CERN Computing Review Recommendations

ATLAS Plenary

22 February 2001

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Outline

- Purpose & Mandate of the review
- Steering Group and Panels
- Key parameters
- Main conclusions & associated recommendations
  - LHC Computing model
  - Software
  - Management & Resources
  - General

Mandate of th

- “It is an appropriate moment to review the computing plans of the LHC experiments and the corresponding preparations of IT division with the following aims:
  - update the assessment of regional and CERN facilities, their relative roles and the estimates of the resources required
    - identify software packages to operate in various places
    - identify services to be provided centrally
    - identify activities which have to be done at CERN
  - assess the analysis software projects, their organisational structures, the role of CERN and possible common efforts
  - review and comment the overall and individual computing management structures and review the resources required”

Mandate of th

- “The results of the review will be the basis for the formulation of Computing Memoranda of Understanding which will describe:
  - commitments of institutes inside the collaborations
  - commitments of CERN to provide computing infrastructure and central facilities for the LHC era
- The review team should recommend actions, in particular
  - common actions between experiments and IT division
- The review reports to the Research Board and the Director General”

Working model

- Steering Committee (21 meetings)
- 3 independent panels
  - Worldwide Analysis and Computing Model (5)
  - Software project (14)
  - Management and Resources (16)
- Report from each panel (not public)
- Final report by the Steering Committee

Steering Committee

- Members:
  - S. Bethke — Chair
  - H.F. Hoffmann — CERN Director responsible for Scientific Computing
  - D. Jacobs — Secretary
  - M. Calvetti — Chair of the Management and Resources Panel
  - M. Kasemann — Chair of the Software Project Panel
  - D. Linglin — Chair of the Computing Model Panel
- In Attendance:
  - IT Division — M. Delfino — L. Robertson
  - ALICE — F. Carminati — K. Safarik
  - ATLAS — N. McCubbin — G. Poulard
  - CMS — M. Pimia — H. Newman
  - LHCb — J. Harvey — M. Cattaneo
- Observers:
  - R. Cashmore — CERN Director for collider programmes
  - J. Engelen — LHCC chairman

Computing Model panel

- Computing Model panel
  - D. Linglin Chair
  - F. Gagliardi Secretary
- Experiment Representatives
  - ALICE A. Masoni A. Sandoval
  - ATLAS A. Putzer L. Perini
  - CMS H. Newman W. Jank
  - LHCb F. Harris M. Schmelling
- Experts:
  - Y. Morita; L. Perini; C. Michau, etc.

Software Project panel

- Software Project panel
  - M. Kasemann — Chair
  - A. Pfeiffer — Secretary and CERN-IT representative
- Experiment Representatives

ALICE	R. Brun	A. Morsch
ATLAS	D. Barberis	M. Bosman
CMS	L. Taylor	T. Todorov
LHCb	P. Mato	O. Callot

- Experts:
  - V. White, etc.

Management & Resources panel

- Members
  - M. Calvetti Chair
  - M. Lamanna Secretary
- Experiment Representatives
  - ALICE P. Vande Vyvre K. Safarik
  - ATLAS J. Huth H. Meinhard
  - CMS P. Capiluppi I. Willers
  - LHCb J. Harvey J.P. Dufey
- Experts:
  - L. Robertson T. Wenaus, etc.

Key parameters

- LHC design
  - E = 14 TeV
  - L = 10^{34} cm $^{-2}$ sec^{-1}
  - σ = 100 mb = 10^{-25} cm^{-2}
  - Collision rate = L. σ = 10^{9} Hz p-p collisions
  - 4 experiments approved

Key parameters

- Approximate numbers to remember (per experiment)
  - 10^6 (1 MB) size of recorder p-p event
    - ATLAS 2 MB
    - ALICE up to 40 MB
  - 10^2 Hz data taking rate
    - ATLAS 270 Hz
  - 10^7 recorded p-p events per day (out of 10^{14})
  - 10^7 data taking seconds per year (excepted ALICE)
  - 10^9 recorded p-p events per year
  - 10^{15} (1 PB) recorded data per year

LHC Computing Model

- (1) The scale of the resource requirements are accepted
- (2) A *multi-Tier hierarchical model* should be the key element of the LHC computing model (similar to the model developed by the MONARC project) ➔
- (3) *Grid Technology* will be used to attempt to contribute solutions to this model
- (4) It is vital that a well-supported Research Networking infrastructure is available by 2006
  - the *bandwidth* between Tier0 and Tier1 centres is estimated to be 1.5 to 3 Gbps for one experiment

Multi-Tier hierarchical model

- Tier0
  - raw data storage (large capacity); first calibration; reconstruction
- Tier1
  - further calibrations; reconstruction; analysis; Monte-Carlo data generation; data distribution; large storage capacity
  - “national” or “supranational”
- Tier2 and “lower”
  - balance of simulation and analysis
    - as important in computing power as Tier1’s
  - “national” or “intranational”
  - Tier3 (“institutional”); Tier4 (end-user workstations)

Multi-Tier hierarchical model

- Tier0 & Tier1
  - open to all members of a collaboration under conditions to be specified in MoUs
    - Tier1 centres should be available for the lifetime of LHC
  - should be managed coherently (Data Grid system)

Software

- (5) *Joint efforts* and *common projects* between experiments and CERN/IT are recommended ➔
  - support of widely used products should be provided
- (6) *data challenges* of increasing size and complexity must be performed ➔
- (7) CERN should sponsor a coherent program to ease the transition from Fortran to OO (physicists)
- (8) concerns:
  - maturity of current planning and resource estimates
  - development and support of simulation packages ➔
  - support and future evolution of analysis tools ➔

Software "common projects"

- Common projects
  - All data Grid systems
  - Data management systems
    - persistency and the data store
    - mass storage system
    - common prototype for data challenges
  - Interactive data analysis tools
  - Simulation packages
  - Common Tools projects

Software
Data Challenges

- ATLAS Data challenges

– DC0	100 GB (0.01%)	end	2001
– DC1	1 TB (0.1%)		2002
– DC2	100 TB (10%)		2003

Software
“support of packages”

- Particular importance of finding satisfactory solutions for the ongoing CERN support of Geant4, Anaphe, object database and the general libraries, along with the introduction of CERN support for FLUKA and ROOT

Management & Resources

- (9) current cost estimates are based on the forecast evolution of price and performance of computer hardware
- (10) on this basis the *hardware costs* for the initial set-up are estimated to 230 MCHF
  - for the 4 experiments, including Tier0; Tier1; Tier2
  - CERN Tier0-Tier1 ~ 1/3
- (11) The total investment for the initial system is due to be spent in 2005-6-7, approximately in equal portions, assuming
  - LHC starts up in 2006
  - LHC reaches design luminosity in 2007

Management & Resources

- (12) The *Core Software teams* of all four experiments are seriously *understaffed* ➔
  - Their contribution will be just as vital to the experiments as major sub-detectors
  - senior Management of the Collaborations must seek solution to this problem with extreme urgency
- (13) *The staffing level of* CERN/IT (as envisaged) is incompatible with an efficient running of the CERN-based LHC computing system and software support

Required human resources (FTE's) to write the Core Software

Year	2000	2001	2002	2003	2004	2005
ALICE	12 (5)	17.5	16.5	17	17.5	16.5
ATLAS	23 (8)	36	35	30	28	29
CMS	15 (10)	27	31	33	33	33
LHCb	14 (5)	25	24	23	22	21
Total	64 (28)	105.5	106.5	103	100.5	99.5

Management & Resources

- (14) The approach to *Maintenance and Operation* of the LHC computing system includes the strategy of rolling replacement within a constant budget. *Maintenance and Operation* will require within each three-year operating period an amount roughly equal the initial investment

Management & Resources

- (15) The construction of a common prototype of the distributed computing system should be launched urgently as a joint project of the four experiments and CERN/IT, along with the Regional Centres
  - should grow progressively in complexity
  - scale to reach ~50% of the overall computing and data handling structure of one LHC experiment
- (16) An agreement should be reached amongst the partners in this project in which
  - construction; cost sharing; goals; technical solution; etc.

General recommendations

- (17) An *LHC Software and Computing Steering Committee* (SC2) must be established
  - composed of the highest level software and computing management in experiments, CERN/IT and Regional Tier1 Centres
  - to oversee the deployment of the entire LHC hierarchical computing structure
- (18) Under the auspices of this committee, *Technical Assessment Groups* (TAGs) must be established to prepare, for example, agreement on a common data management strategy

General recommendations

- (19) Each Collaboration must prepare, on a common pattern, a *Memorandum of Understanding* for LHC computing to be signed between CERN and the funding agencies, describing
  - the funding of and responsibilities for the hardware and the software
  - the human resources
  - the policy for access to the computing systems

  Interim MoU's or software agreements should be set up and signed by the end of 2001 to ensure appropriate development of the software.

ATLAS Computing Resources

	CERN	Tier1	Total
CPU **(kSI95)**	**690**	**1254**	**1944**
Tapes **(TB)**	**8959**	**11034**	**19993**
Disk **(TB)**	**411**	**2190**	**2601**

Computing power & storage capacity at CERN

	CPU (kSI95)	Tape (TB)	Disk (TB)	Tape I/O (MB/s)	Shelf Tape (TB)
ALICE	824	3200	534	1200	0
ATLAS	690	8959	410	800	0
CMS	820	1540	1143	800	2632
LHCb	225	912	330	400	310
Total	2259	14611	2417	3200	2942

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