Patterns and Pains of Migrating Legacy Applications to Kubernetes

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Robert Bichler, Allianz Germany

@adersberger @qaware

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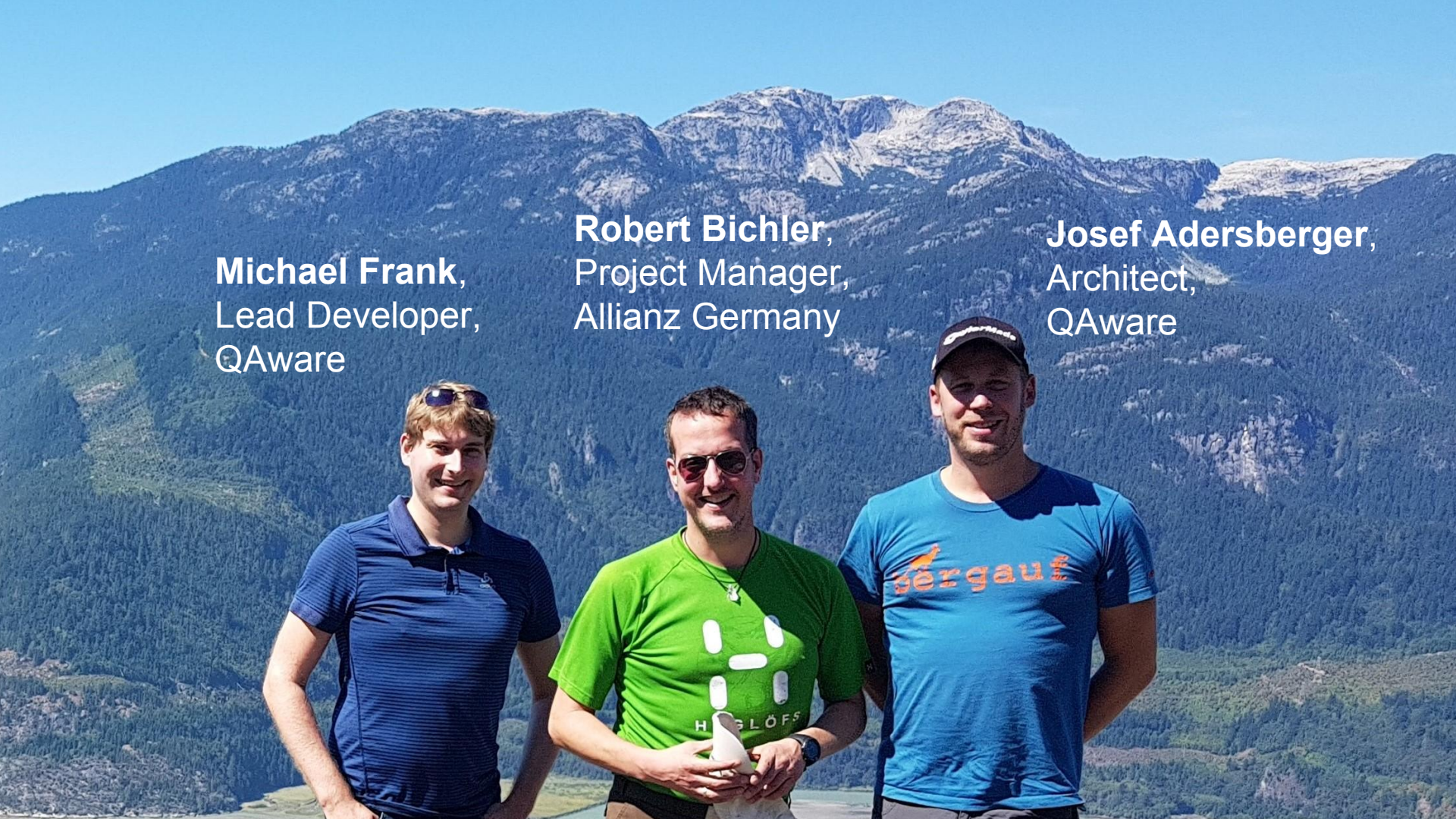
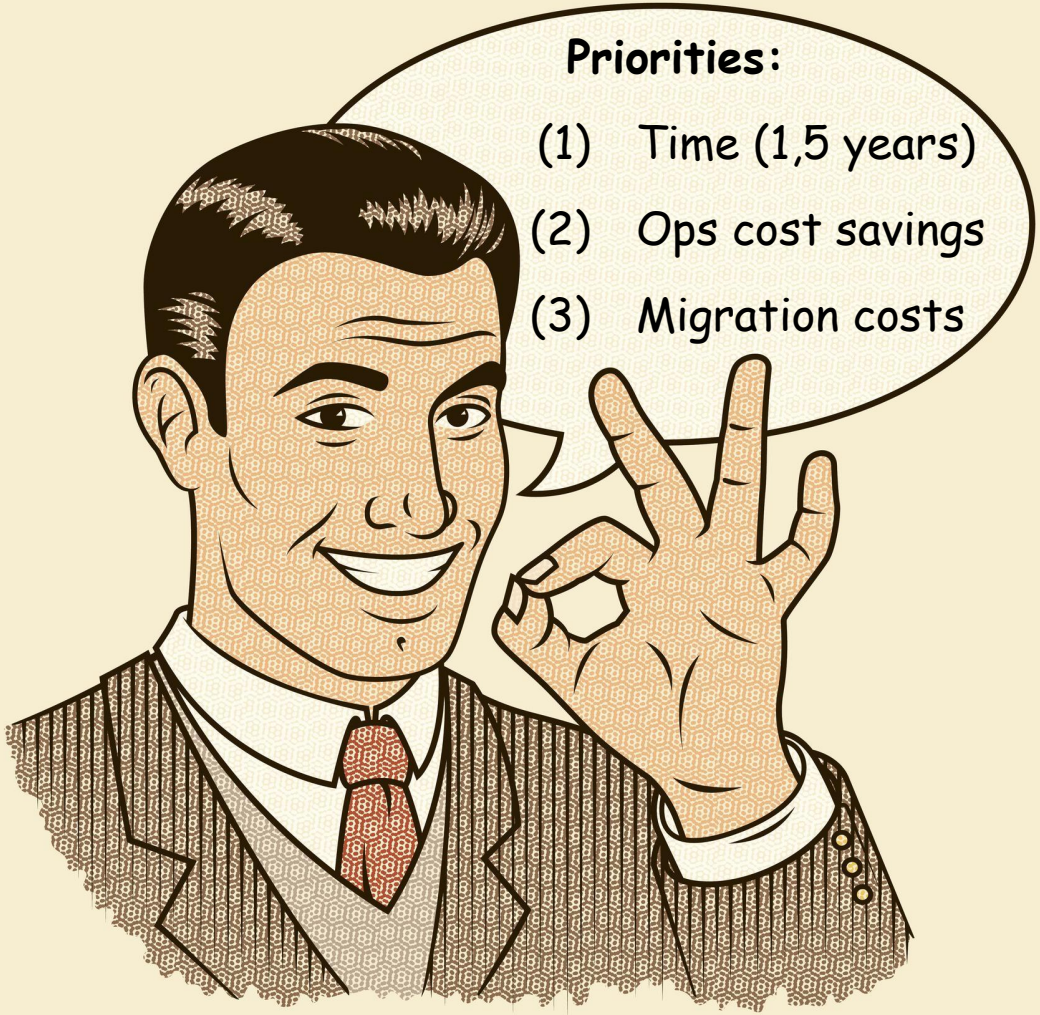

Michael Frank,
Lead Developer,
QAware
Robert Bichler,
Project Manager,
Allianz Germany
Josef Adersberger,
Architect,
QAware

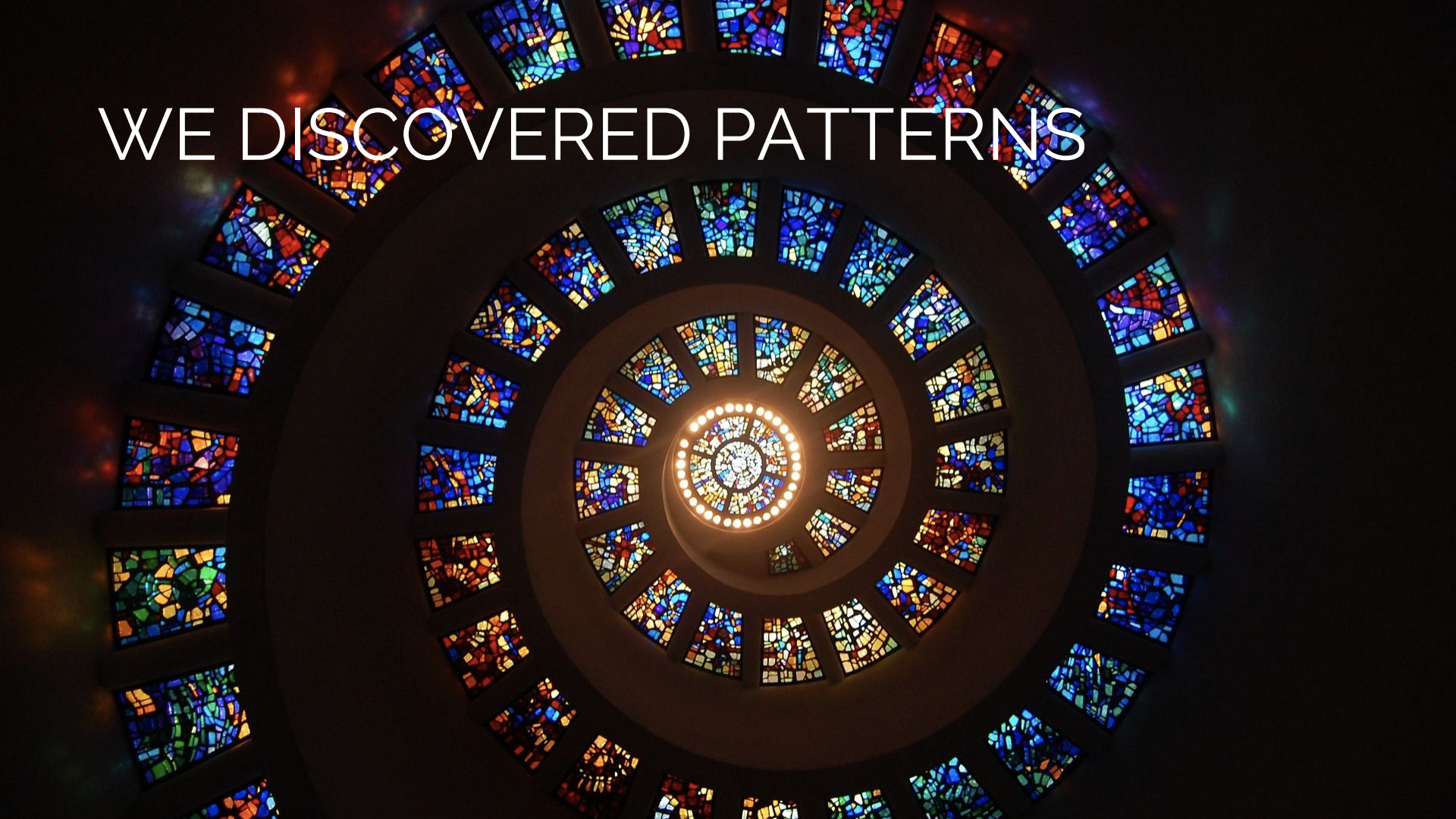

CIO
Let's bring all our web applications onto a cloud native Platform

Digitalization
=> Agile
=> Cloud Native Platforms


Priorities:
(1) Time (1,5 years)
(2) Ops cost savings
(3) Migration costs

WE WERE BRAVE

WE FELT PAIN


WE DISCOVERED PATTERNS

WE WERE SUCCESSFUL

- ❑ All **152 legacy applications migrated** and in production within 17 months
- ❑ All **security-hardened** and modernized to containerized **12-factor-apps**
- ❑ **Benefits leveraged**: strong business case, higher availability, more agile teams

The Architect's Point of View

Patterns for success

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Visibility

The Cloudalyzer

- EAM TOOL
  - SYSTEM PROPERTIES
- QUESTIONNAIRES
  - BASIC
  - TOUR-DE-MIGRATION
- JIRA
  - MIGRATION TASKS
- XLS
  - …
- STATIC ANALYSIS
  - IBM MIGRATION TOOL
  - QAVALIDATOR
  - SONARQUBE
  - OWASP Scanner
  - jQAssistant

MIGRATION DATABASE

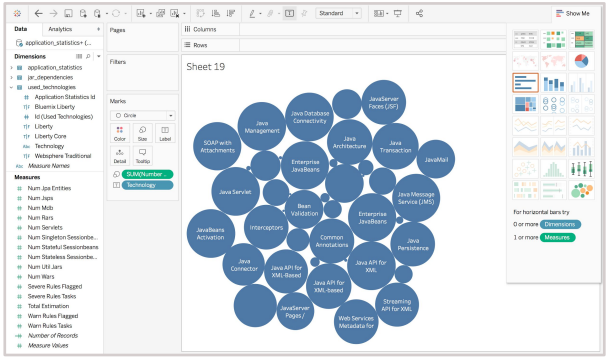

Tableau analysis

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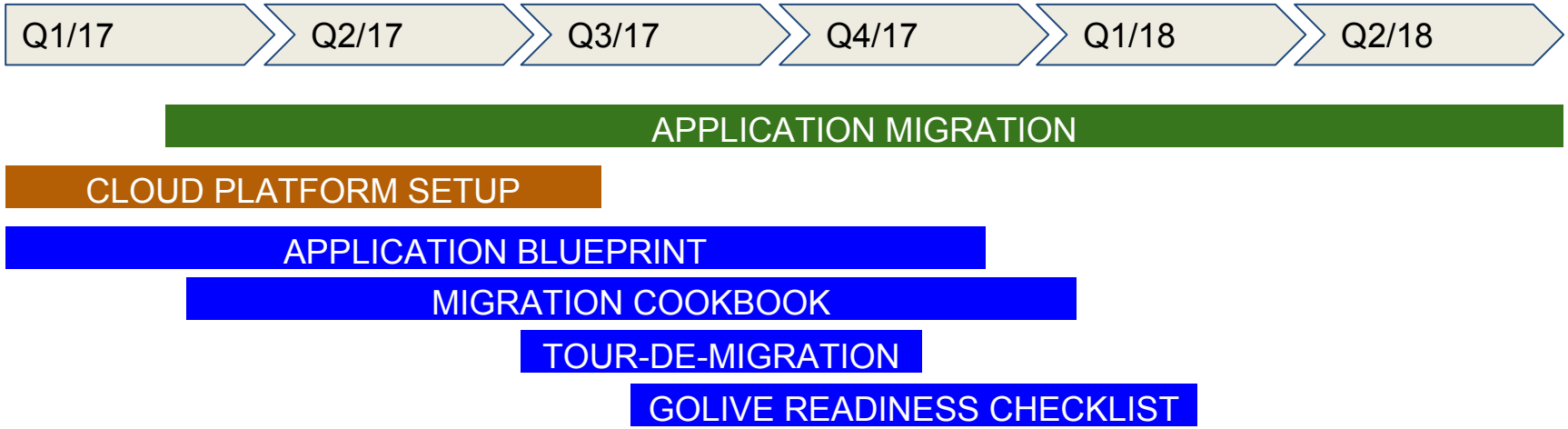
Questionnaire: Typical questions

- **Technology stack** (e.g. OS, appserver, jvm)
- Required **resources** (memory, CPU cores)
- **Writes to storage** (local/remote storage, write mode, volume)
- **Special requirements** (native libs, special hardware)
- Inbound and outbound **protocols** (protocol stack, TLS, multicast, dynamic ports)
- **Ability to execute** (regression/load tests, business owner, dev knowhow, release cycle, end of life)
- Client **authentication** (e.g. SSO, login, certificates)

Emergent design of cloud native software landscapes

Architecting hundreds of applications



- **Application Blueprint**: Describing target architecture and some rules & principles
- **Migration Cookbook**: Guidance on how to migrate the applications based on the application blueprint. Single source of truth & know-how externalization
- **Tour-de-Migration**: Visiting all applications and collect open issues
- **GoLive Readiness Checklist**: Criteria to be checked before GoLive

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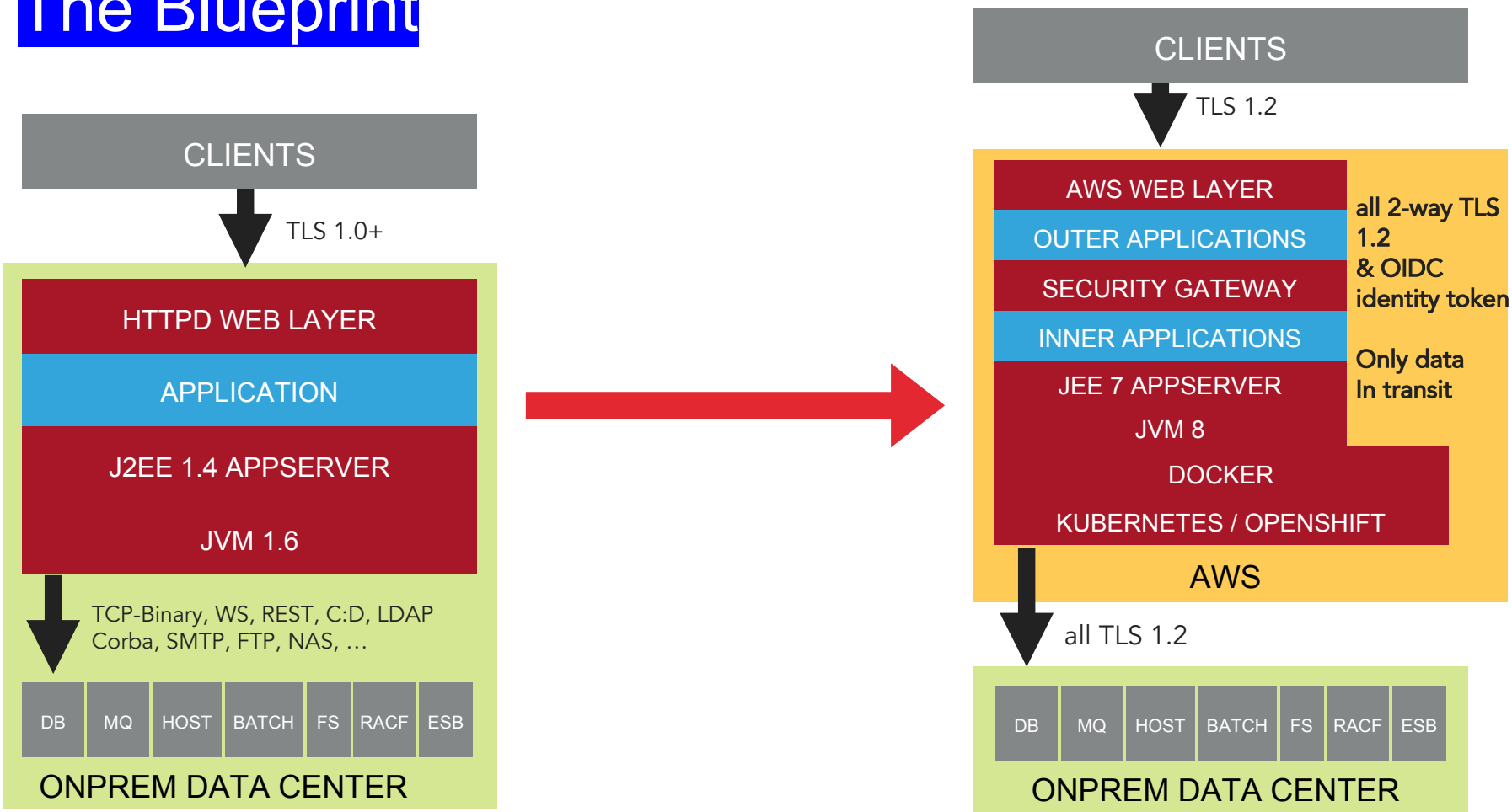
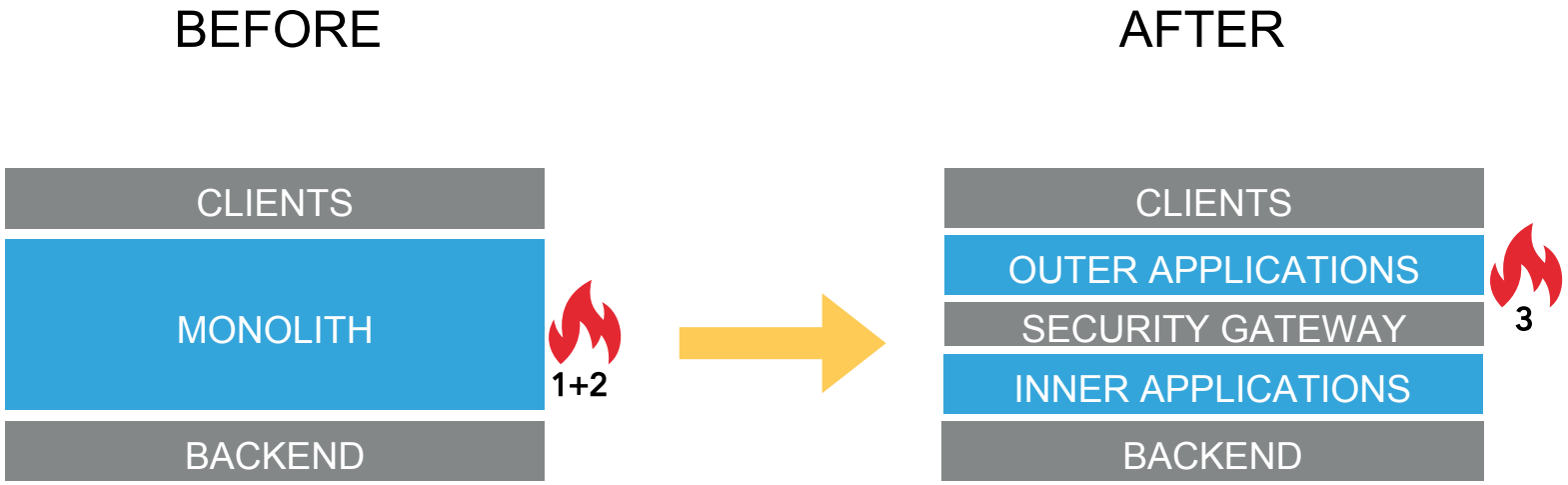
The Blueprint

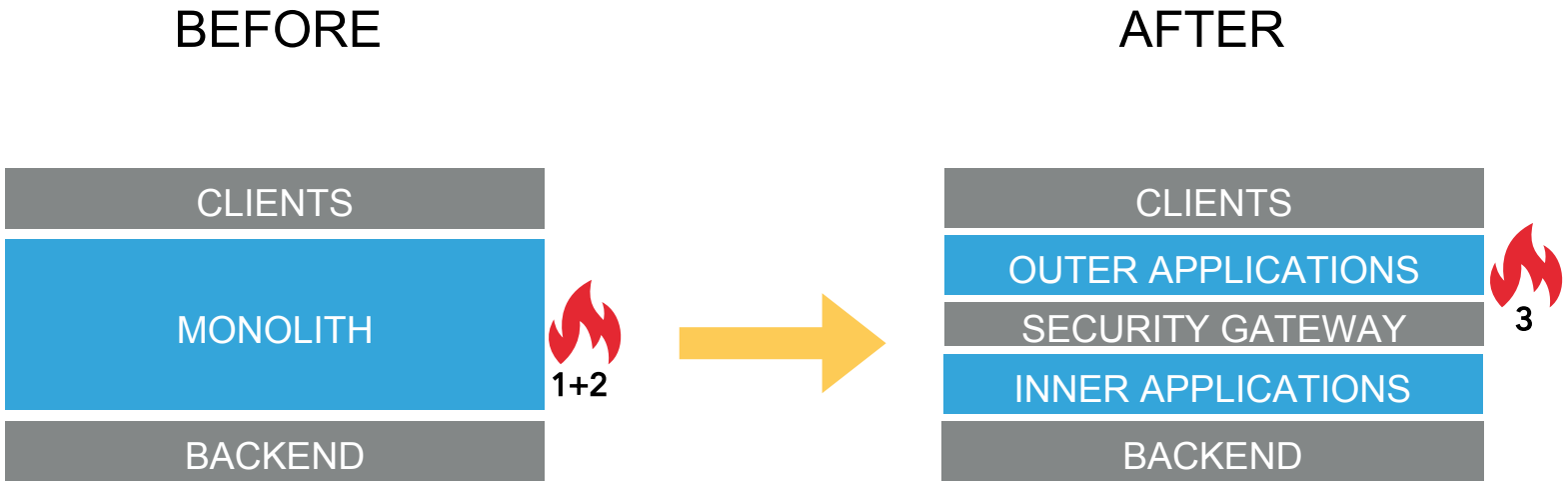




1) how to enhance cloud nativeness?

2) how to cut the monolith?

3) how to obtain an identity token?



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A sweet spot for legacy apps

Put the monolith into a container: do not cut, do not enhance with features in parallel

… and enhance the application according the 12 factors

- Monolithic Deployment
- Traditional Infrastructure

Cloud Friendly Apps

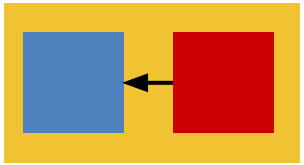
- Containerization
- 12-Factor App Principles

- Microservices
- Cloud-native Apps

Sidecars to the rescue

Container patterns applied

Sidecar: Enhance container behaviour

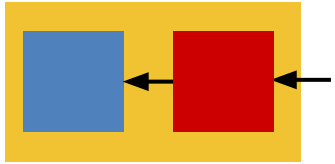


- Log extraction
- Task scheduling

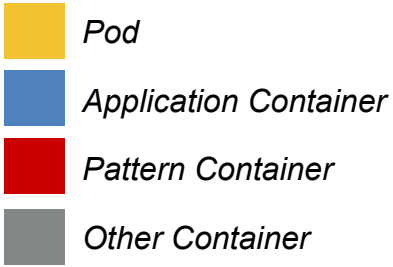
Ambassador: Proxy communication

- mTLS tunnel
- Circuit Breaking
- Request monitoring

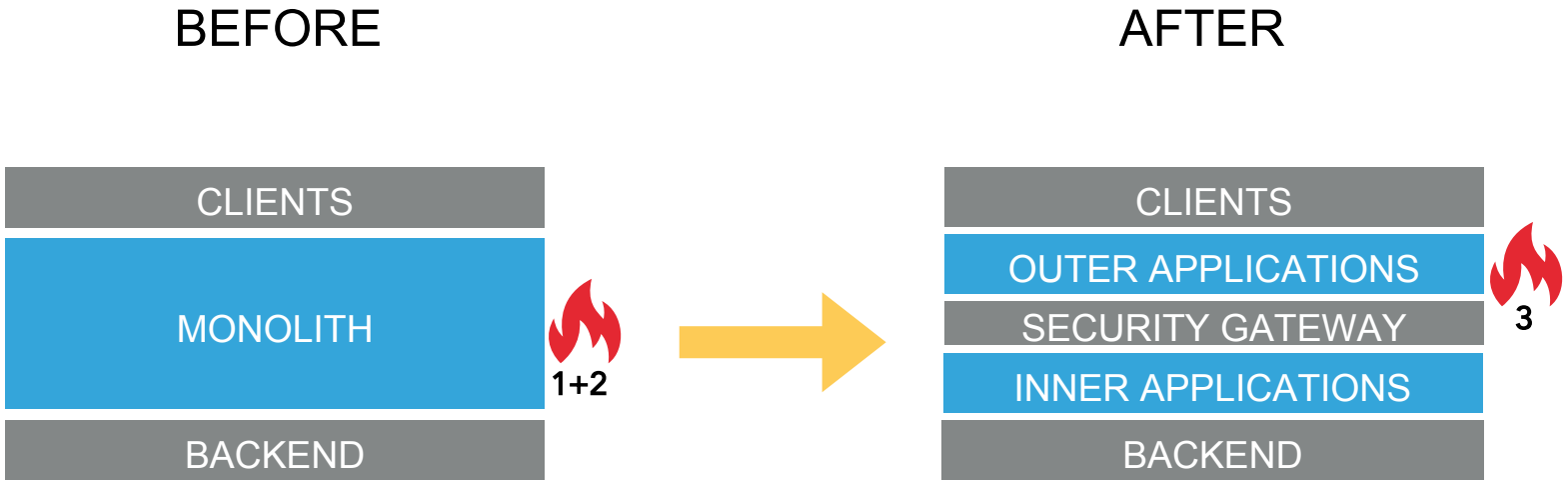
Adapter: Provide standardized interface



- Configuration (ConfigMaps & Secrets to files)



"Design patterns for container-based distributed systems". Brendan Burns, David Oppenheimer. 2016



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Anti-pain rule: Don’t cut the monolith

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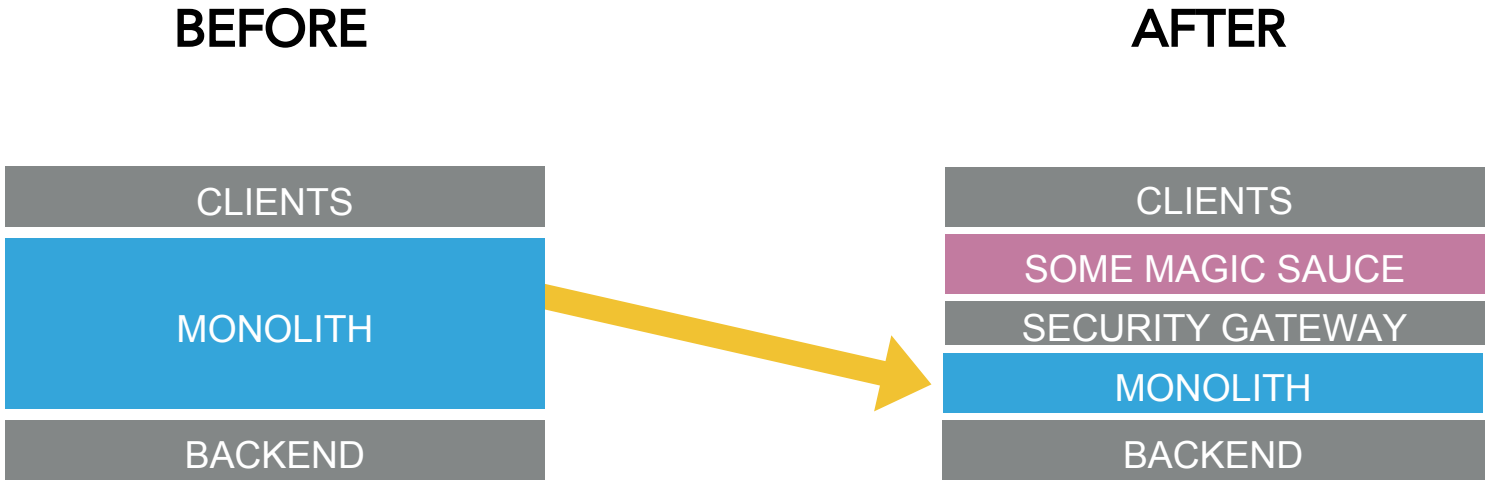

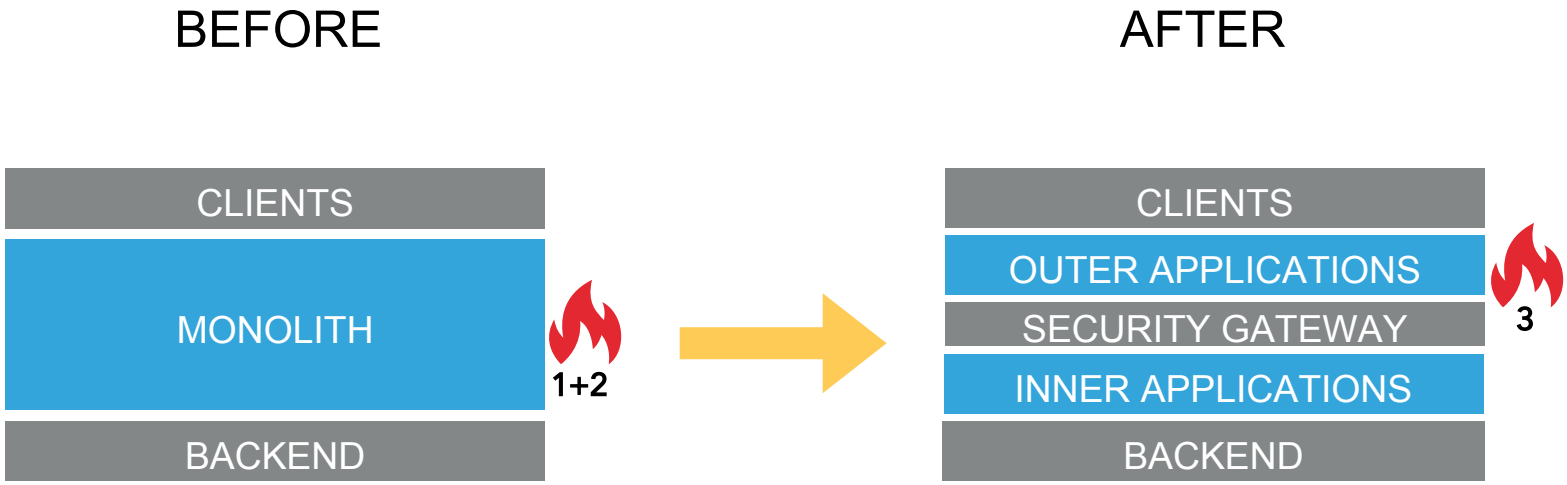

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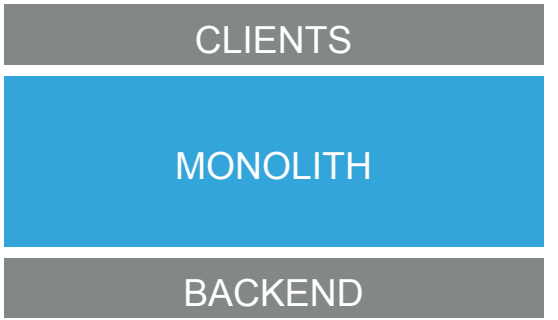
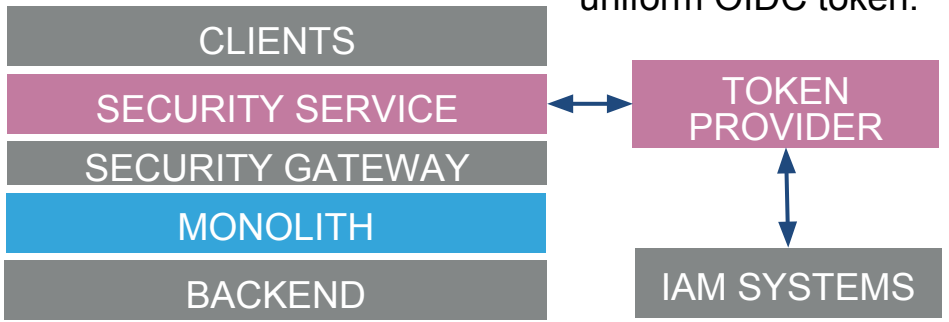
Security service to the rescue

BEFORE



AFTER



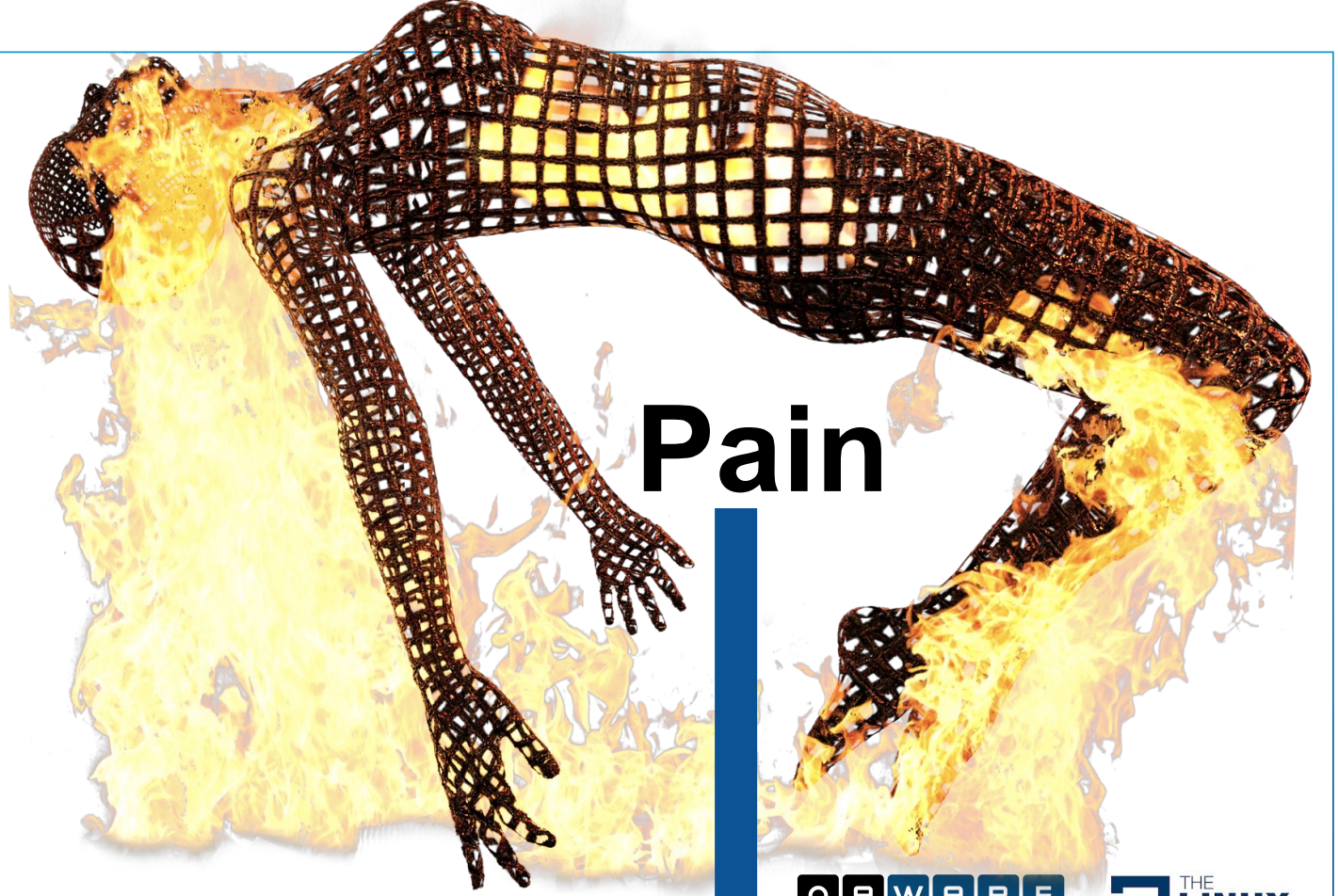
Adapting multiple authentication mechanisms to a uniform OIDC token.

Kubernetes constraints

Initially we thought we'll run into k8s restrictions on our infrastructure like:

- No support for multicast
- No RWX PVC available

We did. But all required refactorings were moderate effort and lead to a better architecture.



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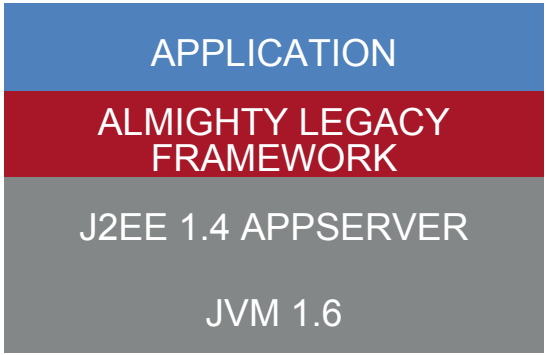
The Lead Developer's Point of View

The almighty legacy framework

- “worry-free package framework” from the early 2000s with about 500kLOC, 0% test coverage and multiple forks
- Strategies:
  - the hard way: **consolidate** forks and **migrate manually** and increase coverage
  - **decorate** with ambassadors, sidekicks and adapters
  - do not migrate parts and **replace** that API within the applications

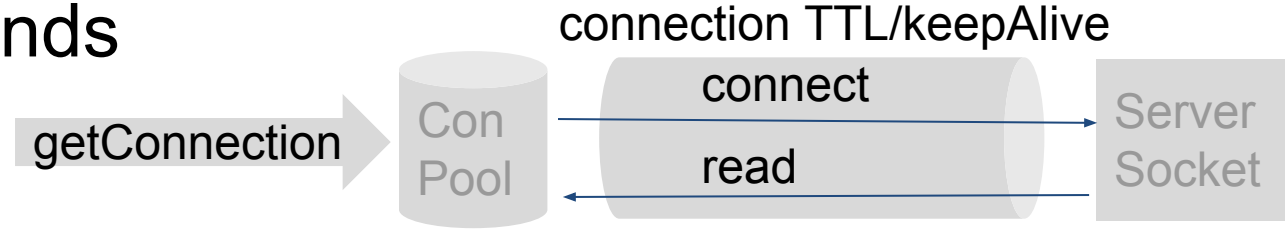


- from J2EE 1.4 to JEE 7 and Java 6 to 8
- add identity token check and relay
- modify session handling (synchronization)
- modify logging (to STDOUT)
- modify configuration (overwrite from ConfigMap)
- enforce TLS 1.2
- place circuit breakers
- predefined liveness and readiness probes


TIME-
OUTS

Timeouts: The pain

- Kinds



- Timeouts often too high. This ...
  - causes bad user experience
  - hurts the stability of your entire cloud
    - Unable to distinguish errors from legitimate waits
    - Diminishes self healing capabilities
    - Promotes cascading failures

Timeouts: The pain

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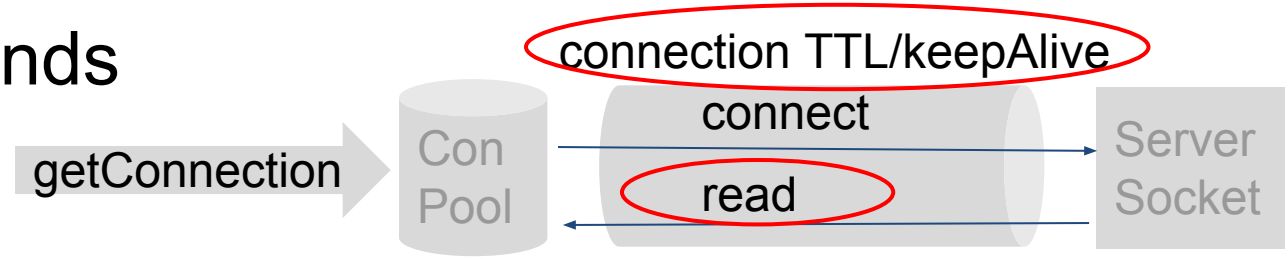

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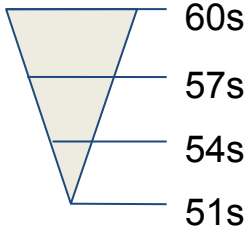
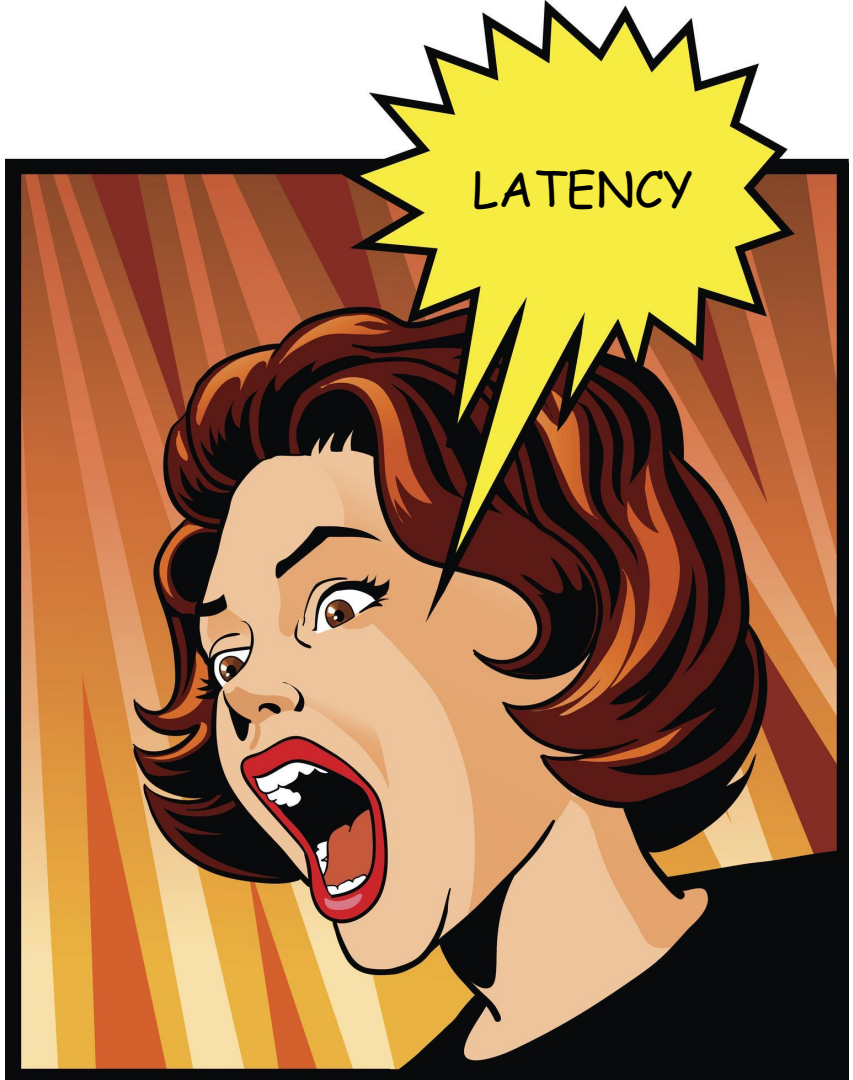
Timeouts: Recommendations

- Keep timeouts within the following ranges
  - 1-3s for getConnection & connect
  - 3-60s for socket/read - aim as low as possible
  - 1-3min for TTL/KeepAlive of pooled connections
    - Allow for dynamic DNS changes and dynamic scaling of backend services
    - Tradeoff between reaction time and performance
- Cascade timeouts
  - outer layer highest
  - inner layer lowest




LATENCY

Latency

- Pain: Dramatic increase in latency
  You can't scale away latency!
  - Every layer and new infrastructure component adds processing time
  - Everything TLS1.2 secured adds processing time
  - Physical distance: Cloud -> OnPrem
- Heaviest impact on n+1 patterns in applications
  - Adjust batch/fetch size
  - Parallel fetch
  - Ultima ratio: on prem (lightweight) service layer close to DB
- General
  - Performance experts in support team
  - Caching
  - Use diagnosability tools...

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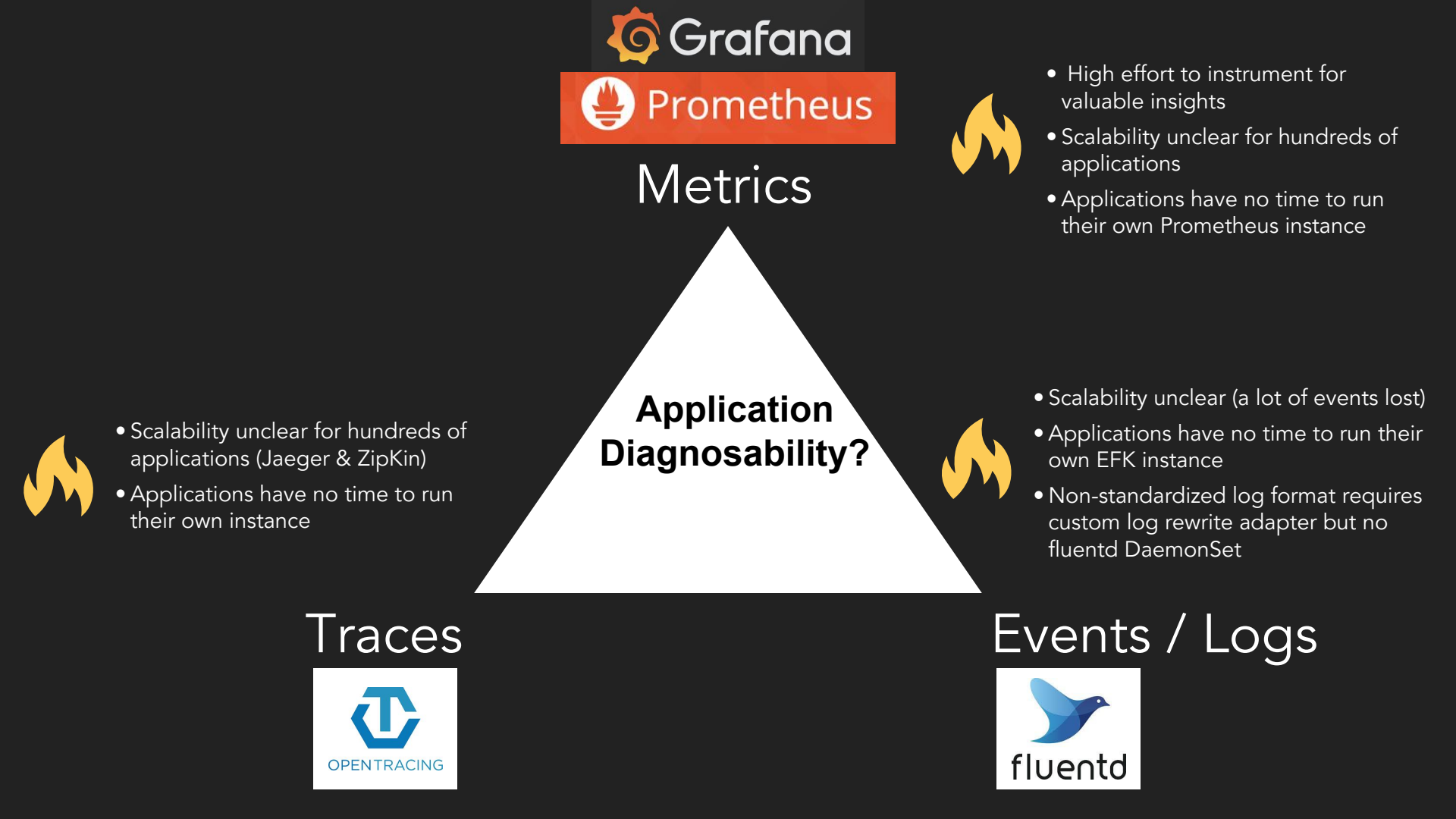
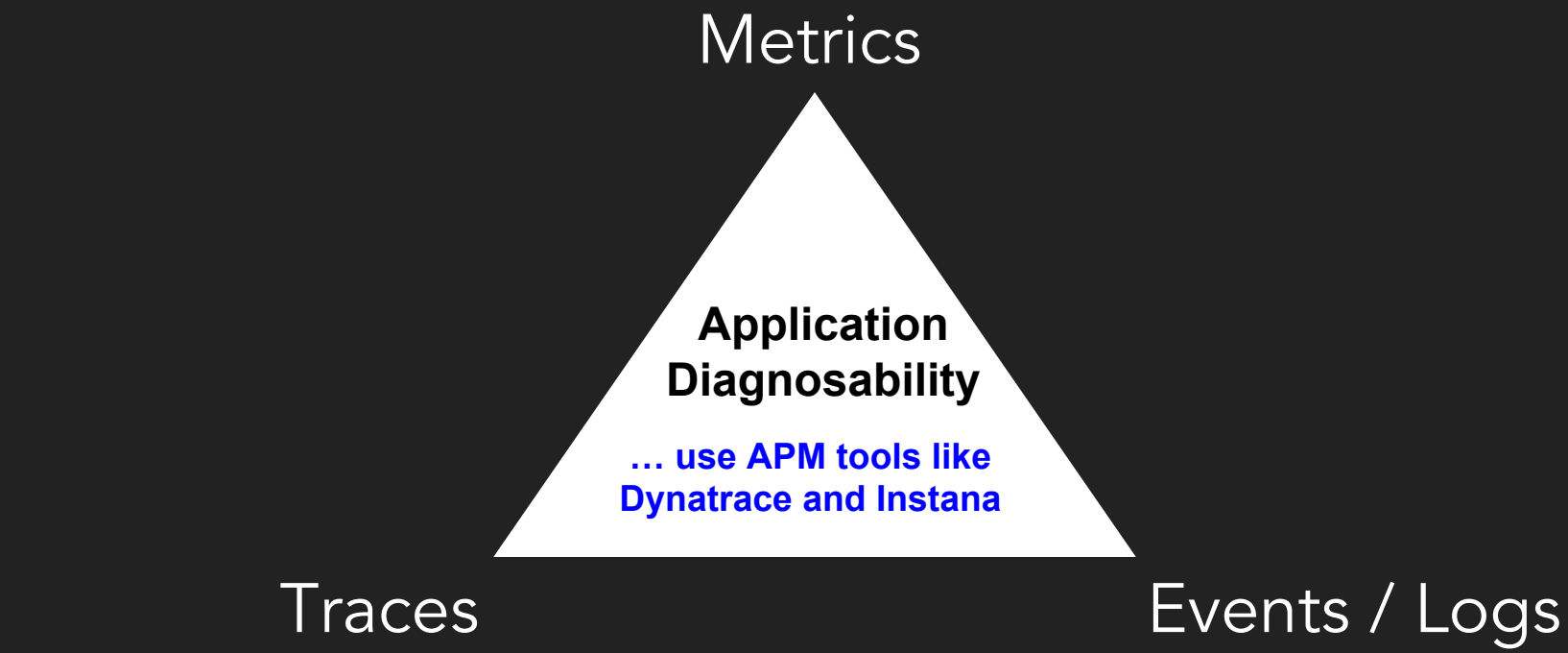
DIAGNO-
SABILITY

Diagnosability

1. **Early on** - diagnose cloud platform issues upfront
2. **Holistic** - monitor and correlate everything
   (infrastructure & apps, multiple levels, metrics & logs & traces)
3. **Mandatory** - everyone has to use it
4. **Automatically** - auto-instrumentation not involving devs


Grafana
Prometheus
Metrics
• High effort to instrument for valuable insights
• Scalability unclear for hundreds of applications
• Applications have no time to run their own Prometheus instance
Application Diagnosability?
• Scalability unclear for hundreds of applications (Jaeger & ZipKin)
• Applications have no time to run their own instance
Traces
OPENTRACING
• Scalability unclear (a lot of events lost)
• Applications have no time to run their own EFK instance
• Non-standardized log format requires custom log rewrite adapter but no fluentd DaemonSet
Events / Logs
fluentd

Want to move fast? Buy first, reduce cost later




SESSION
STATE

Session state

1. Session Stickiness: not within the cloud!
2. Session Persistence
    - Existing DB: perf impact to high ☹
    - Redis: no TLS out of the box and infrastructure required ☹
3. Session Synchronization
    - App-Server: no dynamic peer lookup within k8s ☹
    - Hazelcast: TLS only in paid enterprise edition ☹
    - ...

Session synchronization with Ignite

- Apache Ignite as in-memory data grid
  - Embedded within application or standalone (in sidecar)
  - Cumbersome but working k8s peer lookup
- Look out for ...
  - Java serialization
  - Legacy frameworks with custom session handling
  - Prevent generating sessions for e.g. health check requests
  - Applications putting large things into the “session” and misuse session as cache

Other technical pain points

Pain	Pattern
Legacy crypto without TLS 1.2 and SNI support (e.g. Java 1.6)	• Find matching cipher suites • Add a security proxy
Legacy apps violating HTTP standards	Refactor
Access source URLs in redirect loops (e.g. IDP login)	Use x-forwarded header and provide according filter
No automated test suites	• Automated high-level tests • Test generation (e.g. evosuite)?

The Project Manager's Point of View

Patterns for success

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Management support

- Strong management support
- Clear scope
- Courage to drive the change to cloud native development

Project Marketing & Motivation

Identification & Celebration

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Co-Location space

One LEAP-Area

- ❏ Support- &
- ❏ Industrialization team
- ❏ In case of required support: Migration team

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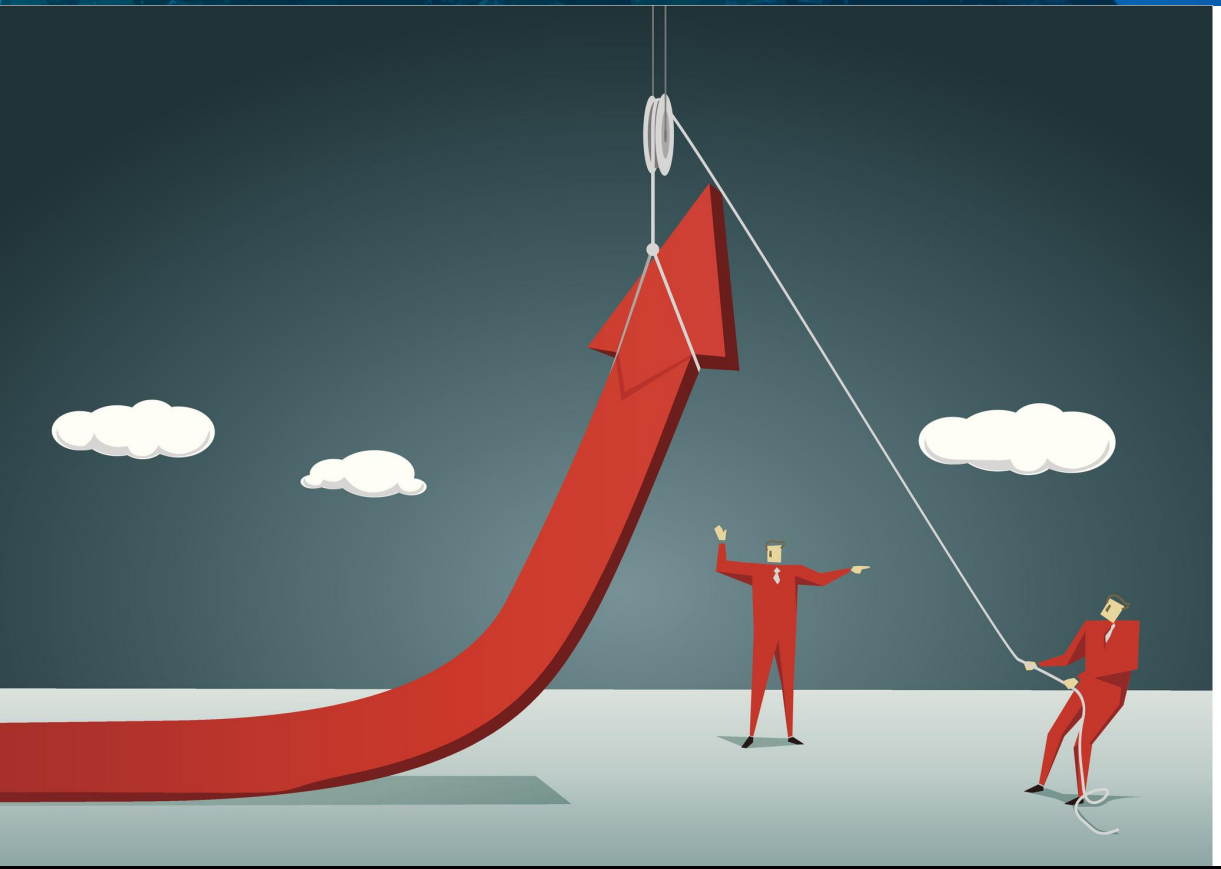
Industrialization



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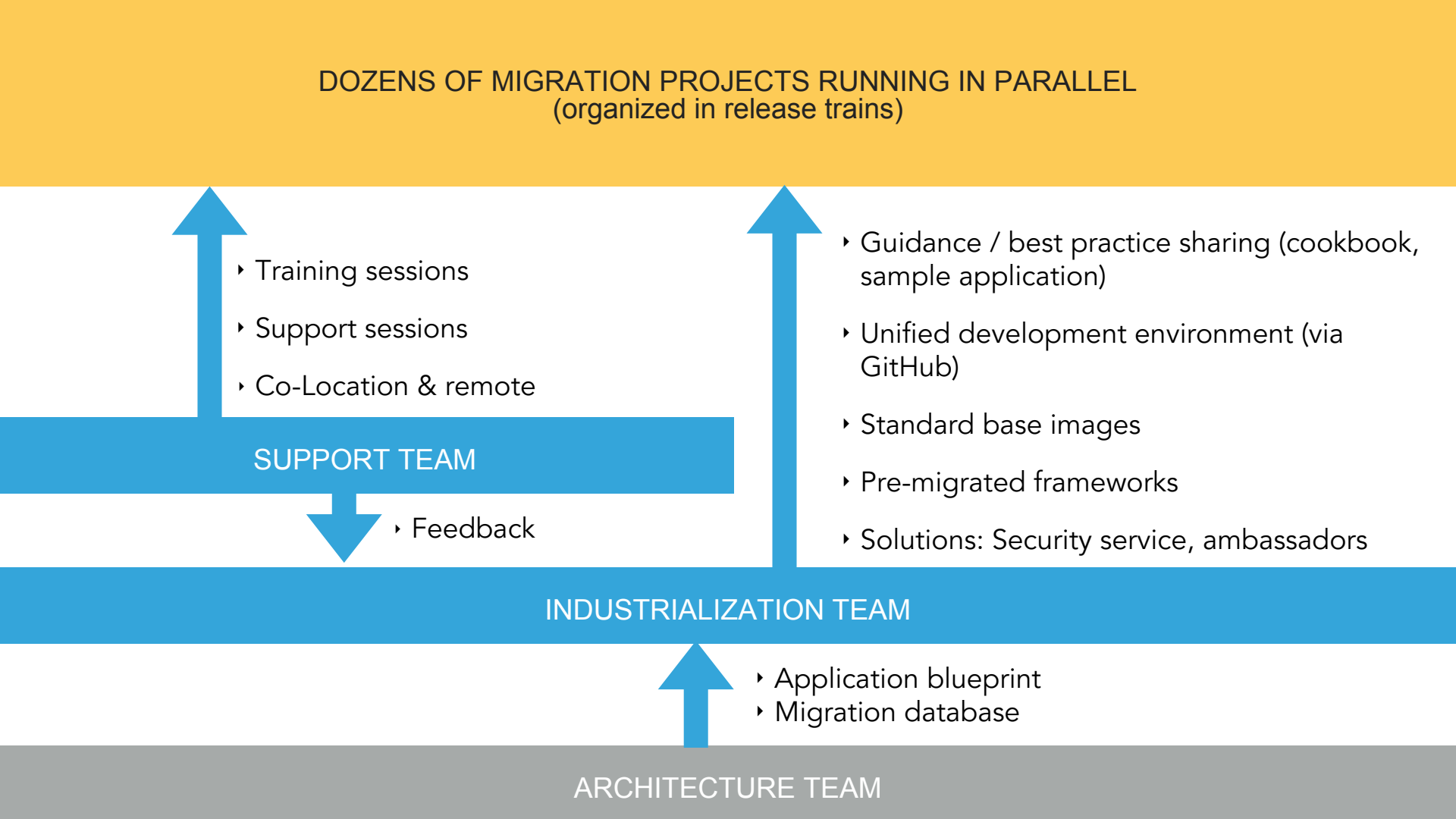
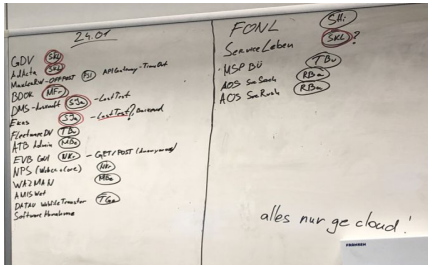
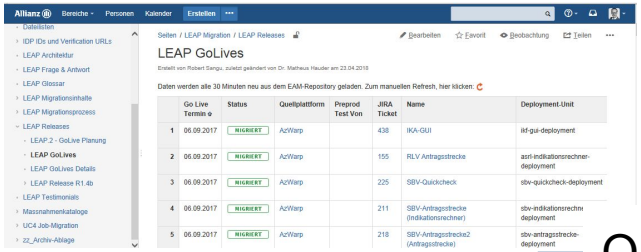

DOZENS OF MIGRATION PROJECTS RUNNING IN PARALLEL
(organized in release trains)
Training sessions
Support sessions
Co-Location & remote
SUPPORT TEAM
Feedback
Guidance / best practice sharing (cookbook, sample application)
Unified development environment (via GitHub)
Standard base images
Pre-migrated frameworks
Solutions: Security service, ambassadors
INDUSTRIALIZATION TEAM
Application blueprint
Migration database
ARCHITECTURE TEAM

Transparency & information radiators

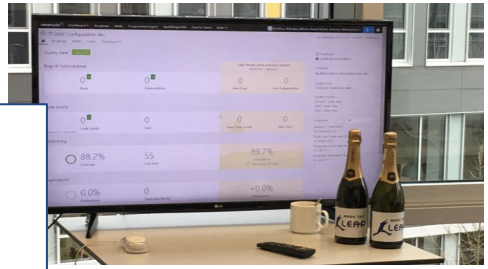
App-Support



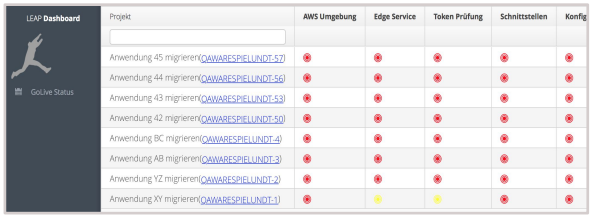
GoLive Planning



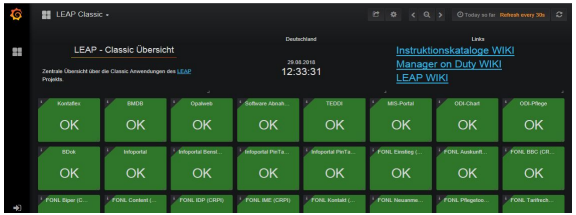
Quality



Activities & Milestones



Operational




a Leap in the right direction
we're walking ou
talk... or if that
Hopping our
croak?
Michael
Frank
Co-SPEAKER
Josef
Adersberger
SPEAKER
adidas

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