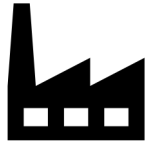

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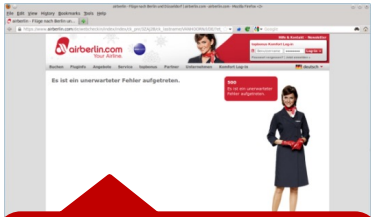
André van Hoorn,  Heiko Holz,  Henning Schulz – *May 19, 2022 #swqd, Vienna*

Experiences from an Industry-Academia Collaboration on Application Performance Management

Gefördert vom
Bundesministerium
für Bildung
und Forschung

Subject of Collaboration:
Application Performance Management

Context: Performance Problems in Application Systems



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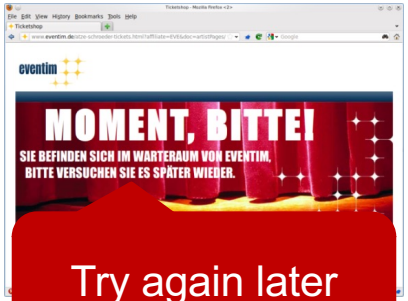
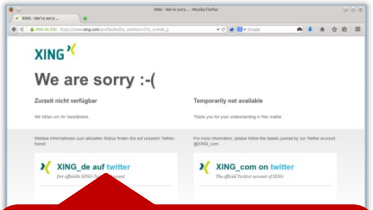


Try again later



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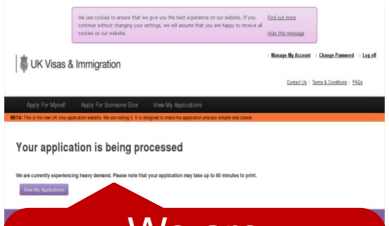
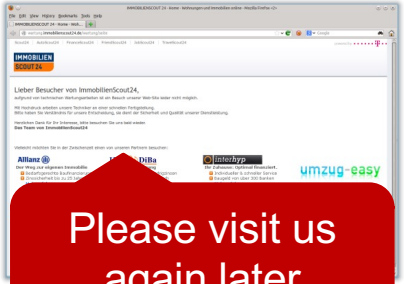


We are experiencing heavy demand



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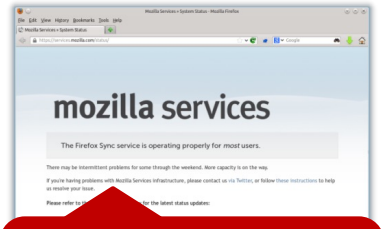
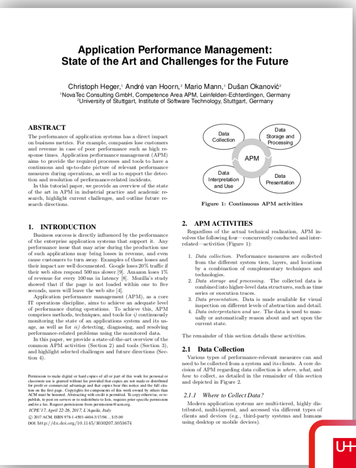


… more capacity is on the way

Application Performance Management (APM) ...

„aims to **achieve an adequate level of performance** during operations. [...]"



Application Performance Management: State of the Art and Challenges for the Future

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[1]NovaTec Consulting GmbH, Competence Area APM, Leinfelden-Echterdingen, Germany
[2]University of Stuttgart, Institute of Software Technology, Stuttgart, Germany

ABSTRACT

The performance of application systems has a direct impact on business metrics. For example, companies lose customers and revenue in case of poor performance such as high response times. Application performance management (APM) aims to provide the required processes and tools to have a continuous and up-to-date picture of relevant performance measures during operations, as well as to support the detection and resolution of performance-related incidents.

In this tutorial paper, we provide an overview of the state of the art in APM in industrial practice and academic research, highlight current challenges, and outline future research directions.

1. INTRODUCTION

Business success is directly influenced by the performance of the enterprise application systems that support it. Any performance issue that may arise during the production use of such applications may bring losses in revenue, and even cause customers to turn away. Examples of these losses and their impact are well documented. Google loses 20% traffic if their web sites respond 500 ms slower [9]. Amazon loses 1% of revenue for every 100 ms in latency [8]. Mozilla's study showed that if the page is not loaded within one to five seconds, users will leave the web site [4].

Application performance management (APM), as a core IT operations discipline, aims to achieve an adequate level of performance during operations. To achieve this, APM comprises methods, techniques, and tools for *i)* continuously monitoring the state of an applications system and its usage, as well as for *ii)* detecting, diagnosing, and resolving performance-related problems using the monitored data.

In this paper, we provide a state-of-the-art overview of the common APM activities (Section 2) and tools (Section 3), and highlight selected challenges and future directions (Section 4).

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DOI: http://dx.doi.org/10.1145/3030207.3053674

Data Collection | Data Storage and Processing | APM | Data Interpretation and Use | Data Presentation

Figure 1: Continuous APM activities

2. APM ACTIVITIES

Regardless of the actual technical realization, APM involves the following four—concurrently conducted and interrelated—activities (Figure 1):

1. *Data collection.* Performance measures are collected from the different system tiers, layers, and locations by a combination of complementary techniques and technologies.
2. *Data storage and processing.* The collected data is combined into higher-level data structures, such as time series or execution traces.
3. *Data presentation.* Data is made available for visual inspection on different levels of abstraction and detail.
4. *Data interpretation and use.* The data is used to manually or automatically reason about and act upon the current state.

The remainder of this section details these activities.

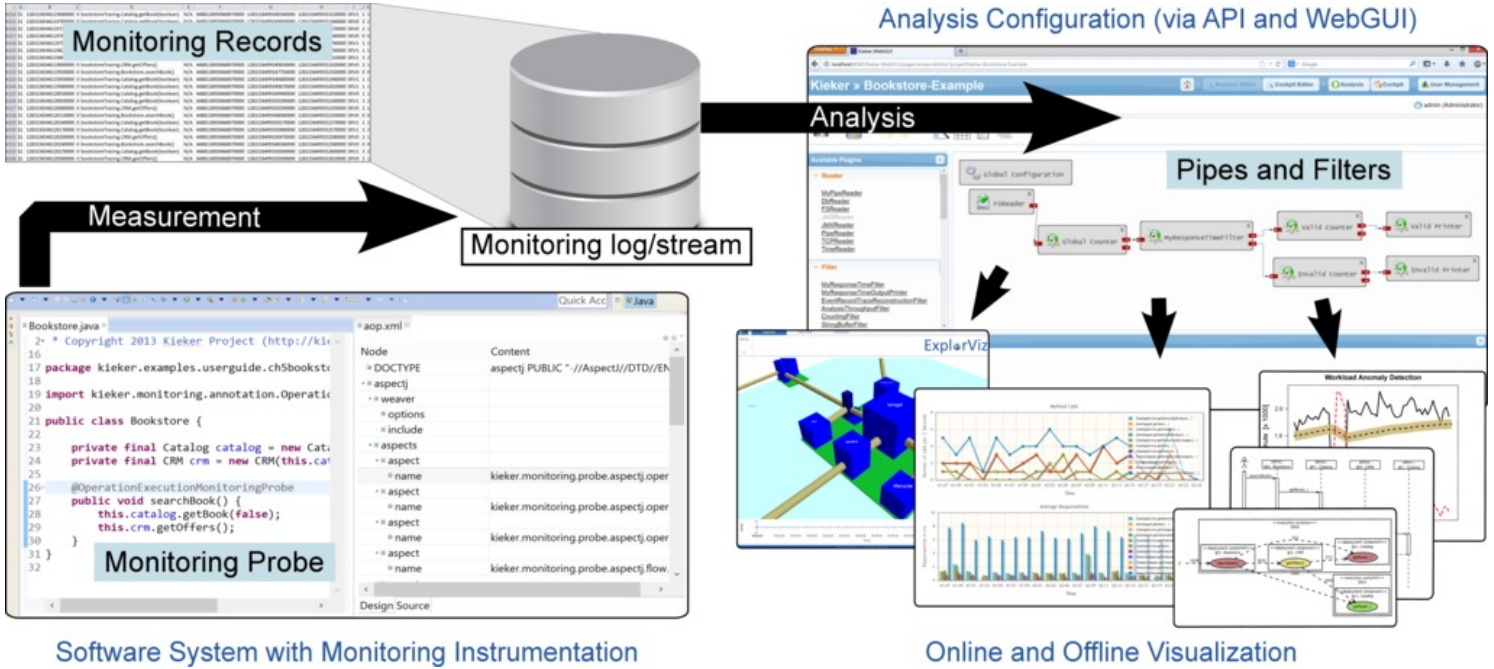
2.1 Data Collection

Various types of performance-relevant measures can and need to be collected from a system and its clients. A core decision of APM regarding data collection is *where*, *what*, and *how* to collect, as detailed in the remainder of this section and depicted in Figure 2.

2.1.1 Where to Collect Data?

Modern application systems are multi-tiered, highly distributed, multi-layered, and accessed via different types of clients and devices (e.g., third-party systems and humans using desktop or mobile devices).

Kieker – An Open-Source APM Tool *(from Academia)*

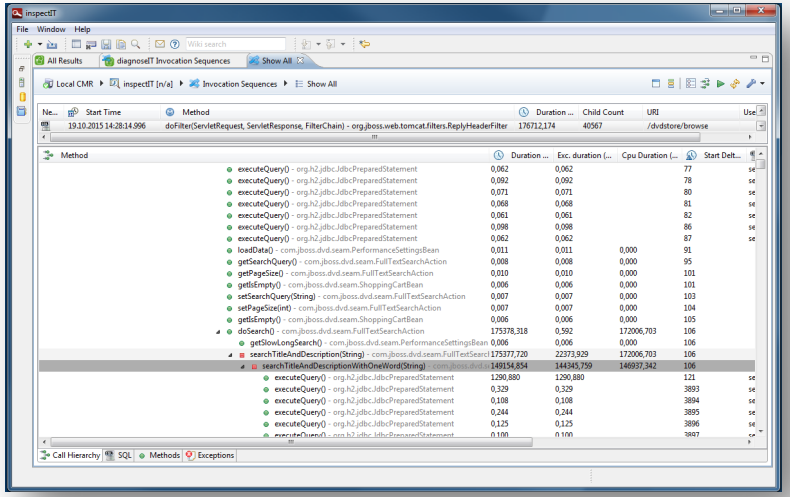


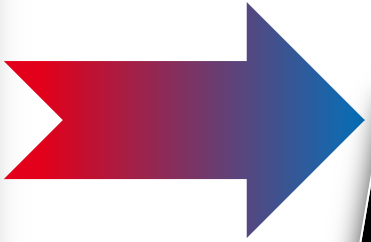
Kieker is distributed as part of SPEC® RG's repository of peer-reviewed tools for quantitative system evaluation and analysis

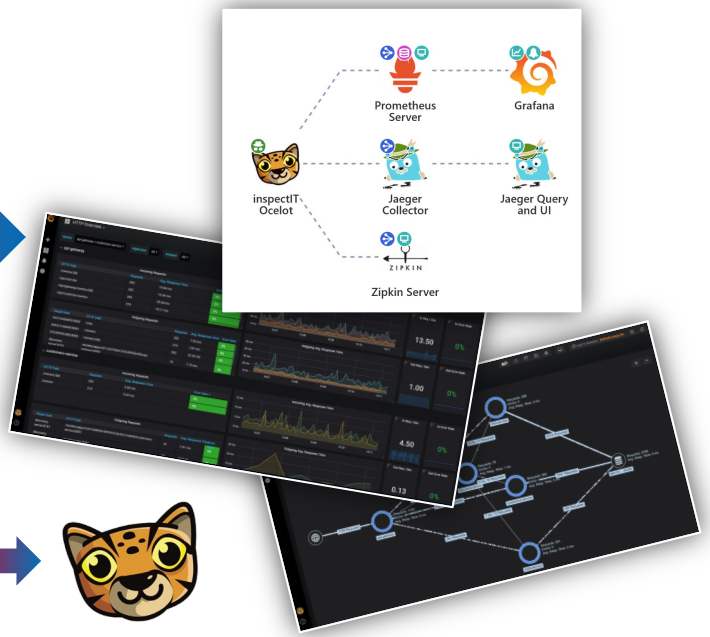
http://research.spec.org/projects/tools.html

2008-2022
Kieker
v. 0.X – 1.16

inspectIT – An Open-Source APM Tool *(from Industry)*







2009
inspectIT
v. 0.X – 1.5

2016
inspectIT
v. 1.6 – 1.9

2019
inspectIT
Ocelot

Partner Profiles:
University of Stuttgart/Hamburg and Novatec

Novatec Consulting GmbH – Profile at a Glance

- SME IT service company (no products)
  - consultancy, support,
  - software customization, software development
- Builds (on) open-source software (OSS)
  - Learned lessons from product to OSS provider
- Extensive APM experience over past 15+ years

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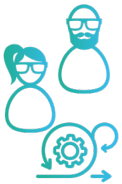
Customer



Novateccies

Uni Hamburg / Uni Stuttgart – Profile at a Glance

Universität Hamburg
DER FORSCHUNG | DER LEHRE | DER BILDUNG

University of Stuttgart

- Research and teaching on intersection of
  - (continuous) software engineering
  - distributed systems architectures
  - software quality engineering (performance, resilience; APM + model-based)
- Collaborations with
  - industry
  - (inter)national researchers

- Build (on) OSS and open data/science

“Collaboration KPIs“ and Selected Results

Some „ Collaboration KPIs“

9 years of collaboration

3 funded research projects

Joint (APM) Projects *(3rd-Party Funded)*

Gefördert vom Bundesministerium für Bildung und Forschung

03/2015 – 06/2027

Expert-guided automatic diagnosis of performance problems in enterprise applications

09/2017 – 02/2020

Automated performance testing in continuous software engineering

03/2022 – ongoing

Domain-centric runtime quality analysis of business-critical application systems

Some „ Collaboration KPIs“

9 years of collaboration

20 publications

1 e-book

3 funded research projects

1 dissertation

OBJEKTspektrum

Application Performance Management (APM)

Kontinuierliche Überwachung von Anwendungsperformance

Universität Stuttgart

diagnoseIT

supported by

Inhaltliche Entwicklung:
Dr.-Ing. André van Hoorn (Prof.-Vertr.) und Stefan Siegl

Einfluss von Performance auf Erfolg

Anwendungsperformance hat direkte Auswirkungen auf den Unternehmenserfolg.

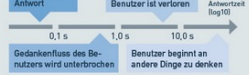
› Z. B Wahrnehmung, Vertrauen, Umsatz

2 Sek. — 50 % der Online-Kunden verlassen eine Seite nach Ladezeiten > 2 Sekunden.

60 % minus — Nur 40 % der Online-Kunden kommen nach einem Performance-Problem zurück.

Quelle: wird noch ergänzt.

Konsequenzen schlechter Performance



Application Performance Management

Durch APM-Werkzeuge und -Prozesse kann Anwendungsperformance kontinuierlich überwacht und sichergestellt werden

… wichtig im gesamten Software-Lebenszyklus

… relevant für alle Systemebenen

… erfordert Zusammenarbeit aller Abteilungen

1. Daten aus dem System abgreifen

Agenten sammeln Daten in sämtlichen Systemebenen. Auf der Anwendungsebene werden häufig technologiespezifische Agenten eingesetzt.

		Aktiv	Passiv
Business	Umsatz, Conversion Rate, Bounce Rate	Stimuliert das System durch eigene Anfragen. Z.B. stichprobenartige Ausführung simulierter Benutzeranfragen	Liest und interpretiert Systemverhalten realer Benutzung. Z.B. Einfügen von Messlogik in den Anwendungscode. Auswertung von Netzwerkverkehr. Ressourcenauslastung oder Log-Dateien
Benutzer	Benutzerinteraktionen, Verweildauer: Ladezeiten, Fehler; Anzahl Ressourcen auf HTML-Seiten		
Anwendung	Komponenteninteraktion, Methodenantwortzeiten, technische Fehlerzustände, Traces		
Middleware	Statistiken zu Warteschlangen, Pooling und Garbage Collection		
Betriebssystem	Statistiken zu File Handles, Threads, Virtualisierung		
Hardware	Auslastung von CPU, Memory, I/O etc.	Für die unteren Systemebenen existiert eine Vielzahl standardisierter Schnittstellen. › Z.B JMX, Nagios	

2. Von Daten zu Informationen

Es hat sich bewährt, Zeitreihendaten für das Monitoring zu erheben und diese mit detaillierten Traces für die Problemanalyse zu unterbauen.

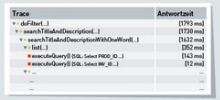
Beispiele in APM-Werkzeugen

› Solche Visualisierungs-Werkzeuge bieten in der Regel eine recht intuitive und schnelle Möglichkeit, Graphen, Metriken, Tabellen, etc. zu konfigurieren

› Hierzu werden Abfragen an die darunterliegende Zeitreihen-Datenbank angegeben, die spezifizieren, welche Zeitreihen visualisiert werden sollen

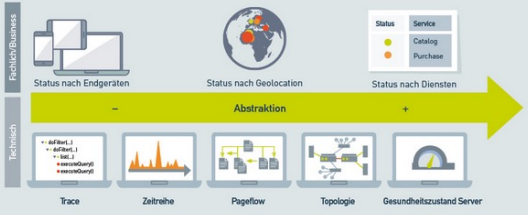
› Weitere Darstellungseigenschaften können dann konfiguriert werden (Legende, Axen etc.)

› Auf diese Weise können einzelne Panels angegeben werden



3. Visualisierung in navigierbaren Sichten

Aufgrund der hohen Menge müssen Informationen aufbereitet werden. Es hat sich bewährt, verschiedene Sichten auf die Daten anzubieten. Die Sichten sind navigierbar, um zu abstrahieren oder detailliertere Sichten zur Beantwortung der jeweiligen Fragestellung zu gelangen.



4. Interpretieren und Nutzen der Informationen

Aus den Informationen lassen sich manuell oder automatisiert Schlüsse ziehen und Aktionen ableiten.

Performance-Probleme erkennen. Typische Probleme sind erhöhte Antwortzeiten oder Ressourcenauslastungen. Erkannt werden sie z. B. durch Vergleich mit Schwellwerten oder „Normalverhalten" (Baselines). Herausforderung: Falsch-Negativ/Positiv-Rate

Ursachen typischer Performance-Probleme erkennen. Z. B. N+1-Problem, zu viele Remote-Calls, schlechte Datenbankabfragen. Diese (z.T. wiederkehrenden) Architektur- und Implementierungsfehler (inkl. Anti-Patterns) lassen sich insbesondere auf Basis aufgezeichneter Trace-Informationen erkennen.

Automatisierte Aktionen. Insbesondere Cloud-Infrastrukturen bieten Dienste zur automatisierten Skalierung auf Basis der Monitoringinformationen an.

APM-Werkzeuge

Übliche Funktionen von APM-Werkzeugen (Gartner-Dimensionen):

› End user experience
› Architecture discovery
› Transaction profiling
› Component deep dive
› Resource Monitoring
› Analytics

Kommerzielle Werkzeuge bieten umfassende Lösungen.

› Z. B AppDynamics, BMC Software, CA APM, Dynatrace, HP Enterprise, IBM, New Relic, Riverbed Technology

Open-Source-Werkzeuge sind i. d. R. weniger mächtig, können jedoch Alternativen darstellen.

› Z. B ICINGA, inspectIT, Kieker, PinPoint, Zipkin, ZMon

APM-Wunschliste

Das Themenfeld APM hat sich in den letzten Jahren stark entwickelt. Es gibt aber noch genug Potenzial. Z. B

Interoperabilität. Einige APM-Werkzeuge bieten einen Daten-Export. Eine erhöhte Interoperabilität (einheitliche Schnittstellen, Formate) ist wünschenswert.

› Z. B OpenTracing, OPEN.xtrace

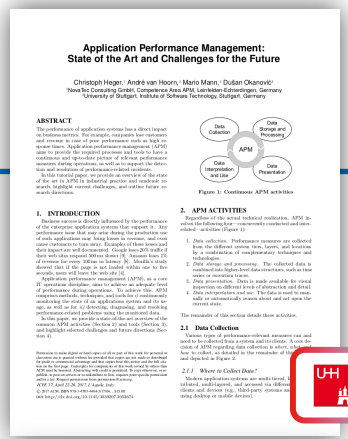
Automatisierung. Manuelle APM-Aktivitäten (z. B. Konfiguration, Problemdiagnose) sind aufwändig und fehleranfällig.

Automatisierung, z. B. basierend auf Best Practices ist wünschenswert.

APM ist kein reines Technikthema. APM wird immer noch stark mit Technik assoziiert, ist aber längst auch ein Business-thema. Bis 2020 wird der Anteil des IT-Betriebs an den Käufern von APM-Lösungen (t. Gartner nur noch 40 % betragen (aktuell 75 %).

Technologietransfer. Forschung und Industrie können stark voneinander profitieren.

› Z. B Austausch von Tra… und Algorithmen, Kom… basierten Ansätzen ub… die „SPEC Research Gr…



Application Performance Management:
State of the Art and Challenges for the Future

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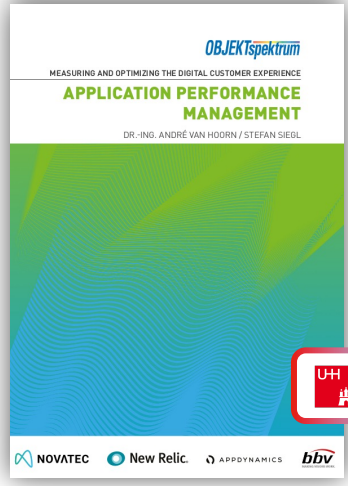
ABSTRACT

1. INTRODUCTION

2. APM ACTIVITIES

Figure 1: Continuous APM activities



OBJEKTspektrum

MEASURING AND OPTIMIZING THE DIGITAL CUSTOMER EXPERIENCE

APPLICATION PERFORMANCE MANAGEMENT

DR.-ING. ANDRÉ VAN HOORN / STEFAN SIEGL

NOVATEC · New Relic. · APPDYNAMICS · bbv

Some „ Collaboration KPIs“

9 years of collaboration

20 publications

>10? new employees

1 e-book

3 funded research projects

1 dissertation

15 Bachelor’s/Master’s theses/projects

Experiences and Lessons

Building Our Industry/Academia Collaboration

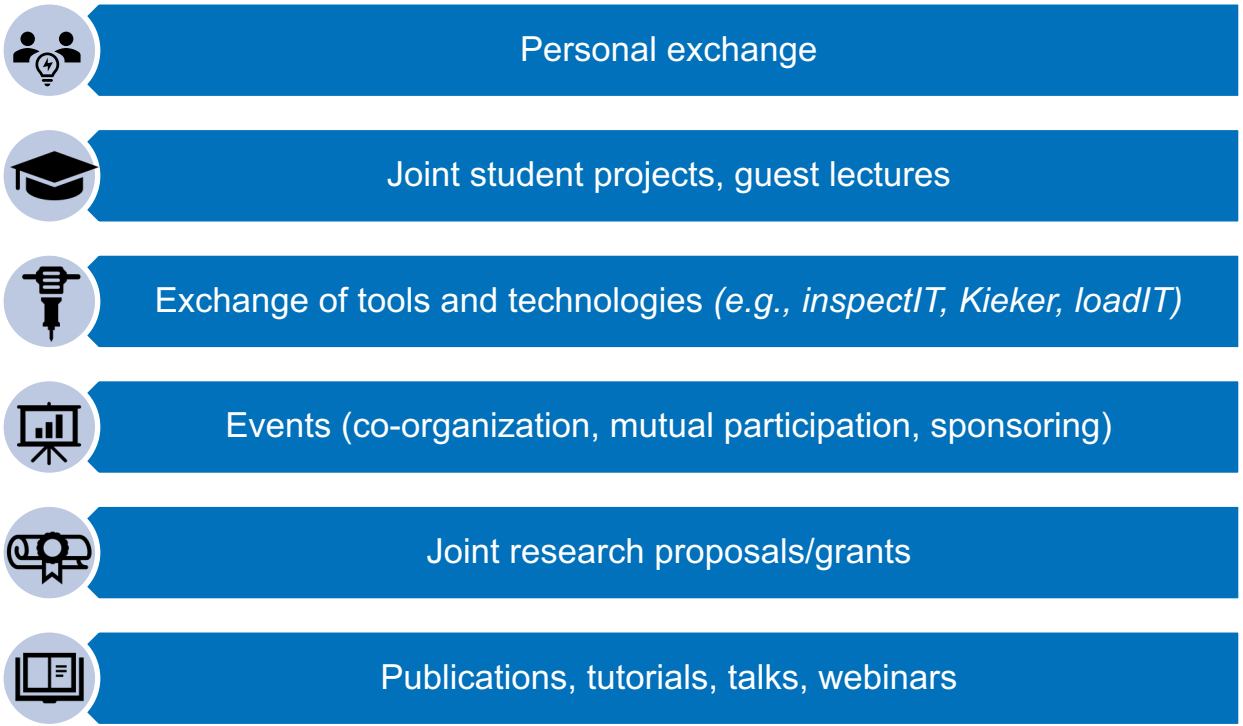
Our collaboration is based on a happy coincidence

„@all friends of the computer science department: any company interested in research collaborations, e.g., on **application performance monitoring** or **load testing**?“

Our collaboration was based on a resulting tight individual connection and grew from there

Our collaboration was directly based on topics and tied to the (APM) application area/team

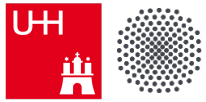
Our (Evolving) Collaboration Building Blocks



Synergies

- Application-oriented research (for students and employees)
- Possibility of external Ph.D.
- Access to scientific culture

  e.g., scientific conferences and articles, publication process, communities
- Access to talents



- Access to „real“ problems, data, and case studies
- Access to industry experts, e.g., for guest lectures
- Keeping up-to-date with current technologies and tools used in practice

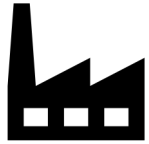
Conflicts

- Hard to keep student assistants at the university – industry pays more

- Allocation of employees to research projects – customer projects more profitable

Lessons Learned

- Open source: promotes visibility, transparency, quality, and reusability
  - enabler for new research projects and publications
- The developed tools should follow conventions and be connected to popular tools so that they can be (re-)used and maintained more easily
  - e.g., for monitoring: OpenAPM standards and tools
- Applying for research funding is effortful and time-consuming
  - … but provides long-term contextual foundation and commitment
- If the outcome of the project does not have a certain degree of maturity, it will most likely not be used and end up in a drawer …



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André van Hoorn,  Heiko Holz,  Henning Schulz – *May 19, 2022 #swqd, Vienna*

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