# Systems Engineering Designs on the Cloud

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# Overview

- What is the Problem?
- What Does Scalability Mean?
- What is Cloud Computing?
- What Does a Commercial Cloud Vendor (Google) Do?
- How Can We Design Software for Scalability?
- Summary

# What Is the Problem?

*"Engineers are engaged today in the design and development of large - scale, interconnected systems of staggering complexity and criticality." Mr. Stephen P. Welby, Deputy Assistant Secretary of Defense for Systems Engineering*

- from INCOSE International Symposium, 6/25/2013

- The systems we build today have millions of parts, distributed worldwide
- They are all interconnected
- Teams of designers, developers, integrators, testers, and operators all take pieces of the problem and try to bring them together in different information environments in their own stovepipes

***The environments of today limit the amount of information that can be captured and shared, because they do not scale to the need***

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# What Does Scalability Mean?

- Many systems and products claim to scale, but what does it mean?
- If the tool and product are limited to a standard client server environment, then the hardware will limit their ability to scale
- But worse, unless the system is designed to scale, the user interface will become so slow and cumbersome that finding anything will be very difficult to impossible

Scalable: "capable of being easily expanded or upgraded on demand"
From http://www.merriam-webster.com/dictionary/scalable

***Can you find what you are looking for on your "P" drive?***

# What is Cloud Computing?

Hint: It's not just a website

# What is cloud computing?

- Definition from NIST:
  - *Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort or service provider interaction. This cloud model promotes availability and is composed of* ***five essential characteristics, three service models, and four deployment models***

*From presentation by Jim Sweeney, GTSI at the Technology Leadership Series 2012 Seminar, January 19, 2012*

# Five Essential Characteristics

- ***On-demand self-service.*** A consumer can unilaterally provision computing capabilities, such as server time and network storage, as needed automatically without requiring human interaction with each service's provider.
- ***Broad network access.*** Capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms (e.g., mobile phones, laptops, and PDAs).
- ***Resource pooling.*** The provider's computing resources are pooled to serve multiple consumers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to consumer demand. There is a sense of location independence in that the customer generally has no control or knowledge over the exact location of the provided resources but may be able to specify location at a higher level of abstraction (e.g., country, state, or datacenter). Examples of resources include storage, processing, memory, network bandwidth, and virtual machines.
- ***Rapid elasticity.*** Capabilities can be rapidly and elastically provisioned, in some cases automatically, to quickly scale out and rapidly released to quickly scale in. To the consumer, the capabilities available for provisioning often appear to be unlimited and can be purchased in any quantity at any time.
- ***Measured Service.*** Cloud systems automatically control and optimize resource use by leveraging a metering capability at some level of abstraction appropriate to the type of service (e.g., storage, processing, bandwidth, and active user accounts). Resource usage can be monitored, controlled, and reported providing transparency for both the provider and consumer of the utilized service.

*From presentation by Jim Sweeney, GTSI at the Technology Leadership Series 2012 Seminar, January 19, 2012*



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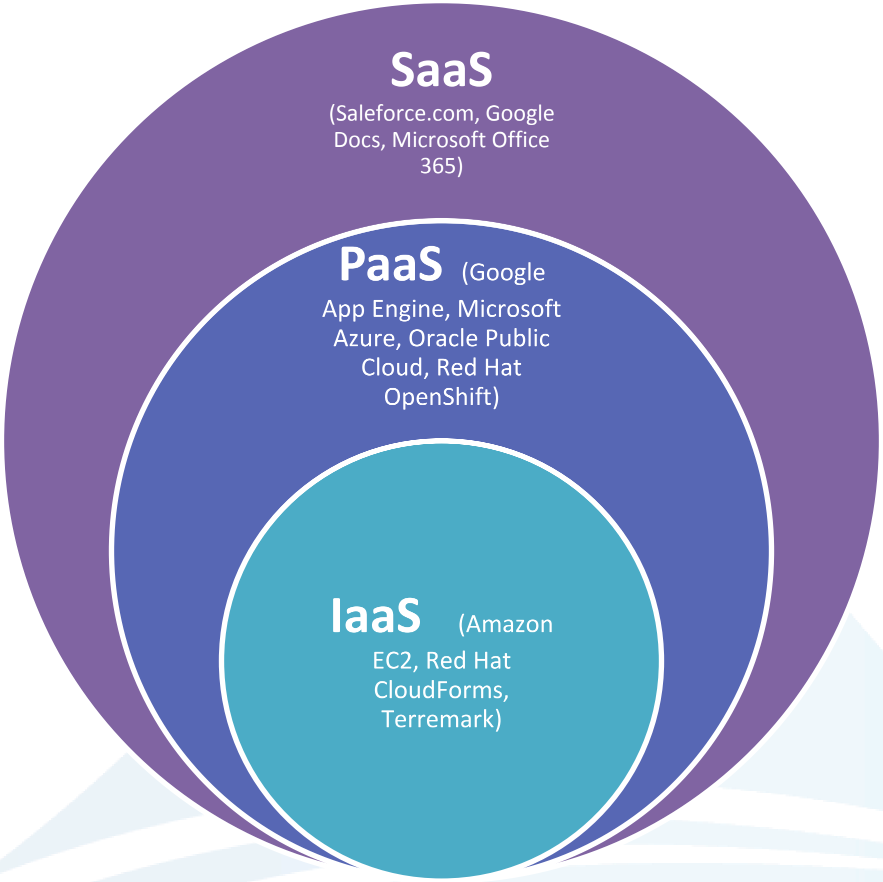
# Three Service Models

- Software as a Service (SaaS): The end user system
- Platform as a Service (PaaS): Tools and services to create a SaaS Application
- Infrastructure as a Service (IaaS): Full control of the software stack and services

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# Four Deployment Models

*Private cloud*
- Operated solely for an organization
- May be managed by the organization or a third party

*Public cloud*
- Available to the general public or a large industry group
- Owned by an organization selling cloud services

*Community cloud*
- Shared by several organizations
- Managed by the organizations or a third party

*Hybrid cloud*
- composition of two or more clouds that remain unique entities but are bound together by standardized or proprietary technology that enables data and application portability

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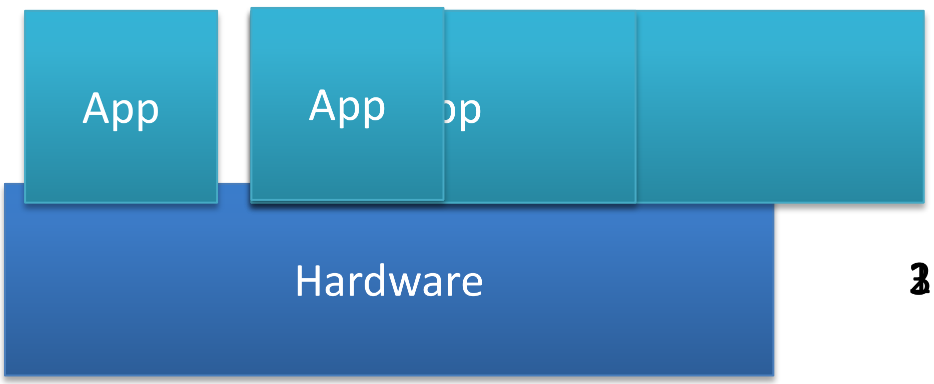
# Normal Server Deployment

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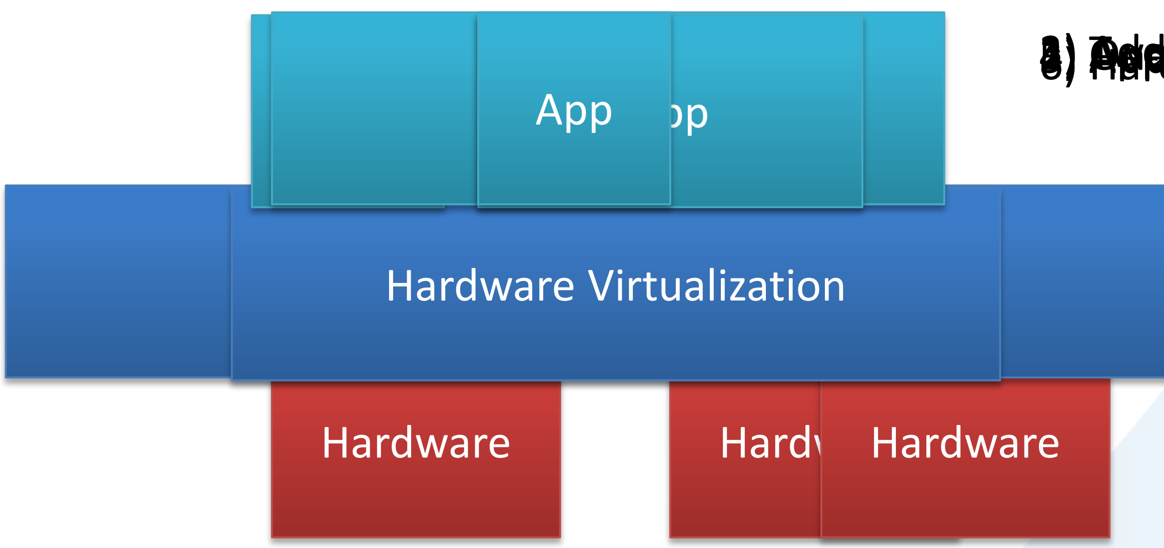
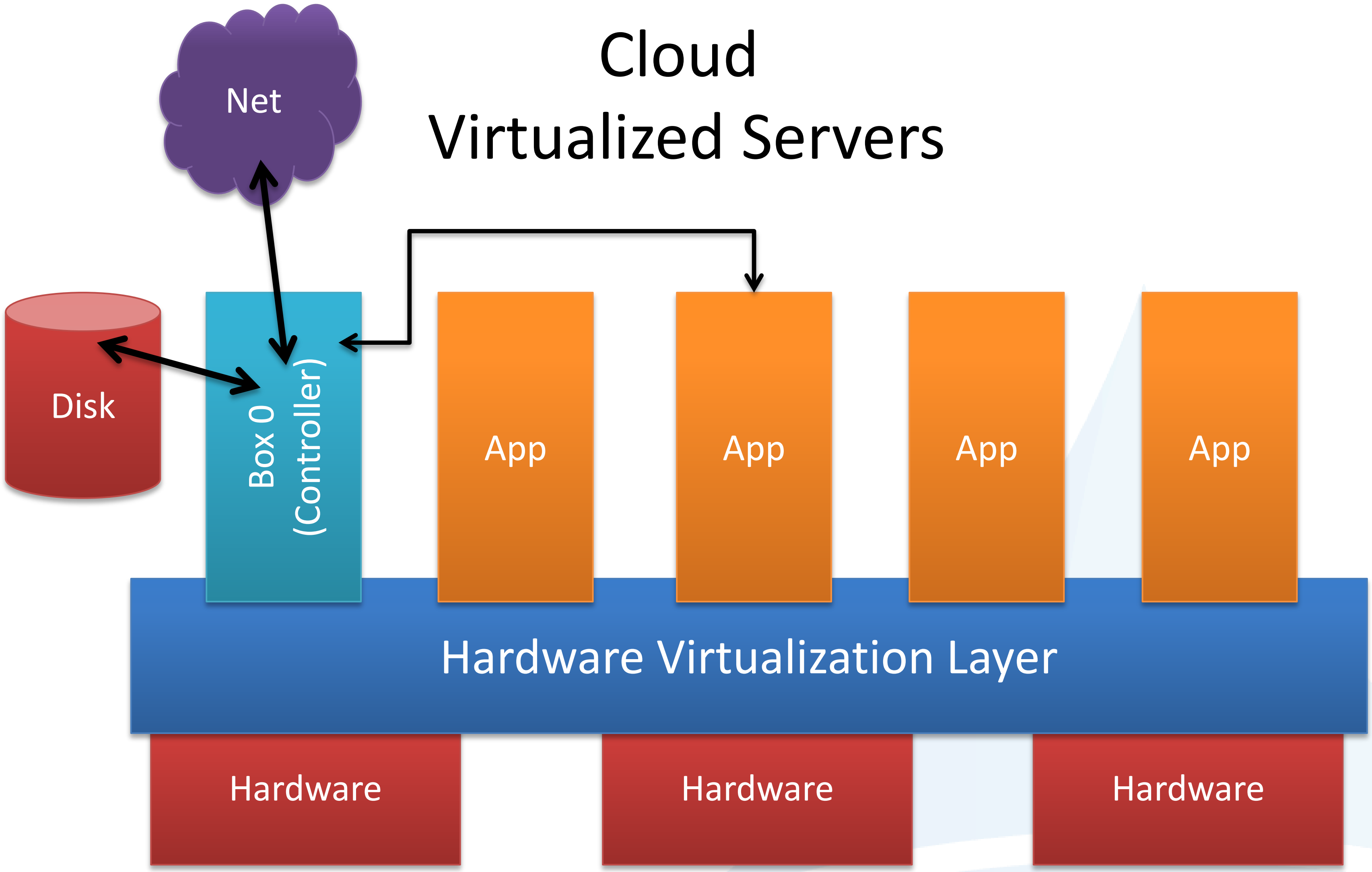
# Virtualized Server Deployment




6) Hardware server crashes; virtualization continues

# Cloud
# Virtualized Servers

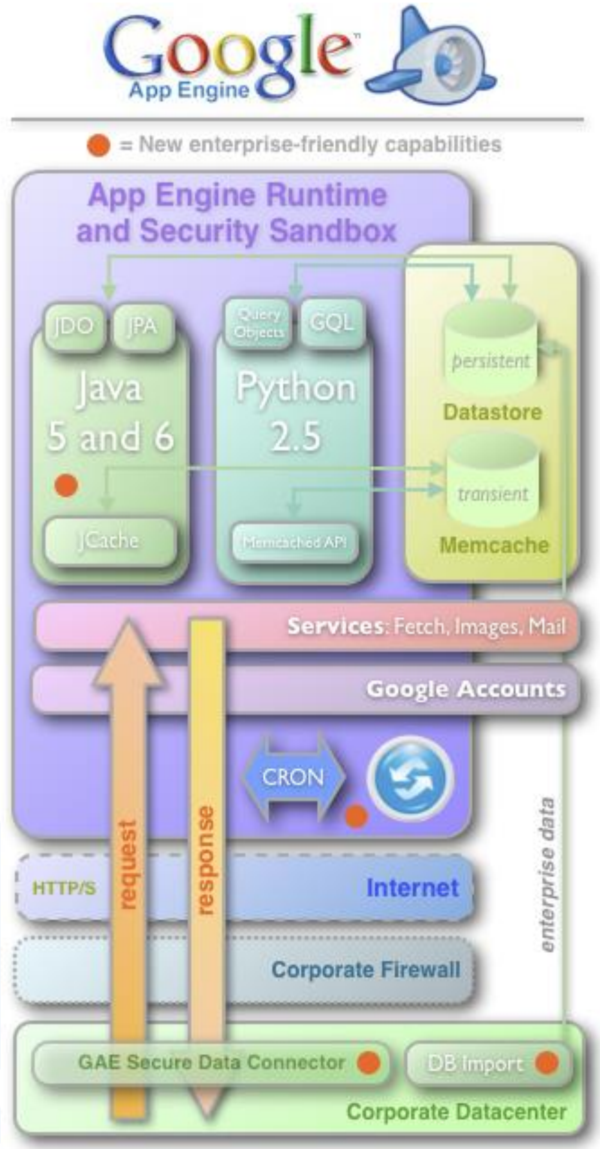


# What Does a Commercial Cloud Vendor (Google) Do?

A leader in cloud computing

# Google AppEngine

- PaaS
- Supports Java, Python, Go and PHP
- Google Cloud SQL
- Memcache
- Task Queues
- Auto-scaling



From http://blogs.zdnet.com/Hinchcliffe

***Runs on Google Data Centers Worldwide***

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# World-wide Data Centers

## Data center locations

We own and operate data centers around the world to keep our products running 24 hours a day, 7 days a week. Find out more about our data center locations, community involvement, and job opportunities in our locations around the world.

### Americas

Berkeley County, South Carolina
Council Bluffs, Iowa
Douglas County, Georgia
Quilicura, Chile
Mayes County, Oklahoma
Lenoir, North Carolina
The Dalles, Oregon

### Asia

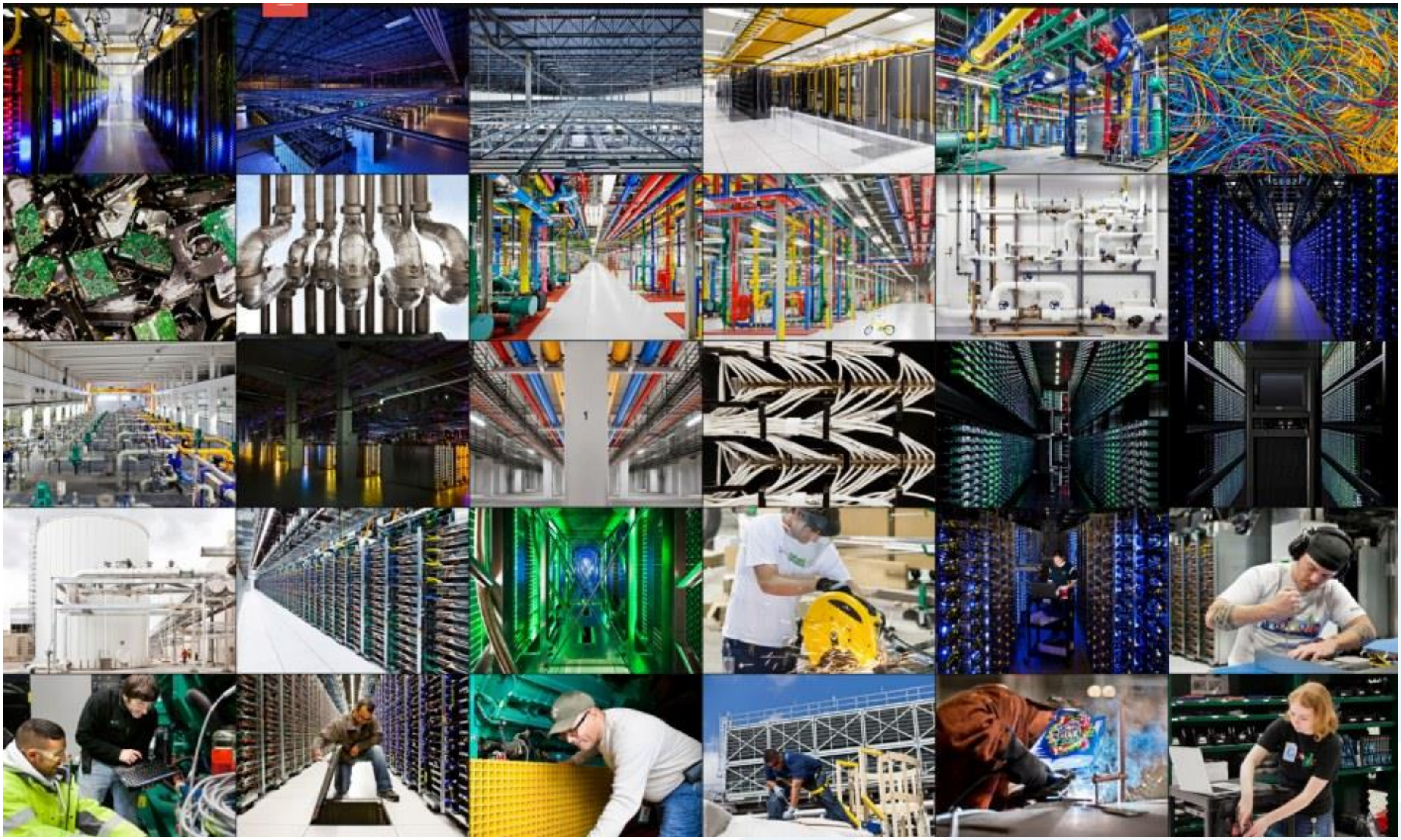
Hong Kong
Singapore
Taiwan

### Europe

Hamina, Finland
St Ghislain, Belgium
Dublin, Ireland

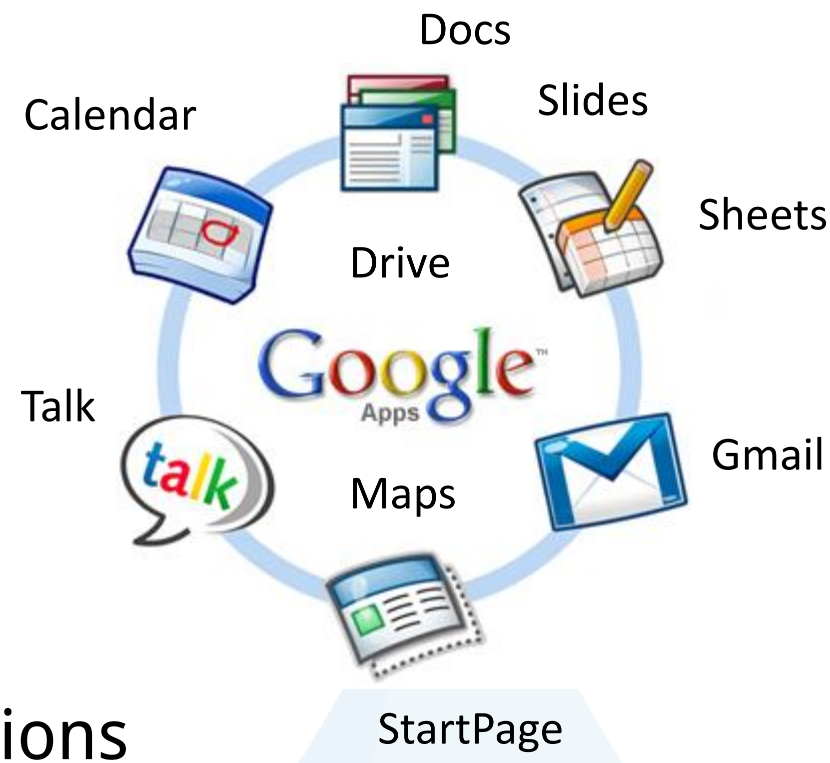
***Regions can be specified***

# Google Data Centers



From http://www.dailymail.co.uk/sciencetech/article-2219188/Inside-Google-pictures-gives-look-8-vast-data-centres.html accessed 9/23/2013

# Google Apps




- Google Apps for Government available
  - FISMA accedited
  - Automatic backups
  - 24x7x365 network operations
  - Your data is yours ("When you put your data in Google Apps, you still own it, and it says just that in our contracts. We don't scan your data in order to show you ads.")
- Designed to scale

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# How Can We Design Software for Scalability?

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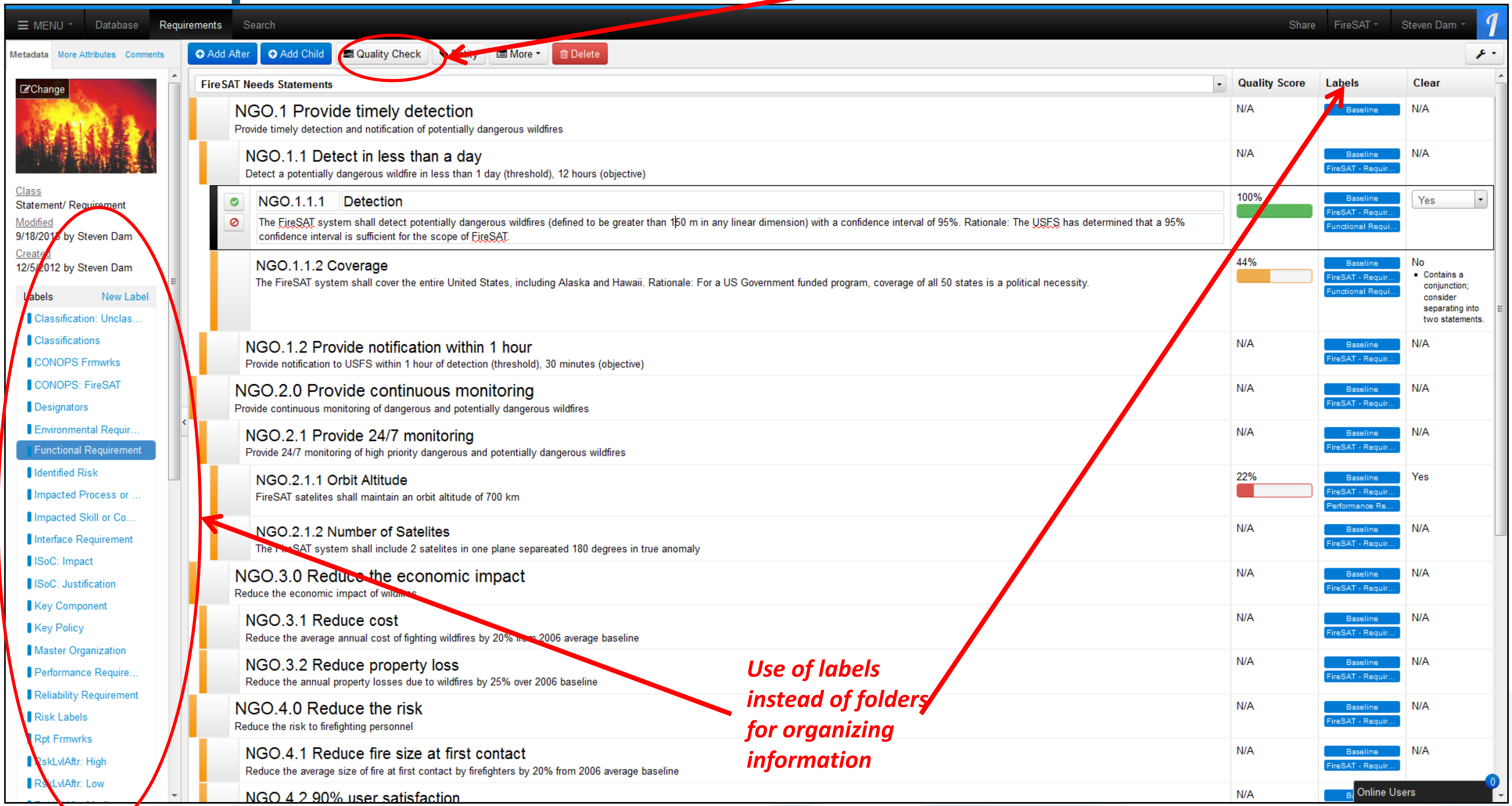
# Designing for Scalability

- To state the obvious: you must take scalability into account all through out the design process
  - User interface
  - Databases
  - Algorithms
- We encountered these problems as we developed Innoslate®

# Requirements View

*Automated Quality Check requires careful algorithm development for large numbers of requirements*




*Use of labels instead of folders for organizing information*



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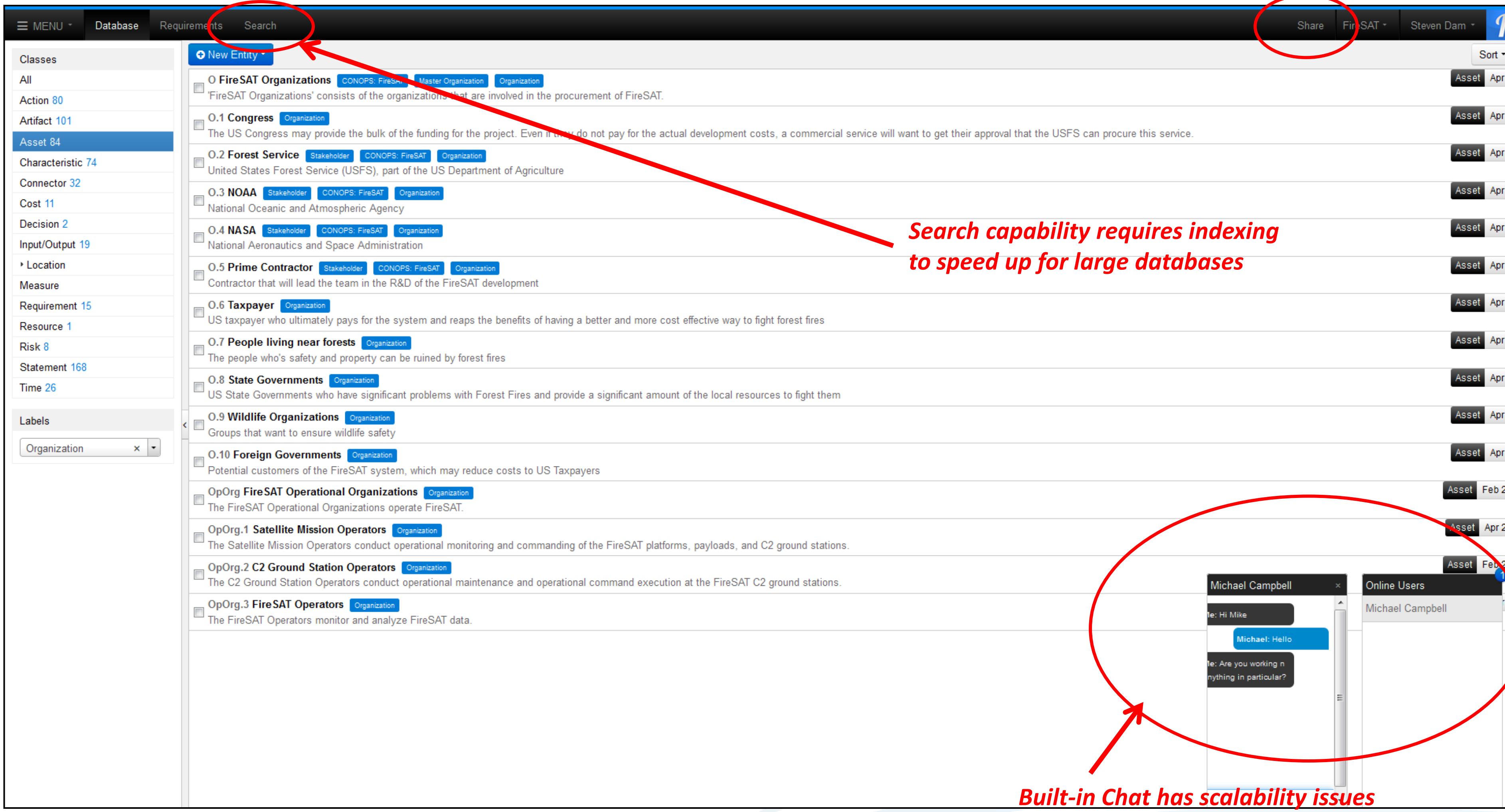
# Database View

***Sharing databases worldwide requires careful design to deal with large numbers of contributors***




***Search capability requires indexing to speed up for large databases***

***Built-in Chat has scalability issues associated with it***

***Designed to scale to large data sets***



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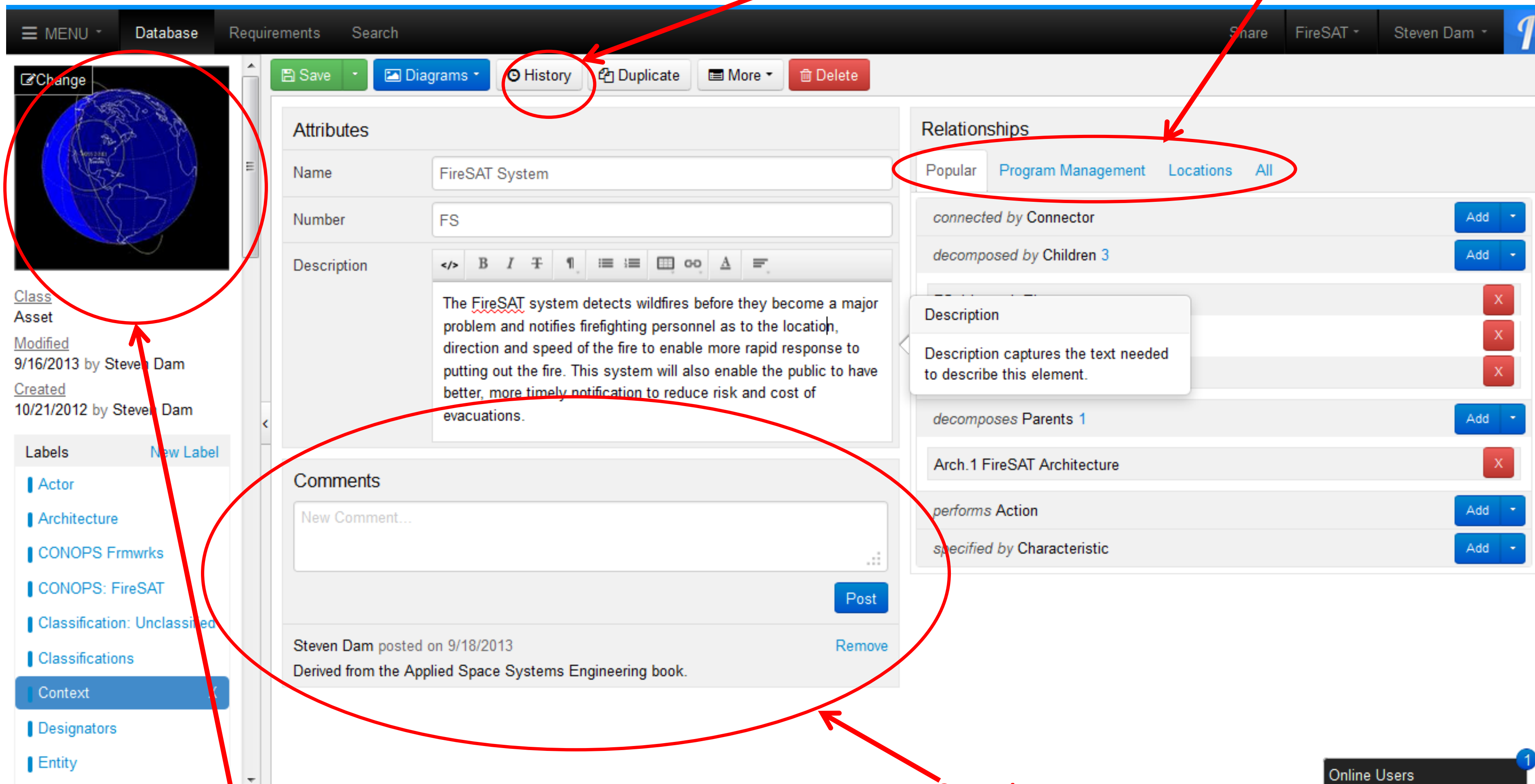
# Entity View

***Detailed history of changes available for each element can become a scaling issue***

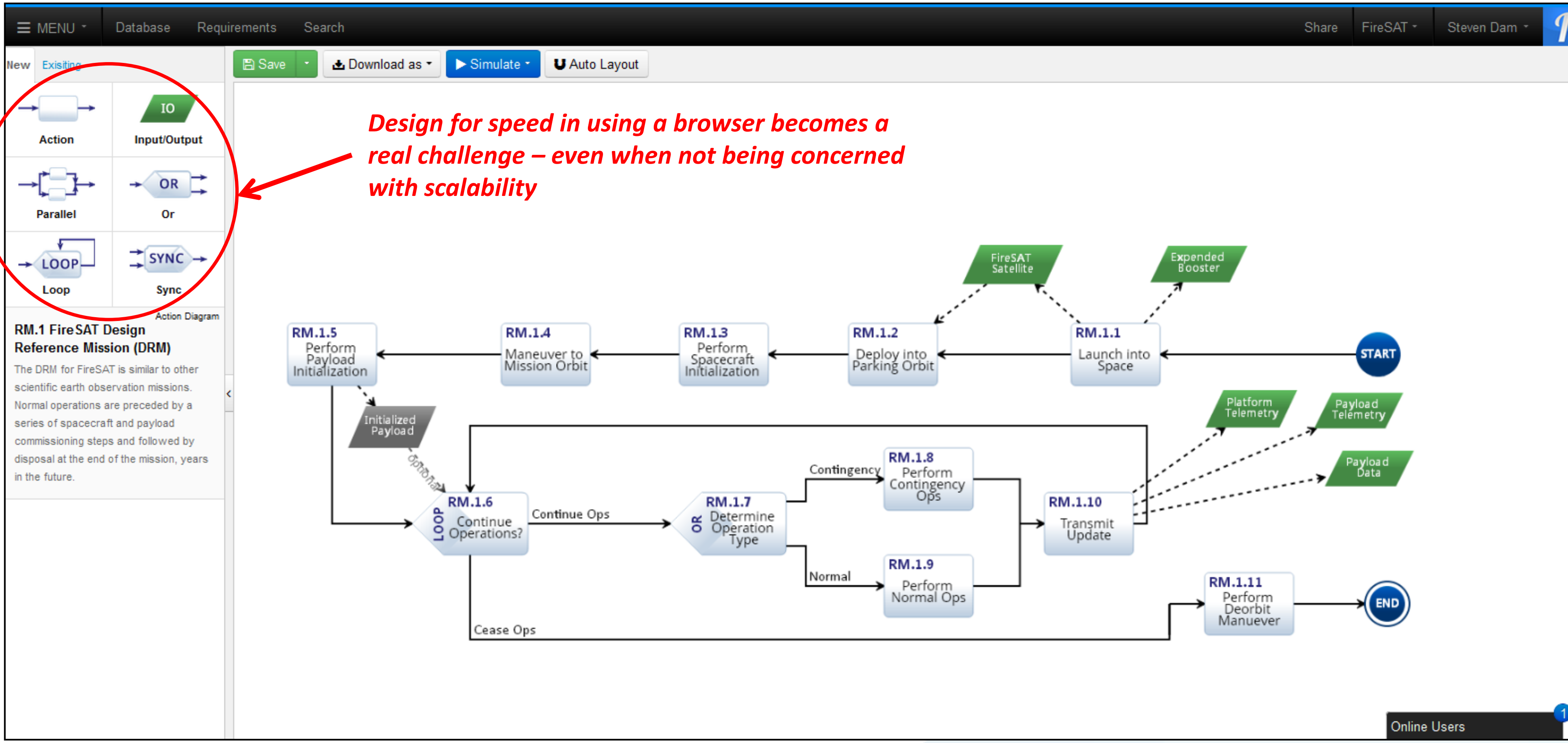
***Tabs for logical grouping of relationships reduces information overload***




***Capture and storage of pictures requires scalability design***

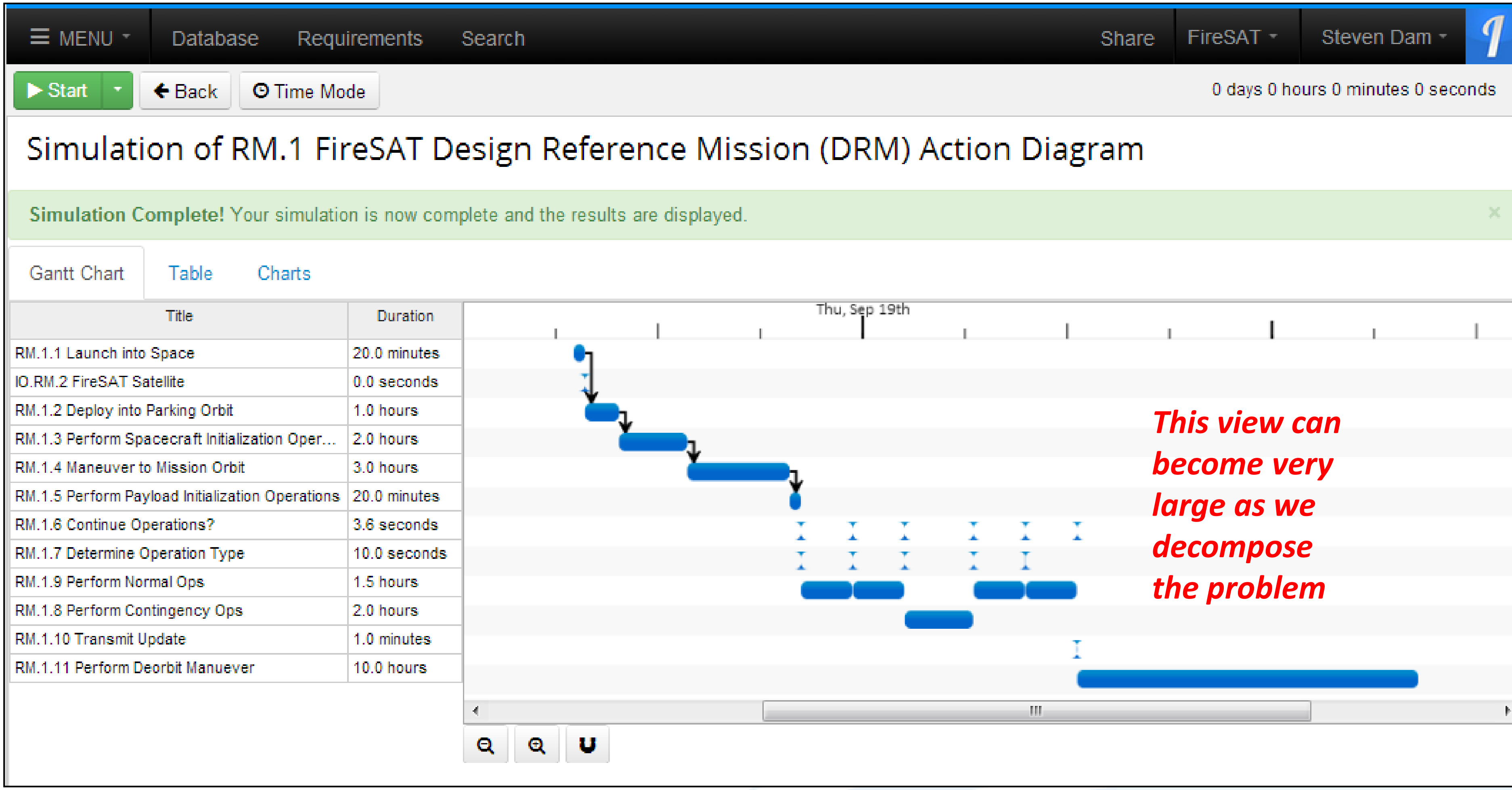
***Capturing comments, like in a blog, has scaling issues***

# Action Modeling (Functional View)




***Action Diagrams for functional modeling designed to work on tablets, such as the iPad***

# Discrete Event Simulation




***Results saved automatically as an Artifact; Monte Carlo available in Professional Edition***

# Summary

# Summary

- Cloud computing is here
  - DoD needs to get fully on-board and leverage the commercial resources, not just re-invent the wheel
- Partitioning becomes less necessary and can now be done for organizational, rather than tool-related reasons
- Do not expect your desktop tools to port over to a cloud environment and scale
- Include scalability in the designs of all the software you build for the future



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