

# Beyond the Clouds, The Discovery Initiative



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

*Inria*

Adrien Lebre

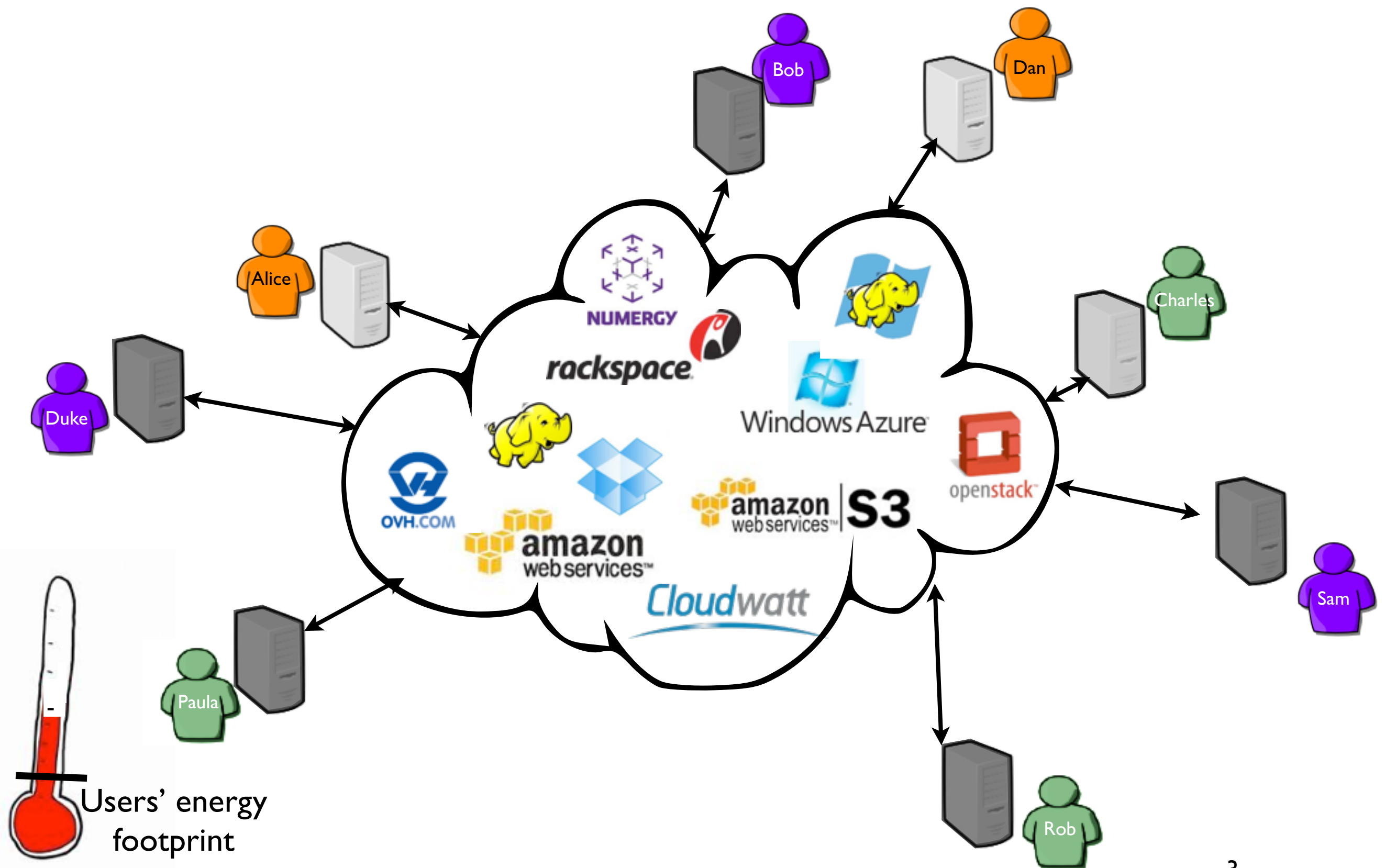
March, 2015 - RENATER - GEANT Association

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

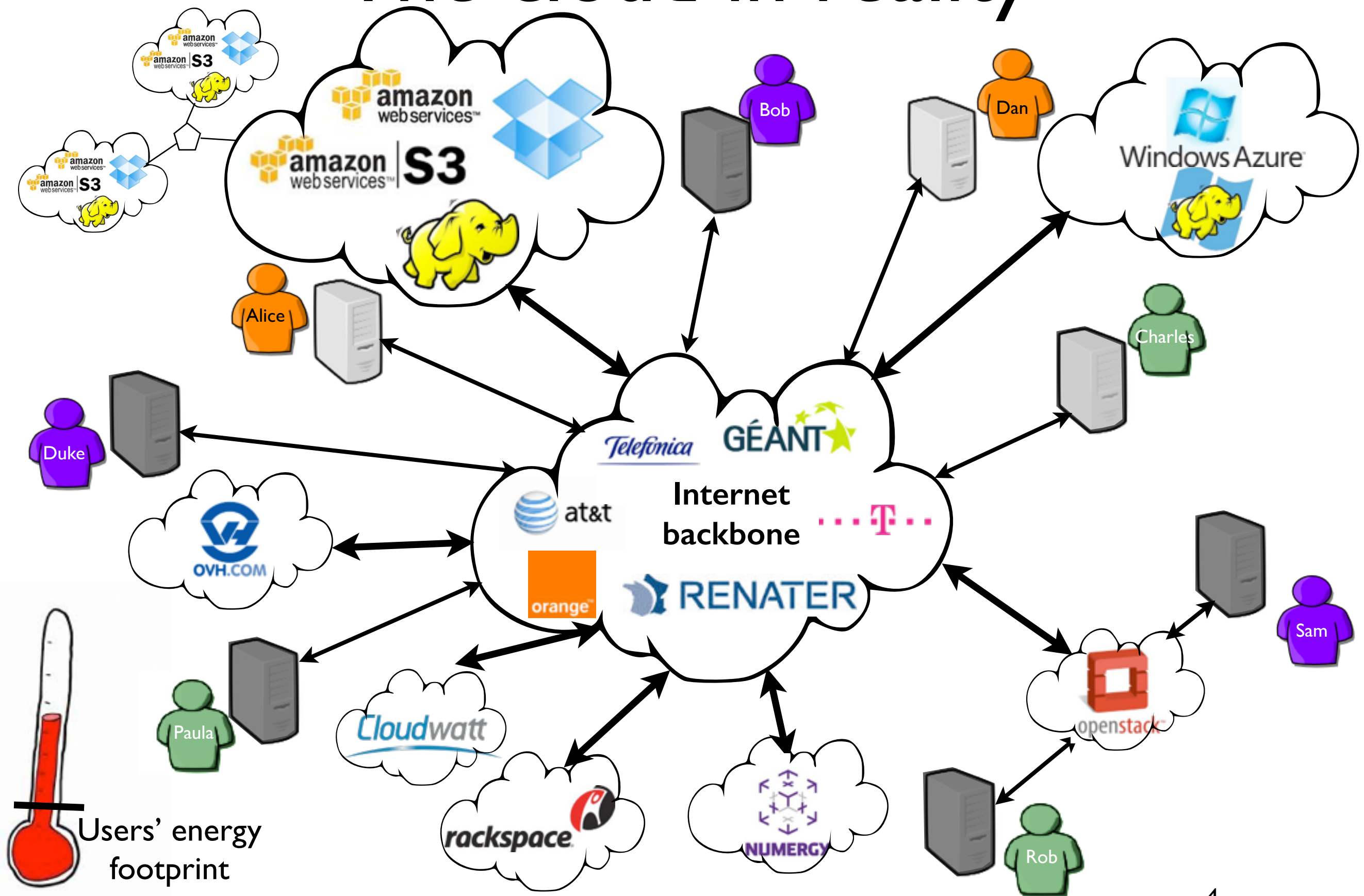
*A simple Idea*

**Bring Clouds back to the cloud**

# The cloud from end-users

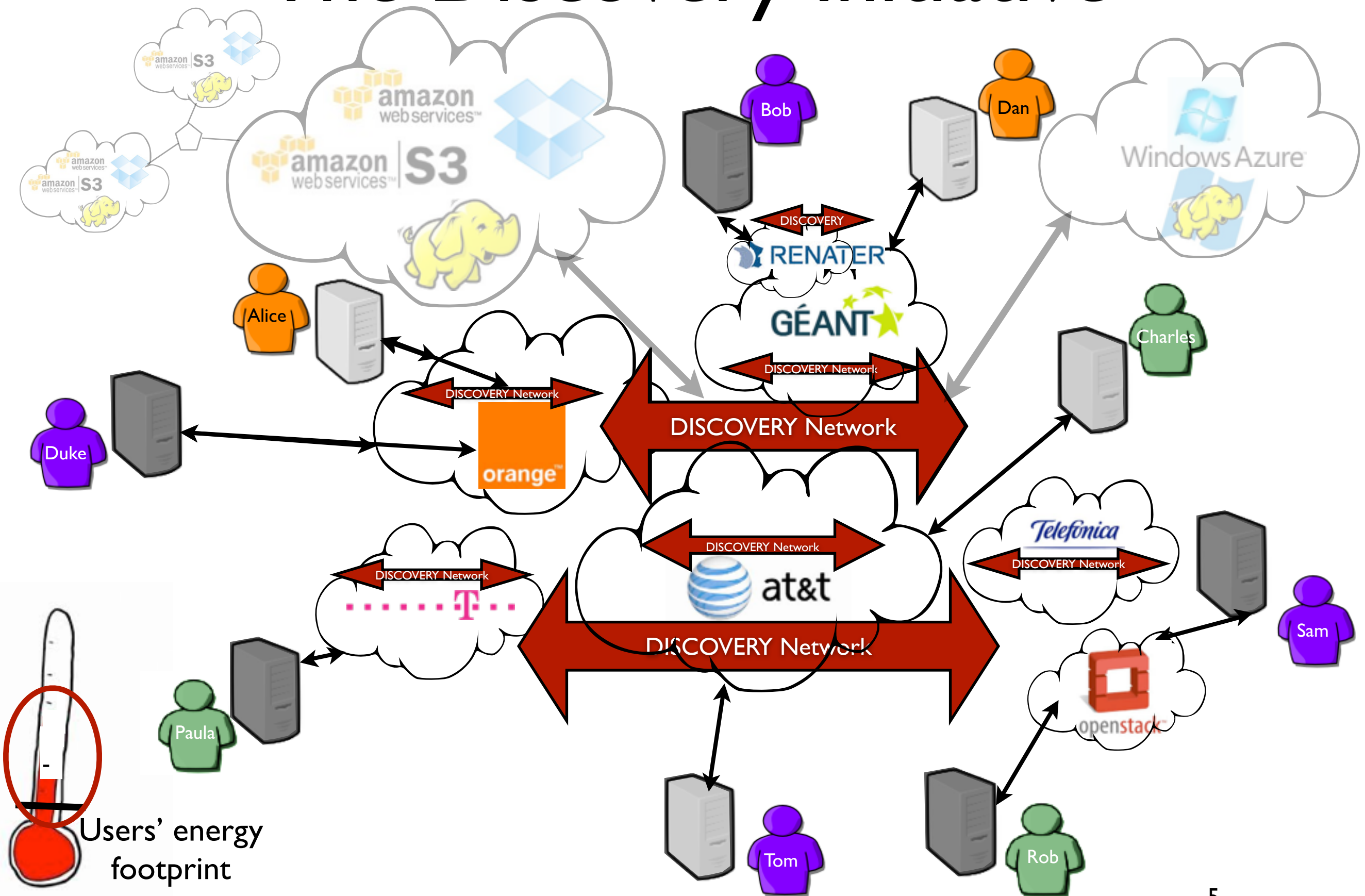


# The cloud in reality





# The Discovery Initiative



*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: [datacenterintelligence.com](https://datacenterintelligence.com), <https://www.google.com/maps/@47.5988889,-122.2188889,15z> Quincy, WA state



# Inherent limitations of current solutions

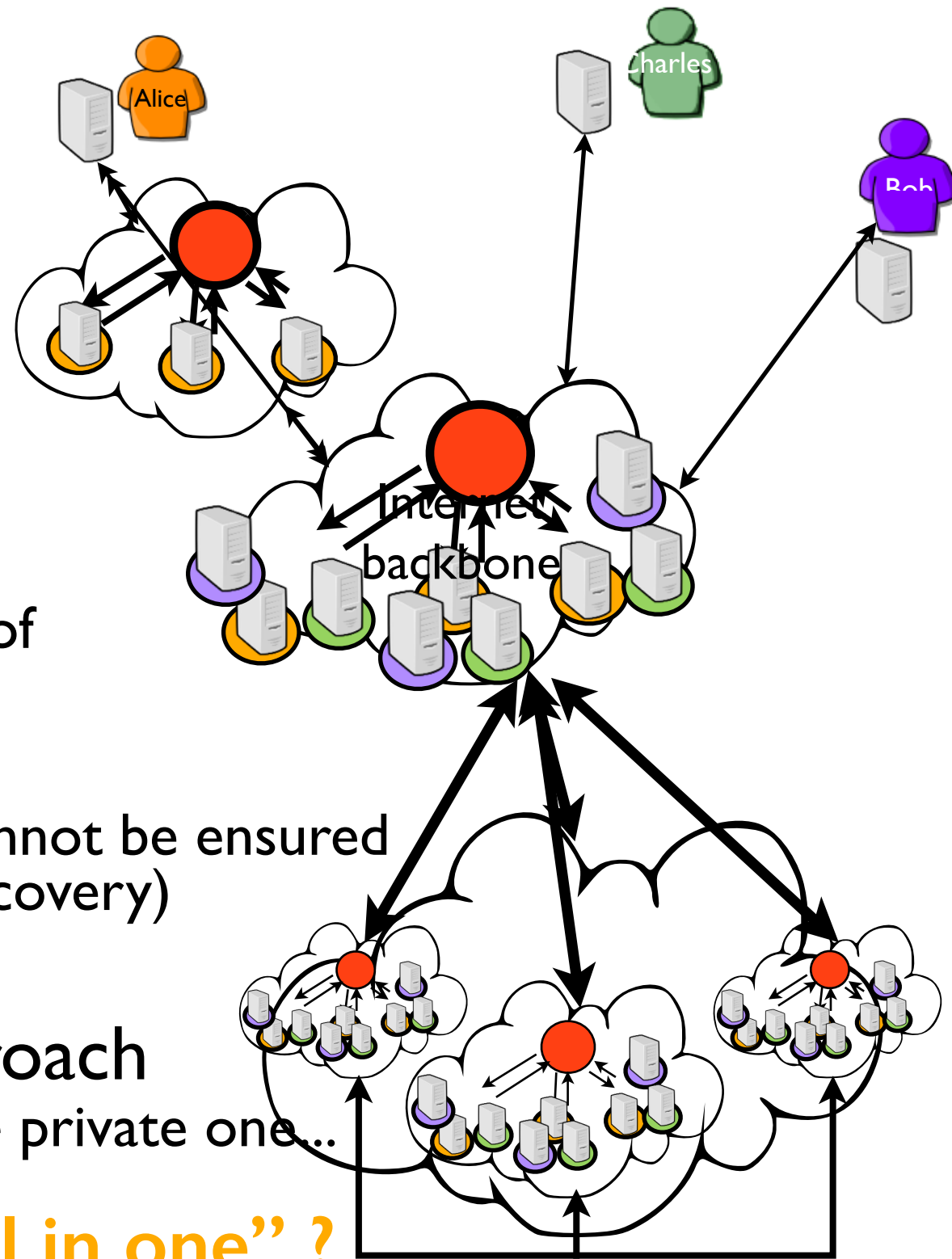
- **Large off shore DCs** to cope with the increasing UC demand while handling energy concerns but...

1. Externalization of private applications/data (jurisdiction concerns, PRISM NSA scandal, Patriot Act)

2. Overhead implied by the unavoidable use of the Internet to reach distant platforms

3. The connectivity to the application/data cannot be ensured by centralized dedicated centers (disaster recovery)

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



**Can we address these concerns “all in one” ?**

**$\mu/n$ DC concept**



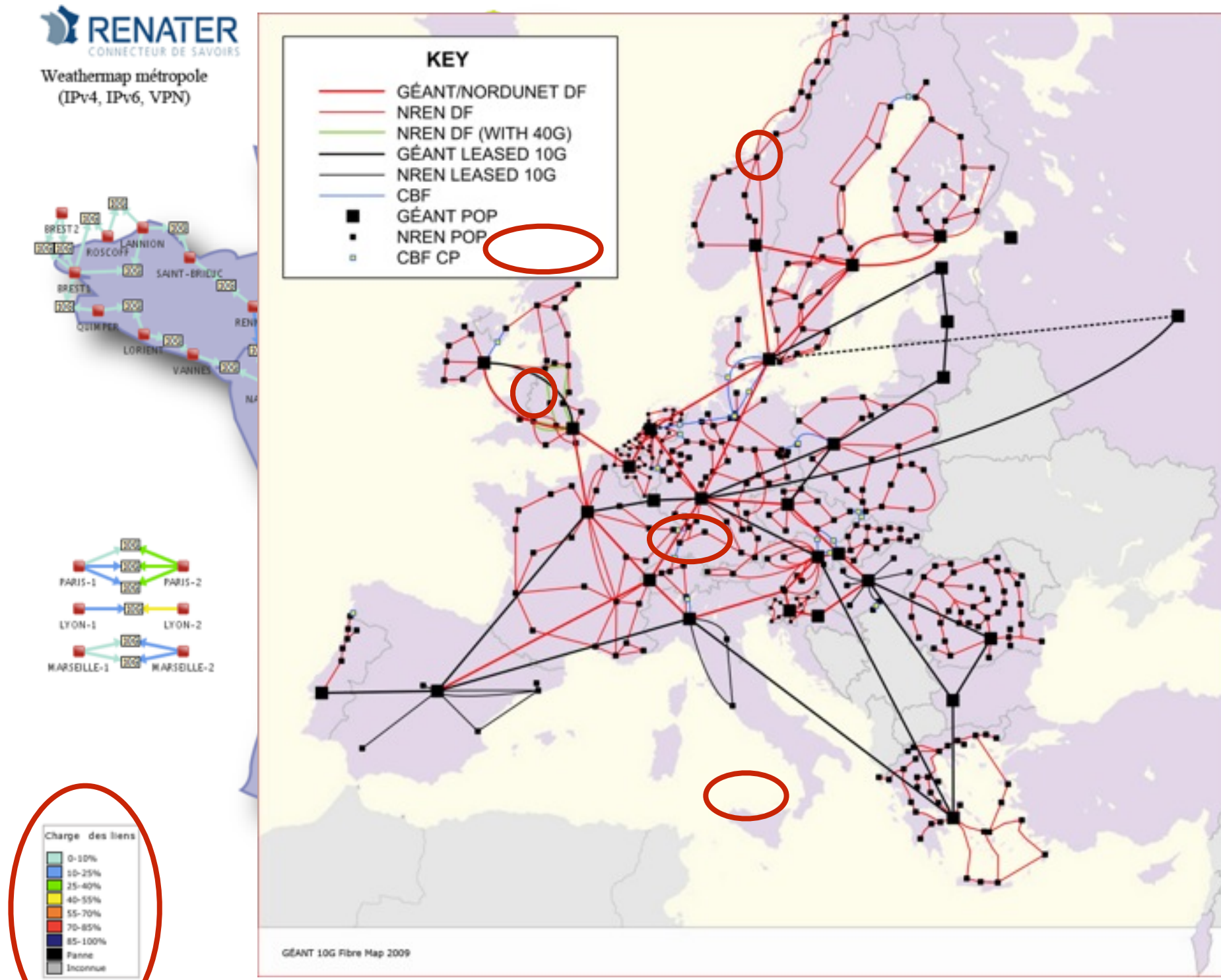
*How and where the  $\mu$ DC concept can be deployed ?*

# 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.



[er.fr/raccourci?lang=fr](http://er.fr/raccourci?lang=fr)

# Beyond the Cloud, the DISCOVERY Initiative

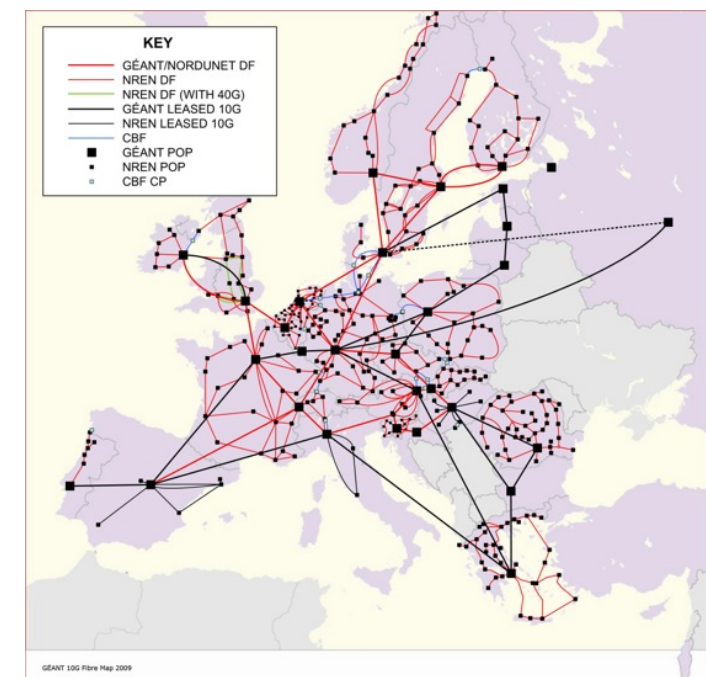
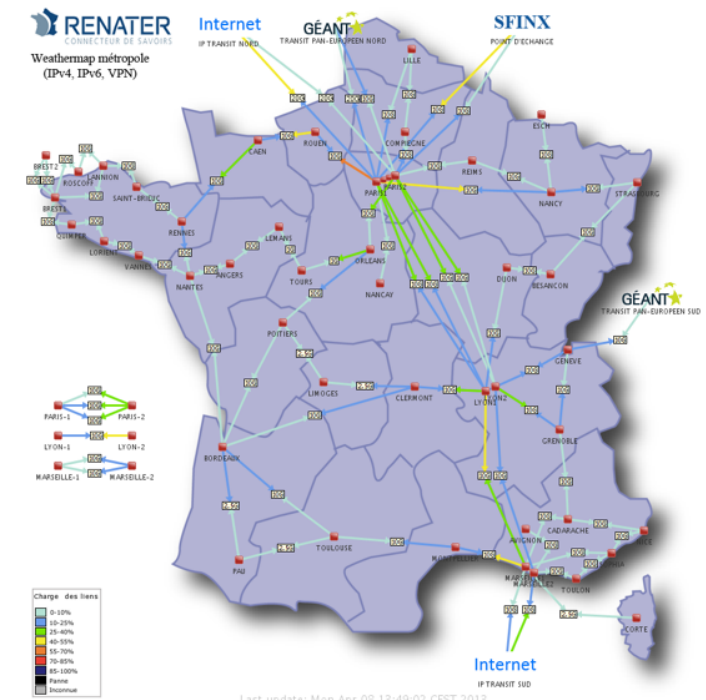
- Locality-based UC infrastructures

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

- 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).

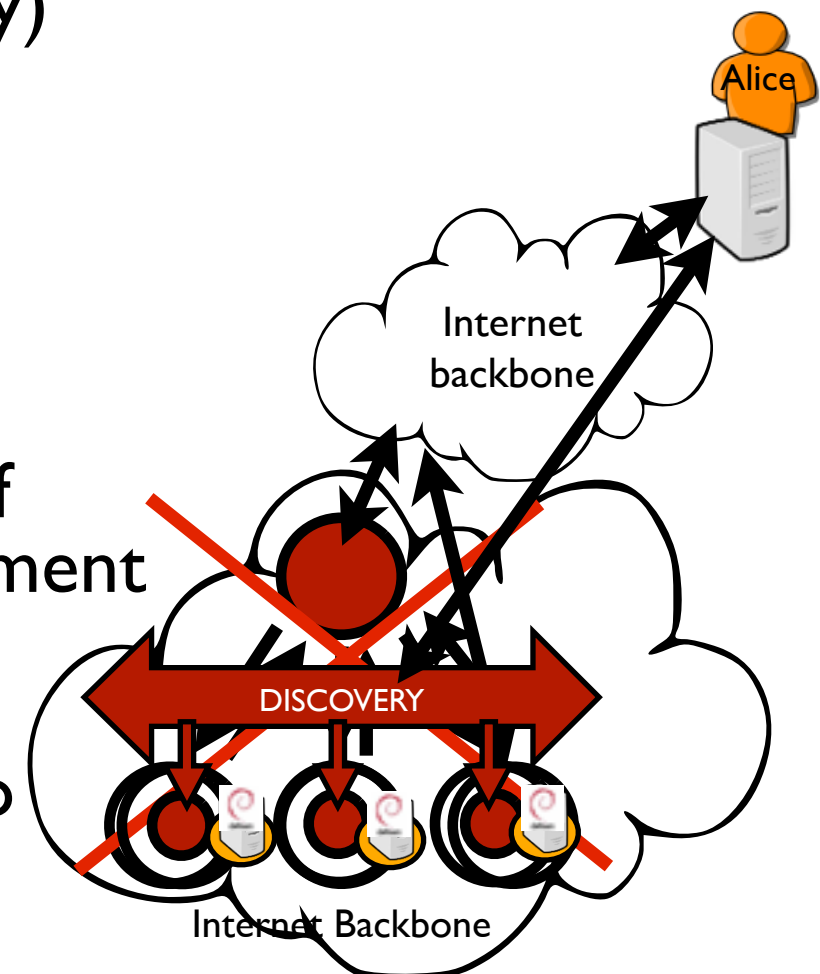
⇒ Operating such widely distributed resources requires the definition of a fully distributed system



# The DISCOVERY Proposal

- DIStributed and COoperative framework to manage Virtual EnviRonments autonomously
- The 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),  
so 1000 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/>

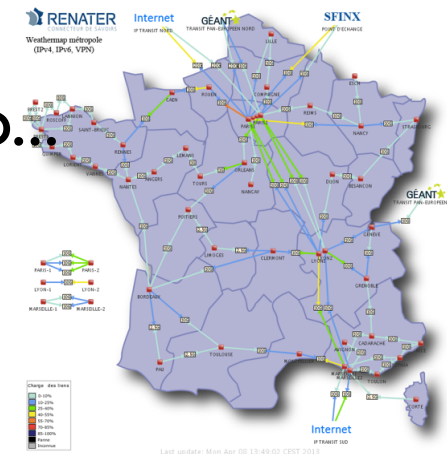


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# Beyond Discovery !

- 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...)

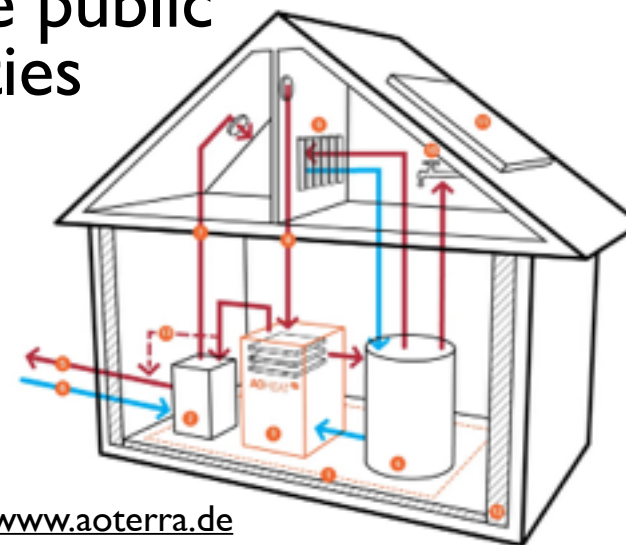
Transfer the green micro/nano DCs concept to the network PoP  
Take the advantage of the geographical distribution



<http://parasol.cs.rutgers.edu>

- 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



<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				<b>236,7</b>	<b>452,7</b>	5400
Shelter	198	0,2		39,6	39,6	
Overall with shelters				<b>276,3</b>	<b>492,3</b>	

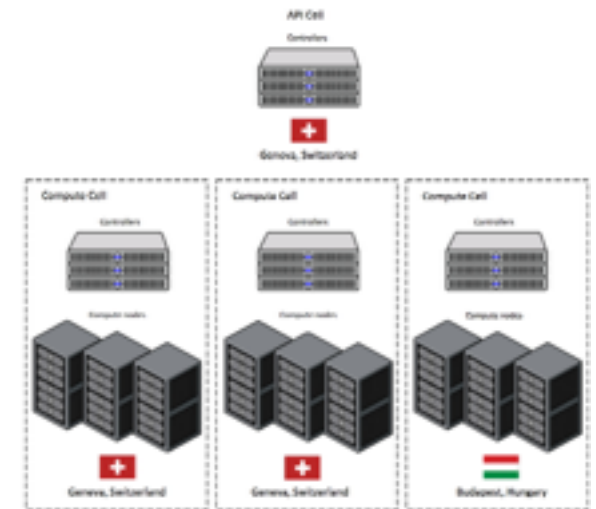
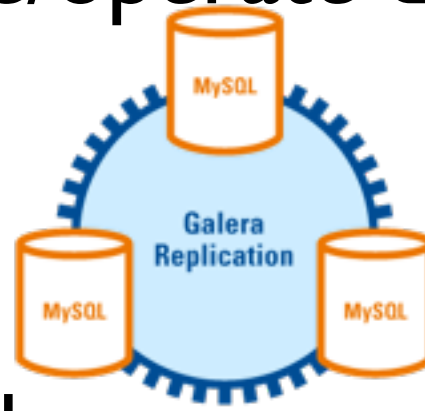
# Where We Are

- 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)



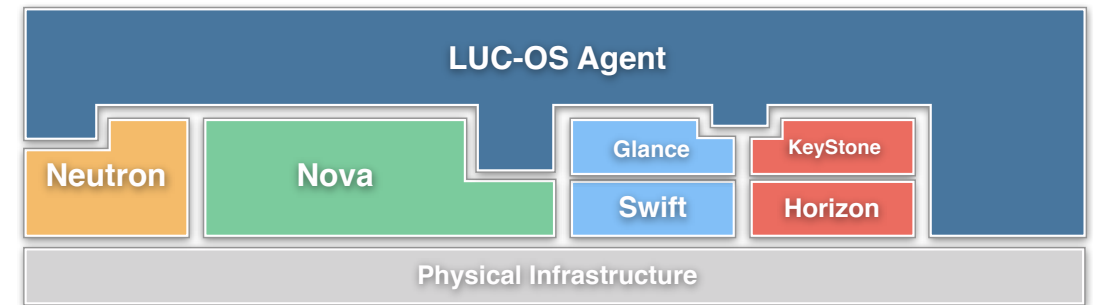
# Revisiting OpenStack (on-going)

- 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)