Identifying Cross-origin Resource Status Using Application Cache

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Web, HTML5, and Threats

- Web and HTML5
  - The most popular distributed application platform
  - Rich functionality introduced by HTML5
- Security and privacy threats
  - Popularity attracts a lot of adversaries.
  - Rich functionality opens security and privacy holes.
- Discovering unrevealed threats of the Web and HTML5 is important.

HTML5 Application Cache (AppCache)

- Enabling technology to offline web application
  - Specify resources to be cached in a web browser
  - Allow fast and offline access to the cached resources
- Potential threat of AppCache
  - Arbitrary cross-origin resources are cacheable.
    - Neither server- nor client-side control
  - Error handing can breach user privacy.
    - Recognize whether a user can cache specific resources

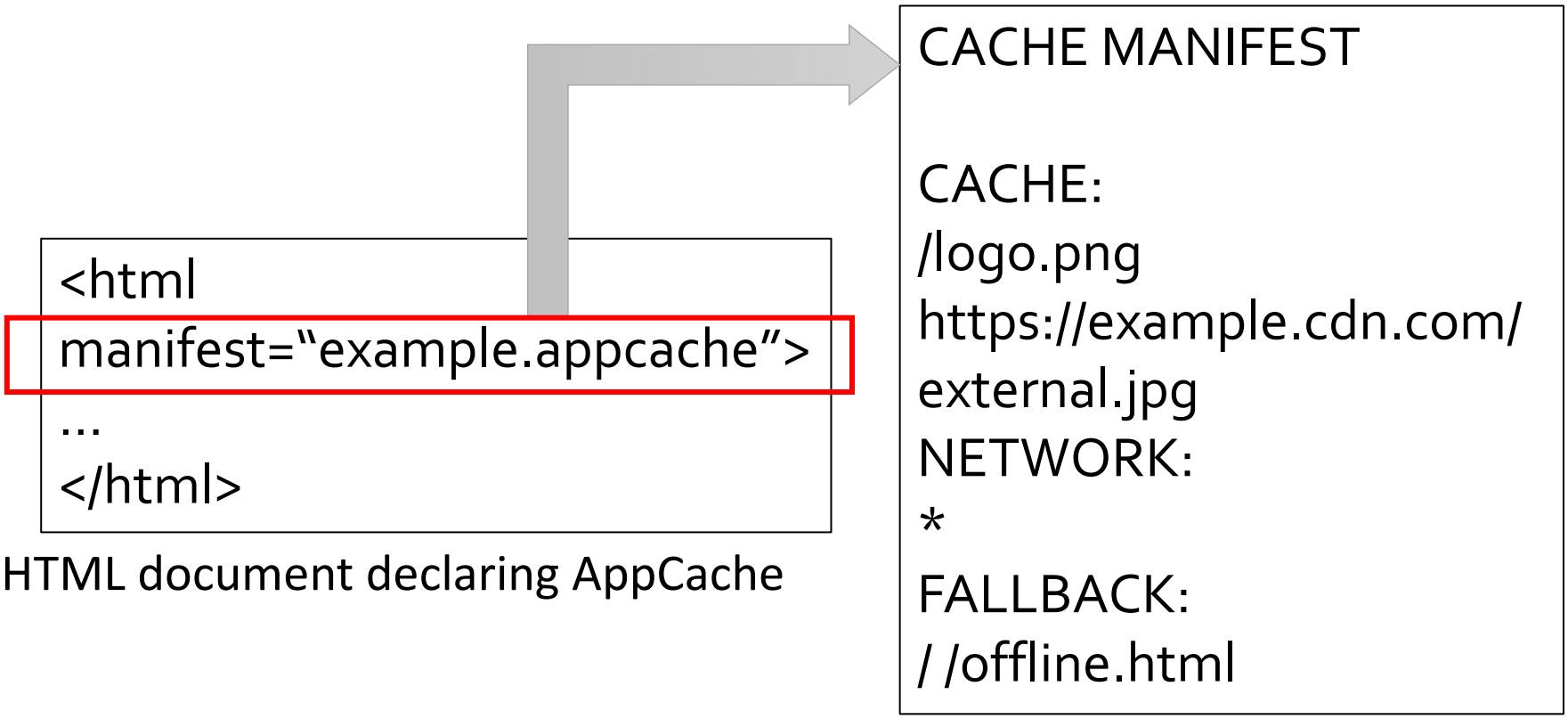
Motivation and Goal

- Motivation
  - In-depth security analysis of new web functionalities is necessary.
  - Security analysis of AppCache is insufficient despite its wide deployment.
- Research goal
  - Analyze and solve security problems of AppCache
    - Discover security problems of AppCache
    - Suggest an effective countermeasure against the security problems

Contents

- Introduction
- **AppCache Details**
  - **Declaration**
  - **Procedure and Failure**
  - **Non-cacheable URLs**
- URL Status Identification Attack
- Discussion
- Conclusion

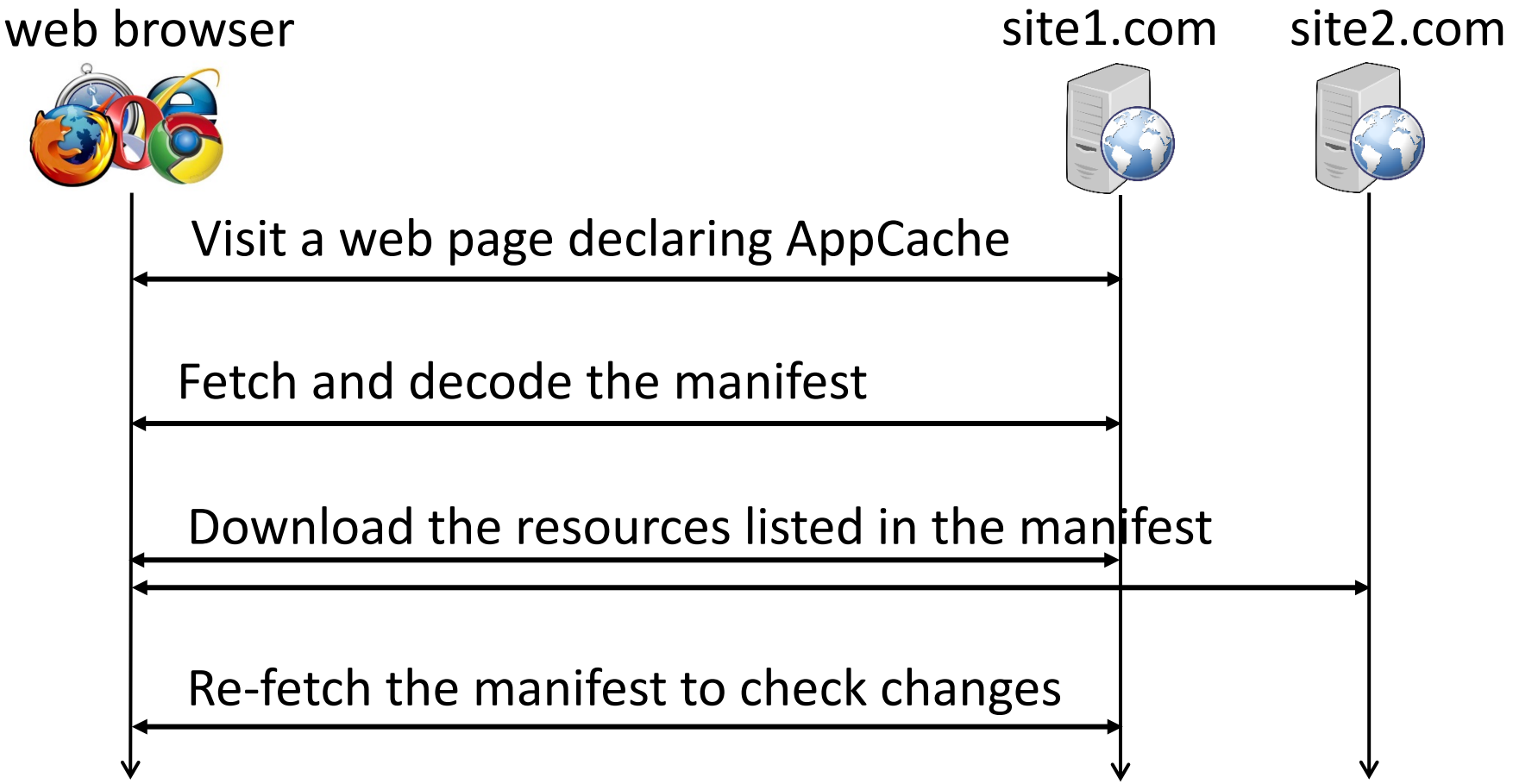
AppCache Declaration



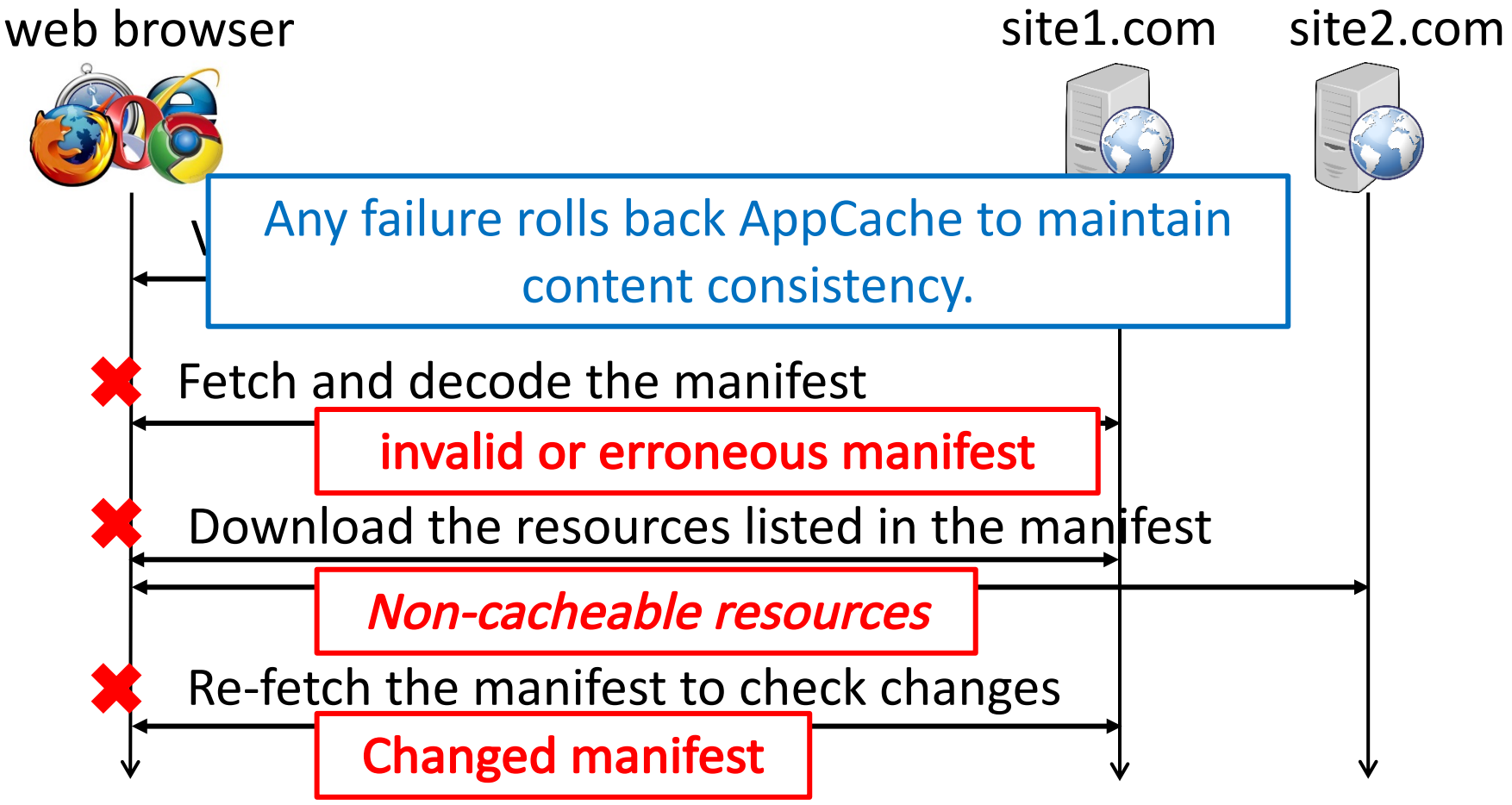
HTML document declaring AppCache

AppCache manifest

AppCache Procedure



When Does AppCache Fail?



Non-cacheable URLs

- Invalid URL
  - No content to be cached
- Dynamic URL
  - Caching dynamic content is less meaningful.
    - Cache-Control: no-store or no Content-Length
- URL with redirections
  - Final URL can be dynamically changed.
  - Violation of the same-origin policy is possible.
    - Refer a cached resource with the URL specified in a manifest

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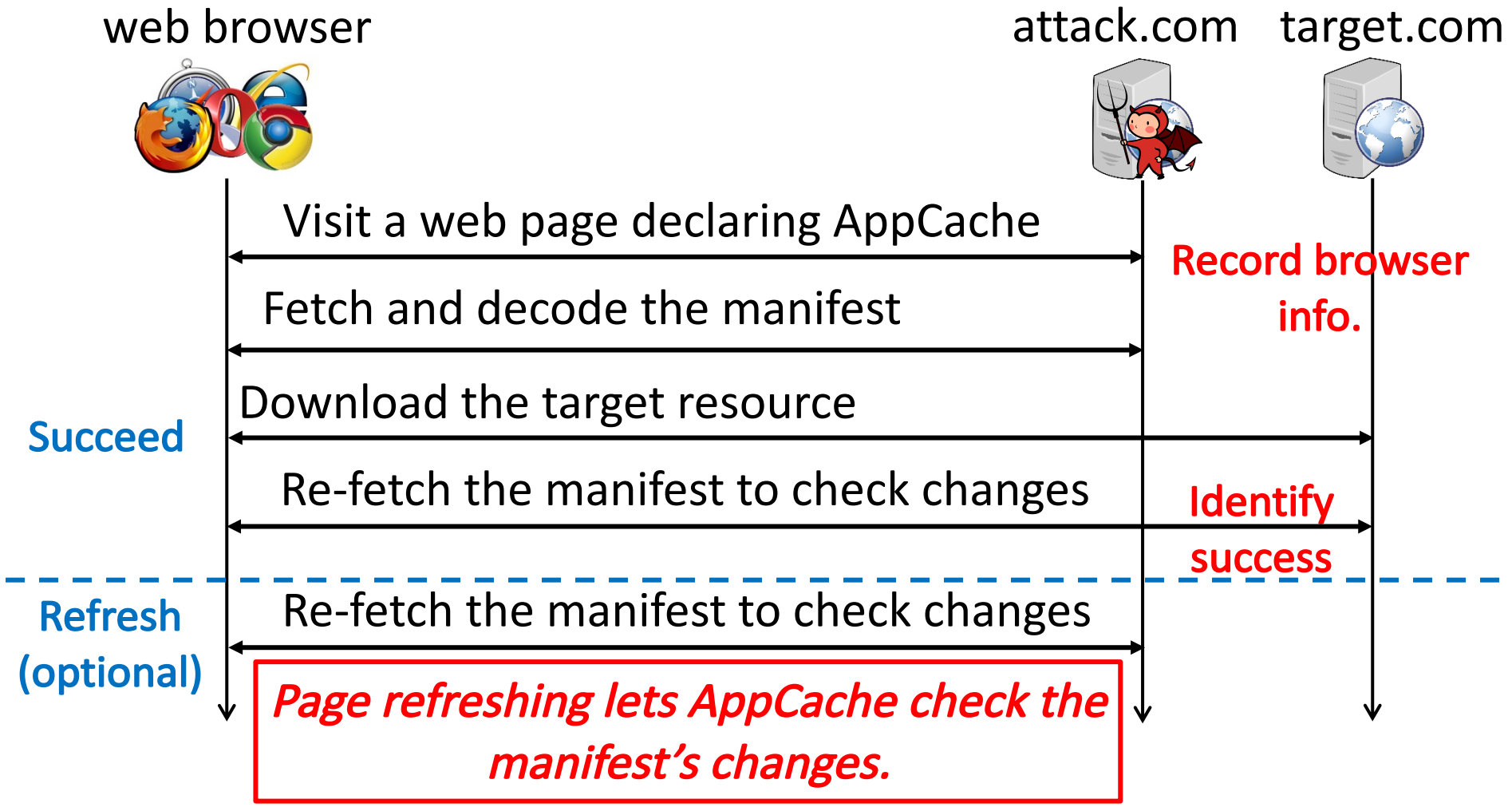
- **URL Status Identification**
  - **Basics and Advantages**
  - **Attack Procedure**
  - **Concurrent Attack**
  - **Application: Determining Login Status**
- Discussion
- Conclusion

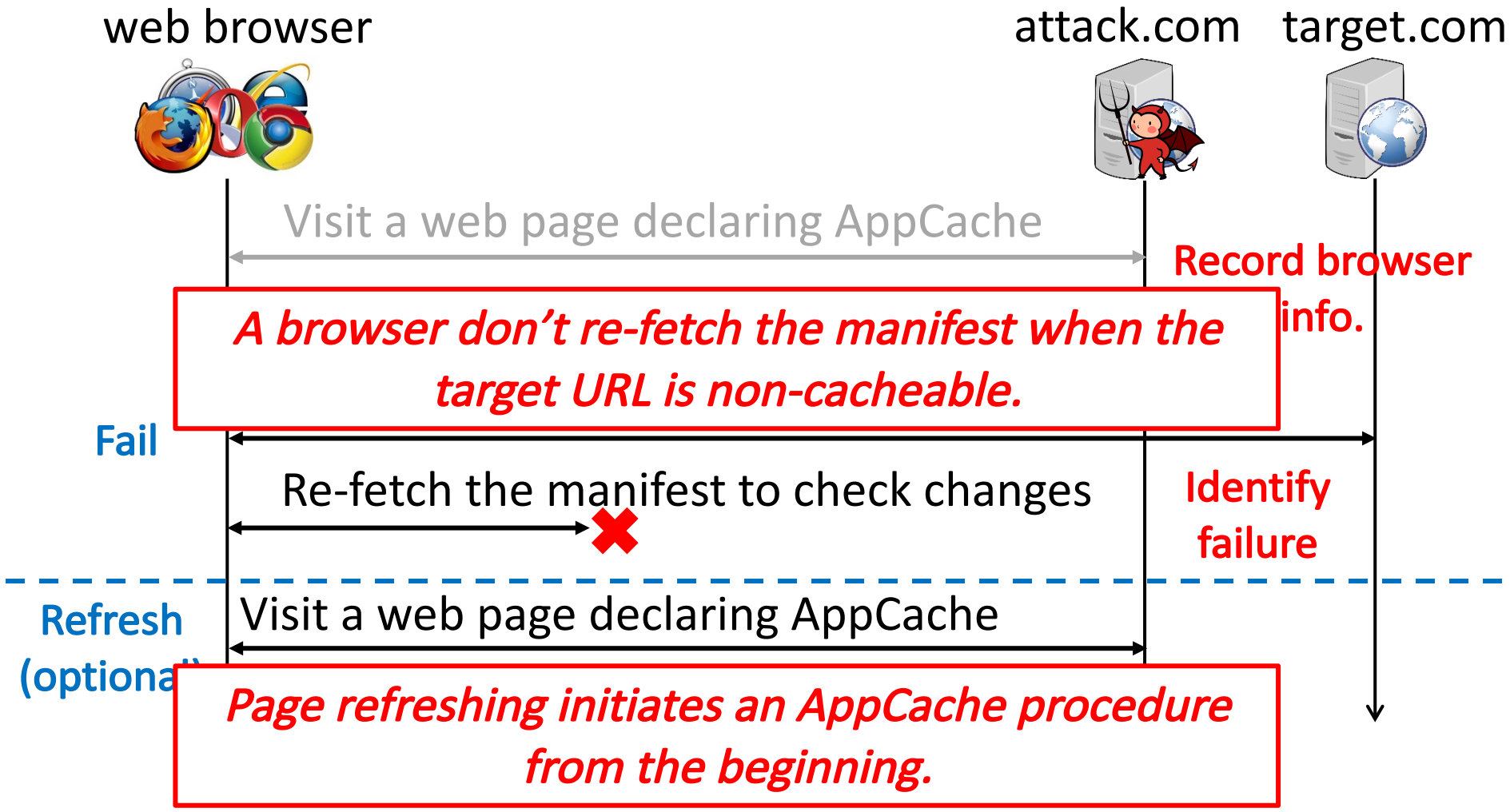
URL Status Identification

- Basics
  - Specify a target URL in an AppCache manifest
  - Check whether AppCache succeeds or fails
- Advantages
  - Deterministic identification: Don’t measure timing
  - Identification of URL redirections
  - Scriptless attack

Attack Procedure: Cacheable URL

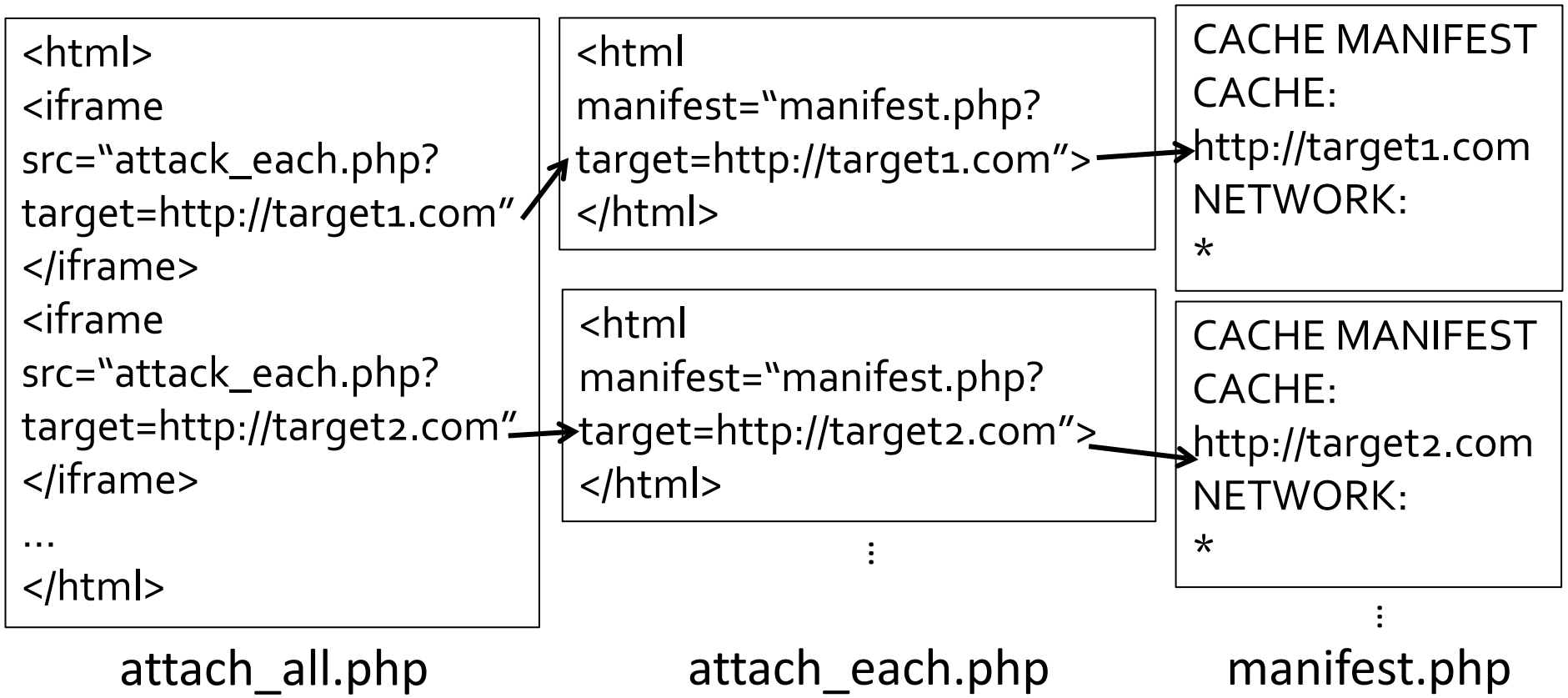


Attack Procedure: Non-cacheable URL



Concurrent Attack

Concurrently inspecting multiple target URLs with multiple iframe tags, web pages, & manifests



Application: Determining Login Status

Determine login status by inspecting URLs with **conditional redirections or errors**

amazon.com/gp/yourstore/home → amazon.com/ap/signin?...
tumblr.com/dashboard → tumblr.com/login?redirect_to=/dashboard
youtube.com/feed/subscriptions → accounts.google.com/ServiceLogin?...

URLs redirecting non-logged-in browsers to login pages

bitbucket.org/account/user/<user-id>
github.com/<user-id>/<repository-name>/settings
<blog-id>.wordpress.com/wp-admin

Private URLs returning errors to unauthorized browsers

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- URL Status Identification Attack
- **Discussion**
  - **Problematic Countermeasures**
  - **Countermeasure: Cache-Origin**
  - **Service Worker**
- **Conclusion**

Problematic Countermeasures

- Ask user permission for AppCache
  - Vulnerable to careless users
- Always/never check changes in manifests
  - Vulnerable to page refreshing attacks
  - Content inconsistency problem
- Eliminate web pages having conditional behaviors
  - Detection and modification of all vulnerable web pages are challenging.

Countermeasure: Cache-Origin

- Attach a Cache-Origin header when requesting resources during AppCache
  - Contain the manifest's origin
  - Notify a web application of who initiate an AppCache procedure
  - Resemble the Origin header of CORS
- Abort suspicious AppCache procedures by returning no-store or error code
  - Cache sensitive resources
  - Be initiated by doubtful servers

Service Worker

- Provide scriptable caches as an alternative to AppCache
  - Intercept and respond to network requests from certain web pages
- Have the same policy to handle URL redirections and errors with AppCache
  - Also vulnerable to our attacks

Conclusion

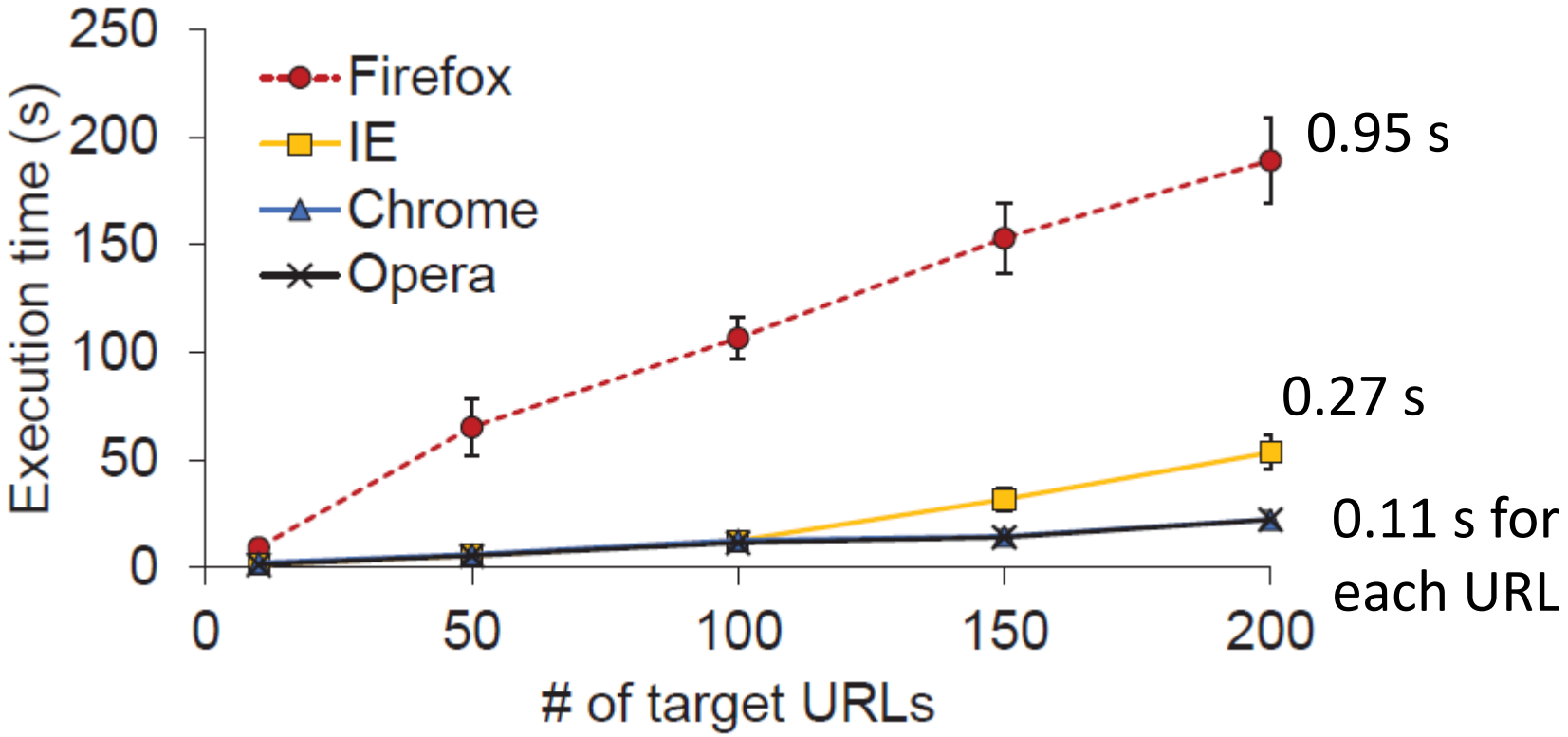
- We introduced a new web privacy attack using HTML5 AppCache.
  - Identify the status of cross-origin resources
  - Do not rely on client-side scripts
  - Can attack major web browsers
- We suggested a Cache-Origin request-header field to mitigate our attacks.
  - Minor variation of the Origin header
  - Easy deployment

Backup Slides

Script-based Identification

```
1  var appCache = window.applicationCache;
2
3  function handleError(e) {
4      // fail to download a given URL
5      var img = new Image();
6      img.src = "/results.png?failure";
7  }
8
9  function handleCached(e) {
10     // succeed to download a given URL
11     var img = new Image();
12     img.src = "/results.png?success";
13 }
14
15 appCache.addEventListener('error', handleError
       , false);
16 appCache.addEventListener('cached',
       handleCached, false);
17 appCache.addEventListener('updateready',
       handleCached, false);
```

Execution Time of Concurrent Attack



Scriptless URL Timing