

a framework for
observing nodes' behavior
in IoT validation platforms

Orange Labs

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Agenda

part 1 IoT protocol validation platforms

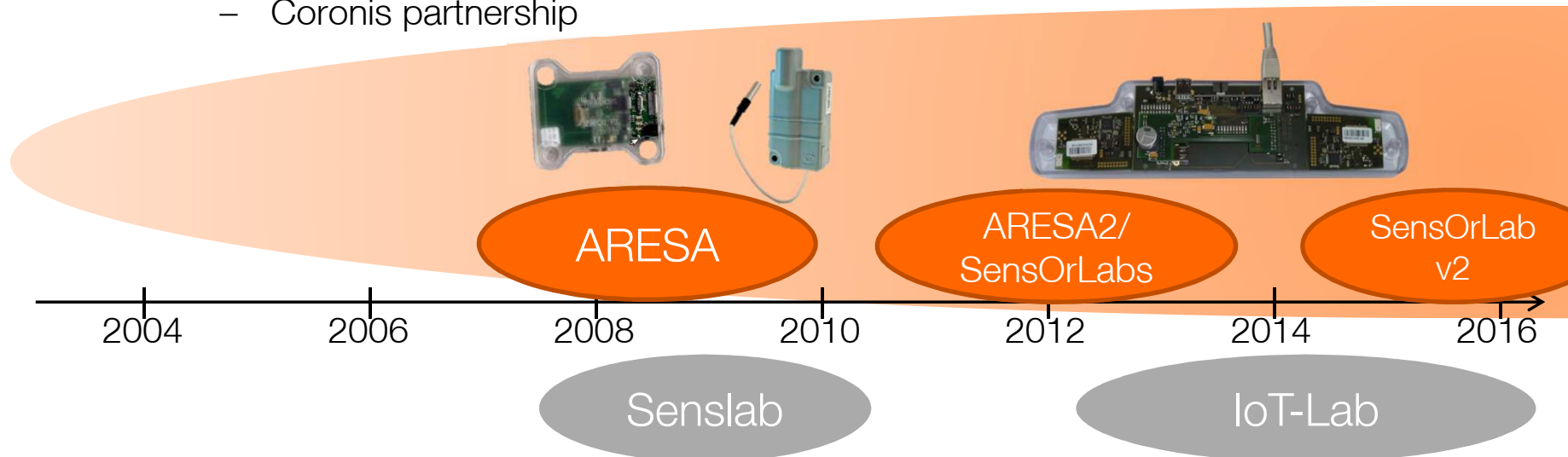
part 2 an observability toolchain

part 3 some results

part 4 the way forward

IoT networks protocol validation, a look back

- 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

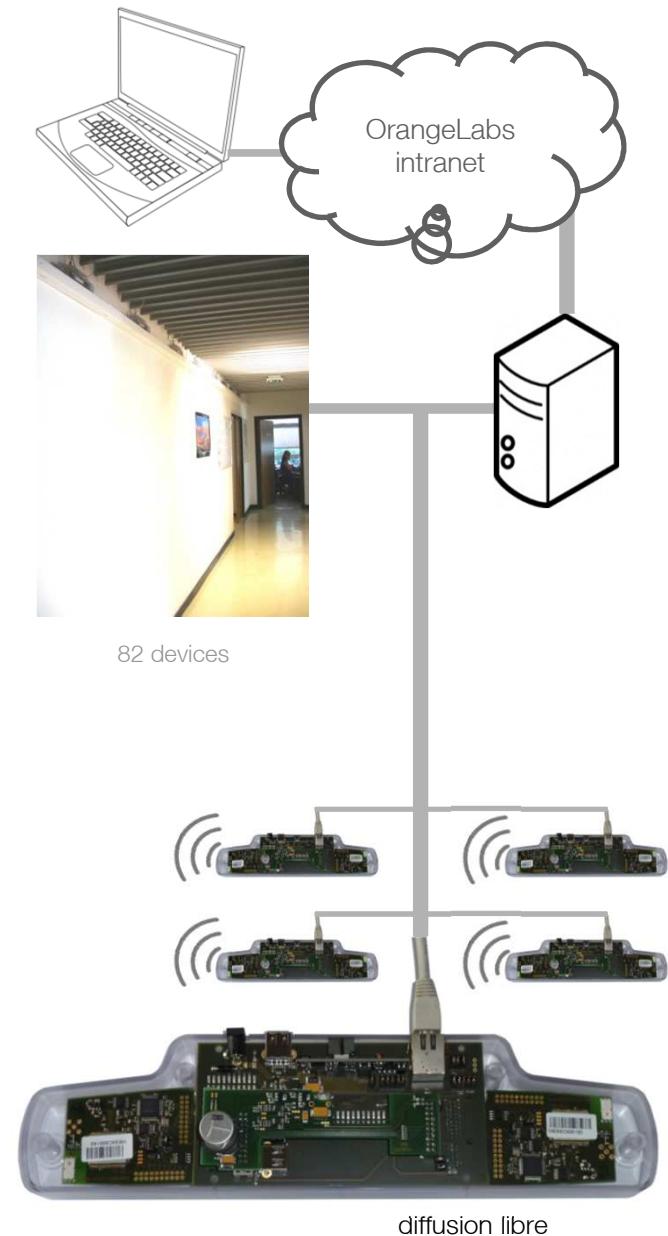


the SensOrLabs platform

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

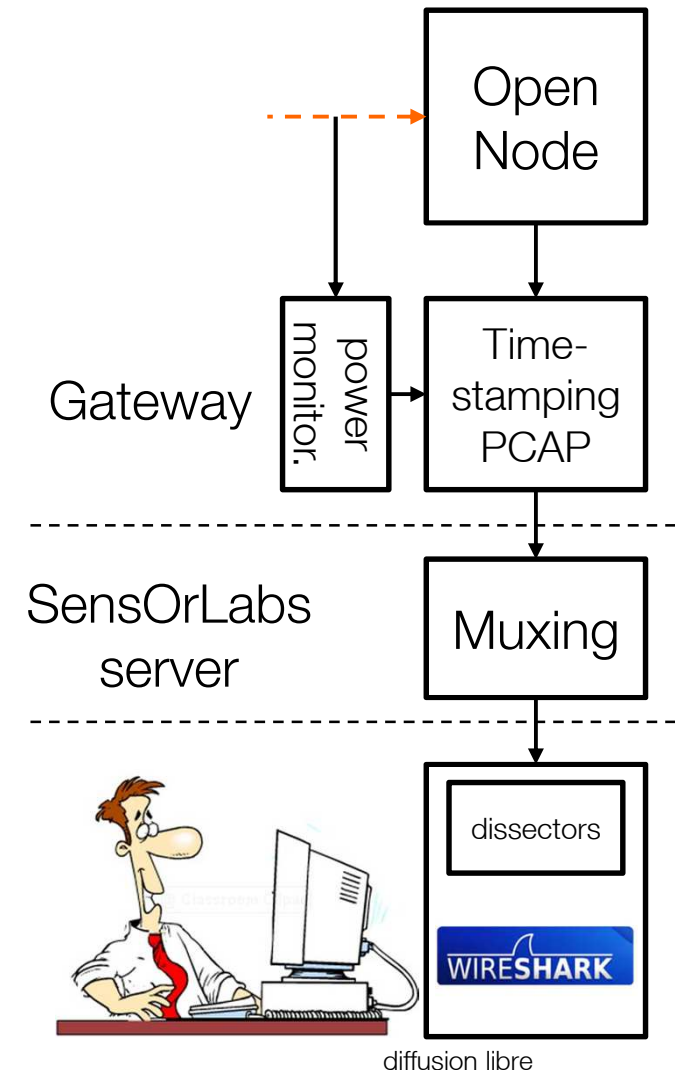


AGENCE NATIONALE DE LA RECHERCHE
ANR ARESA2



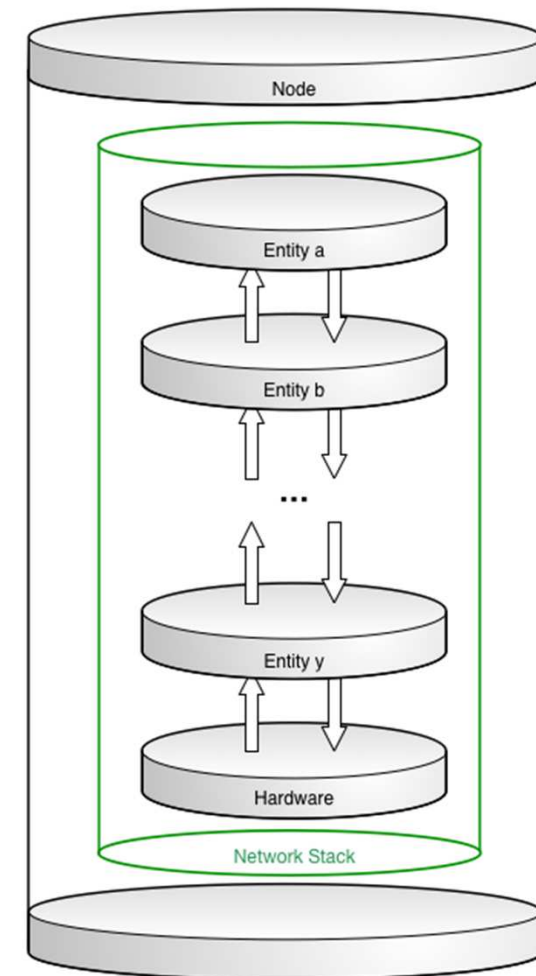
an observability toolchain

- a major hand-holding effort
- open node code instrumentation
- observability message compression
- 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

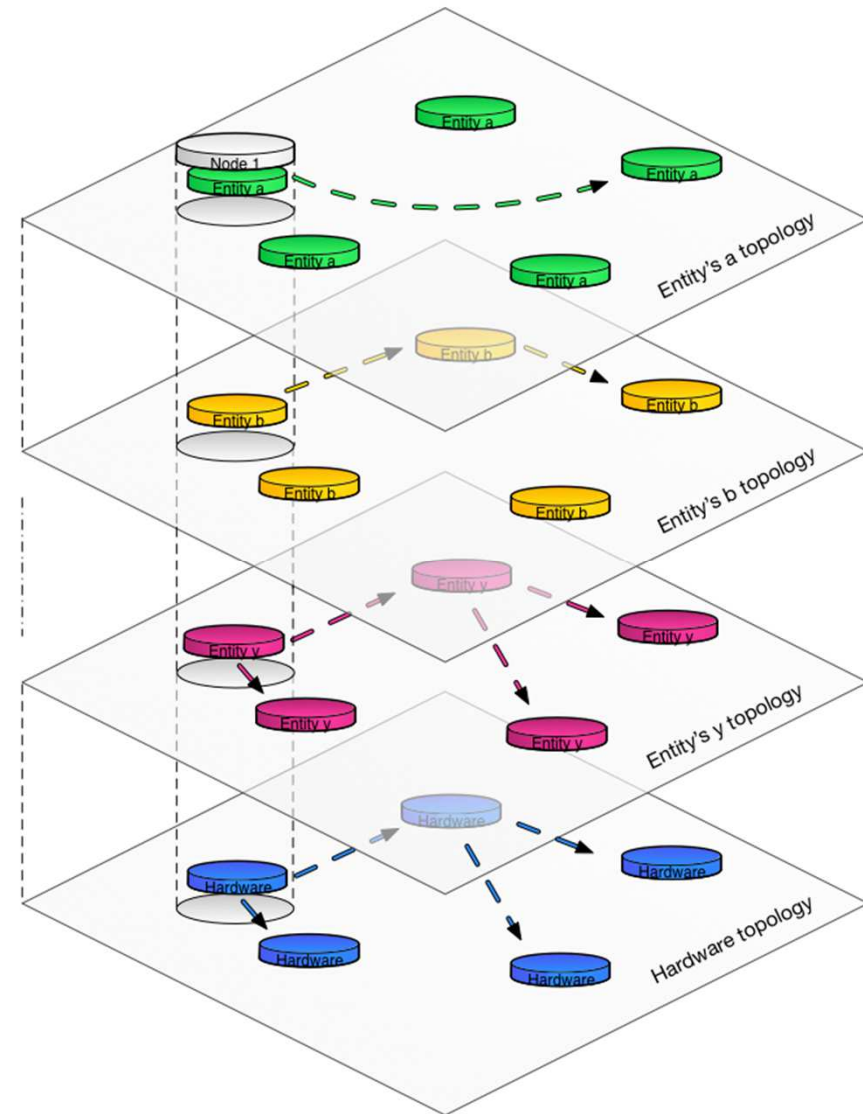
- nodes, entities



an underlying model for the network (2)

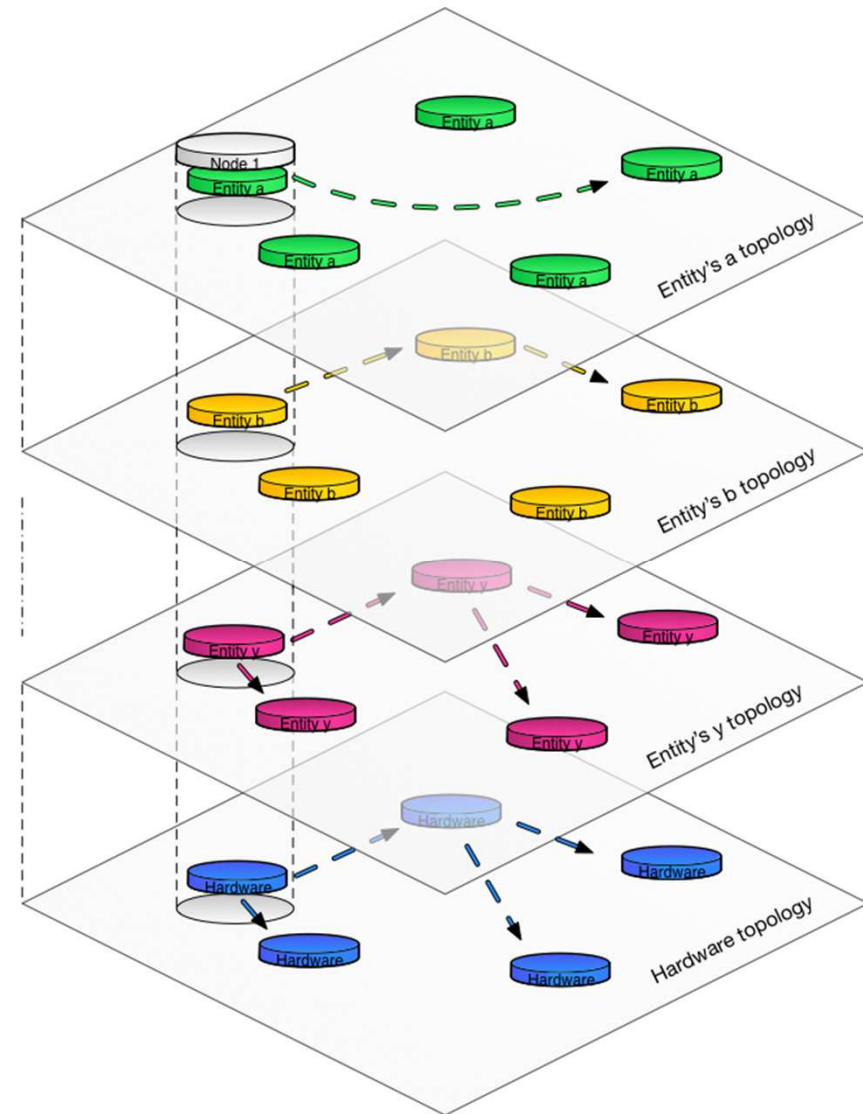
- nodes, entities
- links
- packets

- already applied to very different comm. stacks



a taxonomy of observability events

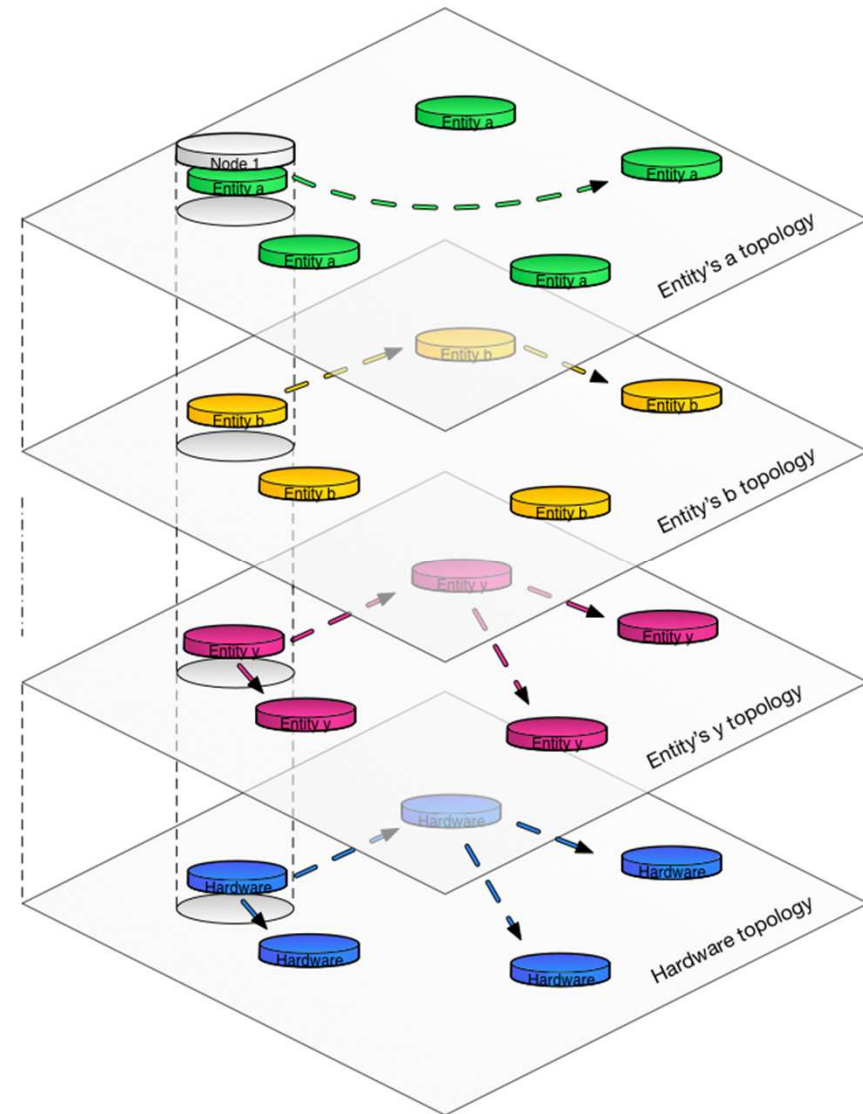
Event name	Hexadecimal value (1 byte)
EVENT_NODE_ADD	0x00
EVENT_NODE_PROPERTY_ADD	0x01
EVENT_NODE_PROPERTY_UPDATE	0x02
EVENT_NODE_REMOVE	0x03
EVENT_ENTITY_ADD	0x10
EVENT_ENTITY_PROPERTY_ADD	0x11
EVENT_ENTITY_PROPERTY_UPDATE	0x12
EVENT_ENTITY_REMOVE	0x13



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

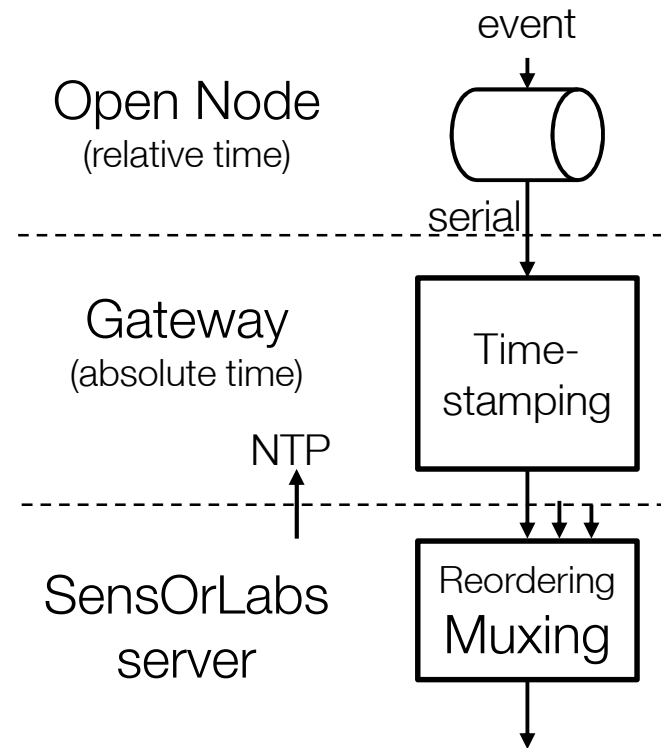
- Wireshark dissectors remain totally generic
 - assuming the network model



Staged timestamping and PCAP encapsulation

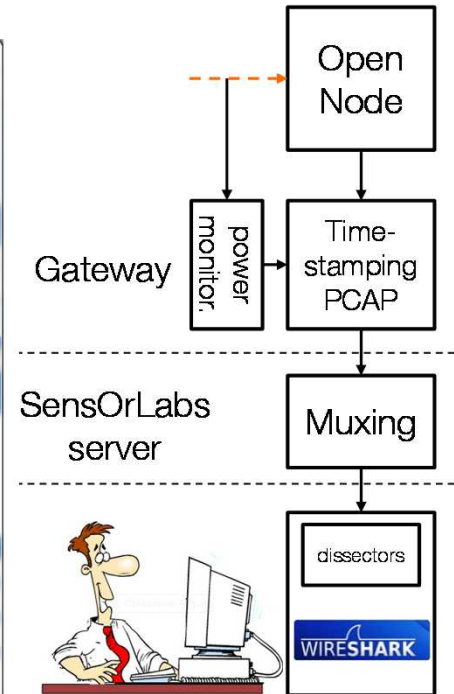
- log time spent in event buffer
 - in open node clock ticks
- compute serialization time
- insert (adjusted) absolute time

- restore platform-wide time monotonicity

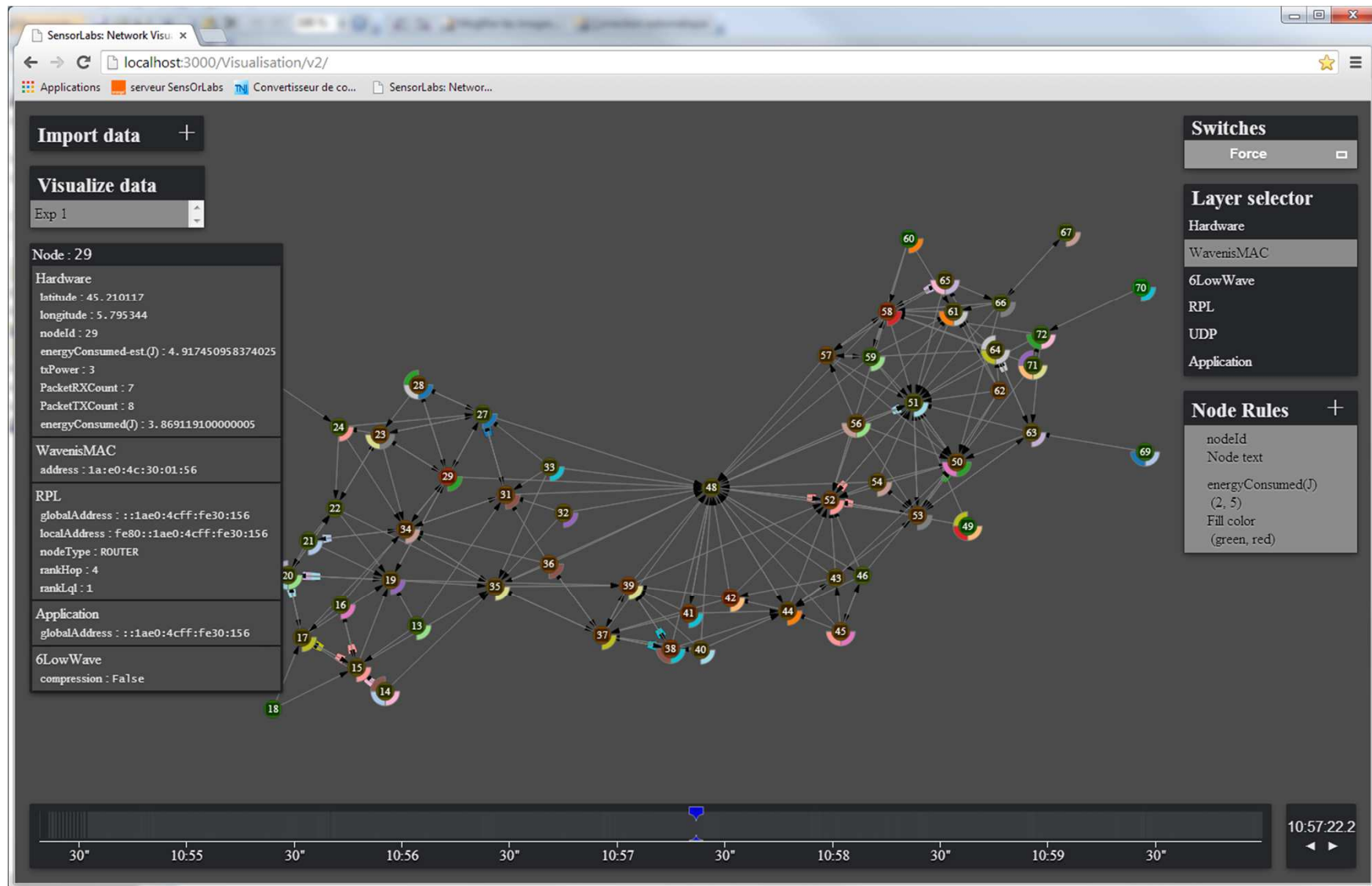


Wireshark output

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



Orange Labs Network visualizer



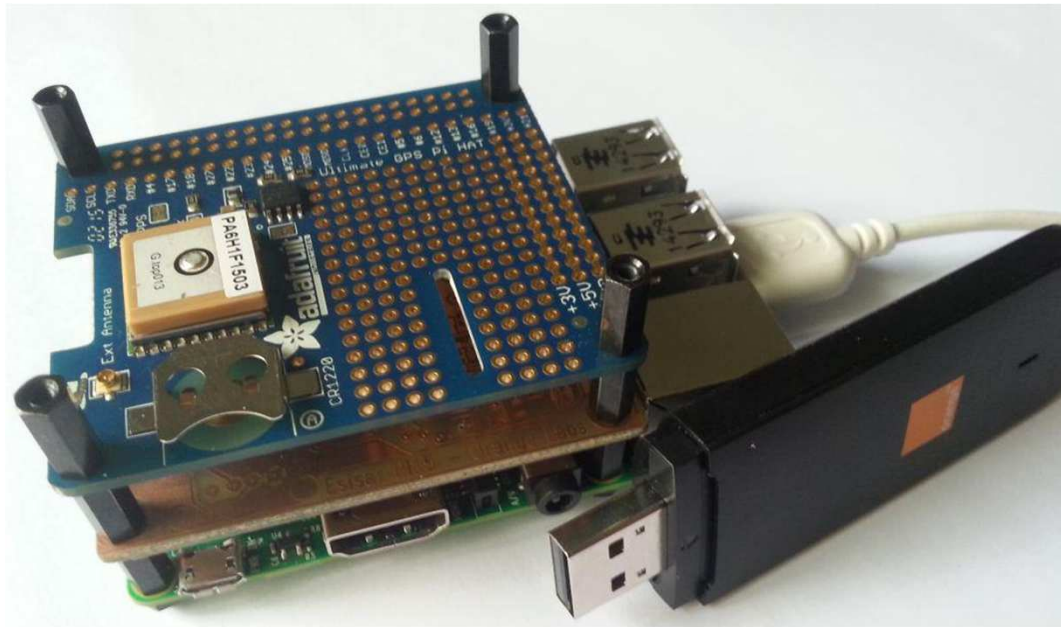
The way forward (1)

- Write “observability event format” specifications
- Make these specifications **public**
- Submit associated Wireshark dissectors for commit

- Provide **Open Source** observability libraries
 - OpenWSN, Contiki, TinyOS, RIOT, FreeRTOS
 - might use a little help on this
- Actually instrument some stacks
 - OpenWSN
 - Contiki
 - LoRaWAN

The way forward (2)

- Version 2 of SensOrLab
 - “standard” open node interface
 - more generic “gateway” board (Raspberry PI2)
 - GPS synchronization, enhanced timestamping/reordering
 - improved current sensing board (optional)



The way forward (3)

- Apply observability techniques to in-band monitoring research
 - completeness/cost trade-off
 - monitoring info compression
 - susceptibility to packet loss
 - blend into existing protocols

thank you