

# LoFi4Green

Local-First Software: An Energy-Efficient Alternative to  
Cloud-Centric SaaS Architectures

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# Outline

- What is a software today
- What observations can we make
- What is a Local-First Software
- Why is it an interesting concept
- What proofs do we have

# What is a software today

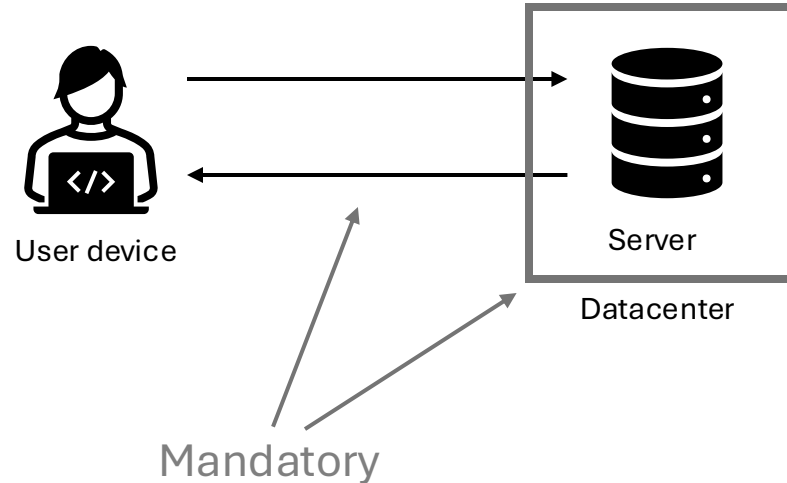
# What is a software today



- Works in the browser
- No longer needs to be updated
- Accessible from anywhere
- Accessible at all times
- Infinite storage
- Works on all devices
- ...

# What is a software today

But everything is in the cloud!



TECH

## Amazon Web Services outage takes down major websites

PUBLISHED MON, OCT 20 2025 5:13 AM EDT | UPDATED 14 MIN AGO



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Katrina Bishop  
@KATRINABISHOP

SHARE



October 2025 :

<https://www.cnbc.com/2025/10/20/amazon-web-services-outage-takes-down-major-websites.html>

# But why?

Many reasons.

- Works in the browser
- No longer needs to be updated
- Accessible from anywhere
- Accessible at all times
- Infinite storage
- Works on all devices
- ...

But also...

- Mobile devices are constrained
- It's more convenient for collaboration
- It's more convenient for development
- Overall, software is richer in features

# What observations can we make

# Time has passed

- Our devices have become much more powerful
  - We are starting to run AI directly on them
- Networks are much more efficient
  - The proof is in the massive adoption of VOD
- But also,
  - The field has matured
  - We have new software technologies (e.g., WebAssembly)
  - We have new algorithms (e.g., CRDT)

# Interestingly...

We are purchasing increasingly powerful devices

We are installing more and more data centres

But...

We are still making very little use of the devices we purchase

We are increasingly overloading our data centres

# In conclusion

# The minitel

Date: 20th century

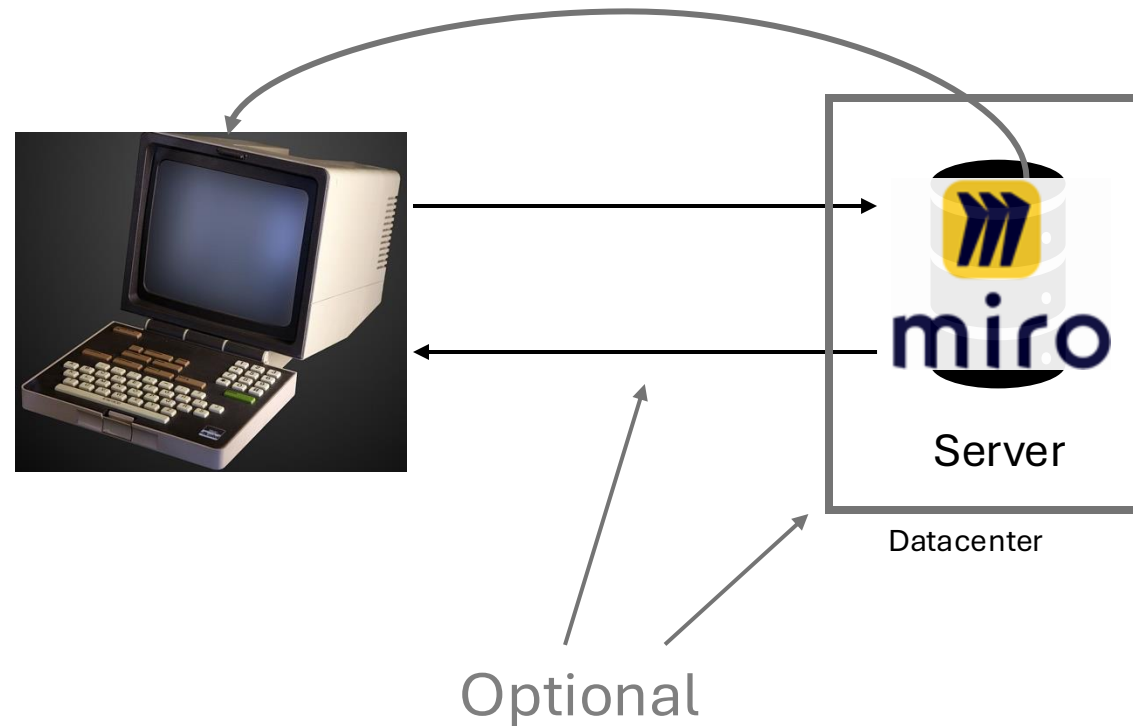
Created by Postes, Télégraphes et  
Téléphones (Post Office)

It was a 'dumb terminal'.



# What is a Local-First Software

# What if we moved the software?



# Local-First Software

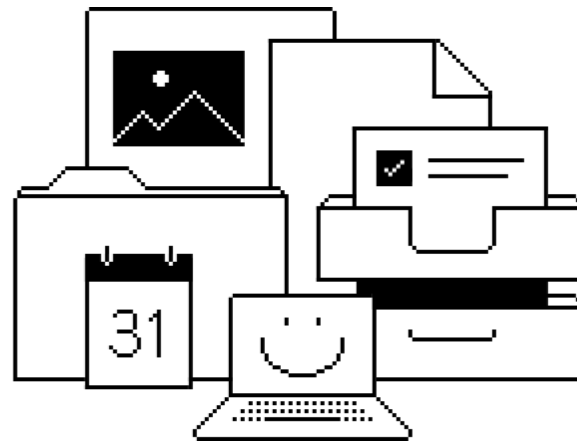
- Local-First Software [1], a set of **7 principles**:
  - **Fast**: No loading time
  - **Multi-device**: Data stored on multiple devices
  - **Offline**: The network is optional
  - **Collaborative**: Enables collaboration
  - **Longevity**: Data can be exported and reused
  - **Privacy by default**: Data remains local, so it is more private than if it were centralised on a server
  - **Data control**: Easy data backup, duplication or deletion

[1] M. Kleppmann et al. doi: 10.1145/3359591.3359737

- **+ Sustainability [2]**: Respects the device it runs on

[2] L. Siffre et al. doi: 10.1109/ICT4S68164.2025.00015

# Some examples

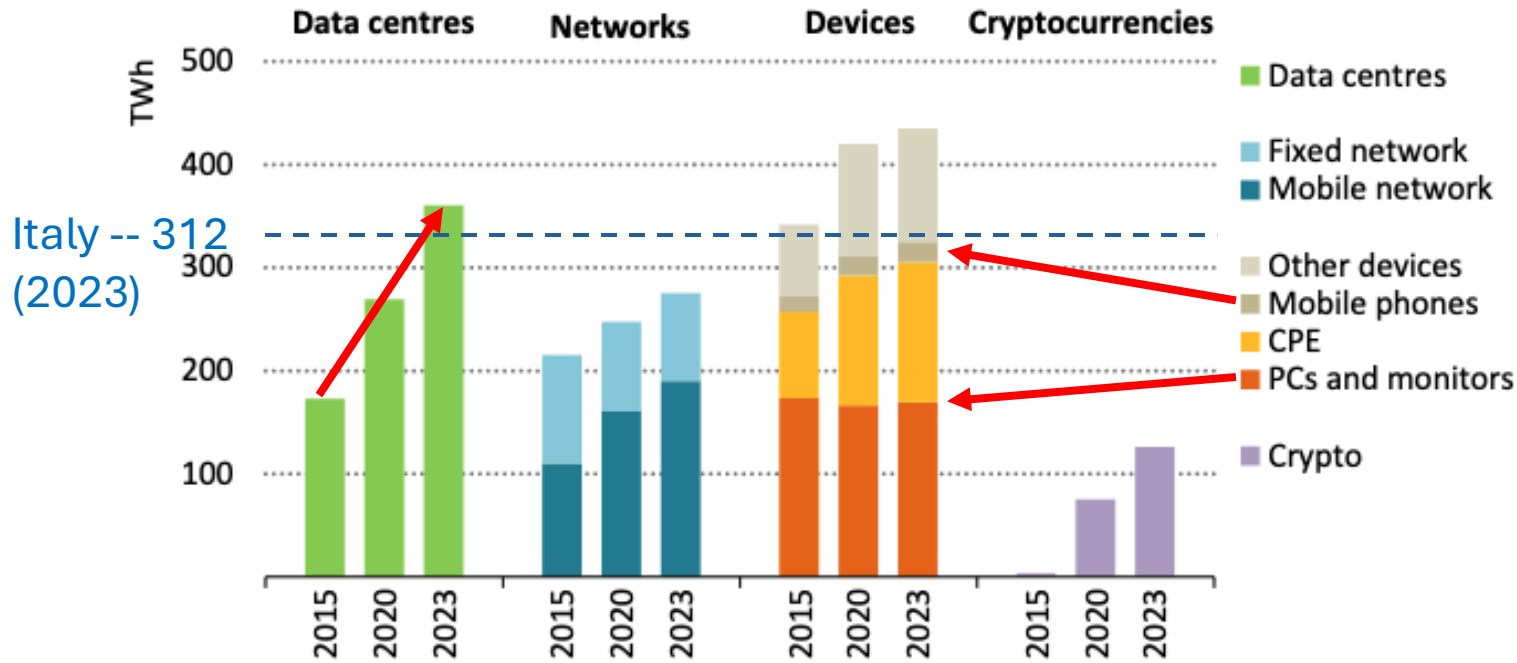


**anytype**

# Why is it an interesting concept

Part I: Context

# Environmental Concern - Energy



IEA

[www.iea.org/reports/energy-and-ai](http://www.iea.org/reports/energy-and-ai)

IEA. CC BY 4.0.

## Intuition:

- **DC consumption has increased**, but so has **their efficiency and number**
- **User terminal consumption has stagnated**, but their number has increased...

So, are user terminals underused? Highly efficient? Both?

# Environmental Concern - Climate

## We must be resilient



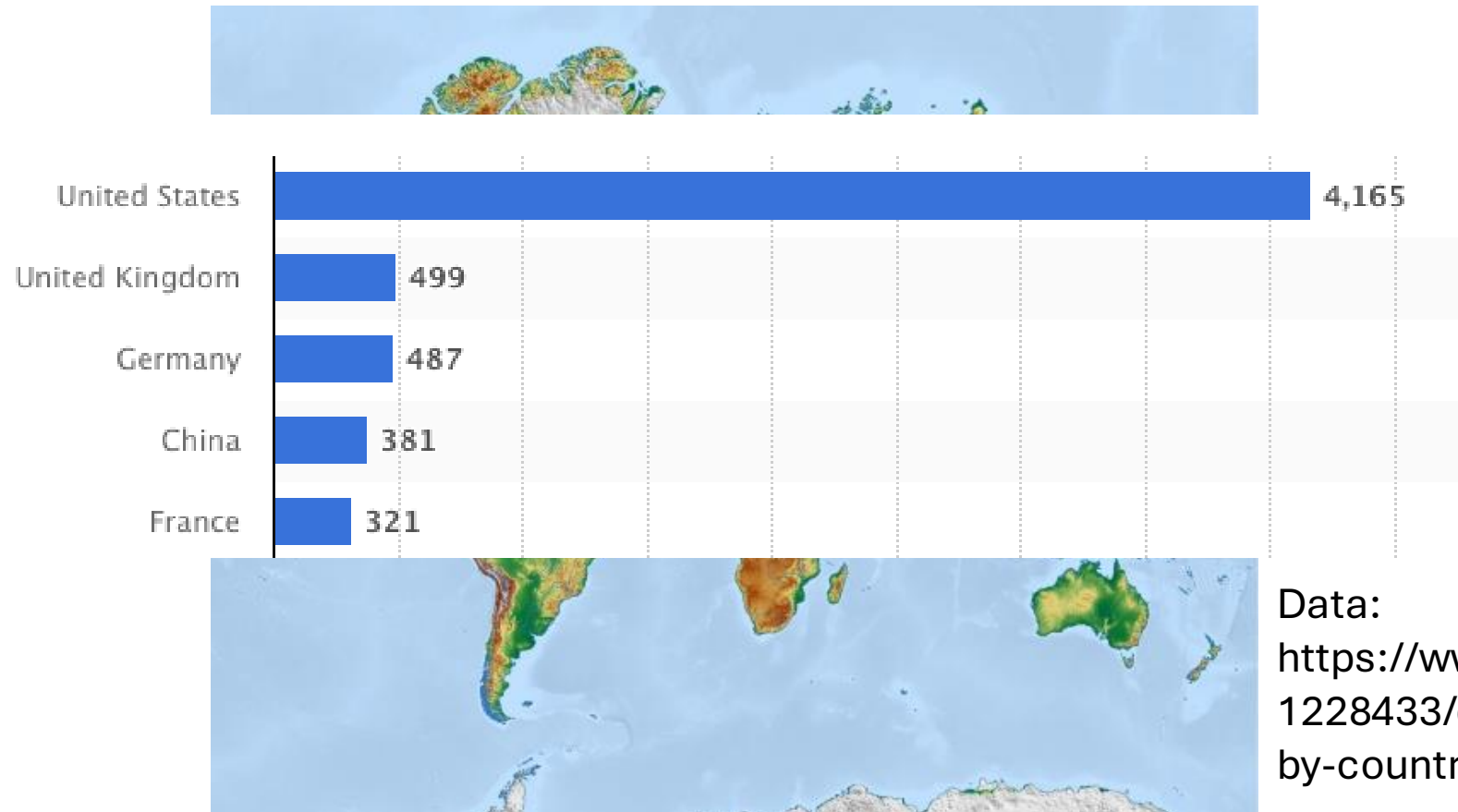
AP Photo



AFP

# Environmental Concern(?) - Politics

## We must be sovereign

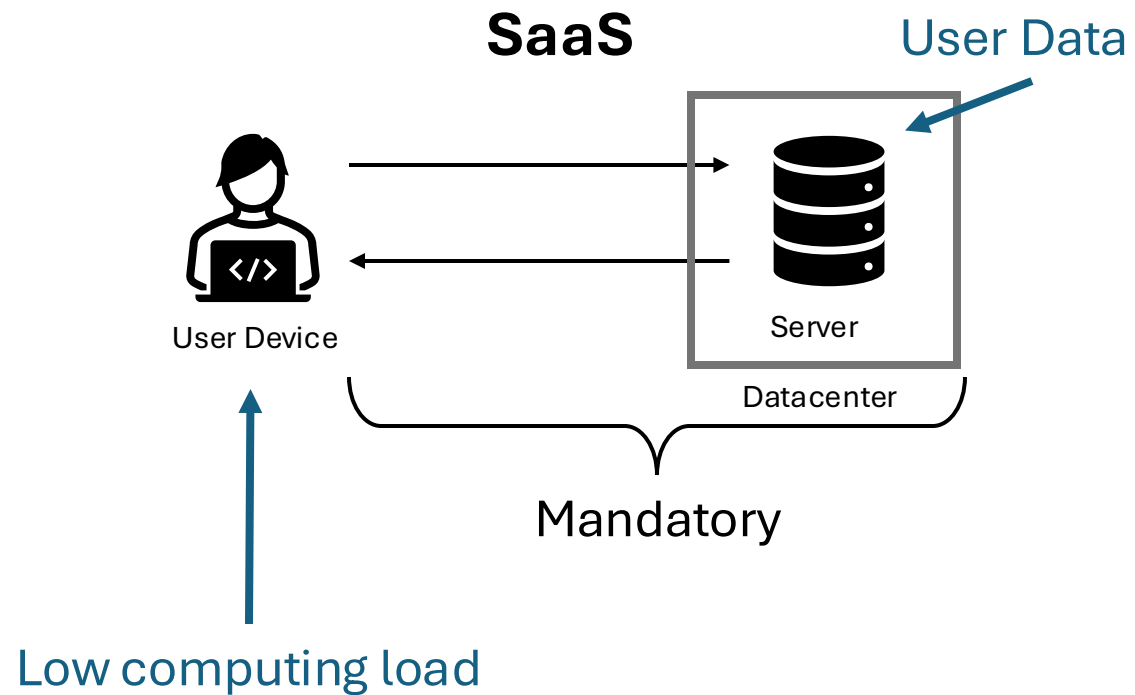


Data:  
<https://www.statista.com/statistics/1228433/data-centers-worldwide-by-country/>

# Why is it an interesting concept

Part II: Local-First Software impacts

# LoFi vs SaaS



# Local-First Software impacts - Our intuition

- Can save energy
- There are many opportunities with Local-First
  - Servers can be turned off
  - Very aggressive caching can be implemented
  - Network usage can be reduced
  - Off-peak hours can be taken advantage of...
  - etc.
- But there are negative effects, mainly related to the demand on the user's device

# Impact on sovereignty and resilience

- Operates independently of the server
- Can be 100% standalone
- Data managed by the client
- If the software is open source, users can have a degree of autonomy
- But what are the risks!

# Risks of Local-First Software

- Premature use of devices
- All a person's data in one place
- Data loss if all devices are lost
- Rebound effect (?)
- It will consume more energy because servers are more mutualized and efficient !
  - Or will it?

# What proofs do we have

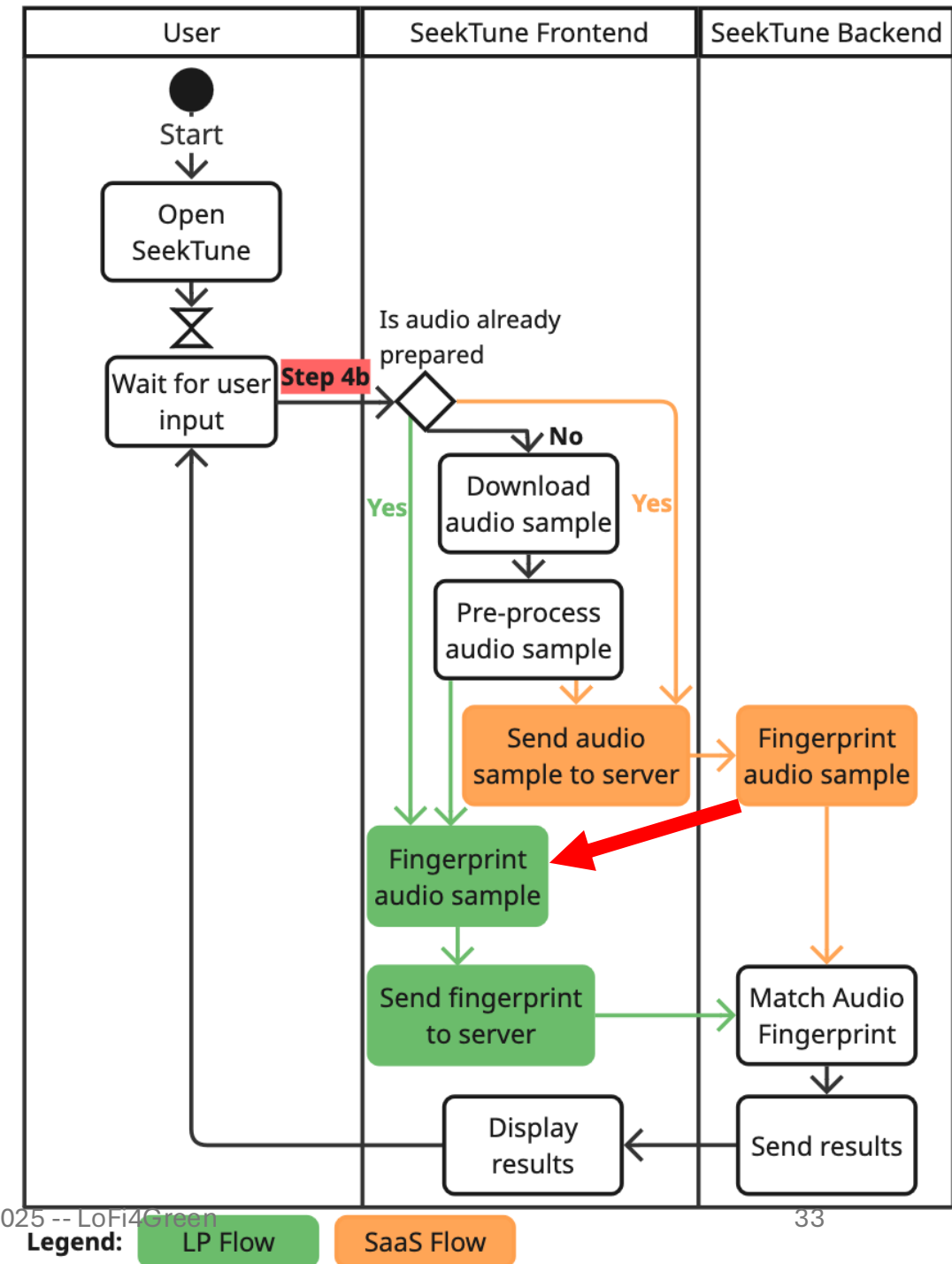
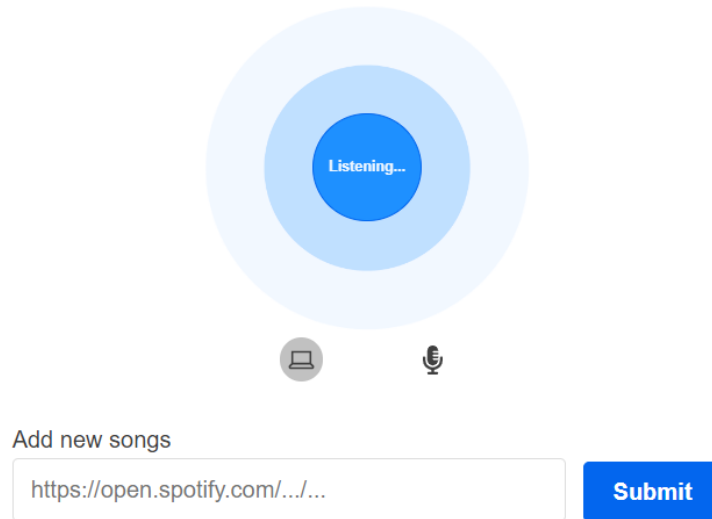
# First answers

*What difference in energy consumption is there if I run the software on my phone rather than on a server?*

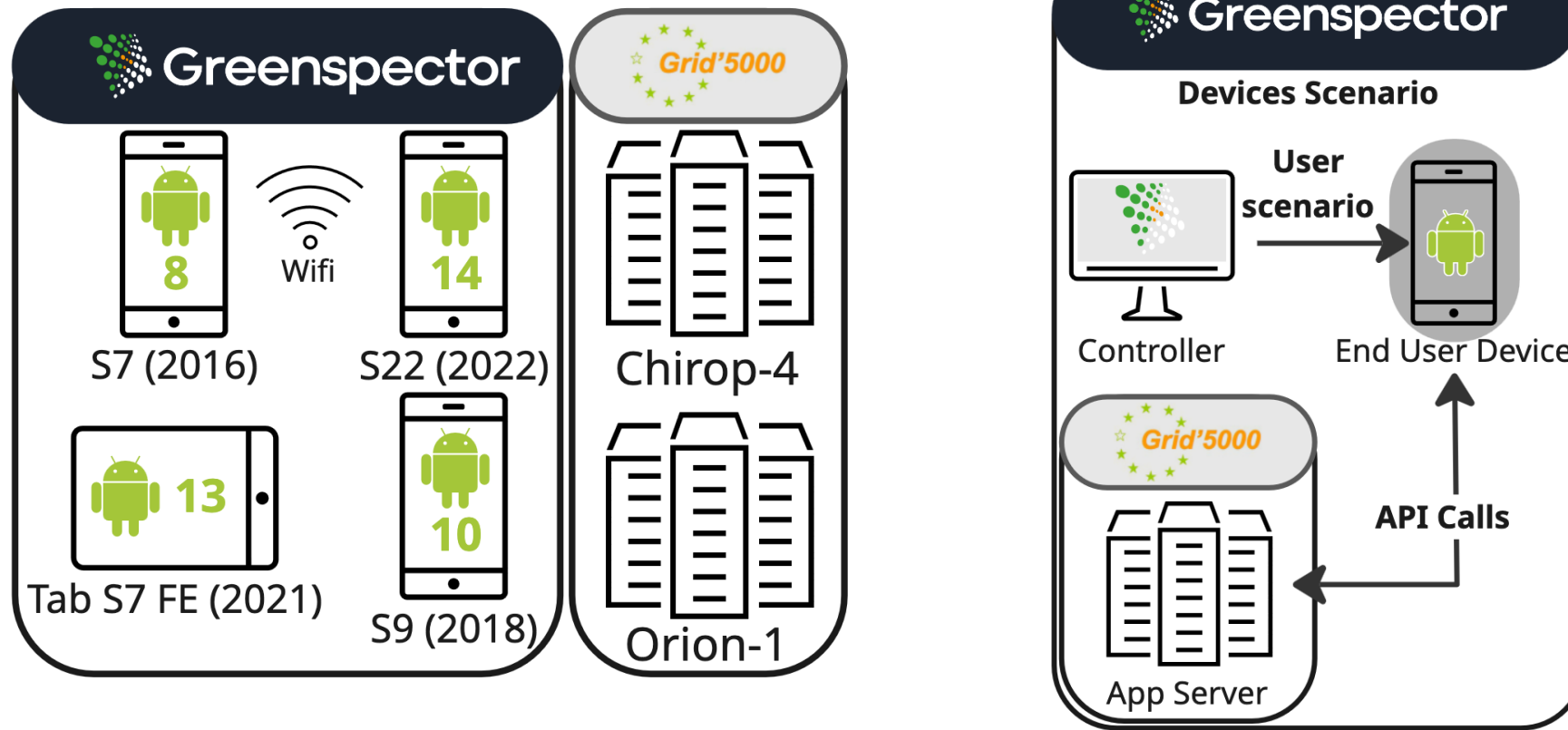
# Methodology - Seektune

SeekTune

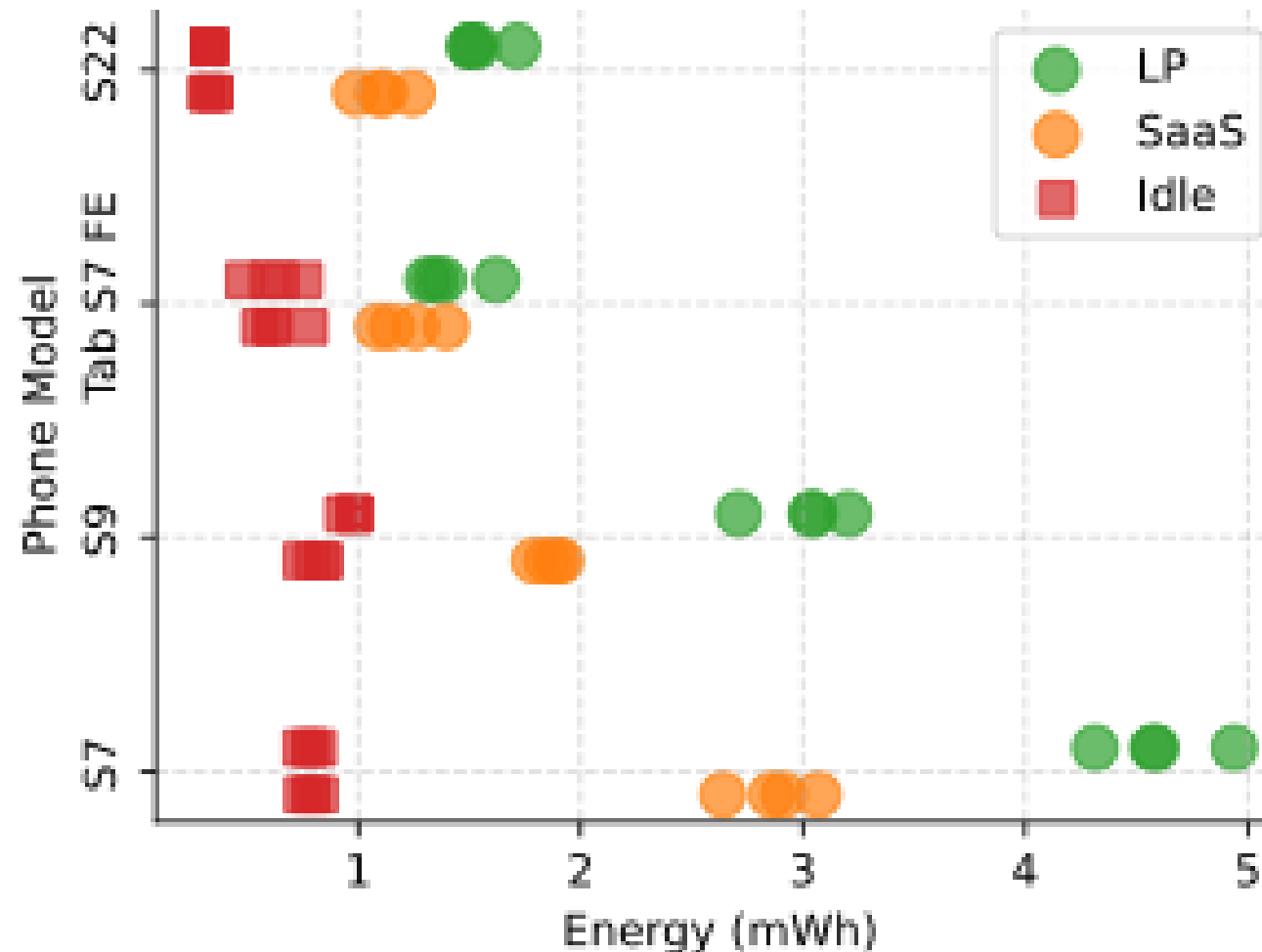
35 Songs



# Methodology - Testbench



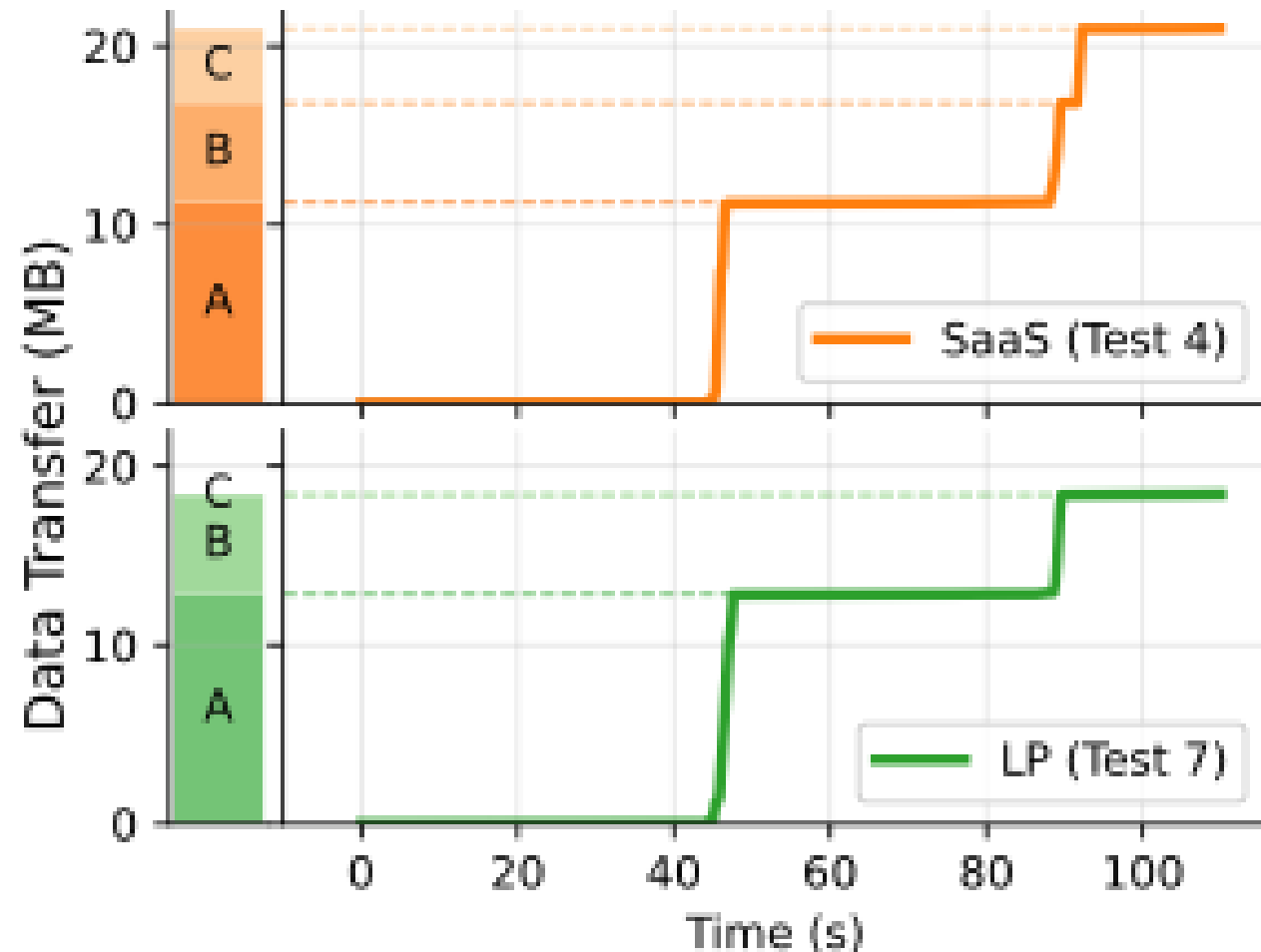
# Results – Phone energy consumption



# Results – Data consumption

## Three categories

- **Cat. A** : Initial website download
- **Cat. B** : Sample sound download
- **Cat. C** : Fingerprinting



# Let's take a step back

- What did we observe:
  1. LoFi consumes **more energy on the phone**
  2. LoFi generates **less network traffic**
- What about the server's energy consumption?

# Results – Whole system energy consumption

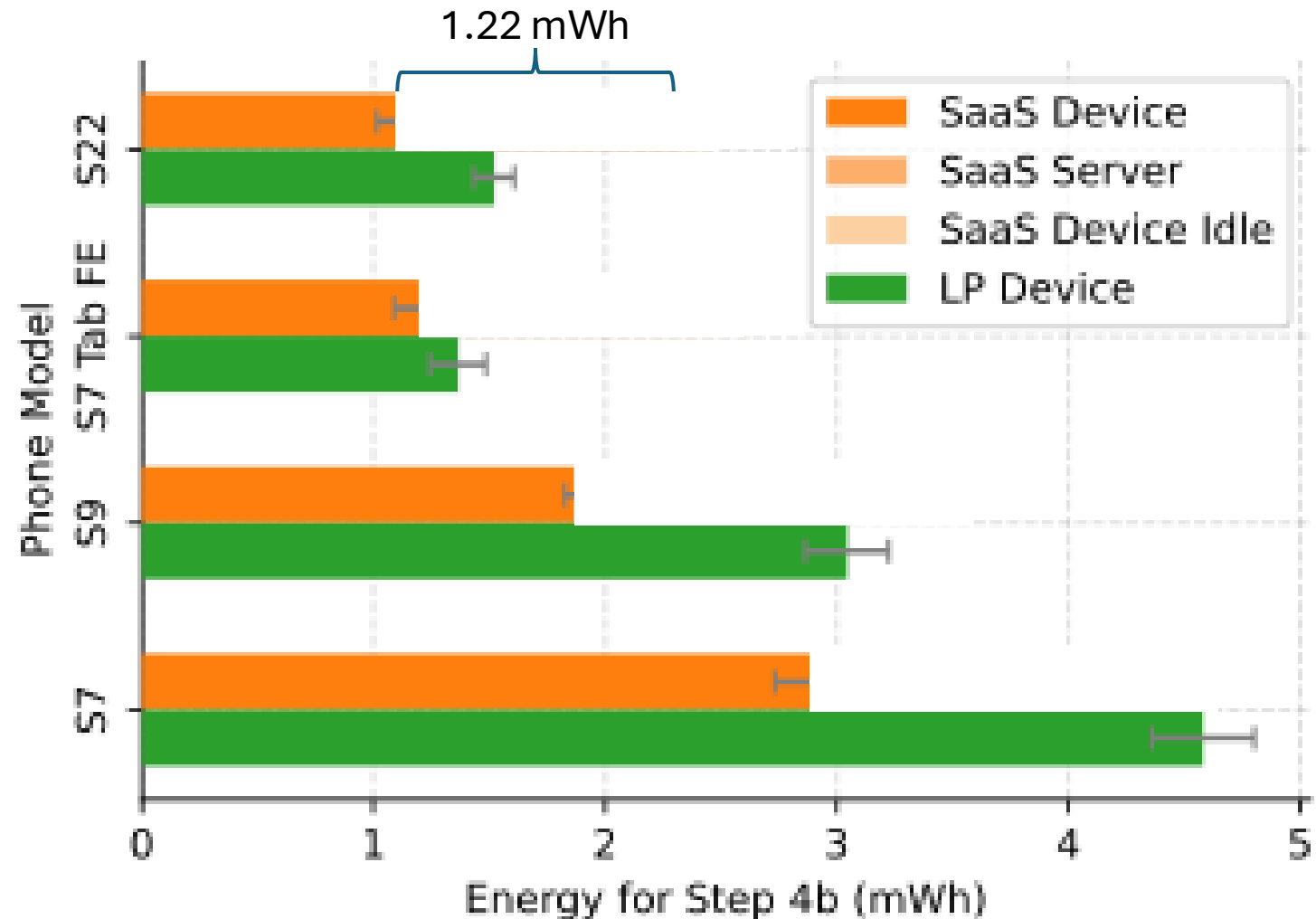
Parameters:

**Maximum latency (SLA) of 1 second**

**Not considered:**

- Air conditioning
- Load-balancer, firewall, etc.

Under these conditions, the theoretical lower limit for energy per request is:  
**1.22 mWh/req**



# Replication Package

<https://github.com/Xonturis/seek-tune-replication-package>



# Conclusion

- The question is not that simple
  - It depends on the devices used
  - But a trend is emerging
- 
- In any case, these results encourage further exploration of this topic

# Future work

# Future work

- Repeat this experiment but with other algorithms to establish a continuum.
  - Here, we tested with an algorithm where the calculation is relatively intensive.
  - What about an algorithm with a lot of I/O?
  - What about a very lightweight algorithm?
- Propose a methodology to shift SaaS applications towards Local-First Software based on previous results
- Study the effectiveness of this methodology

# Call for collaboration - 1

- We are building a phone testbench like Greenspector, but for science
- If you feel like this would be useful for your work, feel free to contact us!

Contact: Lylian Siffre ( [lylian.siffre@imt-atlantique.fr](mailto:lylian.siffre@imt-atlantique.fr) )

# Call for collaboration - 2

- We are looking for some guidance for our future study with engineers and students

Contact: Lylian Siffre ( [lylian.siffre@imt-atlantique.fr](mailto:lylian.siffre@imt-atlantique.fr) )

**“ Can we design Local-First systems that inherently constrain, rather than induce, new resource demand?**