

Tuesday 3/11/14 10:00am

If one was good, two must be better! Poster Sessions that is! We had so many qualified submissions this year, we divided them in to two Poster sessions offering a variety of relevant topics to augment what you'll learn sitting in the Podium sessions.

Poster Sessions are a great way to network through interaction with the poster presenters and other curious bystanders, multitask during a break and stretch your legs after a long session.



This Poster

In-Situ Debug Techniques of SATA Connectors In Storage Servers - and Connector Degradation Phenomena

Trent Johnson—Cleversafe, Inc.

Investigation of Micro Spring Performance

Jiachun (Frank) Zhou, Hui Liu—Smiths Connectors - IDI

Testing Elastomer for HTOL

Ila Pal, Meghann Fedde, Sultan Faiz, Ranjit Patil—Ironwood Electronics, Inc.

COPYRIGHT NOTICE

The paper(s) in this publication comprise the Proceedings of the 2014 BiTS Workshop. The content reflects the opinion of the authors and their respective companies. They are reproduced here as they were presented at the 2014 BiTS Workshop. This version of the papers may differ from the version that was distributed in hardcopy & softcopy form at the 2014 BiTS Workshop. The inclusion of the papers in this publication does not constitute an endorsement by BiTS Workshop, LLC or the workshop's sponsors.

There is NO copyright protection claimed on the presentation content by BiTS Workshop, LLC. (Occasionally a Tutorial and/or TechTalk may be copyrighted by the author). However, each presentation is the work of the authors and their respective companies: as such, it is strongly encouraged that any use reflect proper acknowledgement to the appropriate source. Any questions regarding the use of any materials presented should be directed to the author(s) or their companies.

The BiTS logo and 'Burn-in & Test Strategies Workshop' are trademarks of BiTS Workshop, LLC. All rights reserved.



BiTS 2014



In-Situ Debug Techniques of SATA Connectors In Storage Servers

and Connector Degradation Phenomena
 Trent Johnson Cleversafe, Inc.

Problem Statement:

Deploying petabyte-scale storage brings new challenges to the connector debug process. Hard drive failure is inevitable and expected. The number of connectors in a storage system is large, systems are installed too densely to probe, and equipment is dispersed worldwide. Conditions exist in storage servers to catalyze connector problems; We are at the mercy of hardware vendors to make quality connectors.

Worldwide Data Dispersal

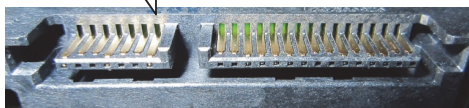


Example: 100 PB Installation

- 700 servers
- 700 CPUs
- 2800 RAM Modules
- 2800 Power Supplies
- **33600 Hard Drives** (most likely to fail)

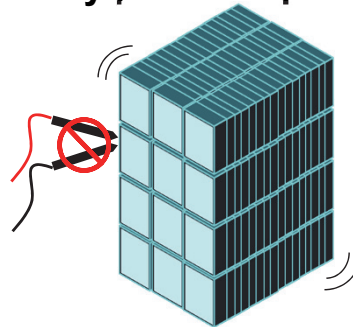
HDD Failure Mechanisms

- Servo
- Head
- Medium (Platter)
- Controller IC
- Firmware
- Software
- Connector



SlimLine SATA Connector

Density prevents probing

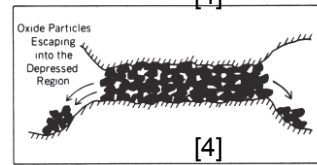
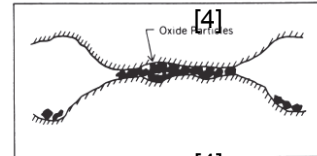
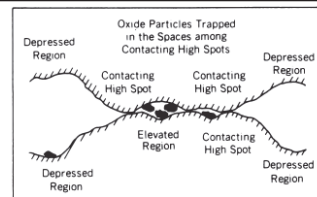
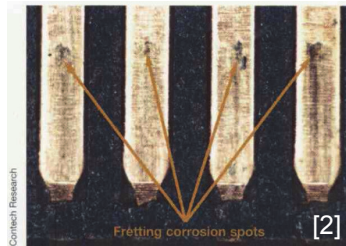
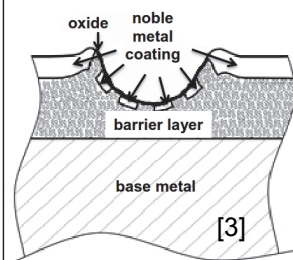


System state is very important when debugging remotely. If proper debug steps are not followed, connector problems, hardware bugs, software bugs and firmware bugs may be misdiagnosed.

Hypothesis: Connector Problems

Possible Cause: Fretting and Oxidation

- Fretting is wear and corrosion due to repetitive motion or vibration of mated surfaces.
- If the gold surface is too thin, it may be breached, allowing oxidation to cover the surface.
- Contamination can exacerbate oxidation.



"In laboratory studies, vibration has resulted in unstable resistance behavior (well into the ohmic range) as fast as eight minutes. Data from studies indicate that this is more probable with 10- to 500-Hz, low-frequency, high-amplitude conditions as opposed to high-frequency, low-amplitude conditions."

-Max Peel [2]



Common HDD Speeds:
 7200 RPM = 120 Hz
 5900 RPM = 98 Hz



"A common misconception is that gold is not susceptible to [fretting corrosion] because gold is noble and will not naturally oxidize. However, when fretting motion wears off gold plating, significant areas of nickel, underplate, or base metal are revealed, which result in fretting corrosion."

-Max Peel [2]

Gold plating designs have conflicting requirements:

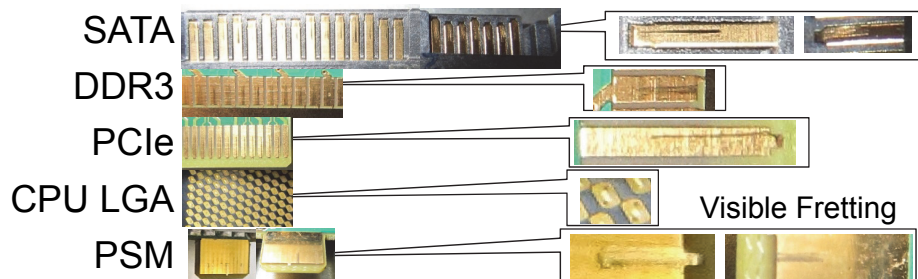
- Thinnest possible coat to reduce mating force
- Thicker coat required to reduce porosity

- Jian Song [3]

Scratched gold catalyzes adsorption of organic materials

- Shigeyuki Mori [1]

Typical registration marks from our servers in the field



We're still investigating connector degradation in the field

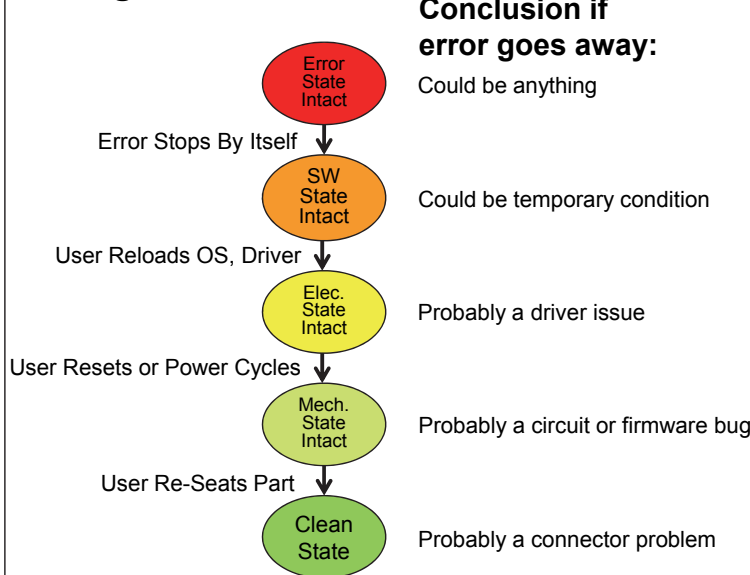
Hardware Debug Strategy

Deconstructing state properly:

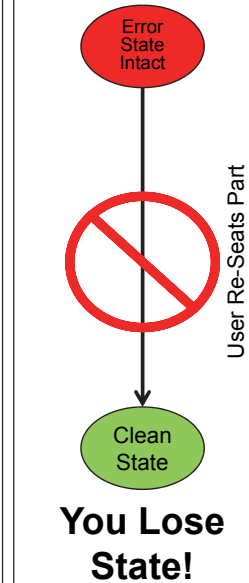
There are several levels of state that need to be considered during debug

- Error State – All states plus the exact data in flight to cause the failure
- Software state – The OS, driver, application software loaded into memory
- Electrical State – The logic and memory operating the device
- Mechanical State – The seating of the part in the socket

Debug Flow Chart



Don't Do This!



Summary:

- It is difficult to debug large scale hardware deployments.
 - Work is still in progress to root-cause a large population of field failures.
 - In order to properly root cause failures, it is important to debug by removing one layer of state at a time. (Immediately re-seating parts destroys evidence)
- Storage servers have the vibration characteristics to cause fretting or oxidation on gold connectors.
- Component manufacturers need to be aware of storage system vibration.

References:

- [1] Mori, S.; Shitara, Y.; Takahashi, K.; Hayashi, M., "Mechanochemical activity of nascent surfaces of gold, silver and copper," *Electrical Contacts, 1997., Proceedings of the Forty-Third IEEE Holm Conference on*, vol., no., pp.183,189, 20-22 Oct. 1997
- [2] Peel, M., "Conquering the untamed failure mechanism of fretting corrosion", *Connector Specifier*, Vol. 20 Issue 7, pp. 12 - 14, Jul. 2004
- [3] Song, J.; Wang, L.; Zibart, A.; Koch, C., "Corrosion Protection of Electrically Conductive Surfaces", *Metals*, pp. 450-477, 2012
- [4] Antler, M., "Contact Fretting of Electronic Connectors", *IEICE TRANSACTIONS on Electronics*, Vol E82-C No 1, pp. 3 - 12 Jan. 25 1999