When "go build" isn't enough: Introduction to Bazel

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Who Am I

- Microsoft SQL Server database developer, +Delphi, C#, Java (2005-20015)
- Go developer (since 2016)
- +Build guy/DevOps (since 2020-2021)
- Not a Google fan, but I mostly use: Go, Bazel, gRPC, Protobuf, and K8s
- Moved to Austin two weeks ago from Ottawa, Canada

Gopher from GoCon Canada 2019

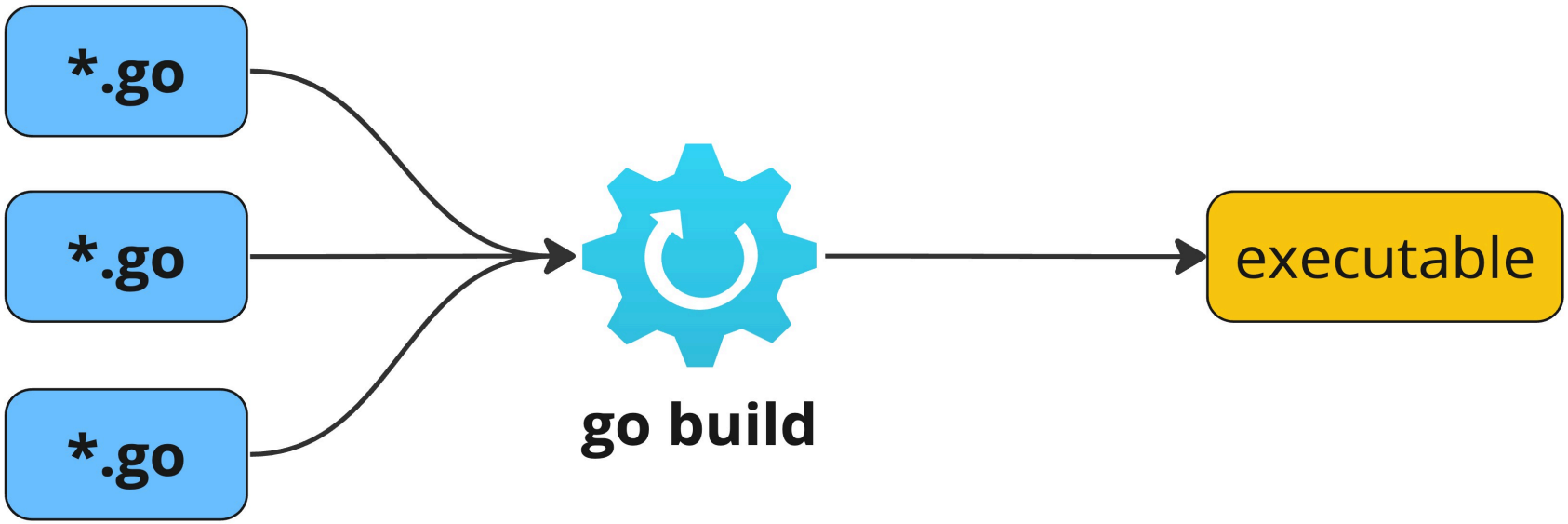
Agenda

- Build process
- Dependencies
- Building a "magic button" with Bazel

Build and dependencies

What is "go build"?

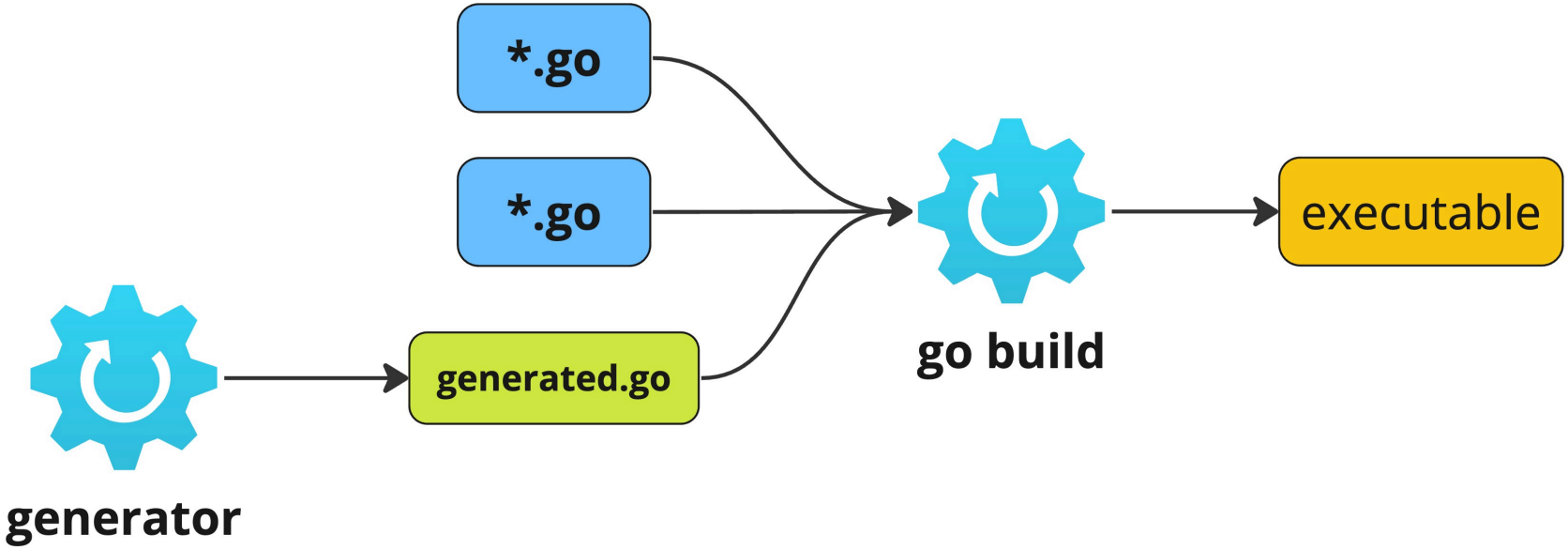
- A command which compiles the packages named by the import paths, along with their *dependencies*.
- **go build** takes a list of ***.go** files as an argument and produces a executable binary.



Compile packages and dependencies (https://pkg.go.dev/cmd/go#hdr-Compile_packages_and_dependencies)

Do we have all of the *.go files from the beginning?

- // go:generate <*some arbitrary binary or script here*>
- make <something>
- shell scripts
- etc.



go:generate Proposal (https://go.googlesource.com/proposal/+/refs/heads/master/design/go-generate.md)

Dependencies: part I

- Go packages
- Go compiler
- Generators

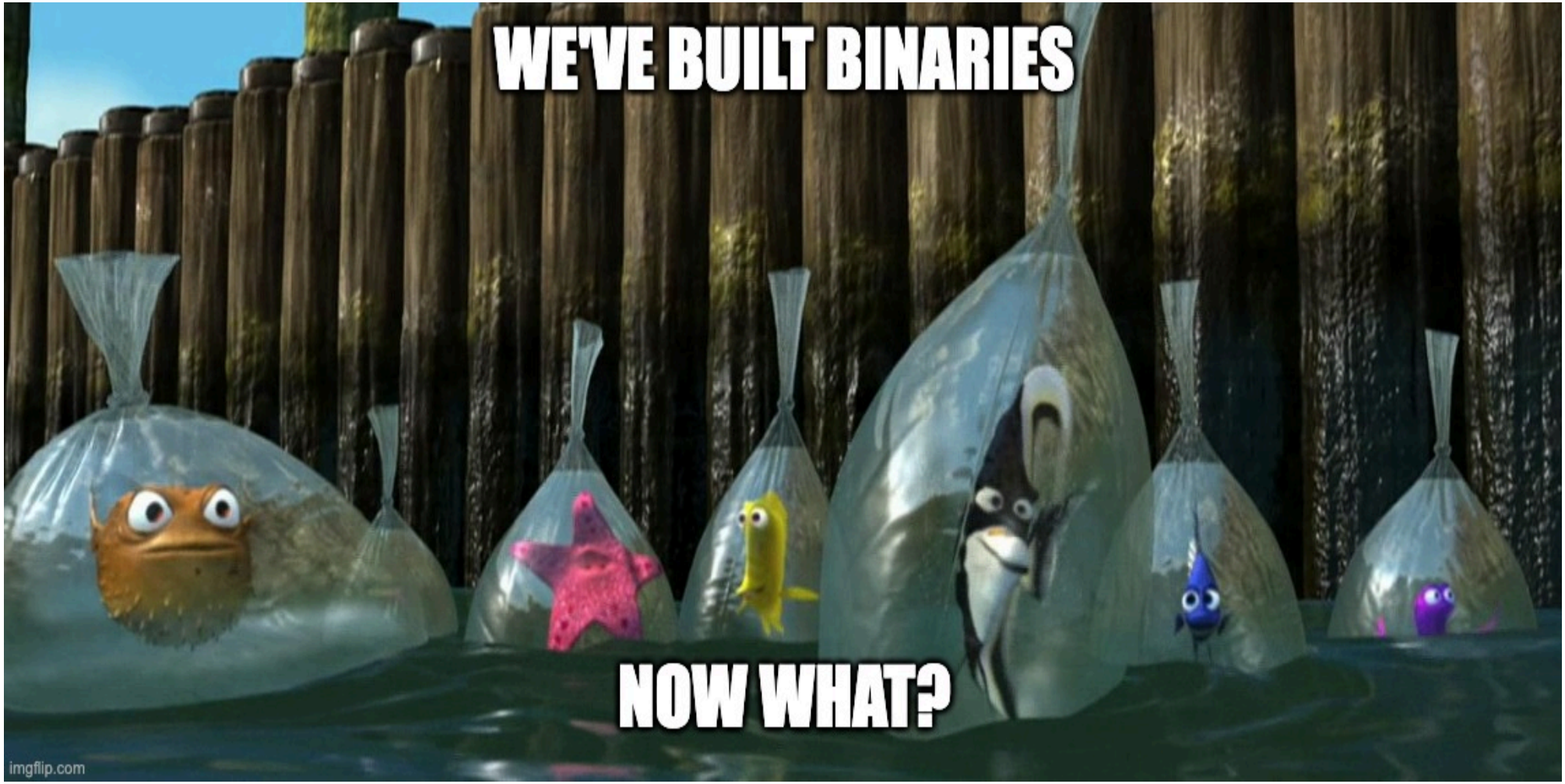
Where do we run our build?

- MacOS / Linux / etc.
- amd64 / arm64 / etc.
- Local machine / CI runner / etc.

Dependencies: part II

- **Host machine** is a machine where we run a build
- **Target machine** is a machine we build software for
- Environment variables

We've built binaries...



Publishing

- Container images
- tar/zip archives: AWS lambdas
- Kubernetes manifests / Helm charts / CloudFormation templates / etc.
- etc.

Dependencies: part III

- Docker
- Kustomize / Ytt / Helm / any other templating tool
- AWS cli
- Make (for some automation of all above)
- etc.

What is the dependency, btw?

How do we control our dependencies?

- **Go packages**: go.mod/go.sum.
- **Go compiler**: specific version pre-installed into container image or random Go version on host machine.
- **Generators**: depends on generator.
- **Platforms**: build flags or running build on a specific platform.
- **Environment variables**: explicitly set during the build.
- **Docker / Kustomize / Ytt / Helm / AWS cli**: do we?

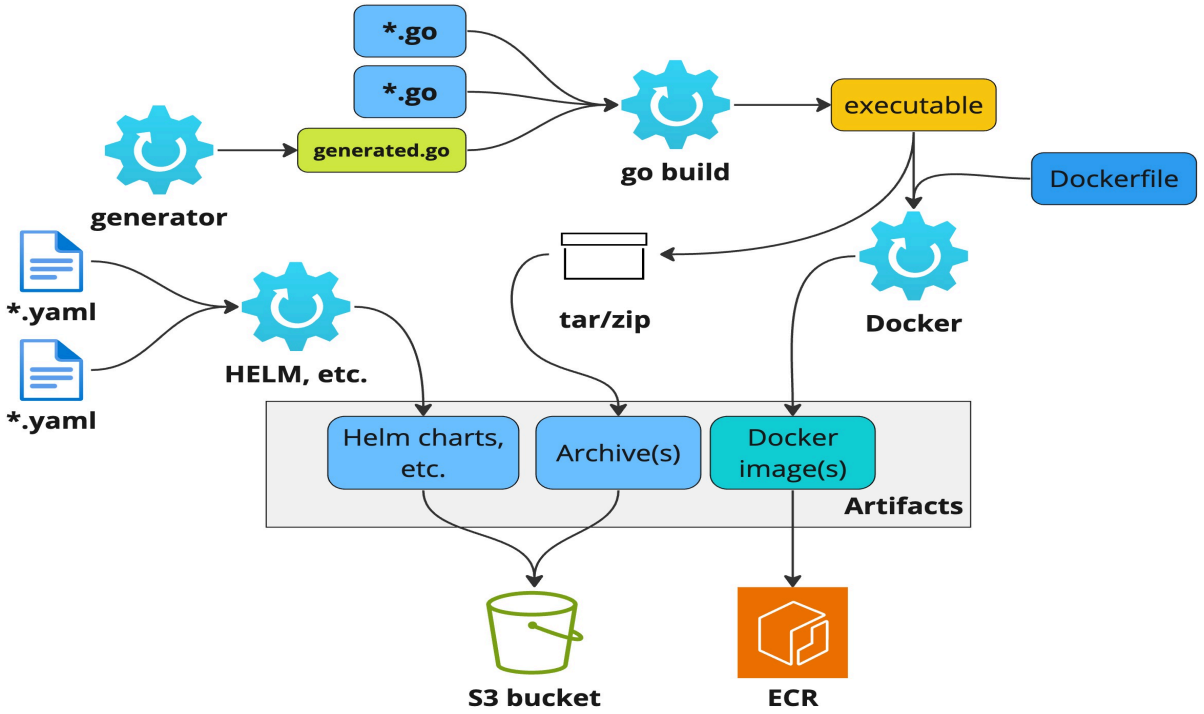
What else should we consider during the build process?

- Is our build reproducible?
- Is our build well isolated/hermetic? (Hello Docker!).
- When build fails, can we restart from the failure point but not from the beginning?

The output of the build process aka artifacts

- Go binaries
- Container images and/or tar/zip archives
- YAML manifests

We're going to build and publish **ready-to-deploy** artifacts, but not to deploy them.



Why "go build" isn't enough?

- **go build** is just an one step of the build process.
- While what we actually need is a Build orchestration.

Problem scope

Automate the following process:

- Download and install **all** necessary dependencies (generators, compilers, tools, etc.)
- Build artifacts.
- Publish artifacts to ECR / S3 / etc.

Other requirements:

- Make a build as isolated as possible.
- Make a build as reproducible as possible, i.e. pin versions of **all** dependencies.

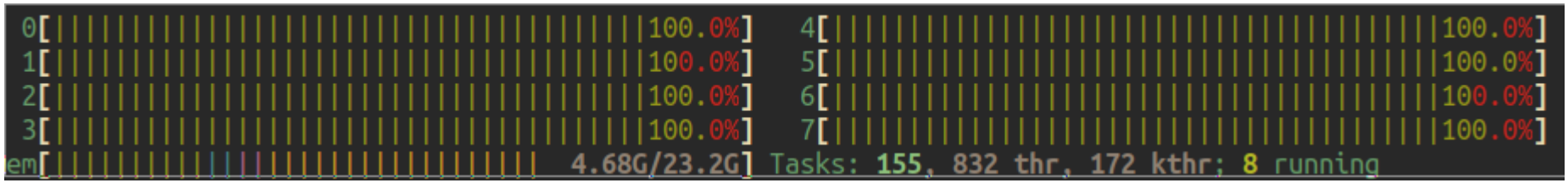
Bazel

Hello Bazel!

- An open-source build and tests tool that uses human-readable, high-level build language to define build in a declarative way.
- Aimed to build large codebases.
- Supports multi-language and multi-platforms builds
- It unifies build approaches across multiple languages and multiples toolchains.

Build & cache

- Parallel build: Bazel uses as many cores as it found.



- Build can be run on a local or remote machine.
- Can build everything from sources including dependencies.
- Bazel caches all downloaded dependencies and intermediate build results.
- Tracks changes in sources and rebuilds changed parts only.

Hermeticity & Sandboxing

Hermiticity:

When given the same input **source code** and **product configuration**, a hermetic build system always returns the same output, i.e. hermetic builds are **insensitive** to libraries and other software installed on the host machine.

Source identity:

Hermetic build systems try to ensure the sameness of inputs by using checksums to identify changes to the build's input.

Sandboxing:

Compilers and other tools during the build have an access to explicitly defined inputs only.

bazel.build/docs/sandboxing (https://bazel.build/docs/sandboxing)

bazel.build/basics/hermeticity (https://bazel.build/basics/hermeticity)

Let's look at the code

Hello world generator (main.go)

```
package main

import "fmt"

func main() {
    fmt.Println(`
            package main

            import "fmt"

            func main() {
                fmt.Println("Hello, World!")
            }
    `)
}
```

github.com/ekhabarov/helloworld-generator (https://github.com/ekhabarov/helloworld-generator)

Hello world generator

```
% go build -o hw_generator main.go

  //go:generate hw_generator > hw.go

% go generate ./...

% cat hw.go
package main

import "fmt"

func main() {
    fmt.Println("Hello, World!")
}

% go build -o hello-world hw.go

% ./hello-world
Hello, World!
```

And with Bazel

```
% bazel run //go:hello-world
Hello, World!
```

- **run** - Bazel command.
- **//go:hello-world** - label, a unique name for a target.
- **//** - project root.
- **//go** - package.
- **:hello-world** - build target.

Hello world generator: Bazelified

- **MODULE.bazel** or **WORKSPACE** *(deprecated)* : defines a project root **//** and may contain external dependencies.
- **BUILD.bazel**: defines a package like **//** or **//go**. Declares zero or more build targets for the package.

```
.
├── BUILD.bazel
├── MODULE.bazel
├── go
│   └── BUILD.bazel
└── go.mod
```

```
there is no *.go files in here
```

Github Repo (https://github.com/ekhabarov/blog-code-snippets/tree/master/how-to-bazel/genereate-and-compile-go-code)

Blog post (https://ekhabarov.com/post/how-to-generate-code-with-bazel/)

WORKSPACE (deprecated)

```
load("@bazel_tools//tools/build_defs/repo:http.bzl", "http_archive")

http_archive(
    name = "io_bazel_rules_go",
    sha256 = "dd926a88a564a9246713a9c00b35315f54cbd46b31a26d5d8fb264c07045f05d",
    urls = [...],
)

load("@io_bazel_rules_go//go:deps.bzl", "go_register_toolchains", "go_rules_dependencies")

go_rules_dependencies()

go_register_toolchains(version = "1.20.3") # Go version

load("@bazel_gazelle//:deps.bzl", "go_repository")

go_repository(
    name = "hw_generator",
    importpath = "github.com/ekhabarov/helloworld-generator",
    sum = "h1:MrREQgX6I0/4cstUhbuqfALzUF3W2Nz8kVZRq6A4q+E=",
    version = "v0.0.1",
)
```

MODULE.bazel

```
bazel_dep(name = "rules_go", version = "0.59.0")
bazel_dep(name = "gazelle", version = "0.47.0")

go_deps = use_extension("@gazelle//:extensions.bzl", "go_deps")
go_deps.from_file(go_mod = "//:go.mod")

use_repo(go_deps, "com_github_ekhabarov_helloworld_generator")
```

- `bazel_dep` pulls modules from Bazel Central Registry https://bcr.bazel.build

go/BUILD.bazel

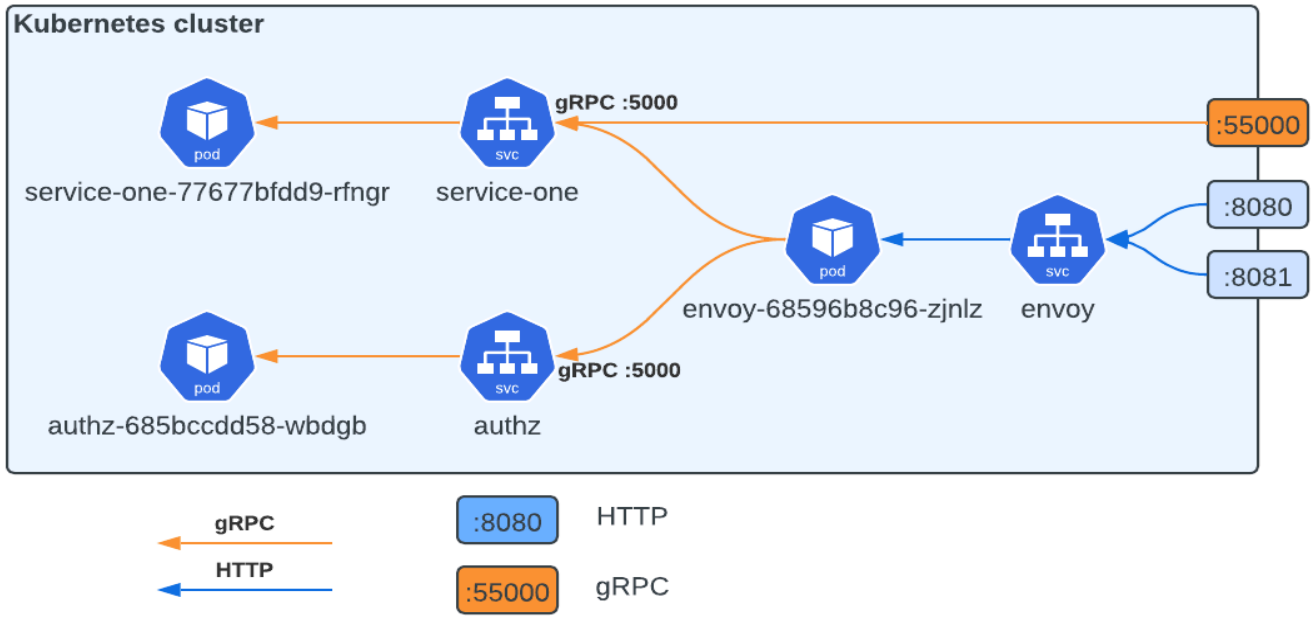
- **Rule**: A function implementation. It takes an input and produces an output.
- **Target**: A buildable unit.

```
load("@io_bazel_rules_go//go:def.bzl", "go_binary", "go_library")

genrule(
    name = "generate_hello_go",
    outs = ["hello.go"],
    cmd = "$(execpath @hw_generator//:helloworld-generator) > $@",
    tools = ["@hw_generator//:helloworld-generator"],
)

go_library(
    name = "hello-world_lib",
    srcs = ["hello.go"],
    importpath = "github.com/ekhabarov/helloworld-generator",
)

go_binary(
    name = "hello-world",
    embed = [":hello-world_lib"],
    importpath = "github.com/ekhabarov/helloworld-generator",
)
```

Build & run

```
bazel run //go:hello-world                                  => runs hello-world binary
  |
  |--> bazel build //go:hello-world                         => creates hello-world binary
        |
        |--> bazel build //go:hello-world_lib               => creates hello-world.a
              |
              |--> bazel build //go:generate_hello_go       => creates hello.go
```

Demo: Microservices, Kubernetes and Tilt



- build two gRPC services
- build Docker images for the services, and for Evnoy proxy
- deploy all into local k8s cluster (minikube)

ekhabarov.com/envoy (https://ekhabarov.com/envoy)

Labels

Common format

```
% bazel (build | test | run) //path/to/package:target
```

Build everything in a workspace

```
% bazel build //...
```

or

```
% bazel build //:all
```

Build everything in package "abc" recursively

```
% bazel build //abc/...
```

or

```
% bazel build //abc/:all
```

Build external dependency

```
% bazel build @hw_generator//...
```

Build one target

```
% bazel build //go:hello-world
```

Run one target

```
% bazel run //go:hello-world
```

Should we write BUILD files manually?

Partially, thanks to Gazelle, which:

- Generates BUILD files
- Keeps them up to date
- Formats BUILD files
- Manages dependencies

Manually added targets:

- Container images
- YAML manifests
- Publishing artifacts

What else?

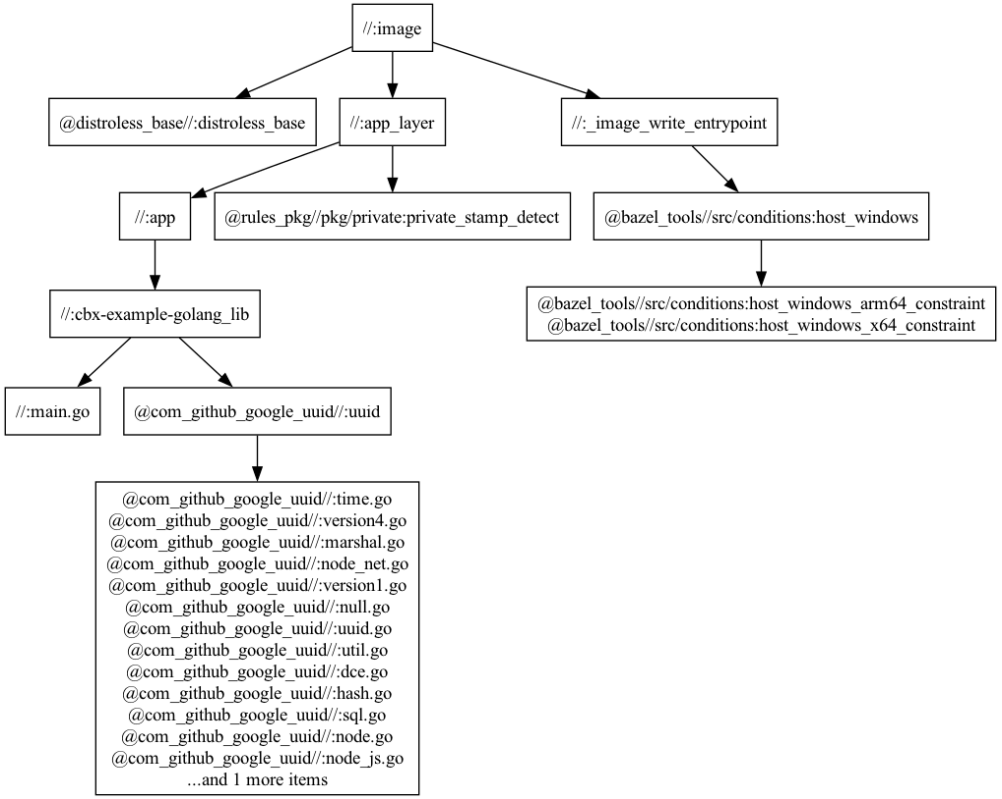
Bazel query

Some questions that query answers:

- What packages use package or tool *X*?
- Which dependencies package *X* has?
- What files are generated *foo* package?
- What rule target(s) contain file *path/to/file.go* as a source?
- Where a transitive dependency came from?

Bazel Query How-To (https://docs.bazel.build/versions/main/query-how-to.html)

Dependency graph




```
$ bazel query --noimplicit_deps 'deps(//:image)' --output graph | grep -v ... > graph.in
$ dot -Tpng < graph.in > graph.png
```

Extensibility

- **Ruleset**: An extension for Bazel.

Available rules:

- rules_go
- gazelle
- rules_oci
- rules_proto
- rules_ytt
- etc.

bazel.build (https://bazel.build)

bcr.bazel.build (https://bcr.bazel.build)

awesomebazel.com (https://awesomebazel.com)

When to use Bazel

- With relatively large (mono)repos
- Many languages
- Multi-step build process
- Bazel solves more issues than it creates
- Hermeticity and reproducibility are mandatory
- Build takes a lot of time

Just one more thing

Thank you

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https://ekhabarov.com (https://ekhabarov.com)