Grid Computing
for LHC Experiments in China

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On Behalf of IHEP Computing Center

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Outline
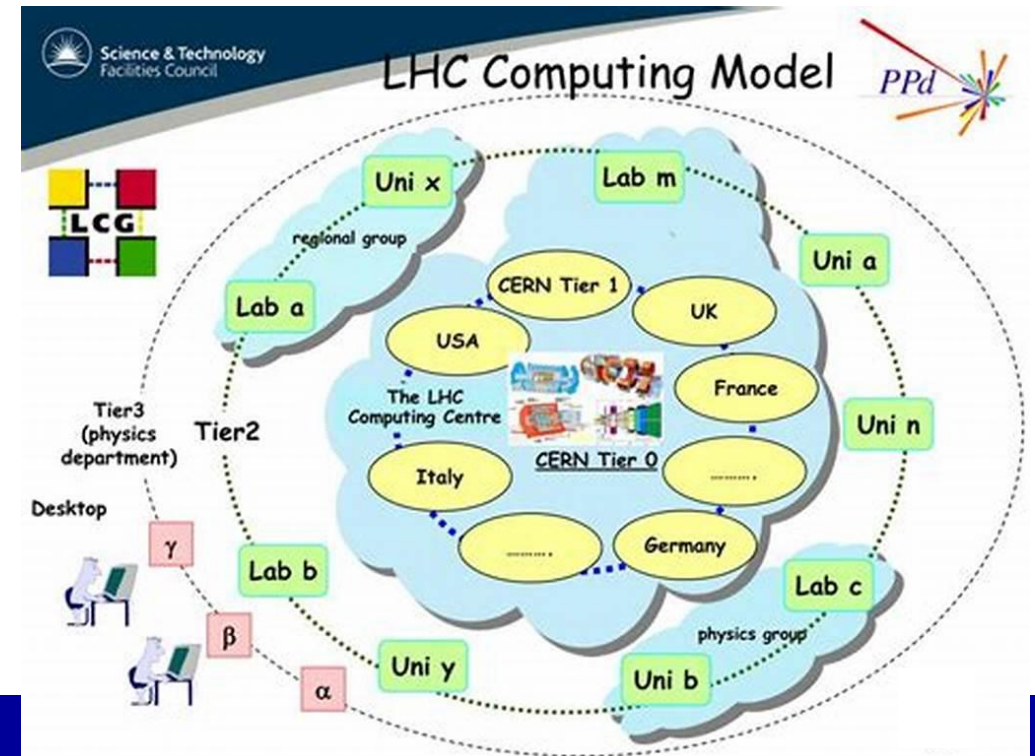
Overview of WLCG Sites in China (1)

- WLCG (The Worldwide LHC Computing Grid)
  - A global collaboration of around 170 computing centers in more than 40 countries
- The history of Chinese WLCG site started in 2006
  - In 2006, IHEP signed the Memorandum of Cooperation with WLCG to build tier-2 sites for ATLAS and CMS
  - In 2018, Chinese LHCb collaboration built Beijing Tier2 site and deployed in IHEP
 - In 2023, the LHCb tier-1 site started construction in IHEP

Overview of WLCG Sites in China (2)
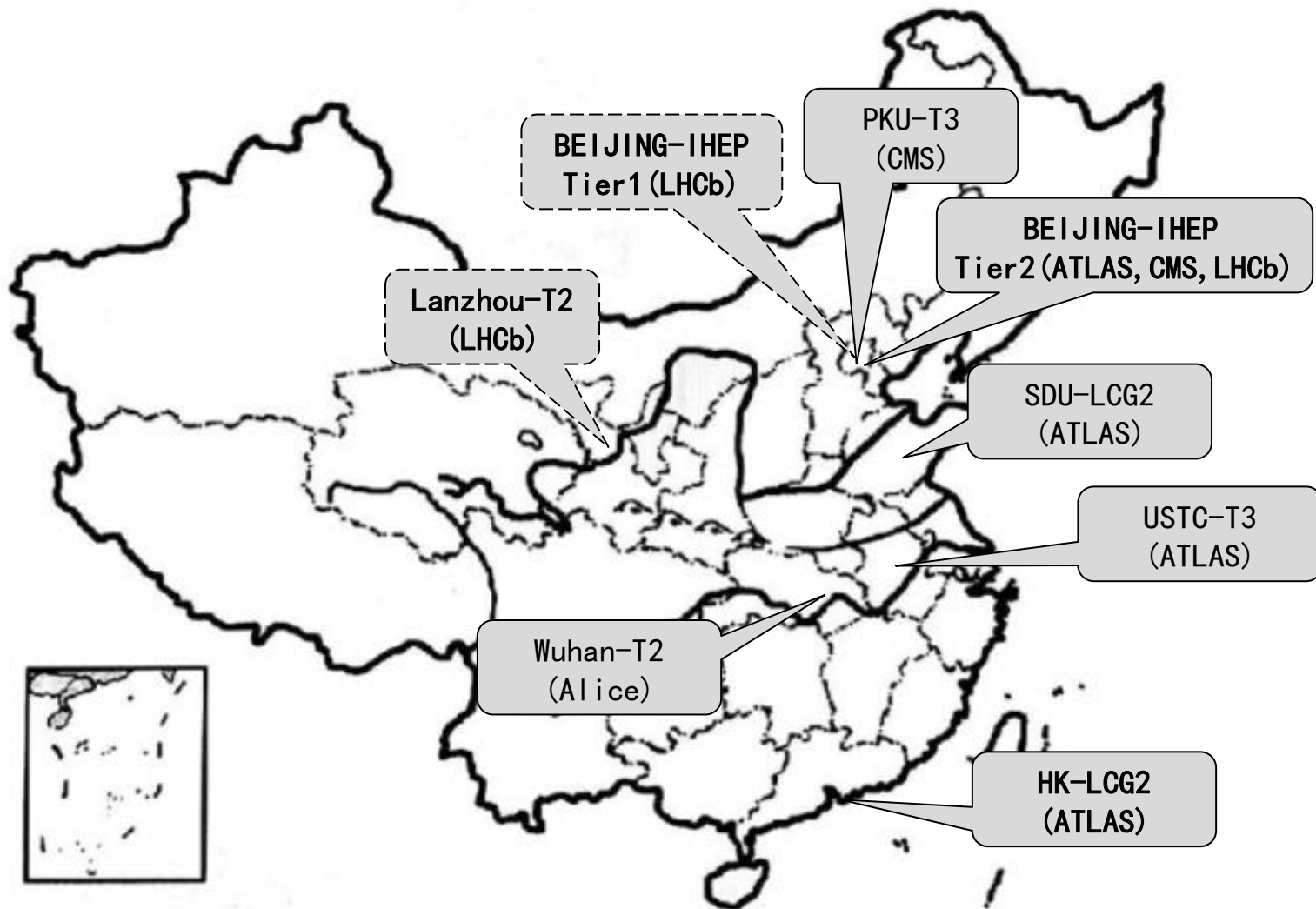
LHCb Tier1 Site Construction (1)

- Chinese LHCb collaboration and IHEP CC decided to construct the tier-1 site in last October

  - Officially got approved from WLCG in last December

- All the hardware is ready

  - Computing: 3216 CPU cores, 40 worker nodes (Intel & AMD)

  - Disk storage: ~3.2PB, 4 sets of storage array

  - Tape storage: ~3PB, 170 tapes, 4 drivers (IBM)

  - Network equipment: 6 switches, 1 router, 2 band cards

  - Management servers: 10 servers

- Currently the tier-1 site is also reusing part of existing hardware

  - Firewall device, tape library, CA system, …

- The network capacity for LHCOPN and LHCONE is ready

  - 20 Gbps bandwidth for LHCOPN
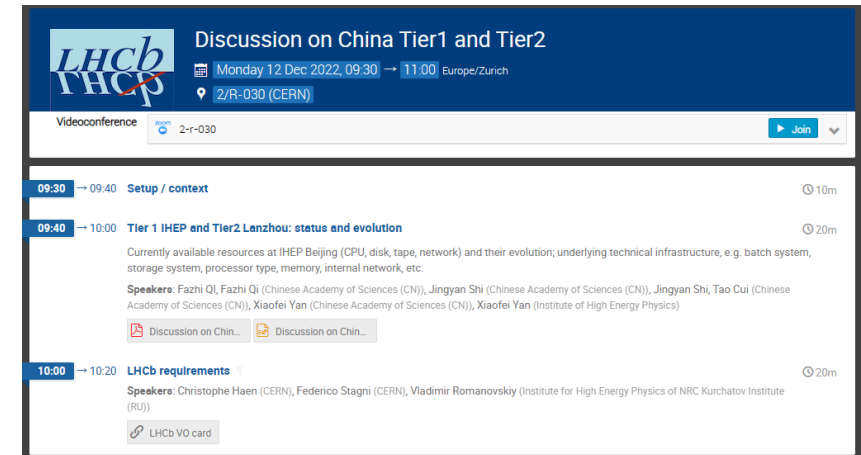
LHCb Tier1 Site Construction (2)

- ## Disk storage: EOS
    - services: QuarkDB, MGM, FST
    - protocol: xrootd and http

- ## Tape storage: EOS & EOS-CTA
    - Protocols: xrootd and http

- ## CE: HTCondor-CE & HTCondor
    - Support for SCIToken and GSI

- ## Other middle software
    - Argus, BDII, APEL
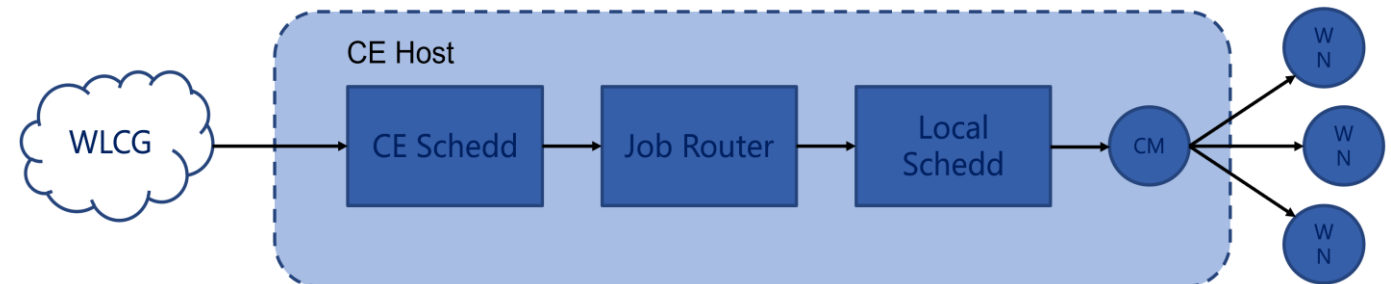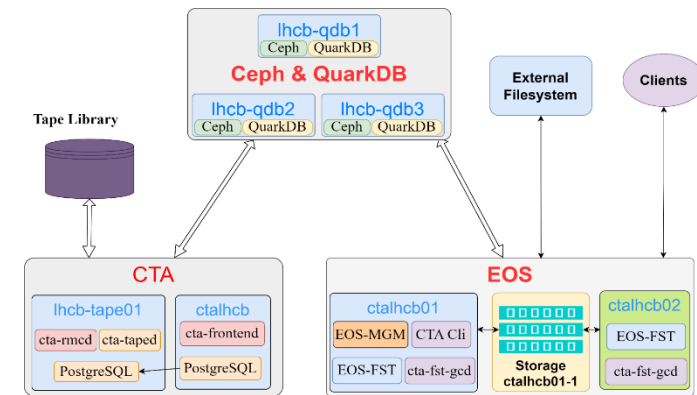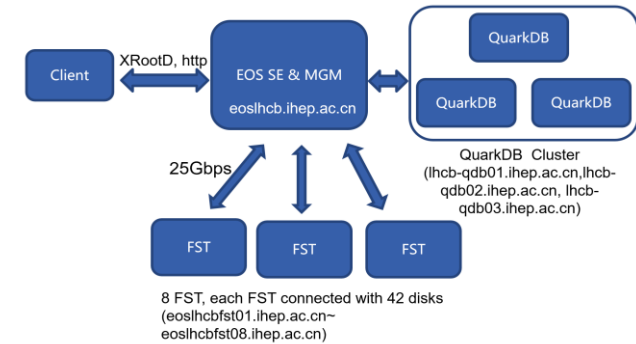
Chinese Tier-2 Site Federation (1)

- **CPU: 4232 cores**
  - Intel Golden 6338: 1152 Cores
  - Intel Golden 6238R: 672 Cores
  - Intel Golden 6140: 2160 Cores
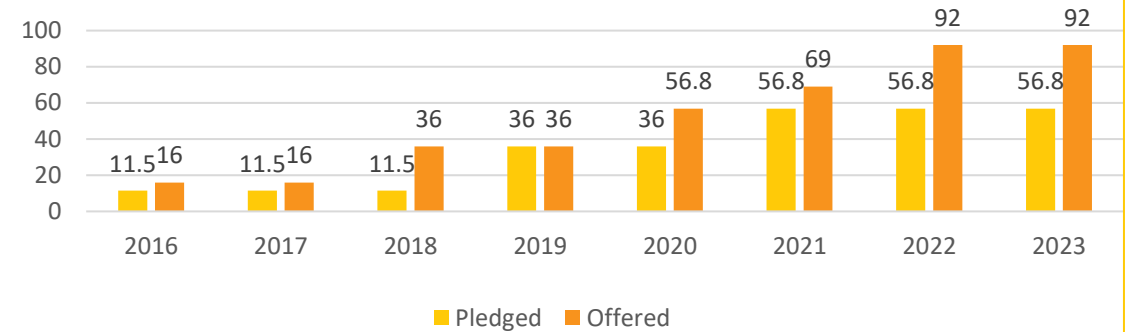 - Intel E5-2680V3: 696 Cores
  - Intel X5650: 192 Cores
- **CE & Batch: HTCondorCE & HTCondor**
- **VO: ATLAS, CMS, LHCb, BelleII, JUNO, CEPC**

CPU (HEP-SPEC06X1000)

Year	Pledged	Offered
2016	11.5	16
2017	11.5	16
2018	11.5	36
2019	36	36
2020	36	56.8
2021	56.8	69
2022	56.8	92
2023	56.8	92

- **Storage: 1750TB**
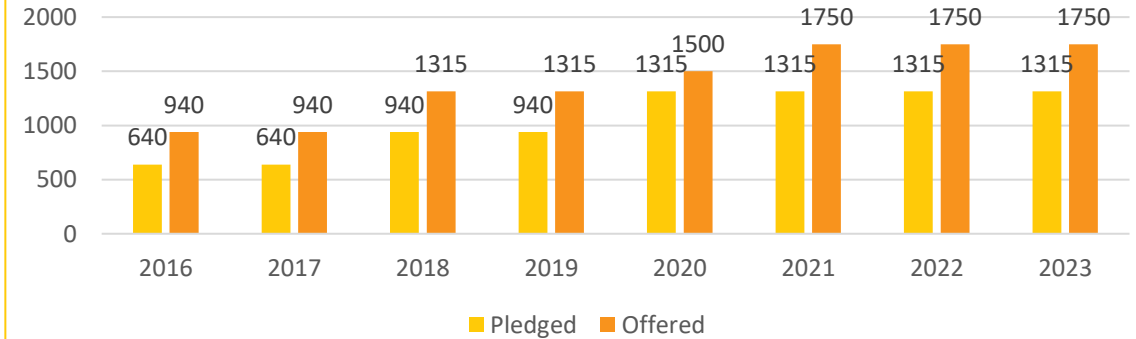 - 4TB * 24 slots with Raid 6, 5 Array boxes
  - DELL MD3860 8TB * 60 slots
  - DELL ME4084 10TB * 42 slots
  - DELL ME4084 12TB * 84 slots

DISK (TBytes)

| Year	Pledged	Offered
2016	640	940
2017	640	940
2018	940	1315
2019	940	1315
2020	1315	1500
2021	1315	1750
2022	1315	1750
2023	1315	1750

Chinese Tier-2 Site Federation (2)

- ALL the three sites in IHEP are running stable

  - Site reliability is > 99%

- The contribution from ATLAS tier-2 site

  - Computing contribution: 178.4k jobs and 2.68 million CPU hours

  - Data contribution: 289 TB transfer in and 676 TB transfer out

- The contribution from CMS tier-2 site

  - Computing contribution: 1.23 million jobs and 5.18 million CPU hours

  - Data contribution: 924.53 TB transfer in and 653.9 TB transfer out

- The contribution from LHCb tier-2 site

  - Computing contribution: 1.5 million jobs and 10.2 million CPU hours

  - Data contribution: 118 TB transfer in and 3.47 PB transfer out

# New Site for LHCb in Lanzhou University

- New Tier-2 site is under construction in Lanzhou University

    - ~3500 CPU cores

    - ~3PB Disk Storage

- A dedicated 2Gbps network link between IHEP and LZU

- CC-IHEP will be responsible for software deployment and maintenance

WLCG

Beijing-T1

Lanzhou-T2
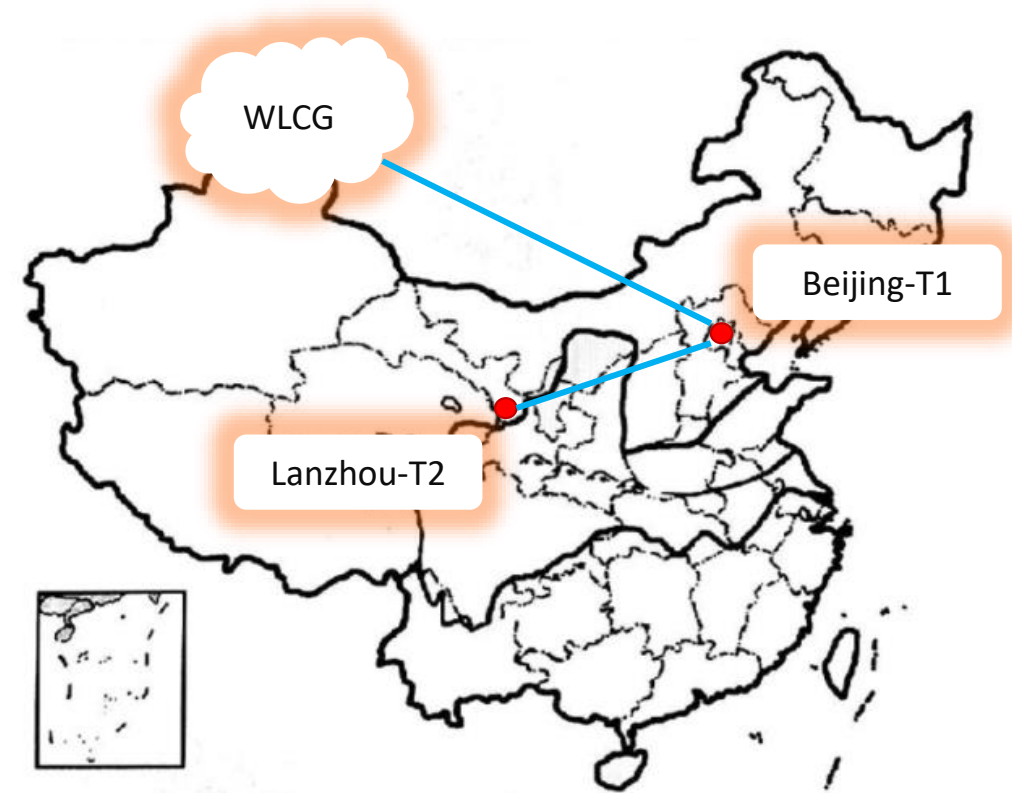
Updates on Network

- A new network link with 100 Gbps bandwidth was established
  - Under the cooperation of CSTNET (CNIC) and IHEPCC
- CN-IHEP is also joining in the LHCOPN
  - LHCOPN is the WLCG Tier0-Tier1 Private Network
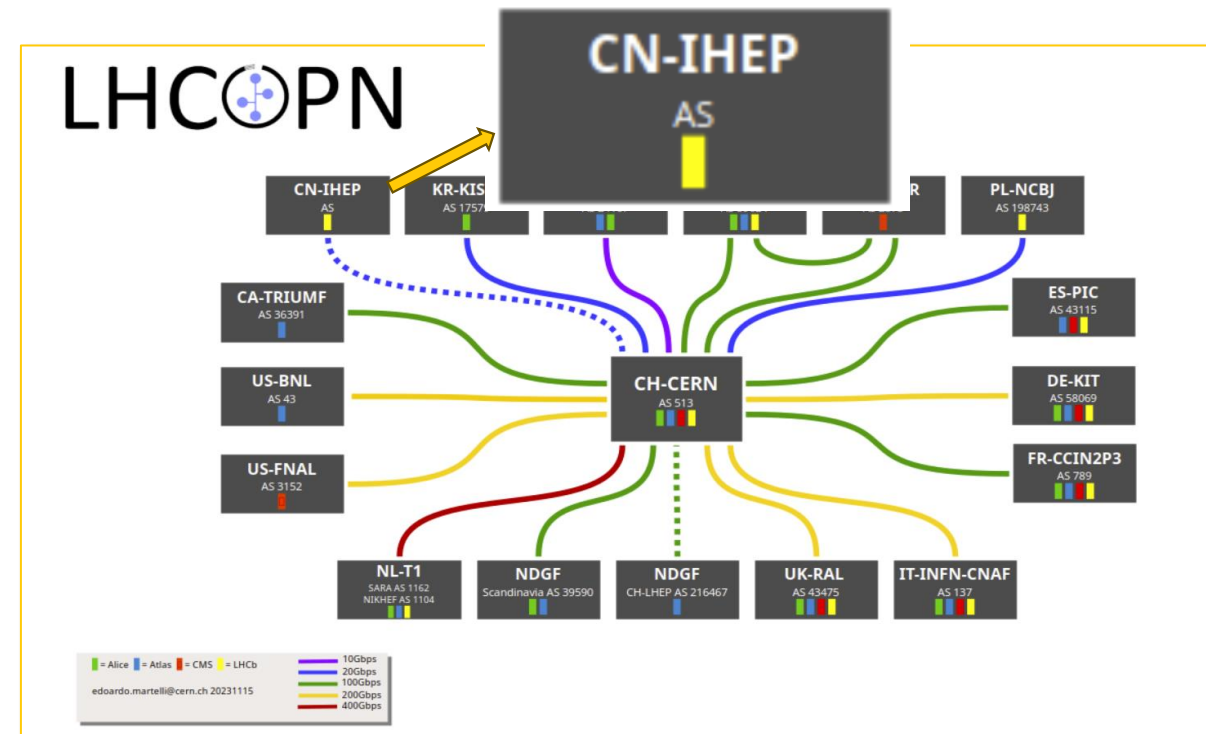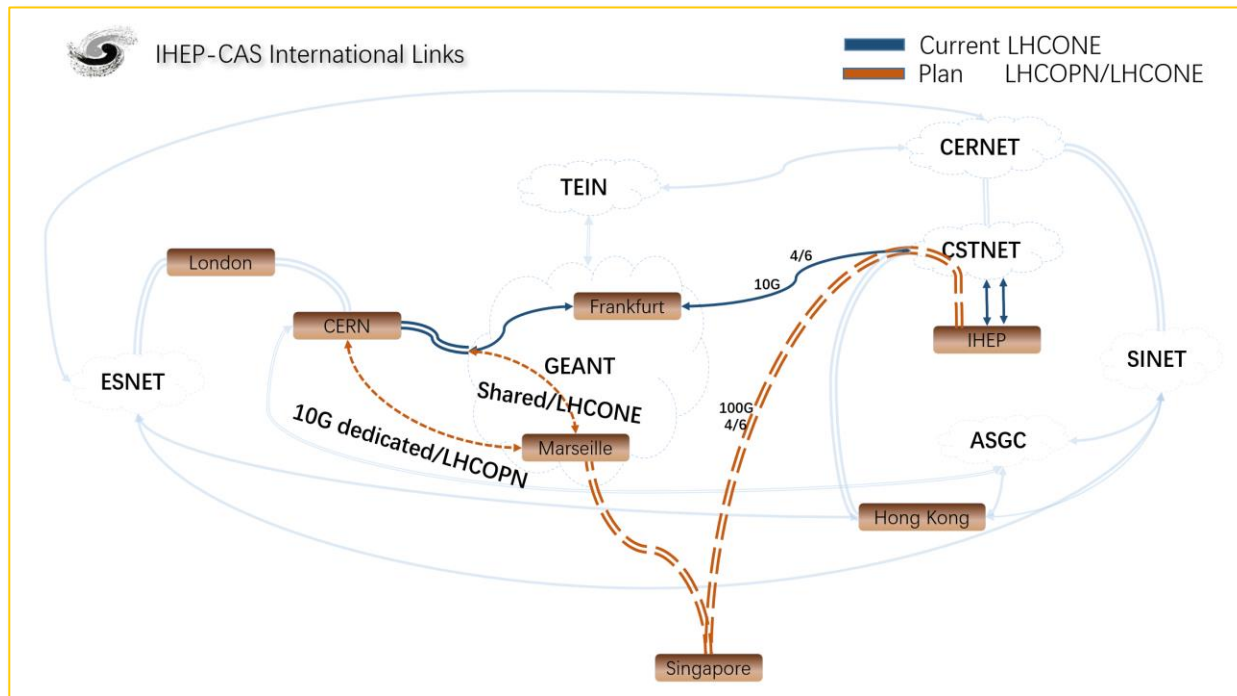
Updates on Storage

- Migrate the storage management system from DPM to EOS
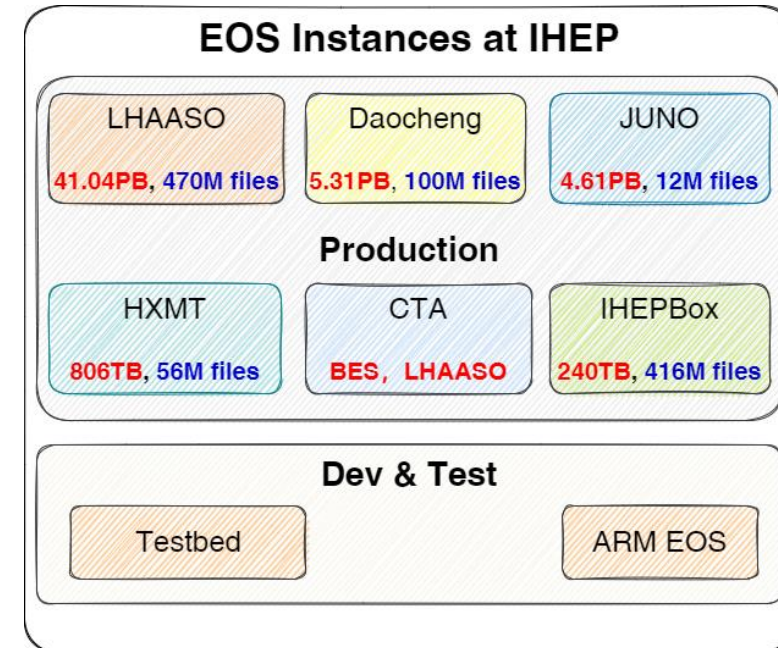
- Why EOS

  - Most new HEP experiments use EOS as main storage

  - IHEP LHCb T1 are using EOS as its storage system

  - EOS is the main storage at CERN

- The migration has been done in May

  - ccsrm.ihep.ac.cn -> cceos.ihep.ac.cn

  - /eos/ihep/atlas

  - /eos/ihep/cms

- New EOS configuration:

  - EOS SE and MGM are deployed on one server

  - Each experiment have an dedicated instance in EOS

EOS Instances at IHEP

LHAASO	Daocheng	JUNO
41.04PB, 470M files	5.31PB, 100M files	4.61PB, 12M files

Production

HXMT	CTA	IHEPBox
806TB, 56M files	BES, LHAASO	240TB, 416M files

Dev & Test

Testbed	ARM EOS

Current Issues

- Part of the devices are quite old and suffers failures

  - Repaired several worker nodes (96 cores) by replacing the problematic components from other retired devices

- The storage space is almost full

  - ATLAS: 400TB 85% Used

  - CMS： 680TB 92% Used

  - LHCB： 250TB 60% Used

- Possible solutions

  - The Chinese LHC collaboration is considering to update the old devices

  - IHEP-CC is trying to apply for projects to support updating the old devices

Plans

- The IHEP tier-1 site and the LZU tier-2 site will go into production

  - Tier-1 site should provide production service before next June

- A possible plan for ALICE tier-2 site

  - The site would be based at IHEP

  - In first phase: ~500 CPU cores and 1 PB storage

Summary

- In the past year, all the WLCG sites are running stably with the cooperation of Chinese LHC collaboration and IHEP Computing Center

- LHCb is building a new tier-1 site in IHEP and a new tier-2 site in Lanzhou university

- A new network link with 100 Gbps bandwidth has been established with the cooperation of CSTNet and IHEP CC

- IHEP CC provides computing services for Chinese LHC collaboration members and if you have any advice or problem on computing, please contact:

  - ATLAS: yanxf@ihep.ac.cn

  - CMS: zhangxuantong@ihep.ac.cn

  - LHCb: jiangxw@ihep.ac.cn

Thanks!

Q&A