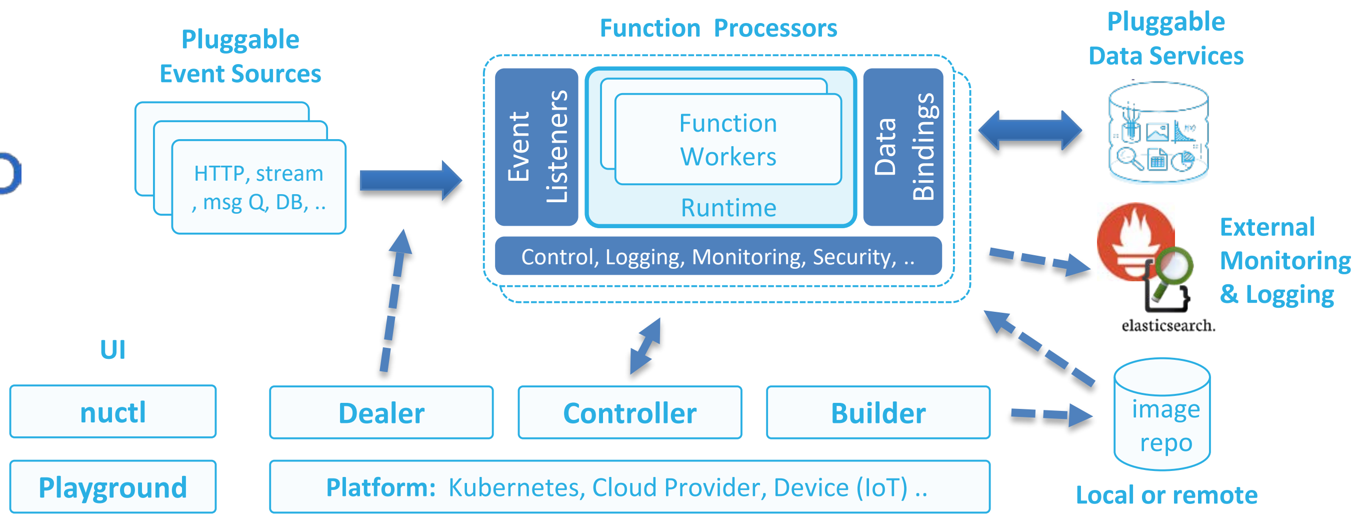
nuclio - Comprehensive, Open, Portable, & Super Fast "serverless"



- Real-time processing, low CPU overhead and maximum parallelism
- Simple debugging, regression, and multi-versioned CI/CD pipeline
- Pluggable data/event sources with common APIs
- Portable across low-power devices, laptops, on-prem and public cloud

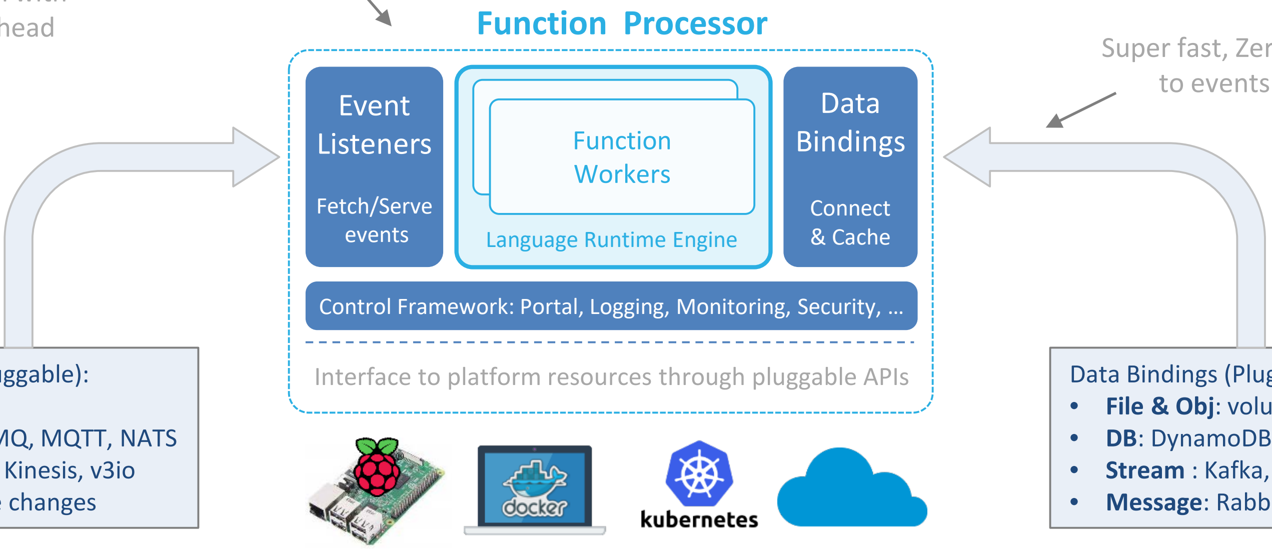
nuclio processor – Fast, Modular & Extensible

400K events/sec per process (100x faster than leading implementations)

Multiple async workers for maximum parallelism with minimum CPU overhead

Events and data abstractions enable re-use and portability

Super fast, Zero-copy access to events and data



Event Sources (Pluggable):
- **Sync**: HTTP
- **Async**: RabbitMQ, MQTT, NATS
- **Stream**: Kafka, Kinesis, v3io
- **Polling**: DB/file changes

Data Bindings (Pluggable):
- **File & Obj**: volumes, S3, v3io
- **DB**: DynamoDB, v3io
- **Stream** : Kafka, Kinesis, v3io
- **Message**: RabbitMQ

Any source and workload

Develop, Test, Run ANYWHERE

Simple, fast, secure, portable data integration

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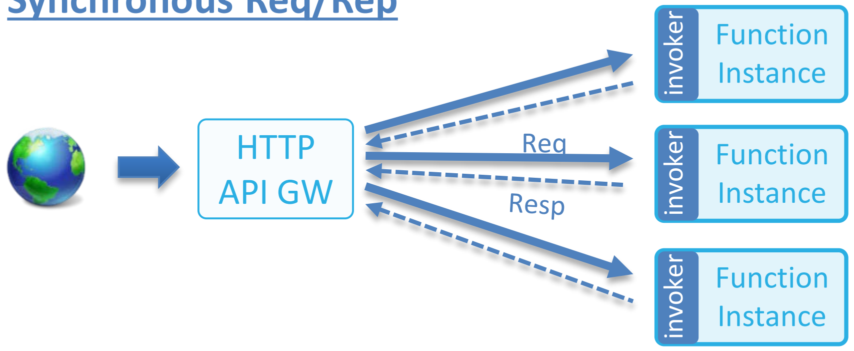
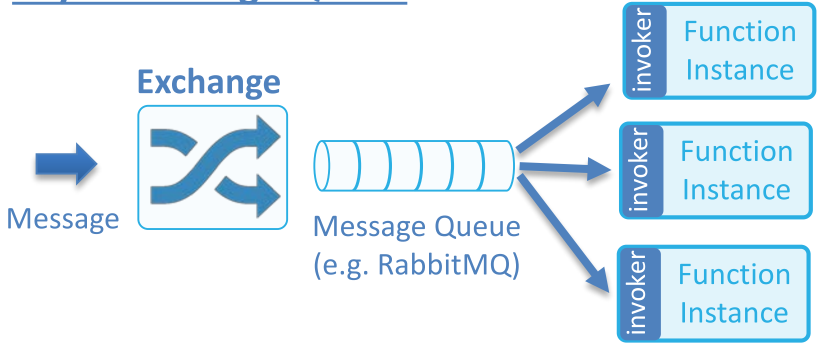
Nuclio invocation modes

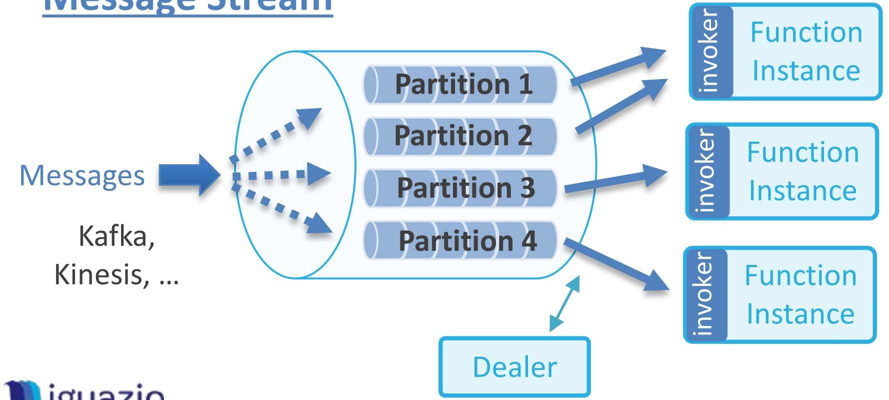
Synchronous Req/Rep



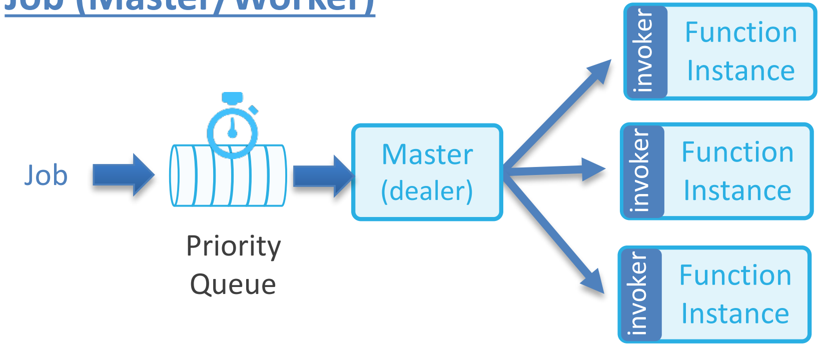
Async Message Queue



Message Stream

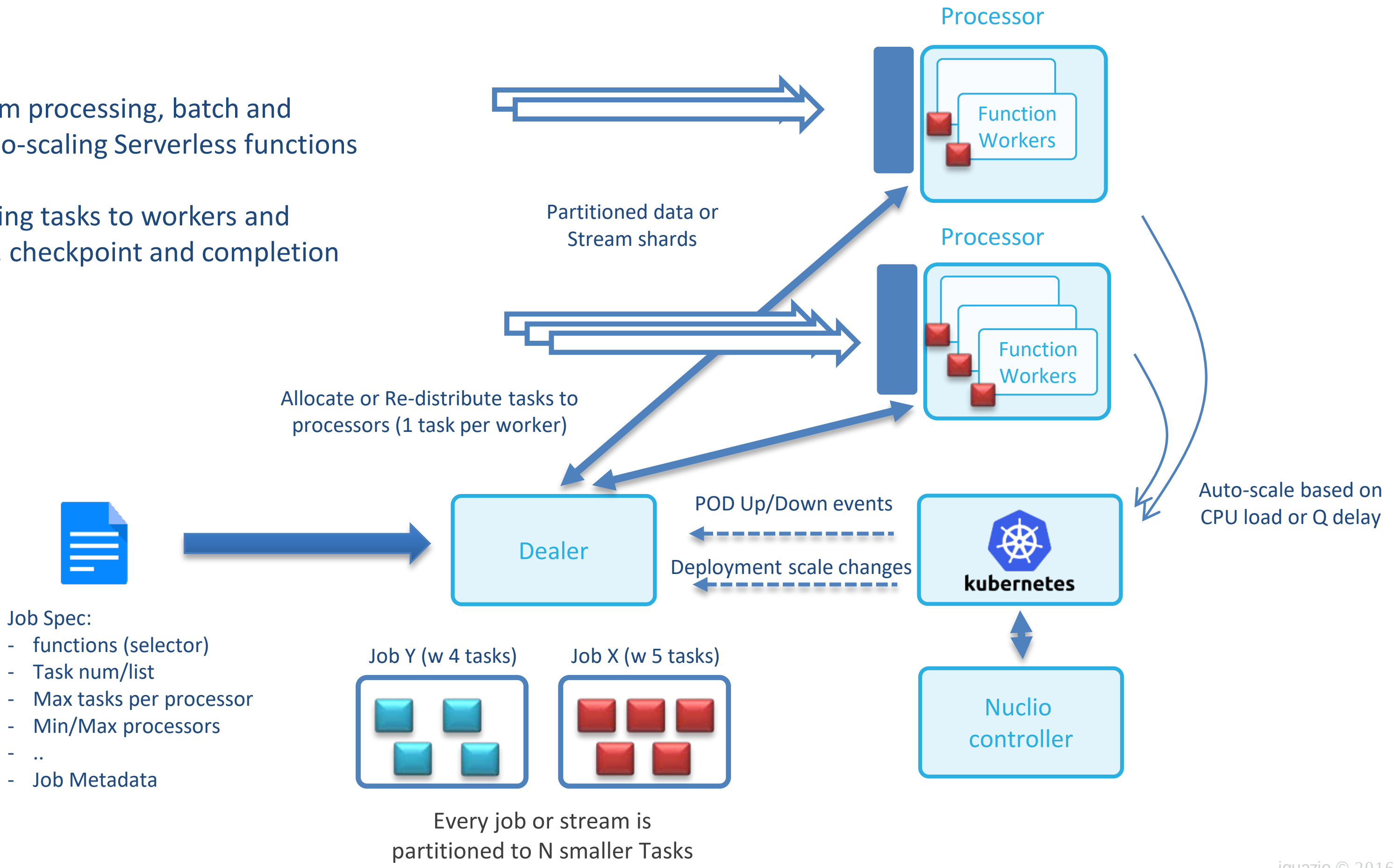


Job (Master/Worker)

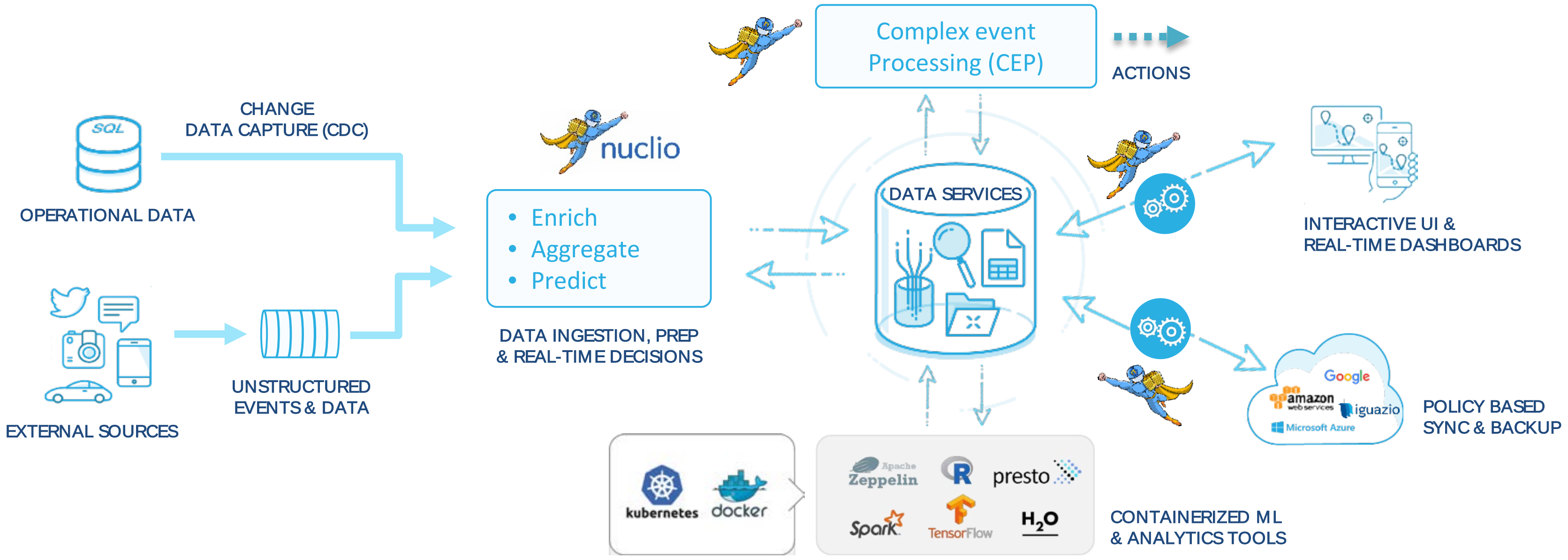


Nuclio Dealer

- Enable real-time stream processing, batch and interactive jobs on auto-scaling Serverless functions
- By dynamically allocating tasks to workers and handling task lifecycle, checkpoint and completion

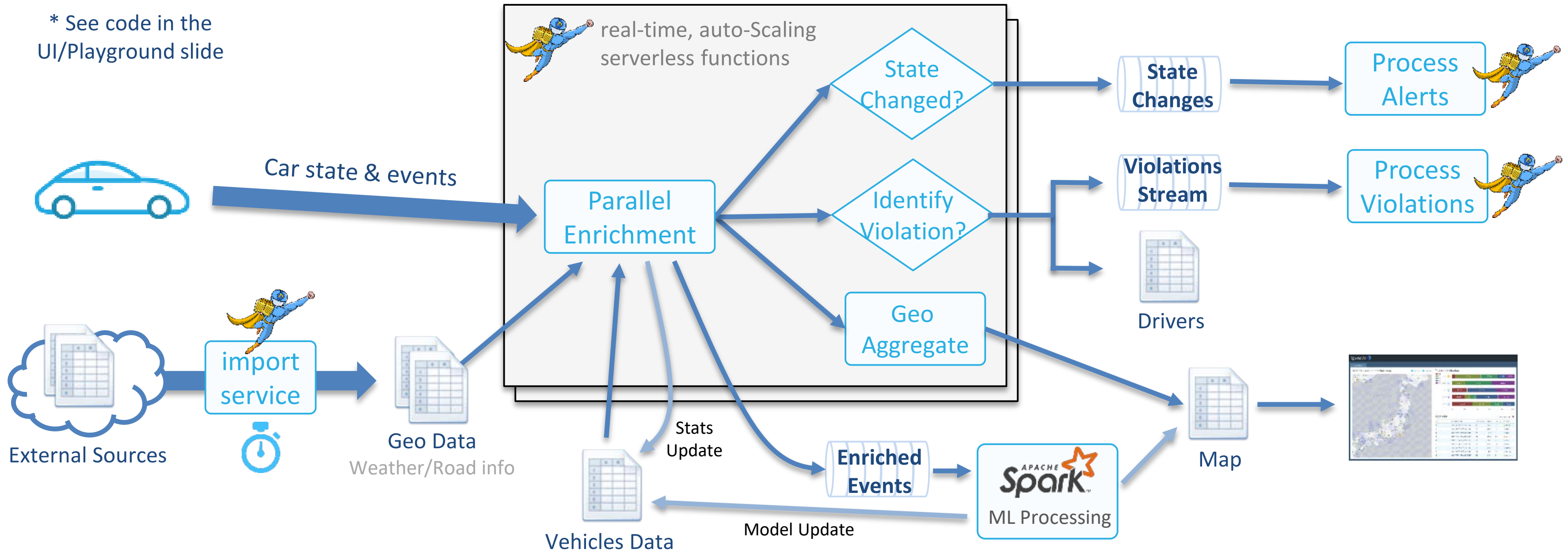


nuclio features & Performance make Serverless broadly applicable


Complex event Processing (CEP)
ACTIONS
CHANGE DATA CAPTURE (CDC)
SQL
OPERATIONAL DATA
nuclio
Enrich
Aggregate
Predict
DATA INGESTION, PREP & REAL-TIME DECISIONS
DATA SERVICES
INTERACTIVE UI & REAL-TIME DASHBOARDS
UNSTRUCTURED EVENTS & DATA
EXTERNAL SOURCES
Google
amazon web services
iguazio
Microsoft Azure
POLICY BASED SYNC & BACKUP
kubernetes
docker
Apache Zeppelin
R
presto
Spark
TensorFlow
H2O
CONTAINERIZED ML & ANALYTICS TOOLS

Higher-Productivity | Faster insights | No infrastructure hassle | Lower TCO

Real example: Event Driven Analytics for Connected Cars



Complex **Events + Data** processed in real-time without the infrastructure hassle

nuclio Function Spec

```
apiVersion: "nuclio.io/v1"
kind: Function
metadata:
  name: example
  namespace: myproject
  labels:
    author: joe
spec:
  image: example:latest
  replicas: 0
  maxReplicas: 10
  env:
  - name: SOME_ENV
    value: abc
  - name: SECRET_PASSWORD_ENV_VAR
    valueFrom:
      secretKeyRef:
        name: my-secret
        key: password
  resources:
    requests:
      memory: "64Mi"
      cpu: "250m"
    limits:
      memory: "128Mi"
      cpu: "500m"
  dataBindings:
      db0:
        class: v3io
        secret: mysecret
        url: http://199.19.70.139:8081/1024
```

namespaced

tags/labels used for search and event sources (Label Selectors)

Various src code options*: inline code, path (local/http/git), or local/remote pre-built image

Control Min/Max Replicas for controlled auto-scale

Pass text or secret environment variables (k8s convention)

Flex resource allocation, GPUs are coming

Pluggable Data Sources

Support Kubernetes CRD:
Functions can be created & deleted using kubectl

*Advanced build instructions & dependencies are in the build.yaml file

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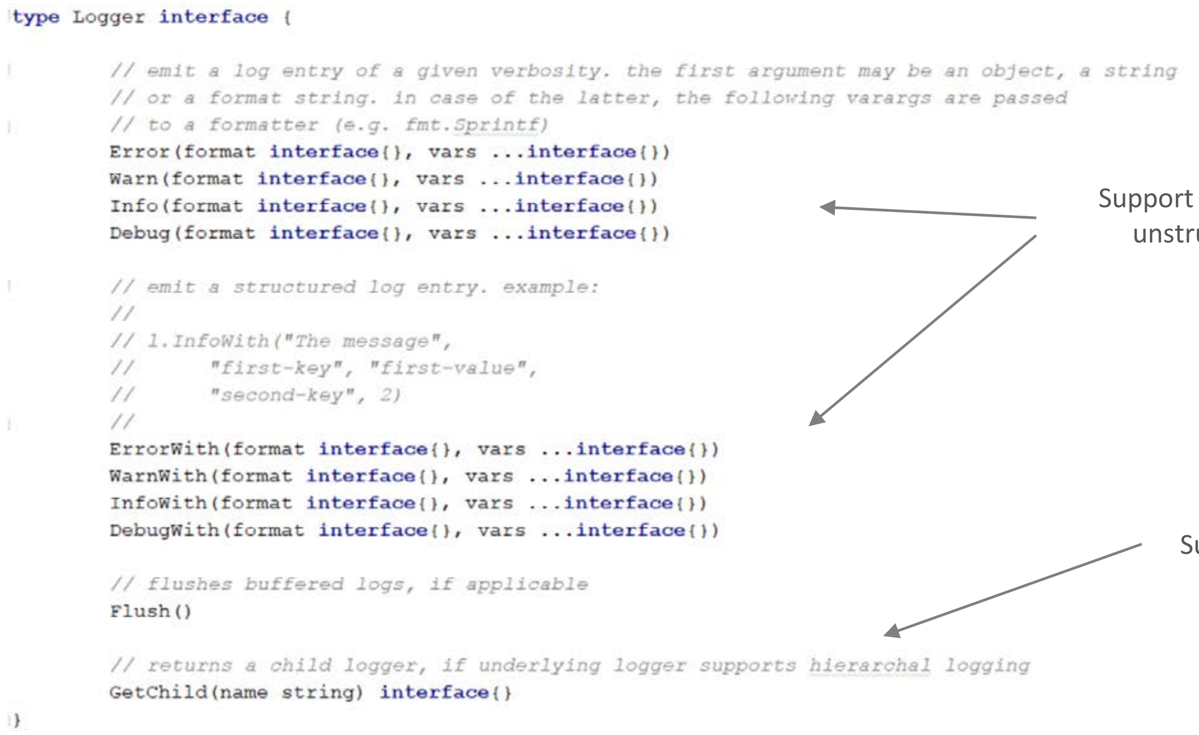
Nuclio common event model

```
type Event interface {
    // Unique ID of the event
    GetID() string
    // Event Source class, kind, ver, schema
    GetEventSource() SourceInfoProvider
    // Event Source address (e.g. origin host IP:port, origin stream, ..)
    GetSourceAddress() string
    // Source identity (e.g. authenticated by a gateway)
    GetSourceIdentity() string
    // Content type e.g. application/json
    GetContentType() string
    // byte array of content, encoding defined by content type
    GetBody() []byte
    // Get header(s) (e.g. HTTP, AMQP, or anything injected by the source)
    // also have convenience methods: GetHeaderByteSlice, GetHeaderString
    GetHeader(key string) interface{}
    GetHeaders() map[string]interface{}
    // Get field(s), decode fields in the body (e.g. json, DB record, ..)
    // Allow functions to ignore the specific event encoding, e.g. emulate DB record via HTTP
    // also have convenience methods: GetFieldByteSlice, GetFieldString, GetFieldInt
    GetField(key string) interface{}
    GetFields() map[string]interface{}
    // Original event timestamp or gateway timestamp (if origin timestamp not specified)
    GetTimestamp() time.Time
    // Logical path requested by the event (e.g. HTTP request path, stream name, etc.)
    GetPath() string
    // URL object for HTTP requests, for convenience
    GetURL() URL
    // HTTP or transport method
    GetMethod() string
    // Translate event to a json byte array
    AsJson() []byte
}
```

Simplify and generalize client implementation

Enable zero copy and zero ser/des when possible

Context.logger Interface



```
type Logger interface {

        // emit a log entry of a given verbosity. the first argument may be an object, a string
        // or a format string. in case of the latter, the following varargs are passed
        // to a formatter (e.g. fmt.Sprintf)
        Error(format interface{}, vars ...interface{})
        Warn(format interface{}, vars ...interface{})
        Info(format interface{}, vars ...interface{})
        Debug(format interface{}, vars ...interface{})

        // emit a structured log entry. example:
        //
        // l.InfoWith("The message",
        //      "first-key", "first-value",
        //      "second-key", 2)
        //
        ErrorWith(format interface{}, vars ...interface{})
        WarnWith(format interface{}, vars ...interface{})
        InfoWith(format interface{}, vars ...interface{})
        DebugWith(format interface{}, vars ...interface{})

        // flushes buffered logs, if applicable
        Flush()

        // returns a child logger, if underlying logger supports hierarchal logging
        GetChild(name string) interface{}
}
```

Support both structured & unstructured logging

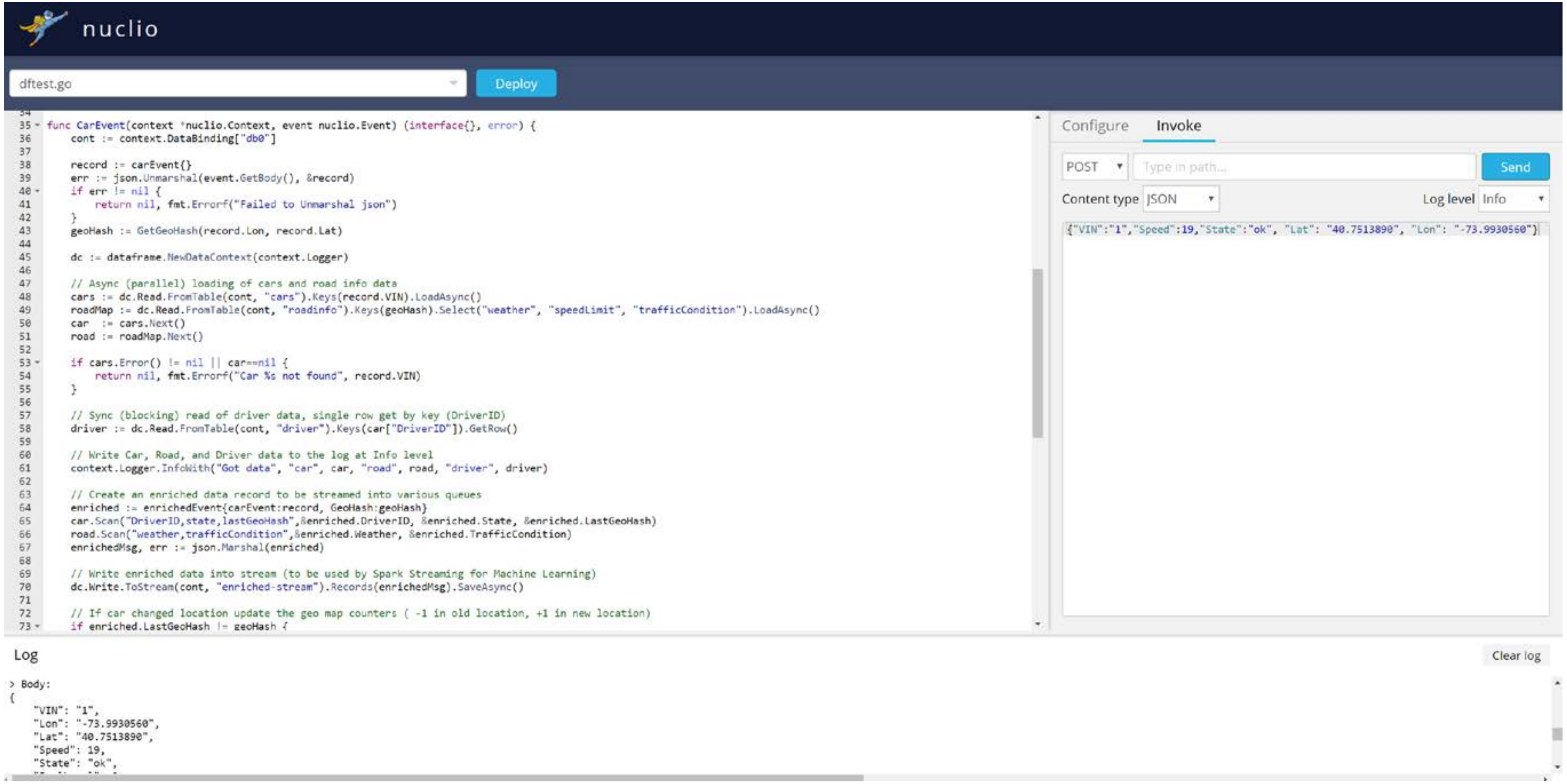
Support nested/hierarchical logs

One log interface, multiple implementations (screen, file, stream, http, ..), extensible

Default Context.DataBinding API (sync & async ver), can be overwritten

Service	Major APIs	Main Request Params
Object e.g. S3, Minio, v3io	**`ListObjects`**	`Bucket, Prefix, MaxKeys`
	`GetObject`	`Bucket, Key, Range`
	`PutObject`	`Bucket, Key ,Metadata, Body`
	`DeleteObject`	`Bucket, Key`
NoSQL e.g. DynamoDB, Cassandra, v3io	**`GetItem`**	`Table, Key ,Projection`
	`GetItems`	`Table, ConditionExpression, ProjectionExpression, Limit`
	`PutItem`	`Table, Key, ProjectionExpression, item`
	`UpdateItem`	`Table, Key, UpdateExpression, ConditionExpression`
	`DeleteItem`	`Table, Key, ConditionExpression`
Stream e.g. Kinesis, Kafka, v3io	**`GetRecords`**	`Stream, ShardId, Location, Limit`
	`PutRecords`	`Stream, Records`
	`Seek`	`Stream, ShardId, SeekType, SeekTime, StartingSequence, Timestamp`
File	**`Open`**	`Path, Mode, flags`
	`Read`	`Handle, offset, size`
	`Write`	`Handle, offset, size, data`

Nuclio Playground (run as isolated k8s deployment)



```go
func CarEvent(context *nuclio.Context, event nuclio.Event) (interface{}, error) {
    cont := context.DataBinding["db0"]

    record := carEvent{}
    err := json.Unmarshal(event.GetBody(), &record)
    if err != nil {
        return nil, fmt.Errorf("Failed to Unmarshal json")
    }
    geoHash := GetGeoHash(record.Lon, record.Lat)

    dc := dataframe.NewDataContext(context.Logger)

    // Async (parallel) loading of cars and road info data
    cars := dc.Read.FromTable(cont, "cars").Keys(record.VIN).LoadAsync()
    roadMap := dc.Read.FromTable(cont, "roadinfo").Keys(geoHash).Select("weather", "speedLimit", "trafficCondition").LoadAsync()
    car  := cars.Next()
    road := roadMap.Next()

    if cars.Error() != nil || car==nil {
        return nil, fmt.Errorf("Car %s not found", record.VIN)
    }

    // Sync (blocking) read of driver data, single row get by key (DriverID)
    driver := dc.Read.FromTable(cont, "driver").Keys(car["DriverID"]).GetRow()

    // Write Car, Road, and Driver data to the log at Info level
    context.Logger.InfoWith("Got data", "car", car, "road", road, "driver", driver)

    // Create an enriched data record to be streamed into various queues
    enriched := enrichedEvent{carEvent:record, GeoHash:geoHash}
    car.Scan("DriverID,state,lastGeoHash",&enriched.DriverID, &enriched.State, &enriched.LastGeoHash)
    road.Scan("weather,trafficCondition",&enriched.Weather, &enriched.TrafficCondition)
    enrichedMsg, err := json.Marshal(enriched)

    // Write enriched data into stream (to be used by Spark Streaming for Machine Learning)
    dc.Write.ToStream(cont, "enriched-stream").Records(enrichedMsg).SaveAsync()

    // If car changed location update the geo map counters ( -1 in old location, +1 in new location)
    if enriched.LastGeoHash != geoHash {
```

```
{"VIN":"1","Speed":19,"State":"ok", "Lat": "40.7513890", "Lon": "-73.9930560"}
```

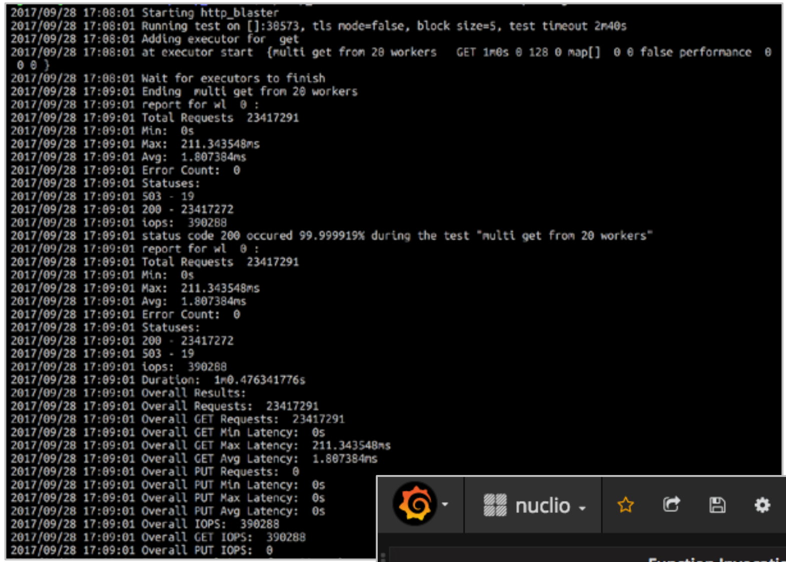
```
> Body:
{
    "VIN": "1",
    "Lon": "-73.9930560",
    "Lat": "40.7513890",
    "Speed": 19,
    "State": "ok",
```

CLI (run command example)

```
$ nuctl run --help
Build, deploy and run a function

Usage:
  nuctl run function-name [flags]

Flags:
      --data string              Comma separated list of data bindings (in json)
      --data-bindings string     JSON encoded data bindings for the function
      --desc string              Function description
  -d, --disabled                 Start function disabled (don't run yet)
  -e, --env string               Environment variables (name1=val1,name2=val2..)
      --events string            Comma separated list of event sources (in json)
  -f, --file string              Function Spec File
  -h, --help                     help for run
  -i, --image string             Docker image name, will use function name if not specified
  -l, --labels string            Additional function labels (lbl1=val1,lbl2=val2..)
      --max-replica int32        Maximum number of function replicas
      --min-replica int32        Minimum number of function replicas
      --no-pull                  Don't pull base images - use local versions
      --nuclio-src-dir string    Local directory with nuclio sources (avoid cloning)
      --nuclio-src-url string    nuclio sources url for git clone (default "https://github.com/nuclio/nuclio.git")
  -o, --output string            Build output type - docker|binary (default "docker")
  -p, --path string              Function source code path
      --port int32               Public HTTP port (node port)
      --publish                  Publish the function
  -r, --registry string          URL of container registry (env: NUCTL_REGISTRY)
      --run-registry string      The registry URL to pull the image from, if differs from -r (env: NUCTL_RUN_REGISTRY)
      --runtime string           Runtime – golang, python, ..
  -s, --scale string             Function scaling (auto|number) (default "1")
      --version string           Docker image version (default "latest")

Global Flags:
  -k, --kubeconfig string    Path to Kubernetes config (admin.conf) (default ~/.kube/config")
  -n, --namespace string     Kubernetes namespace (default "default")
  -v, --verbose              verbose output
```

See more in: https://github.com/nuclio/nuclio/blob/master/docs/nuctl/nuctl.md

Perf results, single process, using basic function

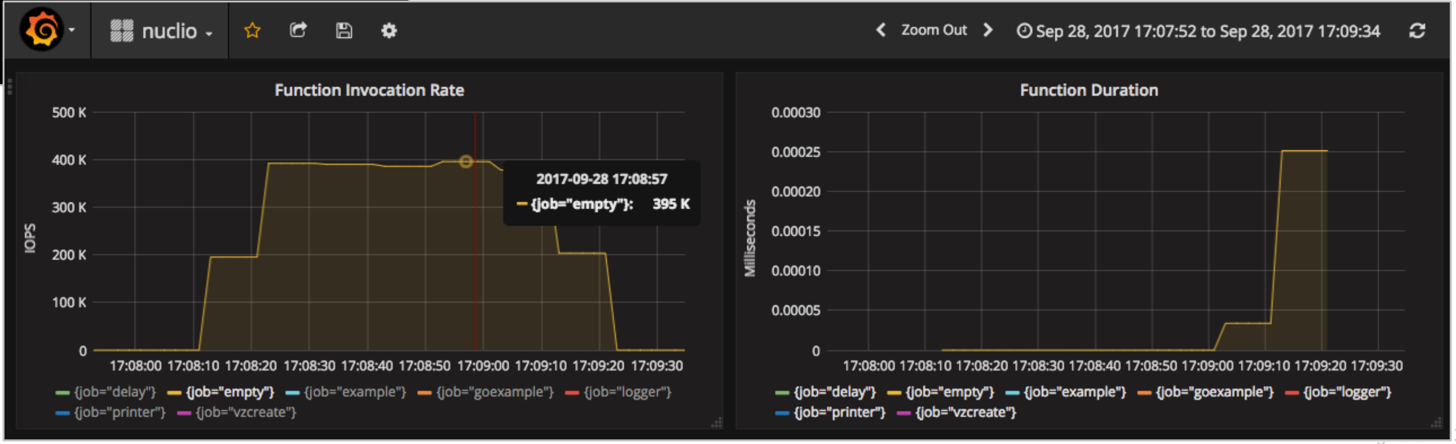


```
2017/09/28 17:08:01 Starting http_blaster
2017/09/28 17:08:01 Running test on []:30573, tls mode=false, block size=5, test timeout 2m40s
2017/09/28 17:08:01 Adding executor for  get
2017/09/28 17:08:01 at executor start  {multi get from 20 workers   GET 1m0s 0 128 0 map[]  0 0 false performance  0
 0 0 }
2017/09/28 17:08:01 Wait for executors to finish
2017/09/28 17:09:01 Ending  multi get from 20 workers
2017/09/28 17:09:01 report for wl  0 :
2017/09/28 17:09:01 Total Requests  23417291
2017/09/28 17:09:01 Min:  0s
2017/09/28 17:09:01 Max:  211.343548ms
2017/09/28 17:09:01 Avg:  1.807384ms
2017/09/28 17:09:01 Error Count:  0
2017/09/28 17:09:01 Statuses:
2017/09/28 17:09:01 503 - 19
2017/09/28 17:09:01 200 - 23417272
2017/09/28 17:09:01 iops:  390288
2017/09/28 17:09:01 status code 200 occured 99.999919% during the test "multi get from 20 workers"
2017/09/28 17:09:01 report for wl  0 :
2017/09/28 17:09:01 Total Requests  23417291
2017/09/28 17:09:01 Min:  0s
2017/09/28 17:09:01 Max:  211.343548ms
2017/09/28 17:09:01 Avg:  1.807384ms
2017/09/28 17:09:01 Error Count:  0
2017/09/28 17:09:01 Statuses:
2017/09/28 17:09:01 200 - 23417272
2017/09/28 17:09:01 503 - 19
2017/09/28 17:09:01 iops:  390288
2017/09/28 17:09:01 Duration:  1m0.476341776s
2017/09/28 17:09:01 Overall Results:
2017/09/28 17:09:01 Overall Requests:  23417291
2017/09/28 17:09:01 Overall GET Requests:  23417291
2017/09/28 17:09:01 Overall GET Min Latency:  0s
2017/09/28 17:09:01 Overall GET Max Latency:  211.343548ms
2017/09/28 17:09:01 Overall GET Avg Latency:  1.807384ms
2017/09/28 17:09:01 Overall PUT Requests:  0
2017/09/28 17:09:01 Overall PUT Min Latency:  0s
2017/09/28 17:09:01 Overall PUT Max Latency:  0s
2017/09/28 17:09:01 Overall PUT Avg Latency:  0s
2017/09/28 17:09:01 Overall IOPS:  390288
2017/09/28 17:09:01 Overall GET IOPS:  390288
2017/09/28 17:09:01 Overall PUT IOPS:  0
```

```go
package empty

import (
    "github.com/nuclio/nuclio-sdk"
)

func Empty(context *nuclio.Context, event nuclio.Event) (interface{}, error) {
    return nil, nil
}
```

Tested using:

https://github.com/v3io/http_blaster



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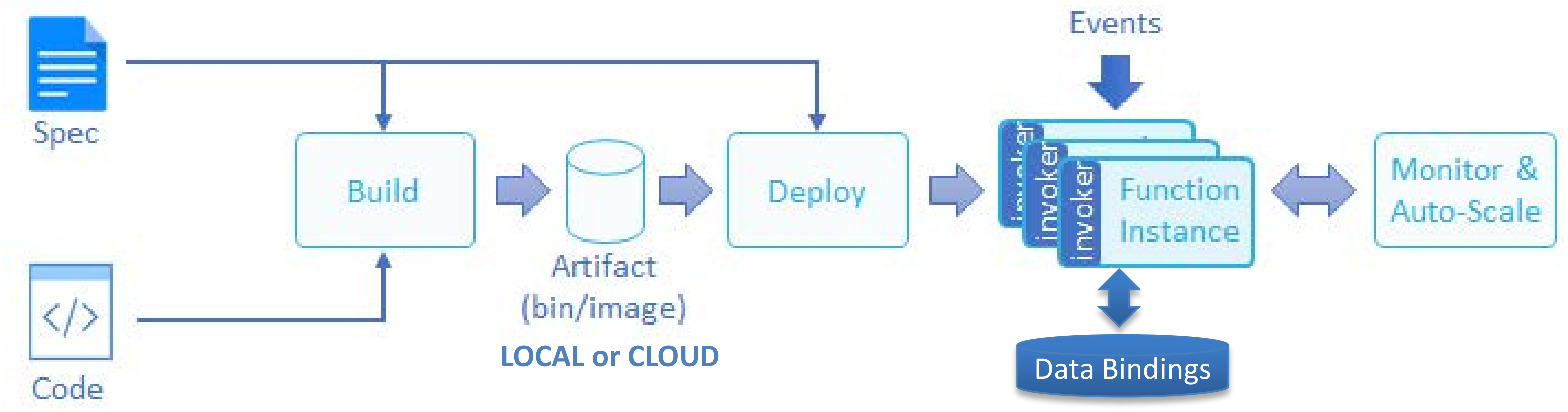
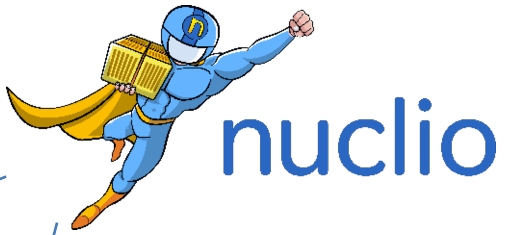
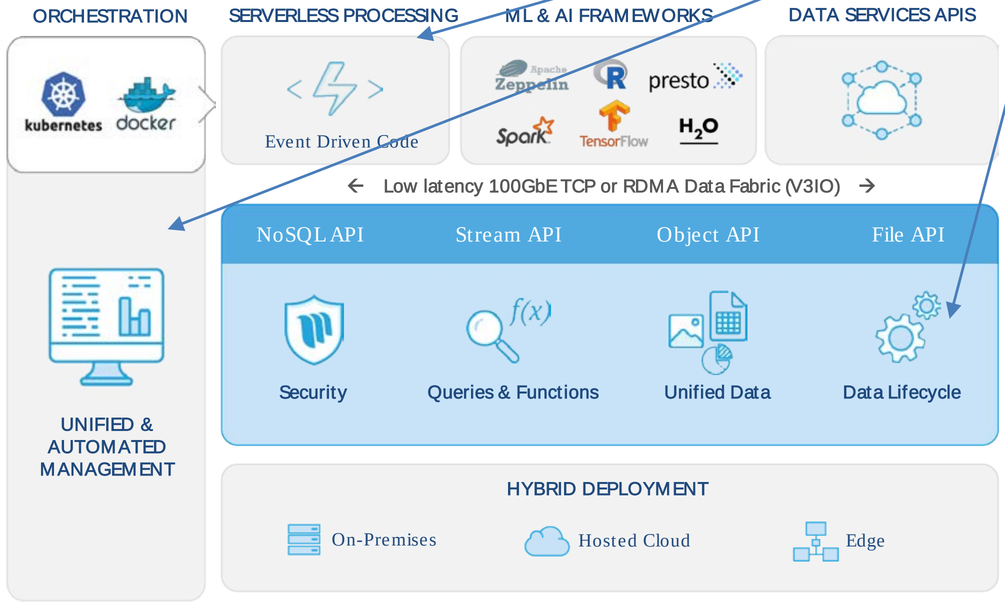
Enabling Simplest and Continuous Dev & Ops (CI/CD)



```
$ nuctl run <name> <source> [options]
```

One Click to test, deploy, upgrade or rollback code
Runs ANYWHERE, Self-healing and Auto-Scaling





- **Used in iguazio platform**
  - Developed for the real world
- **Now completely re-written to:**
  - Support the broader open source & CNCF eco-system
  - Incorporate learnings from G1
  - Future proof the architecture
  - Address new use cases