The Status of HPC Infrastructure and NWP Operation in KMA

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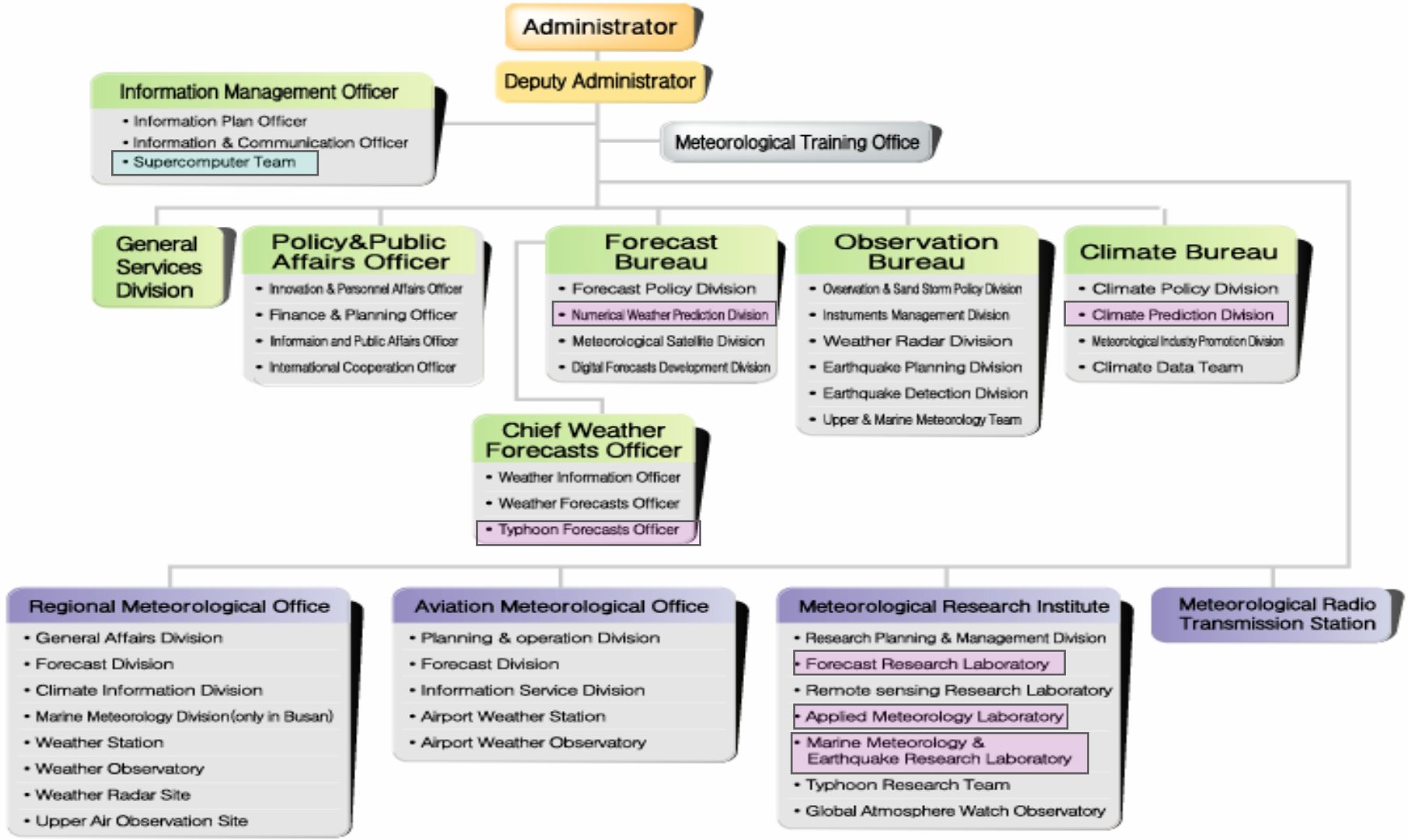
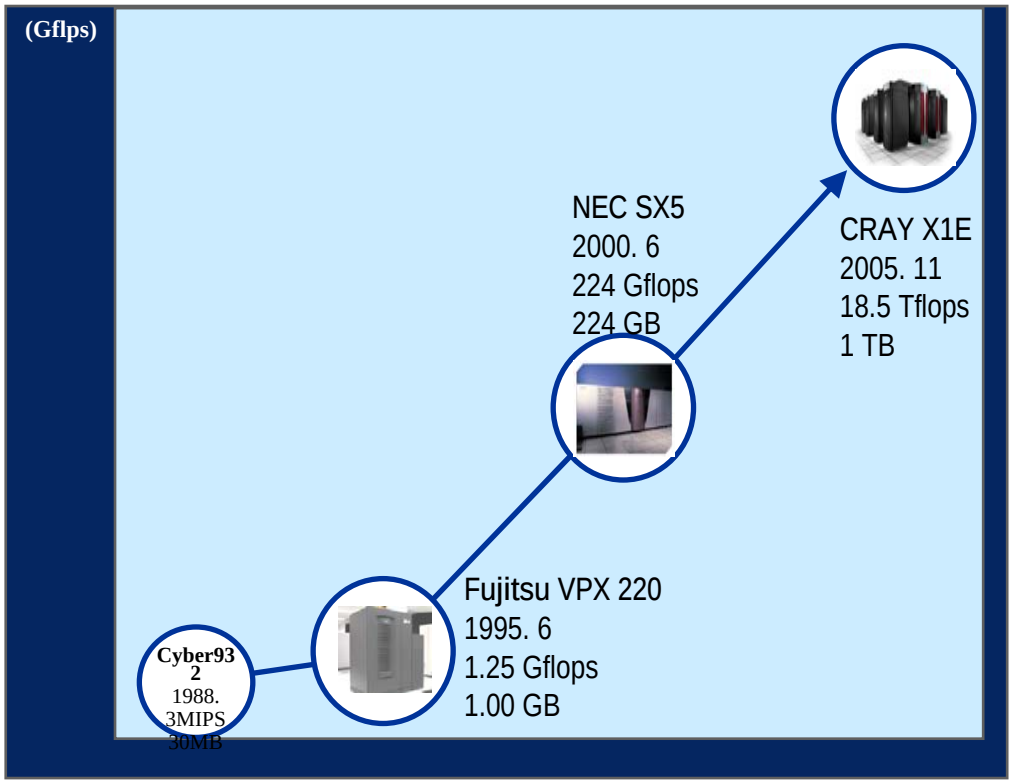
1. Organization of KMA



- H.Q.: 5 Bureaus, 3 Offices, 1 METRI , 1MRTS - REGIONAL: 6 RMOs, 1 AMO
- Total number of KMA staff members : 1230 (H.Q: 379, METRI: 80, Supercomputer: 13)

2. History of System and NWP Model in KMA

Transition of Computing Resources and NWP Model in KMA



※ KMA : Korea Meteorological Administration
- Task Force Team for NWP (1986~1989)
- Numerical Weather Prediction Division(1990~)
- Climate Prediction Division(1999~)
- Supercomputer Team(2005~)

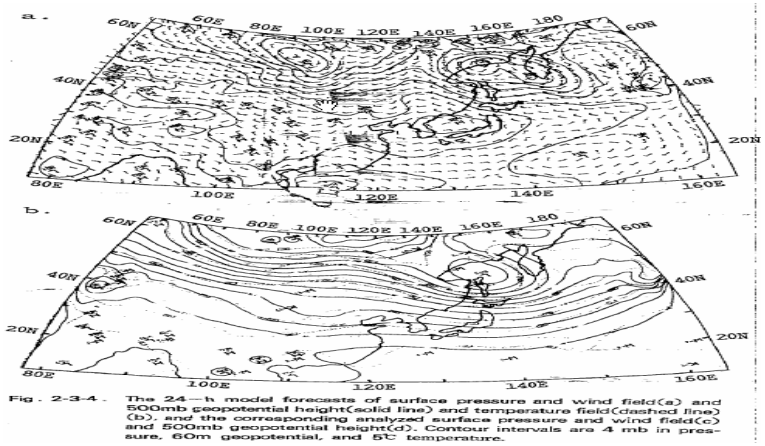
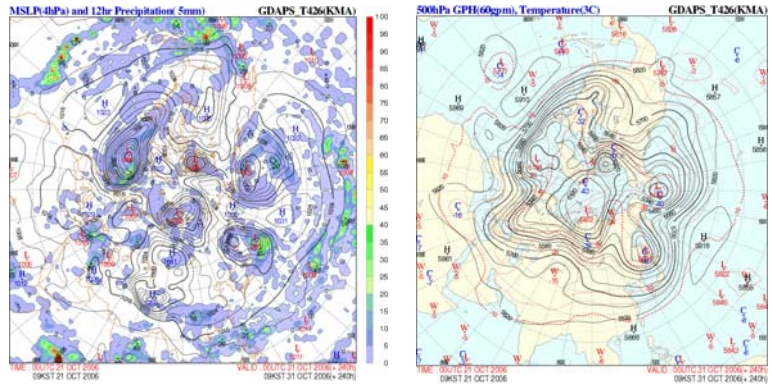


Fig. 2-3-4. The 24-h model forecasts of surface pressure and wind field(a) and 500mb geopotential height(solid line) and temperature field(dashed line) (b), and the corresponding analyzed surface pressure and wind field(c) and 500mb geopotential height(d). Contour intervals are 4 mb in pressure, 60m geopotential, and 5℃ temperature.

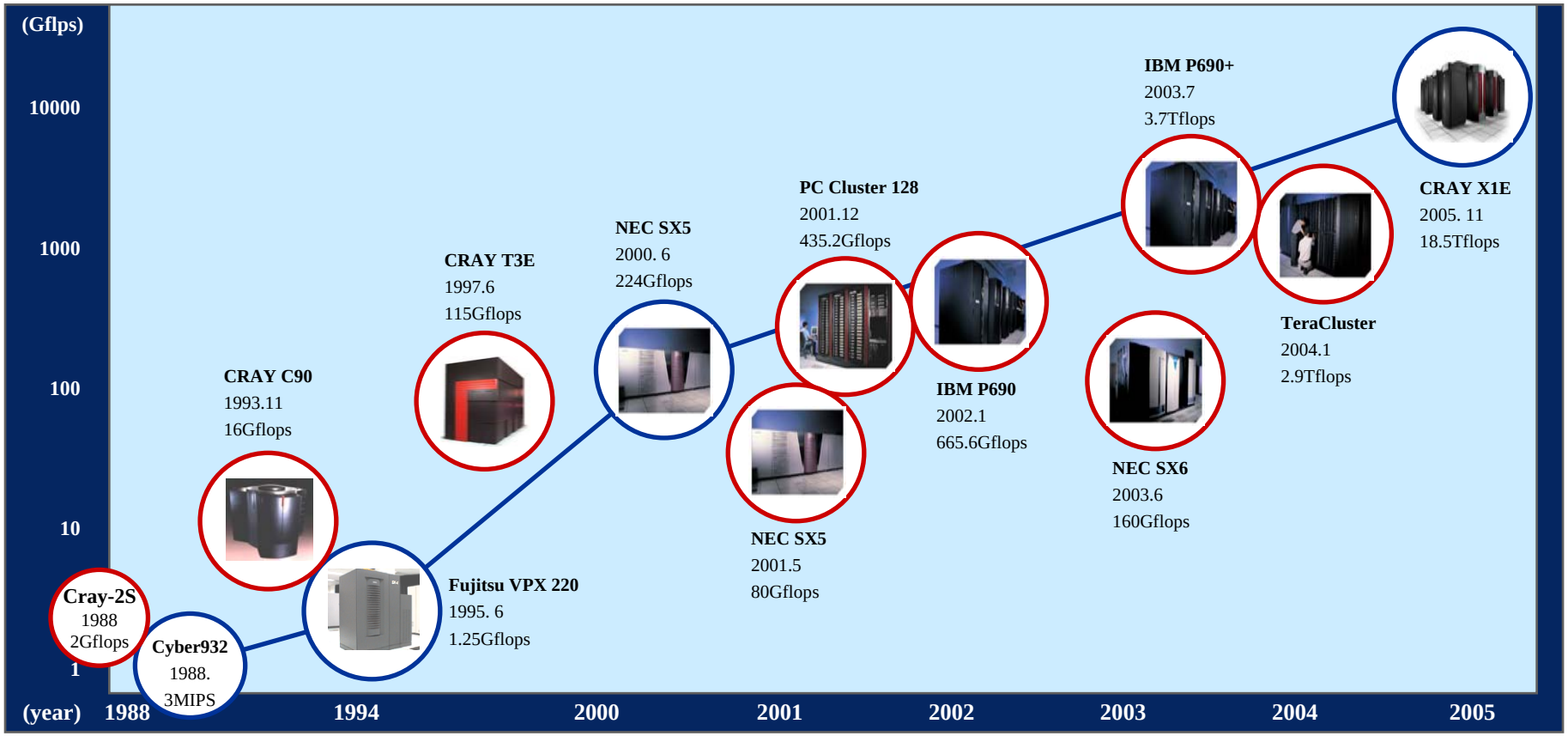
The Oldest NWP Operational Model in KMA(1989)
- LAPEM (Limited Area Primitive Equation Model)



The Newest NWP Operational Model in KMA(2006)
- GDAPS (Global Data Assimilation & Prediction System)

2. History of System and NWP Model in KMA

High Performance computing resources in KMA and KISTI



※ KISTI : Korea Institute of Science and Technology Information

2. History of System and NWP Model in KMA

History of NWP Operation in KMA

YEAR	Model Specification
1989	LAPEM (Limited Area Primitive Equation Model, 80/160km, 10Level, ECMWF & Irish(1984)) MM4 (Meso-Scale Model, 80km, 10Level, 61x46, 2Day, MM4)
1991	FLAM (Fareast Limited Area Model, 80km, 10Level, 61x46, 2Day, MM4) ALAM (Asia Limited Area Model, 160km, 10Level, 2Day, LAPEM) OFM (Ocean Forecast Model, SSW, Wave Height)
1992	FLAM (15Level)
1994	KLAM (Korea Limited Area Model, 40km, 15Level, 2Day, MM4) KTM (Korea Typhoon Model, 109x109, 50km, 8Level, 2Day, TYM) APPM (Application Model, PPM(T max, T min), POP, 2Day)
1995	FLAM (61x46 → 77x63, 3Day)
1997	GDAPS (Global Data Assimilation & Prediction System, T106, 21Level, 2DOI, 5Day, GSM) RDAPS (Regional Data Assimilation & Prediction System, 40km, 23Level, 3Day, MM4) BATS (Barotropic Adaptive-grid Typhoon System, 1Level, 3Day)
1999	GDAPS (5 → 10Day) RDAPS (30km, 33Level, 2Day, MM5) GFDK (Korea Version of GFDL Hurricane Forecast System, 3Day) GoWAM (Global Wave Model, 1.25°, 10Day, WAM(1988)) ReWAM (Regional Wave Model, 0.25°, 66Hour, WAM(1988))

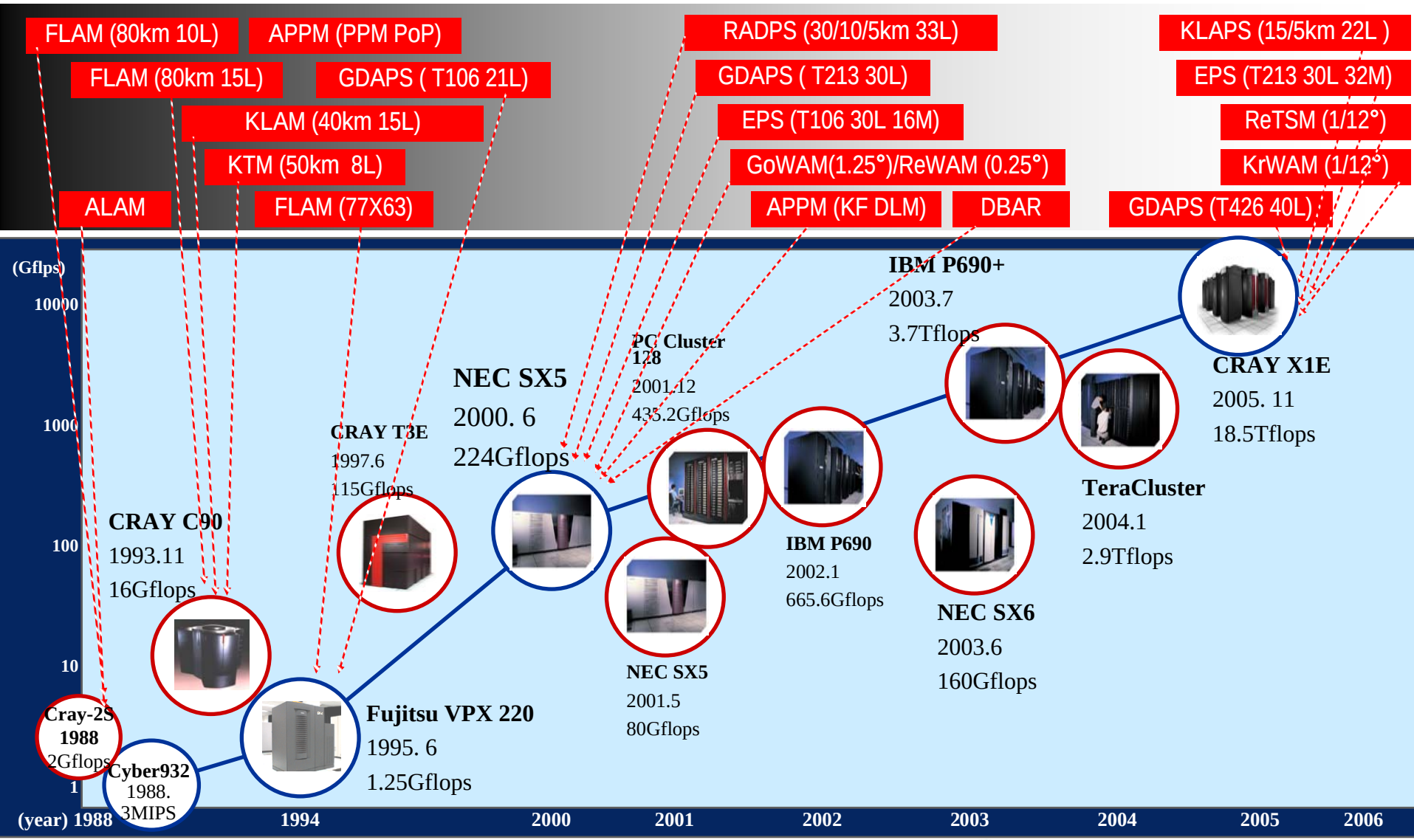
2. History of System & NWP Model in KMA

History of NWP Operation in KMA

YEAR	Model Specification
2001	GDAPS (T213, 23Level, 3DOI, 1DVAR) EPS (Ensemble Prediction System, T106, 30Level, 16Member, 8Day)
2003	GDAPS (3DVAR) DBAR (Double Fourier series Barotropic Typhoon Model, 35km, 3Day) APPM (Application Model, KF, RDLM, 2Day, GDLM , 10Day)
2005	GDAPS (T426, 40Level)
2006	EPS (T213, 40Level, 32Member, 10Day) KLAPS (Korea Limited Analysis & Prediction System, 15/5km, 18Hours, LAPS) ReTSM (Regional Tide Storm Surge Model, 1/12°, 2Day, POM) KrWAM (Korea Wave Model, 1/12°, 66Hour, WAM(1988))

2. History of System and NWP Model in KMA

Relation between Systems and NWP Operational Models in KMA



2. History of System and NWP Model in KMA

NWP Operational Global Models in KMA at Present

MODEL	Resolution Horizontal Vertical	Produce Frequency (# / day)	Prediction Term	Specification
GDAPS (spectral)	~ 30km 40 Level	2	10 Day	T426, 3DVAR Analysis For Short & Medium-range Forecast
	~ 55km 40 Level	2	10 Day	T213, 3DVAR Analysis For Digital Medium-range Forecast
	~ 110km 21 Level	Per 10 Day	120 Day	T213, Ensemble 20 Members For long-term (3 Months) Forecast
	~ 55km 40 Level	Per 6 Month	230 Day	T213, Ensemble 20 Members For long-term (6 Months) Forecast
EPS (spectral)	~ 55km 40 Level	2	10 Day	T213, Ensemble 32 Members For Medium-range Forecast
GoWAM (grid)	~ 150km 1 Level	2	10 Day	Ocean Wave Model For Medium-range Forecast

2. History of System and NWP Model in KMA

NWP Operational Regional Models in KMA at Present

MODEL	Resolution Horizontal Vertical	Produce Schedule (# / day)	Prediction Term	Specification
RDAPS (Triple Mesh)	30km 33 Level	2	66 Hour	For Short-range Forecast Asia Region
	10km 33 Level	4	1 Day	For very Short-range Forecast Korea Region
	5km 33 Level	2	1 Day	For very Short-range Forecast Korea Region
KLAPS	15km 22 Level	4	18 Hour	For Now-casting & 3D Analysis Korea Region
	5km 22 Level	8	18 Hour	For Now-casting & 3D Analysis Korea Region
ReWAM	~ 30km 1 Level	2	66 Hour	For Medium-range Forecast Asia Region, Ocean Wave Model
ReTSM	~ 9km	2	2 Day	Regional Tide Storm Surge Model Korea Region
DBAR	~ 35km 1 Level	4	3 Day	For Typhoon Track and Intensity Northern Pacific Region

2. History of System and NWP Model in KMA

NWP Operational Statistical Models in KMA at Present

MODEL	Resolution Horizontal Vertical	Produce Schedule (# / day)	Prediction Term	Specification
PPM	69 Cities	2	2 Day	For Short-range Max & Min Temperature Forecast
PoP	17 Areas	2	2 Day	For Short-range Probability of Precipitation Forecast
Kalman Filter	73 Cities	2	2 Day	For Short-range Max, Min & 3Hourly Temperature Forecast S.K. 41, N.K. 11, China and Japan 21
GDLM	6 Cities	1	10 Day	For Medium-range Max & Min Temperature Forecast
RDLM	41 Cities	2	2 Day	For Short-range Max & Min Temperature Forecast

3. Plan of NWP Model Development in KMA

Global Data Assimilation Plan

YEAR	Plan
2007	Operation of unified 3dVar and FGAT (First Guess at Appropriate Time) Development of Ensemble Kalman Filter Development of 4dVar
2008	Development of 4dVar GPS Data Assimilation
2009	Test Operation of 4dVar
2010	Operation of 4dVar

Global Model Plan

YEAR	Plan
2007	Test Operation of New Korea Global Model (30km)
2008	Operation of New Korea Global Model (30km)
2009	Development of High Resolution Model(20km, 70Level)
2010	Operation of High Resolution Model(20km, 70Level)

3. Plan of NWP Model Development in KMA

Regional Data Assimilation Plan

YEAR	Plan
2007	Operation of unified 3dVar Development of 4dVar
2008	Test Operation of 4dVar
2009	Operation of 4dVar
2010	Adding Asynoptic Observation Data

Regional Model Plan

YEAR	Plan
2007	Operation of Next Generation Model (KWRF, 10km, 40Level,8/Day) Test Operation of Severe Weather Prediction Model (5km, 70Level)
2008	Operation of Severe Weather Prediction Model (5km, 70Level)
2009	Test Operation of Ensemble Prediction System (10km, 20Member) Improvement of Severe Weather Prediction Model (5km)
2010	Operation of Ensemble Prediction System (10km, 20Member) Test Operation of Ensemble Prediction System (5km, 20Member) Development of Severe Weather Prediction Model (2~3km)

3. Plan of NWP Model Development in KMA

Wave and Ocean Model Plan

YEAR	Plan
2007	Test Operation of Global Wave Model (0.5°, WM3 → WW3) Test Operation of Korea Wave Model (1/12°, WM3 → WW3) Operation of Korea Wave Model (1/12°, WM3) Operation of Regional Tide Storm Surge Model (1/12°, POM)
2008	Operation of Global Wave Model (0.5°, WW3) Operation of Korea Wave Model (1/12°, WW3) Test Operation of Regional Wave Model (1/12°, WM3 → WW3) Test Operation of Coastal Wave Model (1/120°, WW3) Test Operation of Coastal Tide Storm Surge Model (1/120°, POM)
2009	Operation of Coastal Wave Model (1/120°, WW3) Operation of Regional Wave Model (1/12°, WM3 → WW3) Operation of Coastal Tide Storm Surge Model (1/120°, POM)

Typhoon Model Plan

YEAR	Plan
2007 ~ 2009	Operation of Typhoon Weather Research Model (TWRF, 10km) Test Operation of Typhoon Weather Research Model (TWRF, 5km)
2010	Operation of Typhoon Weather Research Model (TWRF, 5km)

3. Plan of NWP Model Development in KMA

Climate Prediction Model Plan

YEAR	Plan
2007 ~ 2008	Development of High Resolution Global Model-1(20km, 60Level) Development of High Resolution Global Model-2(30km, 40Level) Development of Ocean Coupled Global Model(110km, 21Level)
2009 ~ 2010	Test Operation of High Resolution Global Model-1(20km, 60Level) Test Operation of High Resolution Global Model-2(30km, 40Level) Test Operation of Ocean Coupled Global Model(110km, 21Level)
2011	Operation of High Resolution Global Model-1(20km, 60Level) Operation of High Resolution Global Model-2(30km, 40Level) Operation of Ocean Coupled Global Model(110km, 21Level)

4. KMA 1st Supercomputer System

The Specification of KMA 1st Supercomputer System

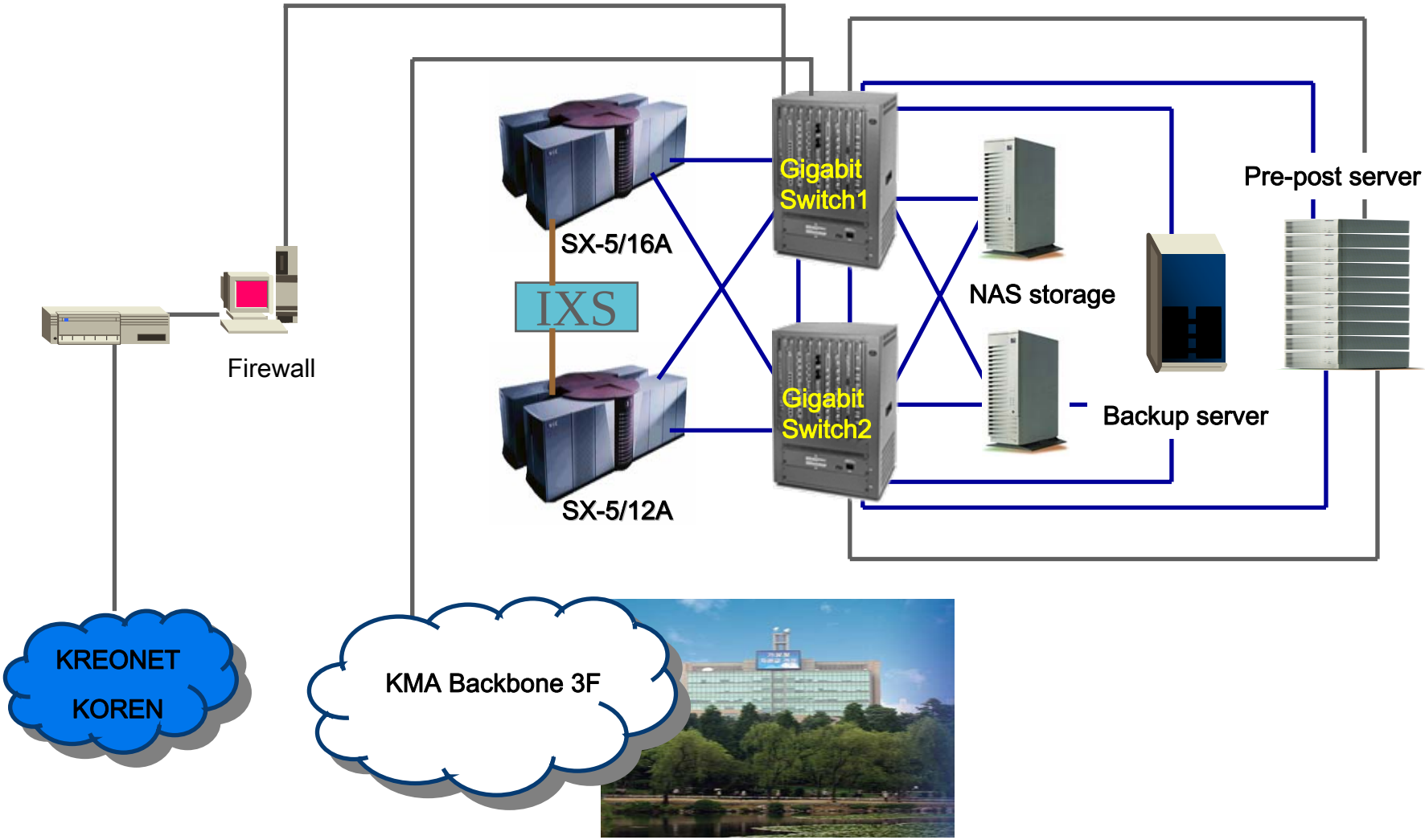
SX-5

StorageTek 14TB

Ref	*NEC SX-5/16A*	*NEC SX-5/12A*
Installation	1999.6.	2000.10.
CPU	16	12
Peak performance	128Gflops	96Gflops
Main Memory	128GB	96GB
Capacity of Raid disk	2.16 TByte	1.62 TByte
Functions	- For NWP Operation	- Research & Development

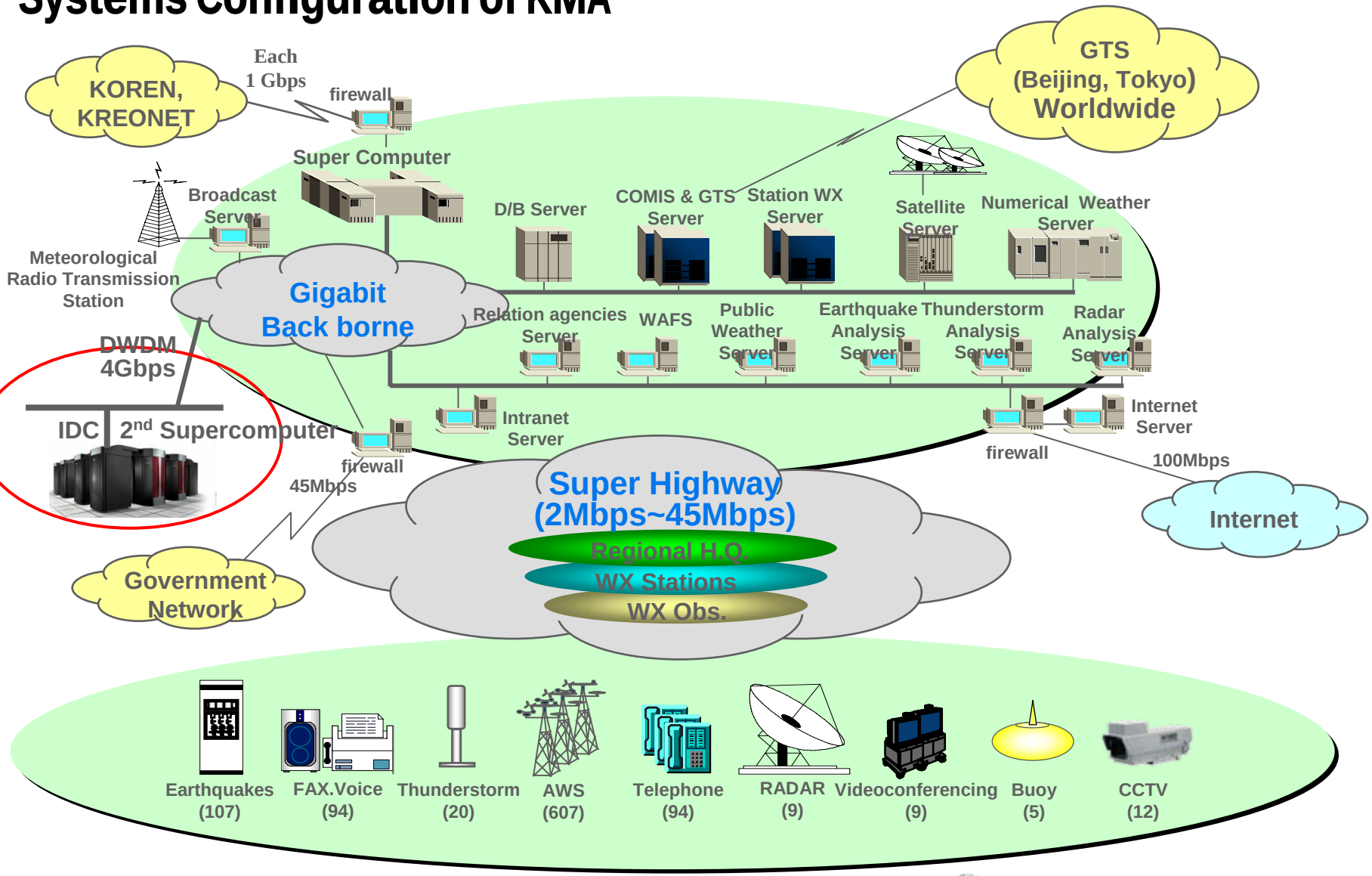
4. KMA 1st Supercomputer System

The Configuration of KMA 1st Supercomputer System



5. KMA 2nd Supercomputer System

Systems Configuration of KMA



5. KMA 2nd Supercomputer System

The Specification of KMA 2nd Supercomputer System

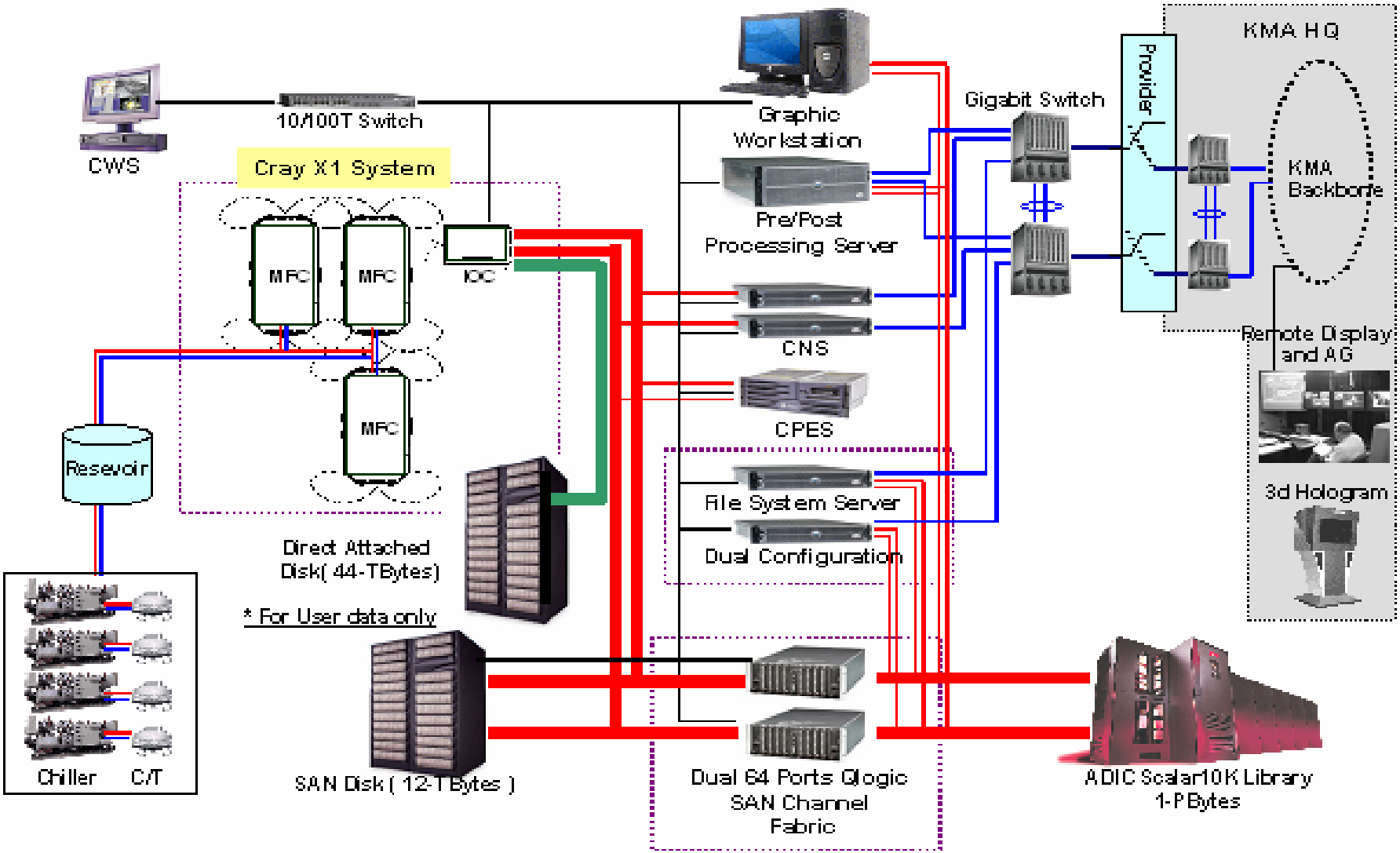
CRAY X1E

ADIC Scalar 10K 1PB

Ref	*CRAY X1E*
Installation	2005. 11
CPU	1024 MSP
Peak performance	18.5 TF
Main Memory	4 TB
Capacity of DAS Disk	67 TB
Capacity of SAN Disk	21 TB
Capacity of Tape drive	1 PB
Functions	For NWP Operation Research & Development

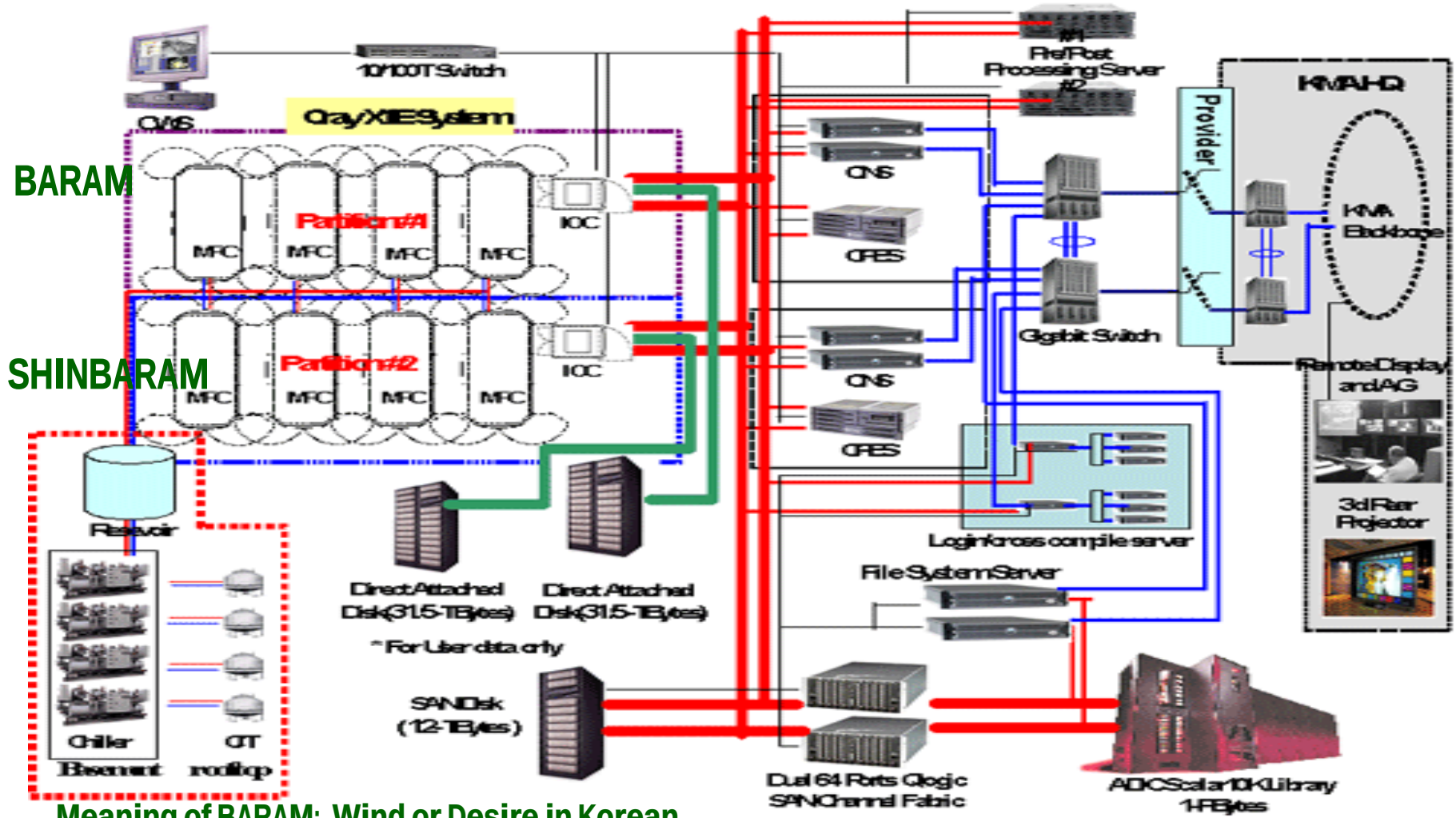
5. KMA 2nd Supercomputer System

The Configuration of KMA 2nd Supercomputer System (Initial, 2004)



5. KMA 2nd Supercomputer System

The Configuration of KMA 2nd Supercomputer System (Final, 2005)



Meaning of BARAM: Wind or Desire in Korean

Meaning of SHINBARAM: Excitement in Korean

5. KMA 2nd Supercomputer System

The Figure of KMA 2nd Supercomputer System

KMA Supercomputer in KIDC, 10 SEP 2005

Appearance of KIDC Building

No. 22 of TOP 500 Ranking on JUN 2006

6. Issues and Plan

- **Improving Job Scheduling and failover including DR (2007)**
  → Applying SMS to Operational Model, Developing the best way and KISTI

- **Reinforcing System Resources (2007)**
  → Adding storages for Huge amounts of Data User (50~100 TB)
  → Increasing Network Speed for Exchange Huge amounts of Data (10gbps)
  → Supporting the Outside Users using One Time Password

- **Constructing Exclusive KMA Supercomputer Building** (Needs more space, cooling and power)
  → Deciding Building Site and Designing Architecture (2007)
  → Constructing Building (2008~2009)
  → Completion of New building (2009)

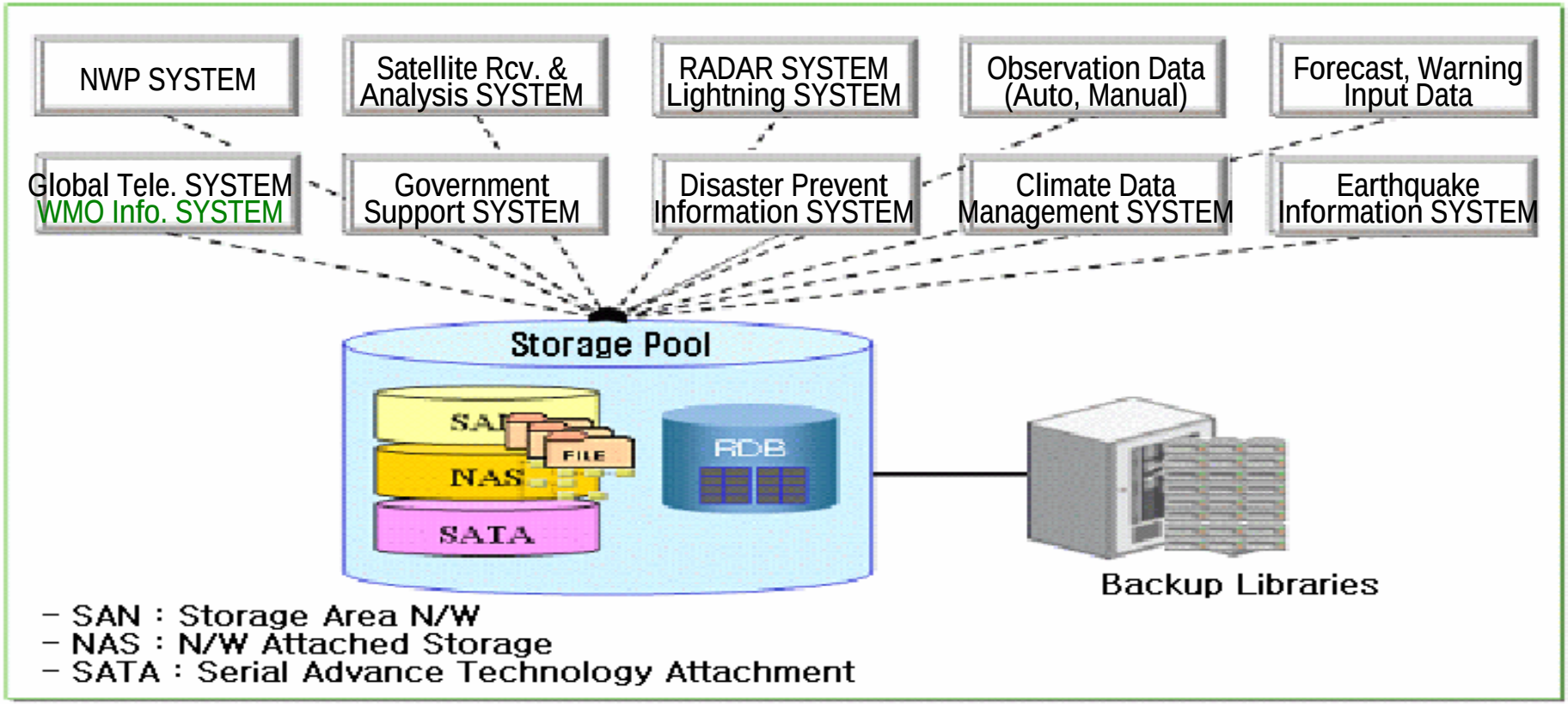
- **Preparing to Introducing KMA 3rd Supercomputer**
  → Feasibility Study of Vector and Cluster Systems, Investigation RFI (2007)
  → Organizing T/F and Preparing RFP (2008)
  → Introducing 3rd Supercomputer (2008)

7. Other Activities

System Replacement for Distributed Data Integration

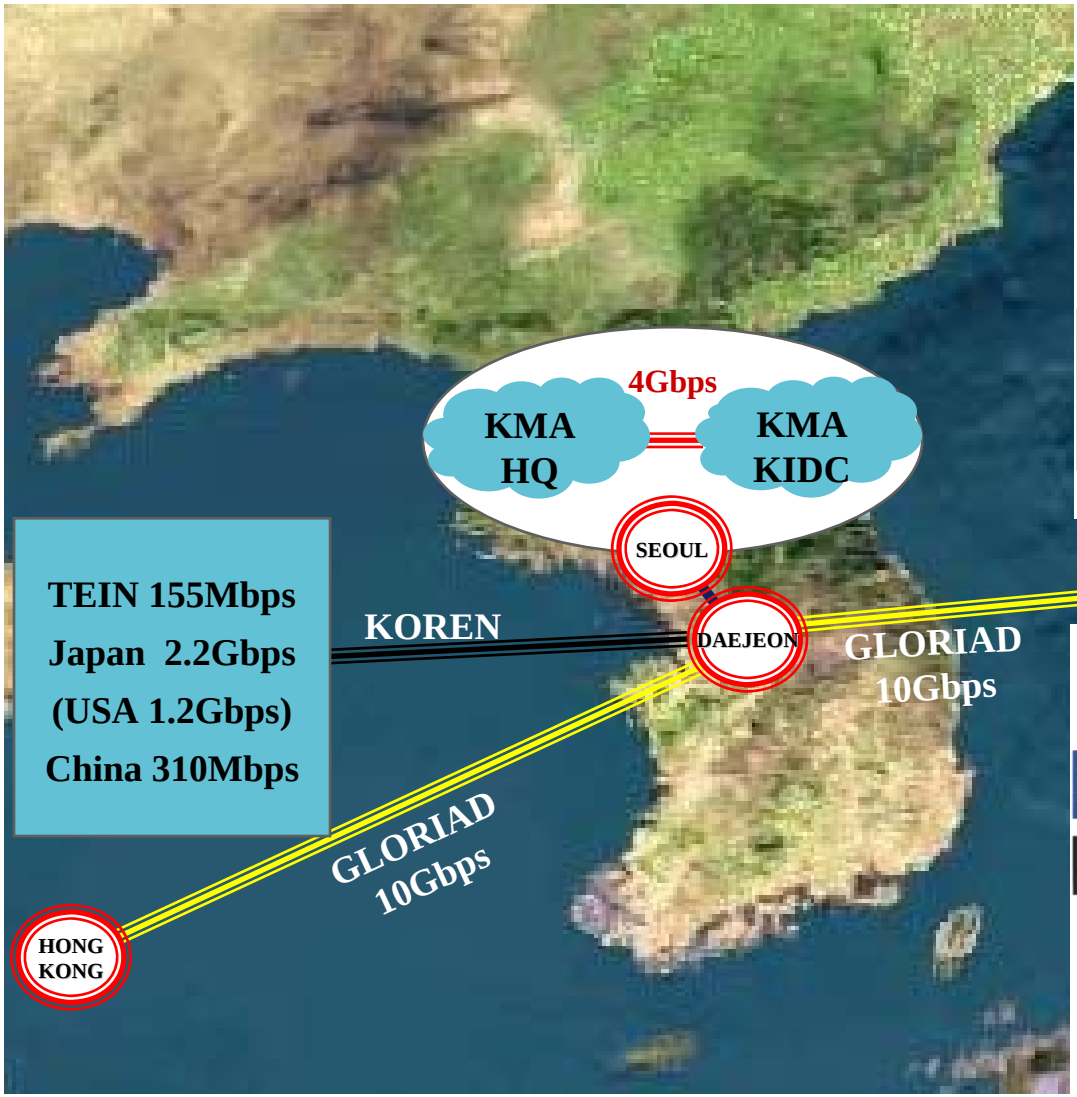
- **COMIS-3 Project (2006)** (Combined Meteorological Information System)
- **Integrated Storage Pool (200TB) for Systematic Data Management and Services**
- **Common RDBMS, Sharing File System, Collecting/Distributing/Processing Data**

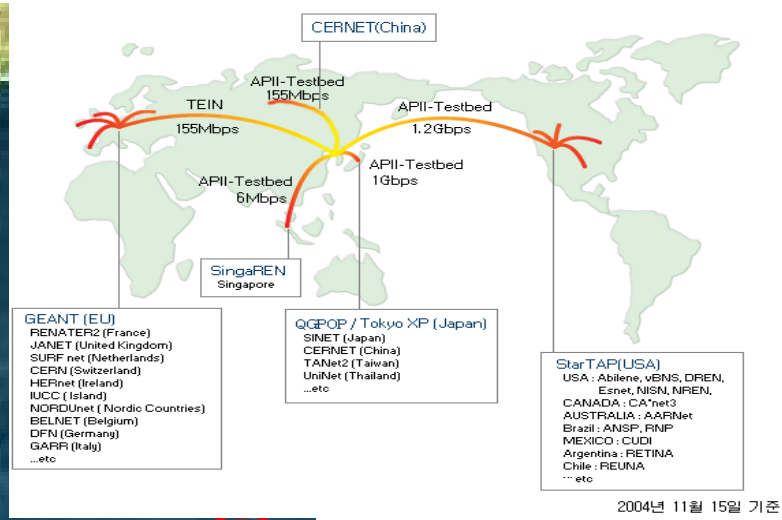
Conceptual Configuration of COMIS-Ⅲ Storage Pool



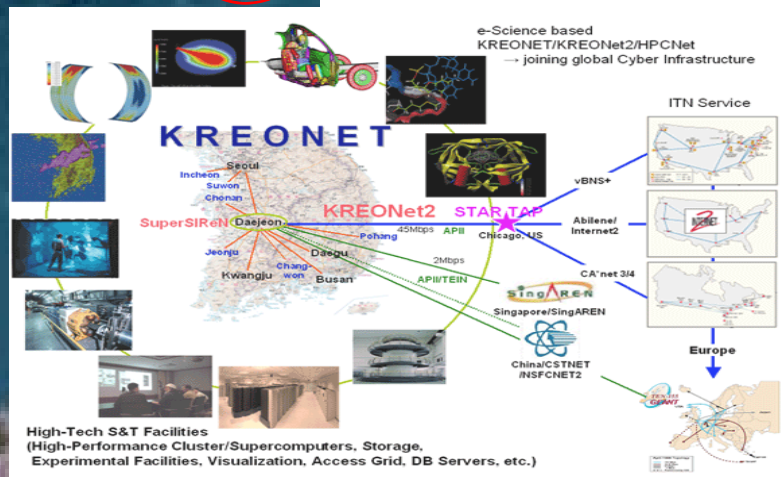
7. Other Activities

The Practical Use of High Performance Network





2004년 11월 15일 기준



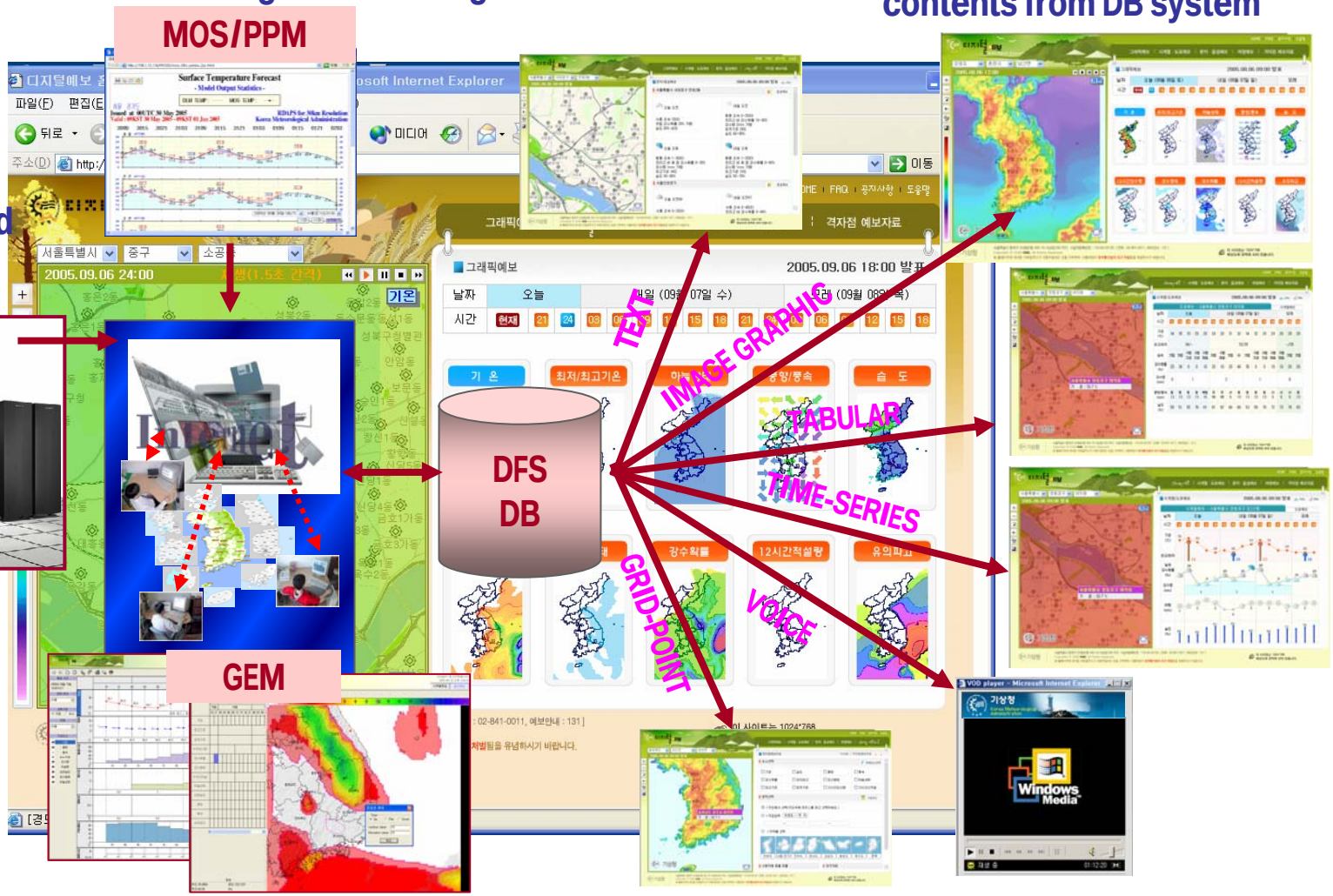
7. Other Activities

Support for KMA Digital Forecast System (http://www.digital.go.kr)

1. Generate 5km grid from NWP output

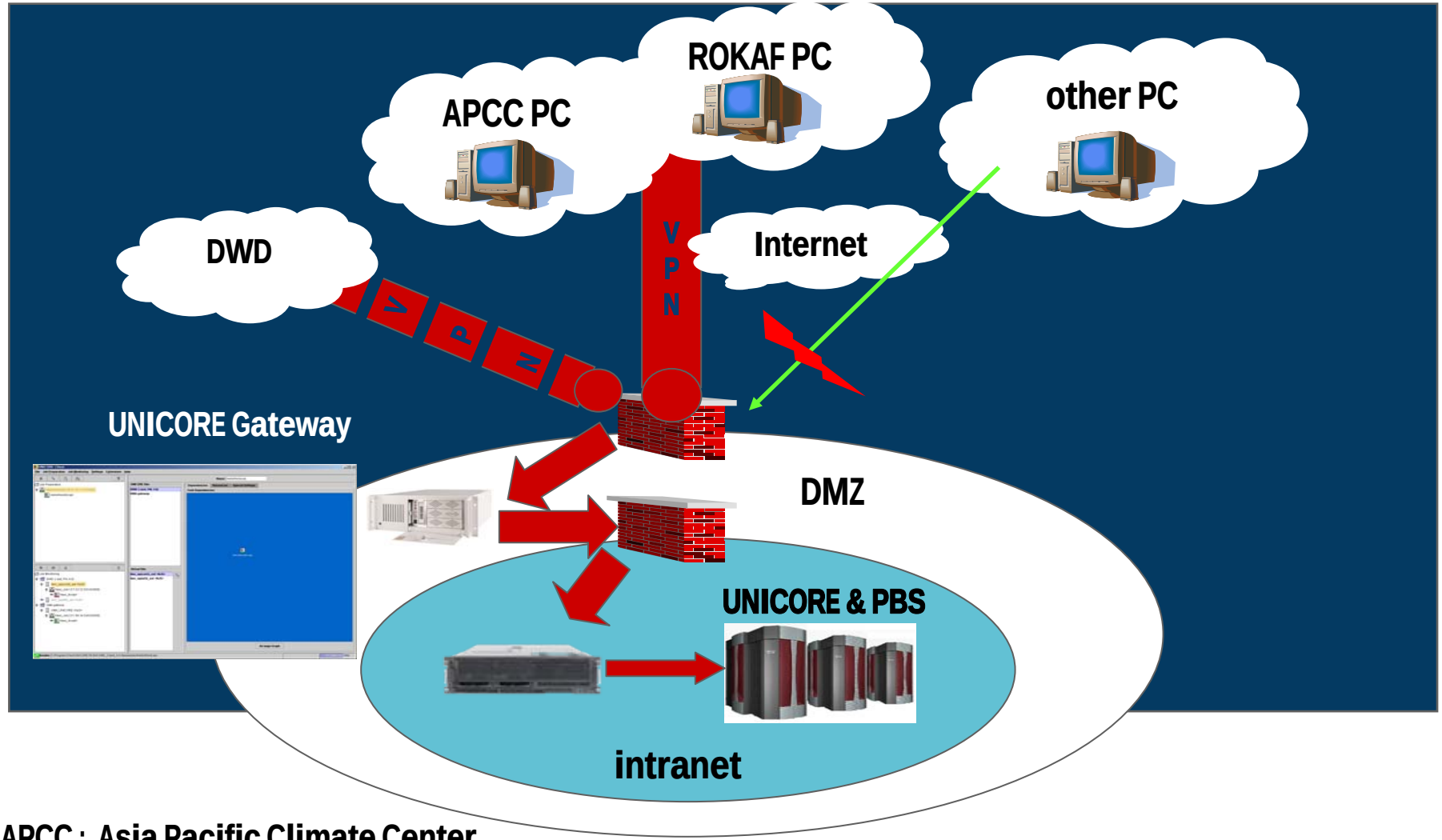
2. Get 5km digital forecast grids

3. Distribute digital forecast contents from DB system



7. Other Activities

Support for Research Group (VPN & GRID)



APCC : Asia Pacific Climate Center
ROKAF : Republic of Korean Air Force

7. Other Activities

Participating in Project and Supporting User

- National Grid Project
- E-Science Project
- Project for Realizing WMO Information System
- Supervising WMO Extraordinary Session of Commission for Basic System 2006
- Collaboration with DWD for developing UNIDART
- Collaboration with ECMWF for developing SIMDAT
- High Performance Network (BcN project)
- Application Programmers and system analysis expert supported by Cray
- KMA-Cray ESRC (ex. Workshop on performance 32-/64bit precision operational models)
- Video Conference with NOAA/NCDC
- Technical Training (Fortran90, System Management etc.)
- Collaboration with NOAA for building GEO Test Bed

Thank you

KMA's symbols

Sunflower: faithful heart for the public

Pine tree: better quality services all the time

Swallow: timely and accurate forecast for the citizens