GIORNATA DI INCONTRO BORSE DI STUDIO GARR "ORIO CARLINI"
MARTEDI' 12 DICEMBRE 2017 - ROMA

Consortium GARR

Progettazione e sviluppo di un sistema di wireless sensor network µIPv6 per il popolamento di Big Data di pubblica utilità

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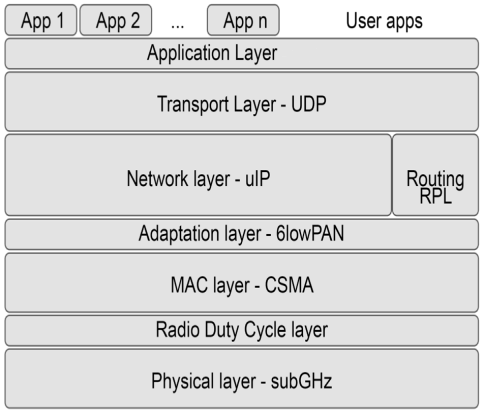
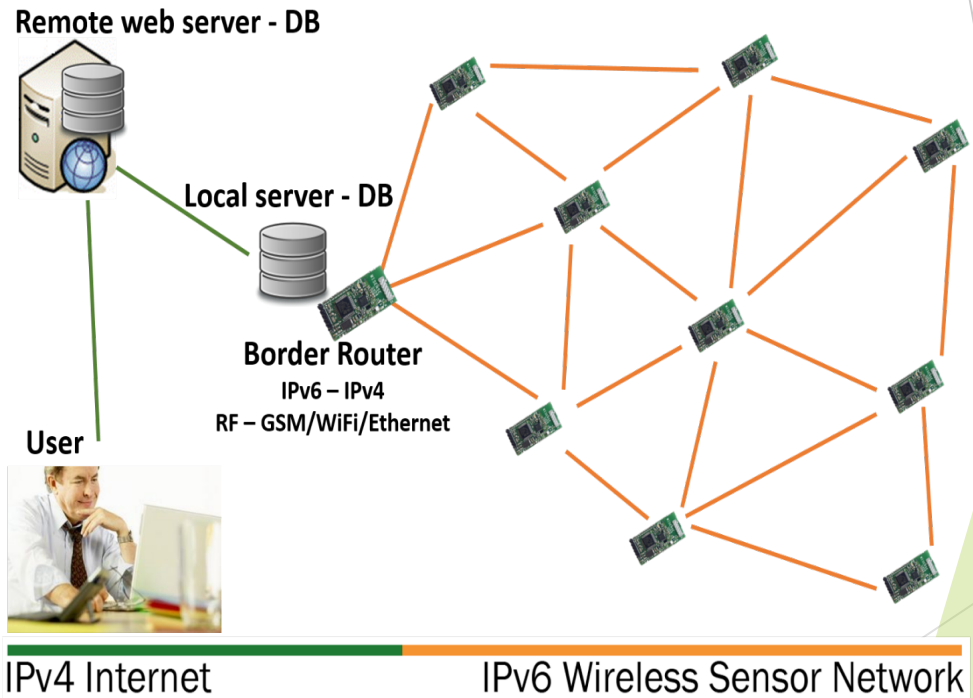
Obiettivo

- Utilizzare una soluzione completa di architettura di WSN per l'IoT che convogli dati nel web per la creazione di Big Data per applicazioni di pubblica utilità.
- La rete sarà autoinstallante ed autoconfigurante e, nella versione prototipale, con centinaia di dispositivi IPv6 collegabili alla mesh di sensori che inviano le informazioni attraverso la dorsale GARR.
- I sensori distribuiti sul territorio, nelle città o negli edifici, consentiranno di raccogliere dati eterogenei provenienti da diverse grandezze e di metterli a disposizione nel web, dove chiunque potrà utilizzarli per creare modelli decisionali, ottimizzare costi e risorse, programmare manutenzioni, creare modelli e sistemi per la prevenzione e la gestione del rischio sismico, proteggere e valorizzare i musei e le opere in essi contenute, ecc.

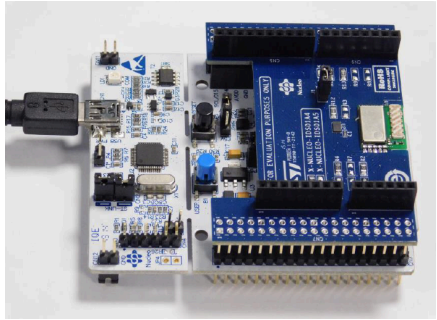
Premesse

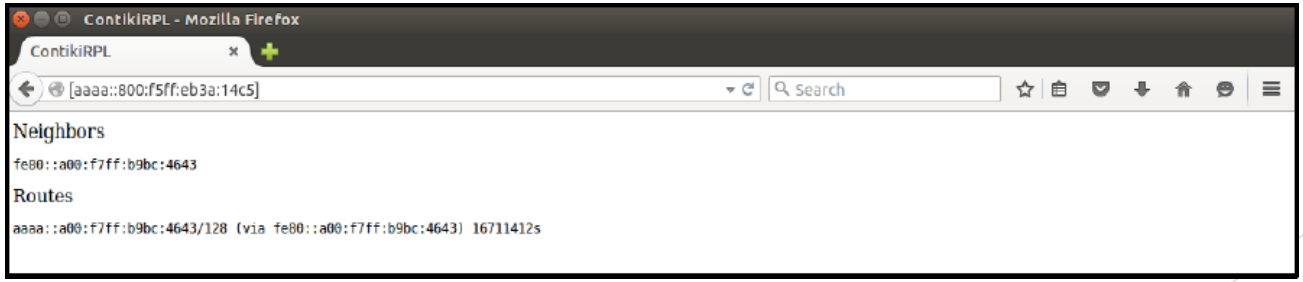

App 1
App 2
...
App n
User apps
Application Layer
Transport Layer - UDP
Network layer - uIP
Routing RPL
Adaptation layer - 6lowPAN
MAC layer - CSMA
Radio Duty Cycle layer
Physical layer - subGHz


Remote web server - DB
Local server - DB
Border Router
IPv6 – IPv4
RF – GSM/WiFi/Ethernet
User
IPv4 Internet
IPv6 Wireless Sensor Network

La rete mesh IPv6

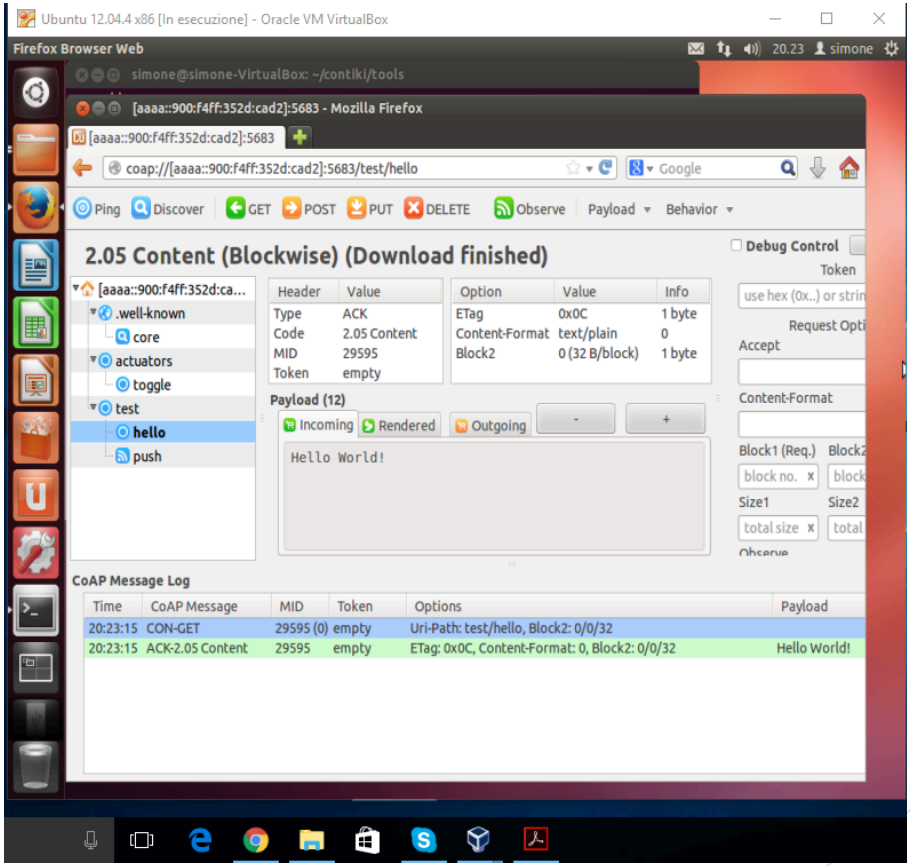
```
********SLIP started on ``/dev/ttyACM0''
opened tun device ``/dev/tun0''
ifconfig tun0 inet `hostname` up
ifconfig tun0 add aaaa::1/64
ifconfig tun0 inet 172.16.0.1 pointopoint 172.16.0.2
ifconfig tun0 add fe80::0:0:0:1/64
ifconfig tun0

tun0      Link encap:UNSPEC  HWaddr 00-00-00-00-00-00-00-00-00-00-00-00-00-00-00-00
          inet addr:172.16.0.1  P-t-P:172.16.0.2  Mask:255.255.255.255
          inet6 addr: fe80::1/64 Scope:Link
          inet6 addr: aaaa::1/64 Scope:Global
          UP POINTOPOINT RUNNING NOARP MULTICAST  MTU:1500  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:500
          RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

*** Address:aaaa::1 => aaaa:0000:0000:0000
Got configuration message of type P
Setting prefix aaaa::
Server IPv6 addresses:
 aaaa::800:f5ff:eb3a:14c5
 fc00::800:f5ff:eb3a:14c5
 fe80::800:f5ff:eb3a:14c5
*** Address:aaaa::1 => aaaa:0000:0000:0000
Got configuration message of type P
Setting prefix aaaa::
Server IPv6 addresses:
 aaaa::800:f5ff:eb3a:14c5
 fc00::800:f5ff:eb3a:14c5
 fe80::800:f5ff:eb3a:14c5
```





CoAP e Copper

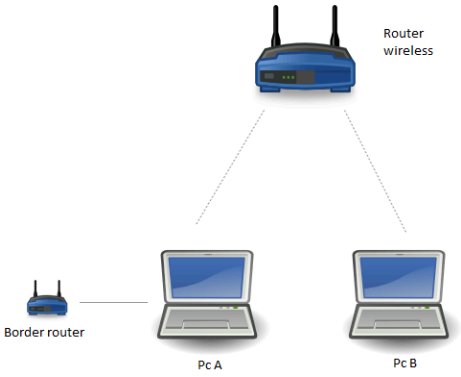
- Constrained Application Protocol
- REST



Lorenzo Palma

Connessione in locale

- RADVD
- open source in grado di effettuare routing ipv6 sfruttando il Neighbor Discovery Protocol e l'autoconfigurazione stateless (SLAAC)
- Sblocco antivirus e firewall



Connessione da remoto tramite rete IPv4

- Hurricane Electrics
  - Necessario abilitare ICMP nel router
  - Configurare la scheda di rete con gli indirizzi forniti
  - Assegnare l'indirizzo globale al border
- Teredo e Miredo
  - Fornisce connettività IPv6 anche se non si dispone di un indirizzo pubblico ma si è "dietro" una NAT
  - Facile da configurare
  - Non modifico impostazioni della scheda di rete

Formato dati in JSON

:352d:cad2]:5683

aaaa::900:f4ff:352d:cad2]:5683/test/json

cover | GET | POST | PUT | DELETE | Observe | Payload | Behavior

tent (Blockwise) (Download finished)

Header	Value
Type	ACK
Code	2.05 Content
MID	17979
Token	empty

Option	Value	Info
ETag	0x2A	1 byte
Content-Format	application/json	50
Block2	1 (32 B/block)	1 byte

Combined Payload (42)

Incoming | Rendered | Outgoing

```
{
  Sens_temperature:
  [ (length 2)
    24.5
    32.1
  ]
}
```

Debug Control

Accept

Content-Format

Block1 (Req.)

Size1

Observe

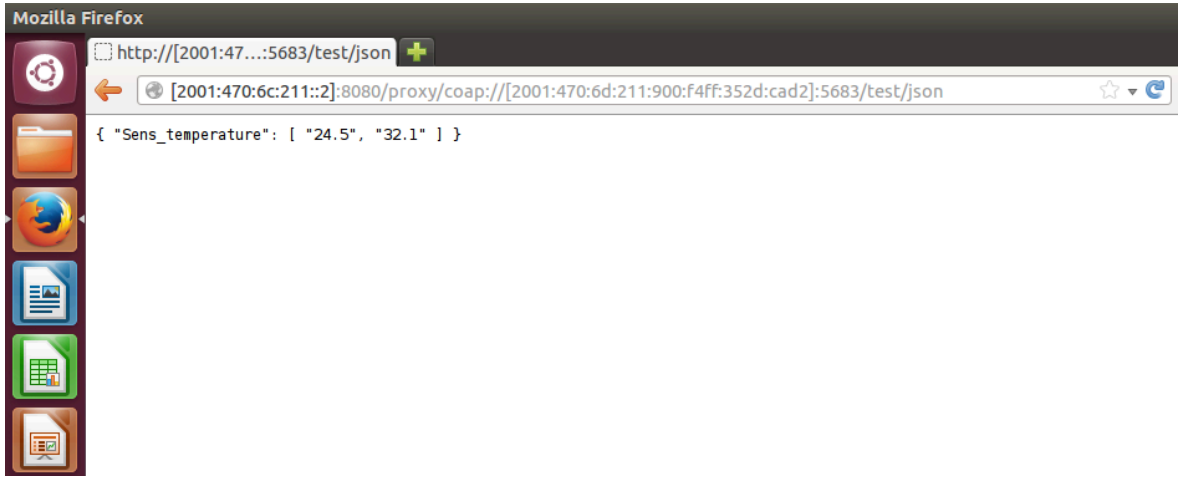
P Message	MID	Token	Options	Payload
-GET	17978 (0)	empty	Uri-Path: test/json, Block2: 0/0/32	
2.05 Content	17978	empty	ETag: 0x2A, Content-Format: 50, Block2: 0/1/32	{"Sens_temperature": ["24.5",
-GET	17979 (0)	empty	Uri-Path: test/json, Block2: 1/0/32	
2.05 Content	17979	empty	ETag: 0x2A, Content-Format: 50, Block2: 1/0/32	"32.1"]}

Border router su Raspberry

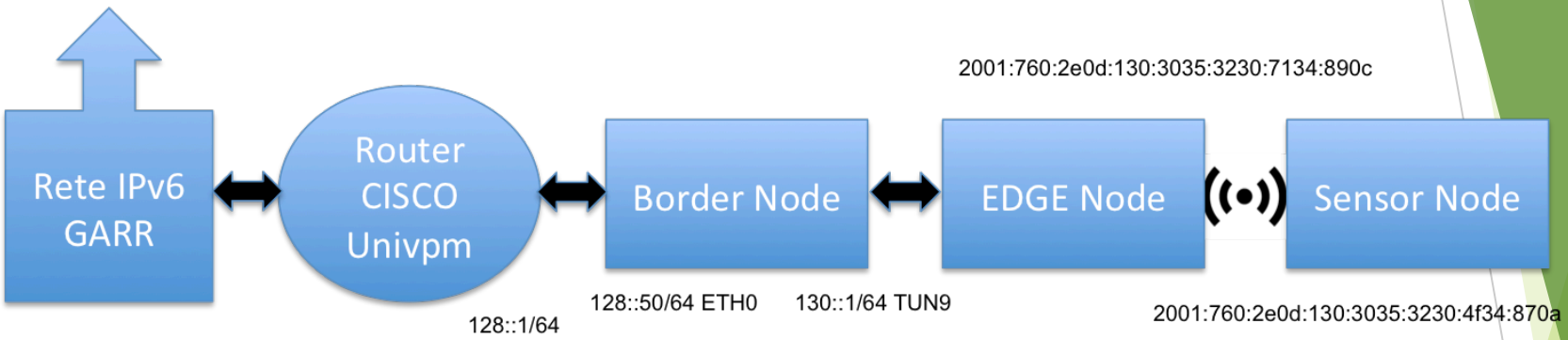
- Sostituzione del PC con un modulo portabile
- Ambiente Linux
- Controllo remoto tramite SSH

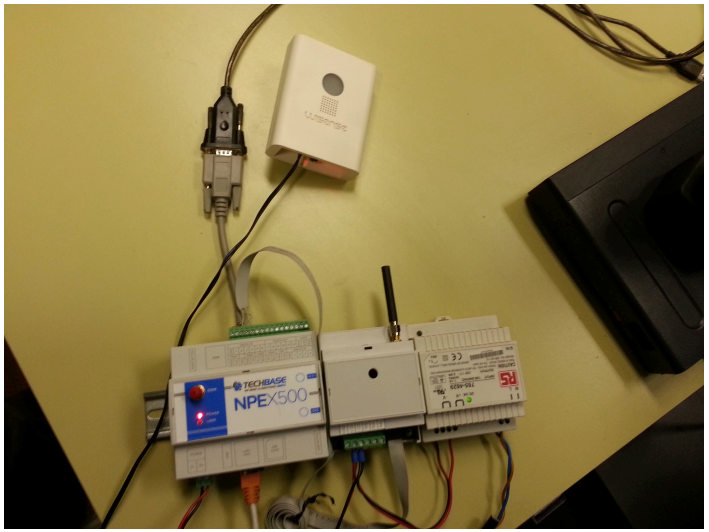
Proxy Californium

- Proxy HTTP-CoAP
- Possibilità di utilizzo dai comuni browser senza Copper
- Framework Java



Connessione alla rete GARR

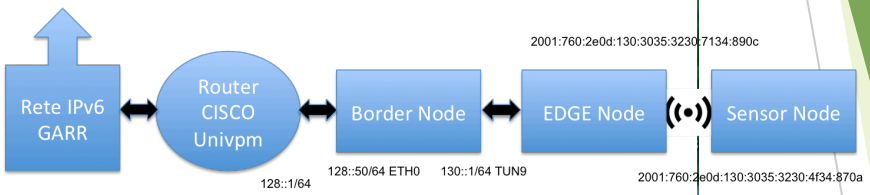




Test della connessione alla rete GARR da PC nella rete

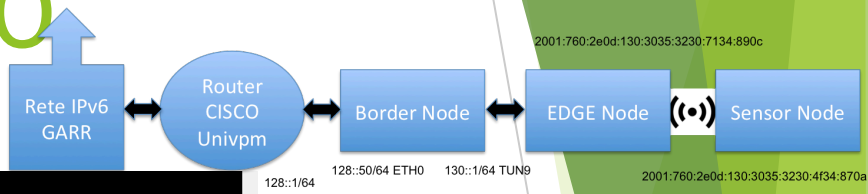
Lorenzo — bash — 204×55

```
^Z
[2]+  Stopped                 ping6 2001:760:2e0d:130:3035:3230:7134:890c
MacBook-Pro-di-Lorenzo:~ Lorenzo$ ping6 2001:760:2e0d:128::1
PING6(56=40+8+8 bytes) 2001:760:2e0d:128:e4d:e9ff:fed0:e273 --> 2001:760:2e0d:128::1
16 bytes from 2001:760:2e0d:128::1, icmp_seq=0 hlim=64 time=4.294 ms
16 bytes from 2001:760:2e0d:128::1, icmp_seq=1 hlim=64 time=0.394 ms
16 bytes from 2001:760:2e0d:128::1, icmp_seq=2 hlim=64 time=0.398 ms
16 bytes from 2001:760:2e0d:128::1, icmp_seq=3 hlim=64 time=0.360 ms
^Z
[3]+  Stopped                 ping6 2001:760:2e0d:128::1
MacBook-Pro-di-Lorenzo:~ Lorenzo$ ping6 2001:760:2e0d:128::50
PING6(56=40+8+8 bytes) 2001:760:2e0d:128:e4d:e9ff:fed0:e273 --> 2001:760:2e0d:128::50
16 bytes from 2001:760:2e0d:128::50, icmp_seq=0 hlim=64 time=1.844 ms
16 bytes from 2001:760:2e0d:128::50, icmp_seq=1 hlim=64 time=0.831 ms
16 bytes from 2001:760:2e0d:128::50, icmp_seq=2 hlim=64 time=0.847 ms
16 bytes from 2001:760:2e0d:128::50, icmp_seq=3 hlim=64 time=0.855 ms
^Z
[4]+  Stopped                 ping6 2001:760:2e0d:128::50
MacBook-Pro-di-Lorenzo:~ Lorenzo$ ping6 2001:760:2e0d:130::1
PING6(56=40+8+8 bytes) 2001:760:2e0d:128:7c46:f18a:7015:f61b --> 2001:760:2e0d:130::1
16 bytes from 2001:760:2e0d:130::1, icmp_seq=0 hlim=64 time=0.914 ms
16 bytes from 2001:760:2e0d:130::1, icmp_seq=1 hlim=64 time=0.851 ms
16 bytes from 2001:760:2e0d:130::1, icmp_seq=2 hlim=64 time=0.878 ms
16 bytes from 2001:760:2e0d:130::1, icmp_seq=3 hlim=64 time=0.983 ms
^Z
[5]+  Stopped                 ping6 2001:760:2e0d:130::1
MacBook-Pro-di-Lorenzo:~ Lorenzo$ ping6 2001:760:2e0d:130::3035:3230:7134:890c
ping6: getaddrinfo -- nodename nor servname provided, or not known
MacBook-Pro-di-Lorenzo:~ Lorenzo$ ping6 2001:760:2e0d:130:3035:3230:7134:890c
PING6(56=40+8+8 bytes) 2001:760:2e0d:128:7c46:f18a:7015:f61b --> 2001:760:2e0d:130:3035:3230:7134:890c
16 bytes from 2001:760:2e0d:130:3035:3230:7134:890c, icmp_seq=0 hlim=63 time=12.861 ms
16 bytes from 2001:760:2e0d:130:3035:3230:7134:890c, icmp_seq=1 hlim=63 time=12.668 ms
16 bytes from 2001:760:2e0d:130:3035:3230:7134:890c, icmp_seq=2 hlim=63 time=12.890 ms
16 bytes from 2001:760:2e0d:130:3035:3230:7134:890c, icmp_seq=3 hlim=63 time=12.924 ms
^Z
[6]+  Stopped                 ping6 2001:760:2e0d:130:3035:3230:7134:890c
MacBook-Pro-di-Lorenzo:~ Lorenzo$ ping6 2001:760:2e0d:130:3035:3230:4f34:870a
PING6(56=40+8+8 bytes) 2001:760:2e0d:128:7c46:f18a:7015:f61b --> 2001:760:2e0d:130:3035:3230:4f34:870a
16 bytes from 2001:760:2e0d:130:3035:3230:4f34:870a, icmp_seq=0 hlim=62 time=81.949 ms
16 bytes from 2001:760:2e0d:130:3035:3230:4f34:870a, icmp_seq=1 hlim=62 time=58.843 ms
16 bytes from 2001:760:2e0d:130:3035:3230:4f34:870a, icmp_seq=2 hlim=62 time=58.765 ms
16 bytes from 2001:760:2e0d:130:3035:3230:4f34:870a, icmp_seq=3 hlim=62 time=59.486 ms
^Z
[7]+  Stopped                 ping6 2001:760:2e0d:130:3035:3230:4f34:870a
MacBook-Pro-di-Lorenzo:~ Lorenzo$ ping6 ipv6sensor.univpm.it
PING6(56=40+8+8 bytes) 2001:760:2e0d:128:7c46:f18a:7015:f61b --> 2001:760:2e0d:130:3035:3230:4f34:870a
16 bytes from 2001:760:2e0d:130:3035:3230:4f34:870a, icmp_seq=0 hlim=62 time=58.658 ms
16 bytes from 2001:760:2e0d:130:3035:3230:4f34:870a, icmp_seq=1 hlim=62 time=58.628 ms
16 bytes from 2001:760:2e0d:130:3035:3230:4f34:870a, icmp_seq=2 hlim=62 time=58.599 ms
16 bytes from 2001:760:2e0d:130:3035:3230:4f34:870a, icmp_seq=3 hlim=62 time=58.721 ms
^X16 bytes from 2001:760:2e0d:130:3035:3230:4f34:870a, icmp_seq=4 hlim=62 time=58.733 ms
16 bytes from 2001:760:2e0d:130:3035:3230:4f34:870a, icmp_seq=5 hlim=62 time=58.546 ms
^Z
[8]+  Stopped                 ping6 ipv6sensor.univpm.it
MacBook-Pro-di-Lorenzo:~ Lorenzo$
```



1. 2001:760:2e0d:128::1 (Router CISCO)
2. 2001:760:2e0d:128::50 (Border-Ethernet)
3. 2001:760:2e0d:130::1 (Border-rete mesh)
4. 2001:760:2e0d:130:3035:3230:7134:890c (EDGE Node)
5. 2001:760:2e0d:130:3035:3230:4f34:870a (Sensore)
6. Per la verifica del DNS il sensore IPv6 noto come ipv6sensor.univpm.it (Sensore)

Test della connessione IPv6 al GARR da Router CISCO




```
       IS - ISIS summary, D - EIGRP, EX - EIGRP external, NM - NEMO
       ND - ND Default, NDp - ND Prefix, DCE - Destination, NDr - Redirect
       O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
       ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2, l - LISP
S   ::/0 [1/0]
     via 2001:760:FFFF:140::
C   2001:760:2E0D:128::/64 [0/0]
     via GigabitEthernet0/3, directly connected
L   2001:760:2E0D:128::1/128 [0/0]
     via GigabitEthernet0/3, receive
S   2001:760:2E0D:130::/64 [1/0]
     via 2001:760:2E0D:128::50
C   2001:760:FFFF:140::/127 [0/0]
     via GigabitEthernet0/1, directly connected
L   2001:760:FFFF:140::1/128 [0/0]
     via GigabitEthernet0/1, receive
L   FF00::/8 [0/0]
     via Null0, receive
c7204vxr#ping 2001:760:2e0d:128::50
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:760:2E0D:128::50, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
c7204vxr#ping 2001:760:2e0d:130::1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:760:2E0D:130::1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
c7204vxr#ping ipv6 2001:760:2E0D:130:3035:3230:4F34:870A
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:760:2E0D:130:3035:3230:4F34:870A, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 104/107/108 ms
c7204vxr#traceroute ipv6 2001:760:2E0D:130:3035:3230:4F34:870A
Type escape sequence to abort.
Tracing the route to ipv6sensor.univpm.it (2001:760:2E0D:130:3035:3230:4F34:870A)

  1 2001:760:2E0D:128:8552:EC0D:9F8:8241 0 msec 0 msec 0 msec
  2 2001:760:2E0D:130:3035:3230:7134:890C 16 msec 12 msec 12 msec
```


Lorenzo Palma

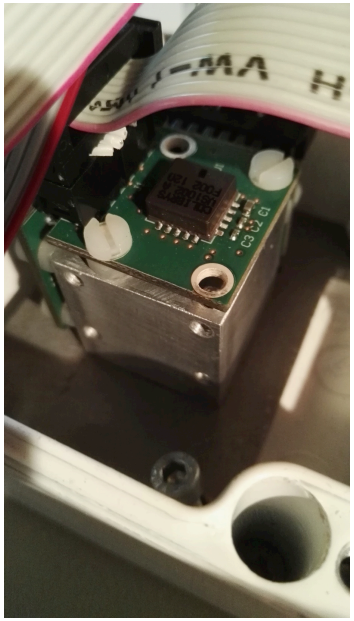
Collaborazione INGV

- Monitoraggio sismico
- Monitoraggio strutturale
- Sistemi di Early Warning

INGV

Sensore sviluppato

- Accelerometro
  - Analisi della propagazione dell'onda sismica
  - Monitoraggio strutturale
  - Creazione di shake map
  - Creazione di sistemi di Early Warning
  - Noise < 5μg/√Hz per suolo
  - Noise < 25μg/√Hz per piani alti



Installazione all'UNIVPM

Proposta di sviluppo per eventuale proroga

- 1. Estensione della numerosità dei sensori ambientali per creare una demo di test fruibile da remoto da chiunque sia autorizzato all'accesso.
- 2. Analisi finale delle prestazioni del sensore accelerometrico per monitoraggio sismico/strutturale, eventuali miglioramenti, progettazione del sistema di acquisizione collegato in IPv6
- 3. Implementazione in laboratorio della rete di sensori per il monitoraggio sismico/strutturale e individuazione del sito di installazione presso l'UNIVPM
- 4. Installazione del sistema di sensori IPv6 per monitoraggio strutturale e definizione di un servizio remoto per l'interazione con i sensori e l'analisi dei dati raccolti