

Batching Was **Yesterday**

Real-Time Tracking & Analysis
For 100+ Million Visitors

Techcamp 2022

Felix Gessert, Wolfram Wingerath

September 28, 2022

Who We Are



First half
of the talk



Felix
CEO

Second half
of the talk



Wollé
Data Engineering &
Research



Research:

- Web Caching
- Stream Processing
- NoSQL & Cloud Systems
- ...



Practice:

- Website Acceleration
- Real-User Monitoring
- Continuous Analytics
- ...



Table of Contents

Why should you care about website performance?

What does tracking data tell you about it?

How do you build a scalable analytics stack?

When can you see the results?

Why Do Businesses Care About Performance?



You Heard the Stories



100 ms slower



-1% Conversion Rate



100 ms faster



+0.7% Revenue Per Session



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.

You Heard the Stories



Page Speed

100 ms slower → -1% Conversion Rate

=



100 ms faster



+0.7% Revenue Per Session

Money



100 ms faster



+1% Revenue

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

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

3 things make your website slow



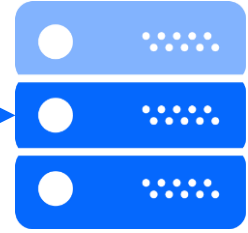
Browser rendering

Page size and weight, image scaling, critical rendering path, ...



Network delays

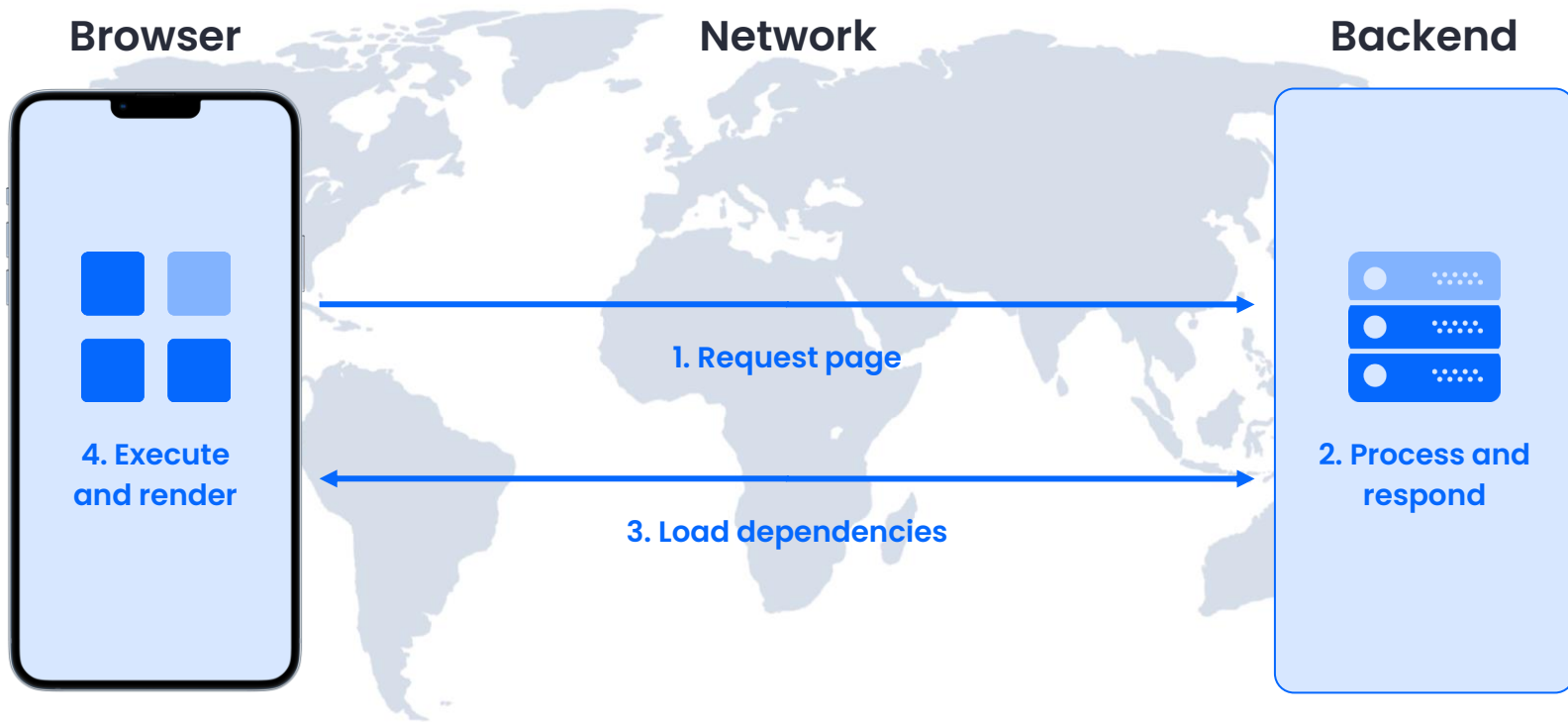
Network latency, access operations, overhead, protocols, ...



Backend processing

Shop system, CMS, database, image servers, microservices, ...

What makes your website slow



We bring performance research to practice



30+ man-years of **web performance research** at University of Hamburg



Novel technology for **caching dynamic data** went into Baqend in 2014



Baqend **launched Speed Kit** as the all-in-one page speed platform in 2018

7,000

customer websites are already using Speed Kit

\$2.6 billion

in annual revenue runs with Speed Kit

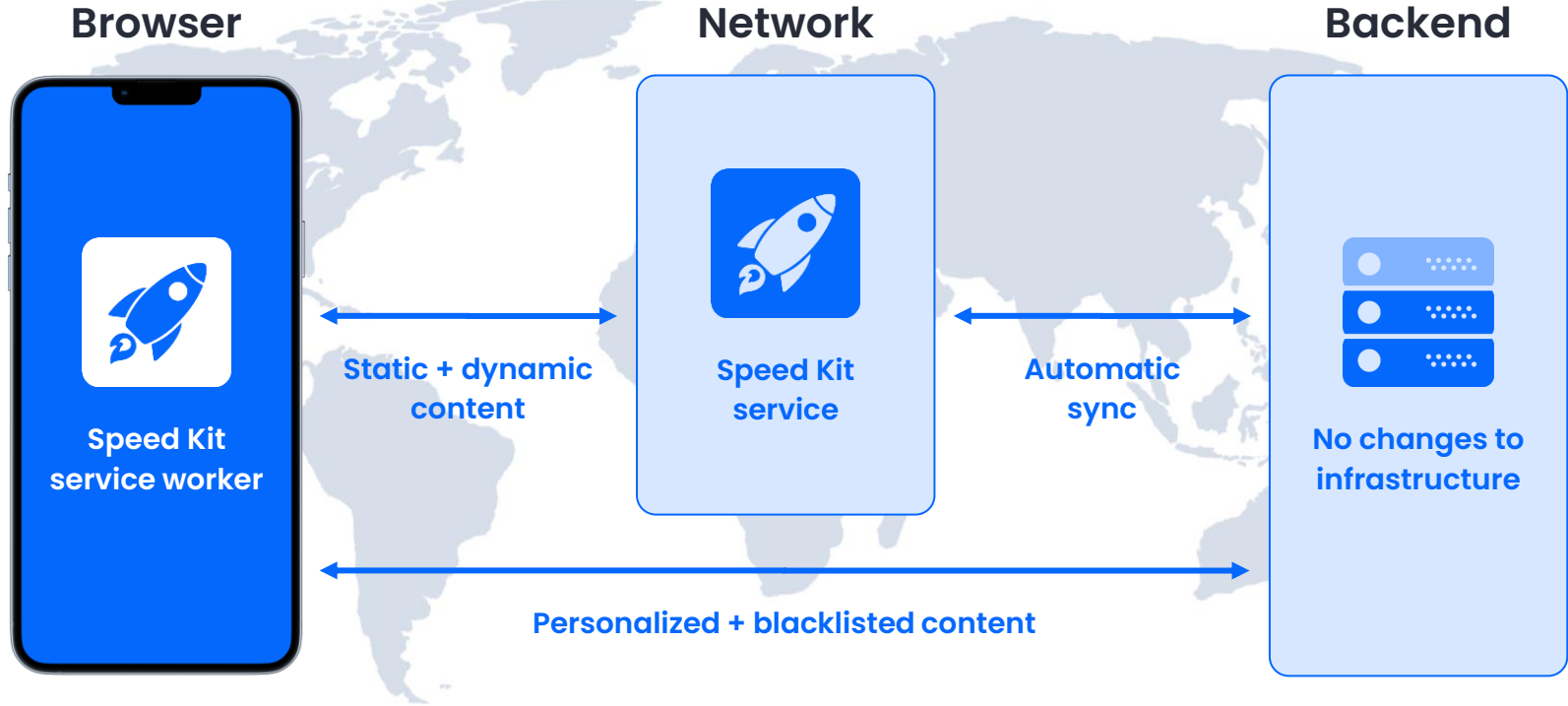
160 million

users per month benefit from Speed Kit

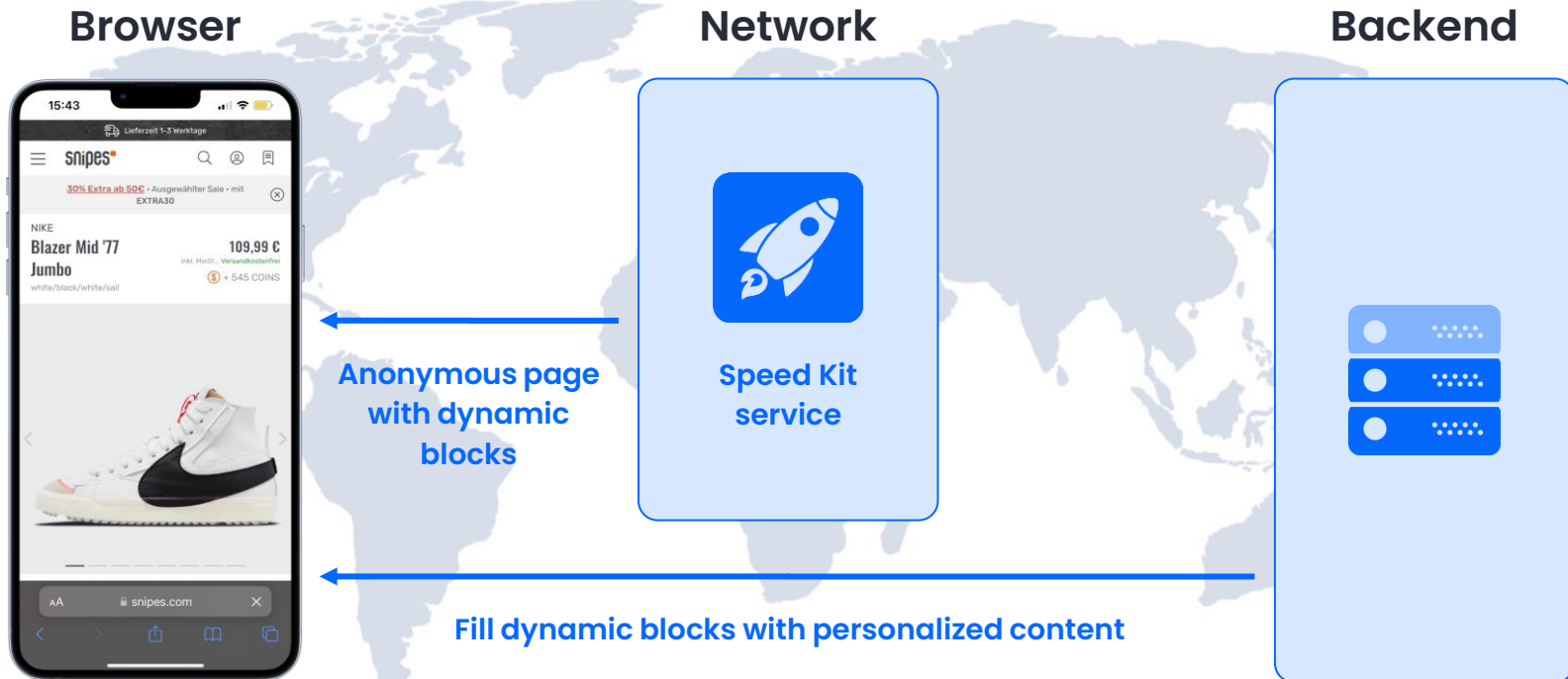
We Kill Load Times



Speed Kit Makes Websites Fast!



Personalization with dynamic blocks



Measuring the Uplift – With SCIENCE!

CDNs, Manual Optimizations



- Only before-after comparison



Speed Kit



Application Features



- Measurable business impact through A/B tests

Measuring the Uplift – With SCIENCE!

CDNs, Manual Optimizations



- Only before-after comparison



Speed Kit



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



Application Features

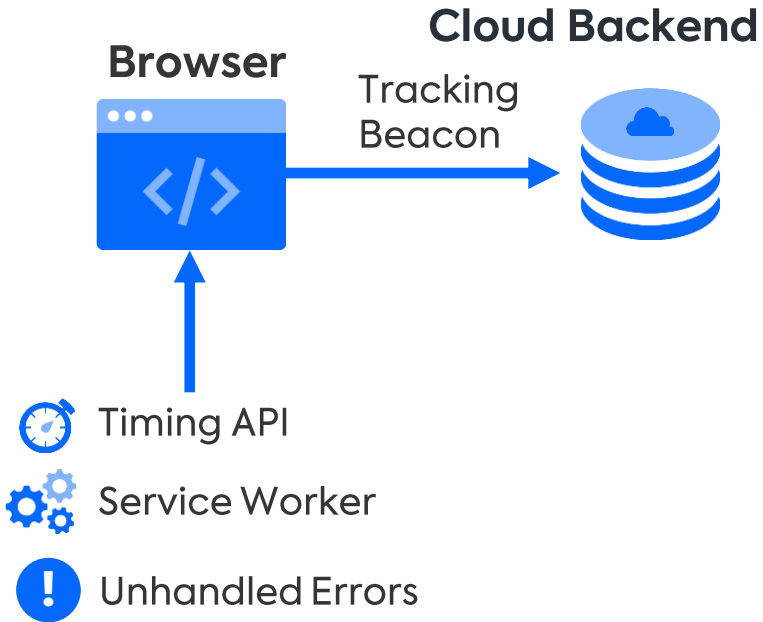


- Measurable business impact through A/B tests

How Do You Measure Web Performance?



The Basic Idea



- Time-to-First-Byte
 - First (Contentful) Paint
 - DOM Timer
 - First Input Delay
- Performance
- Session Length
 - Time on Site
 - First User Interaction
 - Bounce Rate
- User Engagement
- Page Views & Sessions
 - Browser Distribution
 - JavaScript Errors
 - Caching Insights
- QA Metadata

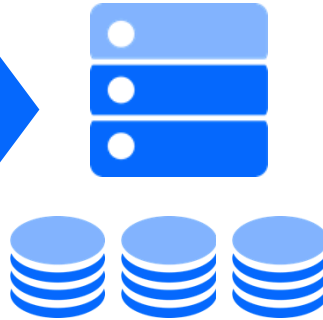
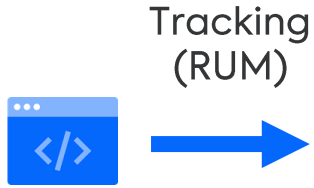
Baqend's RUM Pipeline

Collection

Ingestion

Analytics

Reporting



SQL Interface



Performance Dashboard



QA Dashboard



Real-Time Alerting



Ad-hoc SQL Interface



Custom Reporting

- Raw PI tracking & meta data
- Custom tracking

- Materialized views & aggregations
- Historical data

Baqend's RUM Pipeline

Collection



Tracking (RUM)



Ingestion



- Raw PI tracking & meta data
- Custom tracking

Analytics



- Materialized views & aggregations
- Historical data

Reporting

SQL Interface



Performance Dashboard



QA Dashboard



Real-Time Alerting

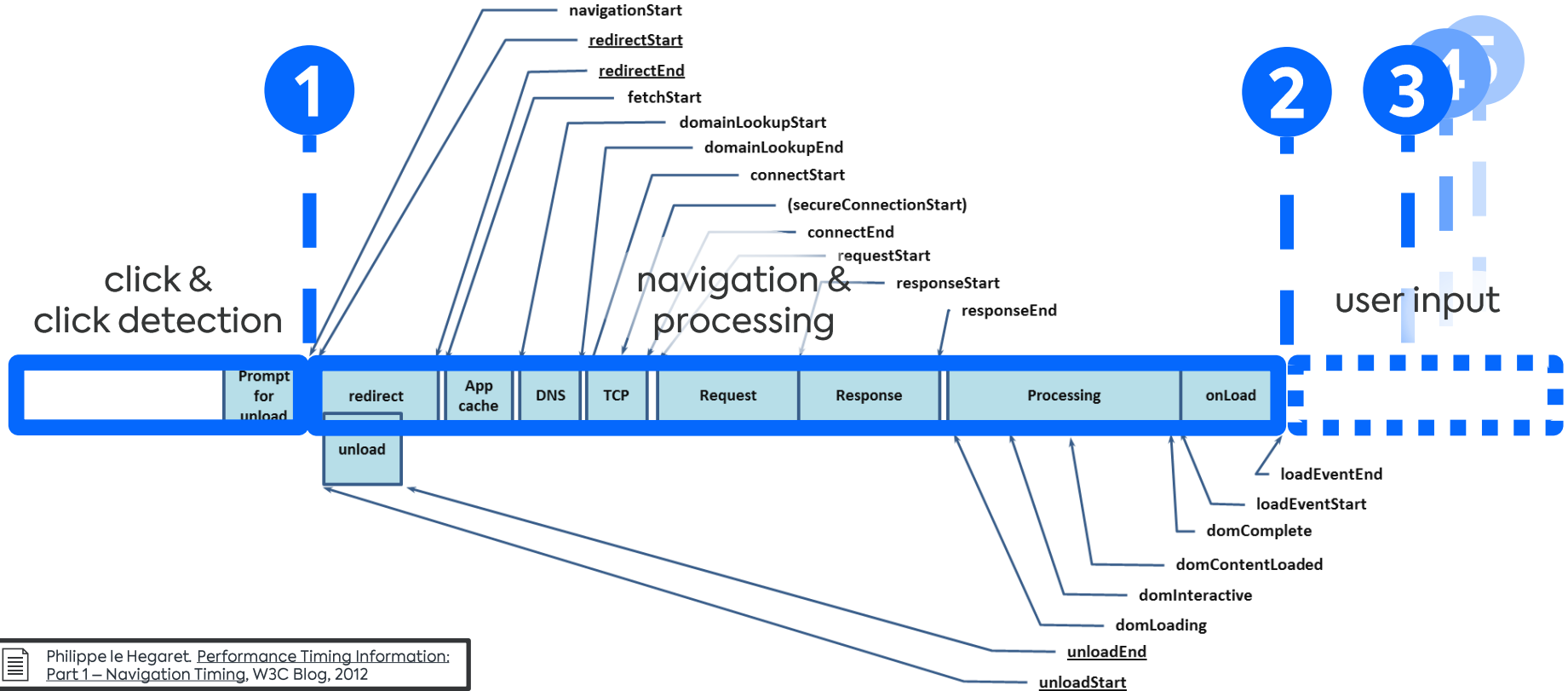


Ad-hoc SQL Interface



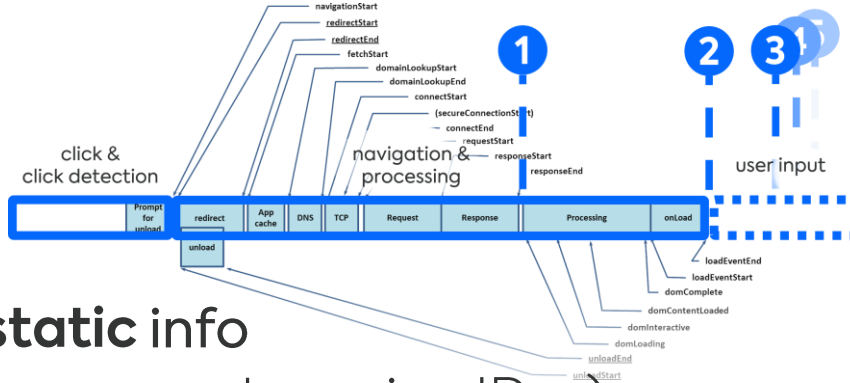
Custom Reporting

When to Send Data Beacons ?



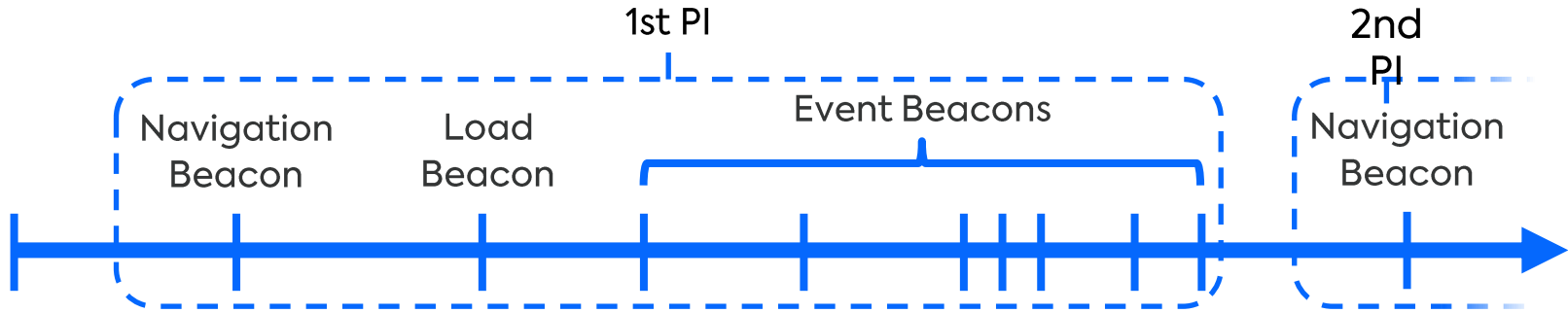
Philippe le Hegaret, *Performance Timing Information: Part 1 – Navigation Timing*, W3C Blog, 2012

Types of Data Beacons



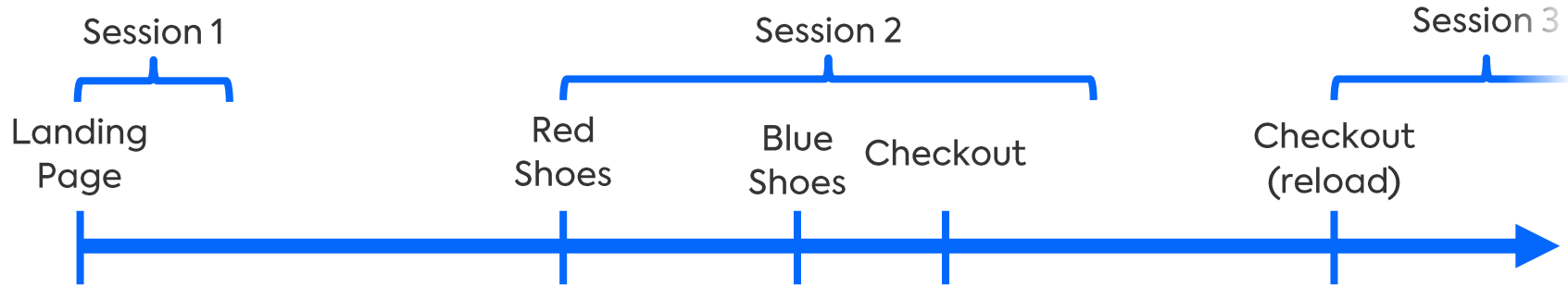
1. 1 for **static** info
(URL, user agent, session ID, ...)
2. 1 for **timings**
(TTFB, load time, FCP, ...)
3. 0-n for **events**
(first input, JavaScript errors, ...)

Schema: Page Impression (PI)



- **Beacon Join → PI:** How do we handle events that come late?
 - Simply wait 5 minutes?
 - Wait for next PI or session timeout?
 - ...?
- How to resolve **user agents**?

Schema: Sessions



- **Bounces & Session End:** find out when and where people leave
- **Session timeout** after 30 minutes of *inactivity*

So What's the Problem?



Speaker Shuffle



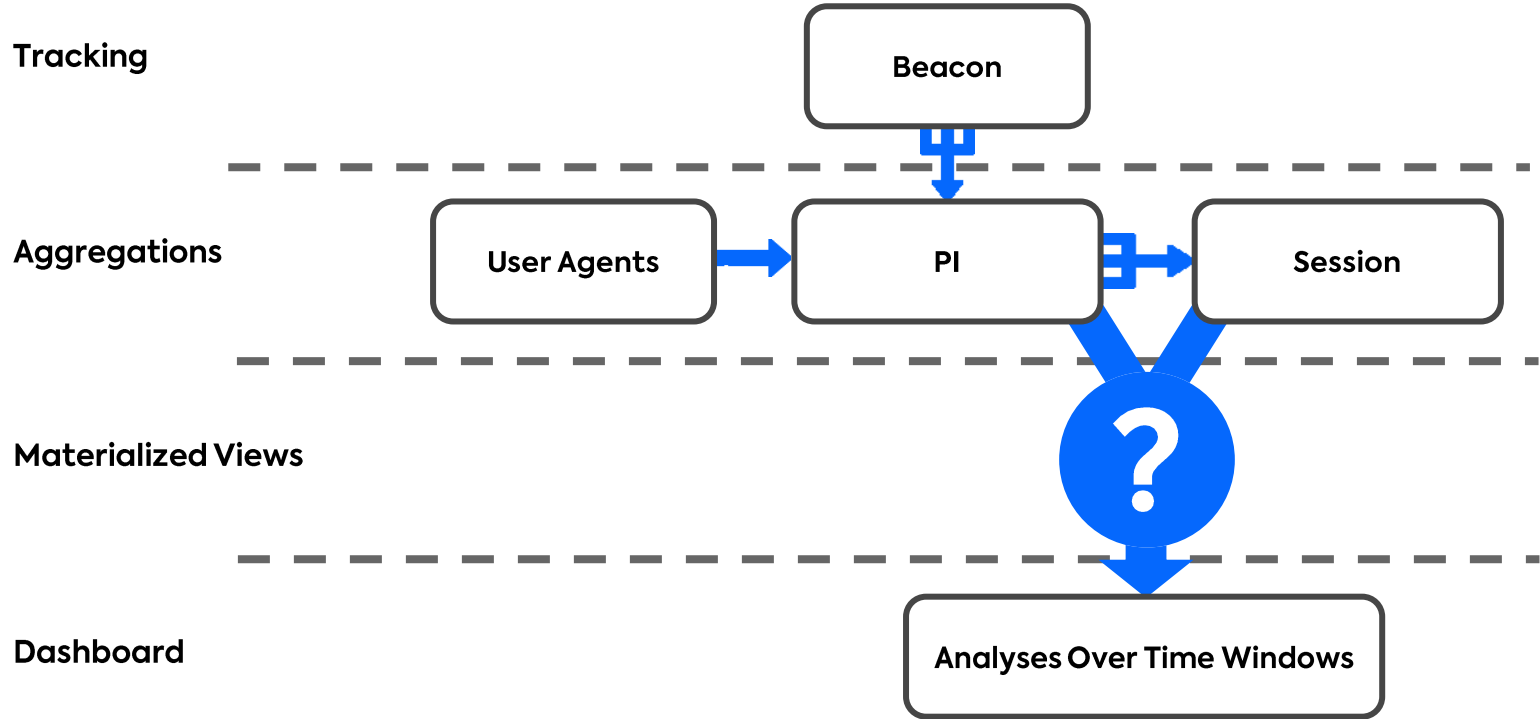
Felix

Speaker Shuffle

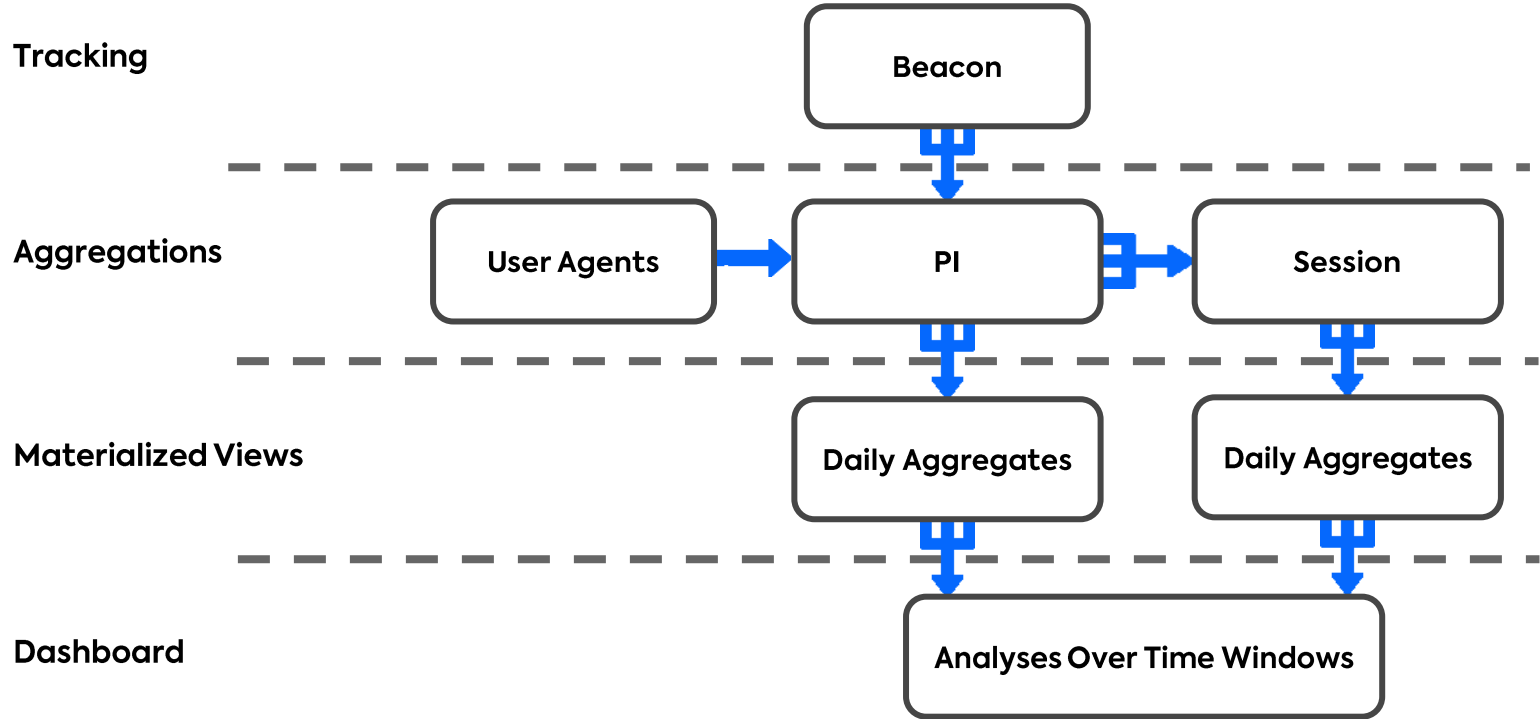


Wolle

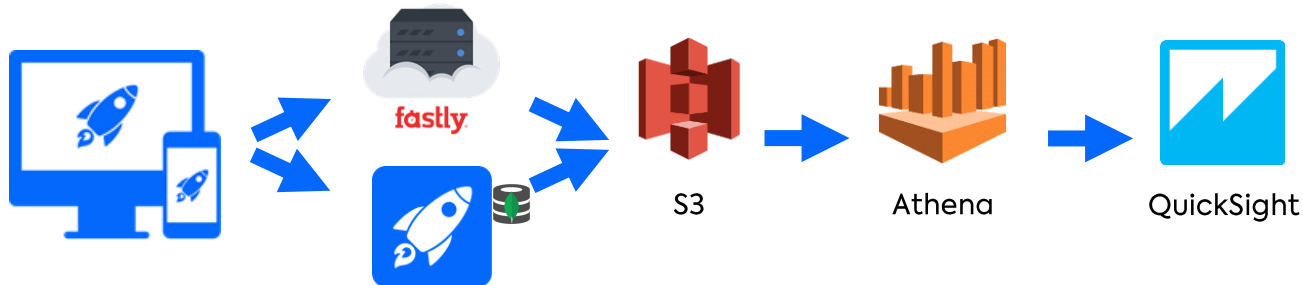
Schema Overview



Schema Overview



Our Batch Analytics Stack



Issues:

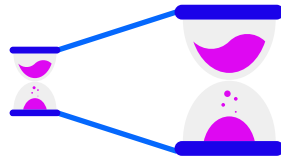
- ✘ Many joins → slow queries
- ✘ 90 minutes discovery time
- ✘ No continuous dashboard (daily materialization)

Processing Stages & Latency

Alerting



Processing Time



Trend Analysis



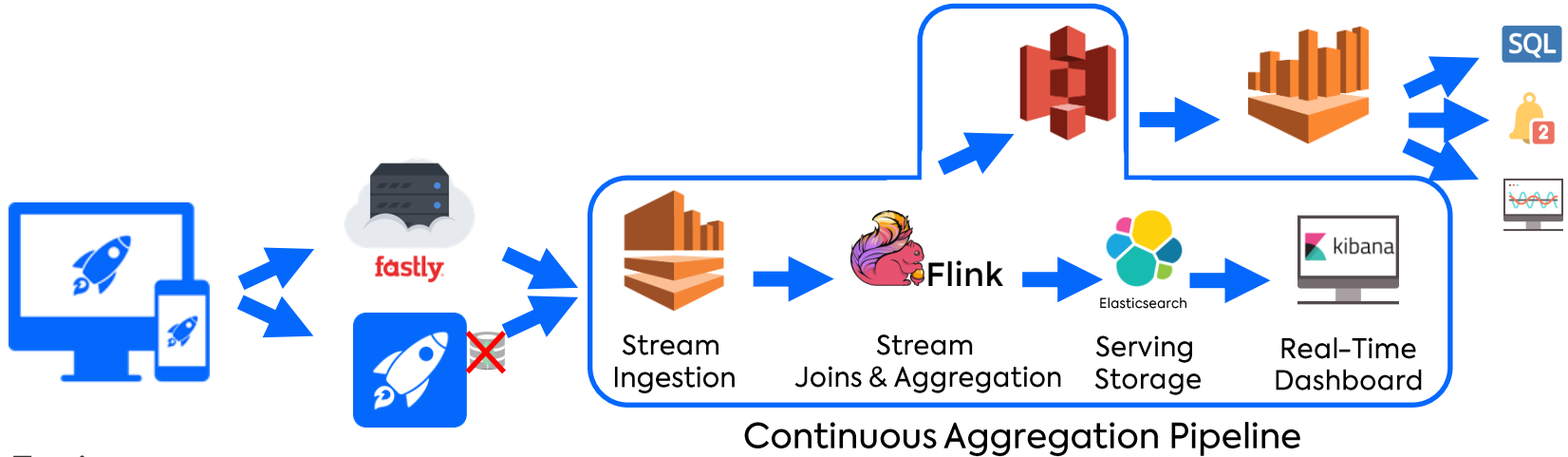
- Simple metrics / little context
 - Counters
 - Extreme values
 - Specific errors

- Complex aggregations / huge time windows
 - Bounce rate
 - Performance by month
 - Seasonal effects

There Must Be a Smarter Way!



Early 2020: AWS Prototyping

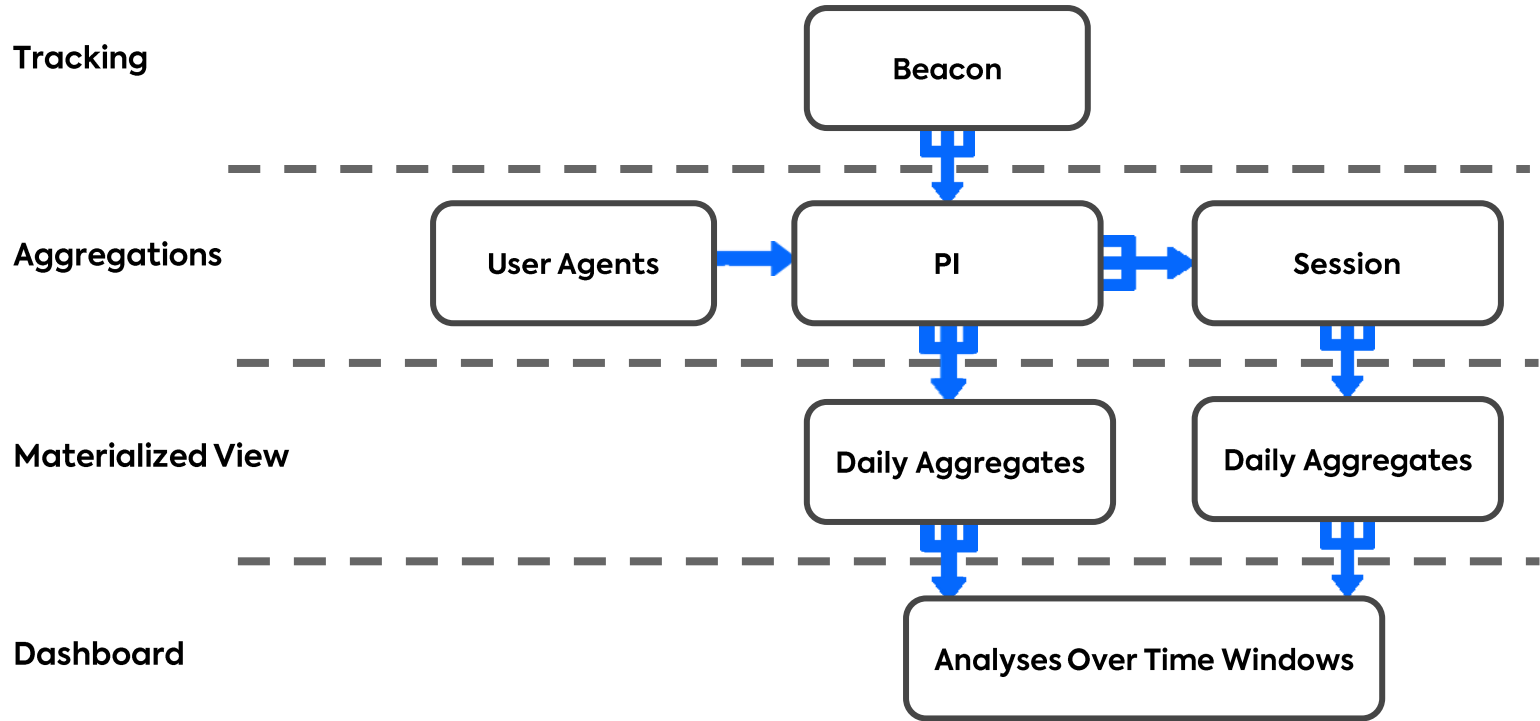


Key Topics:

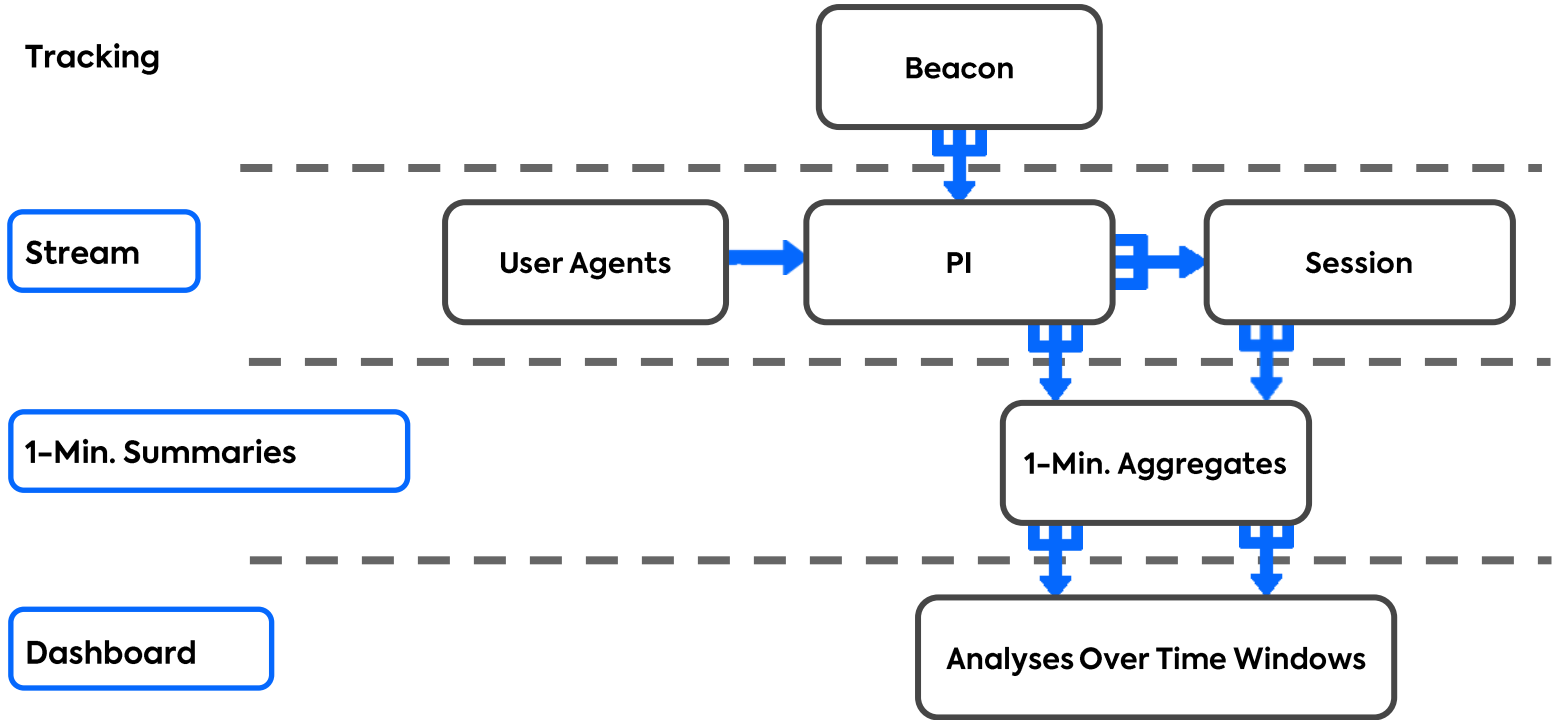
- ✓ No legacy tech => stability & efficiency
- ✓ Faster ingestion => real-time reporting & analytics
- ✓ Fewer joins => faster analytics

W. Wingerath, B. Wollmer, M. Bestehorn, S. Succo, F. Bücklers, J. Domnik, F. Panse, E. Witt, A. Sener, F. Gessert, N. Ritter. *Beaconnect: Continuous Web Performance A/B-Testing at Scale*. VLDB 2022

Shiny & New Schema



Shiny & New Schema



3 Levels of Aggregation

Partial Page Impressions (PPIs)
Enhanced Data Beacons

Time	Browser	Device	Test Group	First Contentful Paint (FCP)
11:05:04.578	Firefox	Mobile	Speed Kit	127ms
11:06:48.139	Chrome	Mobile	Original	958ms

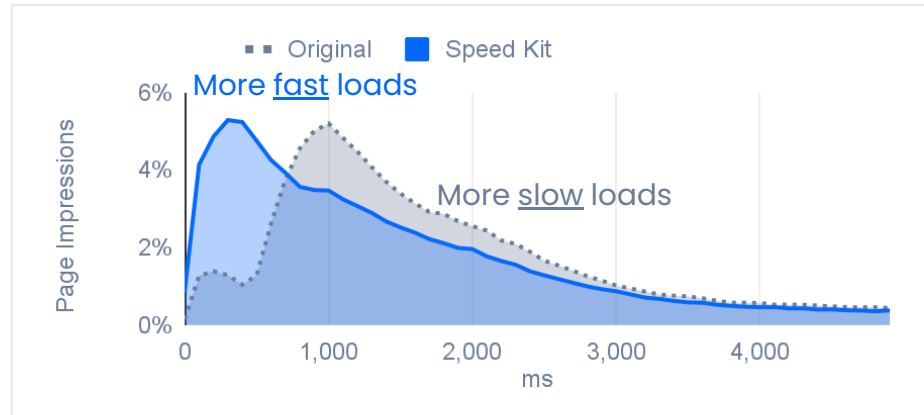
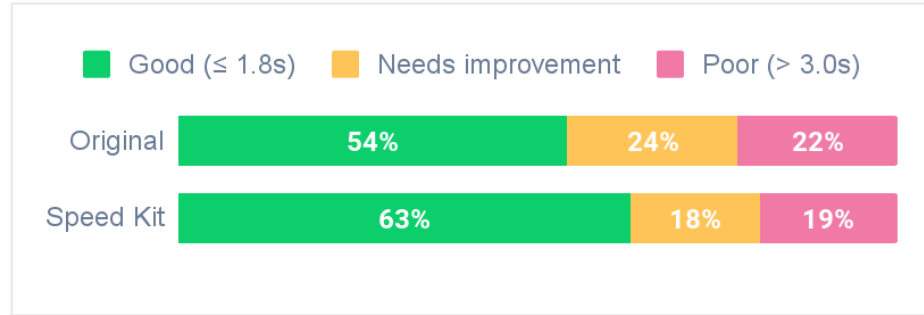
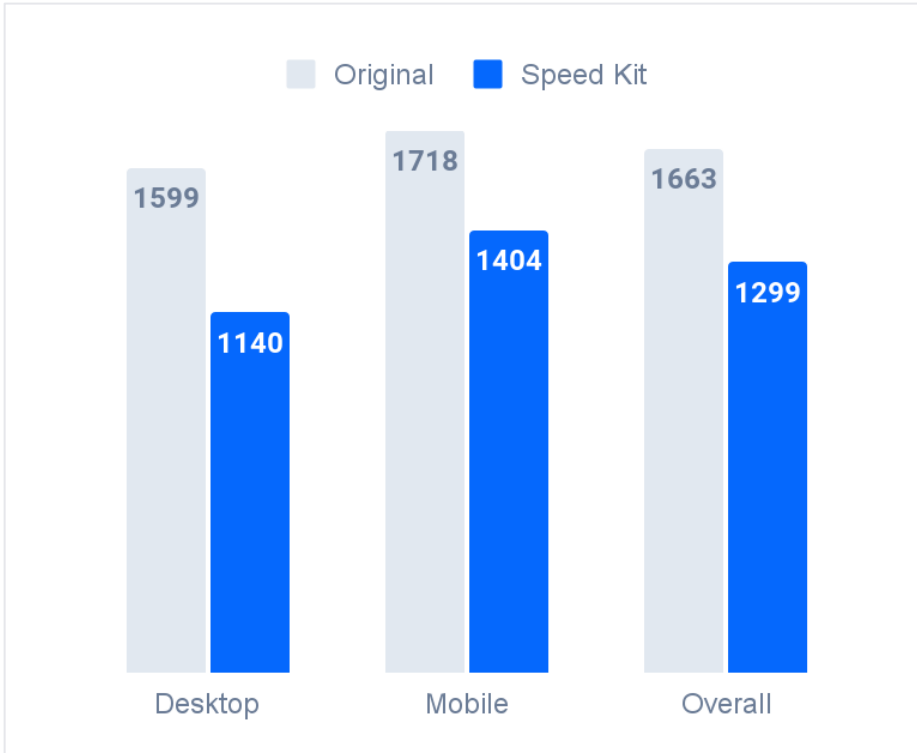
1-Min. Time Windows
Immediate Aggregates (Storage)

	Browser	Device	Test Group	First Contentful Paint (FCP)
11:05	Firefox	Mobile	Speed Kit	{200ms: 1, 500ms: 2}
	Firefox	Mobile	Original	{600ms: 2, 800ms: 5}
	Safari	Desktop	Original	{1100ms: 1}
11:06	Firefox	Mobile	Speed Kit	{200ms: 3}
	Chrome	Mobile	Speed Kit	{400ms: 2}
	Opera	Tablet	Original	{700ms: 1, 1300ms: 2}
	Safari	Desktop	Original	{600ms: 4, 900ms}

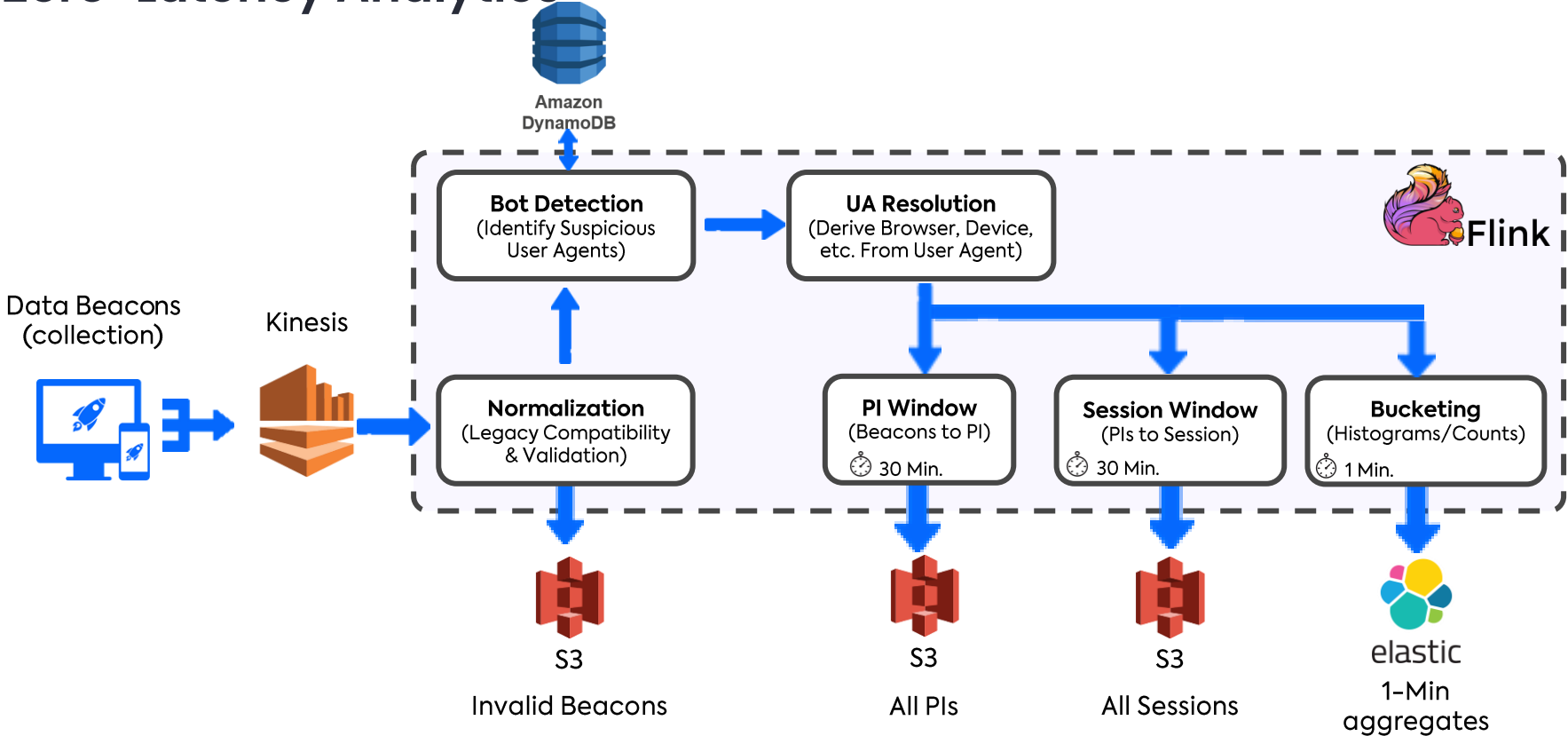
Arbitrary Time Windows
Real-Time Reporting (Dashboard Queries)

	Browser	Device	Test Group	First Contentful Paint (FCP)
11:05				
-				
11:06	Firefox	Mobile	Speed Kit	{200ms: 4, 500ms: 2}

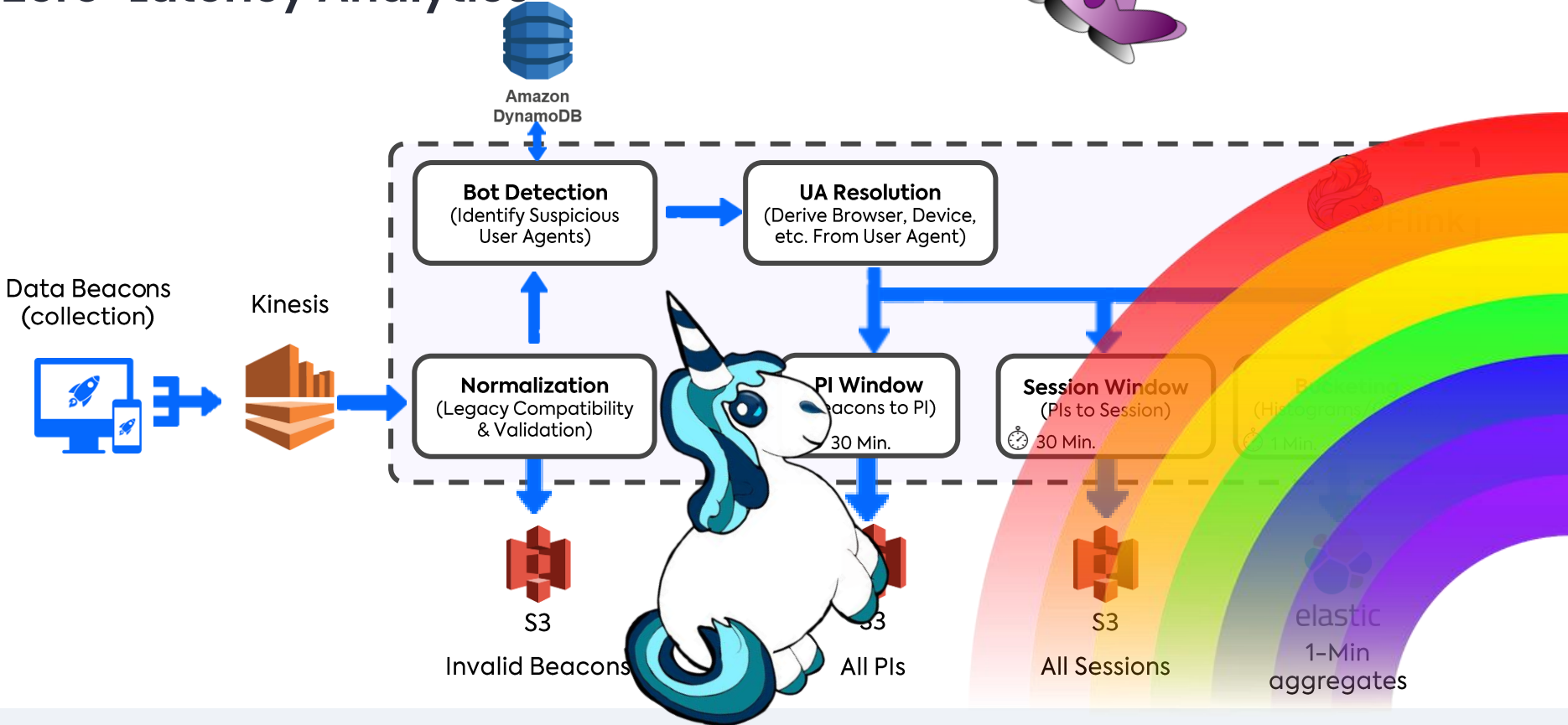
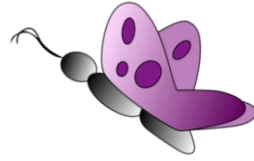
Visualizing Uplift in a Dashboard



Zero-Latency Analytics



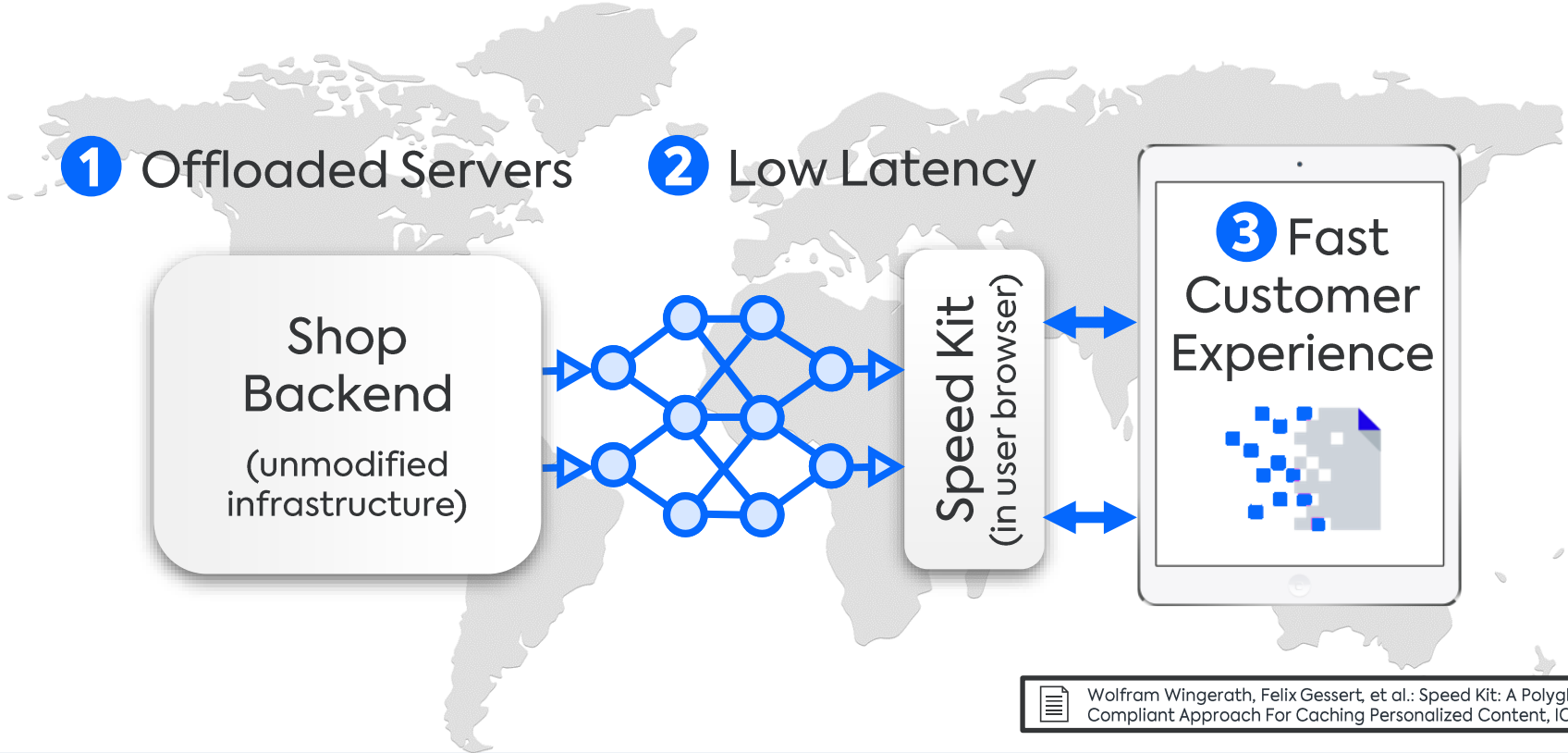
Zero-Latency Analytics



Summary & Outlook



Speed Kit: Web Performance Plugin



Split Testing for Web Performance

Speed Kit Users



Tracking
→

vs.



←
Tracking

Normal Users



- Speed Kit enabled

- **Measurable uplift:**
 - + Performance
 - + User engagement
 - + ...

- Speed Kit disabled
(no acceleration)



W. Wingerath, B. Wollmer, M. Bestehorn, S. Succo, F. Bücklers, J. Domnik, F. Panse, E. Witt, A. Sener, F. Gessert, N. Ritter. *Beaconnect: Continuous Web Performance A/B-Testing at Scale*. VLDB 2022

Learn More: speedhub.org

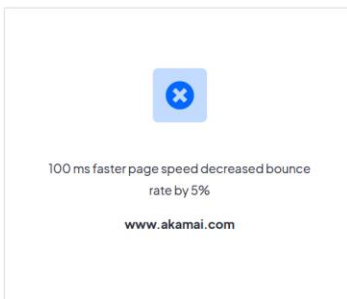


Faster Page Speed

👉 Bounce Rate

Learn how faster page speed can impact the key metrics of your business.

Google Speed Kit Universität Hamburg
DER FORSCHUNG | DER LEHRE | DER BILDUNG



Impact

Studies

Metric [Clear](#)

- SEO Traffic
- Traffic
- Revenue
- Conversions
- Session Length
- Bounce Rate
- Engagement
- User Experience
- Pageviews
- Monthly Active Users
- Retention
- Average Order Value

Search...

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An A/B test focused on optimizing Web Vitals showed that a 31% improvement in LCP led to 8% more sales.

[#PWA](#) [#Bounce Rate](#) [#Conversions](#) [#Revenue](#) [#E-Commerce](#) [#2021](#)

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Team Lead, Seniors & Juniors



Performance Engineering

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Fullstack Development

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Data Engineering

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Thanks!

Questions?



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