國家實驗研究院
National Applied Research Laboratories

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2009 NARL Annual Report 國家實驗研究院

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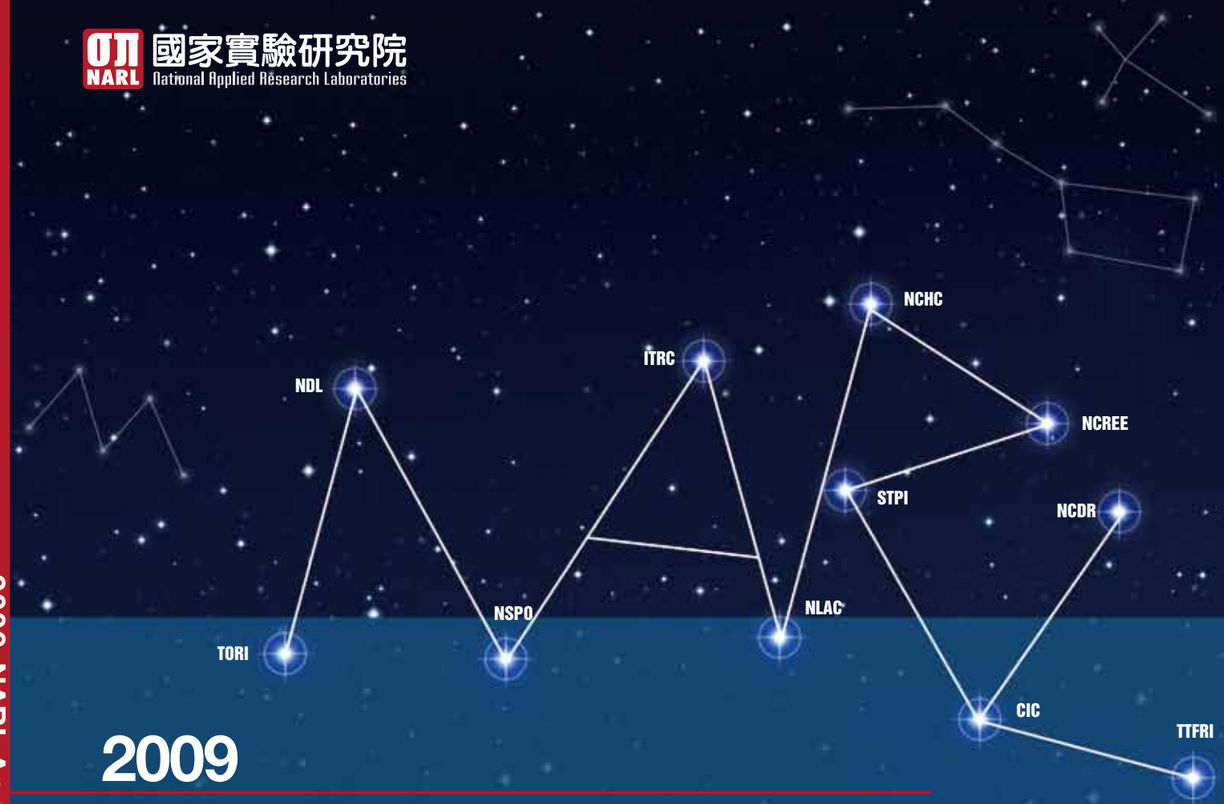
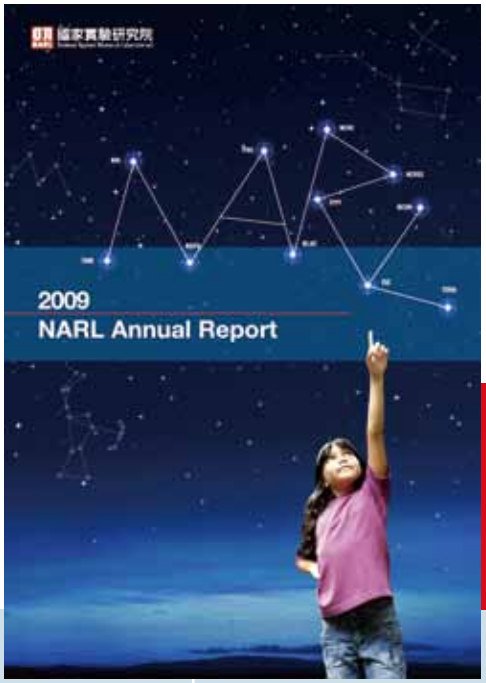


2009
NARL Annual Report



| Establish R&D platforms |
| Support academic research |
| Promote frontier science and technology |
| Foster high-tech manpower |

History

Establishing Year	Our Labs
1974	Instrument Technology Research Center (ITRC)
1974	Science & Technology Policy Research and Information Center (STPI)
1988	National Nano Device Laboratories (NDL)
1990	National Center for Research on Earthquake Engineering (NCREE)
1991	National Space Organization (NSPO)
1991	National Center for High-performance Computing (NCHC)
1992	National Chip Implementation Center (CIC)
1994	National Laboratory Animal Center (NLAC)
2003	National Science and Technology Center for Disaster Reduction (NCDR)
2003	**NARL was established** 6 labs became member laboratories of the NARL NDL, NLAC, NCREE, NSPO, NCHC and CIC
2005	2 labs became member laboratories of the NARL ITRC and STPI
2007	Taiwan Typhoon and Flood Research Institute (TTFRI, Preparatory Office)
2008	Taiwan Ocean Research Institute (TORI)

2009 Contents

Message from the Chairman

The National Applied Research Laboratories (NARL) has been in operation for more than 6 years. 2009 in retrospect, the third Board of Directors was assembled, which appointed Professor Wen-Hwa Chen as the third President. The new management team, based on solid NARL heritage, has shown great ambition to bring the nation's science and technology development into a new era.

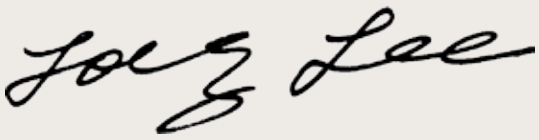
During the past few years, the NARL has grown from its original 6 research centers to current 11 with dedication to many key technological domains of the national priority agenda. In order to generate maximum benefits from its core capacity and facility, the NARL will not only continue to strengthen the momentum in developing individual research center's core technology but also foster cross-center synergy of multidisciplinary research. The NARL's frontier integrated research includes critical technologies with high societal impact or industrial competitiveness. It is the NARL's mandate to accord with government policy to create greater social benefits.

Effective and efficient management of the organization has been our primary goal and a formidable challenge since the NARL was founded. The NARL will continue to introduce modern management system and to harmonize administrative regulatory system. In addition, it will keep improving the practice of Activity Based Costing, ISO Standards, and Program Management System. Through solid implementation of these systems, the NARL is poised to transform itself into an organization of high efficiency and high quality.

Finally, the NARL welcomes suggestions and recommendations from international communities. Let us work hand in hand to make the world better by advancing science and technology.

Lou-Chuang Lee, Ph.D.

Chairman



Message from the President

Since its inception in 2003, the National Applied Research Laboratories (NARL) strives to establish research and development platforms, to support academic research, to promote frontier science and technology, and to foster high-tech manpower. All of these endeavors are to provide social benefits for individual citizens and society at large.

Over the last six years, the NARL has created impacts on science and technology development in the country, attributable to our colleagues' dedication and hard work. Recent achievements of industrial and social significance include the fabrication process of 16 nanometer semiconductor, applications of satellite imageries, seismic diagnosis and anti-seismic reinforcement for school buildings, etc. Many of these achievements have also won us international recognitions and accolades.

Moreover, the NARL is actively involved in research on environmental science and bio-medical technology, both are priority research and development areas in the country, and has made significant progress. In environmental science, the NARL has built the Climate Change Estimation and Information Platform, Disaster Forecasting/ Monitoring System, and High Frequency Radar Observation System for Ocean Surface Currents. In bio-medical technology, NARL developed Medical Visualization, Biomedical Sensor Chip and Genetically Modified Mice Production and Genotyping Analysis. Besides, the NARL serves as a think-tank that conducts research and engages in policy advocacy in issues such as energy, climate change, population aging, and declining birth rate.

The future will bring new challenges and opportunities in science and technology. In this connection, cultivating and reinforcing innovative edge, which ranges from breakthroughs that change the underpinnings of our society to new methods to solve particular problems, is more critical than ever to fulfill the NARL's missions. And this will require a strong foundation of quality research. Toward this end, the NARL is fully committed. In addition, the NARL strives to improve its administrative management system for research efficiency and effectiveness. The measures that are in place include the comprehensive standard operation procedures to ensure the quality and integrity of work carried out within the NARL, an electronic administrative management system to ensure regulatory compliance, and the incentive schemes to inspire both research and administrative staffs with enthusiasm and pride in pursuing productivity and excellence.

In the coming year, the NARL will continue to play a vital role in the implementation of the government policies to develop Hsinchu Biomedical Park and the Advanced Research Park. The former will focus on clinical research and translational medicine to boost Taiwan's biomedical industry, whereas the latter to bring industrial innovation in green energy to central Taiwan. The task is enormous and it requires support from national as well as international scientific communities.

Wen-Hwa Chen, Ph.D.

President

Organization

Board of Directors & Supervisors

Chairman	Lou-Chuang Lee
Managing Director	Jin-fu Chang, Cheng-Hong Chen, Andrew H. J. Wang, Cheng-I Weng
Director	Tai-Jen Chen, Wen-Tsuen Chen, Bruce Cheng, John Hsuan, Jong-Tsun Huang, Norden Eh Huang, Shie-Ming Peng, Chein Tai, Se Hwa Wu, Hsin-Su Yu
Executive Supervisor	Wen-Chang Chang
Supervisor	Wen-Ji Hwang, Der-Tsai Lee, Chin-Lien Yen

President | Wen-Hwa Chen

Vice President | Yeong-Her Wang, Kuang-Chong Wu

Headquarters

Planning & Evaluation Office	Director Jyun-Hwei Tsai
Business Development Office	Director Ming-Chih Cheng
Administration Office	Director Shiann-Jeng Yu
Finance & Accounting Office	Director Ching-Ping Lu
Auditing Office	Director Ying-Yun Lee
Information Management Office	Director Sheng-Hao Tsai

Laboratories

National Nano Device Laboratories (NDL)	Director General Fu-Liang Yang
National Laboratory Animal Center (NLAC)	Director General San-Chi Liang
National Center for Research on Earthquake Engineering (NCREE)	Director General Keh-Chyuan Tsai
National Space Organization (NSPO)	Director General Jiun-Jih Miau
National Center for High-performance Computing (NCHC)	Director General C. Eugene Yeh
National Chip Implementation Center (CIC)	Director General Chin-Long Wey
Instrument Technology Research Center (ITRC)	Director General Ding Ping Tsai
Science & Technology Policy Research and Information Center (STPI)	Director General Bou-Wen Lin
National Science and Technology Center for Disaster Reduction (NCDR)	Director General Liang-Chun Chen
Taiwan Ocean Research Institute (TORI)	Director General Forng-Chen Chiu
Taiwan Typhoon and Flood Research Institute (TTFRI) (Preparatory Office)	Director General Cheng-Shang Lee

(Organization structure as of December 2009)

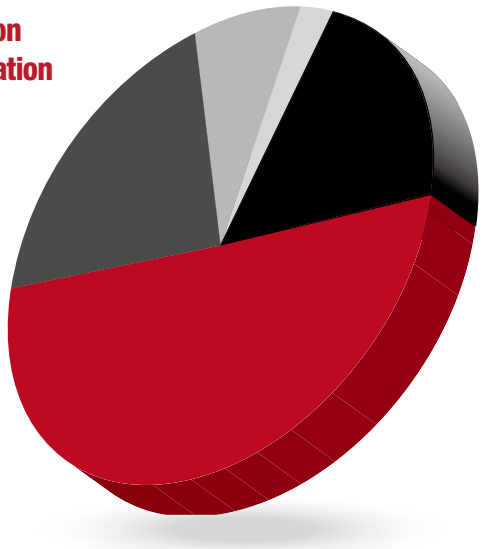
Human Resources

Number of Employee 1417

Human Resource Allocation

R&D Staff	779	55%
Engineer	135	9%
Technician	251	18%
Administrator	252	18%

Education Qualification



Doctoral Degree	261	18%
Master's Degree	716	51%
Bachelor's Degree	290	20%
Associates	119	8%
Other	38	3%

Employees per Laboratory

41	Headquarters	3%
162	National Nano Device Laboratories (NDL)	12%
127	National Laboratory Animal Center (NLAC)	9%
104	National Center for Research on Earthquake Engineering (NCREE)	7%
194	National Space Organization (NSPO)	14%
225	National Center for High-performance Computing (NCHC)	16%
113	National Chip Implementation Center (CIC)	8%
157	Instrument Technology Research Center (ITRC)	11%
121	Science & Technology Policy Research and Information Center (STPI)	9%
87	National Science and Technology Center for Disaster Reduction (NCDR)	6%
61	Taiwan Ocean Research Institute (TORI)	3%
25	Taiwan Typhoon and Flood Research Institute (TTFRI) (Preparatory Office)	2%

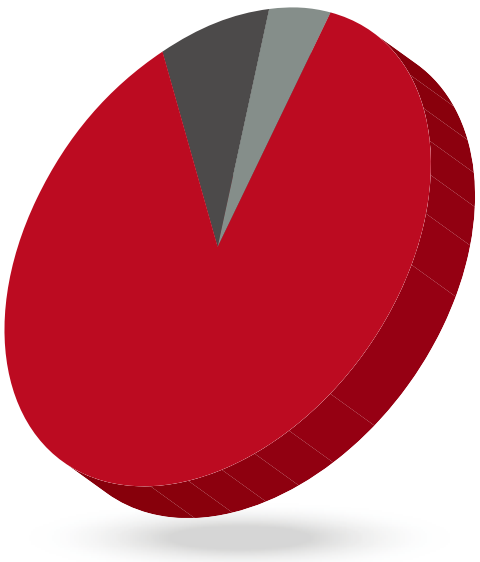
total : 1417

Financial Information

Revenue (FY 2009)

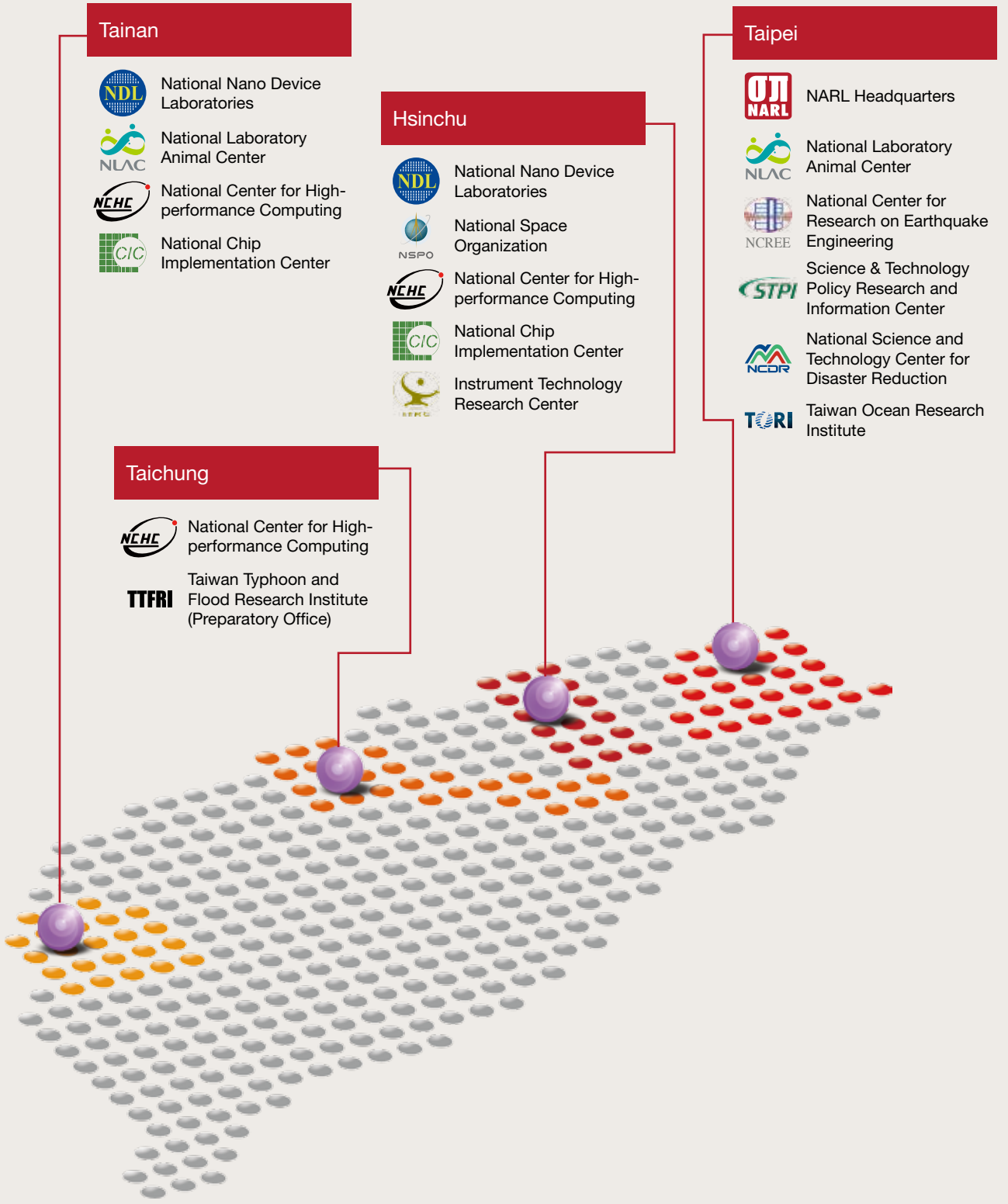
$M USD	Laboratories	%
5	Headquarters	3%
21	National Nano Device Laboratories (NDL)	13%
12	National Laboratory Animal Center (NLAC)	7%
9	National Center for Research on Earthquake Engineering (NCREE)	5%
48	National Space Organization (NSPO)	29%
28	National Center for High-performance Computing (NCHC)	17%
12	National Chip Implementation Center (CIC)	7%
12	Instrument Technology Research Center (ITRC)	7%
8	Science & Technology Policy Research and Information Center (STPI)	5%
4	National Science and Technology Center for Disaster Reduction (NCDR)	3%
5	Taiwan Ocean Research Institute (TORI)	3%
1	Taiwan Typhoon and Flood Research Institute (TTFRI) (Preparatory Office)	1%

total : 165 (Rate: $32.42)



Grant	87%
Fund Raised from Government Agency	8%
Fund Raised from Private Entity	5%

Location


Tainan
National Nano Device Laboratories
National Laboratory Animal Center
National Center for High-performance Computing
National Chip Implementation Center
Hsinchu
National Nano Device Laboratories
National Space Organization
National Center for High-performance Computing
National Chip Implementation Center
Instrument Technology Research Center
Taipei
NARL Headquarters
National Laboratory Animal Center
National Center for Research on Earthquake Engineering
Science & Technology Policy Research and Information Center
National Science and Technology Center for Disaster Reduction
Taiwan Ocean Research Institute
Taichung
National Center for High-performance Computing
Taiwan Typhoon and Flood Research Institute (Preparatory Office)

In Pursuit of Excellence

The mission of the NARL is to promote our society's advancement by developing cutting-edge technologies and catalyzing new opportunities for our nation's S&T development through vertical integration of scientific research. The NARL takes leadership to achieve synergy by concentrating resources and creating added value.

Establishing a world class research institute

In order to fulfill its mission, the NARL aims to establish a structured R&D platform, to support academic research, to promote frontier science and technology, and to foster high-tech manpower. Ultimately the NARL intends to transform itself into a research institute of world renown. The implementation plan is as follows:

- Establishing core technologies: developing frontier research with the following features: 1) clear objectives, 2) great potential to benefit our society, 3) conformity to international research community, and 4) long-term commitment.
- Expanding cooperative alliances: maximizing the efficacy of research capabilities by broadening cooperation with academic institutions, integrating with cross-agency national projects, and facilitating a strategic alliance.
- Increasing industrial applications: improving service to industry, elevating domestic industry's technological expertise, and increasing budget self-reliance by strengthening R&D service platform.
- Assembling elite professionals: attracting outstanding scholars and young graduates and improving training mechanism to foster high-tech R&D manpower.
- Promoting international cooperation: continuing to encourage exchange of researchers within the international community and publishing research results in academic journals and at international conferences, in order to cultivate the talented with a global vision.

Strengthening horizontal integration and achieving synergy

In order to achieve R&D synergy, the NARL has developed mechanisms to make full use of the human resources and research capabilities of its 11 research centers. These mechanisms include cross-center cooperation in the execution of research projects and sharing of researchers. The NARL continues to develop integrated projects in five major areas: environment & disaster reduction, nanoelectronics and system technology service platform, cyber infrastructure, space technology, and biotechnology laboratory resource & platform.

Improving performance management systems

In order to elevate the organization's operations efficiency, in addition to strengthening cross-center cooperation, the NARL continues to improve management systems in program control, budgeting, and procurement. An auditing system was also incorporated to maintain internal oversight and to ensure effective functioning of the systems. At a higher level, the NARL formulated a performance review and advisory committee to conduct performance evaluations. Through this process, the NARL is able to clearly identify core technologies, benchmark targets, key performance indices, and development strategies for each individual research center.

Interacting with people through publicity efforts and public outreach

The NARL has been making efforts to improve public relations to keep in touch with people and to gain popularity. It promotes public outreach through press releases and by holding press conferences. It is essential that NARL communicates its contribution to our society from the major R&D results with the general public.

Enabling NPO function by exercising operational flexibility

In order to increase operational flexibility and efficiency as a non-profit organization, the NARL is conducting a comprehensive review and revision of the organization's regulations, rules, and operating procedures. This will greatly improve the performance of its human resources and funding.

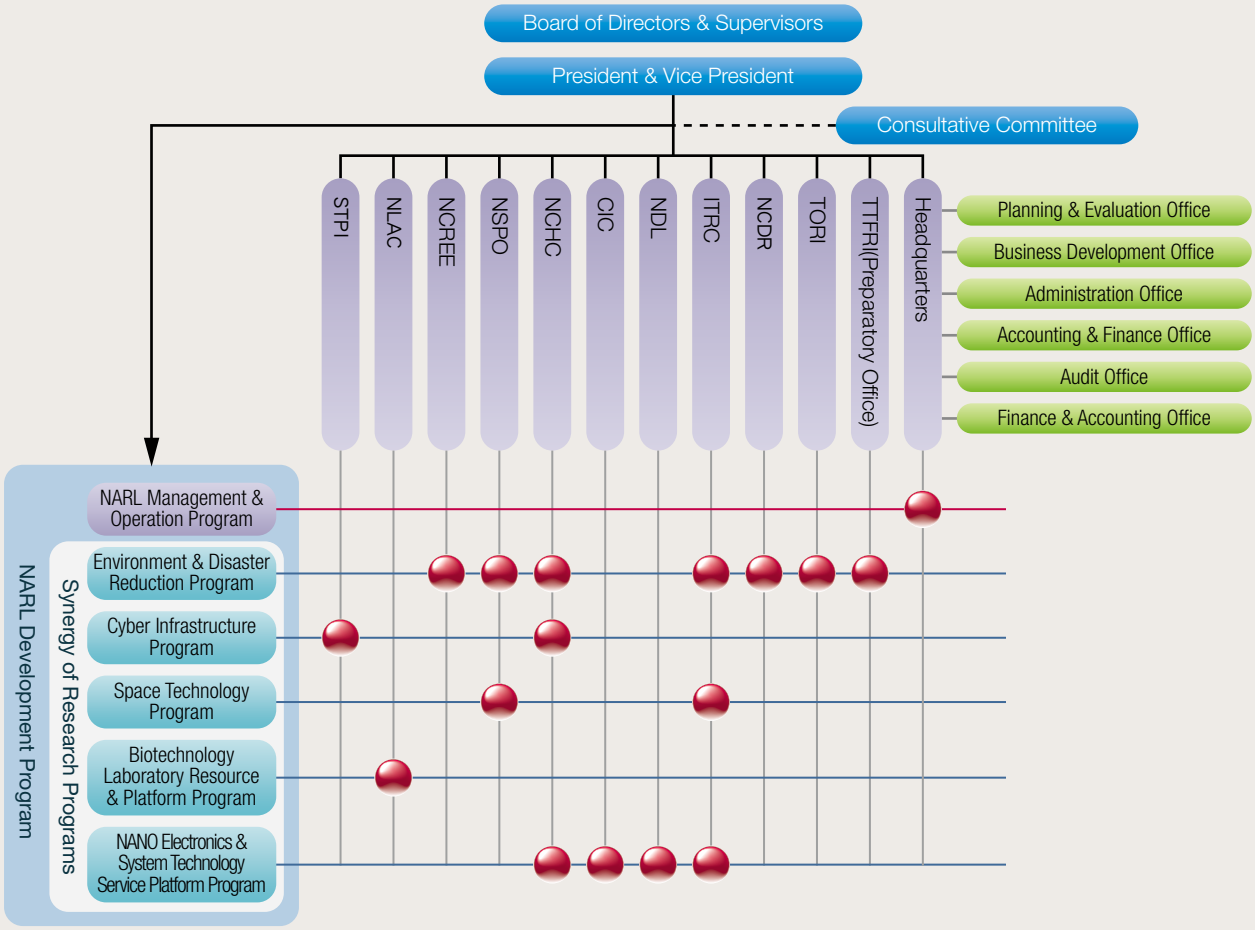
International Cooperation

Each year, the NARL signs several MOU's and MOA's with internationally renowned academic research institutions in the hopes of establishing collaborative research projects, technological cooperation, resource sharing, and exchange programs with other research organizations. Also, the NARL participates in various international conferences, symposiums, and other activities each year with the goal of sharing its research results and promoting its technological R&D accomplishments. The NARL has signed 72 cooperative agreements with research institutions in 22 nations from around the world.

Current status of international cooperation

Synergy of Research Programs

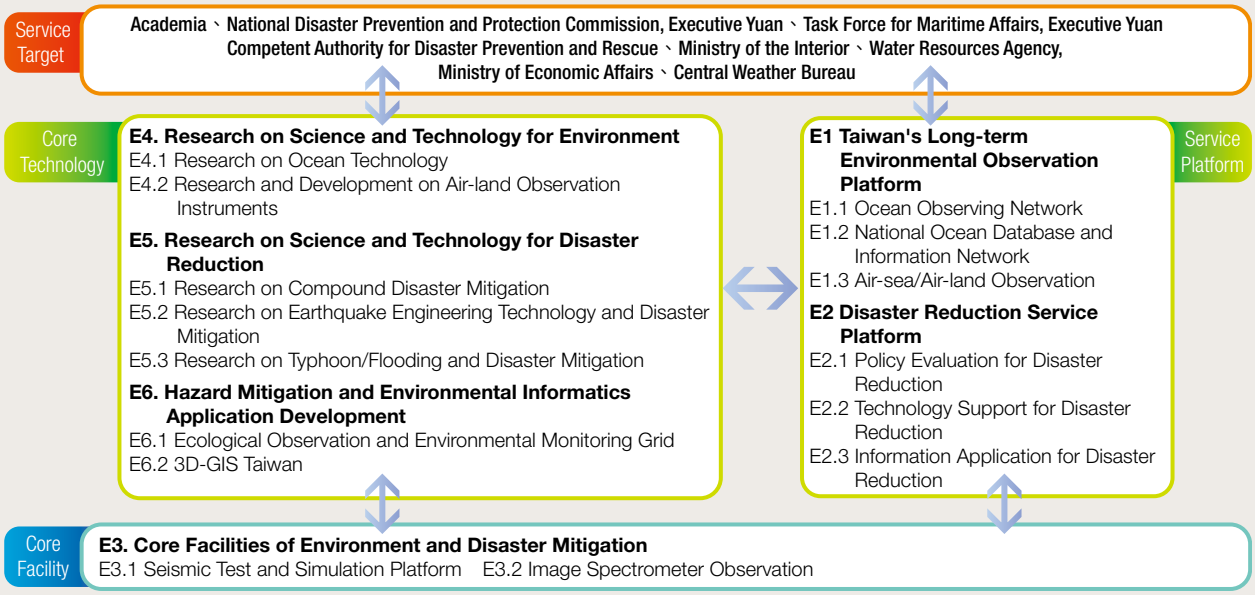
In order to help the Taiwanese government carry out mission/customer-oriented and application-integrated R&D, as well as to bring interdisciplinary cooperation into full play, the core technologies developed by the individual Centers under the NARL require integration. Considering the strength of each individual Center, the demands of society, as well as the trends in future developments, technologies from the NARL were grouped into the following five major domains: (1) Environmental Science and Disaster Prevention, (2) Nano-electronics and System Technology Services, (3) Space Technology Development and Service, (4) Biotechnology Support Platform, and (5) Frontier Technology Information. Integration programs for the corresponding domains were planned and reviewed as described below. Furthermore, Program Management Information System (PMIS), as well as the management meeting mechanism for the integrated programs, were planned. Each Center is fit into one or more integrated programs. 1 illustrates the integrated projects and organization of the NARL in 2009.



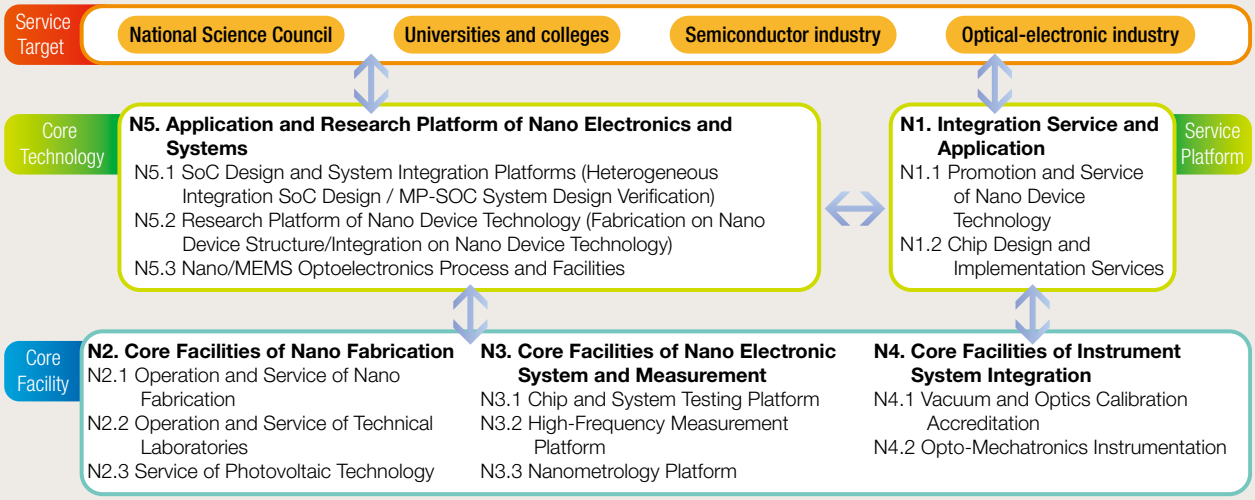
1 The NARL's matrix structure for the laboratories and major programs.

The integrated project of “Environmental Science and Disaster Prevention” is aimed at assisting domestic academic institutions in carrying out various studies that are connected to disaster prevention as well as the environment, and to gain a comprehensive understanding about Taiwan’s natural environment. In this project, the competence to monitor, simulate, and predict ecological changes in the environment will be acquired. They are essential for the development of various disaster prevention and resource exploitation technologies that will significantly reduce loss in an event of a disaster and improve the utilization of Taiwan’s natural resources. A total of six platforms will be established under this project including the “Long-term Monitoring Service of Taiwan’s Environment,” the “Disaster Prevention and Rescue Service,” “Major Facilities for Environment and Disaster Prevention,” “Environmental Technology R&D,” “Disaster Prevention Technology R&D,” and “Advanced Information Application R&D for Environment and Disaster Prevention.” The overall scheme of the integrated project is illustrated in (2).

The integrated project of “Nano-electronics and System Technology Services” project was established to provide the services and environment needed for the local academic institutions to perform nano-electronic and system technology R&D. Over the years, the NARL’s National Chip Implementation Center (CIC), National Nano Device Laboratories (NDL), and Instrument Technology Research Center (ITRC) have accumulated much experience in chip



2 The overall framework of the "Environmental Science and Disaster Prevention" integrated project

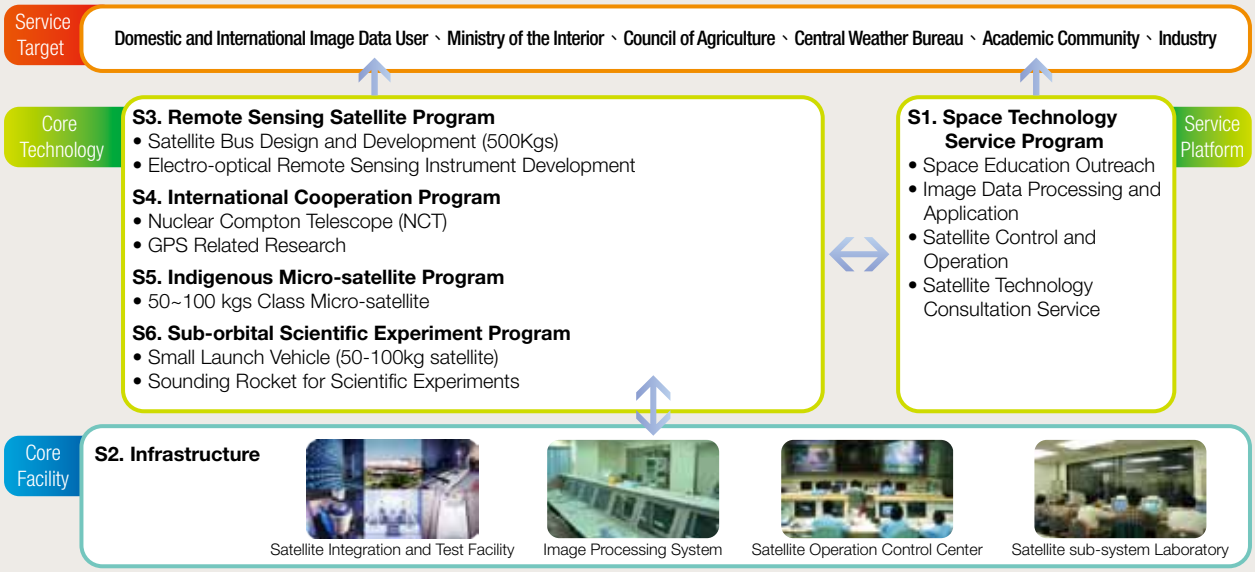


3 The overall framework of the "Nano-electronics and System Technology Services" integrated project

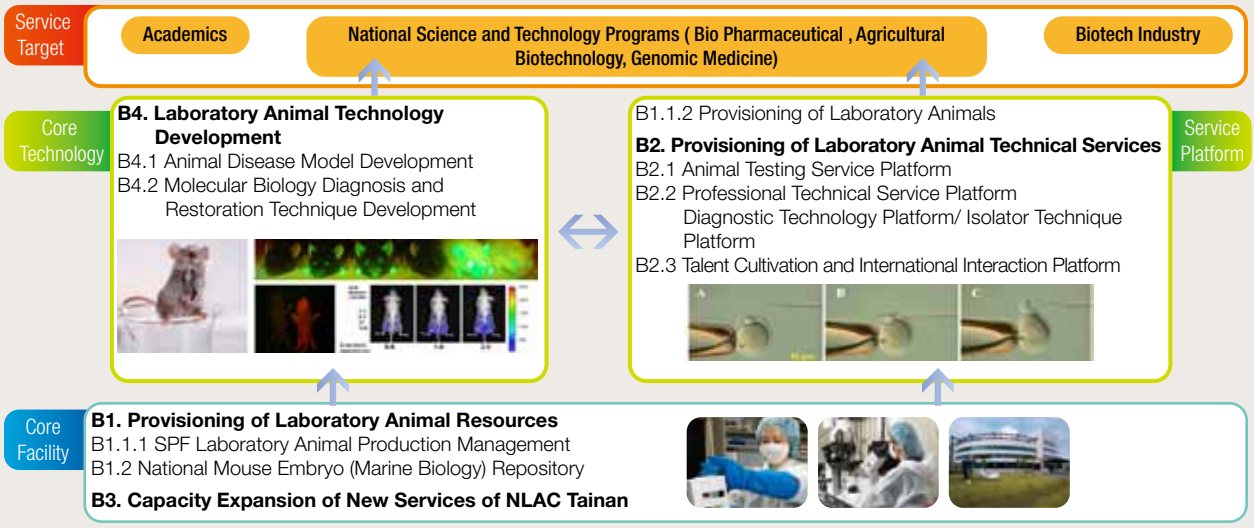
design, production process/equipment development, and instrument inspection. As part of this project, vertical integration-based service platforms, core facilities, and R&D platforms will be constructed. They will be called the "integration application service platform," the "nano production core facility," the "nano-electronic system measurement core facility," the "instrument system integration core facility," and the "nano-electronics and system application R&D platform." The overall framework of the integrated project is shown in 3 .

The mission of the integrated program of 'space technology development and service' is to (1) develop space technology for national needs, (2) establish solid satellite technology by integrating resources of industries, government, academia, and research institute, (3) perform pioneer space scientific research, and (4) promote satellite applications. The goals of the project are to develop the indigenous remote sensing satellite, fabricate the micro-satellite launched by self-developed launch vehicle, and establish a full-spectrum space technology. The overall framework of the program is shown in 4 .

The integrated project of "Biotechnology Support Platform" is targeted to (1) provide the bio databank (including laboratory animals) needed for carrying out national biotechnology development, (2) establish R&D platforms in areas including diagnostic technology, animal imaging technology, and animal disease models, and to support biotechnology development as well as to promote domestic research and industrial development in the life sciences, (3) construct the fundamental framework of biotechnology R&D platforms to support academic studies, and integrate the domestic biotechnology-related resources to provide services to research, academia, and industry to promote the development of the biotechnology industry. The overall framework of the integrated project is shown in 5 .



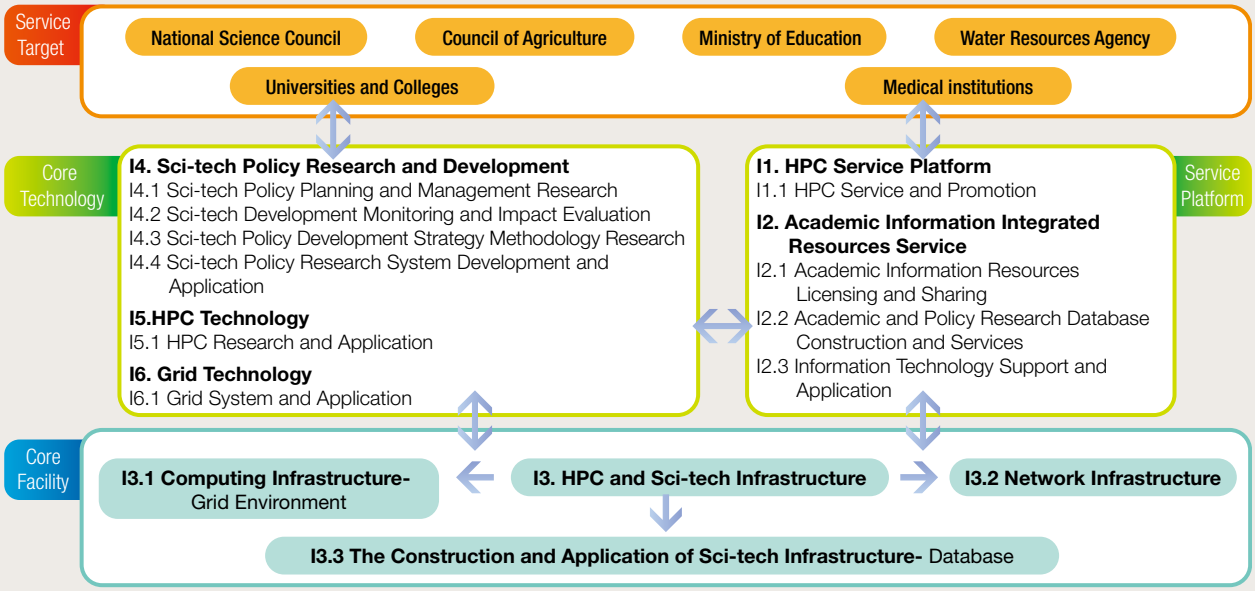
4 The overall framework of the "Space Technology Development and Service" integrated project



5 The overall framework of the "Biotechnology Experiment Resources Support Platform" integrated project

The integrated project of "Frontier Technology Information" is organized to integrate computational models, hardware, information resources & networking, digital sensing equipment, and visualization software. It acts as the cyber infrastructure for offering information technology services. It also provides high-performance computing and technology information fundamental facilities, a high-performance computing service platform, as well as a government academic information resource integrated service platform needed by domestic academia to carry out research. The R&D of high-performance computing technology, grid technology, and scientific technology trend study will also be highlighted in this project. This will be done in order to boost the development of frontier technology in Taiwan. The overall framework of the integrated project is shown in 6 .

Although the NARL projects are integrated into five major categories, each individual Center is still responsible for the related tasks, which makes the management of the projects more difficult. Therefore, in 2010, the NARL will carry out the "NARL Integrated Project" in order to facilitate inter-Center integration. The "NARL Integrated Project" is a cross-Center project established by the NARL after having performed the feasibility or pilot run study for the emerging integrated project. In 2009, a total of nine "NARL Integrated Projects" were planned. Some examples, as described below, include the Earthquake Early Warning System Development Integration Project, the 3D High-resolution Environment Observation Platform Development Integration Project, the Remote Sensing Instrument Technology Development Integration Project, and the Micro Biomedical Analyzing System Development Platform.



6 The overall framework of the "Frontier Technology Information" integrated project

(1) Earthquake early warning system development integrated project

In this integrated project, the R&D and application of the earthquake early warning system was developed jointly by the National Science and Technology Center for Disaster Reduction (NCDR), the National Center for Research on Earthquake Engineering (NCREE), and the National Center for High-Performance Computing (NCHC). The research is aimed to provide an early warning when occurring an earthquake. Before the arrival of the destructive seismic wave (S wave), an early warning signal is delivered to the users for which the apporiate emergency action can be done in advance to reduce the damage caused by the earthquake. The achievements in 2009 include the development of a new method in analyzing the body wave hypocenter parameter. This greatly reduced the prediction errors as well as the computation time. A structure rapid response assessment module is completed and the database of the structure dynamic response is established to increase the computation speed and accuracy. Finally, the system was built and site tested at Fanghe Junior High School in Taipei.

(2) 3-D, high-resolution environment observation platform development integrated project

In this integrated project, 3-D, high-resolution environment observation platform was established jointly by the National Center for High-Performance Computing (NCHC), the National Space Organization (NSPO), the Instrument Technology Research Center (ITRC), the Preparatory Office of Taiwan Typhoon and Flood Research Institute (TTFRI), the National Center for Research on Earthquake Engineering (NCREE), and the National Science and Technology Center for Disaster Reduction (NCDR) to aid the authority in disaster management and decision making . During the catastrophic flood of October 8, 2009 (88 flood), 3-D geographical environment data was immediately delivered to the disaster prevention authorities and was adopted to make strategic decisions for reducing the damage. The platform established in the present project is not only for the transfer of information, but help the authority make rapid response and correct decision. This is totally different from the well-known platform, Google Earth, which only provides user-specified information. The achievements in 2009 include the production of an immersion 3-D virtual reality interactive demonstration and a 3-D real-time scenery interactive viewer for the disaster areas caused by Typhoon Morakot. Moreover, the images before and after the disaster captured by FORMOSAT-2 were applied for comparisonusing the multi-texture technology.

(3) Remote sensing instrument technology development integrated project

In this integrated project, optical remote sensing instrument with ground resolution of 2 meters for black-white image was developed together by the National Space Organization (NSPO) and the Instrument Technology Research Center (ITRC) in coordination with the remote sensing satellite (FORMOSAT-5) project. The prupose of this project is to promote the independent capability of research and production of optical remote sensing instrument. The achievement in 2009 includes the completion of strategic plan for autonomous development of remote sensing instrument; key parts of the electronic units were manufactured domestically. In addition, the optical imaging system parameter design of the remote sensing instrument, the optical imaging system tolerance analysis, the confirmation of structural sub-system, the optical imaging system stray light analysis, and baffle design were completed.

(4) Micro biomedical analyzing system development platform

In this integrated project, a novel silicon nanowire field effect transistor was developed jointly by the National Chip Implementation Center (CIC), the National Nano Device Laboratories (NDL), the Instrument Technology Research Center (ITRC), and the National Center for High-Performance Computing (NCHC). Moreover, CMOS biomedical sensor, readout circuit and micro fluid channel integrated chip system platform were verified. A CMOS biomedical system integration chip testing environment was established. The achievements in 2009 include the attainment of the production and integration technology for sigma-delta analogy-to-digital converter, and the completion of prototype design, assembly and testing.

National Nano Device Laboratories

1988	The Executive Yuan approves the establishment of the National Submicron Meter Device Laboratories
1993	The Laboratory is renamed the National Nano Device Laboratories (NDL)
2002	The NDL is placed under the administration of the National Applied Research Laboratories (NARL)
2006	The NDL receives ISO 9001:2000 Quality Management certification
2007	The NDL's Nano Metrology Laboratory receives ISO 17025 certification
2008	The NDL receives ISO:27001 Information Security certification
	The Nano Metrology Laboratory signs a mutual research agreement with the International Laboratory Accreditation Cooperation (ILAC-MRA) on January 3rd, 2008

Futuristic Research and Breakthrough Innovation- 16nm Node New Device Technology

Taking the lead in worldwide nano device development, the NDL has created the first 16nm functional static random access ram (SRAM) single cell (1). This technology has the capability to fabricate over 15 billion transistors each with a device area of 1 cm^{2}. This is approximately 10x more than what the current 45nm node technology is able to achieve. The 16nm device effectively reduces the size of the circuit boards used in the manufacturing of computers and cell phones and, at the same time, lowers their power consumption. It also makes portable electronics slimmer and more compact. This new development was announced at the International Electron Devices Meeting (IEDM), considered the most important event for developments in the field of electronic devices, which was held in Baltimore, MD., USA, on December 9th, 2009. The corresponding paper was selected by the meeting committee as one of the five late news papers and was chosen as a meeting highlight by foreign electronic media such as EE Times, IEEE Spectrum, and Nikkei Business Publications.

In 2009, the NDL reported three key technologies involving the 16nm nano devices. They include Nano-injection Lithography, 320 degree low-temperature microwave activation, and the research of N-type Ge devices. As compared to the conventional optical lithography technology, Nano-injection Lithography employs a method that is similar to inexpensive printing and requires no photoresist or mask. This amounts to a cost savings on the entire mask set of more than USD 3 million and is free from the relatively complex interference encountered in photoresist. This provides a new lithography option for the semiconductor technology nodes of 16nm and beyond. Since this technology requires a relatively simple tool structure, it is capable of overcoming the physical limitations encountered by conventional optical lithography around 10nm. Also, it can be extended to the fabrication of devices with an ultimate dimension of 5nm. This represents a major breakthrough by the NDL in advanced integrated circuits.

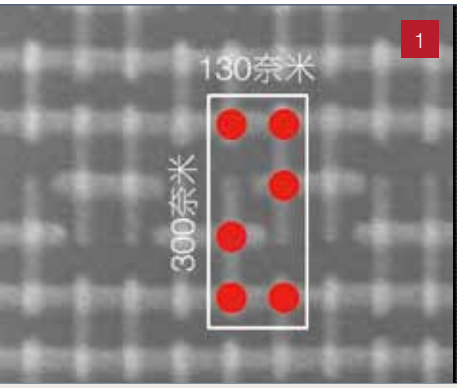
The NDL is also the first company to successfully reduce the conventional annealing temperature from over 900 degrees to 320 degrees by utilizing a microwave process. This new low-temperature activation technique will be key in the upcoming 3D IC fabrication. In the future, IC fabrication will utilize stacking, just like when building houses, to reduce the chip area and meet the "slim and compact" requirements of electronic products. Beginning with the 16nm device node, in order to achieve even faster device performance, research that focuses on replacing Si with Ge has gradually become a major focus. However, the study and progress of N-type Ge transistor development is still relatively slow. In order to address this issue, the NDL has developed a new fabrication process to further improve the carrier velocity of Ge transistors. This new process is expected to play an essential role in the future development of low-power devices.

While non-volatile memory (e.g. flash drives and solid-state hard disks) semiconductor-based devices show the fastest market growth, they will face a technical bottleneck when they reach the 16nm device node size and beyond. The NDL has recently developed a Si quantum dot energy-saving nano storage device which is the first energy-saving device of its kind that is able to store data directly on nano Si quantum dots using electrical fields. Since no current is required to change the state of the data, it is very energy efficient. Because of its tremendous potential in the non-volatile memory module business, having a market in the tens of billions of USD, the technology behind the development of this energy-saving nano storage device was chosen as the cover story for the October 5th, 2009 edition of the prestigious physics journal, Applied Physics Letters (2).

The NDL Provides Taiwan's Academic and Research Communities with Outstanding Nano Fabrication Core Facility Operations and Services

The Establishment of Four Major Research and Development Platforms

Starting December 1st, 2009, the NDL began providing the following four major research and development platforms to its academic and research communities:



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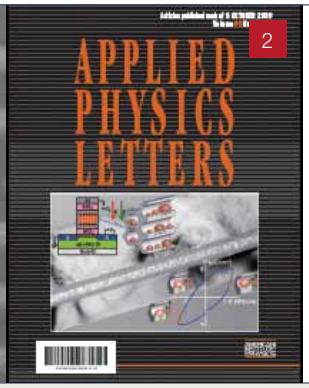

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Achievement Statistics

Scope of Performance	Item	Quantity	Unit
Service Results	Number of clients using facilities and technology services	490	Clients
Service Results	Number of dissertations published by users (incl. SCI and EI)	606	Dissertations
R&D Results	Number of dissertations published by the center (incl. SCI and EI)	191	Dissertations
Talent Cultivation	Number of users who received PhDs or Master	311	People
Talent Cultivation	Number of training participants	6,595	People
Talent Cultivation	Laboratory visitors	2,932	People

1 The 16nm node device (i.e. static random access memory or SRAM) developed by the NDL. As many as six transistors are located within the white box, which translates to a density of 15 billion transistors per cm^2. The capacity of such a device is approximately 10x that of the existing 45nm device and the power consumption is expected to be reduced by half. 2 Selected as the cover story for the renowned physics journal, Applied Physics Letters.

- **90 nm Silicon CMOS Device Service Platform**
  In order to meet the requirements of its academic and research communities for 90nm semiconductor device fabrication, the NDL established the 90nm Silicon CMOS device service platform which combines engineering improvements and process innovation with existing equipment and resources. Through device fabrication process services and technical consulting, users can conduct device fabrication and tests using cutting-edge techniques. These testing areas are not yet mature enough to be used in mass production. They are still in the experimental and theoretical stage and, therefore are more appropriately used within a flexible research environment.

- **Amorphous Si Thin Film Solar Cell Device Service Platform**
  In order to meet the requirements of its academic and research communities for thin film solar cell process research, the NDL is providing an amorphous Si thin film solar cell device service platform that features a system of multiple chambers and large-area process. Users can utilize the multiple-chamber large-area process system to conduct pilot studies on various materials or processes in order to develop thin film solar cells that have low material costs and are suitable for mass production. This, in turn, will allow domestic researchers to catch up with foreign research results in this area.

- **Microelectromechanical System Service Platform**
  In order to meet the requirements of its academic and research communities in the study of microelectromechanical systems, and to expand the technical services it currently offers, the NDL established a microelectromechanical system service platform that includes both surface and body micromachining techniques. This platform allows the NDL's industry, academic, and research communities to conduct studies on various MEMS devices such as metal surface and SOI body micromachining. Users can also pursue innovative studies on process modules such as the stacking and definition of four layers of metals, anisotropic deep etching of the dielectric layer, isotropic bulk Si etching, and isotropic wet etching.

- **Micro-Channel Chip Service Platform**
  In order to meet the requirements of its academic and research communities in the study of micro-channel chips processes, the NDL's Southern Taiwan Business Unit established a micro-channel chip service platform by integrating processes such as lithography, etching, and plasma surface treatment. Its functions include three bonding techniques: one for use with glass substrates and PDMS micro-channels, another for use with glass substrates with small electrodes (e.g. Al, Cr/Au, etc.) and PDMS micro-channels, and a third for use with Si substrate/SiO_2/SiNx and PDMS micro-channels. This micro-fluidic chip service platform can be implemented in areas of research such as micro-mixers, biomedical analysis chips, and micro biochemical reactions.

Established a Production Management System that Enables Users to Remotely Monitor Commissioned Projects in Real-Time

In order to effectively manage and track the process status during production, increase the production capacity and efficiency of the factory, and reduce production costs and risks, the NDL's Hsinchu Business Unit established and put into operation the Manufacturing Execution System (MES) on August 1st, 2009. With this system, users located in remote academic and research communities can conduct commissioned service application and setting of standard parameters of single or continuous processes. Also, by using the system's commission tracking function, users can get real-time information such as expected days to completion and the current status of their commissioned cases. By year's end 2009, there were 1,828 applications that were approved and processed using the system.

Improved Quality and Awarded ISO 17025 Certification

In order to improve the quality of its operation and efficiency and to increase its professional expertise in the laboratory and the credibility of its test results, the NDL's Nano Measurement Laboratory received ISO 17025 certification in 2007. By the end of 2009, five lab services including AFM step height measurement, SEM linewidth measurement, AFM line spacing measurement, TEM line spacing measurement, and SEM surface image observation, had been certified. Having been ISO 17025 certified, the NDL is aiming to provide excellent metrology services, improve the research quality of nano metrology, and move forward onto the world stage and the establishment of international connections.

National Laboratory Animal Center

1986	The National Technology Conference decides to establish a national-level laboratory animal center
1988	The Executive Yuan approves the establishment of a national-level laboratory animal center on Dec. 5th, 1988
1994	The National Science Council (NSC) establishes the National Laboratory Animal Breeding and Research Center
2003	The National Laboratory Animal Breeding and Research Center is officially renamed the National Laboratory Animal Center (NLAC)
2007	The NLAC receives full accreditation from the Association for Assessment and Accreditation of Laboratory Animal Care International(AAALAC International)
2008	The NLAC Tainan Facility becomes operational

The Rodent Model Resource Center (RMRC)

The exchange and sharing of information and resources regarding laboratory animals has become a global trend. The same can be said of the increased cooperation among laboratory animal centers. The primary goal of these interactions is to further enhance the sharing, use, and preservation of the resources between the repositories. As a result, repetition and waste are minimized. In striving to reach international standards, the RMRC, which began providing cryopreservation and breeding services in 2009, is actively forming alliances with repositories in and around Asia.

During 2009, there were a total of 60 cases of repository exchange (1), 90 cases of the mouse cryopreservation (2), 30 cases of derivation (3), and 12 cases of restoration (4) at the RMRC. Institutions and organizations that the RMRC provided these services to included, among others, Academia Sinica, the Institute of Biomedical Sciences, the Agricultural Biotechnology Research Center, the Genomics Research Center, the Institute of Cellular and Organisms Biology, the National Health Research Institute, the Institute of Cellular and System Management, National Cheng Kung University (NCKU), National Yang Ming University (NYMU), the Taipei Veterans General Hospital, National Taiwan University (NTU), Chang Gung University (CGU), National Sun Yat-Sen University (NSYSU), and the Tri-Service General Hospital.

Quality Control of Laboratory Animals

- The use of reverse transcription polymerase chain reaction (RT-PCR) in establishing mouse hepatitis virus tests is a breakthrough in the field because this technique ameliorates the failure of normal serological tests to detect, in the initial stage, MHV infection or signs of infection in mice with immune deficiencies.
- The use of RT-PCR in establishing Hanta virus detection techniques is a useful tool to expedite diagnosis. Together with the NLAC's Enzyme-linked immunosorbent assay (ELISA) and Immunofluorescent assay (IFA) diagnostic techniques, the efficiency and accuracy of detection is elevated.
- The establishment of Single nucleotide polymorphism microarray (SNP microarray analysis) enhances the accuracy of genetic mutation analysis. This further ensures the uniformity of the genetic background in strains, thus, enabling good repeatability and reliability of research results.

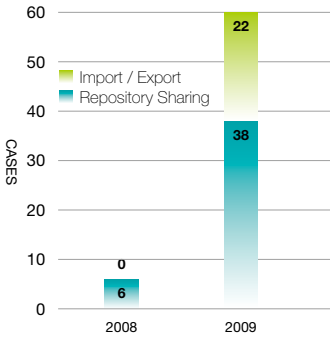
Animal Transportation Container Patent

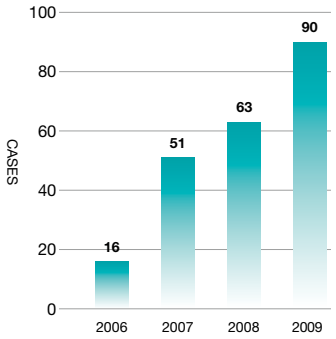
The Ministry of Economic Affairs, Intellectual Property Bureau, issued a patent to NLAC for its in-house-developed animal transportation container. Made of stainless steel, the container is not only safer for the animal and easier to move around, but also incorporates an anti-collision feature. Additionally, it transports the animal in a sterile and comfortable environment.

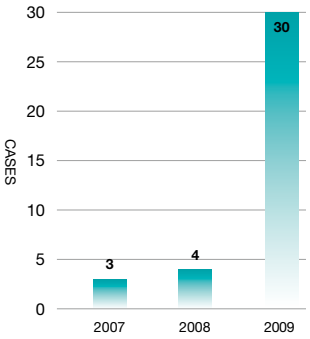
Publication of Laboratory Animal Resources System Strategic Plan

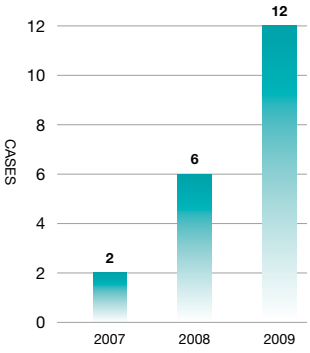
The Strategic Plan of the Laboratory Animal Resources System (5) was published in 2009. It includes the most up-to-date developments in the care of laboratory rodents; rabbits; dogs; guinea pigs; poultry; zebra; fish; non-human primates; and domestic animals. This publication brings together all the related knowledge from domestic experts to assist with the future development of laboratory animal resource supply systems.

5 Laboratory Animal Resources System Strategic Plan





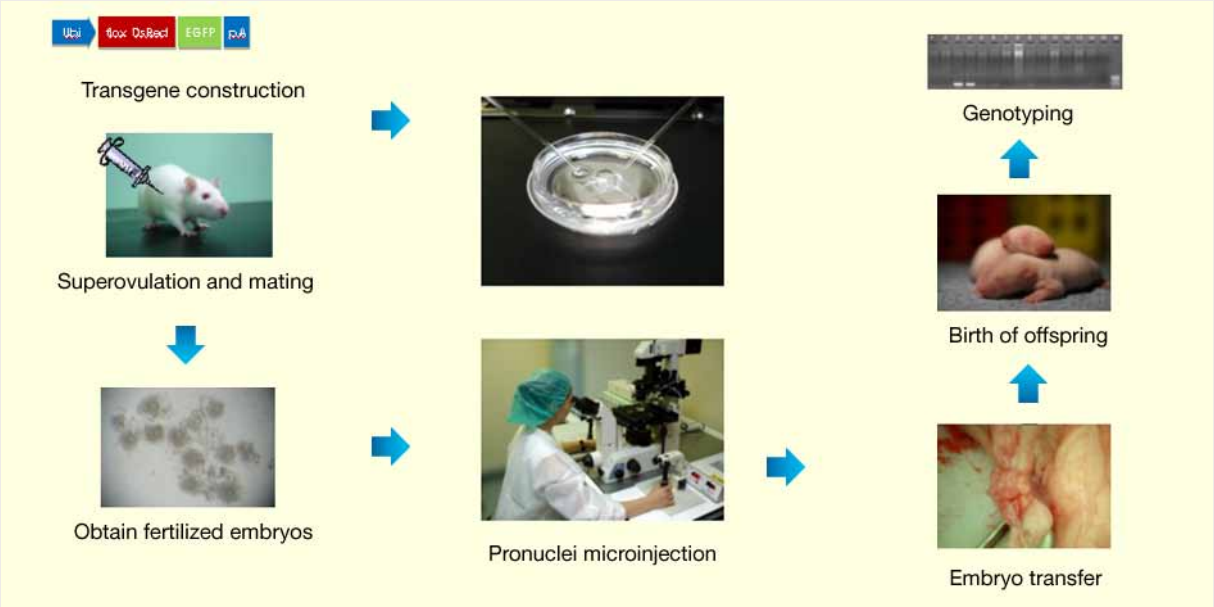




1 Repository Import/Export and Sharing 2006 2 Cryopreservation Services 2006~2009 3 Rederivation Services 2006-2009 4 Repository Restoration Services 2006~2009

Development of the Transgenic Technology Platform

- Successfully established and completed initial quality validation of the embryonic stem cell lines of a specific mouse strain (i.e. NOD.CB17 *Prkdc*^{scid}/J). and confirmed the pluratotipotency of NOD SCID stem cells (6) . The establishment of this platform will facilitate the future provisioning of embryonic stem cell techniques for specific mouse strains.
- NLAC successfully developed a transgenic rat production platform, rat embryo cryopreservation technique, and a SD strain fluorescent transgenic rat. This technique will be applied to future research and will be available as a service to the public, thus, enhancing the domestic development of laboratory animal science.



6 The Production Process of Transgenic Rat

Rodent Pathology Phenotyping Workshop

The NLAC organized the first Phenotyping Workshop in Asia . It included lecturers from Johns Hopkins University, School of Medicine, U.S.A., and Charles River Laboratories in Asia.

There were a total of 85 participants in the workshop including 3 from Singapore, 3 from China, and the remainder from Taiwan. A total of 45 participants attended the laboratory session. Of all whom attended, 55% rated the workshop as "very satisfactory" whereas 40% rated it as "satisfactory" in a survey measuring overall participant satisfaction with the proceedings. The laboratory sessions also received very positive feedback.

Achievement Statistics

Scope of Performance	Item	Quantity	Unit
Service Results	Laboratory mice sales volume	150,409	Animals
Service Results	Organizations using laboratory mice	138	Organization
Service Results	RMRC animal import/exchange & sharing of strains	60	Animals
R&D Results	Academic literature (SCI)	31	Articles
Talent Cultivation	Public education and training workshops/participants	1,384	People
Talent Cultivation	Laboratory visitors	485	People

NCREE

National Center for Research on Earthquake Engineering

1990 The Executive Yuan approves the establishment of the National Center for Research on Earthquake Engineering (NCREE)
1997 The NCREE headquarters building, including its large-scale structural laboratory, becomes operational
2003 The NCREE is privatized and placed under the administration of the National Applied Research Laboratories (NARL)

Seismic Evaluation and Retrofitting of Existing School Buildings

School buildings of all construction types were seriously damaged during the 921 Chi-Chi earthquake. Soon after, NCREE began developing technologies for seismic evaluation and retrofitting. As a result of its in-situ and laboratory experiment achievements, NCREE developed several seismic technologies including a simple survey method, a preliminary evaluation process, a detailed evaluation process, and a retrofit design method (1). NCREE then used this to help write the "Technology Handbook for Seismic Evaluation and Retrofitting of School Buildings." Also, NCREE provides expert earthquake technology training to school administrators and building engineers in Taiwan via training programs and workshops.

For the past several years, NCREE has been assisting the Ministry of Education (MOE) to establish a seismic database for the assessment and retrofitting of school buildings, and with collecting basic information such as the evaluation and retrofitting of all of Taiwan's school buildings. By establishing the actual seismic capacity of all of Taiwan's school buildings, this database has become the foundation for improving their seismic capacity.

Also, as part of Taiwan's Economic Recovery Act, NCREE assisted the MOE with arrangements to accelerate the retrofitting and rebuilding of elementary, junior high, senior high, and vocational school buildings in Taiwan. Currently, the program has a budget of NTD 18.27 billion for 2009~2012 and work has already begun. Moreover, NCREE established a School Project Office for this program to ensure that the work will be carried out in the most economical and effective manner.

In 2009, NCREE held 36 training programs on topics including both preliminary and detailed evaluations of existing buildings, retrofit designs, and review committee conferences. The total number of participants in these programs during 2009 was 2,624. Also during 2009, in cooperation with a total of 1,431 professionals, NCREE held 15 training workshops, authored and produced a technology handbook, developed a seismic evaluation method (i.e. Capacity Spectrum Method), and developed a seismic rehabilitation method for school buildings. Also in 2009, NCREE assisted the MOE conduct 1,267 peer reviews of retrofit designs with 485 school buildings passing. Of these 485 buildings, 93 have already been retrofitted. Also in 2009, NCREE hosted three observation/evaluation workshops, held in the Wan Fang and Da Tong elementary schools, that showcased the benefits of retrofitting.

Research on Seismic Capability of Bridges and Safety Monitoring

There are many old bridges in Taiwan that are at risk of becoming overloaded due to their age and deteriorating condition. These bridges are extremely susceptible to damage from natural disasters such as earthquake, typhoon, or flooding which could result in the loss of life. Over the past few years, NCREE has been monitoring the safety of Taiwan's bridges and working fervently to assess their seismic capacity. NCREE is committed to implementing its findings into practice.

In order to evaluate the seismic capacity of Taiwan's bridges, NCREE helped the Ministry of Transportation and Communications (MOTC) revise the "Regulational Provisions for Railway Bridge Design and Commentary" and the "Regulational Provisions for Seismic Design of Highway Bridges." NCREE also assisted the MOTC with the development of preliminary guidelines for the seismic assessment and retrofitting of existing bridges and applied these guidelines to retrofitting selected bridges on the Sun Yat-Sen Freeway (i.e. National Freeway No.1), administered by the Taiwan Area National Freeway Bureau (NFB), and selected bridges administered by the Directorate General of Highways. NCREE's research and development of bridge safety monitoring technologies was also used to assist the NFB with the Chi-Lu Cable Bridge retrofitting project and its follow-up safety monitoring. In addition, NCREE provided assistance to the National Freeway Bureau for the safety monitoring of the Yuanshan and Bitan Bridges.

Now that the laboratory testing for the bridge scouring monitoring technology has been completed, NCREE is utilizing this technique to assist the NFB to build and pilot a program for monitoring the bridges on National Freeways No.1 and No.3 that cross the Tachia River, as well as for the newly constructed Houfeng Bridge. This program will also help to validate the effectiveness and reliability of the new technology in field applications.

Regarding development of innovative technologies and construction schemes, NCREE assisted the MOTC with the development of bridge seismic isolation technologies that have been widely applied to the construction of new bridges throughout Taiwan. The precast segmental post-tensioned concrete bridge column is another innovative construction method (2). It is especially useful in environmentally sensitive and urban areas in that it minimizes the impact that bridge construction has on the environment and traffic

1 In-situ experiment of existing school building 2 The precast segmental post-tensioned concrete bridge column 3 Diagram of Earthquake Early Warning System (EEWS)

flow. This particular construction method was applied to the building of bridges in the Taichung metropolitan area.

The worst flooding in Taiwan's history came as a result of typhoon Morakot which hit Taiwan on August 8th, 2009. The flooding damaged over 140 bridges. NCREE worked in coordination with the government bridge authority and relevant academic units to carry out a reconnaissance project, the results of which showed that the damage to the majority of the bridges was directly related to the flooding. Most of the damaged bridges were located in mountainous areas and had damage that correlated with local watershed characteristics; rainfall intensity; river geology; channel change; bridge site location; abutment and pier scour conditions; and scour protection at abutments and piers.

To monitor bridge scour conditions, NCREE is working with the Taiwan Typhoon and Flood Research Institute (TTFRI) and the National Science and Technology Center for Disaster Reduction (NCDR) to promote the "Platform on Multidisciplinary Research and Design for Bridge Safety Monitoring." The project, slated to begin in 2010, will provide real-time monitoring information of rising water levels to corresponding government authorities and, as a result, allow them to draft an appropriate emergency response plan.

Earthquake Early Warning System (EEWS)

Advances in new technologies allow forecasters to predict the behavior of typhoons and floods in a much more accurate manner than ever before. Unfortunately, to date, there is still no effective method for predicting earthquakes, including the time of their occurrence, magnitude, or location. Since their occurrence cannot be predicted using today's technology, several earthquake-prone countries have began working together on an Earthquake Early Warning System (EEWS) (3).

In 2009, the NARL helped to coordinate and combine the NCREE, the NCDR, and the National Center for High-performance Computing's (NCHC) individual resources together to implement the inter-center "Development of Earthquake Early Warning System for Taiwan" project. This project uses the dense Taiwan Strong Motion Instrumentation Program (TSMIP) seismology array to detect the arrival of the early P wave tremors associated with earthquakes. This helps to determine the proximity of the earthquake's epicenter just after an earthquake rupture, and can also be used to determine the earthquake's magnitude and hypocenter within a matter of seconds. This early warning message can then be transmitted to other areas prior to the arrival of the much more destructive S wave train and, as a result, allow more time to appropriately respond to the emergency situation. Ultimately, this innovative system can help mitigate life and property losses caused by severe earthquakes.

In cooperation with the NARL, NCREE is currently working on the development of an On-site Earthquake Early Warning System (On-site EEWS). In addition to the EEWS, NCREE also developed rapid estimation modules for earthquake-induced structural response which are able to predict the structural responses in any location based solely on the input earthquake early warning message. When the estimated structural response exceeds the safety margin, the standard operating procedure for earthquake emergency response is automatically activated. This system is especially effective in reducing life and property losses in schools, hospitals and high-tech factories.

In 2009, NCREE tested the prototype On-site EEWS system on a shaking table. The experimental results show that it is, indeed, able to generate an early warning message prior to the arrival of the destructive S wave. NCREE will begin utilizing the On-site EEWS in field applications and collect the data from real events over the next two years. The first application objective for the On-site EEWS will be school buildings. A preliminary demonstration system for the earthquake warning message was installed and tested in Fanghe Junior High School in Taipei city. Based on these test results, the On-site EEWS applications will be further expanded to other schools.

Achievement Statistics

Scope of Performance	Item	Quantity	Unit
Service Results	Number of cases using facility and technical services	87	Cases
Service Results	Number of journal papers related to NCREE (incl. SCI,EI, and conference papers)	40	Papers
R&D Results	Number of journal papers published by NCREE (incl. SCI,EI, and conference papers)	143	Papers
Outreach and Education	Number of Masters/ PhDs participating in programs	91	People
Outreach and Education	Number of education training and visitors	4,069	People

National Space Organization

1991	The National Space Program Office (NSPO) is established to carry out the first stage of the 15-year "Space Technology Long Term Developmental Program," approved by the Executive Yuan
1999	FORMOSAT-1 successfully launches from Kennedy Space Center, U.S.A.
2003	The NSPO is placed under the jurisdiction of the National Applied Research Laboratories (NARL)
2004	FORMOSAT-2 successfully launches from Vandenberg launch site, U.S.A.
2005	The NSPO is officially re-named the National Space Organization
2006	FORMOSAT-3 successfully launches from Vandenberg launch site, U.S.A.

FORMOSAT-2 Imaging Technology Applied to Typhoons Research

In Aug. 2009, Typhoon Morakot ravaged the southern part of Taiwan causing horrific damage. As soon as the Central Weather Bureau (CWB) updated the tropical depression's status to that of a typhoon, the NSPO activated FORMOSAT-2's emergency wide-area image acquisitioning feature. This was done in an effort to provide the government with the most up-to-date information regarding the typhoon's developments, assess the severity of damage, as well as help with damage control.

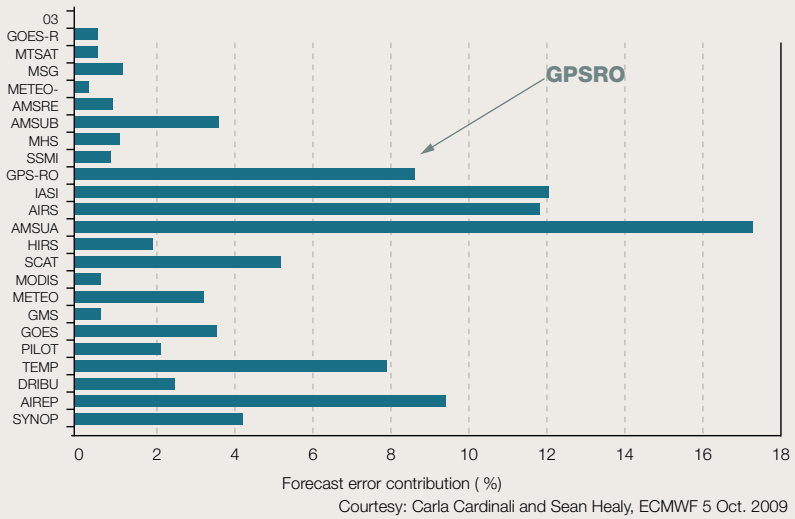
Typhoon Morakot made landfall on 08/07/2009. The NSPO began acquiring images of the affected areas on 08/08 in order to help with the initial assessment. As reports of major damage began to emerge on 08/09, the NSPO decided to activate wide-area imaging using a 5-segment acquisition plan from 08/10 to 08/17. The images acquired during this period provided an important and timely means for the Central Emergency Operation Center (CEOC) to assess the impact of the storm and the damage it caused.

1 shows the pre-and-post Typhoon Morakot images taken by the FORMOSAT-2 satellite of Xiaolin village which is located alongside the Chishan River. The images clearly show the devastating impact that Typhoon Morakot had on the village in particular and the southern part of the island in general. The images acquired by FORMOSAT-2 proved helpful in identifying regions that were heavily damaged and, as a result, were likely to have people living in potentially hazardous living conditions. The NSPO also utilized these images and other data acquired by FORMOSAT-2 to assist in post-disaster reconstruction and recovery.

FORMOSAT-3 Science Data Applications

The FORMOSAT-3 satellite constellation has been in orbit since April 15th, 2006. Three months after the commissioning of the six satellites, all of RO measurements collected by FORMOSAT-3's satellites were freely distributed to registered users located across the globe. With the commissioning of the FORMOSAT-3 constellation, a new chapter has been written in meteorology research and weather forecasting, in which the NSPO and Taiwan have already won international acclaim in the past. This project is also unanimously regarded by its community of users as "the most accurate, precise, and stable atmospheric thermometer in space!"

By the end of 2009, there were more than 1,214 registered users representing 50 different nations receiving measurement data from FORMOSAT-3. Also, weather forecasting centers located in the EU, the United States,



Courtesy: Carla Cardinali and Sean Healy, ECMWF 5 Oct. 2009

2 RO measurements contribution to the prediction error reduction

1 Pre-and-post Typhoon Morakot images of Xiaolin village

Japan, and Korea have incorporated FORMOSAT-3's measurements into their systems as well. Beginning July 2009, Taiwan's Central Weather Bureau also formally began including FORMOSAT-3 RO data in their weather forecasting.

Researches worldwide recognize the significant contribution of FORMOSAT-3's measurements to numerical weather prediction both on a local and global scale. As an example, FORMOSAT-3 RO data was used to successfully predict the route of Typhoon Shanshan in 2006, Typhoons Sinlaku and Kalmaegi in 2008, and Typhoon Morakot in 2009. Also, a report filed in October, 2009 by the European Centre for Medium Range Weather Forecasting (ECMWF) revealed that RO measurements, which account for 4.7% of all measurements collected by satellites including airplanes, contributed 8.5% to their prediction error reduction effort. This means that RO measurements rank #5 as a performance indicator among 24 meteorological observing systems (2). This, in turn, implies the outstanding contribution FORMOSAT-3's RO measurements make toward weather prediction model accuracy.

FORMOSAT-5 & FORMOSAT-3 Follow-on Missions

FORMOSAT-5 makes up the most significant satellite program of Taiwan's 2nd Phase Space Technology Development Plan (2004~2018). FORMOSAT-5's mission will serve as a follow-on mission of FORMOSAT-2, that is, to continuously provide images for domestic and global users. The FORMOSAT-5 program will also serve as a test of Taiwan's self-reliance in space technology. The FORMOSAT-5 satellite will be deployed in a sun-synchronous orbit with an altitude of 720km and a re-visit cycle of two days. In order to perform earth observations, FORMOTSAT-5 will carry an electro-optical Remote Sensing Instrument (RSI) with ground resolutions of 2m panchromatic band and 4m multi-spectrum band.

The FORMOSAT-5 Program completed a System Design Review (SDR) in 2009. The FORMOSAT-5 program has also accomplished the following objectives during 2009: (1) developed a satellite bus design demonstration, the focus of which is on clarifying the subsystem design requirements, the layout of the spacecraft components, and the remote sensing instrument's configuration, (2) held a FORMOSAT-5 user conference for domestic remote sensing image users to update FORMOSAT-5's payload acquisition strategy revision and imaging simulation results, (3) held the FORMOSAT-5 delta System Design Review (SDR) to review the action items arising in the SDR meeting and requirement updates, (4) revised the FORMOSAT-5 Implementation Plan (i.e. revised vision) to review FORMOSAT-5's self-reliant, remote-sensing payload strategy and confirm its expected 2013 launch date.

Based on FORMOSAT-3's RO data impact on meteorological research, several institutions located in the United States, the UK, Germany, Demark, and Korea have signed memorandums on mutual research collaboration. As a result of this cooperative framework, Taiwan has been able to access data from several of its partners, thus, significantly reducing constraints on meteorological data sharing. The meteorological data sharing agreement between Taiwan and the ECMWF is a great example of this. Given the enormous success of the FORMOSAT-3 program, in 2007, the World Meteorological Organization (WMO) recommended that international collaborations on RO observations continue. They also urged the NSPO to continue its current mission. Also, the NSPO and the National Oceanic and Atmospheric Administration (NOAA) have taken the initiative to plan a future mission that will continue to provide benefits for the global weather community.

FORMOSAT-3 is expected to have a mission life of five years, ending in 2011. The new system, which is currently in the planning stage, has the potential to provide up to 14,000 RO soundings per day. This represents a density five times that of the current system. This will help ensure that FORMOSAT-3 continues to benefit Taiwan and the world. The FORMOSAT-3 constellation represents a new chapter in research on meteorology and weather forecasting, and has increased the profile and reputation of both the NSPO and Taiwan. The project's mission planning report is completed and is currently being reviewed by the NSC.

Achievement Statistics

Scope of Performance	Item	Quantity	Unit
Service Results	Registered facility and technical service users	165	Users
Service Results	Satellite images requested	2,390	Images
R&D Results	Thesis/journal paper publications (incl. SCI and EI)	244	Papers
Education Outreach	Masters or PhD student participation	72	Persons
Education Outreach	Training	422	Persons
Education Outreach	Laboratory visitors	3,100	Persons

National Center for High-performance Computing

1988	Taiwan's National Science Council (NSC) proposes the establishment of a national-level supercomputing center
1991	The 5-year establishment plan for the National Center for High-Performance Computing (NCHC) receives approval by Taiwan's Executive Yuan
1993	The NCHC's Hsinchu headquarters begins offering HPC services
2003	The NCHC transforms from a governmentally-funded institute into a corporation
2005	The NCHC receives ISO 9001:2000 Quality Management Certification

The NCHC: Continuously Improving HPC and Networking Services

In 2009, the NCHC continued its support of domestic academic research with its HPC resources including advanced, stable networking, and data storage services. By the end of the year, the NCHC's total computing capacity had reached 31 TFlops and its storage capacity 1.7 PB. The NCHC also completed the planning of a new mainframe. Also in 2009, the NCHC's HPC resources supported a total of 768 NSC projects (just shy of the goal set at the beginning of the year of 830), 40 specialized programs, and 675 published user reports and papers.

The NCHC's Taiwan Advanced Research and Education Network's (TWAREN) overall service availability was 99.99% throughout 2009. By the end of the year, there were a total of 89 domestic academic and research institutions connected to TWAREN serving 500,000+ individuals. Also during 2009, there were a total of 4,062 domestic academic and research institutions connected to the NCHC's Taiwan Academic Network (TANet) serving 4.5 million individuals. TWAREN also made three new international connections during 2009 to Japan's SINET3, the pan-European network, GÉANT, and the Netherlands SURFnet research network.

The NCHC's 2009 HPC and Networking Research Achievements

Mastering the New-Generation GPU Computing Technology

The NCHC has amassed a great deal of practical hands-on experience in utilizing the GPU's powerful computing capabilities. The NCHC used the GPU to create increased efficiency and improve its computer systems specifications. In 2009, the NCHC's GPU Research Team completed the building of a hybrid CPU + GPU cluster computer. This new and exciting computing environment provides a novel computational testing platform for domestic academic and research institutions. During 2009, The NCHC's GPU Research Team developed five programs that use the GPU exclusively and four hybrid programs that use both the CPU and the GPU to accelerate computation, thus, saving researchers valuable time.

Improvement and Innovation- The TWAREN Network Monitoring and Management System

The NCHC's newly developed large-scale mixed-use TWAREN Network Monitoring and Management System had a number of new technologies and features implemented in 2009. These new developments include a range of dynamic threshold-based forecasting techniques that predict the future performance of the network as well as improve the system's warning efficiency. As a direct result of the new enhancements to the TWAREN Network Monitoring and Management System, the NCHC went without a single false network alarm throughout 2009.

The TWAREN Network Monitoring and Management System automatically detects trends in the quality of the network and is able to predict network problems in advance. This, in turn, enables NCHC's networking engineers to put into place preventive measures that effectively reduce the probability of service interruptions.

Also, the TWAREN Network Monitoring and Management System incorporates value-added features such as an easy to use web-based design, remote monitoring of the network backbone, a unified login system, and customized monitor reporting. These features help satisfy the needs of TWAREN's various agencies (1).

The NCHC's 2009 Grid Computing Service Results and New Supercomputer Acquisitions

The continuing development of Grid middleware is one of the NCHC's primary development technologies. In 2009, the NCHC continued its development of distributed computing Grid middleware with the release of its cross-platform Grid WebOS. The Grid WebOS platform combines grid technology with WebOS to offer grid users a friendlier and more easy to use grid environment. Grid WebOS is both user-friendly and more straightforward than traditional Grid interfaces and allows for greatly increased ease of use of distributed grid resources (2).

In 2009, the NCHC built a new grid computing platform made up of its IBM 1350 PC cluster (2,048 CPUs), its Formosa 2 PC cluster (320 CPUs), and National Cheng Kung University's (NCKU) Sun Grid Engine (512 CPUs). This new grid computing platform helped the NCHC achieve heterogeneous platform integration of resources and enhance its computational competitiveness during 2009.

1 TWAREN's integrated network monitoring platform

2 Modeling done by Grid WebOS of pre and post respiratory distress syndrome operation (post operation on the right)

The NCHC's 2009 Promotion of Cross-Regional Resource Sharing

In 2009, the NCHC used its accumulated experience to make further enhancements to its Co-Life video teleconferencing platform. Co-Life is an advanced communication and cooperation platform for group meetings, projects, and lectures. Co-Life is able to simulcast up to 29 individual video streams simultaneously. It can also be used as an educational distance learning platform, for inter-institution meetings, and international academic exchange. Co-Life has been promoted and used across Taiwan in its schools to help overcome the current domestic teacher shortage as well as to share educational content and training materials. The benefits Co-Life offers have proved quite substantial.

The NCHC's R&D Receives Award-Winning Recognition

The NCHC has won yet another Science & Technology Contribution Award. The first such award was awarded to Dr. Fang Pang Lin in 2006. In 2009, NCHC Researcher, Steven Shiau, leader of the NCHC's Open Source software development team, won the award for the DRBL/Clonezilla software his team developed (3).

The Open Source-based free DRBL/Clonezilla software is used to quickly build a large centralized computer management environment for the computer classroom or office. DRBL/Clonezilla's resource consumption is small but its usefulness is quite large in comparison. DRBL/Clonezilla software is especially useful in the educational sector where it simplifies and greatly reduces the costs involved, both in terms of time and money, in managing computers.

The NCHC's 2009 Education and Promotion Results

In order to help meet the growing domestic demand for IT professionals, the NCHC conducts a variety of HPC and network-related courses each year. Via these courses, the NCHC trained 2,000+ computing, scientific, engineering, and technical personnel and professionals throughout 2009.

The NCHC also organizes and hosts science education and K-12 HPC training camps each year in order to promote science and technology education among Taiwan's youth. In 2009, the NCHC hosted a total of 13 such activities throughout the year.

The NCHC's 2009 international promotion achievements and activities included organizing and hosting the HPC Asia 2009 & Asia-Pacific Advanced Network 2009 (APAN 2009) conference and exhibition, the region's most important international HPC conference. Also in 2009, the NCHC hosted a booth at the European-based International Supercomputing (ISC09) conference as well as the US-based Supercomputing (SC09) exhibition. During these exhibitions, the NCHC demonstrated its outstanding 2009 R&D achievements to its HPC community. These international events served to greatly increase the visibility of the NCHC throughout the international HPC community and created new opportunities for international cooperation.

Also in 2009, for the fifth consecutive year, the NCHC hosted the Southeast Asia International Joint Research and Training Program in High-Performance Computing Applications and Networking Technology (SEAIP). This event resulted many new and exciting opportunities for international cooperation as well.

3 NCHC's DRBL and Clonezilla team accept the Executive Yuan's 2008 Award of Contribution to Science & Technology

Achievement Statistics

Scope of Performance	Item	Quantity	Unit
Service Results	Published user reports (incl. SCI and EI)	675	Articles
R&D Results	NCHC published reports (incl. SCI and EI)	181	Articles
R&D Results	HPC capacity	31	TFlops
R&D Results	Storage capacity	1,700	TBs
Training	Education and training	2,314	Attendees
Training	Laboratory visitors	3,123	People

National Chip Implementation Center

1992	The National Science Council (NSC) initiates the Chip Implementation Center Project (CIC Project)
1993	The Project Office is established in the Hsinchu Science Park
1997	The Project is officially named the National Chip Implementation Center (CIC)
2002	The CIC's South Region Office is inaugurated in the Tainan Science Park
2003	The CIC becomes one of the centers under the framework of the National Applied Research Laboratory (NARL)
2007	The CIC's South Region Office relocates to the Chi-Mei Building at National Cheng-Kung University (NCKU)

Integrating and Developing the IC/System Design Environment

The CIC has developed a complete integrated circuits (IC) system (IC/S) design environment in order to meet the future demands of academic research and industrial development. This environment consists of efficient design flows that integrate the Electronic Design Automation (EDA) tools used in today's IC industry. It also utilizes the standard cell library and silicon IPs. The design flows include Electronic System Level (ESL); Cell-based IC, Platform-based SoC; Full-Custom IC; Field-Programmable Gate Array (FPGA); Mixed-Signal IC, RF/MM IC; and MEMS and IC measurements. The EDA tools come from 17 world-class vendors.

In order to satisfy the development of embedded systems, in 2009, the CIC also provided academic researchers with three domestic embedded system platforms (i.e. SunPlus S+Core-SPCE3200 (S+Core-7), AndesCore N1213, and PAC-PMP) including training courses and technical consultation in support of them. The CIC recently developed a MorFPGA platform module that includes a LCD touch panel module for video and audio multimedia applications and three memory modules (1). The MorFPGA platform can be used for instruction, contests, and project research.

Also in 2009, another new LCD touch panel module was built on the MorFPGA platform. It was built for multimedia audio and video applications such as those containing PCB Layout. In order to help academic SoC teams verify chips and solve shortages in MP-SoC, the CIC also developed technology on Multi-Die-Module (MDM) and Silicon in Package (SiP) during 2009.

Providing Chip Fabrication and Measurement Services

In order to meet the future demands of the IC design industry and to foster the education of high-quality IC design professionals, in 2009, the CIC offered several advanced processes to domestic foundries and established several IC fabrication service flows for local academia. Throughout the year, the CIC offered the following nine processes by domestic foundries for use by academia: UMC N90 1P9M CMOS Low-K Process; TSMC 0.13 μm 1P7M RF CMOS; TSMC 0.18 μm 1P6M CMOS; TSMC 0.35μm 2P4M CMOS; TSMC 0.35μm 2P4M CMOS using APM post-CMOS MEMS process; TSMC 0.35μm 2P4M CMOS using APM post-CMOS bio-MEMS process (including gold layer); TSMC 0.18μm 1P6M CMOS using APM post-CMOS MEMS process; TSMC 0.35μm 3P3M SiGe BiCMOS; and WIN 0.15μm pHEMT.

In order to share resources and further reduce fabrication costs, in 2009, the CIC provided 2,633 IC design services and 1,621 chip implementation services including 123 advanced 90nm chips, a 44.7% increase over 2008. The CIC is designing Complementary metal–oxide–semiconductor (CMOS) high frequency applications in the Millimeter Wave design technology for use in 60GHz (and higher) system applications. This achievement was published at the International Solid-State Circuits Conference (ISSCC) 2009. The CIC is also working to establish a better verification environment.

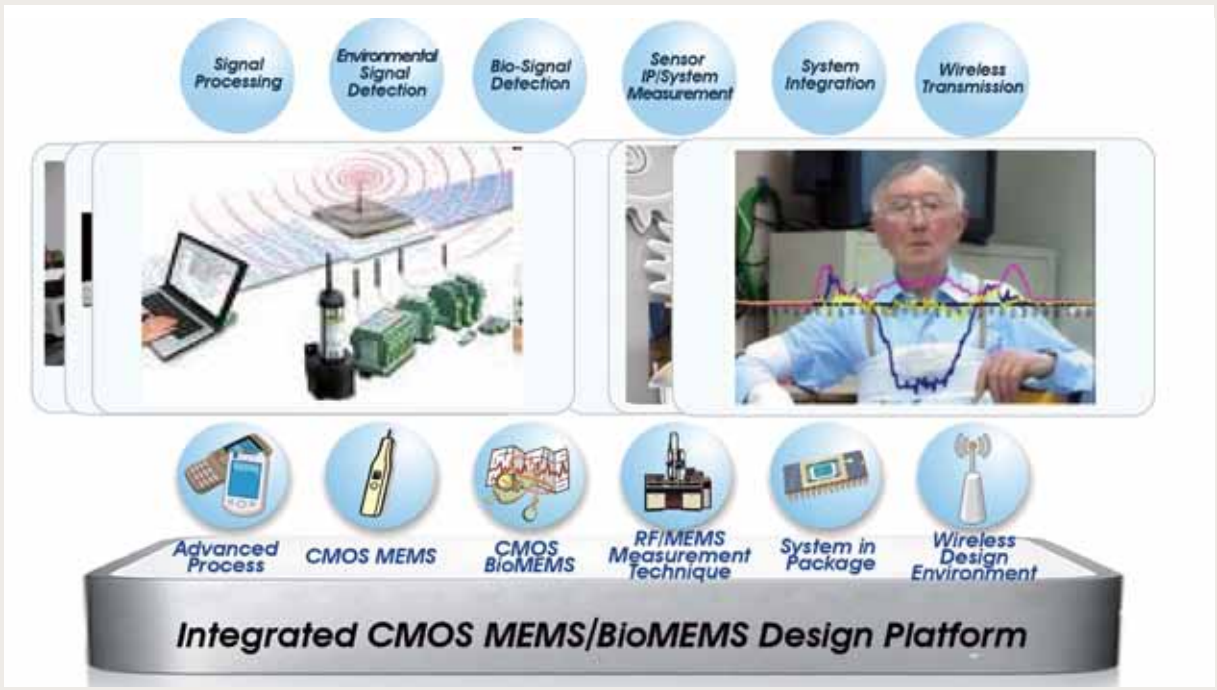
The CIC's newly-released CMOS BioMEMS platform is the world's first bio-sensor chip implementation utilizing a CMOS circuit (2). It will provide academia with many new bio-sensor applications development opportunities in the future. A press conference was held on October 22nd, 2009 to introduce this new development to the public.

Training Courses and Activities

In order to upgrade the IC-related knowledge base of both academia and industry in Taiwan, as well as to cultivate the development of Taiwan's IC designers, the CIC offers intensive, high quality training courses throughout the year. In 2009, the CIC hosted 44 training courses and 149 classes covering 7 IC design categories including Full-Custom IC design; Cell-Based IC design; FPGA design; IC Testing; RF/MMIC design; and SoC/IP design. A total of 7,369 individuals benefited from these training courses, most of which were taught by CIC engineers.

1 LCD touch panel module for video and audio multimedia applications & field-programmable gate array (FPGA) core modules

3 Champion team of 2009 ARM Code-O-Rama Design Contest



2 CMOS BioMEMS Platform

In order to encourage student's engagement in IC/SIP design and further develop their design skills, the CIC co-hosted two contests in 2009, the IC Design Contest and the ARM Code-O-Rama Design Contest. Also, the CIC hosted the Multi-Project Chip Workshop as well during 2009. These activities were held to support and demonstrate the CIC's outstanding advancements in IC design and further promote cooperation between local industry and academia.

Achievement Statistics

Scope of Performance	Item	Quantity	Unit
Service Results	Design environment services	980	Time utilized
Service Results	Chip fabrication services	1621	Chips
Service Results	Journal/conference/patent assisted by CIC (incl. SCI and EI)	722	Articles
R&D Results	Conference/Journal Papers (SCI, EI)	22	Articles
Training	Education and training attendees	7369	Attendees
Training	Training courses	149	Courses

Instrument Technology Research Center

1974	The Instrument Technology Research Center (ITRC) is founded by the Executive Yuan
1987	The ITRC relocates to its present location in the Hsinchu Science Park
2003	The Taiwanese government awards the ITRC its "Excellence in Technological Organization" award
2004	The Executive Yuan awards the ITRC its "Excellence in Technological Management Systems" award
2005	The ITRC is reorganized under the National Applied Research Laboratories (NARL)

Instrument Technology Research Center

In an effort to comply with the nation's science and technology policies and to service domestic academia and industry, the Instrument Technology Research Center (ITRC) is dedicated to developing innovative and cutting edge instruments and instrumentation technologies that will enhance and promote Taiwan's domestic science competence and competitiveness. In retrospect of the year 2009, the ITRC extended its new spirit of "focus" and "progress" through organizational restructuring which has made possible a better use of manpower and resources. Also, in order to provide an even higher standard of professional services to its customers, the ITRC became ISO/IEC 9001 Quality Management Systems, ISO/IEC 27001 Information Security Systems, and ISO/IEC 17025 Accredited Laboratories certified in 2009.

Focus and Progress

As a result of organizational restructuring in 2009, five research teams and five facility shops (under four main research domains) exerted greater strength and depth in helping the ITRC to realize its mission of instrument innovation and technique upgrade. In 2009, the ITRC exploited a number of integrated instrument systems and applications that it uses to serve domestic academia and industry (1). In particular, the ITRC developed a Video MTF Measurement Instrument which is an optical lens inspection system that can measure lens quality and that can be easily customized. It received wide media coverage during a press conference held at the NARL earlier in the year. Also during 2009, the ITRC developed a Droplet Polymerase Chain Reaction Chip (1) which is an integrated system based on ITRC's patented PCR bio-chip, related modules, and heat bio-molecular amplifier. This new technology is ready for technology transfer to companies as an entry access to the field of bio-molecular medical instruments.

Regarding the development of instrument key components in 2009, the ITRC successfully developed Band Pass Filters (e.g. blue and green bands); a Vacuum Coating Controller Unit and HMI Module; a Microfluidic Chip Integrated with a NWFET Biosensor; and a 0.11X Telecentric Lens. Of particular significance is the Microfluidic Chip Integrated with a NWFET Biosensor is a disposable polysilicon nanowire molecules detection chip module that offers highly sensitive disease screening of DNA.

Towards Globalization

In order to incorporate resources and information in the field of instrument technology both domestically and abroad, and to further participate in the international research community, the ITRC established the Institute of Electrical and Electronics Engineers (IEEE) Taipei Section Instrumentation & Measurement Society Chapter in 2009. This was done with the support of the NARL and the IEEE Taipei Section. Also in 2009, the ITRC participated in various research societies, exhibitions, and contests throughout the year. For example, the ITRC hosted the first i-ONE Instrument Technology Innovation Competition which offered the opportunity for researchers and students to help discover and nurture manpower in the field of instrument technology.

In order to gain international exposure and introduce Taiwan's R&D achievements to the world, the ITRC attended numerous international conferences and exhibitions in 2009 including the SPIE Optics+Photonics 2009 held in San Diego, California, U.S.A.; OPTO Taiwan 2009; the Taipei International Industrial Automation Exhibition 2009; the Taipei International Invention Show & Technomart (INST) 2009; and the 61st IENA Nuremburg held in Germany. 2 lists the awards won by the ITRC at these events, where its efforts were well recognized by professionals both domestically and internationally.

1 Key Instrument Systems Developed in 2009

Instrument System	
▸ Nano-structured Deposition System	▸ Hysteresis Parameter of Liquid Lens Inspector
▸ Video MTF Measurement Instrument	▸ Non-Visible Light Profile Inspector
▸ Droplet Polymerase Chain Reaction Chip	▸ Laser Alignment Assembler
▸ Low-Pressure Thermal Cycle Test System	▸ Vacuum Pump Performance Calibration System

1 Droplet Polymerase Chain Detection Chip

2 Chip Defects Inspection Device (Gold Medal of 2009 IENA Nuremberg)

2 Awards Won by the ITRC in 2009

Contest	Award-Winning Invention	Award
Taipei International Invention Shows & Technomart (INST)	Luminous Body Detection Device and Method, Invisible Light Emitting Device and Light Profile Inspector, and Liquid Lens Module Inspection Device	Two gold medals and one bronze medal
IENA Nuremberg	Chip Defects Inspection Device and Inspection Method (in collaboration with GPM Corp) and Lens Measurement Device and Method for Measuring Lens (in collaboration with Chien-Ching Ma, professor of Mechanical Engineering, National Taiwan University).	Two gold medals
National Applied Research Laboratories' Award for Outstanding Contributions in Science and Technology'	Chip Defect Rapid Detection System	Technology Development Category– Mount Maborolas Award
	Preparations and Applications of Oxide Films and Metal Nanoparticles by using Atomic Layer Deposition	Academic Research Category– Mount Siouguluan Award

The ITRC has also extended multilateral cooperation with research institutes and universities worldwide. In 2009, the ITRC signed Memorandum of Understandings (MOU) with the Optoelectronics Research Centre of the University of Southampton, U.K., the Optical Data Storage Center, College of Optical Sciences, University of Arizona, U.S.A., and the Advanced Science Institute, RIKEN, Japan. Among its ongoing cooperation projects, the ITRC has dispatched researchers to RIKEN to conduct research in polarization spectrum inspection technology platforms such as the design of metamaterials and the measurement of optical characteristics.

Research Dissemination

In order to share expertise and disseminate competence for the common good, the ITRC has built an instrument technology service platform that, by the end of 2009, provided local industry, academia, and the research community with services consisting of 1,999 projects involving 107 manufacturers and 21 academic and 8 research institutions. Regarding the ITRC's technology transfers during 2009, the "Nano-ceramic Powder;" "Cordless Caulking Gun Lifetime Test Rod;" "Virtual Reality Embedded Telescope System;" and the "Optoelectronic Smoke Detector Sensitivity Adjustment Device" were all successfully transferred to the private sector. The ITRC also executed a number of cooperation-based research projects in 2009 including the "New (In,Ga)N and Epitaxial ZnO Thin Film Process Technology," the "Magnetron Multi-target Sputtering System," and the "Optoelectronic Semiconductor Equipment- Vacuum Sputtering Coating System" projects. These projects helped the ITRC achieve its objectives of serving the public and maintaining its role as a leader in the field.

Outstanding education and manpower plays a crucial role in a nation's economic competitiveness. This is especially important in the science and technology circles. The ITRC provides local professionals with specialized courses in the areas of ultra-precision engineering; optoelectronic technology; vacuum technology; micro-electromechanical technology; and instrument application, repair, and maintenance. Via these courses, 1,112 professionals obtained skilled training during 2009. Additionally, in an effort to train the research manpower required by the country's high-tech industries, the ITRC also implemented the "Graduate Students Joint Research Program" during 2009. A total of 86 selected graduate students from 17 domestic colleges and universities participated in this program.

Furthermore, for the promotion of science and technology diplomacy and to establish Taiwan as a world leader in the field of instrument technology, the ITRC hosted the international cooperation program, The 14th "International Scientific Instrument Technology Workshop" in 2009. The program was attended by scientific researchers from countries including India; Vietnam; Thailand; Indonesia; the Philippines; Malaysia and other countries in the Asian Pacific region.

In 2009, the ITRC published a book entitled "Nano Inspection Technology" that introduced techniques for inspecting nano structures and properties of components and materials. Six issues of the ITRC's in-house publication, "Instruments Today," were also published in 2009. These issues covered topics such as "New Mass Spectrometry Technologies;" "Synchrotron Light Source and Life Science;" "Synchrotron Light Source and Biomedical Technology;" "Monomolecular Detection;" the "Special Issue Celebrating the 30th Anniversary of Instruments Today;" and "Solar Cells" were also published to provide the industry, academia, and research community with a wealth of instrument technology information.

Achievement Statistics

Scope of Performance	Item	Quantity	Unit
Service Results	Serviced institutes through facility and technical service	136	Institutes
Service Results	Cooperation projects and entrusted cases	1,999	Cases
R & D Results	Journal papers (incl. SCI and EI)	231	Papers
Training	Graduate students in joint research programs	86	People
Training	Professional and technical training	1,112	Attendees
Training	Laboratory visitors	921	People

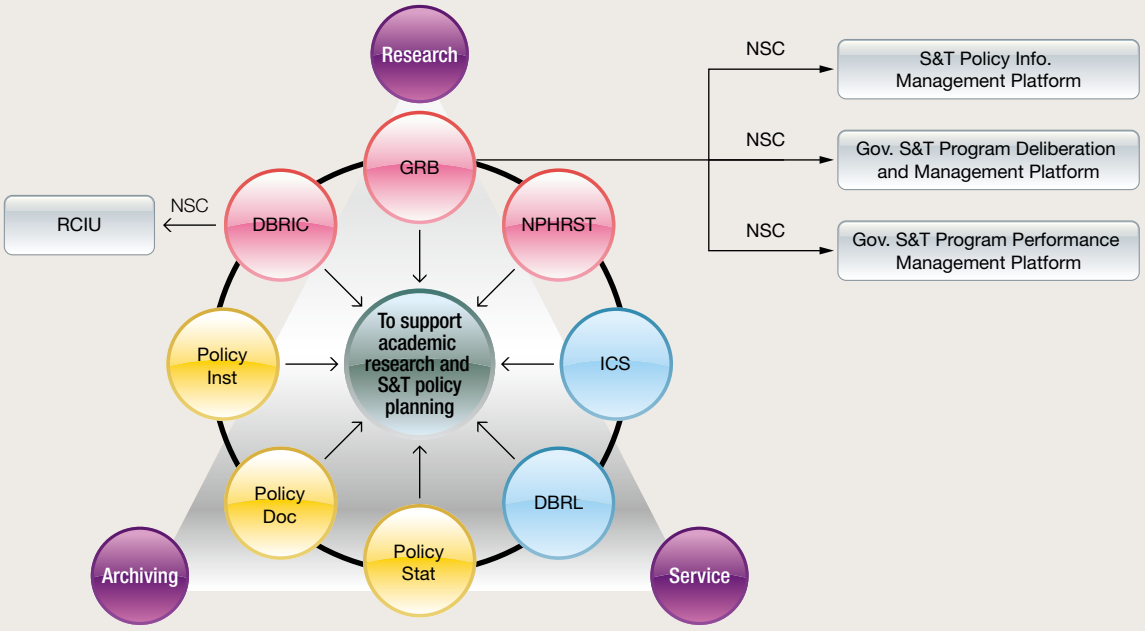
Science & Technology Policy Research and Information Center

1974	The Executive Yuan of Taiwan approves the establishment of the Science and Technology Information Center (STIC)
1998	The STIC begins providing the Government Research Bulletin (GRB) service and established the Consortium on Core Electronic Resources in Taiwan (CONCERT)
1999	The STIC begins providing its online Nationwide Document Delivery Service (NDDS)
2005	The STIC is reorganized as a subordinate to the National Applied Research Laboratories (NARL) and renamed as the Science and Technology Policy Research and Information Center (STPI)

The Science and Technology Policy Research and Information Center

Year 2009 is the fifth year for the newly established STPI and is also the starting point for entering the next stage full of challenges and opportunities. The STPI has completed its core competences in empirical science and technology (S&T) policy research and gradually provided more policy suggestions to the main customers. Simultaneously, the STPI still maintains the information services providing to Taiwan's research communities at a very high level. As such, this year is the turning point for the STPI to strive for its goals for the next four years to better serve the needs of Taiwan's National Science Council (NSC) and other government ministries with S&T jurisdictions. Based on actual operations, experience accumulation, and cooperation with both domestic and international research entities, the STPI aims to develop its core capabilities in supporting every linkage of the government's S&T policy-making cycles such as policy formulation, implementation, and evaluation.

The primary achievements of STPI during 2009, in supporting the related policy-making of the NSC for instance, include "The Analysis and Research on the Performance of Academic Thesis Indicators," "The Preliminary Research of Mid- to Long-Term Development Formulation of Oceanic Energy Technology," and etc. In addition, the STPI published forty-nine S&T policy-related journal articles, eight types of research reports, three analysis reports, along with mentoring thirteen graduate students in the same year. Meanwhile, in expanding its cooperation network, STPI, for the first time, cooperated with the Russian Foundation for Basic Research (RFBR) in analyzing the differences of scientific and innovative energies between Taiwan and Russia. Moreover, the STPI also maintains co-research relationship



3 Academic and policy research databases construction and services.

1 The publications of science and technology policy research

2 Dr. Chen, Deputy Minister of NSC, is speaking in the Research Evaluation and Support Workshop.

with many prestigious domestic research entities such as the Industrial Technology Research Institute (IEK), National Taiwan Normal University (NTNU), and Tunghai University (THU) respectively.

Regarding the establishment of core competences and research methodologies, the STPI continues to present itself as a professional S&T policy research institute capable of performing Scientific Literature Quantitative Analysis, Science Mapping, Foresight Analysis, Text-Mining Roadmap, and Social Network Analysis. In the foreseeable future, the STPI will continue improving its organizational operations as well as accumulating sufficient research energy in assisting related government agencies in Taiwan.

Moreover, in facilitating academic research in Taiwan, the STPI has developed and integrated several academic platforms by utilizing limited resources to produce the highest possible information services. These platforms include the CONsortium on Core Electronic Resources in Taiwan (CONCERT), the Nationwide Document Delivery Service (NDDS), and the REsearch ALI in one (REAL), which provide a more efficient way in shortening the time for information retrieval.

As of 2009, the CONCERT has licensed forty-five systems incorporating 17,000 electronic journals from 106 databases and 7 National Academic Licenses (NAL). This has largely promoted the efficiency of academic information resource usage and at the same time lowered the costs for resource allocation. As such, the CONCERT achieved an overall user satisfaction rating of 99 percent and received the Third Outstanding S&T Contribution Award from the NARL in 2009. Meanwhile, the NDDS has integrated journal resources from 437 domestic libraries. It has total registered users of 110,000 and a total number of system requests of 140,000 including 17,000 provided by STPI. The overall user satisfaction rating is also an outstanding number of 94 percent in 2009. Moreover, the STPI's REAL platform has integrated 700 domestic and international electronic academic resources including 103 open access databases as of 2009. With several features provided such as the personalized function, Citation Linker, and SFX, the REAL has attracted inquiries in millions in supporting the research communities in Taiwan.

In the era of knowledge-based economy and globalization, continuous S&T innovations and discoveries are the main driving forces for further development of economy. Thus, a solid national innovation system is indispensible for rapid and efficient commercialization of S&T research results. With years of operation experience and the 2005 reorganization, the STPI is now positioned as the main national S&T policy research think-tank. The STPI will continue improving Taiwan's S&T competitiveness by enhancing domestic innovation system, advancing S&T trend analysis, promoting cooperation between academia and industry, optimizing the government's policy-making, in reaching its ultimate goal of becoming an international-level S&T policy research institute with sound research capabilities and academic foundation.

4 STPI's positioning and development vision

Achievement Statistics

Scope of Performance	Item	Quantity	Unit
Service Results	Information services provided (time utilized)	9,700,000	Instances
Service Results	Document delivery services	160,000	Articles
R&D Results	Papers (numbers of publication in domestic seminars)	49	Articles
R&D Results	Decision-making references (number of sci-tech or statistic data)	21	Articles
Training	Training courses and promotion activities	2,972	People
Training	Laboratory visitors	32	People

National Science and Technology Center for Disaster Reduction

2003 The Executive Yuan promulgated "The Guidelines for the National Science and Technology Center for Disaster Reduction"
2003 The National Science and Technology Center for Disaster Reduction (NCDR) established
2007 NCDR got NARL Exceptional Service Award: Yushan Mountain Prize
2008 NCDR got NARL Exceptional Service Award: Yushan Mountain Prize
2009 NCDR got NARL Exceptional Service Award: Siouguluan Mountain Prize

The main functions of the National Science and Technology Center for Disaster Reduction (NCDR) include: "R&D promotion", "technical support", and "application implementation". NCDR has important influence on disaster prevention and reduction work in Taiwan. Important achievements in 2009 are as follows:

Post-disaster Investigation Planning and Policy Suggestion of Typhoon Morakot

NCDR assisted the National Science Council for Typhoon Morakot to investigate disaster (1 & 2), to designate disaster areas, and to analyze the mechanism of disaster. These works will be as the reconstruction of the Government in future reference, and application of the next disaster operation.

Research on Flood Response and Disaster Mitigation
NCDR developed progressive technology for analysis of flood disaster response, and supported the flood response of the Central Disaster Emergency Operation Center.

Research on Earthquake Response and Disaster Mitigation

- **Study of selection areas that strengthen earthquake damage prevention and controls**
  Considered the fault parameters, earthquake disaster damage potential and risk factors, and developed the seismic strengthening method of the specified area, such as giving priority to promoting the work of reference for seismic reinforcement.
- **Promotion of real-time earthquake warning system**
  Established a promotional system and preparation of strategies, and then researched, developed and integrated advanced techniques to build a miniature system.

Research on Emerging Disaster Mitigation

Established integration processes for data from all areas, and prepared maps for susceptibility factors of different disasters on climate changes based on the susceptibility of disasters to climate and environmental changes and risk assessments. These quantitative scientific results provided reference for land planning, disaster prevention and mitigation, key infrastructures, industry and population policies, and significant decisions according to climate and environmental changes. The major results in 2009 included the impact research & information platform of climate change of Taiwan (3), and the assessment processes of susceptibility of inundation from climate changes and hazards and hazard mapping.

Implementation and Promotion of Disaster Prevention and Protection Policy

As for an Effect Evaluation for Promotion for Disaster Prevention Communities, NCDR continued to conduct research on the promotion of disaster prevention in communities, in combination with visits and questionnaires to understand the problems and difficulties faced in the promotion of disaster prevention by communities, and then modified the promotional patterns accordingly.

In regard to Training Courses for Professional Personnel of Disaster Prevention Communities, NCDR continued to spread professional skills, train professional personnel in disaster prevention communities, in addition to helping relevant agencies train professional personnel through cooperation with different levels of executive departments and academic institutions.

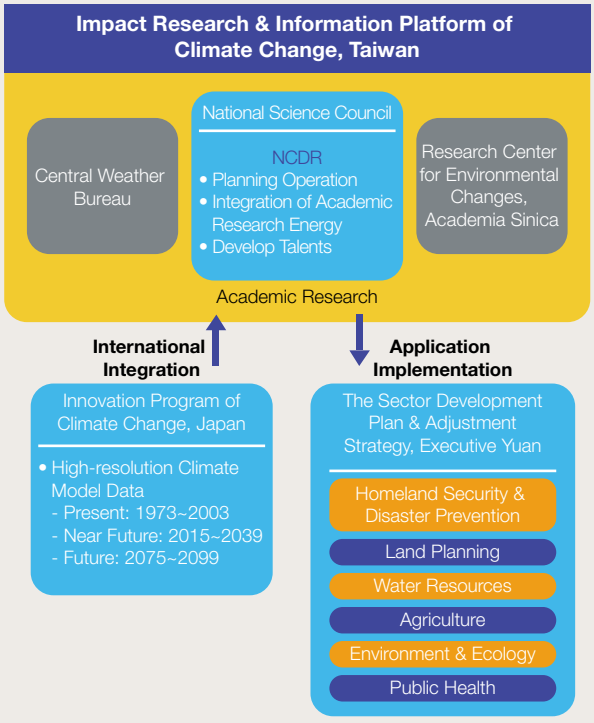
NCDR also communicated with the world continuously to bridge all resources from abroad with fruitful technology researching and developing achievements. In 2009, November 30 to December 1, NCDR hosted the Workshop on the Framework of Long-Term Capacity Building for Disaster Risk Reduction in APEC (4).

1 Driftwood along the Gaoping River

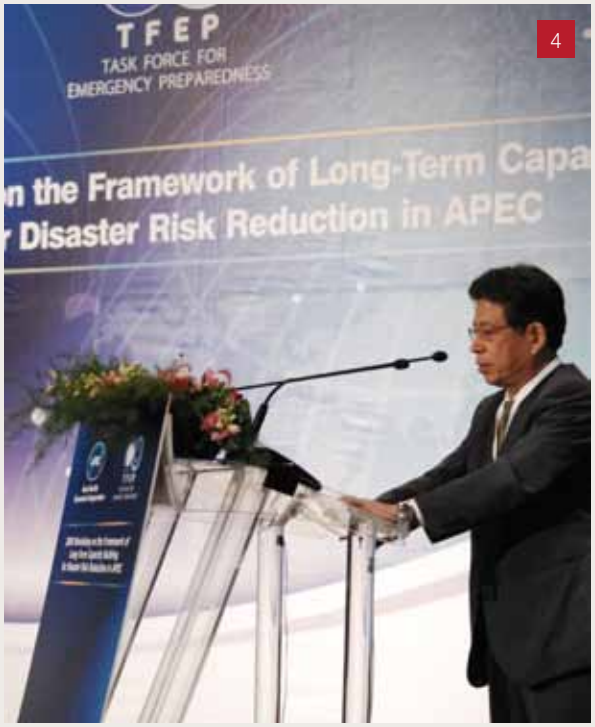
2 Flooding record of Linbian & Jiadung Township

Achievement Statistics

Scope of Performance	Item	Quantity	Unit
Service Results	Technical services	25	Users
Service Results	Assist the government in disaster prevention and reduction missions	11	Cases
Service Results	Assist the public sector in disaster prevention and reduction missions	7	Cases
Service Results	Support of the Central Disaster Emergency Operation Center	307	People
R&D Results	Papers	192	Articles
Training	Education and training	5,926	Attendees
Training	Laboratory visitors	195	People
Training	Professional training of disaster prevention and reduction	265	Attendees
Personnel training	Seminar attendance	1,545	Attendees



3 Impact Research & Information Platform of Climate Change, Taiwan



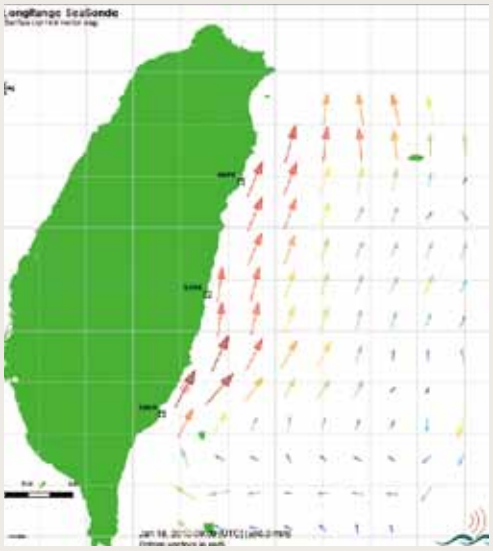
4 Director Chen, Liang-Chun lectured on the Workshop in APEC, 2009

Taiwan Ocean Research Institute

2005	The Taiwan Ocean Research Institute Preparatory Office is established
2007	The Taiwan Ocean Research Institute completes the layout and design of a 2,700 ton New R/V Set
2008	The Taiwan Ocean Research Institute (TORI) is officially established
2008	The TORI completes the building of a 2,700 ton New R/V Set

Observational Platform of the Instantaneous Surface Current Around Taiwan

Established in July 2008, the Taiwan Ocean Research Institute (TORI) has continuously enhanced marine technology-related constructions and observational platforms. The team from TORI's Marine Observation and Modeling Division (MOM) installed the first three High-frequency (HF) Coastal Ocean Dynamics Application Radar (CODAR) systems (located in LyuYe, SiaoYeLiou, and HePing) that link the SeaSonde® network, operated by TORI, on Taiwan's east coast (1 & 2). Antenna Pattern Measurements (APM) were also investigated at the three stations for the system's performance and are currently contributing real-time data of surface current velocities, with coverage reaching the Kuroshio Current regions near by Taiwan.



1 The compound velocity field for the three stations (SiaoYeLiou, LyuYe, and He Ping stations)

TORI held a briefing for the CODAR system to explain its data policy and the unique scale of this research construction for monitoring ocean currents. The briefing was held primarily to attract new CODAR users. The topics covered during the briefing included CODAR's ability to acquire real-time data; the frequencies it uses; its coverage area; possible cooperative opportunities it offers; and how it can be used in emergency situations.

After the briefing, the attendees were asked to complete a survey indicating to what degree they felt CODAR could be used to help them in their respective fields. The results of the survey indicated that CODAR had potential for use in areas of research such as emergency response and rescue: 10.5%; disaster mitigation: 21%; environmental protection: 5.3%; ecology: 5.3%; fishery: 10.5%; earth science: 10.5%; atmospheric science: 15.8%; oil pollution: 15.8%; and other: 5.3%. These suggestions will be considered when developing CODAR applications of the future.

National Oceanographic Database and Information Services

In order to provide marine information services and support marine research including managing marine data, TORI established a national ocean data network system, a marine environmental databank, and a web-based marine information portal. TORI constructed four prototype platforms, all currently operational, in order to provide ocean science technology-related information and to facilitate marine data searches and exchanges. The four platforms are described as follows:

- The Taiwan Ocean information Portal (TOP): http://top.tori.org.tw/
  The ocean research community as a whole, and Taiwan's general public, require an information portal for ocean science and technology. Such a portal can provide easy access to information on ocean sciences and will also serve as an educational platform. Based on this concept, TORI established a web-based platform named TOP that displays information and links relating to ocean science and technology. Further development of TOP's value-added features is currently underway.
- The Taiwan Ocean Data Network (TODnet): http://todnet.tori.org.tw/
  TORI established an integrated marine metadatabase named TODnet which includes metadata from databases from various institutions including the Marine Meteorology Database of the Central Weather Bureau; TaiBNET of the Biodiversity Research Center, Academia Sinica; the Ocean Databank at the Institute of Oceanography; National Taiwan University (NTU); the Harbor Oceanic & Meteorological Database at the Harbor and Marine Technology Center; and the Ministry of Transportation and Communication. Currently, users can access this metadata system through an united catalogue. Metadata information (e.g. locations, distributions, observation types, etc.) on marine geophysical; geological; hydrographical; ocean surface meteorological; and biological data can be checked in a single entry. Additional data is available to most of Taiwan's data repositories via links. In the near future, a distributed physical database system will be constructed as well.

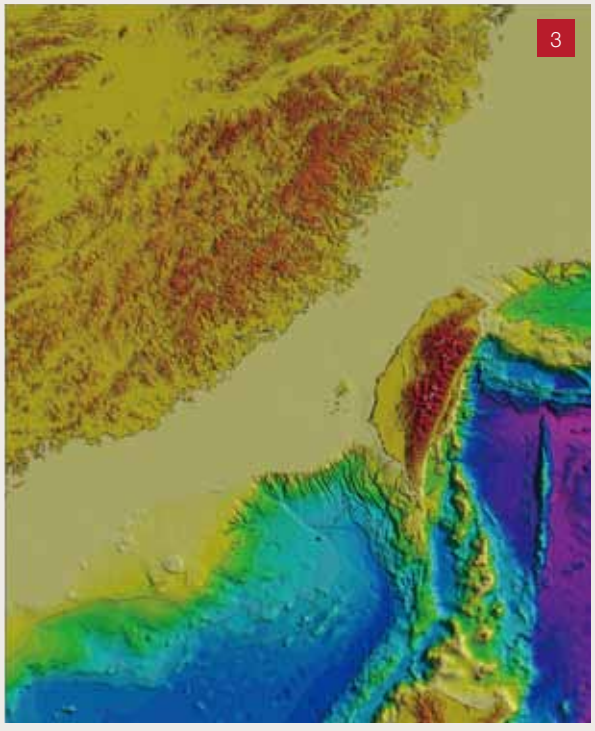
2 The installation of receive antenna at SiaoYeLiou 4 Near real-time surface data buoy recovery

- The Marine Environmental Databank (MED): http://med.tori.org.tw/
  TORI established a marine information databank and service platform called MED that includes many database management functions including processing and archiving. This value-added feature collects various types of data from remote sensors, shipboard underways, ship stations, and mooring observations, and organizes them into various databases for easy search and display.
- The Marine Core Repository & Laboratory (MCRL): http://corelab.tori.org.tw/
  TORI established a platform called MCRL that provides services such as marine core repository, sampling, analyzing, and other core sample-related services. Digital archiving of marine core data, improvements on core analysis capabilities, and information dissemination via e-News have also been carried out by TORI.

Bathymetry Map of the World with Chinese/English Undersea Feature Names

In order to promote ocean awareness and provision marine science educational materials, TORI released a newly compiled-wall map that shows the topography of the world's ocean floors in amazing detail (3)! This Bathymetry Map features undersea feature descriptions in both the Chinese and English languages. The map is specially constructed so that Taiwan is located in its center, and a small duplication makes the viewing of the three major oceans complete within the map.

The map was generated using the latest National Geophysical Data Center (NGDC) 1-arc minute global dataset. As a result, major seafloor features such as mid-ocean ridges, ocean basins, trenches, seamounts, and plateaus are displayed in amazing detail! The size of the map is 36"x87", thus, it is suitable for wall display and can be used as an outstanding educational tool!



3 Bathymetry Map offshore Taiwan

Achievement Statistics

Scope of Performance	Item	Quantity	Unit
Service Results	Technical Services/Inspections	144	Cases
R &D Results	Deep-sea near real-time data buoy	3	Stations
R &D Results	Ocean information and database	84	GB
R &D Results	Papers published (incl. SCI and EI)	41	Papers
Training	Education training	150	Attendees
Training	Laboratory visitors	2,000	Persons

5 CTD and water sampling hydrographic survey

TTFRI Taiwan Typhoon and Flood Research Institute (Preparatory Office)

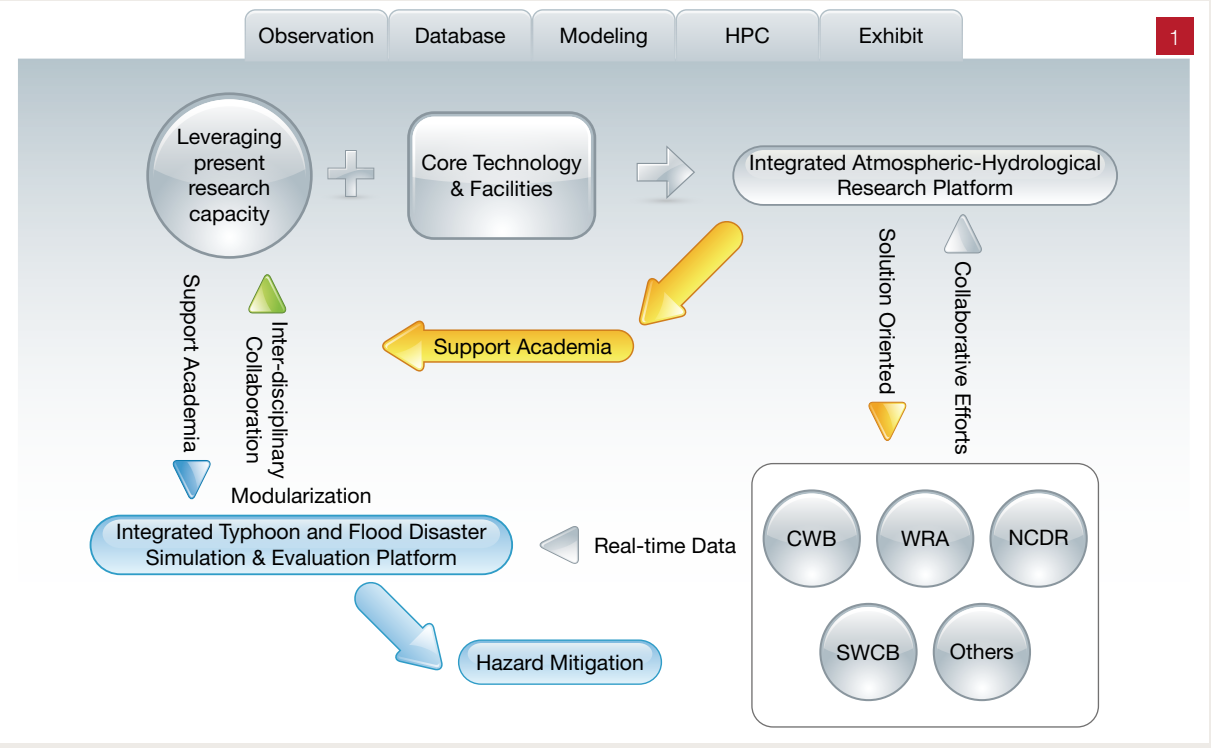
January 2007	The Taiwan Typhoon & Flood Research Institute (TTFRI) Preparatory Office is launched
December 2007	The National Applied Research Labatories' (NARL) Board of Directors officially submits the TTFRI Plan of Establishment to the National Science Council (NSC)
May 2008	The TTFRI officially opens its office in the Central Taiwan (i.e. Taichung, Taiwan) Science Park
January 2010	The TTFRI officially opens its Taipei office.

Integrative Development for Typhoon & Flood Research

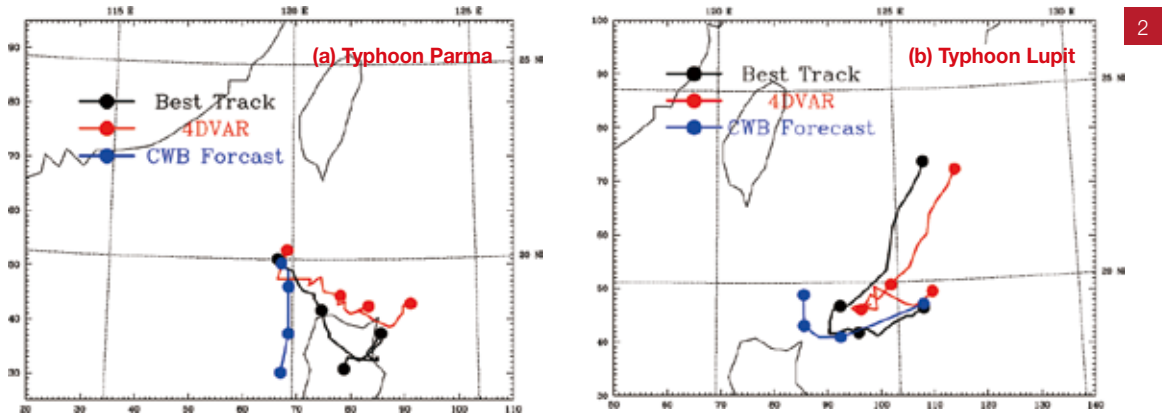
The researchers at the Taiwan Typhoon and Flood Research Institute (TTFRI) are devoted to analyzing and gaining a better understanding of the causes and effects of natural disasters, and in particular, typhoons and floods. TTFRI researchers use atmospheric and hydrological numerical-based models, along with other key disaster forecasting techniques, to gain a better understanding of and deal with the fallout of these naturally occurring phenomena. It is, thus, the TTFRI's mission to establish such a capacity and develop its core facilities to include Frontier Observation Technologies as well as the Integrated Atmospheric-Hydrological Research and Integrated Typhoon and Flood Disaster Simulation and Evaluation Platforms. These platforms support atmospheric and hydrological science R&D with a focus on forecasting techniques for typhoons and floods (1). They are interdisciplinary and integrative by design and encompass both long-term governmental and academic endeavors. Additional TTFRI 2009 accomplishments are illustrated as follows.

The Real-time Simulation System of the Fifth-Generation NCAR / Penn State Mesoscale Model (MM5) and Four-Dimensional Variational Assimilation

The TTFRI established a real-time simulation system for Mesoscale Model and Four-Dimensional Variational Assimilation (MM54DVAR). The system is designed to predict the tracks of typhoons as they approach Taiwan. Typhoon Parma and Typhoon Lupit are the two good examples of events that took place in 2009 which tested the system's performance. The results show the system is capable of producing reasonably accurate typhoon tracking and prediction (2).

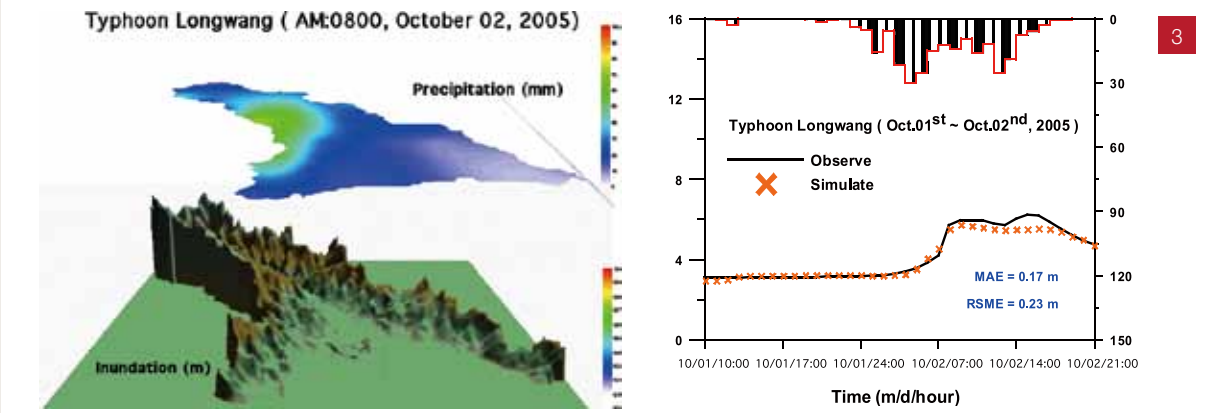


1 The design and relationship of the Integrated Platforms for Atmospheric-Hydrological Research, Disaster Simulation, Evaluation and Academic Support.



2

2 The black line indicates the tracks observed by the Central Weather Bureau (CWB). The blue shows the CWB's forecast whereas the red illustrates the predicted track using MM54DVAR.



3

3 Integrative Atmospheric-Hydrological System test results (Typhoon Longwang; 2005)

Atmospheric-Hydrological Real-time Simulation System

The TTFRI has coupled the Mesoscale Numerical Weather Predication Model (a.k.a. WRF V3.1) with the Numerical Watershed System (a.k.a. WASH123D) to produce a 72-hour simulation that runs twice daily. The system provides approximately 63 leading hours of hydrological forecast for further application (3).

Promoting Public Understanding of Typhoon and Flood Science

An important aspect of the TTFRI's educational outreach program is the promotion of atmospheric and hydrological science to the public. To this end, the TTFRI invited experts in both atmospheric and hydrological research from National Taiwan University (NTU), National Cheng-Kung University (NCKU), the Central Weather Bureau (CWB), and the Water Resources Agency (WRA) of the Ministry of Economic Affairs to speak at a total of ten typhoon & flood-related workshops during 2009. These workshops, sponsored by the NSC, were designed as science education fair-type workshops and were attended by students of all ages. These workshops were also part of the NSC's 50th anniversary celebrating science education including the support of engineering talent, academic development, and leading frontier research. There were a total of 801 workshop participants throughout summer, 2009 (4).

4 Happy campers at the 2009 "Understanding Typhoons & Floods" workshop

Achievement Statistics

Scope of Performance	Item	Quantity	Unit
Academic Support	Number of accounts served by TTFRI's facilities and tech support	7	Accounts
Academic Support	Numerical model improvement	2	Versions
HPC Support	Academic SRU support	54,603,579	SRU
R&D Performance	Number of publications (including SCI and EI)	10	Articles
Education Outreach	Number of registered participants	848	Attendees
Training	Laboratory visitors	69	People

Contact Information

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