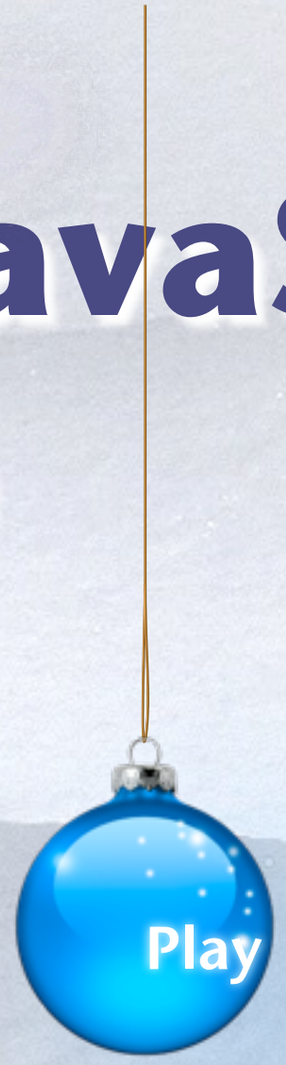
Lecture 12
Asynchronous JavaScript and XML (AJAX)

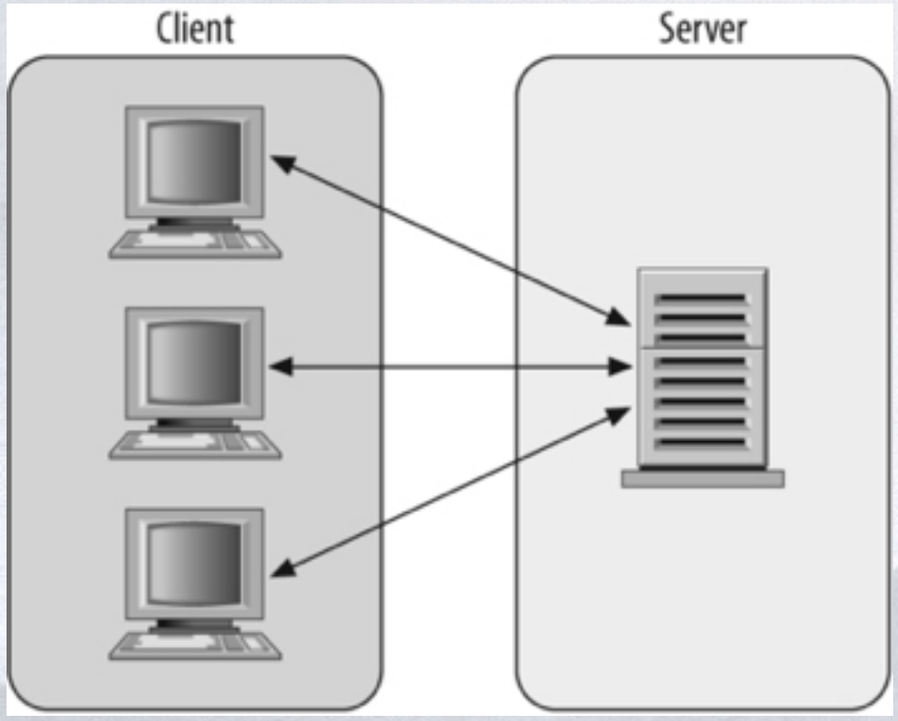


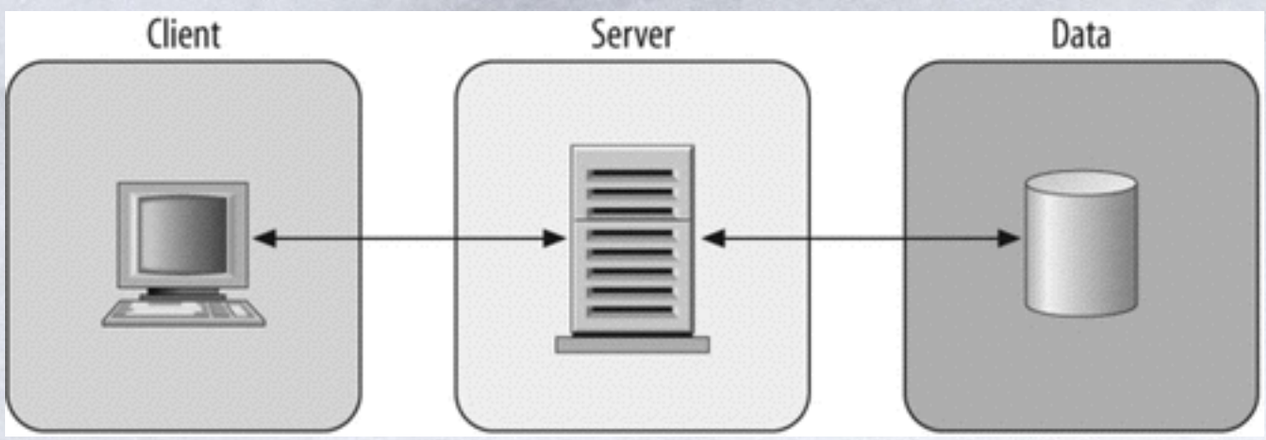
Outline

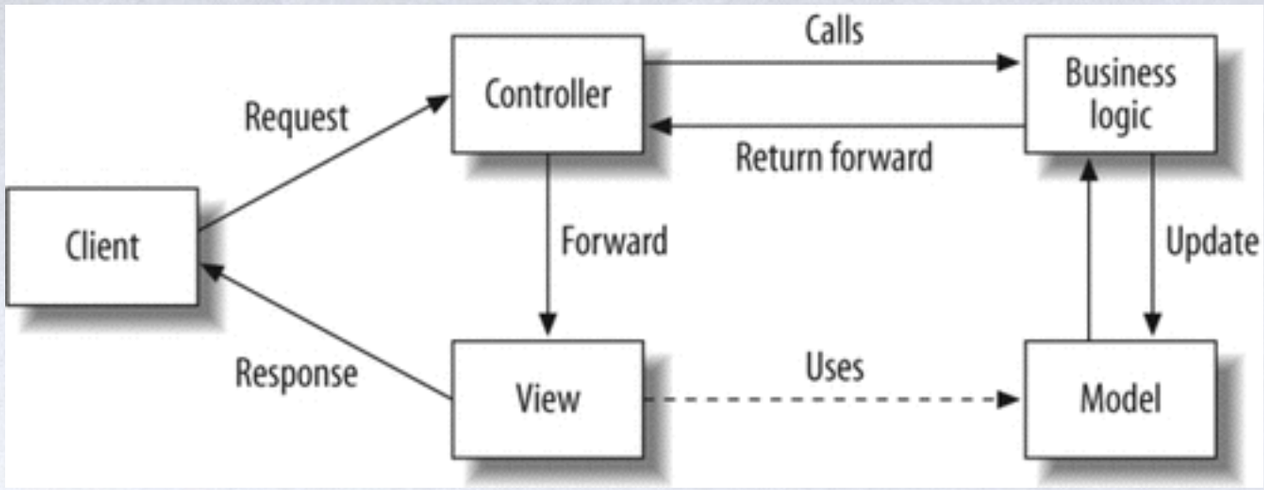
- Rich Internet Applications (RIAs)
- Ajax
- XMLHttpRequest
- Ajax in Prototype
- Limits of Ajax
- Debugging Ajax

From Web Sites to Web Applications

- Client/Server
  - static content
- Basic Three-Tier
  - user interface, business or process logic, and a data access module
- Model-View-Controller
- Rich Internet Applications

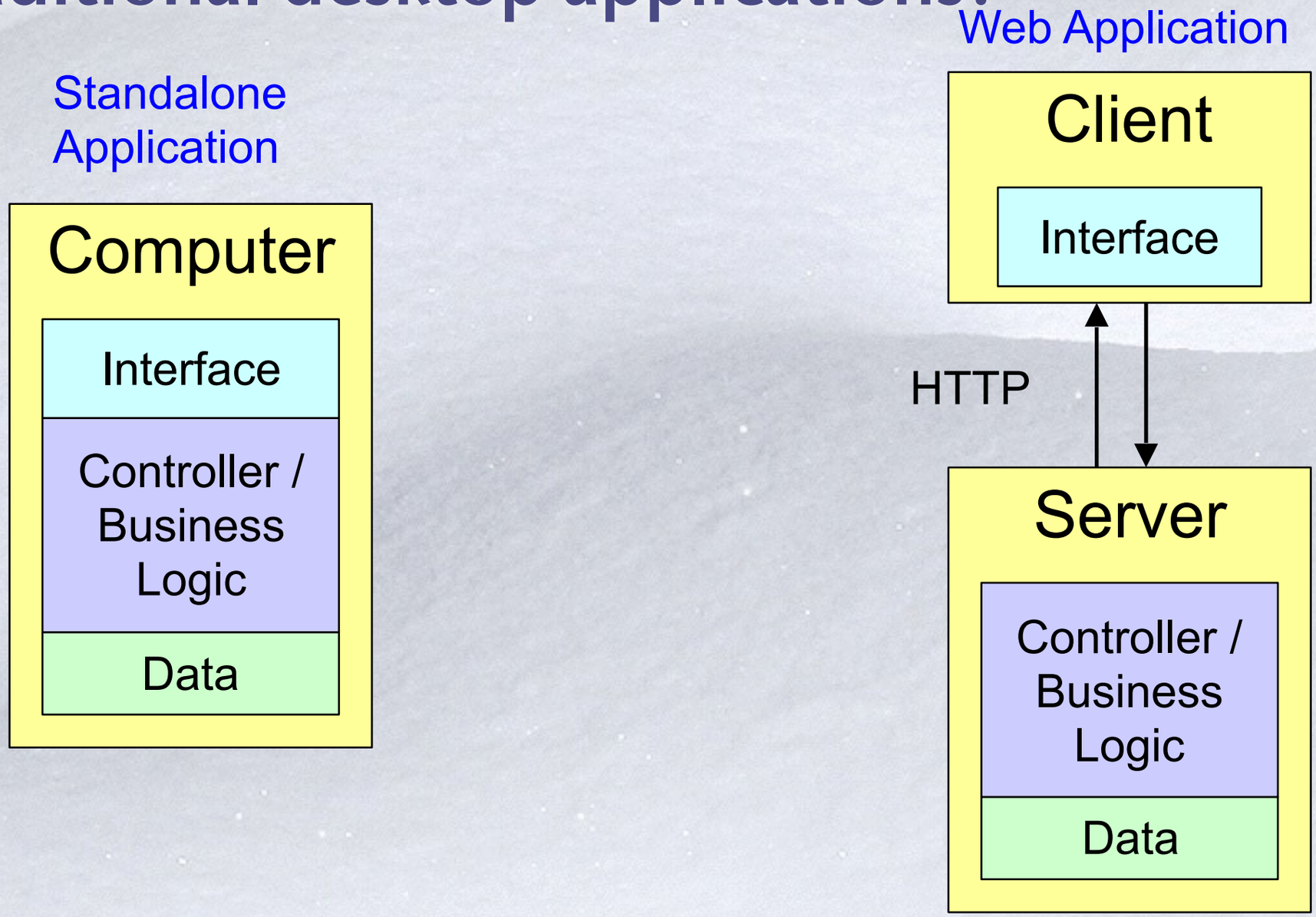




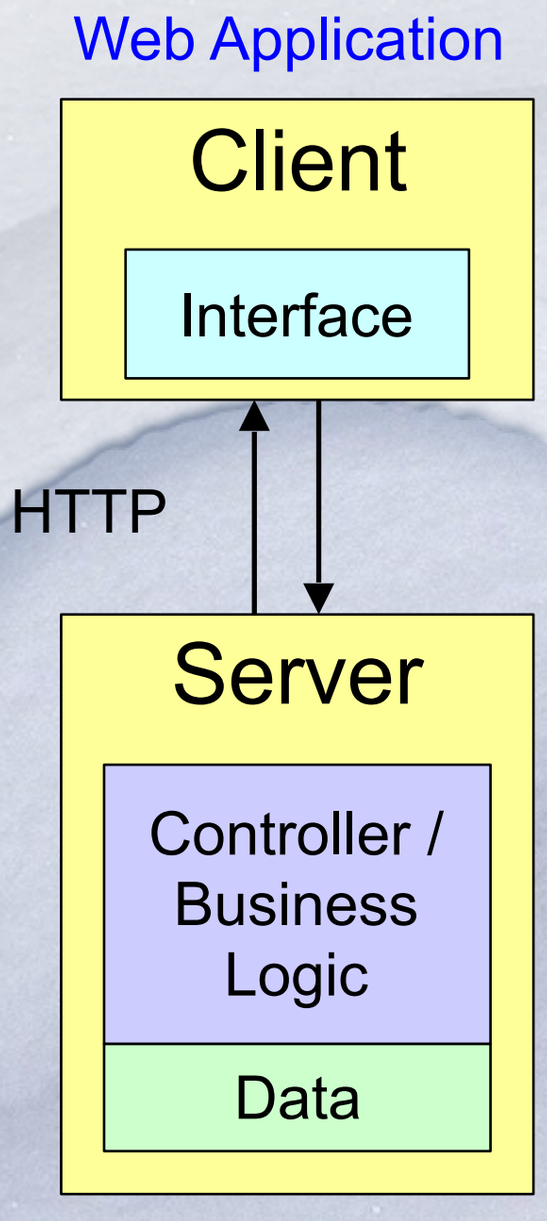


Web Applications Revisited

- How are web applications different from traditional desktop applications?



Attractiveness of Web Applications



- Add interactivity to a website
- Accessible over internet/intranet
  - No software installation required
  - Easier to upgrade
- Platform independent (mostly)
  - From PCs running different OS to mobile devices
- Anymore?

How "Traditional" Web Applications Fair?

- Interface – HTML + CSS + JavaScript + Images
  - Not rich enough
    - No video playing capabilities (need plug-in)
    - No support for vector graphics (no pixel-level manipulation)
  - Not "natural" for creating dynamic GUI components like collapsible tree or for creating behavior like drag-and-drop
  - Less responsiveness (JavaScript is interpreted)

How "Traditional" Web Applications Fair?

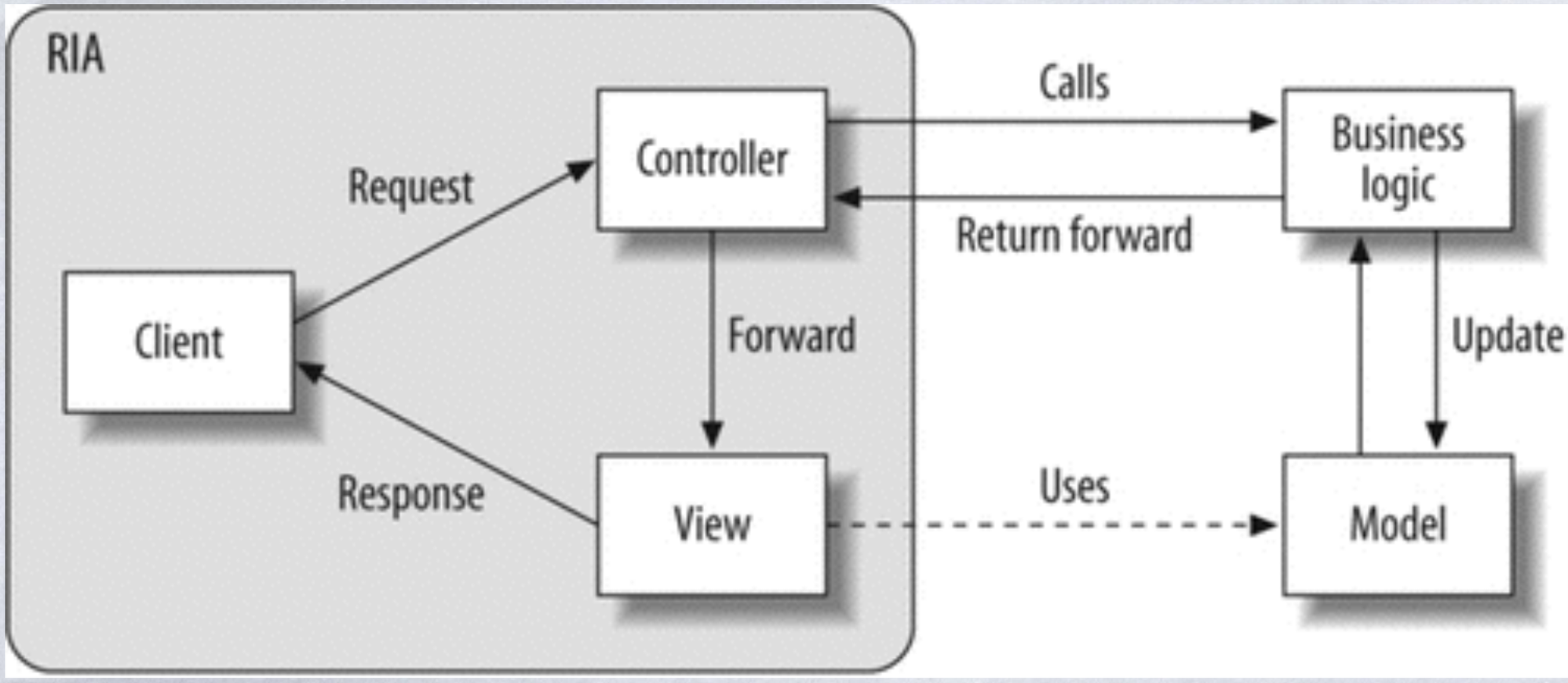
- Thin Client Architecture
  - Servers do most of the work and keep most data → higher traffic volumes

- Synchronous communication
  - For each request sent as a result of some actions, the client cannot interact with the application until the server completes the response.
  - i.e., less interactive user experience

Characteristics of RIA

- Have features and functionality of traditional desktop applications (i.e., highly interactive GUI).
- Run in a web browser or run locally in a secure environment called a sandbox
- Do not require software installation
  - The RIA runtime environment still needs to be installed once per system.

Rich Internet Applications



An RIA implementation on top of MVC

RIA: Pros (In General)

- Installation is not required
- Easy to upgrade
- Easily made available over internet/intranet
- Richer UI
- More responsive UI
- Client/Server Balance
- Asynchronous communication
- Network efficiency

RIA: Cons (In General)

- Loss of visibility to search engines
- Proprietary (as opposed to Open Standard)
- Loss of integrity (RIAs typically don't mix well with HTML)
- Software development complications (What to cache or not to cache at client's computer?)
- RIA architecture breaks the Web page paradigm

RIA Approaches

- Browser plug-in
  - Flash/Flex, Java Swing, Silverlight
  - Potentially greater interactivity, higher barrier to adoption
  - Concerns about openness/control
- In browser, no plug-ins
  - AJAX
  - Lower barrier to adoption
  - Cross-browser mayhem?

Adobe Flash, Adobe Flex and Adobe AIR

- Adobe Flash
  - Contains a rich set of GUI widgets that makes adding animation and interactivity to web pages easier
  - Can manipulate vector and raster graphics and supports bi-directional streaming of audio and video
  - Scriptable using Action Script (based on ECMAScript)
- Adobe Flex = Flash + Ajax liked behavior
- AIR (Adobe Integrated Runtime)
  - A cross-operating system runtime environment for building RIAs, using Adobe Flash, Adobe Flex, HTML and Ajax, that can be deployed as a desktop application

Flex Application Development Process

- Define an application interface using a set of pre-defined components (forms, buttons, and so on)
- Arrange components into a user interface design (e.g.: using MXML)
- Use styles and themes to define the visual design
- Add dynamic behavior (one part of the application interacting with another, for example)
- Define and connect to data services as needed
- Build the source code into an SWF file that runs in the Flash Player

(Copied from Wikipedia:
http://en.wikipedia.org/wiki/Adobe_Flex#Flex_Application_Development_Process)

See the example at http://blog.paranoidferret.com/?p=25

Adobe Flex

- Pros
  - Adobe Flash has wide penetration
  - Flash Player is available to many platforms
- Cons
  - Proprietary
- Examples:
  - http://en.wikipedia.org/wiki/Adobe_Flex#Notable_sites_using_Flex

Microsoft Silverlight

- A browser plugin that allows web applications to be developed with features like animation, vector graphics, and audio-video playback - features that characterize a rich internet application
- Comparable to Adobe Flex
- Allows developers to use .NET languages and development tools when authoring Silverlight applications

Microsoft Silverlight

- Pros
  - Ease of development (especially to .NET developers)
  - Textual content created with Silverlight would be more searchable and indexable than those created with Flash as it is not compiled, but represented as text
    - See: Wiki's XAML and XAML Overview for examples
- Cons
  - Proprietary
  - Only officially supported for Microsoft Windows, Mac OS, mobile devices running Windows Mobile 6, and Symbian (Series 60) phones.
- Examples

JavaFX

- A family of products and technologies from Sun Microsystems
  - Currently comprised of JavaFX Script and JavaFX Mobile
  - JavaFX Script is a highly productive scripting language for content developers to create rich media and interactive content.
  - JavaFX Mobile is a software system for mobile devices

- Scripts written in JavaFX Script are compiled into Java byte codes and run in a JVM.

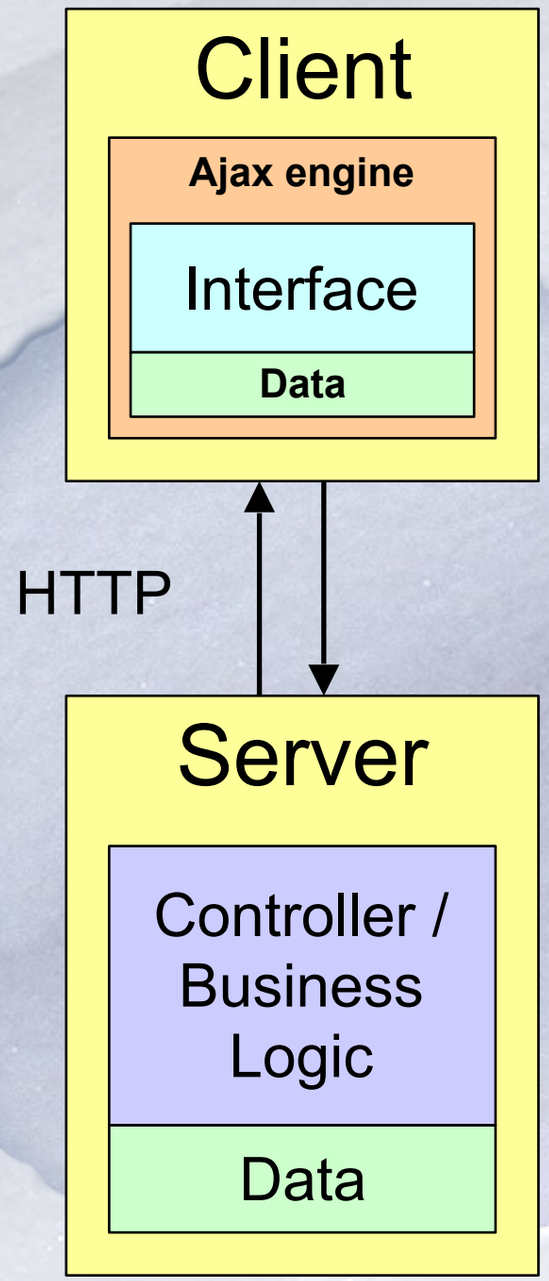
JavaFX

- Pros
  - Has the attractiveness of Java's "write once run anywhere" property (i.e., higher reach of platforms, especially mobile devices)
  - Easier (compare to using Swing package) to build GUI
  - Open Source

- Cons
  - JVM consumes a lot of memory

"Traditional" Web Applications with Ajax

Web Application with Ajax



- Ajax allows a client to send requests (to retrieve data) asynchronously via JavaScript.
- Improved interactivity
- Reduced traffic volume
  - Data can be retrieved gradually on the background

Merits of RIA application

- Ajax web applications require no installation, updating, or distribution, as everything is served up by a web server.
- Ajax web applications are less prone to virus attacks (generally).
- Ajax web applications can be accessed anywhere, and if they are built properly, you can run them on any operating system.

How "Traditional" Web Applications Fair? (Developers' Nightmare)

- Applications can break as a result of
  - Incompatibility among browsers
    - No standardization of JavaScript DOM objects
    - No standardization of Ajax implementation
    - Different browsers of different versions support different subsets of CSS
  - Uncontrollable environments
    - Client may turn off JavaScript support
    - Client may override font sizes, font faces, etc.
- JavaScript is not easy to debug

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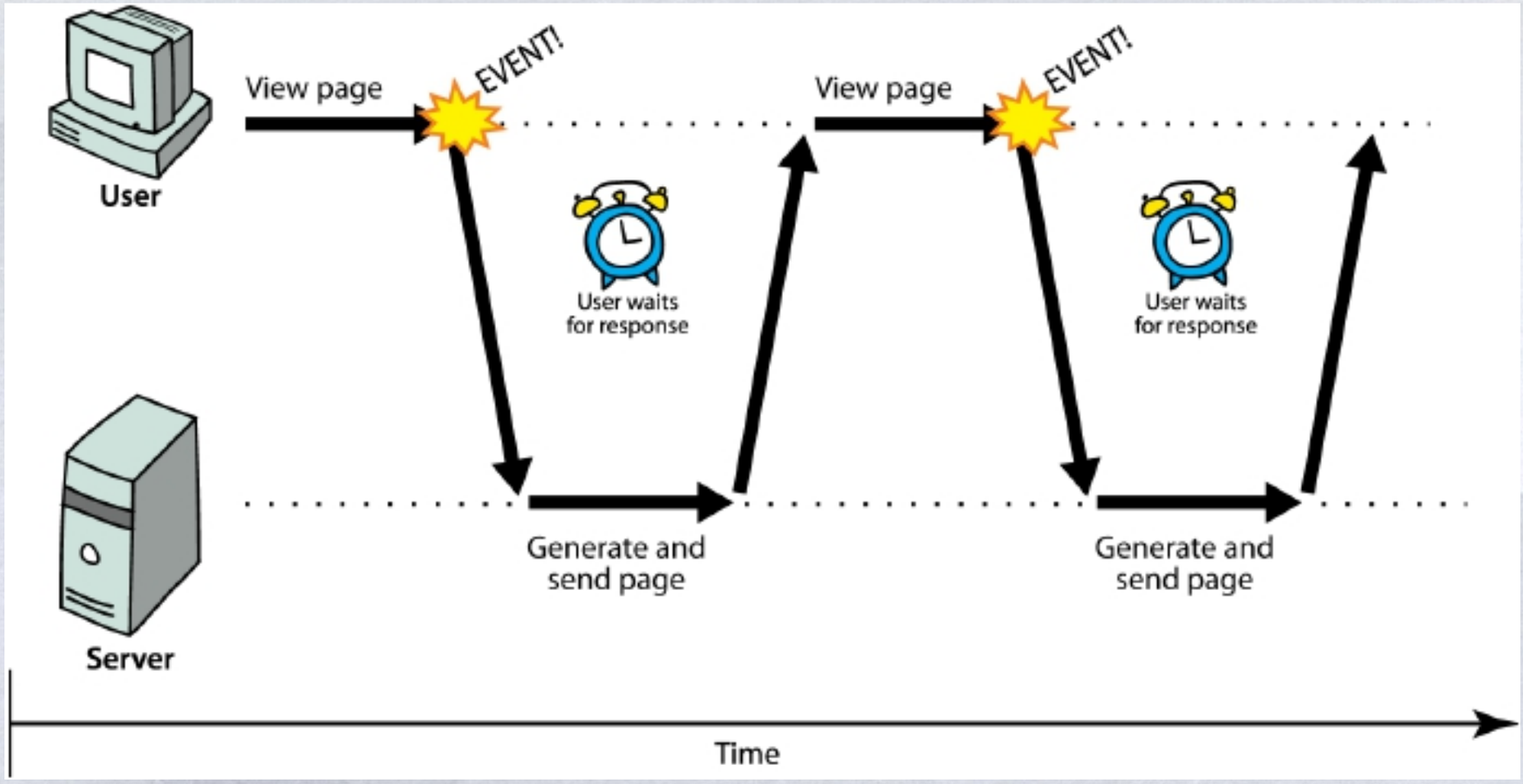
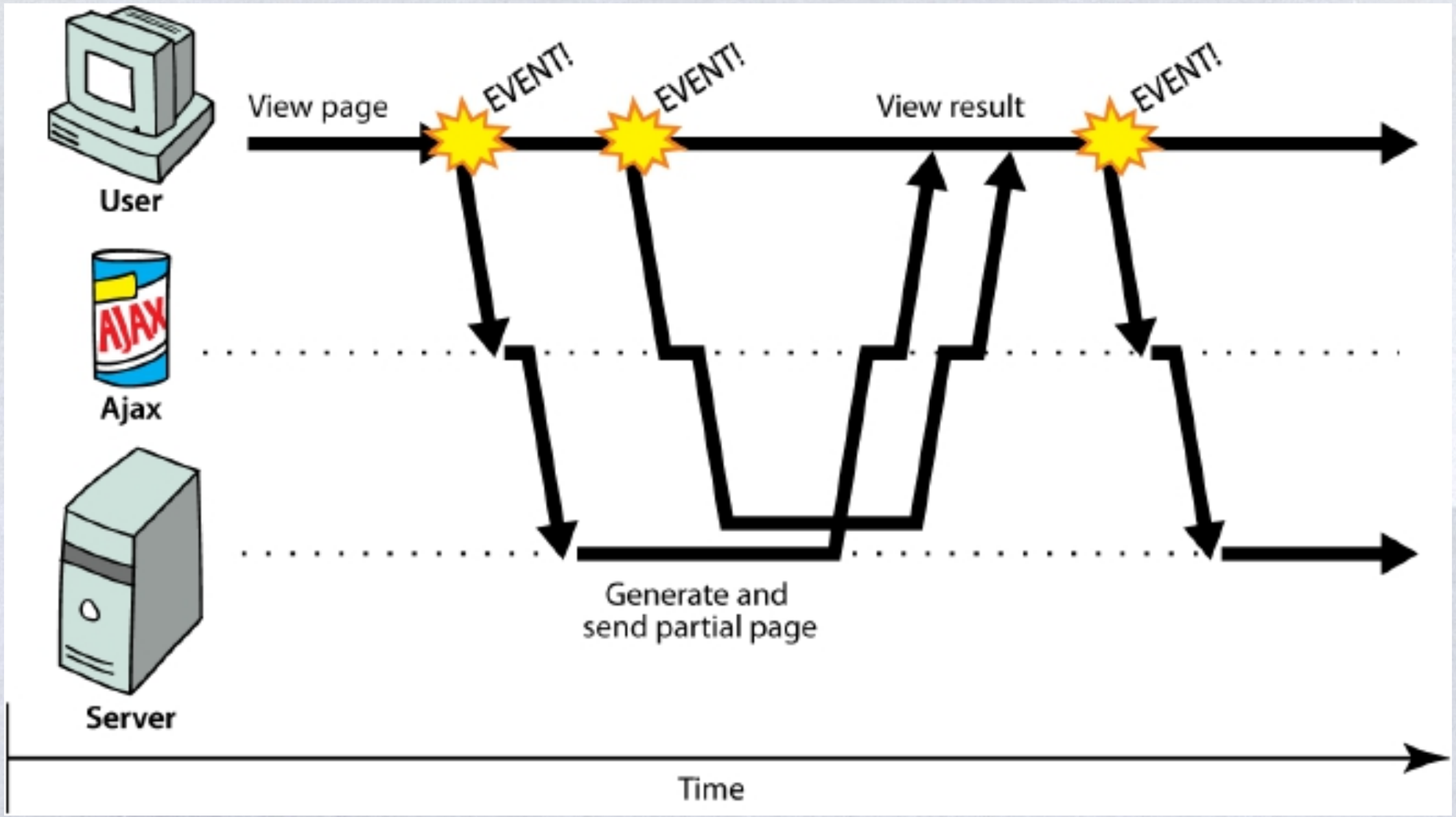
Synchronous web communication



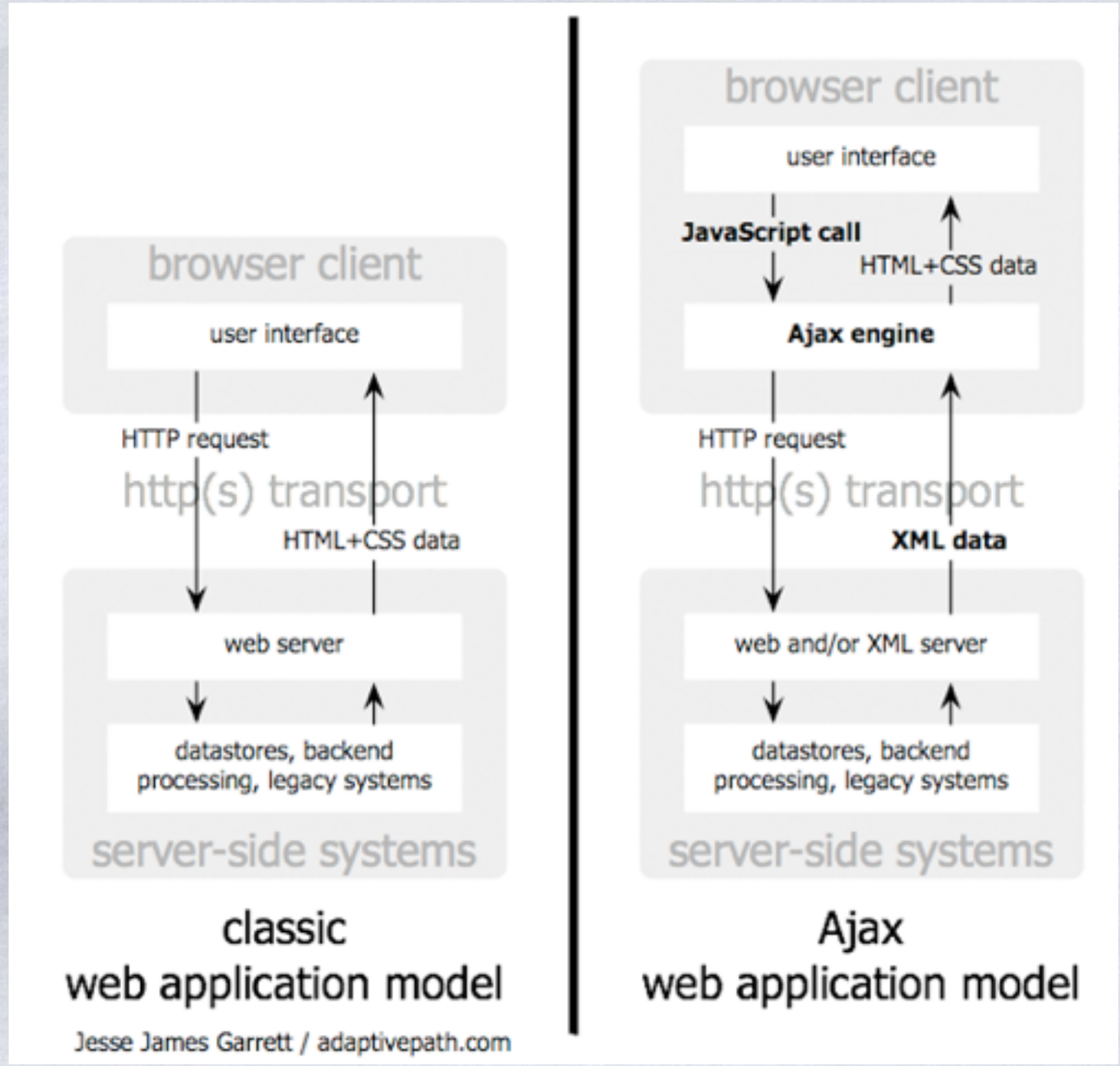
- synchronous: user must wait while new pages load
  - the typical communication pattern used in web pages (click, wait, refresh)
- almost all changes with new data lead to page refresh

Asynchronous web communication



- asynchronous: user can keep interacting with page while data loads
  - communication pattern made possible by Ajax
- Changing with new data but without page refresh

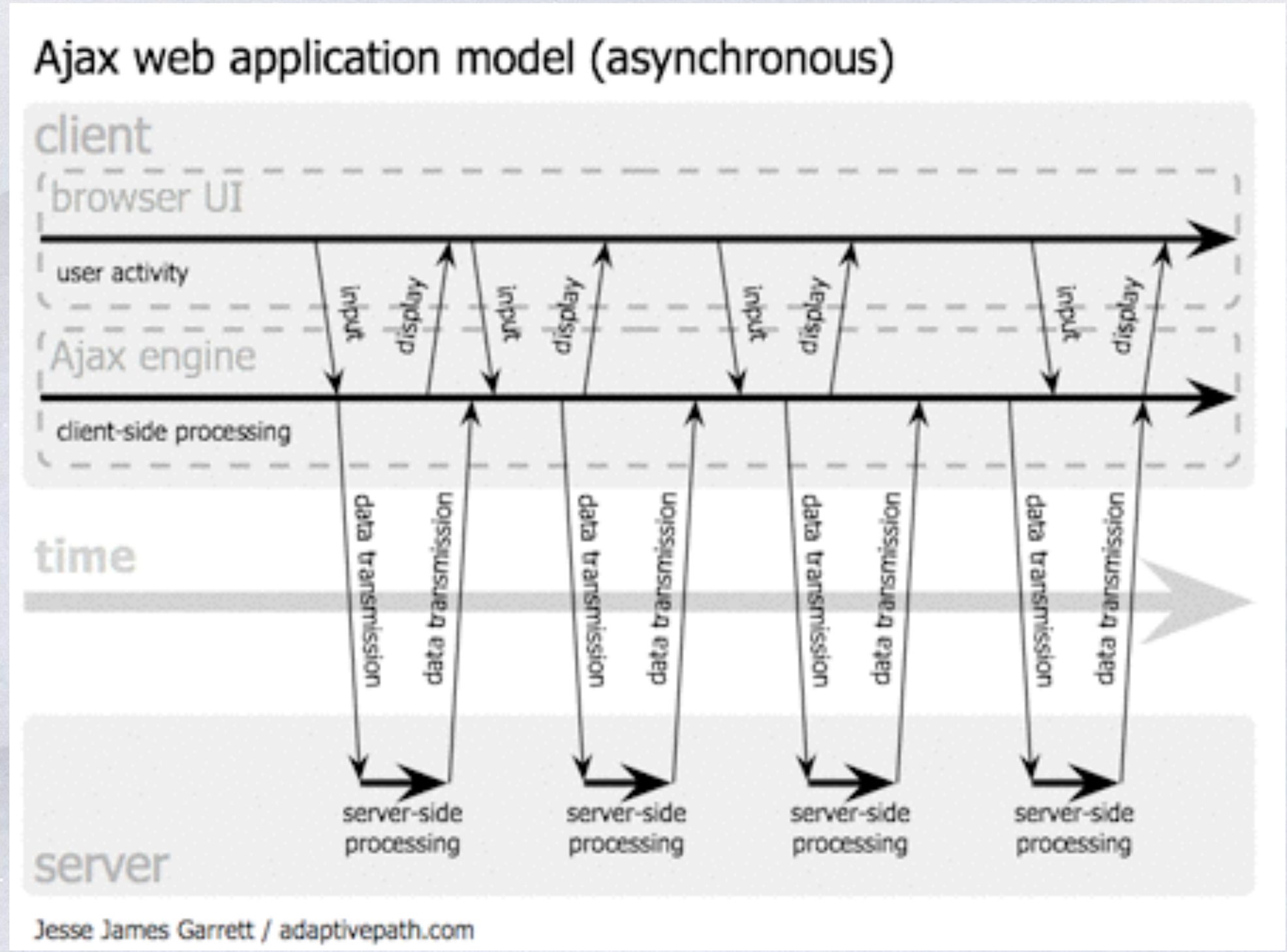
What is AJAX?


browser client
user interface
HTTP request
http(s) transport
HTML+CSS data
web server
datastores, backend processing, legacy systems
server-side systems
classic web application model
Jesse James Garrett / adaptivepath.com
browser client
user interface
JavaScript call
HTML+CSS data
Ajax engine
HTTP request
http(s) transport
XML data
web and/or XML server
datastores, backend processing, legacy systems
server-side systems
Ajax web application model

Web applications and Ajax

- web application: a dynamic web site that mimics the feel of a desktop app
  - presents a continuous user experience rather than disjoint pages
  - examples: Gmail, Google Maps, Google Docs and Spreadsheets, Flickr, A9
- Ajax: Asynchronous JavaScript and XML
  - not a programming language; a particular way of using JavaScript
  - downloads data from a server in the background
  - allows dynamically updating a page
  - avoids the "click-wait-refresh" pattern
  - examples: Google Suggest

AJAX event handling



Advantages and Disadvantages of AJAX

Advantages

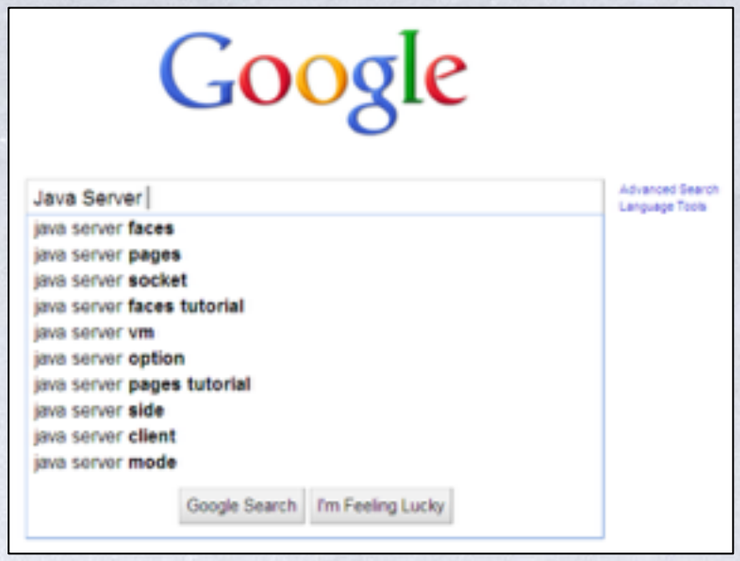
- Better interactivity and responsiveness.
- Your page will be more pleasant to use.
- Reduced connections to the Web server because of partial rendering.
- Because you only load the data you need to update the page, instead of refreshing the entire page, you save bandwidth.
- It helps in reducing the network traffic.

Disadvantages

- The back and refresh buttons become useless.
- Bookmarking this page will become useless.
- Requires JavaScript to be enabled on the Web browser.
- Network latency may break usability.
- Data loaded through AJAX won't be indexed by any of the major search engines. Hence, making it SEO unfriendly.

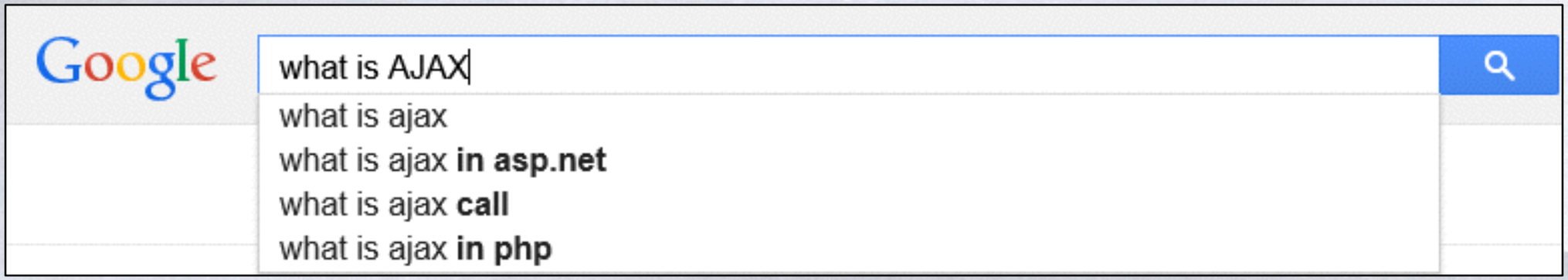
Real-Life Scenarios for Using AJAX

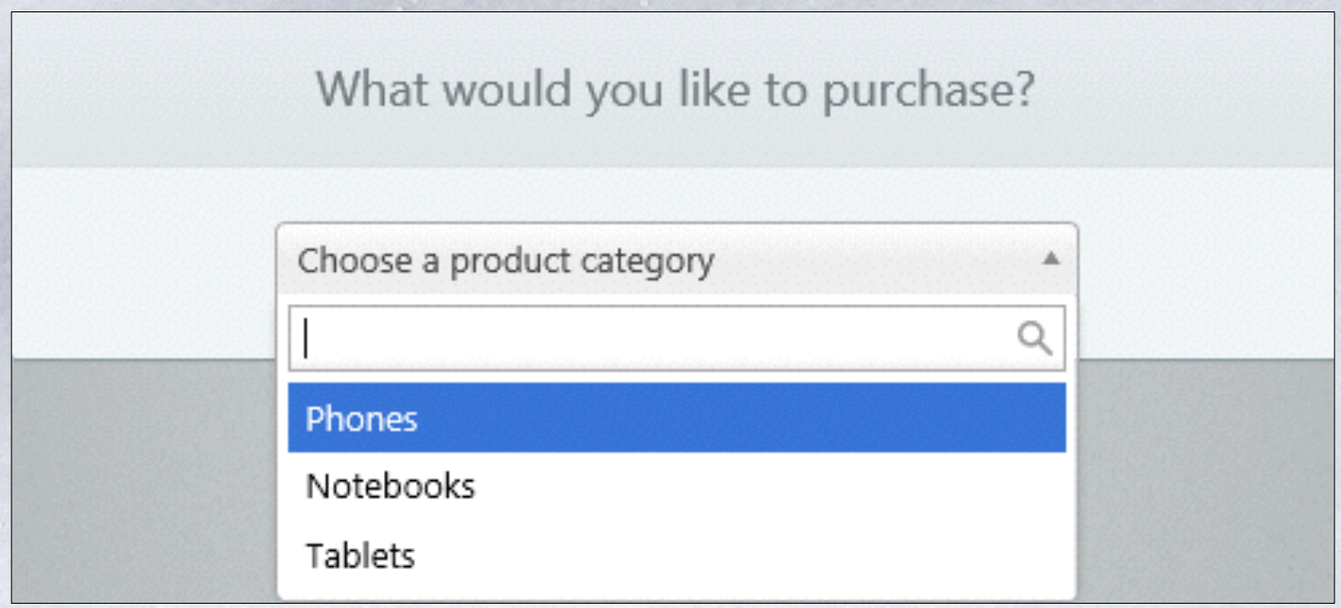
- The following list depicts some real-life scenarios where AJAX can be helpful:
  - Autocomplete search text boxes
  - Cascading dropdown list box
  - Real-time communication, such as instant messaging
  - Real-time data updates, such as score updates
  - Immediate forms validation feedback
  - Auto save user information



Real-Life Examples of AJAX

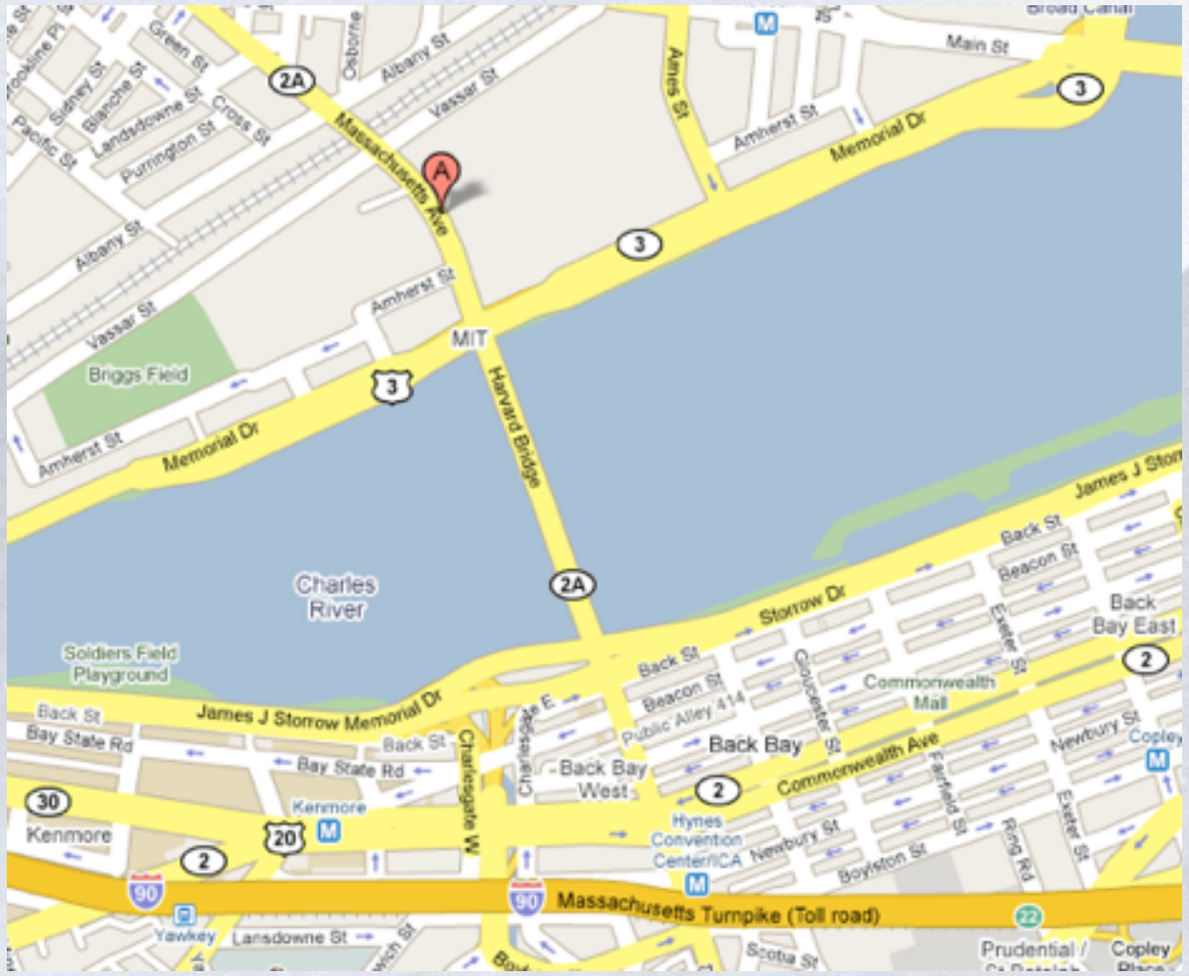
- The following figures depict some examples of using AJAX on your Web page:



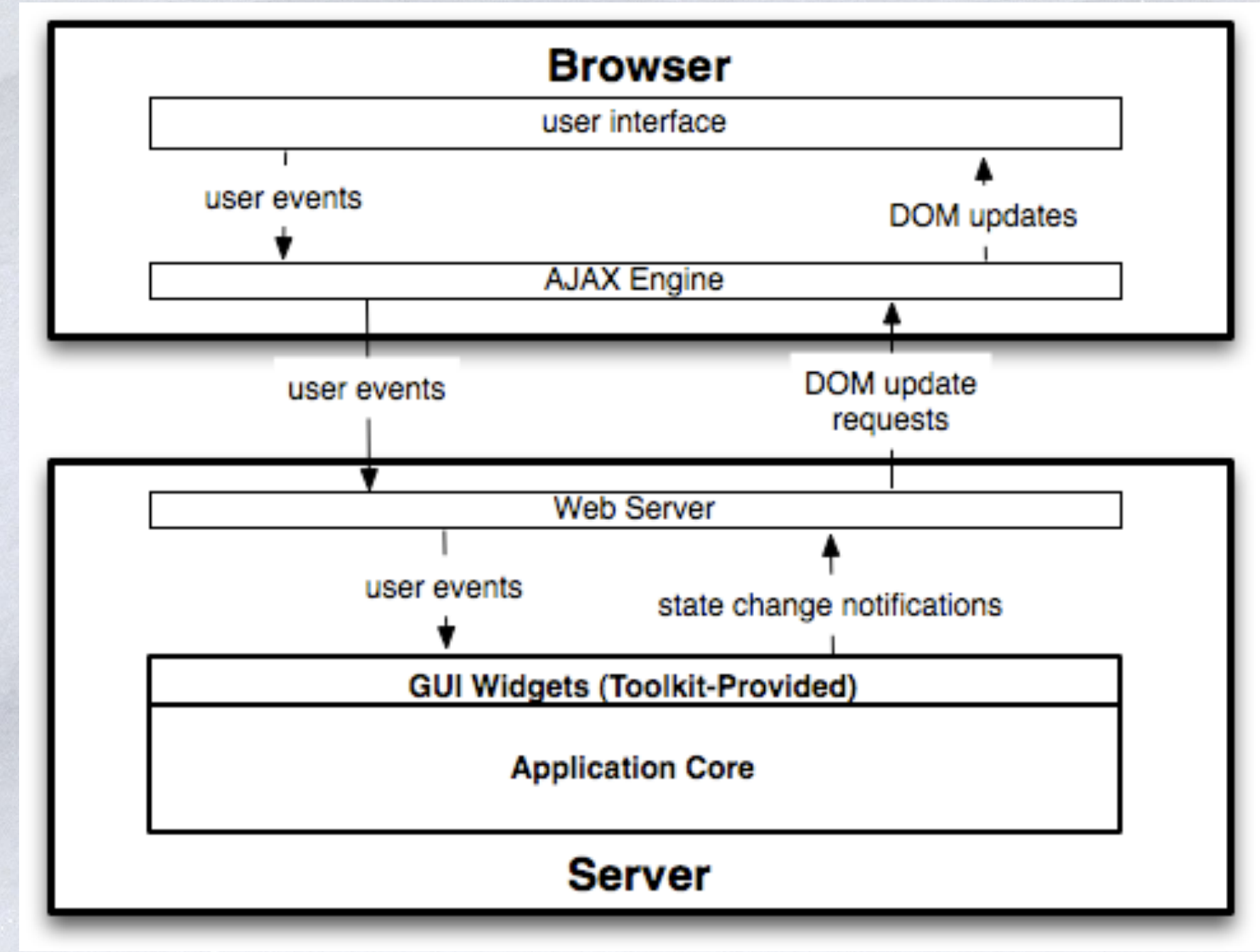


AJAX on the Direct Manipulation Hill

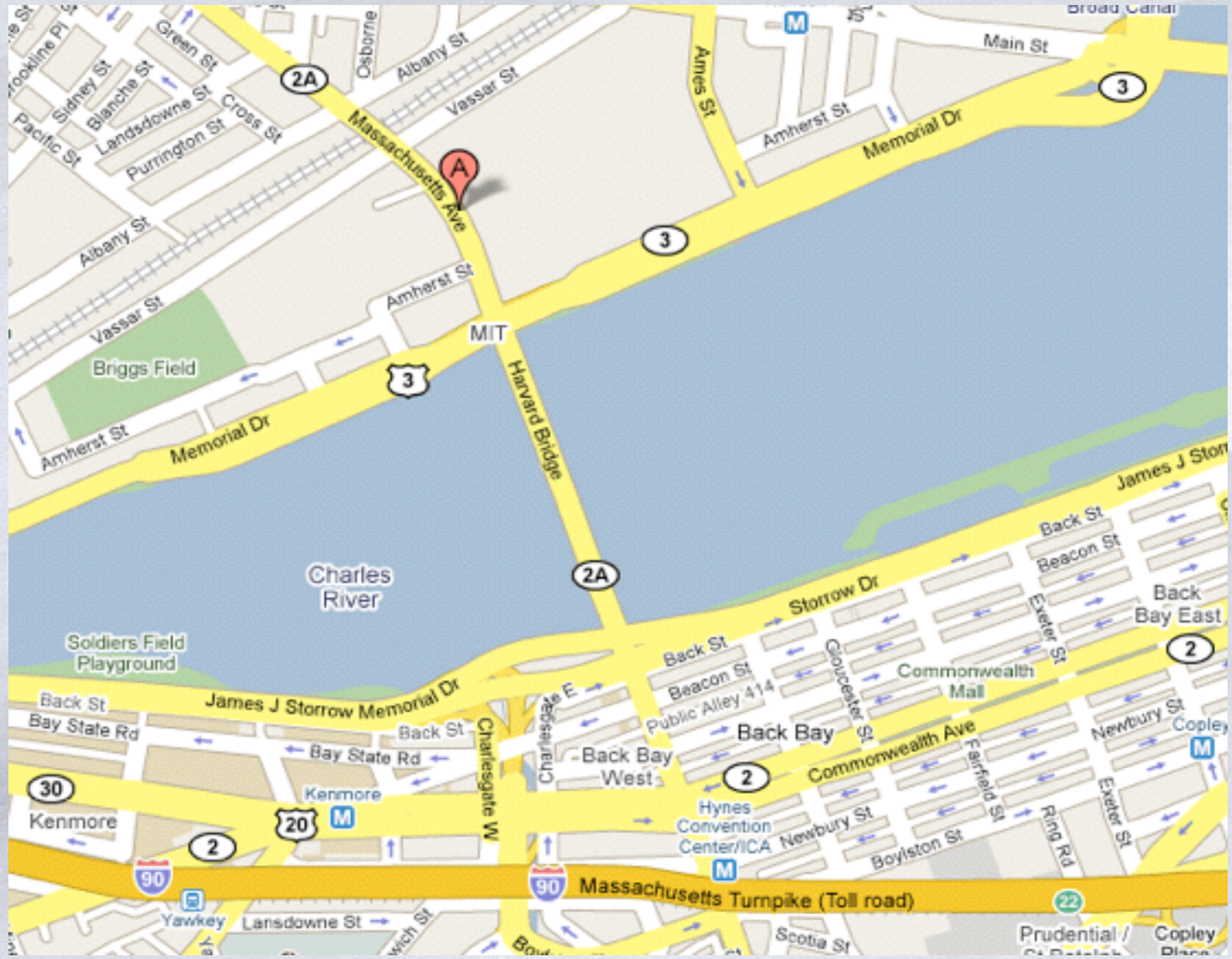
- Separate development environment from runtime environment.
- Runtime environment: HTML/ Javascript/CSS (AJAX)
- Development environment: toolkit in another language
- Two approaches: thin and fat



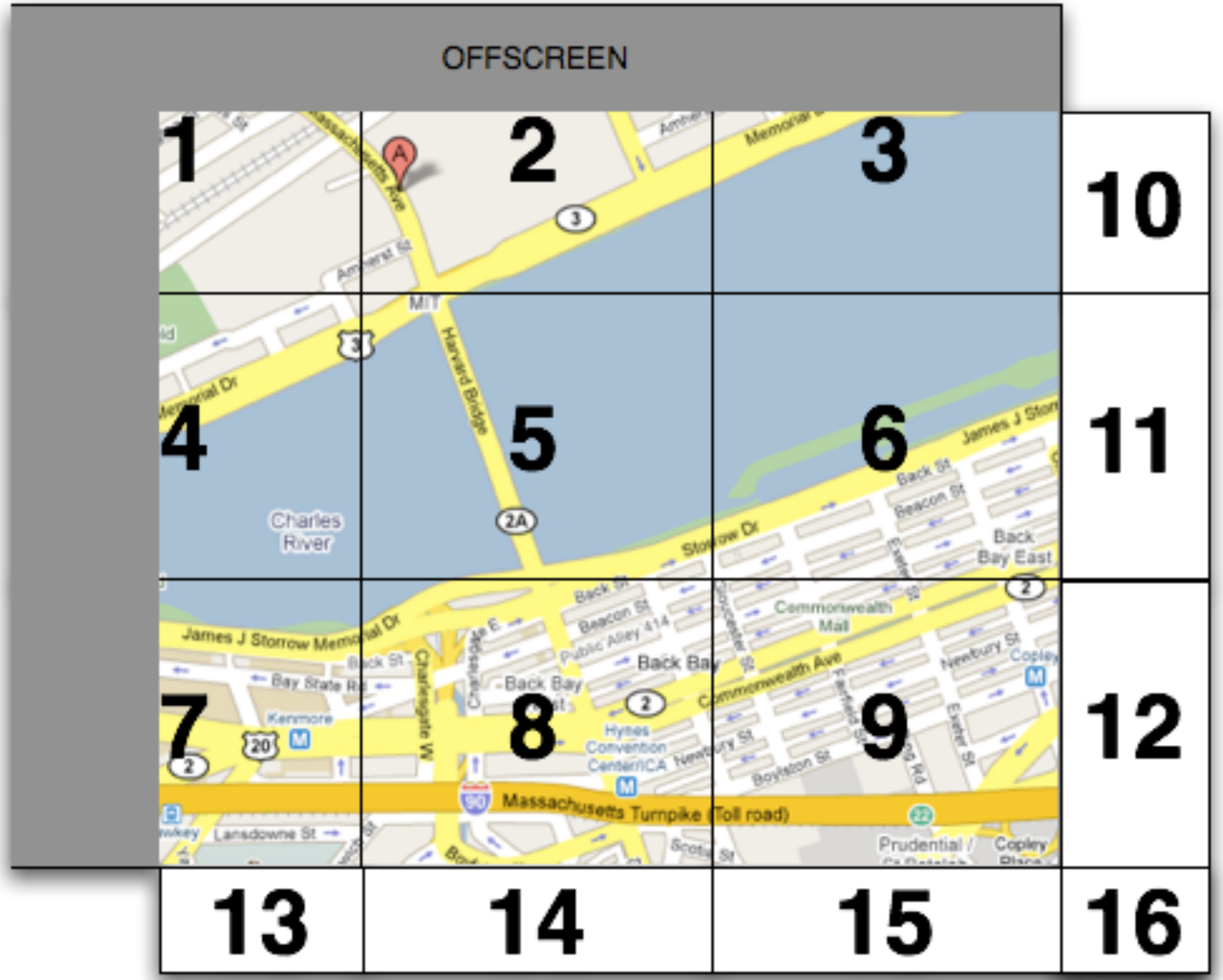
Thin Client AJAX Approach



Example: Google Maps (pretend it's a thin client app)



Example: Google Maps


OFFSCREEN
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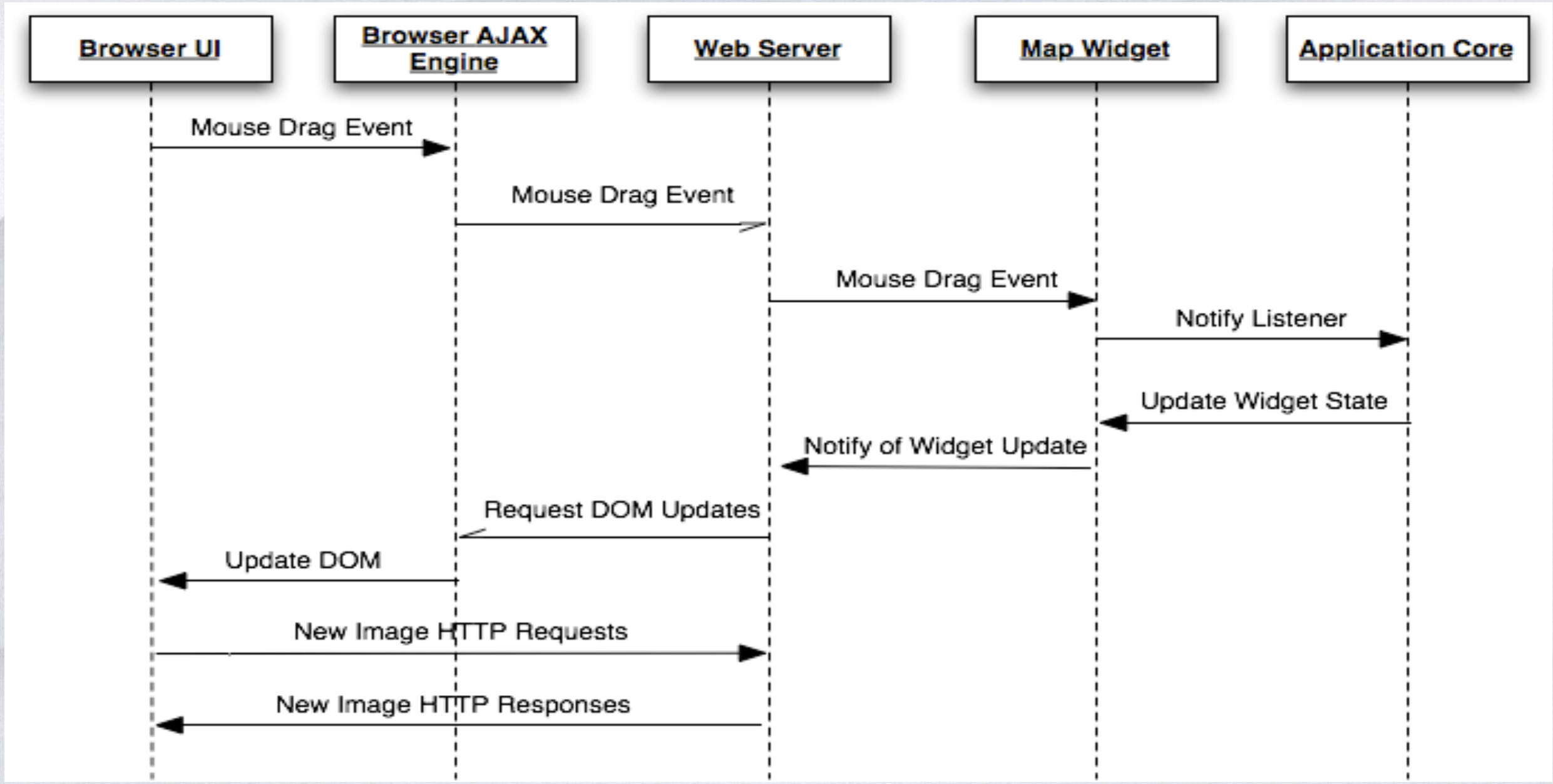
Massachusetts Ave
Amherst St
MIT
Memorial Dr
Harvard Bridge
Charles River
Storrow Dr
James J Storrow Memorial Dr
Back St
Beacon St
Back Bay East
Commonwealth Mall
Commonwealth Ave
Back Bay
Bay State Rd
Kenmore
Charlesgate W
Hynes Convention Center/ICA
Newbury St
Boylston St
Fairfield St
Exeter St
Copley
Massachusetts Turnpike (Toll road)
Lansdowne St
Prudential /
Copley

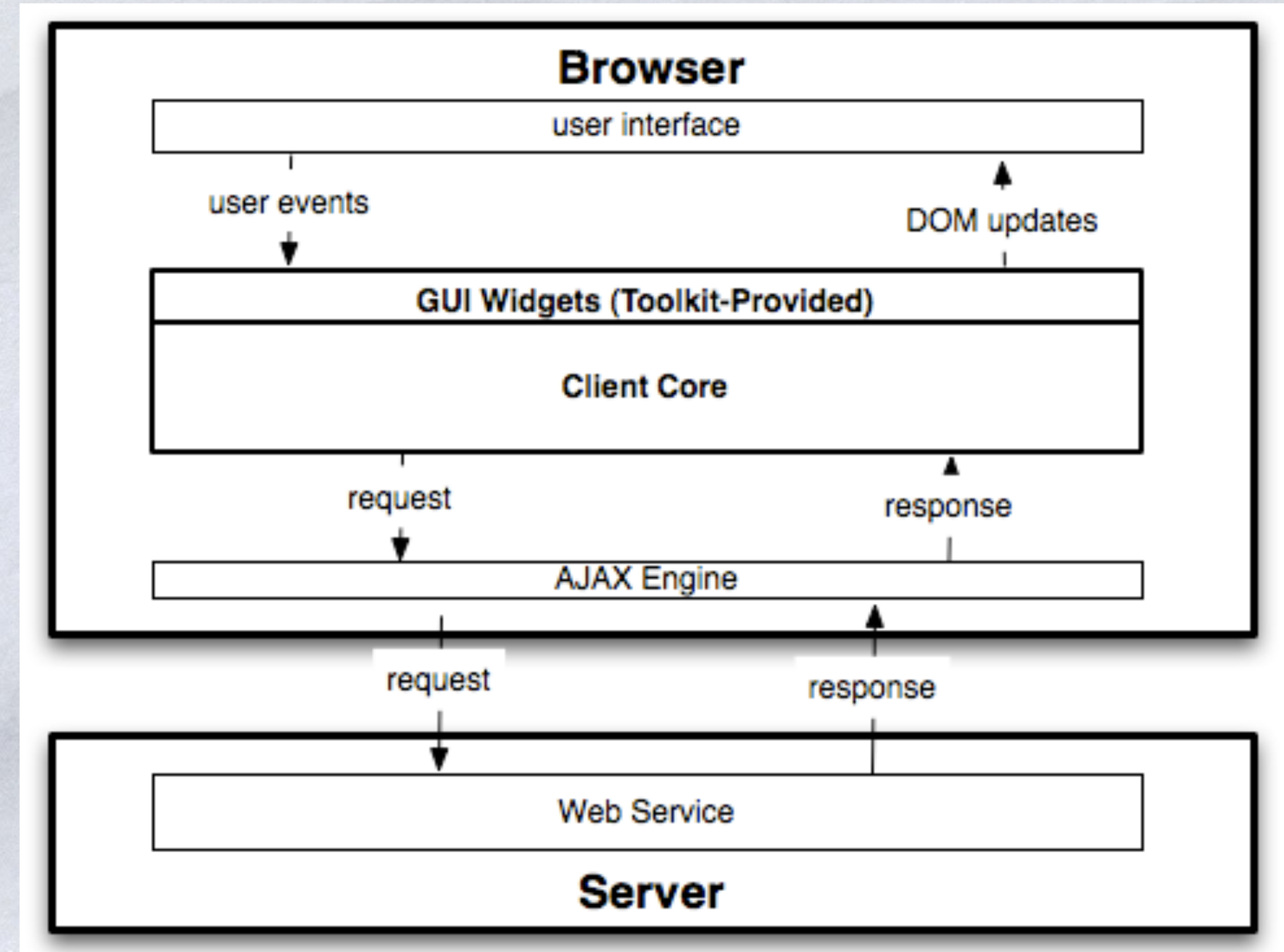
Sequence


Browser UI
Browser AJAX Engine
Web Server
Map Widget
Application Core
Mouse Drag Event
Mouse Drag Event
Mouse Drag Event
Notify Listener
Update Widget State
Notify of Widget Update
Request DOM Updates
Update DOM
New Image HTTP Requests
New Image HTTP Responses

Thin Client Pros and Cons

- + Simple programming: ignore the network
  - + All your code runs server-side
  - + Programmers love it!
- + Undo, behaviors, constraints: all possible!
- – Scalability (server-side state, lots of requests)
- – Slow feedback: network hop for each user action

Fat Client AJAX Approach



Example: Google Maps


OFFSCREEN
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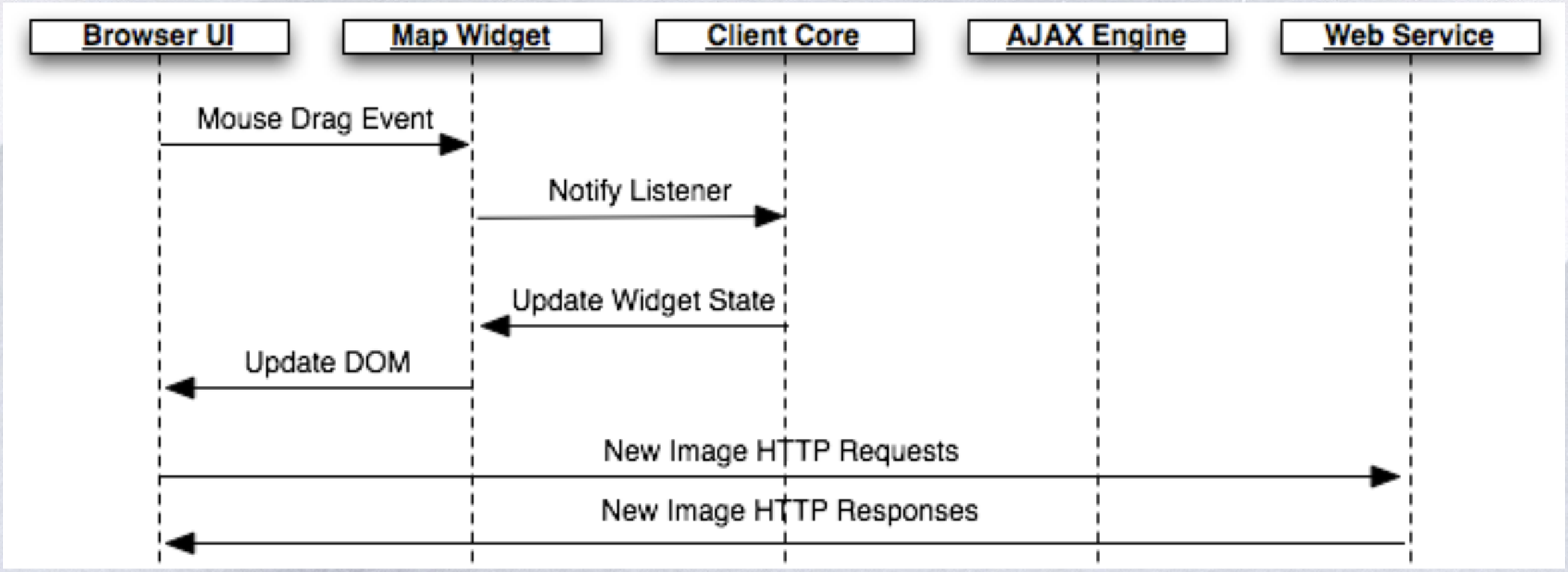
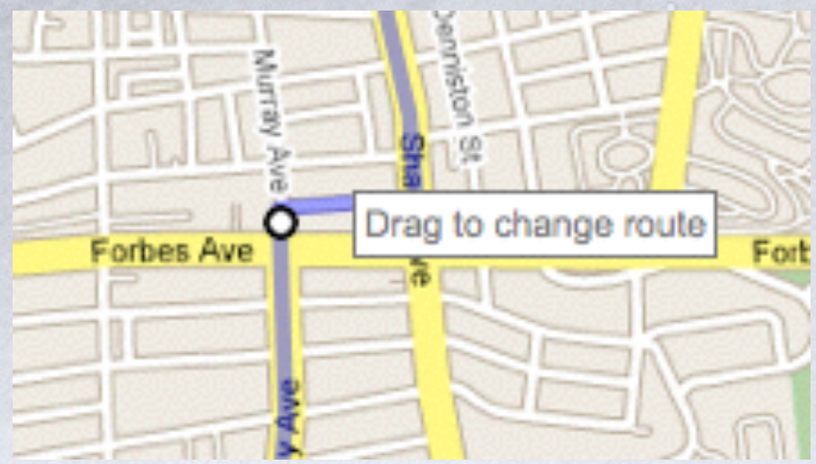
Massachusetts Ave
Amherst St
MIT
Memorial Dr
Harvard Bridge
Charles River
James J Storrow Memorial Dr
Storrow Dr
Back St
Beacon St
Back Bay
Back Bay East
Commonwealth Mall
Commonwealth Ave
Bay State Rd
Kenmore
Charlesgate W
Hynes Convention Center/ICA
Newbury St
Boylston St
Fairfield St
Exeter St
Copley
Massachusetts Turnpike (Toll road)
Lansdowne St
Prudential /
Copley

Sequence


Browser UI
Map Widget
Client Core
AJAX Engine
Web Service
Mouse Drag Event
Notify Listener
Update Widget State
Update DOM
New Image HTTP Requests
New Image HTTP Responses

Wait a second...

- No AJAX calls involved in moving the map around!
  - Mostly Javascript.
  - New image requests are synchronous
- Example AJAX call: adding an intermediate destination



Fat Client Pros and Cons

+Scalable (client-side state, fewer HTTP calls)

+Fast feedback

+Undo, behaviors, constraints possible...

–...but undo more complex than on the desktop

–More complicated: network-aware, distributed

Example AJAX Toolkits

- Google Web Toolkit: Fat Client
  - Write in Java, compiled to Javascript
- Cappuccino: Fat Client
- Echo2: Thin Client
  - Write in Java
  - No HTML/CSS (proprietary stylesheet language)
- Echo3 (Java – Beta): hybrid
  - Thin widgets in Java
  - Fat widgets in Javascript

So, is AJAX viable for RIAs?

	Fat AJAX	Thin AJAX	Plugin (Flash, Swing)
Feedback Speed	**Winner (tied)**		**Winner (tied)**
Interactive Potential			**Winner**
Scalability	**Winner (tied)**		**Winner (tied)**
Cross-platform Consistency			**Winner**
Momentum	Google does a lot of work for you.	?	Adobe does a lot of work for you.
Ease of Programming		**Winner**	

Thin vs Fat AJAX?

- Thin AJAX: Squeezed out
  - Insufficient if interactivity matters
  - Not as easy as an HTTP-oriented application
- Fat AJAX: How does it compare to plug ins?
  - Developer adoption?
  - Application philosophy?

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Components of AJAX

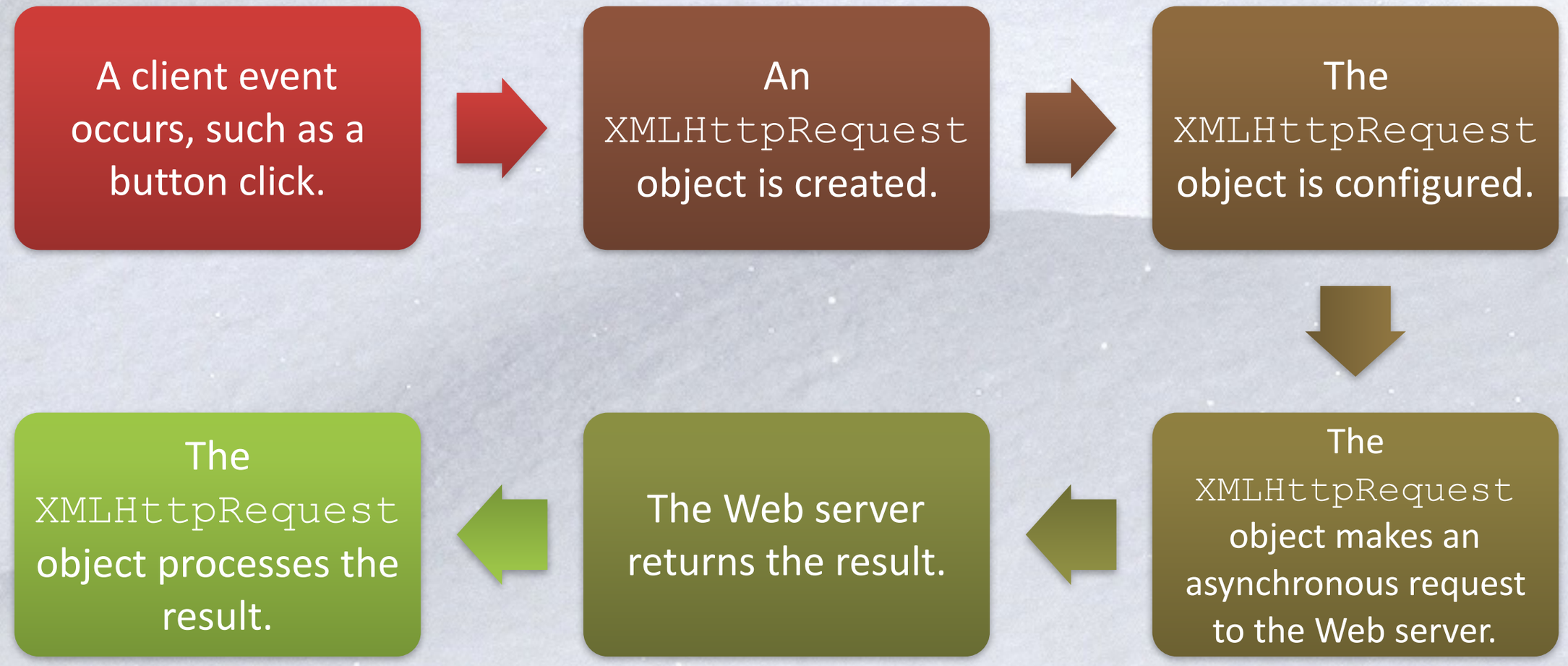
- The AJAX cannot work independently.
- It is used in combination with other technologies to create interactive Web pages that are described in the following list:
  - JavaScript:
    - Loosely typed scripting language.
    - JavaScript function is called when an event occurs in a page.
    - Glue for the whole AJAX operation.
  - DOM:
    - API for accessing and manipulating structured documents.
    - Represents the structure of XML and HTML documents.
  - CSS:
    - Allows for a clear separation of the presentation style from the content and may be changed programmatically by JavaScript.
  - XMLHttpRequest:
    - JavaScript object that performs asynchronous interaction with the server.

XMLHttpRequest Object

- The XMLHttpRequest object:
  - Is the most important component of AJAX.
  - Has been available ever since Internet Explorer 5.5 was released in July 2000.
  - Is an API that can be used by JavaScript, JScript, VBScript, and other Web browser scripting languages.
  - Is used to transfer and manipulate XML data to and from a Web server using HTTP.
  - Establishes an independent connection channel between a Web page's client-side and server-side.
  - Besides XML, XMLHttpRequest can be used to fetch data in other formats, such as JSON or even plain text.
  - Performs following operations:
    - Sends data from the client in the background.
    - Receives the data from the server.
    - Updates the webpage without reloading it.

XMLHttpRequest Object (Contd.)

- The following figure depicts the process cycle of AJAX Web application model:



XMLHttpRequest Object (Contd.)

- The following table describes the common properties of the `XMLHttpRequest` object.

Property	*Description*
`onReadyStateChange`	*Is called whenever readyState attribute changes. It must not be used with synchronous requests.*
`readyState`	*Represents the state of the request. It ranges from 0 to 4, as described in the following list:* • ***0**: UNOPENED, open() is not called.* • ***1**: OPENED, open is called but send() is not called.* • ***2**: HEADERS_RECEIVED, send() is called, and headers and status are available.* • ***3**: LOADING, downloading data; responseText holds the data.* • ***4**: DONE, the operation is completed fully.*
`reponseText`	*Returns response as text.*
`responseXML`	*Returns response as XML.*

XMLHttpRequest Object (Contd.)

- The following table describes the essential methods of the `XMLHttpRequest` object.

Method	*Description*
`void open(method, URL)`	*Opens the request specifying get or post method and URL of the requested Web page.*
`void open(method, URL, async)`	*same as above but specifies asynchronous or not.*
`void open(method, URL, async, username, password)`	*same as above but specifies username and password.*
`void send()`	*sends get request.*
`void send(string)`	*send post request.*
`setRequestHeader(header,value)`	*it adds request headers.*

XMLHttpRequest Object (Contd.)

- The following figure depicts the syntax of creating an `XMLHttpRequest` object for modern Web browsers:

```
Variable = new XMLHttpRequest();
```

- The following figure depicts the syntax of creating an `XMLHttpRequest` object for old versions of Microsoft IE, that is, IE5 and IE6:

```
Variable = new ActiveXObject("Microsoft.XMLHTTP");
```

XMLHttpRequest Object (Contd.)

- To handle all modern Web browsers, including Microsoft IE5 and IE6, you need to check whether the Web browser supports the `XMLHttpRequest` object.
- The following code depicts how to create an `XMLHttpRequest` object for all the modern Web browsers, including Microsoft IE5 and IE6:

```
var xmlhttp;
if (window.XMLHttpRequest)
  {
 //code for IE7+,Firefox,Chrome,Opera and Safari
  xmlhttp=new XMLHttpRequest();
  }
else
  {
  // code for IE6, IE5
  xmlhttp=new  ActiveXObject("Microsoft.XMLHTTP");
  }
```

XMLHttpRequest Object (Contd.)

- After creating an `XMLHttpRequest` object, you need to decide what you want to do after you receive the server response to your request.
- At this step, you need to define the JavaScript function, which will handle the server response.
- This can be done using the `onreadystatechange` property of the `XMLHttpRequest` object, as shown in the following code snippet:

```
xmlhttp.onreadystatechange = function(){
        //process the server response
};
```

XMLHttpRequest Object (Contd.)

- After setting the response function, you need to make the request.
- To make the request, you need to call the open()and send()methods of the XMLHttpRequest object, as shown in the following code snippet:

```
xmlhttp.open('GET','serverpage.php',true);
xmlhttp.send(null);
```

- The following list describes the parameter passed to open()method in the preceding code snippet:
  - The first parameter is the HTTP request method, such as GET, POST, and HEAD.
  - The second parameter is the URL of the Web page that you are requesting.
  - The third parameter, optional, sets whether the request is asynchronous.

XMLHttpRequest Object (Contd.)

- The following figure depicts some samples of using HTTP GET and POST request methods with AJAX:

```
//HTTP GET request without querystring
xmlhttp.open('GET','serverpage.php',true);
xmlhttp.send(null);

//HTTP GET request with querystring
xmlhttp.open('GET','serverpage.php?
username='+Math.random(),true);
xmlhttp.send(null);

//HTTP GET request without querystring
xmlhttp.open('GET','serverpage.php?
username=user1&pass=password",true);
xmlhttp.send(null);

//HTTP POST request
xmlhttp.open('POST','serverpage.php',true);
xmlhttp.send('username=user1&pass=password');
```

XMLHttpRequest Object (Contd.)

- To handle the server's response:
  - First, the response function needs to check the ready state of the request.
    - If the ready state has the value of 4, then you can proceed further.
  - Next, you need to check the response code of the HTTP server response.
- The following code snippet depicts how to handle the server's response:

```
xmlhttp.onreadystatechange = function(){
if (xmlhttp.readyState === 4) {
  // everything is good, the response is received
  if (xmlhttp.status === 200){ // process the response }
  else { // request encountered some problem,
         // for example, the response may contain a HTTP
            404 (Not Found) response code
       }
} else { // still not ready } };
```

Fetching Data using XMLHttpRequest Object (Contd.)

- The following code snippet depicts how to display response from Web server on a Web page:

AJAXExample.htm

```
<HTML>
<HEAD>
<SCRIPT language="JavaScript">
var xmlhttp = false;
if(window.XMLHttpRequest) {
xmlhttp = new XMLHttpRequest();
}
else {
xmlhttpp = new
ActiveXObject("Microsoft.XMLHTTP"
);
}

function getData(){
if(xmlhttp) {
var div =
document.getElementById("OutputDi
v");

xmlhttp.onreadystatechange =
function() {
if (xmlhttp.readyState == 4 &&
xmlhttp.status == 200) {
div.innerHTML =
xmlhttp.responseText;
}
else {
 alert ("Something went
wrong!!");
}}

xmlhttp.open("GET","SampleText.tx
t",true);
xmlhttp.send(null);
}}

</SCRIPT>
</HEAD>
<BODY>
<H1>Fetching response as text
from server with AJAX</H1>
<FORM NAME="form1">
<INPUT TYPE="button" Value="Fetch
Data" onClick='getData()'>
</FORM>
<DIV id="OutputDiv">
<P>The fetched data will be
displayed in this area.</P>
</DIV>
</BODY>
</HTML>
```

Fetching Data using XMLHttpRequest Object (Contd.)

- The following figures depict the output of the preceding code.

Fetching Data using XMLHttpRequest Object (Contd.)

- To display XML data from the server response, you need to make the following changes:

AJAXExample.htm

```
. . . . . .
xmlhttp.onreadystatechange = function()
{
if (xmlhttp.readyState == 4 &&
xmlhttp.status == 200) {
var xmldoc = xmlhttp.responseXML; var
root_node =
xmldoc.getElementsByTagName('root').item
(0);
div.innerHTML =
root_node.firstChild.data;
}
else {
 alert ("Something went wrong!!");
}}
xmlhttp.open("GET","TestFile.xml",
true);
xmlhttp.send(null);
}}
. . . . . .
```

TestFile.xml

```
<?xml version="1.0" ?>
<root>
    This is a test XML file.
</root>
```

Outline

- Rich Internet Applications (RIAs)
- Ajax
- XMLHttpRequest
- Ajax in Prototype
- Limits of Ajax
- Debugging Ajax

Prototype's Ajax model

- construct a Prototype Ajax.Request object to request a page from a server using Ajax
- constructor accepts 2 parameters:
  - the URL to fetch, as a String,
  - a set of options, as an array of key : value pairs in {} braces (an anonymous JS object)
- hides icky details from the raw XMLHttpRequest; works well in all browsers

```
new Ajax.Request("url",
   {
      option : value,
      option : value,
      ...
      option : value
   }
);
```
JS

Prototype Ajax methods and properties

option	description
method	how to fetch the request from the server (default "post")
parameters	query parameters to pass to the server, if any
asynchronous (default true), contentType, encoding, requestHeaders	

- options that can be passed to the Ajax.Request constructor

event	description
onSuccess	request completed successfully
onFailure	request was unsuccessful
onException	request has a syntax error, security error, etc.
onCreate, onComplete, on### (for HTTP error code ###)	

- events in the Ajax.Request object that you can handle

Basic Prototype Ajax template

- attach a handler to the request's onSuccess event
- the handler takes an Ajax response object, which we'll name ajax, as a parameter

```
new Ajax.Request("url",
   {
      method: "get",
      onSuccess: functionName
   }
);
...

function functionName(ajax) {
   do something with ajax.responseText;
}
```
JS

The Ajax response object

- most commonly property is responseText, to access the fetched page

property	description
status	the request's HTTP error code (200 = OK, etc.)
statusText	HTTP error code text
responseText	the entire text of the fetched page, as a String
responseXML	the entire contents of the fetched page, as an XML DOM tree (seen later)

```
function handleRequest(ajax) {
  alert(ajax.responseText);
}
```
JS

Prototype's Ajax Updater

- Ajax.Updater fetches a file and injects its content into an element as innerHTML
- additional (1st) parameter specifies the id of element to inject into
- onSuccess handler not needed (but onFailure, onException handlers may still be useful)

```JS
new Ajax.Updater(
   "id",
   "url",
   {
     method: "get"
   }
);
```

Creating a POST request

- Ajax.Request can also be used to post data to a web server
- method should be changed to "post" (or omitted; post is default)
- any query parameters should be passed as a parameters parameter
  - written between { } braces as a set of name : value pairs (another anonymous object)
  - get request parameters can also be passed this way, if you like

```
new Ajax.Request("url",
   {
     method: "post",    // optional
     parameters: { name: value, name: value, ..., name: value },
     onSuccess: functionName,
     onFailure: functionName,
     onException: functionName
   }
);
```
JS

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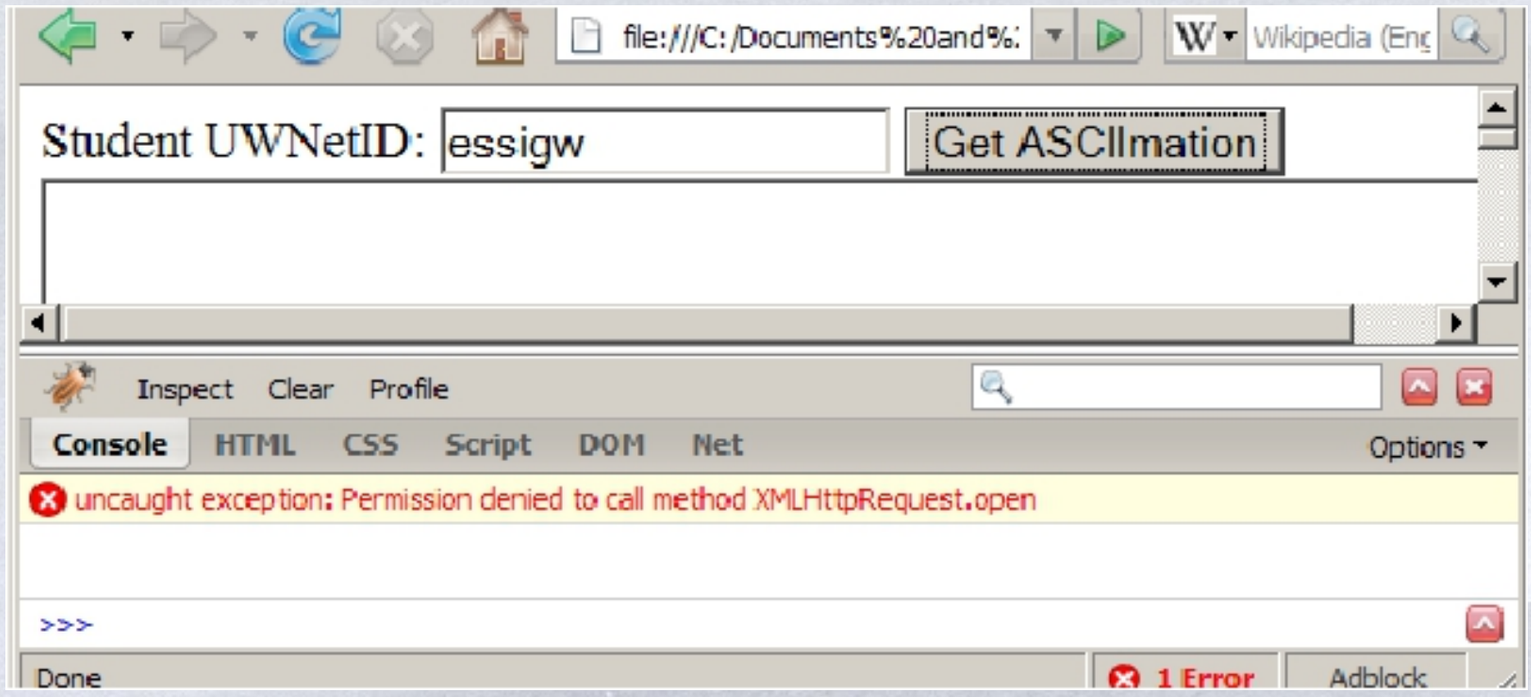
Ajax Risk References

- Bookmarking Issues
- Back and Forward Button Problems
- Security Risks
- Search Engines

XMLHttpRequest security restrictions

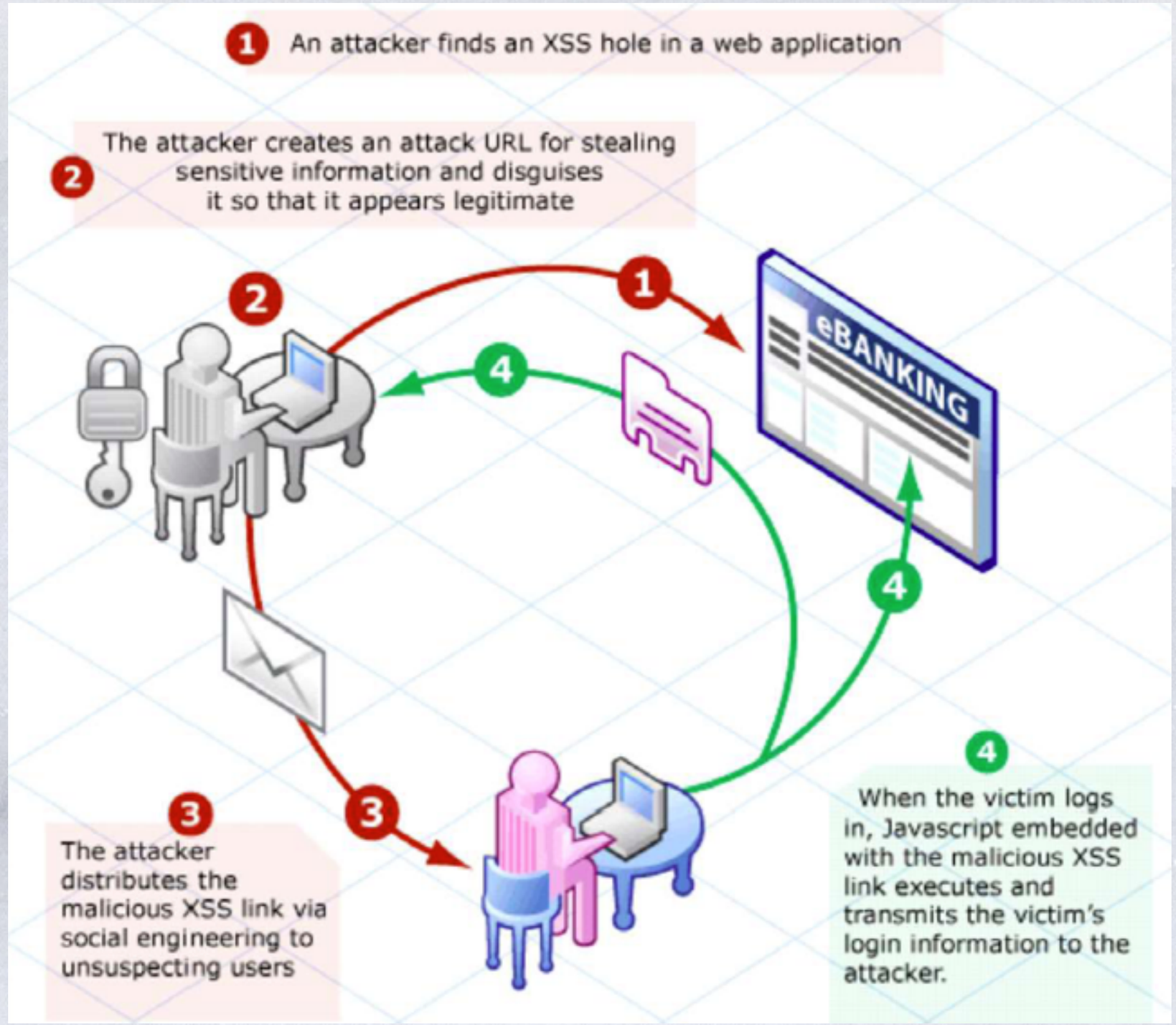


- cannot be run from a web page stored on your hard drive
- can only be run on a web page stored on a web server

What is XSS?

- XSS is a vulnerability that allows an attacker to run arbitrary JavaScript in the context of the vulnerable website.
- XSS bypasses same-origin policy protection
  - “The policy permits scripts running on pages originating from the same site to access each other's methods and properties with no specific restrictions, but prevents access to most methods and properties across pages on different sites.“
  - “The term ‘origin’ is defined using the domain name, application layer protocol, and (in most browsers) TCP port”
  - http://en.wikipedia.org/wiki/Same_origin_policy
- Requires some sort of social engineering to exploit.

Reflected XSS



Reflected XSS Example

- Exploit URL:
  - http://www.nikebiz.com/search/?q=<script>alert('XSS')</script>&x=0&y=0
- HTML returned to victim:
  - <h2>Search Results
 Search: "<script>alert('XSS')</script>"</h2>

Stored XSS

- JavaScript supplied by the attacker is stored by the website (e.g. in a database)
- Doesn't require the victim to supply the JavaScript somehow, just visit the exploited web page
- More dangerous than Reflected XSS
  - Has resulted in many XSS worms on high profile sites like MySpace and Twitter (discussed later)

DOM Based XSS

- Example page
  - <HTML><TITLE>Welcome!</TITLE>
    Hi <SCRIPT>
    var pos = document.URL.indexOf("name=") + 5;
    document.write(document.URL.substring(pos,document.URL.length));
    </SCRIPT>
    </HTML>
- Works fine with this URL
  - http://www.example.com/welcome.html?name=Joe
- But what about this one?
  - http://www.example.com/welcome.html?name=
    <script>alert(document.cookie)</script>

- Source: http://en.wikipedia.org/wiki/Cross-site_scripting
- Source: http://www.owasp.org/index.php/DOM_Based_XSS
- http://www.wooyun.org/bugs/wooyun-2013-021587

2006 Example Vulnerability

- Attackers contacted users via email and fooled them into accessing a particular URL hosted on the legitimate PayPal website.
- Injected code redirected PayPal visitors to a page warning users their accounts had been compromised.
- Victims were then redirected to a phishing site and prompted to enter sensitive financial data.

Source: http://www.acunetix.com/news/paypal.htm

Same Origin Policy

- The Same Origin Policy (SOP) limits browsers only fetching content from the same origin site.
  - except resources: images, scripts, videos, etc.
- The Same Origin Policy (SOP) essentially mandates that Ajax requests cannot access another fully qualified domain than the page from which they're running.
  - even the same domain on another port!
- SOP is all about XSS (cross site script)

AJAX Security - Server Side

- AJAX-based Web applications use the same server-side security schemes of regular Web applications.
- You specify authentication, authorization, and data protection requirements in your web.xml file (declarative) or in your program (programmatic).
- AJAX-based Web applications are subject to the same security threats as regular Web applications.

AJAX Security - Server Side

- CSRF –> Cross – Site Request Forgery
- ATTACKS
  - See what he/she searched for
  - Read emails
  - Steal credit card details through PayPal
- DEFENSE
  - Use authentication tokens

AJAX Security - Client Side

- Hacker can use JavaScript code for inferring server-side weaknesses.
- JavaScript code is downloaded from the server and executed at the client and can compromise the client by mal-intended code.

AJAX Security - Client Side

- Defense
  - NoScript – Accept scripts only from sites you trust
  - AltCookies – Accept cookies only from sites you trust
  - Firebug – Dig deeply into HTML/JAVASCRIPT/CSS AND HTTP

Two-request limit

- The HTTP 1.1 (RFC 2616) recommends that a single-user client SHOULD NOT maintain more than 2 connections with any server or proxy.
- Most browsers (including IE) abide by this rule

prototypejs.org	prototypejs.org	2 KB	17ms
home.css	prototypejs.org	2 KB	159ms
prototype.js	prototypejs.org	18 KB	112ms
code_highlighter.j	prototypejs.org	3 KB	52ms
javascript.js	prototypejs.org	422 b	10ms
html.js	prototypejs.org	279 b	9ms
css.js	prototypejs.org	267 b	6ms
ruby.js	prototypejs.org	316 b	7ms
ebnf.js	prototypejs.org	146 b	4ms
urchin.js	google-analytics.com	6 KB	45ms
__utm.gif	google-analytics.com	35 b	140ms
hdrtile-home.gif	prototypejs.org	3 KB	138ms
codesample1.gif	prototypejs.org	6 KB	348ms
tagline-home.gif	prototypejs.org	8 KB	346ms
14 requests		45 KB	743ms

Outline

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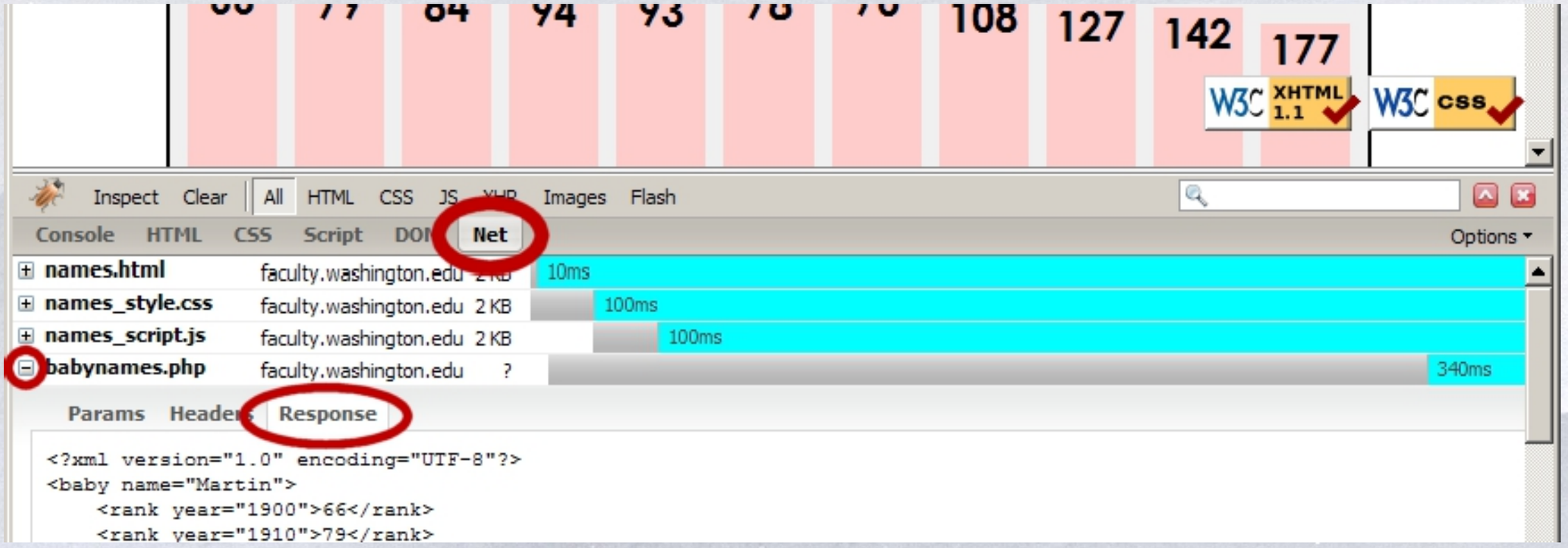
- Tips

Handling Ajax errors

```
new Ajax.Request("url",
   {
     method: "get",
     onSuccess: functionName,
     onFailure: ajaxFailure,
     onException: ajaxFailure
   }
);
  ...
function ajaxFailure(ajax, exception) {
  alert("Error making Ajax request:" +
        "\n\nServer status:\n" + ajax.status + " " + ajax.statusText +
        "\n\nServer response text:\n" + ajax.responseText);
  if (exception) {
    throw exception;
  }
}
```
JS

- for user's (and developer's) benefit, show an error message if a request fails

Debugging Ajax code



- Net tab shows each request, its parameters, response, any errors
- expand a request with + and look at Response tab to see Ajax result

Ajax Optimization

- The way to optimize any Ajax application is to find the best method to optimize every element that may go into it. It is important that the application run as quickly and efficiently as possible.

Communication

- An Ajax application is fast when there is no huge delay in receiving new data from the server. Optimizing two areas will help your application succeed here.
  - The first is to compress all data sent to the client from the server. This is important in terms of quick data transport.
  - The second concerns the data itself. The data that is sent back and forth, both from the client and from the server, should be optimized as much as possible as well.

Data

- When sending data to the server, send what would be considered the minimum amount of information. If you are sending key/value pairs, keep both the key and the value small. Enumerate choices whenever possible. Instead of something like this:
  - user_choice=add_data_to_database&data1=value1&data2=value2
- consider letting each choice be set to a single value, and send that value instead:
  - c=3&d1=value1&d2=value2
- Smaller data makes it harder for intercepted information to be interpreted (a good security benefit) and keeps the size of the data that needs to be sent and parsed smaller.

Code Optimization

- The other important part of Ajax optimization is to optimize the JavaScript code that is executed on the client, and to create the fastest data retrieval that you can.
  - inline SQL queries
  - stored procedures
- On the client, a number of JavaScript techniques will help to increase the execution time of your code. This is especially important when it comes to the DOM manipulation that your code may need to do when the server receives an Ajax response.
- Nothing says that your Ajax application will not run smoothly and efficiently without any optimization. In most cases, the speed of Ethernet connections, the processing power of computers, and the better implementation of JavaScript in browsers will ensure that your applications run well. Optimization will give you an application that runs that much faster. For the user, faster is always better.

Best Practices for AJAX Implementations

- Understand What it All Means
  - WikiPedia
  - MDC on AJAX
  - DevX
- Check for Appropriate Usage Scenarios
- Learn to Implement it With Raw Code

Use a Library

- Libraries not only provide an exhaustive feature set you can make use of but also makes sure your code is compatible with all browsers without you having to do anything extra.
  - jQuery
  - Dojo
  - MooTools
  - Prototype
  - Yahoo Ui Library
  - Google Web Toolkit
- Master the Library

Know the Limitations of Your Ajax Library

- All JavaScript libraries give you access to an Ajax object, which normalizes the differences between browsers and gives you a consistent interface. However, in giving you a unified interface, these libraries must also simplify the interface, because not every browser implements each feature. This prevents you from accessing the full power of XMLHttpRequest.

- Interacting directly with the XHR object also reduces the amount of function overhead, further improving performance. Just beware that by forgoing the use of an Ajax library, you may encounter some problems with older and more obscure browsers.

Utilize Proper Events and Callback Functions

- Make proper use of these events and their respective callbacks to manipulate the UI for a better user experience.

```
$.ajax({
      //Other code
        success: function(msg)
      {
        // Update the UI here to reflect that the request was successful.
        doSomethingClever();
      },
      error: function(msg)
      {
        // Update the UI here to reflect that the request was unsuccessful
        doSomethingMoreClever();
      },
      complete: function(msg)
      {
        // Update the UI here to reflect completion
        doSomethingEvenMoreClever();
      }
});
```

Choose the Right Format for the Job

- When considering data transmission techniques, you must take into account several factors: feature set, compatibility, performance, and direction (to or from the server).
- When considering data formats, the only scale you need for comparison is speed.
- There isn't one data format that will always be better than the others. Depending on what data is being transferred and its intended use on the page, one might be faster to download, while another might be faster to parse.

Data Formats - XML

- XML
  - ✓ extreme interoperability (with excellent support on both the server side and the client side)
  - ✓ strict formatting
  - ✓ easy validation
  - - extremely verbose. Each discrete piece of data requires a lot of structure, and the ratio of data to structure is extremely low.
  - - XML also has a slightly ambiguous syntax.
  - - Parsing this syntax is equally ambiguous,

- XML has no place in high-performance Ajax

JSON

- Formalized and popularized by Douglas Crockford, JSON is a lightweight and easy-to-parse data format written using JavaScript object and array literal syntax.

Verbose JSON :

```
[
{ "id": 1, "username": "alice", "realname": "Alice Smith",
"email": "alice@alicesmith.com" },...]
```

Simple JSON

```
[
{ "i": 1, "u": "alice", "r": "Alice Smith", "e":
"alice@alicesmith.com" }, ......]
```

Array JSON

```
[
[ 1, "alice", "Alice Smith", "alice@alicesmith.com" ], ......]
```

JSON-P

- JSON with padding
  - when dynamic script tag insertion is used, JSON data is treated as just another JavaScript file and executed as native code. In order to accomplish this, the data must be wrapped in a callback function.
- Since the data is treated as native JavaScript, it is parsed at native JavaScript speeds.
- There is one reason to avoid using JSON-P that has nothing to do with performance: since JSON-P must be executable JavaScript, it can be called by anyone and included in any website using dynamic script tag insertion.
- Do not encode any sensitive data in JSON-P, because you cannot ensure that it will remain private, even with random URLs or cookies.

HTML

- HTML, as a data format, is slow and bloated.

Custom Formatting

- This type of format is extremely terse and offers a very high data-to-structure ratio (significantly higher than any other format, excluding plain text)
- one of the most important decisions is what to use as the separators.

```
1:alice:Alice Smith:alice@alicesmith.com;
2:bob:Bob Jones:bob@bobjones.com;
```

Data Format Conclusions

- Favor lightweight formats in general; the best are JSON and a character-delimited custom format. If the data set is large and parse time becomes an issue, use one of these two techniques:
  - JSON-P data, fetched using dynamic script tag insertion. This treats the data as executable JavaScript, not a string, and allows for extremely fast parsing. This can be used across domains, but shouldn't be used with sensitive data.
  - A character-delimited custom format, fetched using either XHR or dynamic script tag insertion and parsed using split(). This technique parses extremely large da- tasets slightly faster than the JSON-P technique, and generally has a smaller file size.

Cache Data

- The fastest Ajax request is one that you don't have to make. There are two main ways of preventing an unnecessary request:
  - On the server side, set HTTP headers that ensure your response will be cached in the browser.
  - On the client side, store fetched data locally so that it doesn't have be requested again.

References

- Ajax: The Definitive Guide.Anthony T. Holdener III. O'Reilly Media.
- Wiki – Rich Internet Application
  - http://en.wikipedia.org/wiki/Rich_Internet_application

Thanks!!!