oueees-201906 talks Part 3/3: Centralized and distributed systems

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Lecture notes

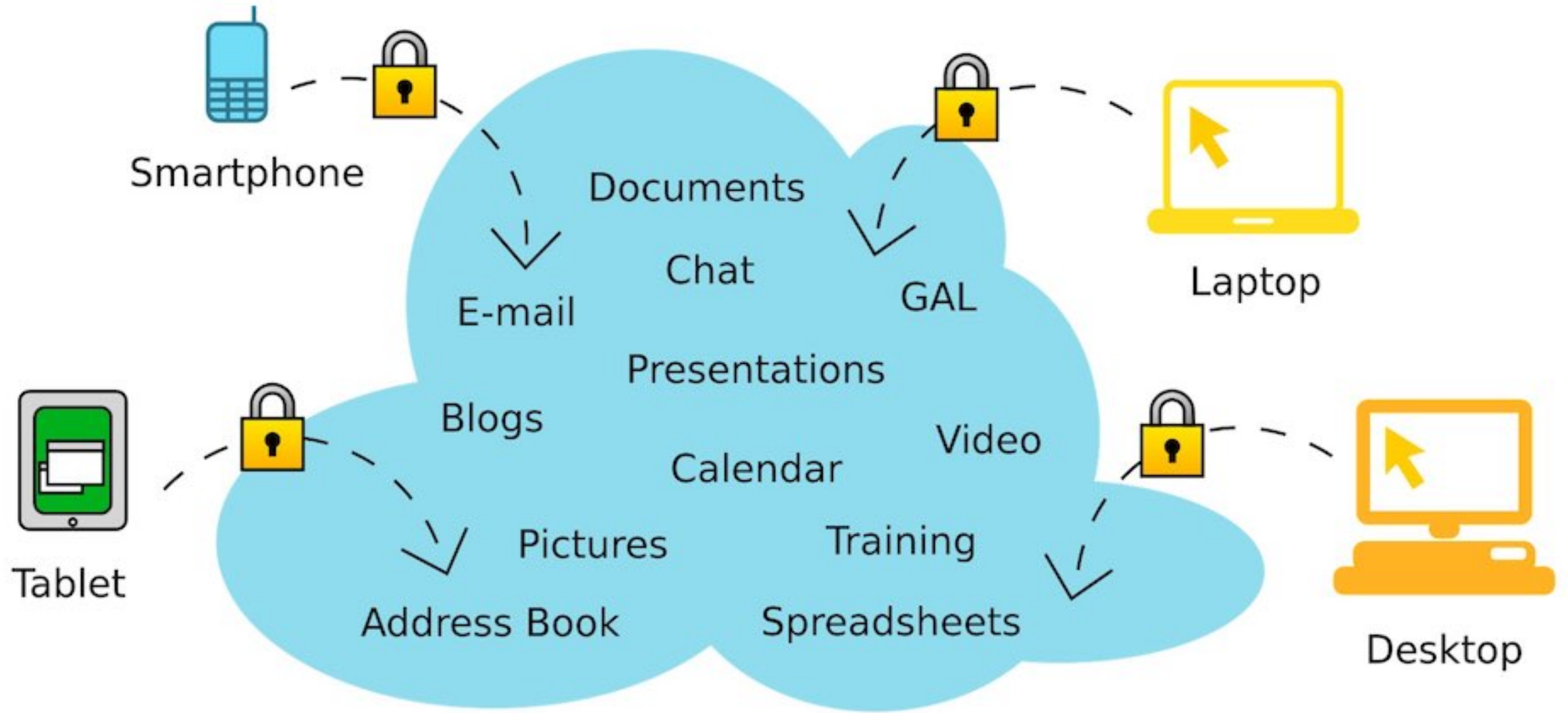
- https://github.com/jj1bdx/oueees-201906-public/
- Check out the README.md file and the issues!

Reporting

- Keyword at the end of the talk
- URL for submitting the report at the end of the talk

Today's topic: centralized and distributed systems

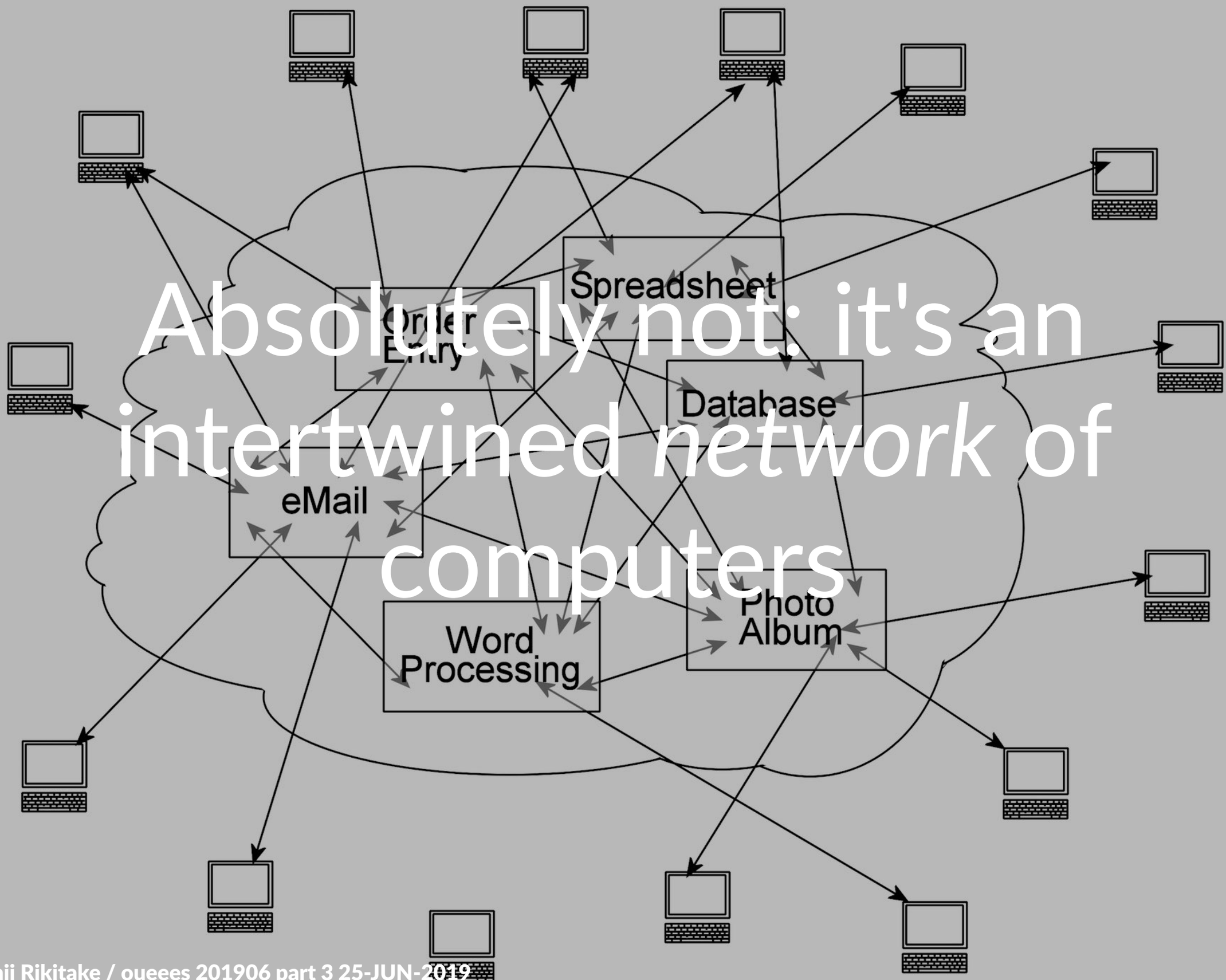
Modern computing *is cloud computing*



Cloud Computing

Having secure access to all your applications and data from any network device

Is cloud really a uniform and single entity?



Absolutely not: it's an intertwined *network* of computers

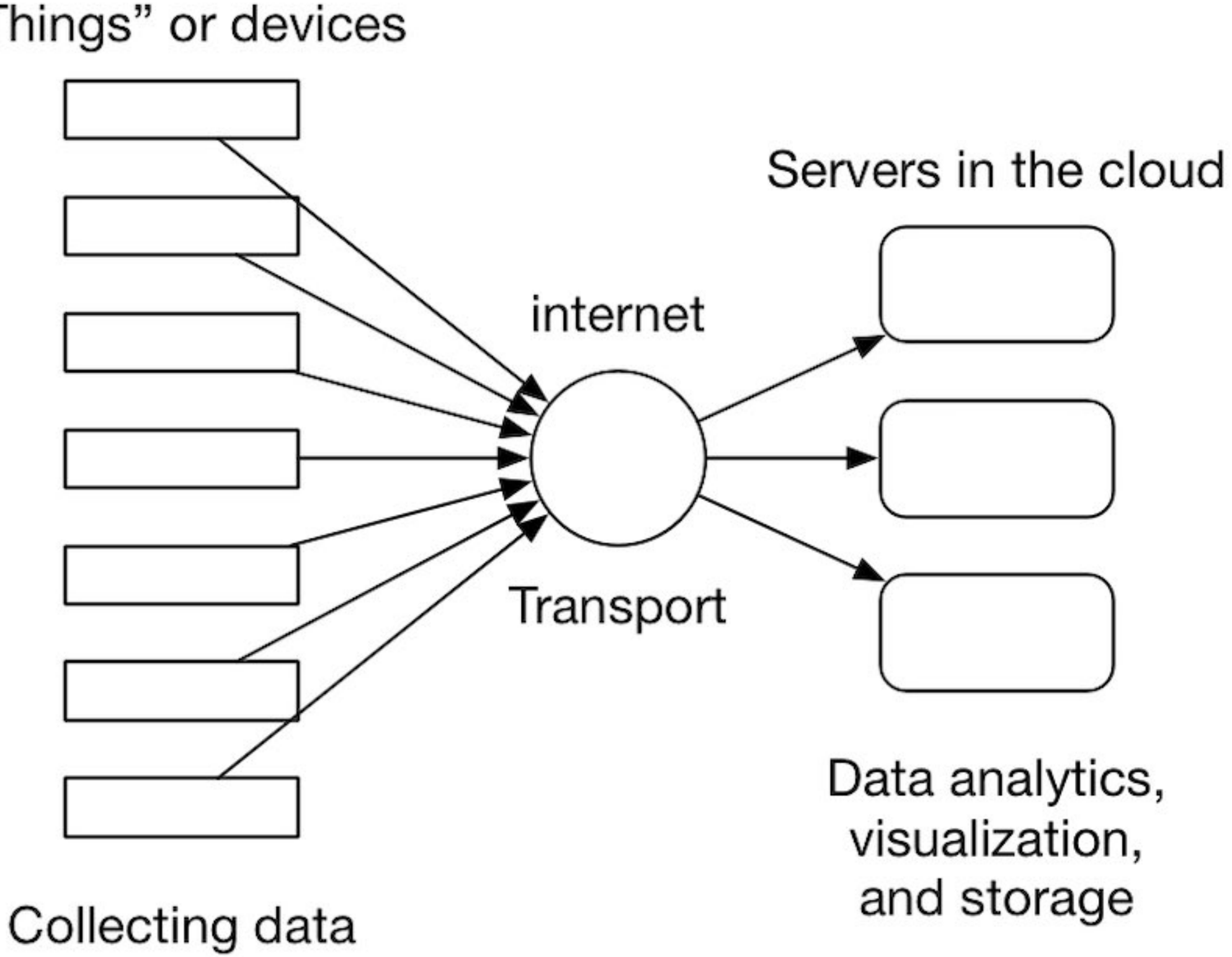
Web services are clusters of computers and networks

Thousands or millions of servers connected together

A physical server is separated into multiple virtual machines

Cloud computing *is* centralization

An example of cloud computing: Internet of Things (IoT) and telemetering



Telemetering

- Mostly unidirectional (not really *the true and genuine internet*)
- Sensors/devices gathering data through internet and feed them to the servers in the cloud computing platforms
- *The servers compute*
- *Extremely centralized*

The social implication of cloud computing

Centralized social behavior accerelated by cloud computing

- Sharing *everything* - no privacy
- *Panopticon* [1] style of governance, filtering, *censorship, or autocracy*
- Complete *externalization* of resources, leading to *no personal control*

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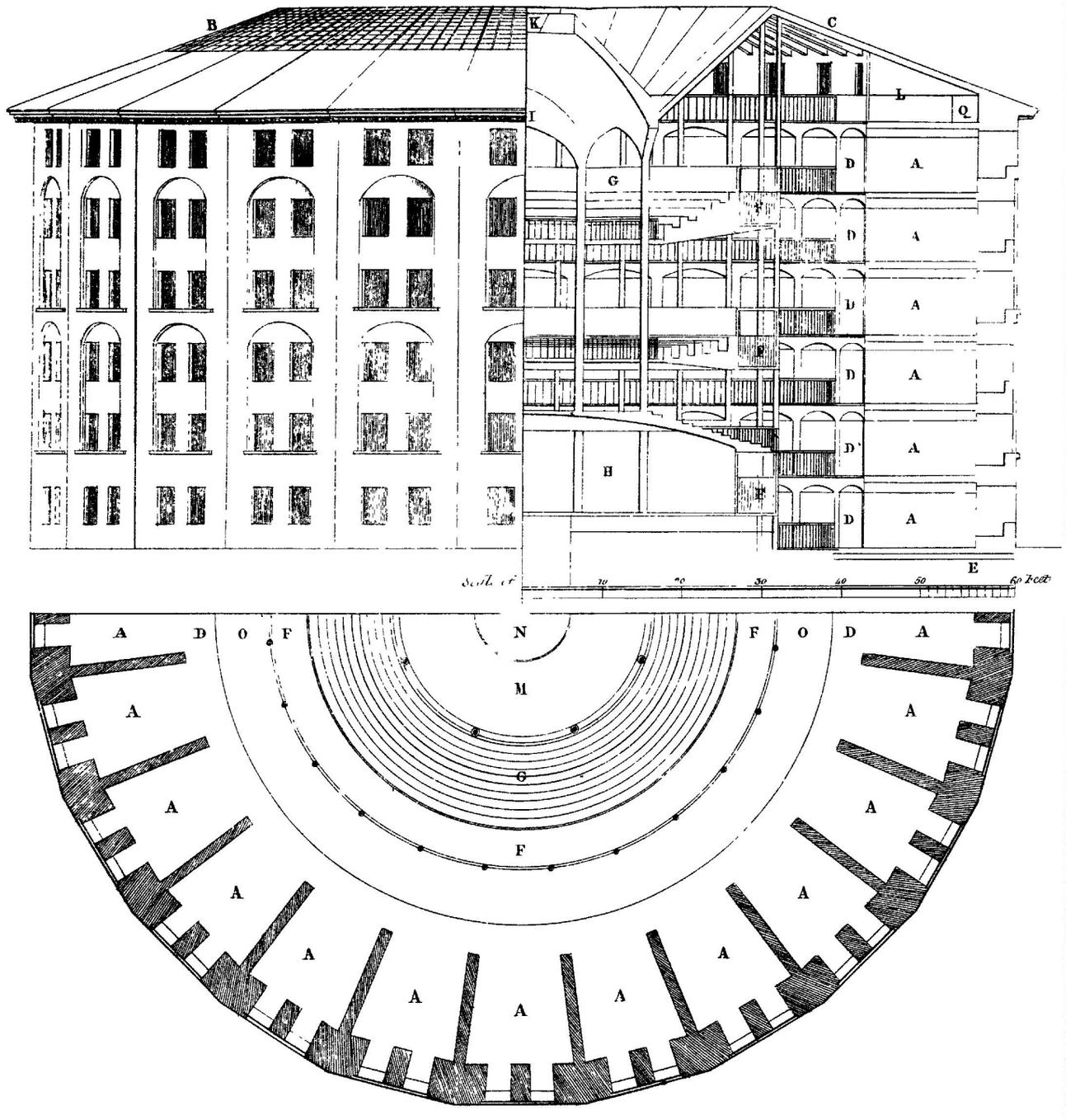
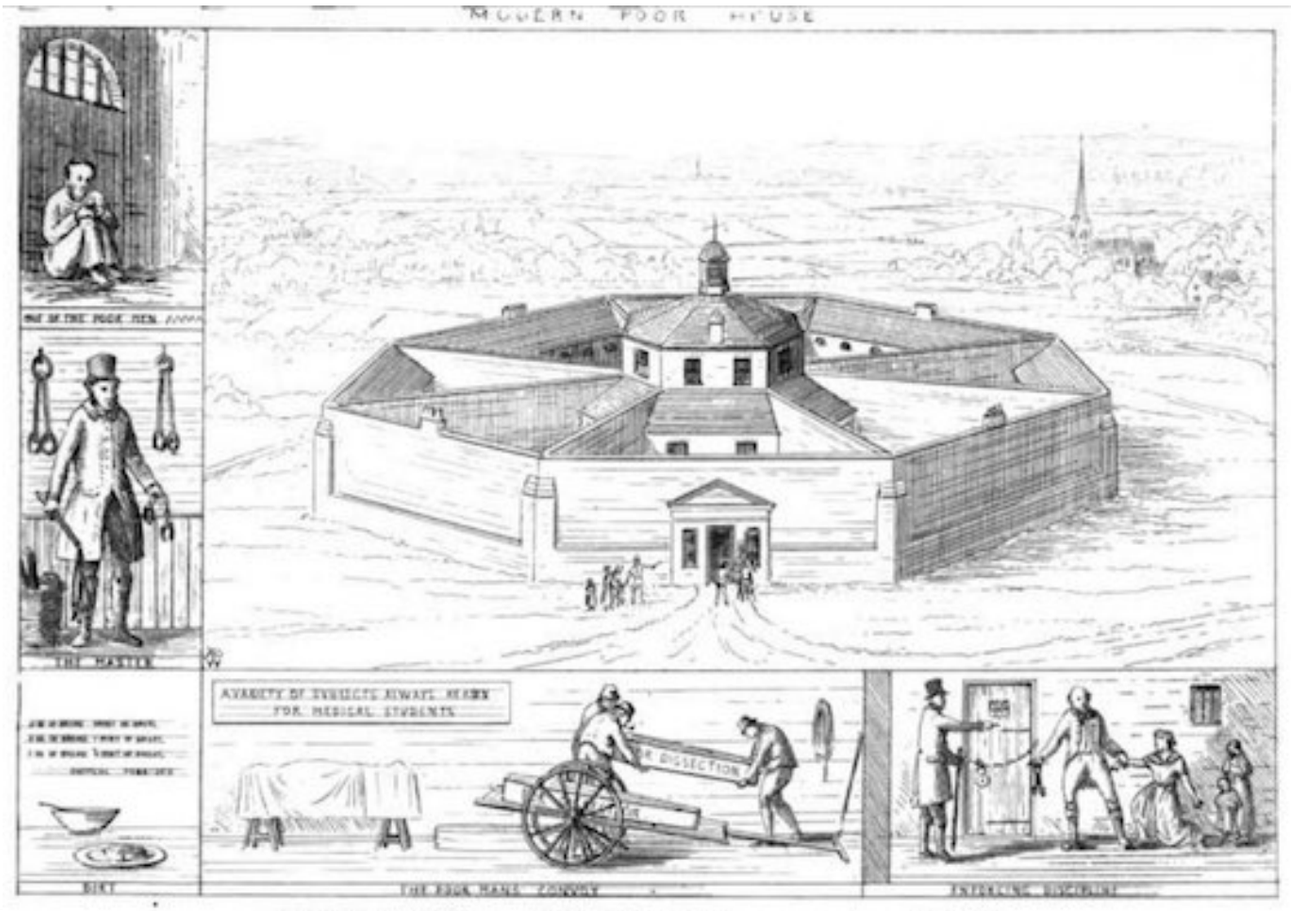
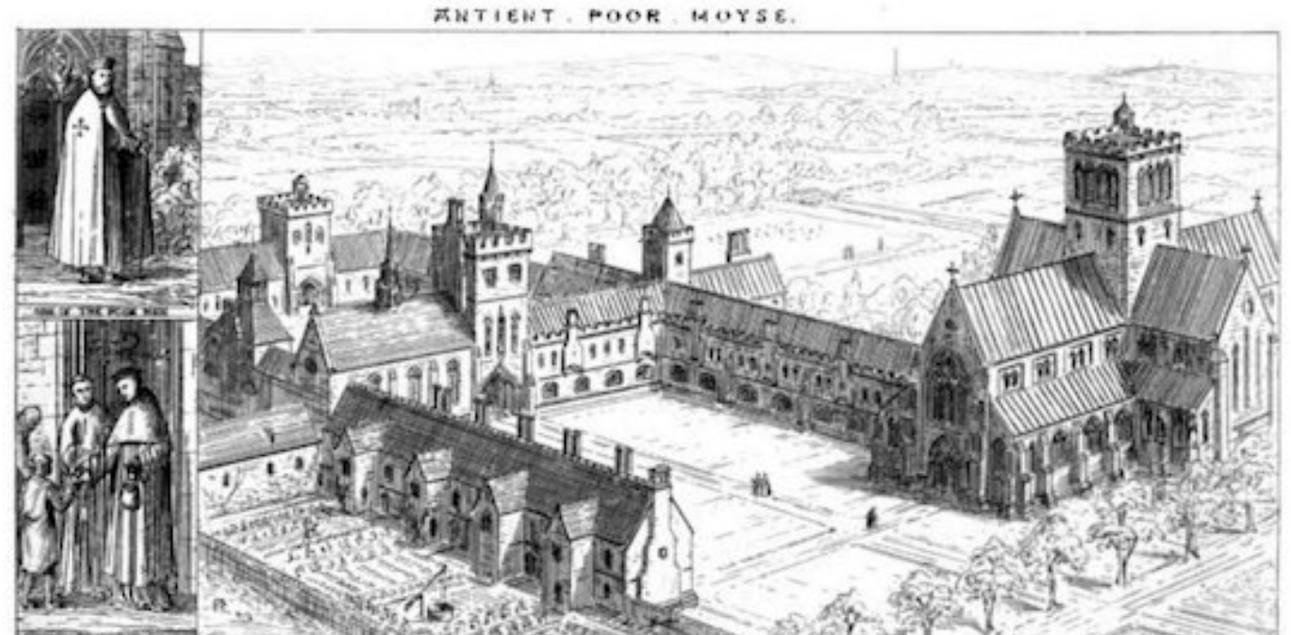
[1] n. a circular prison with cells arranged around a central well, from which prisoners could at all times be observed. (New Oxford American Dictionary, Apple macOS 10.13.6)

Presidio Modelo: a panopticon prison





CONTRASTED RESIDENCES FOR THE POOR



INGSOC: the slogans [2]

- War is peace
- Freedom is slavery
- Ignorance is strength
- Independent thinking = *thoughtcrime*

NOTE: this is a *fiction*!

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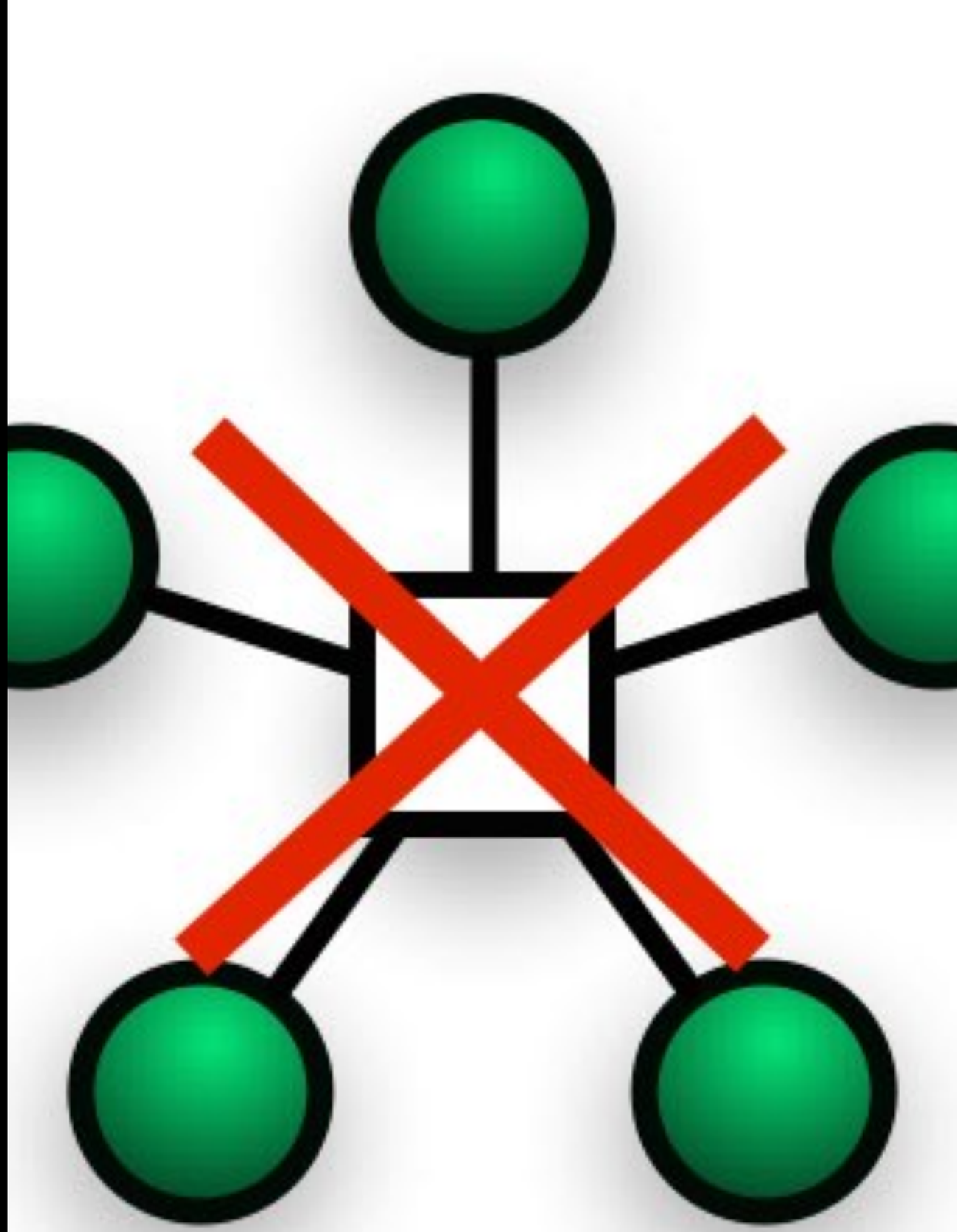
[2] George Orwell, "Nineteen Eighty-Four", 1949.

Why cloud computing has become so *dystopian*? -- because we have sold freedom for *convenience*

- Ubiquitous/global accessibility
- Concentrated data for easy analysis
- Easy control of the information flow
- No extra cost for sharing
- No need to think about where the information locates

The inconvenient truth of centralized systems: what if the core/ cloud fails?



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Inconvenience of centralized systems

- Ubiquity or *no accessibility*
- When the core fails, no alternative
- When the core loses data, *no backup*

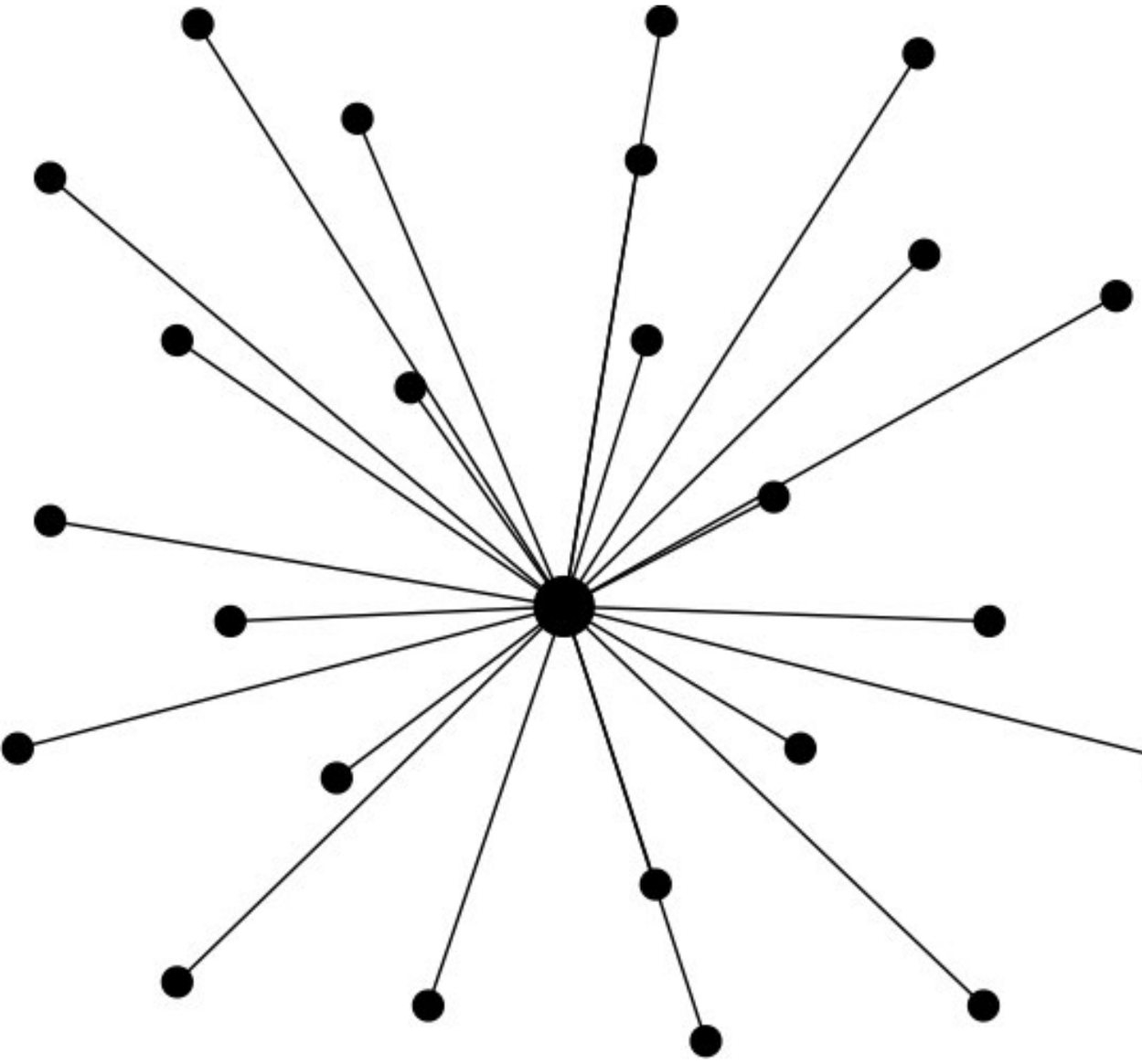
- The system performance is restricted by the capability of the core
- Endpoint systems will lost *all capabilities*

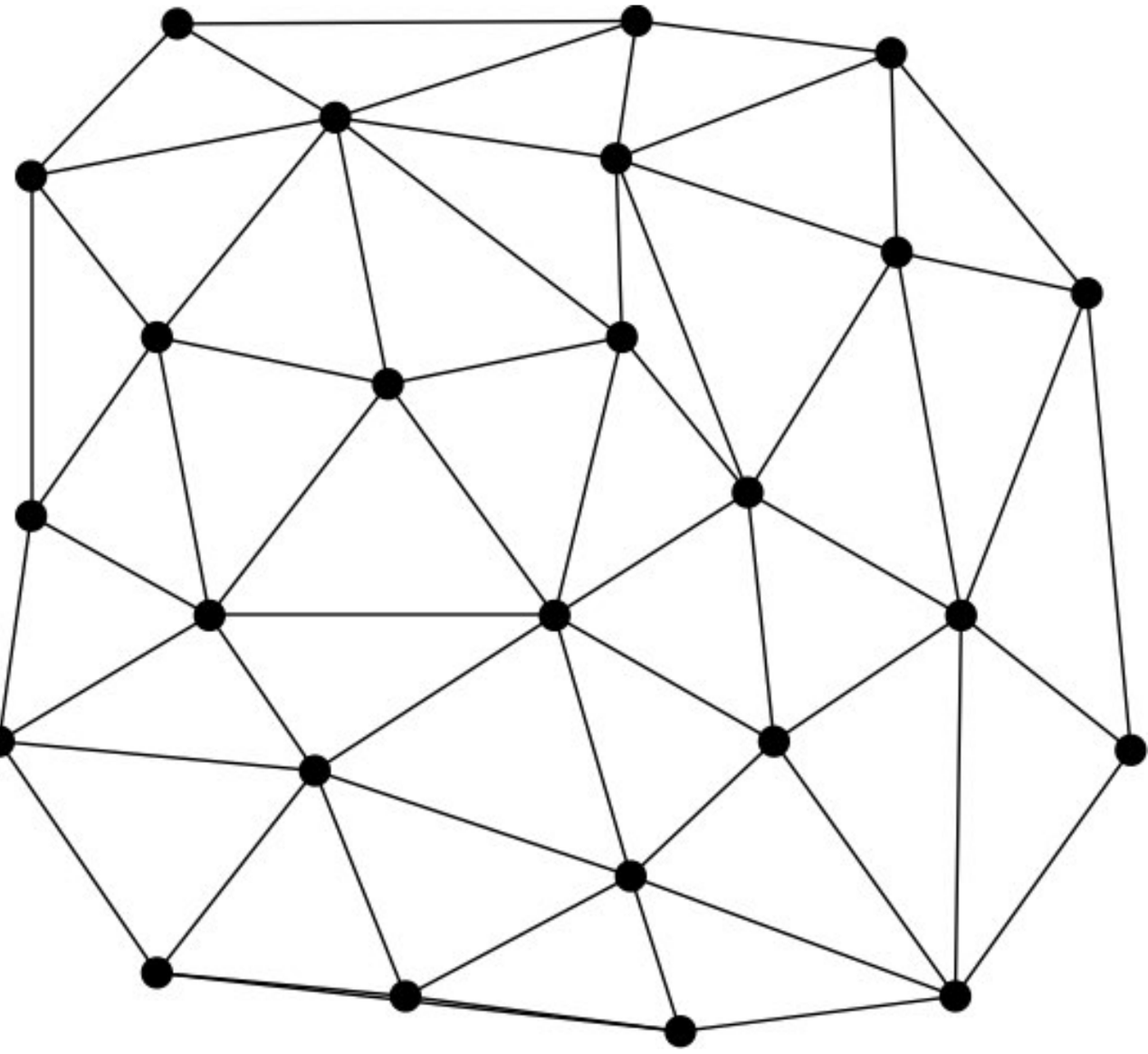
Centralized systems are *not* sustainable

- ...then how cloud computing systems manages the sustainability?

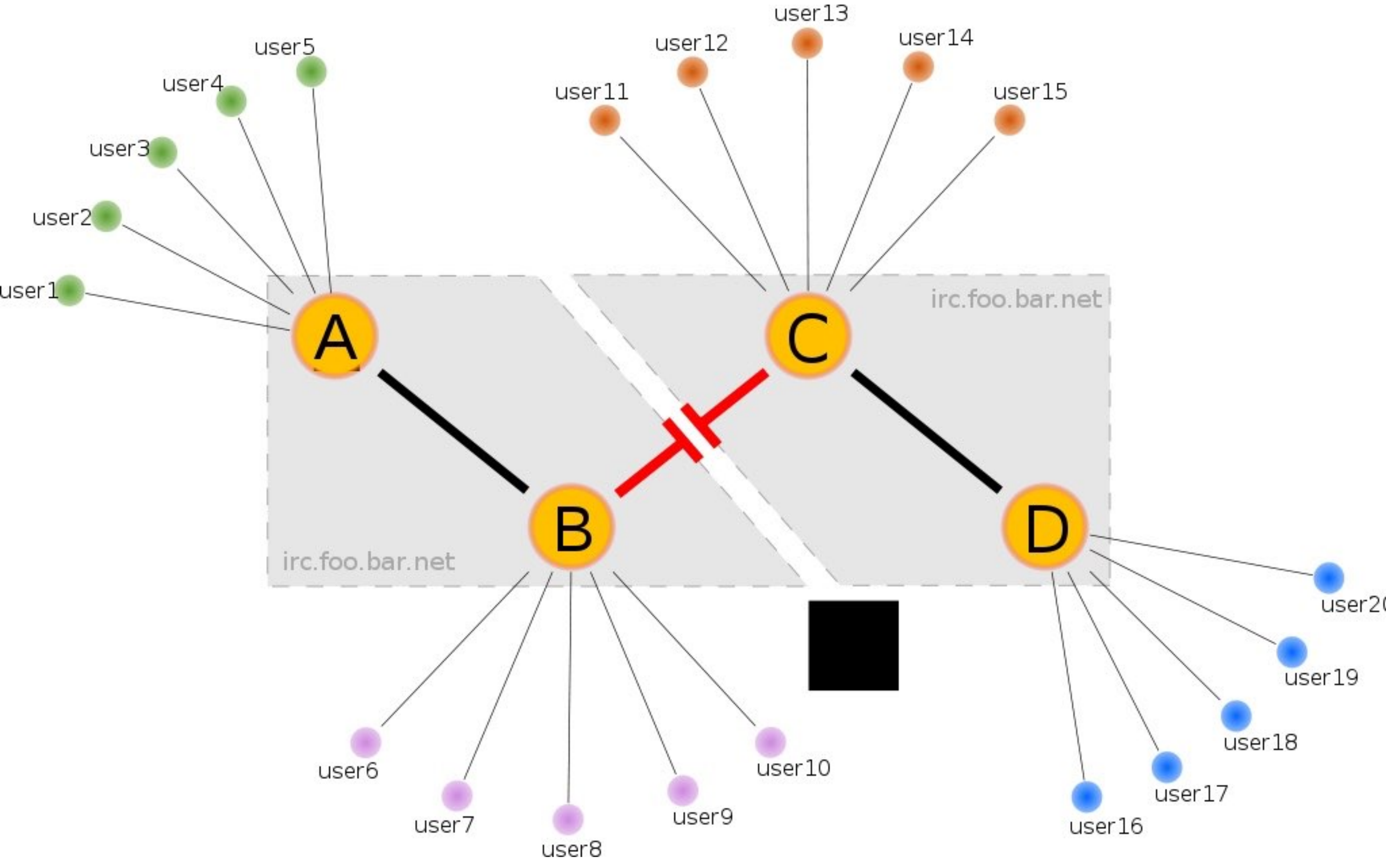
Distributed systems provide sustainability and resilience against failures

Networks






Networks *split*


user1
user2
user3
user4
user5
A
B
irc.foo.bar.net
user6
user7
user8
user9
user10
user11
user12
user13
user14
user15
C
D
irc.foo.bar.net
user16
user17
user18
user19
user20

Partition/fault tolerance: distributed systems should not stop working even if netsplit occurs

Real-world challenges

- Natural disasters
- Device failures
- Human operation errors
- Political impediments
- Social resentments

Handling *failures*

- Redundancy: keeping backup units ready
- Fault tolerance: keeping systems running even the components fail
- Resilience by failing fast: early detection of failures and invocation of the recovery procedures

Why fault tolerance?

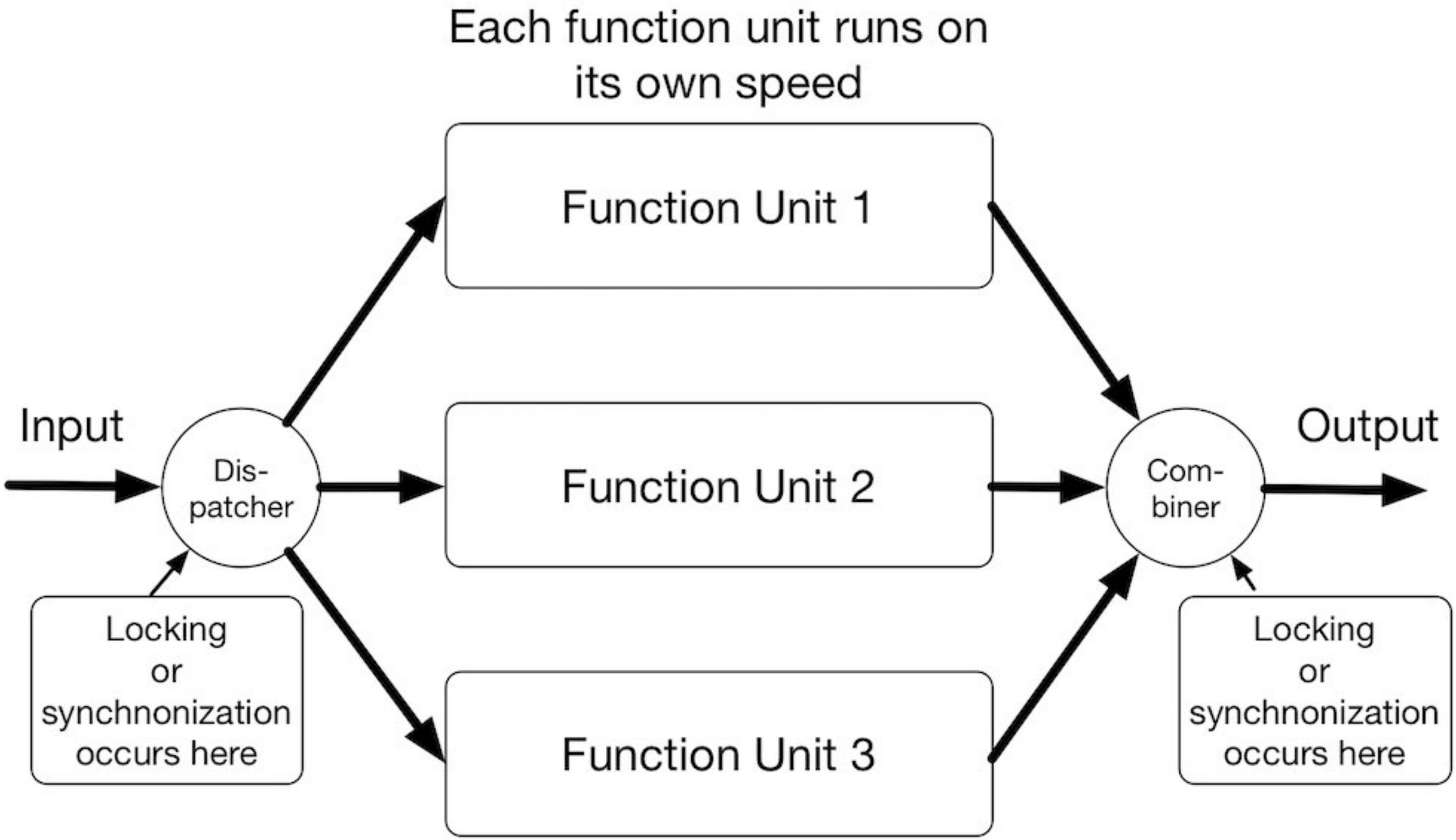
- Hard disk MTBF ~= 1 million hours
- 1000 hard disks running 24 hours x 365 days = 8.76 million hours
- If you're running a system with 1000 hard disks, **9 out of 1000** will fail in a year
- Recovery of a disk content takes often *a day*; you can't stop a system for *a day*, can you?

Requirement to keep the systems fault tolerant

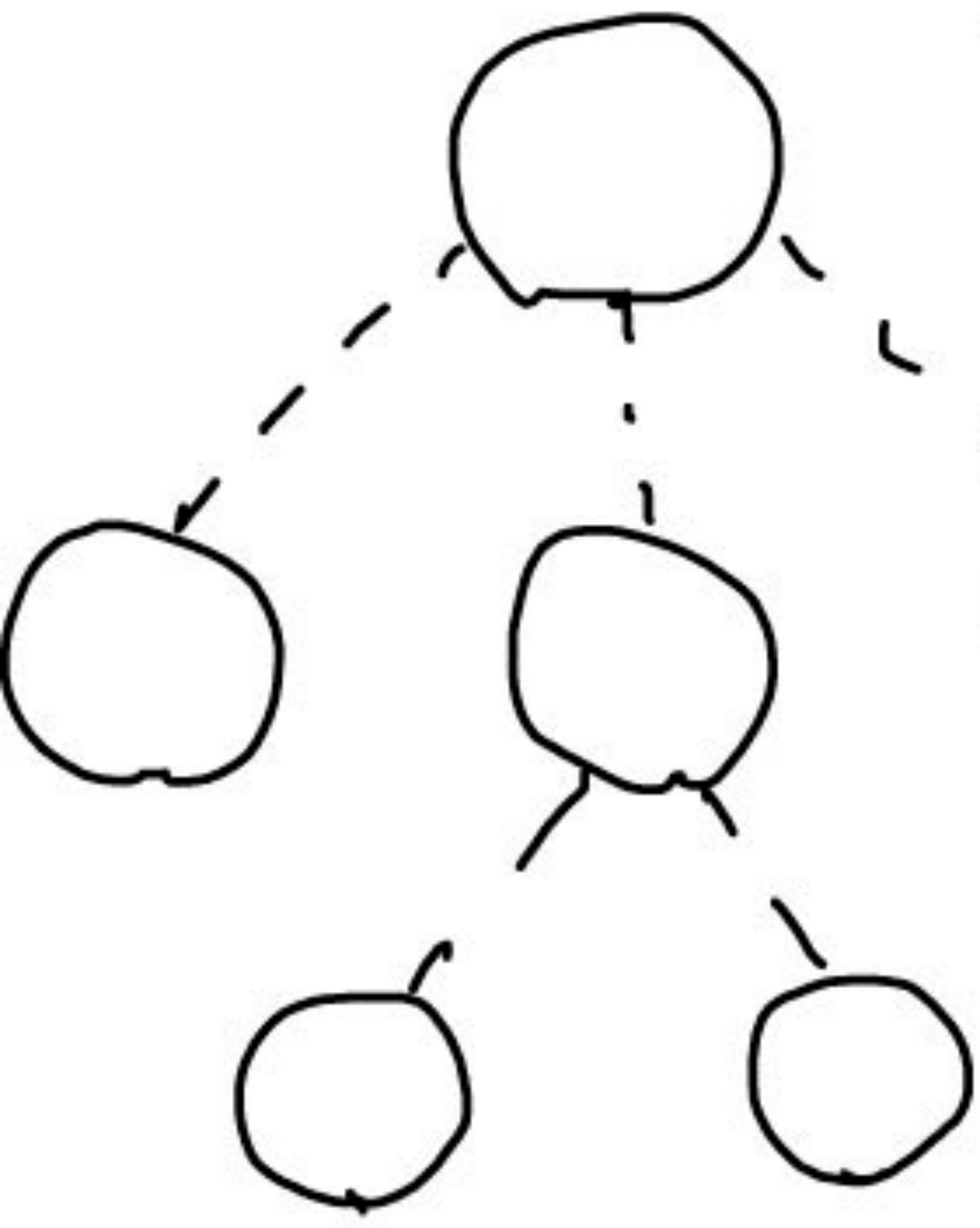
- Redundancy: two or more resources for each unit of processing
- Supervising the failure of the units by an independent supervisor
- Rollback capability: undo the incomplete operations and retry

Consistency issues of distributed systems

- Locking/synchronization: waiting all data to be ready to compute or proceed to next step
- Choosing the *right* data: which data is *correct*?
- Supervision: fault detection and restarting


Each function unit runs on
its own speed
Function Unit 1
Input
Dis-
patcher
Function Unit 2
Com-
biner
Output
Locking
or
synchnonization
occurs here
Function Unit 3
Locking
or
synchnonization
occurs here

Supervision tree example



Try to restart when crashed

Eight Fallacies of Distributed Computing[3] (1/2)

- **The network is reliable**
- **Latency is zero**
- **Bandwidth is infinite**
- The network is secure

[3] https://blog.fogcreek.com/eight-fallacies-of-distributed-computing-tech-talk/

Eight Fallacies of Distributed Computing (2/2)

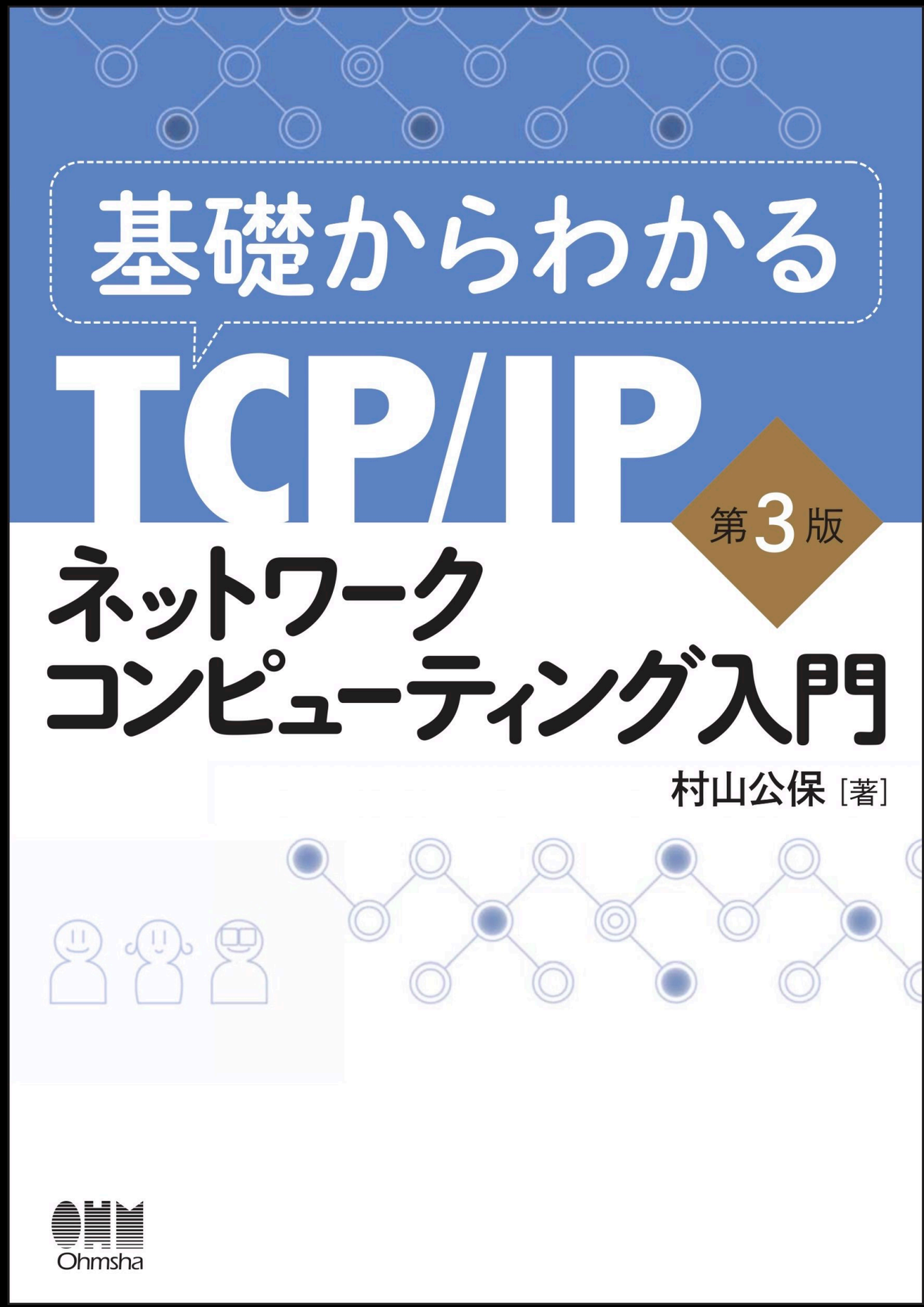
- Topology doesn't change
- There is one administrator
- Transport cost is zero
- The network is homogeneous

Summary: centralized computing is fragile; distributed computing is fault tolerant but hard

Appendix 1: references for further study

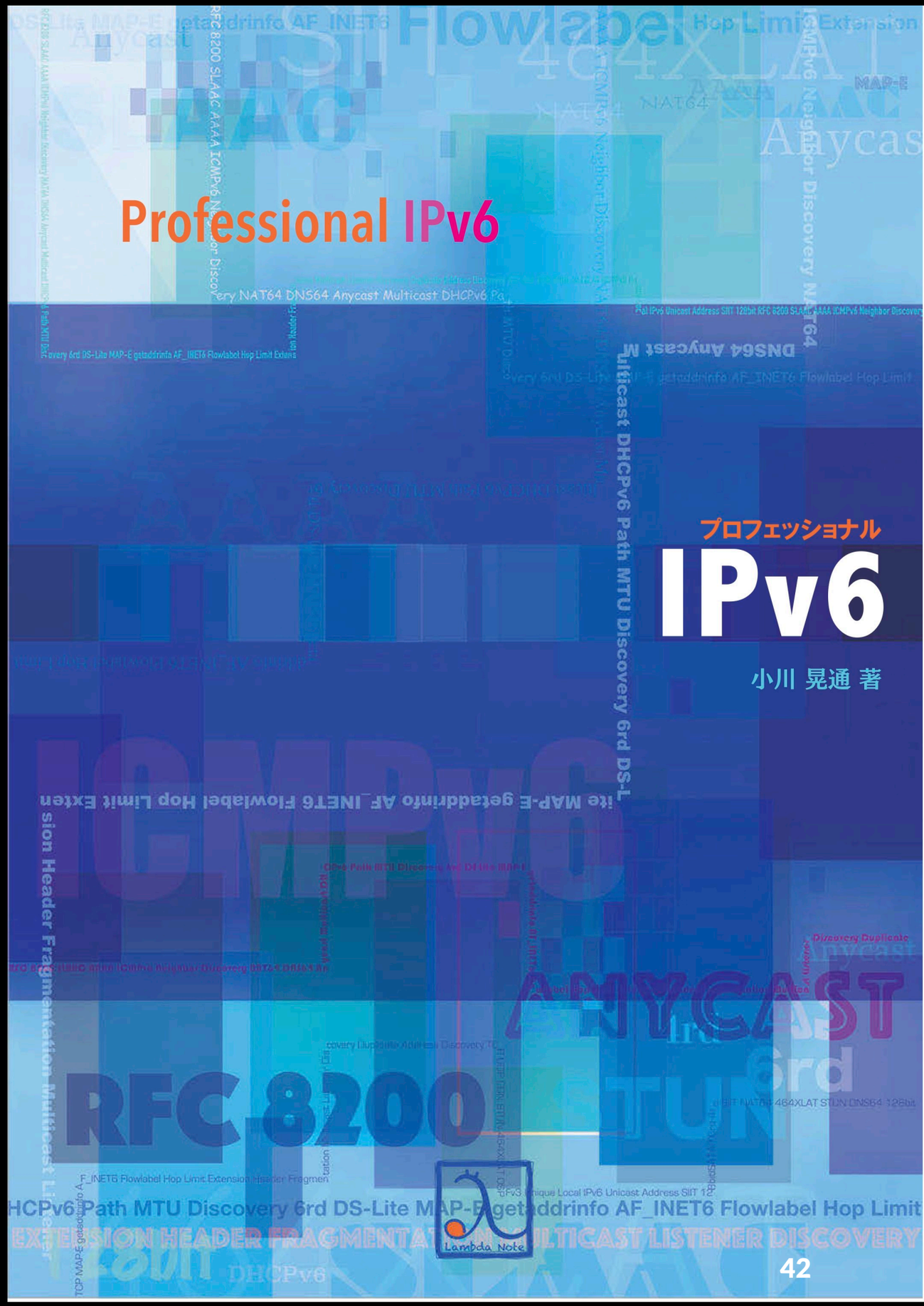
基礎からわかる TCP/IPネットワーク コンピューティング 入門 第3版

- オーム社 ISBN 9784274050732
- 達人出版会の電子書籍



プロフェッショナル IPv6

- ラムダノートの紙の本+電子書籍
- Boothの無料版



Appendix 2: on choosing your career and professionality

When I chose my career and professionality?

- Age 9: computers and English
- Age 10 ham radio and electronics
- Age 14: writing commercial software
- *Age 23: finally decided to make my living on my computer software professionality, with my English proficiency*

If I were at age 22, what I would do after getting a Bachelor's degree?

- Get out of Japan ASAP
- Explore the computer skills
- Do something unpopular

Go abroad

What are the most important things to pursue engineering/scientist career?

- Physical strength
- Mental strength
- Curiosity

Curiosity matters

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- Intertwined network of computers: https://en.wikipedia.org/wiki/File:Cloud_Computing.jpg, licensed under Creative Commons CC0 1.0 Universal Public Domain Dedication
- Web services are clusters of computers: Kenji Rikitake, at Kyoto University ACCMS, April 2017
- Presidio Modelo Prison: By Friman [Public domain], from Wikimedia Commons
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