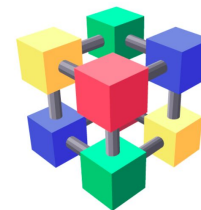# HEP Computing in Slovenia

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Ljubljana

Introduction

- Overview of HEP computing resources
- Involvement HEP experiment & theory
- Computing software development
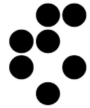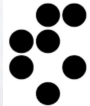- Slovenian computing organization
- Plans and outlook

SiGNET Tier-2

- Site dedicated to ATLAS and Belle II
  - Opportunistic usage by PAO, CTA, others including National TV cartoon rendering
- 6700 cores
- 3.5PB of storage as a part of Nordic Tier-1 dCache (~40% ATLAS space)
- 750TB of shared CephFS
- 20Gb/s connectivity to Geant LHCONE
- Contributing 2-3% to ATLAS

History

- IJS contributed to CPLEAR simulation from 1990
  - HP 9000 workstation cluster, VAX VMS
  - Convex: C3860 in 1990, Convex SPP-1000 in 1993
- Joined WLCG in 2003
  - SiGNET Tier-2 with 40 CPUs and 100TB disk through Nordugrid
- Participation in:
  - EGEE I, II, III, EGI projects
  - Member of Nordugrid collaboration since 2010
- Establishment of Slovenian National Grid Initiative SLING in 2010
  - To promote grid/distributed computing in Slovenia
  - General purpose cluster/HPC at ARNES using grid middleware to serve Slovenian science and academy using HEP distributed computing technologies

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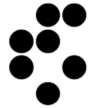
Compute

- Hardware procurement on yearly basis, spending ~300k euro/year since 2003 (manpower, OPEX not included)
- CPUs are a mixture ranging from older AMD 8-core Opteron, some Intel and latest AMD 32-core Epyc, with 64-core Zen2 coming this year
- Procurement always governed by price/performance optimization (cost/HEPSPEC06)
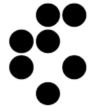
Storage

- Dedicated servers with external RAID-6 controllers, Infortrend EonStore
- Newest upcoming units 1PB/server
- Throughput ~6GB/s
- Storage servers run dCache pool service directly attached to NDGF-T1
  - HW and basic OS operated by IJS
  - dCache service maintained centrally by NDGF team
  - DataLake prototype in production for >10 years

Networking ARNES

- IJS LHCONE - 20Gb/s
- ARNES LHCONE - 30 Gb/s
- LHCONE - 40Gb/s in total

- Plans: N*100 Gb/s in 2020/2021 pending ARNES backbone upgrade

GRID NETWORKS (primarne&backup)

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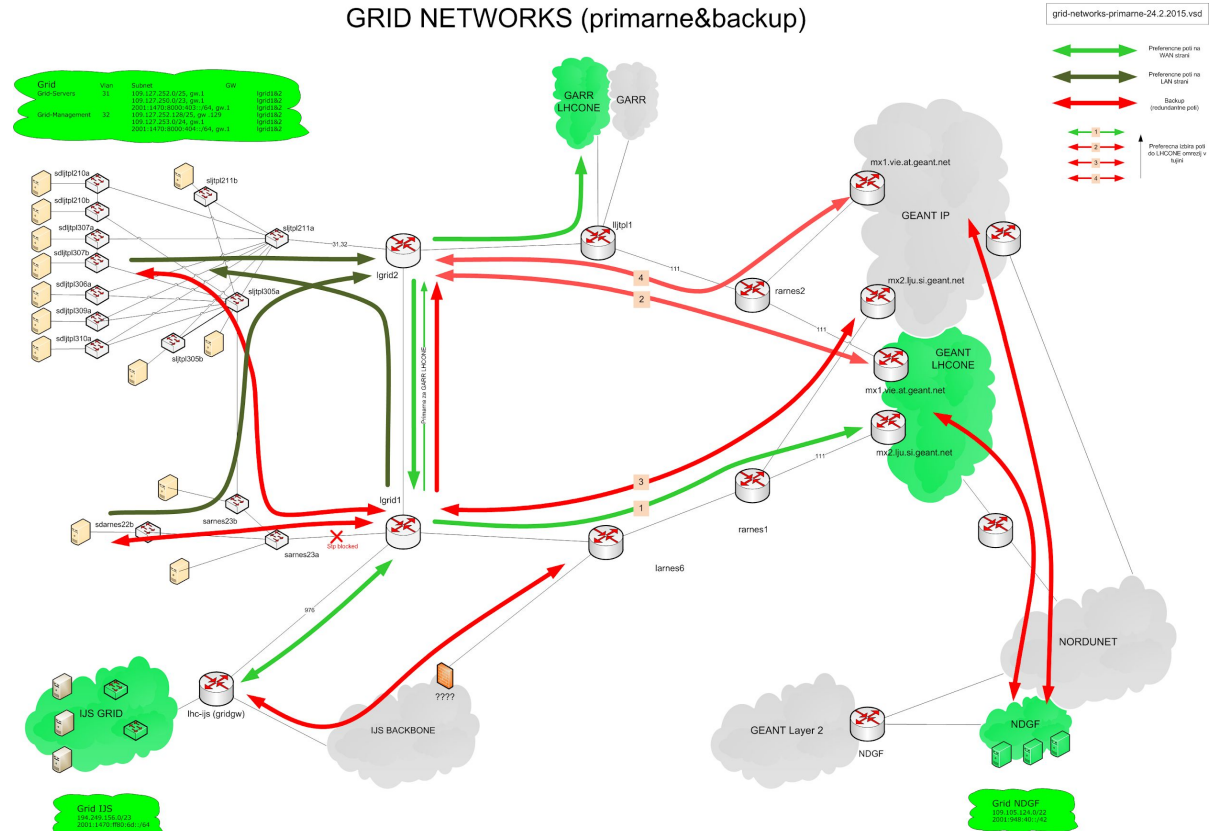
Computing activities in HEP Community

- ~3 FTEs for site maintenance & operations, ATLAS & Belle computing operations, computing software development
- Development of ARC middleware in Nordugrid Collaboration
- Development of arcControlTower
  - ATLAS distributed job submission
  - Personal Analysis job management system, to be used by SLING
- Prototyping ATLAS@Home contributing volunteer CPU resources to ATLAS
- Prototyping access to HPC resources for ATLAS MC Simulation
  - Including 4 Chinese HPCs during Run-1
  - Used today for all EU HPCs
- WLCG projects, Task Force
- Helping new sites to join ATLAS
- Attracting CS students (diploma, thesis)

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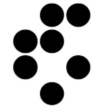
HEP Clusters

- ● SiGNET Tier-2
  - ○ ATLAS, Belle
- ● NSC HPC cluster @ IJS
  - ○ 2000 cores
  - ○ ~20% used by ATLAS
- ● ARNES HPC cluster:
  - ○ 4500 cores
  - ○ ~50% used by ATLAS and Belle

Note: missing data in EGI Accounting - in reality 8000 cores on average

Elapsed time * Number of Processors (hours) by Resource Centre and Month

ARNES — SiGNET

Elapsed time * Number of Processors (hours) by VO and Month

atlas — belle — ops — ops.ndgf.org
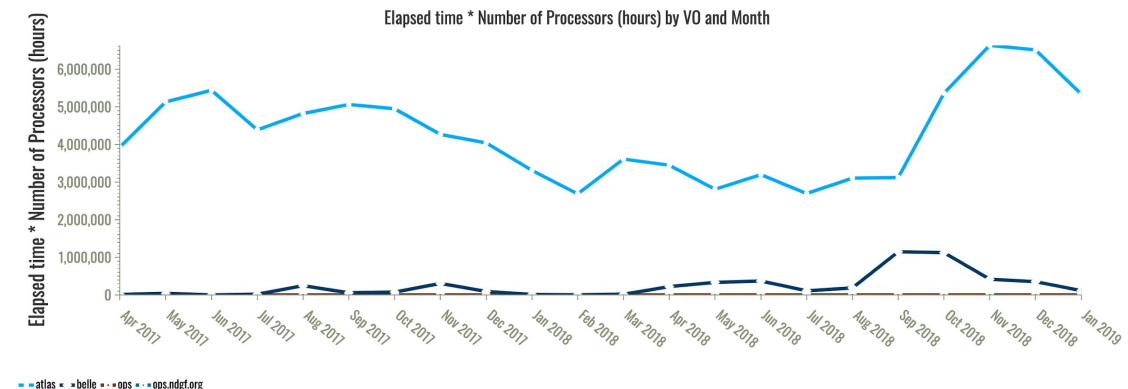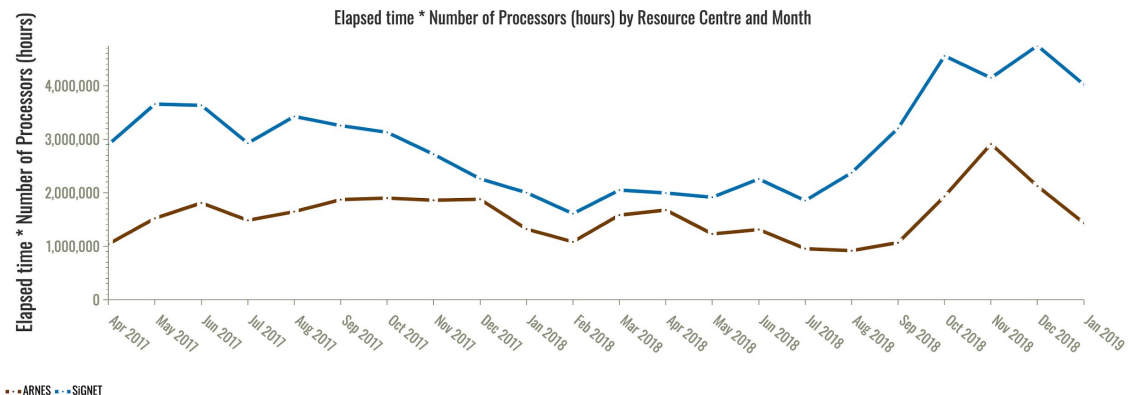
ATLAS

- Pledges:
  - 2010: 5200 HS06, 350TB
  - 2015: 20000 HS06, 1500TB
  - 2019: 50000 HS06, 4000TB
- Marginal data loss in the last 15 years, none due to disk failure
- Pioneering containers since 2016 on modern host OS
- Significant beyond pledge CPU
  - And even disk space

Slots of Running Jobs
117 Weeks from Week 01 of 2017 to Week 13 of 2019

Maximum: 10,206 , Minimum: 0.00 , Average: 7,719 , Current: 6,382
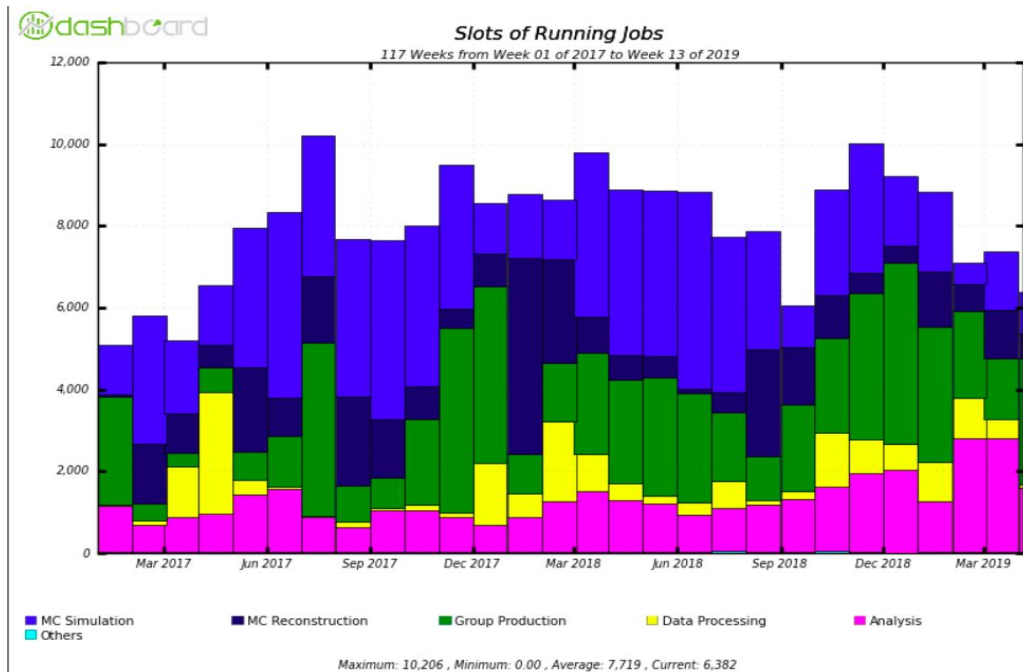
Belle II

- Joined Belle computing in 2008
- Pledges:
  - 2020: 11.900 HS06, 0.5 PB
  - 2024: 29.200 HS06, 1.8 PB

Total Space by site
(18 Weeks from Week 39 of 2018 to Week 05 of 2019)
~30 sites

Max: 9.93, Average: 8.91, Current: 9.92

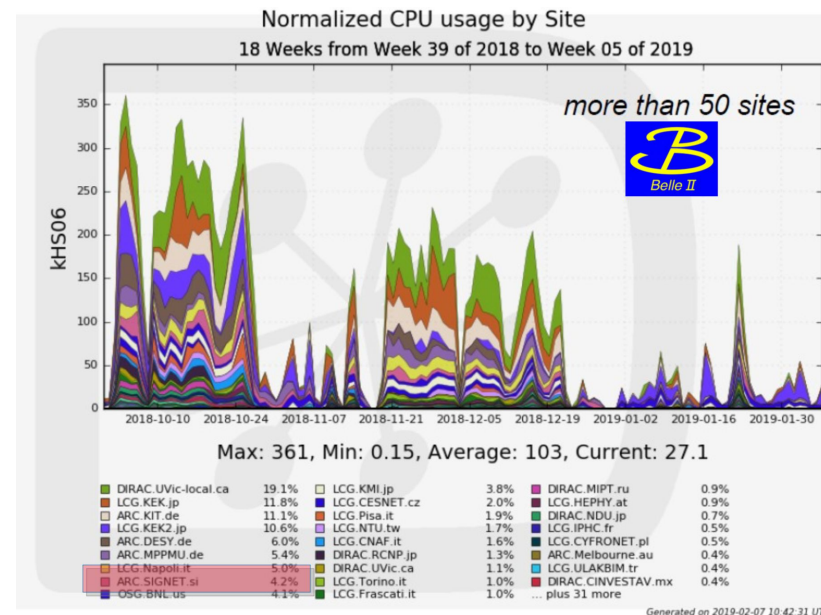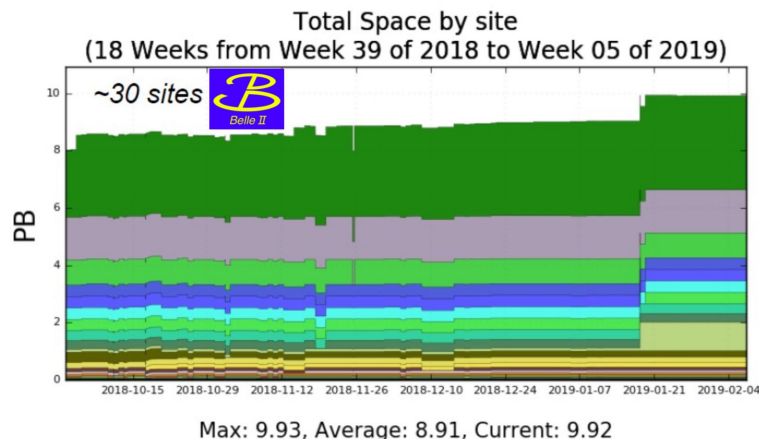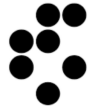|							
KEK2-TMP-SE	34.7%	KMI-TMP-SE	3.3%	Adelaide-TMP-SE	0.6%	LAL-TMP-SE	0.1%
BNL-TMP-SE	16.8%	KEK-DISK-TMP-SE	2.8%	ULAKBIM-TMP-SE	0.4%	Torino-TMP-SE	0.0%
NTUCC-TMP-SE	9.7%	UVic-TMP-SE	2.6%	Melbourne-TMP-SE	0.2%	Roma3-TMP-SE	0.0%
SIGNET-TMP-SE	4.6%	KEK-TMP-SE	2.2%	HEPHY-TMP-SE	0.1%	CINVESTAV-TMP-SE	0.0%
DESY-TMP-SE	4.5%	MPPMU-TMP-SE	1.5%	Frascati-TMP-SE	0.1%	PNNL-TMP-SE	0.0%
KIT-TMP-SE	4.5%	KISTI-TMP-SE	1.2%	CYFRONET-TMP-SE	0.1%	IPHC-TMP-SE	0.0%
Napoli-TMP-SE	4.3%	CESNET-TMP-SE	1.0%	Pisa-TMP-SE	0.1%		
CNAF-TMP-SE	3.9%	TAU-TMP-SE	0.7%	NTU-TMP-SE	0.1%		

Normalized CPU usage by Site
18 Weeks from Week 39 of 2018 to Week 05 of 2019
more than 50 sites

Max: 361, Min: 0.15, Average: 103, Current: 27.1

DIRAC.UVic-local.ca	19.1%	LCG.KMI.jp	3.8%	DIRAC.MIPT.ru	0.9%
LCG.KEK.jp	11.8%	LCG.CESNET.cz	2.0%	LCG.HEPHY.at	0.9%
ARC.KIT.de	11.1%	LCG.Pisa.it	1.9%	DIRAC.NDU.jp	0.7%
LCG.KEK2.jp	10.6%	LCG.NTU.tw	1.7%	LCG.IPHC.fr	0.5%
ARC.DESY.de	6.0%	LCG.CNAF.it	1.6%	LCG.CYFRONET.pl	0.5%
ARC.MPPMU.de	5.4%	DIRAC.RCNP.jp	1.3%	ARC.Melbourne.au	0.4%
LCG.Napoli.it	5.0%	DIRAC.UVic.ca	1.1%	LCG.ULAKBIM.tr	0.4%
ARC.SIGNET.si	4.2%	LCG.Torino.it	1.0%	DIRAC.CINVESTAV.mx	0.4%
OSG.BNL.us	4.1%	LCG.Frascati.it	1.0%	... plus 31 more	

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- DIRAC for job submission
- DDM converging to Rucio

Theory - Quantum field theory on the lattice

used by Sasa Prelovsek Komelj (IJS F1, FMF @ University of Ljubljana, University of Regensburg) & collaborators

computer	cores •hours	typical number of cores run in parallel	collaborators	physics problem
Spinon F1 IJS Ljubljana	2 million	500	Skerbis, Bahtiyar, Petkovic	conventional and exotic hadrons
Dirac Great Britain	7 million	2000	Drach, Janowski, Pica	Strongly coupled field theories beyond Standard Model, composite Higgs models
Athene Regensburg	10 million	1000	Collins, Piemonte, Padmanath	scattering of hadrons
Vienna scientific Cluster Sauron @Graz	0.3 million	128	Graz group and JLQCD	chromodynamics at high temperatures

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SLING

- Slovenian Initiative for Distributed Supercomputing
  - Established in 2010
  - Consortium formally established in 2018 legally represented by ARNES
- Roles:
  - Promote computing in Slovenia
  - Collaborate on computing research and activities
  - Educate and outreach
  - Participate in planning and computing strategy of Republic of Slovenia
- ~20 members from Slovenian universities, research institutes, ministries and SMEs
  - Essentially, all organizations involved in computing - grid, HPC and Cloud - are members
- Representing Slovenia in PRACE, EuroHPC, WLCG and other organizations
- Collaboration with other European and International organizations
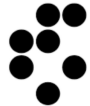
HPC-RIVR

- 20M euro project to establish a national competitive HPC center in Slovenia
  - Funded by EC cohesion 2018-2020
- Located at IZUM in Maribor
  - 10% before this summer
  - The rest will follow during the next 15 months
- All SLING members participate in design, procurement and operation
- Planned capacity:
  - >50k CPU cores with HDR-100 infiniband and 100Gb/s ethernet
  - 30PB of CEPH storage
  - Dedicated GPU partition with ~500 NVIDIA cards
- A significant part will be used by HEP experiments,

EuroHPC

- Slovenia is a full member of the EuroHPC project
- Planning to submit an application for one of the peta-scale EuroHPC machines extending the HPC-RIVR project
- Slovenia joined Italy in application for pre-exascale Hosting Entity
  - In-kind contribution of 1M euro for a period of 5 years, manpower from SLING
  - MoU signed by SLING and Assoziacione BigData
  - MoU signed between Italian Republic and Republic of Slovenia to collaborate on supercomputing
- Research & Innovation
  - 4M euro Slovenian+EC funding planned for a period of 5 years
  - HEP community is participating

Conclusion and Prospects

- Slovenia is participating in HEP computing for more than 30 years and participates above the average in both resources, development and manpower
- Success of HEP computing helped to form stronger collaboration in computing at the national level through SLING
- Slovenia joined EuroHPC and plans to enhance the supercomputing in the country with HEP as a constituent member of the computing community
- HEP Computing in Slovenia has a bright future