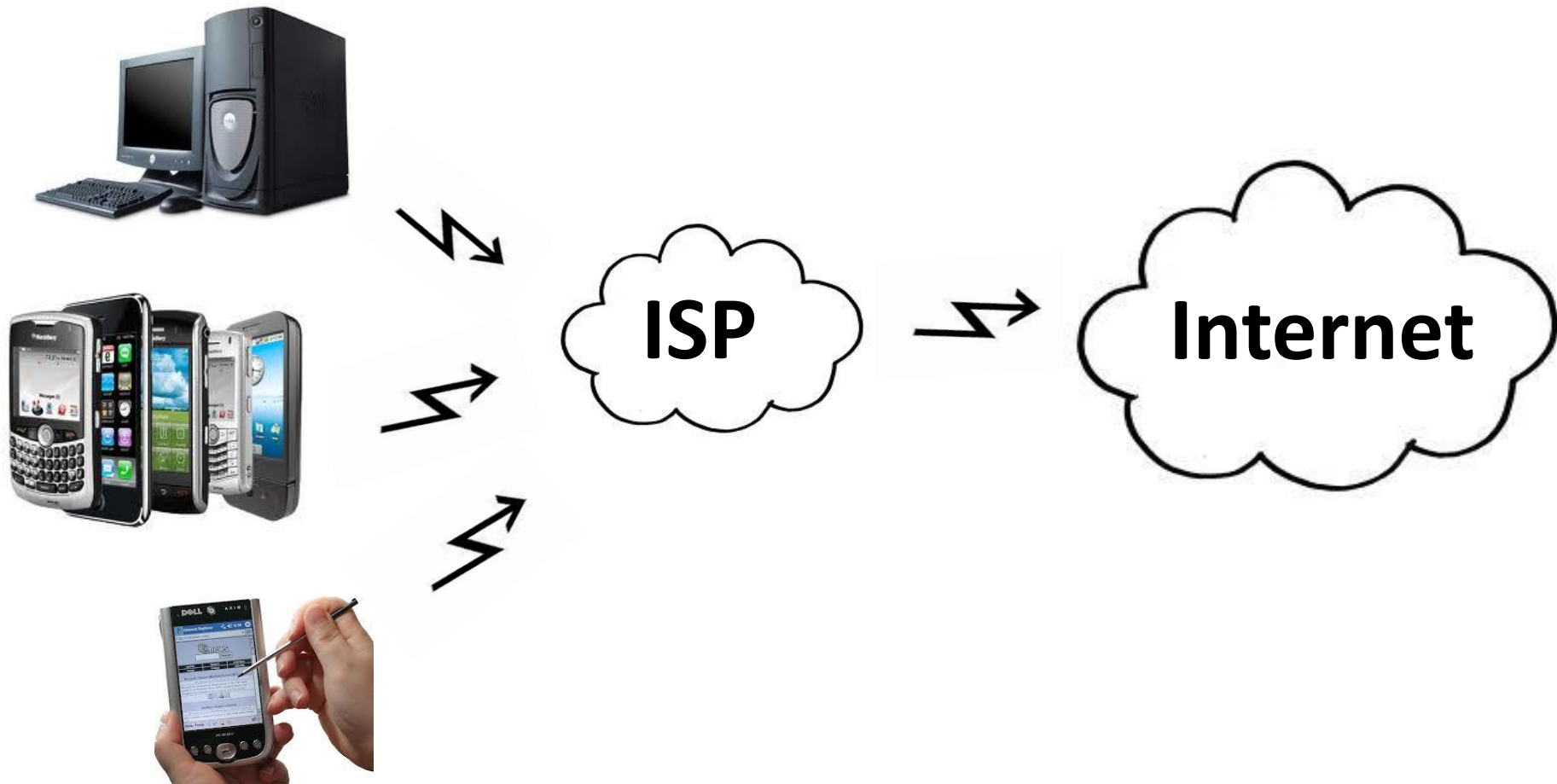


Fathom: A Browser-based Network Measurement Platform

Mohan Dhawan, Justin Samuel, Renata Teixeira,
Christian Kreibich, Mark Allman, Nicholas Weaver
& Vern Paxson

Rutgers University, UC Berkeley, CNRS & UPMC and ICSI

User/edge-centric measurement



User-centric measurement

- Dasu [W-MUST'11]
- HomeNet Profiler [HomeNets'10, PAM'12]
- Hostview [HotMetrics'10]
- Netalyzr [IMC'10]
- Shaperprobe [IMC'11]
- Speedtests

User-centric measurement

- Dasu [W-MUST'11] **Vuze plugin, Java**
- HomeNet Profiler [HomeNets'10, PAM'12] **Java**
- Hostview [HotMetrics'10] **Native App**
- Netalyzr [IMC'10] **Java**
- Shaperprobe [IMC'11] **Native App**
- Speedtests **Flash**

User-centric measurement



User-centric measurement



**No general purpose
measurement platform**

Is there a better platform ?

Is there a better platform ?



+ Ubiquitous

+ All the time

- No proper API

- Security model

Contributions

Fathom is a practical browser-based network measurement platform

- Provides a **programmable interface** for writing and launching measurements from web pages
- Enables unparalleled **access to the edge** via the ubiquity of browsers
- Supports novel analyses via **passive and active** measurements
- Combines existing security primitives to **safely expand capabilities** of in-page JavaScript

Outline

- **Concrete Example**
- **Design**
- **Implementation**
- **Evaluation**
- **Conclusion**

Google Maps: End-user problems

 **HarrierMan** Level 1

2/11/09 

What is up with Google Maps? It is either incredibly slow or pages just don't appear unless I click on the 'Still loading ...Slow? Try Basic HTML' button that has started to appear at the of of the page. This has happening for at least a week, maybe much longer. My connection runs at about 6Mb/sec and is fine for other sites so this is a google map issue. I notice many other posts over the last year where people have had problems at times when I haven't so is just my turn to be frustrated?

Google Maps: Inefficient solution



Mike CH 🇮🇳

3/10/09



Hiya,

To make progress with this, we'll need some more information from you. Ideally, answers to these questions from everyone:

1) When did you first notice this problem?

2) Can you quantify "incredibly slow", eg, "It used to take around 4 seconds to load Maps and now it takes around 20" or "Maps loads fast but search results take at least 15 seconds to come back" etc.

3) Which browsers, operating systems, and (if possible) security patchlevels do you have?

4) What other software is installed on your computer, eg, do you have any toolbars, chat clients, etc installed?

5) If you know how to use the CPU monitoring facility of your operating system, is the CPU maxed out during page load, or does it seem to be waiting on the network?

6) Which area of the world are you connecting from? Metro-area granularity is ideal but I'll take country-level too :-)

Any information you can provide will be very helpful.

Google Maps: Inefficient solution



Mike CH 🇮🇳

3/10/09

Hiya,

To ma
quest

1) Wh

2) Ca
now i
back"

3) Wh

4) Wh
etc in:

5) If y
maxe

6) Wh
country-level too :-)

Any information you can provide will be very helpful.

- Since when ?
- How slow ?
- CPU & N/W load ?
- Location ?

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s to come

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at clients,

CPU

t'll take

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Fathom APIs

- Four main **fathom** namespaces
 - **fathom.socket.***
 - Low-level socket management

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 - **fathom.system.***
 - Controlled access to system utilities

Fathom APIs

- Four main **fathom** namespaces
 - **fathom.socket.***
 - Low-level socket management
 - **fathom.proto.***
 - Implement protocols like DNS, mDNS, HTTP and UPnP
 - **fathom.system.***
 - Controlled access to system utilities
 - **fathom.utils.***
 - Miscellaneous browser APIs, timer, passive metrics, etc.

Fathom API use

```
<html>
```

```
<body>
```

```
<script>
```

```
function tr_callback(results) {...}  
fathom.system.traceroute(  
    "maps.google.com", tr_callback);
```

```
</script>
```

```
</body>
```

```
</html>
```

Security

- Fathom APIs are powerful
 - Malicious scripts can misuse client resources

Security

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 - Malicious scripts can misuse client resources
- Five-fold defense mechanism
 - Client policy
 - User confirmation
 - Script manifest
 - Code signing
 - Server manifest

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Security: User confirmation



<http://www.foo.com>

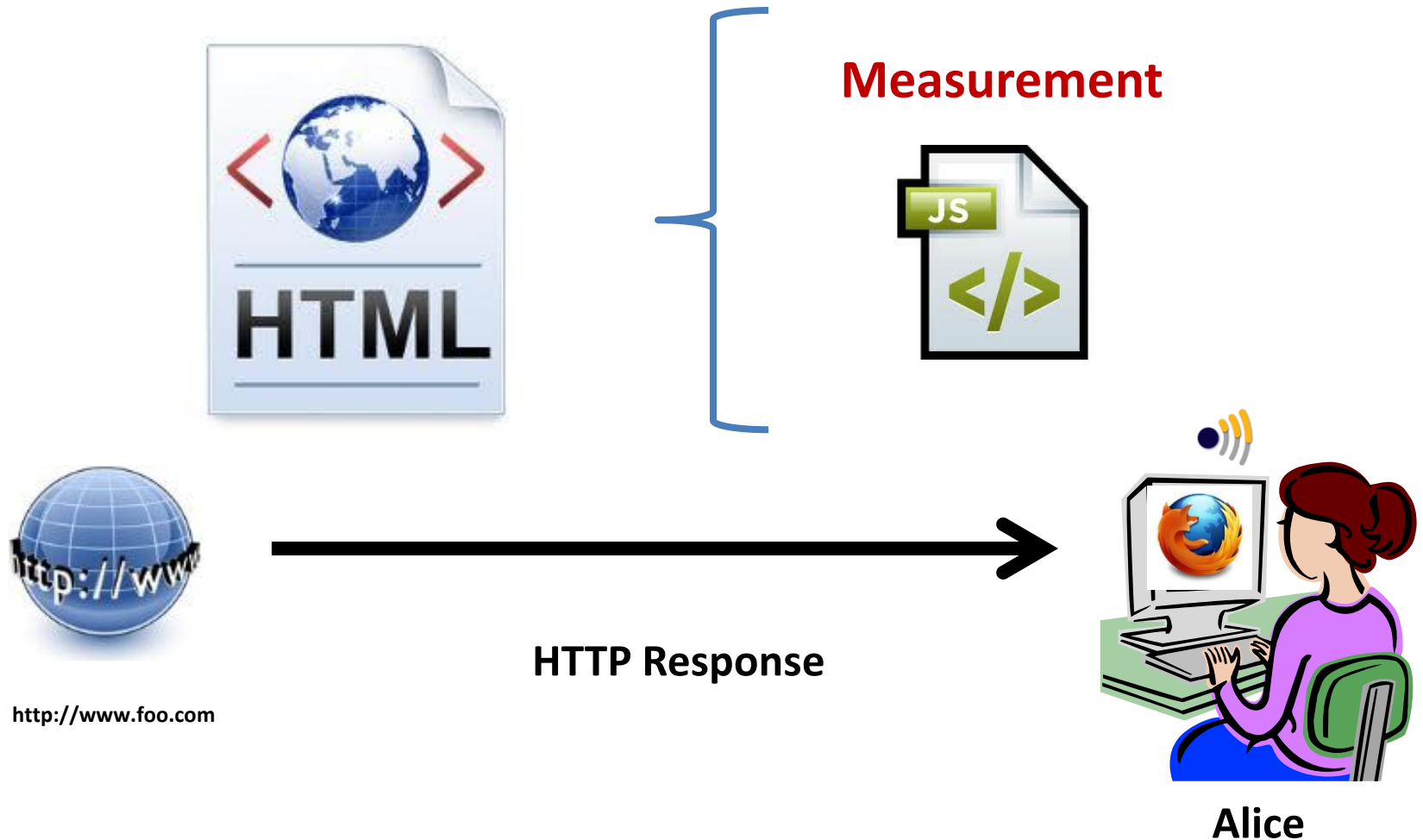


HTTP Request



Alice

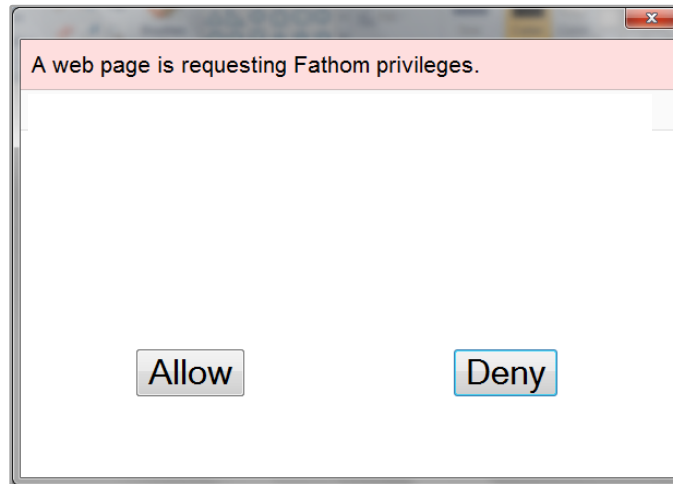
Security: User confirmation



Security: User confirmation



<http://www.foo.com>



Security Dialog



Alice

Security: User confirmation



**This security dialog
is not informative!**



<http://www.foo.com>

Security Dialog



Alice

Security: Script manifest



<http://www.foo.com>

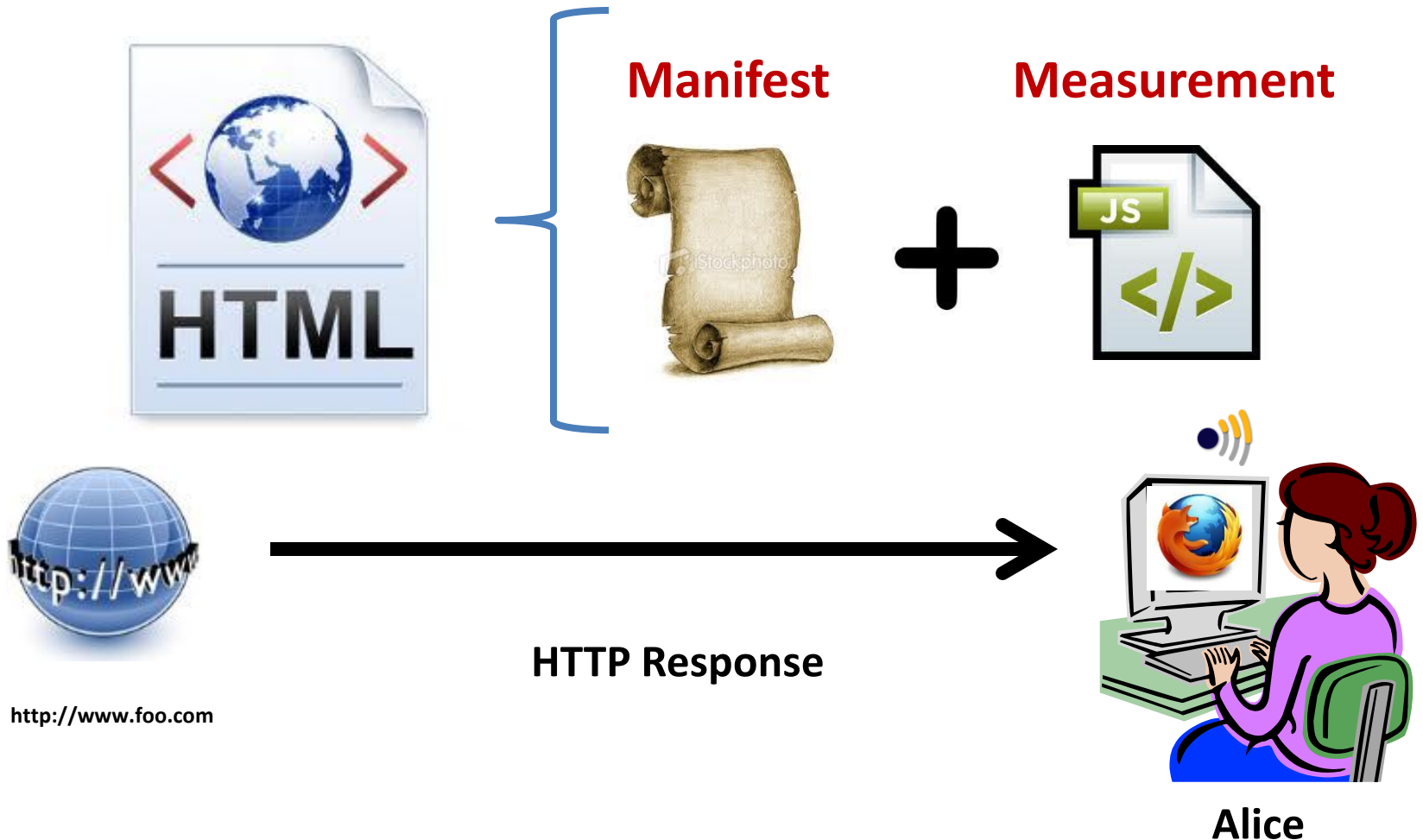


HTTP Request



Alice

Security: Script manifest



Security: Script manifest

```
var manifest = {  
  'api' : [  
    'proto.*',  
    'socket.*',  
    'system.*',  
    'util.*'  
  ],  
  'destinations' : [  
    'http://*.bar.com:*'  
  ]  
};
```

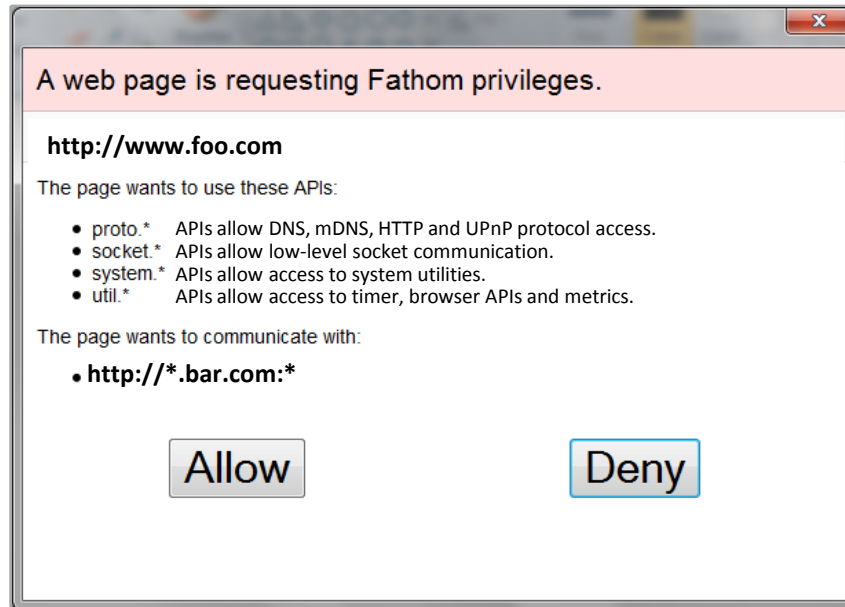


http://www.f



Alice

Security: Script manifest



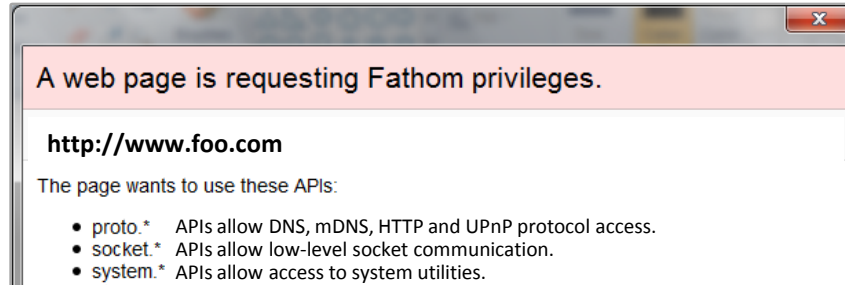
http://www.foo.com

Security Dialog



Alice

Security: Script manifest



**But still difficult for
average users**



http://www.foo.com

Security Dialog



Alice

Security: Server manifest



<http://www.bar.com>

**Untrusted script wants
to open TCP connection
to www.bar.com**



Alice

Security: Server manifest



<http://www.bar.com>



**Fathom requests the
server's manifest file**



Alice

Security: Server manifest

```
<allow-access-from domain="*.google.com"/>  
<allow-access-from ip="198.168.150.25"/>  
  
<deny-access-from domain="*.untrusted.com"/>  
<deny-access-from ip="221.23.42.30"/>
```



http://www.bar.com



Fathom parses the server manifest



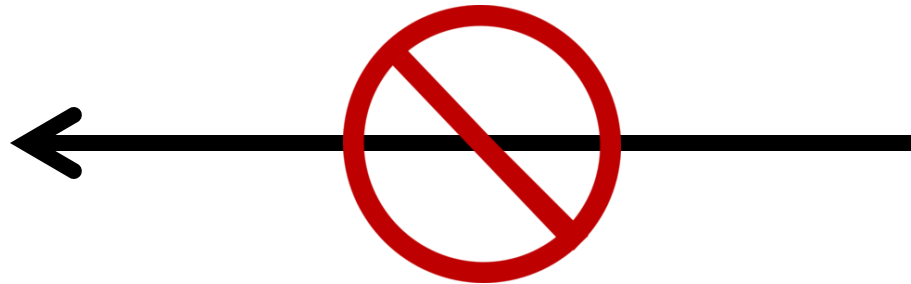
Alice

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http://www.bar.com



Fathom prevents untrusted script
from opening the TCP connection



Alice

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Fathom: A measurement platform for Firefox



- Firefox is a popular browser
- JavaScript-only extension (open source)
 - Rich extension API
 - Portable (across Firefox's platforms)



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Technical details about the implementation are mentioned in the paper.

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Overhead of page load time

- Fathom continuously monitors system & browser

Benchmark	Overhead (%)
Craigslist	1.1
CNN	3.1
ESPN	2.5
Google Maps	2.9
NY Times	1.3
Slashdot	1.4
Yahoo	1.0
YouTube	3.1

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Benchmark	Overhead (%)
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Slashdot	1.4
Yahoo	1.0
YouTube	3.1

Overhead < 3.2%

Accuracy: Methodology

- Timestamp and Timer

Accuracy: Methodology

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- Experiment scenarios
 - No browsing

**No competing
browsing activity**

Accuracy: Methodology

- Timestamp and Timer
- Experiment scenarios
 - No browsing
 - Passive browsing

**Only asynchronous
HTTP requests**

Accuracy: Methodology

- Timestamp and Timer
- Experiment scenarios
 - No browsing
 - Passive browsing
 - Active browsing

**Simultaneous web
page loads in progress**

Accuracy: Methodology

- Timestamp and Timer
- Experiment scenarios
 - No browsing
 - Passive browsing
 - Active browsing
 - Cross-traffic on the host

Saturate the local N/W

Accuracy: Results

- Timestamp

**Accuracy of 1ms under
normal operating conditions**

Accuracy: Results

- Timestamp
 - Accuracy of 1ms under normal operating conditions
 - Degrades with high cross-traffic on host
 - Use `fathom.utils.metrics` to check host traffic

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 - Accuracy of 1ms under normal operating conditions
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 - Degrades with concurrent browsing activity

**Browser tabs share the
same runtime**

Accuracy: Results

- Timestamp
 - Accuracy of 1ms under normal operating conditions
 - Degrades with high cross-traffic on host
 - Use `fathom.utils.metrics` to check host traffic
- Timer
 - Degrades with concurrent browsing activity
 - Check wall-clock time using JavaScript's `Date` API

Case Studies

- Netalyzr (IMC'10)
 - **Researchers** can use Fathom to build complex toolkits
 - Fathom-powered Netalyzr confirms its versatility

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Case Studies

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 - **Researchers** can use Fathom to build complex toolkits
 - Fathom-powered Netalyzr confirms its versatility
- Web access failure
 - “Debug my connection” application
 - Incentive for **end-users** to install Fathom
- Web services debugging (Google Maps)
 - **Web developers** can use Fathom APIs to assist users

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Conclusion

Fathom is a practical browser-based network measurement platform

- Programmable interface for writing and launching measurements from web pages
- Prototype available for Firefox web browser
- Low runtime overhead and acceptable accuracy
- Built-in checks to ensure user security and privacy

Thank You.

Download Fathom at
<http://fathom.icsi.berkeley.edu/>

Contact: fathom@icsi.berkeley.edu