CMS Tier 1 Center and Computing for LHC Physics in the U.S.

Fermilab Long Range Planning Committee
Open Meeting on LHC, Sep 4, 2003

Lothar A.T. Bauerdick/Fermilab
U.S. CMS Software and Computing

We got to be ready on day 1!

LHC 2003

Commissioning a…
Early Physics with …

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On Behalf of the CMS Collaboration

The Start-up LHC Scenario

PHASE 1: LHC commissioning (T_0 to T_0 + 4 months)
- LHC: Set-up machine. Start with one beam. Colliding beams and slowly increase # bunches and **L**. Collisions at L > 5 x 10^{32} at 25, 75 ns bunch spacing.
- CMS: Muon halo triggers, catalog detector problems, synchronization, debug data handling, record first collisions
  → This talk part I

+ 2 pileup events i.e. 10^{33} and 25ns bunch spacing

pixel **Phase2: Shutdown**

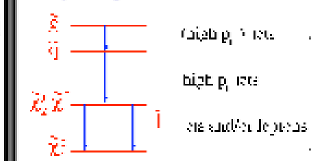
PHASE 3: First physics run (T_0 + 7 mo.→ T_0 + 14 mo.)
- LHC: 25 ns and **L** ~ 10^{33} cm^{-2} s^{-1}
- CMS: Physics run, max. efficiency aiming for 5-10 fb^{-1}
- ~2 events per BX → This talk part II

+ 20 pileup events i.e. 10^{34} and 25ns bunch spacing

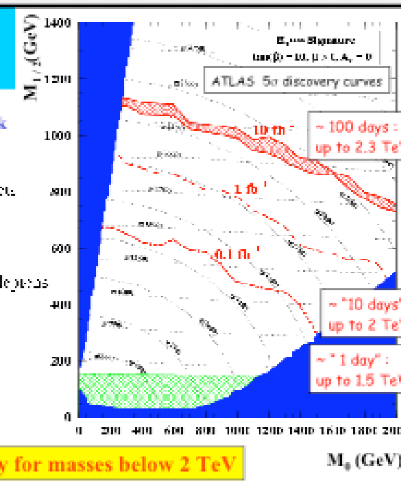
PHASE 4+n: High luminosity running
→ See talk by J.Rohlf on high luminosity

SUSY

Large cross-section for squark and gluino production



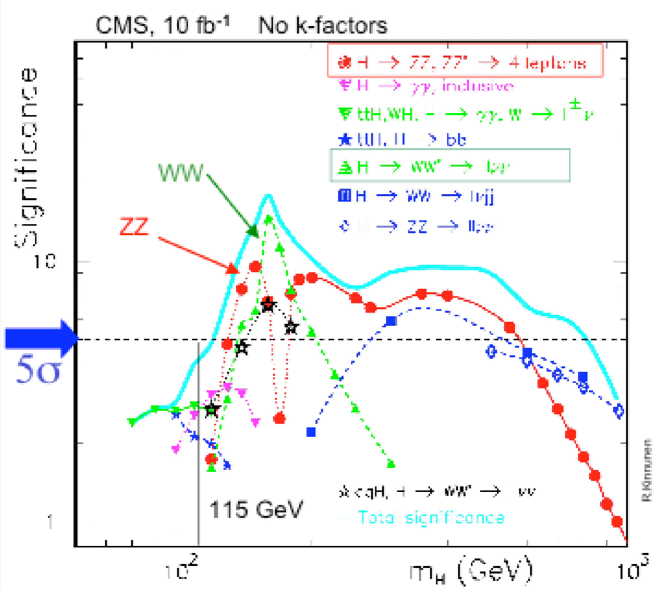
Decay chain leads to
- high p_T jets
- large missing E_T
- isolated leptons



Discovery of SUSY is easy for masses below 2 TeV

May 2nd, 2003 Ivor Fleck ATLAS, Early physics reach

SM Higgs Discovery Potential with 10 fb^{-1}



In the following:

H → 4 leptons, m_H = 120….500 GeV

H → WW → lνlν m_H = 110….200 GeV

K.Hoepfner, RWTH Aachen Early Physics with CMS, LHC Symposium May 2003 24

Conclusions

- Commissioning of detector challenging
- procedures are being developed now
- within first days:
  - Alignment of central detector using muon tracks to < 2 mm
  - Calibration of EM using Z → ee to 0.6 %
- Impact of staging: Need ~ 10 - 15 % more integrated luminosity

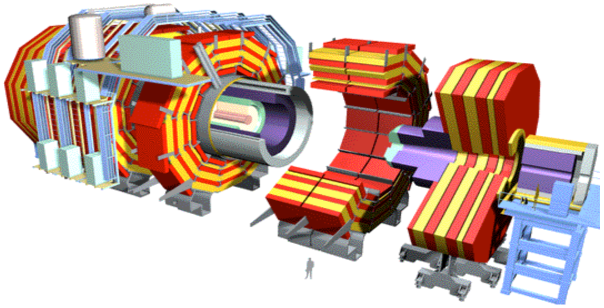
Physics results within first year:
- Higgs boson may be discovered over full mass range (low mass region very challenging)
- MSSM Higgs likely to be seen
- LHC is factory for SUSY particles, discovery immediately first year reach is squark masses up to 2 TeV

Looking forward to many interesting physics analyses

May 2nd, 2003 Ivor Fleck ATLAS, Early physics reach

And We Want to be Ready in the U.S.

Physics Analysis requires Information Technology and Computing Infrastructure



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—> Need an advanced coherent global "Information-Infrastructure"

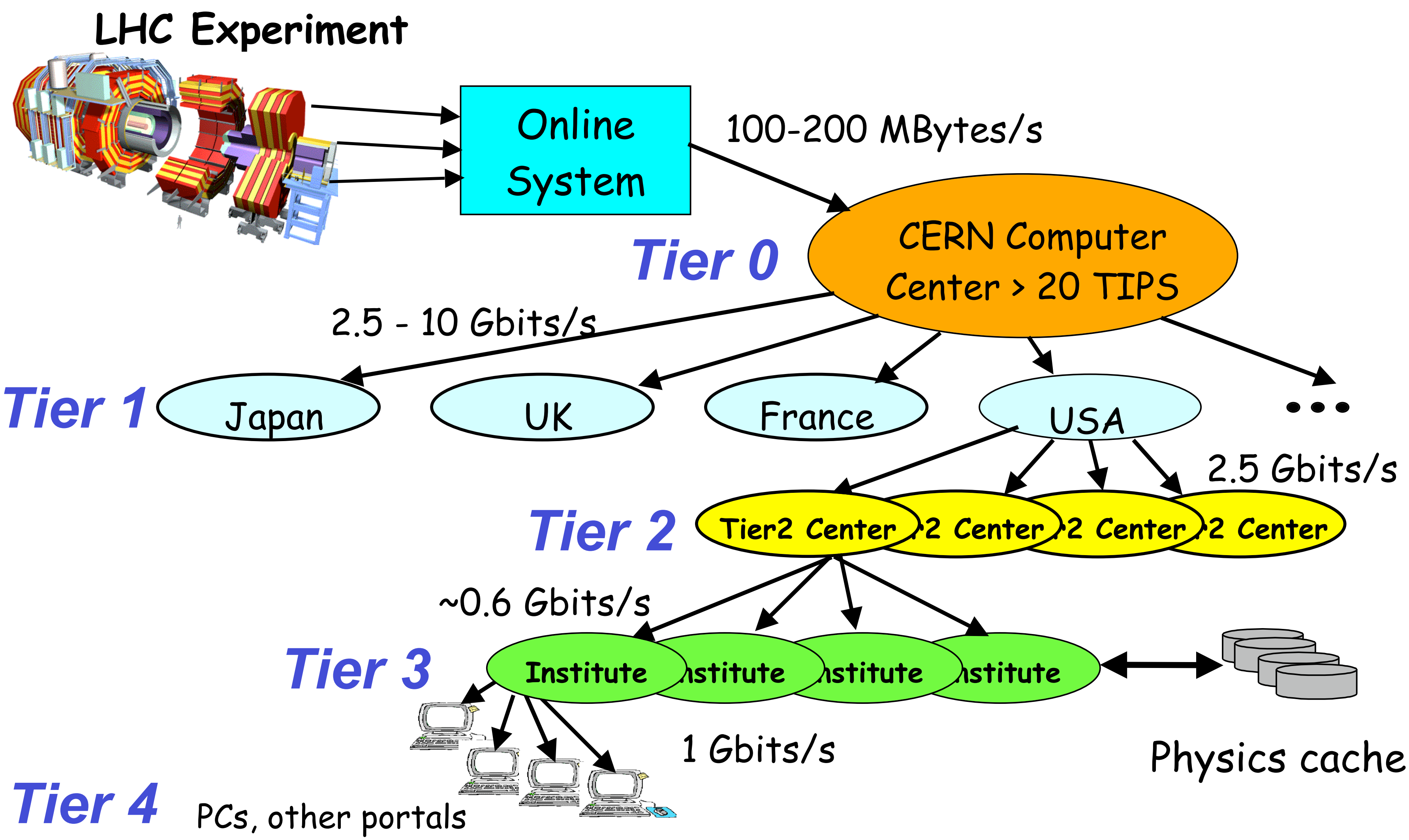
International and Interdisciplinary Partnerships

US LHC: Empower the LHC Scientists at Universities and Labs to do Research on LHC

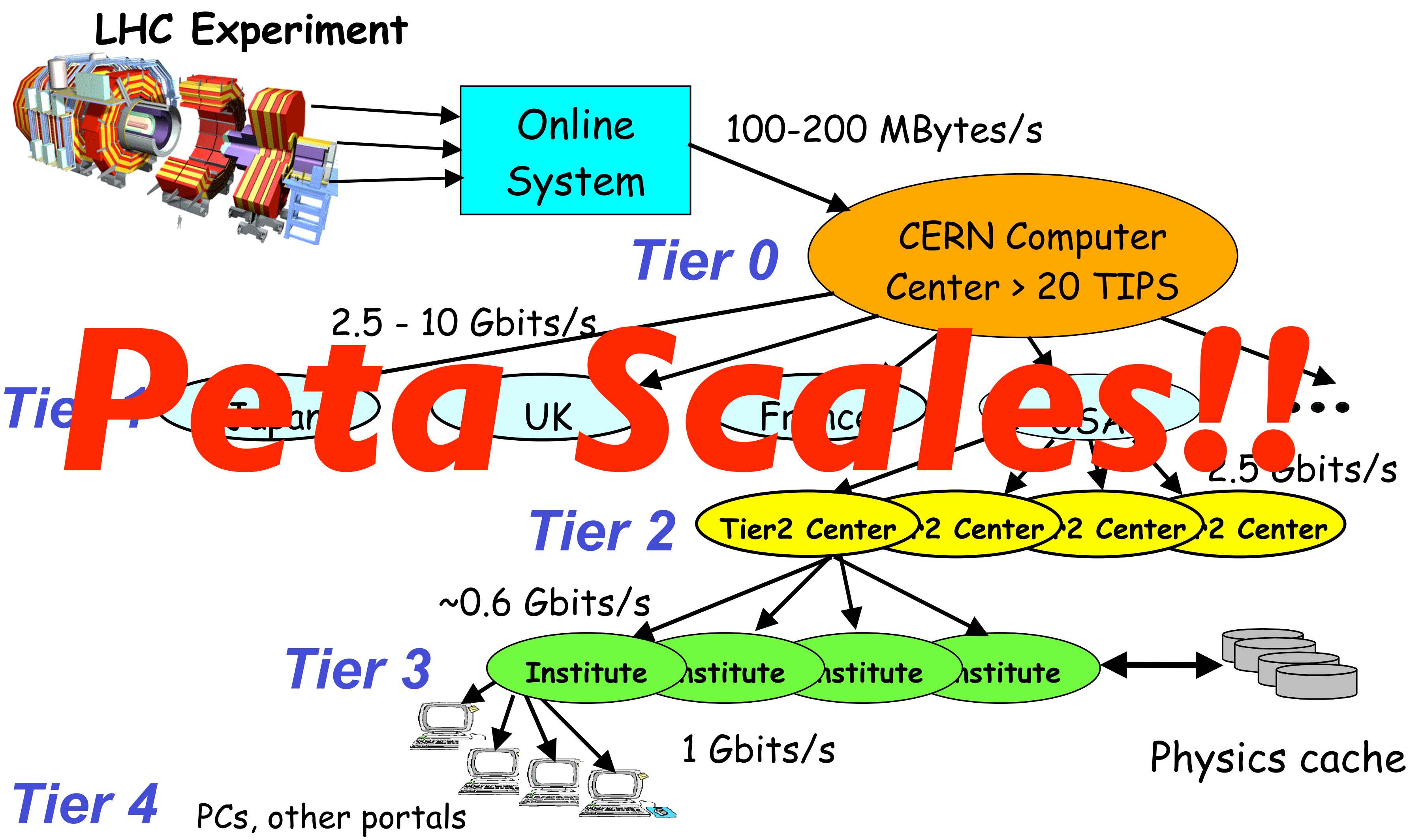
This is why we are pushing Grids and other Enabling Technology

e.g. Gigabit/sec access through WAN may well change the way we will do Analysis

LHC Computing Resources



LHC Computing Resources

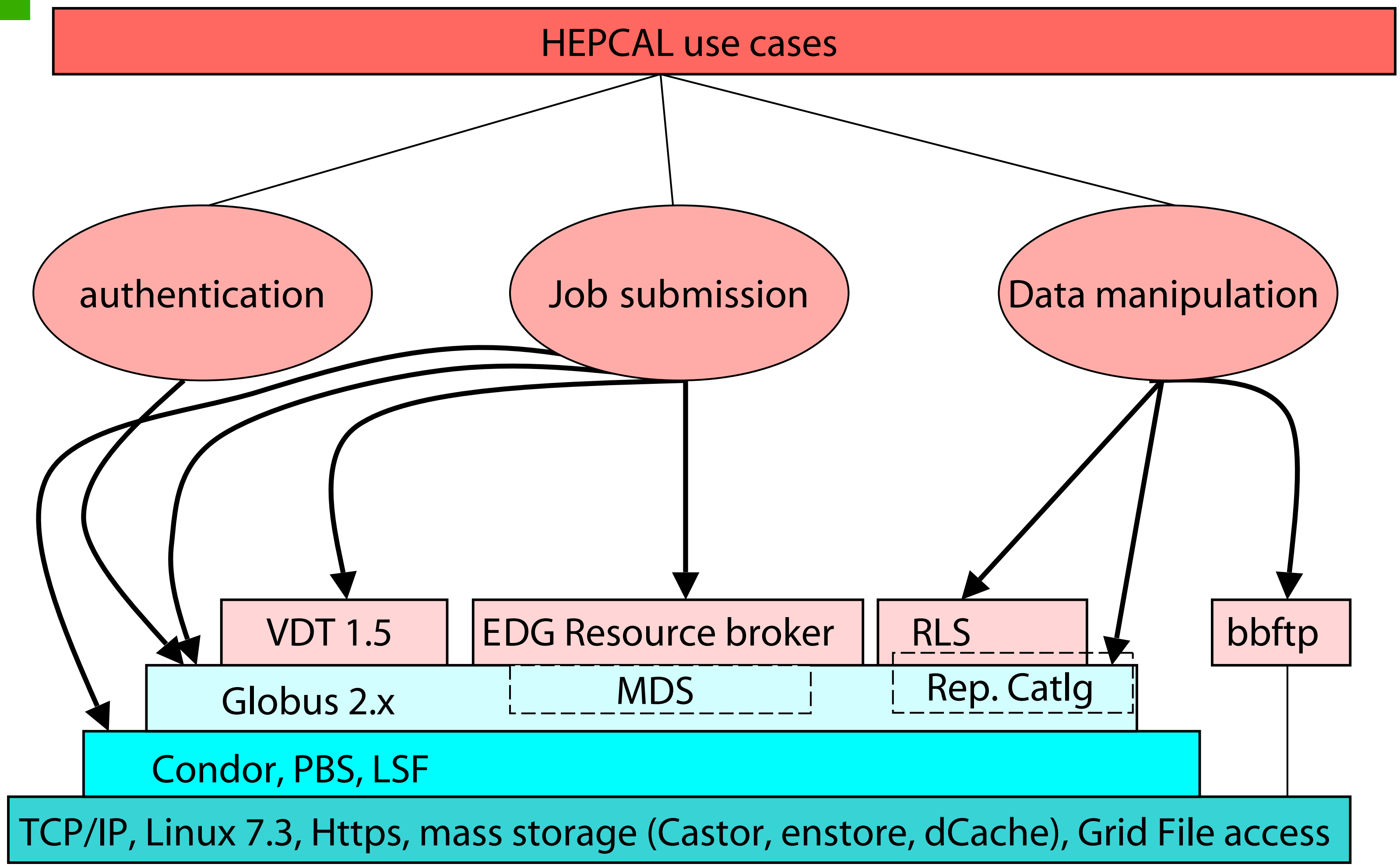


Building a Production-Quality Grid

We need make Grid work, large resources become available to experiments

Distributed Data Analysis

- architecture, engineering and development, testing and integration
- detailed Work on middleware and distributed system architecture



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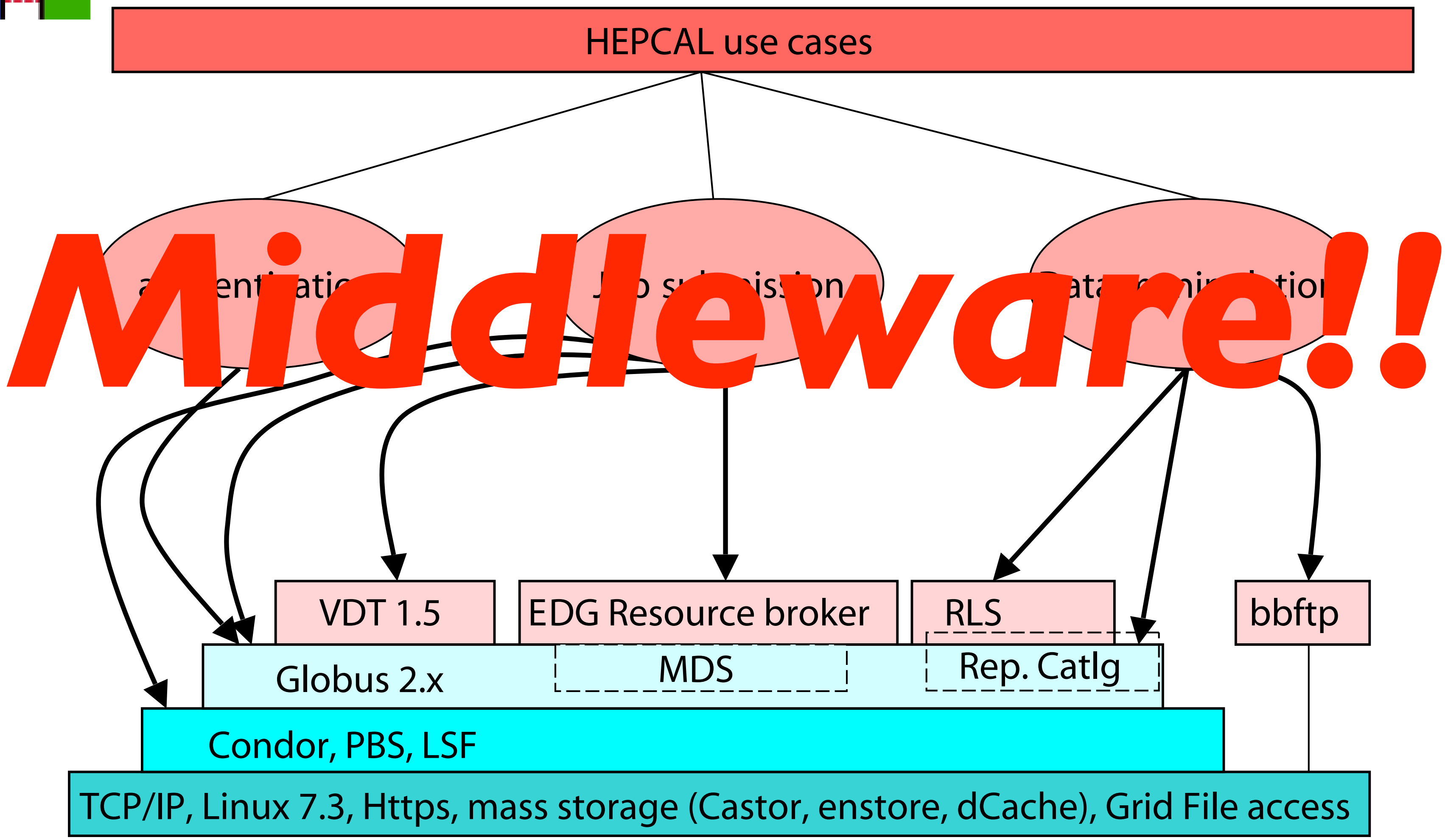
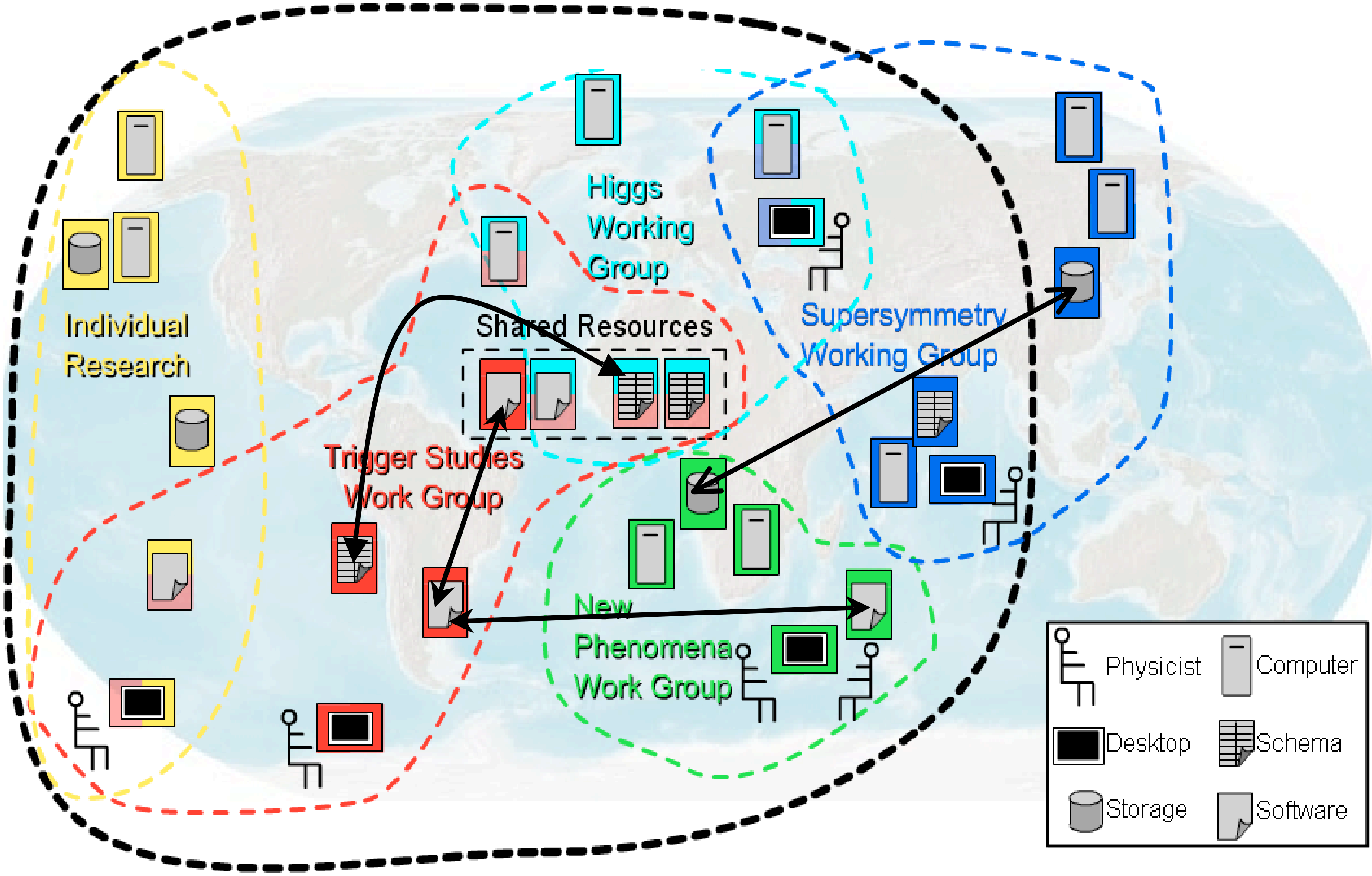


How will Communities of Scientists Work Locally Using the Global Grid

Infrastructure for sharing, consistency of physics and calibration data, software



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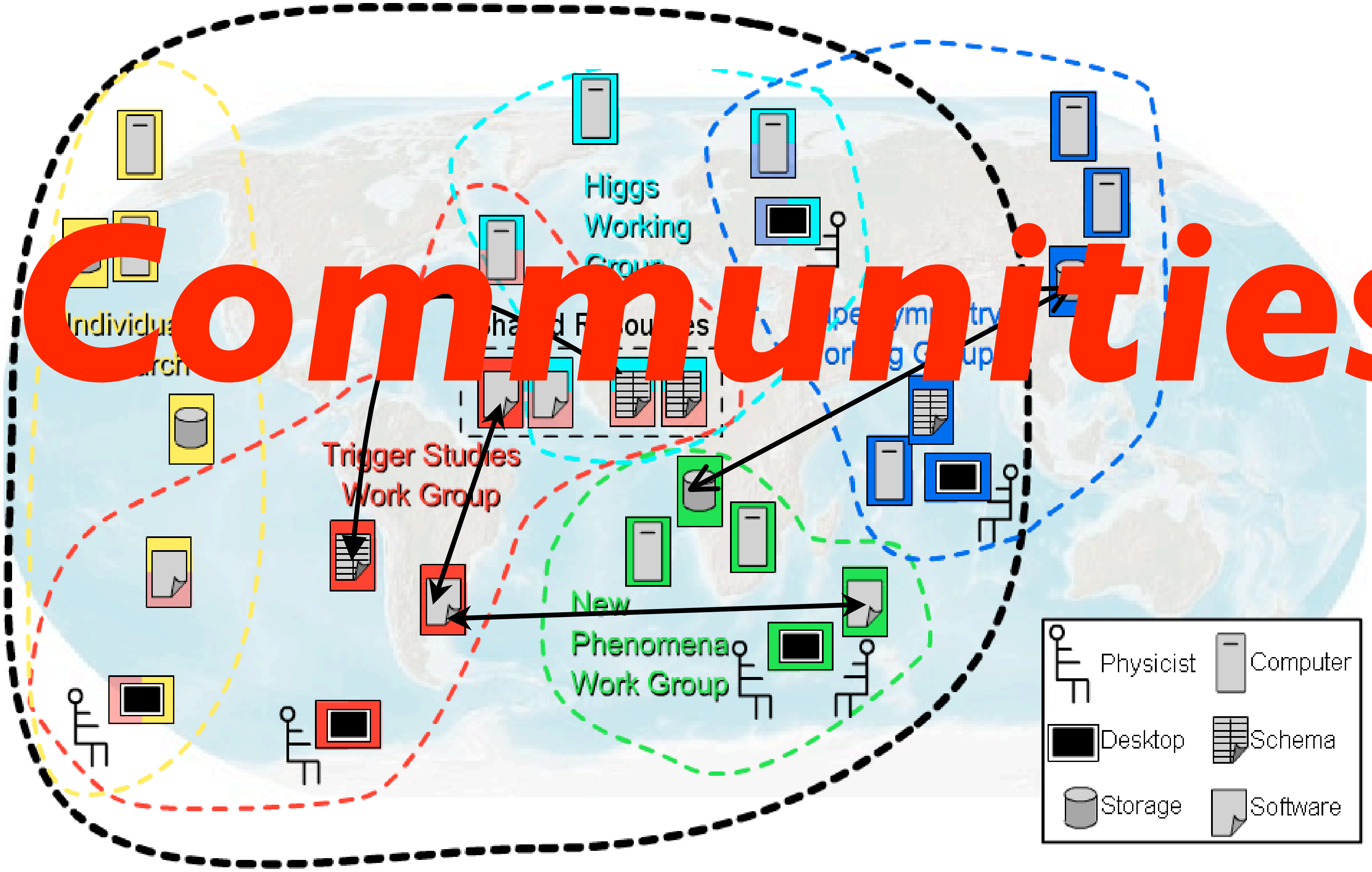
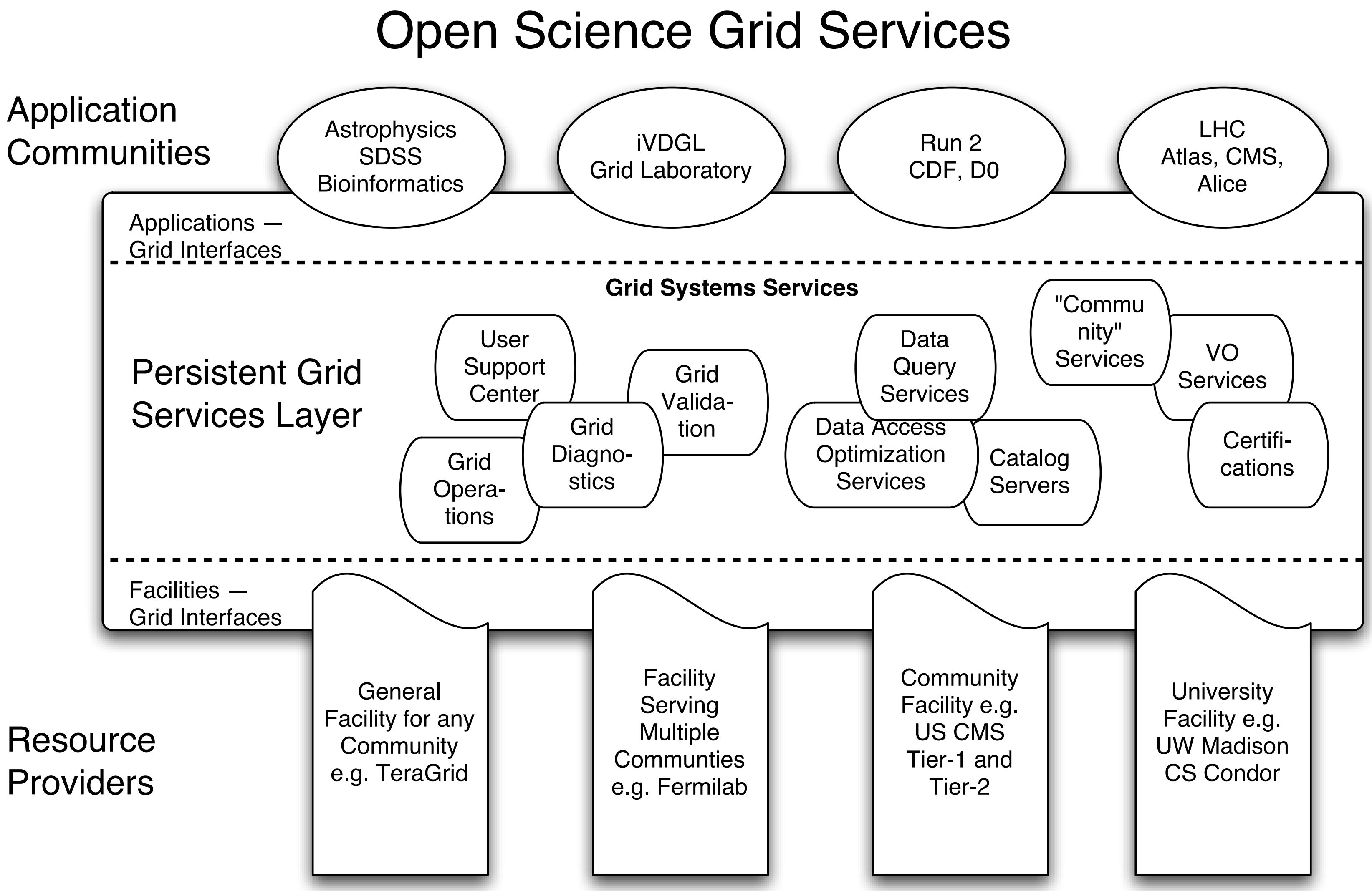


Grid Services Infrastructure

Grid Layer “Abstraction” of Facilities — Rich with Services!



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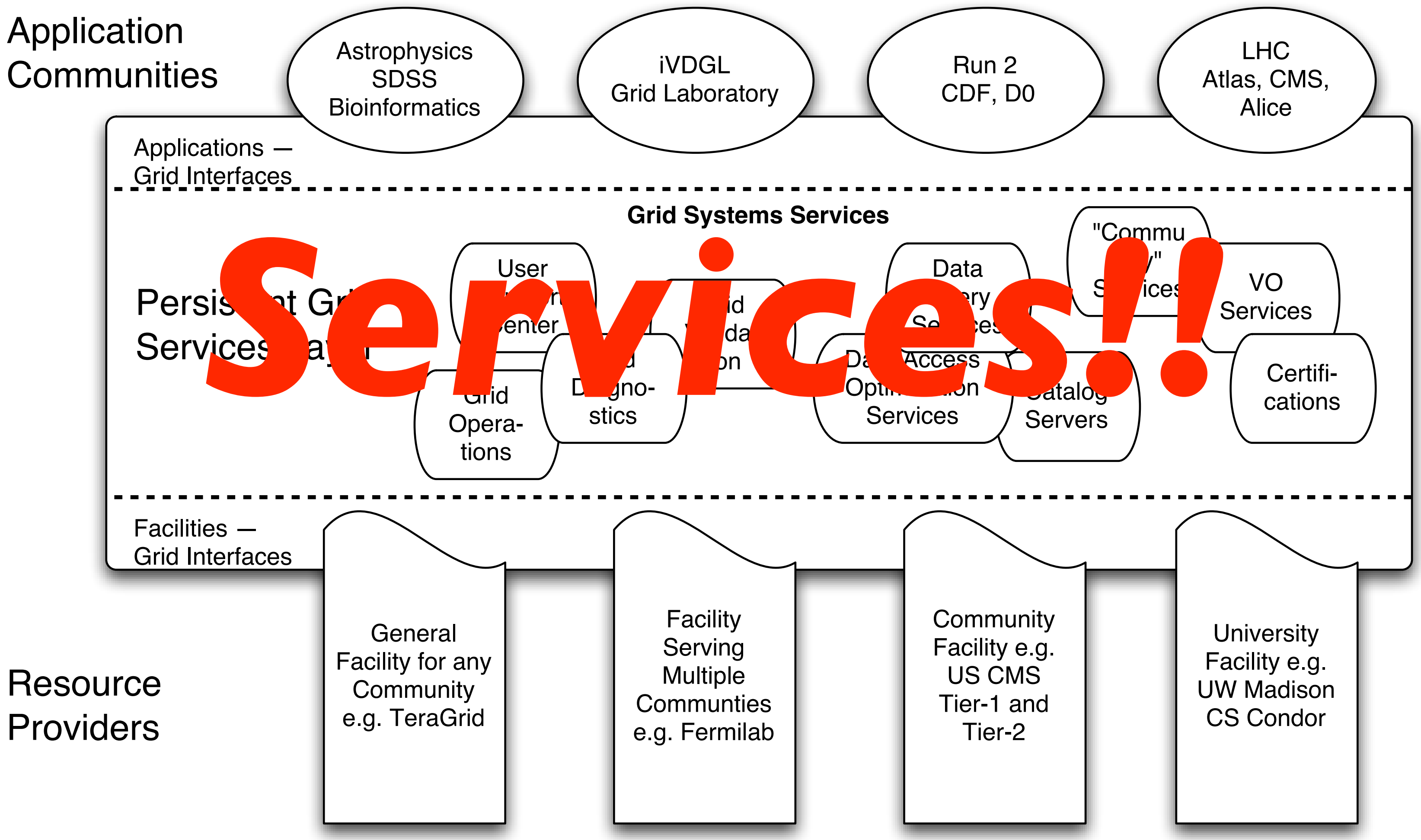
Open Science Grid Services



US LHC Grid Activity Areas

"Peta-Scales" — Building Production Quality Grids

- LHC data production & analysis challenges, LCG-1, Grid2003

"Middleware" — Drafting the Grid Services Architecture

- architecture, engineering and development, testing and integration

"Communities" — Dynamic Workspaces And Collaboratories

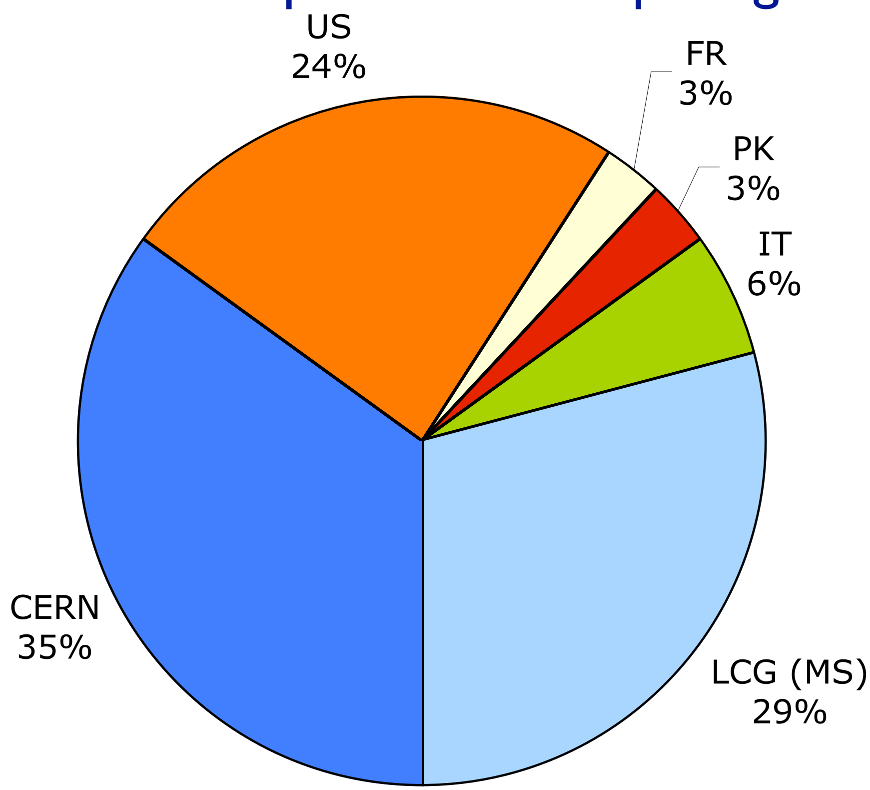
- Proposals to the NSF: "Dynamic Workspaces", "Collaborative Tools"

"Services" — Building the Grid Services Infrastructure for providing the persistent services and the framework for running the infrastructure

- Adapting the US LHC project towards providing a Grid Services Infrastructure
- federating the LHC and other resources: Open Science Grid

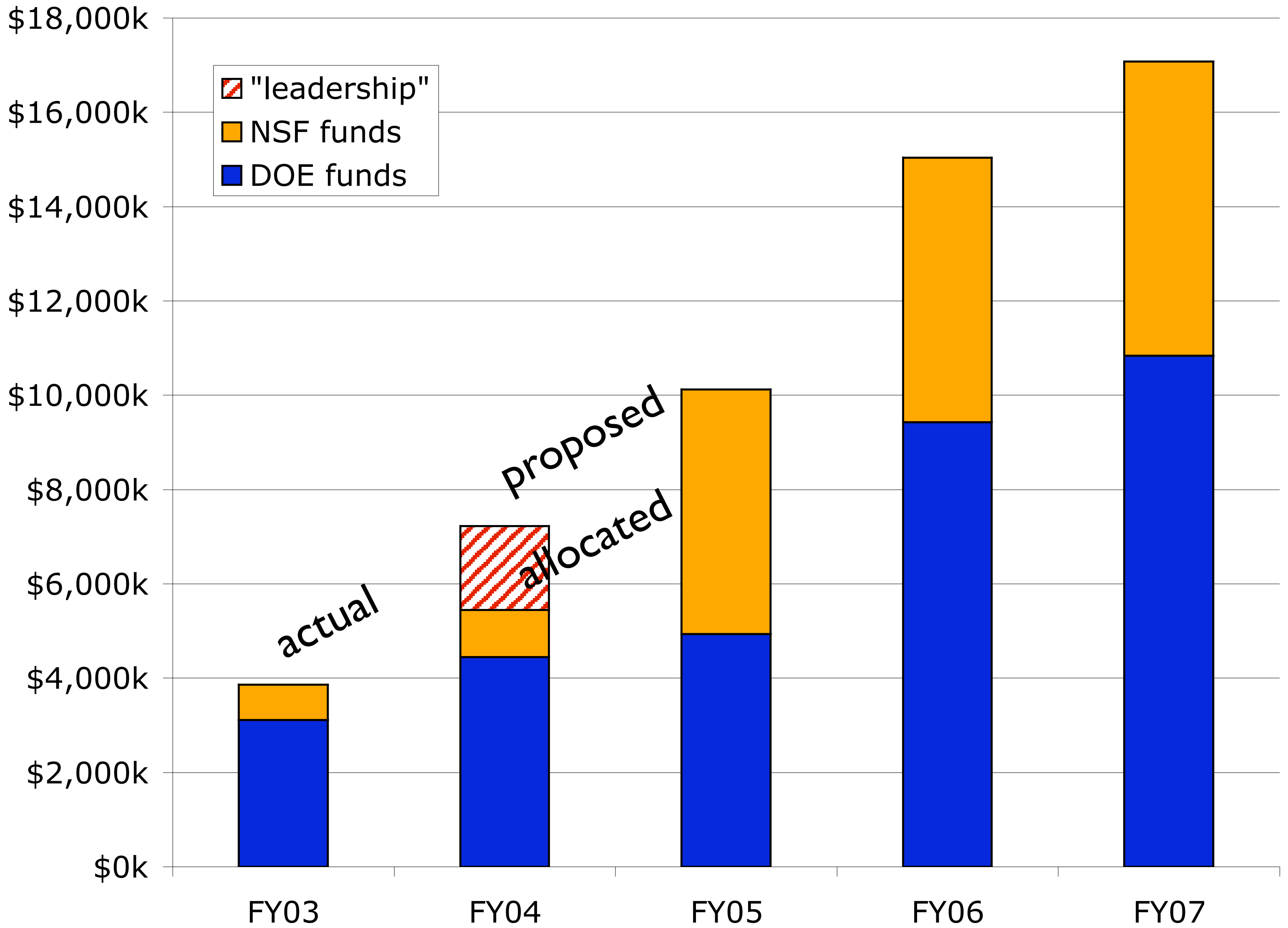
U.S.CMS Contributions to CMS Software

U.S. Contributions to CMS Manpower in Computing and Core Software



- The U.S. is providing a very significant contribution:
  CMS key members at CERN funded through U.S. CMS S&C
- CERN Members State contributions mainly coming through LCG

Funding and Costs U.S. CMS S&C



Fermilab Tier-1 and Open Science Grid

- evolve the idea to provide U.S. LHC computing through a Grid of Tier-1 to Tier-n centers to an open Grid-services infrastructure
- starting with the U.S. LHC grid resources, build and operate a fully functional and production quality grid, that supports Peta-scale operations, and that extends internationally to create a global grid for LHC science.
  - this grid will immediately serve as a backbone to merge grid computing efforts of other experiments in particle and nuclear physics, and can rapidly be extended to other science communities.
- big and broad program of work and an important role for Fermilab recognize RunII expertise and technical excellence of CD
- broader approach allows a range of organizations and sites to tender compute, data storage, network and support services to the Open Science Grid.
- open to include RunII computing and other communities, at Fermilab and University facilities, easing transition for University groups to LHC