NETCOMMONS PROJECT

RESEARCH AND EXPERIMENTATION WITH CNS

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CNs: two Themes

1 - Digital Divide

They lower the cost of the infrastructure and make it possible to operate in digital divide areas

2 - Bottom-up Networks

They offer a new and revolutionary networking model compared to traditional Telco model.

CNs Vs Digital Divide

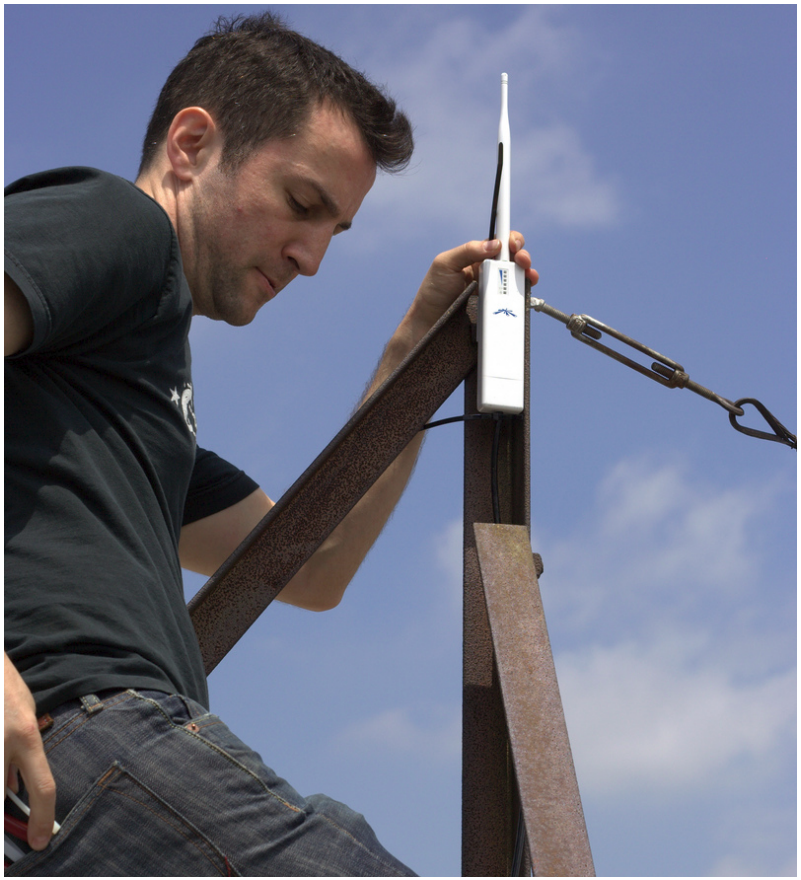
- One of the obstacles for Internet diffusion is the cost of the infrastructure.
- CNs offer a low-cost alternative to other network models, with minimal initial investment and “organic” growth.
- A CN generally start as a wireless mesh network, what does it mean?

Mesh Networks

- A mesh network is a distributed wireless network.
- Each node of the network receives, generates and also routes traffic

Mesh Nodes

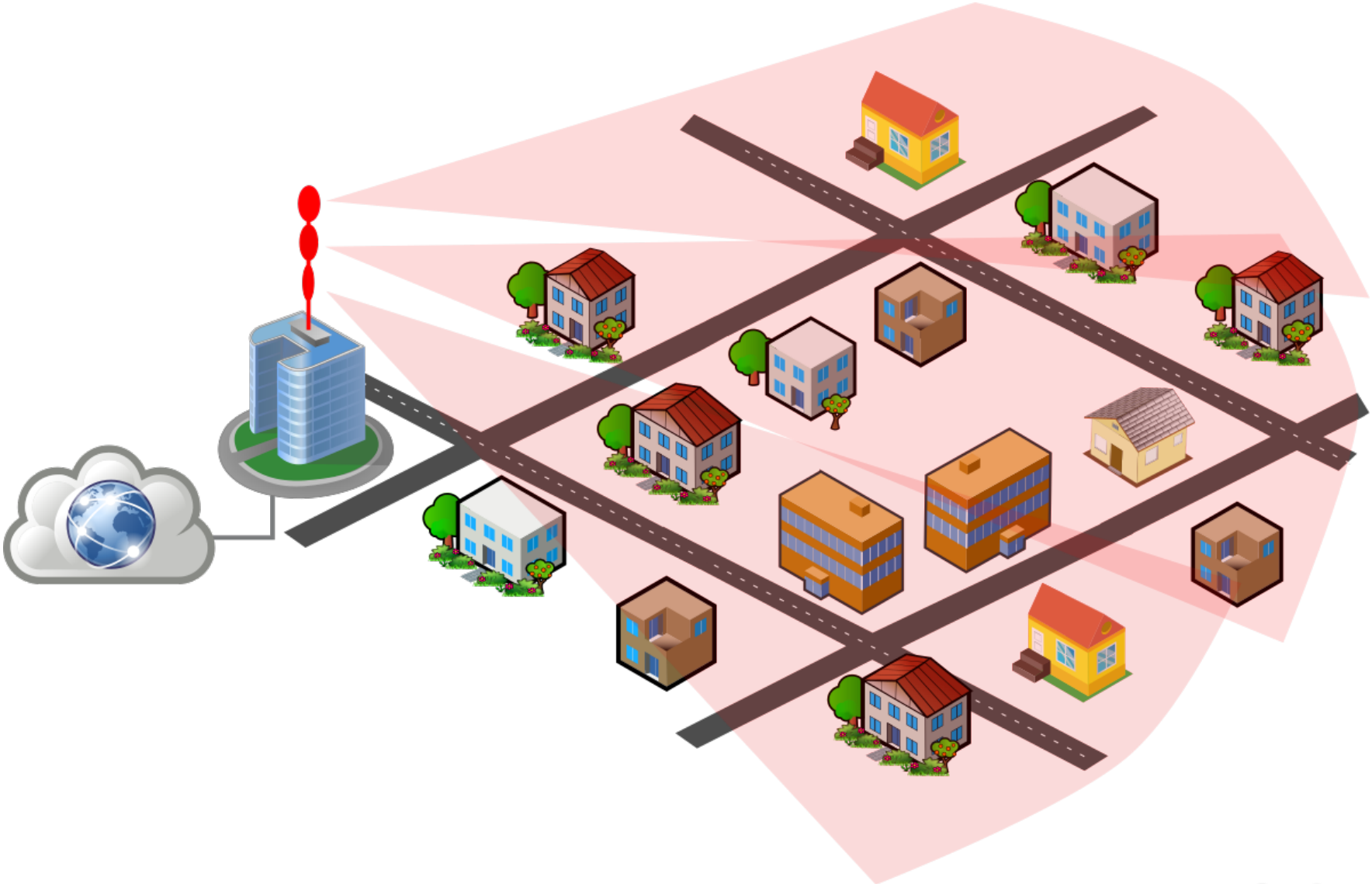
- The market offers devices for less than 60 Euro that can be easily mounted outdoor, and allow to bootstrap a network with a very small investment



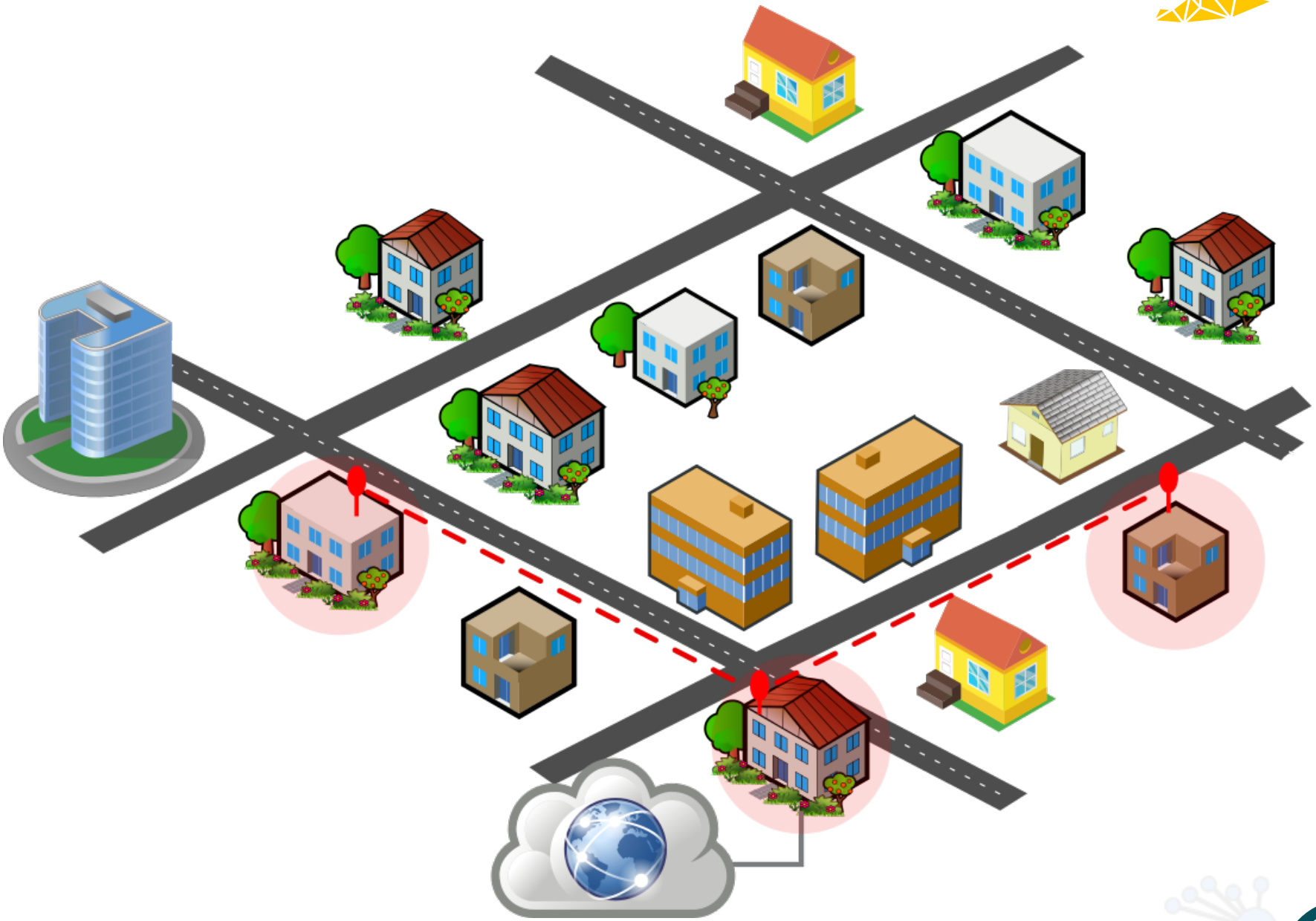
Scaling up Networks

- As networks grow, things get technically more complex, but large networks are still viable and affordable.
- We have studied networks made with this principle that scale to hundreds of nodes, and cover large areas (i.e. the city of Vienna)

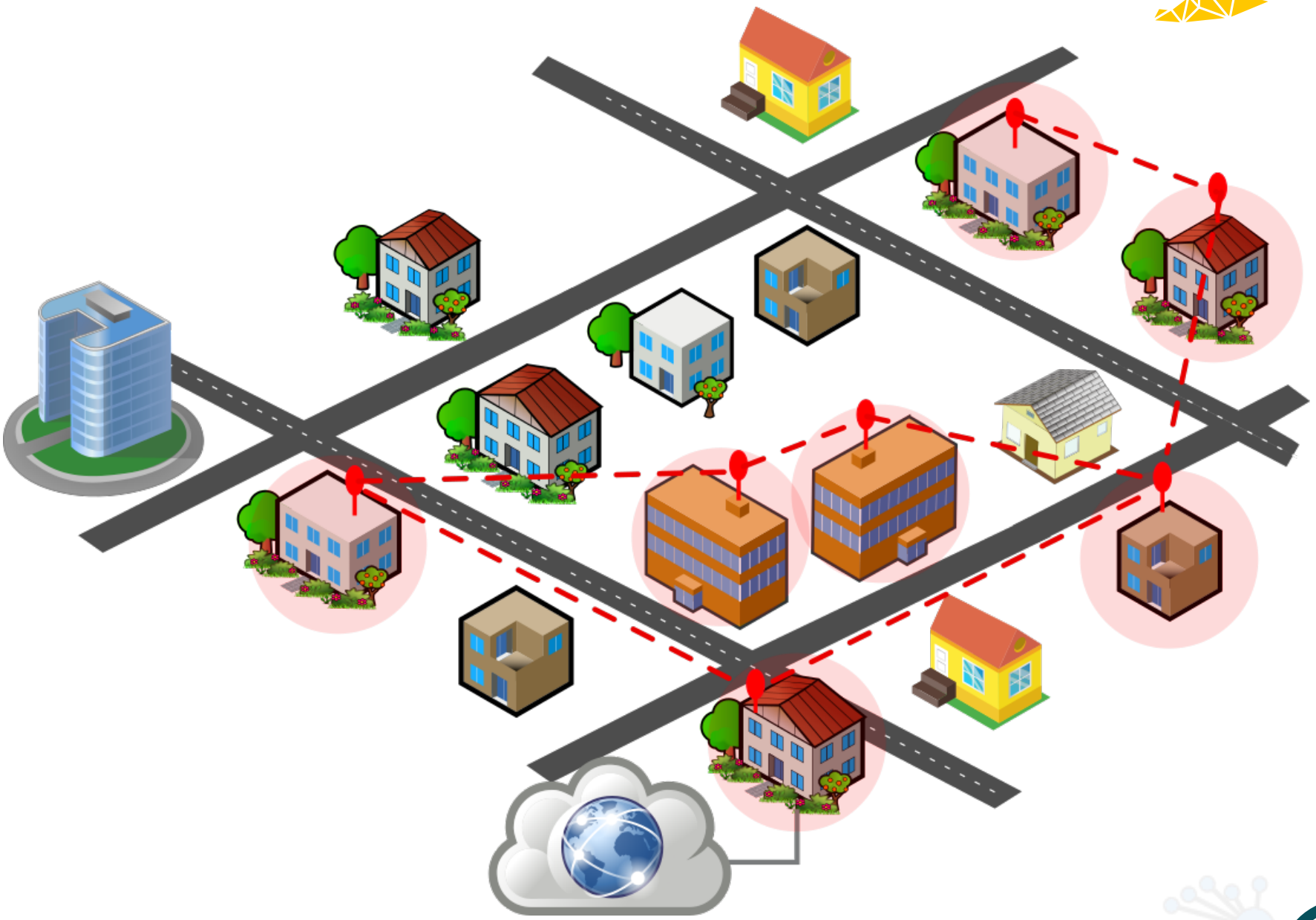
Classical WISP



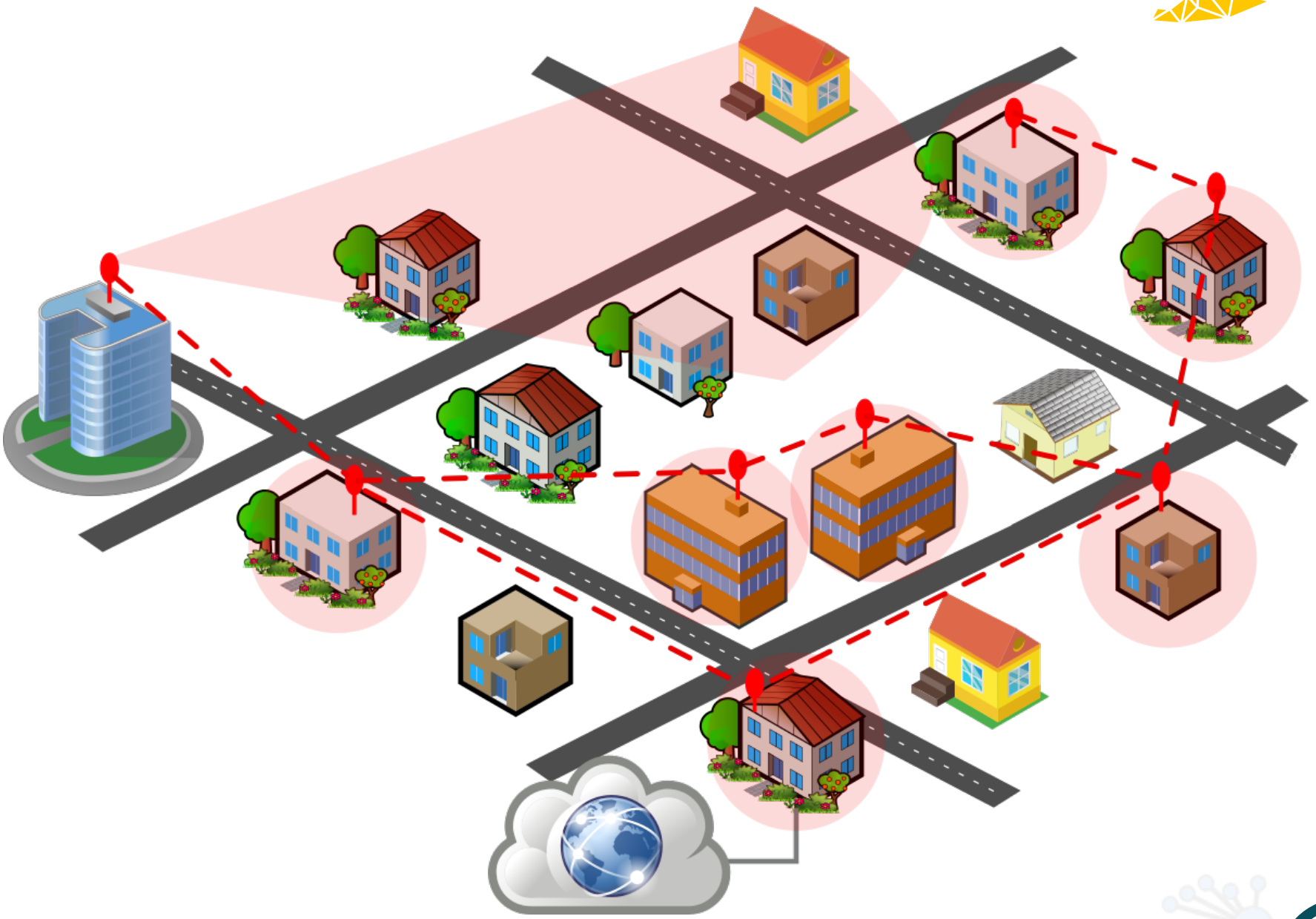
Mesh Model



Mesh Model



Mesh Model



Bottom-up Technology

- The network grows with the community
- To reduce the cost, voluntary participation is a **need**
- People pool their resources to build their own network
  - Roofs
  - Technical skills
  - Energy ...
  - ... in order to keep the price of the infrastructure low

Take Away:

- Affordable technology, no need for large CAPEX, easy to bootstrap
- Scales up to hundreds, which makes it possible for the community to gather momentum and become “serious”
- Based on cooperative organization
- Makes it possible to set-up networks in areas of “market failure”

From Internet Users to *Community Networkers*

- As the network does not come in exchange of a fee, but as a peer production effort, people do not only passively use it.
- They own it.
- As such, they need to self-educate on networking principles, they have to set-up policies, governance, and take collective decisions.
- These decisions are generally different from the decision that an ISP takes, regarding neutrality, openness, and transparency.

CNs do not only tackle digital divide: they propose a new model for Internet development

Wireless Technology Driven?

- A CN must be a Wireless Mesh Network? **NO**
- Mesh networks are a superb instrument to bundle demand, and build a critical mass of people interested in connectivity.
- They also offer a strong techo-social metaphor to express the concept of a CN
- But they are not always usable (they need density and Line of Sight) and they scale up to a certain size
- The same concept of cooperative organization can be used with other technologes: fiber, cellular etc.

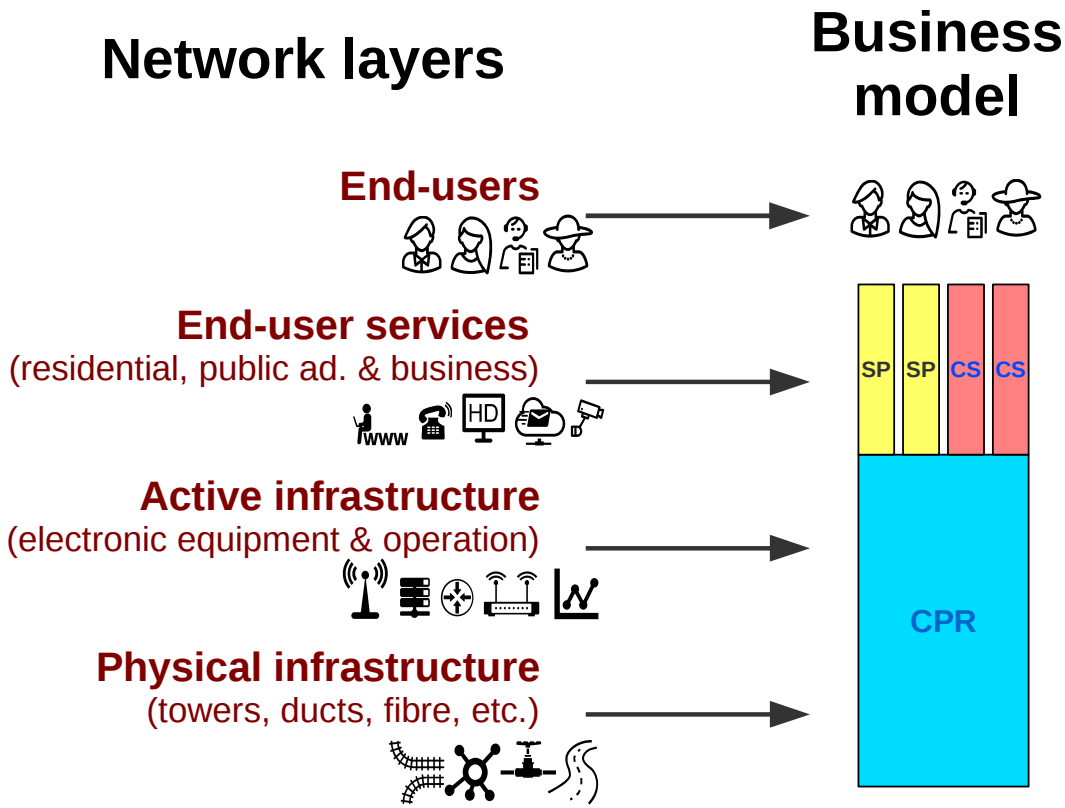
Wired CNs

- There are CNs that rely on wired connections
- Deploying fiber may cost tens of thousands of Euros per km (CAPEX and OPEX)
- How does a community-based approach faces this challenge?
- We have working models proposing a mixed for-profit/not-for-profit approach.

Guifi.net

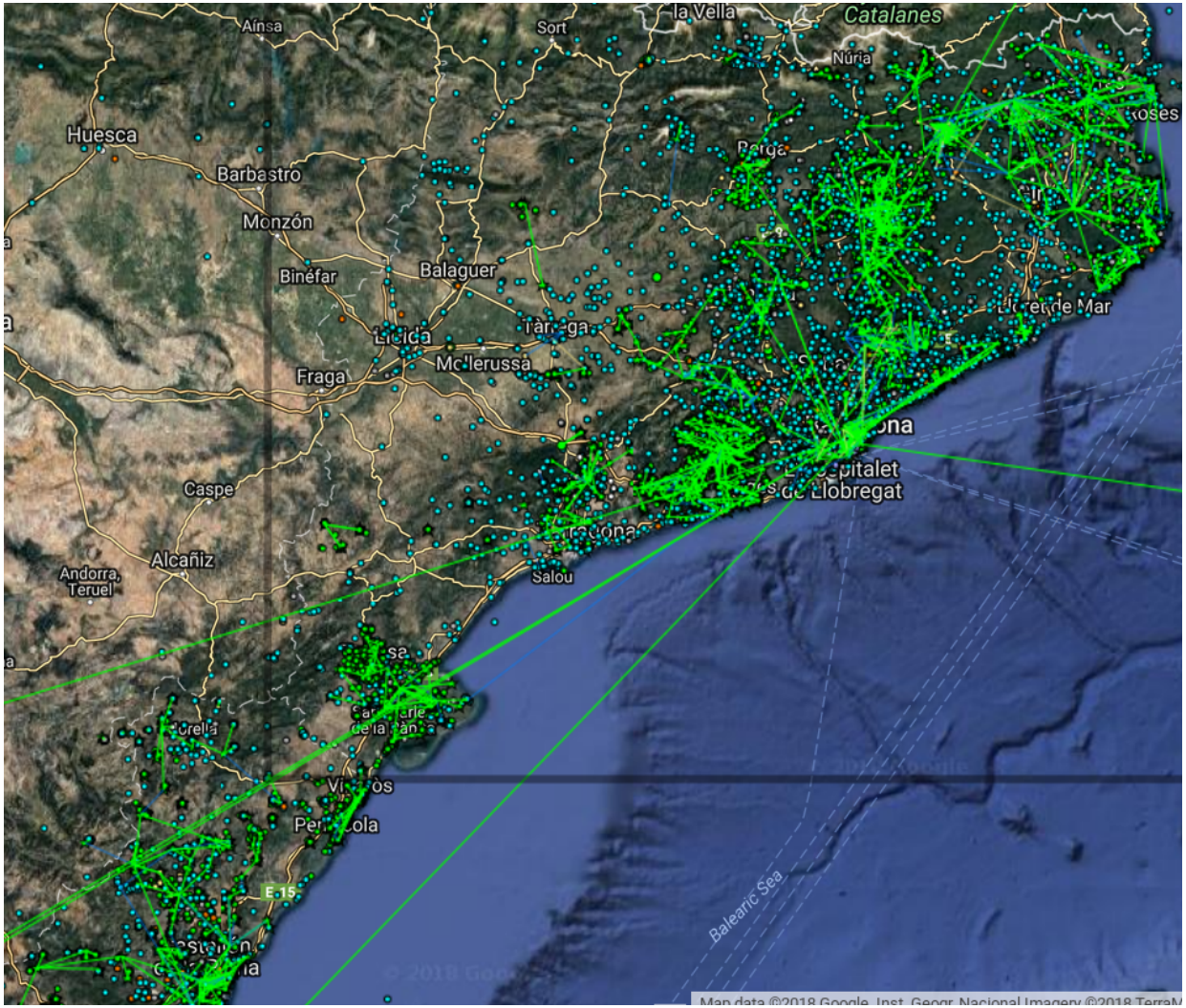
- In Guifi, the passive and active infrastructure is treated as a Common Pool Resource (i.e. by the community)
- For-profit activities are allowed to use it, but they are asked for a fee
- This fee can be monetary, or can be made of verified investments in expanding the network, with a compensation system
- Internet access is one of the many potential applications the network supports.

The Guifi.net Model



Key Theme: Sharing Vs Vertical Integration

The Guifi.net Network



Guifi.net is so far the largest CNs known, with about 35.000 nodes

Context: ninux.org

- The ninux CN is one of the eldest in Europe, it started in Rome in the early 2000s
- It is a fully distributed network, with several disconnected "islands" spread around Italy
- It is one of the most geek-friendly network, in which the community puts a strong focus on experimentation
- I will use ninux as an example of what CNs do to promote the idea and the instruments for a fairer Internet

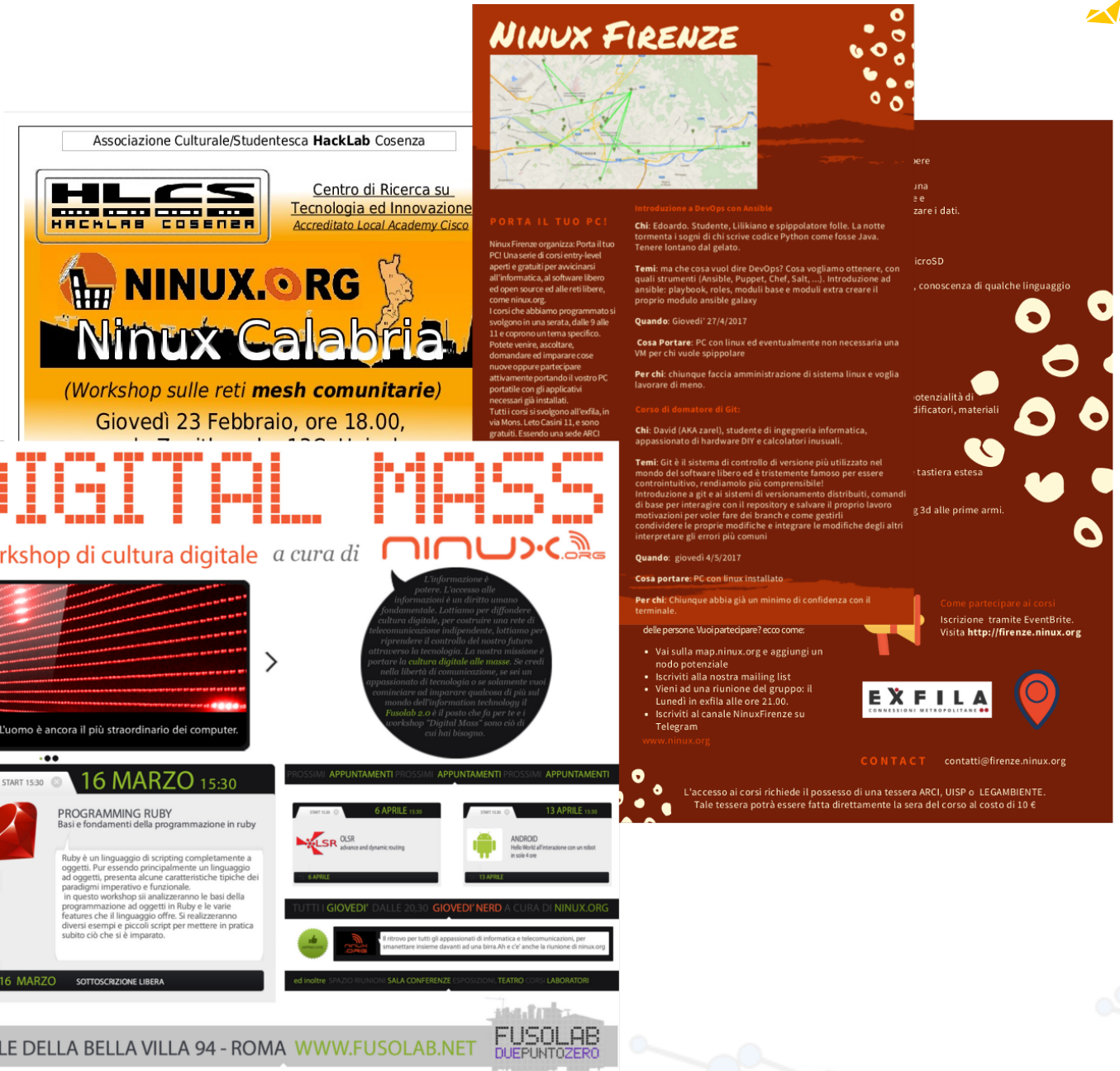
ninux.org

1. ninux is a community of wireless hackers, that enjoys creating their own network
2. to be part of ninux you have to accept the Pico-Peering agreement, which basically states that:
   - you agree to give free transit to other people
   - you collaborate with others that want to peer with you
   - there is no guaranteed service level

We Disseminate the Internet

- Surprisingly enough we still need to disseminate about the importance and the impact of the Internet on society
- CNs are always involved in the realization of courses about Internet technologies and Internet basics
- They are most effective because they are carried out in tight partnerships with local bottom-up organizations

Internet Courses



We Develop the Internet

The Internet is not static, it is constantly "under development". CNs help shaping the Internet, and coordinate to do so. Countless efforts in open source developments and innovation exist:

- Protocols and platforms: OLSRd, Batman advanced, BMX... are examples of protocols designed/improved/implemented by the communities and today widely used outside the CN world
- This year both Freifunk and OpenWISP were recognized by Google as relevant organizations to be financed by the Google Summer of Code program.

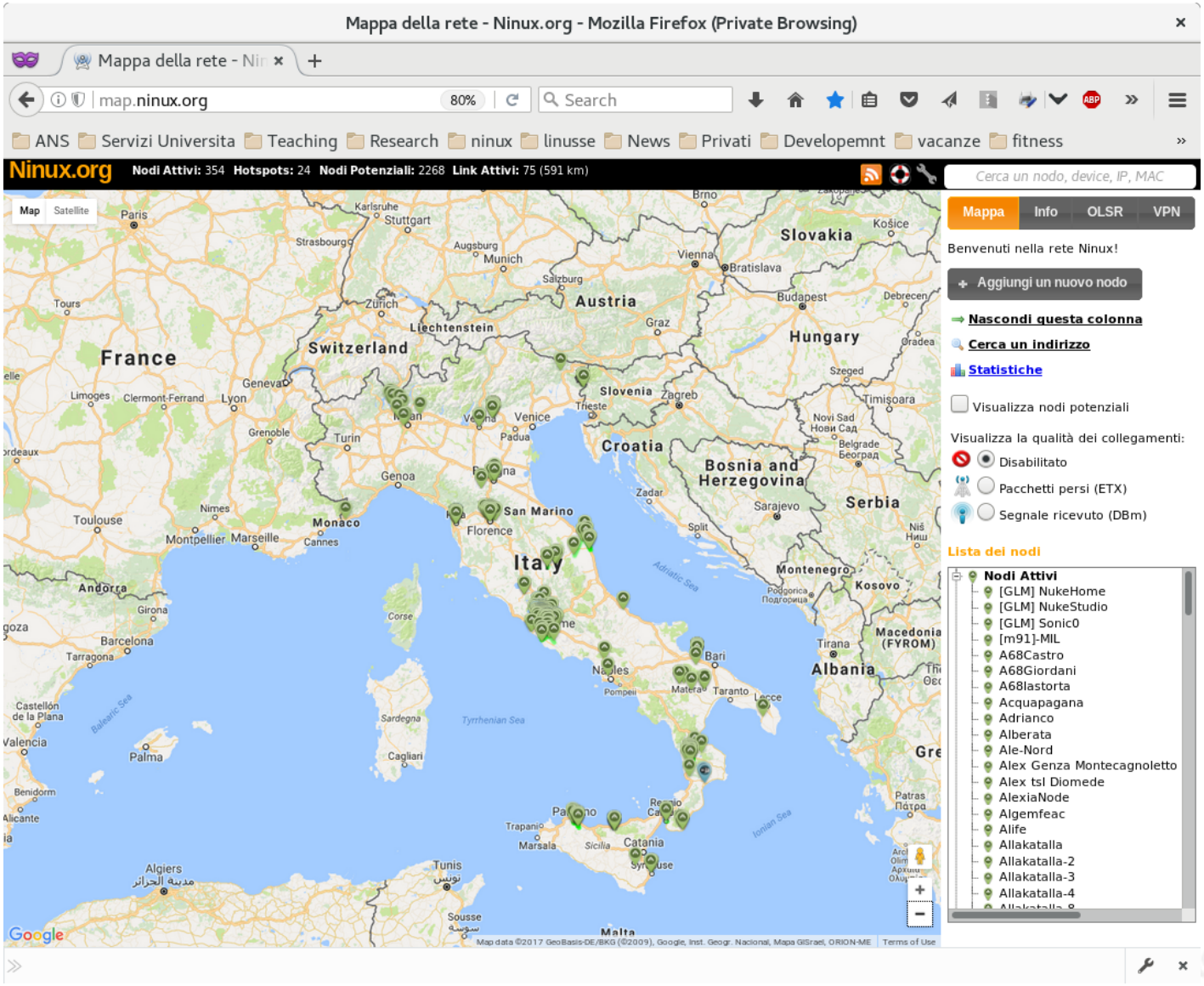
2 - Develop the Internet: Tangible Results

- From the European Battle Mesh experience, LibreRouter is now under development, the first low-cost open source router hardware
- The CONFINE FP7 research project: how 17 research institutions used CNs for real world experimentation
- Broadband innovation award: Guifi (2015) and HUBS (2016)

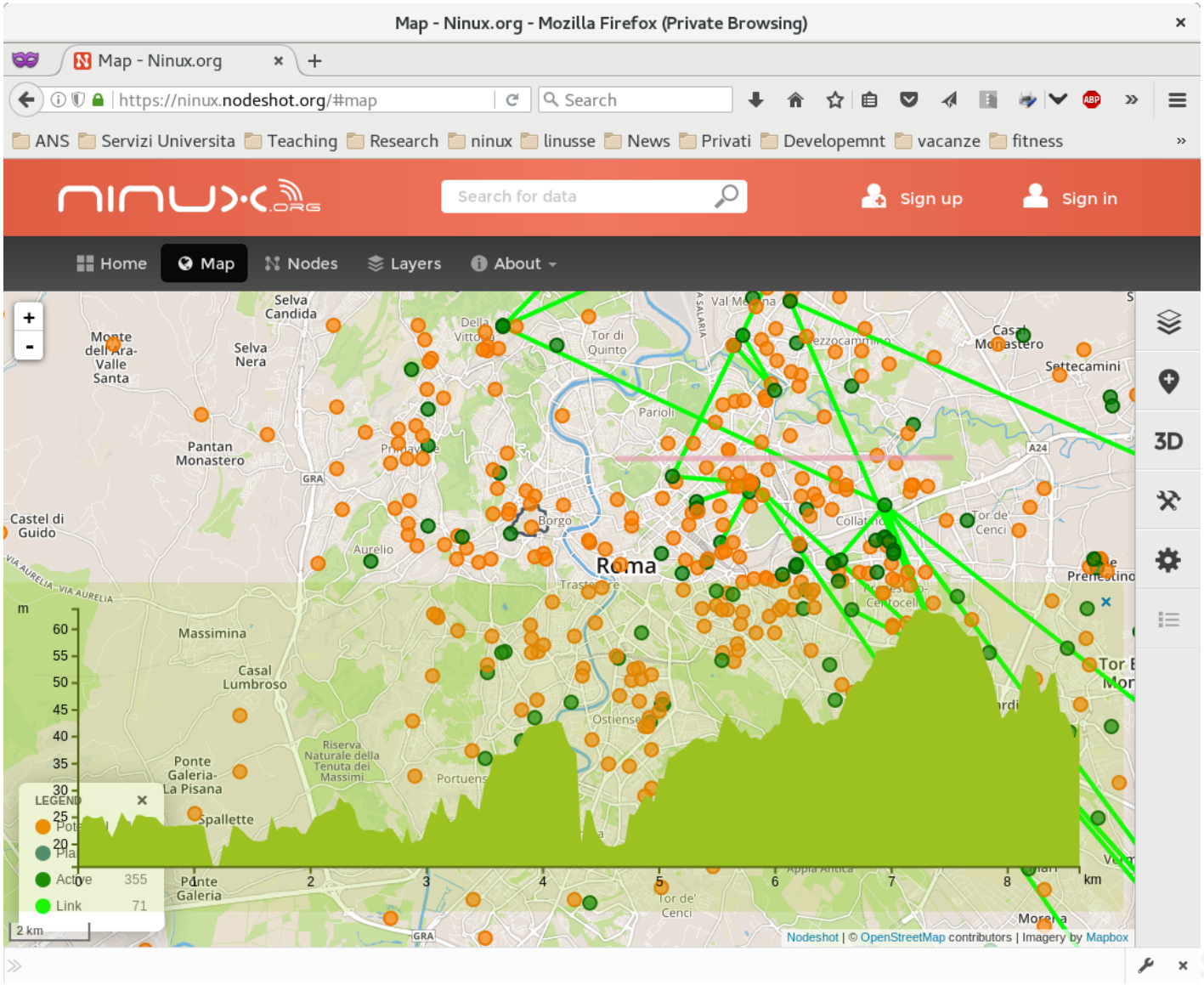
Case study: Story of OpenWISP2

- The ninux community, as all the other community, needs a tool to show the state of the network. Federico Capoano started developing NodeShot in 2011
- A new version of NodeShot was developed in 2013, with added features
- Federico was hired by an Italian PA, which develops OpenWISP, a tool to manage public Wi-Fi networks
- He decided to merge both things, in 2016 OpenWISP2 was born

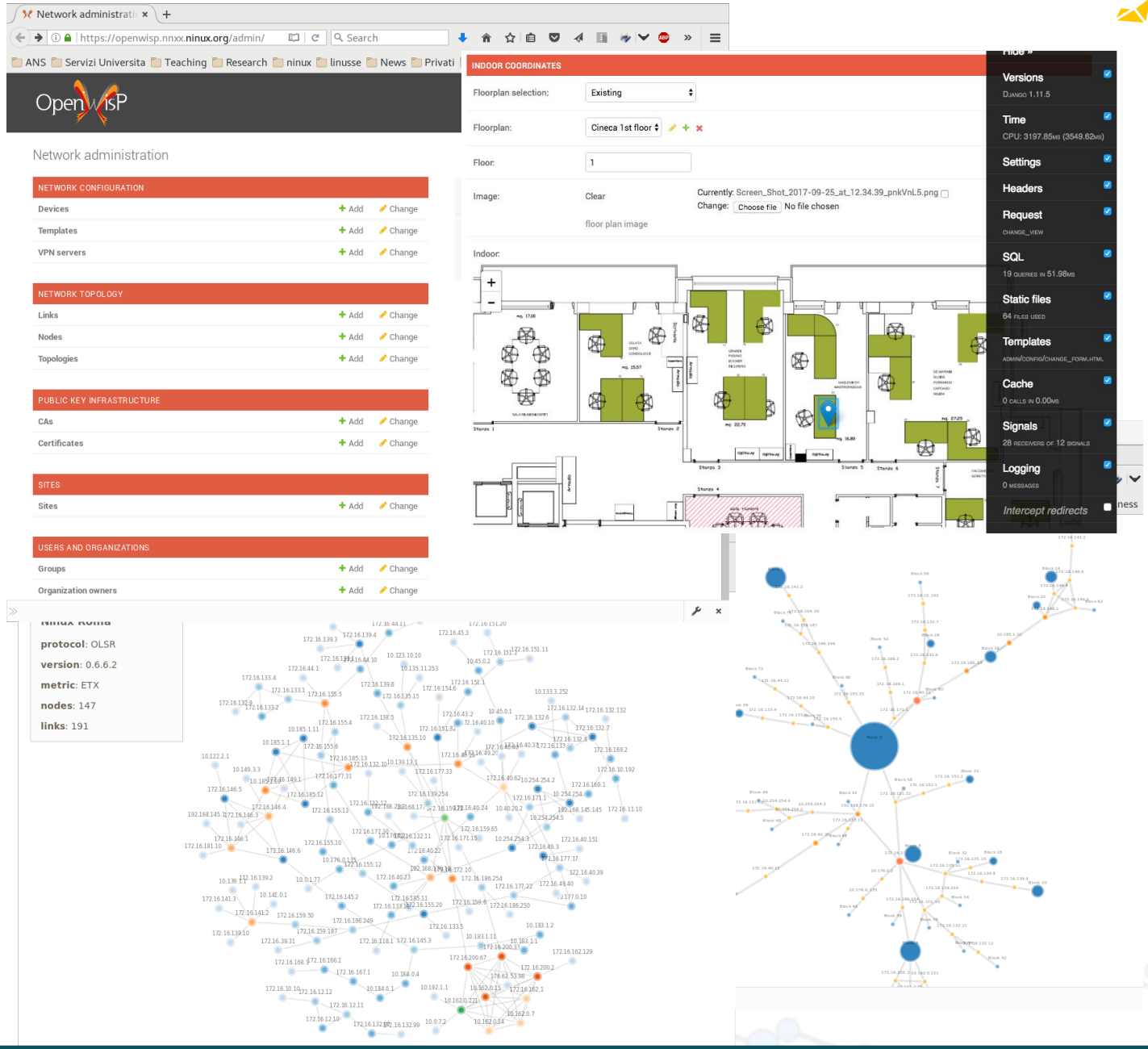
NodeShot


Mappa della rete - Ninux.org - Mozilla Firefox (Private Browsing)
Mappa della rete - Nin
map.ninux.org
80%
Search
ANS
Servizi Universita
Teaching
Research
ninux
linusse
News
Privati
Developemnt
vacanze
fitness
Ninux.org
Nodi Attivi: 354
Hotspots: 24
Nodi Potenziali: 2268
Link Attivi: 75 (591 km)
Cerca un nodo, device, IP, MAC
Map
Satellite
Mappa
Info
OLSR
VPN
Benvenuti nella rete Ninux!
Aggiungi un nuovo nodo
Nascondi questa colonna
Cerca un indirizzo
Statistiche
Visualizza nodi potenziali
Visualizza la qualità dei collegamenti:
Disabilitato
Pacchetti persi (ETX)
Segnale ricevuto (DBm)
Lista dei nodi
Nodi Attivi
[GLM] NukeHome
[GLM] NukeStudio
[GLM] Sonic0
[m91]-MIL
A68Castro
A68Giordani
A68lastorta
Acquapagana
Adrianco
Alberata
Ale-Nord
Alex Genza Montecagnoletto
Alex tsl Diomede
AlexiaNode
Algemfeac
Alife
Allakatalla
Allakatalla-2
Allakatalla-3
Allakatalla-4
France
Switzerland
Austria
Slovakia
Hungary
Slovenia
Croatia
Bosnia and Herzegovina
Serbia
Montenegro
Kosovo
Albania
Italy
Google

NodeShot2


Map - Ninux.org - Mozilla Firefox (Private Browsing)
Map - Ninux.org
https://ninux.nodeshot.org/#map
Search
ANS
Servizi Universita
Teaching
Research
ninux
linusse
News
Privati
Developemnt
vacanze
fitness
Search for data
Sign up
Sign in
Home
Map
Nodes
Layers
About
3D
Roma
Monte dell'Ara-Valle Santa
Selva Candida
Selva Nera
Pantan Monastero
Castel di Guido
Massimina
Casal Lumbroso
Ponte Galeria-La Pisana
Ponte Galeria
Spallette
Aurelio
Borgo
Parioli
Tor di Quinto
Settecamini
Tor de' Cenci
Ostiense
Riserva Naturale della Tenuta dei Massimi
LEGEND
Active 355
Link 71
2 km
km
Nodeshot | © OpenStreetMap contributors | Imagery by Mapbox

OpenWISP2


Network administrati
https://openwisp.nnxx.ninux.org/admin/
Search
ANS
Servizi Universita
Teaching
Research
ninux
linusse
News
Privati
OpenWisP
Network administration
NETWORK CONFIGURATION
Devices + Add Change
Templates + Add Change
VPN servers + Add Change
NETWORK TOPOLOGY
Links + Add Change
Nodes + Add Change
Topologies + Add Change
PUBLIC KEY INFRASTRUCTURE
CAs + Add Change
Certificates + Add Change
SITES
Sites + Add Change
USERS AND ORGANIZATIONS
Groups + Add Change
Organization owners + Add Change
protocol: OLSR
version: 0.6.6.2
metric: ETX
nodes: 147
links: 191
INDOOR COORDINATES
Floorplan selection: Existing
Floorplan: Cineca 1st floor
Floor: 1
Image: Clear
Currently: Screen_Shot_2017-09-25_at_12.34.39_pnkVnL5.png
Change: Choose file No file chosen
floor plan image
Indoor:
Versions
Time
Settings
Headers
Request
SQL
Static files
Templates
Cache
Signals
Logging
Intercept redirects

We are the Interet

- There is a lot of attention on how Internet services and applications work, and their societal impacts
- Little interest instead is given to what there is under the hood. Internet as a communication infrastructure *just works*
- CNs instead unveil what are the societal consequences of the governance of the "physical" Internet (neutrality, just to name one theme)
- CNs engage people in modifying the Internet in a way they consider fair fair, equal and democratic
- CNs are drivers and initiators of awareness and advocacy initiatives

Dissemination/Advocacy Initiatives

The netCommons Project

UNIVERSITY
OF TRENTO - Italy

UPC

cnrs
dépasser les frontières

NetHood

ΟΙΚΟΝΟΜΙΚΟ ΠΑΝΕΠΙΣΤΗΜΙΟ ΑΘΗΝΩΝ
ATHENS UNIVERSITY OF ECONOMICS AND BUSINESS

UNIVERSITY OF WESTMINSTER

- H2020 Financed project (CAPS)
- 2016-2019
- 4 Universities
- 1 Research Center
- 1 not-for-profit association
- 6 countries

netCommons Activities

- Legal research (are CNs really legal, can we do them?)
- Social Science (Are CNs more than just low-cost Internet?)
- Technical research (distributed applications, routing, technical analysis)

We do all this together with CNs.

Legal studies: In a nutshell

Simplifying to the extreme:

- If the network is fully distributed, and there is no legal entity beyond it (as in ninux), then there is individual third party liability: if someone does something wrong with your ADSL or node, you are to blame
- If the community becomes a legal entity, it may become an ISP: no third party liability, but problems with data retention.

Social Studies: In a nutshell

Simplifying to the extreme:

- CNs are much more than low-cost Internet
- In some cases, they don't even offer Internet connection
- In all cases, in order to cut-down costs, you have to cooperate.
- When people cooperate, the governance of the network is transparent, the choices made are close to the people need
  - Neutrality, Privacy, Openness are key values for Community Networks.
- CNs are like "organic food" for connectivity.

Technical Studies: In a nutshell

- We do Distributed Cloud platforms: Cloudy
- We do Distributed live video Streaming: PS-ng
- We do Network Monitoring Tools
- We do Routing protocol Enhancements: Pop-Routing
- We do Bottom-up applications for smart Farming

Community Clouds (CC)

Motivation: explore CC as commons (infrastructure & services)
Goal: experiment & develop CC to CNs: Cloudy[1]

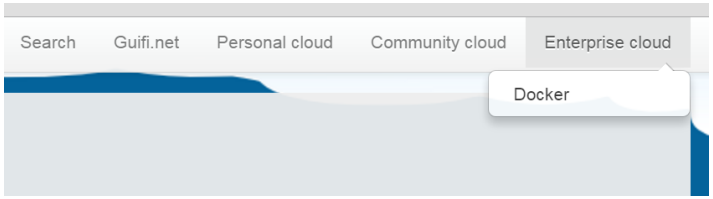
- A Debian GNU/Linux software distribution for CC participants that runs Infrastructure-Platform-Software-aaS on end-user devices. Open source, can be extended with distributed services.

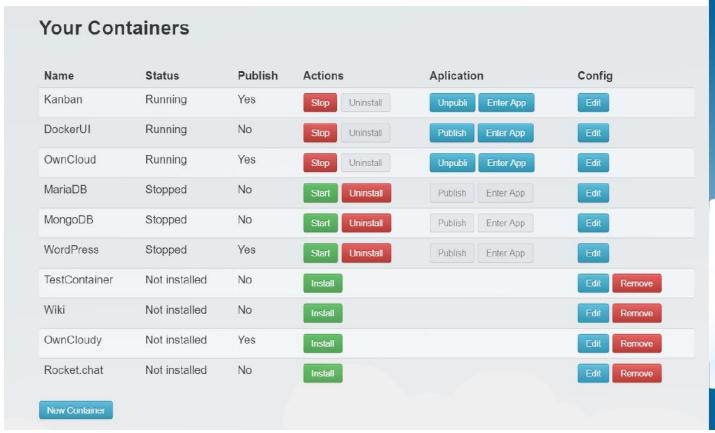
[1] Cloudy started in the Clommunity research project (EC FP7-317879)

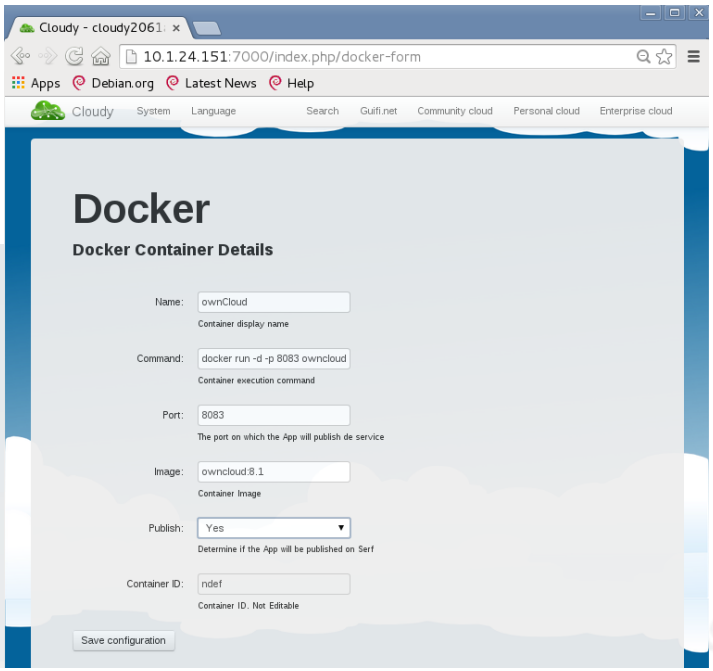
Cloudy services

Users can manage services & applications through a common web interface:

- Activate pre-installed, install additional
- For personal use or community use



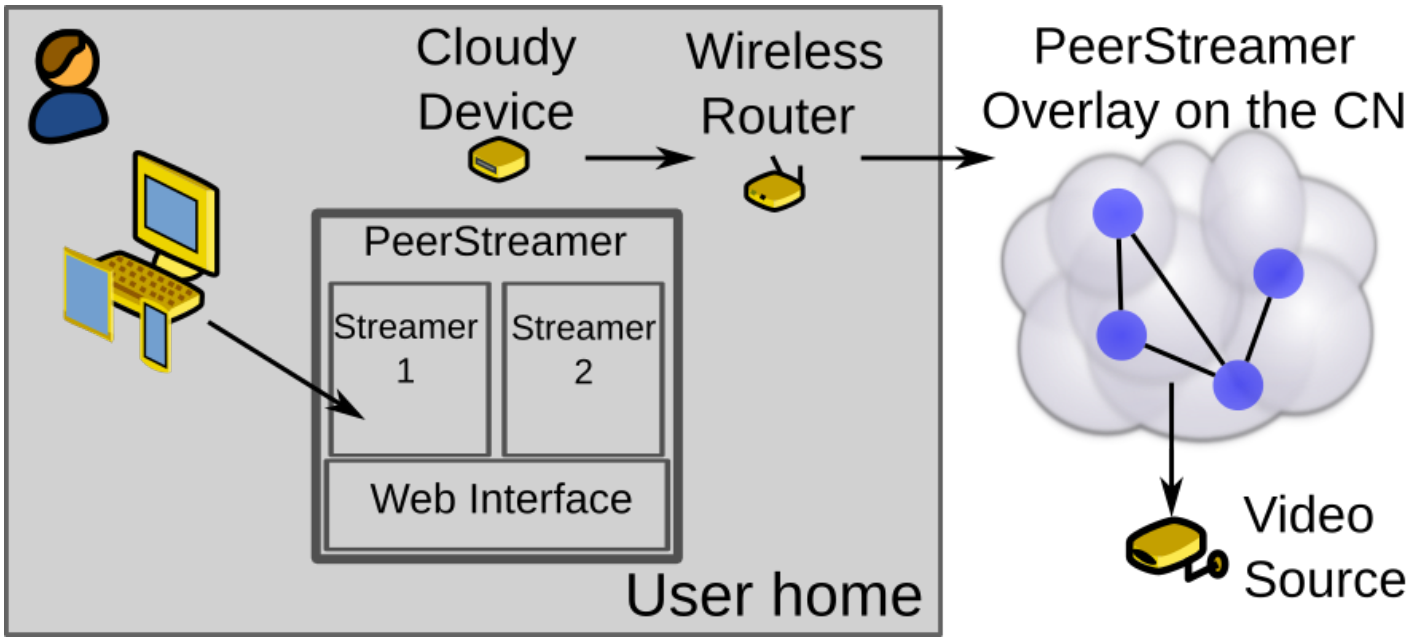




Gossiping Services

- Cloudy uses a Gossiping protocol (Serf) to disseminate the information about services.
- Once you activate the service on your instance of cloudy, everyone else is notified that that service exists
- What service? anything dockerizable and web-controlles
  - Etherpad
  - Wordpress
  - OwnCloud
  - IPFS
  - P2P Video Streaming ...

PS-ng, Vision:


Cloudy
Device
Wireless
Router
PeerStreamer
Overlay on the CN
PeerStreamer
Streamer
1
Streamer
2
Web Interface
User home
Video
Source

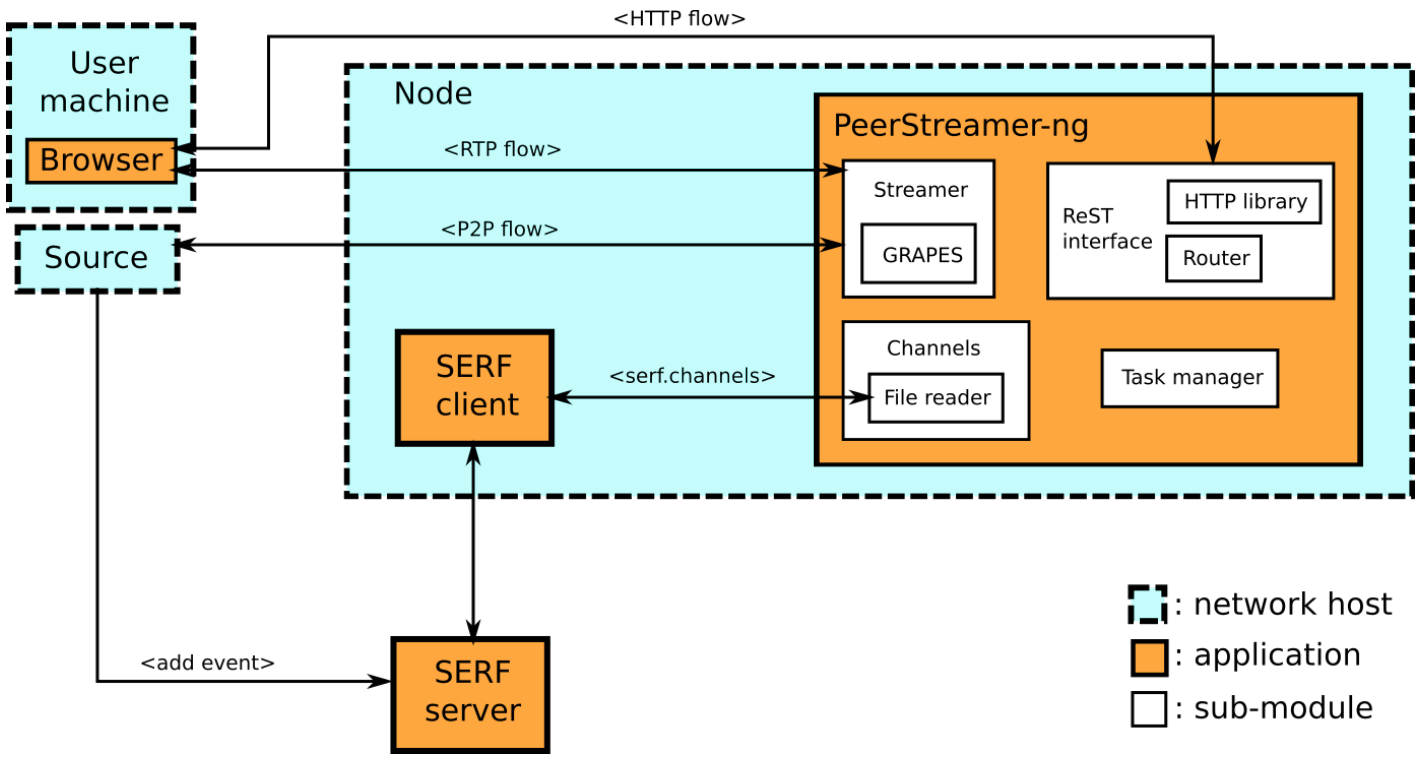
Workflow

- An user starts a streaming session in the network
- The Serf protocol gets notified, information is propagated
- Any other user running PS in Cloudy sees the new stream among the available ones from PS web page
- He/She chooses the stream and watch it on the browser

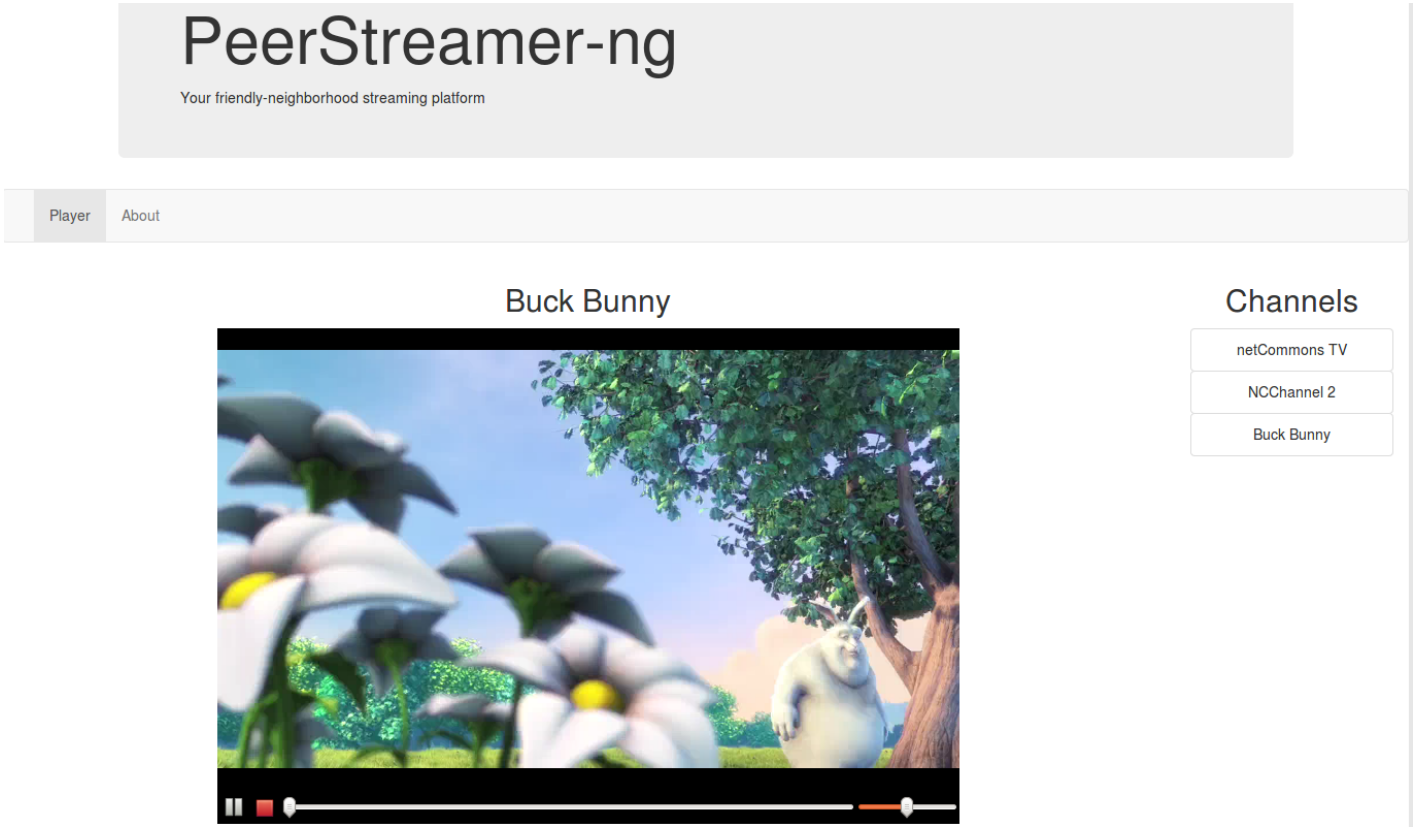
What is available:

- We wrote a client library for Serf, now we can notify Serf of new streams
- We created a Docker image for PeerStreamer-NG
- We created a web-based front-end for PS-ng, controlled via REST
- We created the necessary modules to wire everything together.

PS-ng, components



It works!


PeerStreamer-ng
Your friendly-neighborhood streaming platform
Player
About
Buck Bunny
Channels
netCommons TV
NCChannel 2
Buck Bunny

VLC problems...

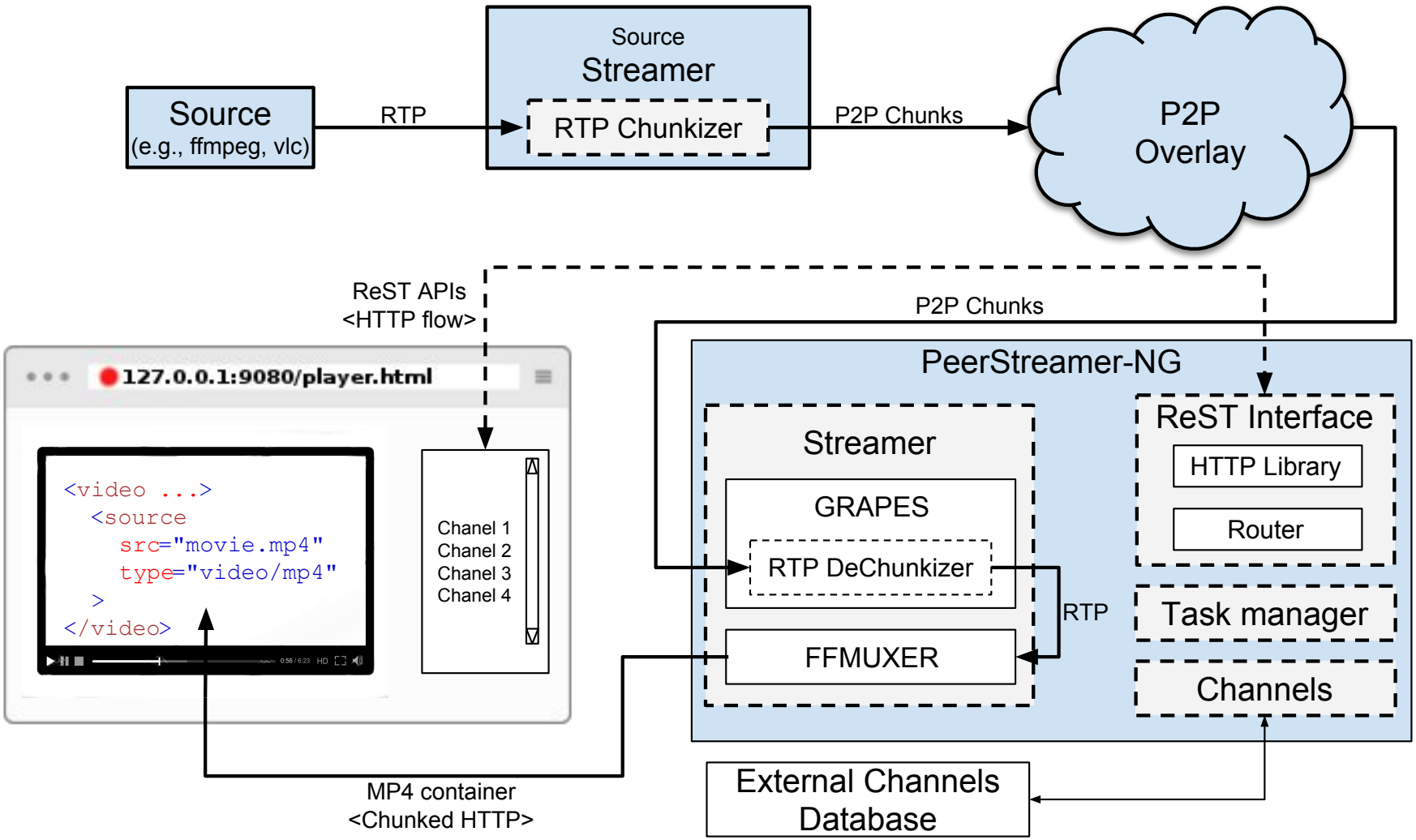
- We stream the video using the UDP-based RTP protocol, which is a better choice than any TCP based transport for live video
- RTP streaming is supported by HTML5, but no browsers currently implement it
- So far, the only way to have RTP on browser was with the VLC plugin. The plugin is widely used and works pretty well.
- In spring, for security reasons, browsers decided not to support plug-ins anymore (Firefox). Now it is cumbersome to enable a plugin in Firefox :-(
- Alternatives are:
  - use HTML5 VIDEO tag
  - use some live-streaming oriented protcol: WebRTC

HTML5 and WebRTC integration

To stream a non-live video using HTML5 you have to:

- reconstruct the video in a local file (or buffer)
- have it read from the web server
- have it served to the client in an HTML video tag.
- Pros:
  - All browsers support it
- Cons:
  - Too many caches: $\leftarrow$ **several seconds delay**

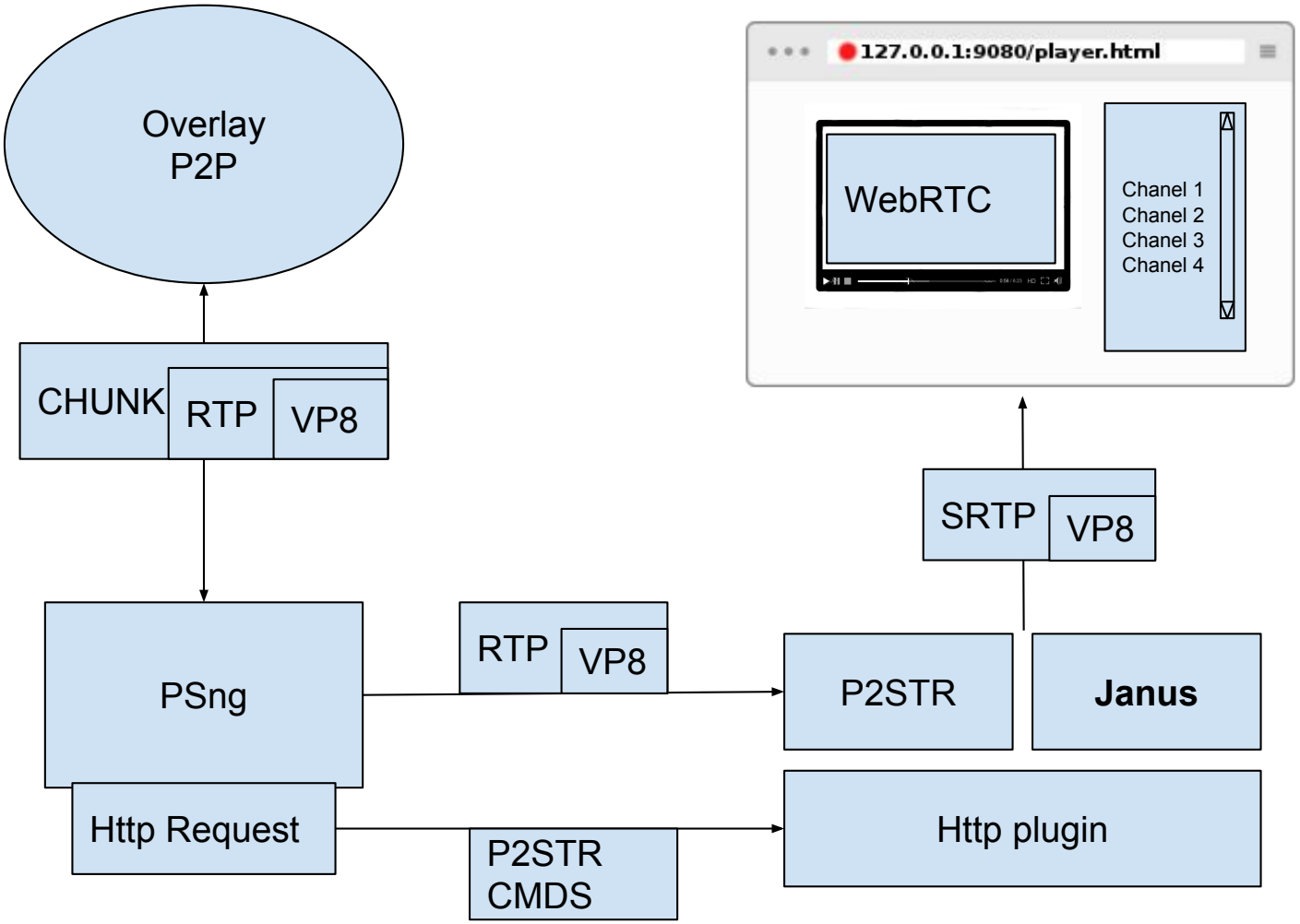
HTML5: implementation



WebRTC:

- WebRTC is a new protocol under standardization for live interactions
- Pros:
  - It is fast
  - It is made for bi-directional interactions (Jitsi uses it).
- Cons:
  - It is very complex
  - It is not yet supported by all platforms (no MS yet)
  - There is no library to support it, need a media gateway (Janus).
- We implemented it and it works well enough to support live video

WebRTC implementation



We Want You

Do you want to Experiment?

- Are you part of a community?
- Do you have a Raspberry Pi?
- Do you want to help us?
- . . . we need to talk.
- We want to test PS-ng in real communities, and we will dedicate this year to this task.

Metrics

We designed metrics for measuring the "pulse" of the CNs include:

- Centrality and robustness indices of the network topologies
- Distribution of ownership across the network nodes to prevent the centralization and the hegemony of a few people on the whole infrastructure;
- Participation level in the on-line social tools (mailing lists, forums etc.) to monitor the inclusiveness of the on-line participation;

In a few words:

Provide the tools to analyze CNs and verify to what extent we can consider them “distributed”, both technically and socially

In a Nutshell

- All the robustness, centrality and hierarchy metrics that were studied so far on the network topology can be used to evaluate the state of the network.
- If mixed with the analysis of the social networking instruments (mailing lists, telegram chats, github interactions etc. . .) they can give a multi-layer overview of the state of the network and of the community.
- What is the best way of integrating them into CN monitoring tools?

ninux management interface

- Currently ninux uses 2 instruments to monitor the state of the network, and to add/remove nodes in the network:
  - http://map.ninux.org: the network visualizer used so-far, based on the home-brew 'nodeshot' interface
  - http://ninux.nodeshot.org: the new network visualizer based on the new, home-brew 'nodeshot2' interface
- both these tools will be dismissed in favour of a third one, based on an open format: NetJSON.

NetJSON

from netjson.org

> *"NetJSON is a data interchange format based on JSON designed to ease the development of software tools for computer networks. NetJSON defines several types of JSON objects and the manner in which they are combined to represent a network: configuration of devices, monitoring data, network topology and routing information."*

NetJSON is under development and it is described in an informational RFC.

NetJSON example

```
"type": "NetworkGraph",
"protocol": "olsr",
"version": "0.6.6",
"revision": "5031a799fcbe...",
"metric": "etx",
"router_id": "172.16.40.24",
"nodes": [
    {
        "id": "172.16.40.24",
        "label": "node-A",
        "local_addresses": [
            "10.0.0.1",
            "10.0.0.2"
        ],
        "properties": {
            "hostname": "node1.my.net"
        }
    },
    {
        "id": "172.16.40.60",
        "label": "node-B",
        "properties": {
            "hostname": "node2.my.net"
        }
    }
],
"links": [
    {
        "source": "172.16.40.24",
        "target": "172.16.40.60",
        "cost": 1.000,
        "cost_text": "1020   bit/s",
        "properties": {
            "lq": 1.000,
            "nlq": 0.497
        }
    }
]
```

NetJSON

The stated goal of NetJSON is :

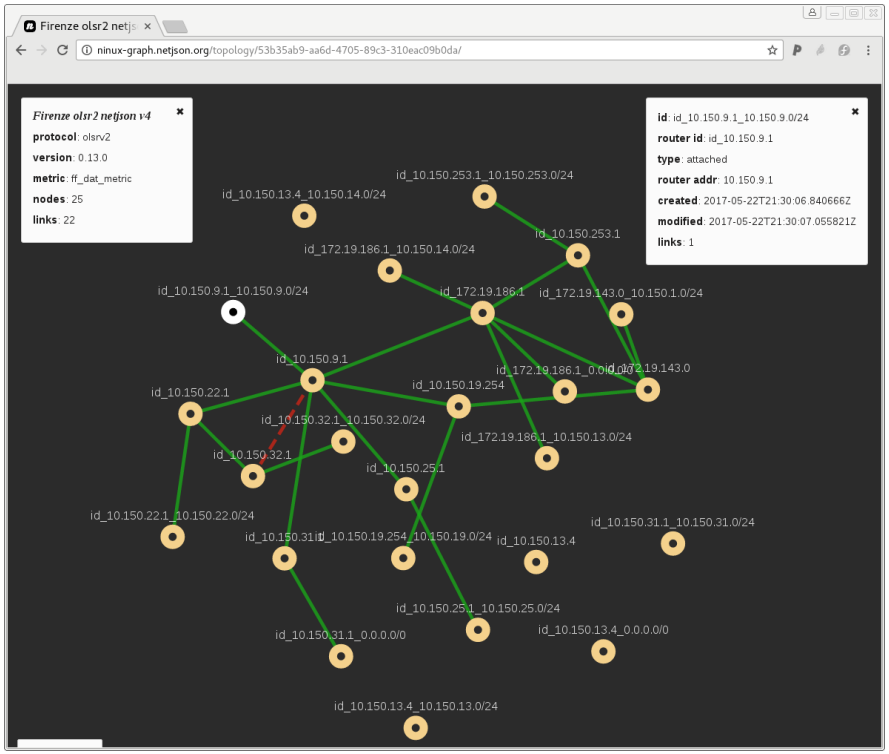
> *"[to] build an ecosystem of interoperable software tools that are able to work with the basic building blocks of layer2 and layer3 networks, enabling developers to build great networking applications faster."*

NetJSON

- The main reason NetJSON was designed is to overcome the current fragmentation of tools that various CNs use to describe/manage/visualize their networks
- Since there is no hope in merging the various (and different) tools used by all the communities, they started from a common description format.
- Several Routing Protocols daemons allow to export the network topology using NetJSON (olsrd, OONF, BMX...).
- Note that not only the network can be described with NetJSON, but also node configuration parameters.

netjsongraph.js

- Once the format is standardized, several applications can be based on it, such as netjsongraph.js, a Javascript library for network visualization[2].



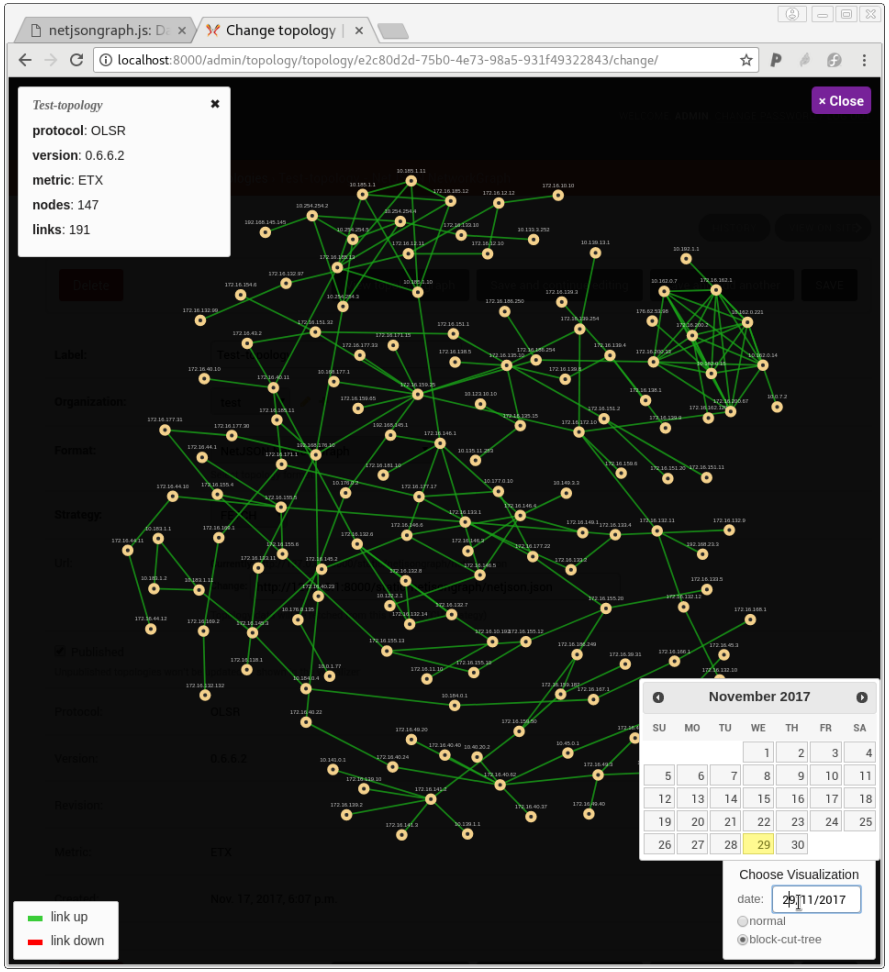
[2] http://ninux-graph.netjson.org/topology/643c4577-cef2-4b5e-b8a4-c29756b10748/

Developments Done

- Modified several components of OpenWISP to add the feature of multiple visualization of networks

Developments Done

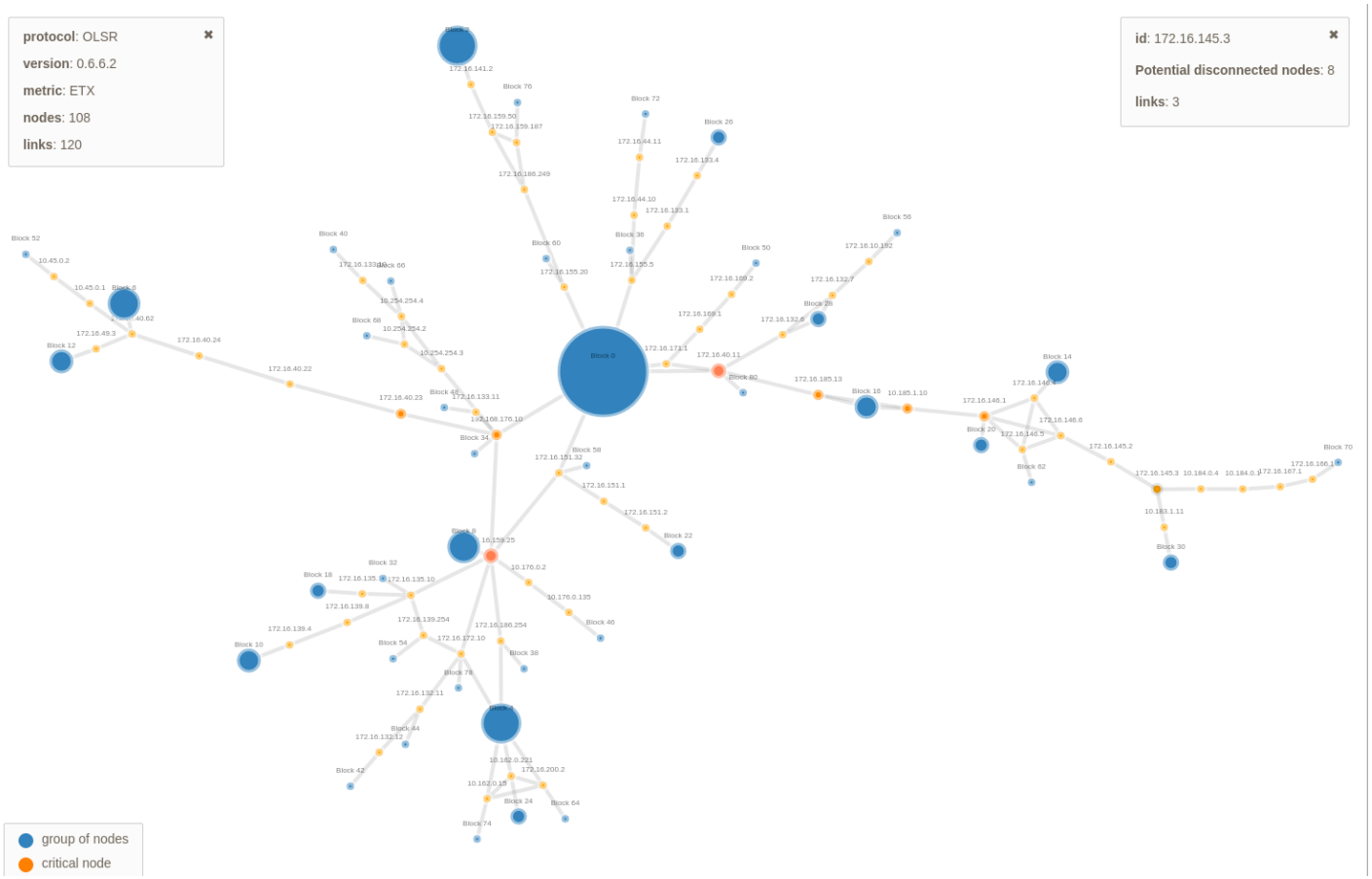
We pass from this visualization:



https://opendata.netcommons.eu/examples/dark.html

Developments Done

To this visualization:



https://opendata.netcommons.eu/examples/condensed-ninux.html

NETCOMMONS PROJECT

RESEARCH AND EXPERIMENTATION WITH CNS

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Department of Information Engineering and Computer Science

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