Worldwide LHC Computing Grid

REPORT ON PROJECT STATUS, RESOURCES AND FINANCIAL PLAN

COMPUTING RESOURCES REVIEW BOARD
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This status report covers the period from October 2012 – March 2013. Further details on progress, planning and resources, including accounting and reliability data, and detailed quarterly progress reports, can be found in the documents linked to the Progress Reports section on the WLCG web site.

CONTENTS

1. THE WLCG COLLABORATION

1.1. WLCG MOU SIGNATURE STATUS

The MoU with Slovakia for a Tier 2 site for ATLAS and ALICE was signed in October 2012.

The MoU with Russia for the new Tier 1 facilities is still in preparation, and has not yet been signed.

1.2. TIER 1 STATUS OF ASGC FOR CMS

In February 2013 the management of the Academia Sinica Grid Centre (ASGC) in Taipei, informed CERN and WLCG that it would no longer be able to provide Tier 1 or Tier 2 resources for CMS. This follows a reduction in funding of ASGC and reflects the fact that Academia Sinica has no CMS physicists. In accordance with the MoU, essential CMS archive data at Taipei will be relocated to CERN and FNAL. This is rather an unfortunate situation as it leaves CMS with no well-networked large facility in the Asia-Pacific region able to support the many Tier 2 sites in the region. ASGC will continue to provide Tier 1 services for ATLAS.

1.3. PROGRESS WITH NEW ASSOCIATE TIER 1 SITES

The Associate Tier 1 at KISTI in S. Korea is making good progress in most areas following the plans presented to the WLCG last year. In terms of resources they are on track to provide what has been pledged for ALICE, and these resources have been used in production for ALICE work. There is a delay in provisioning Tier 1 networking, the current 1 Gb/s line being upgraded to 2 Gb/s in April, and timescale for subsequent increases in capacity is not yet clear. This will be a concern for full exploitation as a Tier 1, and the situation must be followed. In terms of functional testing and reporting, however, progress is good, and first transfer tests of raw data from ALICE to KISTI began following the 2013 p-Pb run.

The two Associate Tier 1 sites in Russia are also making good progress. At both sites the resource ramp up is following the planning announced last October, and tape systems have been installed. The sites are progressing with the necessary functional testing – both for the grid services and the various experiment tests. They are not yet formally publishing accounting or reliability data. The networking to CERN via GEANT is in place at 2 Gb/s for both sites, but the integration with the LHCOPN is not yet done, by agreement with the LHCOPN group, waiting for some restructuring of services within Russia. The goal of these sites was to be ready as a full production Tier 1 for 2015 data taking, and this appears to be achievable.

2. WLCG STATUS AND OVERVIEW

2.1. THE WLCG SERVICE

During the time since the last Computing RRB meeting in October 2012 the first LHC run has ended with the conclusion of the p-p run in December, and a period of p-Pb running in Jan-Feb 2013. The experiments have acquired a significant amount of data. For the 2012-13 run some 27 PB of data was written to tape at the Tier 0. This brings the total LHC data set at CERN to around 70 PB, and the CERN data archive reaching a milestone of 100 PB total at the end of the first LHC run. Not all of the data acquired has been processed – recall that a fraction of data for CMS and ATLAS was taken with the intention of only processing it during LS1 (the so-called "parked" data). However, all of the "prompt" triggers have been processed at least once.

The data taking and operation of the WLCG infrastructure has been rather smooth during the year, with no particular operational areas of concern. Grid workloads and use of resources again continue to be consistently high with close to 100% of available CPU resource being used.

ALICE collected 1.65 PB total in 2012 and 2013, with 340 TB in 2013 (the p-Pb run). The full p-p sample has been processed once, as has the p-Pb sample. Also of note for ALICE is the significant improvement towards the end of the year in the overall efficiency of CPU use (see Section 4.1), now at a high level of around 85%, consistent with the other experiments. This was achieved by optimising the data caching in analysis work as well as moving most of the analysis into the analysis trains (rather than allowing individual user analysis jobs). ALICE consistently run around 32K simultaneous jobs, and observe good stability of the grid system. During LS1 they intend to fully reprocess the 2010/11 data samples with the same calibration schema as used for the 2012 data.

ATLAS reports a timely throughput of analyses to meet their physics needs, by fully exploiting all the resources available to them. They also have an on-going effort in software development to optimise this usage wherever possible. ATLAS have some 140k running jobs at any one time. The possibility of access to additional resources in many sites to cope with the extended running into 2013 was also very much appreciated. In 2013 and 2014 the intention is to continue analysis work, which may require some additional reprocessing of 2010-12 data, as well as the processing of the "parked" data. Also large MC samples must be produced in preparation for the 2015 run. ATLAS have also successfully demonstrated the use of the HLT farm which will provide a significant additional resource during LS1 for some workloads such as simulation.

CMS report good progress with reprocessing of the full data sample, for which they are now able to also use resources at the Tier 0. In addition they are commissioning several large Tier 2s for reconstruction of MC, making use of remote access to MC samples. CMS have also commissioned they HLT farm for offline use during LS1, and have demonstrated its use for part of the reprocessing work. They have also made use of opportunistic resources for a few weeks at San Diego Super Computer Centre (8000 cores).

LHCb have completed the reprocessing of the full 2011+12 data sample which will now be used by all analyses during LS1. They have also fully commissioned the LHCb HLT farm and have been using it for simulation work since February, providing some 55% of the simulation CPU in February even while the p-Pb data taking was in progress. As the other experiments, LS1 will be used for final reprocessing of the full 2010-12 samples, simulation in preparation for 2015, as well as ongoing

analysis work. With the use of the HLT farm their simulation work is now limited only by available storage capacity.

2.1.1. Tier 0 Performance

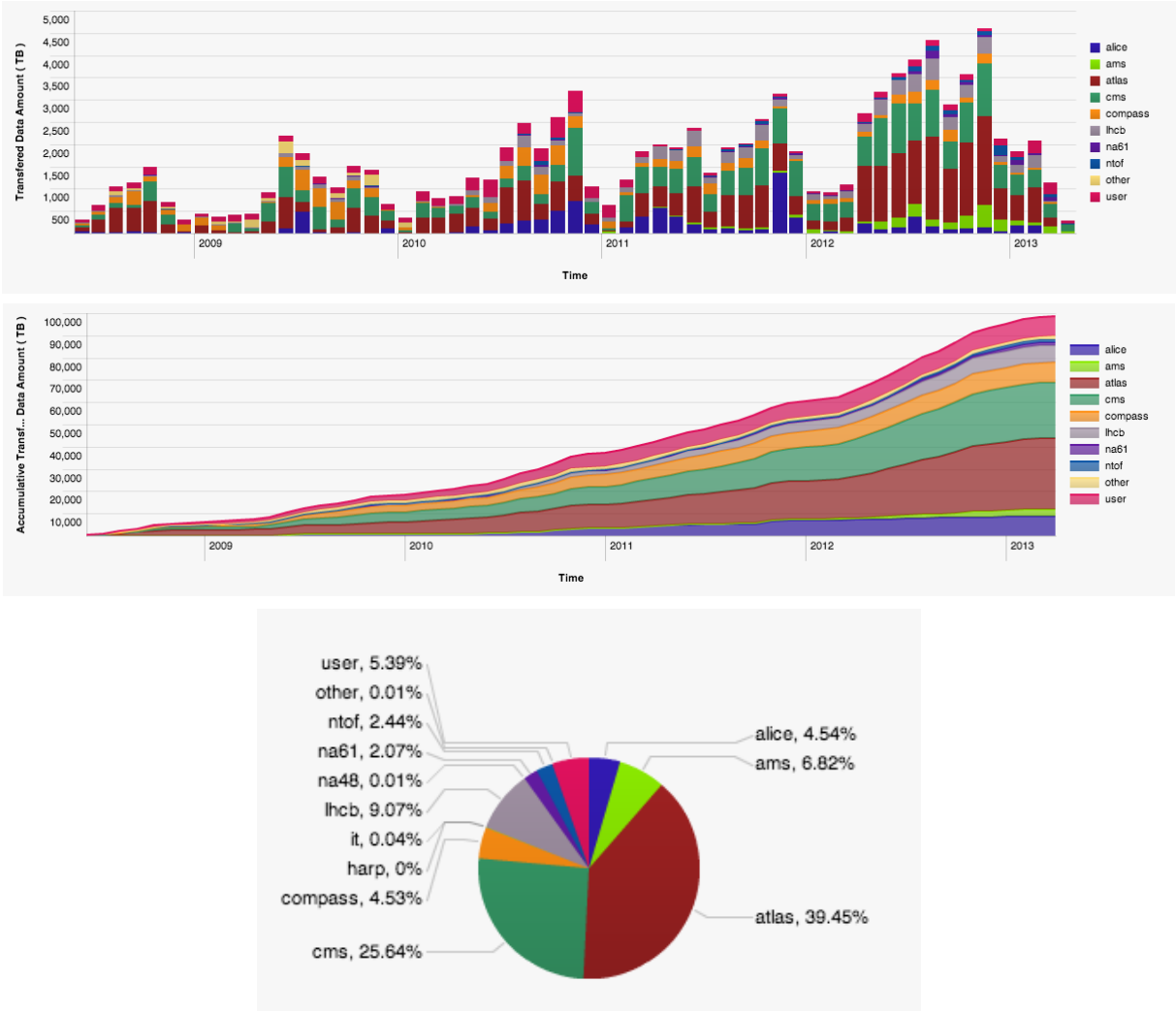

Figure 1: Data written to tape in 2010-12; (top) by month and experiment; (centre) cumulative, showing total archive reaching 100 PB; (bottom) total written by experiment in 2012 and 2013 (p-Pb)

Figure 1 shows the monthly accumulation of data in since 2010. The increased rate in 2012 is clear. The accumulated data by experiment are also shown in the Figure, where the full Tier 0 archive has now reached 100 PB.

The data rates in and out of the Tier 0 mass storage service remain at high levels, up to 4 GB/s input and around 15 GB/s output on average over a year. Instantaneous rates can be significantly higher. There are no operational problems noted in managing these high rates.

During LS1 the Tier 0 resources will be used for reconstruction, simulation, and analysis work, and should become rather more continuously used than during data taking when the usage is more peaky.

2.1.2. WLCG Workloads

Figure 2 and Figure 3 show the continued high use of the grid infrastructure in terms of the numbers of jobs and CPU usage. These figures remain at a high level almost independent of the accelerator running periods as the grid manages differing workloads at different times but always at a high level. The fact that during the year these are essentially constant is another indication that the resource is fully used.

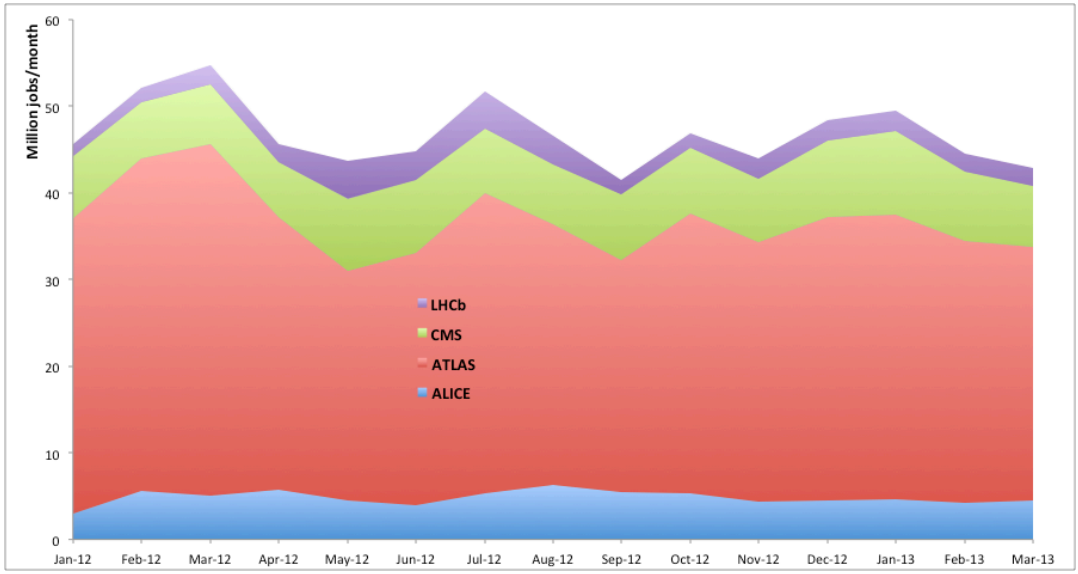

Figure 2: Continued evolution of jobs run per month

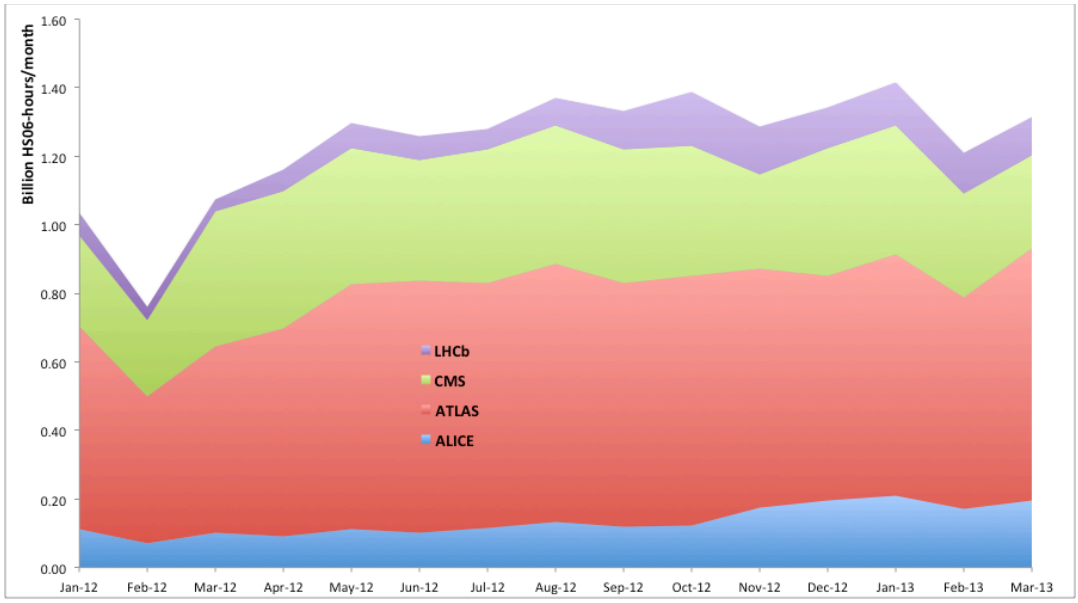

Figure 3: CPU use continues to grow; ~1.4x10^9 HS06-hours/month (equiv. to ~200 k CPU continuous use)

More details on resource usage are given in Section 4.

2.1.3. Data transfers

Data transfer rates continue to be significant – transfers from CERN to Tier 1s are stable around 2 GB/s during the LHC running, while global transfers are continually above 10 GB/s on average, and recently close to 15 GB/s average. These are shown in the Figures below.

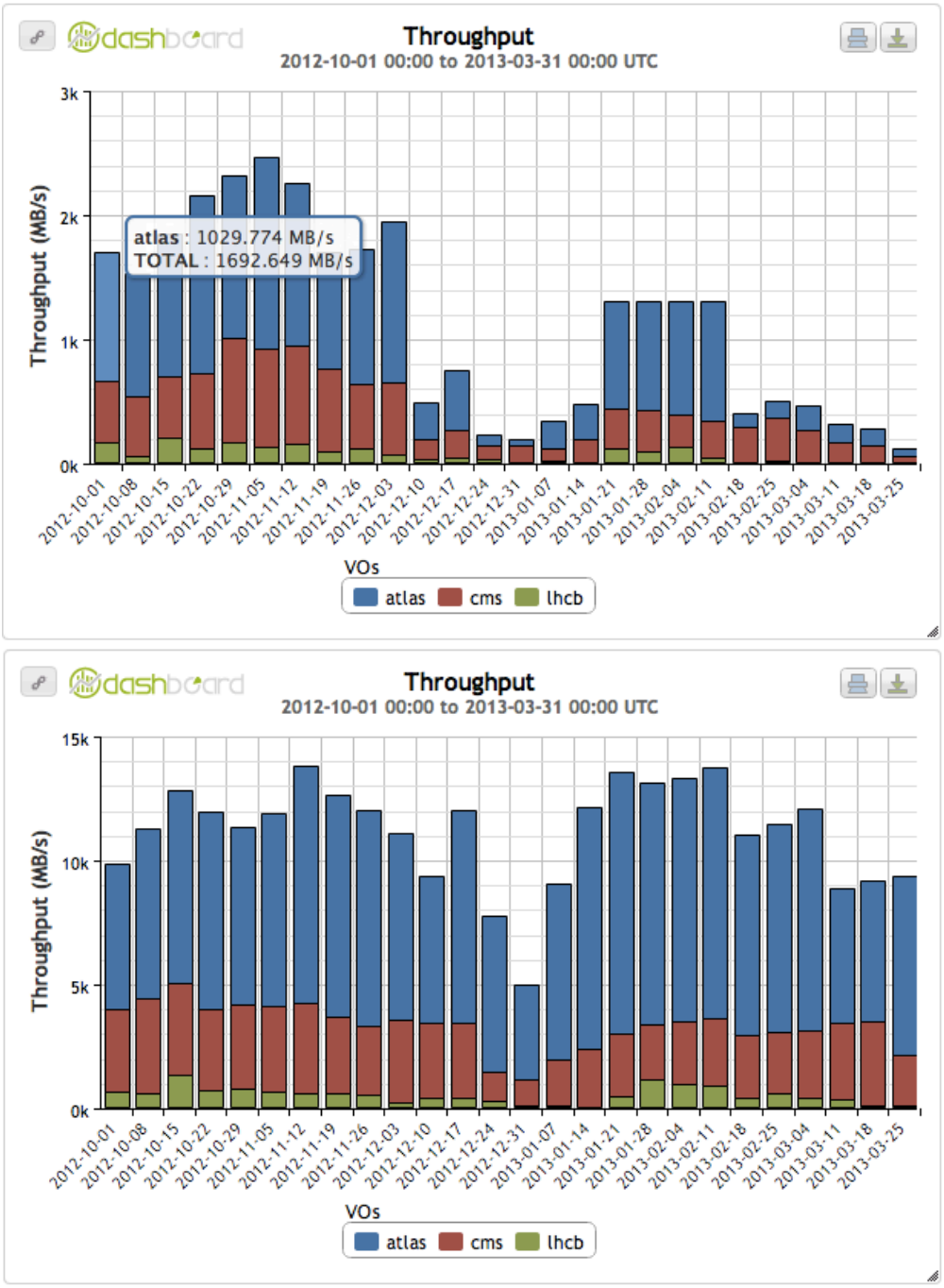

Figure 4: Data transfers: (top) CERN-Tier 1s, (bottom) global transfer rates ~15 GB/s; daily averages for the period Oct 2012-Mar 2013

The data transfers out of CERN during the period of this report clearly show the effect of the end of data taking, and the consequent reduction in data rates. However, the global transfer rates remain at a consistently high average level driven by the steady and continuous workloads, with the only noticeable change during the Christmas period.

2.1.4. WLCG Service Status

As previously described, significant service interruptions require a documented follow up (Service Incident Report). The full list for this period, summarised in the Table below, can be consulted on-line at https://twiki.cern.ch/twiki/bin/view/LCG/WLCGServiceIncidents. The number of incidents serious enough to require this documented follow up remains at a consistently low and reasonable level.

Figure 5 shows the types of incidents and how this has evolved over the last several years. Also shown in the Figure are the lengths of time needed to resolve the problems. The features of these figures have not changed in the recent reporting periods, and give no reason for concern.

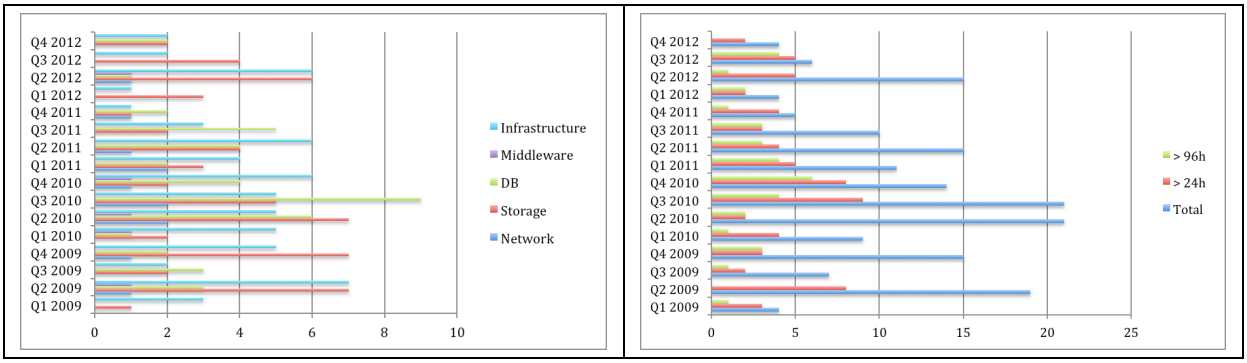

Figure 5: Service Incidents by quarter since 2009: (left) by type; (right) by time to resolve

Table 1: Service Incidents requiring follow-up: Q4 2012 –Q1 2013

Site	Service Area	Date	Duration	Service	Impact
CERN	Infrastructure	Feb 21-22	16h	VOMS	significant number of job and/or data transfer failures for all experiments throughout WLCG
CERN	Batch Computing	Feb 10	8h	Batch	Batch system was down (unavailable for users), then dispatched jobs too slowly
CERN	Storage	Jan 22	8h	CASTOR	CASTOR DB overload causing transfer slowness, mainly affecting CMS
CERN	Infrastructure	Jan 19	9h	all services relying on grid certificates,	many grid services unavailable to many users, large number of jobs lost

				at CERN and elsewhere	
PIC	Storage	Dec 10	-	dCache	LHCb tape deleted (2 unique files lost)
KIT	File Transfer, Storage Element	Nov 27th	20 hours	FTS, dCache, LFC, CondDB	German cloud down for transfers (FTS users)
RAL	all	Nov 20	50h	all	T1 services unavailable
RAL	all	Nov 7	27h	all	T1 services unavailable, 166 ATLAS files lost
CERN	Storage	Oct 16	4h	CASTOR	CASTORCMS severely degraded due to unstable DB execution plan
PIC	Storage	Oct 9	-	dCache	Accidental ATLAS data deletion

During the whole of 2012 and into 2013, the WLCG operations have been rather smooth, with no serious concerns. All experiments report good stability and availability of the sites and resources.

2.2. SITE RELIABILITY

The reliabilities for the last 6 months for CERN and the Tier 1 sites are shown in Table 2.

Table 2: WLCG Tier0/1 Site Reliability

August 2012 - January 2013

Target for each site is 97.0 %

Colors: Green > Target Orange > 90% of Target Red < 90% of Target

Average of 8 best sites (not always the same 8)

Month	Reliability
Aug 2012	100
Sep 2012	100
Oct 2012	100
Nov 2012	100
Dec 2012	100
Jan 2013	100

Average of ALL Tier 0 and Tier 1 sites

Month	Reliability
Aug 2012	99
Sep 2012	99
Oct 2012	99
Nov 2012	98
Dec 2012	99
Jan 2013	98

Site	Aug 2012	Sep 2012	Oct 2012	Nov 2012	Dec 2012	Jan 2013
CH-CERN	95	100	100	98	100	99
CA-TRIUMF	100	98	100	99	99	100
DE-KIT	100	99	100	97	100	100
ES-PIC	100	100	99	100	99	100
FR-CCIN2P3	100	100	99	100	97	99
IT-INFN-CNAF	100	100	100	98	99	92
KR-GSDC-KISTI	91	94	91	95	98	96
NDGF	100	100	100	100	100	100
NL-T1	98	98	100	97	100	97
NL-T1	100	99	100	99	94	98
TW-ASGC	98	98	100	100	98	97
UK-T1-RAL	100	100	100	89	99	100
US-FNAL-CMS	99	100	98	98	99	100
US-T1-BNL	100	100	100	100	100	99
Target	97	97	97	97	97	97

The reliability reported for the new Tier 1 at KISTI continue to improve over this period as the site gains experience and services stabilise. Full reports on the availability and reliability of all sites,

including the readiness measured by the experiments, can be consulted at http://espace.cern.ch/WLCG-document-repository/ReliabilityAvailability.

2.3. APPLICATIONS AREA

2.3.1. ROOT

The ROOT team has made steady progress toward the major ROOT 6 release, which has been delayed for some months mainly to have more time for the completion of Cling, is now expected in the spring of 2013. Development focuses now on the move from the old CINT C++ interpreter to the new Cling interpreter.

2.3.2. Persistency Framework

New releases of CORAL and COOL have been prepared in Q4 2012 for ATLAS and LHCb, including important fixes and enhancements in both packages, as well as the upgrade to the Oracle client. A major enhancement in both packages is the implementation of support for Oracle authentication using Kerberos. COOL and CORAL have also been tested with the Oracle 12c beta client in preparation for a major Oracle version upgrade. Some issues are still pending and are being followed up with the IT support team.

2.3.3. Simulation

The new Geant4 release 9.6 was announced on schedule on November 30th 2012. Release 9.6 features full event reproducibility in all physics models used in production by the LHC experiments. Many improvements to physics processes have been implemented (see latest Quarterly Report for details). A new optimized implementation of G4TessellatedSolid provides substantial CPU performance boost and reduced memory footprint, making it now suitable for import of reasonably complex structures (like the LHCb VELO foil) with hundreds of thousands of facets. Optimized tuning for parameters in G4SmartTrack, now used by default provides 4-5% reduction in total execution time for complex setups.

The latest development release made in January also includes first merging of changes required for multi-threading, ported from the Geant4-MT prototype. Reproducibility of events has been verified compared to the sequential version.

Validation results for the new release 9.6 are comparable to those obtained with the previous release series. The main change is observed in the hadronic showers for their lateral profile: showers in 9.6 are wider in Iron and Copper, and narrower in heavier absorbers, like Tungsten and Lead.

2.4. PLANNING AND EVOLUTION

2.4.1. Tier 0 Evolution

The Wigner data centre in Budapest, Hungary has now been fully refurbished, and from 1st January CERN has been able to install equipment. This is according to the original schedule. Two 100 Gb/s network connections have been provisioned between CERN and the Wigner Centre, one through GEANT, and the other commercially tendered (see Figure below). The network latencies have been measured to be around 10-12 ms (~20 - 24 ms round trip), which is very good and means that latency is unlikely to be a problem for the majority of physics processing tasks. First deliveries of CERN equipment have taken place, and the automated installation procedures tested. Over the next few months the centre will be commissioned and brought into service. As stated previously, the intention is to be able to use this new centre invisibly from the user point of view. Ultimately the centre will

provide up to an additional 2.7 MW of IT power, however in 2013 only a few hundred kW of equipment will be installed.

Figure 6: Networking between CERN and Wigner data centres: 2 independent 100 Gb/s lines

The other activity that has also concluded at the end of 2012 was the consolidation work on the existing Computer Centre (building 513). Here the key features were the provision of better cooling for the UPS system, increasing the critical UPS capacity to 600 kW and restoring the N+1 redundancy for all UPS systems that had been lost as we reached the previous power limits of the building. This work has also increased the overall capacity of the centre from 2.9 to 3.5 MW.

The Tier 0, between CERN and the Wigner centre now has sufficient power capacity for the coming years.

2.4.2. Technical Evolution of WLCG

As described in the last report, there are a number of working groups addressing many aspects of the technical evolution of the infrastructure and services. At the request of the LHCC the WLCG management will provide an update to the experiment computing models and the WLCG services. This will be a single document explaining how things have evolved since the Technical Design Reports published in 2005, and the outlook for the future. This document will also describe the computing models of the experiments in a common way (as far as possible), and give a common outlook for resource requirements and subsequent evolution. In addition it will provide a technical roadmap for the coming years. That roadmap will essentially be a summary of the work that has been done during the past 2 years in the technical working groups. This document will also emphasise what is being done to adapt to new technologies, and crucially to optimise the overall efficiency of resource usage.

The timescale of the outlook to be covered by the report is from now until LS2. It is intended that a first draft should be available for discussion with the LHCC in Autumn 2013.

3. FUNDING AND EXPENDITURE FOR WLCG AT CERN

Table 3 shows the updated current and future estimated expenditure for the years 2013-2018 inclusive based on the CERN Medium term Plan and the current WLCG Personnel and Material planning.

Table 3: LHC Computing budget estimates for 2012-2017

LHC Future Computing Funding and Expenditure Estimates
(all figures in MCHF)

	2013	2014	2015	2016	2017	2018	TOTAL
Funding							
From CERN Budget							
- Personnel	**18.0**	**17.8**	**17.8**	**18.0**	**18.4**	**18.4**	**108.3**
- Materials *	**22.1**	**22.9**	**23.4**	**20.2**	**20.2**	**20.2**	**128.9**
Contributions via Team Accounts							
- Personnel	**0.2**	**0.1**	**0.1**				**0.4**
- Materials							
Total							
- Personnel	**18.2**	**17.9**	**17.9**	**18.0**	**18.4**	**18.4**	**108.7**
- Materials	**22.1**	**22.9**	**23.4**	**20.2**	**20.2**	**20.2**	**128.9**
Total Funding	**40.3**	**40.8**	**41.3**	**38.1**	**38.6**	**38.6**	**237.6**
Expenditure							
- Personnel **	**18.6**	**18.5**	**17.7**	**17.9**	**18.1**	**18.2**	**109.0**
- Materials	**23.2**	**19.6**	**27.5**	**23.8**	**22.3**	**22.7**	**139.1**
Total Planned Expenditure	**41.8**	**38.1**	**45.3**	**41.7**	**40.3**	**41.0**	**248.1**
Balance Personnel	**-0.4**	**-0.6**	**0.1**	**0.0**	**0.4**	**0.2**	**-0.3**
Balance Materials	**-1.1**	**3.3**	**-4.1**	**-3.6**	**-2.1**	**-2.6**	**-10.2**
Balance	**-1.5**	**2.7**	**-4.0**	**-3.5**	**-1.8**	**-2.4**	**-10.5**

*** Includes 2.3 MCHF carry-forward from 2012 to 2015**
**** Excluding EGI/EMI funded personnel and Computer Centre Operators**

For personnel costs, nominative details continue to be entered in the CERN APT planning tool, including current personnel commitments, planned replacements and estimates for on-going recruitment from 2013 and beyond. There is little discrepancy relative to the budget and factors such as internal mobility, resignations, and later than expected start dates can impact these figures at any time.

The Materials planning is based on the current LCG resource planning, based on provisional requirements that evolve frequently, and on the latest LHC accelerator schedule. There are large uncertainties in predicted costs for 2015 onwards, in particular the estimates of the experiment computing requirements for 2015 and subsequent years. In what is shown here the full request of the experiments for resources at the Tier 0 has been assumed to be satisfied. The fluctuations in spending from year to year are driven by specific anticipated expenditures such as commissioning the remote

Tier 0 and network equipment replacements. The cost estimates are less reliable for future years, and will evolve with time.

4. RESOURCES

4.1. RESOURCE ACCOUNTING

Full accounting reports are published monthly for the Tier 0, Tier 1, and Tier 2 sites. These reports are archived in the WLCG Document Repository.

4.1.1. CERN and Tier 1 Accounting

Figure 7: Accounting for Tier 0 + Tier 1s; Jan 2012 - Feb 2013

Figure 7 shows the summary of the usage of CPU, Disk, and Tape at the Tier 0 and Tier 1 sites for 2012 and the first months of 2013. The use is compared globally with the pledges and installed capacity in this Figure, while in Figure 8 the experiments' use of CPU is compared to the pledges directly. As can be seen, the Tier 1 use is close to 100% almost all of the time. It is also clear that at certain times (e.g. early in the year, when the following year pledges start to be installed) the experiments are able to use more than the nominal pledges.

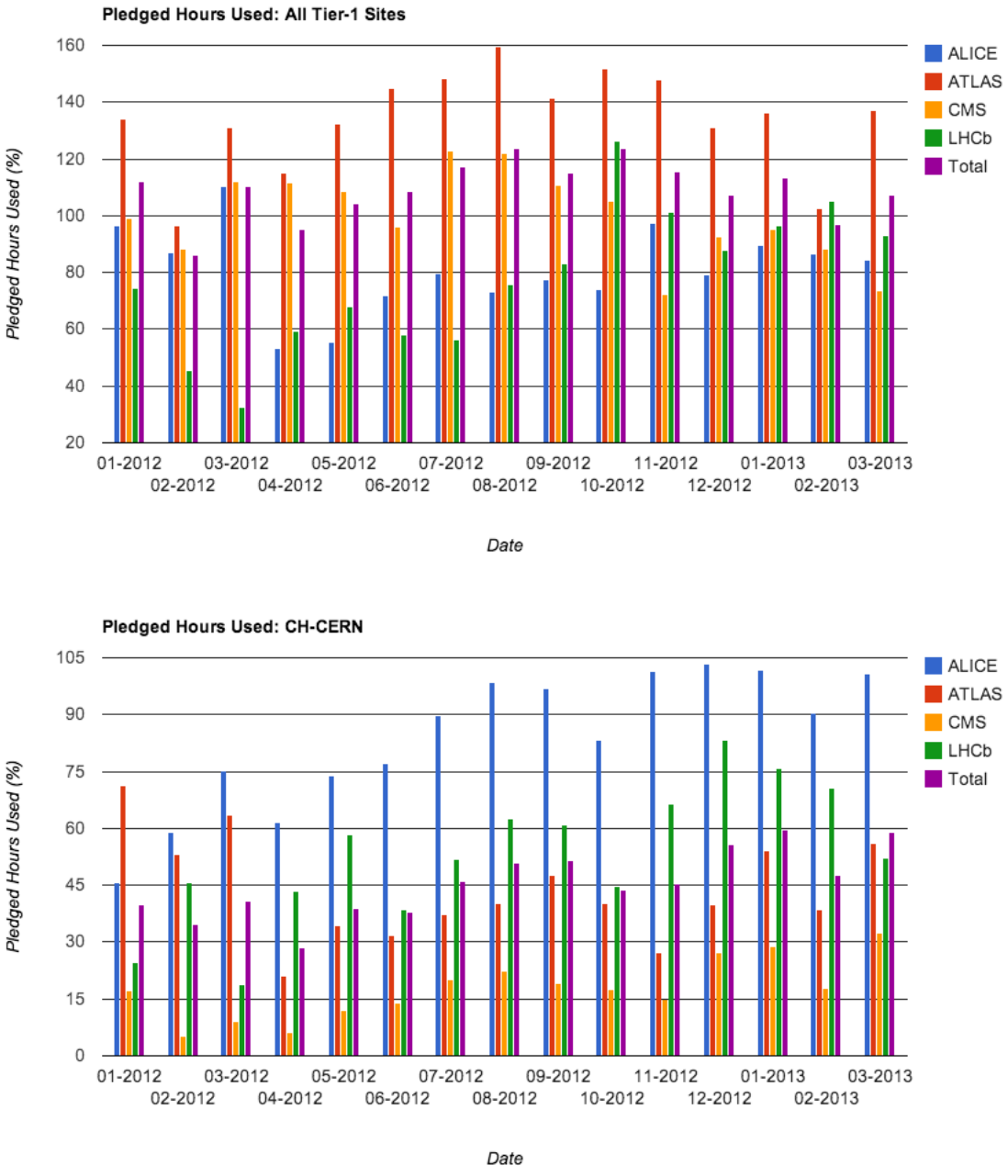

Figure 8: Comparison of CPU usage with pledges for 2012+13;(top) CERN; (bottom) Tier 1s

As noted earlier, the previous problems with low CPU efficiency for ALICE have been addressed through a series of actions, and these have improved the situation for the production and organised analysis activities, and the current situation has an efficiency comparable with the other experiments. This can be seen in Figure 7.

4.1.2. Tier 2 Accounting

Tier 2 accounting reports can also be found in the WLCG Document Repository.

Figure 9 shows the cumulative Tier 2 CPU delivered during 2012 and the first part of 2013 by country. This partitioning is very close to that expected from the pledge values.

Figure 10 compares the Tier 2 CPU delivered in 2012 and 2013 to date with the pledges, for each experiment and overall. Again, as was observed with the Tier 1s the overall use is at or even above 100% (indicating that often more resources are available than actually pledged).

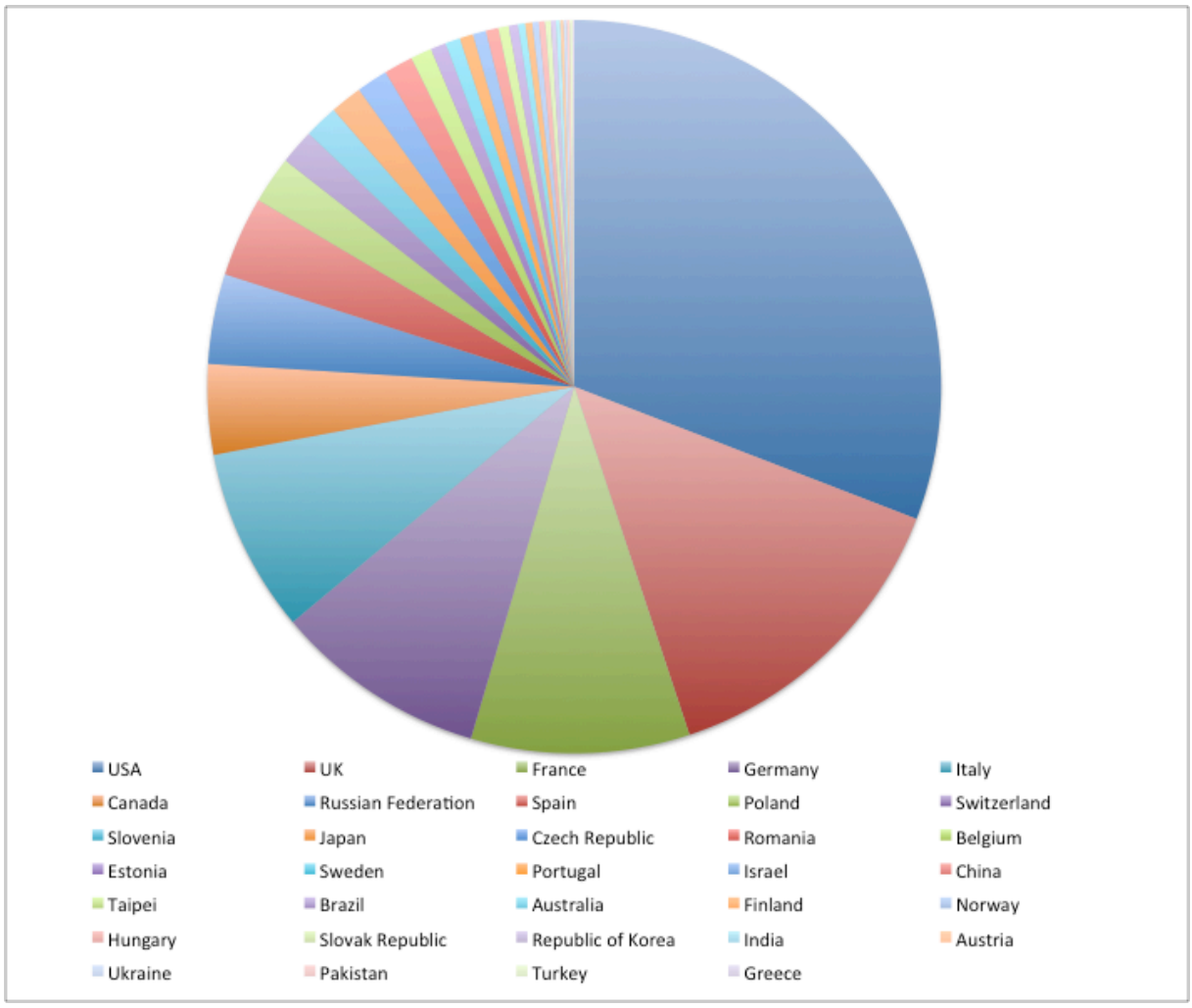

Figure 9: Tier 2 cumulative CPU time delivered by Country (Jan 2012 - Mar 2013)

As noted in the last report it is clear from Figures 8 and 10 that ATLAS has access to a fairly significant amount of CPU in addition to the formally pledged amounts, both at Tier 1s and particularly at Tier 2 sites.

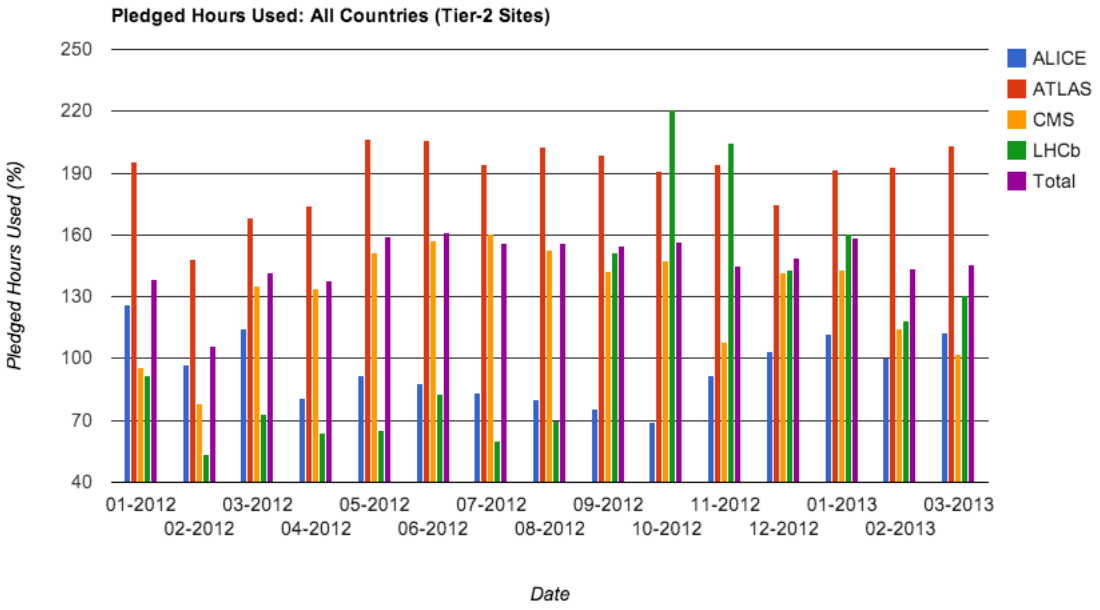

Figure 10: Comparison of CPU usage with pledges for 2012: Tier 2s

The comparison plots of CPU against pledge (such as Figure 8, 10) can be obtained from the MyWLCG portal (http://grid-monitoring.cern.ch/mywlcg/trends/) and in particular can be obtained country by country for the Tier 2s.

4.2. STATUS OF EXPERIMENT REQUIREMENTS AND RESOURCE PLEDGES

As described at an earlier previous RRB meeting, the requirements and pledges are now managed through the online REBUS tool. Figure 11 gives a snapshot of the situation for 2013 and 2014 as of March 2013 (but this can be consulted using the REBUS tool at any time). The annexes of this report give the detailed breakdown by experiment and federation for 2012, 2013 and 2014.

For 2013 this reflects the situation following the previous RRB, with the confirmed pledges and the requirements as agreed by the Scrutiny Group. The 2014 summary reflects the current understanding of the situation, but will be updated following this RRB with the outcome of the scrutiny of the updated experiment requirements.

Tier	Pledge Type	ALICE	Required	Balance	ATLAS	Required	Balance	CMS	Required	Balance	LHCb	Required	Balance	SUM	Required	Balance
Tier 0	CPU (HEP-SPEC06)	90,000	126,000	-29%	111,000	111,000	0%	121,000	121,000	0%	34,000	34,000	0%	356,000	392,000	-9%
Tier 0	Disk (Tbytes)	8,100	11,000	-26%	10,000	11,000	-9%	7,000	7,000	0%	4,000	4,400	-9%	29,100	33,400	-13%
Tier 0	Tape (Tbytes)	22,800	22,800	0%	27,000	23,000	17%	26,000	26,000	0%	6,500	6,500	0%	82,300	78,300	5%
Tier 1	CPU (HEP-SPEC06)	101,155	120,000	-16%	333,023	319,000	4%	149,650	165,000	-9%	92,118	110,000	-16%	675,946	714,000	-5%
Tier 1	Disk (Tbytes)	7,649	10,800	-29%	36,066	33,000	9%	23,961	26,000	-8%	6,997	8,600	-19%	74,673	78,400	-5%
Tier 1	Tape (Tbytes)	14,119	21,000	-33%	41,263	40,000	3%	48,176	50,000	-4%	9,461	10,800	-12%	113,019	121,800	-7%
Tier 2	CPU (HEP-SPEC06)	143,006	145,000	-1%	395,773	350,000	13%	399,606	350,000	14%	46,972	46,000	2%	985,357	891,000	11%
Tier 2	Disk (Tbytes)	11,282	15,800	-29%	48,797	49,000	0%	28,976	26,000	11%	69	0	0%	89,124	90,800	-2%

Tier	Pledge Type	ALICE	Required	Balance	ATLAS	Required	Balance	CMS	Required	Balance	LHCb	Required	Balance	SUM	Required	Balance
Tier 0	CPU (HEP-SPEC06)	90,000	135,000	-33%	111,000	111,000	0%	121,000	121,000	0%	34,000	34,000	0%	356,000	401,000	-11%
Tier 0	Disk (Tbytes)	8,100	11,040	-27%	10,000	11,000	-9%	7,000	7,000	0%	4,000	5,500	-27%	29,100	34,540	-16%
Tier 0	Tape (Tbytes)	26,600	26,100	2%	31,000	23,000	35%	25,300	26,000	-3%	7,300	7,300	0%	90,200	82,400	9%
Tier 1	CPU (HEP-SPEC06)	99,724	130,000	-23%	326,731	355,000	-8%	149,850	175,000	-14%	75,618	110,000	-31%	651,923	770,000	-15%
Tier 1	Disk (Tbytes)	6,940	10,800	-36%	33,123	33,000	0%	22,466	26,000	-14%	5,888	10,400	-43%	68,417	80,200	-15%
Tier 1	Tape (Tbytes)	13,572	23,900	-43%	42,877	44,000	-3%	44,560	55,000	-19%	8,217	11,900	-31%	109,226	134,800	-19%
Tier 2	CPU (HEP-SPEC06)	135,548	200,000	-32%	398,523	350,000	14%	390,438	350,000	12%	37,292	46,000	-19%	961,801	946,000	2%
Tier 2	Disk (Tbytes)	10,243	15,800	-35%	46,853	49,000	-4%	28,847	27,000	7%	65	0	0%	86,008	91,800	-6%

Figure 11: Summary of pledge situation for 2013 and 2014: Experiment requirements as confirmed at October 2012 RRB, compared to current pledge data. 2014 pledge data is incomplete.

4.2.1.1. Future resource requirements

For 2015, first estimates of likely requirements were shown at the October 2012 RRB. In the following months these have evolved somewhat, with the overall requirement now less than a factor 2 above the 2013 pledges. The figure below shows the comparison given the present understanding of the potential requirements. While this looks like a significant increase, it is nevertheless within what could be expected from normal growth over the 2 years, assuming a flat budget. There are still quite some uncertainties in these estimates of the need, and these are expected to evolve over the next year. The estimates assume a certain running scenario in 2015, corresponding to the experience in 2010, and given that experience, it is likely that the full resource would not need to be in place until the second half of the year.

However, it is clear that we must continue to maintain the capability to fully exploit the data that will be produced by the LHC and the detectors. **It is thus essential that the funding for the Tier 0, Tier 1 and Tier 2 centres be maintained at a level sufficient to provide resource increases in line with those that have been requested over the past several years.** As can be seen from recent reporting all of the resources requested by the experiments are fully used on a continual basis, and indeed significant non-pledged resources are also used well.

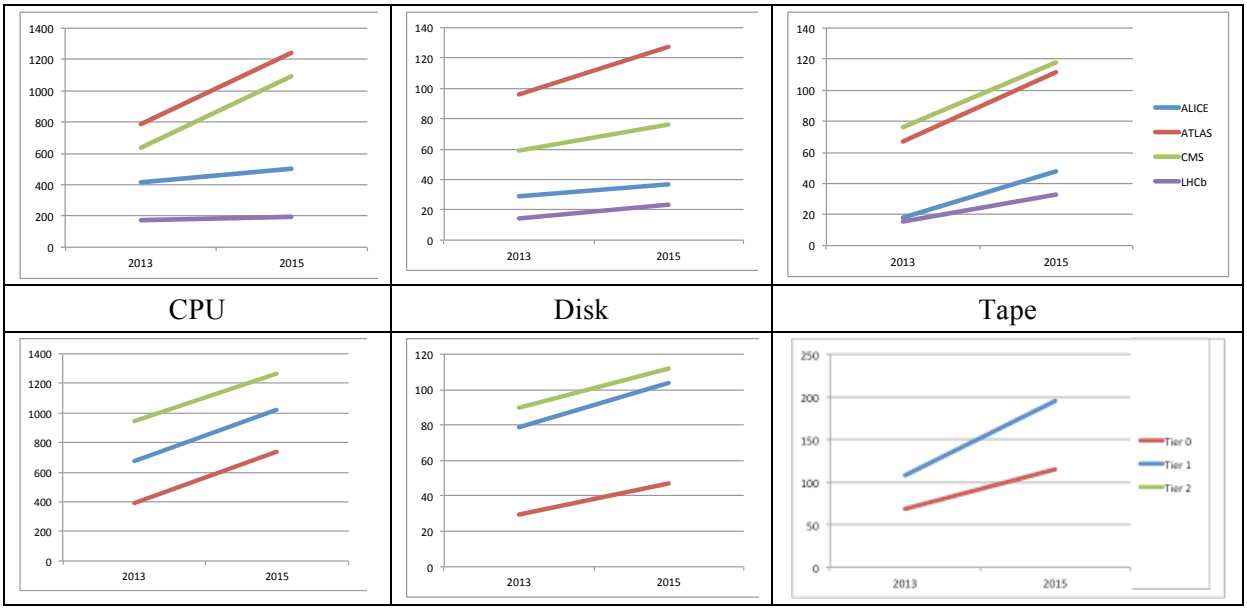

Figure 12: Comparison of 2013 capacity and estimated needs in 2015; (top) by experiment; (bottom) by Tier; for CPU (left), Disk (centre), Tape (right)

5. ANNEX: TIER 0, 1, 2 RESOURCES

WLCG Tier 0-1 Resources

Situation on 26 March 2013

CERN-RRB-2013-015

Annex 1

CERN Tier0 / CAF	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	356000	356000	356000	Offered	90000	111000	121000	34000	356000
				Required	126000	111000	121000	34000	392000
				% of Req.	**71%**	**100%**	**100%**	**100%**	**91%**
Disk (Tbytes)	27600	29100	29100	Offered	8100	10000	7000	4000	29100
				Required	11000	11000	7000	4400	33400
				% of Req.	**74%**	**91%**	**100%**	**91%**	**87%**
Tape (Tbytes)	67400	82300	90200	Offered	22800	27000	26000	6500	82300
				Required	22800	23000	26000	6500	78300
				% of Req.	**100%**	**117%**	**100%**	**100%**	**105%**

Canada Tier1	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	25900	31900	37300	Offered		31900			31900
				% of Total		10%			10%
Disk (Tbytes)	2700	3500	3600	Offered		3500			3500
				% of Total		11%			11%
Tape (Tbytes)	3600	4300	5300	Offered		4300			4300
				% of Total		11%			11%

KIT	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	106580	106575	106575	Offered	30000	39875	17500	19200	106575
				% of Total	25%	13%	11%	17%	15%
Disk (Tbytes)	9885	10875	10875	Offered	2700	4125	2600	1450	10875
				% of Total	25%	13%	10%	17%	14%
Tape (Tbytes)	15900	17050	17050	Offered	5250	5000	5000	1800	17050
				% of Total	25%	13%	10%	17%	14%

IN2P3 Lyon (Note 1)	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	68100	67350	0	Offered	7700	31350	11800	16500	67350
				% of Total	6%	10%	7%	15%	9%
Disk (Tbytes)	6480	7000	0	Offered	710	3540	1550	1200	7000
				% of Total	7%	11%	6%	14%	9%
Tape (Tbytes)	8800	10025	0	Offered	1050	3500	4075	1400	10025
				% of Total	5%	9%	8%	13%	8%

INFN CNAF	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	85000	88050	88050	Offered	18500	30300	22750	16500	88050
				% of Total	15%	9%	14%	15%	12%
Disk (Tbytes)	8500	9680	9680	Offered	1700	3300	3380	1300	9680
				% of Total	16%	10%	13%	15%	12%
Tape (Tbytes)	14100	15800	15800	Offered	3700	4000	6500	1600	15800
				% of Total	18%	10%	13%	15%	13%

Netherlands LHC/Tier1	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	55083	55083	55083	Offered	6220	35015		13848	55083
				% of Total	5%	11%		13%	10%
Disk (Tbytes)	4743	4743	4743	Offered	279	3456		1008	4743
				% of Total	3%	10%		12%	9%
Tape (Tbytes)	5393	6339	6475	Offered	74	4165		2100	6339
				% of Total	0%	10%		19%	9%

NDGF Tier1	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	25764	29010	28752	Offered	11775	17235			29010
				% of Total	10%	5%			7%
Disk (Tbytes)	2690	2710	2687	Offered	1080	1630			2710
				% of Total	10%	5%			6%
Tape (Tbytes)	3672	4280	4251	Offered	2155	2125			4280
				% of Total	10%	5%			7%

GSDC-KISTI (Note 2)	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	18800	25000	31250	Offered	25000				25000
				% of Total	21%				21%
Disk (Tbytes)	1000	1000	1000	Offered	1000				1000
				% of Total	9%				9%
Tape (Tbytes)	500	1500	2000	Offered	1500				1500
				% of Total	7%				7%

Spain PIC	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	26367	30804	33558	Offered		16269	8925	5610	30804
				% of Total		5%	5%	5%	5%
Disk (Tbytes)	2984	3550	3692	Offered		1785	1326	439	3550
				% of Total		5%	5%	5%	5%
Tape (Tbytes)	4743	5345	6370	Offered		2193	2601	551	5345
				% of Total		5%	5%	5%	5%

Taipei ASGC	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	33075	33874	39055	Offered		17199	16675		33874
				% of Total		5%	10%		7%
Disk (Tbytes)	3920	4275	4600	Offered		2250	2025		4275
				% of Total		7%	8%		7%
Tape (Tbytes)	4710	4000	4000	Offered		2000	2000		4000
				% of Total		5%	4%		4%

UK Tier1 (Note 3)	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	62055	76300	76300	Offered	1960	39880	14000	20460	76300
				% of Total	2%	13%	8%	19%	11%
Disk (Tbytes)	7118	8240	8240	Offered	180	4380	2080	1600	8240
				% of Total	2%	13%	8%	19%	11%
Tape (Tbytes)	10116	11780	11780	Offered	390	5380	4000	2010	11780
				% of Total	2%	13%	8%	19%	10%

US-ATLAS Tier1	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	60000	74000	86000	Offered		74000			74000
				% of Total		23%			23%
Disk (Tbytes)	6300	8100	8300	Offered		8100			8100
				% of Total		25%			25%
Tape (Tbytes)	8300	8600	12200	Offered		8600			8600
				% of Total		22%			22%

US-CMS Tier1	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	58000	58000	70000	Offered			58000		58000
				% of Total			35%		35%
Disk (Tbytes)	10000	11000	11000	Offered			11000		11000
				% of Total			42%		42%
Tape (Tbytes)	22000	24000	24000	Offered			24000		24000
				% of Total			48%		48%

Summary Ext. Tier1s	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	624724	675946	651923	Offered	101155	333023	149650	92118	675946
				Required	120000	319000	165000	110000	714000
				Balance	-16%	4%	-9%	-16%	-5%
Disk (Tbytes)	66320	74673	68417	Offered	7649	36066	23961	6997	74673
				Required	10800	33000	26000	8600	78400
				Balance	-29%	9%	-8%	-19%	-5%
Tape (Tbytes)	101834	113019	109226	Offered	14119	41263	48176	9461	113019
				Required	21000	40000	50000	10800	121800
				Balance	-33%	3%	-4%	-12%	-7%

Ext. Tier1 Requ. 2013	ALICE	ATLAS	CMS	LHCb	SUM
CPU (HEP-SPEC06)	120,000	319,000	165,000	110,000	714,000
Disk (Tbytes)	10,800	33,000	26,000	8,600	78,400
Tape (Tbytes)	21,000	40,000	50,000	10,800	121,800

TIER 1 Notes

Note 1: France : No input from France for 2014.

Note 2: GSDC-KISTI : Associate Tier-1 approved at WLCG Overview Board on 9 March 2012, expected to provide full Tier-1 services within a year.

Note 3: UK : UK Tape is provisioned on demand. The full pledge will not be deployed until required.

See also the online WLCG Resources Pledges database at: **http://wlcg-rebus.cern.ch/apps/pledges/resources/**

Australia, University of Melbourne	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	6500	7000	8800	Offered		7000			7000
				% of Total		2%			1%
Disk (Tbytes)	700	800	920	Offered		800			800
				% of Total		2%			1%

Austria, Austrian Tier-2 Federation	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	5057	5057	5057	Offered		1857	3200		5057
				% of Total		1%	1%		1%
Disk (Tbytes)	420	620	420	Offered		120	500		620
				% of Total		0%	2%		1%

Belgium, Belgian Tier-2 Fed. FNRS/FWO	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	9600	12000	12000	Offered			12000		12000
				% of Total			3%		3%
Disk (Tbytes)	1560	1850	1850	Offered			1850		1850
				% of Total			7%		7%

Brazil, SPRACE, Sao Paulo	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	10000	13698	13698	Offered			13698		13698
				% of Total			4%		4%
Disk (Tbytes)	720	787	787	Offered			787		787
				% of Total			3%		3%

Canada, Canada-East Federation	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	6650	8875	10200	Offered		8875			8875
				% of Total		3%			3%
Disk (Tbytes)	1175	1325	1400	Offered		1325			1325
				% of Total		3%			3%

Canada, Canada-West Federation	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	6650	8875	10200	Offered		8875			8875
				% of Total		3%			3%
Disk (Tbytes)	1175	1325	1400	Offered		1325			1325
				% of Total		3%			3%

China, IHEP, Beijing	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	9600	9600	9600	Offered		4800	4800		9600
				% of Total		1%	1%		1%
Disk (Tbytes)	640	640	640	Offered		320	320		640
				% of Total		1%	1%		1%

Czech Rep., FZU, Prague	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	15000	13000	13000	Offered	5000	8000			13000
				% of Total	3%	2%			3%
Disk (Tbytes)	1450	1521	1350	Offered	621	900			1521
				% of Total	4%	2%			2%

Estonia, NICPB, Tallinn	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	10000	45000	45000	Offered			45000		45000
				% of Total			13%		13%
Disk (Tbytes)	750	1000	1000	Offered			1000		1000
				% of Total			4%		4%

Finland, NDGF/HIP Tier-2	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	6300	6300	6300	Offered			6300		6300
				% of Total			2%		2%
Disk (Tbytes)	520	520	520	Offered			520		520
				% of Total			2%		2%

France, CC-IN2P3 AF, Lyon	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	23850	23850	0	Offered	2300	9750	6600	5200	23850
				% of Total	2%	3%	2%	11%	3%
Disk (Tbytes)	2030	2120	0	Offered	300	1310	510	0	2120
				% of Total	2%	3%	2%	-	2%

France, CPPM, Marseille	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	4264	6014	0	Offered		4014		2000	6014
				% of Total		1%		4%	2%
Disk (Tbytes)	404	604	0	Offered		600		4	604
				% of Total		1%		-	1%

France, GRIF, Paris	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	29053	30779	0	Offered	5850	10527	10360	4042	30779
				% of Total	4%	3%	3%	9%	3%
Disk (Tbytes)	2748	2861	0	Offered	474	1617	770	0	2861
				% of Total	3%	3%	3%	-	3%

France, IPHC, Strasbourg	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	11000	11000	11000	Offered	3500		7500		11000
				% of Total	2%		2%		2%
Disk (Tbytes)	800	800	800	Offered	200		600		800
				% of Total	1%		2%		2%

France, LAPP, Annecy	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	4800	6400	6400	Offered		4800		1600	6400
				% of Total		1%		3%	2%
Disk (Tbytes)	462	622	602	Offered		620		2	622
				% of Total		1%		-	1%

France, LPC, Clermont	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	6527	7027	7027	Offered	2278	3360		1389	7027
				% of Total	2%	1%		3%	1%
Disk (Tbytes)	677	796	796	Offered	178	616		2	796
				% of Total	1%	1%		-	1%

France, LPSC Grenoble	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	4222	4172	0	Offered	1252	2920			4172
				% of Total	1%	1%			1%
Disk (Tbytes)	519	574	0	Offered	125	449			574
				% of Total	0%	0%			0%

France, Subatech, Nantes	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	3000	3000	3000	Offered	3000				3000
				% of Total	2%				2%
Disk (Tbytes)	310	310	310	Offered	310				310
				% of Total	2%				2%

Germany, ATLAS Federation, DESY	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	12000	14400	14400	Offered		14400			14400
				% of Total		4%			4%
Disk (Tbytes)	1500	1560	1600	Offered		1560			1560
				% of Total		3%			3%

Germany, ATLAS Federation, U. Goettingen	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	3853	3853	3853	Offered		3853			3853
				% of Total		1%			1%
Disk (Tbytes)	1000	1000	1000	Offered		1000			1000
				% of Total		2%			2%

Germany, CMS Federation DESY RWTH Aachen	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	23625	26690	26400	Offered			26690		26690
				% of Total			8%		8%
Disk (Tbytes)	1950	1950	2000	Offered			1950		1950
				% of Total			8%		8%

Germany, DESY-LHCb	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	3200	3200	3200	Offered				3200	3200
				% of Total				7%	7%
Disk (Tbytes)	2	2	2	Offered				2	2
				% of Total				-	-

Germany, GSI, Darmstadt	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	7000	7000	7000	Offered	7000				7000
				% of Total	5%				5%
Disk (Tbytes)	550	550	550	Offered	550				550
				% of Total	3%				3%

Germany, ATLAS Federation Munich	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	11560	10537	10780	Offered		10537			10537
				% of Total		3%			3%
Disk (Tbytes)	1340	1423	1383	Offered		1423			1423
				% of Total		3%			3%

Germany, ATLAS Fed. Freiburg Wuppertal	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	8860	6504	5240	Offered		6504			6504
				% of Total		2%			2%
Disk (Tbytes)	1566	1308	1128	Offered		1308			1308
				% of Total		3%			3%

Greece, HEP Laboratory, University of Ioannina	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	3040	1870	1870	Offered			1870		1870
				% of Total			1%		1%
Disk (Tbytes)	200	200	200	Offered			200		200
				% of Total			1%		1%

Hungary, HGCC Federation	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	3760	4300	5280	Offered	1100		3200		4300
				% of Total	1%		1%		1%
Disk (Tbytes)	204	282	324	Offered	72		210		282
				% of Total	0%		1%		1%

India, VECC/SINP, Kolkata	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	6000	6000	6000	Offered	6000				6000
				% of Total	4%				4%
Disk (Tbytes)	240	240	240	Offered	240				240
				% of Total	2%				2%

India, TIFR, Mumbai	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	3000	7100	7100	Offered			7100		7100
				% of Total			2%		2%
Disk (Tbytes)	700	900	900	Offered			900		900
				% of Total			3%		3%

Israel, IL-HEP Tier-2 Federation	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	4800	5400	6200	Offered		5400			5400
				% of Total		2%			2%
Disk (Tbytes)	735	840	900	Offered		840			840
				% of Total		2%			2%

Italy, INFN T2 Federation	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	102100	115500	115500	Offered	30000	33000	45500	7000	115500
				% of Total	21%	9%	13%	15%	13%
Disk (Tbytes)	8200	9400	9400	Offered	2400	3500	3500		9400
				% of Total	15%	7%	13%		10%

Japan, ICEPP, Tokyo	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	12000	16000	20000	Offered		16000			16000
				% of Total		5%			5%
Disk (Tbytes)	1200	1600	2000	Offered		1600			1600
				% of Total		3%			3%

Republic of Korea, KISTI, Daejeon	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	600	600	600	Offered	600				600
				% of Total	0%				0%
Disk (Tbytes)	50	50	50	Offered	50				50
				% of Total	0%				0%

Republic of Korea, CHEP of KNU, Daegu	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	3600	6000	6100	Offered			6000		6000
				% of Total			2%		2%
Disk (Tbytes)	250	299	300	Offered			299		299
				% of Total			1%		1%

Norway, UNINETT SIGMA Tier2	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	3275	3190	3190	Offered		3190			3190
				% of Total		1%			1%
Disk (Tbytes)	488	490	490	Offered		490			490
				% of Total		1%			1%

Pakistan, Pakistan Tier-2 Federation	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	5440	6365	6365	Offered			6365		6365
				% of Total			2%		2%
Disk (Tbytes)	300	300	350	Offered			300		300
				% of Total			1%		1%

Poland, Polish Tier-2 Federation	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	15800	17200	19200	Offered	4600	5340	4530	2730	17200
				% of Total	3%	2%	1%	6%	2%
Disk (Tbytes)	1010	1060	1120	Offered	325	465	270		1060
				% of Total	2%	1%	1%		1%

Portugal, LIP Tier-2 Federation	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	6400	6400	6400	Offered		3200	3200		6400
				% of Total		1%	1%		1%
Disk (Tbytes)	420	420	420	Offered		220	200		420
				% of Total		0%	1%		1%

Romania, Romanian Tier-2 Federation	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	32800	34500	37500	Offered	16000	14700		3800	34500
				% of Total	11%	4%		8%	6%
Disk (Tbytes)	2050	2120	2400	Offered	1240	840		40	2120
				% of Total	8%	2%		-	3%

Russian Federation, RDIG (note 1)	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	51498	69776	77716	Offered	18256	24171	27293	56	69776
				% of Total	13%	7%	8%	0%	8%
Disk (Tbytes)	4429	4972	5345	Offered	1301	1722	1945	4	4972
				% of Total	8%	4%	7%	-	5%

Slovak Republic, Slovak Tier2 Federation	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	8050	9600	-	Offered	4800	4800			9600
				% of Total	3%	1%			1%
Disk (Tbytes)	280	360	-	Offered	180	180			360
				% of Total	1%	0%			0%

Slovenia, SiGNET, Jozef Stefan Inst.	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	12000	15000	17000	Offered		15000			15000
				% of Total		4%			4%
Disk (Tbytes)	900	900	1100	Offered		900			900
				% of Total		2%			2%

Spain, ATLAS Federation	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	13300	16050	22200	Offered		16050			16050
				% of Total		5%			5%
Disk (Tbytes)	2350	2800	3000	Offered		2800			2800
				% of Total		6%			6%

Spain, CMS Federation	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	15750	20000	20000	Offered			20000		20000
				% of Total			6%		6%
Disk (Tbytes)	1300	1500	1500	Offered			1500		1500
				% of Total			6%		6%

Spain, LHCb Federation	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	2800	2800	2800	Offered				2800	2800
				% of Total				6%	6%
Disk (Tbytes)	1	1	1	Offered				1	1
				% of Total				-	-

Sweden, SNIC Tier2	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	7870	7870	7870	Offered	2820	5050			7870
				% of Total	2%	1%			2%
Disk (Tbytes)	920	920	920	Offered	400	520			920
				% of Total	3%	1%			1%

Switzerland, CHIPP, Manno	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	17670	28000	28000	Offered		14200	9200	4600	28000
				% of Total		4%	3%	10%	4%
Disk (Tbytes)	1226	1650	1650	Offered		995	645	10	1650
				% of Total		2%	2%	-	2%

Taipei, Taiwan Analysis Facility Federation	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	5320	6000	7580	Offered		3000	3000		6000
				% of Total		1%	1%		1%
Disk (Tbytes)	600	650	850	Offered		390	260		650
				% of Total		1%	1%		1%

Turkey, Turkish Tier-2 Federation	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	9800	9800	9800	Offered		5100	4700		9800
				% of Total		1%	1%		1%
Disk (Tbytes)	900	900	900	Offered		550	350		900
				% of Total		1%	1%		1%

UK, London	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	26225	27547	27547	Offered		10621	15717	1209	27547
				% of Total		3%	4%	3%	4%
Disk (Tbytes)	3079	3033	3033	Offered		1609	1423	1	3033
				% of Total		3%	5%	-	4%

UK, NorthGrid	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	15953	17049	17049	Offered		14118		2931	17049
				% of Total		4%		6%	4%
Disk (Tbytes)	2170	1842	1842	Offered		1841		1	1842
				% of Total		4%		-	4%

UK, ScotGrid	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	9635	9430	9430	Offered		6521		2909	9430
				% of Total		2%		6%	2%
Disk (Tbytes)	1291	1121	1121	Offered		1120		1	1121
				% of Total		2%		-	2%

UK, SouthGrid	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	17536	21349	21349	Offered	3320	4240	12283	1506	21349
				% of Total	2%	1%	4%	3%	2%
Disk (Tbytes)	1585	1863	1863	Offered	316	729	817	1	1863
				% of Total	2%	1%	3%	-	2%

Ukraine, Ukrainian Tier-2 Federation	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	4690	6930	9000	Offered	930		6000		6930
				% of Total	1%		2%		1%
Disk (Tbytes)	380	500	650	Offered	150		350		500
				% of Total	1%		1%		1%

USA, LBNL ALICE Berkeley CA	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	12000	12900	18000	Offered	12900				12900
				% of Total	9%				9%
Disk (Tbytes)	1020	1200	1450	Offered	1200				1200
				% of Total	8%				8%

USA, LLNL ALICE, Livermore CA	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	11500	11500	11500	Offered	11500				11500
				% of Total	8%				8%
Disk (Tbytes)	650	650	650	Offered	650				650
				% of Total	4%				4%

USA, Northeast ATLAS T2	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	12500	15000	17000	Offered		15000			15000
				% of Total		4%			4%
Disk (Tbytes)	1648	2217	2342	Offered		2217			2217
				% of Total		5%			5%

USA, Southwest ATLAS T2	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	12500	15000	17000	Offered		15000			15000
				% of Total		4%			4%
Disk (Tbytes)	2200	2217	2342	Offered		2217			2217
				% of Total		5%			5%

USA, Midwest ATLAS T2	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	12500	22000	26000	Offered		22000			22000
				% of Total		6%			6%
Disk (Tbytes)	2200	3325	3513	Offered		3325			3325
				% of Total		7%			7%

USA, Great Lakes ATLAS T2	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	12500	15000	17000	Offered		15000			15000
				% of Total		4%			4%
Disk (Tbytes)	2200	2217	2342	Offered		2217			2217
				% of Total		5%			5%

USA, SLAC ATLAS T2	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	12500	15000	17000	Offered		15000			15000
				% of Total		4%			4%
Disk (Tbytes)	2200	2217	2342	Offered		2217			2217
				% of Total		5%			5%

USA, Caltech CMS T2	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	12500	12500	12500	Offered			12500		12500
				% of Total			4%		4%
Disk (Tbytes)	1000	1000	1100	Offered			1000		1000
				% of Total			4%		4%

USA, Florida CMS T2	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	12500	12500	12500	Offered			12500		12500
				% of Total			4%		4%
Disk (Tbytes)	1000	1000	1100	Offered			1000		1000
				% of Total			4%		4%

USA, MIT CMS T2	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	12500	12500	12500	Offered			12500		12500
				% of Total			4%		4%
Disk (Tbytes)	1000	1000	1100	Offered			1000		1000
				% of Total			4%		4%

USA, Nebraska CMS T2	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	12500	12500	12500	Offered			12500		12500
				% of Total			4%		4%
Disk (Tbytes)	1000	1000	1100	Offered			1000		1000
				% of Total			4%		4%

USA, Purdue CMS T2	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	12500	12500	12500	Offered			12500		12500
				% of Total			4%		4%
Disk (Tbytes)	1000	1000	1100	Offered			1000		1000
				% of Total			4%		4%

USA, UC San Diego CMS T2	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	12500	12500	12500	Offered			12500		12500
				% of Total			4%		4%
Disk (Tbytes)	1000	1000	1100	Offered			1000		1000
				% of Total			4%		4%

USA, U. Wisconsin CMS T2	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	12500	12500	12500	Offered			12500		12500
				% of Total			4%		4%
Disk (Tbytes)	1000	1000	1100	Offered			1000		1000
				% of Total			4%		4%

Summary Tier2s with Split in 2013	2012	2013	2014	Split 2013	ALICE	ATLAS	CMS	LHCb	SUM 2013
CPU (HEP-SPEC06)	828333	985357	961801	Offered	143006	395773	399606	46972	985357
				Required	145000	350000	350000	46000	891000
				Balance	-1%	13%	14%	2%	11%
Disk (Tbytes)	81264	89124	86008	Offered	11282	48797	28976	69	89124
				Required	15800	49000	26000	0	90800
				Balance	-29%	0%	11%	-	-2%

Requirements 2013	ALICE	ATLAS	CMS	LHCb	SUM
CPU (HEP-SPEC06)	145,000	350,000	350,000	46,000	891000
Disk (Tbytes)	15,800	49,000	26,000	0	90800
Number of T2s					68

TIER 2 Notes

Note 1: Russia: CPU breakdown between VOs is not normally calculated as all CPU resources in all sites are available for all experiments. For the sake of REBUS, the 2013 disk VO allocation percentage has been used to calculate the theoretical breakdown between VOs.

See also the online WLCG Resources Pledges database at: **http://wlcg-rebus.cern.ch/apps/pledges/resources/**