External Dependencies of Java Artifacts with Neo4j

References

- jqassistant
- py2neo

External Package Usage

External Package

A package is categorized as "external" if it is utilized as a dependency, or if any of its enclosed types are used as dependencies, but the code within it has not been analyzed (missing bytecode). This also applies to all build-in Java types, but they are explicitly filtered out here.

External annotation dependency

The aforementioned classification encompasses external annotation dependencies as well. These dependencies introduce significantly less coupling and are not indispensable for compiling code. Without the external annotation the code would most probably behave differently. Hence, they are included in the first more overall and general tables and then left out in the later more specific ones.

Table 1 - Top 20 most used external packages overall

This table shows the external packages that are used by the most different internal types overall. Additionally, it shows which types of the external package are actually used. External annotations are also listed.

Columns:

- *externalPackageName* identifies the external package as described above
- *numberOfExternalTypeCaller* refers to the distinct types that make use of the external package
- *numberOfExternalTypeCalls* includes every invocation or reference to the types in the external package
- *allTypes* represents the total count of all analyzed types in general

- *externalTypeNames* contains a list of actually utilized types of the external package

	externalPackageName	numberOfExternalTypeCaller	numberOfExternalTypeCalls	allTypes	externalTypeNames
0	javax.annotation	325	1419	2506	[Nonnull, Nullable, PreDestroy]
1	org.slf4j	193	541	2506	[LoggerFactory, Logger]
2	javax.persistence	78	339	2506	[MappedSuperclass, IdClass, Id, Index, Table, ...
3	jakarta.persistence	69	327	2506	[Id, MappedSuperclass, IdClass, Entity, Index,...
4	org.hamcrest	61	498	2506	[Matcher, CoreMatchers, Description, StringDes...
5	com.fasterxml.jackson.annotation	54	84	2506	[JsonProperty, JsonCreator, JsonGetter, JsonTy...
6	org.quartz	37	226	2506	[JobDataMap, Job, JobExecutionContext, Schedul...
7	reactor.core.publisher	33	149	2506	[Mono, Flux, FluxSink$OverflowStrategy, FluxSi...
8	com.fasterxml.jackson.databind	15	73	2506	[JsonDeserializer, DeserializationContext, Obj...
9	org.reactivestreams	13	41	2506	[Publisher]
10	com.thoughtworks.xstream.io	9	46	2506	[HierarchicalStreamWriter, HierarchicalStreamR...
11	com.lmax.disruptor	9	29	2506	[RingBuffer, LifecycleAware, EventHandler, Blo...
12	javax.cache.event	8	34	2506	[CacheEntryUpdatedListener, CacheEntryListener...
13	javax.sql	6	24	2506	[DataSource]
14	com.thoughtworks.xstream.converters	6	12	2506	[MarshallingContext, UnmarshallingContext]
15	net.sf.ehcache	5	63	2506	[CacheException, Element, Ehcache]
16	nu.xom	5	16	2506	[Document, ParsingException, Builder]
17	com.thoughtworks.xstream.mapper	5	10	2506	[Mapper, CannotResolveClassException]
18	com.lmax.disruptor.dsl	5	22	2506	[ProducerType, Disruptor, EventHandlerGroup]
19	javax.validation	5	22	2506	[Validation, ConstraintViolation, Validator, V...

Chart 1 - Most called external packages in %

Packages that are used less than 0.7% are grouped into the name "others" to get a cleaner chart with the most significant external packages and how ofter they are called in percent.

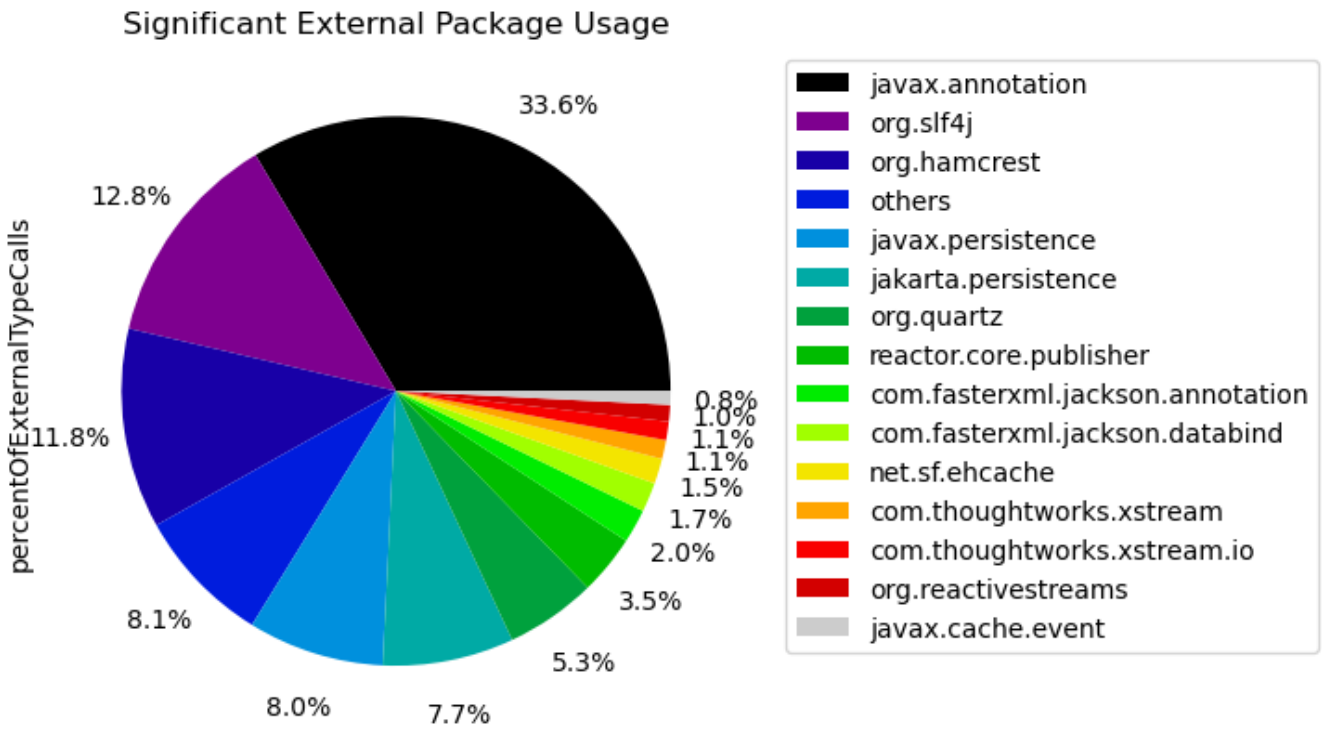

Table 2 - Top 20 least used external packages overall

This table identifies external packages that aren't used very often. This could help to find libraries that aren't actually needed or maybe easily replaceable. Some of them might be used sparsely on purpose for example as an adapter to an external library that is actually important. Thus, decisions need to be made on a case-by-case basis.

Columns:

- *externalPackageName* identifies the external package as described above
- *numberOfExternalTypeCalls* includes every invocation or reference to the types in the external package

	externalPackageName	numberOfExternalTypeCalls
0	org.junit.rules	1
1	org.junit.jupiter.api	1
2	javax.xml.stream	2
3	org.junit.runner	2
4	reactor.core	2
5	org.testcontainers.containers.wait.strategy	2
6	com.fasterxml.jackson.datatype.jsr310	2
7	org.quartz.impl.matchers	2
8	org.dom4j.io	3
9	reactor.util.concurrent	3
10	com.fasterxml.jackson.databind.type	3
11	com.fasterxml.jackson.databind.jsontype	3
12	com.fasterxml.jackson.databind.module	3
13	org.junit.jupiter.api.extension	6
14	reactor.util.context	7
15	com.thoughtworks.xstream.converters.collections	7
16	org.testcontainers.containers	8
17	org.junit.runners.model	8
18	net.sf.ehcache.event	9
19	com.thoughtworks.xstream.mapper	10

Table 3 - External usage per artifact

The following table shows the most used external packages separately for each artifact including external annotations.

Columns:

- *artifactName* is used to group the the external package usage per artifact for a more detailed analysis.
- *externalPackageName* identifies the external package as described above
- *numberOfExternalTypeCaller* refers to the distinct types that make use of the external package
- *numberOfExternalTypeCalls* includes every invocation or reference to the types in the external package
- *numberOfTypesInArtifact* represents the total count of all analyzed types for the artifact

- *externalTypeNames* contains a list of actually utilized types of the external package

	artifactName	externalPackageName	numberOfExternalTypeCaller	numberOfExternalTypeCalls	numberOfTypesInArtifact	externalTypeNames
0	axon-configuration-4.7.5	javax.annotation	12	104	39	[Nonnull]
1	axon-configuration-4.7.5	org.slf4j	9	28	39	[Logger, LoggerFactory]
2	axon-disruptor-4.7.5	org.slf4j	12	22	22	[Logger, LoggerFactory]
3	axon-disruptor-4.7.5	com.lmax.disruptor	9	29	22	[RingBuffer, EventHandler, LifecycleAware, Exc...
4	axon-disruptor-4.7.5	javax.annotation	6	23	22	[Nonnull]
...	...	...	...	...	...	...
61	axon-test-4.7.5	org.testcontainers.containers	2	8	85	[GenericContainer]
62	axon-test-4.7.5	org.junit.runners.model	2	8	85	[Statement]
63	axon-test-4.7.5	org.junit.rules	1	1	85	[TestRule]
64	axon-test-4.7.5	org.junit.runner	1	2	85	[Description]
65	axon-test-4.7.5	org.junit.jupiter.api	1	1	85	[Assertions]

66 rows × 6 columns

Table 4 - External usage per artifact and package

The next table lists internal packages and the artifacts they belong to that use many different external types of a specific external package without taken external annotations into account. Only the first 30 rows are shown.

Columns:

- *artifactName* that contains the type that calls the external package
- *fullPackageName* is the package within the artifact that contains the type that calls the external package
- *externalPackageName* identifies the external package as described above
- *numberOfExternalTypeCaller* refers to the distinct types that make use of the external package
- *numberOfExternalTypeCalls* includes every invocation or reference to the types in the external package
- *numberOfTypesInPackage* represents the total count of all types in that package
- *externalTypeNames* contains a list of actually utilized types of the external package
- *packageName* contains the name of the package (last part of *fullPackageName*)

	artifactName	fullPackageName	externalPackageName	numberOfExternalTypeCaller	numberOfExternalTypeCalls	numb
0	axon-test-4.7.5	org.axonframework.test.matchers	org.hamcrest	38	188	
1	axon-messaging-4.7.5	org.axonframework.queryhandling	reactor.core.publisher	26	115	
2	axon-messaging-4.7.5	org.axonframework.eventhandling.scheduling.quartz	org.quartz	19	95	
3	axon-messaging-4.7.5	org.axonframework.deadline.quartz	org.quartz	18	131	
4	axon-messaging-4.7.5	org.axonframework.eventhandling	org.slf4j	15	55	
5	axon-messaging-4.7.5	org.axonframework.serialization.json	com.fasterxml.jackson.databind	15	73	
6	axon-messaging-4.7.5	org.axonframework.eventhandling.pooled	org.slf4j	13	59	
7	axon-disruptor-4.7.5	org.axonframework.disruptor.commandhandling	org.slf4j	12	22	
8	axon-configuration-4.7.5	org.axonframework.config	org.slf4j	9	28	
9	axon-disruptor-4.7.5	org.axonframework.disruptor.commandhandling	com.lmax.disruptor	9	29	
10	axon-test-4.7.5	org.axonframework.test.saga	org.hamcrest	9	91	
11	axon-eventsourcing-4.7.5	org.axonframework.eventsourcing.eventstore.leg...	org.slf4j	8	15	
12	axon-messaging-4.7.5	org.axonframework.common.caching	javax.cache.event	8	34	
13	axon-messaging-4.7.5	org.axonframework.messaging.annotation	org.slf4j	8	15	
14	axon-messaging-4.7.5	org.axonframework.messaging.responsetypes	reactor.core.publisher	7	34	
15	axon-messaging-4.7.5	org.axonframework.queryhandling	org.reactivestreams	7	27	
16	axon-messaging-4.7.5	org.axonframework.queryhandling	org.slf4j	7	16	
17	axon-test-4.7.5	org.axonframework.test.aggregate	org.hamcrest	7	136	
18	axon-eventsourcing-4.7.5	org.axonframework.eventsourcing.eventstore	org.slf4j	6	9	
19	axon-messaging-4.7.5	org.axonframework.messaging.responsetypes	org.reactivestreams	6	14	
20	axon-messaging-4.7.5	org.axonframework.serialization	com.thoughtworks.xstream.converters	6	12	
21	axon-messaging-4.7.5	org.axonframework.serialization	com.thoughtworks.xstream.io	6	39	
22	axon-modelling-4.7.5	org.axonframework.modelling.saga.repository.jpa	jakarta.persistence	6	68	
23	axon-disruptor-4.7.5	org.axonframework.disruptor.commandhandling	com.lmax.disruptor.dsl	5	22	
24	axon-eventsourcing-4.7.5	org.axonframework.eventsourcing.eventstore.jpa	jakarta.persistence	5	42	
25	axon-messaging-4.7.5	org.axonframework.common	org.slf4j	5	15	
26	axon-messaging-4.7.5	org.axonframework.common.caching	net.sf.ehcache	5	63	

	artifactName	fullPackageName	externalPackageName	numberOfExternalTypeCaller	numberOfExternalTypeCalls	numb
27	axon-messaging-4.7.5	org.axonframework.eventhandling.async	org.slf4j	5	16	
28	axon-messaging-4.7.5	org.axonframework.eventhandling.deadletter.jpa	jakarta.persistence	5	54	
29	axon-messaging-4.7.5	org.axonframework.eventhandling.tokenstore.jpa	jakarta.persistence	5	64	

Table 5 - Top 20 external package usage per type

This table lists the internal types that utilize the most different external types and packages. These have the highest probability of change depending on external libraries. A case-by-case approach is also advisable here because there could for example also be code units that encapsulate an external library and have this high count of external dependencies on purpose.

Columns:

- *artifactName* that contains the type that calls the external package
- *fullPackageName* is the package within the artifact that contains the type that calls external types
- *typeName* identifies the internal type within the package and artifact that calls external types
- *numberOfExternalTypeCaller* and *numberOfExternalTypes* refers to the distinct external types that are used by the internal type
- *numberOfExternalTypeCalls* includes every invocation or reference to the types in the external package
- *numberOfTypesInPackage* represents the total count of all types in that package
- *numberOfExternalPackages* shows how many different external packages are used by the internal type
- *externalPackageNames* contains the list of names of the different external packages that are used by the internal type
- *externalTypeNames* contains a list of actually utilized types of the external package
- *packageName* contains the name of the package (last part of *fullPackageName*)

	artifactName	fullPackageName	typeName	numberOfExternalTypeCaller	numberOfExternalTyp
0	axon-messaging-4.7.5	org.axonframework.serialization.json	JacksonSerializer	9	
1	axon-messaging-4.7.5	org.axonframework.serialization.xml	XStreamSerializer	7	
2	axon-disruptor-4.7.5	org.axonframework.disruptor.commandhandling	DisruptorCommandBus	6	
3	axon-disruptor-4.7.5	org.axonframework.disruptor.commandhandling	DisruptorCommandBus$DisruptorRepository	4	
4	axon-messaging-4.7.5	org.axonframework.deadline.quartz	QuartzDeadlineManager	13	
5	axon-messaging-4.7.5	org.axonframework.messaging.responsetypes	MultipleInstancesResponseType	7	
6	axon-messaging-4.7.5	org.axonframework.queryhandling	SimpleQueryUpdateEmitter	13	
7	axon-messaging-4.7.5	org.axonframework.queryhandling	SimpleQueryBus	6	
8	axon-messaging-4.7.5	org.axonframework.serialization	GapAwareTrackingTokenConverter	6	
9	axon-messaging-4.7.5	org.axonframework.serialization	GapAwareTrackingTokenConverter$ReflectivelyCon...	6	
10	axon-messaging-4.7.5	org.axonframework.serialization	AbstractXStreamSerializer$MetaDataConverter	6	
11	axon-messaging-4.7.5	org.axonframework.serialization.json	MetaDataDeserializer	6	
12	axon-disruptor-4.7.5	org.axonframework.disruptor.commandhandling	BlacklistDetectingCallback	4	
13	axon-disruptor-4.7.5	org.axonframework.disruptor.commandhandling	DisruptorCommandBus$ExceptionHandler	3	
14	axon-eventsourcing-4.7.5	org.axonframework.eventsourcing.eventstore.jpa	SQLErrorCodesResolver	4	
15	axon-eventsourcing-4.7.5	org.axonframework.eventsourcing.eventstore.jpa	JpaEventStorageEngine	6	
16	axon-eventsourcing-4.7.5	org.axonframework.eventsourcing.eventstore.leg...	JpaEventStorageEngine	6	
17	axon-eventsourcing-4.7.5	org.axonframework.eventsourcing.eventstore.leg...	SQLErrorCodesResolver	4	
18	axon-messaging-4.7.5	org.axonframework.deadline.jobrunr	JobRunrDeadlineManager	5	
19	axon-messaging-4.7.5	org.axonframework.eventhandling.deadletter.jpa	JpaSequencedDeadLetterQueue	7	

Table 6 - External package usage distribution per type

The next table shown here only includes the first 20 rows. It shows how many types use one external package, how many use two, etc. . This gives an overview of the distribution of external package calls and the overall coupling to external libraries. The higher the count of distinct external packages the lower should be the count of types that use them. Dependencies to external annotations are left out here.

Have a look above to find out which types have the highest external package dependency usage.

Columns:

- *artifactName* that contains the type that calls the external package

- *artifactTypes* the total count of types in the artifact
- *numberOfExternalPackages* the number of distinct external packages used
- *numberOfTypes* in the artifact where the *numberOfExternalPackages* applies
- *numberOfTypesPercentage* in the artifact where the *numberOfExternalPackages* applies in %

	artifactName	artifactTypes	numberOfExternalPackages	numberOfTypes	numberOfTypesPercentage
0	axon-configuration-4.7.5	39	1	5	12.820513
1	axon-disruptor-4.7.5	22	1	2	9.090909
2	axon-disruptor-4.7.5	22	2	4	18.181818
3	axon-disruptor-4.7.5	22	3	3	13.636364
4	axon-eventsourcing-4.7.5	130	1	12	9.230769
5	axon-eventsourcing-4.7.5	130	2	3	2.307692
6	axon-eventsourcing-4.7.5	130	3	2	1.538462
7	axon-messaging-4.7.5	729	1	100	13.717421
8	axon-messaging-4.7.5	729	2	29	3.978052
9	axon-messaging-4.7.5	729	3	5	0.685871
10	axon-messaging-4.7.5	729	4	4	0.548697
11	axon-messaging-4.7.5	729	5	2	0.274348
12	axon-modelling-4.7.5	149	1	10	6.711409
13	axon-modelling-4.7.5	149	2	3	2.013423
14	axon-test-4.7.5	85	1	28	32.941176
15	axon-test-4.7.5	85	2	2	2.352941
16	axon-test-4.7.5	85	3	3	3.529412

Table 7 - External package usage distribution in percentage

The following table uses the same data as Table 6 but has a column per internal artifact and a row for the number of different external packages used. The values are the percentages of types that fulfill both conditions so they belong to artifact and have the exact count of different external packages used. Dependencies to external annotations are left out here.

artifactName	axon-configuration-4.7.5	axon-disruptor-4.7.5	axon-eventsourcing-4.7.5	axon-messaging-4.7.5	axon-modelling-4.7.5	axon-test-4.7.5
numberOfExternalPackages						
1	12.820513	9.090909	9.230769	13.717421	6.711409	32.941176
2	0.000000	18.181818	2.307692	3.978052	2.013423	2.352941
3	0.000000	13.636364	1.538462	0.685871	0.000000	3.529412
4	0.000000	0.000000	0.000000	0.548697	0.000000	0.000000
5	0.000000	0.000000	0.000000	0.274348	0.000000	0.000000

Chart 2 - External package usage distribution in percentage

The next chart shows the number of types per artifact that use the given number of different external packages as listed in Table 7. Dependencies to external annotations are left out here.

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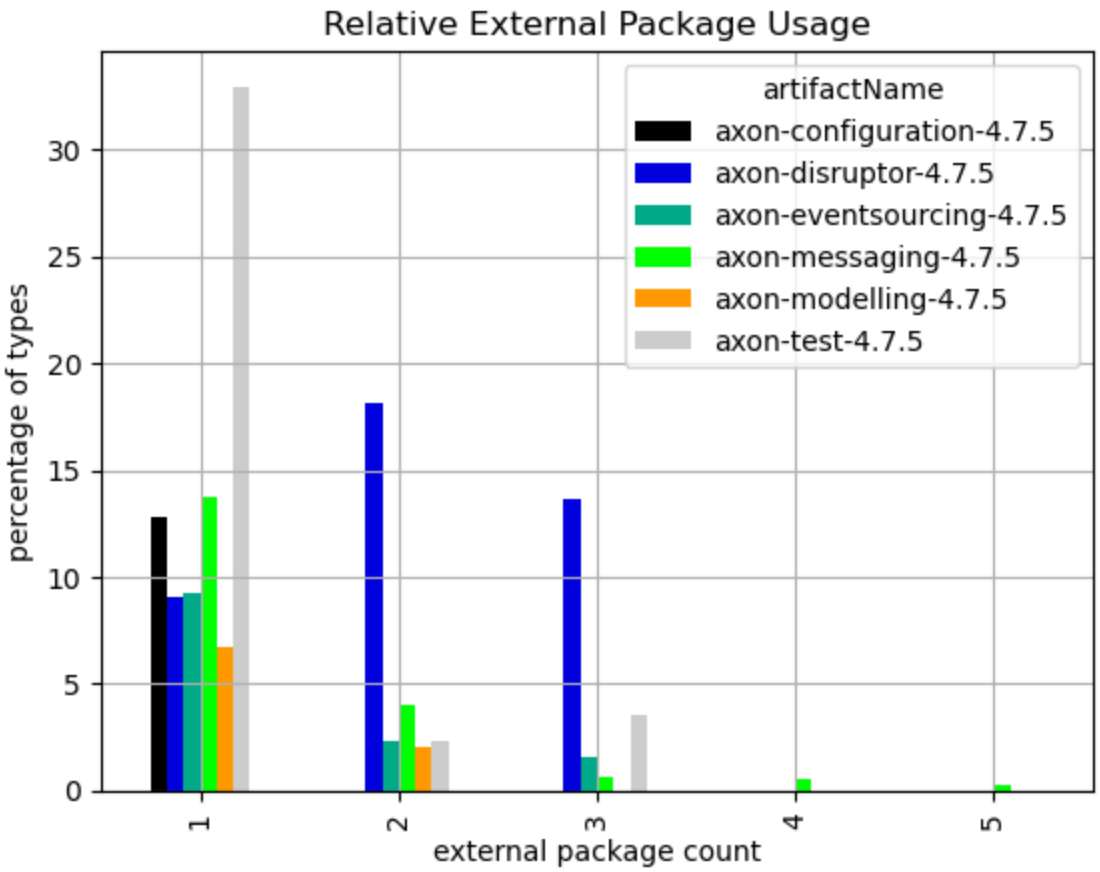

Chart 3 - External package usage distribution in percentage stacked per artifact

The following chart shows a stacked bar for each artifact. Every color represents a different count of different external packages used. The y axis then shows how many percent of types (compared to all types of that artifact) use these external packages. By stacking them above each other it is easier to compare the artifacts and their external package usage. Dependencies to external annotations are left out here.

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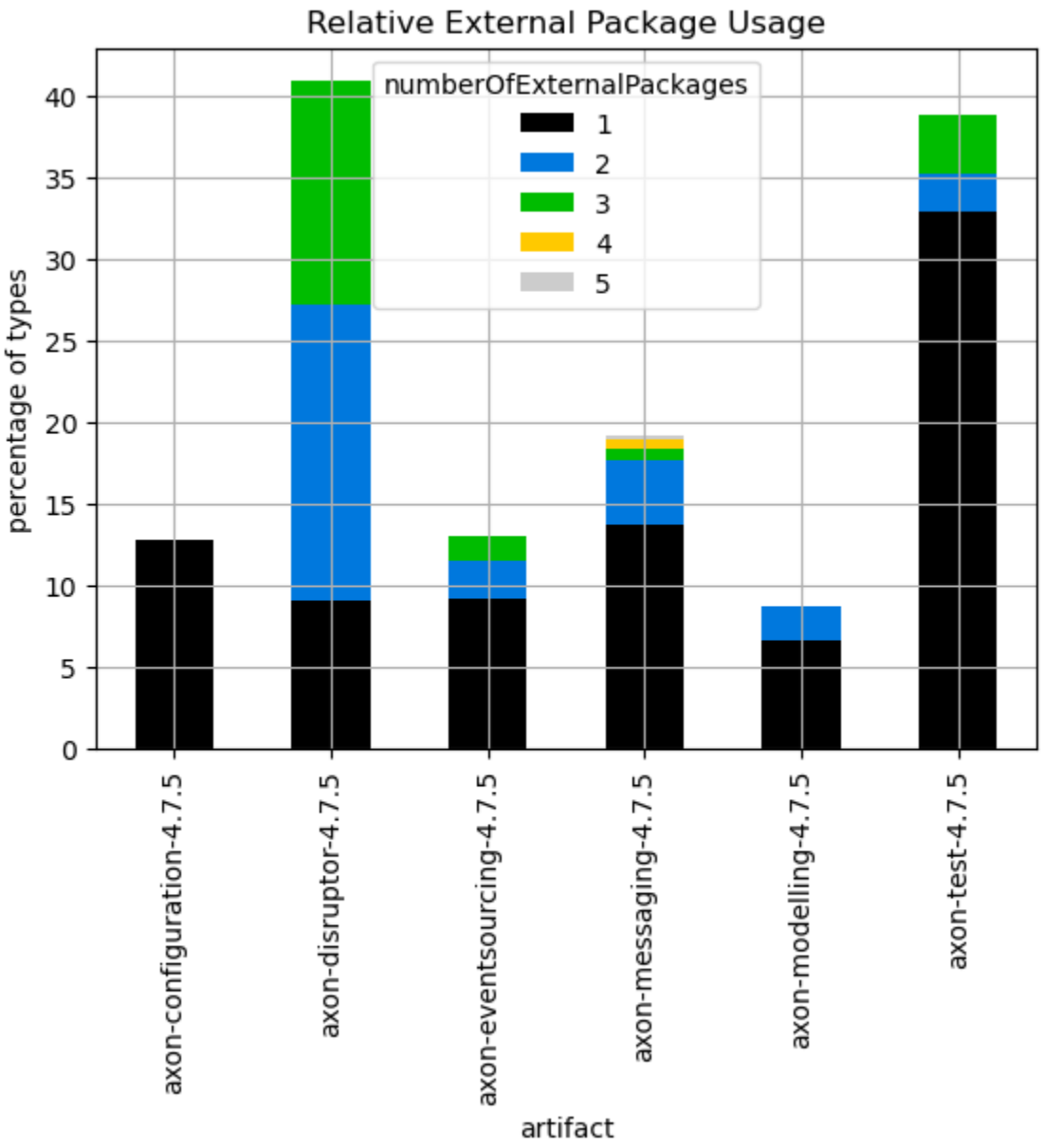

Maven POMs

Table 8 - Maven POMs and their declared dependencies

If Maven is used as for package and dependency management and a ".pom" file is included in the artifact, the following table shows the external dependencies that are declared there.

	pom.artifactId	pom.name	scope	dependency.optional	dependentArtifact.group	dependentArtifact.name
0	axon-configuration	Axon Framework - Configuration	test	False	org.hsqldb	hsqldb
1	axon-configuration	Axon Framework - Configuration	default	False	org.axonframework	axon-messaging
2	axon-configuration	Axon Framework - Configuration	test	False	jakarta.persistence	jakarta.persistence-api
3	axon-configuration	Axon Framework - Configuration	test	False	org.hibernate	hibernate-core-jakarta
4	axon-configuration	Axon Framework - Configuration	default	False	org.axonframework	axon-modelling
...	...	...	...	...	...	...
104	axon-test	Axon Framework - Test Fixtures	default	True	junit	junit
105	axon-test	Axon Framework - Test Fixtures	default	False	${project.groupId}	axon-eventsourcing
106	axon-test	Axon Framework - Test Fixtures	test	False	javax.inject	javax.inject
107	axon-test	Axon Framework - Test Fixtures	default	False	org.junit.jupiter	junit-jupiter
108	axon-test	Axon Framework - Test Fixtures	default	True	org.testcontainers	testcontainers

109 rows × 6 columns