# Towards Incentive-based Resource Assignment and Regulation in *Clouds for Community Networks*

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# Community Networks

Sharing collective to build up ICT infrastructure for local communities

Members share **bandwidth**
And their time and effort

Mobile Ad-Hoc Networks
Mesh Networks
Wi-Fi Hostspots
Bottom-up Broadband

***Community Networks***

freifunk.net

guifi·net

FUNKFEUER FREE NET

AWMN

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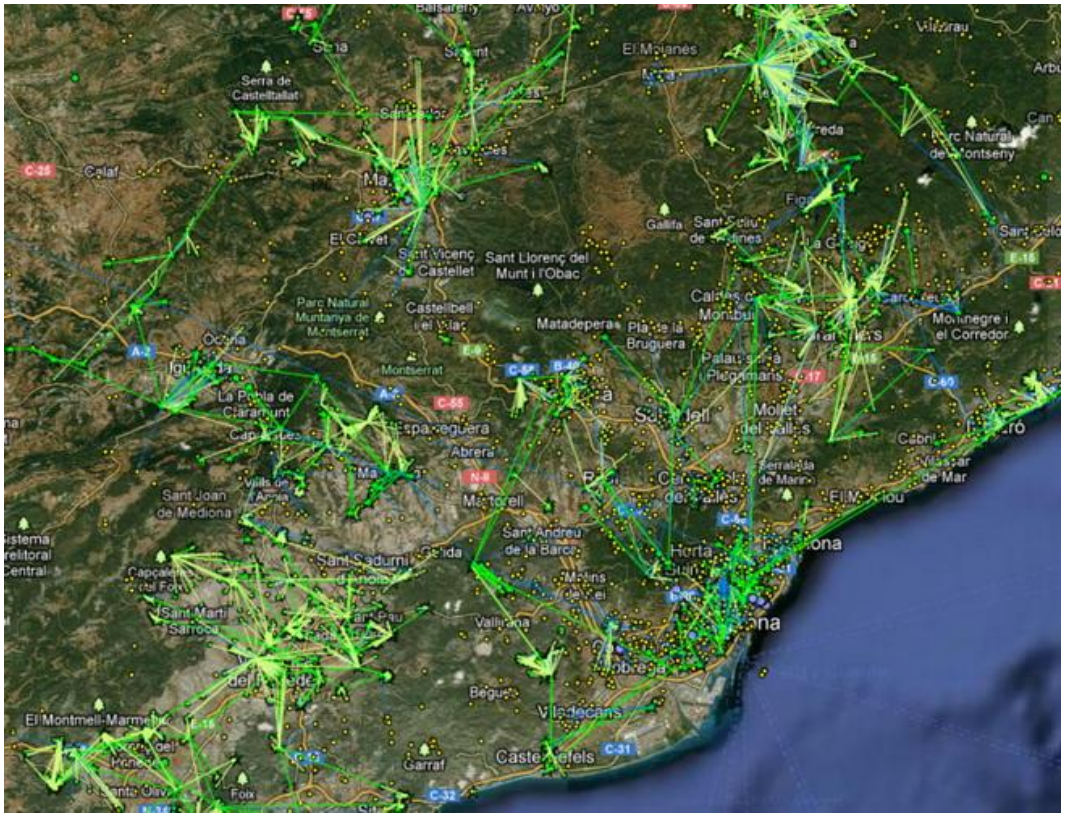
# guifi·net





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# For People, By People

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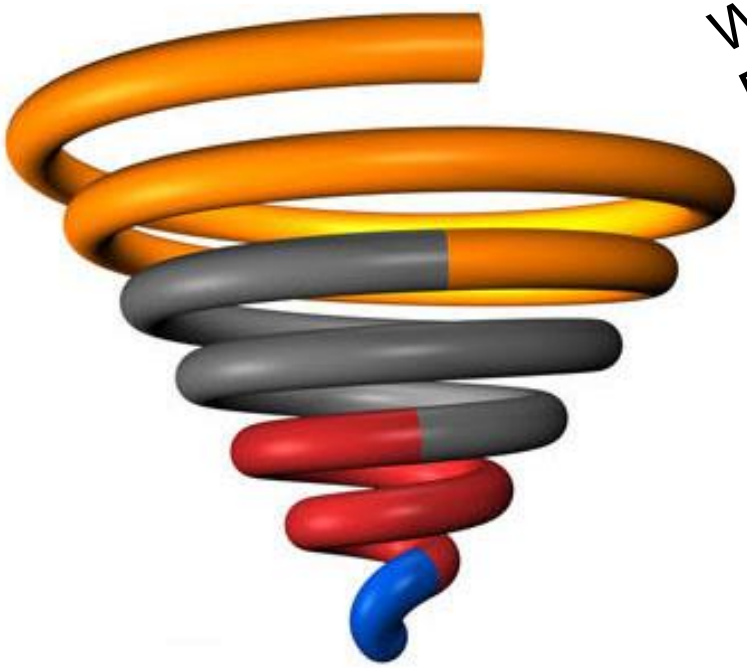
# Can we extend this sharing?

Voluntary Computing
P2P Distributed Storage
Computational Grids
Cycle Sharing
Cloud Computing

Folding@home



Community Networks
Wireless Mesh Networks
Bottom-up Broadband
Social Networks

**Community Cloud**

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# There is a war coming.

Vs

# Are you sure you're on the right side?

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# Data Centres Vs Community Cloud

Is this David vs Goliath?

So you going to replace YouTube?

Seriously. You out of your mind?






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# Data Centres **Vs** Community Cloud

Is this David vs Goliath?

So you going to replace YouTube?

Seriously. You out of your mind?

**No, but …**

More like David meets Goliath!

Augment. Complement. Innovate.

Existing Cloud models and services






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# Our Contributions

**Identify**

Hardware & Configurations

**Realize**

Cloud Scenarios

**Model**

Socio-Economic Context

**Evaluate**

Simulation Experiments
Prototype

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# Hardware in Community Cloud


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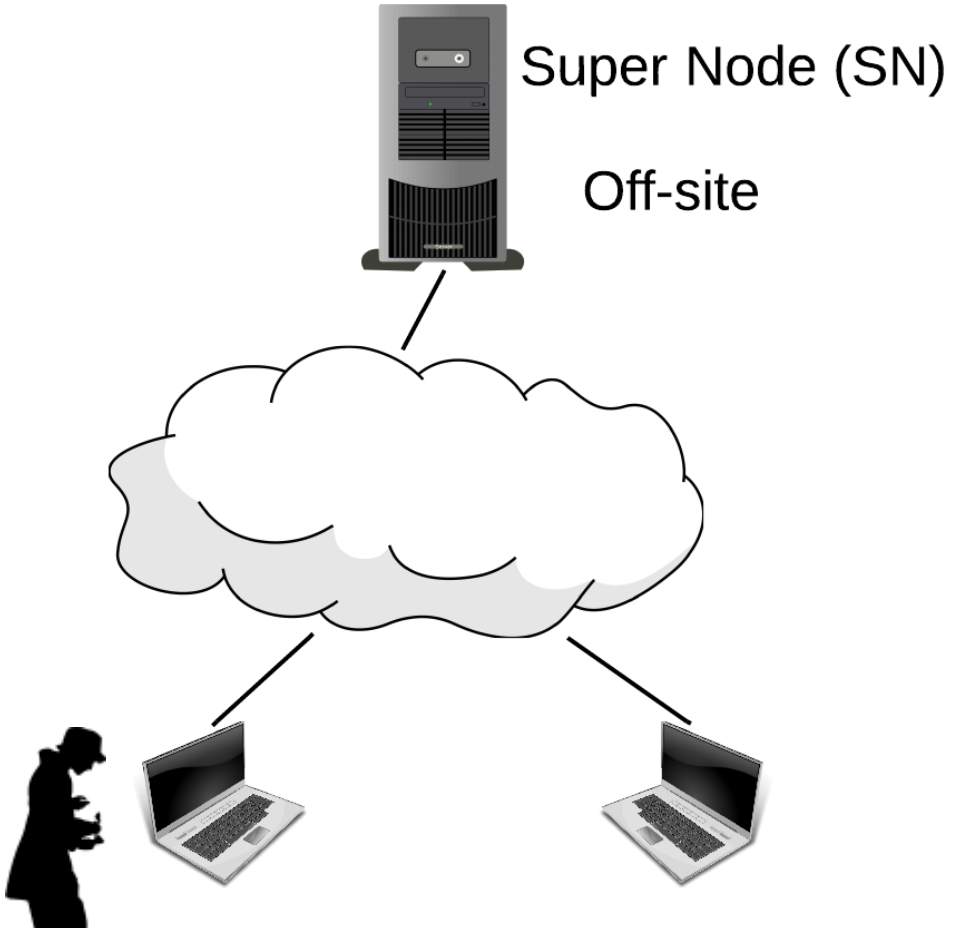
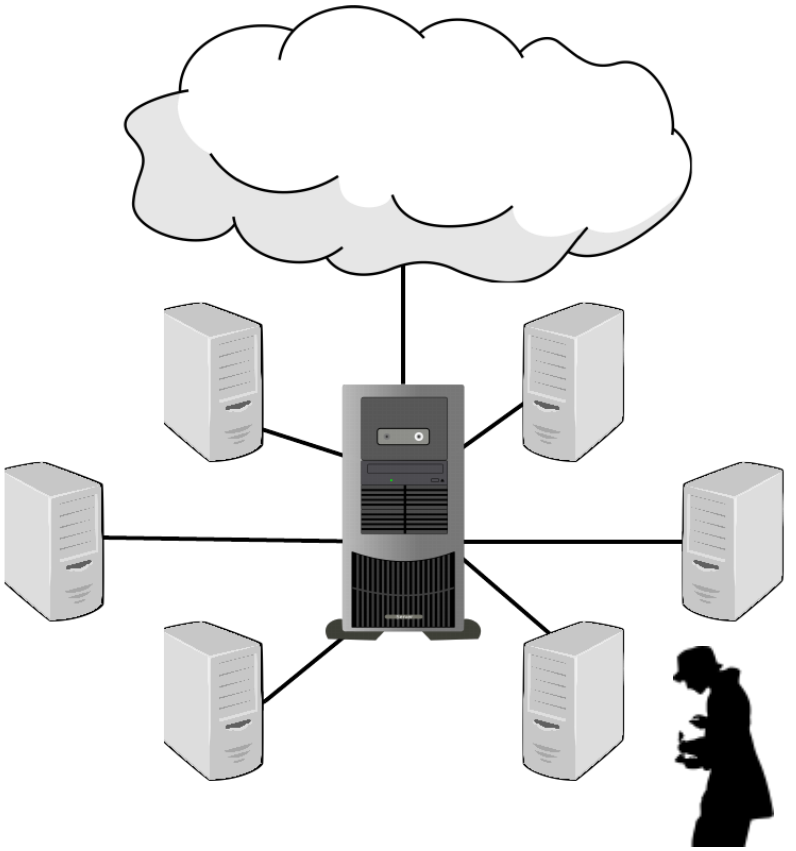
# How to Setup Your Cloud?



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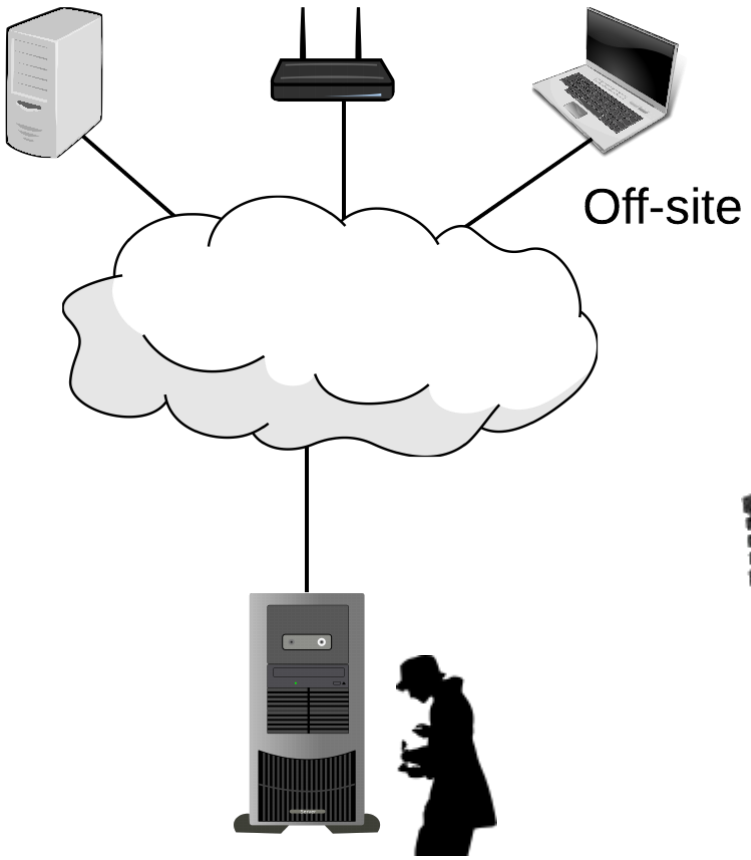
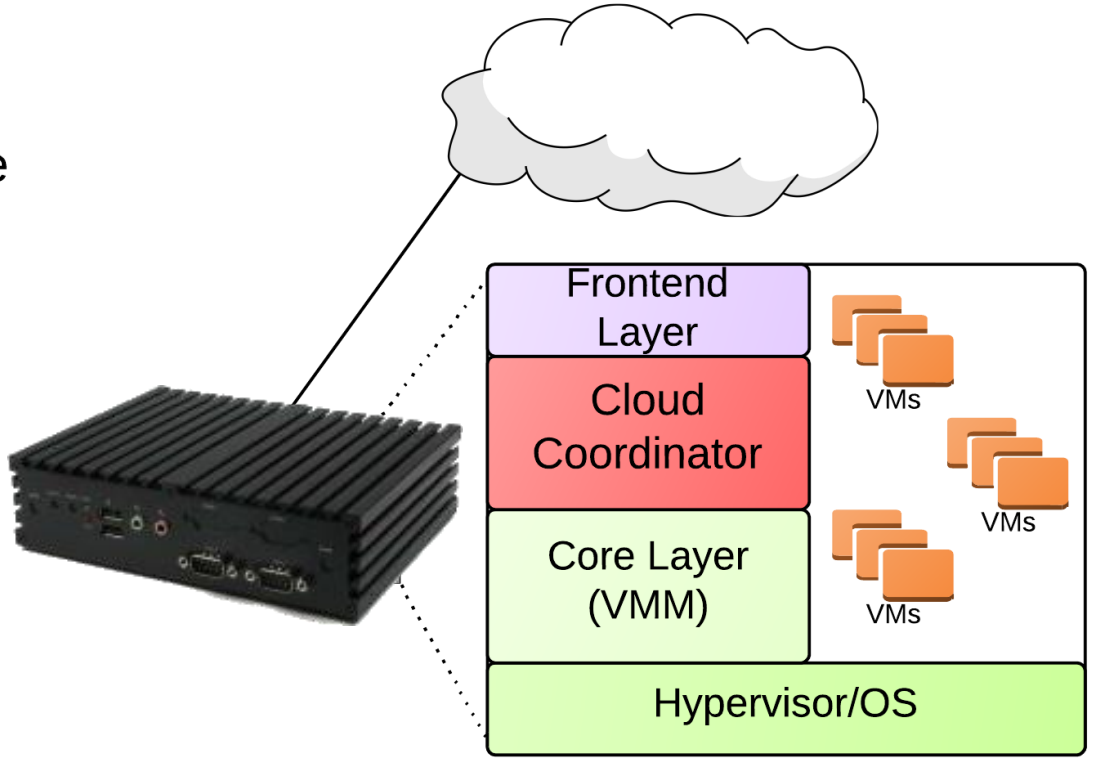
# And Cloud-in-a-Box?

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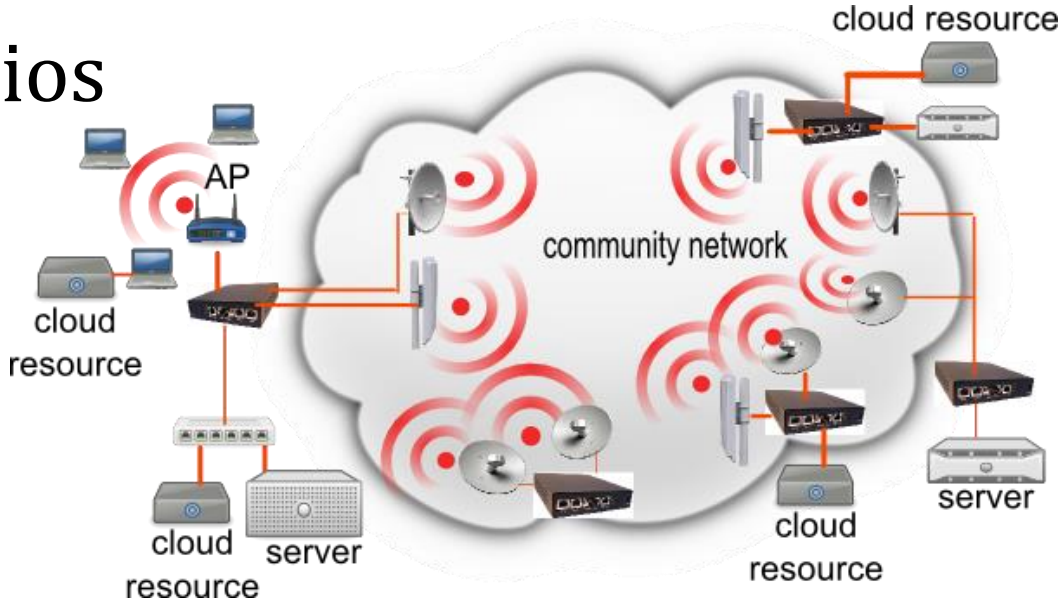
# Zones in Community Networks

More a Socio-Economic Construct than Technical

Detailed Support and Coordination between Zones

Super and Ordinary Nodes in Zones

Community Cloud Scenarios

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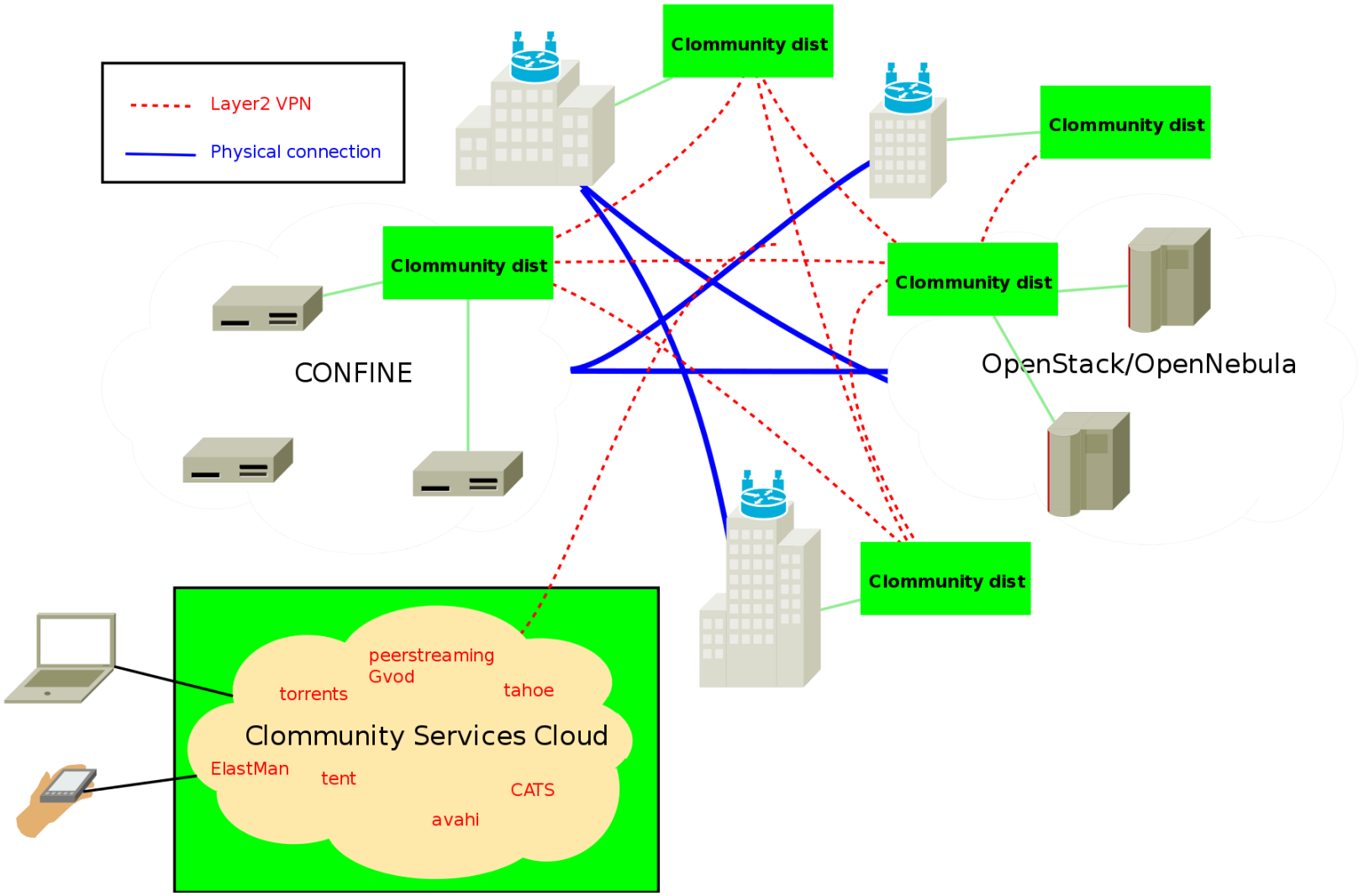
# Local Community Cloud

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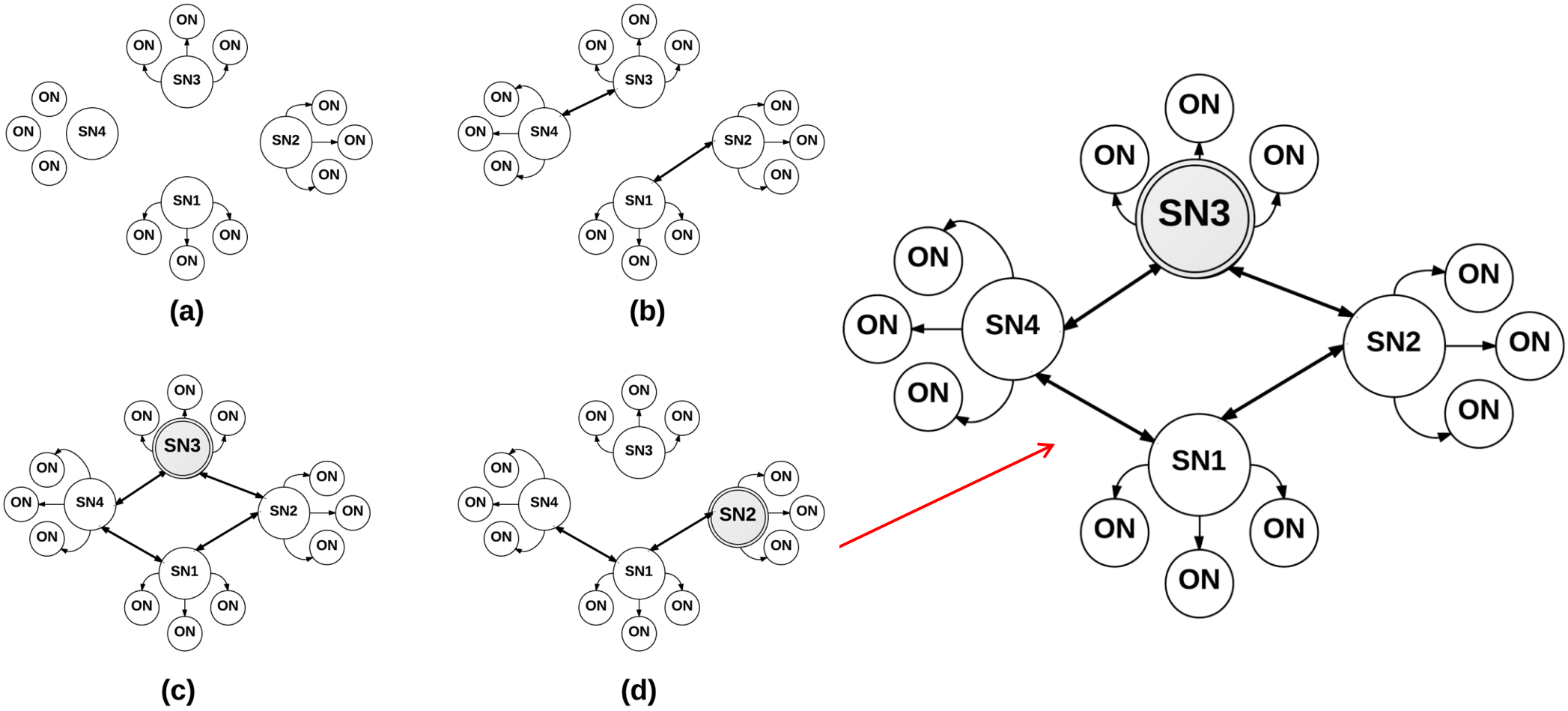
# Federated Community Clouds

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# How this all fits in?

Community Cloud Manager

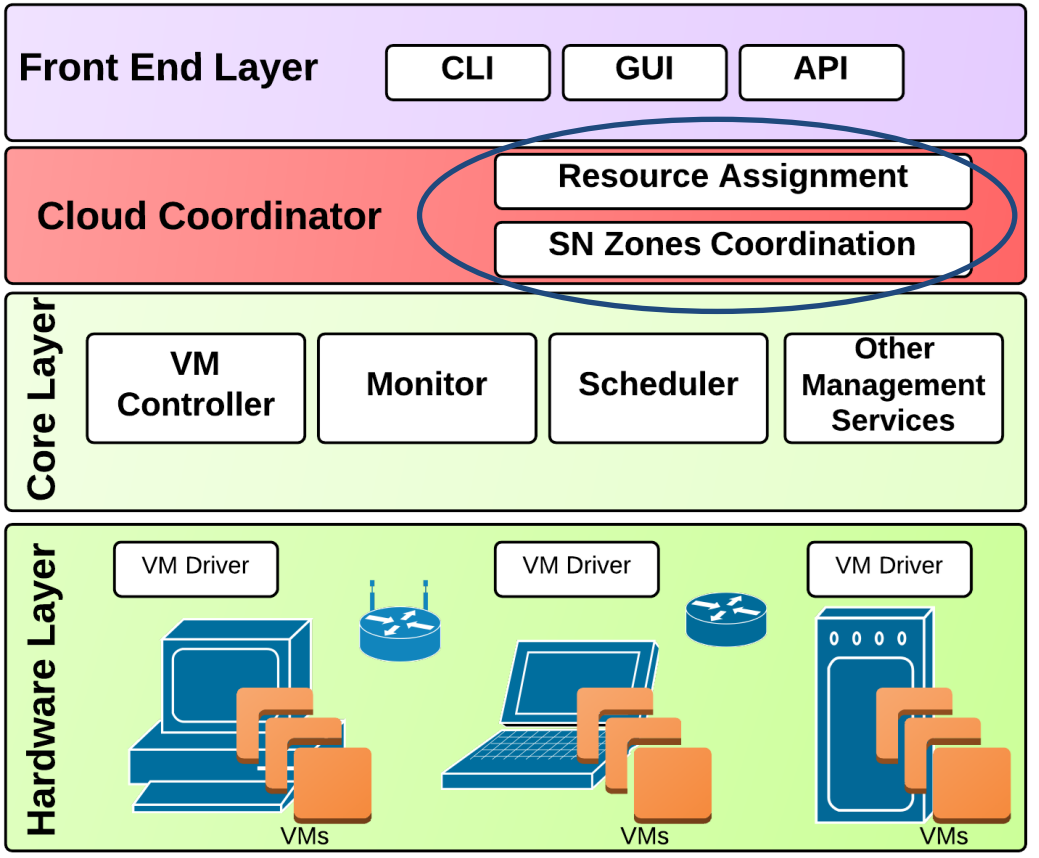
By extending

OpenNebula.org

The Open Source Toolkit for Cloud Computing

Resource Regulation components

Incentive Mechanisms

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# Reciprocity Based Incentives

| Capacity | Variability | Heterogeneity |
| --- | --- | --- |
| Contribution-Based | | Effort-Based |
| You get what you pay! | | *Parecon* Principle |
| Biased toward nodes with higher capacity | | Give everyone equal chance to participate |
| Fairness? | | No matter what their capacity |

*In effort-based, weigh in users' capacity in addition to their contribution*

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# Policies for Selecting Providers

Prioritizing the nodes that need credit the most

One with the lowest credit?

But does it really need credit?

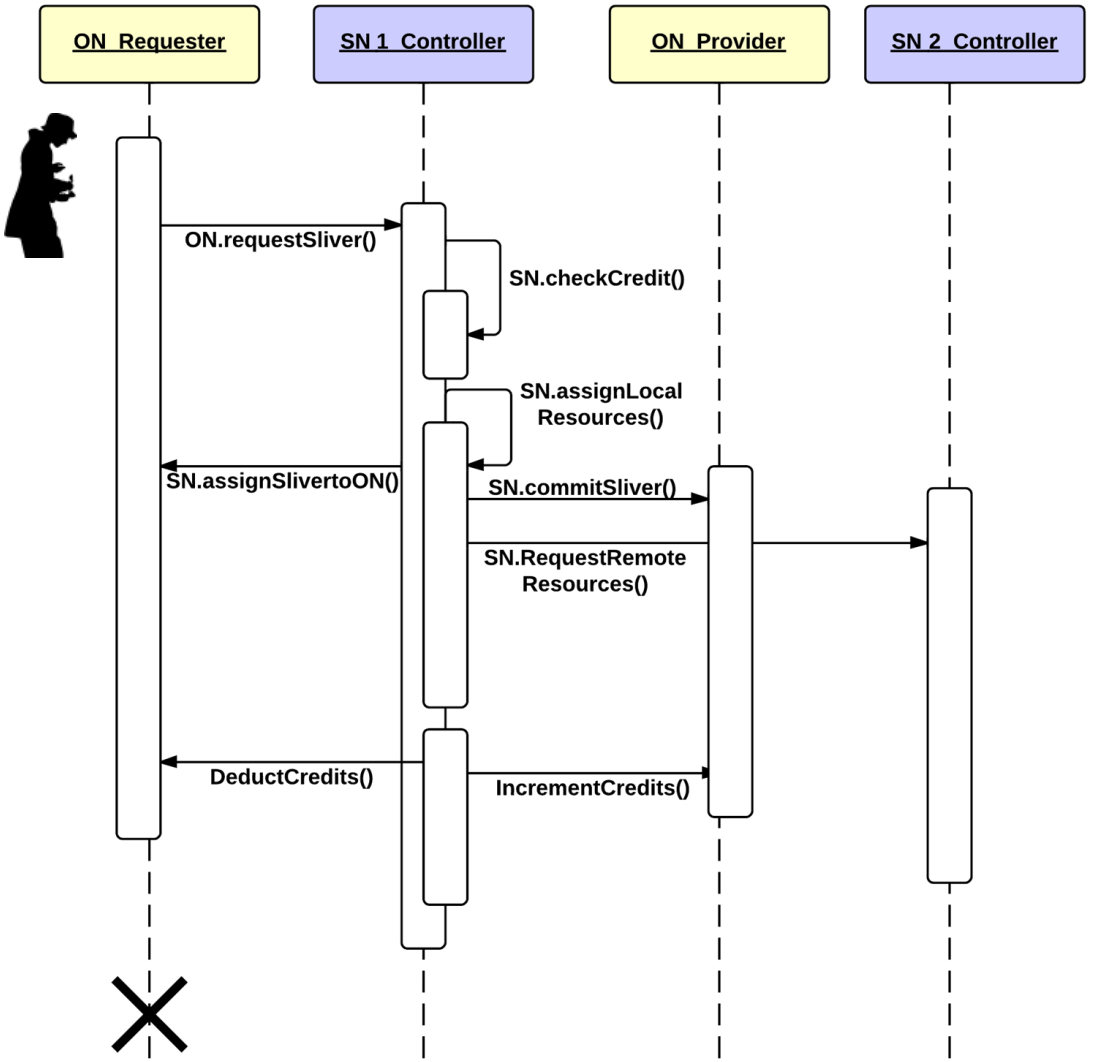
Has it made any requests recently?

Consider credit level and number of failed attempts

Ensuring participation by everyone

# Algorithm for Allocating Resources

- Nodes request resources
- SN checks node's credit
- Resources available in local zone
- If not, request resources from other zones
- Allocate resources
- Assign credits

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# Experimental Setup

Federated Community Cloud with 100 zones

Nodes with different capacity and sharing behavior

Initialize Credits and Periodic Resource Requests

**Table 1.** Configuration for each node in a zone with shared and total instances

| Node Behaviour | Shared | Small capacity | Medium capacity | Large capacity |
|---|---|---|---|---|
| Selfish | 33% | ON1 (1/3) | ON2 (2/6) | ON3 (3/9) |
| Normal | 66% | ON4 (2/3) | ON5 (4/6) | ON6 (6/9) |
| Altruistic | 100% | ON7 (3/3) | ON8 (6/6) | ON9 (9/9) |

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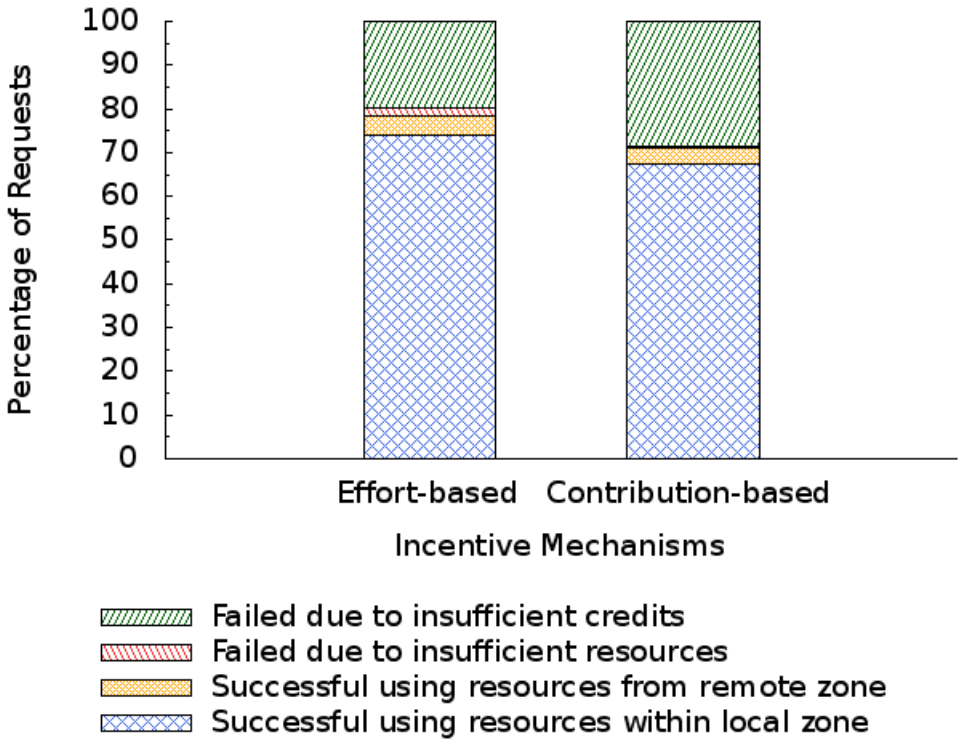
# Requests and Success Ratio

Requests fail because of lack of credit

Or lack of available resources

Few requests met from remote zones

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# Outcome of Requests and Incentives

Success ratio is better with Effort-based Incentives for varying capacity

**Table 2.** Success ration of nodes for different configurations with effort and contribution based incentives

| Node Behaviour | Incentives | Small capacity | Medium capacity | Large capacity |
|---|---|---|---|---|
| Selfish | effort-based | 54% | 53% | 50% |
| | contribution-based | 66% | 59% | 39% |
| Normal | effort-based | 90% | 91% | 86% |
| | contribution-based | 97% | 77% | 66% |
| Altruistic | effort-based | 97% | 94% | 86% |
| | contribution-based | 97% | 85% | 65% |

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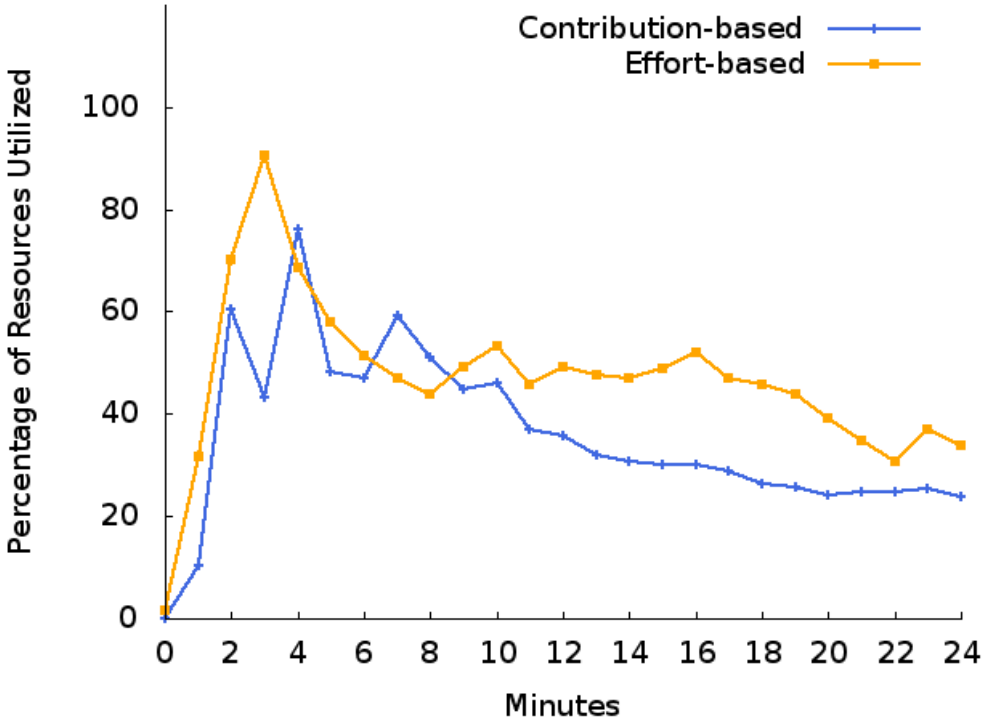
# Resource Utilization

Higher utilization is desirable

Utilization affected by dry up of credit

Effort-based Incentives outperform contribution-based

What if credit wasn't limited?

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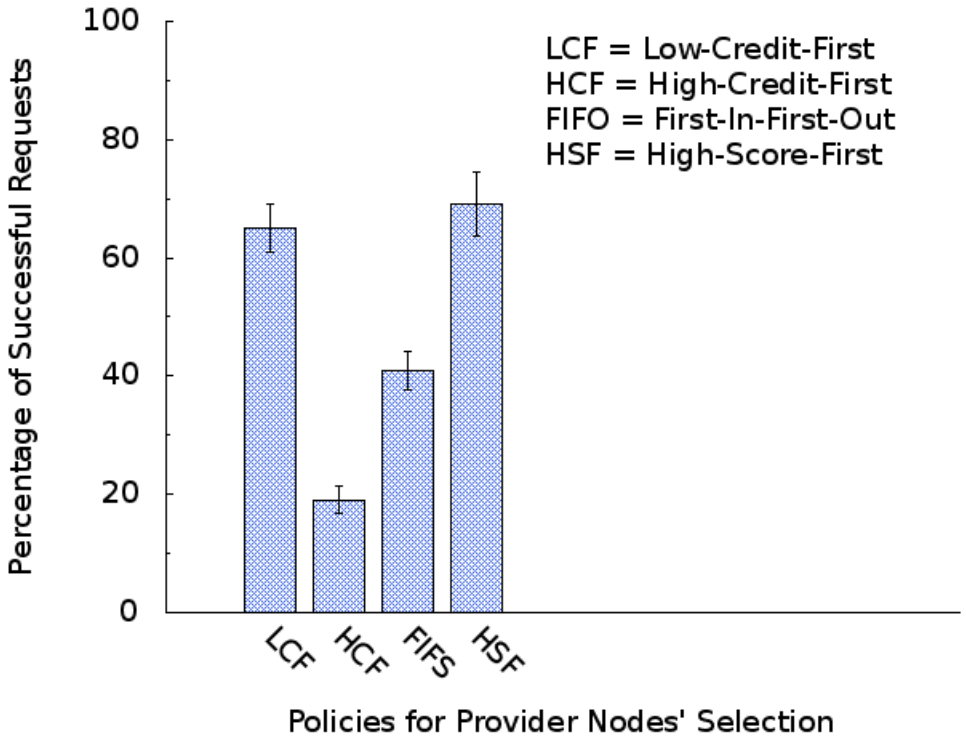
# Providers Selection Policies

Picking the most needy?

Or let rich get richer

First in queue

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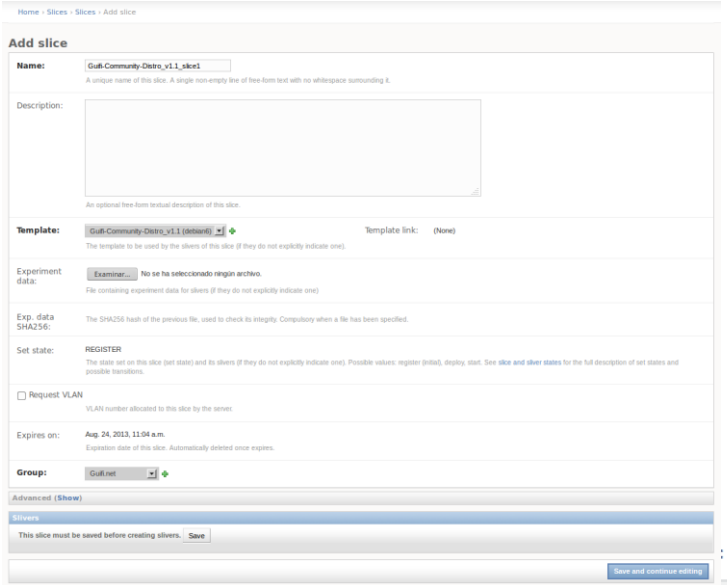
# Outlook: Prototype




| | | | | | |
|---|---|---|---|---|---|
| VicBarriOsonaNord-ST | radio | 10.138.4.65/27 | Working | Up (92.49%) | RouterOSv5.x |
| VicBarriOsonaServer | server | 10.138.4.66/27 | Working | Up (24.67%) | |
| VicBarriOsonaGnrc1 | generic | 10.138.4.74/27 | Working | Down (0.00%) | |
| VicBarriOsonaConfine | confine | 10.138.4.67/27 | Working | Down (0.30%) | |

**Add a new device:**

Wireless device, like a router, bridge, AP... | add

- Wireless device, like a router, bridge, AP...
- Voip handset, telephone
- Server computer
- Firewall, private Network behind a NAT
- ADSL router or device providing internet access
- Network camera. Live view.
- Any device that uses a public IP (PC, game console, laptop, pda..)
- Node Confine/Clommunity

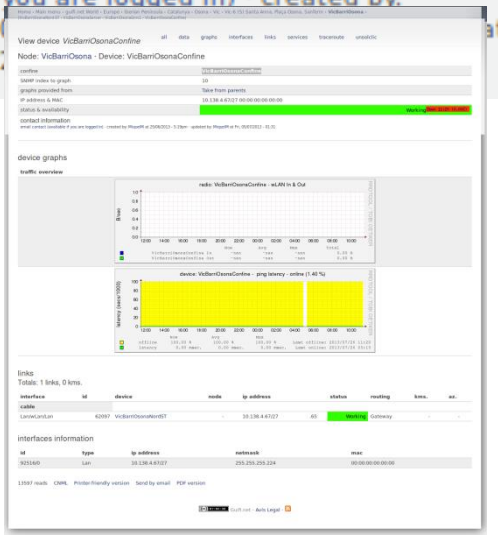
| | | status | kms. | az. |
|---|---|---|---|---|
| **VicBarriOsonaNord-ST - VicBarriOsonaNord-ST-1** | | | | |
| 11185-VicSeminari (VicSeminariST/VicSeminariVicBojons) | 172.25.10.145/172.25.10.146 | Working Up (99.82%) | 2.367 | 354-N |

Total: 2.367 kms.

| | | |
|---|---|---|
| node | 1655 VicBarriOsona | **VicBarriOsona** |
| zone | Vic-6 (S) Santa Anna, Plaça Osona, Sanferm | Antic Camí a Taradell, 26 |
| position (lat/lon) | Lat:41.915561 Lon:2.260303 | 15 meters above the ground |
| available for mesh & status | Yes | Working |
| graphs provided from | Take from parents | |

## contact information

email contact (available if you are logged in) · created by: MiquelM at 30/11/1999 - 1:
by: MiquelM at Mon, 22/10/

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# What Next?

Deeper analysis with larger systems for extended periods with more parameters

Impact of Selfish and Malicious Behavior

Adaptive Model with Continuous Feedback

Prototype System and Communication Middleware

Network-aware Services

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# Conclusion

Identified scenarios from characteristics of CNs

Considered Socio-Economic mechanisms in architecture, and evaluated incentives in simulation

Community Clouds will be open, free and neutral

Promoting CNs as ICT infrastructure of choice

But Economic Incentives and Social Motivation pivotal for adoption, viability, and scalability

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# Clommunity
# A Community networking Cloud in a box

## Thank you

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# Resource Costs

$$transaction\_cost = \gamma R_i \times \rho T_i$$

$$\Omega = \sum_{i}^{all \quad nodes} \omega_i$$

$$\Delta R_i = E_i \times (\Omega - \omega_i)$$

$$E_i = \begin{cases} \frac{credit_i}{\epsilon C_i} & if \quad \frac{credit_i}{\epsilon C_i} < 1 \\ 1 & otherwise \end{cases}$$

$$score_i = \frac{attempts_i}{credit_i}$$

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# Algorithm for Resource Allocation

**Require:** receive query from node $i$ with the requested amount $R_i$ and the time $T_i$

1: calculate($\Delta R_i$)
2: **if** $R_i <= \Delta R_i$ **then**
3: call Decision($i$, $R_i$, $T_i$)
4: **else**
5: send("rejected", $i$)
6: **end if**
7: **function** DECISION($i$, $R_i$, $T_i$)
8: **if** $R_i <= \Omega$ **then**
9: $ProvidersList$[n] $\leftarrow$ high_score_first($ON\_List$, $R_i$)
10: **for each** j in $ProviderList$[n] **do**
11: $CostOfTransaction_{j \rightarrow i} \leftarrow R_j^r * T_j^t$
12: update_credits($CostOfTransaction_{j \rightarrow i}$)
13: update_database($ON\_List$)
14: **end for**
15: **else**
16: $SN \leftarrow$ low_credit_first($SN\_List$,$R_i$, $reserved\_ratio$)
17: forward($SN$,$i$, $R_i$, $T_i$ )
18: **end if**

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