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Practical Way to Build Kubernetes Native Java Controller

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Introduction



Zibo He:  @adohe

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Kubernetes maintainer, working on Ant-Financial PaaS platform. Emeritus co-lead of SIG CLI focusing on CLI, controller-runtime, multi-tenancy and secure container runtime.



Min Jin:  @yue9944882

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Kubernetes sub-project owner, working on Ant-Financial PaaS platform. Focusing on SIG API-Machinery: apiserver flow-control, CRD, OpenAPI facilities.

Agenda



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General approaches to build controllers multilingually

Merit of developing controller in Java

Program using official Kubernetes Java library

Future enhancement for Java controller framework

Q&A

Existing Controller Framework

Builder-Based:

- Kube-builder/Controller-runtime/Controller-tools
<https://github.com/kubernetes-sigs/kubebuilder>
- Operator SDK
<https://github.com/operator-framework/operator-sdk>
- Apiserver-builder-alpha
<https://github.com/kubernetes-sigs/apiserver-builder-alpha>

Callback-Based:

- Meta-controller
<https://github.com/GoogleCloudPlatform/metacontroller>

Controller Pattern



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	Builder-Based	Callback-Based
Operator Lifecycle Management	No	Yes
Needs Deploying Extra Component	No	Yes
Scaffolding	Yes	No
Testing Solution	Yes	No
List-Watching At Client-side	Yes	No
Cache Management At Client-side	Yes	No
Multilingual	No	Yes

Controller in Java vs Golang



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- *Heap dumping*
- *Performance Diagnose*
- *Thread/Routine model*
- *Inheritance & Generics*
- *Open-source Community Resources*
- *And More..*

Heap Dumping



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(Java)

Controller.java Allocator.java Main.java java_pid50964.0

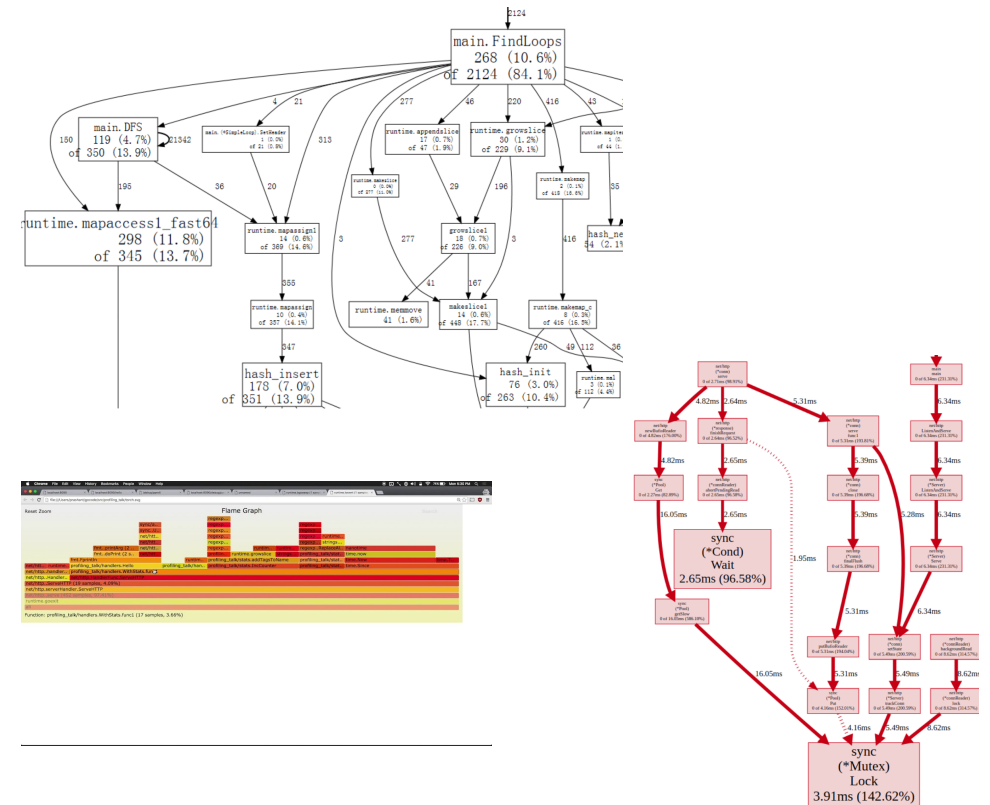
Overview Histogram merge_shortest_paths [selection of 'Liste...'] path2gc [selection of 'Liste...']

Status: Found 6 paths. No more paths left.

Class Name

- <Regex>
- com.example.mat.Listener @ 0x7f3000098
 - [61271] java.lang.Object[132385] @ 0x7f36d2830
 - elementData java.util.ArrayList @ 0x7f42d2dd8
 - com.example.mat.List1 @ 0x7f42b0180
 - p2 class com.example.mat.Controller @ 0x7fb2749f8** (highlighted with red arrow)
 - [1] java.lang.Object[10] @ 0x7f42ca6d8
 - elementData java.util.Vector @ 0x7f42c4f30
 - classes sun.misc.Launcher\$AppClassLoader @ 0x7f42b4000
 - contextClassLoader java.lang.Thread @ 0x7f39d5ae8 Attach
 - contextClassLoader java.lang.Thread @ 0x7f42b0238 Signal
 - contextClassLoader java.lang.Thread @ 0x7f42b20e8 main

(Go)



Performance Diagnoses



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(Java)

```
java_lang_GarbageCollector_CollectionCount
java_lang_GarbageCollector_CollectionTime
java_lang_GarbageCollector_LastGcInfo_GcThreadCount
java_lang_GarbageCollector_LastGcInfo_duration
java_lang_GarbageCollector_LastGcInfo_endTime
java_lang_GarbageCollector_LastGcInfo_id
java_lang_GarbageCollector_LastGcInfo_memoryUsageAfterGc_committed
java_lang_GarbageCollector_LastGcInfo_memoryUsageAfterGc_init
java_lang_GarbageCollector_LastGcInfo_memoryUsageAfterGc_max
java_lang_GarbageCollector_LastGcInfo_memoryUsageAfterGc_used
java_lang_GarbageCollector_LastGcInfo_memoryUsageBeforeGc_committed
java_lang_GarbageCollector_LastGcInfo_memoryUsageBeforeGc_init
java_lang_GarbageCollector_LastGcInfo_memoryUsageBeforeGc_max
java_lang_GarbageCollector_LastGcInfo_memoryUsageBeforeGc_used
java_lang_GarbageCollector_LastGcInfo_startTime
java_lang_GarbageCollector_Valid
java_lang_MemoryManager_Valid
java_lang_MemoryPool_CollectionUsageThreshold
java_lang_MemoryPool_CollectionUsageThresholdCount
java_lang_MemoryPool_CollectionUsageThresholdExceeded
java_lang_MemoryPool_CollectionUsageThresholdSupported
java_lang_MemoryPool_CollectionUsage_committed
java_lang_MemoryPool_CollectionUsage_init
java_lang_MemoryPool_CollectionUsage_max
java_lang_MemoryPool_CollectionUsage_used
java_lang_MemoryPool_PeakUsage_committed
java_lang_MemoryPool_PeakUsage_init
java_lang_MemoryPool_PeakUsage_max
java_lang_MemoryPool_PeakUsage_used
java_lang_MemoryPool_UsageThreshold
java_lang_MemoryPool_UsageThresholdCount
java_lang_MemoryPool_UsageThresholdExceeded
java_lang_MemoryPool_UsageThresholdSupported
java_lang_MemoryPool_Usage_committed
java_lang_MemoryPool_Usage_init
java_lang_MemoryPool_Usage_max
java_lang_MemoryPool_Usage_used
```

```
java_lang_MemoryPool_Valid
jmxremote_jmx_connector_server_Active
jvm_gc_collection_seconds_count
jvm_gc_collection_seconds_sum
jvm_info
jvm_memory_bytes_committed
jvm_memory_bytes_max
jvm_memory_bytes_used
jvm_memory_pool_bytes_committed
jvm_memory_pool_bytes_max
jvm_memory_pool_bytes_used
```

(Go)

```
go_gc_duration_seconds
go_info
go_goroutines
go_memstats_alloc_bytes
go_memstats_alloc_bytes_total
go_memstats_buck_hash_sys_bytes
go_memstats_frees_total
go_memstats_gc_cpu_fraction
go_memstats_gc_sys_bytes
go_memstats_heap_alloc_bytes
go_memstats_heap_idle_bytes
go_memstats_heap_inuse_bytes
go_memstats_heap_objects
go_memstats_heap_released_bytes
go_memstats_heap_sys_bytes
go_memstats_last_gc_time_seconds
go_memstats_lookups_total
go_memstats_mallocs_total
go_memstats_mcache_inuse_bytes
go_memstats_mcache_sys_bytes
go_memstats_mspan_inuse_bytes
go_memstats_mspan_sys_bytes
go_memstats_next_gc_bytes
go_memstats_other_sys_bytes
go_memstats_stack_inuse_bytes
go_memstats_stack_sys_bytes
go_memstats_sys_bytes
```

Thread Model



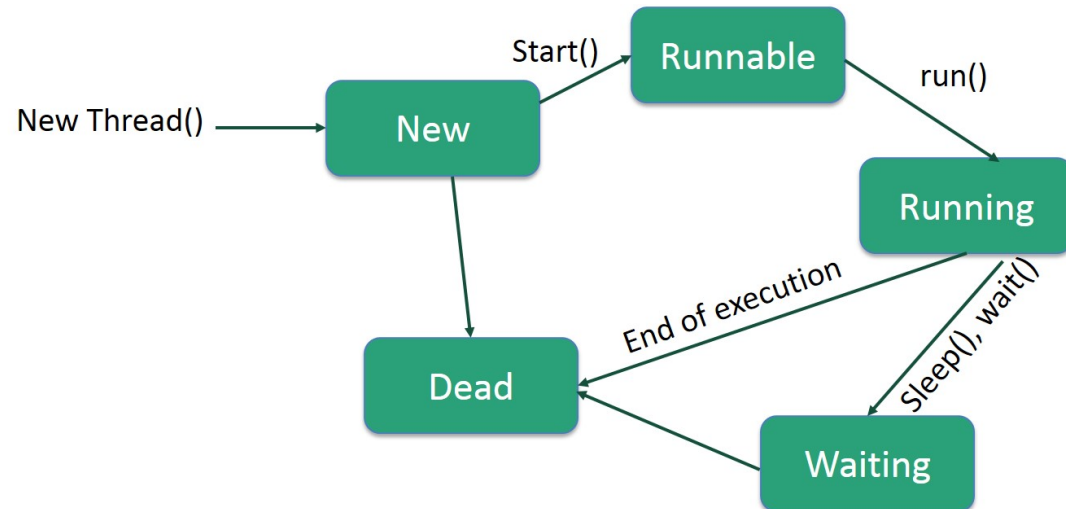
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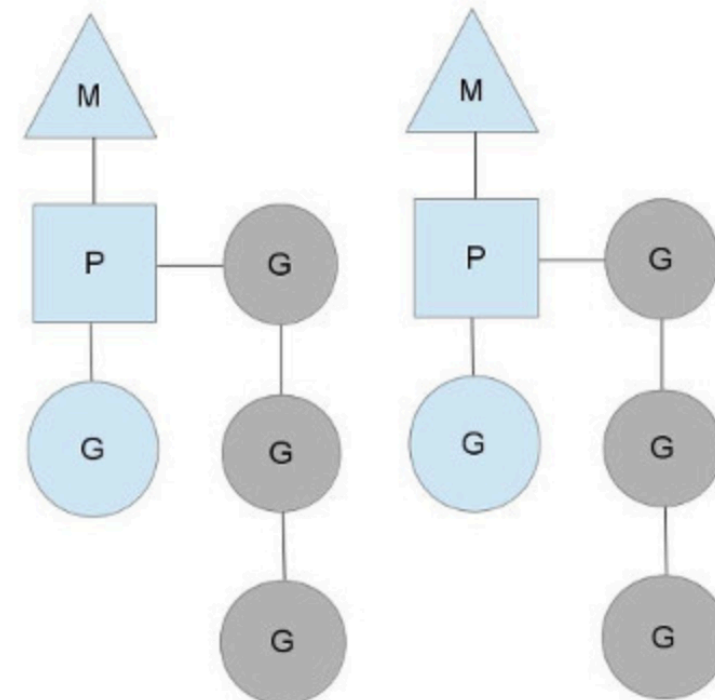
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Inheritance & Generics



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Open-Source Resource

(Java)



(Go)



Java Controller SDK



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We Are Providing:

- *List-Watcher/Informer Library*
- *Java “Controller-Runtime” Library*
- *Leader Election/Lock*
- *CRD Java Model Code-Generation*
- *And More..*

Java Controller SDK



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Demo

Check out more examples at: <https://github.com/kubernetes-client/java>

Java Controller SDK



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<https://github.com/kubernetes-client/java/blob/master/examples/src/main/java/io/kubernetes/client/examples/ControllerExample.java>

```
// Use builder library to construct a default controller.
Controller controller =
    ControllerBuilder.defaultBuilder(informerFactory)
        .watch(
            (workQueue) ->
                ControllerBuilder.controllerWatchBuilder(V1Node.class, workQueue)
                    .withWorkQueueKeyFunc(
                        (V1Node node) ->
                            new Request(node.getMetadata().getName())) // optional, default to
                    .withOnAddFilter(
                        (V1Node createdNode) ->
                            createdNode
                                .getMetadata()
                                .getName()
                                .startsWith("docker-")) // optional, set onAdd filter
                    .withOnUpdateFilter(
                        (V1Node oldNode, V1Node newNode) ->
                            newNode
                                .getMetadata()
                                .getName()
                                .startsWith("docker-")) // optional, set onUpdate filter
                    .withOnDeleteFilter(
                        (V1Node deletedNode, Boolean stateUnknown) ->
                            deletedNode
                                .getMetadata()
                                .getName()
                                .startsWith("docker-")) // optional, set onDelete filter
                .build())
        .withReconciler(nodeReconciler) // required, set the actual reconciler
        .withName("node-printing-controller") // optional, set name for controller
        .withWorkerCount(4) // optional, set worker thread count
        .withReadyFunc(
            informer
                ::hasSynced) // optional, only starts controller when the cache has synced up
        .build();
```

```
static class NodePrintingReconciler implements Reconciler {

    private Lister<V1Node> nodeLister;

    public NodePrintingReconciler(SharedIndexInformer<V1Node> nodeInformer) {
        this.nodeLister = new Lister<>(nodeInformer.getIndexer());
    }

    @Override
    public Result reconcile(Request request) {
        V1Node node = this.nodeLister.get(request.getName());
        System.out.println("triggered reconciling " + node.getMetadata().getName());
        return new Result(false);
    }
}
```

Lessons




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- Manage CRD Yaml Definition **CAREFULLY** 
- Traps in operator's graceful shutdown
- Decouple your operators as a standalone component
- Understand your operator model better before developing
- And ...

Future Enhancement



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- *Kubernetes OpenAPI v3 schema publishing* (<https://github.com/kubernetes/enhancements/pull/1263>)
 - Multi-Returning
 - Unwound “int-or-string”
 - Per-group publishing
 - ...

Future Enhancement



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- *Advanced Extensions for Large-scale Cluster Controller*
- *Controller Canary Release*
- *Multi-Cluster Extensions*

Q&A



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