Importance of diversity

From regional IXes to time and frequency distribution

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The argument for diversity

Geographical diversity is a good thing. But we know it comes at a cost that is not simply financial.

Look at the fibre cuts in France: diversity in fibre paths enabled ISPs to recover quickly.

We also had the fire at the OVH data centre a few years ago in Germany.

Redundancy and diversity

- Redundancy is nice, but diversity is the shit
- Distribution of services can either be a kludge or a feature
- What happens at one node should never impact other nodes
  - Otherwise your only bonus is lower RTT
- Connecting to more than one node can be done in multiple ways
  - Either by building your own attachment
  - Or by having it as a service
  - You do not even have to choose, both alternatives exist

Diverse nodes

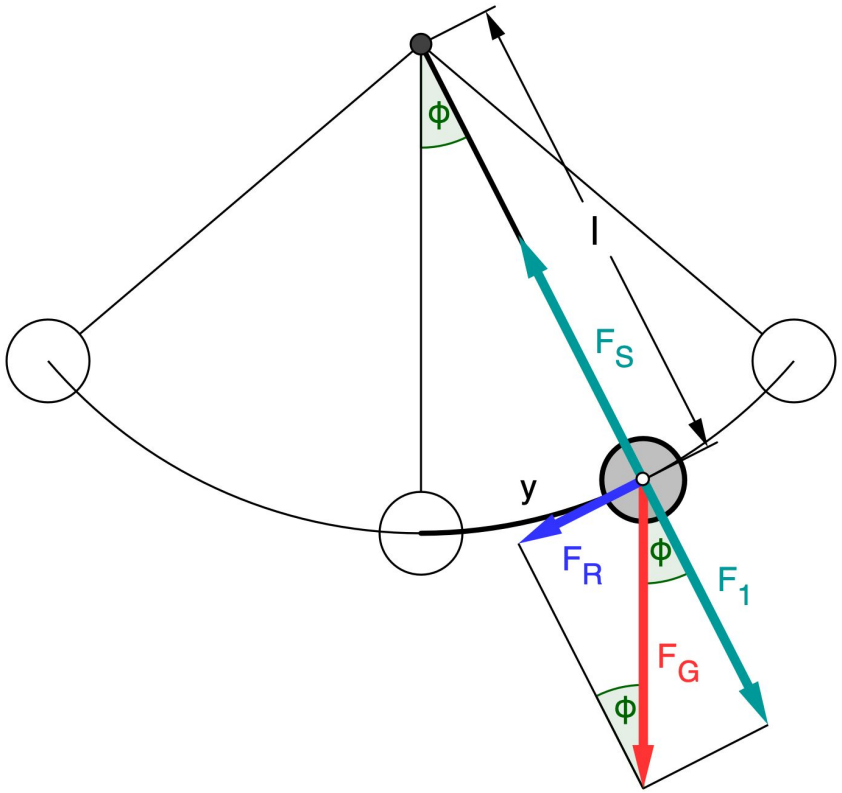
- Stockholm
- Gothenburg
- Copenhagen / Malmö
- Oslo
- Helsinki
- Sundsvall / Gävle
- Luleå

Points of presence

- Stockholm (10 locations)
- Gothenburg (2 locations)
- Copenhagen / Malmö (4 locations)
- Oslo (4 locations)
- Helsinki (3 locations)
- Sundsvall / Gävle (3 locations)
- Luleå (1 location)

Example: time and frequency

- Stockholm (2 diverse nodes)
- Gothenburg
- Malmö
- Sundsvall
- Luleå


ϕ
l
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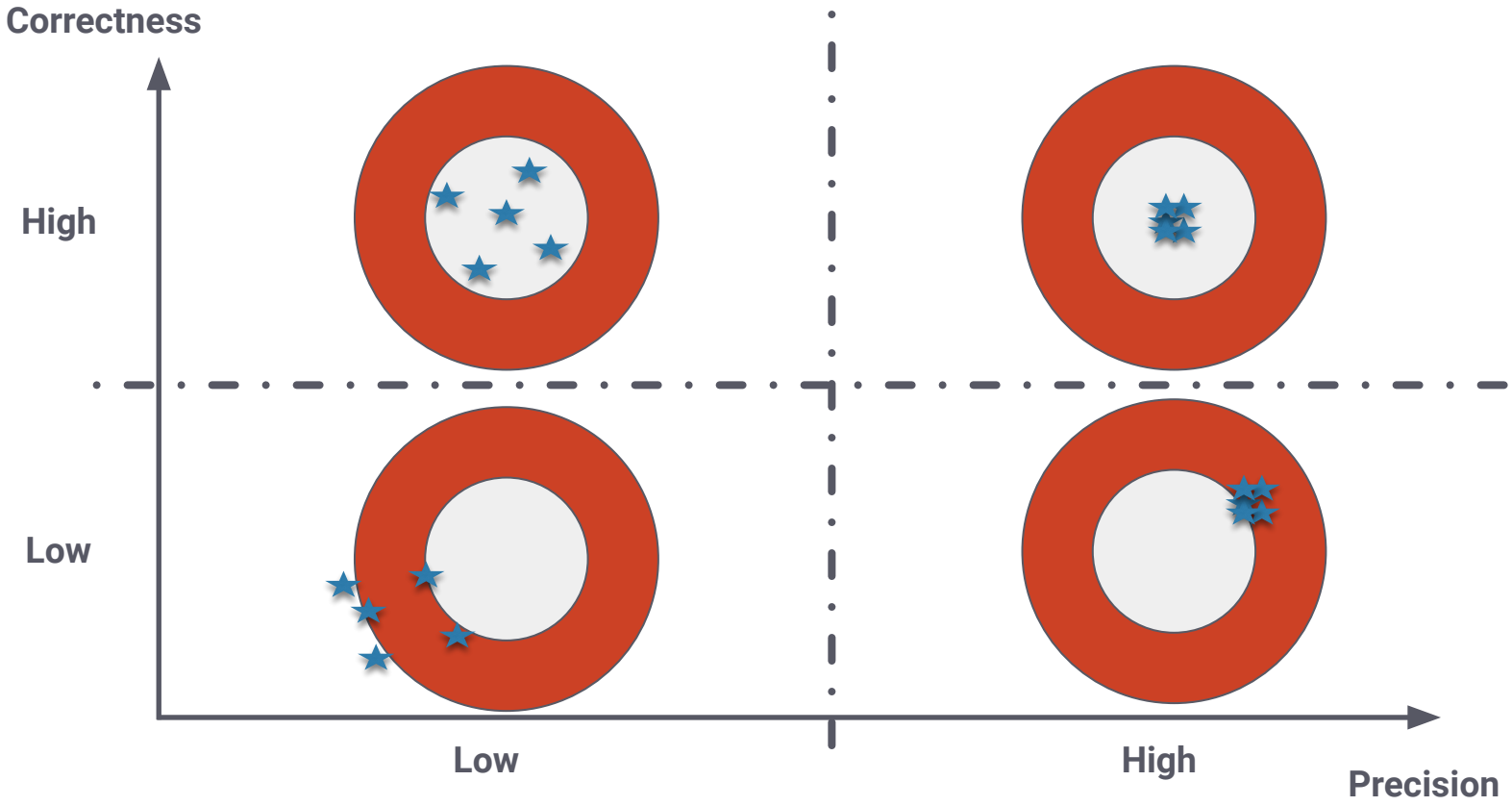
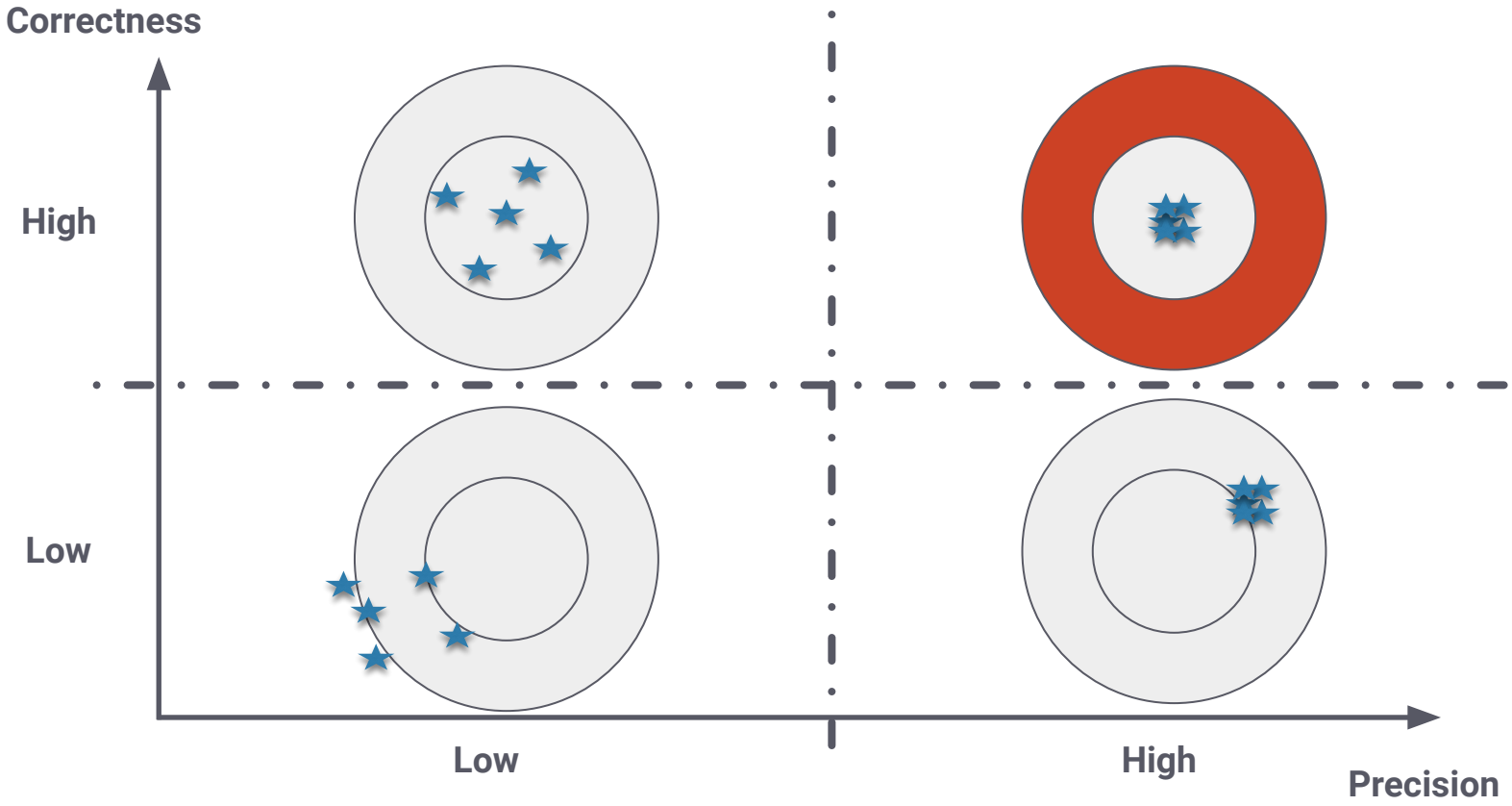
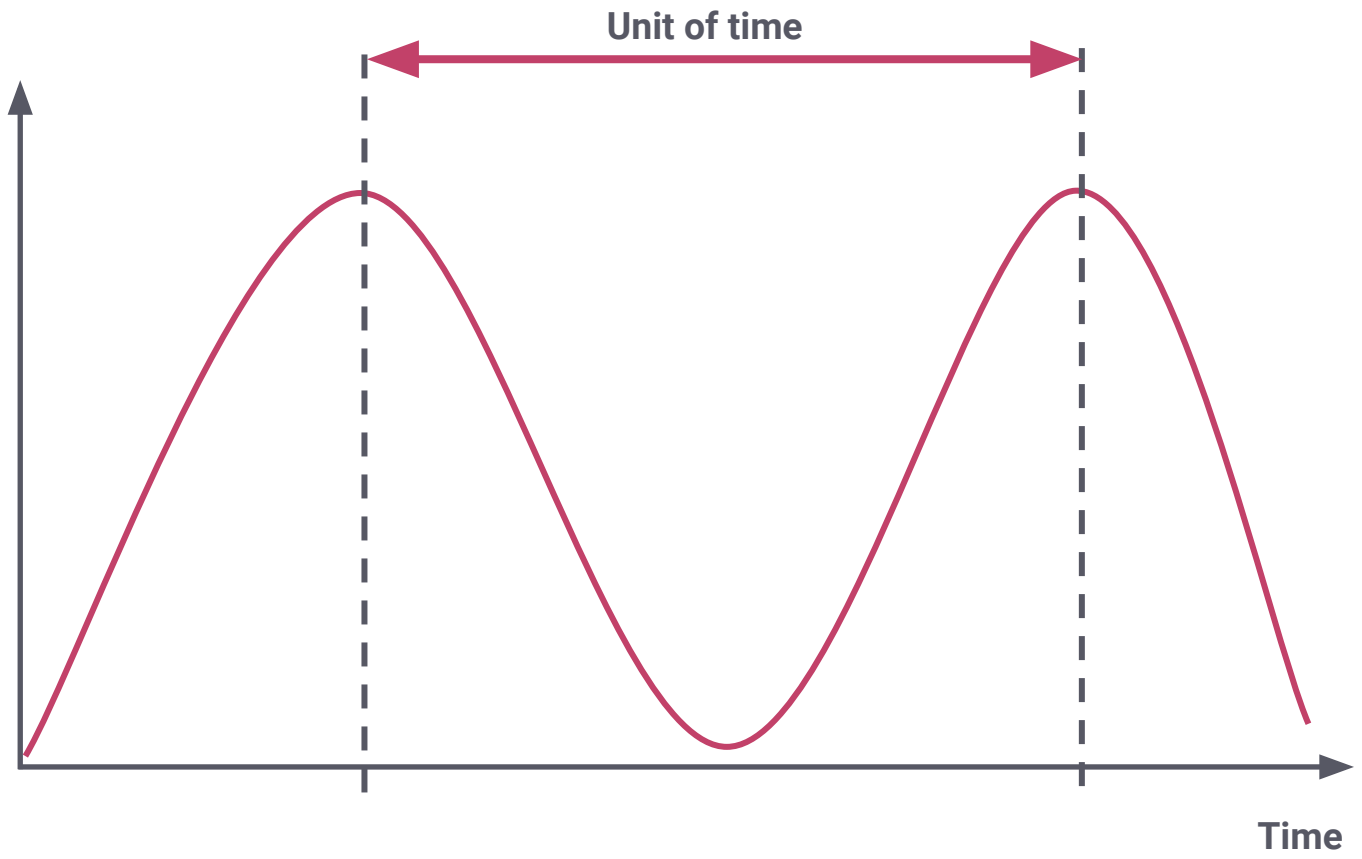
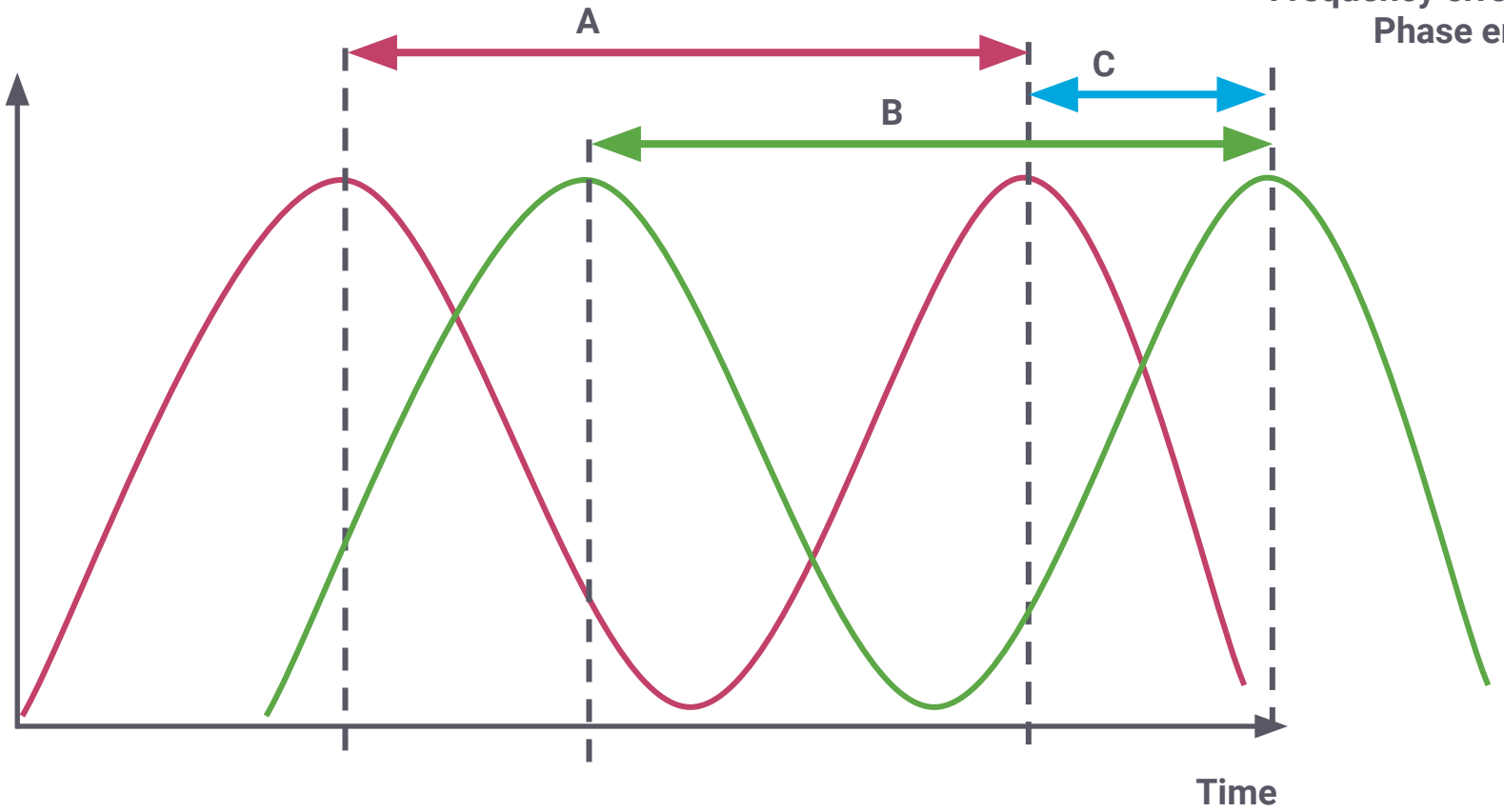
F_R
ϕ
F_1
F_G
ϕ


Correctness
High
Low
Low
High
Precision


Correctness
High
Low
Low
High
Precision

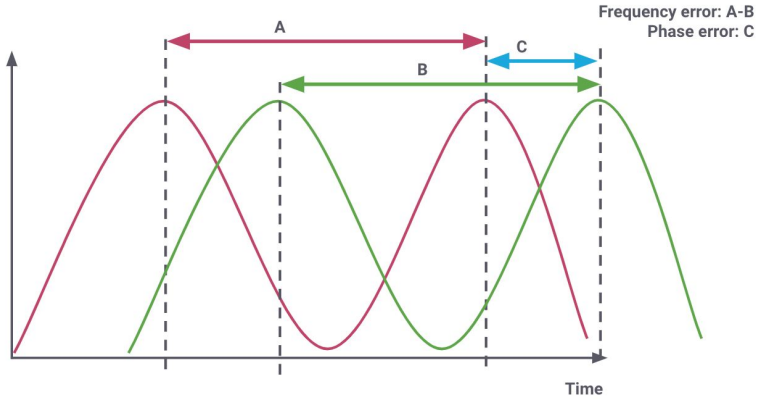

Unit of time
Time

Frequency error: A-B
Phase error: C

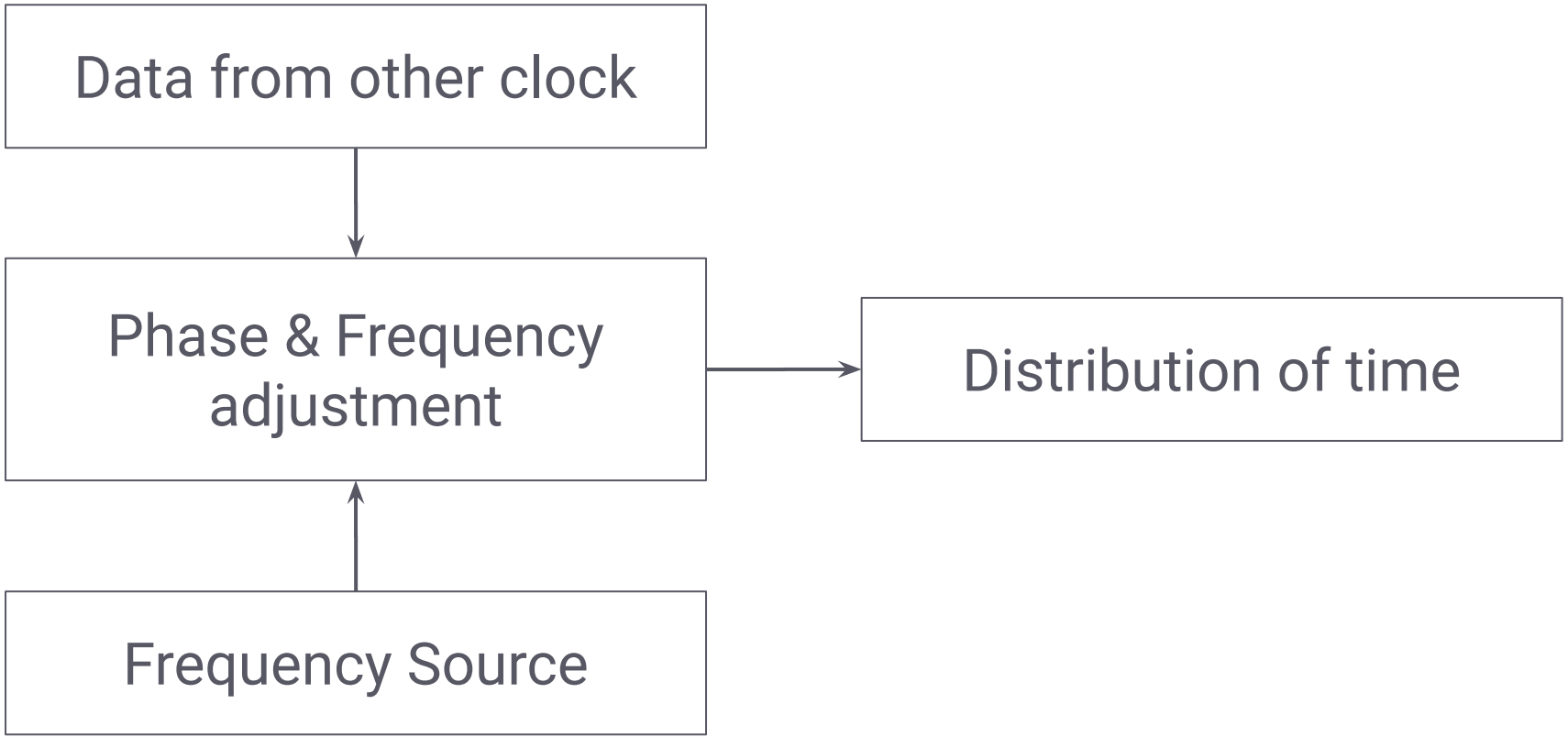


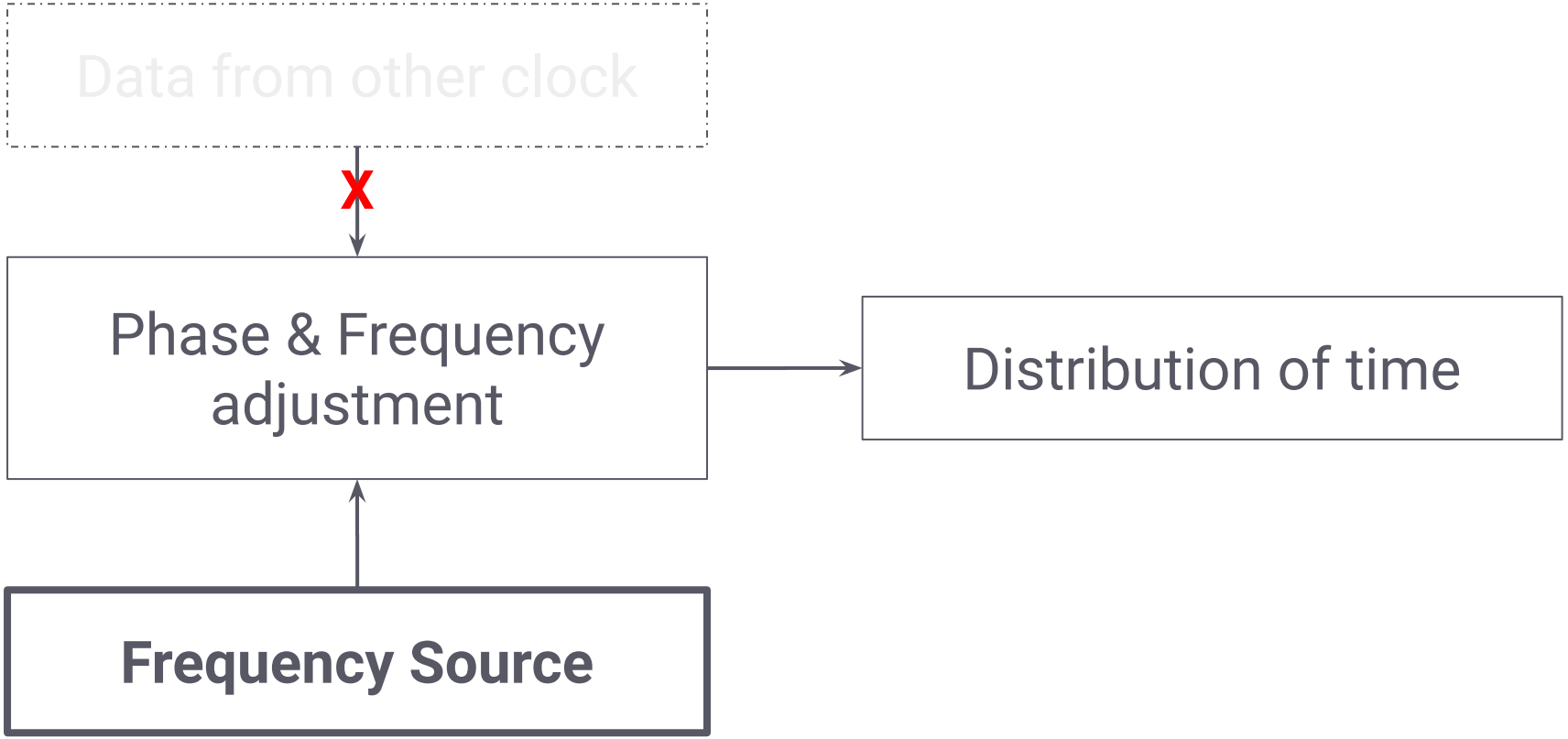
Source: A

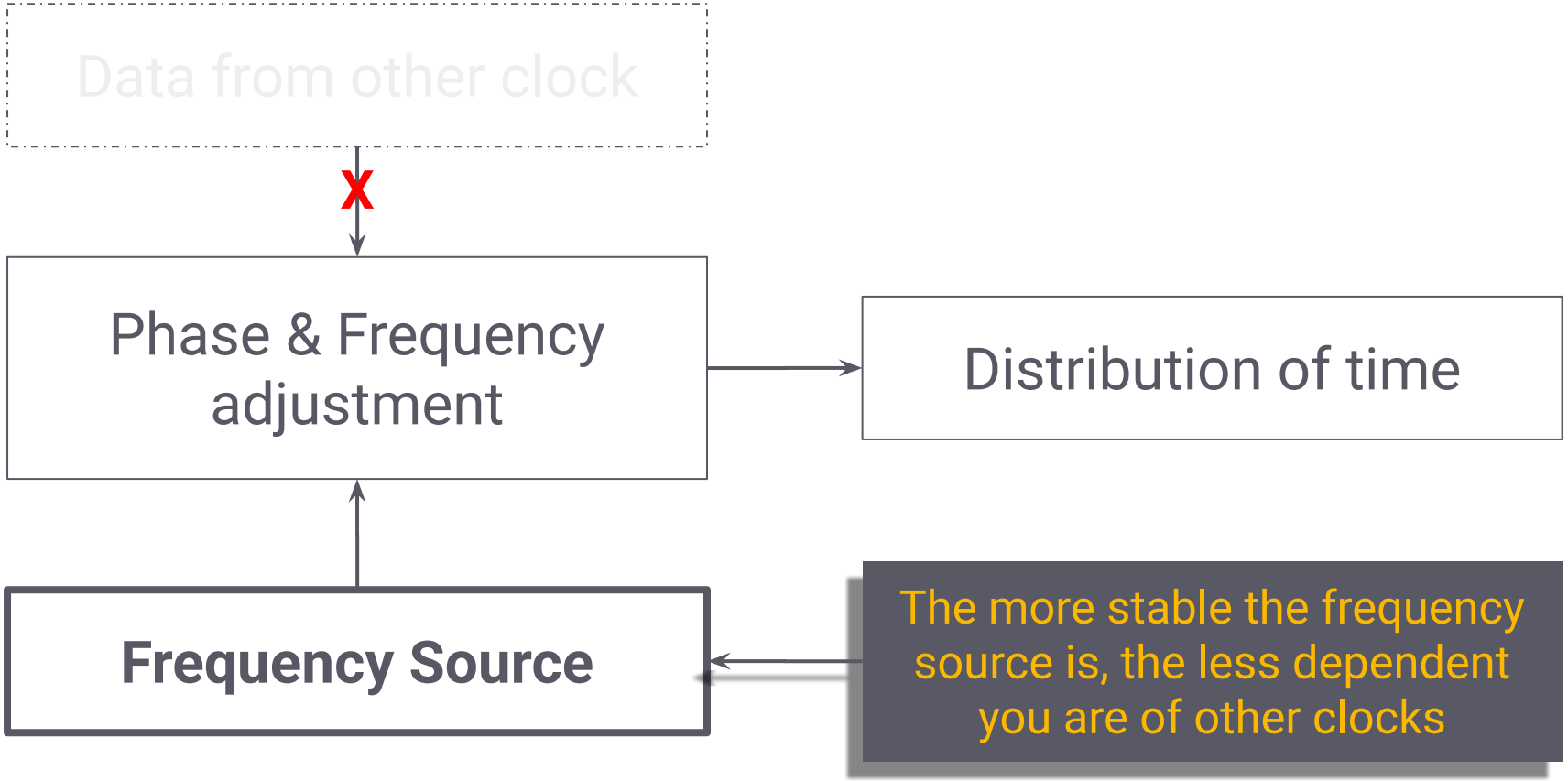
Target: B

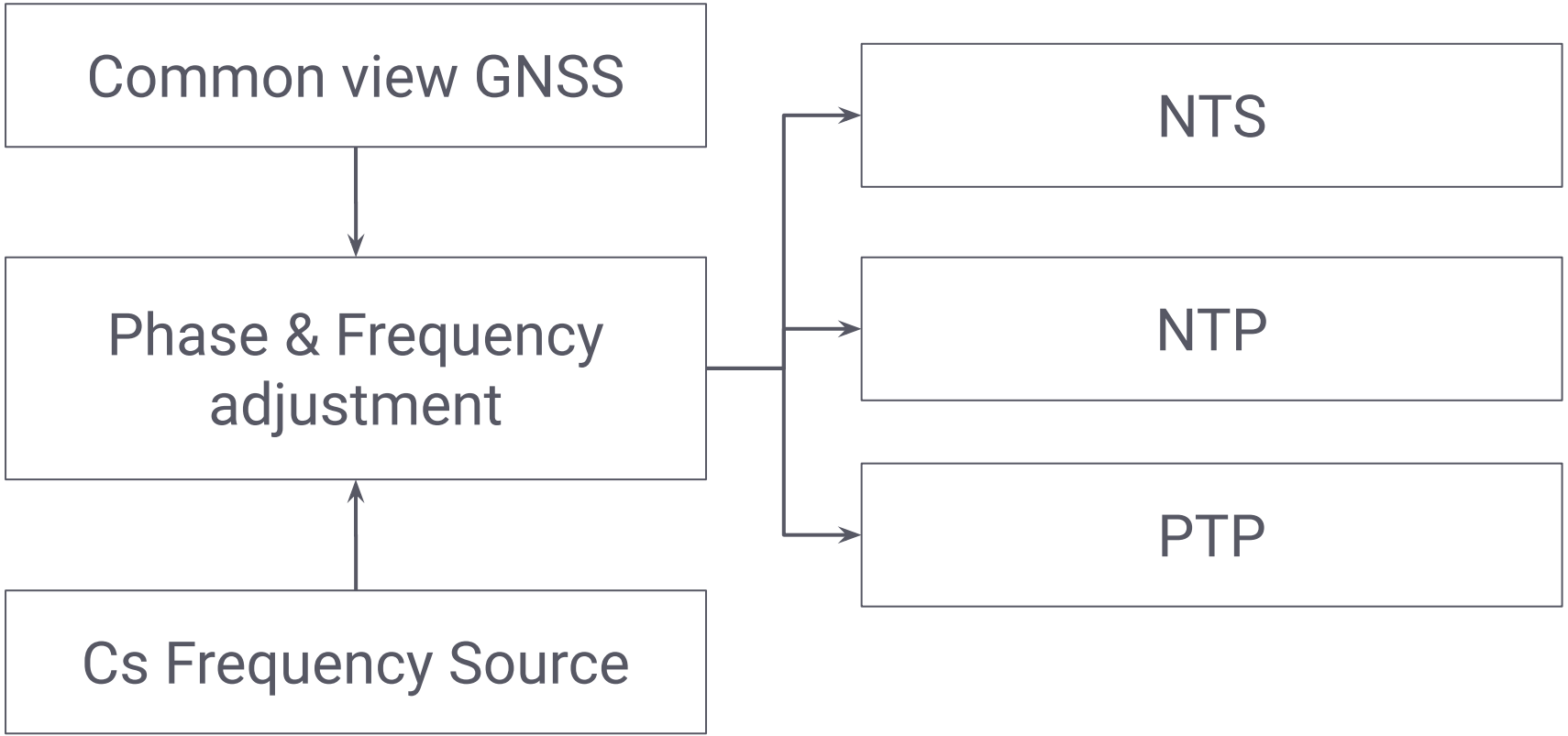


- Signal propagation time: ∂
- We also have:
  - Variation in propagation time
  - Asymmetry in propagation time


Data from other clock
Phase & Frequency adjustment
Distribution of time
Frequency Source


Data from other clock
X
Phase & Frequency adjustment
Distribution of time
Frequency Source


Data from other clock
X
Phase & Frequency adjustment
Distribution of time
Frequency Source
The more stable the frequency source is, the less dependent you are of other clocks


Common view GNSS
Phase & Frequency adjustment
Cs Frequency Source
NTS
NTP
PTP

Arista 7130L NTS FPGA

Measurement- and web servers

NTP Servers

PTP and GNSS

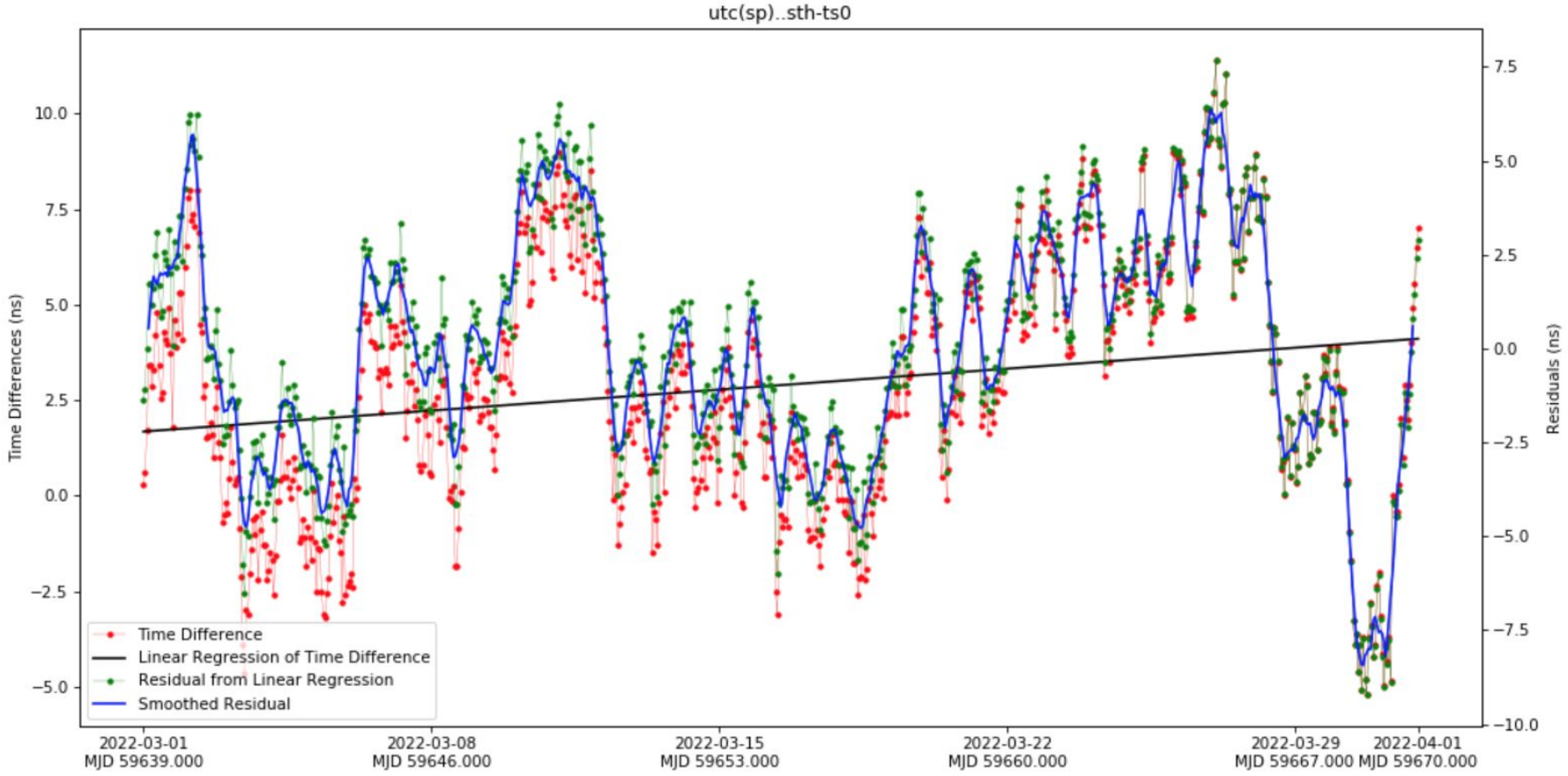
Frequency distribution

Frequency measurement

Frequency amplifier

Frequency and phase adjustment

Frequency generator (Cs)


utc(sp)..sth-ts0
Time Differences (ns)
Residuals (ns)
10.0
7.5
5.0
2.5
0.0
−2.5
−5.0
7.5
5.0
2.5
0.0
−2.5
−5.0
−7.5
−10.0
Time Difference
Linear Regression of Time Difference
Residual from Linear Regression
Smoothed Residual
2022-03-01
MJD 59639.000
2022-03-08
MJD 59646.000
2022-03-15
MJD 59653.000
2022-03-22
MJD 59660.000
2022-03-29
MJD 59667.000
2022-04-01
MJD 59670.000

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