

ouees-202206 topic 05:

Network fault-tolerance

Network services and programming
trends

Kenji Rikitake

21-JUN-2022

School of Engineering Science, Osaka University

On the internet

@jj1bdx

Copyright ©2018-2022 Kenji Rikitake.

This work is licensed under a [Creative Commons Attribution 4.0 International License](#).

CAUTION

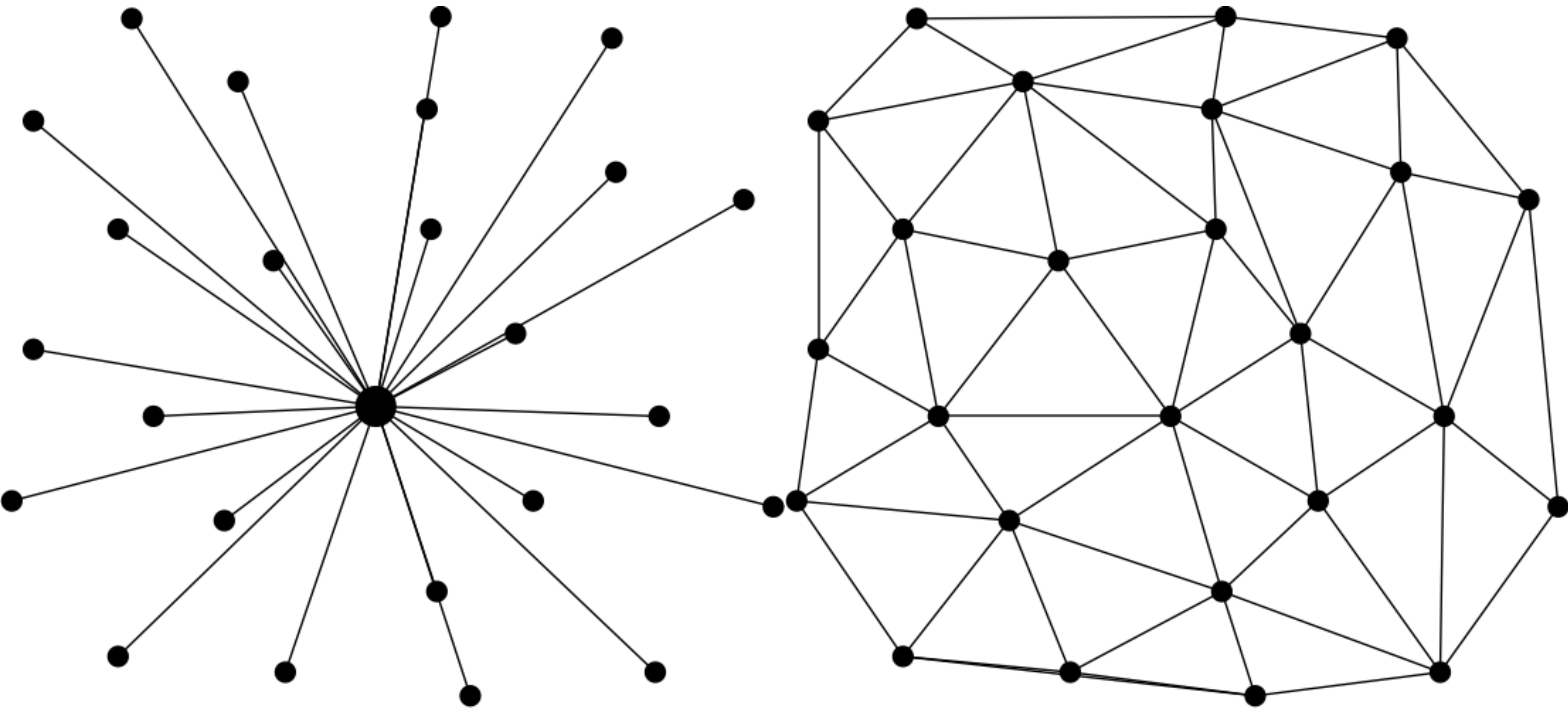
Osaka University School of Engineering Science prohibits copying/redistribution of the lecture series video/audio files used in this lecture series.

大阪大学基礎工学部からの要請により、本講義で使用するビデオ/音声ファイルの複製や再配布は禁止されています。

Lecture notes and reporting

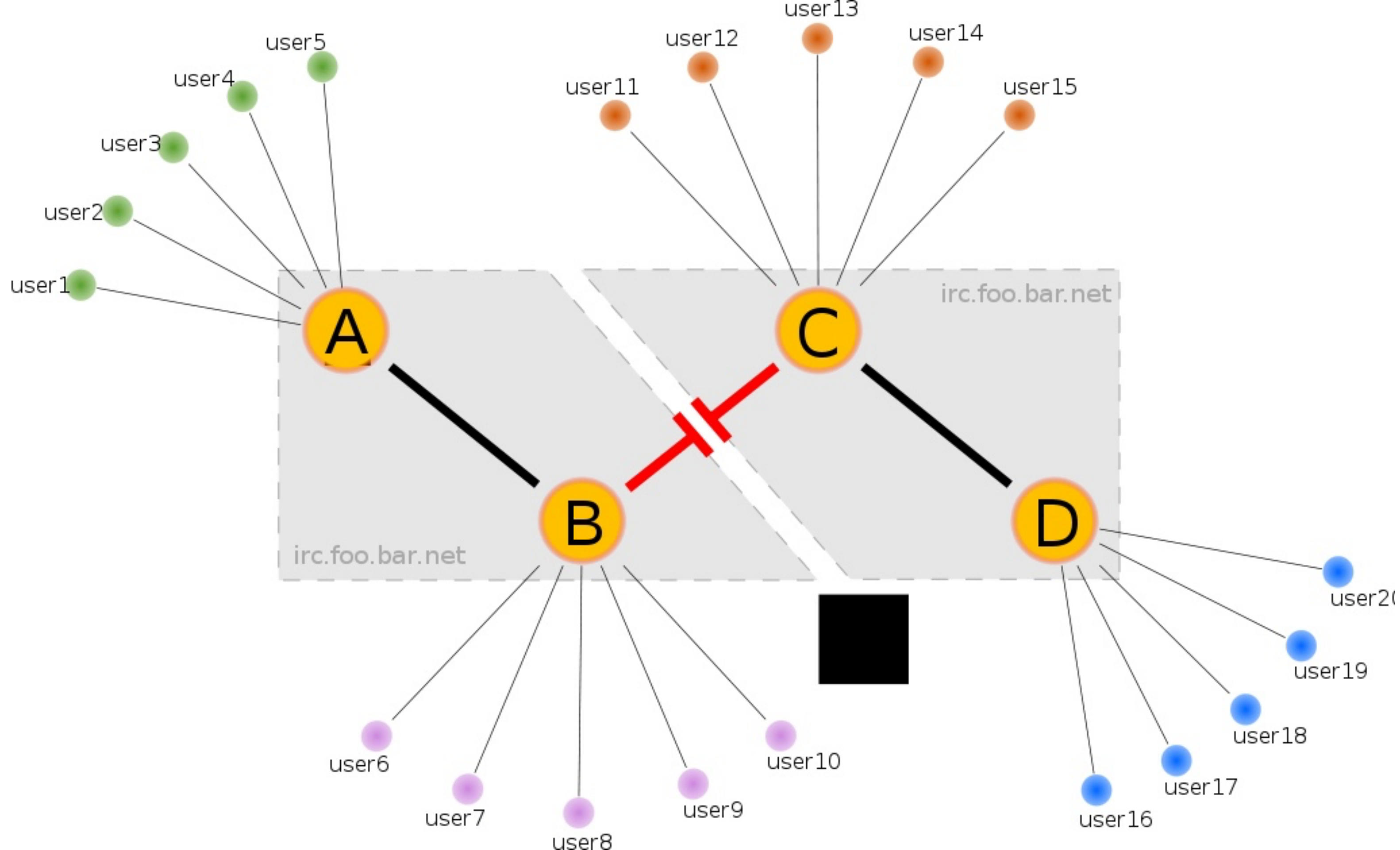
- <https://github.com/jj1bdx/oueees-202206-public/>
- Check out the README.md file and the issues!
- Keyword at the end of the talk
- URL for submitting the report at the end of the talk

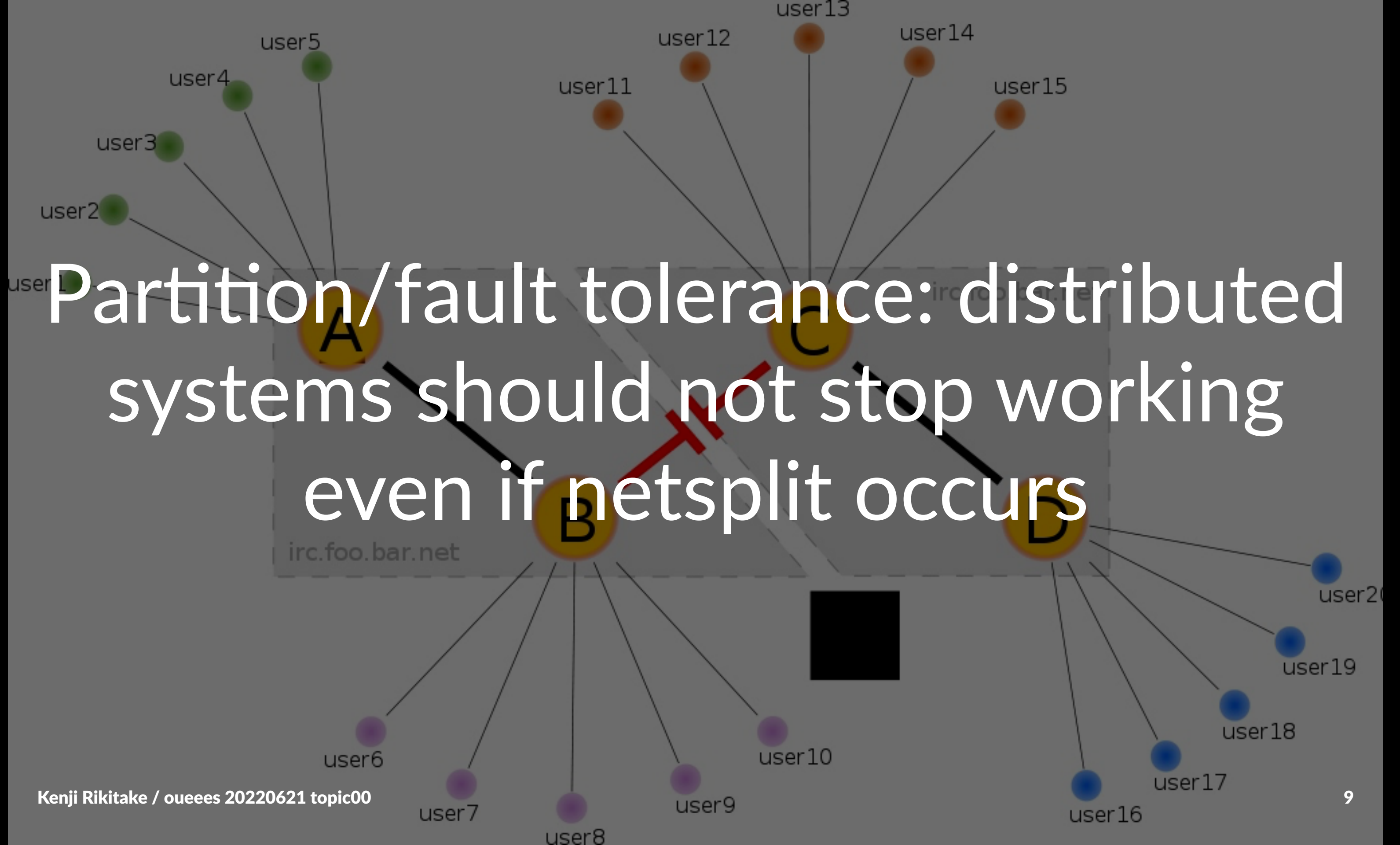
Network fault-tolerance





Networks *split*





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 \approx 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?

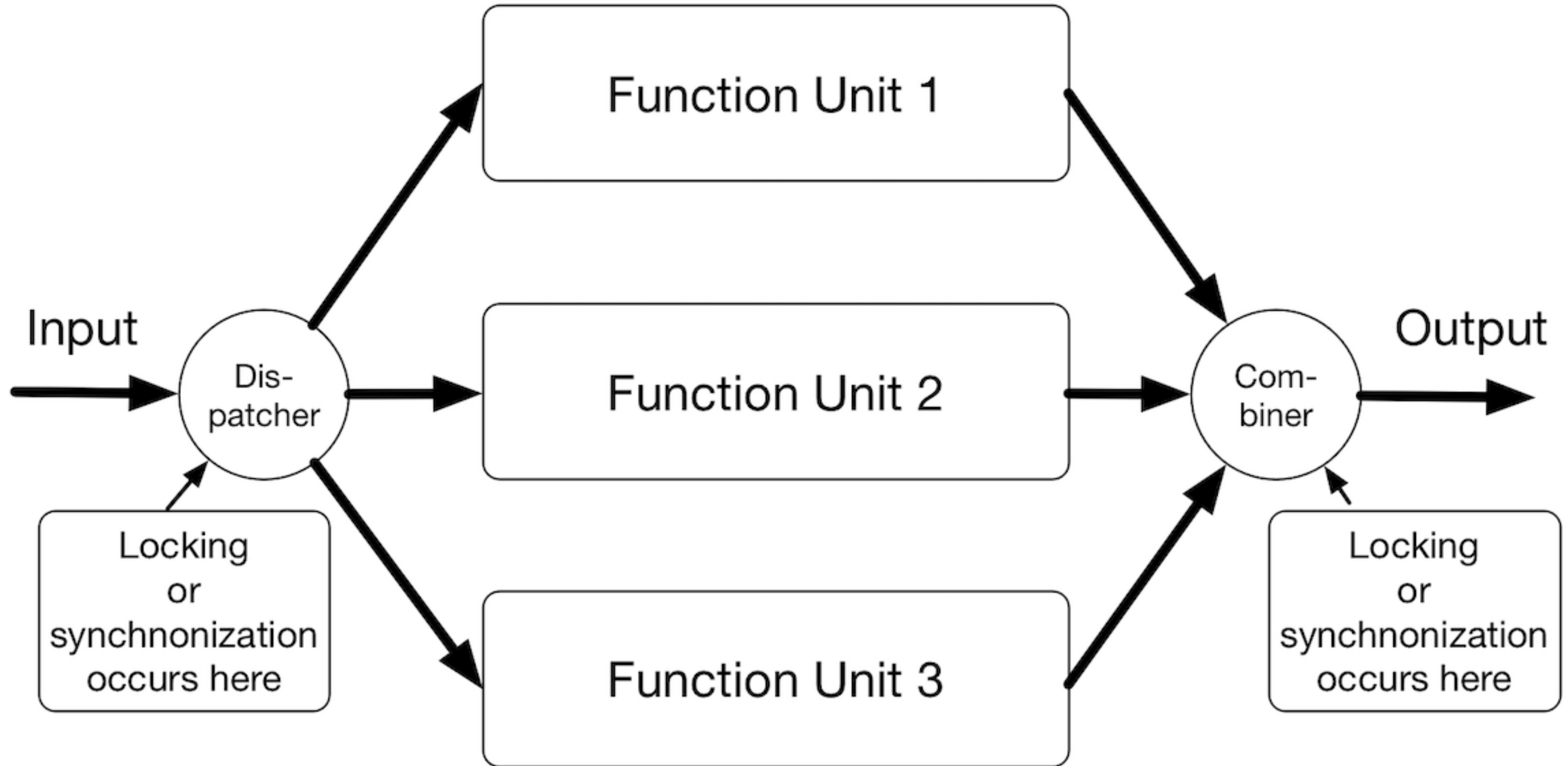
Requirement to keep the systems fault tolerant

- 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

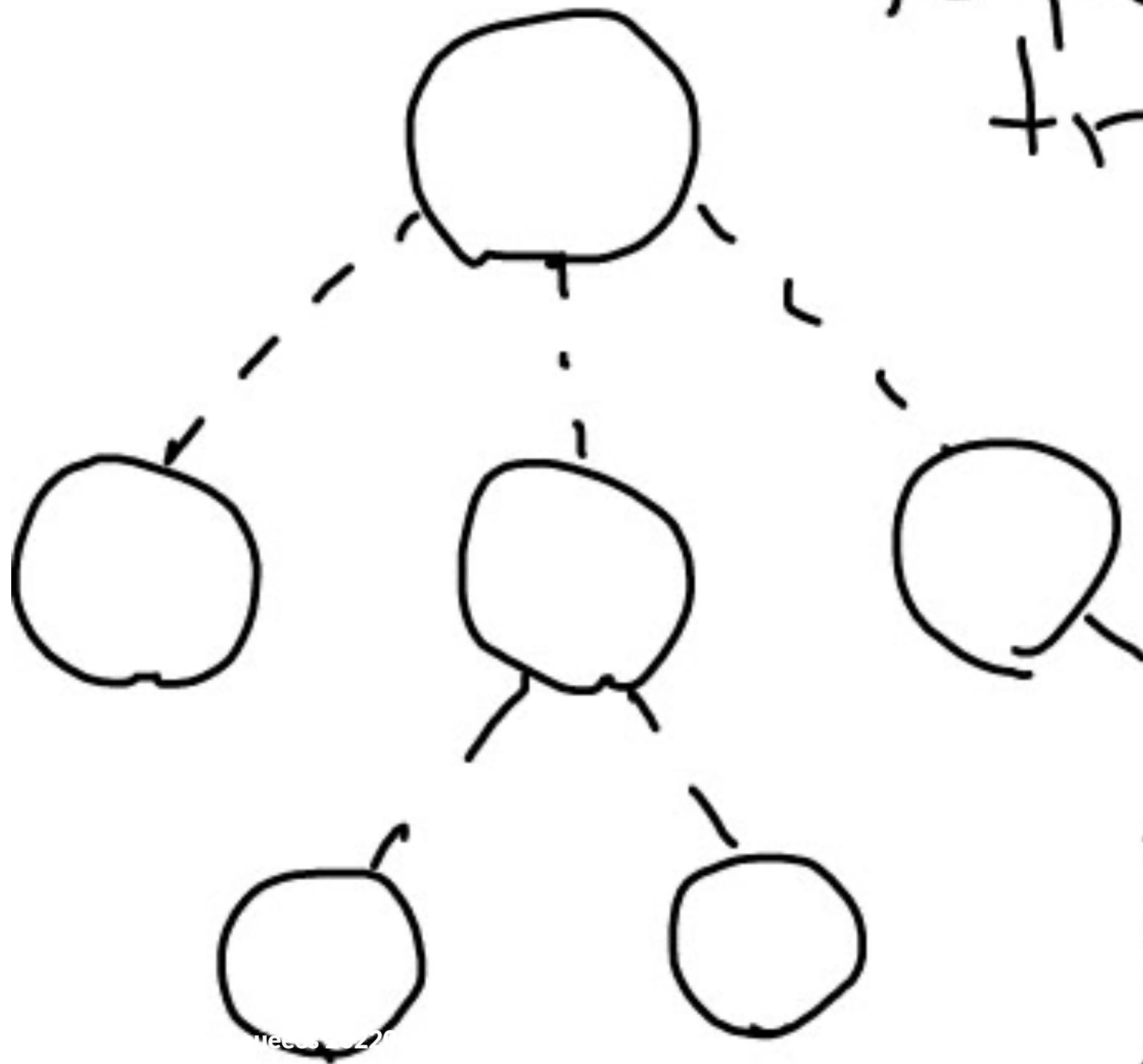
Each function unit runs on
its own speed



Supervision
tree example

Try to
restart

when
crashed



Eight Fallacies of Distributed Computing³ (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

Network services and programming trends

Trends of (network) services

- Becoming hybrid and more complex, many different parts
- Web design: user experience (UX), accessibility, usability
- Development: database, web frontend, web backend
- Site Reliability Engineering (SRE), infrastructure and operation
- Security: vulnerability assessment, incident response

Why learning programming?
Programming = making software
Programming is the only way to fabricate a system
Computers can only do their job through programming
It's often *you* need to write the code, not somebody else

Programming is a language

There are various languages which fit and don't fit your requirement

There are no good or bad programming languages

Modern software development: team, library, and ecosystem

- Development as a *team*, not just individual
- Depending on *libraries*, not just newly-written code
- Depending on the *ecosystem*, not just you and your team

So what to learn?

- Popular ones (C++, JavaScript, Python, etc.)
- *Required* ones by your tasks (old languages)
- For experiments and prototyping (esoteric languages)
- Learning a programming language can change your mind

My suggestions: Erlang/Elixir for concurrency

- Concurrency is the key for distributed network programming
- Erlang for learning the basic functional programming
- Elixir for applying functional programming for web
- Disclaimer: these languages are not necessarily popular, but will surely change how you understand computer programming

すごいErlangゆかいに学ぼう!

- オーム社 ISBN 9784274069123
- 達人出版会の電子書籍



プログラミングElixir 第2版

- オーム社 ISBN 9784274226373
- 達人出版会の電子書籍

プログラミング Elixir 第2版

Programming Elixir ≥ 1.6

Functional
|> Concurrent
|> Pragmatic
|> Fun

Dave Thomas 著
笹田耕一・鳥井 雪 共訳



Photo and image credits

- All photos and images are modified and edited by Kenji Rikitake
- Photos are from Unsplash.com unless otherwise noted
- Networks: Irina Blok
- Networks Split: Pietro De Grandi
- Netsplit: https://commons.wikimedia.org/wiki/File:Netsplit_split.svg, in public domain