OA-II VEH Storage System Design

DR00006

Rev: A01

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1 Introduction

1.1 Scope

This document covers a variety of storage technologies for use in the OA-II VEH system.

1.2 Purpose

The OA-II system design has a variety of sensors which must be recorded, camera feeds, and software logging information. This information is very important for future reports, analysis, and debugging. There must be a reliable system for storing this information on-board the flight vehicle, as it is not possible to transmit all of this information back to the base station reliably. For simplicity, only flash based storage methods are considered.

1.3 Relevant Documents

- DR00001 - OA-II Backplane Bus System Design

1.4 Revision History

Rev	Author	Approver	Changes	Date
A01	Gabriel Smolnycki		Initial draft	2019-07-25

Table 1: Summary of Revision History

2 Bandwidth and Total Storage Requirements

From DR00001, total bus requirements are ~10MB/s. This does not include software logging information, or any live calculations which must also be logged, or filesystem and file format overhead. Applying a conservative factor of safety of 4, assume that the total bandwidth requirements are $10MB/s \times 4 = 40MB/s$.

Total storage is more difficult to calculate, as the length of a given mission or test run is highly variable. However, it is unlikely that any run will have a data logging period greater than 60 minutes. This gives a total storage requirement of $40MB/s \times 60s/min \times 60min = 144GB$.

3 Available Protocols

3.1 SD

SD (Secure Digital) cards are a common method of data storage in embedded systems. A microSD card can store up to 1TB, with exterior dimensions of only 15x11x1mm. Newer cards support very high interface speeds, depending on the generation: 104MB/s for UHS-I, 312MB/s for UHS-II, 624MB/s for UHS-III, and up to 985MB/s using the newest SD Express variant. However, SD cards are primarily a consumer standard, and do not contain features such as ECC, encryption, increased redundancy or wear leveling. The connector is also not easily physically secured against vibration and shock, or available in ruggedized variants. [1]

Pros	Cons
High density	Low reliabilty
High speed	Not ruggedized
Low cost	Consumer standard
Easy to implement interface	Limited advanced features

Table 2: SD card pros vs cons

3.2 USB

USB (Universal Serial Bus) is a very common external bus, which is often used for consumer storage devices. In particular, the USB mass storage device class allows for devices which use flash storage. USB bandwidth varies from 1.5Mbps to 20Gbps, depending on generation. USB is also a consumer standard, and typically used over cabling rather than as a board-to-board interconnect. The USB standard supports many different types of devices, although devices are not required to implement all of them. USB bandwidth is typically limited by the host, and by bus overhead [2]. USB connectors and flash memory are available in ruggedized variants from companies such as Amphenol [3].

Pros	Cons
High speed	Typically cable interface
Very versatile	Consumer standard
Ruggedized variants available	Low reliability
Low cost	Large physical size

Table 3: USB Mass Storage pros vs cons

3.3 eMMC

eMMC (embedded Multi-Media Controller) is a standard for embedded storage chips which contain both a flash controller and flash memory device in a single package. eMMC devices interface with many processors directly, and are used in consumer, industrial, and embedded applications. There are multiple standard eMMC packages, which are eMMC is also small and typically low-cost, with high density [4]. Since eMMC has a flash controller onboard, it has built-in functionality for ”performance, security and reliability” [5].

Pros	Cons
High speed	Difficult to replace
Low cost	Limited capacity
Easy/common interface	
Industrial variants available	

Table 4: eMMC pros vs cons

3.4 PATA

PATA (Parallel ATA) is an older standard used for PC hard drives. Originally ATA for AT Attachment, and also called IDE in later versions, PATA uses a 40 pin standard interface. PATA supports speeds up to 100MB/s. While the ATA command set remains in the form of SATA, the interface itself is essentially obsolete today. [6] The Compact Flash standard is substantially similar and electrically identical to PATA, providing support for more modern, high speed flash devices. [7]

Pros	Cons
Low cost	Obsolete
Easy to implement	Wide electrical interface
Widely supported	Low performance

Table 5: PATA pros vs cons

3.5 SATA

SATA (Serial ATA) is a newer standard used for PC hard drives. It is substantially based on PATA, using the same command set, but over a newer, modern serial interface. SATA supports speeds up to 6Gb/s, significantly faster than PATA. The SATA physical interconnect supports SAS or Serial Attached SCSI, for high performance drives. SATA is one of the most common storage protocols today. [8] SATA is also available with ruggedized connectors, as well as ruggedized SSDs [9] [10].

Pros	Cons
High speed	Moderately difficult to implement
Narrow electrical interface	Moderate cost
Widely supported	

Table 6: SATA pros vs cons

3.6 NVMe

NVMe (Non-Volatile Memory express) is a storage technology which works over PCI Express. NVMe was specifically designed for flash storage, and is used in very high performance applications [11]. NVMe is capable of speeds up to 2.8GB/s with 8 PCIe lanes, faster than any other current storage technology [12]. There are multiple different form factors available for NVMe drives, including U.2, M.2, and single chip solutions [13].

Pros	Cons
Very high speed, scalable	Difficult to implement
Narrow electrical interface	High cost
Widely supported	

Table 7: NVMe pros vs cons

3.7 eUFS

eUFS is a new standard intended to replace eMMC. Unfortunately not much information about eUFS is available at this time.

3.8 Raw Flash

Flash storage can be used without any of the above protocols. There are two basic types of flash used: NOR and NAND. NAND is the more common type. However, both styles of flash do not take care of several important features, such as wear leveling, error correction, bad block handling, and power failure handling [14]. As a result, it is highly advantageous to use a standard controller, as with the above protocols.

4 Bibliography

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