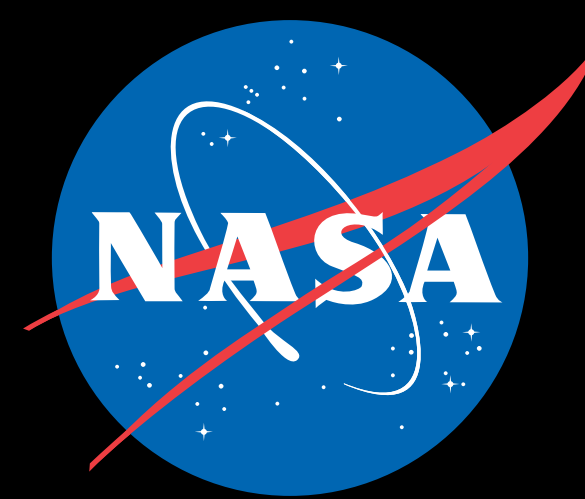National Aeronautics and
Space Administration

Single Board Computer Radiation Test Results and Radiation Test Software

Single Board Computers (SBCs) are quickly evolving and gaining capability as their cost comes down. As their footprints, cost, and power requirements decrease, their processing power increases. This makes them very attractive for use on space missions and an enabling technology as spacecraft size decreases and computational demand increases. One of the major challenges electronics face in the space environment is radiation. In 2019, the NASA Johnson Space Center (JSC) tested a selection of SBCs to low Earth orbit (LEO) radiation levels and evaluated their susceptibility and survivability. For this test campaign, JSC developed a Python software suite to better characterize the SBCs performance and intends to share the software.

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Test Description

Units were subject to a total ionizing dose (TID) of 600 rads (1E10 protons/cm2) at a proton therapy center in Tennessee. Failures and their corresponding fluence were used by the JSC radiation effects group to calculate MTBF for the LEO region. SD cards were shielded during the test.
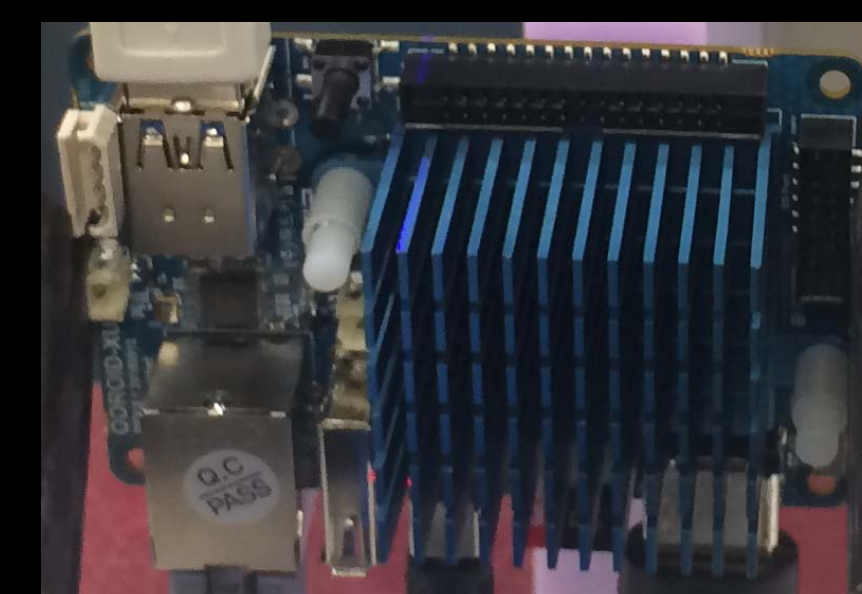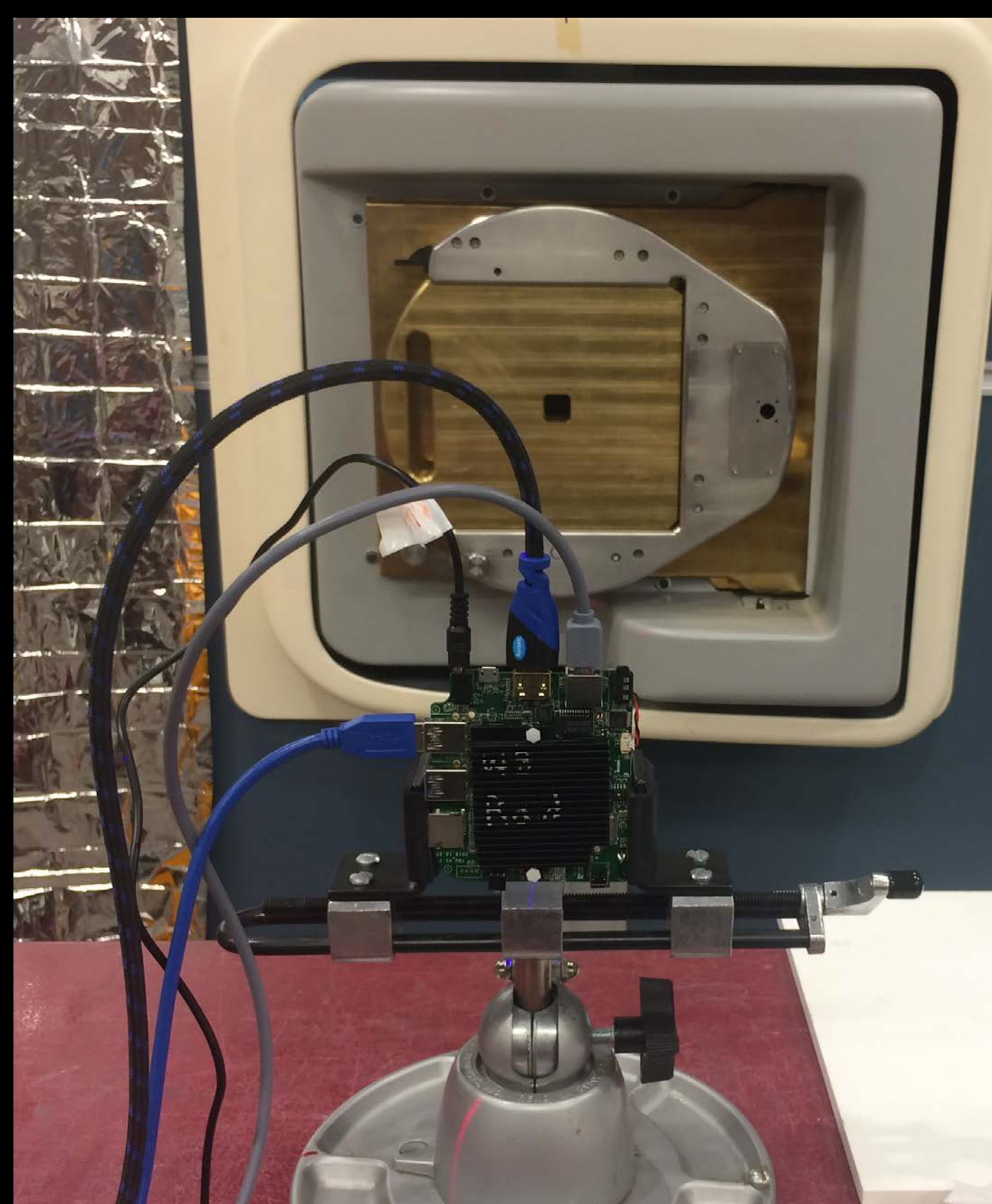
Results

Computer	Configuration	OS	MTBF in LEO (days)	Common Failures
ACEPC W8	Intel Atom x5-Z8350, 2GB RAM, 32GB eMMC	Windows 10	104	system hang, BSOD, RAM bit flip
LattePanda	Intel Atom x5-Z8350 , 2GB RAM, 32GB eMMC	Ubuntu 16.04	168	RAM bit flip, crash
ACEPC AK1	Intel Celeron J3455, 4GB RAM, 64GB eMMC	Windows 10	76	RAM bit flip, system hang
Raspberry Pi 4B	ARM A72, 2GB RAM, SD card	Raspbian Buster	7	RAM bit flip, crash
Odroid XU4Q	ARM A15 and A7, 2GB RAM, SD card	Odroid Ubuntu 18.04	43	Ethernet failure, crash, RAM bit flip
NanoPi M4	ARM A72 and A53, 2GB RAM, SD card	Armbian	41	RAM bit flip
Raspberry Pi 3B+	ARM A53, 1GB RAM, SD card	Raspbian Buster	39	system hang, RAM bit flip

Test Software

Python code was developed to test and log data pertaining to the RAM and the network usage. The code works across Windows and Unix operating systems and is intended to provide a baseline capability that others can contribute to in order to create a standard for computer assessment in radiation testing. The code is stored in a Git repository and is intended to be shared. Contact us for more information (**samuel.m.pedrotty@nasa.gov**).