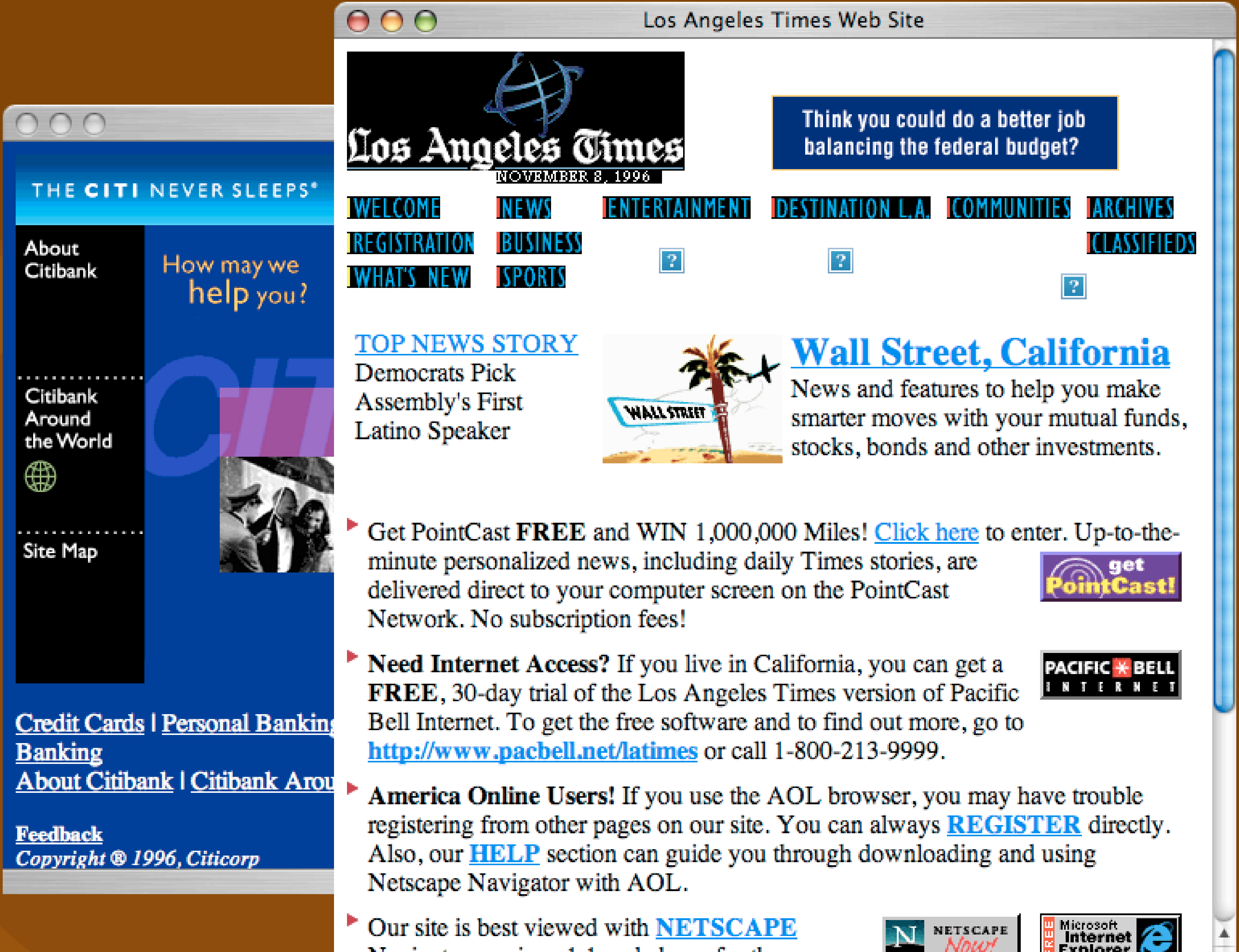
A Unified Security Model for Web Applications

Richard S. Cox, Steven D. Gribble,
Henry M. Levy



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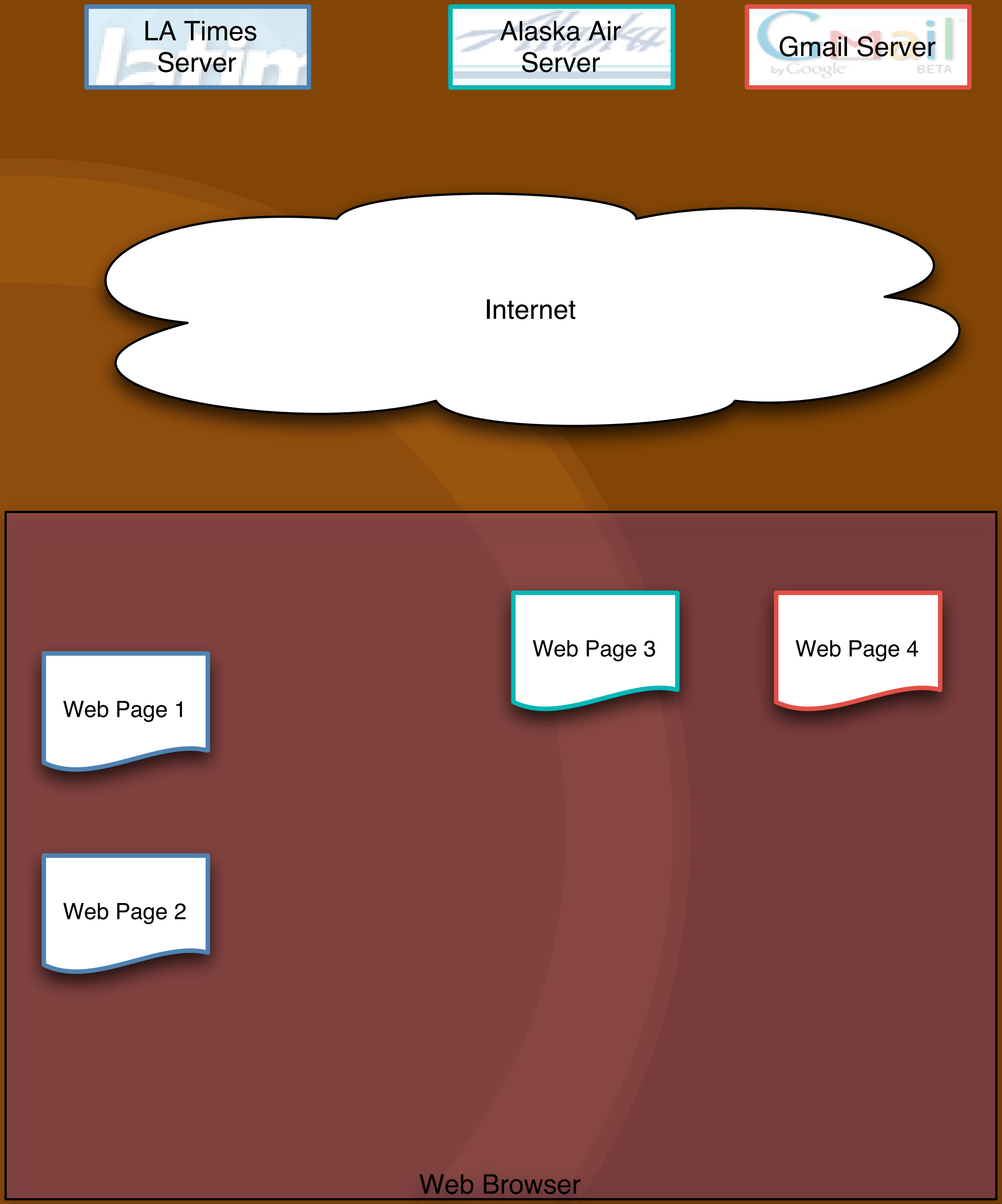
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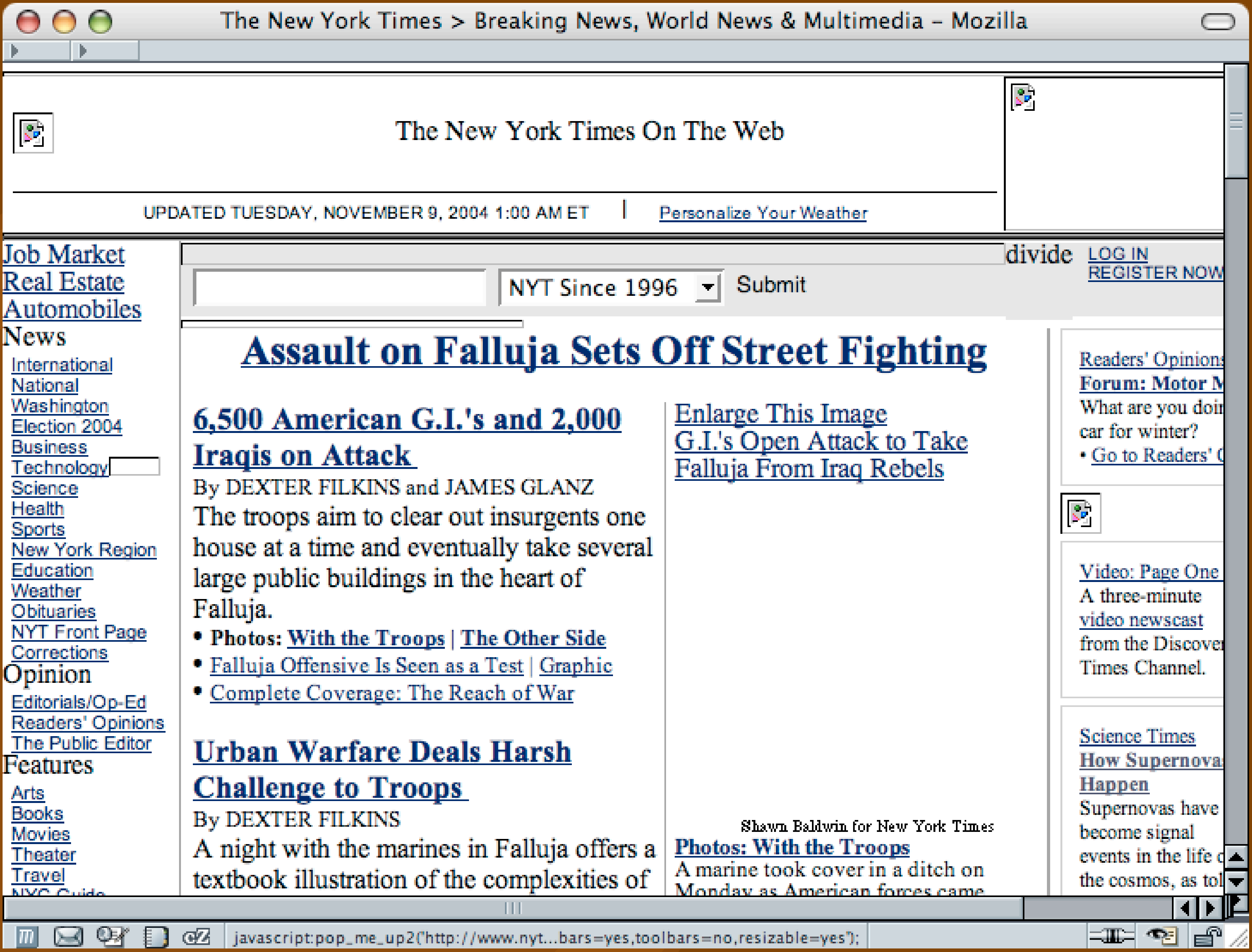

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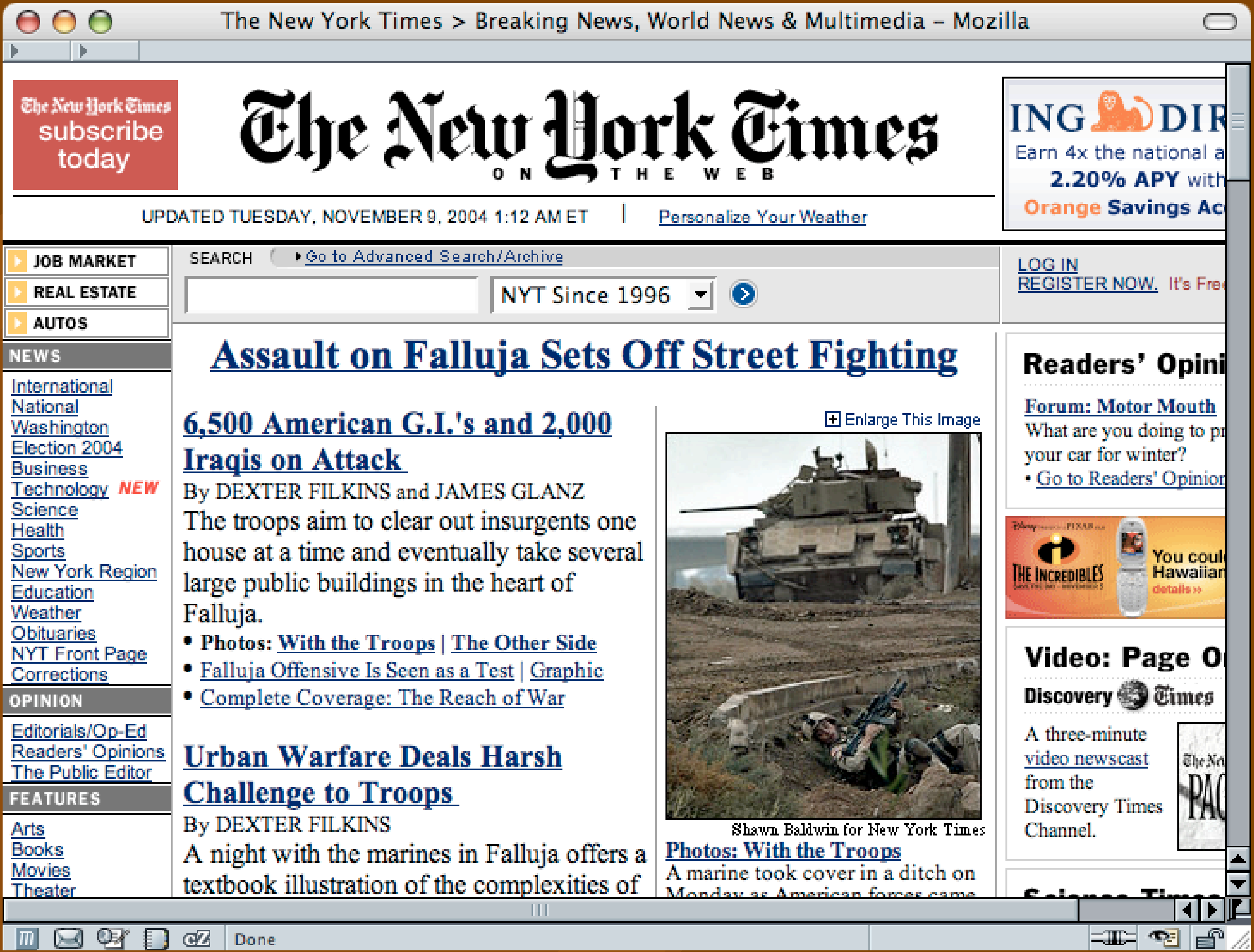

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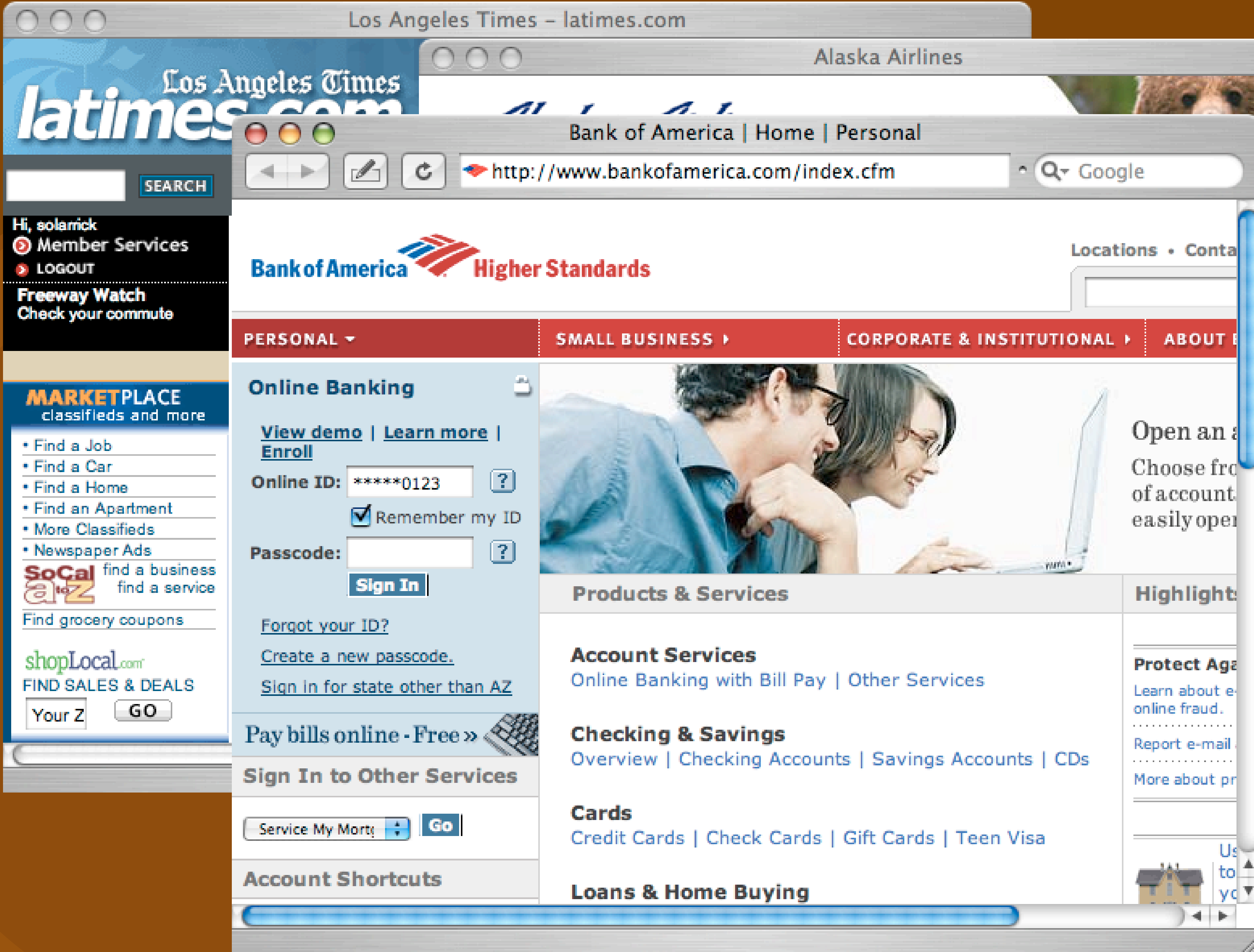

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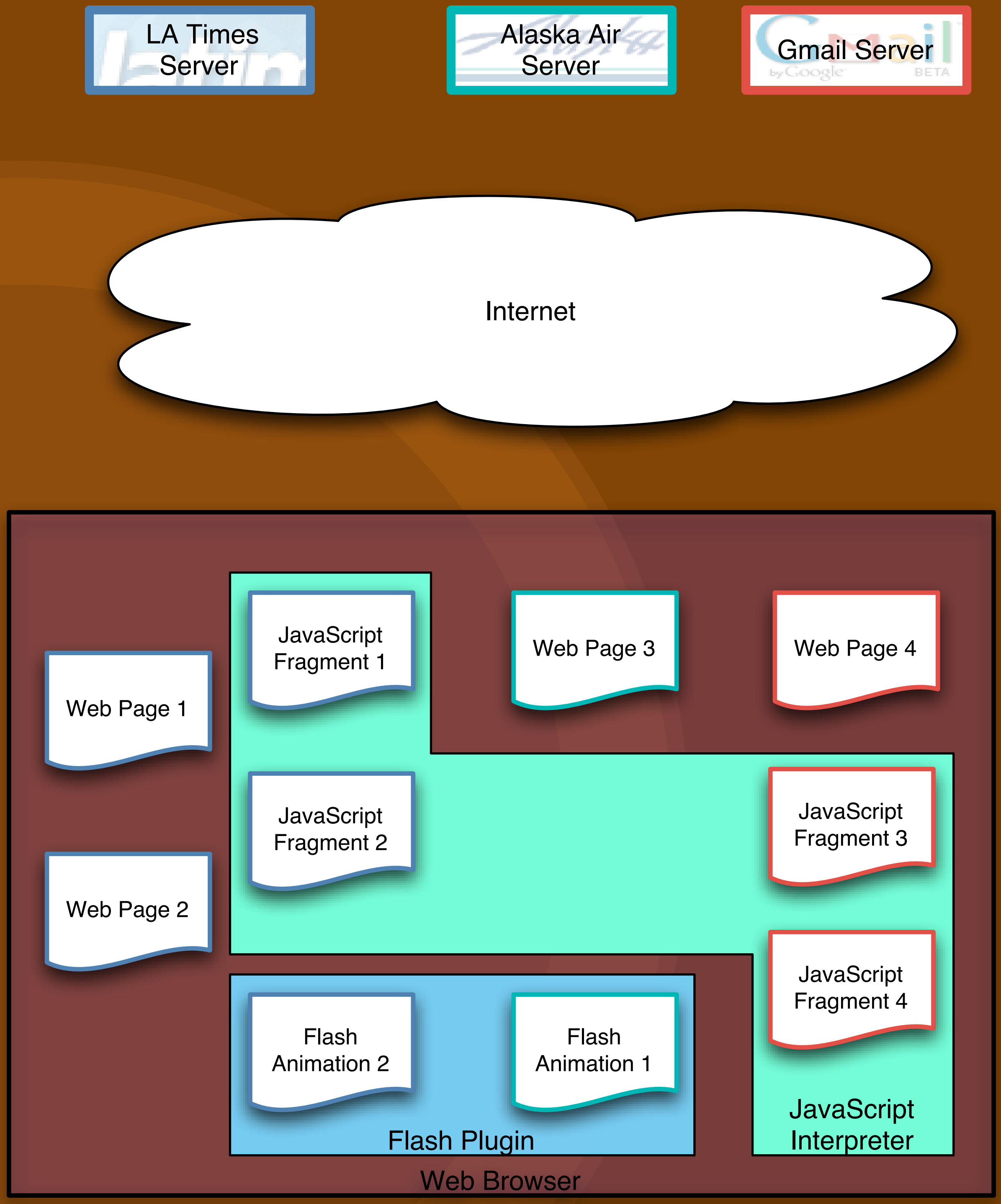
- 90+ HTTP connections
- 40+ pieces of code
  - JavaScript, VisualBasic, Flash
  - From 5 different servers
- 11 images from external sites
- 3 forms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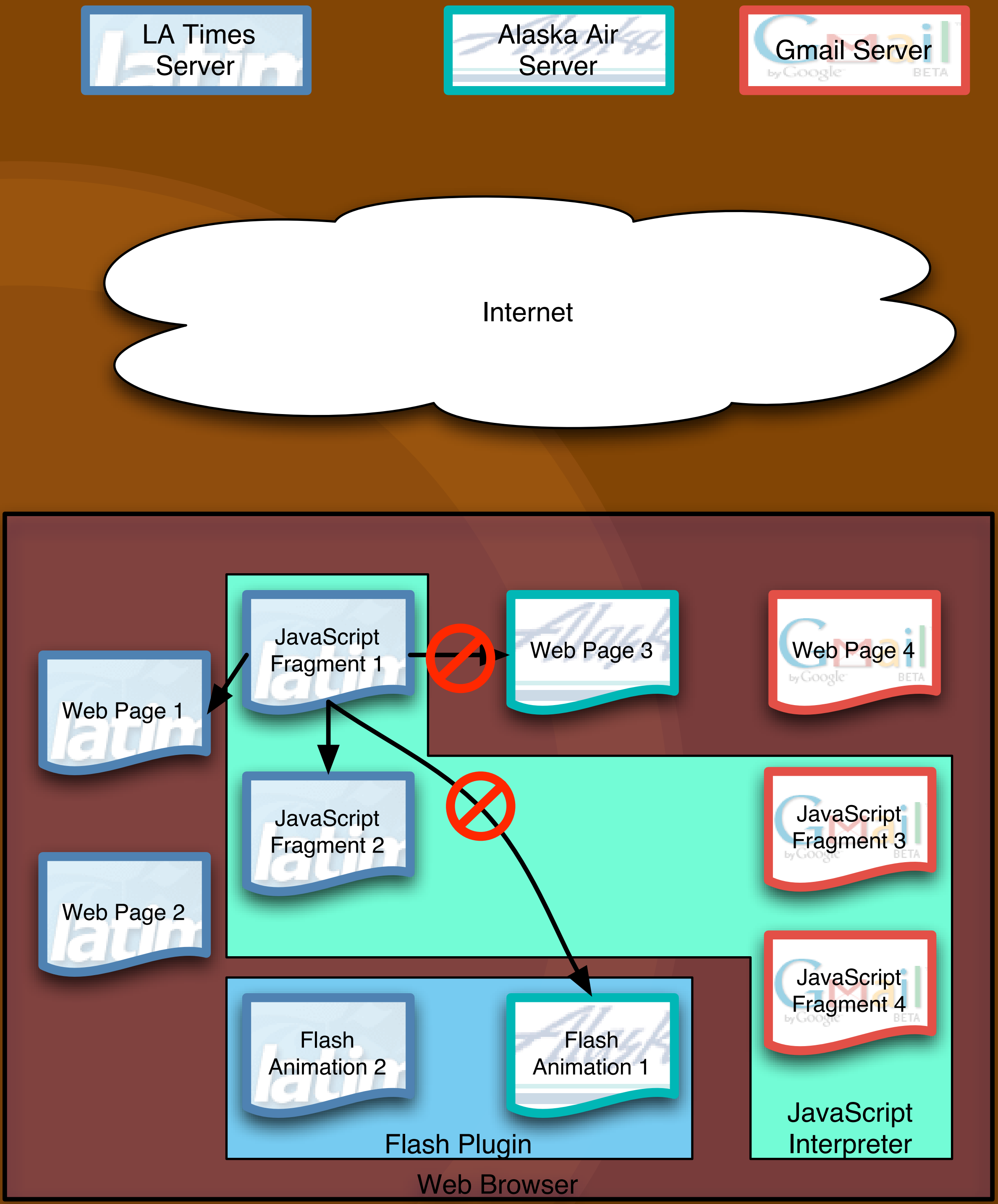
Internet
Web Page 1
Web Page 2
JavaScript Fragment 1
JavaScript Fragment 2
Web Page 3
Web Page 4
JavaScript Fragment 3
JavaScript Fragment 4
Flash Animation 2
Flash Animation 1
Flash Plugin
JavaScript Interpreter
Web Browser

Same Origin Policy

- Each object labeled with domain that sent it
- Allow access if domains are equal
- Used by JavaScript, Flash, ActiveX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JavaScript Fragment 2
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Web Page 2
JavaScript Fragment 4
Flash Animation 2
Flash Animation 1
Flash Plugin
JavaScript Interpreter
Web Browser

Browser = OS

- Provides
  - Abstractions/APIs
  - Resource Allocation
  - Isolation
- Sites do not directly interact with host OS (mostly)

Outline

- Web Evolution
- Problem 1: Implementation Bugs
- Problem 2: User Interface
- Applications, not Documents
- Conclusions

Implementation Bugs

Threat Model

- Attacker can send any content to browser (e.g. in email)
- Browser has bugs
- Attacker cannot modify base browser

Attacker Goals

- Compromise host OS
- Steal data from external sites
  - User-input, displayed content, cookies, cache, etc.
- Spoof

Attacker Goals

- Modify external sites
  - Insert advertising (AdWare)
  - Just to mislead user

Vulnerabilities

- Of 55 Mozilla security bugs:
- Code Injection: 14
  - Buffer overflows: 10
- Sharing Policy/Mechanism: 36
- User Interface: 3
- Other: 2

User Interface

Controlling Apps

- Users cannot manage the web sites
  - Closing a window != Quit
  - Can't delete only one app
- No accounting
  - Who is playing that MIDI?

End-to-End Security

- Last link is from screen to user
- Need to secure that link too
- Users do not reason well about security today

SSL is per-document

- How do I know if hfs.washington.edu is affiliated with www.onlinecardoffice.com?
- SSL only tells me that each of them is who they claim to be

Apps, not Docs

Why?

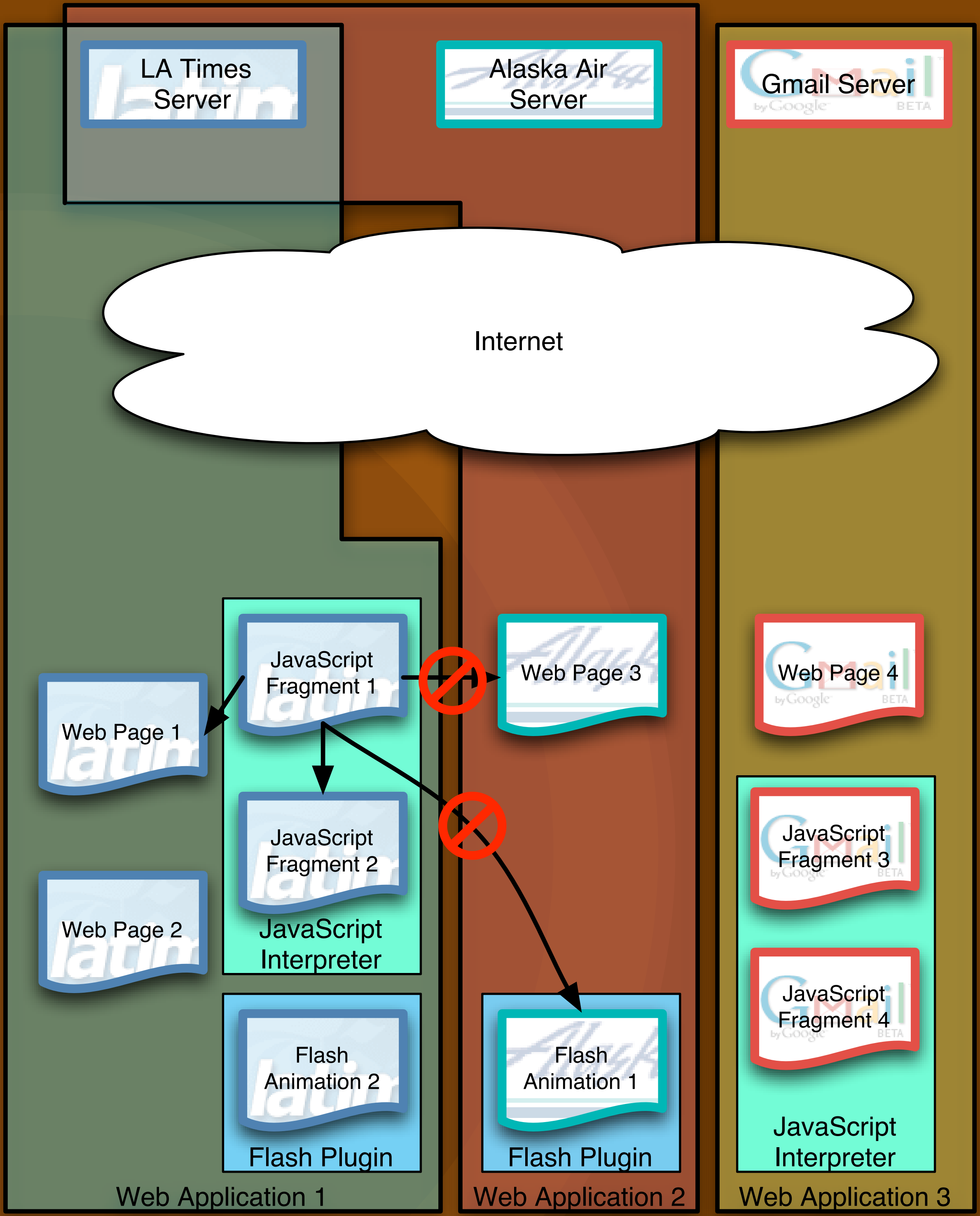
- Treat web sites as applications, not collections of documents
- Inter-document interfaces are complex
- Inter-application interfaces are very narrow

What is a Web App?

- Collection of
  - Servers speaking HTTP(S)
  - HTML, image, movie, sound documents
  - JavaScript, Flash, Java, ActiveX client-side code
  - Client-side state (cookies)

What is a Web App?

- All cooperating to implement a single service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Flash Animation 2
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Flash Plugin
Web Application 1
Web Application 2
Web Application 3

Application Interface

- Draw in window
- File access (rare)
- Print
- Play sound
- Make network connections
  - What to do about SSL?

App Manifests

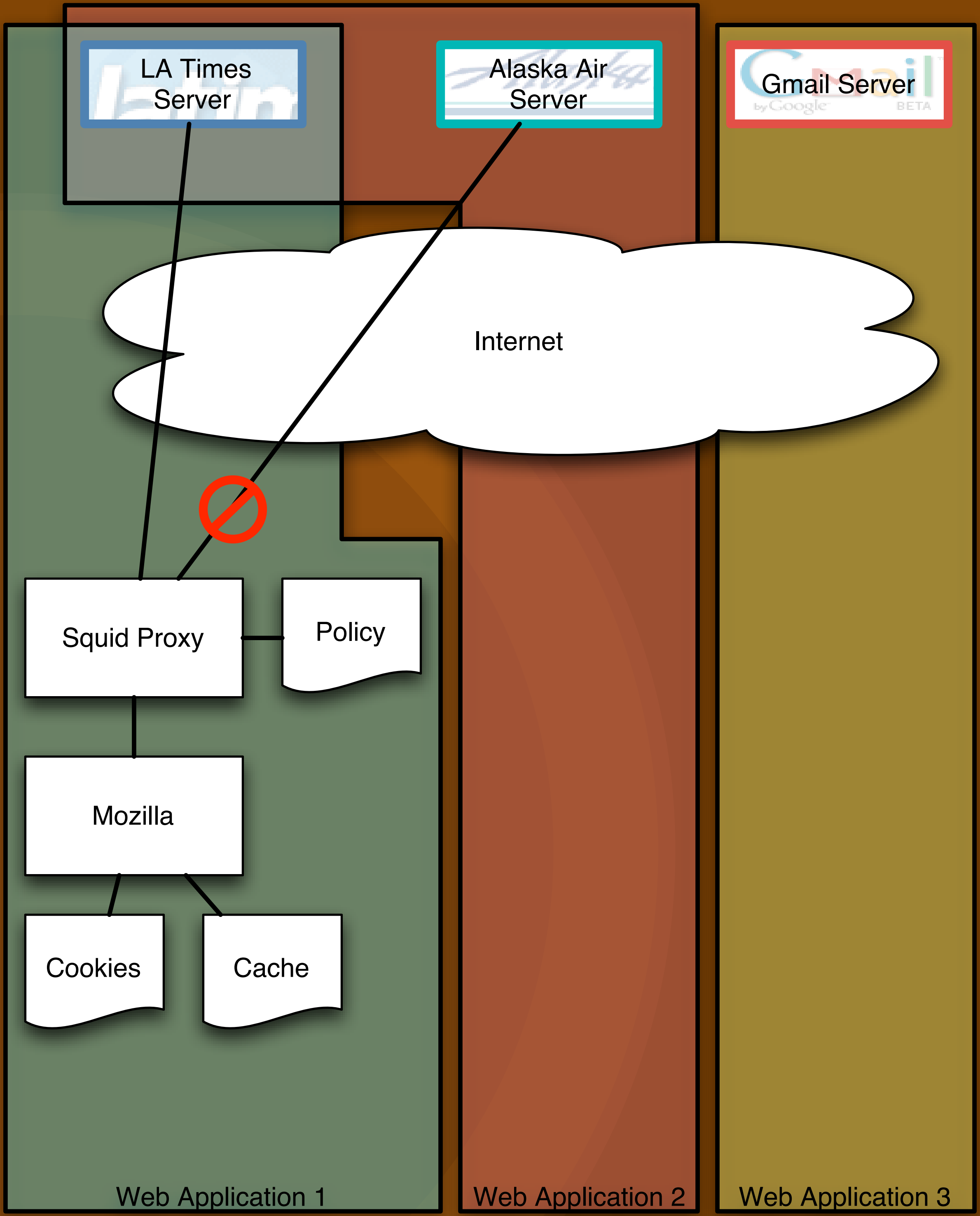
- Problem: What goes in each box?
- Web applications defined by a manifest file
- One* manifest per application
- Provided by server

App Manifests

- Defines the content that is part of application
  - By hostname, certificate, hash
- Defines network resources app expected to use
- Digitally signed

Current Prototype

- Use a full Mozilla per app
  - Private cookies, cache, prefs, bookmarks
- Squid proxy enforces policy
- Isolated in UNIX processes


LA Times Server
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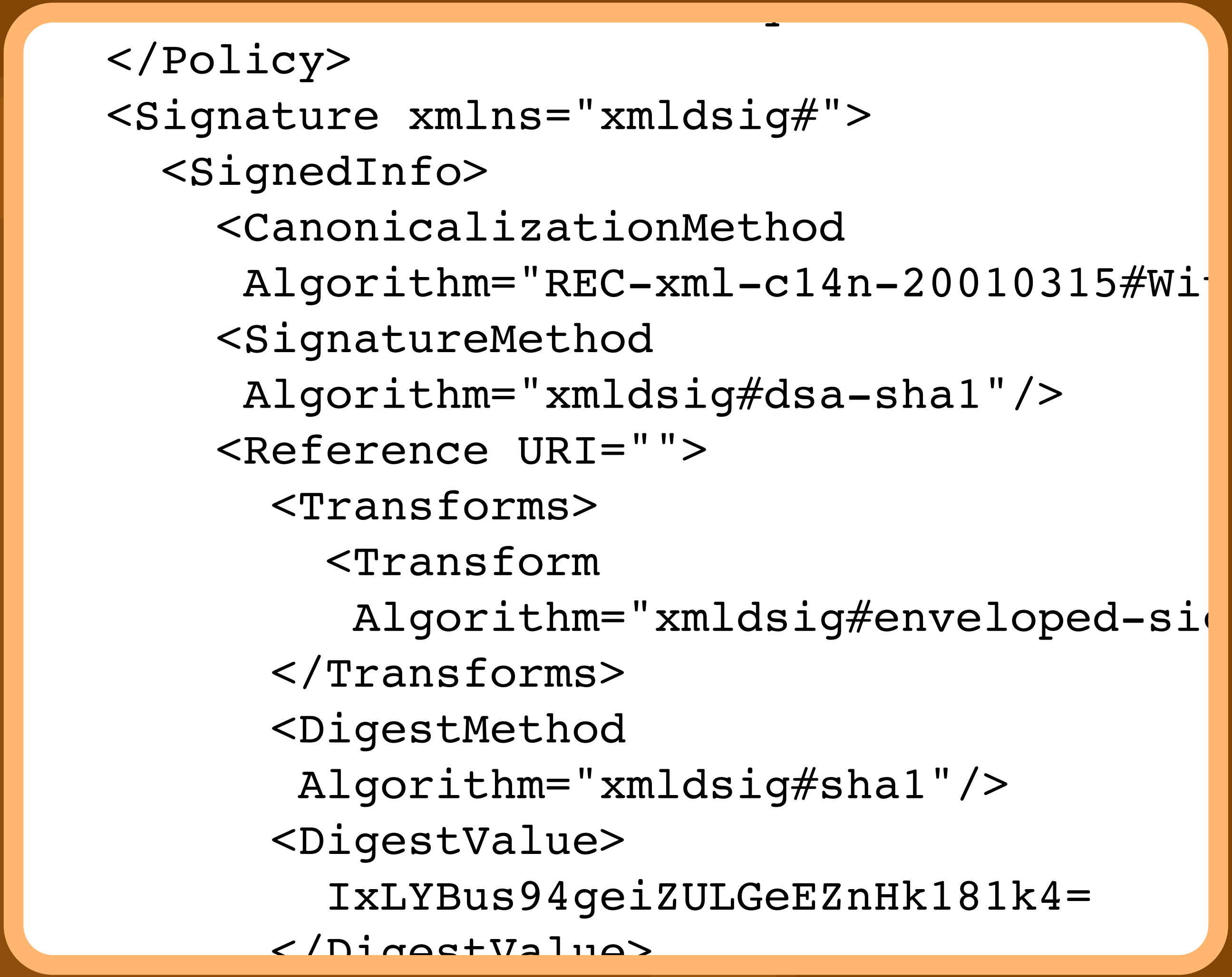
Gmail Server
Internet
Squid Proxy
Policy
Mozilla
Cookies
Cache
Web Application 1
Web Application 2
Web Application 3

Example Manifest

```
<?xml version="1.0"?>
<tahoma-application>
  <name>urn:orkut.com:applications:orkut</r
  <start-url>http://www.orkut.com/</start-u
  <browser-configuration/>
  <Policy ...>
    ...
    <Rule RuleId="connect:443:0" Effect="Pe
      <Target>
        ...
        <Actions>
          <Action>
            <ActionMatch
          MatchId="function:string-equal">
              <ActionAttributeDesignator
               DataType="string"
         AttributeId="action:action-id"/>
```

```
<Rule RuleId="connect:443:0" Effect="P
  <Target>
    ...
    <Actions>
      <Action>
        <ActionMatch
     MatchId="function:string-equal">
          <ActionAttributeDesignator
           DataType="string"
    AttributeId="action:action-id"/>
          <AttributeValue
           DataType="string">
              CONNECT
          </AttributeValue>
        </ActionMatch>
      </Action>
    </Actions>
```

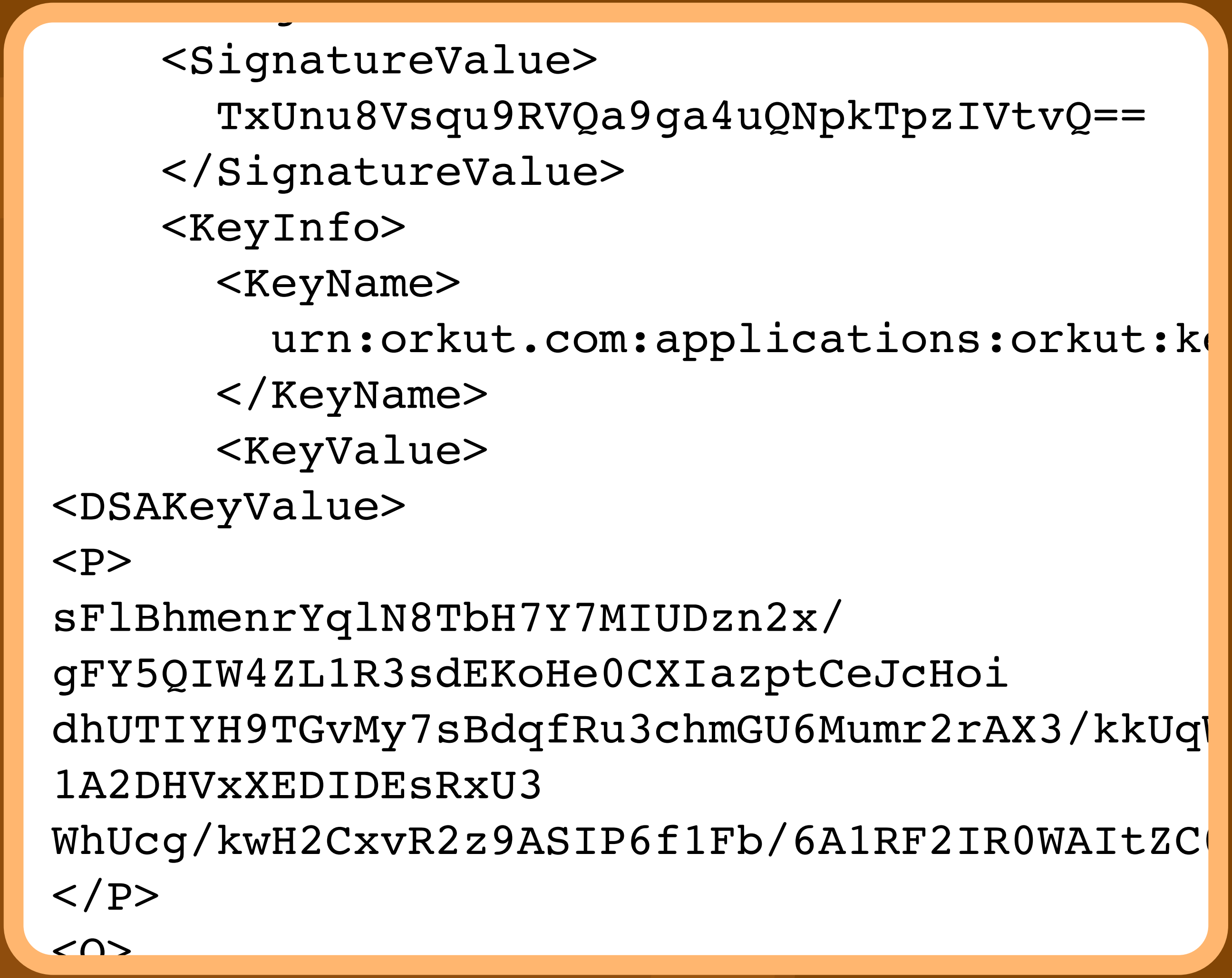
Example Manifest



```
</Policy>
<Signature xmlns="xmldsig#">
  <SignedInfo>
    <CanonicalizationMethod
     Algorithm="REC-xml-c14n-20010315#Wi
    <SignatureMethod
     Algorithm="xmldsig#dsa-sha1"/>
    <Reference URI="">
      <Transforms>
        <Transform
         Algorithm="xmldsig#enveloped-si
      </Transforms>
      <DigestMethod
       Algorithm="xmldsig#sha1"/>
      <DigestValue>
        IxLYBus94geiZULGeEZnHk181k4=
      </DigestValue>
```

Example Manifest

Example Manifest



```
    <SignatureValue>
      TxUnu8Vsqu9RVQa9ga4uQNpkTpzIVtvQ==
    </SignatureValue>
    <KeyInfo>
      <KeyName>
        urn:orkut.com:applications:orkut:k
      </KeyName>
      <KeyValue>
<DSAKeyValue>
<P>
sFlBhmenrYqlN8TbH7Y7MIUDzn2x/
gFY5QIW4ZL1R3sdEKoHe0CXIazptCeJcHoi
dhUTIYH9TGvMy7sBdqfRu3chmGU6Mumr2rAX3/kkUq
1A2DHVxXEDIDEsRxU3
WhUcg/kwH2CxvR2z9ASIP6f1Fb/6A1RF2IR0WAItZC
</P>
<Q>
```

Managing Web Apps

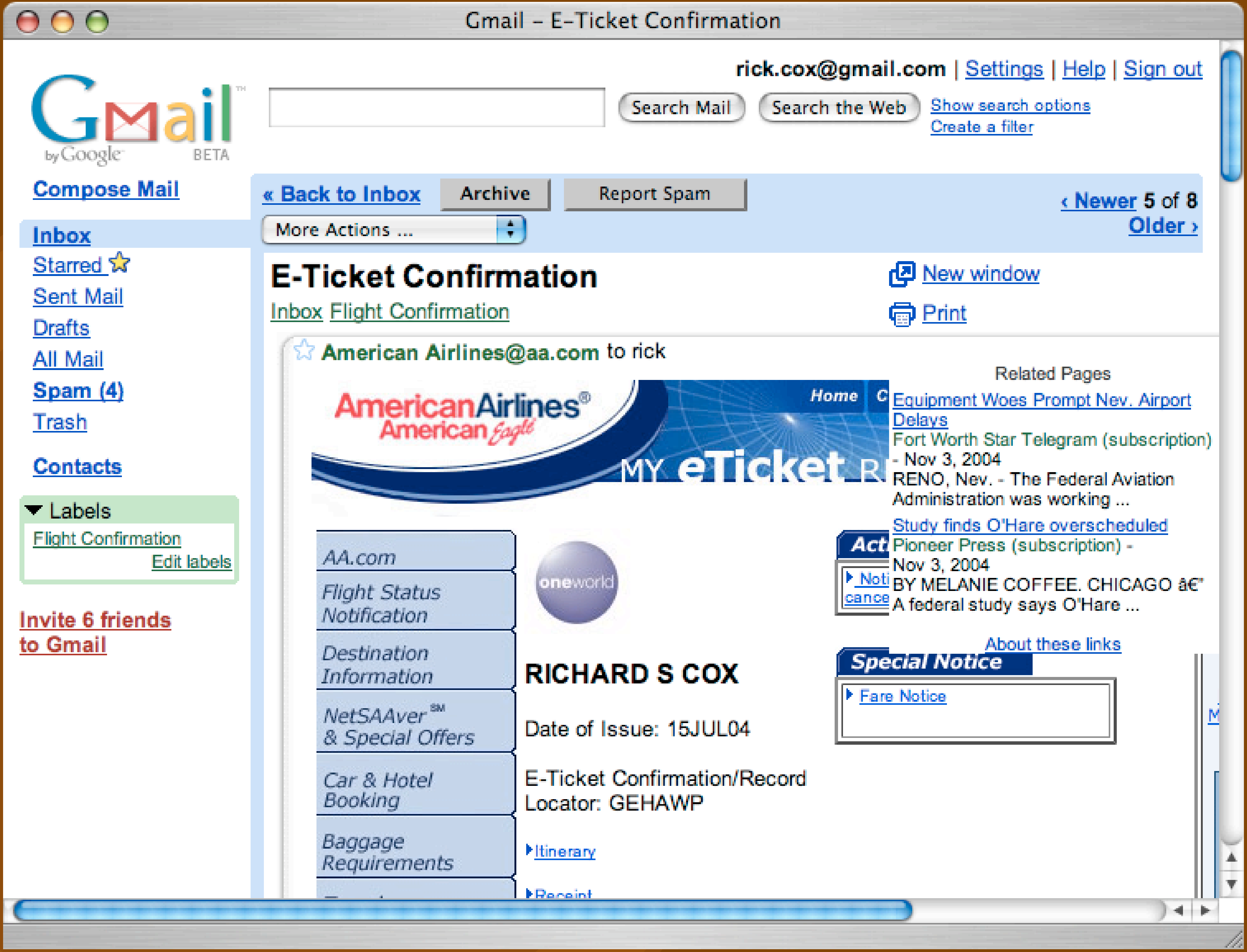
- Install: Download manifest, verify identity
- Run: Create new environment, load first piece of content
- Quit: Reclaim all memory of running app
- Uninstall: Delete manifest, cookies, etc.

Potential Fixes

- Bugs that would still be:
- Code Injection: 0/14
  - Buffer overflows: 0/10
- Sharing Policy/Mechanism: 3/36
- User Interface: 2/3
- Other: 2/2

Delivery Independent

- Manifests can authenticate content not delivered over HTTP(S)
  - Emails
  - By hash, signature, or other
- Can grant that content same access as rest of app



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- Use our delivery independence
- Gmail delivers
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  - Manifest
- Manifest either included in email or new, temporary manifest

Conclusions

- Browsers do not implement the world users expect
- Isolation of web applications, not particular content-types, is the solution