The App Shell Model

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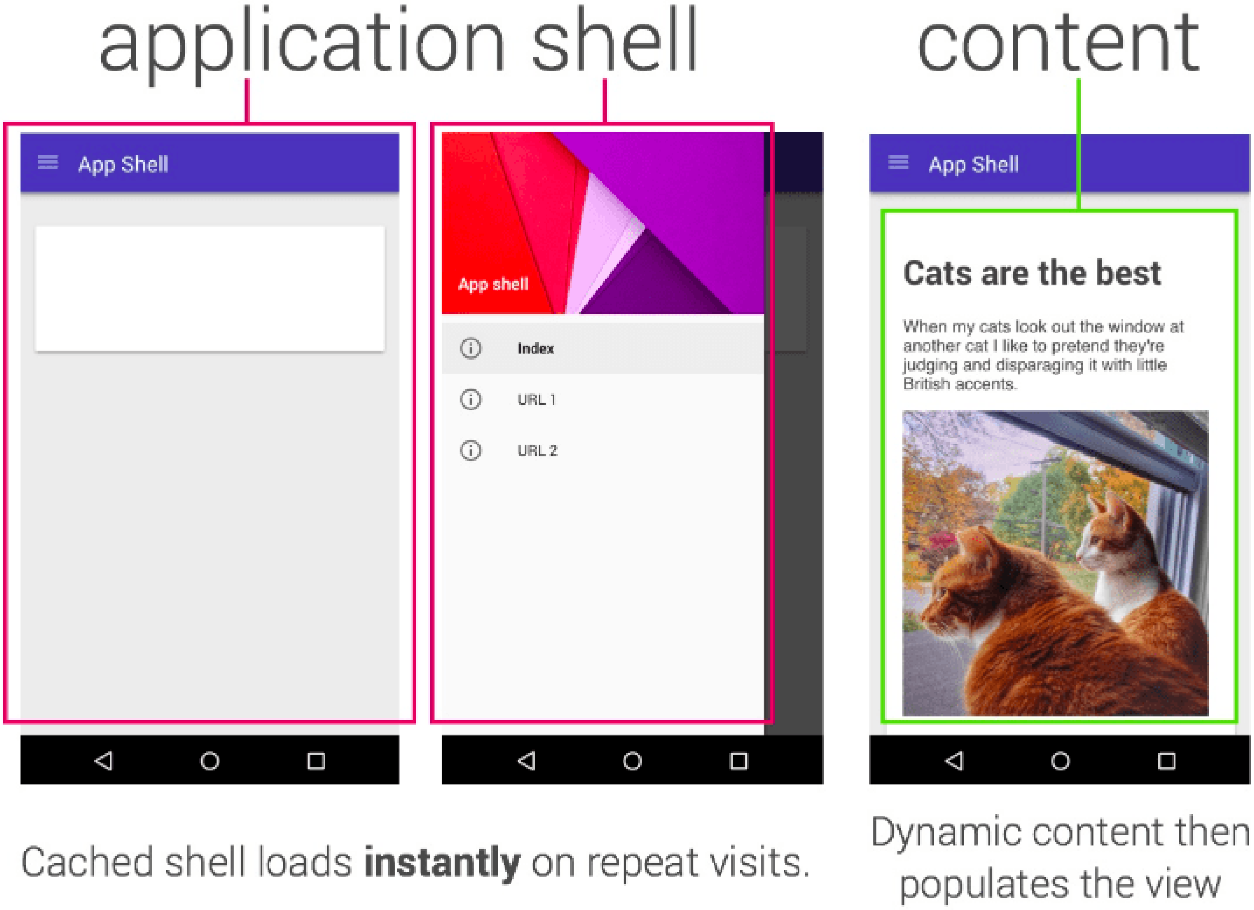
An **application shell** (or app shell) architecture is one way to build a Progressive Web App that reliably and instantly loads on your users' screens, similar to what you see in native applications.

The app "shell" is the minimal HTML, CSS and JavaScript required to power the user interface and when cached offline can ensure **instant, reliably good performance** to users on repeat visits. This means the application shell is not loaded from the network every time the user visits. Only the necessary content is needed from the network.

For single-page applications with JavaScript-heavy architectures, an application shell is a go-to approach. This approach relies on aggressively caching the shell (using a service worker) to get the application running. Next, the dynamic content loads for each page using JavaScript. An app shell is useful for getting some initial HTML to the screen fast without a network.


application shell
content
App Shell
App shell
Index
URL 1
URL 2
App Shell
Cats are the best
Cached shell loads **instantly** on repeat visits.
Dynamic content then populates the view

When my cats look out the window at another cat I like to pretend they're judging and disparaging it with little British accents.

Put another way, the app shell is similar to the bundle of code that you'd publish to an app store when building a native app. It is the skeleton of your UI and the core components necessary to get your app off the ground, but likely does not contain the data.

Note: Try the First Progressive Web App codelab to learn how to architectect and implement your first application shell for a weather app. The Instant Loading with the App Shell model video also walks through this pattern.

When to use the app shell model

Building a PWA does not mean starting from scratch. If you are building a modern single-page app, then you are probably using something similar to an app shell already whether you call it that or not. The details might vary a bit depending upon which libraries or frameworks you are using, but the concept itself is framework agnostic.

An application shell architecture makes the most sense for apps and sites with relatively unchanging navigation but changing content. A number of modern JavaScript frameworks and libraries already encourage splitting your application logic from its content, making this architecture more straightforward to apply. For a certain class of websites that only have static content you can still follow the same model but the site is 100% app shell.

To see how Google built an app shell architecture, take a look at Building the Google I/O 2016 Progressive Web App. This real-world app started with a SPA to create a PWA that precaches content using a service worker, dynamically loads new pages, gracefully transitions between views, and reuses content after the first load.

Benefits

The benefits of an app shell architecture with a service worker include:

- **Reliable performance that is consistently fast**. Repeat visits are extremely quick. Static assets and the UI (e.g. HTML, JavaScript, images and CSS) are cached on the first visit so that they load instantly on repeat visits. Content *may* be cached on the first visit, but is typically loaded when it is needed.
- **Native-like interactions**. By adopting the app shell model, you can create experiences with instant, native-application-like navigation and interactions, complete with offline support.
- **Economical use of data**. Design for minimal data usage and be judicious in what you cache because listing files that are non-essential (large images that are not shown on every page, for instance) result in browsers downloading more data than is strictly necessary. Even though data is relatively cheap in western countries, this is not the case in emerging markets where connectivity is expensive and data is costly.

Requirements

The app shell should ideally:

- Load fast
- Use as little data as possible
- Use static assets from a local cache
- Separate content from navigation
- Retrieve and display page-specific content (HTML, JSON, etc.)
- Optionally, cache dynamic content

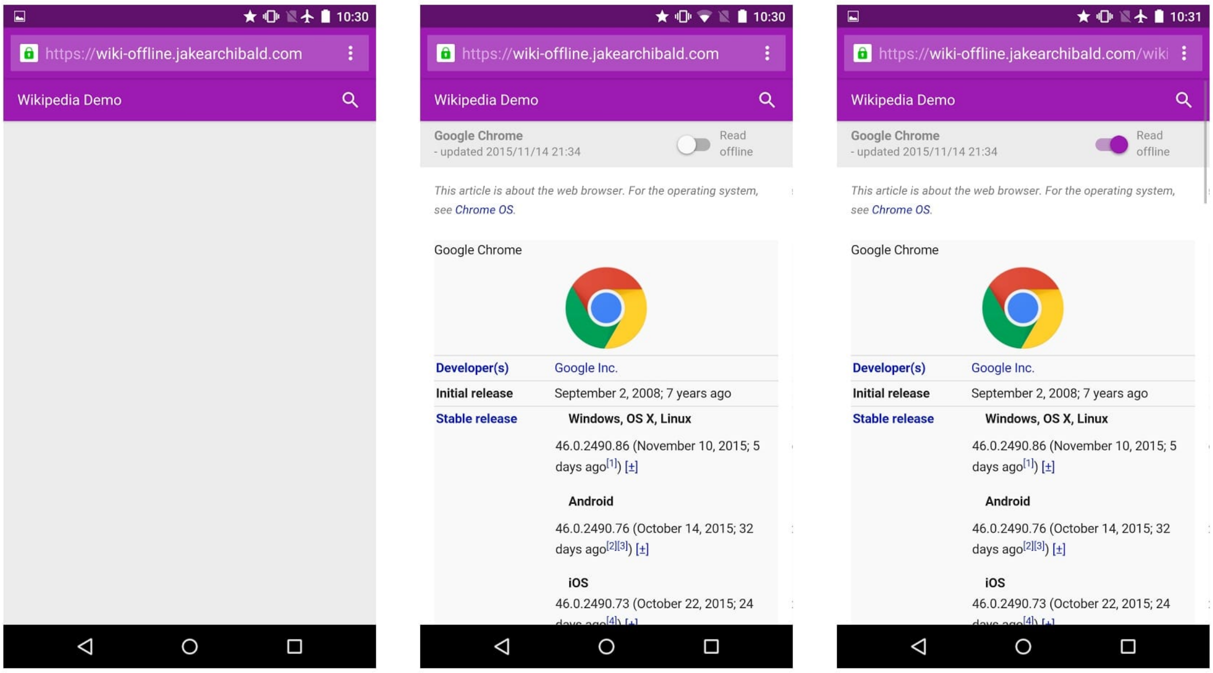
The app shell keeps your UI local and pulls in content dynamically through an API but does not sacrifice the linkability and discoverability of the web. The next time the user accesses your app, the latest version displays automatically. There is no need to download new versions before using it.

Note: The Lighthouse auditing extension can be used to verify if your PWA using an app shell hits a high-bar for performance. To the Lighthouse is a talk that walks through optimizing a PWA using this tool.

Building your app shell

Structure your app for a clear distinction between the page shell and the dynamic content. In general, your app should load the simplest shell possible but include enough meaningful page content with the initial download. Determine the right balance between speed and data freshness for each of your data sources.

Offline Wikipedia webapp


10:30
https://wiki-offline.jakearchibald.com
Wikipedia Demo
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https://wiki-offline.jakearchibald.com
Wikipedia Demo
Google Chrome
- updated 2015/11/14 21:34
Read offline
10:31
https://wiki-offline.jakearchibald.com/wiki
Wikipedia Demo
Google Chrome
- updated 2015/11/14 21:34
Read offline

This article is about the web browser. For the operating system, see Chrome OS.

Google Chrome	
Developer(s)	Google Inc.
Initial release	September 2, 2008; 7 years ago
Stable release	Windows, OS X, Linux 46.0.2490.86 (November 10, 2015; 5 days ago[1]) [±] Android 46.0.2490.76 (October 14, 2015; 32 days ago[2][3]) [±] iOS 46.0.2490.73 (October 22, 2015; 24 days ago[4]) [±]

Cached application shell

Content dynamically loaded in

Content can also be cached for offline viewing

Jake Archibald's offline Wikipedia application is a good example of a PWA that uses an app shell model. It loads instantly on repeat visits, but dynamically fetches content using JS. This content is then cached offline for future visits.

Example HTML for an app shell

This example separates the core application infrastructure and UI from the data. It is important to keep the initial load as simple as possible to display just the page's layout as soon as the web app is opened. Some of it comes from your application's index file (inline DOM, styles) and the rest is loaded from external scripts and stylesheets.

All of the UI and infrastructure is cached locally using a service worker so that on subsequent loads, only new or changed data is retrieved, instead of having to load everything.

Your **`index.html`** file in your work directory should look something like the following code. This is a subset of the actual contents and is not a complete index file. Let's look at what it contains.

- HTML and CSS for the "skeleton" of your user interface complete with navigation and content placeholders.
- An external JavaScript file (app.js) for handling navigation and UI logic as well as the code to display posts retrieved from the server and store them locally using a storage mechanism like IndexedDB.
- A web app manifest and service worker loader to enable off-line capabilities.

```
<!DOCTYPE html>
<html>
<head>
  <meta charset="utf-8">
  <title>App Shell</title>
  <link rel="manifest" href="/manifest.json">
  <meta http-equiv="X-UA-Compatible" content="IE=edge">
  <meta name="viewport" content="width=device-width, initial-scale=1.0">
  <link rel="stylesheet" type="text/css" href="styles/inline.css">
</head>

<body>
  <header class="header">
    <h1 class="header__title">App Shell</h1>
  </header>

  <nav class="nav">
  ...
  </nav>

  <main class="main">
  ...
  </main>
  <div class="dialog-container">
  ...
  </div>

  <div class="loader">
    <!-- Show a spinner or placeholders for content -->
  </div>

  <script src="app.js" async></script>
  <script>
  if ('serviceWorker' in navigator) {
    navigator.serviceWorker.register('/sw.js').then(function(registration) {
      // Registration was successful
      console.log('ServiceWorker registration successful with scope: ', registrat
    }).catch(function(err) {
      // registration failed :(
      console.log('ServiceWorker registration failed: ', err);
    });
  }
  </script>
</body>
</html>
```

Note: See https://app-shell.appspot.com/ for a real-life look at a very simple PWA using an application shell and server-side rendering for content. An app shell can be implemented using any library or framework as covered in our Progressive Web Apps across all frameworks talk. Samples are available using Polymer (Shop) and React (ReactHN, iFixit).

Caching the application shell

An app shell can be cached using a manually written service worker or a generated service worker using a static asset precaching tool like sw-precache.

Note: The examples are provided for general information and illustrative purposes only. The actual resources used will likely be different for your application.

Caching the app shell manually

Below is example service worker code that caches static resources from the app shell into the Cache API using service worker's `install` event:

```
var cacheName = 'shell-content';
var filesToCache = [
  '/css/styles.css',
  '/js/scripts.js',
  '/images/logo.svg',

  '/offline.html',

  '/',
];

self.addEventListener('install', function(e) {
  console.log('[ServiceWorker] Install');
  e.waitUntil(
    caches.open(cacheName).then(function(cache) {
      console.log('[ServiceWorker] Caching app shell');
      return cache.addAll(filesToCache);
    })
  );
});
```

Using sw-precache to cache the app shell

The service worker generated by sw-precache will cache and serve the resources that you configure as part of your build process. You can have it precache every HTML, JavaScript, and CSS file that makes up your app shell. Everything will both work offline, and load fast on subsequent visits without any extra effort.

Here is a basic example of using sw-precache as part of a gulp build process:

```
gulp.task('generate-service-worker', function(callback) {
  var path = require('path');
  var swPrecache = require('sw-precache');
  var rootDir = 'app';

  swPrecache.write(path.join(rootDir, 'service-worker.js'), {
    staticFileGlobs: [rootDir + '/**/*.{js,html,css,png,jpg,gif}'],
    stripPrefix: rootDir
  }, callback);
});
```

To learn more about static asset caching, see the Adding a Service Worker with sw-precache codelab.

Note: sw-precache is useful for offline caching your static resources. For runtime/dynamic resources, we recommend using our complimentary library sw-toolbox.

Conclusion

An app shell using Service worker is powerful pattern for offline caching but it also offers significant performance wins in the form of instant loading for repeat visits to your PWA. You can cache your application shell so it works offline and populate its content using JavaScript.

On repeat visits, this allows you to get meaningful pixels on the screen without the network, even if your content eventually comes from there.

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