing. Not incidentally, Toshiba is one of the premier providers of notebooks, many of them equipped with embedded 802.11

wireless radios and controllers. Thus, to stimulate hardware sales and generate additional revenue streams, the company has created a new focus on wireless and mobility through infrastructure investments.

These efforts and many others around the world — such as those by T-Mobile (United States), STSN (United States), Softbank (Japan), Yahoo! BB (Japan), Megabeam (United Kingdom), and WLAN AG (Germany) — which under some circumstances might be viewed as competitive, are in fact additive in today's market. They all stimulate primary demand and are based on standardized technology. Rather than interfering with each other, these groups represent the growing interest in building out the wireless infrastructure. Many others are likely to join them in good time.

#### **ENABLING THE UNTETHERED LIFESTYLE**

One of the most interesting but least quantifiable benefits of Centrino mobile technology is the new lifestyle that it will enable. It is difficult to emphasize how different computing will be when the requirement to locate an AC outlet and communications jack is virtually eliminated during business hours. Those two cords, power and data communications, are the only obstacles that are keeping the user from a much more flexible and fluid computing lifestyle.

With improved reflective screens and the possibility of smaller form factors, a variety of new outdoor computing scenarios opens up. Corporate users will be able to be connected at all times when on campus, whether inside the buildings or between them in courtyards or gardens. Upon arriving home, these same users will be able to compute while sitting by the pool or on the deck.

Hotspots will enable computing in many public places, such as hotel lounges, conference areas, and outdoor spaces. Some hotspots will be in obvious places, such as airport lounges, but other, more surprising locations will also turn up, such as at the beach, ball game, or bar. People will be able to compute in restaurants while waiting for their companions to show up.

In all of these scenarios, the edges of personal time will blend more smoothly into work time. In return for a willingness to work in more situations and during a greater spread of hours, mobile workers will be able to maintain a more manageable pace and rhythm.

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Soon enough, wide area wireless access points will be hooked to wireless LANs, allowing workers to stay connected when using collective transportation modes, such as airplanes, trains, and buses.

Eventually (not in this particular spin of silicon, but in the near future), the interaction of LANs and WANs will be commercially feasible. At that point, clients will be handed off smoothly from 802.11 to satellite or microwave networks and back again, taking their identities and billing properties over the bridge with them with no perceptible break in service. In this mode, wide area wireless will allow continuously mobile connected computing in ever more remote locations.

Different users will find ways to be marginally productive with this new freedom from place and time. It is not impossible to imagine people, including those in the following groups, commonly using systems in ways never tried before:

- ☒ **Corridor cruisers.** This species of corporate personality will be able to march about, checking on this or that project and having multiple human interactions, all while staying in touch by instant message, Web, and email.

- ☒ **Transport passengers.** Mobile computing, really invented for flying, takes off in other forms of public transport, such as buses and trains.
- ☒ **Workday extenders.** The ability to work at odd hours — to wake up in the middle of the night and take a mobile computer out of sleep to jot down a quick thought that was keeping you awake, to sit at a table with a screen to read the news over breakfast, to finish that business proposal over the weekend — will become a common option.

Part of what makes the arrival of this new technology not a burden but a liberation is that it returns the control of time to the worker. In this context, lightness counts. If you have to carry this device, then more portability is better. When you're moving around, every ounce makes a difference in your likelihood to use the device.

With its combination of power management, wireless, security, and performance in a more compact package, Centrino mobile technology enables not only traditional mainstream notebooks and ultraportables but other form factors as well, including tablets.

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#### C O N C L U S I O N

- ☒ Although our modeling shows that Centrino will have the greatest effect in the high-salary segment, anyone with any degree of mobility can benefit from the platform's principal features.
- ☒ Centrino targets the general mobile audience across the entire spectrum of form factors, from small slates to full-size notebooks.
- ☒ Initial interest will likely be in the corporate arena, but lifestyle is evolving all the time toward an increasing overlap between work and life. Thus, consumers are also likely to begin adopting the platform for the same types of reasons that will appeal to corporate users.
- ☒ Anywhere computing is right around the corner.

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