GridCloud

Killer Apps Enabled by GridCloud

sponsored by the Department of Energy ARPA-E program

Context

➢**Challenging questions with highly elastic apps**

- Rapid elasticity at scale
- Predictability /consistency of such elasticity

#1: Mitigation Control

➢**Rare combination of events do happen**

- Have led to many blackouts when not mitigated!

➢ **E.g., N-3 contingency never planned for**

- Infrequent but hugely expensive to analyze
- GridCloud commissions thousands of nodes analyzing candidate mitigation steps in parallel

➢**Acknowledgements: Prof. Mani V. (WSU)**

#2: Robust Adaptive Topology Control

➢**Use software to optimize grid topology switching as the control resource**

➢**Technology: use topology control to enhance ops and manage disruptions in grid**

➢ **Massively parallel computations to**

- Detect, classify, and respond to grid disturbances
- Ensure the grid maintains efficient operations while guaranteeing reliability

➢**Acknowledgements: Prof. Mladen Kezunivoc (Texas A&M University)**

- Funded by the ARPA-E GENI program

#3: Ultimate Scale: Tertiary Monitoring Centers

➢**Balancing authorities (144 in NAmer) must have remote backup control centers**

➢**TVA found great value in having a tertiary control center**

- Limited to monitoring: control outputs computed but not used
- Obvious candidates for the cloud

➢**Major problem today: balancing authorities have almost no visibility anywhere in grid except for a few places in a few neighbors**

- "Flying blind", The Economist, 2004
- Why not just share more?
- Data stored at another utility is problematic for owner

➢**Storing in cloud could alleviate this**

- Only access a subset of data and/or derived info

➢**Above so far is static (default steady state)**

➢**Could also drill down on demand with elastic computations & data feeds**

- Using higher-fidelity algorithms and higher-resolution data

➢**Acknowledgements: Russell Robertson (Grid Protection Alliance), for the TVA example (though not the cloud possibilities)**

#4: Multi-dimensional Computations over Space & Time (A *Family* of Apps)

➢**Two existing WSU/GridSim apps can be combined in rich ways possible only with cloud computing**

1. **Hierarchical linear state estimation (see poster #1)**
2. **Oscillation monitoring**
   - Uses moving window of time (a few seconds typically)
   - Over streaming data
   - Produces a single number: damping factor
   - Obvious parallel computations over different sets of data with different time windows and algorithms

➢**Combination: provide rich set of two-dimensional (space, time) data to any desired location**

- Enables extremely powerful new families of applications operating coherently over both space and time
- At each location: different time windows, different algorithms, different sets of data
- If available, people would inevitably think of many uses for this data

➢**Acknowledgements: Prof. Anjan Bose (Washington State University)**

#5: Oscillation Alarm Processing

➢**Grids oscillate between regions**

- Negatively damping can lead to blackout
- E.g., Oregon/California in July 1996: 0.3 Hz (!!)

➢**GridCloud commissions massive parallel computations exploring huge permutation space**

- Looking for trends and correlations of alarm data
- Also huge number of model-based simulation's too
- Finds root cause much faster than possible today in much broader set of conditions

➢**Acknowledgements: Prof. Mani Venkatasubramanian (Washington State U.)**

#6: Multi-Res. Frequency Disturbance Visualization

➢**Grid operates in very narrow range unless stressed**

➢ **Frequency disturbance recorder (FDR): new device recording frequency disturbances at high rates (1.44 Khz)**

➢**GridCloud commissions thousands of parallel frequency rendering computations**

- Provide operators a rich suite of visualizations with which to better understand present excursion

➢**Acknowledgements: Prof. Yilu Liu (University of Tennessee, Knoxville)**