Breaking Bad Performance

Mobile Site Speed and the Impact on E-Commerce

NFQ Summit 2020, Vietnam – Felix Gessert

This Talk = Teaser of Ongoing Study

Speedstudy.info

Mobile Site Speed and the Impact on E-Commerce

Google

Baqend

Universität Hamburg
DER FORSCHUNG | DER LEHRE | DER BILDUNG

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

Speed Kit Optimizes End-To-End

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

Think Fast, The 2019 Page Speed Report Stats & Trends for Marketers, Unbounce, 2019.

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

Performance Matters, 9 Key Consumer Insights, Akamai, 2014

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

Think Fast, The 2019 Page Speed Report Stats & Trends for Marketers, Unbounce, 2019.

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

Performance Matters, 9 Key Consumer Insights, Akamai, 2014

Android v iOS market share 2019 Q2, DeviceAtlas, 2019

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

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

Performance Matters, 9 Key Consumer Insights, Akamai, 2014

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

Delay	User Perception
0 – 100 ms	Instant
100 – 300 ms	Small perceptible delay
300 – 1000 ms	Machine is working
1+ s	Mental context switch
10+ s	Task is abandoned

Stay under 1000 ms to keep users' attention

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

Greg Linden. Make Data Useful. Stanford Data Mining Class CS345A, 2006

Shuhei Kagawa, Jeff Cybulski, David Martin Jones, et. al.. Loading Time Matters. Zalando Tech Blog, 2018

C. Crocker, A. Kulick, B. Ram. Real-User Monitoring at Walmart, SF & SV Web Performance Group, 2012.

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

Lucia Moses. How GQ Cut Its Webpage Load Time By 80 Percent, Digiday, 2015.

Marissa Mayer, Conference Keynote, Web 2.0, 2006

Sam Meder, Vadim Antonov, Jeff Chang. Driving User Growth With Performance Improvements, Pinterest Blog, 2017

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

Forrester. The Total Economic Impact ™ Of Accelerated Mobile Pages, 2017

Lars Bognar. Mobile Speed Race der Otto Group Verbessert Mobile Ladezeiten, TWG, 2019

Akamai. Akamai Online Retail Performance Report: Milliseconds Are Critical, Akamai Blog, 2017

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

Tammy Everts. Mobile Web Stress: The Impact of Network Speed on Emotional Engagement and Brand Perception, Radware, 2013

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

T. Goodman, R. Spence. The Effect of System Response Time on Interactive Computer Aided Problem Solving, ICL, 1978

Summary: The Business Impact of Site Speed

How Do you Measure
Page Speed?

What Do Users Perceive?

Synthetic Performance Testing

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

Largest Contentful Paint

Now available in Chrome!

Image taken from Philip Walton, Largest Contentful Paint, web.dev, 2019

CrUX Data Analysis

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

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

Summary: Measuring Performance

Synthetic

- WebPagetest
- Lighthouse
- GTMetrix

✓ User-centric metrics

✗ Only simulated

RUM

- Google Analytics
- mPulse
- Adobe Analytics

✓ Data from actual users

✗ Complex to operate

Logs

- CrUX
- CDN Logs
- Server Logs

✓ 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

- Stati[illegible]ound **split** [illegible]
- Clean measurement of performance & business uplifts

Shop Features

- Measurable business impact through A/B tests

Appelrath.com

Without
Speed Kit

3.9x faster

StoGoly?

With
Speed Kit

Appelrath: CrUX Data Analysis

*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

Scholl-Shoes.com

Without
Speed Kit

17x faster

Really?

Go!

With
Speed Kit

Scholl-Shoes: Performance Uplift

*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%**

Stylefile.com

Without
Speed Kit

2.1x faster

Really?

Go!

With
Speed Kit

Stylefile: Uplift in Google Terminology

*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!

Really?

After
Speed Kit

Overall Performance Uplift For Baur.de

First Contentful Paint Histogram

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

Decathlon.de

Before
Speed Kit

After
Speed Kit

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)

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

How We Solved Cache Coherence

Automatic **Browser Cache** Coherence

invalidate

False-Positive Rate: $f \approx \left(1 - e^{-\frac{kn}{m}}\right)^k$ Hash-Functions: $k = \left\lceil \ln(2) \cdot \left(\frac{n}{m}\right) \right\rceil$

With 20.000 entries and a 5% false positive rate: **11 Kbyte**

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

Validate **Freshness**

Add to Server Cache Sketch

Compact **Cache Sketch**

0	1	0	1	1

0	3	0	4	1

In Action: Speed Kit Waterfalls

Accelerated **personalization**

Built-in **cache coherence** mechanism

Accelerated **3rd parties**

Lower **server time** (TTFB)

HTTP/2 multiplexing

Network stack tuning: TCP, TLS, IPv6

On-the-fly **image optimization**

All resources **offline-available**

Automatic **browser + CDN caching**

How Fast Are You?

Summary & Outlook

Study Timeline

Today

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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THE LARGEST SYSTEMATIC STUDY OF

Mobile Site Speed and the Impact on E-Commerce

Your Email

SUBSCRIBE FOR UPDATES

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Ready to Load Instantly?

Join the study!

Details & newsletter on

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