Mobile Site Speed and the Impact on E-Commerce

Breaking Bad Performance
This Talk = Teaser of Ongoing Study

THE LARGEST SYSTEMATIC STUDY OF

Mobile Site Speed and the Impact on E-Commerce

Google

Baqend
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**
   - Shop Backend (unmodified infrastructure)

2. **Low Latency**
   - Speed Kit (in user browser)

3. **Fast Customer Experience**
How Do Users Perceive Web Performance?
**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
**Device Distribution**

**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

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

References:
- Greg Linden. Make Data Useful. Stanford Data Mining Class CS345A, 2006
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
Load Time & User Engagement

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

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

Akamai
+2s load time → +103% Bounce Rate
Load Time & User Satisfaction

Radware

+500 ms network delay ➔ +26% peak frustration

Aberdeen Group

+1 s delay in response times ➔ -16% customer satisfaction

Imperial College London

+50% response time ➔ -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

Better

Faster

Worse

Slower

Aberdeen Group

radware

Google

Akamai

Forrester

GQ

Pinterest

Otto

Walmart

zalando

Imperial College London
Summary: The Business Impact of Site Speed

Page Speed = Money

Better

Slower

Faster

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

Speed Index: avg. time to visibility
First Meaningful Paint: greatest visible change

Integral equation: \( \int_0^{\infty} 1 - VC(t) \, dt \)
Synthetic Performance Testing

User Request

Server (e.g. WebPagetest)

loads website

Result

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
Data Analysis

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

- Publicly available
- Performance distributions (histograms)
- SEO-critical
## Summary: Measuring Performance

<table>
<thead>
<tr>
<th>Synthetic</th>
<th>RUM</th>
<th>Logs</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="WebPageTest" /></td>
<td><img src="image" alt="Google Analytics" /></td>
<td><img src="image" alt="CrUX" /></td>
</tr>
<tr>
<td><img src="image" alt="Lighthouse" /></td>
<td><img src="image" alt="mPulse" /></td>
<td><img src="image" alt="CDN Logs" /></td>
</tr>
<tr>
<td><img src="image" alt="GTMetrix" /></td>
<td><img src="image" alt="Adobe Analytics" /></td>
<td><img src="image" alt="Server Logs" /></td>
</tr>
</tbody>
</table>

- **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
• Statistically sound split testing
• Clean measurement of performance & business uplifts

Shop Features
• Measurable business impact through A/B tests
Appelrath.com

Without Speed Kit

3.9x faster

With Speed Kit
Appelrath: CrUX Data Analysis

First Paint

*comparing appelrath.com Chrome UX report data from October 2018 with January 2019

*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

1.7x faster

With Speed Kit
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

With Speed Kit

2.1x faster
Stylefile: Uplift in Google Terminology

Original

- Green (<1s): 12%
- Yellow (1-2.5s): 53%
- Red (>2.5s):

with Speed Kit

- Green (<1s): 47%
- Yellow (1-2.5s): 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%
Before Speed Kit

After Speed Kit

1.5x faster
Overall Performance

For Baur.de

Original
Speed Kit

Median 1361 ms
Median 2087 ms

First Contentful Paint Histogram

*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
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)
Network

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

3rd Parties

Origin Backend
How We Solved Cache Coherence

Automatic Browser Cache Coherence

Validate Freshness

Expiration Cache

Invalidation Cache

invalidate

Add to Server Cache Sketch

Compact Cache Sketch
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
- ...
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Your Email

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Google Baqend
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Details & newsletter on speedstudy.info

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