Local Scheduling for Volunteer Computing

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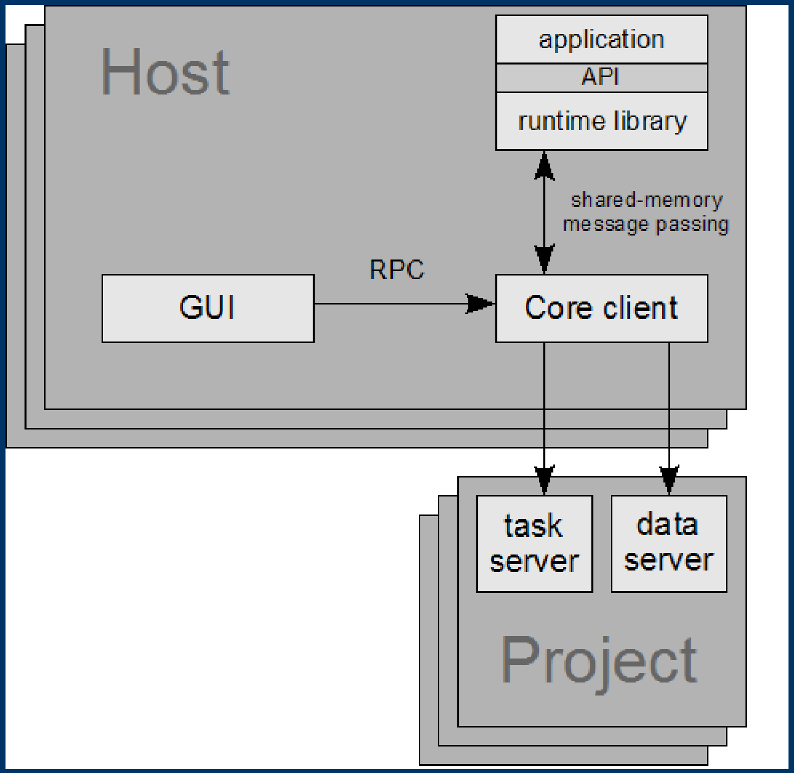
BOINC projects and volunteers

- Projects
  - Einstein@home, CPDN, etc.
  - independent, separate servers
  - may be down or not have work
- Volunteers
  - run BOINC client on PC
  - “attach” client to projects
    - > 1 project recommended
  - client queues jobs
- Scheduler RPCs
  - initiated by client
  - request X seconds of work



Local scheduling policies

- CPU scheduling
  - what job(s) to run
- Work fetch
  - when to get more jobs
  - what project to get them from
  - how much work to ask for

Inputs to the policies: host

- Host hardware
  - # CPUs, FP/int benchmarks
  - RAM size
- Host availability
  - % time BOINC is running and allowed to compute
  - % time network connected

Inputs: user

- User preferences
  - project resource shares
  - whether to compute when user active
  - time-of-day limits
  - CPU throttling
  - RAM usage limits while active/idle
  - Network connection interval
  - SchedulingInterval (~1 hour)
- User controls
  - suspend/resume all computation
  - suspend/resume/attach/detach project
  - suspend/resume/abort job

Inputs: static job parameters

- Each job has:
  - deadline
  - estimate of FP ops
  - limits on disk/RAM/FP ops
- Redundant computing and deadlines:
  - if a job is not reported by its deadline, it’s increasingly likely that it will get no credit, and have no value to the project.

Inputs: dynamic job parameters

- Checkpointing
  - requested periodically by BOINC client
  - reported by application
- Fraction done
  - reported periodically by application

Goals of local scheduling policies

- Maximize rate of granted credit
  - utilize CPU
  - avoid missed deadlines
- Enforce resource shares over long term
  - don’t count long unavailable periods
- Maximize project variety
  - avoid running 1 project for weeks

Scheduling scenarios

ConnInterval: 12 hrs
MaxCPUS: 1

Projects	P1	P2	P3
Resource share	0.4	0.3	0.3
Job length	100 hrs	6 hrs	3 hrs
Job deadline	200 hrs	12 hrs	5 hrs

Early scheduling policies

- CPU scheduling: round-robin, weighted by resource share
- Work fetch: maintain at least ConnInterval work, proportional to resource share, at least one job per project
- This fail disastrously for the given scenario (all deadlines missed)
- Earliest deadline first: a little better, but most deadlines missed

Current scheduling policies

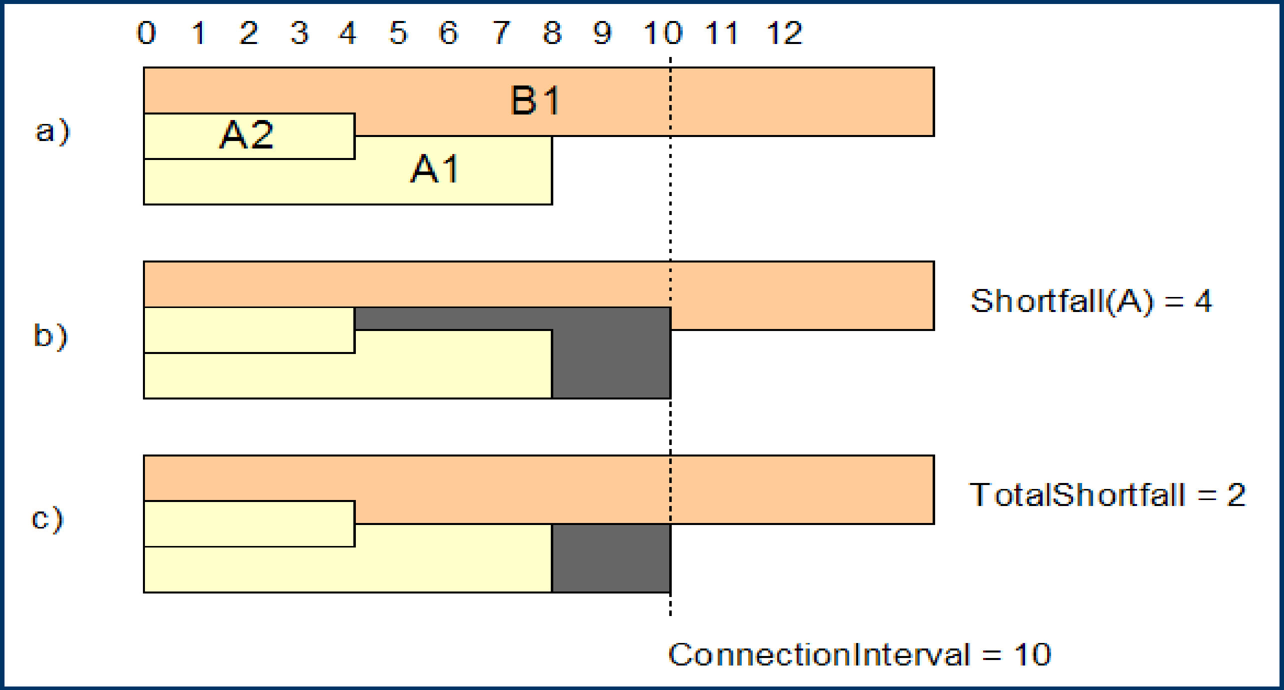
- Job completion estimation
  - maintain “duration correction factor” estimate

  estimate: FA + (1-F)B
  where F is fraction done,
  A is estimate based on CPU time and F,
  B is estimate based on FP count and benchmarks

- Debt (per project)
  - short-term: used for CPU scheduling
  - long-term: used for work fetch

Round-robin simulation

- Computes: deadline misses; per-project CPU shortfall; total CPU shortfall
- Example: 2 CPUs; project A has share 2 and jobs A1, A2; project B has share 1 and job B1



CPU scheduling policy

- Do round-robin simulation
- EDF among projects with deadline misses
- weighted round-robin among others
- avoid preempting jobs that haven’t checkpointed recently

Work fetch policy

- A project is “overworked” is
  LongTermDebt(P) < -SchedulingInterval

  (this happens if P’s jobs have tight deadlines and are usually run in EDF mode)

- Policy: find a project P that maximizes
  LongTermDebt(P) + Shortfall(P)
  and is not overworked, and has no deadline misses
- Ask it for max(Shortfall(P), TotalShortfall/share) work

Memory-aware scheduling

- Periodically measure working-set size of running applications, maintain smoothed average
- Run only a set of jobs that fits in allowed RAM

Future work

- More intelligence in server
  - scheduler RPC includes list of queued jobs, including deadlines and fraction done
  - scheduler runs EDF simulation to see if each prospective job will jeopardize deadlines
- Maintain better statistical info on
  - job run-times
  - availability, network connectivity info
- Develop simulator to evaluate policies