



LHC Computing Grid Project

Cost Estimates for the Construction and Operation of the Tier 0+1 Facility at CERN in Phase 2 of the LCG Project - 2006-08

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The cost of the Tier 0+1 facility at CERN was estimated in 2001 during the *Review of LHC Computing*¹ and included in the final report of the Review in February 2001. The Review established the requirements at CERN assuming that this would amount to one third of the total resources available in the Tier 0, Tier 1 and Tier 2 Centres. The cost estimate was revised in February 2002 as a result of Task Force 1², one of the CERN committees mandated at that time to find cost savings at CERN. The revision took account of the change in the LHC machine schedule, and reductions in the requirements proposed by Task Force 1. These estimates formed the basis of the cost of computing at CERN for Phase 2 presented to Council in March 2002³.

In February 2003, the Fabric Area of the LCG project organised a re-assessment of the requirements and costs taking account of experience that had been gained by the experiments since the Review of LHC Computing, and the conclusions on technology and cost evolution arising from the PASTA III study⁴.

The results of the new cost assessment are summarised in the following table, which gives the installed capacity in each year for the major classes of resource, together with an estimate of the costs incurred in each year. These results were presented at an LCG Seminar on 26 June 2003.

Capacity and Cost Summary for the CERN Tier 0+1 Centre - July 2003								
The capacity model is based on the Review of LHC Computing (report published in February 2001), adjusted by "Task Force 1" in February 2002, and brought up to date by the experiments in May 2003.								
The costs are based on an implementation model that takes account of the technology and cost evolution estimates of the PASTA III study (2003).								
		LCG Phase II Installation and Commissioning			Maintenance			
Total installed capacity - all experiments								
resource	units	year	2006	2007	2008	2009	2010	
processing	K SI/2000		3,700	8,200	19,100	25,000	34,000	
disk	PB		1.0	2.0	3.8	5.0	6.7	
tape media	PB		6	14	25	36	48	
tape I/O	GB/sec		1.1	2.3	3.9	3.9	3.9	
Estimated costs (KCHF)								
Costs due in each year for new equipment installed, replacement of obsolete equipment and maintenance								
resource	year	2006	2007	2008	2009	2010	total cost for Phase II	
processors		3,900	3,200	5,100	2,000	2,500	12,200	
disks		5,100	3,300	3,500	1,600	1,300	11,900	
mass storage		6,500	11,500	9,800	7,100	10,600	27,800	
cluster network		2,200	4,300	900	900	1,600	7,400	
systems administration		1,000	1,000	1,500	1,500	1,500	3,500	
physics WAN		2,000	2,000	2,000	2,000	2,000	6,000	
Total cost (computing equipment)		20,700	25,300	22,800	15,100	19,500	68,800	
Total cost (computing equipment) estimate Feb 2002 - corrected (see text below)			21,400	22,500	27,300	23,000	19,900	71,200
Comp. Centre Infrastructure (deferred from Phase 1)			400	400	400			1,200
TOTAL COST - Tier0+1 Centre			21,100	25,700	23,200	15,100	19,500	70,000

The new estimate of the cost of the installation and operation of the computing equipment for the Tier 0+1 Facility at CERN for Phase 2 is CHF 68.8M. This is CHF 2.4M less than the cost estimate made in February 2002. However, CHF 1.2M of the costs of the computing centre infrastructure have now been moved from Phase 1 to Phase 2. This covers additional batteries for the uninterruptible power supply

¹ [CERN-LHCC-2001-04](#), Report of the Steering Group of the LHC Computing Review, 22 February 2001

² [Report on CERN's Research Programme by Task Force 1](#), 28 February 2002; [Re-calculation of the costs of LHC Computing – First Physics in 2007](#) – Version 2, L.Robertson, 6 February 2002; [Spreadsheet with detailed costings](#)

³ CERN/CC/2430, Status and Schedule of the LHC Machine, Experiments and Computing, 12 March 2002

⁴ [PASTA III Final Reports](#)



(UPS), which are not required during Phase 1. This was discussed at the Computing Resource Review Board in October 2002⁵. The full cost of installation and operation of Phase 2 is therefore now estimated as CHF 70.0M.

Previous estimates have all included a substantial error in the calculation of the tape capacity required in the years 2006-8, leading to an understatement of the costs. The February 2002 cost estimate was thus understated in CERN/CC/2430 (*Status and Schedule of the LHC Machine, Experiments and Computing, 12 March 2002*) as CHF 63.7M instead of the correct figure of CHF 71.2M. The new cost estimate, including the deferred infrastructure costs, is therefore 10% more than the number that was used for the current budget planning.

Membership of the Cost Estimate Task Force

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Related documents

1. Detailed requirements and cost calculations are available in an Excel workbook prepared by Bernd Panzer-Steindel - version 14, 28 July 2003 - (http://www.cern.ch/lcg/peb/documents/recosting_july03.xls)
2. *CERN-LCG-PEB-2003-017 Explanatory Notes for Costs Estimates for LHC Tier 0/1 Computing Resources at CERN*, Bernd Panzer-Steindel, Gordon Lee, 25 July 2003 (http://www.cern.ch/lcg/peb/documents/recosting_july03.doc)
3. CMS Update for CERN T0/1 Re-Costing Exercise, David Stickland, May 2003, Version 2.1, (<http://cms-project-ccs.web.cern.ch/cms-project-ccs/ctdr/cms%20recosting.pdf>)
4. ATLAS requirements at LHC startup, September 2003, (<http://atlas.web.cern.ch/Atlas/GROUPS/SOFTWARE/OO/computing-model/StartupResources.html>)

⁵ This is explained in *CERN-C-RRB-2002-05 - LCG Phase 1 Project Resources at CERN*, October 2002 (http://lcg.web.cern.ch/LCG/C-RRB/2002-05/RRB2_Report1610.doc)