



Faculty of Computing Health and Science

Research Unit Reporting Guide and Template

Level I Research Groups, level II Research Centres and Centres of Excellence:

First page should include:

- Name of Research Unit;
- Name of Document and year (eg. Annual Report 2009);
- Faculty of Computing Health and Science and ECU logo;
- Brief overview of the Research Unit, including strategies and goals for the reporting period only.

Subsequent pages should include:

- List Membership of the group;
- List Grants;
- List Publications, Book Chapters, Articles, Refereed Books, Reports and Conference Presentations;
- List Names and research degree of current HDR load;
- List HDR completions, including the full title of the thesis;
- List key visitors and Collaborators;
- Brief overview of international, national and local community engagement and linkages;
- Brief summary of activities undertaken in the reporting year and their alignment with the goals of the Research Unit;
- Brief overview of future plans, strategies and direction.

Level III Research Institutes:

Where a Level III Research Institute is made up of a consortium of level I and level II research units, it is appropriate for this research unit to refer to the annual reports of the relevant Level I and Level II research units for grants, publications and HDR statistics.

Length: An annual report should be approximately 5 – 10 pages, depending on the amount of activity generated in your centre.

Presentation: You may present the above information in a report style of your choice. A template is provided should you wish to use this format.



Faculty of Computing Health and Science

Research Group, Research Centre or Research Institute Report

RESEARCH UNIT NAME: CENTRE FOR COMMUNICATIONS ENGINEERING RESEARCH (CCER)

RESEARCH UNIT LEVEL (tick):

Level I Research Group:

Level II Research Centre:

Level III Research Institute:

Centre of Excellence:

REPORT TYPE: ANNUAL REPORT

YEAR: 2009

BRIEF OVERVIEW (1 – 2 paragraphs):

The Centre for Communications Engineering Research (CCER) aims to conduct applied engineering research in the area of communications and networking technology that has high impact on the community. Research strengths of CCER include quality of service in optical and wireless networks, design of survivable networks, wireless sensor networks, signal and image processing, multimedia communications, and smart grid systems. Currently the centre consists of 13 HDR students and 10 academic staff engaged in active research into the design issues of next generation communication technologies.

The goals of the research centre in the reporting period were:

To conduct collaborative research projects with the industry and interdisciplinary partners;

To provide a stimulating environment for the pursuit of research in the field of communications, including acquisition, processing, transmission and networking of information;

To disseminate research outcomes through international journal and conference publications, workshops, community focused seminars and University's teaching programs.

MEMBERSHIP (Full Title of Researchers, including staff, research students, adjuncts):

Faculty:

Prof Daryoush Habibi (Leader)

Dr Stefan Lachowicz

Dr Alfred Tan

Dr Douglas Chai

Dr Iftekhar Ahmad

Dr Alex Rassau

Dr Octavian Dranga

Dr Ganesh Kothapalli

Dr Steven Hinckley

Dr Hiroko Kato

Mr Graham Wild

NEW GRANTS (Identify Funding Body, Value of grant, Years Funded, Chief Investigator, collaborators, title):

D. Chai and A. Tan, "Prototype development for commercialisation of ECU invention: the MMCC barcode," ECU Strategic Initiative Funding Program, \$295,000 (2009 – 2011).

I. Ahmad and D. Habibi, "High speed communication services on public transports", Nortel research grant, \$24,993, 2009-2010.

D. Habibi, "Establishment of an Australian teaching and research centre in Fieldbus technologies", Founation Fieldbus End-user Group, \$100,000.

GRANTS CONTINUING FROM PREVIOUS YEARS

A. Tan, "Fetal Heart Rate Monitoring via Smart Phone Project," Microsoft Research, USD\$150,000, 2008-2010.

D. Habibi and I. Ahmad, "Video Networking for Central Monitoring of Security Cameras on Public Trains," Public Transport Authority, \$150,000, 2009-2011.

**PUBLICATIONS, REFEREED BOOKS, CHAPTERS, JOURNAL ARTICLES,
CONFERENCE PAPERS, REPORTS:**

BOOK-CHAPTER:

I. Ahmad and D. Habibi, Quality of Service in WiMAX, WiMAX Network Planning and Optimization, pp. 3-18, Auerbach Publications, CRC press New York, 2009.

JOURNAL:

H. Nguyen, D. Habibi, and Q. Phung, 'Efficient optimization of network protection design with p-cycles', Photonic Network Communications, 2009, DOI 10.1007/s11107-009-0207-9.

S. Lachowicz, H. Pfeleiderer, "FPGA Implementation of a Numerically Controlled Oscillator with Spur Reduction", Electronics and Telecommunications Quarterly, vol. 55, no 4, pp. 617-624, Journal of the Polish Academy of Sciences, 2009.

K. T. Tan, S. K. Ong and D. Chai, "JPEG color barcode images analysis: a camera phone capture channel model with auto-focus," International Journal of Signal Processing, Image Processing and Pattern Recognition, vol. 2, no. 4, pp. 39-47, Dec. 2009.

S. H. Eng, F. Reinholz and D. Chai, "A high-resolution wavefront compensating system using a liquid-crystal on silicon chip," Microwave and Optical Technology Letters, vol. 51, no. 12, pp. 2979-2985, Dec. 2009.

S. H. Eng, F. Reinholz and D. Chai, "A TN-LCoS adaptive optics aberrometer and wavefront corrector," SPIE Journal of Biomedical Optics, vol. 14, no. 4, article 044014, Jul/Aug. 2009.

PATENT:

D. Habibi, J. Wyatt, A. Rassau and I. Ahmad, "A network access control mechanism", US provisional patent (60/991,842), 2009.

A. Tan and D. Chai, "Mobile Multi-Colour Composite (MMCC(tm)) 2D-barcode", AU provisional patent, 2009.

CONFERENCE:

D. Habibi, I. Ahmad, and K. Zen, "A New Algorithm to Improve Mobile Sensor Node Connectivity Based on Link Quality Indicator," in proc. IEEE TENCON, pp.1-6, Singapore, 2009.

H. Zen and D. Habibi, 'Resolving Collision in 802.11 Contention Mode by means of Scheduling Reserved Contention Window', in proc.12th International Symposium on Wireless Personal Multimedia Communications (WPMC'09), September, Japan, 2009.

T. Bednarz, C. Caris, and O. Dranga, "Human-Computer Interaction Experiments in an Immersive Virtual Reality Environment for e-Learning Applications", in proc. Australasian Association for Engineering Education Conference (AAEE2009), Adelaide, pp. 834-839, December 2009.

H. Pfliegerer and S. Lachowicz, "Numerically Controlled Oscillator with Spur Reduction", in proc. 16th International Conference mixed design of integrated circuits and systems mixdes, pp. 667-670, June 2009.

K. T. Tan, S. K. Ong and D. Chai, "Modelling of camera phone capture channel for JPEG colour barcode images," International Conference on Signal Processing and Pattern Recognition (SIP'2009), Jeju Island, Korea, Dec. 2009. [Conference Date: 10-12 Dec 2009]

S. K. Ong, D. Chai and K. T. Tan, "Performance of mobile camera on colour 2D barcode," IEEE International Symposium on Intelligent Signal Processing and Communication Systems (ISPACS'2009), Kanazawa, Japan, pp. 497-500, Dec. 2009.

H. Kato, K. T. Tan and D. Chai, "Novel colour selection scheme for 2D barcode," IEEE International Symposium on Intelligent Signal Processing and Communication Systems (ISPACS'2009), Kanazawa, Japan, pp. 529-532, Dec. 2009.

M. de Gouveia, A. Osseiran and D. Chai, "Speed sign detection," Tenth Postgraduate Electrical Engineering & Computing Symposium (PEECS'2009), Edith Cowan University, Perth, Australia, Oct. 2009.

S. O'Sullivan and D. Chai, "Four-Bit Colour Models for 2D Colour Barcodes," Tenth Postgraduate Electrical Engineering & Computing Symposium (PEECS'2009), Edith Cowan University, Perth, Australia, Oct. 2009.

S. K. Ong, D. Chai and K. T. Tan, "Innovative border for colour 2D barcode," Tenth Postgraduate Electrical Engineering & Computing Symposium (PEECS'2009), Edith Cowan University, Perth, Australia, Oct. 2009.

G. Wild, S. Hinckley, "Acoustic Communications: A Link Between SHM and Robotic NDE" in proc. 7th International Workshop on Structural Health Monitoring, pp. 870-877, Stanford University, California, USA 2009.

G. Wild, and S. Hinckley, “Distributed Optical Fibre Smart Sensors for Structural Health Monitoring: A Smart Transducer Interface Module,” in proc. International Conference on Intelligent Sensors, Sensor Networks and Information Processing, pp. 373-378, Melbourne, Australia 2009.

G. Wild, and S. Hinckley, “A Smart Transducer Interface Module for Fibre Bragg Grating Sensors,” in proc. Australian Conference on Optical Fibre Technology, pp. 521-522, Adelaide, Australia, 2009.

HIGHER DEGREE BY RESEARCH LOAD (List name of candidate and degree type)

Mr Viet Quoc Phung (PhD candidate)

Ms Kartinah Zen (PhD candidate)

Mr Mahir Meghji (PhD candidate)

Mr Siong Khai Ong (PhD candidate)

Ms Kelly Eng (PhD candidate)

Mr Graham Wild (PhD candidate)

Mr Paul Jansz (PhD candidate)

Mr Biswojit Bose (PhD candidate) - research scholarship fully supported by CCER

Mr Rajesh Ramraj (PhD candidate) - research scholarship fully supported by CCER

Mr Thair Mahmood (PhD candidate)

Mr Waleed Alnaqbi (PhD candidate)

Mr Derryn Harvie (PhD candidate)

Mr Irfan Ullah (Masters candidate) - research scholarship fully supported by CCER

HIGHER DEGREE BY RESEARCH COMPLETIONS (List name, degree, title of thesis)

Hushairi Zen, PhD.

Hoang Nghia Nguyen, PhD.

Hiroko Kato, PhD.

VISITORS AND COLLABORATIONS (List the organisation's name and short summary of the nature of the collaboration. Separate into local, national and international)

The center has established links with a number of research organisations in Australia and overseas.

Links at national level include:

Public Transport Authority, WA.

(currently conducting a collaborative project on video surveillance on public trains)

Monash University, Australia.

(working with the communication network research group at Gippsland School of IT, Monash University).

University of Sydney, Australia.

(collaborating with Dr Guoqiang Mao at the School of Electrical and Information Engineering)

University of Wollongong, Australia.

(Initiated collaboration with Professor Farzad Safaie, ICT Institute).

The University of Western Australia, Australia.

(collaborating with Professor Brendan Griffin and Associate Professor Martin Saunders, Centre for Microscopy, Characterisation and Analysis, CMCA).

CSIRO, Brisbane

(collaborating with Dr Tomasz Bednarz on a joint project).

Links at international level include:

Gwangju Institute of Science and Technology (GIST), Korea

(collaborating with Associate Professor Saeed Nooshabadi, Department of Information and Communications).

Ulm University (Germany).

(collaborating with Professor Hans-Jörg Pfliederer from the Institute of Microelectronics of Ulm University, Germany for a project on optimization of Direct Digital Frequency Synthesis algorithms for FPGA (Field Programmable Gate Array) implementation).

COMMUNITY ENGAGEMENT ACTIVITIES AND LINKAGES (Provide an overview)

INDUSTRY ENGAGEMENT: Foundation Fieldbus End-User Group

CCER has been collaborating with Foundation Fieldbus End-User Group (FFEUG) towards expanding ECU's teaching and research capabilities in Fieldbus technologies. A funding of \$100k has been received for the establishment of an Australian centre of expertise in Fieldbus technologies.

INDUSTRY ENGAGEMENT: Perth Energy

Members of CCER have been working with Perth Energy, a major retailer of electricity in Perth metropolitan area, towards mutual areas of interest in smart grids and smart energy systems. There is a notional agreement at this stage that Perth Energy will provide PhD scholarships to support research in these areas.

INDUSTRY ENGAGEMENT: ECU Buildings and Maintenance Services

A research project was established to investigate power factor problems on the Mount Lawley Campus of ECU. The project has been successful, resulting in a set of recommendations which will reduce ECU's electricity bill for ML campus. These recommendations are being implemented by Building and Maintenance Services.

INDUSTRY ENGAGEMENT: HWE

HWE are currently working with CCER members to establish a project for the development of an intelligent system to fully automate the process of changing tyres on mining trucks. Currently this process is only semi-automatic, resulting in a larger number of injuries per year.

INDUSTRY ENGAGEMENT: Perth Transport Authority (PTA)

Significant progress has been made towards the establishment of a wireless video network across the rail network of PTA for live monitoring of trains through a central control room. Two PhD scholarships have been awarded from the research funds of this project, and the addition of two PhD candidates to this project has boosted our human resources to ensure good quality outcomes for PTA.

CONFERENCE PARTICIPATION

IEEE TENCON, Singapore, 2009 .

7th International Workshop on Structural Health Monitoring, USA, 2009.

International Conference on Intelligent Sensors, Sensor Networks and Information Processing, Melbourne, Australia 2009 .

Australian Conference on Optical Fibre Technology, Adelaide, Australia, 2009 .

Australasian Association for Engineering Education Conference (AAEE2009), Adelaide, Australia 2009.

WORKSHOPS/SEMINAR PARTICIPATIONS

"What is the Smart Grid and What is Needed to Make it a Reality" by Prof. Saifur Rahman, Virginia Tech, organised by IEEE.

"Role of Renewable Energy in Mitigating the Need for Large Central Station Power Plants", by Prof. Saifur Rahman, Virginia Tech, organised by IEEE.

"Hybrid Power Stations for Marble Bar & Nullagine – The Two Hottest Towns in WA" by Thom Fox, Horizon Power, Australia.

Seminar on Matlab & Simulink organized by Mathworks.

FUTURE PLANS AND DIRECTION (Provide an overview)

The centre will continue to work with ORI towards commercialisation of the products that have been developed at the centre. Two products on which the centre has provisional patents have good potential to either form the basis for the formation of a company, or, be licensed to existing vendors and product developers.

In coming years, the centre will maintain its efforts and strategy to attract more HDR students to further strengthen the research capabilities and outcomes of the Faculty and University. Members of the centre believe that successful completions of their on-going projects (please see Appendix A) will lead to more successes in terms of collaborative projects, community engagement and enrolment of HDR students. The centre aims to establish more linkages with industry towards research collaboration and funding, and with various national and international research groups and organisations. The centre will put more emphasis on interdisciplinary projects, particularly in collaboration with health, and/or environmental science. The centre will continue its efforts to secure competitive grants at the national and international levels. The centre participated in the ARC discovery grant application round in the past three years (please see Appendix A). Although the centre has not been successful to secure an ARC grant, members of the centre are confident that their experience from previous rounds will assist them to secure successful ARC grants for the centre in near future.

DATE OF NEXT FORMAL REVIEW

August 2010

APPENDIX A

ARC RESEARCH GRANT APPLICATIONS LODGED IN 2009

I. Ahmad and D. Habibi, "A wireless communication framework for low cost broadband access in rural/regional/urban areas.," ARC Discovery Grant.

MAJOR ON-GOING RESEARCH PROJECTS

Video surveillance network for real-time central monitoring of passenger safety and security on public trains.

Public transportation has regained its popularity over the last few years mainly due to a sharp increase in fuel price and environmental awareness. This offers a new challenge for the public transport authority to introduce an improved safety and security management. As a measure to improve the safety and security management, most of the public transport stations are now equipped with CCTVs. The issue that still remains a major research challenge is to enable CCTV on public transports when they are on the move. The aim of this project is to develop new strategies to increase uploading video data rate from moving public transports so that a centrally monitored real-time video surveillance system can be facilitated on public transports.

New strategies to improve throughput in mobile WiMAX and LTE-A communications.

The IEEE 802.16 standard, also known as WiMAX, has emerged as an exciting technology for broadband wireless communications with potentials to offer high throughput and support high bandwidth demanding applications. WiMAX however, has yet to prove its effectiveness when the end terminals are not fixed and have the capacity to move from one place to another at different speeds. Multipath fading that causes high bit error rate at the receiver end is a key reason for low throughput at high speed. In this project, we aim to propose new techniques to improve throughput in Mobile WiMAX communication. This research will have significant impacts on diverse wireless applications starting from the Internet facilities on moving vehicles to video surveillance applications on public transports.

Capacity design for multiple quality of protections in shared risk link groups optical mesh networks.

The aim of this research is to study the capacity design problem in survivable optical mesh networks. The research question is to how to employ multiple appropriate protection schemes to protect different Multiple Quality of Protection (MQoP) service classes with minimum capacity requirements. In addition, due to economic issues, our research focuses on investigating real optical networks which usually comprise of many Shared Risk Link Group (SRLG) in which many fibre links are bundled in a conduit.

Medium access control protocol for guaranteed quality of service of (QoS) voice and video in wireless local area networks.

The media access control (MAC) layer is responsible for controlling which node of the wireless network is allowed to access the shared channel and how nodes communicate with each other, hence it is directly responsible for the throughput, delay and jitter characteristics observed at each node. Many different wireless MAC schemes have been developed to support a wide variety of services whilst trying to ensure that QoS is guaranteed. The existing MAC schemes however, are not efficient in terms of throughput and QoS guarantee. The aim of this project is to improve throughput and QoS of end applications in wireless communications.

Quality of services for multimedia applications in Wireless LAN.

The deployment of wireless local area networks (WLANs) has been on the rise over the last decade. Unfortunately, support to provide QoS for multimedia applications is not yet available. The existing protocol standard like the IEEE 802.11b does not support QoS while the IEEE 802.11e provides certain degree of QoS support, but further research is required to optimize the protocol. The objective of this research is to design a MAC protocol that provides QoS guarantee for real-time traffic in wireless communications.

A MAC protocol to provide efficient mobility in wireless sensor networks.

The aim of this research is to enhance the MAC protocol for mobile sensor networks based on the standard IEEE 802.15.4 so that it can overcome the synchronization, association and collisions problems due to the movement of the nodes. The current standard only supports static wireless sensor networks and the protocol is believed to degrade the network performance if it is applied in mobile sensor networks. The main objective of this research is to make sure that the enhanced protocol maintains the throughput and consumes minimum energy when operates in mobile sensor networks environment. The synchronization, re-association and association problems will be improved by making the node aware of its position whether it is moving away or towards to its original coordinator.

2D barcode design for mobile phone applications.

The project investigates the design of a novel color 2D barcode optimized for camera-enabled mobile phone platform. The integration of 2D barcode technology and camera phone technology provides general users with interesting and convenient applications. Examples of such applications include web link, online shopping and e-ticketing. Captured on a camera phone, the information encoded in the format of a 2D-barcode is decoded and used to perform certain applications. Considering that mobile phones have become a part of many daily lives and are always within reach, people can use such mobile applications according to their convenience. This research also aims to establish a standard 2D barcode, on which the third party software vendors and manufactures can develop new functions and applications. This will, in turn, provide general users with more available mobile applications.

Wireless acoustic communications for autonomous agents in structural health monitoring sensor networks.

In this project, we demonstrate wireless acoustic communications methods that include both electro-acoustic and acousto-optic communications. The communications methods are intended

for use by autonomous robotic agents in the Non-Destructive Evaluation (NDE) of structures containing a distributed acoustic emission sensor network. The acoustic emission sensors can be based on either piezoelectric or optical fibre sensors. Distributed acoustic emission sensors are used in Structural Health Monitoring (SHM) for the detection of impacts and/or strain, in real time. Secondary damage may result from the initial impact or strain. This damage may include surface pitting, erosion, or cracking. These types of secondary damage may not be detectable, and hence may not be able to be monitored by the SHM system; specifically in optical fibre based sensing systems. The integration of NDE by robotic agents into a SHM sensor network enables the detection and monitoring of a wider variety of damage. Acoustic communication represents a wireless communication method that does not require any additional hardware, as piezoelectric transducers are commonly used in the NDE of materials. Various modulation methods are being investigated for the communications channel. These include Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), and Phase Shift Keying (PSK). Successful communication was achieved using both the piezoelectric and optical fibre receivers. The optical fibre sensor is based on a Fibre Bragg Grating (FBG).

A transmit reflect detection system for fibre Bragg grating photonic sensors.

Traditional Fibre Bragg Grating (FBG) sensing systems acquire data about the measurand via the spectral response of the FBG. Edge filter methods are also used in the acquisition of data from FBGs. In edge filter systems, the spectral shift in the FBG due to the measurand is converted into an optical power change. This optical power change can then be easily measured using conventional optoelectronic devices. In this research, we have developed a Transmit Reflect Detection System (TRDS) for Fibre Bragg Grating (FBG) sensors. The TRDS is in essence a dual edge filter detection method. In conventional edge filter detection schemes, the reflected portion of the incident spectrum is monitored to determine the change in the measurand. In the TRDS, both the transmitted and reflected portions of the input spectrum, from a narrow band light source, are utilised. The optical power of the transmitted and reflected signals are measured via two separate photoreceivers, where each generates a single edge filter signal. As the spectral response of the FBG shifts due to the measurand, the transmitted power will increase, and the reflected power will decrease, or vice versa. By differentially amplifying the transmitted and reflected components, the overall signal is increased. This results in improved sensitivity and efficiency of the photonic sensor.

A novel microphotonic structure for generating true time delays for application to optical coherence tomography.

Conventional time domain Optical Coherence Tomography relies on the detection of an interference pattern generated by the interference of backscattered light from the sample and a reference Optical Delay Line (ODL). By referencing the sample interference with the scan depth of the ODL, constructive interference indicates depth in the sample of a reflecting structure. Conventional reference ODLs require some physical movement of a mirror to scan a given depth range. This movement results in instrument degradation. Also in some situations it is necessary to have no moving parts. Stationary ODL include two discrete step types: dual reflective Spatial Light Modulator (SLM) systems and single transmissive SLM with match-

arrayed-waveguide systems. In this research, we are developing low cost stationary ODLs based on a novel Stepped Mirrored Structures (SMS) structures.