Carpenter (Gen. 2): SM18's test follow-up tool

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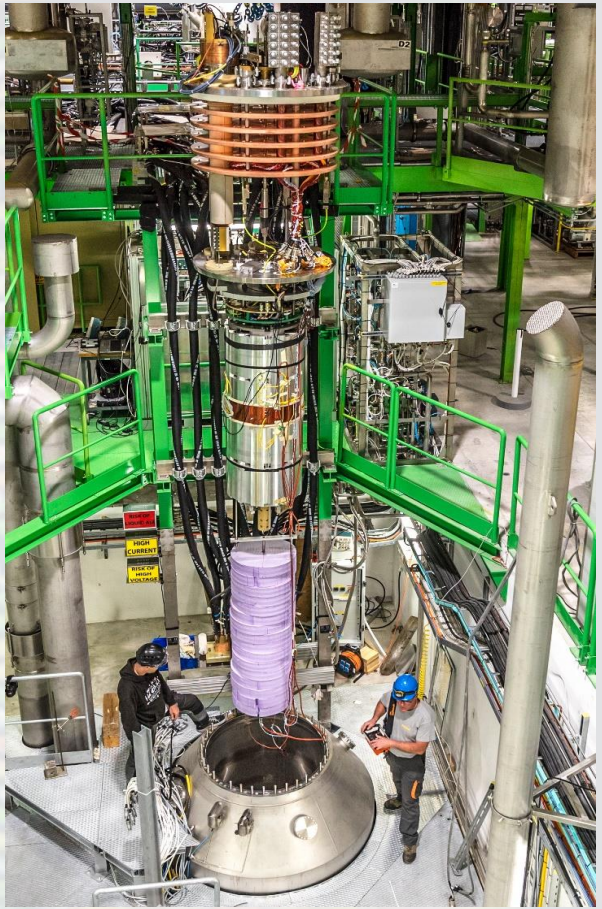
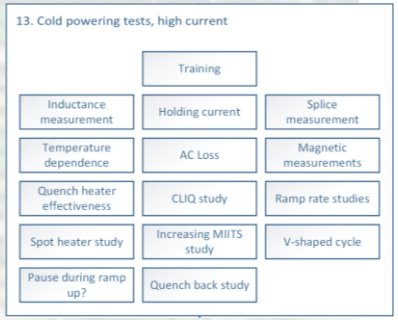
Magnet is a complex device

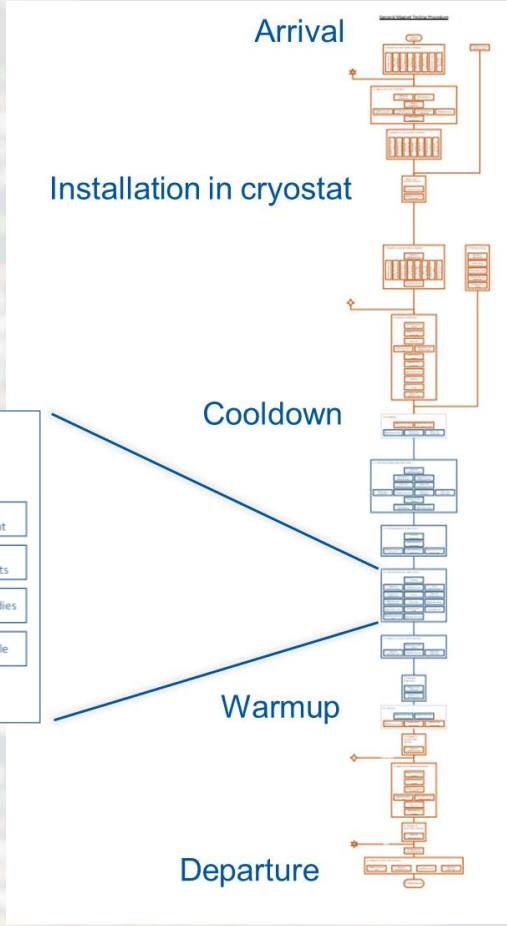
- Test facility needs input from other sections
  - Superconductor limits
  - Max allowed HV for insulation test
  - Magnet inductance
  - Details about powering (nominal current and ramp rate…)
  - Max hotspot temperature, quench integral
  - Magnet instrumentation
  - …
- Many people interested in test progress and results



Testing is a complex process

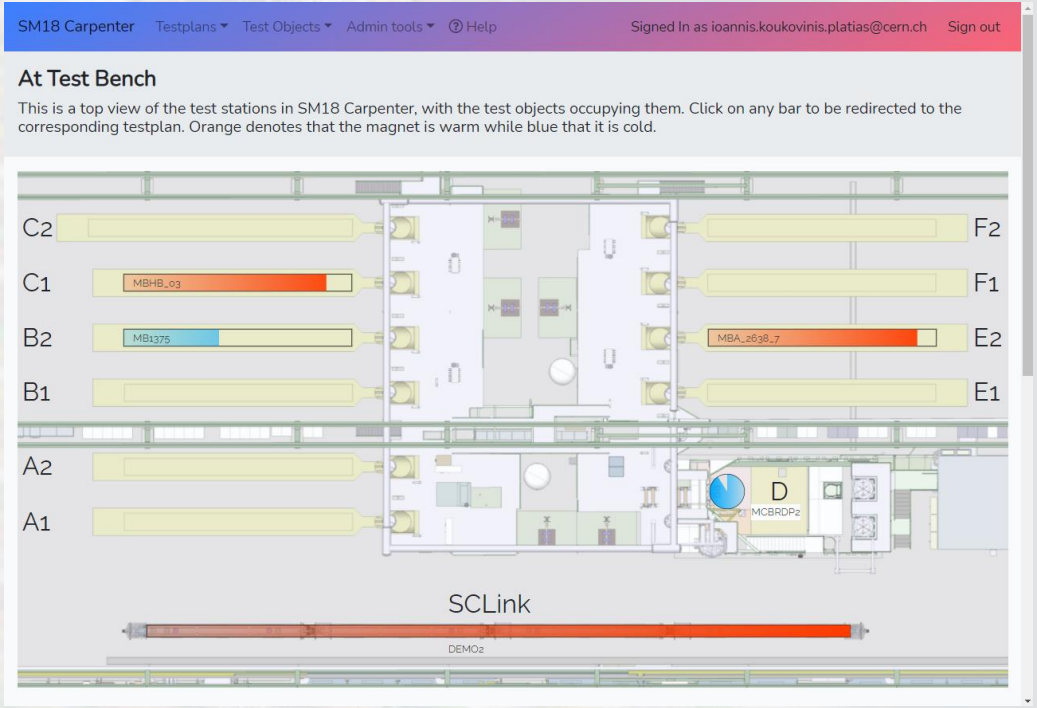
- Between ~50-150 different activities to be done depending on item type
- Keep track of:
  - Magnet basic information
  - Testing setup
  - Test plan procedure
  - Activities done, not finished, problems, comments…
- Store measurements data
- Reports, tables, summaries





Carpenter solution

- **Quality Assurance / Quality Control:**
  - Test progress tracking (who/when/what, results & events)
  - Efficient communication between ourselves and with other groups
  - Allow authorized users to see what we are doing
- **Data processing and storage:**
  - Store data from selected activities (e.g. quench, HV test)
  - Easy statistics and data filtering/mining
  - Reporting options



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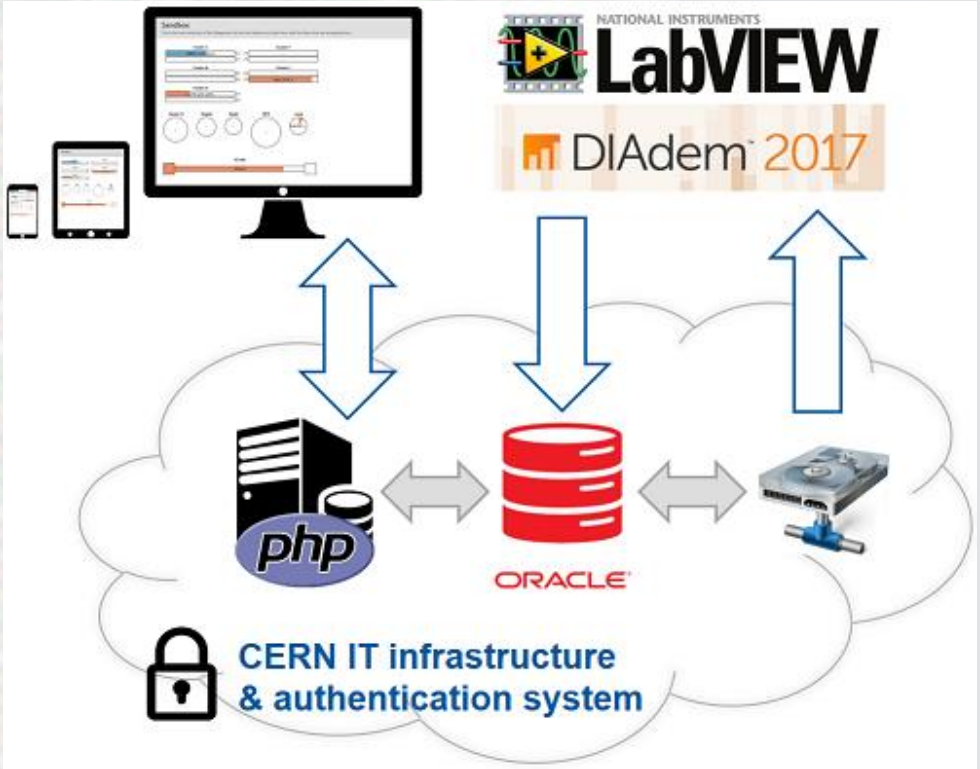
Introduction

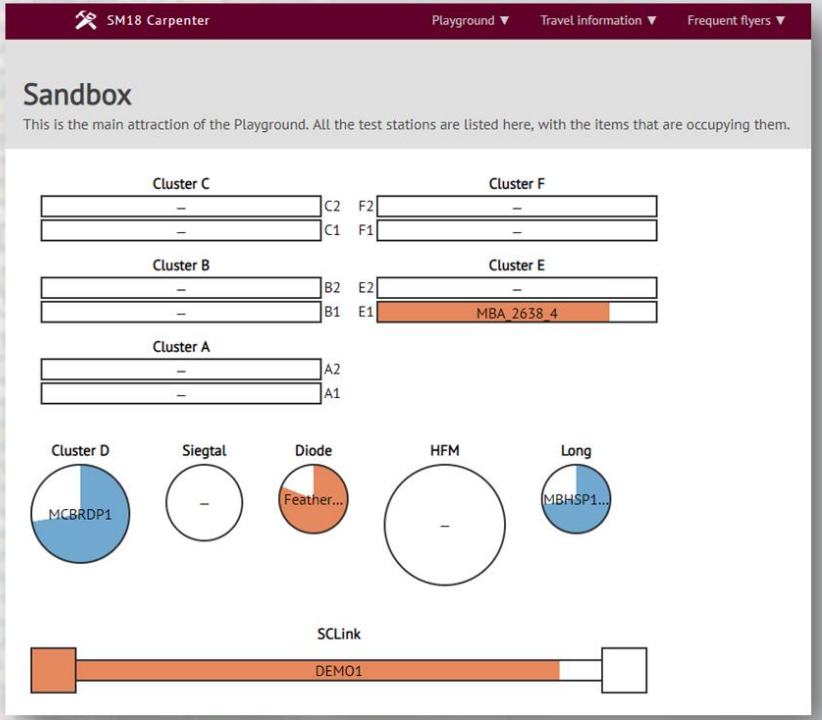
Carpenter ecosystem

- Main two parts of **Carpenter ecosystem**:
  - **Carvings DB**: Oracle Database
  - **Carpenter**: web interface to interact with Carvings DB
- Other DB access points: *OAQ, Wooden Bridge, Status board*



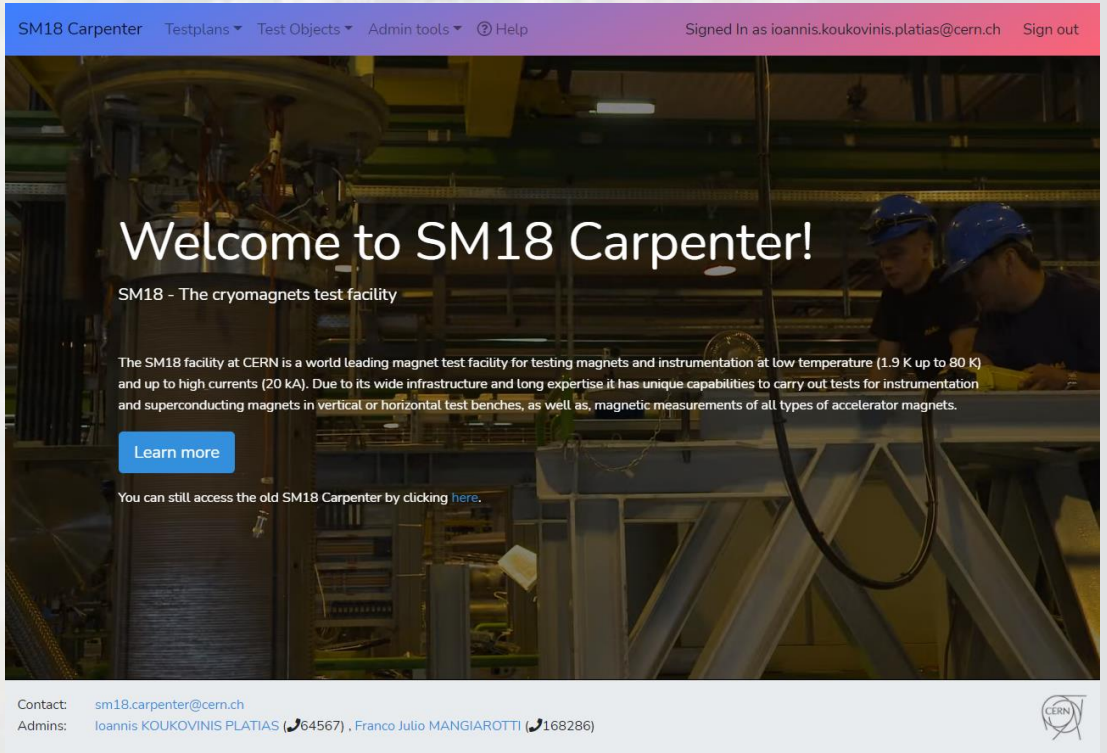
Carpenter Versions

- Version 1:
  - In development from mid-2017 to Q1-2019 by two developers
  - Entirely written in **PHP**
  - **DFS-hosted** website
  - Quick deployment
  - Technical limitations on technology utilized due to DFS hosting (e.g. PHP v5.6 → no MVC framework can be utilized)
  - Server not configurable
  - Lack of standardization

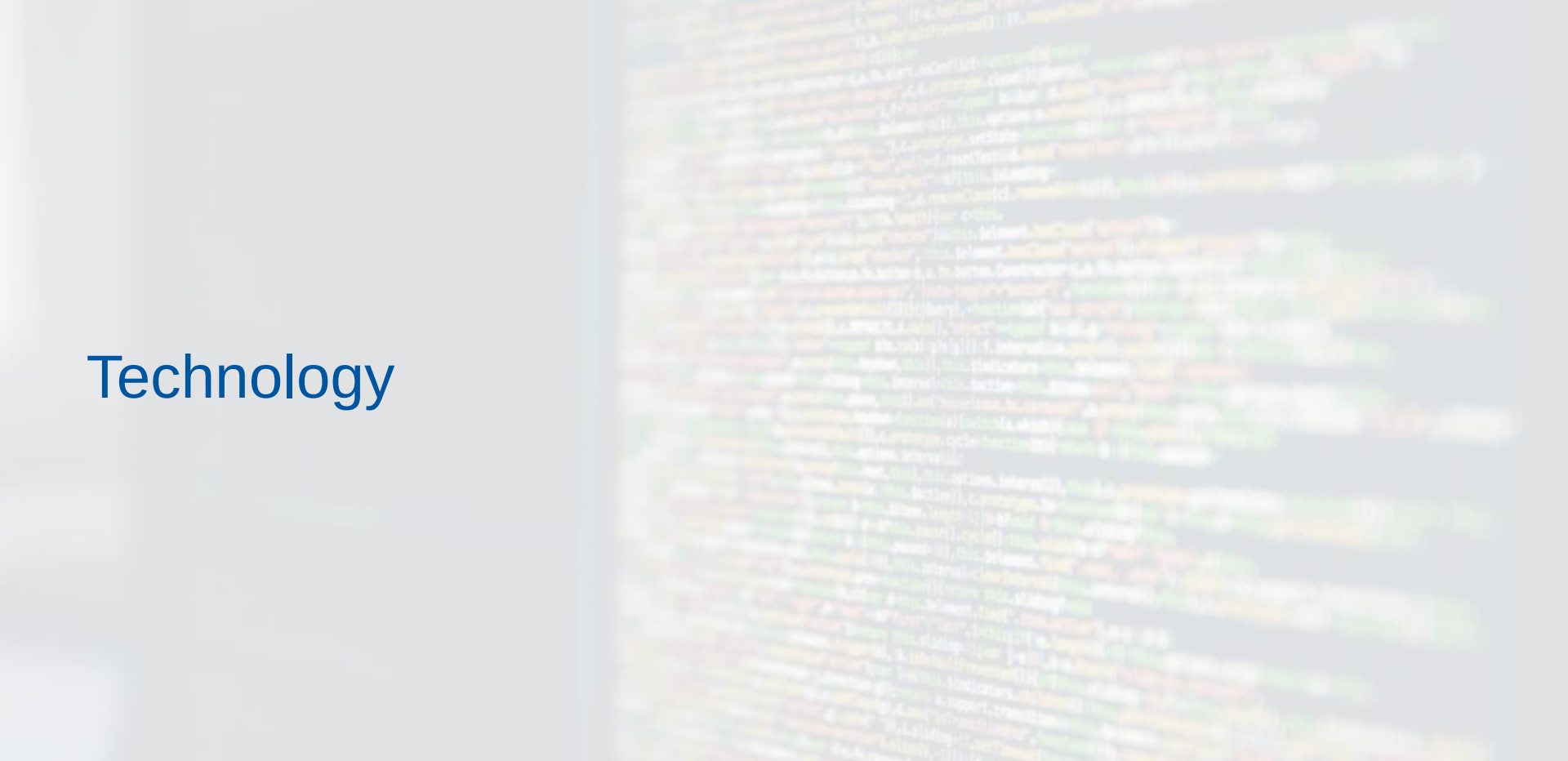


Carpenter Versions

- Version 2 improvements:
  - User friendliness: Highly interactive and mobile-friendly
  - Feature-richness: Server totally configurable & expandable to current & future needs
  - Standardization: Maintainability, ensures project's longevity

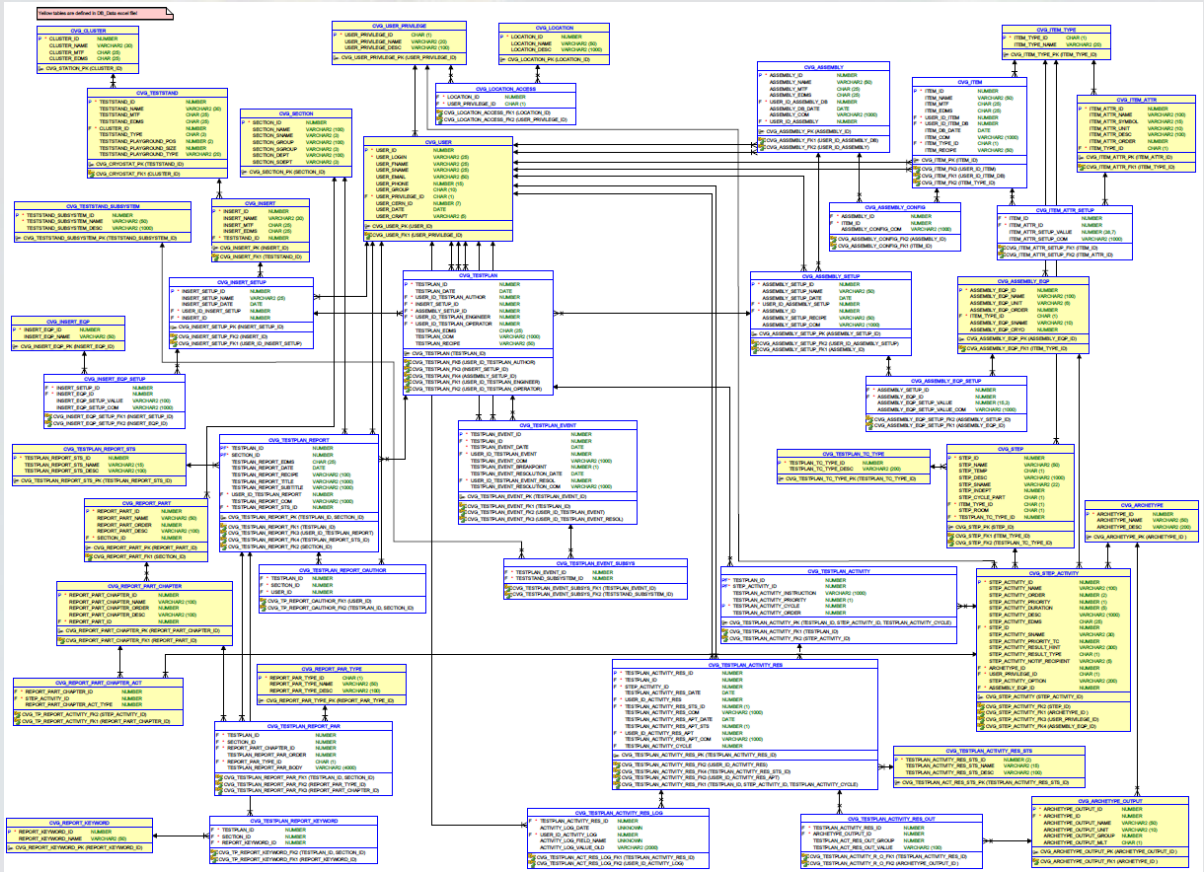


Technology



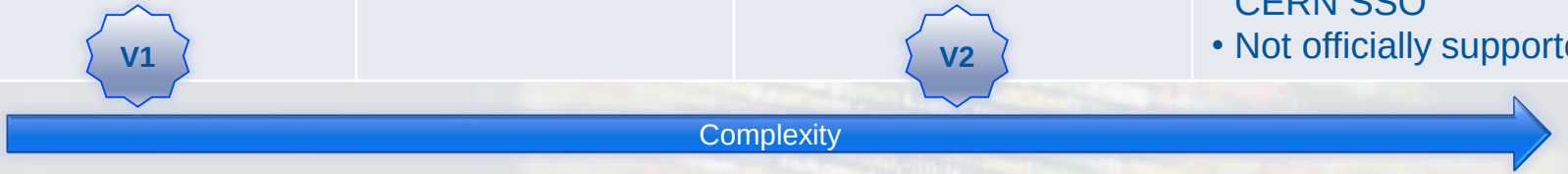
Carvings DB

- **Oracle** Database
- At the moment consists of **> 40 tables** and **> 60 views**
- Constantly evolving and expanding
- Currently holding **> 380.000 result entries**



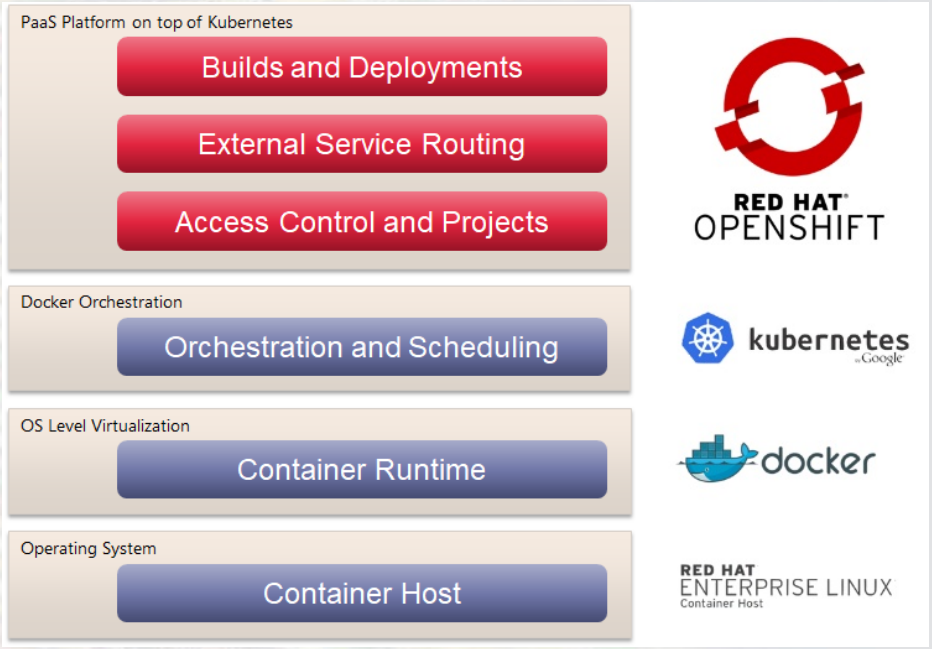
Web hosting options

	DFS hosting, EOS hosting	Sharepoint, Drupal, Social	PaaS/OpenShift	Openstack Virtual CENTOS7 Server
Pros	• Simple deployment (copy-paste) • Easy to setup CERN SSO	• Simple setup • Straightforward development	• Totally configurable and expandable • Easy to setup CERN SSO	• Totally configurable and expandable • Total control of server
Cons	• PHP v5.6 • Server not really configurable	• Limited options for customization	• More complex setup	• Responsibility to keep server running, safe and secure • Not easy to setup CERN SSO • Not officially supported



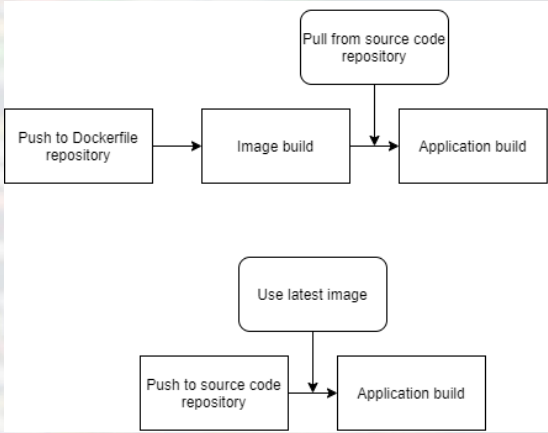
PaaS with OpenShift/Kubernetes/Docker

- **Docker** containers resemble Virtual Machines but are more lightweight, smaller and have better performance
- **Kubernetes** provides orchestration, scheduling, and management of Docker containers (e.g. auto-scaling, load distribution, failure protection)
- Simplistically put, **OpenShift** is a front-end management tool built on top of Kubernetes
- **Platform as a service (PaaS)** is a cloud computing model where a third-party provider delivers software tools (and even hardware) to users over the internet



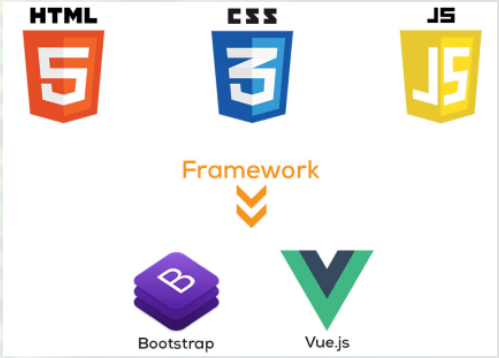
Gitlab, CI/CD, CERN SSO

- **Two Gitlab repositories** used: one for the **Dockerfile** (system recipe) and another for the **Carpenter source code**
- Continuous Integration/Continuous Delivery (**CI/CD**) with **Gitlab Webhooks**:
  - A push to the Dockerfile repository triggers a new image (system) build. A successful image build triggers an application build using the latest commit to the source code repository
  - A push to the source code repository triggers a new application build (injecting newly-submitted source code), using the latest image as basis
  - If a new pod is successfully created, previous pods are terminated
- **CERN-SSO-PROXY:**
  - Builds and hosts a Docker image that provides an Apache reverse proxy that does Single Sign-On authentication
  - Acts as middleware for requests to our website → they pass through cern-sso-proxy pod before reaching our application pod
  - Flexible configuration



Frameworks and libraries

- **Back-end** (server-side): **Laravel** (PHP)
  - Most popular PHP framework
  - Follows the model–view–controller (**MVC**) architectural pattern
  - Highly robust and secure
  - Straightforward syntax and enforced project structure → maintainability
  - Easy to install additional PHP & JS packages with included dependency management tools
- **Front-end** (client-side): **Bootstrap** (CSS), **Vue.js** (JavaScript)
  - **Bootstrap** is the most popular CSS Framework for developing responsive and mobile-friendly websites
  - **Vue.js** is a progressive front-end framework and one of most popular JS frameworks
  - Reactive → makes state management simple and intuitive
  - Both come pre-installed with Laravel → tight integration
- Various JS libraries like: jQuery, DataTables, handlebars.js, etc.



Functionality

Overview

- Four categories in navigation bar:
  - **Testplans**
  - **Test Objects**
  - **Tools** (work in progress)
  - **Admin Tools**
- Interactive tables & links

Items / Assemblies / Setups / Testplans

Item Registration → Assembly Creation → Assembly Setup → Testplan Creation

vertical magnet: MBHSP109

Item Information

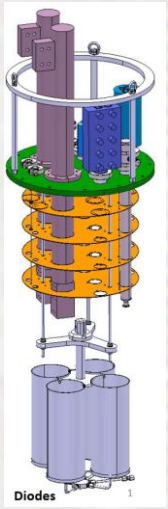
Item owner: Frederic SAVARY
HCMBHSP001-CR000091 in MTF

Number of apertures	1
Number of coils	2
Superconductor (1-Nb3Sn, 2-NbTi, 3-other)	1
Number of strands	40
Strand diameter	700e-6 m
Weight	4e3 kg
Diameter	560e-3 m
Length	2 m
Max allowed dT	150 K
Max stored enery	1e6 J
Maximum voltage @ 300K	1e3 V
Maximum voltage @ 4.5K	1e3 V
Low current Inductance	11e-3 H
High current Inductance	11e-3 H
Max quench integral	15e6 A^2 s

Last updated by Franco Julio MANGIAROTTI on 26/11/2018 09:49:25

Edit item registration

- Multiple magnets on one insert
- Stack of diodes
- Cryomodule assembly



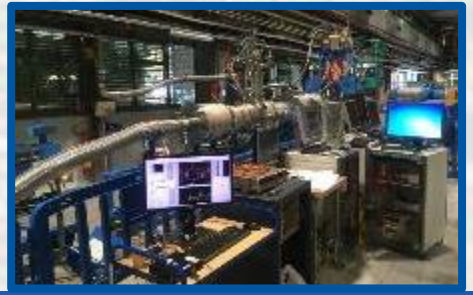
Standalone test setup "SP109 in long"

Setup Information

Quench antennas	7 #
Dump resistor	60e-3 Ohm
Strain gages	1 #
Power supply	20 kA
Quench heaters	4 #
Voltage taps	40 #
VT PotAIM cards	1 #

Last updated by Franco Julio MANGIAROTTI on 26/11/2018 09:51:41

Edit setup information



New Testplan Creation: MBHSP109 (SP109 in long)

Testplan General Information

Bench name*	Cluster D
Testplan engineer*	DUDA Michal
Testplan operator*	DESBIOLLES Vincent
Testplan edms #	
Testplan comment	
Testplan recipe name	

Testplan Activities Information

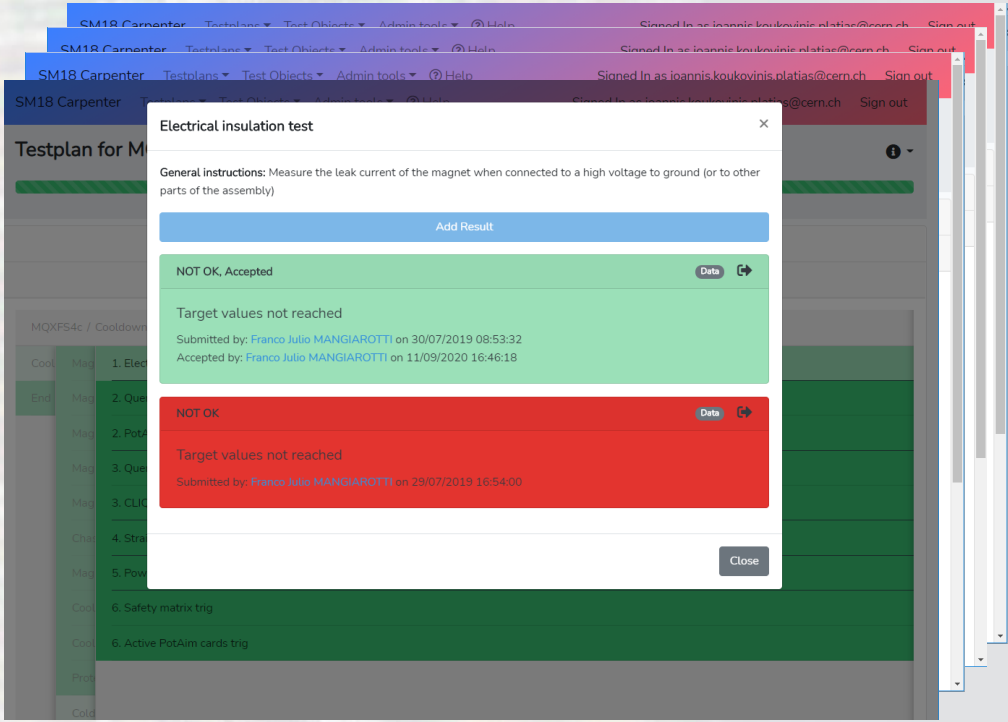
Order & Activity Name	Special Instructions
Magnet welcome	
1.1.1 Magnet reception in SM18	
Magnet on stand, before cooldown	
1.1.1 Define polarity	
1.1.1 Voltage taps continuity test	
1.1.1 Electrical insulation test	
1.1.1 Strain gages verification	
1.1.2 Fiber optic verification	
1.1.1 Quench heater resistance measurement	
1.1.2 Accelerometer/acoustic sensor installation	
1.1.3 Transfer function	
1.1.3 Capacitive discharge	
Magnet onto insert installation	
1.1.2 Magnetic measurement shaft installation	
1.1.1 Quench antenna installation	
1.2.1 Magnet installation in insert	

Interactive wizard

- Smallest unit: Assembly containing one or more Items
- Each Assembly needs to be assigned a Setup before a Testplan can be created
- Setup affects available/mandatory Testplan activities
- Form validation
- Recipes: pre-filled forms
- Available features depending on user permission level

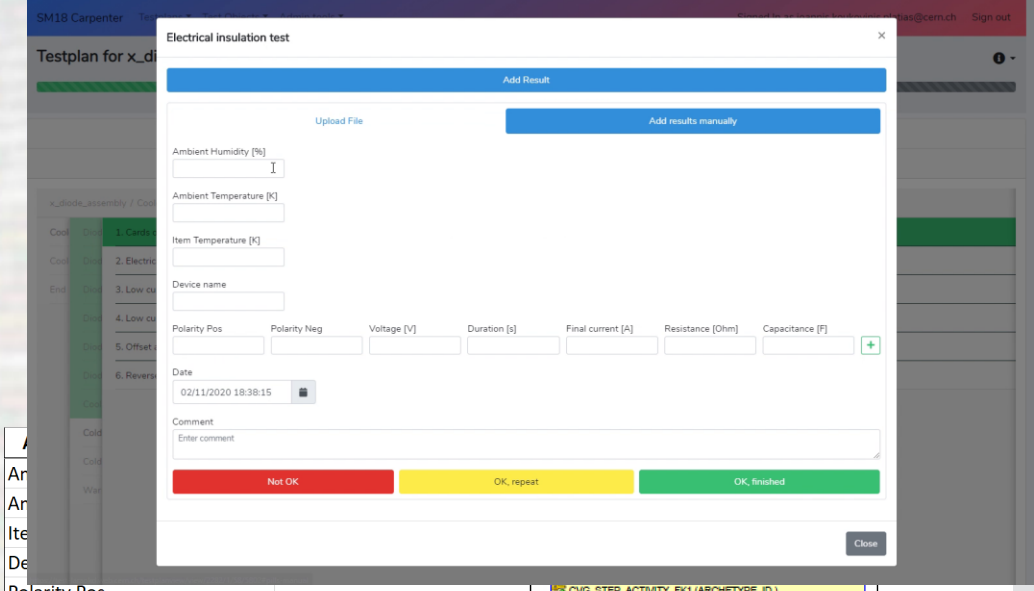
Testplan view terms

- A Testplan can consist of more than one **Cooldowns**
- Each Cooldown consists of **Steps**, which are a collection of related **Activities**
- **Results** can be added to activities
- Depending on the activity, the **result type varies** from simple checkbox to values from a list, to input fields/file input or both
- Results have a **result status** and an **acceptance status** (e.g. it might be desirable to accept a result even though it failed)
- Multiple results can be added to an activity until one is “Accepted”

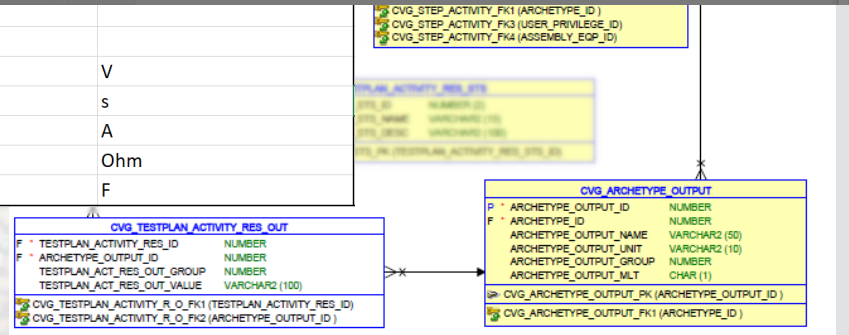


Archetypes

- Some activities can save values from input fields or values parsed from uploaded files
- The idea of **Archetypes** allows grouping of fields based on the activity type
- Nothing is hardcoded, archetypes fetched dynamically → flexible solution, makes adapting to new requirements easy
- Same idea applied to many tables used throughout the website



Polarity Pos	
Polarity Neg	
Voltage	V
Duration	s
Final current	A
Resistance	Ohm
Capacitance	F



Testplan view

- Test progress tracking:
  - Hierarchical structure to guide and follow the test
  - Only test engineer and operators can input data
  - Keeps track of what has been done, when, by whom
- Data Storage:
  - Loaded files from analysis software are automatically parsed
- Smart features like:
  - Result submission control
  - Multi-value entries
  - User notification

Events

- **Two types:**
  - Breakpoint
  - Information
- **Breakpoint Events** prevent new results submission until resolved
- **Information Events** are simply for informational purposes

Tools

- Data filtering/mining (existing in V1, work in progress in V2)
  - Data can be filtered and then downloaded for further offline analysis
  - Future: statistics, training plots, etc.

Data Archetypes

- [x] HV test
- [ ] Resistance
- [ ] RRR
- [x] Quench
- [ ] Hold current
- [ ] Inductance
- [ ] AC Loss
- [ ] V-I
- [ ] Diode endurance
- [ ] Diode reverse

Assemblies

Vertical Magnets: MBHSP102, MBHSP103

SCLinks: DEMO1

Horizontal Magnets: MBA_2638_4, xMB_000

Diodes: MDA2126, MDA2127

Results

Download **HV test** results: html, txt

Download **Quench** results: html, txt

Magnet Nam	File name	Test Date	Test Type	Trigger Type	Temperature [K]	Current [A]
MBHSP106	HCMBHSP0001_0000106__M1712051708_na003(0)	05-12-17 17:08	Training	Natural quench	4.5	8623
MBHSP106	HCMBHSP0001_0000106__M1712060933_na004(0)	06-12-17 09:33	Training	Natural quench	4.5	9270
MBHSP106	HCMBHSP0001_0000106__M1712061104_na005(0)	06-12-17 11:04	Training	Natural quench	4.5	10460
MBHSP107	HCMBHSP0001_0000107__M1807111726_ta007(0)	11-07-18 17:26	Training	Natural quench	1.9	10425
MBHSP107	HCMBHSP0001_0000107__M1807120929_a002(0)	12-07-18 09:29	Training	Natural quench	1.9	10637
MBHSP107	HCMBHSP0001_0000107__M1807121023_a004(0)	12-07-18 10:23	Training	Natural quench	1.9	11610
MBHSP109	HCMBHSP0001_0000109__M1812041804_ta006(0)	04-12-18 18:04	Training	Natural quench	1.9	6551
MBHSP109	HCMBHSP0001_0000109__M1812041836_a001(1)	04-12-18 18:36	Training	Natural quench	1.9	8796
MBHSP109	HCMBHSP0001_0000109__M1812041944_a002(0)	04-12-18 19:44	Training	Natural quench	1.9	10810

Next steps

- Release Version 2 officially
- Reach 100% functionality of Version 1
- Advanced statistics and visualizations
- Automatic report generation / report filtering
- + more new features

Summary

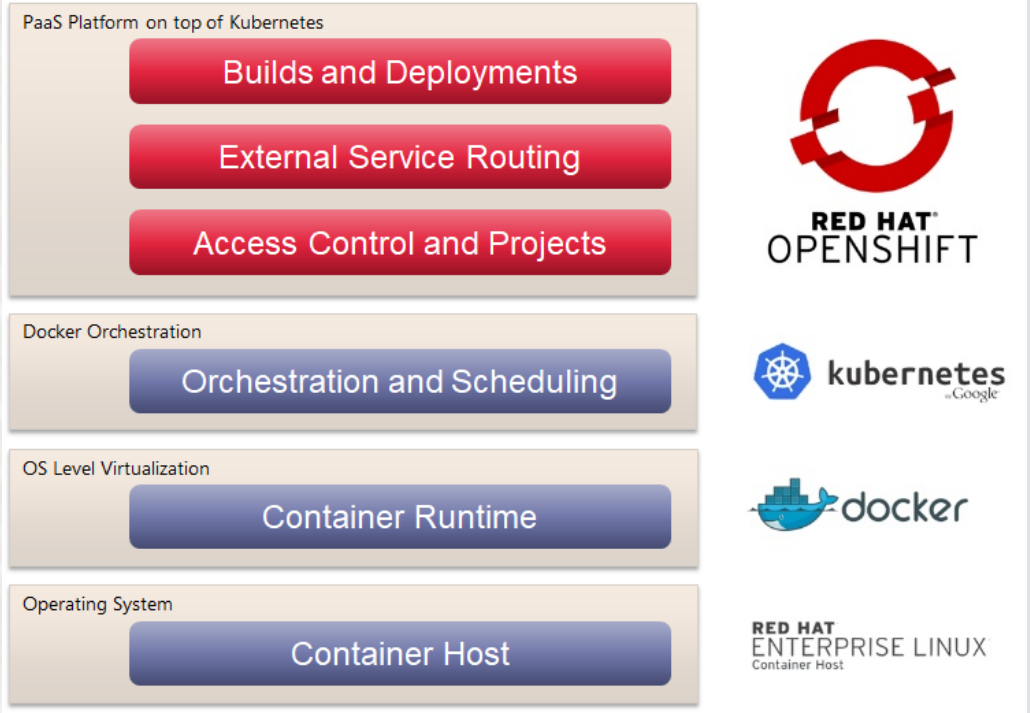
- Carpenter is SM18's test follow-up tool able to:
  - Track test progress (who/when/what, results & events)
  - Retrieve a wealth of information
  - Add new/edit entries to Carvings database
  - Filter and retrieve data
  - Inform members
- Built with modern technology ensuring:
  - User-friendliness
  - Rich features
  - Maintainability and project longevity

Questions / Comments

Annex

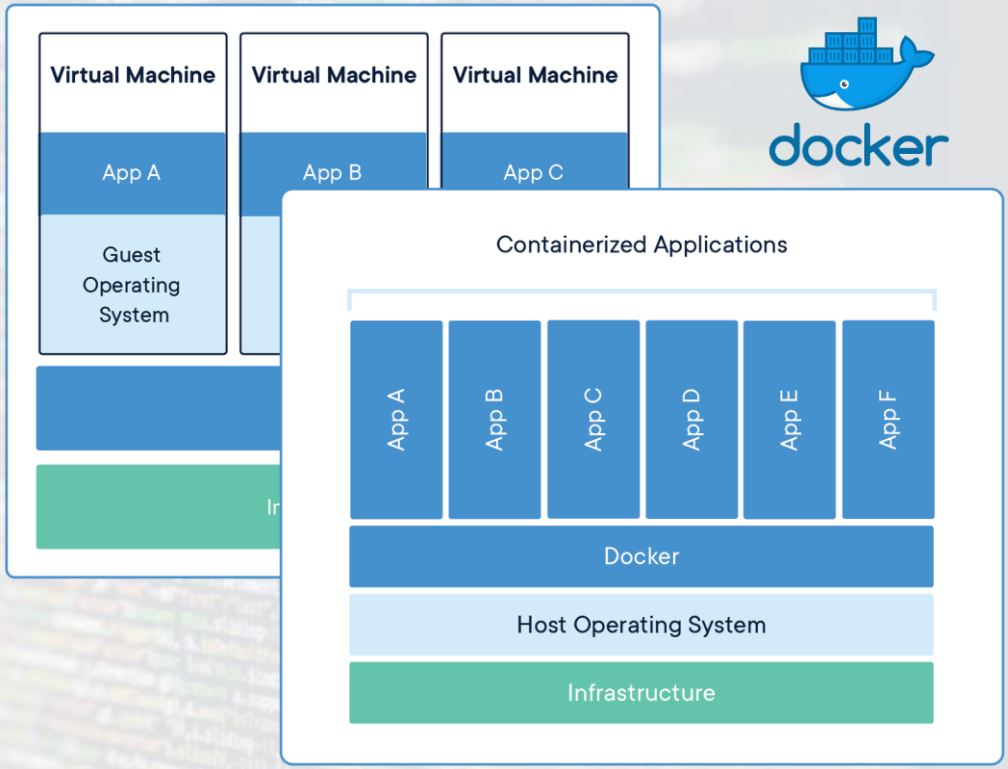
PaaS with OpenShift/Kubernetes/Docker

- **Platform as a service (PaaS)** is a complete development and deployment environment in the cloud
- Red Hat **OpenShift** is a PaaS for organizations that deploy and manage OpenShift on their own on-premises hardware or on the infrastructure of a certified cloud provider
- OpenShift is built on top of **Kubernetes**
- **Kubernetes** orchestrates Docker containers



What is Docker

- Docker provides containerization at the OS level (a bit like a virtual machine)
- Unlike a virtual machine, rather than creating a whole virtual operating system, Docker allows applications to use the same Linux kernel as the system that they're running on and only requires applications be shipped with things not already running on the host computer → similar to VMs but more lightweight
- Significant performance boost
- Reduces the size of the application
- Docker Containers = Containerized Apps



What is Kubernetes

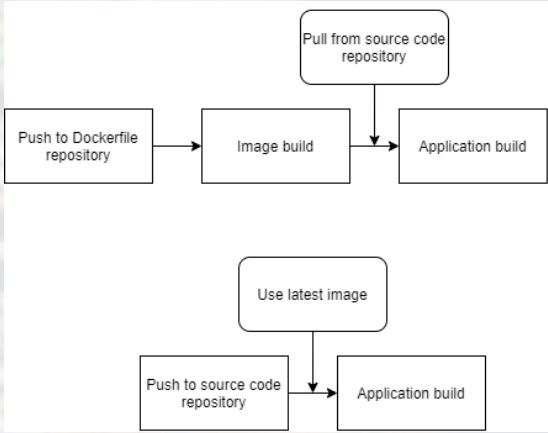
- Kubernetes is an open source container orchestration solution, providing orchestration, scheduling, and management of Docker containers
- Kubernetes manages groups of containers called clusters.
- Auto-scales containers
- Distributes load between containers
- Manages storage required by containers
- Provides resiliency of containers in case of failure

What is OpenShift

- OpenShift is a PaaS solution by Red Hat built upon Kubernetes and Docker projects, adding deployment, orchestration and routing functionality on top of container scheduling and management provided by the Kubernetes core
- Provides developers with an integrated development environment (IDE) for building and deploying Docker-formatted containers, and then managing them with the open source Kubernetes container orchestration platform → simplistically put, OpenShift is a front-end management tool built on top of Kubernetes

Gitlab Webhooks & CI/CD

- **Two Gitlab repositories** used: one for the **Dockerfile** and another for the **Carpenter source code**
- Docker can build images automatically by reading the instructions from a **Dockerfile**. A Dockerfile is a text document that contains all the commands a user could call on the command line to assemble an image
- Continuous Integration/Continuous Delivery (**CI/CD**) with **Gitlab Webhooks**:
  - A push to the Dockerfile repository triggers a new image (system) build. A successful image build triggers an application build using the latest commit to the source code repository
  - A push to the source code repository triggers a new application build (injecting newly-submitted source code), using the latest image as basis
  - Our application is an instance of the application build, called an OpenShift pod
  - If a new pod is successfully created, previous pods are terminated



Adding CERN SSO

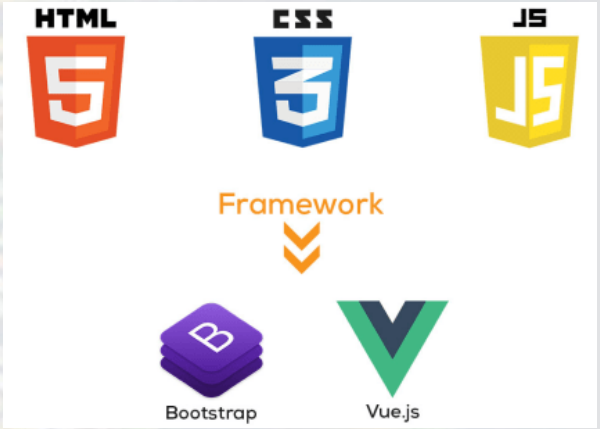
- The **CERN SSO** (Single Sign-On) service allows Web based applications to authenticate users and retrieve their information including their group membership to manage authorizations
- **CERN-SSO-PROXY**:
  - A SSO authenticating proxy for OpenShift applications
  - Builds and hosts a Docker image that provides an Apache reverse proxy that does Single Sign-On authentication
  - Acts as middleware for requests to our website → they pass through cern-sso-proxy pod before reaching our application pod
  - Flexible configuration

What is Laravel Framework

- **Laravel** is a free, open-source PHP web framework based on Symfony intended for the development of web applications
- Most popular PHP framework
- Follows the model–view–controller (**MVC**) architectural pattern
- Has its own templating language called **Blade** to create HTML layouts
- Comes with **Composer**, a PHP dependency management tool, as well as **NPM**, used to manage JavaScript dependencies → easy to add functionalities by installing additional packages
- Highly robust and secure
- Straightforward syntax and enforced project structure → maintainability

Bootstrap, Vue.js + additional JavaScript packages

- **Bootstrap** is the most popular CSS Framework for developing responsive and mobile-first websites
- Comes with Laravel → tight integration
- **Vue.js** is an open-source model–view–viewmodel (MVVM) front end JavaScript framework for building user interfaces
- Incrementally adoptable → can be integrated into existing projects or exclusively used to power Single-Page Applications
- Reactive → makes state management simple and intuitive
- Many more JavaScript packages used, like: jQuery, DataTables, handlebars.js, etc.




CERN