

Institute for Infocomm Research

Annual Report FY2002



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Executive Summary

It has been a year of change with the merger of the Institute for Communication Research (ICR) and the Laboratories for Information Technology (LIT), culminating in the official and legal formation of the Institute for Infocomm Research (I²R). Within days after the announcement of the formation of I²R on 5 November 2002, a strategic planning retreat involving all senior staff from ICR and LIT was conducted. As a follow-up, merger and planning taskforces were formed; and I²R went through intensive planning and operational alignment exercises.

The participative approach taken in these exercises enabled a smooth transition that resulted in rapid adoption by the new consolidated I²R community. Today, I²R has a Strategic Plan, it has clarity on its research directions with a roadmap that has been fine-tuned with the assistance and inputs from the Scientific Advisory Board. It is ready to face the challenges ahead.

Meanwhile, the momentum of existing programmes and projects continued unabated resulting in significant technical achievements and continued contributions and partnerships with industry and academia. Our creative research teams have achieved recognition through their award winning innovations on several fronts. A number of major projects with companies have ensured our relevance to industry. Our close collaborations with NUS and NTU through joint programmes and joint supervision of graduate research students help to bring elements of use-inspired research to academia while at the same time contributing to the development of future research talent for Singapore.

Our goal is to position I²R as an institute that will be admired globally. This goal will help to create more intellectual property and know-how for Singapore; to expand her R&D talent pool and related R&D activities; to assist the local enterprises in climbing the technology ladder; as well as to attract major investments in manufacturing and R&D of advanced infocomm systems and components to Singapore. These developments are crucial to the next phase of Singapore's value-creation based economy.



Professor Lawrence Wong
Executive Director

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Executive Summary

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I. Introduction

Mission & Vision Statements

With the continuing importance of the ICT industry to the economy of Singapore, I²R is well positioned to play a crucial role in knowledge creation, high-level manpower training, and supporting the local ICT industry to create economic impact for Singapore. To do this successfully, I²R must strive to attract and nurture the best team with the dedication and passion to excel and to yield the best outcomes that will earn a place for I²R in the annals of technical achievement globally.

Putting it simply, our vision is:

“To be a globally admired research institute”

In addition, we will strive in our mission to:

“Advance Infocomm Technology to benefit humanity and create prosperity for Singapore.”

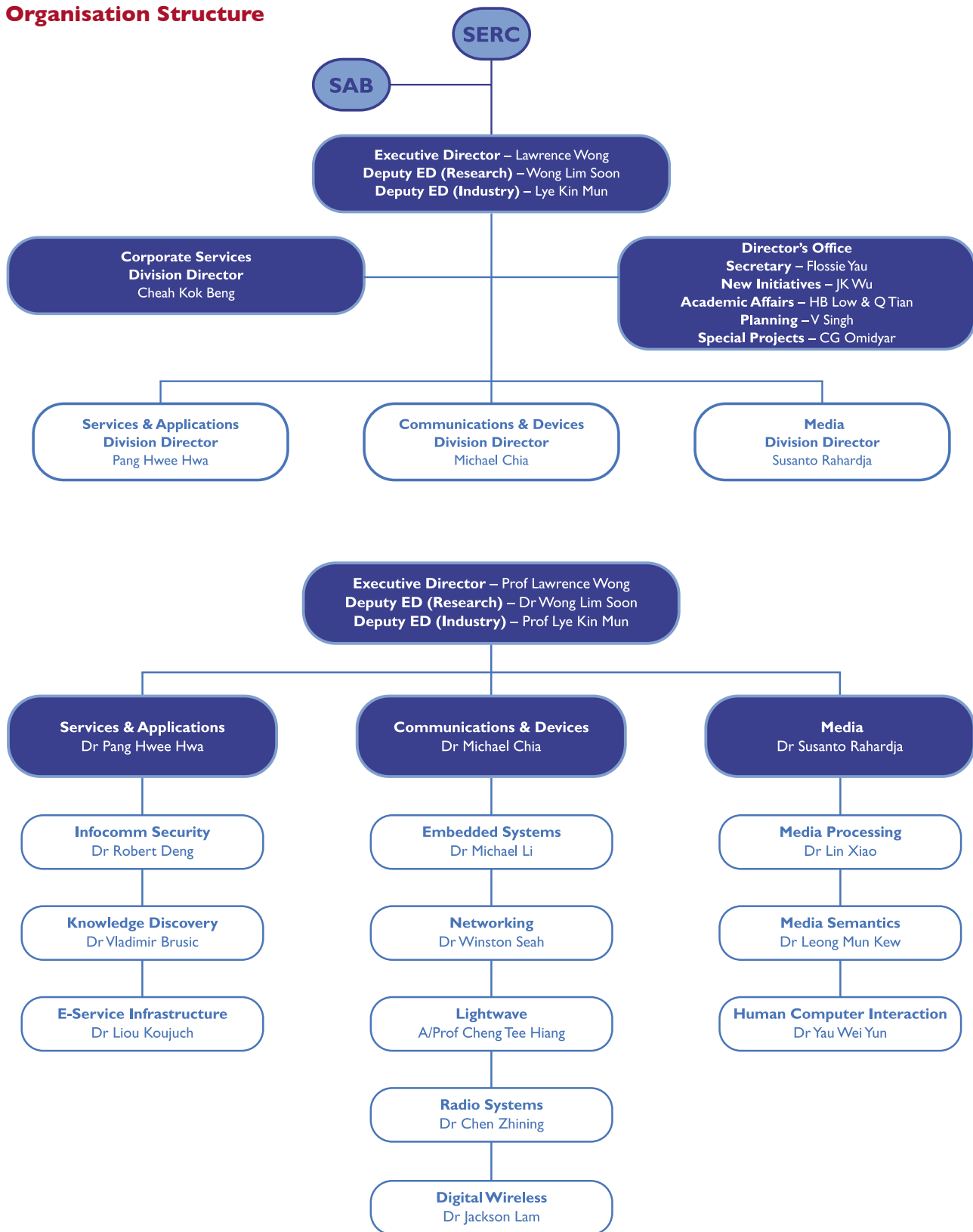
Having the right culture and mindset is essential to reach these lofty goals.

To move us in the right direction, we need an environment that fosters creativity and innovation. Incentives and recognition systems must be in place to encourage a “Dare to Dream” culture tempered with a balanced realization of practicalities and of the need to ensure that the fruits of our intellectual pursuits are pertinent to the needs of industry.

Quality processes are needed to monitor, assist and manage the knowledge creation activities aided by appropriate use of automation and IT. A transparent and well-administered performance-based system instils confidence and direction so that each and every staff strives to do his best.



Organisation Structure



Management Committee

Prof. Lawrence Wong
Dr. Wong Lim Soon
Prof. Lye Kin Mun
Dr. Pang Hwee Hwa
Dr. Michael Chia

Executive Director
Deputy Executive Director (Research)
Deputy Executive Director (Industry)
Division Director (Services & Applications)
Division Director (Communications & Devices)

II. Significant Achievements for FY02

I²R made impressive achievements over the past FY2002 in the following areas:

- Creation of intellectual capital
- Creation of human capital
- Transfer of technology & know-how to industry
- R&D collaboration with industry

I²R produced 60 invention disclosures, commercialized 10 new prototypes, and published over 200 research papers this year. An example of the new exciting technology produced was the award-winning FaceStar technology that was able to reduce error rate of typical face matching methods by an order of magnitude using the face synthesis approach. I²R also prototyped a UWB transceiver capable of transferring 500Mbps over 2m and within the FCC masks. In addition, 19 of our earlier patent filings were granted this year.

I²R trained 29 postgraduate students this year. In addition, I²R transferred 60 RSEs to industry. I²R also commercialized 16 of our patents and 10 of our prototypes. I²R also spun out 4 companies—Vislog, Trustcopy, muvee, and BIGontheNet.



I²R collaborated on 6 projects with industry funding.

Some specific significant achievements are listed below:

- Our researcher, Dr. Susanto Rahardja, received the prestigious **2002 IEE Hartree Premium Award**.
- The FaceStar technology. This face synthesis based innovation reduced the error rate of typical face matching systems by 10 fold. It won an **award for best poster technological innovation at Biometrics 2002**. It has been licensed to a local start-up biometrics company, in April 2003.
- The Drowning Early Warning System (DEWS) is a working concept for detecting drowning from analyzing the behaviour pattern of the swimmer using overhead video cameras. We were the first in the world to propose and solve such a problem using analysis of swimmers' behaviour. The project won the **TEC Innovator award 2002**, as well as the **Enterprise Challenge Incubator Award 2002** for I²R.
- Advanced Audio Zip (AAZ). This technology was evaluated by the MPEG international standard committee in Dec 02. **The codec came in best in terms of compression ratio and bit rate scalability**, as well as backward compatibility, and was the only codec that met all the requirements spelled out in the specifications of the Call for Proposal by MPEG.





- UWB Technology. We demonstrated, in the first quarter of 2003, a prototype **UWB transceiver capable of transmitting data at 500Mbps over a distance of 4m**, effectively five times the transmission rate of existing systems demonstrated by others. This was the first prototype in the world to achieve such high-speed transmission.
- Security Analysis of Security Algorithms, Protocols, and Systems. We broke a Global Key Recovery System and Fair Exchange Protocol; published methods to attack stream cipher COS, another stream cipher ALPHA, a hash function based on block cipher and a threshold undeniable signature scheme; more significantly, **discovered three extremely serious flaws in the e-banking system of a major local bank** and demonstrated to the relevant authority that the system can be broken into in a few seconds time.
- Designed and implemented a New Public Key Infrastructure (PKI). Certificates revocation has been a significant burden to PKI operation. We proposed a revocation-free public-key framework, in which the

maximum lifetime of a certificate was divided into short periods and the certificate could expire at the end of any period under the control of the certificate owner (or his manager in a corporate environment). The **verifier could check the status of such a certificate without retrieving the revocation information from a central directory**.

- The first practical steganographic file system (StegFS). Unlike other steganographic schemes proposed previously, our construction satisfied the prerequisites of a practical file system in ensuring integrity of the files, achieving high read/write performance, and maintaining efficient space utilization. We completed an implementation on Linux, and experiment results confirmed that **StegFS achieved an order of magnitude improvement in performance and/or space utilization over existing alternatives**.
- Nebula Project. The Nebula project was demonstrated during the 9th "Communications Horizons" Seminar on 19 September 2002. The Nebula project was an attempt to integrate the four ITEC (Internet Technologies Programme) projects (AINet2, PING, RATTLESNAKE and AMASE, all IPv6 based), demonstrating interoperability between them. The demonstration covered these aspects: Mobility, Quality of Service (QoS), wireless TCP performance improvement and IPv6 protocol stack development.
- Polarisation-mode dispersion (PMD) mitigation using forward error correction and wavelength diversity technique. We captioned PMD mitigation using forward error correction and wavelength diversity technique. We developed a very accurate analytical model to analyze the bit error rate (BER) performance for their technique. We verified through numerical simulation that our model was indeed able to estimate BER very accurately and that our proposed scheme yielded significant BER improvement.
- Fibre Grating Fabrication System. Fibre Bragg Gratings (FBGs) were widely used in optical communication systems and sub-systems. We completed the design and set up of a state-of-the-art Fibre Bragg Gratings (FBGs) fabrication system. Our in-house testing showed that our system was able to achieve a higher degree of precision and flexibility than some of the best-known systems. The critical requirement of FBG fabrication was a positional accuracy of better than 0.1 Angstrom over the length of the grating of about a centimetre. As such, we designed the system

to allow the fibre (on which gratings are to be written) to be translated on air bearing stages with a laser interferometer to track the relative position between the fibre holder and ultraviolet (UV) fringes with a resolution in the sub-nanometre range. To maintain such a high positional accuracy, environmental stability was crucial for the performance of the system, so the writing system was built on a granite based vibration free optical table and the whole system is housed within a class 1000 clean booth. We developed sophisticated software to synchronize the triggering of the UV laser and the translation of the air bearing stage. With this state-of-the-art design, our system was able to fabricate very complicated FBGs with stringent requirements and with better performance.

- Robust Header Compression (RFC 3095) was a protocol that compressed the headers of Internet packets that were sent across low-bandwidth, wireless links, in order to increase good throughput and reduce chances of corruption over wireless links. We recently successfully completed interoperability tests with EffNet, Ericsson and Acticom at the last Interop in Berlin.

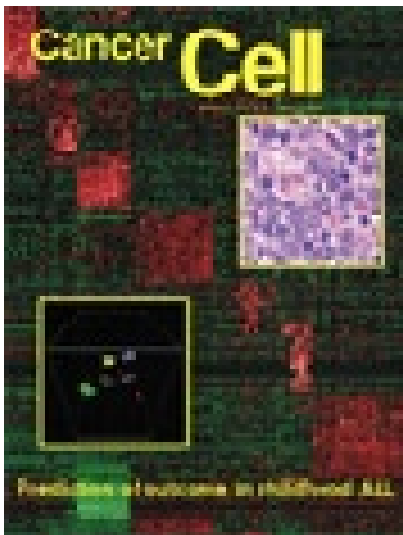
- Recent results confirmed that our Dragon ERE (Estrogen Response Elements) Finder was capable of detecting functional ERE patterns not included in the training set. E.g., (a) the system correctly detected recently characterized functional EREs [Seth P, et al. Cellular and molecular targets of estrogen in normal human breast tissue. *Cancer Res.* 2002 Aug 15;62(16): 4540-4] in human (Genbank accession X99133, NGAL gene) and mouse lipocalin 2 genes at the default sensitivity setting; (b) the system detected ERE motifs (p17d1, p17daTA, p17d2) for which binding of ER α and ER β was experimentally shown [Yi P, et al. The effects of estrogen-responsive element- and ligand-induced structural changes on the recruitment of cofactors and transcriptional responses by ER α and ER β . *Mol Endocrinol.* 2002 Apr;16(4):674-93].



In addition, some of the significant achievements reported in previous years borne additional fruits this year. For example:

- Based on the radio frequency identification (RFID) technology developed by I²R, ETPL concluded a **licensing deal to a leading Japanese company**, resulting in a significant sum of licensing revenue, as well as creating knock-on businesses for some local enterprises.

- Dragon Promoter Finder and Gene Start Finder. Continued world leadership of this Dragon suite of technologies for recognizing gene start region. In a test in FY02 on the mouse genome we achieved more than 200% better association with newly released cDNA data from RIKEN than Genescan (the current industry standard workhorse on this topic). The technologies **were licensed in the fourth quarter of 2002 by a biometrics company** and incorporated into their world-leading product in April 2003.



- Prediction by Collective Likelihood of Emerging Patterns. This highly accurate and highly comprehensive data mining and classification technology was used to produce models for diagnosing subtypes of childhood leukaemia based on gene expression profiles. **The paper announcing the application of this technology to childhood leukaemia (March 2002 issue of Cancer Cell) has been cited at least 85 times in the past 12 months.**
- Major Histocompatibility Complex (MHC)-binding Peptide Prediction. I²R made some MHC-binding peptide predictions on MAGE-6 antigen two years ago. **Four of the 14 predicted binders were recently confirmed in experiments by Storkus group in Pittsburgh,** as reported in the March 2003 issue of *Clinical Cancer Research*.
- 3G mobile prototype terminal development: Demonstrated basic functional elements of the prototype and completion of phase I of the project. The successful partnership of phase I resulted in **STMicroelectronics' significant expansion of its wireless communications R&D activities in Singapore.**

III. Core Research & Technology Areas

With the formation of the Institute for Infocomm Research (I²R) on 5 November 2002, our core research & technology areas were broadly grouped into three divisions (Services & Applications, Communications & Devices and Media) and one programme (New Initiatives).

Services & Applications

There are three departments in this division, namely E-Service Infrastructure, Infocomm Security, and Knowledge Discovery. The E-Service Infrastructure department aims to develop a storage and delivery infrastructure that enables consumers to create unique services, using their electronic devices and vendor-provisioned computing utilities as building blocks. The department's research in data-in-networks, secure storage and residential gateways helps accelerate the race towards a single interconnected ecosystem. The Infocomm Security department's main thrust is to provide practical solutions in cryptography, network security, and information security to make cyberspace more secure and reliable for commerce. The Knowledge Discovery department develops advance technologies for data mining, knowledge management, knowledge extraction, and decision-making. They also apply these technologies for the better understanding, diagnosis, and cure of diseases.

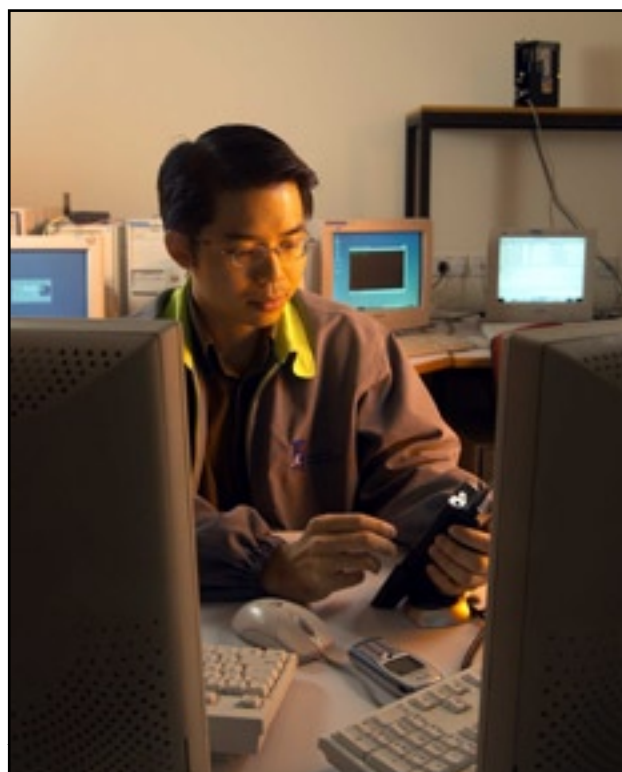
Related old programs: Ubiquitous Computing, Knowledge & Discovery, Distributed Systems

Relevance: Strengths (since 1997) in Infocomm Security, Knowledge Discovery, and E-services infrastructure. This addresses the security & trust infrastructure, web services & portals, and software & computing sectors in the EDB-iDA Technology Roadmap 2002

End users: Healthcare, defense, and finance sectors.

Communications & Devices

This division conducts research primarily in the physical, data-link, network and transport layers of the OSI (Open Source Initiative) for wireless & optical communication system. The major competencies are divided into five departments, namely: Radio Systems, Digital Wireless, Embedded Systems, Lightwave and Networking. The Radio Systems department is responsible for the physical layer of communications that requires microwave signal, ultra high speed analog/mixed signal processing and real-time algorithms. Current focuses are transceiver, antenna, radio-over-fiber and Ultra Wide Band (UWB). The Digital Wireless department's thrusts are digital signal processing and system architecture for digital communications to improve the spectral efficiency, speed, range and reliability of communications over wireless channels. Primary focuses are modem technology, Multiple Access and Smart Antenna system. The Embedded Systems department develops embedded systems for advanced



wireless access modes. The core competencies are in the multimodes (3G, Beyond 3G) and Software Defined Radio. The Lightwave department focuses on novel fibre-based components, WDM systems, and optical network design for optical access network. The Networking department's main thrust are new protocols and algorithms for networking in infrastructure and infrastructure-less which is expected to support a wide range of applications with diverse quality of service (QoS) requirements, independently of whether their location is fixed or mobile. Current focuses are in the next generation IP, end to end QoS, mobile ad-hoc, mobile sensor network and mobile middleware.

Related old programs: Future Mobile Communication Systems (FMCS), Piconets and Broadband Access Networks (PBAN), Internet Technologies (ITEC), Mobile Device to Device Communications (MD2D), WDM systems (WDMS), Optical Network Design and Management (ONDM) and Fibre Devices (FBDV)

Relevance: Strengths in wireless and optical communications, e.g. UWB, Fiber Technology & 3G terminals

End users: Consumer electronics, computers peripherals, broadband to the home, hand-phones, etc



The Media division deals with the entire value chain of media; starting from the creation of the media, leading to its processing and analysis, followed by the production, distribution and presentation of the final media product. The Media team at I²R has developed advanced media signal processing, media content analysis and production technologies that are clearly distinctive, as evidenced through performance comparisons against international standards, global companies and strong research contributions and publications in these areas. This has been further validated by major wins at international media technology competitions.

The division has three departments, focusing on Media Processing, Media Semantics, and Human Computer Interaction. The Media Processing department is focused on multimedia coding for efficient delivery of media. The Media Semantics department helps in the understanding of media and what users desire so that hidden contents can be made explicit through the generation of new media. The Human Computer Interaction department works on biometrics, surveillance, dialogue processing.

Related old programs: Media Engineering, Signal Processing, Knowledge & Discovery

Relevance: Key strengths in signal and media processing. This addresses part of iDA technology Roadmap 2002 and media cluster in the ERC ICT Working Group recommendation.

End users: local media companies, government, public, defense.

New Initiatives

The primary role of the New Initiatives programme is to actively nurture and pursue new research initiatives in emerging and/or converging areas, and grow them to be major competitive research programs in 3-5 years time, contributing to I²R as a world class research institution. New Initiatives will pro-actively identify, facilitate and conduct flagship or integrative projects of significance to generate national and economic impact. One Flagship or integrative project will be initiated and conducted by NI each year.

VI. Intellectual Capital Development

Collaborating with Academia

I²R has actively sought research partnerships with both local universities and international organizations such as IBM Microelectronics Division (USA), Konkuk University (Korea), Beijing Glass Research Institute (China), University of Science and Technology (Hong Kong), Wright State University, CRL - Wireless Access Group (Japan), National University of Singapore (NUS), Nanyang Technological University (NTU), Georgia Institute of Technology, etc.

There were a total of six joint R&D collaborations initiated in FY2002 with local universities and another 6 with international research organisations. Two SERC-RI-RI collaboration projects under “Embedded Hybrid Systems”, namely: “Reactive Embedded Systems: Efficient Implementation Technologies” and “Smart Laboratory Initiatives” were successfully completed.

To name a few of the initiated research collaborations in FY2002:

- I²R and Computer Science Department of Hong Kong University of Science and Technology initiated a joint collaboration on service networks.
- I²R, Communications Research Laboratories (Japan) and NTU School of EEE initiated a research project on radio-over-fibre technology.
- I²R and Konkuk University Computer Science Engineering department (Korea) initiated joint R&D on networking technologies.
- I²R and Beijing Glass Research Institute (China) initiated joint R&D on photonic crystal fibre.
- I²R, NUS Department of Electrical and Computer engineering, and Georgia Institute of Technology initiated a research project on e-textile technologies.

Creating Intellectual Property

Creating Intellectual Property is the raison d’etre of a research institute. We are focused on putting in place a strategy in our pursuit of developing Intellectual Property (IP) at I²R.

Our publication process is strengthened by a streamlined publication, repository, and tracking process using our in-house online Publication Tracking Tool (PTT). A ranking list of publications in various reputed journals and conferences further provides good guidelines for ensuring quality of publication.

Our patenting endeavours are oriented towards solving use-inspired problems in the market place, and aim to be both opportunistic and clustered. We work with Exploit Technologies for improving the quality of our patent portfolio.

We strive to generate Invention Disclosures (IDs) that satisfy the three C’s of patenting. The IDs/patents we produce would be in clusters (showing strength), has continuity (developed on previous patents), and are current (showing continuity within I²R).

To name a few granted patents as examples:

- “Method and Apparatus for Encrypting and Decrypting Data” by Bao Feng and Robert Deng Huijie was granted a SG patent on 23-May-02.

- “Motion Information Extraction System” by Huang Qingming, Tian Qi and Lo Sheng was granted a SG patent on 19-Nov-02.

- “Method and Apparatus for Generating Pulses from Analog Waveform” by Lye Kin Mun and Jurianto Joe was granted a US patent on 5-Nov-02.

- “Circuitry with Resistive Input Impedance for Generating Pulses from Analog Waveform” by Jonathan Liu, Jurianto Joe, Yong Siong Siew and Lye Kin Mun was granted a US patent on 26-Nov-02.

In terms of intellectual property created, I²R produced a total of 284 publications, 34 filed patents, 19 granted patents, and 52 submitted Invention Disclosures during FY02.

Commercializing Intellectual Property

I²R has actively sought opportunities to commercialize her IPs. In FY2002, a total of 15 patents were commercialized. Examples of such commercialization include:

- Two patents relating to Radio Frequency (RF) radiation detector and transponder commercialized. The technology acted as a microwave guard device that measured radiation leakage from microwave ovens and warns users if the leakage exceeded safety levels.

- Two patents relating to Radio Frequency (RF) technologies commercialized to develop a 2.45GHz Passive RF-ID System to track items.

- One patent relating to video processing and, in particular, to systems for extracting motion information from an encoded video sequence, including traffic monitoring applications.

- Ultra Wide Band technologies to detect UWB signals using circuitry having nonlinear dynamics characteristics. Commercialization was through patent licensing agreement.

Working closely with Exploit Technologies, 10 new technologies were commercialized. Some of the notable ones include:

- **Dragon PF/GSF system.** This was a highly accurate DNA gene transcription start site recognizer. The system aimed at recognizing transcription start sites/ gene starts in genomic DNA. It used different feature sensors and an artificial neural network to achieve the task.

- **SecureDisc File System.** The SecureDisc was a security solution that performed on-the-fly file encryption and decryption for computer desktops and networks. The core of the solution relied on implementing kernel-level drivers to intercept messages received from applications and to perform the necessary encryption and decryption of files, be it from a local drive, or across a network. At all time these files were in encrypted form in the physical storage, and the decrypted (original) data only exists in the memory when a user or application requested the files.

- **Text Categorization Expert.** This knowledge management software automatically categorized information such as digital documents into user defined folders. This software was licensed to two companies.

I²R also developed with Exploit Technologies hand-over processes to ensure proper technology transfer to our industry partners, as well as internal archiving procedures.

V. Industrial Capital Development

Collaborating in R&D with the Industry

Through collaborating in R&D with industry, I²R was able to develop broader and deeper research capabilities. Such collaboration is seen as crucial for achieving impact for the institute.

We had several notable R&D collaborations in FY2002. We initiated a total of 7 industrial collaborative R&D projects. All of these projects were with industry cash funding.

I²R developed a reference design and prototype for a full-service Residential Gateway working with a consortium of Singapore based companies under the iDA-led Residential Gateway Task Force (RGTF) and the Broadband Applications Task force (BATF). This Residential Gateway was identified by iDA as a critical technology component in iDA's Connected Homes Programme. This programme aimed to develop, pilot, and deploy innovative and integrated end-to-end broadband solutions for Singapore homes.

A major collaboration and licensing deal was signed with a major Japanese MNC to develop a Radio Frequency Identification (RFID) system for deployment initially in Japan. The collaboration will also involve A*STAR's Institute for Microelectronics and is expected to be completed in FY03.

Other projects which received cash funding included:

- Wireless remote monitoring technology with PWD and Keppel Digihub
- Wireless Gateway technology with MediaCorp Radio and GoMobile
- Biometrics technology with Infineon Technologies AG

Sharing R&D Resources with the Industry

I²R's Prototyping facilities and the Anechoic Chamber were made available to a local company Gigawavetech for performance measurement of their communication design prototypes.

There were a significant number of conferences, seminars, and workshops organized specially for the industry. Total of 54 such events were accountable under this grouping. Of these, 20 were talks by visiting international experts, 12 were staff seminars which were open to industry and academic collaborators, and 8 other seminars were organized in collaboration with the NUS School of Computing for the summer school program.



The major international conferences held included the International Conference on Information and Communications Security (ICICS 2002), the International Conference on Optical Communications and Networks (ICO CN 2002) and the Personal Wireless Communications Conference. A Joint Singapore-Canada Workshop on "The Interface of Biology with Information Technology" was held in March 2003. The Communications Horizons Seminar was held for its ninth year. Other ad-hoc seminars organized included a CISCO- I²R Seminar and a Focus Seminar and Exhibition on Pervasive Multimedia in the 21st Century. All of those were geared towards industry and academic participation.

VI. Human Capital Developing

Science Outreach

Events for Reaching Out the Young

There were a variety of activities rolled out by I²R to attract the young to Science and Technology. They included:

a) A total of 5 activities were organised for Secondary Schools / Junior Colleges. E.g.

- “ICAAS-NLB Life Sciences @ Courtyard” series of public lectures. 7 lectures on life sciences were organized in FY02 for the general public, including secondary and JC students. Dr. Wong Lim Soon was the main organizer.
- “ICAAS-NLB IT @ Orchard” series of public lectures on information technology. 10 lectures were organized in FY02 for the general public, including secondary and JC students. Dr. Lee Hing Yan was the main organizer.

b) Mentorship Programs

This was not a form of student attachments where students came to RI for a few weeks during their vacation and the researchers asked them to do (or to watch) some of our works. Rather, it was students' own year-round on-going hobby carried out at their own time and own pace. They would meet the mentor(s) about 1—2 times a month to seek advice and discuss about their progress, issues, and thoughts. Usually, the projects were proposed by the students and adjusted through some brainstorming sessions with the mentors. A total of 2 Mentor-ship programs with Hwa Chong JC and MOE's Gifted Education Programme were conducted.

c) Community Services

- ICAAS Most Outstanding Junior College Science Student Award. Dr. Wong Lim Soon and Dr. Low Hwee Boon participated in the selection of the ICAAS Most Outstanding Junior College/Institute Science Student Award. Dr. Wong was the chairman of the selection panel. The award is organized by the Imperial College Alumni Association of Singapore
- Dr. Wong Lim Soon also participated in several selection and organizing committees such as National Science Talent Search, Defense Science Award, Tan Kah Kee Young Inventors Award Competition, Singapore-British Business Council Life Sciences Study Group Publishing Subcommittee.
- Dr. Low Hwee Boon is the co-chair for the Tan Kah Kee Young Inventors Award Competition organizing committee.

VII. Scientific Advisory Board

The members of the Scientific Advisory Board (SAB) for I²R are:

- Professor Kung Hsiang Tsung, Harvard University (Chairman)
- Professor Randy Howard Katz, University of California, Berkeley (Dy. Chairman)
- Dr Louis-Francois Pau, Ericsson Engineering
- Professor James L. Flanagan, Rutgers University
- Professor Jeffrey Ullman, Stanford University
- Professor John E. Midwinter, University College of London
- Dr Bernard S. Meyerson, IBM
- Professor Nikil Jayant, Georgia Centers for Advanced Telecommunications Technology

VIII. Other Significant Events and Awards

Other Significant Events

The institute hosted many local and international visitors in the course of the year from universities, research organizations, vendor companies, and government-affiliated agencies. The most significant visit took place on 28 January 2003 when the then Acting Minister of the Ministry of Information and The Arts, Mr. David Lim, led a delegation from various national agencies on a familiarization visit to the institute. Lord Ronald Oxburgh, Deputy Chairman of the SERC Board visited in August 2002. There were also visits by representatives of foreign governments like Japan, Mauritania and Canada. In FY 2002, there were at least 26 instances of interactions with the media in the form of media interviews, briefings, press releases and video features.



Awards

On the international front, Dr. Susanto Rahardja received the 2002 IEE Hartree Premium Award while the FaceStar technology won the Best Poster Technological Innovation at Biometrics 2002 in London.

P Shum, Y D Gong, M K Rao, C Lu, T H Cheng and D Y Tang won the best paper award for their paper "Closely Spaced Bound Solitons with FWHM Duration of 326fs and Separation of 938fs from a Passively Mode-Locked Fibre Ring Laser" at the 3rd International Conference on Microwave and Millimeter Wave Technology (ICMMT2002), China, August 2002.

Locally, I²R won a National Infocomm Award 2002 in the Most Innovative Infocomm Product/Service category for the muvee technology. They also won the TEC Innovator Award 2002 for Drowning Early Warning System (DEWS) and the Innovation Incubator Awards 2002 for the organization.

IX. Directions/Strategies for FY03

Directons

The recent Economic Review Committee reports, the Infocomm Development Authority (IDA) technology road maps, and articles from various government bodies, such as the Economic Development Board (EDB) and the Ministry of Information, Communications & The Arts (MITA), indicate several potential high growth areas within the infocomm technology sectors that Singapore should focus on. These areas can help transform the Singapore economy and include:

- Mobile client and services,
- Converged network infrastructure,
- Multimedia processing and management,
- Web services and portals, and
- Security and trust infrastructure.

I²R will help Singapore evolve from a value-added to a value-creation based economy. She will achieve this by focusing on 3 research areas that serve the industry sectors mentioned above, viz.

- Media
- Services & applications
- Communications & Devices

These 3 areas are selected because they benefit from I²R's distinctive core competencies and natural advantages arising from her diverse range of researchers, and because they represent research challenges that appeal to I²R's world-class researchers.

9 Key Tasks

We aim to create more intellectual property and know-how for Singapore; to expand R&D talent pool and undertake related R&D activities; to assist the local enterprises in climbing the technology ladder; as well as to attract major investments in manufacturing and R&D of advanced Infocomm systems and components to Singapore.

To achieve I²R's mission and to provide for both the current and future needs of the local infocomm industry, I²R has 9 key tasks as our goals. These are:

- Creating Intellectual Property
- Commercialising Intellectual Property

- Training RSEs
- Collaborating in R&D with Industry
- Sharing Human Capital with Industry
- Training Graduates and Postdocs
- Research Collaborations With Universities and Hospitals
- Science Outreach to Schools
- Sharing R&D Resources with industry.

Technology Roadmap

As mentioned earlier, the three broad areas of research undertaken by I²R are Services and Applications, Communications and Devices, and Media.

In Services and Applications, we intend to leverage and extend on our significant experience and know-how in technologies of the digital future – information security, network services, knowledge discovery, e-commerce and database infrastructure.

In Communications and Devices, we intend to focus on the twin pillars of wireless and optical technologies. The unifying theme is to deliver solutions for mobile, broadband and end-to-end multimedia communication applications based on converged Internet Protocol technologies.

In the domain of Media, we deal with the entire value chain of media, starting from the creation of the media, leading to its processing and analysis, followed by the production, distribution and presentation of the final media product. We intend to continue our distinctive and pioneering achievements in advanced media signal processing, media content analysis and production technologies. This area has also been singled out for nurturing by the Singapore ERC report on info communication.

These main efforts are supplemented by the New Initiatives Programme which has the twin responsibilities to (a) explore emerging technology areas that the institute has never worked in before, and (b) pursue integrative flagship projects that leverage on technologies from multiple departments.

X. Concluding Statements/Remarks

We have, indeed, gone through very major changes within the Institute as a result of the merger of ICR and LIT. We are confident that the new I²R will be in a better position to contribute to the development of human, intellectual and industrial capital. An exciting journey lies ahead with the opportunities of developing new synergies, both internally within the Institute as well as with our academic and industry partners. In particular, cross discipline competencies arising from the convergence of IT and Communications, will enable I²R to tackle new and complex technical challenges.

The achievements of the past year have demonstrated the core strength, resilience and relevance of the combined technical teams. We envisage that creative and innovative endeavours will continue to grow and to make an impact on Singapore's economy and advancement.