DE LA RECHERCHE À L'INDUSTRIE

CEA SITE REPORT

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SLURM User Group - September 2018 | R.Gaudin

Agenda

CEA Computing Center

Focus on Tera1000

Using slurm at CEA

CEA Computing Center

CEA/DAM/DIF

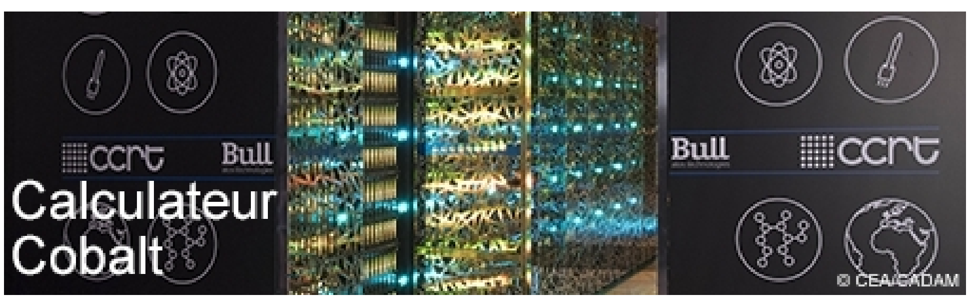
Military Application Division of the French Atomic Energy Commission

- Ile de France, Paris Area division of CEA
- Bruyères-le-chatel (30km south of Paris)
- Involved in 3 major HPC projects

HPC Projects

CCRT

- French Industrial and research partners shared computing center
- Project started in 1998
- Hosted at TGCC “Tres grand centre de calcul du CEA”
- Cobalt Supercomputer
  - 1422 nodes bi-sockets 28 cores Intel® Xeon® E5 Broadwell
  - 128 Go memory per node
  - InfiniBand EDR interconnect.



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HPC Projects

GENCI

- Project Started in 2007

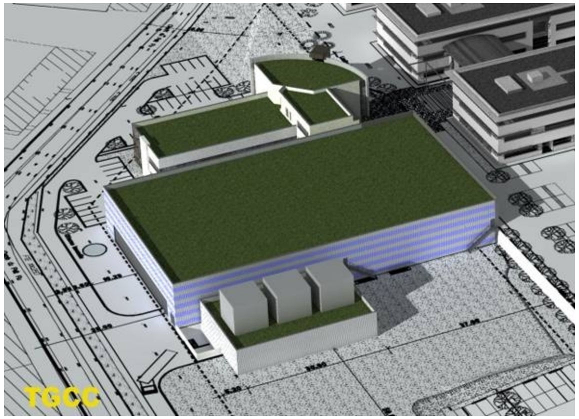
- Hosted at TCCC “Tres grand Centre de Calcul du CEA”
  - Owned by GENCI “Grand Equipement National pour le Calcul Intensif”
  - European research project

    PRACE “Partnership for Advanced Computing in Europe”

- Irene Supercomputer
  - 1656 x 24 cores Intel Skylake 8168 bi-sockets nodes
  - 192 GB of DDR4 memory / node
  - InfiniBand EDR interconnect.

  and

  - 666 x monosocket 68 cores Intel KNL 7250
  - 96 GB memory/node + 16 GB MCDRAM memory/node,
  - Bull eXascale Interconnect (BXI).



HPC Projects

TERA

- Hosted at CEA Defense computing Center
- Project started in 1998
  - Part of the Simulation project for French Nuclear Deterrence

2001 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19

TERA-1: 5 Tflops

TERA-10: 60 Tflops

TERA-100 : 1000 Tflops

TERA-1000 : 12PFlops

TERA

- TERA-1K supercomputer
  - Installed between 2015 and 2016
  - 2 clusters T1K1.2 and T1K2.2 :

~ 2200 nodes of bi-sockets 32 cores INTEL haswell
~ 125GB memory per node
Infiniband Interconnect

~ 8000 nodes monosocket 68 cores in 29 Bull Sequana with Intel KNL
~ 190GB memory + 16GB MCDRAM per node
Bull eXascale Interconnect (BXI).
12000 TFlops

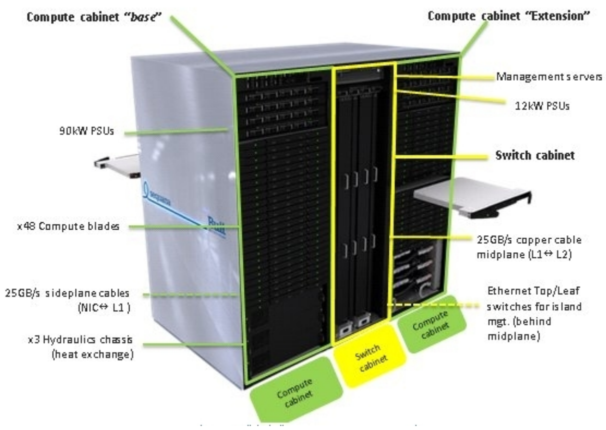
Focus on TERA1K2.2

Focus on TERA1000

Architecture T1K2.2

- Computing Islands x 29
  - ATOS/BULL Sequana “islands”of 276 nodes (8004 nodes) managed by 2 machines named ISMA

    + 30th island contains 24 Skylakes nodes completed with KNL
  - BULL/ATOS BXI Interconnect

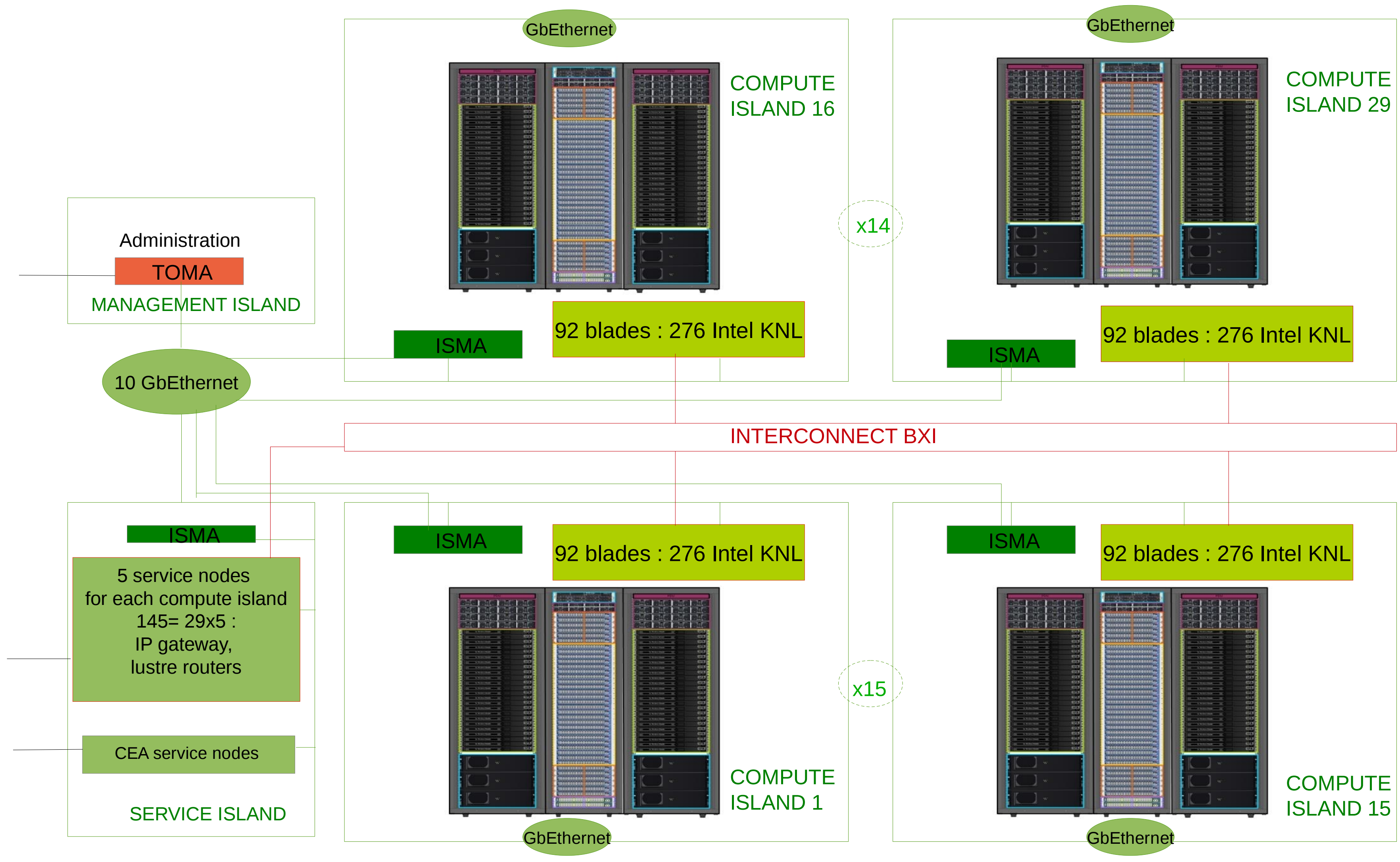


- Service Island
  - 2 ISMA nodes
  - 16 CEA services nodes
  - 5 service nodes (lustre router, gateway) x 29 (for each compute island)
- Management Island

  2 management nodes named TOMA for managing total ISMA nodes

Focus on TERA1000

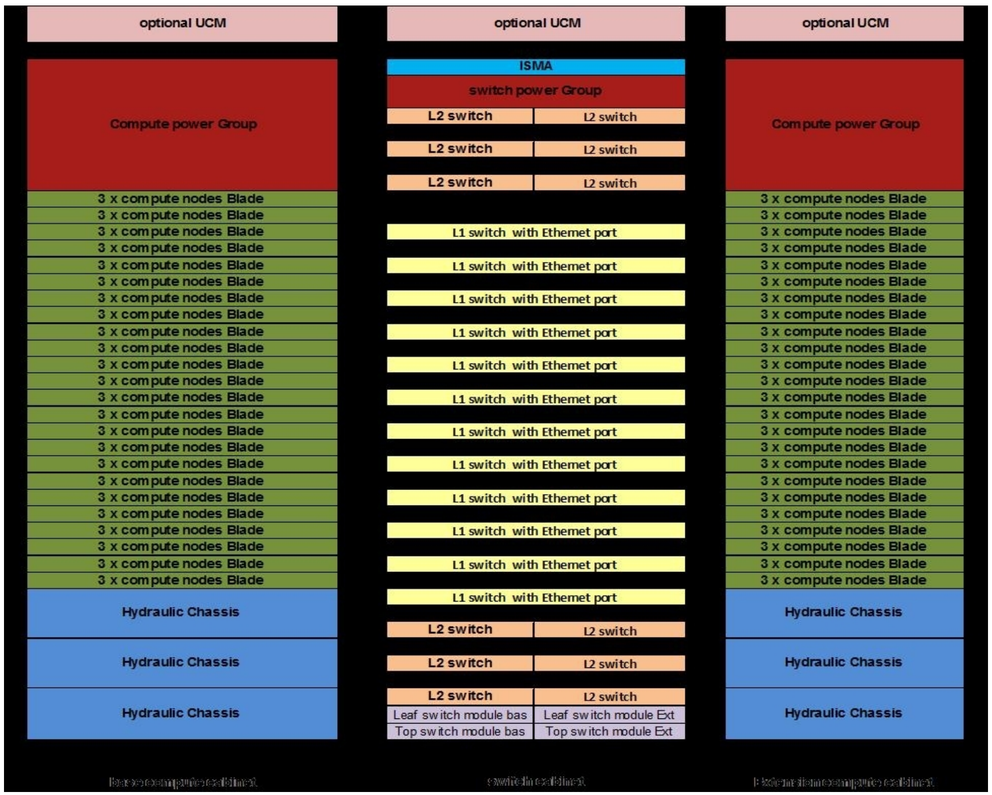
Architecture T1K2.2



Focus on TERA1000

Architecture T1K2.2

- ATOS/BULL Sequana (computing island x 29)



- Up to 96 blades x 3 nodes : 288 nodes

T1K2.2: 276 computing nodes

- 2X service nodes "ISMA": executing virtual machines managing its island

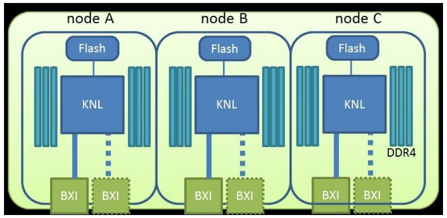
- 12 L1 switch BXI
- 12 L2 switch BXI

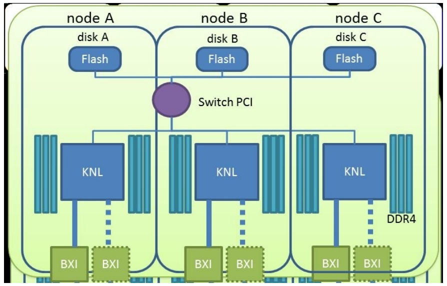
- Hydraulic cooling

Focus on TERA1000

Architecture T1K2.2

- Computing nodes





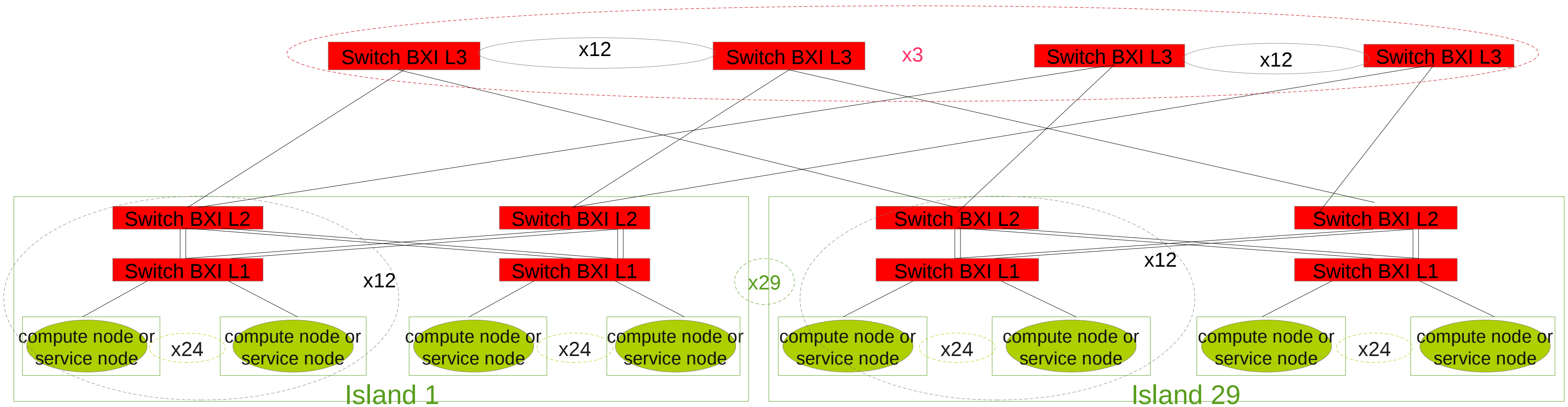
Blade of 3 computing nodes with

- Intel KNL Xeon Phi 6250 x 68 cores
- 192 GB DDR memory
- 16GB MCDRAM
- diskless 15 islands
- disk full 10 islands
- 4 islands PLX
  (shared disks across 3 nodes)
- Hydraulic cooling

Focus on TERA1000

Architecture T1K2.2

Interconnect ATOS/BULL BXI – 72 L3 switches, 29x12 L2,L1 switches



Focus on TERA1000

Where is Slurm on T1K2.2 ?

- Slurm on T1K 2.2
  - Virtual machines mslurm on ISMA of service island
  - HA between the 2 ISMA on service island
    managed by pacemaker (ATOS/BULL SCS5)
  - Resource groups :
    grp-mslurm (fs-data-mslurm, slurmctld, munge)
    grp-mslurmdbd (data-slurmdbd, mariadb, slurmdbd)
  - TCP communications between controller and slurmd nodes are routed through service nodes of each island

Using Slurm at CEA

Slurm footprint

- Versions and support
  - All major clusters introduced since 2009 and operated by CEA

    TERA : tera-1000 (T1K)
    GENCI : irene
    CCRT : cobalt

  - slurm-16.05.x for GENCI and CCRT, slurm-17.11.x for TERA
    Migrating myql_slurmdbd (size 6.5GB) from 16 to 17 : 1h10mns on virtual machi

    Slurm from SCS5 – ATOS/BULL

    Completed with CEA patches

  - SLURM supported by the supercomputer vendor for the 3 HPC projects
    BULL/ATOS

CEA Slurm customization

- CEA uses in production
  - System confinement
  - Feature flags
  - Lua plugins :
    filesystem licensing, dynamic user's setting, check node health
- CEA studies
  - Lua plugin : requested switch
  - Forward algorithm
  - MPMD

System Confinement

- Operating System noise reduces by its isolation
- Improve Performance of parallel applications
- Mechanism for core specialization :
  - consumable resource required :
    SelectType=select/cons_res in slurm.conf
    CoreSpecPlugin=core_spec/none in slurm.conf (except for cray)
  - cgroup required :
    TaskPlugin=task/cgroup in slurm.conf
    ConstrainCores=yes in cgroup.conf

System Confinement

- Nodes definition, in slurm.conf, needs specialized cores

  CPUSpecList=<comma separated list of CPU Ids>

- Use in conjunction at boot time with kernel parameter isolating cpus from kernel scheduling

  isolcpus=^{C}*<comma separated list of CPU Ids >*

- Result with 4 specialized cores: ~10% better performance

  srun –core-spec=0 -n 64 -p knl my_pi_hybrid_loop: 64s
  srun -n 64 -p knl my_pi_hybrid_loop: 58s

Feature flags

- Uses for nodes validation after maintenance
- Allow to point some nodes in a global node partition instead of creation of multiple partitions
- Nodename=node1 Feature=island,flag2 in slurm.conf
- Use specific flagged nodes in a global partition

  srun –constraint=”islandN” -p validation mybinary

Filesystems Licensing Lua Plugin

- Interfer with slurm_job_submit setting job_desc.licenses : job_submit.lua
- Allow live maintenance on filesystem by suspending only concerned jobs
- Only new jobs asking for maintained/unsane filesystems will wait
- Simple configuration in slurm.conf

  Licenses=fs_name_1:10000,fs_name_2:10000
- Worth precising which filesystem code will use at launch:

  srun –licenses=fs_name_1 hostname

Dynamic User's settings Lua Plugin

- User can change kernel parameter only for his job : perf.lua
  - Interfer with slurm_spank_init, init_post_opt, job_prolog_epilog
  - srun –-perf_enable :
    allow usage of perf tool or vtune by allowing acces
    to hardware processor counters

    echo > /proc/sys/kernel/perf_event_paranoid
  - srun –-want_thp :
    allow usage of transparent hugepage
    echo > /sys/kernel/mm/transparent_hugepage/enabled

    options are honored only in exclusive mode

Check node health Lua Plugin

- Drain sick nodes according to dmesg found pattern : check-dmesg.lua
  - Interfer with slurm_spank_init, slurm_spank_task_exit
  - Patterns = {“corrupted-journal” = “Error was encountered while opening journal”}
  - Rules = {

```
        [“corrupted-journal”] = {
          trigger =”count > 0”,
          log_info =”Journal is corrupted”,
          action=”drain_node('%hostname',”Corrupted journal”)
          }
```

  - sinfo -Rl

REASON	USER	STATE	NODELIST
Corrupted journal	slurm	drain	machine

Request switch setting Lua Plugin

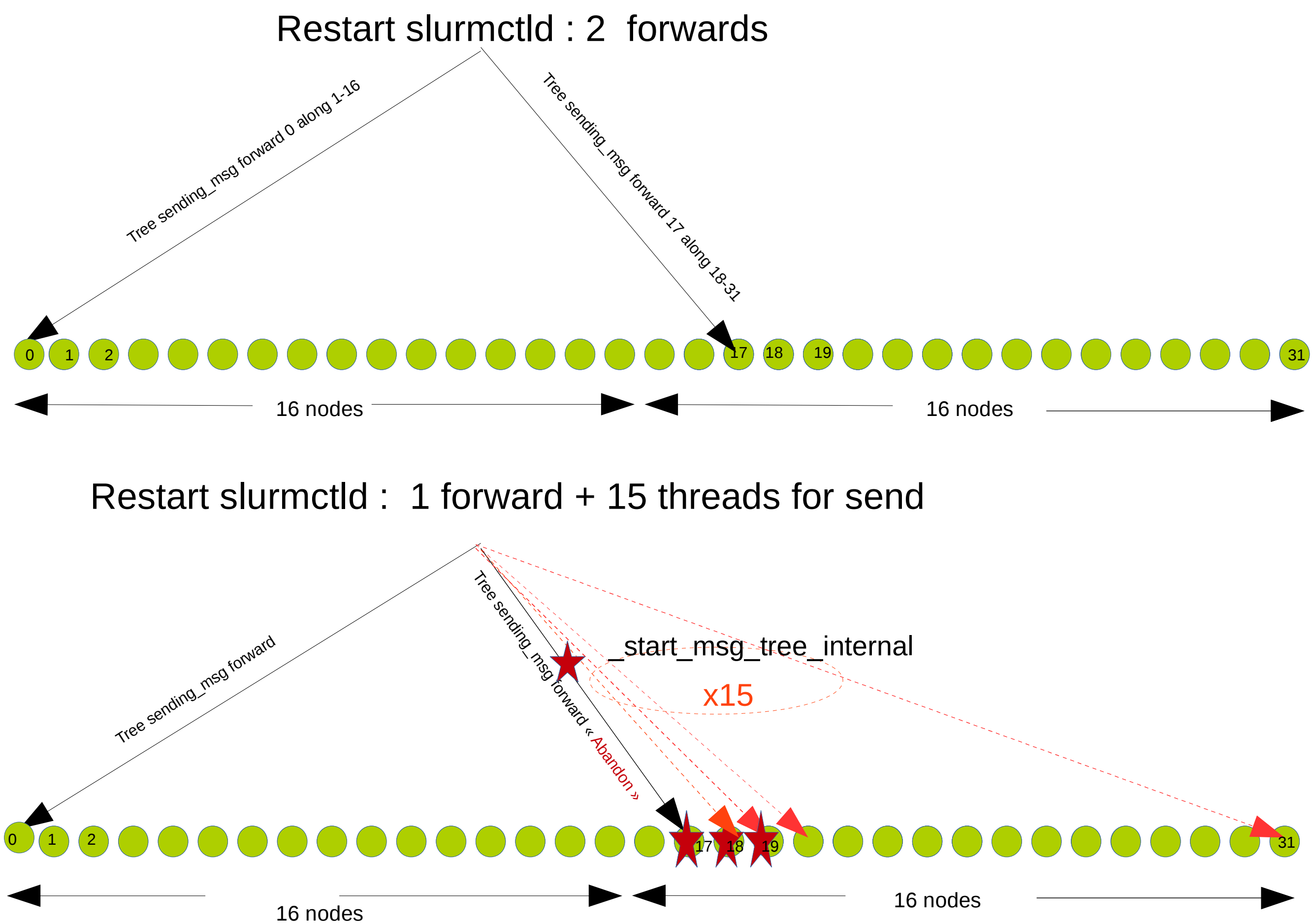
- « --req-switches=auto » for avoiding large jobs spreading across fabric switches via job_submit.lua
  - Jobs with big numbers of nodes might be spread across several interconnected switches,

    preferable to wait for nodes on the same switch availability
  - Interfer with slurm_job_submit setting job_desc.req_switch
  - Description of nodes distribution across switches in slurm_jobsubmit_config.lua
  - Automatic computation and setting of minimum –switch option for asked resources (if –switch not set by user)
  - Waiting time defined in slurm.conf

Forward Algorithm

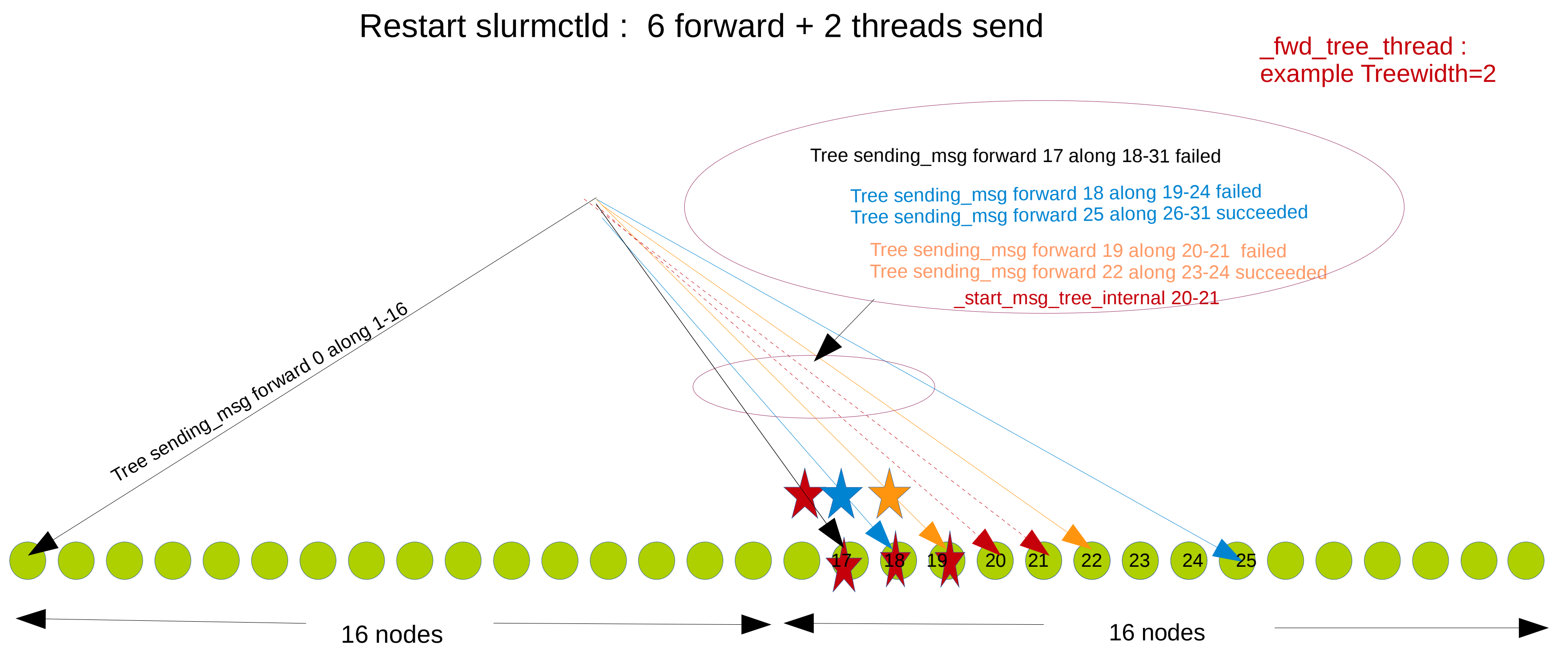
- Current Forward Algorithm

_fwd_tree_thread : example
Treewidth=2



Forward Algorithm

- Forward Algorithm without « abandon »



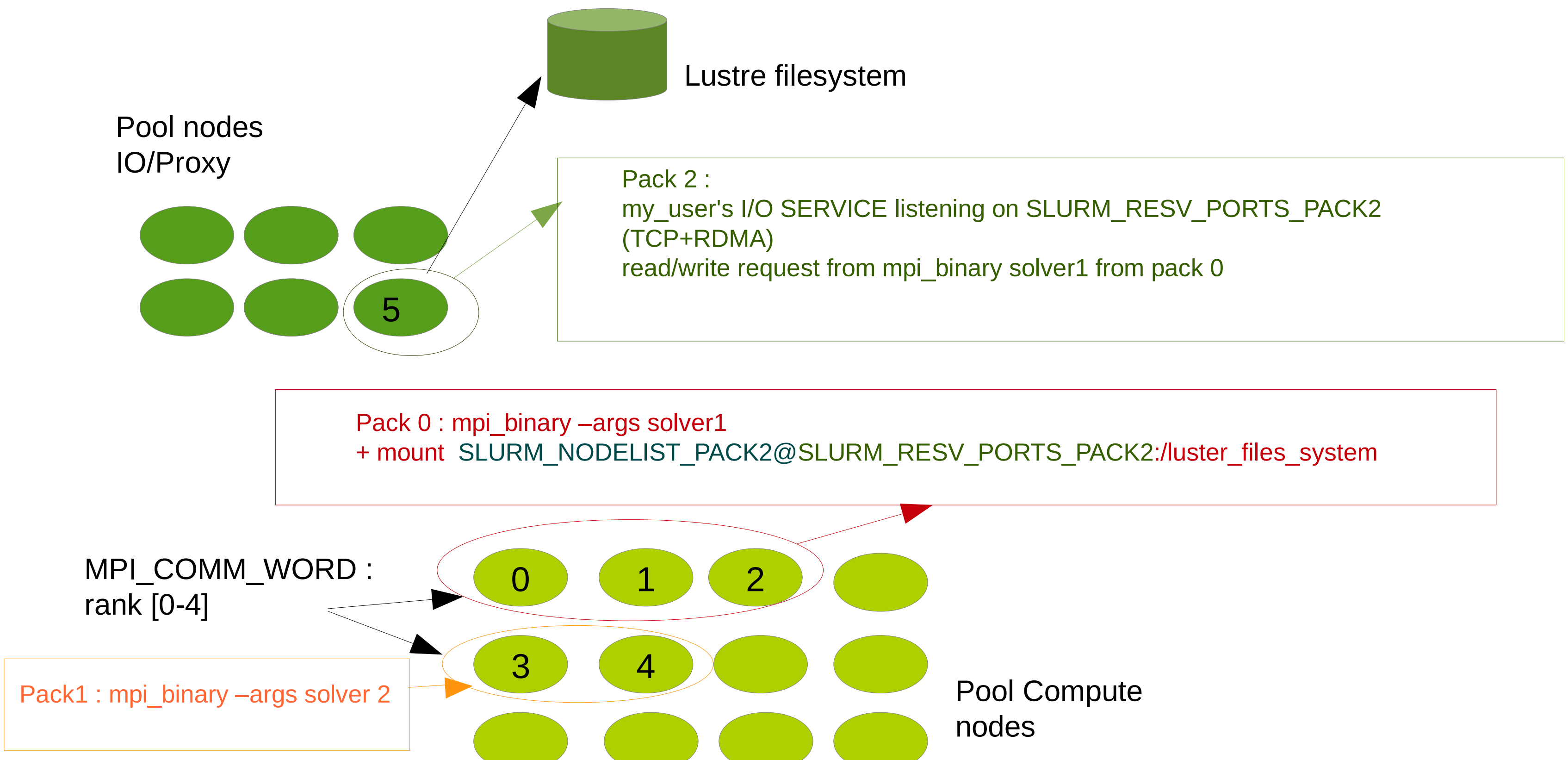
Using Slurm at CEA

MPMD

- Our need “heterogeneous job” : example IO/PROXY with dedication of nodes with job packs

salloc -n 3 -N 3 -p compute –mpi_combine=yes : -n 2 -N 2 --mpi_combine=yes -p compute : -N 1 -p IOPRoxy --mpi_combine=no

srun -n 3 --pack-group=0 mpi_binary –args solver1 : -n 2 –pack-group=1 mpi_binary –args solver2



MPMD

- So MPMD needs are :
  - mpi_combine=yes/no with both setting across heterogeneous jobs
  - SLURM jobs pack environment variables such as:
    SLURM_NODELIST_PACK_GROUP_* , SLURM_RESV_PORTS_PACK_GROUP_*
- MPMD tests in 17.11.6
  - Unrecognized option '--mpi_combine'
    Release notes “Remove srun's --mpi-combine option (always combined)”
  - SLURM_PACK environments : SLURM_RESV_PORTS not available
  - will see in 18 ?

Questions ?

Thank you for your attention