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KubeCon
CloudNativeCon
North America 2019


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Kubernetes in Your 4x4
Continuous Deployment Directly to the Car
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PhD @ Polish Academy of Sciences

@b3rnoulli

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Continuous Delivery

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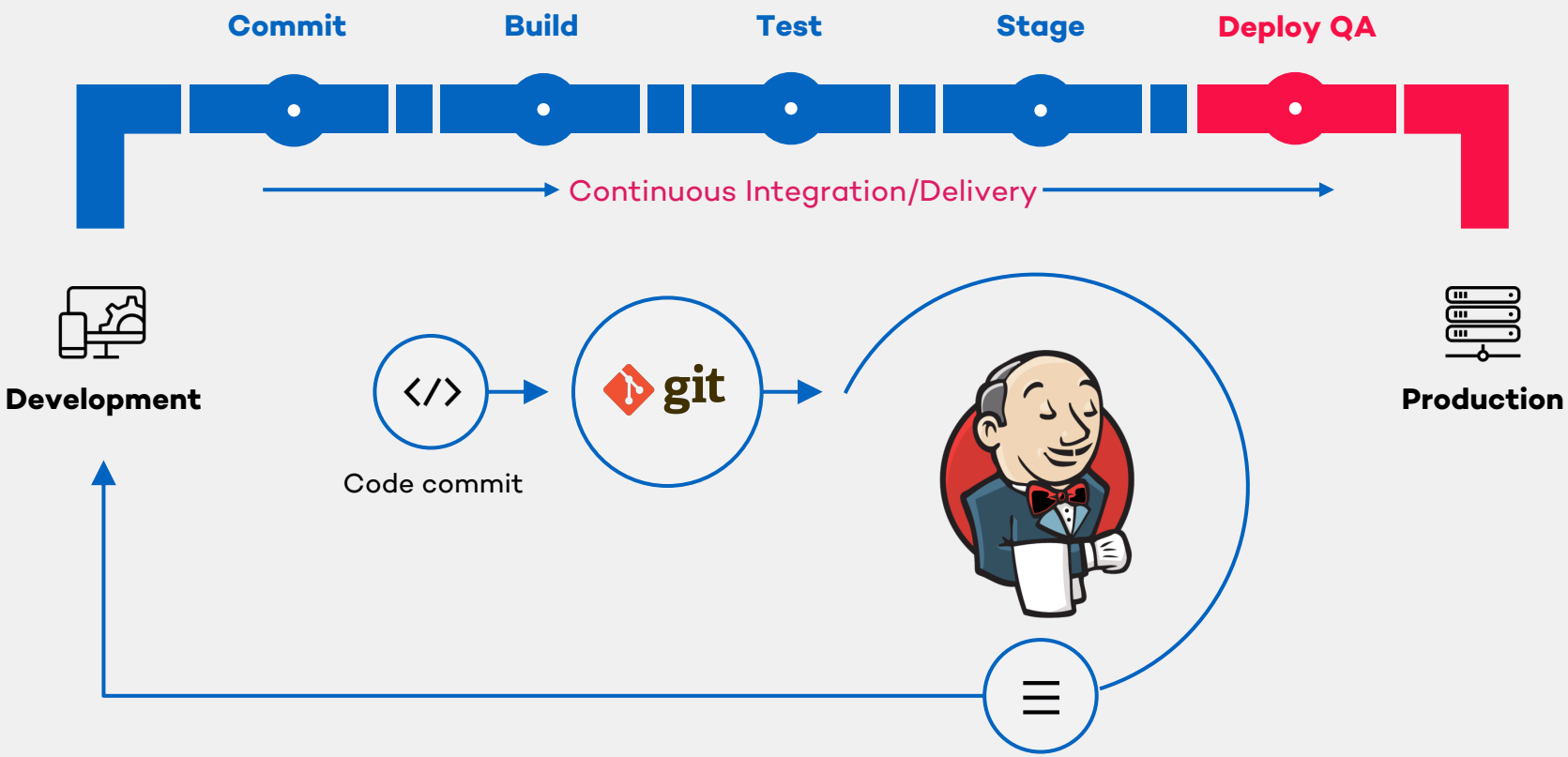
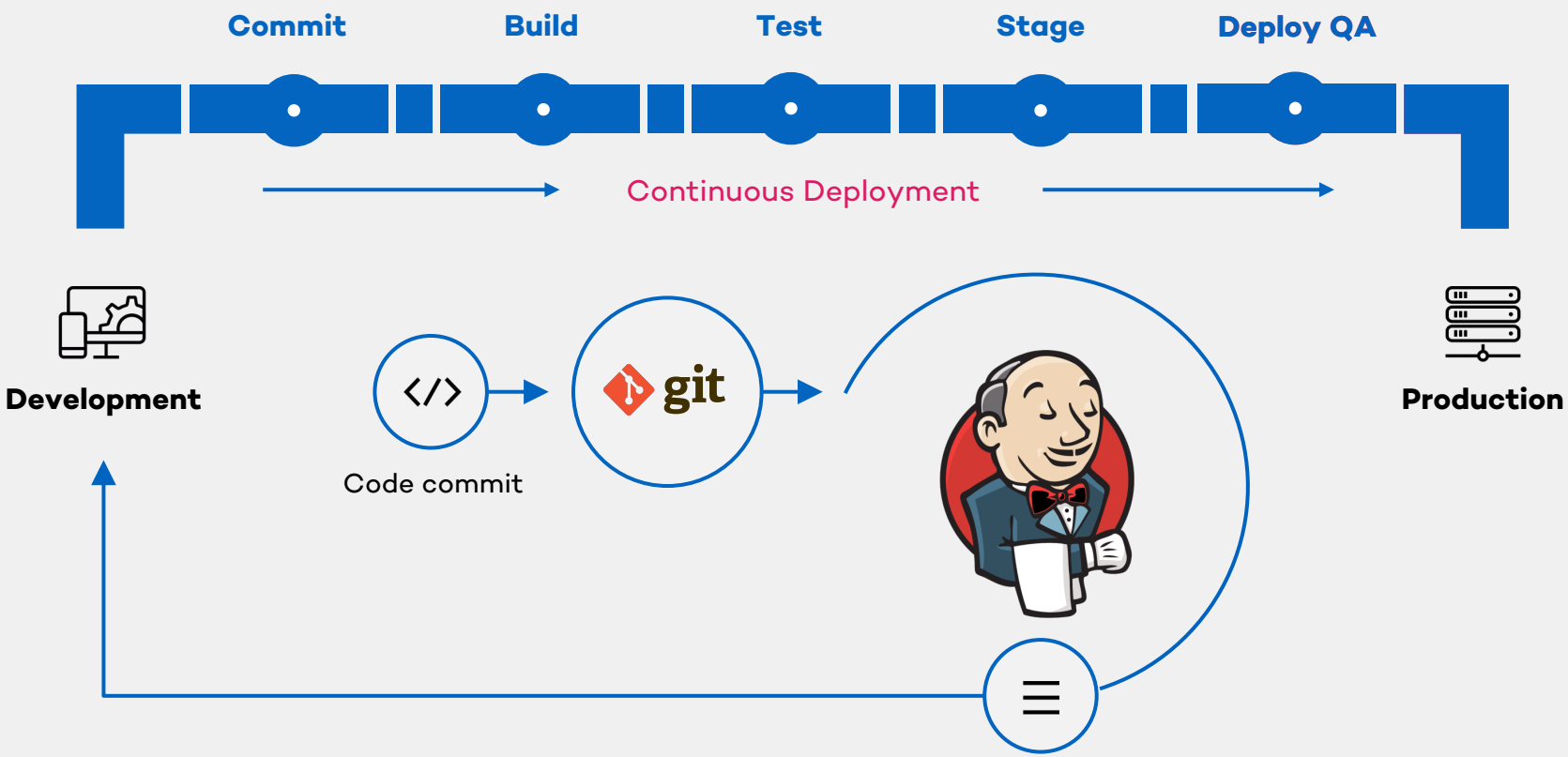


Continuous Deployment



Deployment in the Cloud

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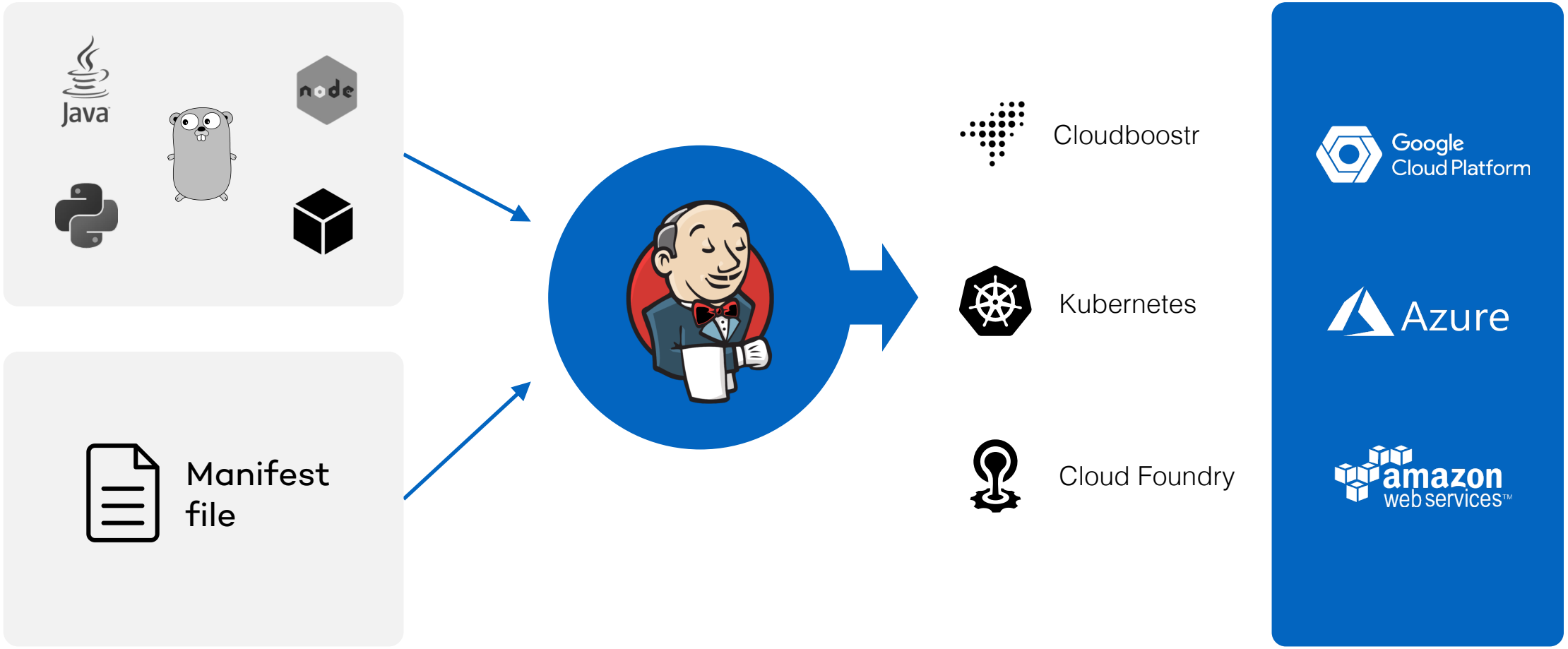

Deployment to the Car

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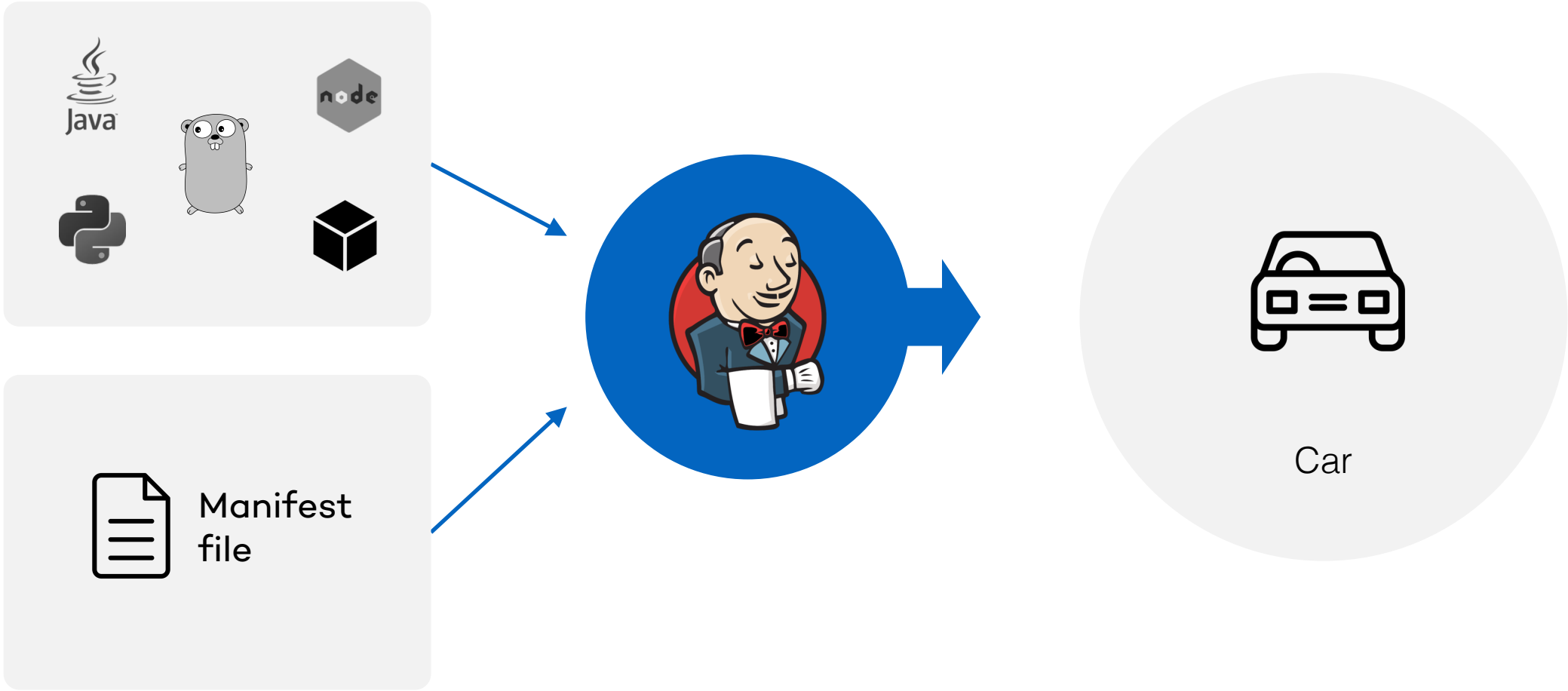

Car architecture

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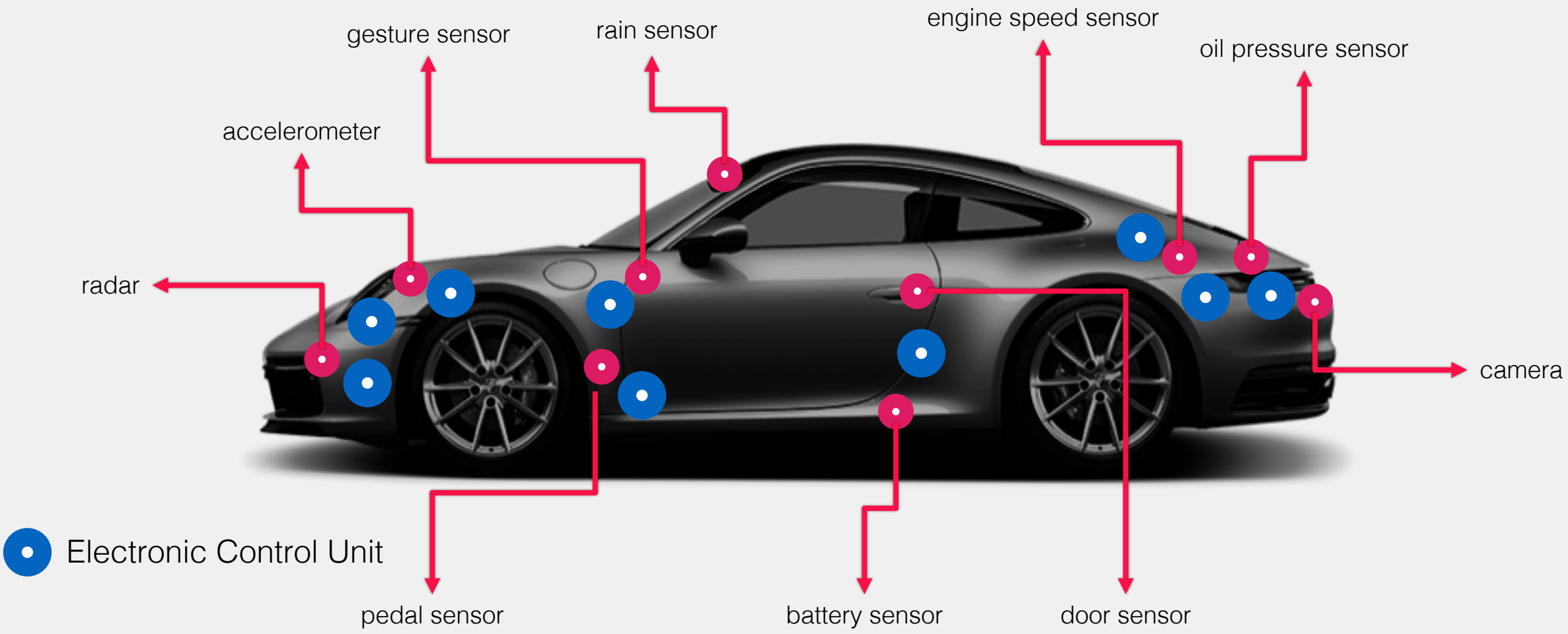

Old fashined deployment

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0 1 0 1 1 1 0 1 0 0 .....

Consolidation of Electronic Control Units in modern cars

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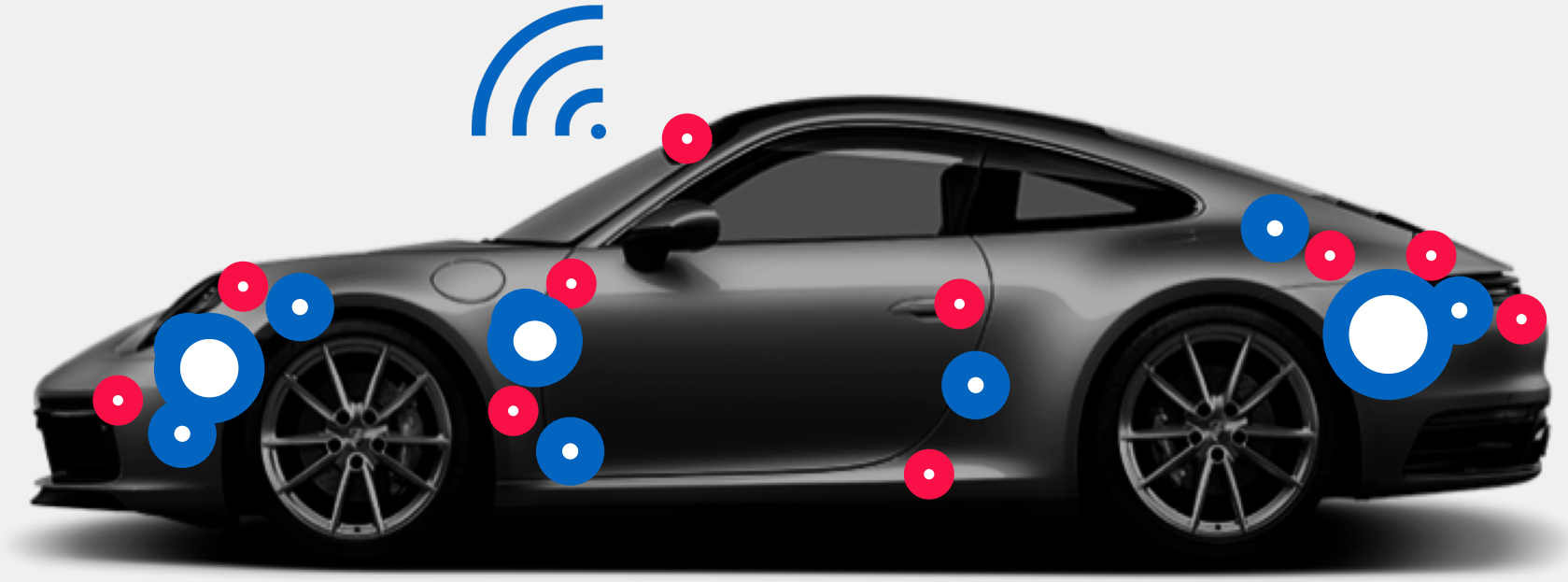

High Performance ECU

Connected Car

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0 1 0 1 1 1 0 1 0 0 .....

Kubernetes in the car

Quite challenging

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Most of Kubernetes distributions don’t support ARM

Kubernetes wasn’t designed for embedded software

Kubernetes consume a lot of resources (up to 4gb of RAM)

Kubernetes has a lot of features not required in edge devices

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- Fits resource constraints environments
- Support offline operations
- MQTT-based communication
- SDK based Development for Device Addition etc.

Kubernetes in the car

First try – KubeEdge

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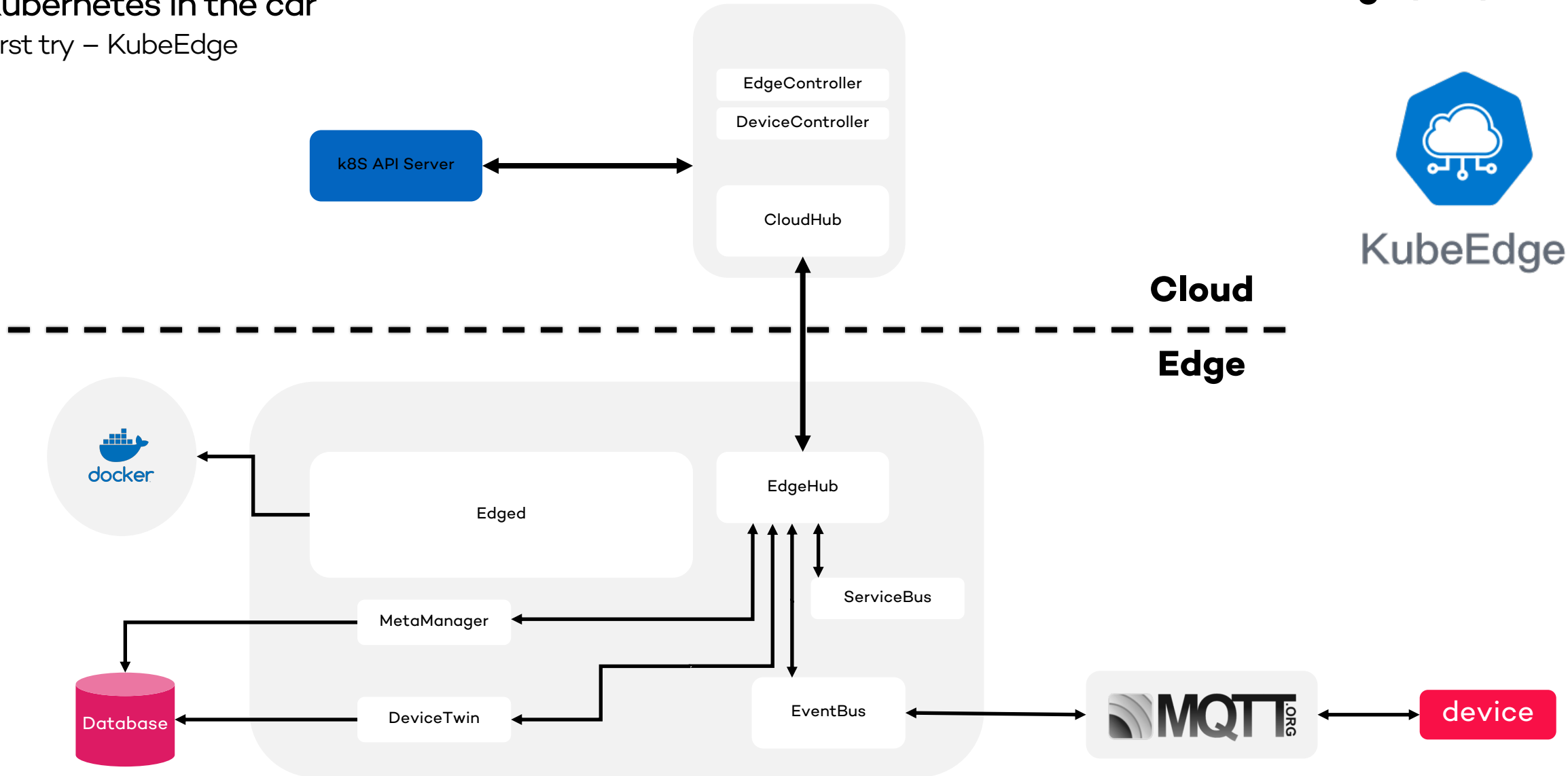

Kubernetes in the car

Revisited architecture

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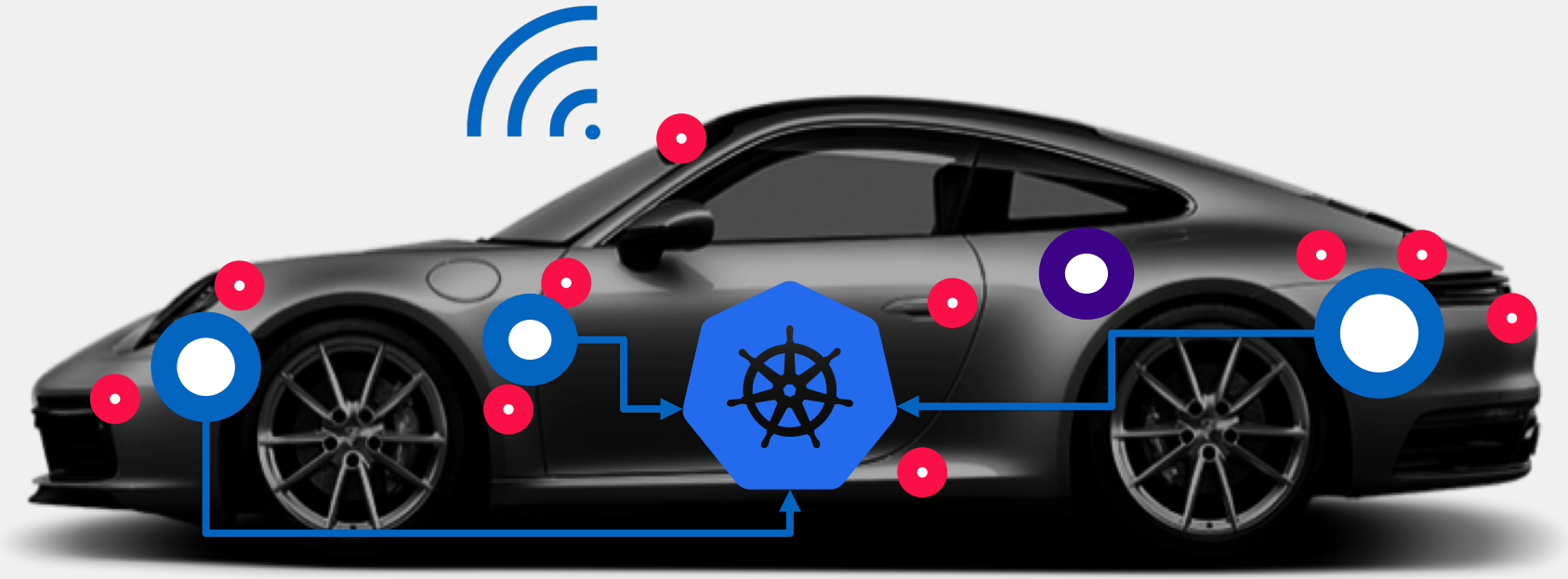

ECUs as workers

Let's build the pipeline

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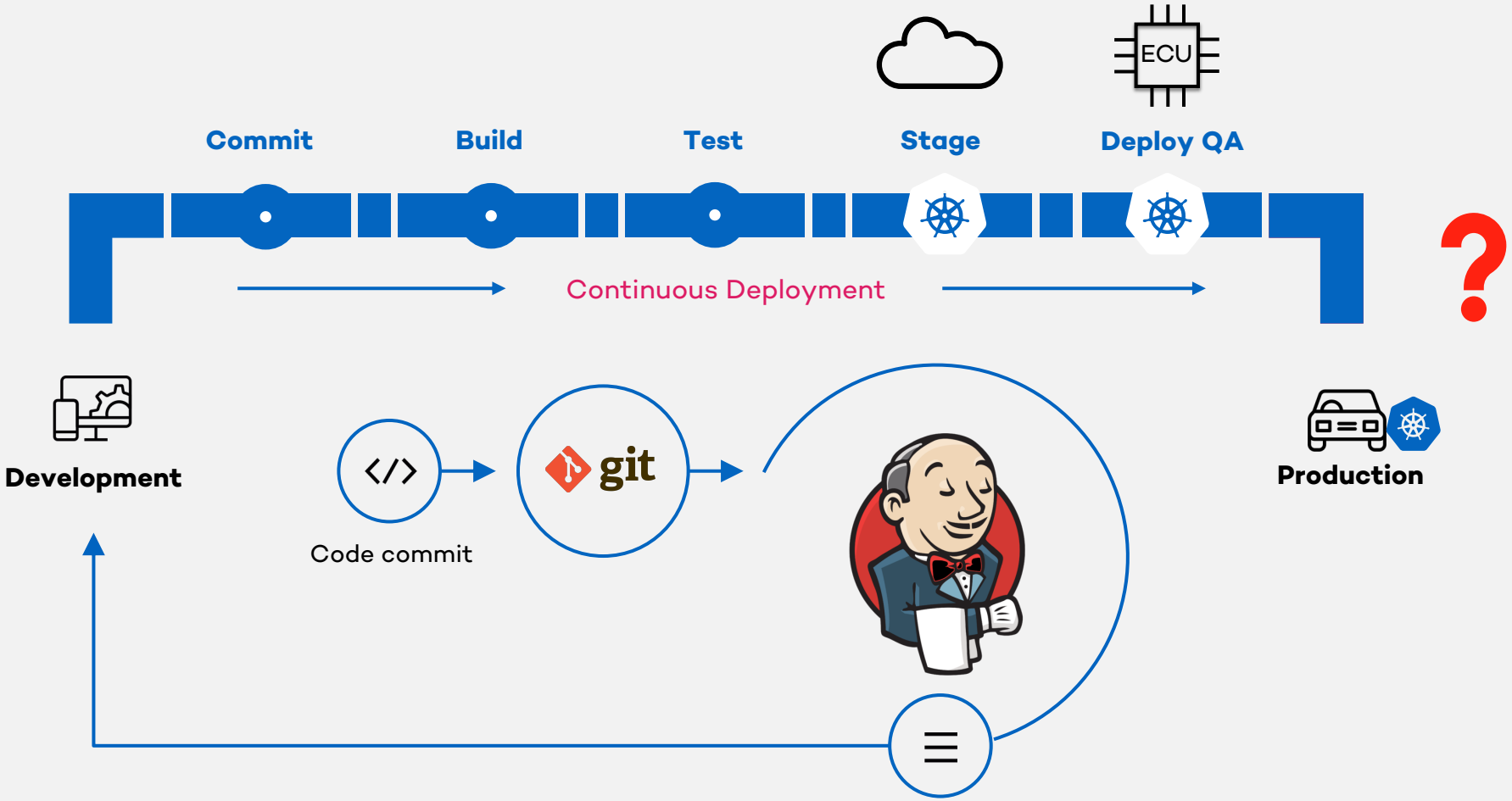

Let's build the pipeline

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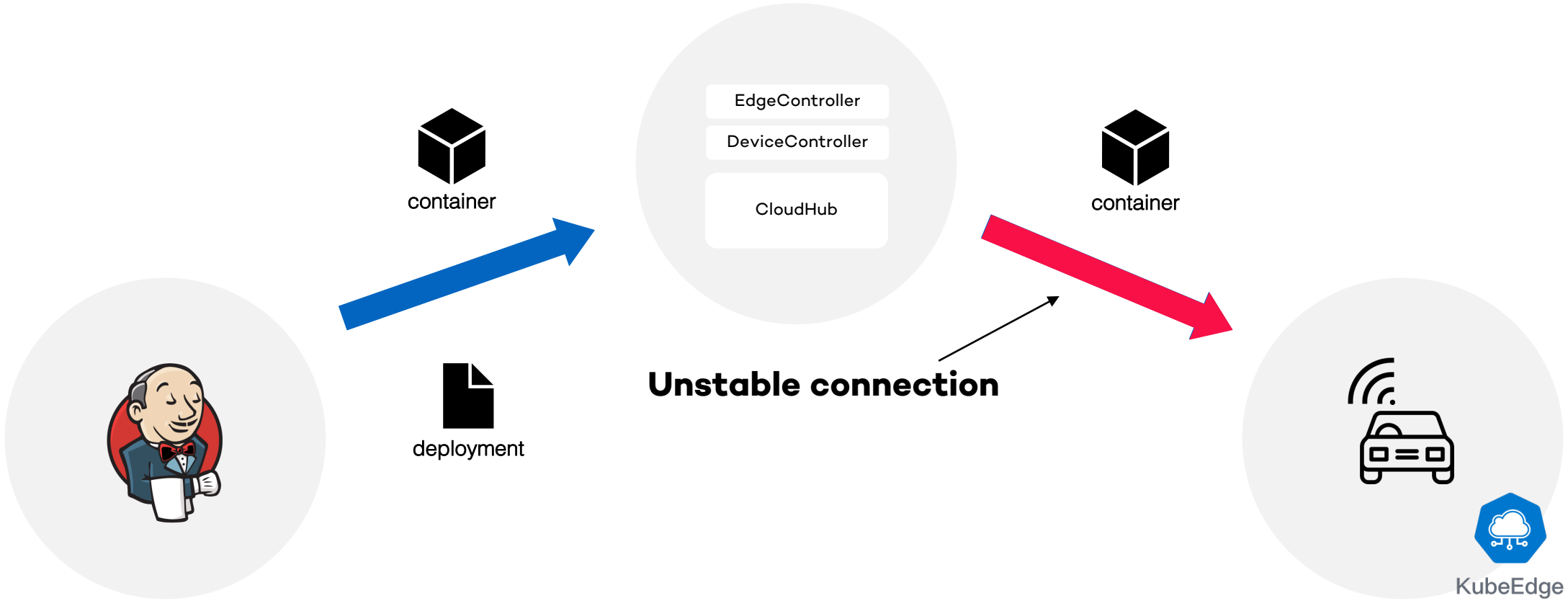

Kubernetes in the car

First try – KubeEdge

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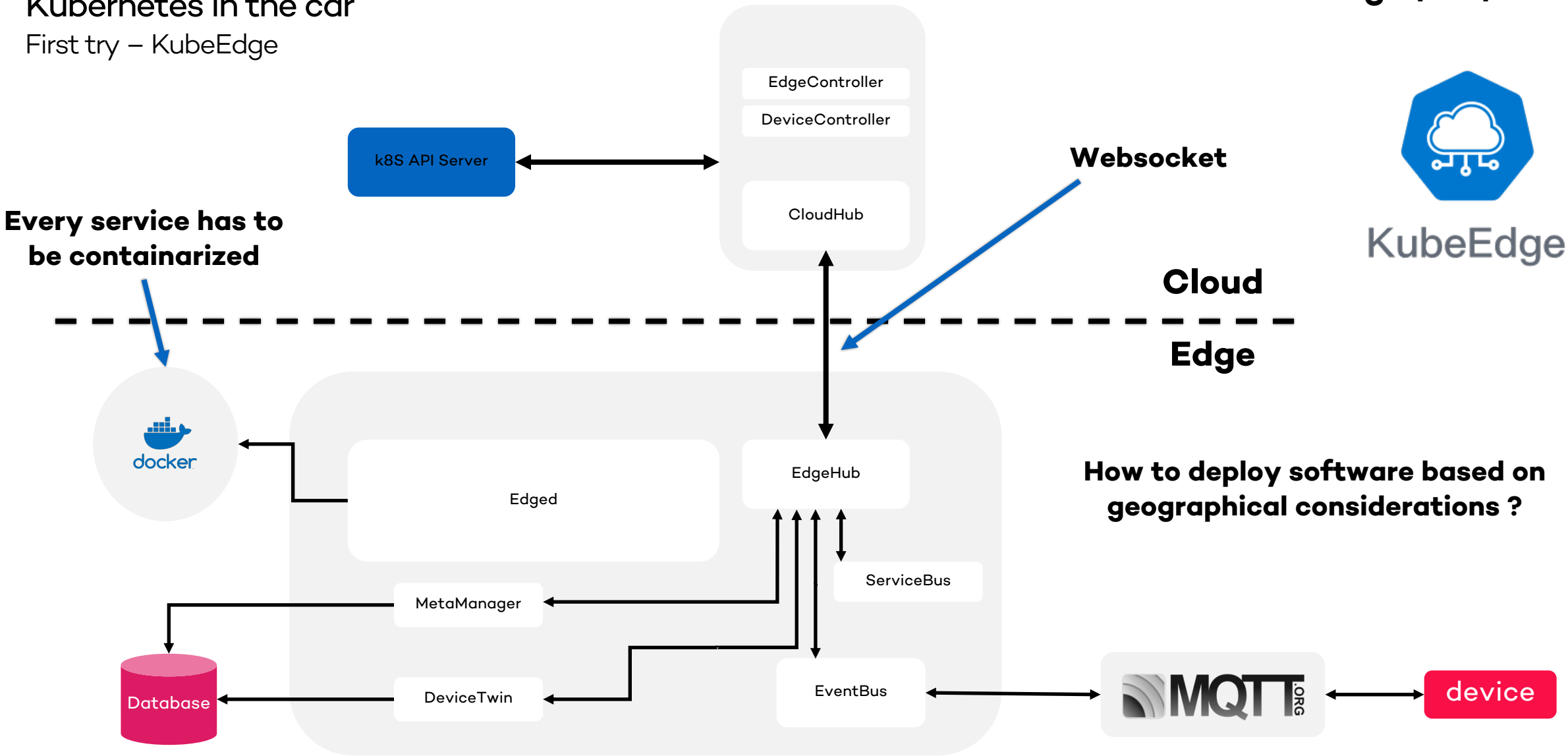

KubeEdge

How to deploy software based on geographical considerations ?

Kubernetes in the car

Second try – k3s

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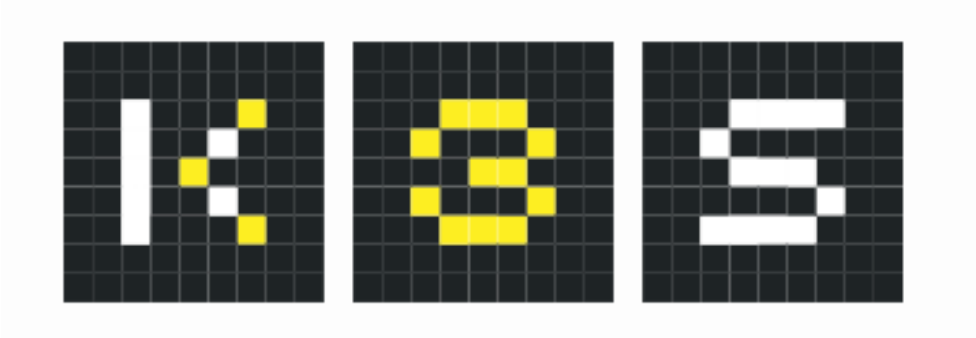

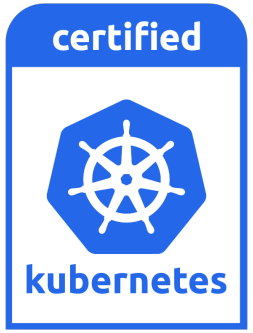

- Kubernetes lightweight distribution
- Fits resource constraints environments
- Support offline operations
- 200MB disk space and 512MB RAM

Kubernetes in the car
Second try– k3s

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Removes

- Legacy and non-default features
- Alpha features
- In-tree cloud providers
- In-tree storage drivers
- Docker (optional)

Adds

- Simplified installation
- SQLite3 support in addition to etcd
- TLS management
- Automatic Manifest and Helm Chart management
- containerd, CoreDNS, Flannel

k3s architecture

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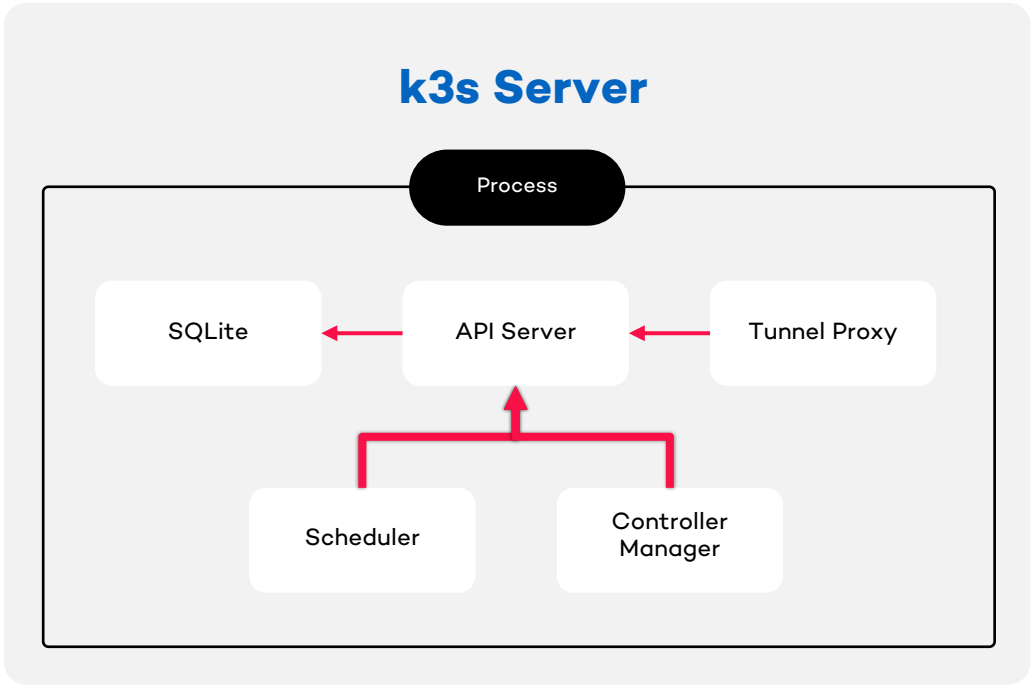

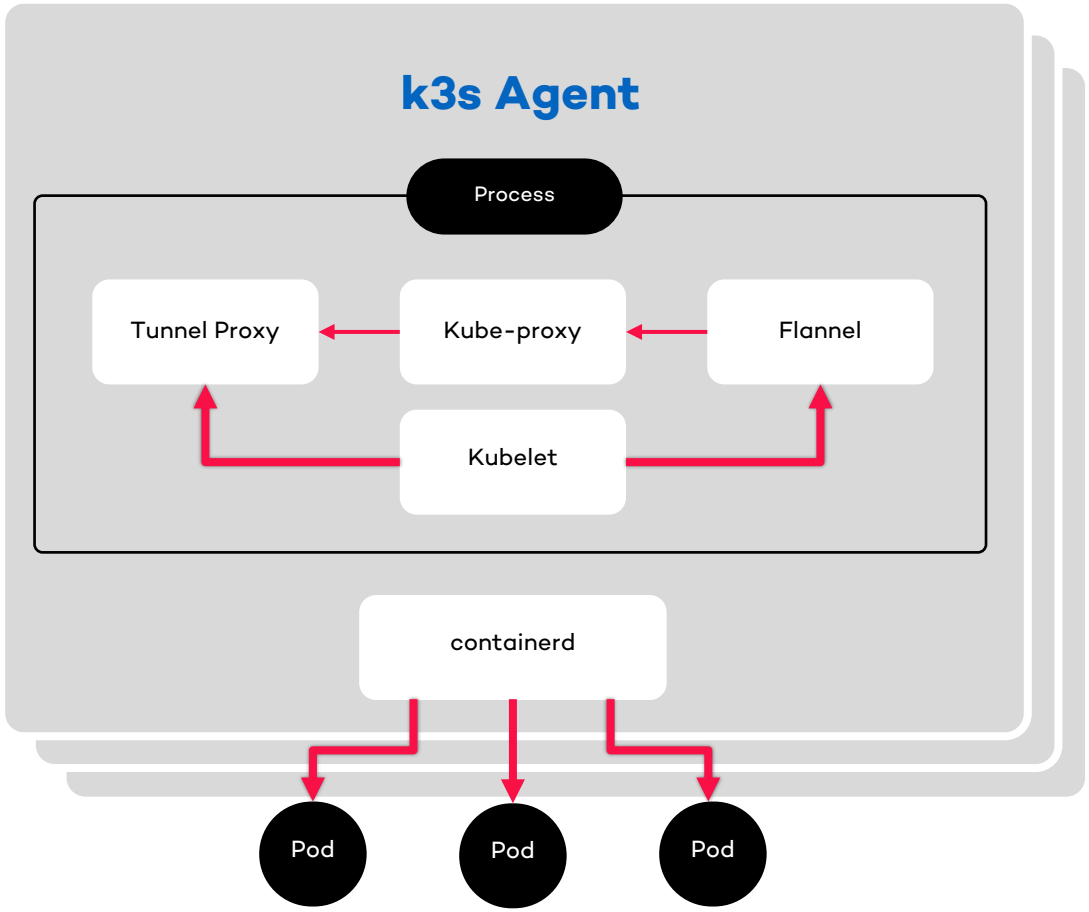

Let's build the pipeline

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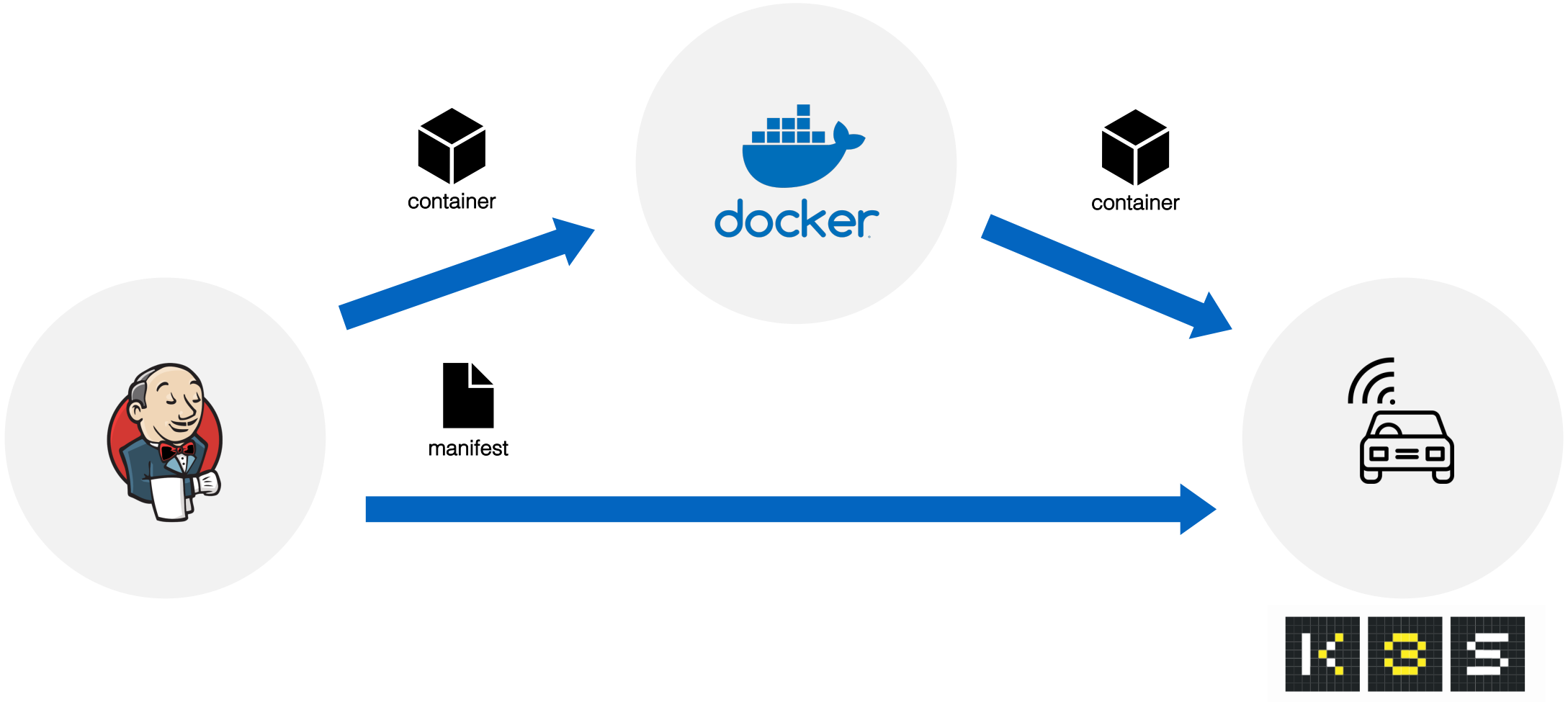

Digital Twin pattern

in continuous deployment pipeline

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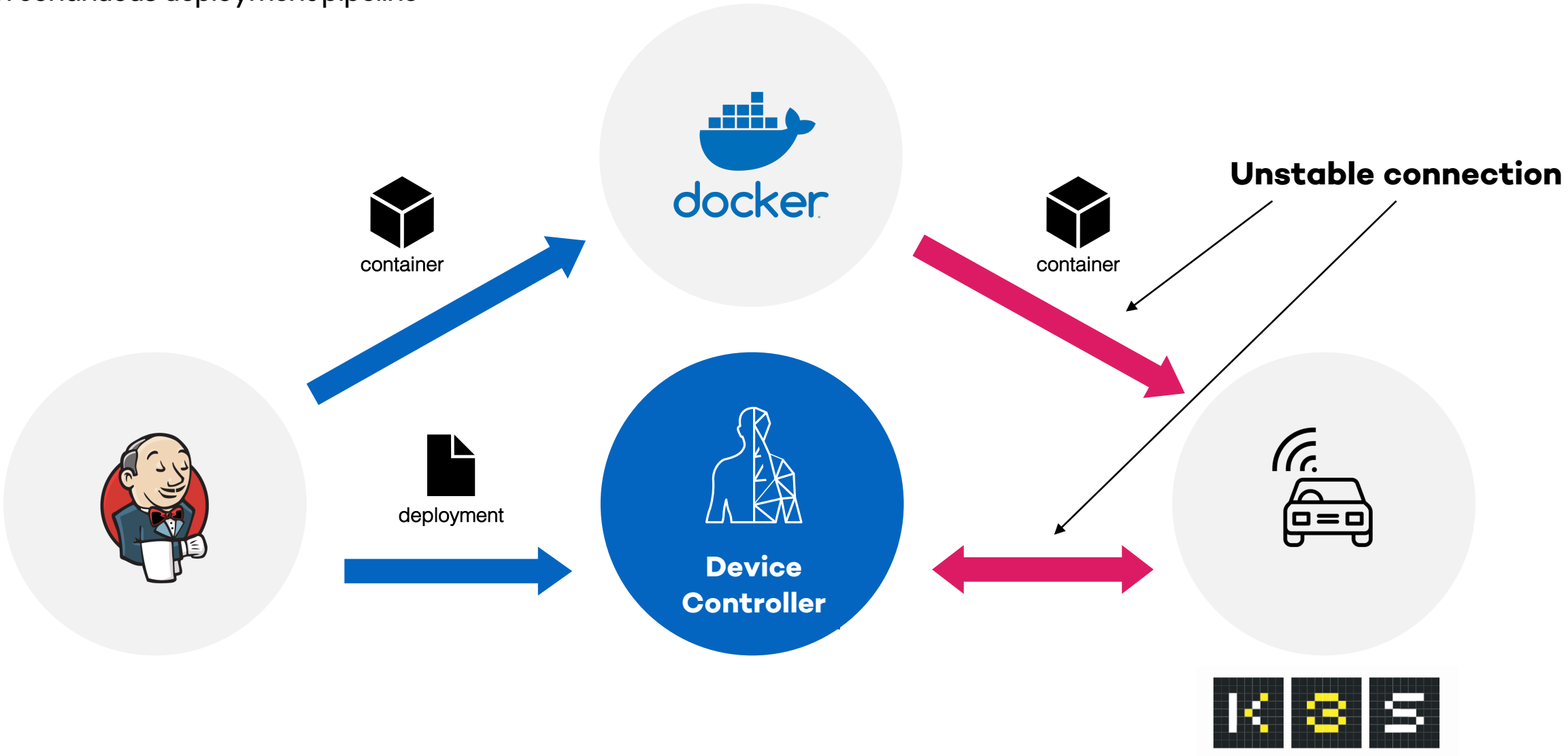

RSocket to the rescue!

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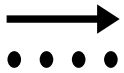
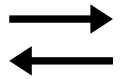
RSocket is **framed, message-based, binary,** bi-directional protocol , based on reactive streams back pressure and four-elements interaction model

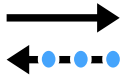
- Interaction is broken down into frames
- It can run on top of the TCP / Web Socket / Aeron
- **Payload could be anything – even large thing**
- Rich interaction model



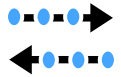
Fire & Forget



Request - Response



Request- Stream



Channel

Resumability in Socket

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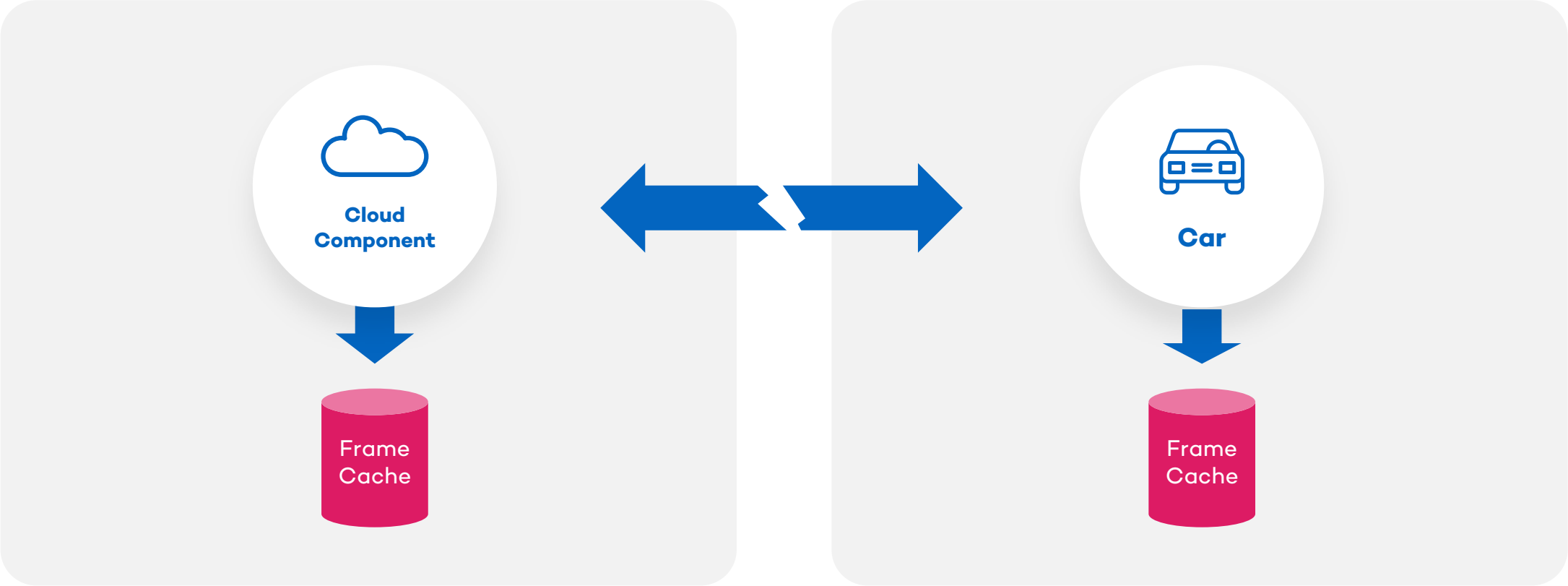

Digital Twin

in continuous deployment pipeline

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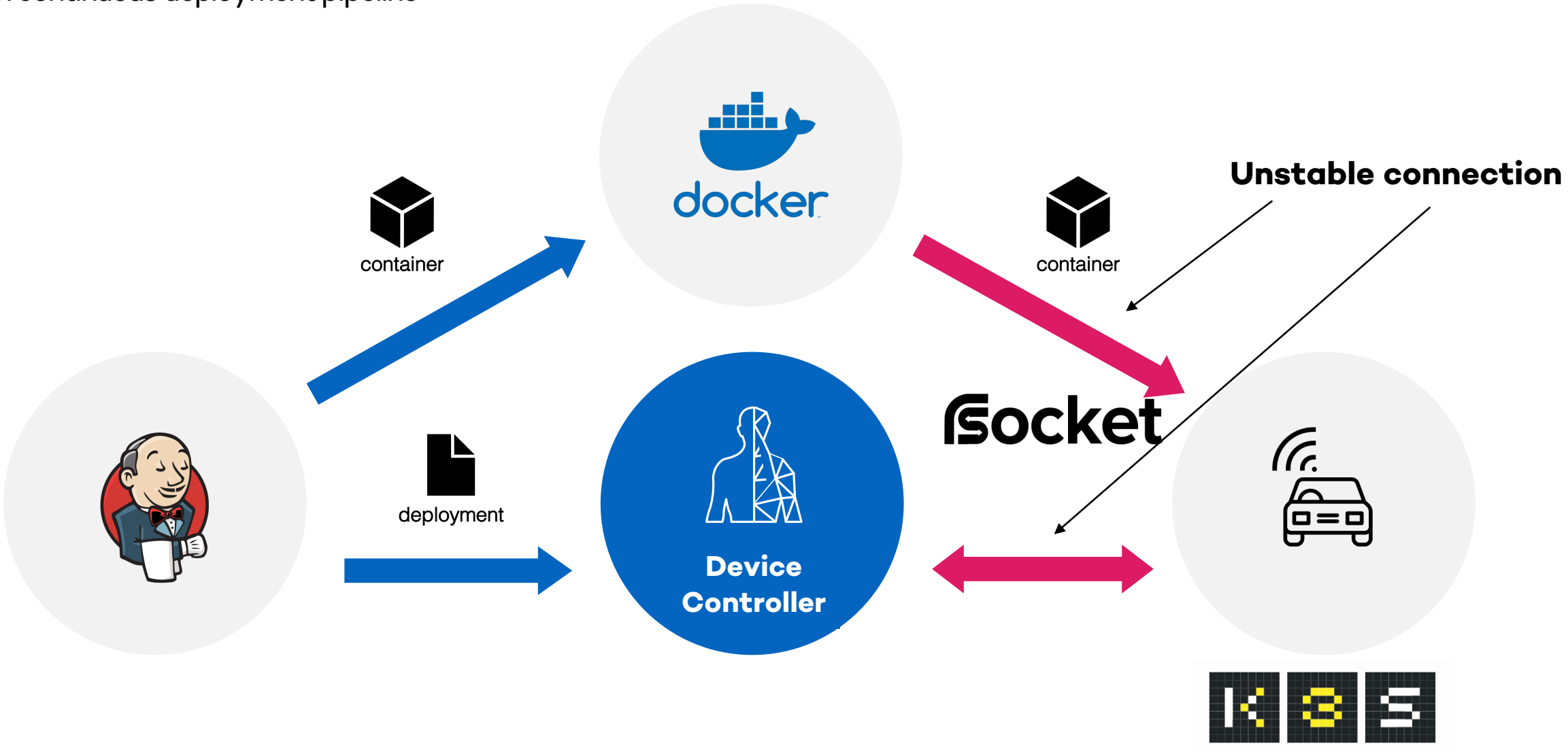

Digital Twin

as a deployable units cache

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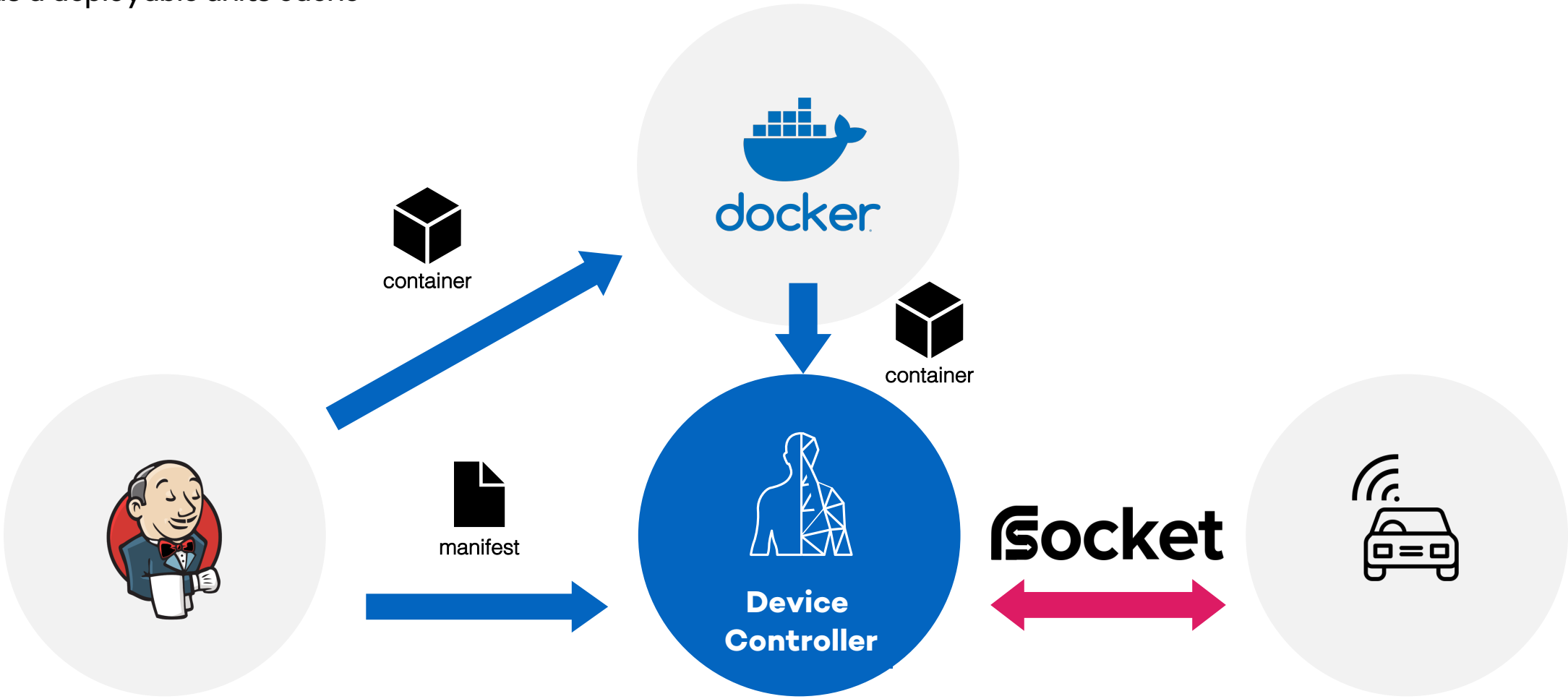

Let's put the deployment flow together

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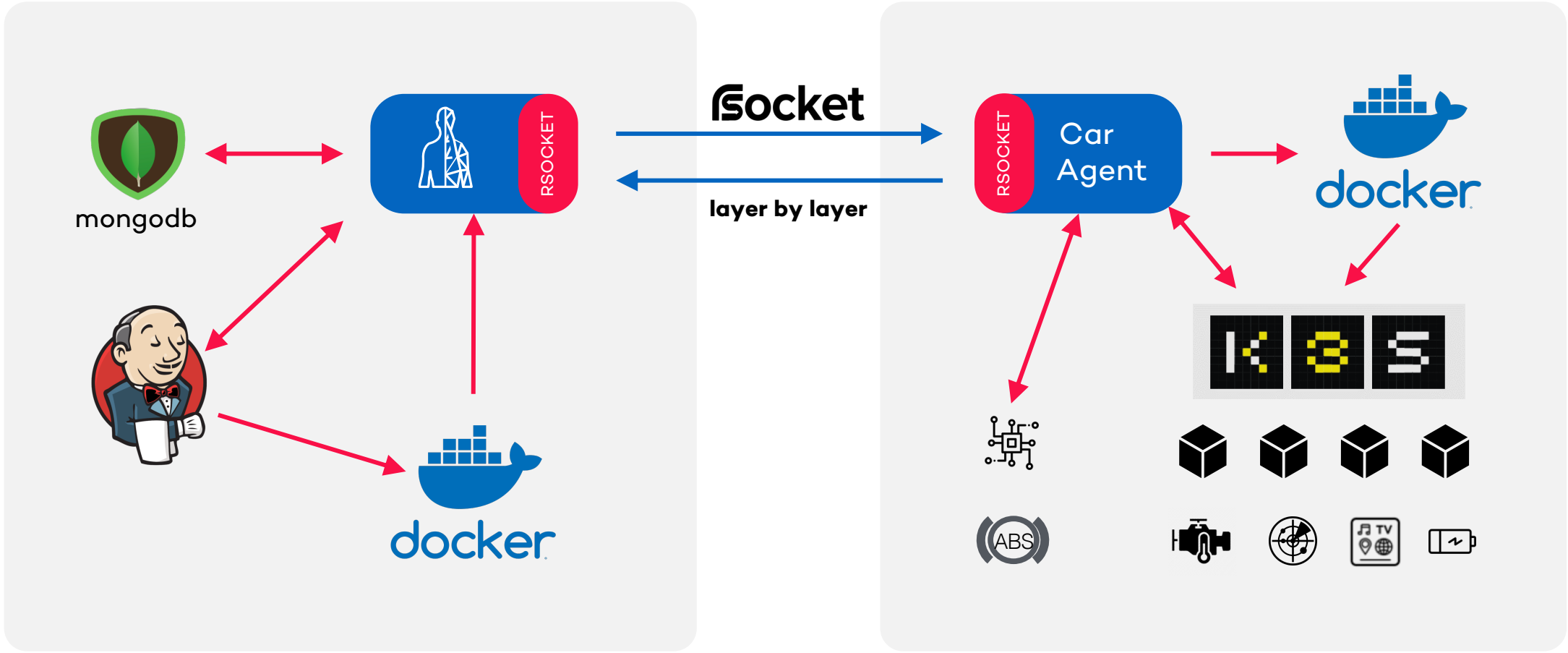
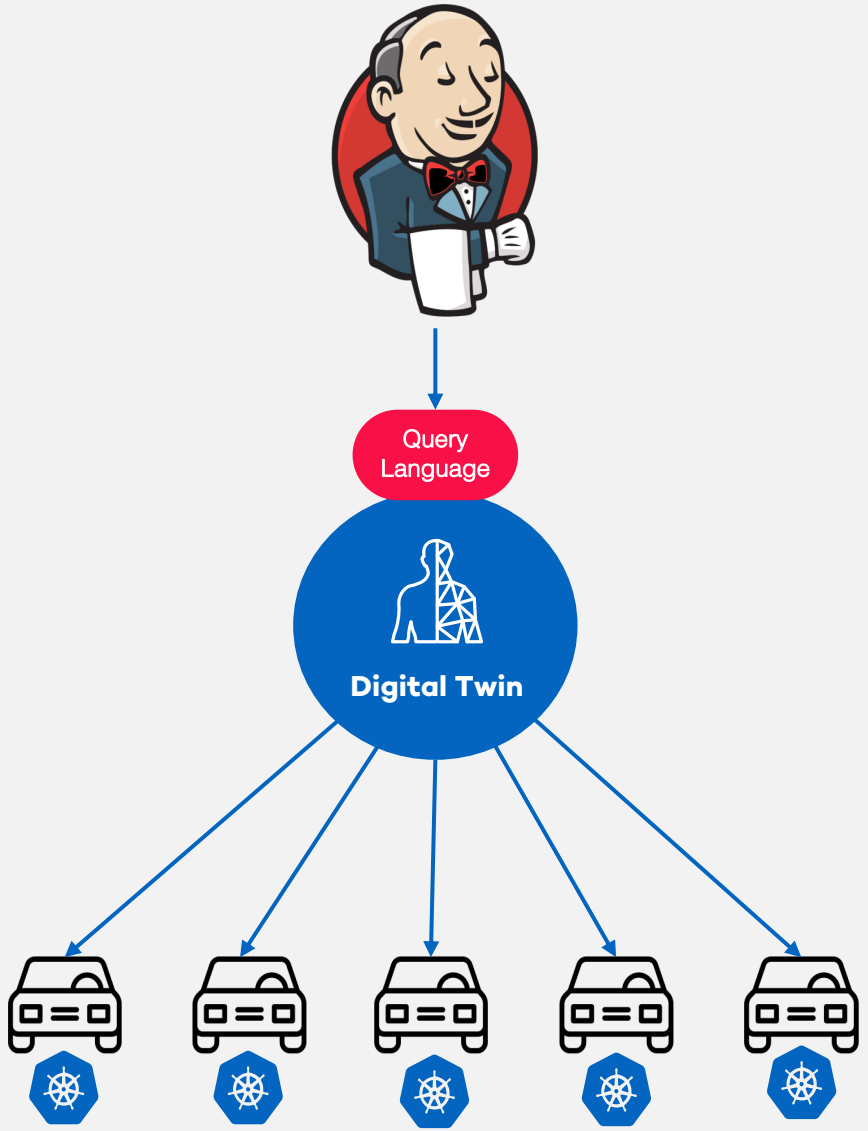


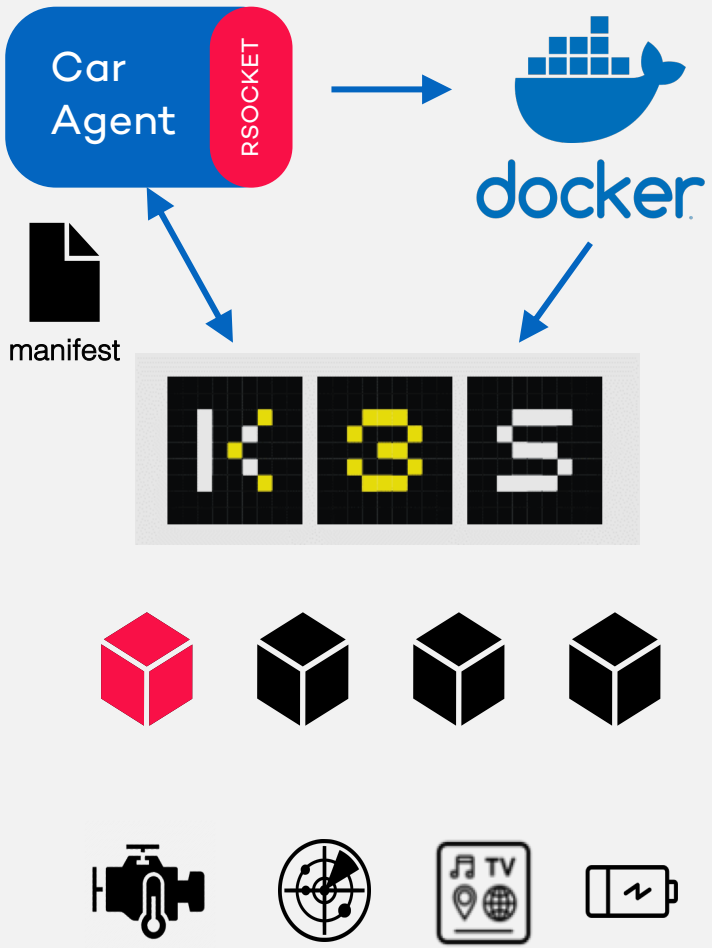
What if I have thousands of cars to update ?

- Nothing changes – cars will act based on the information provided by Digital Twin
- Twin enables **selective deployment**
- **Time to live support**



What about rollback?

- Car has it's own **registry**, so that the switch to previous version of the component is a matter of seconds
- The **car agent is responsible of monitoring** of the deployed components
- Usually two versions of software running in paralel (canary deployment)



Summary

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- Thanks to **μPaas** solutions (like KubeEdge, k3s) we can run “cloud” on the edge. It applies only to large/complex devices, usually we are not fully cloud native.
- **Connectivity** and **number of devices to handle** are main concerns in terms of software delivery to the car – both can be addressed by Digital Twin pattern
- **μPaas and RSocket** helps in unification of the runtime environment and the communication protocols