Lightweight Sites – SIMPLE framework

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Diversity in WLCG

Types of **CE/Batch/WN/Middleware** packages

Technologies preferred by site admins for managing their infrastructure

The Vision

- **Reduce operational efforts** and **oversight** required to **set up and maintain** grid services at sites.
- Leverage modern **infrastructure automation**, **configuration management** and **containerization** tools to install, configure, deploy and maintain grid services.

Site Admin's Perspective

- Lightweight Sites Survey: http://cern.ch/go/rhV9
- 51 Sites responded to the questionnaire that shows potential benefits of **shared repositories**
- **Conclusion:**
  - Most sites still require **classic grid services** which can be complicated to configure/deploy
  - **Simpler mechanisms** for orchestration of sites utilizing **modern infrastructure tools** will be beneficial
  - Strong support for **Docker, Puppet, OpenStack images**

SIMPLE

- **S**olution for **I**nstallation, **M**anagement and **P**rovisioning of **L**ightweight **E**lements
- Support diversity in WLCG sites with **minimal oversight and operation efforts**
- Keep **functionality the same**, but easier for site admins to set up and maintain

SIMPLE: Usage Overview

- Create **site-level-configuration-file.yaml**
  - Describe infrastructure and grid services that will be deployed at the site.
- Execute the SIMPLE Grid Framework
  - The framework will configure all the hosts and deploy appropriate containers that run the required grid services.
  - The framework combines:
    - configuration management tools (Puppet/Ansible)
    - container orchestrators (Docker Swarm/ Kubernetes)
    - containerization technologies (Docker)

Site Level Configuration File

A single YAML file to describe:

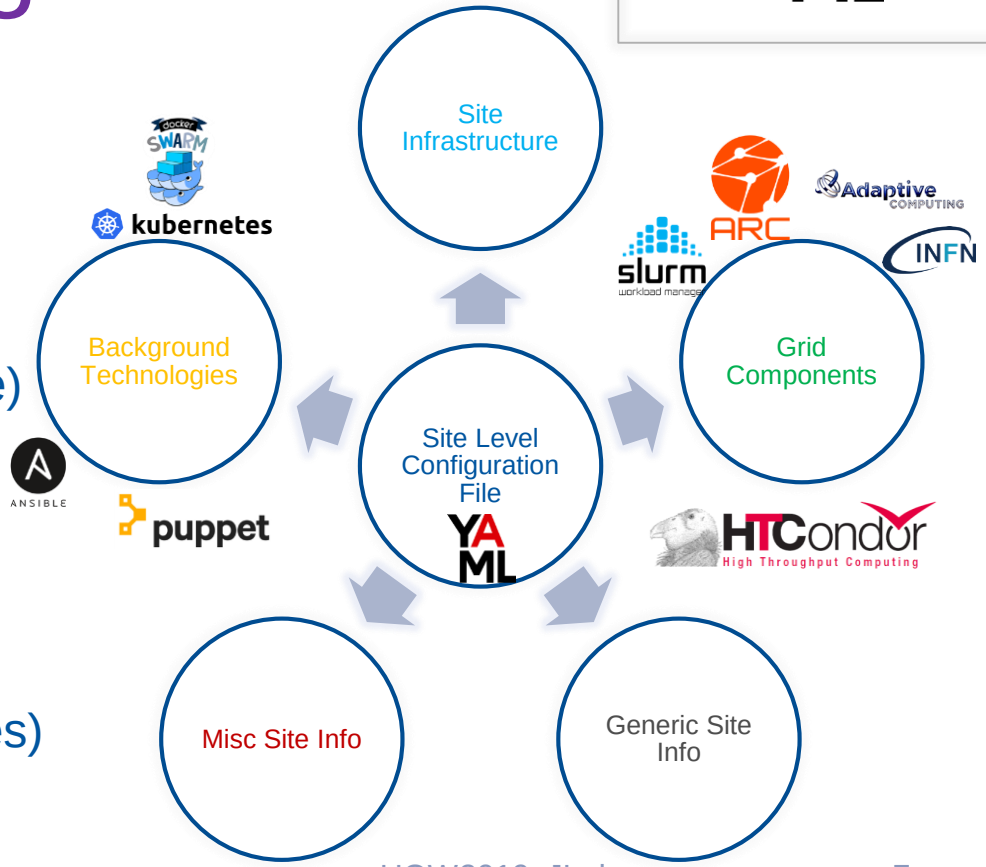
Site-Infrastructure (Hostnames, IP addresses, OS/Kernel, Disk/Memory)

Grid Components (What grid components to install and configure)

Generic Site Info (Users, Groups, Supported VOs)

Misc. Site Info (Security emails, location etc.)

Background Technologies (Puppet/Ansible, Docker/Kubernetes)



Section: site_infrastructure

Site-Infrastructure

Nodes on which grid services will be deployed

```
site_infrastructure:
  - fqdn: ce01.mysite.domain
    ip_address: 192.168.10.2
  - fqdn: wn01.mysite.domain
    ip_address: 192.168.10.70
  ...
```

Section: lightweight_components

lightweight_components

URL for grid service container repository

Node on which grid service should be deployed

Config params for grid service container

```yaml
- name: WN-Pbs
  type: worker_node
  repository_url: "https://github.com/WLCG-Lightweight-Sites/wlcg_lightweight_site_wn_pbs"
  repository_revision: "master"
  execution_id: 1
  lifecycle_hooks:
    pre_config:
      - /etc/simple_grid/lifecycle/wn_pre_config.sh
    pre_init:
      - /etc/simple_grid/lifecycle/wn_pre_inst1.sh
    post_init:
      - /etc/simple_grid/lifecycle/wn_post_inst1.sh
  deploy:
    - node: wn01.mysite.domain
      container_count: 2
  preferred_tech_stack:
    level_2_configuration: yaim
  config:
      ce_host: *pbs_runtime_var_ce_host
      batch_server: pbs
  supplemental_config:
    some_additional_parameter: some_value
```

Section: lightweight_components

lightweight_components (advanced features)

```yaml
- name: WN-Pbs
  type: worker_node
  repository_url: "https://github.com/WLCG-Lightweight-Sites/wlcg_lightweight_site_wn_pbs"
  repository_revision: "master"
  execution_id: 1
  lifecycle_hooks:
    pre_config:
      - /etc/simple_grid/lifecycle/wn_pre_config.sh
    pre_init:
      - /etc/simple_grid/lifecycle/wn_pre_inst1.sh
    post_init:
      - /etc/simple_grid/lifecycle/wn_post_inst1.sh
  deploy:
    - node: wn01.mysite.domain
      container_count: 2
  preferred_tech_stack:
    level_2_configuration: yaim
  config:
      ce_host: *pbs_runtime_var_ce_host
      batch_server: pbs
  supplemental_config:
    some_additional_parameter: some_value
```

Custom scripts to fine tune configuration of hosts and containers, if required.

Additional config params

Advanced features

- **Variables**
  - Declare YAML anchors and reuse them anywhere in the site-level-configuration file

```yaml
### Variable declaration:
vars:
  - &lightweight_component01_ip_address 192.168.0.4
  - &lightweight_component01_fqdn lightweight_component01.cern.ch
  - &lightweight_component02_ip_address 192.168.0.5
  - &lightweight_component02_fqdn lightweight_component02.cern.ch
```

- **Default Values**
  - Several **sensible default variables** already exist in the framework to make configuring a site more efficient.

```yaml
supported_virtual_organizations:
  - *default_vo_alice
  - *default_vo_dteam
  - *default_vo_ops
```

Advanced features

- **Override default values**
  - Override default values based on your configuration requirements.

```
supported_virtual_organizations:
  - *default_vo_alice
    <<: default_se: 'my-se.mydomain'
  - *default_vo_dteam
  - *default_vo_ops
```

- **__include__ keyword**
  - Split site-level-config-file into smaller, logically related configuration files

```
site_infrastructure:
  __include__: "./my-site-info.yaml"
```

SIMPLE: Practical Insights

- Initial Test Deployment:
  - **Centro Brasileiro de Pesquisas Físicas** (CBPF, Tier-2 in Brazil)
    - Site level configuration file is around **100-200 lines of YAML** code.
    - Takes between 20-30 minutes to deploy **CREAM-CE**, **Torque Batch system** and **Torque worker nodes** on a mini test site.
    - Technologies: Puppet, Docker-Swarm, Docker and YAIM
- Upcoming test deployment:
  - **Institute of Physics of the Czech Academy of Sciences** (Tier-2, Prague, Czech Republic)

SIMPLE: Deployment steps

For the 1st implementation featuring Puppet, Docker-Swarm and Dockerized grid services:

- Install Puppet on all the nodes.
- Install SIMPLE Grid Puppet module on all the nodes.
- Write the site-level-configuration file
- Execute the SIMPLE Grid Framework.

SIMPLE: Note to Users

While the framework abstracts and automates low level configuration required by supported grid services, a **site admin must** still:

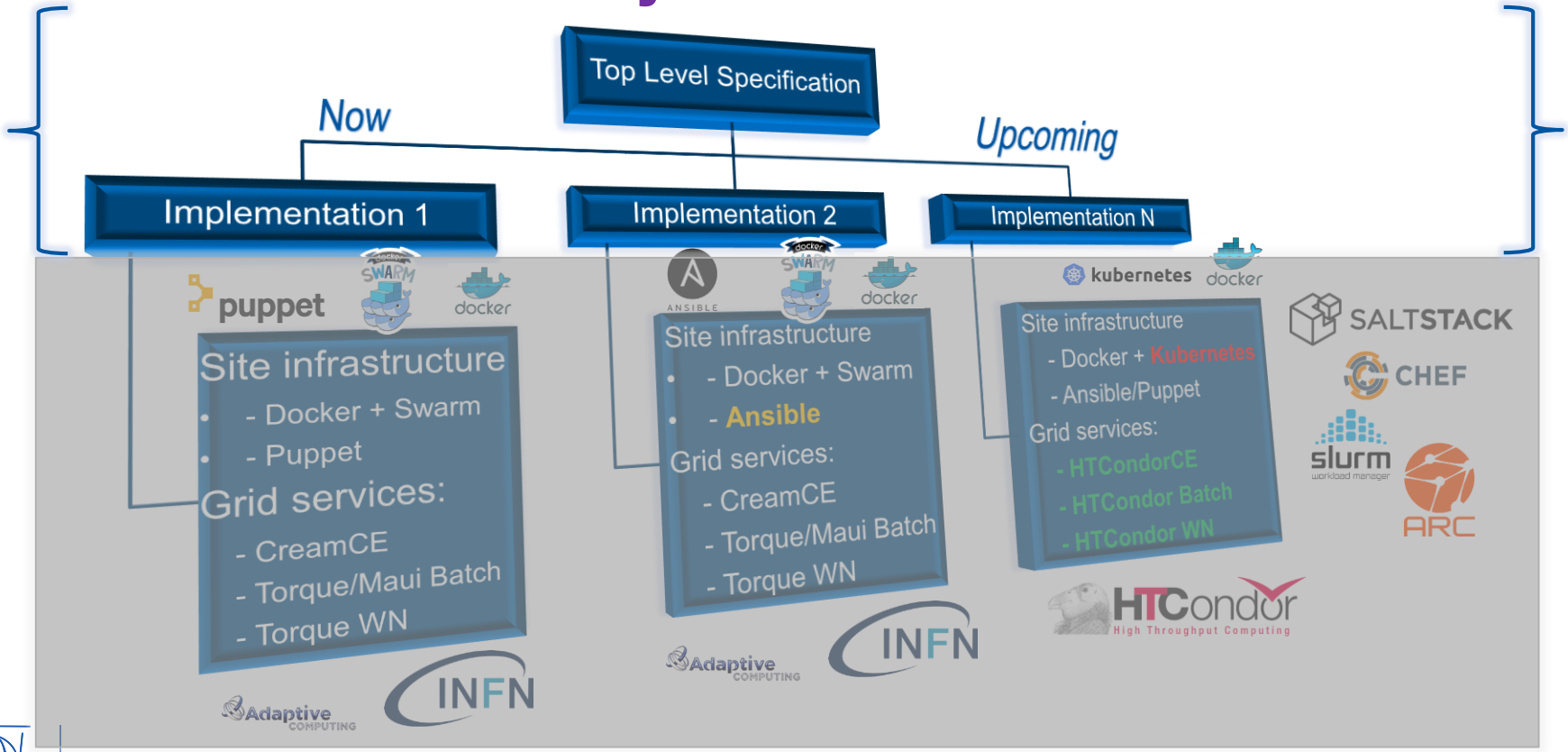
- Have basic understanding of the grid services they wish to configure using the framework. For instance,
  - **Queues** to create for the chosen batch systems.
  - **VOs** to be supported by their sites.
  - **Pool Accounts** that shall be created for the jobs.
- Ensure that the host machines have **sufficient resources** (compute, memory, storage) to run the grid service
- Ensure **availability of a healthy network** (physical/virtual) between the hosts.

SIMPLE: basic vs. advanced usage

- Basic usage is the first goal
  - An admin only needs to consider parameters etc. that cannot (easily) be determined by the SIMPLE framework
  - See examples on the previous page

- Support for advanced usage is a second goal
  - An admin can “look under the hood” to see how to enhance / extend the framework
  - Discover how popular technologies are being used
    - Container orchestration
    - Configuration management
  - Add or change some functionality in existing components
  - Add new (grid) components

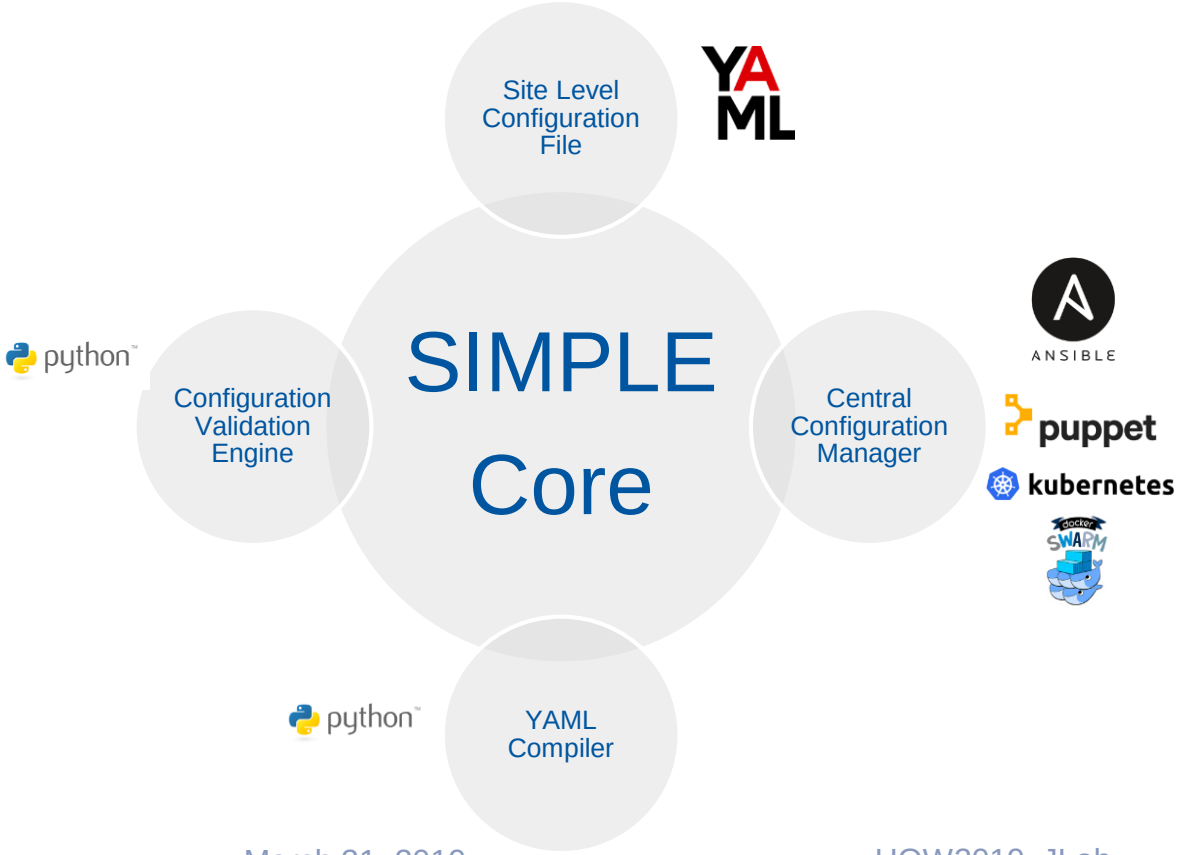
SIMPLE – Project Structure



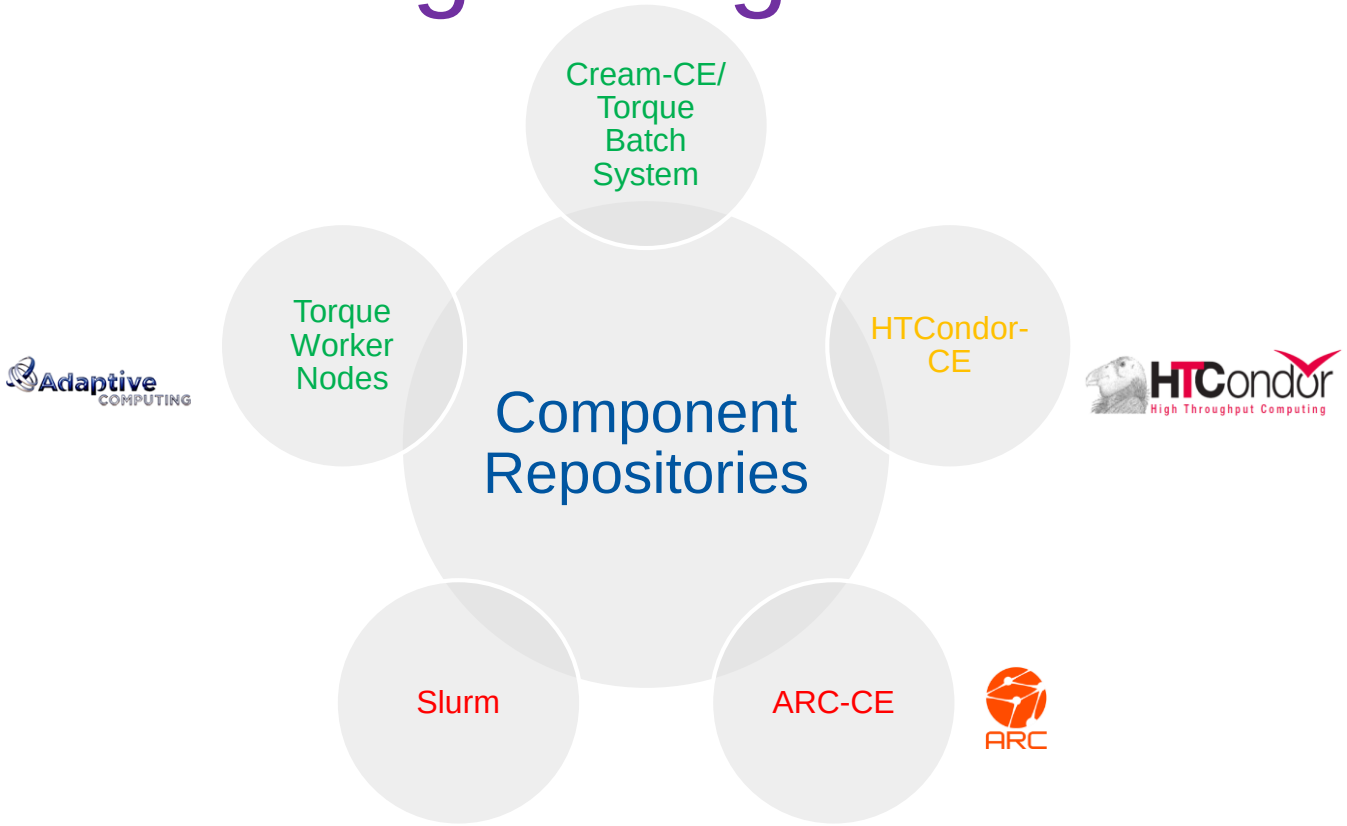
SIMPLE – Specification

- Define **components** of the SIMPLE Grid Framework.
- Define **functions** of each framework component.
- Define the **execution pipeline** i.e. the sequence in which the functions are invoked in order to deploy a grid site.

SIMPLE – Core Components



SIMPLE – Lightweight Elements



Component Repositories

- Publicly hosted repositories on GitHub that provide
  - **Dockerized** CE/WN/Batch/Squid etc.
  - **Meta information** for configuration of images using different configuration management tools
- 1 repository for every component (for instance, CreamCE, HTCondorCE, Torque, Slurm reside in separate repositories)
- Examples: CreamCE, TorqueWN

SIMPLE – Execution Pipeline

- Grid components are deployed via the following stages:
  - **Installation Stage**: install the various components of the framework.
  - **Configuration Stage**: configure the various components of the framework and compile/validate site level configuration file.
  - **Pre-Deployment Stage**: Prepare hosts, container orchestrators.
  - **Deployment Stage**: Deploy the containerized grid services
  - **Testing/Reporting Stage**: Fetch logs from hosts and containers about success/failure of the deployment.

SIMPLE – Execution Pipeline

1 . Installation

- Installation of configuration management technology by the site admin
- Installation and configuration of the SIMPLE central configuration manager modules implemented in the chosen configuration management technology
- Description of the Site Level Configuration File

2 . Configuration

- Process Site Level Configuration File
- Validate Site Level Configuration File
- Validate Site Infrastructure

3 . Pre-Deployment

- Install Container Orchestrator
- Implement a networking strategy for the containers

Aggregate lifecycle callback scripts for each component repository

4 . Deployment

- Download component repositories on their respective nodes.
- Prepare Lightweight Component hosts for deploying containers(configure Firewalls, SELinux, CVFMS etc.)
- Deploy containers on the respective hosts and appropriately execute the lifecycle callbacks.

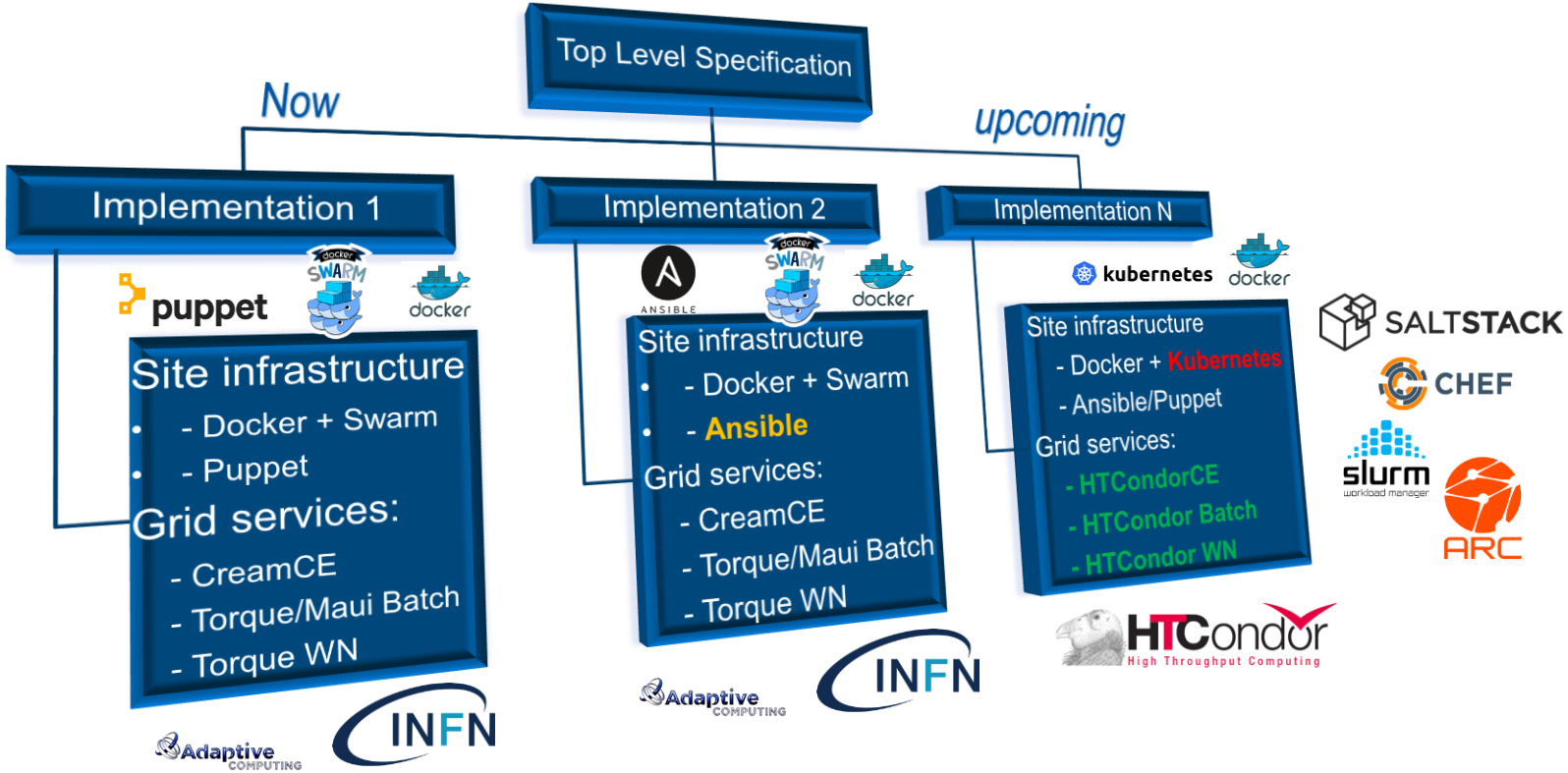
5 . Testing

- Test state of the hosts that were configured by the CCM
- Submit test jobs to the compute element to validate the success/failure of the end to end configuration.

6. Reporting/Cleanup

- Remove temporary files and restore original state of the hosts.
- Generate reports and logs to summarize all stages and the overall configuration.

Flashback – Project Structure



Try it out via SIMPLE Dev-Kit

- Simulate a grid site on your machine.
- Used to Develop/Test/Debug the framework
- Works locally until the pre-deployment stage of execution pipeline.
- https://github.com/maany/simple_grid_puppet_dev_kit/tree/master

The Community

Project Homepage

http://cern.ch/go/9lHd

GitHub Repositories

http://cern.ch/go/kr7p

Simple Grid Specification

http://cern.ch/go/X7cr

Technical Discussion List (E-Groups)

Name: WLCG-Lightweight-Sites-Dev
Link: http://cern.ch/go/l9wZ

Open Source Community

Name: WLCG Lightweight Sites
Link: http://cern.ch/go/Hz7S

Mattermost (IM):

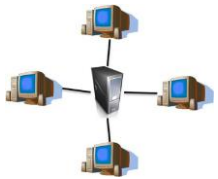
Team: WLCG
Name: WLCG-Lightweight-Sites
Link: http://cern.ch/go/8HWP

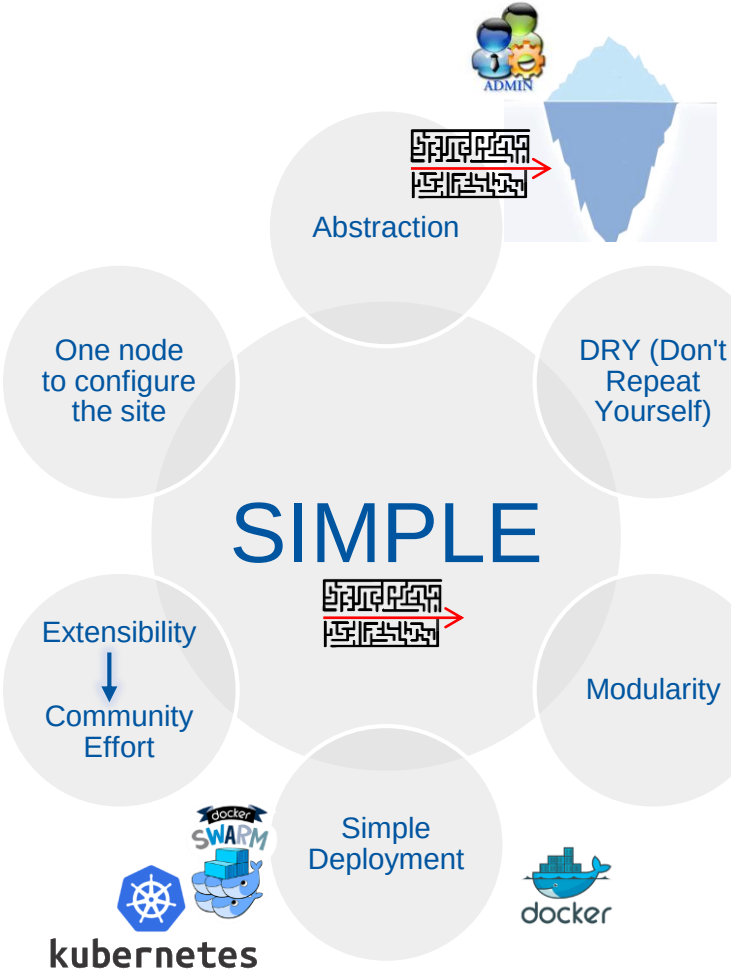
Conclusions

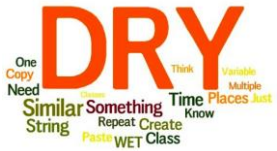
- Set up a **grid site with O(100) lines** of YAML
- **Modular** and easy to extend to **support other grid services**
- **Community Driven**: Open source and open discussion channels. Join Now!!

Additional Slides

Principles




ADMIN
Abstraction
One node to configure the site
DRY (Don't Repeat Yourself)
SIMPLE
Extensibility
Community Effort
Modularity
Simple Deployment
docker SWARM
kubernetes
docker


DRY
One
Copy
Need
Similar
String
Something
Repeat
Create
Paste
WET
Class
Time
Know
Places
Just
Variable
Multiple
Think


slurm
workload manager
ARC
HTCondor

Configuration Validation

- Configuration validation engine to ensure information supplied in site configuration file:
  - **meets the configuration requirements** of desired site component
  - is **realizable on the available infrastructure** using available background technologies
- http://cern.ch/go/CvS8
- Possibility to inject custom validation rules

Site Level Configuration File

- **Minimize configuration** requirements via
  - **Variables**
  - Sensible **default values** for site-level configurations
  - Ability to **override values**
  - **support additional parameters** not defined in the system
  - Tested: **O(100) lines of YAML code** to set up the site
  - Split configuration into **multiple logically related YAML files** that can be shared

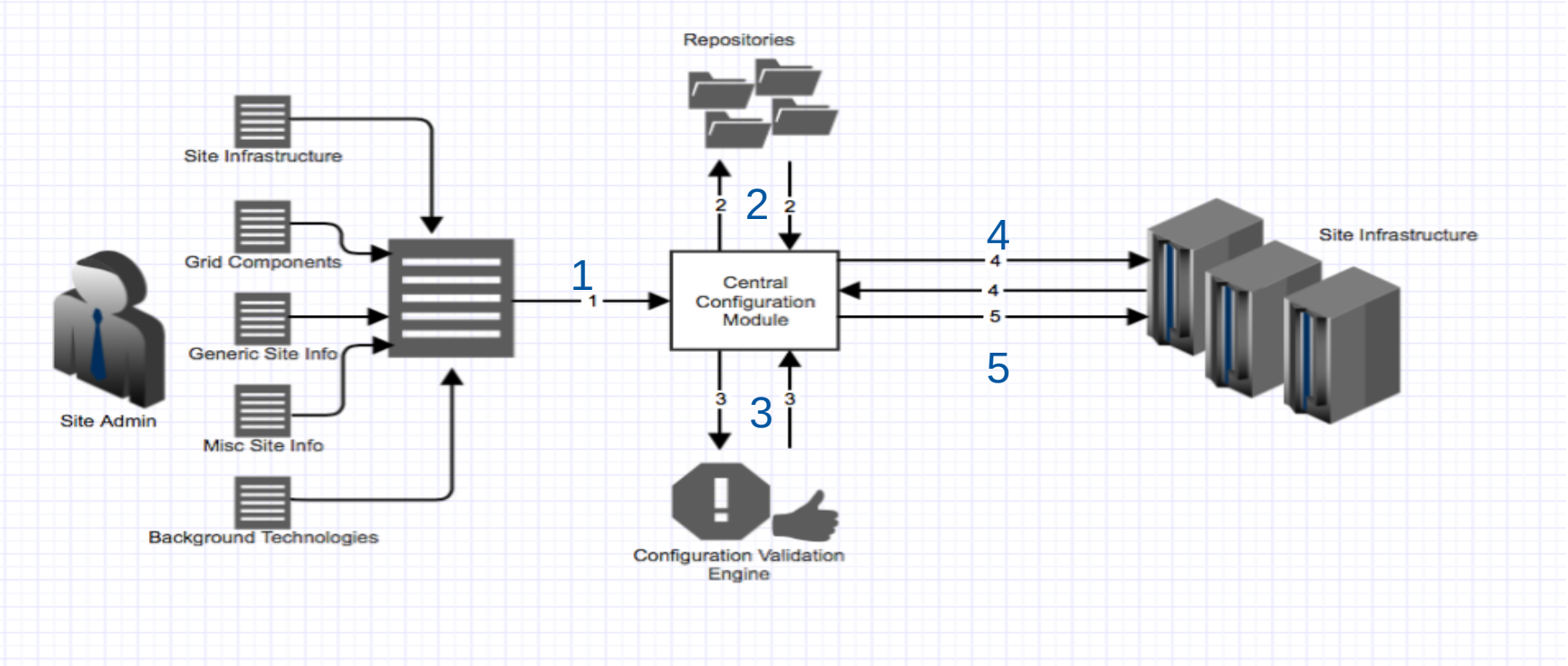
Central Configuration Manager

- The **main module** for centrally configuring everything at the site
- **Uses Validation Engine** to check site-configuration file
- Checks **status of available Site Infrastructure** that needs to be orchestrated
- Installs and **configures Grid components** from the repositories

Central Configuration Manager

- Implements a **Networking strategy** (overlay/dedicated)
- Ensures availability of **CVMFS** to the containers
- Runs **tests** to check for success or failure of site configuration

Specification: Putting it Together



Implementations

- **Site Level Configuration File YAML Compiler**
  - Python command line utility
- **Configuration Validation Engine**
  - Python command line utility
- **Repositories for Grid Components**
  - Cream Compute Element + Torque Batch System
  - Torque Worker Node
  - …
- **Central Configuration Management System**
  - Puppet
  - Ansible
  - …

Google Summer of Code 2018 Project + proposal for 2019