Agenda

- Intro to OpenAPI specs schemas
- CRD validation using OpenAPI
- Typical Kubernetes API patterns expressed in OpenAPI
- Towards a standard openapi-spec-gen to extract specs from Go types
- Expressivity and limits of OpenAPI

@the_sttts

```go
type Example struct {
    metav1.TypeMeta
    metav1.ObjectMeta
    Spec    Spec
    Status  Status
}

type Spec struct {
    Schedule string
    Command  string
}

type Status struct {
    Phase string
}
```

```yaml
apiVersion: apiextensions.k8s.io/v1beta1
kind: CustomResourceDefinition
metadata: examples.kubecon.io
spec:
  validation:
    openAPIV3Schema:
      type: object
      properties:
        spec:
          type: object
          properties:
            command:
              type: string
            schedule:
              type: string
        status:
          type: object
          properties:
            phase:
              type: string
```

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}

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    Phase string
}
```

```yaml
apiVersion: apiextensions.k8s.io/v1beta1
kind: CustomResourceDefinition
metadata: examples.kubecon.io
spec:
  validation:
    openAPIV3Schema:
      type: object
      properties:
      required: ["spec"]
      spec:
        type: object
        properties:
          command:
            type: string
            minLength: 1 # non-empty
          schedule:
            type: string
            anyOf:
            - pattern: "<ISO8601-regex>"
            - pattern: "<unix-timestamp>
      required: ["command","schedule"]
      status:
        type: object
        properties:
          phase:
            type: string
```

value validation

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      type: object
      properties:
        spec:
          type: object
          properties:
            command:
              type: string
            schedule:
              type: string
        status:
          type: object
          properties:
            phase:
              type: string
```

Structural validation

OpenAPI v3 schemas

Used in CRDs: `spec.validation.openAPIV3Schema`

Standard: github.com/OAI/OpenAPI-Specification/versions/3.0.0.md

Published by kube-apiserver as v2:   `/openapi/`<mark>`v2`</mark>

To be published as v3:   `/openapi/v3`

Used by `kubectl explain` and client-side validation.

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              type: string
            schedule:
              type: string
        status:
          type: object
          properties:
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              type: string
```

complete structural validation

@the_sttts

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      properties:
        spec:
          type: object
          - properties:
              command:
                type: string
          anyOf:
          - properties:
              schedule:
                type: string
                pattern: <ISO-8601-regex>
          - properties:
              schedule:
                type: string
                pattern: <unix-timestamp>
        status:
          type: object
          properties:
            phase:
              type: string
```

```go
type Example struct {
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    metav1.ObjectMeta
    Spec    Spec
    Status  Status
}

type Spec struct {
    Schedule string
    Command  string
}

type Status struct {
    Phase string
}
```
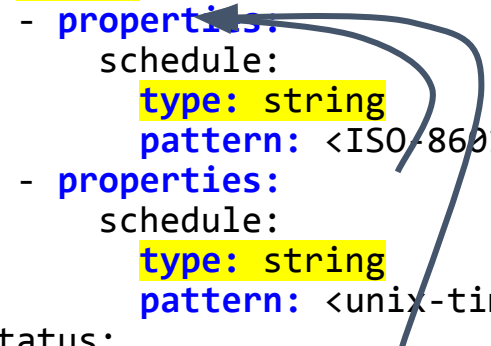
```yaml
apiVersion: apiextensions.k8s.io/v1beta1
kind: CustomResourceDefinition
metadata: examples.kubecon.io
spec:
  validation:
    openAPIV3Schema:
      type: object
      properties:
        spec:
          type: object
          - properties:
              command:
                type: string
          anyOf:
          - properties:
              schedule:
                type: string
                pattern: <ISO-8601-regex>
          - properties:
              schedule:
                type: string
                pattern: <unix-timestamp>
        status:
          type: object
          properties:
            phase:
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        spec:
          type: object
          - properties:
              command:
                type: string
              schedule:
                type: string
          anyOf:
          - properties:
              schedule:
                pattern: <ISO-8601-regex>
          - properties:
              schedule:
                pattern: <unix-timestamp>
        status:
          type: object
          properties:
            phase:
              type: string
```

✔️

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      properties:
        spec:
          type: object
          - properties:
              command:
                type: string
              schedule:
                type: string
          anyOf:
          - properties:
              schedule:
                pattern: <ISO-8601-regex>
          - properties:
              schedule:
                pattern: <unix-timestamp>
        status:
          type: object
          properties:
            phase:
              type: string
```

Structural Schema

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    openAPIV3Schema:
      type: object
      properties:
        spec:
          type: object
          - properties:
              command:
                type: string
              schedule:
                type: string
          anyOf:
          - properties:
              schedule:
                pattern: <ISO-8601-regex>
          - properties:
              schedule:
                pattern: <unix-timestamp>
        status:
          type: object
          properties:
            phase:
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```

structural schema

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```yaml
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        spec:
          type: object
          - properties:
              command:
                type: string
              schedule:
                type: string
          anyOf:
          - properties:
              schedule:
                pattern: <ISO-8601-regex>
          - properties:
              schedule:
                pattern: <unix-timestamp>
        status:
          type: object
          properties:
            phase:
              type: string
```

structural schema

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Kubernetes 1.15+

```
$ kubectl create -f non-structural-crd.yaml -o yaml
...
status:
    conditions:
    - message: '[
        spec.validation.openAPIV3Schema.properties[metadata]: Forbidden:
          must not specify anything other than name and generateName, but
          metadata is implicitly specified,
        spec.validation.openAPIV3Schema.type: Required value: must not be empty
      ]'
      reason: Violations
      status: "True"
      type: NonStructuralSchema
      lastTransitionTime: "2019-05-17T19:41:30Z"
```

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The Future of CRDs: current KEPs

KEP Vanilla OpenAPI Subset: Structural Schema – beta in 1.15

Theme: Towards CRD GA

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KEP Defaulting – alpha in 1.15

KEP Unions

WIP KEP: Unified Golang API Tags

Theme: Towards CRD GA

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KEP Unions

WIP KEP: Unified Golang API Tags

Theme: Towards CRD GA

all new features require structural schema

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OpenAPI consumers

OpenAPI publishing ⟶ client-side validation

server side apply

CRDs only:

kubectl explain

client generators

doc generator

kube-aggregator

IDEs like IntelliJ for input completion

server-side validation

Pruning

Defaulting

Protobuf[1]

server-side read-only fields[1]

1) possibly in the future

OpenAPI v2 at /openapi/v2

validation OpenAPI <mark>v3</mark>

properties:
  foo:
    type: string
  bar:
    minimum: 42
anyOf:
- **properties**:
  foo:
    pattern: abc
  bar:
    type: string
- **properties**:
  bar:
    type: integer

published OpenAPI <mark>v2</mark>

properties:
  foo:
    type: string
  bar:
    minimum: 42

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```
kubectl explain <crd-name>
```

TBD

OpenAPI in Kubernetes
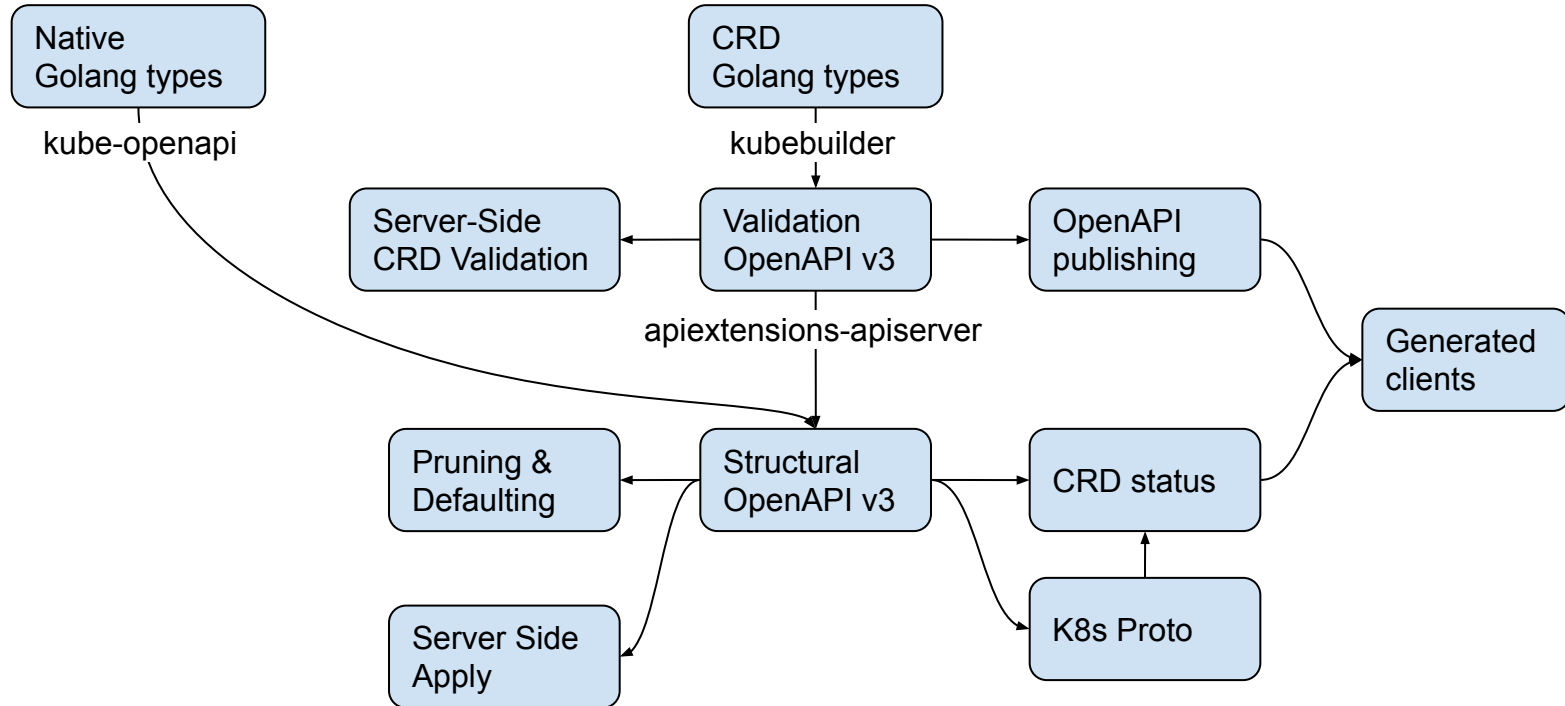
@the_sttts

OpenAPI v2 at /openapi/v2

validation OpenAPI <mark>v3</mark>

```
properties:
  foo:
    type: string
  bar:
    minimum: 42
anyOf:
- properties:
    foo:
      pattern: abc
    bar:
      type: string
- properties:
    bar:
      type: integer
```

published OpenAPI <mark>v2</mark>

```
properties:
  foo:
    type: string
  bar:
    minimum: 42
```

<mark>no anyOf in v2</mark>

Problematic OpenAPI v3

validation OpenAPI <mark>v3</mark>

```
properties:
  foo:
    type: string
  bar:
    minimum: 42
anyOf:
- properties:
    foo:
      pattern: abc
    bar:
      type: string
- properties:
    bar:
      type: integer
```

mix of types and logic

polymorphic types

published OpenAPI <mark>v2</mark>

```
properties:
  foo:
    type: string
  bar:
    minimum: 42
    type: undefined
```

@the_sttts

==structural== validation OpenAPI v3

```
type: object
properties:
 foo:
   type: string
 bar:
   type: string
   minimum: 42
anyOf:
- properties:
  foo:
    pattern: abc
- properties:
  bar:
    minimum: 1
    maximum: 0
```

published OpenAPI ==v2==

```
type: object
properties:
  foo:
    type: string
  bar:
    type: string
    minimum: 42
```

==complete structure==

@the_sttts

Limits of Expressivity

```
kind: Pod
apiVersion: v1
spec:
  containers:
  - name: apiserver
    volumeMounts:
    - name: serving-cert
      mountPath: /var/run/apiserver/serving-cert
  - name: sidecar

    ...
  volumes:
  - name: serving-cert
    secret: {"secretName":"serving-cert"}
```

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Limits of Expressivity

```
kind: Pod
apiVersion: v1
spec:
  containers:
  - name: apiserver
    volumeMounts:
    - name: serving-cert
      mountPath: /var/run/apiserver/serving-cert
  - name: sidecar

  ...
  volumes:
  - name: serving-cert
    secret: {"secretName":"serving-cert"}
```

unique associative lists

exists

OpenAPI producers

kube-openapi — native type schemas compiled into API servers

controller-tools — CRD validation schemas

    controller-gen — kubebuilder's code-generation tool
    crd-schema-gen — work-in-progress non-opinionated tool

manually written — CRD validation schemas

{controller,crd-schema}-gen

- generator for CRD OpenAPIV3Schemas
- github.com/kubernetes-sigs/controller-tools/cmd

// +optional

// +nullable

// +kubebuilder:validation:pattern=<ISO8601-regex>

// + …

Work in progress KEP for a unified tag / marker language

```
$ cd example-project
$ ls manifests/*-crd.yaml
example-crd.yaml
$ crd-schema-gen
    --api-packages ./pkg/apis/…
    --manifest-dir ./manifests
Found 1 CRD manifests.
Updating schema for Example in example.kubecon.io at spec.validation.ope
```

prototype
PR #183

Pruning

preserveUnknownFields: false

Pruning with a structural schema

```
kind: Example
apiVersion: examples.kubecon.io/v1
metadata:
  name: hello
  foo: bar
spec:
  command: echo 'Hello world!'
  schedule: 1558125753
  privileged: true
status:
  phase: Running
  conditions:
  - message: Executing
    type: Terminate
    status: False
```

pruning →

```
type: object
properties:
  spec:
    type: object
    properties:
      command:
        type: string
      schedule:
        type: string
  status:
    type: object
    properties:
      phase:
        type: string
```

complete structural schema

Pruning with a structural schema

```
kind: Example
apiVersion: examples.kubecon.io/v1
metadata:
  name: hello
  foo: bar
spec:
  command: echo 'Hello world!'
  schedule: 1558125753
  privileged: true
status:
  phase: Running
  conditions:
  - message: Executing
    type: Terminate
    status: False
```

pruning →

```
type: object
properties:
  spec:
    type: object
    properties:
      command:
        type: string
      schedule:
        type: string
  status:
    type: object
    properties:
      phase:
        type: string
```

complete structural schema

```
kind: Example
apiVersion: examples.kubecon.io/
spec:
  command: echo 'Hello world!'
  schedule: 1558125753
  privileged: true
status:
  phase: Running
```

@the_sttts

Controlling Pruning

```
kind: CustomResourceDefinition
spec:
  preserveUnknownFields: false
  validation:
    openAPIV3Schema:
      properties:
        embeddedObject: # RawExtension
          type: object
          x-kubernetes-embedded-resource: true
          x-kubernetes-preserve-unknown-fields: true
        rawJSON:
          x-kubernetes-preserve-unknown-fields: true
        intOrString:
          x-kubernetes-int-or-string: true
```

defaults to true in v1beta1
must be false in v1 on creation

@the_sttts

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all new features
require structural schema

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