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# RN'R building of an experimentation platform for the Edge

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# RN'R building of an experimentation platform for the Edge

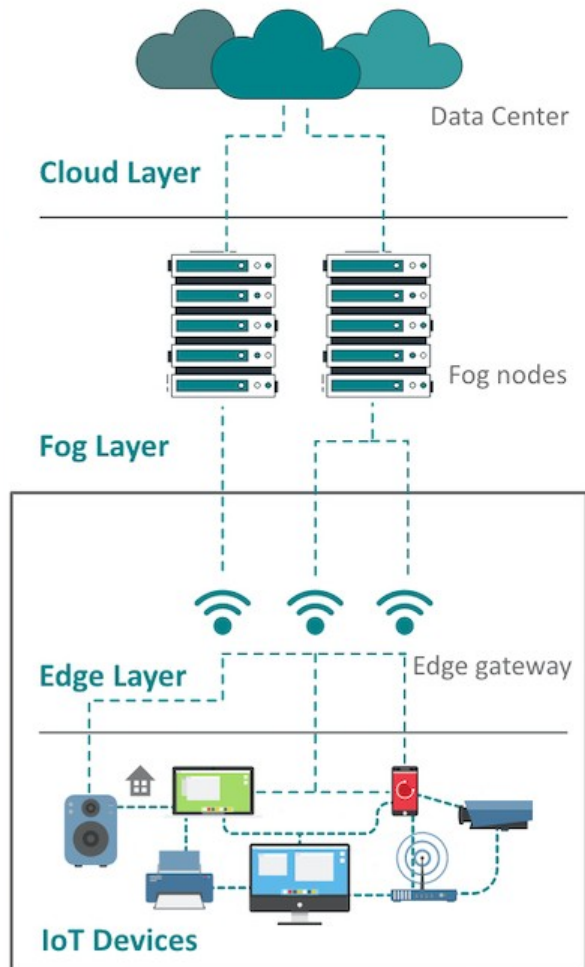
Journée Datamove 2024

Pierre Neyron - Ingénieur de Recherche LIG/CNRS

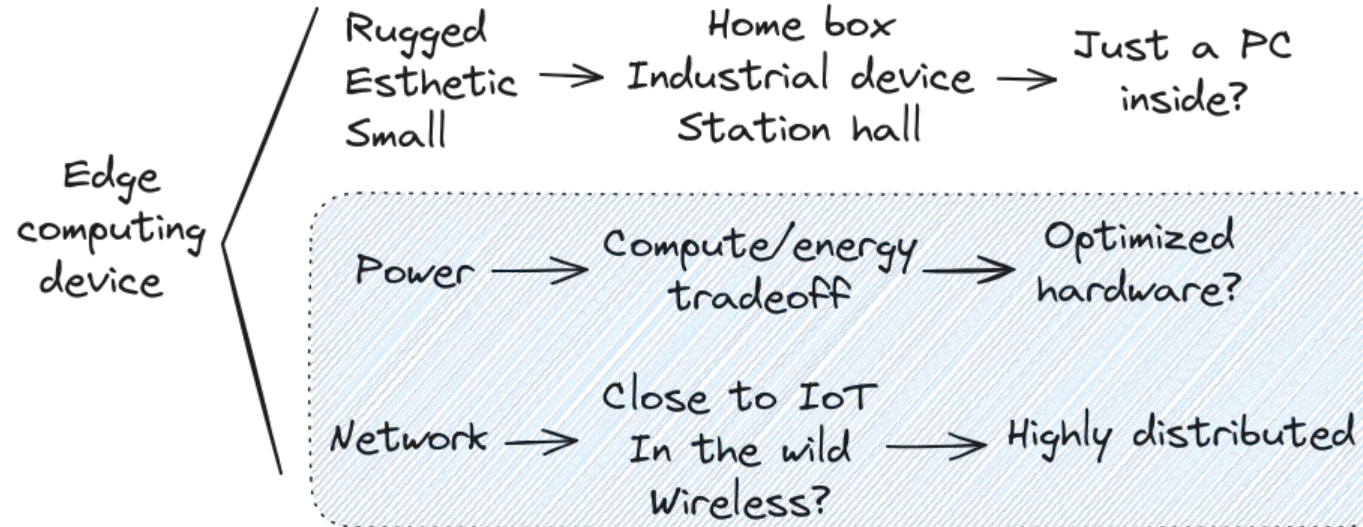
6 juin 2024



# Edge computing devices?



Cloud	Fog	Edge	IoT
Thousand of DC	Millions of nodes	Billion of devices	
Infrastructure		End-devices	
High bandwidth, e.g. wired		Low power, possibly wireless	
Linux or equiv.			RTOS/baremetal



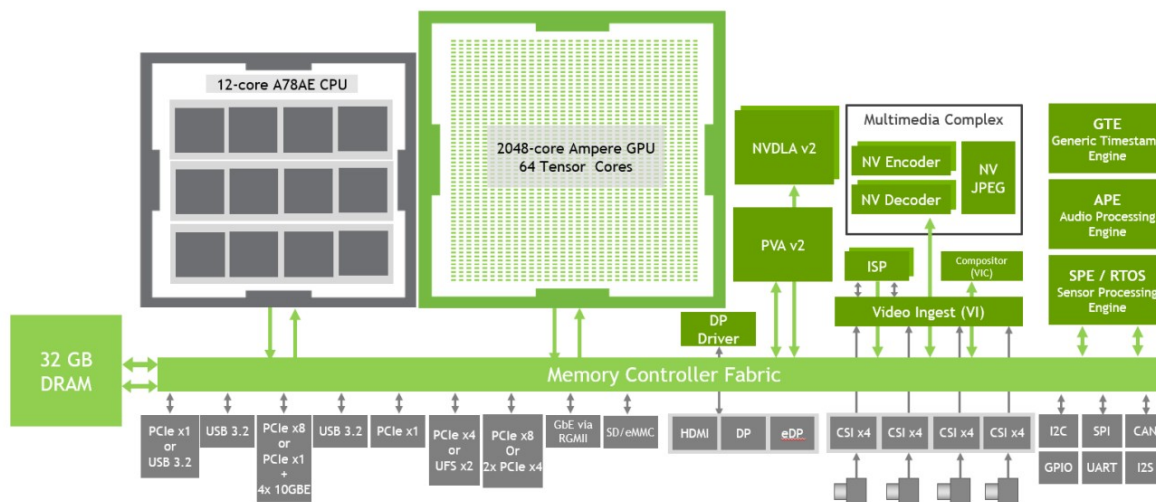


# Edge computing devices?



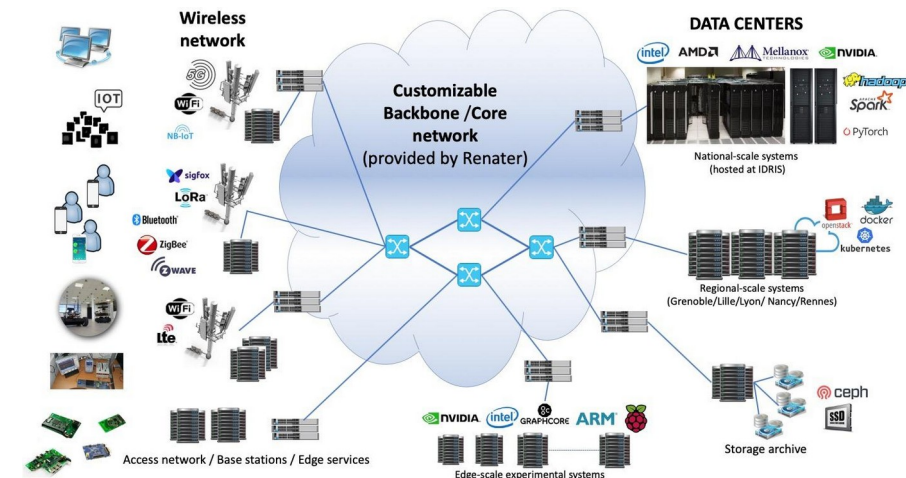
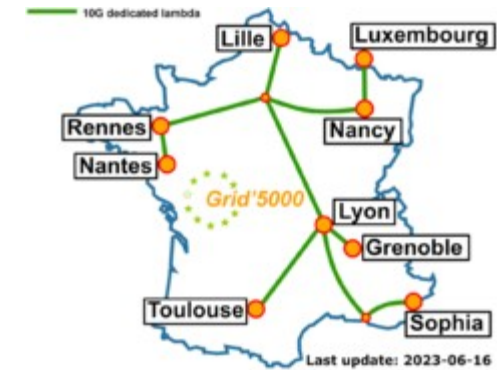
- Typical edge computing device: **Nvidia Jetsons**

- ▣ System on Chip (SoC) – CPU+GPU+... all in one
- ▣ ARM CPU – Low power, fewer cores (4 → 16) than servers
- ▣ Nvidia embedded GPU – smaller/one gen behind servers
- ▣ Other accelerators (DL, Vision, ...)



# Platforms for research 1/2

- Grid'5000
  - 2004...
  - Large scale experiments, distributed clusters : 750 nodes
  - Various hardware: CPUs, Accelerators, Memory/Disks, Network
  - Services for research: HPC, Grid, Cloud, P2P, Network, ..., IA, ...  
→ an experimental data-center: **only server-class machines**
    - Form-factor: rackable
    - Server components: e.g. only server-class CPU, GPU, RAM, Network
    - Locality: centralized places (regional DC)
- Toward “Slices”
  - ... 2040
  - Continuum from Cloud to IoT
  - Work-in-progress



# Platforms for research 2/2

- Slices builds from other platforms also:

- Fit-IoT-Lab

- The Grid'5000 of IoT
- Grid of sensors, mobile devices, ...

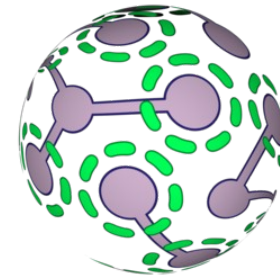
- Walt (Drakkar)

- Networked devices deployment

- Others...

- Integrating Edge computing devices is pretty new

- → *How does it fit in the Grid'5000 model ?*



# Grid'5000 integration

## Technical challenges

- Device constraints

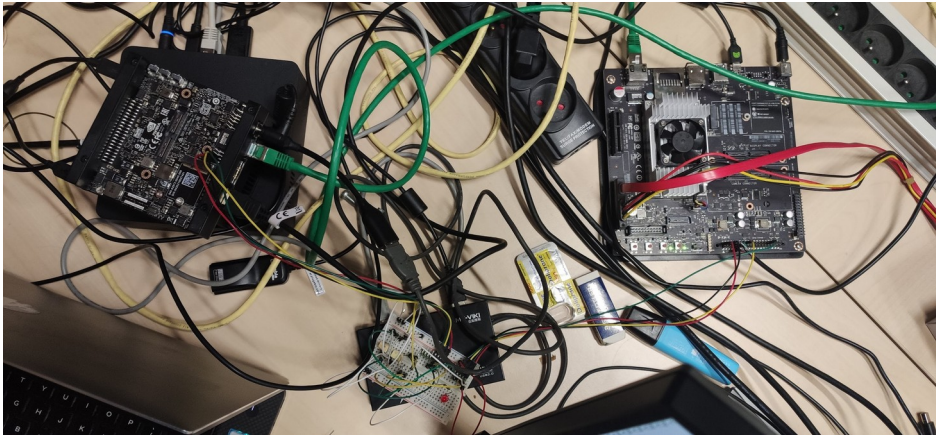
- Exotic purchase
- Exotic form factor
- Exotic architecture
- Exotic/lack of components
- Exotic/lack of boot mechanism
- Exotic OS stack

- Grid'5000 constraints

- Datacenter hosting
- Control over network
- OS reconfiguration **X 1000 ?**
- Hardware validation
- Network topology reconfiguration
- Power meters



# Grid'5000 integration make it to the data-center!

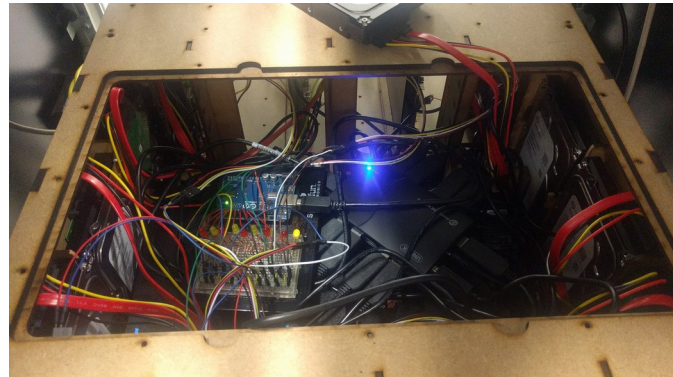


From the devkit to a ***data-center compatible*** chassis

- With out-of-band control (on/off, serial console)
- With out-of-band power meters

2 considered options:

- fablab made chassis → more work
- industrial solution → less flexible





# Grid'5000 Integration

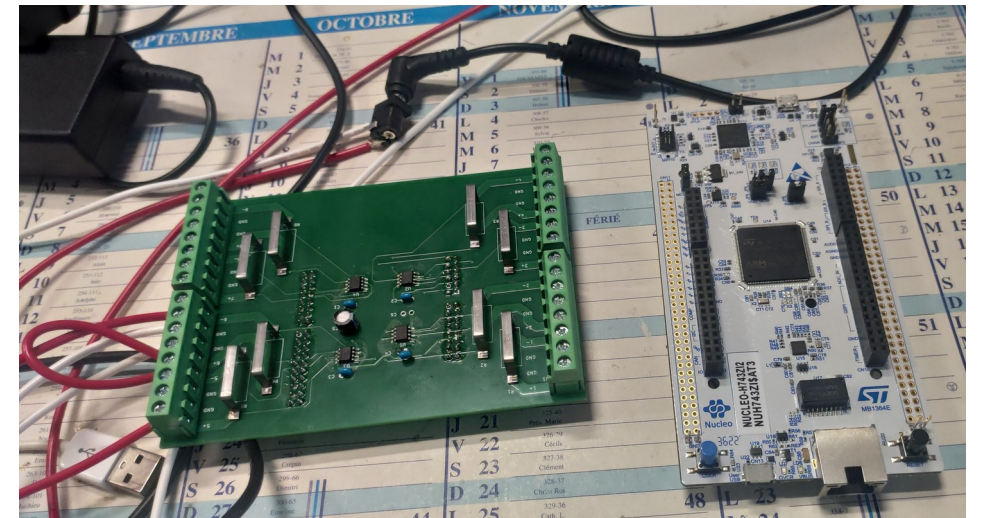
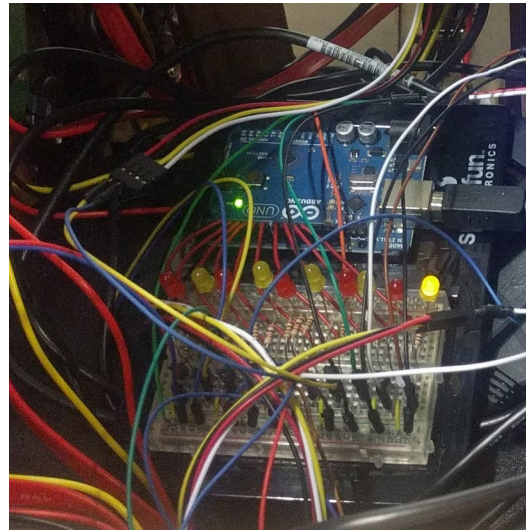
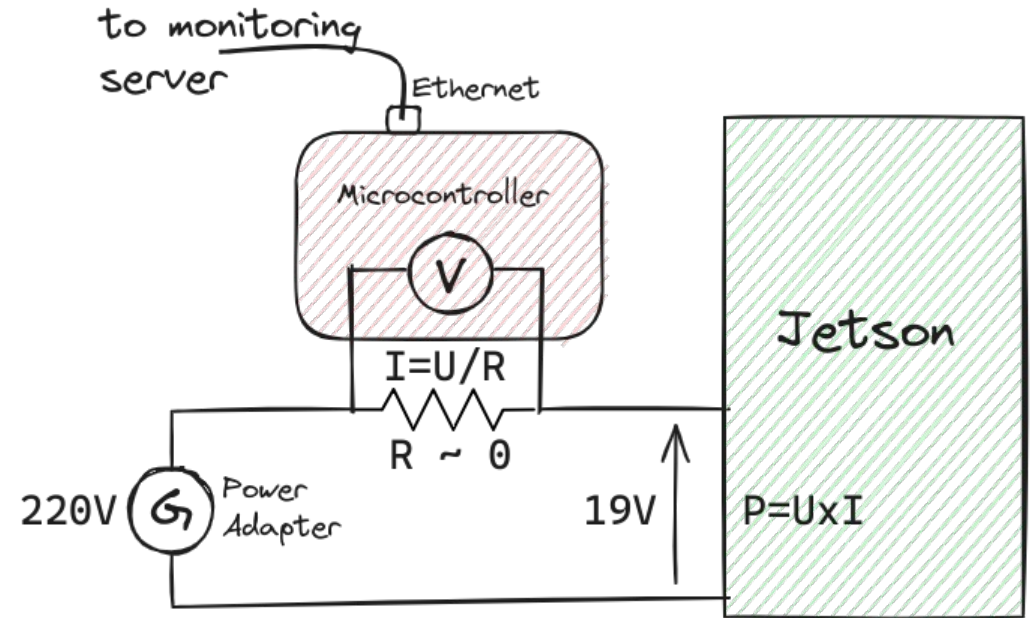
## Out-of-band control

Data-center servers come with a BMC. What about Edge devices ?

Required functions:

- On/Off
- Serial console (if no network)
- Recovery
- **Power meter**

No on-the-shelf solution ?  
DiY with microcontroller ?



# Grid'5000 Integration OS swing – Boot switch

Datacenter servers come with PXE network boot

→ allow to remotely choose what to boot (**key to kadeploy**)

Embedded devices boot mechanism varies...

- Some have U-boot with network support: **good!**
- Nvidia happened to have a vendor bootloader without network: **bad**
- UEFI without working PXE: **bad**

Boot switch over USB ? Programmable USB device ? **wow**

Post Linux kernel swing ? (giving up on allowing to change kernel)... **mmm**



# Grid'5000 Integration

## OS reconfiguration

Edge == Embedded Linux devices come with exotic software stacks.

E.g. for Nvidia Jetson: ***Complex stacking of software layers***

- Base OS (e.g. Ubuntu)
- Nvidia layer, with specific kernel, libs (cuda, ...), services
- + Nvidia Partner layer: custom device description, additional drivers, ...

Non-standard machinery for installation (flash)

Required to ***reverse-engineer*** the installation process.

Need to automate: ***Kameleon*** to the rescue with build recipes!

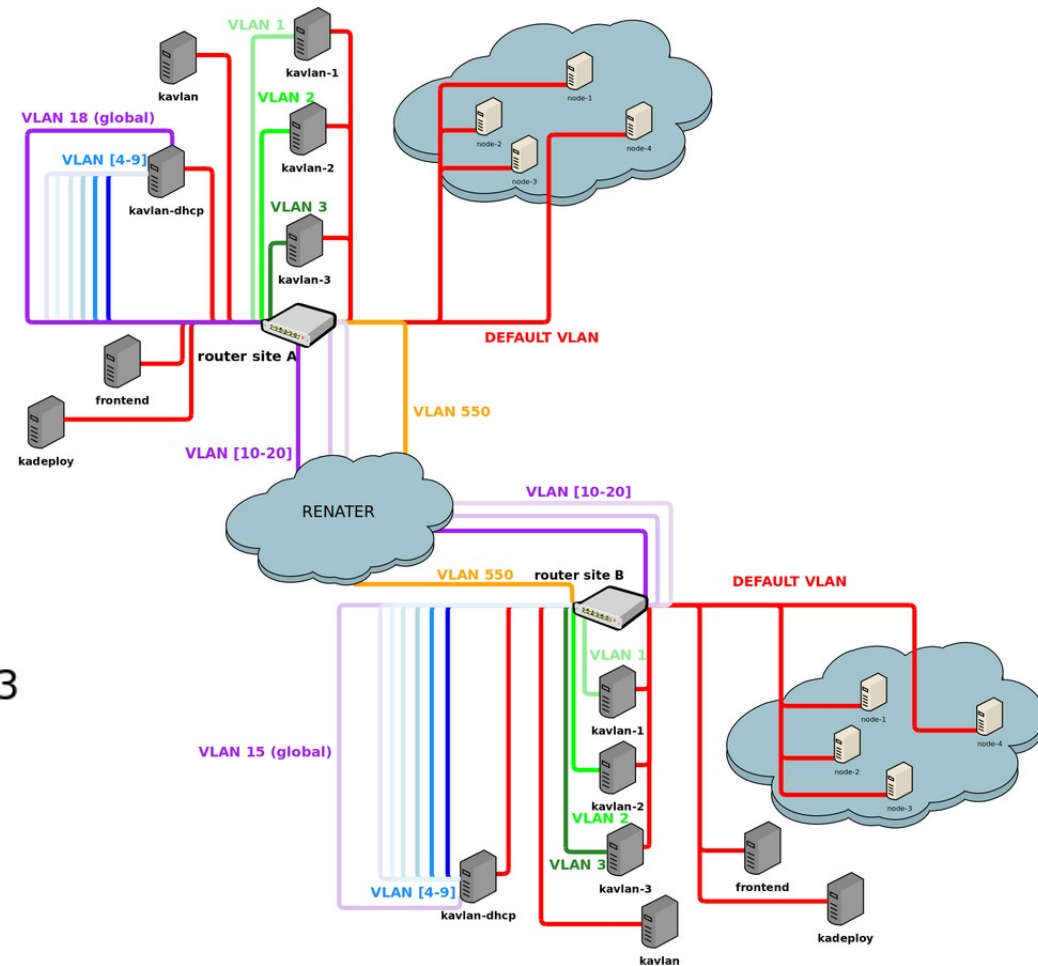
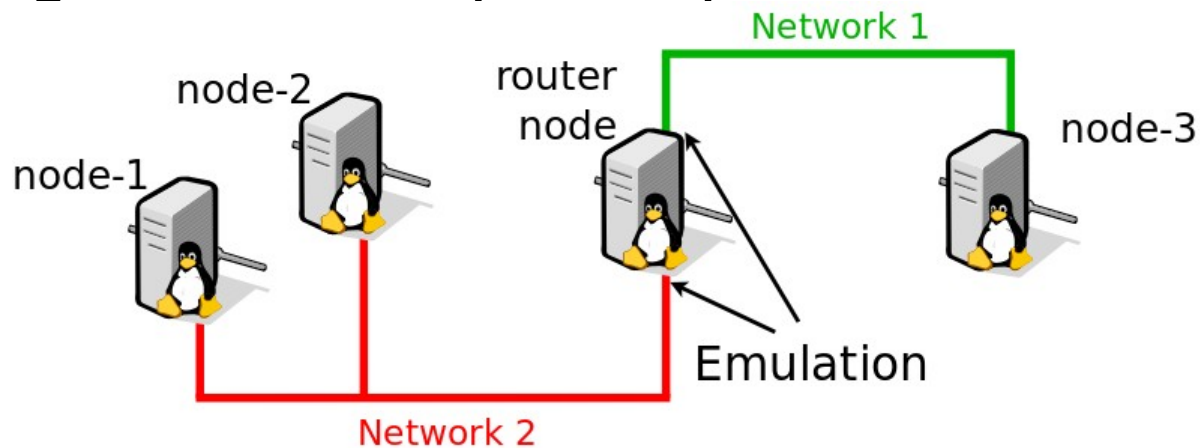


# Grid'5000 Integration

## Network topology emulation

User control of the physical network topology of hundreds of devices is out of the scope of Grid'5000.

→ Emulation with the G5K network reconfiguration tool (kavlan) + Linux tools





# Take away message

- Hard technical work (years!) but:
  - 12 Edge nodes in “production”, available in G5K Toulouse
  - A few services missing:
    - Many platform tests → need reworking the whole Grid’5000 test infra
    - Network topology emulation → kavlan-ng in dev, should support it
    - Out-of-band power meters → go custom design if still not on the shelf?
  - Used for Mathilde & Tuan’s work: federated learning
    - 100 nodes better → what about 1000 ?
- More to come in Slices...