國家實驗研究院
National Applied Research Laboratories

2011
NARL Annual Report

www.narl.org.tw/en

Global Excellence

Local Impact

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

NARL History

2003 NARL is established

6 labs become member laboratories of the NARL

- National Chip Implementation Center (CIC)
- National Center for High-performance Computing (NCHC)
- National Center for Research on Earthquake Engineering (NCREE)
- National Nano Device Laboratories (NDL)
- National Laboratory Animal Center (NLAC)
- National Space Organization (NSPO)

NCDR is established

National Science and Technology Center for Disaster Reduction

2005 2 labs become member laboratories of the NARL

- Instrument Technology Research Center (ITRC)
- Science & Technology Policy Research and Information Center (STPI)

2008 TORI is established

Taiwan Ocean Research Institute

2011 TTFRI is established

Taiwan Typhoon and Flood Research Institute

2011 Contents

Message from the Chairperson

Under the environment of a fast-forward world, fierce global competition, and the rise of Mainland China, Singapore and South Korea in economic terms, Taiwan's science-and-technology (S&T) development will be confronted with a myriad of severe challenges. The quest for competitive efficiency taken by various countries has not only posed risks for Taiwan's industries, but also forced to reflect on what was once well operational model of Taiwan's efficiency-oriented economy

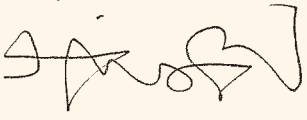
Considering the prevailing international environment, the pace of the S&T transition for Taiwan must quicken. In this regard, there was a general consensus from the 31st Science and Technology Advisory Board Meeting of the Executive Yuan, that Taiwan's economy must be transformed from efficiency-driven stage to innovation-driven stage along with the creation of innovation ecosystem. The process entails that the remarkable achievements of the cutting-edge upstream research-and-development (R&D) must be effectively connected with the low stream applications in livelihood promotion and industrial development.

For the innovation ecosystem, the NARL will serve as a platform to align upstream and downstream segments along the R&D continuum, which will be one of the crucial aspects in Taiwan's S&T transformation process. In this connection, the pressing task for the NARL is to augment the "translation" function and maximize its roles in selected projects of various fields with potentials for success. For example, the establishment of platforms of next-generation smart electronics and experimental biological materials is to elevate the development potentials in Taiwan's information and communication technology and bio-technology industries. Nonetheless, the related connection and integration shall proceed with the formulation of complementary measures and implementation of performance management so to meet the future needs in developing the country's innovative R&D programs and economic system. For this, it relies on the joint efforts of all the NARL staff along with all sectors of society.

At this crucial turning point, the NARL urgently needs to collaborate with all the experts who cherish the broad values to accelerate the translation function of R&D platforms. At the same time, it needs to draw the experts who are committed to transnational, interdisciplinary and cross-institutional approaches to work together, and to cultivate more local high-tech talents. Only in this way, we can consolidate our S&T establishment, have an opportunity to stay ahead of the competition, and stay on continuous innovation.

I trust every member of the NARL community will become a supporting force in the innovation and transformation process. Moreover, I sincerely hope all of us will dedicate ourselves to find the best prescription to upgrade Taiwan's scientific research environment with a broader perspective of insights and more integrated care for Taiwan's future.

Chairperson



Message from the President

It is my greatest honor to become a member of the NARL community, working together with all of the NARL colleagues for the future of Taiwan's innovative science and technology (S&T). Acting in my capacity as the newly appointed president, I would like to extend my immense appreciation to all the NARL staff for their dedication that has contributed to Taiwan's S&T development. In addition, I am grateful for their hard work in research-and-development (R&D) endeavor that has led the NARL to become a growing powerhouse in applied aspects of S&T to be reckoned internationally.

The R&D platform established by NARL carries the mission of creating social benefits and values. In a time when individual technologies can no longer meet future needs of society and industry in a fast-changing economic context, we have to take advantage of the NARL's established research capacity as a platform to collaborate with Taiwan's outstanding multidisciplinary research teams in fostering various R&D initiatives that are forward-looking and challenging as well as of social value. These initiatives are to encourage the youth to engage in innovative R&D, and guide them into relevant, focused and coherent S&T activities. Hopefully these emerging talents will create new opportunities in their own respective fields in the future. This is not only a duty for the NARL, but also an achievement worth considerable efforts from all the NARL staff.

Facing the future challenges, while advancing with forward-looking R&D, the NARL must further grasp major global S&T trends and their potentials, and identify future social and industrial development needs. Embracing the vision of achieving global excellence that coupled with local impacts, the NARL is to effectively integrate all resources for the establishment of an R&D environment that is appropriate for Taiwan's development as well as brings substantial social and industrial benefits. It is expected that all the NARL's affiliated centers will set the global competitiveness of their respective fields as their strategic goals, and develop key technologies that are beneficial to the society at large. Furthermore, they are to leverage promising intellectual properties from the academia in developing new applications for the future of industrial development. In so doing, the NARL's mission is achieved for the era. As *The NARL Annual Report 2011* highlights, engaging R&D activities meet these strategic goals, manage the risks, and seize the opportunities has been central to the NARL's work over the past year.

It takes a village to make ideas come true. Because of this, I look forward that we all take up our respective responsibilities. And I believe as long as our strategic goals are well defined and the directions consistent, we will turn a new page for the future of Taiwan society as well as the creation of innovative and forward-looking S&T development.

President

Liang-Gee Chen

Organization

Board of Directors & Supervisors

Chairperson	Cyrus C.Y. Chu
Managing Director	San-Cheng Chang, Shang-Yi Chiang, Shaw-Chen Liu, Tsong-Pyng Perng
Director	Wen-Chang Chang, Chien-Jen Chen, Tai-Jen Chen, Jenn-chuan Chern, Bon-chu Chung, Yan-Hwa Wu Lee, Frank Shu, Yu Wang
Executive Supervisor	Wen-Ji Hwang
Supervisor	Der-Tsai Lee, Chein Tai

President	Liang-Gee 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 Chun-Yen Yang
Finance & Accounting Office	Director Ching-Ping Lu
Auditing Office	Director Ying-Yun Lee
Information Management Office	Director Shih-Chieh Lee

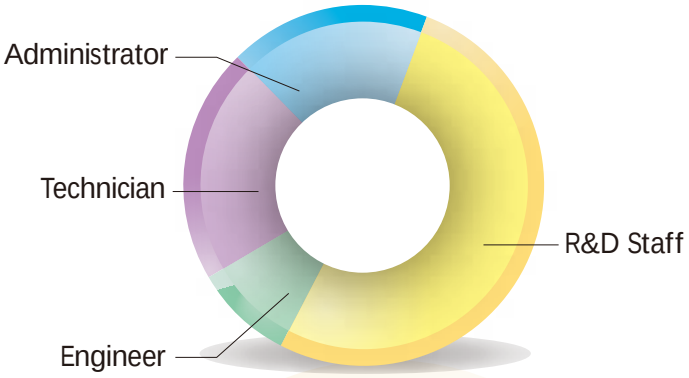
Laboratories

National Chip Implementation Center (CIC)	Director General Tzi-Dar Chiueh
Instrument Technology Research Center (ITRC)	Director General Yeong-Her Wang (Acting)
National Science and Technology Center for Disaster Reduction (NCDR)	Director General Liang-Chun Chen
National Center for High-performance Computing (NCHC)	Director General Kuo-Ning Chiang
National Center for Research on Earthquake Engineering (NCREE)	Director General Kuo-Chun Chang
National Nano Device Laboratories (NDL)	Director General Fu-Liang Yang
National Laboratory Animal Center (NLAC)	Director General Chun-Keung Yu
National Space Organization (NSPO)	Director General Guey-Shin Chang
Science & Technology Policy Research and Information Center (STPI)	Director General Bou-Wen Lin
Taiwan Ocean Research Institute (TORI)	Director General Chia Chuen Kao
Taiwan Typhoon and Flood Research Institute (TTFRI)	Director General Cheng-Shang Lee

Human Resources

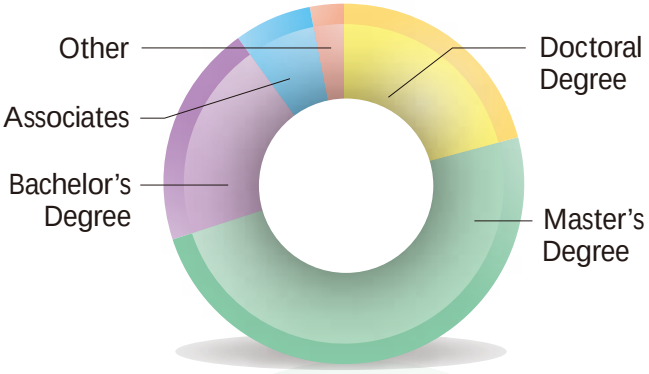
Number of Employee ***1416***

Human Resources Allocation



R&D Staff	739	52%
Engineer	127	9%
Technician	301	21%
Administrator	249	18%

Education Qualification



Doctoral Degree	305	21%
Master's Degree	691	49%
Bachelor's Degree	282	20%
Associates	99	7%
Other	39	3%

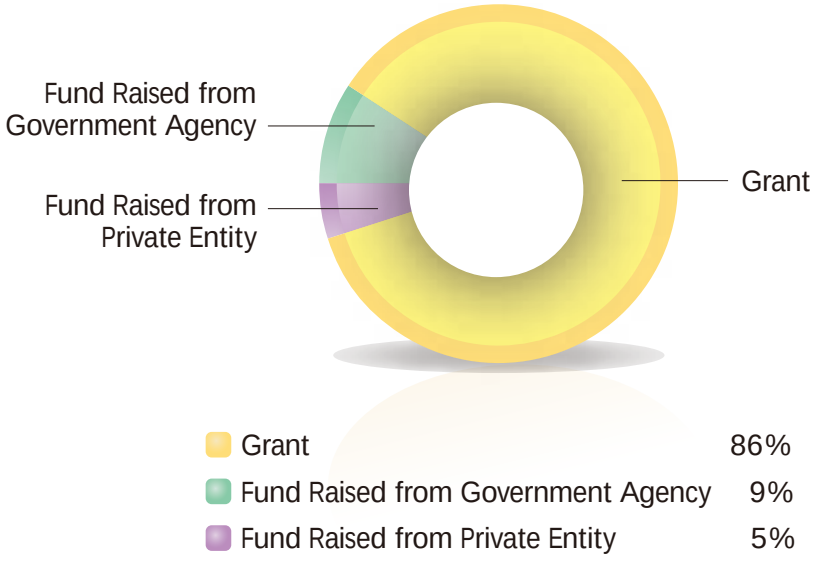
Employees per Laboratory

Laboratories	Head Count	Percentage
Headquarters	45	3%
CIC	115	8%
ITRC	150	11%
NCDR	93	7%
NCHC	205	14%
NCREE	101	7%
NDL	161	11%
NLAC	134	9%
NSPO	194	14%
STPI	114	8%
TORI	67	5%
TTFRI	37	3%

Financial Information

Revenue (FY 2011)

Laboratories	$M USD	Percentage
Headquarters	4	2%
CIC	14	8%
ITRC	14	8%
NCDR	6	4%
NCHC	28	16%
NCREE	12	7%
NDL	19	11%
NLAC	14	8%
NSPO	43	25%
STPI	9	6%
TORI	6	4%
TTFRI	2	1%
(Rate:$30.325)	**Total 171**	



Location

Headquarters

National Science and Technology Center for Disaster Reduction

National Center for Research on Earthquake Engineering

National Laboratory Animal Center

Science & Technology Policy Research and Information Center

Taiwan Typhoon and Flood Research Institute *

Taipei

National Chip Implementation Center

Instrument Technology Research Center

National Center for High-performance Computing

National Nano Device Laboratories

National Space Organization

Hsinchu

Taichung

National Center for High-performance Computing *

Taiwan Typhoon and Flood Research Institute

Tainan

Kaoshiung

National Chip Implementation Center *

National Center for High-performance Computing *

National Nano Device Laboratories *

National Laboratory Animal Center *

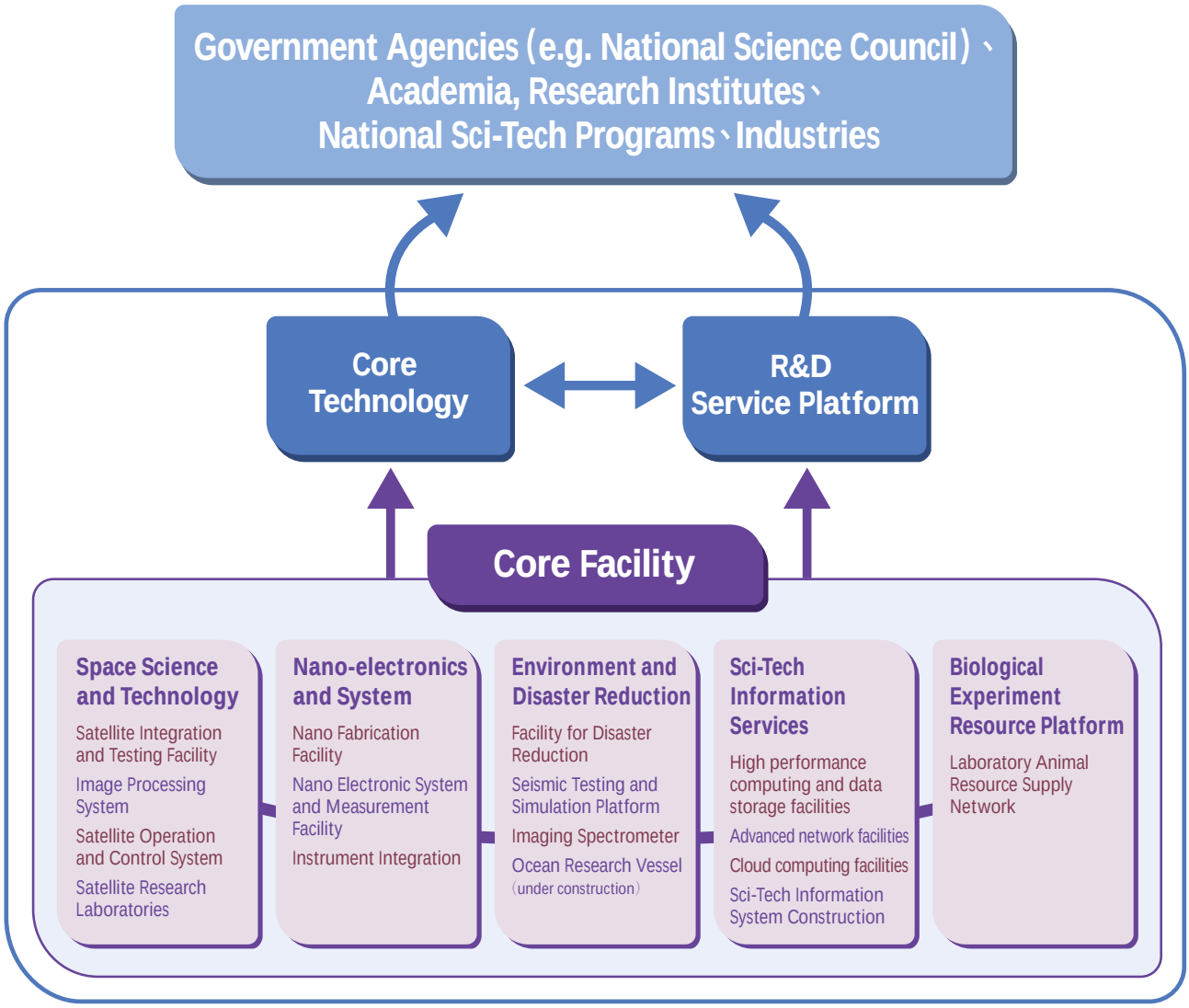
Taiwan Ocean Research Institute

* Branch Office

Development

1. Comprehensive Project Structure

The strategic goal of the NARL is to provide advanced core technologies, and science and technology service platforms for Taiwan's long-term development of science and technology. Ultimately, it is to enhance the socio-economic well-being of the people in the context of growing international competition and climate change. The NARL's thematic focus in 2011 was to cluster acquired knowledge and skills, and available human resources and technology services from space science and technology, nano-electronics, circuits and systems, environment and disaster reduction, science and technology information, and experimental biology. Its primary objective was to promote foresight research and development in nano-electronics, chip design, instrument technology, space science and technology, information network, science and technology policy, earthquake engineering, disaster prevention and mitigation, marine science and technology, typhoon and flood research, and animal experiments; diffusion of knowledge and subsequent applications; and development of high-caliber human resources. The NARL's established core facilities, core technologies and science and technology service platforms, as illustrated in the following sketch, are to serve the National Science Council and other governmental agencies, the academia, the inter-ministerial national science and technology programs, and the industrial sector.



2. Overview of NARL Research and Development

(1) Strategies and Achievements of NARL's Integrated Projects

In compliance with the guidelines set in the national science and technology policy, the NARL management integrates core technologies, critical resources and comparative strengths from its affiliated centers for achieving the NARL's strategic goal. During the year, the NARL implemented a program for integrated inter-disciplinary science and technology development and services. The thematic mandates under this integrated research and development program include remote sensing technology, biomedical electronics, earthquake early warning system, bridge safety monitoring system, and near real-time high-resolution 3D earth monitoring platform. The following provides overview of activities and key players.

Earthquake early warning system

With current level of science and technology, earthquakes are extremely difficult, if not impossible, to precisely predict. Nevertheless, by detecting non-destructive, fast-moving P waves and referring to the past earthquake data, the arrival time and intensity of destructive, late-coming S waves can be estimated. This renders precious seconds to transmit warning messages and to reduce disastrous impacts of earthquakes. Based on this principle, the National Center for Research on Earthquake Engineering (NCREE) has successfully developed an on-site real-time earthquake early warning system (EEWS). Take the 921 earthquake of 7.3 on the Richter scale with an epicenter in central Taiwan that occurred in 1999 as an example, based on the distance from the epicenter, the EEWS could provide 11, 7, 17, and 27 seconds of warning time for Chiayi County, Taichung City, Hsinchu County, and Taipei City, respectively. Before the destructive S waves arrive, the EEWS could automatically trigger warning messages to be transmitted via radio programs, subtitle apparatuses, and TV inception broadcasting. The system could also be programmed to automatically warn school kids to duck and take cover, stop the elevator at the nearest floor, shut off water and gas valves, turn on back-up generators for hospitals, etc. in reducing casualties and other collateral damages. In partnership with the Central Weather Bureau and the NARL's National Science and Technology Center for Disaster Reduction, the NCREE has established the real-time EEWS demonstration stations at Fang-he junior high school in Taipei City; Yilan elementary school, Nanan junior high school and SECOM security company in Yilan County; Hualien train station, Kuang-fu elementary school and Yu-tong junior high school in Hualien County; and National Chung Cheng University and Kang-ping elementary school in Chiayi Country. These stations serve for long-term validation of the EEWS, and make earthquake disaster prevention education and management possible.

Bridge safety monitoring

The bridge, which dictates traffic flow, is increasingly vulnerable to rising occurrence of natural disasters. In addressing the issue, the NARL has clustered the expertise of its affiliated centers—National Center for Research on Earthquake Engineering, the National Science and Technology Center for Disaster Reduction, the Taiwan Typhoon and Flood Research Institute, and the National Nano Device Laboratories—to improve the safety of cross-river bridges. The task is to develop comprehensive monitoring system and innovative disaster prevention technology. A significant number of achievements for 2011 are as follows:

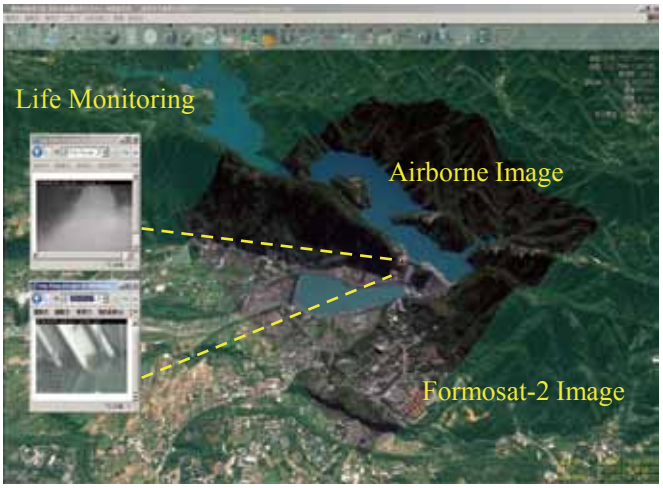
- Several recently-developed sensing devices were integrated and validated in the laboratory to be effective in the bridge safety monitoring system. And they were installed in the field bridges as part of the experimental on-site bridge safety monitoring system for disaster prevention.
- A preliminary network database for an interdisciplinary bridge safety monitoring system was constructed. A location-based service to include data for specific location and time was also implemented to enhance disaster prevention technology and resource integration.
- An artificial neural network forecasting model for the precipitation-water level on the Chuoshuei River was constructed. The model can be used to estimate water level, design flood and inundation simulation models, and construct bridge scour safety database.
- A movable bed flume platform was constructed for hydraulic experiments. This platform facilitates researchers to test, apply, and validate in relation to the cross-water bridge safety.

3D GIS Taiwan project

The "3D GIS Taiwan" project is to develop near real-time, high-resolution, global earth observation 3D platform for disaster monitoring and assessment in Taiwan. The project integrated earth observation technologies, data warehousing, 3D visualization, grid computing, cloud computing, and disaster prevention technologies. The project engaged six of the NARL's affiliated centers.

The aforesaid project has developed three core technologies: 1) multi-scale earth observation; 2) multi-scale 3D GIS display technologies and systems; and 3) networked 3D GIS system 1 and WMS (Web Map Service) cloud system. These developed technologies ease near real-time image acquisition and processing for fast application needs in disaster reduction and emergency preparedness.

Applications of the core technologies in environment protection and disaster preparedness in 2011 include: 1) acceleration of near real-time FORMOSAT-2 image processing from about one day to less than four hours to support disaster warning and response management; 2) 3D GIS image interpretation and integration of thematic disaster events for post-disaster reconstruction and review; 3) rapid disaster damage loss assessment in early after-earthquake stage with the Taiwan Earthquake Loss Estimation System; and 4) integration of inundation simulation model and 3D GIS photos of Lanyang Basin in NE Taiwan to forecast potential inundation areas.



1 web 3D GIS platform

Development of remote sensing instrument

Taiwan's first optical remote sensing instrument (RSI) to be placed in FORMOSAT-5 is completely designed, manufactured, and assembled by the NARL's affiliated centers—the National Space Organization (NSPO), the Instrument Technology Research Center (ITRC) and the National Chip Implementation Center—in partnership with the industrial sector. The RSI will have a 2-meter resolution and a 24-km swath. The major feats for 2011 are as follows.

- The NSPO and the Aerospace Industrial Development Co. jointly developed and manufactured crucial space-qualified components of the main supporting structure of RSI.
- The NSPO and the CMOS Sensor Inc. jointly developed the key components of the CMOS Focal Plane Assembly. The key technologies related to the CMOS image sensor were proven to work effectively for the next step of refinement.
- The ITRC has developed an engineering model of band-pass filters. Its transmission performance is better than requirement and out-of-band rejection is comparable to the one in FORMOSAT-2.

The aforementioned components and technologies, and other fabricated flight components will be assembled, and the integrated RSI tested in 2012.

Biomedical electronics R&D platform

A platform for developing biomedical electronics was instituted by integrating well-established semiconductor technologies developed within the country. The effort was to work with the academia in all facets of developing biomedical detection devices and monitoring systems. This integrative platform involved the NARL's affiliated centers,the National Chip Implementation Center, the National Nano Device Laboratories, the Instrument Technology Research Center, the National Center for High-performance Computing and the National Laboratory Animal Center, and has since successfully developed three novel technologies—CMOS BioMEMS sensing technology, silicon nanowire biological sensing device, and bio-molecular detection apparatus. This integrative platform and its preliminary outputs lay the foundation to facilitate the operation of the Biomedical Science Park that will be completed in 2013, encourage the industrial sector in the manufacturing of biomedical electronic products, and improve technologies and quality of medical services in the country.

B. Major Achievements

Improved seismic resistance for school buildings

Taiwan has 3,621 public schools with more than 20,000 buildings. Most of these buildings are intensively used.

And in case they are destroyed or damaged by earthquakes, the number of casualties would be immense. To retrofit these buildings for seismic resistance, the Ministry of Education (MOE) is facing a great challenge with limited budget and time constraints for the retrofitting task. To overcome the challenge, a team from the National Center for Research on Earthquake Engineering (NCREE) has developed a set of cost effective techniques for detailed evaluation and retrofitting design of the school buildings. In the work, the procedure for seismic upgrading involved simple survey, preliminary assessment, detailed evaluation, retrofit design, and reinforcement construction. Each step of the procedure was subject to discernible methods of assessment and rigorous reviews by the scientists and professional engineers to ensure the appropriate selection and reconstruction of the school buildings for increasing earthquake resistance. The aforesaid procedure had saved the need of reinforcement construction or demolition for reconstruction in many school buildings. In the process, the acquired comprehensive information on the earthquake resistant capacity of school buildings was also collected, collated and stored in the databank that is used to assess the progress, quality and characteristics of the engineering work of retrofitting. Moreover, the concerned authorities are utilizing the information in the databank to formulate policies for earthquake disaster reduction. In partnership with the MOE, the NCREE team has reinforced more than 1,900 school buildings from 2009-2011. This ensures the safety of more than 1.51 million students and teachers, and saves the government vast sums of money. In recognizing its contribution towards the society at large, the ROC Executive Yuan conferred the NCREE team with the 2011 Award for Outstanding Contributions in Science and Technology . 2

2 the ROC Executive Yuan conferred the NCREE team with the 2011 Award for Outstanding Contributions in Science and Technology

A new center for precision forecasts of landfalling typhoons

In 2011, the NARL has instituted the Taiwan Typhoon and Flood Research Institute (TTFRI) for the advancement of critical technologies in accurate predictions of typhoons and floods. Right after its inception, the TTFRI strives to developing four core technologies including numerical weather modeling (ensemble forecast), quantitative precipitation estimate/forecast techniques, hydrological modeling (coupled with rainfall model), and integrated atmospheric and hydrologic observation techniques. These technologies are to improve forecast capabilities for typhoon and flood events under Taiwan's diverse terrain, and to maximize the efficacy of early warning systems for these weather hazards. In this connection, the TTFRI, in collaboration with the NARL's National Science and Technology Center for Disaster Reduction and National Center for High-performance Computing, as well as Taiwan's Central Weather Bureau, has conducted the typhoon quantitative precipitation ensemble forecast research. The obtained results show that the ensemble forecast is able to provide 2- to 3-day forecasts of typhoon precipitation to meet the needs at the regional level. By coupling with atmospheric and hydrologic models, the precipitation ensemble forecast can also be used in operational forecasting for raising river water level, flood-prone areas and flooding situation. These improvements will effectively assist the concerned agencies to forecast the direction of typhoon and its associated precipitation, and to prompt any necessary preventive measures so to minimize the loss of life and property.

A new chapter for the nation's ocean research

The Taiwan Ocean Research Institute launched its 2,700-ton research vessel on June 10, 2011. This opens a new chapter in the nation's ocean research efforts. Christened as the *Ocean Researcher V (OR V)*, it is the largest research vessel ever commissioned in Taiwan. *OR V* will play a crucial role in marine survey, coastal and marine natural disaster observations, marine conservation, national land conservation and ocean floor exploration. It will explore for seabed oil and gas deposits, deep sea water, offshore wind power and natural gas hydrates (e.g. methane clathrate). Designed to operate at sea continuously for up to 250 days and withstand waves generated by winds up to 40 knots in precipitous sea, the 72.6 m x 15.4 m *OR V* is set to serve as a safe and technically advanced mobile research platform for seagoing scientists.

Taiwan's space science marches on

After 20 years of endeavor in the implementation of FORMOSAT-1, -2 and -3 satellite programs, the National Space Organization (NSPO) has laid a solid foundation for Taiwan's R&D capacity in space science and technology. FORMOSAT-2 with life span of five years is a high-resolution photographic surveillance satellite with a daily revisit capability. Its total photographic area since launch in 2004 has reached five times more than the world's total land area. With the self-developed image processing system, the NPSO continues to provide remote sensing images to 89 academic institutions and 125 government agencies in Taiwan for use in national land planning and disaster assessment. FORMOSAT-3/COSMIC with life span of five years is a joint Taiwan/US science mission for weather, climate, space weather, and geodetic research. Six identical micro satellites, each carrying an advanced GPS radio occultation (RO) receiver, a tiny ionospheric photometer, and a tri-band beacon were deployed. Since launch in 2006, the FORMOSAT-3/COSMIC program has provided a daily average of 2,500 atmospheric profiles to 1,700 users in 57 countries that have improved accuracy of global weather forecasting. To strengthen the country's independent R&D capacity in space science and technology, the NARL is integrating the NPSO with the NARL's two other centers, the Instrument Technology Research Center and the National Chip Implementation Center, for the development of the payload remote sensing instrument. And due to the success of FORMOSAT-3/COSMIC, the NPSO is partnering with the US National Oceanic and Atmospheric Administration on the development of FORMOSAT-7/COSMIC-II program. It targets for a more accurate forward operator and on acquiring GPS-RO observations from other missions in real time for evaluation and implementation in the operational global forecast system.

A new supercomputer for science and engineering applications

The Windrider (ALPS), built by the National Center for High-performance Computing, is Taiwan's largest supercomputer. Its Rmax value reaches 177 trillion floating point operations per second. In June 2011, the Windrider was ranked in the 42nd position on the TOP500 List for its high performance capacity, and the 25th position on the Green500 List for its energy saving at 400Mflops/W. Since August 2011 the Windrider has provided on-line computing services that will help to expand the scale and increase the competitiveness of Taiwan's science and engineering research.

New stacked chip MorPack

The National Chip Implement Center has come up with a morphing packaging technology called MorPack that will speed development of multi-chip systems. MorPack is three-dimension heterogeneous integration system platform that can integrate several different kinds of chips. And it can cut down development time and cost, because MorPack allows for the easy integration of chips with different functions into one tightly-bound package. The MorPack technology allows various electronic developers for devices in communications, medicine, green energy, smart cars, etc. to stack chip modules with different functions on top of each other.

3. Management and Integration

Key performance indicators implemented

To create synergy between the NARL's 11 affiliated centers and to meet the dual demands of accountability and quality assurance, the common set of key performance indicators, also known as KPIs, was designated to assess the performance of the individual researchers against the NARL strategic goals. In this connection, the KPI platform was established to monitor number of publications, quality of publications, number of patents, number of invitations to address and participate in international conferences, number of awards and citations, internal and external services, input-output measures, etc. in order to more rigorously and empirically assess scientific and service performance. These KPIs will help the management define and measure progress toward the NARL strategic goals.

Performance bonus plan adopted

The growing competitiveness in science and technology and global trade, emerging issue of climate change and global warming, and increasing demand from diverse sectors of society obligate the NARL to improve its productivity, i.e., to improve its core mission performance. For this reason, the NARL continues to invest in its workforce and in an environment that develops talent, nurtures operational efficiency and rewards initiative and innovative work. Towards this direction, the NARL has adopted the performance bonus plan that was approved by its supervising authority, the National Science Council, on November 9, 2011. The plan is to recognize and reward the individual performance of employees who meet or exceed certain key metric targets and make a tangible contribution to the NARL's success.

Accreditations of NARL's operations

To continually maximize the organization management efficiency, the NARL in 2011 has launched the certification renewal cycle of ISO 9001 and ISO 27001, which are the internationally recognized standards for the quality management systems and information security management systems, respectively. The scope of reassessment covered the NARL headquarters and all of its affiliated centers including their regional offices in southern Taiwan. All of them successfully passed the reassessments, some even without a single defect. This attests once again to the rigor and maturity of the NARL's comprehensive management system that puts the focus on the satisfaction of all of its stakeholders. Furthermore, to ensure the competent operation of various testing and calibration laboratories, the NARL has arranged accreditations of these laboratories with internationally recognized accreditation bodies. The accreditation certificates from the International Organization for Standardization, the Taiwan Accreditation Foundation, and/or the Association for Assessment and Accreditation of Laboratory Animal Care provide evidence that the specific standards of these laboratories have been met. In 2011 the NARL's specialized laboratories have passed 36 inspections. And it is expected that 40 specific scientific functions of the NARL laboratories will be certified by the end of 2013.

NARL's outstanding awards

The NARL established the Award for Outstanding Contributions in Science and Technology and the Award for Outstanding Services in 2007 and 2010, respectively. The primary purpose is to enhance research capacity, improve service quality, promote research, cultivate the talent, and upgrade internal service protocol. These awards recognize individual employees or teams who have demonstrated the range and significance of their contributions in science and technology endeavors or service works. The awardees and their citations for 2011 are as follows:

NARL Award for Outstanding Contributions in Science and Technology

Academic Research:

National Nano Device Laboratories for "9nm memory with ultra-low power"

National Center for High-performance Computing for "Three-dimensional reconstruction of brain-wide wiring networks in Drosophila at single-cell resolution"

Technology Development:

National Chip Implementation Center for "MorPACK-Heterogeneous aystem integration and prototyping platform"

National Nano Device Laboratories for "An approach for high efficiency photo detector by optical MEMS technology"

Technology Service:

Science & Technology Policy Research and Information Center for "The government science and technology program: Review and performance assessment of management platform construction and services"

National Chip Implementation Center for "Hyperspectral imager and technology platform"

NARL Award for Outstanding Services

National Nano Device Laboratories for "Effective energy saving and safety and quality improvement for facility"

Instrument Technology Research Center for "The contribution in the service of Taiwan Accreditation Foundation (TAF) accredited laboratory"

National Chip Implementation Center for "High quality and efficiency promotion plan for chip implementation service"

International Cooperation

The NARL's success is due in part to collaborations with highly reputable research laboratories and universities in the United States, Europe, Japan, South Korea, and others. Currently, the NARL has signed the agreements of cooperation with 60 research institutes from 19 countries in joint projects and/or exchanging data, results, and researchers. With these agreements, the NARL not only gains access to state-of-the-art technologies and information, but also contributes to the international science community at large. Some of highlights include:

- The National Space Organization (NSPO) took part in the AMS-02 program, a particle physics experiment module that is mounted on the International Space Station to study the formation of the universe. The program, the first ever in space science, is an international collaboration that involves more than 600 scientists in 56 research institutes from 16 countries under the direction of Nobel Laureate Samuel Chao Chung Ting. The AMS-02 was launched on May 16, 201 with Space Shuttle Endeavor.
- The NSPO also continues its pivotal role in Sentinel Asia, which is a collaborative initiative of 25 countries to support disaster management in the Asia-Pacific region by applying the earth observation satellites data. In this regard, the FORMOSAT-2, a high-resolution photographic surveillance satellite, has promptly provided real-time images in the aftermath of the 2011 great east Japan earthquake and tsunami, Typhoon Talas in western Japan in 2011, Thailand floods in 2011, plus nine other disasters in the region.

National Chip Implementation Center

- ▶ 1992 The Chip Implementation Center Project (CIC Project) is initiated
- ▶ 1997 The CIC Project is renamed the National Chip Implementation Center (CIC)
- ▶ 2002 CIC launches its branch office in the Southern Taiwan Science Park
- ▶ 2003 CIC is subordinated to the National Applied Research Laboratories (NARL)

Integrating and Developing the IC/System Design Environment

Providing EDA tools and design flows

Responding to academic research needs and industrial development, CIC continued its efforts in 2011 to introduce an array of widely employed electronic design automation (EDA) tools. In 2011, CIC provided EDA tools from 19 world-renowned companies, supplied seven complimentary chip and system design flows to universities and students, implemented software and a module database for users, and provided necessary technological consulting service. All in all, CIC helped local R&D teams to focus on innovative R&D, improve success rate of chips, and accelerate research progress.

Developing platform technology on CONCORD, MorPACK, and MorFPGA

For the design and evaluation environment of the chip system and platform technologies, CIC continued R&D of CONCORD and MorPACK in 2011. In the 2011 version of CONCORD, CIC mainly conducted calibration and optimization of the platform and simultaneously received requests from National Chung Cheng and Chiao Tung Universities to build a health box digital test system and a nano-sensor measure test system based on CONCORD platforms, greatly enhancing practicability of the platform. The 2011 version of the MorPACK platform strengthened the functions of its small, slim, and lightweight intelligent electronic system. The key chips were redesigned and manufactured with the TSMC 90nm procedure. CIC also improved comprehensive system effectiveness of the systematic structure. This achievement was reported by IEEE Spectrum, and the IEEE International Conference also invited CIC to IC Design and Technology (ICICDT-2011) to publish this accomplishment. For this achievement, CIC also won the 2011 Technological Outstanding Contribution Award from National Applied Research Laboratories.

The 2011 version of MorFPGA earned a good reputation in the industry for its practicability and commercial value. MorFPGA technologies have been adopted for mass production and will receive royalties and franchise fees.

Providing Chip Fabrication and Measurement Service

Providing chip fabrication service

To meet development requirements of the integrated circuit design business and to incubate chip designers, CIC continues to provide chip fabrication service and has established an environment for new production procedure.

In 2011, CIC provided 12 manufacture procedures for chip fabrication service (including CMOS, MEMS/BioMEMS, and GIPD procedures) and real-time data update testing and description, including two added procedures, the TSMC 40nm 1P9M CMOS procedure and the TSMC 90nm 1P9M MS General Purpose procedure. CIC has made contribution to the production of over 740 theses and patent right announcements, and 1,705 chips. Among these chips, 230 adopted the advanced 90nm procedure (47.4% of growth compared to 2010), and 10 use 40nm, accounting for 14% of total chips, to which the chip utility rate has exceeded 70%.

Establishing the Security Laboratory

In order to save the huge expense of advanced procedures, in 2011 CIC launched the Security Laboratory with SOP and its own doctrines. Up to now, the Security Laboratory has successfully helped 32 professors and 86 students to design

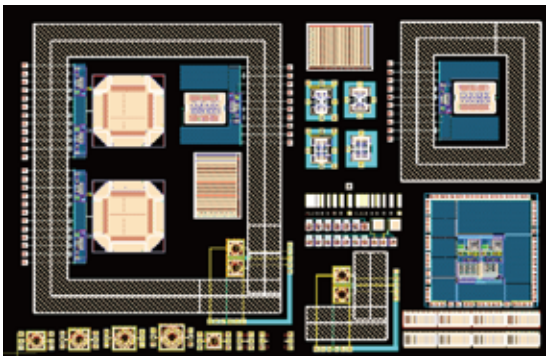
with authorized data of the TSMC 40nm advanced manufacture procedure. Meanwhile, CIC has started developing related chip platform technologies including sensing, biomedical, green energy, and system sealing and packaging, to enhance the value of mature manufacture procedures. Therefore, CIC has emphasized its effectiveness with limited funds (funding for advanced procedures has not increased since 2007). This effort has enabled CIC to attract professors in academia to implement cross-field cooperation to improve industrial development.

Providing heterogeneous integration service

For platform technology, CIC used the CMOS-IPD manufacturing procedure provided by Taiwan's comprehensive industrial environment to acquire bumping technology from the ASE Group in 2011. CIC can thus propel academia to implement hetero-circuit integration with the advantages of all types of manufacture procedures. This niche has increased CIC competitiveness in the radio frequency circuit system. The IPD procedure has also enabled CIC to complete circuit design and practices used in the 60 GHz antenna, bandpass filters, and couplers. This achievement has confirmed that current IPD procedures could be applied to the design of V-band circuits and greatly expands the application field of the IPD procedure. These achievements have been announced in critical international conferences such as IEEE and APMC.

Developing on CMOS MEMS platform

CIC has acquired patent rights of independently developed CMOS MEMS platform technology in both Taiwan and the U.S. In addition to the platform's practicality, CIC has also developed design kits including material parameters, DRC command files, procedure description files, an inductor library, a quality control and test component, and Sensor IP. These will help designers complete structural analysis, sensor analyses, layouts, and references. The design kits will assist R&D personnel to lower the design threshold and accelerate R&D. The characteristics of the G sensor chip manufactured with the 0.18 um CMOS MEMS platform 1 are similar to those on the market. CIC can further assist domestic design companies to develop an embedded sensing chip to access the tens of billions of dollars in the CMOS sensor markets.



1 Layout of 0.18um CMOS MEMS manufacture procedure

Training Courses and Activities

Organizing IC design training courses

CIC has launched winter and summer training courses and e-learning on different IC design flows to train and incubate Taiwan's IC designers. In 2011, CIC completed 175 classes (11 of which are new) of 60 training courses in seven criteria to help 8,620 participants master various design methods. Since 2011, CIC has been authorized by the Industry Bureau of the Ministry of Economics to offer training courses at the Semiconductor Academy, featuring outstanding lecturers within CIC and senior professors from universities, to further train the industry's work force.

Organizing IC contests

In order to stimulate and inspire excellent IC designs from amongst students and teachers, CIC annually organizes IC contests, including the IC Design Contest (authorized by the Ministry of Education), the ARM Code-O-Rama Design Contest, and the Multi-Project Chip Workshop.

▶ Achievement Statistics

Scope of Performance	Item	Quantity	Unit
Service Results	Design environment services	2,309	Cases
	Paper published by CIC users	740	Articles
	Chip fabrication services	1,705	Chips
R&D Results	Papers published by CIC	37	Articles
Training/Education Outreach	Training workshop participants	8,620	Persons
	Training workshop courses	175	Courses

Instrument Technology Research Center

- ▶ 1974 The Executive Yuan approves the establishment of the Instrument Technology Research Center (ITRC)
- ▶ 1987 ITRC relocates to the Hsinchu Science Park
- ▶ 2003 ITRC is awarded as the Excellent Technological Organization by the government
- ▶ 2004 ITRC receives Excellent Technological Management System Award from the Executive Yuan
- ▶ 2005 ITRC is subordinated to the National Applied Research Laboratories (NARL)

Intelligent and instinctive – innovative instrument technology

Onto its 37th year of establishment, ITRC has established an instrument technology platform that incorporates four main research dimensions, namely remote sensing instrument, biomedical instrument, green technology and disaster prevention and rescue technology in contributing to the national science and technology policies of Taiwan. Based on the four dimensions, ITRC stands out as the strong hand in supporting the academia and industry circles through the involvement in projects of various levels and topics, and by extension to advance the national science competence and competitiveness.

Current research outputs feature on more than 40 in-house built systems developed under collaborative projects with the academia and industry, including "*in-situ* FTIR Analysis System" 1 , "Automatic Spinneret Inspection System," "Automatic Optometry Instrument," "Optical Chopper Measurement Module," etc. and 6 cases of technology transfer. Representative collaboration projects include "Wafer Inspection System," "Microscopy for Bead Inspection," "Development of High Expansion Ratio Beam Expander for He-Ne Laser," etc. that help to connect research to the market.

1 *in-situ* FTIR Analysis System

Prosperity in globalization

Further expanding the map of international cooperation, ITRC has cooperated with word renowned research institutes and universities through various channels such as MOUs, projects and joint researches. The cooperation partners bonded by MOUs include the Optical Data Storage Center of University of Arizona, USA; Optoelectronics Research Center of the University of Southampton, UK; Advanced Science Institute of RIKEN, Japan; Center for Information Storage Device of Yonsei University, Korea; Photonics Advanced Research Center of Osaka University, Japan; and Université de Technologie de Troyes, France. Cooperation in a less formal way has also been initiated with the Hong Kong Chinese University and the Microelectronics Research Institute of A*STAR, Singapore.

In year 2011, ITRC organized "The 3rd International *i*-ONE Instrument Technology Innovation Competition" 2 and "Remote Sensing Satellite Conference," co-organized "The 8th International Conference on Networked Sensing Systems," "IEEE International Workshop on Electromagnetics: Applications and Student Innovation Competition," and participated in more than ten competitions and exhibitions home and abroad.

2 Group photo of the 3rd *i*-ONE International Instrument Technology Innovation Competition award winners

Excellence in service and talent cultivation

To provide the highest standard of service quality, ITRC continued its efforts in maintaining the ISO 9001 Quality Management Systems, ISO/IEC 27001 Information Security Systems and ISO/IEC 17025 Laboratory Accreditations on six laboratories of vacuum, thin film testing, optoelectronic calibration, scanning probe microscopy and scanning electron microscopy. With the affirmation from these acknowledgements, ITRC is proud to provide its 201 clients from the academia, research and industry circles of 1861 cases with the most professional service.

Aside from the establishment of such service platform, ITRC has further broadened its service scope to instrument environment technologies that mean to elevate the efficiency and utility of instruments. A team has been built corresponding to this emerging field. Six issues of the Chinese bimonthly periodical Instruments Today and a number of technical monographs were published as the channel for competence proliferation.

To carry out "science diplomacy" and to foster the cultivation of personnel required for the future development of instrument technology, ITRC has been organizing the International Scientific Instrument Technology Workshop for the 16th year in a row. In 2011, the workshop was joined by high-end professionals and government S&T officers from Thailand, Vietnam, Indonesia, India, the Philippines and Malaysia; among the participants, 85% had obtained PhD degrees, 48% received their degrees overseas, and one recognized as a fellow of IEEE.

▶ Awards obtained in 2011

Award	Title	Rank
2011 iENA International Trade Fair (Professional Group)	Non-Contact Power Trip Detection Device	Special Recognition 3
	Eccentric Inspection Device of Optical Lens	Gold Medal
	Image Sync Measuring Apparatus	Silver Medal
	Telescopic Observation Method for Virtual and Augmented Reality and Apparatus Thereof	Silver Medal
IEEE Instrumentation and Measurement Society Annual Best Chapter Award	IEEE Instrumentation and Measurement Society Taipei Section Chapter	Annual Best Chapter Award
Taiwan Photonics Society	Vegetation Change Detection System	Optoelectronics Technology Contribution Award
2011 Taipei International Invention Show and Technomart	Non-Contact Power Trip Detection Device	Gold Medal
	Pulse Generator Triggered by Event	Bronze Medal
The 6th Osaka University Photonics Center Symposium	The Fabrication of Three-dimensional U Shape Metamaterials	Best Poster Paper Award

3 Special recognition awarded by 2011 iENA International Trade Fair

▶ Achievement Statistics

Scope of Performance	Item	Quantity	Unit
Service Results	Facility and technical services	201	Institutes
		1,861	Cases
R&D Results	Papers published by ITRC	240	Articles
Training/Education Outreach	Graduate students in joint research programs	91	Persons
	Training workshop participants	1,239	Persons
	ITRC visitors	675	Persons

National Science and Technology Center for Disaster Reduction

▶ 2003 The Executive Yuan promulgates the "Guidelines for the National Science and Technology Center for Disaster Reduction"

▶ 2003 The National Science and Technology Center for Disaster Reduction (NCDR) is established

NCDR incorporates cross-field professionals for a series of research programs; including "Research on Typhoon/Flooding Disaster Response and Mitigation," " Research on Earthquake Disaster Response and Mitigation," " Research on Emerging Disaster Mitigation Operations," and "Promotion & Implementation of Disaster Prevention Technologies." NCDR chief important achievements in 2011 are outlined as follows:

Research on Typhoon/Flooding Disaster Response

Major typhoon event data establishment and analysis

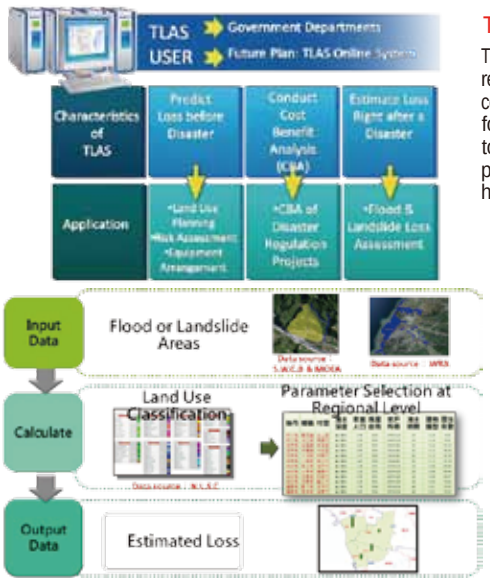
- NCDR has a database for 17 major natural disasters worldwide. The analyses of these disasters can help Taiwan to improve its disaster governance mechanism.
- Development of Taiwan Typhoon Loss Assessment System, TLAS TAIWAN: The system incorporates GIS technology and records of loss during typhoons and floods in the past decade. It can enhance efficiency of loss assessment of typhoon or flood events. 1

Disaster Simulation and Early Warning Analysis

- Disaster Simulation and Disaster Mitigation Analysis: NCDR has completed three cases of technology R&D, namely the conceptualization of disaster-prone weather conditions, automatic operation of real-time precipitation data management, and output data management at flood warming mode.
- Assessment on the slope land disaster impact: The item is to structure the operation framework for large-scale landslide disaster, that the promotion strategy includes short, medium, and long term objectives.

Development of Decision Support System for Disaster Information

Development of disaster data and decision-making support system: NCDR focuses on value-added, mature and advanced typhoon disaster alert review system.



Loss Assessment System of TLAS Taiwwan

TAIWAN TYPHOON LOSS ASSESSMENT SYSTEM (TLAS TAIWAN)

TLAS Taiwan can quickly estimate flood or landslide losses and can then present the results spatially. For the purpose of disaster reduction, it can be used to conduct cost-benefit analysis of regulation projects. As for disaster mitigation, it can have a role for land use plan.Regarding the phase of disaster response, it can assist governments to find potential areas with large losses and then to arrange spatiallly disaster prevention equipment according to the results. Finally, for disaster recovery, it can help to form financial plans of different regions based on the disaster loss amounts.

Applications of TLAS Taiwwan

1 Taiwan Typhoon Loss Assessment System

Research on Natural Disaster Mitigation and Recovery Strategy

- Assessment on socio-economic impacts of disasters and vulnerability to disasters: NCDR has established a method of disaster risk-assessment and management for social welfare organizations. For now, this method focuses on the phase of disaster response. Later, the focus will be shifted to other phases of disaster.
- Disaster recovery survey of typhoon Morakot: This survey examines post-disaster social and mental recovery as well as challenges of the recovery phase.

Study on the emergency response and hazard mitigation for the earthquake disaster

- To Build up the grid-based GIS information: Loss assessments can be quickly provided after catastrophic earthquake occurred. The areas with high risk of disaster are immediately circled and provided by utilizing the gridding skill of hazard analysis, which can improve the efficiency of emergency response.

Research on Emerging Disaster Mitigation Operations

Strategies for Disaster Reduction and Climate Change Adaptation

- Completed "The Science Report for Taiwan Climate Change 2011", the first scientific report on the topic in Taiwan
- Established Climate Change Projection and Information Platform, which provides the information of Taiwan climate change in the past to government units and researchers.

Development of Disaster Risk Management on Critical Infrastructure (CI) Protection

- Assessment Method and Impact Indexing on CI failure Analysis - NCDR focuses on a specific region, considering one or multi facility conditions, to evaluate loss of CI and its impact consequence.
- CI Interdependency Analysis Methods - two methods (qualitative and quantitative) of system interdependency analysis have been developed for using on different scenarios and system characteristics.

Promotion & Implementation of Disaster Prevention Technologies

Setting up local government disaster mitigation consultant organization and review re-build area policy

Working items: 1. Providing natural disaster intelligence and assisting local government response; 2. Assisting the production and application of the disaster potential of map; 3. Assisting the post-disaster survey on special area ;4. Providing assistance on local education and training workshop.

Implementation and Promotion of Disaster Prevention Technologies:

- Support Mechanism Establishment and Post-disaster Recovery Review: Disaster risk map production and application for potential landside and flood areas: NCDR has produced 1,119 potential risk maps for the central and local governments. These are tools for disaster prevention operation in Taiwan.

Contribute to Disaster Prevention and Response Operation with Executive Yuan

- Assist National Science Council in promoting major programs for cross-sectorial disaster prevention and response technology R&D: NCDR wrapped up the four-year enhancement program and helped to promote, plan disaster mitigation technology planning and application.
- Support Disaster Response/ Drill/ Investigation Operations: NCDR participated in information screening and judgment during typhoon Nanmadol and the 311 Japanese earthquake and tsunami disaster.

Promotion of National Geographic Information System in Disaster reduction and prevention Application

- Value-added and integrated application and services of Disaster reduction and prevention information: NCDR provides a cross-sectorial shared environment through disaster reduction and prevention application service platform.

▶ Achievement Statistics

Scope of Performance	Item	Quantity	Unit
Service Results	Support of CEOC- typhoon events	155	Persons
	Assistance to the public sector in disaster prevention & reduction missions	21	Times
	Launch of websites providing information services	12	Websites
R&D Results	Papers published by NCDR	158	Articles
	Research/technical reports	40	Reports
Training/Education Outreach	Education and promotional training	116	Seminars
	Training workshop participants	487	Persons

National Center for High-Performance Computing

- ▶ 1991 The Executive Yuan approves the establishment of the National Center for High-performance Computing (NCHC)
- ▶ 1993 NCHC's headquarters in the Hsinchu Science Park starts to operate
- ▶ 2003 NCHC is subordinated to the National Applied Research Laboratories (NARL)
- ▶ 2005 NCHC launches its branch office in the Southern Taiwan Science Park
- ▶ 2008 NCHC launches its branch office in the Central Taiwan Science Park

Advances and Integrates HPC Environments

The NCHC is Taiwan's only national laboratory possessing large-scale high-performance computing platforms and networking facilities open for public use. It provides integrated computing, networking, and storage services to Taiwan's information, science, and engineering communities.

In 2011, the NCHC's high-performance computing (HPC) capacity totaled 200 Tflops. An availability rating of better than 99.9 percent is achieved for the computing mainframe and storage facilities during the same year. Also in 2011, The NCHC's HPC resources served 759 National Science Council (NSC) projects and 42 large-scale computing and specialized projects. The NCHC's services also contributed to the publication of 726 professional and scientific papers nationwide in 2011.

In terms of network research, in 2011, an additional three, eight, three, and four schools became IPv4, SSL-VPN, VPLS, and DNS remote backup connected respectively. Also in 2011, the overall service availability of the Taiwan Advanced Research and Education Network (TWAREN) increased to 99.99 percent. Additionally, the R&D results of the Future Internet testbed in Global Lambda Integrated Facility (GLIF) (and its exhibition at SC11) attracted much attention, as well as served to further elevate the competitiveness of academic research in Taiwan.

Establishes Progressive HPC Services

The NCHC's Newest Supercomputer, Windrider -- Ushering in a New Era of Large-Scale HPC in Taiwan

The NCHC's newest supercomputer acquisition, Windrider, is a new generation of supercomputer for HPC. Windrider possesses computing capacity of 177 Tflops and was ranked 42nd in the 37th TOP500 and 25th in the Green500 supercomputer lists. 1 Windrider not only can satisfy the computing needs for research applications, but also has been internationally recognized for its energy conservation and ecological considerations. It officially opened for public use on August 1st, 2011.

Successfully Building of the Formosa Series - The Proof of Capability in Making Taiwan-branded Supercomputers

The NCHC developed the Formosa Series to address the need for cloud computing in Taiwan. In the Formosa Series, Formosa 3 provides users with Infrastructure as a Service (IaaS) by leasing out virtual machines, thus allowing users to install their own operating systems and software according to their individual needs. Also, the NCHC's independently-built Formosa 3 is Taiwan's first and fastest render farm that allows remote computing and provides rendering services for Taiwan's animation and special effects computing communities. Formosa 4, with its CPU/GPU hybrid computing framework and fine-tuned efficiency, placed 234th in the 38th TOP500 and 37th in the Green500 supercomputer lists.

Integrated and Built the Application Software Service Platform, Thus Ushering in an User-Friendly Environment

The NCHC established a single portal software service platform that offers users rapid and easy utilization of the application software so as to solve various scientific and engineering problems. Additionally it serves to improve Taiwan's academic research environment.

Gains Domestic and International Innovative R&D Technology Awards

The NCHC's R&D achievements performed splendidly in 2011! "Three-Dimensional Reconstruction of Brain-wide Wiring Networks in *Drosophila* at Single-Cell Resolution" made the cover of the internationally-renowned scientific journal, Current Biology, 2 and the Clonezilla software was selected as one of the best free software as well as one of the top 50 Linux application software worldwide. Both of these honors serve to further accentuate the research and development prowess of the NCHC. Additionally, the NCHC won one gold and two bronze medals at the 7th Taipei International Invention Show & Technomart with three of its patents, "Virtual Set-Top Box System and Method," "Liquid Level Detection Method," and "Remote Camera Synchronization Controlling System."

"Three-Dimensional Reconstruction of Brain-wide Wiring Networks in *Drosophila* at Single-Cell Resolution" and "A Fictitious Time Integration Method for Multi-Dimensional Nonlinear and Nonhomogeneous Backward Heat Conduction Problems" won the *Superior* and an *Excellent* awards respectively in the Academic Research Category of National Applied Research Laboratories (NARL) Science & Technology Contribution Award. The "Improvement of Advanced Network Management Technologies over TWAREN" won an *Excellent* award in the Technological Service Category and "Crawlzilla - A Toolkit for Deploying Cluster Search Engines Quickly and Easily" won an *Excellent* award in the Technological Development Category.

Internationally, "Remote Camera Synchronization Controlling System" and "Liquid Level Detection Method" won the gold and silver medals at iENA, Germany. These two inventions were also used by Taiwan's Water Resources Agency to monitor water resources and were applied in disaster prevention and rescue efforts as well.

A student team from the National Tsing Hua University (NTHU), supported by the NCHC, Acer, and NVIDIA, represented Taiwan

1 The NCHC's supercomputer - Windrider

2 The 3-D Neural Network Imagery Database achieved significant breakthroughs during 2011 and was showcased on the cover of *Current Biology*.

to win the world championship at the international SC11 Student Cluster Competition for the second time! Winning the SC Student Cluster Competition two years in a row is a clear indicator of the NCHC's leading position in HPC in Taiwan.

The NCHC, the University of Edinburgh (United Kingdom), the University of Catania (Italy), and Stichting Centrum voor Wiskunde en Informatica (CWI) (Netherlands), began the joint undertaking of a three year €2.5 million research project in 2011, *Fish4Knowledge*, under the European Union's Seventh Framework Programme (FP7). This collaboration serves to further enhance the NCHC's international reputation and exposure.

In 2011, the NCHC actively conducted cloud computing-related conferences, exhibits, and contests such as the NCHC Student Cluster Competition, the Taiwan Anti-Hacking Technology & Cloud Security Conference, the Southeast Asia International Joint Research and Training Program in High- Performance Computing Applications & Networking Technologies, and the 1st Workshop on Nanoscience: Graphene.

▶ Achievement Statistics

Scope of Performance	Item	Quantity	Unit
Service Results	Capacity of storage facility for high-performance computing	2,750	TBs
	Papers published by NCHC users	726	Articles
R&D Results	Papers published by NCHC	127	Articles
Training/Education Outreach	Training workshop participants	2,134	Persons
	NCHC visitors	1,014	Persons

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 NCREE's office building and large structural laboratory start to operate
- 2003 NCREE is subordinated to the National Applied Research Laboratories (NARL)
- 2009 The new Multi-Axial Testing System (MATS) is completed

Seismic Design, Evaluation, and Retrofit Technologies

Updating seismic code documents and design guidelines

NCREE continued its efforts in developing the seismic evaluation and retrofit technologies for buildings and bridges, and also assisting with updating seismic code documents and design guidelines. NCREE revised the design earthquake recommendations for the Matsu, Penghu, and Kinmen area, now pending review at the Construction and Planning Agency (CPA) of the Ministry of the Interior. NCREE also assisted the National Expressway Engineering Bureau (NEEB) of the Ministry of Transportation and Communications (MOTC) in drafting the domestic framework for bridge seismic design regulations, which will serve as a basis for future revisions.

Developing seismic evaluation and retrofit method on existing buildings

NCREE developed street-front household building seismic assessment and reinforcement technologies to analyze school buildings and obtain seismic assessment and reinforcement data. In response to various demands of seismic design from different counties, safe column-to-floor ratio of school buildings was established to serve as reference to future development in fast seismic safety assessment technologies for street-front houses. Tests on cement structure and brick walls were completed to further examine street-front household structure. NCREE organized a good number of training workshops and on-site surveys and helped review the technical aspect of retrofit design schemes (RC jacketing, wing wall, shear wall), and also contributed to maintaining the seismic database for the evaluation and retrofit of school buildings.

Prolonging the durability and service life of bridges

NCREE made significant progress in prolonging the durability and service life of bridges via various seismic experiments. Achievements included the establishment of a hydraulic test platform that simulates bridges subjected to scouring from flood and drift logs, and a shaking table test platform to study the dynamic soil-pile-structure interaction in case of foundation exposure under saturated sand soil condition. Relevant research achievements may serve as reference in drafting the guideline of bridge safety evaluation under both earthquake and flood events. The development of optimal fiber altimeter, with field test on Ji-lu bridge at Nantou now completed, can provide real-time bridge safety monitoring. The experiment to verify the mechanical behaviors of three-cell corrugated bridge has been completed, providing an empirical base to design and apply the construction details to the Taichung Belt Way (National Freeway No. 4) project. 1

1 The experiment to verify the mechanical behaviors of three-cell corrugated bridge in the Taichung Belt Way (National Freeway No. 4) project.

Developing new material, construction method, and technology

New theories are applied to distribute damping coefficients to each story of a building structure with a damping system, proportional to the story shear strain energy. This proposed method can offer the industry an economical and effective energy dissipation design reference. The optimal building mass damper (BMD) design method is derived under reasonable considerations of mass ratios and objective functions. A series of numerical analysis and shaking table tests are performed to verify the effectiveness of the BMD system on seismic protection of building structures.

Strengthening geotechnical earthquake engineering research

To analyze a series of pushover experiment on a caisson foundation of the old Niudou Bridge was conducted, and the method was proposed to improve existing analytical methods for predicting the foundation behavior. The development of the damage assessment technology for geotechnical structures, vibration measurements on the Shibin Bridge were conducted prior to, during, and posterior to the flooding season to investigate the influence of foundation scour on the dynamic characteristics of the superstructure of bridges.

Earthquake Emergency Response, Risk Assessment, and Management

Improving the scenario-based simulation technology

In order to answer the demand from the practices of seismic emergency response and risk management, notable efforts were made to develop related earthquake disaster simulation and hazard potential evaluation technologies. Regarding earthquake disaster simulation, software and early loss estimation tool for assessing the damage and serviceability of water systems following earthquakes have been preliminarily developed.

Developing Seismic potential assessment technology

The seismic engineering parameter database was established, and thirty spectral acceleration decay of structural period was built to provide important reference on the evaluation of structural damage assessment. NCREE formulated the Near Fault Adjustment Factor table NA and NV for Category I Active Faults as a supplement to the existing Taiwan building code documents and a reference to related parties. Furthermore, the observation of relation between radon gas variation in soil and earthquake through existing observation station were conducted, and the radon gas real-time database was also completed.

Earthquake Engineering Testing and Simulation Services

NCREE provides simultaneous operation of its shaking table, reaction-wall, and MATS facilities. In 2011 alone, NCREE provided a considerable number of earthquake engineering testing services domestically, including 45 shaking table tests, 59 reaction-wall tests, 14 MATS tests, and eight 500-ton universal testing machine tests. Since the Brace On demand (BOD) open to public by September 2011, this cloud design system has been signed in by 700 man-time, and the execution of BOD cloud computation has conducted the Welded End-Slot Buckling Restrained Brace (WES-BRB) detail design more than 6000 times.

Educational Outreach and Application of R&D Results

To promote and implement its research achievements, NCREE continued to organize national and international conferences, training workshops, and educational outreach campaigns in 2011. The 2011 International Training Program for Seismic Design of Structures (ITP2011) featured speeches from a total of 28 world leading experts and professors from fourteen countries. NCREE organized 19 outreach events that attracted 2299 participants in 2011, including the Introducing and Demonstrating Earthquake Engineering Research in Schools (IDEERS) of 471 students from 9 countries. Among its other accomplishments in 2011, NCREE obtained ten patents either domestically and internationally, and transferred sixteen innovative technologies to authorized companies in Taiwan.

▶ Achievement Statistics

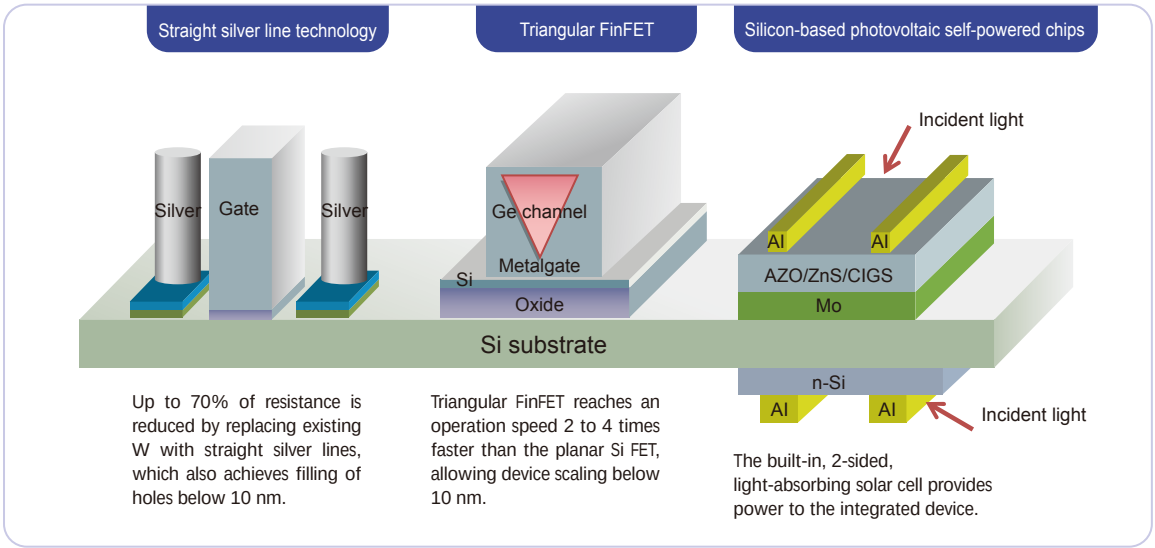
Scope of Performance	Item	Quantity	Unit
Service Results	Facility and technical services	117	Cases
	Papers published by NCREE users	46	Articles
R&D Results	Papers published by NCREE	143	Articles
Training/Education Outreach	Graduate students in joint research programs	115	Persons
	Training workshop participants	2,299	Persons
	NCREE visitors	780	Persons

National Nano Device Laboratories

- ▶ 1988 The Executive Yuan approves the establishment of the National Submicron Meter Device Laboratories.
- ▶ 2002 This Laboratories is renamed the National Nano Device Laboratories (NDL)
  NDL launches branch office in the Southern Taiwan Science Park
- ▶ 2003 NDL is subordinated to the National Applied Research Laboratories (NARL)
- ▶ 2010 NDL develops world's smallest 9nm functional resistive random access memory (R-RAM) array cells

Introduction of New Materials and Green Technology—New Generation of High-efficiency, Green Nano-chips Enabled by Silver, Germanium, and Solar Energy

NDL presented 4 papers at the International Electron Devices Meeting (IEDM), the most important event in electronics field which was held in Washington, DC, USA, in December 2011. It is worth mentioning that around 200 papers were selected for publication from over 600 submitted ones , and among the 20 papers from Taiwan that were selected for presentation, 4 of them were from NDL, closely following behind NCTU of 6 and Micronix of 5. The 4 papers by NDL cover technology that introduces silver and germanium as new materials and a built-in, Si-based solar cell self-powered circuit module, a green initiative energy-harvesting technology upgraded from the passive energy-saving technology. The 10 nm device's technology and the introduction of new materials and green technology will be vital for future efficacy improvement and chip miniaturization. By implementing low-resistance silver and high-speed germanium, the straight silver technology and triangular FinFET surpass the limits of conventional materials and achieved nearly 3-fold of improvement in transistor speed. IEDM highlighted the papers from NDL on Ge-transistors and Si-based solar cells with self-powered circuit modules , impressing the international academia and research communities in microelectronics with the message that these technologies are vital options for the 10 nm device generation.



Establish the First Thin-film Si Solar Cell Service Platform in Taiwan

NDL has provided the service platform for the research of third generation thin-film Si solar cells with conversion efficiencies of up to 9%. By utilizing the world's first high-density plasma deposited low-defect thin-film technology, degradation was turned as low as 10% in conversion efficiency for cells after illumination. This is the first thin-film Si solar cell service platform in Taiwan and a significant achievement for the development of renewable energy technology in Taiwan.

Establish the Research and Development Platform for 15 nm Devices Key Technologies

The core technologies being developed for the 15 nm devices research platform at NDL include (1) 10 nm electron beam and injection lithography, (2) Ge transistor, (3) Non-Cu metal nano interconnect, (4) low-temperature doping activation, and (5) resistive memory. Based on these technologies, the "Industry-academia Alliance of 12-8 nm Device Research and Development" was established, inviting faculty involved with national program on nano technology, ITRI, semiconductor foundries such as TSMC, UMC, Micronix, etc., research faculty in related fields from domestic universities, and foreign universities/corporations. The patent strategy for the R&D platform of 12-8 nm devices is to combine the efforts of industry, academia, and research institutions with key FEOL process technology, key BEOL process technology, and memory device technology as the three major thrusts.

Establish and Maintain the Service Environment for Nano-device Research

The NDL offers Taiwan's only "One Stop Operation," all-inclusive commissioning service, which is an open environment of experiments and research. This service provides a common research and development platform that enables the domestic industries, academics, and research groups to exchange their research results and technologies through various types of collaborative projects. Utilization of the instruments and equipment at NDL not only achieves resource sharing, shortens process development time and increases research efficiency, but also cultivates talents in the involved fields of research. The 90 nm Advanced Device Service has completed the verification of basic circuit performance of ring-oscillators and operational amplifiers. In addition, the maintenance of the baseline conditions of the CMOS Device platform is conducted using the mask design and associated design rule planning for the test units required by the 90 nm SPICE Model to improve the yield and stability of CMOS circuits. The technology that enables the Si nanowires device platform with a line width of sub-50 nm has been successfully developed utilizing the existing equipment and DOE, which has been moved forward for further study by the Instrument Technology Research Center, the National Chip Implementation Center, and NTU.

Simplify Administration Flow using E-platform

NDL has introduced and integrated several modules with new functions to the External Service System, MES, and the Equipment WEB Control System to maintain service quality, developing new functions with versatility. The MES provides remote commissioned operation service, which can effectively manage and track the production status of products. Remote users can control the progress of their products, which enables more convenient commissioning, increase NARL production capacity and efficiency, and reduce production costs and risks. In order to maintain the security of various information assets for the operation and maintenance of the information house, a secure system and network environment is constructed, improving laboratory information security management techniques and capability and effectively managing laboratory business information risk. The information house received ISO 27001 Information Security certification in 2008, which was renewed in 2010 after passing the new evaluation. NDL received ISO9001:2008 certification and ISO/IEC 27001:2005 Information Security Certification again in 2011.

Expand International Collaboration, Exchange

On November 7th, NDL signed joint research agreement with the National Institute of Advanced Industrial Science and Technology (AIST) in Japan. Both parties have conducted the research of gate stack process development and application for CMOS devices, which will further improve the capability of nano-device fabrication and analysis and enable joint development of process modules of low temperature annealing and other associated devices. NDL also published a joint paper with Current Scientific in the USA under the title of , "Amorphous-layer Regrowth and Activation of P and As implanted Si by Low-temperature Microwave Annealing" on the journal of IEEE Transaction on Electron Devices.

▶ Achievement Statistics

Scope of Performance	Item	Quantity	Unit
Service Result	Facility and technological services	1,363	Users
	Papers published by NDL users	527	Articles
R&D Results	Papers published by NDL	190	Articles
Training/Education Outreach	Users awarded with Ph. D or master's and degree	318	Persons
	Training workshop participants	5,665	Persons
	NDL visitors	3,449	Persons

National Laboratory Animal Center

- ▶ 1986 The 3rd National Technology Conference decides to establish a "national laboratory animal center"
- ▶ 1994 The National Science Council establishes the "National Laboratory Animal Breeding and Research Center (NLABRC)"
- ▶ 2003 NLABRC is renamed the "National Laboratory Animal Center (NLAC)"
- ▶ 2007 NLAC is awarded full accreditation from the Association for Assessment and Accreditation of Laboratory Animal Care (AAALAC) International
- ▶ 2008 NLAC Tainan starts to operate
- ▶ 2010 Both NLAC Taipei and NLAC Tainan are awarded full accreditation from AAALAC

Establishment of National Genetically Modified Mouse Resource Center and Assay Technology Platform

The development, assay, and application of genetically modified (GM) laboratory animals are a global trend. Connections among repository sites around the world facilitate exchange and interactions of laboratory animal resources. Linking the disease model development team and national cryopreservation laboratory, National Laboratory Animal Center (NLAC) worked with the globalized Rodent Model Resource Center (RMRC) and Taiwan Rodent Model Database (TRMD) and established a national GM mouse resource center to enrich the national laboratory mouse resources, help the research staff to acquire animal models, and strengthen the sharing and interactions of laboratory animals in Taiwan.

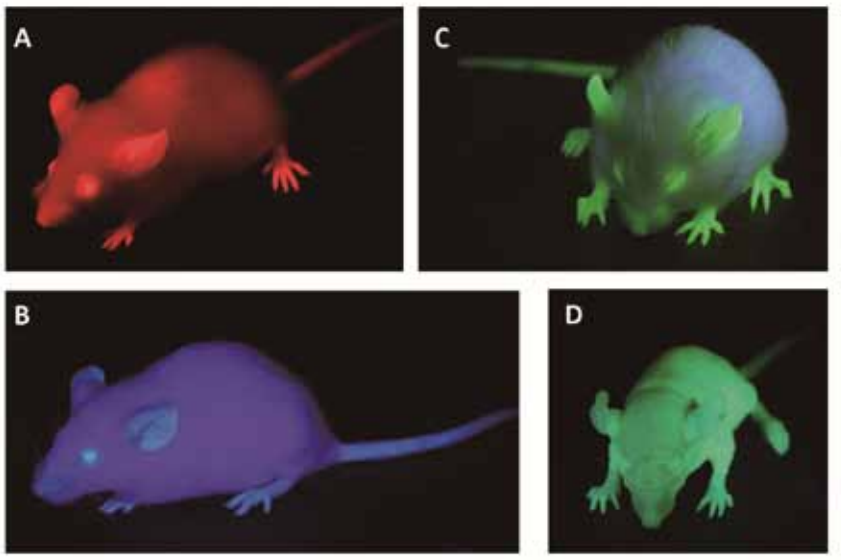
In order to meet the analysis requirement following the production of GM mice, the animal center integrates pathology phenotyping, behavior phenotyping, immune phenotyping, and imaging technology to establish the GM mouse assay technology platform progressively, constantly develop GM mouse genotype identification and phenotype analysis technology, construct GM mouse database, and support new drug research and development and translational medicine research.

New Animal Strain Development

The development of model animals is an important subject of modern biomedical research. In addition to stable supply of top-quality laboratory animal resources, NLAC also self-develops model animals using the established transgenic technology platform. NLAC self-developed 12 strains in 2011, including fluorescent mice, Cre mice, and inducible Cre mice. 1 Some of them already come with established databases and supplies are available. The new animal strains will be developed persistently to support the national biomedical research needs. The R&D Team of the Repository Service Division received the 5th Outstanding Contribution Award of National Applied Research Laboratories with their "One-Stop Shop for Gene Manipulation Technology Platform".

Innovative and Professional Laboratory Animal Technology

In order to offer top-quality laboratory animal quality control technology service, NLAC has been relentlessly improving laboratory animal feeding and breeding management technology, quality control technology, and diagnosis technology, while accreditation system guarantees management quality and technical capacity. This year, the diagnosis laboratory once again received the accreditation extension from the Taiwan Accreditation Foundation with the expansion to 13 accreditations to safeguard the health quality of laboratory animals in Taiwan.



1 Fluorescent nude mice developed by the GM team of NLAC

A. Red fluorescent nude mice

B. Blue fluorescent nude mice

C. Green fluorescent nude mice

D. Green fluorescent nude mice

Regarding quality control technology, the water quality control – coliform testing technology was established this year to offer water quality/environment monitoring service in 2012. Various diagnosis services developed for specific diseases are available, including *in situ* hybridization, Theiler's murine encephalomyelitis virus molecular diagnosis technology, and non-biotin HRP immunohistochemistry technology. These laboratory animal technologies developed will be made available to external parties in succession.

International Exchange and Collaboration Development

On a continual basis, NLAC staff has been dispatched to organizations under the MoU to learn, interact, and build mutual collaboration relationships. This year, visits were paid to the Center for Animal Resources and Development (CARD) of Kumamoto University in Japan for cryopreservation technology exchange, and to the Institute of Developmental Biology and Molecular Medicine of Fudan University in Shanghai, China, for GM mouse feeding management system learning and interactions.

The NLAC continues to develop a range of technology platforms and animals for disease models, laying emphasis in enhancing global exchange. This year, NLAC held three international symposiums and sent staff to attend national and international conferences and symposiums; there were 7 publications in national and international journals, and 34 in national and international conferences.

The NLAC also actively participates in the international laboratory animal federation conferences and academic symposiums to facilitate international academic collaborations and exchanges, for example the Asian Mouse Mutagenesis and Resource Association (AMMRA) Annual Meeting held in Singapore and Asian Mouse Phenotyping Consortium (AMPC) meeting held in Korea. The objectives were to understand the current international laboratory mouse resource distribution, conduct technical exchanges and resource sharing, and participate in the discussions of important issues.

▶ Achievement Statistics

Scope of Performance	Item	Quantity	Unit
Service Results	Laboratory mice sales	160,574	Animals
	RMRC animal import/exchange & sharing of strains	128	Strains
	Health monitoring services	32,442	Tests
R&D Results	Animal hotel	13,791	Cages
	Papers published by NLAC	41	Articles
Training/Education Outreach	Training workshop participants	1,802	Persons
	NLAC visitors	531	Persons

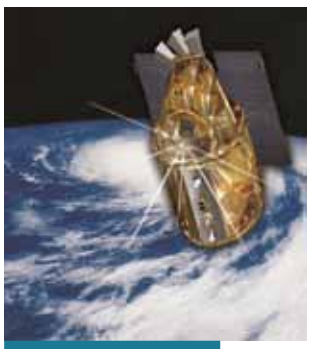
National Space Organization

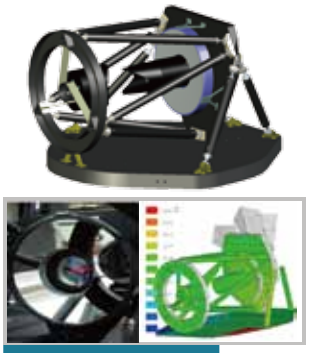
- ▶ 1991 National Space Program Office (NSPO) is established to carry out the first stage of a 15-year "Space Technology Long Term Developmental Program", approved by the Executive Yuan
- ▶ 1999 FORMOSAT-1 is successfully launched from the Kennedy Space Center, U.S.A.
- ▶ 2003 NSPO is subordinated to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

FORMOSAT-5 Towards a New Milestone

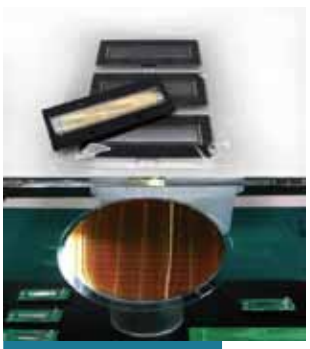
FORMOSAT-5 is Taiwan's first self-reliant remote sensing satellite with ground resolution of 2m in panchromatic band and 4m in multispectral bands. For the EO image sensor of FORMOSAT-5, NSPO integrates technology capabilities from Instrument Technology Research Center (ITRI), Chip Implementation Center (CIC), Chung- Shan Institute of Science and Technology (CSIST) and domestic companies to develop the CMOS-based Remote Sensing Instrument (RSI). In 2011, NSPO completed several milestones for FORMOSAT-5 program, such as Critical Design Reviews (CDR) for spacecraft bus, image processing system, and launch vehicle as well as System Acceptance Review (SAR) for ground systems.

For the development of critical satellite components, NSPO has completed functional and environmental tests for Command and Data Management Unit (CDMU) and Power Control and Distribution Unit (PCDU) engineering models, verification and validation for new version of Flight Software (FSW), and functional verification for power sub-subsystem of satellite engineering model. 1 The FORMOSAT-5 program has formally passed the design phase and moved on toward the manufacturing phase.


FORMOSAT-5


RSI


CDMU & PCDU

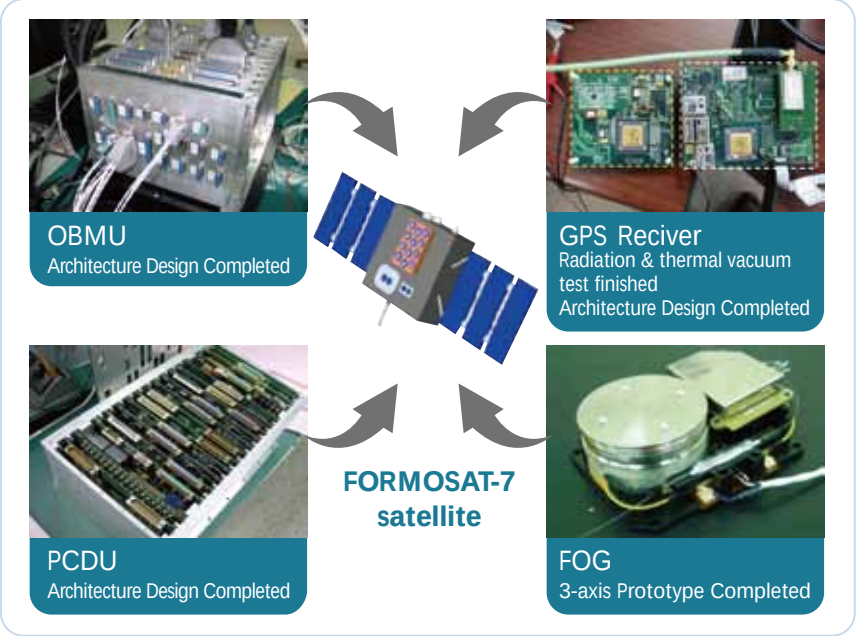

CMOS Sensor

1 Indigenous key components of FORMOSAT-5

FORMOSAT-7/COSMIC-2 Taiwan-US. Cooperation Program

The FORMOSAT-7/COSMIC-2 constellation program, which includes 12 satellites and 1 self-reliant satellite, is an international collaborative effort between Taiwan and US. In this program, NSPO is responsible for system integration, spacecraft bus and mission operation while NOAA is responsible for mission payload, launch vehicle, ground station and data processing. The Taiwan-US. Executive Steering Committee (ESC) has held two meetings in 2011 to discuss the responsibility of this joint project.

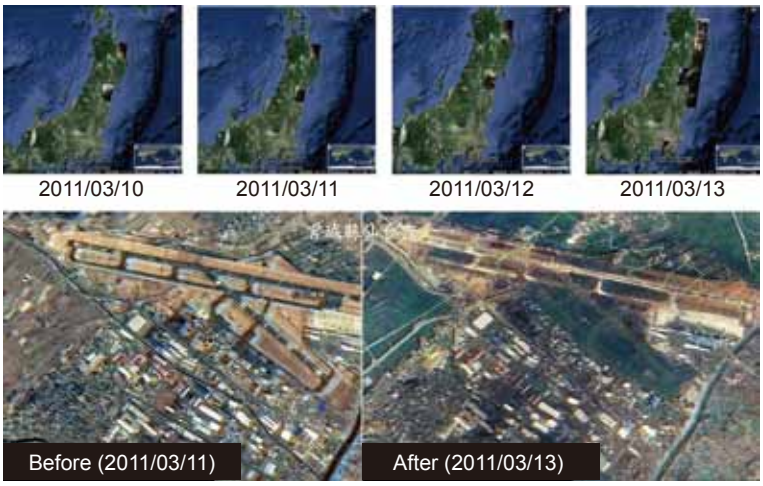
In 2011, NSPO has completed FORMOSAT-7 constellation mission design, satellite system design and developed the critical components, such as a space grade Fiber Option Gyroscope (FOG), a prototype of GPS receiver, on-board computer, and PCDU engineering model. 2 In the mean time, NSPO, Taiwan Typhoon and Flood Research Institute (TTFRI) and academic institutes formed a research team for GPS osculation data processing and the team has completed the system analysis and some preparatory works in 2011 as well.



2 NSPO-Built Satellite Key Component Status

FORMOSAT-2 Remote Sensing Images for the Application of Disaster Prevention

In 2011, when typhoon Nanmadol and Aere hit Taiwan, NSPO supported corresponding disaster relief authorities with FORMOSAT-2 images, both during and post disaster, for rescue operations. and disaster management. In addition, NSPO teamed up with various international organizations such as UNOSAT, International Charter, Sentinel Asia and the Tzu Chi Foundation, for relief and environmental monitoring related research efforts. In 2011, NSPO completed 56 imaging tasks for emergency response during 311 Japan earthquake, 3 as well as disaster area assessment of floods in Thailand and wildfire in New Mexico. These efforts serve as great examples of NSPO's contribution toward the societies of Taiwan and the world.



3 Crises of Japan 311 Earthquake

Successful Launch of Hybrid Sounding Rockets

Two hybrid sounding rockets, developed by National Chiao Tung University (NCTU) and National Cheng Kung University (NCKU) with NSPO respectively, were launched successfully in 2011. The two launches reached the altitude of 13 km and validated the capability of telemetry communication between rocket and the ground station. In the meantime, these successful launches demonstrated the achievements of science experiment on sounding rocket, validations of space grade component, and enhancement of sounding rocket technology.

▶ Achievement Statistics

Scope of Performance	Item	Quantity	Unit
Service Results	Facility and technical services	161	Users
	Satellite image services	1,768	Images
R&D Results	Papers published by NSPO	356	Articles
Training/Education Outreach	Graduate students in joint research programs	99	Persons
	Training workshop participants	611	Persons
	NSPO visitors	3,830	Persons

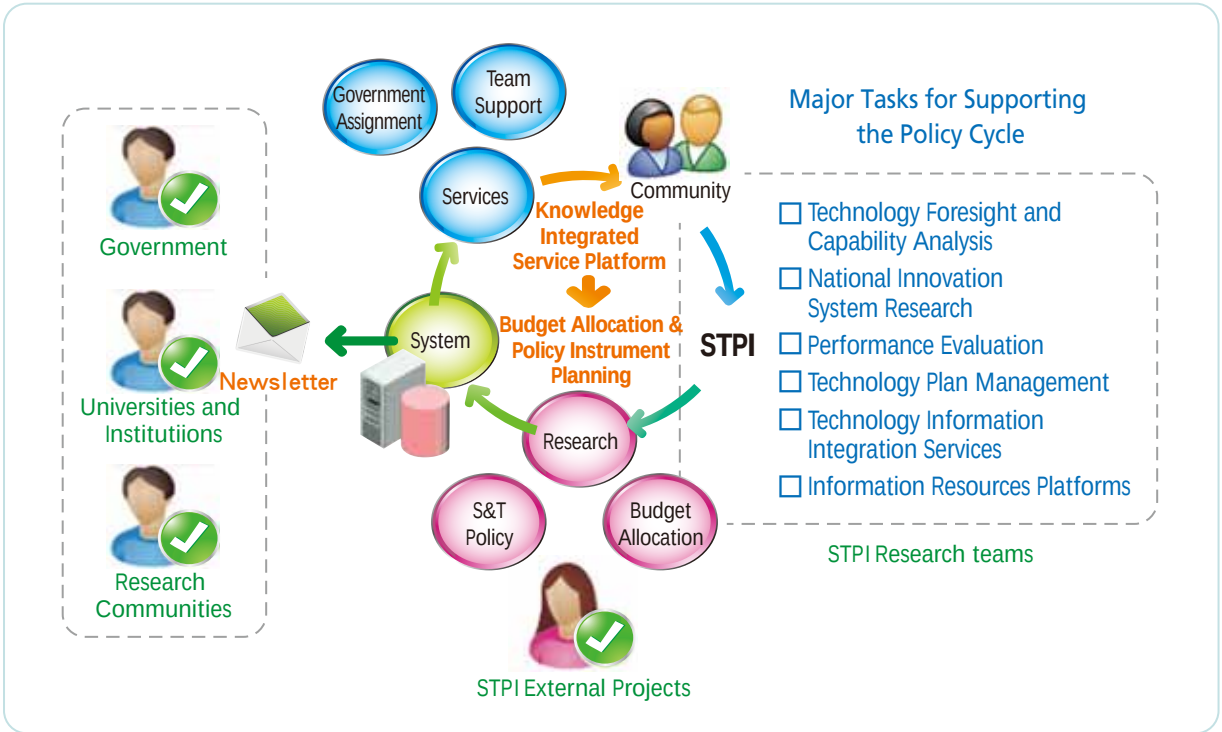
Science & Technology Policy Research and Information Center

- ▶ 1974 The Executive Yuan approves the establishment of the Science and Technology Information Center (STIC)
- ▶ 2005 STIC subordinated to the National Applied Research Laboratories(NARL) and is renamed the Science and Technology Policy Research and Information Center (STPI)
- ▶ 2009 STPI enhances its core competencies in order to serve as a think-tank to articulate policy on national S&T development for the government

The Science and Technology Policy Research and Information Center (STPI) serves as a think-tank and knowledge center to articulate policy on national science and technology (S&T) development for the government as well as the academic community. Its core competencies include S&T insight consultation, system innovation, S&T program management and evaluation, and integrated information services. The interdisciplinary research teams address the direction and pace of scientific change and innovation, the promotion and management of innovation, the regulation of technological risks, the search for effective S&T policies and paths to a more sustainable society. STPI maintains close and collaborative working relationships with a wide variety of government, academic, and non-government organizations. With sound academic foundation and empirical research capabilities, STPI is advancing toward its major goal as a world-class policy research institution.

Enhancing core competences to support governmental S&T decision-making

To underpin the government's S&T policy planning, STPI's research teams conduct in-depth research on issues important to future national development for provision to government and other parties, and engage in systematic and long-term S&T policy research and talent development. Functioning as the main government think-tank to support S&T policy planning, evaluation and project management, STPI takes advantage of its years of experience in collecting, collating and disseminating S&T information for the purposes of innovation, competitiveness, sustainable development and social well-being. Served as the platform for incorporating domestic policy research communities and institutions, the Knowledge



1 Installation of S&T Development Support System

Integrated Service Platform for S&T Policies has been built and provided knowledge sharing, communication and research achievements archives for the purpose of strengthening the research community networks. Moreover, to make it in line with international practice, the Platform will become a neutral, objective and professional S&T policy research platform. 1

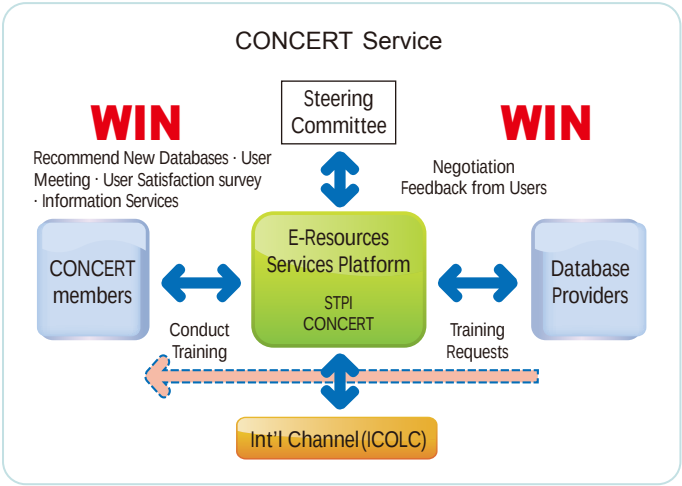
In terms of outputs and achievements, in 2011 STPI produced 10 research reports, 11 planning and analysis reports, 6 SSCI and SCI journal papers and 29 conference and journal papers. In addition, STPI has supplied 30 items of policy-making information to the National Science Council (NSC) and the Science and Technology Advisory Group of the Executive Yuan (STAG), provided various logistic services to NSC's forums and activities, and formulated numerous recommendations related to intellectual property management and strategies on commercialization of S&T research outputs that were deliberated at the 31st STAG Board meeting.

Developing application information system and analyzing databases to support the management of S&T projects

To enhance the efficiency of managing S&T policy research, STPI upholds platforms on S&T policy management information, S&T project proposal evaluation, project performance evaluation, and NSC project management information. And to back NSC in its project management, STPI has developed the national S&T project management system and S&T project proposal preparation and review system. Moreover, STPI has proactively focused on the government promoted topics by conducting a systematic inventory on prevailing Government Research Bulletin (GRB) and providing inquiry services. The topics include the 6 emerging industries, such as biotechnology, medical care, quality agriculture, green energy, tourism, cultural creativity, and the other 9 issues which are energy, information security, gender issues, eco-technology and biodiversity, disaster reduction, industry-academy cooperation, manpower cultivation and recruitment, science parks, and cloud-computing, with producing 11 research reports to be given to the related ministries and S&T policy researchers for their reference.

Offering nationwide information services to support academic community

To support the academic community, STPI is administering the Consortium on Core Electronic Resources in Taiwan (CONCERT) and the Nationwide Document Delivery Service (NDDS). The former is an association of 224 academic institutions in Taiwan to facilitate acquiring licenses, loading and training of electronic academic resource from abroad. 2 In 2011, CONCERT introduced 45 systems of electronic information resources including 111 databases and helped to save up to NT$1.6 billion of electronic journals purchasing costs. The NDDS, the other important information service mechanism for researchers, collated all journals from 430 libraries in the country and integrated the retrieval system for speedily delivering high-quality document services to all interested parties in the country. There were 130,000 requests to the NDDS and nearly 12,000 titles of journals (18% of the total) were applied for the copies in 2011. NDDS has enhanced the efficiency of document delivery and saved journal purchasing costs about NT$20 million by resource sharing. In 2011, STPI has hosted conferences and training courses on S&T information management for a total of 3,000 participants.



2 The Consortium on Core Electronic Resources in Taiwan (CONCERT) Service

▶ Achievement Statistics

Scope of Performance	Item	Quantity	Unit
Service Results	Information services provided (item utilized)	10,450,000	Instances
	Document delivery services	131,000	Articles
	Decision-making references (number of S&T or statistic data)	30	Articles
R&D Results	Papers published by STPI	35	Articles
Training/Education Outreach	Training courses and promotion activities	3,369	Persons
	STPI visitors	48	Persons

Taiwan Ocean Research Institute

- ▶ 2005 National Science Council, Executive Yuan approves the establishment of the "Ocean Science and Technology Research Center Preparatory Office"
- ▶ 2008 TORI is subordinated to the National Applied Research Laboratories (NARL)
- ▶ 2008 Construction begins for the 2700-ton research vessel
- ▶ 2010 TORI launches Xingda office in Kaohsiung
- ▶ 2011 The 2700-ton research vessel "Ocean Researcher V (OR V)" launches
- ▶ 2011 TORI relocates to Xingda office in Kaohsiung

The Consolidation of Administration and Service System

The Establishment of Xingda Provisional Headquarter

TORI was established in 2008. It has initially 7 offices scattering in Taipei Science and Technology Building, National Taiwan University, National Sun Yat-Sen University, National Taiwan Ocean University, Kaohsiung Harbour, Chaojing Park in Keelung and Jiaosi in Ilan. In 2010, TORI set up its provisional headquarter in Xingda, Kaohsiung. In October 2010, the first group of staff transferred to Xingda. In August 2011, all the crew and technical staffs congregated to Xingda. Thanks to the relocation, TORI has largely improved the administrative efficiency and enhance the project implementation.

The Construction and Christening Ceremony of "OR V"

The construction of the 2700-ton class research vessel "Ocean Researcher V (OR V)" **1** started in 2008. In June 2011, OR V was officially launched, marked by a launching ceremony hosted by Mr. Wang Jin-Pyng, President of the Legislative Yuan. President Wang lit incense in a traditional blessing prayer for OR V, while his wife, Ms. Chen Tsai-lien, christened the ship by breaking a bottle of champagne over its bow. **2** Former Minister of NSC, Prof. Lee

1 Ocean Researcher V

Lou-Chuang, then President of NARL, Prof. Chen Wen-Hwa, and hundreds of marine researchers attended the ceremony and bid best wishes for the event. By December, 2011, the construction of OR V has completed more than 90%. The shipbuilding company has scheduled plant trial and public trial of the ship inspection procedures starting in February, 2012. The formal delivery of OR V is expected in July 2012. Due to its size, OR V can resist strong waves and thus is expected to work up to 250 days per year. OR V can travel long-haul and carry out diversified marine surveys along the coasts as well as in the sea. By strengthening the ability of collecting long-term marine data and of carrying out of the marine resources, the marine ecology and undersea fault survey continuously, OR V will boost Taiwan's capability of marine research.

2 Christening Ceremony: Chairman of the Legislative Yuan, Jin-Pyng Wang, and Chairman's wife smashed champagne bottle

The Enhancement of Scientific Research Energy

The Implementation of Real-Time HF Radar Current Monitoring System

Monitoring surface currents of the coastal ocean is essential to ensure safe navigation, mitigate ocean disasters and manage oceanic rescue. HF radar is nowadays the main instrument for large-scale ocean surface current measurement. By 2011, TORI has set up 15 CODAR sites. Using this information and the principles of the Doppler shift, CODAR is able to provide the speed and direction of the surface current within 150km offshore in a real-time hourly manner.

The Development and Validation of Ocean-Bottom Seismometer

TORI has developed the ocean-bottom seismometer (OBS) named YardBird, a vehicle for integrated earth sciences and oceanographic researches, with joined efforts from Academia Sinica and Sun Yat-sen University. In 2011, YardBird successfully completed field-test at a water depth of 2100 m and validated its commercial features, such as low noise level at high-frequency band, low power consumption and low weight. In addition, innovative design for housing with new material has increased operation depth up to 5000 meters, meeting the geological challenge of Taiwan's east coast.

The Advancement of Frontier Technology in Ocean Engineering

On the basis of official policy and NSC's assignment, TORI started the development of advanced technologies in Ocean Engineering since 2011. The main focus of the research falls on the engineering techniques required by offshore wind energy and oceanic energy explorations, featuring the design and construction of an offshore wind tower, measurement technique on turbulent and wind profile, and underwater engineering technique.

The Promotion of International Synergy and Collaboration

TORI maintains vast international cooperation with several international research institutions. In Oct 2011, 4 TORI developed Yardbirds were deployed offshore in Busan, Korea, in cooperation with Korean Ocean Research and Development Institute (KORDI). In Dec 2011, TORI and Japanese Hydrospheric Atmospheric Research Center (HyARC/NU) signed a MOU to jointly develop the current data processing technique to study the spatial-temporal characteristic of Kuroshio offshore north-eastern Taiwan coast.

▶ Achievement Statistics

Scope of Performance	Item	Quantity	Unit
Services Results	Technical services/inspections	158	Cases
R & D Results	Deep-sea near real-time date buoys	4	Station
	Oceanographic data	88	GB
	Paper published by TORI	45	Articles
Training/Education Outreach	Research groups	11	Persons
	Graduate students in joint research programs	21	Persons

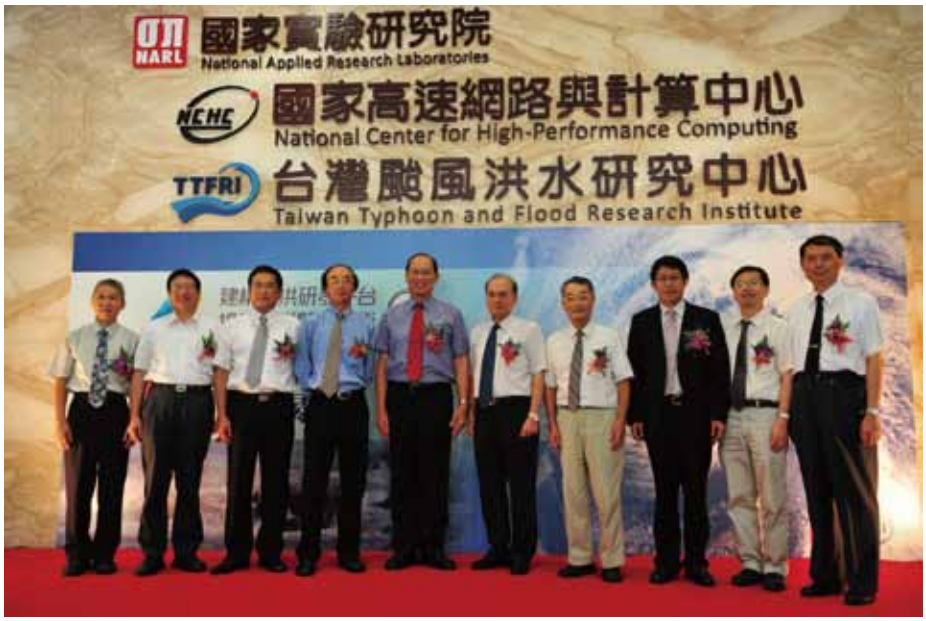
Taiwan Typhoon and Flood Research Institute

- ▶ 2007 National Science Council, Executive Yuan approves the establishment of the Taiwan Typhoon and Flood Research Institute (TTFRI) Preparatory Office in the Hsinchu Science Park
- ▶ 2008 TTFRI Preparatory Office relocates to the Central Taiwan Science Park
- ▶ 2010 TTFRI Preparatory Office launches its branch office in Taipei
- ▶ 2011 TTFRI is established

National Science Council (NSC) approved the establishment of Taiwan Typhoon and Flood Research Institute (TTFRI) in April 2011. The launch ceremony of TTFRI was held on Aug. 17 of the same year. 1 The major missions of TTFRI are to advance the core capabilities of typhoon and flood researches and to develop the key technology for the simulation of typhoon and flood. These include development of numerical weather prediction model, quantitative precipitation forecast techniques, hydro-meteorological simulations, and advanced observational capabilities. TTFRI aims to decrease the impact of typhoon and flood disasters. The achievements of TTFRI in 2011 are as follows:

Typhoon Quantitative Precipitation Ensemble Forecast Experiment

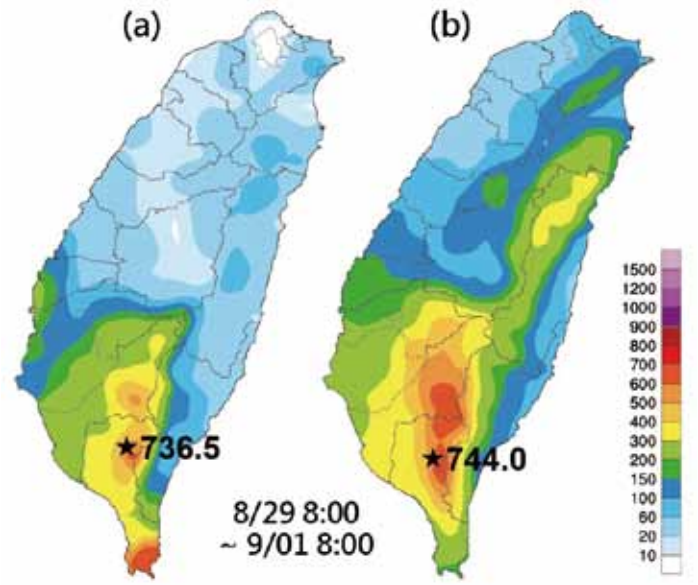
To help improve the research and development of Typhoon Quantitative Precipitation Forecast techniques, TTFRI initiated the Typhoon Quantitative Precipitation Ensemble Forecast Experiment (TyQPEFE). The participants of TyQPEFE include CWB, NCDR, NCHC, NTU, NTNU, NCU and CCU. This year TTFRI applied different initial perturbations, different strategies of data assimilation, and more ensemble members to improve the accuracy of the precipitation forecast. 2 shows that although the TyQPEFE was not yet able to predict exactly the precipitation distribution during the period when Nanmadol (2011) was affecting Taiwan, it could indicate that the heavy rainfall tended to occur around southern Taiwan. Furthermore, a new TyQPEFE platform system was developed in July 2011. This new system allows the users to display weather maps, typhoon tracks as well as the precipitation information (including probability for heavy rainfall) for watersheds, counties or stations to meet their need. This system is opened to the government agencies and the academic research centers related to the disaster mitigation. TTFRI hopes that our efforts can help improve the overall effectiveness of government disaster prevention operations.



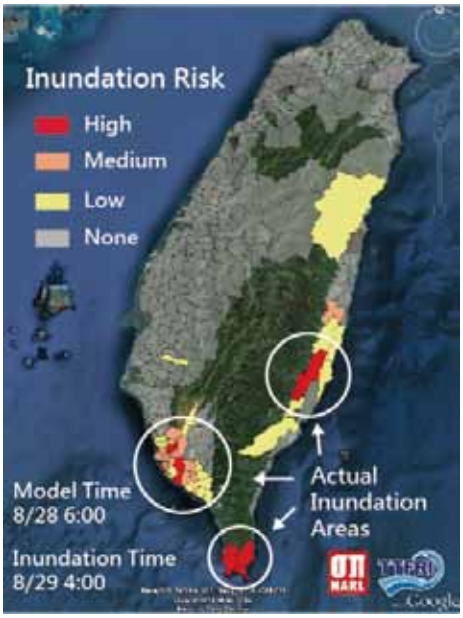
1 The unveiling ceremony of TTFRI was held on Aug. 17, 2011.

Taiwan Rapid Evaluating System for Urban Inundation (TRESUI)

A WebGIS-based system, called the Taiwan Rapid Evaluating System for Urban Inundation (TRESUI), is developed for a quick evaluation of the inundation potential for urban areas in Taiwan. Incorporating the predicted rainfall data of TYQPFE and the design capacity of urban drainage system, the TRESUI categorizes the regional inundation potential as high, medium, low, and no risk. **3** shows the evaluated inundation potential and the actual inundation area during the period when Typhoon Nanmadol (2011) was affecting Taiwan. Results show that the TRESUI can provide valuable information regarding the areas where inundation might occur before typhoon is going to affect Taiwan.



2 The 3-day accumulated precipitation amount when Nanmadol (2011) was affecting Taiwan. Fig. 2(a) is the observation; Fig. 2(b) is the prediction result by TYQPFE



3 The urban inundation risk evaluated by TRESUI and the actual inundation areas (circled) when Nanmadol (2011) was affecting Taiwan.

Atmospheric and Hydrological Research Database

To setup the atmospheric and hydrological research databank, a new system including hardware and software has been implemented and tested. In the databank, TTFRI collects and stores not only the domestic data but also the grid point data from international organizations. The data amounts to 1.7TB in total, and the number of files is approximately 2,043,500. The databank was officially opened to the academics and research communities on Oct. 10 2011. By December 2011, a total of 378 members have been authorized to access the databank. The total download count is up to 516,500.

Educational Programs of Typhoon, Flood, and Disaster Prevention

The 2011 International Workshop on Typhoon and Flood (2011 IWTF) was held collaboratively with the Dept. of Atmospheric Sciences, NCU and the Water Resources Planning Institute, WRA, MOEA. In the meeting, in-depth discussion was conducted regarding how to integrate the efforts from both the atmospheric sciences and hydrology communities to increase the effectiveness of disaster reduction operation. A total of 61 Ph.D. and MS students shared the pleasure to join the poster presentation section. In addition, a Typhoon Exhibition, hosted by TTFRI, National Science and Technology Museum, National Taiwan Science Education Center, National Museum of Natural Science, and the Japan Science Society, is held to attract public awareness of typhoon science. Visitors learned the details of Typhoon and how to prepare for the typhoon season from various interesting interactive demonstrations and hands-on experiments.

▶ Achievement Statistic

Scope of Performance	Item	Quantity	Unit
Service Results	Facilities and database services	378	Users
	Academic SRU support	103,672,547	SRU
R & D Results	Numerical modeling development/simulation	6	Versions
	Papers published by TTFRI	49	Articles
Training/Education Outreach	Workshop participants	526	Persons
	Training courses and promotion activities	7	Seminars

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