Mobile Site Speed and the Impact on E-Commerce
This Talk = Teaser of Ongoing Study

Speedstudy.info

Mobile Site Speed and the Impact on E-Commerce

Google

Baqend

Universität Hamburg
We Are Baqend

We bring performance research to practice.

30+ man-years of web performance research

Novel technology for caching dynamic data

Speed Kit – SaaS for e-commerce speed
3 Things Make Your Website Slow

1. Backend Processing
2. Network Delays
3. Client
Speed Kit Optimizes End-To-End

1. Offloaded Servers
2. Low Latency
3. Fast Customer Experience

Shop Backend (unmodified infrastructure) → Speed Kit (in user browser) → Fast Customer Experience
How Do Users Perceive Web Performance?
User Profile

Gender
Young women are less likely to buy on slow pages

Region
Speed influences New Yorkers more than Californians

Nationality
Japanese have the highest expectations

Age
18-to-24-year-olds tend to be more demanding


Brain Food, Speed Matters, Designing for Mobile Performance, Google, 2017.

iOS vs. Android
iOS users are more demanding

Purchases
Mobile users buy more frequently than desktop users

Market Share
iOS dominant in US/UK, Android in other markets

Comparing
Mobile is also preferred for comparing products
Context Matters

**Situation**
Pages feel slower when on the move

**State of Mind**
Pages feel faster when relaxed

**Sale**
Pages feel slow during sales

**Availability**
Slow eventually becomes unavailable

References:
Mobile is strong and growing
Users perceive speed slower than it actually is
On the move, things are even worse
# Delay Psychology: Rules of Thumb

<table>
<thead>
<tr>
<th>Delay</th>
<th>User Perception</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 100 ms</td>
<td>Instant</td>
</tr>
<tr>
<td>100 – 300 ms</td>
<td>Small perceptible delay</td>
</tr>
<tr>
<td>300 – 1000 ms</td>
<td>Machine is working</td>
</tr>
<tr>
<td>1+ s</td>
<td>Mental context switch</td>
</tr>
<tr>
<td>10+ s</td>
<td>Task is abandoned</td>
</tr>
</tbody>
</table>

Stay under 1000 ms to keep users’ attention

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I. Grigorik, High performance browser networking, O'Reilly Media, 2013

Jakob Nielsen, Usability Engineering, Morgan Kaufmann, 1994
How Do Businesses Measure Web Performance?
You Heard The Stories

Amazon: 100 ms slower → -1% Conversion Rate

Zalando: 100 ms faster → +0.7% Revenue Per Session

Walmart: 100 ms faster → +1% Revenue
Load Time & SEO

GQ  From 7 s to 2 s Loads  ➔  +80% Traffic

Google  500 ms Slower Loads  ➔  -20% Traffic

Pinterest  40% Faster Loads  ➔  +15% SEO Traffic

Forrester®
-80% load time → +60% Session Length (Mobile)

OTTO
-42% time to FCP → +25% Session Length

Akamai
+2s load time → +103% Bounce Rate

Forrester. The Total Economic Impact™ Of Accelerated Mobile Pages, 2017
Lars Bognar. Mobile Speed Race der Otto Group Verbessert Mobile Ladezeiten. TWG, 2019
Load Time & User Satisfaction

**radware**  
+500 ms network delay $\rightarrow$ +26% peak frustration

**Aberdeen Group**  
+1 s delay in response times $\rightarrow$ -16% customer satisfaction

**Imperial College London**  
+50% response time $\rightarrow$ -50% productivity


The Performance of Web Applications: Customers Are Won or Lost in One Second. Aberdeen Group, 2008

Summary: The Business Impact of Site Speed

Page Speed = Money

Better

Faster

Worse

Slower
How Do you Measure Page Speed?
What Do Users Perceive?

**Speed Index**
avg. time to visibility

**First Meaningful Paint**
greatest visible change

\[
\int_{0}^{\infty} 1 - VC(t) dt
\]
Synthetic Performance Testing

User Request
Enter URL here...

Server (e.g. WebPagetest)

loads website

Result

Waterfall View

measurements, video analysis, etc.
Real-User Monitoring (RUM)

Browser
- Load timers & meta data
- Custom tracking

Ingestion
- Receive data beacons
- Data storage

Data Warehouse
- Materialized views & aggregations
- Historical data

Visualization
- Dashboards & alerting
- Custom analytics & reporting
Who has qualified for the September debates, so far

Only eight candidates have already qualified for the third Democratic debate hosted by ABC and Univision.

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How to make money with merch from a viral debate moment. Andon Cooper: This is the question for 2020 Democrats. Whether you trust scientists may depend on your political party, survey says.
CrUX Data Analysis

- Performance data from Chrome desktop & mobile users
- Domain granularity

- Publicly available
- Performance distributions (histograms)
- SEO-critical

BigQuery
PageSpeed Insights
CrUX Dashboard
Search Rank
Summary: Measuring Performance

**Synthetic**
- WebPageTest
- Lighthouse
- GTMetrix

**RUM**
- Google Analytics
- mPulse
- Adobe Analytics

**Logs**
- CrUX
- CDN Logs
- Server Logs

- ✔️ User-centric metrics
- ✗ Only simulated
- ✔️ Data from actual users
- ✗ Complex to operate
- ✔️ Readily available
- ✗ Hard to interpret
How Does Speed Correlate To Business Success Exactly?
Measuring the Uplift – With SCIENCE

CDNs, Manual Optimizations
- Only before-after comparison

Speed Kit
- Static sound split
- Clean measurement of performance & business uplifts

Shop Features
- Measurable business impact through A/B tests
First Paint
Chrome UX Report Comparison

*comparing appelrath.com Chrome UX report data from October 2018 with January 2019*
Appelrath: Business Impact

- User-based Conversion Rate: + >10%
- Overall Time for Speed Kit Setup: 2 Days
Without Speed Kit

With Speed Kit

17x faster?
Scholl-Shoes: Performance Uplift

**Time to First Byte (TTFB)**
- Original: 0.5 s
- Speed Kit: 0.14 s

**First Paint**
- Original: 1.2 s
- Speed Kit: 0.7 s

*Median performance on non-blacklisted pages compared between the two A/B test split groups*
Scholl-Shoes: Business Impact

Transactions: + 2.95%
Overall Revenue: + 3.20%
Without Speed Kit vs. With Speed Kit: 2.1x faster?
Stylefile: Uplift in Google Terminology

Original

12%  53%

- green <1s
- yellow 1-2.5s
- red >2.5s

with Speed Kit

47%  73%

*First Paint out of Speed Kit RUM data ranked according to Google CrUX methodology
Stylefile: Business Uplift

User-Based Conversion Rate  + 1.9%

Average Order Value  + 3.8%
Baur.de

Before Speed Kit

15x faster?

Go! After Speed Kit
Overall Performance Uplift For Baur.de

First Contentful Paint Histogram

Median 1361 ms
Median 2087 ms

*Histogram of first contentful paint on PDV pages compared between the two A/B test split groups*
Before Speed Kit

After Speed Kit

2.5x faster

Decathlon.de

Go!
Performance
Best Practices
Frontend

Page Weight & CRP

Compression, above-the-fold optimization, Accelerated Mobile Pages (AMP), ...

Responsive Images

Serve the right dimensions and best format for every device

Browser Caching

Retrieve content without accessing the network, Progressive Web App (PWA)
Reduce Latency

Accelerate requests through CDNs and edge caching

Optimize Protocols

Optimize low-level TCP, DNS, and TLS protocol parameters

Leverage HTTP/2

Send user traffic through HTTP/2 connections and use its features
**Backend**

**Server Stack Efficiency**
Minimize the time to first byte (TTFB) through fast server-side processing

**Scale Horizontally**
Build an architecture that scales with increasing data and request volume

**High Availability**
Transparent error handling and failover mechanisms
How Speed Kit Works

Website + **Speed Kit JS** (Service Worker)

- Fast Requests
- Speed Kit Cloud
- Real-Time Sync
- Origin Backend
- 3rd Parties
False-Positive Rate: 
\[ f \approx \left(1 - e^{-\frac{kn}{m}}\right)^k \]

Hash-Functions: 
\[ k = \left\lfloor \ln(2) \cdot \left(\frac{n}{m}\right) \right\rfloor \]

With 20,000 entries and a 5% false positive rate: **11 Kbyte**

**Consistency:** Δ-Atomicity, Read-Your-Writes, Monotonic Reads, Monotonic Writes, Causal Consistency

Compact **Cache Sketch**

0 1 0 1 1

0 3 0 4 1

Automatic **Browser Cache Coherence**

Add to Server Cache Sketch

Validate Freshness

invalidate
How Fast Are You?
Study Setup

Implementation
A/B-Tested Speedup

Evaluation
Quantified On-Site Uplift

Long-Term Effects
Not Evaluated

- First Paint
- Time to Interaction
- ...

- Conversion Rate
- Time on Site
- ...

- SEO Rank
- Returning Visitors
- ...
THE LARGEST SYSTEMATIC STUDY OF

Mobile Site Speed and the Impact on E-Commerce
Ready to Load Instantly?

Join the study!
Details & newsletter on speedstudy.info

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