Resources for the ATLAS Offline Computing

Basis for the Estimates

ATLAS Distributed Computing Model

Cost Estimates

Present Status

Sharing of Resources

Alois Putzer, Heidelberg (ATLAS NCB Chairman)

Estimate for Computing Resources based on

- Trigger Rates and Sample Sizes
- CPU power to reconstruct, simulate and analyse events
- Ideas how ATLAS Physicists will access the data for physics analyses

- Calculation of Costs based on
- Number of Expected Regional Centres
- Technology trends
- LHC Start-up scenario

More on Rates and Event Size

- **End 1994, ATLAS Technical Proposal:**
  - **Total rate ~ 100 Hz**
  - **Event size ~ 1 MB**

- **March 2000, HLT/DAQ/DCS Technical Proposal:**
  - **Total rates : ~ 270 Hz low L**
  - **~ 425 Hz high L**
  - **Event size : ~ 2.2 MB**

Impact on offline computing resources: storage, CPU

HLT TP based on much more detailed studies than ATLAS TP. Full simulation studies in most cases.

Work is not finished and refinements/optimization is foreseen for Trigger/DAQ TDR.

Discussion of computing resources for the CERN Computing Review has accelerated this process.

Strategy / plans for further rate optimization

(F. Gianotti, S. Tapprogge, V. Vercesi)

- **Start with low luminosity.**

First, consider "harmless" actions: refinement of selection algorithms, larger use of combined information from several sub-detectors, higher thresholds for "non-discovery" triggers, pre-scaling, etc. ® small impact on physics expected

If this is not enough, consider more "drastic" actions: higher thresholds, less-inclusive menus, etc.

- **® impact on physics expected**
- **® this phase requires more study and global optimization**

First preliminary results from "harmless actions" indicated the good trend.

Work will continue in the next months.

Definitions

- **RAW** real raw data
- **SIM** simulated raw data
- **ESD** event summary data (reconstruction)
- **AOD** physics analysis object data
- **TAG** event tags

- RAW will stay at CERN (few % exported)
- All other data sets will be exported or exchanged between Tier 0 and lower Tiers

Item	Unit	2006
Average Luminosity	$10^{33}s^{-1}$	1
Trigger Rate	Hz	270
Physics Rate	Hz	155
Recorded Events	10^{9}	2,70
Physics Events	10^{9}	1,55

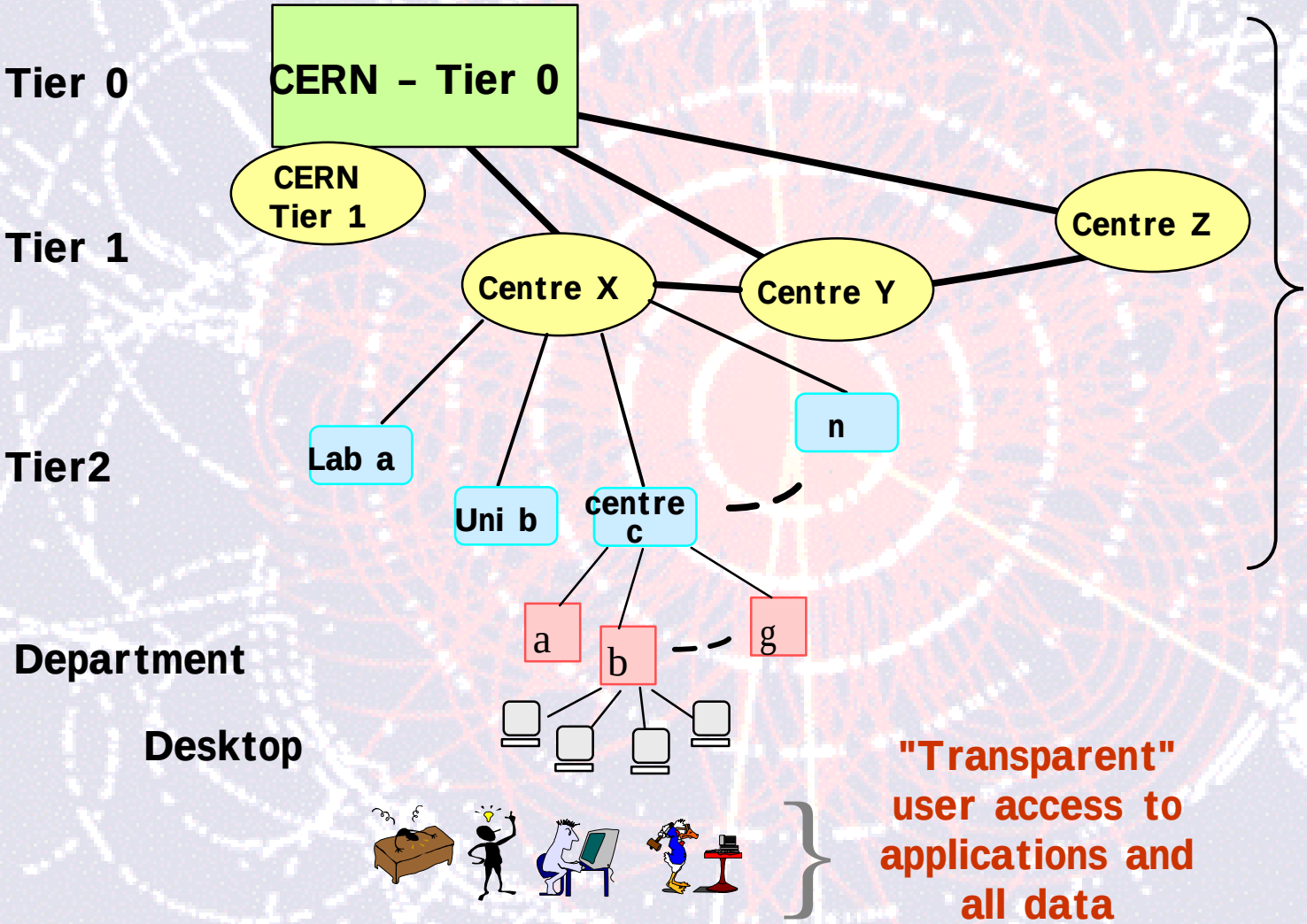
Input Parameters for the Resources Calculation

Item	Unit	Value
Raw Data Size	MB	2
ESD Size	MB	0,5
AOD Size	kB	10
TAG Size	kB	0,1
Sim. Data Size	MB	2
Sim. ESD Size	MB	0,5
Time/Reco 1ev	kSI95-sec	0,64
Time/Simu 1ev	kSI95-sec	3

ATLAS Distributed Computing Model

- Need to replicate the data to satisfy the large community of physicists, need to match regional interests, do only at CERN what needs to be done there Þ distributed computing model
- Exploit established computing expertise & infrastructure in national labs, universities
- Reduce dependence on links to CERN
  - full "Event Summary Data" available nearby - through a fat, fast, reliable network link
- Tap funding sources not otherwise available to HEP (?)

The ATLAS Distributed Computing Model



ATLAS WWCM

- **RAW** : Completely stored at the CERN Tier0; some fractions copied to the Tier1's (on demand)
- Events reconstructed in 'real-time' ('270 Hz')
- Reprocessing within 3 months ('155 Hz')
- **SIM** : $1{,}2 \times 10^8$ events/y; done in Tier1's/Tier2's
- (hope : can do a lot with fast simulation)
- **ESD** : Complete copies ('155Hz' + SIM) send to each Tier1
  - 25% of current version on disks
  - 10% of previous version on disks
- **AOD + TAG** : Completely on disks
- Use GRID middleware for sharing of resources

Present Plans For Atlas Regional Centres

- **Tier1 Centres (Most of them for all 4 LHC Experiments)**
  - France (Lyon)
  - Germany (Karlsruhe)
  - Italy (Bologna)
  - UK (RAL)
  - USA (BNL, ATLAS only)
- **'Reduced' Tier1 Centres**
  - Japan
  - Nordic Countries ?, Russia ?
- **Tier2 Centres**
  - Canada, Switzerland
  - China ?, Poland ?, Slovakia ?, Spain ?, Portugal ?, ++....

ATLAS Offline Resources

	CPU (kSI95	Tape (TB)	Disk (TB)
CERN (T0+T1)	690	8959	411
Each T1	209	1839	365
6 External T1's	1254	11034	2190
Total	1944	19993	2601

CPU needs dominated by user analysis

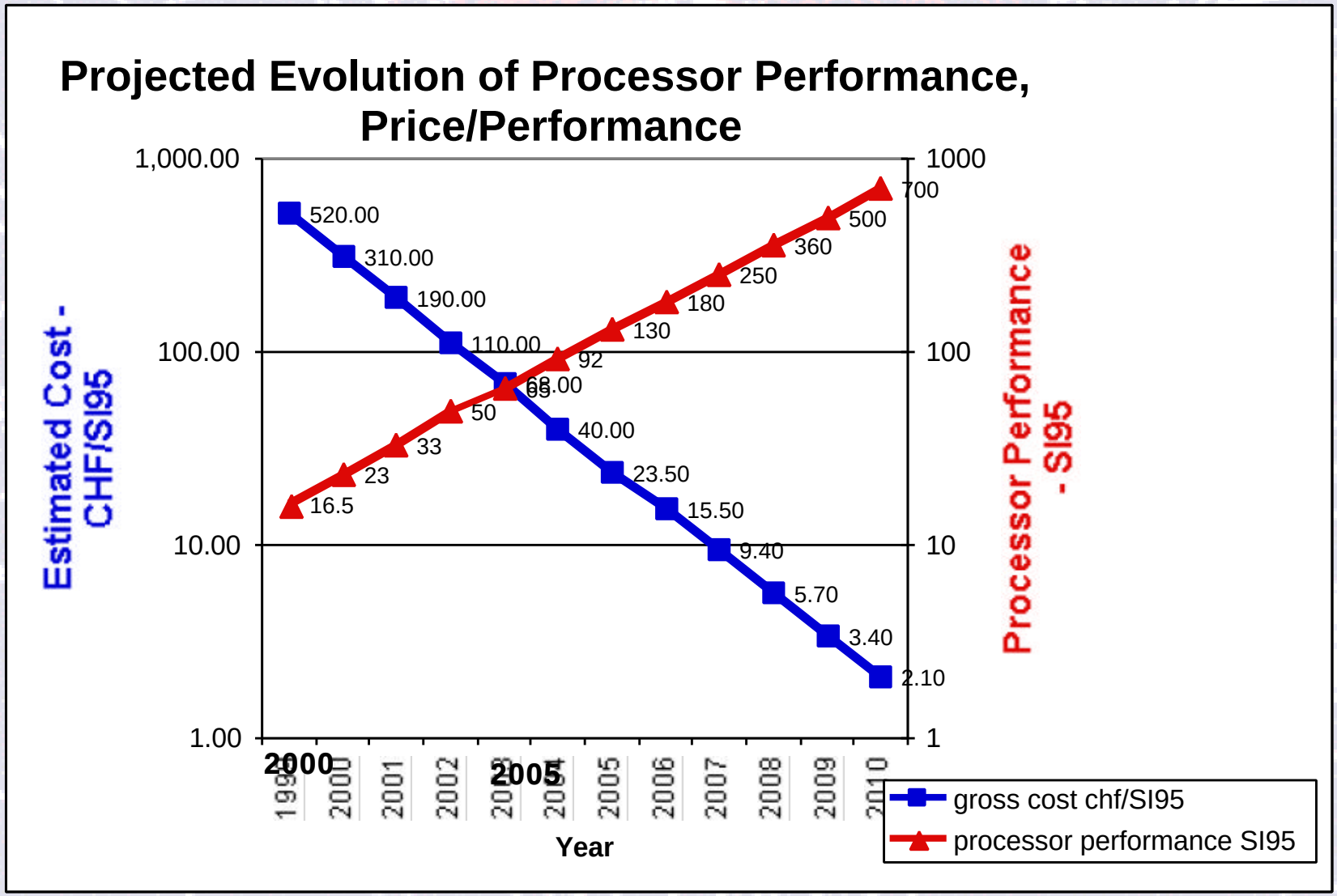
(For comparison 1 PC today = 20 SI95)

CERN Review Recommendations

- About equal share between T0/T1 at CERN, external T 1's and lower level Tiers
- CERN/‡ (Tier 1)/‡ (all Tier 2, etc) =1/1/1 (following the 1/3 2/3 rule)
- Perform "Data Challenges" of increasing size and complexity until LHC start-up

. Set-up a common testbed now with the goal of reaching a significant fraction of the overall computing and data handling capacity of one experiment in 2003

Technology watch (PASTA)



Cost Estimates for th Offline Resources

Assumption : 30% 2005; 60% 2006; 100% 2007

	MCHF
CERN (T0+T1)	23,7
Each T1	8,5
6 External T1's	51,3
Total	75,0
CERN/Total	32 %

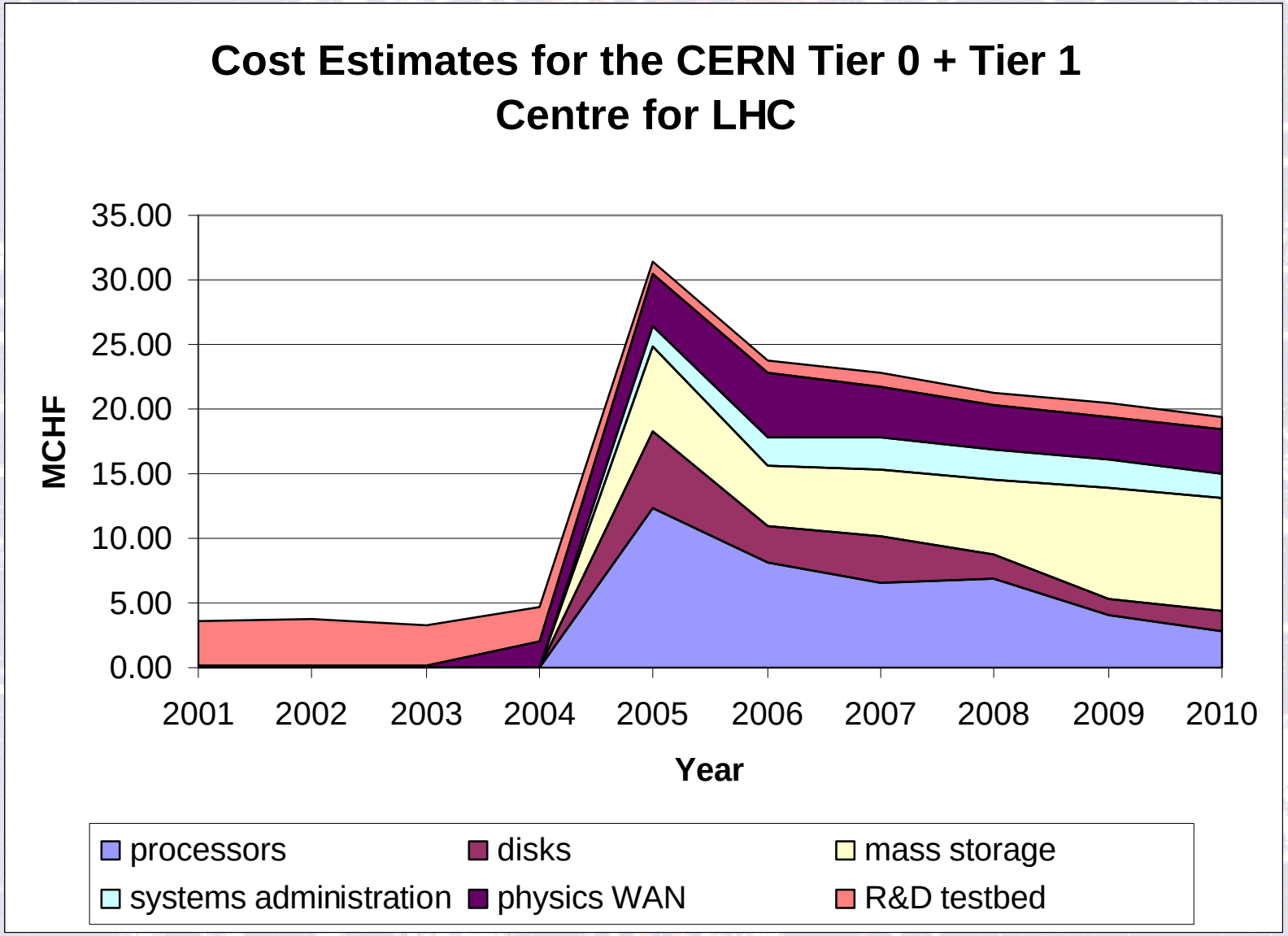
Discussions with the funding agencies on the way
(Similar Numbers for the other LHC Experiments)

CERN Prototype

CPU (kSI95)	Tape (TB)	Disk (TB)	Tape I/O (MB/s)
120	150	300	1200

2001	2002	2003	Total
3 MCHF	3 MCHF	12 MCHF	18 MCHF

Prototypes (Testbeds) are planned for all major Regional Centres and should be included in the prototype agreement


Cost Estimates for the CERN Tier 0 + Tier 1 Centre for LHC
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
MCHF
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
Year
processors
disks
mass storage
systems administration
physics WAN
R&D testbed

Comments on Cost figures

- Material cost estimates based on commodity components
- The start-up scenario of LHC machine and experiments has a very important influence on cost
- Manpower and operation cost for all Tiers (0->Desktop) are not included.

Sharing of Resources

- Centres are Regional and NOT National
- Physicists from other Regions should have also Access to the Computing Resources
- Profit from GRID Middleware for
  - access control
  - priority handling
  - information on available resources
- Agreement as part of the Computing M.o.U.
- However, all Institutes have to contribute adequately to the ATLAS GRID Infrastructure and Maintenance.

Work For the Near Future

- Define the ATLAS Tier Structure (<End 2001)
- Discuss the Rules for the Sharing of Resources
- Agreements for the Testbeds (Summer 2001)
- Perform MDCs (2001,2002, 2003)
- Get the GRID successfully off the ground
- Computing TDR (End 2002)
- M.o.U. for Computing (Begin 2003)
- Update the ATLAS WWCM when more precise information is available on
  - startup scenario
  - trigger rates and event sizes
  - etc.