Kubernetes Config Management Landscape

Tomasz Tarczyński, Gigaset

1. **Configuration Management**
2. Kubernetes
3. Declarative application management
4. Tools Landscape

Configuration Management

"Of all the problems we have confronted, the ones over which the most brainpower, ink, and code have been spilled are related to managing configurations."

Borg, Omega, and Kubernetes (2016)
Brendan Burns, Brian Grant, David Oppenheimer, Eric Brewer, John Wilkes

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Configuration Management

- **Infrastructure as Code**
- **GIT** – as a single source of truth
- **Tools:**
  CFEngine / Puppet / Chef / Ansible

Configuration Management

- **Tools:**
  - **CFEngine**   (1993)   Mark Burgess
  - **Puppet**   (2005)   Luke Kanies
  - **Chef**   (2009)   Adam Jacob
  - **Ansible**   (2012)   Michael DeHaan

Puppet

- **Declarative** – describe the desired state
- **Resources automation** – Types / providers
- **DSL** – a simple and constrained language
- **Templates** – ERB
- **Modules** – public and private
- **Code / data separation** – Hiera

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- **Control plane** provides a **Declarative API**
- Declare the **desired state**
- **Control plane** makes sure that the **actual state** converges to the **desired state**

Kubernetes

```yaml
1  apiVersion: apps/v1
2  kind: Deployment
3  metadata:
4    name: nginx-deployment
5  spec:
6    selector:
7      matchLabels:
8        app: nginx
9    replicas: 2
10   template:
11     metadata:
12       labels:
13         app: nginx
14     spec:
15       containers:
16       - name: nginx
17         image: nginx:1.14.2
18         ports:
19         - containerPort: 80
```

```yaml
1  apiVersion: v1
2  kind: Service
3  metadata:
4    name: nginx
5    labels:
6      app: nginx
7  spec:
8    ports:
9    - port: 80
10     protocol: TCP
11   selector:
12     app: nginx
```

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- **Counting the YAMLs** (real env example)
  - 54   standard k8s resource types
  - 50   CRD types
  - 790   API object (user-provided)
  - 5,500   API objects (total)
  - 107,000   lines of YAML (user-provided)
  - **507,000**   lines of YAML (total)

Kubernetes

- **"Are we all YAML engineers now?"**
  – Bob Walker at CfgMgmtCampt 2018

Kubernetes

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```
---
slide: 14
kubernetes: "YAML generating
YAML"
```

GDS

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- "Declarative application management in Kubernetes"
  – article by Brian Grant, 2017

- **Central Idea:**
  - Composable tools
  - Manipulate configuration data
  - Declarative data model
- **NOT:** Configuration as Code

Kubernetes: Declarative application management

- **Configuration as Data**
  - Code goes into controllers (control loops)
  - Data in native Kubernetes API format

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Kubernetes: Declarative application management

- **Declarative** — k8s API
- **Resources automation** — k8s controllers
- **DSL** —
- **Templates** —
- **Modules** —
- **Code / data separation** — controllers / API

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1. Configuration Management
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4. **Tools Landscape**

Tools Landscape

[Public] Kubernetes application management tools

File   Edit   View   Insert   Format   Data   Tools   Add-ons   Help

100%   View only

Helm

	Project	URL	License	Stars	Issues	PRs	Contributors	Abstraction	Internal DSL	External DSL	YAML/data	Uses K8s client
				GitHub				Type				
3	Compose	https://github.com/docker/compose	Apache 2	14688	553	51	257	Yes	No	Yes	Yes	
4	Helm	https://github.com/kubernetes/helm	Apache 2	9198	594	92	250	Yes	No	No	Yes	client-go
5	OpenShift templates	https://docs.openshift.org/latest/dev_guide/templates.html	Apache 2	5565	417	131	100	No	No	No	Yes	client-go
6	gitkube	https://github.com/hasura/gitkube	Apache 2	2365	34	1	9					
7	Podex	https://github.com/kubernetes/contrib/tree/master/podex	Apache 2	2082	22	26	100	No	No	No	No	
8	Rio	https://github.com/rancher/rio	Apache 2	2054	125	5	39					rio
9	Kompose	https://github.com/kubernetes-incubator/kompose	Apache 2	1940	81	8	32	Yes				client-go
10	Spread	https://github.com/redspread/spread	Apache 2	1845	44	9	4	No	No	No	Yes	client-go
11	Crossplane	https://github.com/crossplaneio/crossplane	Apache 2	1600	243	10	26	Yes	No	No	Yes	Yes
12	Draft	https://github.com/Azure/draft	MIT	1589	90	9	34	No	No	No	Yes	
13	Kustomize	https://github.com/kubernetes-sigs/kustomize	Apache 2	1535	52	6	53	No	No	No	Yes	
14	Deis workflow	https://github.com/deis/workflow	MIT	1068	57	3	191	Yes	No	No	No	
15	jsonnet	https://github.com/google/jsonnet	Apache 2	1020	99	1	23	No	No	No	No	
16	Skylark	https://github.com/google/skylark	BSD	947	8	2	12	No			No	
17	Keptn	https://github.com/keptn/keptn	Apache 2	458	95	3	28	No	No	Yes	Yes	client-go
18	Konfd	https://github.com/kelseyhightower/konfd	Apache 2	428	3	0	2	No	No	No	Yes	kubectl
19	fabric8 client	https://github.com/fabric8io/kubernetes-client	Apache 2	313	163	9	69	No	Yes	No	No	
20	Flux	https://github.com/weaveworks/flux	Apache 2	312	112	2	19	No	No	No	No	kubectl
21	kubernetes-deploy	https://github.com/Shopify/kubernetes-deploy	MIT	312	25	9	20	No	No	No	Yes	kubeclient ruby
22	kube-applier	https://github.com/box/kube-applier	Apache 2	254	6	3	3	No	No	No	Yes	kubectl
23	Nulecule	https://github.com/projectatomic/nulecule	GPL	227	30	4	29	Yes	No	No	Yes	
24	kubecfg	https://github.com/ksonnet/kubecfg	Apache 2	185	17	7	9	No	No	Yes	No	client-go

- List by Brian Grant
- Currently **125 tools** on the list

- **Approaches to config:**
  - Fork
  - Overlay / patch
  - Parametrization
  - Generation
  - DSL (domain-specific language)
  - GPL (general-purpose language)

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- **3 most widely used tools:**
  - Jsonnet (2014) 4,5k ⭐
  - Helm (2015) 18,6k ⭐
  - Kustomize (2018) 6,5k ⭐

- **Jsonnet**
  - Data templating language (DSL)
  - Generates JSON
  - Hermetic / side-effect free
  - Superset of JSON

- **Helm**
  - Template YAML (with Go template)
  - Package cfg into charts
  - Simple sharing (public / private repos)
  - Manage releases (in Kubernetes)

- **Kustomize**
  - Template-free / DSL-free
  - Plain YAML
  - Customize Kubernetes objects
  - Built into kubectl

- **GitOps tools:**
  - Flux CD (2016) 5,9k ⭐
  - Argo CD (2018) 4,6k ⭐

- **GitOps tools:**
  - Keep Kubernetes clusters in sync with Git
  - Use operator in the cluster
- **Integrations:**
  - Flux CD   – Helm, Kustomize
  - Argo CD   – Helm, Kustomize, Jsonnet

- **More tools:**
  - Kapitan   (2017)   1,3k ⭐
  - Tanka   (2019)   1,2k ⭐
  - Kpt   (2019)   0,7k ⭐

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- **Kapitan:**
  - **Template** engines – **Jsonnet**, Jinja2, Kadet, **Helm**
  - **Inventory** – YAML-based, hierarchical
  - **Compile** k8s manifests and store in **git**

- **Tanka:**
  - By Grafana Labs
  - Powered by **Jsonnet**
  - Jsonnet Kubernetes library
  - Replacement for ksonnet
  - Integrates with: Helm, Kustomize

- **Kpt:**
  - Treat configuration as data
  - Provides a packaging solution (Git-based)
  - Run functions to: generate, transform, validate cfg
  - Integrates with: Kustomize, Helm, (anything via fns)

- **More tools:**
  - ○ Ytt　　　　(2019)　0,7k ⭐
  - ○ Cue　　　　(2019)　2,4k ⭐

- **ytt:**
  - YAML structure-aware templating
  - Based on Starlark (Python-like language)
  - Conceptually close to Jsonnet
  - Supports patch/overlay approach

- **Cue:**
  - Data constraint language
  - Superset of JSON
  - Data validation
  - Reduce boilerplate

- **IaC tools:**
  - Terraform   (2014)   25,2k ⭐
  - Pulumi   (2016)   7,3k ⭐
  - Cdk8s   (2020)   1,9k ⭐

- **Terraform:**
  - **HCL** (HashiCorp Configuration Language)
    - **JSON compatible DSL**
    - Declarative
  - Providers:
    - **Kubernetes** – 34 core resource types
    - **Kubernetes-alpha** – any resource (incl. CRDs)
    - **Helm** – manage charts

- **Pulumi:**
  - Infrastructure as Code **SDK**
  - General-purpose programming language:
    - JavaScript, TypeScript, Python, Go, .NET
  - Supports: **Helm**, **Kustomize**, plain YAML
  - SDK API:
    - 100% compatible with the Kubernetes API
    - Supports CRDs

- **Cdk8s:**
  - **CDK** for Kubernetes
  - General-purpose programming language:
    - Typescript, JavaScript, Python, and Java
  - Supports: **Helm**, plain YAML
  - Covers:
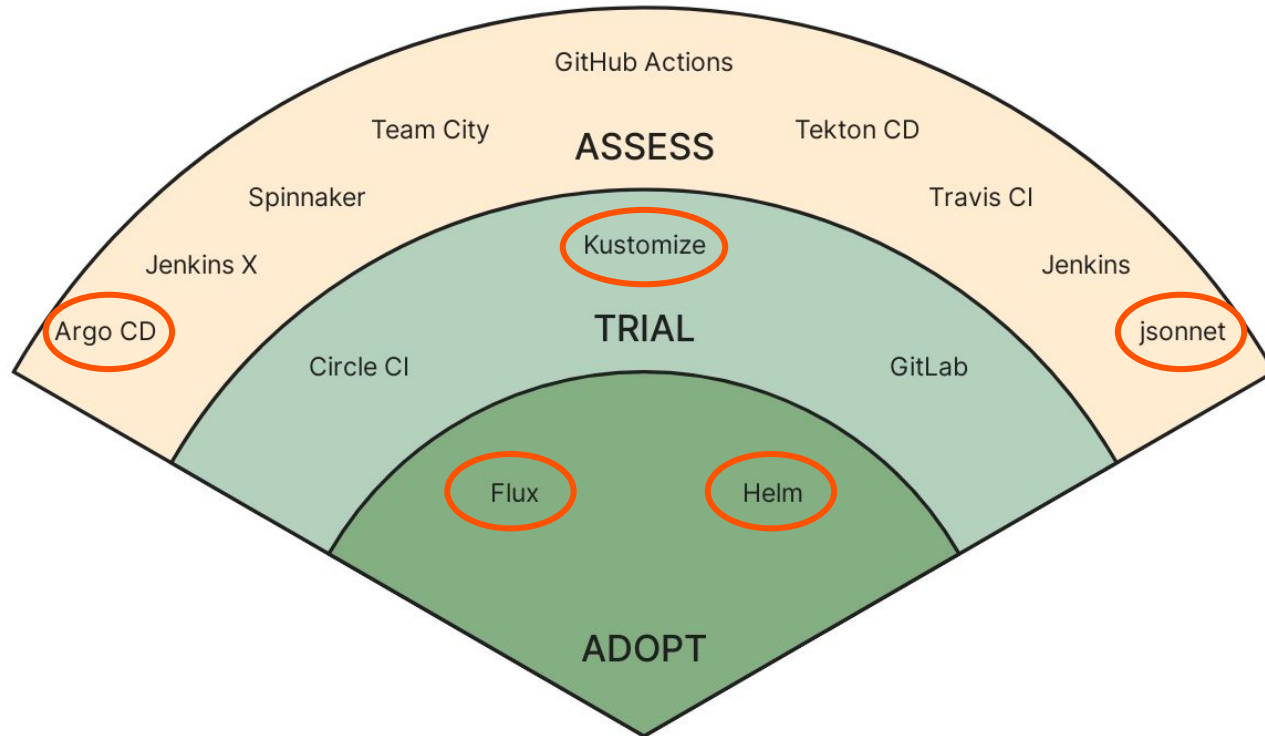   - 100% of the Kubernetes API
    - CRDs

Tools Landscape – summary

	Tool	Website	Created	Stars	Forks	Issues	PRs	Releases	Contributors		Helm	Kustomize	Jsonnet	Jinja2	store in GIT	apply to cluster
1	Jsonnet	https://jsonnet.org/	2014-08-01	4,558	307	490	386	33	88						YES	
2	Helm	https://helm.sh/	2015-10-06	18,656	5,307	5,201	3,932	138	715						YES	YES
3	Kustomize	https://kustomize.io/	2018-05-11	6,576	1,207	1,303	2,108	181	253							
4	Flux CD	https://fluxcd.io/	2016-07-07	5,895	1,021	1,540	1,799	127	254		YES	YES				YES
5	Argo	https://argoproj.github.io/argo-cd/	2018-02-09	4,640	983	2,577	2,553	135	351		YES	YES	YES			YES
6	Kapitan	https://kapitan.dev/	2017-10-09	1,329	129	201	469	107	39		YES		YES	YES	YES	
7	Tanka	https://tanka.dev/	2019-07-17	1,189	73	178	270	22	53		YES	YES	YES		YES	YES
8	Kpt	https://googlecontainertools.github.io/kpt/	2020-01-06	764	96	696	630	50	54		YES	YES			YES	YES
9	ytt	https://get-ytt.io/	2019-03-01	763	61	193	67	31	31						YES	
10	Cue	https://cuelang.org/	2019-01-28	2,402	150	483	86	28	45						YES	
11	Terraform k8s	https://www.terraform.io/	2017-06-05	842	483	513	588	30	136		YES					YES
12	Pulumi Kubernetes	https://www.pulumi.com/	2018-01-09	182	51	709	693	176	31		YES	YES			YES	YES
13	cdk8s	https://cdk8s.io/	2020-02-09	1,953	141	193	310	41	34		YES				YES	

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CNCF Technology Radar   Continuous Delivery, June 2020

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Tools Landscape – CNCF Tech Radar

Level	Name	Votes
Adopt	Helm	
	Flux	
Trial	Circle CI	
	Kustomize	
	GitLab	
Assess	Jenkins X	
	Travis CI	
	jsonnet	
	Spinnaker	
	GitHub Actions	
	Argo CD	
	Jenkins	
	Tekton CD	
	Team City	

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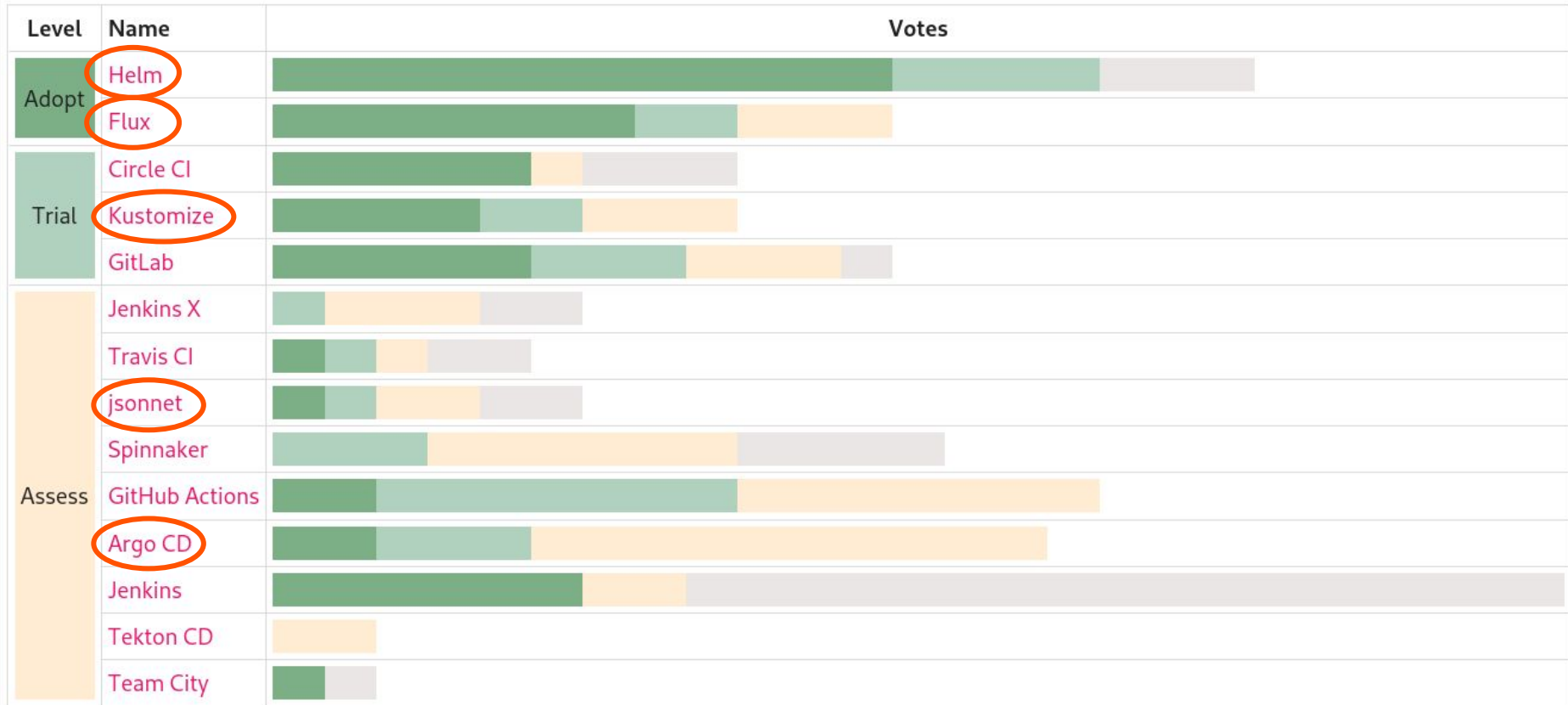
Links

1. [Borg, Omega, and Kubernetes](#) – Brendan Burns, Brian Grant, David Oppenheimer, Eric Brewer, John Wilkes, 2016
2. [Are we all YAML engineer now?](#) – Bob Walker at CfgMgmtCampt, 2018
3. [Declarative application management in Kubernetes](#) – Brian Grant, 2017
4. [Kubernetes application management tools](#) – Brian Grant, 2017
5. [CNCF End User Technology Radar – Continuous Delivery](#) – CNCF, 2020
6. [All materials used for this talk](#) – me, 2021
7. [Tools comparison spreadsheet](#) – me, 2021

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Thanks!

Tomasz Tarczynski

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Gigaset