

a framework for
observing nodes' behavior
in IoT validation platforms

Orange Labs

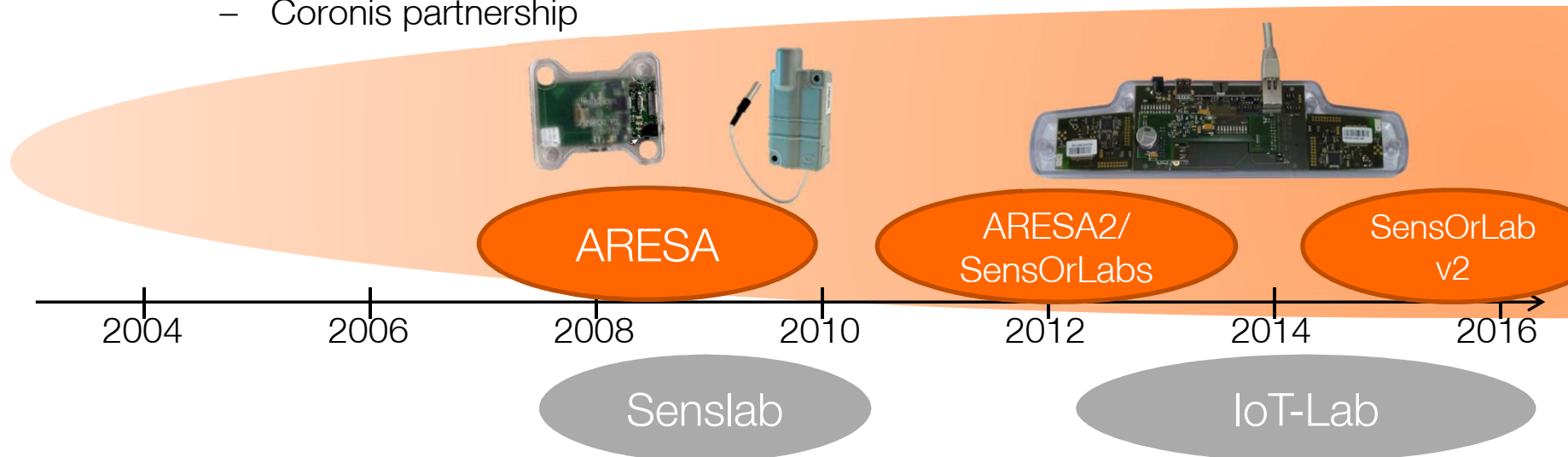
Quentin Lampin, Dominique Barthel
Nov 6th 2014, "IoT workshop" at INRIA, Montbonnot

Agenda

- part 1 a look back
- part 2 SensOrLabs
- part 3 an observability toolchain
- part 4 some results
- part 5 the way forward

A look back: project knitting

- Orange Labs working on WSN protocols since 2002
- ARESA1 demo (2008)
 - 86 nodes, full source code, in-band limited monitoring
- ARESA1 demo (2009)
 - 56 nodes, Coronis black-box radio, in-band limited monitoring
- Dec 2013 OLRE / ARESA2 demo
 - a 82-node fully observable platform (SensOrLabs)
 - out of band monitoring, systemic approach to observability
 - Coronis partnership

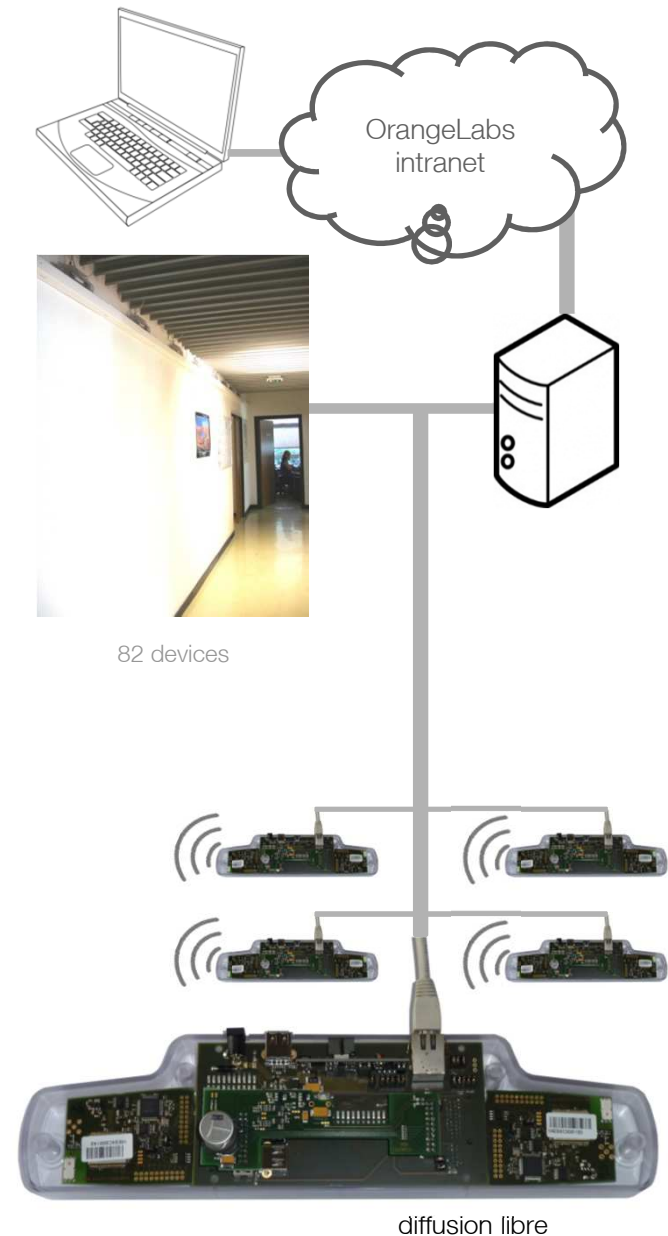


the SensOrLabs platform

- largely Senslab-inspired, but
 - rewrote infrastructure software
 - redesigned “gateway” board assembly
 - redesigned power monitoring board
 - hosts Elster/Coronis Excelyo nodes
- 82 nodes at Orange Labs Meylan
 - plugged into any site Ethernet socket

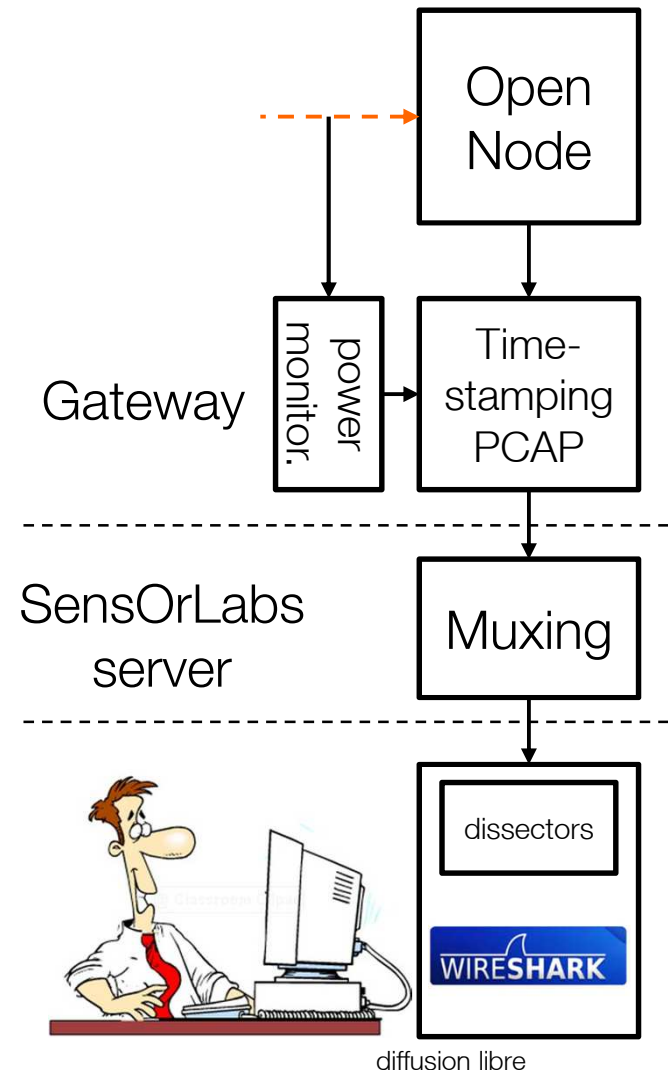


AGENCE NATIONALE DE LA RECHERCHE
ANR ARESA2



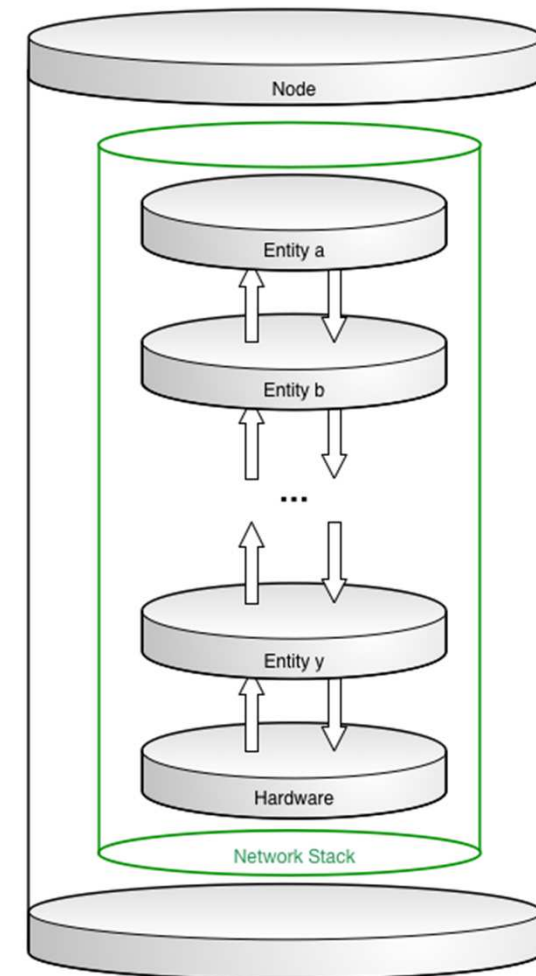
an observability toolchain

- a major hand-holding effort
- open node code instrumentation
- power monitoring processed similarly
- event timestamping
- PCAP encapsulation
- flow multiplexing
- Wireshark as a general event browsing and display tool



an underlying model for the network

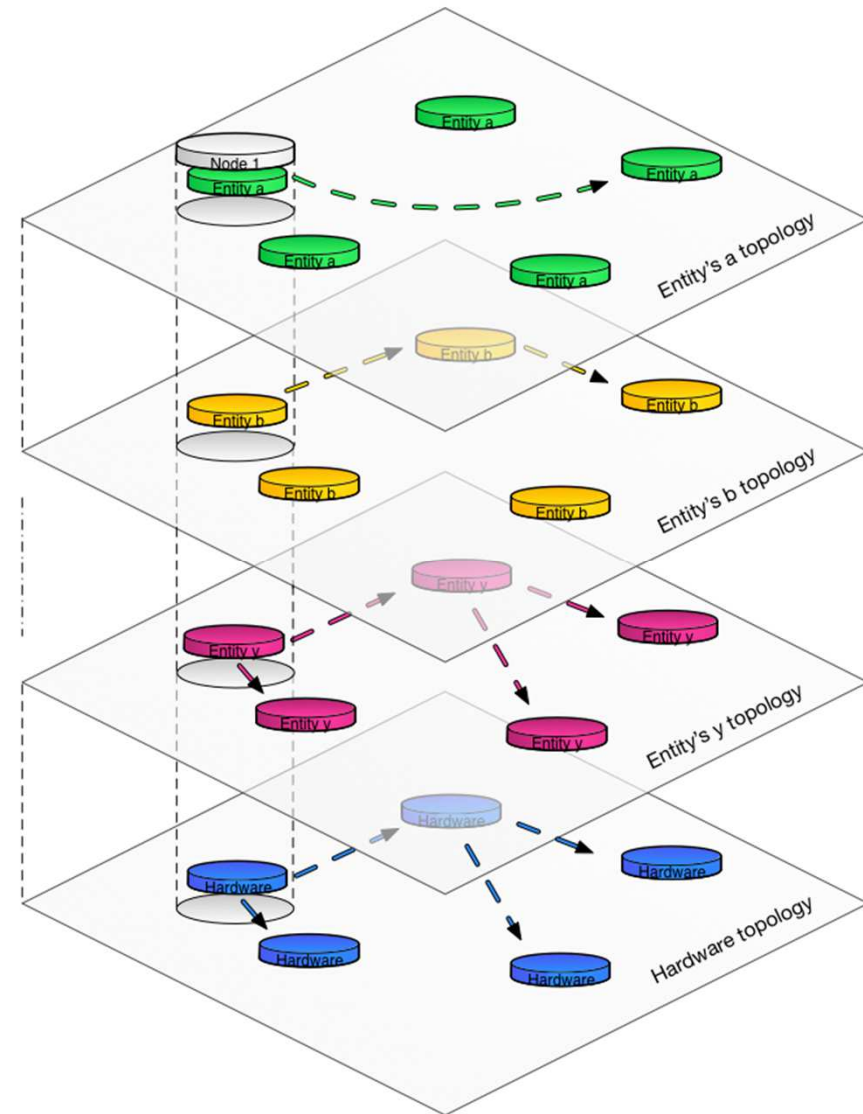
- nodes, entities



an underlying model for the network (2)

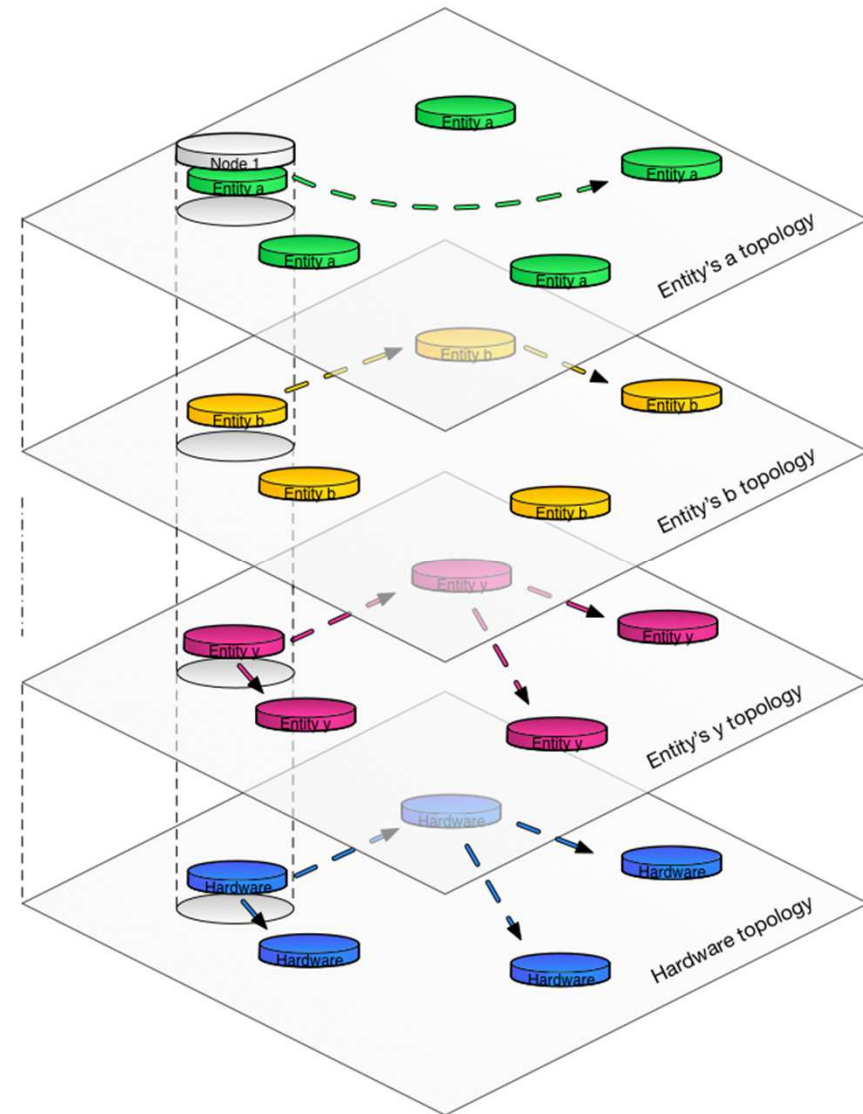
- nodes, entities
- links
- packets

- already applied to very different comm. stacks



a taxonomy of observability events

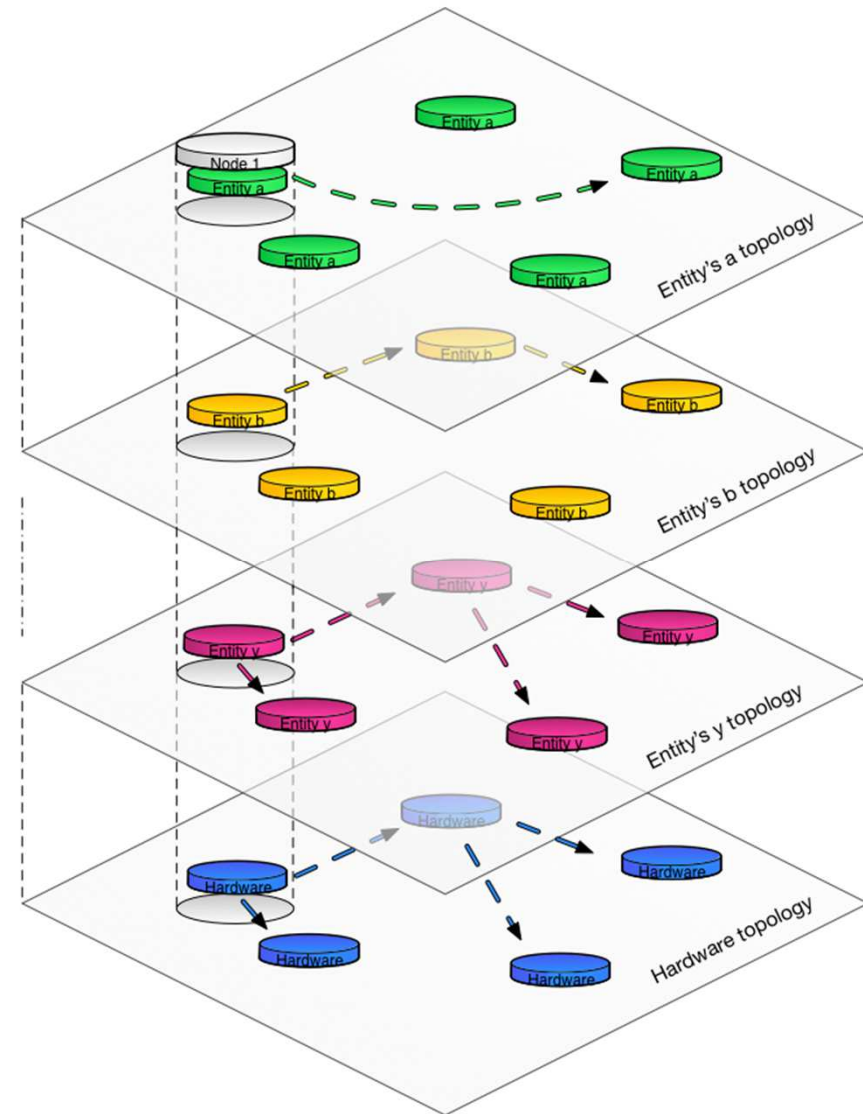
Event name	Hexadecimal value (1 byte)
EVENT_NODE_ADD	0x00
EVENT_NODE_PROPERTY_ADD	0x01
EVENT_NODE_PROPERTY_UPDATE	0x02
EVENT_NODE_REMOVE	0x03
EVENT_ENTITY_ADD	0x10
EVENT_ENTITY_PROPERTY_ADD	0x11
EVENT_ENTITY_PROPERTY_UPDATE	0x12
EVENT_ENTITY_REMOVE	0x13



a taxonomy of observability events (2)

Event name	Hexadecimal value	
EVENT_LINK_ADD	0x20	
EV		
EVENT_LINK_PROPERTY_ADD	0x21	
EV		
EVENT_LINK_PROPERTY_UPDATE	0x22	
EV		
EVENT_LINK_REMOVE	0x23	
EV		
EVENT_FRAME_PRODUCE	0x30	
EV		
EVENT_FRAME_PROPERTY_ADD	0x31	
EV		
EVENT_FRAME_PROPERTY_UPDATE	0x32	
EV		
EVENT_FRAME_DATA_UPDATE	0x33	
EV		
EVENT_FRAME_TX	0x34	
EV		
EVENT_FRAME_RX	0x35	
EV		
EVENT_FRAME_CONSUME	0x36	

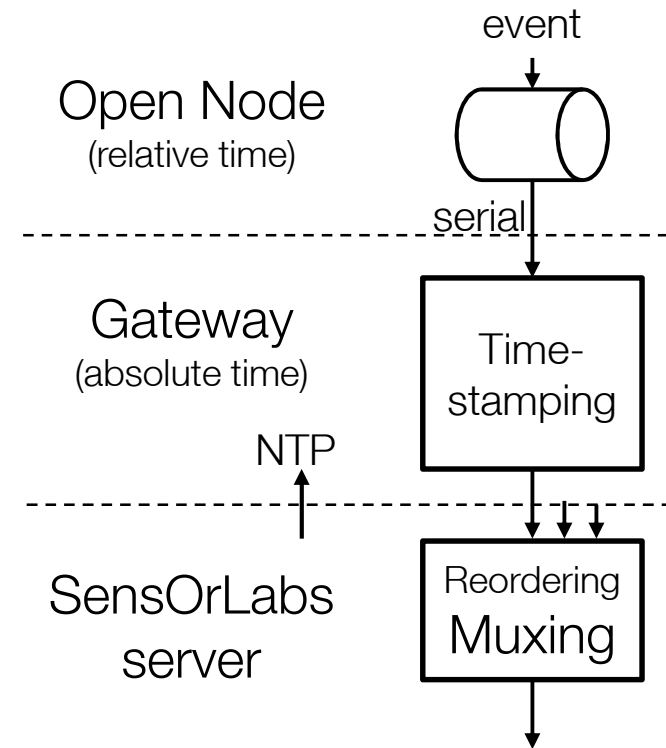
- Wireshark dissectors remain totally generic
 - assuming the network model



Staged timestamping and PCAP encapsulation

- log time spent in event buffer
 - in open node clock ticks
- compute serialization time
- insert (adjusted) absolute time

- restore platform-wide time monotonicity



Wireshark output

1109-2013-12-03-18h23m.pcap [Wireshark 1.10.2 (SVN Rev 51934 from /trunk-1.10)]

Filter: observability.event != NodeUpdate

Time	Node	Protocol	Event	Info	Type
2013-12-03 19:29:38.61790800	23	6LowWave	NotifyFrameTx	[2.5] 6LowWave notifies frame with local ID: 71	Observability message
2013-12-03 19:29:38.62233100	23	WavenisMAC	NotifyFrameTx	[2] WavenisMAC notifies frame with local ID: 71	Observability message
2013-12-03 19:29:38.68517300	23	Hardware	TransmitFrame	[1] Hardware transmit frame with local ID: 71	Observability message
2013-12-03 19:29:38.70180200	41	RPL	ConsumeFrame	[3] RPL consumes frame with local ID: 57 [type : DIO]	Observability message
2013-12-03 19:29:38.70673200	39	RPL	ConsumeFrame	[3] RPL consumes frame with local ID: 52 [type : DIO]	Observability message
2013-12-03 19:29:38.75609200	38	RPL	LinkAdd	[3] RPL adds link with targets: [localAddress : fe80::1ae0:4cff:fe30:171] with	Observability message
2013-12-03 19:29:38.75611200	37	RPL	ProduceFrame	[3] RPL produces frame with local ID: 55 [type : DAO]	Observability message
2013-12-03 19:29:38.77014600	37	6LowWave	NotifyFrameTx	[2.5] 6LowWave notifies frame with local ID: 55	Observability message
2013-12-03 19:29:38.77039100	37	WavenisMAC	NotifyFrameTx	[2] WavenisMAC notifies frame with local ID: 55	Observability message
2013-12-03 19:29:38.82806600	37	Hardware	TransmitFrame	[1] Hardware transmit frame with local ID: 55	Observability message
2013-12-03 19:29:38.89603700	38	RPL	LinkRemove	[3] RPL removes link with targets: [localAddress : fe80::1ae0:4cff:fe30:171]	Observability message
2013-12-03 19:29:38.90475500	38	RPL	ConsumeFrame	[3] RPL consumes frame with local ID: 59 [type : DIO]	Observability message
2013-12-03 19:29:39.08340600	27	RPL	ProduceFrame	[3] RPL produces frame with local ID: 54 [type : DAO]	Observability message
2013-12-03 19:29:39.09270500	27	6LowWave	NotifyFrameTx	[2.5] 6LowWave notifies frame with local ID: 54	Observability message
2013-12-03 19:29:39.09754100	27	WavenisMAC	NotifyFrameTx	[2] WavenisMAC notifies frame with local ID: 54	Observability message
2013-12-03 19:29:39.15541300	27	Hardware	TransmitFrame	[1] Hardware transmit frame with local ID: 54	Observability message
2013-12-03 19:29:39.22624100	56	RPL	ProduceFrame	[3] RPL produces frame with local ID: 64 [type : DIO]	Observability message
2013-12-03 19:29:39.23548700	56	6LowWave	NotifyFrameTx	[2.5] 6LowWave notifies frame with local ID: 64	Observability message
2013-12-03 19:29:39.24036800	56	WavenisMAC	NotifyFrameTx	[2] WavenisMAC notifies frame with local ID: 64	Observability message
2013-12-03 19:29:39.29769600	31	RPL	ProduceFrame	[3] RPL produces frame with local ID: 51 [type : DAO]	Observability message
2013-12-03 19:29:39.30219300	56	Hardware	TransmitFrame	[1] Hardware transmit frame with local ID: 64	Observability message
2013-12-03 19:29:39.30702400	31	6LowWave	NotifyFrameTx	[2.5] 6LowWave notifies frame with local ID: 51	Observability message

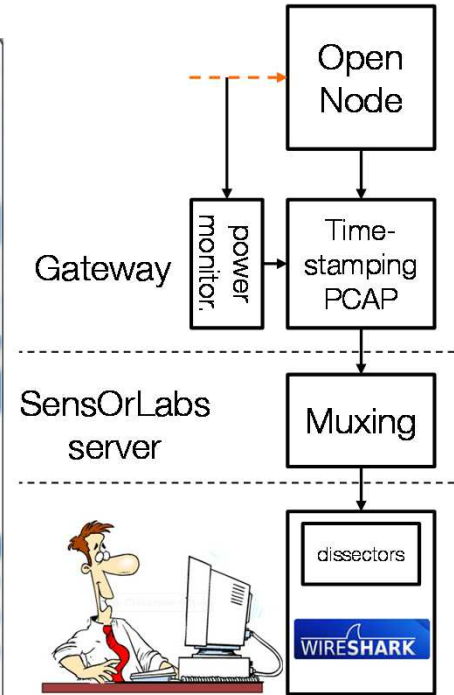
Selected packet details:

- Internet Protocol Version 6, Src: fe80::1ae0:4cff:fe30:149 (fe80::1ae0:4cff:fe30:149), Dst: fe80::1ae0:4cff:fe30:15f (fe80::1ae0:4cff:fe30:15f)
- Version: 6
- Traffic class: 0x00000000
- FlowLabel: 0x00000000
- Payload length: 50
- Next header: ICMPv6 (58)
- Hop limit: 64
- Source: fe80::1ae0:4cff:fe30:149 (fe80::1ae0:4cff:fe30:149)
- Destination: fe80::1ae0:4cff:fe30:15f (fe80::1ae0:4cff:fe30:15f)
- Type: RPL Control (155)
- Code: 2 (Destination Advertisement Object)
- Checksum: 0xbcc8 [correct]
- RPLInstanceID: 0
- Flags: 0x80
- Reserved: 00

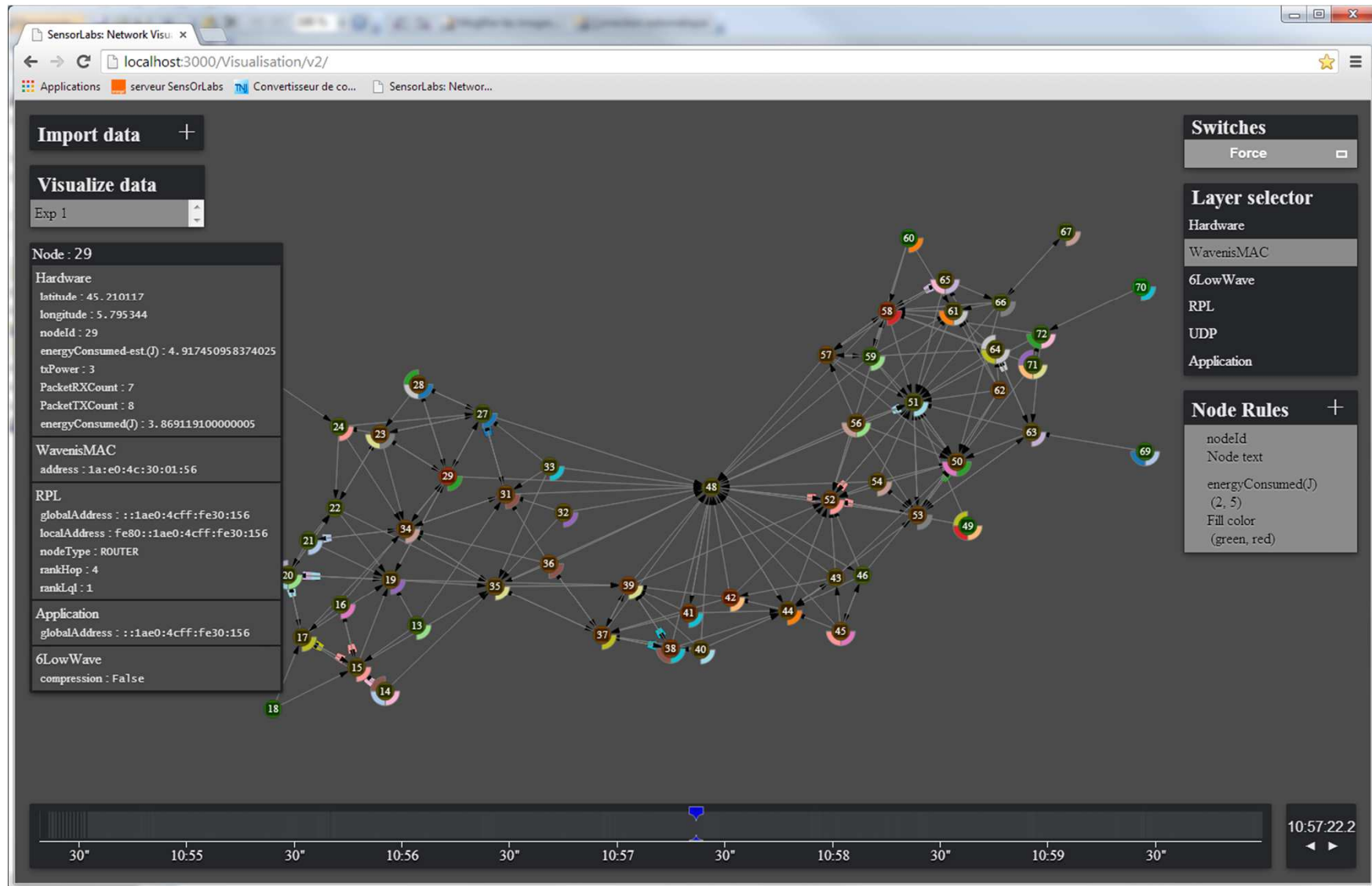
Packet bytes:

```

0000 1b 00 88 9b 00 09 00 f4 0b 01 00 36 00 5a 00 60 .....6.Z.
0010 00 00 00 00 32 3a 40 fe 80 00 00 00 00 00 00 1a .....2:@.
0020 e0 4c ff fe 30 01 49 fe 80 00 00 00 00 00 00 1a ...L.O.
0030 e0 4c ff fe 30 01 5f 9b 02 bc c8 00 80 00 10 05 ...L.O.
0040 12 00 80 00 00 00 00 00 00 00 00 00 00 00 00 00 ...L.
0050 30 01 49 06 14 00 00 00 ff 00 00 00 00 00 00 00 ...L.
0060 00 1a e0 4c ff fe 30 01 5f 0c 00 05 00 04 00 74 ...L.O.
0070 79 70 65 00 44 41 4f 00 .....type.DAO
    
```



Orange Labs Network visualizer



The way forward

- Make observability event specifications **public**
- Submit Wireshark dissectors for commit

- Provide **Open Source** observability libraries
 - Contiki, TinyOS, RIOT, FreeRTOS
 - might use a little help on this one

- Version 2 of SensOrLab
 - “standard” open node interface
 - more generic gateways (e.g. Raspberry Pis)
 - GPS synchronization, enhanced timestamping/reordering

thank you