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Lecture 2
virtualization

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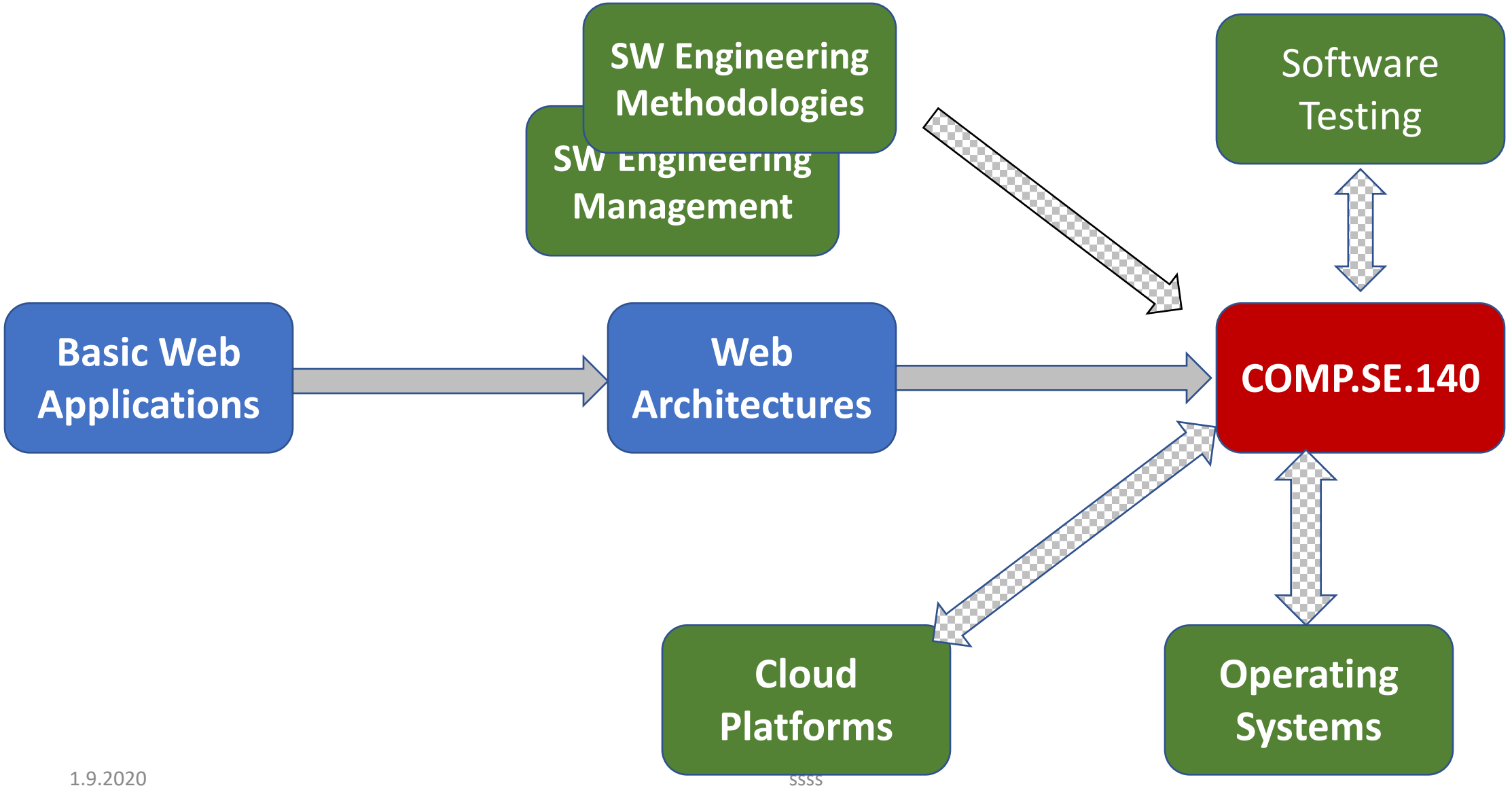
Content

- General course related matters
- Recap of DevOps
- Virtualization – what and why?
  - Software engineer point of view
- Containers
- Containers in practice: Docker
- Summary


SW Engineering Methodologies
SW Engineering Management
Software Testing
Basic Web Applications
Web Architectures
COMP.SE.140
Cloud Platforms
Operating Systems

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General course related matters

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Numbers & statistics

- Combine list from Sisu and Plus: 89
- Sign-ups in plus: 85
- Responses to initial questionary: 36 (still time left)
  - Heterogenous background
  - Some students lack relevant courses
  - Most responders work full- or part-time
  - Surprisingly, many students have taken Cloud Platforms

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Communication

- Fast messages: email
  - If you have not received, let me know
- Static info: plussa
- Sisu is updated seldom, if ever.

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DevOps practices

- Organizational
  - increased scope of responsibilities for developers;
  - intensified cooperation between development and operations.

- Technical
  - automation,
  - monitoring
  - measurement

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What is DevOps (there are several definitions)

- Lucy Lwakatare:
  - DevOps is a concept that embodies a **cultural and mindset change** that is substantiated with a **set of practices** to encourage **cross-disciplinary collaboration between software development and IT operations** within a software company. The main purpose for the collaboration is to enable the **fast release of quality software changes** while simultaneously **operating resilient systems**.
  - From a **socio-technical perspective**, DevOps practices are focused on the **automation practices** of software deployment and infrastructure management, specifically automation of configuration management and monitoring.

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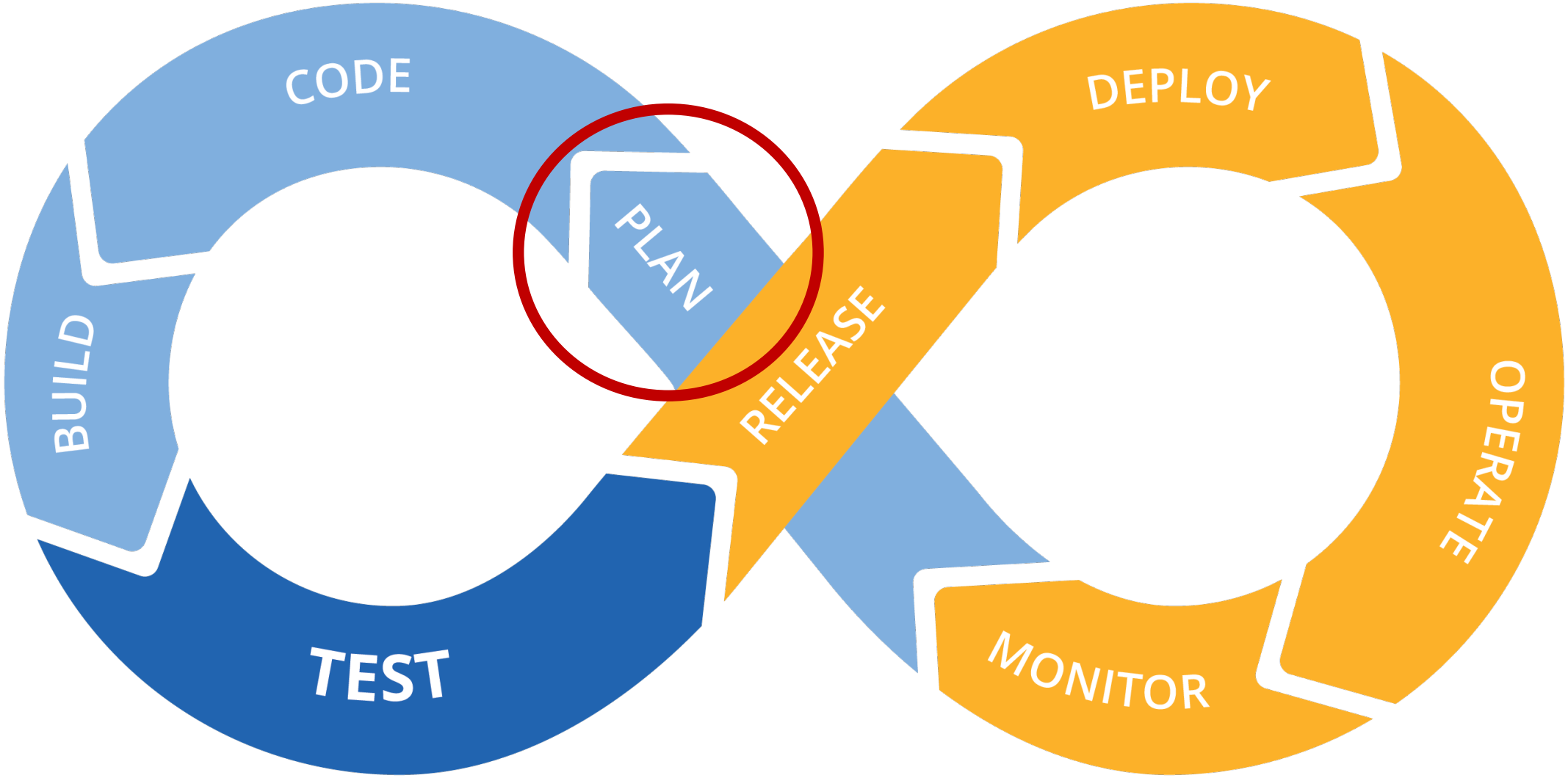
DevOps



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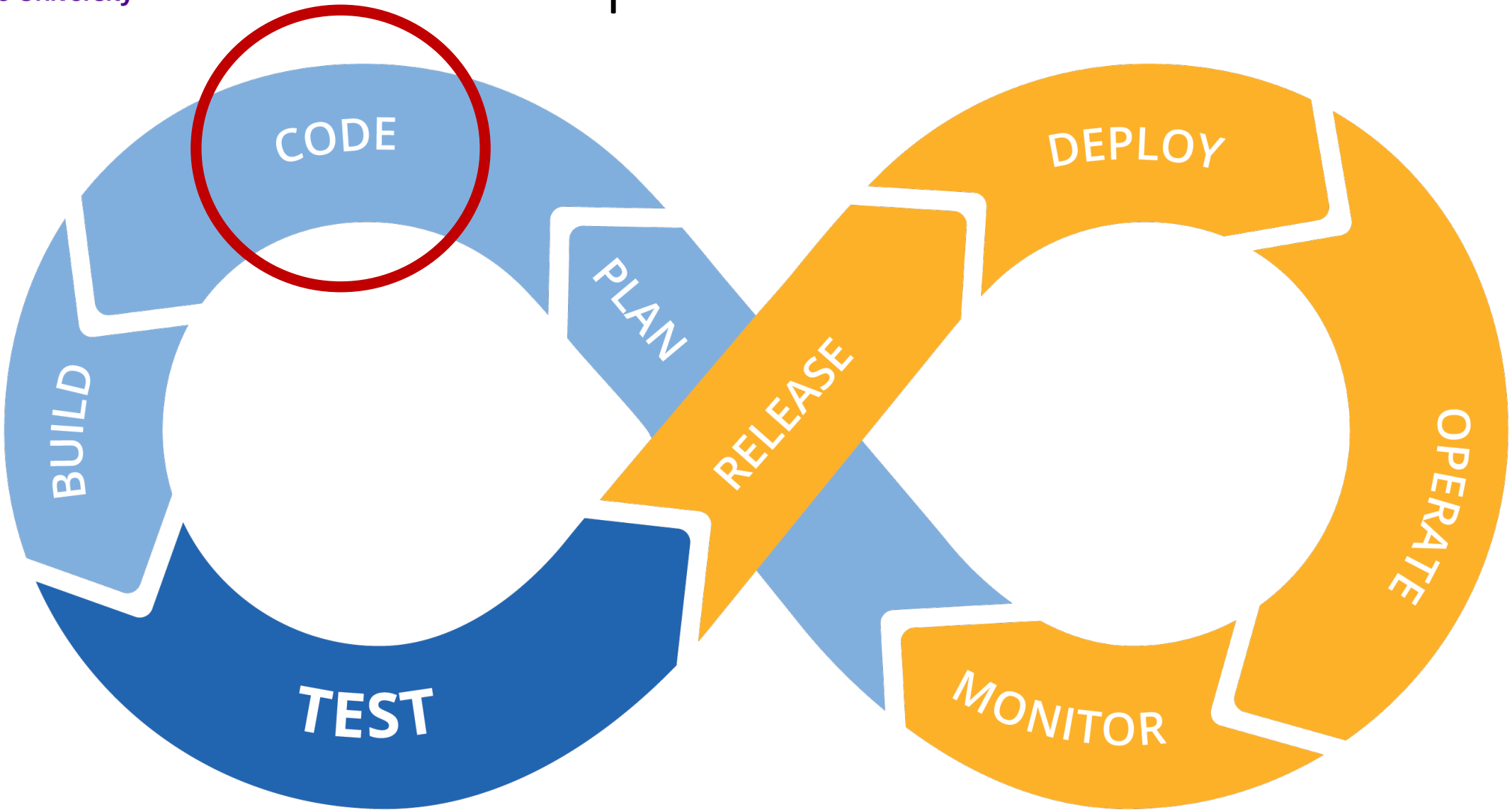
DevOps



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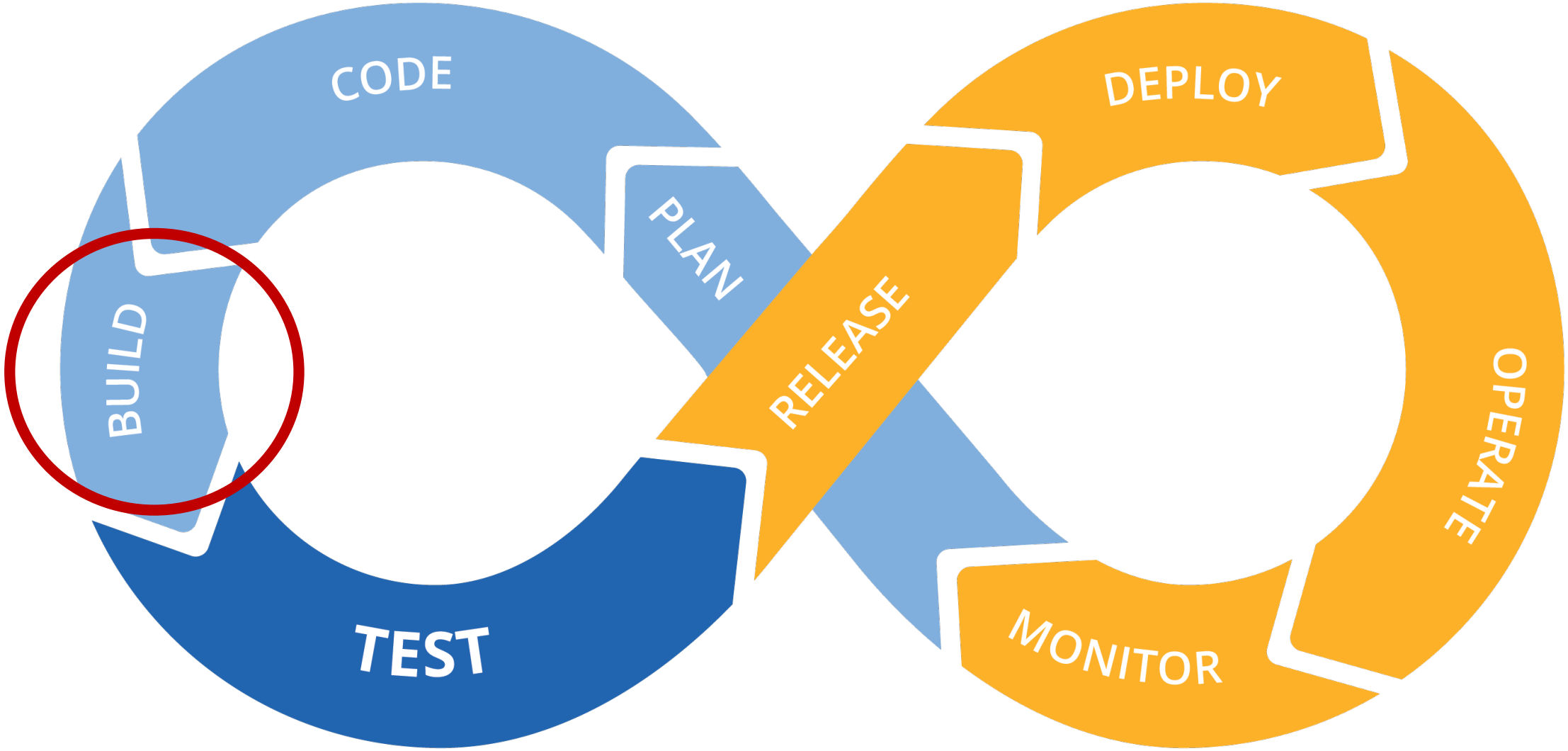
DevOps



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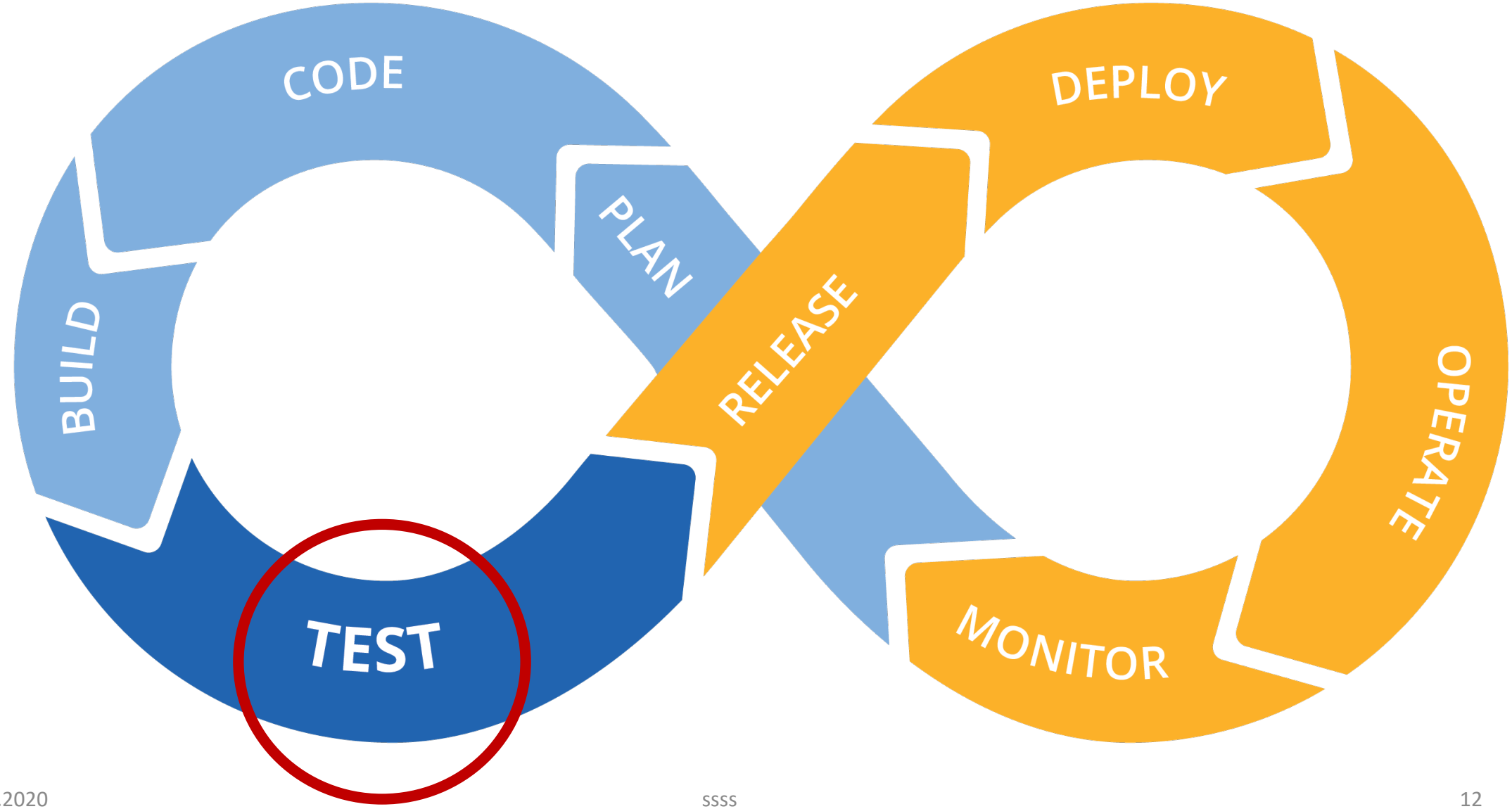
DevOps



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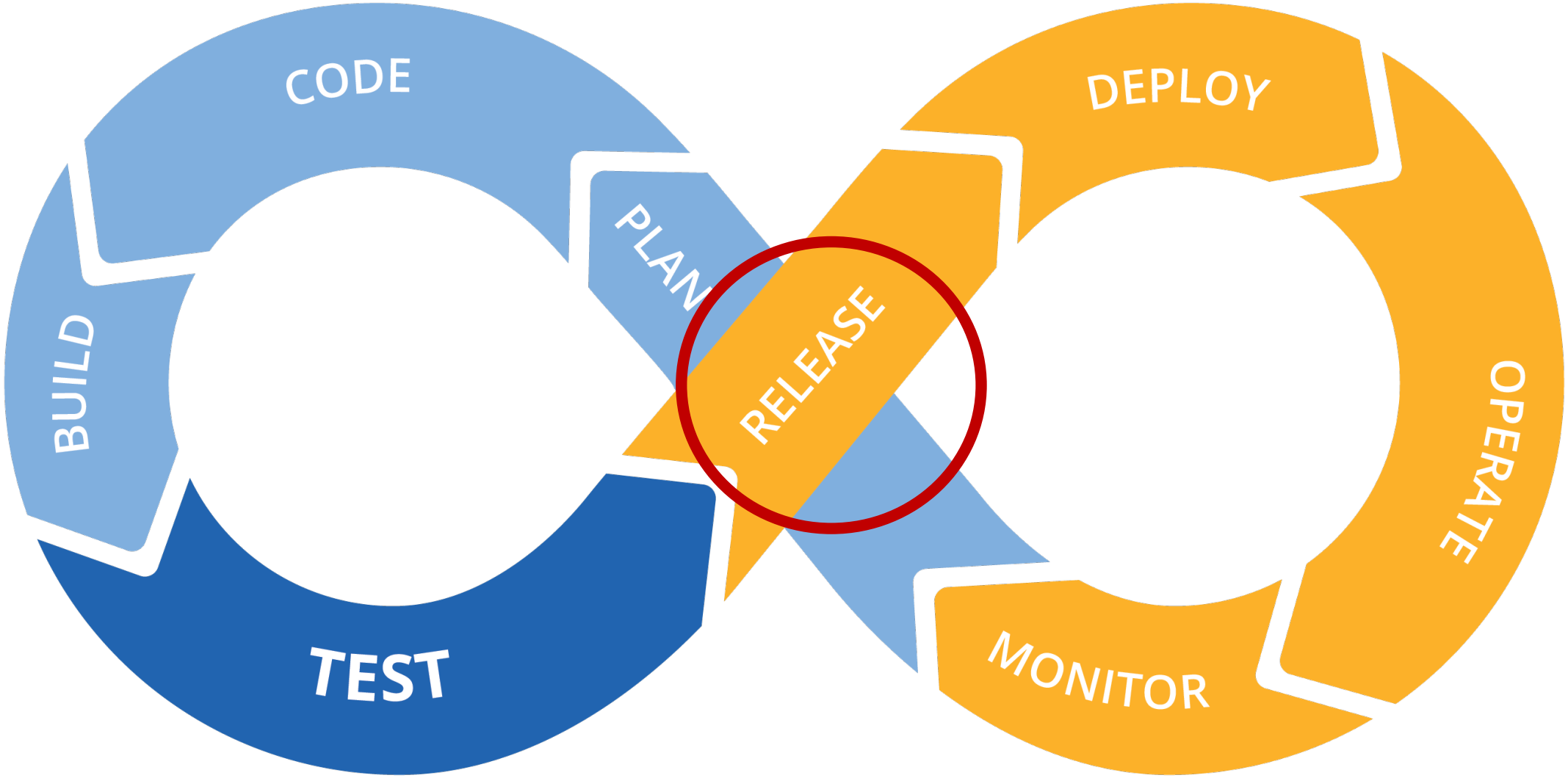
DevOps



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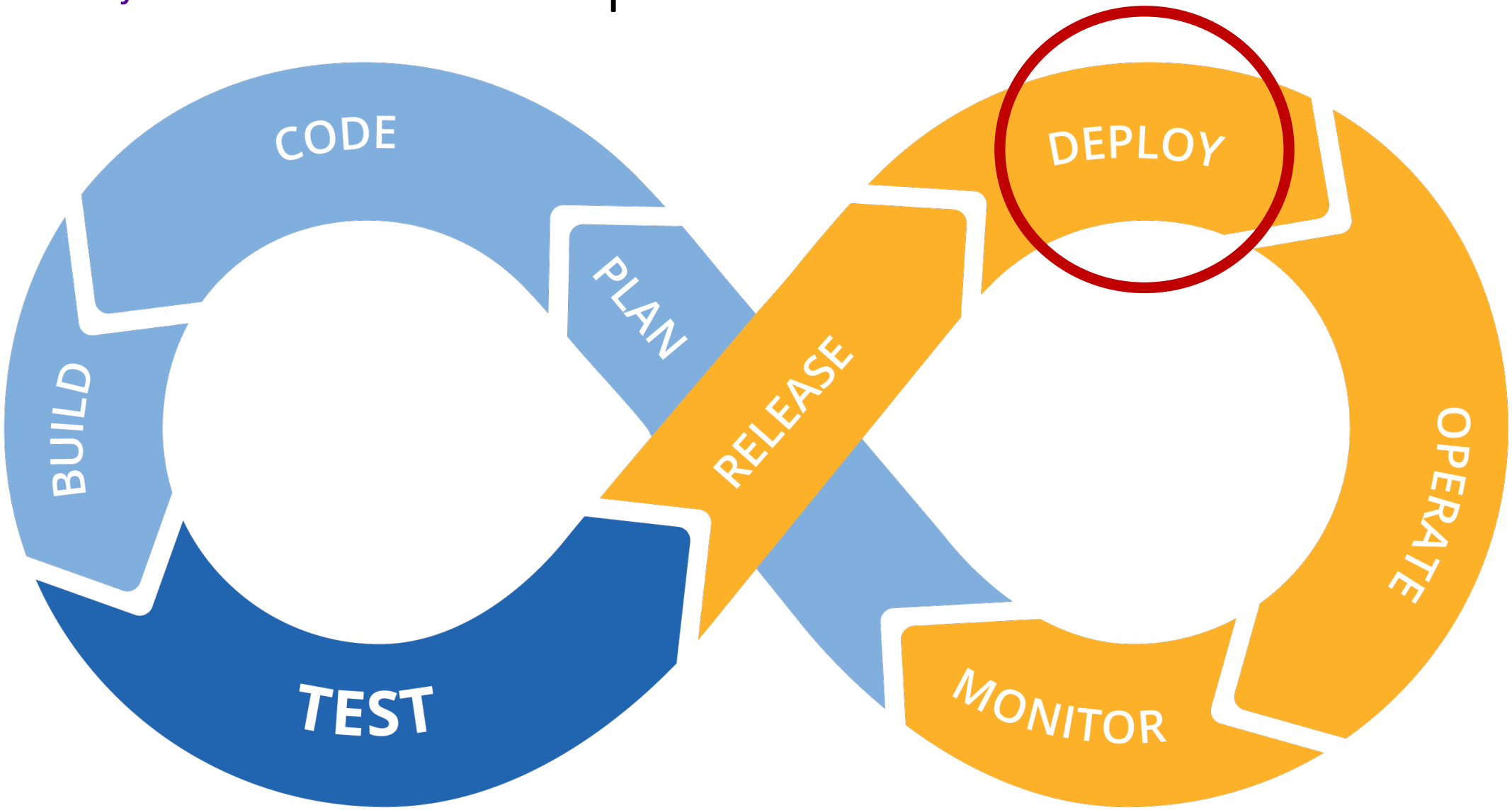
DevOps



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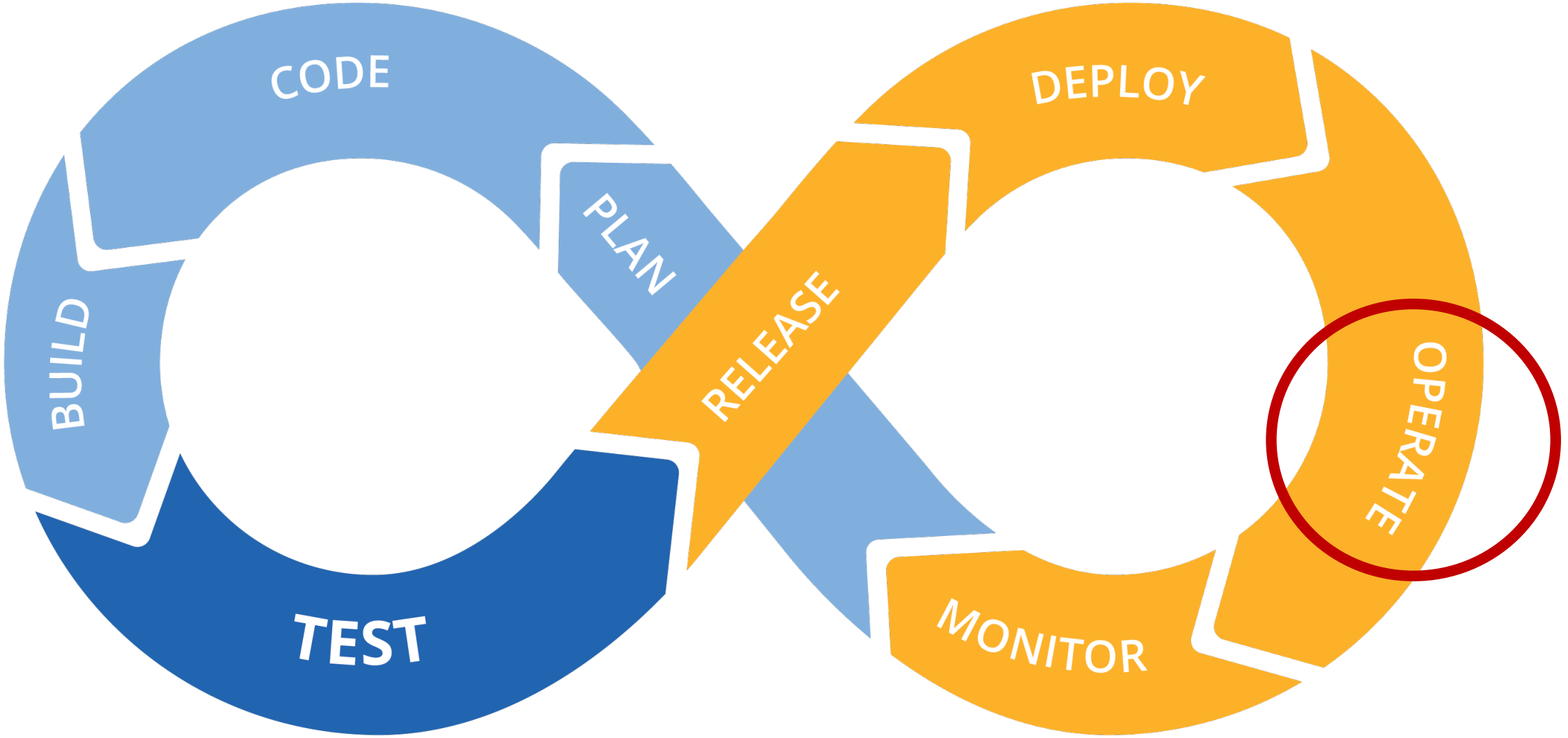
DevOps



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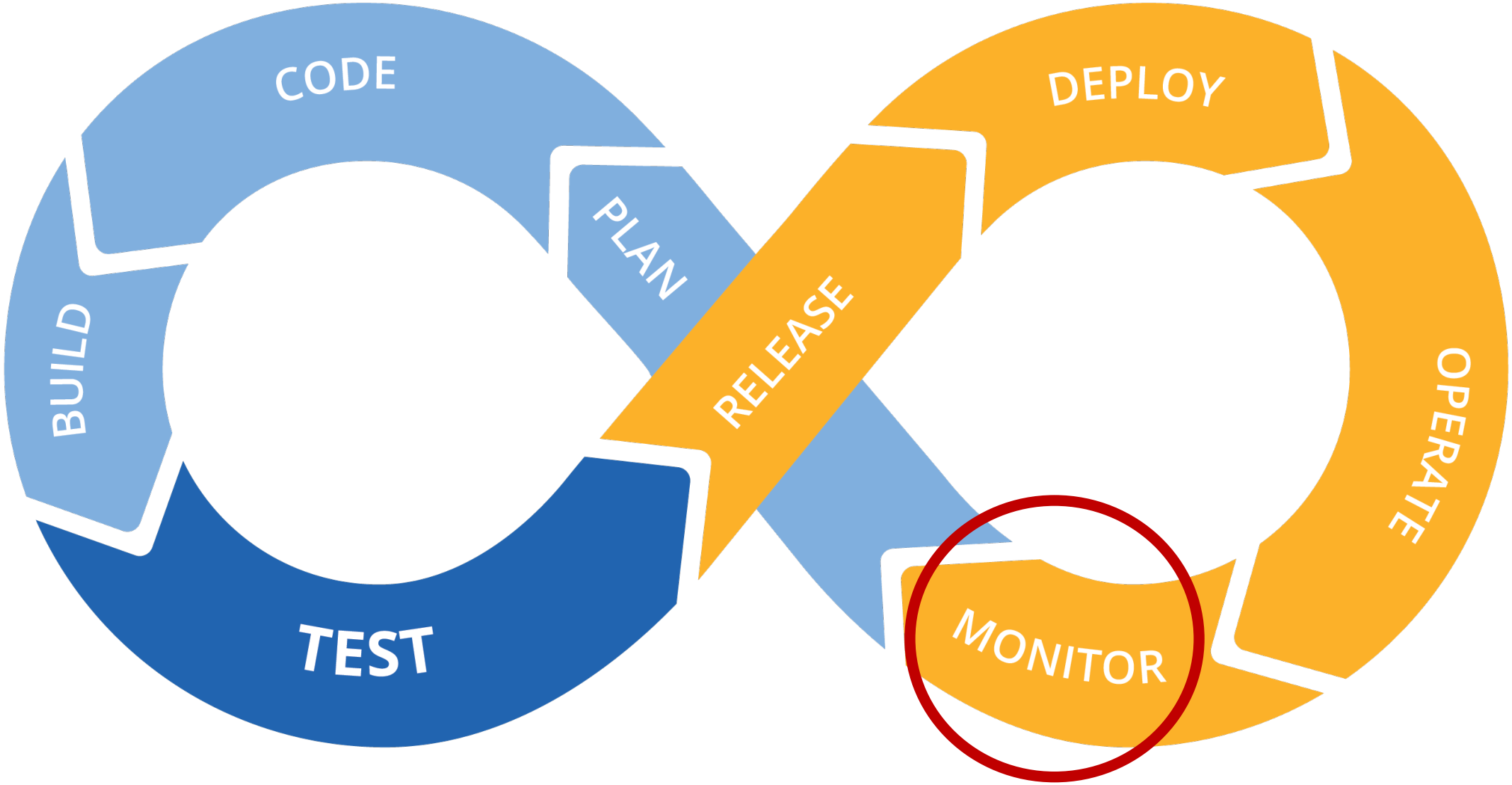
DevOps



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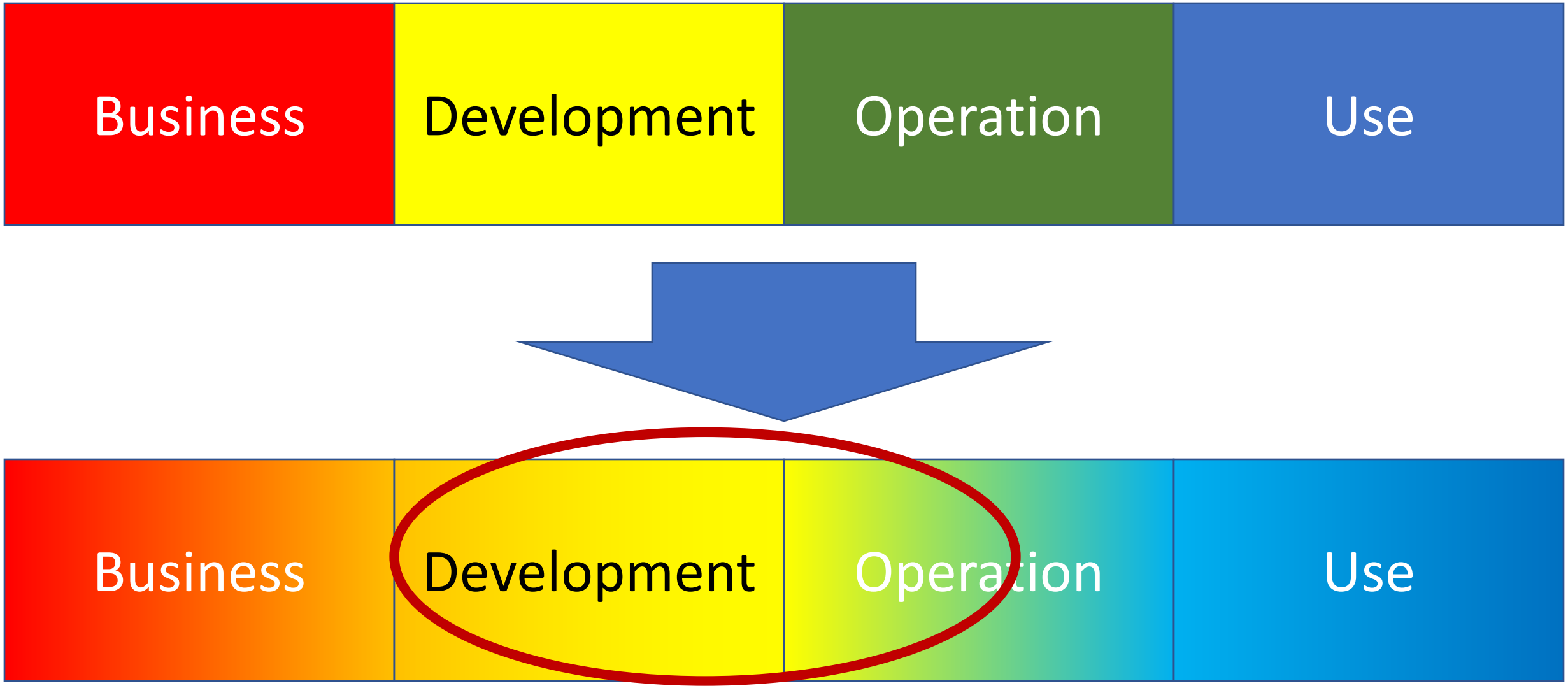

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Virtualization – what and why?

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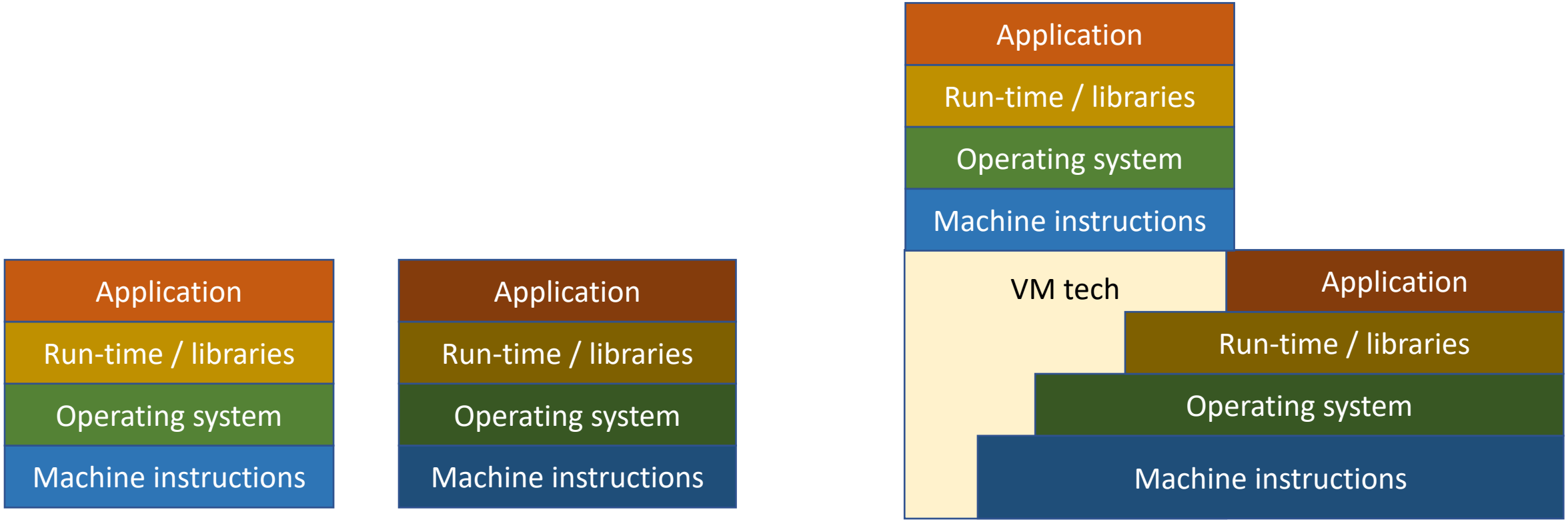
Use case 1: run ”foreign” software



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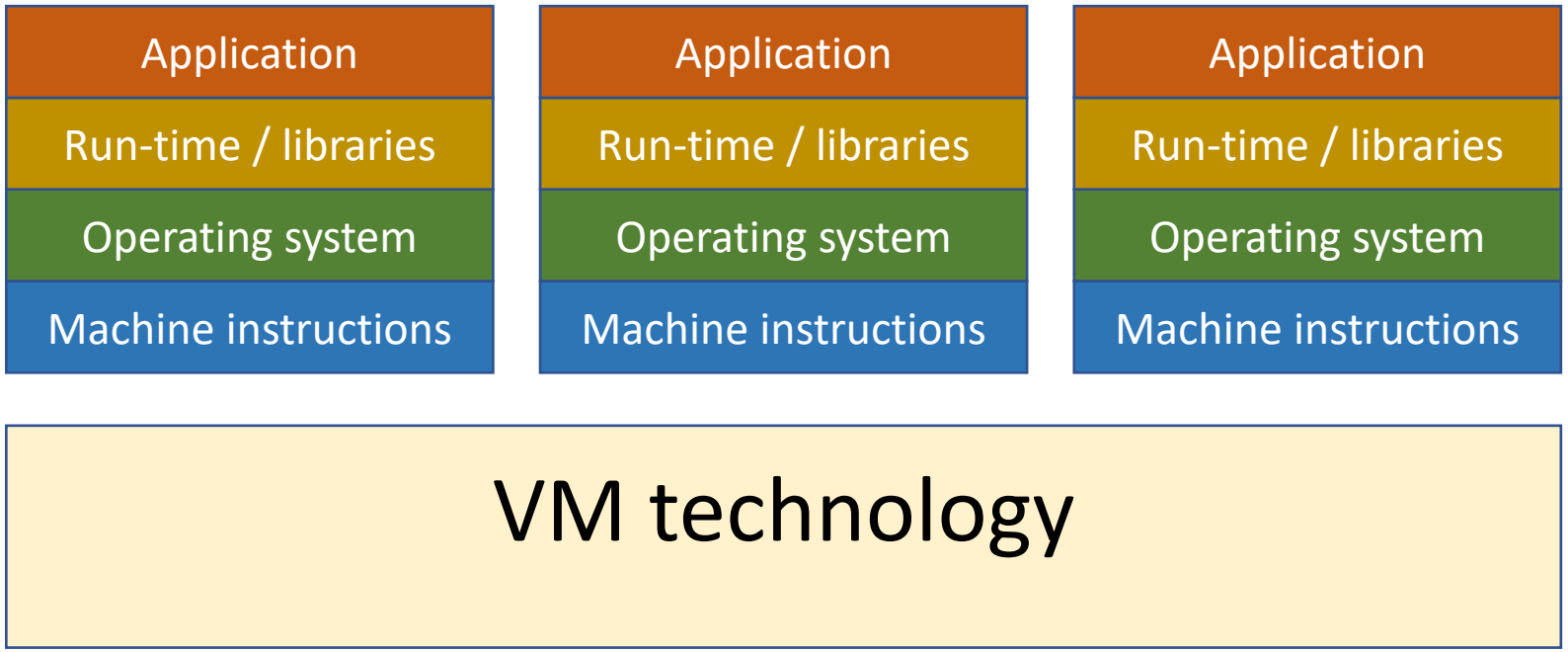
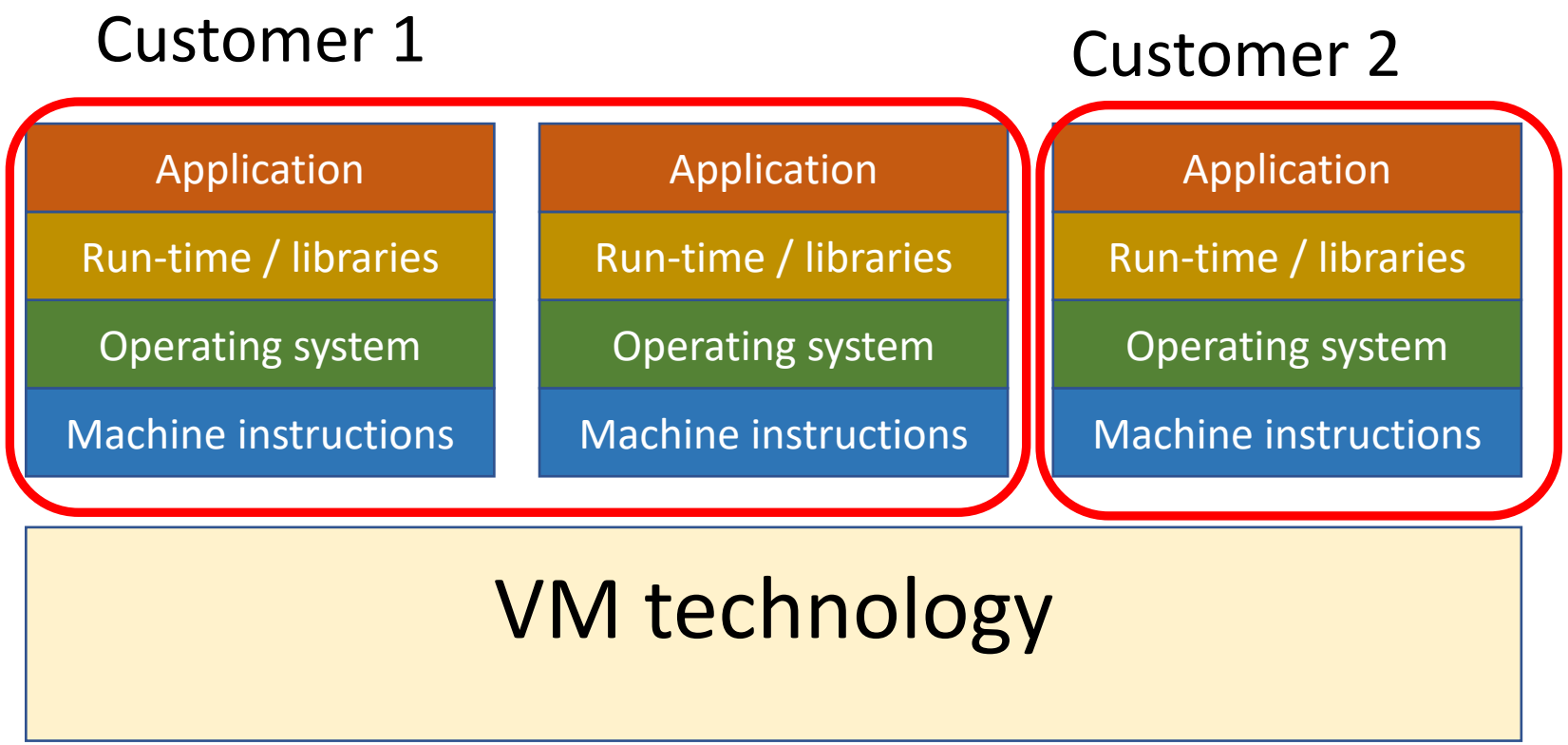
Use case 2: isolate



Use case 3: scale



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Levels of virtualization

- Hardware virtualization
- Operating system virtualization
- Desktop virtualization
- Application virtualization
- Network virtualization

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Network virtualization

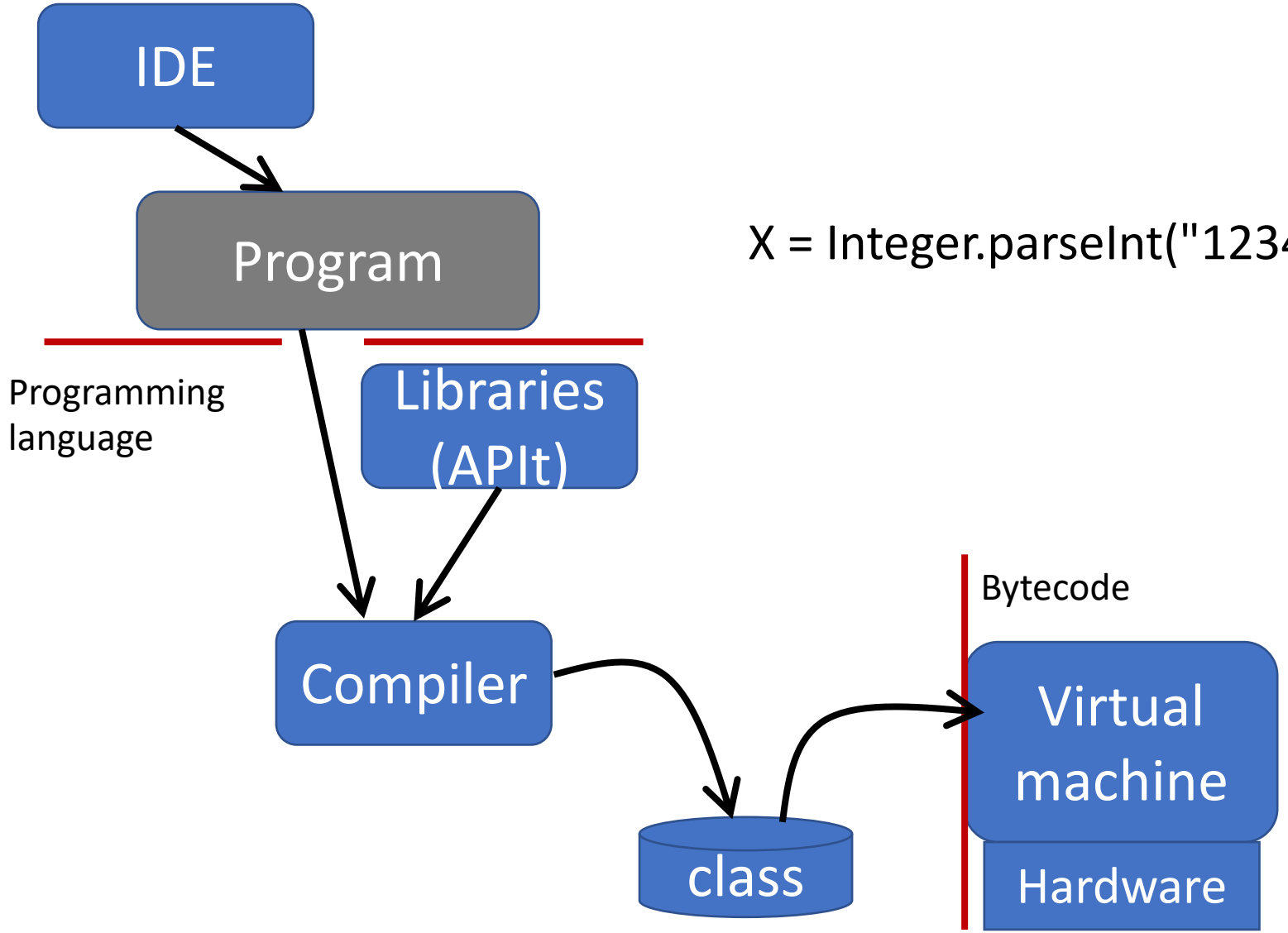
- Network, its HW and protocols, is simulated with software so that it looks like a different network to applications
- Different from OSI layer models

- Is VPN a virtual network?

Application virtualization

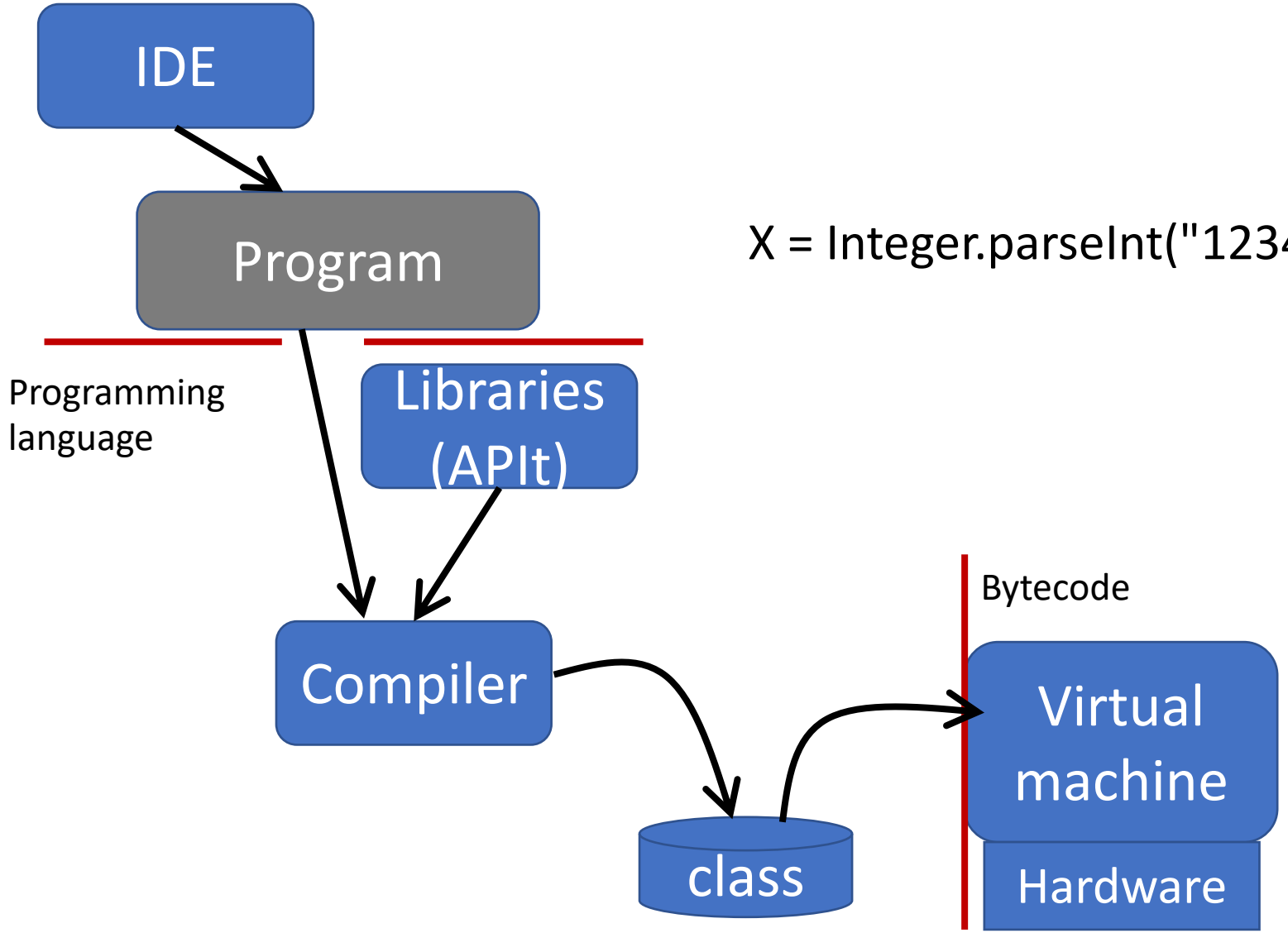
- Applications are compiled to machine-independent ”machine ” code
- Applications are run with a virtual machine
- Benefits
  - Same code can be run on different CPUs
  - Increased safety. Why?
- Problems
  - Performance

Example: java




```
X = Integer.parseInt("1234");
```

Java security




```
X = Integer.parseInt("1234");
```

```
$ javap -c test
Compiled from "test.java"
class test {
  int X;


  test();
    Code:
       0: aload_0             // this
       1: invokespecial #1    // Method java/lang/Object."<init>":()V
       4: return


  void foo();
    Code:
       0: aload_0
       1: ldc           #2    // String 1234
       3: invokestatic  #3    // Method java/lang/Integer.parseInt:(Ljava/lang/String;)I
       6: putfield      #4    // Field X:I
       9: return
}
```

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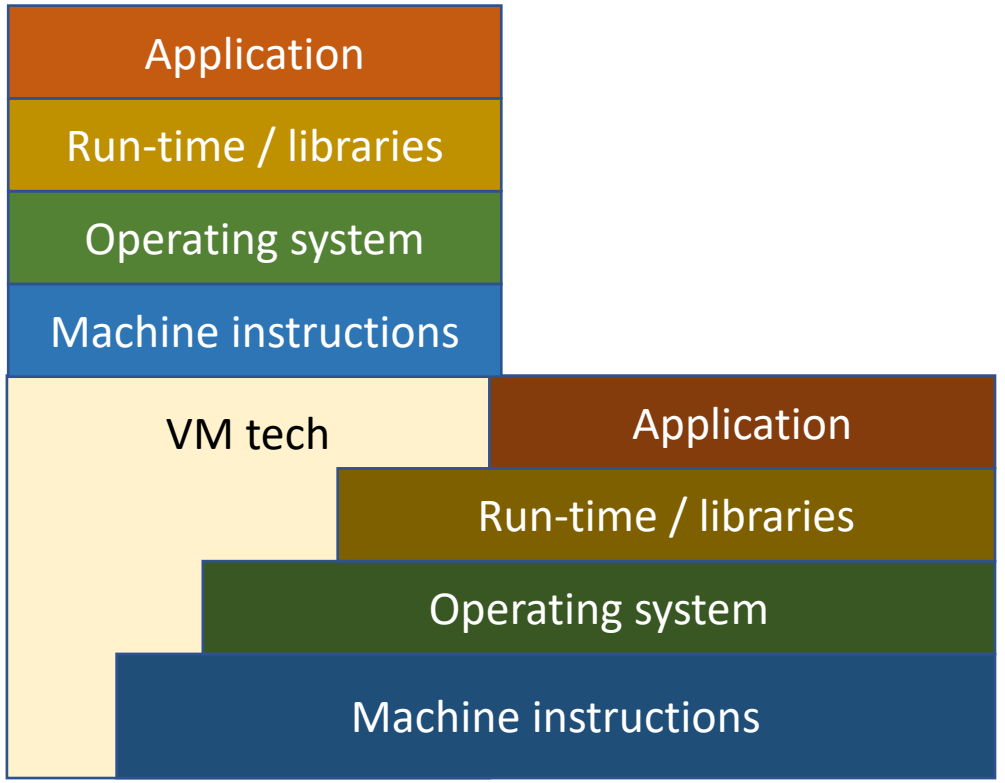
Desktop virtualization

- When you run the ”linux-desktop” (linux-desktop.cc.tut.fi) on your windows machine

Hardware virtualization

- Hypervisor
  - HW and/or SW based



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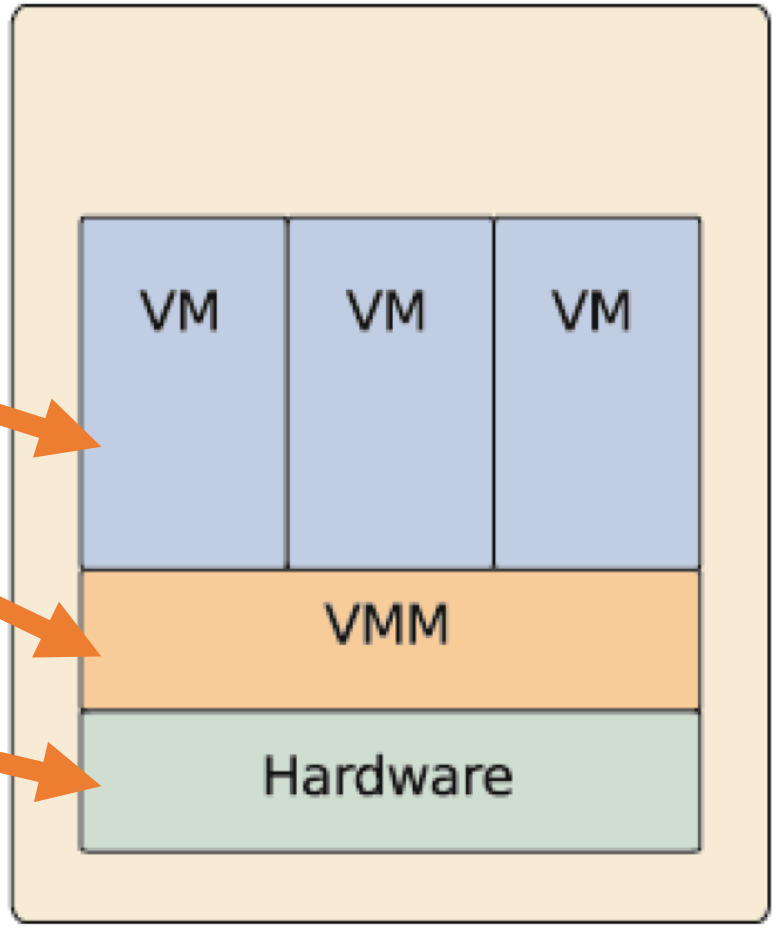
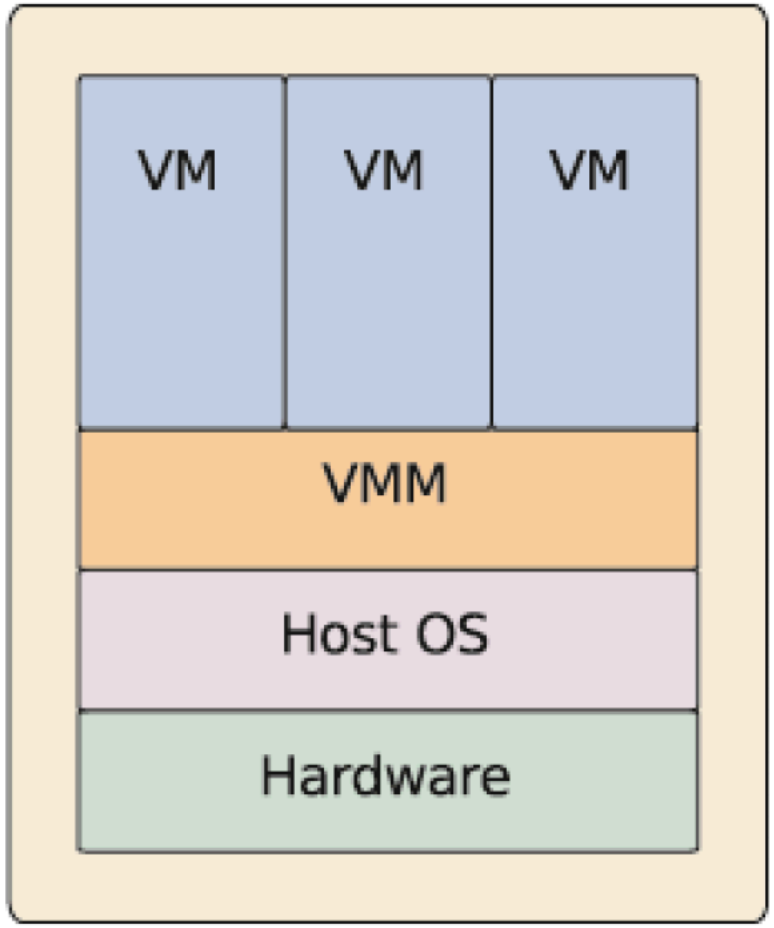
Guest

Virtual Machine Mngr
(Hypervisor)

Host



Hypervisor Type I



Hypervisor Type II

Mika Kaaretkoski,
Master thesis, 2018

F. Rodrguez-Haro et al., “A summary of virtualization techniques,” Procedia Technology, vol. 3, pp. 267 { 272, 2012, the 2012 Iberoamerican Conference on Electronics Engineering and Computer Science. [Online]. Accessed: 4.8.2018 Available: http://www:sciencedirect:com/science/article/pii/S2212017312002587

Type-1, native or bare-metal hypervisors

- Examples of virtualization that uses hardware assisted are Kernel-based Virtual Machine (KVM), VirtualBox, Xen, Hyper-V, and VMware products
- Hardware-assisted
- Pros & cons
  + efficient
  + provides service to all the guests in equivalent way
  - requires cleaning of the existing system clean
  - I/O device drivers must be available for installation in the VMM

Different approached (source of pictures: VMWARE)

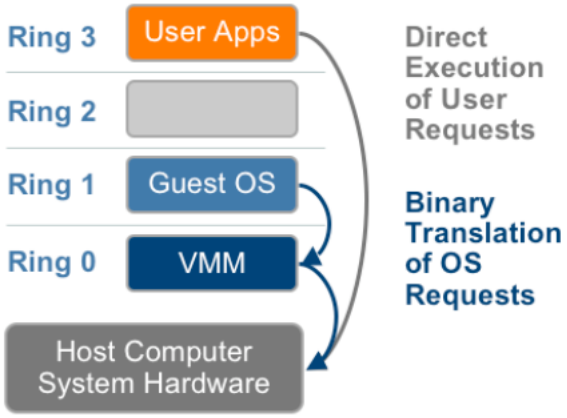
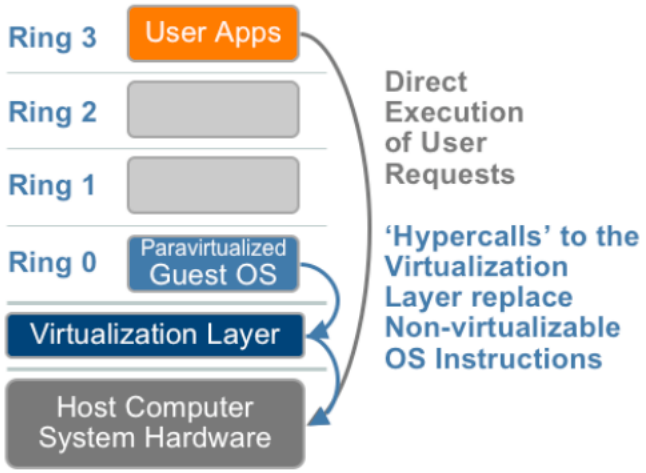


Figure 5 – The binary translation approach to x86 virtualization



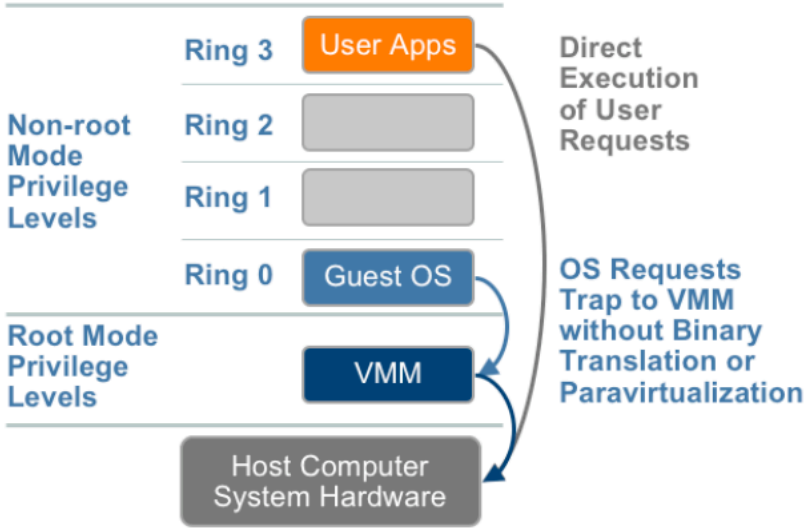


Figure 7 – The hardware assist approach to x86 virtualization

Skipped 2020

Type-2 or hosted hypervisors

- A guest operating system runs as a process on the host.
- VMware Workstation, VMware Player, VirtualBox, Parallels Desktop for Mac and QEMU
- Emulation or binary translation
- Pros & cons
  + Virtualizing SW use device drivers and other lower-level services of host
  - Loss of efficiency because more layers of SW involved

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Containers

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Basic of containers

- Lightweight virtualization
- Guests share OS kernel with host
- In Linux (LXC) basically Separate namespaces
  - IPC – inter-process communication
  - Network
  - Mount – Filesystem
  - PID – Processes
  - User
  - UTS – hostname and domains
  - Cgroup –
- Nice tutorial (with commercial at the end) https://www.youtube.com/watch?time_continue=2&v=n-JwAM6XF88

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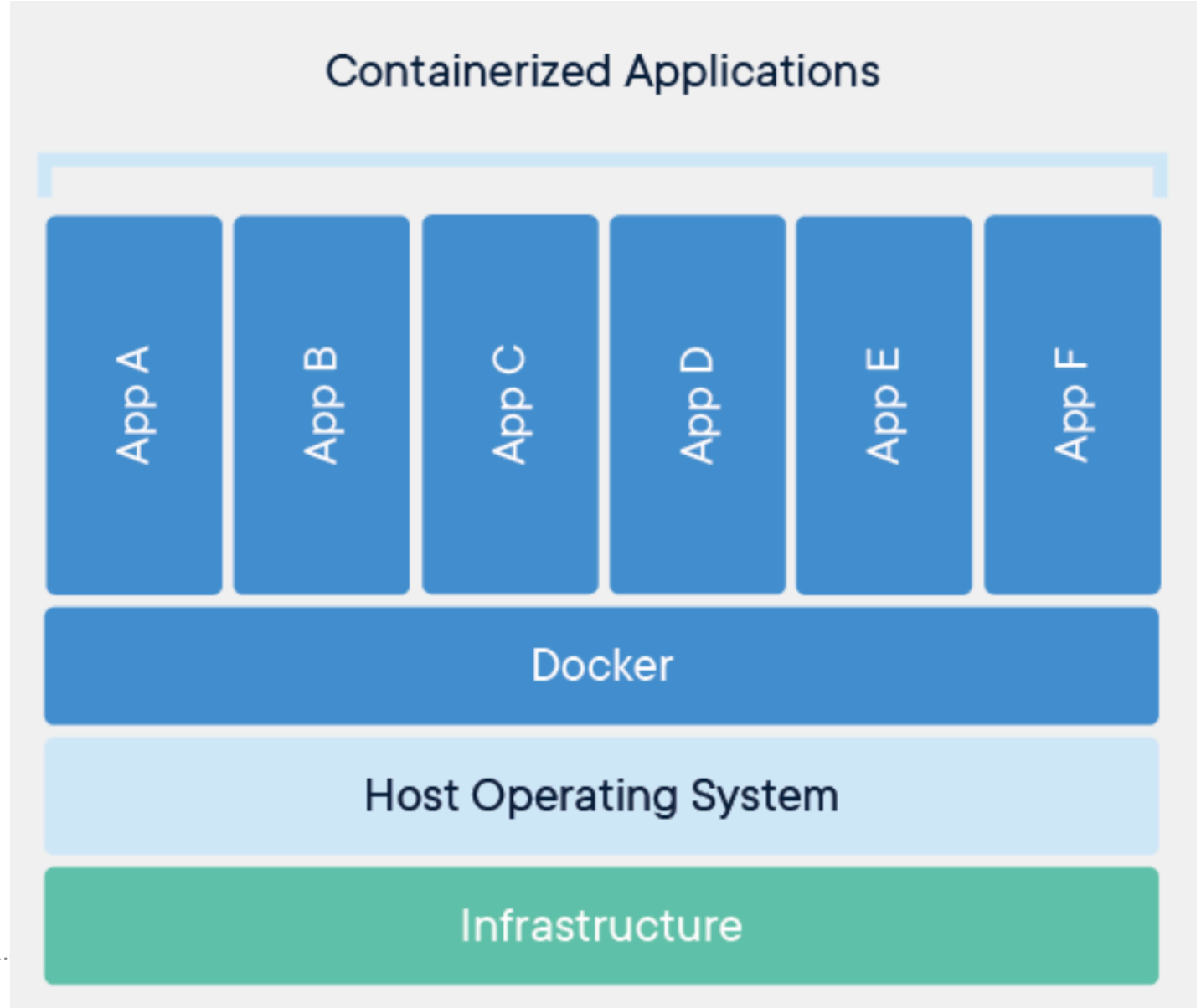
The dominant way to manage containers: Docker

So dominant that we go details of one technology

From docker.com



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Use case example

- Your application needs
  - Certain version of nodejs
  - Set of libraries (certain versions)
  - Mongo database

- Your system has
  - Wrong version of nodejs
  - Mongo serving another application

- Solution
  - Create a docker image (container)
  - Install the image
  - Run the image

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https://www.katacoda.com/courses/container-runtimes

(thanks to your fellow student 2019)

```
Terminal +
Your Interactive Bash Terminal. A safe place to learn and execute commands.


$
$ docker pull redis:3.2.11-alpine
3.2.11-alpine: Pulling from library/redis
ff3a5c916c92: Pull complete
aae70a2e6027: Pull complete
87c655da471c: Pull complete
bc3141806bdc: Pull complete
53616fb426d9: Pull complete
9791c5883c6a: Pull complete
Digest: sha256:ebf1948b84dcaaa0f8a2849cce6f2548edb8862e2829e3e7d9e4cd5a324fb3b7
Status: Downloaded newer image for redis:3.2.11-alpine
$
```

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Let investigate a bit

```
$ docker image ls
REPOSITORY          TAG                 IMAGE ID            CREATED             SIZE
redis               3.2.11-alpine       ca0b6709748d        15 months ago       20.7MB
```

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I could not resist

```
$ docker run ca0b6709748d
1:C 05 Sep 17:27:18.972 # Warning: no config file specified, using the default config. In order to s
s-server /path/to/redis.conf
                _.-
            _.-``__ ''-._
       _.-``    `.  `_.  ''-._           Redis 3.2.11 (00000000/0) 64 bit
   .-`` .-```.  ```\/    _.,_ ''-._
  (    '      ,       .-`  | `,    )     Running in standalone mode
  |`-._`-...-` __...-.``-._|'` _.-'|     Port: 6379
  |    `-._   `._    /     _.-'    |     PID: 1
   `-._    `-._  `-./  _.-'    _.-'
  |`-._`-._    `-.__.-'    _.-'_.-'|
  |    `-._`-._        _.-'_.-'    |           http://redis.io
   `-._    `-._`-.__.-'_.-'    _.-'
  |`-._`-._    `-.__.-'    _.-'_.-'|
  |    `-._`-._        _.-'_.-'    |
   `-._    `-._`-.__.-'_.-'    _.-'
```

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What did we just see?

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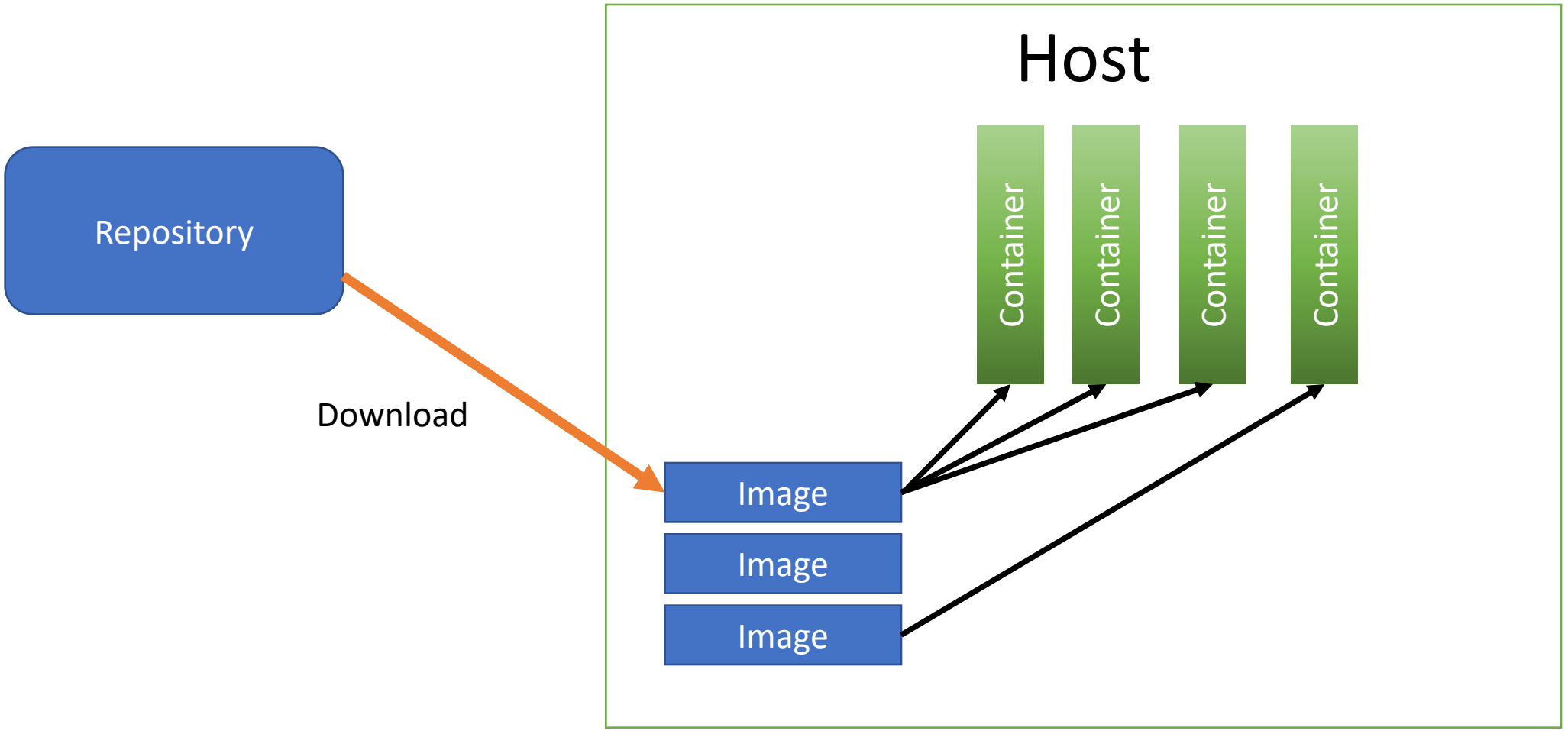
Typical set-up



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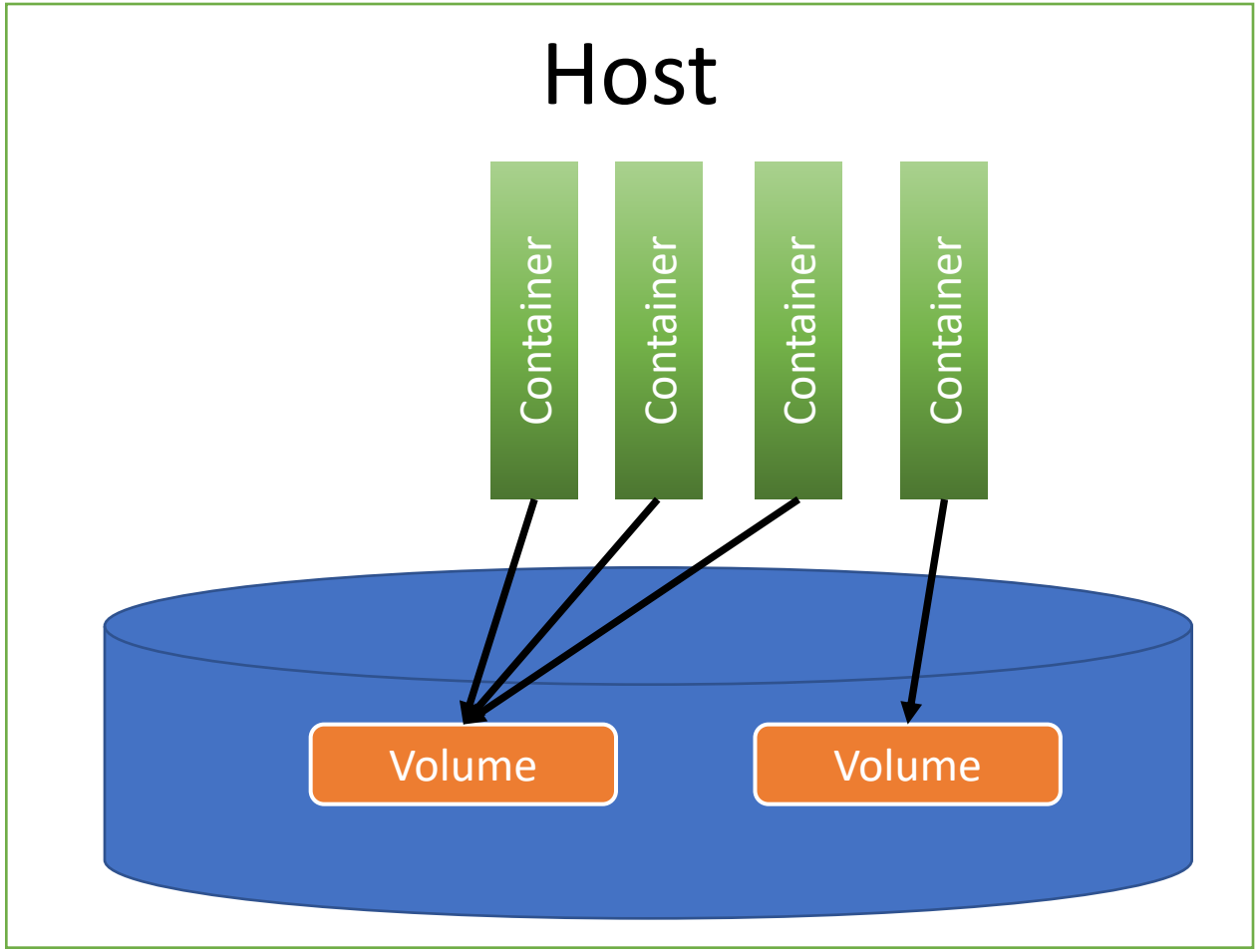
Typical set-up

Volumes are for
- Persistent data
- Data sharing



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Dockerfile

```
#This is a sample Image
FROM ubuntu
MAINTAINER demousr@gmail.com
RUN apt-get update
RUN apt-get install -y nginx
CMD [“echo”,”Image created”]
```

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- `$ docker image history 874176ca6a7c`

```
IMAGE          CREATED         CREATED BY                                      SIZE COMMENT
874176ca6a7c 6 months ago  /bin/sh -c #(nop)  CMD  ["/bin/sh" "-c" "nodeâ¦     0B
e477afdf62b1 6 months ago  /bin/sh -c #(nop)  EXPOSE  8893                     0B
bbb82ecea436 6 months ago  /bin/sh -c #(nop)  ENV PORT=8893                    0B
f7e49216f8f8 6 months ago  /bin/sh -c #(nop)  WORKDIR /home                    0B
75bf5968b264 6 months ago  /bin/sh -c #(nop)  COPY  dir:fed108fd8e77a8ed8â¦ 553kB
1fb4fbe8beb7 7 months ago  /bin/sh -c #(nop)  USER root                        0B
8232a8b9c483 2 years ago   /bin/sh -c #(nop)  CMD  ["node"]                    0B
<missing>    2 years ago   /bin/sh -c apk add --no-cache  --virtual .buiâ¦  3.56MB
<missing>    2 years ago   /bin/sh -c #(nop) ENV YARN_VERSION=0.21.3          0B
<missing>    2 years ago   /bin/sh -c adduser -D -u 1000  node && apâ¦      45.4MB
<missing>    2 years ago   /bin/sh -c #(nop) ENV NODE_VERSION=6.10.0          0B
<missing>    2 years ago   /bin/sh -c #(nop) ENV NPM_CONFIG_LOGLEVEL=iâ¦      0B
<missing>    2 years ago   /bin/sh -c #(nop) ADD file:3df55c321c1c8d73fâ¦   4.81MB
```

```
FROM node:6.10.0-alpine
# Never run processes as root!
USER root

# Copy application itself:
COPY . /home

WORKDIR /home

# Set port on …:
ENV PORT=8893

# Expose port 8893:
EXPOSE 8893

CMD node pinger.js
```

A layer describes a difference to the previous layer.

Layers of size 0 are ”intermediate” layers

Non-zero layers are created with RUN, COPY and ADD.

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Schedule for coming weeks

Week	Lecture	Plussa exercises (deadlines)
-1		
0		17.08 Plussa open for students
1 / 35	25.08 Intro to the course and topic.	20.08 Background survey opens
2 / 36	01.09 Virtualization, what, why and how. Intro to containers and Docker.	04.09 Background survey closes
3 / 37	08.09 Cloud and scalability, implications to SW development and business	11.09 Docker exercise closes
4 / 38	15.09 Continuous deployment, what and why	14.09 Docker compose e. opens
5 / 39	21.09 Continuous deployment, tools and techniques	
6 / 40	28.09 Issues on cloud-SW: isolation, dependency management etc	01.10 Docker compose e. closes