[544] Docker Networking

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Learning Objectives

- configure SSH tunneling and Docker port forwarding to communicate with an app in a container on a different machine
- deploy multi-container apps with Docker compose
- identify situations where replication and/or some variant of partitioning is useful

Outline

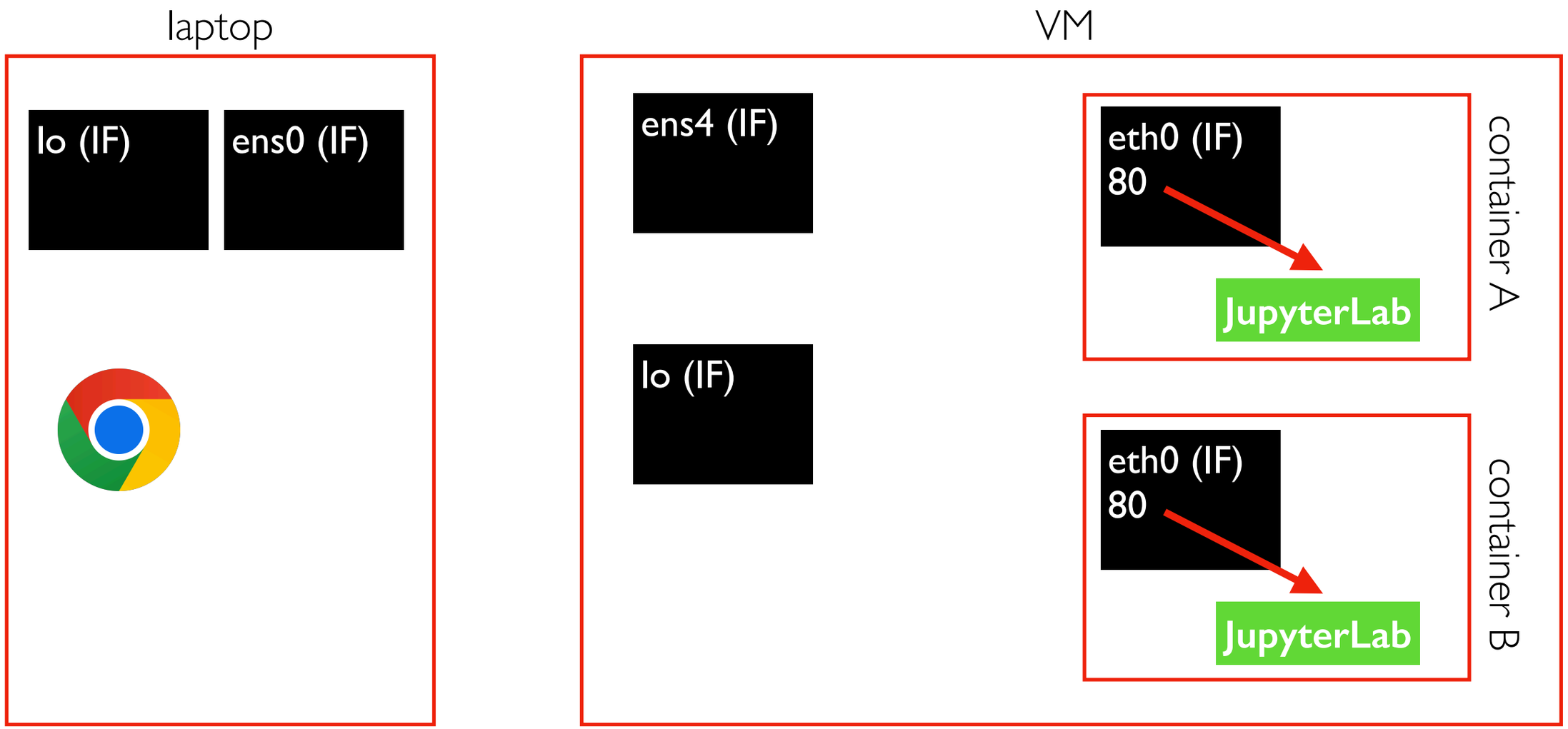
Docker Port Forwarding

Docker Compose

Partitioning and Replication

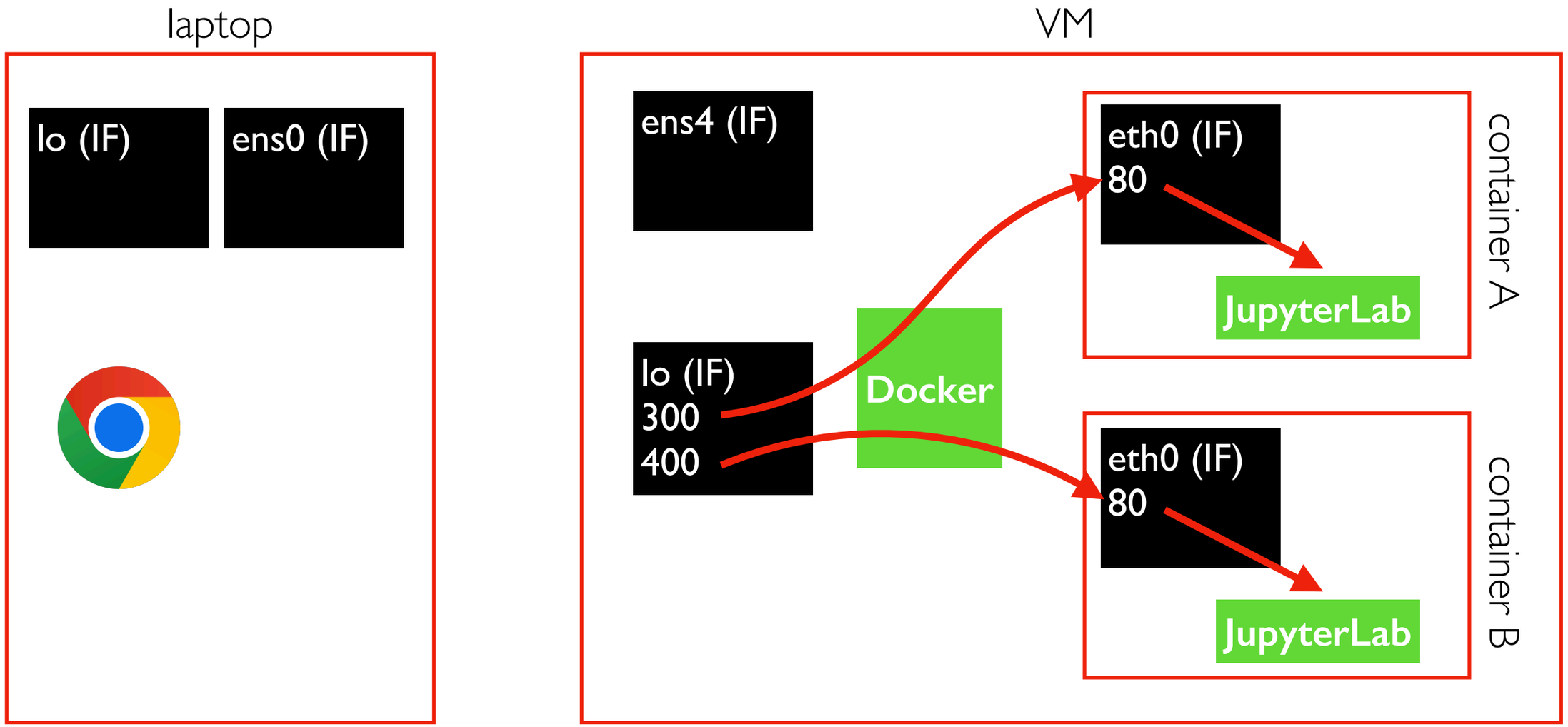
Interfaces (IF) and Ports

both containers have
a virtual port 80



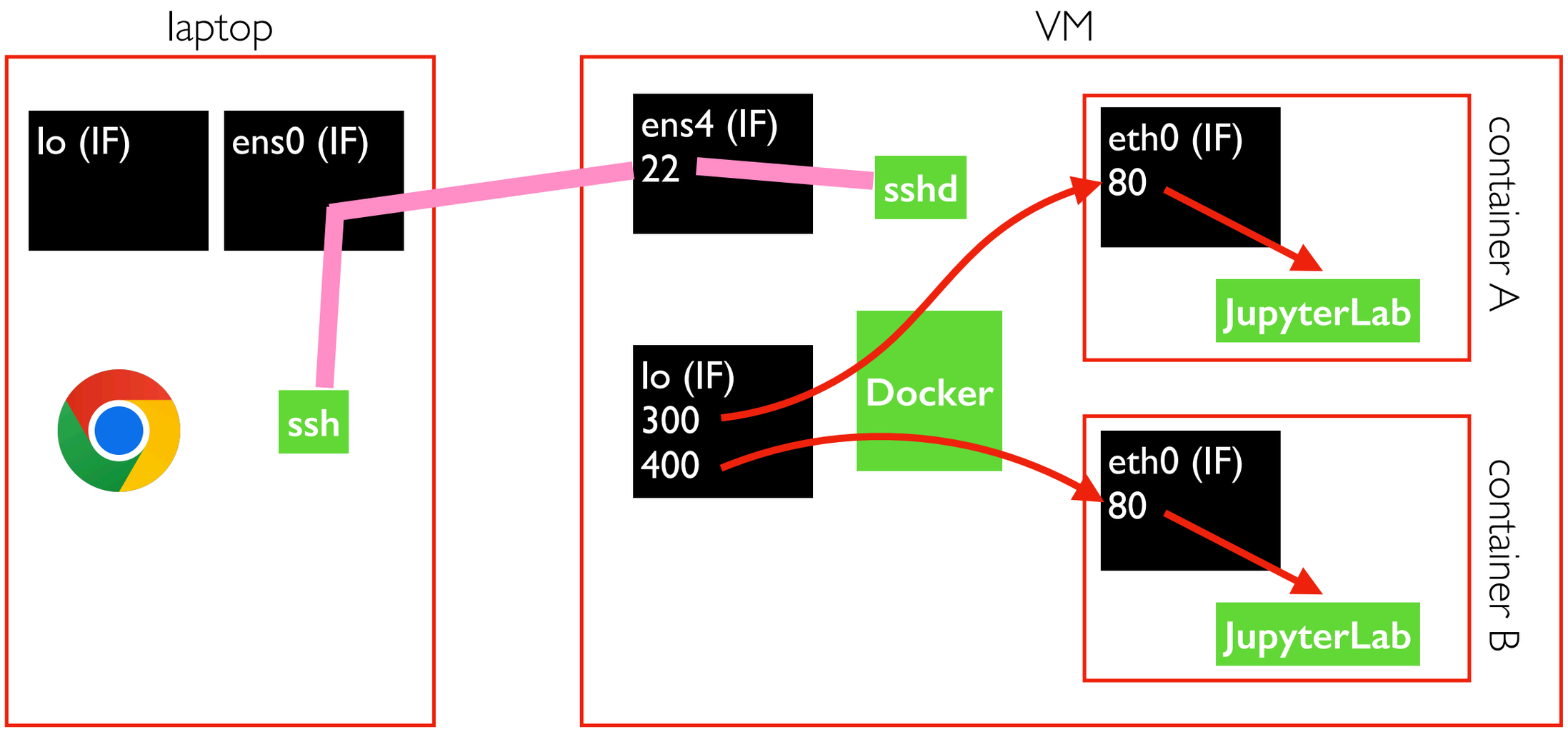

```
docker run -d myimg
docker run -d myimg
```

Interfaces (IF) and Ports




```
docker run -d -p 127.0.0.1:300:80 myimg
docker run -d -p 127.0.0.1:400:80 myimg
```

Interfaces (IF) and Ports

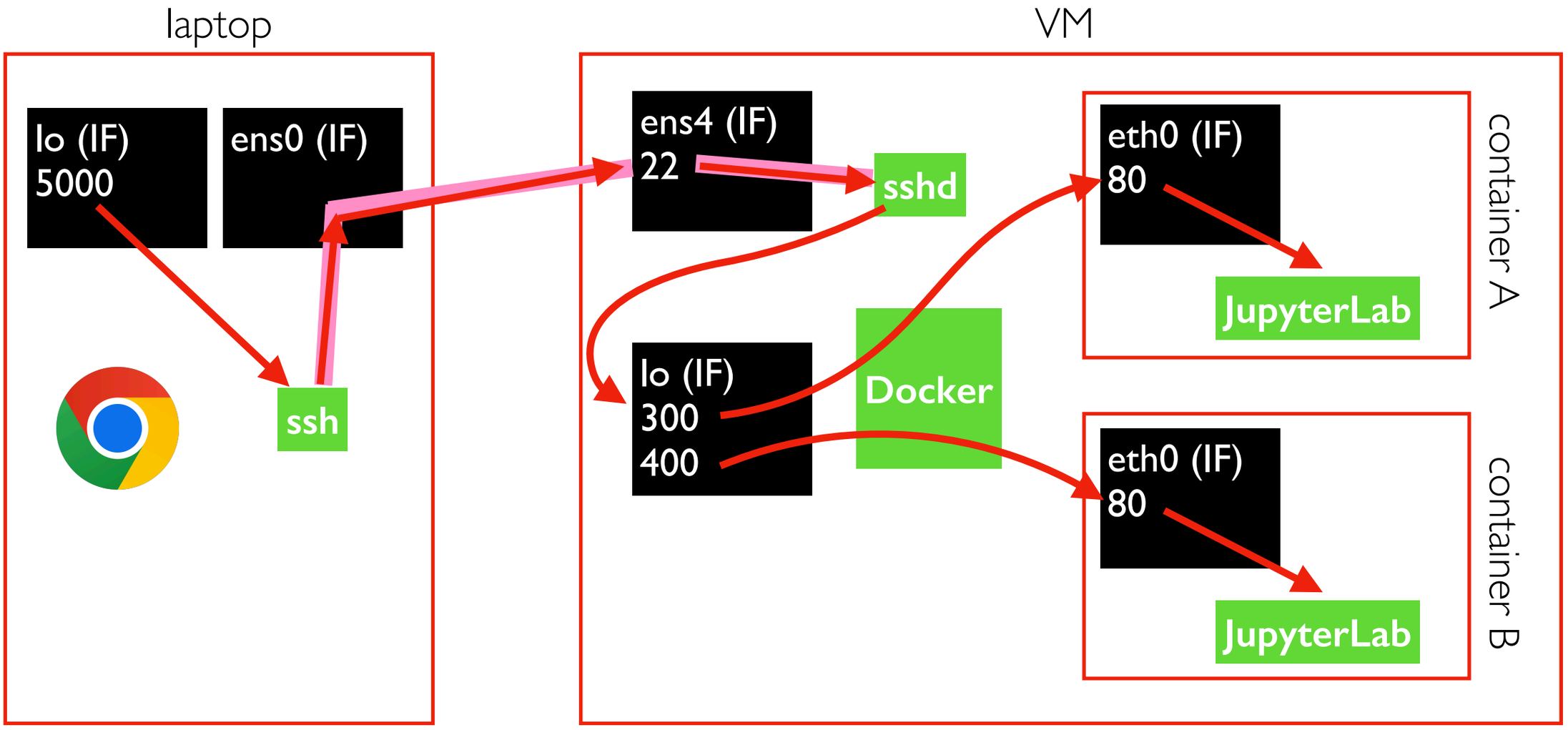


ssh USER@VM

docker run -d **-p** 127.0.0.1:300:80 myimg
docker run -d **-p** 127.0.0.1:400:80 myimg

the SSH connection can be used to send comands and/or forward network traffic

Interfaces (IF) and Ports

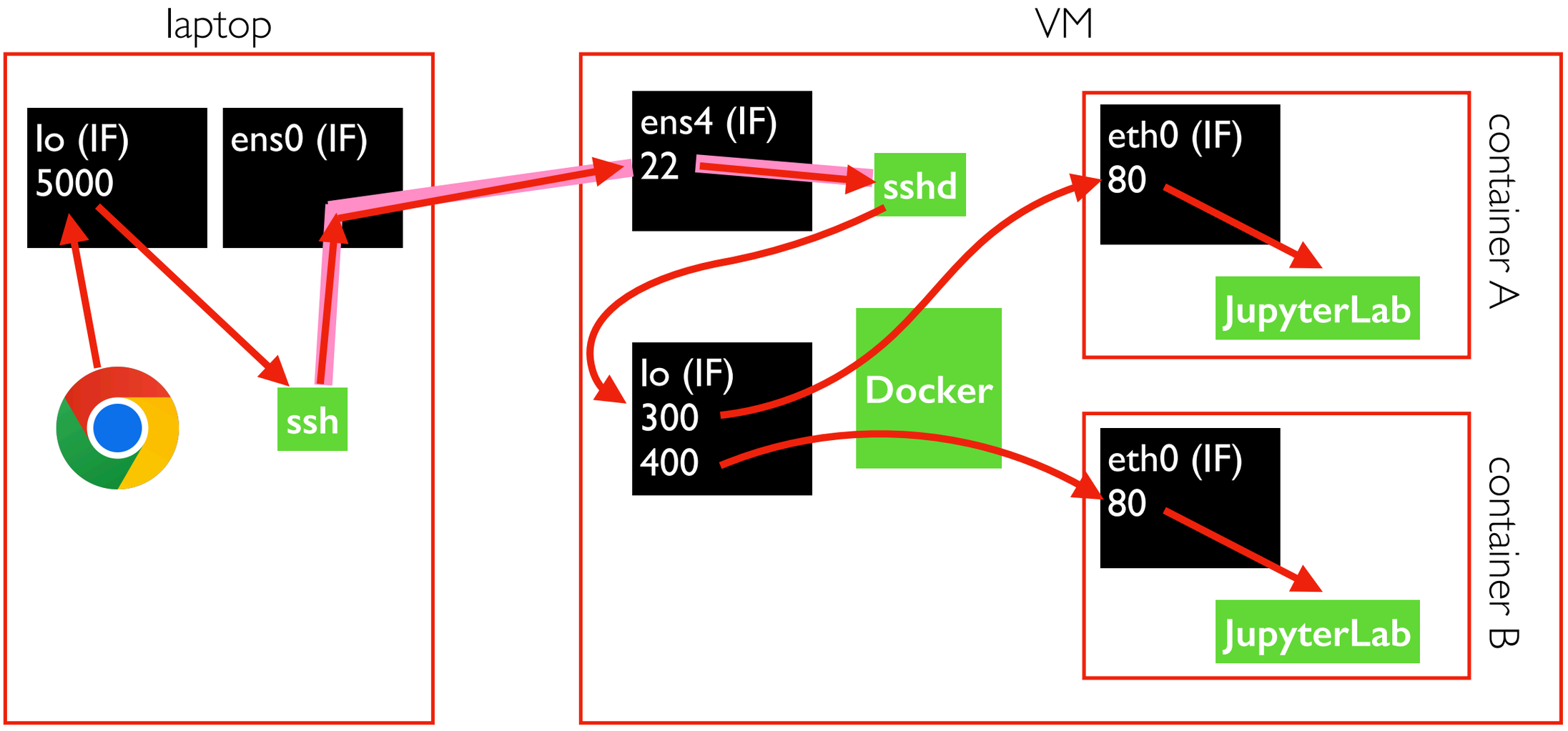


ssh USER@VM **-L** localhost:5000:localhost:300

docker run -d **-p** 127.0.0.1:300:80 myimg
docker run -d **-p** 127.0.0.1:400:80 myimg

the SSH connection can be used to send comands and/or forward network traffic

Interfaces (IF) and Ports



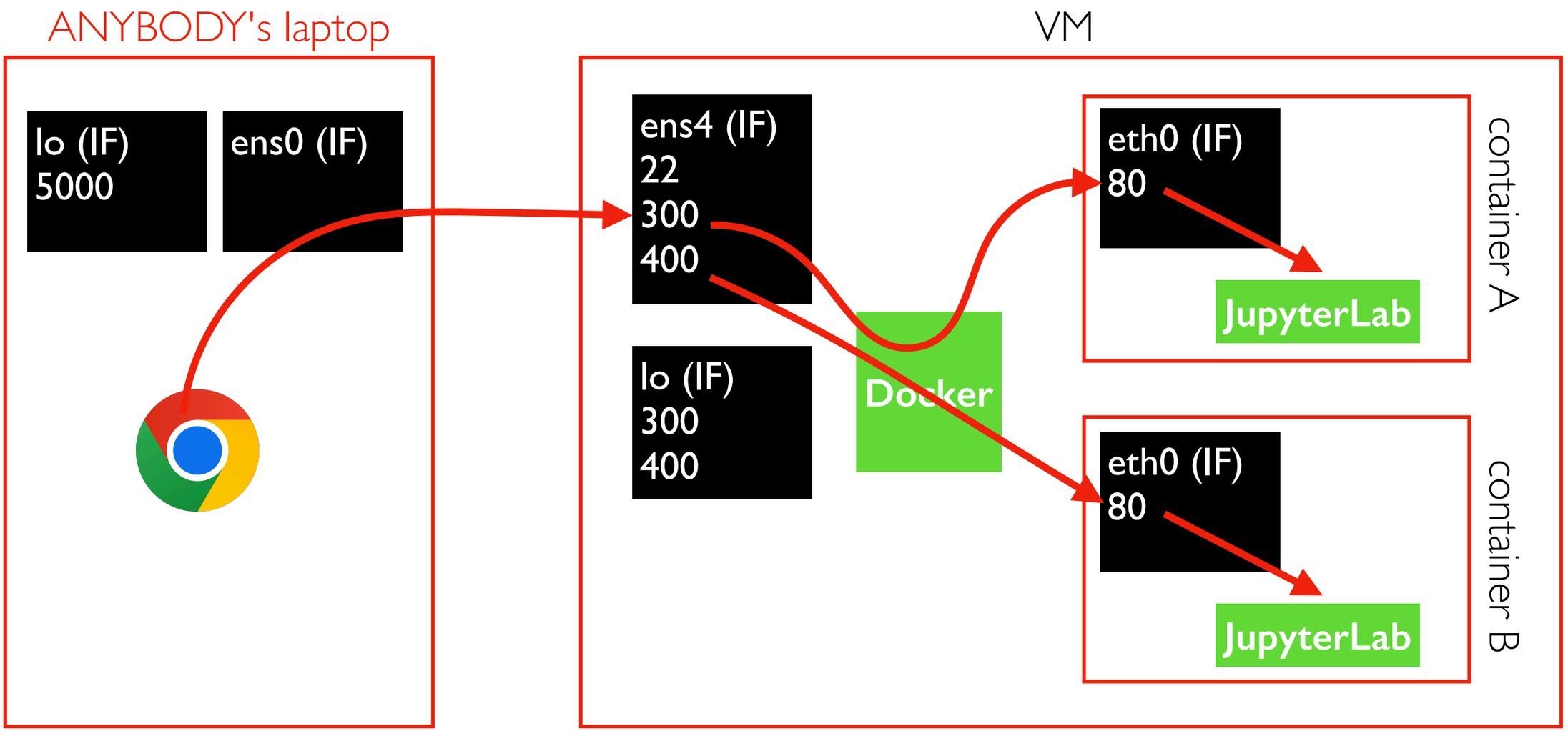
ssh USER@VM **-L** localhost:5000:localhost:300

docker run -d **-p** 127.0.0.1:300:80 myimg
docker run -d **-p** 127.0.0.1:400:80 myimg

http://localhost:5000/lab (in browser)

yay! You can connect to JupyterLab
inside a container running on your VM

Interfaces (IF) and Ports



docker run -d **-p** 300:80 myimg

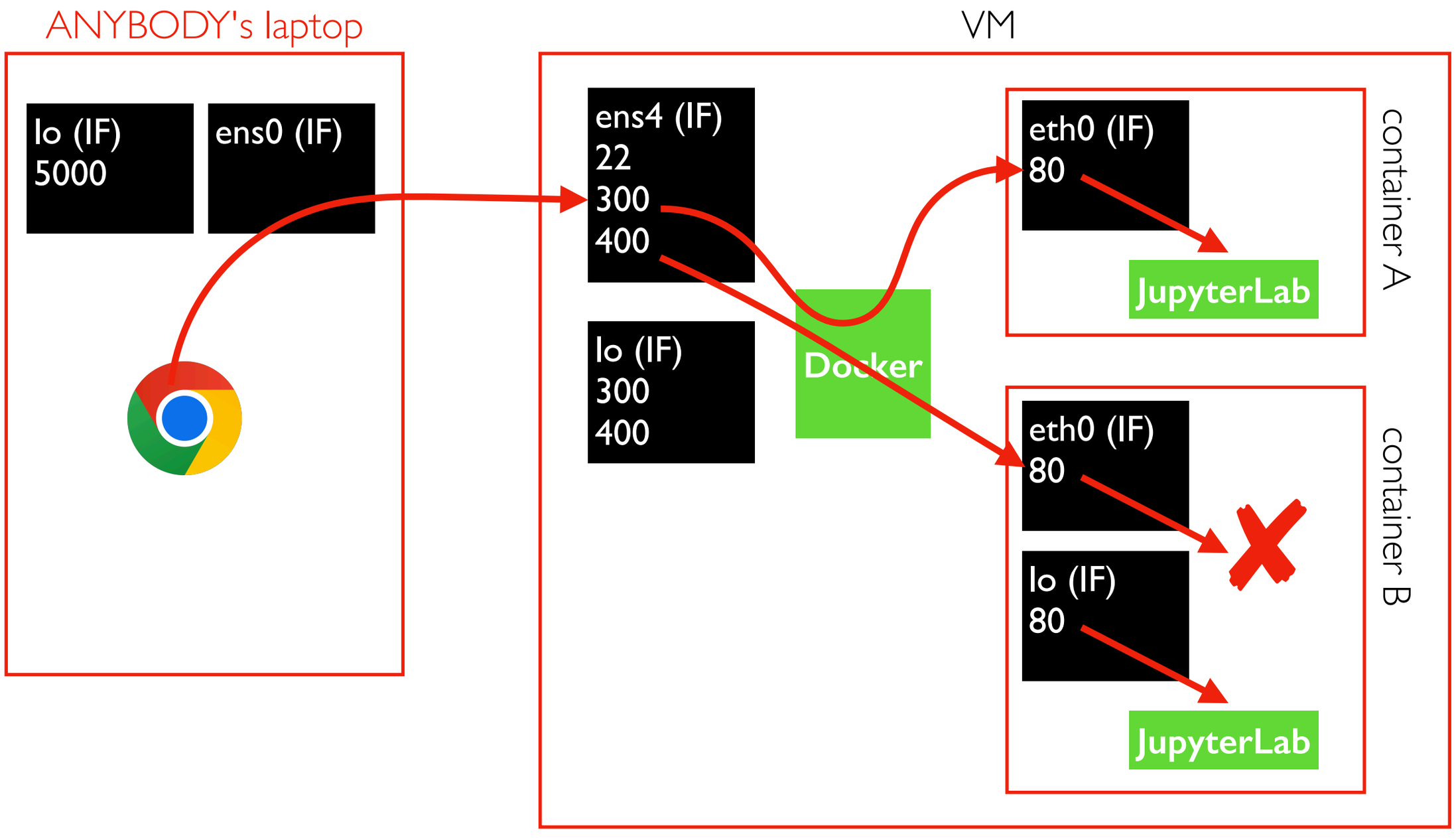
docker run -d **-p** 0.0.0.0:300:80 myimg

Careful, default is to listen on all NICs!

Other security options:

- firewall (block port 300)
- password (in JupyterLab)

Interfaces (IF) and Ports



Port forwarding never goes to loopback inside container

- don't use localhost or 127.0.0.1 inside container!
- easiest: use 0.0.0.0 inside container (for all) to port-forwarded traffic

Demo and TopHat...

Outline

Docker Port Forwarding

Docker Compose

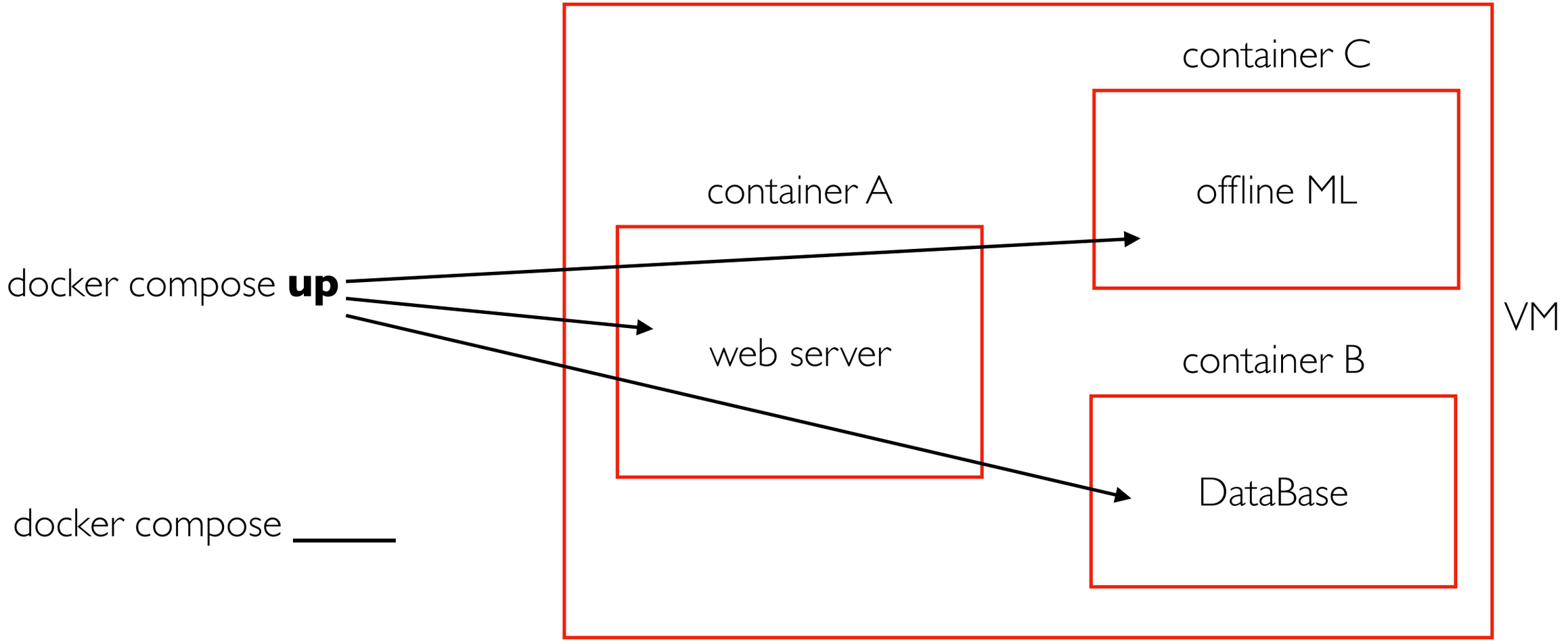
Partitioning and Replication

Container Orchestration

Orchestration lets you deploy many cooperating containers across a cluster of Docker workers.

Kubernetes (K8s) is the most well known.

Docker compose is a simpler tool that lets you deploy cooperating containers to a single worker.



Demos...

Outline

Docker Port Forwarding

Docker Compose

Partitioning and Replication

Data Placement

Say we have large dataset, and many machines.

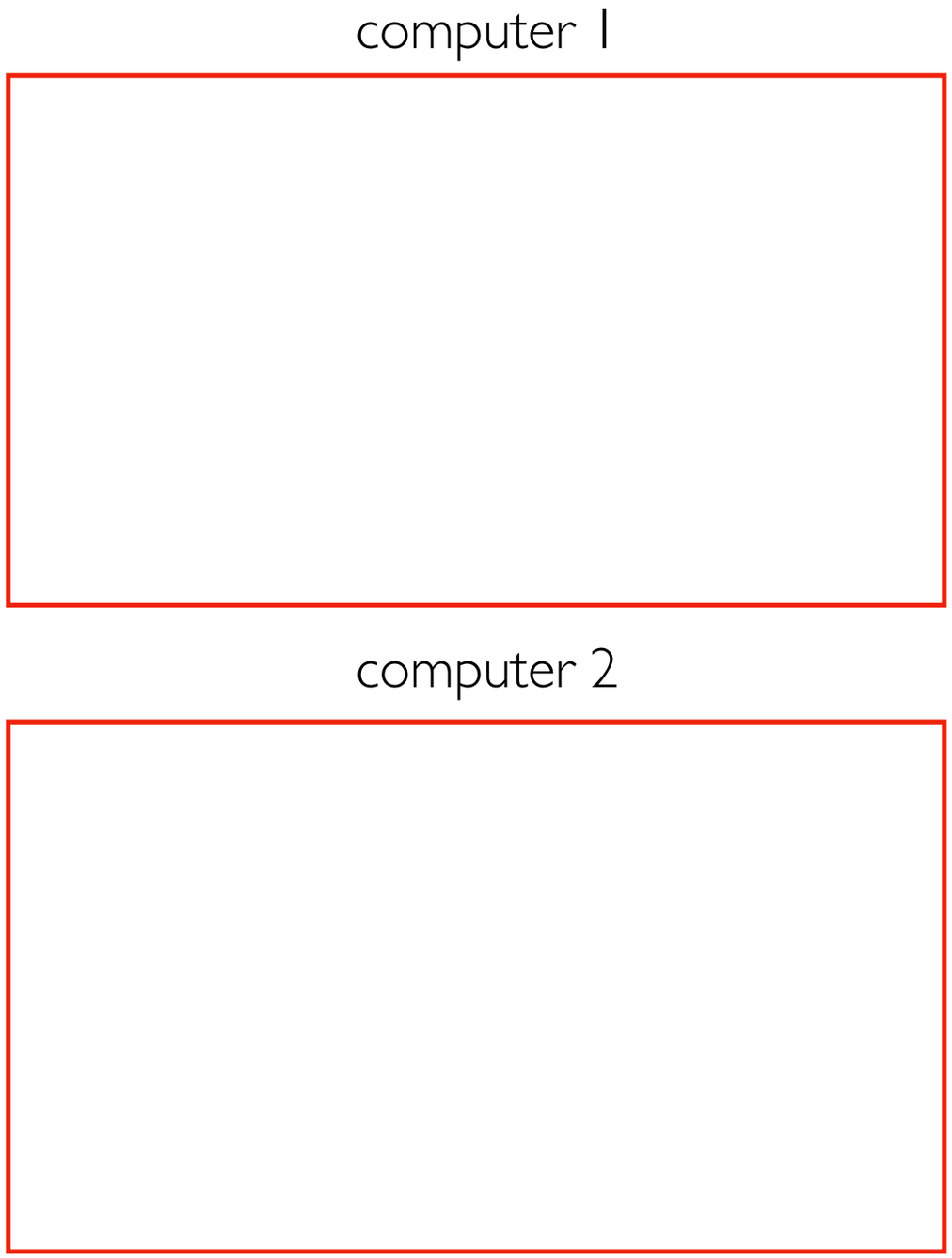
- can we breakup the dataset (partitioning) so different machines can each help with part of it?
- should we have multiple copies (replication) of the same data so that we don't lose information if a machine fails?

Partitioning

Scenario: we have two computers, and want an app that lets instructors lookup student IDs by name.

dataset

Name	Student ID
Aarav Patel	9031231234
Chen Wei	8123456789
Fatima Al-Farsi	7234567890
Hiroshi Tanaka	6345678901
Isabella Rossi	5456789012
John Smith	4567890123
Liam O’Connor	3678901234
Maria Garcia	2789012345
Nia Kofi	1890123456
Yuki Nakamura	1001234567



Simple Partitioning

Scenario: we have two computers, and want an app that lets instructors lookup student IDs by name.

dataset

Name	Student ID
Aarav Patel	9031231234
Chen Wei	8123456789
Fatima Al-Farsi	7234567890
Hiroshi Tanaka	6345678901
Isabella Rossi	5456789012
John Smith	4567890123
Liam O'Connor	3678901234
Maria Garcia	2789012345
Nia Kofi	1890123456
Yuki Nakamura	1001234567

Challenge: might not easily know which computer to "ask" for a given name (less efficient to ask both each time)

computer 1

first half

Name	Student ID
Aarav Patel	9031231234
Chen Wei	8123456789
Fatima Al-Farsi	7234567890
Hiroshi Tanaka	6345678901
Isabella Rossi	5456789012

computer 2

second half

Name	Student ID
John Smith	4567890123
Liam O'Connor	3678901234
Maria Garcia	2789012345
Nia Kofi	1890123456
Yuki Nakamura	1001234567

Range Partitioning

If we partition by range, we definitely know which compute to ask for a given name.

dataset

Name	Student ID
Aarav Patel	9031231234
Chen Wei	8123456789
Fatima Al-Farsi	7234567890
Hiroshi Tanaka	6345678901
Isabella Rossi	5456789012
John Smith	4567890123
Liam O'Connor	3678901234
Maria Garcia	2789012345
Nia Kofi	1890123456
Yuki Nakamura	1001234567

Challenge: it might be hard to find good split points, especially if the dataset is changing.

computer 1

A-M

Name	Student ID
Aarav Patel	9031231234
Chen Wei	8123456789
Fatima Al-Farsi	7234567890
Hiroshi Tanaka	6345678901
Isabella Rossi	5456789012
John Smith	4567890123
Liam O'Connor	3678901234
Maria Garcia	2789012345

computer 2

N-Z

Name	Student ID
Nia Kofi	1890123456
Yuki Nakamura	1001234567

Hash Partitioning

First, choose key column, then hash it. A hash function returns a seemingly arbitrary number for any input, but the same input always produces the same number.

dataset

key

Name	Student ID	hash(Name)
Aarav Patel	9031231234	360993
Chen Wei	8123456789	70525
Fatima Al-	7234567890	913591
Hiroshi	6345678901	121696
Isabella Rossi	5456789012	258452
John Smith	4567890123	438815
Liam	3678901234	588279
Maria Garcia	2789012345	388236
Nia Kofi	1890123456	679776
Yuki	1001234567	160849

Challenge: not good if you want to do lookup for all names in an alphabetic range

computer 1

even hash

Name	Student ID	hash(Name)
Hiroshi	6345678901	121696
Isabella	5456789012	258452
Maria	2789012345	388236
Nia Kofi	1890123456	679776

computer 2

odd hash

Name	Student ID	hash(Name)
Aarav	9031231234	360993
Chen Wei	8123456789	70525
Fatima Al-	7234567890	913591
John	4567890123	438815
Liam	3678901234	588279
Yuki	1001234567	160849

Partitioning Vocabulary

TERMINOLOGICAL CONFUSION

What we call a *partition* here is called a *shard* in MongoDB, Elasticsearch, and SolrCloud; it's known as a *region* in HBase, a *tablet* in Bigtable, a *vnode* in Cassandra and Riak, and a *vBucket* in Couchbase. However, *partitioning* is the most established term, so we'll stick with that.

Chapter 6. Partitioning

Replication

Sometimes, we want multiple copies (called replicas) on different computers so we don't lose data when a machine dies.

Replication and partitioning can be used together or independently.

Example of replicated files in HDFS (later lecture...)