DGAS-Sim

*Simulation of economic brokering*

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DGAS
simplified working scheme
Computational Energy

• We define the *computational energy* “consumed” by a job as the product of a *performance factor* or *power* $p$ (e.g. CPU speed) and the *amount of usage* $u$ (e.g. CPU time).

• $UCE = \text{unit of computational energy}$
Pricing schemes for economic brokering (I)

• goal: improve workload balancing by including price information in the resource selection process.

• examine pricing schemes that do not compute or approximate global equilibrium prices, but determine resource prices “locally” (for single resources):
  - less information required (less network traffic)
  - less computational overhead
  - local policies of different VOs can be respected
Pricing schemes for economic brokering (II)

- **Hybrid Pricing Model:**

  \[ \text{price} = P_0 + \Delta P \left( \frac{W - \frac{1}{2}W_{\text{max}}}{\frac{1}{2}W_{\text{max}}} \right) \quad 0 \leq W \leq W_{\text{max}} \]

  - **static parameters:** base price \( P_0 \), variation limit \( \Delta P \) and maximum Queue Wait Time \( W_{\text{max}} \)
  - **dynamic parameter:** current (estimated) Queue Wait Time \( W \)

  price dynamically varies between \( P_0 - \Delta P \) and \( P_0 + \Delta P \)
Pricing schemes for economic brokering (III)

- **Derivative Follower Model:**
  - approximates game-theoretic equilibrium prices (demand equals supply) by incrementally increasing/decreasing prices until the observed (immediate) profitability level falls, then the direction of price adjustments is reversed.
  - problem: can balance incoming workload, but does not consider pre-existing unbalanced queues.
  - possible adaption for DGAS: use QWT and its variation as stimulus for price adjustments (instead of profit).
DGAS-Sim(ulator)

**IMPORTANT:**
all classes are synchronized.
GIS, RB, CE and PA implemented as threads.
First simulations

- Hybrid Pricing Model
- Price-sensitive utility function (RB selects the resource with the lowest price per UCE)
- Cases:
  - overdemand (demand > supply)
  - underdemand (demand < supply)
  - market equilibrium (demand = supply)
First results: overdemand (I)

Queue Wait Times, over-demand case

- CEO (red) with CPU power of 2 UCE/second
- CE1 (green) with CPU power of 4 UCE/second
- CE2 (blue) with CPU power of 10 UCE/second

- submitted jobs require about 160 UCE per second
- maximum QWT is 10000 time units
- broker utility function: price sensitive
- pricing module: hybrid

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First results: overdemand (II)

Resource prices, over-demand case

- CEO (red) with CPU power of 2 UCE/second
- CE1 (green) with CPU power of 4 UCE/second
- CE2 (blue) with CPU power of 10 UCE/second

Submitted jobs require about 160 UCE per second.

Pricing module: hybrid
Base price is 1000 GridCredits
Maximum variation is 50 GridCredits

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First results: overdemand (III)

Queue Wait Times, over-demand case

- CE0 (red) with CPU power of 8 UCE/second
- CE1 (green) with CPU power of 12 UCE/second
- CE2 (blue) with CPU power of 16 UCE/second
- CE3 (violet) with CPU power of 20 UCE/second
- CE4 (light blue) with CPU power of 24 UCE/second

submitted jobs require about 160 UCE per second
maximum QWT is 5000 time units
broker utility function: price sensitive
pricing module: hybrid

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First results: underdemand

Queue Wait Times, under-demand case

- CE0 (red) with CPU power of 50 UCE/second
- CE1 (green) with CPU power of 50 UCE/second
- CE2 (blue) with CPU power of 50 UCE/second
- CE3 (violet) with CPU power of 50 UCE/second
- CE4 (light blue) with CPU power of 50 UCE/second

First results: market equilibrium

Queue Wait Times, demand equals supply

CE0 (red) with CPU power of 50 UCE/second
CE1 (green) with CPU power of 50 UCE/second
CE2 (blue) with CPU power of 50 UCE/second
CE3 (violet) with CPU power of 50 UCE/second
CE4 (light blue) with CPU power of 50 UCE/second

submitted jobs require about 250 UCE per second
maximum QWT is 5000 time units
broker utility function: price sensitive
pricing module: hybrid

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Advantages and disadvantages of the Hybrid Pricing Model

• simplicity and low computational overhead.

• fixed limits of price variations prevent a long-term degeneration of prices (resource exchange fairness).

• requires definition of maximum QWTs for predefined queue classes (e.g. short, medium, long …)

• requires an accurate estimation of current QWTs (and thus an estimation of job requirements in terms of computational energy.

  => possible: estimation by user or based on historical data for similar jobs

• requires agreement on common base prices \( P_0 \) and variation limits \( ?P \) for optimal scheduling decisions.
… to be continued …

- simulation of more realistic Grid settings:
  - consider *data location* and network traffic
    => eventually integrate DGAS-Sim with OptorSim (WP2)?
  - Price Authorities might *apply different pricing schemes* (different VO policies).
  - consider different resource types and *matchmaking*.
  - simulate RB utility functions (for CE selection after the matchmaking) that consider *different job preferences*. Example: data-intensive HEP analysis will focus on low data access time and low prices, while computing-intensive Monte Carlo simulations will focus on high performance and low prices (low QWT)

- examine the effect of QWT estimation on load balancing
- examine Derivative Follower Model