



# **Business Benefits of Wireless Computing**

## **How wireless improves productivity and return on investment**

Intel recently demonstrated and quantified the business benefits of wireless network access. We also identified specific activities, work styles, and user groups that especially benefit from wireless technology.

September 2004

## Executive Summary

Intel IT and Intel Finance recently identified how wireless technology can measurably improve worker productivity and lead to positive impacts on time, schedules, and quality. We linked return on investment (ROI) to productivity gains from wireless network access. We then built an ROI model based on Intel and IT's business case for deploying wireless LANs. Through rigorous data-gathering techniques, we demonstrated how wireless LANs could deliver business benefits to the organization.

---

**We found significant benefits to wireless technology, resulting from the advantages that wireless has over wired network access, including increased access, flexibility, and lower cost.**

---

In particular, we found the following significant benefits:

- Costs savings of installing wireless in a 3,000 employee building, about half as much as installing wired connections
- Time savings of 52 minutes per user per week through multitasking during meetings
- Financial benefits of implementing a wireless infrastructure in conference rooms

These benefits resulted from the advantages that wireless technology has over wired network access, including increased access, flexibility, and lower cost.

We also found qualitative benefits in the following areas:

- Perceived productivity
- Spontaneous meetings enabled by wireless
- Wireless at home

Of course, the benefit that organizations receive from wireless will differ. The greatest benefits will likely materialize in environments where collaboration needs are high, where fast access to information and rapid decision making are important.

## Contents

The Business Challenge .....	3
Study Methodology .....	3
User Profile .....	3
Study Methods .....	4
Data Analysis Methods .....	4
Results .....	4
Ability to Successfully Connect .....	5
Time Savings .....	6
Financial Impact of Using Wireless in Meetings .....	6
Further Benefits of Wireless .....	6
Flexible Connectivity at Work .....	6
Why Multitasking During Meetings is Beneficial .....	7
Spontaneous Wireless Collaborative Meetings .....	7
Responding to Important Situations .....	8
Wireless at Home .....	8
Conclusion .....	8
Acronyms .....	8

---

## The Business Challenge

Previous Intel white papers have measured productivity benefits of wireless technology for office workers, mobile workers, and factory workers. (To learn about these other business value studies, visit [www.intel.com/IT](http://www.intel.com/IT).) This study expands previous research by further examining the impact of wireless technology on office worker behavior.

We particularly focused on measuring the impact of wireless connectivity in meetings and how that impacts productivity. Although Intel already supports wired network access during meetings in many locations, such as conference rooms, each location has only so many wired network ports, which limits the number of wired users. Wireless can host a higher number of users and allows those users greater flexibility.

The Intel IT Business Value Program performed a study to establish whether wireless technology had quantifiable benefits over wired technology for office workers. Our goal for this study was to understand the value of wireless in a business environment.

We first tried to determine whether wireless network access had any advantages over wired access in meetings. More specifically, we wanted to determine if wireless users were able to do more multitasking in meetings, away from their

desk, than wired users. We also examined users' comments and survey data to better understand the impact of using wireless at home and to gather additional insights on the benefits of using wireless.

## Study Methodology

### User Profile

In an effort to get a representative sample of Intel office workers, we obtained a random sample of wired and wireless notebook participants from seven different Intel facilities: five in the U. S. and two in Europe. We used a screening survey that was sent out to notebook users in these locations asking people to participate in our study.

We restricted our request to sites that had at least some buildings with wireless access. Because wireless was in the process of being implemented at some of the facilities, many of the facilities had buildings both with and without wireless. Some of the wired users were at locations that had wireless but they did not have notebooks that supported wireless access.

We categorized our participants by how they connected to the network in meetings that were not at their desk, in conference rooms, the Intel cafeteria, and so forth.

- Wireless users were defined as notebook users who used wireless to connect to the network in these meetings.
- Wired users were defined as notebook users who used wired connections to connect to the network in these meetings.

We had 122 participants in the wired group and 170 participants in the wireless group, and 29 participants who did not connect to the network in any meetings away from their desk. The 29 participants who did not connect to the network in any meetings away from their desks were excluded from data analyses intended to directly compare wireless and wired behavior.

## Study Methods

To understand the impact of wireless on user behavior and productivity, our team employed three data collection techniques:

- Interviews of wireless users
- Self-report activity log
- Survey

We interviewed wireless users to obtain information on possible areas to measure. We surveyed users to understand how they connected to the network, how they did various tasks, and to get examples of how wireless impacts their lives and working behavior. We used self-report activity logs to measure user behavior. Activity logs are generally considered to be more precise than surveys as a way to measure user behavior because people track what they are doing during a specific time period, rather than attempting to estimate their behavior only from memory. The activity logs were used to measure (1) frequency—how often participants did a particular activity; and in some cases (2) duration—how much time participants spent doing this activity.

Participants filled out activity logs, tracking their behavior and recording it each day for one week. For example, participants recorded the amount of time that both wired and wireless users connected to the network during meetings away from worker offices, such as in conference rooms and other locations. The activity log also contained survey questions that participants only answered once. These survey questions included: (1) method used to accomplish a particular task; (2) under what circumstances did participants do this task; (3) open ended questions about how wireless impacted their lives; and (4) perceptions about the impact of different types of connection types on their lives.

In analyzing the data from the activity logs, we paid particular attention to differences between employees who connect wirelessly to the network and employees who use traditional wired network connections. Participants also reported their experiences using wireless or wired access. These reports helped us identify further noteworthy differences between wired and wireless access.

## Data Analysis Methods

We used t-tests to analyze the differences between three of the measurements in this study. A t-test measures the difference between sets of observations. It evaluates the statistical significance of the difference using the value generated by the test, a t-value, and the associated degrees of freedom. The degrees of freedom are a function of the number of participants and allow us to determine whether the t-value is significant—what is the likelihood that the results are due to chance? Statistical analysis typically considers two thresholds to determine whether the pattern of results is due to chance: probability of chance is less than or equal to 5 percent, for example  $p < .05$  (the results are *significant*), and probability of chance is less than or equal to 1 percent, for example  $p \leq .01$  (the results are *very significant*). We used a t-test comparison test for the following measures:

- Percentage of meetings per week that wireless users bring their notebooks to meetings as compared to wired users
- Percentage of meetings per week that wireless users were able to connect successfully as compared to wired users
- Number of minutes doing network connected activities in meetings for wireless users as compared to wired users

## Results

Our study showed that use of wireless access influences user behavior. Figure 1, on the next page, illustrates how the type of network access influences whether users bring notebooks to meetings.

We found that wireless users brought their notebooks to meetings 16 percent more often than did wired users, 84 percent for wireless users as compared to 68 percent for wired users. These results were statistically significant, with the probability of the results being due to chance less than .0001 [ $t(302) = 5.955, p < .0001$ ].<sup>1</sup>

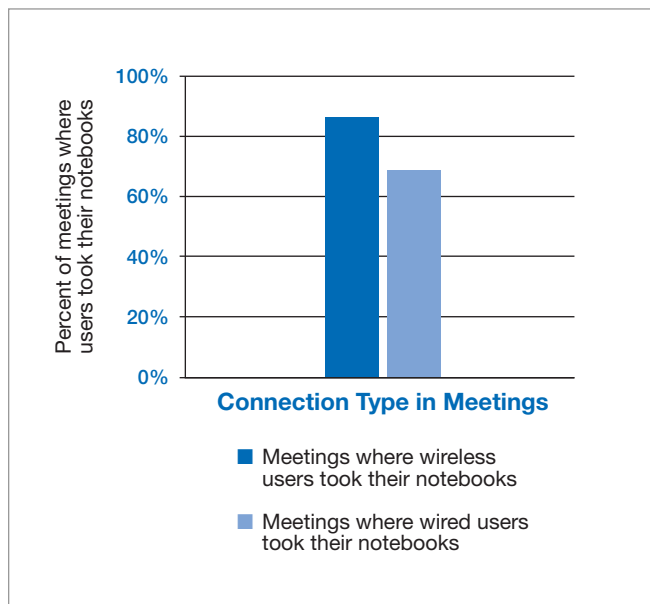
---

<sup>1</sup> All analyses comparing wired to wireless connections in meetings excluded 29 participants who answered “Not Applicable” to the question of how they connected to the network in meetings.

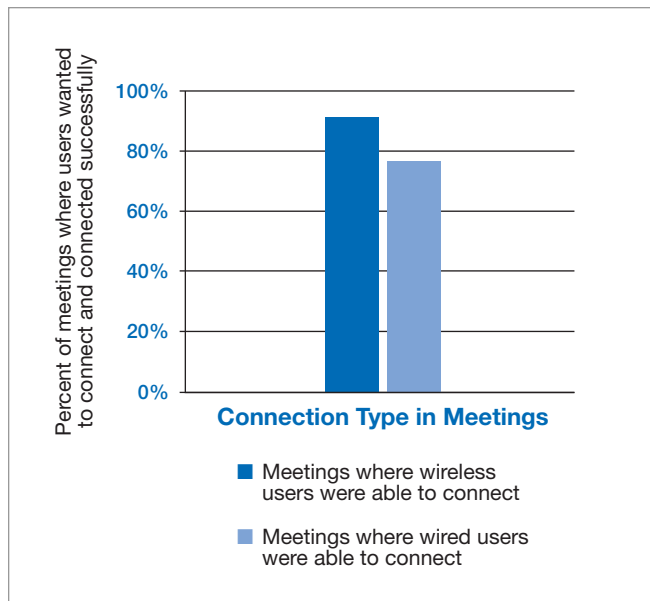
Our interpretation, based on user comments, is that this was partly due to the convenience of avoiding cables and connection ports and partly due to the fact that users can connect in meeting areas that they could not have connected in previously, such as conference rooms that are full or the cafeterias that have only wireless network access.

Interestingly, the comments from our wired users who wish they had wireless also supported this finding. 3 percent of our wired user comments indicated that if they had wireless that they would bring their notebooks to meetings more often.

**Figure 1. Users with wireless access are more likely to bring their notebooks to meetings than users with wired access**



**Figure 2. Users with wireless access are more likely to connect successfully than users with wired access**



## Ability to Successfully Connect

We asked users how many meetings they wanted to connect in and how many of those meetings they were successfully able to connect in. We then calculated the percentage of meetings where wireless and wired users were able to connect successfully. We found that wireless access users were able to connect successfully more often than wired users.

As Figure 2 shows, wireless users connected successfully in 92 percent<sup>2</sup> of their meetings as compared to 79 percent of wired users. This difference was statistically significant with the probability of the results being due to chance less than .0001 [ $t(301) = 5.670, p < .0001$ ].<sup>3</sup> This finding is supported by our users' comments. 20 percent of our user comments stated that a key benefit of wireless was being able to connect in conference rooms when there are not enough wired network ports. An additional 18 percent mentioned that wireless enabled them to connect in meetings in a cafeteria or a lab where they could not have connected previously.

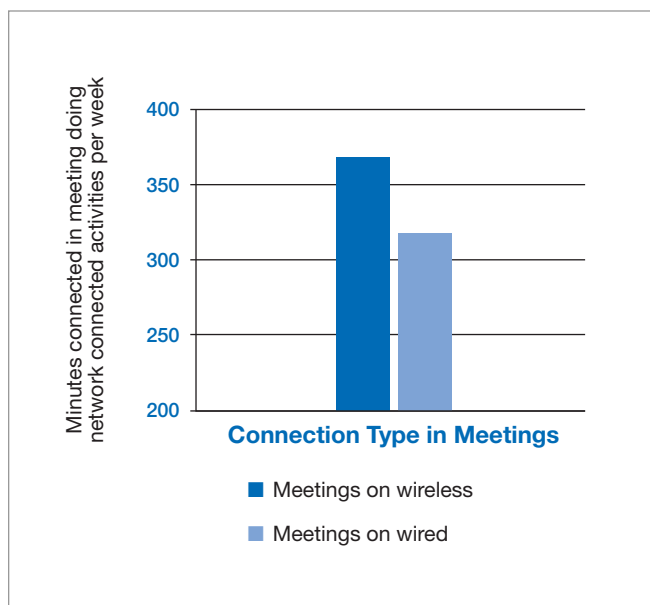
It's generally easier to provide wireless access than wired access. For one thing, while it's difficult to anticipate how many wired ports you need in a location, wireless service is more elastic. Plus, wireless access is less expensive. Intel IT estimates that it costs about half as much to wire a 3,000 employee building with wireless as compared to wired, about 1 million dollars as compared to about 2 million dollars. We also estimate that maintenance costs of a wireless network are less than for a wired network.

With more wireless users bringing their notebooks to meetings and successfully connecting to the network, we expect that more wireless users would multitask during meetings. These users would realize the benefits of multitasking.

<sup>2</sup> This study was done when some of the Intel sites had only partial wireless coverage. Three of the user comments and two of the preliminary interviewees indicated that users experienced this. For example, one interviewee told us that wireless was implemented in some of their buildings where he had meetings but not others, preventing him from connecting successfully 100 percent of the time. This was also true at other sites.

<sup>3</sup> One outlier was excluded from this analysis because data reported by the user resulted in a percentage greater than 100 percent.

**Figure 3. Total number of minutes per week that wireless users worked (multitasked) connected in meetings, compared to wired users**



## Time Savings

As depicted in Figure 3, our data shows that wireless users performed network connected activities in meetings 368 minutes per week as compared to 316 minutes per week for wired users. Wireless users were able to complete 52 more minutes per week of connected activities during meetings than wired users, thereby increasing their productivity. These results were statistically significant with the probability of the results being due to chance less than .001 [ $t(296) = 3.447, p < .0006$ ].<sup>4</sup>

## Financial Impact of Using Wireless in Meetings

We evaluated the financial impact of the productivity improvements due to wireless for office workers by looking at the cost of each employee's time. When estimating this benefit we used the formula:

$$\text{Productivity Value} = \text{Time Saved} \times \text{Employee Cost}$$

The 52 minutes per week represents a productivity improvement of approximately 2.17 percent, or about 41.6 hours per year. So for example, a company with 25,000 employees and a per-employee total cost/burden rate of \$50 per hour would realize approximately \$52,000,000. However when estimating these

types of benefits as part of the IT Business Value program, we discount the dollar amount by 50 percent. So the benefit after the 50 percent discount would be \$26,000,000.

Of course all corporations will be different. Some corporations may have a culture that prevents a change in behavior of taking notebooks to multitask in meetings or they may have meetings where the user must devote full attention to all aspects of the meeting, limiting any type of multitasking. Other companies may not have the same need as Intel to be connected to the network in meetings. In other cases, companies may have no previous wired infrastructure in meeting areas. All of these factors could alter any benefit. We believe that any multitasking strategy in meetings should be done intelligently, in a manor that will strengthen the impact of what needs to be accomplished in a meeting rather than detracting from it.

## Further Benefits of Wireless

In addition to the quantifiable benefits listed above, comments from the wireless users helped us identify other benefits that we could not measure. These include additional benefits of multitasking in meetings, spontaneous collaborative meetings, and wireless at home.

## Flexible Connectivity at Work

Wireless user comments indicated that wireless connectivity allows greater flexibility to connect to the network at work. In fact 47 percent of the wireless users in our study reported that greater flexibility was a key benefit of wireless over wired network connections. For example, because of a limited number of conference rooms, Intel employees use the cafeteria to hold meetings. In response, we installed wireless access points in Intel cafeterias to provide network access, and now employees can gather there or at some other isolated location that does not have any wired network connections and still be connected to the network.

One factor that may contribute to this flexibility is greater ease of connectivity — 14 percent of wireless user comments indicated that they liked the fact that they did not have to carry network cables or dongles around with them, and 16 percent of our wireless users stated that wireless made it quicker and easier to connect to the network.

<sup>4</sup> Six outliers were excluded from this analysis using a box plot strategy.

## Why Multitasking During Meetings is Beneficial

Our wireless users were able to multitask in meetings 52 minutes more per week than wired users. Aside from the productivity benefit, what additional benefits might there be? We suggest that it enabled more of the same kinds of benefits that being connected in meetings in general enables.

Being connected to the network in meetings enables workers to:

- **Gather required information from outside the meeting.**

38 percent of our wireless user comments indicated that their wireless gave them access to information outside of the meeting. User comments indicated that this helps them answer questions, make decisions faster, and speeds up the overall process of getting things done. This is especially apparent in meetings in places like the cafeteria where no other network connectivity is available.

“[Wireless enables me to] bring my notebook everywhere I go with full data availability.”

- **Share information with meeting members more easily.**

28 percent of our wireless users indicated that sharing data or presentations with other meeting members was enhanced by their ability to connect wirelessly in meetings. For example:

“In one conference room, the hub was not working. Only wireless notebook users were able to connect to [our data sharing application].”

“We were not able to reserve a notebook projector for our meeting, but we were able to all sit in a conference room and share a presentation over the [data sharing application], thanks to wireless!”

- **Use meeting time more efficiently.** For example, people who have several meetings in a row in the cafeteria can now be more productive in-between meetings because wireless enables them to stay connected and get more done. 14 percent of wireless users expressed how wireless enabled them to make better use of their time in meetings. 41 percent mentioned how they could take care of additional meeting scheduling or other meeting related activities during the meeting instead of having to follow up after the meeting.

“Online in a common area — can’t do that wired! Made better use of time between 1:1<sup>5</sup> in our cafeteria.”

<sup>5</sup> 1:1 refers to a meeting where one person meets with one other person.

Wireless enables users to be connected to the network more, providing a greater opportunity to take advantage of the benefits of network connectivity in meetings.

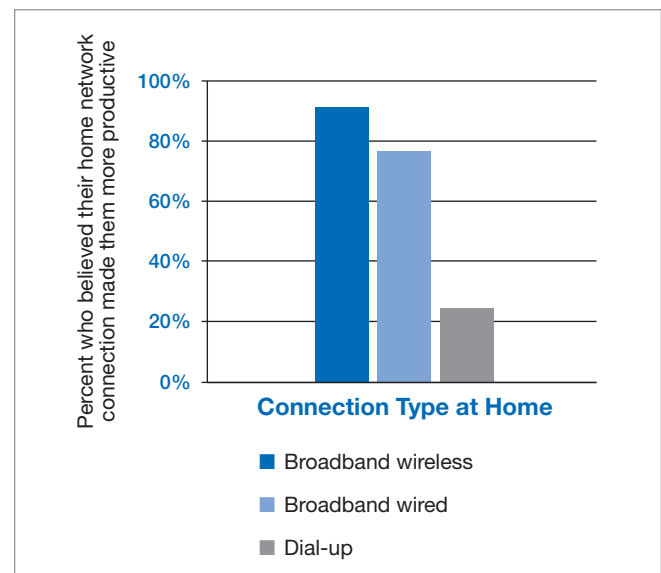
## Spontaneous Wireless Collaborative Meetings

Spontaneous wireless meetings occur when a wireless user takes their notebook to another person’s cubicle or to another common area like the cafeteria to collaborate. These spontaneous meetings are a wireless benefit because they occur in places where wireless offers the only method of connecting to the network. Our user comments indicate that spontaneous meetings have significant benefit. Just over 9 percent of our wireless user comments indicated that spontaneous meetings are a significant wireless benefit.

“Wireless makes it very easy to move around the building from meeting to meeting or to [hold] spontaneous meetings and still have full access to design data and applications.”

For example, a spontaneous meeting to discuss a design problem that is facilitated by bringing a wireless notebook to another worker’s office can quickly and effectively resolve a problem.

**Figure 4. Percent of users who believe that their home network connection makes them more productive, comparing wireless, wired, and dial-up**



## Responding to Important Situations

4 percent of our wireless users mentioned that wireless enabled them to respond to important situations more quickly. Wireless workers can be connected a higher percentage of the time in meetings or in other locations and be more available to respond to important situations.

“[\[Responded to\] request from fab to make process adjustment to allow tool to continue running production wafers instead of delaying 3 hours until meeting was finished.](#)”

## Wireless at Home

Of those who use wireless at work, 66 percent also have wireless networks at home. 36 percent of those who have wireless at home expressed how wireless at home gave them greater flexibility. User comments indicated that this flexibility included being able to work in a quieter location, a more comfortable location, a more enjoyable location. It also included being able to multitask with home activities like watching the kids.

This flexibility also helped some people keep up with heavy workloads. It enabled some people to work from home in spite of competing factors that would have otherwise prevented it. For example:

“[When I work from home, I use Wi-Fi\\* so I can be anywhere in my house and work. If I didn't have Wi-Fi, I would probably work from home a lot less.](#)”

Wireless users also perceived that wireless helped them be more productive. In our survey, 93 percent of wireless users believed that their network connection at home made them more productive, compared to 78 percent of broadband wired users and only 21 percent of dial-up users (see Figure 4, on the previous page).

## Conclusion

This study compared the differences between wired and wireless network technologies for office workers. One of the main areas of comparison was how wireless impacts productivity in meetings. Although Intel already supports wired network access during meetings in many locations such as conference rooms, each location has only so many wired network ports, which limits the number of wired users.

Wireless access works differently. Although a wireless access point supports only a limited number of concurrent users, it can host a much higher effective number of users and allow those users greater flexibility. We have found that wireless users are more confident about being able to connect than wired users and, as a result, are more likely to bring their notebooks to meetings where they can be more productive through multitasking. Wireless users were able to connect more often in meetings and were able to multitask 52 minutes more per week in meetings.

We found ways to demonstrate that wireless technology can measurably improve worker productivity, which participant comments indicate may lead to faster problem solving and answers to questions. We found other benefits through using wireless in spontaneous collaborative meetings and work and greater flexibility and productivity at home. Of course, the benefit that organizations receive from wireless will differ. The organizations that can benefit most have high collaboration needs, where fast access to information and rapid decision making are important.

**For more information, visit our site on the World Wide Web:  
[www.intel.com/IT](http://www.intel.com/IT)**

This document and related materials and information are provided “as is” with no warranties, express or implied, including but not limited to any implied warranty of merchantability, fitness for a particular purpose, non-infringement of intellectual property rights, or any warranty otherwise arising out of any proposal, specification, or sample. Intel assumes no responsibility for any errors contained in this document and has no liabilities or obligations for any damages arising from or in connection with the use of this document.

Intel and the Intel logo are trademarks or registered trademarks of Intel Corporation or its subsidiaries in the United States and other countries.

\*Other names and brands may be claimed as the property of others.  
Copyright © 2004 Intel Corporation. All rights reserved.

