



## **Carry Small, Live Large**

*A vision of the mobile, connected future that is being realized by Intel's research and development labs*

### **Introduction**

Carry Small, Live Large is a vision of the mobile future. It is a vision of computing where our experiences—while we work, play and simply go about our daily routines—are greatly amplified and enriched. Through powerful, small form factor mobile devices that have new ways of interacting with the environment around them, offer new ways for users to interact with the device and provide new ways of experiencing internet based data and services, our daily personal entertainment, interactions with others and the environment around us will soon be greatly enhanced.

This paper describes the mobile computing environment of the future and outlines the research and development efforts that are underway at Intel to fulfill its promise.

### **The mobile future**

Imagine a day when a single, small form factor device—not much bigger than today's cell phones—has the power of a laptop and can deliver a rich computing, telephony, media, gaming and Internet experience. Imagine a day when this device knows who you are, where you are, your tendencies and preferences and what you desire to do at any given moment. Imagine a day when this device is not constrained as a standalone unit, but can dynamically become a hybrid combination of other computing devices in close proximity.

Welcome to the mobile future, where computing devices are small, intelligent, aware of their surroundings, continually tuning themselves to your needs and able to share resources with other computing appliances to amplify your experiences.

The Carry Small, Live Large vision reflects our lives and how they can be enhanced, simplified and enabled through mobile technology. But realizing this vision requires more than just removing the tangle of wires binding people and their devices. It requires eliminating each barrier that keeps one type of device from seamlessly communicating with another. It also demands that our devices know us better, including our

preferences, habits, current environment and possible intentions and requires web based services to deliver the rich content we need when we need it.

Research and development behind the Carry Small, Live Large vision is already underway and aims to:

- Enable ever smaller form factor devices with optimal performance and power usage
- Significantly change how devices interact with the environment around them
- Significantly change how we interact with these devices
- Encourage and lead the development of standards to make the vision a reality

## Amplifying your experiences

To truly understand the breadth and promise of the Carry Small, Live Large vision, it is helpful to peek into the mobile future through a few examples of how the vision could impact our daily lives and amplify our experiences:

### Work

A saleswoman walks into a conference room at a customer site. Using her Mobile Internet Device (MID), she locates a presentation file and taps the screen to display it using the conference room projector. Once the presentation begins, the lights in the conference room dim.

Behind the scenes, the MID recognizes that the woman is in a conference room with a projector. The meeting organizer, who is an employee, has previously given the saleswoman trusted access to the projector thereby enabling her MID to automatically connect to it. Because she often gives presentations when in conference rooms, the MID places a one-touch command button on the front screen of its interface for displaying a presentation file using the connected projector. The MID also knows that the saleswoman likes to dim the lights when giving presentations, and does so automatically. During the presentation, the saleswoman selects to play a short video. Her device securely connects to her corporate network and streams the latest high definition video to the projector.

Furthermore, because she is in a conference room, the MID turns off all incoming email messages, instant message pop-ups, IT alerts, phone ring tones and other alerts that might interfere with the meeting—all without her initiating these actions.

### Play

A student is touring Tiananmen Square in Beijing. The student's MID is aware of the location and displays a Global Positioning System (GPS) map with nearby landmarks and monuments. As the student approaches points of interest, she can point her MID's camera at the monuments and structures to get further information about them. She can also point her MID at local signs to get instantaneous translation of their wording in her native tongue.

Should the student decide that she wants to pick up some souvenirs, she can quickly consult her MID for the nearest gift shops, which are provided via GPS. Once in a gift shop, she can point the MID at a product to get further information on it, as well as be alerted to other items that may be of interest to her..

### Live

A family is searching for a new home and plans to drive through several prospective neighborhoods one afternoon. As they get into the car, their MID recognizes the environment and displays GPS and multimedia capabilities. The driver asks the MID to stream a movie from the web into the backseat for the children. At the

same time, the MID allows the front seat passenger to search the Web for new home listings. Desired listings are displayed via GPS and directions are provided.

Once outside a house for sale, the MID uses the GPS coordinates to retrieve information on the listing, neighborhood, school district, crime in the area and comparable homes nearby. The family never has to leave the vehicle and the movie being watched in the backseat is never interrupted.

Behind the scenes, the MID communicates with the car's internal network, engine monitoring system and data hard drive. With prior permission from the user, if a problem is detected, the device automatically sends an automobile status message to the family's mechanic, who can follow up with maintenance or repair suggestions if necessary.

## Carry Small

The first component of the Carry Small, Live Large vision—Carry Small—is focused on enabling users to carry only essential and convenient computing resources in powerful, small form factor devices.

Today, many of us frequently carry laptops, personal data assistants (PDAs), cellular phones, mp3 players, mobile gaming systems, digital cameras and the like when we leave our homes. This mishmash of disconnected technologies is cumbersome and in many cases, limited in functionality. Devices are locked into specific networks and operating modes. Battery lives are too short. Most devices can't communicate with each other. And with the exception of laptops, few mobile devices deliver a true, full Internet experience.

The research and development behind Carry Small technologies will produce small, powerful mobile devices. These devices will offer multifaceted functionality in a single unit, eliminating the need for many of the separate computing, phone and media appliances. They will offer more powerful processors, be more energy efficient and feature longer battery lives than the mobile appliances of today. Tomorrow's mobile devices will have ubiquitous connectivity, able to automatically recognize and connect to WiFi, WiMAX and 3G networks, among others. And they will offer a true, full-fledged Internet experience.

## Live Large

The second component of the Carry Small, Live Large vision—Live Large—is focused on taking advantage of the available computing resources in any given setting to amplify and enhance the utility of our portable devices.

Carry Small technologies will wirelessly connect us to surrounding device and network resources in our everyday environment, while Live Large will free us from hauling large-scale displays, keyboards, storage resources and the like. Mobile devices will be able to detect, connect and share functionality with other computing devices in their immediate vicinity, allowing us to Live Large without carrying a full complement of computing elements.

Living Large also means that your experiences are relevant to your current context. Based on permissions you have enabled, mobile devices will be aware of your environment and your preferences, and able to alter their interface and behavior accordingly. This may mean adjusting front screen options based on your current context (at home, in the car, at work, etc.) or providing additional information for and interactivity with the things around you. Mobile devices will also be able to receive, filter and customize information being broadcast from other computing devices (i.e., advertising, sale information and coupons when in a mall), depending on the user's preferences and permission.

## The research behind Carry Small, Live Large

At Intel's research and development labs, multiple teams are working collaboratively to establish the technical underpinnings of the Carry Small, Live Large vision, advance industry standards for next-generation mobile technologies and lead the charge toward an unwired, integrated world.

The primary research areas of Carry Small, Live Large include:

### *Form factor, performance and power*

#### Radio Research

This research is aimed at making wireless radios and antennas smaller, more flexible and more energy efficient. Digital multi-radios will be able to reconfigure themselves for different networks, seamlessly transfer a connection from one wireless standard to another and even use multiple wireless standards concurrently. They will also use less power and have the ability to deftly cope with an onslaught of interference.

#### Energy Efficiency

This research is focused on greatly extending the battery life of wireless devices. Platform power management will improve how devices manage their use of power during both idle and active states. Specific subsystem improvements, such as adaptive snoozing of communication systems will further improve energy efficiency.

#### Platform on a Chip

This research is aimed at integrating a complete set of platform components into a single chip. Deep integration would deliver an overall smaller component footprint, performance improvements, power efficiency and component and potentially manufacturing cost improvements.

### *Device interactions with their environment*

#### Wireless Sharing

This research is focused on enabling wireless devices to discover, identify and connect with other computing devices. In doing so, they will be able to compose ad-hoc computing systems that are capable of sharing functionality and computing power. Compression and power efficient communication techniques will enable maximum use of available wireless bandwidth.

#### Privacy/Security

This research is identifying technologies that will help maintain a trusted environment and protect users' privacy and security. As computing systems become more integrated and able to share information about their users, it is essential that this information exchange be appropriate, secure and initiated/approved by the user.

### *Personal interaction with devices*

#### Context Awareness

This research is aimed at making mobile devices smarter and able to dynamically tune themselves to each user and the user's present situation. Tomorrow's mobile devices will know where you are and have the ability to anticipate your needs. They will make interactions with your applications, the internet, and other devices more

relevant. For example, when in a car, GPS is automatically turned on and word processing capabilities are turned off.

### Sensors

This research is geared towards improving the use of context. Off the shelf sensors are readily available. How we use the data they provide is a critical aspect to improving context. More data does not necessarily lead to better context. Sensor data interpretation and inferencing from that data is critical to accurate and meaningful context.

## Summary

Carry Small, Live Large is a vision of the integrated, mobile future. On the surface, the vision is that of a world where we carry less and have the ability to do more. At its core, it is a vision of adaptable mobile technologies that alter their interface and computing paradigm based on the user and their surroundings.

At Intel, research is already underway to make mobile devices smaller, smarter and context-aware. And work is being done to ensure these devices can take advantage of the computing resources around them to enhance users' experiences while maintaining personal privacy and data security.

Many companies are striving to make mobile technologies smaller while countless others are finding ways to make them more functional. It is at the *intersection* of form and function, however, where Intel will truly transform and drive the future of mobile technology. It is at the intersection of Carry Small and Live Large where composable and context-aware computing capabilities become real. And it is at this intersection where our everyday experiences are greatly amplified and enriched.

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