DØ Regional Analysis Center Concepts

CHEP 2003
UCSD

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Roadmap of Talk

- **The Mission**
- **The Resource Potential**
- **DØ Regional Strategy**
- **RAC Details**
- **RAC progress**
- **Summary and Future**

DØ Offsite Analysis Task Force

Official members (and other participants)

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A Complex Mission!

We have a very complex physics mission:

- Billions of recorded triggers
- Dozens of physics analysis areas
- Complex analyses, Precision measurements, Minute signal searches, subtle systematics
  - Understand the underlying event consistent with 5 MeV/c^2 statistical precision on M_W
  - Understand the jet energy scale to more precisely measure M_{top}
  - Tag and vertex *B* mesons in an environment of 5-10 overlapping interactions

- Estimated R2a (through 2004) computing needs for MC, Reconstruction, and Analysis. Needs beyond 2004 are larger still.
  - 4 THz CPU
  - 1.5 PB total data archive

Many Potential Resources, But…

- **We have many potential resources**
  - **Technology and Computing Resources abound.**
    - **CPU and memory are inexpensive**
    - **Networking is becoming more pervasive**
    - **Disk and tape storage is affordable**
  - **An army of Physicists, Over 600 collaborators, are "available"**

- **But, they are not all in one place anymore, and they are not really "ours"**
  - **The resources are distributed around the world at 80 institutions in 18 countries on 4 continents.**
  - **In most places, the resources are shared with other experiments or organizations**
- **Management, Training, Logistics, Coordination, Planning, Estimating needs, and Operation are real hard**
- **Infrastructure and tools needed to pull this all together are essential.**

The Good News is …

There are ~~$$$~~, ~~€€€~~, and ~~£££~~ for computing.

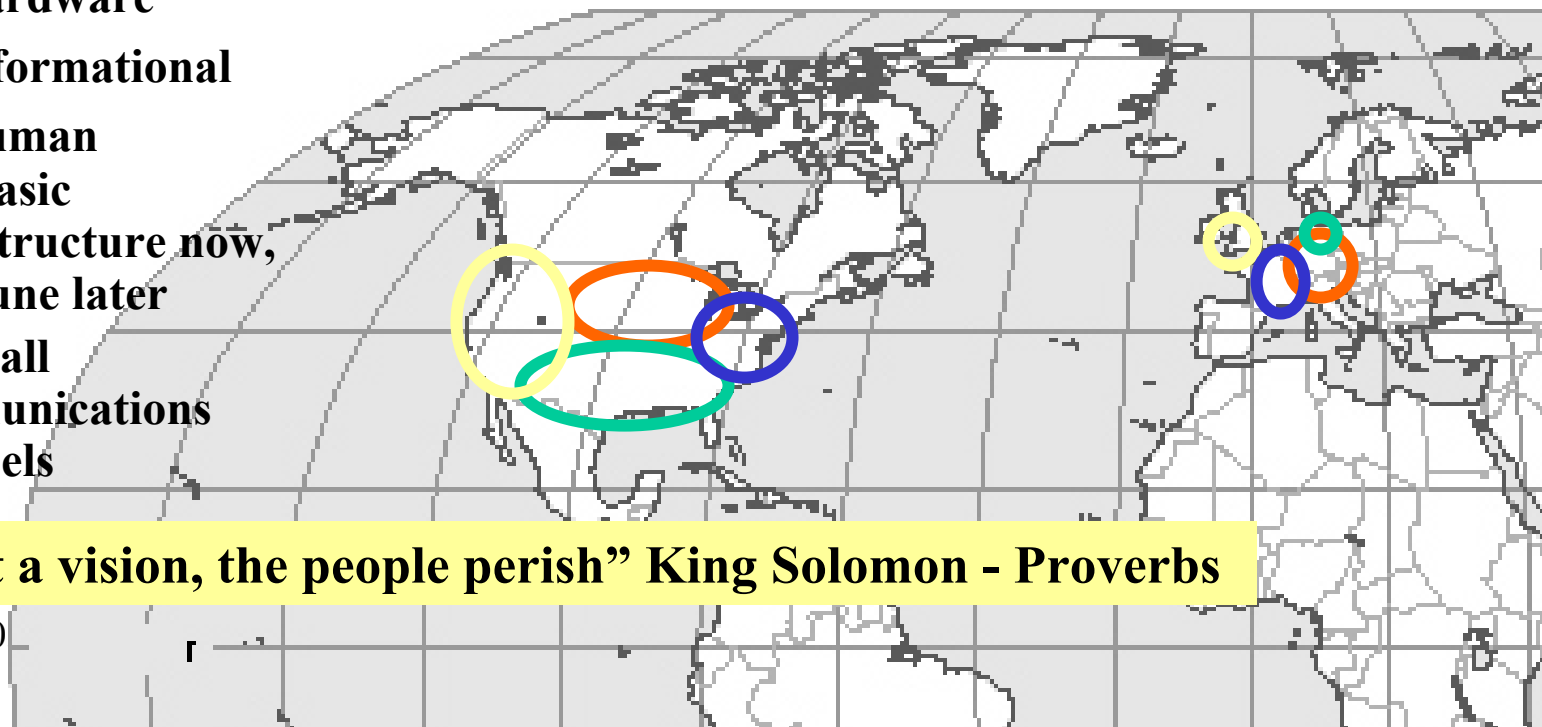
The Rub is…

It is for many projects, LHC, Grid, and multi-disciplinary…

so we need to share and be opportunistic

The Overall Game Plan

- **Divide and conquer**
  - **Establish 6-10 geographical/political regions.**
  - **Establish a Regional Analysis Center (RAC) in each area.**
  - **Define responsibilities for each region.**
- **Enable the effective use of all resources**
  - **Hardware**
  - **Informational**
  - **Human**
- **Lay basic infrastructure now, fine-tune later**
- **Open all communications channels**



"Without a vision, the people perish" King Solomon - Proverbs

The DØ Process

- **1998: DØ Computing Model- The distributed computing concepts in SAM were embraced by the DØ management. All of DØ 's Monte Carlo was produced at remote centers.**
- **2001: D0RACE – Remote Analysis Coordination Effort team helped to get the basic DØ infrastructure to the institutions. With this effort, 60% of the DØ sites have official analysis code distributions and 50% have SAM stations.**
- **2002: RAC grassroots team – Met throughout spring and summer to write a formal document outlining the concepts.***
- **2002: OATF - Offsite Analysis Task Force – Charged by the Spokespersons to further study the needs of offsite computing and analysis**
- **DØ Finance committee – decides how the collaboration as a whole will contribute remote computing resources to the experiment.**
- Plans for MOU's are being made.

D0 DH in section 8.

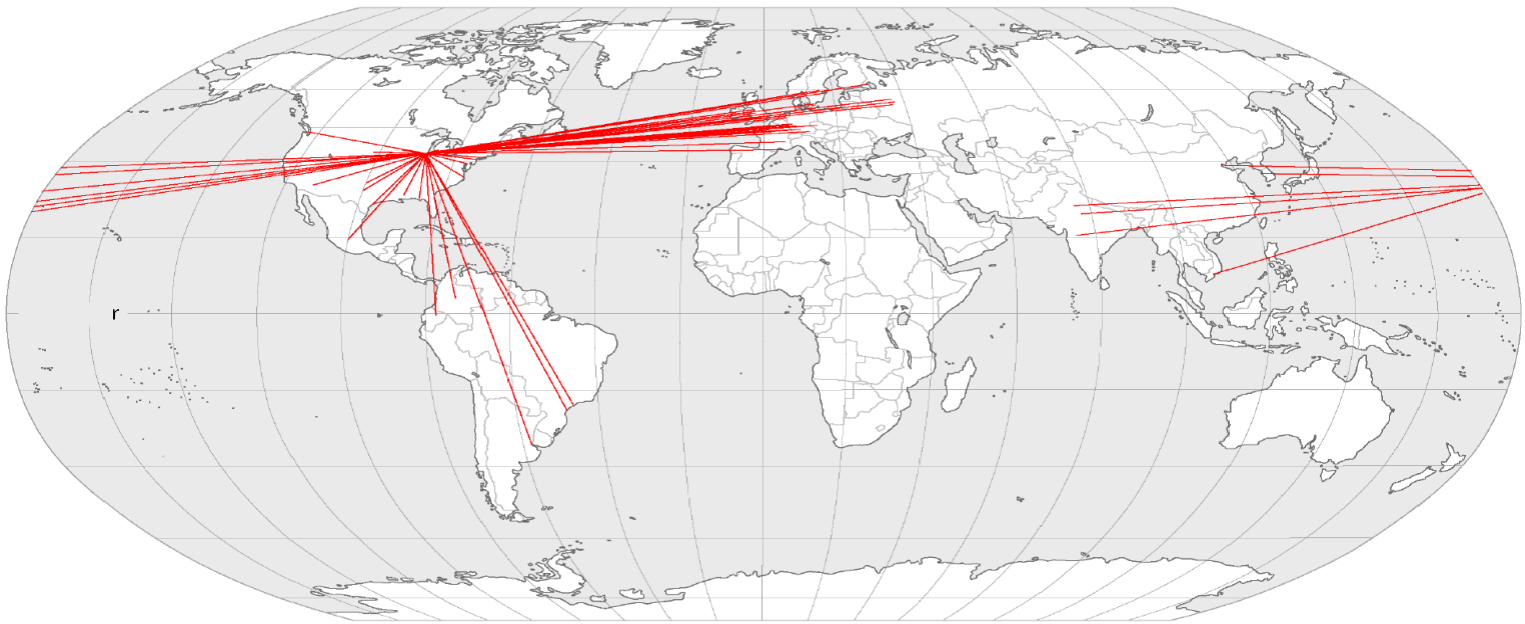
***Bertram, *et al.*, "A Proposal for DØ Regional Analysis Centers", DØ Internal Note # 3984, Unpublished(2002)**

Why Regions are Important

1. **Opportunistic use of ALL computing resources within the region**
2. **Management for resources within the region**
3. **Coordination of all processing efforts is easier**
4. **Security issues within the region are similar, CA's, policies…**
5. **Increases the technical support base**
6. **Speak the same language**
7. **Share the same time zone**
8. **Frequent Face-to-face meetings among players within the region.**
9. **Physics collaboration at a regional level to contribute to results for the global level**
10. **A little spirited competition among regions is good**

Deployment Model

- **Fermilab-centric SAM infrastructure is in place, …**



…now we transition to more hierarchical Model →

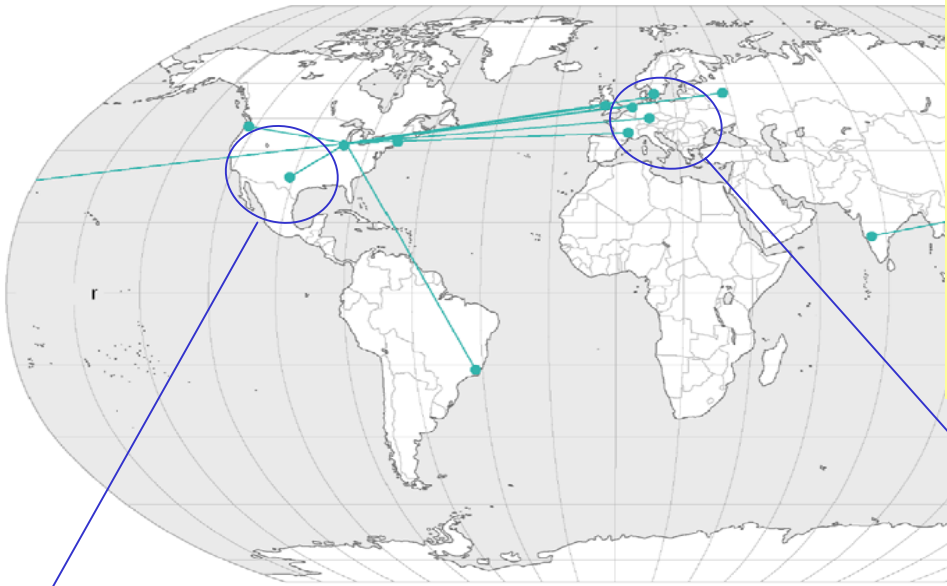
Hierarchical Model

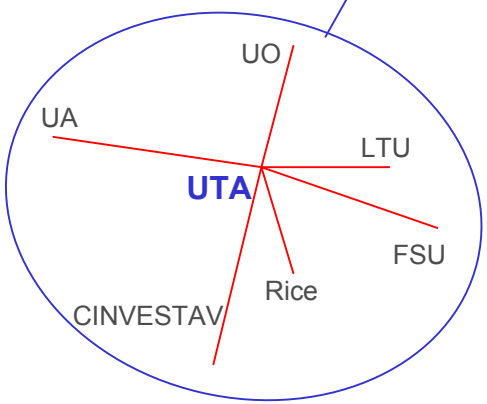
CAC – Central Analysis Center (Fermilab)

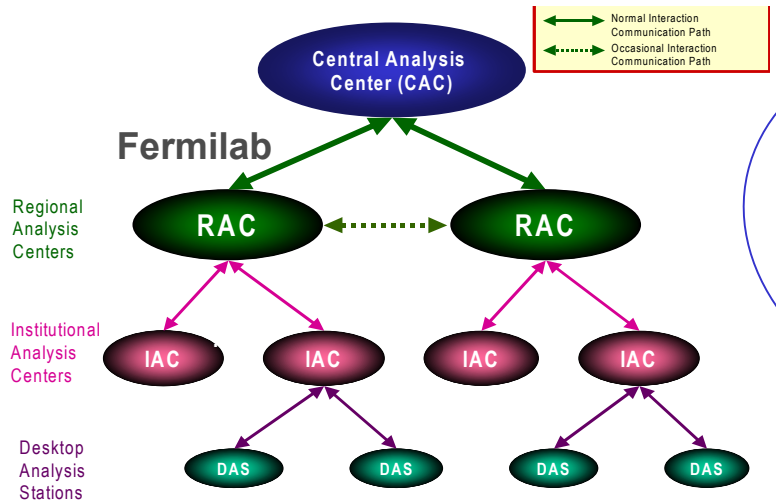
RAC – Regional Analysis Center (6-10)

IAC – Institutional Analysis Center

DAS – Desktop Analysis Station







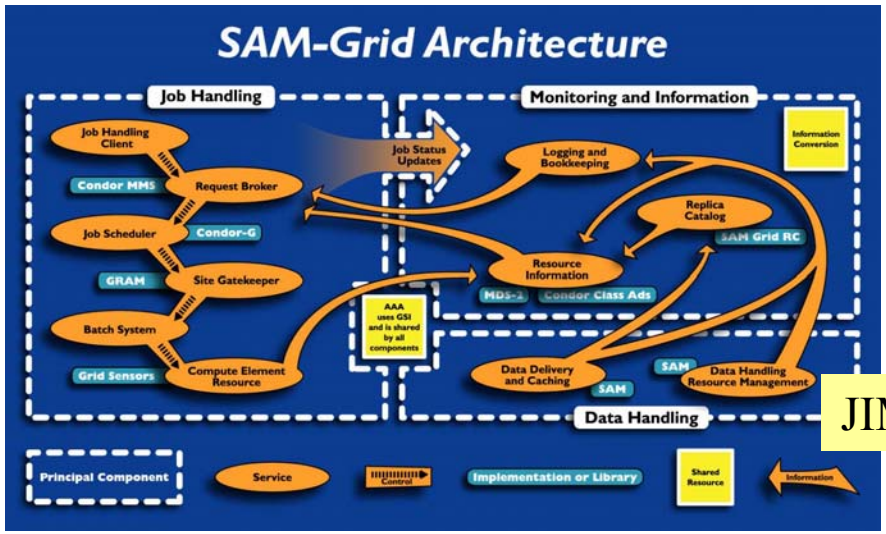
RAC Functionality

- **Preemptive caching**
  - **Coordinated globally**
    - **All DSTs on disk at the sum of all RAC's**
    - **All TMB files on disk at all RACs, to support mining needs of the region**
  - **Coordinated regionally**
    - **Other formats on disk: Derived formats & Monte Carlo data**
- **On-demand SAM cache: ~10% of total disk cache**

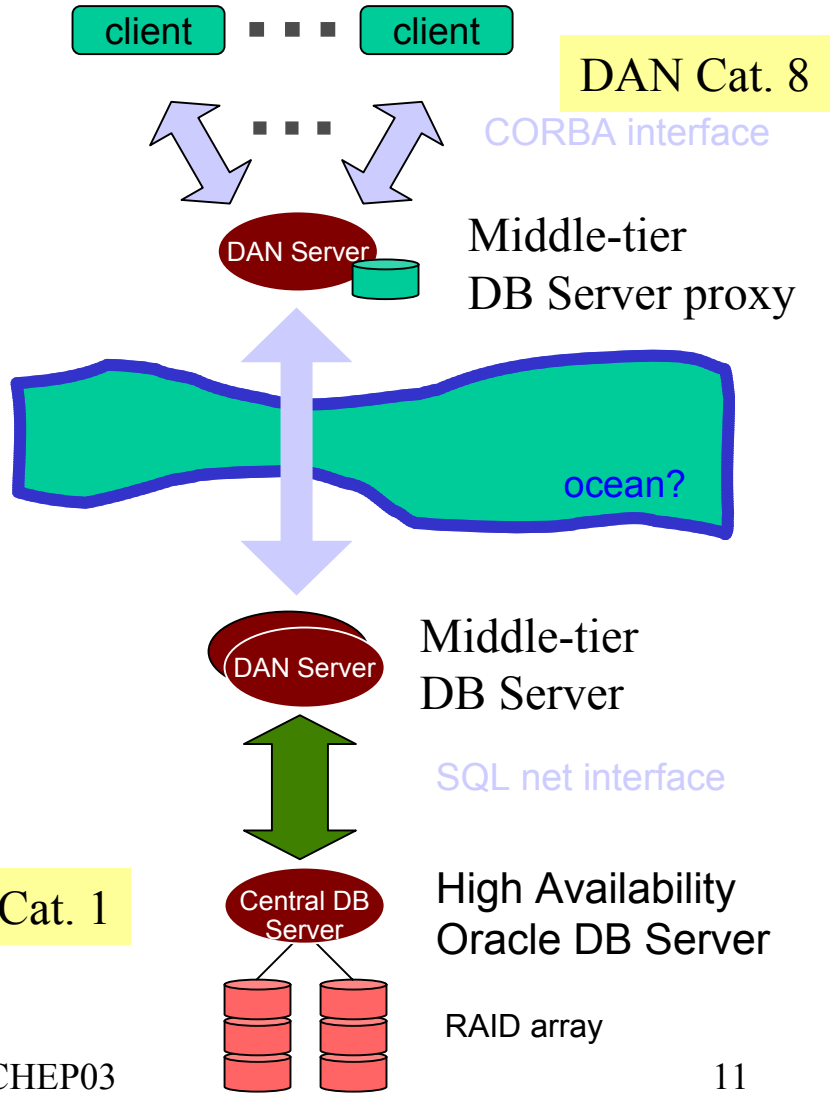
- **Archival storage (tape - for now)**
  - **Selected MC samples**
  - **Secondary Data as needed**
- **CPU capability**
  - **supporting analysis, first in its own region**
  - **For re-reconstruction**
  - **MC production**
  - **General purpose DØ analysis needs**
- **Network to support intra-regional, FNAL-region, and inter-RAC connectivity**

Required Server Infrastructure

- **SAM-Grid (SAM + JIM) Gateway**
- **Oracle database access servers (DAN)**
- **Accommodate realities like:**
  - **Policies and culture for each center**
  - **Sharing with other organizations**
  - **Firewalls, private networks, et cetera**



JIM Cat. 1

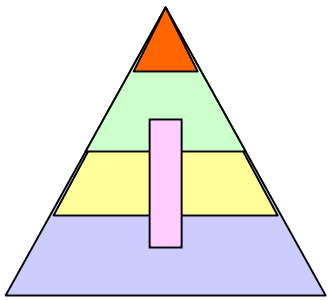


Data Model

Fraction of Data Stored per Region

Data Tier	Size/event (MB)	FNAL Tape	FNAL Disk	Remote Tape	Remote Disk
RAW	0.25	1	0.1	0	0
Reconstructed	0.50	0.1	0.01	0.001	0.005
DST	0.15	1	0.1	0.1	0.1
Thumbnail	0.01	4	1	1	2
Derived Data	0.01	4	1	1	1
MC D0Gstar	0.70	0	0	0	0
MC D0Sim	0.30	0	0	0	0
MC DST	0.40	1	0.025	0.025	0.05
MC TMB	0.02	1	1	0	0.1
MC PMCS	0.02	1	1	0	0.1
MC root-tuple	0.02	1	0	0.1	0
Totals RIIa/RIIb		**1.5PB/ 8 PB**	**60TB/ 800 TB**	**~50TB**	**~50TB**

Data Tier Hierarchy



Metadata ~0.5TB/year

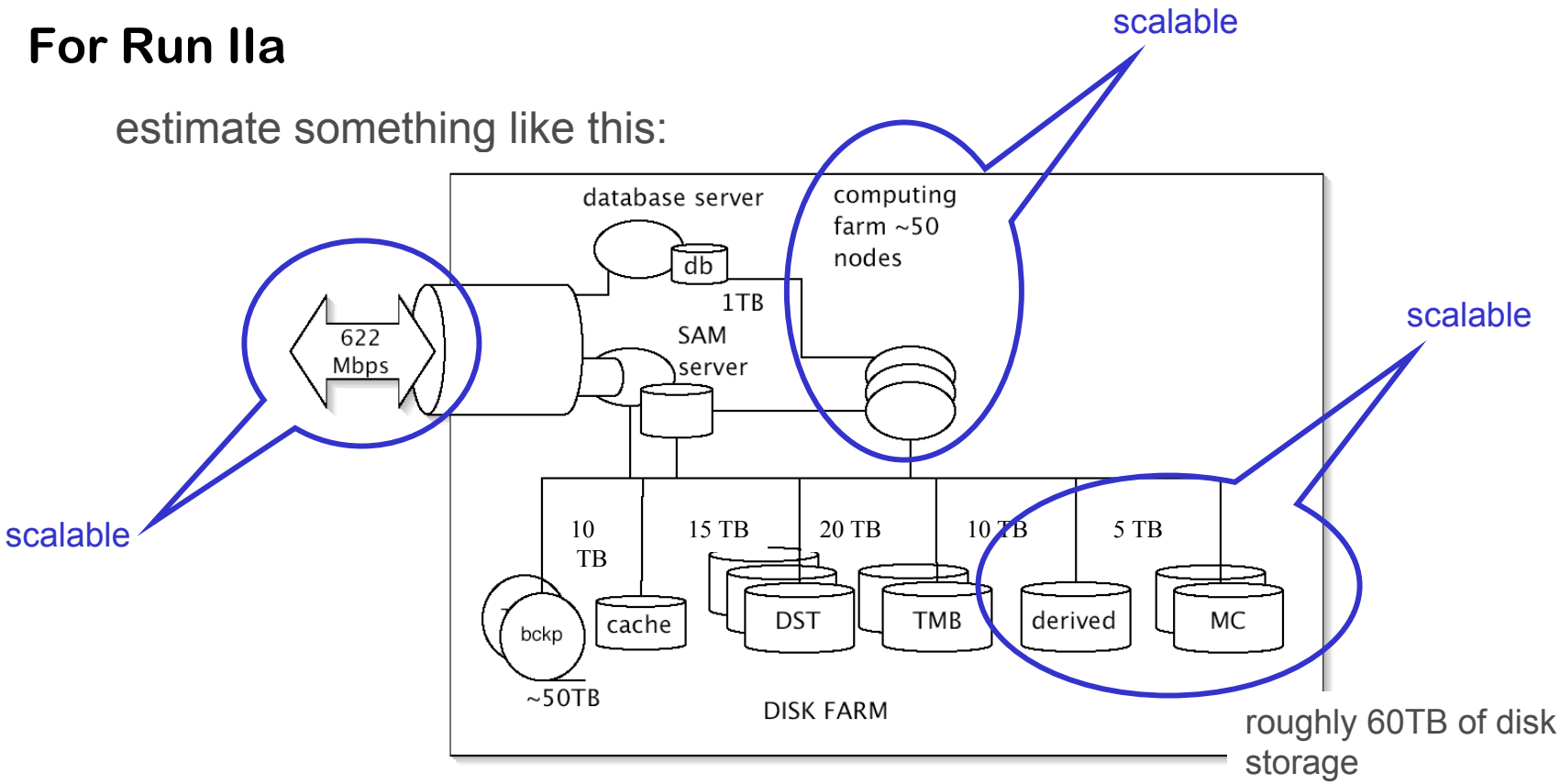
Numbers are rough estimates

the cpb model presumes:
25Hz rate to tape, Run IIa
50Hz rate to tape, Run IIb
events 25% larger, Run IIb

Summary of the *minimum* RAC

For Run IIa

estimate something like this:



- **This alone adds > 500 cpu's, deployed in an efficient way - where the physicists are**
- **IAC's should have have considerable additional capability**
- **All in host countries.**

Characterizing RAC's

Hardware needed to achieve various levels of RAC utility

Hardware	Good	Better	Best
Network Connectivity	1 Gbps	1 Gbps	10 Gbps
Disk Cache	60 TB	80 TB	100 TB
Archival Storage	0	100 TB	500 TB
HA Servers	1	2	4
Processing CPU's	50 x (Clock Rate de Jour)	100 x (Clock Rate de Jour)	200 x (Clock Rate de Jour)
Estimated Cost	$250k	$500k	$1M

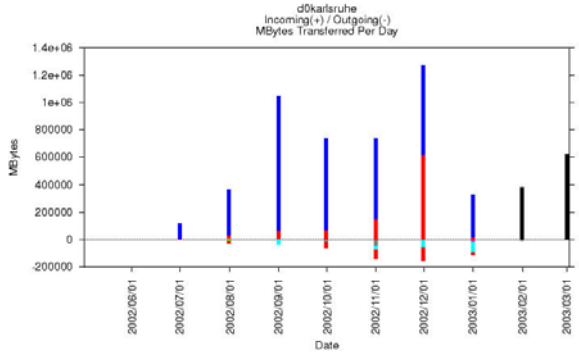
This is the Run IIa investment

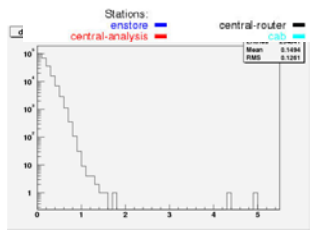
Challenges

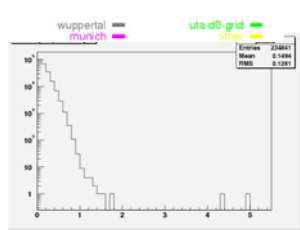
- **Operation and Support**
  - **Ongoing shift support: 24/7 "helpdesk" shifters (trained physicists)**
  - **SAM-Grid station administrators: Expertise based on experience installing and maintaining the system**
  - **Grid Technical Team: Experts in SAM-Grid, DØ software + technical experts from each RAC.**
  - **Hardware and system support provided by centers**
- **Production certification**
  - **All DØ MC, reconstruction, and analysis code releases have to be certified**
- **Special requirements for certain RAC's**
  - **Forces customization of infrastructure**
  - **Introduces deployment delays**
- **Security issues, grid certificates, firewalls, site policies.**

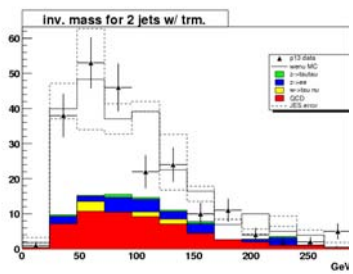
RAC Prototype: GridKa

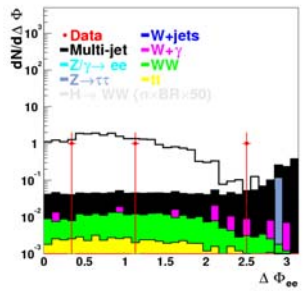
- **Overview:Aachen, Bonn, Freiburg, Mainz, Munich, Wuppertal**
  - **Location: Forschungszentrum Karlsruhe (FZK)**
  - **Regional Grid development, data and computing center. Established: 2002**
  - **Serves 8 HEP experiments: Alice, Atlas, BaBar, CDF, CMS, Compass, DØ, and LHCb**
- **Political Structure: Peter Mattig (wuppertal) FNAL rep. to Overview Board, C. Zeitnitz (Mainz), D. Wicke (Wuppertal) Tech. Advs. Board reps.**
- **Status: Auto caching Thumbnails since August**
  - **Certified w/ physics samples**
  - **Physics results for Winter conferences**
  - **Some MC production done there**
  - **Very effectively used by DØ in Jan and Feb.**











- **Resource Overview: (summarized on next page)**
  - **Compute: 95 x dual PIII 1.2GHz, 68 x dual Xeon 2.2 GHz. D0 requested 6%. (updates in April)**
  - **Storage: DØ has 5.2 TB cache. Use of % of ~100TB MSS. (updates in April)**
  - **Network: 100Mb connection available to users.**
  - **Configuration: SAM w/ shared disk cache, private network, firewall restrictions, OpenPBS, Redhat 7.2, k 2.418, D0 software installed.**

Summary of Current & Soon-to-be RACs

RAC	IAC's	CPU ΣHz (Total*)	Disk (Total*)	Archive (Total*)	Schedule
GridKa @FZK	**Aachen, Bonn, Freiburg, Mainz, Munich, Wuppertal,**	52 GHz (518 GHz)	5.2 TB (50 TB)	10 TB (100TB)	Established as RAC
SAR @UTA (Southern US)	**AZ, Cinvestav (Mexico City), LA Tech, Oklahoma, Rice, KU, KSU**	160 GHz (320 GHz)	25 TB (50 TB)		Summer 2003
UK @tbd	**Lancaster, Manchester, Imperial College, RAL**	46 GHz (556 GHz)	14 TB (170 TB)	44 TB	Active, MC production
IN2P3 @Lyon	**CCin2p3, CEA-Saclay, CPPM-Marseille, IPNL-Lyon, IRES-Strasbourg, ISN-Grenoble, LAL-Orsay, LPNHE-Paris**	100 GHz	12 TB	200 TB	Active, MC production
DØ @FNAL (Northern US)	**Farm, cab, clued0, Central-analysis**	1800 GHz	25 TB	1 PB	Established as CAC

*Numbers in () represent totals for the center or region, other numbers are DØ's current allocation.

From RAC's to Riches

Summary and Future

- **We feel that the RAC approach is important to more effectively use remote resources**
- **Management and organization in each region is as important as the hardware.**
- **However…**
  - **Physics group collaboration will transcend regional boundaries**
  - **Resources within each region will be used by the experiment at large (Grid computing Model)**
  - **Our models of usage will be revisited frequently. Experience already indicates that the use of thumbnails differs from that of our RAC model.**
  - **No RAC will be completely formed at birth.**
- **There are many challenges ahead. We are still learning…**