HIDDEN PEARLS

for

HIGH-PERFORMANCE-PERSISTENCE

The Introduction

Who is speaking?

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Youtube: [DE] - bit.ly/Youtube-Sven

Introduction

What is the target of this talk?

Internal web applications with a few users but dealing with some TB of data

Apps on embedded devices

- Today's slides are posted
- Video link will soon be posted
- Rate My Talk
- Enter the raffle to win An Amazon Echo Show or 1 of 10 JFrog T-Shirts (winners will be selected in 3 business days & contacted by email)

SCAN ME

http://jfrog.co/JUGSaxonyTShirts

JFrog The Liquid Software Company

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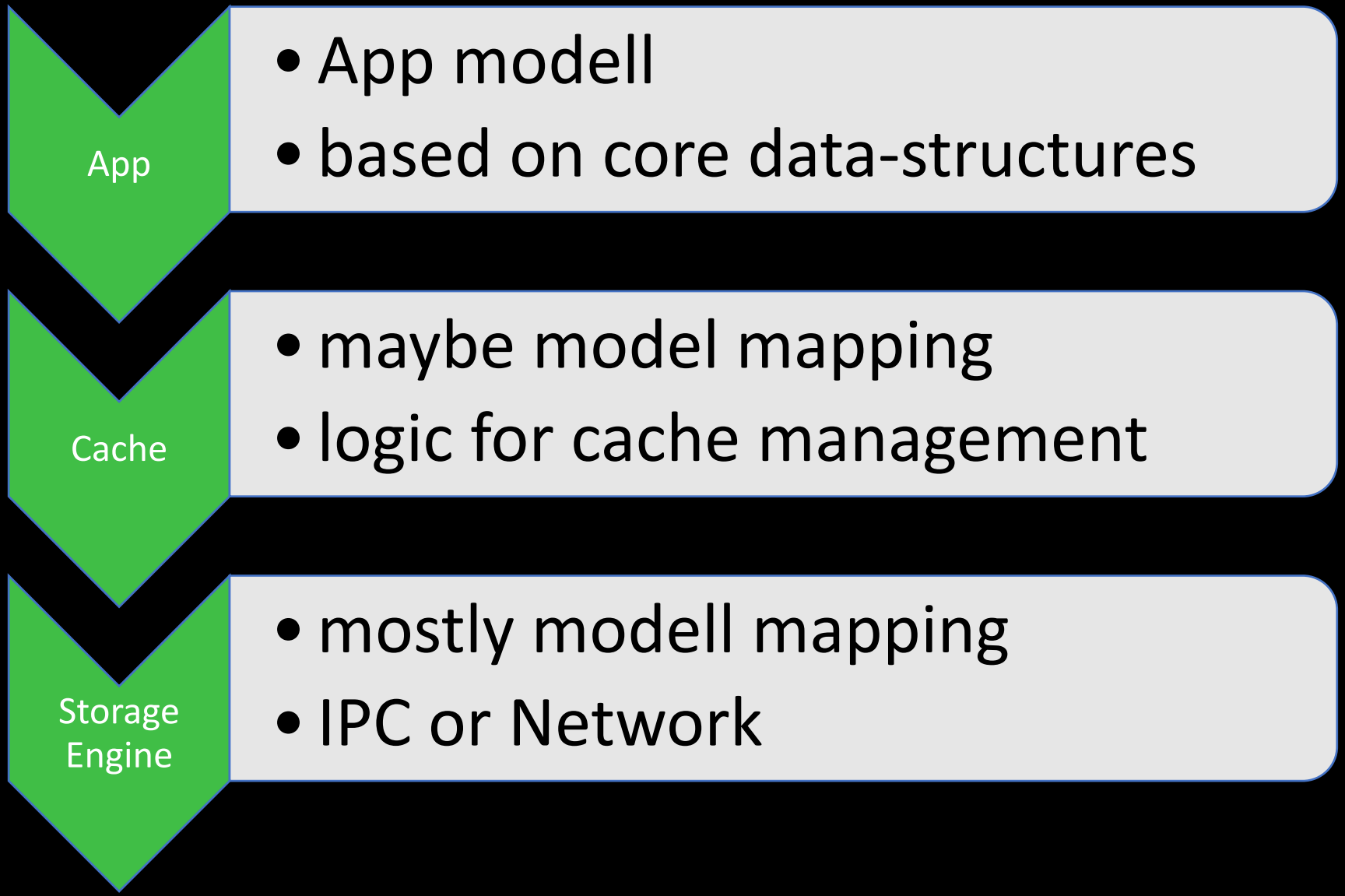
The Basic Ideas

Persistence BirdEye-View



Basic questions about the data behaviour

Basic questions about the data behaviour

How stable is your data?

Write once, archive it, never touch it

A sliding window of hot data, rest is archived

All data is hot

How to navigate through the data?

SQL , Cypher , Streams , ??

All attributes? Calculated fields? Dynamic Views?

MVCC

Multi-Version Concurrency Control

MVCC

https://github.com/aidanmorgan/pojo-mvcc

No dependency – Core Java / Apache Lic

This project contains a simple in-memory Multi-version concurrency control cache for use in Java projects.

In short words: Multi-version concurrency control (MVCC) is a standard technique for avoiding conflicts between reads and writes of the same object. POJO-MVCC guarantees that each transaction sees a consistent view of the object by reading non-current data for objects modified by concurrent transactions. MVCC is a fairly common technique in database transaction implementation and is becoming more common in caching implementations.

https://en.wikipedia.org/wiki/Multiversion_concurrency_control

MVCC

In short words:

For every object that will be modified
the kernel will hold multiple versions of the object

every object version will
get different timestamps or transaction numbers for
reads and modifications

positive: non-blocking reads

negative: multiple versions of
an object in memory

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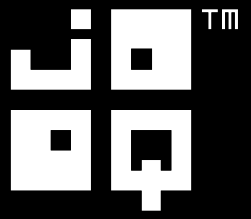
Some random approaches

Some Random Approaches



JOOQ

```
create
.select(BOOK.TITLE)
.from(BOOK)
.where(BOOK.PUBLISHED_IN
.eq(2011))
.orderBy(BOOK.TITLE)
```

Mapping SQL to Java DSL – SQL-style

Generated from the DB Schema

Some Random Approaches

Streams over JDBC

Generated from the DB Schema

JPAStreamer.org

JPAstreamer is released under the LGPL 2.1 License.

Streams over JPA

Some Random Approaches


```
jpaStreamer
.stream(Film.class)
.filter(Film$.rating.equal("G"))
.sorted(Film$.length
                .reversed()
                .thenComparing(Film$.title
                                        .comparator()))
.skip(10)
.limit(5)
 .forEach(System.out::println);
```

Some Random Approaches

Solutions are focussing on convenience only.

Try to get the API Java-like

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Chronicle Maps/Bytes

Chronicle Maps/Bytes

Chronicle Bytes contains all the low level memory access wrappers. It is built on Chronicle Core's direct memory and OS system call access.

https://github.com/OpenHFT/Chronicle-Bytes

Chronicle Map is a super-fast, in-memory, non-blocking, key-value store, designed for low-latency, and/or multi-process applications such as trading and financial market applications.
The size of a Chronicle Map is not limited by memory (RAM), but rather by the available disk capacity.

https://github.com/OpenHFT/Chronicle-Map

Chronicle Bytes

```
<dependency>
        <groupId>net.openhft</groupId>
        <artifactId>chronicle-bytes</artifactId>
        <version>XYZ</version>
</dependency>
```

```
Bytes<ByteBuffer> bytes = Bytes.elasticHeapByteBuffer(64);
bytes.writeBoolean(0, true);

boolean flag = bytes.readBoolean(0);
```

```
MappedBytes mb = MappedBytes
  .mappedBytes(new File("mapped_file"), 1024);
mb.appendUtf8(“Hello")
    .append(42.42f);
```

Chronicle Maps

```
<dependency>
        <groupId>net.openhft</groupId>
        <artifactId>chronicle-maps</artifactId>
        <version>XYZ</version>
</dependency>
```

```
ChronicleMap<LongValue, CharSequence> persistedMap
  = ChronicleMap
    .of(LongValue.class,
        CharSequence.class)
    .name("value-map")
    .entries(50)
    .averageValue("Value-with-Typical-Length")
    .createPersistedTo(new File("/dataFile.dat"));
```

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XODUS

XODUS

Transactional schema-less embedded database used by JetBrains YouTrack and JetBrains Hub.

https://github.com/JetBrains/xodus

- **Xodus is transactional and fully ACID-compliant.**
- **Xodus is highly concurrent. Reads are completely non-blocking due to MVCC and true snapshot isolation.**
- **Xodus is schema-less and agile. It does not require schema migrations or refactorings.**
- **Xodus is embedded. It does not require installation or administration.**
- **Xodus is written in pure Java and Kotlin.**
- **Xodus is free and licensed under Apache 2.0.**

XODUS

Snapshot isolation - ONLY

LOG-structured design of XODUS.

All changes are written sequencially to a log. (*.xd – files)
The log is immutable !!

persistent functional data structure

Garbage Collector - Needed

XODUS

```
<dependency>
        <groupId>org.jetbrains.xodus</groupId>
        <artifactId>xodus-openAPI</artifactId>
        <version>1.3.232</version>
</dependency>
```

Environments	org.jetbrains.xodus:xodus-environment:1.3.232
Entity Stores	org.jetbrains.xodus:xodus-entity-store:1.3.232
Virtual File Systems	org.jetbrains.xodus:xodus-vfs:1.3.232

XODUS - Environments

In short, Environment is a transactional key-value storage. Store is a named collection of key/value pairs. If a Store is not allowed to contain duplicate keys, then it is a map. Otherwise, it is a multi-map.

```
try (Environment env = Environments
   .newInstance("/home/me/.myAppData")) {
      env.executeInTransaction(txn -> {
        final Store store = env.openStore("Messages",
                                          StoreConfig.WITHOUT_DUPLICATES,
                                          txn);
        store.put(txn,
                  StringBinding.stringToEntry("Hello"),
                  StringBinding.stringToEntry("World!"));
              });
}
```

XODUS - Entity Stores

The Entity Stores layer is designed to access data as entities with attributes and links. Use a transaction to create, modify, read and query data. Transactions are quite similar to those on the Environments layer, though the Entity Store API is much richer in terms of querying data.

```
try (PersistentEntityStore entityStore = PersistentEntityStores.newInstance("/home/me/.myAppData")) {
            entityStore.executeInTransaction(txn -> {
                        final Entity message = txn.newEntity("Message");
                        message.setProperty("hello", "World!");
            });
}
```

XODUS - Virtual File Systems

The VirtualFileSystem lets you deal with data in terms of files, input, and output streams. VirtualFileSystem works over an Environment instance:

```
try (Environment env = Environments.newInstance("/home/me/.myAppData")) {
            final VirtualFileSystem vfs = new VirtualFileSystem(env);
            env.executeInTransaction(txn -> {
                        final File file = vfs.createFile(txn, "Messages");
                        try (DataOutputStream output = new DataOutputStream(vfs.writeFile(txn, file))) {
                                    output.writeUTF("Hello ");
                                    output.writeUTF("World!");
                        } catch (IOException e) {
                                     throw new ExodusException(e);
                        }
            });
             vfs.shutdown();
}
```

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MapDB

MapDB

MapDB combines embedded database engine and Java collections.
It is free under Apache 2 license.

MapDB is flexible and can be used in many roles:

- Drop-in replacement for Maps, Lists, Queues and other collections.
- Off-heap collections not affected by Garbage Collector
- Multilevel cache with expiration and disk overflow.
- RDBMs replacement with transactions, MVCC, incremental backups etc…
- Local data processing and filtering. MapDB has utilities to process huge quantities of data in reasonable time.

https://github.com/jankotek/mapdb

Commercial support is offered by the project owner

MapDB

```
<dependency>
        <groupId>org.mapdb</groupId>
        <artifactId>mapdb</artifactId>
        <version>VERSION</version>
</dependency>
```

```
DB db = DBMaker .fileDB("/some/file")
                .encryptionEnable("password")
                .make();

ConcurrentNavigableMap<Integer,String> map = db.treeMap("collectionName",
                                                        Serializer.INTEGER,
                                                        Serializer.STRING)
                                                .createOrOpen();
map.put(1,"one");
map.put(2,"two");           //map.keySet() is now [1,2] even before commit
db.commit();                //persist changes into disk
map.put(3,"three");         //map.keySet() is now [1,2,3]
db.rollback();              //revert recent changes //map.keySet() is now [1,2]
db.close();
```

MapDB

```
DB dbDisk = DBMaker .fileDB(file) .make();

// Big map populated with data expired from cache
DB dbMemory = DBMaker .memoryDB() .make();

// fast in-memory collection with limited size
HTreeMap onDisk = dbDisk .hashMap("onDisk") .create();

HTreeMap inMemory = dbMemory .hashMap("inMemory")
                             .expireAfterGet(1, TimeUnit.SECONDS)       //overflow to `onDisk`
                             .expireOverflow(onDisk)                    //background expiration
                             .expireExecutor(Executors.newScheduledThreadPool(2))
                             .create();
```

Possible to build cascaded data-structures with different attributes.
Combination between caching and persistence.
Transactions based on MVCC

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Microstream

Microstream

https://microstream.one/java-native-persistence

Free to use / will be open source soon

MicroStream is a storage technology that stores Java object-graphs natively, which means similar as they are in the RAM, without expensive transformation to any incompatible data structure.
That is the key difference to all database-systems and provides you the following benefits.

- Only 1 data structure (object-graph), only 1 data model (Java classes)
- no mapping
- No loss of performance through mapping
- Simple architecture, super easy to use
- Simplifies and accelerates your entire database development process

Microstream

Free to use / not open source

```
<repository>
        <id>microstream-releases</id>
        <url>https://repo.microstream.one/repository/maven-public/</url>
</repository>

<dependency>
        <groupId>one.microstream</groupId>
        <artifactId>storage.embedded</artifactId>
        <version>04.00.00-MS-GA</version>
</dependency>
<dependency>
        <groupId>one.microstream</groupId>
        <artifactId>storage.embedded.configuration</artifactId>
        <version>04.00.00-MS-GA</version>
</dependency>
```

Microstream

Free to use / not open source

```
public class HelloWorld {
	private String value;
	public String getValue() {
		return value;
	}
	public void setValue(String value) {
		this.value = value;
	}
}


final HelloWorld value = new HelloWorld();
value.setValue("HelloWorld");

final EmbeddedStorageManager storageManager = EmbeddedStorage.start();
storageManager.setRoot(value);
storageManager.storeRoot();
storageManager.shutdown();
```

Microstream

Free to use / not open source

Use a Collection as root – node

Just store your model as it is

No transaction mechanism until now

Loading partial graphs – Virtual Proxies –

```
private Lazy<ArrayList<MyClass>> myClasses = Lazy.Reference(new ArrayList<>());
```

Cycles in the graph are not a problem

No special Inheritance

https://dzone.com/articles/high-performance-persistence-with-microstream-part

Microstream and MVCC

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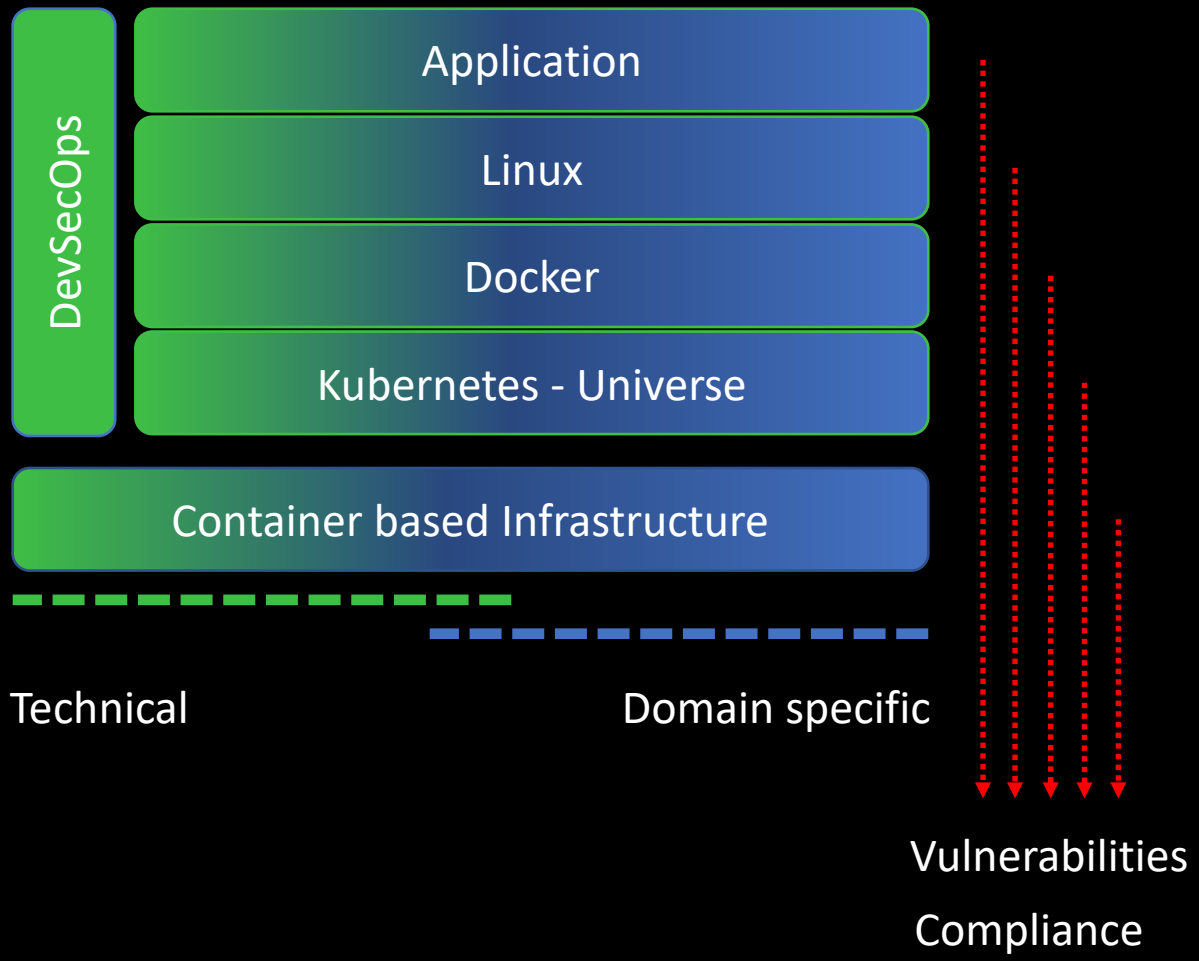
DevSecOps / Security

Persistence and Dev(Sec)Ops



Every layer we can remove – will remove vulnerabilities

bit.ly/DevSecOps-QuickWins-DE

Low-hanging Fruits - Dependencies

Compliance

One time effort to define allowed Lic

Machine is doing the job

Vulnerabilities

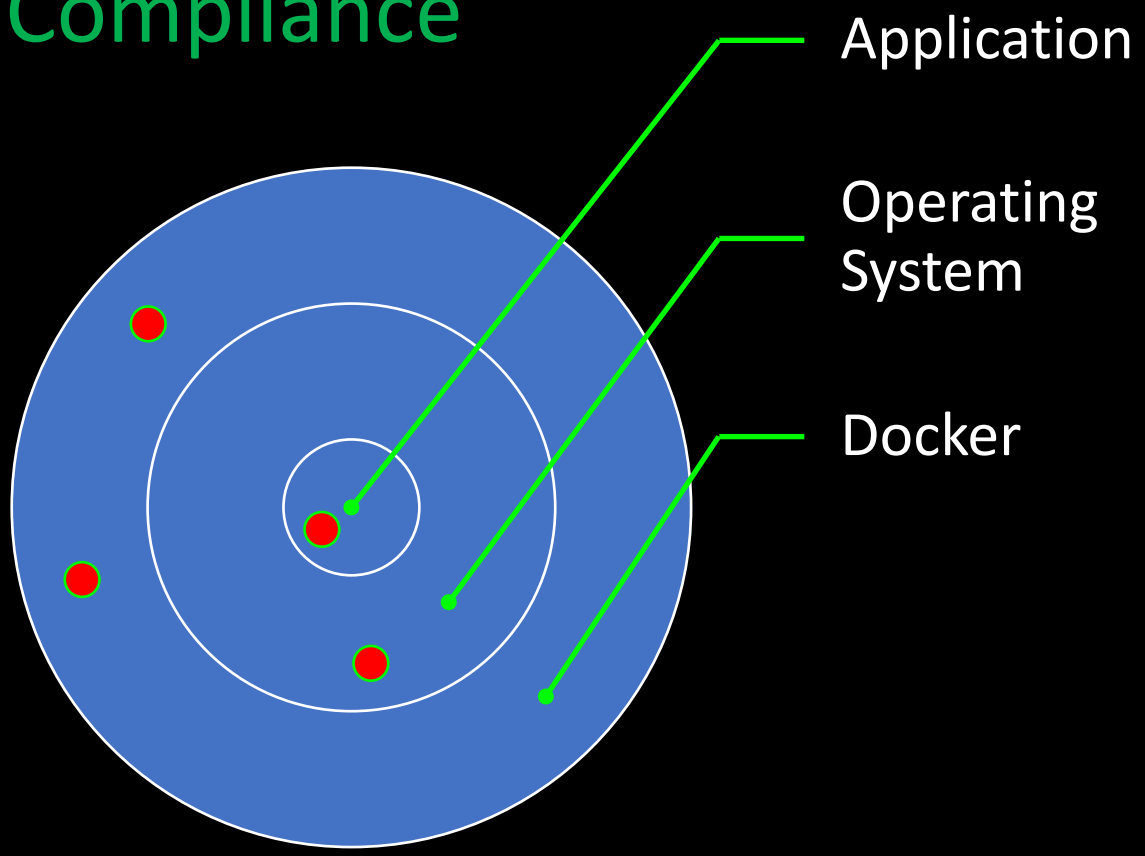
recurrent effort

Machine is scanning

Human is deciding

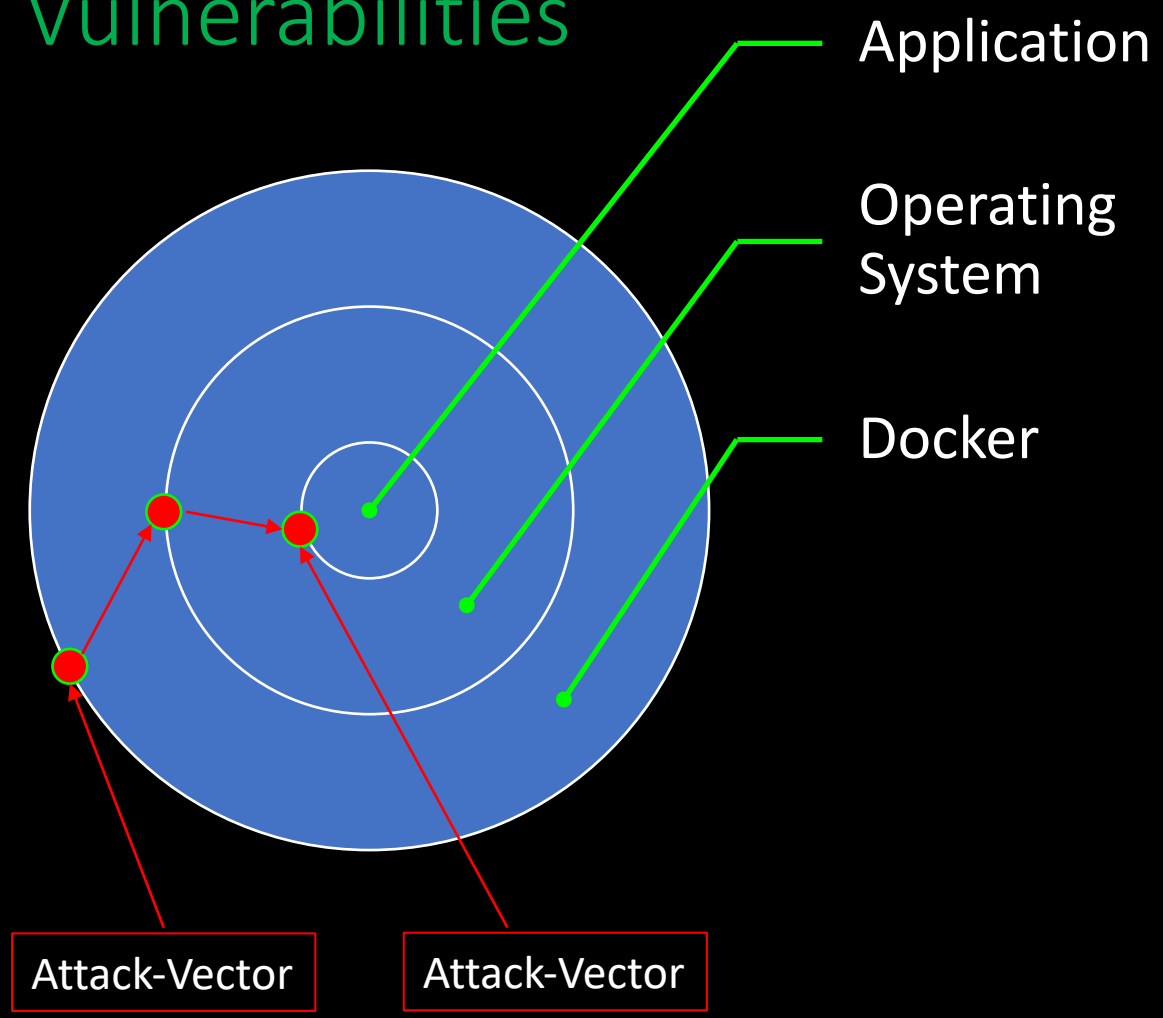
Low-hanging Fruits - Dependencies

Compliance



Low-hanging Fruits - Dependencies

Vulnerabilities



Low-hanging Fruits - Dependencies

Vulnerabilities / Compliance

Good Test-Coverage is your safety-belt

Optimize your deployment times

Dependencies are the biggest part

Youtube: [DE] - bit.ly/Youtube-Sven

Dependency Management

has the highest impact

Persistence and Dev(Sec)Ops

Random thoughts

- Smaller amount of components – mostly easier to handle
- Shorter RamUp / RampDown times for TDD
- Datamigration – depends on the system itself
- DataDrivenTesting – just a few binaries hosted in a repo
  - Generic Repository in Artifactory - immutable

Compliance / Security Issues

- Lic check of all components
- Security check of al dependencies , including transitive ones
- As Early as possible #ShiftLeft

Persistence and Dev(Sec)Ops

Only one of the discussed systems
have a Security Issue right now

Based on the missing components
the general amount of
attack vectors are smaller

Complete stack is managed via maven

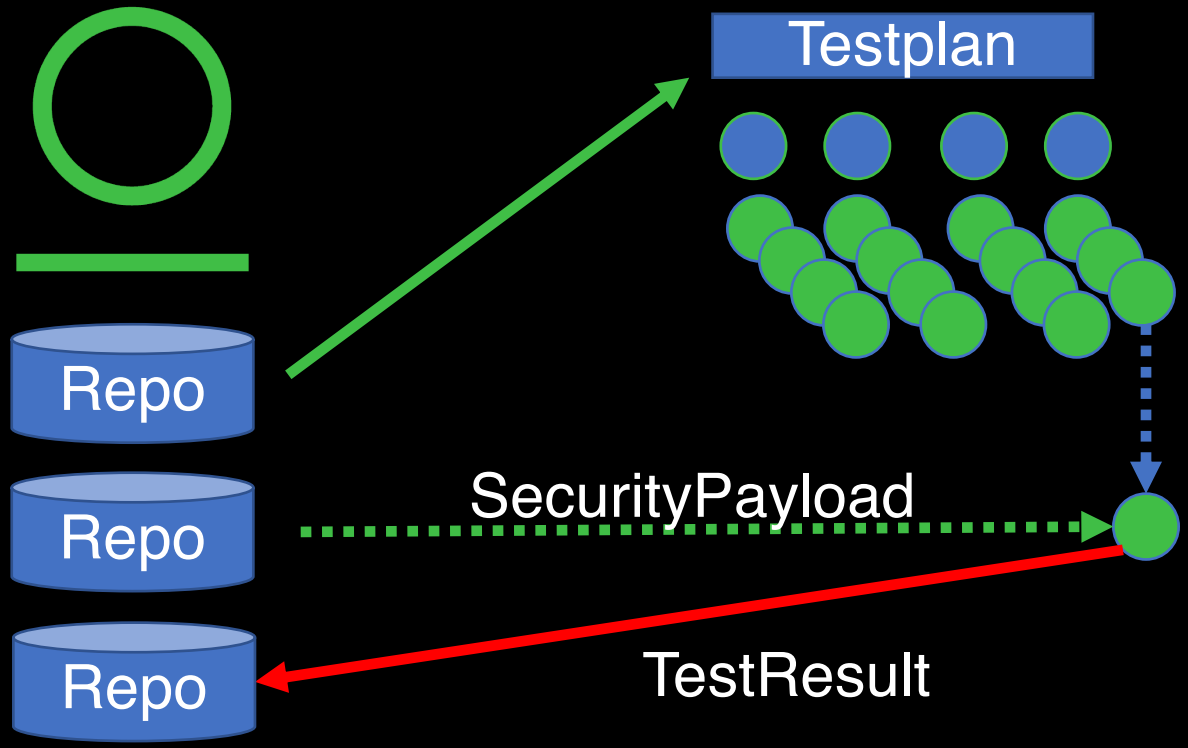
- Easy to integrate into CI environments
- IDE Support via CodeCompletion

Tooling is not complete:

- DataNavigation / AdHoc query
- Backup / Restore
- …

SecurityPayload Generator Injection

- Load binary data from Artifactory – Generic Repo
- SecurityPayload Generator Injection
- Store a TestPlan with the BuildInfo
- Store a TestResults with the BuildInfo



Additional Content

- https://microstream.one/
- https://github.com/JetBrains/xodus
- https://github.com/jankotek/mapdb
- https://github.com/OpenHFT/Chronicle-Bytes
- https://github.com/OpenHFT/Chronicle-Map

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THANK YOU!