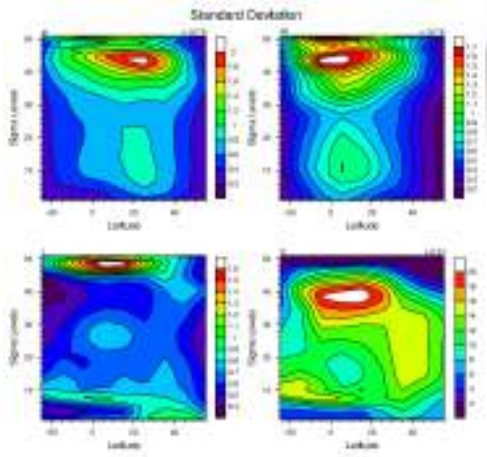


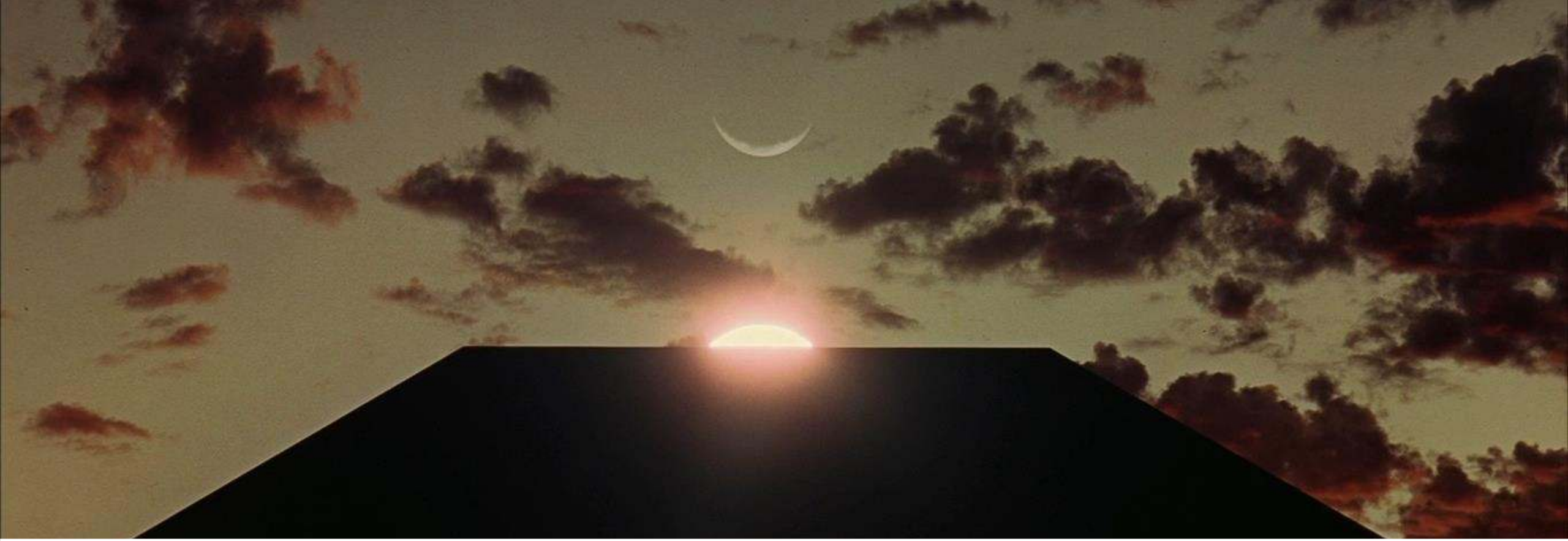
HPC in Thailand Past Present and Future

Assistant Professor Dr. Putchong Uthayopas

Acting Vice President for Information,

Kasetsart University Bangkok, Thailand

putchong@ku.th

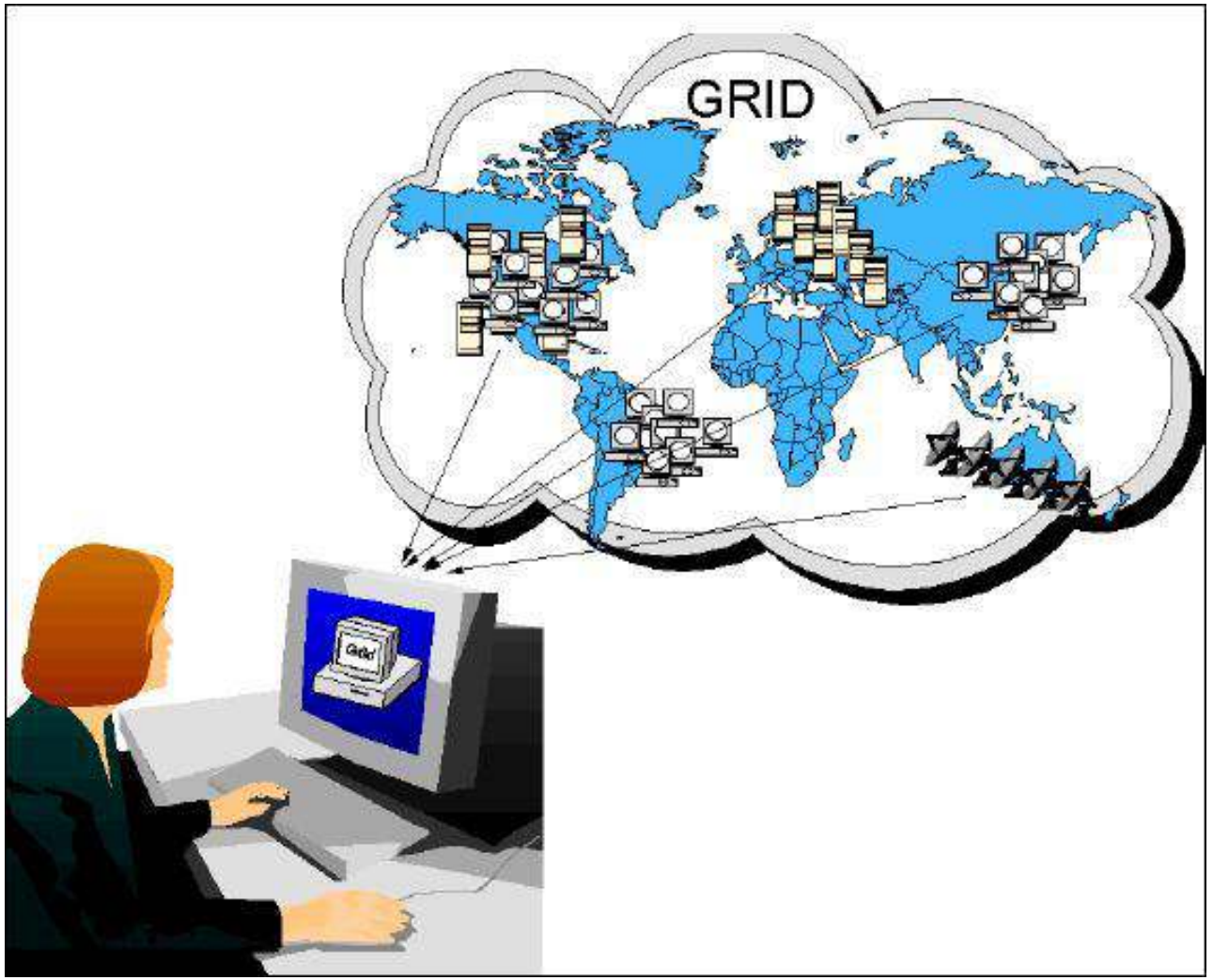


First Generation: The dawn of HPC

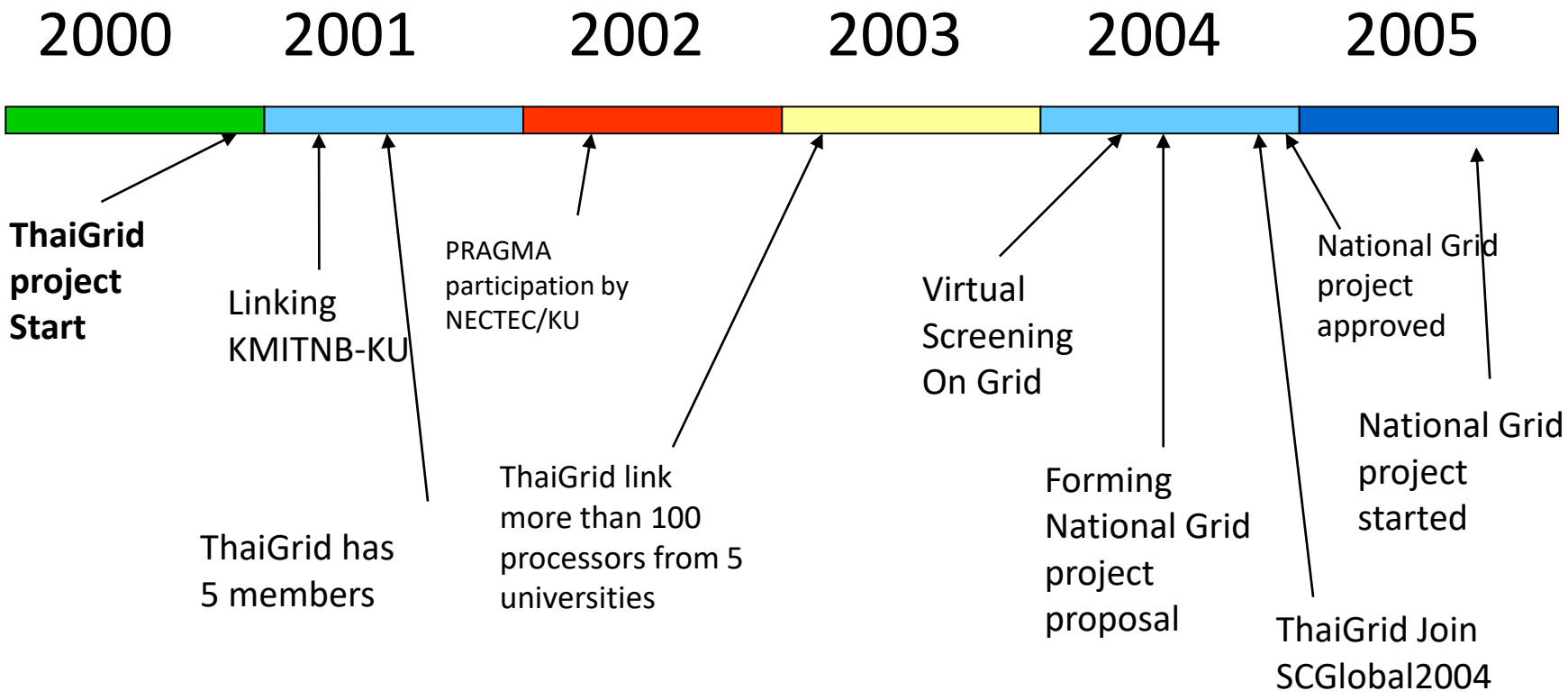
The dawn of HPC

- **1994** NECTEC put Thailand's first vectorized multiprocessor supercomputer, the Cray EL98
  - Computational Chemistry
  - Computational Physics
- **1996** Thai Meteorological Department (TMD) use IBMSP
  - NWP (Numerical Weather Prediction) project
- **1997** the Computational Science and Engineering Program Consortium was established as a cooperative effort among Thai universities and the National Science and Technology Development Agency (NSTDA).
- **1999** Kasetsart University built 72 nodes Beowulf Cluster “Pirun”
  - Academic and research applications
  - Start of the booming of Beowulf Cluster in Thailand
- **2001** Thailand transition into Grid Era by the start of “ThaiGrid” Project between KMITNB and KU later many universities join : AIT, KMUTT, Burapa, Chula

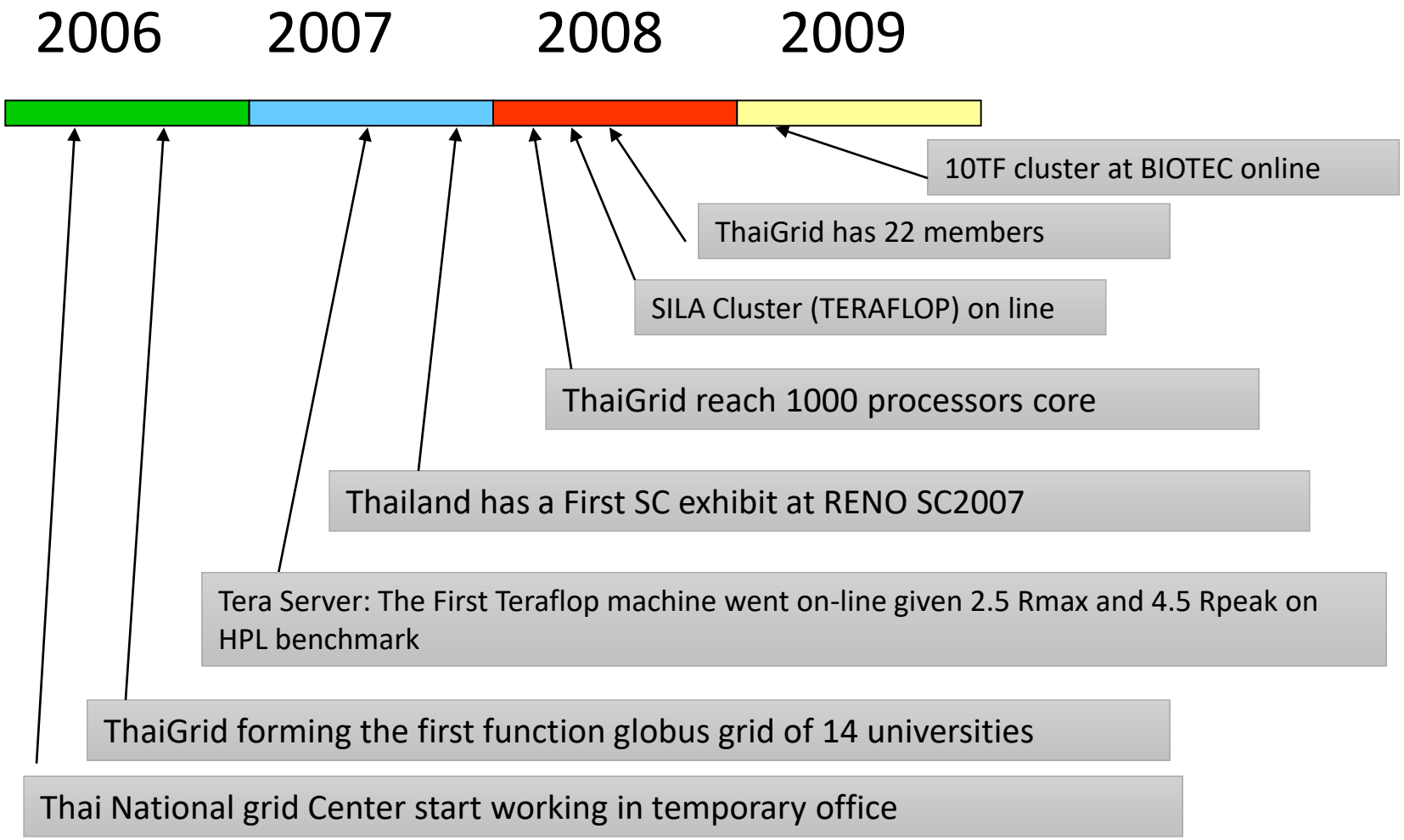
Second Generation: Grid Computing



Second Era: Thai Grid Computing 2000-2005



Grid Computing
2006-2008

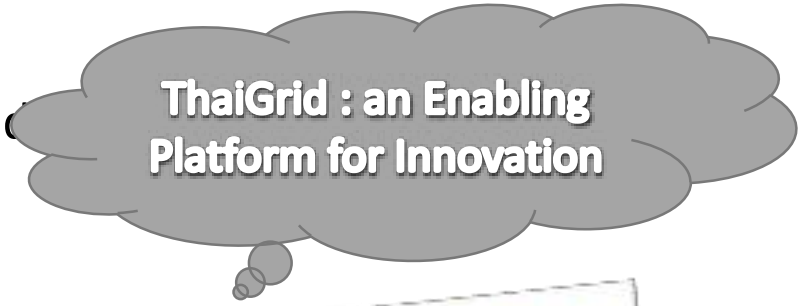


Introduction to ThaiGrid

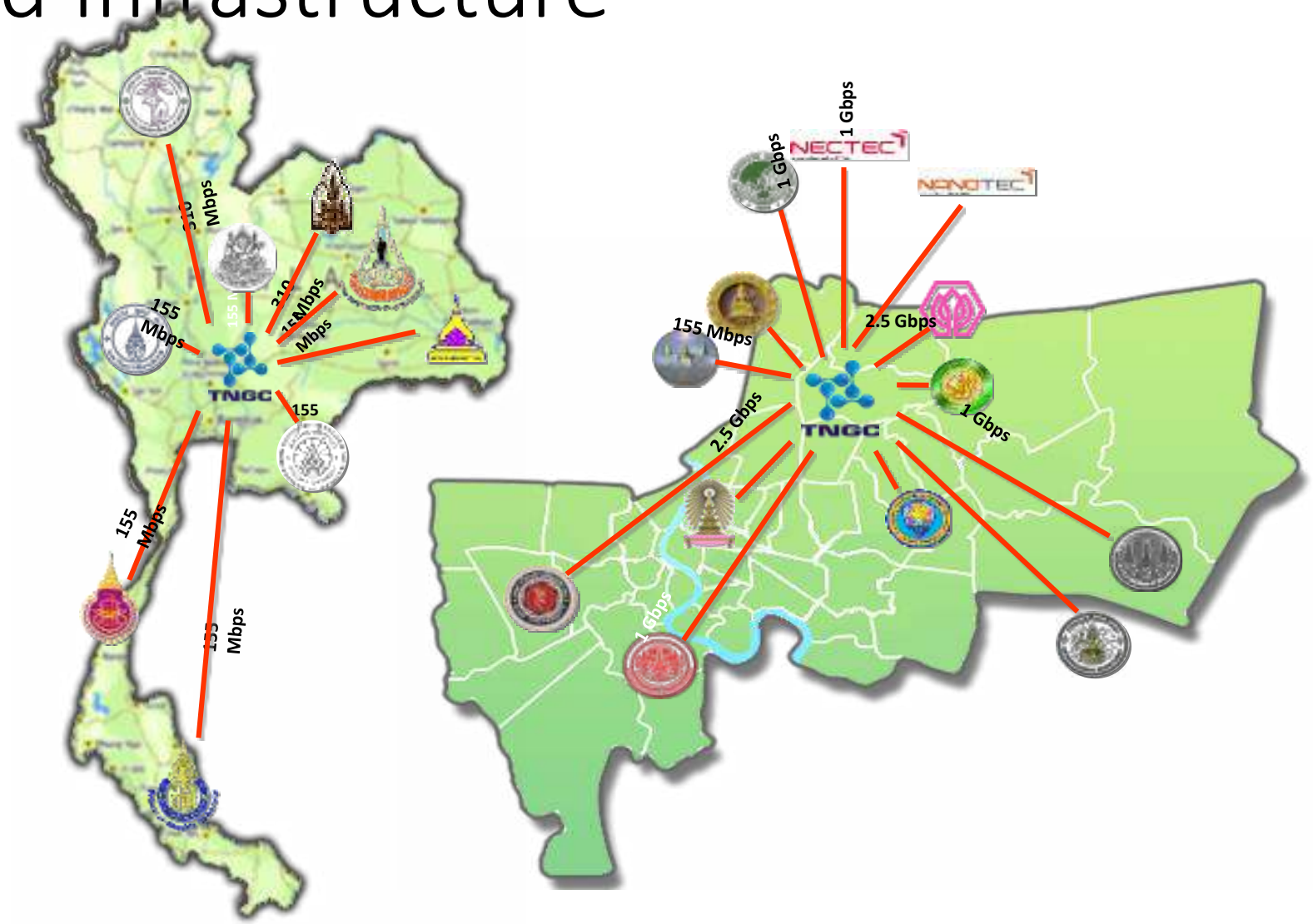
- A National Project under Software Industry Promotion Agency (Public Organization) , Ministry of Information and Communication Technology
- Started in 2005 from 14 member organizations
- Expanded to 22 organizations in 2008

Objective

- Driving better research and education using grid and HPC as an enabling technology
- Making Thailand more competitive by applying HPC and Grid Technology

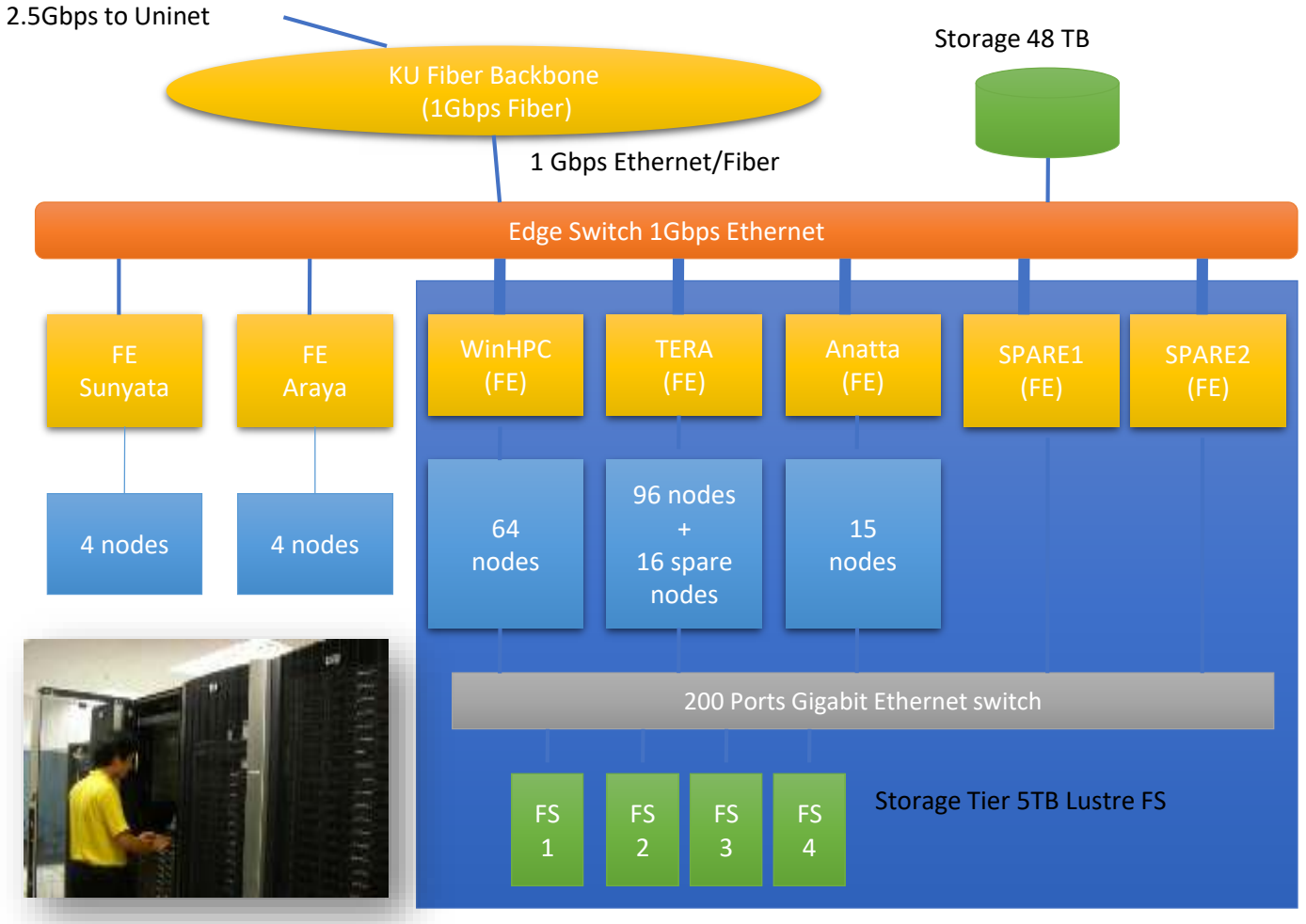


Thai Grid Infrastructure

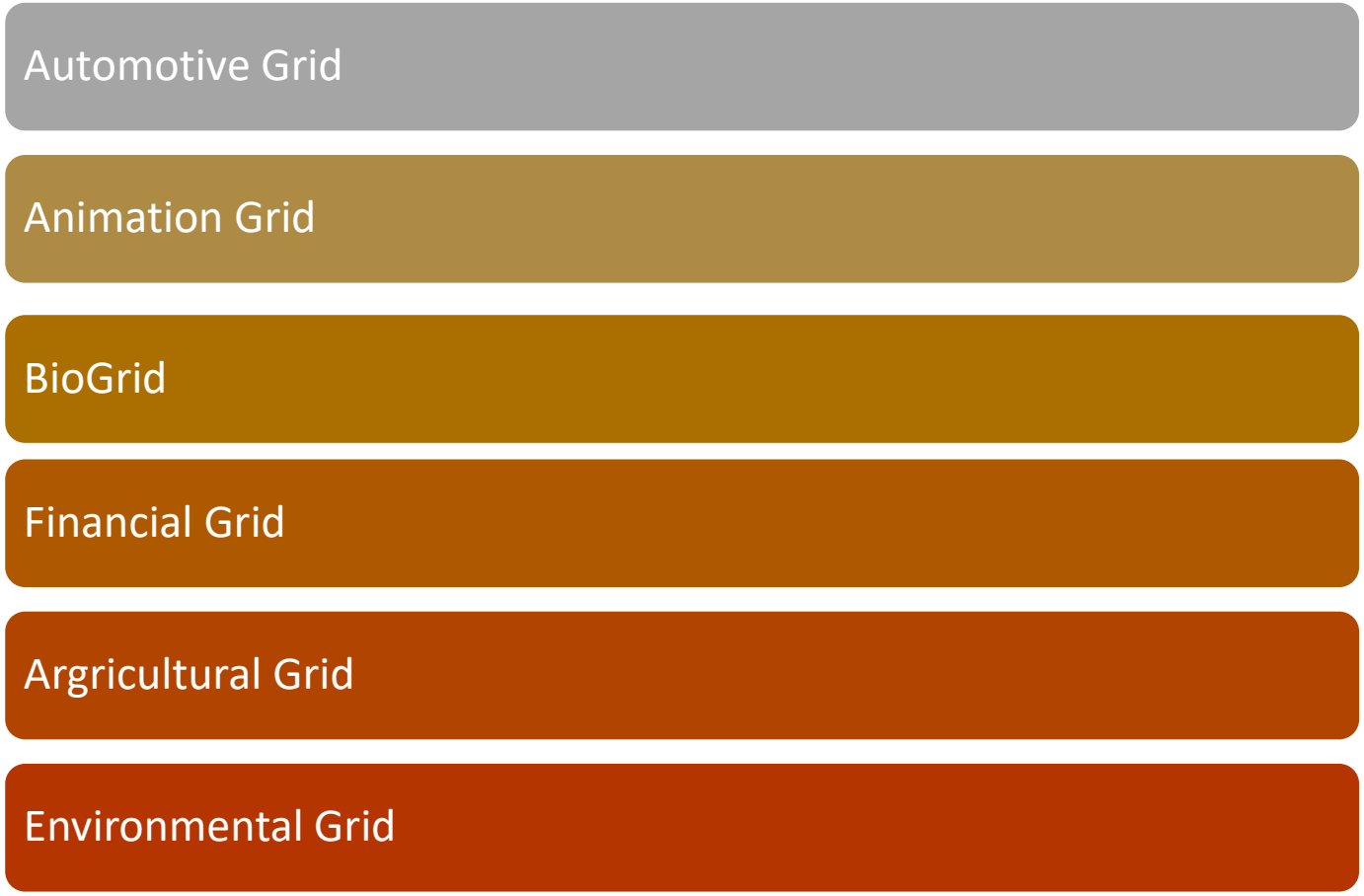


TERA Cluster

- 1 Frontend (HP ProLiant DL360 G5 Server) and 192 computer nodes
  - Intel Xeon 3.2 GHz (Dual core, Dual processor)
  - Memory 4 GB (8GB for Frontend & infiniband nodes)
  - 70x4 GB SCSI HDD (RAID1)
- 4 Storage Servers
  - Lustre file system for TERA cluster's storage
  - Attached with Smart Array P400i Controller for 5TB space

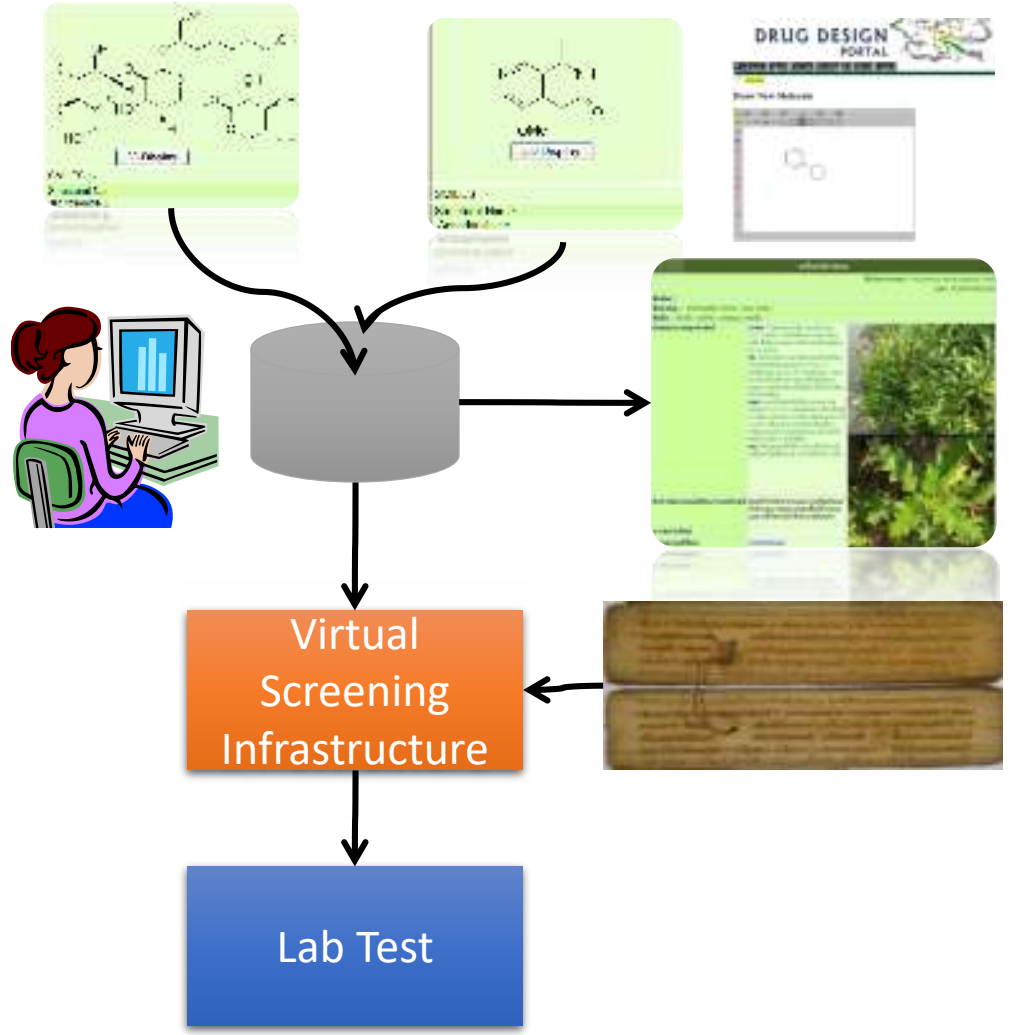


Potential Area

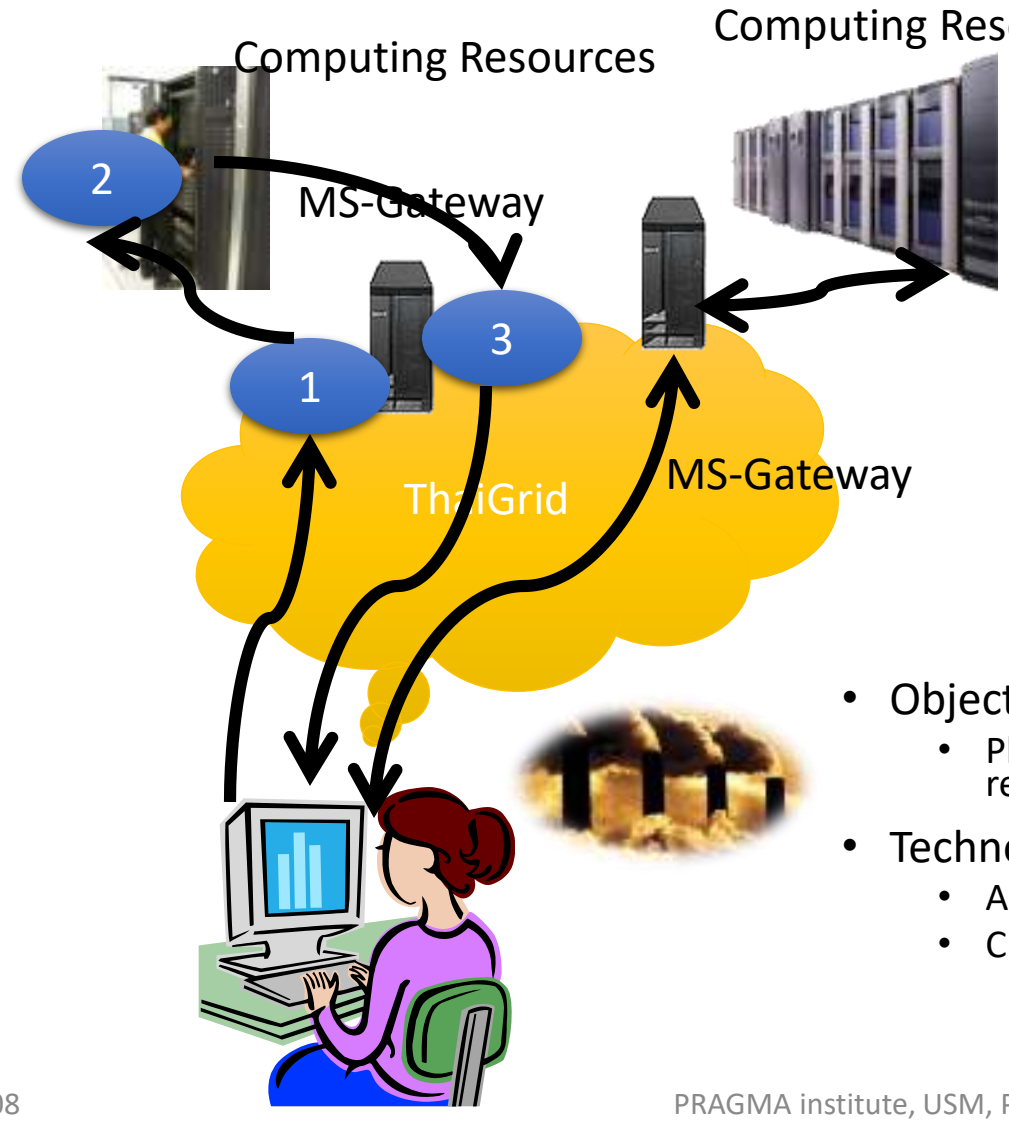


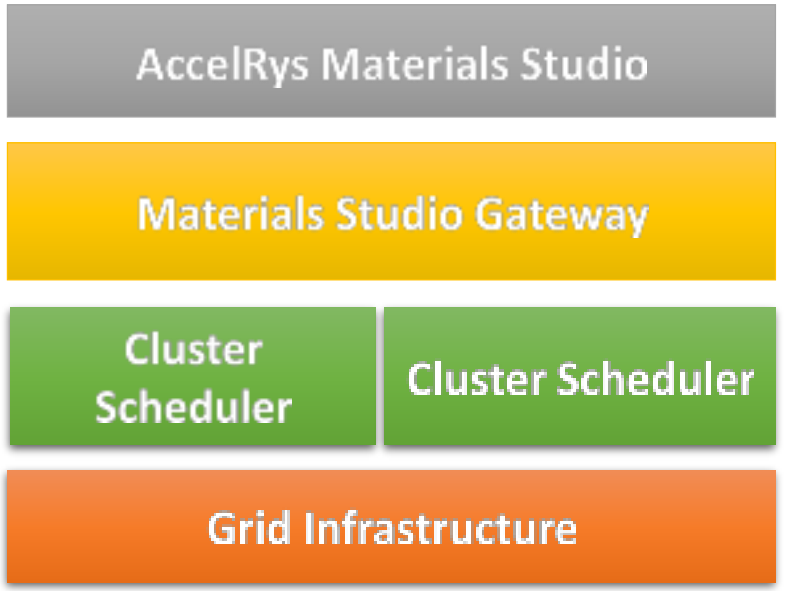
Medicinal Herb Research

- Partner
  - Cheminformetics Center, Kasetsart University (Chak Sangma and team)
- Objective
  - Using 3D-molecular database and virtual screening to verify the traditional medicinal herb
- Benefit
  - Scientific proof of the ancient traditional drug
  - Benefit poor people that still rely on the drug from medicinal herb
  - Potential benefit for local pharmaceutical industry



NanoGrid



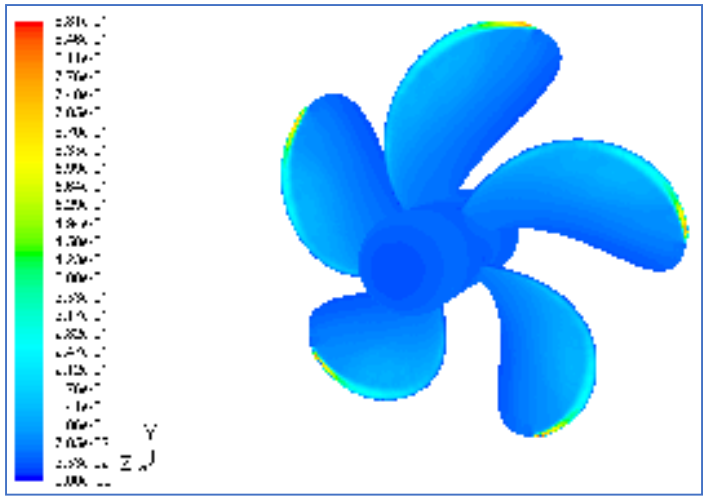


- Objective
  - Platform that support computational Nano science research
- Technology used
  - AccelRys Materials Studio
  - Cluster Scheduler: Sun Grid Engine and Torque

Simulation of Cavitations on Marine Propeller Using CFD

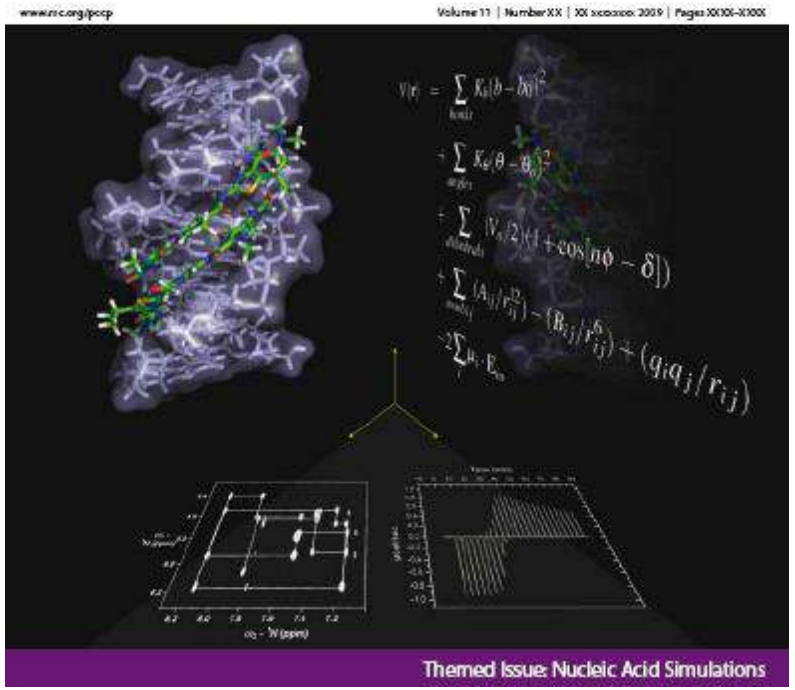
Department of Mechanical Engineering, Faculty of Engineering,

Kasetsart University, Bangkok, Thailand.



Kaewkhiaw, P., Tiaple, Y., Dechaumphai, P. and Juntasaro, V. (2011) "Application of Nonlinear Turbulence Models for Marine Propulsors",

ASME Journal of Fluids Engineering, Vol. 133, pp. 031101-1—031101-7.



A detailed binding free energy study of 2:1 ligand-DNA complex formation by experiment and simulation

Witcha Treesuwan,*[1] Kitiyaporn Wittayanarakul,*[2] Nahoum G. Anthony,b Guillaume Huchet,a Hasan Alniss,b Supa Hannongbua,a Abedawn I. Khalaf,c Colin J. Suckling,c John A Parkinson,c and Simon P. Mackayb

PhysChemChemPhys, inpress, 2009 (**FRONT COVER**)

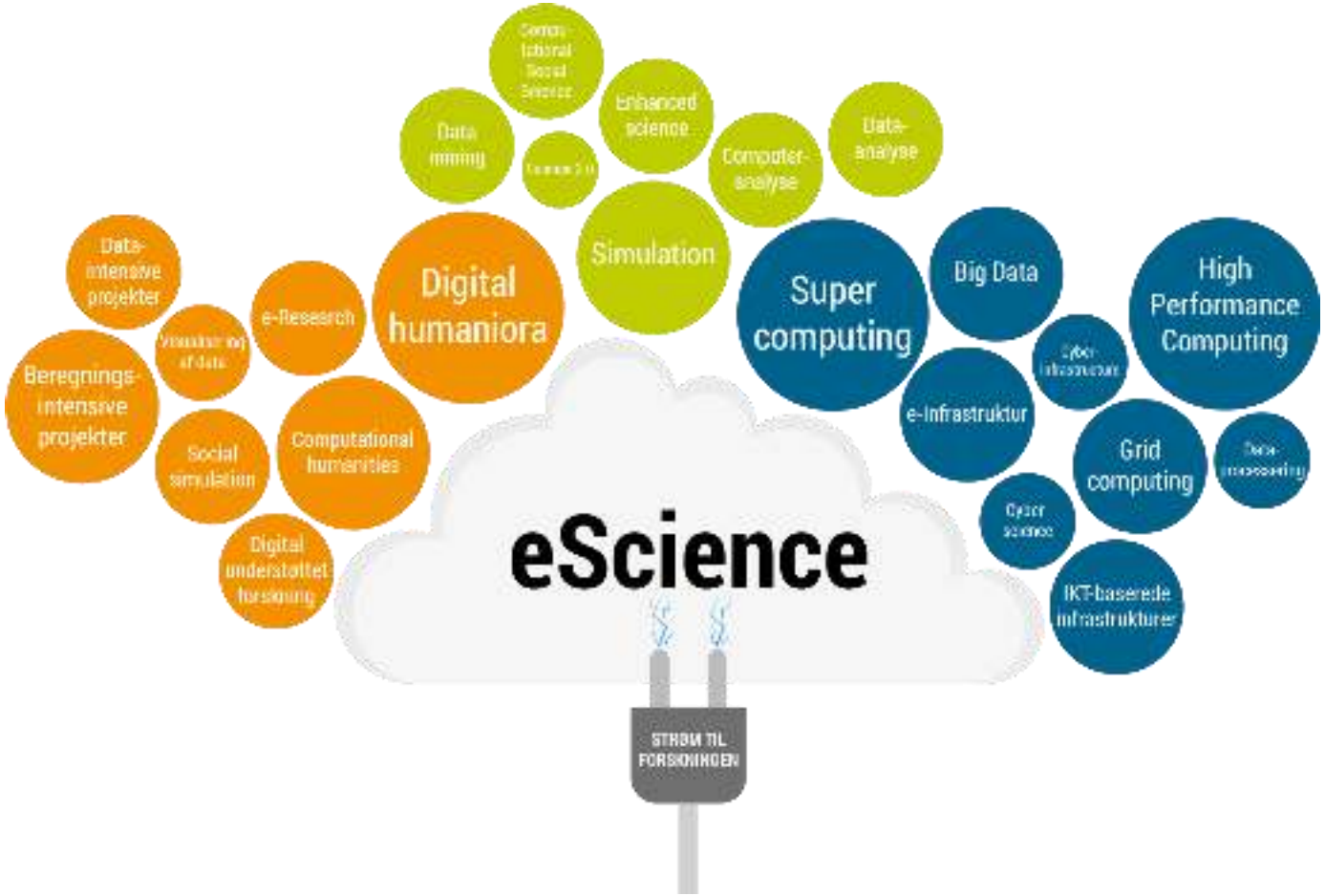
ThaiGrid Achievement until 2008

- The building of a community of 22 universities.
- Trained more than 2000 people to workforce during 3 years
- Initiate 2 national competition
  - train 500-600 high school students on grid/mpi
  - 73 teams, 200 people from 20+ schools compete on coding MPI to solve N body simulation using MPI
  - Winning team make application 10 times faster on 16 nodes cluster
- One Thai book on using Taverna for bioinformatics
- A many technology transfer activities , seminars, conferences, activities, small research projects.

2009-2012

- Thaigrid was inactive after 2008 due to budget challenge.
- There are many scattered activities conducted by universities.
- Computational Science and Engineering Association of Thailand was founded in 2008
- Anyway, more development has come in 2009-2012
  - The country wide fiber optic development under Uninet2 Infrastructure
  - The establishment of National e-science Infrastructure consortium

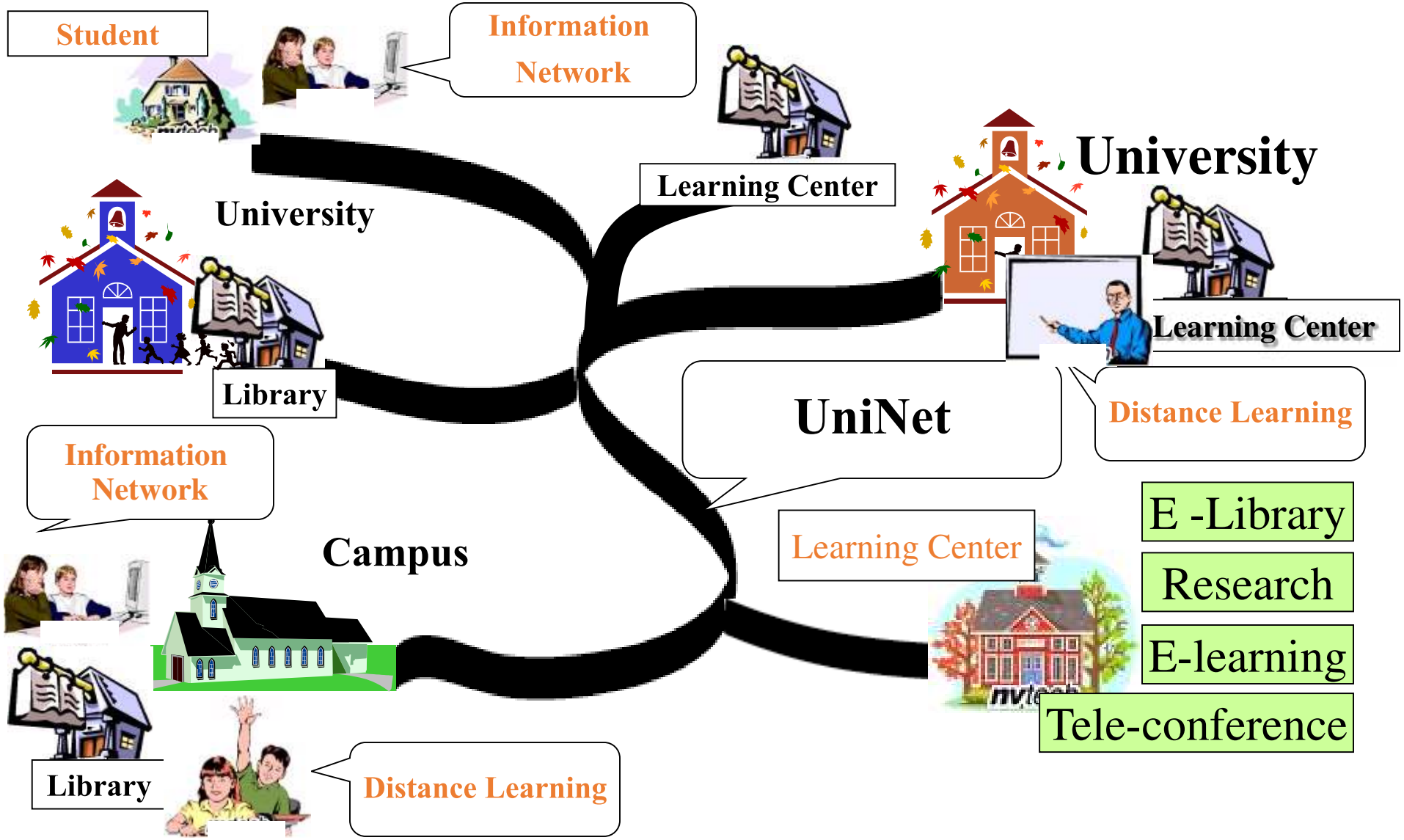
Third Generation: Uninet2 and National E-science Infrastructure Consortium



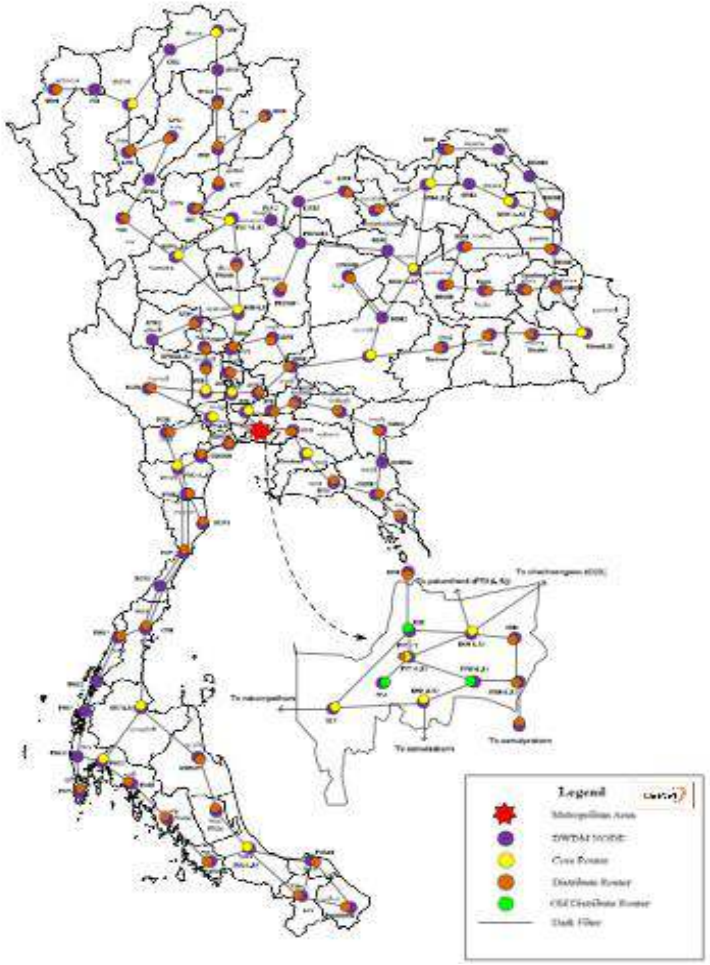
UniNet ional Education Network

- Thai Government approved Stimulus Package (SP2) in 2009
  - 116 M US$ to Integrate all Education Network to National Education Network (NEdNet)
  - This project belong to Uninet a government agency under the Ministry of Education.
- Road Map 2009-2012
  - Fiber optic to accommodate the core network (Backbone) that can support bandwidth 20 - 50 Gbps.
  - Interconnecting educational institutes on fiber optic with the following target
    - **293 Universities (1,000 Mbps each of the N x 1,000 Mbps).**
    - **415 Vocational Education (100 - 1,000 Mbps)**
    - **3,000 schools (10 - 100 Mbps).**

UniNet Conceptual model



National Research and Education Network : NREN



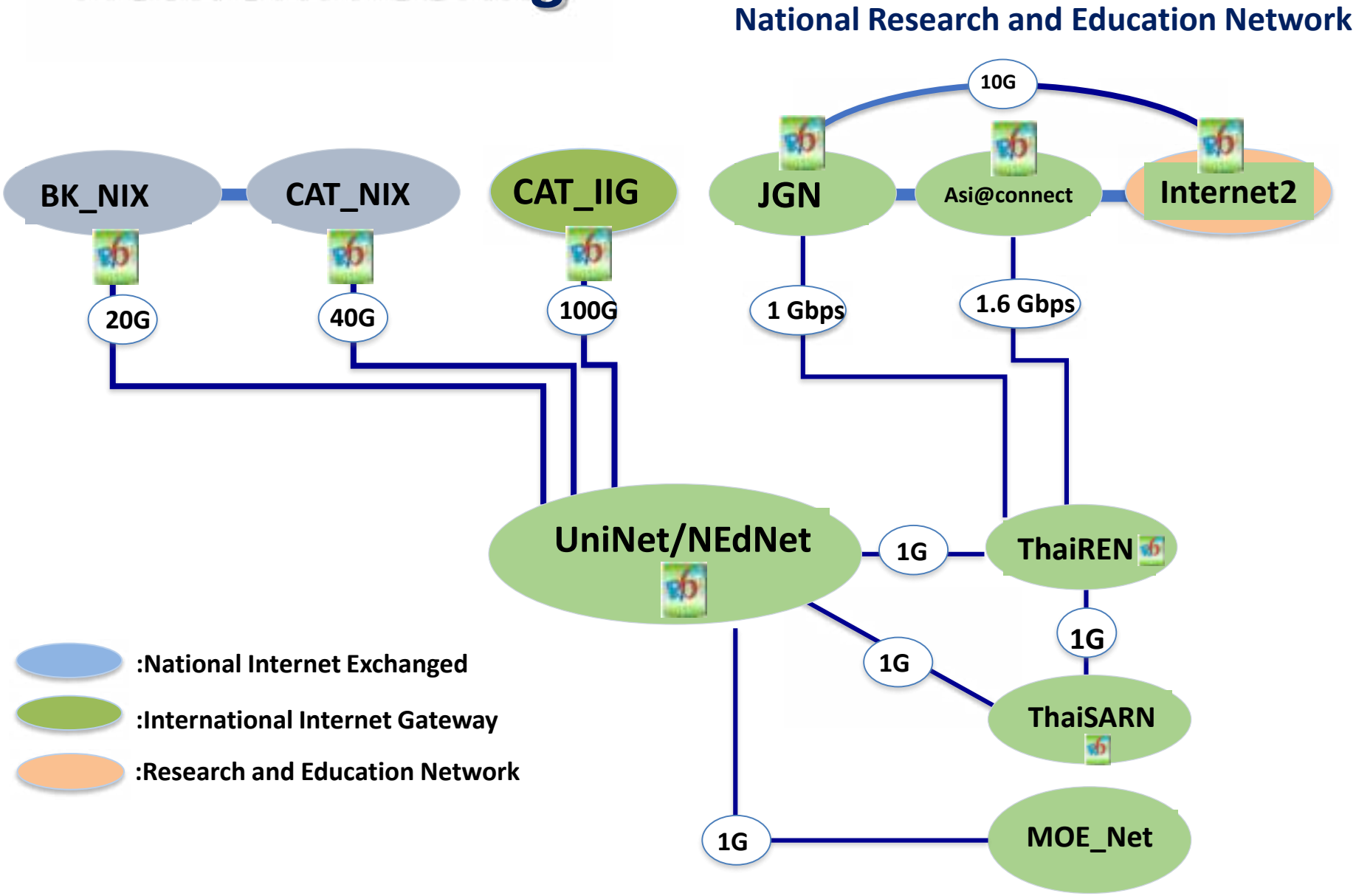
- Optical Network Backbone with DWDM @ N x 10 Gbps
- Fiber to the University @ Gbps (NxGbps)
- Fiber to the school @ 100-1000 Mbps
- Public libraries @ 100-10000 Mbps

Type	Number of Institutes
University and College	➢ 190
Research Center/ Institute	➢ 15
School	> 10,000
Others	>10

Number of member institutions

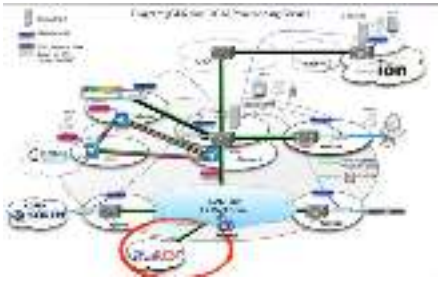
Members	Number of Members
Universities/Institutes	194
Vocational Education	415
Educational Service Area	185
Basic Education (schools)	9,749
Municipality Public Library	151
Research and other Education	51
Total	**10,745**

Network Peering



Examples of Network Services, Applications, and Project Collaborations

- Project E-Science
- IPv4/IPv6
- eduroam
- E-learning/Tele-education
- Tele-medicine
- Live video stream transmission
- Earth observation data transfer
- Cloud Education
- Future Internet technology



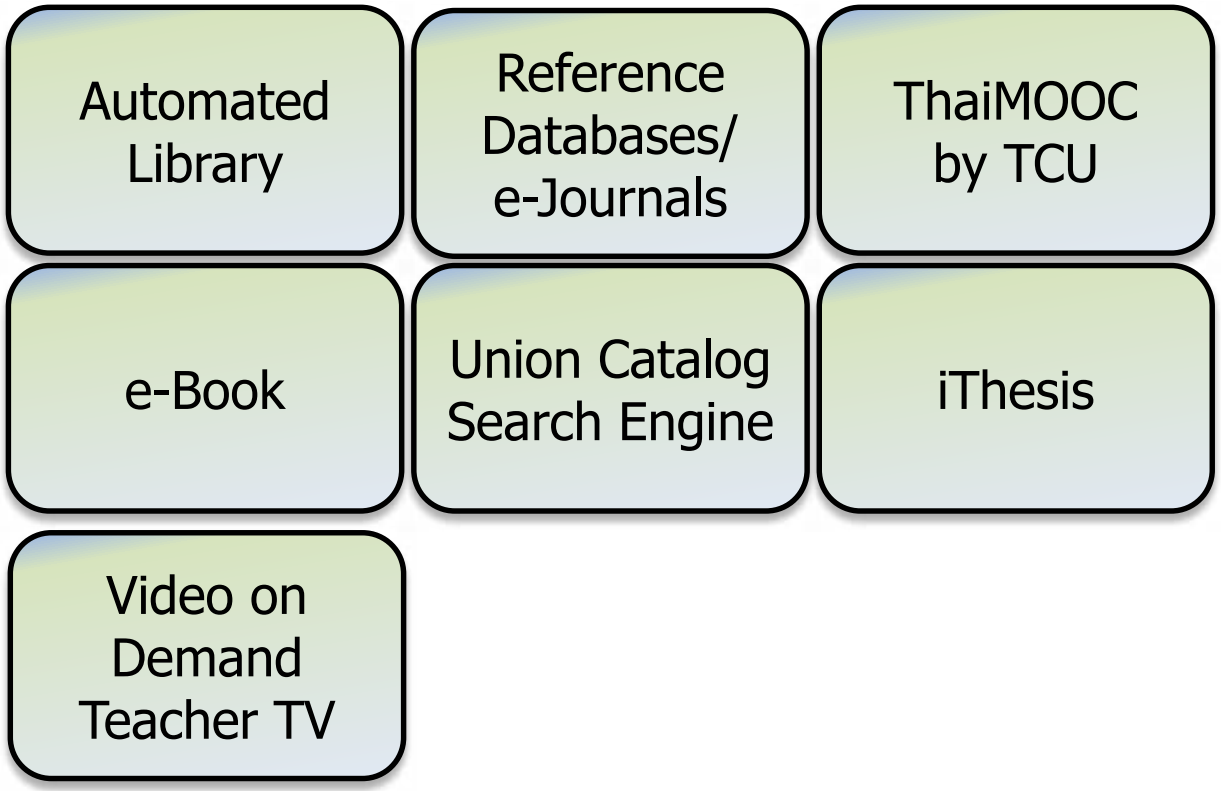
THEOS's Earth Observation Data Transfer

Raw THEOS images are transmitted to the Swedish Space Corporation's Ground Receiving Station in Kiruna, Sweden and returned to Thailand for processing.
The data is routed over inter-connected national and regional research and education networks

Tele Medicine

Thailand side
- Mahidol U.
- Chulalongkorn U.

E-Learning resources and services



NATIONAL E-SCIENCE
INFRASTRUCTURE CONSORTIUM
หน้าแรก
โครงการ e-Science
VO และบริการ
ข่าวสาร
ภาพกิจกรรม
ผังเว็บไซต์
ติดต่อเรา
Particle Physics Consortium
Hot News
2014

NECTEC
a member of NSTDA

Thailand's National e-Science Infrastructure Consortium

NATIONAL E-SCIENCE
INFRASTRUCTURE CONSORTIUM

Dr. Chalee Vorakulpipat

National Electronics and Computer Technology Center (NECTEC)

National Science and Technology Development Agency (NSTDA)

NECTEC
a member of NSTDA

e-Science in Thailand

- Founded in 2011 as The National e-Science Infrastructure Consortium by five institutes.
- The objective is to develop computing, data storage and fundamental datasets as a sustainable infrastructure to support research in Thailand.

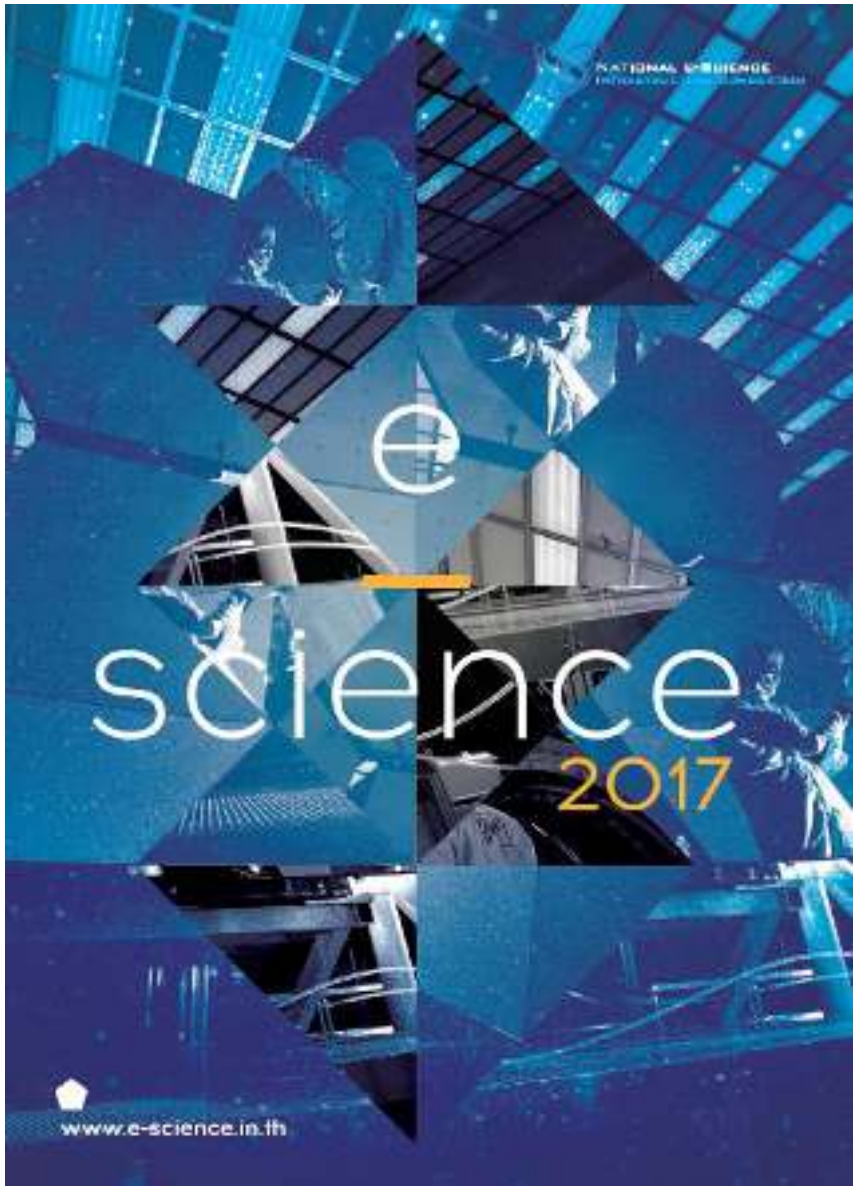
NECTEC
a member of NSTDA

Project Areas

- Computational Science and Engineering
- Computer Science and Engineering
- Water Resource
- Energy and Environment Management
- Climate Change
- High Energy Particle Physics

ภาคีสมาชิกปัจจุบัน

Booklet 2017



NECTEC
a member of NSTDA

Total Resources

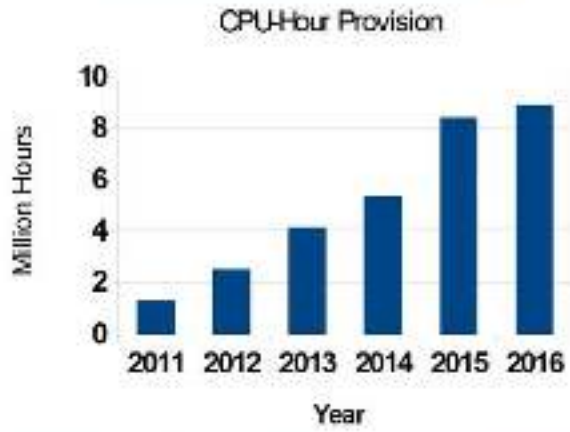
Sites	CPU (cores)	Storage (TB)	Application
HAII	896	112	Weather, Water resources
NSTDA	688	660	Chem, Bio, Hydrology, Eng, Design
SUT	656	150	HEP (CMS), Comp, Chem, Bio
CU	340	106	HEP (ALICE), Chem
KMUTT	224	30	Comp, Eng
NARIT	540	100	Comp. Astrophysic & Cosmology
EGA	80	13	Big Data
Total	3,424	1,171	

Resources

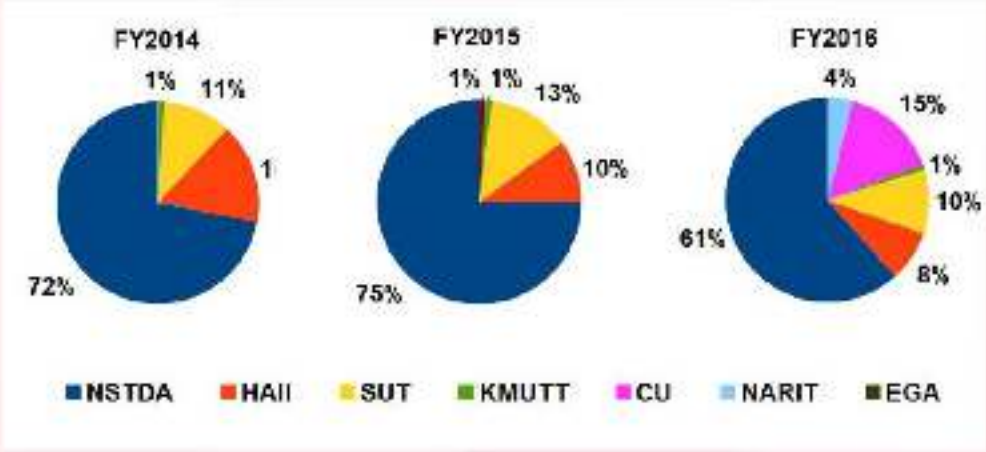
NECTEC
a member of NSTDA

Resource Growth

CPU-Hour Provision



Member Contribution



Outputs

No. projects	99
Journal	32
Int. Conf.	16
Other publications	31
Undergrad.	4
Postgrad.	11

NECTEC
a member of NSTDA

Collaboration with WLCG

- Joined WLCG in 2013.
- One two-tier site

Site name	Status
T2-TH-SUT (formerly TH-SUT-NPP)	Production in October 2014 128 cores 100 TB Utilization 90% ALICE data 46 TB Planning to upgrade to 256 cores

Consortium Activities

(1) Workshop on e-Science and High Performance Computing (eHPC 2017)
conjunction with JCSSE2017 :The 14th International Joint Conference on Computer Science and Software Engineering in Nakorn Si Thammarat, Thailand

(2) The21st International Annual Symposium on Computational Science and Engineering (ANSCSE21), Pathumthani, Thailand.

(3) Training on Material Science and Big Data

(4) Computational Chemistry Symposium

(5) Other activities

Introduced e-Science in universities

Main Project Examples

NECTEC
a member of NSTDA

Development of a Scalable Reactive Molecular Dynamics Simulation on Many-Core Processor
Nanoscale Simulation Laboratory, NANOTEC, NSTDA

Discovery of new and highly potent anti-TB drug based on computer aided molecular design
Faculty of Science, Department of Chemistry,
Ubon Ratchathani University

KitWai: Cloud Platform for Data Mining and Big Data Analytics
NECTEC, NSTDA

Thai Text to Speech Project
NECTEC, NSTDA

Weather Simulation Software
Thai Meteorological Department

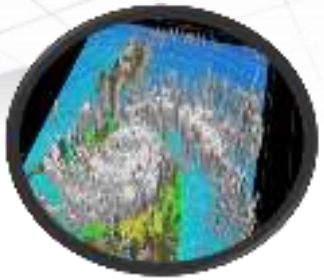
“Development of Weather Forecasting System with High Performance Computing (Phase 1) "

By Somkuan Tonjan

Numerical Weather Prediction Sub-Division

Weather forecast Bureau

Thai Meteorological Department, Thailand (TMD)



2. HPC TMD's System.

Thai Meteorological Department (TMD) have been running the Weather Research and Forecasting (WRF) Model version 3.8.1 was made fully operational in October 2017. Now, Weather Research and Forecast (WRF) Model is running and generate daily output on Website and utilize daily weather forecast and special weather forecast. Necessary arrangements for the physical parameterization and sensitivity testing on the performance of the Model need to carry out. TMD run WRF with data assimilation technique by Grid point Statistical Interpolation System (GSI) 3DVAR Assimilation, and future plan to run 4DVAR and Hybrid

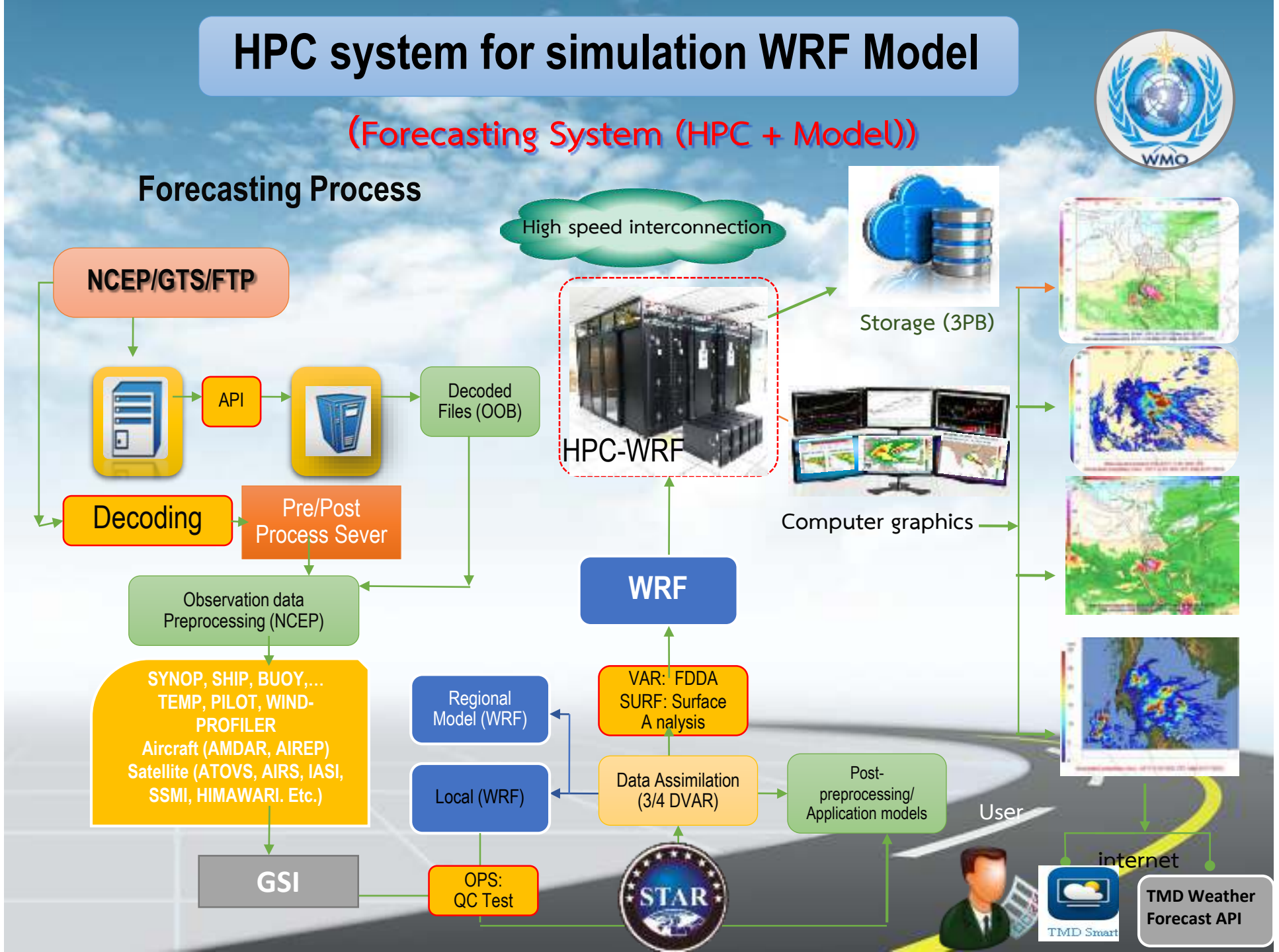
System computer types

-HPE Apollo 2000 series
Proliant XL170r Gen 9
- 192 Nodes (compute) (3 types)
- Performance : 228 TF
-Main memory : 128 GiB per node
-High-speed storage: 3PB
Operating system : Linux
Model : WRF-ARW

HPC system for simulation WRF Model

(Forecasting System (HPC + Model))

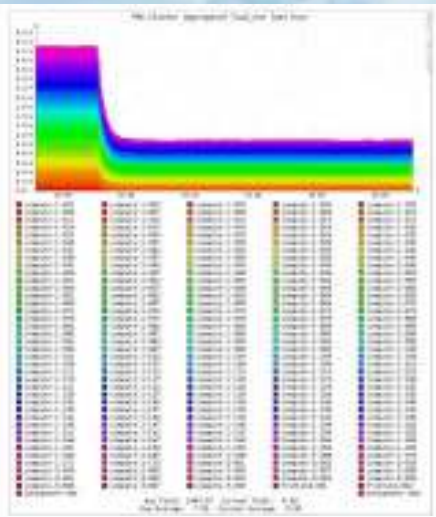
Forecasting Process



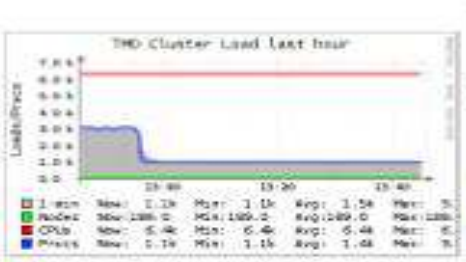
• Forecasting system

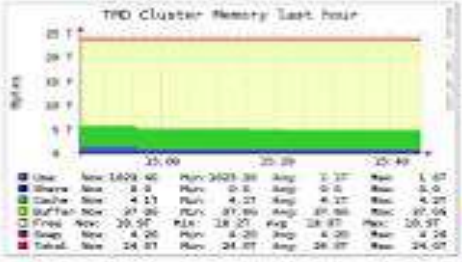
The Cycle run four time per day at 00, 06, 12 and 18UTC with forecast. There are 3 domain for operational which are the WRFV3.8.1 (changing to WRFV 3.9.1.1) and . 1 domain for climate model.

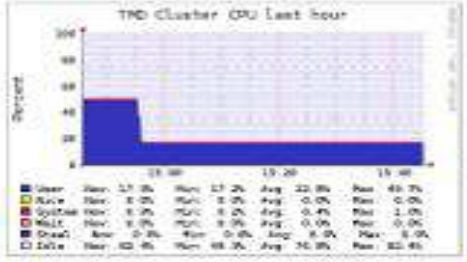
- **Short range forecast (0-72 hours):**
  - Forecast +48 hours run spacing grid 2 km^2. output hourly
  - Forecast +72 hours run spacing grid 6 km^2. output hourly
- **Medium-range forecasting system (4 – 10 days)**
  - Forecast +10 days run spacing grid 18 km^2. output 3 hourly
- **Long range forecast (climate model)**
  - Forecast +126 days run spacing grid 27 km^2. output 6 hourly

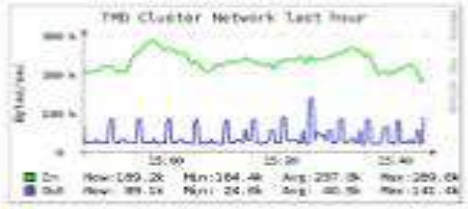


•The WRF models use the initial and boundary data from the National Centers for Environmental Prediction Global Forecast System (NCEP GFS) at a resolution of 0.25° X 0.25° and data for GSI provide by NCEP (gdas, prebufr)

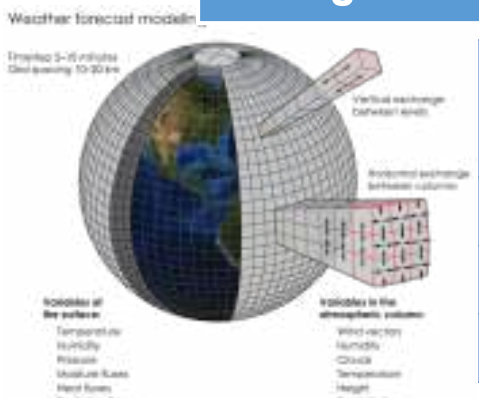




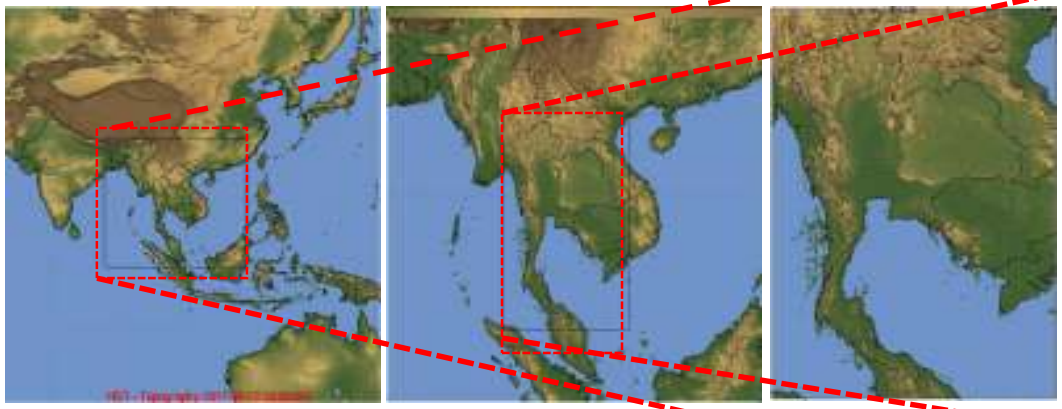


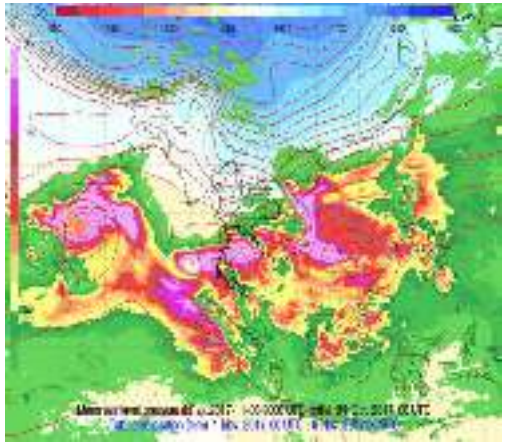


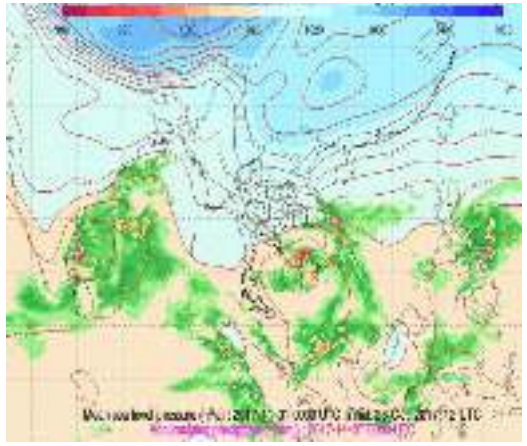
Configuration domains for run WRF on HPC (Phase 1) and Examples

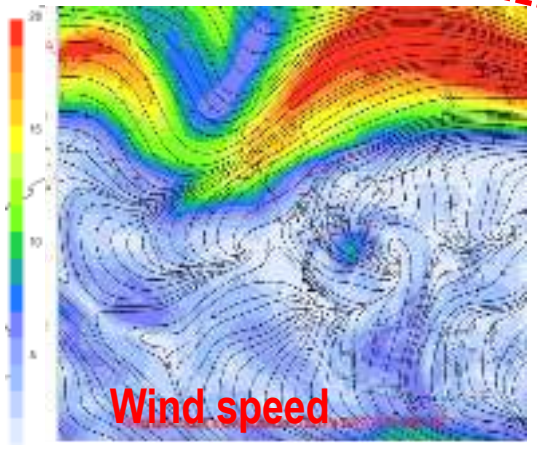


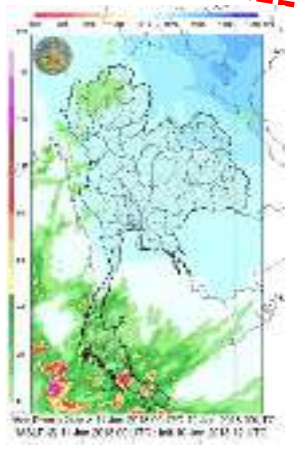
Grid point	Grid spacing/time forecast
1483x741X19=20,879,157	27 กม. (Fc 126 Days)
585x555x40=12,987,000	18 กม. (Fc 10 Days)
547x544x40=11,902,720	6 กม. (Fc 3 Days)
547x913x40=19,976,440	2 กม. (Fc 2 Days)



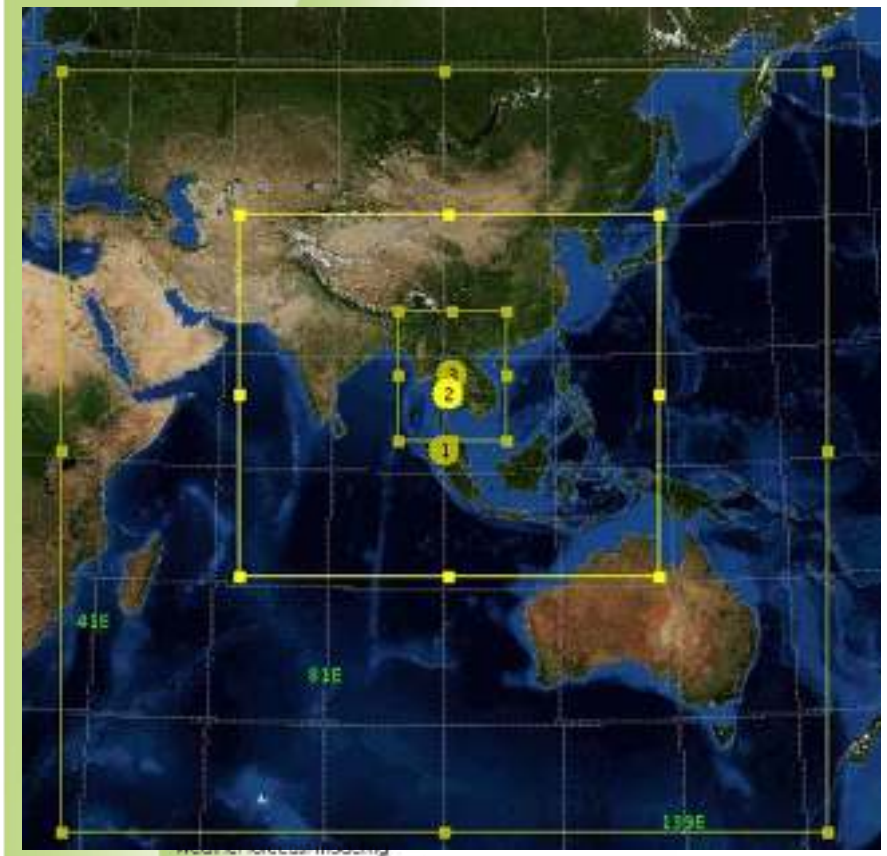


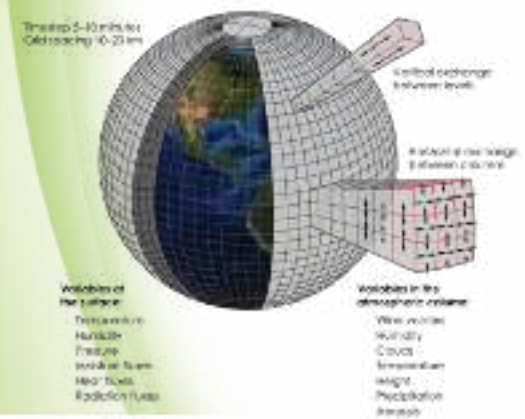






3. Configuration HPC-WRF Model in TMD

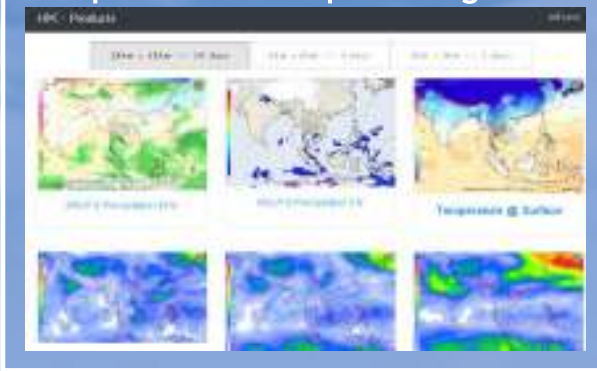




1. DATA : GFS 0.25 Initial & Boundary Conditions
2. Data Assimilated : GSI Technique (3DVAR)
3. Resolution 18,6 and 2 km Horizontal Grid Spacing (18 km outer grid)
4. 52 Vertical Levels
5. Non-hydrostatic Dynamics
6. Cumulus Parameterization :New Tiedtke scheme (16)
7. Options *(cu_physics)* No CU Scheme in 2 km,
8 Microphysics Scheme : WSM 6-class graupel scheme ; Scheme
9. Yonsei University Scheme (YSU) PBL Scheme
10. Long Wave and short wave Radiation Scheme : :Rapid Radiative Transfer Model (RRTMG)
11. Land Surface Options: Unified Noah Land Surface Model *(sf_surface_physics)*
12 Shortwave Radiation Scheme : Dudhia

- Represents the main parameters through the application. on the mobile phone . Website and API applications.

http://www.nwp.tmd.go.th/

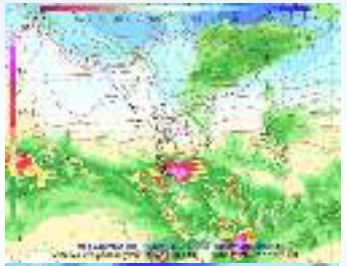


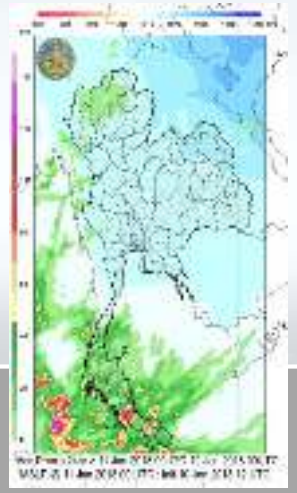
TMD SMART SIM
Meteorological Department

TMD Smart

Mobile Application :
TMD Smart SIM

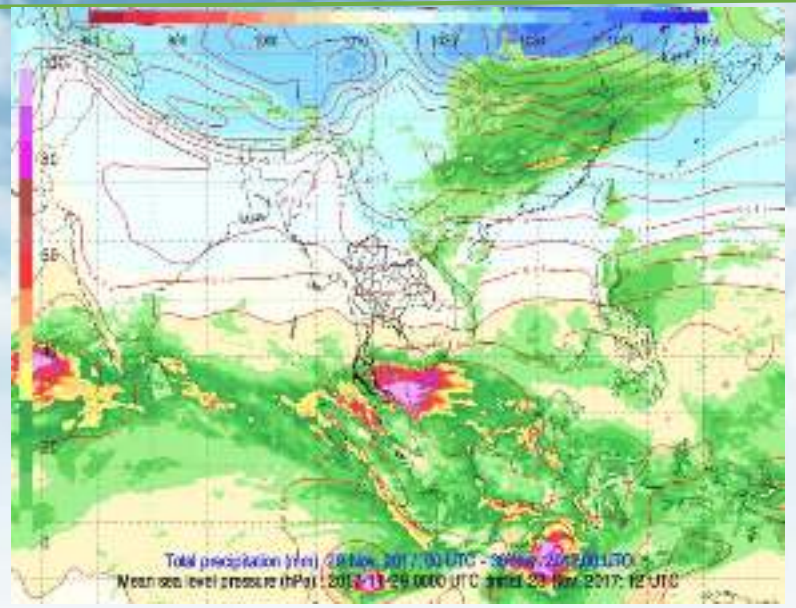
http://data.tmd.go.th/nwpapi/

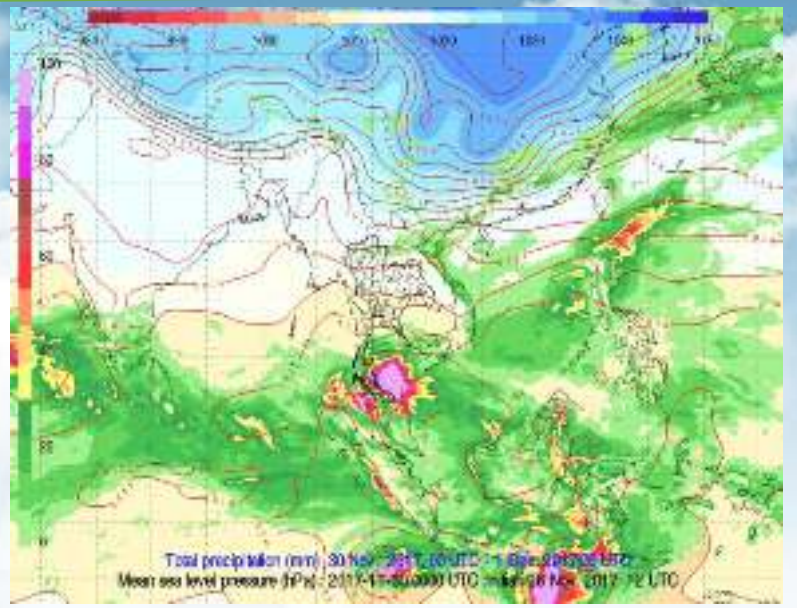


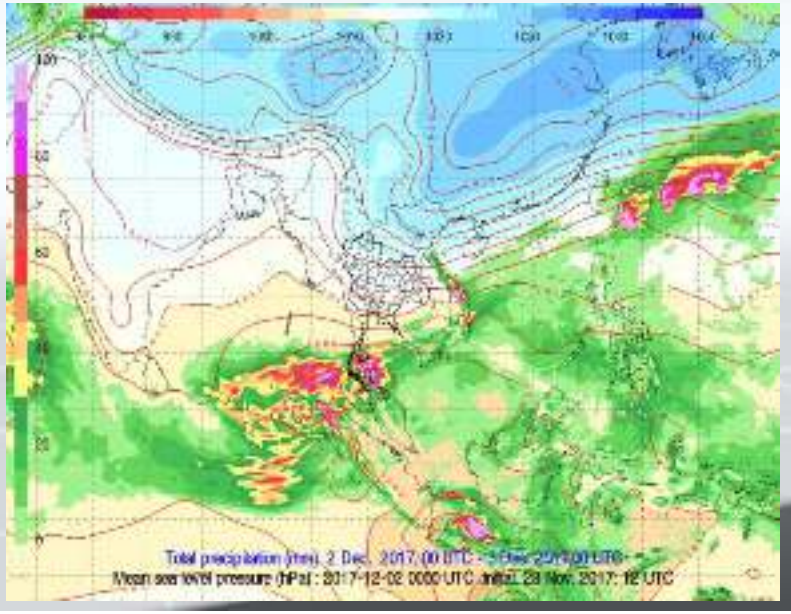


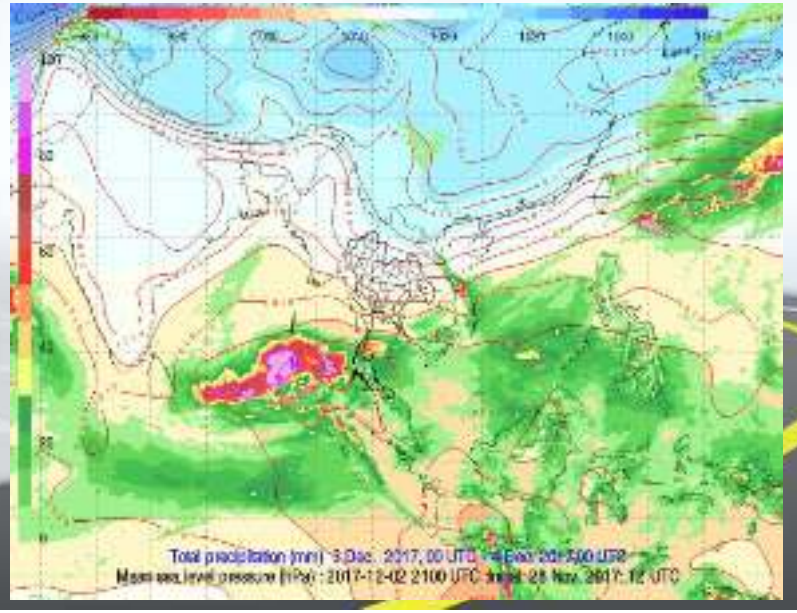
Example output on website

18 km. resolution forecast 10 days



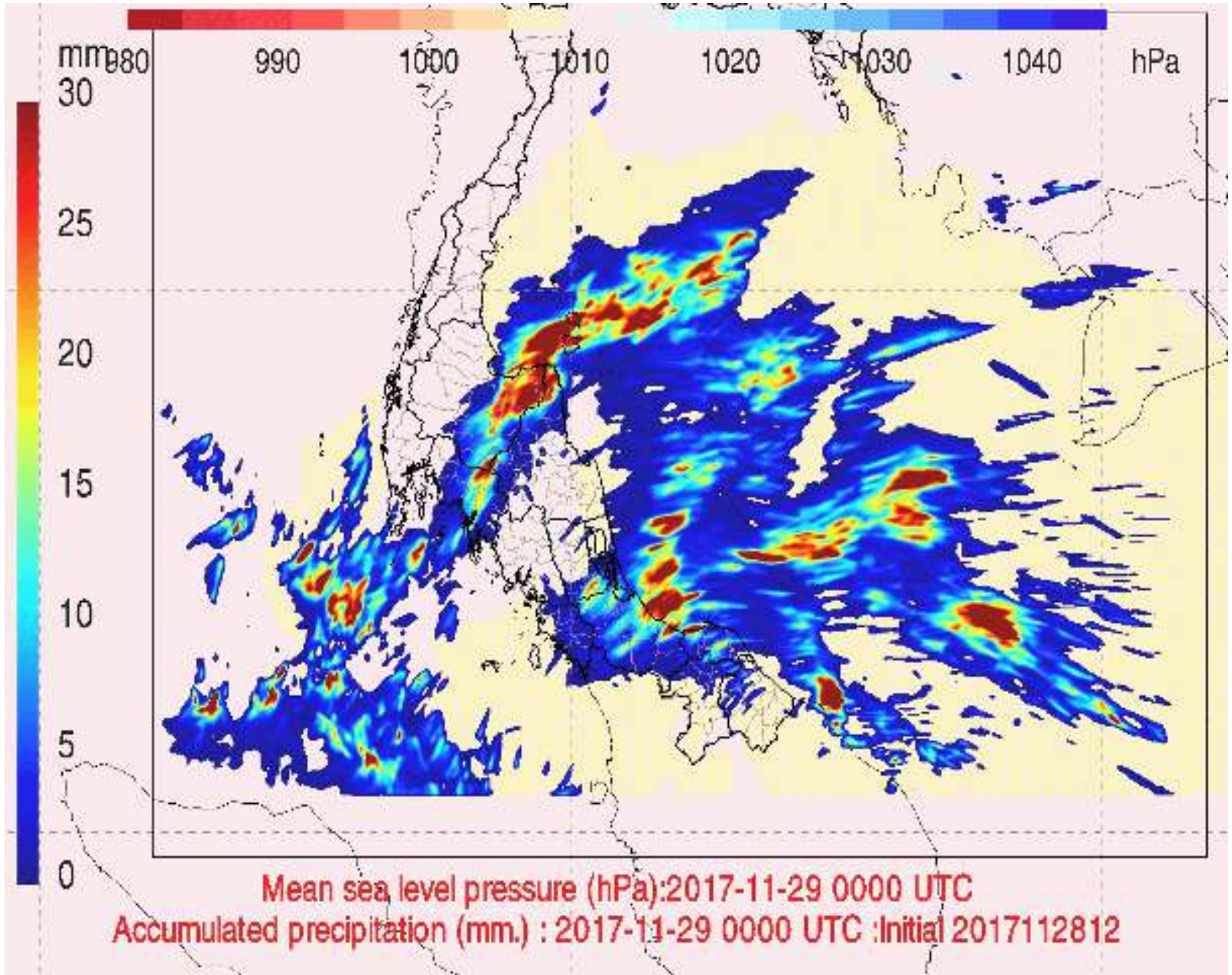






Accumulated Precipitation hourly 48 h lead time

(between 29 – 30 November 2017 based on 28 November 2017, 12 UTC}



Accumulated Precipitation hourly 48 h lead time

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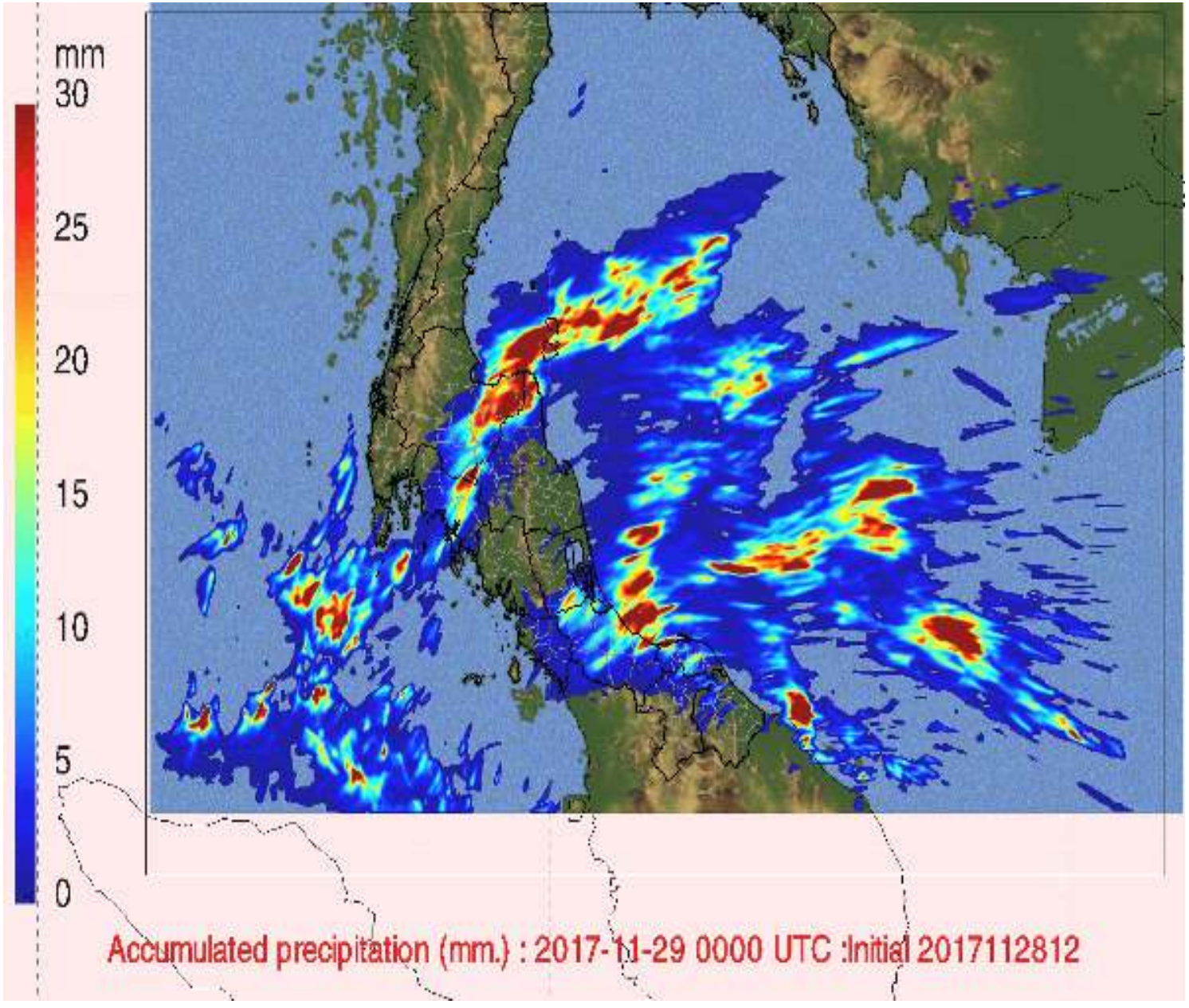

The Fourth Generation?

- Expansion of Traditional HPC
  - CFD, Computational Chemistry, Physics, Biology
- Big Data
  - Banking, Retail, Telco
- AI and machine learning
  - Advanced data analytics
  - Specialized GPU system for deep learning
- NSTDA Platform is a new exciting project

References

1. Panjai Tantasanawong, NREN update, The 3rd Asi@Connect Project Meeting/ March 26 2018 Matrix Building, Biopolis, Singapore
2. Somkuan “Development of Weather Forecasting System with High Performance Computing (Phase 1) “, Numerical Weather Prediction Sub-Division,Weather forecast Bureau , Thai Meteorological Department, Thailand (TMD)
3. Thailand National E-science Consortium , Dr. Chalee Vorakulpipat, National Electronics and Computer Technology Center (NECTEC)

Thank you