Beyond the Clouds, The Discovery Initiative

How Should Next Generation Utility Computing Infrastructures Be Designed to Solve Sustainability & Efficiency Challenges ?

Adrien Lebre

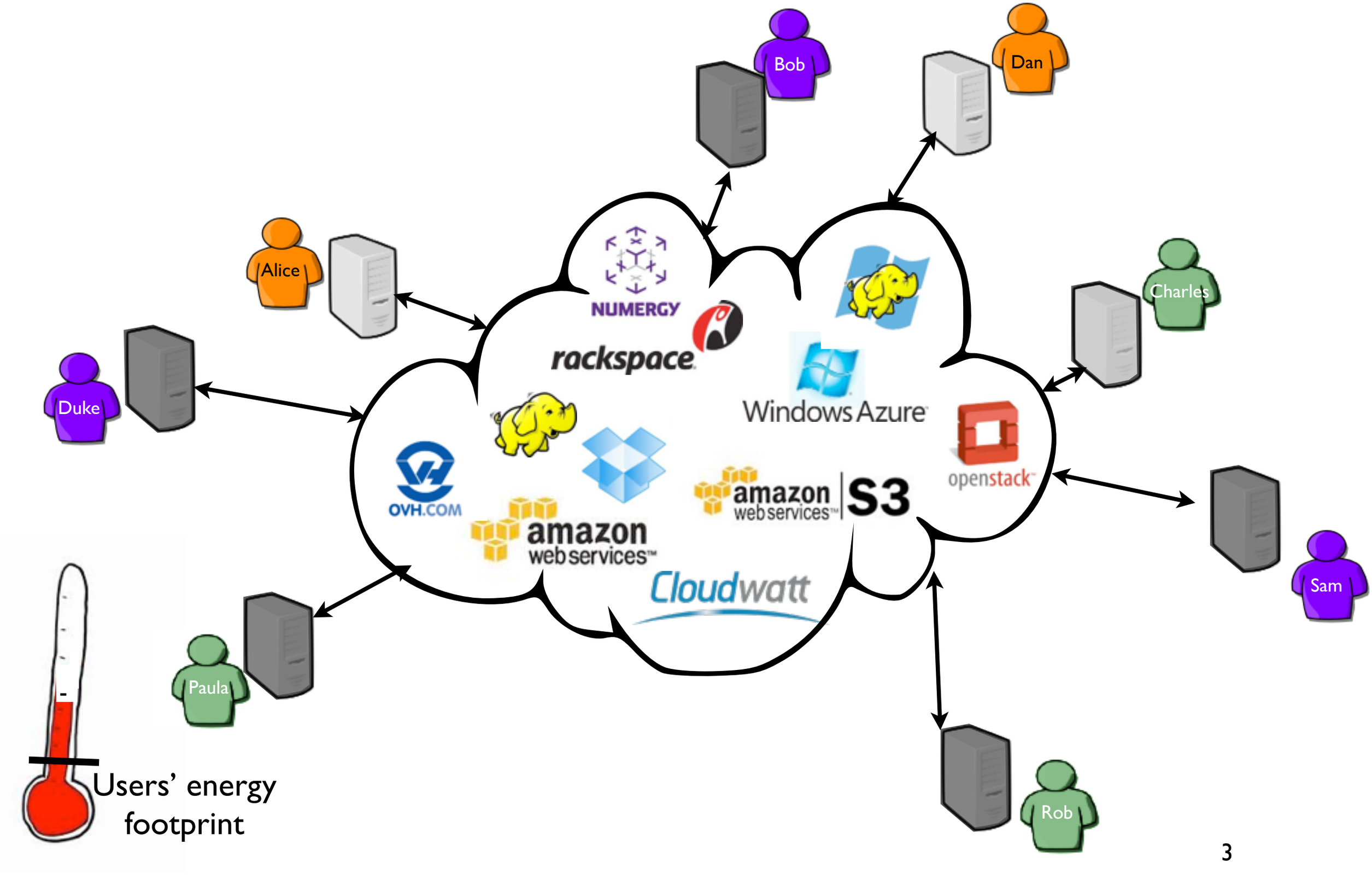
June, 2015 - RENATER

Localization is a key element to deliver *efficient* as well as *sustainable* **Utility Computing** solutions

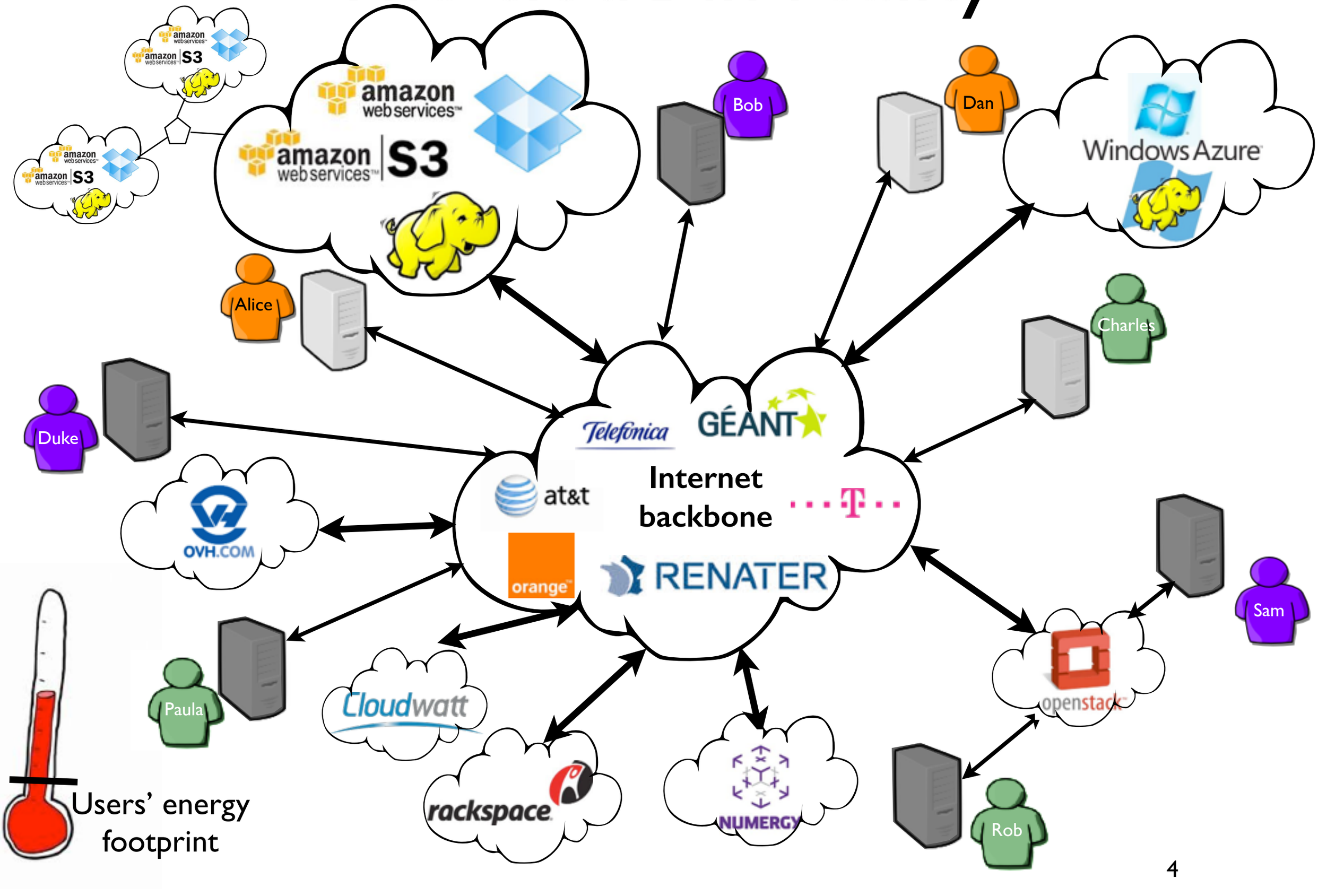
A simple Idea

Bring Clouds back to the cloud

The cloud from end-users



The cloud in reality



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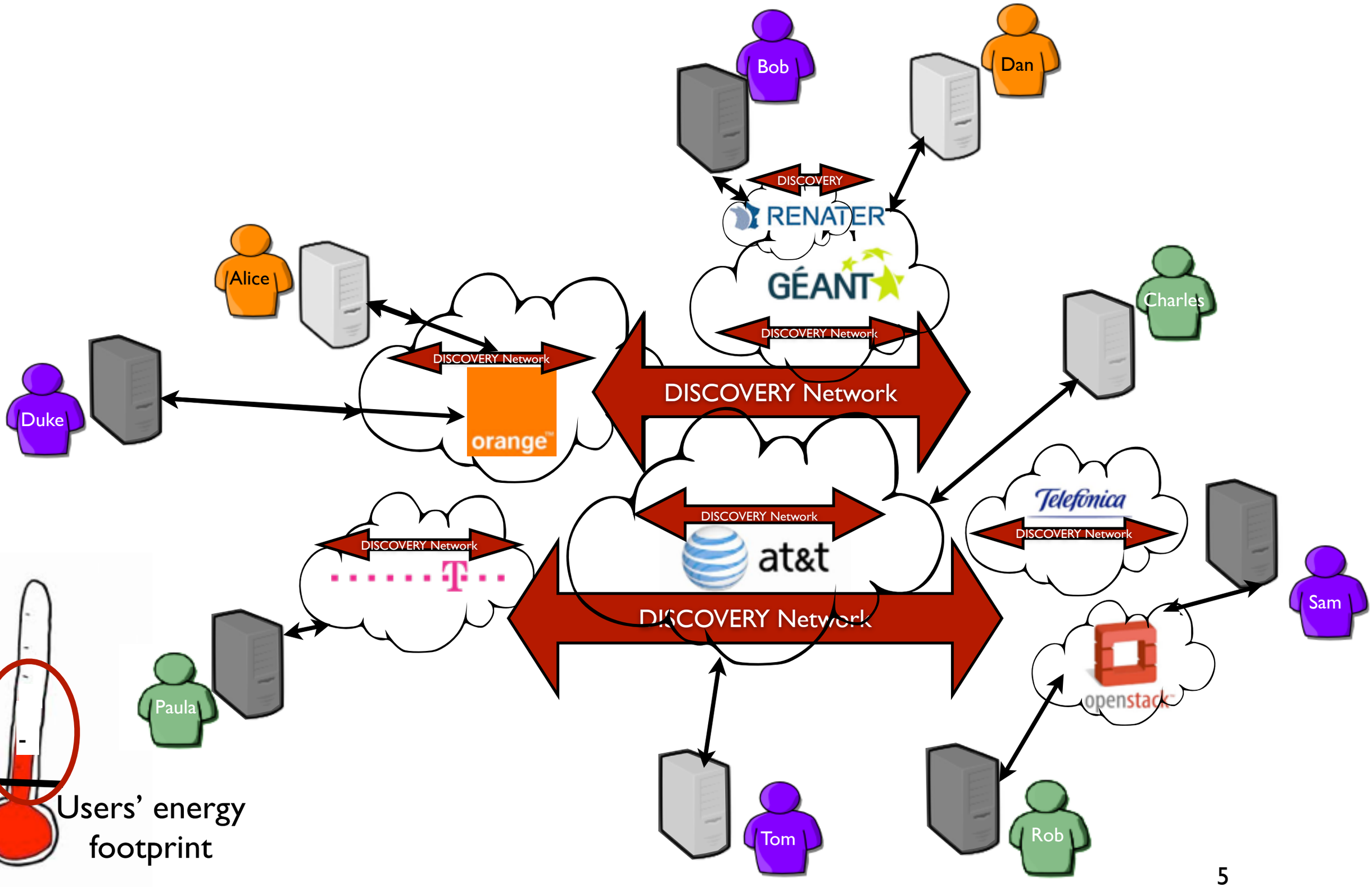

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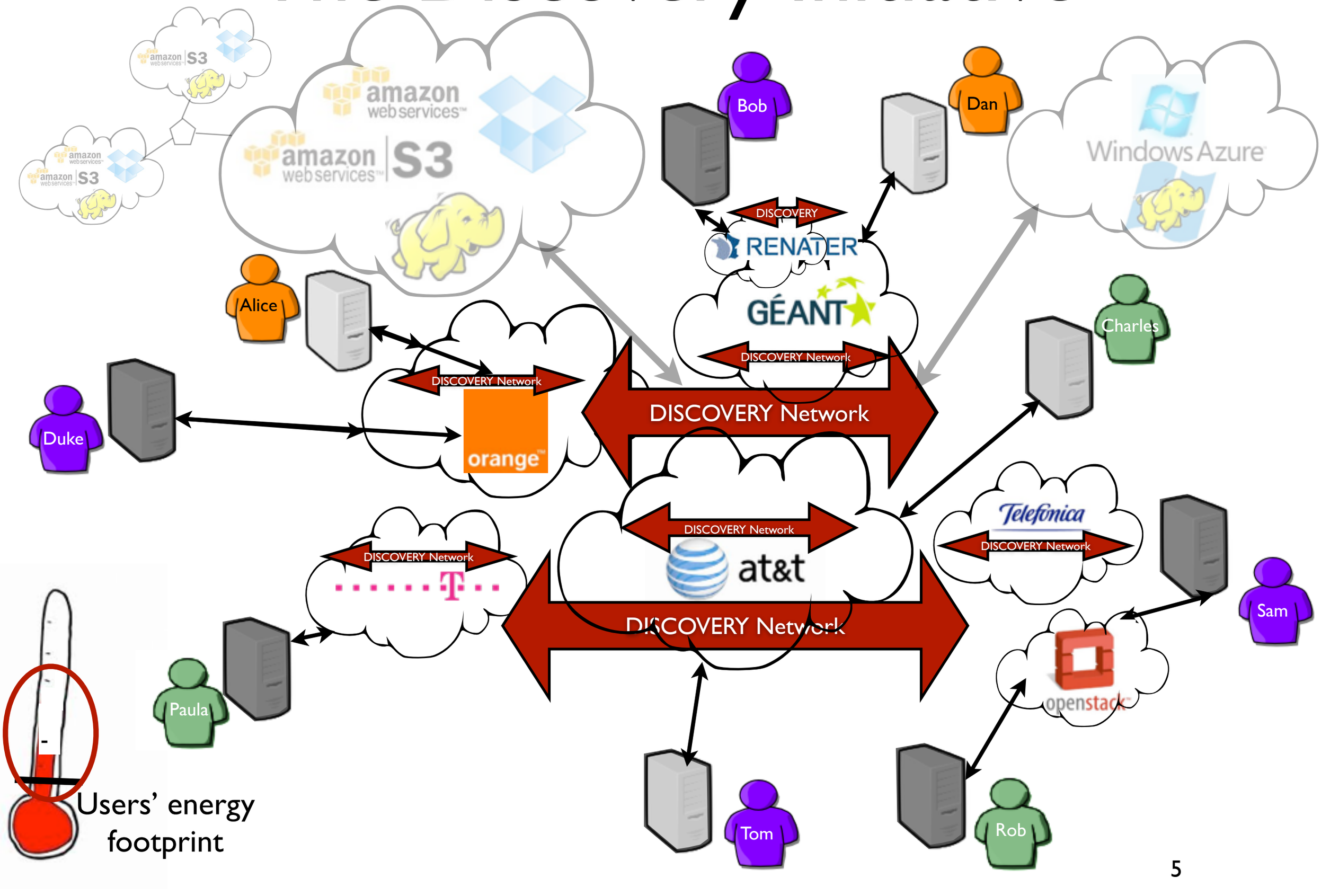

Users' energy footprint

Why ?

Let's give a look to the current situation

The Current Trend: Large off shore DCs

- To cope with the increasing UC demand while handling energy concerns but…

credits: datacentertalk.com - Microsoft DC, Quincy, WA state

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credits: google map - Quincy

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credits: coloandcloud.com

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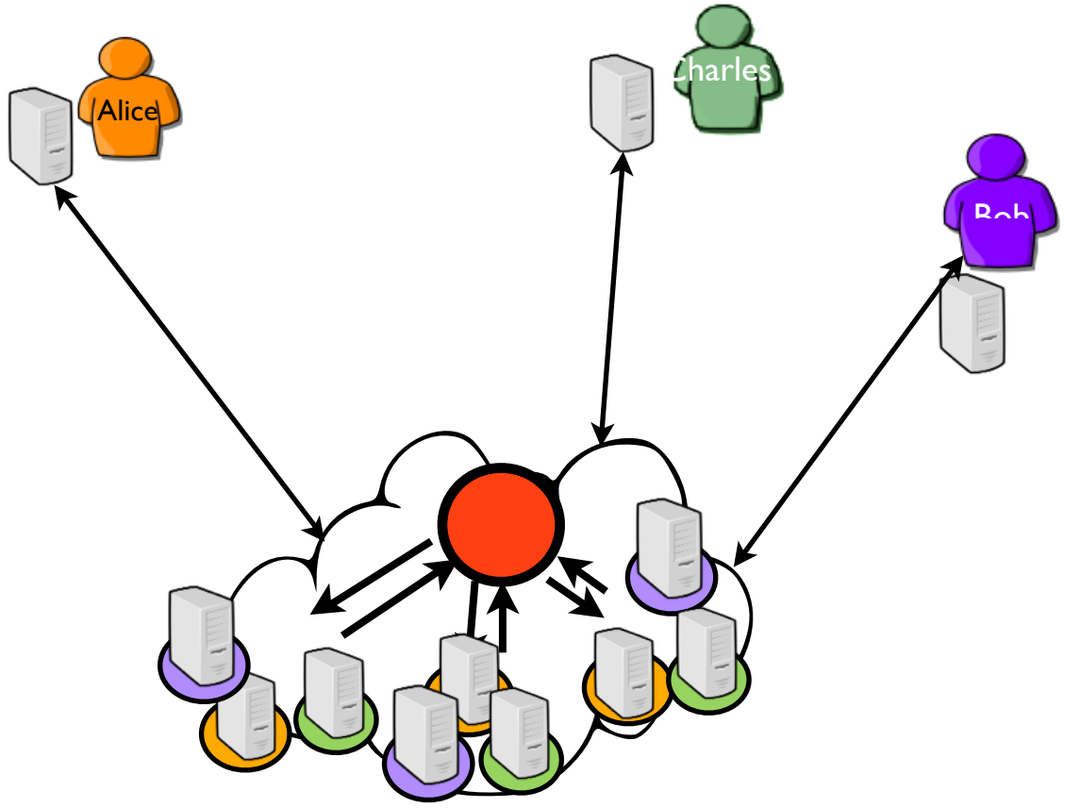

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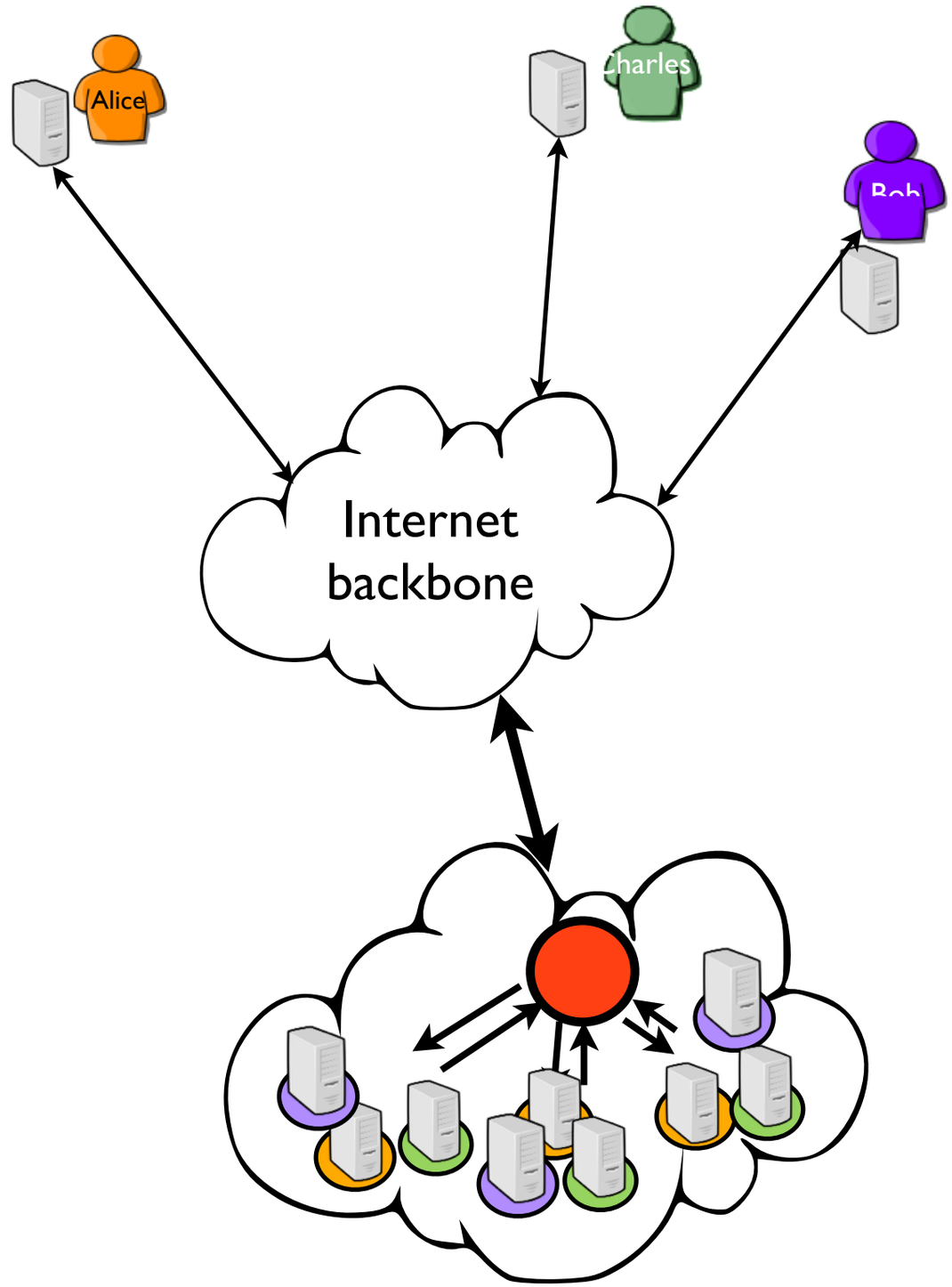

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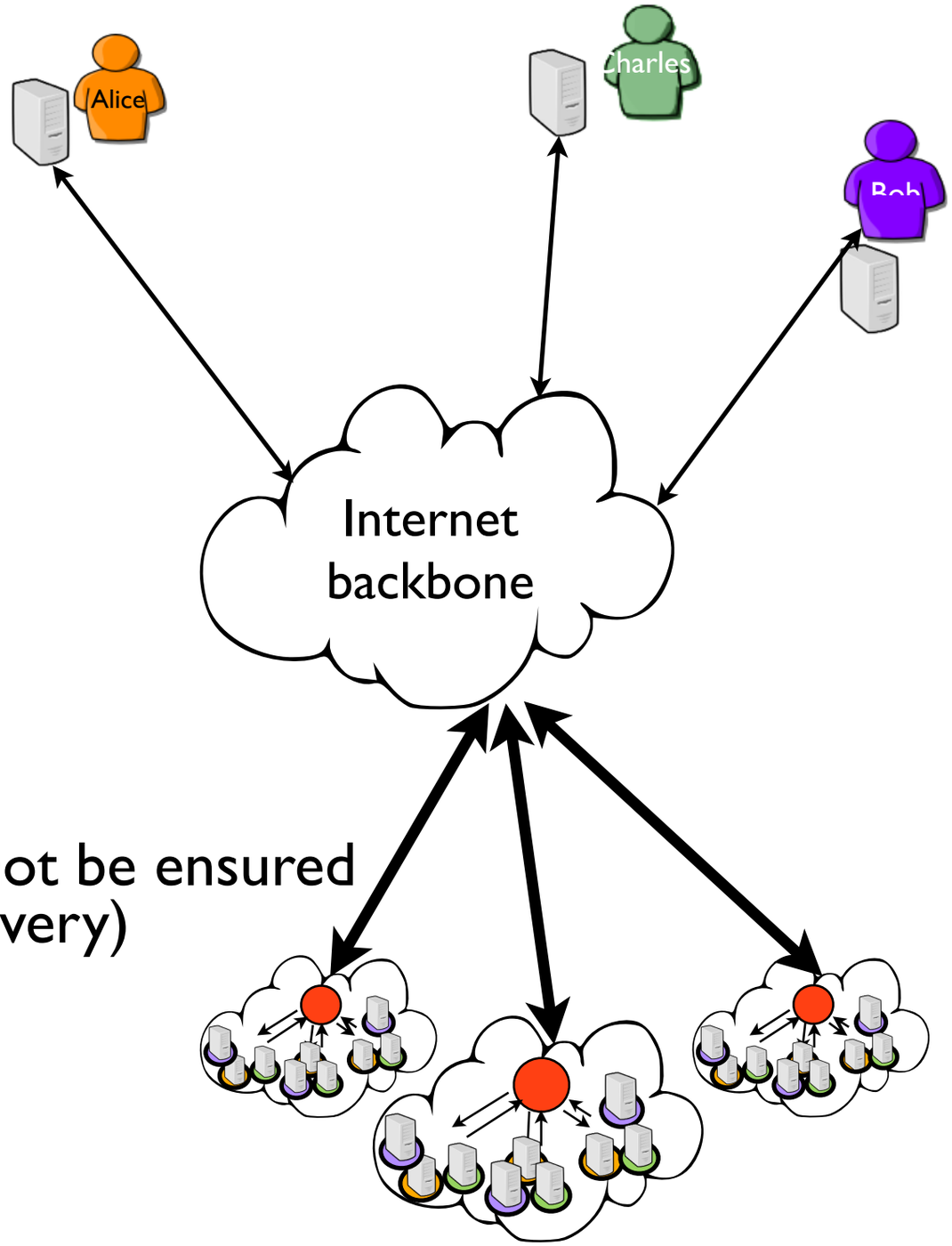

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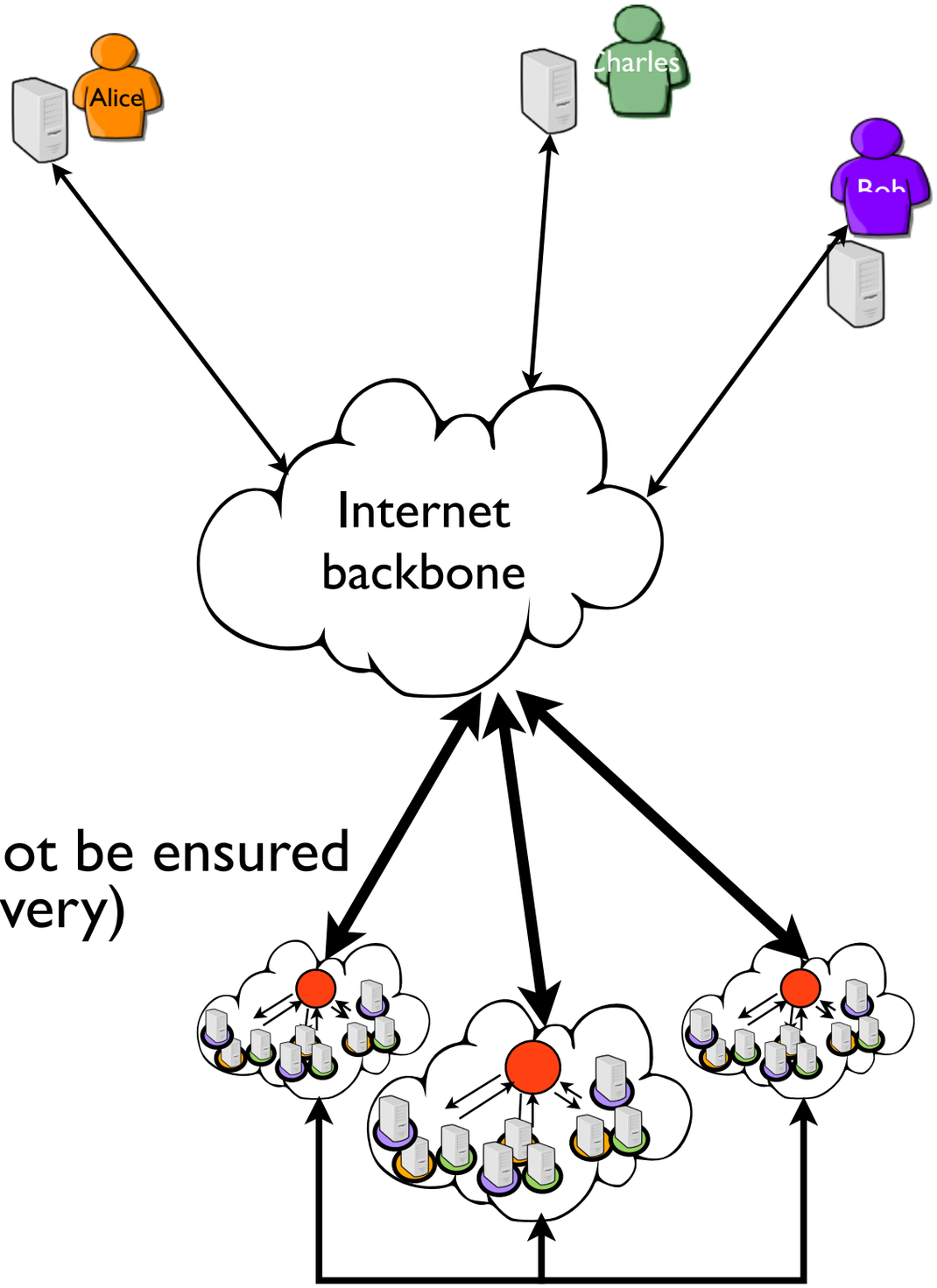

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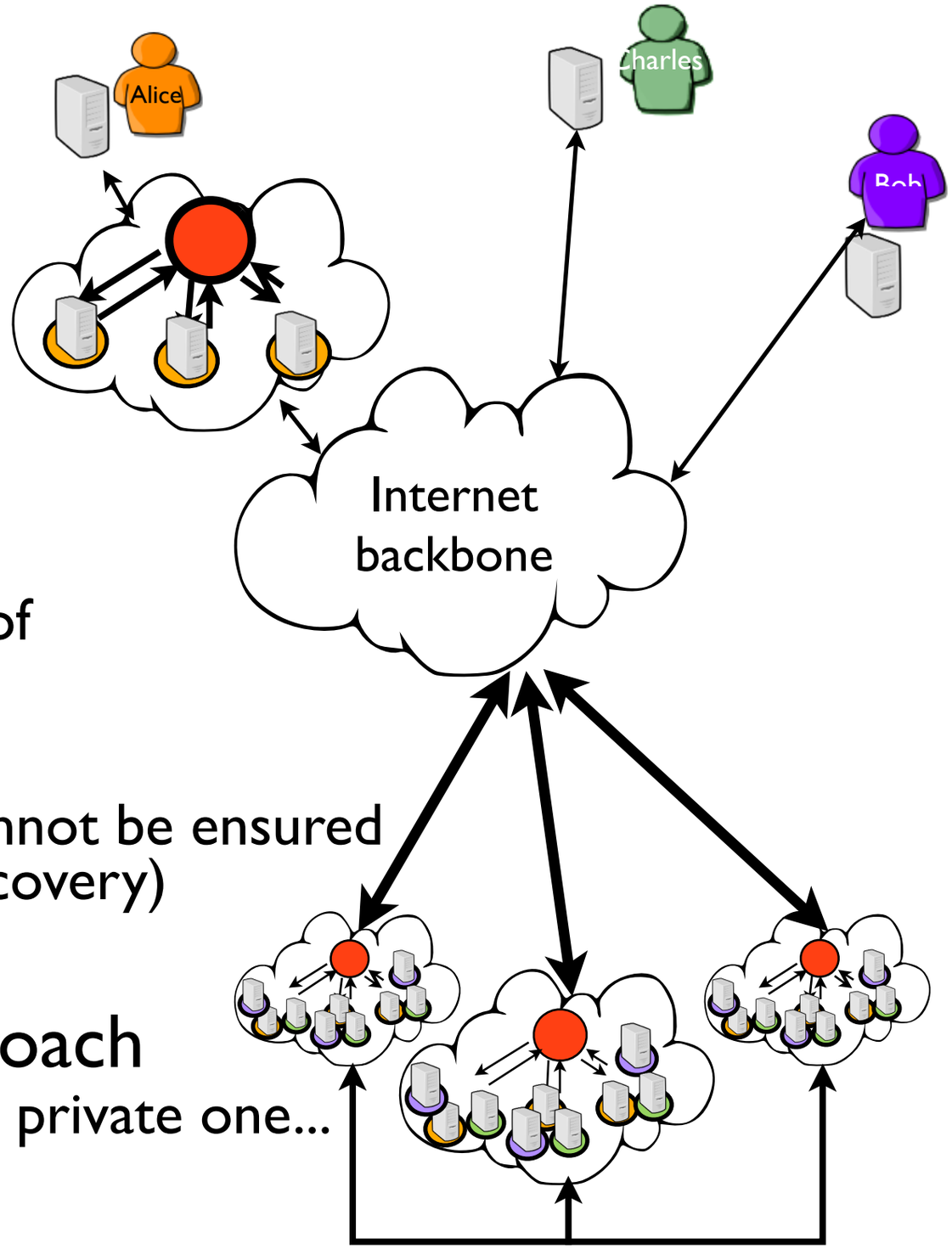

- Hybrid platforms: a promising approach

  It depends how you are going to extend the private one...

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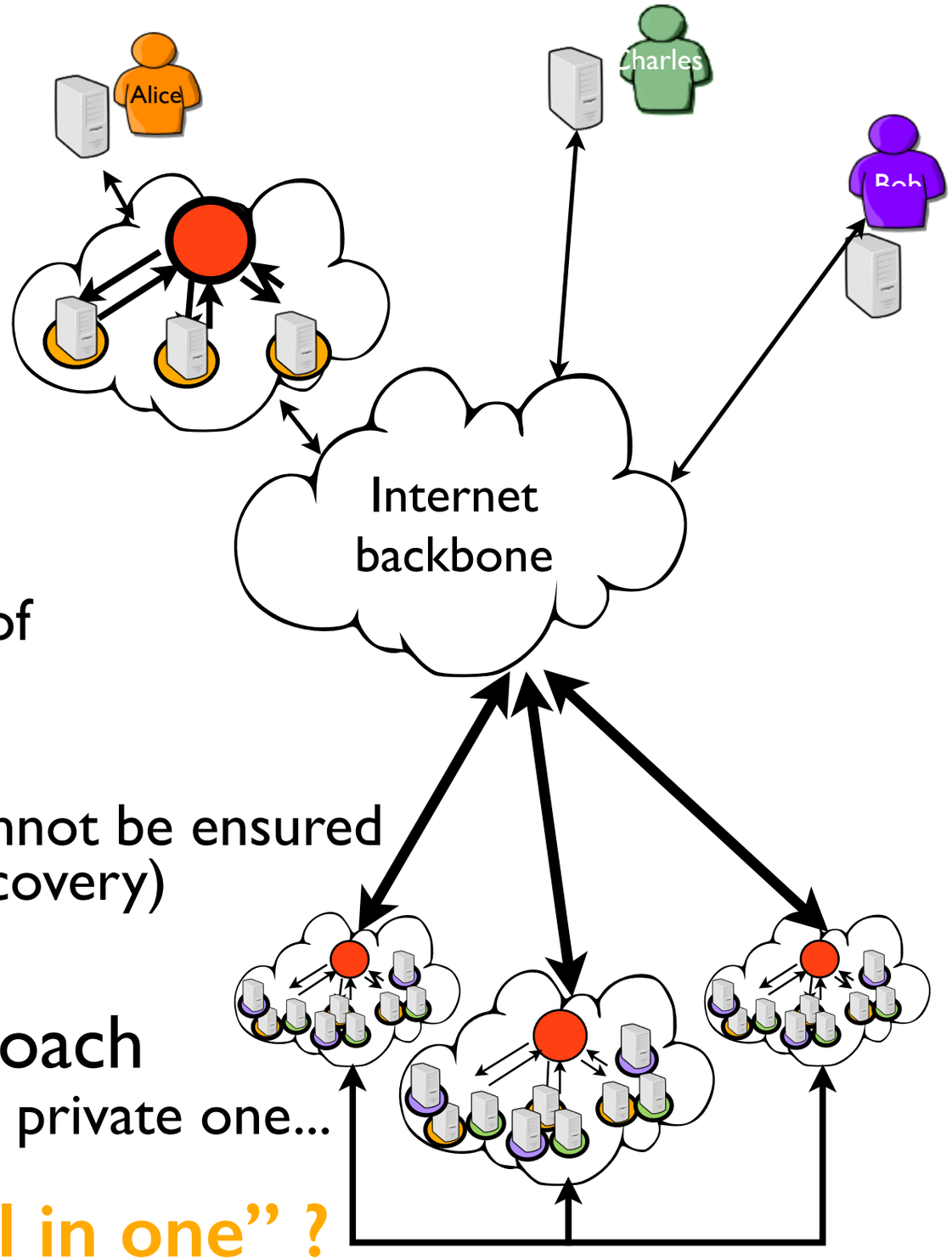


- Hybrid platforms: a promising approach
  It depends how you are going to extend the private one...

Can we address these concerns "all in one" ?

µ/nDC concept

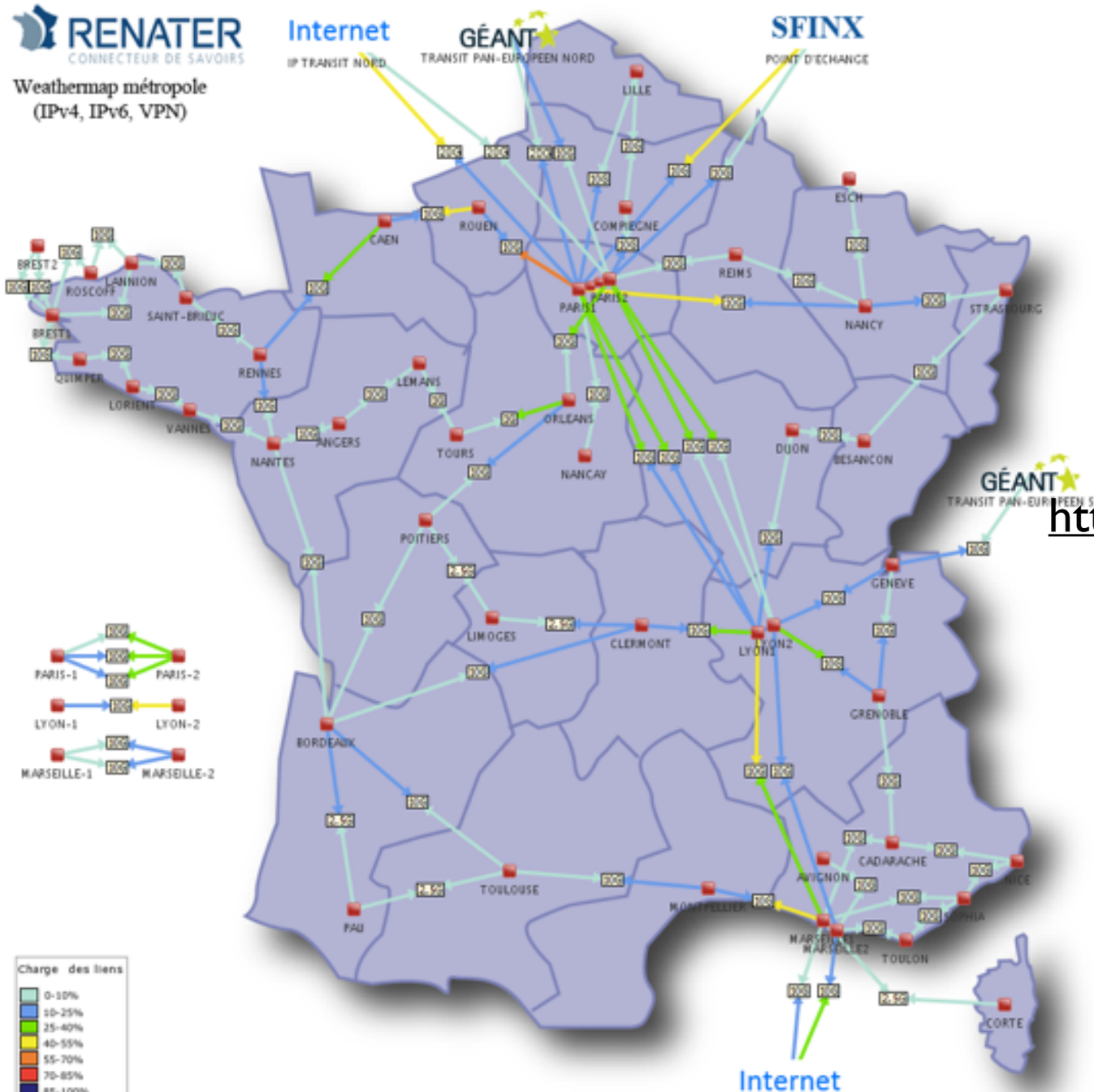
How and where the μDC concept can be deployed ?

Locality Based Utility Computing Toward LUC Infrastructures

Beyond the Clouds, the DISCOVERY Initiative

- Locality-based UC infrastructures

  A promising way to deliver highly efficient and sustainable UC services is to provide UC platforms as close as possible to the end-users.



http://www.renater.fr/raccourci?lang=fr

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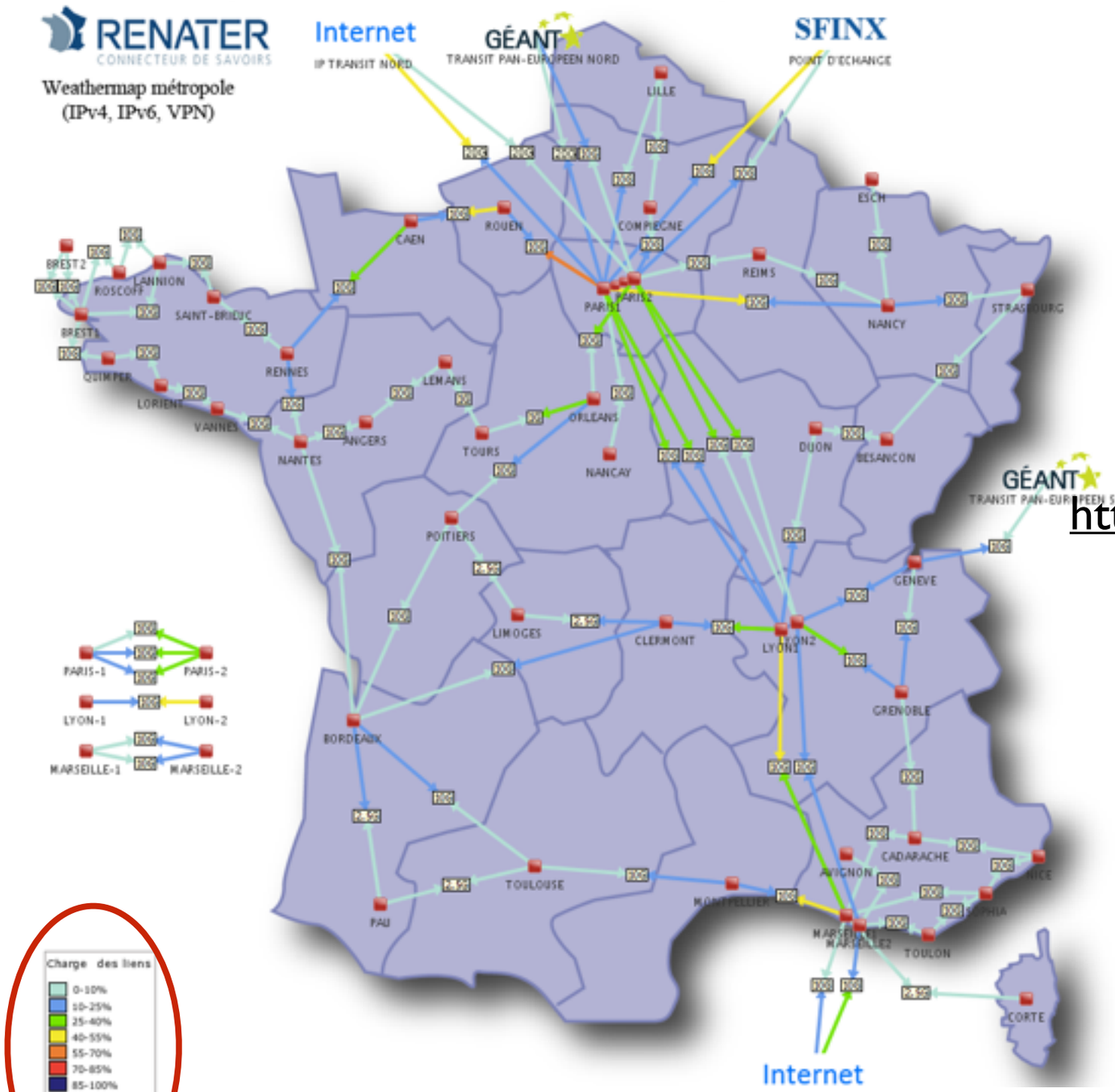

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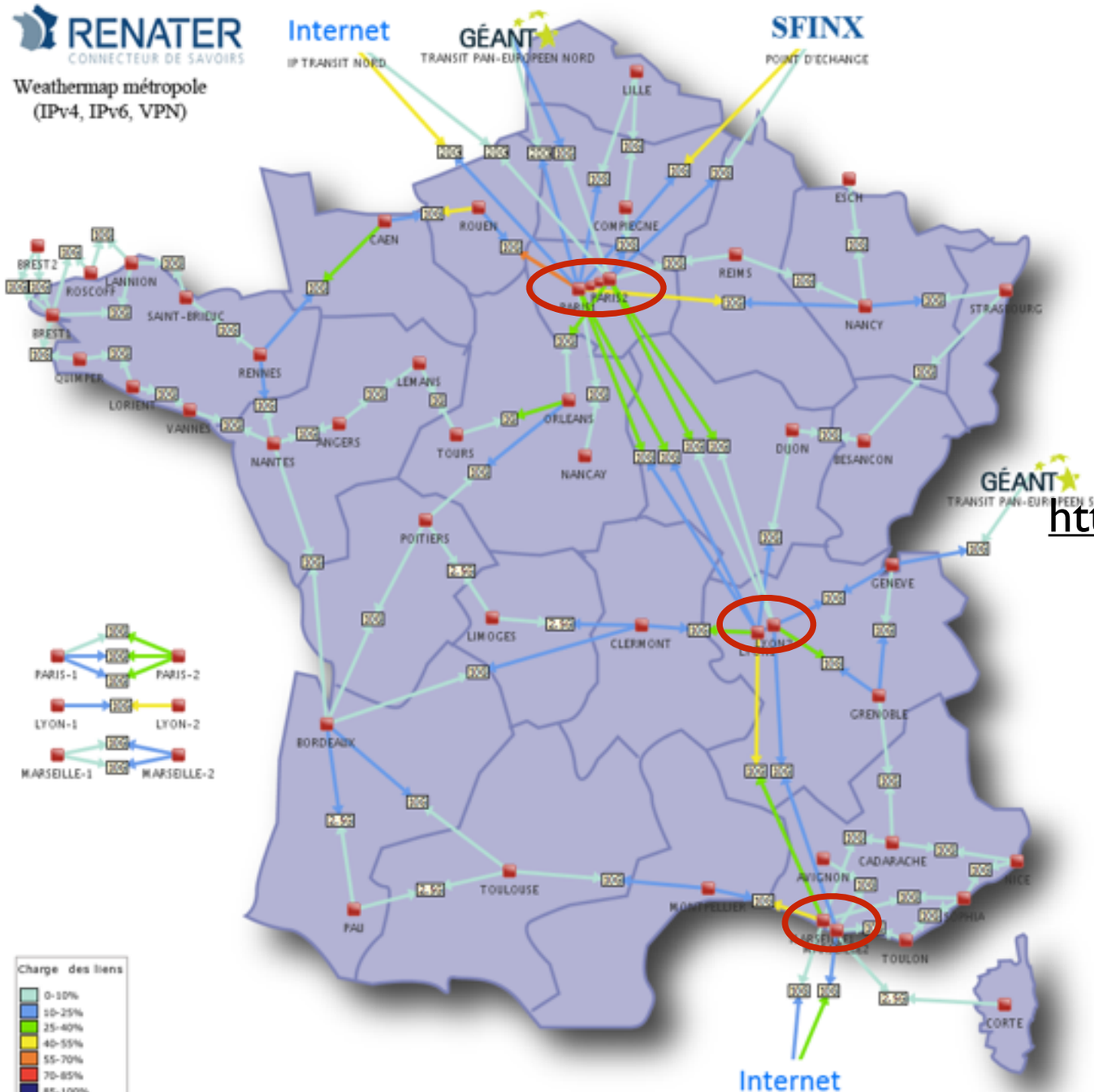

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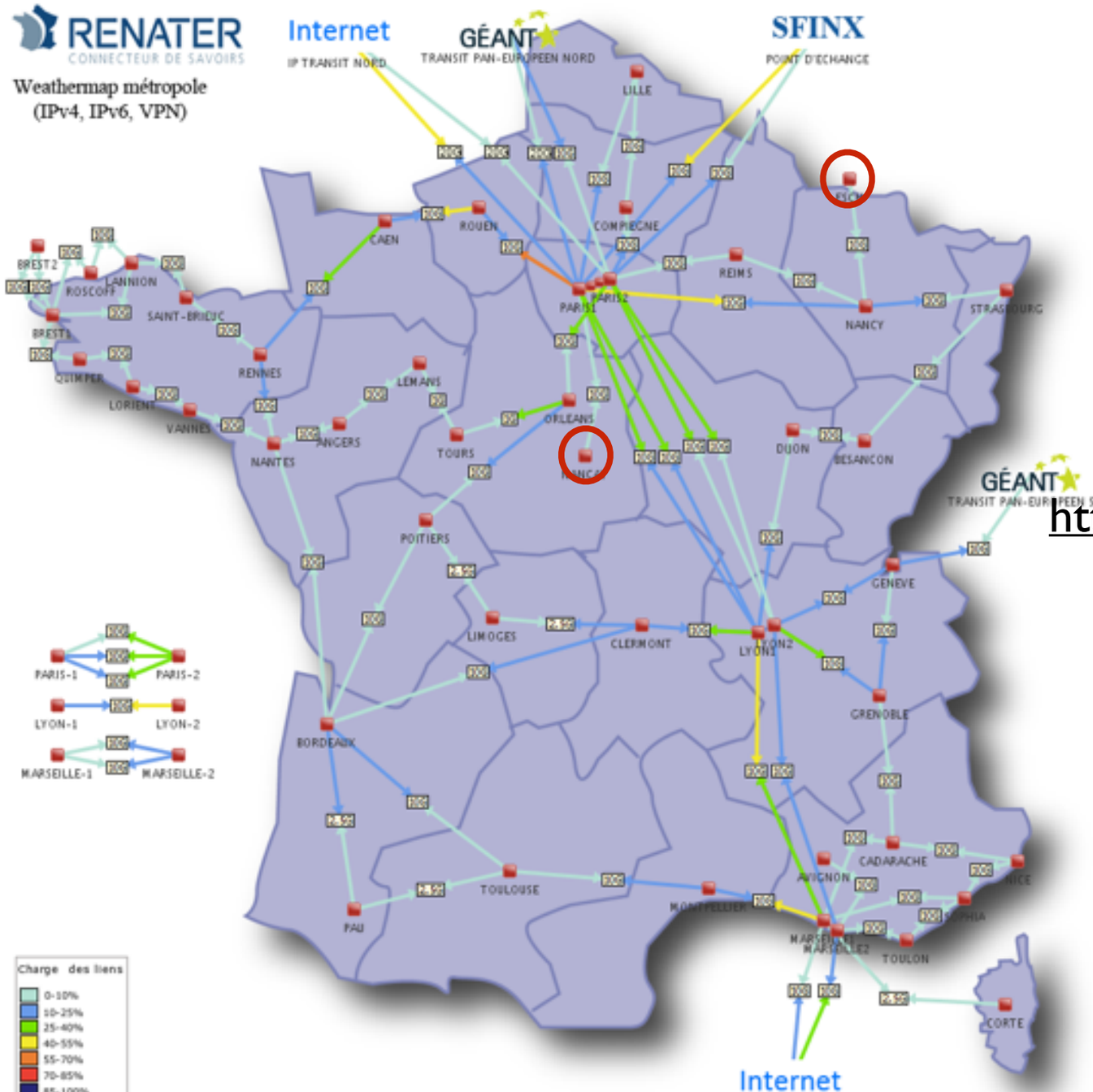

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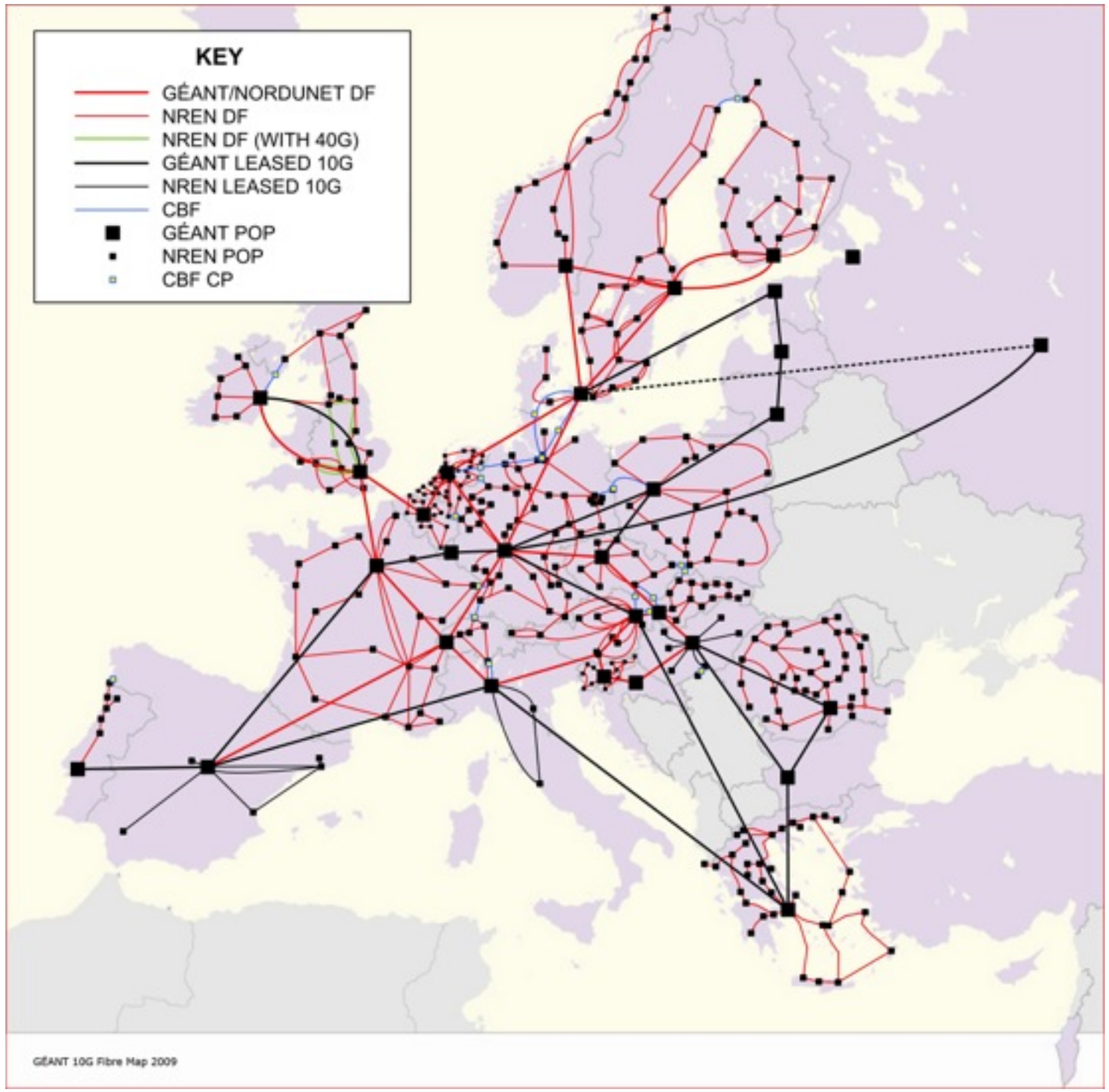

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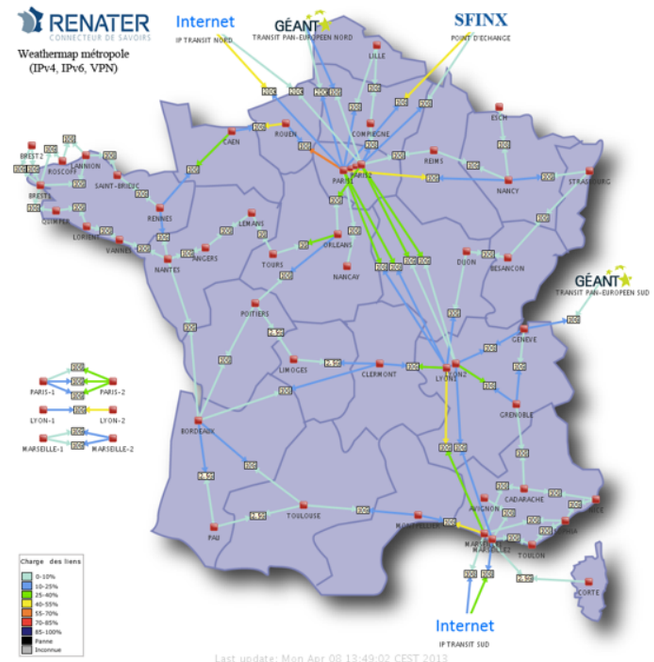
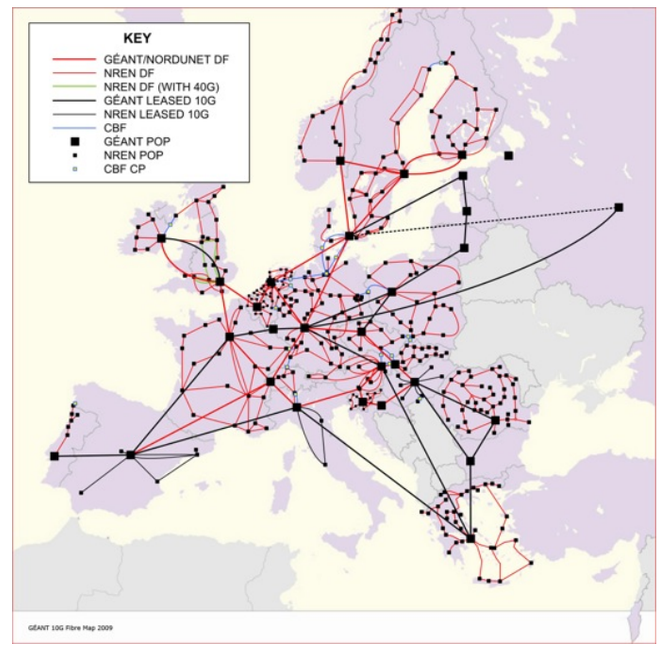


- Leveraging network backbones

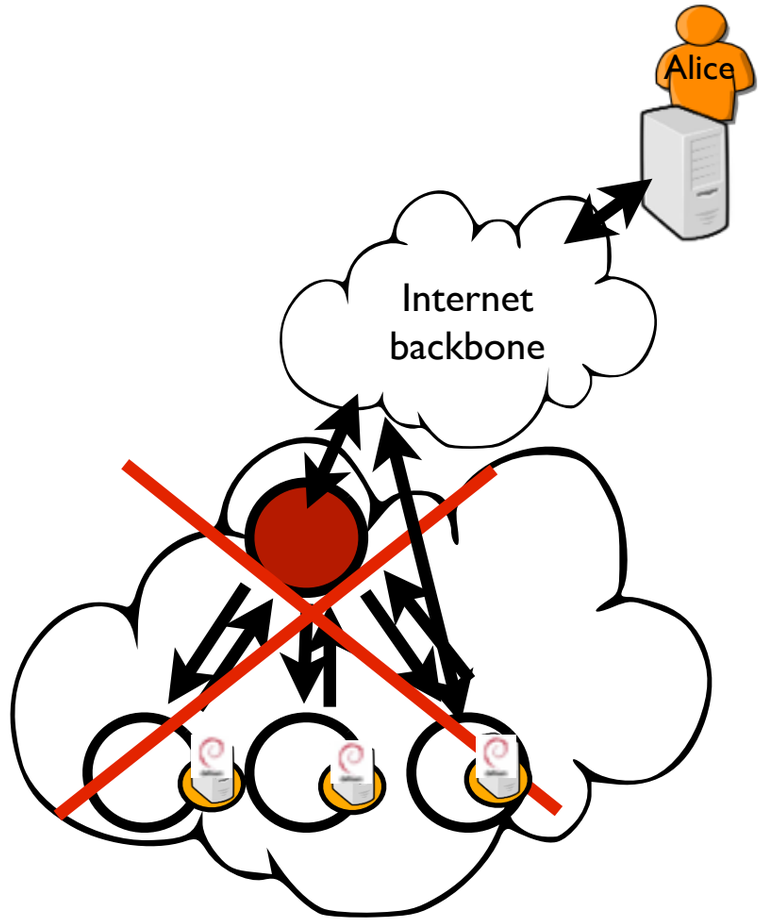
  Extend any point of presence of network backbones with UC servers (from network hubs up to major DSLAMs that are operated by telecom companies and network institutions).



⇒ Operating such widely distributed resources requires the definition of a fully distributed system

The DISCOVERY Proposal

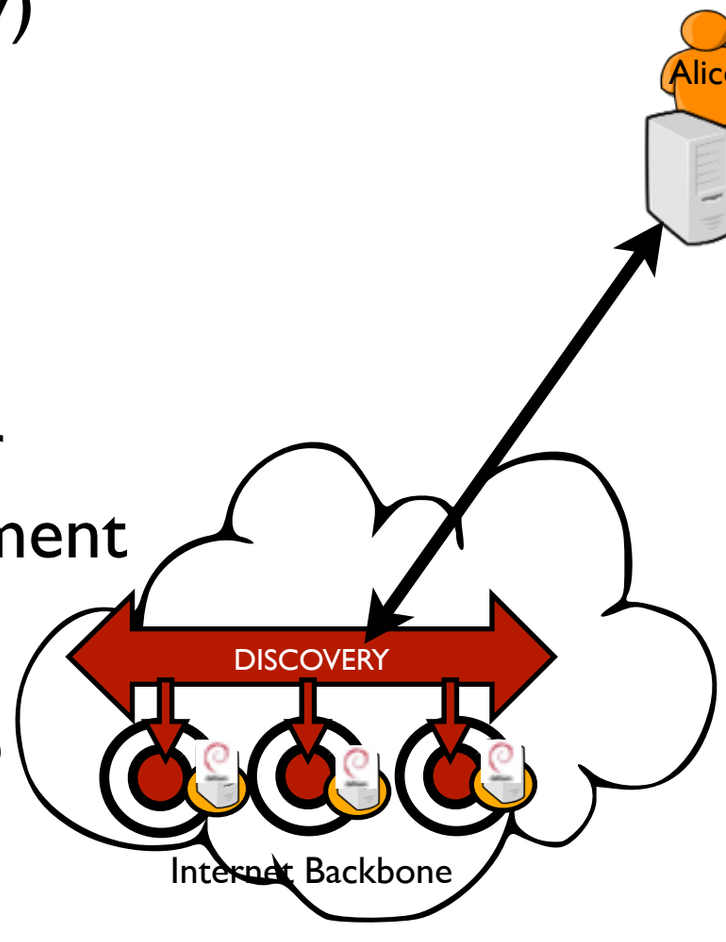
- DIStributed and COoperative framework to manage Virtual EnviRonments autonomously



The DISCOVERY Proposal

- DIStributed and COoperative framework to manage Virtual EnviRonments autonomously
- The LUC OS
  - A fully distributed IaaS system and not a distributed system of IaaS systemS. We want to/must go further than high level cloud APIs (cross-cutting concerns such as energy/security)
  - Leverage P2P algorithms and self-* approaches
- lots of scientific/technical challenges

Cost of the DISCOVERY network !? partial view of the system !? Impact on the others VMs !?, management of VM images !? Which software abstractions to make the development easier and more reliable (distributed event programming)? How to take into account locality aspects? …



The Discovery Initiative Pros/Cons

- Pros

  Locality (jurisdiction concerns, latency-aware apps, minimize network overhead)

  Reliability/redundancy (no critical point/location/center)
  The infrastructure is naturally distributed throughout multiple areas

  Lead time to delivery
  Leverage current PoPs and extend them according to UC demands

  Energy footprint (on-going investigations with RENATER)

  Bring back part of the revenue to NRENs/Telcos

- Cons

  Security concerns (in terms of who can access to the PoPs)

  Operate a fully IaaS in a unified but distributed manner at WAN level

  Not suited for all kinds of applications : Large tightly coupled HPC workloads
  50 nodes/1000 cores, 200 nodes / 4000 cores (5 racks),
  so1000 nodes in one PoP does not look realistic …

  Peering agreement / economic model between network operators

Conclusion

- Cloud Computing technology is changing every day

  New features, new requirements (IaaS ++ services)

  One more challenge will be to ensure that such new features/ mechanisms can run in a distributed manner.

- Distributed Cloud Computing is happening !

  Dist. CC workshop (2 editions UCC 2013, SIGCOMM 2014)
  FOG Computing workshop (collocated with IEEE ICC 2013)

  More and more academic papers
  Decentralizing the Cloud: How Can Small Data Centers Cooperate IEEE P2P 2014…

The DISCOVERY Initiative

- Thank you / Questions ?
- Several researchers, engineers, stakeholders of important EU institutions and SMEs have been taking part to numerous brainstorming sessions (BSC, CRS4, Unine, EPFL, PSNC, Interoute, Orange Labs, Peerialism, TBS Group, XLAB, …)

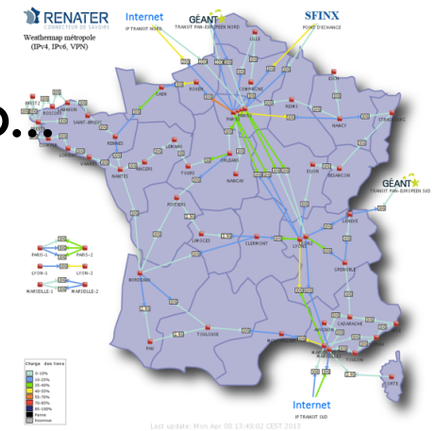
http://beyondtheclouds.github.io/

adrien.lebre@inria.fr

Beyond Discovery !

- From sustainable data centers to a new source of energy

  A promising way to deliver highly efficient and sustainable UC services is to provide UC platforms as close as possible to the end-users and to...



- Leverage "green" energy (solar, wind turbines...)

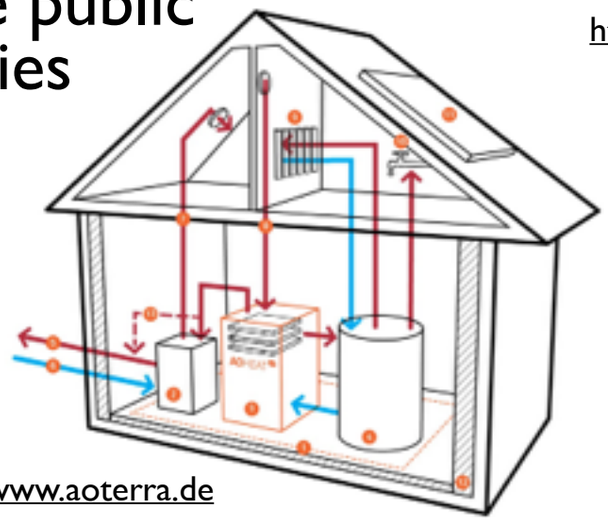
  Transfer the green micro/nano DCs concept to the network PoP

  Take the advantage of the geographical distribution

- Leveraging the data furnaces concept

  Deploy UC servers in medium and large institutions and use them as sources of heat inside public buildings such as hospitals or universities

http://parasol.cs.rutgers.edu



https://www.aoterra.de

Additional slides

Deploying a LUC on top of RENATER

Infrastructure	IT's Energy	Network Energy	Total	Nb	Overall
Large PoP	7,6	1,3	8,9	6	53,4
Medium PoP	2,7	0,35	3,05	30	91,5
Small PoP	2,2	0,35	2,55	36	91,8
				Overall	236,7
Shelter		0,2		198	39,6
				Overall with shelters	276,3

Energy consumption of RENATER
(estimates in kW)

Infrastructure	Total Energy (IT + Network)	Nb	Overall	Nb VMs
1 unit of 100 VMs (10 nodes)	4	50	200	5000

Energy consumption of one 500 nodes cloud
(estimates in kW)

Deploying a LUC on top of RENATER

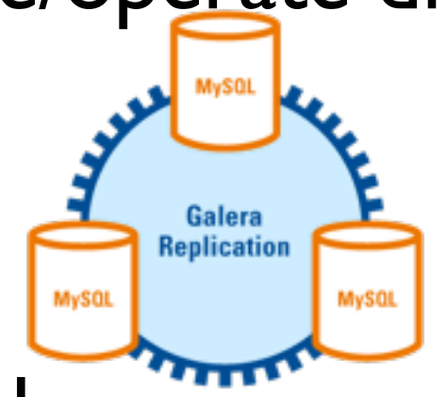
Infrastructure	Nb	Total	Available Energy/PoP	Overall	Overall (after extension)	Nb VMs
Large PoP	6	8,9	16	53,4	149,4	2400
Medium PoP	30	3,05	4	91,5	211,5	3000
Small PoP	36	2,55	0	91,8	91,8	
			Overall	**236,7**	**452,7**	5400
Shelter	198	0,2		39,6	39,6	
			Overall with shelters	**276,3**	**492,3**	

Where We Are

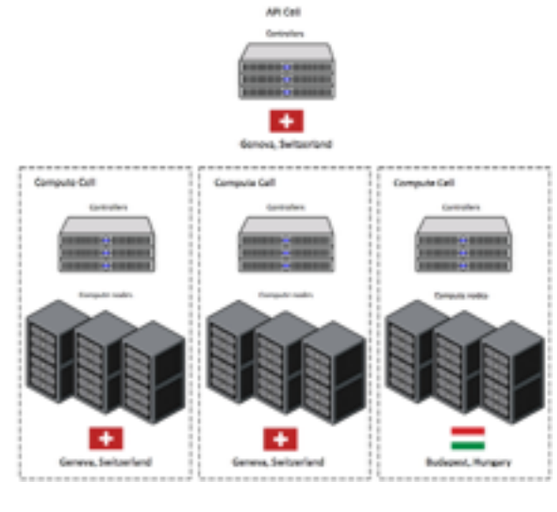
- Validation of the LUC model
  (on-going work with RENATER, the French NREN)
  - From energy/efficiency/economical point of views
  - On a brick basis (100 VMs) and by considering the cost of the network.
- An academic POC for validating the feasibility of major blocks (scheduling of VMs, migration between distinct sites…)
  - Two PhDs, Two PostDocs
  - Managing 10K VMs on top of Grid'5000 like normal processes on a laptop.
- A POC is nice but can we push this idea further ?
  - Making a complete system is a huge/non sense effort for researchers
    ⇒ Revisit OpenStack (on-going/promising work, started 9 months ago)

Revisiting OpenStack (on-going)

- Few proposals to federate/operate distinct OpenStack DCs
  - Leveraging Galera
    ⇒ Scalability issues



  - Hierarchical approaches
    - Cells based (CERN: 3 Sites / 50K cores)
      ⇒ the top cell is a central point

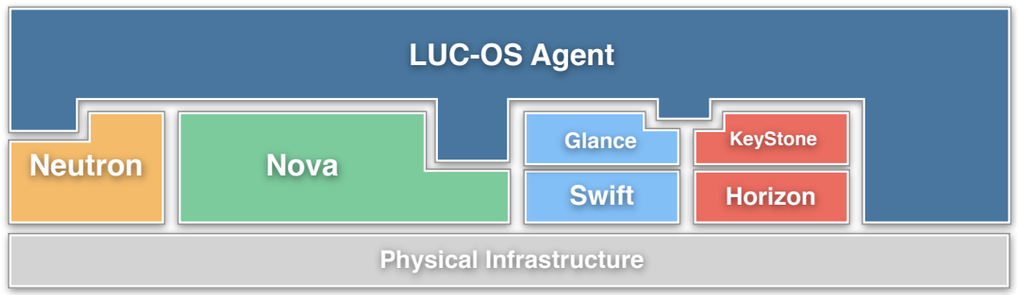


    - Cascading OpenStack (Huawei, Oct 2014 summit)
      A more advanced CELLS like approach (nova, neutron,…)
      ⇒ a unique cascading OpenStack,
      build on top of the OpenStack API (a system of systems)

- You know others ! ? please mail us.
  We try to maintain a dedicated webpage

Revisiting OpenStack (on-going)

- Our target is to deliver a multi-agent architecture composed of several OpenStack that can natively cooperate (i.e. without specific or priority elements)



- Some components should require only minor changes / extensions to fit the Discovery's requirements (Swift, CephFS).
- Others, which have been built on top of centralised components (such as SQL DBs) must be revisited
- Identify centralized architecture issues (almost done for Nova, Neutron, Cinder/Glance and Keystone) and propose appropriate mechanisms to distribute them
- A Nova POC soon (Nova + REDIS, validation is on-going)