

EUMETCast Receivers using the TBS6909X PCIe Card

1 Scope

This is all about using GNU/Linux and TBS PCIe cards to build affordable and well performing EUMETCast receivers. Special DVB routers such as the Ayecka SR1 or the NOVRA S300N are common place and recommended by EUMETSAT. I for one have always considered these solutions as too expensive. I also think that with the start of a second EUMETCast transponder DVB USB-boxes have become obsolete. With MTG at the horizon and EUMETSAT talking about opening a third or even fourth downlink transponder it's time to think about powerful affordable reception concepts. One option is the TBS6909X using the special (Oxford) STiD135 demodulator chip.

2 History

In 2014 I had the first EUMETCast receiver running GNU/Linux and a TBS6925 PCIe card. This card used the stv0900 AAC chip also built into the TBS5925 and the SR1.

<https://groups.io/g/MSG-1/topic/9663908#18221>

With the announcement of EUMETCast second transponder T2 we already had the TBS6983 using the more advanced stv0910 demodulator that is also VCM capable in dual mode. As such a card had the potential to replace two Ayecka SR1 there was quite some FUD on the net whether this card could really cope with 2 EUMETCast transponders. The limiting factor seemed to be the LDPC (FEC error correction) as EUMETSAT's downlinks operate with 16APSK and 33 Msymb/s. In dual mode the stv0910 using 16APSK is limited by the common LDPC block to 33.75 Msymb/s. In an attempt to prove that a TBS6983 could handle 2 full EUMETCast transponders Arne van Belle demonstrated under Windows (using a RAM-disk and a special edition of my MVMSG.cmd script) that he could receive T1 + T1 running 4 TC clients for two times (BASIC + HVS-1) on moderate PC hardware. Due to the different DVB setup under GNU/Linux using the static multicast router "smcroute" the same was not possible. But I showed to receive one T1 running two TC clients and one T1 running dvbsnoop on the second data stream. The TBS6983 was replaced by the TBS6903 using a novel PCIe bridge chip ECP3. By now all TBS cards use this ECP3 bridge that allows for 8 transponders (8 DVB adapters under GNU/Linux). As T1 and T2 are even in the same band and have the same polarisation it's possible to receive both transponders with a single LNB cable (no splitter needed). Receiving all EUMETCast services with one TBS6903 using a single cable is now widespread and shows good results under GNU/Linux and Windows. There is also the TBS6908 as a (full height) TWIN TBS6903 that does/will allow for 4 TC transponders. Due to its higher price it is less common under EUMETCast amateurs. During all this time CrazyCat has had an exceptional role in providing DVB driver solutions for both Windows and GNU/Linux.

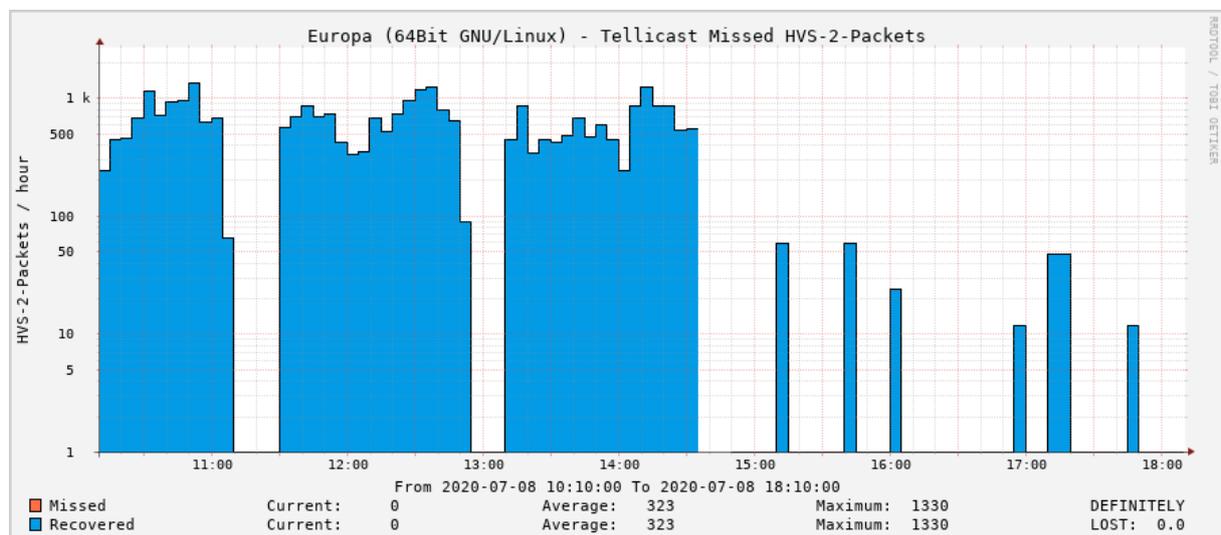
3 The Oxford chip

In 2018 I tested the new TBS6909X under GNU/Linux while Mike Stevens did the same for Windows. Unfortunately this card -- using the very powerful but also

complex new STiD135 (Oxford) chip that ST had developed in collaboration with leading players like NEWTEC – did never work as expected with EUMETCast transponders using VCM. It was not clear whether we faced a driver, ECP3 firmware or even hardware problem. While the TBS6909X was originally meant to replace the TBS6908 in the long run there was also a TBS6903X using the Oxford chip as a direct replacement for the TBS6903 with DVB-S2X functionality and much higher symbol rates. So our tests went on with the TBS6903X but this card could not be said to work as stable and perform as well as the proven TBS6903. In summer 2019 TBS seemed to have found a Linux driver problem that caused excessive packet loss in EUMETCast receivers due to VCM. I tested these latest STiD135 drivers with a TBS6903X on a Debian 10 (Buster) amd-64 GNU/Linux receiver in early 2020. But reception was worse than ever before. I do not know whether EUMETSAT ever tested one of these two new TBS cards but other professional users reported problems especially with the TBS6909X as well. There is a thread on github that shows some aspects of what seemed to be driver problems and ended as statement that there actually is a hardware issue to be treated in a modified design called V2.

https://github.com/tbsdtv/media_build/issues/16

In July 2020 I was contacted by TBS for testing the TBS6903X V2 in an EUMETCast receiver under GNU/Linux. I setup 4 receivers under Devuan 3 (Beowulf) GNU/Linux. I had my proven 11 years old Fujitsu/Siemens Esprimo P7935 (Core Duo, 8GB DDR2 RAM) Mini Tower and the 7 years old DELL OptiPlex 7010 (I5, 8GB DDR3 RAM) SFF. Two reference receivers were on my LAN while the testbed receivers were in a DMZ with SSH access for CrazyCat and TBS. RSA keys and additional subnet filters made the SSH port forwarding rather safe. While the new TBS6903X V2 card sometimes worked (rather) well in the DELL OptiPlex PC it could suddenly change to bad again. There was no way to get the card running in the Esprimo PC.

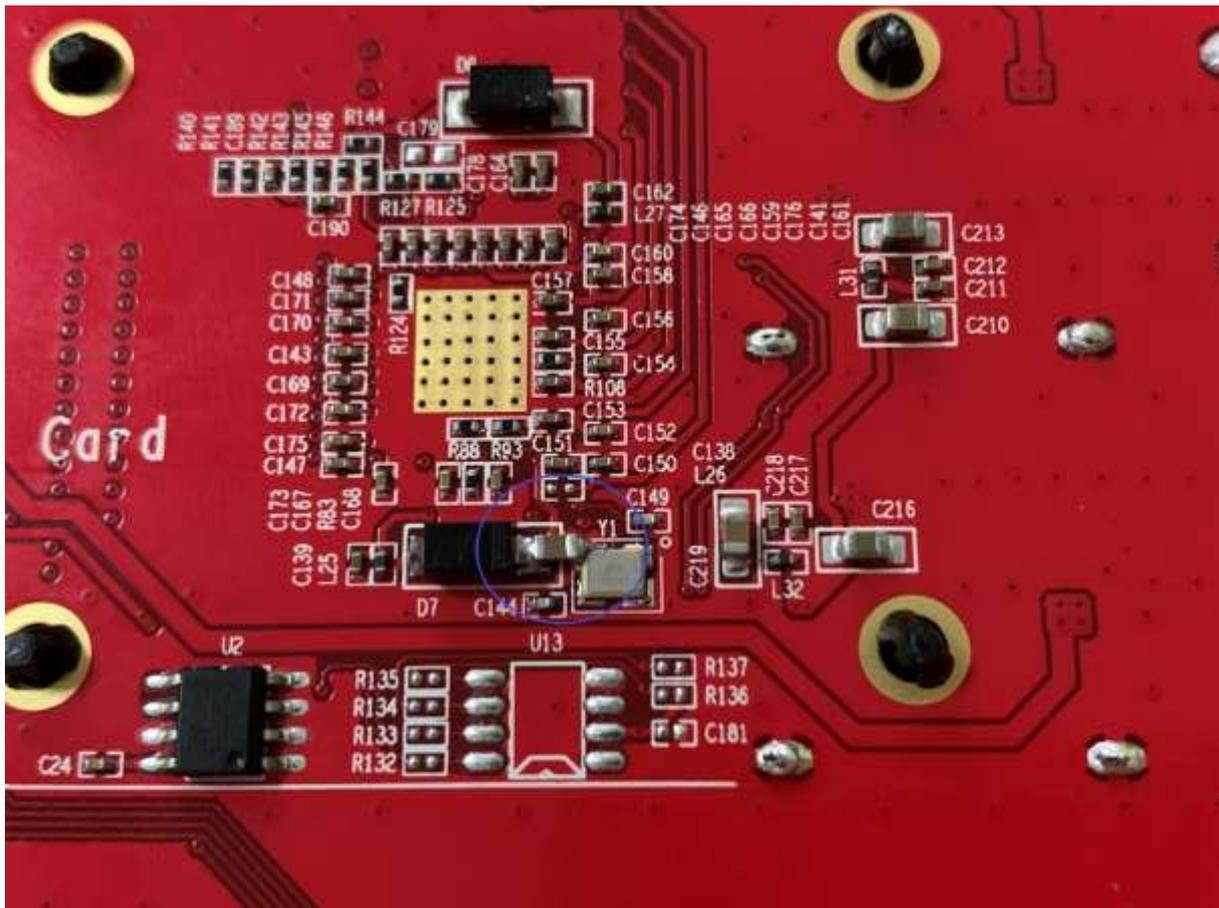


This timeline of HVS-2 missed and recovered packets demonstrates the unstable behaviour of the TBS6903X V2 at the beginning of our tests. Europa was a DELL OptiPlex SFF. The system was powered down completely (mains unplugged 5') and then restarted shortly before 15:00 UTC. No other changes have been made. After restart the receiver had only about 0.001 of the missed and recovered UDP packets.

The OptiPlex SFF suffered from additional problems with the 2.5" WD-Blue HDDs because of SMR recording not declared by Western Digital and unusable for TC data tmp + received (meanwhile HDD manufacturers specify SMR/CMR in datasheets):

<https://groups.io/g/MSG-1/message/29669>

After months of testing try and error TBS finally proposed a last on the fly change for the TBS6903X V2 hardware design. They asked me for the possibility to solder a tiny 22uF SMD capacitor between a Schottky diode (K) and a 27.000MHz quartz (GND).



This image shows the latest August 2020 hardware modification on a TBS6903X V2. I had to tell TBS that my soldering iron was only good for fixing a broken cable in our dish washing machine but as a plan B I could look for someone who can do this job.

I got one TBS6903X V12 produced 2019 modified that way in China and it worked out of the box with both PC models. I had my older TBS6903X V12 from 2018 and also the new TBS6903X V2 from 2020 fixed with this 22uF SMD capacitor in the electronics department of a professional school in Bern, Switzerland. More weeks of testing showed that the TBS6903X V2 + 22uF capacitor worked now equally well as the proven classic TBS6903 with the stv0910 demodulator. All four receivers were single cable multi transponder (T1 + T2) and received about 460GB of files per day. They were additionally loaded with on the fly Sentinel-A and Sentinel-B OLCI EFR image processing each in three RGB variants using SNAP 4.0 and Image Magick.

Here is part of my final report to TBS after testing the two modified TBS6903X V2.

Statistics of EUMETCast UDP packets for 7 days, (pack_0=BAS, pack_1=HVS-1, pack_2=HVS-2)

Receiver	Start	Stop	Service	Missed	Recovered	Lost	Received
terra	2020-09-03	2020-09-09	pack_0	43	43	0	323275421
terra	2020-09-03	2020-09-09	pack_1	18	18	0	556329771
terra	2020-09-03	2020-09-09	pack_2	21	9	12	1635597934
io	2020-09-03	2020-09-09	pack_0	53	53	0	322150842
io	2020-09-03	2020-09-09	pack_1	17	17	0	554749817
io	2020-09-03	2020-09-09	pack_2	32	11	21	1629163888
europa	2020-09-03	2020-09-09	pack_0	43	43	0	323276437
europa	2020-09-03	2020-09-09	pack_1	18	18	0	556330279
europa	2020-09-03	2020-09-09	pack_2	77	9	68	1635599036
titan	2020-09-03	2020-09-09	pack_0	45	45	0	322151377
titan	2020-09-03	2020-09-09	pack_1	18	18	0	554750206
titan	2020-09-03	2020-09-09	pack_2	36	11	25	1629164423

terra (Esprimo P7935) with card 1 TBS6903X V2 produced 2027 modified + 22uF capacitor
io (Esprimo P7935) reference receiver with classic TBS6903 V12 produced 1719
europa (Optiplex 7010) with card 2 TBS6903X V2 produced 2027 modified + 22uF capacitor
titan (Optiplex 7010) reference receiver with classic TBS6903 V12 produced 1552

Most of the "Lost" packet events were caused by the EUMETCast UPLINK or TRANSPONDER as these could be seen all over Europe (checked with station in Germany by Christian Peters). We can now truly testify that the TBS6903X V2 *modified* with a 22uF capacitor works as fine as the classic TBS6903/08 cards, the best TBS PCIe cards we had for EUMETCast so far.

I proposed TBS to also test the TBS6909X when the latest modifications would be integrated in the board design and standard manufacturing. These latest (future) models should be labelled TBS6903X V21 and TBS6909X V21. TBS offered to send me two samples of the TBS6909X V21 and I expected those to arrive from a new production batch in October or November but they arrived already September 19th and turned out to be TBS6909X V11 from 2019 + 22uF capacitor added by hand soldering. TBS said, that they have fixed all cards in their stock and that they would readily replace TBS6903X and TBS6909X cards should customers have problems (this especially under VCM or when using the TBS6909X with many transponders) because of that 22uF capacitor is missing. So at the time of writing it is not clear, whether the final design of both cards will be labelled V2, V21 or V13 and V12.

As this latest hardware patch apparently also fixed the older models I even had my TBS6909X V11 from 2018 adapted that way. The 22uF Murata Multilayer Ceramic SMD Capacitor we bought at MOUSER Electronics (P/N: GRM21BR61E226ME4K).

4 Setting up a QUAD transponder EUMETCast receiver

The idea was to demonstrate that the TBS6909X can easily handle four transponders of the T1 and T2 kind that are currently used by EUMETSAT for EUMETCast Europe. Copying the mentioned Windows demonstration of Arne van Belle with reception of T1 + T1 it should this time be 2 x (T1 + T2) = 4 transponders and 6 TelliCast clients.

One of the most important parts in setting up a GNU/Linux EUMETCast receiver is a script called dvb-eumetcast. This starts tuning the DVB cards, sets up all interfaces, starts the Static Multicast Router "smcroute" and configures all necessary multicast routes in the Linux kernel. I have long had my own version of this script but what I did

now is only possible with the latest version of smcroute that has significantly changed in Debian 10 and Devuan 3. It is now possible to run more than one instance of the router daemon “smcrouted” each with its own private routing table. So I was able to have a bash script dvb-eumetcastA that tunes adapter 0 and 1 to transponder T1 and T2 and sets up the necessary interfaces and multicast routes between dvb0_N and dvb1_N and the multicast interfaces dummy0, dummy1, and dummy2. A second script dvb-eumetcastB tunes adapter 2 and 3 again to transponder T1 and T2, sets up more interfaces and can set up the same necessary multicast routes between dvb2_N and dvb3_N and the multicast interfaces dummy3, dummy4, and dummy5. Six TC clients tc-recv_0 to tc-recv_5 then attach to interfaces dummy0 to dummy5. This Q&D adaption of my dvb-eumetcast also scales for 6 or even 8 transponders.

5 Built receivers and results

Reference receiver lo was setup with a proven TBS6908 V10 using two LNB cables.

-Maximum symbol DVB-S2 rate limitations (Msymb/s)

Msymb/s	Demod	LDPC	Single	Dual
QPSK	67.5	135	67.5	67.5
8PSK	67.5	90	67.5	45
16APSK	67.5	67.5	67.5	33.7
32APSK	67.5	54	54	27

This is the same table as for the TBS6903. The TBS6908 is just two times TBS6903 on the same full height card but with only one (not further limiting) ECP3 PCIe bridge.

Testbed receiver Terra using a TBS6909X V11 + 22uF cap and a single LNB cable.

Maximum symbol DVB-S2X/S2 rate limitations (Msymb/s)

Msymb/s	Demod	LDPC	4 simultaneous demodulators	6 simultaneous demodulators	8 simultaneous demodulators
QPSK	64	720	64	60	45
8PSK	64	720	60	45	30
16APSK	64	720	45	30	22.5
32APSK	51	720	36	24	18
64APSK	43	720	30	20	15

This table suggests that 4 simultaneous 16APSK 33 Msymb/s transponders can be handled by the LDPC. Depending how the LDPC is shared (either by master/slave pair of adapters or actually by active adapter) we can even think of 5 simultaneous EUMETCast transponders. A per active adapter share should result in 36 Msymb/s. To run 6 simultaneous EUMETCast Europe transponders will never work for sure.

A first Q&D test with receiver Terra showed zero missed packets with 4 EUMETCast transponders and 6 TC clients after running 4 hours. When starting 5 transponders and 8 TC clients there was about one burst of missed but all lost HVS-2 packets every 4 hours (maybe partly disk I/O related). Running with 6 transponders and 9 TC clients showed bursts of missed but all lost HVS-2 packets about every 15 minutes.

A more reliable test taking 4 transponders for one full day with good weather showed no missed packets for both the reference receiver Io and the testbed receiver Terra. After that we had severe weather with cold fronts passing overhead. When it cleared up again some missed and lost packets then and when remained on both receivers. The assumption was that the RAID0 slowly filling up could not cope with 6 TC clients writing their tmp + received. I also stopped all image processing as I noticed that this slowly but steadily built up swap usage. As my receivers only had 8GB of RAM there was no way to use a RAM disk for 6 TC clients. So I setup a third receiver using an AXXIV custom built Server with a XEON 3.30GHz processor and 16GB of ECC RAM. This third TC receiver Saturn with a second TBS6909X V11 + 22uF cap used an 8GB RAM-disk for tmp + received and deleted all fully received files after one minute on the RAM-disk. So we could be sure that no disk I/O-waits would disturb TC reception.

It is quite obvious that we still lack an adequate benchmark for HDD subsystems with regard to usage as TC tmp + received devices. Today HDDs are advertised and sold as SATA III 6 Gbit/s devices which makes you think they can perform read/write with up to 600 MBytes/s. The truth is you can plug them to SATA II 3 Gbit/s sockets and they will be as fast as before with typically some 140 to 200 MBytes/s for "buffered disk reads". You can fill 1TB of data per day constantly writing 11.57 MBytes/s only. A typical T1 (BASIC + HVS-1) TC receiver could take a "little" as 200 GBytes per day meaning 2.3 MBytes/s. This is "only" two full good old 3.5" floppies per second. The problem is that TC clients are almost randomly writing to different files at once. This means mechanical stress for HDDs and also includes the file system type overhead. That's entirely different from writing or reading a big file or long sequence of blocks. So unless we are willing to study advanced disk test procedures with tools like fio under GNU/Linux or CrystalDiskMark under Windows we can just play try and error. This video shows CrystalDiskMark testing a 3.5" WD Blue 1TB (WD10EZEX, CMR):

<https://www.youtube.com/watch?v=qE3SmJb6o4Q>

Here is a CrystalDiskMark video showing the 3.5" Toshiba P300 1TB versus 2TB. The 2TB HDD (HDWD120UZSVA, CMR) was used for RAID0 arrays in Io and Terra:

<https://www.youtube.com/watch?v=PKUj7UWr81I>

One thing is for sure and I had to learn it the hard way. That's why I repeat it here: Don't ever use HDDs with "Shingled Magnetic Recording" (SMR) for tmp + received.

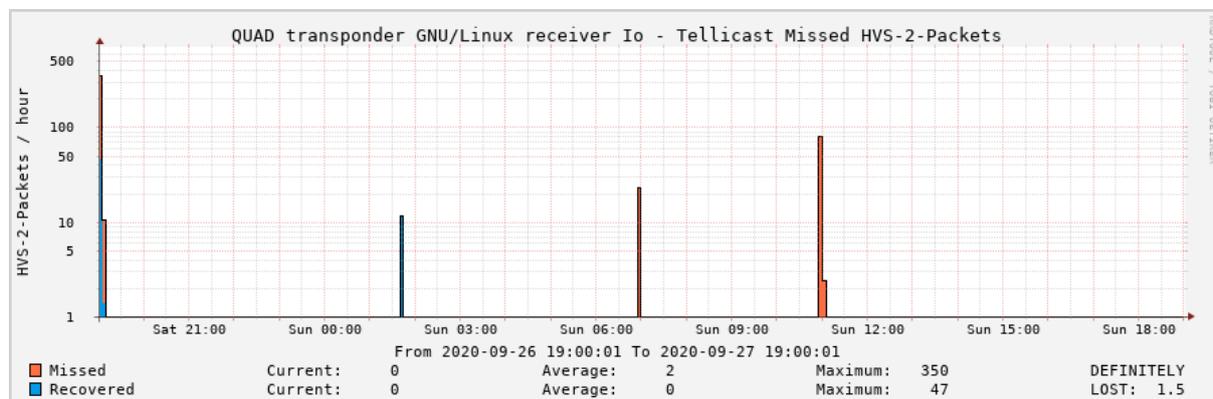
Both 4TB RAID0 devices on Io and Terra were emptied and mounted “noatime” for additional speed. On September 25th 2020 about 18:00 UTC all three receivers had their RRDtool/eLuna graphs reset and were running with 6 TC clients and an identical set of configuration files receiving some 926 GB per day. This time the weather was windy, overcast and sometimes rainy. After the first 24 hours none of the 18 working TC clients had missed one single UDP packet. After 48 hours we did a first overview:

pack_0 = BAS(A), pack_1 = HVS-1(A), pack_2 = HVS-2(A), with eLuna graphs
 pack_3 = BAS(B), pack_4 = HVS-1(B), pack_5 = HVS-2(B), *NO* eLuna graphs

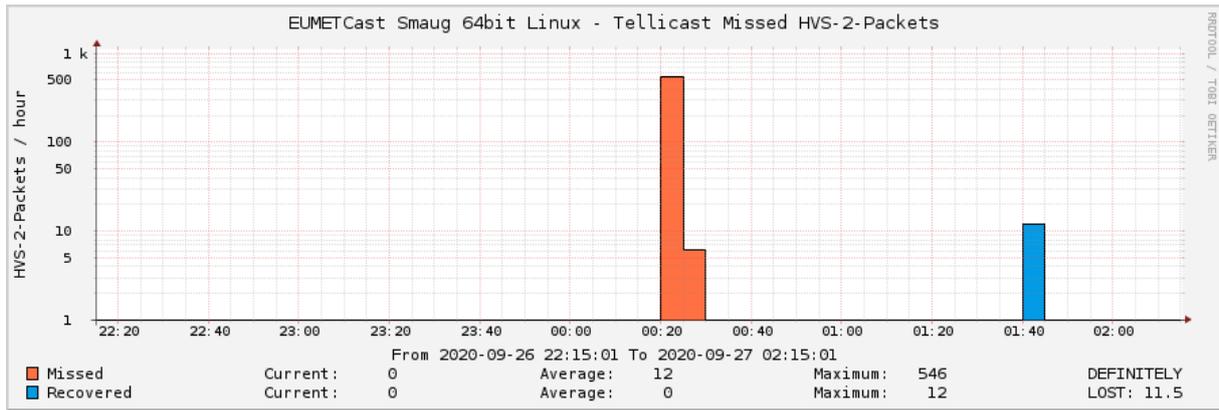
Receiver	Date	Time	pack_0	pack_1	pack_2	pack_3	pack_4	pack_5
io	2020-09-25	2020-09-27	0	0	0	0	0	172484832
io	2020-09-25	2020-09-27	0	0	0	0	0	308781216
io	2020-09-25	2020-09-27	40	5	35	0	0	903817885
io	2020-09-25	2020-09-27	0	0	0	0	0	172484826
io	2020-09-25	2020-09-27	0	0	0	0	0	308781154
io	2020-09-25	2020-09-27	56	*1	55	0	0	903818314
terra	2020-09-25	2020-09-27	0	0	0	0	0	172577295
terra	2020-09-25	2020-09-27	0	0	0	0	0	308866787
terra	2020-09-25	2020-09-27	*1	*1	0	0	0	903818789
terra	2020-09-25	2020-09-27	0	0	0	0	0	172577306
terra	2020-09-25	2020-09-27	0	0	0	0	0	308866784
terra	2020-09-25	2020-09-27	46	*1	45	0	0	903816509
saturn	2020-09-25	2020-09-27	0	0	0	0	0	183767647
saturn	2020-09-25	2020-09-27	0	0	0	0	0	330194016
saturn	2020-09-25	2020-09-27	*1	*1	0	0	0	960340985
saturn	2020-09-25	2020-09-27	0	0	0	0	0	183767647
saturn	2020-09-25	2020-09-27	0	0	0	0	0	330194015
saturn	2020-09-25	2020-09-27	*1	*1	0	0	0	960339375

Io and Terra have been UP 45 hours, Saturn 48 hours (diff total packets)
 * Was seen all over Europe, problem in the TS caused by UP- or DOWNlink!

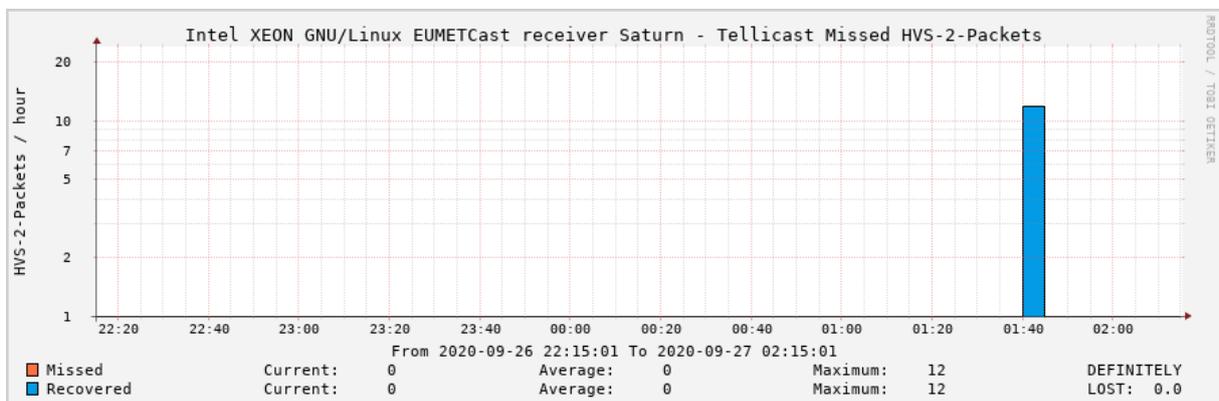
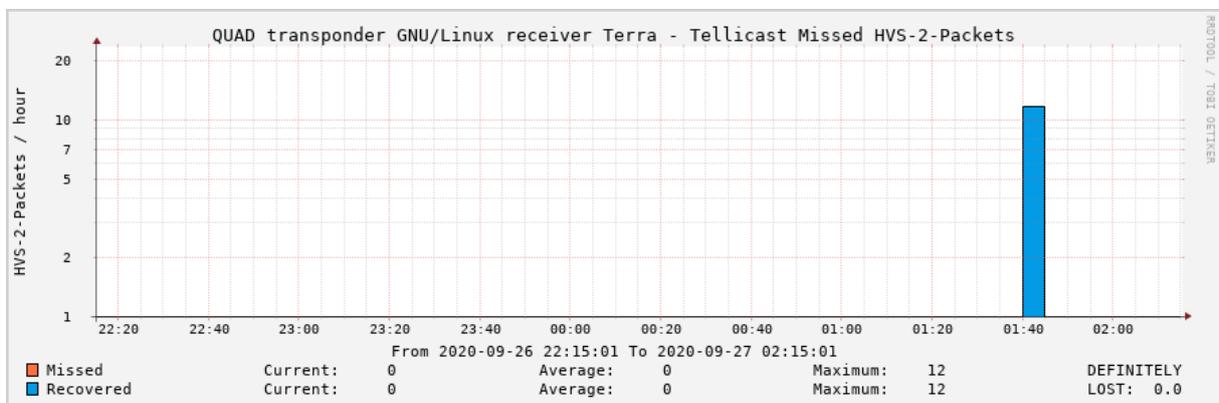
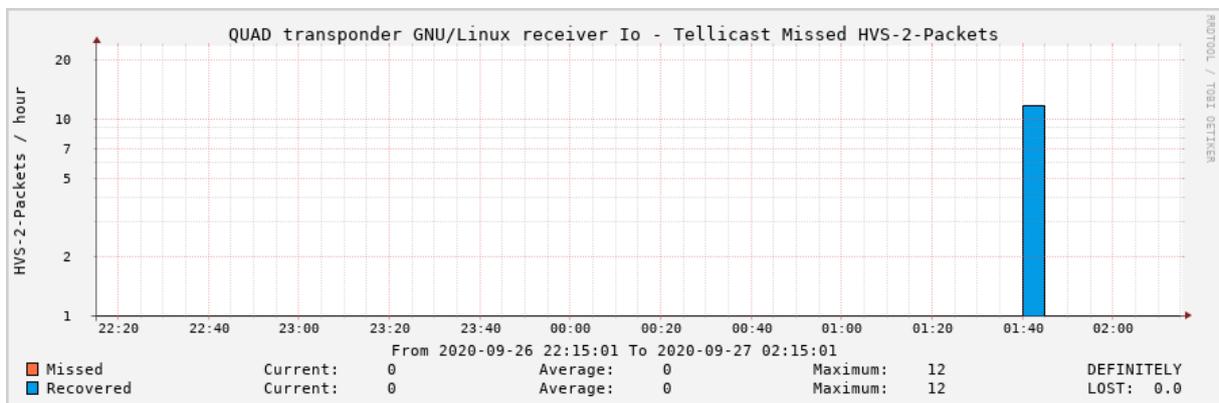
The reference receiver Io using the TBS6908 V10 showed now a couple of missed packets all on the second day and all on HVS-2. Terra also had one burst of missed packets that can't be shown as a graph as it was on HVS-2 (B) not eLuna monitored.

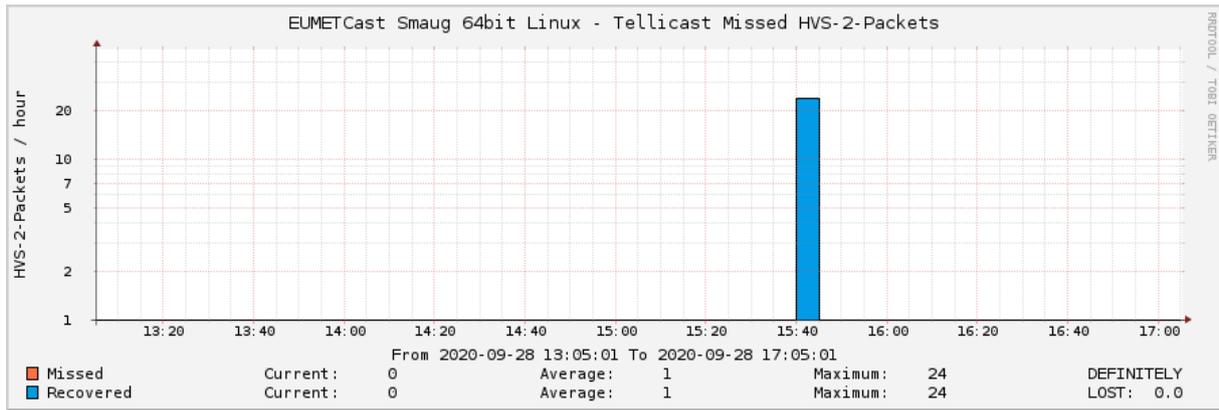


There was one single UDP packet missed and recovered by all HVS-2 clients. This was a Europe wide glitch in the TS also registered by Christian Peters in Germany. Said packet, plotted as 12 Packets/h, was registered Sun 2020/09/27 01:40 UTC. This was the only one packet Saturn registered, showing a stunning performance.

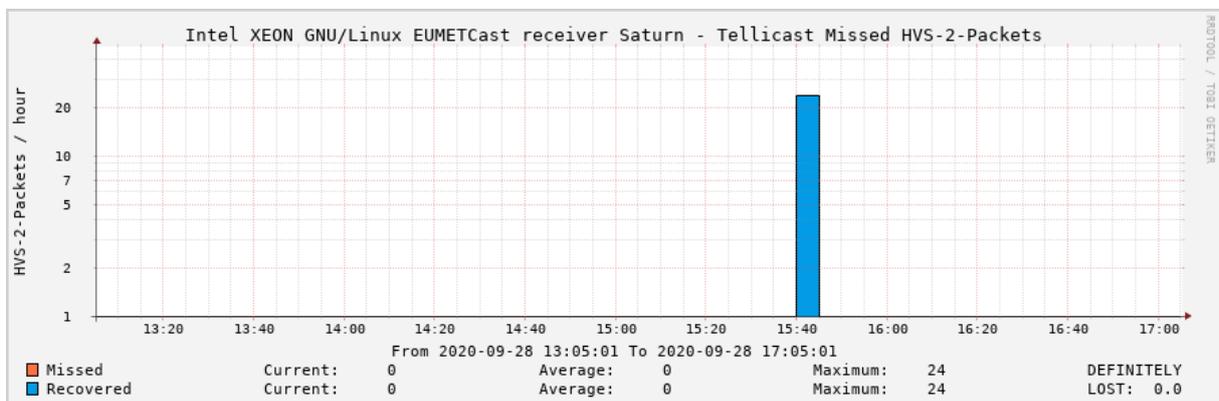
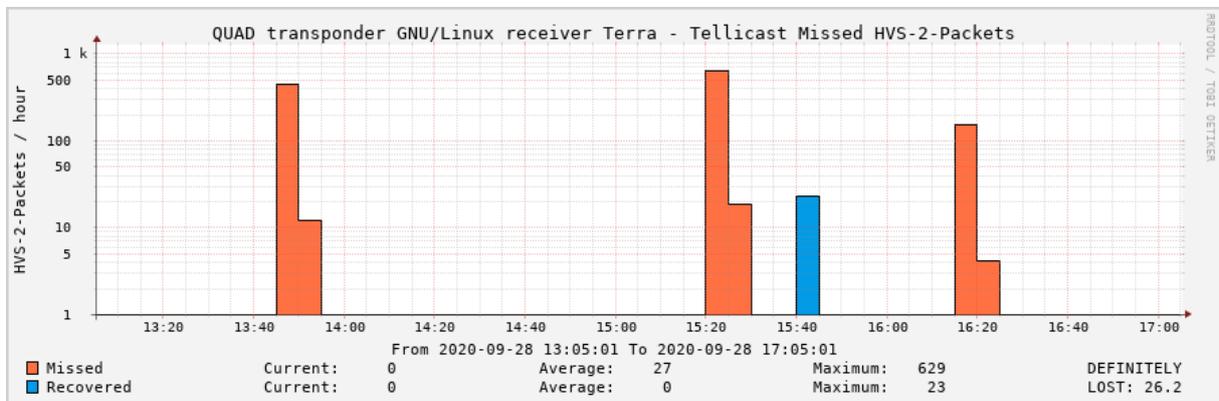
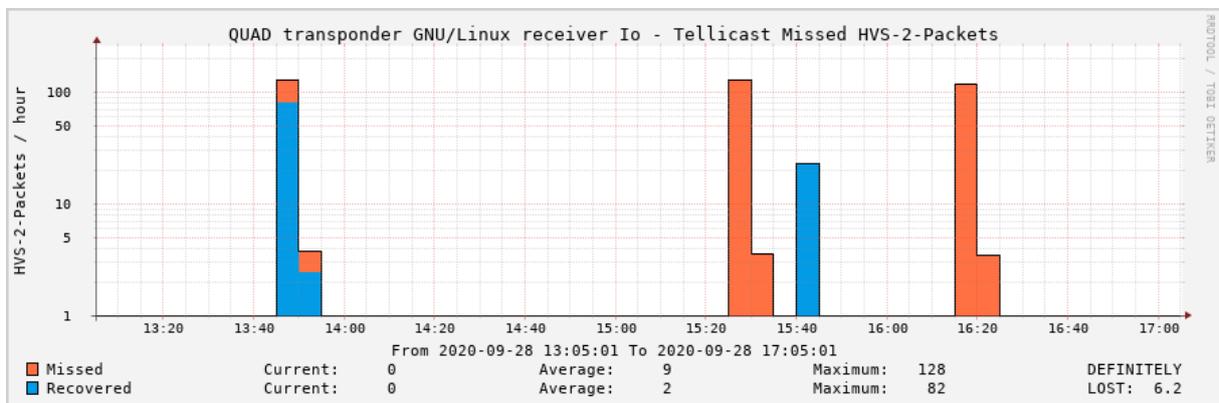


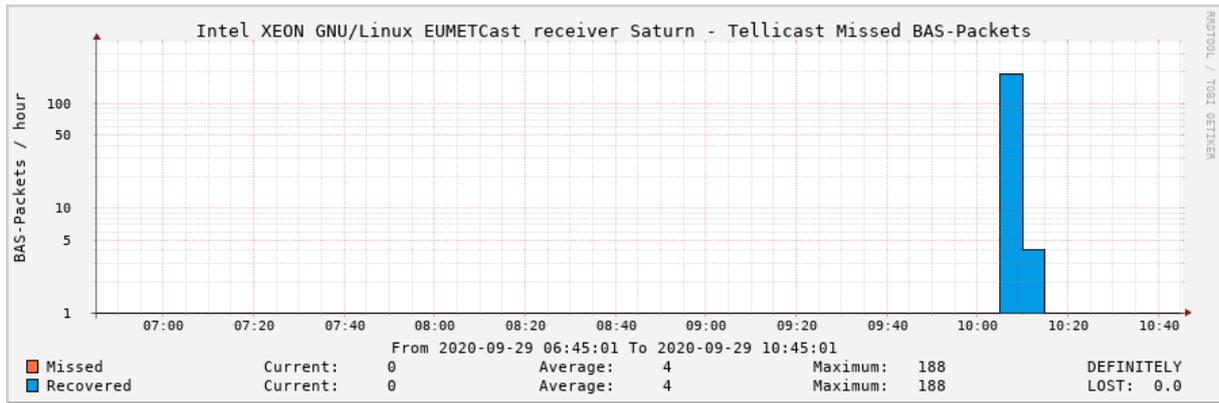
Christian Peters has several receivers under GNU/Linux running 24/7 in Germany. Smaug uses two TBS5925 boxes to receive BAS, HVS-1 and HVS-2 (single cable).



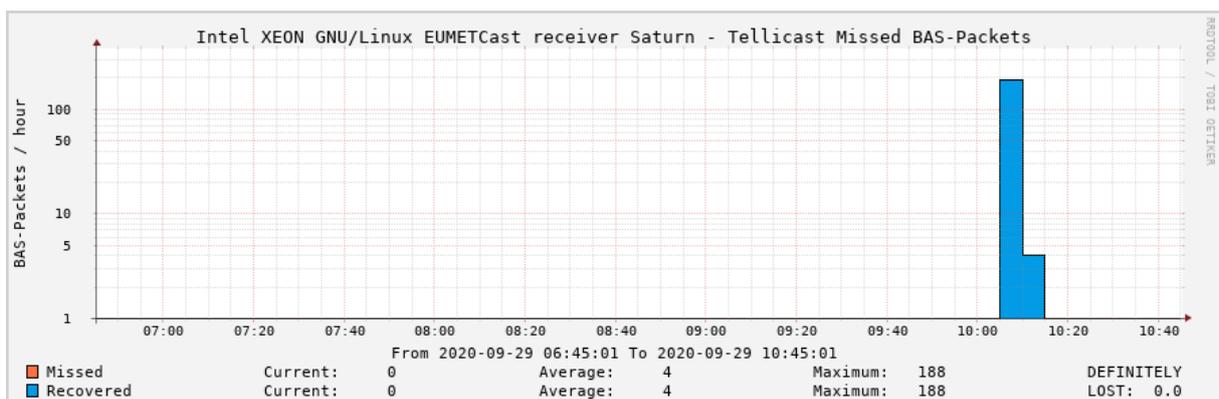
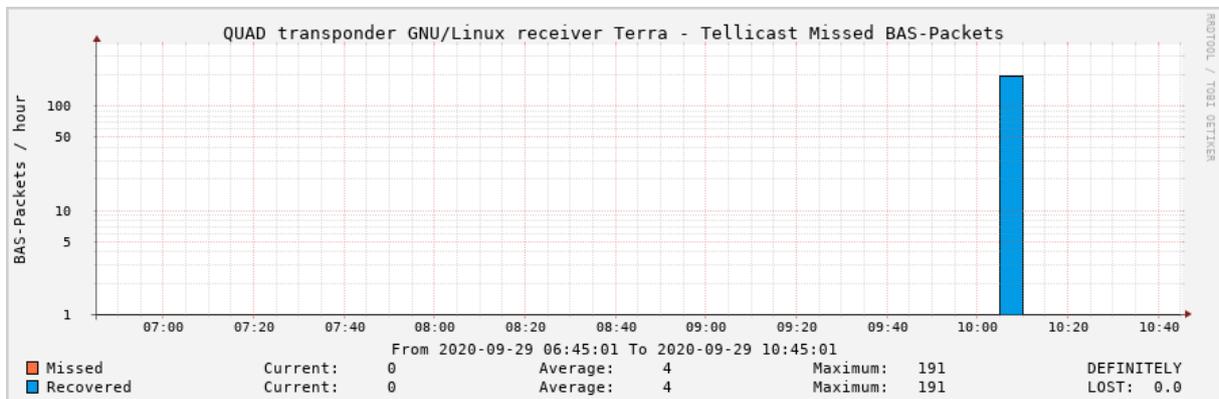
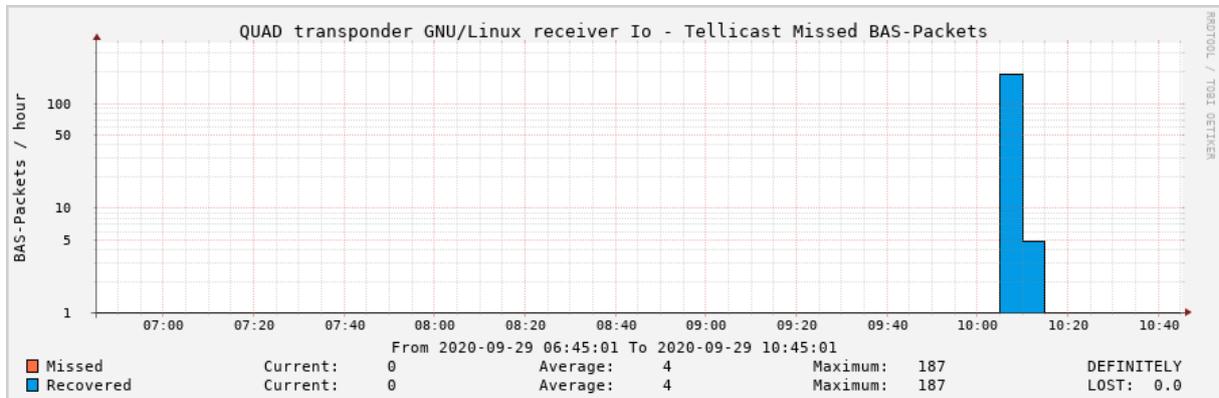


September 28th 15:40 UTC there was again a Europe wide event. This time two UDP packets were missed and recovered by all HVS-2 clients. No other events on Saturn.





September 29th 10:05 UTC there was a third Europa wide event. Many UDP packets were missed and recovered by all BASIC clients. Again Saturn had no other events.



September 29th 2020 in the afternoon, after 4 full days of reception the 4TB RAID0 devices of Io and Terra ran 96% full with increased frequency of lost packets. During the last hours iostat statistics were gathered every 5 seconds to be analysed later and possibly be correlated with lost packet events. XEON server Saturn on the other hand had received more than 6 Billion UDP packets without a single glitch. The only events seen were Europe wide on the TS as described but not a single packet lost.

```
Receiver / From / To / Packets Missed / Recovered / Lost / Total Received
pack_0 = BASIC(A), pack_1 = HVS-1(A), pack_2 = HVS-2(A), with eLuna graphs
pack_3 = BASIC(B), pack_4 = HVS-1(B), pack_5 = HVS-2(B), *NO* eLuna graphs
+-----+-----+-----+-----+-----+-----+-----+-----+
| io | 2020-09-25 | 2020-09-29 | pack_0 | 16 | 16 | 0 | 378336365 |
| io | 2020-09-25 | 2020-09-29 | pack_1 | 0 | 0 | 0 | 672625574 |
| io | 2020-09-25 | 2020-09-29 | pack_2 | 261 | 15 | 246 | 1959383430 |
| io | 2020-09-25 | 2020-09-29 | pack_3 | 16 | 16 | 0 | 378336346 |
| io | 2020-09-25 | 2020-09-29 | pack_4 | 0 | 0 | 0 | 672625477 |
| io | 2020-09-25 | 2020-09-29 | pack_5 | 296 | 5 | 291 | 1959383215 |
+-----+-----+-----+-----+-----+-----+-----+-----+
| terra | 2020-09-25 | 2020-09-29 | pack_0 | 16 | 16 | 0 | 378428965 |
| terra | 2020-09-25 | 2020-09-29 | pack_1 | 0 | 0 | 0 | 672711698 |
| terra | 2020-09-25 | 2020-09-29 | pack_2 | 489 | 11 | 478 | 1959376848 |
| terra | 2020-09-25 | 2020-09-29 | pack_3 | 16 | 16 | 0 | 378429009 |
| terra | 2020-09-25 | 2020-09-29 | pack_4 | 0 | 0 | 0 | 672711630 |
| terra | 2020-09-25 | 2020-09-29 | pack_5 | 453 | 14 | 439 | 1959372546 |
+-----+-----+-----+-----+-----+-----+-----+-----+
| saturn | 2020-09-25 | 2020-09-29 | pack_0 | *16 | *16 | 0 | 389619119 |
| saturn | 2020-09-25 | 2020-09-29 | pack_1 | 0 | 0 | 0 | 694037979 |
| saturn | 2020-09-25 | 2020-09-29 | pack_2 | * 3 | * 3 | 0 | 2015925767 |
| saturn | 2020-09-25 | 2020-09-29 | pack_3 | *16 | *16 | 0 | 389619121 |
| saturn | 2020-09-25 | 2020-09-29 | pack_4 | 0 | 0 | 0 | 694037978 |
| saturn | 2020-09-25 | 2020-09-29 | pack_5 | 3 | 3 | 0 | 2015924191 |
+-----+-----+-----+-----+-----+-----+-----+-----+
* Within 4 days only 3 UDP *external* packet events (*seen over all Europe*)
generated in Up- or Downlink. Over 6 Billion packets received, none lost!
```

Io and Terra had no HVS-1 packets missed and most problems with HVS-2. This also points to a I/O-problem of the RAID0 disk subsystem. These further tests were done:

- An attempt to correlate the time stamped iostat results with lost packet events didn't work as expected. For all parameters related to high disk loads the five greatest values were compared with lost packet events, no accordance found.
- Saturn was started for 1 hour with 6 and 5 EUMETCast transponders. While the TC clients could handle the situation with lots of missed but all recovered packets it was clearly shown that the LDPC can only cope with 4 EUMETCast transponders (done by monitoring MPE errors while `dvb_demux_tscheck = 1`).
- The receiver card of Io was replaced with a TBS6909X + 22uF capacitor. Io was started for half a day with a 4GB RAM-disk and immediate file deletion. It worked error free showing that indeed the disk subsystem was the bottleneck.
- Io was then started with the 4GB RAM-disk and a script that moved the files every minute from RAM-disk to the 4TB RAID0 device. This also worked for one full day with no packet loss while it slowly but steadily built up swap usage to final 2%. This hinted that 8GB RAM of Io was insufficient for this use case.
- Io was then started as above but setting `swappiness = 1` (default 60). This way swap usage stayed at 0.01% while program memory usage stabilised at 70%. For two more days I let Io fill up the 4TB RAID0 device with no packet missed.
- Saturn had the 8 RAM-disk replaced with a 2TB RAID0 device built by two WD Blue 1TB HDDs (WD10EZEX, CMR). This md0 device seemed to be able to

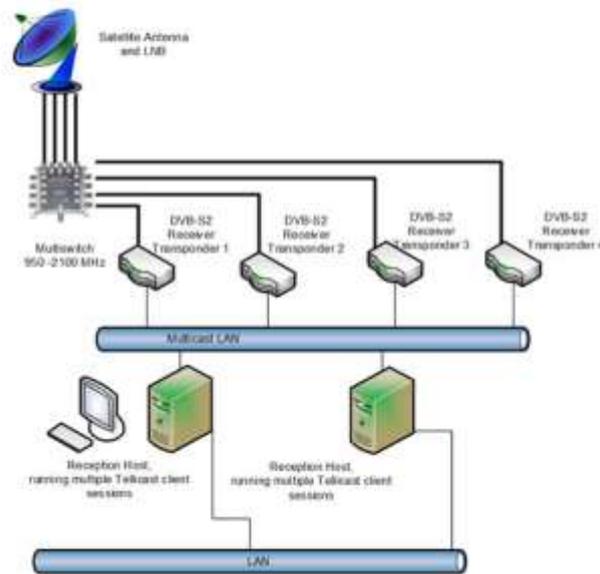
cope with the tmp + received data stream of four EUMETCast transponders. But when the RAID0 device was filled up to 60% we had all lost packets again.

- Saturn was then started with the 8GB RAM-disk and a script that moved the files every minute from RAM-disk to the 2TB RAID0 device. This worked fine. The 2 TB RAID0 device could be filled without a single packet missed locally.

6 Discussion

Though MTG is still some years ahead, EUMETSAT has published ideas for future station setups and asks EUMETCast users to prepare for the steep rise of data flow.

User Impact – Receiver chain – scaling up for performance (or redundancy)



This image showing a QUATTRO LNB, multiswitch and 4 EUMETCast routers that feed a multicast LAN has been taken from the EUMETSAT site under the headline:

Evolutions to EUMETCast services for the MTG era

It has been shown that, at least under GNU/Linux and except for the redundancy host, an equivalent receiver functionality can be realised with a single old PC and one TBS6909X which currently sells for US\$ 279.— from China. However it must be noted that this cannot be setup with the standard GNU/Linux EUMETCast package currently distributed. Most EUMETCast amateurs run their stations under Windows and depend on “point and click”. No equivalent test to what this paper describes has yet been done under Windows. As the card only began to work for EUMETCast after the 22uF fix there is no easy **TBS6909X Setup Guide** provided by EUMETSAT yet.

7 Conclusions

This paper demonstrates, that the TBS6909X + 22uF capacitor fix is an affordable multi transponder EUMETCast receiver with exceptional results under GNU/Linux. About 10 TB of EUMETCast data has been downloaded in two QUAD transponder setups with 6 TC clients running. Not a single packet has been missed locally. There have been some glitches in the transport stream seen all over Europe that resulted in some missed but all recovered packets. Like in the past the bottleneck in the receiver chain turned out to be the tmp + received HDDs for data storage. There has been some progress recently making a two transponder (T1 + T2) all amd64 GNU/Linux receiver work without a RAM-disk taking BAS + HVS-1 + HVS-2 running 3 TC clients. But doubling again to 2 x (T1 + T2) and 6 TC clients that download about 1TB per day cannot be done even when the data HDDs (that must have CMR) are setup as software RAID0. For reception of 4 EUMETCast transponders 16GB of RAM must be recommended. The receiver card is now working fine. Receiver system integration and resolution of the existing weak points must now be worked out by EUMETCast users depending on their needs. Very different system solutions already exist here.

Even with current EUMETCast transponders T1 and T2 there is a very interesting setup to be tested next. It should be possible to run a system that uses three out of eight demodulators for taking BASIC only (MODCOD filtered), HVS-1 (including but not using BASIC data), and HVS-2. This can all be done using one single LNB cable. For this to work the Linux card driver has to be slightly adapted to allow BASIC only. This will be the equivalent of using three SR1 routers with multiple PCs and cabling.

The card driver is already very versatile now. It allows for QUATTRO LNBs (needs 4 LNB cables for the 2 bands and 2 polarisations). But it also works with QUAD LNBs where you can use 4 demodulator pairs in a master/slave configuration. In this mode you can also feed the card from different LNBs of antennas pointing to different satellites. As shown it can also be fed with a single cable where you can receive up to 8 transponders that must be of the same band (high/low) and polarisation (H/V).

Equivalent testing is now needed for the Windows operating system. I have never setup such an EUMETCast receiver and (though this paper has been written on Windows 10) I never will. But it's a fact that Windows 10 is now wide spread under EUMETCast amateurs and there is a hand full of operators that can easily do the thorough tests still needed. The best solution would be that EUMETSAT also makes equivalent tests and updates their suite of **Setup Guides** for DVB-S2(X) PCIe cards.