Mode S Beast vs Airspy

Blort November 29, 2015

Reasons for Beast vs Airspy Test

- This past year has introduced the Airspy with ADS-B software that runs on a low-power Linux Computer
- Because the Airspy is cheaper that the Mode S Beast (hereafter referred to as "Beast"), I wanted to see if the Airspy was a viable alternative to the Beast
- So I put together a test of the two devices and researched the costs of Beast and Airspy ADS-B systems

Beast vs Airspy Test

- The test simultaneously runs both the Beast and the Airspy from the same RF source using Odroid computers
- Unfortunately, I don't have two Odroid XU4s so I used an Odroid XU4 for the Airspy (as it has the most powerful processors) and an Odroid U3 for the Beast
- The test did not enable Mode A/C on either device as this this data is really only useful for Plane Plotter applications and it creates a huge volume of data to record
- See the Cable Setup page which shows how the Odroids are connected to the Beast and the Airspy
- See the Configuration Data page which has the Hardware, Firmware and Software Configuration Data





Beast hardware version 1.1 with Firmware 1.42-019 Airspy Original with Firmware NOS v1.0.0-rc5-0-g648c14f 2015-05-20 Mini-Circuits Splitter ZAPD-2-S+ Mini-Circuits Filter VBFZ-1065-S+ Antenna DPD Productions ADS-B Vertical Outdoor Base Antenna Antenna to Filter cable is a 40 foot Bury-FLEX Low-Loss Coax Same length, manufacturer and type of cable used to connect the Splitter with the Beast and Airspy (RG402 Coax – 15 cm) Odroid U3 – modemixer2 - v.20150628 Odroid XU4 – modedeco2 - v.20150628

Beast Configuration

- The Beast is connected to an Odroid U3 via a USB
 2.0 port on the Odroid
- The Odroid U3 has modesmixer2 running which reads the Mode S Frames from the Beast, forwards the data to decodeadsb and provides graphical and textual metrics regarding the data
- The Odroid U3 has decodeadsb running which reads data from modesmixer2, records the Mode S frames, forwards the data to Plane Plotter and calculates metrics regarding the data

Airspy Configuration

- The Airspy is connected to an Odroid XU4 via a USB 3.0 port on the Odroid
- The Odroid XU4 has modesdeco2 running which decodes the digital signals into Mode S Frames, forwards the data to decodeadsb and provides graphical and textual metrics regarding the data
- The Odroid XU4 has decodeadsb running which reads data from modesdeco2, records the Mode S frames, forwards the data to Plane Plotter and calculates metrics regarding the data

Starting the Beast and Airspy Test

- The Beast and the Airspy are started by a "hand" using a telnet session and start within 2 seconds of each other
- The logs from decodeadsb confirm this:
 - Beast Program Start Time = GMT Time = Sunday November 29, 2015 17:41:39.369
 - Airspy Program Start Time = GMT Time = Sunday November 29, 2015 17:41:38.630
- With the software starting almost simultaneously, the metrics can be easily compared
- Screen shots are recorded within a few seconds of each other so that the data can be easily compared as well

During the Test

- Screen shots are taken, from both the Beast and Airspy, showing:
 - The graphical and textual metrics from modedeco2 / modemixer2
 - Plane Plotter display
 - Odroid Processor Utilization Rates
 - decodeadsb running metrics

Beast Initial Web Page Chart



Airspy Initial Web Page Chart



Beast Initial Web Page Stats

Mode√ſſ	lixer2 cr	harts	Stats	Flights	Map Log	v.20)150628 A	46 S 70 O	18:03 UTC O 10:03	3 UTC-8
Total				Mode S			ADS-B		Mode A/C	
Message	es B	ytes		Total	Long	Short	Total	Positions	Total	
881369	18	522252	4	738514	5447	733067	142855	59820		
DF	Messages	s Des	cription			DF Subty	/pe Message	s Description		
0	337998	SHO	RT AIR-AIF		CE (ACAS)	0	17	No position informatio	n	
4	89664	SUR	VEILLANC	E ALTITUDE RI	EPLY	2	5268	Aircraft ID Cat. C		
5	2708	SUR	VEILLANC	E IDENTITY RE	PLY	4	6539	Aircraft ID Cat. A		
11	301579	ALL	-CALL REP	LY		7	549	Surface, RC < 75.0 m		
16	13	LON	LONG AIR-AIR SURVEILLANCE (ACAS)			8	3	Surface, RC > 185.2		
17	137390	EXT	EXTENDED SQUITTER (ADS-B)			10	2110	Airborne, RC < 25 m		
18	5284	EXT	EXTENDED SQUITTER/SUPPLEMENTARY			11	53371	Airborne, RC < 75 m		
20	4264	CON	/IM-B ALTIT	UDE REPLY		40	2024	< 185.2 m		
21	1160	CON	/IM-B IDEN	TITY REPLY		12	3931	Airborne, RC < 370.4	m	
						10	10/1	Airborne, RC > 37.04	KM OF UNKNOWN	
Format				C	ount	19	62901	Airborne velocity		
No positio	n information			1/	(23	853			
None				14	1	29	3556	Status information		
Aircran op	erational Status			2.	:0	31	2364	Aircraft operational st	atus	
Aircraft et	atus			00	3		200.			
Identificati	n and category			11	824					
Target stat	e and status			31	62					
Airborne V	elocity			62	2984					
Airbonne	osition			60	1662					

Airspy Initial Web Page Stats

 192.168.1.102/i post Visited Y PB Mode/De Total Message 590448 DE 	F PP W Ø fitglob CO2 Cha	DB DB PP 🌺 Irts Stats	BST 🗍 BB 🥎 PP Flights Map Mode S	PB 🌏 Nif	♥ 🤁 WTR 💀 SDW v.2015	Search / 🔶 RT 🚮 BST 50628 🛛 🗛 3	kam 🧭 RC 🖬 BW 8 S 54 ⓒ 18	C 👚 😕 S	■ ₩ pia >> UTC-8
Total Message 590448	PPW j fitglob CO2 Cha	DB Y PP 🌺	BST 🗍 BB 🥱 PP Flights Map Mode S	PB 췉 Nif	99 🚬 WTR n SDW V.2015	V 🖕 RT 🛃 BST	鄕 ham 🕵 RC 🛃 BW 8 🕓 54 ⓒ 18	M AIR Z TV 🥱 me 🕻	□ pp <mark>ት</mark> pia » UTC-8
Total Message 590448	eco2 Cha	ytes	Flights Map	Log	v.2015	i0628 A 3	8 S 54 O 18	3:03 UTC (9 10:03	UTC-8
Total Message 590448	es B:	ytes	Mode S						
Message 590448	es Bi	ytes	T-4-1			ADS-B		Mode A/C	
590448	10		iotal	Long	Short	Total	Positions	Total	
DF		0113048	486645	3576	483069	103803	43601		
	Messages	s Description			DF Subtype	Messages	Description		
0	228534	SHORT AIR-AIR	R SURVEILLANCE	E (ACAS)	0	1	No position information		
4	65633	SURVEILLANC	E ALTITUDE REP	PLY	2	5150	Aircraft ID Cat. C		
5	2197	SURVEILLANC	E IDENTITY REP	LY	3	1	Aircraft ID Cat. B		
11	185901	ALL-CALL REP	PLY		4	4781	Aircraft ID Cat. A		
16	369	LONG AIR-AIR	SURVEILLANCE	(ACAS)	7	579	Surface, RC < 75.0 m d	or RC < 185.2 m	
17	98504	EXTENDED SC	UITTER (ADS-B)		8	4	Surface, RC > 185.2 m	or unknown	
18	5166	EXTENDED SQ	UITTER/SUPPLE	MENTARY	10	904	Airborne, RC < 25 m ar	nd VPL < 37.5 m	E
20	2661	COMM-B ALTIT	UDE REPLY		11	40020	Airborne, RC < 75 m ar	nd VPL < 112 m or RC	
21	532	COMM-B IDEN	TITY REPLY		10	2549	< 105.2 m		
					12	2040	Airborne, RC \leq 370.4 m		
Format			COL	Int	10	45309	Airborne, RC > 57.04 K	In or unknown	
No position	n information		1		23	65	Test message		
Aircraft on	erational status		105	3	28	440	TCAS Status		
Surface po	erational status		583	,	29	1951	Status information		
Aircraft sta	itus		440		31	1251	Aircraft operational stat	us	
Target stat	e and status		1954	4					
Identificatio	on and category		9948	8					
Airborne V	elocity		4530	65					
Airborne p	osition		4419	94					

Beast Plane Plotter



Airspy Plane Plotter



Beast Processor Utilization

🗗 root@odroidU3: ~										- 0 ×
1 [2 [3 [4 [Mem[Swp[113/	10.5%] 15.1%] 1.3%] 0.0%] 2022мв] 0/ОМВ]	Ta Lo Up	sks: ad av time:	30, 5 /erage : 00:2	thr; 3 : 0.07 0 7:38	running .23 0.24	
PID USER	PRI	NI	VIRT	RES	SHR S	CPU%	MEM%	TIME+	Command	
1184 root	17	-3	78440	77308	828 R	15.2	3.7	4:01.53	./decode	adsb COMP
1156 root	20	0	24096	4652	2420 R	5.3	0.2	1:28.04	./modesm	ixer2i 🚽
1153 root	20	0	2728	1364	920 R	1.3	0.1	0:16.69	htop	
1159 root	20	0	24096	4652	2420 S	0.0	0.2	0:02.58	./modesm	ixer2i
1158 root	20	0	24096	4652	2420 S	0.0	0.2	0:00.33	./modesm	ixer2i
1029 ntp	20	0	4228	1564	1160 S	0.0	0.1	0:00.11	/usr/sbi	n/ntpd -p
1091 root	20	0	9704	3032	2292 S	0.0	0.1	0:00.27	sshd: ro	ot@pts/1
825 root	0	-20	3024	2816	1828 S	0.0	0.1	0:00.08	/usr/bin	/atop -a 😑
999 root	20	0	9704	3032	2292 S	0.0	0.1	0:00.17	sshd: ro	ot@pts/0
1 root	20	0	3396	1956	1100 s	0.0	0.1	0:03.62	/sbin/in	it
262 root	20	0	2616	1268	508 S	0.0	0.1	0:00.47	upstart-	udev-brid
268 root	20	0	9760	1364	808 S	0.0	0.1	0:00.25	/lib/sys	temd/syst
458 messagebu	20	0	3272	932	620 <u>s</u>	0.0	0.0	0:00.12	dbus-dae	monsys
498 root	20	0	3352	1340	1056 s	0.0	0.1	0:00.01	/lib/sys	temd/syst
F1Help F2Setup	F3Se	earch	F4 <mark>Filt</mark>	erF5Tre	e F6So	rtBy	7 <mark>Nice</mark>	-F8Nice	+F9Kill	F10Quit -

With the Beast, the CPU utilization is very low because the Beast processes the digital signals into Mode S Frames.

Airspy Processor Utilization

學 root@odroidxu4: ~			
1 [2 [3 [4 [Mem[15.8%] 30.3%] 10.4%] 28.5%] 545/1990мв]	5 [1.4%] 6 [0.0%] 7 [00.0%] 8 [9.2%] Tasks: 33. 19 thr: 4 running	*
Swp [0/Омв]	Load averáge: 1.84 1.93 1.56 Uptime: 00:28:51	
PID USER PRI	NI VIRT RES SHR	S CPU% MEM% TIME+ Command	١
1118 root 20 1123 root 20	0 310M 257M 2528	5 145. 12.9 38:59.70 ./modesdeco2a1	
1123 root 20	-3 78516 77312 832	540.4 3.8 $10:40.77$ /decodeadsb COMP	
1124 root 20	0 310M 257M 2528	s 32.8 12.9 8:27.30 ./modesdeco2ai	
1125 root 20	0 310M 257M 2528	s 14.3 12.9 3:39.90 ./modesdeco2ai	
1115 root 20	0 2 984 1 396 932	R 1.4 0.1 0:26.94 htop	
1122 root 20	0 310M 257M 2528	S 0.0 12.9 0:06.10 ./modesdeco2ai	-
1121 root 20	0 310M 257M 2528	S 0.0 12.9 0:01.32 ./modesdeco2ai	
961 ntp 20	0 4676 1580 1168	S 0.0 0.1 0:00.40 /usr/sbin/ntpd -p	
1051 root 20	0 10736 2960 2264	S 0.0 0.1 0:00.71 sshd: root@pts/1	
927 root 20	0 10736 2952 2264	S 0.0 0.1 0:00.46 sshd: root@pts/0	
1 root 20	0 316 3040 1624	S 0.0 0.1 0:10.54 /sbin/init	
921 kernoops 20	0 5168 952 692	S 0.0 0.0 0:00.0/ /usr/sbin/kernelo	
FIHelp F2Setup F3Se	archF4F1IterF5Tree F	6SortByF/Nice -F8Nice +F9Kill F10Quit	-

With the Airspy, the CPU utilization is very high because the CPU processes the digital signals into Mode S Frames.

Beast decodeadsb Metrics

root@odroidU3: ~/modesdeco2mixer2

```
Total # Mode S Frames = 5261044, Total # Good Mode S Frames = 5156555
Time of metrics (GMT seconds) = 1448825982, Operating for 0000:01:58:00 (dddd:hh
:mm:ss)
Metrics Averages (bytes/sec): Entire Test Period: 12780, This interval: 12782
Minimum interval value: 10453, Maximum interval value: 15143
Aircraft Records Metrics: Totál ARs = 4000, Used ARs = 181, Free ARs = 3819, Max
Used ARs = 269
Current CPU \% = 17, Max CPU \% = 20, MIN CPU \% = 14
Metrics Averages (Mode A/C Frames/sec): This interval: 0
Minimum interval value: 0, Maximum interval value: 0
Metrics Averages (Short + Long Mode S Frames/sec): This interval: 743
Minimum interval value: 595, Maximum interval value: 899
Metrics Averages (DF=17 ADS-B Frames/sec): This interval: 103
Minimum interval value: 61, Maximum interval value: 152
Metrics Averages (DF=18 TIS-B/ADS-R Frames/sec): This interval: 7
Minimum interval value: 4, Maximum interval value: 57
Metrics Averages (Good (Same as PP) Mode S Frames/sec): This interval: 733
Minimum interval value: 572, Maximum interval value: 849
% Mode S Good Frames: 98%, Óverall % Mode S Good Frames: 98%
Total # Mode S Frames = 5305689, Total # Good Mode S Frames = 5200541
Time of metrics (GMT seconds) = 1448826042, Operating for 0000:01:59:00 (dddd:hh
:mm:ss)
```

Airspy decodeadsb Metrics

- D X

Proot@odroidxu4: ~/modesdeco2mixer2

```
Total # Mode S Frames = 3428410, Total # Good Mode S Frames = 3323804
Time of metrics (GMT seconds) = 1448825981, Operating for 0000:01:58:00 (dddd:hh
:mm:ss)
Metrics Averages (bytes/sec): Entire Test Period: 8395, This interval: 8238
Minimum interval value: 6450, Maximum interval value: 10178
Aircraft Records Metrics: Total ARs = 4000, Used ARs = 144, Free ARs = 3856, Max
 Used ARs = 232
Current CPU \% = 42, Max CPU \% = 46, MIN CPU \% = 39
Metrics Averages (Mode A/C Frames/sec): This interval: 0
Minimum interval value: O, Maximum interval value: O
Metrics Averages (Short + Long Mode S Frames/sec): This interval: 476
Minimum interval value: 368, Maximum interval value: 610
Metrics Averages (DF=17 ADS-B Frames/sec): This interval: 70
Minimum interval value: 41. Maximum interval value: 111
Metrics Averages (DF=18 TIS-B/ADS-R Frames/sec): This interval: 6
Minimum interval value: 3, Maximum interval value: 54
Metrics Averages (Good (Same as PP) Mode S Frames/sec): This interval: 466
Minimum interval value: 359, Maximum interval value: 555
% Mode S Good Frames: 97%, Overall % Mode S Good Frames: 96%
Total # Mode S Frames = 3457043, Total # Good Mode S Frames = 3351776
Time of metrics (GMT seconds) = 1448826041, Operating for 0000:01:59:00 (dddd:hh
:mm:ss)
```

After the Test

- Screen shots are taken, from both the Beast and Airspy, showing:
 - The graphical and textual metrics from modedeco2 / modemixer2
 - decodeadsb running metrics and final metrics
- After the test, the data recorded by decodeadsb is then
 - Plotted using Google Earth which graphically shows all of the recorded flights
 - Plotted using gnuplot which graphically shows Mode S and ADS-B metrics

Beast Final Web Page Chart



Airspy Final Web Page Chart



Beast Final Web Page Stats

🛪 Mode	SMixer2 (131)	× +				10	10		10.1	
()	2.168.1.107/#					⊽ C Q Se	earch	☆ 自	V A 9 5	- 🗵 🗉 -
Most Visit	ed 📉 Y PB PP	W 🤕 fitglob	Day DB 🍸 PP 👌	s BST 🗍 BB 🦠 PP	🎬 PB 👌 Nil	PP 🔜 WTR 🐽 SDW	🍅 rt 🛃 bs	ST 🎉 ham 🌠 RC 🛃 BW	🗙 AIR 🗷 TV 🦠 me	🗌 pp ⊁ pia 🔹
∕∿ M	ode∫Mixe	er2 Ch	arts Stats	Flights Map	b Log	v.20150	0628 A	60 S 71 O 02:	12 UTC 🛈 18:12	2 UTC-8
	Total			Mode S			ADS-B		Mode A/C	
	Messages	Byte	5	Total	Long	Short	Total	Positions	Total	
	22389223	3876	98130	18994538	157466	18837072	3394685	1390687		-
	DF	Messages	Description	1		DF Subtype	Messages	Description		
	0	9056315	SHORT AIR-	AR SURVEILLANCE	(ACAS)	0	818	No position information		
	4	2383939	SURVEILLAN	CE ALTITUDE REPL	Y	2	121159	Aircraft ID Cat. C		-
	5	74667	SURVEILLAN	ICE IDENTITY REPL	Y	4	150940	Aircraft ID Cat. A		
	11	7320901	ALL-CALL RE	PLY		6	3169	Surface, RC < 25.0 m		-
	16	18497	LONG AIR-AI	R SURVEILLANCE (ACAS)	7	35931	Surface, RC < 75.0 m or	RC < 185.2 m	
	17	3252700	EXTENDED S	QUITTER (ADS-B)	8	12643	Surface, RC > 185.2 m d	Surface, RC > 185.2 m or unknown		
	18	141685	EXTENDED S	QUITTER/SUPPLEM	10	97918	Airborne, RC < 25 m and	Airborne, RC < 25 m and VPL < 37.5 m		
	20	112645 COMM-B ALTITUDE REPLY				11	1043369	Airborne, RC < 75 m and < 185.2 m	I VPL < 112 m or RC	E
	21	20319	COMIN-BIDE			12	128759	Airborne, RC < 370.4 m		
	Format			Count	:	13	32853	Airborne, RC < 1111.2 m	or RC < 926 m	
	No position inf	ormation		818		14	13	Airborne, RC < 1852 m		
	None			6304		15	2408	Airborne, RC < 3.704 km	1	
	Aircraft operati	ional status		117777		16	10	Airborne, RC < 7.408 km	or RC < 14.816 km	
	Surface position	on		51743		17	713	Airborne, RC < 37.04 km	1	
	Aircraft status			46241		18	69482	Airborne, RC > 37.04 km	ı or unknown	
	Identification a	nd category		272118		19	1409039	Airborne velocity		_
	Target state ar	nd status		114855		21	2	Airborne position, RC < 2	25 m and VPL < 37.5	
	Airborne Veloc	ity		140916	8	23	6304	Test message		
	Airborne positi	ion		137566	61	28	46240	TCAS Status		
	Name	Value				29	114847	Status information		
	Name Start Time	2015 11 00 0	0.41.10			31	117768	Aircraft operational statu	S	
	Start Time	2015-11-29 (19:41:19							
	Uptime	8 hours 31 n	ninutes							-

Airspy Final Web Page Stats

Mode	SDeco2 (96)	× +		10.00								X
() 🛞 19	92.168.1.102/#					V C Q Se	arch	☆ 🖻		9 🕄	≡	- 10
Most Visit	ed 🍸 Y PB PP	W 🤕 fltglob 🎴	ey DB 🝸 PP 🎍	🖕 BST 🗌 BB 🔦 PI	PB 🚖 NiP	P 🔜 WTR 🖻 SDW	🍅 rt 🛃 bs'	T 🎋 ham 🌠 RC 🚮 BW	🍸 air 🗷 tv 🗧	<mark>></mark> me []] рр 🔭	pia »
^{رم} Wo	de/Deco	02 Charts	s Stats	Flights Map	Log	v.20150	628 A	51 S 45 🕑 02	:12 UTC 🛛 🛈	18:12	UTC-8	
	Total			Mode S			ADS-B		Mode A/C			
	Messages	Bytes	i	Total	Long	Short	Total	Positions	Total			
	14442900	25215	0180	11984677	105936	11878741	2458223	1001956				
	DF	Messages	Description	n		DF Subtype	Messages	Description				
	0	5830366	SHORT AIR-	AIR SURVEILLANC	E (ACAS)	0	368	No position information				
	4	1694339	SURVEILLAN	NCE ALTITUDE REF	νLY	2	118405	Aircraft ID Cat. C				
	5	58686	SURVEILLAN	ICE IDENTITY REP	LY	3	9	Aircraft ID Cat. B				
	11	4294902	ALL-CALL RE	EPLY		4	109567	Aircraft ID Cat. A				
	16	18997	LONG AIR-AI	IR SURVEILLANCE	(ACAS)	5	2	Surface, RC < 7.5 m				
	17	2319785	EXTENDED S	SQUITTER (ADS-B)		6	2575	Surface, RC < 25.0 m				
	18	138272	EXTENDED SQUITTER/SUPPLEMENTARY			7	37452	Surface, RC < 75.0 m or	75.0 m or RC < 185.2 m			E
	20	73119	COMM-B AL	TITUDE REPLY		8	13525	Surface, RC > 185.2 m	or unknown			
	21	13818	COMM-B IDE	ENTITY REPLY		9	3	Airborne, RC < 7.5 m an	id VPL < 11 m			
						10	64839	Airborne, RC < 25 m and	d VPL < 37.5 m			
	Format No position inf	formation		368	unt	11	748595	Airborne, RC < 75 m and < 185.2 m	d VPL < 112 m o	r RC		
	None			436	1	12	92900	Airborne, RC < 370.4 m				
	Aircraft operat	ional status		813	93	13	26181	Airborne, RC < 1111.2 m	or RC < 926 m			
	Surface positi	on		535	54	14	13	Airborne, RC < 1852 m				
	Aircraft status			319	70	15	1381	Airborne, RC < 3.704 km	n			
	Target state a	nd status		761	60	16	9	Airborne, RC < 7.408 km	n or RC < 14.816	i km		
	Identification a	ind category		227	997	17	211	Airborne, RC < 37.04 km	n			
	Airborne Veloo	ity		999	462	18	48754	Airborne, RC > 37.04 km	n or unknown			
	Airborne posit	ion		982	958	19	999393	Airborne velocity				
	Name	Value				21	3	Airborne position, RC < m	25 m and VPL <	37.5		
	Start Time	2015-11-29 09	:41:18			23	4361	Test message				
	Uptime	8 hours 31 mi	nutes			28	31968	TCAS Status				-

Beast Metrics – First Set

_ D X

Proot@odroidU3: /dev/shm

```
Metrics Averages (bytes/sec): Entire Test Period: 12651, This interval: 12983
Minimum interval value: 9847, Maximum interval value: 15154
Aircraft Records Metrics: Total ARs = 4000, Used ARs = 141, Free ARs = 3859, Max
Used ARs = 269
Current CPU \% = 17, Max CPU \% = 20, MIN CPU \% = 13
Metrics Averages (Mode A/C Frames/sec): This interval: 0
Minimum interval value: 0, Maximum interval value: 0
Metrics Averages (Short + Long Mode S Frames/sec): This interval: 748
Minimum interval value: 544, Maximum interval value: 954
Metrics Averages (DF=17 ADS-B Frames/sec): This interval: 129
Minimum interval value: 57, Maximum interval value: 152
Metrics Averages (DF=18 TIS-B/ADS-R Frames/sec): This interval: 4
Minimum interval value: 4, Maximum interval value: 57
Metrics Averages (Good (Same as PP) Mode S Frames/sec): This interval: 736
Minimum interval value: 563, Maximum interval value: 867
% Mode S Good Frames: 98%, Overall % Mode S Good Frames: 98%
Total # Mode S Frames = 22659206, Total # Good Mode S Frames = 22226996
Time of metrics (GMT seconds) = 1448849742, Operating for 0000:08:34:00 (dddd:hh
:mm:ss)
777
Terminating Program, signal = Terminated
```

Airspy Metrics – First Set

- - X

Proot@odroidxu4: /dev/shm

```
Metrics Averages (bytes/sec): Entire Test Period: 8229, This interval: 8644
Minimum interval value: 5771, Maximum interval value: 10473
Aircraft Records Metrics: Total ARs = 4000, Used ARs = 114, Free ARs = 3886, Max
Used ARs = 232
Current CPU \% = 42, Max CPU \% = 48, MIN CPU \% = 35
Metrics Averages (Mode A/C Frames/sec): This interval: 0
Minimum interval value: 0, Maximum interval value: 0
Metrics Averages (Short + Long Mode S Frames/sec): This interval: 491
Minimum interval value: 313, Maximum interval value: 647
Metrics Averages (DF=17 ADS-B Frames/sec): This interval: 100
Minimum interval value: 35, Maximum interval value: 121
Metrics Averages (DF=18 TIS-B/ADS-R Frames/sec): This interval: 4
Minimum interval value: 3, Maximum interval value: 54
Metrics Averages (Good (Same as PP) Mode S Frames/sec): This interval: 479
Minimum interval value: 326, Maximum interval value: 586
% Mode S Good Frames: 97%, Overall % Mode S Good Frames: 97%
Total # Mode S Frames = 14635344, Total # Good Mode S Frames = 14203135
Time of metrics (GMT seconds) = 1448849741, Operating for 0000:08:34:00 (dddd:hh
:mm:ss)
777
Terminating Program, signal = Terminated
```

Beast Metrics – Second Set

🛃 root@odroidU3: /dev	/shm		-			- X					
<pre>DF Metrics # Discarded due to a major decoding error (wrong frame size, CRC error) # Filtered Out due to DF filtering or the Quick Filter # Recorded is the total amount recorded # Recorded (with) Errors have minor decoding errors (fields with illegal values, can't locate 24-bit ICAO) kept mostly to later examine for a decodeadsb software error or in case the 24-bit ICAO is later proved to be valid # Recorded OK means kept without any errors at all</pre>											
DF # Received 0 9121384 4 2399649 5 75167 11 7374084 16 18552 17 3281087 18 269714 20 113237 21 26441	# #Discarded 76987 14733 757 217237 2922 2787 5456 897 287	Filtered Out # 0 0 0 0 0 0 0 0 0 0 0	# Recorded 9044397 2384916 74410 7156847 15630 3278300 264258 112340 26154	# Recorded # Errors 0 0 0 0 0 0 0 94650 15725	<pre># Recorded #</pre>	Check Count 9121384 2399649 75167 7374084 18552 3281087 269714 113237 26441					

Airspy Metrics – Second Set

Proot@odroidxu4: /dev/shm										
<pre>DF Metrics # Discarded due to a major decoding error (wrong frame size, CRC error) # Filtered Out due to DF filtering or the Quick Filter # Recorded is the total amount recorded # Recorded (with) Errors have minor decoding errors (fields with illegal values, can't locate 24-bit ICAO) kept mostly to later examine for a decodeadsb software error or in case the 24-bit ICAO is later proved to be valid # Recorded OK means kept without any errors at all</pre>										
<pre># Filtered # Recorded # Recorded #</pre>	Check									
DF # Received #Discarded Out # Recorded Errors OK	Count									
0 5866921 82031 0 5784890 0 5784890	5866921									
4 1704314 18737 0 1685577 0 1685577	1704314									
5 59047 895 0 58152 0 58152	59047									
11 4325352 243251 0 4082101 0 4082101	4325352									
16 19098 9632 0 9466 0 9466	19098									
17 2341046 3196 0 2337850 0 2337850	2341046									
18 245641 4410 0 241231 0 241231	245641									
19 5 5 0 0 0 0	5									
20 73505 902 0 72603 61036 11567	73505									
21 13884 291 0 13593 8147 5446	13884 —									
	-									

Beast Google Earth Plot #1



Airspy Google Earth Plot #1



Beast Google Earth Plot #2



Airspy Google Earth Plot #2



Beast Graph #1





Airspy Graph #1

151129airspy Data - % CPU / % Good Mode S Frames VS Mode S / ADS-B (DF=17) / DF=18



Percent

Beast Graph #2



Percent

Airspy Graph #2

151129airspy Data - % CPU VS ADS-B (DF=17) / DF=18 100 140 % CPU ADS-B (DF=17) Frames / Sec 120 DF=18 Frames / Sec 80 of Frames Per Second 100 60 80 60 40 40 # 20 20 0 0 29|09 29|10 29|11 29|12 29|13 29|14 29|15 29|16 29|17 29|18 29|19 Local Timezone Day of the Month and Hour (24 hr) started on November 29, 2015

Beast Graph #3

151129beast Data - % CPU VS ADS-B (DF=17) / Mode S / Mode A/C



Airspy Graph #3

151129airspy Data - % CPU VS ADS-B (DF=17) / Mode S / Mode A/C



Percent

Beast System Cost

- The Beast costs 284 Euro Assembled = \$300
- It can be combined with a Raspberry Pi 2 (\$40)
 + microSD (\$12) + Case (\$10) + Power supply (\$10) for satisfactory performance (Total = \$72)
- Total cost = \$372
- The cost does NOT include the cost of an Antenna

Airspy System Cost

- The Airspy costs \$200
- It needs to be combined with a powerful multi-processor microprocessor such as an Odroid XU4 (\$76) + microSD (\$12) + Case (\$8) (Total = \$96)
- Total Cost = \$296
- The cost does NOT include the cost of an Antenna

RTL-SDR System Cost

- The RTL-SDR costs \$25
- Can combine with a Raspberry Pi 2 (\$40) + microSD (\$12) + Case (\$10) + Power supply (\$10) for satisfactory performance (Total = \$72)
- Total cost = \$97
- The cost does NOT include the cost of an Antenna

Beast – Summary Impression

- The Beast receives about 35% more Good Mode S Frames
- The Beast's Range is better (see Google Earth plots and modesdeco2/modesmixer2 charts)
- The cost difference is relatively small as the Beast System costs \$76 or 25% more than the Airspy System

Airspy – Summary Impression

- It is a good idea to buy an Airspy if you want to "spy" on a variety of RF frequencies and only want to periodically obtain ADS-B data
- Despite having a very powerful microprocessor performing the digital signals to Mode S Frames conversion, one of the processors was running at 98%
- Errors were sporadically logged by modesdeco2 that it lost data
- The Airspy is a good solution but the Beast is a much better solution for a dedicated ADS-B data receiver

Linux Computer Cost Comparisons

- Caveat:
 - I am not an employee of Odroid, they did not give me anything, they haven't paid me anything
- Raspberry Pi 2 (\$40) + microSD (\$12) + Case (\$10) + Power supply (\$10) (Total = \$72)
- Odroid XU4 comes with a power supply (\$76) + microSD (\$12) + Case (\$8) (Total = \$96)
- For \$24 more you get a computer running twice as fast with twice the number of processors
- I have several different Odroids (XU, XU3 Lite, XU4, C1, U2, U3) and all of them have been solid performers except for the C1
 - The only "problem child" was the C1 when it was first introduced as Odroid unsuccessfully tried to speed up the microSD
 - It took about 3 weeks for Odroid to fix the problem
 - Since the Odroid fixed the problem, it has done fine
- If you aren't using the Raspberry Pi I/O header then the Odroid is worth the extra \$24