Cloudy Inside:
Use of Cloud Computing in Ground Systems Development

INNOVATING SOLUTIONS

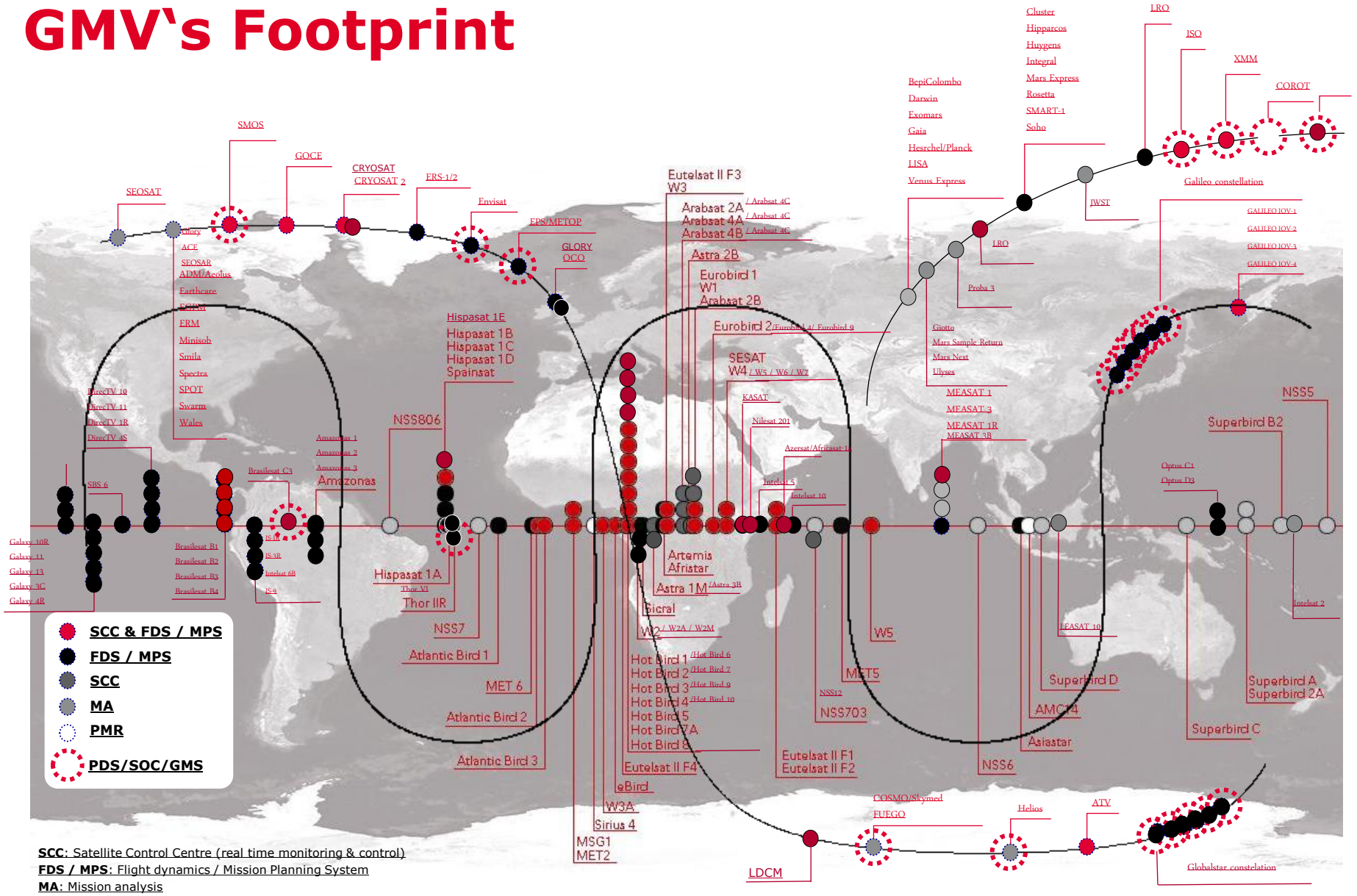
Motivation

- Business considerations for a Ground System COTS vendor
  - Mission Critical applications
    - Any deployment, even a bug fix, must be tested in an integrated environment
  - Multiple Projects
    - The COTS model depends on having multiple customers to drive product evolution with new license purchases and support
    - Every customer's concept of operations, and technical requirements, are different
  - Multiple Products
    - To be competitive the product suite must cover several application areas
  - Long support horizons
    - Customers are on separate upgrade cycles
    - Long periods of inactivity are punctuated by urgent requests

Bottom line:

Need to support customers efficiently and responsively.

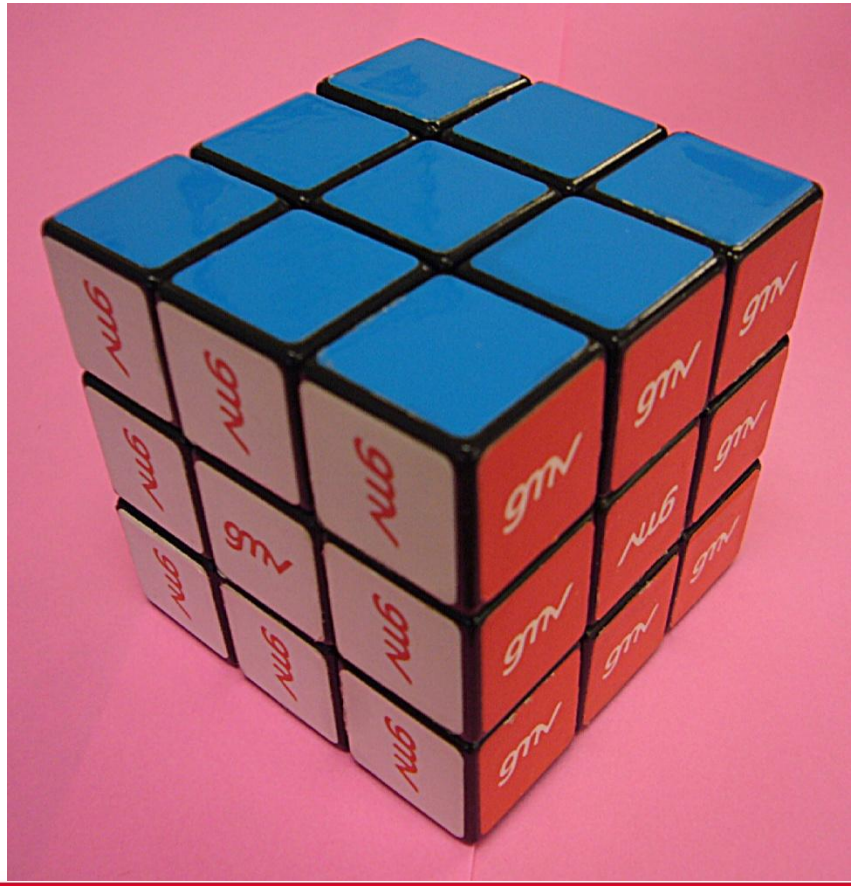
GMV's Footprint



SCC: Satellite Control Centre (real time monitoring & control)
FDS / MPS: Flight dynamics / Mission Planning System
MA: Mission analysis
PMR: Payload management & reconfiguration
PDS/SOC/GMS: Payload Data Segment / Science Operations Centre, Ground Mission Segment

Example Configuration

- Three simultaneous projects
  - A (products X & Y, Red Hat Linux 4 32 bit)
  - B (products X & Z, Red Hat Linux 4 64 bit)
  - C (products Y & Z, SUSE Linux 10 32 bit)
- Three versions per project
  - Deployed
  - Acceptance testing
  - Next release
- Three machines per version
  - Build
  - Server
  - Client



One Year Later

- Project A has entered long-term maintenance
- Project B is upgrading to SUSE Linux 11 64 bit
  - Deployed version will remain on SUSE 10 for one more year
- Project C has added redundancy requirements and will require a second server

Mismatch

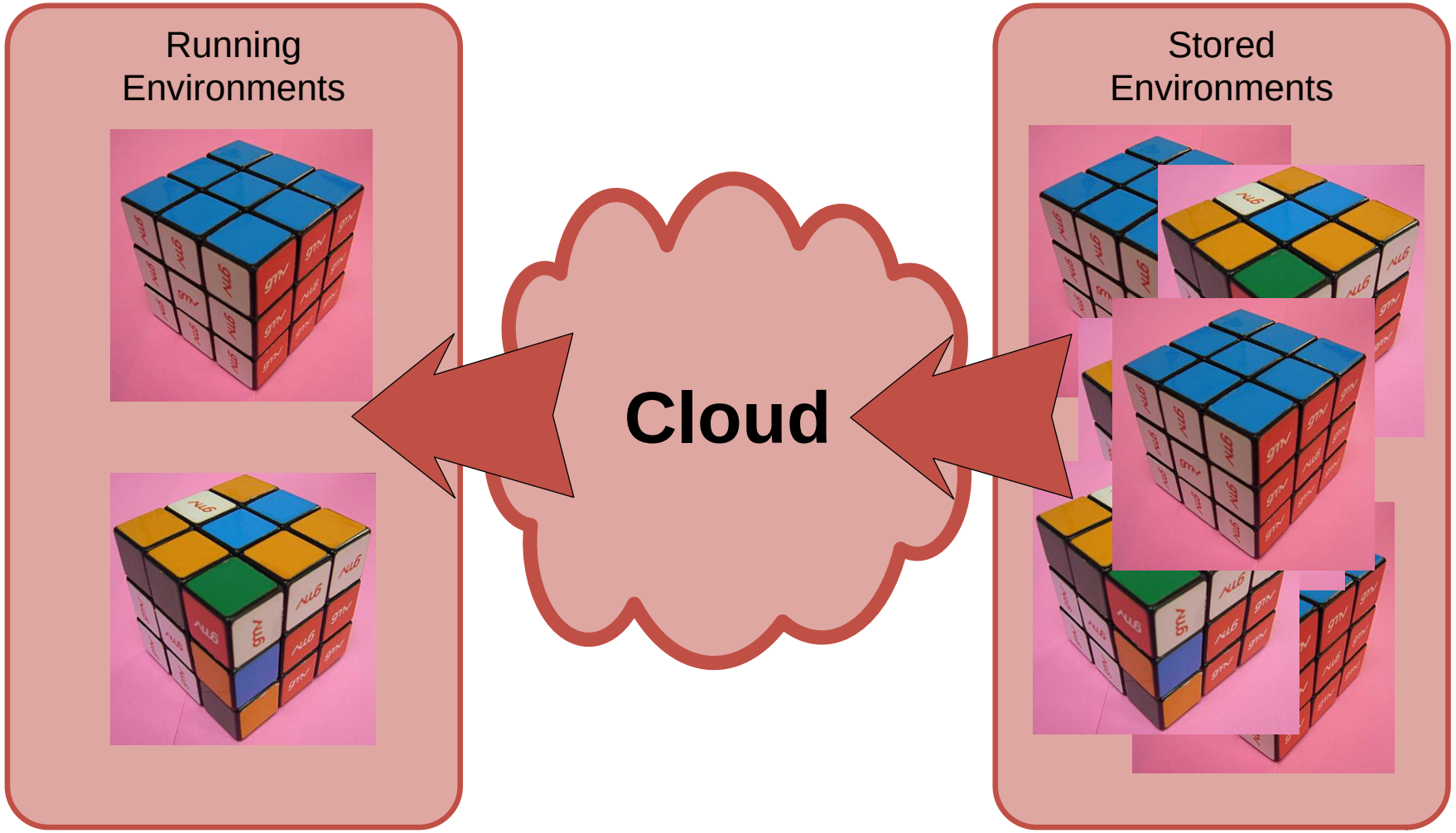
- The numbers of required environments increases monotonically
  - Projects stay in support for a very long time
- Computer resource requirements are proportional to current workload
  - Developers and testers transition to new projects as old ones ramp down (i.e. team size is relatively constant)
  - New software versions tend to require more resources than old
- Space, power and money are scarce resources
  - Filling the office space with computers is not sustainable
  - Constantly reconfiguring the existing computers is not efficient

How do we scale the computing resources with the workload, and not with the environment count?

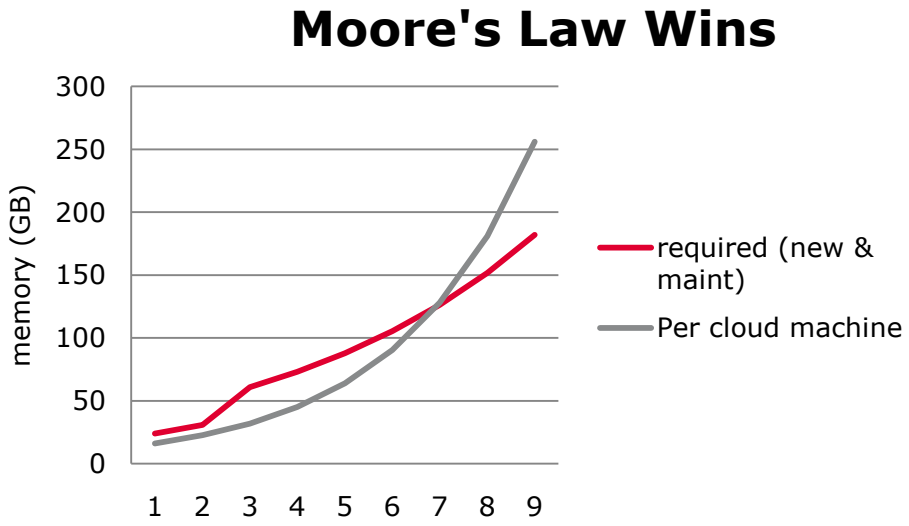
Enter the cloud

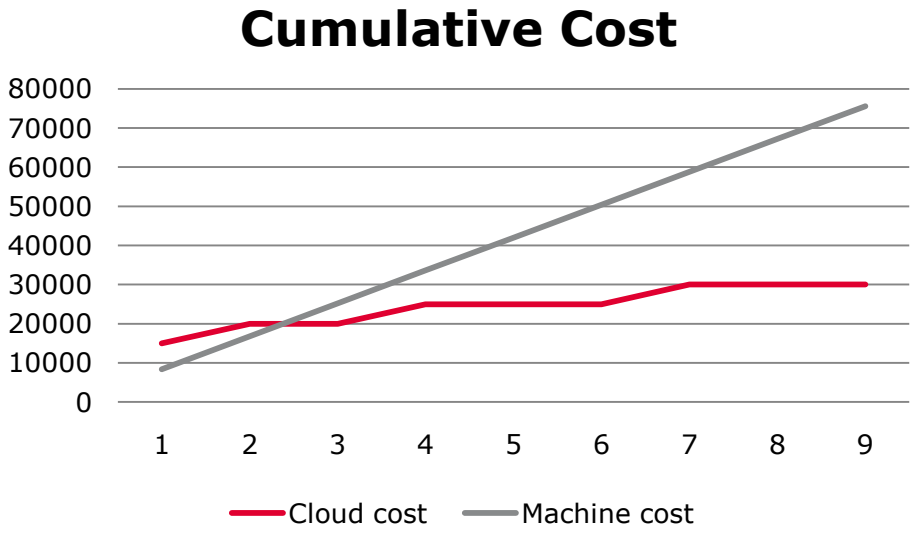
- Enabling factors
  - All configurations run on compatible hardware
    - 64 bit Intel processors (Core 2 and later)
    - New hardware is backwards compatible (i.e. old instruction sets supported)
  - Available hardware exceeds required performance for all roles
    - Installable memory
    - Number of processor cores
  - Hardware price/performance grows as fast as the workload
    - Lab workload grows with the requirements of new software versions, not with the number of projects
- Approach:
  - Size hardware for the current workload
  - Configure a set of virtual machines for each project/version
    - Includes simulators for spacecraft and network link delays
  - Run the appropriate sets of virtual machines for the current work
    - Automatic load balancing, or fixed configurations, as required

Lab Concept



Results





- Assumptions
  - 4 new projects/year, 1 year duration
  - Old projects require 1 month maintenance every year
  - 3 machines/project
  - 2 GB + 20%/year memory requirement per machine
  - Memory capacity doubles every two years (Moore's law)
  - Individual machine $700 (2GB), Cloud server $5000 (16 GB)

Conclusion

- Ground Systems development has characteristics that cause proliferation of lab environments (build and test)
  - High degree of project-specific customization
  - Long-lived deployments
- Cloud computing enables efficient reuse of hardware
  - Similarly to how the team's resources are allocated to projects according to their level of activity
  - Saves space, power and money
- This enables GMV to support a growing customer base efficiently and responsively

To the cloud!


Thank you
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