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CECS eNEWS

Center for Embedded Computer Systems, University of California, Irvine

Project Profile: Adaptive Network Assimilations through System Reconfigurability

- Hessam Kooti

Highlights

Inside this Issue:

I started my PhD in fall 2008 under the supervision of Prof. Eli Bozorgzadeh, after graduating from Sharif University of Technology (Iran), with a M.S. degree in Computer Engineering. Currently I'm working on a NSF granted project titled: "Adaptive Network Assimilations through System Reconfigurability" which is a collaboration between the Reconfigurable Computing Lab (led by Prof. Eli Bozorgzadeh) and the Networking Lab (led by Prof. Luke Bao). One solution to the network assimilation problem is based on Software Defined Radios (SDRs), in which a wide variety of strategies and protocols can be implemented in software. Fig 1 shows a SDR-based base station that supports both WiFi and GPRS network systems. Although the complete processor-based SDR systems provide the ultimate flexibility for SDR configurations, DSP processing mandates that SDR platforms be supported by both processors and hardware (mainly FPGAs). Reconfigurable FPGAs such as Xilinx Virtex devices are solutions coupling reconfigurable logic and embedded multi-processors while enabling partial reconfiguration of the system. Hardware reconfiguration as well as software programmability enables not only the radio to implement multiple waveforms and standards while meeting the networking protocols' time budget, but also brings significant savings in energy and cost compared to pure software implementation of SDR systems.

An SDR-based reconfigurable architecture is illustrated in Fig 2. Various non-time stringent data link layer protocols run in the software portion of the SDR platform, while the hardware portion implements the time stringent and computationally intensive modulation/demodulation (modem) functions. We propose a scheduler to bridge the gap between these two layers. Since the topper layer is not time stringent, it is our scheduler's job to schedule the protocols (tasks) and make it time stringent for the lower layer.

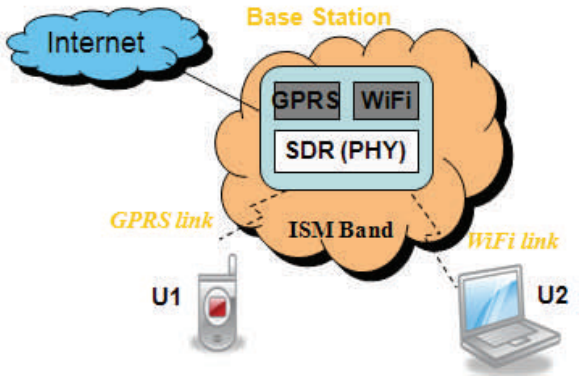

Fig 1: Baseband for Multi Communication

Due to increase in demand for reconfigurability and flexibility in embedded systems, task scheduling in real time embedded systems is challenged by reconfiguration overheads that cannot be ignored. In real time task scheduling

Continued on page 3

VISITOR & STUDENT PROFILES

Visitor Profile

- CECS

Dr. Hong Rok Kim is a visiting scholar at UC Irvine, hosted by Professor Pai H. Chou, from October 2008 through April 2010. He received his Ph.D. degree in electronics engineering and computer science from Hanyang University, Korea in 2005. He has been a principal researcher of the Center for Embedded Software Technology (CEST, http://www.cest.re.kr) since 2005.

CEST is a leading research organization of WPAN (Wireless Personal Area Network) technology and 30 researchers are working for stability and high performance through field tests and international certifications. He directly participated in the development of the WPAN system. The wireless digital picking system has been deployed to five vehicle factories since 2006, and over 200 wireless sensor nodes were operated in the same network stably. Recently ZigBee modem, dongle and gateway were commercialized in 2007 and the electronic shelf label system was developed and successfully installed into retail stores.

Now, he is developing the system software for a water pipe monitoring system and a bridge monitoring system at UC Irvine. He says, “I am very pleased to work with Professor Chou and his graduate students. I hope this research collaboration will be helpful in enhancing the relationship between CEST and CECS.”

Student Profile

- Chang Lee

I have been here in Southern California for about 11 years since leaving my country after high school. After that, I settled in Irvine, considered to be one of best place to live in the United States. Since last September when I joined UCI CECS, I have been researching GF-IMU (Gyro Free Inertial Measurement Unit) under my advisor Professor Pai H. Chou. Our current project mostly deals with our ultra-compact wireless sensor called ‘ECO’, which can sense the accelerometer values. With these experimental data, we will analyze these data and will develop a system based on a mathematical model.

In Irvine, I would like to use my opportunity to work with one of best engineers and faculties, to spur my professional study, which will shine and be a part of great momentum of my career and life. Also, I am very happy with my research experience with Professor Chou and it will be a great opportunity to collaborate with other colleagues here in UCI. I am certain that this experience at UCI is the best possible step to accomplish my goals and I would regard my research not only as a great honor but also as a great responsibility and an obligation to work hard.

Project Profile: Adaptive Network Assimilations through System Reconfigurability

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on reconfigurable architectures, multiple tasks are scheduled on multiple processing units. However, the underlying hardware needs to be reconfigured (partially or fully) between the executions of two consecutive tasks on a processing unit if each requires a

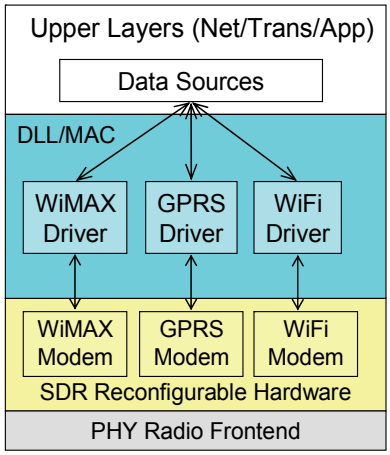

Fig 2: The Base-Station Software/Hardware Architecture for Spectrum Access Scheduling Based on SDR

different configuration of the processor unit. The time needed to reconfigure the hardware depends on both the current and the next task. So unlike other existing scheduling algorithms in which changing the ordering of the tasks doesn't change the total execution time of the tasks, in our problem changing the ordering may change the total execution time of the tasks. We formulate the problem as a special class of network flow problem referred to as *Vehicle Routing Problem* and provide an integer linear programming solution to non-preemptive real time task scheduling problem in which the transition overheads between tasks are considered.

We compare our results with EDF algorithm and optimal scheduling with fixed transition overhead. Results show that the proposed scheduling provides 30% improvement in comparison with non-preemptive EDF and as high as 38% improvement in comparison

with fixed transition overhead scheduling in terms of quality of service. Also the total transition overhead using EDF is up to 6 times greater than the case using our scheduler.

CECS Grad Student Summer Internship Experiences

- CECS

During this past summer, several CECS graduate students applied their academic knowledge at industrial settings with internships at various companies. Here are a select few who wished to share their experiences:

Carmen Badea
Intel Corporation
Santa Clara, CA

This summer, I interned full-time at the Intel Corporation in Santa Clara. The dates of my internship were June 13th to September 18th. During the time I spent there this summer, I worked on testing browser benchmark suites, analyzing browser performance, in particular that of Mozilla Firefox,

Continued on page 4

Summer Internships

CECS Grad Student Summer Internship Experiences

continued from page 3

finding browser optimization opportunities, prototyping these optimizations, and determining the performance improvements yielded by the developed prototypes on many platforms available at Intel. I am currently continuing my internship for the Intel Corp. as a part-time intern.

Ines Viskic
Microsoft
Palo Alto, CA

I started my 12-week summer internship in Microsoft Products in June, 2 months after receiving notice that my all-day on-site interview with their group Danger Inc, was successful.

Danger Inc was a successful startup located in Palo Alto, CA that develops client-server software for mobile communication, media sharing, entertainment and personalization in devices such as T-Mobile Sidekick. In 2008. Danger Inc. got acquired by Microsoft's Premium Mobile Experiences (PMX) team, a group within the Mobile Communications Business (MCB) of the Entertainment and Devices Division. Danger Inc now works together with Microsoft teams in Redmond and Boston on new and exciting mobile products.

My internship project was a real-time monitoring tool of the mobile traffic, used by the group for testing and debugging of mobile services under development. My internship experiences have been truly amazing. The group is young, smart and highly professional. The team's enthusiasm for the project they're developing was inspiring and their welcome was sincere and hear-felt. They provided me full access to their resources and gave me encouragement and feedback every step of the way. After the successful final presentation of the internship project, I was sent to Microsoft headquarters to demo the tool. The teams in Redmond also received my presentation with great praise.

My internship resulted in an offer for full employment with Microsoft, which I accepted. I will go back to Palo Alto and join Danger group after graduating UCI, in 2010. In closing, I sincerely recommend anyone and everyone to submit their application for a summer internship in Microsoft!

Yonghyun Hwang
Microsoft
Seattle, WA

Last summer, I had my internship at Microsoft research center in Redmond. Specifically, I had interned full-time in the embedded system group in Microsoft research. I started my work on June 22nd and my internship was over on September 11th. During my internship, my research focus was on the communication framework between FPGA and a host PC for HPC (High Performance Computing) environment.

I investigated the full potential of the communication framework by virtualizing the communication between FPGA and a host PC. To this end, the new communication framework, FARM (FPGA and Accelerator Resource Management), was proposed and fully implemented. FARM implements a set of communication APIs to realize transparent and reliable access to FPGA for an application programmer without any hardware background, while providing several services such as resource management and secure communication. Once copyright issues with Microsoft are resolved, FARM will be released to the public as a solid foundation for FPGA communication. I really enjoyed working at Microsoft research. I recommend everyone in CECS to try out the internship in Microsoft research center.

PUBLICATIONS

The following papers were published by CECS affiliates between July 2009 to September 2009.

Focus	Title, Author, Publication
Lower-Power K-Best MIMO Decoders	Sudip Mondal, Ahmed M. Eltawil, and Khaled N. Salama, "Architectural Optimizations for Low-Power K-Best MIMO Decoders," *IEEE Transactions on Vehicular Technologies*, Volume 58, Issue 7, Page(s):3145 – 3153, Sept. 2009.
Autonomous Robots	Cox BR, Krichmar JL., "Neuromodulation as a Robot Controller: A Brain Inspired Design Strategy for Controlling Autonomous Robots," IEEE Robotics & Automation Magazine September 2009.
Real-Time Medical Equipment	S. Sirowy, T. Givargis, F. Vahid, "Digitally-Bypassed Transducers: Interfacing Digital Mockups to Real-Time Medical Equipment," Int. Conf. of the IEEE Engineering in Medicine and Biology Society (EMBC), Sept 2009.
Networks Under Received Power Constraint	Alireza S. Behbahani, and Ahmed Eltawil, "Amplify-and-Forward Relay Networks Under Received Power Constraint," *To be published in IEEE Transactions on Wireless Communications*, (accepted August. 2009).
Flash-Based Networked Embedded Systems	Jinsik Kim and Pai H. Chou, "Remote Progressive Firmware Update for Flash-Based Networked Embedded Systems," International Symposium on Low Power Electronics and Design (ISLPED), San Francisco, CA, USA, August 19-21, 2009.
Loop-level Parallelism	Arun Kejariwal, Alexander V. Veidenbaum, Alexandru Nicolau, Milind Girkar, Xinmin Tian, Hideki Saito , "On the exploitation of loop-level parallelism in embedded applications," ACM Trans. Embedded Computer Syst. 8(2) 2009
Automotive Radars	Vipul Jain, Babak Javid, and Payam Heydari, "A BiCMOS Dual-Band Millimeter-Wave Frequency Synthesizer for Automotive Radars," *IEEE Journal of Solid-State Circuits*, vol. 44, no. 8, pp. 2100-2113, Aug. 2009.
Pulse-Radar Receiver Front-End	Vipul Jain, Sriramkumar Sundararaman, and Payam Heydari, "A 22-29GHz UWB Pulse-Radar Receiver Front-End in 0.18µm CMOS," *IEEE Trans. on Microwave Theory and Techniques*, vol. 57, no. 8, pp. 1903-1914, Aug. 2009.
EcoPlex: Empowering Compact Wireless Sensor Platforms	Chung-Yi Ke, Nai-Yuan Ko, Chih-Hsiang Hsueh, Chih-Hsuan Lee, and Pai H. Chou, "EcoPlex: Empowering Compact Wireless Sensor Platforms via Roaming and Interoperability Support,"' to appear in *Proc. The Sixth Annual International Conference on Mobile and Ubiquitous Systems: Computing, Networking, and Services* (MobiQuitous 2009), July 13-16, 2009, Toronto, Canada.
Endosymbiotic Computing	Pai H. Chou, "Endosymbiotic Computing: Enabling Surrogate GUI and Cyber-Physical Connectivity," to appear in Proc. 46th Design Automation Conference (WACI paper), San Francisco, CA, July 26-31, 2009.
Reconfigurable Multi-Antenna Systems	Chitaranjan P. Sukumar, Hamid Eslami, Ahmed M. Eltawil and Bedri A. Cetiner, "Link Performance Improvement using Reconfigurable Multi-Antenna Systems," *To be published in IEEE Antennas and Wireless Propagation Letters*, Volume 8, 2009 Page(s):873 – 876, (accepted July 2009).
Radiation-Induced Transient Faults	Xiaobin Li and Jean-Luc Gaudiot, "Tolerating Radiation-Induced Transient Faults in Modern Processors," International Journal of Parallel Programming (IJPP), Springer, Vol. 37, No. 6, pp., July 2009 (in Press).
RHE: Lightweight JVM Tool	Shaoshan Liu, Chengrui Deng, Xiao-Feng Li, and Jean-Luc Gaudiot, "RHE: A Lightweight JVM Instructional Tool," Proceedings of the IEEE Computer Software and Applications Conference (COMPSAC 2009), Seattle, Washington, USA, July 20-24, 2009.
Dynamic Coprocessors	C. Huang, F. Vahid, "Dynamic Transmuting Coprocessors," IEEE/ACM Design Automation Conference, July 2009.

Continued on page 6

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Center for Embedded Computer Systems, University of California, Irvine

***CECS** Mission Statement:*

To conduct leading-edge interdisciplinary research in embedded systems emphasizing automotive, communications, and medical applications, and to promote technology and knowledge transfer for the benefit of the individual and society.

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The following papers were published by CECS affiliates between July 2009 - September 2009 (and unreported papers from previous eNews). (cont'd from page 5)

Impulse-Radio UWB Transceiver

Lei Zhou, Zhiming Chen, Chun-Cheng Wang, Fred Tzeng, Vipul Jain, and Payam Heydari, "A 2Gbps RF-Correlation-Based Impulse-Radio UWB Transceiver Front-End in 130nm CMOS," *IEEE RFIC Symposium*, June 2009.

Voltage-Frequency Scaling

Avesta Sasan, Houman Homayoun, Ahmed M. Eltawil, Fadi J. Kurdahi, "Process Variation Aware SRAM/Cache for aggressive voltage-frequency scaling," Design, Automation and Test in Europe, DATE 2009, Nice, France, April 20-24, 2009. IEEE 2009.

Code-Modulated Path-Sharing

Amin Jahanian, Fred Tzeng, Payam Heydari, "Code-Modulated Path-Sharing Multi-Antenna Receivers: Theory and Analysis," *IEEE Trans. on Wireless Communications*, vo. 8, no. 5, pp. 2193-2201, May 2009.

CMOS Code-Modulated Path-Sharing

Fred Tzeng, Amin Jahanian, Deyi Pi, Payam Heydari, "A CMOS Code-Modulated Path-Sharing Multi-Antenna Receiver Front-End," *IEEE Journal of Solid-State Circuits*, vol. 44, no. 5, pp. 1321- 1335, May 2009.

Automotive Radars

Vipul Jain, Fred Tzeng, Lei Zhou, and Payam Heydari, "A Single-Chip Dual-Band 22-to-29GHz/77-to-81GHz BiCMOS Transceiver for Automotive Radars," *IEEE Int'l Solid-State Circuits Conference* (*ISSCC*), Feb. 2009.

Ultra-Low Power Applications

Le Zheng, Hsin-Cheng Yao, Fred Tzeng, and Payam Heydari, "Design and Analysis of a Current-Reuse Transmitter for Ultra-Low Power Applications," *IEEE Int'l Symp. on Circuits and Systems* (*ISCAS*), May 2009.