

Memo



Date: January 5, 2011
To: Kevin Stewart
From: Markus Ritsch
Subject: December 2010 ALERT Data Analysis

I. ALERT Data Source

Raw ALERT data records extracted from the Urban Drainage and Flood Control District's Nova Star 4.0 base station (ALERT 2) were analyzed for the period December 1 through December 31, 2010.

II. General System Analysis Summary

A total of 340,233 ALERT (legacy) data reports were analyzed from the ALERT 2 base station. Meteorological sensors account for 83 percent, water level sensors 3 percent, and rain sensors 2 percent of the total monthly records.

The system-wide radio traffic loading was 10,975 reports per day with an average hourly loading of 457 reports. The peak hourly traffic loading was 829 reports, which occurred on December 9, between 8:00 AM and 9:00 AM. A plot of monthly average and peak hourly traffic loading is provided.

A. Specific Issues Identified this Month

Performance of the following sensors (Table 1) was unacceptable this month.

Table 1. Rain Sensors with Unacceptable Performance Characteristics

Rain ID	Description	Timer	Event	Comments
140	Wx-Blue Mountain	76%	100%	Poor timer performance
1440	Wx-Elbert	74%	100%	Poor timer performance
1460	Wx-Urban Farm	77%	100%	Poor timer performance
1520	Wx-Marston Lake North	77%	100%	Poor timer performance
2710	Wx-Highlands Ranch WTP	100%	75%	Poor event performance
4010	Crescent	92%	100%	Large number of invalid reports
4030	Red Garden	94%	100%	Large number of invalid reports
4060	Lakeshore	92%	100%	Large number of invalid reports
4080	Twin Sisters	97%	100%	Large number of invalid reports
4090	Wx-Magnolia	100%	100%	Large number of invalid reports
4110	Betasso	100%	67%	Poor event performance
4330	Hansen Rain	66%	100%	Poor timer performance
4490	Apple Valley	84%	100%	Marginal timer performance
4850	Porphory Mountain	89%	100%	Marginal timer performance

The largest concern this month centers upon the fact that a large number of transmissions/reports are currently being received from undefined sensors. Almost two percent of the total reports received this month were from unknown sensors.

III. Rain Sensor Timer Reporting Summary

The following analysis assumes that each rain sensor has a 12-hour timer-reporting interval. The worst performing rain sensors for the month are summarized (Table 2).

Table 2. Monthly Summary of Sensors with Poor Timer Performance (Sensor ID)

Jan**	Feb**	Mar*	Apr	May	Jun	Jul	Aug	Sep	Oct*	Nov**	Dec**
--	--	--	2970	2970	2970	2980	2980	2230	--	4490	4330
--	--	--	3010	700	1710	2930	2930	4270	--	1460	1440
--	--	--	700	2240	4330	2990	2990	4040	--	4850	140
--	--	--	4860	4330	2270	3020	3020	4330	--	4010	1460
--	--	--	4330	4490	2240	2810	2810	2240	--	4790	1520
--	--	--	4170	4270	4470	4330	4330	1710	--	140	4470

*- Due to system start-up/shut-down, timer statistics are not evaluated for the months of March and October. **-Only sensors that operate year-round (weather stations and stations in Boulder County) are included for the analysis in these months.

Sensors identified as having poor timer performance in multiple months are shaded with unique colors. A developing trend can thus be identified from the color shading as the year progresses.

IV. Rain Sensor Event Reporting Summary

A. District-Wide Total Tip/Count Statistics

The incrementing reports from all 1-mm rain sensors were analyzed to quantify the District-wide statistical total monthly tip summary (Table 3).

Table 3. District-Wide Total Tip/Count Statistical Summary

Statistical Parameter	Value	Comments
Mean	3.31	Only the 1-mm rain sensors were included in the analysis
Median	2	Only the 1-mm rain sensors were included in the analysis
Standard deviation	3.38	Only the 1-mm rain sensors were included in the analysis
Mean plus three standard deviations	13.44	Only the 1-mm rain sensors were included in the analysis
Minimum total count	1	Multiple Sensors
Maximum total count	15	ID 4260 (Taylor Mountain Rain Boulder County)

B. Monthly Average Tip/Count Summary

A monthly summary of the District-wide mean total tip/count is presented (Table 4).

Table 4. Monthly Summary of District-Wide Mean Total 1-mm Tip/Count

Year	Jan	Feb*	Mar*	Apr	May	Jun	Jul	Aug	Sep	Oct*	Nov	Dec	Ave
2006	4.62	5.92	18.39	20.47	19.44	13.75	74.03	46.89	24.17	41.13	5.04	16.45	24.19
2007	11.56	5.40	29.75	65.03	68.30	15.87	36.20	46.38	22.13	29.50	6.54	11.29	29.00
2008	4.05	7.38	12.26	20.57	54.82	26.06	16.43	90.20	37.54	19.59	2.82	9.24	25.08
2009	6.33	3.11	11.37	59.26	63.45	68.00	65.00	20.00	27.29	30.24	11.00	5.60	30.89
2010	5.97	11.90	32.54	70.57	39.63	56.04	50.23	31.01	4.18	18.31	8.30	3.31	27.67

*-Event statistics are skewed in these months because system start-up/shut-down occurs. The rain network is operational between April 1 and October 15. Only the weather stations remain operational throughout the year.

C. Sensors with a Jump of Six or More in the Sequential Count

Several sensors experienced a large jump in the sequential tip count (Table 5).

Table 5. Sensors with a Jump of 6 or More in Sequential Count

Sensor Description	Sensor ID	Comment
Wx-Highlands Ranch WTP	2710	A jump of 22 counts was recorded in sequential reports on 12/9/2010 at 3:57:05 PM Field maintenance was performed on this day which accounts for the large jump.
Magnolia	4090	The reports from 12/01/2010 through 12/09/2010 at 11:31 AM are bad.

D. Sensor-by-Sensor Incrementing Count Summary

The system-wide reception rate of incrementing, 1-mm tip reports for the month was approximately 97.21 percent. A total of 174 incrementing reports were received and a total of 179 reports were expected. The total loss of incrementing reports for the month was approximately 2.79 percent. Those sensors with the worst event transmission performance are summarized (Table 6).

Table 6. Monthly Summary of Sensors with the Most Missed Tips

Jan**	Feb**	Mar*	Apr	May	Jun	Jul	Aug	Sep	Oct*	Nov**	Dec**
--	--	--	2970	700	2900	870	2270	110	--	4110	4470
--	--	--	700	2280	2190	540	2980	2970	--	4080	2710
--	--	--	940	2970	2930	2980	2280	720	--	4070	4110
--	--	--	430	2980	4330	2900	4090	1900	--	4470	4270
--	--	--	2900	2190	2980	4330	310	2270	--	4490	--
--	--	--	4330	2240	2970	2230	4330	4040	--	4510	--

*- Due to system start-up/shut-down, timer statistics are not evaluated for the months of March and October. **-Only sensors that are operational year-round (weather stations and stations in Boulder County) are included for the analysis in these months.

Sensors identified as having poor event performance in multiple months are shaded with unique colors. A developing trend can thus be identified from the color shading as the year progresses.

V. Heavy Radio Traffic Analysis

Periods exceeding 500 messages per hour were analyzed independently in an attempt to quantify data loss rates from rain sensors using the sequential tip count series.

A. The Heaviest Hourly Traffic Periods This Month

The hourly periods of highest radio traffic this month are shown (Table 7). Each hour exceeding 500 reports was analyzed to quantify the number of missing rain reports for that hour.

Table 7. Heavy Radio Traffic Periods

Peak Traffic Periods	Reports/hour	Missing Rain Reports (% loss)	Hour Beginning
Peak Hourly Traffic	829	0 %	12/9/2010 8:00 AM
2nd Max	823	0 %	12/8/2010 7:00 AM
3rd Max	813	0 %	12/8/2010 5:00 AM
4th Max	790	0 %	12/8/2010 6:00 AM
5th Max	787	0 %	12/8/2010 9:00 AM

VI. Unknown Device Analysis – Received Data Log

The ALERT IDs present in the audio signal received by the decoder are compared against a list of “active” device IDs that are defined within NovaStar. Those IDs received by the decoder that are not defined within NovaStar are considered to be “unknown” and may be the result of radio noise or problems with the telemetry system. The reception of “unknown” device reports for the month is summarized (Table 8).

Table 8. Summary of Unknown IDs

Description	Quantity
Total number of unknown IDs (IDs without a device definition)	2,265
Total reports from unknown IDs	6,396
Unknown IDs with only a single received report (potential noise)	1,192
Total reports from all IDs – RecData Log entire month	340,233
Unknown reports as a fraction of total reports	1.88%

The total number of reports from unknown sensors is very small relative to the total reports received for the month. Shown below (Table 9) are the total reports received from unknown sensor IDs for each month of the year.

Table 9. Monthly Summary of Total Reports from Unknown IDs

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2010	1,220	1,474	1,276	1,174	721	5,707	610	1,738	442	533	2,857	6,396

The fraction of reports from unknown sensors relative to the total number of reports is shown below (Table 10).

Table 10. Monthly Percent of Unknown Sensor Reports

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2010	0.42%	0.56%	0.38%	0.32%	0.20%	1.61%	0.17%	0.49%	0.13%	0.16%	0.93%	1.88%

A number of “unknown” sensors had multiple reports, which may indicate the existence of a transmitter that is sending information on an ID that is not currently defined within NovaStar. The unknown IDs with multiple reports including the number of reports received by each are shown (Table 11).

Table 11. Reports Received by Unknown IDs

Unknown ID	Reports
2993	68
8191	68
4093	64
4087	60
4091	59
4094	58
1470	44
4063	42
4062	33
8189	30
1423	29
7679	29
7935	29
8159	29
6143	28
4083	27
8183	27
2748	25
4092	25
8063	25
7167	23
8175	23
1454	22
1953	22
8127	22
1453	21
1926	21
1951	21
1933	20
4086	20
8190	20
1918	19
8187	19
7159	17
7903	17
8158	17
1934	16
7933	16
1923	15
3967	15
7663	15
8151	15
3071	14
4014	14
7871	14
8123	14
1446	13
2784	13
4061	13
4863	13
5119	13
6111	13
7165	13
7647	13
7678	13
8047	13
8111	13
1954	12
2239	12
2746	12
2768	12
4011	12
5631	12
6110	12

6127	12
7039	12
7163	12
7166	12
8031	12
8059	12
8095	12
8119	12
8167	12
8174	12
1443	11
1457	11
1478	11
1528	11
1534	11
2047	11
4081	11
4862	11
6141	11
6655	11
7135	11
8062	11
8125	11
8182	11
154	10
1919	10
2775	10
2808	10
2811	10
4607	10
7615	10
7934	10
8055	10
8179	10
8181	10
8188	10
1458	9
1486	9
2745	9
2753	9
2776	9
3007	9
3575	9
3838	9
4079	9
4082	9
4605	9
4735	9
4853	9
5887	9
5983	9
6651	9
7407	9
7423	9
7551	9
7662	9
7675	9
7927	9
8126	9
8155	9
8171	9
8173	9

The “unknown” device reports are analyzed temporally to understand when they are received during the day (Table 12). The goal of this analysis is to determine a pattern of occurrence that may correspond to a source of noise in the system, such as the use of a wireless microphone nearby.

Table 12. Temporal Distribution of Received Reports

Hour (AM)	Reports	Hour (PM)	Reports
0:00-00:59	311	12:00-12:59	159
1:00-1:59	311	1:00-1:59	124
2:00-2:59	305	2:00-2:59	230
3:00-3:59	282	3:00-3:59	234
4:00-4:59	306	4:00-4:59	260
5:00-5:59	325	5:00-5:59	297
6:00-6:59	297	6:00-6:59	284
7:00-7:59	295	7:00-7:59	323
8:00-8:59	283	8:00-8:59	314
9:00-9:59	237	9:00-9:59	289
10:00-10:59	180	10:00-10:59	297
11:00-11:59	155	11:00-11:59	298

VII. Sensors with Invalid Reports

The following precipitation sensors had a large number of invalid reports (bit flip/contention errors/random decode):

Sensor ID	Description	Nov 10	Dec 10	Jan 11	Feb 11	Mar 11
140	Wx-Blue Mountain	3	5			
1420	Wx-Diamond Hill	2	0			
1440	Wx-Elbert	2	4			
1460	Wx-Urban Farm	2	2			
2190	Wx-Squaw Mountain	2	1			
4010	Crescent	13	6			
4030	Red Garden	4	6			
4060	Lakeshore	13	7			
4080	Twin Sisters	5	6			
4090	Magnolia	65	27			
4530	Winiger Ridge	3	2			
4570	St. Antons	3	1			
4730	Wx-Sugarloaf	7	0			
4770	Wx-Cal Wood Ranch	2	0			
4830	SBC - San Souci	7	4			
4840	SBC - S. Boulder Ditch	3	1			
4860	Fairview Peak	8	4			

General System Analysis

Database Name P:\A207-UDFCD-Data-Analysis\2010\12-2010\Novastar_extract_2010Dec

First Date in Database	12/1/10 12:00 AM	Total Days	31.0
Last Date in Database	12/31/10 11:59 PM	Total Hours	744.0

Total Records Analyzed 340233

Records by Group

Temperature	60087	18%
Relative Humidity	58732	17%
Wind Gust	58587	17%
Barometric Pressure	30405	9%
Wind Speed Average & Azimuth	27292	8%
Wind Direction	20144	6%
Wind Speed Average	19773	6%
Solar Radiation	8964	3%
Precipitation	6529	2%
Unknown	6396	2%
Fuel Moisture	5580	2%
Fuel Temperature	5553	2%
Battery Voltage HSE	5366	2%
Water Level PT-HSE	4278	1%
Battery Voltage Analog	3733	1%
Battery Voltage Digital	3534	1%
Water Level Float	3339	1%
Battery	3066	1%
Soil Moisture	2718	1%
Repeater Status Report	2467	1%
Water Level PT	1789	1%
Wing Gust	734	0%
Repeater Pass List	639	0%
12Hr Status Report	366	0%
Battery Voltage	92	0%
Repeater ON Count	19	0%
Solar Power	18	0%
Repeater Battery Check	12	0%
ALERT/A2 Testing	8	0%
Hayman Battery	6	0%
Handar 585 ALARM Status	3	0%
Hayman Stream	3	0%
Hayman Stage	1	0%
Total	340233	

Records by Major Group

Meteorologic Sensors	283984	83%
Sensor Status Transmissions	16126	5%
Soil and Fuel Sensors	13851	4%
Water Level Sensors	9406	3%
Rain Sensors	6529	2%
Total	329896	

Traffic Loading Summary

Alert Reports	340233	
Average Daily Traffic	10975	
Average Hourly Traffic	457	
Median Hourly Traffic	448	hour beginning
Peak Hourly Traffic	829	12/9/10 8:00 AM
2nd Max	823	12/8/10 7:00 AM
3rd Max	813	12/8/10 5:00 AM
4th Max	790	12/8/10 6:00 AM
5th Max	787	12/8/10 9:00 AM

Rain Timer Performance

Boulder County and UDFCD Weather Stations

Analyze Rain Sensors

Rain ID	Description	Rcv	Timer	Ave Exp	87% Performance
4330	Hansen Rain	41	17:08	62.00	66%
1440	Wx-Elbert	46	15:12	62.00	74%
140	Wx-Blue Mountain	47	15:39	62.00	76%
1460	Wx-Urban Farm	48	14:36	62.00	77%
1520	Wx-Marston Lake North	48	14:44	62.00	77%
4470	Little Narrows	50	14:42	62.00	81%
4490	Apple Valley	52	14:07	62.00	84%
2930	Wx-Spring Valley Rd-DougCn	54	13:53	62.00	87%
4040	Martin Gulch	54	13:34	62.00	87%
3020	Wx-West Creek WX	55	13:21	62.00	89%
900	Wx-Aurora Reservoir	55	13:20	62.00	89%
4850	Porphyry Mtn	55	13:21	62.00	89%
4510	Pinewood Springs	55	13:08	62.00	89%
4820	Doudy Draw	56	13:05	62.00	90%
4360	Justice Center	56	13:17	62.00	90%
4290	Red Hill	56	13:04	62.00	90%
4260	Taylor Mountain	56	12:42	62.00	90%
4240	Sunset	56	12:52	62.00	90%
4230	Golden Age	56	13:03	62.00	90%
4200	Lazy Acres	56	13:06	62.00	90%
4190	Slaughterhouse	56	12:52	62.00	90%
4710	Wx-Ward C-1	57	13:01	62.00	92%
4730	Wx-Sugarloaf	57	12:53	62.00	92%
4170	Pine Brook	57	12:51	62.00	92%
4060	Lakeshore	57	12:50	62.00	92%
4010	Crescent	57	12:36	62.00	92%
4310	Johnny Park	58	11:58	62.00	94%
4270	Cannon Mountain	58	12:24	62.00	94%
4250	Geer Canyon	58	12:37	62.00	94%
4220	Fling's	58	12:12	62.00	94%
4140	Logan Mill	58	12:37	62.00	94%
4030	Red Garden	58	12:25	62.00	94%
750	Wx-Quincy Reservoir	59	12:22	62.00	95%
4750	Wx-Louisville Lake	59	12:24	62.00	95%
4860	Fairview Peak	59	12:25	62.00	95%
4570	St. Antons	59	12:13	62.00	95%
4180	Gold Lake	59	12:24	62.00	95%
2730	Wx-Salisbury Park	60	12:06	62.00	97%
1420	Wx-Diamond Hill	60	12:00	62.00	97%
4770	Wx-Cal-Wood Ranch	60	12:12	62.00	97%
1920	Wx-Brighton	60	12:12	62.00	97%
4840	SBC@S Boulder Ditch	60	12:22	62.00	97%
4810	Shanahan Ridge	60	12:10	62.00	97%
4100	Filter Plant	60	11:59	62.00	97%
4080	Twin Sisters	60	12:10	62.00	97%
4050	Walker Ranch	60	12:09	62.00	97%
4020	Rio Grande	60	12:10	62.00	97%
2990	Wx-Tomah Rd-DougCnty	61	12:08	62.00	98%
2190	Wx-Squaw Mountain	61	12:00	62.00	98%
2210	Wx-Hiwan G.C.	61	12:00	62.00	98%
4790	Wx-Button Rock	61	12:00	62.00	98%
920	Wx-Aurora Town Hall	61	12:00	62.00	98%
4830	SBC @ San Souci	61	11:58	62.00	98%
4550	Boulder Jail	61	11:57	62.00	98%
4530	Winiger Ridge	61	11:45	62.00	98%
4520	Eagle Ridge	61	12:00	62.00	98%
4350	Conifer Hill	61	11:58	62.00	98%
4340	Riverside	61	11:58	62.00	98%
4160	Sunshine	61	11:58	62.00	98%
4150	Gold Hill	61	11:58	62.00	98%
4130	Swiss Peaks	61	11:59	62.00	98%
2710	Wx-Highlands Ranch WTP	62	12:00	62.00	100%
2750	Wx-Castle Rock	62	11:48	62.00	100%
4300	Big Elk Park	62	11:45	62.00	100%
4110	Betasso	62	11:35	62.00	100%
4070	Bear Peak	62	11:46	62.00	100%
4090	Magnolia	66	10:45	62.00	106%
1570	Wx-Brighton Ditch	70	9:54	62.00	113%

Rain Event Performance				Analyze Rain Sensors					Boulder County and UDFCD Weather Stations				
		Reports Received	174										
	Systemwide Avg	Total Tips	179										
	97.21%	Data Loss	2.79%										
Rain ID	Performance	1-tips	2-tips	3-tips	4-tips	5-tips	6-tips	>6-tips	Rcv	Exp	Miss	Hold	Bucket
1350	50%	0	1	0	0	0	0	0	1	2	1	0	0.0393701
4470	50%	0	1	0	0	0	0	0	1	2	1	0	0.0393701
2710	67%	1	1	0	0	0	0	1	2	3	1	0	0.0393701
4110	67%	1	1	0	0	0	0	0	2	3	1	0	0.0393701
4270	75%	2	1	0	0	0	0	0	3	4	1	0	0.0393701
1420	100%	1	0	0	0	0	0	0	1	1	0	0	0.0393701
1460	100%	1	0	0	0	0	0	0	1	1	0	0	0.0393701
1520	100%	2	0	0	0	0	0	0	2	2	0	1	0.0393701
1640	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701
1700	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701
2190	100%	1	0	0	0	0	0	0	1	1	0	0	0.0393701
2370	100%	1	0	0	0	0	0	0	1	1	0	0	0.0393701
2930	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701
2990	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701
3020	100%	4	0	0	0	0	0	0	4	4	0	0	0.0393701
4020	100%	1	0	0	0	0	0	0	1	1	0	0	0.0393701
4030	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701
4040	100%	1	0	0	0	0	0	0	1	1	0	0	0.0393701
4060	100%	1	0	0	0	0	0	0	1	1	0	0	0.0393701
4070	100%	1	0	0	0	0	0	0	1	1	0	0	0.0393701
4080	100%	1	0	0	0	0	0	0	1	1	0	0	0.0393701
4090	100%	2	0	0	0	0	0	2	2	2	0	0	0.0393701
4100	100%	1	0	0	0	0	0	0	1	1	0	0	0.0393701
4130	100%	3	0	0	0	0	0	0	3	3	0	0	0.0393701
4140	100%	3	0	0	0	0	0	0	3	3	0	0	0.0393701
4150	100%	3	0	0	0	0	0	0	3	3	0	0	0.0393701
4160	100%	1	0	0	0	0	0	0	1	1	0	0	0.0393701
4180	100%	4	0	0	0	0	0	0	4	4	0	0	0.0393701
4190	100%	4	0	0	0	0	0	0	4	4	0	0	0.0393701
4200	100%	1	0	0	0	0	0	0	1	1	0	0	0.0393701
4220	100%	10	0	0	0	0	0	0	10	10	0	0	0.0393701
4240	100%	4	0	0	0	0	0	0	4	4	0	0	0.0393701
4250	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701
4260	100%	15	0	0	0	0	0	0	15	15	0	0	0.0393701
4290	100%	1	0	0	0	0	0	0	1	1	0	0	0.0393701
4300	100%	14	0	0	0	0	0	0	14	14	0	0	0.0393701
4310	100%	9	0	0	0	0	0	0	9	9	0	0	0.0393701
4330	100%	3	0	0	0	0	0	0	3	3	0	0	0.0393701
4340	100%	8	0	0	0	0	0	0	8	8	0	0	0.0393701
4350	100%	5	0	0	0	0	0	0	5	5	0	0	0.0393701
4360	100%	1	0	0	0	0	0	0	1	1	0	0	0.0393701
4490	100%	1	0	0	0	0	0	0	1	1	0	0	0.0393701
4510	100%	5	0	0	0	0	0	0	5	5	0	0	0.0393701
4520	100%	1	0	0	0	0	0	0	1	1	0	0	0.0393701
4530	100%	4	0	0	0	0	0	0	4	4	0	0	0.0393701
4570	100%	7	0	0	0	0	0	0	7	7	0	0	0.0393701
4710	100%	14	0	0	0	0	0	0	14	14	0	0	0.0393701
4730	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701
4770	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701
4790	100%	3	0	0	0	0	0	0	3	3	0	0	0.0393701
4810	100%	1	0	0	0	0	0	0	1	1	0	0	0.0393701
4820	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701
4850	100%	2	0	0	0	0	0	0	2	2	0	0	0.01
4860	100%	2	0	0	0	0	0	0	2	2	0	0	0.01
	Total Tips	169	5	0	0	0	0	3	174	179	5	1	

Monthly Traffic Loading

2010 Monthly ALERT Radio Traffic Summary

