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**UNU-IIST**

International Institute for  
Software Technology

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# UNU-IIST Annual Report 2007

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Mike Reed, Chris George, Wendy Hoi Lok Wa

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## UNU-IIST and UNU-IIST Reports

UNU-IIST (United Nations University International Institute for Software Technology) is a Research and Training Centre of the United Nations University (UNU). It is based in Macao, and was founded in 1991. It started operations in July 1992. UNU-IIST is jointly funded by the government of Macao and the governments of the People's Republic of China and Portugal through a contribution to the UNU Endowment Fund. As well as providing two-thirds of the endowment fund, the Macao authorities also supply UNU-IIST with its office premises and furniture and subsidise fellow accommodation.

The mission of UNU-IIST is to assist developing countries in the application and development of software technology.

UNU-IIST contributes through its programmatic activities:

1. Advanced development projects, in which software techniques supported by tools are applied,
2. Research projects, in which new techniques for software development are investigated,
3. Curriculum development projects, in which courses of software technology for universities in developing countries are developed,
4. University development projects, which complement the curriculum development projects by aiming to strengthen all aspects of computer science teaching in universities in developing countries,
5. Schools and Courses, which typically teach advanced software development techniques,
6. Events, in which conferences and workshops are organised or supported by UNU-IIST, and
7. Dissemination, in which UNU-IIST regularly distributes to developing countries information on international progress of software technology.

Fellows, who are young scientists and engineers from developing countries, are invited to actively participate in all these projects. By doing the projects they are trained.

At present, the technical focus of UNU-IIST is on formal methods for software development. UNU-IIST is an internationally recognised center in the area of formal methods. However, no software technique is universally applicable. We are prepared to choose complementary techniques for our projects, if necessary.

UNU-IIST produces a report series. Reports are either Research **[R]**, Technical **[T]**, Compendia **[C]** or Administrative **[A]**. They are records of UNU-IIST activities and research and development achievements. Many of the reports are also published in conference proceedings and journals.

Please write to UNU-IIST at P.O. Box 3058, Macao or visit UNU-IIST's home page: <http://www.iist.unu.edu>, if you would like to know more about UNU-IIST and its report series.

G. M. Reed, Director



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## **Abstract**

This document covers UNU-IIST's activities in 2007. It describes the implementation of UNU-IIST's research, development, and training projects, its reports and its publications.



Contents



## 1 Executive Summary

Within its target area of software technology, UNU-IIST seeks to balance the activities of research, training, and development. It focuses on the needs and opportunities of developing countries. It also balances the need for computing to be seen as a science, and for education in it to be rooted in fundamentals of that science, with the need to work with new and emerging technologies. Projects are chosen both to further the science and to meet the needs of software development in developing countries.

### 1.1 Projects

Major themes for projects in 2007 have included:

- theories and tools for software technology
- electronic governance
- open source software for environmental applications

#### 1.1.1 Theories and tools for software technology

Projects were conducted in the following areas:

- object and component systems
- real-time systems
- distributed and concurrent systems
- incremental methods for software technology
- computer security
- software verification
- human-machine interaction

The above projects have been directly funded by UNU-IIST, the European Union, and the Macao Science and Technology Development Fund, with external funding exceeding 300,000 USD per year. Indirect funding via travel support and research collaboration of approximately 100,000 USD has been provided by our research partners in Europe, China, and India.

### 1.1.2 Electronic Governance

To strengthen further Electronic Governance-related activities in UNU-IIST, the Center for Electronic Governance was established in January 2007. The aim of the Center is to build capacity and provide know-how and advice in planning, implementing and evaluating programs for e-Governance, working in partnership with governments and universities from developing countries, and with international and UN organizations. To this end, the Center carries out research, dissemination, as well as human, organizational and technical development to connect the theory and practice of Electronic Governance.

Following successful completion of the first phase of the e-Macao Project, the Center continues to provide both high-level advice and technical directions to the Government of Macao SAR on e-Government issues as part of the on-going three-year e-Macao Program. In terms of high-level advice, the Center provides inputs into the policies and strategies for e-Government and the necessary alignment with the Public Sector Reform agenda in Macao SAR. In the area of technical intervention, its contributions include the specification and development of software infrastructure for public services, methodology and toolkit for strategic IT planning for public agencies, and the provision of standards and best practices for e-Government.

The outcomes obtained through various projects run by the Center are being disseminated to developing countries within the framework of the UNeGov.net initiative. The aim of UNeGov.net is to build a global community of practice for e-Governance. In 2007, the Center organized 12 regional and national UNeGov.net events - workshops, schools and conferences in: Colombia, India, Macao, Mongolia, Nepal, North Korea, South Korea, and the USA. Notable among these events were: 1st International Conference on Theory and Practice of Electronic Governance (ICEGOV2007), Macao, attended by 200 participants from government, academia and industry from 50 countries; 9th UNeGov.net Workshop and 6th School in Bogota, Colombia, attended respectively by 250 and 120 participants from Colombian Government; 10th Regional Workshop and 7th Regional School in Incheon, South Korea, attended by 36 participants from 19 Asian countries; 8th UNeGov.net School in Pyongyang, North Korea; 4th International Conference on Distributed Computing and Internet Technologies, Bangalore, India; and an event in UN Headquarters on Building South-South Cooperation for Electronic Governance, New York.

During 2007, the Center continued building partnerships with: governments in developing countries, particularly in Colombia, Mongolia, Nepal and Nigeria; UN organizations such as UN-DESA Division for Public Administration and Development Management, UNDP Special Unit on South-South Cooperation, and UNESCAP Asia Pacific Center for ICT for Development; organizations such as the Canada School for Public Service, Korea Agency for Digital Opportunity and Promotion and Open Courseware Consortium; UNU RTC/Ps such as the UNU Center, UNU-ONY, UNU-INWEH and UNU-MERIT; other centers of excellence in e-Governance such as the Center for Technology in Government, University at Albany, State University of New York; and private-sector organizations like Microsoft.

Currently external funding for the Center is approximately 500,000 USD per year.

### 1.1.3 Open source software for environmental applications

Environmental modelling to support water management has a proven success record but is very expensive. So expensive that it cannot be afforded in most places in developing countries. At the same time watersheds, rivers and lakes are under increasing stress from growing populations, industries, and agriculture which both consume water and pollute water resources. The aim is to create a generic model of water resources together with a decision support system intended for use in developing countries that is cheap to instantiate while being effective in operation. The system will support the modelling of existing situations as well as the generation and comparison of results for possible alternative scenarios. Thus it will support such activities as development planning, the exploration of ways to counteract environmental degradation, and the mitigation of events such as global warming or polluting accidents. The tools will as far as possible be free of charge and open source, and capable of using free data from the internet as well as local data. The prototype tools now exist and are being tested. The project is primarily in collaboration with UNU-INWEH, and combines the expertise of INWEH in water modelling and management with the expertise of IIST in software development. Initial funding was provided by the UNU collaboration fund. We are now seeking external funding.

## 1.2 Training

UNU-IIST's main concern is the development of software technology in developing countries, and it concentrates on capacity building through postgraduate training.

Training takes five forms: fellowships at UNU-IIST (19 fellows from 9 countries); joint PhD students with associated universities (2); postdoctoral fellows at UNU-IIST (4); fellowships for computer science lecturers at universities in developing countries to train in developed countries (7 fellows from 5 countries); and schools/courses/workshops in developing countries (19 in 14 countries).

## 1.3 Events organised

In 2007 we organised, jointly with partners, 14 international scientific meetings and conferences in 7 countries (Macao, China, Nepal, USA, Columbia, South Korea, and India).

## 1.4 Milestones in 2007

**External funding** During 2007, for the first time, UNU-IIST has been successful in (1) obtaining a large grant for basic research from the Macao Science and Research Council, (2) establishing eligibility and receiving significant research funds from the European Union, and (3) forming a partnership and obtaining funding from a major software company

(Microsoft). During 2007, UNU-IIST also secured a three-year commitment from Macao Government to continue the e-Macao Project and turn it into a government program. As advisory party, UNU-IIST will receive between 1,125,000USD and 1,350,000USD during 2007-2009.

**Representation by women** During 2007, for the first time, UNU-IIST has appointed (1) a female postdoc and (2) a female member of the Board. During 2008, it is expected that UNU-IIST will appoint the first female Research Fellow to the academic staff.

**Continued concentration on Africa** Conferences and schools organised during 2006-2007 in Ghana, Nigeria, Sudan, and Tunisia, with others planned in Cameroon, Mozambique, and Tanzania during 2008. Also during 2007, UNU-IIST appointed the first African Research Fellow to the academic staff.

**Presence in Europe** The Director and Zhiming Liu were appointed to Interlink, a committee set up by the European Commission to decide future areas for calls for EU-funded research projects in computer science; UNU-IIST is a partner with ARTIST2, a consortium of over 40 European institutions aimed at establishing collaboration between Europe and China on the development of embedded systems.

## 2 Status of implementation of project activities

### 2.1 Formal Methods for Object and Component Systems

**Staff responsible** Zhiming Liu

**Project abstract** Motivated by the need to improve the dependability and quality of software systems, the aim of this project is to a software development methodology, the rCOS methodology, to deal with the challenges of

- handling the complexity of software development projects, using separation of concerns, and
- ensuring correctness, using formal techniques and tools for modeling, design and verification.

The methodology is founded on a semantic model of object and component systems and includes techniques of modeling, design and analysis supported by a tool suite that is integrated in development processes and environments. The tool suite is to enhance the support for component-based software development; the increased degree of automation available in component-based development methods and to provide an improvement in quality and reliability of computer systems for safety critical applications. Our ambition is to achieve the aim of this project by developing and teaching a coherent and comprehensive methodology that begins with design for verification and validation and integrates

verification into development. Therefore, the project includes theoretical research, tool development, experiments on software development and technology transfer via UNU-IIST schools and training courses in developing countries.

**Main achievements** The team has published 13 papers and edited four volumes of proceedings. A great deal of effort has been spent applying the rCOS methodology to the Common Component Modelling Example (<http://agrausch.informatik.uni-kl.de/CoCoME>) and the result published.

**Status and plans** We will continue this project and make major investigations into tool development, further extension and extension of rCOS to deal with concurrency, real-time, fault-tolerance, and web-based computing.

**Sources of funding** UNU-IIST and the HQSoftD grant from Macao Science and Technology Development Fund (75 000 USD, started in 2006) and HTTS grant from Macao Science and Technology Development Fund (USD 350,000 for three years started in August 2007). Some former fellows from China have also been supported by grants from the Chinese NSF.

**Collaborations** Positioned within the Worldwide Collaborative Research on the Grand Challenge: “Verified Software: Theories, Tools and Experiments” (VSTTE), our main research will continue to focus on the theory and techniques for component software modelling, specification, designs and verification. We will contribute to VSTTE in the area of Correct Software Construction by Verified Designs. The project enjoys collaboration with the University of Macau, Macau University of Science and Technology, Prof. Anders Ravn’s group at Aalborg University (Denmark), Tata Research and Design Development Centre (India), Nanjing University (China), East China Normal University (China), National Key Lab for Parallel and Distributed Computing (China).

**Assessment** The remarkable progress of this project has been recognized in the community of formal aspects both object-oriented and component-based. It has been reflected in the collaborators (already listed) seeking association with the project; and our framework is now a topic of research projects in a number of universities (Beijing University, Nanjing University and East China Normal University) in China, funded by the Chinese NSF. Several other universities and institutes (in Beijing, Guizhou, Hunan, Nanchang, and Xi’an) start to study the results of our research. In Europe too, our research is gaining attention and it is now studied, used and even taught in classes in universities, such as Graz University of Technology (Austria) and University of Aalborg (Denmark). We have also used results and ideas in our teaching.

## 2.2 Center for Electronic Governance at UNU-IIST

**Staff responsible** Tomasz Janowski

**Project abstract** The Center for Electronic Governance at UNU-IIST (UNU-IIST-EGOV) was established in January 2007 to support the mission of UNU-IIST through high-impact

activities focusing on Software Technology and Human Capacity Development for Electronic Government, enable the acquisition and execution of projects, enhance local and international visibility, and increase opportunities for partnership and funding.

The aim of the Center is to build capacity and provide know-how and advice in planning, implementing and evaluating programs for Electronic Governance, working in partnership with institutions from developing countries, as well international and UN organizations. In line with its aim, the Center has four major goals: (1) produce concrete benefits to its stakeholders - primarily governments in developing countries; (2) connect beneficiaries - institutions in developing countries - in sharing experiences and establishing cooperation initiatives; (3) work closely with partners to access complementary capabilities and resources; and (4) continuously develop its internal capacity and capabilities.

To fulfill its mission, the Center is engaged in research, dissemination and a number of development activities - good practice development, human capacity development, institutional development and community development. To carry out such activities, the Center relies on its strong capabilities in e-Government research, education and training, software and organizational development, as well as experience in providing high-level advice to Electronic Governance initiatives worldwide. The Center currently comprises a team of 10 staff: 4 senior staff, 2 junior staff and 4 fellows, including 2 from government. This number is expected to grow to 18 staff before the end of 2008 due to the current project portfolio and international commitments.

The Center is presently engaged in all its activity areas, strategically relying on existing institutional partnerships as well as developing new ones.

The Center maintains its portal at <http://www.egov.iist.unu.edu>.

**Achievements, status and plans** The Center has recorded a number of achievements since the commencement of its operations in January 2007, in the areas of: strategic direction and internal workings, organization of events and conferences, research and development, networking and strategic partnerships, fellowships and international outreach. These achievements are briefly described below.

1. *Strategy* - To provide a clear strategic direction for the Center which is well-aligned with the mission of UNU-IIST and the UNU, a five-year strategic plan has been developed and presented to UNU-IIST Board in May 2007. Extensive organizational infrastructure has also been put in place to enable the Center cope with its growing range of activities.
2. *Projects* - A total of seven projects is currently executed by Center and described by different sections of this report: (1) UNeGov.net - Community of Practice for Electronic Governance - Section 2.3, (2) Standards for Electronic Government - Section 2.4, (3) Strategic IT Planning for Public Organizations - Section 2.5, (4) Software Infrastructure for Electronic Government - Section 2.6, (5) Semantic Interoperability for Electronic Government - Section 2.7, (6) Developing Open Courseware - Section 2.8, and (7) South-South Cooperation on Software Technology - Section 2.9.
3. *Events* - There has been a considerable increase in the number of workshops, schools and other e-government-related events organized and planned in 2007. Through its

UNeGov.net initiative, the Center organized four workshops and six schools (both national and regional) in: Colombia, India, Macao, Mongolia, Nepal, North Korea and South Korea, most organized in partnership with host governments. In addition, four other events were organized in Macao and the US. Notably, the Center organized an event on “Developing Electronic Governance in the South - New Models for South-South Cooperation” which took place on 18 October 2007 at the UN Headquarters in New York. The event brought together key international players in Electronic Governance and Regional Cooperation from Africa, Asia and South America, and various international and UN organizations such as UNDP, UNDESA, Canada School of Public Service and Academy for Educational Development.

4. *Conferences* - Two major international conferences were organized by the Center:
  - ICEGOV2007 - 1st International Conference on Theory and Practice of Electronic Governance, 10 - 13 December 2007, Macao, [www.icegov.org](http://www.icegov.org), was organized by the Center for Electronic Governance at UNU-IIST, jointly with the Center for Technology in Government, University at Albany, State University of New York, and the UN Asia-Pacific Center for ICT for Development, South Korea. The conference brought together practitioners, developers and researchers from government, academia, industry and non-governmental organizations to share the latest findings in the theory and practice of Electronic Governance. It attracted 159 paper submissions, and was attended by 200 participants from governments, academia and industry and non-governmental organizations from 53 countries. It offered a rich program of 3 invited talks, 6 tutorials, 6 workshops, 7 panel discussions, poster presentation, 12 regular paper sessions, etc. by leading researchers and international experts in the field. Conference proceedings were published by ACM Press in its International Conference Proceedings Series [1].
  - ICDCIT2007 - 4th International Conference on Distributed Computing and Internet Technology, 17 - 20 December 2007, Bangalore, India, was organized by Kalinga Institute of Industrial Technology, Bhubaneswar, India, and co-organized by the Center for Electronic Governance at UNU-IIST. In the tradition of ICDCIT conference series, ICDCIT2007 welcomed presentations of research ideas and results in theory, methodology and applications of Distributed Computing and Internet Technology. In addition, the conference emphasized that research in this area can play an important role to build a foundation for the development of e-Society Applications (e-Applications) and at the same time, that e-Applications can provide relevance and context for such research. A total of 177 papers from 20 countries were submitted for ICDCIT2007, and 33 were accepted for presentation at the conference. Conference proceedings were published by Springer as a volume of Lecture Notes in Computer Science [2].
5. *Research* - There has also been significant increase in research activities and outputs from the Center in 2007. A number of conference and seminar presentations have been made, including 16 publications - 2 at national [3, 4], 13 at international conferences [5, 6, 7, 8, 9, 10, 11, 12, 4, 13, 14, 15, 16] and 1 in a journal [17]. Most publications were in the area of foundations, models and software infrastructures for e-government. The Center is also engaged in research collaboration with Microsoft in the area of

Semantic Interoperability for Electronic Government.

6. *Fellowships* - In addition to the regular fellowship program, the Center has commence the training of “International Government Fellows”. These fellows would spend from one to three months at the Center and in other partner institutions to obtain training expected for a position of Chief Information Officer in Public Administration (the scope is similar to the training through regular UNeGov.net workshops and schools), and carry out concrete research and project in specific areas of interest to their governments. Two government fellows received such training in the Center during 2007: Ganbold Nyamdorj from the ICT Authority of the Government of Mongolia, and Bimal Shah from the National Information Technology Center, Government of Nepal. The number is expected to increase to about six per year in 2008.
7. *Partnerships* - A number of partnership agreements have been developed and formalized. Memoranda of Understanding were formulated and signed with Governments of Mongolia and Nigeria to define frameworks for intervention and technical assistance. Discussions are underway with other government partners. Partnerships with international and other UN organization are also emerging. For instance, United Nations Department for Economic and Social Affairs, Canada School for Public Service and the Academy for Educational Development have all participated in the Center’s events in 2007. In addition, the Center for Technology in Government, University at Albany, State University of New York, co-organized ICEGOV2007 with the Center.
8. *Outreach* - To increase the visibility of UNU-IIST and the UNU in general, the Center has been participating in the activities of the Open Courseware Consortium, particularly its governance committee. The Center is also leading the establishment of the Asia-Pacific Society for Electronic Governance as a sister society of the North American Digital Government Society. In addition, the Center staff gave several invited presentations at various events and locations during 2007: University of Hong Kong; Asia Development Bank and Government of Nepal, Kathmandu; Engineering Institute, Tribhuvan University, Kathmandu; Africa e-Government Forum, Accra, Ghana; Microsoft Government Leaders Forum, Beijing, China; Government Technology Exhibition and Conference, Ottawa, Canada; Pennsylvania State University, University Park, USA; UNU-MERIT, Maastrich, Netherlands; Open Courseware Conference, Utah, USA; International Conference on Theory and Practice of Software Engineering, Orlando, USA; Korea Aeronautics University, Seoul, South Korea; National Information Technology Agency, Seoul, South Korea; Korea Agency for Digital Opportunity and Promotion (KADO), Seoul, South Korea; KADO’s Digital Opportunity Forum, Jakarta, Indonesia; KADO’s Digital Opportunity Forum, Hanoi, Vietnam; Utkal University, Bhubaneswar, India.

The Center will in the first half of 2008 be completing its first project contributions to the e-Macao Program. The Center will also continue to build its internal capacity and capabilities to cope with the likely increase in project activities and events.

**Sources of funding** The Center and its activities are funded by several sources including: Government of Macao SAR through Macao Foundation, Macao Institute for Tourism Studies, Macao Education and Youth Affairs Bureau, Microsoft Corporation, UNDP Special Unit

for South-South Cooperation, UN Asia Pacific Center for ICT for Development, UNU Joint Activities Fund, UNU-IIST, and contributions by partners.

**Collaborations** The Center includes several partners such as: Macao Government and many of its agencies - SAFFP, DSC, DSF, IFT, etc.; ICT Authority, Government of Mongolia; NITC, Government of Nepal; Agenda Conectividad, Government of Colombia; National IT Development Agency, Government of Nigeria; Universidad de Externado, Colombia; Center for Technology in Government, University at Albany, State University of New York; United Nations Department for Economic and Social Affairs; Microsoft Corporation; Canada School for Public Service; Korea Agency for Digital Opportunity and Promotion (KADO); Kalinga Institute for Industrial Technology, India; Pennsylvania State University, USA; Utkal University, India; International Fund for Animal Welfare; UNU-MERIT

**Assessment** The achievements recorded so far confirm in concrete terms that the Center fulfills its objectives, its design is successful, and its operations are sustainable in the long run.

### 2.3 UNeGov.net - Community of Practice for Electronic Governance

**Staff responsible** Elsa Estevez

**Project abstract** The UNeGov.net - Community of Practice for Electronic Governance initiative aims to build a global Community of Practice, comprising researchers and practitioners interested in developing, sharing and applying concrete solutions for e-Governance.

The initiative established an activity framework comprising: (1) a community portal to document all activities of the community, coordinate its work and maintain a repository of resources relevant to Electronic Governance, (2) a series of network-building workshops to bring together various parties with major stakes in local development of Electronic Governance, (3) a series of schools and courses to build local capacity in addressing various aspects of Electronic Governance, (4) a community-wide practice framework in collaborative problem-solving based on the common repository of resources, (5) a series of state-of-the-art and state-of-practice reports about Electronic Governance in various countries, (6) a curriculum for training public officials in planning, developing and managing Electronic Governance initiatives, (7) research, development and capacity-building projects promoting Public Sector Modernization through Electronic Governance, and (8) a series of International Conferences on the Theory and Practice of Electronic Governance.

Within this framework, community actions are carried out in the scope of various thematic areas relevant to e-Governance, such as: business process reengineering, free and open-source software, government enterprise architectures, human capacity development, innovation patterns in government, international cooperation, organizational change, public benefits management, public-private partnerships, public services for rural areas, readiness assessment, security and privacy, software infrastructure, stakeholder management, standards and interoperability, strategic planning, technology adoption, and others.

More information about UNeGov.net can be found at <http://www.egov.iist.unu.edu/cegov/projects/unegovnet> and <http://www.unegov.net>.

**Achievements, status and plans** During 2007, the UNeGov.net initiative was promoted in: Asia through events organized in Nepal, Mongolia, South Korea, North Korea and India; South America through events organized in Colombia; and Africa through event involvement in Ghana. The current number of members is 520 from 35 countries.

During 2007, UNeGov.net organized 10 workshops and schools:

1. *8th UNeGov.net Network-Building Workshop on Electronic Governance in Developing Countries, Kathmandu, Nepal, 12 February 2007* - The workshop was co-organized by the National Information Technology Center (NITC), Ministry of Environment, Science and Technology (MoEST); High Level Commission for Information Technology (HLCIT); and UNU-IIST-EGOV. The event was attended by around 120 representatives from government, academia and industry in Nepal.
2. *4th UNeGov.net School on Foundations of Electronic Governance, Kathmandu, Nepal, 13 - 15 February 2007* - The school was co-organized by the National Information Technology Center (NITC), Ministry of Environment, Science and Technology (MoEST); High Level Commission for Information Technology (HLCIT); and UNU-IIST-EGOV. Around 80 people attended the school, mostly government officials and academics from Nepal.
3. *5th UNeGov.net School on Foundations of Electronic Governance, Ulaanbaatar, Mongolia, 1 - 3 May 2007* - The school was co-organized by the Information and Communication Technology Authority, Government of Mongolia, the World Bank, and UNU-IIST-EGOV. Around 85 people attended, mostly government officials, academics and members of non-governmental organizations in Mongolia.
4. *9th UNeGov.net Network-Building Workshop on Electronic Governance, Bogota, Colombia, 27 August 2007* - The workshop was co-organized by the Observatory for Society, Government and Information Technology, Externado University of Colombia; Agenda for Connectivity, Government of Colombia; and UNU-IIST-EGOV. The workshop was attended by around 250 participants from government and academia in Colombia.
5. *6th UNeGov.net School on Foundations of Electronic Governance, Bogota, Colombia, 28 - 30 August 2007* - The school was co-organized by the Observatory for Society, Government and Information Technology, Externado University of Colombia; Agenda for Connectivity, Government of Colombia; and UNU-IIST-EGOV. The school was attended by around 120 participants, mostly government officials from the national- and local-level governments across Colombia.
6. *10th UNeGov.net Regional Network-Building Workshop on Electronic Governance, Incheon, South Korea, 8 October 2007* - The workshop was co-organized by the Asian and Pacific Training Centre for Information and Communication Technology for Development (UN-APCICT), part of the UN Economic and Social Commission for Asia and the Pacific (UN-ESCAP), and UNU-IIST-EGOV. The workshop was attended by 36 government officials from 19 countries in the Asia-Pacific region.
7. *7th UNeGov.net Regional School on Foundations of Electronic Governance, Incheon, South Korea, 9 - 11 October 2007* - The school was co-organized by the Asian and Pacific Training Centre for Information and Communication Technology for Development (UN-APCICT), part of the UN Economic and Social Commission for Asia

and the Pacific (UN-ESCAP), and UNU-IIST-EGOV. The school was attended by 36 government officials from 19 countries in the Asia-Pacific region, responsible for the implementation of e-Government and ICT projects in their respective countries.

8. *8th UNeGov.net School on Foundations of Electronic Governance, Pyongyang, North Korea, 28 - 30 November 2007* - The school was co-organized by the State Academy of Sciences of DPR Korea and UNU-IIST-EGOV. The school was attended by 62 participants from 12 government and academic institutions from North Korea.
9. *11th Network-Building Workshop on Electronic Governance, Bhubaneswar, India, 21 December 2007* - The workshop was co-organized by the Kalinga Institute for Industrial Technology, KIIT University; Orissa Government; the Union Government of India; and UNU-IIST-EGOV. It was attended by about 100 participants from academia and government.
10. *9th UNeGov.net School on Foundations of Electronic Governance, Bhubaneswar, India, 21 - 23 December 2007* - The school was co-organized by the Kalinga Institute for Industrial Technology, KIIT University; Orissa Government; the Union Government of India; and UNU-IIST-EGOV. It was attended by about 80 participants from academia and government.

Besides workshops and schools, the major event organized by the Center in 2007 was ICEGOV2007 - 1st International Conference on Theory and Practice of Electronic Governance, Macao, 10-13 December 2007, [www.icegov.org](http://www.icegov.org). Taking place under the official patronage of Macao Government, ICEGOV2007 was organized by UNU-IIST-EGOV, jointly with the Center for Technology in Government, University at Albany, State University of New York, USA (CTG); and United Nations Asian and Pacific Training Centre for Information and Communication Technology for Development (APCICT), Incheon, South Korea. The conference brought together practitioners, developers and researchers from government, academia, industry and non-governmental organizations to share the latest findings in the theory and practice of Electronic Governance. By design, the conference created ample opportunities for close interactions between these three categories of participants, so that each could benefit from the interaction with others.

ICEGOV2007 created a rich program comprising invited talks, tutorials, workshops, panel discussions and regular paper sessions, by leading international experts and practitioners in the field. Invited speakers - Sharon S. Dawes, USA; Olu Agunloye, Nigeria and Elia Armstrong on behalf of Guido Bertucci, United Nations - represented academic, government and non-governmental perspectives on Electronic Governance. In addition, a series of six tutorial-workshop events was organized on various aspects of Electronic Governance: (1) Formal Engineering Methods for Electronic Governance; (2) Interoperability in Electronic Government; (3) Knowledge Management in Public Administration; (4) Electronic Governance and Organizational Transformation; (5) Policy Development for Electronic Governance; and (6) Economics for Electronic Governance. Tutorials, held on Monday 10 December, provided the audience with general foundations and basic understanding of the area, while the workshops, held on Thursday 13 December presented state-of-the-art research and applications.

Regular paper sessions comprised presentations of the papers accepted for the conference.

Altogether, 159 abstracts and 130 full papers were submitted from 53 countries. A total of 97 papers were received from 27 developing countries: Argentina, Bangladesh, Benin, Brazil, China, Colombia, Egypt, Ghana, India, Iran, Kenya, Malaysia, Maldives, Mongolia, Morocco, Mozambique, Nepal, Nigeria, Pakistan, Palestine, Russia, Sri Lanka, Sudan, Syria, Thailand, Tunisia and Vietnam, and 61 from 26 developed countries/economies: Australia, Austria, Belgium, Canada, Czech Republic, France, Germany, Greece, Hong Kong, Iceland, Italy, Japan, Lithuania, Macao, Netherlands, New Zealand, Portugal, Serbia, Singapore, South Korea, Spain, Switzerland, Taiwan, UK, United Arab Emirates and USA. Among 159 submissions, 63 were research papers, 74 were practice papers and 22 were solutions papers. After review, 33 submissions were accepted as long (10 page) papers, 38 as short (4 page) papers, and 20 as posters (2 pages). Regular paper sessions covered a range of topics from e-Participation, Diffusion and Implementation, through Innovative Applications, Development and Rural e-Government, to Cases, Research and Applications.

ICEGOV2007 is planned to continue annually at different locations: Africa (2008), America (2009), Europe (2010) and Asia (2011), returning back to Macao in 2012.

Finally, six UNeGov.net thematic areas were developed during 2007 through various projects: human capacity development, semantic interoperability, software infrastructure development, south-south cooperation, standards and best practices, and strategic planning.

**Sources of funding** UNU-IIST plus individual partners contributions. Generally, UNU-IIST covers the cost of international travel for UNU-IIST-EGOV staff, while the host covers the remaining costs, perhaps through contributions from international organizations (e.g. World Bank for the school on Mongolia). Individual partners are listed in the Collaborations section below. In addition, ICEGOV2007 enjoyed financial and in-kind contributions from Macao SAR Government through Macao Foundation, UN Asia and Pacific Center for ICT for Development, Macao Polytechnic Institute, Macao Government Tourist Office, Macao Government Education and Youth Affairs Bureau, and Macao Post. External financial contributions to ICEGOV2007 totalled 82,500 USD.

**Collaborations** National Information Technology Center (NITC), Nepal, Ministry of Environment, Science and Technology (MoEST), Nepal; High Level Commission for Information Technology (HLCIT), Nepal; Information and Communication Authority, Government of Mongolia; World Bank; Observatory for Society, Government and Information Technology, Externado University of Colombia; Agenda for Connectivity, Government of Colombia; Asian and Pacific Training Centre for Information and Communication Technology for Development, part of the United Nations Economic and Social Commission for Asia and the Pacific (UN-ESCAP); State Academy of Sciences of DPR Korea; Kalinga Institute for Industrial Technology, KIIT University; Orissa State Government, India; Union Government of India

**Assessment** The project has achieved its objectives during 2007 in terms of: the number of workshops and schools organized; the level and diversity of participation at such events; the number of new project partners including governments, universities and international organizations; and the number of members registered.

## 2.4 Standards for Electronic Government

**Staff responsible** Bernd Friedrich

**Project abstract** Standards and generally accepted good practices are proven to facilitate strategic and operational outcomes for public organizations. Standards are essential for streamlining operations of government and for enabling exchanges between public agencies. However, identifying the required standards and determining the optimum configuration of modalities for the adoption of these standards with due sensitivity to innovations and constraints in individual government agencies could be a long and difficult learning process. This is particularly true when implementing e-government initiatives.

This project aims to define a system for the management of standards and good practices for the development, implementation and operation of e-Government services offered by public administrations, and populate this system with an initial set of standards relevant for setting up an e-Government infrastructure (technical, managerial, regulatory).

Specific objectives of the project are: (1) establish a repository of agreed and documented standards and practices for the development, implementation and operations of e-Government services; (2) develop a pool of government employees competent - educated and skilled - to successfully apply these standards when developing, implementing and operating e-Government services; (3) design a management system for the lifecycle of standards; (4) design a support system for the implementation and operations of standards and practices at central government as well as local government levels. Fulfilling these objectives is particularly important for implementing seamless, cross-agency e-government services through government-wide initiatives.

The outcomes of the project will be applied in the context of the e-Macao Program and Macao e-Government initiatives in general. Besides creating direct benefits for Macao Government, project results would also be packaged for dissemination in developing countries.

More information about this project can be found at <http://www.egov.iist.unu.edu/projects/standards>.

**Achievements, status and plans** The project commenced in May 2007 with a comprehensive survey carried out in 10 Macao Government agencies. The survey comprised questions from the following areas: (1) strategy, (2) operations, (3) resources, (4) IT policies and regulations and (5) challenges and opportunities.

During July and August 2007, a Project Initiation Document was developed, serving as a contract between the Project Board (comprising Public Administration and Civil Service Bureau and UNU-IIST-EGOV) and the Project Manager based on the common understanding regarding deliverables, quality, risks, reporting, project organization, and the approach to developing the solution. Since September 2007, the agreed deliverables are being produced. A draft report was produced by the end of December 2007, and will be finalized by the end of March 2008.

**Sources of funding** The project is funded by the Government of Macao SAR through Macao Foundation, and UNU-IIST.

**Collaborations** Eleven agencies of Macao SAR Government: DSAJ - Legal Services Bureau; DSC - Macao Post Office; DSF - Financial Services Bureau; DSFSM - Public Security Forces Affairs Bureau; DSRT - Bureau for Telecommunication Regulations; DSSOPT - Lands, Public Works and Transport Bureau; DST - Government Tourism Office; FSS - Social Security Fund; IACM - Civic and Municipal Affairs Bureau; SAFFP - Public Administration and Civil Service Bureau; and SS - Health Services Bureau.

**Assessment** The project has achieved its objectives agreed for 2007: Objective 1 - Repository and 2 - Training, and possibly 3 - Lifecycle. The project may continue beyond 2007 to complete Objective 4 - Support System, and to start the implementation of standards in several pilot agencies involved in the development of cross-agency e-Government services.

## 2.5 Strategic IT Planning for Public Organizations

**Staff responsible** Adegboyega Ojo

**Project abstract** Strategic Information Technology Planning is essential for government institutions to effectively support their socio-economic and organizational objectives with Information Technology (IT). The alignment of IT strategies with public sector reform initiatives is equally required to transform and improve the internal workings of governments, how they deliver public services, and how they meet the needs of various stakeholders. Developing and aligning IT strategies at various levels of governments (central, state, provincial and local) as well as across ministries, departments and agencies, is imperative for coherence of purpose and the optimal use of public resources. However, the requisite capabilities for developing IT strategies which can concretely support e-government development are not readily available within governments in general.

By exploiting the experience and outcome of the IT Master Plan Project for Macao Institute for Tourism Studies, carried out during 2006, and international best practice frameworks for IT Governance and Strategic IT Planning, this project aims to develop a methodology and a set of toolkits to support strategic IT planning in public agencies. Specific objectives of the project include: (1) developing a Strategic IT Planning Framework comprising an IT Planning Process and an IT Planning Toolkit to support organizationally and technically the execution of the planning process; (2) carrying out a number of strategic IT planning exercises with selected government agencies in Macao as part of the ongoing e-Macao Program; (3) developing training manuals and training government officials in the application of the developed process and toolkit; and (4) disseminating the IT Planning Framework to developing countries through the UNeGov.net initiative.

More information about this project can be found at <http://www.egov.iist.unu.edu/projects/planning>.

**Achievements, status and plans** This project is presently being executed within the framework of the e-Macao Program. The technical details of the methodology to be adopted have been documented and the strategic IT planning process has been defined. Three agencies are undergoing pilot IT Planning exercises. The development of the supporting

toolkits, and the IT Planning exercises at the selected government agencies are to be completed by the end of March 2008. Development of training manuals, training of government officials in Macao, and preparation of a course for training public officials in developing countries in the use of the methodology/toolkit are planned for the first half of 2008.

**Sources of funding** The project is funded by the Government of Macao SAR through Macao Foundation, and UNU-IIST.

**Collaborations** Twelve agencies of Macao SAR Government: DSAJ - Legal Services Bureau; DSC - Macao Post Office; DSF - Financial Services Bureau; DSFSM - Public Security Forces Affairs Bureau; DSRT - Bureau for Telecommunication Regulations; DSSOPT - Lands, Public Works and Transport Bureau; DST - Government Tourism Office; FSS - Social Security Fund; IACM - Civic and Municipal Affairs Bureau; IFT - Macao Institute for Tourism Studies; SAFP - Public Administration and Civil Service Bureau; and SS - Health Services Bureau.

**Assessment** Three of the four objectives: 1 - Framework, 2 - Exercises and 4 - Dissemination, can be fully met by the end of March 2008. Objective 3 - Training is planned to be completed by the end of June 2008.

## 2.6 Software Infrastructure for Electronic Government

**Staff responsible** Elsa Estevez

**Project abstract** This project aims to rigorously develop a production-quality software infrastructure consisting of components, frameworks and services to support the rapid development, deployment and execution of Electronic Public Services using open-standards and open-source technologies. The infrastructure comprises five major elements: (i) Front Office Framework, (ii) Back Office Framework, (iii) Workflow Service, (iv) Messaging Service and (v) Infrastructure Management Service. Due to the complexity and size of the project, a staged development of these five elements has been adopted, starting with the development of the Messaging Service called Messaging Gateway.

The Gateway will enable the exchange of information and documents among government agencies and in general facilitate collaboration between them. It will also provide the required organizational and semantic support to such collaborations in selected public sector domains such as social benefits, health care, disaster management and tourism.

In the current phase of the project, two main activities are carried out during 2007 and early 2008: the development of the Messaging Gateway to provide a set of enhanced messaging services suitable for a government environment, and the development of the Semantic Interoperability Extension for the Gateway. Concrete project objectives include: (1) building design models for the Gateway able to provide basic as well as enhanced communication services for seamless delivery of Electronic Public Services; (2) implementing the Gateway based on the design models using robust, open-standards-compliant components

and tools; (3) developing a knowledge base to answer queries about the Gateway and provide services to operate and manage this repository; (4) investigating organizational and semantic interoperability requirements for inter-agency collaborations in delivering major government services in Macao; (5) developing specialized ontologies to support inter-agency collaborations in selected domains, including conversations, messages types and allowed message instances; (6) configuring the Gateway to support semantically-sound collaborations among government agencies using the ontologies; and (7) developing a repository and the corresponding services to publish and maintain ontologies and data schemas for inter-agency message exchange.

More information about this project can be found at <http://www.egov.iist.unu.edu/projects/infrastructure>.

**Achievements, status and plans** Two kinds of activities were carried out in 2007: development of the Messaging Gateway and development of the Semantic Interoperability Extension to the Gateway. The former includes: identifying communication and coordination needs for Electronic Government, determining to what extent existing messaging solutions can fulfill these needs, building models to describe basic communication services for Electronic Government, and defining requirements for the Messaging Gateway, based on the models, to fulfill the identified needs. The latter activities involve: determining state-of-the-art in Semantic Interoperability, Enterprise Architectures and Semantic Web; building foundational models for Semantic Interoperability Middleware (SIM); and identifying requirements for the SIM inline with the extension requirements for the Gateway. By the end of 2007, the requirements were defined, a set of analysis and design models were developed, and core messaging services as well as several extensions such as validation, transformation, logging, and (partly) semantic interoperability, were implemented.

The plans for 2008 are: to complete the development of the Gateway and the Semantic Interoperability extension; to apply the Gateway in support of Electronic Public Services in Macao; and to disseminate project results through UNeGov.net. Later phases of this project will develop the remaining infrastructure elements.

**Sources of funding** The project is funded by the Government of Macao through Macao Foundation, and UNU-IIST.

**Collaborations** Eleven agencies of Macao SAR Government: DSAJ - Legal Services Bureau; DSC - Macao Post Office; DSF - Financial Services Bureau; DSFSM - Public Security Forces Affairs Bureau; DSRT - Bureau for Telecommunication Regulations; DSSOPT - Lands, Public Works and Transport Bureau; DST - Government Tourism Office; FSS - Social Security Fund; IACM - Civic and Municipal Affairs Bureau; SAFP - Public Administration and Civil Service Bureau; and SS - Health Services Bureau.

**Assessment** The project has produced concrete research outputs during 2007 to guide the development of the infrastructure: eight papers [5, 6, 7, 8, 9, 10, 11, 12] were published and presented at international conferences, and several development artifacts - requirements, specifications, use cases, conceptual models and software code - were produced as a result of the development. Objectives (1), (2) and (3) were fulfilled by the end of 2007. Objectives (4) through (7) are planned to be finished by mid-2008.

## 2.7 Semantic Interoperability for Electronic Government

**Staff responsible** Tomasz Janowski

**Project abstract** Semantic Web and the underlying family of web technologies, from XML, through Web Services, to various ontology-description languages like OWL, can considerably reduce system integration time and effort. They can also provide a level of independence from environmental changes that would otherwise require extensive re-engineering of software systems. A case in point are systems supporting the working of government organizations, particularly the production and delivery of public services to citizens, businesses and other arms of the government, and their dependence on changing administrative rules and regulations. The aim of this project is to develop foundational and technical solutions to the problem of semantic interoperability, particularly for public organizations, and disseminate the findings among e-Government experts and practitioners.

In line with this aim, the objectives of the project are: (1) establish the current state of research and practice in Semantic Interoperability for e-Government; (2) build precise models to capture requirements for Semantic Interoperability particularly for public organizations; (3) specify and implement prototype middleware software (SIM) to meet such requirements; (4) illustrate how new applications can be built on top of this middleware; and (5) build a Community of Practice to disseminate the findings of the project and further advance the area.

A set of five tasks is planned to realize these objectives: (1) Survey - document the state-of-the-art and current challenges in the areas of Electronic Government, Interoperability, Enterprise Architectures, and Semantic Web Technologies; (2) Foundation - build a foundation for SIM, from Domain Models, through Enterprise Architectures, to SIM specifications; (3) Software - build a pair of reference implementations for the SIM using Microsoft and Open Source technologies; (4) Process - define a process to build applications on top of the SIM with concrete examples of its use; and (5) Community - develop a UNeGov.net thematic area on Semantic Interoperability and e-Government.

More information about the project can be found at <http://www.egov.iist.unu.edu/projects/interoperability>.

**Achievements, status and plans** Three project meetings have taken place in 2007. The first took place in Macao on 24 January 2007 with the aim to discuss the design - aim, objectives, deliverables, schedule, and framework of the project. It was organized by UNU-IIST-EGOV, and was attended by 12 participants - 3 from Microsoft and 9 from UNU-IIST. The second took place in Redmond, USA on 30 March 2007 with the aim to present the progress on the first two tasks of the project, and discuss future tasks. It was organized by Microsoft, and was attended by 10 participants - 2 from UNU-IIST-EGOV and 8 from Microsoft. The third took place during ICEGOV2007 in Macao to demonstrate initial outcomes of the project.

The project has made progress on all its tasks as described below. Survey Task - A report summarizing the findings of the survey on state-of-the-art in Electronic Government, Interoperability, Enterprise Architectures and Semantic Web Technologies was completed

in early 2007 and presented during the workshop in March. A paper has been written to describe the findings of the survey [3]. Foundation Task - Based on the survey, models and requirements for the SIM were identified and documented in a report completed in late June. Software Task - A platform-independent design, architecture and detailed design for the SIM were defined and documented. Furthermore, a concrete need for a flexible solution to semantic interoperability was identified, and two technologies were chosen: the semantic reasoner - Pellet and the knowledge representation language - OWL. Three main components of the SIM - Semantic Validation, Mediation and Discovery - are currently implemented. Process Task - A process describing how to build new applications on top of the SIM implementation is also under development, with concrete applications to illustrate its use. Community Task - A thematic area on Semantic Interoperability for Electronic Government was initiated as part of UNeGov.net. Upon finalizing these tasks, a report will be written to consolidate all findings and outcomes of the project.

**Sources of funding** Microsoft (50,000 USD) and UNU-IIST

**Collaborations** Microsoft

**Assessment** Objectives 1 - Survey and 2 - Foundations have been completed, while Objectives 3 - Software, 4 - Process and 5 - Community are under development, to be completed by the end of March 2008.

## 2.8 Developing Open Courseware for the United Nations University

**Staff responsible** Tomasz Janowski

**Project abstract** This project aims to promote the development, use and distribution of Open Courseware (OCW) and related free and open educational materials particularly in developing countries, and carry out research and development on advanced software tools for OCW. This project is carried out in the context of the ongoing UNU Open Courseware Project involving other Research and Training Centers and Programmes (RTC/Ps) within the university, and aligned with the overall objectives of the Open Courseware Consortium (OCWC) where UNU is a member.

In collaboration with other RTC/Ps, the project is to achieve the following objectives: (1) setting up a UNU-OCW website; (2) developing at least 10 courses to be hosted on the website and made available under the Creative Commons License for use and adaptation by educators and learners; (3) increasing the awareness of OCW and its benefits to RTC/Ps beyond initial participants of the project; and (4) creating a network of UNU staff willing and capable to add new courses to the UNU-OCW website.

More information about this project can be found at <http://www.egov.iist.unu.edu/projects/courseware>.

**Achievements, status and plans** Following successful submission of the project proposal to the UNU Joint Activities Fund, an initial project meeting and workshop were held during 31 August - 1 September 2007 at the UNU Center in Tokyo. The aim was to formulate a

strategy for achieving the target of uploading 10 courses to the UNU-OCW portal, as required for full participation of UNU in the OCW Consortium. The project also contributed to the development of the governance structure for OCWC through its membership in the OCWC Governance Committee, development of a “Community-Based OCWC Governance Model”, and contribution to the OCW Consortium Conference in September 2007. By the end of December, the Center uploaded to the UNU OCW portal six courses on various aspects of Electronic Government: (1) Introduction to Electronic Government; (2) Strategic Planning for Electronic Government; (3) Structures and Processes for Implementing and Operating Electronic Government; (4) Workflow and Business Process Management for Electronic Government; (5) Building a Community of Practice for Electronic Government; and (6) Ontology, Semantic Web and Electronic Government. Other project partners contributed the remaining courses.

**Sources of funding** A total of 18,815 USD was provided by the UNU Joint Activities Fund to the project to support its execution by the Center.

**Collaborations** This project is carried out in collaboration with other RTC/Ps: UNU Media Studio (part of the UNU Center), UNU-MERIT and UNU-INWEH.

**Assessment** The project has achieved its objectives for 2007.

## 2.9 South-South Collaboration on Software Technology and Electronic Governance

**Staff responsible** Adegboyega Ojo

**Project abstract** This project aims to carry out follow-up studies on South-South Collaboration in the area of Software Technology and Electronic Governance. Based on the knowledge created by the South-South Report on Software Technology, developed by the Center for UNDP Special Unit on South-South Cooperation (SU/SSC), this project seeks to foster effective collaboration within the countries of the South to build capacity for Electronic Governance and ability to develop high-quality software for the delivery of electronic public services. Such collaborations typically include experience sharing, technology and capability transfer, human capacity development and multilateral trade agreements.

A major challenge in carrying out studies on South-South collaboration is lack of data on the state of cooperation. Therefore, a major objective of the project is to continuously collect and analyze data on existing and emerging cooperation in the areas of Software Technology and Electronic Governance. Other specific objectives include: (1) facilitating and enabling cooperation in the area of Electronic Governance through the UNeGov.net platform - events and communities; (2) making available capacity development and training programs to regional cooperation initiatives in the area of Electronic Governance; (3) identifying and establishing partnerships with centers of excellence in Electronic Governance to jointly support countries in the South.

More information about this project is provided at <http://www.egov.iist.unu.edu/projects/southsouth>.

**Achievements, status and plans** Following successful completion of the South-South Report on Software Technology for UNDP, a paper was presented and published at the conference “Southern Engines of Global Growth: China, India, Brazil and South Africa”, Helsinki, Finland, 7-8 September 2007, organized by UNU-WIDER [13].

In addition, an event on “Developing Electronic Governance in the South - New Models for South-South Cooperation” was organized at the UN Headquarters on 18 October 2007, with support from the UNU Office in New York (UNU-ONY). This event brought together the stakeholders from academia, government, non-governmental and UN organizations in order to: (1) discuss the limitations of traditional North-South cooperation to develop Electronic Governance in the South; (2) present the state of South-South cooperation in this area; (3) highlight the challenges in developing effective South-South cooperation frameworks in the area of Electronic Governance; (4) recommend new models for effective South-South cooperation to build Electronic Governance in the South; and (5) review the roles of stakeholders, particularly the UN system, in the new models. Three government speakers represented national experiences from: Colombia - Connectivity Agenda, Ministry of Communications; Kenya - e-Government Directorate, Office of the President; and Mongolia - ICT Authority. Three more speakers represented regional and global experiences in facilitating effective cooperation in the South: Academy for Educational Development (AED); Canada School for Public Service (CSPS); United Nations Department for Economic and Social Affairs (UNDESA); and United Nations Development Program (UNDP), South-South Collaboration Unit.

**Sources of funding** UNU-IIST, following a 15,000USD contribution from UNDP in 2006.

**Collaborations** AED, CSPS and UNDESA are major contributors to the project. Official partnership arrangements will be developed over time.

**Assessment** Significant results have been produced by the project despite its modest funding base. The degree to which the objectives will be achieved is subject to availability of funds.

## 2.10 Design techniques for real-time embedded systems

**Staff responsible** Dang Van Hung

**Project abstract** As a continuation of the project “Specification and Design of Hybrid Systems”, this project has a focus on the techniques for the development of the software component of embedded systems. Embedded systems are Real-time Hybrid systems in which a computer with digital control programs is embedded to control the systems to meet their requirements. Our research in this period has concentrated on:

- Extension of rCOS for modelling real-time component systems, and reasoning about quality of services in Probabilistic Duration Calculus
- Schedulability analysis-based resource usage of components and resource constraints
- Specification and verification techniques for probabilistic real-time systems, verification tools and case studies.

**Achievements, status and plans** Our main achievements include

**Formal model for real-time component based system using the UTP approach**

We add to the specification of a method a time constraint which is a relation between the resource availability and the amount of time spent to perform the method. We define a contract to include method specification, and define a component as an implementation of a contract. We enhanced this model with the interaction protocols that can express concurrency. We developed a technique to reason about the quality of services with the model.

Our model supports the separation between functional and non-functional requirements, and the formal compositional verification of component-based real-time systems, and the schedulability analysis on the basis of resource availability [18, 19].

**Model Checking Techniques for Probabilistic Timed Automata**

We introduce an extension of Duration Calculus called Simple Probabilistic Duration Calculus (SPDC) to express dependability requirements for real-time systems, and address the problem of verification of a SPDC formula of probabilistic timed automata. We develop a model checking technique to solve this problem for a class of SPDC [20, 21]. We carry out a formal performance analysis of the air traffic control system with the PRISM model checking tool for probabilistic real-time systems [22].

**Sources of funding** UNU-IIST

**Assessment** The progress and achievements of the project have fulfilled its objectives and plan.

## 2.11 CREDO: Evolutionary Structures for Distributed Services

**Staff responsible** Bernhard K. Aichernig (Associate Research Fellow)

**Project abstract** The objective of the CREDO project is the development and application of an integrated suite of tools for compositional modelling, testing, and validation of software for evolving networks of dynamically reconfigurable components. UNU-IIST's contribution is to investigate the theory of fault localization and to build a test-case-generation tool.

**Achievements, status and plans** Two fellows (one PhD and one post-doctoral) have been hired. To implement the assertion-based testing strategy, a method of test case generation by use of weakest precondition computation and symbolic evaluation is being considered. The effects of concurrency require the development of new formalisms and algorithms to represent the interdependencies of conditions over active objects. The facts that the closed system assumption holds in a testing environment and that interleaving points are clearly defined in the CREOL language are being exploited. A bounded version of the basic test-case-generation algorithm of Tretmans over I/O-labelled transition systems was implemented in Maude. Work is ongoing to extend this basic approach to other types of automata and algorithms, with the aim of test case generation for the CREOL components and network.

Furthermore we have completed our general theory of mutation testing including three test-case generation techniques: (1) an algebraic characterization of mutation tests via refinement, (2) mutation testing for pre- postcondition contracts and (3) for a simple, but nontrivial, programming language via normal-form transformation.

**Sources of funding** CREDO is an EU-funded project on *Modeling and analysis of evolutionary structures for distributed services* within FP6 *Information Society Technologies*, activity IST-2005-2.5.5-Software and Services. UNU-IIST's funding is Euro 200 000 over 3 years, having started on September 1, 2006.

**Assessment** In the past year, UNU-IIST activities have produced one journal article, four invited departmental seminars, one colloquium presentation and presentations at meetings in Graz and Oslo.

## 2.12 Formal Analysis of Human Behaviour in Interactive Systems

**Staff responsible** Antonio Cerone

**Project abstract** This project aims to define a generic formal framework for the analysis of goal-based tasks with respect to usability, recoverability, safety and security requirements. Formal analysis of case studies has been carried out at two different levels: (a) *high-level*, where the cognitive model is specified in a process algebra language and the patterns of human behaviour are expressed as temporal logic properties and are analysed using model-checking techniques; (b) *low-level*, where single actions of a human-computer interaction process are specified and organised in the appropriate sequence to achieve a given task while model-checking is used to verify the absence of specific errors, such as post-completion errors, or the ability to recover from errors.

**Achievements, status and plans** The high level analysis was performed using an Air Traffic Control task case study by defining and decomposing the task failure into the behavioural patterns of a human operator that may cause it. Model-checking has been used to verify the soundness and completeness of the decomposition.

The low-level analysis was performed by

- Using a Groupware System case study (together with Norzima Elbegbayan, Fellow from Mongolia) and a Vending Machine case study (work done by Thomas Anung Basuki, Fellow from Indonesia) to show how model-checking can be used to drive the design of interactive systems.
- Modelling complex patterns of behaviours where the enabling condition is a social element and defining taxonomies of patterns of behaviour that lead to security breaches.
- Using model-checking to analyse recoverability properties in a context where the user undergoes an habituation process.

The work described by the last two bulletpoints has been carried out together with Shaikh Ahmed Siraj, Postdoc at UNU-IIST until September 2007.

In total 3 conference papers and 1 technical report have been published, 1 book chapter published, 1 book chapter accepted (shared with the project “Formal Models for Security”), 1 journal paper accepted, 2 workshop proceedings edited, and 2 journal special issues edited to appear in 2008.

Two workshops on “Formal Methods for Interactive Systems” (FMIS) have been organised in October 2006 in Macau and in September 2007 in Lancaster, UK. A course on “Formal Methods for Interactive Systems” has been presented in February-March 2007 in Pisa within the joint PhD Programme between UNU and the University of Pisa. The “1st International School on Methodologies and Tools for Human-computer Interaction” was organised in Rio de Janeiro, Brazil, in September 2007, and included a course on “Methodologies for the Formal Analysis of Human-computer Interaction”. Both courses provided the background knowledge to work in the project as well as advanced topics related to the project results.

**Sources of funding** UNU-IIST.

**Collaborations** University of Queensland, Brisbane, Australia; Bond University, Gold Coast, Australia; Queen Mary University London, UK; University College London, UK; ISTI-CNR, Pisa, Italy; Swansea University, UK; University of Minho, Portugal; University of Koblenz, Germany; Pontifícia Universidade Católica do Rio de Janeiro, Brazil; University of Toulouse III, France.

**Assessment** The project has met all objectives mentioned in the Project Summary, in particular:

- Regarding the high-level analysis, the definition of a formal framework to analyse safety properties, which has been applied to an Air Traffic Control task.
- Regarding the low-level analysis, the use of model-checking to drive the secure design of interactive systems, also taking usability and recoverability criteria into account.

Many collaborations have been started within the project and have contributed to the success of publications and organisation of events. During the 2nd FMIS Workshop a European Research Network on “Formal Methods for Interactive Systems” has been established, coordinated by UNU-IIST (where the network website will be hosted), with the aim to apply for an EU Grant in 2008. The project has also benefited from the cross-fertilisation with the project on “Formal Models for Security”, which has provided new objectives and an injection of new ideas.

The teaching of the courses on “Formal Methods for Interactive Systems” at the PhD School of the University of Pisa has strongly contributed to the implementation of the joint PhD Programme between UNU and the University of Pisa. Together with the course on “Methodologies for the Formal Analysis of Human-computer Interaction” it has also provided dissemination of the outcomes of the project.

## 2.13 Formal Models for Security

**Staff responsible** Antonio Cerone

**Project Abstract** The aim of the project is first to explore different formal approaches to security, in different areas such as access control and authentication protocols, analysing case studies in different application domains, and then to define a formal framework for the specification and verification of qualitative aspects of security.

**Achievements, status and plans** The work on the analysis of workflow systems carried out in 2006 has been extended in 2007 to deal with human workflows, using model-checking to verify that a given workflow process satisfies authorisation constraints in a Role-based Access Control framework. This work has been carried out in cooperation with Peking University, China, and Bond University, Australia.

The work carried out together with Shaikh Ahmed Siraj, Postdoc at UNU-IIST until September 2007, includes:

- The Integration of different verification approaches and social and HCI aspects of information security. Outcome: an accepted chapter to contribute to the book “Social and Human Elements of Information Security”, to be published in Spring 2008 (shared with the project “Formal Analysis of Human Behaviour in Interactive Systems”).
- The analysis of security and quality aspects of Open Source Software (OSS) and the development of an initial quality model for OSS. Outcome: a conference paper presented at OpenCert 2007.
- The organisation of a course on “Network Security” taught by Siraj in August in Maputo, Mozambique, as part of a school organised through a cooperation between UNU-IIST and IFIP.

Siraj has also worked at the formal analysis and design of authentication protocols in a theorem-proving framework that makes use of rank functions. Outcome: an accepted chapter to contribute to the book *Handbook of Research on Information Security and Assurance*.

1 conference paper and 1 technical report have been published, 2 book chapters accepted (1 shared with the project “Formal Analysis of Human Behaviour in Interactive Systems”) and 1 conference paper presented.

**Sources of funding** UNU-IIST.

**Collaborations** Bond University, Gold Coast, Australia; Queensland University of Technology, Brisbane, Australia; University of Pisa, Italy; Imperial College London, UK; Siemens Research, Munich, Germany; Technical University Graz, Austria; and Cuza University, Romania.

**Assessment** The project has met the objectives mentioned in the Project Summary, by completing the exploration of different formal approaches to security and defining a formal framework for the specification and verification of qualitative aspects of security using model-checking. A theorem-proving approach to verification has been applied to the formal analysis and design of authentication protocols. Many collaborations have been started within the project and have contributed to the success of publications and organisation of events. The project has also benefited from cross-fertilisation with the project on “Formal

Analysis of Human Behaviour in Interactive Systems”, which has provided new objectives and an injection of new ideas. The teaching of security courses during 2006 and 2007 has provided dissemination of the outcomes of the project.

## 2.14 Formal methods tools and applications

**Staff responsible** Chris George

**Project abstract** This project (a) maintains and extends the tools for the RAISE formal method and (b) uses RAISE on application projects by fellows.

**Achievements, status and plans** There were several activities in 2007:

- Jong Hyo Jin, a fellow from DPRK, started work in September 2006 on developing an internet multicast protocol. Work concentrated on specifying components of the final protocol, such as joining and leaving a group of subscribers, extending this model to allow for a hierarchical subgroup structure, dealing with packet loss, and dealing with dynamically allocated communication channels. These components were specified in CSP and model-checked using FDR. The work was reported in Jong Hyo Jin’s final technical report [23]. Siraj Shaikh and Wang Xu assisted in this work.
- Two fellows from Peru, Lizet Tapia and Abigail Vargas, came to UNU-IIST in April/May 2007. They are working on using FDR to model-check applicative concurrent specifications in RSL, via a translator to CSP. This involves in particular understanding the semantic differences between RSL and CSP and imposing suitable restrictions to make a translator sound.
- A number of problems in the confidence condition checking version of the SAL translator were identified and fixed.
- Ana Garis from Argentina came to UNU-IIST as a visitor in September 2007. She is working part-time on (a) completing the user guide for the existing translator from RSL to SAL and (b) investigating the translation of LTL formulae to CSP processes and hence the possible use of LTL formulae in FDR.

**Sources of funding** UNU-IIST

**Assessment** Jong Hyo Jin started with little formal background and with limited English language skills. But he made very good progress and produced a good final report. He expects what he has learned to be very useful in his future work in the same area back in DPRK.

The SAL translator still needs a user guide so that it can be released as part of the RAISE tools. We expect this to be complete early in 2008.

The work on translating part of RSL to CSP and hence using FDR has identified and resolved many of the technical issues.

## 2.15 WaterBase: tools for water resource management

**Staff responsible** Chris George

**Project abstract** Environmental modelling to support water management has a proven success record but is very expensive: so expensive that it cannot be afforded in most places in developing countries. At the same time watersheds, rivers and lakes are under increasing stress from growing populations, industries, and agriculture which both consume water and pollute water resources. The aim of the *WaterBase* project is to create a generic model of water resources together with a decision support system intended for use in developing countries that is cheap to instantiate while being effective in operation. The system will support the modelling of existing situations as well as the generation and comparison of results for possible alternative scenarios. Thus it will support such activities as development planning, the exploration of ways to counteract environmental degradation, and the mitigation of events such as global warming, storms, or polluting accidents.

The system will be free, open source, and instantiable using GIS data freely available on the internet.

**Achievements, status and plans** Substantial progress was made during 2006 on a prototype system MWSWAT, to be built on top of the GIS system *MapWindow* and using the hydrological model *SWAT*.

One researcher left the project at the end of 2007 (as he was taking up full-time employment); the other, Luis Leon, who provides the hydrology expertise to the project, has continued during 2007: he works one day a week as a postdoc.

During 2007 our first aim was a working prototype by May to be presented at a UNU event at the UN in New York. The prototype was ready but the event had, unfortunately, to be postponed. We intend to organise a similar event later.

New requirements for the prototype system were identified at the SWAT Conference in July 2007, and were implemented by mid-September. There was a slight delay caused by some problems in *mapWindow*, but the release of MWSWAT was made in December 2007. It is available from the WaterBase web site <http://www.waterbase.org>, along with global data sets for soil, landuse, river basins, and climate. There is substantial documentation and example data sets for two river basins, San Juan in Mexico and Linthipe in Malawi.

**Sources of funding** UNU-IIST. External funding will be sought for later phases.

**Collaborations** The project is a collaboration between UNU-IIST and UNU-INWEH. Also involved are the universities of Guelph and Waterloo in Ontario, Canada, the University of Idaho in the US, Texas A&M University in the US, and EAWAG in Switzerland.

UNU-IIST has been invited as a partner in a proposed EU collaborative project eWater-Ability.

**Assessment** The prototype MWSWAT tool was presented at the SWAT Conference in the Netherlands in July, and was very well received. One paper was presented at the ISESS conference in Prague in May, and another was published in the online Open Hydrology

Journal. Other presentations were made at a workshop on hydrology in Cameroon and the WITFOR conference in Ethiopia, both in August. Reactions were very positive.

The WaterBase web site was established.

## 2.16 Independence and Concurrency in System Verification

**Staff responsible** Xu Wang

**Project abstract** The ultimate goal of this project is the development a new semantic model for the important CSP/FDR notation and tool that is able accurately to express and exploit true concurrency. It has been inspired by recent advances in semantic theory and model-checking, which show that such models can be profitably exploited to impact industrial applications, *e.g.* semantic theory of Message Sequence Charts and Partial Order Reduction and Petri-net Unfolding in model-checking. Accordingly the project is being driven by promising application, with the knowledge gained only later being used guide theoretical study. Four specific applications are planned: diamond mining and FDR2; rule-based system verification; the Java memory model; and semi-commutation and ‘globally asynchronous and locally synchronous systems’.

**Sources of funding** UNU-IIST

**Achievements, status and plans** Plans for the four areas of application are as follows.

*Diamond mining and FDR2.* A diamond is the name given to a parallelogram in the labelled transition system of a parallel process, which represents the process performing a pair of independent events. Although classic partial order reduction techniques are all based on exploiting diamonds, that can be very costly. So most existing methods in their implemented forms use just those diamonds that are easy to find, sacrificing some reductions. Recently, a compositional theory has been developed that can be exploited to find more diamonds cheaply, as has been confirmed by experiment. We plan, as a next step, to extend that approach to even more effective reduction algorithms.

*Rule-based system verification.* A key challenge for verification of rule-based systems is scalability: the ability to verify properties of systems consisting of hundreds or thousands of rules. We plan to model inference systems as massively concurrent systems. Facts (*i.e.*, processes with 2-3 states) synchronise with each other on the rules (*i.e.*, events or channels) of which they jointly form the antecedent and fire them to enable or disable other facts in the consequent. CSP/FDR2 is particularly efficient when verifying massively parallel systems of small processes. Classically, most inference systems are confluent, *i.e.* inference steps are independent of one another. Therefore, notions like untangled actions can be exploited to make effective reduction.

*Java Memory Model.* The Java Memory Model (JMM) gives semantics to shared-memory multithreading Java programs. The existing JMM formal specification is low-level and operational in nature, so it is complicated and difficult to understand (actually, a previous version of JMM has been found unusable). Based on recent investigations we propose an abstract, high-level, independence-based model for JMM which appears promising. We intend to carry on with this work to develop the full model and compare it with existing

JMM specification.

*Semi-commutation and GALS.* Independence implies commutativity amongst events (*i.e.* diamonds). However, for producer and consumer systems, inputs depend on outputs: they do not commute. To devise a semantic model and reduction techniques for this type of input/output system, *e.g.* Globally Asynchronous and Locally Synchronous systems (GALS), we need a more general notion, called semi-commutativity. It has been found that for semi-commutative systems, since some execution sequences can carry more information (*i.e.* unlike the commutative case) than others, they can be selected as representatives such that all the other execution sequences can be ignored in verification. This opens the gate to substantial state space reduction for input/output systems like GALS.

Preliminary progress has been made for FDR2 Diamond mining, Rule-based system verification, and the Java Memory Model. We are actively working on these topics while also looking at the possibility of external funding.

## 2.17 An incremental approach to information systems

**Staff responsible** J W Sanders, UNU-IIST.

**Project abstract** The purpose of this research is to expand the established approach of Formal Methods to produce incremental methods for specifying, designing, implementing and analysing information systems. Examples of target system behaviour are: distribution and action refinement, object-orientation (OO), probabilism, reconfigurability, testability, asynchronicity, quantum computation and security. The approach is to build complex behaviour level-by-level (which might be viewed as being ‘orthogonal’ to module-by-module, which we take for granted), both for systems and for the theories used to construct and analyse them. To link the various levels, Galois connections are used that preserve specification and programming combinators (and so relate laws of behaviour) to link levels of abstraction. However a single incremental (meta) discipline is to be followed. The planned outcome is progress in semantic models and laws for reasoning about systems like those mentioned above, as well as a general framework for incremental system development.

**Achievement, status and plans** The project has benefited by visits from Ying (Tsinghua) and Zuliani (Oxford) in quantum computing, Kammüller (Berlin) in OO, Krisnan (Bond) in testing, and Chen (Durham) in general theory and OO. OO has also been the focus of a four-day visit by three members of JAIST. One fellow has begun work on probabilistic systems, one on reconfigurable systems, and two fellows, shared with Dr Wang, have begun work on asynchronicity and OO in a functional setting. Regular meetings have been held with Drs Wang and Xu (Macau) on action refinement. It is planned to submit a grant application and, when convenient for UNU-IIST, to visit Tsinghua to work with Ying on quantum computation. Between February and September, 7 UNU-IIST Technical Reports have been released.

**Sources of funding** UNU-IIST.

## 2.18 Virtual Library

**Staff responsible** Antonio Cerone

**Project abstract** The aims of the project are to expand the online digital library of UN research reports, which was developed within the RUN project in 2004-2006, explore becoming the centre for all UNU e-learning materials, transfer digital library and e-learning technologies to developing countries, provide support to local libraries and organisations in Macao and China to enhance their local virtual libraries, and carry out research in the field of digital libraries.

**Achievements, status and plans** Thomas Anung Basuki and Dian Andriana, two Fellows from Indonesia, have been working at the formal specification of digital libraries using RAISE. After Dian's departure, the work has been continued by Thomas Anung by converting the RAISE model into B and performing analysis on it, and by exploring the use of CSP in defining usability and security properties aiming at quality assurance in digital libraries.

A collaboration has been established with the Federal University of São Carlos, Brazil, aiming at research and development in e-learning.

An in-house course on "How to Build Digital Libraries" was taught in March 2006 by George Buchanan, Swansea University, UK.

**Sources of funding** UNU-IIST.

**Collaborations** University of Waikato, Hamilton, New Zealand; University College London, UK; Swansea University, UK; Federal University of São Carlos, Brazil.

**Assessment** The project has met reasonable objectives among the ones mentioned in the Project Summary, given the low budget assigned to the project. In particular, some research work in the field of digital library has been carried out.

Digital libraries technologies have been transferred to developing countries through the course taught by George Buchanan in 2006.

The collaboration with the Federal University of São Carlos, Brazil, is a first step for the transfer of e-learning technologies to developing countries.

## 2.19 Research in the UN

**Staff responsible** Antonio Cerone

**Project abstract** This project originated from a proposal made at CONDIR 25 to develop an on-line repository of UNU research materials, possibly to be extended to other UN agencies. The project started on December 2003 with the selection and adaptation of the open source library package DSpace and the creation of a prototype, which has been so far populated with UNU reports (from IAS, IIST, INTECH and WIDER) and UNRISD

reports. All data is held on a web server maintained by UNU-IIST and located in Macao. This centralised implementation will allow the repository to act as an archive for long-term protection of the data and provide robust and efficient access for users. Each collection can now be managed separately, with the data extended and edited remotely using on-line forms by the organisation that owns it.

**Development of the Prototype** The project started on December 2003 with the selection and adaptation of the open source library package DSpace and the subsequent creation of a prototype. Materials are organised into “communities”. Each community contains materials from a single UN agency and is partitioned into “collections”. Collections can be browsed and searched, and global search is also possible. Search is on some of the meta-data associated with each entry.

**Achievements, status and plans** Activities in 2007 were limited to the maintenance of the repository.

**Sources of funding** UNU-IIST (No funding was requested from Macao Foundation for 2007).

**Collaborations** University of Waikato, Hamilton, New Zealand; University of Wales, Swansea, UK.

## 2.20 Development of Computer Science Departments in Developing Countries

**Staff responsible** Dang Van Hung and Adegboyega Ojo

**Project abstract** This project aims to strengthen all aspects of computer science teaching in universities in developing countries.

Under the project, we are trying to arrange for (generally young) computer science lecturers or professors from universities in developing countries to learn new courses at partner universities in industrialised countries for one semester as a fellow, at the same time providing them with the supporting course materials. Then when they return to their own universities they use the knowledge they gain, together with the supporting course materials, as the basis for improving and updating existing courses or introducing new courses into the teaching curriculum of their own university. With our arrangement, the partner universities provide the use of their facilities free of charge and in particular without payment of tuition fees. UNU-IIST provides recommended text books for each of the courses the fellows study, and these text books become the property of the fellows' home department when they return.

**Status of implementation** In the year 2007, 7 lecturers from 6 universities in 5 developing countries have been trained under the project. See appendix A for the complete list of the fellowships by the project in 2007.

We also continued to support one PhD candidate from Pakistan in her second year at Eindhoven, the Netherlands, and one PhD candidate from Argentina at the University of York, UK.

**Partner Institutions in Developing Countries** So far 34 institutions in developing countries have benefited from this project. They are:

Mongolian Technical University, Ulaanbaatar, Mongolia  
 National University of Mongolia, Ulaanbaatar, Mongolia  
 University of Natural Sciences, Ho Chi Minh City, Vietnam  
 Hanoi University of Telecommunication and Transport  
 University of Technology, Ho Chi Minh City, Vietnam  
 University of Natural Sciences, Vietnam National University, Hanoi, Vietnam  
 Hanoi University of Technology, Hanoi, Vietnam  
 Posts and Telecommunications Institute of Technology, Ha Tay, Vietnam  
 University of Dschang, Cameroon  
 University of Yaoundé I, Yaoundé, Cameroon  
 University of Buea, Buea, Cameroon  
 University of Lagos, Lagos, Nigeria  
 University of Ibadan, Ibadan, Nigeria  
 Chittagong University, Bangladesh  
 Obafemi Awolowo University, Ile-Ife, Nigeria  
 Kathmandu University, Nepal  
 Gui Zhou University, Gui Yang, China  
 Wuhan University of Technology, Wuhan, China  
 Xian University of Post and Telecommunications, Xian, China  
 Nanjing University, Nanjing, China  
 East China Normal University  
 Northwest University, Xian, China  
 National University of Laos  
 Nong Lam University, HoChiMinh City, Vietnam  
 Technological University of Tajikistan, Dushanbe, Tajikistan  
 University Of Agriculture, Abeokuta, Nigeria  
 University of Zimbabwe, Harare, Zimbabwe  
 University of Catamarca, Argentina  
 University of Science and Technology, Chittagong, Bangladesh  
 Quaid-i-Azam University Islamabad, Pakistan  
 South West China University, ChongQing, China  
 Thai Nguyen University, Thai Nguyen, Vietnam  
 Universidad San Pablo, Arequipa, Peru  
 Hanoi University of Transport and Communication, Hanoi, Vietnam  
 Hue University of Sciences, Hue City, Vietnam  
 San Pablo Catholic University, Arequipa, Peru

**Partner Institutions in Industrialised Countries** 11 institutions in industrial countries have been involved in training lecturers from developing countries in this project. They are (with currently active ones marked by \*):

Queen's University, Belfast, UK  
\* University of Leicester, UK  
University of Oxford, UK  
\* University of Queensland, Brisbane, Australia  
University of Toronto, Canada  
\* University of York, UK  
\* University of Calgary, Calgary, Canada  
\* Swinburne University of Technology, Australia  
South Bank University, London, UK  
\* National University of Singapore  
Kwangju Institute of Science and Technology, South Korea  
\* Eindhoven University of Technology, the Netherlands  
De Montfort University, Leicester, England  
\* Ball State University, USA  
\* Bond University, Australia

**Status and plans** Currently ongoing.

**Sources of funding** UNU-IIST and partner institutions in industrialised countries.

**Assessment** The objectives for the project are achieved for this year according to the plan.

## 2.21 IT training courses and schools in developing countries

**Staff responsible** Antonio Cerone, Dang Van Hung, Chris George, Tomasz Janowski, Adegboyega Ojo, Jeff Sanders, Wang Xu, Zhiming Liu.

**Project abstract** Under the project *IT Training Courses and Schools in Developing Countries*, UNU-IIST aims to disseminate sound modern approaches to software development in developing countries. IT Schools and Courses are organised jointly with host institutions. The courses are in three categories: formal methods; software engineering and system development; and Electronic Governance.

The aim of the courses is to propagate research into and application of formal software development techniques, with the hope that developing countries can accelerate their progress in being self sufficient in software technology, and even become providers of services and products elsewhere.

The courses on software engineering and system development aim to introduce the advanced methods, techniques and tools that are widely used in industries for software development. They cover Project Management, Object-Oriented Software Development with UML and the Rational Unified Development Process, Component-Based Software Development, and Software Testing. These topics are often taught together with the those on formal methods so that the participants can integrate formal methods and practical software engineering in their further study and practice.

IT Schools, however, have a wide range of topics in computer science not just in software technology, and consist of several courses. Courses in a school are taught by experts invited from universities and industries as well, not just by UNU-IIST staff. Typically an IT School lasts a fortnight and consists of four courses.

An Electronic Governance School typically lasts three days and comprises seven roughly half-day modules. For instance, a school on Foundations of Electronic Governance comprises the following modules: (1) Introducing Electronic Government; (2) Strategic Planning for Electronic Government; (3) Developing Technical Solutions for Electronic Government; (4) Engineering Structures and Processes for Electronic Government; (5) Aligning Technological and Organizational Development; (6) Sharing Best Practices in Electronic Governance; and (7) Building a Community of Practice for Electronic Governance.

**Status of implementation** UNU-IIST organised the following schools in 2007.

**School on Advanced Techniques in Software Development** Arequipa, Peru, 19 February – 9 March. The school was co-organised with San Pablo Catholic University and the Peruvian Computer Society, and included 6 courses: 2 were taught by UNU-IIST staff, Chris George and Dang Van Hung, and 4 were taught by lecturers from Latin America and Spain. 40 people attended the school, including lecturers from universities across Peru. They took the opportunity to discuss the computer science curricula in Peruvian universities, and another school is being planned to take place in Lima in 2008.

**International Training School for African Countries on Computer Hardware/-Software/Network Technology** Guiyang, China, 15 July – 16 August. Organised by Guizhou Academy of Sciences and supported by UNU-IIST, the school had 41 students from 21 African countries. There were 7 courses, 1 taught by Chris George, another by UNU-IIST Associate Fellow He Jifeng, and 5 others taught by lecturers from China.

**ICTAC07 Training School** Shanghai, China, 10–21 September. The training school that UNU-IIST organises with ICTAC was organised in cooperation with East China Normal University in their campus in Shanghai. The first week was a course on Security, the second week included 4 courses loosely based on the work of Dines Bjørner and Zhou Chaochen. There were two lecturers from UNU-IIST, Chris George and Dang Van Hung, and 4 from Europe. 35 students attended the school. The lecture notes were published a volume of Springer Lecture Notes in Computer Science and its editors are Chris George (from UNU-IIST), Zhiming Liu (from UNU-IIST) and Jim Woodcock.

**2nd ARTIST2/UNU-IIST School on Embedded System Design** Suzhou, China, 1–10 August. The training school is organised jointly by UNU-IIST and ARTIST2 network of excellence on Embedded Systems. There were four lecturers sent from Europe and three seminar speakers (two from China, one from Europe and Zhiming Liu from UNU-IIST). 115 student attended the school. The lecturers and the seminar speakers are all first class researchers in the areas related real-time embedded systems. ARTIST2 paid for the travel expenses of the lecturers and Suzhou University covered the local costs.

**UNeGov.net Schools on Foundations of Electronic Governance** Six schools were organized by the Center for Electronic Governance during 2007:

1. 4th UNeGov.net School, Kathmandu, Nepal, 13–15 February
2. 5th UNeGov.net School, Ulaanbaatar, Mongolia, 1–3 May
3. 6th UNeGov.net School, Bogota, Colombia, 28–30 August
4. 7th UNeGov.net Regional School, Incheon, South Korea, 9–11 October
5. 8th UNeGov.net School, Pyongyang, North Korea, 27–29 November
6. 9th UNeGov.net School, Bhubaneswar, India, 22–24 December

See Section 2.3 for details.

**1st International School on Methodologies and Tools for Human-computer Interaction**

The school was co-organised with the Institut de Recherche en Informatique de Toulouse (IRIT) and the Pontificia Universidade Católica do Rio de Janeiro (PUC-Rio), and was held in Rio de Janeiro, Brazil, during 17–21 September. Antonio Cerone taught a course on Methodologies for the Formal Analysis of Human-computer Interaction. There were 25 participants from Brazil and 1 from Uruguay.

**IFIP-UNU Advanced Course on Networking and Security** The school was co-organised with the Instituto Superior de Transportes e Comunicações (ISUTC) and the International Federation of Information Processing (IFIP), and was held in Maputo, Mozambique, during 9–20 July and 13–17 August. Siraj Shaikh taught a course on Network Security. There were 35 participants from Mozambique.

UNU-IIST organised the following courses in 2007.

**Chris George** taught four courses in South America:

*Model Checking*, Bahia Blanca, Argentina, 29 October–2 November, with 8 attendees from Argentina;

*Formal Software Development Using RAISE*, Neuquen, Argentina, 5–9 November, with 14 attendees from Argentina;

*Software Project Management*, San Luis, Argentina, 12–16 November, with 17 attendees from Argentina;

*Formal Software Development Using RAISE*, Talca, Chile, 19–23 November, with 16 attendees from Chile, 1 from Colombia.

**Zhiming Liu and Wang Xu** organised *Software Engineering with UML* and *Formal Modelling and Verification in CSP*, Obafemi Awolowo University, Ile-Ife, Nigeria, 14–25 May, with 51 attendees, 35 from Nigeria.

**Dang Van Hung** organised *System Specification and Model Checking*, University of Lagos, Nigeria, 2–13 July, with 38 attendees from Nigeria.

### 3 Postgraduate training/teaching activities

#### 3.1 Fellowships

During 2007 UNU-IIST has hosted 4 post-doctoral fellows, trained 18 fellows from 8 developing countries and 1 externally supported fellow from an industrialised country at UNU-IIST, and 7 fellows from 5 developing countries have studied at a university in a developed country. See appendix A for details.

#### 3.2 Supervisions

UNU-IIST staff have been involved in supervising 4 post-doctoral fellows, 8 PhD students and 2 Masters student during 2007.

- Chris George is Postdoc supervisor for Dr Luis Leon, University of Waterloo, Ontario, Canada. Subject: Hydrology for the WaterBase project.
- Jeff Sanders is Postdoc supervisor for Dr Hu Jun. Subject: Policies for reconfigurable systems.
- Tomasz Janowski is
  - PhD supervisor for Ms Elsa Estevez, National University of the South, Bahia Blanca, Argentina. Subject: Programmable Messaging for Electronic Government.
  - PhD supervisor for Mr Wang Yong, ICT Institute, Chinese Academy of Sciences. Subject: Measuring and Analyzing Peer-Peer Networks.
  - MSc supervisor for Mr Alejandro Sanchez, National University of San Luis, San Luis, Argentina. Subject: Semantic Interoperability for Programmable Messaging Middleware.
- Zhiming Liu is
  - Postdoc supervisor for Dr Volker Stolz. Subject: Theories and Tools of Component-Based Systems.
  - Postdoc supervisor for Dr Charles Morisset. Subject: Harnessing Theories for Tool Support in Software.
  - Postdoc supervisor for Dr Naijun Zhan, Institute of Software, Chinese Academy of Sciences. Subject: rCOS model of coordination.
  - PhD supervisor for Mr Liang Zhao within UNU-IIST joint PhD Programme with the University of Pisa. Subject: Formal Theories and Methods of Computing.
  - PhD supervisor for Mr Chen Xin, Nanjing University, China. Subject: Formal method of component and object systems.

- PhD supervisor for Ms Yang Lu, Nanjing University, China. Subject: Formal method of component and object systems.
- PhD supervisor for Mr Chen Zhenbang, National Lab of Parallel and Distributed Computing, China. Subject: Formal Method of Component and Object Systems.
- PhD supervisor for Mr Ke Wei, University of Science and Technology of Macao. Subject: Syntax and Semantics of rCOS.
- MSc supervisor for Mr Liu Jicong, Zhongshan University, China. Subject: Prototyping Tools of Component-based Software Development.
- Antonio Cerone is
  - Postdoc supervisor for Dr Siraj Ahmed Shaikh. Subject: Formal Aspects of Secure Distributed Systems.
  - PhD supervisor for Mr Thomas Anung Basuki within UNU-IIST joint PhD Programme with the University of Pisa. Subject: A Formalism to Model Biological Systems.
- Adegboyega Ojo is
  - PhD supervisor for Mr. Rilwan Basanya, University of Lagos. Subject: Ontological Annotations
- Bernhard Aichernig, supported by Antonio Cerone, is
  - Postdoc supervisor for Dr Andreas Griesmayer within the CREDO Project. Subject: Computing Preconditions in Concurrent Systems.
  - PhD supervisor for Mr Rudolf Schlatter within the CREDO Project. Subject: Test Case Generation from Formal Specifications for Functional Testing.

Juan Perna from Argentina was sponsored by UNU-IIST in 2006 as a joint PhD student with the University of York in the UK. After the first year York decided on the basis of his progress that they would allow him to complete all of his PhD there, funded entirely by York, rather than continuing with UNU-IIST support and with the second year spent at UNU-IIST. We are pleased with Juan's success at York, but will in future joint degree agreements require repayment of financial support in such situations.

## 4 Publications and dissemination

### 4.1 Publications

#### 4.1.1 UNU-IIST reports

In 2007, UNU-IIST staff and fellows have produced 36 reports, which are available for downloading via the UNU-IIST web page and also available in the UNU-IIST library. These reports are [24, 25, 26, 27, 19, 22, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 23, 20, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55]

#### 4.1.2 External Publications

A total of 32 papers has been published in conference proceedings, 13 have been published in journals or as a book chapter, and 5 conference proceedings and one book have been edited. See appendix B for the full list of external publications in 2007.

UNU-IIST staff have served on the Programme Committees of 20 international or national conferences: ICTAC07, SEFM07, IJCAI'07, ICFEM07, QAPL07, FACS07, FMIS 2007, TTSS'07, ICECCS 07, IFM 07, ICEGOV 2007, ICDCIT 2007, CACIC 2007, PROVE 2007, ICGCC 2007, SEPT 2007, ECEG 2007, CACIC 2007, WSEDB 2007, ASSE 2007.

These included 6 PC co-chair positions.

## 5 List of academic meetings and events

Academic meetings and events comprise the workshops, conferences and seminars that UNU-IIST has (jointly) organised with other institutions.

**ICTAC 2007** , Macau, 26-28 September, 2007. The 4th International Colloquium on Theoretical Aspects of Computing was organised by UNU-IIST (Mike Reed was a conference co-chair, Chris George was the Organisation Chair and Zhiming Liu was a PC co-chair). The proceedings have been published as volume of Springer Lecture Notes in Computer Science. The volume editors are Cliff Jones, Zhiming Liu (from UNU-IIST) and Jim Woodcock. Co-located with the colloquium there were two international events:

- **Festschrift Symposium** Dedicated to the 70th birthdays of Prof. Dines Bjørner and Prof. Zhou Chaochen, two former UNU-IIST directors, held on the 24th and 25th September. 24 computer scientists from the world were invited to present their

work, and there were about 60 participants. The event was supported by the Macao Foundation and Macau Polytechnic Institute. Local VIPs attended the opening ceremony, and the event was reported in the local newspapers. The papers are published as a volume of Springer Lecture Notes in Computer Science, edited by Cliff Jones, Zhiming Liu (from UNU-IIST) and Jim Woodcock.

- **1st International Workshop on Harnessing Theories for Tool Support in Software (TTSS07)**, held on the 22nd and 23rd September. Volker Stolz (a postdoc research fellow at UNU-IIST) was the organiser and Zhiming Liu was an Advisor). The papers are to be published as an issue of Electronic Notes on Theoretical Computer Science (ENTCS), edited by Geguang Pu and Volker Stolz (from UNU-IIST).

**Workshop on Digital Governance and Hotspot Geo-Informatics** Macao SAR, China, 10–11 January 2007. The workshop was organized by the Center for Electronic Governance, conducted by Dr. Ganapati P. Patil, Director of the Penn State Center for Statistical Ecology and Environmental Statistics, and attended by 20 staff and students from Macao Government, University of Macao and UNU-IIST.

**Workshop on Semantic Interoperability for e-Government** Macao SAR, China, 24 January 2007. See Section 2.7 for details.

**Workshop on Semantic Interoperability for e-Government** Redmond, USA, 30 March 2007. See Section 2.7 for details.

**UNeGov.net Network-Building Workshops** A series of four UNeGov.net Network-Building Workshops on Governance in Developing Countries were organized by the Center for Electronic Governance with local government or academic partners:

1. 8th UNeGov.net Workshop, Kathmandu, Nepal, 12 February 2007
2. 9th UNeGov.net Workshop, Bogota, Colombia, 27 August 2007
3. 10th UNeGov.net Workshop, Incheon, South Korea, 8 October 2007
4. 11th UNeGov.net Workshop, Bhubaneswar, India, 22 December 2007

See Section 2.3 for details.

**Developing e-Governance in the South: New Models for South-South Cooperation** UN Headquarters, New York, 18 October 2007. The event was co-organized by the Center for Electronic Governance and the UNU Office in New York. See Section 2.9 for details.

**ICDCIT 2007** 4th International Conference on Distributed Computing and Internet Technology, 17–20 December, Bangalore, India was co-organized by Kalinga Institute for Industrial Technology, India, and the Center for Electronic Governance. See Section 2.2 for details.

**ICEGOV2007** 1st International Conference on Theory and Practice of Electronic Governance, 10–13 December, Macao, was co-organized by the Center for Electronic Governance; Center for Technology in Government, University at Albany, State University of New York; and the Asian and Pacific Training Centre for ICT for Development, part of the UN Economic and Social Commission for Asia and the Pacific (UN-ESCAP). See Section 2.3 for details.

## 6 UN and host country linkages

### 6.1 Collaboration within the UN

1. Joint development of WaterBase software with UNU-INWEH.
2. Study of South-South cooperation in Software Technology, prepared and published as part of the UNDP-funded South Report. Several UN agencies are part of this project. See Section 2.9 for details.
3. An event on “South-South Cooperation for Electronic Governance - New Models of Collaboration” co-organized by the Center for Electronic Governance at UNU-IIST and the New York Office of UNU, held at UN Headquarters in October. See Section 2.9 for details.
4. We are building partnerships on Electronic Governance with UNDESA, UNDP, and UN-ESCAP. See Section 2.2 for details.
5. Open Courseware is a joint project with UNU-HQ, UNU-MERIT, UNU-WIDER, and UNU-ONY. See Section 2.8 for details.

### 6.2 Collaboration within Macao

We continue to have good relations with the Macao Government and other local institutions, particularly the Macao Foundation and the University of Macau:

**e-Macao Program** funded by Macao SAR Government involves a number of government and academic partners from Macao.

**ICEGOV2007** took place under official patronage of Macao SAR Government, with venue, funding and support provided by various government agencies.

**UNU Research Repository** This on-line repository of research materials is a UNU-wide collaboration, and starting to involve other UN agencies: see section 2.19. The Macao Foundation is sharing the cost.

**Macao Science and Technology Committee** is a major funding source within Macao and we currently have two projects partly funded by it, Integrating Methods and Tools for High Quality Software Development (HighQSoftD) and Harnessing Theories for Tool Support (HTTS).

**3 conferences** were organised at premises provided at no charge by Macao Polytechnic Institute.

### 6.3 Other collaborative projects

**Semantic Interoperability for Electronic Government** This project is a collaboration between the Center for Electronic Governance and Microsoft to carry out research, development and community-building on semantic interoperability in the context of public organizations, funded by Microsoft and UNU-IIST. See Section 2.7 for details.

**UNeGov.net Initiative** This project, described in Section 2.3, collaborates with various government, non-government and international organizations to build a Community of Practice for Electronic Governance. Established partnerships include: National IT Agency, Government of Nepal; ICT Authority, Government of Mongolia; National IT Development Agency, Government of Nigeria; and Agenda Conectividad, Government of Colombia; Canada School for Public Service, Korea Agency for Digital Opportunity and Promotion, Center for Technology in Government, University at Albany, New York; United Nations Department for Economic and Social Affairs; Asia and Pacific Training Center for ICT for Development, UNESCAP. See Section 2.3 for details.

**CREDO** is an EU-funded project on “Modeling and analysis of evolutionary structures for distributed services”. UNU-IIST’s funding is Euro 200 000 over 3 years, which will pay for a post-doctoral researcher, who will collaborate in particular with Dr. Bernhard Aichernig at the University of Graz, Austria: see section 2.11.

**Tata** in India is a partner in one of our research projects and in an annual school.

## 7 Personnel/staffing situation

### 7.1 Staff

The following is the staffing situation in 2007:

1. Dr. George Michael Reed, Director
2. Mr. Chris George, Associate Director
3. Dr. Jeffrey Sanders, Principal Research Fellow
4. Dr. Tomasz Janowski, Senior Research Fellow
5. Dr. Antonio Cerone, Research Fellow
6. Dr. Dang Van Hung, Research Fellow, until 4 October 2007
7. Dr. Zhiming Liu, Research Fellow
8. Dr. Adegboyega Kolawole Ojo, Research Fellow

9. Dr. Wang Xu, Assistant Research Fellow
10. Ms. (Wendy) Hoi Iok Wa, Administrative and Programme Services Officer
11. Ms. (Kitty) Chan Iok Sam, Computer Systems Assistant
12. Ms. (Sandy) Lee Yuen Kwan, Administrative Assistant
13. Ms. (Michelle) Ho Sut Meng, Finance Assistant
14. Ms. (Alice) Pun Chong Iu, Programme Assistant
15. Ms. (Coffee) Ieong Soi Cheng das Dores, Library Clerk
16. Ms. Lei Sao Chi, Messenger

## 7.2 Temporary Staff

1. Ms. Kam Mui Fok, 22 January - 20 July 2007, Macau

## 7.3 Post-doctoral Fellows and Project Staff

1. Ms. Elsa Clara Estevez, 1 November 2004 - 31 December 2009, Argentina
2. Dr. Volker Stolz, 1 August 2006 - 31 July 2008, Germany
3. Dr. Siraj Shaikh, 1 October 2006 - 30 September 2007, Pakistan
4. Mr. Nguyen Viet Khoi, 26 November 2006 - 30 June 2008, Vietnam
5. Mr. Bernd Friedrich, 13 January - 31 December 2007, Germany
6. Dr. Rudolf Schlatte, 1 February 2007 - 31 January 2010, Austria
7. Dr. Andreas Griesmayer, 15 February 2007 - 14 February 2010, Austria
8. Dr. Charles Morisset, 17 October 2007 - 16 October 2008, France
9. Mr. Remi Chandran, 4 November 2007 - 31 December 2008, India
10. Mr. Rilwan Basanya, 9 March 2007 - 31 December 2009, Nigeria
11. Mr. Alejandro Sanchez, 17 January 2007 - 30 June 2008, Argentina
12. Dr. Luis Leon, 1 July 2006 - 31 December 2007, Mexico
13. Dr. Charles Morisset, 18 October 2007 - 31 August 2008, France

## 7.4 Visiting Researchers

The following were Visiting Researchers at UNU-IIST during 2007:

1. Mr. Young Sik Kim, 12-16 March 2007, South Korea
2. Dr. Yifeng Chen, 7 April - 2 May 2007, UK
3. Dr. Padmanabhan Krishnan, 8 April - 4 May 2007, Australia
4. Prof. Ying Mingsheng, 9-15 May 2007, China
5. Ms. Marzia Buscemi, 7-9 June 2007, Italy
6. Dr. Dimitar P. Guelev, 24 July - 26 September 2007, Bulgaria
7. Dr. Zhang Naijun, 20 August - 20 November 2007, China
8. Dr. Hyeun-Suk Rhee, 11-13 June 2007, South Korea
9. Prof. Carlo Montangero, 21 September - 20 November 2007, Italy
10. Prof. Zhu Hong, 22 June 2007, China
11. Dr. Liu Yongmei, 29 June 2007, China
12. Prof. Florian Kammuehler, 22 July - 7 August 2007, Germany
13. Prof. Teodor C. Przymusinski, 16-17 July 2007, USA
14. Profs. Tiziana Margaria and Bernhard Steffen, 19 July 2007, Germany
15. Profs. Kokichi Futatsugi, Kazuhiro Ogata and Weiqiang Kong, 6-10 August 2007, Japan
16. Dr. Gabriel Ciobanu, 21 September - 11 October 2007, Romania
17. Prof. Anders Ravn, 22 September - 4 October 2007, Denmark
18. Profs. Abdullah Mohd Zin, Abdul Razak Hamdan, Zarina Shukur and Syahanim Mohd Salleh, 6-7 September 2007, Malaysia
19. Dr. Paolo Zuliani, 10-13 June, 19-25 August and 28 October - 4 November, UK
20. Prof. Grigoris Antoniou, 19 October, Greece.
21. Prof. Ursula Martin, 9 November, UK
22. Prof. Sharon Dawes, 10-14 December, USA
23. Dr. Theresa Pardo, 10-14 December, USA
24. Prof. Wojciech Cellary, 10-14 December, Poland
25. Dr. Robert Schware, 10-13 December, USA

## 8 Tables of fellowships, schools and courses

Fellows' Continents	2003	2004	2005	2006	2007
Asia	18	12	16	21	17
Africa	2	3	5	2	6
South America	0	5	3	3	3
Europe	0	2	1	0	2
Total	20	22	25	26	28

Table 1: UNU-IIST fellowships

Fellowships in table 1 include fellowships at UNU-IIST and at other universities.

Schools and Courses	2003		2004		2005		2006		2007	
	S/Cs	Parts	S/Cs	Parts	S/Cs	Parts	S/Cs	Parts	S/Cs	Parts
Asia	6	274	4	207	6	180	6	213	9	654
Africa	1	18	2	57	0	0	3	191	3	124
S America	3	143	4	95	3	90			7	242
Europe							1	21	0	0
Total	10	435	10	359	9	270	10	425	19	1020

Table 2: Schools and courses organised by UNU-IIST with numbers of participants

Publications	2003	2004	2005	2006	2007
Conference papers	16	25	21	16	32
Journal articles and book chapters	5	7	4	12	13
Books and Journals	1	0	5	4	6
Total	22	32	30	32	51

Table 3: UNU-IIST publications

## A Fellowships

### Fellows at UNU-IIST (2007)

	Period of fellowship	Country	Project
Abdel Hakim Hannousse	15/01/07 -- 14/10/07	Algeria	Object Comp. Sys.
Wang Yong	26/02/07 -- 02/11/07	China	E-government
Rudolf Schlatte	01/02/07 -- 31/01/10	Austria	CREDO
Andreas Griesmayer	15/02/07 -- 15/02/10	Austria	CREDO
Kamel Boumaza	15/03/07 -- 14/12/07	Algeria	CSP Verification
Silvia Lizeth Tapia	22/04/07 -- 12/04/08	Peru	RAISE tools
Abigail P. Vargas	05/05/07 -- 05/05/08	Peru	Checking RSL
Ndukwu Ukachukwu	01/06/07 -- 06/02/08	Nigeria	Formal Methods
Bouneb Zine Abidine	04/06/07 -- 03/03/08	Algeria	Obj. Orientation
Liu Jicong	16/07/07 -- 15/06/08	China	UML Models
Chan Heng	16/07/07 -- 15/07/08	China	Comp. Sys.
Hu Jun	21/08/07 -- 08/04/08	China	Reconfig. Sys.
Zhan Naijun	21/08/07 -- 20/11/07	China	Real-Time Aspects
Ganbold Nyamdorj	10/09/07 -- 14/12/07	Mongolia	E-government
Bimal Pratap Shah	10/09/07 -- 14/12/07	Nepal	E-government
Douwe H. Vincent	13/09/07 -- 31/12/08	Cameroon	E-government
Yang Kehua	20/09/07 -- 19/06/08	China	Formal Methods
Sun Haoyu	20/09/07 -- 19/06/08	China	Formal Methods
Lei Bin	01/12/07 -- 31/08/08	China	Formal Methods

### Fellows for Development of Computer Science Departments

	Period of fellowship	Country	Partner Univ.
Chen Wu	26/02/07 -- 26/07/07	China	Univ. of New South Wales, Australia
Maria Pilar Rodriguez	17/08/07 -- 07/12/07	Peru	Ball State University Indiana, USA
Adewole Usman Rufai	31/08/07 -- 07/12/07	Nigeria	Ball State University Indiana, USA
Hoang Quang	21/07/07 -- 27/10/07	Vietnam	Univ. of Queensland Australia
Tangtang Xie	02/08/07 -- 27/10/07	China	Univ. of Queensland Australia
Sin Ok	20/09/07 -- 20/03/08	DPR Korea	University of Singapore

Ri Hyon Sul	20/09/07 -- 20/03/08	DPR Korea	University of Singapore
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Fellows for PhD Programme

	Period of fellowship	Country	Partner Univ.
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Thomas Anung Basuki	01/02/07 -- 31/01/10	Indonesia	Pisa University, Italy
Zhao Liang	02/09/07 -- 31/08/10	China	Pisa University, Italy

## B List of External Publications

1. Antonio Cerone and Paul Curzon (editors). *Proceedings of the 1st International Workshop on Formal Methods and Interactive Systems*. Macau SAR China, 31 October 2006, *Electronic Notes in Theoretical Computer Science*, **183**, Elsevier, 2007.
2. Antonio Cerone and Paul Curzon (editors). *Pre-proceedings of the 2nd International Workshop on Formal Methods for Interactive Systems FMIS 2007*, Lancaster, 4 September 2007. Technical Report RR-07-08, Queen Mary, University of London, Dept. of Computer Science.
3. Antonio Cerone and Norzima Elbegbayan. Model-checking driven design of interactive systems. In *Proceedings of the 1st International Workshop on Formal Methods for Interactive Systems*, Macau SAR China, 31 October 2006, *Electronic Notes in Theoretical Computer Science*, **183**:3-20, Elsevier, 2007.
4. Antonio Cerone and George Milne. Property Verification within a Process Algebra Framework. Chapter 7 of *Real-Time Systems: Modeling, Design, and Applications*, (Dan Ionescu and Aurel Cornell, eds.), *AMAST Series in Computing*, **8**:153-174, 2006.
5. Siraj A. Shaikh, Padmanabhan Krishnan and Antonio Cerone. A formal approach to human error recovery. Presented at and published in the *Pre-proceedings of the 2nd International Workshop on Formal Methods for Interactive Systems FMIS 2007*, Lancaster, 4 September 2007. Technical Report RR-07-08, Queen Mary, University of London, Dept. of Computer Science, pp. 101 – 115.

6. Siraj A. Shaikh. Impact of migrant academics on host higher education institutions, Learning Together: Reshaping higher education in a global age, July 22–24, 2007, Institute of Education (IoE), London, UK URL: <http://ioewebsserver.ioe.ac.uk/ioe/cms/get.asp?cid=14744>
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8. Bernhard K. Aichernig and Jifeng He. Mutation Testing in UTP. *Formal Aspects of Computing*, 2007.
9. Zhiming Liu and R. Venkatesh. Methods and Tools for Formal Software Engineering. In B. Meyer and J. Woodcock (Eds.), *Verified Software, Theories, Tools and Experiments*, Lecture Notes in Computer Science **4171**, Springer, 2007.
10. Bernhardt K. Aichernig, He Jifeng, Zhiming Liu and Mike Reed. Integrating Theories and Techniques for Program Modelling, Design and Verification. In B. Meyer and J. Woodcock (Eds.), *Verified Software, Theories, Tools and Experiments*, Lecture Notes in Computer Science **4171**, Springer, 2007.
11. A. H. Hannousse, O. Kazar, D. Meslati and Z. Liu. A cohabitation framework for AOSD Models. *International Review on Computer and Software*, **2**(4):285–291, 2007.
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14. Dang Van Hung and Pham Hong Thai. Towards a Template Language for Component-Based Programming. Technical Report 354, UNU-IIST, P.O.Box 3058, Macau, April 2007. Presented at and published in the proceedings of the 2007 International Conference on Software Engineering Research and Practice, SERP’07, Las Vegas, June 25–28, 2007, pp. 326–332, Hamid R. Arabnia and Hassan Reza (eds), WORLDCOMP’07, CSREA Press, 2007.
15. Dang Van Hung and Zhang Miaomiao. On Verification of Probabilistic Timed Automata against Probabilistic Duration Properties. Presented at and published in the proceedings of the 13th IEEE International Conference on Embedded and Real-Time Computing Systems and Applications RTCSA 2007, Daegu, Korea, August 21–24, 2007. IEEE Computer Society Press, Los Alamitos, California, pp. 165–172.

16. Michael R. Hansen, Dang Van Hung: A Theory of Duration Calculus with Application, Book Chapter, Domain Modeling and the Duration Calculus 2007, Lecture Notes in Computer Science 4710, Springer 2007, pp. 119–176.
17. Dang Van Hung. Specifying Various Time Models with Temporal Propositional Variables in Duration Calculus. Formal Methods and Hybrid Real-Time Systems 2007: 170–187.
18. Choe Changil and Dang Van Hung. On Verification of Linear Occurrence Properties of Real-Time Systems. Presented and published in the proceedings of the 1st International Workshop on Harnessing Theories for Tool Support in Software TTSS'07 22-23 September 2007 Macau SAR, China. To be published as an ENTCS issue.
19. Chris George and Luis Leon. WaterBase: Prototype of Open Source Toolkit for Environmental Modeling using SWAT in MapWindow. Presented at and published in the proceedings of the International Symposium on Environmental Software Systems, ISESS, Prague, Czech Republic, May, 2007.
20. Chris George and Luis Leon. WaterBase: free, open source support for SWAT. Presented at the 4th International SWAT Conference, Delft, the Netherlands, July 2007.
21. Chris George and Luis Leon. WaterBase: SWAT in an Open Source GIS. The Open Hydrology Journal, volume 2, 2008, pp. 1–6.
22. Chris George and Anne E. Haxthausen. The Logic of the RAISE Specification Language. In Dines Bjørner and Martin Henson (eds), Logics of Specification Languages, Springer, 2008, pp. 349–399.
23. Juan I. Perna and Chris George. Model Checking RAISE Applicative Specifications. Presented at and published in the proceedings of the 5th IEEE International Conference on Software Engineering and Formal Methods, SEFM, London, UK, September 2007.
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25. Chris George, Padmanabhan Krishnan, P A P Salas, and J W Sanders. Specification for Testing. Published in “Formal Methods and Hybrid Real-Time Systems: Essays in Honour of Dines Bjørner and Zhou Chaochen on the Occasion of Their 70th Birthdays”, LNCS 4700, Springer, 2007.
26. Xu Wang and Marta Kwiatkowska. On process-algebraic verification of asynchronous circuits. Fundamenta Informaticae, **80**, 2007.
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34. Volker Stolz. Temporal Assertions with Parametrised Propositions. Runtime Verification (RV’07). To be published as LNCS, Springer, 2007.
35. Lu Yang. Integrating refinement into software development tools. 1st Intl. Workshop on Harnessing Theories for Tool Support in Software (TTSS’07). To be published in ENTCS, Elsevier, 2007.
36. Zuohua Ding, Zhenbang Chen and Jing Liu. A Rigorous Model of Service Component Architecture. 1st Intl. Workshop on Harnessing Theories for Tool Support in Software (TTSS’07). To be published in ENTCS, Elsevier, 2007.
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## C Partners

### C.1 UN Partners

- UNU-INWEH
- UNU-MERIT
- UNDESA
- UNESCAP/APCICT
- UNDP
- UNU-ONY

### C.2 Government Partners:

- The Government of Macao SAR, China
- Institute for Tourism Studies, Macao
- National IT Development Agency, Government of Nigeria
- National IT Agency, Government of Nepal
- ICT Authority, Government of Mongolia
- Agenda Conectividad, Government of Colombia

- Canada School for Public Service, Government of Canada
- Korea Agency for Digital Opportunity and Promotion, Government of Korea

### C.3 NGO/NPO Partners:

- Macao Foundation, Macao SAR, China
- FME - Formal Methods Europe, Netherlands
- EASST - European Association of Software Science and Technology, Germany
- IEEE CS - The Institute of Electrical and Electronics Engineers Computer Society, USA
- National e-Government Strategy Limited, Nigeria

### C.4 Academic Partners

- Academy of Sciences, DPR Korea
- Universidad Nacional del Sur, Argentina
- Universidad Nacional de San Luis, Argentina
- Universidad Nacional de Comahue, Neuquen, Argentina
- Universidad Catolica del Maule, Talca, Chile
- Externado University of Colombia
- East China Normal University, Shanghai, China
- Nanjing University, China
- Institute of Software, Chinese Academy of Sciences, Beijing, China
- Ball State University, USA
- University of Macau, China
- Polytechnic Institute of Macao, China
- Macao University for Science and Technology, China
- North West Polytechnic University, China
- South West University, China
- University of Guelph, Ontario, Canada
- University of Waterloo, Ontario, Canada
- Danish Technical University, Lyngby, Denmark
- University of Aalborg, Denmark
- University of the South Pacific, Suva, Fiji
- Alzaiem Alazhari University, Khartoum, Sudan
- Bond University, Gold Coast, Australia
- University of Waikato, Hamilton, New Zealand
- University of Wales, Swansea, UK
- Charles University, Prague, Czech Republic
- Centrum voor Wiskunde en Informatica (CWI), The Netherlands
- The University of Queensland, Brisbane, Australia
- Romanian Academy, Iași, Romania
- "A.I. Cuza" University, Iași, Romania

- Peking University, Beijing, China
- Imperial College London, UK
- University College London, UK
- Queen Mary University London, UK
- University of Pisa, Italy
- ISTI-CNR, Pisa, Italy
- Technical University of Graz, Austria
- University of Minho, Braga, Portugal
- University of Cambridge, UK
- University of York, UK
- University Tunis El Manar, Tunisia
- Centre for Technology in Government, University of Albany, New York

### C.5 Private Sector Partners

- Microsoft, Redmond, USA
- Siemens Corporate Technology, Munich, Germany
- Tata RDDC, Pune, India
- INESC-Macau, China

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