SMA -2 Full Proposal

on

Engineering Systems:
Leaders in Information Systems and Architectures (LISA)

submitted by

Angela GOH
NTU

Stuart MADNICK
MIT

March 11, 2004

Leaders in Information Systems and Architectures (LISA)

Overall Programme Executive Summary

Leaders in Information Systems and Architectures (LISA) is a collaboration among the School of Computer Engineering (SCE), Nanyang Technological University; the Engineering Systems Division (ESD), MIT; and the School of Computing (SOC), National University of Singapore. The program represents an interdisciplinary approach to large-scale information systems and architecture engineering challenges of the 21st century. The teaching program is modeled after ESD's Leaders for Manufacturing degree program.

The LISA research will be focused on the important theme of the "information grid" - the next generation combination of the Internet and Computing Grids to address the challenge of high-performance locating, accessing, organizing, and integrating of information from distributed, heterogeneous, autonomous information sources.

The LISA flagship project objective is to develop the Singapore-MIT Information Grid Infrastructure (SMIGI), which includes information grid services such as (1) information access & delivery, (2) information integration & exchange, (3) semantics & ontology, (4) quality/reliability/performance, (5) directory and discovery, (6) policy, authority & management, and (7) intelligent agent.

The LISA Inter-University research will be focused on exploring and utilizing the SMIGI in important application areas, such as (1) manufacturing logistics/supply chain, (2) product design, (3) bioinformatics, (4) healthcare, and (5) national security.

Impact on Singapore and Industrial Relevance

The Economic Review Committee's recommendations in remaking Singapore contained a key component that aims to position the nation as a key node in the global networked economy[1]. In order to become the hub of business operations for the region, it is imperative that Singapore supports an information grid. The services and capabilities of such a grid will enable enterprises to collaborate with global business partners. The academic program will focus on knowledge and practice in information systems and their architecture. It retains a strong flavor of existing ESD programs by providing both breadth and depth in engineering systems. The research portion will investigate issues and develop solutions relating to the information grid. Existing expertise found in the collaborating institutions provide a strong base for this research to take place. We have sought advice from the Infocomm Development Authority of Singapore (IDA) and their response is summarized as follows: "*The research focus on Information Grid is in line with IDA's Strategic Infocomm Technology Roadmap from 2002 to 2007… In one sentence, the White Paper is on the right track*."

Benefits of Incorporating ESD into SMA

ESD has a dual mission: to define and evolve engineering systems as a new field of study and to transform engineering education and practice. ESD is a priority in the MIT School of Engineering's view of the future, with a history of success in developing innovative teaching programs with a close relationship to industry. (Further background material on ESD can be found in Appendix 3.)

---

[1] Economic Review Committee, **Executive Summary - A Globalised, Entrepreneurial and Diversified Economy**, chapter 5, pp. 5-8, http://www.mti.gov.sg/public/PDF/CMT/ERC_Comm_ExecSum_v2.pdf?sid=150&cid=1479

The proposed program is unique and important. LISA is a visionary program that is different from traditional theoretical computer science and traditional business information systems groups. It combines the best of these programs and expands beyond the traditional views.

Benefits to and Collaboration with Singapore Research Institutes

The academic program is an ideal match with the universities' plans to provide a broad-based education and build partnerships with Singapore Research Institutes. Our proposed research team includes participants from Singapore's Institute for Infocomm Research (I2R), Singapore Institute of Manufacturing Technology (SIMTech), Singapore Institute for High Performance Computing (IHPC), and National Grid Office. Research institutes and university faculty will have opportunities to work with the diverse and rich pool of researchers affiliated with NTU, MIT, and NUS. As future leaders, the students will have a unique opportunity to be exposed to the systems-approach to complex engineering problems.

Deliverables for Educational Programme

The LISA educational will produce high-quality highly-deserved graduates, both at the Masters degree level and at the PhD level. The dual Masters degrees are designed to incorporate both breath and depth in Informations Systems and InfoComms Engineering. It is anticipated that the graduates will be highly sought after by industry, as evidenced by the letters of support received. The PhD graduates will be an important source of innovation and an asset to the academic base of Singapore. The programs are also planned in a way to enhance student retention.

Deliverables for the Research Programme

FlagShip Research: We propose to develop and deliver an operational Singapore-MIT Information Grid Infrastructure (SMIGI). This will include theory, software, and testing facilities. In addition, we will produce high quality academic papers for referred journals and conferences.

SMIGI will be an evolving system. As an analogy, let us consider the evolution of the "Web." In its earliest form, it had the HTTP network protocol, the HTML document format, and simple web browser (i.e., Mosiac). Even at that stage, it was very useful … but it did not have dynamic web pages, search engines, user-friendly web page editing tools, and many more capabilities that we now assume. Likewise, our information grid will evolve and expand in its capabilities, functionalities, and performance in the many areas identified in our research plan. We expect to "release" a new version of SMIGI approximately once a year – that will be the key deliverable. Some examples of detailed components are described in the research section of this proposal, but – much like the Web – we expect that unexpected and exciting capabilities will emerge out of this research effort.

Inter-University Research: The Inter-University research serves a dual set of purposes: (1) demanding stress tests for SMIGI and (2) the application of SMIGI to important application areas: manufacturing logistics/supply chain, product design, bioinformatics, healthcare, and national security. The deliverables from these efforts, similar to the flagship research, will be both scholarly academic papers and studies and actual operational applications demonstrating the value of SMIGI.

LISA-Sponsored Annual International Conference on Information Grid Research (ICIGR): We propose that LISA sponsor and host an annual conference on information grid research. It will invite the submission of papers, to be refereed, from key researchers around the world, as well as the LISA researchers. It will provide a forum to present the LISA

research findings, gain insight on related research elsewhere, and generally increase the stature and prestige of LISA, and the SMA-2 program, in the academic community.

Summary of funding requirements

LISA is an ambitious educational and research program involving the contributions of over 38 faculty and research staff at MIT, NTU, and NUS, plus more than a dozen post-docs, and graduate and undergraduate research assistants. The necessary funding requirements, with explanations, are described in detail in Appendix 6.

MIT Teaching and Research Faculty

Senior Faculty:

Nazli CHOUCRI, Professor of Political Science, MIT School of Humanities and Social Studies, and Associate Director of the Technology and Development Program

C. Forbes DEWEY, Jr., Professor of Mechanical Engineering and Bioengineering, MIT School of Engineering

Daniel HASTINGS, Professor of Aeronautics and Astronautics and Engineering Systems, MIT School of Engineering and Co-Director, Engineering Systems Division, MIT School of Engineering

Steven LERMAN, Class of 1922 Professor of Civil and Environmental Engineering, MIT School of Engineering

Nancy LEVESON, Professor of Aeronautics and Astronautics and Professor of Engineering Systems, MIT School of Engineering

Stuart MADNICK, John Norris Maguire Professor of Information Technology, MIT Sloan School of Management and Professor of Engineering Systems, MIT School of Engineering

Joel MOSES, Institute Professor of Computer Science and Engineering and Professor of Engineering Systems, MIT School of Engineering

Deborah NIGHTINGALE, Professor of the Practice of Aeronautics and Astronautics and Engineering Systems, MIT School of Engineering, and Director, Lean Aerospace Initiative

Yossi SHEFFI, Professor of Civil and Environmental Engineering and Engineering Systems, MIT School of Engineering, and Director, Center for Transportation and Logistics

John STERMAN, Jay W. Forrester Professor of Management, MIT Sloan School of Management; Director of System Dynamics Group

Joseph SUSSMAN, JR East Professor Professor of Civil and Environmental Engineering and Engineering Systems, MIT School of Engineering

John WILLIAMS, Associate Professor of Civil and Environmental Engineering, MIT School of Engineering and Professor of Engineering Systems, MIT School of Engineering.

Daniel WHITNEY, Senior Lecturer in Engineering Systems, MIT School of Engineering and Senior Research Scientist, Center for Technology, Policy and Industrial Development, MIT School of Engineering.

Junior Faculty:

Benjamin GROSOF, Douglas Drane Assistant Professor in Information Technology, MIT Sloan School of Management

NTU-NUS Teaching and Research Faculty

Angela Eck Soong GOH, Professor and Vice Dean, NTU School of Computer Engineering

Francis Bu Sung LEE, Associate Professor and Vice Dean, NTU School of Computer Engineering

Ee Peng LIM, Associate Professor and Head, Division of Information Systems, NTU School of Computer Engineering

Wee-Keong NG, Associate Professor and Director, Center for Advanced Information Systems, NTU School of Computer Engineering

Stephen John TURNER, Associate Professor and Director, Parallel and Distributed Computing Centre, NTU School of Computer Engineering

Ah-Hwee TAN, Associate Professor, NTU School of Computer Engineering

Narendra CHAUDHARI, Associate Professor, NTU School of Computer Engineering

Simon Chong-Wee SEE, Associate Professor (Adjunct), NTU Nanyang Supercomputing and Visualisation Centre

Sourav Saha BHOWMICK, Assistant Professor, NTU School of Computer Engineering

Chunyan MIAO, Assistant Professor, NTU School of Computer Engineering

Kevin Kok Wai WONG, Assistant Professor, NTU School of Computer Engineering

Xueyan TANG, Assistant Professor, NTU School of Computer Engineering

Yew Soon ONG, Assistant Professor, NTU School of Computer Engineering

Kuiyu CHANG, Assistant Professor, NTU School of Computer Engineering

Kiam Tian SEOW, Assistant Professor, NTU School of Computer Engineering

Beng Chin OOI, Professor and Vice Dean (Academic Affairs and Graduate Studies), Dept of Computer Science, NUS School of Computing

Tok Wang LING, Professor, Dept of Computer Science, NUS School of Computing

Kian-Lee TAN, Associate Professor and Deputy Head, Dept of Computer Science, NUS School of Computing

Chew Lim TAN, Associate Professor, NUS School of Computing

Yong-Meng TEO, Associate Professor, NUS School of Computing

Janice Mong-Li LEE, Assistant Professor, NUS School of Computing

Stéphane BRESSAN, Senior Fellow, NUS School of Computing

I2R/SIMTech/National Grid/IHPC Teaching and Research Associates

Hwee Hwa PANG, Director of the Services and Applications Division, Institute for Infocomm Research

Mun Kew LEONG, Manager of the Media Semantics Department, Institute for Infocomm Research

Eng Wah LEE, Senior Scientist, Singapore Institute of Manufacturing Technology (SIMTech)

Puay Siew TAN, Senior Research Engineer, Singapore Institute of Manufacturing Technology (SIMTech)

Hing Yan LEE, Deputy Director, Singapore National Grid Office

Terence Gih Guang HUNG, Programme Manager, Institute of High Performance Computing

MIT Principal Research Associates

Michael SIEGEL, Principal Research Associate, Information Technologies Group, MIT Sloan School of Management; co-head MIT PROductivity from Information Technology (PROFIT) Program.

Richard WANG, Principal Research Associate; Director, MIT Information Quality Program, Center for Technology, Policy, and Industrial Development (CTPID), MIT School of Engineering and Co-director, Total Data Quality Management (TDQM) Program, MIT Sloan School of Management.

MIT Teaching Program Administration (Head, ESD Education Committee)
Richard DE NEUFVILLE, Professor of Civil and Environmental Engineering, MIT School of Engineering and Professor of Engineering Systems, MIT School of Engineering

MIT Research Program Administration (Director, CTPID)
Fred MOAVENZADEH, James Mason Crafts Professor of Systems Engineering and Civil and Environmental Engineering, , MIT School of Engineering and Professor of Engineering Systems, MIT School of Engineering

MIT Overall Program Administration (Co-Directors of ESD)
Dan ROOS, Japan Steel Industry Professor of Civil and Environmental Engineering, MIT School of Engineering and Associate Dean of Engineering Systems, Director of Engineering Systems Division, MIT School of Engineering

Table of Contents

1. Education Program

1.1 Host Department / Academic Units

The host departments in Singapore are the School of Computer Engineering, NTU and the School of Computing, NUS. With a combined strength of over 200 faculty members, the two schools offer undergraduate courses in Computer Engineering and Computer Science and post-graduate courses by research and course-work.

The host department at MIT is the Engineering Systems Division within the MIT School of Engineering. The MIT faculty involved in this effort are amongst the most senior at MIT and are drawn from three Schools of MIT and five departments. (Further background material on ESD can be found in Appendix 2.)

1.2 Type of Degrees and Overview of Educational Program

Degrees

Dual Masters Degree: LISA will be a Dual Masters Degree program of duration of 18 months. Incoming students will earn dual Master's degrees, one SM Degree in Information Systems from NTU/NUS and an SM in Engineering Systems (from Information Systems track) from the ESD of MIT. We expect to admit about 16 students a year to this program – based upon sufficiently high quality applicants.

Candidates should possess a good undergraduate degree in Engineering or Science in a field which is related to their intended LISA thesis program. Some students with undergraduate preparation in management or economics would be admissible, provided that they have a strong technical background. All students in this LISA program are expected to have a solid background in the basics of computers and information technology (e.g., programming languages, data structures, etc.)

NTU/NUS PhD Degree program with SMA certificate: LISA will admit about 3 students, who have completed the dual SM degree requirements, per year into an NTU/NUS PhD Degree program with SMA certificate. Such students will apply to be admitted to NTU/NUS PhD Degree before the completion of the dual degree and will be admitted on a competitive basis.

Additionally, another 4 NTU/NUS PhD candidates will be accepted onto the Program to undertake research in the flagship themes. These students are expected to possess a Masters degree in related areas and should possess the necessary entry qualifications deemed acceptable by NTU/NUS. The normal minimum entry qualifications for admission as a candidate for the degree of Doctor of Philosophy are a Master's degree (research based) and the ability to pursue research in the candidate's proposed field of advanced study. Recommendations from three academic referees are required for the application. All candidates are required to complete requisite postgraduates modules and a term paper in their first year of study. In order to be confirmed as a doctoral student, evaluation is conducted by an appointed panel and is based on the student' work and proposals.

We envisage that the LISA program will attract very talented Singapore students, due to the challenging dual degree requirements as well as opportunities to further their studies in the PhD program. Hence, it is anticipated that at least half the cohort will comprise Singaporeans and Singapore Permanent Residents.

Distance Learning

Because not all MIT courses are offered in both semesters of the academic year and to get the students ready for more advanced courses, some of the courses will be offered via distance teaching. For SMA-2, this could be bi-directional, i.e., some MIT courses will be taught while students are in Singapore, and some NTU/NUS courses will be taught while students are at MIT.

1.3 Degree Requirements at Each Partner University

ESD Degree Requirements

The ESD Masters degree is constructed around a core set of classes. This is the same core as the ESD PhD core. The ESD core classes are chosen to give the student competence in systems theory and methods that can be applied to research in engineered systems to advance theory, policy or practice.

Students must satisfy a breadth and depth requirement. A student must take a minimum of 66 units[2] with one course in each of the three breadth areas of (I) Systems Theory, Design and Architecture, (II) Socio-Technical/Enterprise Systems and (III) Research Methods. The student then takes two courses in one area of depth in Information Systems and one course in an area of advanced applications of information systems. These areas of depth and advanced applications are closely related to the research theme, namely, the Information Grid.

The program described in Section 1.4 is based upon the current structure of the ESD SM Program and existing courses. It is expected that modifications to the program will occur and new courses will be developed as part of this SMA-2 LISA effort.

NTU/NUS Degree requirements

For a Master of Science degree, the requirement is six courses plus one thesis. These courses include core in **Systems Theory, Design and Architecture** and **Socio-Technical/Enterprise Systems** as offered by ESD. Two additional core courses are required in the Research Methods together with three more electives from the following modules in the Information Systems.

1.4 Curricula and key subjects (detailed course descriptions are provided in Appendix 3).

I. Systems Theory, Design and Architecture (one of the following)
- **ESD.34J System Architecture**
- **ESD.xxx[3] Foundations of System Architecture**

II. Socio-Technical/Enterprise Systems
- **ESD.565J Integrating Information Systems: Technology, Strategy, and Organizational Factors**

III. Research Methods
    ESD Requirement (one of the following)
    –   Systems Dynamics
- **ESD.74J System Dynamics for Engineers**

---

[2] MIT has a peculiar unit scheme which consists of the sum of classroom lectures hours, expected laboratory hours, and expected homework hours per week. Typical MIT subjects are either 9 or 12 units and roughly correspond to 3 or 4 unit courses at other universities.

[3] This is a new course being developed by Professor Moses, course number has not been assigned.

- **15.874 System Dynamics for Business Policy**

NTU/NUS Requirement (two of the following)
- **H6429 Computational Intelligence, Methods and Applications**
- **CPE428 Modeling and Simulation**
- **DM6121 Human Computer Interaction**
- **CS5223 Distributed Systems**
- **CS5221 Parallel Computer Systems**

IV. Depth in Information Systems

ESD Requirement (two of the following):
- **ESD.264J Database, Internet, and Systems Integration Technologies**
- **ESD.341J Web System Architecting: Building Web Services**
- **ESD.355J Concepts in the Engineering of Software**
- **ESD.132J Law, Technology, and Public Policy**

other possible ESD choices may include (subject to approval of faculty):
- **ESD.127 Telecommunications Modeling and Policy Analysis**
- **ESD.210J Computer Algorithms for Systems Analysis**
- **ESD.221J An Introduction to Intelligent Transportation Systems**

NTU/NUS Requirement (three of the following courses or two from IV. plus one from V: Challenging Applications of Information Systems)
- **H6404 Data Mining**
- **CPE403 Advanced Data Management Techniques**
- **CPE429 Software Testing**
- **DM6102 Multimedia Information Management**
- **CSC416 Intelligent Agents**
- **CS5231 Cryptographic Techniques and Data Security**
  .

V. Challenging Applications of Information Systems

ESD Requirement (one of the following)
- **ESD.260J/1.260J/15.770J Logistics Systems**
- **ESD61J/16.852J Integrating The Lean Enterprise**
- **2.771J/BE.43J/HST.958J Biomedical Information Technology**
- **6.872J/ HST.950J Medical Computing**
- **17.422 Field Seminar in International Political Economy**

NTU/NUS Requirement (option of one of the following in lieu of one course in IV: Depth in Information Systems)
- **BI6121 High Performance Computing for Bioinformatics**
- **CS5238 Combinatorial Methods in Bioinformatics**

VI. Mandatory seminar series
- **SMA001 – LISA Joint Research Seminar**

We wish to highlight a key component of the educational program, the proposed LISA joint research seminar. This novel approach to collaborative research spans the entire period of the dual degree programs. This seminar will occur weekly with speakers alternating between MIT and Singapore (the sessions will be conducted via distance

education). This will expose the LISA students to a diverse set of research topics related to the information grid theme of LISA and well as introduce the LISA faculty. This will provide the students with an important "head start" towards identifying thesis research topics. This seminar is a core requirement of both the ESD and NTU/NUS LISA degree programs.

At MIT, students with weaker backgrounds might be asked to take:
- **1.001 Introduction to Computers and Engineering Problem Solving**

<u>**Summary of Courses and Teaching Faculty Responsibilities**</u>

Subject Number	Hosting Institution	Cross-listing Institution	Required or Elective	Teaching Faculty
ESD.34J	MIT	NTU/NUS	Select 1	J. Moses
ESD.xxx	MIT	NTU/NUS		J. Moses
ESD.565J	MIT	NTU/NUS	Required	S. Madnick
ESD.74J	MIT	NTU/NUS	Select 1	K.F. Hansen
15.874	MIT	NTU/NUS		J. D. Sterman
H6429	NTU	MIT	Select 2	K. Wong
CPE428	NTU	MIT		S. Turner
DM6121	NTU	MIT		A.H. Tan
CS5223	NUS	MIT		T.W.Ling/B.C. Ooi
CS5221	NUS	MIT		Y.M.Teo
ESD.264J	MIT	NTU/NUS	Select 2	G. Kocur
ESD.341J	MIT	NTU/NUS		J. Williams
ESD.355J	MIT	NTU/NUS		N. Leveson
ESD.132J	MIT	NTU/NUS		N. A. Ashford, C. C. Caldart
ESD.127	MIT	NTU/NUS		*Staff*
ESD.210J	MIT	NTU/NUS		*Staff*
ESD.221J	MIT	NTU/NUS		J. Sussman
H6404	NTU	MIT	Two options: A: select 3 B: select 2	W.K. Ng
CPE403	NTU	MIT		E.P.Lim/A.Goh
CPE429	NTU	MIT		C.Y. Miao
DM6102	NTU	MIT		X. Tang
CSC416	NTU	MIT		K.T. Seow
CS5231	NUS	MIT		K.L. Tan
ESD.260J	MIT	NTU/NUS	Select 1	Y. Sheffi
ESD.61J	MIT	NTU/NUS		D. Nightingale
2.771J	MIT	NTU/NUS		C. F. Dewey, Jr
6.872J	MIT	NTU/NUS		P. Szolovits
17.422	MIT	NTU/NUS		N. Choucri
BI6121	NTU	MIT	Select 1 if selected B	
CS5238	NUS	MIT		ML. Lee
SMA001	MIT /NTU/NUS	MIT /NTU/NUS	Required	Multiple faculty
1.001	MIT	NTU/NUS	Elective	Lerman

Teaching Collaboration Plan and Track Record

The faculty selected for this program have had extensive experience with educational efforts similar to LISA involving complex faculty collaboration, such as:

- Distance education – Systems Design and Management (SDM) and SMA-1 programs
- Dual degree programs – Leaders for Manufacturing (LFM)
- Innovative educational technology – OpenCourseWare (OCW)

Existing "Smart Classes" with video conferencing equipment will be used to facilitate distance learning. ELearning portals such as NTU's edveNTUre will be exploited to support courseware and student/faculty communication.

1.5 Typical Student Trajectory

The dual SM degree students will spend their second semester at MIT and the rest in Singapore. In addition to building theoretical foundations, coursework of the first semester also establishes preliminary research interests among students. While they are at MIT, students will be taking courses and at the same time, exploring research topics in more depth. Thesis research will be conducted during the summer and the following third semester. This arrangement allows students to most effectively use their residence at MIT to interact with faculty and other students and at the same time, to promote collaborative research. The thesis research will be co-advised by NTU/NUS and MIT faculty.

LISA Dual Masters degree program and "internal" Doctoral students Trajectory

Assuming an 18 month schedule for the dual Masters degrees (starting in July):

Period (*Location*)	Courses (NTU/NUS + MIT + joint distant)	Milestones
Year 1: July		**Admit 16 students to complete dual LISA degree**
Year 1: July-Dec (*Singapore*)	5 + 0 + 1	5 Courses at NTU/NUS + SMA-2 LISA research seminar (joint distant)
Year 1: Jan-June (*MIT*)	0 + 5 + 1	5 Courses at MIT (including 1 compressed in Jan) + SMA-2 LISA research seminar (joint distant) Identify supervisors and research topics
Year 2: July-Dec (*Singapore*)	1 + 1 + 1	Full time research on thesis + SMA-2 LISA research seminar (joint distant) Apply for PhD program
Year 2: December		**16 students graduate with dual LISA degrees**
		3 of these students admitted to NTU/NUS PhD program
Year 2: January - June		Undertake qualifying exams + preliminary investigation into possible research areas

Year 3 onwards		Undertake research relating to doctoral thesis, spent one semester at MIT working with collaborators on the Flagship/IUP
Approx. Year 5		**3 students graduate with NTU/NUS PhD program, with SMA Certificate**

LISA "external" Doctoral students Trajectory

Period (*Location*)	Milestones
Year 1: July	**Admit 4 students to NTU/NUS doctoral program**
Year 1: (*Singapore*)	Undertake requisite courses, do groundwork on doctoral proposal and take qualifying exams at the end of this period
Year 2: July-Dec (*Singapore*) Jan-June (*MIT*)	Spent one semester at MIT working with collaborators on the Flagship/IUP
Year 3: (*Singapore*)	Undertake research relating to doctoral thesis
Year 4: (*Singapore*)	**4 students graduate with NTU/NUS PhD program, with SMA Certificate**

LISA Doctoral degree program

As mentioned in section 1.2, we project a cohort of 7 PhD candidates per year in steady state. These students will be registered in NTU/NUS under the supervision of Flagship/Inter-University research faculty, and co-supervised by an MIT counterpart working on the same project. As part of the project, such doctoral students will spend one semester on the MIT campus as MIT Special Students. The students will be required to complete the course requirements stipulated by NTU/NUS including successful completion of qualifying examinations.

Summary of LISA Masters and PhD Graduates

Planned yearly graduation rates: 16 dual Masters per year and approximately 7 PhDs per year. The former are expected to reach steady state in late 2006 while the latter would only graduate from 2009/2010 onwards. The total number of dual Masters degrees in 5 cohorts are projected to be 65. Another 15 students are expected to graduate with dual Masters and PhD from NTU/NUS. The budget also makes provision for a total of 20 NTU/NUS PhD students who will be working on the Flagship and Inter-University projects. For students on the dual Masters program, the percentage in residence at MIT is approximately one-third (one semester of the 18-month program).

1.6 Trajectory for Alternative
Not applicable.

1.7 Provision for Research Co-Supervision and Residency for Doctoral Students

All doctoral students, whether they be from the Dual Masters program or in the direct entry NTU/NUS PhD programs, will be co-supervised by faculty from MIT and NTU/NUS. Such students will be resident in MIT for not more than 1 semester, in order to have further interaction with their MIT advisors. It is also envisaged that as MIT collaborators visit Singapore as part of the flagship project, additional contact with the students will be made. There will also be provision for communication via video-conferencing.

1.8 Student and Industry Interest

The LISA program is inline with the vision and roadmap of Singapore's Infocomm Development Authority. This involves the educating of knowledge workers at a postgraduate level in the specific domains of engineering and information systems.

SCE/NTU has existing MOUs with multinational corporations, such as SUN and HP, in research as well as postgraduate education programs. Specifically, the Master of Science in Bioinformatics has already received warm support from the industry. Such partnerships could be extended for this SMA program. Companies such as SES Systems Pte Ltd, a subsidiary of Singapore Technologies Electronics Limited and Sybase have also expressed interests in research and manpower with software and knowledge management engineering skills. They could be potential partners of our research projects and provide test sites for implementing our research outcomes as well as recruiters of the LISA graduates.

1.9 Student Retention Mechanisms

The program has been designed and structured to achieve an optimum student retention rate. It should be noted that the mandatory MIT residency period is placed in between two periods in Singapore. This effectively ensures that the student commences and concludes the dual degree program in Singapore. With the close collaboration between the partners in Singapore and MIT, students enjoy the guidance of professors and researchers in both locations. The program does not allow for one degree from only one of the collaborating parties. It is an all or nothing approach. In addition to potential job opportunities with industry collaborators, we plan to implement other mechanisms that will create both social and economic interests for LISA graduates to seek career opportunities in Singapore. These include at least the following:

- Organize regular social events for students to interact with local SMA alums
- Work with career service office to provide placement assistance
- Organize annual career fairs
- Organize annual business plan competition similar to MIT 50K to promote entrepreneurship
- Internship with industry as mentioned in the letters of support. IDA, for example, has welcomed students to spend time with their proof-of-concept lab.

2. Research Program

2.1 Summary of General Research Theme: Information Grid

Singapore is poised to play a major role as an information and technology hub in East Asia and has aspired to build up indigenous research expertise that will be strategic in attaining and sustaining a competitive advantage in Information Systems and Information Technology. The research theme on **Information Grid** suggests that tremendous advantages may accrue to Singapore by taking a lead in the research, development, and deployment of an important set of integrated value-added information grid services leveraging on the excellent network and information infrastructure.   These capabilities will enable Singapore to transform herself into an important information hub providing the knowledge processing capabilities critically needed by global enterprises in the information age.

This research theme will leverage on the expertise of diverse research groups from MIT, NTU, NUS, I2R, SIMTech, IHPC and National Grid Office through an integrated large-scale experiment to:

- Establish a shared global Information Grid infrastructure
- Identify and experiment with important information-intensive application areas, such product design, logistics, bioinformatics, healthcare, and national security
- Research, design, and develop Information Grid tools and services
- Demonstrate the effectiveness of the theories, tools, and methodologies through technology transfer to industry.

The Internet and the World-Wide-Web have collectively provided the basis for an important infrastructure for connecting enormous amounts of computing and information resources on a global scale. It is increasingly obvious, however, that this kind of "physical connectivity" alone is not sufficient – this complex system must be effectively managed and vastly enhanced, through an **Information Grid**, to provide maximum value. This proposal suggests that tremendous advantages may accrue to Singapore and beyond by taking a lead in the research, development, and deployment of such an Information Grid.

The Information Grid has certain parallels and analogies to an Electric Power Grid:
- There are many different heterogeneous information sources.
- Large volumes of data are collected electronically and are made available on the internet.
- The information sources may be owned by different enterprises or individuals.
- The consumers of the information, in general, should not care which source provides its needed information and in what form or which language.
- The information should be easily transformable to serve the specific needs of the diverse users and applications.
- The Grid should be dynamic and resilient to changes. It should be able to dynamically and automatically substitute alternative information sources for inaccessible or damaged information sources.
- The Grid should be able to balance and effectively manage its resources.
- High degrees of local autonomy should be allowed and supported. On the other hand, in the event there are situations where autonomy can be meaningfully traded for efficiency and quality, sources can opt for a quasi-autonomy mode by adopting some specific service protocols that facilitate management and sharing of computing computation and information resources.

Background and Related Work

Before we proceed on to describe the individual information grid services, we would like to examine the motivations for building an information grid. Two questions to pose are:
1) Is a grid infrastructure necessary, as opposed to just using the Internet?
2) Do current web-based technologies suffice for building our proposed information services?
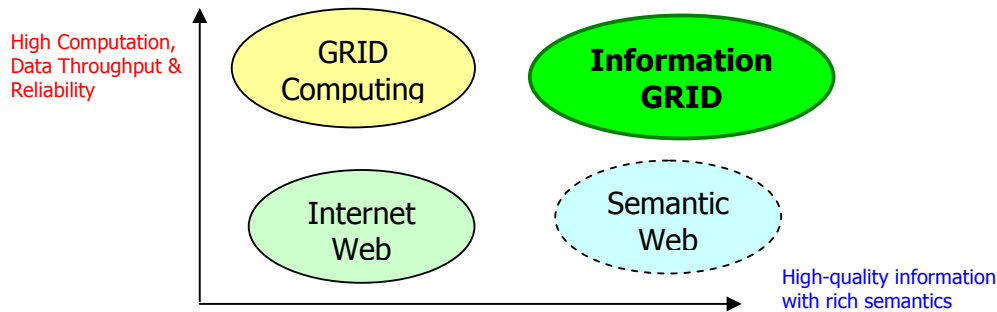
Figure 1: Positioning the Information Grid with respect to current (internet and grid) and future (semantic web) technologies. With gradual adoption and advent of pervasive computing, the information GRID will continuously shift diagonally (along the 45 degrees line) outwards.

Both questions can be rephrased with respect to Figure 1 as follows:
1) How far along the y-axis should the Information Grid be positioned?
2) How far along the x-axis should the Information Grid be positioned?

To answer the first question, we feel that although the computational and bandwidth requirements of the Information Grid at present may not be as high as some scientific grid applications which require as much as 100Gb/s data throughput and few hundred years worth of computational resources, they are still way beyond the current capabilities of the internet. For instance, the world's largest computer maker, Dell computer, logs several tens of gigabytes (GB) of online transaction data daily. The world's largest retailer, Wal-Mart, maintains an up-to-date massive 7.5 terabytes (TB) central database of purchase transaction logs culled from 2,900 stores in 6 countries. Further, an industry for credit-card fraud prevention (also known as credit risk management) currently exists in the US dedicated to the collection and aggregation of detailed credit card transaction data (including lists and dollar amounts of purchased products, addresses, etc.) from a consortium of participating merchants. In all of these examples, real time data-mining analysis is not performed on the collected data precisely due to the lack of an adequate information grid infrastructure.

Imagine the number of enhanced applications enabled by the information grid: real-time fraud detection across multiple online and/or brick-and-mortar merchants (currently hard to detect based solely on the credit-card history perspective of the issuing bank), real-time recommendation of products and services based on the current buying trend data-mined from the information grid, decision support for credit/loan application based on real-time classification of an applicant into several demographic groups. In fact, the data and real-time computational requirements of the information grid will increase by leaps and bounds when multiple merchants and financial institutions around the world begin to collaborate on mutually-beneficial and computational-intensive tasks such as global risk-management analysis. Further down the road, when ubiquitous computing becomes "pervasive", only our proposed Information Grid will be capable of providing the personalized information access and delivery to the plethora of devices and individuals based on their locations, preferences, histories/logs, and similarity to other persons/devices.

With regards to the second question, while numerous intelligent information analysis tools/services have been developed for the Internet/web, most of them are ad-hoc, and do not assume a distributed computing metaphor, and therefore are not designed to operate optimally in a grid environment. On the other hand, at a lower level, the web-services specification, originally designed for the Internet, has been adopted by the OGSA (Open Grid

Services Architecture) [Foster02], and forms an integral part of any solutions developed on top of it.

Singapore's National Grid Project aims to create a permanent inter-grid between the major Universities and research institutes in Singapore and abroad. This initiative will provide the infrastructure upon which the proposed information grid can be built. Most of the currently existing grid initiatives around the world focus on raw data-crunching applications for a particular domain such as earth-sciences, genomics, etc. The closest resemblance to our proposed information grid architecture is the knowledge grid [CT03] and the semantic grid [Roure03], both of which are also still unproven research efforts. The first proposes an abstract grid architecture for applying classical data-mining techniques, while the second is a grid version of the still non-existing semantic web. All in all, our proposed Information Grid provides significant semantic enhancement over the traditional web and grid architecture, and yet retains a practical and reasonable scope.

Information Grid Architecture

Figure 2 shows a set of seven information grid services built on top of a basic grid and network services layer, which provides low-level OGSA compliant services such as security, raw resource allocation and management, data transfer, etc. OGSA is a widely adopted grid architecture that has become the de-facto basis of the majority of international grid-computing initiatives including NASA's Information Power Grid[HiNo00] and the Discovery Net at Imperial College[CGG*02].

The actual architectural design and specification of the Information Grid, including the functionality and interfaces of each of the services, is an important part of this research effort. Furthermore, the overall management of the research team to insure the interoperability of these services in support of our flagship project is another important goal of this research effort. That is, although the individual research sub-projects will be pursued independently and in parallel, much like the design and manufacture of the various components that make up a car, they are intended to fit together to provide an integrated Information Grid infrastructure.
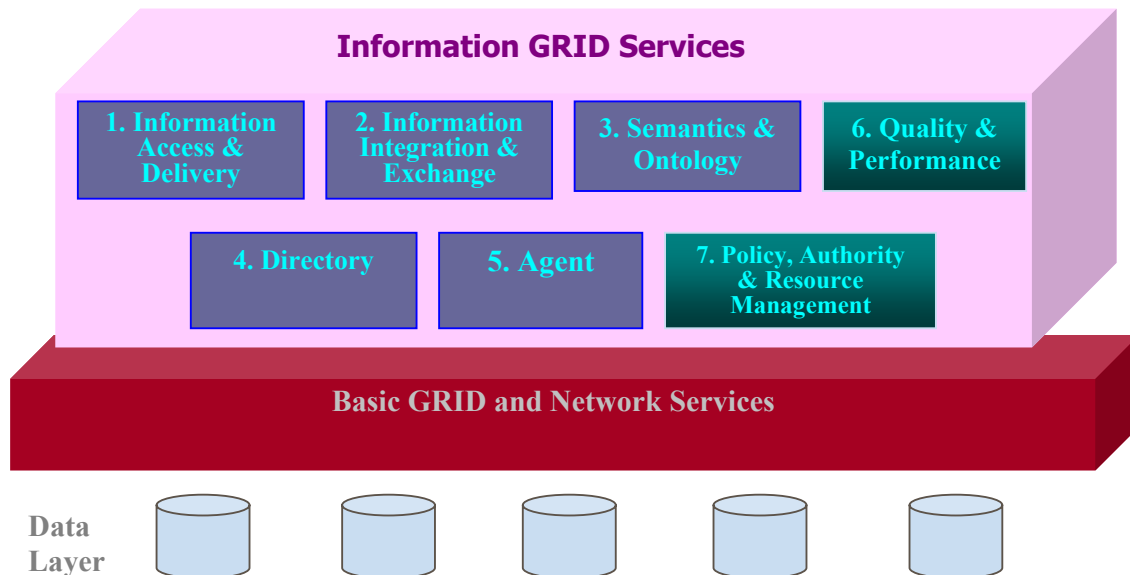
Figure 2: Information Grid Architecture (1-5: Core Services, 6-7: Extended Services)

The seven information grid services are summarized below:

Core Services

1. Information Access & Delivery Services
   - Provides personalized multi/cross-lingual information retrieval and query services over vast number of autonomous/quasi-autonomous and heterogeneous data sources
   - Provides conversion/transformation/wrapper services to access and deliver diverse data formats
   - Provides caching of information closer to users in order to reduce the information access overheads

2. Information Integration & Exchange Services
   - Provides integration and aggregation functions over heterogeneous data sources
   - Provides efficient query processing on autonomous heterogeneous data sources
   - Provides update detection for data sources to ensure data integrity

3. Semantics & Ontology Services
   - Provides collaborative ontology and rules management and maintenance services over different domains, thereby allowing domain-experts to collaboratively maintain ontologies and rule-bases
   - Provides services for the convenient and rapid acquisition of new ontology and rules
   - Provides tools to semantically enrich (mark-up) data/services using ontologies and rules
   - Provides translations between heterogeneous forms of ontologies and rules
   - Provides inferencing services for ontologies and rules

4. Directory Services
   - Provides indexing services to create and maintain a distributed smart information and service directory (yellow page) based on intelligent data-mining of resources
   - Provides match-making services to discover relevant consumers and publishers alike

5. Agent Services
   - Provides intelligent agent services for automating and aggregating various Information Grid functionalities or for realizing new and novel functions

<u>Extended Services</u>
6. Quality/Reliability/Performance Services
   - Provides services to incorporate domain-specific metrics/methods/notions for the automatic or semi-automatic assessment/rating of service quality
   - Provides capabilities for measuring and improving data quality
   - Provides approaches to improve software quality and reduce or eliminate system failures
   - Provides monitoring, tuning, and fault-tolerant mechanisms for achieving desired performance and/or quality
   - Provides capabilities for monitoring execution and validating services relevant to negotiated agreements

7. Policy, Authority & Resource Management Services
   - Provides fine-granularity security services for the access of information and services
   - Provides authority aggregation/inference services for multiple resources of varying authority
   - Incorporates mechanisms to address and support regulatory policies on information reuse and repurposing

Example– Port Operation Logistics

As an illustration of the problems created by the disparities underlying the way information is provided, represented, interpreted, and used, consider the example depicted in Figure 3 below. It assumes a collaborative effort, somewhat like the SMA programs, whereby various groups maintain information sources but using their own local and heterogeneous practices and information systems for accessing them.

There are also multiples users of these information sources located in various countries around the world with their own information systems and practices (depicted on the right-hand side). What if each of these users wished to answer a fairly common, but important, type of question: "How much time and cost is needed to ship 100 standard containers from Houston, Texas, USA to Beijing, China via Singapore". The cost calculation in this case is conceptually quite simple; merely add up the daily operational costs of shipping, trucking and warehouse storage in all three areas, multiplied by the number of days required. The estimated time needed, however, has to be derived based on in-depth knowledge of the current utilization and availability of container storage warehouses and shipping schedules in three different locations. There are multiple challenges to be overcome; a few key ones are summarized below.
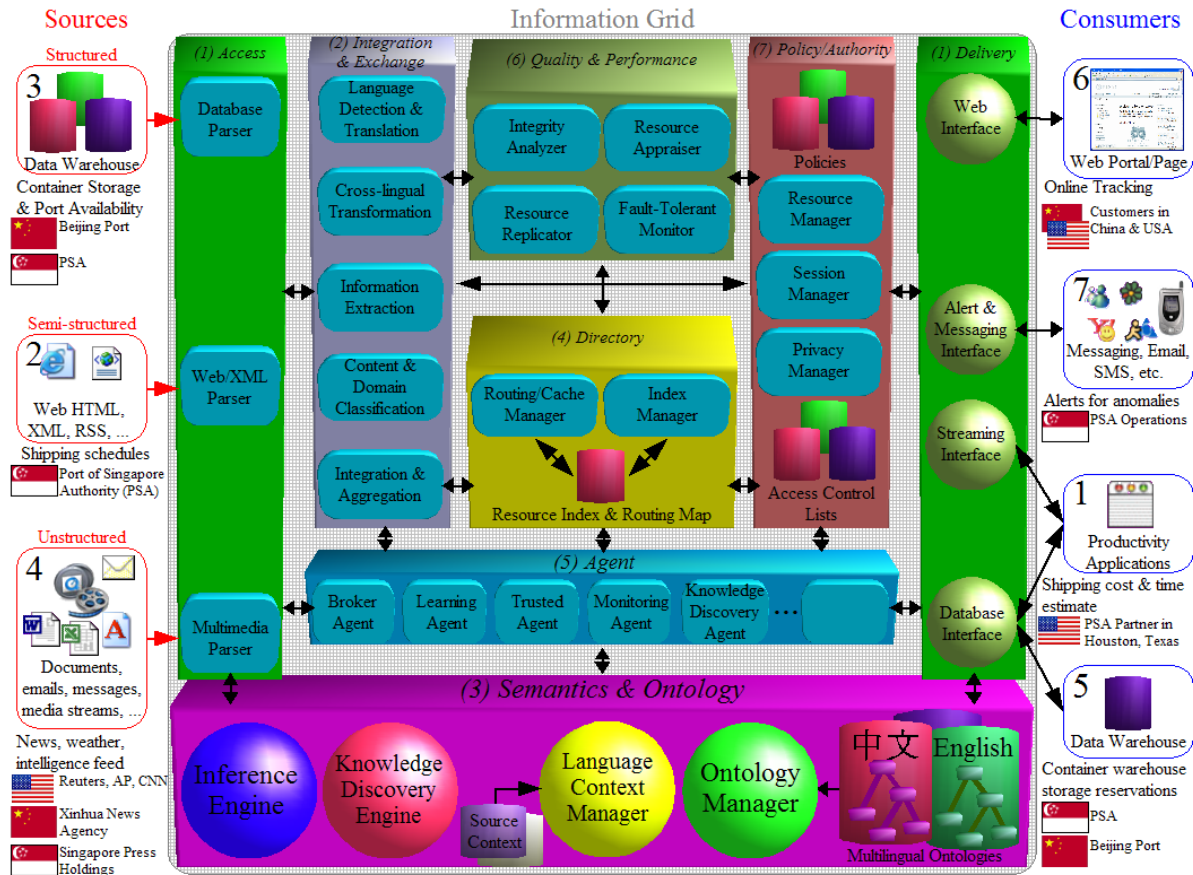
Figure 3. Example of Challenges to be addressed by Information Grid

It is increasingly apparent that to exploit the proliferation of information sources that are becoming available, we require an Information Grid so that the information can be obtained from disparate sources and can be meaningfully assimilated. In Figure 3, we can see how the various Information Grid services interrelate and coordinate with each other to derive a solution for the simple example (as elaborated below).

Suppose a shipload of 50 containers, currently at sea, was originally scheduled to arrive at Singapore from Houston, Texas. However, due to some unforeseen circumstances the American owner of the cargo would like to re-ship the cargo to Beijing, China as soon as possible upon arriving in Singapore. Suppose the American customer approaches Port of Singapore Authority's (PSA) representative/partner in Houston to negotiate the price/time for rerouting the cargo to Beijing. The following simplified flow of events (as numbered in the right and left of Figure 3) would ensue.

- First, the PSA representative in US (1) has to query the Singapore port (2) for available shipping schedules, via the information grid. The shipping schedule is assumed to be available on the PSA intranet in semi-structured form such as a web site, which the representative was able to quickly navigate to, thanks to the Information Grid's Directory Service. Further, the Quality & Performance Service, together with the Directory Service, ensure that even if a site hosting the desired data is down, a reasonably reliable backup version is accessible elsewhere.

- Next, the PSA representative queries both the PSA and Beijing ports (3) for container storage availability and cost, based on a set of estimated shipping schedules derived from the previous step.
- Third, a set of knowledge-discovery agents (4) running continuously on the information grid to mine for relevant news and intelligence would automatically alert the PSA representative about the associated risks. For example, whether there is increased tension between Taiwan and China in the months following the Taiwanese election, or whether there has been any pirate activity in the vicinity of the tentative shipping routes, or whether there has been any recent delays due to typhoons in the proposed routes, etc. Note that the agents would have to make full use of the semantics & ontology service in order to intelligently interpret the myriad of news and intelligence sources in different languages, e.g. Chinese news websites.
- The finalized cost, time, and risk analysis estimates can be derived and aggregated from the different sources (2, 3, 4) via the Integration and Exchange service, and sent to the PSA representative via the Information Delivery service, either in database or office productivity application (e.g. excel) formats. Note that during the whole operation, the PSA representative may not actually see the underlying raw figures, depending on his/her level of access-level as dictated by the Policy/Authority service. Moreover, he/she can still sign on to the information grid and obtain useful data relatively quickly via a trusted agent/proxy.
- Once the American customer and the PSA representative have mutually agreed upon a shipping deal, the PSA representative can then send out reservations for container storage facilities in Singapore and China (5).
- The American customer and its Chinese counterpart can regularly monitor the status of the shipment via a web portal (6) driven by the Web interface of the Information delivery service.
- Knowledge Discovery agents on the information grid would also constantly monitor the various data warehouse, news and weather sources, exchanged emails, for any anomalies (e.g. bomb blast in Bali) that might potentially disrupt the current shipment, and react immediately by sending alerts to the PSA operations team and/or the customer via instant messaging, email, or SMS (7).

Potential Applications of an Information Grid

The need for an Information Grid is especially important to information-intensive global applications, such as Transportation/Logistics (e.g., In-Transit Visibility), Military (e.g., Total Asset Visibility), Government (e.g., Terrorist Information Awareness), Biotechnology (e.g., Distributed Bioinformatics), Manufacturing (e.g., Integrated Supply Chain Management / Logistics), and Financial Services (e.g., Global Risk Management). Several of these application areas will be explored as part of the Inter-University Research efforts.

It is our intention to make the generic Information Grid infrastructure being developed by LISA available to other possible SMA-2 programs, such as in Manufacturing and Biotech, for possible use by them.

2.2 Inter-University (IU) Research

The inter-university research will draw upon the findings and results from the Information Grid Flagship research and extend the investigation to cover research topics peculiar to various information-intensive global application domains and special environments, and incorporate research to address the extended services of the Information Grid.

The following is an initial list of possible inter-university research projects. The budgeted funds for Inter-University Research are insufficient to pursue all these exciting projects in depth – unless additional sources of funds are found. It is our intention to investigate all of these areas during the first year. Then, depending upon the findings (and amount of additional funding, possibly from our sources), we will determine which areas to focus on in depth for subsequent years.

Information Grid Applications

IU-1 MANUFACTURING LOGISTICS / SUPPLY CHAIN INFORMATION GRID
- Angela GOH (PI), Benjamin GROSOF, Eng Wah LEE, Yossi SHEFFI (Co-PI), Puay Siew TAN

Motivation: Manufacturing continues to be a cornerstone in Singapore's economy. To maintain competitiveness in the future, there is a need to extend traditional supply-chain approach to achieve value-chains. With higher expectations from customers, reduced product life cycles, global operations, and more complex product designs, it is necessary to develop an infrastructure to add value to existing supply chains [IBM03]. There is a wide spectrum of logistics and supply chain topics in this domain. The multiplicity and heterogeneity of data sources from manufacturers, vendors, transporters, and other parties creates many challenges that we propose to research, some examples are:

(a) *Diverse sources*. To support information integration from varied data sources

(b) *Semantic precision*. To provide more semantically precise query capabilities for identification and retrieval of resources

(c) *Dynamic value chains*. To exploit intrinsic knowledge through mining algorithms and visualization techniques in order to support dynamic value chains

IU-2 PRODUCT DESIGN INFORMATION GRID
- Ng Wee KEONG (PI), Deborah NIGHTINGALE (Co-PI), Dan WHITNEY

Motivation: The objective of this research is to investigate and address key challenges of supporting and accelerating the new product design process using the information grid as a base platform. This involves all aspects of new product design:

(a) *Customer Preference Learning*: Take into consideration the information gathered to learn customer preferences to make recommendations for future consumers.

(b) *Component Recommendation*: Based on historical data on product components and assemblies, recommend likely components/assemblies for a similar line of products.

(c) *Data Mining and Analysis*: Process the large amount of historical data on product information, customer preferences, human design expertise to derive decision rules and knowledge to facilitate component recommendation and various types of cost estimation.

(d) *Cost Estimation*: Traditionally, a designer would have to wait for weeks before the cost engineering department computes the cost of a new product. If the cost is too high, the design has to be changed. We propose to eliminate such delays by estimating the cost of manufacturing a product within seconds using neural network technology.

(e) *Lead Time Prediction*: Predict lead time to manufacture, which is dependent on several factors including product design, engineering and manufacturing aspects.

(f) *Decision-Making*: Help the engineer to decide if a new product design is viable. This module would take as inputs, the above modules and outputs a list of possibilities with probabilities of success. A decision support system will be developed to allow product designers to explore design alternatives and obtain cost estimates of these alternatives quickly.

IU-3 BIOINFORMATICS INFORMATION GRID
- Sourav Saha BHOWMICK (Co-PI), C. Forbes DEWEY (PI)

Motivation: Information generated in life sciences research is so large that no single person or group owns or controls all the needed data sources. A pharmaceutical company, for example, combines information from 40 sources on average to conduct research in drug development. Even when much of this information is publicly available, heterogeneity in data structure and semantics limits the ability of life science researchers to easily integrate and exploit research data. A Bioinformatics Information Grid will provide a collaborative problem solving platform for life science researchers. Example research activities include:

(b) *Pathway Integration*: Biologists often think in terms of *pathways* (i.e., an ensemble of molecules that are functionally related and act together). May it be sequence analysis, functional genomics, proteomics or literature search -- it always makes sense to present the results in terms of pathways. Pathways, discovered by different groups do not have a uniform representation; therefore it is often a big challenge to have an integrated view of a variety of pathways. Pathway integration will be critical to systemic understanding how the cell works; and will significantly speed up advances in the field.

(b) *Data and computationally demanding*. An attainable grand-challenge goal for biology during the next decade is to develop a complete quantitative description of the internal architecture and protein kinetics of individual cells. This will involve, for each cell, roughly 2,000 proteins, 20,000 individual equations describing their interaction, and about 30,000 quantitative rate coefficients for the reactions being described. The complete problem can be subdivided into roughly 100 complex individual biological pathways, each with its own set of equations and, more importantly, its own knowledge domain that has a rich scientific history and a distinct set of scientific experts. The means for assembling and solving such a complex problem is unknown at the present time.

(c) *Text extraction from unstructured sources*: Life science researchers often need to query research publications to interpret the results of their experiments. For example, cancer researchers, try to find out a pathway from research papers available from PubMED that correlate with their micro-array experiments. The ability to query unstructured data sources such as research publications is critical to hypothesis generation, testing, and knowledge discovery.

Example research agenda, related to (*a*) and (*c*) above: One of the functionalities of this bioinformatics grid will be the provision of text extraction services for unstructured data sources. For the Bioinformatics Information Grid we will explore the integration of MIT's Cameleon technology [FMS00a, FMS00b] with the state of the art Natural Language Processing tools such as MIT's MonthLingua & OMCSNET; and WordNET dictionary as a lexical Ontology. This integration will enable us to query research publications with ease by using the popular SQL syntax. The most important functionality of the grid will be enabling semantic interoperability between life science information sources, which have diverse data representations and semantics. We will couple emerging Semantic Web standards such as RDF and OWL with novel abductive and constraint logic programming techniques to represent diverse pathways and reconcile semantic differences between them. Unlike existing

tools, the grid, built on a new wave of integration approach, will simultaneously support multiple views. For example, rather than adopting a single gene centric view as the standard way of viewing data, the system will adjust data automatically if the researcher wants to view the data in terms of function, disease, phenotype, or organ. Similarly, data semantics will be adjusted automatically reflecting the assumptions of a particular researcher: be it a biologist, geneticist or a medical researcher.

Another example research agenda related to (*b*) above: This research will explore new methods to connect these knowledge domains and allow computations where the predictions of one domain can be used to influence the results of computations made within other domains. This coupling, or federated computing, will first be applied to test problems where the complexity is much smaller and the answers are known. The results will then be used to interpret much larger assemblies of pathways and, eventually, predictions of the behavior of whole cells. Some of the challenging issues in this research are as follows. First, the problem will require the equivalent of a petaflop of computational power to achieve a practical solution time. The many grid-based efforts such as Eurogrid, Grid PP2, and Datagrid as well as several specialized computational and database grids for astronomy (SETI) and medical imaging (BIRN) do not address the fundamental problem of simultaneity between solutions at the many points within the grid. Second, due to the existence of switch-like pathways, it is a challenging problem to design a robust computational infrastructure. Third, due to the scarce knowledge of the rate constants in pathways, it is important to be able to assess the sensitivity of the resulting computed state of a cell to uncertainties in the constants that were used in the calculation. Finally, an information architecture is required that can store the large amount of data describing each pathway and track changes to the model, its coefficients and rate constants, and the archival publications that furnish these data. In order to achieve this we need to explore various nontrivial challenges such as efficient and scalable storage and indexing mechanism, integration of pathway data from various sources, query processing and query optimization techniques, and change management mechanisms.

IU-4 HEALTHCARE INFORMATION GRID
- Ee-Peng LIM (PI), Stuart MADNICK (Co-PI) , Xueyan TANG

Motivation: A tremendous amount of information is gathered about individuals related to their healthcare – by hospitals, doctors, pharmacies, insurance companies, etc. Although there are on-going efforts to increase centralization and standardization, the reality is that this information is widely distributed. With the increasing use of electronic and sensor devices in hospitals and clinics, it is now possible to garner enormous amount of sensor information useful for health monitoring, data analysis, and disease control. There are tremendous advantages to be gained through the more effective integration of these information sources via a Healthcare Information Grid.

Example research activities include:

(a) *Patient record integration*: To effectively and safely treat a patient, it is important that the doctor have all the relevant patient information – from prior stays at hospitals (possibly from the same hospital consortium, or hospitals in foreign countries especially in the case of patients from other countries coming for treatment in Singapore), insurance providers, doctors and other sources.

(b) *Clinical trials*: One of the major costs in evaluating and gaining approval for new drugs is the clinical trial process and the related data gathering – which often comes for multiple sources and must be validated for quality and integrated in an effective way.

(c) *Patient participation*: One of the major movements in modern medicine is the pro-active role of the patient in his or her healthcare. Making patient record information to the individual available in a timely, informative, and appropriate manner is becoming an

increasingly important differentiating factor.

(d) *Tracing and responding to epidemics and other disease patterns*: Due to the recent outbreaks of SARS (Severe Acute Respiratory Syndrome) and other flu viruses worldwide, hospitals today have to work together to share information and other resources in order to jointly manage the spreading of infectious diseases.

(e) *Maintain appropriate levels of privacy*: The system must ensure that appropriate levels of security and privacy are maintained and that the information is only used in authorized manners.

Example research agenda: Information grid is ideal for providing the integration and sharing of information across different hospitals and other healthcare information sources. In this proposed project, advanced database storage schemes and algorithms for a ***healthcare information grid*** will be developed to share healthcare related information among the hospitals, doctors, and other sources, to track the health status of patients, doctors, nurses and other users in different hospitals so as to quickly detect the existence of users infected by some dangerous viruses, determine those who may possibly be infected and their extent of infection within hospitals, and take the necessary actions to prevent spreading of viruses.

Another example research agenda: By tagging all hospital users with sensors that periodically disclose their locations and health status to the base stations, the hospital information grid can effectively route patient information to the right place at the right time. The grid also creates and maintains a realtime health status database for supporting a wide range of query and analytical operations, e.g. finding users who have been in contact with an infected patient (or a group of patients), or determining the numbers of users with fever for each of the past 7 days. By linking the information grid to a centralized disease control centre, more sophisticated applications that draw data from different hospitals can be implemented.

IU-5 NATIONAL SECURITY INFORMATION GRID
- CHANG Kuiyu(Co-PI), Nazli CHOUCRI (PI), Daniel HASTINGS, Stuart MADNICK, Michael SIEGEL

Motivation: With the increasing frequency and global scope of terrorism, national security has entered a more complex and challenging era. Information systems can play a critical role in anticipating, preventing, and responding to such threats. There are several important research areas, some examples are:

(a) *Integration of diverse information databases*. A recent USA National Research Council study, *Making the Nation Safer: The Role of Science and Technology in Countering Terrorism*, found that: "Although there are many private and public databases that contain information potentially relevant to counter terrorism programs, they lack the necessary context definitions (i.e., metadata) and access tools to enable interoperation with other databases and the extraction of meaningful and timely information" [NRC02] We propose to demonstrate our information grid's capabilities to address these needs through several sample scenarios.

(b) *Integration of real-time information*. Visualize a national security grid of video cameras strategically placed at various public locations, combined with ID-linked authentication (e.g. ATM cash withdrawal, NETS purchase) where available. Every individual who appears in public can be tracked. The system would involve a central face image repository node, which can be linked to other grid nodes. Challenges include the difficulty of identifying and matching individual persons/faces from video images, and linking an image to a particular pictureless ID. Further, the daily amount of video/text data accumulated would be enormous. Efficient and intelligent ways will have to be devised to store and index this stream of security data. Privacy concerns can be partially alleviated by

placing the cameras at public locations or localized to a company or organization. For example, an organization may require all employees to carry a device for tracking purposes.

Extended Information Grid Services

IU-6 QUALITY/RELIABILITY/PERFORMANCE SERVICE
- Janice Mong Li LEE, Mun Kew LEONG, Nancy LEVESON, Stuart MADNICK, Wee-Keong NG, Beng Chin OOI (Co-PI), Hwee Hwa PANG, Richard WANG (PI), John WILLIAMS

Motivation: A grid system provides an infrastructure that facilitates communication and information sharing among heterogeneous data sources. These sources typically maintain raw data such as transaction data, pictures, sound, text documents, etc. The large number of information sources in a grid system raises the following research issues that we will address:

(a) *Quality of Aggregated Data*. Data quality problem arises as a result of abbreviations, data entry mistakes, duplicate records, missing fields etc. This problem is aggravated when multiple data sources need to be integrated in data warehouses, federated databases, and global information systems. Data warehouses load and frequently update large amounts of data from heterogeneous sources, further increasing the likelihood of introducing errors to its data. These data warehouses are mined for decision-making information and it is difficult for corporate managers to make logical and well-informed decisions if the quality of data is in doubt. Data cleaning refers to a series of processes employed to deal with the problems of detecting and removing errors and inconsistencies from data. Given the "garbage in, garbage out" principle, clean data is crucial for database integration, data warehousing, and data mining. Hence, we aim to define the attributes of information quality, establish metrics, and design methods for the automatic or semi-automatic assessment and improvement of data quality.

(b) *Quality Knowledge*. Although the number of information sources available has been increasing rapidly, the quality of information sources remains a serious concern. In fact, this has been expressed as "we now have more and more information sources about which we know less and less." This issue becomes even more critical when information from multiple sources is merged or integrated. In this part of the effort, attributes of information quality will be defined, metrics established, and methods for incorporating this "quality knowledge" into the query processing determined. Since one source of "data errors" is caused by misinterpretation of the information, we also plan to provide explication services so that users will be able to more fully understand the information that they are using.

(c) *Reliability of Data Sources*. In order to ensure that the information grid is dynamic and resilient to changes, the system should be able to dynamically and automatically substitute alternative information sources for inaccessible or damaged information sources. Thus, it is important to improve software quality and reduce or eliminate system failures. To this end, we will examine monitoring, tuning, and fault-tolerant mechanisms to deliver optimal performance for the information grid. New metrics for calibrating performance and the extent of autonomy required by the various information sources will be investigated.

(d) *Performance*. Traditional grid-based documents sharing systems relies on keyword matching to retrieve the relevant documents. These systems are similar to search engines on the web that are designed to access relevant documents efficiently, but typically do not yield precise answers. In a global competitive environment, virtually every organization has to depend on business intelligence systems for effective decision-making. This requires systems that can provide high retrieval accuracy and recall. The widely used XML data representation and exchange format provides for the encoding of concise contextual information in the form of XML paths to aid in the retrieval process. We will

investigate novel context-aware query processing techniques and question-answering methods to improve the effectiveness of search in the information grid.

(e) *Tools to Ease Use of Grid Computing Technologies*. Another area of interest is the effective use of Grid Computing, especially with respect to Infrastructure Protection (we have done some work on OGSA GT3) and developing our own Grid Environment based on .NET (it will also run on Linux using Mono). Trying to implement some of Ian Fosters ideas in GT3 have helped us understand some of the shortcomings of OGSA and Web Services in general. One area of weakness is the lack of any programming model for distributed computing. Most "power users" of parallel/distributed computing presently use MPI and OGSA does not explicitly provide this kind of messenger model. Another weakness of Web Services (WSDL), especially when used for information access, is the lack of an appropriate UI. This proposed research will foster the convergence of Grid Computing (predominantly university driven) and Web Services (predominantly industry driven).

(f) *Information Grid Software Safety*. Although we have assumed that the underlying Grid and Network services provide a certain level of reliability and safety of operation, we must also address these issues at the Information Grid level as well. Large, distributed, and heterogeneous networks of information systems are being a critical part of the infrastructure in any areas, such as air traffic management, health care, and power and other utility grids. Judging from the large percentage of failures of the projects to create such grids, we are in need of sophisticated design environments that include modeling and analysis of not only the technical components but also the social components within which the networked systems will operate. Important research areas include socio-technical simulation and modeling tools; support for distributed, collaborative decision making; and automated design environments and tools that support those attempting to design, construct, and operate such grids. We also need techniques that will ensure that the behavior of such systems will not endanger human safety or health. Current system safety engineering techniques, developed for the simpler mechanical systems of the past, no longer suffice. New types of accident models and approaches to safety are required to provide the confidence society expects about the safety aspects of these systems.

IU-7   POLICY AND AUTHORITY SERVICES
- Sourav Saha Bhowmick (Co-PI), Benjamin GROSOF, Mun Kew LEONG, Ee Peng LIM, Tok Wang LING, Stuart MADNICK (PI), Hwee Hwa PANG

Motivation: As more and more companies transact business over the Information Grid, issues of controlled access to sensitive information, security of information, and information ownership arise. Some research issues are:

(a) *Access Control Mechanisms*: The eXtensible Markup Language (XML) has the potential to be the vehicle for exchanging and representing data over the Information Grid. As companies transact business over the Information Grid, letting authorized customers access and even modify data stored in XML documents or in other format over the Grid offers many advantages in terms of cost, accuracy, and timeliness. However, this raises an important question on security due to the sensitive nature of business data, access should be given to the requester in a selective manner. Thus there is an imminent need for a *fine-grained distributed access control* system for data on the Information Grid. The unique nature of the Information Grid poses new challenges that are not addressed by the existing access control mechanism for semistructured or unstructured data. For example, existing access control mechanisms for XML documents do not take into account the semantic and structural heterogeneity of a set of information sources while processing authorization rules. Due to this heterogeneity, different sources may have different access rules for the

semantically identical information for a particular requester. The key challenge here to *automatically evaluate and integrate results of a user's request for accessing certain information over such semantically and structurally heterogeneous access rule databases* over the grid. Furthermore, as information sources are autonomous and may have local access control mechanism, one of the key issues is to ensure that the authorization rules are not conflicting in nature across the sources. Another interesting issue is that some of the sources may not have any local access control mechanism. However, they may contain semantically related information compared to sources that have full-fledged access control mechanism. Is it possible to use *remote access control mechanism* of other sources to be able to control access of requesters on sources that do not have any native access control mechanism? Some other novel issues are *maintenance of access rules*, access control mechanism that *preserves the privacy policies* of the information sources. In this project, we explore and address the above issues in the Information Grid environment. We believe that access control over the Information Grid is an important new application area, combining commercial interests, with intriguing research questions.

(b) *Legal and Regulatory Policy Issues Impacting Information Re-Use and Re-Purposing.* Different approaches and views towards information re-use and re-purposing are emerging around the world. Sometimes extreme positions have emerged with a movement toward strict regulation coming from the European Union Data Base Directive while the United States has taken a much more benign approach. But in "cyberspace" such geographic boundaries have less meaning. A global view and recommendations for policies and regulations, incorporating perspectives from Asia, needs to be studied.

2.3 FlagShip (FS) Project: Singapore-MIT Information Grid Infrastructure (SMIGI)

We refer to our flagship research effort (described in more detail below) as the **Singapore-MIT Information Grid Infrastructure (SMIGI).** It is to be an intense collaborative effort involving NTU, MIT, and NUS and the Research Institutions, I2R, IHPC and SIMTech. This collaboration will result in an Information Grid architecture together with its functional components. The research findings and experience will also be highly relevant to the construction of information grids for applications in many domains, and will result in the transfer of critical technological know-how and expertise to the IT industry in Singapore. The innovations and expertise that are developed through this research collaboration will play a significant role in shaping and supporting efforts in the development of a national information infrastructure and Singapore's transformation to an intelligent island. In the long run, these can be critical factors in shaping a long-term sustainable competitive advantage for Singapore.

Flagship Research: SINGAPORE-MIT INFORMATION GRID INFRASTRUCTURE (SMIGI)

This flagship proposal has a focus on addressing the complex design, systems and policy issues pertaining to the development of the Singapore-MIT Information Grid Infrastructure (SMIGI). The SMIGI to be developed as part of this research effort comprises a set of generic services (sometimes referred to as a "horizontal grid"). These services, as depicted in Figure 2, can be customized and utilized to address a range of applications. To demonstrate and test these capabilities, we have decided to apply these services to several application domains (sometimes referred to as a "vertical grid") – as described in the Inter-University Research section earlier.

It is the LISA program's intention that the work on each of the Information Grid Services be conducted by joint teams drawn from researchers from Singapore and MIT. The

brief descriptions below illustrate some of the possible sub-projects. Furthermore, the Information Grid must be scaleable, adaptable, and extensible to provide decision makers with the appropriate services in an efficient and timely manner in their environments and their applications. Thus, the overall architectural design of the Information Grid is an important goal of this project (referred to as project category 8 below). This list is neither complete nor final and the full membership on these research teams will evolve over time.

FS-1   INFORMATION ACCESS and DELIVERY SERVICES
- Sourav BHOWMICK, Eng Wah LEE, Ee Peng LIM, Tok Wang LING, Stuart MADNICK, Wee Keong NG (PI), Ah Hwee TAN, Kian Lee TAN, Beng-Chin OOI, John WILLIAMS (Co-PI)
Motivation: An Information Grid provides a single, virtualized view of information access and delivery on the vast and disparate resources forming the Grid. The technological challenges to realize such a uniform view includes providing:

(a) *Personalized multi/cross-lingual information retrieval and query services over vast number of autonomous/quasi-autonomous and heterogeneous data sources.* Traditionally, this service slows down information access because an access query must be interpreted and sent to disparate and geographically distributed data sources for execution. The results must be re-integrated before delivery to the user. In an Information Grid, this service will play the important role of providing the user seamless and uniform access to information. Unlike conventional federated database approaches, the technical challenges that one must address are the issues of scalability (several orders of magnitude higher than current systems), and fast integration of data resource into the Grid.

(b) *Conversion/transformation/wrapper services to access and deliver diverse data formats.* This service addresses the fast integration of data resource into the Grid. Conventional wrapper technology does not generalize easily for complex data sources, which are usually proprietary. Building expressive and flexible wrapper systems that can be instantiated with minimal effort is a key technology for the Information Grid.

(c) Network caching of information closer to users. This alleviates the problem of having to move a large volume of data across a network to facilitate remote processing. Caching research has mostly been performed on standalone systems. It is a major challenge and a relatively unexplored issue to study the technical feasibility of user-level network caching in large scale Information Grid involving large numbers of simultaneous users. Some deliverables:
  a. Mediator generator tool: Generate appropriate mediators for user-defined view of the Info Grid. These mediators map the underlying heterogeneous resources to the uniform user-defined view, and vice-versa.
  b. View Definition tool: Assist user to create uniform and personal view of the Info Grid for querying and retrieval purposes.
  c. Information exchange tool: Assist users to customize all data conversion semantics and formats, as these tasks cannot be fully automated. It will maintain a database of such exchange formats.
  d. Techniques for network-wide data caching, including their performance.

FS-2   INFORMATION INTEGRATION AND EXCHANGE SERVICES
- Stephane BRESSAN, Kuiyu CHANG, Benjamin GROSOF, Mong-Li LEE, Ee Peng LIM, Tok Wang LING, Stuart MADNICK (PI), Hwee Hwa PANG, Kian Lee TAN (Co-PI), Michael SIEGEL
Motivation: This service works closely with other services (e.g., Information Access & Delivery, Semantics & Ontology, and Directory & Discovery) to provide users with fast

and semantically correct answers. Unlike existing data integration systems, we attempt to address several technical challenges that have not been previously adequately addressed. We shall discuss this as we examine each component of this service:

(a) *Information Integration & Aggregation*. In our Information Grid, we expect information integration at two levels. In intra-source integration, we examine the data heterogeneity problem within an information source. For example, web pages from the same web site are usually created by different people and the logical structure of the web site is loosely defined. It is therefore necessary to merge them into semantically richer information units. The construction of semantic information units requires a combination of knowledge about the information source and the ability to construct information units. As part of this process, we need to assign semantic labels to the information units. At the inter-source integration, we need to address the scalability issue in terms of both the number of sources, and the number of different types of information (e.g., images, text, xml, databases, etc). Reconciling the semantics of these information from different sources remains an open problem. One direction that we will adopt is to design novel data mining techniques to facilitate the discovery and visualization of trends and correlations. We will also need to define the interface between this component and the Semantic & Ontology Services to tap into the available ontology and semantic information

(b) *Query Optimization & Processing*. Processing a query that is submitted to the Information Grid raises several challenges. First, as the sources are autonomous, the system has no control over the resource availability, server workload, etc. Second, the environment is no longer static and its behavior predictable. Traditional query optimization is no longer applicable as plans generated at compile time may not be optimal at runtime (due to changes in the environment). We advocate the design of a light-weight optimizer that generates a good plan during compile time, and introduce adaptivity to the query processor to be able to react to the changing environment. For example, an initial query plan can be reordered at runtime. In addition, as sources are maintained autonomously, there could be inconsistency and incomplete information among them. As a result, conventional syntactic query rewriting techniques cannot guarantee that equivalent query evaluation plan can be generated. Instead, we need to develop a methodology to employ the semantics about sources to generate "correct" query plans.

(c) *Equational and Temporal Context*. Equational context [FGM02] refers to the knowledge such as "average GDP[4] per person (AGDP)" means "total GDP" divided by "population." In some data sources, AGDP explicitly exists (possibly with differing names and in differing units), but in other cases it may not explicitly exist but could be calculated by using "total GDP" and "population" from one or more sources – if that knowledge existed and was used effectively. We propose to extend MIT's current COntext INterchange (COIN) technology [GBMS99] to exploit simultaneous symbolic equation solving techniques through the use of Constraint Handling Rules (CHR) [Früh98], a high-level language extension of constraint logic programming (CLP). This extension, coupled with our context based approach to detecting and reconciling data semantics, provides an elegant and powerful solution to the problem of detecting and resolving equational conflicts. This combines the advantages of logic programming and constraint solving by providing a declarative approach to solving problems, while at the same time allowing users to employ special purpose algorithms in the sub problems. Temporal context refers to variations in context not only across sources but also over time. Thus, the implied currency for France's GDP prior to 2002 might be French Francs, but after 2002 it is Euros. If one were performing a longitudinal study over multiple years from multiple sources, it is essential that variation in context over

---

[4] GDP is the Gross Domestic Product, a measure of economic activity for a country.

time be understood and processed appropriately. We propose to formalize the context knowledge representation [ZMS04] to include a specification of the history of all contextual attributes in the ontology. Mathematically, it is set of *<contextual_attribute, history>* pairs, where history is a set of *<value, valid_interval>* pairs. Then temporal reasoning can be treated as a constraint solving problem, using constraint handling rules similar to [Früh94].

(d) *Update/Change Management*. Information in the sources may change or be updated. Such updates must be quickly detected by the integrator. Updates occur at two levels. At the data level, an update may involve information stored at multiple sources. In our Information Grid, an update asserts that certain objects must be made to have certain values in the updaters' context. There is a need to check that the update is unambiguous and feasible, and if so, what source data updates must be made to achieve the intended results. If unambiguous or otherwise infeasible, we would like to be able to indicate what additional constraints would clarify the updater's intention sufficiently for the update to proceed. We will build on COIN's abductive reasoning framework, and extend the expressiveness and the reasoning capabilities leveraging ideas developed in different yet similar frameworks such as Description Logic and classification. At another level, the data schema may change, e.g., updates on XML documents. We will also study how to detect such changes.

Some deliverables:
1. Research Publications on all the above.
2. Implementation and evaluation of the various techniques
3. A prototype that incorporates some, if not all, of the components.

FS-3   SEMANTICS AND ONTOLOGY SERVICES
- **Stephane BRESSAN, Kuiyu CHANG, Benjamin GROSOF, Mun Kew LEONG, Michael SIEGEL (PI), Ah Hwee TAN (Co-PI), Chew-Lim TAN, John WILLIAMS**

Motivation: To provide the key services of the Information Grid, including information access and delivery, information integration and exchange, as well as resource location and discovery, in a seamless manner, it is imperative to have a common set of terminologies and languages for users, software, services, and resources to communicate with each other. Semantics and ontology services are therefore an integral component of the Information Grid to ensure seamless collaboration and computation on a global scale.

Whereas most existing efforts on semantics and ontology services focus on the languages and infrastructures for describing, advertising, location, and management of ontologies [Roure03], we single out two challenging problems, namely identification/exploitation of context and supporting inference and knowledge discovery, in the grid environment. The following research will be pursued in conjunction with efforts in agent services so that semantics and ontology services can be delivered through agent technologies in a natural and transparent way.

(a) *Representation/Exploitation of Context*: We have developed the COIN Domain Model and Ontology [GBMS99] for supporting the capture and processing of "context knowledge" for any application domain. Although it has been used in limited financial services and logistics applications, the full scope of its capabilities have not been tested. Tools need to be developed to facilitate the convenient and rapid acquisition of new contextual knowledge. In addition to the types of domain and context knowledge currently supported, we also need to add capabilities for both the representation and reasoning to provide support for temporal context and multimedia information content.

(b) *Inference and Knowledge Discovery*: Besides translations between heterogeneous forms of ontologies and rules, inference technologies (both query-answering/backward and data-driven/forward) for ontologies and rules will add a far more superior level of capabilities

to the Information Grid through knowledge exchange. A broader challenge here is how to support various forms of analysis and knowledge discovery based on the data and resources available on the grid. We will enhance existing knowledge discovery techniques, e.g. classification and clustering, etc. by exploiting the ontological knowledge of the underlying data, and propose new technologies for performing link analysis and associative discovery across data and resources.

Some deliverables:
1. Extended model and new tools incorporating the new temporal context and multimedia capabilities.
2. New inference and knowledge discovery algorithms
3. Tools for supporting analysis and discovery in the Information Grid environment.

FS-4   DIRECTORY SERVICES
- Terence HUNG, Bu Sung LEE, Stuart MADNICK, Simon SEE, Michael SIEGEL (Co-PI), Xueyan TANG, Yong Meng TEO, Stephen John TURNER (PI), Richard WANG

Motivation: Each Virtual Organization (VO) on the information grid normally has at least one local Index service or has access to one, which provides a searchable directory of grid services and service data available at that VO. The directory infrastructure should be able to connect large number of nodes (possibly world-wide), efficiently route point-to-point messages among nodes, support addition of new nodes and departure of existing nodes with minimum disturbance of the overall information grid system. However, overhead such as communication bandwidth increases exponentially with the number of VO's and limits performance and scalability. To improve scalability, some aggregation structure on the VO's can be imposed. The challenges of such aggregation include:

(a) *Merging of Indices*. How can the indices of each child VO be meaningfully merged so that a query on the parent VO will almost always find the relevant information contained within? Can a distributed signature be devised to efficiently represent the service data and grid services associated with a group of VO's?

(b) *Dynamic reconfiguration*. How to dynamically re-configure/balance the various clusters such that popular VO's lie near the top of each cluster's entry-point? This involves dynamic promotion/demotion of VO's in the structure based on usage, reliability (persistence), and other factors. Could self-organizing intelligence be built into each VO cluster?

(c) *Replication*. How to intelligently replicate or cache popular resources for guaranteed levels of fault-tolerance? Only when this problem is solved can a robust application service platform be created, enabling the development of applications that require high reliability (e.g., military and hospital applications).

To tackle challenges (a)-(c) above, a mixture of compact probabilistic set representations (e.g., Bloom filters and skip lists) and fully distributed indexing methods (e.g., Distributed Hash Tables (DHT)) will be investigated. Another approach is to overlay a logical/virtual (without aggregation) grid over the existing physical grid [RF02], which results in faster search at the expense of the additional overhead needed to update and optimize the overlay network.

(d) *Novel Approaches to Automatic Source Selection and Attribution*. As the number of sources of information grows, it becomes increasingly unrealistic to expect the user to know of all of the sources. Thus, techniques for automatic source identification and selection have to be developed. We propose to use Description Logic to represent comprehensive source scope information (especially sizing knowledge, such as "contains at least 10 companies from each European country") to develop more intelligent source selection.

Finally, we want to be able to reverse the process so that a user can essentially ask "where and how did the system get this information", we call this source attribution. Source attribution can also be an important tool for improving data quality.

Some deliverables:

1. Framework and algorithms for optimized distributed indexing using innovative signatures, intelligent self-organizing aggregation, and high-availability replication services.
2. Prototypes of the above technologies using Globus Toolkit wherever feasible.

FS-5   AGENT SERVICES
- N.S. CHAUDHARI, Angela GOH, Benjamin GROSOF, Chunyan MIAO, Yew Soon ONG, Kiam Tian SEOW (PI), John WILLIAMS (Co-PI), Kevin WONG Kok Wai

Motivation: It is envisaged that a *service/market-oriented Grid* can provide the infrastructure for single, specialized high-end applications. Importantly, this allows many "simple" users to transparently access distributed computing resources, services anyhow, anywhere and anytime. Playing a central role in service/market-oriented grid is the idea of negotiation. In essence, negotiation is an information exchange process by which distributed agents in a grid interactively work out a mutually acceptable agreement. The objective of this research is to explore dynamic service negotiations among agents in such a Grid. The concept of agents in a Grid - an *Agent Grid* - originated with the DARPA ISO's CoABS program, and has been well accepted by the Grid community. The extremely dynamic and therefore unstable nature of a Grid, especially in terms of resource availability, makes agent negotiation a new challenging research topic. The following issues have been identified:

(a) *Collaborative negotiation among distributed agents*. The project aims to develop a coalition framework for agents, which may be inherently or artificially distributed, to form teams and decide 'who should do what task' *by collaborative negotiation.* The negotiation mechanism will be based on a *Belief-Desire-Intention* (BDI) model. The agents will assemble and reassemble in teams via negotiation in attempting to accomplish the various assigned tasks in an unstable Grid environment.

(b) *Dynamic agent negotiation model*. The project aims to propose a new agent negotiation model based on Fuzzy Cognitive Map (FCM) theory, and its extension, Dynamic Cognitive Network (DCN). With this proposed model, agents have the ability to model the extremely dynamic negotiation process in the grid and perform the reasoning process rapidly.

(c) *Autonomous Learning of negotiation agents*. The project aims to propose new agent negotiation mechanisms based on a few neural network and computational learning approaches. Two such approaches include, (i) constructive approaches Binary Neural Networks (mainly developed during last decade), and (ii) construction of minimal cover automata for strings.

(d) *Theory of Trusted Agents*. An important use of the Information Grid technology can be to support the development of automated "trusted agents" that can act as information brokers, such as matching up customers with appropriate suppliers without revealing unnecessary proprietary information from either the potential customers or suppliers.

Some deliverables:

1. New agent collaboration/negotiation/learning models for grid service negotiation.
2. Negotiation based service/market oriented grid infrastructure.
3. New theory for developing trusted agents.

FS-6 SMIGI SYSTEM ARCHITECTURE
- Angela GOH (Co-PI) , Hing Yan LEE, Ee Peng LIM, Stuart MADNICK, Joel MOSES (PI), John STERMAN, Joseph SUSSMAN, Dan WHITNEY

Motivation: One of the most important tasks for this research is the precise definition of the Information Grid services, including their functionality and interfaces, to ensure effective interoperability. System architecture is an abstract description of the entities of a system and the relationships between those entities. The architecture of a system has a strong influence on its behavior. These systems are intended to have certain primary functions plus other properties often called *ilities*: scalability, reliability, security, durability, maintainability, flexibility, and so on. In most cases, it is very challenging to design a complex system to achieve all of its primary functions and all of its *ilities*. Some specific research issues include:

(a) *Trade-off analysis*. In some instances one has to resolve tradeoffs between desirable properties for the short term versus desirable life-cycle properties. The benefits of such architectural decisions are uncertain and might only be realized in the future, or not at all. Methods for evaluating uncertain events and providing for them in advance are discussed in [deN*04].

(b) *Emergent behaviors*. Complex systems have behaviors and properties that no subset of their elements have. While achieving these behaviors, the designers often accept certain undesirable behaviors or side effects. In addition, systems have unanticipated behaviors commonly called emergent. These may turn out to be desirable in retrospect, or they may be undesirable. Emergent behaviors are similar to incidental interactions identified in [UE00].

(c) *System complexity.* The architecture of a system is an important determinant of its complexity, for good or ill. Sometimes, architectures are designed or evolve to minimize complexity, but, as systems grow in size, a point is usually reached where their complexity becomes overwhelming, creating a limit on what we can do to operate them, predict their behavior, or change them. Many systems gain both their benefits and their vulnerabilities from what would appear to be complexity, such as the interconnections in a nation's electrical grid. These interconnections permit power to flow from regions with excess to those with shortages, a common occurrence. If each region were its own grid, there would be no way to share the load. But exactly the same complexity works in the opposite direction as well. When the shortage in one region is too great and it breaks down, this breakdown can propagate along the same connections and bring down other parts of the grid that have no problems. Empirical evidence for the influence of complexity is given by [Ster00].

(d) *Coordinating high level and low level requirements*. Software designers often create a hierarchy of functions. In most cases, there are system-wide behaviors or characteristics, such as performance, safety, ease-of-use, that are visible to the customer. During system design, the requirements of upper levels in the hierarchy are decomposed and flowed down to the lower levels. This is intended to create separate manageable pieces that can be worked on independently. Carried to its extreme, this is called "reductionism." Major challenges include remembering all the requirements, keeping them consistent, and understanding the many interactions between branches of the hierarchy.

Project Duration, Research Plan, and Milestones

The proposed flagship initiative comprises research and development activities over a 5 years period. The core information grid services will be implemented in an incremental and iterative manner to ensure that demonstrable/operational software will be available at any project stages. In particular, software prototypes equipped with basic core functions will be implemented at the end of Year 1. Although limited in capabilities, we believe that even this first "release" will be usable for certain demonstrable applications. We anticipate new

release approximately once a year. These prototypes will be enhanced and transformed into reusable software components in Years 2 and 3. In Year 4, the core information grid services will be ready for the development of very advanced applications. In Year 5, the main focus will be given to software evaluation and the implementation of administration modules for managing core services.

<u>**Summary of Flagship Project Personnel**</u>
MIT: Stuart MADNICK (MIT Coordinator), Benjamin GROSOF, Michael SIEGEL, John WILLIAMS, Joel MOSES, Joseph SUSSMAN, Dan WHITNEY
NTU: Wee Keong NG (NTU Coordinator), Ah Hwee TAN, Stephen John TURNER, Kuiyu CHANG, Angela Eck Soong GOH, N.S. CHAUDHARI, Kiam Tian SEOW, Kevin WONG, Chun Yan MIAO, Xueyan TANG, Ee Peng LIM, Sourav BHOWMICK, Yew Soon ONG, Bu Sung LEE
NUS: Kian Lee TAN (NUS Coordinator), Beng Chin OOI, Tok Wang LING, Yong Meng TEO, Chew-Lim TAN, Stephane BRESSAN, Mong-Li LEE
I2R: Hwee Hwa PANG, Mun Kew LEONG
IHPC: Terence HUNG
SIMTech: Eng Wah LEE
National Grid Office: Hing Yan LEE
SUN Microsystems: Simon SEE
In addition to the above personnel, the flagship research will involve 7 post doctoral associates (3 in Singapore and 4 in MIT), 6 programmers (in Singapore), and 19 PhD/Master students (12 in Singapore and 7 in MIT). The post doctoral associates will be working directly with the various project leaders to conduct focused research on various sub-problems. They will also coordinate and help on day-to-day basis the development of research programme. The programmers will be primarily responsible for the development of components of core information grid services. The remaining graduate students will participate in various parts of the flagship project in their thesis research pursuit.

2.4 <u>Research Collaboration Plan and Track Record</u>
The MIT researchers, with informal collaboration with colleagues from Singapore, have developed an initial theory, architecture, and prototype for such an initial set of Information Grid services, referred to as COntext INterchange (COIN) [BGL*00, GBMS99] through funding from the USA Defense Advanced Research Projects Agency (DARPA) and corporate sponsors. Research groups in Singapore, such as the Electronic Commerce & Database Research Laboratory at NUS and the Center for Advanced Information Systems at NTU, have also been engaged in related research.
All of the researchers involved in this effort have had significant experience and success with such large-scale collaborative projects.

Annual International Conference, Workshops, and Other Interactions Amongst LISA Participants
There are various venues being provided to facilitate interaction amongst the LISA Participants as well as other related researchers. Many of these activities will take place during the two week period that the MIT participants will be in Singapore. These activities include
   - One-on-one meetings amongst LISA faculty and graduate students.
   - Meetings amongst the participants in individual Flagship and Inter-University sub-projects.

- Workshops to discuss the entire LISA research efforts, including both the Flagship SMIGI and the Inter-University projects. This will help to facilitate the coordination and knowledge sharing across the entire effort
- An Annual International Conference on Information Grid Research will provide a platform via which we will invite the submission of papers, to be refereed, from key researchers around the world, as well as the LISA researchers. It will make available a forum to present the LISA research finding, gain insight on related research elsewhere, and generally increase the stature and prestige of LISA, and the SMA-2 program, in the academic community

2.5 Joint Appointment of SMA Post-Doctoral Fellows

We envisage that the post-doctoral fellows be appointed in MIT and NTU/NUS. Depending on where the appointment takes place, we expect about 75% of the time to be spent in that location. The total period of residency is not expected to exceed 6 months in the collaborator's institution.

2.6 Plans for Collaboration with RIs and/or Industry

Research Institute Collaboration

The following Singapore Research Institute collaborators have been identified and are playing a major role in the development of this proposal:

- Institute of Infocomm Research (I2R) (http://www.i2r.a-star.edu.sg), previously the Laboratories for Information Technology (LIT), Kent Ridge Digital Labs (KRDL), and Institute of Systems Science, has related activities in database research. Primary contacts:
  - o **Dr Hwee-Hwa PANG**, Division Director, Services & Applications
  - o **Dr Mun-Kew LEONG,** Manager, Media Semantics

- Singapore Institute of Manufacturing Technology (SIMTech) (http://www.simtech.a-star.edu.sg) has an Industrial IT program (http://www.tliap.nus.edu.sg/TSRPworkshop2003/) and a Web Services lab (http://www.jssl.org/jssl/index.html) that relate to our proposed research areas. Primary contacts:
  - o **Dr. Eng Wah LEE**, Senior Scientist and in-charge Java Smart Services Lab, PLP.
  - o **Puay Siew TAN**, Senior Research Engineer, Singapore Institute of Manufacturing Technology (SIMTech)

- Institiute of High Performance Computing (IHPC) (http://www.ihpc.a-star.edu.sg) has a software and computing program that deploys Grid technology for numerically intensive modeling and computational science and engineering (CSE) research. Primary contacts:
  - o **Dr. Terence HUNG**, Programme Manager, Software and Computing Programme.

- National Grid Office (http://www.ngp.org.sg) has overall responsible for the development of Grid infrastructure for Singapore. Primary contacts:
  - o **Dr Hing-Yan LEE**, Deputy Director

Other Possible Singapore Research Institute Collaborators

- Bioinformatics Institute (BII) (http://www.bii.a-star.edu.sg)
  - Distributed Computing in Biomedicine (http://www.bii.a-star.edu.sg/dcbg)
  - Medical Informatics (http://www.bii.a-star.edu.sg/mig)

<u>Interest from Industry and Other Organizations</u>

As explained in Sections 2 and 4, the LISA program and the Information Grid research can have a significant impact in industry in Singapore and around the world. Current and past sponsors of related research eventually might become sponsors of the LISA research program. Some of the potential collaborators are listed in Appendix 5.

2.7 **Interest of Industry and Funding Agencies**

Discussions have begun with several major organizations to cooperate in our Flagship research effort. We expect that this list will evolve as the research plan is further developed.

3. Personnel

3.1 Matrix of Participants

Name	Institution	Role of Key Participants (if roles are not confirmed, teams can indicate relevant participation with an "X")		
		Flagship Research Project	**Teaching**	**Inter-University Project**
Nazli CHOUCRI	MIT		17.422	IU-5(PI)
C. Forbes DEWEY, Jr	MIT		2.771J	IU-3(PI)
Benjamin GROSOF	MIT	FS-2, FS-3, FS-5		IU-1, IU-7
Daniel HASTINGS	MIT			IU-5
Steven LERMAN	MIT		1.001	
Nancy LEVESON	MIT		ESD.355J	IU-6
Stuart MADNICK	MIT	FS-1, FS-2(PI), FS-6	ESD.565J	IU-4(CoPI), IU-5, IU-6, IU-7(PI)
Joel MOSES	MIT	FS-6(PI)	ESD.34J, ESD.xxx	
Deborah NIGHTINGALE	MIT		ESD.61J	IU-2(PI)
Yossi SHEFFI	MIT		ESD.260	IU-1 (CoPI)
Michael SIEGEL	MIT	FS-2, FS-3(PI), FS-4(CoPI)		IU-5
John STERMAN	MIT	FS-6	15.874	
Joseph SUSSMAN	MIT	FS-6	ESD.221J	
Peter SZOLOVITS	MIT		6.872J	
Richard WANG	MIT	FS-4		IU-6(PI)
John WILLIAMS	MIT	FS-1(CoPI), FS-3, FS-5(CoPI)	ESD.341	IU-6
Daniel WHITNEY	MIT	FS-6		IU-2
Sourav Saha BHOWMICK	NTU	FS-1		IU-3(CoPI), IU-7(CoPI)

Stephane BRESSAN	NUS	FS-2, FS-3		
Kuiyu CHANG	NTU	FS-2, FS-3		IU-5(CoPI)
Narendra CHAUDHARI	NTU	FS-5		
Angela Eck Soong GOH	NTU	FS-5, FS-6(CoPI)	CPE403	IU-1 (PI)
Terence Gih Guang HUNG	IHPC	FS-4		
Eng Wah LEE	SIMTech	FS-1		IU-1
Francis Bu Sung LEE	NTU	FS-4		
Hing Yan LEE	SNGO	FS-6		
Mong Li LEE	NUS	FS-2	CS5238	IU-6
Mun Kew LEONG	I2R	FS-3		IU-6, IU-7
Ee Peng LIM	NTU	FS-1, FS-2, FS-6	CPE403	IU-4(PI), IU-7
Tok Wang LING	NUS	FS-1, FS-2	CS5223	IU-7
Chunyan MIAO	NTU	FS-5	CPE429	
Wee-Keong NG	NTU	FS-1(PI)	H6404	IU-2 (PI), IU-6
Yew Soon ONG	NTU	FS-5		
Beng Chin OOI	NUS	FS-1	CS5223	IU-6(CoPI)
Hwee Hwa PANG	I2R	FS-2		IU-6, IU-7
Simon Chong-Wee SEE	NTU	FS-4		
Kiam Tian SEOW	NTU	FS-5(PI)	CSC416	
Ah-Hwee TAN	NTU	FS-1, FS-3(CoPI)	DM6121	
Chew Lim TAN	NUS	FS-3		
Kian-Lee TAN	NUS	FS-1, FS-2(CoPI)	CS5231	
Puay Siew TAN	SIMTech			IU-1
Xueyan TANG	NTU	FS-4	DM6102	IU-4
Yong-Meng TEO	NUS	FS-4	CS5221	
Stephen John TURNER	NTU	FS-4(PI)	CPE428	
Kevin Kok Wai WONG	NTU	FS-5	H6429	

3.2 Biographical Sketches of Participants

Please see Appendix 4 for detailed Curriculum Vitae

3.3 Plans for Joint/Visiting/Adjunct Appointments of Faculty Members & Researchers

Both NTU/NUS already have in place mechanisms for appointing RI staff to adjunct positions. These staff are involved in teaching and/or research. Our experience with such adjunct appointments has been a positive one with benefits for all parties involved. We are therefore confident that similar mechanisms can be used in the SMA program.

4. Administration

4.1 Summary of Management Plan

Steering Committee: The proposed LISA program will be managed by an 8 member Steering Committee, co-headed by Professor Stuart Madnick from MIT and Professor Angela Goh Eck Soong from NTU to manage day-to-day operations of the program. Two faculty members from each side will be selected to serve on the committee. In addition, the administrations of MIT and NTU will be represented on the committee by Professor Daniel Roos, Director of ESD at MIT, and Professor Seah Hock Soon, Dean of Computer Engineering at NTU.

   The committee will meet once a year in person, alternating between Singapore and USA, and three additional times a year (or as needed) via video conference. The committee will be responsible for overall management of the education and research efforts of the program, e.g., admissions, curriculum development and improvement, review of research projects, budgeting and planning, and coordination with industry and government sponsors.

Advisory Board: We also plan to create an external advisory board that will include representatives from the A*STAR research institutes, Singaporean industry, and other relevant parties (such as representatives from international industry that are collaborating with either the LISA educational or research programs).   The composition and operation of this Advisory Board will be determined prior to the commencement of the programme.

Administrative Office: An administrative office will oversee the day-to-day operations and maintain liaison with external partners. The office will be located in NTU and will be responsible for student matters, faculty administrative affairs and functions such as purchasing. Upon start of the program, the students will be located in NTU before and after spending the mid-period at MIT. However, as teaching and research will take place in MIT/NTU/NUS, facilities at all three sites will be provided. Selected students will be confirmed as PhD candidates; these students will be located in the research centers of their respective advisors.

4.2 Letters of Commitment and Support from Relevant Academic Units and Research Institutes
   These letters can be found in Appendix 5.

   Summary of Current Letters of Commitment

Organizaiton	Representative
Infocomm Development Authority of Singapore (IDA)	Dr Tan Geok Leng Director, Network and Enabler Technologies Technology Group
Infocomm Development Authority of Singapore (IDA)	Lo Yoong Khong Deputy Director Manpower Development Industry Group
SES Systems Pte Ltd	Chang Yew Kong President

National Grid	Dr Lee Hing-Yan
	Deputy Director
Yokogawa Engineering Asia Pte Ltd	Ng Keng Siang
	Vice President
	Information Systems and Services Division
Institute for Infocomm Research	Prof Limsoon Wong
	Deputy Executive Director, Research
Institute for Infocomm Research	Prof Lawrence Wong
	Executive Director
Sybase (Singapore) Pte Ltd	Ms Ho Yean Fee
	Director
	Sybase Asia Development Centre
Hewlett-Packard Singapore (Sales) Pte Ltd	Mr Dennis Ang
	Director
	High Performance Technical Computing
	Asia Pacific
Singapore Institute of Manufacturing Technology (SIMTech)	Dr. Lim Kiang Wee
	Executive Director

4.3 Signed Forms
    Please refer to Appendix 7

4.4 Program Budget
    Please refer to Appendix 6

APPENDIX 1 – REFERENCES

[BGL*00] BRESSAN, S., GOH, C.H., LEVINA, N., MADNICK, S., SHAH, A., SIEGEL, M **(2000)** "Context Knowledge Representation and Reasoning in the Context Interchange System," *Applied Intelligence: The International Journal of Artificial Intelligence, Neutral Networks, and Complex Problem-Solving Technologies,* 12(2), pp. 165-179

[CT03] CANNATARO, M., TALIA, D. (2003) "The Knowledge Grid: Designing, building, and implementing an architecture for distributed Knowledge discovery". *Communications of the ACM*, 46(1), 89—93.

[CGG*02] CURCIN, V., GHANEM, M., GUO, Y., KOHLER, M., ROWE, A. SYED, J., WENDEL, P. (2002) "Discovery Net: Towards a Grid of Knowledge Discovery", *ACM Conference on Knowledge Discovery and Data Mining.*

[Coates01] COATES, A. B., , "The Role of XML in Finance", *XML 2001 Conference.*

[deN*04] de Neufville, Richard, et al (2004) "Uncertainty Management for Engineering Systems Planning and Research," Proceedings of the MIT Engineering Systems Symposium, Cambridge, March 29-31.

[eDiam] eDiamond project. http://www.ediamond.ox.ac.uk/

[FMS00a] Firat, A., Madnick, S., Siegel, S. (2000) "The Caméléon Web Wrapper Engine", *Proceedings of the VLDB2000 Workshop on Technologies for E-Services,* September 14-15.

[FMS00b] Firat, A., Madnick, S., Siegel, S. (2000) "The Caméléon Approach to the Interoperability of Web Sources and Traditional Relational Databases," *Proceedings of the Workshop on Information Technology and Systems*, December.

[FGM02] Firat, A., Grosof, B., Madnick, S. (2002) "Financial Information Integration In the Presence of Equational Ontological Conflicts," *Proceedings of the Workshop on Information Technology and Systems*, Barcelona, Spain, December 14-15: 211-216

[Früh94] Frühwirth, T. (1994) "Temporal Reasoning with Con-straint Handling Rules," ECRC-94-5.

[Früh98] Frühwirth, T. (1998) "Theory and Practice of Constraint Handling Rules", Special Issue on Constraint Logic Programming (P. Stuckey and K. Marriot, Eds.), Journal of Logic Programming, 37(1-3): 95-138.

[Foster02] FOSTER, I., KESSELMAN, C., NICK, J., TUECKE, S. (2002) "The Physiology of the Grid: An Open Grid Services Architecture for Distributed Systems Integration". Open Grid Service Infrastructure WG, *Global Grid Forum*, June. http://www.globus.org/research/papers.html#OGSA

[GBMed] Grid Based Medical Devices for Everday Health, http://www.gridoutreach.org.uk/docs/pilots/meddev.htm

[GTMed] Grid technologies for the medical community, http://www.innovations-report.com/html/reports/information_technology/report-24951.html

[Gros04] Grosof, B. (2004) "Representing E-Commerce Rules Via Situated Courteous Logic Programs in RuleML", Electronic Commerce Research and Applications journal, to appear.

[GHVD03] Grosof, B., Horrocks, I., Volz, R., Decker, S. (2003) "Description Logic Programs:Combining Logic Programs with Description Logic", Proc.12th International Conference on the World Wide Web,.

[GP04]   Grosof, B., Poon, T. (2004) "Representing Agent Contracts with Exceptions using Semantic Web Rules, Ontologies, and Process Descriptions", International Journal of Electronic Commerce, to appear.

[GBMS99] GOH, C.H., BRESSAN, S., MADNICK, S., SIEGEL, M., "Context Interchange: New Features and Formalisms for the Intelligent Integration of Information," *ACM Transactions on Office Information Systems*, 17(3): 270-293.

[HiNo00] HINKE, T. H., NOVOTNY, J., *Proceedings Ninth IEEE International Symposium on High Performance Distributed Computing*, Pittsburgh, PA, August 2000.

[IBM03]   Supply Chain Management research, IBM, Nov 2003, http://www-1.ibm.com/industries/education/doc/conten

[LGF03]   Li, N., Grosof, B., Feigenbaum, J. (2003) "Delegation Logic: A Logic-based Approach to distributed Authorization", ACM Transactions on Information Systems Security.

[Mad03]   Madnick, S., "Oh, So That is What you Meant! The Interplay of Data Quality and Data Semantics," Proceedings of the 22nd International Conference on Conceptual Modeling (ER'03), Chicago, October 2003; in Conceptual Modeling – ER 2003, (ISBN 3-540-20299-4) Springer-Verlag, 2003, pp. 3-13.

[NRC02]   National Research Council (2002), "Making the Nation Safer: The Role of Science and Technology in Countering Terrorism." Washington, D.C., National Academies Press. [http://www.nap.edu/html/stct/index.html]

[RF02]   M. Ripeanu, I. Foster, *"A Decentralized, Adaptive, Replica Location Service," 11th IEEE International Symposium on High Performance Distributed Computing (HPDC-11)* Edinburgh, Scotland, July 24-16, 2002.

[Roure03] ROURE, D., JENNINGS, N. R., SHADBOLT, N. R. (2003) "The Semantic Grid: A Future e-Science Infrastructure". In *Grid Computing: Making The Global Infrastructure a Reality* by BERMAN, F., HEY A. J. G., FOX. G., John Wiley & Sons, 437—470.

[RJS03]   D. De Roure, N. Jennings, and N. Shadbolt (2003) "The Semantic Grid: A Future e-Science Infrastructure", *in Grid Computing: Making The Global Infrastructure a Reality*, F. Berman, A. J.G. Hey and G. Fox (eds), pages 437-470.

[Ster00]   Sterman, J. (2000). Business dynamics : Systems Thinking and Modeling for a Complex World. Boston, Irwin/McGraw-Hill.

[WKM93] Wang, R., Kon, H., and Madnick, S (1993). "Data Quality Requirements Analysis and Modeling", International Conference on Data Engineering, 670-677

[UE00]   Ulrich, Karl T. and Steven D. Eppinger (2000) *Product Design and Development*, 2nd ed. New York: Irwin/McGraw-Hill.

[ZMS04] Zhu, H., Madnick, S., and Siegel, M. (2004) "Effective Data Integration in the Presence of Temporal Semantic Conflicts," CISL Working Paper.

APPENDIX 2 – BACKGROUND ON ESD

ESD is the first new educational division at MIT in over a quarter of a century – but the faculty that constitute ESD have been responsible for many important developments and innovations. This section briefly summarizes some of them.

MIT created ESD to tackle the large-scale engineering challenges of the 21st century. ESD creates and shares interdisciplinary knowledge about complex engineering systems through initiatives in education, research, and industry partnerships. ESD broadens engineering practice to include the context of each challenge as well as the consequences of technological advancement.

ESD has a dual mission: to define and evolve engineering systems as a new field of study and to transform engineering education and practice.

As a division, ESD establishes an intellectual home for key academic programs and research centers, engages faculty across departments and disciplines, and fosters discourse about engineering innovation. Through ESD's affiliated faculty, students, and researchers, the Division fosters a new synthesis of knowledge and practice.

Academic: ESD's current academic programs include Master's Degree programs in: Engineering Systems; Leaders for Manufacturing; System Design and Management; Transportation; and Technology and Policy. Ph.D.s are offered in Transportation and in Technology, Management, and Policy. The academic component of this SMA-2 Program will be a new track in Information Systems in the existing ESD Engineering Systems Master's Degree.

Research: ESD includes four research centers with an annual research volume of nearly $20 million: the Center for Technology, Policy, and Industrial Development (CTPID); the Center for Transportation and Logistics (CTL); the Industrial Performance Center (IPC); and the Center for Innovation in Product Development (CIPD). The research component of this SMA-2 Program will be administered by CTPID.

Relation to LISA: Information technology and computer science plays an increasingly critical role in modern societies. Although there are important areas that are strictly technology, the complex "systems" aspects are becoming even more difficult and crucial. The LISA program is intended to provide an educational program that will prepare the student to be effective in dealing with these issues. The research program will be closely aligned and lead to innovations both in practice and to the teaching materials.

Some ESD highlights:

· MIT believes that Engineering is going to change in the 21st century. ESD will help revolutionize, re-define, and re-invent the future. ESD is a priority in the MIT School of Engineering's view of the future.

· ESD has a history of success with innovative teaching programs and close relationship to industry involving distance education, such as the Systems Design and Management (SDM) program, and dual degree programs, such as the Leaders for Manufacturing (LFM program.

· ESD has had many successes in large-scale research, such in the *Machine that Changed the World* and *Lean Aerospace Initiative (LAI)*.

· The ESD Knowledge Network will offer many benefits to this effort.

I. Systems Theory, Design and Architecture (one of the following)

- **ESD.34J System Architecture**

    Covers principles and methods for technical System Architecture. Presents a synthetic view including: the resolution of ambiguity to identify system goals and boundaries; the creative process of mapping form to function; the analysis of complexity and methods of decomposition and re-integration. Industrial speakers and faculty present examples from various industries. Heuristic and formal methods are presented.

- **ESD.xxx[5] Foundations of System Architecture**

    Advantages and disadvantages of generic system architectures, such as tree structures, networks or grids, and layers. Relationship between architectures and design methodologies. Relationships between architectures and properties, such as flexibility or interoperability, and system characteristics, such as complexity. Complexity and flexibility measures. Modeling techniques using combinatorics and abstract algebra.

II. Socio-Technical/Enterprise Systems

- **ESD.565J Integrating Information Systems: Technology, Strategy, and Organizational Factors**

    Emphasis on modern communications and Internet technologies and database and web technologies, and their role in supporting the integration of information systems. Presents frameworks for understanding integrating concepts and the strategic and organizational factors impacting success of IT in business. Issues addressed include: Technical factors -- local-area, wide-area, and Internet communications networks, distributed databases, data extraction from web sites, semantic web, semantic reconciliation among heterogeneous sources; Strategic factors -- globalization and integration of information, competitive forces, interlinked value chains; Organizational factors -- loosely coupled organizations, development of standards, motivating strategic alliances.

III. Research Methods

   ESD Requirement (one of the following)
   –   Systems Dynamics
- **ESD.74J System Dynamics for Engineers**

    System dynamics is a modeling technique which has proven very valuable in modeling and simulating a variety of social, political, and managerial systems. Subject introduces the methodology and then develops applications to large-scale engineering systems, such as the design and construction of mega projects; the impacts of organization on system performance; and the interrelationships between technical systems and the social/political context in which such systems operate.

- **15.874 System Dynamics for Business Policy**

    Why do so many business strategies fail? Full-term introduction to system dynamics modeling applied to corporate strategy. Uses simulation models, management "flight simulators," and case studies to develop conceptual and modeling skills for

---

[5] This is a new course being developed by Professor Moses, course number has not been assigned.

the design and management of high-performance organizations in a dynamic world. Case studies of successful applications of system dynamics in growth strategy, management of technology, operations, software project management, and others. Principles for effective use of modeling in the real world.

NTU/NUS Requirement (one of the following)
- **H6429 Computational Intelligence, Methods and Applications**
  Computational Intelligence (CI) is based on inspiration from statistical, pattern recognition, neural network, machine learning, fuzzy logic, evolutionary computing, scientific visualization and other sources. This course covers basic theory, the use of software packages implementing many CI algorithms and examples of practical applications of CI methods to data in technical, medical and bioinformatics domains. Topics: Types of adaptive systems, learning and applications, Visualization and exploratory data analysis, Statistical approaches to learning, Statistical algorithms, Similarity based methods, Improving CI models

- **CPE428** Modeling and Simulation
  Introduction and basic simulation procedures. Different types of simulation models: Monte Carlo simulation, discrete-event simulation, continuous system simulation. Simulation packages. Input and output analysis: sample generation, interval estimation. Model verification and validation. Queuing networks: analytical modeling and simulation of queuing systems. Experimental design. Parallel and distributed simulation: conservative and optimistic protocols. Interoperability and resusability of simulation models. Web-based simulation. Distributed simulation on the Grid.

- **DM6121 Human Computer Interaction**
  The course focuses on both theoretical issues and practical techniques in Human Computer Interaction. The emphasis is to develop good systems designs—systems with interfaces the typical user can understand, predict, and control. The coverage includes development methodologies, evaluation techniques, and user-interface building styles. Topics: Human Factors Of Interactive Software: Goals Of User-Interface Design; Motivations For Human Factors in Design. Managing Design Processes: Organizational Design To Support Usability; Development Methodologies; Ethnographic Observation. Participatory Design; Direct Manipulation And Virtual Environments. Examples Of Direct-Manipulation Systems; Visual Thinking And Icons. Direct-Manipulation Programming; Remote Direct Manipulation. Menu Selection, Form Fill-In, And Dialog Boxes. Interaction Devices. Keyboards And Function Keys; Pointing Devices; Speech Recognition, Digitization, And Generation; Image And Video Displays. Presentation Styles: Balancing Function And Fashion. Error Messages; Nonanthropomorphic Design; Color. Response Time And Display Rate. Expectations And Attitudes; User Productivity; Variability. Expert Reviews, Usability Testing, Surveys, And Continuing Assessments. Usability Testing And Laboratories; Surveys; Acceptance Tests; Evaluation During Active Use. Multiple-Window Strategies. Computer-Supported Cooperative Work. Asynchronous Interactions: Different Time, Different Place; Synchronous Distributed: Different Place, Same Time; Face To Face: Same Place, Same Time. Hypermedia And The World Wide Web. Hypertext And Hypermedia; Information Abundant Web Sites; Object-Action Interface Model For Web Site Design

- **CS5223 Distributed Systems**
  The module shall lead to deepened knowledge in distributed systems and algorithms. The topic of Distributed Systems is now garnering increasing importance, especially with the advancement in technology of the Internet and WWW. The aim of this module is to provide students with basic concepts and principles of distributed systems, basic distributed algorithms, and orientation about distributed middleware. The module is taught in seminar style, and several case studies are included. Topics include: Introduction to distributed systems; Process communication in distributed systems; Naming; Distributed synchronization Consistency and replication; Fault Tolerance; Security; Distributed object-oriented systems. In addition an introduction to distributed algorithms is covered. The part includes: Models of distributed computation; Algorithms for synchronization and election, distributed agreement, replicated data management, checkpointing and recovery. Finally a study of peer-to-peer systems is covered including Distributed Hash Tables (DHTs).

- **CS5221 Parallel Computer Systems**
  This module aims to give students an overview on the state-of-the-art technological advancements in the field of parallel processing, in particular, the importance of shared models of parallel computing that lead to specific types of parallel languages and hardware designs. The module is divided into four parts comprising theoretical foundation, technologies, parallel architecture and parallel software. Topics include: parallel computer models; program and network properties, principles of performance analysis, processors and memory technologies, multiprocessor and multi-computer architectures; multithreaded and dataflow architectures, parallel programming models, languages and compilers, parallel program development and environments, and operating systems for parallel computers.

IV. Depth in Information Systems
ESD Requirement (two of the following courses)
- **ESD.264J Database, Internet, and Systems Integration Technologies**
  Survey of information technology covering database modeling, design, and implementation with an emphasis on relational databases and SQL. Internet technologies: http, html, XML, SOAP, security. Brief introduction to components and middleware. Introduction to design and implementation of multi-tier architectures, benchmarks, and performance. Data networking protocols and technologies. Students complete project that covers requirements/design, data model, database implementation, web site, and system architecture.

- **ESD.341J Web System Architecting: Building Web Services**
  Subject introduces the software architecting and design of web systems in the context of a start-up company. Subject targeted at future CTO's who must understand both the business and technical issues involved in architecting enterprise scale web systems. Students operate in a team that confronts a technically challenging problem. Lectures and readings cover core database, web server components and browser issues in a Windows2000, IIS, and SQL200 environment.

- **ESD.355J Concepts in the Engineering of Software**
  A reading and discussion subject on issues in the engineering of software systems and software development project design. Includes the present state of software engineering, what has been tried in the past, what worked, what did not, and why. Topics may differ in each offering, but will be chosen from: the software process and lifecycle; requirements and specifications; design principles; testing, formal analysis, and reviews; quality management and assessment; product and process metrics; COTS and reuse; evolution and maintenance; team organization and people management; and software engineering aspects of programming languages.

- **ESD.132J Law, Technology, and Public Policy**
  Examination of the relationship between law and technological change, and the ways in which law, economics, and technological change shape public policy. Areas addressed include: responses of the legal system to problems created by new or existing technology; how law can be used to influence and guide technological change; how law and markets interact to limit or encourage technological development; and how law can affect the distribution of wealth and social justice. Topics covered include genetic engineering; telecommunications; health, safety, and environmental regulation; cost/benefit analysis as a decision tool; public participation in governmental decisions affecting science and technology; and law and economics as competing paradigms to encourage sustainability.

other possible ESD choices may include (subject to approval of faculty):
- **ESD.127 Telecommunications Modeling and Policy Analysis**
  Subject examines techniques for building and analyzing models of advanced telecommunications networks and services, technology characteristics, policy issues, and socioeconomic factors. Students learn methods for assessing economic and policy issues raised by information technology. Data sets for analysis are drawn from research and publications on the ongoing development of the internet and global information infrastructure. Subject studies K-12 school networks and internet telephony. Policy analyses consider the perspectives of various stakeholders in infrastructure development. Students participate through formal presentations, group activities, and informal class discussions.

- **ESD.210J Computer Algorithms for Systems Analysis**
  Teaches techniques and tools for design, analysis, and computer implementation of efficient algorithms for systems analysis. An integrated view of algorithms, data structures, and computer architecture is emphasized. Various algorithm design techniques are presented and specialized to solve practical problems arising in engineering systems applications such as transportation systems, logistics systems, and communication systems. Methods covered in class illustrated by on-line case studies. Students complete a term project to integrate and apply knowledge gained in class.

- **ESD.221J An Introduction to Intelligent Transportation Systems**
  Basic elements of intelligent transportation systems. Technological, systems, and institutional aspects of ITS considered, including system architecture, congestion pricing, public/private partnerships, network models, ITS as industrial policy, and implementation case studies. Term project required.

NTU/NUS Requirement (Two of the following courses)

- **H6404 Data Mining**
  This course provides an introduction to the current state of the art in data mining, covering the ideas and technologies from many different fields that are used in data-mining. It also introduces the software tools commonly available for solving data-mining problems. Topics: Data Warehousing. Data Mining as a Process. Statistical Evaluation. Data Preparation: Transformations, Missing Data, Time-Series Data, Text. Data Reduction. Prediction Methods: Statistical, Neural, Trees, Rules. Solution Analyses. Specialized Mining: Text Mining, Web Mining, Distributed Data Mining. Case Studies.

- **CPE403 Advanced Data Management Techniques**
  The main objective of this course is to introduce methods of data processing and analysis for very large amount of data. The course covers techniques for cleaning of data, latent information discovery from data, and presentation of processed data. Different data types will also be covered: text data, multimedia, semi-structured data, biological data, statistical data, and temporal and spatial data. A balance between theory and practice is maintained so that the students can either work on application-specific problems in industry or can proceed to study on more advanced problems for their academic careers

- **CPE429 Software Testing**
  The subject provides an overview of some key practices that help make software testing successful within the general context of an iterative development lifecycle. The emphasis is to prepare students to effectively use a systematic testing process in developing object-oriented applications. Topics: Testing context. Risk analysis. Basic object-oriented concepts. Testing analysis and design models. Testing classes. Testing State-based classes. Parallel architecture for component testing. Planning for component testing. Measuring the effectiveness of component testing. System testing. Organizing for testing.

- **DM6102 Multimedia Information Management**
  This course focuses on multimedia database management including the fundamental principles underlying the new generation of multimedia databases, and describes how such databases can be designed. It covers information retrieval techniques, multimedia interfaces, memory management, high-speed multimedia, and contains case studies on prototype systems. Topics: Data Modeling: Modeling Time-Based Media; Document Model Issues for Hypermedia. Information Retrieval Techniques: Content-Based Indexing and Retrieval; Video and Image Content Representation and Retrieval; Video Segmentation for Video Data Management. Multimedia Interfaces: Visual Interfaces to Multimedia Databases; Visualization of web applications and database structure. Multimedia Presentation: Composite Models.Memory Management: Memory Management: Codecs; Design of Large-Scale Multimedia-on-Demand Storage Servers and Storage Hierarchies. Prototype Systems: Image Database Prototypes; Video Database Systems - Recent Trends in Research and Development Activities; Third-Generation Distributed Hypermedia Systems.

- **CSC416 Intelligent Agents**
  Intelligent agents are a relatively new breed of hardware/software systems that can autonomously perform tasks for users. The ideal agent can perceive its environment, communicate with other agents, and take a series of actions to achieve a complex goal. The course will cover the underlying theory of agents, the common agent architectures, techniques and algorithms for implementing agents, and a variety of case studies of intelligent agent applications. Topics: Agent Theory, Agent architectures, Agent Learning, Believable Agents, Multi-Agent Systems, Agent Languages and Implementation, Agent Languages and Implementation, Agent Applications and Social Issues.

- **CS5231 Cryptographic Techniques and Data Security**
  With the widespread use of computers and Internet as well as electronic commerce, data security becomes more and more important. This module introduces the main cryptographic methods for communication and computer system security. Topics covered include: symmetric cyphers, public key cryptography, stream ciphers and block cyphers, digital signature, message authentication, operation system security, access control, entry authentication and key distribution mechanisms, network security. The module will use case studies for illustrating relevant topics, and cover international standards that implement the concepts.
  .

V. Challenging Applications of Information Systems
ESD Requirement (one of the following)

- **ESD.260J/1.260J/15.770J Logistics Systems**
  Introduction to inventory theory and control with emphasis on supply chain management. Analysis of tradeoffs between transportation and inventory cost. Routing and scheduling with inventory considerations, distribution networks design and carrier networks design, optimization of carrier operations with emphasis on truck and rail networks. Integration of carrier and shipper perspectives in system models. Logistics system performance metrics and the impact of logistics activities on an enterprise's financial performance.

- **ESD61J/16.852J Integrating The Lean Enterprise**
  Addresses some of the important issues involved with the planning, development, and implementation of lean enterprises. People, technology, process, and management dimensions of an effective lean manufacturing company are considered in a unified framework. Particular emphasis on the integration of these dimensions across the entire enterprise, including product development, production, and the extended supply chain. Analysis tools as well as future trends and directions are explored. A key component of this subject is a team project

- **2.771J/BE.43J/HST.958J Biomedical Information Technology**
  The problem of integrating and querying heterogeneous, voluminous biomedical resources is of immense importance. Most bioinformatics research relies on a combination of a wide set of related public and private data sources. These sources can contain annotated genomic sequence information, or the results of new high-throughput techniques such as microarray experiments, curated

databases containing carefully scrutinized existing research systematically compiled by domain experts, and biomedical images. It is a key goal to correlate these diverse data with medical records, information on disease, references in the scientific literature, and databases containing information on the properties of chemicals and their molecular structure. We focus on the information architecture of data storage, integration, querying and management of biomedical data. The primary objective of this course is to introduce the students to state-of-the-art techniques to address the above issues. Key topics include: ontologies for data objects; expressing ontologies in database schema; federating separate databases; and using the information architecture to efficiently perform complex queries.

- **6.872J/ HST.950J Medical Computing**
  Analyzes computational needs of clinical medicine, reviews systems and approaches that have been used to support those needs, and examines new technologies. Topics: the nature of clinical data; architecture and design of healthcare information systems; privacy and security issues; medical expert systems; and computing support for medical education. Case studies of contemporary systems. Term project using a large pseudonymized clinical dataset integrates classroom topics.

- **17.422 Field Seminar in International Political Economy**
  Review of International Political Economy field covering previous and core research focusing on dual national objectives in a global context, namely pursuit of power and pursuit of wealth. Surveys major paradigms of international political economy, including neoclassical economics, development and ecological economics, lateral pressure, and perspectives and structural views of power relations. Examines interaction of politics and economics on international trade, capital flows, foreign investment, intellectual property rights, international migration, and select issues in foreign economic policy in global context. Examines the evolution of international economic institutions and attendant political implications.

NTU/NUS Requirement (One of the following courses)

- **BI6121 High Performance Computing for Bioinformatics**
  This subject covers practical programming methods and skills for development of bioinformatics software, especially with high performance computing (HPC) systems. Introduction: bioinformatics data processing, algorithm design for sequence and structure analysis, programming language, bioinformatics software packages and toolkits; Infrastructure of HPC systems: client / server architecture, compute cluster, resource management system; Parallel and distributed programming: Amdahl's law, message passing interface, parallel programs for genomic sequence and structure data analysis; Imaging and visualisation: visualizing 3D protein structures, interactive 3D graphics programming. Case studies and hands-on sessions are conducted in the NTU BioInformatics Research Centre.

- **CS5238 Combinatorial Methods in Bioinformatics**
  Biology data are too enormous. Handling them using brute-force approaches becomes impossible and efficient algorithms are required. This module has an in-

depth study of some of these advance algorithms. Through the course, students not only are able to understand these algorithms in detail, but are also given chances to solve some research problems in this field. Topics include sequence comparison, structure comparison and prediction, phylogenetic tree reconstruction and comparison, sequencing by hybridisation, Genome rearrangements, gene network, micro-array.

At MIT, students with weaker backgrounds might be asked to take:
- **1.001 Introduction to Computers and Engineering Problem Solving**
  Fundamental software development and computational methods for engineering and scientific applications. Object-oriented software design and development. Weekly programming problems cover programming concepts, graphical user interfaces, numerical methods, data structures, sorting and searching, computer graphics and selected advanced topics. Emphasis is on developing techniques for solving problems in engineering, science, management, and planning. The Java programming language is used.

APPENDIX 4 -- INDIVIDUAL CURRICULUM VITAE

SUMMARY

MIT Teaching and Research Faculty
*Senior Faculty***:**

C. Forbes DEWEY, Jr., Professor of Mechanical Engineering and Bioengineering, MIT School of Engineering

Nazli CHOUCRI, Professor of Political Science, MIT School of Humanities and Social Studies, and Associate Director of the Technology and Development Program

Daniel HASTINGS, Professor of Aeronautics and Astronautics and Engineering Systems, MIT School of Engineering and Co-Director, Engineering Systems Division, MIT School of Engineering

Steven LERMAN, Class of 1922 Professor of Civil and Environmental Engineering, MIT School of Engineering

Nancy LEVESON, Professor of Aeronautics and Astronautics and Professor of Engineering Systems, MIT School of Engineering

Stuart MADNICK, John Norris Maguire Professor of Information Technology, MIT Sloan School of Management and Professor of Engineering Systems, MIT School of Engineering

Joel MOSES, Institute Professor of Computer Science and Engineering and Professor of Engineering Systems, MIT School of Engineering

Deborah NIGHTINGALE, Professor of the Practice of Aeronautics and Astronautics and Engineering Systems, MIT School of Engineering, and Director, Lean Aerospace Initiative

Yossi SHEFFI, Professor of Civil and Environmental Engineering and Engineering Systems, MIT School of Engineering, and Director, Center for Transportation and Logistics

John STERMAN, Jay W. Forrester Professor of Management, MIT Sloan School of Management; Director of System Dynamics Group

Joseph SUSSMAN, JR East Professor Professor of Civil and Environmental Engineering and Engineering Systems, MIT School of Engineering

John WILLIAMS, Associate Professor of Civil and Environmental Engineering, MIT School of Engineering and Professor of Engineering Systems, MIT School of Engineering.

Daniel WHITNEY, Senior Lecturer in Engineering Systems, MIT School of Engineering and Senior Research Scientist, Center for Technology, Policy and Industrial Development, MIT School of Engineering.

Junior Faculty:

Benjamin GROSOF, Douglas Drane Assistant Professor in Information Technology, MIT Sloan School of Management

NTU-NUS Teaching and Research Faculty
Angela Eck Soong GOH, Professor and Vice Dean, NTU School of Computer Engineering

Francis Bu Sung LEE, Associate Professor and Vice Dean, NTU School of Computer Engineering

Ee Peng LIM, Associate Professor and Head, Division of Information Systems, NTU School of Computer Engineering

Wee-Keong NG, Associate Professor and Director, Center for Advanced Information Systems, NTU School of Computer Engineering

Stephen John TURNER, Associate Professor and Director, Parallel and Distributed Computing Centre, NTU School of Computer Engineering

Ah-Hwee TAN, Associate Professor, NTU School of Computer Engineering

Narendra CHAUDHARI, Associate Professor, NTU School of Computer Engineering

Simon Chong-Wee SEE, Associate Professor (Adjunct), NTU Nanyang Supercomputing and Visualisation Centre

Sourav Saha BHOWMICK, Assistant Professor, NTU School of Computer Engineering

Chunyan MIAO, Assistant Professor, NTU School of Computer Engineering

Kevin Kok Wai WONG, Assistant Professor, NTU School of Computer Engineering

Xueyan TANG, Assistant Professor, NTU School of Computer Engineering

Yew Soon ONG, Assistant Professor, NTU School of Computer Engineering

Kuiyu CHANG, Assistant Professor, NTU School of Computer Engineering

Kiam Tian SEOW, Assistant Professor, NTU School of Computer Engineering

Beng Chin OOI, Professor and Vice Dean (Academic Affairs and Graduate Studies), Dept of Computer Science, NUS School of Computing

Tok Wang LING, Professor, Dept of Computer Science, NUS School of Computing

Kian-Lee TAN, Associate Professor and Deputy Head, Dept of Computer Science, NUS School of Computing

Chew Lim TAN, Associate Professor, NUS School of Computing

Yong-Meng TEO, Associate Professor, NUS School of Computing

Janice Mong-Li LEE, Assistant Professor, NUS School of Computing

Stéphane BRESSAN, Senior Fellow, NUS School of Computing

I2R/SIMTech/National Grid/IHPC Teaching and Research Associates

Hwee Hwa PANG, Director of the Services and Applications Division, Institute for Infocomm Research

Mun Kew LEONG, Manager of the Media Semantics Department, Institute for Infocomm Research

Eng Wah LEE, Senior Scientist, Singapore Institute of Manufacturing Technology (SIMTech)

Puay Siew TAN, Senior Research Engineer, Singapore Institute of Manufacturing Technology (SIMTech)

Hing Yan LEE, Deputy Director, Singapore National Grid Office

Terence Gih Guang HUNG, Programme Manager, Institute of High Performance Computing

MIT Principal Research Associates

Michael SIEGEL, Principal Research Associate, Information Technologies Group, MIT Sloan School of Management; co-head MIT PROductivity from Information Technology (PROFIT) Program.

Richard WANG, Principal Research Associate; Director, MIT Information Quality Program, Center for Technology, Policy, and Industrial Development (CTPID), MIT School of Engineering and Co-director, Total Data Quality Management (TDQM) Program, MIT Sloan School of Management.

MIT Teaching Program Administration (Head, ESD Education Committee)
Richard DE NEUFVILLE, Professor of Civil and Environmental Engineering, MIT School of Engineering and Professor of Engineering Systems, MIT School of Engineering

MIT Research Program Administration (Director, CTPID)
Fred MOAVENZADEH, James Mason Crafts Professor of Systems Engineering and Civil and Environmental Engineering, , MIT School of Engineering and Professor of Engineering Systems, MIT School of Engineering

MIT Overall Program Administration (Co-Directors of ESD)
Dan ROOS, Japan Steel Industry Professor of Civil and Environmental Engineering, MIT School of Engineering and Associate Dean of Engineering Systems, Director of Engineering Systems Division, MIT School of Engineering

Bio-sketches
Interesting bio-sketches of most of the LISA faculty can be found at:
http://web.mit.edu/smadnick/www/SMA-2/LISAbiosketches.doc

Nazli CHOUCRI
Professor of Political Science
& Associate Director, Technology and Development Program, MIT.
Email: nchoucri@mit.edu **Phone**: 1-617-253-6198
Web: http://web.mit.edu/polisci/faculty/N.Choucri.html

EDUCATION
Ph.D., Political Science, Stanford University , USA, 1967
MA.,   Political Science, Stanford University, USA, 1964
B.A., Social Sciences, American University, Cairo, Egypt (High Honors), 1962

POSITIONS
Massachusetts Institute of Technology, Professor, 1978 - current
Massachusetts Institute of Technology, Assistant/Associate Professor, 1969-1978
MIT Associate Director, Technology and Development Program, 1976 – current
Queen's University, Canada, Assistant Professor, 1967-1969

HONORS/AWARDS
Elected to European Academy of Sciences, 2003
Founding Editor, MIT Press Series on Global Environmental Accords, 1993-
Co-Editor, International Political Science Review, 1994-2000
Board of Editors, Business & the Contemporary World, 1992-1994

PATENT
United States Patent States Patent #5752023, May 12, 1998 Networked Database System for
Geographically Dispersed Global Sustainability Data.

RESEARCH SUPPORT (CURRENT PROJECTS)
    1.   PI, Global Accord, Best Practice, & IT for Sustainability (2003-2004):
Funding amount: $120,000.
Co-PI: (2003-2004): IT & Megacities Sustainability, Funding Amount: &40,000.

SELECT PUBLICATIONS
N. Choucri, 2002. "Migration and Security: Some Key Linkages", Journal of International
Affairs, vol. 56, no. 1: 98-121.
N. Choucri, 2001 "Knowledge Networking for Global Sustainability: New Modes of
Cyberpartnering" in D.J. Richards, B.R. Allenby, and W.D. Compton (eds) *Information
Systems and the Environment.* Washington" national Academy Press, pp. 195-210.
N. Choucri. 2000. "Governance and International Management," in Ted Munn, ed.,
    Encyclopedia of Global Environmental Change. London: John Wiley and Sons.
N. Choucri. 1999. "Strategic Partnerships with Multilingual Functionality for Globalisation
and Localisation," Proceedings, European Commission Directorate-General Information
Society Workshop on "Sustainability and E-nvironment," IST99 Conference in Helsinki,
November 1999, Finland.

PARTICIPATION IN THE EDUCATION PROGRAM
   17.422
PARTICIPATION IN THE RESEARCH PROGRAM
   IU-5(PI)

C. Forbes DEWEY, Jr. Ph.D.
Professor of Mechanical Engineering and Bioengineering
Massachusetts institute of Technology
Email: cfdewey@mit.edu **Phone:**+1=617-253-2235 **Web:** http://icmit,mit,edu

EDUCATION
 Ph.D., Aeronautics, California Institute of Technology, Pasadena, USA, 1959-1963
 M.S., Mechanical Engineering, Stanford University, Palo Alto, USA, 1956-1957
 B.S. , Mechanical Engineering, Yale University, New Haven, USA 1952-1956

POSITIONS
 Assistant Professor, University of Colorado, Boulder 1963-1968
 Associate Professor, Professor of Mechanical Engineering and Bioengineering, MIT, 1968-present
 Head, Fluid Mechanics Laboratory, MIT 1973-83 and 2001-2003
 Director, MIT Summer course, Medical Imaging Infrastructure, 1995-2001

HONORS/AWARDS
Chair, MIT United Way Campaign 1996-1997
Editorial Board, Telemedicine and eHealth Journal, 1995-present
Editorial Board, IEEE Transactions on Information Technology in Biomedicine, 2000-present
Director, Fidelity Non-Profit Management Foundation, 2001-present
Listed in Who's Who in America, 1982-present
IR100 Research and Development Awards, 1974 and 1979
Senior Member, Biomedical Engineering Society (BMES)
Founding Fellow, American Institute of Medical and Biological Engineering (AIMBE)
Smithsonian/Computerworld Awards for Innovation, 1996 and 1999

RESEARCH SUPPORT (CURRENT PROJECTS)
1. Co-PI, Mechanotransduction in cardiovascular cells. NIH. $4,255,182 total (5 years)
2. PI, Actin Dynamics in Vascular Endothelium. NIH, $460,000/yr (continuing, 13 years)
3. PI, Biological Information Technology. Pacific Northwest National Laboratory, $140,000/yr

SELECTED PUBLICATIONS (Books/Proceedings: 3; Book Chapters: 4; Journal Papers: 113; Conference Papers: 68)
1. Dewey, C. Forbes, Jr. Bussolari, Steven R. Gimbrone, Michael A., Jr. Davies, Peter F. The dynamic response of vascular endothelial cells to fluid shear stress J. Biomech. Eng 103 177-185, 1981.
2. Dao, N., McCormick, P. J. & Dewey, C. F., Jr. (2000) The human physiome as an information environment*Annals of Biomedical Engineering* **28,** 1032-1042.
3. Cheng, Y., Hartemink, C. H., Hartwig, J. H. & Dewey, C. F., Jr. (2000) Three-dimensional reconstruction of the cell cytoskeleton from stereo images. *J. Biomech.* **33,** 105-113.
4. Bindschadler, M., Osborn, E.A., Dewey, C.F. Jr. and McGrath, J.L.(2004) A mechanistic model of the actin cycle, *Biophys. J.* (in press)

PARTICIPATION IN THE EDUCATION PROGRAMME
 2.771J

PARTICIPATION IN THE RESEARCH PROGRAMME
 IU-3(PI)

Benjamin GROSOF
Douglas Drane Assistant Professor of Information Technology,
Information Technology Group,
Sloan School of Management, Massachusetts Institute of Technology
Email: bgrosof@mit.edu   **Phone:** 617-253-8694   **Web:** http://ebusiness.mit.edu/bgrosof

EDUCATION
Ph.D., Computer Science, Stanford University, Oct. 1992 (Artificial Intelligence)
B.A. (High Honors), Applied Mathematics, Harvard University, 1980 (Econ./Mgmt. Sci.)

POSITIONS
MIT Sloan School of Management, Assistant Professor, 2000-present
IBM T.J. Watson Research Center, Senior Research Scientist, 1988-2000
Higher Order Software, Graphics Software Consultant, 1982 (a startup)
Abt Computer Graphics Corporation, Graphics Software Developer, 1980-1981 (a startup)
M.A. Schapiro & Co., Financial Analyst Intern, summers 1977 & 1978 (Wall St.: bank stocks)

HONORS/AWARDS
Co-Founder and Co-Chair, Rule Markup Language Initiative (emerging standards body), 2000-
Co-Editor, Language Committee, Semantic Web Services Initiative (standards/research), 2003-
Tutorials Co-Chair, 4th ACM Conference on Electronic Commerce, 2003
Program Co-Chair, E-Commerce & Security Area, 10th Intl. Conf. on World Wide Web, 2001
Co-Chair, AAAI-2000 Workshop on Knowledge Based Electronic Markets
Co-Chair, AAAI-99 Workshop on Artificial Intelligence in Electronic Commerce
Full Graduate Fellowships: Hertz Foundation 1986-88; NSF 1983-86; GE Foundation 1982-83.

RESEARCH SUPPORT (CURRENT PROJECTS)
PI, DARPA Agent Markup Language program grant, $543,000. (2000-2005). On semantic web rules & services.

SELECTED PUBLICATIONS (out of 49 refereed conference/journal publications)
Grosof, B. & Poon, T., "SweetDeal: Representing Agent Contracts with Exceptions using Semantic Web Rules, Ontologies, and Process Descriptions". *International Journal of Electronic Commerce,* (~35 pages), to appear, summer 2004.
Grosof, B., "Representing E-Commerce Rules Via Situated Courteous Logic Programs in RuleML". *Electronic Commerce Research and Applications* journal, (~22 pages), to appear, early 2004.
Grosof, B., Horrocks, I., Volz, R., & Decker, S., "Description Logic Programs: Combining Logic Programs with Description Logic". *Proc. 12th Intl. Conf. on the World Wide Web,* (10 pages), 2003.
Li, N., Grosof, B., & Feigenbaum, J., "Delegation Logic: A Logic-based Approach to Distributed Authorization". *ACM Transactions on Information Systems Security* 6(1):128-171, 2003.

PARTICIPATION IN THE EDUCATION PROGRAMME

PARTICIPATION IN THE RESEARCH PROGRAMME
Flagship: FS-2 Information Integration and Exchange Services; FS-3 Semantic and Ontology Services; FS-5 Agent Services.
Inter-university: IU-1 Manufacturing Logistics / Supply Chain Information Grid; IU-7 Policy and Authorization Services.

Daniel Hastings
Professor of Engineering Systems and Aeronautics & Astronautics,
Department of Aeronautics and Astronautics and Engineering Systems Division
Co- Director of the Engineering Systems Division, MIT
Email: hastings@mit..edu **Phone:** 6172530906 **Web:**
http://esd.mit.edu/Faculty_Pages/hastings/hastings.htm

EDUCATION
 Ph.D., Plasma Physics, MIT, 1978-1980
 SM, Aeronautics and Astronautics, MIT, 1976-1978
 B.A, Mathematics, Oxford University, UK, 1973-1976
POSITIONS
2003-present   Co-director, Engineering Systems Division, MIT
2001-2003   Associate Director, Engineering Systems Division, MIT
1997-1999   US Air Force Chief Scientist
1993-present   Professor of Aeronautics and Astronautics, MIT
HONORS/AWARDS
    2002 AIAA Losey Award
    1999 Air Force Distinguished Civilian Award
    1997 AIAA Fellow
RESEARCH SUPPORT (CURRENT PROJECTS)
    Project/Proposal Title: Changing the Nature of the Space Enterprise (DARPA)
        Total Award Amount: $215,000 per year: Total Award Period Covered: 5/1/00-
    5/31/05
    Project/Proposal Title: A Center for Space System Architecting(NRO)
        Total Award Amount: $2,200,000: Total Award Period Covered: 6/15/00–9/31/04:
    Project/Proposal Title: Interactions of electric propulsion plumes with a complete
    spacecraft cluster(AFOSR)
        Total Award Amount: $300,000:Total Award Period Covered: 6/1/01–5/31/04:
    Project/Proposal Title: Joint TPP/CU curriculum development effort (CMI)
        Total Award Amount: $273,000 per year:Total Award Period Covered: 3/15/02-
    3/14/05
SELECTED PUBLICATIONS (Books/Proceedings: 1; Journal Papers: 103;)
    Shaw, G., Miller, D., and Hastings, D. E., "*Development of the Quantitative Generalized
        Information Network Analysis (GINA) Methodology for Satellite Systems*", Journal of
        Spacecraft and Rockets, Vol 38, No. 2, pp257-269, March 2001.
    Gumbert, C., Violet, M., Hastings, D.E., Hollister, W. M. And Lovell, R, "*Assessing
        Personal Mobile Communication Satellite Systems Using a Cost per Billable Minute
        Metric*" Journal of Spacecraft and Rocket, Vol 35, No. 1, (1998).
 D. Hastings, A. Weigel, E, Lamasourre, J, Saleh "Policy Enablers for the Development of a
 Space-Based Infrastructure", Thissen, W.A.H. and P.M. Herder (Eds), Critical
 Infrastructures - State of the Art in Research and Application, Kluwer Academic
 Publishers, Boston/Dordrecht/London, USA, pp.123-138, (ISBN 1-4020-7601-0), 2003.
PARTICIPATION IN THE EDUCATION PROGRAMME
 Oversee as ESD Co-Director
PARTICIPATION IN THE RESEARCH PROGRAMME
 IU-5

Steven R. LERMAN
Class of '22 Professor, MIT, Deputy Co-Director, SMA and Director, CECI
Department of Civil & Env. Engineering, MIT
Email: lerman@mit.edu   **Phone:** 617-253-4277   **Web:** http://web.mit.edu/~lerman/www

EDUCATION
 Ph B.S., Civil Engineering, 1972, MIT
 M.S., Civil Engineering, 1973, MIT
 Ph.D., Transportation Systems Analysis, 1975, MIT

POSITIONS
 Director, MIT Center for Educational Computing Initiatives, 1991-present
 Professor of Civil and Environmental Engineering, Massachusetts Institute Technology (1984-present)
 Associate Professor of Civil Engineering, Massachusetts Institute of Technology (1979-1984)
 Assistant Professor of Civil Engineering, Massachusetts Institute of Technology (1975-1979)

HONORS/AWARDS
 Gilbert Winslow Career Development Professor, Massachusetts Institute of Technology (1977-1979)
 Class of 1922 Distinguished Professor of Civil and Environmental Engineering, Massachusetts Institute of Technology (1991-present)
 Associate Editor, Journal of Science Education and Technology (1992-present)
 Lilly Teaching Award (1976-1977)
 Civil Engineering Effective Teaching Award (1977)
 Chair of the Faculty, MIT (1999-2001)

RESEARCH SUPPORT (CURRENT PROJECTS)
1. co-PI, i-Labs, (2001-present) $800,000/year. Supported by Microsoft
2. co-PI, Educational Technologies, (2001-present), $250,000/year. Supported by Singapore-MIT Alliance
3. co-PI, Pilot Study of Use of Web-Enabled Labs in Africa (2003-present), $50,000. Supported by the Carnegie Corporation

SELECTED PUBLICATIONS
1. Lerman, Steven R., *Problem Solving and Computation for Scientists and Engineers: An Introduction Using C*, Prentice-Hall, 1993
2. Manski, Charles F. and Steven R. Lerman, "The Estimation of Probabilities from Choice Based Samples," Econometrica, Vol. 45, No. 8, 1977.
3. Lerman, Steven R. , "Some Criteria for the Evaluation of Multimedia Computer Applications", in School Improvement through Media in Education, Bertelsmann Foundation Publishers,Gutersloh, 1995.
4. Lehman, L. and S. Lerman, "Discovering Network Neighborhoods Using Peer-to-Peer Lookups", Proceedings of the Singapore-MIT Alliance Annual Symposium, January, 2003.

PARTICIPATION IN THE EDUCATION PROGRAMME
 1.001

PARTICIPATION IN THE RESEARCH PROGRAMME
 Cannot participate in research because of role as Deputy Co-Director of SMA.

Nancy G. LEVESON
Prof. Aeronautics and Astronautics and Engineering Systems
Massachusetts Institute of Technology
Email: leveson@mit.edu **Phone:** 617-258-0505 **Web:** http://sunnyday.mit.edu

EDUCATION
  Ph.D., Computer Science, UCLA, 1980
  M.S., Operations Research, Anderson School of Management, UCLA
  B.A., Mathematics, UCLA

POSITIONS
  MIT, Aeronautics and Astronautics, Professor, 1999-2004
  MIT, Hunsaker Visiting Professor, Aeronautics and Astronautics, 1997-1998
  University of Washington, Boeing Professor of Computer Science, 1993-1999
  University of California, Irvine, Professor, 1980-1993
  IBM, System Engineer, 1967-1970

HONORS/AWARDS
  Member, National Academy of Engineer*ing*
  1999 ACM Allen Newell Award
  1995 AIAA Information Systems Award
  Editor-in-Chief, IEEE Transactions on Software Engineering (1991-1995)
  Distinguished Professor, Computing Research Association (2004)
  Member, NASA Aerospace Safety Advisory Panel, (1999-2003)

RESEARCH SUPPORT (CURRENT PROJECTS)
  - PI, Model-Based System and Software Engineering for Real-Time, Safety-Critical Systems (2000-2004), NSF, $1,500,000
  - PI, Model-Based Hazard Analysis (2001-2004), NASA Ames, $700,000

SELECTED PUBLICATIONS (Books: 1; Book Chapters: 9; Journal Papers: 36; Conference Papers: 102; Misc: 23)
  1. Nancy G. Leveson, *Safeware*: System Safety and Computers, Addison-Wesley, 1995.
  2. Nancy G. Leveson, "Intent Specifications: An Approach to Building Human-Centered Specifications," *IEEE Trans. on Software Engineering*, 26:1, 2000.
  3. Nancy G. Leveson and Clark Turner, "An Investigation of the Therac-25 Accidents," *IEEE Computer*, July 1993 (Translated in Braille and sound recordings for the blind, reprinted in Kevin Bowyer, *Ethics in Engineering*, IEEE Computer Society Press, 1995; Reprinted in Johnson and Nissenbaum, *Computers, Ethics, and Social Values*, Prentice Hall, 1995.)
  4. John C. Knight and Nancy G. Leveson, "An Experimental Evaluation of the Assumption of Independence in N-Version Programming," *IEEE Trans. on Software Engineering*, 12:1, 1986.

PARTICIPATION IN THE EDUCATION PROGRAMME
  ESD.355J: Concepts in Software Engineering

PARTICIPATION IN THE RESEARCH PROGRAMME
  IU-6

Stuart MADNICK

John Norris Maguire Professor of Information Technology, MIT Sloan School of Management
and Professor of Engineering Systems, MIT School of Engineering
Email:smadnick@mit.edu **Phone**:6172536671
Web:http://web.mit.edu/smadnick/www/home.html

EDUCATION
  Ph.D., Computer Science, MIT, 1972
  M.S., Alfred P. Sloan School of Management & M.S., Electrical Engineering MIT, 1969
  B.S., Electrical Engineering, MIT, 1966

POSITIONS
  MIT, Assistant/Associate/Full/Chaired Professor, 1972-2004
  MIT, Leaders for Manufacturing Professor of Management Science (term chair),1990-1995
  Visiting Professor at Harvard University, Nanyang Technological University (Singapore),
  University of Newcastle(England),Technion(Israel), and Victoria University(New Zealand).

HONORS/AWARDS
  Jay Wright Forrester Award: "Best Contribution to the field of System Dynamics in preceding
  five years" awarded by the System Dynamics Society, 1994; Board of Governors, IEEE
  Computer Society, 1979-81; Chairman, IEEE Technical Committee on Database Engineering,
  1980-82;VLDB Endowment,Vice President 1991-97;Treasurer 1989-91; Executive Committee,
  International Workshop on Information Technology & Systems, 1995-04; 3 USA Patents.

RESEARCH SUPPORT (CURRENT PROJECTS)
  1. Center for eBusiness @MIT / Suruga Bank, "The Impact of the Internet on the Future of the
  Financial Services Industry," $550,000, 2000-2004.
  2. Center for eBusiness @MIT/Vision Fund,"Globalization of eBusiness," $75,000, 2001-2003.
  3. Total Data Quality Management (TDQM) Program Consortium, $395,000, 1992-2005.
  4. Merrill Lynch, "Digital Factory," $500,000, 1999-2004.
  5. MITRE Corporation, "Collaboration with MIT on the Semantic Web," $360,000, 2000-2003.
  6. MUST-Motorola, "Intelligent Information Integration," $120,000, 2002-2003.

SELECTED PUBLICATIONS (Books 5; Book chapter 7; Referred publications 165)
  1. Firat, A., S. Madnick, and Grosof, B., "Financial Information Integration In the Presence
     of Equational Ontological Conflicts," *Proceedings of the Workshop on Information
     Technology and Systems*, Barcelona, Spain, December 14-15, 2002, pp. 211-216 [Best
     Paper Award]
  2. Bresson, S., C. Goh, N. Levina, S. Madnick, A. Shah, and M. Siegel, "Context
     Knowledge Representation and Reasoning in the Context Interchange System," *The
     International Journal of Artificial Intelligence*, Neutral Networks, and Complex
     Problem-Solving Technologies, Volume 12, Number 2, September 2000, pp. 165-180.
  3. Goh, C., S. Bresson, S. Madnick, and M. Siegel , "Context Interchange: New Features
     and Formalisms for the Intelligent Integration of Information," *ACM Transactions on
     Information Systems*, July 1999.
  4. Choucri, N., Madnick, S., Moulton, A., Siegel, M., and Zhu, H, "Information Integration
     for Counter Terrorism Activities: The Requirement for Context Mediation,", to appear in
     the Proceedings of the 2004 IEEE Aerospace Conference, Big Sky, Montana, March 6-
     13, 2004

PARTICIPATION IN THE EDUCATION PROGRAMME
       ESD.565J
PARTICIPATION IN THE RESEARCH PROGRAMME
       FS-1, FS-2(PI), FS-6; IU-4(CoPI);   IU-5, IU-6, IU-7(PI)

Joel MOSES

Institute Professor, Professor of Computer Science and Engineering, Professor of Engineering Systems, MIT

Email: moses@mit.edu, **Phone:** 617-253-8592

Education: BA, magna cum laude, Columbia (1962), MA Columbia (1963), PhD MIT (1967)

Academic Positions

Assistant Professor (EE, MIT) 1967-1971

Associate Professor (EE) 1971-1977

Tenure 1975-present

Professor of Computer Science and Engineering (EECS) 1977-present

Head, Mathlab Group, Laboratory for Computer Science, 1971-1983

Associate Director, Laboratory for Computer Science, 1974-1978

Associate Head for Computer Science and Engineering, 1978-1981

Head, Department of Electrical Engineering and Computer Science, 1981-1989

D.C. Jackson Professor of Computer Science and Engineering, 1989-1999

Visiting Professor of Business Administration, Harvard Business School, 1989-1990

Dean, School of Engineering, 1991- 1995

Provost, 1995- 1998

Professor of Engineering Systems, Engineering Systems Division, 1999-present

Institute Professor 1999-present

Honors

Paper chosen for volume Best Computer Papers -1975

MIT Laboratory for Computer Science Achievement Award, 1984

Member, National Academy of Engineering, 1986

Fellow, American Academy of Arts and Sciences, 1987

Fellow, IEEE, 1990

Fellow, American Association for the Advancement of Science, 1996

Institute Professor, 1999

Chancellor's Distinguished Lecturer, LSU, 2002

Research Support (Current Projects)

Foundations of Engineering Systems, Engineering Systems Symposium – Multiple sponsors

New Approach to Classical Artificial Intelligence – Internal MIT Support

Selected Recent Publications

1) J. Moses, "The Anatomy of Large Scale Systems," ESD Internal Symposium, MIT, May 2002

2) J. Moses, "Foundational Issues in Engineering Systems: A Framing Paper," Engineering Systems Symposium, MIT, March 2004

3) J. Moses, "Three Design Methodologies, their Associated Organizational Structures and Relationship to Various Fields," Engineering Systems Symposium, March 2004

Participation in the Education Programme

ESD.34J, ESD.xxx

Participation in the Research Programme

FS-6(PI)

Deborah NIGHTINGALE Ph.D.
Director, Lean Aerospace Initiative, Professor of Practice
Aeronautics and Astronautics and Engineering Systems Division
Massachusetts Institute of Technology
Email: dnight@mit.edu **Phone:** 617-253-7339

EDUCATION
 BS, University of Dayton, Dayton, Ohio, USA, 1970
 MS, Ohio State University, Columbus, Ohio, USA, 1974
 Ph.D., Ohio State University, Columbus, Ohio, USA, 1979
POSITIONS
 Massachusetts Institute of Technology, Professor of Practice, 1999-Present
 Massachusetts Institute of Technology, Senior Lecturer, 1997- 1999
 AlliedSignal Aerospace, Engines Division, Executive Strategy/International Business
   Operations, Engineering and Program Management, 1979-1996
 Wright-Patterson, Senior Research Engineer, 1971-1979
HONORS/AWARDS
 National Academy of Engineering   1993
 International Academy of Astronautics (IAA),
   Engineering Book Award   2003
 Distinguished Alumni Award, Ohio State University   1995
 Special Achievement Alumni Award,
   University of Dayton   1994
 Fellow, Institute of Industrial Engineers   1994
RESEARCH SUPPORT (CURRENT PROJECTS)
 Lean Aerospace Initiative (Enterprise Value Phase)
       October 2002 to September 2003 $3.325M
       October 2003 to September 2004 $3.15M
       October 2004 to September 2005 $2.825M
SELECTED PUBLICATIONS
 1. Murman, Earll, Deborah J. Nightingale, et. al., <u>Lean Enterprise Value</u>, Palgrave, March 2002.
 2. Nightingale, Deborah J., Mize, Joe H., Development of a Lean Enterprise Transformation Maturity Model, <u>Journal of Information Knowledge Systems Management (IKSM)</u>, December 2002.
 3. Allen, Thomas and Deborah J. Nightingale, Engineering Systems: An Enterprise Perspective, Monograph, MIT Engineering Systems Symposium, March, 2004.
 4. Nightingale, Deborah J., et. al., Transitioning To A Lean Enterprise: A Guide For Leaders, Volume I Executive Overview, MIT Lean Aerospace Initiative, September 2000.
PARTICIPATION IN THE EDUCATION PROGRAM
 ESD.61J Integrating the Lean Enterprise
PARTICIPATION IN THE RESEARCH PROGRAM
 IU-2(PI)

Yossi SHEFFI
Professor of Engineering Systems, MIT
Professor of Civil and Environmental Engineering, MIT
Director, MIT Center for Transportation and Logistics
Founder and Director, MIT Master of Engineering in Logistics
Email: Sheffi@mit.edu   **Phone:** 617-253-5316   **Web:** http://mit.edu/sheffi/www/index.html

EDUCATION
 Ph.D., Civil Engineering, MIT, Cambridge USA, 1977-1978
 SM, Engineering, MIT, Cambridge USA, 1975-1977
 B.Sc. (Suma Cum Laude), Civil Engineering, Technion, Israel, 1971-1975

POSITIONS
 MIT, Professor, 1985-
 MIT Associate Professor, 1981-1985
 MIT, Assistant Professor 1978 – 1982
 Cambridge University, UK, Visiting Professor, 2002 – 2003

HONORS/AWARDS
 Distinguished Service Award, Council of Logistics Management,
 Best Paper, 2002, International Journal of Logistics management
 Best Paper, 1998, International Journal of Logistics management
 E. Grosvenor Plowman Prize Best Paper Award, 1989, NCPDM.

RESEARCH SUPPORT (CURRENT PROJECTS)
 1. PI, Analysis of Supply Chain Disruptions (2003 – 2005). Supported by CMI, $750,000
 2. PI, The MIT-Zaragoza Logistics Program (2003 – 2008). Supported by the Government
    of Aragon, $16,000,000

SELECTED PUBLICATIONS
 1. Sheffi, Y. Supply Chain Management Under the Threat of International Terrorism,
    International Journal of Logistics Management, Vol. 12, No. 1, pp 1 – 11, 2002
 2. McFarlane, D. and Y. Sheffi, The Impact of Automatic Identification on Supply Chain
    Operation, International Journal of Logistics management, Vol 14 No. 1, 2003
 3. Caplice, C. and Sheffi, Y. Theory and Practice of Optimization-based Bidding for Motor
    carrier Transportation Services. Journal of Business Logistics, Forthcoming, 2004.
 4. Sheffi, Y. Combinatorial Auctions in the Procurement of Transportation Services,
    Interfaces. Forthcoming, 2004.

PARTICIPATION IN THE EDUCATION PROGRAMME
 ESD.260 Logistics Systems (but all other courses in the MLOG program should be
candidates)

PARTICIPATION IN THE RESEARCH PROGRAMME
 IU-1 (CoPI)

Michael D. SIEGEL, PhD
Principal Research Scientist, Sloan School of Management
Massachusetts Institute of Technology
Email: msiegel@mit.edu **Phone:** 617-253-2937 **Web:**
http://web.mit.edu/msiegel/www/index.htm

EDUCATION
  Ph.D. in Computer Science, Boston University, Boston, MA. 1985-1989
  M.A. in Computer Science, Boston University, Boston, MA. 1983-1985
  M.S. in Engineering, University of Wisconsin-Madison. 1978-1980
  BS in Engineering, Trinity College, Hartford, CT. 1973-1977

POSITIONS
  Principal Research Scientist, Massachusetts Institute of Technology. 1993-
  Director Global Financial Services Special Interest Group, Center for eBusiness at MIT.
2001 -
  Senior Lecturer, Sloan School of Management, Massachusetts Institute of Technology.
1998
  Co-Director, Finance Research Center (FRC). 1996-1999
  Research Scientist, Sloan School of Management. 1989-1993

HONORS/AWARD
  1. "Querying and Retrieving Semi-Structured Data from Heterogeneous Sources," PAT.
  NO. 6,282,537, 1999.
  2. "Data Extraction from World Wide Web Pages" with Stuart Mandick, PAT. NO.
  5,913,214, 1996.
  3. "Querying Heterogeneous Data Sources Distributed over a Network Using Context
  Interchange" with Stuart Madnick, PAT. NO. 5,953,716, 1996.

RESEARCH SUPPORT (CURRENT PROJECTS)
  1. Suruga Bank, Ebusiness Center at MIT $100K/yr for 3 years

SELECTED PUBLICATIONS (Book Chapters: 3; Journal Papers: 10; Conference Papers:
44)
  1. Madnick, A. Moulton, M. Siegel, H Zhu, "Information Integration for Counter
  Terrorism: The Requirement for Context Mediation" IEEE Aerospace Conference, Big Sky
  , MT, March 2004.
  2. Madnick, Stuart and M Siegel, "Seizing the Opportunity : Exploiting Web Aggregation,"
  MISQ Executive, Vol 1, No. 1, March 2002, pp. 35-46. [SWP #4351, CeB #144, CISL #01-
  13].
  3. Bresson, Stephane, C. Goh, N. Levina, A. Shah, and M. Siegel, "Context Knowledge
  Representation and Reasoning in the Context Interchange System," The International
  Journal of Artificial Intelligence, Neutral Networks, and Complex Problem-Solving
  Technologies, Volume 12, Number 2, September 2000, pp. 165-180, [SWP #4133, CISL
  #00-04].
  4. Goh, Cheng, Stephane Bresson, Stuart Madnick, and Michael Siegel , "Context
  Interchange: New Features and Formalisms for the Intelligent Integration of Information,"
  Transactions on Information Systems, Publication expected in July 1999.

PARTICIPATION IN THE EDUCATION PROGRAMME
PARTICIPATION IN THE RESEARCH PROGRAMME
  FS-2, FS-3(PI), FS-4(CoPI)**,** IU-5

John D. STERMAN
Jay W. Forrester Professor of Management
Director, System Dynamics Group, Sloan School of Management,
Massachusetts Institute of Technology
Email: jsterman@mit.edu Phone: 617-253-1951   Web: http://mit.edu/jsterman/www

EDUCATION
PhD., MIT Sloan School of Management, 1982
A.B., Dartmouth college, 1977. Phi Beta Kappa, Summa cum Laude
Major: Engineering and Environmental Systems; Minor: Philosophy
POSITIONS
2002 -present Jay W. Forrester Professor of Management, Sloan School of Management.
1996 – 2002   J. Spencer Standish Professor of Management, Sloan School of Management.
1989 -present Director, System Dynamics Group, Massachusetts Institute of Technology
1994 – 1996   Professor of Management Science, Sloan School of Management, MIT.
1986 – 1993   Associate Professor, Sloan School of Management, MIT.
HONORS/AWARDS
- 2002 Jay W. Forrester Award, given by the System Dynamics Society for the best published work in the field over the previous five years.
- 2001 Accenture Award, for best paper published in California Management Review (with Nelson Repenning, for "Nobody Ever Gets Credit for Fixing Problems That Never Happened" (Vol. 43, n. 4).
- 1988 Jay W. Forrester Award, given by the System Dynamics Society for the best published work in the field over the previous five years, for "Modeling Managerial Behavior: Misperceptions of Feedback in a Dynamic Decision Making Experiment." Management Science. 35(3), 321-339.
- Five Awards for Excellence in Teaching, Sloan School of Management, MIT. Named one of the Sloan School's "Outstanding Faculty" by the 2001 Business Week Guide to the Best Business Schools.

RESEARCH SUPPORT (CURRENT PROJECTS)
CO-PI project on Innovation in Markets and organization ($12 million over 5 years); CO-PI's R. Gibbons, R. Henderson
SELECTED PUBLICATIONS
- Sterman, J. (2000) Business Dynamics: Systems Thinking for a Complex World. Irwin/McGraw-Hill.
- Ford, D. and J. D. Sterman (2003). "The Liar's Club: Concealing Rework in Concurrent Development." Concurrent Engineering: Research and Applications 11(3): 211-220.
- Oliva, R., J. D. Sterman, et al. (2003). "Limits to Growth in the New Economy: Exploring the 'Get Big Fast' Strategy in e-commerce." System Dynamics Review 19(2): 83-117.
- Repenning, N. and J. Sterman (2002). "Capability Traps and Self-Confirming Attribution Errors in the Dynamics of Process Improvement." Administrative Science Quarterly 47(2): 265-295.

PARTICIPATION IN THE EDUCATION PROGRAMME
    15.874
PARTICIPATION IN THE RESEARCH PROGRAMME
FS-6

Joseph M. SUSSMAN
JR East Professor
Professor of Civil & Environmental Engineering and Engineering Systems
Massachusetts Institute of Technology
E-mail: sussman@mit.edu; Phone: 617.253-4430; Fax: 617.258-5942;
web: http://web.mit.edu/civenv/html/people/faculty/sussman.html

EDUCATION
  Ph.D., Massachusetts Institute of Technology, Cambridge, MA, 1968
  M.S.C.E., University of New Hampshire, Durham, NH, 1963
  B.C.E., City College of New York, New York City, NY, 1961

POSITIONS
  JR East Professor, Professor of Civil & Environmental Engineering and Engineering
    Systems, 1991-2004
  Member, MIT Faculty since 1967

HONORS
  CUTC Award for Distinguished Contribution to University Transportation Education and
    Research, presented at the CUTC Awards Dinner at the Annual Meeting of the
    Transportation Research Board, January 2004.
  Faculty Appreciation Award, presented by the students of the Massachusetts Institute of
    Technology Technology and Policy Program, May 2002.
  ITS Massachusetts instituted the "Joseph M. Sussman Leadership Award" to be given
    annually for leadership in the ITS field, April 2002.
  Transportation Research Board's 2001 Roy W. Crum Award for distinguished research,
    Washington, DC, January 2002.

RESEARCH SUPPORT (CURRENT PROJECTS)
  1. Principal Investigator, Rail Risk & Reliability, East Japan Railway Company
  2. Principal Investigator, Technology Scanning for the International Rail Industry,
     Union Internationale des Chemins des Fer (UIC)
  3. Research, Mexico City Air Quality Project

SELECTED PUBLICATIONS
  Perspectives on ITS, (in press), Kluwer Academic Publishers, Dordrecht, Boston, New
    York and London, 2004.
  "Earthquake Loss Under Limited Transportation Capacity: Assessment, Sensitivity and
    Mitigation", 7th USNCEE Conference, Boston, MA, July 2002 (with D. Veneziano,
    U. Gupta, S. Kunnumkal).
  "The MCMA Transportation System: Mobility and Air Pollution", Chapter 6 in *Air
    Quality in the Mexico Megacity: An Integrated Assessment*, Luisa T. Molina and
    Mario J. Molina, Eds., Kluwer Academic Publishers, Boston, 2002 (with several co-
    authors).
  "Transitions in the World of Transportation", *Transportation Quarterly*, Vol. 56, No. 1,
    Winter 2002, Eno Transportation Foundation, Washington, DC, 2002.
  Introduction to Transportation Systems, Artech House Publishers, Boston and London,
    2000.

PARTICIPATION IN THE EDUCATION PROGRAMME
  ESD.221J

PARTICIPATION IN THE RESEARCH PROGRAMME
  FS-6

Richard Y. WANG
Director for MIT Information Quality Program
Center for Technology, Policy, and Industrial Development, MIT
Email: rwang@mit.edu Tel: (617) 739-7234 Web: http://mitiq.mit.edu

EDUCATION
B.S., Electrical Engineering, National Taiwan University, 1975
M.B.A., Business Statistics, University of Wisconsin, Madison, 1979
Ph.D., Information Technology, Massachusetts Institute of Technology, 1979-1985

POSITIONS
Massachusetts Institute of Technology
- Director of MIT Information Quality Program, CTPID (2002 – current)
- Co-Director for Total Data Quality Management Program (1990 - current)
- Associate Professor of Information Technologies (1994 - 1996)
- Assistant Professor of Information Technologies (1989 - 1993)
- Visiting Assistant Professor of Information Technologies (1987 - 1989)

Primary Non-MIT Experience
- Visiting Professor, CITM, University of California, Berkeley (2002-2003)
- Associate Professor, Information Systems Department, Boston University (1999 - 2002)
- ASEE Fellow, Naval Command, Control and Ocean Surveillance Center, (1994)
- Co-founder, General conference chair, Chairman of the Board, International Conference on Information Quality, (1996 – Present)

Industrial Activities
- Co-founder, Cambridge Research Group, Cambridge, MA (1994 - 1999)
- Technical Consultant, At&T Cambridge Training Center, Cambridge, MA (1980 - 1986)

RESEARCH SUPPORT (CURRENT PROJECTS)
- Customer Centric Information Quality Management (CCIQM) Workgroup (2004). Supported in part by Axciom Corporation. Funding: $75,000
- Total Data Quality Management (2004). Supported by FirstLogic. Funding: $50,000

SELECTED PUBLICATIONS
1. Richard Wang, Mostapha Ziad, and Yang Lee, Data Quality, Kluwer Academic Publisher, Advanced Database Systems Series, 2001.
2. Kuan-Tsae Huang, Yang Lee, and Richard Wang, Quality Information and Knowledge, Prentice Hall, 1999.
3. Richard Wang, Yang Lee, Leo Pipino, and Diane Strong, "Managing Information as a Product," Sloan Management Review, Vol. 39, No. 4, Summer 1998, pp. 95-105.
4. Richard Wang and Diane Strong, "Beyond Accuracy: What Data Quality Means to Data Consumers," Journal of Management Information Systems, Vol. 12, No. 4, Spring 1996, pp. 5-34.

PARTICIPATION IN THE EDUCATION PROGRAMME
PARTICIPATION IN THE RESEARCH PROGRAMME
FS-4, IU-6(PI)

Daniel E. WHITNEY
Senior Research Scientist and Senior Lecturer
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
(617) 253-6045, (617) 258-6794 FAX, dwhitney@mit.edu

Education
PhD 1968, Massachusetts Institute of Technology (Mechanical Engineering)

Positions

Assistant Professor, Mechanical Engineering,   1968 - 1971
Associate Professor, Mechanical Engineering,   1971 – 1974
Charles Stark Draper Laboratory, Inc   1974-1993
Office of Naval Research Foreign Field Offices in Tokyo and London, 1991 and 1992
Senior Research Scientist, MIT   1994 – present
Senior Lecturer, MIT   2002 - present

Professional Memberships/Societies/Honors
        ASME - Fellow
        IEEE - Fellow

National Committees and Advisory Boards
        National Academy of Engineering - Japan-USA Team on Manufacturing Research
        National Academy of Engineering - member of ad hoc committee on Design
        Theory and Methodology
        NSF Advisory Committee on Design and Manufacturing

Selected publications
1. *Mechanical Assemblies: Their Design, Manufacture, and Role in Product Development*, New York: Oxford University Press, 2004
2. Mantripragada, R. and Whitney, D. E., "The Datum Flow Chain," *Research in Engineering Design*, (1998) 10: pp 150-165.
3. Krishnan, V., Eppinger, S., and Whitney, D., "A Model-based Framework to Overlap Product Development Activities, " Management Science, v 43, no 4, April 1997, pp437-451
4. Whitney, D. E. "Why Mechanical Design Will Never be Like VLSI Design," Research in Engineering Design, (1996) 8: 125-138.
5. Fine, Charles, and Whitney, Daniel, "Is the Make-Buy Decision a Core Competence?" Moreno Muffatto and Kulwant Pawar (eds.), *Logistics in the Information Age*, Servizi Grafici Editoriali, Padova, Italy, 1999, pp. 31-63.

Current Research
1. Ford-MIT Research Alliance: System Integration for Design of Complex Subsystems
2. Ford-MIT: Models and Computing Methods for Mechanical Assemblies

PARTICIPATION IN THE EDUCATION PROGRAMME
  ESD.34J and ESD.xxx (Foundations of Architecture)
PARTICIPATION IN THE RESEARCH PROGRAMME
  IU-2 and FS-6

John R. WILLIAMS
Associate Professor of Information Engineering
Engineering Systems Division and Civil and Environmental Engineering Department
Massachusetts Institute of Technology, MA 02139 USA
Phone: (617)253-7201, Fax: (617)253-6324 jrw@mit.edu

Education

1977   Ph.D.   Computational Mechanics - Civil Engineering, University College Swansea, U.K.

1973   M.Sc.   Physics, UCLA.

1971   B.A.   Physics, Oxford University, England, UK.

Positions held:

    1. Associate Professor, CEE and Engineering Systems Division, MIT

    1989-1990   Senior Lecturer, University of Wales, Swansea, UK

    1988-1989   Principle Research Associate, MIT.

    1981-1987   Vice President, Applied Mechanics Inc., Lakewood CO

Most Closely Related Publications

Prakash, J. and Williams, J.R. "**Security Models for Collaboration**," Computers and Information Technology in Civil Engineering, Montreal, Oct. 20-23, 1998.

Lin,X. and Williams, J.R., **A Grid Computing Architecture for Applications in Computational Mechanics**, *7th US Congress on Computational Mechanics,* Albuquerque, NM, July 27-31, 2003

Williams, J.R., Perkins, E., Cook, B.K., and Preece, D. **"Generalized Spatial Binning of Bodies of Different Sizes,"** *International Journal of Computer Aided Methods in Engineering - Engineering Computations,* Vol. 2 No 3, 2004

Williams, J.R. and Lin, X. **A Grid Computing Architecture for Applications in Discrete Mechanics**, accepted to *the Numerical Modeling in Micromechanics via Particle Methods, 2nd International PFC Symposium*, Tokyo, Japan, Oct. 29-29, 2004

Research Support

Motorola - PI	Web Service Architectures	$150,000	2003-2004
Microsoft I-Campus-PI	Robot World – E-Education	$592,000/year	2003-2004
Sandia National Laboratories -PI	Discrete Element Simulation	$105,000	2001-2004
CIPD	Collaboration for Design	$ 40,000/yr	2001-2004
Shell Oil	Data Mining	$70,000	2003-2004
Kajima Corporation-PI	Expert System for Building Design	$30,000	2003-2004
ESLC	E-Education	$20,000	2003-2004

Participation in Educational Program

  ESD 341J Web System Architecting

Participation in Research Program

  FS-1(CoPI), FS-3, FS-5(CoPI), IU-6

SAHA BHOWMICK Sourav MIEEE, MACM
Assistant Professor, Division of Information Systems
School of Computer Engineering, Nanyang Technological University
Email: assourav@ntu.edu.sg   **Phone:** 67904320 **Web:** http://www.ntu.edu.sg/home/assourav

EDUCATION
  Ph.D., Computer Engineering, Nanyang Technological University, 1997-2001
  M.S., Computing, Griffith University, Australia, 1995 - 1997
  B.E. Mechanical Engg, Visvesvaraya Regional College of Engg, 1989-1993
POSITIONS
  Nanyang Technological University, Assistant Professor, 2000 - date
HONORS/AWARDS
 Guest Editor, Special Issue, Data and Knowledge Engineering Journal, Elsevier Science
 Editorial Review Board, Int'l Journal on Data Warehousing & Mining (IJDWM), Idea Grp
 Program Chair, International Workshop on Biological Data Management (BIDM), 2003-
  2004
 Recipient of *Lecturer of the Year Award* (2002-2003) for Year 1 undergraduate course.
 Nominated for the *Teacher of the Year Award* in the School of Computer Engineering for
  2003 & 2004(only 5 academic staff are nominated).
RESEARCH SUPPORT (CURRENT PROJECTS)
   1. Co-PI, PET-DEVICE++ (Push-pull Extraction Tool for Distributed Audio Visual
      Content Terminal), University Reseach Grant, Total funding $269,545.00
SELECTED PUBLICATIONS ((Books: 1; Book Chapters: 7; Journal Papers: 12;
Conference Papers: 42)
   1. A Laud, S S Bhowmick, P Cruz, D T Singh, G Rajesh, **"**The gRNA: A Highly
       Programmable Infrastructure for Prototyping, Developing and Deploying Genomics-
       Centric Applications,**"**, Proceedings of the VLDB, Hong Kong, 2002.
   2. S S. Bhowmick, Ng Wee-Keong, S K. Madria, **"**Detecting and Representing Relevant
       Web," Deltas in WHOWEDA. IEEE TKDE, 15(2), March – April, 2003
   3. S S. Bhowmick, Ng Wee-Keong, S K. Madria., **"**Constraint-driven Join Processing in a
       Web Warehouse," Data and Knowledge Engineering (DKE), 45(1), Elsevier Science,
       2003
   4. S S Bhowmick, V Vedagiri, A Laud, **"**HyperThesis: The gRNA Spell on the Curse of
       Bioinformatics Applications Integration," Proceedings of ACM CIKM, New Orleans,
       2003
PARTICIPATION IN THE EDUCATION PROGRAMME
PARTICIPATION IN THE RESEARCH PROGRAMME
 FS-1
 IU-3(CoPI), IU-7(CoPI)

BRESSAN Stéphane
Senior Lecturer
School of Computing, National University of Singapore
Email: steph@nus.edu.sg   **Phone:** 68743543   **Web:** http://www.comp.nus.eud.sg/~steph

EDUCTATION

Ph.D., Computer Science, University of Lille, France, 1988-1992
M.Sc., Computer Science, University of Lille, France, 1987-1988
B.Sc.,   Electrical Engineering, University of Lille, France, 1985-1986
Diplome d'Ingénieur de l'Ecole Universitaire d'Ingénieur de Lille, Lille France,1984-1987

POSITIONS

National University of Singapore, Fellow, Senior Fellow, Senior Lecturer, 1998-date
Massachusetts Institute of Technology, Sloan School, Research Associate, 1996-1998
European Computer-industry Research Center, Researcher, 1990-1996

HONORS/AWARDS

Chairman, Program committee of the 1st, 2nd, and 3rd workshops on Practical Information
Mediation, Brokering and Commerce on the Internet (I'MEDIATE'98, 99, 2000)
Chairman, Program committee of the first, second, third, fourth and fifth International
  workshops and conferences on Information Integration and Web-based Applications &
  Services (iiWAS99, 2000, 2001, 2002, 2003, 2004)
Chairman, Program committee of the first VLDB workshop on Efficiency and Effectiveness
    of XML Tools, and Techniques (EEXTT2002)
Member of the editorial board of the Columbian Review of Computer Science (ISSN
  1657-2831)
Associate Editor of the Journal of Digital Information Management (ISSN 0972-7272)
Associate Editor of Radiomatics - Jou. of Comms Engng (ISSN : 1693-5152)

RESEARCH SUPPORT (CURRENT PROJECTS)

1. IDEA ESPRIT 6333 (ECRC's site leader and work-package manager)
2. (ECRC's site leader and work-package manager)PI, Design and Implementation of a
    Digital Library Infrastructure for Distributed Geospatial Data (2001-2003). Supported
    by A*Star under the I3 NUS ARP 3970628 (140K S$, (co-PI))
3. G-Atlas NUS ARP R-252-000-052-112 (130K S$)
4. SINGA I NUS ARP R-252-000-064-112/107 (33K S$)
5. SINGA II NUS ARP R-252-000-083-112 (56K S$)
6. EBH NUS ARP R-252-000-082-112 (46k S$, (co-PI))

SELECTED PUBLICATIONS (Books/Proceedings: 9; Book Chapters: 2; Journal Papers: 6; Conference and Workshop Papers: 63)

1. Goh, C.H., BRESSAN, S., Madnick, S., and Siegel M., "Context Interchange: New
   Features and Formalisms for the Intelligent Integration of Information". ACM
   Transactions on Information Systems (July 1999)..
2. BRESSAN, S., Goh, C.H., Levina, N., Madnick, S., Shah, A., and Siegel, M., "Context
   Knowledge Representation and Reasoning in the Context Interchange System". Applied
   Intelligence, 13, 2 (2000): 165-180.
3. Nambiar, U., Lacroix, Z., BRESSAN, S., Lee, M.L. and Guang, L.Y., "Contemporary
   Approaches to XML Management: A Comparison". IEEE Internet Computing 6, 4 (1
   July 2002): 43-51.

PARTICIPATION IN THE EDUCATION PROGRAMME
PARTICIPATION IN THE RESEARCH PROGRAMME

FS-2, FS-3

CHANG Kuiyu MIEEE, MACM, MIAPR
Assistant Professor, Division of Information Systems
School of Computer Engineering, Nanyang Technological University
Email: askychang@ntu.edu.sg **Phone:** 6790-4293 **Web:**
http://www.ntu.edu.sg/home/askychang

EDUCATION
 Ph.D., Computer Engineering, University of Texas, Austin, USA, 1995-2000
 M.Sc., Electrical Engineering, University of Hawaii, Manoa, USA, 1992-1994
 B.Sc., Electrical Engineering, National Taiwan University, 1988-1992
POSITIONS
 Nanyang Technological University, Assistant Professor, 2003 – date
 ClearCommerce, Texas, Senior Risk Management Analyst, 2003
 Mosuma, Texas, Chief Technical Officer and Founder, 2002 – 2003
 Interwoven, Texas, Member of Technical Staff, 2000 – 2002
HONORS/AWARDS
 Organizer, 6th International Real-Time Linux Workshop, Singapore, 2004
 Program Committee, 2nd SIAM International Conference on Data Mining, Virginia, 2002
 Best Paper, Motorola Corporate Engineering Council, USA, 1996
RESEARCH SUPPORT (CURRENT PROJECTS)
 1. PI, Knowledge File System (2003). Supported by NTU/SCE. Funding amount: S$5000
SELECTED PUBLICATIONS (Journal Papers: 1; Conference Papers: 9)
 1. 1.Kui-yu CHANG, Joydeep Ghosh, "A Unified Model for Probabilistic Principal
    Surfaces," IEEE Transactions on Pattern Analysis and Machine Intelligence, 23(1):22-
    41, 2001
 2. 2.Kui-yu CHANG, Joydeep Ghosh, "Three-dimensional model-based object
    recognition and pose estimation using probabilistic principal surfaces,"
    SPIE:Applications of Artificial Neural Networks in Image Processing V Proceedings,
    3962:192-203, 2000
 3. 3.Kui-yu CHANG, Joydeep Ghosh, "Probabilistic principal surfaces," International
    Joint Conference on Neural Networks, No.605, 1999
 4. 4.Kui-yu CHANG, Joydeep Ghosh, "Principal curve classifier – a nonlinear approach
    to pattern classification," International Joint Conference on Neural Networks, 695-700,
    1998
PARTICIPATION IN THE EDUCATION PROGRAMME
PARTICIPATION IN THE RESEARCH PROGRAMME
        FS-2, FS-3, IU-5(CoPI)

CHAUDHARI Narendra S., FIETE
Associate Professor, Division of Information Systems
School of Computer Engineering, Nanyang Technological University
Email: asnarendra@ntu.edu.sg **Phone:** 67906185
Web: http://www.ntu.edu.sg/home/asnarendra/

EDUCATION
 Ph.D., Computer Science & Engg, I.I.T. Bombay, India, 1983-1988
 M.Tech. (Computer Science), I.I.T. Bombay, India 1981-1983
 B.Tech. (First Class with Distinction) (Elec. Engg), I.I.T. Bombay, India 1977-1981
POSITIONS
 Nanyang Technological University, Associate Professor, 2001- date
  Freie Universitat, Berlin, Germany, Visiting Academic (Acd. Exchange pgm – DAAD),
  1999
 Southern Cross University, Lismore, NSW, Australia, Visiting Academic, 1997-1998
 Devi Ahilya University, Indore (M.P.) India, Professor of Computer Science, 1990-2001
 Devi Ahilya University, Indore (M.P.) India, Reader, Computer Science, 1989-1990
 I.I.T. Bombay, India, Senior Software Engineer (Computer Engg.), 1988
HONORS/AWARDS
 Fellow, Institute of Electronics and Telecommunication Engineers, India, 2000
 Certificate of Merit for Research in Computer Engineering : Institution of Engineers,
 (India) Calcutta, India, 1995
 Member, Editorial Board, Journal of Indian Academy of Mathematics (India).
 Member, Editorial Board, International Journal of Management and Systems (Delhi, India).
RESEARCH SUPPORT (OLD PROJECTS- Completed)
 1. PI, Optimization Techniques: Interior Point Algorithms and applications. Supported by
    Science and Engg. Research Council (SERC), Ministry of Science and Technology,
    Govt. of India (1991-1994). Funding amount: INR 7,50,000/-.
 2. PI, Computational Learning, Supported by All India Council for Technical Education
    (AICTE), Govt. of India (1999-2001). Funding amount: INR 3,00,000/-.
SELECTED PUBLICATIONS (Books/Proceedings: 2; Book Chapters: 7; Journal Papers:
35; Conference Papers: 41)
 1. Di Wang, and Narendra S. CHAUDHARI, "An approach for construction of Boolean
    neural networks based on geometrical expansion," Neurocomputing, in press.
 2. Di Wang, and Narendra S. CHAUDHARI, "Binary Neural network training algorithms
    based on linear sequential learning," International Journal of Neural Systems, Vol. 13,
    No. 5 (2003) 333-351.
 3. Xiangrui Wang, and Narendra S. CHAUDHARI, "Classification automaton and its
    construction using learning" Proceedings, AI2003: The sixteenth Canadian Conference
    on Artificial Intelligence, Berlin: Springer Verlag, Vol. LNAI 2671, (2003) pp. 515-519.
PARTICIPATION IN THE EDUCATION PROGRAMME
PARTICIPATION IN THE RESEARCH PROGRAMME
 FS-5

GOH Eck-Soong (Angela) FBCS, SmSCS, MACM
Professor & Vice-Dean (Academic)
School of Computer Engineering, Nanyang Technological University
Email: asesgoh@ntu.edu.sg **Phone:** 67904929 **Web:** http://www.ntu.edu.sg/home/asesgoh

EDUCATION

Ph.D., Computation, University of Manchester Institute of Science and Technology, 1976-1979

B.Sc. (M.Sc.), University of Manchester Institute of Science and Technology, 1975-1976

B.Sc. (Honours), University of Manchester Institute of Science and Technology, 1972-1975

POSITIONS

Nanyang Technological University, Senior Lecturer/Associate Professor/Professor, 1991-date

The Centre for Computer Studies, Ngee Ann Polytechnic, Asst. Director, 1984-1991

Deliottes, Haskins & Sells, Singapore, 1980-1984

Nanyang University, Lecturer, 1979-1980

HONORS/AWARDS

Member, Public Sector R&D Projects Review Panel, SERC

Council member, National IT Standards Committee

Member, Advisory Committee, School of InfoComm Technology, Ngee Ann Polytechnic

Editorial Board member, Journal of Web Engineering/Int. Journal of Information Technology

Chairman, Tech. Eval. Subcomm & *Member*, Steering Committee, PlugFest 2002 & Plugfest 2004

Member, International Advisory Panel, IES journal of IT

RESEARCH SUPPORT (CURRENT PROJECTS)

1. Co-PI, Dynamic Integration and Collaboration Using Smart Services
2. Portal for Singapore eLearning Framework with eLearning Competency Centre
3. Co-PI, Advanced Database Technologies for Concurrent Engineering (1997-2001). Supported by Gintic: $1,400,000

SELECTED PUBLICATIONS (Books/Proceedings: 2; Book Chapters: 3; Journal Papers: 39; Conference Papers: 60)

1. C.Y. Miao, A. GOH, Y. Miao and Z.H. Yang, "Agent that Models, Reasons and Makes Decisions". Knowledge-Based Systems, Vol.15, No.3, 2002, pp.203-211.
2. S. Liu S. and A. GOH, "A Formal Framework to Support Workflow Adaptation", International Journal of Software Engineering & Knowledge Engineering, Vol.12, No.3, 2002, pp.245-267.
3. A. GOH, Y.K Koh. and D.Dragan, "ECA Rule Based Support for Workflows", Artificial Intelligence in Engineering, Vol.15, No.1, 2001, pp.37-46.
4. G.S. Chinchwadkar and A. GOH, "Vertical partitioning in object oriented databases", The Computer Journal, Vol.42, No.1, 1999, pp.39-50.

PARTICIPATION IN THE EDUCATION PROGRAMME

CPE403

RESEARCH PROGRAMME

FS-5, FS-6(CoPI)

IU-1 (PI)

HUNG Gih Guang, Terence Ph.D.
Programme Manager, Software & Computing
Institute of High Performance Computing
Email: terence@ihpc.a-star.edu.sg   **Phone:** 64191232

EDUCATION

Ph.D., Electrical Engineering, University of Illinois at Urbana-Champaign, Illinois, USA, 1991-1993

M.S., Electrical Engineering, University of Illinois at Urbana-Champaign, Illinois, USA, 1998-1991

B.Sc. (Highest Honours), University of Illinois at Urbana-Champaign, Illinois, USA, 1985-1988

POSITIONS

Institute of High Performance Computing, Programme Manager, 2003-date

Commerce Exchange Pte Ltd, VP Technology, 2000-2003

Institute of High Performance Computing, Division Manager, 1994-2000

HONORS/AWARDS

National Grid Project – Middleware and Applications Sub-committee member, 2003

International Advisory Panel member, Commerce Exchange Pte Ltd, 2003

Program Committee member, HPC Asia 2004

Technical Program Committee member, Int'l Conference on Scientific and Engineering Computation 2004

Organizing committee for Physical Science Grid Symposium (Singapore), April 2003

RESEARCH SUPPORT (CURRENT PROJECTS)

1. IHPC-PI, Development of e-engineering infrastructure using Grid technologies for efficient management and secured access of HPC resources. Research collaboration with NTU School of Computer Engineering.
2. IHPC-PI, Grid-enabled Computational Electromagnetic. Supported by British Aerospace for PDRF. Funding amount: £20,000.
3. IHPC-PI, Grid-based engineering simulation and visualization for turbine engines. Research collaboration with Rolls Royce.

SELECTED PUBLICATIONS (Journal Papers: 3; Conference Papers: 7)

1. Yeo, BK, HUNG, T, Khoo, B, "Agent-based Grid Flow Management Framework in Problem Solving Environment (PSE)", GlobusWorld 2004, Jan 20-23 2004, San Francisco, USA.

2. Qian L, HUNG T, "Parallel SVM for Large Dataset Mining", Data Mining 2003, Rio de Janeiro, Brazil, 1 – 3 Dec 2003.

3. Kamalesh V., Kuralmani V., Goh L.P., Qian L., Fu XJ, and HUNG G.G., "Statistical Modelling of SARS Epidemic Propagation via Branching Processes", Mathematics and Statistics of SARS, 4 June 2003, National University of Singapore, 4th June 2003.

4. "G.-G. HUNG, Y.-C. Wen, K. Gallivan, and R. Saleh, *Improving the Performance of Parallel Relaxation-based Circuit Simulators*, IEEE Trans. on CAD and Syst., Vol. 12, No. 11, Nov. 1993, pp. 1762-1774.

PARTICIPATION IN THE EDUCATION PROGRAMME

PARTICIPATION IN THE RESEARCH PROGRAMME

FS-4

LEE Eng Wah
Senior Scientist
Singapore Institute of Manufacturing Technology
Email: ewlee@simtech.a-star.edu.sg   **Phone:** 67938349

EDUCATION
 Ph.D., Mechanics of Materials, University of Strathclyde, UK, 1989
 B.Sc. (1st Class Hons), Mechanical Engineering, University of Strathclyde, 1982
POSITIONS
 Singapore Institute of Manufacturing Technology / Teaching Associate, Research Fellow,
 Senior Research Fellow, Group Manager, Senior Scientist 1990- date
 Defence Science Organisation, Singapore / Defence Engineer, 1989-1990
HONORS/AWARDS
 Program Committee Member, iiWAS2004
 Co-chair, Organisation for Advancement of Structured Information Systems (OASIS, USA)
 Technical Committee, FWSI (Framework for Web Services Implementation), 2003-2005
 Reviewer, XSYM2003
 Chairman, Information Exchange Technical Committee, of IT Standards Committee,
 Singapore, 1999-2004
RESEARCH SUPPORT (CURRENT PROJECTS)
 1.Manager, Java Smart Services Lab (JSSL) – Web Service Initiative for Industry. (April
    2002-March 2004). Sponsored by SIMTech, IDA, Sun Microsystems, BEA, Oracle,
    Software AG, Borland, ILOG, BlueBoot, Netrust, IBM-Rational. Funding amount :
    S$2.51M and approx. S$1.3 M contribution in kind)
 2. PI, QuickMold – Advanced Research and Development Project for Plastic Injection
    Mould Design based on 3 Dimensional, Computer aided Design and Object-oriented
    Software Technologies. (1996-1999), Funding amount : S$1 M.
 3. Investigator, MATIC Programme – Manufacturing Advancement Through International
         Collaboration. (Japan, Korea, Indonesia, Malaysia, Thailand and Singapore, 1994-
    1998). Local Industry Partnership : Aiwa Singapore .   Funding amount (from Aiwa
    S$200K)
SELECTED PUBLICATIONS
 1.EW LEE, "Information Exchange – XML Integration Platform for SCM"
    XMLAsia2003, Sep 2003
 2.EW LEE, "XIP for SME Businesses", Synthesis Journal 2002, pp.23-32, 2002
 3.Wang Jia Ye, LEE Eng Wah, Boey Seng Heng, "Optimal Expected Time Algorithm for
    Finding Largest Empty Circle and its Application of PCM Stamping Mold Design,
    ICCIM' 97, Oct 21-24, 1997
 4.Ong Nan Shing, Chua Chee Kai & LEE Eng Wah, "Geometry analysis of Parts from a 3-
    D Solid model for Manual Assembly Times", Integrated Manufacturing Systems – The
    International Journal of Manufacturing Technology Management, UK, Vol.8, No.3,
    pp137-147, 1997
PARTICIPATION IN THE EDUCATION PROGRAMME
PARTICIPATION IN THE RESEARCH PROGRAMME
 FS-1, IU-1

LEE Bu Sung MIEEE, MIEE
Vice-Dean (Research) & Associate Professor, Division of Computer Communication
School of Computer Engineering, Nanyang Technological University
Email: ebslee@ntu.edu.sg **Phone:** 67905371

EDUCATION
Ph.D., Electronic & Electrical Engineering, Loughborough University of Technology, 1982 - 1987
B.Sc (Honours), Loughborough University of Technology, 1978-1982

POSITIONS
Nanyang Technological University, Vice-Dean (Research), 2003-date
Nanyang Technological University, Head of Division, 2002-2003
Nanyang Technological University, Associate Professor, Since 1999
Network Technology Research Center/NTU, Deputy Director, 1994-2002

HONORS/AWARDS
President, Singapore Advance Research and Education Network Society, 2003
Director, Asia Pacific Advance Network: Technology, 2001- 2003
Chairman, National Gird Network Working Group, 2001-
Chairman, Nanyang Campus Grid, 2001-

RESEARCH SUPPORT (CURRENT PROJECTS)
1. SingAREN project 2001-2003 : $18 million. 2001-2003
2. International Videoconference Network. SingAREN/A*STAR Broadband project. 2001-2003
3. Multicast Qos. SingAREN/A*STAR Broadband project.2001-2003
4. Seamless Communication. Joint I2R-School of computer Engineering, NTU. Awaiting approval from SERC.

SELECTED PUBLICATIONS (Book Chapters: 3; Journal Papers: 51; Conference Papers: 110)
1. TM Lim, BS LEE and CK Yeo,"Path and Oracle Discovery protocol for centralized Bandwidth reservation Mechanism", Journal of Network and System Management. 2003
2. BC Seet, BS LEE, and CT Lau, " On Optimisating Route Discovery of Topology-based On-Demand Routing protocols for Ad Hoc networks", Journal of Communications and Network, Sept'2003
3. KJ Wong, BS LEE, BC Seet,"BUSNET: Model and Usage of regular traffic patterns in Mobile Ad Hoc networks for inter-vehicular communications", International Conference on Information and Communication Technology.
4. BS LEE, CK Yeo, J Song, and SM Poon," RQRP protocol for video delivery over IP", International Journal of Communication Systems, 2001

PARTICIPATION IN THE EDUCATION PROGRAMME
PARTICIPATION IN THE RESEARCH PROGRAMM

FS-4

LEE Mong Li
Assistant Professor
School of Computing, National University of Singapore
Email: leeml@comp.nus.edu.sg **Phone:** 67794580**Web:** http://www.comp.nus.edu.sg/~leeml

EDUCATION
  Ph.D., Computer Science, National University of Singapore, 1999
  MSc., Computer Science, National University of Singapore, 1992,
  B.Sc. (Honours), Computer Science, National University of Singapore, 1985-1989

POSITIONS
  National University of Singapore, Assistant Professor , 2001-date
  QUIQ Incorporated, USA, Consultant, 1999-2000
  University of Wisconsin-Madison, Visiting Faculty, 1999-2000
  National University of Singapore, Senior Tutor/Fellow, 1989-2000

HONORS/AWARDS
  Program Committee member, International Conference on VLDB(2002-2004)
  Program Committee member, International Conference on Database Systems for Advanced
   Applications (2003, 2004, 2006)
  Program Committee member, International Conference on Conceptual Modelling, (1998,
   1999, 2001, 2003, 2004)
  Editor (with S. Bressan, A.B. Chaudhri, J. Yu and Z. Lacroix), Proceedings of VLDB 2002
    Workshop EEXTT and CAiSE 2002 Workshop DIWeb, LNCS #2590, Springer-Verlag,
    Berlin-Heidelberg-New York, 2003
  Editor (with T.W. Ling and S. Ram), Conceptual Modeling - Proceedings of the 17th
  International Conference on Conceptual Modeling. LNCS Science #1507, Springer-Verlag,
  Berlin-Heidelbert-New York, 1998.

RESEARCH SUPPORT (CURRENT PROJECTS)
  1. PI, Medical Image Analysis and Visualization (July 2003 - June 2006)
     InfoComm & InfoTech Initiative (ICITI), Funding amount: S$142,000
  2. PI, RETINA, a RETinal INformation Analysis system (May2001-April 2004)
      NUS-A*STAR Grant ,Funding amount: $600,000
  3. PI, EBH: Inventing the Next Generation Business Hub (Dec 2000-Sept 2002)
      NUS Academic Research Fund, Funding amount: S$46,000

SELECTED PUBLICATIONS
  1. Xiaodong Wu, Mong Li LEE, Wynne Hsu. A Prime Number Labeling Scheme for
      Dynamic Ordered XML. Trees, in 20th International Conference on Data Engineering
      (ICDE), Boston, USA, 2004.
  2. Mong Li LEE, Wynne Hsu, Christian S. Jensen, Bin Cui, Keng Lik Teo. Supporting
      Frequent Updates in R- Trees: A Bottom-Up Approach, 29th International Conference
      on Very Large Databases, Berlin, Germany, 2003.
  3. Mong Li LEE, Masaru Kitsuregawa, Beng Chin Ooi, Kian-Lee Tan and Anirban
      Mondal. Towards Self-Tuning Data Placement in Parallel Database Systems**,** in
      Proceedings of ACM SIGMOD, Dallas, Texas, 2000
  4. Venkatesh Ganti, Mong Li LEE and Raghu Ramakrishnan. ICICLES: : Self-
      tuningSamples for Approximate Query Answering, in Proceedings of the 26th Int.
      Conference on VLDB Cairo, Eygpt, 2000

PARTICIPATION IN THE EDUCATION PROGRAMME
  CS5238

PARTICIPATION IN THE RESEARCH PROGRAMME
  FS-2; IU-6

LEONG Mun Kew
Manager, Media Semantics Department
Institute for Infocomm Research
Email: mkleong@i2r.a-star.edu.sg   **Phone:** 68747864   **Web:** n/a

EDUCATION

Ph.D., Philosophy & Symbolic Systems, Stanford University, Stanford, USA, 1989-1994

B.Sc. (with High Distinction), (a) Cognitive Science & Aritificial Intelligence (b) Computer Science, University of Toronto, 1983-1987

POSITIONS

Institute for Infocomm Research (and previous incarnations), Researcher, 1987- date

Vice-President and Chief Technology Officer, BIGontheNet Pte Ltd., 1999-2001, (secondment)

Stanford University, Teaching Assistant, 1990-1991

HONORS/AWARDS

Editorial board, International Journal of Information Processing & Management

Steering Committee member, The IRAL Workshops

Steering Committee member, Asian Information Retrieval Symposium

Program Co-Chair, ACM SIGIR 2000, Athens, Greece

Program Chair & Organizing Chair, 3rd International IRAL Workshop, 1998

Organizing Chair/ Co-Chair/Committee member, various conferences, workshops, etc.

RESEARCH SUPPORT (CURRENT PROJECTS)

Not Applicable. I^{2}R is a research institute and a large number of the research projects are co-funded by government grants or industry contributions.

SELECTED PUBLICATIONS (Invited Keynotes: 1, Invited Talks/Papers: 12, Books/Proceedings: 5; Book Chapters: 1; Journal Papers: 5; Conference Papers: 12, Patents: 3 filed)

1. Mun-Kew LEONG, "Are We Still Far Away from Talking about Media Semantics", Keynote Address, International Workshop on Advanced Imaging Technologies, 2004, Singapore.
2. Mun-Kew LEONG, "Conversational Design as a Paradigm for User Interaction on Mobile Devices", Lecture Notes in Computer Science: Vol 2954 Mobile and Ubiquitous Information Access, Springer-Verlag, 2004.
3. Mun-Kew LEONG, "Reach and Focus in the Evaluation of Search Sources for Business Intelligence", OnlineWorld, 2000.
4. Mun-Kew LEONG, "Multilingual Normalisation as an Alternative Paradigm for Answering Soft Questions", Proceedings of the SIGIR 1999 Workshop on Multilingual Information Discovery Access (MIDAS), 1999.

PARTICIPATION IN THE EDUCATION PROGRAMME

Not applicable.

PARTICIPATION IN THE RESEARCH PROGRAMME

FS-3

IU-6, IU-7

LIM Ee Peng SMIEEE, MACM
Head & Associate Professor, Division of Information Systems
School of Computer Engineering, Nanyang Technological University
Email: aseplim@ntu.edu.sg   **Phone:** 67904802   **Web:** http://www.cais.ntu.edu.sg/~aseplim

EDUCATION
 Ph.D., Computer Science, University of Minnesota, Minneapolis, USA, 1989-1994
 B.Sc. (Honours), Computer Science, National University of Singapore, 1985-1989
POSITIONS
 Nanyang Technological University, Assistant/Associate Professor, 1994- date
 Chinese University of Hong Kong, Visiting Associate Professor, 2002-2003
 University of Minnesota, Research/Teaching Assistant, 1989-1994
HONORS/AWARDS
 Associate Editor, ACM Transactions on Information Systems (TOIS)
 Associate Editor, Int'l Journal on Data Warehousing & Mining (IJDWM), Idea Grp
 Editorial Review Board, Database Management Journal (JDM), Idea Group
 Program Co-Chair, ACM/IEEE Joint Conf. on Digital Libraries, Tucson Arizona, USA
 2004
 Conference Co-Chair, Int'l Conf. on Asian Digital Libraries, Shanghai, China 2004
 Co-Chair, ACM Workshop on Web Information & Data Mgt., New Orleans, 2003
RESEARCH SUPPORT (CURRENT PROJECTS)
  1. PI, G-Portal: An Implementation of a Web Portal for Searching and Enquiring
      Geography Metadata (2004). Supported by Ministry of Education. Funding amount:
      $50,000
  2. PI, Design and Implementation of a Digital Library Infrastructure for Distributed
      Geospatial Data (2001-2003). Supported by A*Star under the SingAREN21 initiative.
      Funding amount: $315,000
  3. Co-PI, Design and Implementation of a Data Warehousing System for Web Information.
      (1997-2000). Supported by AcRF. Funding amount: $240,000
SELECTED PUBLICATIONS (Books/Proceedings: 7; Book Chapters: 7; Journal Papers:
34; Conference Papers: 103)
  1. Aixin Sun, Ee Peng LIM, Wee-Keong Ng, Jaideep Srivastava, "Blocking Reduction
      Strategies in Hierarchical Text Classification," IEEE Transactions on Knowledge and
      Data Engineering (TKDE), in press.
  2. David Woon, Wee-Keong Ng, Ee Peng LIM, "A Support-Ordered Trie for Fast Frequent
      Itemset Discovery," IEEE Transactions on Knowledge and Data Engineering (TKDE),
      in press.
  3. Cecil Chua, Roger Chiang, Ee Peng LIM, "Instance based Attribute Identification in
      Database Integration," Very Large Database (VLDB) Journal, in press.
  4. Ee Peng LIM, Chiang Roger, Cao Yinyan, "Tuple Source Relational Model: A Source-
      Aware Data Model for Multidatabases", Knowledge & Data Engineering Journal
      (KDE), North Holland, 29(1):83-114, 1998.
PARTICIPATION IN THE EDUCATION PROGRAMME
CPE403
PARTICIPATION IN THE RESEARCH PROGRAMME
 FS-1, FS-2, FS-6
 IU-4(PI), IU-7

LING Tok Wang, MIEEE, MACM, MSCS
Professor, Department of Compute Science
School of Computing, National University of Singapore
Email: lingtw@comp.nus.edu.sg **Phone:** 6874 2734
Web: http://www.comp.nus.edu.sg/~lingtw

EDUCATION
   Ph.D., Computer Science, University of Waterloo, Canada, 1973-1978
   M.Math., Computer Science, University of Waterloo, Canada, 1972-1973
   B.Sc. (Honours), Mathematics, Nanyang University, Singapore, 1967-1971

POSITIONS
   National University of Singapore, Associate Professor/Professor, 1979 - date
   Bell Northern Research, Canada, Scientific Staff, 1978-1979

HONORS/AWARDS
   Member of Board of Editors of the following 5 journals:
   J. Data & Knowledge Engineering; Int. J. of Cooperative Information Systems, J. of DB
   Management, J. of Data Semantics; World Wide Web: Internet and Web Info. Systems.
   Steering Committee Chair of the Int. Conf. on Database Systems for Advanced applications
   SC Vice Chair of the International Human.Society@Internet Conference.
   Former *SC Chair* and currently *member* of the Int. Conf. on Conceptual Modeling (ER)
   Former *SC Member* of the Int. Conf. on Deductive and Object Oriented Databases (DOOD)
   Conference Chair/Co-chair of the following 4 conferences: 1st
   Int.Human.Society@Internet Conference, 2001, Seoul, Korea; 2nd Int. Human.Society
   @Internet Conference, 2003, Seoul, Korea; 5th Int. Conf. on Web-Age Information
   Management, 2004, China; 23rd Int. Conf. on Conceptual Modeling (ER'2004), China.
   PC Co-chair of the following conferences (limited to recent conferences):
   3rd Int. Conf. On Web Information Systems Engineering (ISE2002), Singapore, 2002;
   22nd Int. Conference on Conceptual Modeling (ER'2003), Chicago, Illinois, USA.
   PC members of over 110 international database conferences since 1985, including VLDB,
   EDBT, ER, DASFAA, etc.

RESEARCH SUPPORT (CURRENT PROJECTS)
   1. PI, Integrating Data Warehouses on the Web (2004) Funding amount: $ 127,200.
   2. PI, Building a semi-structured data repository (2005) Funding amount: $90,600.

SELECTED PUBLICATIONS (Books/Proceedings: 7; Book Chapters: 8; Journal Papers:
25; Conference Papers: 109)
   1. Ya Bing Chen, Tok Wang LING, Mong-Li Lee: Automatic Generation of XQuery
      View Definitions from ORA-SS Views. ER 2003: 158-171
   2. Mengchi Liu, Gillian Dobbie, Tok Wang LING: A logical foundation for deductive
      object-oriented databases. ACM Trans. Database Syst. 27(1): 117-151 (2002)
   3. Mong-Li Lee, Tok Wang LING, Wai Lup Low: Designing Functional Dependencies
      for XML. EDBT 2002: 124-141
   4. Sin Yeung Lee, Tok Wang LING, Hua-Gang Li: Hierarchical Compact Cube for
      Range-Max Queries. VLDB 2000: 232-241

PARTICIPATION IN THE EDUCATION PROGRAMME
 CS5223

PARTICIPATION IN THE RESEARCH PROGRAMME
 FS-1, FS-2, IU-7

MIAO Chun Yan MIEEE
Assistant Professor, Division of Information Systems
School of Computer Engineering (SCE), Nanyang Technological University (NTU)
Email: ascymiao@ntu.edu.sg **Phone:** 67906197
Web: http://www.ntu.edu.sg/home/ascymiao

EDUCATION
 Ph.D., Computer Engineering, Nanyang Technological University, Singapore, 1999-2003
 M.Eng., Computer Engineering, Nanyang Technological University, Singapore, 1996-1998
 B.Sc., Computer Science, Shandong University, China, 1984-1988

POSITIONS
 Nanyang Technological University, Singapore, Assistant Professor, 2003- date
 Simon Fraser University, Canada, Instructor/Visiting Researcher, 2001-Jan. 2003
 Singapore Institute of Manufacturing Technology, Associate Research Fellow, 1998-2001
 Nanyang Technological University, Singapore, Research Associate, 1996-1997
 Singapore Network Services, Software Engineer, 1993-1995

HONOURS/AWARDS

RESEARCH SUPPORT (CURRENT PROJECTS)
1. PI, Negotiation in Agent Mediated Gird, SCE/NTU, Singapore. (2003-date). Start
     Up Grant. Funding amount : $16,000
2. Co-PI, Modeling Semantics on the Web, Simon Fraser University, Canada, NSERC grant,
    (2001-2003). Funding amount: $108,000.00
3. Co-PI, Fuzzy Cognitive Agents for Personalized ECommerce Recommendation, Simon
     Fraser University, NSERC & IRIS grant, Canada, (2001-2002). Funding amount:
     $180,000

SELECTED PUBLICATIONS
1. C.Y.MIAO, Z.Q.Liu, Y.Miao and A.Goh, "Dynamic Cognitive Multi-Agent Architecture
    for Large Decision Support Systems", To appear in International Journal of Fuzzy
    Systems.
2. C.Y.MIAO, A.Goh, Y.Miao and Z.H.Yang, "Agent that Models, Reasons and Makes
    Decisions", Knowledge Based Systems, Vol. 15, Issue 3, 2002.
3. C.Y.MIAO, A.Goh and Y. Miao, "A Multi-Agent Framework for Collaborative
    Reasoning", Intelligent Systems: Technology and Applications, CRC Press, 2002.
4. Z.H.Yang, R.Gay and C.Y.MIAO, "Architecting Multi-Agent System, A Middleware
    Perspective", Intelligent Systems: Technology and Applications, CRC Press, 2002.

PARTICIPATION IN THE EDUCATION PROGRAMME
CPE429

PARTICIPATION IN THE RESEARCH PROGRAMME
 FS-5

NG Wee Keong MIEEECS, MACM

Director & Associate Professor, Division of Information Systems

School of Computer Engineering, Nanyang Technological University

Email: awkng@ntu.edu.sg   **Phone:** 67906929   **Web:** http://www.ntu.edu.sg/home/awkng

EDUCATION

Ph.D., Computer Science and Engineering, University of Michigan, USA, 1990-1996

B.Sc. (Honours), Computer Science, National University of Singapore, 1986-1990

POSITIONS

Nanyang Technological University, Assistant/Associate Professor, 1996-date

University of Michigan, Research/Teaching Assistant, 1990-1996

HONORS/AWARDS

Editorial Review Board, Database Management Journal (JDM), Idea Group

Publicity Chair, Int'l Conf. on Web Information Systems and Engineering, 2002

Organizer, Int'l Workshop on Web Knowledge Discovery and Data Mining, Kyoto, Japan, 2000.

RESEARCH SUPPORT (CURRENT PROJECTS)

1. PI, Design and Implementation of a Digital Library Infrastructure for Distributed Geospatial Data (2001-2003). Supported by A*Star under the SingAREN21 initiative. Funding amount: $315,000

2. IT Framework for the Management of Innovative Financial Instruments and Processes for A Knowledge-Based Economy, Co-investigator, Academic Research Fund, Nanyang Technological University, June 1999-June 2002.

3. Co-PI, Design and Implementation of a Data Warehousing System for Web Information. (1997-2000). Supported by AcRF. Funding amount: $240,000

SELECTED PUBLICATIONS (Books/Proceedings: 3; Book Chapters: 6; Journal Papers: 25; Conference Papers: 90)

1. Aixin Sun, Ee Peng Lim, Wee-Keong NG, Jaideep Srivastava, "Blocking Reduction Strategies in Hierarchical Text Classification," IEEE Transactions on Knowledge and Data Engineering (TKDE), in press.

2. David Woon, Wee-Keong NG, Ee Peng Lim, "A Support-Ordered Trie for Fast Frequent Itemset Discovery," IEEE Transactions on Knowledge and Data Engineering (TKDE), in press.

3. Detecting and Representing Relevant Web Deltas in WHOWEDA, by S. S. Bhowmick, S. K. Madria, W. K. NG. IEEE Transactions on Knowledge and Data Engineering, 2002.

4. Product Schema Integration for Electronic Commerce: A Synonym Comparison Approach, by G. Yan, W.-K. NG, E.-P. Lim. IEEE Transactions on Knowledge and Data Engineering, 2001.

PARTICIPATION IN THE EDUCATION PROGRAMME

H6404

PARTICIPATION IN THE RESEARCH PROGRAMME

FS-1(PI)

IU-2 (PI), IU-6

ONG Yew Soon MIEEE
Assistant Professor, Division of Information Systems
School of Computer Engineering, Nanyang Technological University
Email: asyong@ntu.edu.sg **Phone:** 67906448 **Web:** http://www.ntu.edu.sg/home/asysong

EDUCATION

  Ph.D., School of Engineering Science, University of Southampton, UK, 2000-2002
  M.Eng., Electrical and Electronics Engineering, Nanyang Technological University, 1998-
  1999
  B.Eng.(Honours), Electrical & Electronics Eng., Nanyang Technological University, 1996-
  1998

POSITIONS

  Nanyang Technological University, Assistant Professor, 2002-date
  Systems and Computer Organisation, DSTA, Singapore, Software Engineer, 1999-2000
  General Motors, Engineering Assistant, Singapore, 1995-1996

HONORS/AWARDS

  Program Committee, Int'l Conf. on Scientific and Engineering Computation, Singapore,
  2004
  Session Chair, Int'l Conf. on Control, Automation, Robotics and Vision, Kunming,
  China, 2004
  Session Co-Chair, Int'l Conf. on Comp. Intell., Robotics and Autonomous Sys., Singapore
  2003
  Outbound Attachment Award, A*STAR, 2003-2004
  Uni. Tech. Partnership Scholarship, EPSRC, BAE & Rolls-Royce, UK, 2000-2002
  National Science and Technology Board PTI Scheme Award, Singapore, 1998
  Philip's Cash Prize for Outstanding Academic Performance, Singapore, 1992

RESEARCH SUPPORT (CURRENT PROJECTS)

  1. PI, Stochastic Optimization of Computationally Expensive Problems (2003-2004), SCE
     Startup Grant. Funding amount : $12,500
  2. PI, Optimization and Machine Learning: A marriage towards intelligent search algorithms
     for real world applications (2003-2005), Singapore Technology, Funding amount: $51,000
  3. Co-PI, An Integrated Software Environment for Algorithms Development – A Platform for
     Problem Solving and Engineering Design Optimization (2003-2005), Singapore Technology,
     Funding amount: $259,000

SELECTED PUBLICATIONS (Book Chapters: 2; Journal Papers: 5; Conference Papers:
18)

  1. Y. S. ONG and A.J. Keane, "Meta-Lamarckian in Memetic Algorithm", IEEE Transactions
     On Evolutionary Computation, 2004, in press.
  2. Y. S. ONG, P.B. Nair and A.J. Keane, "Evolutionary Optimization of Computationally
     Expensive Problems via Surrogate Modeling", American Institute of Aeronautics and
     Astronautics Journal, 2003, 40(4), pp. 687-696.
  3. Y. S. ONG and A.J. Keane, "A domain knowledge based search advisor for design problem
     solving environments", Engineering Applications of Artificial Intelligence, 2002, Vol. 15,
     No. 1, pp. 105-116.
  4. Y. S. ONG, A.J. Keane and P.B. Nair, "Surrogate-Assisted Coevolutionary Search", 9th
     International Conference on Neural Information Processing, Special Issue on Trends in
     Global Optimization, 2002.

PARTICIPATION IN THE EDUCATION PROGRAMME
PARTICIPATION IN THE RESEARCH PROGRAMME

  FS-5

OOI Beng Chin
Professor & Vice Dean (Academic Affairs & Graduate Studies)
School of Computing National University of Singapore
Email: ooibc@comp,nus.edu.sg **Phone:** 68744860
Web: http://www.comp.nus.edu.sg/~ooibc

EDUCATION
  Ph.D., Computer Science, Monash University of Melbourne, Australia, 1989
  B.Sc. (1 st Class Honours), Monash University of Melburne, Australia, 1985

POSITIONS
  National University of Singapore, Professor & Vice Dean (Academic Affairs
  And Graduate Studies

HONORS/AWARDS
  PC Member, SIGMOD'94,03 VLDB'95-97,99-02, ICDE'02,04,05, EDBT'98,02,04,
    DASFAA'93-04, ACM-GIS'98-01, SSD'93-99
  Vice PC Chair, ICDE'00,04
  PC chair, SSD'93
  Workshop Chair, FEGIS'93
  Conference Chair, MDM'02
  Editor, GeoInformatica Journal of GIS, ACM SIGMOD Disc, VLDB Journal & IEEE
    Transactions on Knowledge and Data Engineering

RESEARCH PROJECTS
  1. Grant reviewer for Research Grants Council (RGC) of Hong Kong, Australian Research
     Grants
  2. Council, Canadian Natural Sciences and Engineering Research Council (NSERC),
     Norwegian
  3. Research Council, Singapore Economic Development Board (EDB) and Agency for
     Science
  4. and Technology Research (A*STAR's SERC).

SELECTED PUBLICATIONS (Journal Papers & Conference Papers: 80)
  1. B. Cui, B. C. OOI, J. Su, K.L. Tan: Contorting High Dimensional Data for Efficient
      Main Memory Processing. ACM SIGMOD Int'l. Conference on Management of Data
      (SIGMOD), San Diego, 2003.
  2. P. Kalnis, W.S. Ng, B. C. OOI, D. Papadias and K.L. Tan: An Adaptive Peer-to-Peer
      Network for Distributed Caching of OLAP Results. ACM SIGMOD Int'l. Conference
      on Management of Data (SIGMOD), Wisconsin, 2002**.**
  3. C. Yu, B.C. OOI, K.L. Tan and H.V. Jagadish: Indexing the Distance: An Efficient
      Method to KNN Processing. Int'l Conference on Very Large Data Bases (VLDB),
      Roma, Italy, 421-430, September 2001.
  4. H.V. Jagadish, H. Jin, B. C. OOI and K.L. Tan: Global Optimization of Histograms.
      ACM SIGMOD Int'l. Conference on Management of Data (SIGMOD), Santa Barbara,
      California, May (2001)

PARTICIPATION IN THE EDUCATION PROGRAMME
  CS5223

PARTICIPATION IN THE RESEARCH PROGRAMME
  FS-1
  IU-6(CoPI)

PANG Hwee Hwa
Division Director, Services and Applications Division
Institute for Infocomm Research
Email: hhpang@i2r.a-star.edu.sg **Phone:** 668747859 **Web:** http://dataquality.i2r.a-star.edu.sg/hhpang

EDUCATION
 Ph.D. in Computer Science, University of Wisconsin-Madison, USA, 1990-1994
 M.Sc. in Computer Science, National University of Singapore, 1989-1991
 B.Sc. (1st Class Honors) in Computer and Information Sciences, National University of
 Singapore, 1985-1989

POSITIONS
 Adjunct Associate Professor, School of Computing, National University of Singapore,
 2003-date
 Faculty Member, NUS Graduate School for Integrative Science and Engineering, from 2003
 Adjunct Scientist, BioInformatics Center, National University of Singapore, 1996-1997

HONORS/AWARDS

RESEARCH SUPPORT
 1. Principal Investigator, Mobile Client Grant from the Singapore National Science and
    Technology Board; value: S$2.8 million, duration: 1997 to 2000

SELECTED PUBLICATIONS (Journal Papers: 5; Conference Papers: 14; Patents: 3)
 1. HweeHwa PANG, Kian-Lee Tan, Xuan Zhou, "Steganographic Schemes for File
    System and B-Tree", IEEE Transactions on Knowledge and Data Engineering, accepted
    for publication, 2004.
 2. Y.C. Tay, HweeHwa PANG, "Load Sharing in Distributed Multimedia-on-Demand
    Systems", IEEE Transactions on Knowledge and Data Engineering, Volume 12,
    Number 3, May 2000, 410-428.
 3. HweeHwa PANG, Michael J. Carey, Miron Livny, "Partially Preemptible Hash Joins",
    Proceedings of the ACM SIGMOD International Conference on Management of Data,
    Washington D.C., May 1993, 59-68.

PARTICIPATION IN THE EDUCATION PROGRAMME

PARTICIPATION IN THE RESEARCH PROGRAMME
 FS-2
 IU-6, IU-7

SEE Chong-Wee Simon MIEEE,MIEE, MSCS, SIAM
Associate Professor (Adjunct), Nanyang Supercomputing and Visualisation Center
Nanyang Technological University
Email:simon.see@sun.com. Phone: 62397886. Web: http://apstc.sun.com.sg

EDUCATION
  Ph.D., Electrical Engineering and Applied Mathematics, University of Salford,
  Manchester, England, 1989-1993
  M.Sc, EE and Control Engineering, U. of Salford, 1986-1987

POSITIONS
  Nanyang Technological University, Associate Professor, 1994-date
  National University of Singpapore, Adjuct Research Fellow, 1998
  Sun Microsystems Inc., Technology Director, 2001-2004
  Silicon Graphics Inc., Manager/Center Director, 1996-2001
  DSO National Lab, Senior Research Engineer, 1993-1996
  International simulation Ltd (UK), Research Assistant, 1991-1993
  DSO National Lab, Research Engineer, 1988-1991
  IBM, software engineer, 1987-1988

HONORS/AWARDS
  2002 Sun Microsystems Inc SunRise
  2001 SGI- Spirit Award
  2000   SGI- Asia South local Spirit Award
  1999   SGI Asia South local Excellence Group Award
  1999   SGI Industry Marketing Breakthrough Award
  1998   SGI –Spirit Award
  1991   DSO National Lab- Individual Excellence Award
  1991   University of Salford - Graduate Scholarship
  Program Co-Chair, PDCAT, Tucson Arizona, Singapore 2004

RESEARCH SUPPORT (CURRENT PROJECTS)
  1. PI, GridE. Supported by EDB.
  2. PI, Grid Superscheduler Supported by EDB
  3. PI, BioInformatics Grid, supported by Sun Microsystems Inc.
  4. PI, MCAE and EDA Grid Infrastructure, supported by Sun Microsystems Inc.

SELECTED PUBLICATIONS (Books/Proceedings: 1; Journal/Conference Papers: 40;
technical report 20)

PARTICIPATION IN THE EDUCATION PROGRAMME
PARTICIPATION IN THE RESEARCH PROGRAMME
 FS-4

SEOW Kiam Tian
Assistant Professor, Division of Computing Systems
School of Computer Engineering, Nanyang Technological University
Email: asktseow@ntu.edu.sg   **Phone:** 67904288

EDUCATION
 Ph.D., EE, Nanyang Technological University, Singapore, 1998
 M.Eng, EE, Nanyang Technological University, Singapore, 1993
 B.Eng. (Hons), EE, National University of Singapore, 1990

POSITIONS
 Nanyang Technological University, Assistant Professor, 2003-date
 Korea Advanced Institute of Science and Technology, Korea, Institute Fellow, 2002-2003
 DSO National Labs, Singapore, Member of Technical Staff, 2000-2002
 Nanyang Technological University, Research Fellow, 1998-2000
 Temasek Polytechnic, Singapore, Lecturer, 1996-1997
 Nanyang Technological University, Research Associate , 1996
 Nanyang Technological University, Research/Teaching Assistant, 1990-1995
 Institute of Systems Science, Singapore (now, Institute for Infocomm Research), Software
 Engineer,1990

HONORS/AWARDS
 A*STAR Overseas Attachment Programme (2003), A*STAR, Singapore
 Listed in Marquis Who's Who in Science and Engineering (7th Edition, 2003), USA
 "Brain Korea 21" Institute Fellowship (2002-2003), KAIST, Korea
 Research Fellowship (1998-2000), Nanyang Technological University, Singapore
 Visiting Fellowship (1997-1998), Systems Control Group, University of Toronto, Canada

RESEARCH SUPPORT (CURRENT PROJECTS)
  PI, Coordination Planning for Autonomous Agents, Nanyang Technological University
 Start-Up Grant, $21,000. (Pending, 2004)

SELECTED PUBLICATIONS (Books: 2; Journal Papers: 06; Conference Papers: 16+2)
 1. K.T. SEOW, "Existence Characterizations of Temporal-Safety Supervisors," *IEEE Transactions on Automatic Control*, vol. 47, no. 10, pp. 1779-1783, October 2002, USA.
 2. K.T. SEOW and K.Y. How, "Collaborative Assignment : A Multiagent Negotiation Approach Using BDI Concepts," *Proceedings of the International Conference on Autonomous Agents and Multiagent Systems* (AAMAS'02), 2002, Bologna, Italy.
 3. J.H. Kim, D.H. Kim, Y.J. Kim and K.T. SEOW, *Soccer Robotics*, Springer Verlag, Berlin / Heidelberg. Book accepted for publication in Springer Tracts in Advanced Robotics (STAR Series), 2004.

PARTICIPATION IN THE EDUCATION PROGRAMME
 CSC416
PARTICIPATION IN THE RESEARCH PROGRAMME
 FS-5(PI)

TAN Ah Hwee MIEEE, MACM
Associate Professor, Division of Information Systems
School of Computer Engineering, Nanyang Technological University
Email: asahtan@ntu.edu.sg   **Phone:** 67904326   **Web:** http://www.ntu.edu.sg/home/asahtan

EDUCATION
 Ph.D., Cognitive & Neural Systems, Boston University, USA, 1994
 M.Sc., Computer & Info Science, National University of Singapore, 1991
 B.Sc. (1st Class Hons), Computer & Info Science, National University of Singapore, 1989
POSITIONS
 Nanyang Technological University, Associate Professor, 2003-date
 Institute of Infocomm Research, Research Manager, 2002-2003
 Laboratories for Information Technology, Research Manager, 2002
 Research Staff, Kent Ridge Digital Labs, Senior Member, 1998-2001
 Staff, Institute of Systems Science, Member/Associate/Research Staff, 1994-1997
HONORS/AWARDS
 Optimal Gold Award (2003)
 KRDL High Achiever Award (1999)
 NUS Overseas Graduate Fellowship (1990-1994)
 Tan Kah Kee Young Inventor Award (Silver) (1991)
 Editorial Board Member, Applied Intelligence, Kluwer Publisher (1998-)
 Guest Editor, Special Issue on Text and Web Mining, *Applied Intelligence,* 2003
 Co-chair, International Workshop on Language, Semantics, and Web, Singapore, 2003
 Co-chair, PAKDD'2002 Workshop on Text Mining, Taipei, May 2002
 Co-chair, PRICAI'2000 Workshop on Text and Web Mining, Melbourne, August 2000
RESEARCH SUPPORT (CURRENT PROJECTS)
  1. PI, Cognitive Information Systems (2003). SCE Start Up Grant. Funding amount:
     $14,000
  2. PI, Intelligent Cyber Agents (2001-2003). A*Star Core Research Funding.
  3. PI, Text Mining (1998-2000). A*Star Core Research Funding.
SELECTED PUBLICATIONS (Patents Pending: 6, Books/Proceedings: 3; Book Chapters:
4; Journal Papers: 12; Conference Papers: 30)
  1. Ji He, Ah-Hwee TAN, and Chew-Lim Tan. Self-organizing Networks for Efficient
     Clustering under Constraint. IEEE Transactions on Neural Networks, accepted.
  2. Ah-Hwee TAN, Hwee-Leng Ong, Hong Pan, Jamie Ng, and Qiu-Xiang Li. "Towards
     Personalized Web Intelligence". Knowledge and Information Systems Journal, accepted.
  3. K. Rajaraman and Ah-Hwee TAN. "Mining Semantic Network for Knowledge
     Discovery", IEEE ICDM, Melbourne, USA, pp 633-636, November 19-22, 2003.
  4. Ah-Hwee TAN and Philip S. Yu. Guest Editorial: "Text and Web Mining". Applied
     Intelligence: Special Issue on Text and Web Mining, Vol. 18, No. 3 (May-June 2003)
     239-241.
PARTICIPATION IN THE EDUCATION PROGRAMME
 DM6101
PARTICIPATION IN THE RESEARCH PROGRAMME
 FS-1, FS-3(CoPI)

TAN Chew Lim
Associate Professor
School of Computing, National University of Singapore
Email: tancl@comp.nus.edu.sg **Phone:** 6874-2900
Web: http://www.comp.nus.edu.sg/~tancl

EDUCATION
  Ph.D., Computer Science, University of Virginia, USA, 1982-1986
  M.Sc., Radiation Studies, University of Surrey, UK, 1972-1973
  B.Sc. (Honours), Physics, University of Singapore, 1967-1971

POSITIONS
  National University of Singapore, Associate Professor, 1996-date
  National University of Singapore, Senior Lecturer, 1989-1995
  National University of Singapore, Lecturer, 1986-1988
  National University of Singapore, Senior Tutor, 1982-1986
  Ministry of Health, Scientific Officer/Sr Scientific Officer, 1974-1982

HONORS/AWARDS
  Associate Editor, Pattern Recognition
  Program Committee Member: International Conference on Document Analysis and
  Recognition (ICDAR 2005), International Workshop on Document Image Analysis for
  Libraries (DIAL 2004), Workshop on Document Image Analysis and Retrieval (DIAR
  2003),
  International Workshop on Graphics Recognition (GREC 2003), Web Document Analysis
  Workshop (WDA 2001, 2003), International Conference on Pattern Recognition (ICRP
  2002).

RESEARCH SUPPORT (CURRENT PROJECTS)
  1. PI, Information Extraction for Biology Literature, Joint Research with I2R, supported
     by A*STAR, (2003-2006) Funding amount: $188,920
  2. PI, Document Information Miniaturization and Portability, Supported by A*Star (2002-
     2005) Funding amount: $471,060
  3. PI, Image-based Text Mining Research (2000-2004). Supported by Ministry of
     Education and A*STAR, Funding amount: $565,000

SELECTED PUBLICATIONS (Book Chapters: 7; Journal Papers: 43; Conference Papers:
137)
  1. Yue Lu, Chew Lim TAN, "Information Retrieval in Document Image Databases,"
     IEEE Transactions on Knowledge and Data Engineering (TKDE), in press.
  2. Ji He, Ah-Hwee Tan, Chew Lim TAN, "Modified ART 2A Growing Network Capable
     of Generating a Fixed Number of Nodes," IEEE Transactions on Neural Networks
     (TNN), in press.
  3. Chew Lim TAN, Ruini Cao, Peiyi Shen, "Restoration of Archival Documents using a
     Wavelet Technique," IEEE Transactions on Pattern Analysis and Machine Intelligence
     (PAMI), Vol.24, No.10, pp.1399-1404, Oct 2002.
  4. Chew Lim TAN, Weihua Huang, Zhaohui Yu and Yi Xu, "Image document text
     retrieval without OCR," IEEE Transaction on Pattern Analysis and Machine
     Intelligence (PAMI), Vol.24, No.7, July 2002.

PARTICIPATION IN THE EDUCATION PROGRAMME
PARTICIPATION IN THE RESEARCH PROGRAMME
  FS-3

TAN Kian Lee MACM, MIEEECS
Deputy Head & Associate Professor, Department of Computer Science
School of Computing, National University of Singapore
Email: tankl@comp.nus.edu.sg **Phone: +65-**68742862
Web: http://www.comp.nus.edu.sg/~tankl

EDUCATION
 Ph.D., Computer Science, National University of Singapore, Singapore, 1991-1994
 M.Sc, Computer Science, National University of Singapore, Singapore, 1989-1991
 B.Sc. (Honours), Computer Science, National University of Singapore, 1985-1989

POSITIONS
 National University of Singapore, Assistant/Associate Professor, 1995- 2003
 CSIRO, Canberra Lab, Australia, Visiting Scientist, 1994-1995
 National University of Singapore, Teaching Assistant, 1989-1994

HONORS/AWARDS
 University Best Researcher Award, National University of Singapore, 1998
 Editorial Review Board, Database Management Journal (JDM), Idea Group
 Program Co-Chair, International Conference on Mobile Data Management, Singapore,
  2002
 Vice Chair, International Conference on Data Engineering, 2005

RESEARCH SUPPORT (CURRENT PROJECTS)
 1. PI, Peer Based Data Management. Faculty Research Funding, S$83,000, 01.07.2003-
    30.06.2005
 2. PI, Data Authentication and Dissemination in Edge Computing, Faculty Research
    Funding, S$67,000, 01.03.2004-28.02.2006.

SELECTED PUBLICATIONS
 1. The Hierarchical Degree-of-Visibility Tree L. Shou, Z. Huang, K.L. TAN, *IEEE
    Transactions on Knowledge and Data Engineering*, IEEE CS, accepted Feb 2004.
 2. Steganographic Schemes for File System and B-Tree H. Pang, K.L. TAN, X. Zhou, *IEEE
    Transactions on Knowledge and Data Engineering*, IEEE CS, accepted Jan 2004.
 3. Main Memory Processing: A Case for BD-tree B. Cui, B.C. Ooi, J. Su, K.L. TAN, *IEEE
    Transactions on Knowledge and Data Engineering*, IEEE CS, accepted 2003
 4.Demand-driven Caching in Multi-User Environment S.T. Goh, B.C. Ooi, K.L. TAN,
    IEEE Transactions on Knowledge and Data Engineering, IEEE CS, Vol. 16, No. 1, Jan
    2004, pp. 112-124

PARTICIPATION IN THE EDUCATION PROGRAMME
CS5231

PARTICIPATION IN THE RESEARCH PROGRAMME
 FS-1, FS-2(CoPI)

TAN Puay Siew
Senior Research Engineer, Java Smart Services Lab (JSSL)
Singapore Institute of Manufacturing Technology (SIMTech)
Email: pstan@simtech.a-star.edu.sg   **Phone:** 67938377
Web: http://www.simtech.a-star.edu.sg

EDUCATION
 M.Eng, School of MPE, Nanyang Technological University, Singapore, 1992-1993
 B. Eng. (Honours), Mechanical & Production Engineering, National University of
  Singapore, 1987-1991

POSITIONS
 Singapore Institute of Manufacturing Technology (SIMTech, renamed from Gintic), Senior
  Research Engineer, 2003 – date
 Gintic Institute of Manufacturing Technology, Research Fellow, 1997-2003
 National Computer Systems (JSAIC & ITI), Member of Technical Staff, 1994-1997
 Nanyang Technological University, Research/Teaching Assistant, 1992-1993
 Philips (DAP) Singapore Pte Ltd, QA Engineer, 1991-1992

HONORS/AWARDS
 Programme Chair, XMLAsia2004, Singapore, 2004

RESEARCH SUPPORT (CURRENT PROJECTS)
 1. Technical Lead, Java Smart Services Lab (JSSL). Supported by Infocomm
    Development Authority (IDA) at $1.5 million and Industry Partners at $1.2million.
    (2002-2004)
 2. Investigator, Parts Library. Supported by National Computer Board (NCB) at $0.5
    million (199601998)

SELECTED PUBLICATIONS (Patents Pending: 3, Book Chapters: 1; Journal Papers: 6;
Conference Papers: 7)
 1. P.S. TAN, B.K.A. Lee,S.S.G. Lee, L.E.N., Lim, "A Knowledge-based Advisor for the
    Automatic Selection and Sequencing of Orienting Devices for Vibratory Feeding",
    Journal of Engineering Application - Artificial Intelligence, 1995.
 2. L.E.N., Lim, B.K.A. Lee, S.S.G. Lee, S.W. Lye, P.S. TAN, "Feature-based Framework
    for the Selection and Sequencing of Orienting Devices for Vibratory Bowl Feeder,"
    International Journal of Production Research (IJPR), 1994.
 3. TAN Puay Siew, "XML Standards Convergence - Walking the Technology Tightrope",
    e-Biz Expo 2001 CALS Expo International, Seoul,Korea, 2001.
 4. TAN Puay Siew, "A Standards-Based Web Service Framework", Synthesis Journal,
    2003.

PARTICIPATION IN THE EDUCATION PROGRAMME
PARTICIPATION IN THE RESEARCH PROGRAMME
 IU-1

TANG Xueyan MIEEE

Assistant Professor, Division of Computer Science

School of Computer Engineering, Nanyang Technological University

Email: asxytang@ntu.edu.sg   **Phone:** 67905356 **Web:** http://www.ntu.edu.sg/home/asxytang

EDUCATION

  Ph.D., Computer Science, Hong Kong Univ. of Science & Technology, Hong Kong, 1998-
  2003

  B.Eng., Computer Sci. & Eng., Shanghai Jiao Tong University, Shanghai, China, 1994-1998

POSITIONS

  Nanyang Technological University, Assistant Professor, 2003-date

HONORS/AWARDS

  Technical Program Committee Member, IEEE Infocom'2004

  Review/Referee, IEEE Trans. on Computers; IEEE Trans. on Parallel and Distributed
  Systems; IEEE Trans. on Knowledge and Data Engineering; IEEE Network; Journal of
  Parallel and Distributed Computing; Computer Networks; ACM/Kluwer Wireless
  Networks; IEEE Infocom; IEEE ICNP; IEEE ICDCS; IEEE MDM

SELECTED PUBLICATIONS (Journal Papers: 7; Conference Papers: 10)

  1. X. TANG and S. T. Chanson. "Minimal Cost Replication of Dynamic Web Contents
      under Flat Update Delivery." Accepted to appear in *IEEE Transactions on Parallel and
      Distributed Systems*.

  2. X. TANG and S. T. Chanson. "The Minimal Cost Distribution Tree Problem for
      Recursive Expiration-Based Consistency Management." *IEEE Transactions on Parallel
      and Distributed Systems*, vol. 15, no. 3, pp. 214-227, March 2004.

  3. J. Xu, X. TANG, and D. L. Lee. "Performance Analysis of Location-Dependent Cache
      Invalidation Schemes for Mobile Environments." *IEEE Transactions on Knowledge
      and Data Engineering*, vol. 15, no. 2, pp. 474-488, March/April 2003.

  4. X. TANG and S. T. Chanson. "Coordinated En-Route Web Caching." *IEEE
      Transactions on Computers*, vol. 51, no. 6, pp. 595-607, June 2002.

PARTICIPATION IN THE RESEARCH PROGRAMME

DM6102

PARTICIPATION IN THE RESEARCH PROGRAMME

  FS-4

  IU-4

TEO Yong Meng, MBCS, MIEEE, MSCS
Associate Professor, Department of Computer Science
School of Computing, National University of Singapore
Email: teoym@comp.nus.edu.sg **Phone:** 68742830 **Web:**http://www.comp.nus.edu.sg/~teoym

EDUCATION
CEng, Engineering Council, UK, since 1992
PhD, Computer Science, University of Manchester, UK, 1987-1989
MSc, Computer Science, University of Manchester, UK, 1986-1987
BTech (1st Class Honours), Computer Science, University of Bradford, UK, 1979-1983

POSITIONS
National University of Singapore, Senior Tutor/Associate Professor, 1985-date
Singapore-MIT Alliance, Fellow, 1999-date
Hitachi Central Research Laboratory (Tokyo, Japan), Senior Research Scientist, 1996
National Computer Board (currently IDA), Systems Engineer, 1984-1985

HONORS/AWARDS
1. *Chair*, Governance & Policy Working Group, Singapore National Grid, 2002-
2. *Advisor*, 3rd IDA Infocomm Technology Roadmap (ITR-3) on Next Generation Internet Applications, 2001-02
3. *Member of Advisory Committee*, IEEE CS Task Force on Cluster Computing, 1998-
4. Overseas Research Studentship Award (1986-89), UK
5. Research Studentship Award, University of Manchester (1986-89), UK

RESEARCH SUPPORT (CURRENT PROJECTS)
1. PI, Fault-Tolerant Consensus in Distributed Systems, supported by ARF, 2004-2005
2. PI, A Framework for Large-Scale Grid-Enabled Distributed Simulation, supported by Singapore-MIT Alliance Inter-University Research Grant, October 03-Sep 05
3. PI, Performance Improvements of Web Servers, supported by Fujitsu Computers (Singapore) Pte Ltd and ARF, 1999-2002, $143K
4. PI, Parallel Simulation Techniques and Applications (PaSTA), supported by Ministry of Education and The Port of Singapore Authority, 1997-2001, $380K

SELECTED PUBLICATIONS (Books/Proceedings: 3; Book Chapters: 7; Journal Papers: 10; Conference Papers: 60, Invited papers/talks: 4)
1. Y.M. TEO and B.S.S. Onggo, "Formalization and Strictness of Simulation Event Orderings", Proceedings of the IEEE/ACM Workshop on Parallel and Distributed Simulation, IEEE Computer Society Press, Kufstein, Austria, May 16-19, 2004.
2. S C Tay, Y M TEO and C H Ng, "A Globally Optimised Checkpointing Scheme for Time Warp", Intl Journal of Modeling and Simulation, Vol. 23, No. 2, pp. 117-128, 2003.
3. Y M TEO, B S S Onggo and S C Tay, "Effect of Event Orderings on Memory Requirement in Parallel Simulation", Proceedings of the 9th International Symposium on Modelling, Analysis and Simulation of Computer and Telecommunication Systems, pp. 41-48, IEEE Computer Society Press, Cincinnati, Ohio, USA, August 2001.
4. C Wang and Y M TEO, "Supporting Parallel Computing on a Distributed Object Architecture", Journal of Systems and Software, Elsevier Science, pp. 261-278, 56 (2001).

PARTICIPATION IN THE EDUCATION PROGRAMME
CS5221

PARTICIPATION IN THE RESEARCH PROGRAMME
FS-4

Stephen John TURNER MA, MSc, PhD, MBCS, MIEEE, CEng
Associate Professor, Director, Parallel & Distributed Computing Centre
School of Computer Engineering, Nanyang Technological University
Email: assjturner@ntu.edu.sg **Phone:** 6790 4054
Web: http://www.ntu.edu.sg/home/ASSJTurner

EDUCATION

 M.Sc/Ph.D., Computer Science, University of Manchester, UK, 1973-1976
 M.A. (Honours), Mathematics & Computer Science, University of Cambridge, UK, 1968-
 1971

POSITIONS

 Nanyang Technological University, Associate Professor, 2000-date
 Nanyang Technological University, Visiting Senior Fellow, 1999 – 2000
 Exeter University, UK, Lecturer/Senior Lecturer, 1979 – 2000
 CAD Centre, Cambridge, UK, Systems Consultant, 1977 – 1979
 International Computers Ltd, Kidsgrove, UK, Senior Programmer, 1976 – 1977

HONORS/AWARDS

 Steering Committee Chair (2002-04), *General Chair* (2000) and *Program Chair* (1999,
 2005): ACM/IEEE/SCS Workshop on Parallel and Distributed Simulation (PADS).
 Organizer (2004): ICCS Workshop on HLA-Based Distributed Simulation on the Grid.
 General Chair (2002-04) and *Program Chair* (2001): IEEE Symposium on Distributed
 Simulation and Real Time Applications (DS-RT).
 Associate Editor: Simulation: Transactions of the Society for Modeling and Simulation Intl.

RESEARCH SUPPORT (CURRENT PROJECTS)

 1. PI, Large Scale Distributed Simulation on the Grid (2004-2006). Supported by UK
    EPSRC e-Science Sister Program. Funding amount: GBP 40,000.
 2. PI, Development of e-Engineering Infrastructure using Grid Technologies for Efficient
    Management of and Secured Access to HPC Resources (2004-2006). IHPC
    Collaborative Research Project: 67 man-month project
 3. PI, Technology for Secure and Robust Distributed Supply Chain Simulation (2001-2004)
    SIMTech Collaborative Research Project: 58 man-months project

SELECTED PUBLICATIONS (Books/Proceedings: 7; Book Chapters: 3; Journal Papers:
18; Conference Papers: 110)

 1. S.P. Zhou, W. Cai, B.S. Lee, S.J. TURNER, "Time-Space Consistency in Large Scale
    Distributed Virtual Environments", ACM Transactions on Modeling and Computer
    Simulation, 2004.
 2. D. Chen, S.J. TURNER, B-P. Gan, W. Cai, J. Wei, N. Julka, "Alternative Solutions for
    Distributed Simulation Cloning", Simulation: Transactions of The Society for Modeling
    and Simulation International, 2003, vol 79, no. 5-6, pp. 299-315.
 3. W. Jie, W. Cai, S.J. TURNER, "POEMS: A Parallel Object-oriented Environment for
    Multi-computer Systems", The Computer Journal, 2002, vol. 45, no. 5, pp. 540-560.
 4. S.J. TURNER, W. Cai, B.P. Gan, "Distributed Supply-chain Simulation Using High
    Level Architecture", Transactions of the Society for Computer Simulation International,
    2001, vol. 18, no. 2, pp. 98-109.

PARTICIPATION IN THE EDUCATION PROGRAMME
CPE428

PARTICIPATION IN THE RESEARCH PROGRAMME
 FS-4(PI)

WONG Kok Wai (Kevin) SMIEEE
Assistant Professor, Division of Computer Science
School of Computer Engineering, Nanyang Technological University
Email: askwwong@ntu.edu.sg **Phone:** 6790 4327 **Web:**http://www.ntu.edu.sg/home/askwwong/

EDUCATION
Ph.D., Electrical Engineering, Curtin University of Technology, Western Australia, 1996-2000

B.Eng. (Honours), Computer Systems Engineering, Curtin University, 1992-1994

Dip.Eng., Electronics and Communication Engineering, Singapore Polytechnic, 1988-1991

POSITIONS
Nanyang Technological University, Assistant Professor, 2003-date

Murdoch University, Lecturer, 2001-2003

Murdoch University, Research Associate, 2000-2001

South East Metropolitan College of TAFE, Lecturer, 1999-2000

Dynamics Technology, Software Engineer, 1998-1999

Matsushita Electronics (Singapore) Pte. Ltd., Assistant Engineer, 1991-1992

HONORS/AWARDS
Guest Editor, The Australian Journal of Intelligent Information Processing Systems, 2004.

Conference Program Committee, Australian Joint Conference on Artificial Intelligence (AI04)

Conference International Program Committee, IEEE Int. Conf. on Fuzzy Systems, 2004.

Awarded Scholarship (CIRS) 1996/97 by Curtin University of Technology

Awarded Scholarship in 1997 by Formation Evaluation Society of Western Australia, FESWA

RESEARCH SUPPORT (CURRENT PROJECTS)
1. PI, Data Mining Using Neural Fuzzy Techniques for Customer Relationship Management. (2002). Funded by Murdoch University Early Career Researcher Grant. Funding amount :A$9,000
2. Associate Investigator, Neural Networks and Hybrid Neuro-fuzzy Methods for Improved Mineral Prospectivity Analysis and Target Identification in Mineral Exploration (2001-2003). Funded by Australia Research Council. Funding amount: A$78,736.

SELECTED PUBLICATIONS (Book Chapters: 4; Journal Papers: 12; Conference Papers: 52; Newsletter: 2)
1. Chong, A., Gedeon, T.D., WONG, K.W. "Extending the Decision Accuracy of A Bioinformatics System," in Reznik, L., and Kreinovich, V. (Eds.) Soft Computing in Measurement and Information Acquisition, Studies in Fuzziness and Soft Computing, Physica-Verlag, Springer-Verlag, June, pp. 151-163, 2003.
2. WONG, K.W., Fung, C.C., Eren, H., and Gedeon, T. "Determination of Parameter d50c of Hydrocyclones Using Improved Multidimensional Alpha-cut Based Fuzzy Interpolation Technique," IEEE Transactions on Instrumentation & Measurement, Vol. 52, No. 6, December, pp. 1865 – 1869, 2003.
3. Seow, K.T., and WONG, K.W. "Collaborative Assignment Agents: Using Arbitrated Self-optimal Initialisations for Faster Negotiation," Proceedings the CIRAS 2003,.

PARTICIPATION IN THE EDUCATION PROGRAMME
H6429

PARTICIPATION IN THE RESEARCH PROGRAMME
FS-5

APPENDIX 5 – LETTERS OF COMMITMENT & SUPPORT

Organizaiton	Representative
Infocomm Development Authority of Singapore (IDA)	Dr Tan Geok Leng Director, Network and Enabler Technologies Technology Group
Infocomm Development Authority of Singapore (IDA)	Lo Yoong Khong Deputy Director Manpower Development Industry Group
SES Systems Pte Ltd	Chang Yew Kong President
National Grid	Dr Lee Hing-Yan Deputy Director
Yokogawa Engineering Asia Pte Ltd	Ng Keng Siang Vice President Information Systems and Services Division
Institute for Infocomm Research	Prof Limsoon Wong Deputy Executive Director, Research
Institute for Infocomm Research	Prof Lawrence Wong Executive Director
Sybase (Singapore) Pte Ltd	Ms Ho Yean Fee Director Sybase Asia Development Centre
Hewlett-Packard Singapore (Sales) Pte Ltd	Mr Dennis Ang Director High Performance Technical Computing Asia Pacific
Singapore Institute of Manufacturing Technology (SIMTech)	Dr. Lim Kiang Wee Executive Director

iDA
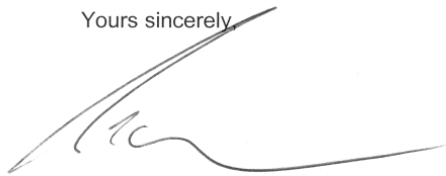## SINGAPORE

Catalyst for Change

23rd February 2004

Professor GOH Eck-Soong, Angela
Vice-Dean (Academic)
Block N4, #02b-50
Nanyang Avenue
Singapore 639798

Dear Professor Goh,

**EXPRESSION OF SUPPORT: Engineering Systems: Leaders in
Information Systems and Architectures (LISA).**

1. The proposed research is in line with the Info-communications Development Authority (IDA) of Singapore's **Connected Singapore Master Plan** launched in March 2003. IDA is the regulator and lead promoter of infocommunications for Singapore.

2. The proposed research into the Information GRID brings together many technologies that IDA has identified as being strategic to Singapore; these include Web Services, Semantic Web, GRID and Collaborative Engineering. In particular, we hope to be able to draw on the findings of LISA to help us architect and deploy information exchange systems that enable seamless and secure content exchange between players within and outsides of Singapore.

3. Our Technology Group people would be prepared to work with members of the LISA project by taking on suitable interns to validate certain key concepts of LISA in our Proof of Concept Lab.

4. I look forward to this cooperation with you and your colleagues.

Yours sincerely,

Dr. Tan Geok Leng
Director, Network and Enabler Technologies
Technology Group, IDA

INFOCOMM DEVELOPMENT AUTHORITY OF SINGAPORE
8 Temasek Boulevard #14-00 Suntec Tower 3 Singapore 038988 Tel 65- 6211 0888 Fax 65- 6211 2222 www.ida.gov.sg

iDA
SINGAPORE

Catalyst for Change

Professor Angela Goh
Vice Dean and Professor, School of Computer Engineering
Nanyang Technological University
Blk N4, Room 2b-50
Nanyang Avenue, Singapore 639798

Dear Angela

I am writing to express support to the proposed SMA2 programme on "Leaders in Information Systems and Architectures (LISA)".

The research focus on Information Grid is in line with IDA's Strategic Infocomm Technology Roadmap from 2002 to 2007. This area encompassing Web Services, Peer-to-Peer Computing and Grid Computing will gain prominence in the future. We also envisage that Grid applications may be commercialised in 2005 and more commercial organisations will turn to Grid Computing when it becomes more affordable. Bandwidths will also increase due to Grid deployment and embedded devices will be able to provide resources for Grid infrastructure. The proposed programme will be able to produce graduates who are skilled in this field.

In addition, you may want to partner with the National Grid Office who rolled out the Pilot Grid in November 2003 to help drive R&D projects.

In summary, the proposal is on the right track and we hope that the proposed programme will be a success. Thank you.

Yours faithfully,

Lo Yoong Khong
Deputy Director
Manpower Development
Industry Group

SES Systems Pte Ltd

A company of Singapore Technologies Electronics

24 Ang Mo Kio Street 65
Block D Level 5
Singapore 569061
Tel: (65) 6481 8888
Fax: (65) 6481 0693
www.stee.st.com.sg
www.ses.st.com.sg

1 March 2004

Professor Angela Goh
Vice Dean and Professor, School of Computer Engineering
Nanyang Technological University
Blk N4, Room 2b-50
Nanyang Avenue, Singapore 639798

Dear Prof Goh,

Leaders in Information Systems and Architectures (LISA)

SES Systems specializes in real time mission critical systems. We develop Defence Command and Control applications, Homeland Security systems and Enterprise solutions for both civil and defence customers worldwide. The proposed Information Grid Infrastructure can offer better and more efficient access for information intensive applications. Its research in theories, tools, methodologies and services can potentially provide new benefits to industries.

We are therefore supportive of the proposed SMA2 programme on "Leaders in Information Systems and Architectures (LISA)" and we look forward to the outcomes of this project.

Yours truly,

Chang Yew Kong
President

SINGAPORE
QUALITY
AWARD
for business excellence
2002 Winner
Singapore Technologies Engineering

ISO 9000
P S B
CERT. NO: 2000-1-0213
SS ISO 9001 : 2000

**Singapore Technologies
Electronics**
A company of Singapore Technologies Engineering

National Grid

NG

SINGAPORE

5 February 2004

Professor Angela Goh
Vice Dean, School of Computer Engineering
Nanyang Technological University
Block N4, Room 2b-50, Nanyang Avenue
Singapore 639798

Dear *Angela*

I write to confirm my interest in collaborating on the proposed research entitled "Engineering Systems: Leaders in Information Systems and Architecture (LISA)". The research that you proposed will be relevant to the work of the National Grid Office.

The National Grid Office was established in January 2003 to realize "a Singapore where computer resources can be connected together via a high-speed network such that these resources can be shared in a secure, reliable & efficient manner by authenticated users for education, commercial, entertainment, R&D, national security & other purposes so as to improve the economic & technological competitiveness of Singapore & also the quality of life in Singapore."

In this light, the proposed research theme on Information Grid and its application in various industrial, healthcare and business services is aligned with our emphasis on promoting Grid Computing to the industry. And hence there exists a great potential to derive synergy from such collaboration.

We look forward to this collaboration with you and your colleagues.

Yours truly,

LEE Hing-Yan (Dr.)
Deputy Director

21 Heng Mui Keng Terrace, Singapore 119613 * Fax: (65) 6872-1361 * www.ngp.org

Yokogawa Engineering Asia Pte Ltd

5 Bedok South Road
Singapore 469270

Tel : (65) 2419933
Fax : (65) 2412606

YOKOGAWA

15 February 2004

Dr Angela Goh Eck Soong
Vice Dean and Professor
School of Computer Engineering
Nanyang Technological University
Blk N4, Room 2b-50
Nanyang Avenue, Singapore 639798

Dear Professor Goh,

I am writing to express our interest to support the research described in the SMA2 proposal on "Engineering Systems: Leaders in Information Systems and Architectures (LISA)".

At Yokogawa, our business covers industrial automation and control, test and measurement, information systems, and industry support. The Information Grid research you propose will certainly have applicability to a number of our industrial projects in Singapore and the region. With the integration between teaching and research and a curriculum focusing on information systems and architecture, we believe that the students trained under the programme will be able to meet the high expectations of the industry we specialize in.

We will also be happy to consider hiring the graduates of the programme and offer them internships during their course of study should this be possible.

Finally, we look forward to our future collaborations in the proposed programme.

Yours truly,

Ng Keng Siang
Vice President
Information System and Services Division
Yokogawa Engineering Asia Pte Ltd

Institute for
Infocomm Research

A★STAR

11 February 2004

Professor Angela Goh
Vice Dean
School of Computer Engineering
Nanyang Technological University

Dear Professor Goh

I am writing to confirm our organization's interest in collaborating with you on the research as detailed in the SMA2 proposal entitled "Information Grid".

The Services & Applications Division in the Institute for Infocomm Research is embarking on a new research effort in information quality, with the aim of investigating how authority and quality attributes of input data can be combined to reflect the authority and quality of database query results. This is in line with the "Quality, Reliability and Performance Services" topic within the "Information Grid" theme, and we look forward to working synergistically with your SMA faculty members.

Sincerely yours,

Professor Limsoon Wong
Deputy Executive Director, Research

Institute for
Infocomm Research

A★STAR

4 March 2004

Professor Angela Goh
Vice Dean (Academic)
School of Computer Engineering
Nanyang Technological University
Block N4, Level 2, Rm N4-02a-32
Nanyang Avenue
SINGAPORE 639798

Dear Professor Goh

I am writing to confirm our organization's interest in collaborating with you on the research as detailed in the *SMA2* proposal entitled *"Information Grid"*.

The *Services & Applications Division* in the *Institute for Infocomm Research* is embarking on a new research effort in information quality, with the aim of investigating how authority and quality attributes of input data can be combined to reflect the authority and quality of database query results. This is in line with the *"Quality, Reliability and Performance Services"* topic within the *"Information Grid"* theme, and we look forward to working synergistically with your *SMA* faculty members.

Yours sincerely

LAWRENCE WONG (PROF)
EXECUTIVE DIRECTOR

SYBASE

Sybase Asia Development Centre
Sybase (Singapore) Pte Ltd
438B Alexandra Road, #04-01/06
Alexandra Technopark
Singapore 119968

Tel (65) 370 5100
Fax (65) 370 5151

Professor Angela Goh
Vice Dean and Professor, School of Computer Engineering
Nanyang Technological University
Blk N4, Room 2b-50
Nanyang Avenue, Singapore 639798

Dear Professor Goh,

I am writing to endorse the proposed SMA2 programme on "Leaders in Information Systems and Architectures (LISA)".

As you may know, Sybase delivers open-architecture solutions that provide the data management and mobility necessary to create the Unwired Enterprise. Sybase solutions integrate platforms, databases, and applications. With Sybase, organisations can attain maximum value from their data assets by getting the right information to the right people at the right time and place.

The research focus on Information Grid is in line with Sybase's vision of the Unwired Enterprise. The proposed project will help us better understand the complex technologies involved in grid services and their applications.

We have a strong interest in this area of research and we look forward to the outcomes of this project.

Sincerely,

Ho Yean Fee (Ms)
Director
Sybase Asia Development Centre

8 March 2004

Dr Lim Ee Peng
Associate Professor and Head
Division of Information Systems
Nanyang Technological University
50 Nanyang Drive
Singapore 637553

Dear Dr Lim

I am writing to express our interest to support the research, as proposed under SMA2 proposal, in Engineering Systems: Leaders in Information Systems and Architectures (LISA).

Hewlett-Packard (HP) has been one of the pioneer IT companies in deploying Grid infrastructure for Computation and Information resources. We have developed a focus global business division, spearheaded by a Vice President, to develop solution in promoting Grid as next technology era. The current research program certainly has applicability to many efforts by the division in the Grid development. We believe that the students trained under the program will be able to meet the high expectations of this specialize technology.

We will be happy to explore with your institute for the area of collaboration pertaining to the above research program. We will also be happy to explore hiring the graduates of the program and offer them internship during their course of study.

Finally, we look forward to our future collaborations in the proposed program.

Yours sincerely,

Dennis Ang
Director
High Performance Technical Computing
Asia Pacific

Singapore Institute of Manufacturing Technology
A*STAR

LETTER OF SUPPORT

Proposed SMA2 Course on Leaders in Information Systems and Architectures

The Singapore Institute of Manufacturing Technology (SIMTech) is pleased to confirm our involvement in the proposed SMA2 Course on Leaders in Information Systems and Architectures. As indicated in the proposal, SIMTech, through Dr Lee Eng Wah and Tan Puay Siew will participate in Project 1 of the Flagship programme.

We wish the LISA team success in this proposed programme.

Lim Khiang Wee
Executive Director

11 March 2004

APPENDIX 6 – BUDGET

Budget pages are inserted here (from separate file).

APPENDIX 7 – SIGNED FORMS

Signed forms are inserted here (from separate file).

APPENDIX 8 – SUGGESTED SCIENTIFIC PEER REVIEWS

Suggested Scientific Peer Reviews inserted here (from separate file).