Handover of Control System Infrastructure

Remy Mudingay

ICS Division

Group leader Controls Infrastructure

www.europeanspallationsource.se

2018-04-08

Outline

- **Introduction**
  - Areas of responsibility
  - Introduce the group

- **Technical Network**
  - ESS Network
  - Technical Network
  - Network Installations and supporting tools

- **Containers & Virtualisation tools**
  - Why, What and How
  - Demo

Control System Infrastructure

Areas of responsibility 1/3

The group's responsibilities are to Design, Implement and Operate the IT Infrastructure needed to reliably run the Experimental Physics Industrial Control System (EPICS) eco-system.

The main activities can be grouped into the following work units:

- *Main Control Room*

- *Data Centre*

- *Technical Network*

- *Software Infrastructure*

Main Control Room - Human factors analysis and ergonomic design of the ESS Main Control Room. Control room equipment procurement and installation.

Data Centre

File and storage services for data produced by the machine for '*on-line*' and *'off-line'* analysis. Computer systems and backup and restore.

Control System Infrastructure

Areas of responsibility 3/3
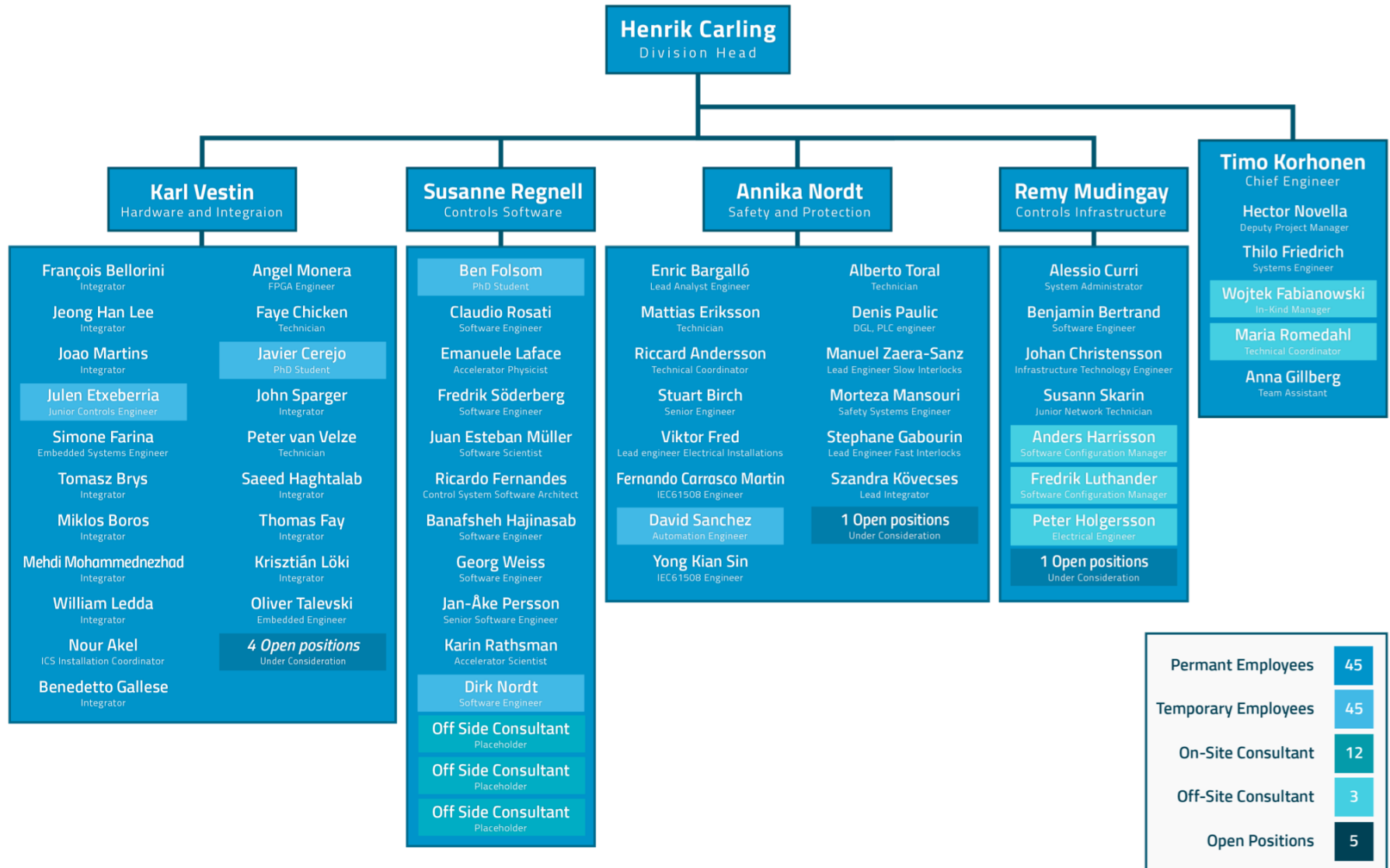
Technical Network

is a secure Network that interconnects private machine networks. Ethernet cabling, network equipment and monitoring tools and network services.

Software Infrastructure

Implements and manages the development life-cycle for software produced by ICS and other stakeholders. Configuration management and software deployment tools.
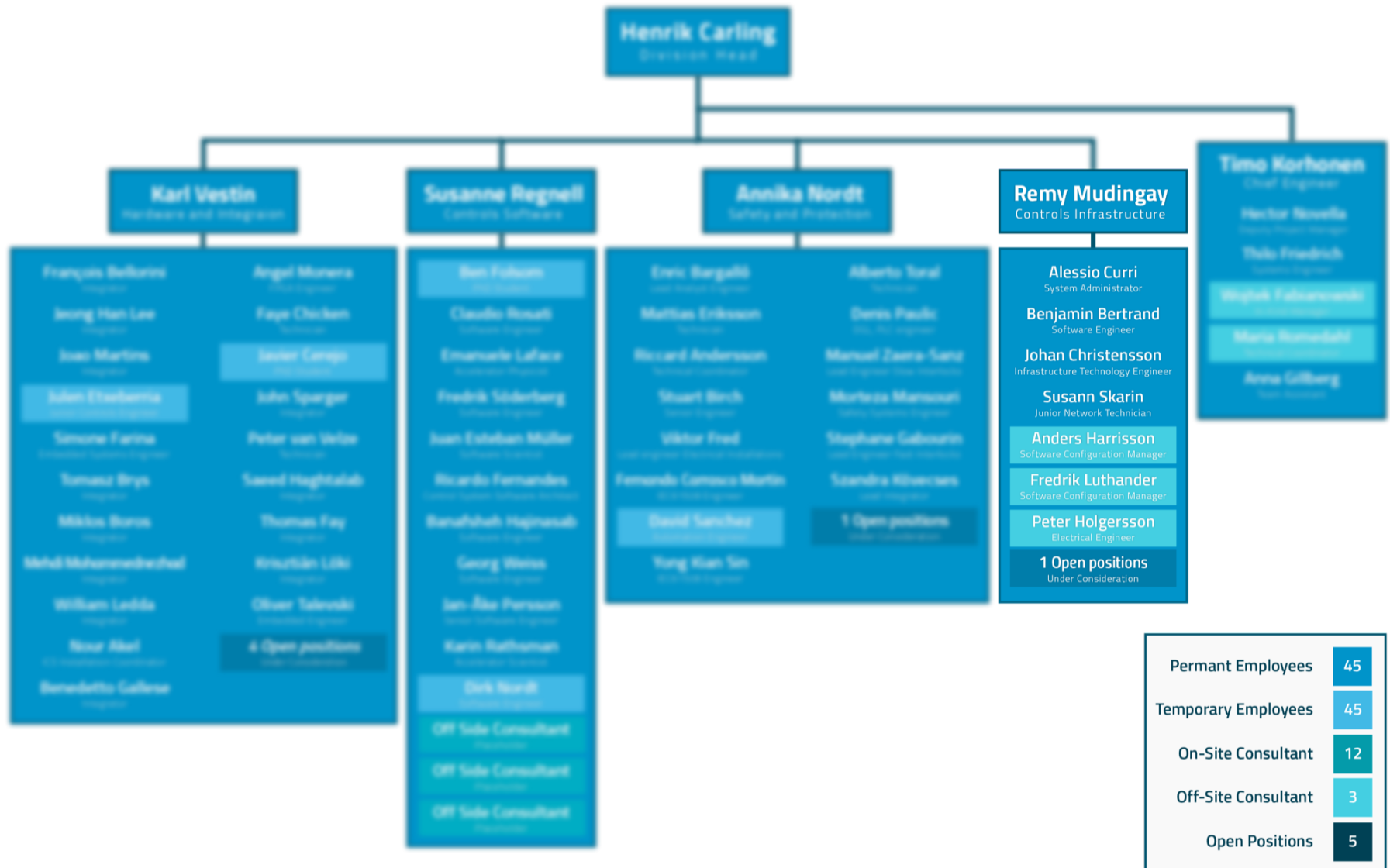
ICS Organization

2018-04

EUROPEAN SPALLATION SOURCE

Henrik Carling
Division Head

Karl Vestin
Hardware and Integraion

François Bellorini Integrator	**Angel Monera** FPGA Engineer
Jeong Han Lee Integrator	**Faye Chicken** Technician
Joao Martins Integrator	**Javier Cerejo** PhD Student
Julen Etxeberria Junior Controls Engineer	**John Sparger** Integrator
Simone Farina Embedded Systems Engineer	**Peter van Velze** Technician
Tomasz Brys Integrator	**Saeed Haghtalab** Integrator
Miklos Boros Integrator	**Thomas Fay** Integrator
Mehdi Mohammednezhad Integrator	**Krisztián Löki** Integrator
William Ledda Integrator	**Oliver Talevski** Embedded Engineer
Nour Akel ICS Installation Coordinator	*4 Open positions* Under Consideration
Benedetto Gallese Integrator	

Susanne Regnell
Controls Software

Ben Folsom
PhD Student

Claudio Rosati
Software Engineer

Emanuele Laface
Accelerator Physicist

Fredrik Söderberg
Software Engineer

Juan Esteban Müller
Software Scientist

Ricardo Fernandes
Control System Software Architect

Banafsheh Hajinasab
Software Engineer

Georg Weiss
Software Engineer

Jan-Åke Persson
Senior Software Engineer

Karin Rathsman
Accelerator Scientist

Dirk Nordt
Software Engineer

Off Side Consultant
Placeholder

Off Side Consultant
Placeholder

Off Side Consultant
Placeholder

Annika Nordt
Safety and Protection

Enric Bargalló Lead Analyst Engineer	**Alberto Toral** Technician
Mattias Eriksson Technician	**Denis Paulic** DGL, PLC engineer
Riccard Andersson Technical Coordinator	**Manuel Zaera-Sanz** Lead Engineer Slow Interlocks
Stuart Birch Senior Engineer	**Morteza Mansouri** Safety Systems Engineer
Viktor Fred Lead engineer Electrical Installations	**Stephane Gabourin** Lead Engineer Fast Interlocks
Fernando Carrasco Martin IEC61508 Engineer	**Szandra Kövecses** Lead Integrator
David Sanchez Automation Engineer	*1 Open positions* Under Consideration
Yong Kian Sin IEC61508 Engineer	

Remy Mudingay
Controls Infrastructure

Alessio Curri
System Administrator

Benjamin Bertrand
Software Engineer

Johan Christensson
Infrastructure Technology Engineer

Susann Skarin
Junior Network Technician

Anders Harrisson
Software Configuration Manager

Fredrik Luthander
Software Configuration Manager

Peter Holgersson
Electrical Engineer

1 Open positions
Under Consideration

Timo Korhonen
Chief Engineer

Hector Novella
Deputy Project Manager

Thilo Friedrich
Systems Engineer

Wojtek Fabianowski
In-Kind Manager

Maria Romedahl
Technical Coordinator

Anna Gillberg
Team Assistant

Permant Employees	45
Temporary Employees	45
On-Site Consultant	12
Off-Site Consultant	3
Open Positions	5

ICS Organization
2018-04

EUROPEAN SPALLATION SOURCE

Henrik Carling
Division Head

Karl Vestin
Hardware and Integration

Susanne Regnell
Controls Software

Annika Nordt
Safety and Protection

Remy Mudingay
Controls Infrastructure

Timo Korhonen
Chief Engineer

Karl Vestin group
- François Bellorini — Integrator
- Jeong Han Lee — Integrator
- Joao Martins — Integrator
- Julen Etxeberria — Embedded Systems Engineer
- Simone Farina — Embedded Systems Engineer
- Tomasz Brys — Integrator
- Miklos Boros — Integrator
- Mehdi Mohammednezhad — Integrator
- William Ledda — Integrator
- Nour Abel — ICS Installation Coordinator
- Benedetto Gallese — Integrator

- Angel Monera — Electrical Engineer
- Faye Chicken — Technician
- Javier Cereijo — Unix Analyst
- John Sparger — Integrator
- Peter van Velze — Technician
- Saeed Haghtalab — Accelerator Physicist
- Thomas Fay — Integrator
- Krisztián Löki — Integrator
- Oliver Talevski — Embedded Engineer
- 4 Open positions — Under Consideration

Susanne Regnell group
- Ben Folsom — Fire Analyst
- Claudio Rosati — Software Engineer
- Emanuele Laface — Accelerator Physicist
- Fredrik Söderberg — Software Engineer
- Juan Esteban Müller — Software Scientist
- Ricardo Fernandes — Control System Software Architect
- Banafsheh Hajinasab — Software Engineer
- Georg Weiss — Software Engineer
- Jan-Åke Persson — Senior Software Engineer
- Karin Rathsman — Accelerator Scientist
- Dirk Nordt — Software Engineer
- Off Site Consultant — Placeholder
- Off Site Consultant — Placeholder
- Off Site Consultant — Placeholder

Annika Nordt group
- Enric Bargalló — Lead Analyst Engineer
- Mattias Eriksson — Technician
- Riccard Andersson — Technical Coordinator
- Stuart Birch — Senior Engineer
- Viktor Fred — Lead Engineer Electrical Installations
- Fernando Camsco Martin — RF/LLRF Engineer
- David Sanchez
- Yong Kian Sin — RF/LLRF Engineer

- Alberto Toral — Technician
- Denis Paulic — PSS, PSS Engineer
- Manuel Zaera-Sanz — Lead Engineer Slow Interlocks
- Morteza Mansouri — Safety Systems Engineer
- Stephane Gabourin — Lead Engineer Fast Interlocks
- Szandra Kövecses — Lead Integrator
- 1 Open positions — Under Consideration

Remy Mudingay group
- **Alessio Curri** — System Administrator
- **Benjamin Bertrand** — Software Engineer
- **Johan Christensson** — Infrastructure Technology Engineer
- **Susann Skarin** — Junior Network Technician
- **Anders Harrisson** — Software Configuration Manager
- **Fredrik Luthander** — Software Configuration Manager
- **Peter Holgersson** — Electrical Engineer
- **1 Open positions** — Under Consideration

Timo Korhonen group
- Hector Novella — Deputy Project Manager
- Thilo Friedrich — Systems Engineer
- Wojtek Fabianowski — Controls Engineer
- Maria Romedahl
- Anna Gillberg — Team Assistant

Permant Employees	45
Temporary Employees	45
On-Site Consultant	12
Off-Site Consultant	3
Open Positions	5

Group Structure

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┌──────────────────────┐
│   ESS Staff          │
├──────────────────────┤
│   Consultants        │
└──────────────────────┘
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Control System Infrastructure Group
Group Leader - Remy Mudingay

Work Unit 14.07.01
Control Room
- Remy Mudingay
  Coordinator

Work Unit 14.07.02
Data Centre
- Alessio Curri
  System Administrator

- Linux Administrator
  Vacant

Work Unit 14.07.03
Control System Network
- Susann Skarin
  Network technician
- Johan Christensson
  Infrastructure engineer

- Peter Holgersson
  Electrical engineer

Work Unit 14.07.05
Software Infrastructure
- Benjamin Bertrand
  Software engineer

- Fredrik Luthander
  Software Configuration Manager
- Anders Harrisson
  Software Configuration Manager

Technical Network

Networks @ ESS

- Technical Network
    - Channel/PV access
    - PROFINET (non time-critical data ~ 10ms)
    - S7 protocol (Ethernet)
    - Private (non-routable networks)
    - Point-to-point networks (not included!)
    - Timing system (optical)

- General Purpose Network
    - Office network (wired and wireless)
    - Internet facing network
    - Remote access from the outside->in

- Neutron Data Network
    - Data acquisition from neutron instrument to data aggregator
    - High performance computing
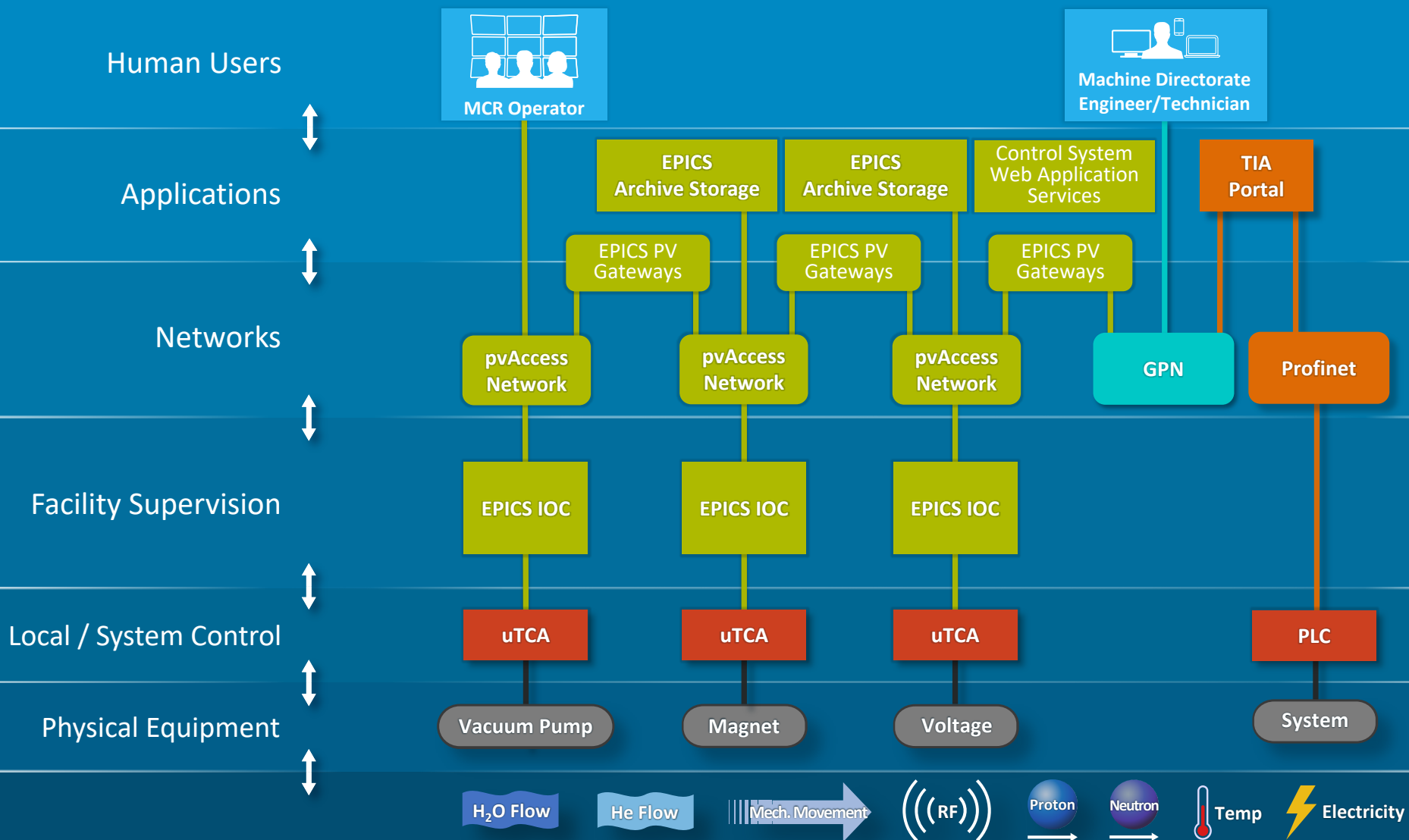
Network Topology

- The logical network topology:
- collapsed Core and access layer
- Two routes from the core to the access layer
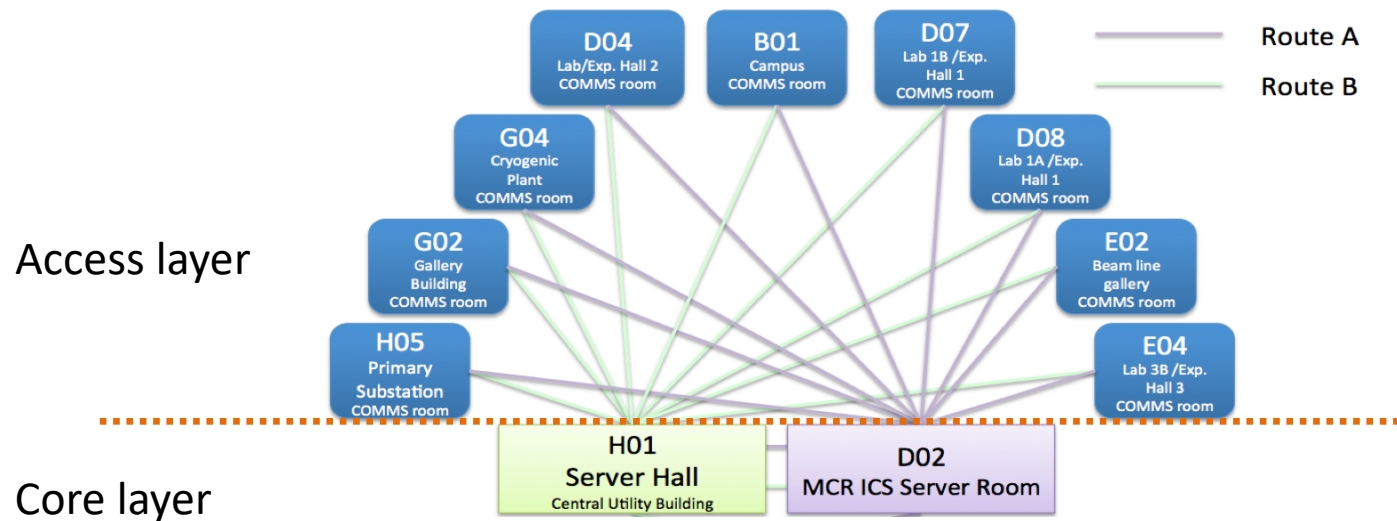
Network Topology

Example: access layer switch (stack)

Network stack in FEB90 ZDF

Access layer
(Leaf)

Core layer
(Spine)

D04
Lab/Exp. Hall 2
COMMS room

301
Campus
COMMS room

G04
Cryogenic
Plant
COMMS room

G02
Gallery
Building
COMMS room

E02
Beam line
gallery
COMMS room

COMMS room

H05
Primary
Substation
COMMS room

E04
Lab 3B /Exp.
Hall 3
COMMS room

H01
Server Hall
Central Utility Building

D02
MCR ICS Server Room
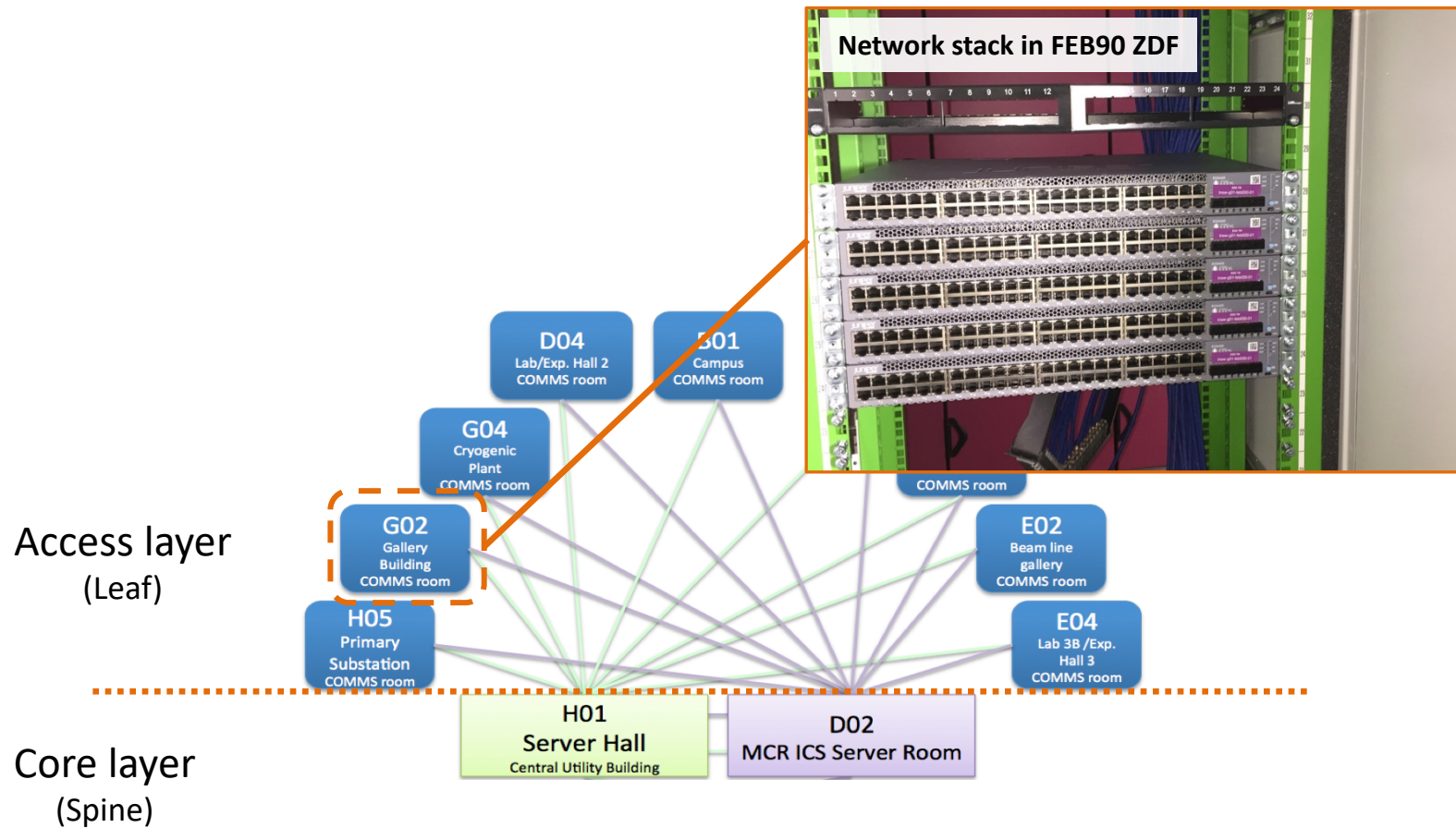
Network Topology
Example: core layer switch
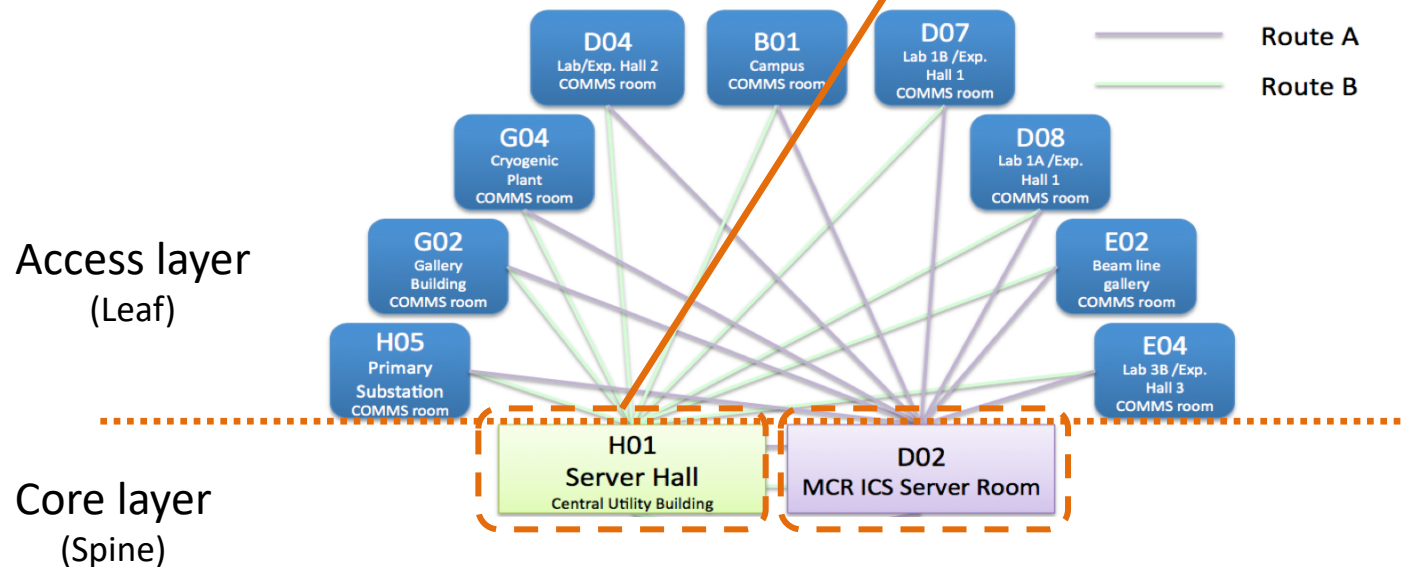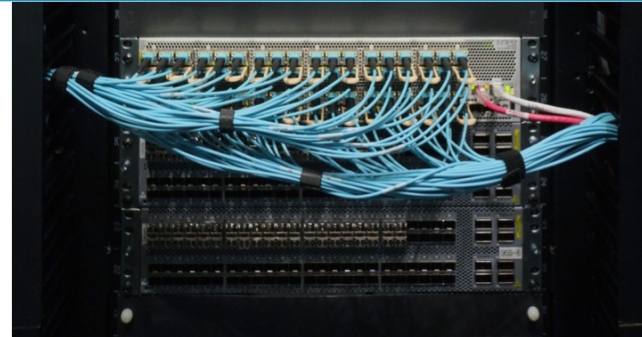
Technical Network Equipment
Configuration management

12 x Top of rack switch: 12 x 40 GbE & 32 x 10GbE

2 x Core: 24 x 100GbE/72 x 40GbE/288 x 10Gb

155 x Edge switch: 2 x 40GbE & 4 x 10GbE & 48

How do you manage these in a consistent manner?

Configuration management
Automation using Ansible modules
- LAX
- NAPALM
- OpenConfig
- YANG

Python code executed here

Ansible Control Host

SSH
Netconf
eAPI
NX-API

Network Device

Inventory File

sw1
r1
fw1

Playbook

play 1
hosts: all
- task 1
- task 2
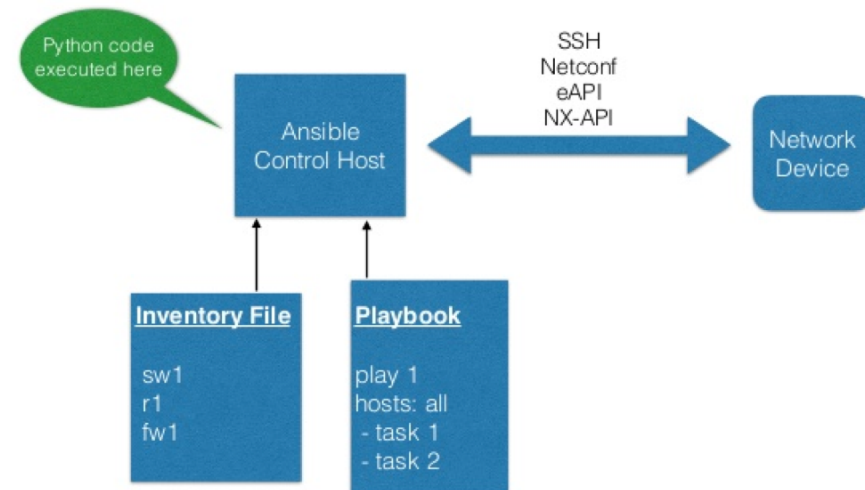
Network Design Drawings
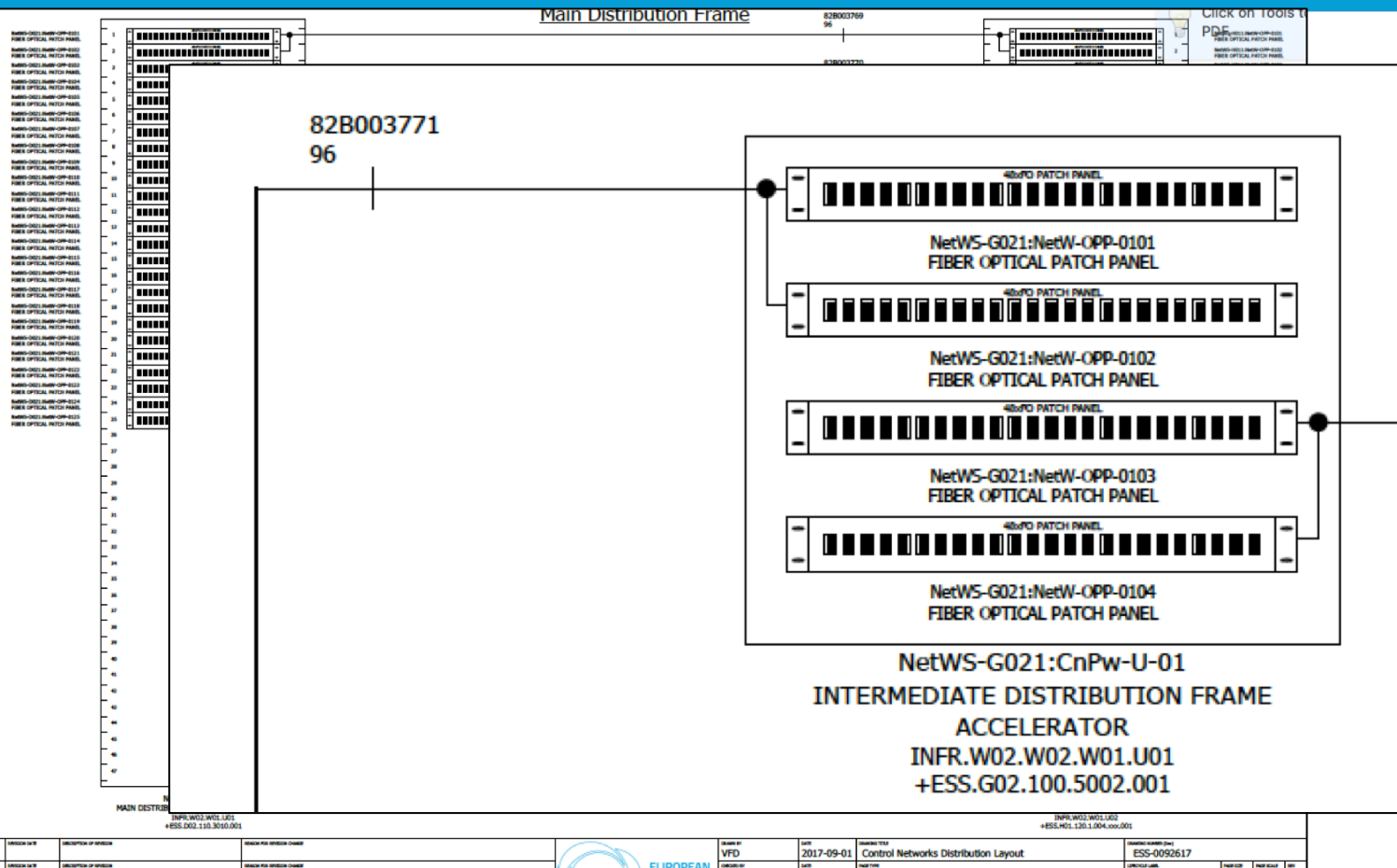
Physical Network Architecture
ISO/IEC 24764

EO — Equipment outlet

Zone Distribution Frame (**ZDF**)

Intermediate Distribution Frame (**IDF**)

Main Distribution Frame (**MDF**)
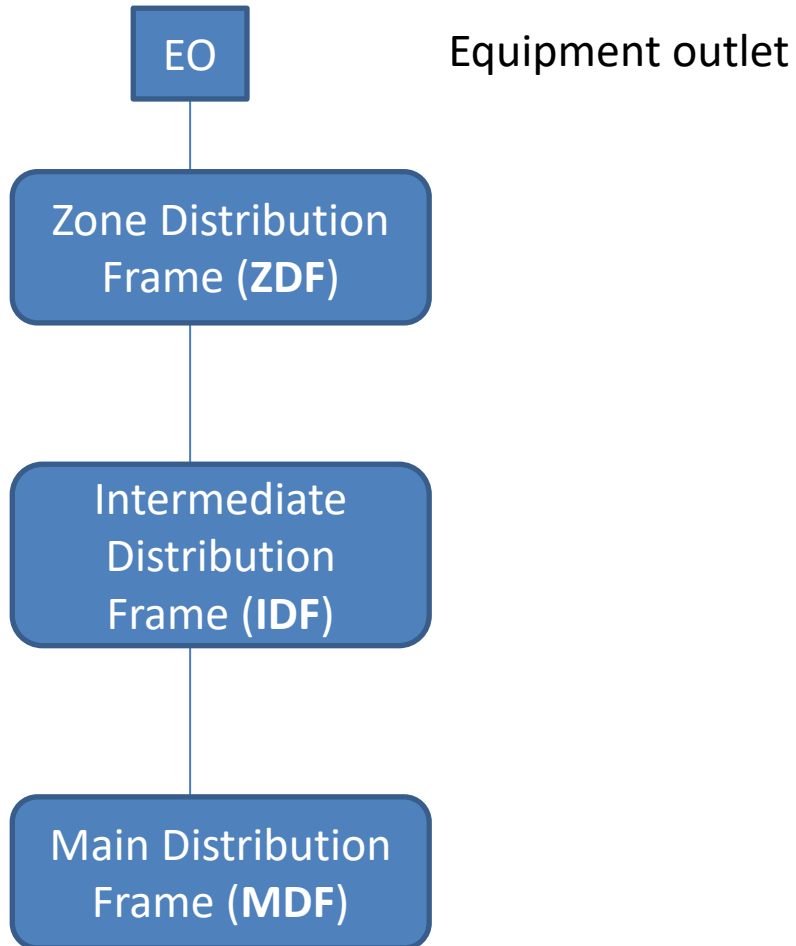
Physical Network Architecture

device/equipment outlet

EO

Zone Distribution Frame (**ZDF**)

Intermediate Distribution Frame (**IDF**)

Main Distribution Frame (**MDF**)

FEB90

Example rack in FEB90

Physical Network Architecture

EO

Zone Distribution Frame (**ZDF**)

Intermediate Distribution Frame (**IDF**)

Main Distribution Frame (**MDF**)

FEB90

Network distribution in FEB 90 (ZDF)
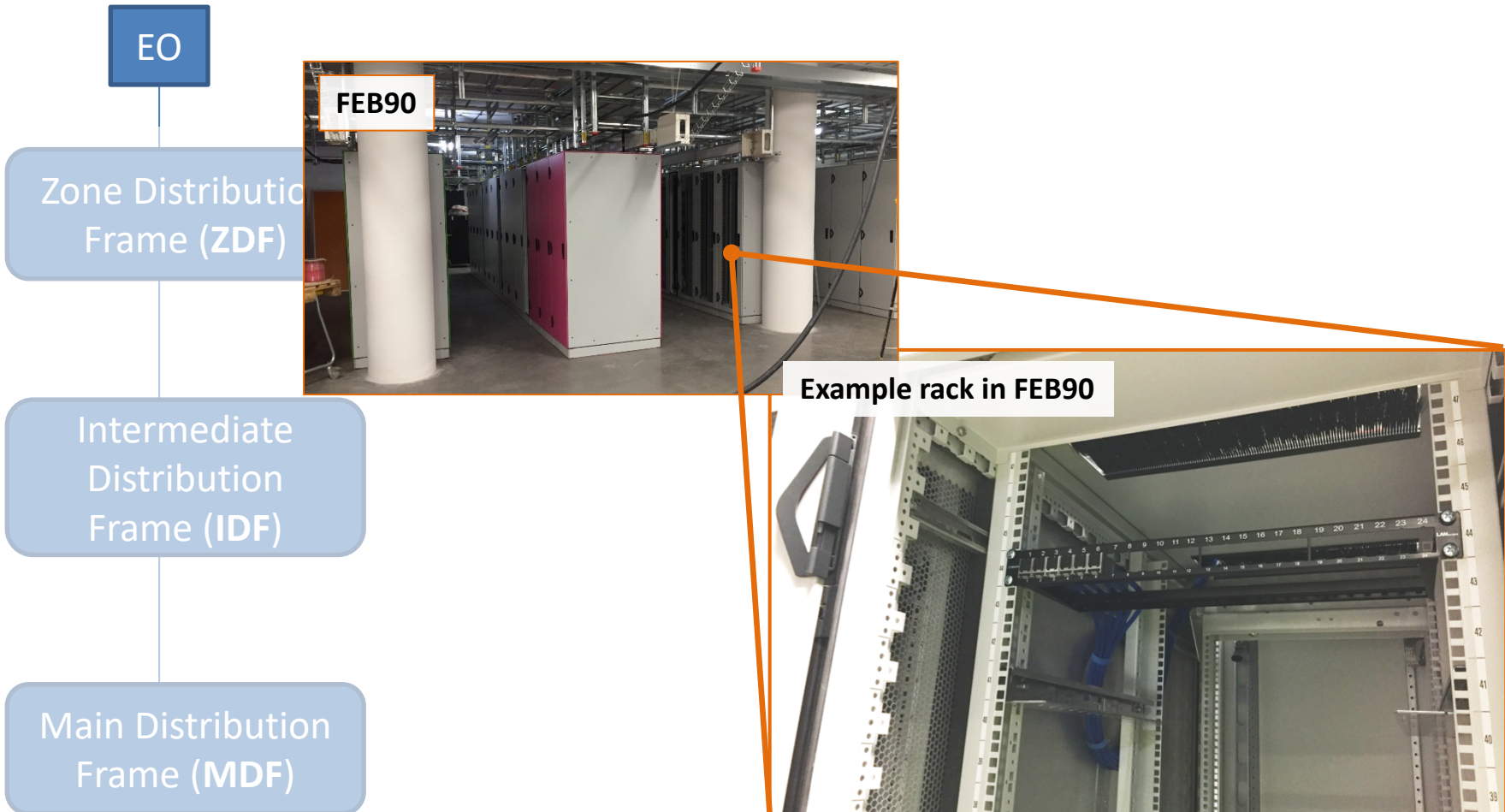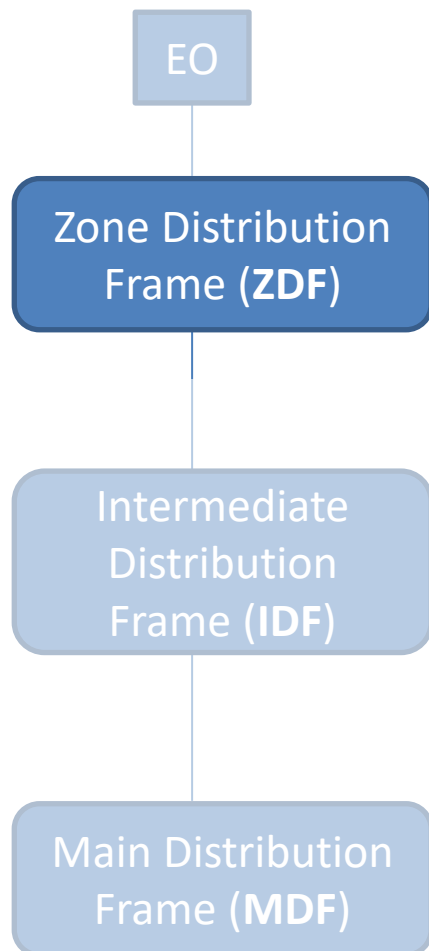
- Provides network outlets to devices
- Located in all racks that need network connectivity
- Modular system that an be easily expanded

Physical Network Architecture

EO

Zone Distribution Frame (ZDF)

Intermediate Distribution Frame (IDF)

Main Distribution Frame (MDF)

IDF racks in G02 comms rooms

- Aggregates ZDF to a communication rooms
  - Using optical fibre
- Permits direct connection across the gallery

Physical Network Architecture

EO

Zone Distribution Frame (**ZDF**)

Intermidiate Distribution Frame (**IDF**)

Main Distribution Frame (**MDF**)

- Interconnects IDFs
- Located in server rooms
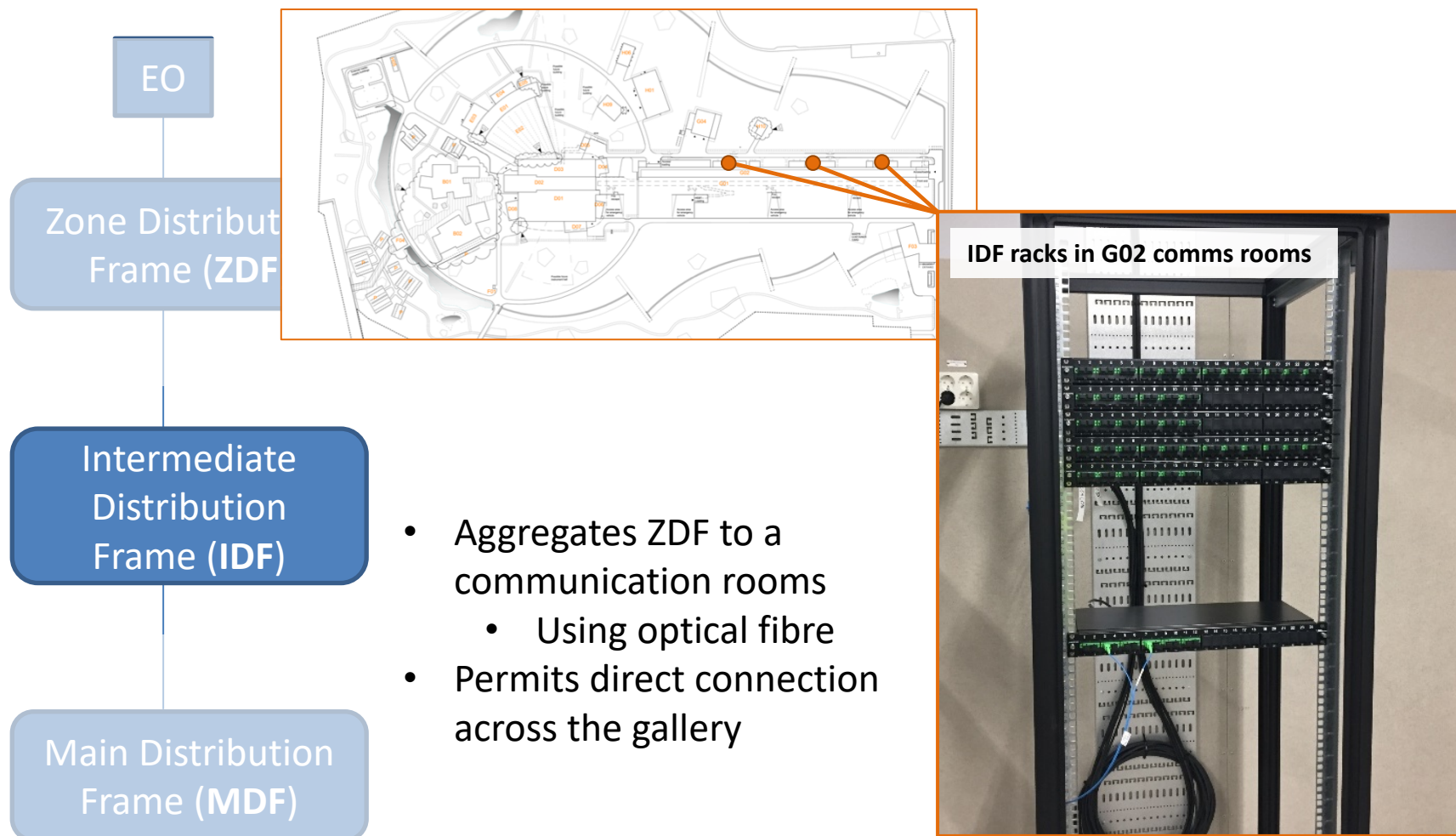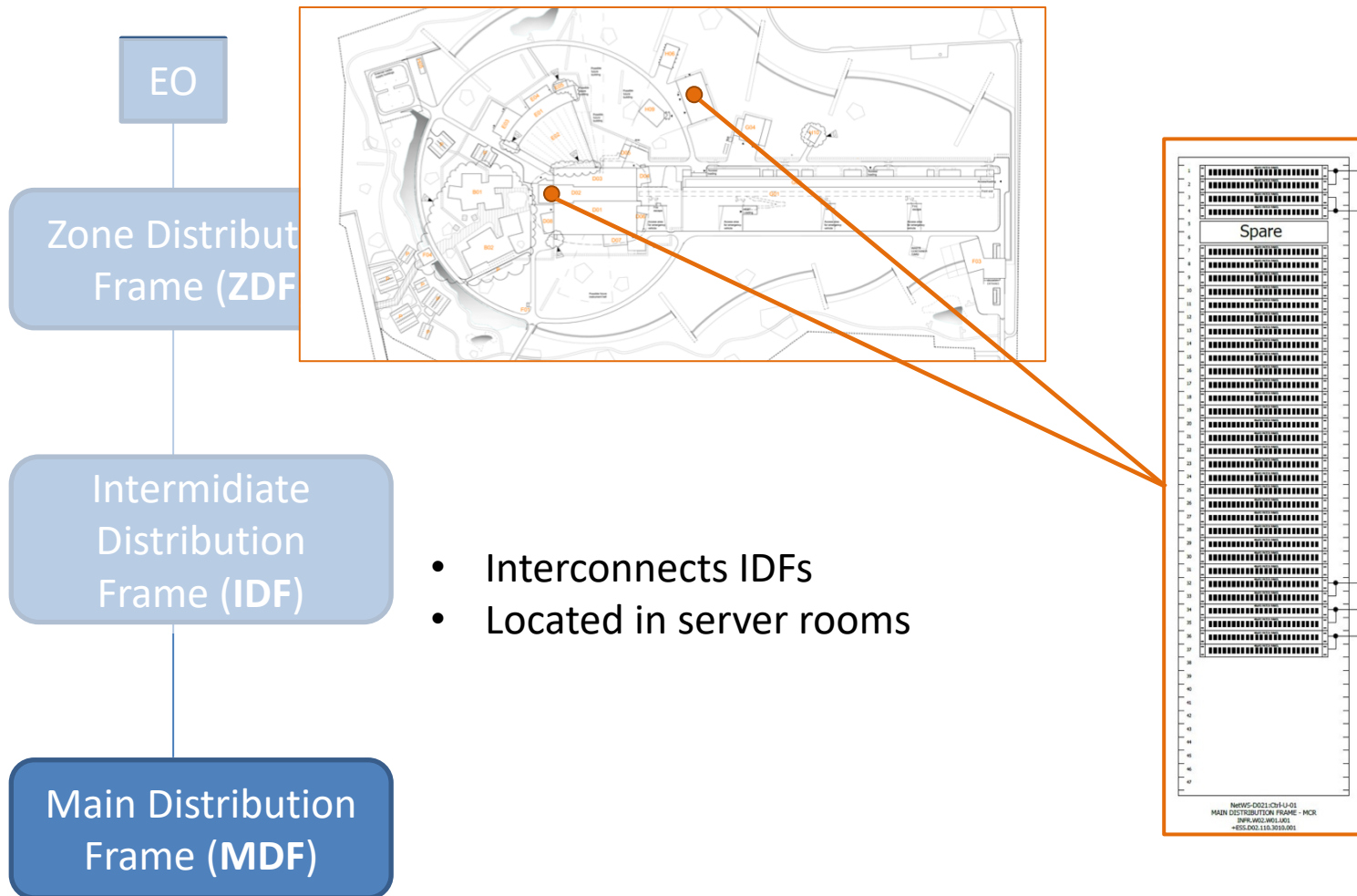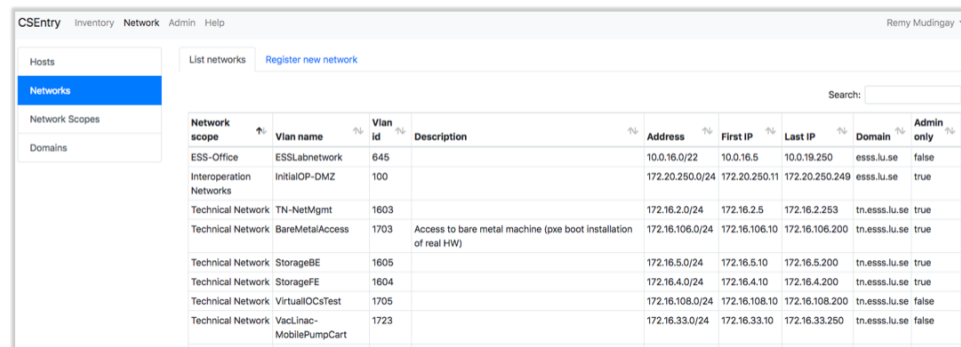
Network Installations and Supporting Tools

User requests

- JIRA
  - Description of issue or need

- CSEntry (control system entry)
  - Web application
  - Role-based access
    - Read-only
    - Read-write
    - Administrator
  - Inventory
  - Declarative network tool
    - Define networks (name, subnet, catalogue)
    - Define host (hostname, aliases, multiple ip addresses)

Containers, Virtual Machines, Oh my!

- A **virtual machine (VM)** is an emulation of a computer system (network, storage, memory, operating system, etc.)

Application
Operating system
Emulated hardware
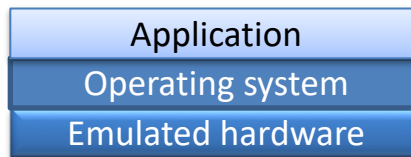
- A **container** is a an application environment (libraries, binaries) that has been isolated from other applications without the overhead of emulating a computing system.

Application
Binaries / Libraries

Containers and Virtualisation

Comparison

Traditional

| Application |
| Operating System |
| Hardware |

Virtualisation

| Application |
| Operating System |
| Hardware |

Containers

| Application |
| Operating System |
| Hardware |
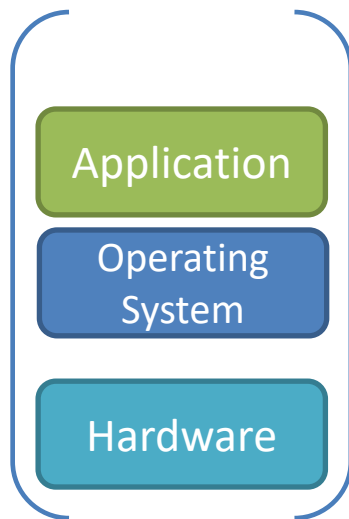
- Typically applications are deployed onto physical systems with a 1:1 relationship
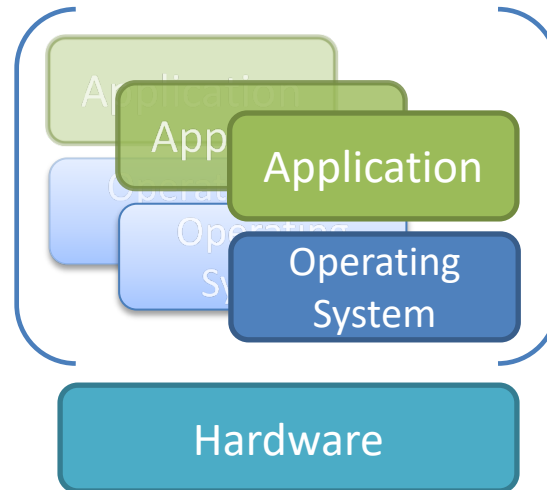
- Higher consolidation ratios and better utilisation
- Faster deployment
- Application benefit from virtual machine features (live migration & high availability)
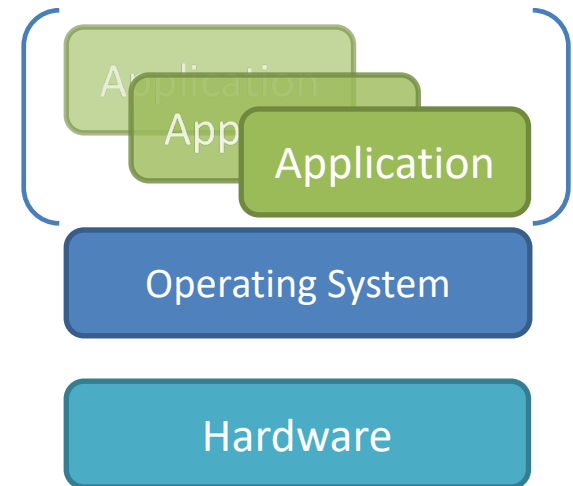
- Even higher consolidation ratios and maximises on the utilisation or resources.
- Software deployments take seconds
- Application benefit from virtual machine features (live migration & high availability) + bare-metal performance

Containers and Virtualisation tools

Why use them?

- Objectives:
  - **Easy deployment** :
    - Facilitate the deployment of applications
    - Automate creation, change and updates

  - **Straight-forward workflow** should be intuitive and transparent to all authorised users

  - **Traceability** and **availability**
    - Using common and widely available open source tools that are actively maintained
    - Who did what, when.
    - Provide highly available systems that are redundant and failover (without user intervention)

Containers and Virtualisation tools
What applications have we containerised/virtualised?

- Provides a stable, redundant environment where we can run our applications
  - **Deployed**
    - Archiver Appliances
    - Channel access gateways
    - Continuous Integration workflows
  - **Testing**
    - IOCFactory, CableDB, CSEntry, [...]
  - **Planned**
    - vIOCs (1000+)
    - Everything that does not require direct access to specialized hardware

Virtual machine creation
How is this achieved?

CSEntry (control system entry)

- Self service platform
  - Create a VM
    - Or a vIOC
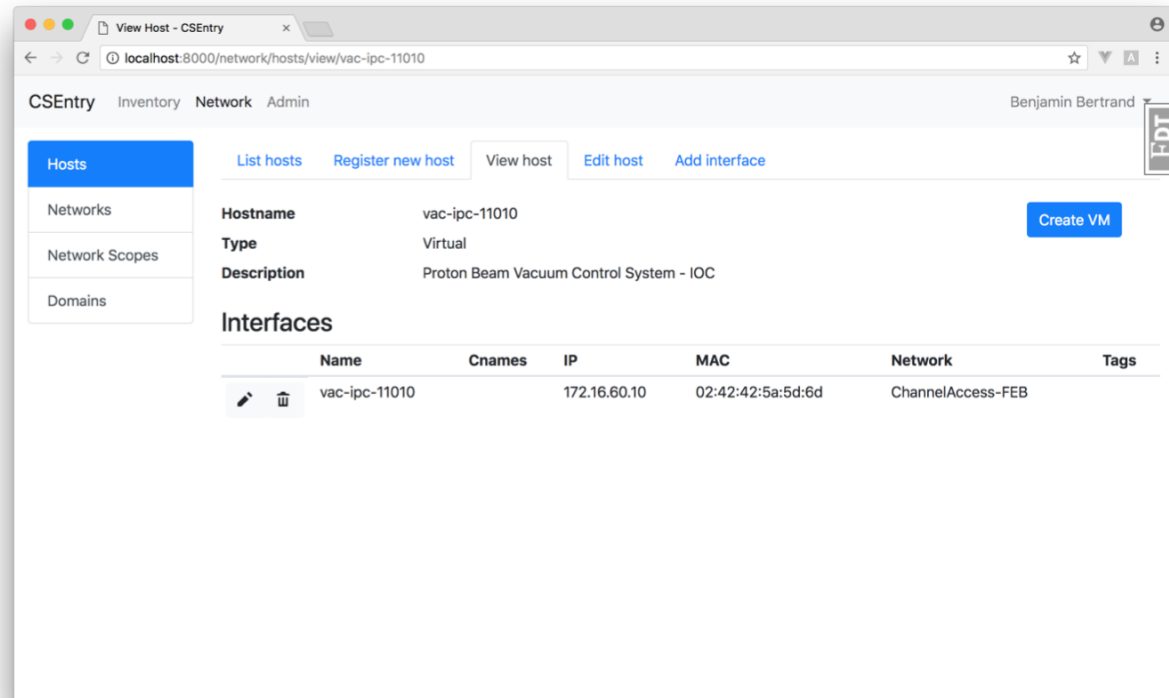
Virtual machine creation
DEMO

- CSEntry

- Use case
  - CA gateway
    - Restart (speed)
  - Virtual IOC
    - Example IOC
  - …

Thank You for Your Attention