# An Embedded Computer System for Ubiquitous Communications

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*Abstract:* - An embedded computer system is proposed for ubiquitous communication systems in this paper. The theme includes subjects on systems of ubiquitous communication and embedded computer to the next generation.

Fundamental concept and design of the ubiquitous communication system is first described, which is thought of cellular phone services supported by enhanced reliable data and high quality pictures. Configuration and characteristics of an embedded computer system (or the ubiquitous computer) is secondly described to support the services, which is also thought of enhancement of presently applied ubiquitous tag system. A prototype model is designed and fabricated to evaluate basic capabilities for a future communication and computer services.

*Key-Words:* - Ubiquitous communication, embedded computer, high quality pictures

## 1 Introduction

Mobile communication is now the most important and effective system of public communication systems[1]. Computer is also the most important tool for business and the other human activities[2].

Communication tools under public conditions and computer tools under de-facto standard are rarely different basis for design and production. However these two themes are mutually connected based on highly capable CPU chips.

System and equipment engineers are attracted with the embedded system, which is as customized tool for individual systems and as programmable system on a MPU in place of the complicated circuit. The Sakamura computer is proposed and actualized as electronic tag systems for inventory control system.

In this paper, in place of conventional electronic tag system, an embedded system is first presented the concept of newly introduced embedded computer system. Basic functions, software and hardware configurations are studied to compose a new computer based on the above concept. Lastly in this paper a prototype system is written with photograph under operation.

This system is also intended to be used finally for the area of conventional general computer with varieties of functions.

## 2 Ubiquitous Communication and Embedded Computer System

Digital divide provides people with severe differences for effect of information. Grate part of civil cannot use computer tools in office, and not well educated to use general computers. Grate part of civil use cellular phone in every life, but they are not provided with high quality video and data services.

Ubiquitous network society is expected to be given by developing both technology of communication and computer sufficiently enough for human activities.

### 2.1 Ubiquitous Communication

Video transmission technologies are introduced in cellular mobile system to enhance the capability of communications. Limited quality video and low reliability causes limited application area including business and life. Wideband spread spectrum modulation scheme is taken for wideband data radio communication channel[3][4][5][7][8].

### 2.2 Embedded Systems

Data processing capabilities are also enhanced by the progress of semi-conductor MPU. The knowledge on IT technologies including soft wares and operations should be enough to utilize these processors as general computer.

## 3 Embedded Computer System

### 3.1 Basic Concept

Personal computers provide people with variety of data processing capabilities. The following pattern appeared for computers, (a) embedded multiple computers within equipments applied to each purpose, (b) a person accessible to a computer with himself anywhere, anytime. In this paper, embedded computer is taken as the common concept. The ubiquitous tag and the TRON by professor Sakamura correspond to (a).

The computer of this study corresponds basically to (b), except that the computer is intended to general use. The embedded computer for ubiquitous communication is taken in this paper based on the purpose described above.

### 3.2 Composition of Functions

The following functions are necessary for an embedded computer:
(a) digital signal processing,
(b) digital data operation and
(c) process control an embedded computer.
They are requested for communication, computation, and control for communication and computer respectively.

Table 1 shows concept of functions and configuration necessary for ubiquitous communication: They are requested for communication, computation, and control for communication and computer respectively.
(a) digital data operation for video signal processing
(b) digital signal processing for speech and sound signal processing,
(c) communication control, and
(d) control functions for this and the other computers

### 3.3 Composition of Software

Basic concept of software configuration is shown in Table 1 including operation system (OS) and applications. The specifications of the computer in this paper are compared with the conventional embedded system (Sakamura computer) in the Table.

| Novel Embedded Computer System for Ubiquitous Communications | Ref. SAKAMURA Computer Based on TRON |
|---|---|
| 1. Public Communication-specific; including Highly IT business & research | 1. Customized application real-time electron circuit replaced |
| 2. Specific OS programming is available to customers. | 2. Selectable OS & System configuration programming is not available to customers. |
| 3. Communication Protocol widely applied. | 3. Communication Protocol predefined on demand |
| 4. Multi-Process / Real-time Priority control / Memory Protection | 4. Multi-Process non, w/o mobile phone ( Windows CE) |
| 5. Distributed Computing reconfiguring of hardware | 5. Distributed Computing non |
| 6. Closed OS high security | 6. Nonspecific Application opened OS, less secure |

Table 1 Comparison of system concepts of embedded operation systems.

### 3.4 Composition of Hardware

Basic concept of hardware configuration is shown in Figure 1. This system is based on both of communications and computer. Communications require essentially real time (i.e. online) and fast, and computers require flexible menus of operations and speed except eventual applications (i.e. offline). Considering these variations of data processing time, multiple LSI chips are adopted to compose diversity of the capabilities of ubiquitous communication computer.

(a) Micro processor unit (MPU)

Flexible data processing and management of computations are assigned to MPUs.

(b) Digital signal processor (DSP)

DSP conducts one hundred times higher than MPU as an example for digital signal processing, of which algorithm is determined. Parametric operations of filtering, mathematical calculation of numeral and data are assigned to DSP.

(c) Field Programmable Gate Array (FPGA)

FPGA is recently attracted to be applied for radio signal processing, which requires so short data processing time and flexible update or revision of algorithm.

FPGA is effectively utilized to compose mainly high data rate signal processing areas in this development.

(d) Customized LSI circuit

In this study, grater part of hardware could be changed into customized LSI circuit to reduce hardware size power consumption.

A prototype model shown in Fig.2 is designed and fabricated to evaluate the basic capabilities.

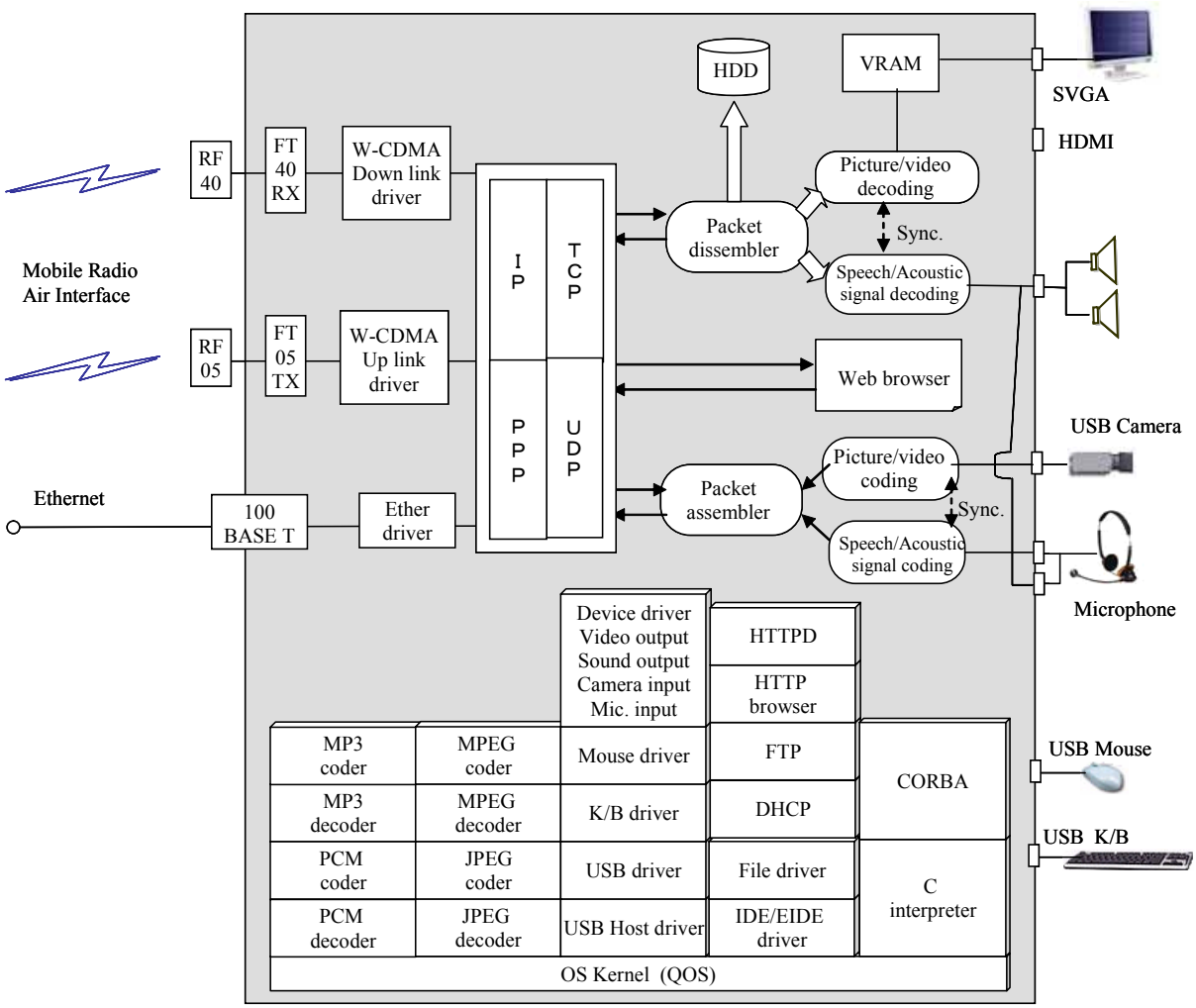


Fig 1. Configuration of the proposed Embedded Computer System.


Fig. 2 The prototype model of embedded computer system developed by the authors.

## 4 Conclusion

Basic concept and a practical design are shown in this paper to develop the ubiquitous communication coming after the cellular phone. Ubiquitous communication system will be supported by both of wideband mobile radio channel technology and its embedded computer technologies advanced to the present embedded system capabilities. This paper was focused clarify required technologies to be implemented a ubiquitous communication terminal equipment.

*References:*

[1] Saki Yatano, Yumi Takizawa, Atsushi Fukasawa, "Wideband Spread Spectrum Modulation System for Ubiquitous Communication Services," WSEAS Applied Informatics & Communications, No. 564-260, Athens, Greece, 2007.

[2] Mark Weiser, "The Computer for the 21st Century" - *Scientific American Special Issue on Communications, Computers, and Networks,* September, 1991

[3] Yumi Takizawa, Cindy Bernadeth Tjitrosoewarno, and Atsushi Fukasawa, "A Mathematical Scheme of Multi-User Receiver in W-CDMA Mobile Communication based on the Conjugate Gradient Method," WSEAS Transactions on Signal Processing, Issue 2, Vol.1, November 2005, pp.244-248, 2005.

[4] Tani. S., Tjitrosoewarno C. B., Sugihara H., Fukasawa A., Takizawa Y., "Enhancement of the W-CDMA Scheme based on Parallel Matched Filters," WSEAS Transactions on Communications, Issue 5, Vol. 4, pp. 211-215, May 2005.

[5] Tani S., Tjitrosoewarno C. B., Fukasawa A., Kashima T., Takizawa Y., "Multi-path Signal Receiver with Parallel Matched Filter for the W-CDMA Systems," WSEAS Transactions on Information Science and Applications, Issue 3, Volume 1, pp.937-941, 2004.

[6] Makio Ishiguro, Yumi Takizawa, Atsushi Fukasawa, Tadashi Shibata and Toshihiko Yamasaki, - *"Recent Technologies on Information, Data Processing, and LSI Designs,"* The Text on ISM Open Lectures, Japanese Edition, Nov. 30, 2005.

[7] Y. Iijima, S. Inoue, T. Kashima, A. Fukasawa, Y. Takizawa, "Coherent SS Modulation with Estimation and Compensation of Phases Rotation using Pilot Channel," Journal on Circuits, Systems, and Computers, vol.13, No.2, pp.361-373, 2004.

[8] Igarashi K., Arai Y., Sakai T., Fukasawa A., Takizawa Y., "Multi-user Detection for Wideband CDMA based on the Conjugate Gradient Method," Advances in Communications and Software Technologies, Electrical and Computer Engineering Series, WSES Press, pp.140-145, 2002.