The PRPL Pattern

By Addy Osmani
Eng Manager, Web Developer Relations

Dogfood: PRPL is a new pattern we feel has great potential. At this stage, we welcome experimentation with it while we iterate on the ideas in the pattern and collect more data on where it offers the greatest benefits.

The mobile web is too slow. Over the years the web has evolved from a document-centric platform to a first-class application platform. Thanks to advancements in the platform itself (such as Service Workers) and in the tools and techniques we use to build apps, users can do virtually anything on the web they can do in a native app.

At the same time, the bulk of our computing has moved from powerful desktop machines with fast, reliable network connections to relatively underpowered mobile devices with connections that are often slow, flaky or both. This is especially true in parts of the world where the next billion users are coming online.

Unfortunately, the patterns we devised for building and deploying powerful, feature-rich web apps in the desktop era generally yield apps that take far too long to load on mobile devices – so long that many users simply give up.

This presents an opportunity to craft new patterns that take advantage of modern web platform features to granularly deliver mobile web experiences more quickly. PRPL is one such pattern.

The PRPL pattern

PRPL is a pattern for structuring and serving Progressive Web Apps (PWAs), with an emphasis on the performance of app delivery and launch. It stands for:

- **Push** critical resources for the initial URL route.
- **Render** initial route.
- **Pre-cache** remaining routes.
- **Lazy-load** and create remaining routes on demand.

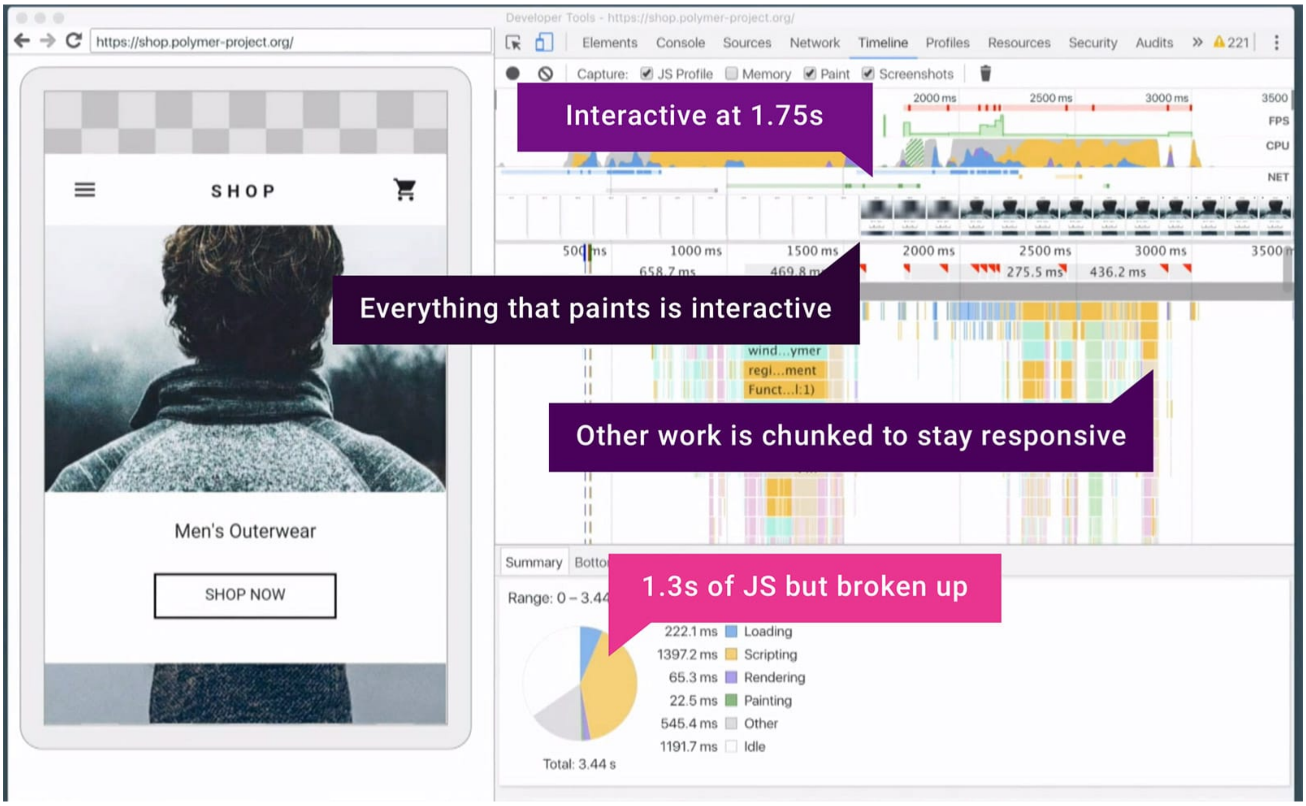
Beyond targeting the fundamental goals and standards of PWAs, PRPL strives to optimize for:

- Minimum time-to-interactive
    - Especially on first use (regardless of entry point)
    - Especially on real-world mobile devices
- Maximum caching efficiency, especially over time as updates are released
- Simplicity of development and deployment

PRPL is inspired by a suite of modern web platform features, but it’s possible to apply the pattern without hitting every letter in the acronym or using every feature.

In fact, PRPL is more about a mindset and a long-term vision for improving the performance of the mobile web than it is about specific technologies or techniques. The ideas behind PRPL are not new, but the approach was framed and named by the Polymer team and unveiled at Google I/O 2016.

Polymer's Shop e-commerce demo is a first-class example of an application using PRPL to granularly serve resources. It achieves interactivity for each route incredibly quickly on real-world mobile devices:


Interactive at 1.75s

Everything that paints is interactive

Other work is chunked to stay responsive

1.3s of JS but broken up

Range: 0 – 3.44

```
222.1 ms  Loading
1397.2 ms Scripting
65.3 ms   Rendering
22.5 ms   Painting
545.4 ms  Other
1191.7 ms Idle
```

Total: 3.44 s

For most real-world projects, it’s frankly too early to realize the PRPL vision in its purest, most complete form – but it’s definitely not too early to adopt the mindset, or to start chasing the vision from various angles. There are many practical steps that app developers, tool developers and browser vendors can take in pursuit of PRPL today.

App structure

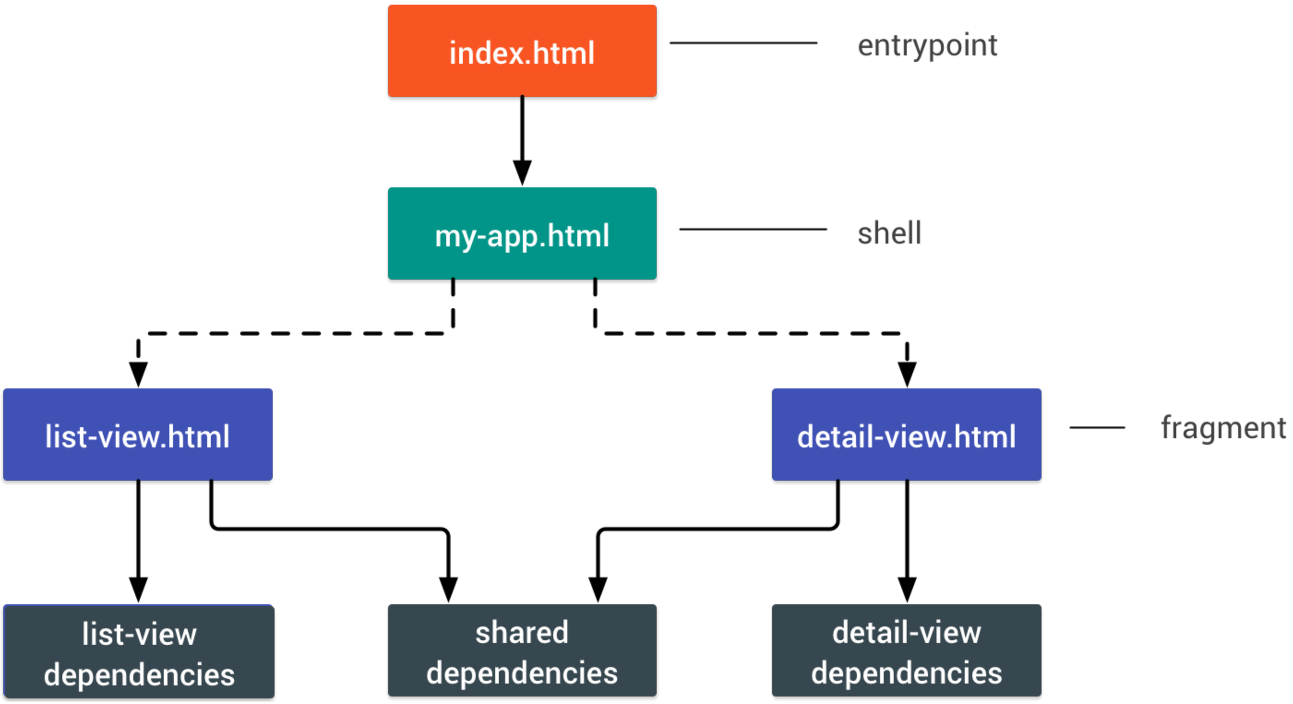
PRPL can work well if you have a single-page app (SPA) with the following structure:

- The main *entrypoint* of the application which is served from every valid route. This file should be very small, since it will be served from different URLs and therefore be cached multiple times. All resource URLs in the entrypoint need to be absolute, since it may be served from non-top-level URLs.
- The *shell* or app-shell, which includes the top-level app logic, router, and so on.
- Lazily loaded *fragments* of the app. A fragment can represent the code for a particular view, or other code that can be loaded lazily (for example, parts of the main app not required for first paint, like menus that aren't displayed until a user interacts with the app). The shell is responsible for dynamically importing the fragments as needed.

The server and service worker together work to precache the resources for the inactive routes.

When the user switches routes, the app lazy-loads any required resources that haven't been cached yet, and creates the required views. Repeat visits to routes should be immediately interactive. Service Worker helps a lot here.

The diagram below shows the components of a simple app that might be structured using Web Components:



Note: although HTML Imports are Polymer's preferred bundling strategy, you can use code-splitting and route-based chunking to achieve a similar setup with modern JavaScript module bundlers.

In this diagram, the solid lines represent *static dependencies*: external resources identified in the files using `<link>` and `<script>` tags. Dotted lines represent *dynamic* or *demand-loaded dependencies*: files loaded as needed by the shell.

The build process builds a graph of all of these dependencies, and the server uses this information to serve the files efficiently. It also builds a set of vulcanized bundles, for browsers that don't support HTTP/2.

App entrypoint

The entrypoint must import and instantiate the shell, as well as conditionally load any required polyfills.

The main considerations for the entrypoint are:

- Has minimal static dependencies, in other words, not much beyond the app-shell itself.
- Conditionally loads required polyfills.
- Uses absolute paths for all dependencies.

App shell

The shell is responsible for routing and usually includes the main navigation UI for the app.

The app should lazy-load fragments as they're required. For example, when the user changes to a new route, it imports the fragment(s) associated with that route. This may initiate a new request to the server, or simply load the resource from the cache.

The shell (including its static dependencies) should contain everything needed for first paint.

Build output

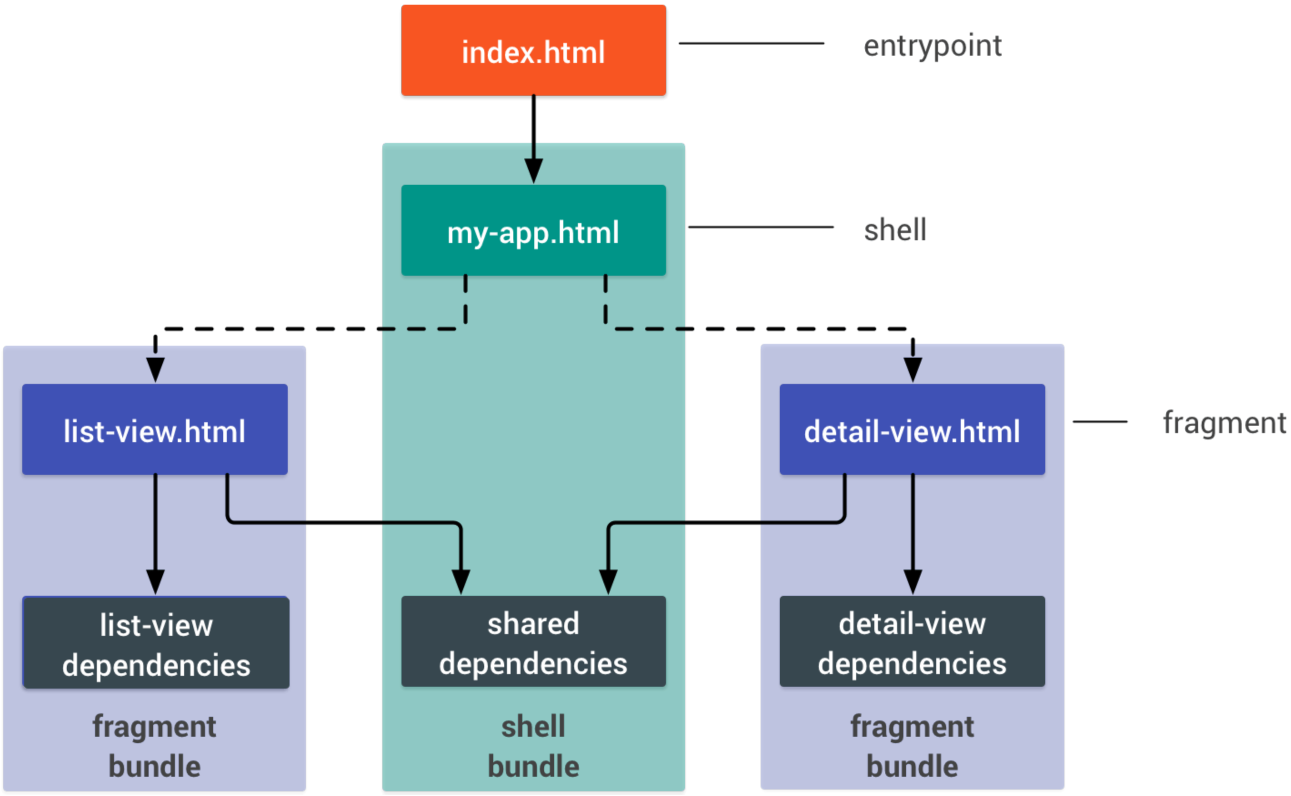
Although it isn't a hard requirement for using PRPL, your build process could produce two builds:

- An unbundled build designed for server/browser combinations that support HTTP/2 to deliver the resources the browser needs for a fast first paint while optimizing caching. The delivery of these resources can be triggered efficiently using `<link rel="preload">` or HTTP/2 Push.
- A bundled build designed to minimize the number of round-trips required to get the application running on server/browser combinations that don't support server push.

Your server logic should deliver the appropriate build for each browser.

Bundled build

For browsers that don't handle HTTP/2, the build process could produce a set of different bundles: one bundle for the shell, and one bundle for each fragment. The diagram below shows how a simple app would be bundled, again using Web Components:



Any dependency shared by two or more fragments is bundled with the shell and its static dependencies.

Each fragment and its *unshared* static dependencies are bundled into a single bundle. The server should return the appropriate version of the fragment (bundled or unbundled), depending on the browser. This means that the shell code can lazy-load `detail-view.html` *without having to know whether it is bundled or unbundled*. It relies on the server and browser to load the dependencies in the most efficient way.

Background: HTTP/2 and HTTP/2 server push

HTTP/2 allows *multiplexed* downloads over a single connection, so that multiple small files can be downloaded more efficiently.

HTTP/2 server push allows the server to preemptively send resources to the browser.

For an example of how HTTP/2 server push speeds up downloads, consider how the browser retrieves an HTML file with a linked stylesheet.

In HTTP/1:

- The browser requests the HTML file.
- The server returns the HTML file and the browser starts parsing it.

- The browser encounters the `<link rel="stylesheet">` tag, and starts a new request for the stylesheet.
- The browser receives the stylesheet.

With HTTP/2 push:

- The browser requests the HTML file.
- The server returns the HTML file, and pushes the stylesheet at the same time.
- The browser starts parsing the HTML. By the time it encounters the `<link rel="stylesheet">`, the stylesheet is already in the cache.

In the simplest case, HTTP/2 server push eliminates a single HTTP request-response.

With HTTP/1, developers bundle resources to reduce the number of HTTP requests required to render a page. However, bundling can reduce the efficiency of the browser's cache. if resources for each page are combined into a single bundle, each page gets its own bundle, and the browser can't identify shared resources.

The combination of HTTP/2 and HTTP/2 server push provides the *benefits* of bundling (reduced latency) without actual bundling. Keeping resources separate means they can be cached efficiently and be shared between pages.

HTTP/2 Push needs to be utilized with care, as it forces data to the browser, even if the file is already in the browser’s local cache or bandwidth is already saturated. If done wrong, performance can suffer. `<link rel="preload">` might be a good alternative to allow the browser to make smart decisions about the prioritization of these requests.

Conclusion

Loading the code for routes more granularly and allowing browsers to schedule work better has the potential to greatly aid reaching interactivity in our applications sooner. We need **better architectures that enable interactivity quickly** and the PRPL pattern is an interesting example of how to accomplish this goal on real mobile devices.

It’s all about headroom and giving yourself enough once you’re done loading your abstractions. If tapping on a link is delayed by seconds of script that prevents input events from dispatching, that’s a strong indication there is work to be done on performance. This is a common problem with applications built using larger JavaScript libraries today, where UI is rendered that looks like it should work but does not.

PRPL can help deliver the minimal functional code needed to make the route your users land on interactive, addressing this challenge.

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