High Performance Computing at CMA

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Outline

1. Overview of the HPC at CMA
2. Resource Statistics & Analysis
3. NWP and Climate Prediction
4. Future Plan & Work

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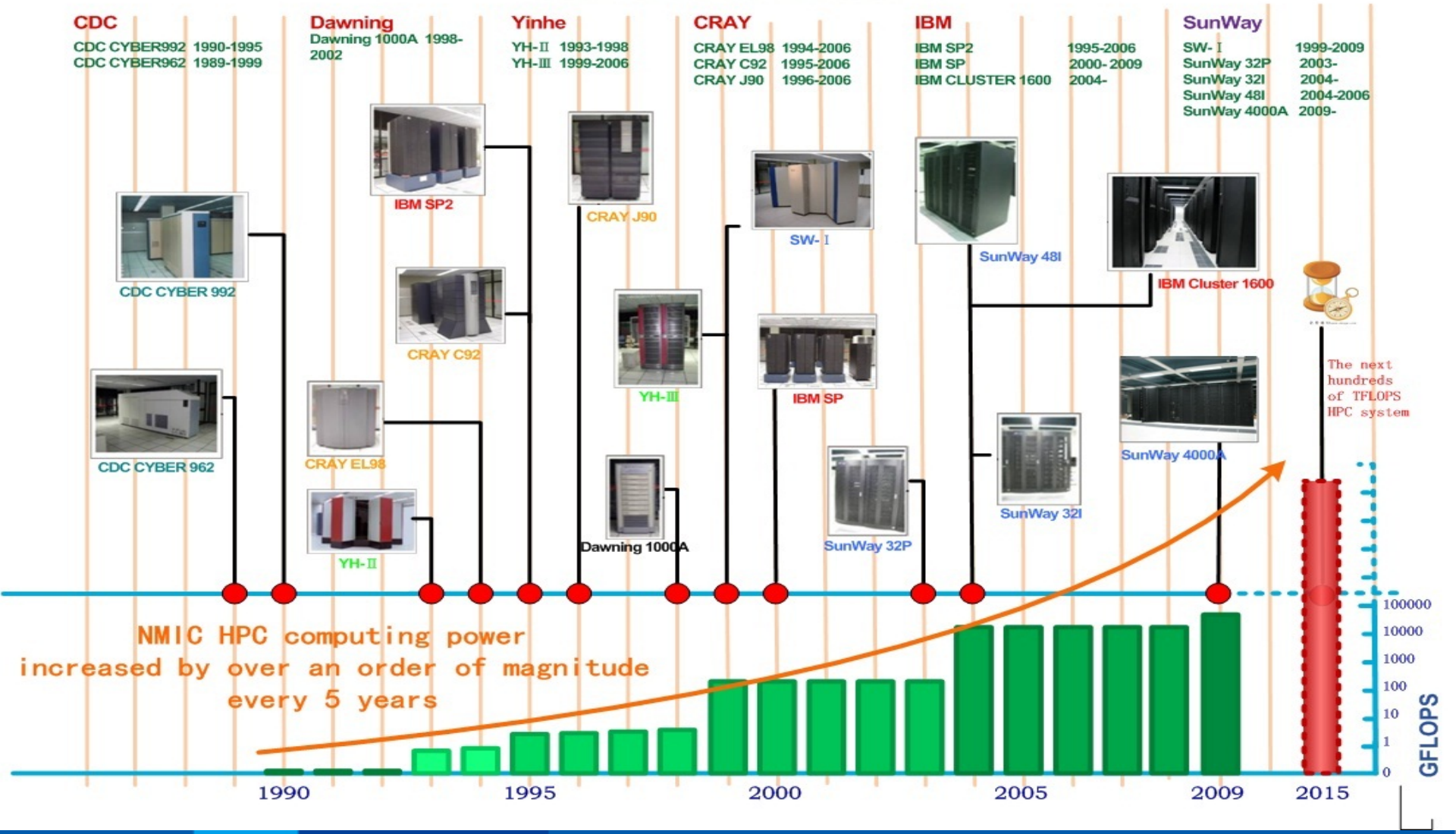
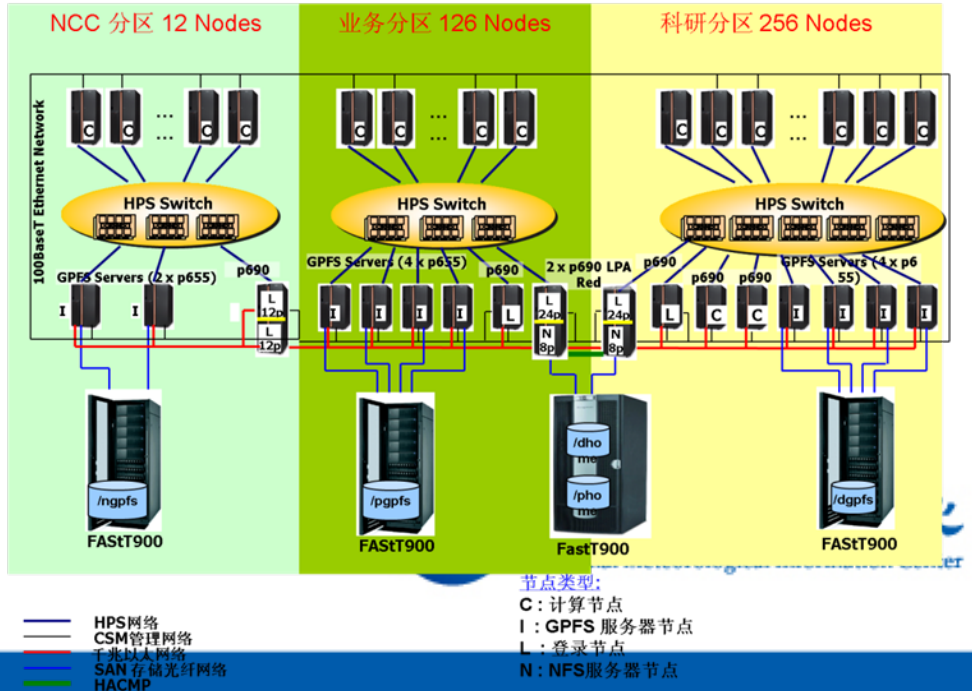
Evolution of HPC at CMA



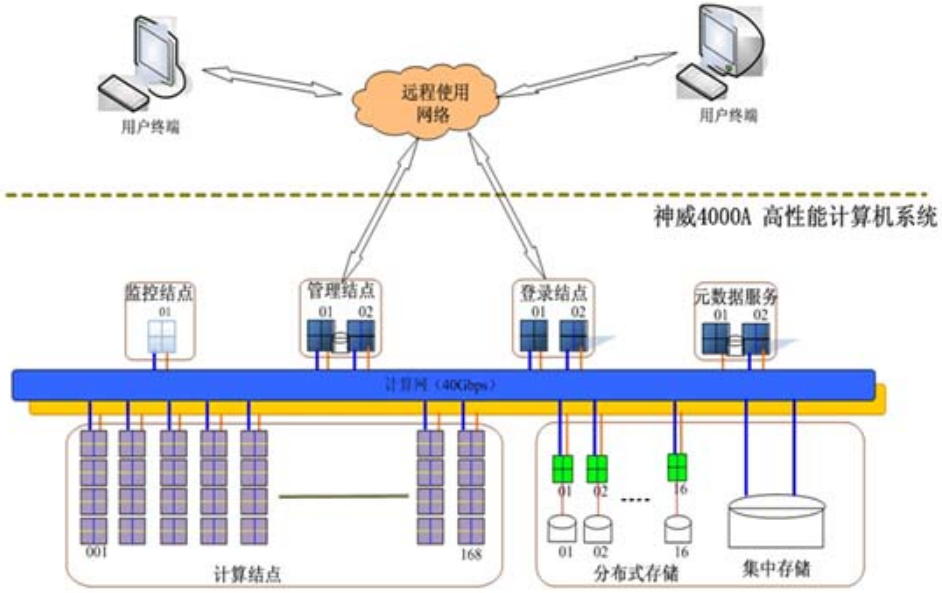
IBM Cluster 1600

- **2005 in operation：**
  - 21.5TFLOPS
  - IBM HPS
  - GPFS 128TB，Mem 8224GB



SunWay 4000A

- **200908 installed**
  - 15.75TFLOPS
  - Storage 143TB，Mem 6.048TB
  - Infiniband BW 40Gbps



BCC_CSM Experiment(IPCC-AR5)

Procs					Total Procs	Iteration Time	Speedup
atm	lnd	ice	ocn	cpl			
8	2	4	4	1	19	5160	1
8	2	8	8	1	27	2700	1.91
16	4	8	8	1	37	2940	1.76
64	8	16	64	1	153	580	8.90
64	8	16	96	1	185	410	12.59
64	8	16	128	1	217	389	13.26
64	16	32	128	1	241	405	12.74

Optimized 185CPU/core
Fastest 217CPU/core

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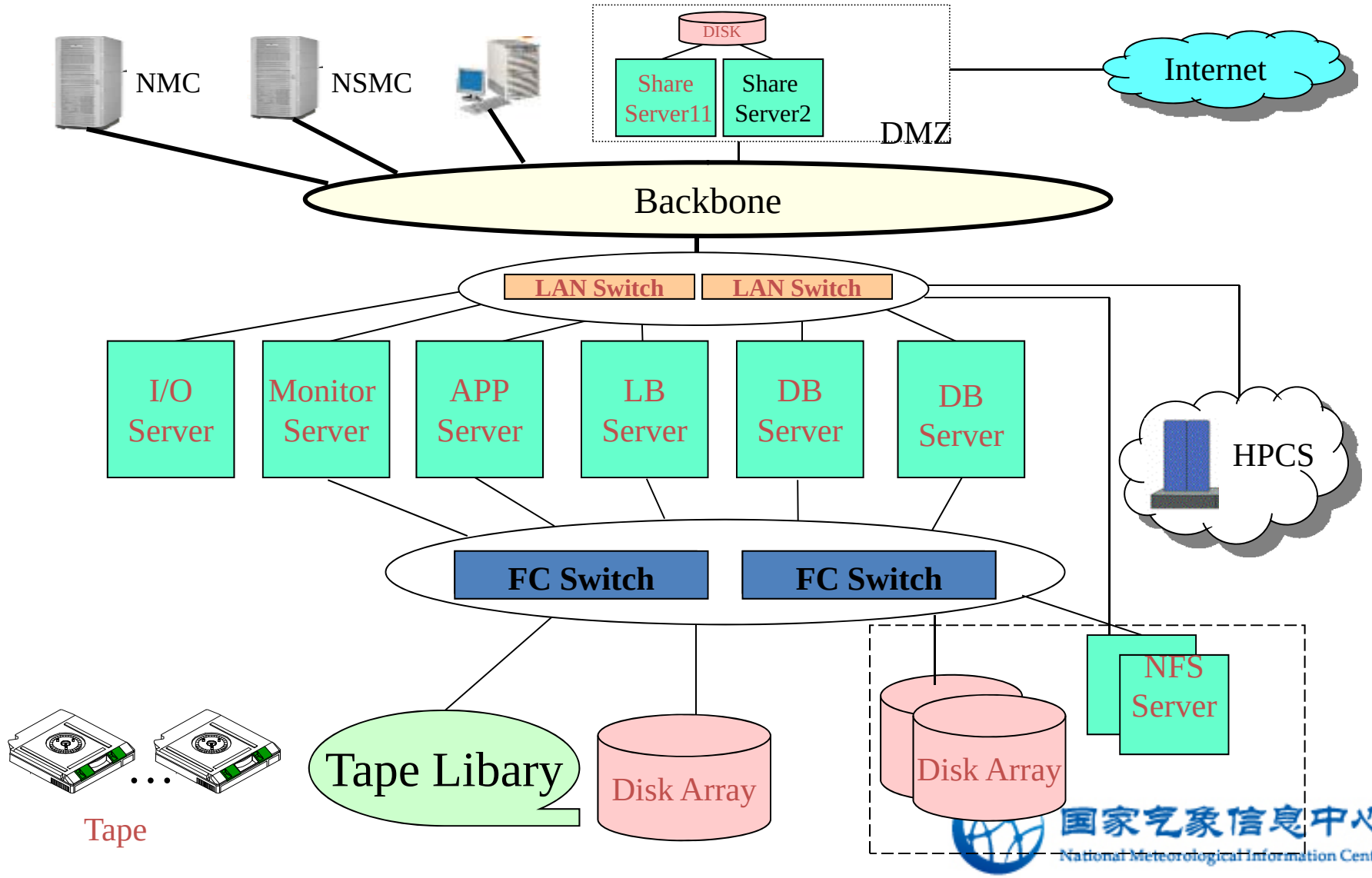
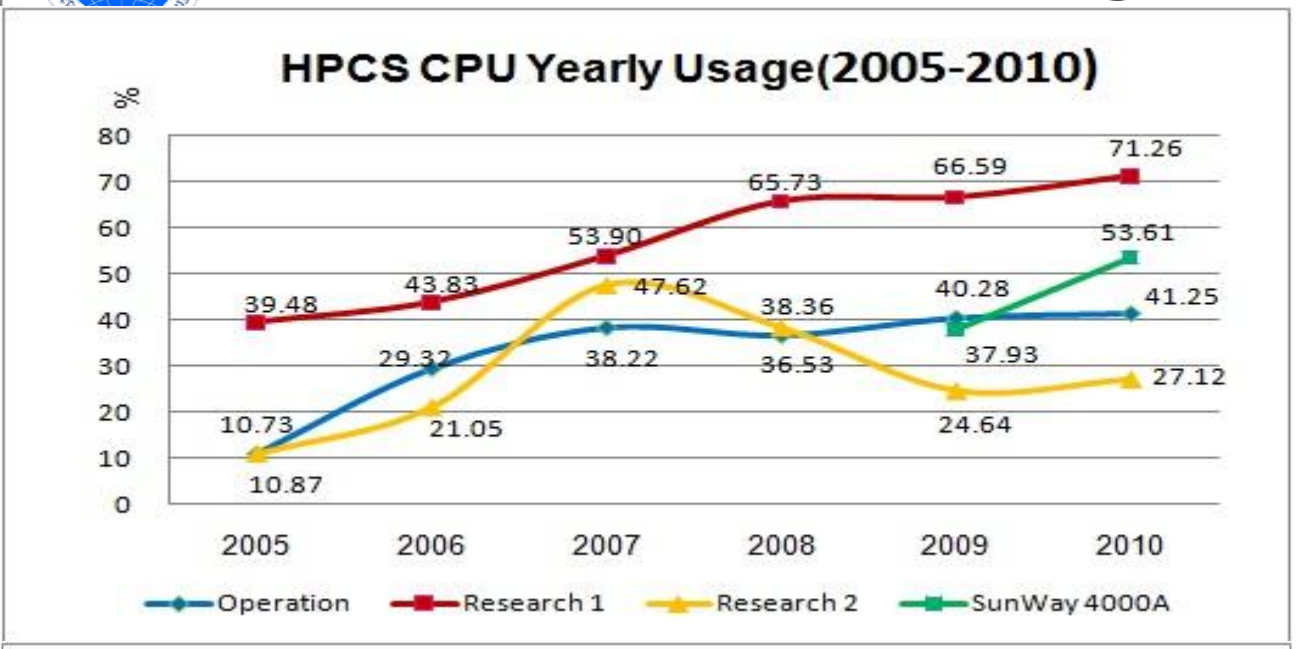
Comparison of CMA's main system

Machines	IBM Cluster 1600	SunWay 4000A
Nodes	382	168
CPUs/Cores	3200	1344
Total Mem (TB)	8.224	6.048
Total Disk (TB)	128	143
Peak Perf (Tflops)	21.5	15.75

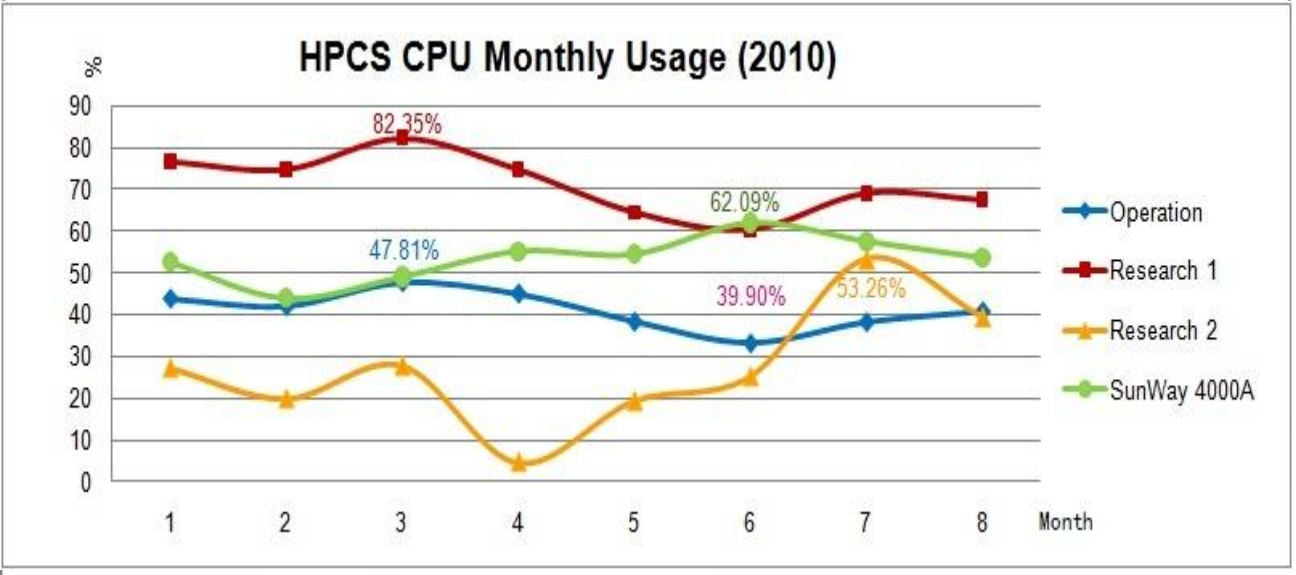
Mass Data Storage System



CPU Usage



Increased yearly 2010 2X 2005



Low level in holidays

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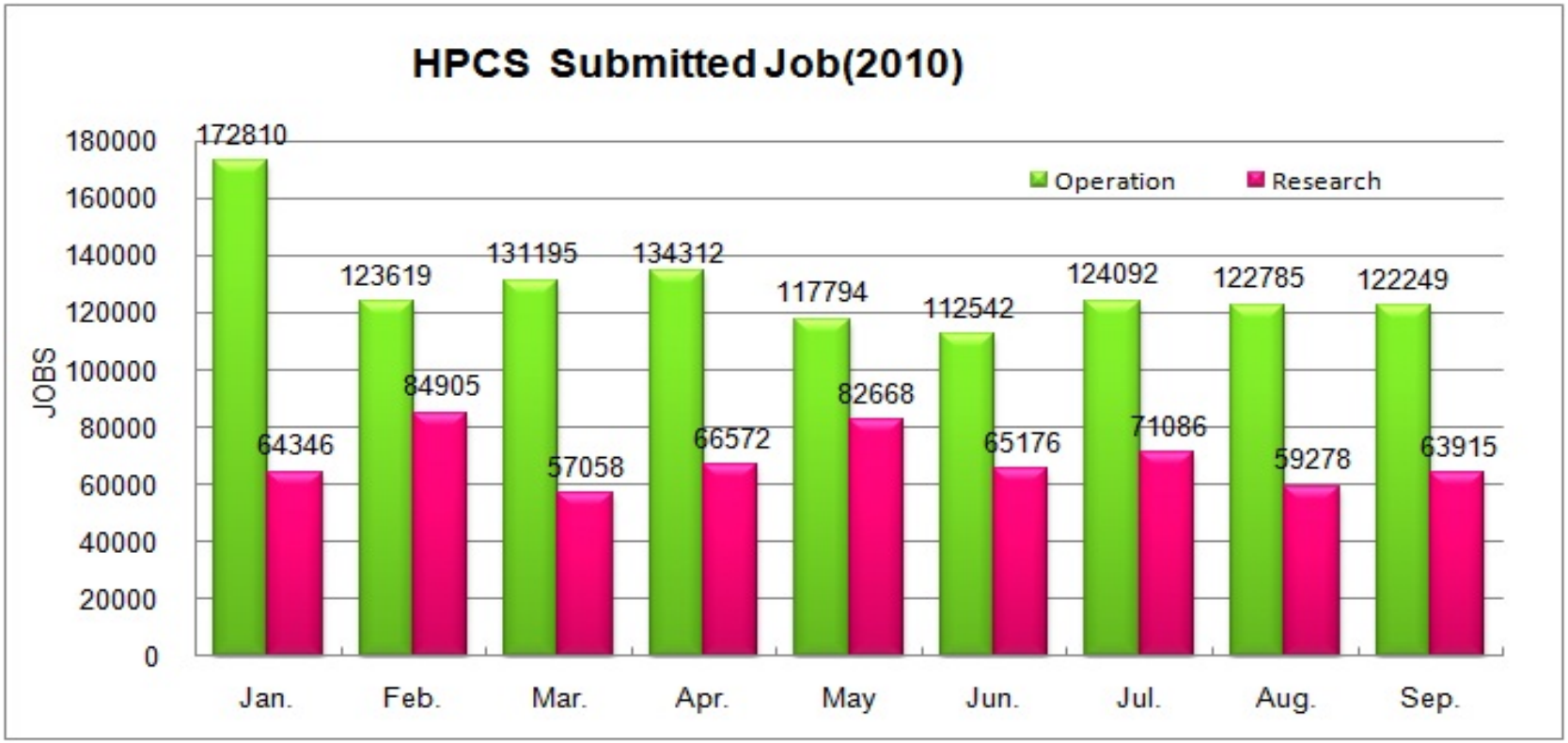
Job



Relative stable

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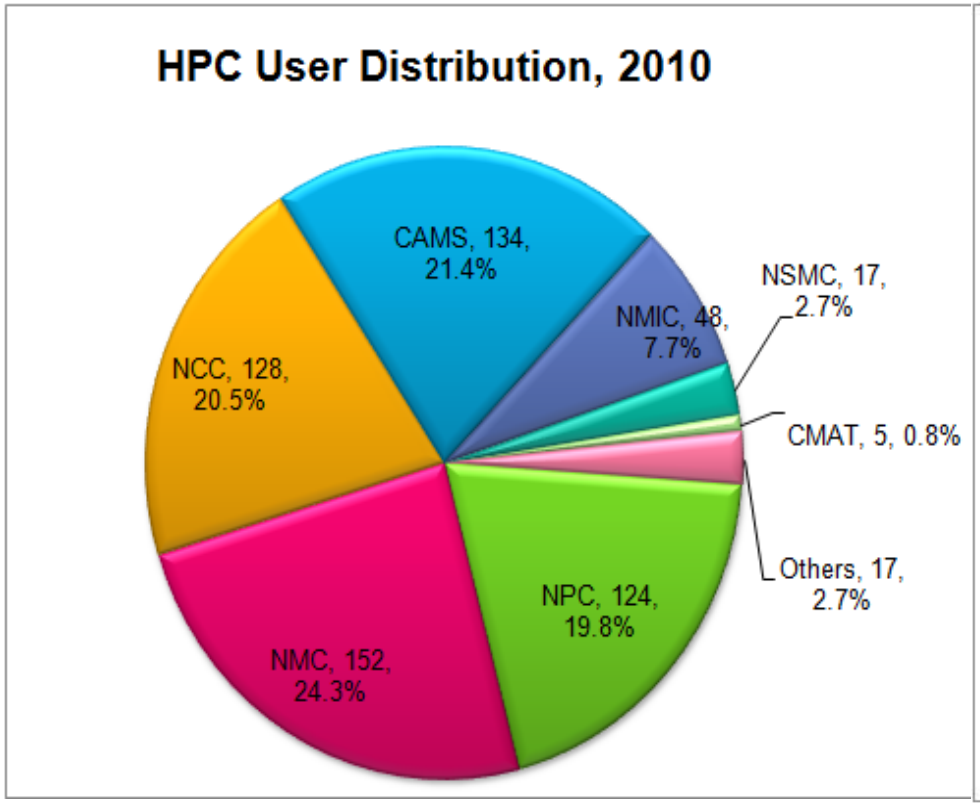
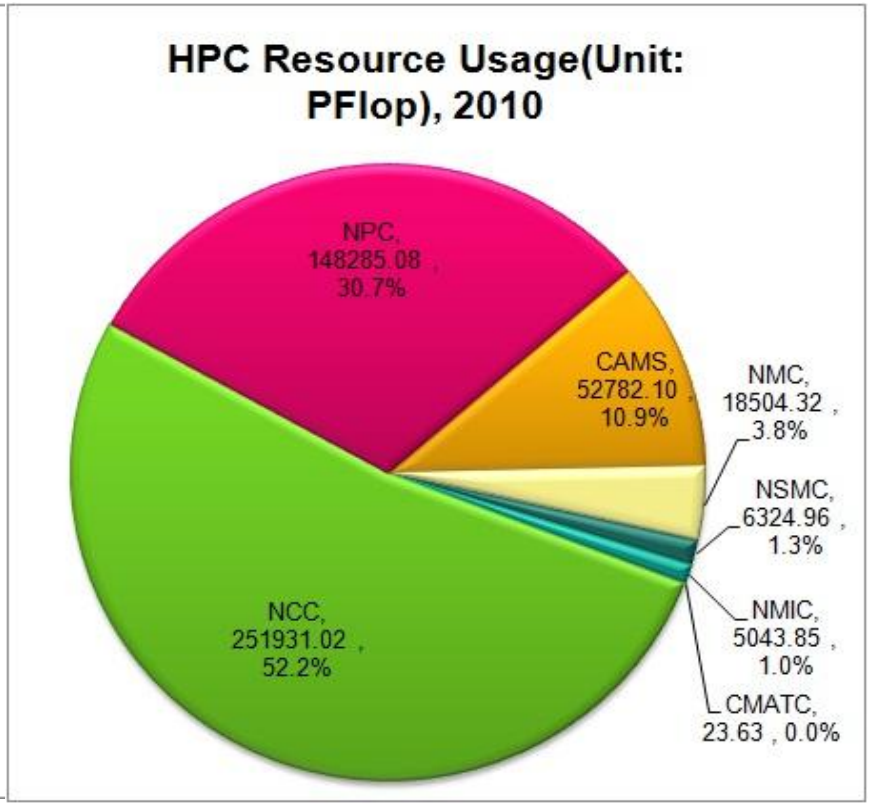
User/Centre





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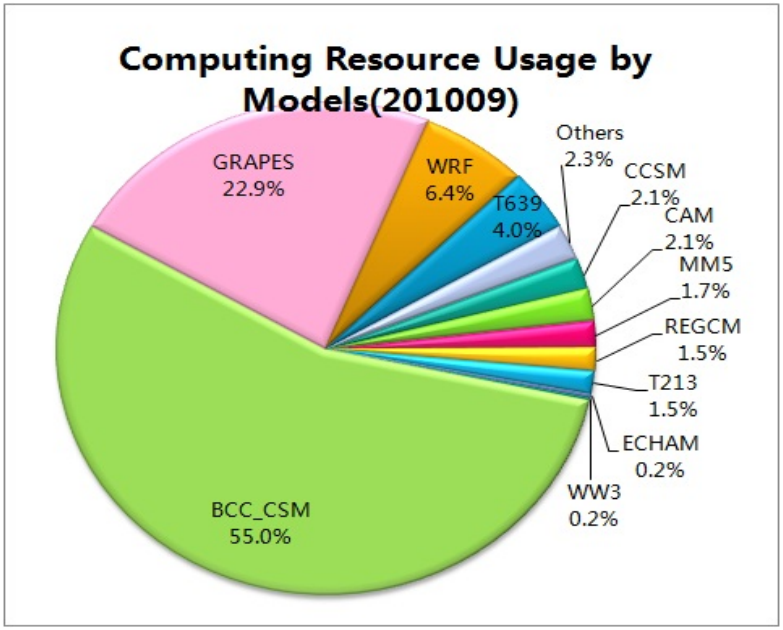
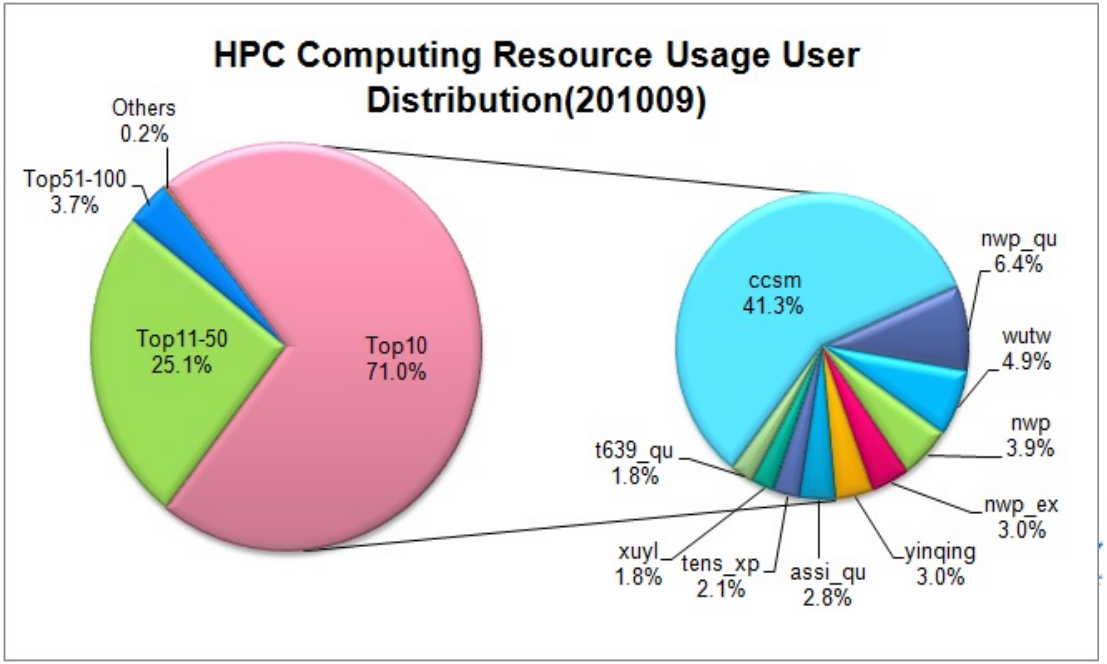
Model/Top user

Resource distribution by model applications

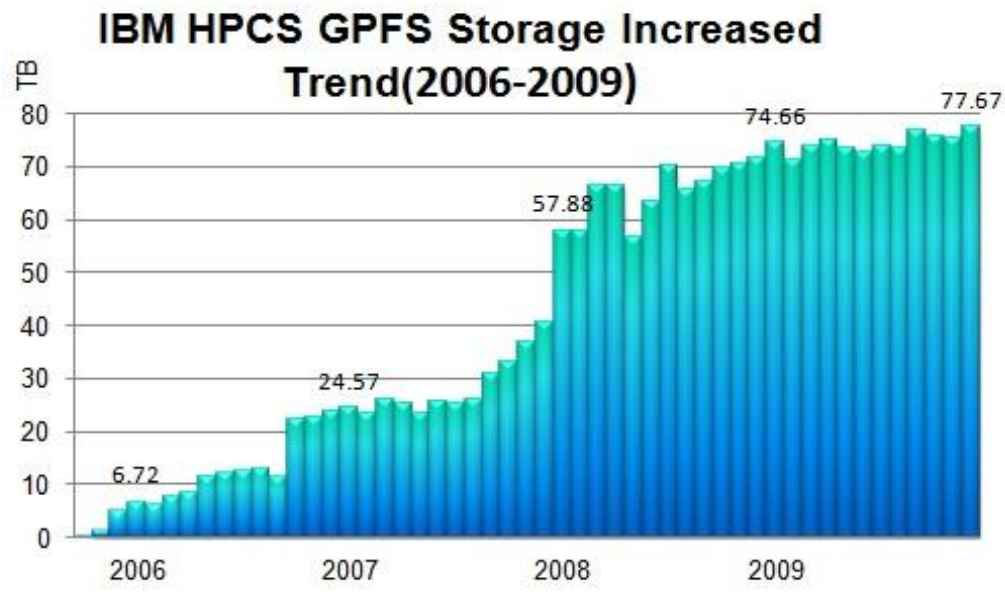


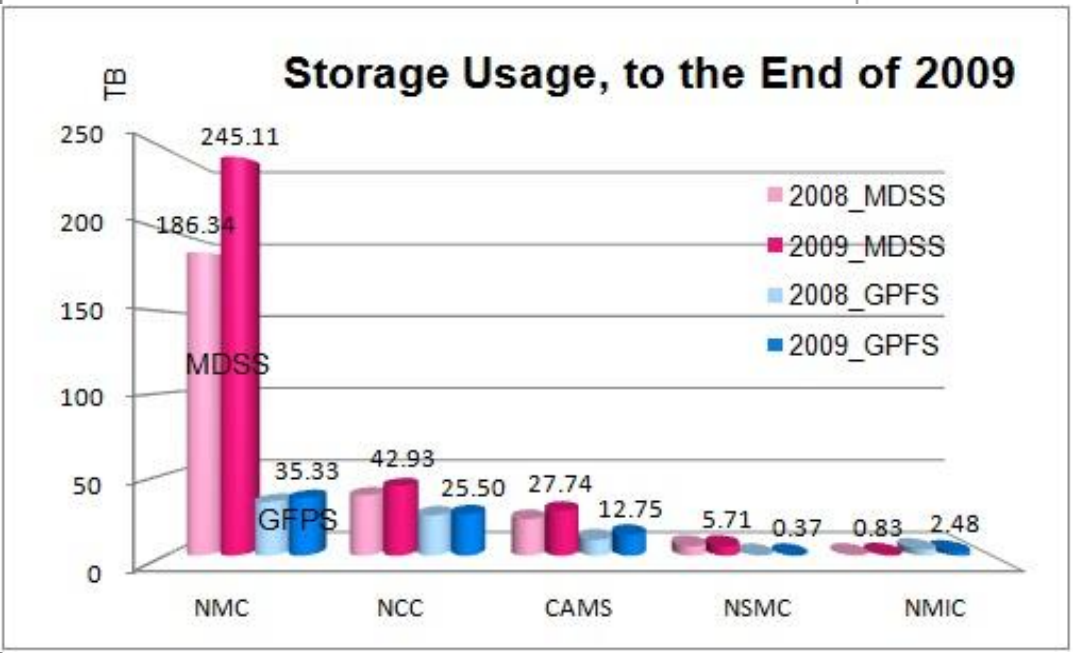
Top 10 user occupy the most resource



Storage Usage

Increased year by year





MDSS more than GPFS
Top 3 centers: NMC/NCC/CAMS

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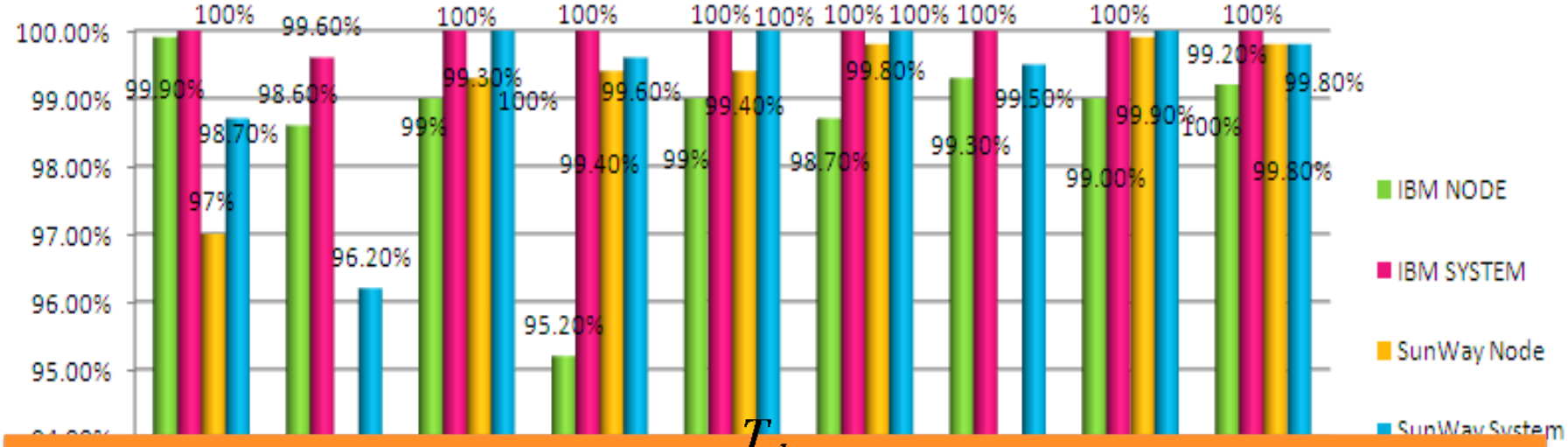
Node & System Availability(2010)



- Availability = $(1-\frac{T_{down}}{60\times 24\times Day})\times 100\%$

  T_{down_system}: Time of more than one nodes halted or the whole system paralyzed (minutes)

  T_{down_node}: Time of only one node halted in system (minutes)

System design

- Multi-cluster system planning and design
- High reliable and available features of components

Health check and real-time monitor

- Daily health check and periodic backup
- Establish a HPC system monitor platform using SMS

Failure diagnosis and treatment

- Immediate response and standard procedures
- Common repair parts preparation
- Failure causes analysis

User Supporting

- New User training
- Special group for user guide and application/compiling support

High

Reliable & Available

System

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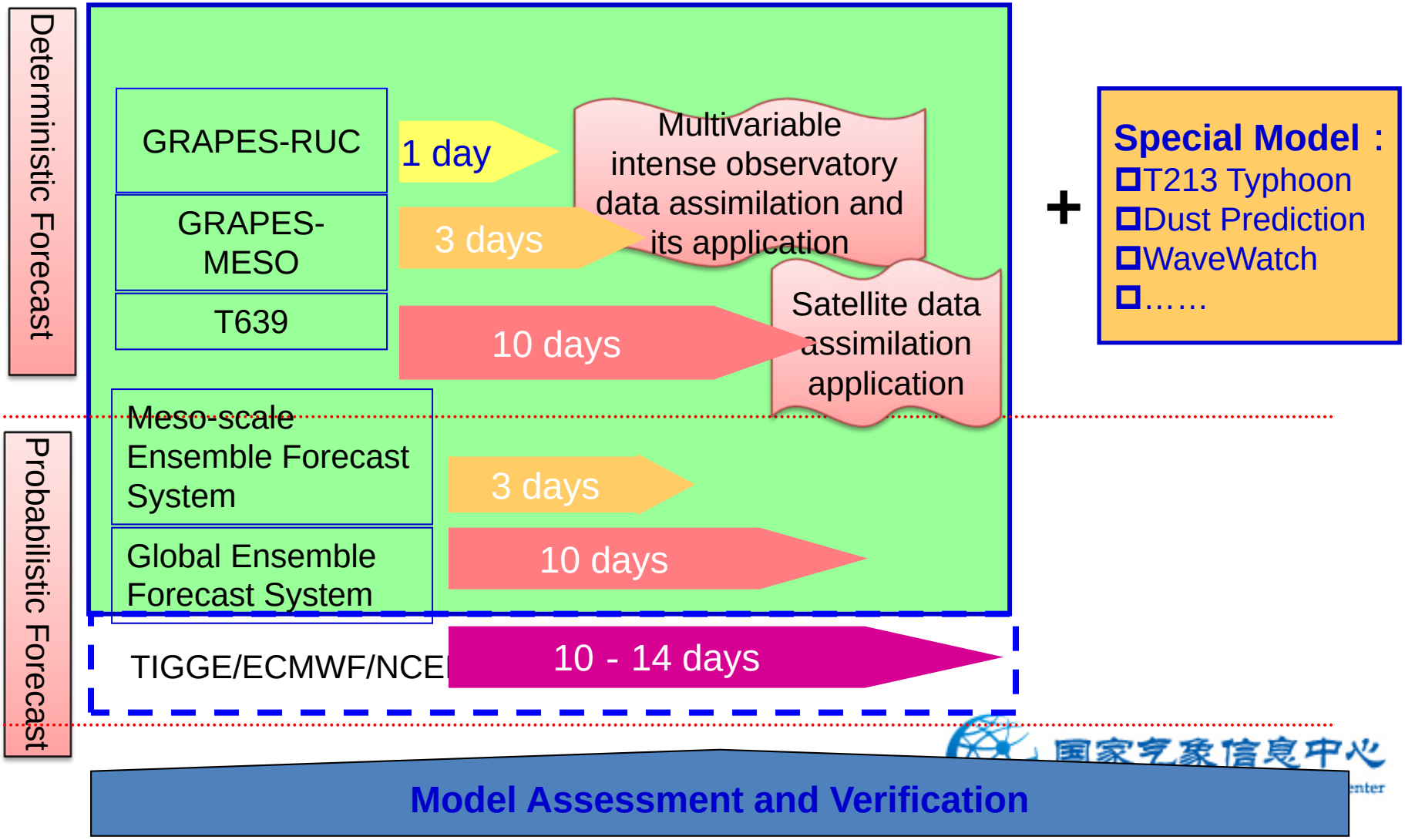
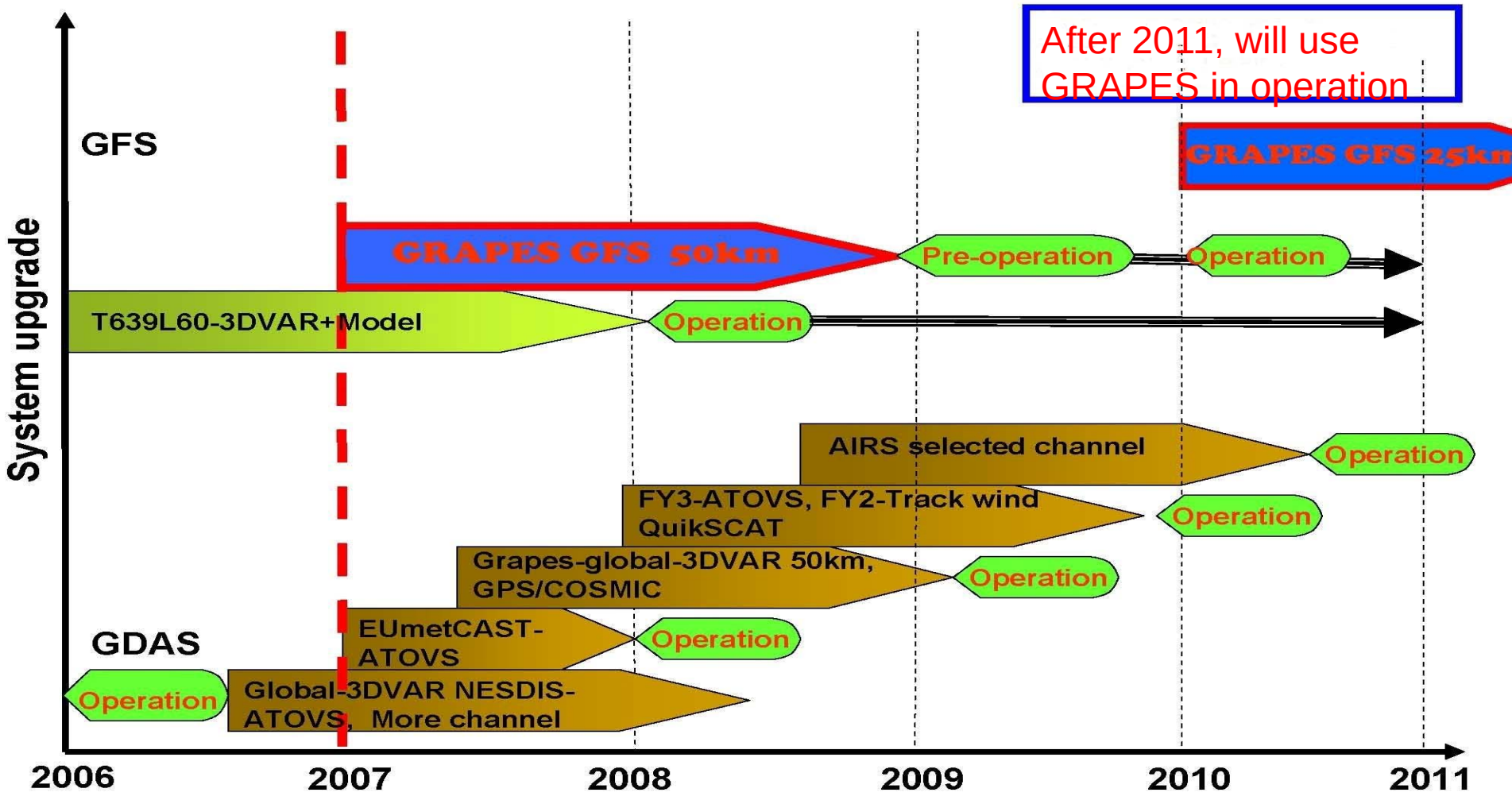
Operational Forecast System



Current NWP Operational models in CMA

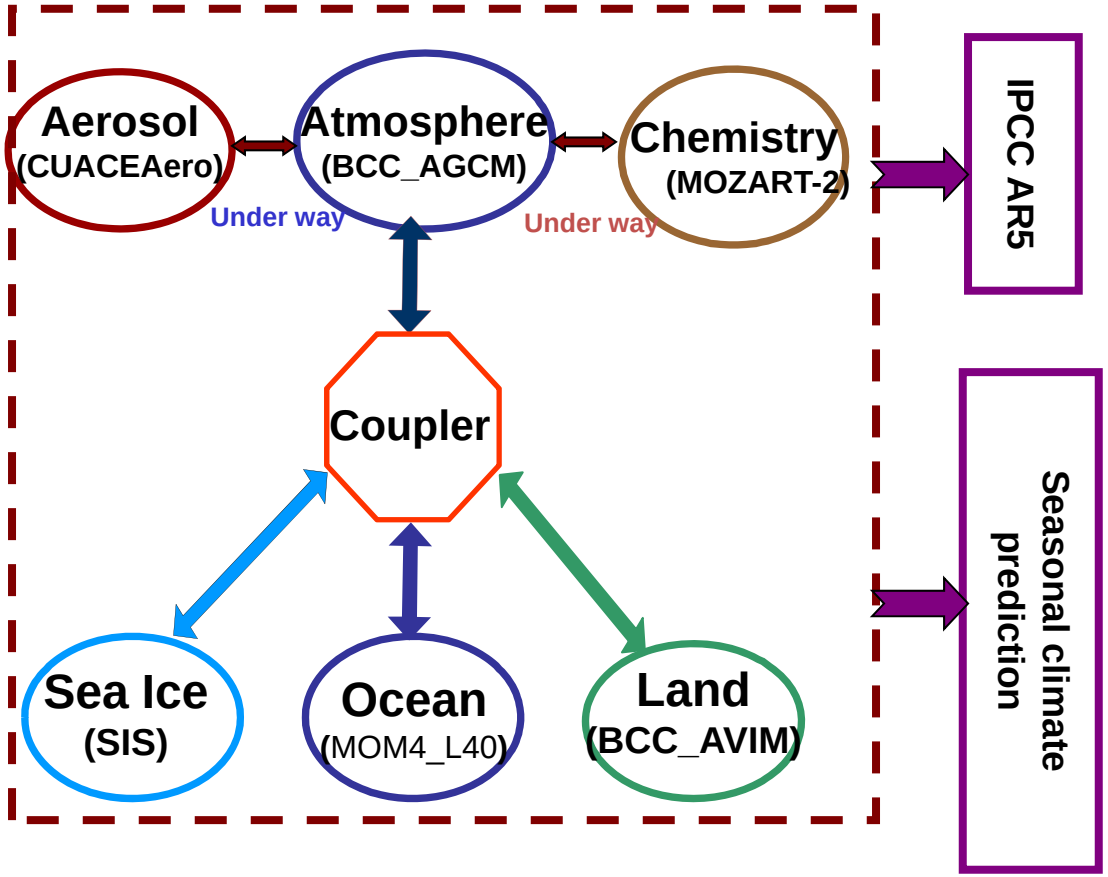
	Global Spectral Model (T_L639L60)	Meso Scale Model (GRAPES_Meso)	10day Ensemble (T_L213L31)	Typhoon deterministic & Ensemble forecast
Forecast range	Short- and Medium-range forecast	Rainfall forecast Short-range forecast	10day forecast	Typhoon forecast
Forecast domain	Global	East Asia (8340km x 5480km)	Global	
Horizontal resolution	T_L639(0.28125 deg)	15km	T213(0.5625 deg)	
Vertical levels / Top	60 0.1 hPa	31 10hPa	31 10 hPa	
Forecast Hours (Initial time)	240 hours (00、12 UTC)	72 hours (00, 12UTC)	240 hours (00、12 UTC) 15 members	120 hours (00, 06, 12, 18 UTC) 120 hours (00、12 UTC) 15 members
Step Time	600sec	90sec	600sec with ensemble perturbations Perturbations are produced by Breeding-method	

Evolution of CMA global forecast system



Beijing Climate Center Climate System Model (BCC_CSM)

BCC_CSM1.1 = BCC_AGCM2.1 + BCC_AVIM1.0 + MOM4_L40 + SIS



BCC_AGCM2.0 (T42L26):

Originated from CAM3.

Developed by BCC.

Model Dynamics: Wu et al.(2008, *J.Atmos.Sci.*)

Model Physics：Wu et al. (2010, *Climate Dynamics*)

BCC_AVIM1.0:

Developed by BCC.

Coupled with the dynamic vegetation and land carbon cycle processes.

MOM4_L40 (gx1v1):

Developed by GFDL.

Modified by BCC.

A carbon cycle module (from OCMIP2) with simple biogeochemical processes was introduced.

SIS(gx1v1):

Developed by GFDL.

Future Plan & Work

- New building
- HPC system
  - Tens of TFLOPS → PetaFLOPS in 5 years
- Storage System
  - HPSS…
    - NWP & Climate

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GRAPES model

- Global forecast

  GRAPES_GFS（4DVAR）
- Meso forecast

  GRAPES_Meso（4DVAR）
- Global ensemble forecast

  GRAPES_GFS based on SV
- Regional ensemble forecast

  GRAPES_Meso：SV+stochastic physics
- Global typhoon track forecast

  based on GRAPES_GFS
- GRAPES_RUC

Climate Model

- To develop the climate system model BCC_CSM2
- To establish the operational Dynamical Climate Model Prediction System (DCMPS2)
- To develop high resolution BCC_AGCM4 (T266L40, 0.45ox0.45o)
- To develop the Earth System Model BCC_ESM (T42L26)

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