Technical Committee on Software Radio 3rd-year
Kenta Umebayashi, Seishi Hanaoka, Mitsuhiro Shimozawa, Masahiro Koya,
Takeo Fujii, Jun-ichi Takada
Technical Committee on Software Radio

1. Introduction

Technical Committee on Software Radio (TCSR) has promoted research on software radio, cognitive radio, and their related technologies since 1999. It was third year of TCSR since it was restructured to a permanent committee of IEICE in 2005. The steering committee members of TCSR in 2007 are shown below:

Chair: Jun-ichi Takada (Tokyo Inst. of Tech.)
Vice Chair: Kazuhiro Uehara (NTT), Yukitoshi Sanada (Keio Univ.)
Secretary: Kei Sakaguchi (Tokyo Inst. of Tech.), Takeo Fujii (Univ. of Electro-Commun.)
Assistant: Kenta Umebayashi (Tokyo Univ. of Agriculture and Tech.), Tsuguhide Aoki (Toshiba Corp.)

TCSR organized five technical conferences, and a special section on the Transactions in fiscal year of 2007. This article summarizes the latest activities of TCSR.

2. The 1st technical conference in May 2007 (Joint workshop with SDRF and panel discussion)

- Date: May 24-25, 2007
- Topics: Joint workshop with SDRF, Panel discussion
- Venue: The University of Electro-Communications
- Number of papers: 21 (Joint workshop 6, Panel discussion: 4, Regular: 11)
- Number of participants: 93

Introduction

The SR technical conference was held at The University of Electro-Communications from May 24th to 25th. There were a joint workshop with SDRF, a panel session and general sessions. This workshop was the last workshop for Dr. Harada (NICT) as the committee chairman.

Joint workshop with SDRF

The first SR technical committee invited Dr. John M. Chapin (VANU) and organized the joint workshop. At first, Dr. Chapin gave two presentations entitled “Commercialization of SDR in the USA –Vanu anywave cellular Basestation –” and “Activities and progress of the SDR Forum and related international organizations”. In the first presentation, the SDR base station and the design architecture were introduced. In the second presentation, the activities of the SDR Forum were introduced. From TCSR side, there are four presentations as follows. At first, the committee chair, Dr. Harada, introduced the activities of TCSR. Prof. Sanada (Keio University) gave a presentation entitled “Sampling Rate Selection in Cognitive Radio” and presented sampling techniques in cognitive radio. Mr. Horiguchi (Toshiba) gave a presentation entitled “A Framework for Modern LSI Design Based on SDR Architecture”. Finally Dr. Yamaguchi (NTT) gave a presentation entitled “Recent Advances in RF Devices for Future Wireless Systems” and several research achievements regarding RF were introduced.

Panel Discussion

A panel discussion entitled, “Propagation and spectrum sharing in software radio and cognitive radio” was held. In the panel discussion Dr. Kashiki (KDDI) acted as a chairman and four panelists had presentation at first as follows. Prof. Takada (Tokyo Institute of Technology) had a presentation entitled “Propagation model for interference study”. He talked about the channel model for evaluation of interference at primary user side for cognitive radio. A difference between cognitive radio and UWB in the context of spectrum sharing was described. Dr. Fujii (Softbank) gave a presentation entitled “Time-spatial propagation model for wideband mobile radio”, which included the proposed channel model for the evaluation of IMT-Advanced in ITU-R. Prof. Sato (Tokyo University of Technology) presented about standardization activities of radio propagation in ITU-R and spectrum sharing. Finally, Dr. Taromaru (ATR) had a presentation entitled “Desired RF and Analog Device Technologies Required for Practicable Software Radios”. In the discussion, the following issue was discussed; which channel models are proper to evaluate cognitive radio techniques and what should be evaluated.

General Sessions

In the conference, there are totally 11 presentations in the general sessions. From Keio University, 5 presentation regarding sampling techniques for cognitive radio and software defined radio. In addition, there are several presentations about cognitive radio techniques.
Award Presentation

TCSR has newly established the awards for the excellent presenters in TCSR Technical Conferences. The first awards are presented to the following researchers:

**Best Paper Award:** Makoto Ozone (SANYO), “Software Defined Radio with Reconfigurable Processor Based on ALU Array Architecture” (SR2006-38)

**Young Investigator Award:** Kei Sakaguchi (Tokyo Inst. of Tech.), “Cognitive MIMO Mesh Network” (SR2006-43)

**Special Technical Award:** Akihisa Yokoyama, Takashi Matsumura (Toyota ITC), and Hiroshi Harada (NICT), “Implementation of broadcasting receiver on our original signal processing platform for software defined radio” (SR2006-17)

Conclusion

In the conference, there were joint workshop, panel discussion and general sessions. The conference got a lot of participant (93 participants and 21 presentations).

3. The 2nd technical conference in July 2007 (Technical Exhibition & Tutorial)

- Date : July 26-27, 2007
- Topics : Technical Exhibition, Tutorial
- Venue : Yokosuka Research Park
- Number of papers : 28 (Technical exhibition : 15, Tutorial : 2, Regular: 11)
- Number of participants : 193

Introduction

The second SR technical conference was held at the Yokosuka Research Park (YRP) YRP Center No. 1 Building from July 26th to 27th. There were a technical exhibition, a tutorial presentations and general sessions. Before the technical exhibition, Prof. Sakaguchi (Tokyo Inst. of Tech.) interviewed presenters for introduction of individual exhibitions. There were prototypes and posters of SDR and cognitive radio.

Technical Exhibition

There were 15 presentations and Figures 1–3 depict the technical exhibition, opening, interview and presentation. As shown the figs, there were not only presentations but also many discussions between presenters and audiences.

Four booths by KDDI, Mitsubishi, Hitachi and ATR exhibited the outcomes of the project on the integrative cognitive radio networks and the related techniques granted by MIC (Ministry of Internal Affairs and Communications of the Japanese Government). In their exhibitions, prototypes and hardware were ashown. Mr. Akabane (NTT) gave a presentation entitled “Network System using Autonomous Adaptive Control Technology”. The prototype using several wireless network systems adaptively and autonomously was introduced.

There were 3 presentations related to MIMO technique as follows: RF-MEMS devices for MIMO system was presented by Fujitsu and MIMO channel measurement and fading simulator were presented by Tokyo University of Science.

There are 3 presentations regarding a RF component in SDR as follows: Mr. Moteki (Yokohama National Univ.) introduced a prototype of RF sampling receiver with FPGA was introduced. Mr. Fukuda (NTT Docomo) introduced a technique for multimode receiver. Mr. Kawai (NTT Docomo) introduced a tunable RF filter.

Various important techniques for cognitive radio and software radio were introduced as follows. A dynamic spectrum access control to utilize vacant spectrum was introduced by Prof. Sampei (Osaka Univ.). An energy based sensing system was introduced by Ms. Maharajan (Tokyo Inst. of Tech.). Mr. Takemoto (Univ. of Electro-Commun.) had a presentation entitled “Development of Total Recording System for Digital Terrestrial TV and Adaptive Array based on Radio Signal Processing”. A total recording system for ISDB-T was introduced where an effective diversity technique with the recoding method is used.
Prof. Seungwon Choi (Hanyang University) gave a presentation entitled Smart Antenna Radio Access System for WiBRO/WiMAX with Beamforming and MIMO Capability” and prototype of WiBro/WiMAX RAS (Radio Access Station) with smart antenna was introduced. There were many discussions among the presenters and audiences.

Invited Tutorial Presentations

In this session, Prof. Araki (Tokyo Inst. of Tech.) acted as a chair man and there were two tutorial presentations. Prof. Okada (Tokyo Inst. of Tech.) gave a talk about RF CMOS. Dr. Fujiwara (ArrayComm) had a presentation about DSP and smart antenna technique.

General Sessions

There were 11 presentations. Several presentations about important technologies of software defined radio were introduced by Dr. Hamada (Mitsubishi) and Dr. Kishi (Samsung). Dr. Fujimoto (KDDI) gave a presentation entitled “A Propagation Status Monitoring using the Software Radio -- for Cognitive Radio --”.

Mr. Sekiguchi (Tokyo Univ. of Agri. and Tech.) had a presentation entitled “A feasibility study of software defined radio based on off-line multi-functional blind signal processing”.

A technique of bandpass sampling in DS-UWB was presented by Mr. Muto (Niigata Univ.). Sensing techniques were introduced by Prof. Sasaki (Niigata University) and Mr. Po (Tokyo Inst. of Tech.). Dr. Harada (NICT) gave a presentation entitled “A feasibility Study on Software Defined Cognitive Radio Equipment”.

Conclusion

In this conference, there are technical exhibition and invited tutorial presentations and general sessions. There are 28 presentations and 193 participants for 2 days.

4. The 3rd technical conference in November 2007 (Joint workshop with E2RII)

- Date: Nov. 26-27, 2007
- Topics: Cognitive Radio, Panel Discussion, Technical Session
- Venue: Hiroshima International University
- Number of papers: 27 (Regular: 10, Poster: 7, Invited: 1, Special: 2, Joint workshop: 7)
- Number of participants: 96

Introduction

The 3rd SR technical conference was held at Hiroshima International University (Kure) from November 26th to 27th. In this conference, a joint workshop with E2R II was held on first day, and poster sessions were held on second day.

In the technical conference, total number of participants during two days was about 100.

Workshop with E2RII

TCSR organized “Joint E2R II and TCSR Workshop” with E2RII (End-to-End Reconfigurability phase II), an EU IST project.

From Japan, Prof. Takada (Tokyo Inst. of Tech.) introduced recent TCSR activities. After that, Mr. Hanaoka (Hitachi), Mr. Murakami (NICT) and Mr. Yamaguchi (ATR) presented their latest activities regarding cognitive radio. From E2RII, Dr. Moessner (Univ. Surrey) introduced E2R II programs towards cognitive radio systems and flexible spectrum management studied in E2RII. After that, Dr. Clemo (Toshiba Res. Europe) introduced reconfigurable equipment architecture.

TCSR decided to continue to promote their activities in cooperation with E2RII, and gave commemorative trophy to E2RII (Fig. 4).

Poster Session
In total, 7 poster presentations were made on second day. In the poster sessions, presentations on research efforts of universities were numerous, because this poster session was intended to encourage mainly students and freshmen to present their research efforts. This plan ended with success and many participants discussed their research efforts enthusiastically.

Special Invited Session
An invited lecture was given by Dr. Ishizu (NICT) and latest standardization status of IEEE P1900.4 and NICT’s activities towards IEEE P1900.4 were introduced. IEEE P1900.4 scopes in heterogeneous wireless access network and will define the building blocks of network/device resource managers and information to be exchanged between building blocks.
And more, two special reports by attendees of major international conferences were given. One was of 2007 SDR Technical Conference, and the other was of PIMRC (The 2007 International Symposium on Personal, Indoor and Mobile Radio Communications).

Regular Sessions
In total, 10 regular presentations were made during two days conference. Presentations of research on cognitive radio were particularly numerous.

Conclusion
The 3rd conference was held at Hiroshima International University and the TCSR had a joint workshop with E2R II. In 2008, the TCSR will continue their activities to promote research on software defined radio, cognitive radio, and their related technologies in cooperation with E3, which is the follow up project of E2R II.

5. The 4th technical conference in January 2008

- Date: January 24-25, 2008
- Topics: Software Radio, Cognitive Radio, Panel Discussion, Technical Session
- Venue: Tateyama Prince Hotel (Omachi, Nagano)
- Number of papers: 20 (Invited: 3, Panel discussion:1, Regular: 16)
- Number of participants: 55

Introduction
The 4th SR technical conference was held at the Tateyama Prince Hotel near the North-Alpine, in Omachi city, Nagano, from January 24th to 25th. There were an invited session, a panel discussion, an evening session, and regular sessions in two-days conference. In the invited session and the panel discussion, two themes that are (1) cognitive radio viewed from application developers and users, and (2) cognitive radio in the community, were discussed. In the evening session, broadband access in the rural area were discussed. In the regular sessions, 16 papers were presented during two day conference.

Invited session
Mr. Yomogida (Nikkei BP) presented the expectation toward cognitive radio. He also expressed concern about the negative attitude by Japanese telecommunications carriers and handset manufacturers for cognitive radio comparing to foreign companies, for example in the standardization activities.
Mr. Ushigoe, the mayor of Omachi city, introduced community information system and communication infrastructures in his city. He pointed out the problem about the regional imbalances, cost effectiveness, human resources in the information system.
Prof. Handa (Shinshu University) presented the ad-hoc network application for the security of the community using wireless system for the disaster prevention.

Panel discussion
The panelists were Mr. Yomogida and Prof. Handa, invited speakers, Prof. Araki (Tokyo Inst. of Tech.), and Prof. Takada (Tokyo Inst. of Tech., chair of TCSR). Based on the presentation by the Mr. Yomogida and Prof. Handa in the invited session, active discussions about (1) activity of telecommunications carriers and handset manufacturers for cognitive radio in Japan, and (2) cognitive radio for the community, were held including attendances. Standardization activities by companies in (1), and contribution of the SDR and cognitive radio for the community in (2) were debated, respectively.

Evening session
Almost all attendances to SR Technical Committee took part in the evening session. The session theme was "Broadband access in the rural area". Prof. Sanada (Keio University) showed that the wireless broadband access can be ready for use only in the urban area in Japan. Prof. Takada pointed out that there are many areas in foreign countries where even the fixed-line telephone is insufficiently supplied. The role of cognitive radio and SDR for the communication in the rural area was discussed.

Regular session
In the conference, 3 regular papers in the first day and 13 regular papers in the second day were presented. Many papers regarding H/W such as processors, devices, and prototypes of transceiver for cognitive radio and SDR were presented.

6. The 5th technical conference in March 2008 (Workshop on Mobile Communications cosponsored
with TCs on AN, MoMuC, RCS, WBS)

- Date: March 6-7, 2008
- Topics: Workshop on Mobile Communications
- Venue: Yokosuka Research Park
- Number of papers: 24 (Special: 4, Organized: 7, Regular: 13)
- Number of participants: 215
- Number of exhibition: 17 (Technical: 4, Commercial: 13)

The 5th SR technical conference was held at YRP (Yokosuka Research Park) from March 6th to 7th. This conference was a part of the Joint Workshop on Mobile Communications with technical committees on AN, RCS, MoMuC, and WBS. This workshop has been held on every March for these 12 years. From two years ago, the TCSR involved to the workshop. This year, TCSR organized a special session on outcomes of R&D projects granted by MIC sourced from Spectrum User Fee, an organized session and regular sessions.

**Special Session on Outcomes of R&D Projects sourced from Spectrum User Fee**

TCSR organized a special session entitled “Outcomes of R&D projects granted by MIC sourced from Spectrum User Fee” which had continued for about two and a half years. Four special talks were presented by Dr. Hiroshi Harada (NICT), Dr. Makoto Taromaru (ATR) /Mr. Atsushi Ohta (NTT), Dr. Mitsuo Nohara (KDDI Lab) and Mr. Kazunori Yamanaka (Fujitsu).

Dr. Harada presented elemental technologies on cognitive radio equipments such as RF devices, H/W and S/W platform. Dr. Taromaru and Mr. Ohta talked about studies on efficient spectrum use in space domain such as SDM and Multi-user MIMO. Dr. Nohara presented their research results on cognitive radio networks such as radio resource management and routing control. Finally, Mr. Yamanaka talked about small-size superconducting tunable filter for microwave band.

**Organized General Sessions**

First, Dr. Yoshino (NTT Docomo) talked on report of ITU-R World Radiocommunication Conference (WRC-07) and new spectrum for IMT-Advanced. After Dr. Yoshino’s talk, six key researchers presented on research topics which are closely related with SR technical committee. Dr. Homare Murakami (NICT), Dr. Seishi Hanaoka (Hitachi), Prof. Kenta Umebayashi (Tokyo Univ. of Agri. and Tech.), Prof. Hidekazu Murata (Kyoto Univ.), Prof. Kei Sakaguchi (Tokyo Inst. of Tech.) and Prof. Yukitoshi Sanada (Keio Univ.) presented recent research results including tutorial parts on cognitive radio(network, sensing, multihop corporation), base station corporation MIMO and signal processing for direct conversion receiver.

Totally 17 organizations exhibited their research results and commercial products related to software radio and cognitive radio.

Exhibitions included software radio prototype, DSP/FPGA, software simulation tool, measurement equipment and so on. It was a good opportunity for mutual interactions between sales persons and engineers.

**Regular Sessions**

In total, 13 regular papers were presented during two day conference. Research topics were cognitive radio system such as dynamic spectrum access and radio resource control, RF devices and signal processing method for cognitive radio and so on.

**7. Special Section of IEICE Transactions on Communications in January 2008**

The Special Section on Cognitive Radio and Spectrum Sharing Technology has been published on January 2008 issue of IEICE Transactions on Communications. 45 papers and 4 letters have been submitted. After fair and square review, 2 invited papers related to IEEE P1900.4 and reconfigurable RF devices, 15 papers and 1 letters were accepted for publication. These papers cover topical subjects such as cognitive network, spectrum sharing, spectrum sensing, distributed optimization, and enabling technologies.

**8. Conclusion**

Technical committee on software radio (TCSR) held five conferences in fiscal year 2007. TCSR makes a strong effort to international collaboration with the research organization of software defined radio and cognitive radio fields all over the world. In this year, we had two joint workshops with international organizations. One was with SDR forum in May and the other one was with E2RII in November. We have aggressive discussion in these joint workshops. TCSR is also interested in a technical exhibition of SDR equipments for exchanging the related information of hardware. We have one Technical Exhibition in July. In FY 2008 we will plan five conferences as follows:

- May 2008: Yokohama National Univ.
- Oct. 2008: Okinawa (Joint Workshop on Wireless Distributed Networks cosponsored with TCs on AN, RCS, USN)
- Jan. 2009: Kyoto (Joint workshop with E3)
- March 2009: Yokosuka Research Park (Workshop on Mobile Communications cosponsored with TCs on AN, MoMuC, RCS).

TCSR welcomes contributions from newcomers. We are looking forward to meeting you at conferences.