National Aeronautics and Space Administration
GODDARD SPACE FLIGHT CENTER

Next Generation Modeling and Simulation Engineering using Cloud Computing

A presentation of use cases and possible benefits to the Flight Project Development Efforts at GSFC from a Individual Product Development Lead's Perspective

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Code 561

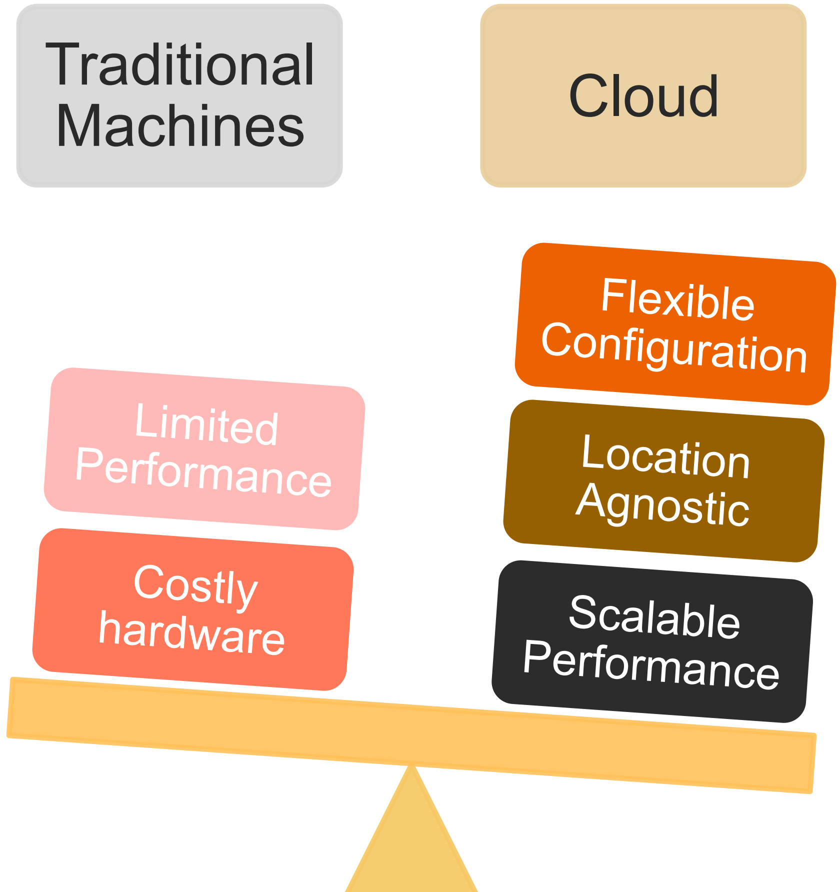
Introduction

- Purpose: To express possible use cases where the utilization of cloud computing resources at GSFC could benefit Product Development and Electronic Hardware Design.
- Intended Audience:
  - IS&T Colloquium
  - Engineering and Information Technology Communities at GSFC
- Note: This presentation doesn't offer project funding, but is an expression of ideas or use cases
- One PDL's perspective. Not representing the organization as a whole.

Why Cloud Computing?

- GSFC is exploring the use of recent innovations in cloud computing architectures and implementations
  - See page: http://itcd.gsfc.nasa.gov/content/cloud-architecture-overview#.VI9oNSvF_GI
- Cloud computing provides capabilities that can benefit engineering at GSFC:
  - Scalable processing for large engineering analysis / simulation jobs
  - Centralized Ground Command Systems (ITOS, ASIST, etc)
  - Centralized GSE infrastructure / networking

Why Cloud Computing?



Concerns / Risks

- Security
  - **Most Space Flight project data is considered ITAR or SBU at a minimum.**
  - **Cloud configuration must be able to host such data securely**
- Cost
  - **Project are cost constrained, and typically can't make large investments in infrastructure**
- Training
  - **Personnel will need to be trained on using the cloud for engineering work**

Use Case #1

An engineer is developing firmware for a flight FPGA program. He needs to run a simulation on his design to check for any bugs or problems. He typically would start the simulation on his work laptop and let it run while he does other work (typical duration 2-6 hours). He would like to speed up the simulation process and free up his work laptop resources so he can perform other tasks.

Use case need: scalable (high performance) resources for short periods

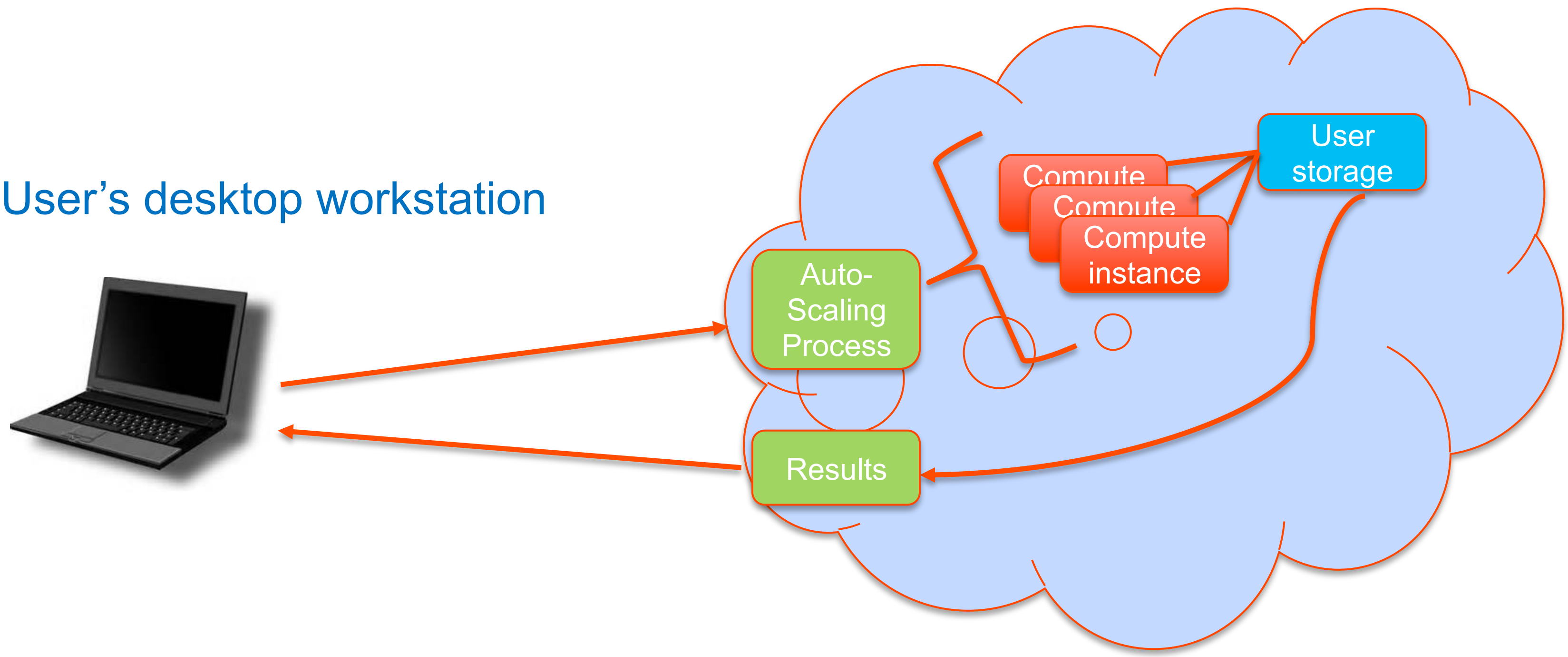
Comparable commercial cloud example: AWS EC2 with Auto Scaling

Use Case #1 (cont)

Use case #1 example topology

Private / Secure cloud

User's desktop workstation

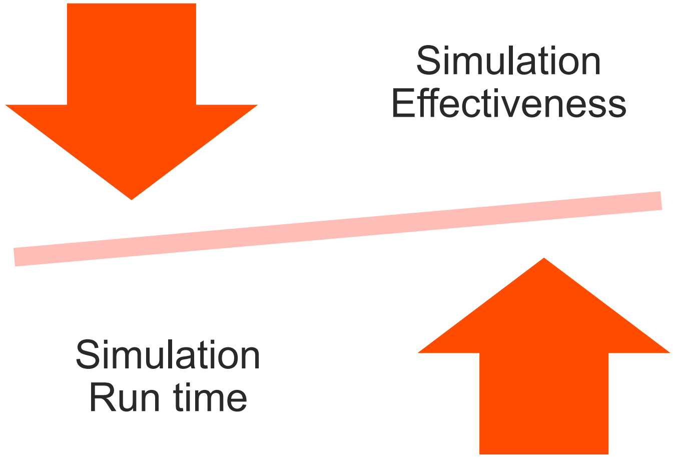


Use Case #1 (cont)

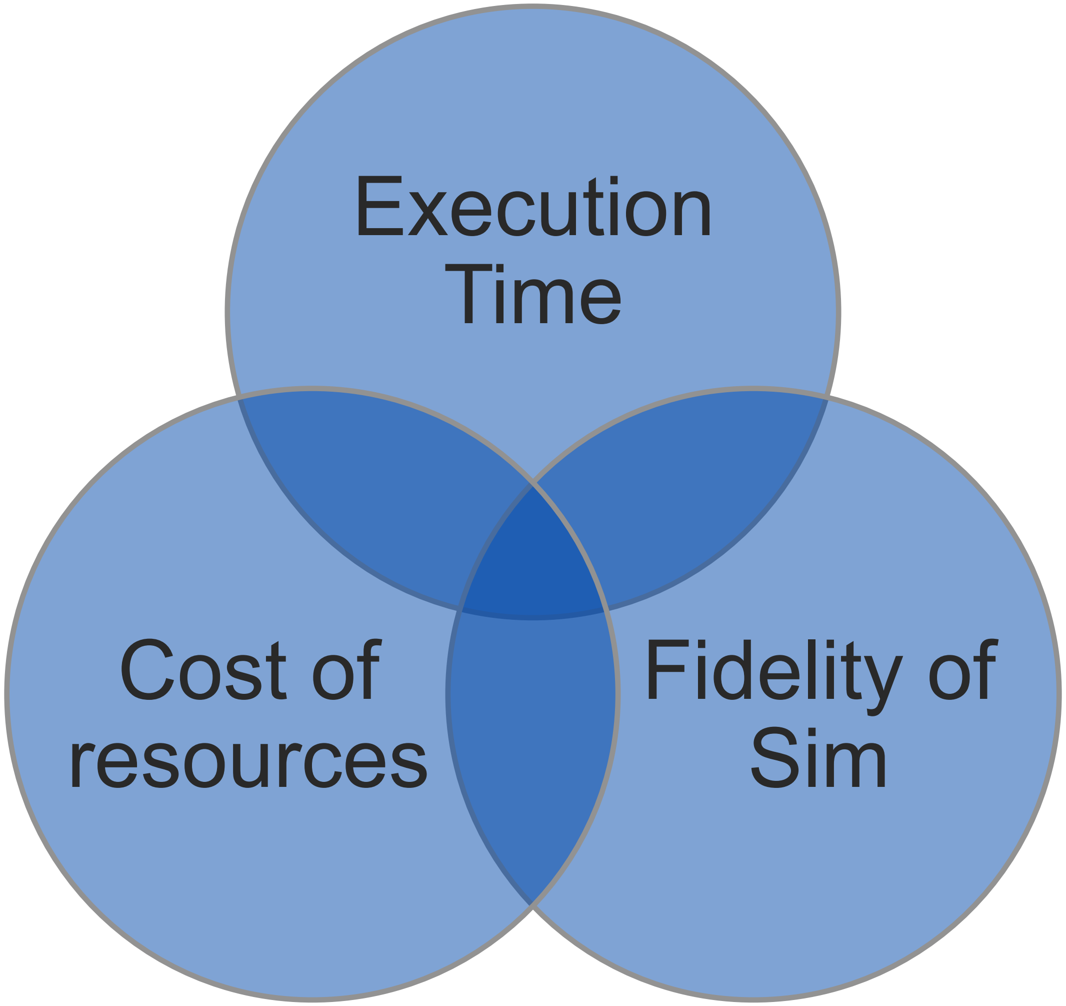
- Advantages:
  - **Shorter task run-time:**
    - Typical run-times of engineering based simulations using engineer's primary workstation computer/laptop:
      - FPGA design simulation (ModelSim): 2 to 10 hours (or more depending on fidelity of sim run)
      - Signal Integrity / Power Integrity PC Board Design Simulation: 2 to 10 hours (or more depending on complexity of design)
    - If these run times can be reduced to 1 hour or less, the engineering time and resources can be used much more efficiently.

Use Case #1 (cont)

- **Higher fidelity simulations:**
  - Typically, fidelity or thoroughness of simulations is limited in order to be completed in a reasonable amount of execution time.
    - Less fidelity = higher likelihood of missing a bug, issue, or problem
    - Higher fidelity = higher likelihood of finding bugs, issues, or problems with design earlier in the process, saving projects time and money



Use Case #1 (cont)



Lessons Learned and Preliminary Results

- Benefits vary depending upon the Engineering Application requirements and constraints
- Connectivity to license servers and local services is crucial and important to be investigated early
- Single thread processes on typical laptop compared to single thread processes on cloud virtual instance already show approx. 20% improvement in performance.
- Next steps: enabling the multi-thread capabilities of engineering application could result in much larger performance increases / benefits.

Backup Charts

Requirements for Pilot of Use Case #1

- In order to attempt a pilot trial of use case #1, the following requirements are needed of the cloud processing solution:
  - **AWS GovCloud hosted (certified to handle ITAR data)**
    - Note: Initial prototype activity will use publically available reference example designs to benchmark capability, and will not contain any ITAR sensitive designs.
    - Once the private cloud is approved for project specific ITAR / SBU data, then we can try to use real project data
  - **Operating System: Windows 7 Professional or Windows Server 2008 (64-bit)**
  - **User Applications to be run:**
    - Xilinx ISE Design Suite
    - Mentor Graphics Modelsim
    - TotoiseSVN Client
  - **Memory (RAM): 8 GB Minimum, scalable to 32 GB.**
  - **Storage: 100 GB SSD (direct EBS), with access to S3 archive space**
  - **Network access: VPN connection to GSFC CNE network (for license server access)**

Constraints for each application

- Xilinx ISE:
  - **# of threads (cores) that can be used:**
    - Mapping functions: up to 2 threads
    - Placement and routing: up to 4 threads
    - Simulation: No limit specified (open ticket with Xilinx to know if there's a limit)
    - Recommend allocating 8 large cores for initial experimentation
- Modelsim:
  - **Possible that this application can only run on one thread/core (To be confirmed)**
    - Recommend allocating one core of maximum performance for initial experimentation.