GOTO
Guide

LET US HELP YOU

Ask questions through **the app**

★★★★★

also remember to rate session

THANK YOU!

#GOTOams

Fighting Climate Change by Building Sustainable Software

Ioannis Kolaxis – Software Architect / Distinguished Expert

GOTO Amsterdam 2022

© Atos

Atos

Short Biography

Ioannis Kolaxis
Architect / Distinguished Expert

- Book author: Green Software
- Inventor (5 Patents)
- 1st winner: Atos Innovation Week 2021 & 2020
- Worked for IBM, SIEMENS
- Speaker (Oracle Code One 2019)

@IoannisKolaxis

kolaxis.dev

Atos

You Can Fight Climate Change!

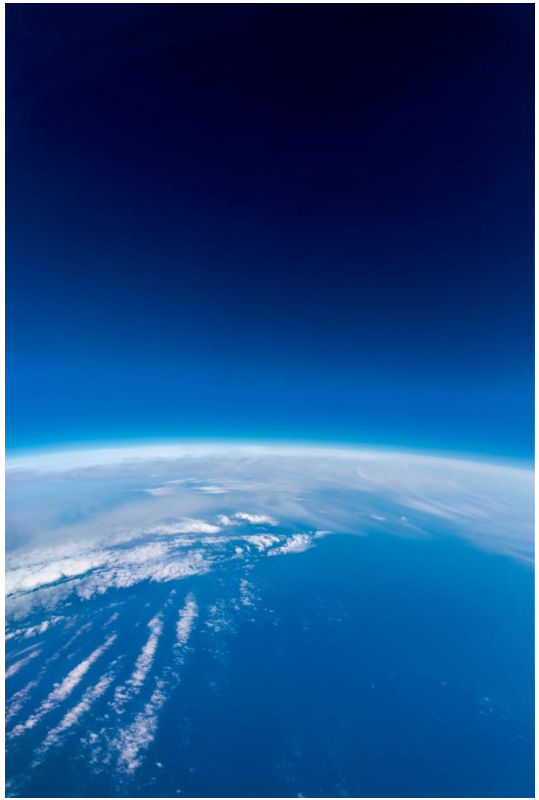
By Following Sustainable Practices in Your Work

By the end of this talk, you will be able to make a real impact in your work as IT professional, to help prevent climate change

Atos

Climate Change

What is the Problem?



Greenhouse gases (CO_2, CH_4, …) in earth’s atmosphere trap heat

→ increasing temperature

Atos

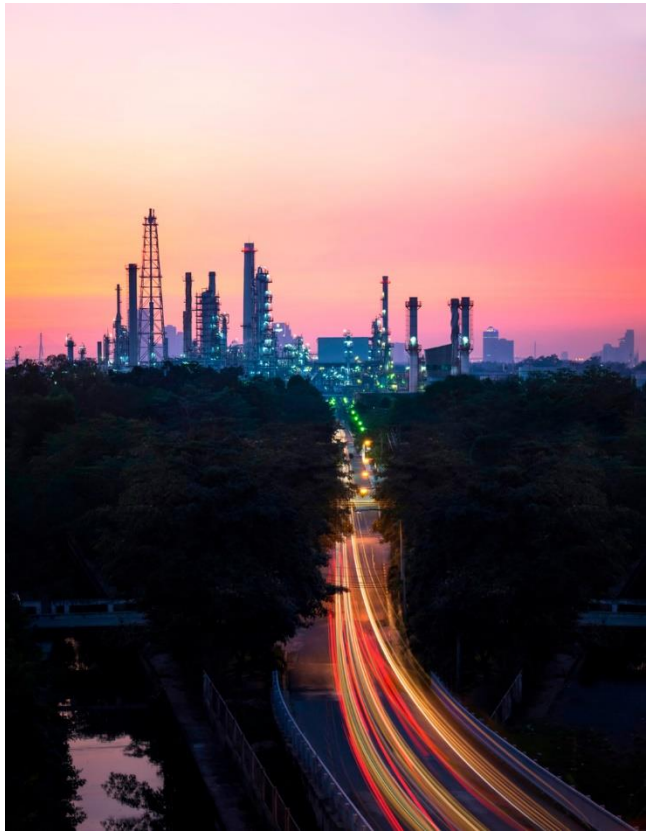
Who emits the most carbon?

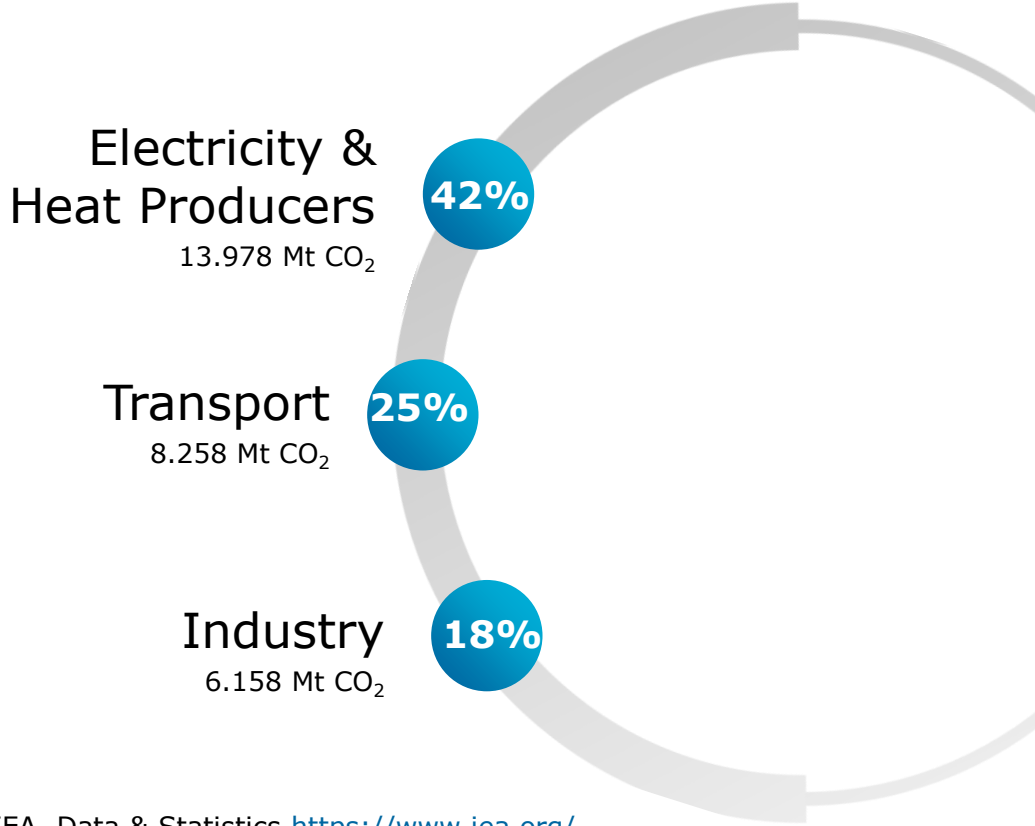
a. Industry

b. Transport

c. Electricity &
Heat Producers

CO_2 Emissions Per Sector (2018)



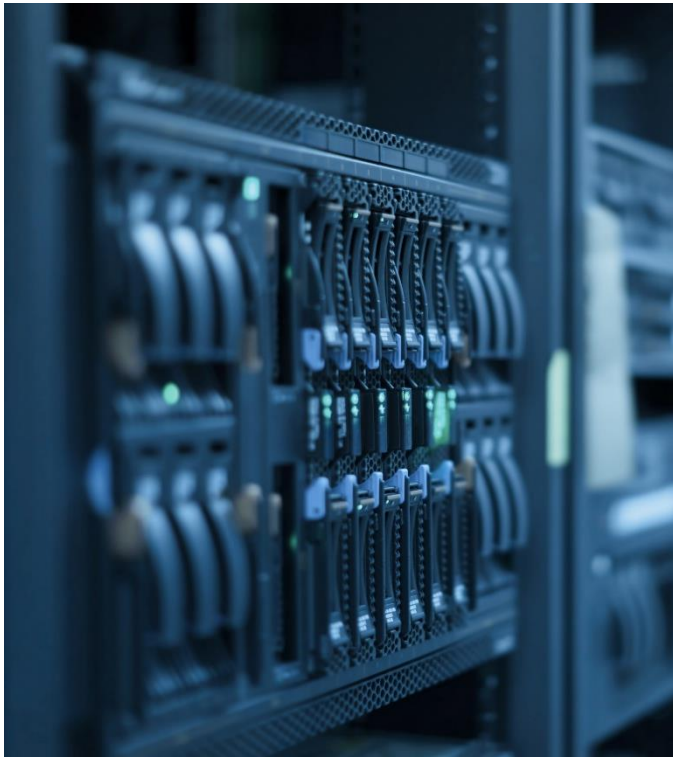


Source: IEA, Data & Statistics https://www.iea.org/

Atos

Our Contribution To Climate Change

Electricity Consumed by IT



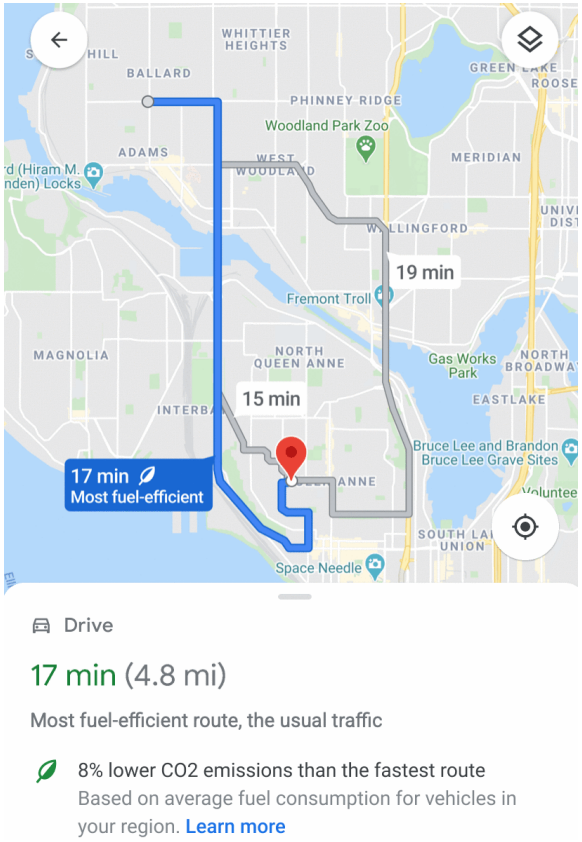
~2% of global electricity in 2019 was consumed by:

- **Data centers** (200 TWh)
- **Data networks** (250 TWh)

Source: IEA (2020), Data Centres and Data Transmission Networks, IEA, Paris
https://www.iea.org/reports/data-centres-and-data-transmission-networks

Atos

Finding the Best Route



- Options:
  - Fastest route
  - Shortest distance
  - Fuel-efficient route

Source: https://blog.google/products/maps/redefining-what-map-can-be-new-information-and-ai/

Data Networks

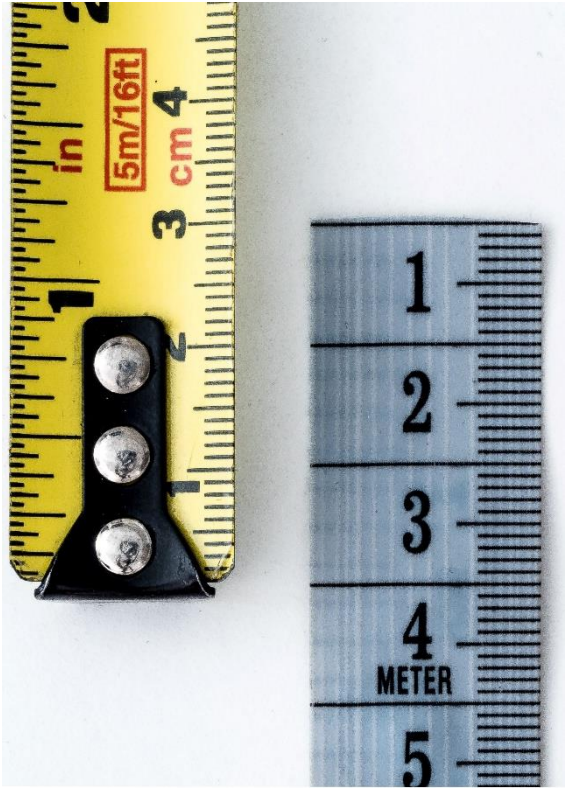
How can we consume less electricity?

- Minimize distance (hops) for data transferred over the network
  - Place your servers close to your customers
  - Process data at its source (Edge)

Atos

Data Networks

How can we consume less electricity?



- Reduce size of data sent over the network
  - Filter out unnecessary data
  - Compress before transfer

Atos

Journey to Decarbonization

Don’t send your data around the world!

Atos

Data Centers

How can we consume greener electricity?

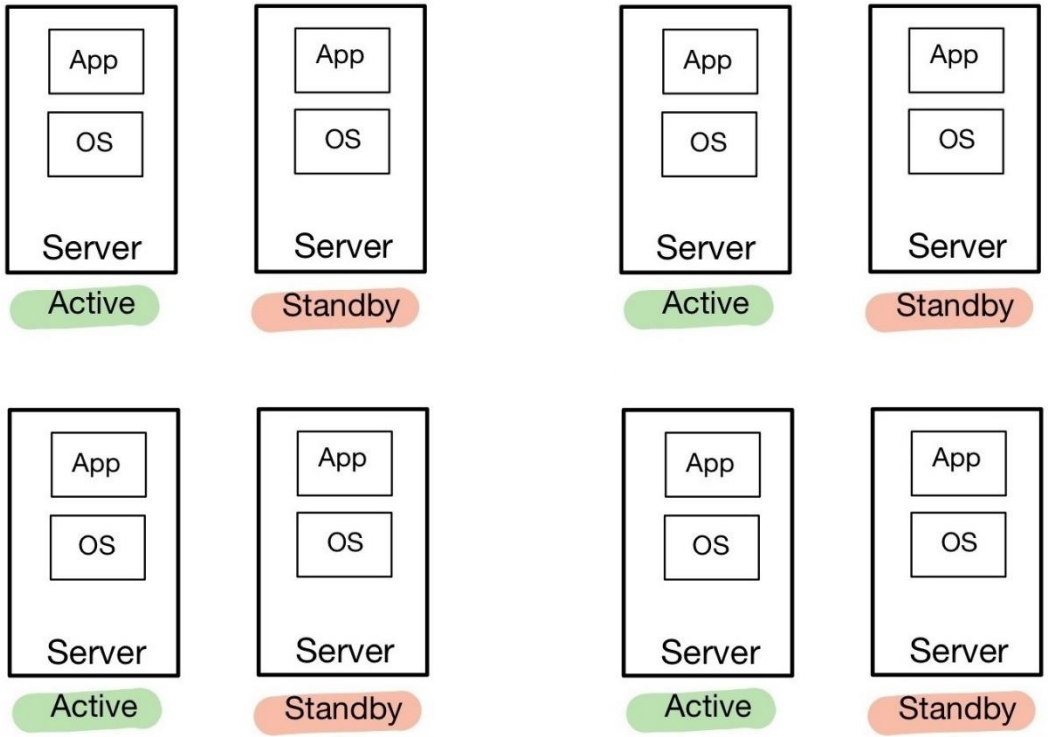
- Host your application in a region that consumes clean energy
  - Europe: Finland, Belgium, Zurich
  - North America: Montréal
  - South America: São Paulo
  - USA: Oregon, Iowa

Source: https://cloud.google.com/sustainability/region-carbon

Data Centers

How can we consume less electricity?

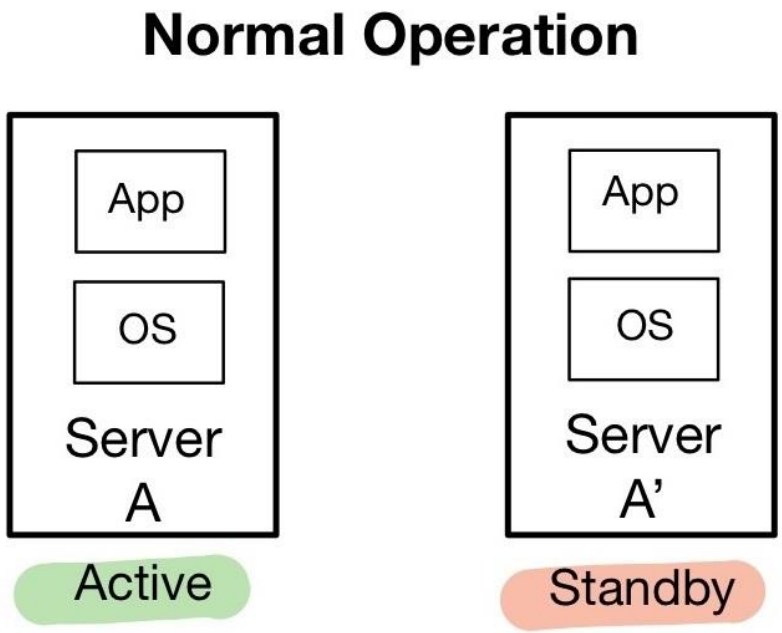
Up to **50%** of the servers in your data center are idle, doing nothing: they just **waste energy**!



Atos

Using Redundant Servers

For Highly-Available Applications



Server A handles every request to the application

Server A' is redundant, not serving any requests, just waiting for a failure to happen

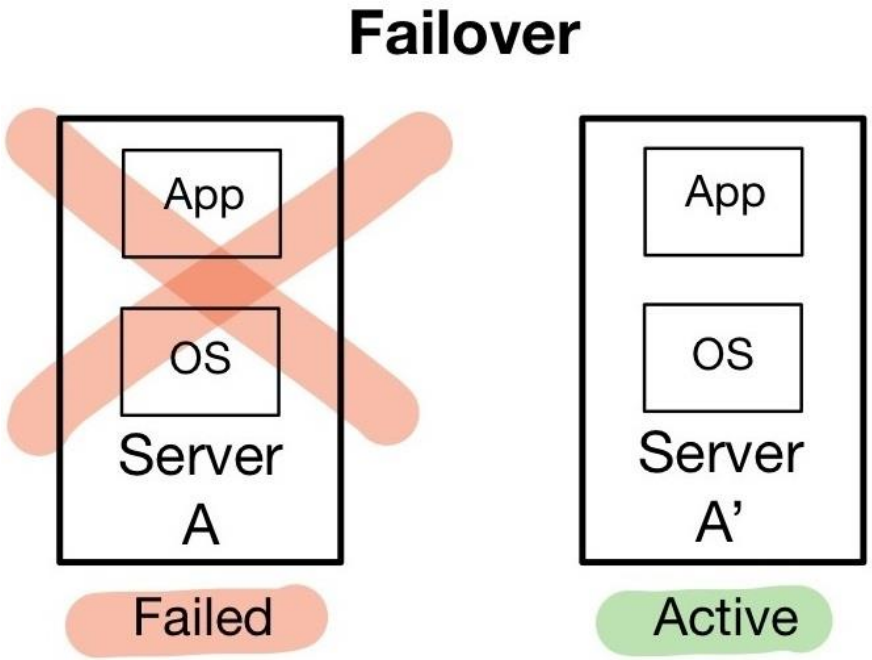
Atos

Using Redundant Servers

For Highly-Available Applications

Server A had failed!

Server A' (previously standby/redundant) now handles every request to the application



Atos

A Car With Redundant Engine

- Citroën 2CV Sahara (1958-1966)
  - 2 engines for redundancy
  - 2 petrol tanks

Atos

Redundant Servers

Why Do We Need Them?

Containers can be started in a fraction of the time it takes for **Virtual Machines**

- If we didn't have a redundant server ...
  - How long would it take us to spin up a new instance?

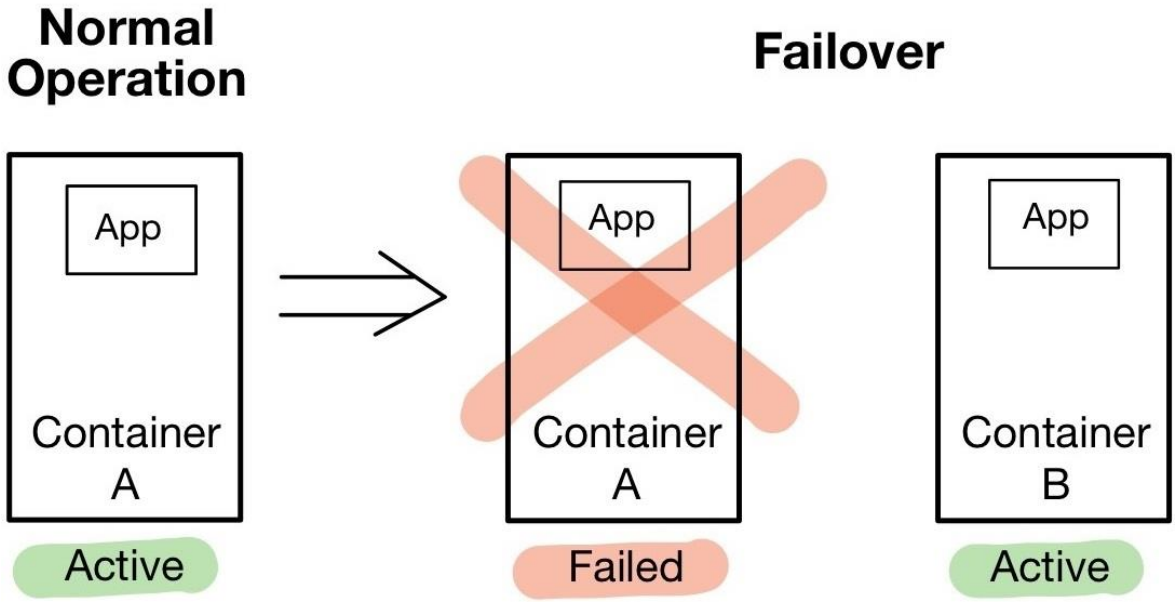
	Virtual Machines	Containers
Size	GB	MB
Startup time	Minutes	Seconds

Atos

Leveraging Containers

For Highly-Available Applications

You don’t have to run any redundant instances of your application!



Atos

Journey to Decarbonization

You don’t need redundant servers on the cloud!

Atos

Modern Cars With Stop/Start

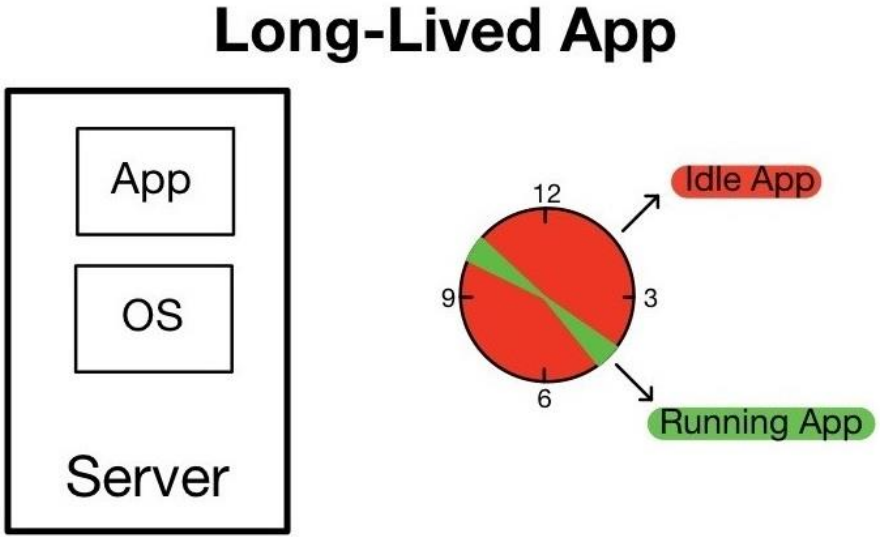
- Improved fuel efficiency by stopping the engine when not needed:
  - Traffic jams
  - Red traffic lights

Atos

Consuming Resources

Although the Application is Idle

Is your application waiting most of the time, without doing any actual work?



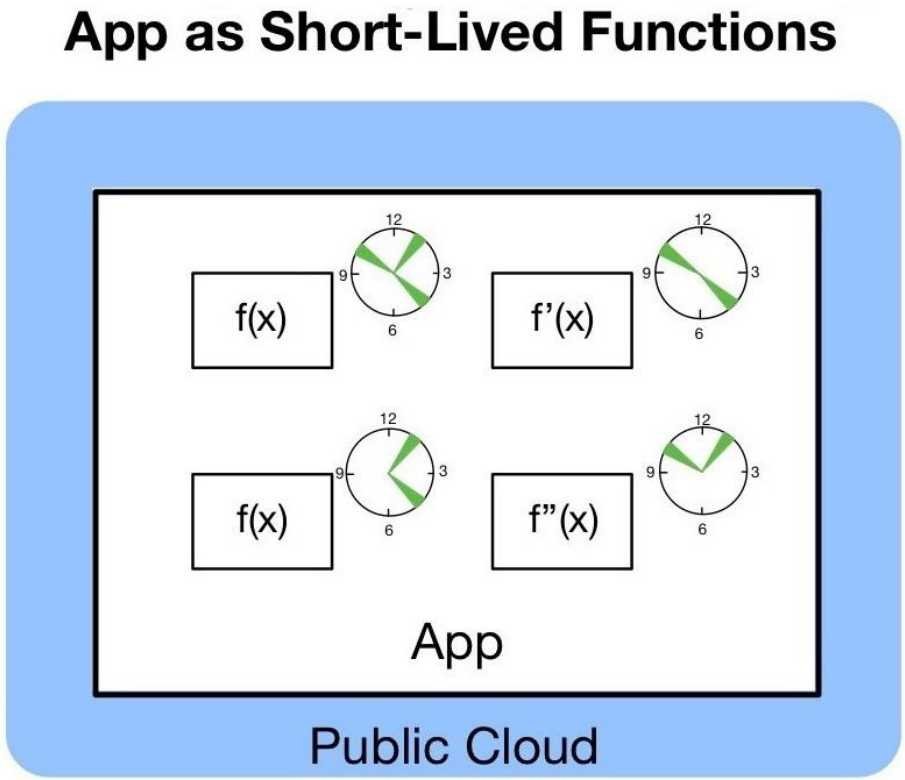
Atos

Rearchitecting Applications

That Are Idle Most of the Time

Functions are triggered by:

- HTTP requests
- Events (e.g., file upload)
- New messages in queue
- Tasks scheduled at a given time (cron jobs)



Serverless Functions

Run Your Code Without Managing Servers

- Automatic scaling of individual functions
- Your code consumes energy only while processing requests!
- Supported languages in Azure:
  - Java
  - C#
  - F#
  - JavaScript
  - TypeScript
  - Python
  - PowerShell

AWS Lambda

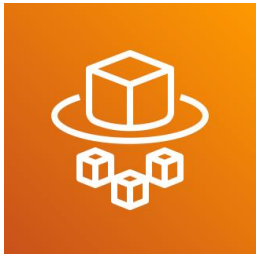
Azure Functions

Google Cloud Functions

Atos

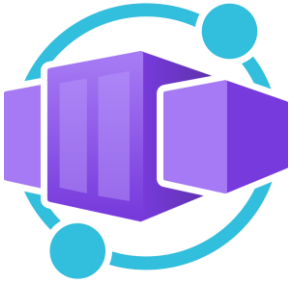
Serverless Applications

Run Containers Without Managing Servers



AWS Fargate

- More flexibility than Serverless Functions:
  - Run code written in any language (packaged in a container)
  - Support long-running tasks (days, weeks)



Azure Container Apps

Google Cloud Run

Atos

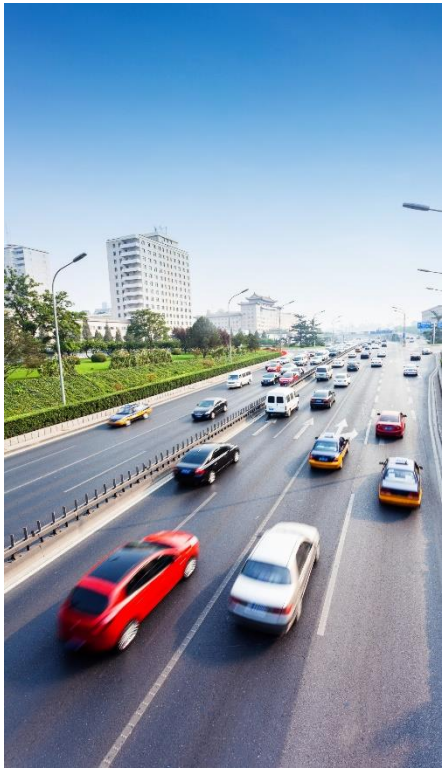
Journey to Decarbonization

Introduce a stop/start mechanism in your software applications

Atos

Green Cars

Transitioning to Environmentally-Friendly Cars



- Car fuels make the difference:
  - Diesel
  - Petrol
  - LPG
  - Electricity
- The “fuel” for software apps → Programming languages:
  - Compiled
  - Running on VMs
  - Interpreted

Atos

Programming Languages

Language	Type	Energy
C	Compiled	1.00
Rust	»	1.03
C++	»	1.34
Ada	»	1.70
Java	Virtual Machine	1.98
C#	»	3.14
JavaScript	Interpreted	4.45
TypeScript	»	21.50
PHP	»	29.30
Ruby	»	69.91
Python	»	75.88
Perl	»	79.58

Compiled languages tend to be the fastest and **most energy-efficient** ones.

Source: R. Pereira, M. Couto, F. Ribeiro, R. Rua, J. Cunha, J. Fernandes, J. Saraiva, "Energy efficiency across programming languages: How do energy, time, and memory relate?", International Conference on Software Language Engineering, Oct 2017.

Journey to Decarbonization

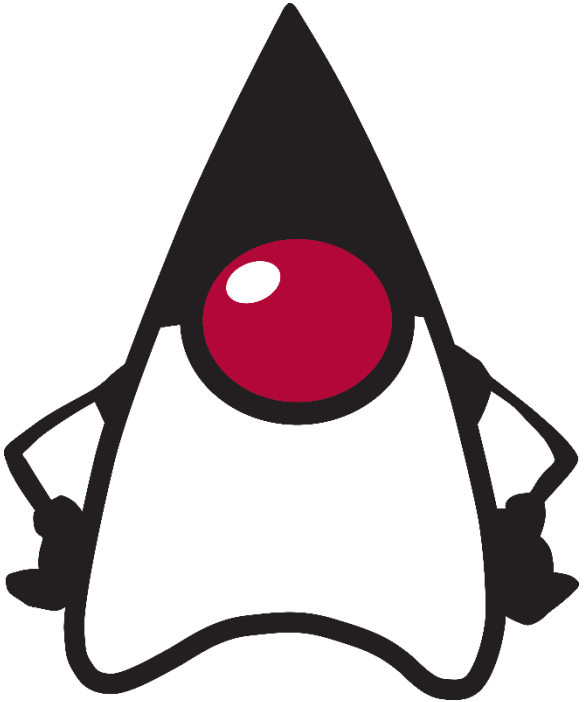
Identify energy consuming components,

used by many users,

and rewrite them in an energy-efficient language

Atos

Java in the Spotlight



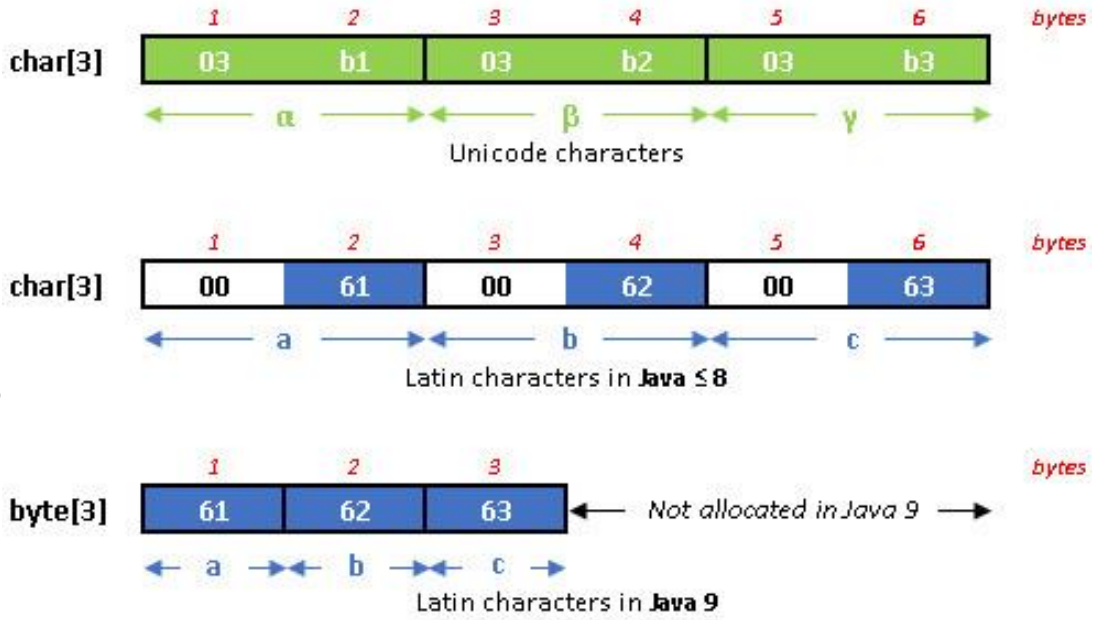
- Java ranks as the 2nd primary language used by developers
- Java 8 is used by 72% of them
  - Latest release: Java 18 (March 2022)

Source: JetBrains (2021), State of the Developer Ecosystem Survey
https://www.jetbrains.com/lp/devecosystem-2021/

Use the Latest Version of Java

To Benefit From Smaller Memory Footprints

- Since Java 9: enhanced memory allocation for String objects
- Memory footprint & performance improvements of up to 10%

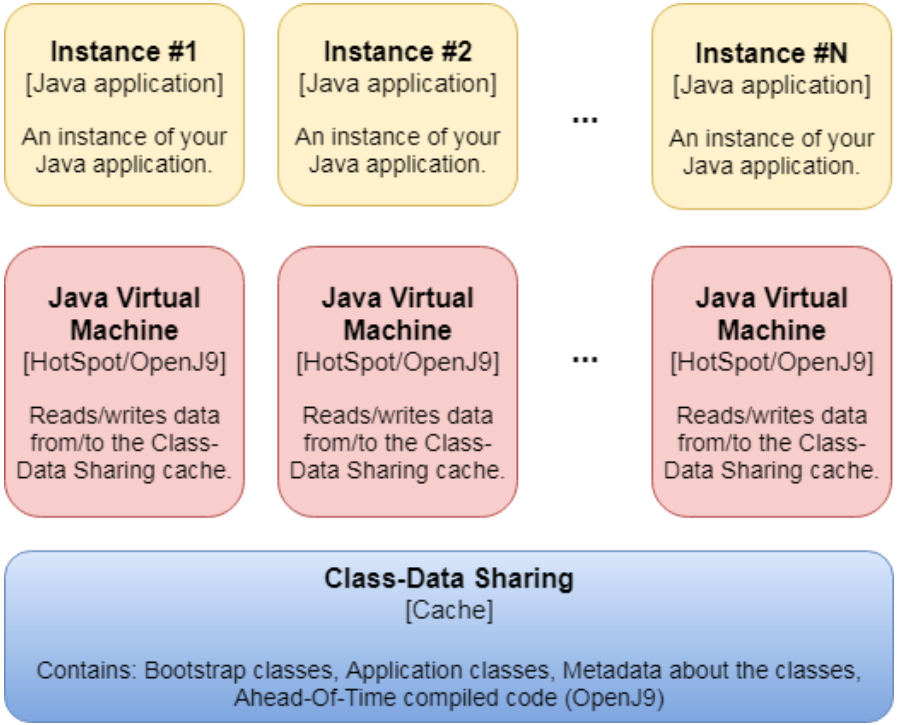


More info: https://www.kolaxis.dev/will-your-applications-run-faster-with-java-9

Atos

Use the Latest Version of Java

To Benefit From Smaller Memory Footprints

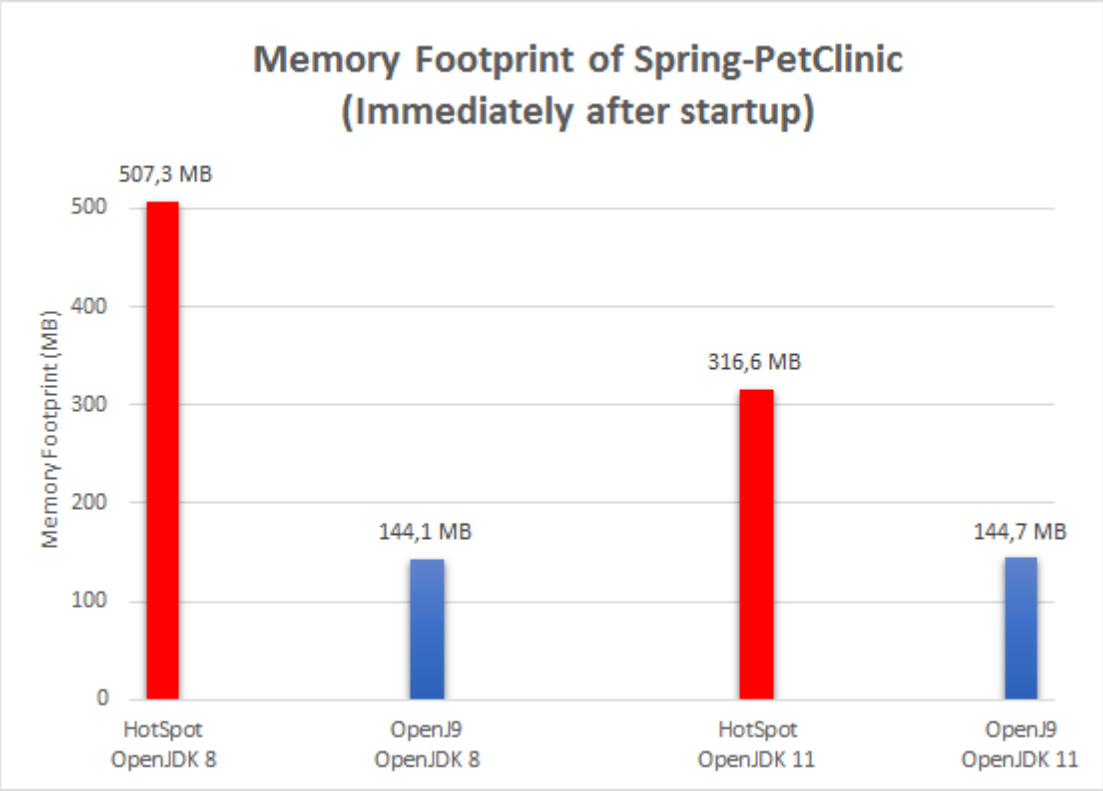


- Since Java 10: applications running on the same host can leverage Class-Data Sharing (CDS)
- Reduce memory footprint by ~15%

More info: https://www.kolaxis.dev/reduce-the-cloud-bill-of-your-java-applications

Atos

Use a Lightweight JVM



- OpenJ9 consumes less memory compared to HotSpot
  - Enables you to host more apps on a given server → Higher density
  - Reduce your cloud bills

More info: https://www.kolaxis.dev/reduce-the-cloud-bill-of-your-java-applications

Atos

Journey to Decarbonization

Upgrade to the latest version of Java

Atos

Less is... Green!

Reduce Your Cloud Bills for Sustainable Software

- Cloud bills depend on:
  - Network traffic,
  - Used resources (CPU, RAM) x Time
- Less money spent on cloud bills
  - More energy-efficient software

Atos

<Your Cloud> Well-Architected

Frameworks of Best-Practices

- A Critical score (0-33%) in Azure Well-Architected implies an energy-inefficient application.

Take the assessment here:
https://docs.microsoft.com/en-us/assessments/

AWS, Azure & Google Cloud all have **Architecture Frameworks** that assess your application against:

- Cost
- Performance

Atos

Sustainability is the newest “-ility”

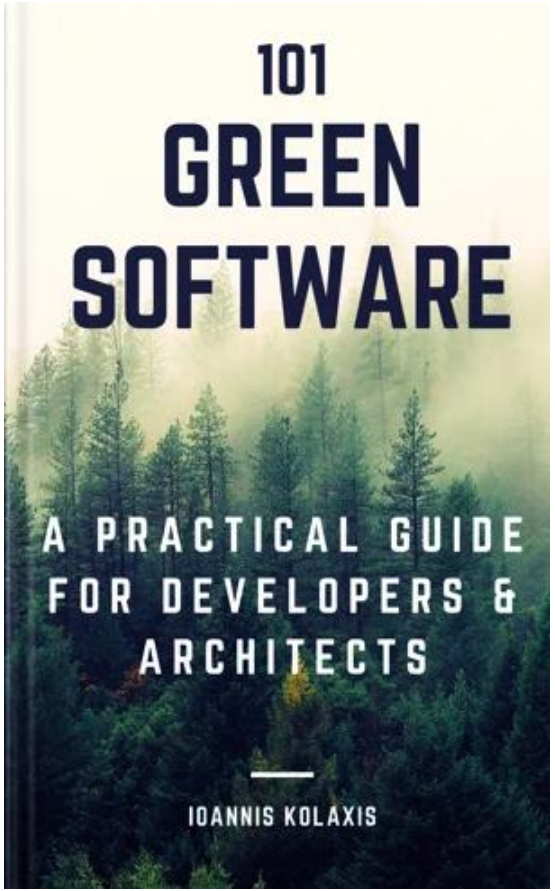
- Include sustainability in your discussions:
  - Availability,
  - Scalability,
  - Maintainability,
  - …

Atos

The Green Software Book

Wrote a practical guide for

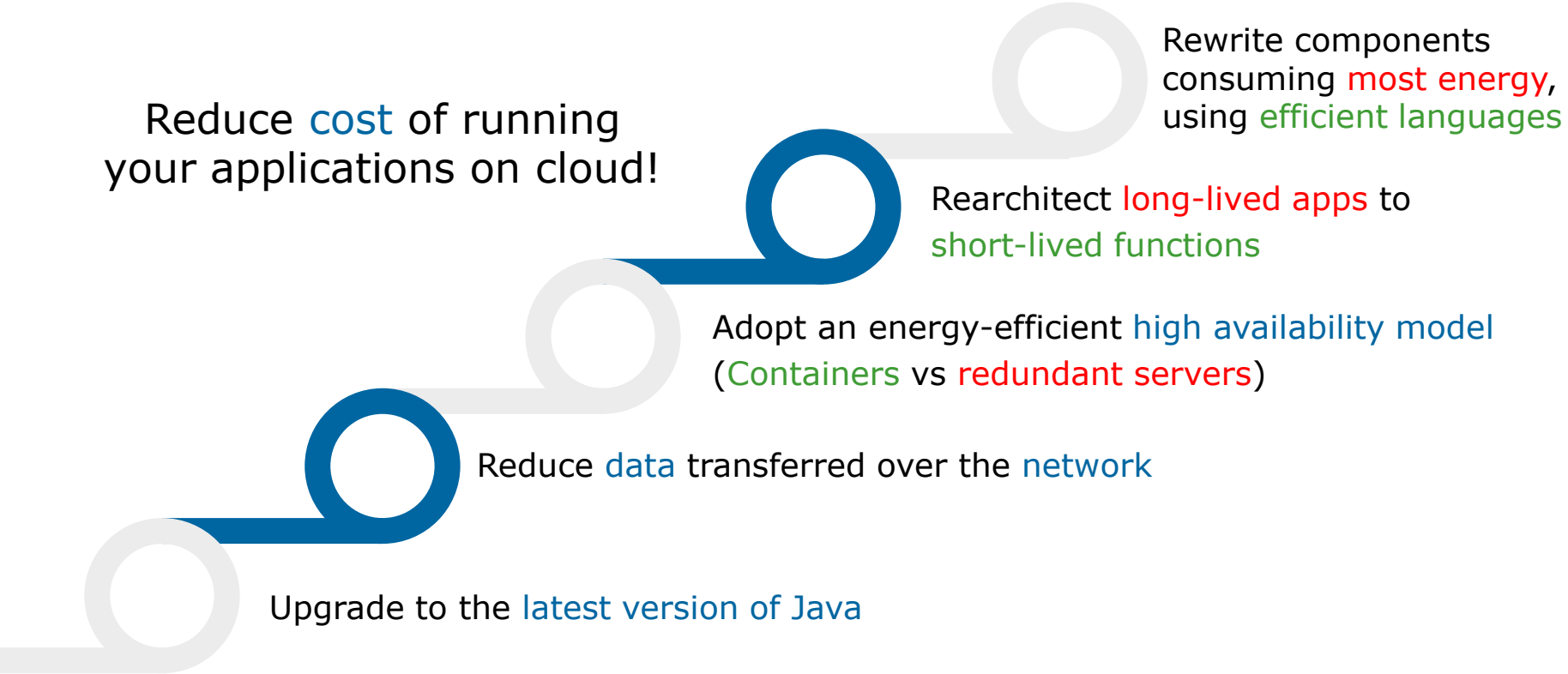
developers & architects



kolaxis.dev/green

Atos

Your Journey to Decarbonization



What actions will you take to help prevent climate change?

Tweet your answer!

Thank you

@IoannisKolaxis

kolaxis.dev

Atos, the Atos logo, Atos|Syntel are registered trademarks of the Atos group. April 2021.
© 2021 Atos. Confidential information owned by Atos, to be used by the recipient only.
This document, or any part of it, may not be reproduced, copied, circulated and/or
distributed nor quoted without prior written approval from Atos.

Atos

GOTO
Guide

Remember to **rate this session**

THANK YOU!

#GOTOams