ICE 2.0: Restructuring and Growing an Instructional HPC Cluster

Nov 12, 2023
HPC SysPros Workshop – SC23
Denver, CO

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ICE 2.0: Restructuring and Growing an Instructional HPC Cluster

Credit to the whole team:

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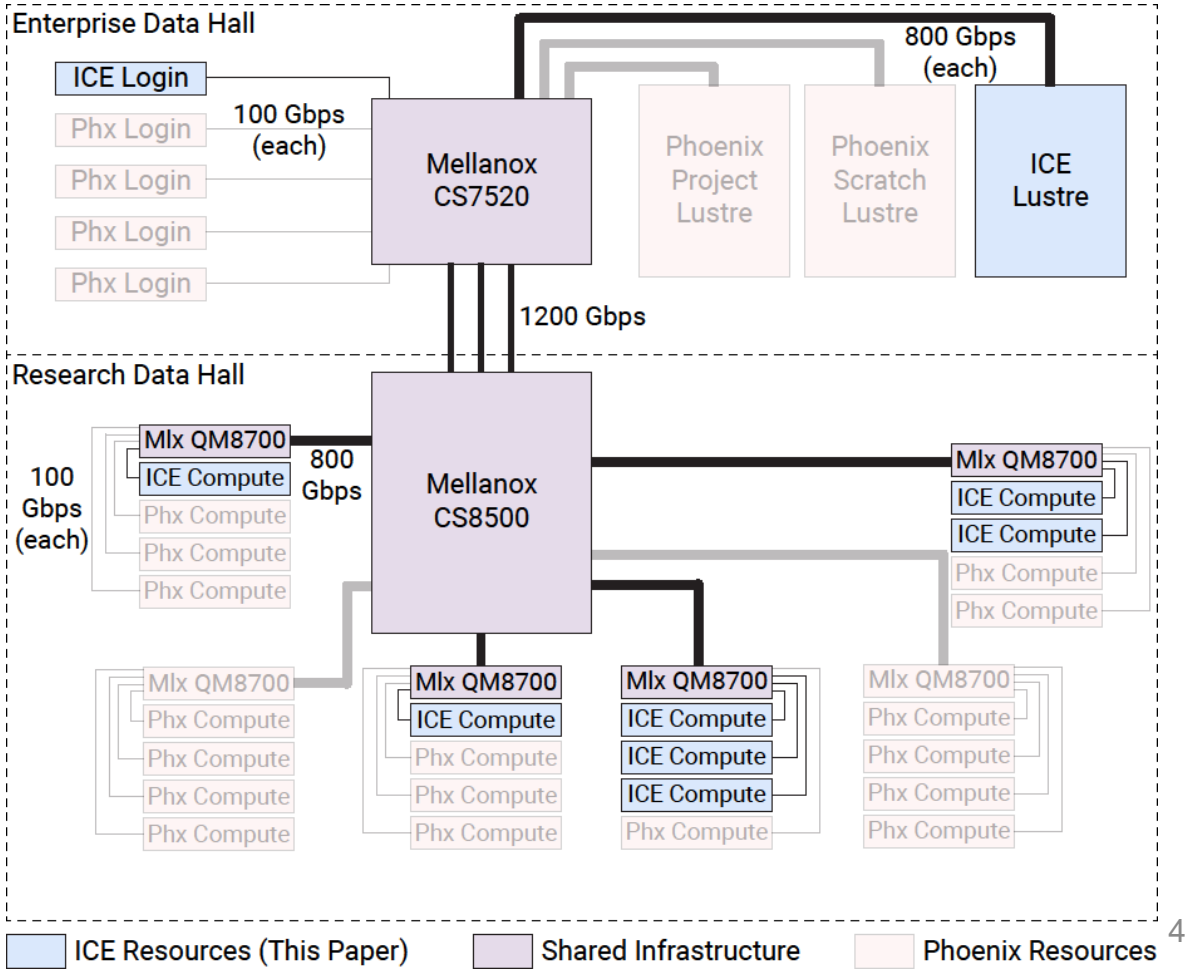
What is ICE? (Instructional Cluster Environment)

- Yes we do talk about "the ICE Cluster" and I die a little bit every time
- HPC environment purely for supporting courses and student projects at Georgia Tech
- Mix of CPU and GPU hardware, collaboration between PACE and the College of Computing
- Available to any course at GT, priority access to some hardware based on funding source



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Goals of this Project (Problems to solve)

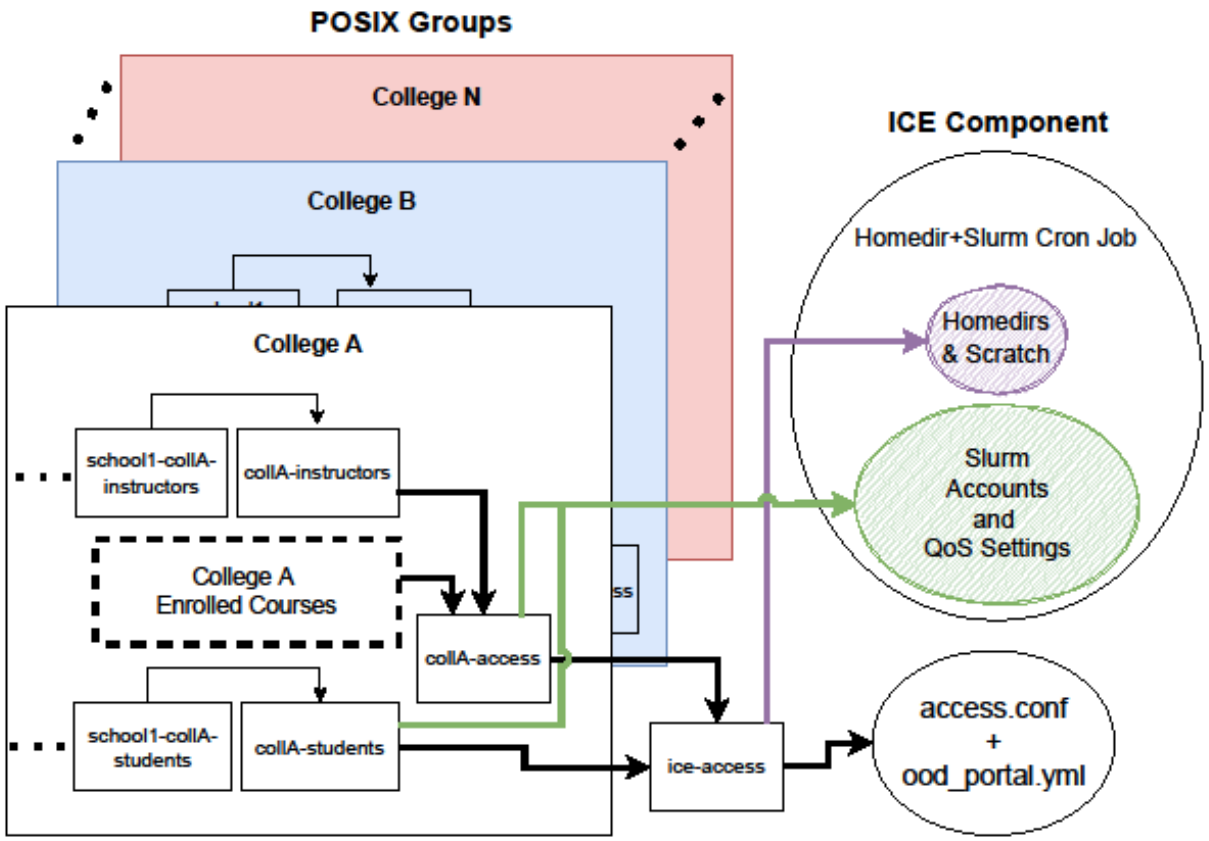
- In the beginning...
  - There were TWO ICEs (one for PACE, one for College of Computing (CoC)
- Merge the ICEs
  - Including user account data
  - Course data
  - Accounts
    - Naturally this is a perfect time to also figure out which accounts need to be pruned
- Migrate to Slurm (Previously on Torque)

How ICE Works

- Instructors request access
- We add the course to a special group, which we call "entitlements" to an internal roles system
- Everyone enrolled in that course now gains access (and loses it accordingly)
- This extends to special workshops, PACE-led training, etc.
- In the process of extending to departmental membership

Accounting Design

- Cron jobs regularly check membership in those entitlements
- Several things happen as a result:
  - Home and scratch directories are created
  - Scheduler accounts are created
    - At an appropriate QoS level
    - Includes departmental affiliation for metrics
  - Login access is granted
  - Lots of error checking



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Entitlements Design

- Top level “access entitlement”
- College-level entitlements contain:
- Separate Student/Instructor entitlements
  - Separated by School at each of those levels
  - Student entitlements are populated by Course Enrollment rules

- PACE exists at the “College” level for workshops and training sessions
- Easily extensible as new Colleges or Schools participate in ICE

Data Migration+Merger

- Back to the TWO ICES – some 20K accounts to migrate and merge
  - Total of 7TB for homedir data, an additional ~1TB for course data
- Migrated to /newhome/{oldICE_1,oldICE_2} directories to preserve data
  - Since some accounts existed on both ICEs
- Parallel rsync (being very careful about sparse files! –S on initial sync, -W on final) took about 5 days
  - Scripts included in artifact

Storage Design

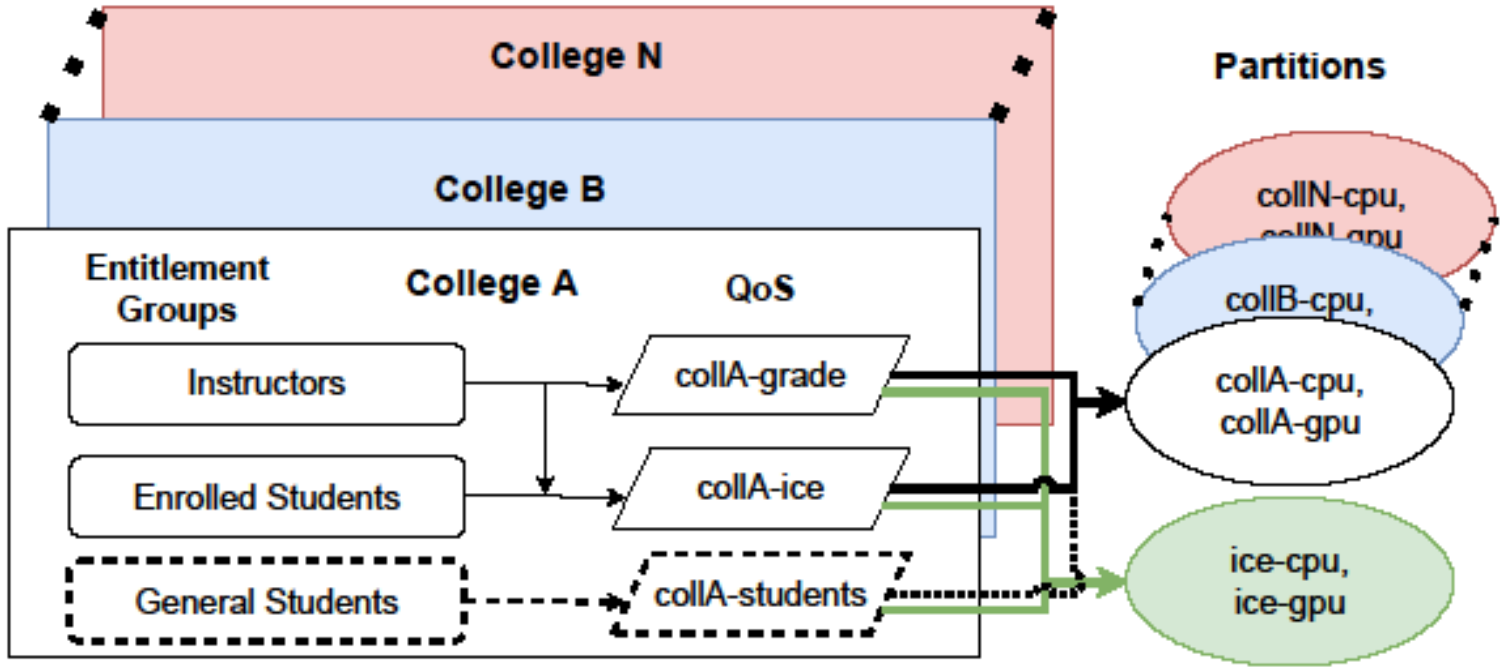
- Home and Scratch space, with separate spaces for course data
- Roughly 16K extant homedirs, planning for all 40K students eventually having access
- Able to trim down to ~14K based on current GT affiliation (long overdue…)
- Homedirs and scratch bucketed by last 2 digits of UID:
  - /home/${uid: -2:1}/${uid: -1}/${username}
  - /scratch/${uid: -2:1}/${uid: -1}/${username}
- Mounted via AutoFS, which has to override homedir provided by SSSD via dynamic map (which was *fun* to discover/set up!)
  - Config included in artifact

Data Policies

- 15GB of data in /home (NetApp)
- 100GB in /scratch (Lustre)
- No quota on shared course data directories (backed by NetApp)
- Semesterly cleanup
  - Any files not touched in 120 days at the end of the semester are removed from /scratch dirs.
  - Any home directories without active entitlement OR login activity for 1 year are removed

Scheduler Design

- Allowed QoS determined by entitlement memberships
- People who buy hardware have the option of priority access
- Instructors have priority access for grading needs (repro student submissions)



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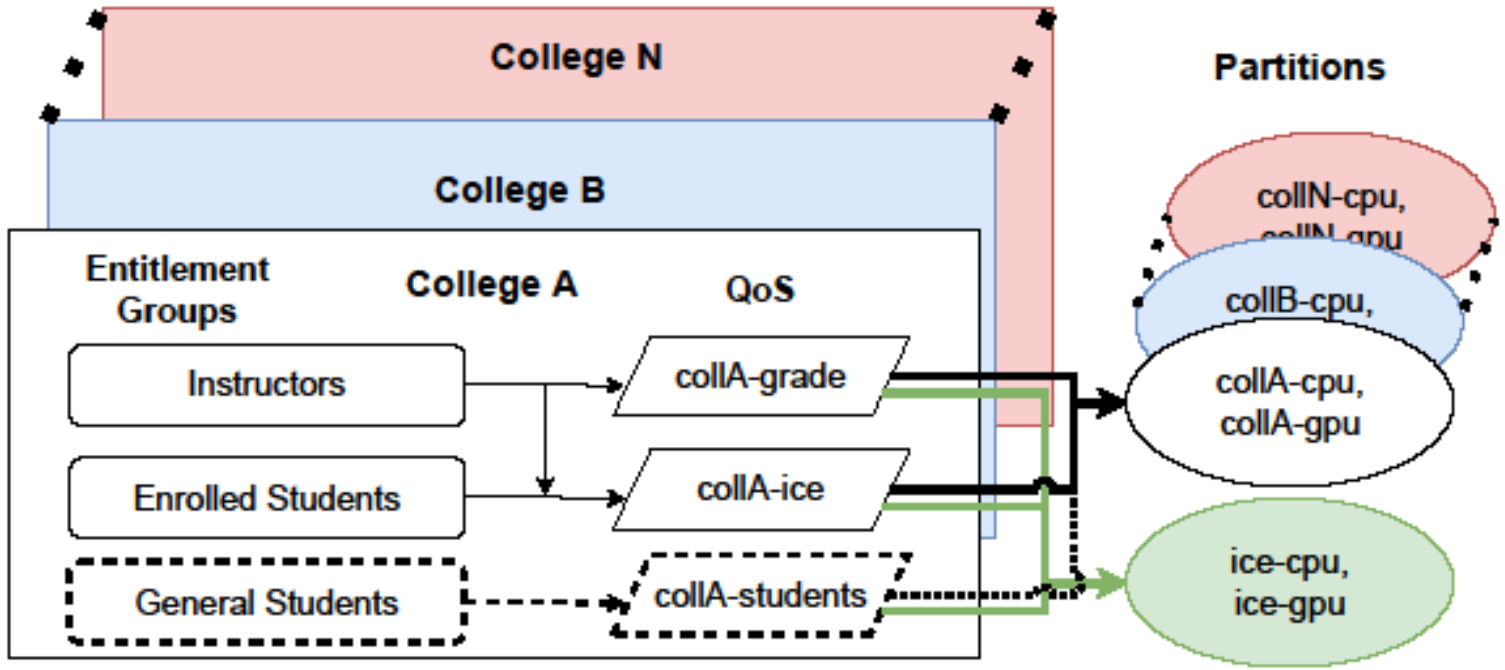
Scheduler Design

- Job routing by job_submit.lua based on QoS and resource needs
- Simplify necessary Slurm scripts as much as possible for student use with sensible defaults
- Configs available in our artifact!



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Questions?

- **Scripts and config examples available in GitHub: https://github.com/pace-gt/hpcsyspros-SC23-ICE**
- **Previous ICE Paper: (Includes some more details around accounting, policy, and design):** https://dl.acm.org/doi/pdf/10.1145/3219104.3219112
- **Contact us: j.eric@gatech.edu**