folio3

# StackOverflow Architectural Overview

# Folio3 – Overview

# Who We Are

- We are a Development Partner for our customers
  - **Design** software solutions, not just implement them
  - **Focus on the solution** – Platform and technology agnostic
- Expertise in building applications that are:

Mobile

Social

Cloud-based

Gamified

# What We Do

## Areas of Focus

- **Enterprise**
  - Custom enterprise applications
  - Product development targeting the enterprise

- **Mobile**
  - Custom mobile apps for iOS, Android, Windows Phone, BB OS
  - Mobile platform (server-to-server) development

- **Social Media**
  - CMS based websites for consumers and enterprise (corporate, consumer, community & social networking)
  - Social media platform development (enterprise & consumer)

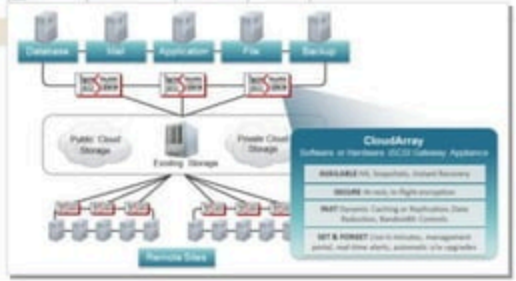
# Folio3 At a Glance

- Founded in 2005
- Over 200 full time employees
- Offices in the US, Canada, Bulgaria & Pakistan

# Areas of Focus: Enterprise

- Automating workflows
- Cloud based solutions
- Application integration
- Platform development
  - Healthcare
  - Mobile Enterprise
  - Digital Media
  - Supply Chain





# Some of Our Enterprise Clients






















# Areas of Focus: Mobile

- Serious enterprise applications for Banks, Businesses
- Fun consumer apps for app discovery, interaction, exercise gamification and play
- Educational apps
- Augmented Reality apps
- Mobile Platforms




# Some of Our Mobile Clients




















# Areas of Focus: Web & Social Media

- Community Sites based on Content Management Systems
- Enterprise Social Networking
- Social Games for Facebook & Mobile
- Companion Apps for games

# Some of Our Web Clients






















# StackOverflow Architectural Overview

# What?

- Study the architecture and design
- Compare Old & New Technology stack
- Analyze evolution of architecture and scalability
- Lessons learned over time

# Introduction

- Two top bloggers and forum poster
  - Jeff Atwood
  - Joel Spolsky
- A very few things about stackoverflow have been made public to world (like their data, and their WMD WYSIWYM Markdown Editor), it is highly unlikely to do it with their code-base, as they are offering their software to generate revenue.
- It's true there's not much about their architecture. All we know is about their machines, their tool chain, and that they use a two-tier architecture where they access the database directly from the web server code.
- Although there are some copies of their idea out there (cnprog.com, code.google.com/p/cnprog, code.google.com/p/stacked).

# Old Technology Stack

## tackOverflow technology stack

| Stack | Technology |
|---|---|
| framework | **Microsoft ASP.NET (version 3.5 SP1)** |
| language | **C#** |
| development environment | **Visual Studio 2008 Team Suite** |
| web framework | **ASP.NET MVC** |
| browser framework | **JQuery** |
| database | **SQL Server 2008** |
| data access layer | **LINQ to SQL** |
| source control | **Subversion** |
| compare tool | **Beyond Compare 3** |
| source control integration | **VisualSVN 1.5** |

## Other dependencies

| Type | Dependency |
|---|---|
| Captcha | **ReCaptcha** |
| Authentication | **DotNetOpenID** |
| Editor | **wmd initially (rewritten by them)** |
| jQuery charts | **flot** |

## Hardware

| **Web Tier** |
|---|
| 2 x Lenovo ThinkServer RS110 1U |
| 4 cores, 2.83 Ghz, 12 MB L2 cache |
| 500 GB datacenter hard drives, mirrored |
| 8 GB RAM |
| 500 GB RAID 1 mirror array |
| |
| **Database Tier** |
| 1 x Lenovo ThinkServer RD120 2U |
| 8 cores, 2.5 Ghz, 24 MB L2 cache |
| 48 GB RAM |

# Old Technology Stack

- A fourth server was added to run superuser.com. All together the servers also run Stack Overflow, Server Fault, and Super User.
- QNAP TS-409U NAS for backups. Decided not to use a cloud solution because the bandwidth costs of transferring 5 GB of data per day becomes prohibitive.
- Hosting at http://www.peakinternet.com/. Impressed with their detailed technical responses and reasonable hosting rates.
- SQL Server's full text search is used extensively for the site search and detecting if a question has already been asked. Lucene.net is considered an attractive alternative.

# Stats Excerpt

- From highscalability.com (2009)
  - 16 million page views a month
  - 3 million unique visitors a month (Facebook reaches 77 million unique visitors a month)
  - 6 million visits a month
  - 86% of traffic comes from Google
  - 9 million active programmers in the world and 30% have used Stack Overflow.
  - Cheaper licensing was attained through Microsoft's BizSpark program. My impression is they pay about $11K for OS and SQL licensing.
  - Monetization strategy: unobtrusive adds, job placement ads, Dev-Days conferences, extend the software to target other related niches (Server Fault, Super User), develop StackExchange as a white label and self hosted version of Stack Overflow, and perhaps develop some sort of programmer rating system.

# New Technology Stack

**Data Centers**
1 Rack with Peak Internet in OR (Hosts our chat and Data Explorer)
2 Racks with Peer 1 in NY (Hosts the rest of the Stack Exchange Network)

| **Resources** | |
|---|---|
| Host | PEAK Internet |
| Developers | 14 |
| System Admin | 2 |
| License | Creative Commons Attribution-Share Alike 2.5 Generic |
| Standards | Open-Search, Atom |
| **Type** | **Dependency** |
| Captcha | ReCaptcha |
| Authentication | DotNetOpenID |
| Editor | wmd initially (rewritten by them) |
| jQuery charts | dsnfbsdn |
| Source code highlight | Prettify |
| Analytics | Google Analytics |
| Network Monitoring | Cacti |
| Syntax Formatting | MarkdownSharp |
| Reverse proxy Server | Nginx |
| Version Control | Kiln |
| Delivering Web Static content | CDN |

| **Stack** | **Technology** |
|---|---|
| framework | Microsoft ASP.NET (version 4.0) |
| language | C# |
| development environment | Visual Studio 2010 Team Suite |
| web framework | ASP.NET MVC 3 |
| View Engine | Razor 3 |
| browser framework | JQuery |
| database | SQL Server 2008 R2 (enterprise x64) |
| data access layer | LINQ to SQL |
| source control | Previously Mercurial and Kiln, now Git using a self-hosted GitLab |
| compare tool | Beyond Compare 3 |
| source control integration | VisualSVN 1.5 |
| compare tool | Beyond Compare 3 |
| OS | Windows Server 2008 R2 x64 |
| Web Server | IIS 7.0 |
| Load Balancer | HAProxy |
| Distributed Cache | Redis |
| Automated Builds | CruiseControl.NET |
| Search | Lucene.NET |
| Backups | Bacula |
| Monitoring | Nagios |
| Logs | Splunk |
| SQL Server monitoring | SQL Monitor from Red Gate |
| DNS | Bind |
| External Monitor & ping Service | Pingdom |

# New Technology Stack

## Hardware

**Web Tier**
10 Dell R610 IIS web servers (3 dedicated to Stack Overflow)
2x Intel Xeon Processor E5640 @ 2.66 GHz Quad Core with 8 threads
16 GB RAM
Windows Server 2008 R2

**Database Tier**
2 Dell R710 database servers
2x Intel Xeon Processor X5680 @ 3.33 GHz
96 GB RAM
8 spindles
SQL Server 2008 R2

**Proxy Servers**
2 Dell R610 HAProxy servers
1x Intel Xeon Processor E5640 @ 2.66 GHz
4 GB RAM
Ubuntu Server

**Networks**
2 Linux routers
5 Dell Power Connect switches

**Radis Servers**
2 Dell R610 Redis servers
2x Intel Xeon Processor E5640 @ 2.66 GHz
16 GB RAM
CentOS

**Backup Servers**

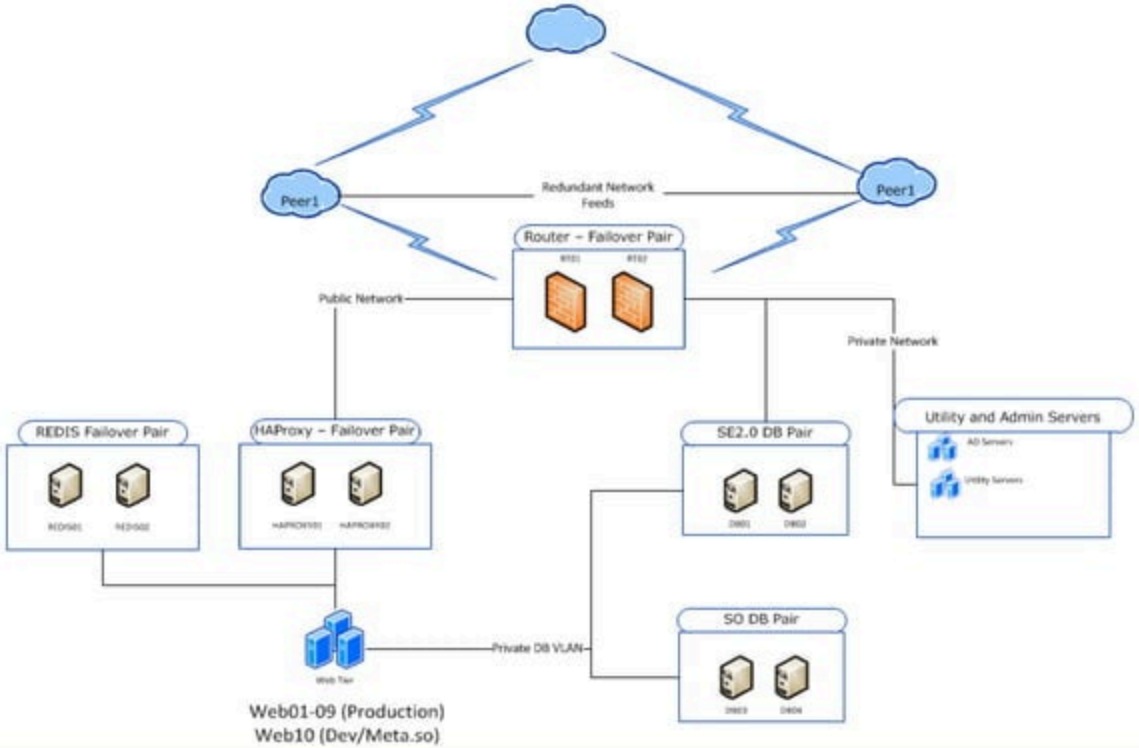
1 Dell R610 Linux backup server running Bacula
1x Intel Xeon Processor E5640 @ 2.66 GHz
32 GB RAM

**Nagios Server**
1 Dell R610 Linux management server for Nagios and logs
1x Intel Xeon Processor E5640 @ 2.66 GHz
32 GB RAM

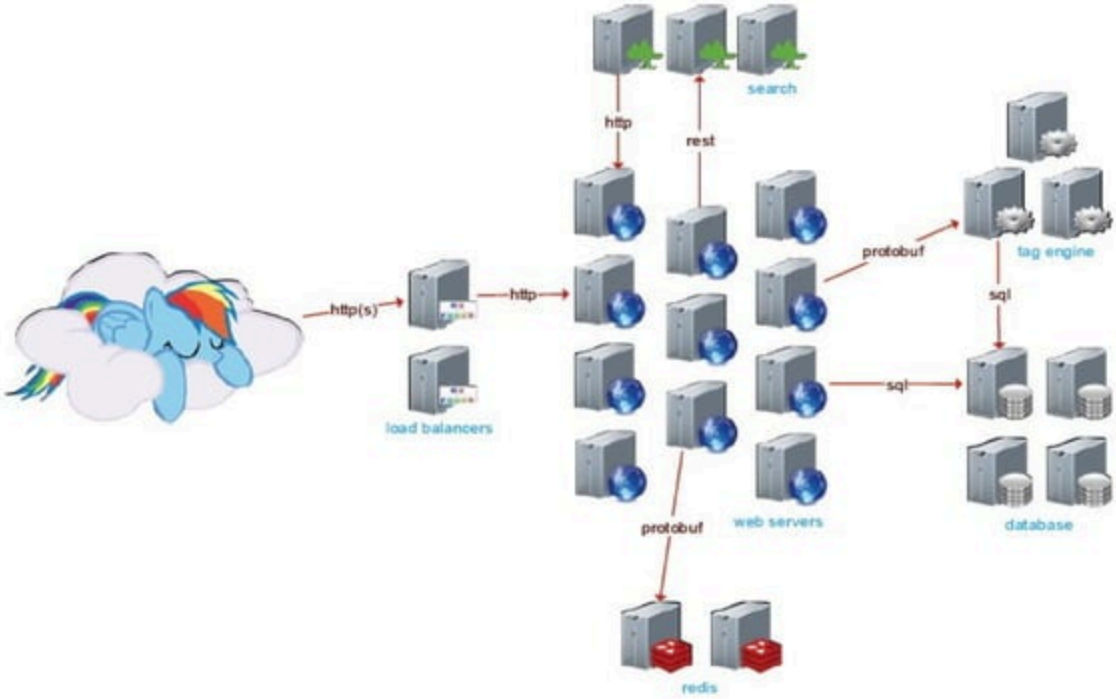
**Domain Controller**

2 Dell R610 VMWare ESXi domain controllers
1x Intel Xeon Processor E5640 @ 2.66 GHz
16 GB RAM

# New Technology Stack



# New Technology Stack



# Stats excerpt

- Latently (2011 - 2012), Stack Overflow has grown up by more then doubling in size to over 16 million users and multiplying its number of page views nearly 6 times to 95 million page views a month.
  - 95 Million Page Views a Month
  - 800 HTTP requests a second
  - 180 DNS requests a second
  - 55 Megabits per second
  - 16 Million Users - Traffic to Stack Overflow grew 131% in 2010, to 16.6 million global monthly unique

# Obvious Differences Across Time

- **Just More**. More users, more page views, more datacenters, more sites, more developers, more operating systems, more databases, more machines. Just a lot more of more.
- **Linux**. Stack Overflow was known for their Windows stack, now they are using a lot more Linux machines for HAProxy, Redis, Bacula, Nagios, logs, and routers. All support functions seem to be handled by Linux, which has required the development of parallel release processes.
- **Fault Tolerance**. Stack Overflow is now being served by two different switches on two different internet connections, they've added redundant machines, and some functions have moved to a second datacenter.
- **NoSQL**. Redis is now used as a caching layer for the entire network. There wasn't a separate caching tier before so this a big change, as is using a NoSQL database on Linux.

# Lessons Learned (from Jeff's & Joel's posts)

- If you're comfortable **managing servers** then buy them. The two biggest problems with renting costs were
  - The insane cost of memory and disk upgrades
  - The fact that they [hosting providers] really couldn't manage anything.
- Make **larger one time up front investments** to avoid recurring monthly costs which are more expensive in the long term.
- **Updating all network drivers** enhanced performance from 2x slower to 2x faster.
- **Upgrading to 48GB RAM** required upgrading MS Enterprise edition.
- **Memory** is incredibly cheap. Max it out for almost free performance.
- Stack Overflow copied a key part of the Wikipedia database design. This turned out to be a mistake which will need massive and painful **database refactoring** to fix.
- **CPU speed** is surprisingly important to the database server. Going from 1.86 GHz, to 2.5 GHz, to 3.5 GHz CPUs causes an almost linear improvement in typical query times. The exception is queries which don't fit in memory.
- The **bottleneck is the database** 90% of the time.
- At low server volume, the key cost driver is not rack-space, power, bandwidth, servers, or software; it is **Network Equipment's**. You need a gigabit network between your DB and Web tiers

# Lessons Learned (from Jeff's & Joel's posts)

- **EC2 is for scaling horizontally**, that is you can split up your work across many machines (a good idea if you want to be able to scale).
- Scaling out is only frictionless when you use open source software. Otherwise **scaling up** means paying less for licenses and a lot more for hardware, while scaling out means paying less for the hardware, and a whole lot more for licenses.
- **Separate application and database** duties so each can scale independently of the other. **Databases scale up** and the **applications scale out**
- **Applications should keep state in the database** so they scale horizontally by adding more servers.
- With larger form factors like 7U power and cooling become critical issues. **Using something between 1U and 7U** might be easier to make work in your data center
- As you add more and more database servers the **SQL Server license costs can be outrageous**. So by starting scale up and gradually going scale out with non-open source software you can be in a world of financial hurt.

# Lessons Learned (from Jeff's & Joel's posts)

- **HAProxy** is used instead of Windows NLB because HAProxy is cheap, easy, free, works great as a 512MB VM
- A **CDN** is not used because even "cheap" CDNs like Amazon one are very expensive relative to the bandwidth they get bundled into their existing host's plan
- Full Text Search in SQL Server is very badly integrated, buggy, deeply incompetent, so they went to **Lucene**
- Aggressively **cache** everything
- For their IO system they selected a **RAID** 10 array of Intel X25 solid state drives
- **Intel NICs** are replacing Broadcom NICs and their primary production servers. This solved problems they were having with connectivity loss, packet loss, and corrupted arp tables.

# Badges

- **Microsoft Stack Badge** - The Microsoft Stack Badge was earned because Stack Overflow uses the entire Microsoft Stack: OS, database, C#, Visual Studio, and ASP .NET.
- **Scale Up Badge** - The Scale Up Badge was awarded because Stack Overflow uses a scale up strategy to meet their scaling requirements. When they reach a limit they scale vertically by buying a bigger machine and adding more memory. And there are still directions they can take if they need to scale (caching, more web servers, faster disks, more de-normalization, more memory, some partitioning, etc). All-in-all it's a well done and very useful two-tier CRUD application.

# Conclusion

- Overall they believe that they are in a good place and have plenty of room to grow given our current setup. As always they will constantly be looking at our infrastructure and tweaking it to get the best performance possible and give our users the best experience possible.

# Contact

- For more details about our services, please get in touch with us.

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