Trip Report and Preliminary Test Results from 29 January, 2002
10 Gbps OMNET Flyable Link Proton Tests

On 1/28/02 Peter Wiley and Greg Rash of China Lake NAVAIR joined the NASA GSFC group at the U.C. Davis Crocker Nuclear Laboratory for the purpose of performing an initial round of proton radiation evaluations on the DARPA funded 10 Gbps Flyable Link OMNET hardware. This event followed the successful demonstration of a similar (1st generation) version of the same hardware on an F-18 test pod, and the coordination leading to these tests was the culmination of extensive discussions between Dick Swensen (formerly of China Lake and now with Mayo), Paul Marshall (NASA contractor), Ken LaBel of NASA GSFC, and Peter Wiley of China Lake. Authorization for these tests by Dave Honey of DARPA was also a critical step and is greatly appreciated.

The primary goal of this first round of tests was to examine the Single Event Effect (SEE) sensitivity of the OMNET link to proton-induced disturbances. A secondary goal was to familiarize GSFC personnel with the operation of the Flyable Link (fully populated 2nd generation) so that further testing could be accomplished on a later date. We achieved both objectives with a series of 21 nondestructive tests.

During these tests, we examined the optoelectronic transmit and receive modules from New Focus, and also the Giga GD16585 and GD16584 transmit and receive Mux and DeMux devices. We avoided high exposure levels to assure nondestructive tests, but were nevertheless able to gain adequate information of error modes and error rates.

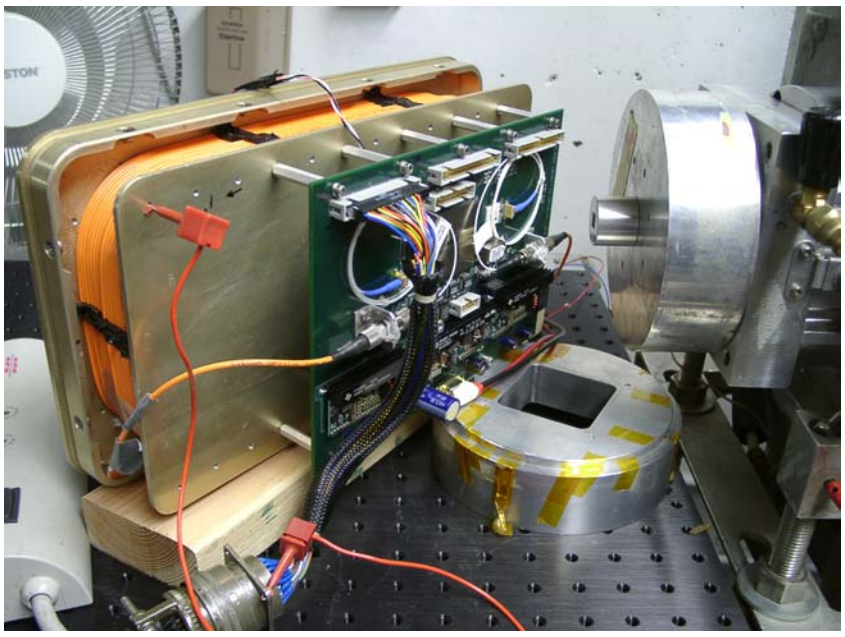

Figure 1. To allow direct access to the proton beam (see aperture on right), the flight housing cover for the Flyable Link was removed. During test, the fan (upper left) was used to manage heat and assure error free conditions in the absence of protons.

While testing, we encountered one complication. The 486-based computer module, though not in the proton beam, did appear to be sensitive to stray neutrons near the end of the beam line. Consequently, many of our tests were terminated due to a hang-up in the computer. Nevertheless, we obtained valid data on the 4 devices we tested. All testing was done with 63 MeV protons and

at with the serial data rate of the 10 Gbps SONET standard. The link optical power was not measured or controlled, and there was no attenuation aside from the 100 Meters of 62.5/125 multimode fiber. During initial testing, we used the fact that the proton beam could initiate isolated single events to check out the performance of the software for capturing error histories. This level of interrogation had not been possible prior to proton testing, and the first 4 runs were used to debug a cable connection.

Valid data for runs 5-21 are shown in the following table. Runs 5-10 and 19-21 indicate sensitivity in the New Focus receiver that is consistent with our previous studies of high speed photonic links. Further, the last 3 runs indicating angular dependence of the sensitivity support the claim that errors are due primarily to proton ionization in the receiver photodiode. No errors were noted in the New Focus receiver to proton doses exceeding 1 krad(Si) (runs 11 and 12). The Giga parts showed sensitivity levels characteristic of high speed bipolar technologies (runs 13-18). However, at this point is not known why the demux appeared to be more sensitive than the mux. Preliminary assessment is that the error signatures we noted could easily be mitigated and this commercially available hardware could be well suited for NASA's flight interests.

Run #	DUT	Time sec	Fluence per cm^2	Intv dose rad(Si)	Angle degrees	# Events	Error cross-section
5	Rx-Bd1	115	1.00E+08	1.35E+01	0	25	2.50E-07
6	Rx-Bd1	59	1.00E+08	1.35E+01	0	30	3.00E-07
7	Rx-Bd1	58	1.00E+08	1.35E+01	0	44	4.40E-07
8	Rx-Bd1	70	1.00E+08	1.35E+01	0	22	2.20E-07
9	Rx-Bd1	60	5.00E+08	6.80E+01	0	155	3.10E-07
10	Rx-Bd1	60	5.00E+08	6.80E+01	0	151	3.02E-07
11	Tx-Bd-1	58	5.00E+08	6.70E+01	0	0	0.00E+00
12	Tx-Bd-1	118	1.00E+10	1.35E+03	0	0	0.00E+00
13	Tx-giga-Bd-1	116	1.00E+09	1.35E+02	0	5	5.00E-09
14	Tx-giga-Bd-1	252	4.30E+09	5.77E+02	0	12	2.79E-09
15	Tx-giga-Bd-1	252	4.30E+09	5.77E+02	0	5	1.16E-09
16	Tx-giga-Bd-1	168	2.88E+09	3.87E+02	0	6	2.08E-09
17	Tx-giga-Bd-1	176	2.96E+09	3.98E+02	0	3	1.01E-09
18	Rx-giga-Bd-1	584	1.00E+10	1.34E+03	0	196	1.96E-08
19	Rx-Bd-1	367	3.37E+08	4.50E+01	45	1	2.97E-09
20	Rx-Bd-1	286	9.87E+09	1.33E+03	45	69	6.99E-09
21	Rx-Bd-1	439	1.52E+10	2.04E+03	45	75	4.93E-09

The test hardware has been officially transferred to NASA. In our next round of tests (planned for early April) we will explore the link sensitivity to variations in optical power by inserting an attenuator and power meter into the link, and mount the board to a stage for more careful studies of the angular dependence of errors in the receiver.

Test Personnel for this test were: Peter Wiley and Greg Rash of China Lake, Paul Marshall and Hak Kim (NASA contractors), and Robert Reed of NASA GSFC. Please forward questions or comments to Paul Marshall (pwmarshall@aol.com) at 434-376-3402. We appreciate funding from the NASA Electronics Radiation Characterization Project and the Defense Threat Reduction Agency.