

## 2. Introduction to site performance optimization.

### Website speed / website performance:

- refers to how quickly a browser is able to load fully functional webpages from a given site.
- poorly performing sites - render slowly - drive users away.
- sites that load quickly - receive more traffic - have better conversion rates.

### importance of site speed:

#### 1. conversion rate:

- rate at which users complete desired action.
- more users stay on fast-loading sites - also convert at higher rates.
- decrease in page load times of a few milliseconds increases conversion.
- improving site performance is a huge part of conversion rate optimization.

#### 2. Bounce rate:

- the percentage of users who leave a website after viewing only one page.
- users - close window / click away if page does not load within a few seconds.
- BBC - lost lot. of total users.  
for every additional second it took for their pages to load.

### 3. SEO best practices:

- Google - prioritize - getting relevant information to users as quickly as possible.
- site performance - important factor in Google search rankings.
- site performance on mobile devices is especially important.

### 4. User Experience:

- long page load times / poor response times
  - bad user experience
- frustrating - waiting for content to load
- provokes user to leaving the site or application altogether.

### factors affecting site speed:

#### 1. Page weight:

- amount of resources a website needs to load.
- significant weight or load time -  
Large Javascript files, video content, heavy CSS file, high-definition images.
- more difficult to keep website light  
↓  
small file sizes, quick loading pages
- since web technologies have increased capabilities and websites have become more complex.
- average total page weight is increasing rapidly.

## 2. Network conditions.

- a light weight website may not load quickly due to network slowness.
- local networking equipments, mobile devices using 3G, 4G, slow network connections. it is largely out of developer's hands.
- for delivering web resources over slow connection -
  1. minification.
  2. compression.
  3. Hosting content with CDN.

## 3. Hosting location:

- content has to travel a long way to arrive where it is needed, results in a high amount of network latency.
- HTML & CSS - ohio  
images - florida  
user - west coast.
- needs to wait till all of these files travel thousands of miles to their device.

## \* Website performance metrics:

### 1. Load time:

- time required for entire webpage to appear in the browser.
- every HTTP request has to be fulfilled.

### 2. Page size:

- the total file size of all the resources that need to be loaded for the page to function.

### 3. Time to First Byte (TTFB) :

- the amount of time between a browser's request for a webpage and when the very first byte of the response arrives.

### 4. No. of round trips:

- how many times a request / response needs to travel all the way to an origin server and back.

### 5. Round Trip Time (RTT) :

- amount of time it takes for requests to make a round trip.
- request reaches the origin server and the response travels back to the device that made the request.

## \* core web vitals (CWV):

- are the set of three web performance metrics
- Google's search engine measures these three metrics and incorporates them into its decisions about which pages to display in search results.
- To improve page ranking - webpage's core web vitals should be optimized.
- The CWV's are:
  1. Largest contentful paint (LCP), which measures loading speed.
  2. First Input Delay (FID), which measures page interactivity.
  3. Cumulative Layout Shift (CLS), which measures visual stability.

## \* Google page experience update .

- page load times - important part of SEO
- mid-2021 - the CWV's become a part of Google's ranking algorithm.
- CWV's would be factored into page experience signals - helps to determine a page's search rankings.
- other experience factors - HTTPS-security, mobile friendliness, absence / presence of intrusive interstitials (pop-ups).

This is known as Google's page experience update .

## \* Largest Contentful paint (LCP):

- measures the amount of time it takes to load the largest piece of webpage.
- usually an image or block of text.
- LCP measurement - Good - under 2.5 sec. faster is always better.
- LCP - measure of loading an entire webpage X benchmark to indicate how fast the webpage is loading ✓
- biggest element on webpage - its main content . time when it loads. - user perceives that the page has loaded .
- earlier version of LCP is FMP.  
FMP - first meaningful point . measure of time when primary content on a page becomes visible.
  - unreliable metric
  - removed it from its reporting tools .

## \* First Input Delay (FID):

- measurement of the time between user's first attempt to interact with a webpage and when it responds.
- quantifies - How quickly a person can first click on the screen and make something happen .
- Good FID - 100 milliseconds / less .
- FID - does not measure how long it takes for the requested event to actually occur

- only measures the time between the request and when the request starts to be fulfilled.
  - It is the field metric - something that is measured based on observation of real users rather than hypothetically in lab.
- \* cumulative layout shift (CLS):
- How much a webpage "jumps around" as it loads.
  - the largest burst of shifts in the page's layout.
  - Good CLS - 0.1 (equal to / less than)
  - Layout shift - when page content moves up-down or in any other directions from where it originally appeared.
  - burst - Group of layout shifts that all happen within a second of each other.
    - upto 5 sec. long - contain any number of layout shift.
  - layout shift impact score =  $\frac{\text{impact fraction} \times \text{distance fraction}}{\text{distance fraction}}$ .
  - Impact fraction - percentage of the screen that changes when layout shifts occurs.
  - Distance fraction - how far an element on the screen moves, also as a percentage of the screen.

## How to measure core web vitals:

The following are all offerings directly from Google:

### 1. Chrome UX Report (CrUX):

- offers field data reported by Chrome users,
- giving site owners data about how actual users experience their website.

### 2. Google Lighthouse

- is a free tool that provides lab metrics about CWVs.
- offers actionable insights for improving performance, SEO, accessibility and more.

### 3. Google PageSpeed Insights

- combines the functionality of CrUX and Lighthouse
- offering both field & lab data on CWVs and other web vitals.
- users can check performance for websites whether or not they own them.

### 4. Google search console

- based in part on CrUX field data.
- CWVs performance data by URL and group of URL.

## improve core web vitals :

### \* improve LCP:

#### 1. use content delivery network (CDN):

CDNs cache content in locations all over the world so that content reaches users more quickly.

#### 2. optimize images:

- largest element of a page.
- Reducing image file size can help speed up an image's load time.

#### 3. implement lazy-loading:

lazy-loading: website resources are only loaded when a user needs them.

- makes website loading more efficient.
- overuse correlates with lower LCP.
- limiting lazy-loading of images "below the fold" or to the parts of the webpage a user has to scroll to see.

### \* improve FID:

#### 1. reduce the size of javascript functions:

- code-heavy dynamic webpages causes input delays.
- browser has to wait for all the code to load before it can execute it.
- javascript minification can help this process go faster.

#### 2. build static webpages:

- static HTML webpages load faster than dynamic pages.
- especially when distributed via. CDN.

## - static site generators / JAMstack -

a development philosophy that emphasizes static content.

## 3. Remove unnecessary third-party tools and scripts.

### \* Emp -

loading additional tools on your website can also slow down the performance.

To improve FID - reduce the amount of third party tools on website.

### \* Improve CLS -

#### 1. minimize third party page elements:

- third party elements - load from separate locations compared to the rest of the page.
- They may load at a slightly different time
- change the page's layout as they load.
- minimizing the use of these third-party elements reduces the no. of resulting layout shifts.

#### 2. Reserve space for embedded content:

- Many third party elements - such as ads essential to a website's functionality.
- business model and cannot be eliminated.
- reserve space on webpage for these elements to load before the browser fetches the actual elements.

#### 3. ensure images load in the optimal size:

- slightly different process than optimizing images in general.
- img. at different size - screens vary in size.
- If a browser loads the large, desktop-optimized image first.

- then needs to get the mobile optimised image because the device in use is smartphone.
- this can cause the content on the page to jump around when the differently sized image loads.

#### 4. Include height and width for images & video:

- height and width - tells browsers how large an image will be so they reserve that space before the image or video loads.

## How to test website performance:

What should be evaluated:

A good place to start is the

Core Web Vitals: - A set of three metrics which measure important web performance aspects:

- 1) Largest Contentful Paint: measures how quickly the largest element on page loads.
- 2) First Input Delay: measures how quickly a page responds to user input.
- 3) Cumulative Layout Shift: measures the visual stability of page's elements.

No guaranteed blueprint for strong web performance, following are the best practices to help boost site speed and reliability:

- 1) Optimize images.
- 2) Limit the no. of HTTP requests.
- 3) Use browser HTTP caching.
- 4) Remove unnecessary render-blocking JavaScript.
- 5) Limit the use of external scripts.
- 6) Limit redirect usage.
- 7) Minify CSS and JavaScript files.

## Lighthouse Test

- It is an open source, automated tool for improving the quality of web pages.
- Can run it against any web page, public or requiring authentication.
- Has audits for performance, accessibility, progressive web apps, SEO & more.
- Can run Lighthouse in Chrome DevTools, from the command line, or as a Node module.
- Give Lighthouse a URL to audit, it runs a series of audits against the page.
- Generates a report on how well the page did.
- failing audits can be used as indicators on how to improve the page.

Choose the Lighthouse workflow that suits you best:

- 1) In Chrome DevTools: Easily audit pages that require authentication, and read your reports in a user-friendly format.
- 2) from the command line: automate Lighthouse runs via shell scripts.
- 3) As a Node module: Integrate Lighthouse into your continuous integration systems.
- 4) from a web UI: Run Lighthouse and link to reports without installing a thing.

Run Lighthouse in Chrome DevTools:

Lighthouse has its own panel in Chrome DevTools

To run a report:

1. Download Google Chrome for Desktop.

2. In Google Chrome, go to the URL you want to audit.

3. Open Chrome Dev Tools.

4. Click the Lighthouse tab.

5. Click Analyze page load

DevTools shows you a list of audit categories

Leave them all enabled.

6. Click Run audit.

After 30-60 sec. Lighthouse gives you a report on the page.

\* Install and run the Node command line tool

To install the node module:

1. Download Google Chrome for Desktop.

2. Install the current Long-term Support version of node.

3. Install Lighthouse. The -g flag installs it as a global module.

```
npm install -g lighthouse.
```

To run an audit:

```
lighthouse <url>
```

To see all the options:

```
lighthouse --help
```

## > \* Run PageSpeed Insights

To run lighthouse on PageSpeed Insights:

1. Navigate to Page Speed Insights.
2. Enter a web page URL.
3. Click Analyze.

## \* Run Lighthouse as a Chrome Extension

To install the extension:

1. Download Google Chrome for Desktop.
2. Install the Lighthouse Chrome extension from the Chrome Webstore.

To run an audit:

1. In Chrome, go to the page you want to audit.
2. Click the Lighthouse, it should be next to the Chrome address bar.  
If not, open Chrome's extension menu and access it from there.
3. Click Generate report.

Lighthouse runs its audits against the currently-focused page - then opens up a new tab with a report of the results.

## \* Share and view reports online.

Use the Lighthouse viewer to view and share reports online.

## unpacking the lighthouse report and metrics

- 5 different categories.
- All of them serve at improving the overall quality of web pages.

### 1. Performance Audit:

#### first contentful point (FCP):

- Marks the first point when a user can see anything on the screen.
- it is considered the perceived load speed as a result.
- 10% weighting towards the performance score.
- best sites - 1.5 seconds.
- FCP under - 2 seconds.

#### speed index (SI) -

- shows how quickly the contents of a web page are visibly populated.
- 10% weighting while calculating the performance score.
- ideally - 4.3 seconds.
- Speed Index score 75 and above.

#### Largest contentful point (LCP):

- measures how long it takes the largest visible element on the site to be rendered.
- 25% weighting - most imp. element to optimise the performance score.
- Good score - 2.5 seconds or less.

## Total Blocking Time (TBT):

- quantify page's load responsiveness to user input.
- it can be used to replace your FID (First Input Delay)
- 30% weighting - a crucial component of the performance score.
- Good TBT - anything less than 300 milliseconds.

## Cumulative Layout Shift (CLS):

- measures how visually stable a page is.
- 25% weighted in overall performance score.
- A good CLS score - 0.1 or less.

## 2. Accessibility Audit:

- relates to how usable your website is for all users.
- site should perform just as well for those who have visual, motor, hearing or cognitive impairments.
- aim to get perfect 100.

## 3. Best practices Audit

- No. of audits - to look for best practice web development components.
- if not 100 - look for the audits that didn't pass.
- implement the changes to optimize the particular metric.

#### 4. SEO Audit :

- second-to-last section.
- analyze site to ensure that it is optimized for search engine ranking.
- making sure that overall structure of page is set up well for ranking purposes.
- should be authentic and above board.

#### 5. Progressive Web APP (PWA) Audit

- last section.
- validate the aspects of a progressive web APP.
- built and enhanced app that delivers better capabilities, reliability and stability for everyone.

#### \* Optimize Lighthouse performance score:

##### 1. Set up page caching

speeds up server response time significantly and helps to improve LCP.

##### 2. Optimize browser caching

ensure that you have the right policies for maintaining static files.

##### 3. Optimize fonts, images and code:

ensure that you're not loading unnecessary CSS or unused Javascript files that get in the way of your main content and LCP score.

##### 4. Optimize your fonts.

use font preloading to improve cumulative layout shift (CLS) performance.

##### 5. Use content delivery network (CDN)

for operating in multiple countries so to ensure that deliver a great experience all across the world.

use server level compression.

to reduce site's file size for fast loading.

7. Ensure all your images and embeds have dimensions :-

Helps to improve CLS.

8. Don't dynamically inject any content above existing content: unless it's in response to a user's action reduce the CLS.

9. Defer or remove unnecessary JavaScript or CSS.  
improve TIE (time to interactive)  
TBT (total blocking time)

10. minimize main thread work or reduce JavaScript execution time to improve speed index (SI).

## PageSpeed Insights

- PSI - reports on the user experience of a page on both mobile and desktop devices
  - provides suggestions on how that page may be improved.
  - provides both lab and field data about a page.
- Lab data - useful for debugging issues
  - collected in a controlled environment.
  - may not capture real-world bottlenecks.
- Field data - useful for capturing true, real-world exp.
  - more limited set of metrics.
- Real-user experience data
  - In PSI it is powered by CRUX dataset.
  - reports real user's FCP, INP, LCP, CLS experiences over the 28-day collection period.
  - reports experiences of the experimental metric TTFB.
  - as well as deprecated metric FID.
- Assessing quality of experiences:
  - 3 Buckets - Good
    - Needs improvement.
    - Poor.
  - has predefined set of thresholds in alignment with the web vitals initiative.

## Distribution of and selected metric values:

- presents a distribution of these metrics so that developers can understand the range of experiences for that page or origin.
  - 3 categories:
    - Good
    - Needs Improvement
    - Poor
    - green
    - amber
    - red
  - values are classified as good / needs improvement / poor by applying the thresholds shown in the metric values.
  - core web vitals:
    - common set of performance signals critical to all web experiences.
    - may be aggregated at either the page or origin level
    - assessment passed if the core web vital score of all these metrics is 75 percentiles. considered as Good.
    - Insufficient data for INP - 75 percentiles of LCP & CLS.
    - LCP or CLS have insufficient data ~~aggregation~~ aggregation can not be passed.
  - Differences between field data in PSI and CRUX
    - PSI - data is updated daily.
    - CRUX dataset on BigQuery - updated monthly and limited to original level data.
- Both data sources represent trailing 28-day periods.

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## Lab diagnostics

- uses Lighthouse to analyze the given URL in a simulated environment.
- for the best performance, accessibility and best practices and SEO categories.

## Score

- at the top of the section score is there.
- determined by running Lighthouse to collect & analyze diagnostic information.
  - 90 or above → good
  - 50 to 89 → needs improvement
  - below 50 → poor.

## Metrics :

Page's performance on different metrics incl. first contentful paint, Largest contentful paint, speed index, cumulative layout shift, time to interactive and total blocking time.

Each metric is scored and labeled with icon:

- Good - green circle
- Needs Improvement - amber informational square
- Poor - red warning triangle

## Audits :

Each category <sup>there</sup> are audits that provides information on how to improve page's user experience.