

CMAD Foundations

About Me

- Maruthi R Janardhan
 - Been with IBM, ANZ, HCL-HP, my own startup Leviossa..
 - Total 16 years programming/consulting C, C++, Java, Javascript, Ruby, Perl, Python, PHP, etc
 - Two pending Indian Patents

Please Download

- Flipboard
- Instagram

Foundations of MAD

- Conceptual overview of what's involved in Modern Application Design
 - A little history
 - A little discussion
 - A little case studies

History - First Website - 90s

**[http://line-mode.cern.ch/www/hypertext/WWW/
TheProject.html](http://line-mode.cern.ch/www/hypertext/WWW/TheProject.html)**

World Wide Web

The WorldWideWeb (W3) is a wide-area [hypermedia](#) information retrieval initiative aiming to

Everything there is online about W3 is linked directly or indirectly to this document, includin

[What's out there?](#)

Pointers to the world's online information, [subjects](#) , [W3 servers](#), etc.

[Help](#)

on the browser you are using

[Software Products](#)

A list of W3 project components and their current state. (e.g. [Line Mode](#) ,[X11 Viola](#) ,[I](#)

[Technical](#)

Details of protocols, formats, program internals etc

[Bibliography](#)

Paper documentation on W3 and references.

[People](#)

A list of some people involved in the project.

[History](#)

A summary of the history of the project.

[How can I help ?](#)

If you would like to support the web..

[Getting code](#)

Getting the code by [anonymous FTP](#) , etc.

Evolution of Table based sites

- Demonstration of Table Structures
- Div and CSS Layouts
- Age of dancing text and flashy colors http://www.burlingtonnews.net/burlington_ufo_center.html

Flash - Spice of Web

- Flash Introduced a runtime on the “dumb” browsers to get smart content running (Read as animation)
- Websites with extensive animation surfaced (those lengthy intro pages)
- Flash was fancy and even built flex framework for webapps

Downsides of Flash

- Slow load times
- Plugin required
- Bad for accessibility and SEO
- Expensive to Maintain
- Adobe finally discontinued support on Android and iOS
- Javascript and HTML5 have become serious alternatives

PHP/CGI

- Dynamic Content using server side templating
- Demo of PHP

Advent of Cascading Style Sheets

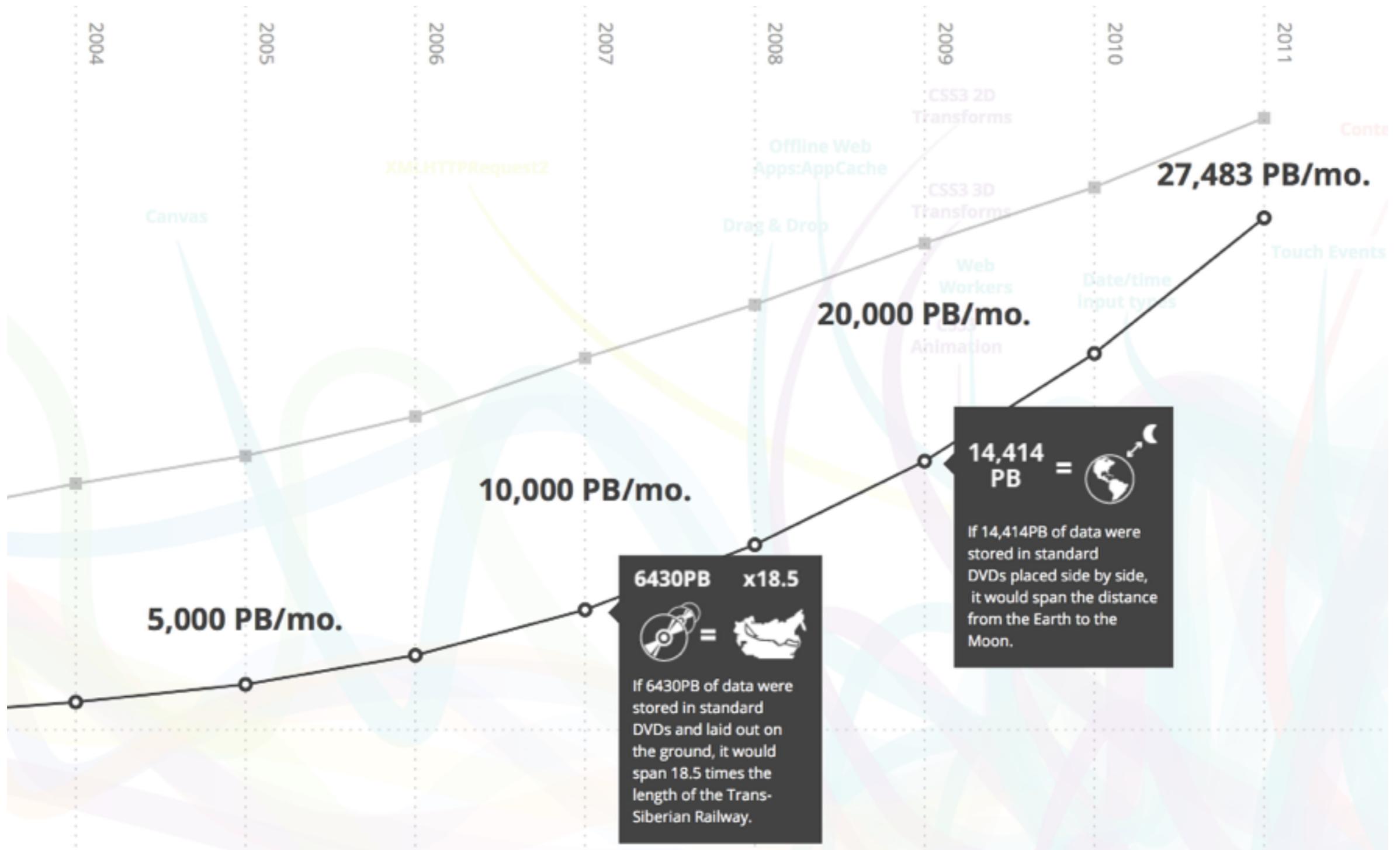
- Separated content structure from presentation
- Multiple styles cascade into each other

Design Evolution

- Tables to divs
- Menus move to the top
- Tall designs instead of short and wide
- Drop down navigation appeared
- Complex pages to clean designs - minimalist revolution
- Multimedia content
- Mobile specific design
- Responsive Design
- Single Page Applications

Some Stats

(<http://www.evolutionoftheweb.com>)



Web Scale IT

- Web-scale IT methodology pertains to designing, deploying and managing infrastructure at any scale and can be packaged in a number of ways to suit diverse requirements
- Can scale to any size of business or enterprise.

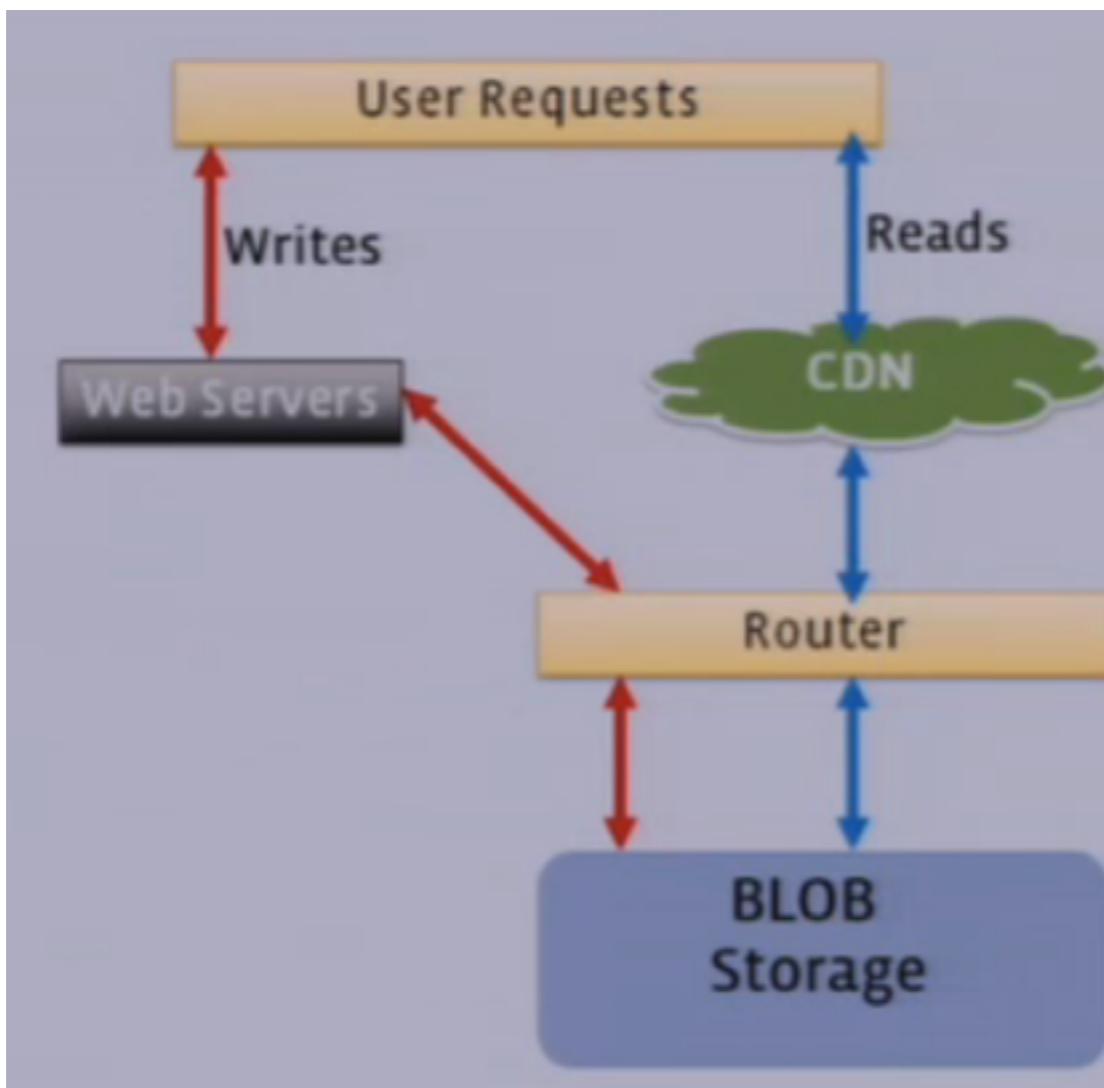
Web Scale Challenges

- Bandwidth
- Memory
- Storage
- Logging
- Fault Tolerance
- Data Consistency

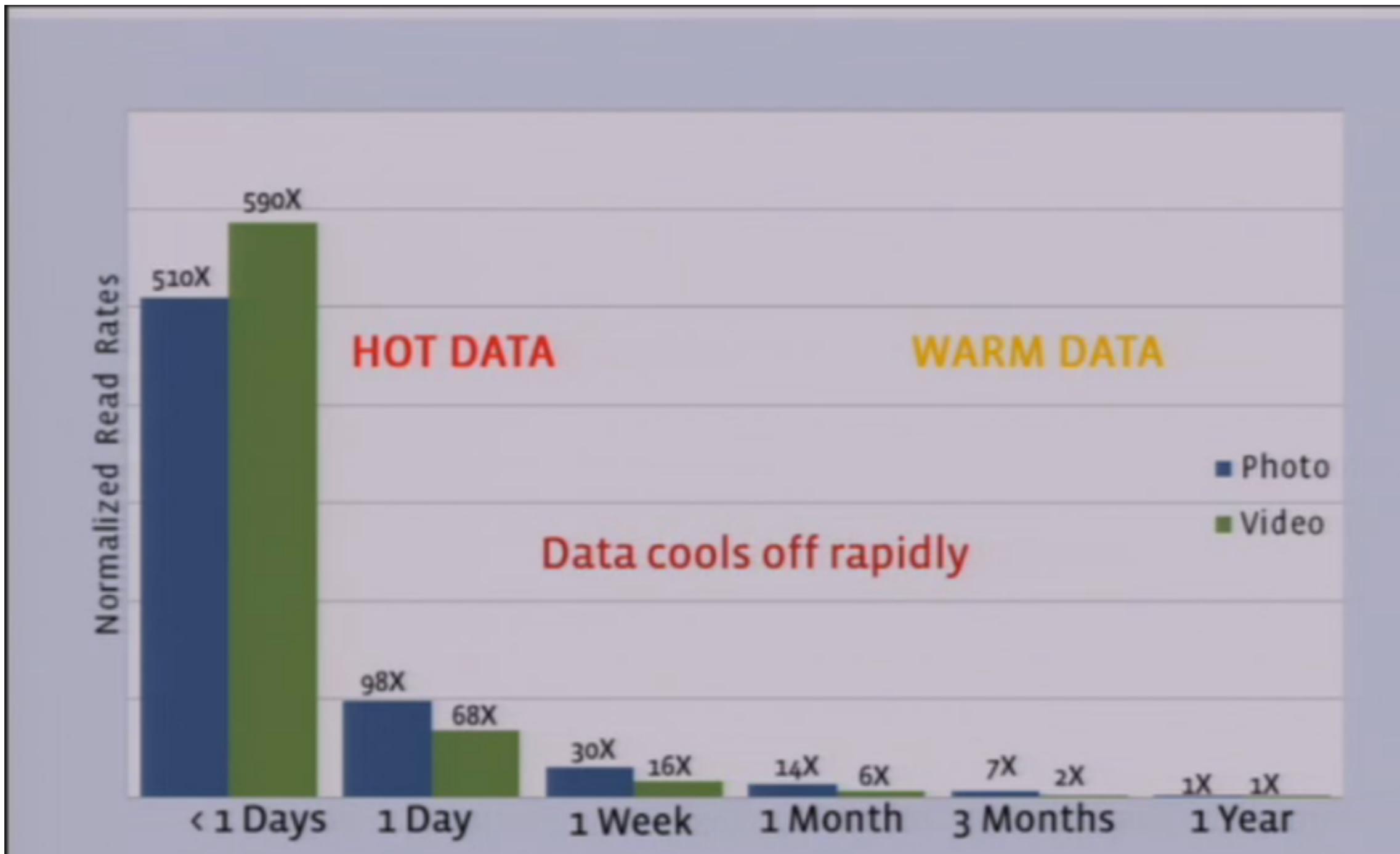
Web Scale Case Study

- Facebook's f4 storage system stores 65PB of data
= 65,000,000 GB of data
- f4 is a warm blob storage system jointly developed with university of southern California. A paper was presented on this at OSDI 2014
 - Primary storage data for FB is blob - a photo or a video that's immutable, written once and read many times or else deleted

Typical Web Scale Storage Architecture



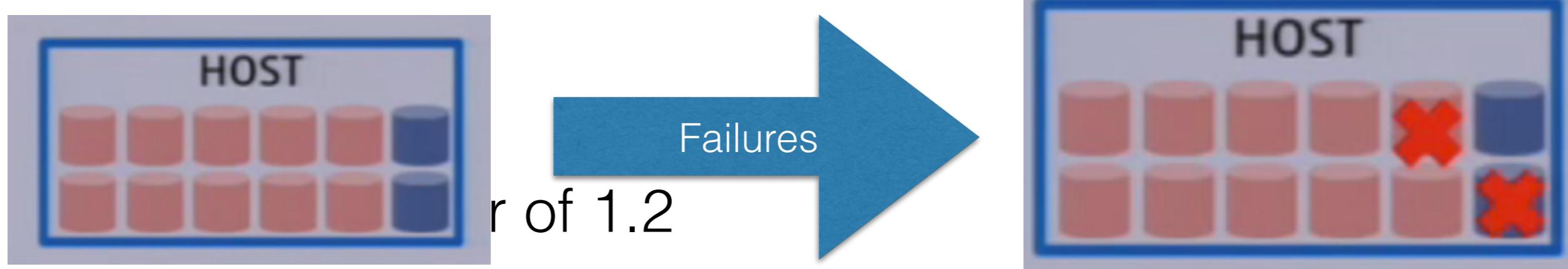
BLOB access as they age



Meaning of Backup In Web Scale

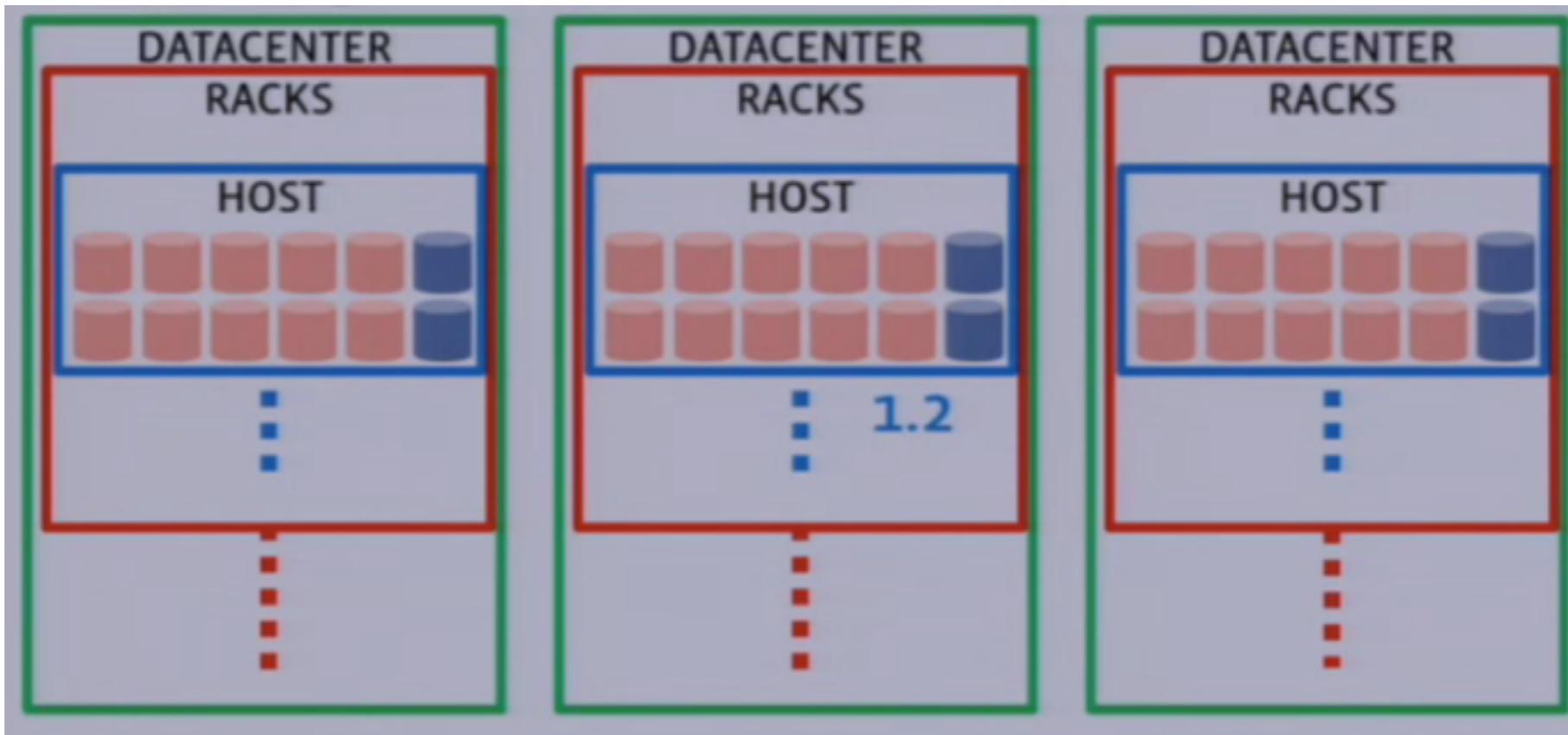
- Typical systems backup data using jobs at certain intervals.
 - Web Scale systems maintain a replicated copy of data to improve redundancy and also achieve load balancing at the same time

Hardware RAID 6



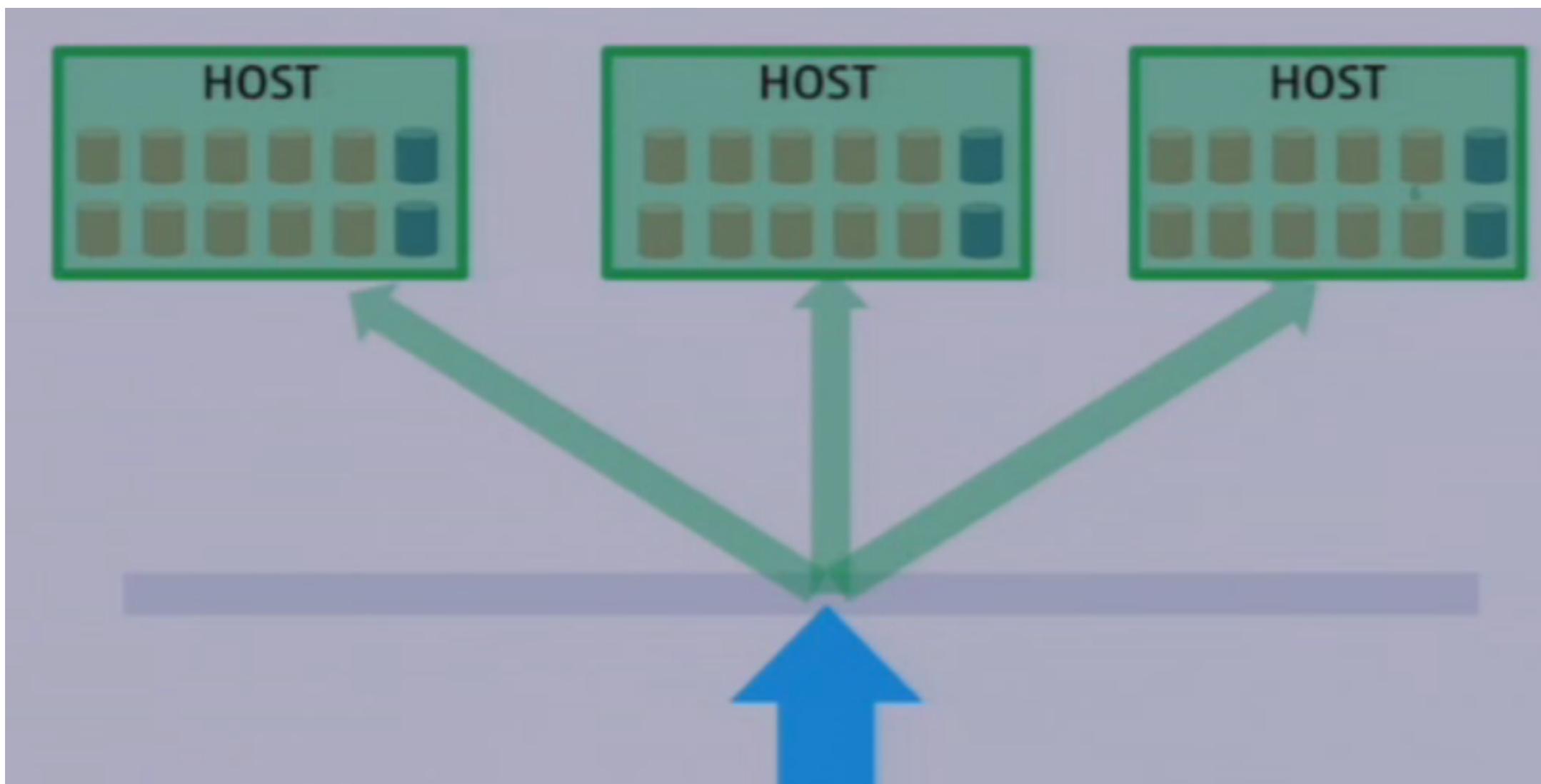
- In their haystack system they keep three copies of the data on 3 RAID hosts
- Failure is irrecoverable when 9 disks or all 3 hosts fail

Hosts Span Multiple Racks/ Data Centers



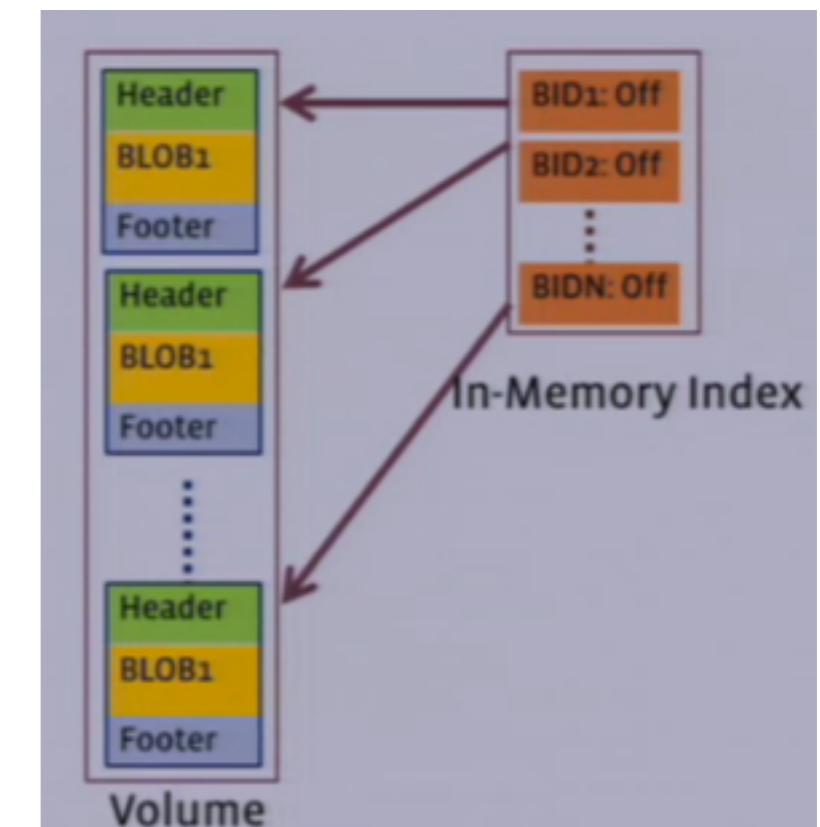
- Overall overhead = $1.2 \times 3 = 3.6$

Replication Also Helps Load



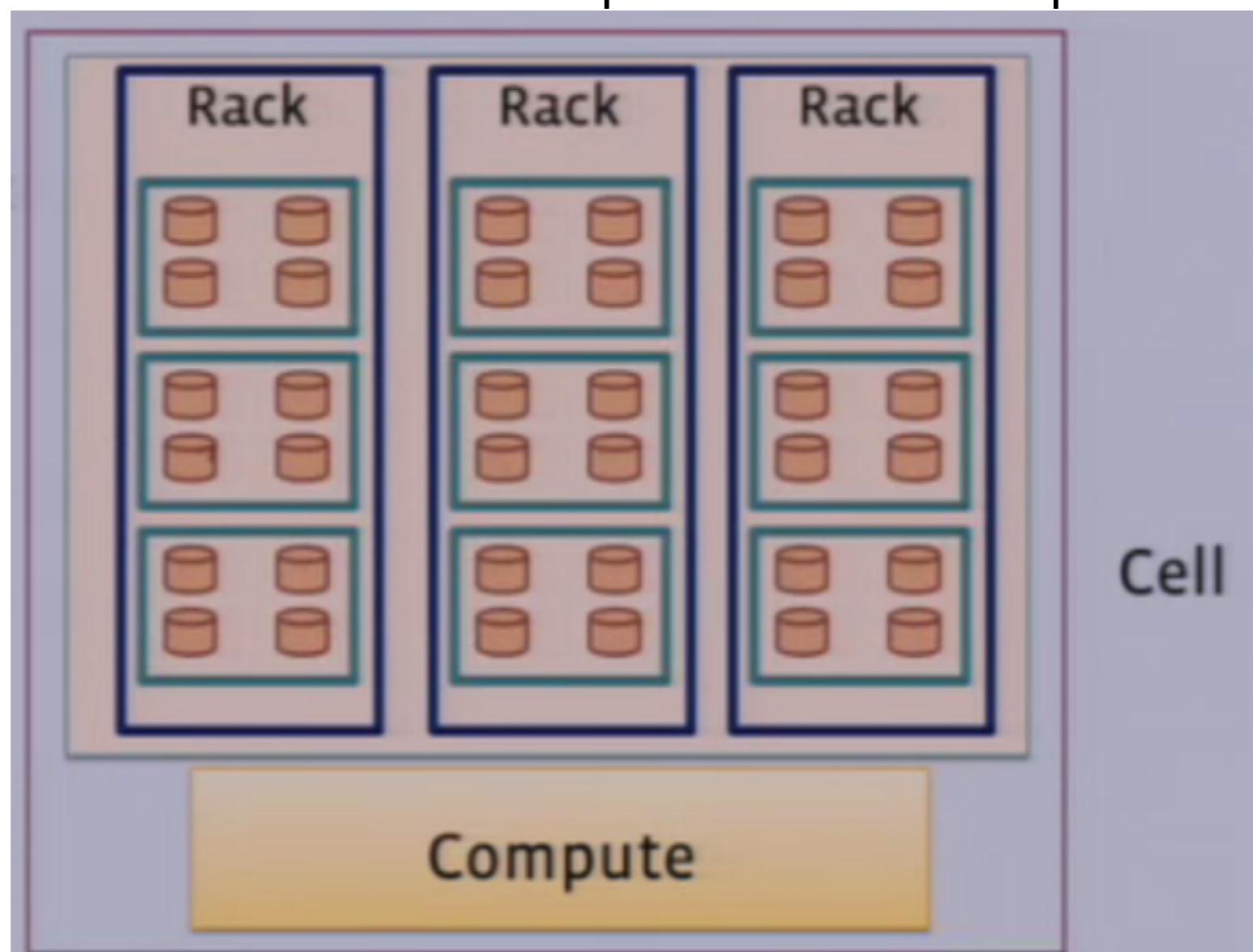
Haystack Volumes

- Haystack stores blobs in a single large appendable files called volumes
- In memory index contains an offset for each blob id. So any blob can be read with a single disk access



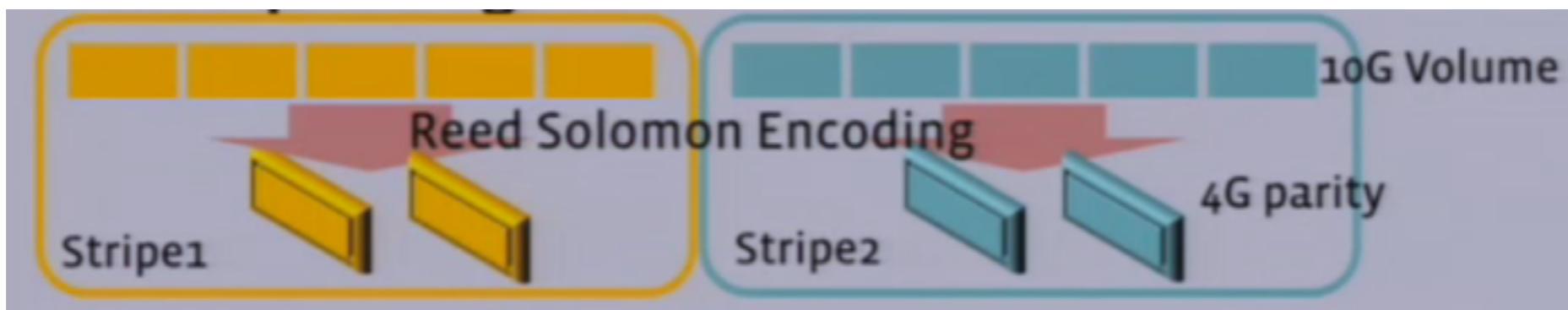
f4 Cells

- f4 cells consist of multiple hosts with disks, memory indexes and some computational capability



Data Storage

- A 10Gig Volume is broken down into 1 Gig blocks. For every 5 blocks, 2 parity blocks are added as per reed-solomon encoding. Data + Parity is called stripe.



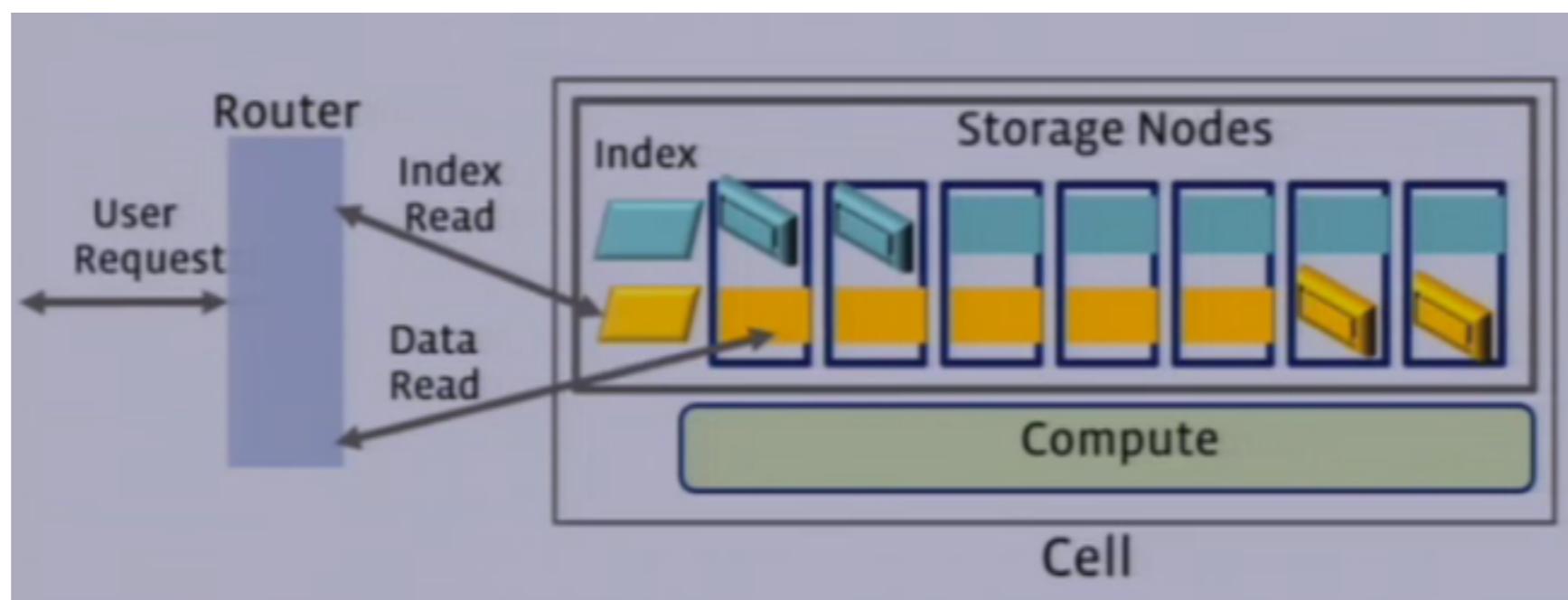
- Any block can be recovered given any 5 other blocks within a stripe

Storage of Blocks

- These $10 + 4$ blocks are stored in 14 different racks.
 - Allows us to recover in case there was upto 4 rack failures
 - Storage overhead will be 1.4

Reading Data

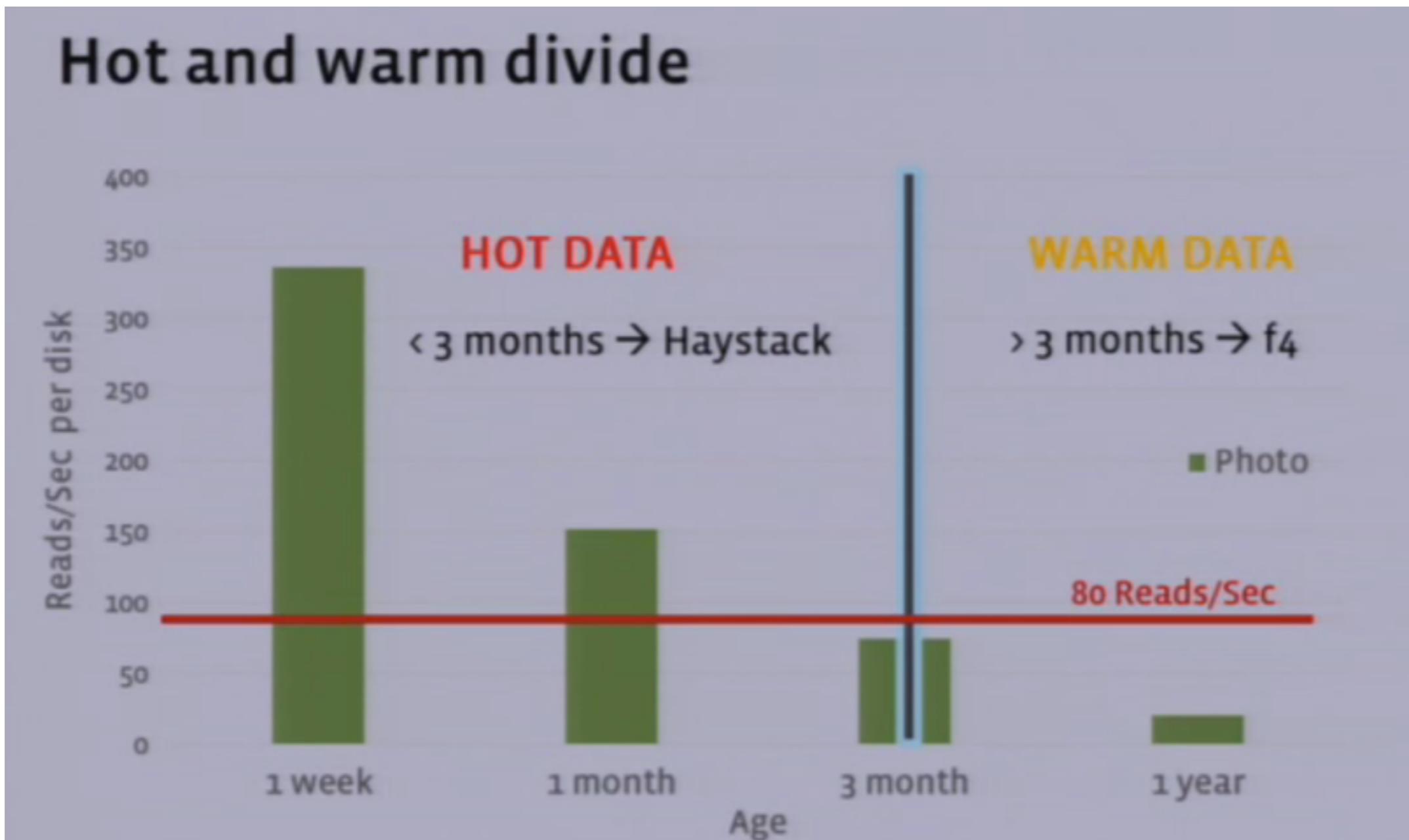
- Data location is first read using an in-memory index. Then an actual data read is performed
- In case the host which has the data is down, the compute module figures out the data using parity redundancy
- Data redundancy is achieved with mirrored data centres with an overall overhead of 2.8



More Improvements

- With cross-data centre encoding an overhead of 2.1 is achieved.
- Data centre failures are highly rare and this scheme provides sufficient redundancy for warm data loads

HayStack and f4 Combination



Considerations

- Efficiency is Important: Small change adds up in web scale. Stress is back on efficient code
- Services live longer than hardware: Fault tolerance, upgradation, hardware life cycle should be seamless
- Delivery life cycles are small: New features delivered more often

Where is all this infrastructure sitting?

- Huge dedicated data centers?
- Operating system management?

- Remember these?



Cloud and Converged Infrastructure

- Converged infrastructure is VM based dynamic segregation of compute, storage and network resources
- Cloud is a group of instance of hyper converged instances stitched together to form PaaS, SaaS and IaaS offerings.
 - AWS, Azure, Rackspace (IaaS)
 - Google App Engine, Heroku (PaaS)
 - Salesforce (SaaS)

Rise of the mobile apps

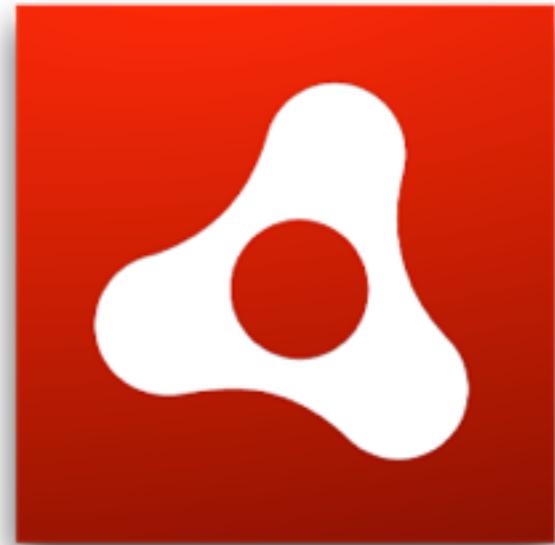
- App Store and Android Market launched in 2008
- Jan 22 2011 - 10 billionth app downloaded, May 11 2011 - Apple approves 500000th app
- Currently play store has 1.5 million apps and app store 1.4 million



Mobile Landscape

- iOS objective C native
- Android Java
- Windows C#
- Adobe Air
- Sencha HTML5 + Phonegap

Adobe Air



- In essence, AIR is the Flash player supplemented by additional features to enable applications that are not browser-hosted.
- Uses Flex style declarative UI
 - Declarative approach considered best for UI
 - ActionScript based - flexible and object oriented
 - Rich design and multimedia

Non-Declarative UI with Air

```
public class HelloWorld extends Sprite
{
    public function HelloWorld():void
    {
        var textField:TextField = new TextField();
        textField.text = "Hello World!";
        textField.autoSize = TextFieldAutoSize.LEFT;
        var format:TextFormat = new TextFormat();
        format.size = 48;
        textField.setTextFormat ( format );
        this.addChild( textField );
    }
}
```

Declarative UI in Air

```
<?xml version="1.0" encoding="utf-8"?>
<s:WindowedApplication xmlns:fx="http://ns.adobe.com/mxml/2009"
    xmlns:s="library://ns.adobe.com/flex/spark"
    xmlns:mx="library://ns.adobe.com/flex/mx"
    title="Hello World">
    <s:Label text="Hello AIR" horizontalCenter="0" verticalCenter="0"/>
</s:WindowedApplication>
```

HTML UI in Air

```
<html>
  <head>
    <title>Hello World</title>
    <script type="text/javascript" src="AIRAliases.js"></script>
    <script type="text/javascript">
      function appLoad() {
        air.trace("Hello World");
      }
    </script>
  </head>
  <body onLoad="appLoad()">
    <h1>Hello World</h1>
  </body>
</html>
```



Sencha Touch

- Sencha Touch is a MVC-based JavaScript framework for building cross-platform mobile web applications.
- Phonegap/Cordova allows html5 apps to be converted into native deployable app on iOS and Android

Sencha UI is like most JS Frameworks

```
Ext.define('myapp.view.Main', {
    extend: 'Ext.Carousel',
    xtype: 'main',
    requires: [
        'Ext.TitleBar'
    ],
    config: {
        direction: 'vertical',
        items: [{
            html: 'Settings Form'
        }, {
            itemId: 'mainview',
            cls: 'textview'
        }]
    }
});
```

Architectural Shifts

- Native -> Web
 - MS Word Native to Word on Web/Google docs
 - Online apps are not as full featured as native
 - Many apps have gone online - salesforce, leadoutcome, SAP

On Desktop - Native Edge

- Native is still the most full featured app environment
- Web apps are good with data entry and data viewing
 - Try putting a web app at a POS
- Multimedia is best kept native
 - Adobe photoshop, Camtasia

KEY PLAYERS IN HTML5 TECH

What are the most important HTML5 development tools?

Architectural frameworks



CSS UI frameworks



Foundation

Topcoat

JavaScript UI frameworks



Web wrappers



Web-to-Native Converters



titanium

game{closure}



Native Javascript APIs



2D Gaming Engines



3D Gaming Engines



Hybrid Development

- Instagram
 - Home view is HTML5
 - Rest are native
- Performance issues
- Lack of multithreaded strategy
- Problem with DOM manipulation and layout
- Memory Management
- Lack of debugging tools

HTML5 Development

- Facebook 4.1, LinkedIn
- DOM Manipulation is Slow
 - Facebook aborted
 - LinkedIn continues

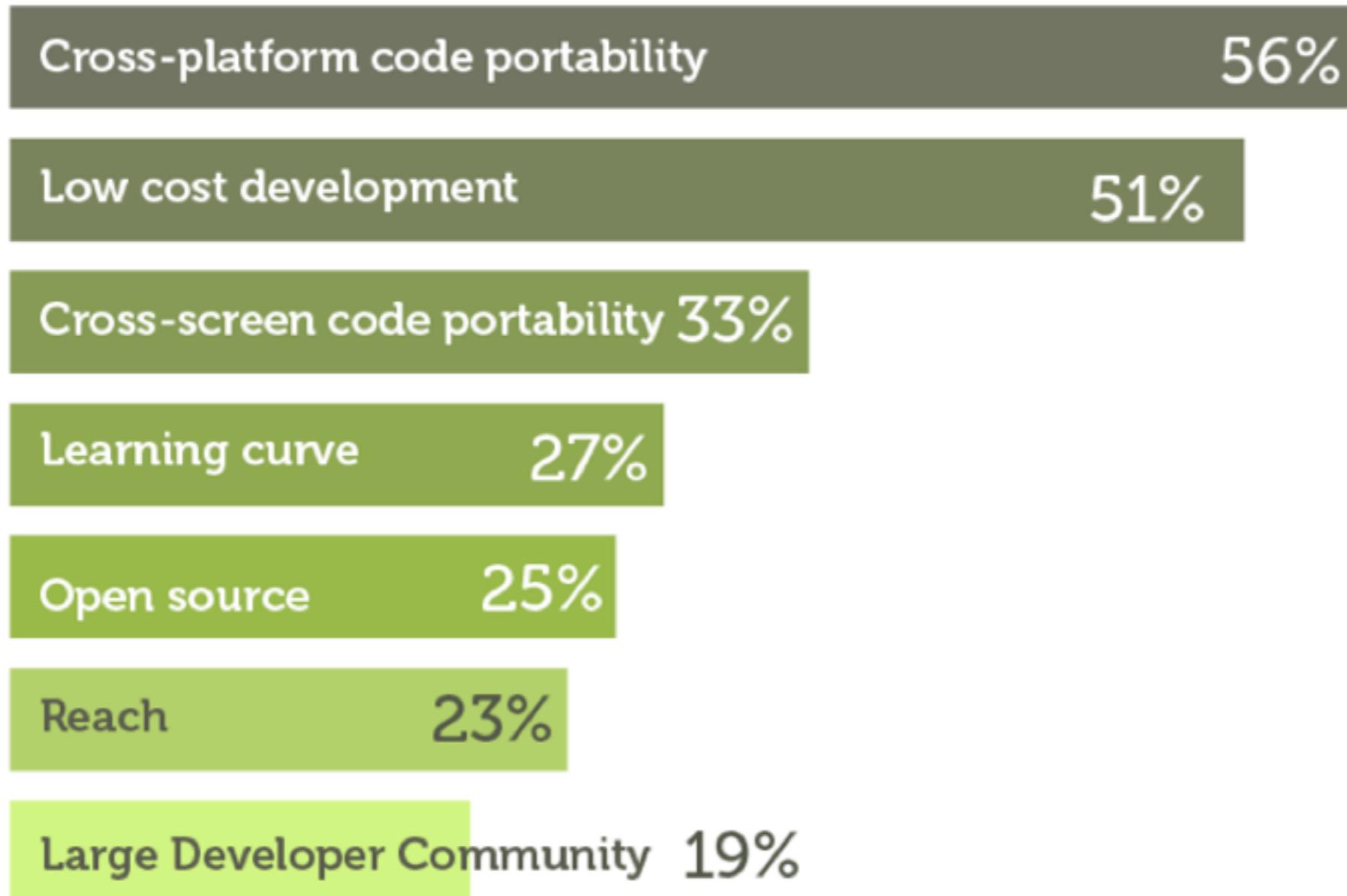
	Load Times in seconds <u>FB Version 4.1.1 - HTML5</u>	Load Times in seconds <u>FB Version 5.0 – Native</u>	Notes
Show Feed On Login	22.215 s	13.559 s	
Show My Profile	8.4646 s	6.263 s	
Show Photos Of Me	6.288 s	5.987 s	
Show Albums	0.00 s	0.00 s	
Show Friends	7.928 s	2.063 s	Now in List View, previously Gallery
Show Friend Details	7.373 s	9.256 s	Higher screen res., more images on detail screens
Show My Messages	6.453 s	1.588 s	MQTT as messaging bus to improve performance*
Show My Notifications	10 s	0.00 s	MQTT as messaging bus to improve performance*

**instead of polling periodically for new data, Facebook implemented the MQTT messaging bus that delivers data asynchronously*

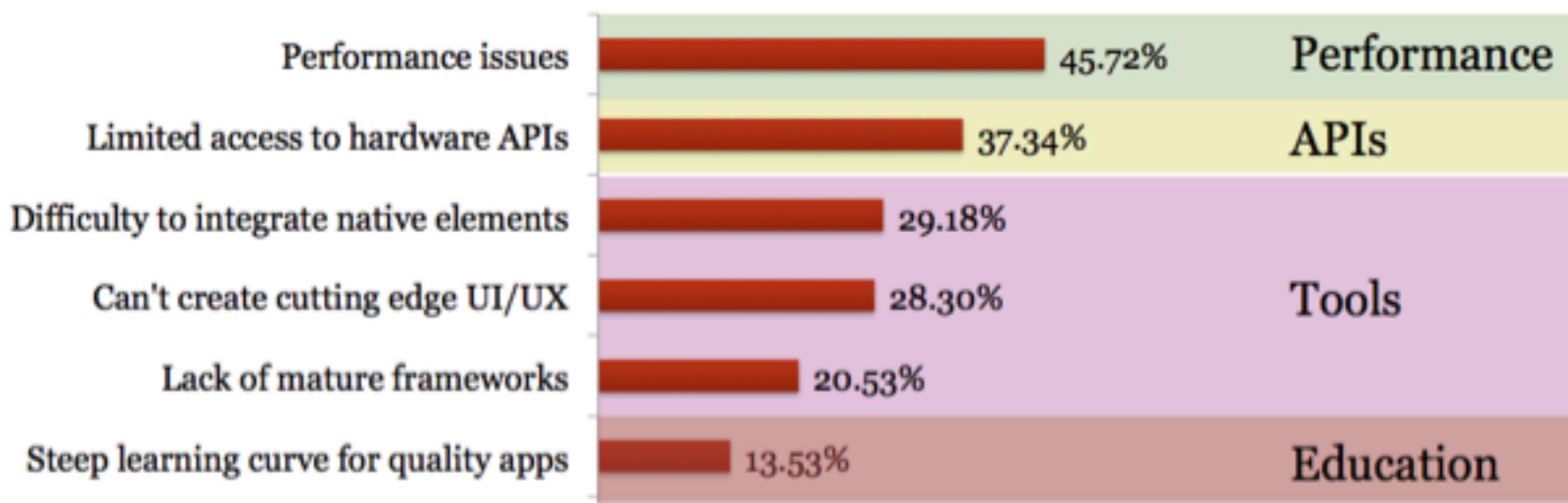
Flipboard

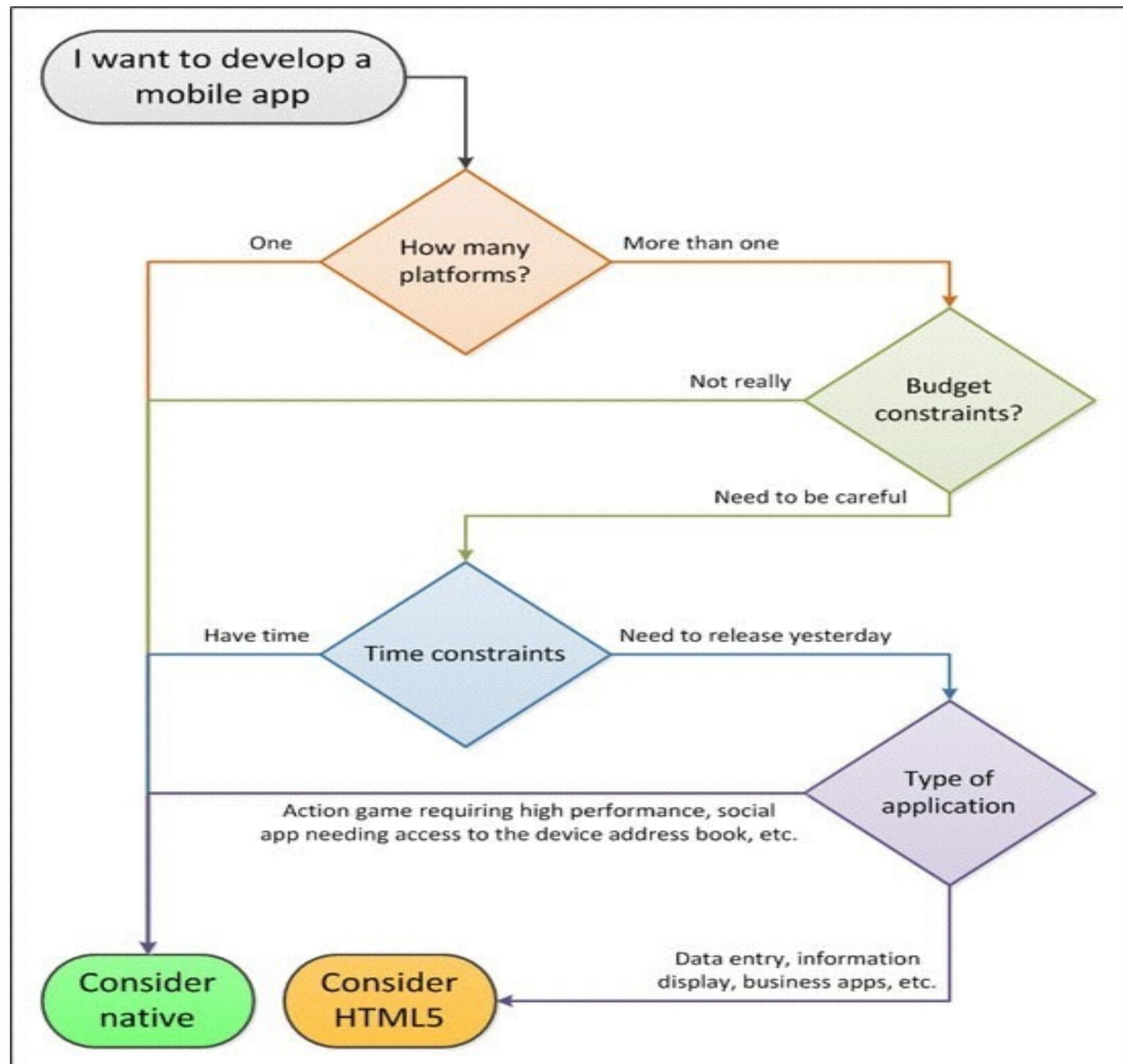
- 60FPS using HTML5 Canvas
 - Canvas is a non retentive UI API unlike the DOM which retains an object structure of the UI that it renders
 - Flipboard built an abstraction on Canvas to make it a little easier to program

WHAT DRIVES MOBILE DEVELOPERS TO USING HTML5?



WHAT STOPS MOBILE DEVELOPERS FROM USING HTML5?





Architectural Shifts

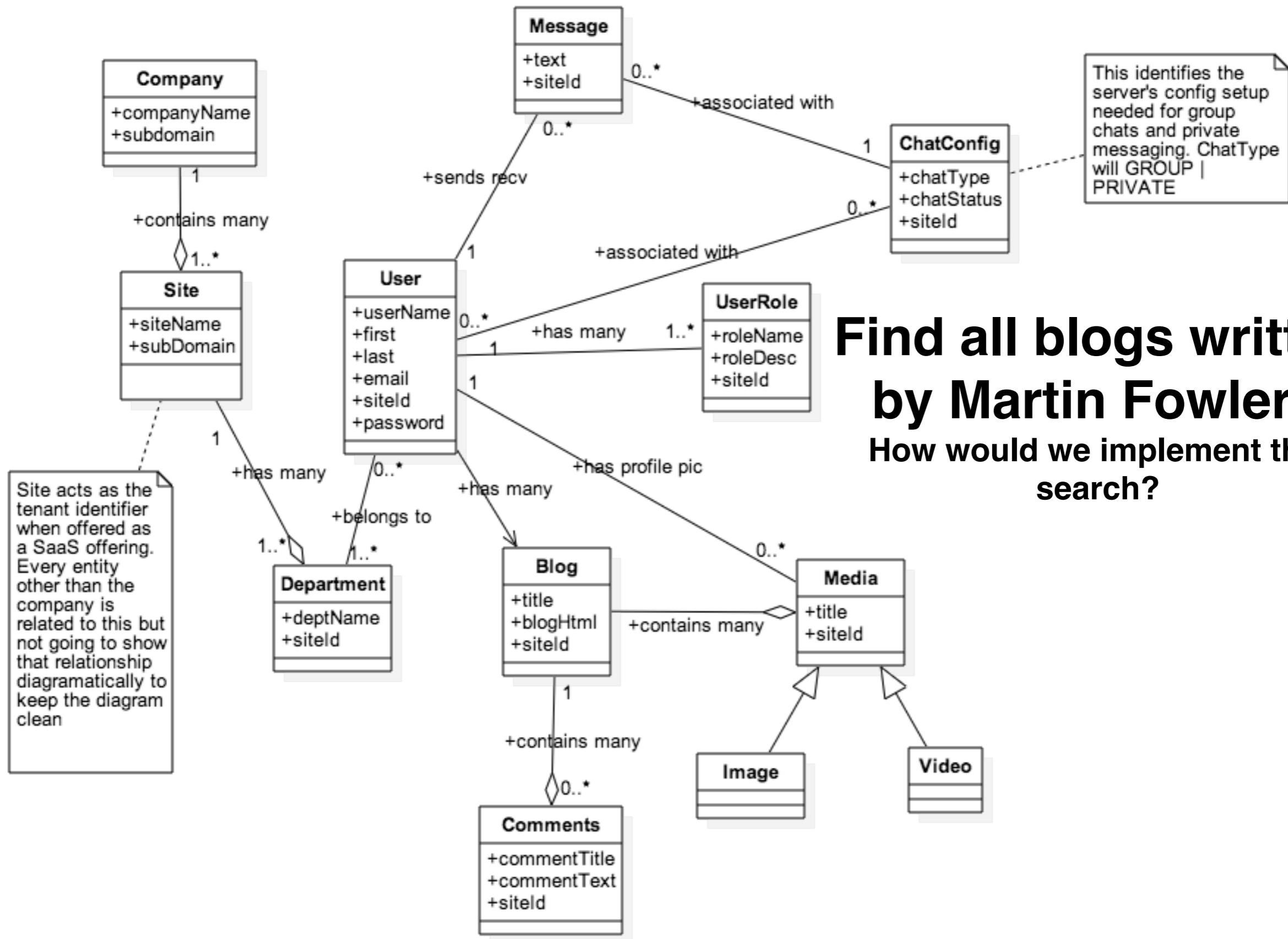
- Server side -> Client side
- Demo Examples of both
- How scalability and performance is impacted

Web 3.0

- The Semantic Web is an extension of the Web through standards by the W3C.
- The standards promote common data formats and exchange protocols on the Web, most fundamentally the Resource Description Framework (RDF).
- Web as a database
- Searches will no longer be keyword search. It will be contextual

Resource Description Framework

- Its like a DB schema where the relationship is named and not just having a multiplicity
- How confusing has aggregation, composition, association been in OOAD?
- Consider a model diagram in UML

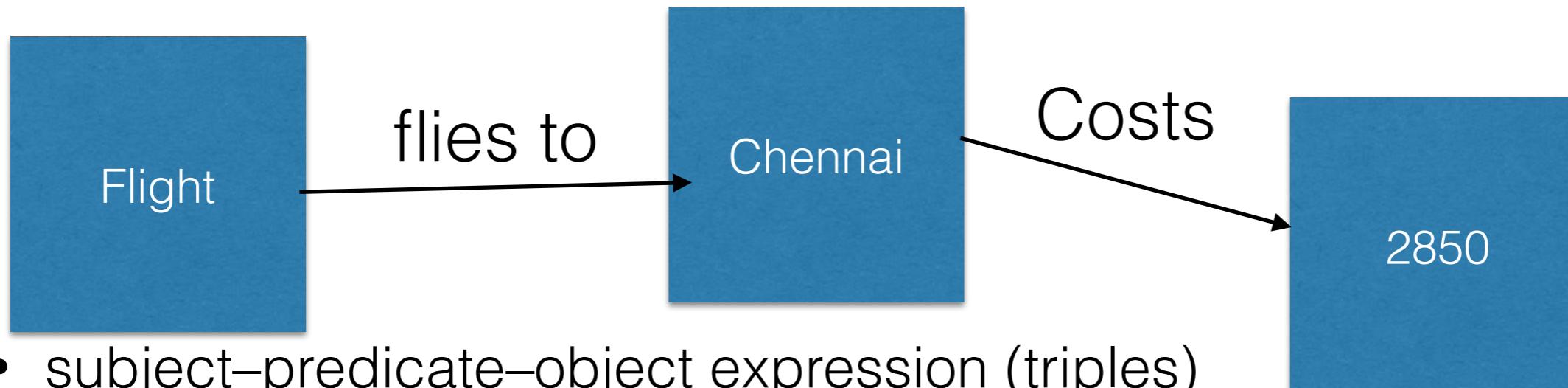


Find all blogs written by Martin Fowler?

How would we implement this search?

Questions Web 3.0 can answer

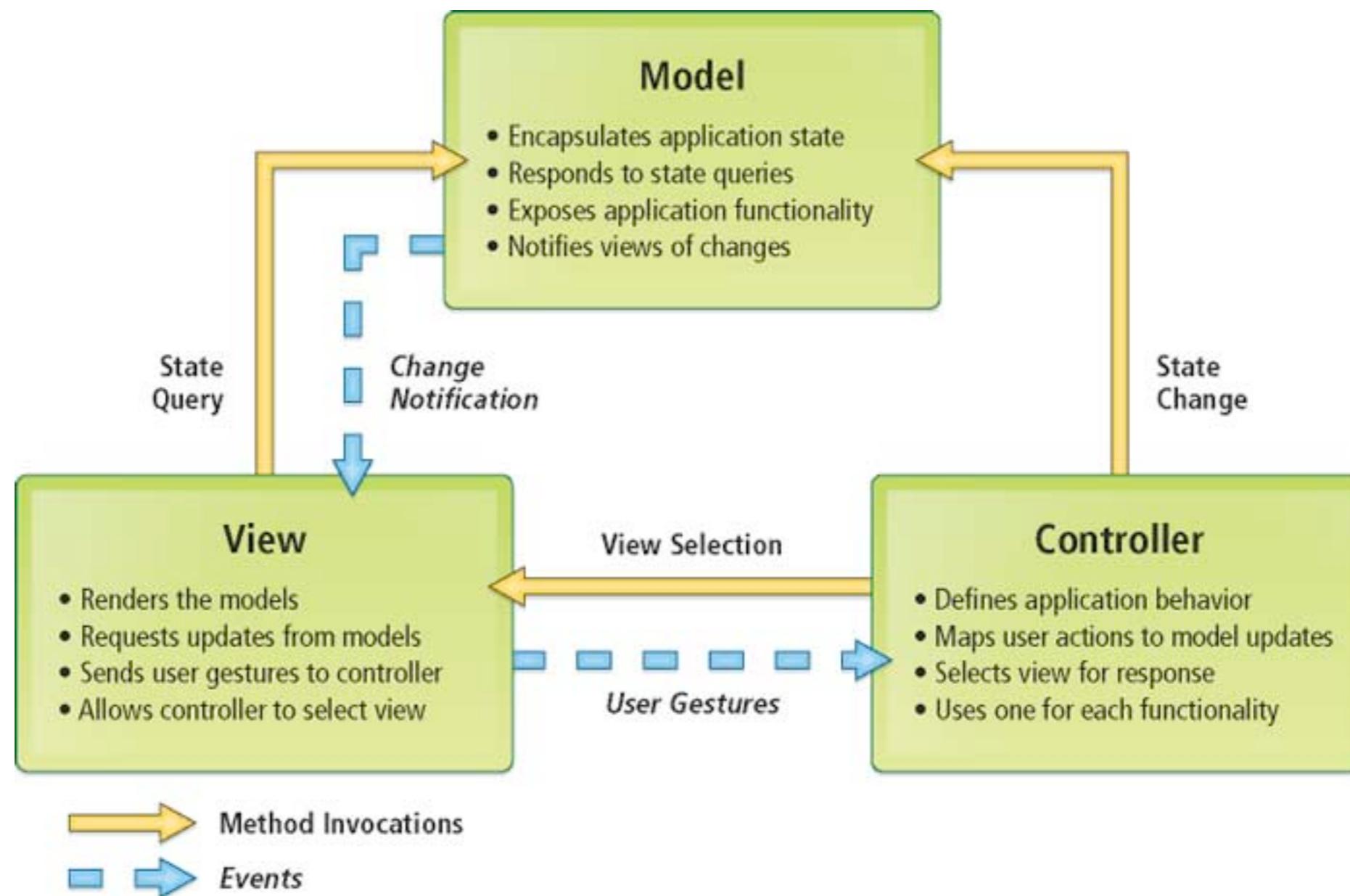
- Find all flights to chennai that's priced less than 3000



- subject–predicate–object expression (triples)

```
<div xmlns:dc="http://purl.org/dc/elements/1.1/" xmlns:mc="http://myschema.org/"  
    about="http://www.makemytrip.com/flights/jet">  
    <span property="dc:title">9W810</span>  
    <span property="mc:flies_to">Chennai</span>  
    <span property="dc:costs">2850</span>  
</div>
```

Model View Controller (Demo)



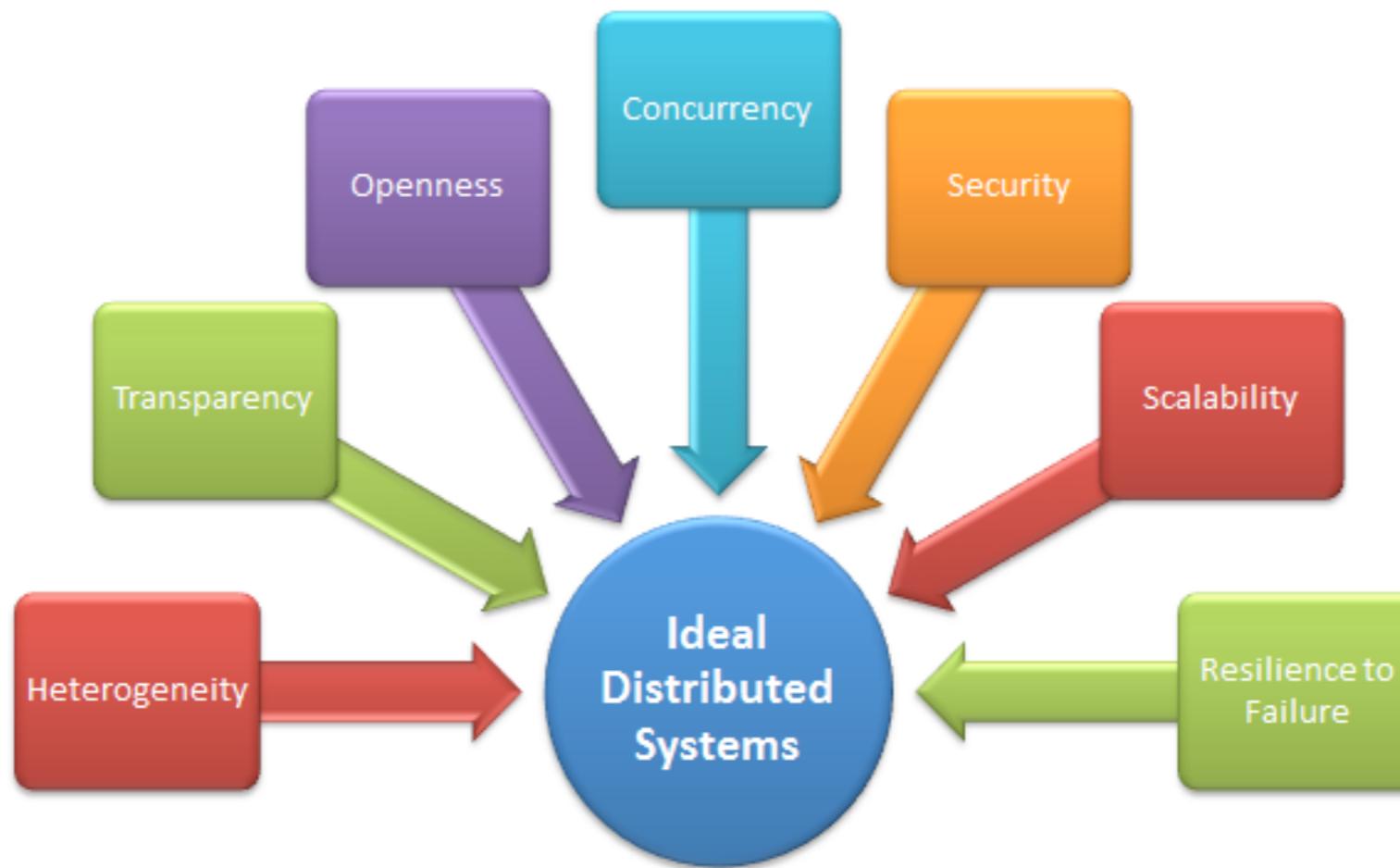
Transactions and Transaction Managers

- Transactions and Transaction Isolation
 - Dirty Reads
 - Non-repeatable Reads
 - Phantom Reads
- Demo of Lock Issues

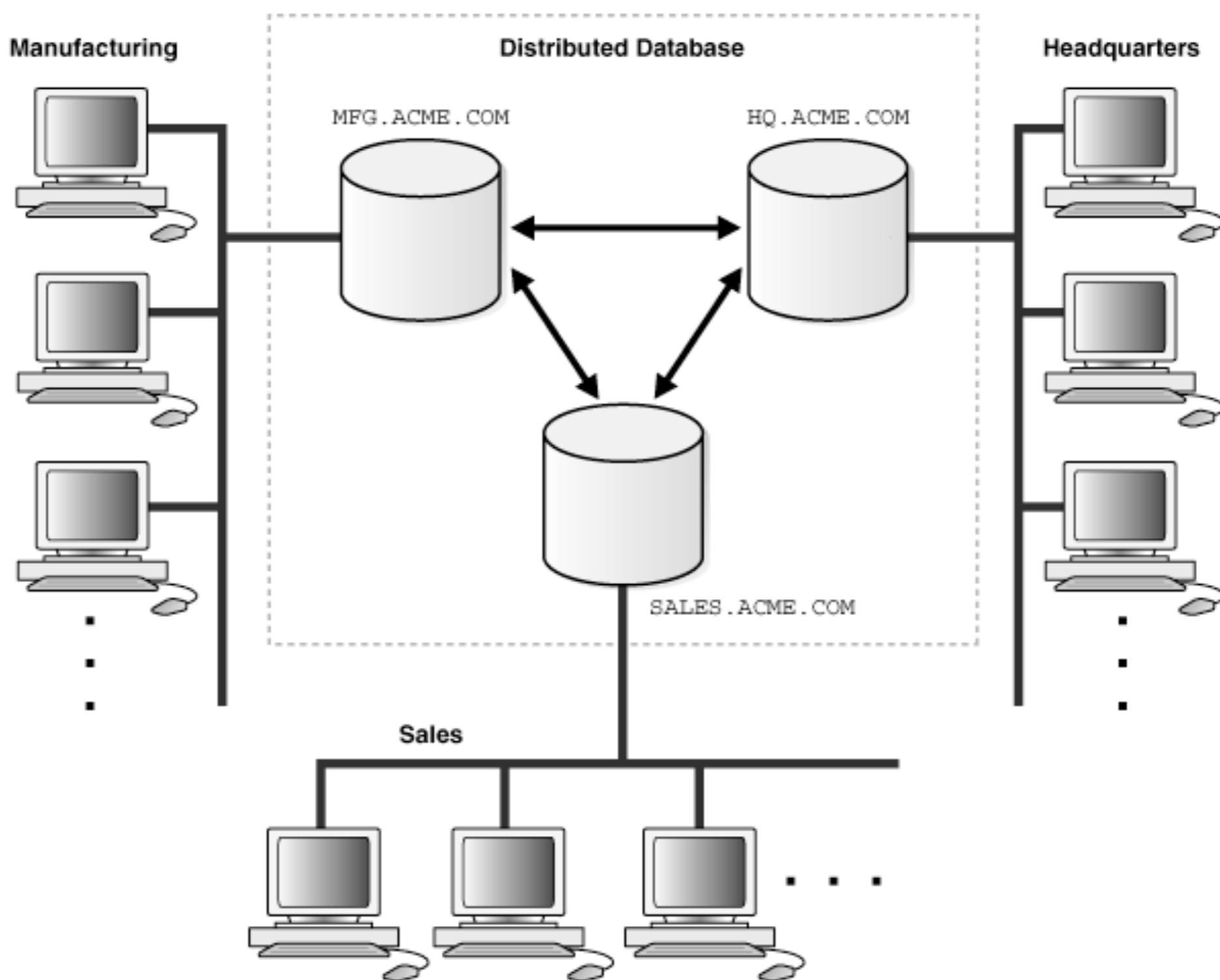
Distributed Transactions

- Distributed Transactions need an external transaction manager
- JEE provides JTA
 - Distributed transactions work with two phase commits

Distributed Systems

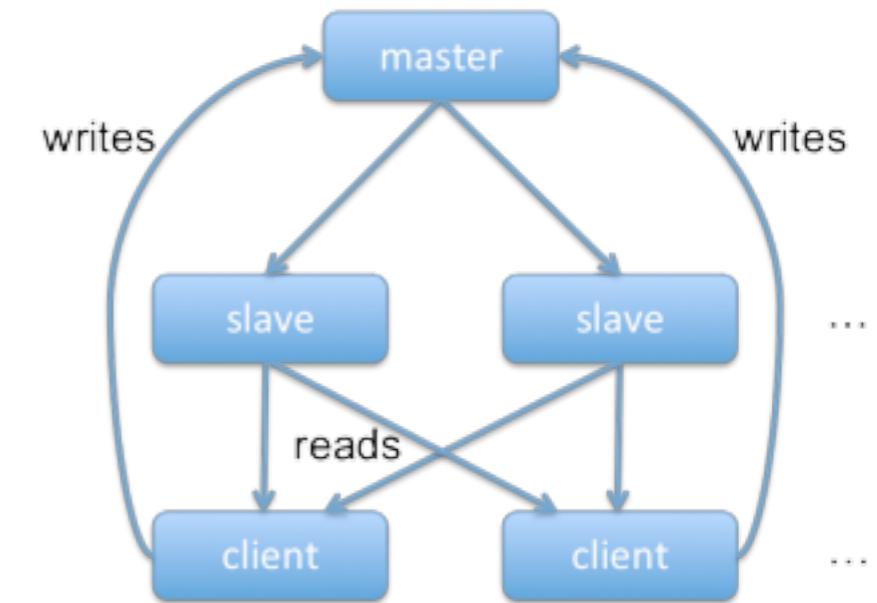


Distributed Databases



Distributed Databases

- Data Sharding
- Data Replication (Master Slave)
- Both Sharding and Replication
- MySql, Mongodb and Cassandra



ACID, BASE, CAP

- Atomic: Everything in a transaction succeeds or the entire transaction is rolled back.
- Consistent: A transaction cannot leave the database in an inconsistent state.
- Isolated: Transactions cannot interfere with each other.
- Durable: Completed transactions persist, even when servers restart etc.
- BASE - Basic Availability, Soft state, and Eventual consistency
- CAP
 - Consistency (all nodes see the same data at the same time)
 - Availability (a guarantee that every request receives a response about whether it succeeded or failed)
 - Partition tolerance (the system continues to operate despite arbitrary message loss or failure of part of the system)

Consensus

- Consensus is a mechanism for different nodes in a distributed system to agree on a value to store.
 - This could be any record update/insert/delete
- Many algorithms exist - RAFT/Paxos/Quorum
- Zookeeper for application level consensus
 - Uses ZAB - Zookeeper Atomic Broadcast

Asynchronous Programming

- Emergence of new asynchronous programming models
 - Node.JS
 - Vert.x
- Contrast this with threading based traditional server systems
- Performance comparison demo

Changing a Pull Only web

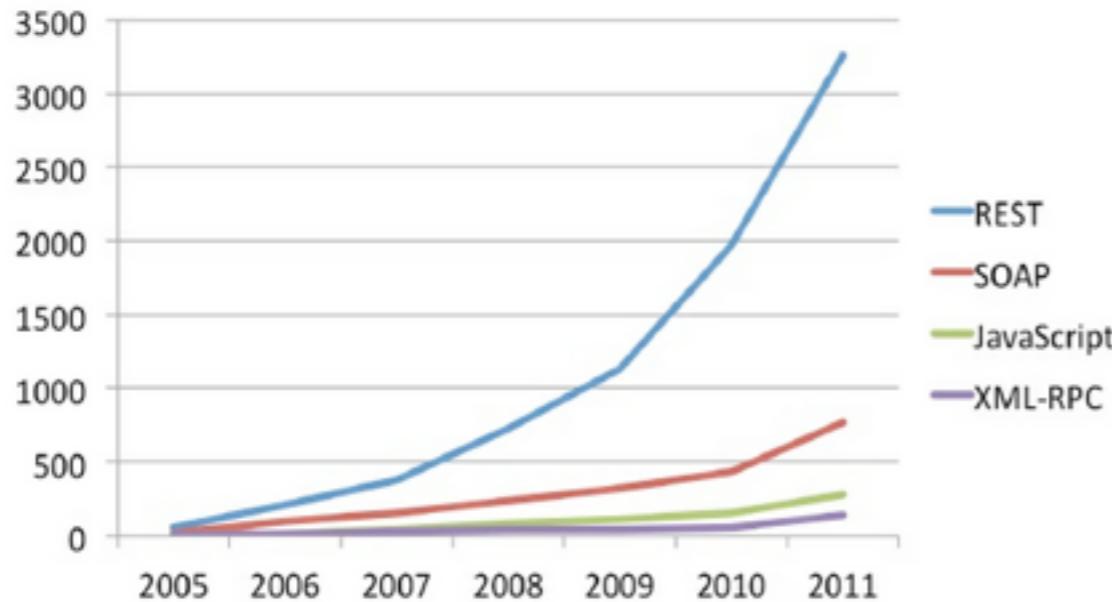
- Two techniques to make web support push approach
 - Long polling
 - Web Sockets

API Backends

- REST and SOAP are two most popular API backends
 - Rest works mostly with JSON and url and query parameters
 - SOAP works with up and down XML payloads

REST is winning

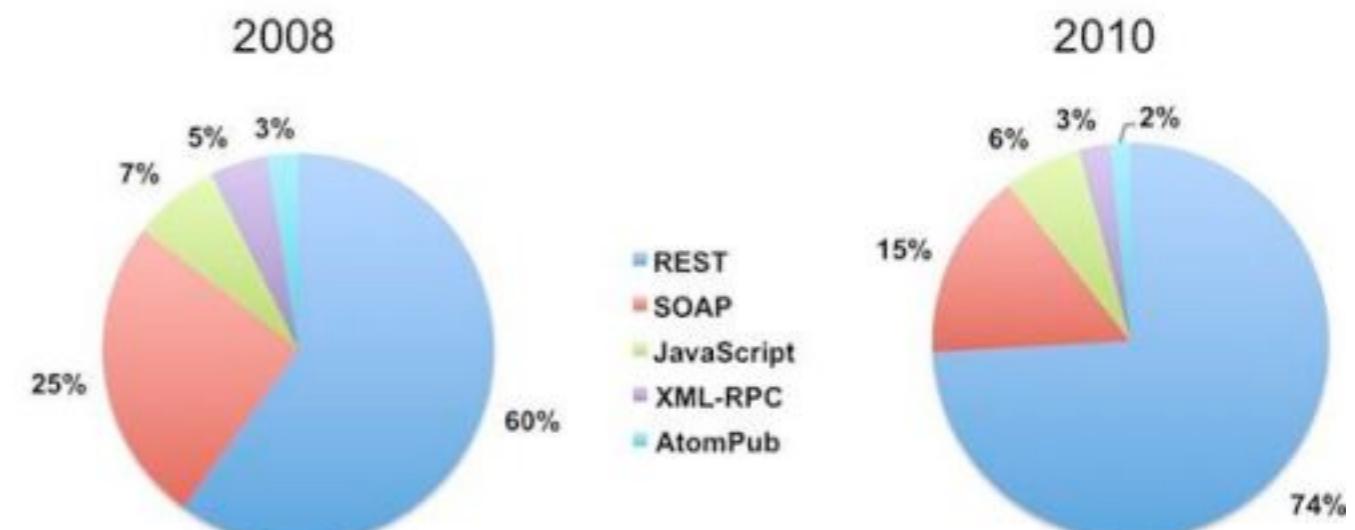
- SOAP is well standardized and has good implementations such as Apache CXF. Its easy to implement any interfaces we need and publish as a wsdl. However...
- REST uses json that's smaller and faster to parse especially since it does not have a schema to validate against
- REST is built for web
- REST has sufficient security though WS-Security provides more than authentication
- REST Data binding is simple Java bean to JSON. (unlike JAXB in SOAP)
- API versioning is simple



API protocols and styles

Based on directory of 5,100 web APIs listed at ProgrammableWeb, February 2012

REST vs SOAP



How Security Is Handled

- Security
 - Authentication, Authorization, Message Integrity, Secrecy
 - Security for regular Web
 - Security for REST
 - Security for SOAP

Messaging & JMS

- Messaging enables distributed communication that is loosely coupled
- The sender and the receiver do not have to be available at the same time in order to communicate
- The sender does not need to know anything about the receiver
- JMS is a Java API that allows applications to create, send, receive, and read messages

Messaging Service

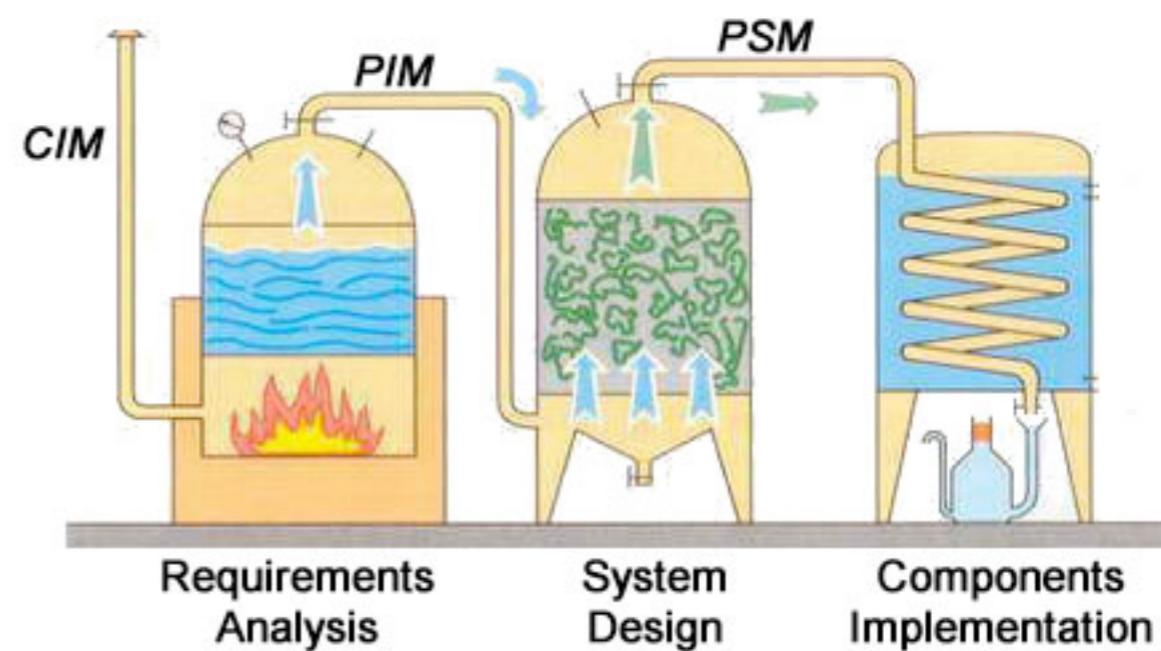
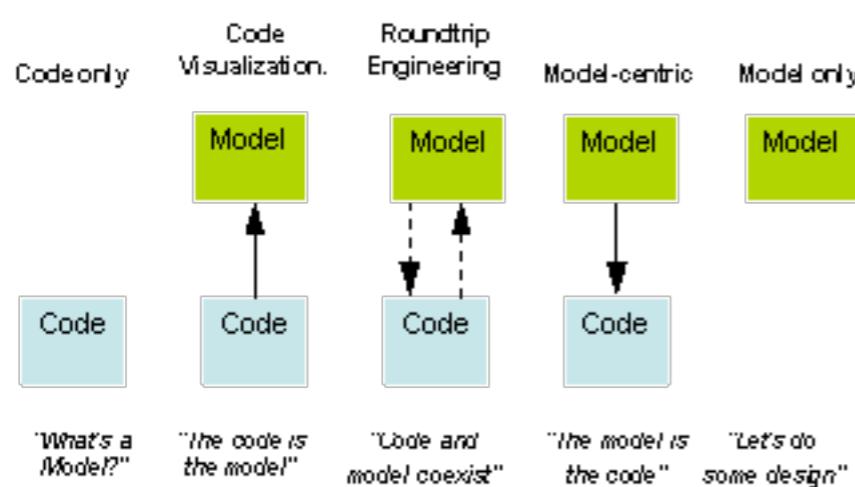
- Also known as JMS Providers
- ActiveMQ, WebsphereMQ, SonicMQ etc
- Integrated into App Server or independent. Basic to elaborate
- Centralised Messaging and Distributed Messaging
- Accessible via proprietary APIs as well as JMS

JMS and JTA

- Concept of loose coupling in display
- JMS are transactional resources like databases
- What does a transaction in JMS mean

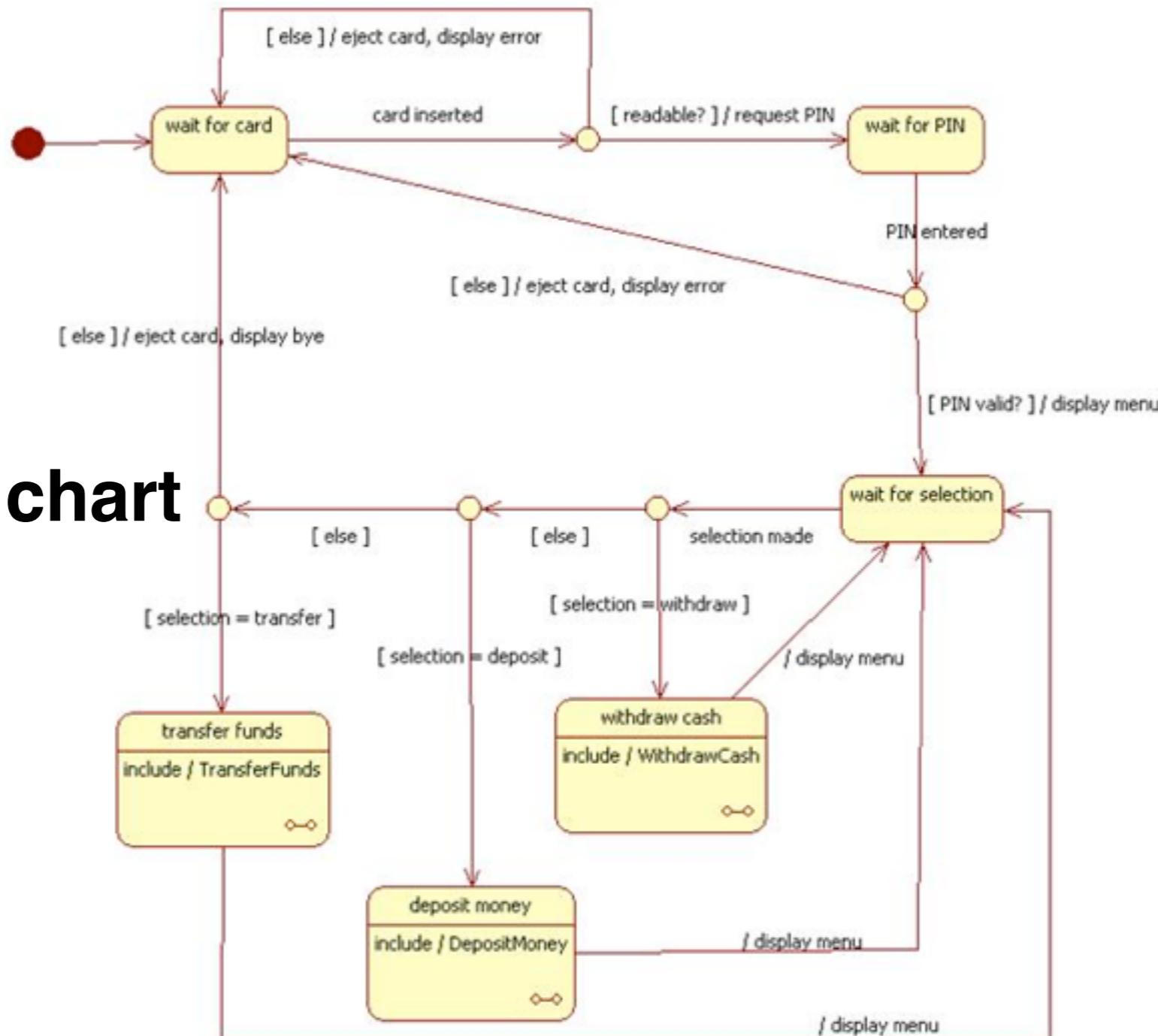
Model Driven Architecture

- In 2001 the OMG adopted the Model Driven Architecture as an approach for using models in software development



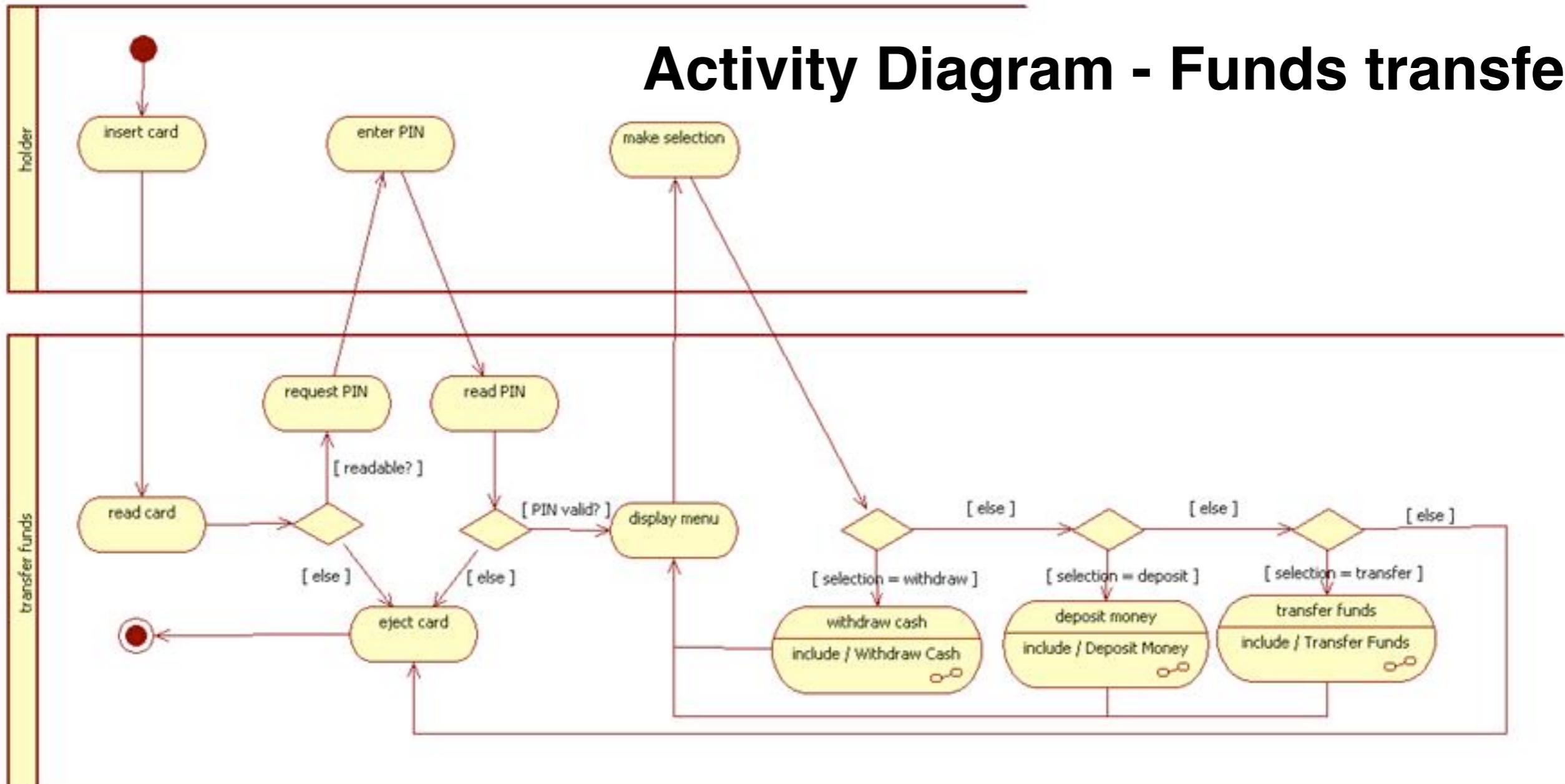
Computation Independent Model

ATM State chart

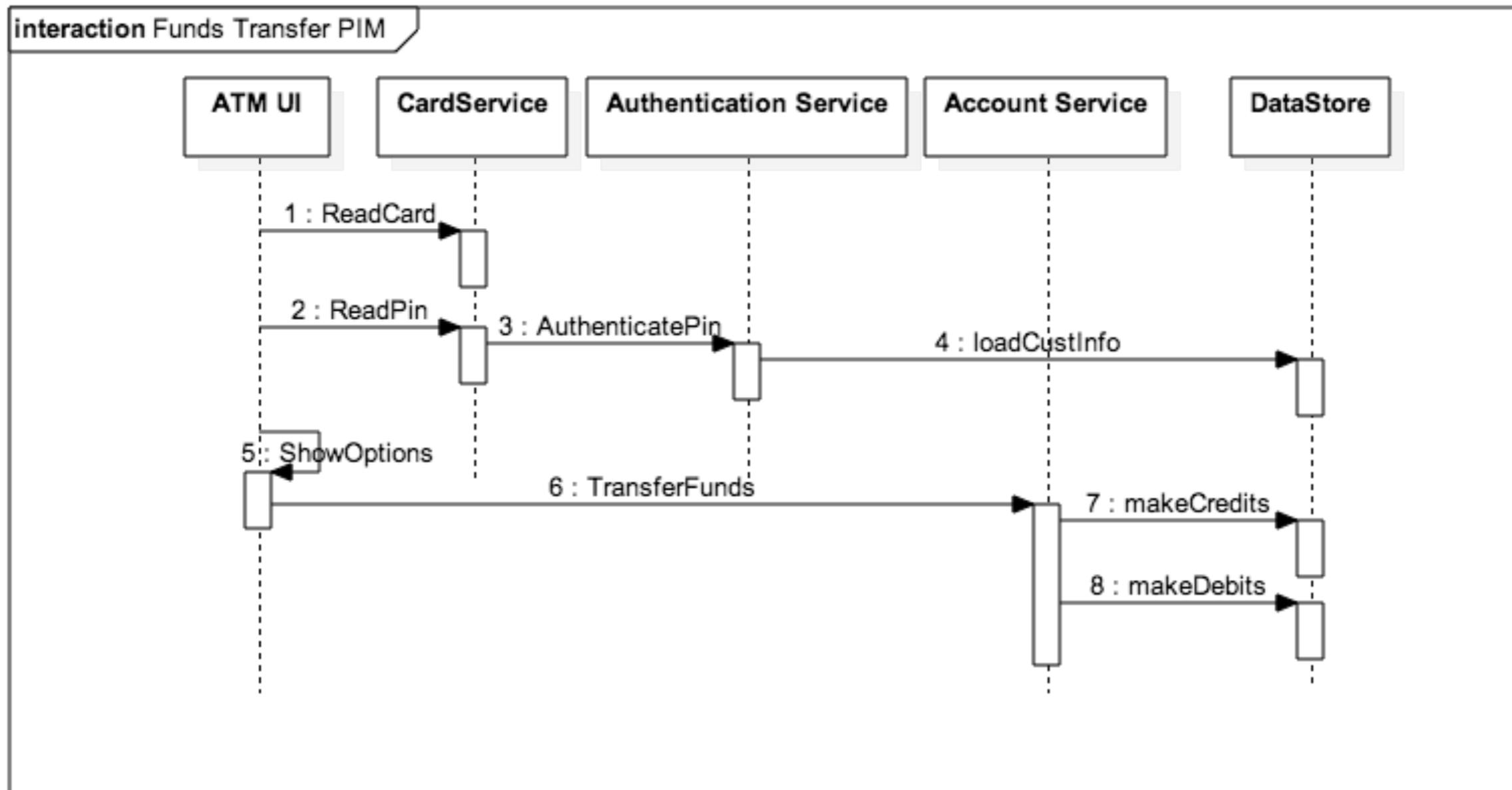


CIM

Activity Diagram - Funds transfer



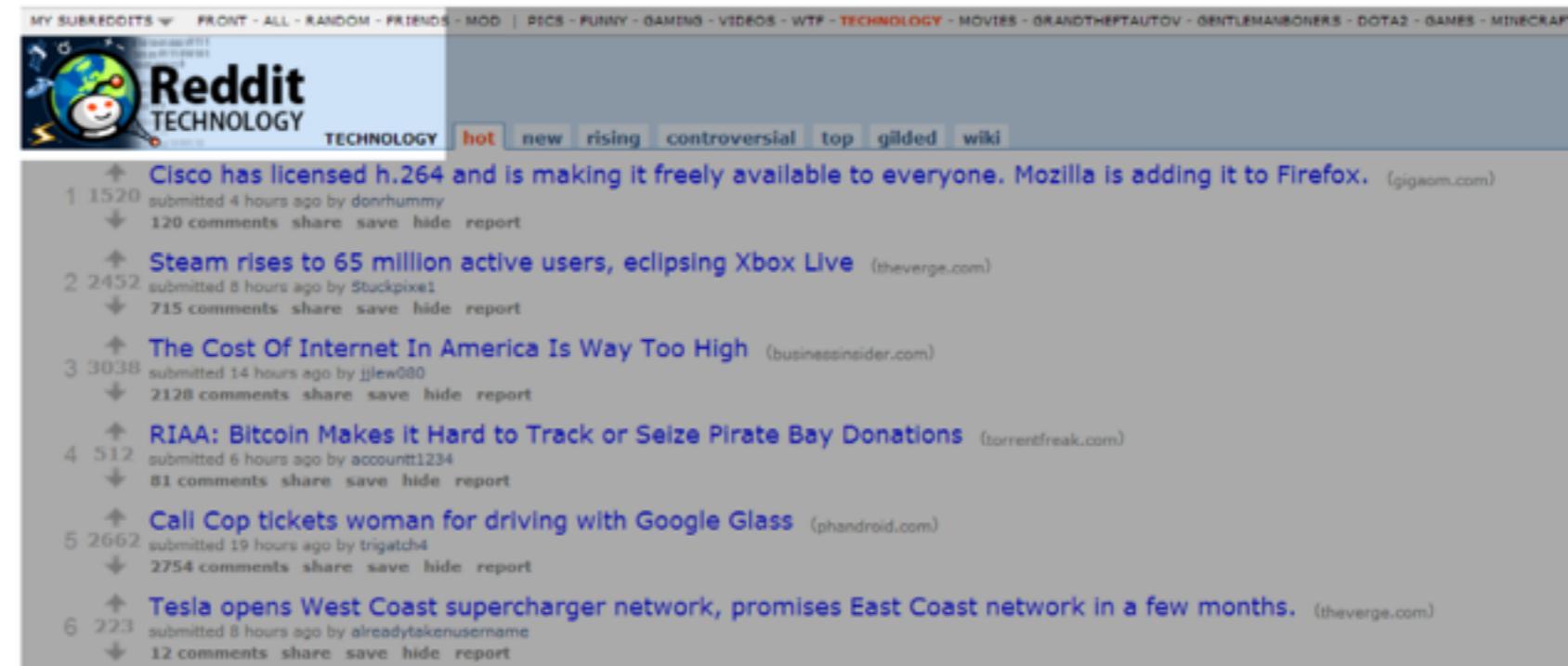
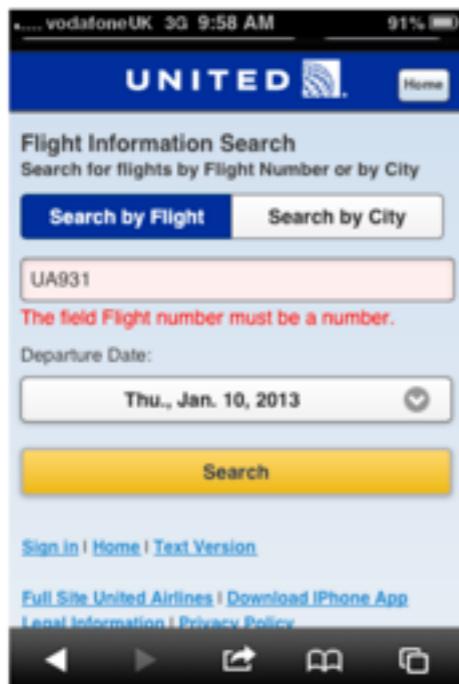
Platform Independent Model (PIM)



Platform Specific Model (PSM)

- Elaborate each of the services into platform specific items such as SOAP/REST services, Spring Interfaces, EJBs etc and build the actual set of interfaces in the language of choice

UI and UX



**Good UI/
Bad UX**

**Bad UI/
Good UX**

UI is like a joke. If you have to explain it, its no good

Plan your journey

From Ballincollig West (Classes Lake)

To Cork (Parnell Place Bus Station)

Date Day Month Year

Time Hr Min Departure

Plan your Journey ➤

Titleist Golf 913D2 Aldila RIP
Phenom 70 Driver



Click for Price

- Home Delivery ✓
- Deliver to Store ✓
- Reserve & Collect in Store ✓

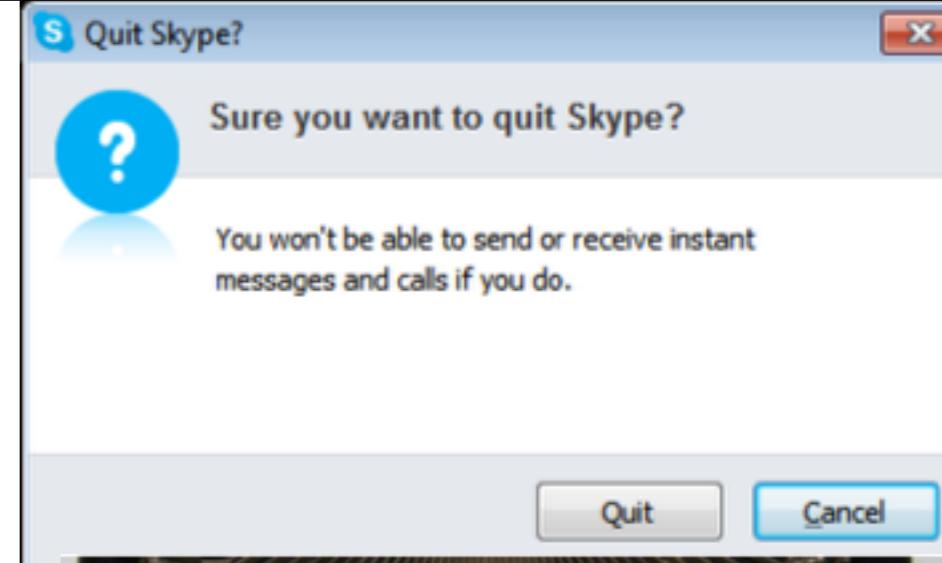
More Info

Really? 5 drop downs for a date selection?

I clicked on quit menu option and I dont know this? This isn't accidental exit protection

Nice way to deter people

And the remote simplification



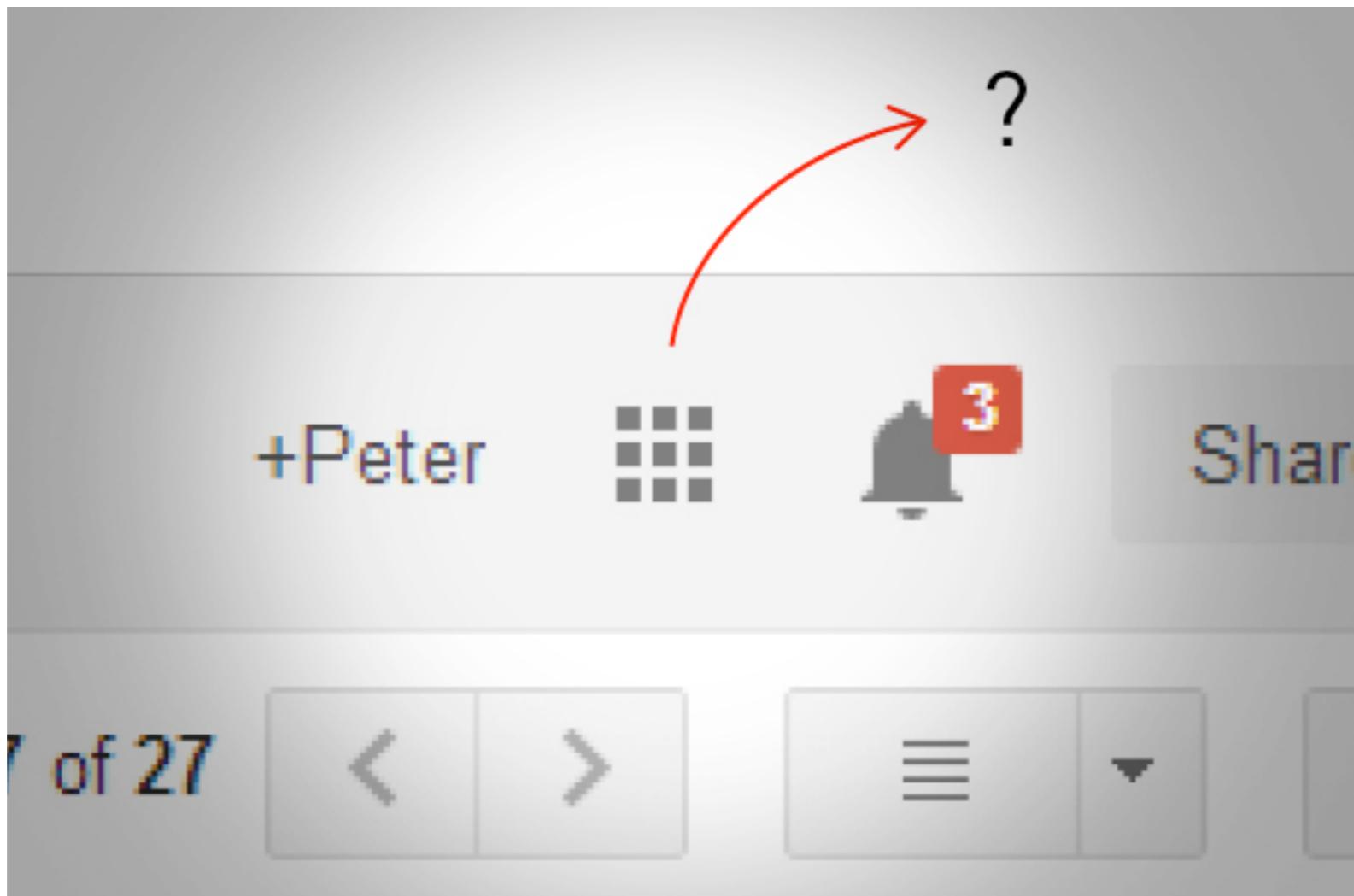
"There Grandma, I fixed it!"

When Applications Dont Use UX

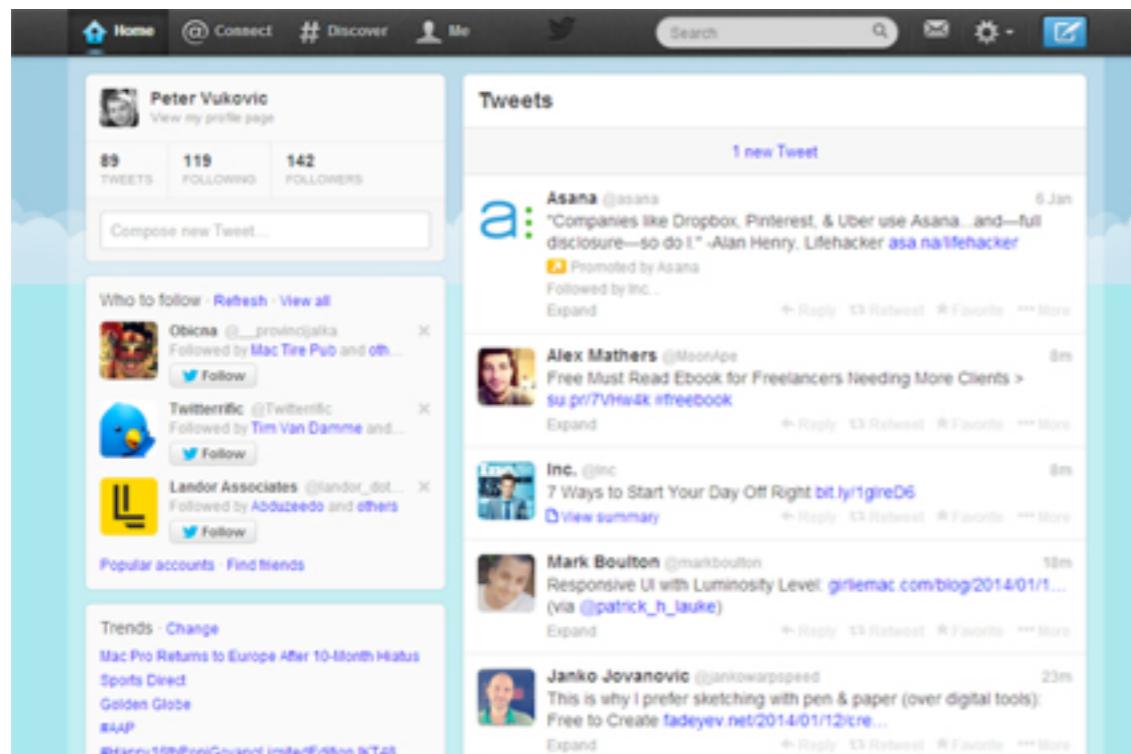
- Washers and dryers are almost always used together but no one thought they should be designed as a unit and not independently



Clarity: People avoid unclear icons



Preferred Action: Its like selling what you want



A screenshot of a Twitter profile page for Peter Vukovic (@PeterVukovic). The page shows 89 tweets, 119 following, and 142 followers. The tweets section displays several recent tweets from other users, such as Asana (@asana), Alex Mathers (@MoonApe), Inc. (@inc), Mark Boulton (@markboulton), and Janko Jovanovic (@jankowarpseed). Each tweet includes a preview of the content, a timestamp, and options to reply, retweet, favorite, or view more details.

Coke Music Profile Registration

Fill out the form below to create an account. * indicates required fields

* Email Address:

* Date of birth: Month Date Year

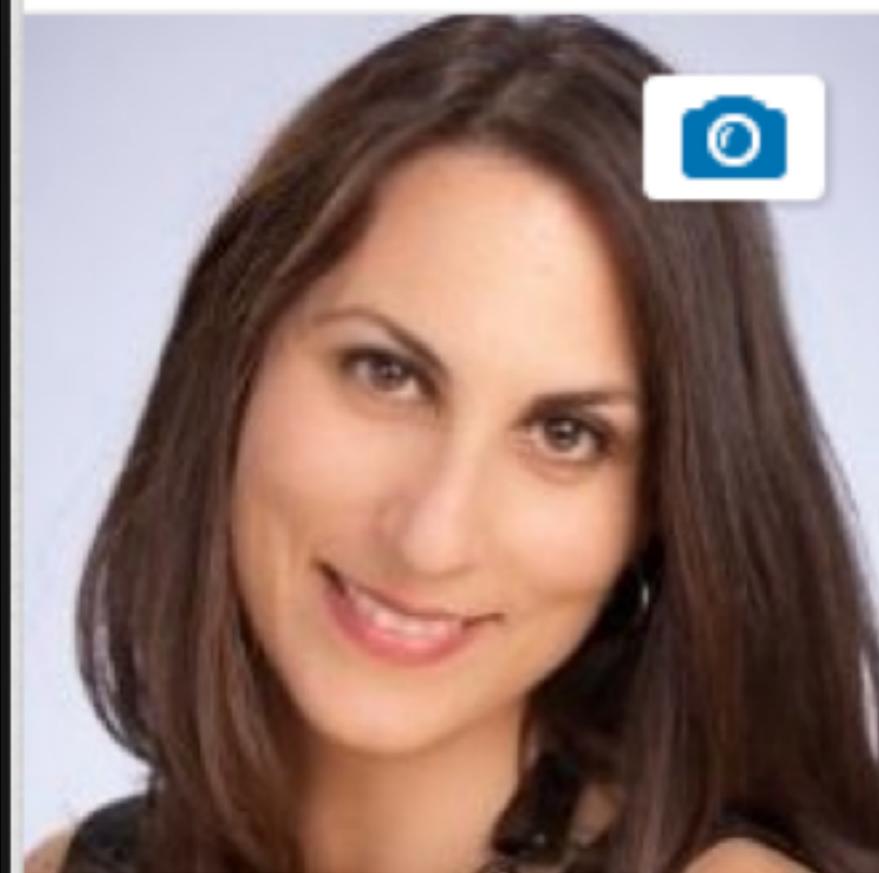
* I live in US


Can't read this?

* Enter Security Code:
Security Code is case-sensitive

CANCEL **SUBMIT**

Context: Controls and Objects of control to be grouped



 **Donna Serdula**   

 Writer of POWERFUL LinkedIn® Profiles  Author ✓
Speaker ✓ Social Media Advisor ✓ Web Strategist ►

 Let's Connect!!

 Greater Philadelphia Area | Marketing and Advertising

 Done editing

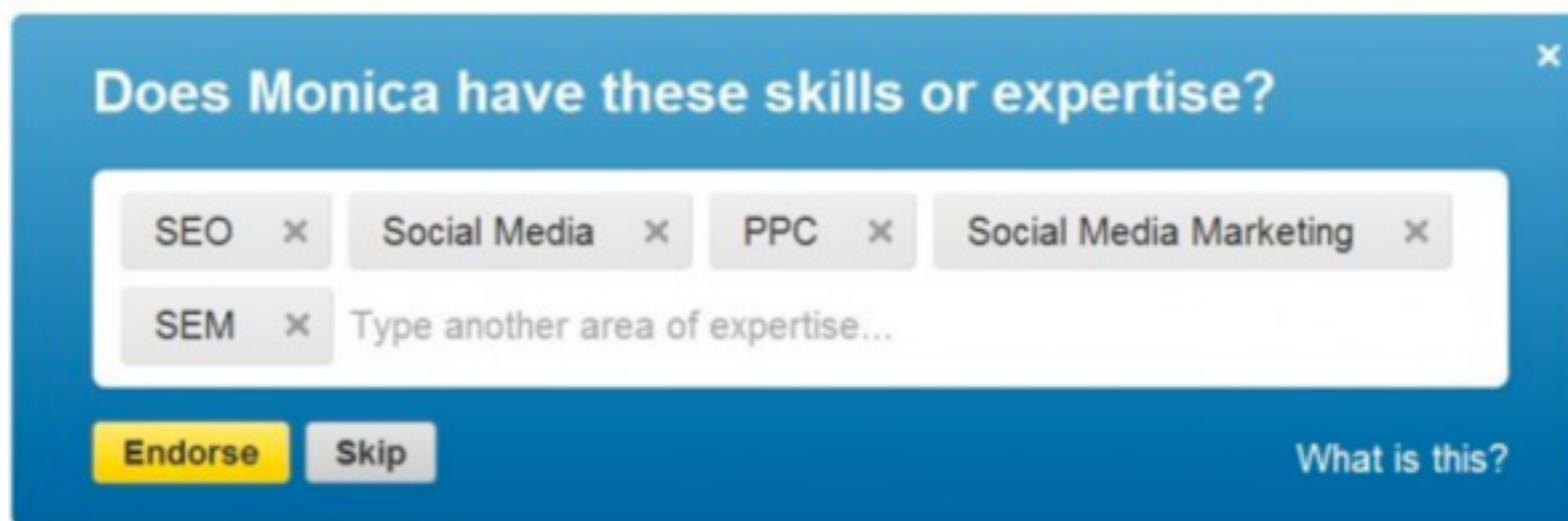
500+
connections

Defaults should be great.

- <https://www.youtube.com/watch?v=xIJZkkKVcUQ>
- <https://youtu.be/yq0EmbY3Xyl>
- Because other than enthusiasts, most people never change defaults on software

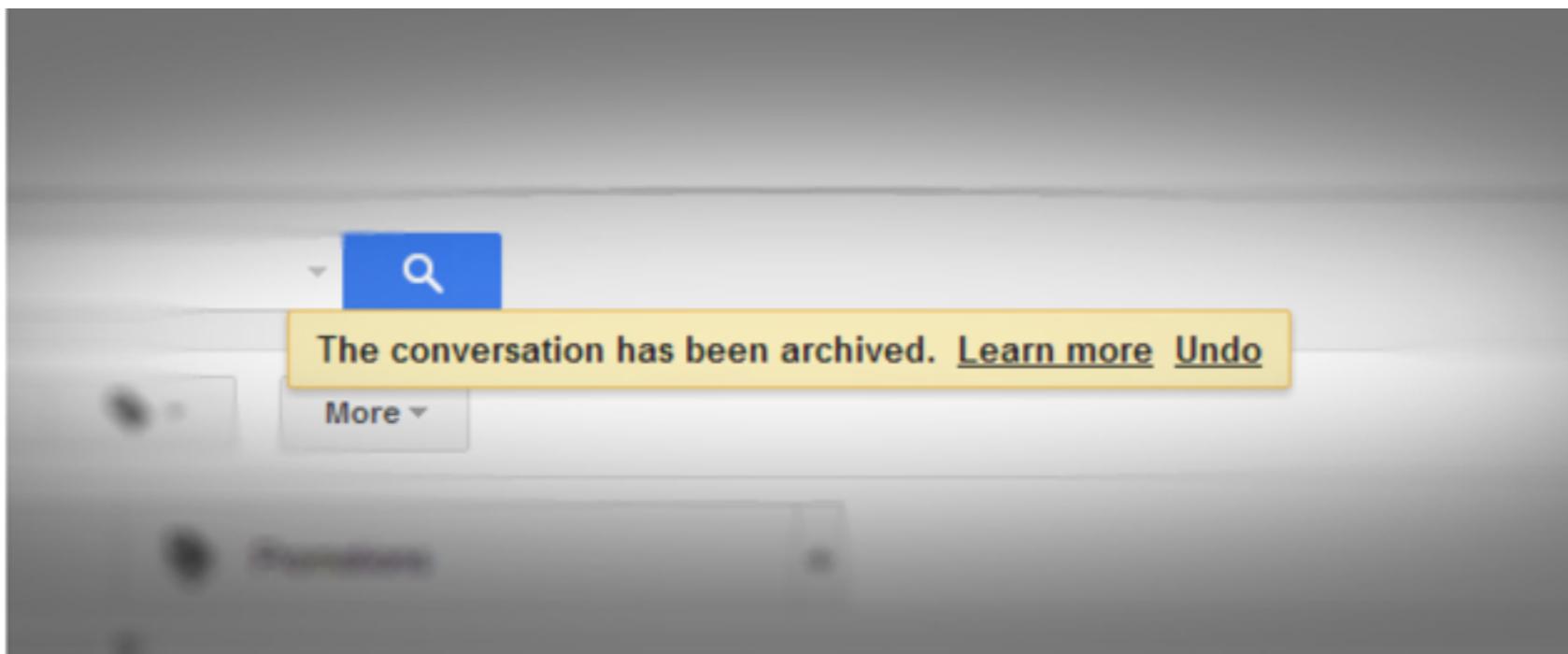
Guided Action

- Push users to do what you would like them to with simple clicks



Feedback on UI

- gmail even says “still trying...” when connections are timing out



Breakdown Complex Action

 **Submit An Announcement**

Click here for guidelines and more information about submitting wedding and celebratory "Vows" video series, to The Times.

Type of Celebration

Legal Marriage
 Civil Union
 Commitment Ceremony

Legal Date of Marriage (Not Ceremony)

Bride

Title

First Name (required) Middle Name

Last Name (required) Suffix

Date of Birth (required)

Education

Occupation (required)

Contact Information

Email Address (required)

1. Create Account **2. Contact Information**

Step 1: jQuery Tools Account

Please enter your login information:

1. Enter Your Email Address *

Your password will be sent to this address. Your address will not be published.

2. Pick a username

Your preferred username to be used when logging in.

3. Choose a Password * **Verify Pass**

Must be at least 8 characters long.

UX Techniques

- website analytics
- cognitive walkthrough
 - The focus of the cognitive walkthrough is on understanding the system's learnability for new or infrequent users.
- heuristic evaluation
 - It specifically involves evaluators examining the interface and judging its compliance with recognized usability principles

UX Techniques

- ethnography
 - Researching the cultural inclinations and tendencies of people with technology
- card sorting
 - Card sorting has a characteristically low-tech approach. The concepts are first identified and written onto simple index cards or Post-it notes. The user group then arranges these to represent the groups or structures they are familiar with.
- affinity mapping
 - Group brainstorming about ideas and putting them together in categories for UX

Responsive UI & SPA

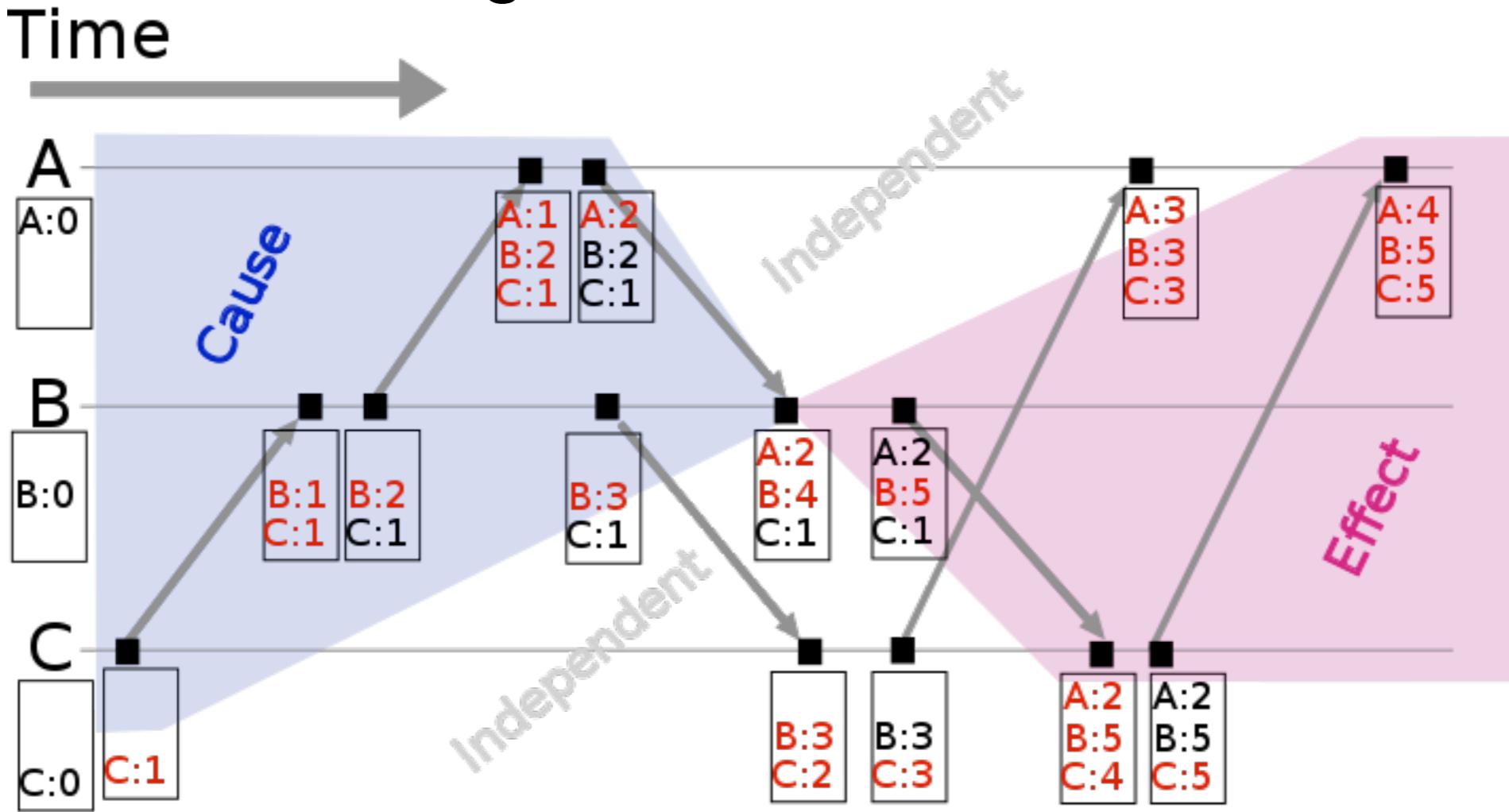
- Demonstration of using bootstrap for responsive UI
- Demonstration of Angular app as a Single Page App
- Demonstration of Flikbuk as a bookmarked SPA

Predictive Analytics

- Users no longer choose what they want fully. We kind of lead them along
- Part revealing titles (Yahoo home page)
- Tag clouds (instagram, flikbuk)
- Interest estimation based on past searches (Google ads)

Causality in Distributed Systems

- Partial Ordering with Vector Clocks



- wikipedia image

Distributing Logic - Map

```
public long[] getSquares(int[] nums){  
    long[] squares = new long[nums.length];  
    for (int j=0; j< nums.length; j++){  
        squares[j] = nums[j]*nums[j];  
    }  
    return squares;  
}
```

```
public long getSquare(int num){  
    return num*num;  
}
```

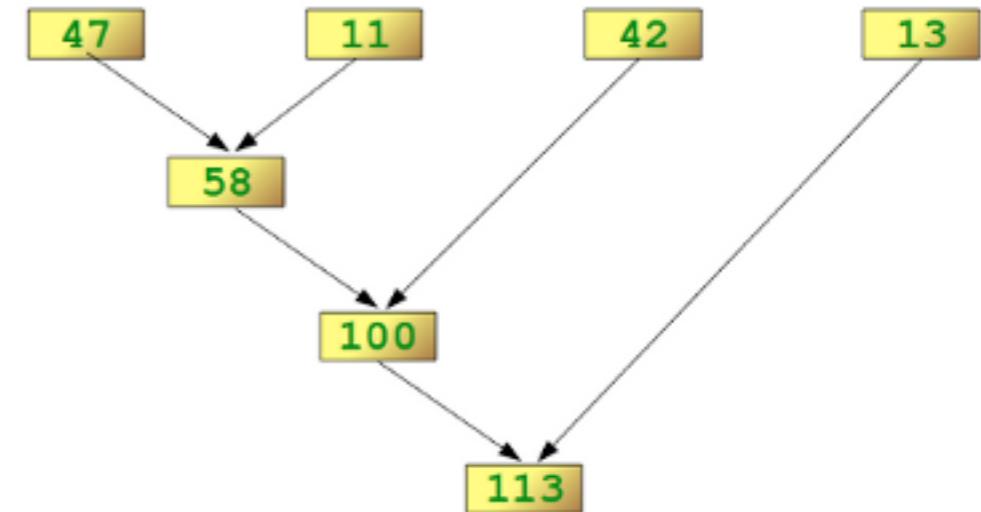
```
public long[] getSquaresMap(int[] nums){  
    long[] squares = new long[nums.length];  
    for (int j=0; j< nums.length; j++){  
        squares[j] = getSquare(nums[j]);  
    }  
    return squares;  
}
```

Distributing Logic - Reduce

```
public long getSum(int[] arr){  
    long sum=0;  
    for (int i : arr) {  
        sum+=i;  
    }  
    return sum;  
}
```

```
public long getSum(long prev, int next){  
    return prev+next;  
}
```

```
public long getSumReduce(int initialValue, int[] arr){  
    long reduced = initialValue;  
    for (int i : arr) {  
        getSum(reduced, i);  
    }  
    return reduced;  
}
```



Distributing Logic - Filter

```
public Integer[] removeEvens(int[] nums){  
    ArrayList<Integer> odds = new ArrayList<Integer>();  
    for(int i: nums){  
        if(i%2!=0){  
            odds.add(i);  
        }  
    }  
    return odds.toArray(new Integer[0]);  
}
```

```
public boolean evenFilterFunction(int val){  
    return val%2!=0;  
}
```

```
public Integer[] removeEvensFilter(int[] nums){  
    ArrayList<Integer> odds = new ArrayList<Integer>();  
    for(int i: nums){  
        if(evenFilterFunction(i)){  
            odds.add(i);  
        }  
    }  
    return odds.toArray(new Integer[0]);  
}
```