Microservices Status Report

Technical Remarks Edition

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ITk TDAQ Session
ATLAS ITk Week
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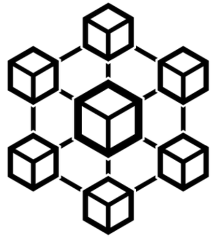
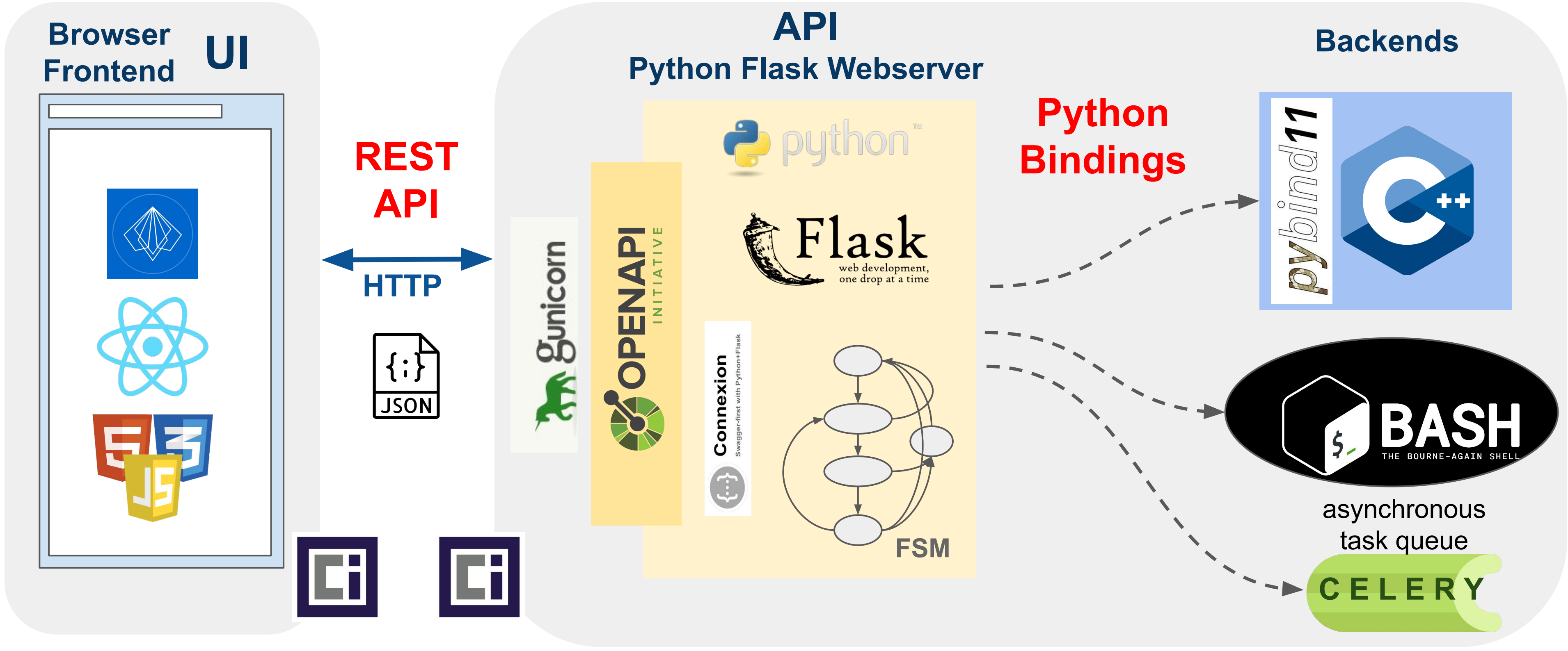
Reminder: What are the "microservices"?

- New top-level ITk **online software** UI framework designed from scratch.
- Partition system in small web servers that do
  "one thing and one thing well": microservices
- This effort situates itself *upstream* of **all** other sw development for Phase II
- Aim to provide top level online operation interface.
  - ***No*** time critical tasks (in the DAQ / TTC context).
  - ***No*** duplication of existing functionality.
- Learn from and improve on features of current ID online software.
- Part of ITk Pixel Systemtest LLS FDR.



https://microservices.io/

Architecture of a Microservice



Leveraging Microservices Similarity

- Same basic directory tree for every microservice.
- Enables lateral maintenance between microservices.
- Still decoupled to allow independent development / updating.
- Matrix (not yet used in software management) can be used to track status / progress.
- Ideally automate with script which can also format, lint, analyse semantics (security issues etc.).

- Developers still need to learn the API/UI stack once.

Microservices			template	dashboard	optoboard	felix	daqapi	configdb	resultviewer	GALE
Frontend		ui/								
		package.json								
	Development	tasks.sh								
	Containerization	Dockerfile								
		docker-compose								
	Deployment	...								
OpenAPI		openapi/								
		openapi.yml								
Python	project	pyproject.toml								
		itk_demo_{service}/								
	Flask	app.py								
	FSM	states.py								
	Celery	celery.py								
		tasks.py								
	Backend	backend.py								
	Development	tasks.sh								
	Containerization	Dockerfile								
		docker-compose								
	CI	gitlab-ci.yml								
	Deployment	...								

Containerization and GitLab CI/CD

- **Microservices have fully embraced containerization.**
- Goal: largely remove need for local software building / installation at system test sites.
- "Only" need to adjust local configuration "Infrastructure-as-Code".
- Configurations can live in private repos in `/deployments` GitLab subgroup.
- Need to develop **`Dockerfiles`**, **`docker-compose.yml`** and **`gitlab-ci.yml`**
- Ideal workflow still under development.
  - Using cascade of bash scripts.
  - Probably heavily use `docker compose`

- Take full advantage of CERN GitLab Premium DevOps.
- Automatic builds using CI (Continuous Integration).
- Use GitLab Runners to build images
  - CERN shared (w. cvmfs mounts).
  - dedicated servers for testing.

KB0005851

- Images stored directly in GitLab
- For third-party tools
  - Preference for official images.
  - Copy to CERN harbor registry.

registry.cern.ch

- CD (Continuous Deployment): Working on automated deployment of testing environment based on emulator.
- Local building + running possible during development:
  - **`tasks.sh`** script

Continuous Integration Details

- CI pipelines defined in `.gitlab-ci.yml` KB0003690
- Use kaniko builder image from CERN Linux Service https://gitlab.cern.ch/ci-tools/docker-builder
- On every push to Git repo :
  - build image
  - tag with commit hash SHA, push
  - tag also with :latest
- On every tag of Git repo:
  - build image
  - tag with Git tag
- Image naming convention:
  - `{repo registry URL}/{repo name}-{suffix}:{tag}`

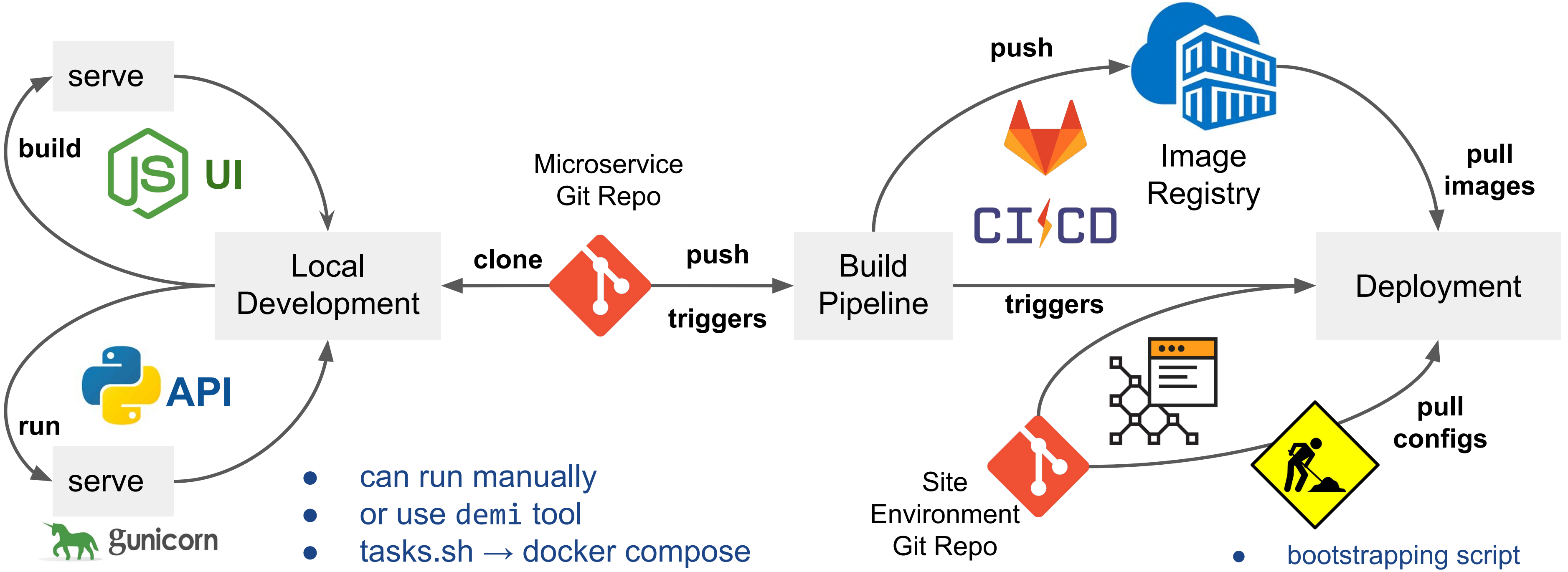
can be used as local short tag

Example:

`gitlab-registry.cern.ch/atlas-itk-pixel-systemtest/itk-demo-sw/itk-demo-configdb/itk-demo-configdb-ui:00ffe95e56adfe15de7a93c4d4dd712b53712386`

- Typically two images per microservice
  - `{repo name}-api` Flask server
  - `{repo name}-ui` Frontend
- Backends usually built in extra images eg. `containers/felix-container`

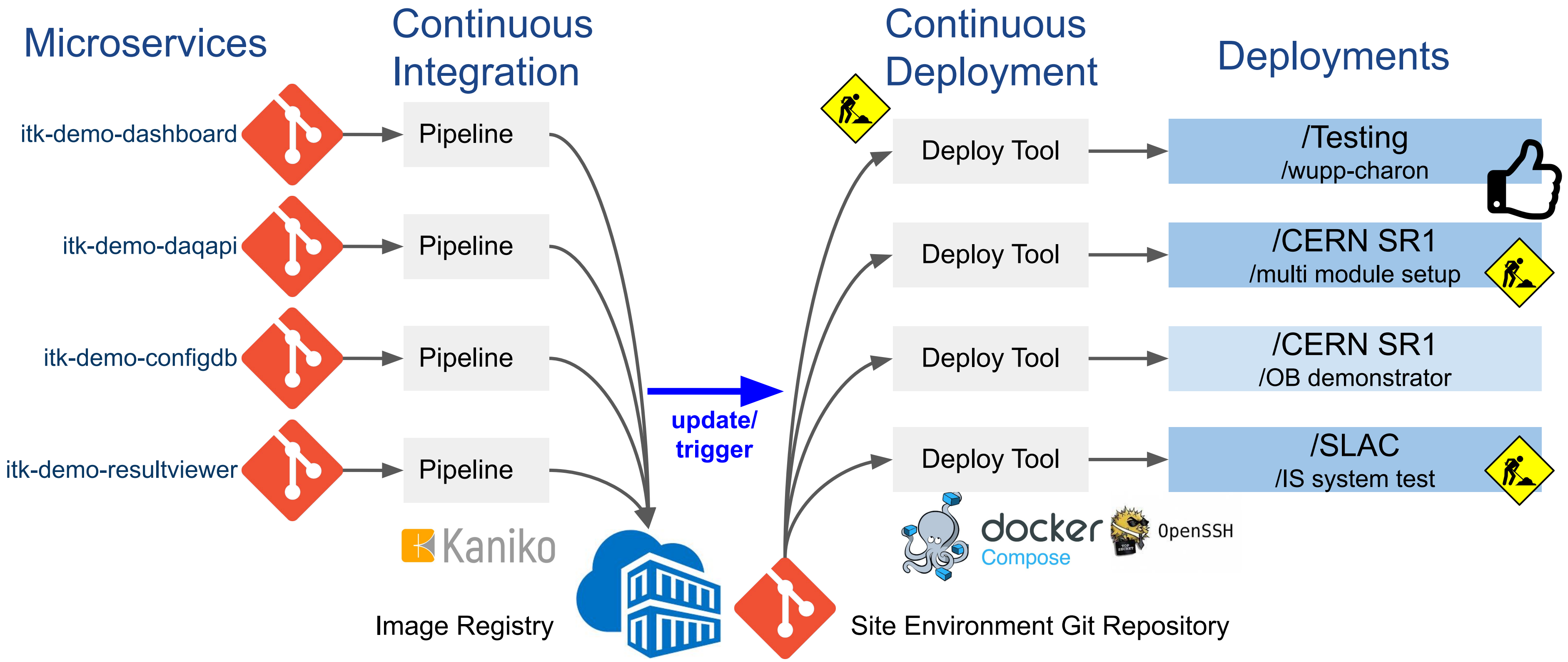
Microservices Development: DevOps + GitOps Workflow



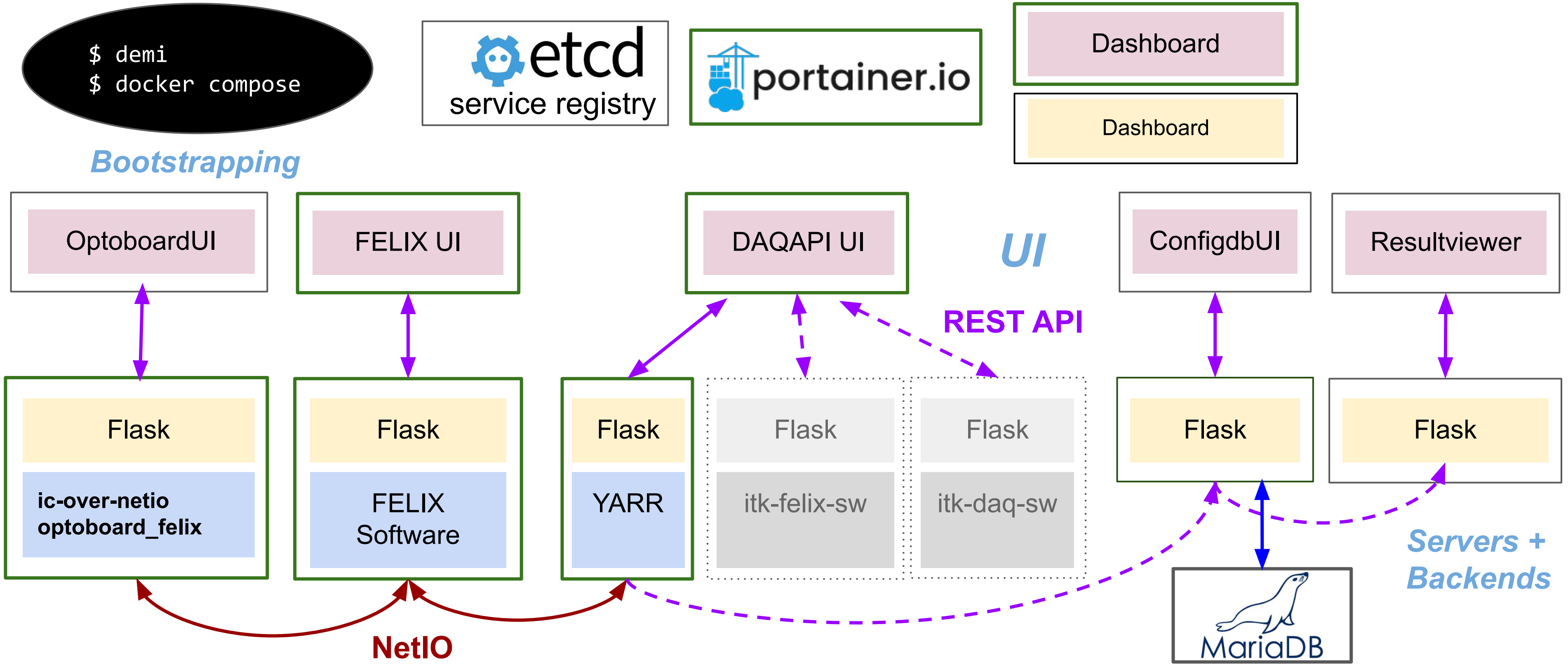
- can run manually
- or use `demi` tool
- tasks.sh → docker compose
- (option for dockerless deployment)

- bootstrapping script
- CD → docker compose
- I-a-C/GitOps tool?

Microservices + Site Deployment Workflow



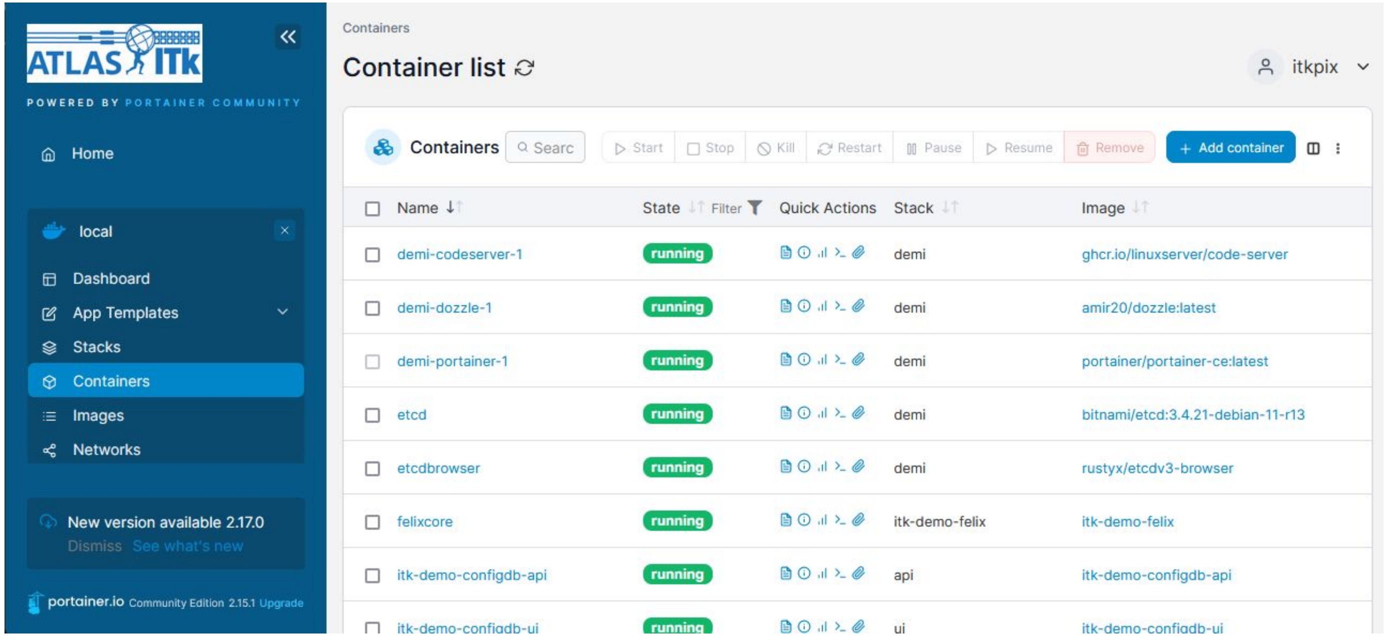
Overview over containerized SR1 deployment



Portainer - Container Management Platform

portainer.io

- Open Source third-party tool to manage Docker containers.
- Possible to start / stop / update / inspect and log in to containers.
- Comprehensive generic tool useful in addition to custom microservice UIs
- Stand-in for dedicated ITk UIs



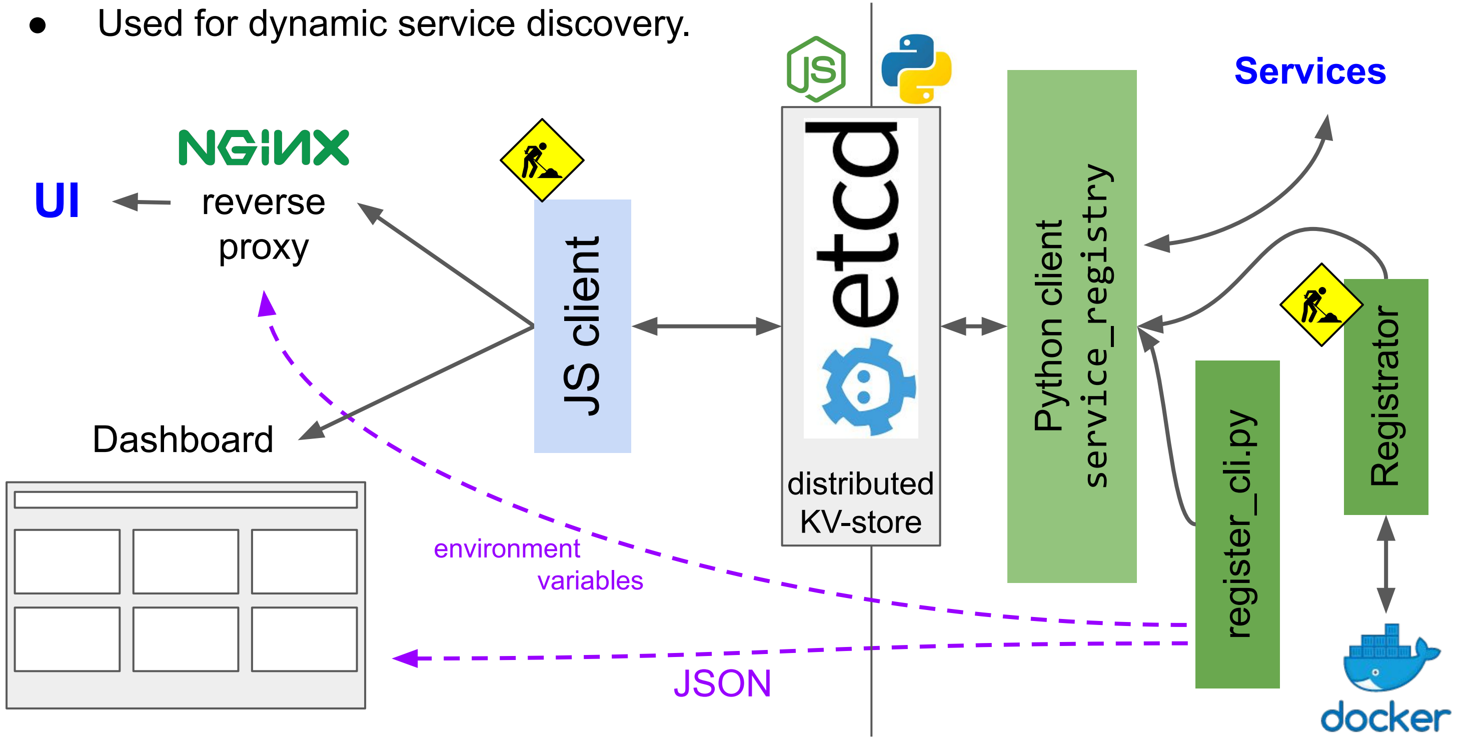
New version available 2.17.0
Dismiss See what's new

Name	State	Quick Actions	Stack	Image
demi-codeserver-1	running		demi	ghcr.io/linuxserver/code-server
demi-dozzle-1	running		demi	amir20/dozzle:latest
demi-portainer-1	running		demi	portainer/portainer-ce:latest
etcd	running		demi	bitnami/etcd:3.4.21-debian-11-r13
etcdbrowser	running		demi	rustyx/etcdv3-browser
felixcore	running		itk-demo-felix	itk-demo-felix
itk-demo-configdb-api	running		api	itk-demo-configdb-api
itk-demo-configdb-ui	running		ui	itk-demo-configdb-ui

Portainer running in SR1

Service Registry

- Single source of truth for all runtime configuration.
- Used for dynamic service discovery.



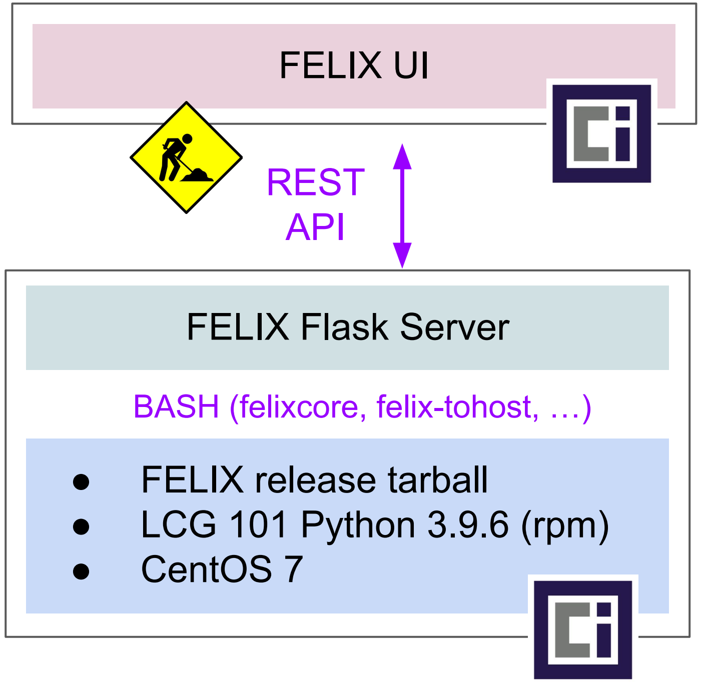
- Currently services registered at startup via CLI (scripted).
- **Registrator** will constantly inspect Docker and do health checks to keep registry up-to-date.
- Services query via Python client.
- Frontends query via JS client.

Status of FELIX Software Container

itk-demo-felix

- Based on special `felix-bin-container` using latest FELIX binary releases

  https://gitlab.cern.ch/atlas-itk-pixel-systemtest/itk-demo-sw/containers/felix-bin-container
- In discussion with FELIX group to move to FELIX
  https://gitlab.cern.ch/atlas-tdaq-felix/felix-image
- Shell tests successful (→ Portainer screenshots)
  - configured FELIX and elinks
- Under discussion how to manage felixcore / felix-star processes inside container
  - s6 init system https://skarnet.org/software/s6/
  - supervisord http://supervisord.org/
  - restart container from GUI?
- GUI needs overhaul to reflect functionality.

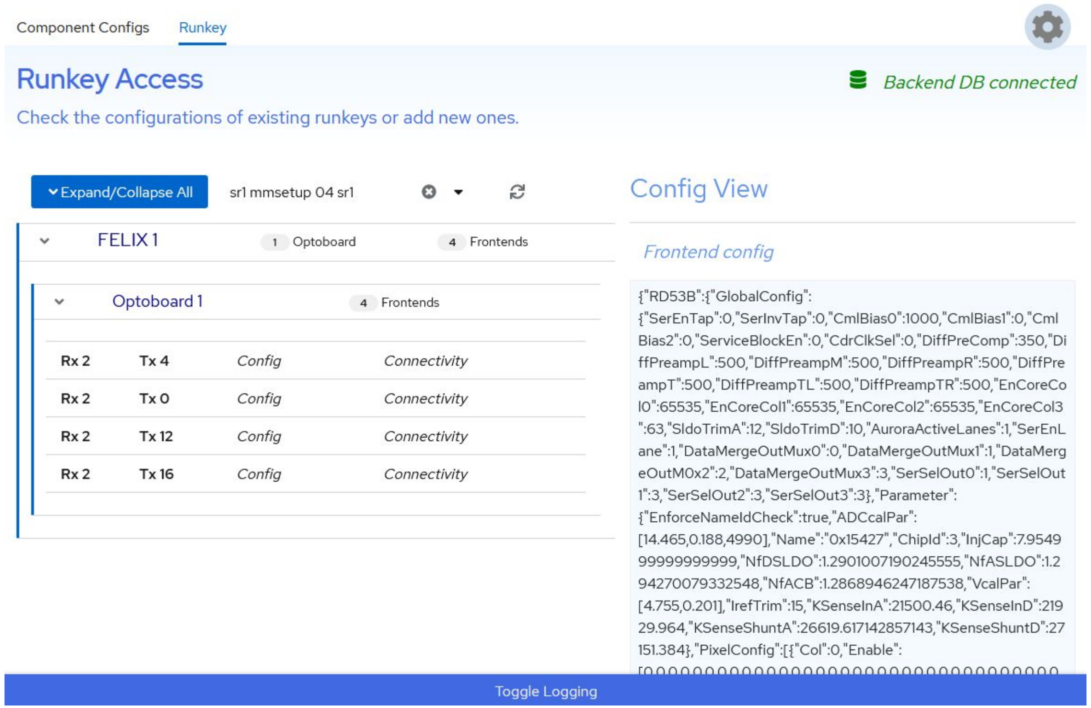


ConfigDb Microservice Status

itk-demo-configdb

- ConfigDb stores Runkeys (sets of configurations) and scan results.
- For FDR using a simple “matrix” data model with one data path for each FE to SWROD.
- Implemented Backends for FDR: SQLite and **MariaDb**
- Bootstrapping being finalized.

- ***Next version of ConfigDb with a more flexible configuration and connectivity data model currently under development →***



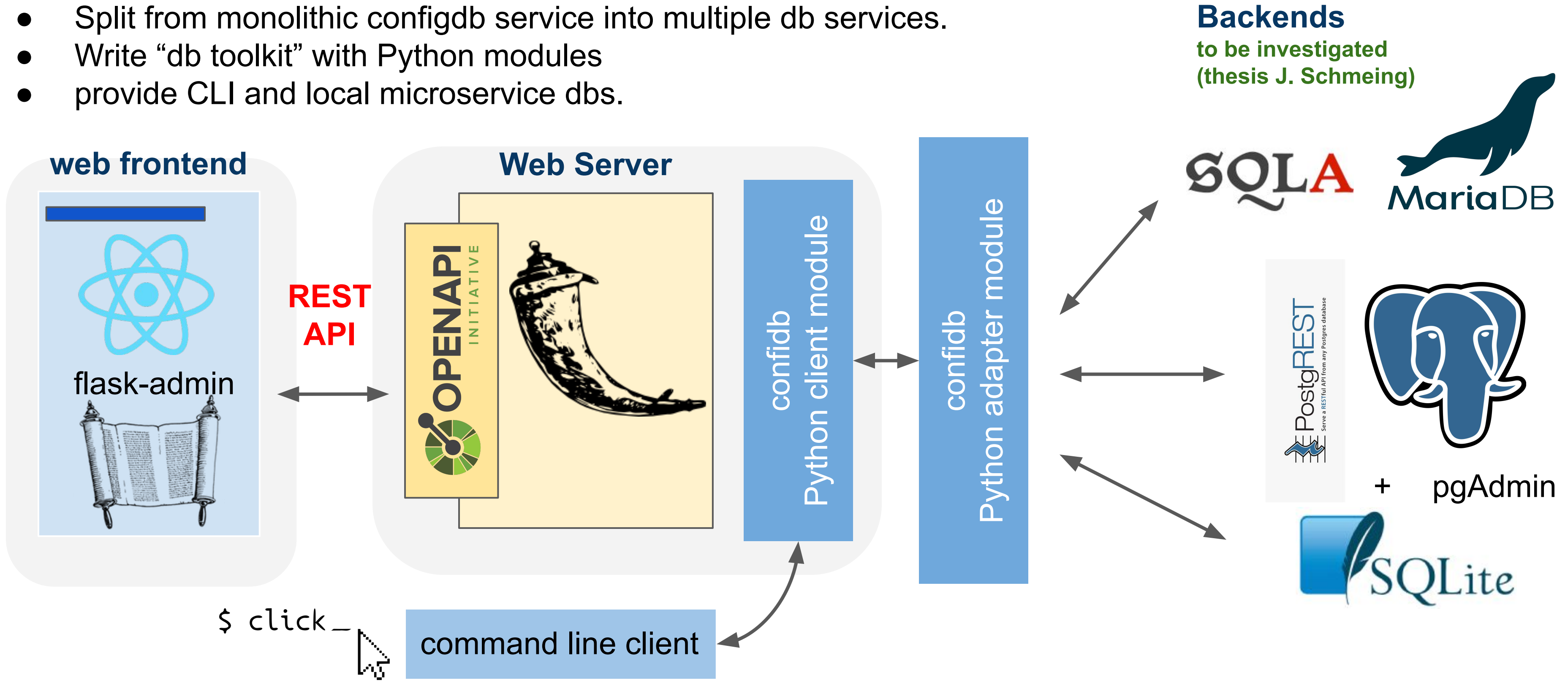
Rx 2	Tx 4	Config	Connectivity
Rx 2	Tx 0	Config	Connectivity
Rx 2	Tx 12	Config	Connectivity
Rx 2	Tx 16	Config	Connectivity

{"RD53B":{"GlobalConfig":{"SerEnTap":0,"SerInvTap":0,"CmlBias0":1000,"CmlBias1":0,"CmlBias2":0,"ServiceBlockEn":0,"CdrClkSel":0,"DiffPreComp":350,"DiffPreampL":500,"DiffPreampM":500,"DiffPreampR":500,"DiffPreampT":500,"DiffPreampTL":500,"DiffPreampTR":500,"EnCoreCol0":65535,"EnCoreCol1":65535,"EnCoreCol2":65535,"EnCoreCol3":63,"SldoTrimA":12,"SldoTrimD":10,"AuroraActiveLanes":1,"SerEnLane":1,"DataMergeOutMux0":0,"DataMergeOutMux1":1,"DataMergeOutM0x2":2,"DataMergeOutMux3":3,"SerSelOut0":1,"SerSelOut1":3,"SerSelOut2":3,"SerSelOut3":3},"Parameter":{"EnforceNameIdCheck":true,"ADCcalPar":[14.465,0.188,4990],"Name":"0x15427","ChipId":3,"InjCap":7.954999999999999,"NfDSLDO":1.2901007190245555,"NfASLDO":1.294270079332548,"NfACB":1.2868946247187538,"VcalPar":[4.755,0.201],"IrefTrim":15,"KSenseInA":21500.46,"KSenseInD":21929.964,"KSenseShuntA":26619.617142857143,"KSenseShuntD":27151.384},"PixelConfig":[{"Col":0,"Enable":[0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0

Runkey Access tab in ConfigDb UI.

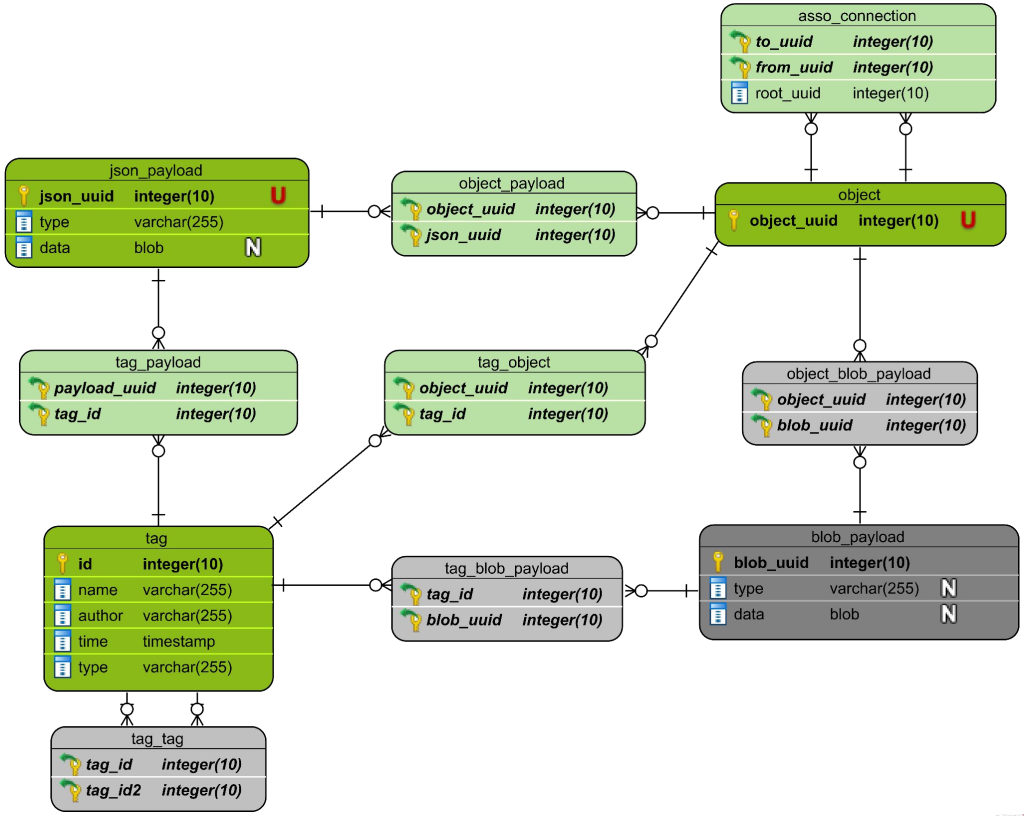
ConfigDb Under Development

- Split from monolithic configdb service into multiple db services.
- Write “db toolkit” with Python modules
- provide CLI and local microservice dbs.

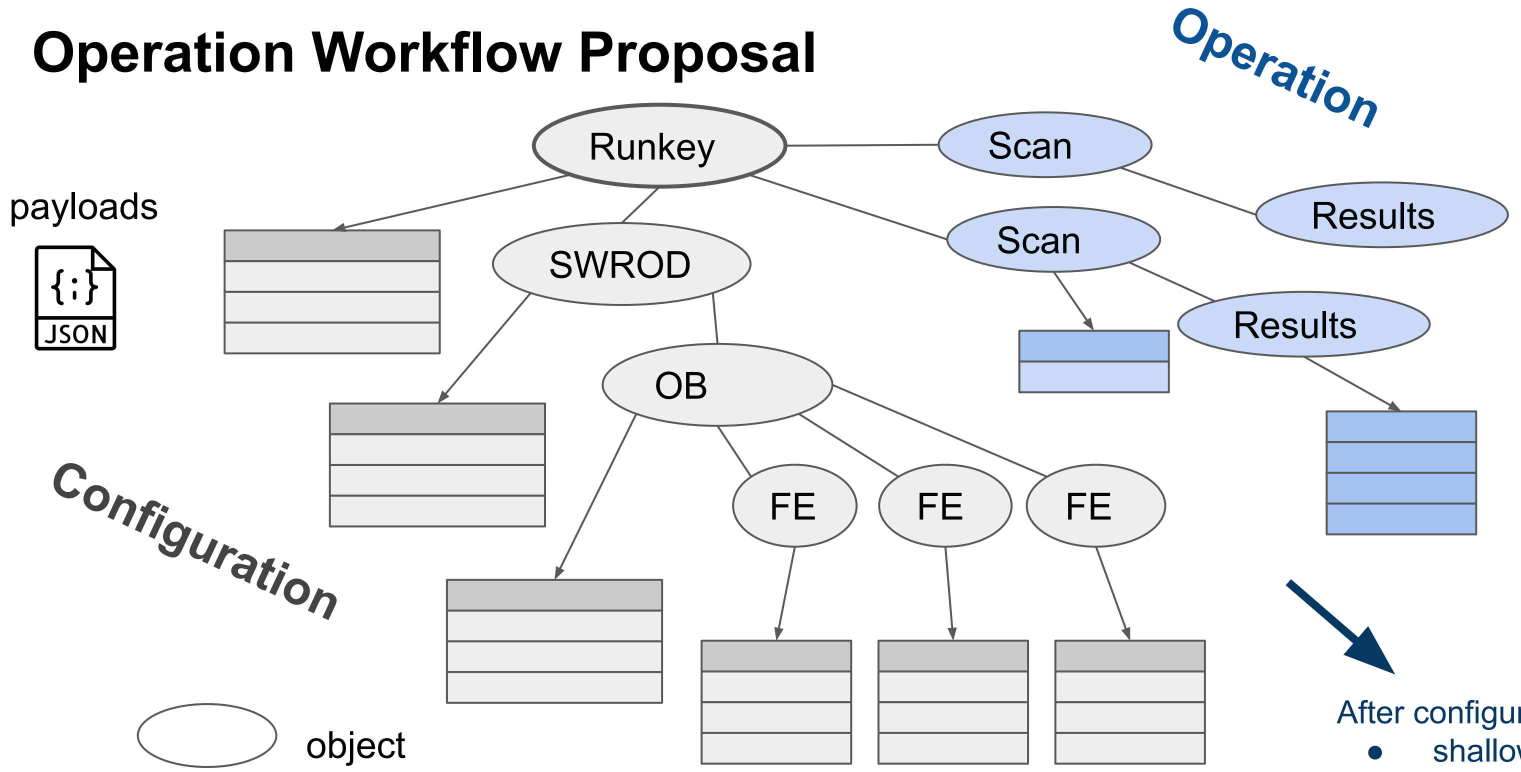


Current Schema Proposal

- Decouple functional blocks using UUIDs as primary keys.
  → Possibility to separate into multiple databases or point at external databases (LocalDb, itkdb).
- Generic objects.
- JSON payloads.
  - Encode binary blobs in base64.
- Tag system to flexibly label everything.
- Connectivity becomes simply standard association table between objects.
- Runkey is root object of traversable tree(s).
- Design started from current ID Pixel CoralDb schema.



Operation Workflow Proposal



tags can point at objects for labelling, grouping and to point at reference objects

▨ immutable info (eg. module id, metadata, parents)

☐ mutable info (eg. FE config, results)

After configuration changing scan:

- shallow-copy to obtain next runkey
- copy-on-write when generating/ editing next runkey

Summary

- The Microservices project has spent a lot of effort on containerization and implementing CI/CD.
  - Effort is starting to pay off - don’t need build images locally anymore.
- Integration efforts progressing but several dots still need to be connected.
  - Feasibility of running FELIX and DAQ Software in containers demonstrated.
- Development has started on the next version of a flexible database for ITk connectivity, configuration and result storage.
- Automated Bootstrapping / easy deployment at testing sites still major construction site.
  - Have temporary solution based on cascade of BASH scripts.
  - Need to develop a light-weight container orchestration solution adapted to our specific use case.

Ressources

Meeting	Bi-Weekly Wednesday 1700 CEST.
Egroup	**atlas-itk-demo-sw-devel**
Mattermost	https://mattermost.web.cern.ch/itkpixel ○ /itk-demo-sw-users ○ /itk-demo-sw-devel
GitLab	https://gitlab.cern.ch/atlas-itk-pixel-systemtest/itk-demo-sw ○ also hosts Wiki ○ PyPi and npm package registries. ○ OCI image registry
JIRA	https://its.cern.ch/jira/projects/ITKDEMOSW

https://gitlab.cern.ch/groups/atlas-itk-pixel-systemtest/itk-demo-sw/-/wikis/resources

NASA Open-Source Science Initiative
TOPS
Open Source Used by NASA (A Small Sampling!)
SQLAlchemy
NumPy
scikit-image
image processing in python
blender
git
OSGeo Project
RAILS
QGIS
NGINX
Ubuntu
node JS
SUBVERSION
Flask
scikit learn
BASH
THE BOURNE-AGAIN SHELL
APACHE
RabbitMQ

NASA at FOSDEM 2023 - similar selection of Open Source tools

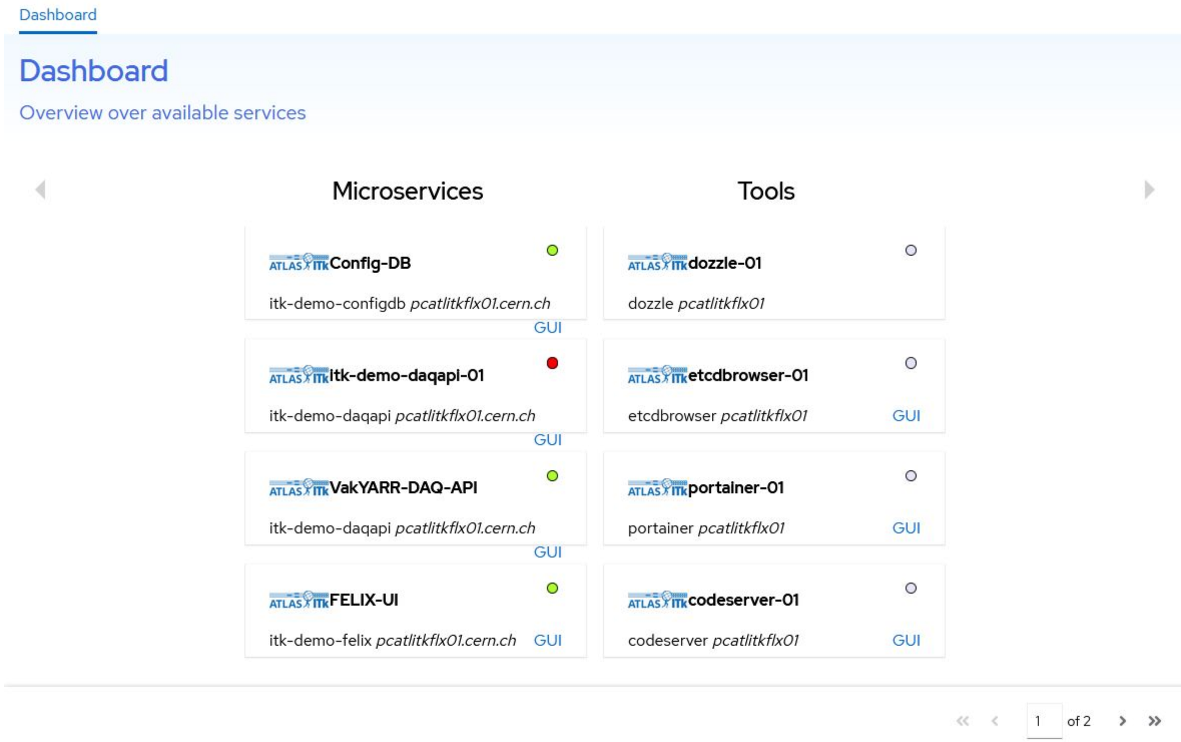
B A C K U P

Dashboard Microservice

itk-demo-dashboard

- Top-level page for system test operation.
- Populated from services in service-registry.
  - Microservices and third-party tools.
  - Currently fed by JSON file → Implement service-registry JS client
- Summary information cards.
  - Health indicator.
- Links to UI(s).
  - Individual microservice UIs will offer more fine-grained control.
- For expert / admin operations and debugging tools like Portainer, Flower, PhpMyAdmin … are linked.

- Layout being overhauled to be more comprehensive


Dashboard

Dashboard

Overview over available services

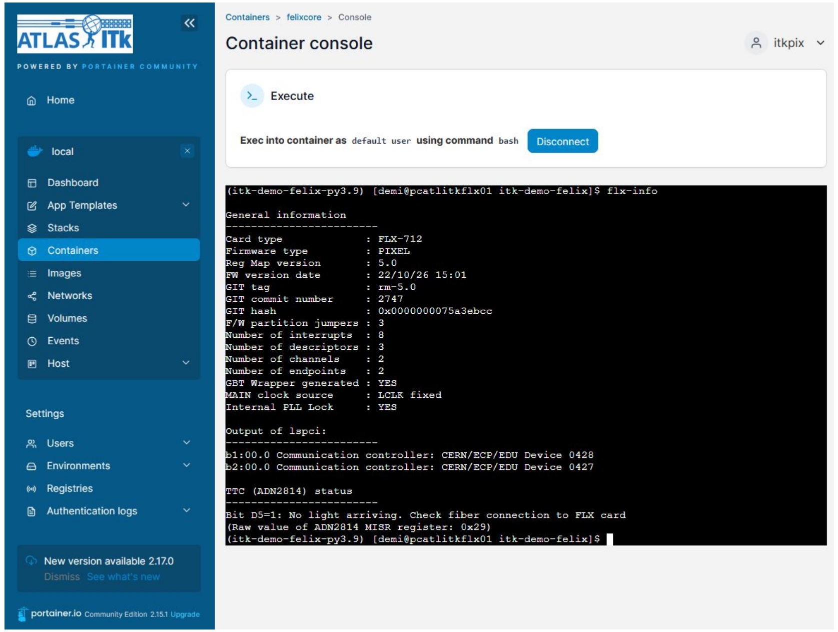
Microservices	Tools
Config-DB ● — itk-demo-configdb *pcatlitkflx01.cern.ch* GUI	dozzle-01 ○ — dozzle *pcatlitkflx01*
Itk-demo-daqapi-01 ● — itk-demo-daqapi *pcatlitkflx01.cern.ch* GUI	etcdbrowser-01 ○ — etcdbrowser *pcatlitkflx01* GUI
VakYARR-DAQ-API ● — itk-demo-daqapi *pcatlitkflx01.cern.ch* GUI	portainer-01 ○ — portainer *pcatlitkflx01* GUI
FELIX-UI ● — itk-demo-felix *pcatlitkflx01.cern.ch* GUI	codeserver-01 ○ — codeserver *pcatlitkflx01* GUI

1 of 2

Example of Dashboard running in SR1.

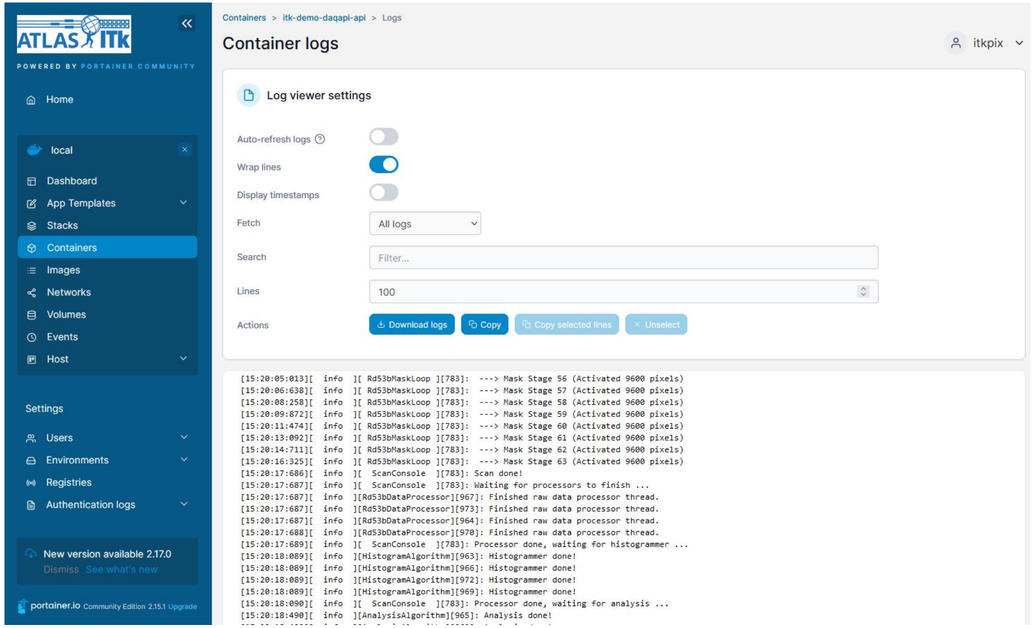
Portainer - More Operation Examples

portainer.io



Exec into container as `default user` using command `bash`

```
(itk-demo-felix-py3.9) [demi@pcatlitkflx01 itk-demo-felix]$ flx-info

General information
------------------------
Card type              : FLX-712
Firmware type          : PIXEL
Reg Map version        : 5.0
FW version date        : 22/10/26 15:01
GIT tag                : rm-5.0
GIT commit number      : 2747
GIT hash               : 0x0000000075a3ebcc
F/W partition jumpers : 3
Number of interrupts  : 8
Number of descriptors : 3
Number of channels    : 2
Number of endpoints   : 2
GBT Wrapper generated : YES
MAIN clock source     : LCLK fixed
Internal PLL Lock     : YES

Output of lspci:
------------------------
b1:00.0 Communication controller: CERN/ECP/EDU Device 0428
b2:00.0 Communication controller: CERN/ECP/EDU Device 0427

TTC (ADN2814) status
------------------------
Bit D5=1: No light arriving. Check fiber connection to FLX card
(Raw value of ADN2814 MISR register: 0x29)
(itk-demo-felix-py3.9) [demi@pcatlitkflx01 itk-demo-felix]$
```



Auto-refresh logs: off
Wrap lines: on
Display timestamps: off
Fetch: All logs
Search: Filter...
Lines: 100

```
[15:20:05:013][  info  ][ Rd53bMaskLoop ][783]:  ---> Mask Stage 56 (Activated 9600 pixels)
[15:20:06:638][  info  ][ Rd53bMaskLoop ][783]:  ---> Mask Stage 57 (Activated 9600 pixels)
[15:20:08:258][  info  ][ Rd53bMaskLoop ][783]:  ---> Mask Stage 58 (Activated 9600 pixels)
[15:20:09:872][  info  ][ Rd53bMaskLoop ][783]:  ---> Mask Stage 59 (Activated 9600 pixels)
[15:20:11:474][  info  ][ Rd53bMaskLoop ][783]:  ---> Mask Stage 60 (Activated 9600 pixels)
[15:20:13:092][  info  ][ Rd53bMaskLoop ][783]:  ---> Mask Stage 61 (Activated 9600 pixels)
[15:20:14:711][  info  ][ Rd53bMaskLoop ][783]:  ---> Mask Stage 62 (Activated 9600 pixels)
[15:20:16:325][  info  ][ Rd53bMaskLoop ][783]:  ---> Mask Stage 63 (Activated 9600 pixels)
[15:20:17:686][  info  ][  ScanConsole  ][783]: Scan done!
[15:20:17:687][  info  ][  ScanConsole  ][783]: Waiting for processors to finish ...
[15:20:17:687][  info  ][Rd53bDataProcessor][967]: Finished raw data processor thread.
[15:20:17:687][  info  ][Rd53bDataProcessor][973]: Finished raw data processor thread.
[15:20:17:687][  info  ][Rd53bDataProcessor][964]: Finished raw data processor thread.
[15:20:17:688][  info  ][Rd53bDataProcessor][970]: Finished raw data processor thread.
[15:20:17:689][  info  ][  ScanConsole  ][783]: Processor done, waiting for histogrammer ...
[15:20:18:089][  info  ][HistogramAlgorithm][963]: Histogrammer done!
[15:20:18:089][  info  ][HistogramAlgorithm][966]: Histogrammer done!
[15:20:18:089][  info  ][HistogramAlgorithm][972]: Histogrammer done!
[15:20:18:089][  info  ][HistogramAlgorithm][969]: Histogrammer done!
[15:20:18:090][  info  ][  ScanConsole  ][783]: Processor done, waiting for analysis ...
[15:20:18:490][  info  ][AnalysisAlgorithm][965]: Analysis done!
```

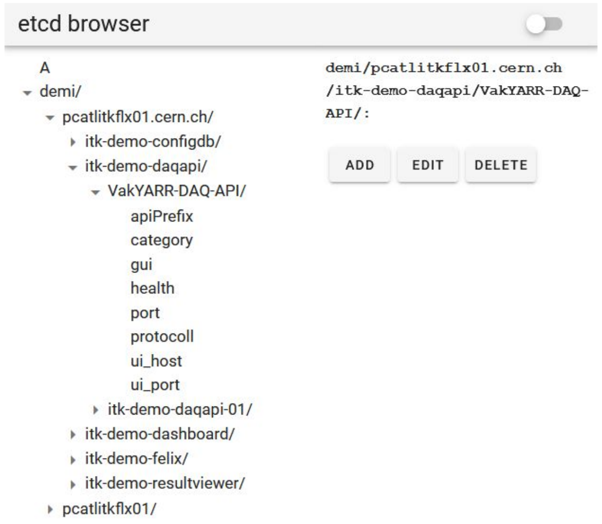
Example of operating felixcore (flx-info) in container via web terminal.

Example of VakYARR scan log output inspection. Digital Scan on ITkPixV1 mm setup (no merging).

Other Third-Party Tools Examples

demi container tools up

- Want to provide complete operations and development environment in the browser
- No more VNC

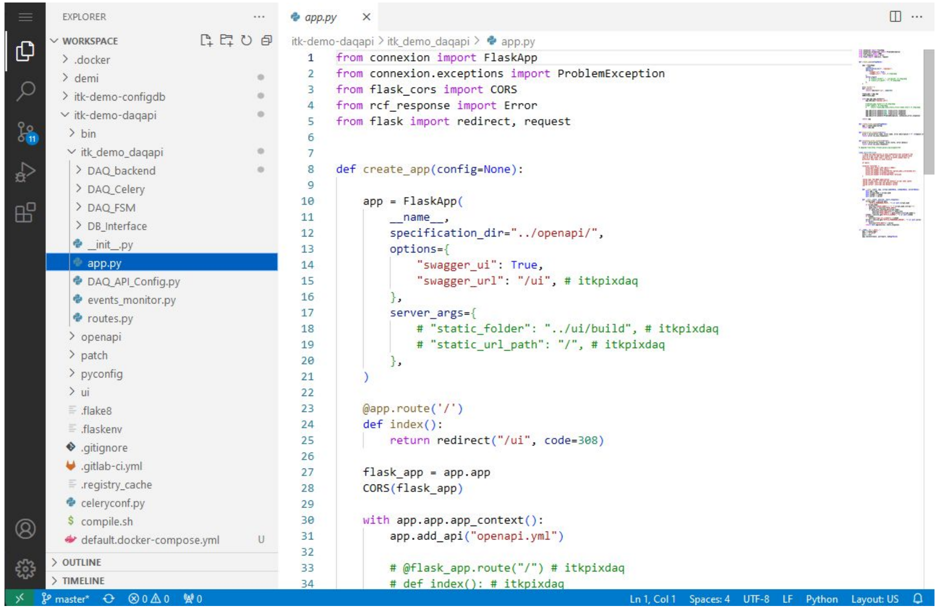


etcd browser

```
A
▾ demi/
    ▾ pcatlitkflx01.cern.ch/
        ▸ itk-demo-configdb/
        ▾ itk-demo-daqapi/
            ▾ VakYARR-DAQ-API/
                apiPrefix
                category
                gui
                health
                port
                protocoll
                ui_host
                ui_port
            ▸ itk-demo-daqapi-01/
        ▸ itk-demo-dashboard/
        ▸ itk-demo-felix/
        ▸ itk-demo-resultviewer/
    ▸ pcatlitkflx01/
```

demi/pcatlitkflx01.cern.ch/itk-demo-daqapi/VakYARR-DAQ-API/:

etcd (service-registry) Browser

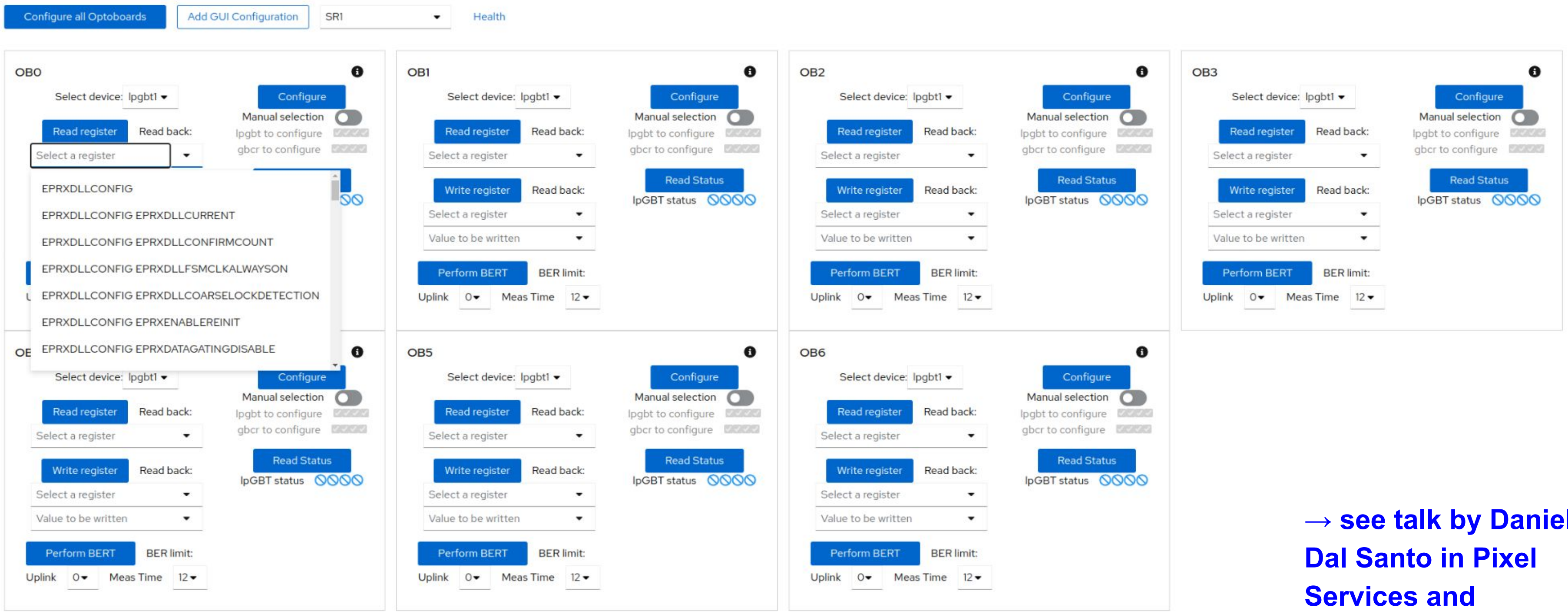


```python
from connexion import FlaskApp
from connexion.exceptions import ProblemException
from flask_cors import CORS
from rcf_response import Error
from flask import redirect, request


def create_app(config=None):

    app = FlaskApp(
        __name__,
        specification_dir="../openapi/",
        options={
            "swagger_ui": True,
            "swagger_url": "/ui", # itkpixdaq
        },
        server_args={
            # "static_folder": "../ui/build", # itkpixdaq
            # "static_url_path": "/", # itkpixdaq
        },
    )

    @app.route('/')
    def index():
        return redirect("/ui", code=308)

    flask_app = app.app
    CORS(flask_app)

    with app.app.app_context():
        app.add_api("openapi.yml")

        # @flask_app.route("/") # itkpixdaq
        # def index(): # itkpixdaq
```

Codeserver (VSCode) DeMi workspace text editor

Optoboard Microservice UI Status

itk-demo-optoboard



→ see talk by Daniele Dal Santo in Pixel Services and Electronics

Optoboard Microservice Status in SR1

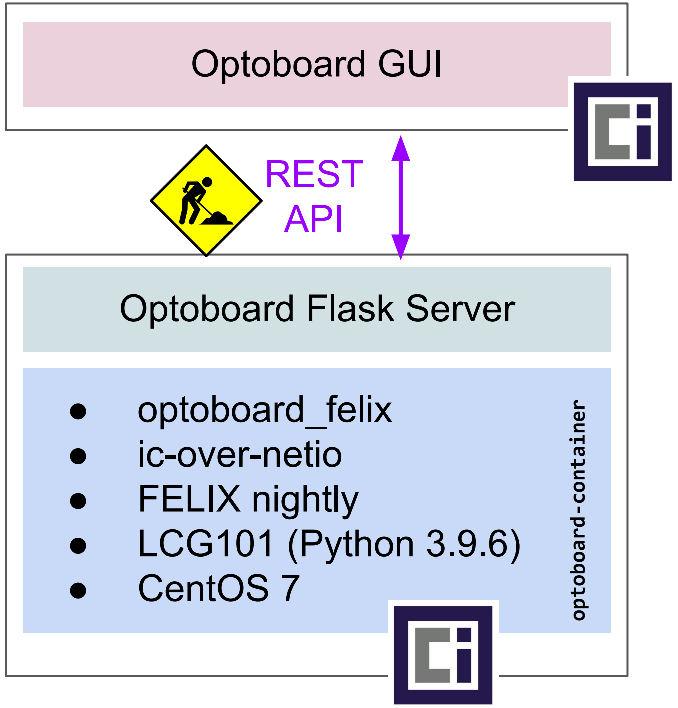
itk-demo-optoboard

- Built on special image `optoboard-container` with all necessary software installed.

  https://gitlab.cern.ch/atlas-itk-pixel-systemtest/itk-demo-sw/containers/optoboard-container

- Tests in SR1
  - Configuration files copied to container
  - Talks ok to felixcore over netio
  - Can read OB status ok
  - *OB Configuration currently unstable, crashes*
  - Plan to try with felix-star and local HEAD of `optoboard_felix`
- Need to try UI with API
- Need to store configurations in configdb

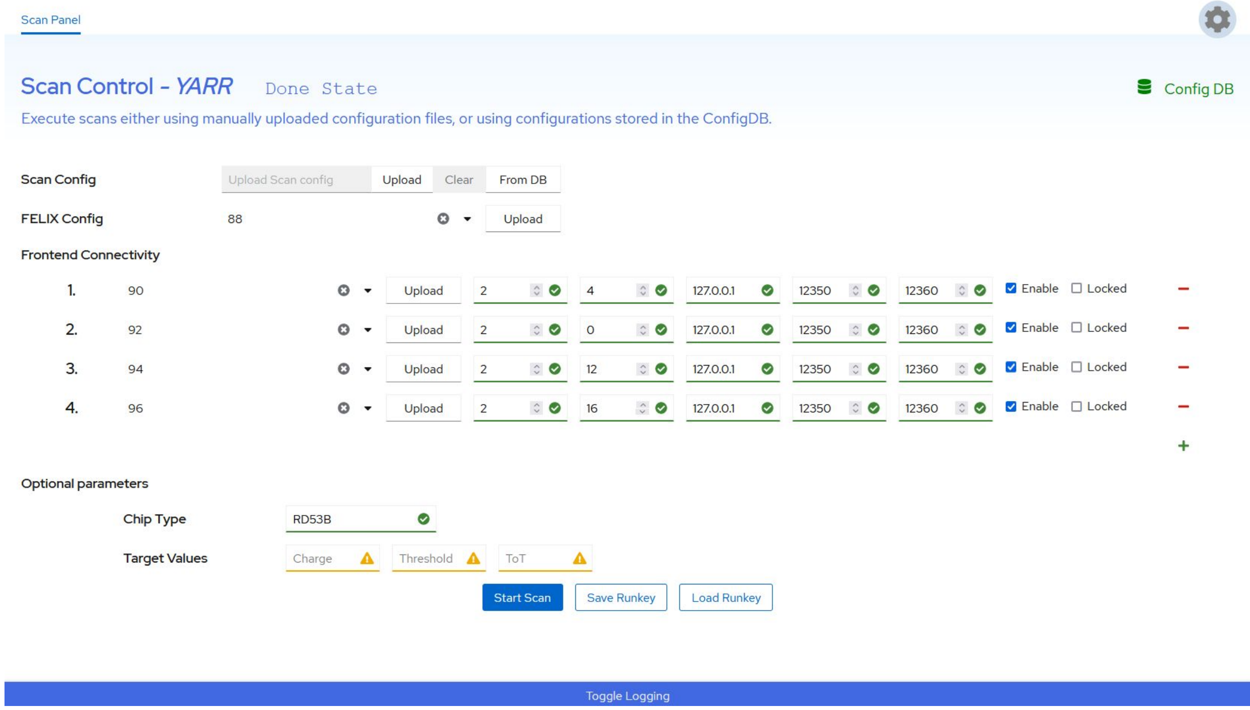
→ **see talk by Daniele Dal Santo in Pixel Services and Electronics**



itk-demo-daqapi

DAQAPI Microservice UI

- Single UI to control different DAQ software flavors currently in existence.
- Backend consists of python bindings (eg. pyYARR) with common adapter.
- Runkeys (complete sets of configuration data) can be
  - Edited by hand using local files.
  - Used with the ConfigDB.



Scan Panel

Scan Control - *YARR*   Done State   Config DB

Execute scans either using manually uploaded configuration files, or using configurations stored in the ConfigDB.

Scan Config: Upload Scan config | Upload | Clear | From DB

FELIX Config: 88 | Upload

Frontend Connectivity

1.	90	Upload	2	4	127.0.0.1	12350	12360	✓ Enable ☐ Locked
2.	92	Upload	2	0	127.0.0.1	12350	12360	✓ Enable ☐ Locked
3.	94	Upload	2	12	127.0.0.1	12350	12360	✓ Enable ☐ Locked
4.	96	Upload	2	16	127.0.0.1	12350	12360	✓ Enable ☐ Locked

Optional parameters

Chip Type: RD53B

Target Values: Charge | Threshold | ToT

DAQAPI with "VakYARR" backend running in SR1

itk-demo-daqapi

Status of DAQAPI Microservice Container

- Works well with YARR emulator.
  - useful for local and automated testing.
- Real Scan works from shell
  - not yet ran from UI.

Backends to be added:

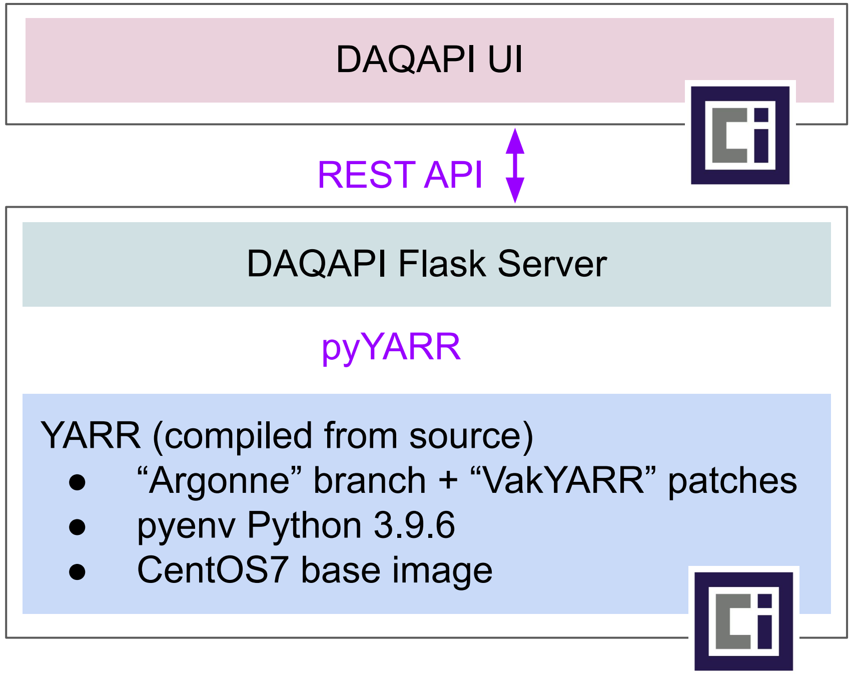
- itk-felix-sw
  - Implementation similar to optoboard container.
- itk-daq-sw

  → see talk by Vakhtang in ITk TDAQ Session
- RCE

  → see talk by SLAC

Other Plans:

- Option to read connectivity from JSON file.
- Factor out runkey editor in dedicated microservice.



Result Viewer Microservice Status

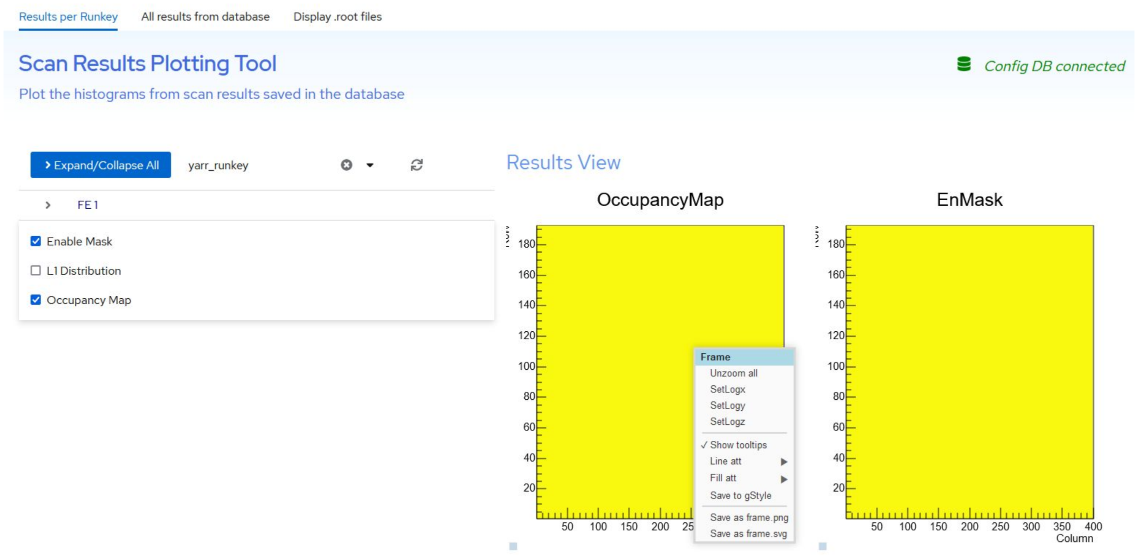
itk-demo-resultviewer

- Allows inspection of scan results (histograms in JSON format).
- Currently based on JSRoot

JSROOT 7.3.0

- Other plotting backends possible.
- Plots generated client-side and fully interactive.
- Results can be read from ConfigDb or uploaded as ROOT file.

- API based on slim Python container (no backend bindings).


Results per Runkey | All results from database | Display .root files

Scan Results Plotting Tool

Plot the histograms from scan results saved in the database

Config DB connected

Expand/Collapse All   yarr_runkey

FE 1

- [x] Enable Mask
- [ ] L1 Distribution
- [x] Occupancy Map

Results View

Resultviewer microservice showing emulated "digital scan" results.