

***"Collecting Real Signals from WSNs"
Activity Report***

Riccardo Masiero

Objective

Generating two data structures as follows:

1)

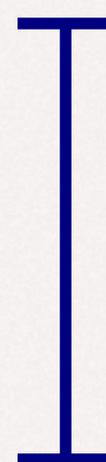
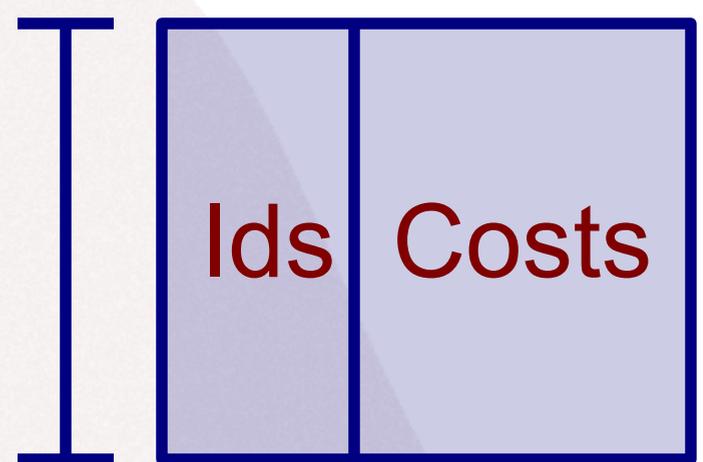


t time samples



N nodes

2)



Activity's Overview

- WSN Discovery
- Signal Collections
- Topology-Cost Generation

WSN Discovery

WSN deployment spotting



EPFL

LUCE

St Bernard



WSN Discovery

WSN deployment spotting

EPFL (meteo)



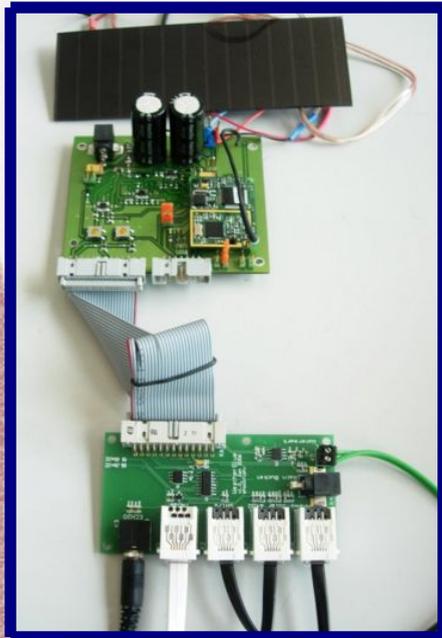
Measured signals:

- Ambient Temperature [$^{\circ}\text{C}$]
- Surface Temperature [$^{\circ}\text{C}$]
- Solar Radiation [W/m^2]
- Relative Humidity [%]
- Soil Moisture [%]
- Watermark [kPa]
- Rain Meter [mm]
- Wind Speed [m/s]
- Wind Direction [$^{\circ}$]

WSN Discovery

WSN deployment spotting

EPFL (monitoring)



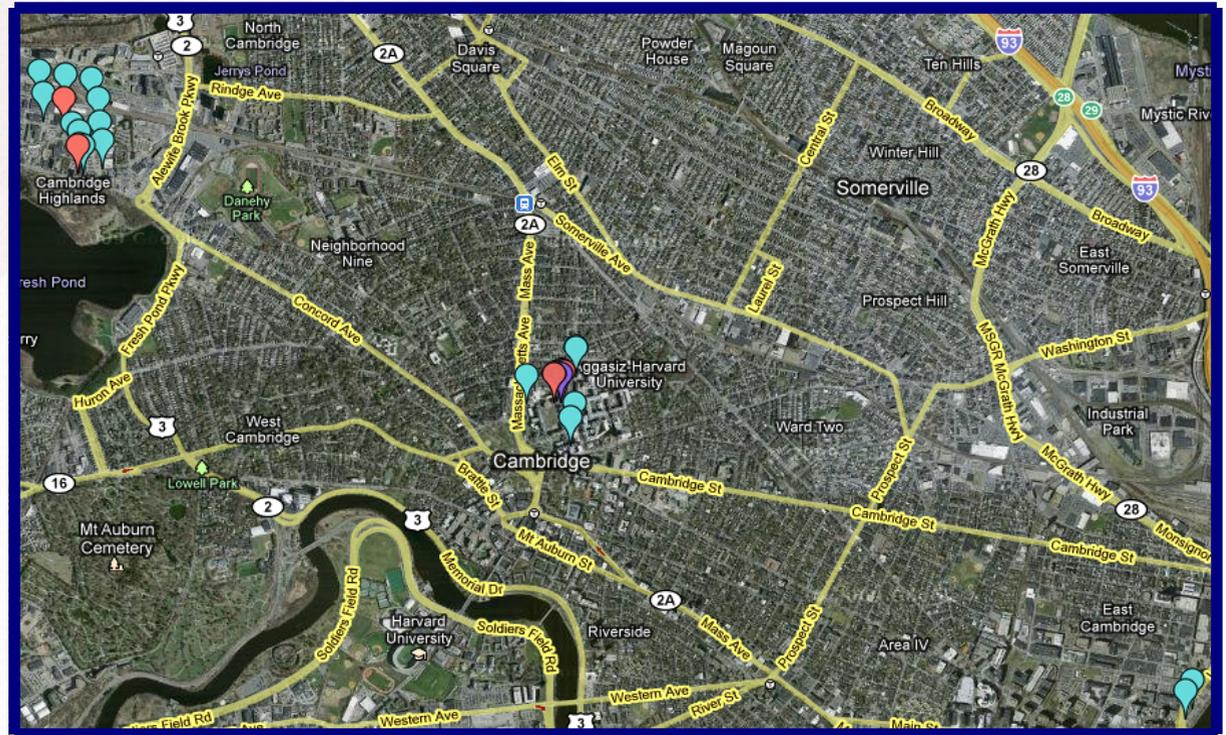
Measured signals:

- Primary Buffer Voltage [V]
- Secondary Buffer Voltage [V]
- Solar Panel Current [mA]
- Global Current [mA]

WSN Discovery

WSN deployment spotting

CitySense



Harvard University & BBN Technologies

WSN Discovery

WSN deployment spotting

CitySense



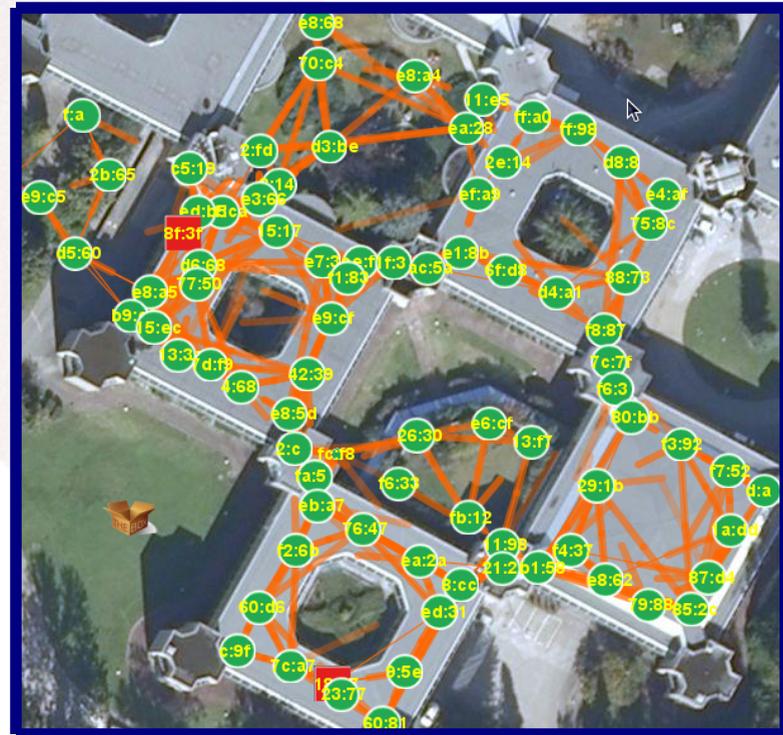
Measured signals:

- Air Pressure [hPa]
- Air Temperature [°F]
- Relative Humidity [%]
- Wind Direction [rad]
- Wind Speed [Km/h]
- Rain Amount [inch]
- Rain Duration [inch/h]
- Rain Intensity [inch Hg]
- CO2 Density (parts-per-million)
- Sound Level (db)

WSN Discovery

WSN deployment spotting

Orange Lab



France Telecom, INRIA, CITI Laboratory

WSN Discovery

WSN deployment spotting

Orange Lab



Measured signals:

- Battery [W, V, mA ?]
- Temperature [°C]
- Light [A/W ?]
- IR [A/W ?]

WSN Discovery

WSN deployment spotting

DEI



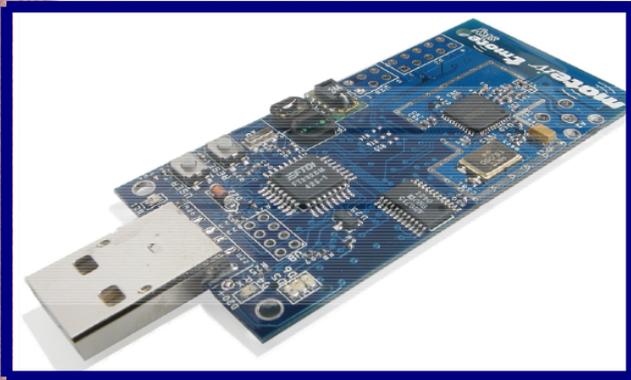
Padova University & CaRiPaRo

WSN Discovery

WSN deployment spotting

DEI

Measured signals:



- Temperature [$^{\circ}\text{C}$]
- Humidity [%RH]
- Voltage [V]
- Photo Sensitivity (320-730 nm) [A/W]
- Photo Sensitivity IR (320-1100 nm) [A/W]

Signal Collection

* WSNname

**MatLab
developed
tools**



**plot1
plot2**

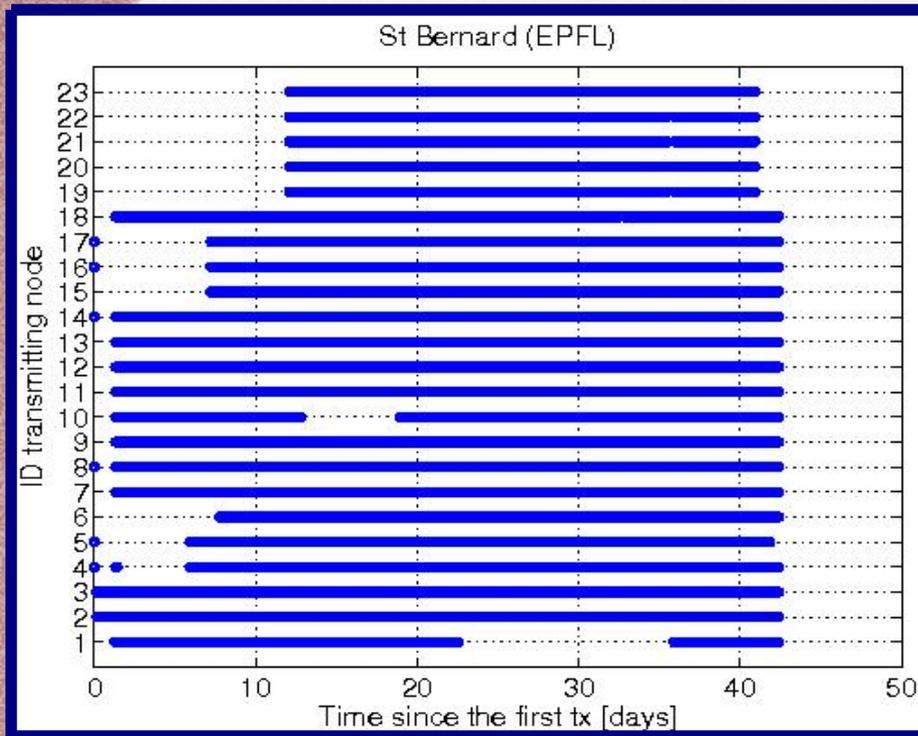


**dettagli
g_t_t**

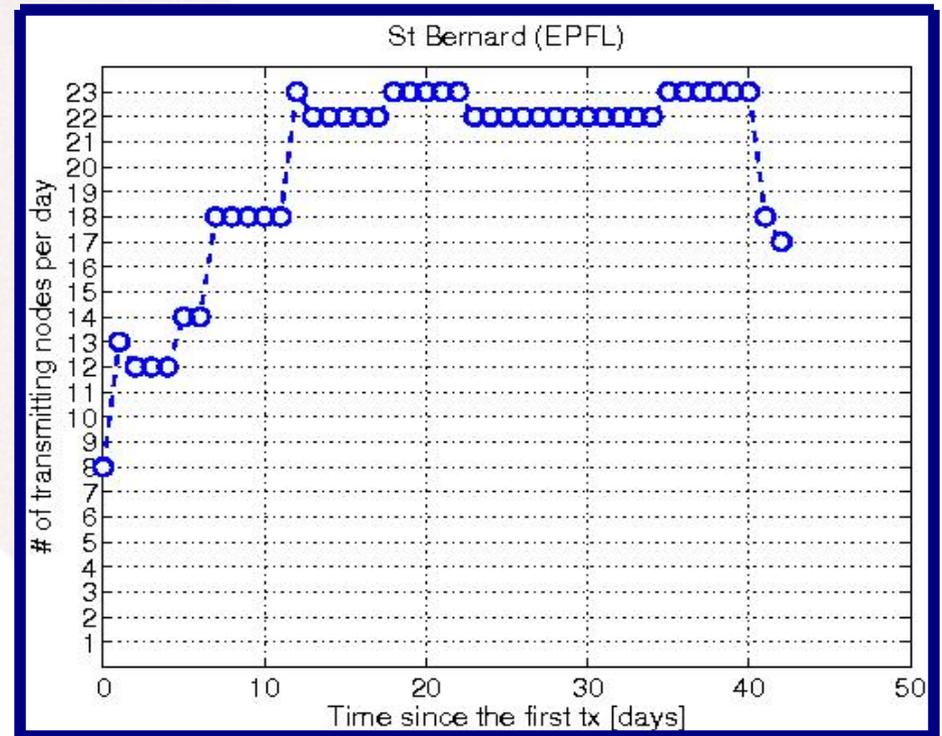
Signal Collection

23 nodes
43 days

St Bernard EPFL deployment Meteo



Txs for each node

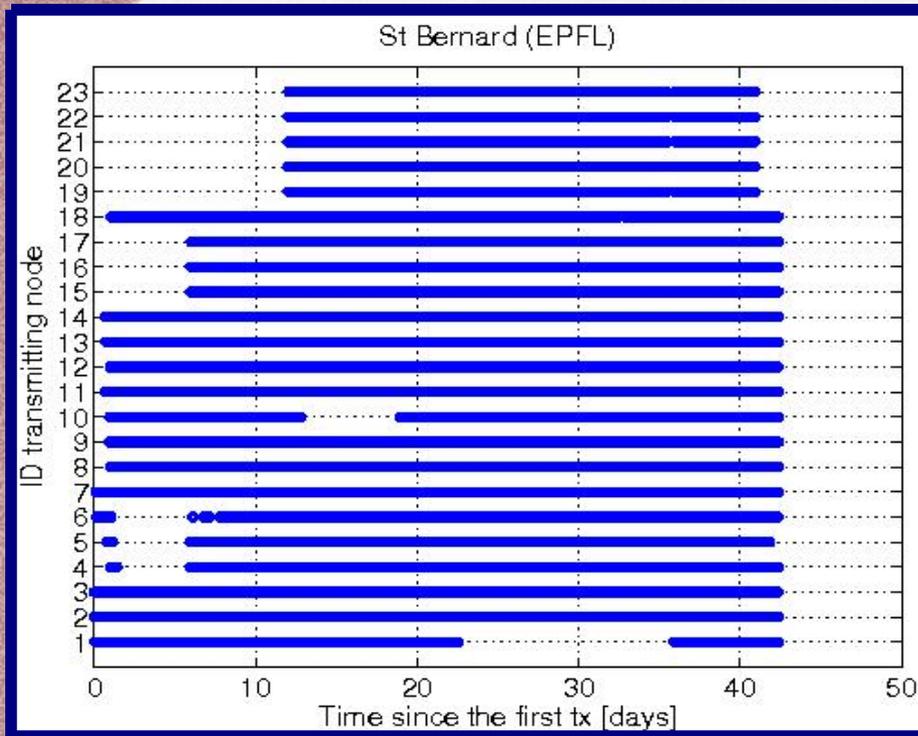


of tx nodes per day

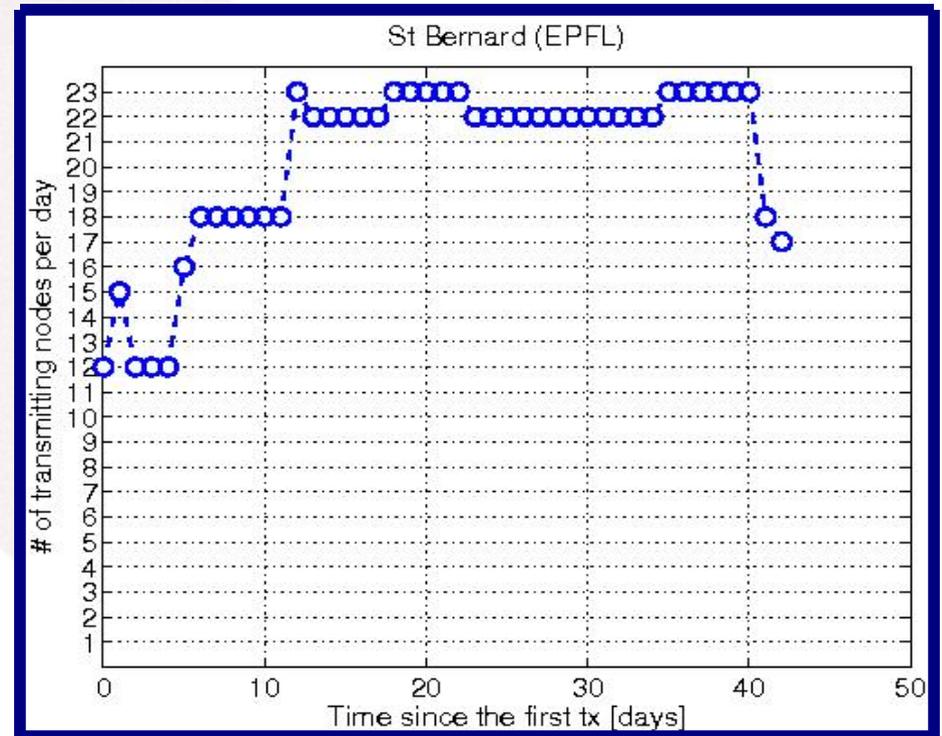
Signal Collection

23 nodes
43 days

St Bernard EPFL deployment Monitoring



Txs for each node



of tx nodes per day

Signal Collection

St Bernard EPFL deployment Selections

Campaign A - Meteo

- Nodes: 23/23; frame length: 5 min; # of collected frames: 742
- Starting time: October 3rd, 2007 12:35:37 PM, Wednesday, G.M.T.
- Stopping time: October 6th, 2007 02:35:37 AM, Saturday, G.M.T.

Campaign B - Meteo

- Nodes: 22/23; frame length: 5 min; # of collected frames: 756
- Starting time: October 19th, 2007 12:35:37 PM, Friday, G.M.T.
- Stopping time: October 22nd, 2007 03:35:37 AM, Monday, G.M.T.

Campaign C - Monitoring

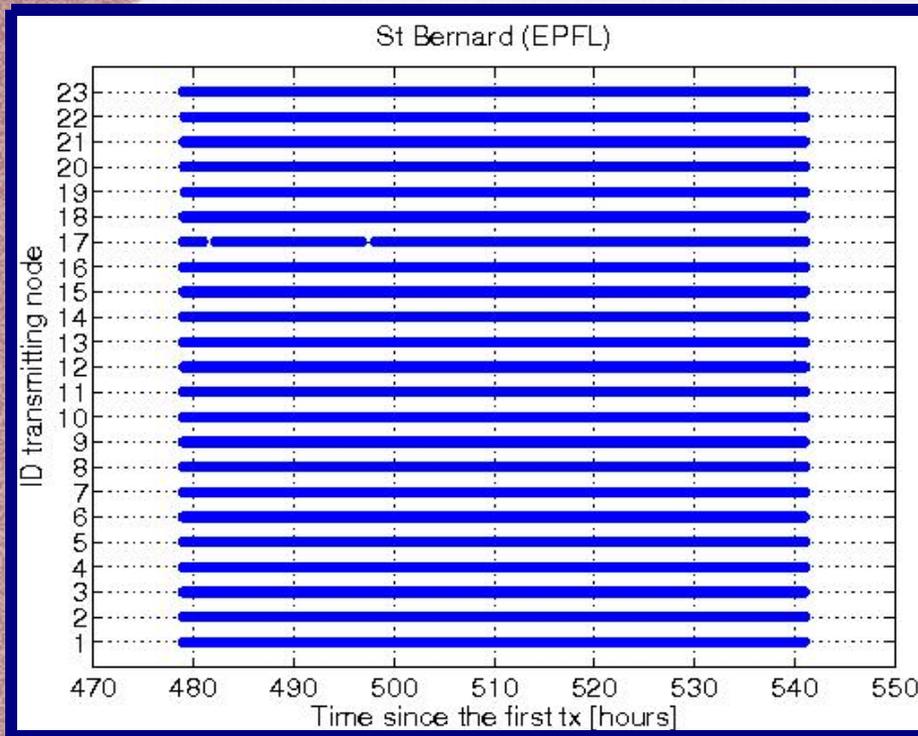
- Nodes: 22/23; frame length: 30 min; # of collected frames: 778
- Starting time: October 2nd, 2007 07:06:05 AM, Tuesday, G.M.T.
- Stopping time: October 19th, 2007 12:06:50 AM, Friday, G.M.T.

743 frames
of 5 min

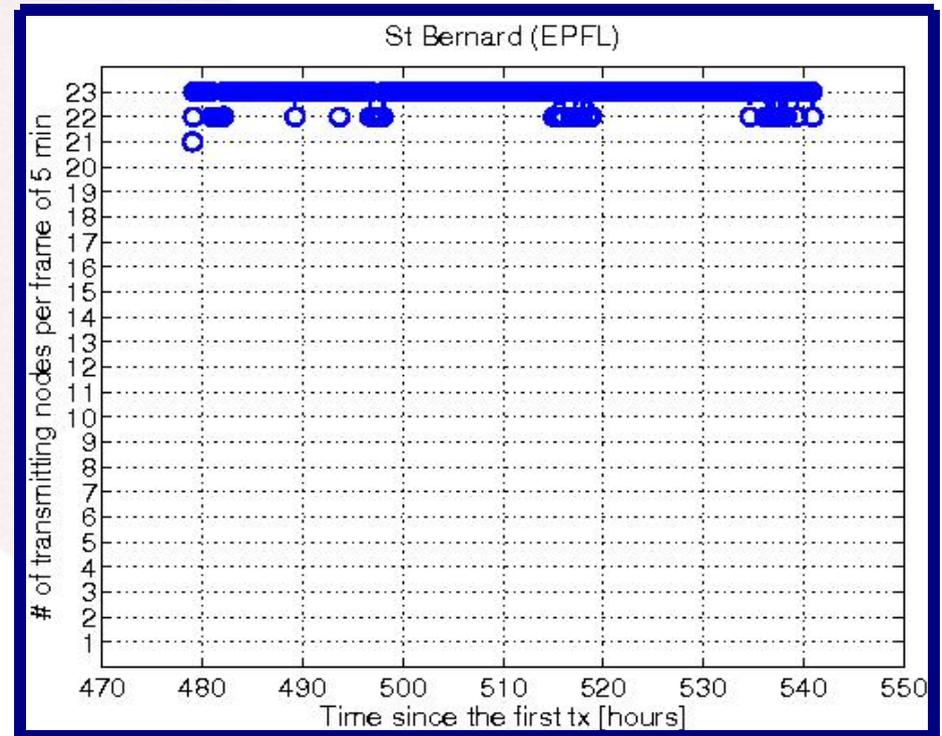
Signal Collection

23 nodes
62 hours

St Bernard EPFL deployment Campaign A



Txs for each node



of tx nodes per frame

743 frames
of 5 min

Signal Collection

23 nodes
62 hours

St Bernard EPFL deployment Campaign A

	AT	ST	SR	RH	SM	W	RM	WS	WD
n1	127	0	0	1061	0	0	0	914	0
n2	0	0	0	54	0	0	0	814	0
n3	0	0	0	0	0	0	0	943	0
n4	0	0	0	0	0	0	0	1036	0
n5	0	0	1858	0	1858	1858	0	982	0
n6	0	0	1853	0	0	0	0	933	0
n7	0	0	1860	0	1860	1860	0	872	0
n8	0	0	1788	0	0	0	0	1027	0
n9	0	0	1950	0	0	0	0	1112	0
n10	0	0	1884	0	0	0	0	972	0
n11	0	0	1947	0	0	0	0	1113	0
n12	0	0	1859	0	0	0	0	1034	0
n13	0	0	1859	0	0	0	0	1037	0
n14	0	0	1858	0	1858	1858	0	989	0
n15	0	0	1801	13	0	0	0	1070	0
n16	0	0	1860	0	0	0	0	1237	0
n17	0	0	1795	0	0	0	0	1007	61
n18	0	0	1860	0	0	0	0	966	0
n19	0	0	0	0	0	0	0	1403	0
n20	0	0	0	0	0	0	0	1604	0
n21	0	0	0	0	0	0	0	1201	0
n22	0	0	0	0	0	0	0	1578	36
n23	0	0	0	0	0	0	0	1285	0

of recorded NaNs

	AT	ST	SR	RH	SM	W	RM	WS	WD
n1	33	1	1	365	1	1	1	187	1
n2	0	0	0	21	0	0	0	172	0
n3	0	0	0	0	0	0	0	164	0
n4	0	0	0	0	0	0	0	259	0
n5	0	0	743	0	743	743	0	249	0
n6	1	1	743	1	1	1	1	208	1
n7	0	0	743	0	743	743	0	222	0
n8	10	10	743	10	10	10	10	294	10
n9	0	0	743	0	0	0	0	269	0
n10	0	0	743	0	0	0	0	232	0
n11	0	0	743	0	0	0	0	265	0
n12	0	0	743	0	0	0	0	266	0
n13	0	0	743	0	0	0	0	266	0
n14	0	0	743	0	743	743	0	252	0
n15	11	11	743	13	11	11	11	298	11
n16	0	0	743	0	0	0	0	374	0
n17	31	31	743	31	31	31	31	282	51
n18	0	0	743	0	0	0	0	240	0
n19	0	0	0	0	0	0	0	470	0
n20	0	0	0	0	0	0	0	584	0
n21	1	1	1	1	1	1	1	349	1
n22	0	0	0	0	0	0	0	574	5
n23	1	1	1	1	1	1	1	399	1

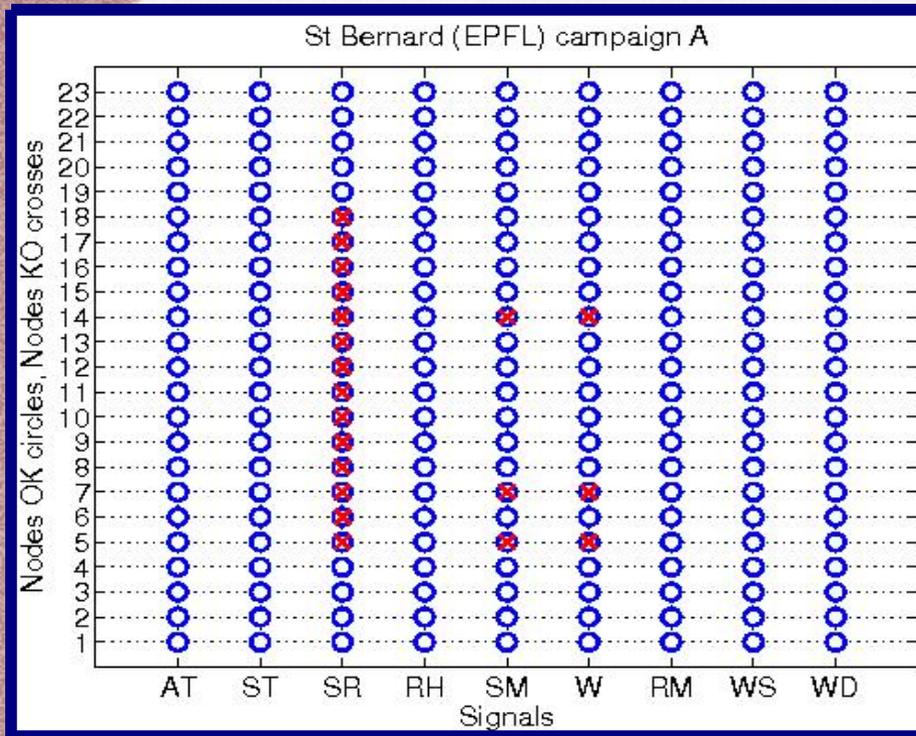
of corrected frames

743 frames
of 5 min

Signal Collection

23 nodes
62 hours

St Bernard EPFL deployment Campaign A



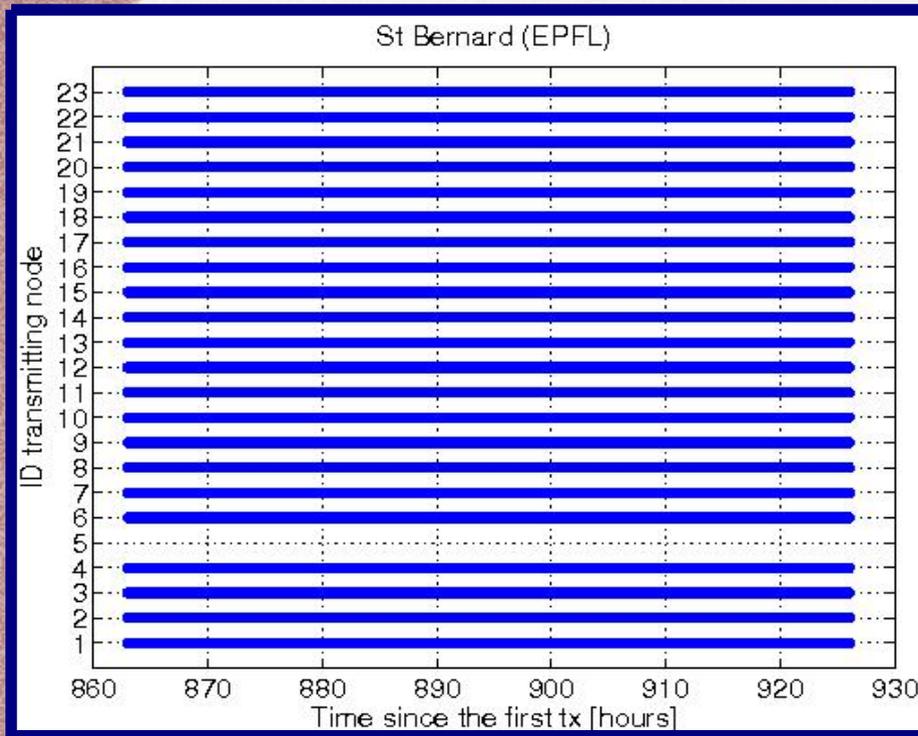
OK nodes & KO nodes

756 frames
of 5 min

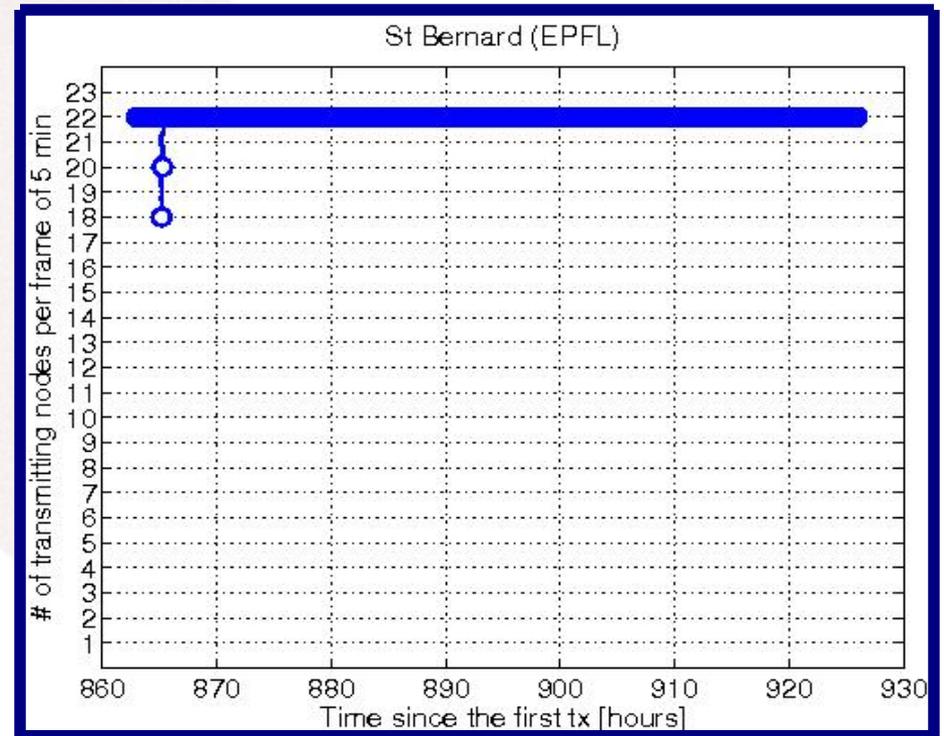
Signal Collection

22 nodes
63 hours

St Bernard EPFL deployment Campaign B



Txs for each node



of tx nodes per frame

756 frames
of 5 min

Signal Collection

22 nodes
63 hours

St Bernard EPFL deployment Campaign B

	AT	ST	SR	RH	SM	W	RM	WS	WD
n1	0	0	0	1890	0	0	0	97	0
n2	0	0	0	0	0	130	0	27	0
n3	0	0	0	0	0	0	0	1	0
n4	0	0	0	0	567	0	0	697	0
n5	-	-	-	-	-	-	-	-	-
n6	11	0	1899	770	0	0	0	197	0
n7	0	0	1889	0	1889	1889	0	802	0
n8	0	0	1899	0	0	1715	0	638	0
n9	0	0	1894	0	0	0	0	876	0
n10	0	0	1909	0	1909	2	0	474	0
n11	0	0	1898	0	0	0	0	710	0
n12	0	0	1947	0	0	0	0	746	0
n13	0	0	1895	0	856	0	0	619	0
n14	0	0	1902	0	1902	1902	0	350	0
n15	0	0	1896	0	1896	0	0	713	0
n16	0	0	1901	0	0	0	0	1058	0
n17	0	0	1898	0	0	0	0	657	0
n18	0	0	1891	0	0	1	0	372	0
n19	0	0	0	0	0	0	0	78	0
n20	0	0	0	0	0	0	0	301	0
n21	0	0	0	1890	0	0	0	36	0
n22	0	0	0	0	0	0	0	404	31
n23	0	0	0	0	0	0	0	44	0

of recorded NaNs

	AT	ST	SR	RH	SM	W	RM	WS	WD
n1	0	0	0	755	0	0	0	26	0
n2	0	0	0	0	0	33	0	4	0
n3	0	0	0	0	0	0	0	0	0
n4	1	1	1	1	225	1	1	265	1
n5	-	-	-	-	-	-	-	-	-
n6	0	0	755	287	0	0	0	51	0
n7	0	0	755	0	755	755	0	226	0
n8	0	0	755	0	0	664	0	223	0
n9	0	0	755	0	0	0	0	293	0
n10	1	1	755	1	755	1	1	155	1
n11	0	0	755	0	0	0	0	219	0
n12	0	0	755	0	0	0	0	256	0
n13	1	1	755	1	326	1	1	178	1
n14	0	0	755	0	755	755	0	100	0
n15	1	1	755	1	755	1	1	270	1
n16	1	1	755	1	1	1	1	359	1
n17	1	1	755	1	1	1	1	244	1
n18	0	0	755	0	0	0	0	107	0
n19	0	0	0	0	0	0	0	11	0
n20	0	0	0	0	0	0	0	27	0
n21	0	0	0	755	0	0	0	0	0
n22	0	0	0	0	0	0	0	51	1
n23	0	0	0	0	0	0	0	1	0

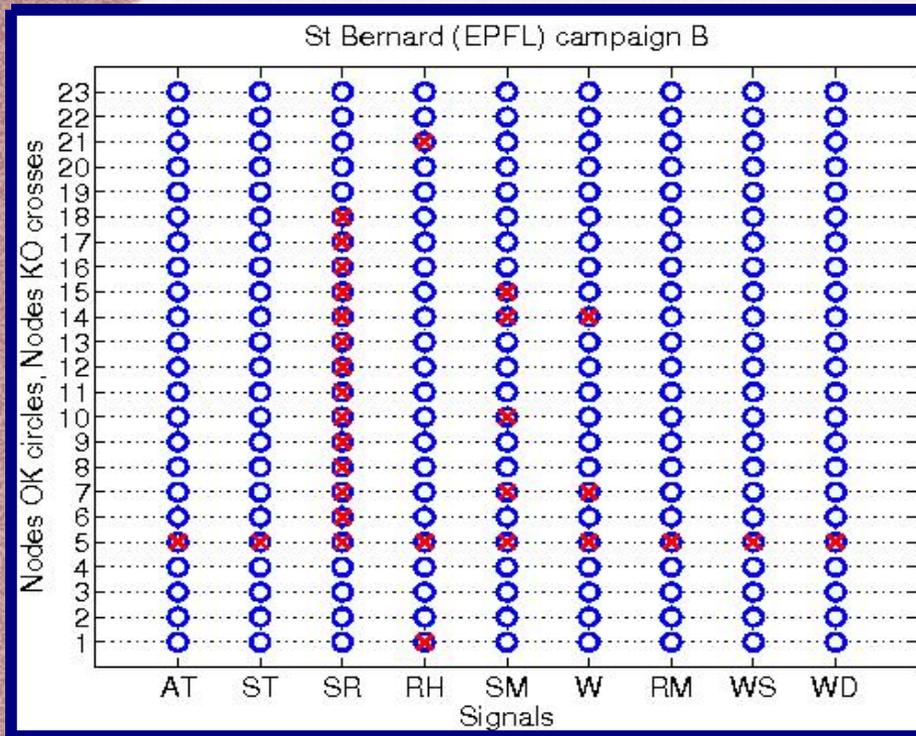
of corrected frames

756 frames
of 5 min

Signal Collection

22 nodes
63 hours

St Bernard EPFL deployment Campaign B



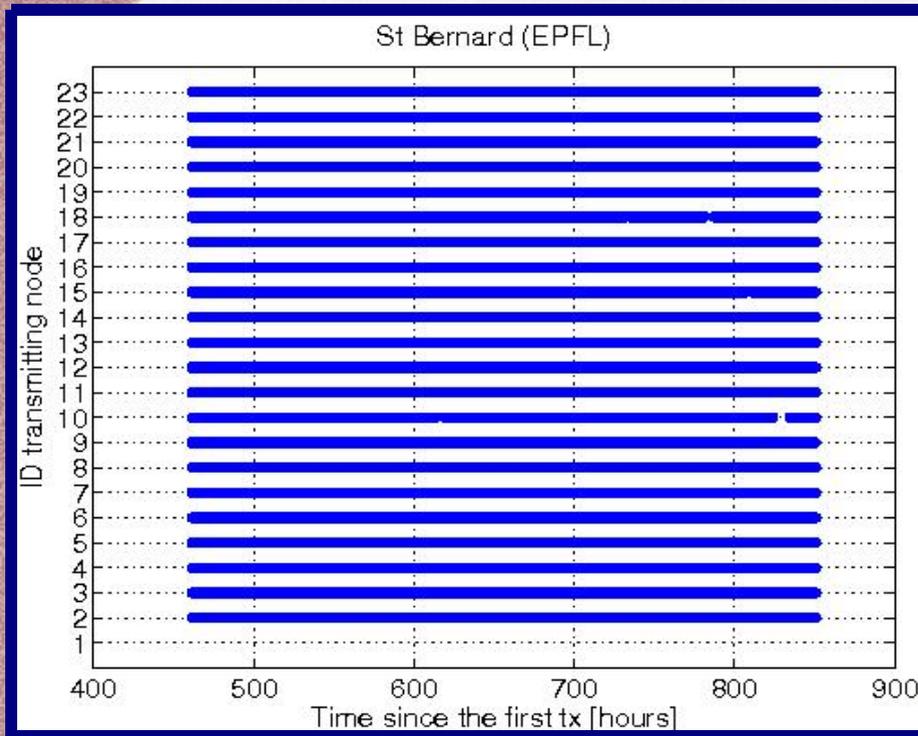
OK nodes & KO nodes

778 frames
of 30 min

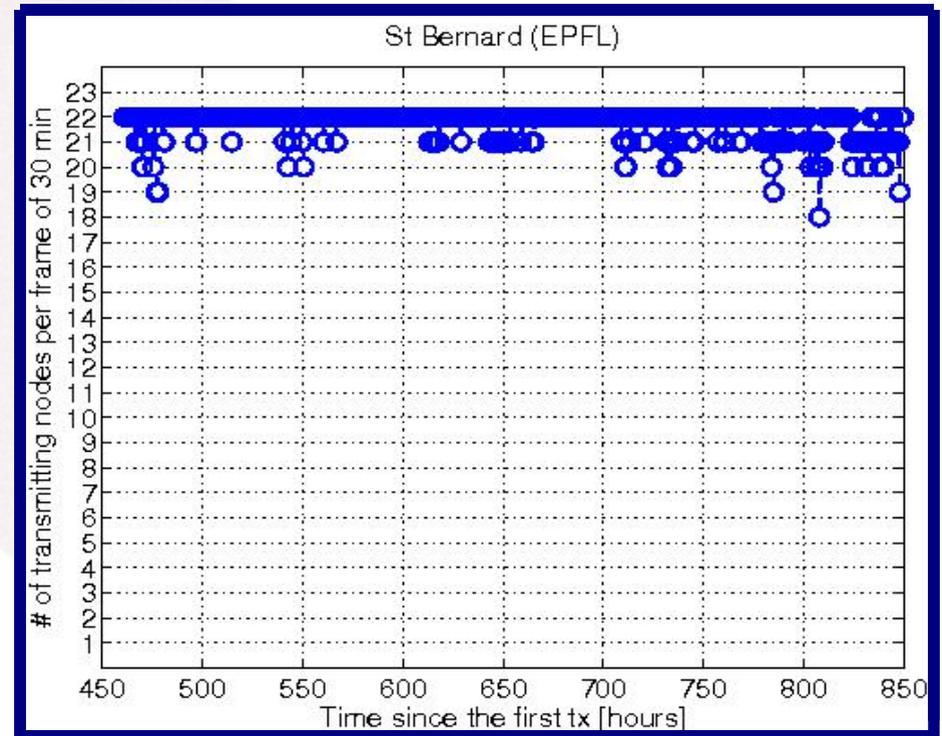
Signal Collection

22 nodes
16 days

St Bernard EPFL deployment Campaign C



Txs for each node



of tx nodes per frame

778 frames
of 30 min

Signal Collection

22 nodes
16 days

St Bernard EPFL deployment Campaign C

	PBV	SBV	SPC	GC
n1	-	-	-	-
n2	0	0	0	0
n3	0	0	0	0
n4	0	0	0	0
n5	0	0	0	0
n6	0	0	0	0
n7	0	0	0	0
n8	0	0	0	0
n9	0	0	0	0
n10	0	0	0	0
n11	0	0	0	0
n12	0	0	0	0
n13	0	0	0	0
n14	0	0	0	0
n15	0	0	0	0
n16	0	0	0	0
n17	0	0	0	0
n18	0	0	0	0
n19	0	0	0	0
n20	0	0	0	0
n21	0	0	0	0
n22	0	0	0	0
n23	0	0	0	0

of recorded NaNs

	PBV	SBV	SPC	GC
n1	-	-	-	-
n2	0	0	0	0
n3	0	0	0	0
n4	0	0	0	0
n5	0	0	0	0
n6	8	8	8	8
n7	0	0	0	0
n8	6	6	6	6
n9	11	11	11	11
n10	67	67	67	67
n11	0	0	0	0
n12	0	0	0	0
n13	0	0	0	0
n14	0	0	0	0
n15	35	35	35	35
n16	6	6	6	6
n17	25	25	25	25
n18	21	21	21	21
n19	1	1	1	1
n20	4	4	4	4
n21	0	0	0	0
n22	4	4	4	4
n23	4	4	4	4

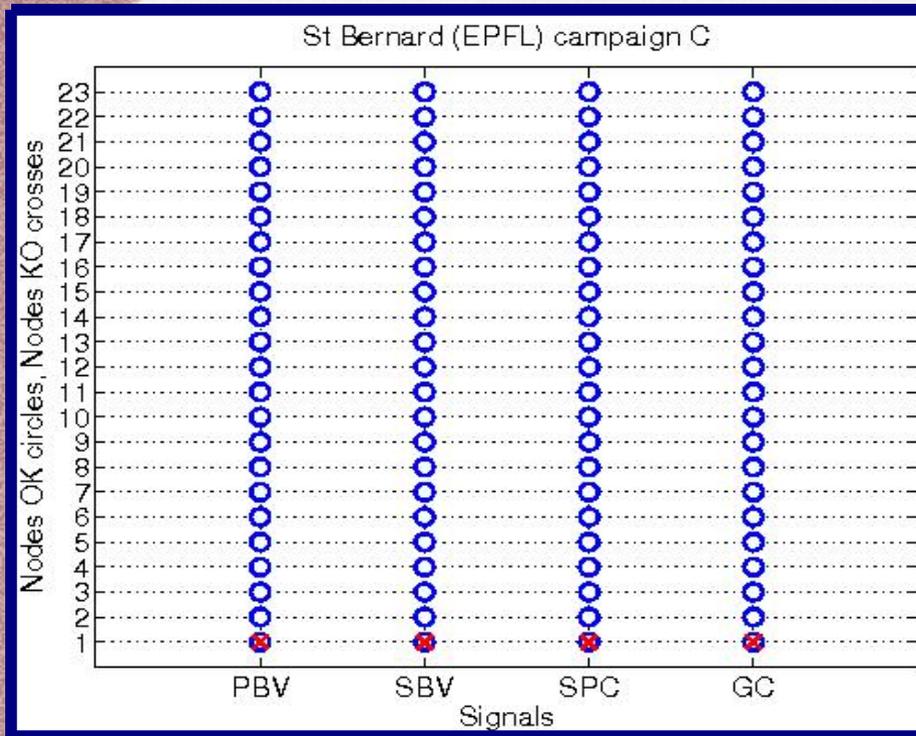
of corrected frames

778 frames
of 30 min

Signal Collection

22 nodes
16 days

St Bernard EPFL deployment Campaign C



OK nodes & KO nodes

Signal Collection

LUCE EPFL deployment Selections

Campaign A - Meteo

- Nodes: 85/87; frame length: 5 min; # of collected frames: 865
- Starting time: January 12th, 2007 03:09:26 PM, Friday, G.M.T.
- Stopping time: January 15th, 2007 03:13:26 PM, Monday, G.M.T.

Campaign B - Meteo

- Nodes: 72/87; frame length: 5 min; # of collected frames: 841
 - Starting time: May 6th, 2007 04:09:26 PM, Sunday, G.M.T.
- Stopping time: May 9th, 2007 02:13:26 PM, Wednesday, G.M.T.

Campaign C - Monitoring

- Nodes: 83/87; frame length: 30 min; # of collected frames: 772
- Starting time: February 2nd, 2007 05:09:26 PM, Friday, G.M.T.
- Stopping time: February 18th, 2007 07:09:26 PM, Sunday, G.M.T.

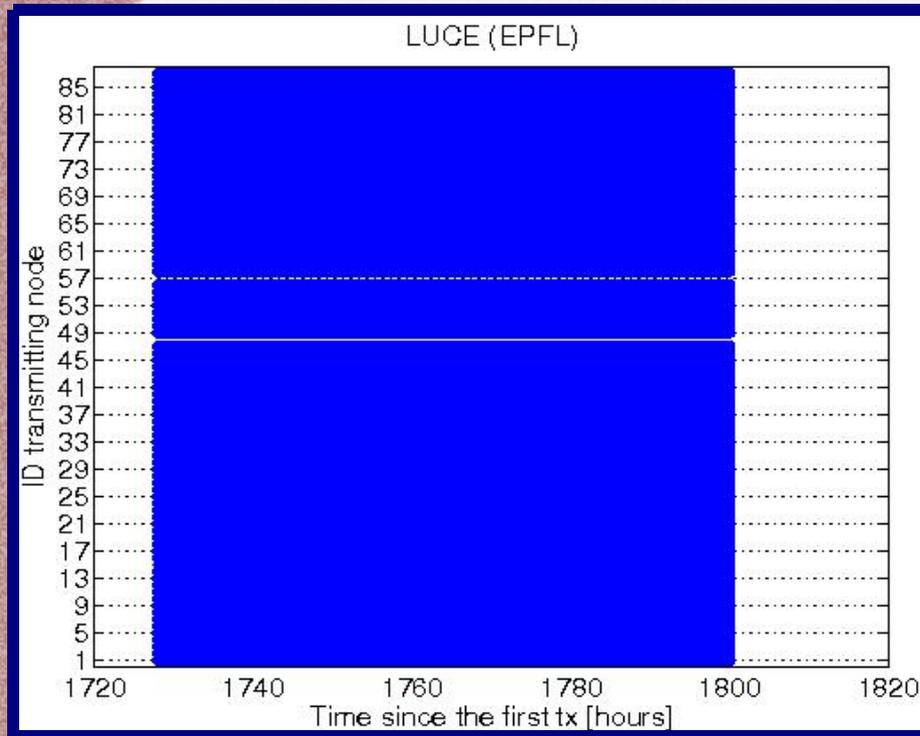
865 frames
of 5 min

Signal Collection

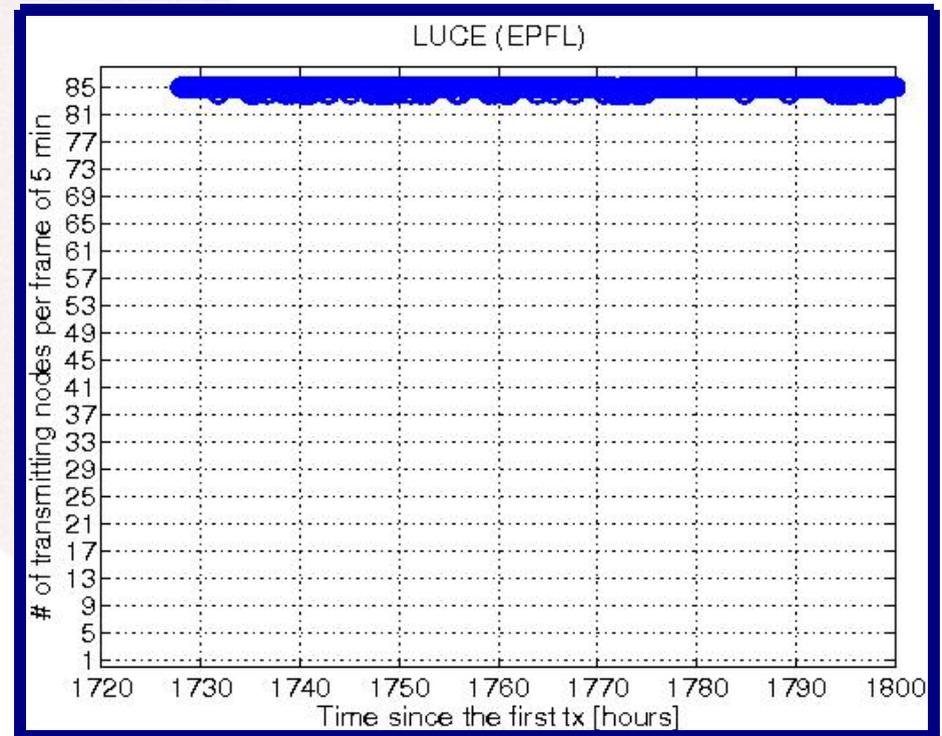
85 nodes
72 hours

LUCE EPFL deployment

Campaign A



Txs for each node



of tx nodes per frame

865 frames
of 5 min

Signal Collection

85 nodes
72 hours

LUCE EPFL deployment

Campaign A

	AT	ST	SR	RH	SM	W	RM	WS	WD
n1	8746	8746	0	8746	0	8746	0	8746	0
n2	0	1	26402	0	26402	26402	26402	26402	26402
n3	0	0	8697	625	0	0	0	8388	0
n4	0	0	0	0	0	0	0	8870	0
n5	0	0	0	0	8778	8778	8778	7860	0
n6	0	0	8859	0	8859	8859	8859	8859	8859
n7	0	0	8804	0	8804	8804	8804	8804	8804
n8	0	0	8769	0	8769	8769	8769	8769	8769
n9	0	0	0	0	8795	8795	8795	8091	0
n10	0	0	0	0	8778	8778	8778	8238	0
n11	105	31	0	105	8762	8762	8762	7924	0
n12	0	0	0	0	8836	8836	8836	8809	291
n13	42	42	0	42	8805	8805	8805	8568	0
n14	0	0	8883	0	8883	8883	8883	8883	8883
n15	0	0	0	0	0	8827	8827	8734	0
...

of recorded NaNs
(first 15 nodes)

	AT	ST	SR	RH	SM	W	RM	WS	WD
n1	864	864	1	864	1	864	1	864	1
n2	0	0	864	0	864	864	864	864	864
n3	2	2	864	57	2	2	2	730	2
n4	0	0	0	0	0	0	0	864	0
n5	0	0	0	0	864	864	864	717	0
n6	0	0	864	0	864	864	864	864	864
n7	0	0	864	0	864	864	864	864	864
n8	1	1	864	1	864	864	864	864	864
n9	1	1	1	1	864	864	864	688	1
n10	0	0	0	0	864	864	864	750	0
n11	10	1	0	10	864	864	864	692	0
n12	1	1	1	1	864	864	864	851	24
n13	4	4	0	4	864	864	864	783	0
n14	0	0	864	0	864	864	864	864	864
n15	0	0	0	0	0	864	864	835	0
...

of corrected frames
(first 15 nodes)

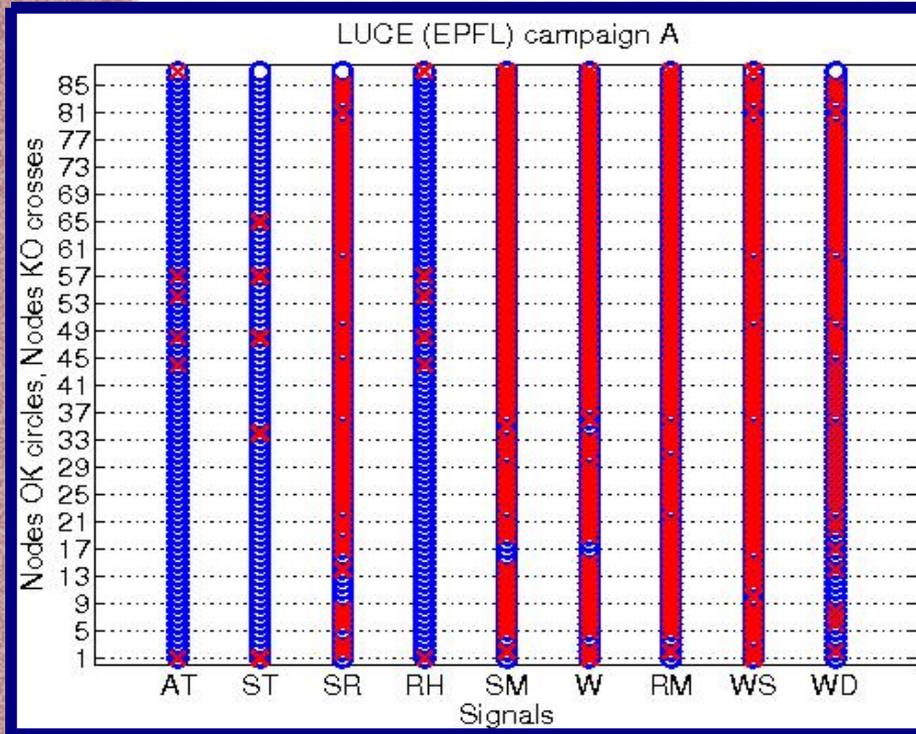
865 frames
of 5 min

Signal Collection

85 nodes
72 hours

LUCE EPFL deployment

Campaign A



OK nodes & KO nodes

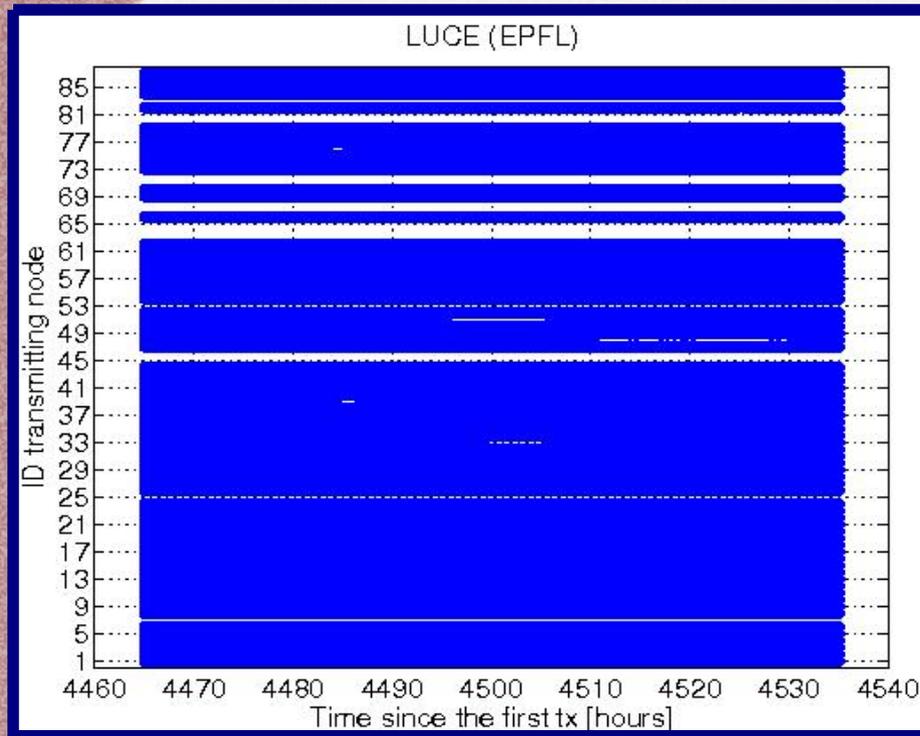
841 frames
of 5 min

Signal Collection

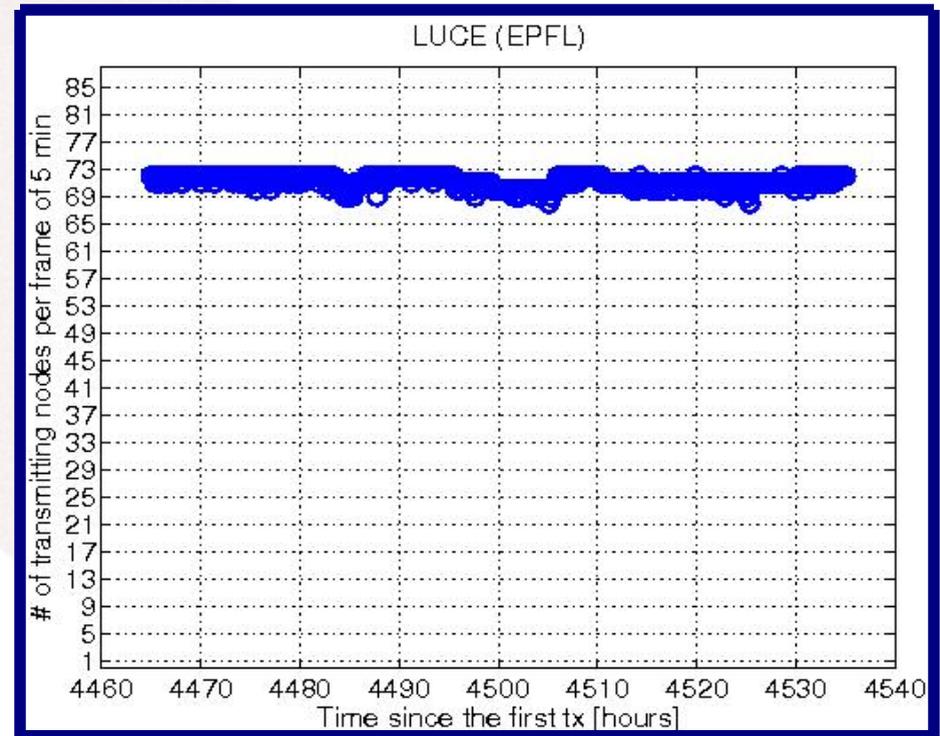
72 nodes
70 hours

LUCE EPFL deployment

Campaign B



Txs for each node



of tx nodes per frame

841 frames
of 5 min

Signal Collection

72 nodes
70 hours

LUCE EPFL deployment

Campaign B

	AT	ST	SR	RH	SM	W	RM	WS	WD
n1	5	5	4	4	4	6	4	7198	4
n2	437	1307	25995	689	25995	25995	25995	25995	25995
n3	2	10	8621	5	4	8619	6	8235	112
n4	184	405	51	255	142	398	109	7737	63
n5	43	75	14	57	4206	75	4226	4201	20
n6	5	8	7667	8	5	29	7667	7667	7667
n7	-	-	-	-	-	-	-	-	-
n8	10	22	8614	14	8614	8614	8614	8614	8614
n9	55	73	14	94	7550	7550	7550	6946	124
n10	88	265	43	141	8626	8626	8626	7554	188
n11	5	6	3	4	8535	8535	8535	7743	43
n12	6	9	7	8	8600	8600	8600	6938	419
n13	34	110	17	50	8570	8570	8570	5916	137
n14	2	8	8624	3	3	12	8624	8624	8624
n15	21	12	3	27	7	8440	8440	8254	3
...

of recorded NaNs
(first 15 nodes)

	AT	ST	SR	RH	SM	W	RM	WS	WD
n1	0	0	0	0	0	0	0	411	0
n2	0	0	840	0	840	840	840	840	840
n3	0	0	840	0	0	838	0	630	0
n4	2	4	3	4	2	4	2	721	2
n5	0	0	0	0	820	0	840	816	0
n6	5	5	840	5	5	7	840	840	840
n7	-	-	-	-	-	-	-	-	-
n8	0	0	840	0	840	840	840	840	840
n9	35	33	30	37	840	840	840	668	29
n10	0	0	0	0	840	840	840	488	6
n11	1	1	1	1	840	840	840	658	1
n12	0	0	0	0	840	840	840	355	0
n13	0	0	0	0	840	840	840	301	1
n14	0	0	840	0	0	0	840	840	840
n15	7	7	7	7	7	840	840	737	7
...

of corrected frames
(first 15 nodes)

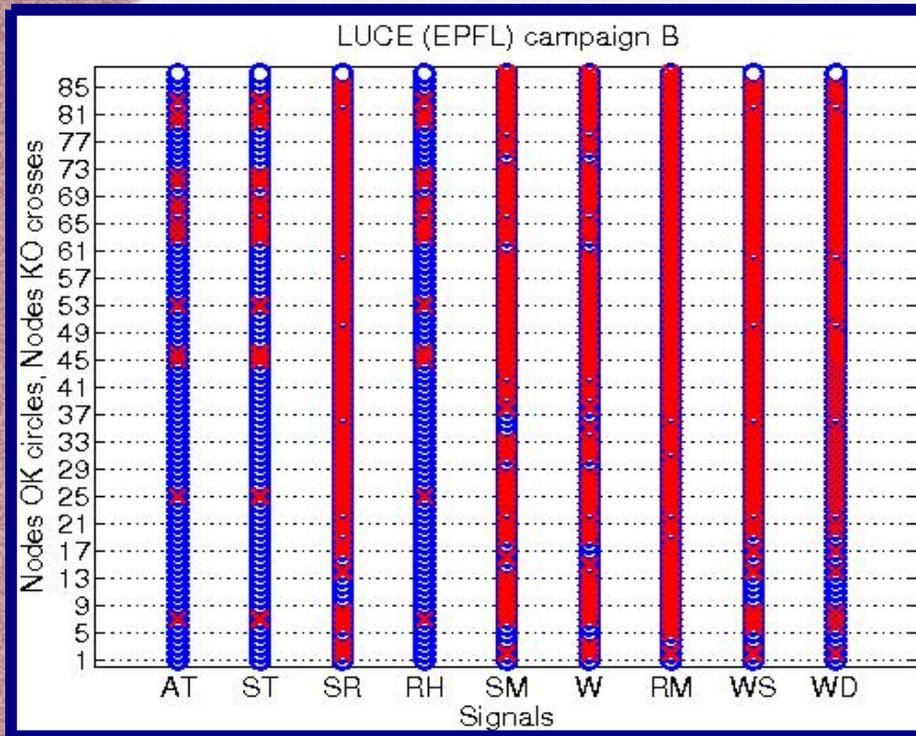
841 frames
of 5 min

Signal Collection

72 nodes
70 hours

LUCE EPFL deployment

Campaign B



OK nodes & KO nodes

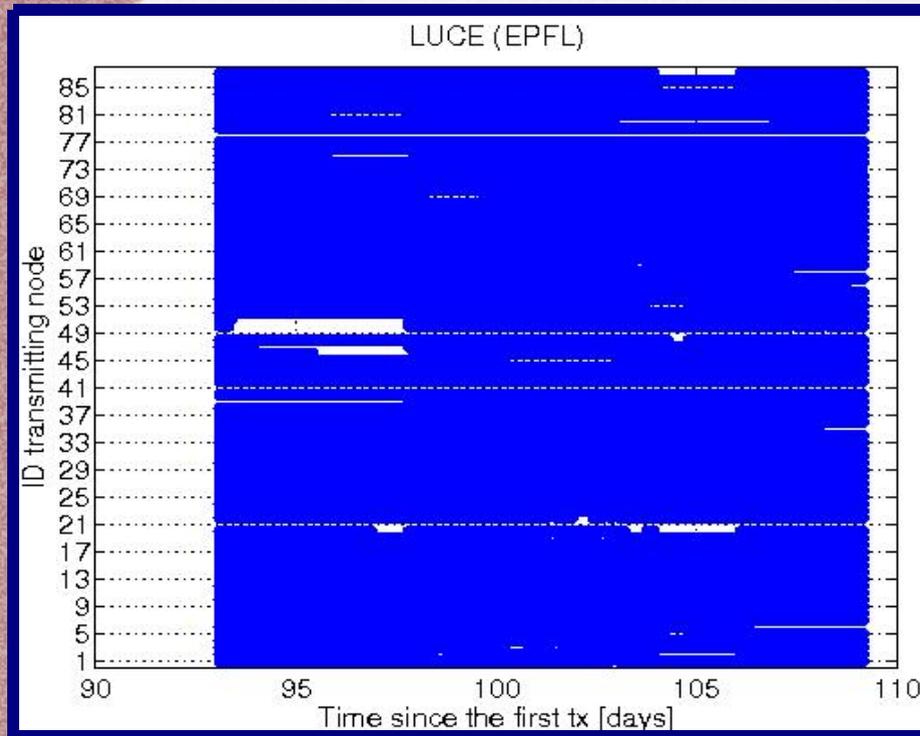
772 frames
of 30 min

Signal Collection

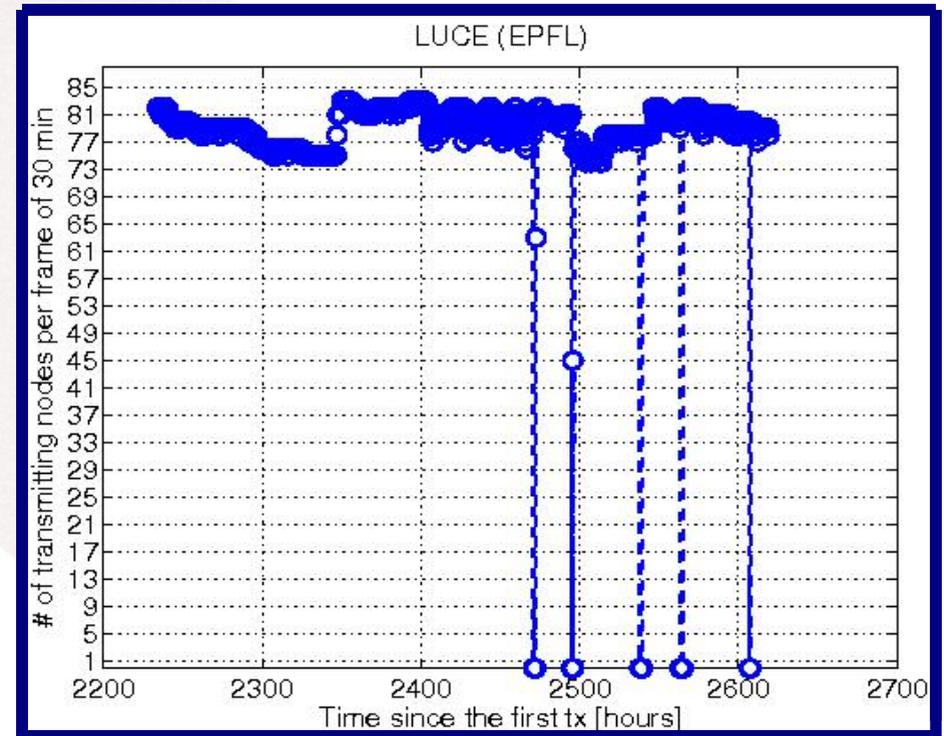
83 nodes
16 days

LUCE EPFL deployment

Campaign C



Txs for each node



of tx nodes per frame

772 frames
of 30 min

Signal Collection

83 nodes
16 days

LUCE EPFL deployment

Campaign C

	PBV	SBV	SPC	GC
n1	0	0	0	0
n2	0	0	0	0
n3	0	0	0	0
n4	0	0	0	0
n5	0	0	0	0
n6	0	0	0	0
n7	0	0	0	0
n8	0	0	0	0
n9	0	0	0	0
n10	0	0	0	0
n11	0	0	0	0
n12	0	0	0	0
n13	0	0	0	0
n14	0	0	0	0
n15	0	0	0	0
...

of recorded NaNs
(first 15 nodes)

	PBV	SBV	SPC	GC
n1	35	35	35	35
n2	128	128	128	128
n3	84	84	84	84
n4	16	16	16	16
n5	46	46	46	46
n6	147	147	147	147
n7	15	15	15	15
n8	20	20	20	20
n9	17	17	17	17
n10	16	16	16	16
n11	16	16	16	16
n12	17	17	17	17
n13	16	16	16	16
n14	55	55	55	55
n15	26	26	26	26
...

of corrected frames
(first 15 nodes)

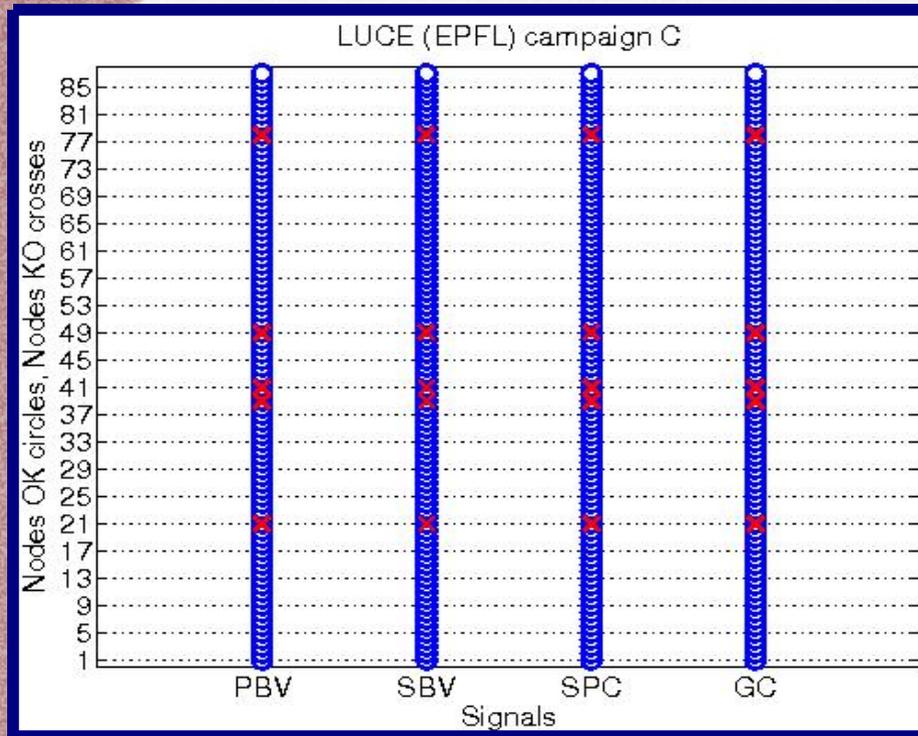
772 frames
of 30 min

Signal Collection

83 nodes
16 days

LUCE EPFL deployment

Campaign C



OK nodes & KO nodes

Signal Collection

CitySense deployment

	1999	2000	2001 - 2006	2007	2008	2009
airPressure [HundredPascal, hPa]	-	-	-	2	-	-
airTemperature [Celsius Degree, C]	4	2	-	3	5	9
avgWindDirection [Degree, deg]	-	-	-	2	-	1
avgWindSpeed [Meters per Second, m/s]	-	-	-	-	-	-
co2Density [Parts per Million Vol, ppmv]	1	1	-	-	1	4
co2Temp [Celsius Degree, C]	-	-	-	-	-	-
largeParticles [Count, cnt]	-	-	-	-	-	-
maxWindDirection [Degree, deg]	-	-	-	-	-	1
maxWindSpeed [Meters per Second, m/s]	-	-	-	-	-	1
minWindDirection [Degree, deg]	5	1	-	3	5	9
minWindSpeed [Meters per Second, m/s]	-	-	-	-	-	4
precipAmount [Inch, in]	1	1	-	1	1	3
rainDuration [Seconds, s]	2	-	-	2	5	8
rainIntensity [Millimeters per Hours, mm/h]	-	-	-	-	-	-
relativeHumidity [Percent, %]	-	-	-	-	-	-
smallParticles [Count, cnt]	-	-	-	-	-	1
soundLevel [Decibel, dB]	-	-	-	-	-	1

of nodes transmitting at least one packet per year

Signal Collection

CitySense deployment

Selections

Campaign A - airTemperature

- Nodes: 8/25; frame length: 60 min; # of collected frames: 887
- Starting time: October 14th, 2009 02:01:57 PM, Wednesday, G.M.T.
- Stopping time: November 21st, 2009 12:01:57 AM, Saturday, G.M.T.

Campaign B - minWindDirection

- Nodes: 8/25; frame length: 60 min; # of collected frames: 888
- Starting time: October 14th, 2009 01:00:01 PM, Wednesday, G.M.T.
- Stopping time: November 21st, 2009 12:00:01 AM, Saturday, G.M.T.

Campaign C - rainDuration

- Nodes: -; frame length: -; # of collected frames: -
 - Starting time: -
 - Stopping time: -

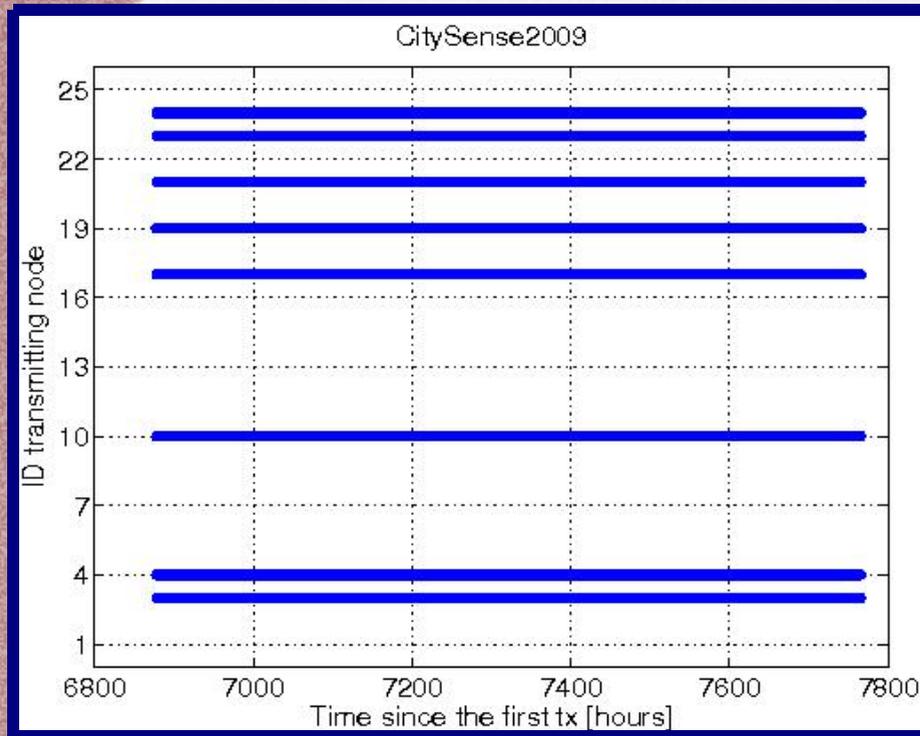
frames 887
of 60 min

Signal Collection

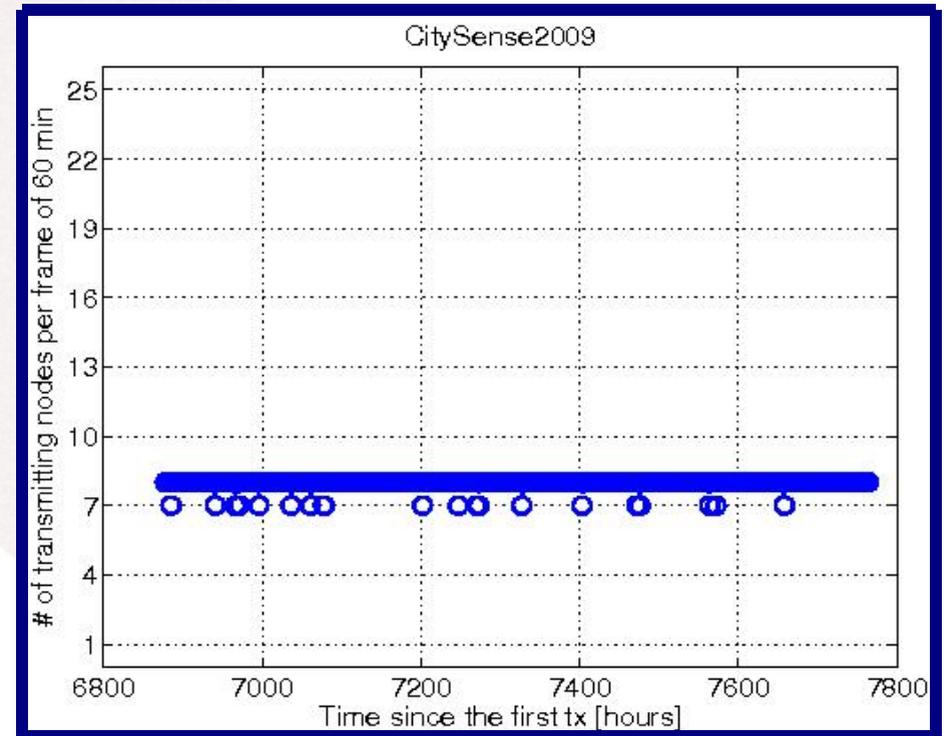
8 nodes
37 days

CitySense deployment

Campaign A



Txs for each node



of tx nodes per frame

frames 887
of 60 min

Signal Collection

8 nodes
37 days

CitySense deployment

Campaign A

	AT	ST	SR	RH	SM	W	RM	WS	WD
n1	127	0	0	1061	0	0	0	914	0
n2	0	0	0	54	0	0	0	814	0
n3	0	0	0	0	0	0	0	943	0
n4	0	0	0	0	0	0	0	1036	0
n5	0	0	1858	0	1858	1858	0	982	0
n6	0	0	1853	0	0	0	0	933	0
n7	0	0	1860	0	1860	1860	0	872	0
n8	0	0	1788	0	0	0	0	1027	0
n9	0	0	1950	0	0	0	0	1112	0
n10	0	0	1884	0	0	0	0	972	0
n11	0	0	1947	0	0	0	0	1113	0
n12	0	0	1859	0	0	0	0	1034	0
n13	0	0	1859	0	0	0	0	1037	0
n14	0	0	1858	0	1858	1858	0	989	0
n15	0	0	1801	13	0	0	0	1070	0
n16	0	0	1860	0	0	0	0	1237	0
n17	0	0	1795	0	0	0	0	1007	61
n18	0	0	1860	0	0	0	0	966	0
n19	0	0	0	0	0	0	0	1403	0
n20	0	0	0	0	0	0	0	1604	0
n21	0	0	0	0	0	0	0	1201	0
n22	0	0	0	0	0	0	0	1578	36
n23	0	0	0	0	0	0	0	1285	0

of recorded NaNs

	AT	ST	SR	RH	SM	W	RM	WS	WD
n1	33	1	1	365	1	1	1	187	1
n2	0	0	0	21	0	0	0	172	0
n3	0	0	0	0	0	0	0	164	0
n4	0	0	0	0	0	0	0	259	0
n5	0	0	743	0	743	743	0	249	0
n6	1	1	743	1	1	1	1	208	1
n7	0	0	743	0	743	743	0	222	0
n8	10	10	743	10	10	10	10	294	10
n9	0	0	743	0	0	0	0	269	0
n10	0	0	743	0	0	0	0	232	0
n11	0	0	743	0	0	0	0	265	0
n12	0	0	743	0	0	0	0	266	0
n13	0	0	743	0	0	0	0	266	0
n14	0	0	743	0	743	743	0	252	0
n15	11	11	743	13	11	11	11	298	11
n16	0	0	743	0	0	0	0	374	0
n17	31	31	743	31	31	31	31	282	51
n18	0	0	743	0	0	0	0	240	0
n19	0	0	0	0	0	0	0	470	0
n20	0	0	0	0	0	0	0	584	0
n21	1	1	1	1	1	1	1	349	1
n22	0	0	0	0	0	0	0	574	5
n23	1	1	1	1	1	1	1	399	1

of corrected frames

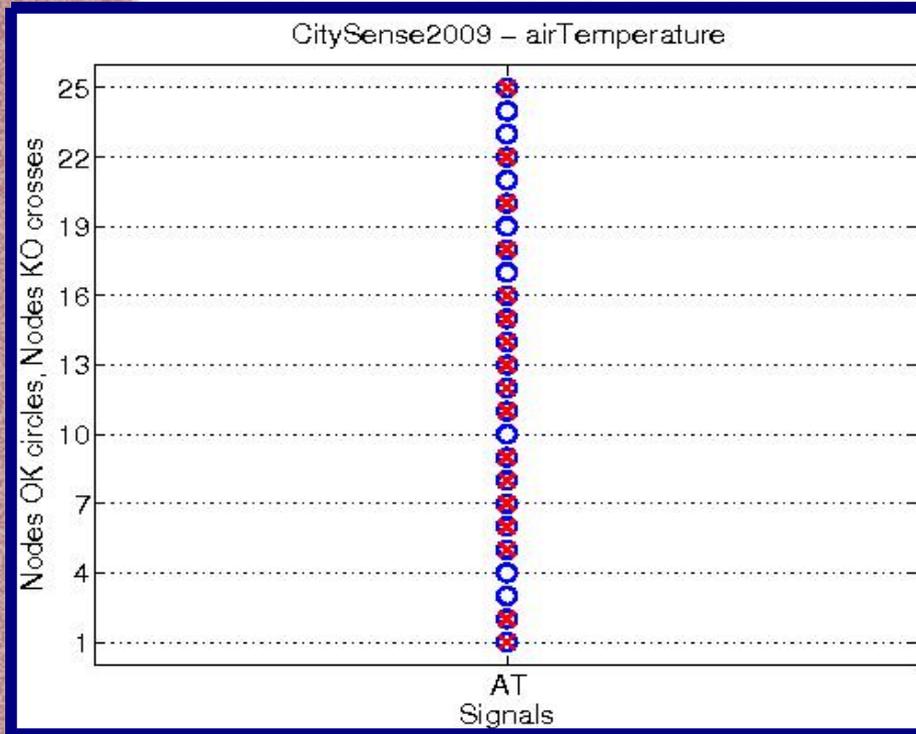
frames 887
of 60 min

Signal Collection

8 nodes
37 days

CitySense deployment

Campaign A



OK nodes & KO nodes

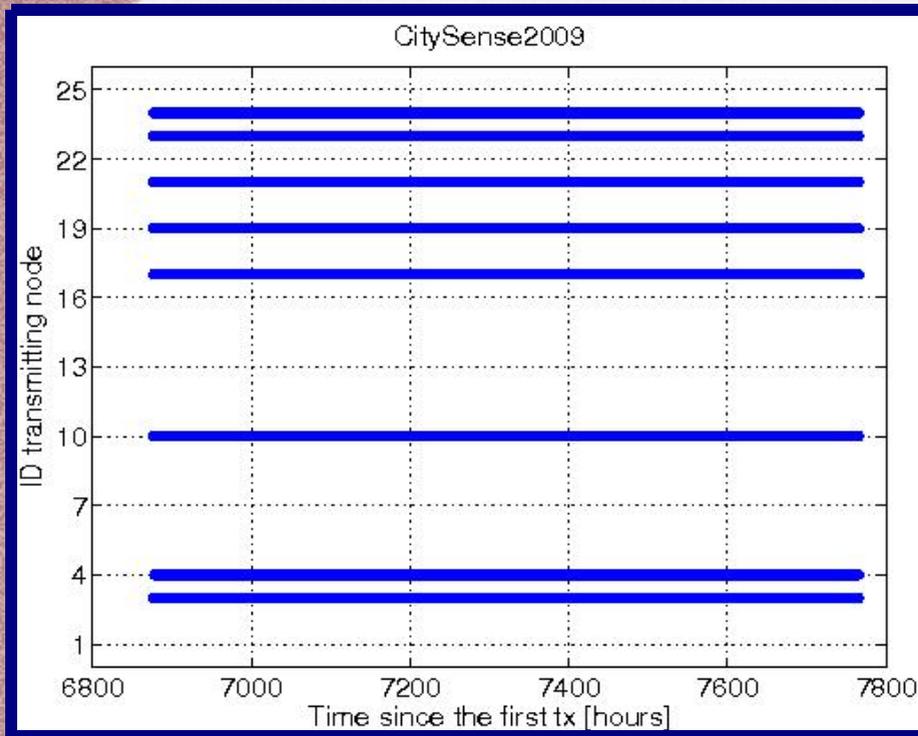
frames 888
of 60 min

Signal Collection

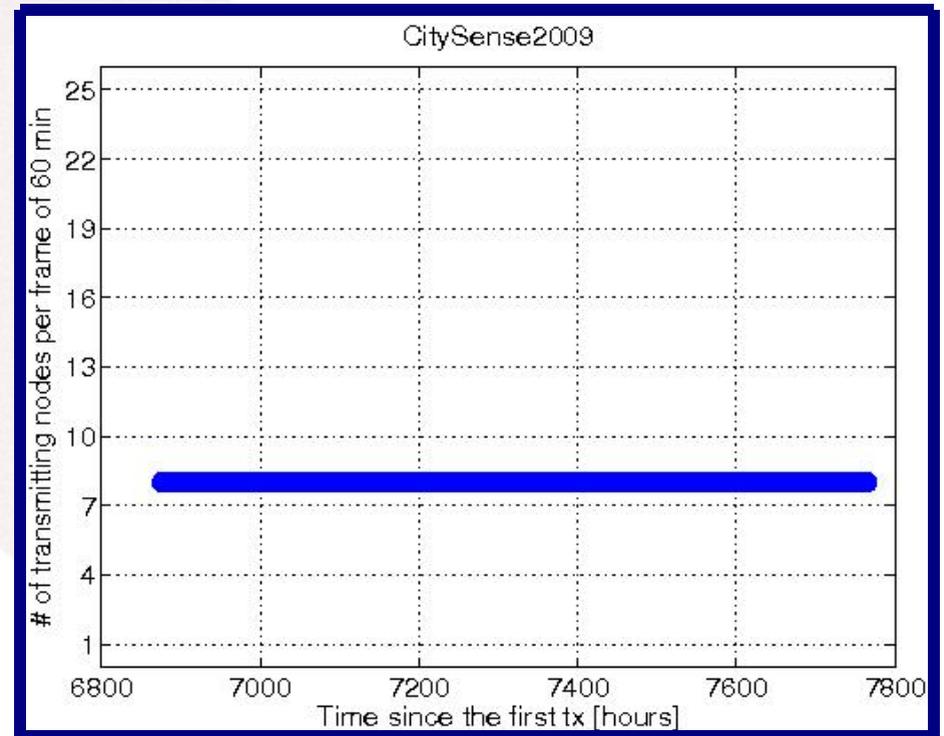
8 nodes
37 days

CitySense deployment

Campaign B



Txs for each node



of tx nodes per frame

frames 887
of 60 min

Signal Collection

8 nodes
37 days

CitySense deployment

Campaign B

	AT	ST	SR	RH	SM	W	RM	WS	WD
n1	127	0	0	1061	0	0	0	914	0
n2	0	0	0	54	0	0	0	814	0
n3	0	0	0	0	0	0	0	943	0
n4	0	0	0	0	0	0	0	1036	0
n5	0	0	1858	0	1858	1858	0	982	0
n6	0	0	1853	0	0	0	0	933	0
n7	0	0	1860	0	1860	1860	0	872	0
n8	0	0	1788	0	0	0	0	1027	0
n9	0	0	1950	0	0	0	0	1112	0
n10	0	0	1884	0	0	0	0	972	0
n11	0	0	1947	0	0	0	0	1113	0
n12	0	0	1859	0	0	0	0	1034	0
n13	0	0	1859	0	0	0	0	1037	0
n14	0	0	1858	0	1858	1858	0	989	0
n15	0	0	1801	13	0	0	0	1070	0
n16	0	0	1860	0	0	0	0	1237	0
n17	0	0	1795	0	0	0	0	1007	61
n18	0	0	1860	0	0	0	0	966	0
n19	0	0	0	0	0	0	0	1403	0
n20	0	0	0	0	0	0	0	1604	0
n21	0	0	0	0	0	0	0	1201	0
n22	0	0	0	0	0	0	0	1578	36
n23	0	0	0	0	0	0	0	1285	0

of recorded NaNs

	AT	ST	SR	RH	SM	W	RM	WS	WD
n1	33	1	1	365	1	1	1	187	1
n2	0	0	0	21	0	0	0	172	0
n3	0	0	0	0	0	0	0	164	0
n4	0	0	0	0	0	0	0	259	0
n5	0	0	743	0	743	743	0	249	0
n6	1	1	743	1	1	1	1	208	1
n7	0	0	743	0	743	743	0	222	0
n8	10	10	743	10	10	10	10	294	10
n9	0	0	743	0	0	0	0	269	0
n10	0	0	743	0	0	0	0	232	0
n11	0	0	743	0	0	0	0	265	0
n12	0	0	743	0	0	0	0	266	0
n13	0	0	743	0	0	0	0	266	0
n14	0	0	743	0	743	743	0	252	0
n15	11	11	743	13	11	11	11	298	11
n16	0	0	743	0	0	0	0	374	0
n17	31	31	743	31	31	31	31	282	51
n18	0	0	743	0	0	0	0	240	0
n19	0	0	0	0	0	0	0	470	0
n20	0	0	0	0	0	0	0	584	0
n21	1	1	1	1	1	1	1	349	1
n22	0	0	0	0	0	0	0	574	5
n23	1	1	1	1	1	1	1	399	1

of corrected frames

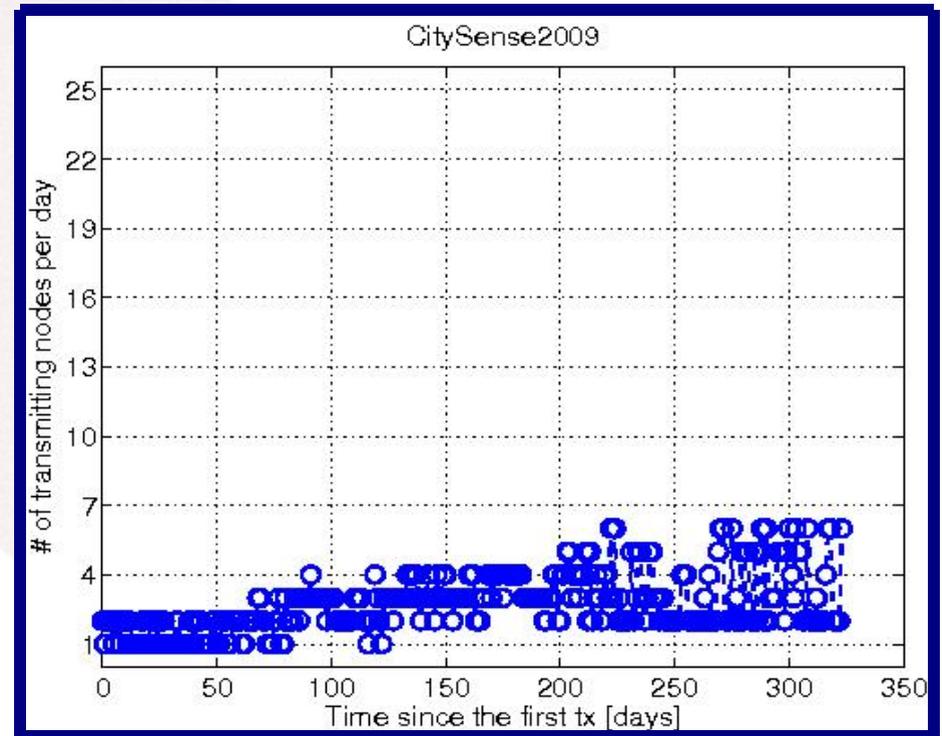
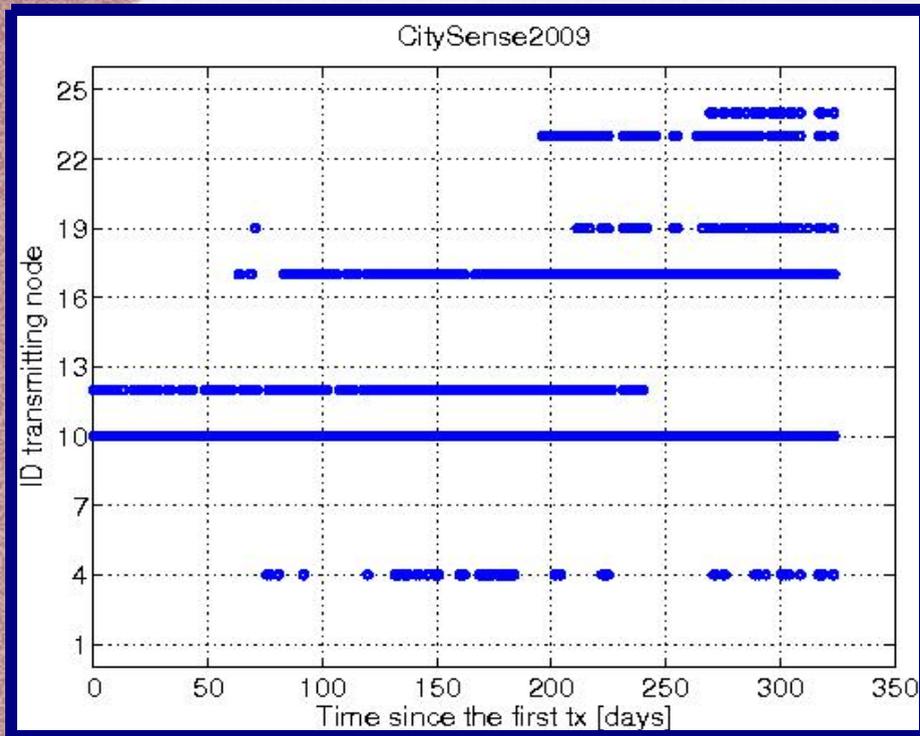
not enough samples

Signal Collection

not enough nodes

CitySense deployment

Campaign C



Txs for each node

of tx nodes per frame

Signal Collection

OrangeLab deployment

Selections

Campaign A - light

- Nodes: 71/86; frame length: 15 min; # of collected frames: 65

Campaign B - temperature

- Nodes: 75/86; frame length: 15 min; # of collected frames: 65

Campaign C - battery

- Nodes: 70/86; frame length: 15 min; # of collected frames: 65

Campaign D - IR

- Nodes: 77/86; frame length: 15 min; # of collected frames: 65

For all the campaigns

- Starting time: August 26th, 2008 02:46:46 PM, Tuesday, G.M.T.
- Stopping time: August 27th, 2008 07:31:07 AM, Wednesday, G.M.T.

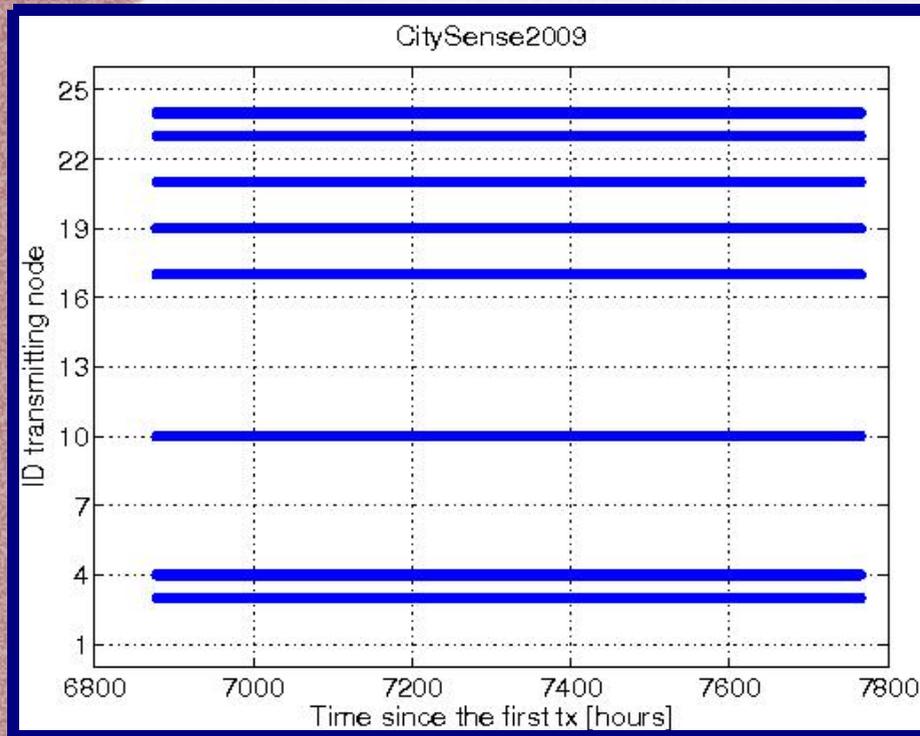
frames 887
of 60 min

Signal Collection

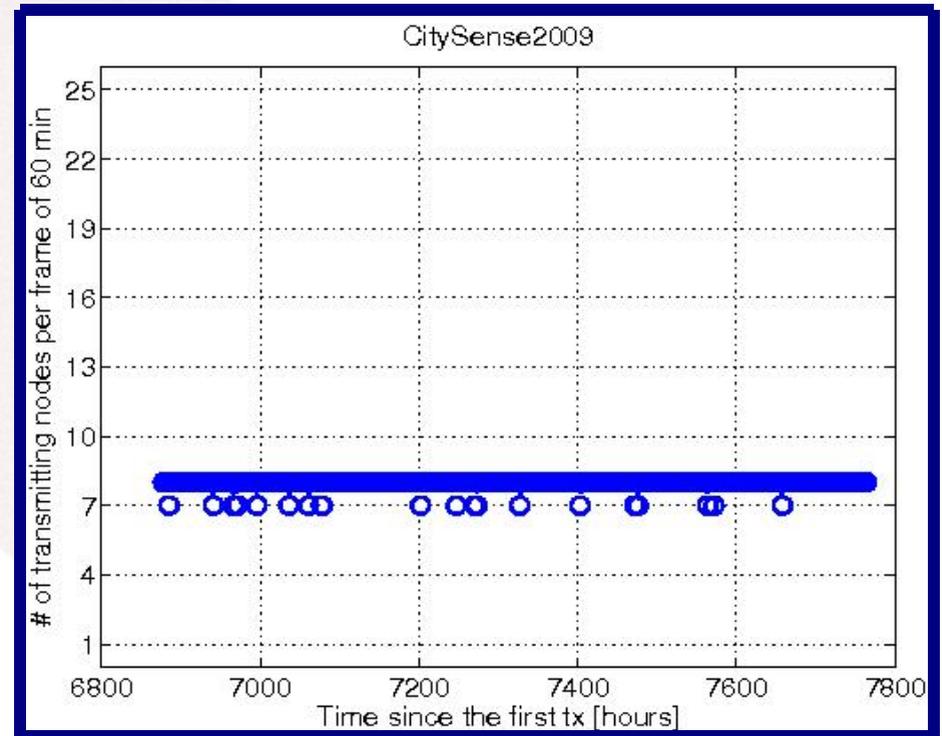
8 nodes
37 days

OrangeLab deployment

Campaign A



Txs for each node



of tx nodes per frame

frames 887
of 60 min

Signal Collection

8 nodes
37 days

OrangeLab deployment

Campaign A

	AT	ST	SR	RH	SM	W	RM	WS	WD
n1	127	0	0	1061	0	0	0	914	0
n2	0	0	0	54	0	0	0	814	0
n3	0	0	0	0	0	0	0	943	0
n4	0	0	0	0	0	0	0	1036	0
n5	0	0	1858	0	1858	1858	0	982	0
n6	0	0	1853	0	0	0	0	933	0
n7	0	0	1860	0	1860	1860	0	872	0
n8	0	0	1788	0	0	0	0	1027	0
n9	0	0	1950	0	0	0	0	1112	0
n10	0	0	1884	0	0	0	0	972	0
n11	0	0	1947	0	0	0	0	1113	0
n12	0	0	1859	0	0	0	0	1034	0
n13	0	0	1859	0	0	0	0	1037	0
n14	0	0	1858	0	1858	1858	0	989	0
n15	0	0	1801	13	0	0	0	1070	0
n16	0	0	1860	0	0	0	0	1237	0
n17	0	0	1795	0	0	0	0	1007	61
n18	0	0	1860	0	0	0	0	966	0
n19	0	0	0	0	0	0	0	1403	0
n20	0	0	0	0	0	0	0	1604	0
n21	0	0	0	0	0	0	0	1201	0
n22	0	0	0	0	0	0	0	1578	36
n23	0	0	0	0	0	0	0	1285	0

of recorded NaNs

	AT	ST	SR	RH	SM	W	RM	WS	WD
n1	33	1	1	365	1	1	1	187	1
n2	0	0	0	21	0	0	0	172	0
n3	0	0	0	0	0	0	0	164	0
n4	0	0	0	0	0	0	0	259	0
n5	0	0	743	0	743	743	0	249	0
n6	1	1	743	1	1	1	1	208	1
n7	0	0	743	0	743	743	0	222	0
n8	10	10	743	10	10	10	10	294	10
n9	0	0	743	0	0	0	0	269	0
n10	0	0	743	0	0	0	0	232	0
n11	0	0	743	0	0	0	0	265	0
n12	0	0	743	0	0	0	0	266	0
n13	0	0	743	0	0	0	0	266	0
n14	0	0	743	0	743	743	0	252	0
n15	11	11	743	13	11	11	11	298	11
n16	0	0	743	0	0	0	0	374	0
n17	31	31	743	31	31	31	31	282	51
n18	0	0	743	0	0	0	0	240	0
n19	0	0	0	0	0	0	0	470	0
n20	0	0	0	0	0	0	0	584	0
n21	1	1	1	1	1	1	1	349	1
n22	0	0	0	0	0	0	0	574	5
n23	1	1	1	1	1	1	1	399	1

of corrected frames

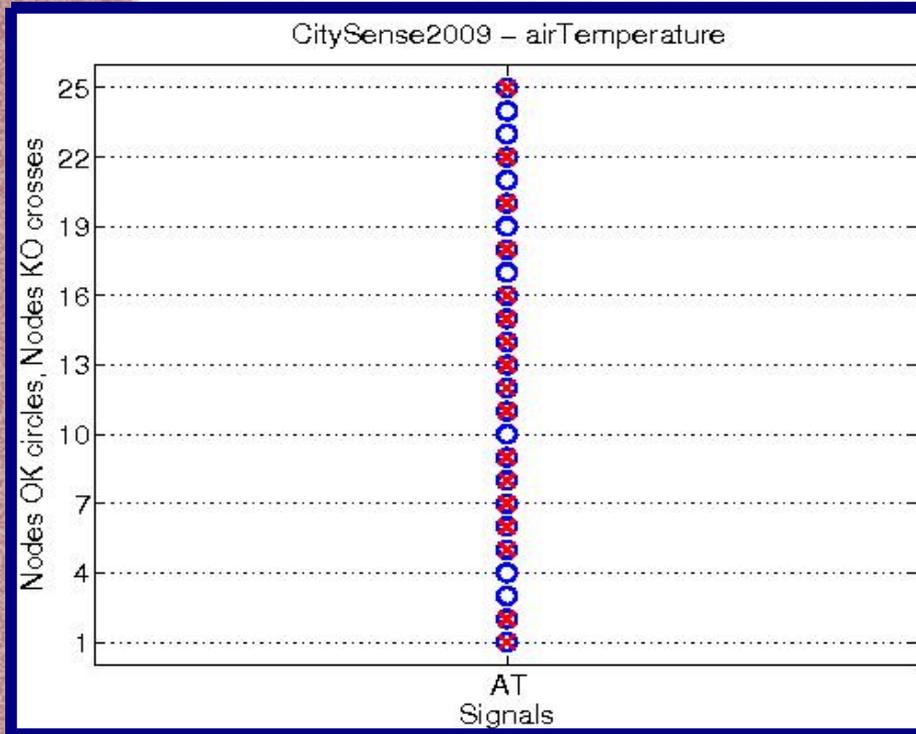
frames 887
of 60 min

Signal Collection

8 nodes
37 days

OrangeLab deployment

Campaign A



OK nodes & KO nodes

Signal Collection

DEI deployment

Selections

Campaign A

- Nodes: 37/68; frame length: 5 min; # of collected frames: 783
 - Starting time: March 13th, 2009
- Stopping time: March 16th, 2009 (after 65 hours from the beginning)

Campaign B

- Nodes: 45/68; frame length: 5 min; # of collected frames: 756
 - Starting time: March 19th, 2009
- Stopping time: March 22th, 2009 (after 63 hours from the beginning)

Campaign C

- Nodes: 31/68; frame length: 5 min; # of collected frames: 571
 - Starting time: March 24th, 2009.
- Stopping time: March 26th, (after 47 hours from the beginning)

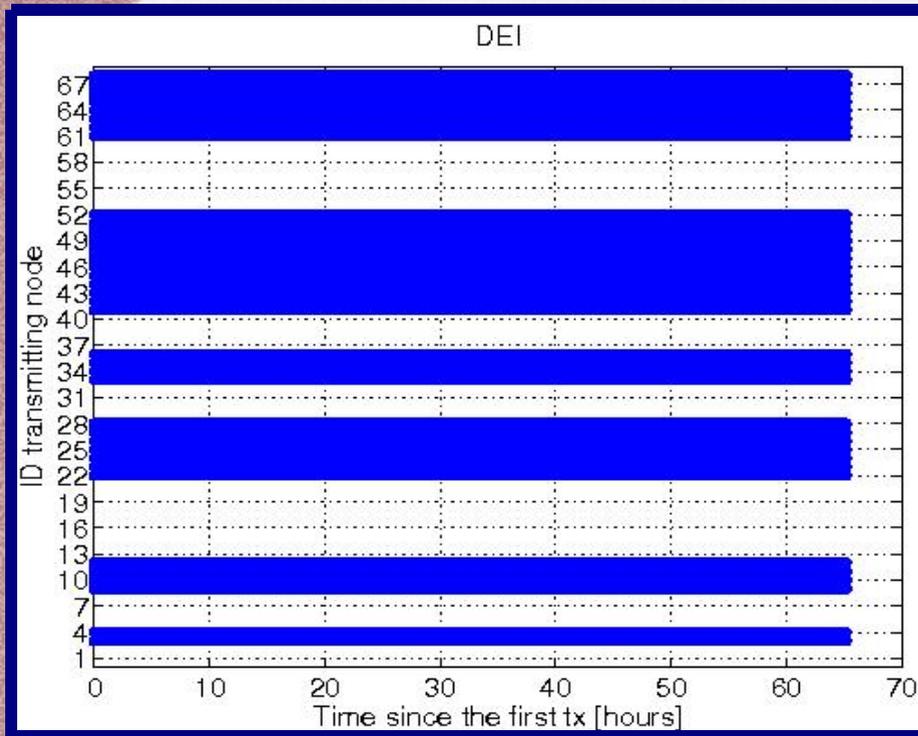
783 frames
of 5 min

Signal Collection

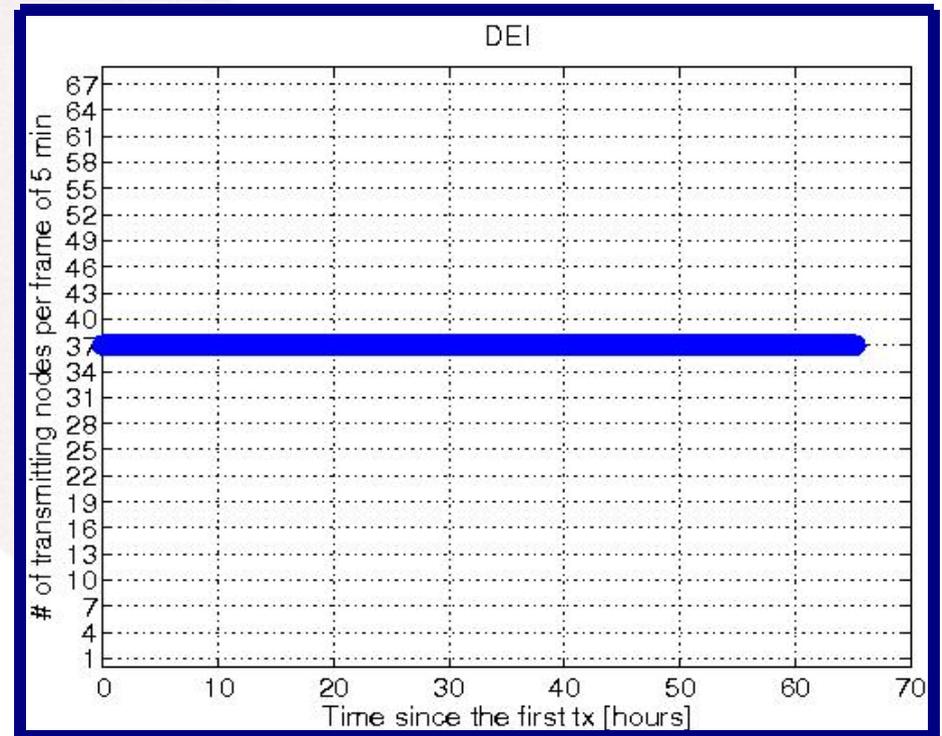
37 nodes
65 hours

DEI deployment

Campaign A



Txs for each node



of tx nodes per frame

783 frames
of 5 min

Signal Collection

37 nodes
65 hours

DEI deployment

Campaign A

	T	H	V	L1	L2
n1	-	-	-	-	-
n2	-	-	-	-	-
n3	0	0	0	0	0
n4	0	0	0	0	0
n5	-	-	-	-	-
n6	-	-	-	-	-
n7	-	-	-	-	-
n8	-	-	-	-	-
n9	0	0	0	0	0
n10	0	0	0	0	0
n11	0	0	0	0	0
n12	0	0	0	0	0
n13	-	-	-	-	-
n14	-	-	-	-	-
n15	-	-	-	-	-
...

of recorded NaNs
(first 15 nodes)

	T	H	V	L1	L2
n1	-	-	-	-	-
n2	-	-	-	-	-
n3	0	0	0	0	0
n4	0	0	0	0	0
n5	-	-	-	-	-
n6	-	-	-	-	-
n7	-	-	-	-	-
n8	-	-	-	-	-
n9	0	0	0	0	0
n10	0	0	0	0	0
n11	0	0	0	0	0
n12	0	0	0	0	0
n13	-	-	-	-	-
n14	-	-	-	-	-
n15	-	-	-	-	-
...

of corrected frames
(first 15 nodes)

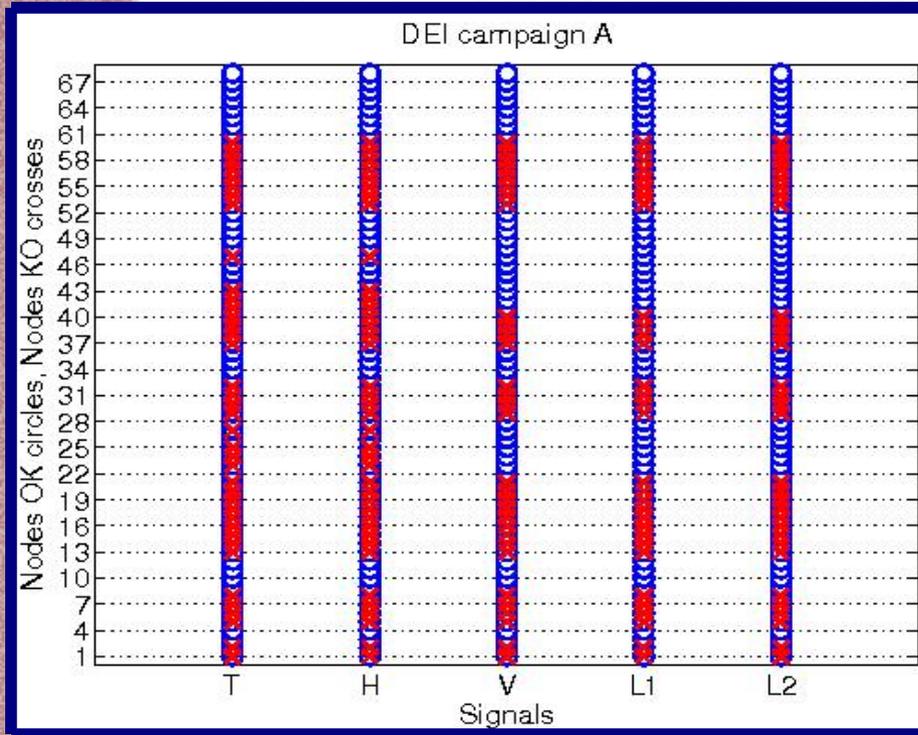
783 frames
of 5 min

Signal Collection

37 nodes
65 hours

DEI deployment

Campaign A



OK nodes & KO nodes

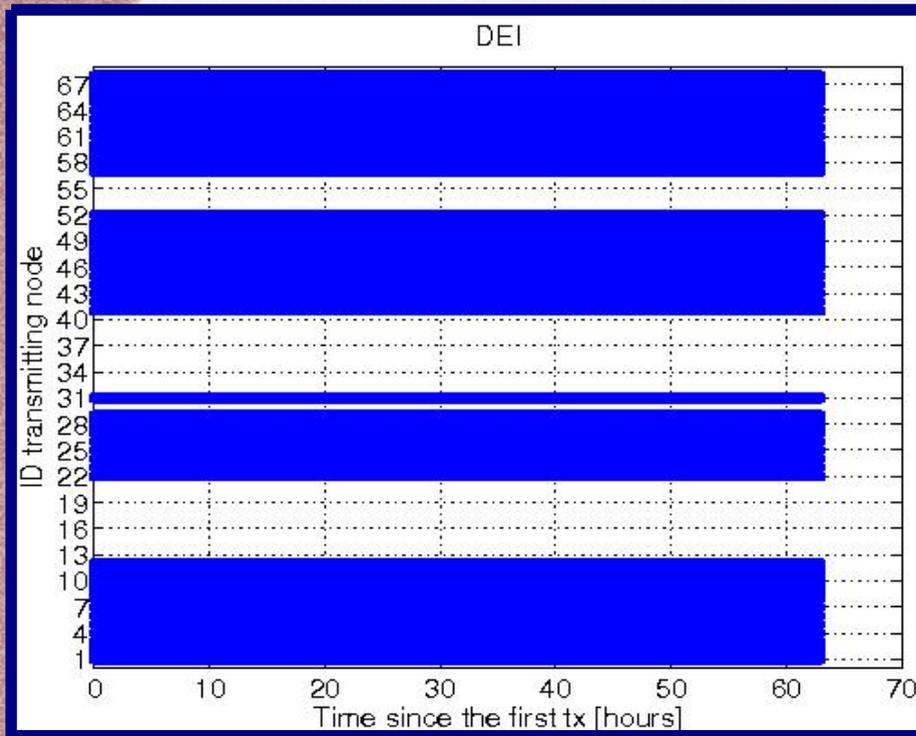
756 frames
of 5 min

Signal Collection

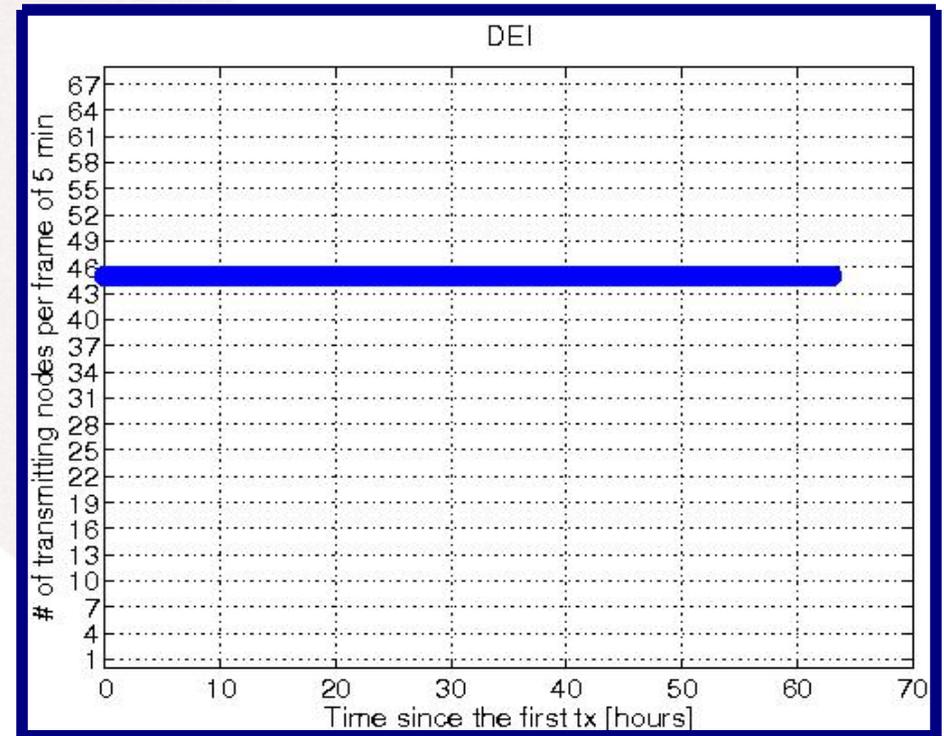
45 nodes
63 hours

DEI deployment

Campaign B



Txs for each node



of tx nodes per frame

756 frames
of 5 min

Signal Collection

45 nodes
63 hours

DEI deployment

Campaign B

	T	H	V	L1	L2
n1	0	0	0	0	0
n2	0	0	0	0	0
n3	0	0	0	0	0
n4	0	0	0	0	0
n5	0	0	0	0	0
n6	0	0	0	0	0
n7	0	0	0	0	0
n8	0	0	0	0	0
n9	0	0	0	0	0
n10	0	0	0	0	0
n11	0	0	0	0	0
n12	0	0	0	0	0
n13	-	-	-	-	-
n14	-	-	-	-	-
n15	-	-	-	-	-
...

of recorded NaNs
(first 15 nodes)

	T	H	V	L1	L2
n1	0	0	0	0	0
n2	0	0	0	0	0
n3	0	0	0	0	0
n4	0	0	0	0	0
n5	0	0	0	0	0
n6	0	0	0	0	0
n7	0	0	0	0	0
n8	0	0	0	0	0
n9	0	0	0	0	0
n10	0	0	0	0	0
n11	0	0	0	0	0
n12	0	0	0	0	0
n13	-	-	-	-	-
n14	-	-	-	-	-
n15	-	-	-	-	-
...

of corrected frames
(first 15 nodes)

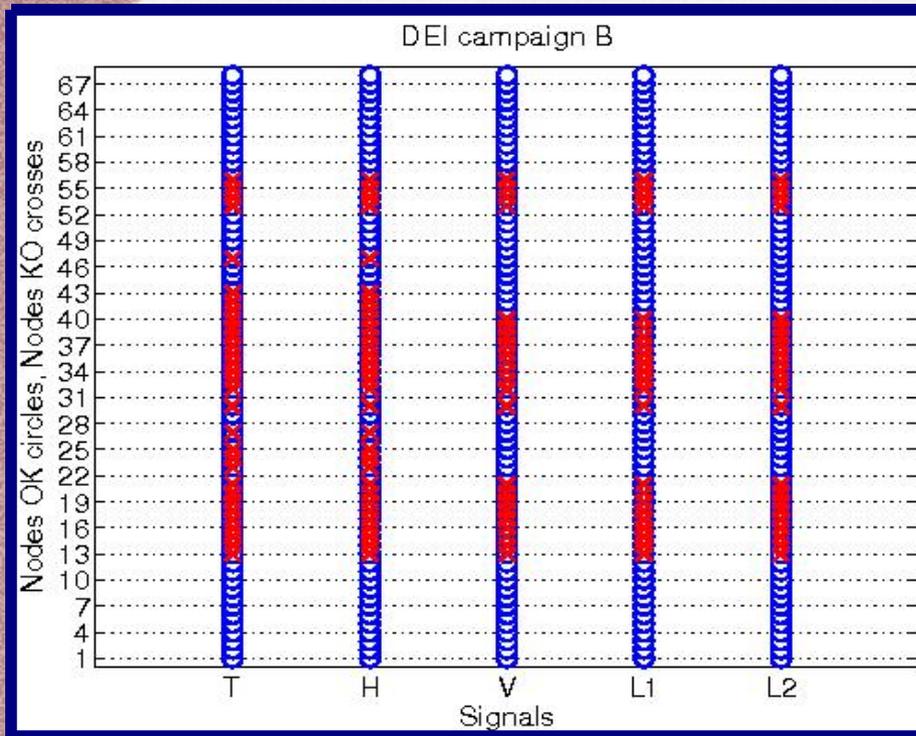
756 frames
of 5 min

Signal Collection

45 nodes
63 hours

DEI deployment

Campaign B



OK nodes & KO nodes

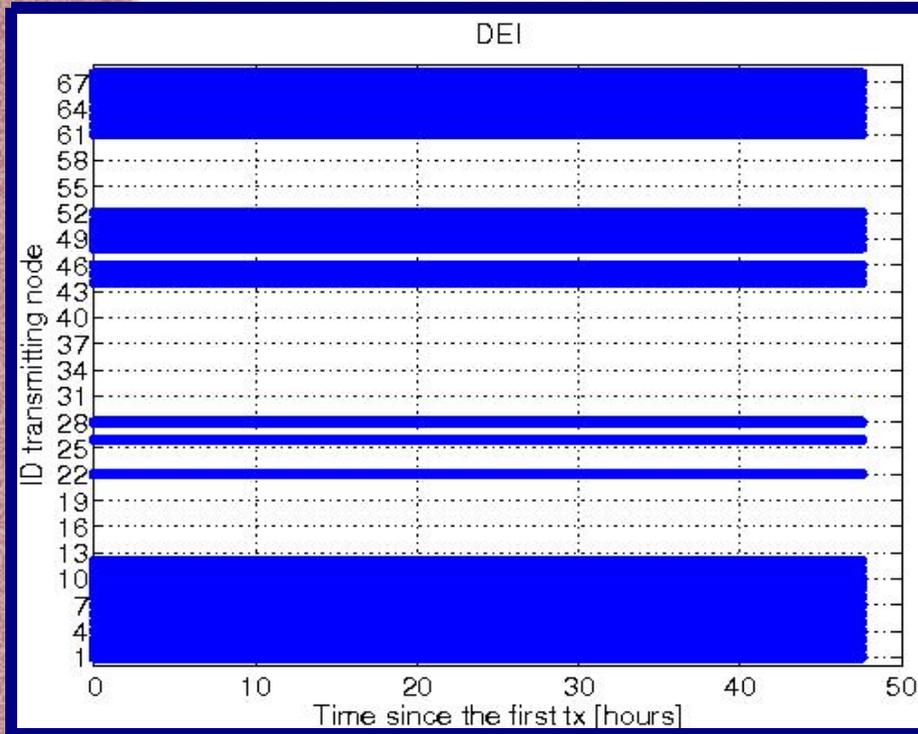
571 frames
of 30 min

Signal Collection

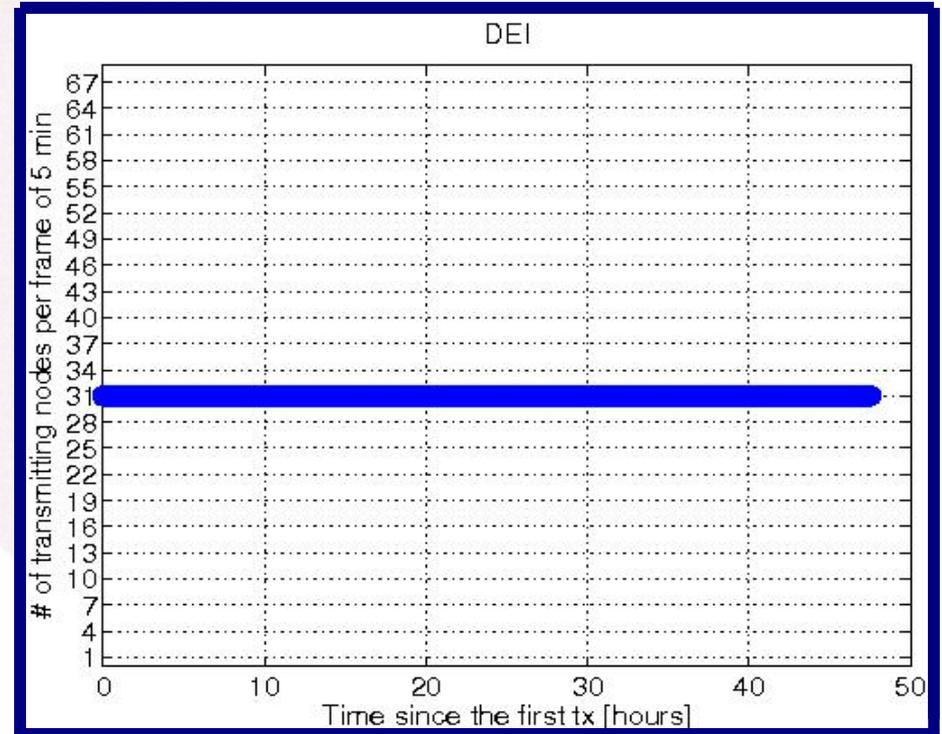
31 nodes
47 hours

DEI deployment

Campaign C



Txs for each node



of tx nodes per frame

571 frames
of 30 min

Signal Collection

31 nodes
47 hours

DEI deployment

Campaign C

	T	H	V	L1	L2
n1	0	0	0	0	0
n2	0	0	0	0	0
n3	0	0	0	0	0
n4	0	0	0	0	0
n5	0	0	0	0	0
n6	0	0	0	0	0
n7	0	0	0	0	0
n8	0	0	0	0	0
n9	0	0	0	0	0
n10	0	0	0	0	0
n11	0	0	0	0	0
n12	0	0	0	0	0
n13	-	-	-	-	-
n14	-	-	-	-	-
n15	-	-	-	-	-
...

of recorded NaNs
(first 15 nodes)

	T	H	V	L1	L2
n1	0	0	0	0	0
n2	0	0	0	0	0
n3	0	0	0	0	0
n4	0	0	0	0	0
n5	0	0	0	0	0
n6	0	0	0	0	0
n7	0	0	0	0	0
n8	0	0	0	0	0
n9	0	0	0	0	0
n10	0	0	0	0	0
n11	0	0	0	0	0
n12	0	0	0	0	0
n13	-	-	-	-	-
n14	-	-	-	-	-
n15	-	-	-	-	-
...

of corrected frames
(first 15 nodes)

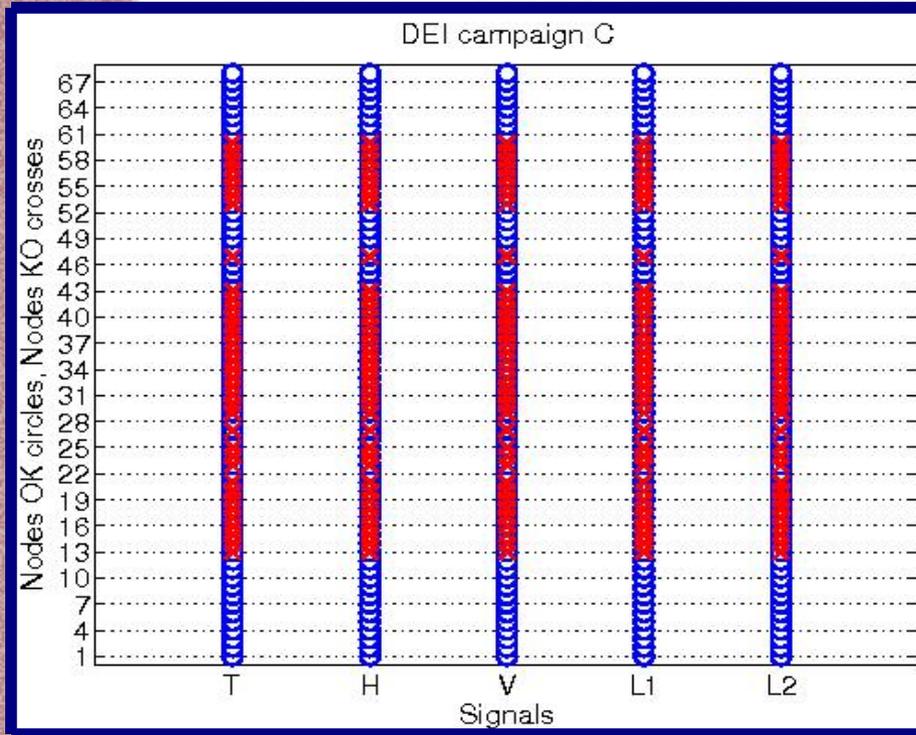
571 frames
of 30 min

Signal Collection

31 nodes
47 hours

DEI deployment

Campaign C

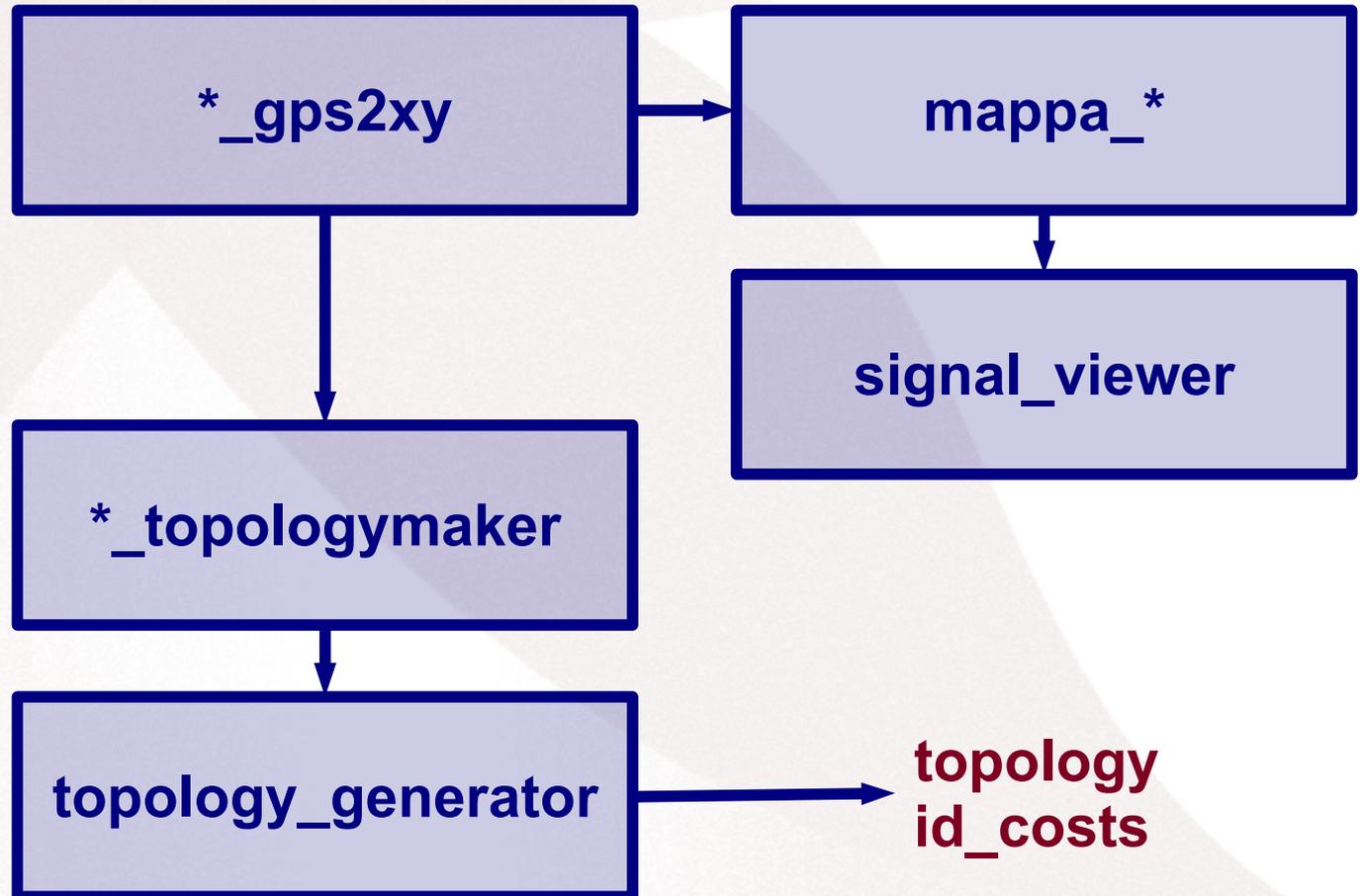


OK nodes & KO nodes

Topology-Cost Generation

* WSNname

**MatLab
developed
tools**



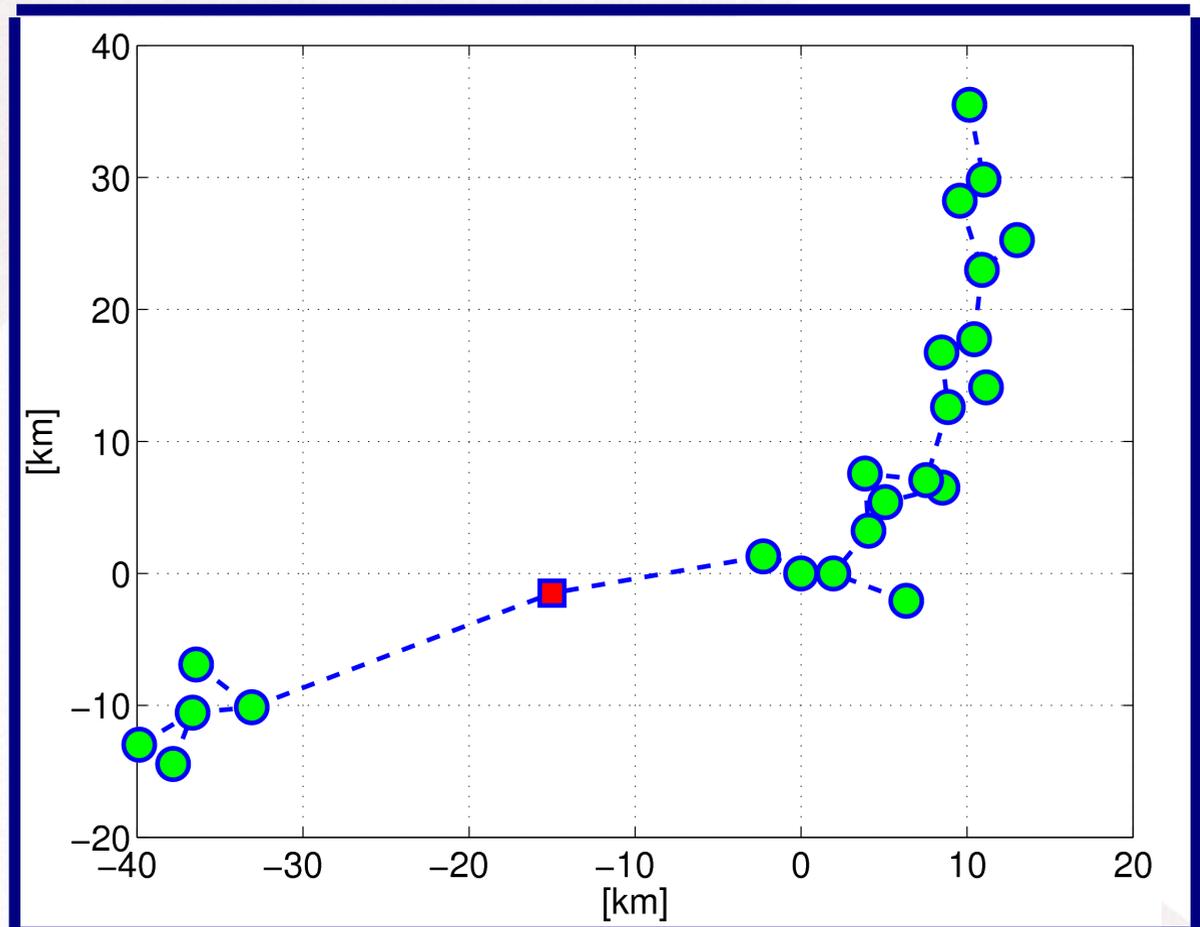
Topology-Cost Generation

St Bernard EPFL deployment

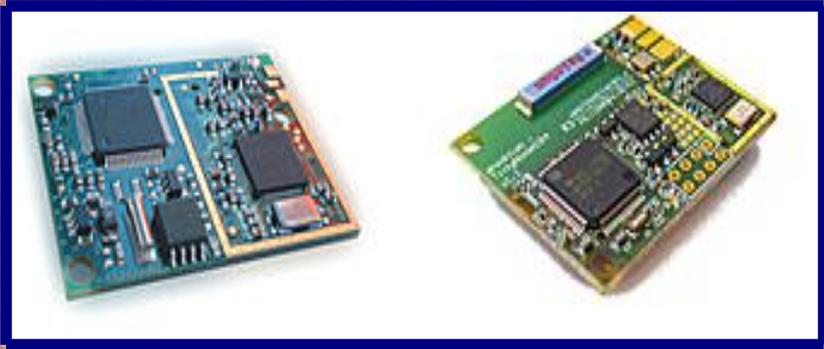
- **Multi-hops**
- **Energy aware**
- **Realistic**

Metrics:

- **# of hops**
- **TOT P_{tx} [dBm]**



Topology-Cost Generation



EPFL

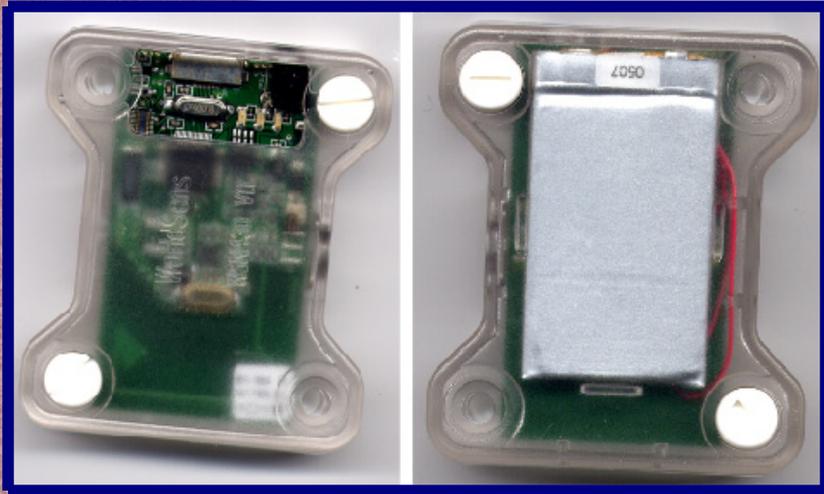
TinyNode

$P_{tx} \sim [-11, +10]$ dBm

Sensitivity ~ -100 dBm

$f_c = 869$ MHz

Topology-Cost Generation



Orange Lab

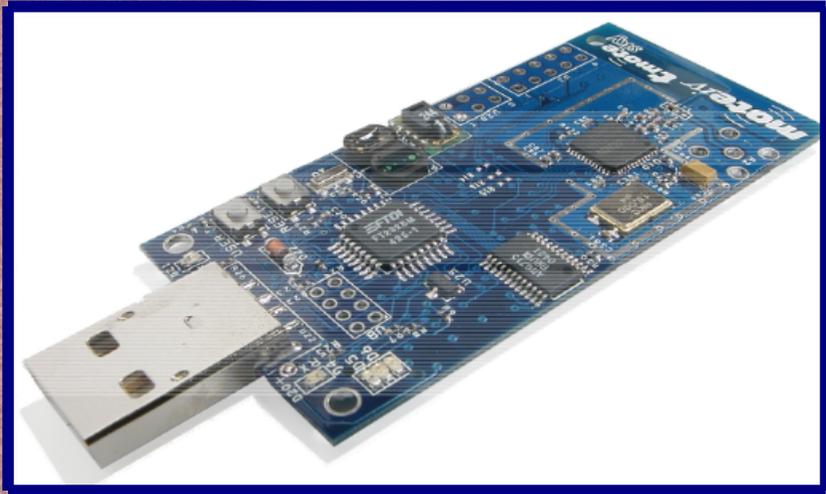
WSN430

$P_{tx} \sim [-30, +10]$ dBm

Sensitivity ~ -88 dBm

$f_c = 315/433/868/915$ MHz

Topology-Cost Generation



DEI

Tmote SKY

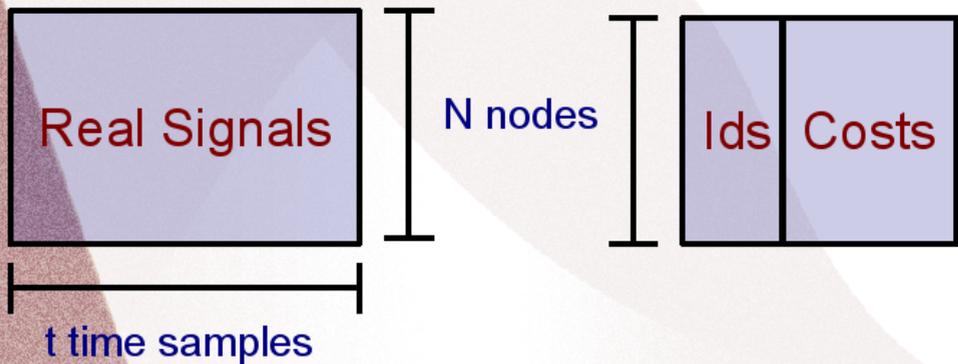
$P_{tx} \sim [-25, +0]$ dBm

Sensitivity ~ -90 dBm

$f_c = 2.4$ GHz

Conclusions

What we get so far ...



in each .mat file!

Where:

- the **Real Signal** [Nxt] matrix is called **g_t_t**
- the **Ids-Costs** [Nx3] matrix is called **id_costs**
- the **2nd** column of **id_costs** is the **# of hops**
- the **3rd** column of **id_costs** is the **TOT P_{tx} [dbm]**