VLA/VLBA Interference Memo No. 30

Memorandum
September 16, 2002
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Computer Emissions Test Summary

In July of 2002, a concern about introducing new Dell 2GHz personal computers at the VLA for fear of RFI problems caused tests of the 2GHz pc's to be conducted. In addition to the Dell 2GHz pc's a number of computers were selected for testing in the same period of time to take advantage of new, more sensitive equipment and the new shielded chamber at the VLA site. The test procedures, data, and conclusions are chronicled in this report.

Test Equipment:

All of the emissions tests for computers were performed in the shielded chamber located in the NW corner of the warehouse at the VLA site. The shielding effectiveness of the chamber is about 55dB at 1GHz and about 35dB at 10GHz. The receiver for all of the tests was an HP 70000 series spectrum analyzer .01-22GHz with RBW from 10Hz-3MHz. The receiving antenna was a Stoddard 1-10GHz directional off-tip conical log spiral, LCP; which fed the receiver through an Andrew 3/8" heliax cable, a bulkhead connector, and a piece of semi-rigid coax to the input of the spectrum analyzer.

Test Procedure:

Test procedures for these emissions tests adopted many characteristics from MIL-462 and IEEE guidelines for radiated emissions testing. A common separation distance of 8m was used for the test setup boundary. All EUT and Rx equipment was kept at least 1m from the walls of the chamber at all times. For the tests, each computer was set up in a fully operational configuration and turned on. Emissions were measured while in startup and while running awaiting network passwords. No significant differences in emissions were noted between these two operating states. Also, emissions for each component of the system were measured separately. The monitor, keyboard, and mouse did not tend to act as RFI sources in the frequency bands of concern. The first part of each test was to record the emissions from 0-5GHz while the spectrum analyzer was in peak hold mode with an RBW of 100kHz and the preamp on, an approximate hold time of 1min. was used in the tests. Plots were made of these scans using a data capture program on a laptop and then transferring the data to a pc for analysis in Excel. Plots from this are given in the test results. The second was a more detailed look with a lower RBW (to lower the noise floor of the spectrum analyzer) above 5GHz to as high as 20GHz. No significant emissions were detected above 5GHz in these tests.

Computation:

The data for each test was put through a standard algorithm for computing the EIRP of the radiated emissions. The calculation itself is given below, and provides for computation of EIRP at the source of the emissions when a dBm power level is measured and the ACF (antenna correction factor) and frequency of each point of measurement is known.

$$EIRP=10Log\left[\frac{4\pi \bullet 10^{((P(dBm)-30)/10)}}{10^{((20Log(F\,(MHz))-29.8-ACF)/10)}}\right]-[10Log(RBW_{Hz})]-[10Log(1/4\pi r^2)]$$

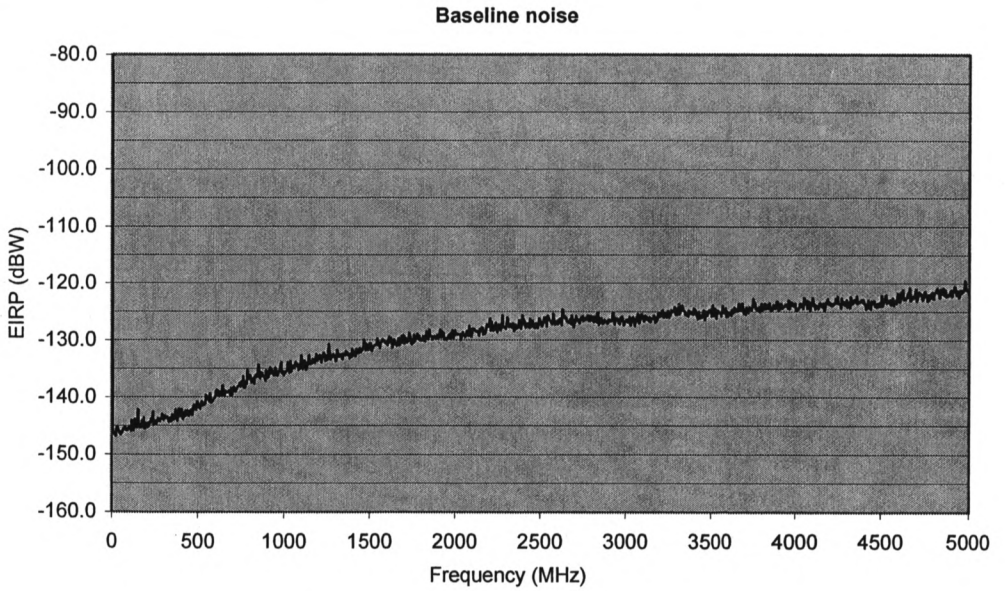
Where the ACF is given in an antenna characterization file and interpolated statistically by a quadratic regression from 1-10GHz in this case by the equation:

$$ACF= -0.2254(F_{(Hz)})^2 +4.5919(F_{(Hz)})+23.68$$

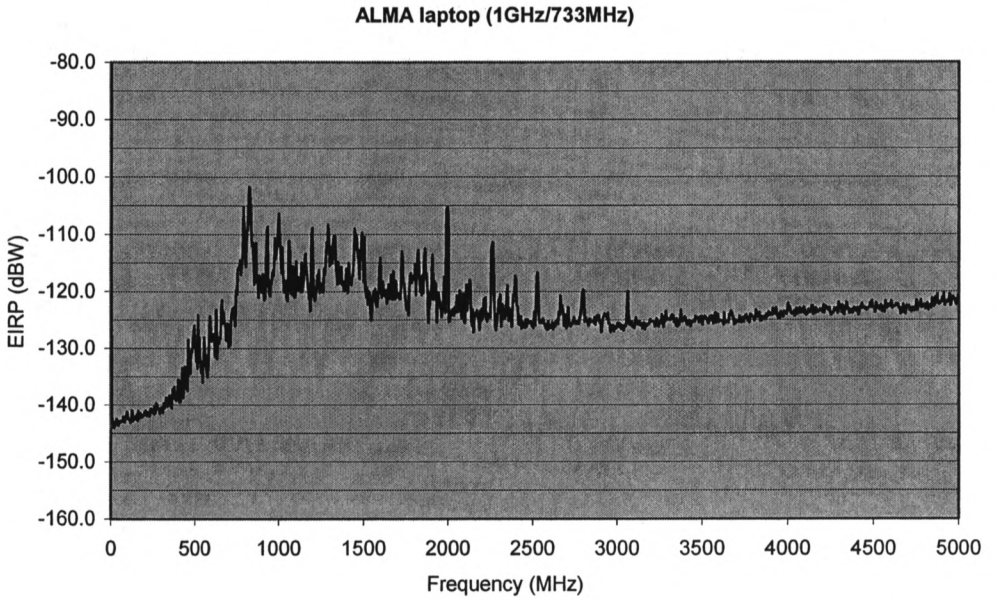
This equation models the given characterization data very well with a correlation coefficient of greater than 0.97.

Test Results:

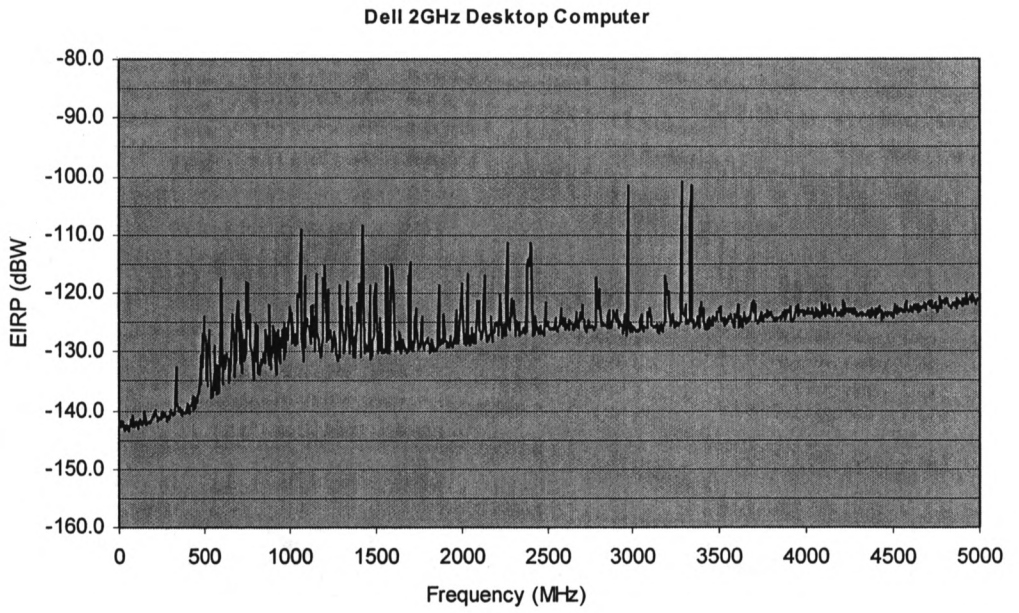
The results found by these tests show large amounts of powerful discrete frequency spikes in P and L band as well as some emissions in S and C band. The plots below give absolute calibrated power levels at the equipment in dBW. A representative selection of computers used at the VLA is given; testing has shown that there is some variation in the number and power of spikes radiated from each individual computer. The baseline sensitivity plot of the entire test setup is also given as a reference.



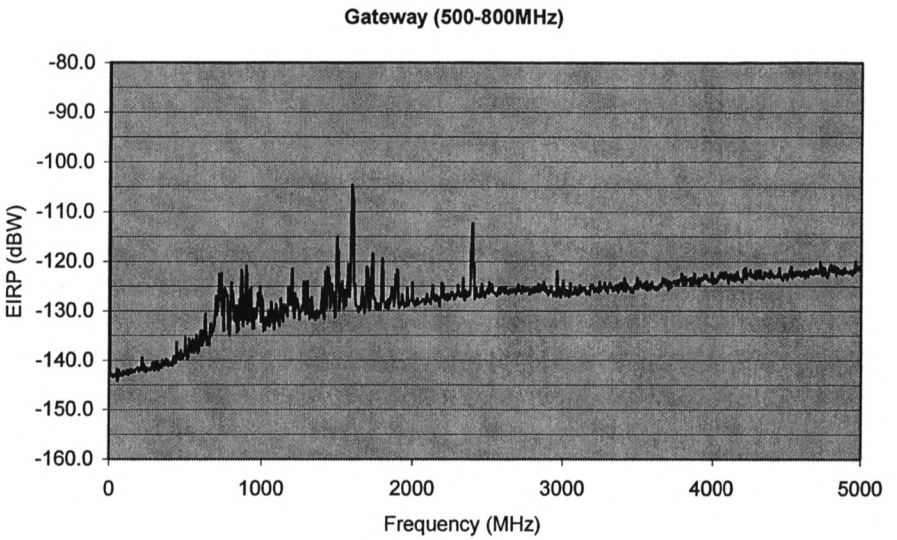
Baseline noise of the system used for the tests.



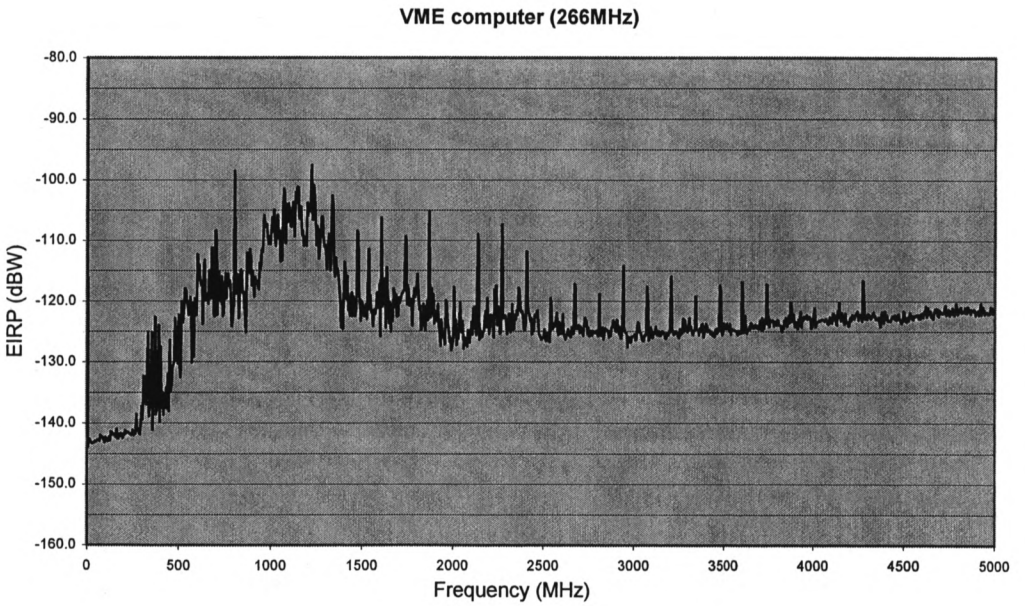
The ALMA laptop used in the weather station at the ATF.



ALMA owned Dell 2GHz desktop computer.



Representative plot of Gateway computers in use at the site.



A computer with a VME bus structure and a 266MHz processor.

All of the results above are fairly typical within a bus structure/case composition family. Differences occur when one of these parameters is varied; but it is worth noting that with a change in processor speed there is little or no difference. All of the computers tested after shielding and path loss to the nearest array element for the VLA, from any standard area of computer usage, is above both the ITU guidelines and the EVLA detrimental levels in P and L bands. Emissions from P-band in the plots are suppressed 20dB or more by the pre-amp in the spectrum analyzer.

Conclusions:

All of the tests conducted on computers at the VLA show that there is a large potential problem; one which is very widespread that could be interfering with observations currently, and one which is certain to cause problems with the increased sensitivity of the EVLA. This is a problem that may have been ruining certain observations for some time now. Recently, due to increased sensitivity in RFI monitoring with the implementation of a mobile monitoring system, a computer was found to be the cause of a ruined observation in L-band. This first case may just be the tip of a much larger iceberg of computer emissions problems whose severity may not be fully discovered until the implementation of the EVLA. Shielding of computers at the VLA site may be necessary in the near future to promote the integrity of astronomical data gathered by the facility. Research of methods of cost-effective shielding for computers is currently under way, and some solution of this problem should present itself through this research.