Sustainable Software Engineering

Bill Johnson - Azure SRE
SLO: 1.5°C average global temperature

30 year rolling average compared against 20th century average

2020 Value: 1.02°C
Projected breach: 4-7 years
Electricity is 20% of GHG emissions

8.275\text{\(_{\text{gt}}\)}
“One of the most important things that distinguishes software engineering from programming is considering the wider impact of your work, and applying systems thinking.”

https://twitter.com/jezhumble/status/1386758745342971904
Moore’s Law
Number of transistors doubles every 2 years
Starting to slow down

Dennard Scaling
Performance per watt doubles every 2 years
Haven’t met since 2012

Natural Resources
Don’t have enough material in the world to meet projected growth rates

Power & Cooling Demands
More expensive to power and cool

Technical

Hardware & software
functionality of the system

Operational

Human toil needed to maintain a technical system
Sustainability = Reliability over time
Environmental Sustainability

The impact on the planet of our Technical and Operational choices
In general, an SRE team is responsible for the availability, latency, performance, efficiency, change management, monitoring, emergency response, and capacity planning of their service(s). — Introduction in SRE Book
Latency

Errors

Traffic

Saturation

SRE

Golden Signals
Low Latency

- Less bottlenecks
- Reduced wait times on client/server
- 50% of power is used just to have a machine on
Low Error Rates

- Reduced overall traffic
- Reduced processing
- Require less resources
Latency

Errors

Traffic

Saturation

High Traffic Support

- Maximize utilization
- Maximize code efficiency
- Maximize scale up/down efficiency
“Right-sized” Saturation

- Maximize utilization
- Maintain buffers
- Faster requests
- CPUs balance out at ~70%
**Frequency**

3.5Ghz ---- 40% ------ 5Ghz

**Power**

50W ------ 250% ----- 175W
Holistic systems thinking is already part of the job

Reducing carbon benefits your system (save $$$!)

Planet is running out of materials and resources

Aligns to SRE Golden Signals

Aligns to good engineering practices and hygiene

Reliability over time is Sustainability
Sustainable Software Engineering
https://principles.green

1. Build Carbon-Efficient Applications
2. Build Energy-Efficient Applications
3. Maximize Utilization
4. Minimize Carbon Intensity
5. Minimize Embodied Carbon
6. Minimize Data Amount & Travel Distance
7. Shape Demand To Supply
8. End-to-End Optimization Of Carbon Efficiency
Carbon Intensity over 24 hours

~350 g/kWh
~300 g/kWh
~200 g/kWh

https://electricitymap.org
Quantcast

Saving Millions by Dumping Java Serialization

Switched java serializer from proprietary to Rowfiles

https://www.quantcast.com/blog/saving-millions-by-dumping-java-serialization/
AI computation costs have increased $300,000x$ over 6 years.
Carbon Footprint Benchmarks

in lbs of CO₂ equivalent

- R/T Flight NY to SF: 1,984 lbs
- Human (1 year): 11,023 lbs
- American (1 year): 36,156 lbs
- US Car (lifetime): 126,000 lbs
- 213M parameter NLP: 626,155 lbs
Pigeons!

Detecting cancer in medical imaging
AI Algorithms: ~90% accuracy
Flock of Pigeons: ~99% accuracy

Fig 9. Flock sourcing. A “flock-sourcing” score was calculated by summing the responses of individual birds as described in the text. Pooling the birds’ decisions led to significantly better discrimination than that achieved by individual pigeons. The dotted line represents no discrimination between benign and malignant exemplars.

doi:10.1371/journal.pone.0141357.g009

https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0141357
SRE Responsibilities

- Availability
- Latency
- Performance
- Efficiency
- Monitoring
- Capacity Planning

Sustainable Software Principles

- Carbon-Efficiency
- Energy-Efficiency
- Utilization
- Carbon Intensity
- Embodied Carbon
- Data Amount & Travel Distance
- Shape Demand To Supply
- E2E Carbon Optimization
Carbon Efficiency

Saves $$$

Reduces complexity

Reduces Resource Requirements

Increases Resiliency

Increases Performance

= Reliability!

= Reliability!

= Reliability!

= Reliability!
Takeaways

1. Everyone has a part to play, especially SREs
2. Set Sustainability SLOs (Power, Utilization, Carbon Intensity)
3. SRE Principles align with “Green” Principles
4. Share your stories, projects, tools, failures!
“A habitable planet is the ultimate in reliability”

Read
- aka.ms/sse/blog
- branch.climateaction.tech
- heated.world

Join
- principles.green
- ClimateAction.tech
- GreenConf.io