Global Collaborative Research to support ubiquitous Healthcare (u-Health)

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Asia-Pacific u-health research Centre (APuHC)

• UNSW Research Centre set up in Dec 2006 involving UNSW faculties of Business, Engineering and Medicine and UNSW Asia for three years (2007-2009) with a total funding of $3 million from various sources
• Strong Partnership with international bodies (e.g., WHO, ITU-D), Industry (Netstar and CAL2CAL) and overseas institutions
• Inaugurated in UNSW Asia (the only research centre) in Jan 2007

Broadband Infrastructure and Ubiquitous Healthcare

• Ability to reach healthcare anywhere at anytime (e.g., in emergency)
• Need for broadband mobile infrastructure to carry images, voice and data
• Some Asian countries have highest broadband coverage (nearly 80%) in the world and growing service sector
• Many problems (e.g., inefficiency and error) in healthcare system and ageing population in most countries
• Need for privacy and security e-Health

International Ubiquitous Healthcare (u-Health) Initiative

• Launched at Med-e-Tel (one of the largest events in e-Health in Europe, organised by the International Society for Telemedicine) 2006 in Luxembourg on April 6, 2006
• Current Partners: Australia, France, Greece, India, Japan, Singapore, Taiwan, South Korea, USA
• Resolution to set up a series of APuHC nodes all over the world

APuHC Research Goals

• u-Health Systems in different layers (Network, Applications, Service, Process and Governance)
• Ontology-Based Multi Agent Systems (OBMAS) strategies for semantic interoperability and disaster management
• Studies on the impact of u-Health
• Models for integrating u-Health in governance and business processes
• Paradigms for Promoting Healthy Life with the help of governments and businesses
• Pandemic and Bio-terrorism Control in collaboration with other global centres, such as WHO GOARN, APEC EAN-HIV, Korean Centre for Genome Sciences and APEC EINET
• To Showcase the u-Health technologies, processes, and services at IEEE Healthcom

Research Programs

1. Cooperative Management and Semantic Interoperability- attracted 6 (including four ARC) Research grants since 2000 with UNSW (CSE), WCH (Aust), CGU, SNHU, SJSU (USA)
2. Service Level Management and icare- attracted 5 (including one ARC, one international and 1 industry) research grants since 2004 with NCCU (Taiwan), IBM-Global, Netstar (Aust), UC-Irvine, RPI (USA), I2R Singapore
3. E-Health for Developing Countries- attracted 2 (including WHO and ITU-D initiatives) since 2005 with NTU (Taiwan) and six developing countries (India, China, Vietnam, Thailand and Philippines)
Program 1 Projects

• Cooperative Management and Semantic Interoperability (3 Ongoing ARC Grants)
  - Australian Research Council (ARC) Discovery 2007 Grant: "Managing E-Business using Ontology-Based Multi-Agent Systems (OBMAS)" (Approx $230,000) for 2007-2009; Chief Investigators: Pradeep Ray, Ram Bhar, N. Parameswaran, R. Jamieson (UNSW) and Lundy Lewis (USA)
  - Australian Research Council (ARC) Linkage Projects 2005 Round 2 Grant: "Distributed Autonomic Management: A New Paradigm for Integrated Network Management" (Approx $220,000) for 2005-2008; Chief Investigators: Pradeep Ray, N. Parameswaran (UNSW) and Lundy Lewis (USA), Industry Partner: Netstar
  - TOPIC: Intelligent Situation Management: A New Paradigm for Disaster Management (UNSW Goldstar 2008)
    • Chief Investigators: Pradeep Ray, N. Parameswaran, Fethi Rabhi (UNSW), Lundy Lewis (USA)
    • Collaborators: Karlsruhe University (Germany), WHO

Program 1 Projects-II

  • Chief Investigators: Pradeep Ray, R. Bhar, N. Parameswaran, R. Jamieson (UNSW) and Lundy Lewis (USA)
  • Collaborators: NICTA Smart Applications For Emergencies (SAFE) Program

• Ontology-Based Multi-Agent Systems (OBMAS)
  - Development of Ontologies for driving Intelligent Agents
  - A Generic Multi-layer Framework for Ontologies to work with any Agent Platform
  - Applications in Healthcare, Finance and Telecommunications

Program 1 Projects-III

  • Chief Investigators: Pradeep Ray, N. Parameswaran (UNSW) and Lundy Lewis (USA)
  • Industry Partner: Netstar
  - The Internet based e-services are being used by many businesses as part of the modern e-business environment (e.g., e-health). Management of e-services over the Internet involves complex correlation of events, and their sequences over geographically dispersed networks, systems and software applications. The integration of management information is a challenging problem due to the semantic differences of services across different business sectors (e.g., healthcare). This project aims to develop a new framework for the integrated management of networked services using multiple software agents, some of them are already a part of the current Internet infrastructure. Management of Privacy and Security are major concerns.
  - One APAI PhD, Two M.Phil, two honours (completed)
Security and Privacy of u-Health

- Integrate e-Business (incl e-Health) Security Management based on Ontology Based Multi-Agent Systems (OBMAS)
- Facilitate automated negotiation of security (including fraud) services for u-Health
- Cooperative Management of Privacy in Consumer Health

Privacy and Technology

Program 1 Project -IV

- Chief Investigators: Pradeep Ray, N. Parameswaran (UNSW) and Lundy Lewis (USA)
- This project aims to develop a new paradigm (based on the biological phenomena of antibiotics) for integrated network management solutions that would be suitable for the next generation of dynamic networked services that would have to be protected from cyber-terrorism. Besides, these solutions would be able to cater for evolving, increasingly intelligent network components, without using too much resources in the network. We have been working on paradigms, such as Artificial Immune Systems for this purpose.
- One PhD, four honours (completed)

Program 2 Projects

- Service Level Management and I-care (One International and one DEST grant)
  - Milestone 2 "Development of Interactive Management Environment for eHealth" (Approx $245,000), part of DEST Innovation Science Linkage Competitive Grant titled "Efficient Management of Information Resources Over Ad-Hoc Data Grids" in Round 10 funding of $852,772 led by A/Prof Fethi Rabbi
  - International Service Science Award - IT-Shaped Service Innovation for Optimizing Business Objectives in e-Caring Industry (Approx $400,000) for 2006-2008; Chief Investigators: Prof Soe-Tsyr Yuan et al (NCCU, Taiwan), Prof. Kwei-Jay Lin, (Univ of California-Irvine, USA), Prof James Tien (RPI, USA) and P.Ray (UNSW), jointly supported by IBM Shared University Research (SUR) Grant 2006 and participant organisations

Program 2 Project -I

- Development of Interactive Management Environment: 2008-2009 (part of DEST ISL Grant 2006 on Ad-hoc Data Grids led by Fethi Rabbi in collaboration with European universities)
- Chief Investigators: Pradeep Ray, Fethi Rabbi, Boualem Benatallah, Mike Briers and Schahram Dustdar (Austria)
- This is a collaborative project to develop tools for managers to automate the analysis of ad-hoc data based on domain-specific descriptions (e-Health in this case). We will also deliver an interactive environment where the processed data is summarized, clustered and visualized in the context of a e-Health situation, using ad-hoc data grids.
- One Post Doc, One PhD

Program 2 Project-II

- IT-Shaped Service Innovation for Optimizing Business Objectives in e-Caring Industry:International Service Science Award jointly supported by IBM Shared University Research (SUR) Grant 2006 and participant organizations in US, Taiwan and Singapore
  - Chief Investigators: Prof Soe-Tsyr Yuan et al (NCCU, Taiwan), Dr. Chen (NTU, Taiwan) Prof. Kwei-Jay Lin, (Univ of California-Irvine, USA), Prof James Tien (RPI, USA) and P.Ray (UNSW)
- This project aims to develop and validate the business and software architecture models for comprehensive intelligent care (e.g., aged care) in the modern e-enabled society. The project plans to use the Service Oriented Architecture and the evolving Service Science paradigm.
Comparison of Issues In Developed and Developing Countries

- Developing Countries
  - Stand to gain a lot from e-Health to reach healthcare to masses
  - Suffer from many problems including lack of infrastructure and frequent disasters
  - Mobile wireless technologies offer solutions
- Developed Countries
  - Face the problem of ageing population
  - Interoperability Problems
  - Need sophisticated IT Solutions, such as intelligent agent systems
  - Emerging Concerns on Privacy for Web-based Consumer Health

Program 3 Projects

- E-Health in Developing Countries (Grants from various sources)
  - World Health Organisation (WHO) Initiative “Research on Assessment of e-Health for Health Care Delivery (eHCD)”, Total Outlay approx $20,000 involving eight countries
    Principal Investigators: Dr. Steffen Groth (WHO) and Pradeep Ray (UNSW) with collaborators from India, China, Vietnam, Philippines, Thailand and Sri Lanka
  - IEEE/ITU-D Mobile e-Health Initiative for Developing Countries (20 countries in the consortium) in disaster management, Pandemic/ Bioterrorism control, Joint Leaders: A/Prof Pradeep Ray, UNSW and Prof Isao Nakajima, Tokai University, Japan
    Chronic Illness Management, Chief Investigators: P. Ray, L. Pilotto, N. Parameswaran and S. Chattopadhyay (UNSW), P. Snelling (RPA), D. Gration (GSAHS) and H.S. Chen (NTU)

Program 3 Projects-I

  - Principal Investigators: Pradeep Ray (UNSW) and Dr. Steffen Groth (WHO) + R. Jayasuriya and Lesley Land
  - There have been claimed successes by technologists on Telemedicine and e-Health. However, the recent studies by the European Union e-Health research funding group show that the uptake of e-Health technologies has been slow in Europe and some other developed countries. It seems many of the findings of IT researchers do not conform to “evidence-based research” methodologies used by healthcare researchers. This project aims to address this problem by using evidence-based research in pilot projects in e-Health (to assess the use of e-Health for Healthcare Delivery) formulated by healthcare professionals in a number of developing countries in the Asia-Pacific region.
    - One Post Doc, One M.Phil

Program 3 Project-II

- Topic: ITU-D Mobile eHealth Initiative for Developing Countries
  - Leaders: P. Ray (UNSW) and I. Nakajima (Tokai Univ, Japan) + Mahbub Hassan, N. Parameswaran, S. Chattopadhyay and Pieter Aquilia (Singapore)
  - Collaborators: CAL2CAL-USA, Rockefeller Foundation, IPSTAR (under discussion)
  - This initiative is developing eHealth kiosks for emergency telemedicine, pandemics and bioterrorism
    - One PhD, One honours (completed)

Pilot projects

1. Demonstration of cost-effectiveness in introducing EPR in PHCs in a country
2. Demonstration of value of e-referrals of the patients in a country
3. Demonstration of training effects and improved quality through teleconsultation in dermatology
4. Demonstration of training effects and improved quality through teleconsultation in cardiology (ECG)
5. Demonstration of training effects and improved quality through Tele-consultation in Radiology
6. Demonstration of training effects and improved quality through teleconsultation in histopathology
7. Demonstration of the effects of EPR, email and consultation services on referral pattern in PHCs
8. Evaluation of the usage of e-learning modalities in PHCs
ITU-D/IEEE Mobile eHealth Initiative for Developing Countries

- Joint Effort of ITU-D Q14 and IEEE Healthcom started in 2004 (consortium of twenty countries)
- Use of Mobile Wireless Technologies for supporting eHealth for applications, such as
  - Emergency Telemedicine
  - Epidemic Control
  - Combating Bioterrorism

Trials in Tsunami Affected areas

- Trials in Indonesia and India
- Collaboration with the Healthcare IT vendors
- Mobile unit with diagnostic equipment and communication link-up with natural referral hospital(s) (district / medical college / specialty hospitals)
- Communication link between remote site and major hospital through various wireless mobile technologies, such as satellites, GSM cellular, WiFi, WiMAX etc.
- Operated by trained general practitioner/health worker from within the public health system

Tackling Pandemic/Bioterrorism

Stakeholders / Communities:
1. Intelligence Agencies, Law Enforcements, ...
2. Researchers, Scientists, ...
3. Public, Farmers, ...

Events:
A – Traditional Terrorist Attacks
B – Bioterrorism
C – Natural Outbreaks

Multi-layer Information Model

- Establish and maintainence of process models
- Provide standardized, efficient, and sufficient services & applications that are accessible anywhere, anytime
- Provide infrastructure and technologies

A Global u-Health Framework for Pandemic Control

- Org/Gov
- Process
- Service
- Appl
- ICT

e.g., connectivity

Stages: Prevention, Detection & Verification, Response, Recovery

- Disease Prevention
- Disease Control
- Disease Treatment
Program 3 Project-III

- **Topic**: Chronic Illness Management
- **Leaders**: P.Ray, L.Pilotto, N. Parameswaran and S. Chattopadhyay (UNSW), P. Snelling (RPA), D. Gratton (GSAHS) and H.S. Chen (NTU)
- **Collaborators**: Greater Southern Area Health Service (GSAHS), NTU (Taiwan)
- This project aims to develop an Ontology-Based Intelligent System for the Management of Chronic Illnesses of a number of types, such as renal illnesses, mental illnesses and cancer through collaborations with organisations in Australia (e.g., GSAHS) and overseas (e.g., NTU Taiwan)

APuHC Performance

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Research Collaborations

- **Academic Collaborators**:  
  - National Taiwan University and National Cheng-Chi University, Taiwan  
  - Claremont Graduate University and SNHU, USA  
  - Karlsruhe University-Germany  
  - Institute of Information Science, National Chiao Tung University, Taiwan  
  - Institute for Infom Research (I2R), Singapore  
  - WHO, Geneva  
  - ITU-D, Geneva  
  - Ministry of Health in India, China, Vietnam and Philippines

- **Government and Industry partners**:  
  - Netstar Networks, Australia  
  - IBM  
  - Institute for Infom Research (I2R), Singapore  
  - WHO, Geneva  
  - ITU-D, Geneva  
  - Ministry of Health in India, China, Vietnam and Philippines

Plans for 2007 and 2008

- WHO Collaborating Centre on eHealth for Health Care Delivery (eHCD) expected approval in 2008, involving Zixiu Guo, Louis Pilotto, A. Whelan
- Two ARC Grants Applications Submitted, more planned in 2008
- Ten refereed articles (including 3 ISI-listed journal papers) accepted in 2007, more under development
- Rockefeller Foundation Project Mekong Delta Basin Surveillance (Kthon Kaen University, Thailand) involving Farhad Daneshgar, Geoff McDonnel
- New Projects on e-Health for Chronic Illness Management (UNSW Asia Internal grant+ GSAHS) in collaboration with NTU Taiwan involving Steve Tipper
- New Collaborative research project on Bio Terrorism and Disaster management (ARC/ABCRC-Aust, CAL2CAL, NDU-USA, Karlsruhe Univ-Germany, LORIA-France) involving Ali Abbas