6G SATA protocol: Development, Test Challenges & Test Coverage using development tools
Finisar at a Glance

Global technology leader
in fiber optic components and subsystems
and storage infrastructure test and diagnostics

- Rich technology history and market-share leadership
- Innovative products enabling high-speed, multi-protocol communications for LAN, SAN, WAN
- The “gold standard” for product developers of storage network systems and components
- Home of the Xgig & Bus Doctor Protocol Analyzers
Finisar at a Glance - World Wide Presence

4200+ Employees

- Sunnyvale, California
- Richardson, Texas
- Austin, Texas
- Sao Paulo, Brazil
- Singapore
- Ipoh, Malaysia
- Shanghai, China
Topics

1. 6 Gb/s standard: SATA Revision 3.0
2. Test equipment challenges at 6 Gb/s SATA
3. Test Coverage using Finisar tools
Finisar has ‘gone first’ for 6G SAS/SATA

- Started 6 Gb/s development 2+ years ago
- Attendee for and contributor to SAS-2 & SATA Revision 3.0 standards
- Works daily with customers in development, SQA, and manufacturing

What we’ve seen…
SATA IO Naming Guidelines

Confusion surrounding current SATA technologies
SATA IO recommends the following

- Don't use "SATA I" or "Gen 1": instead, use "SATA Revision 1.x" or "SATA first generation" or "SATA 1.5Gb/s."
- Don't use "SATA II" or "SATA Gen 2": instead, use "SATA Revision 2.x" or "SATA second generation" or "SATA 3.0Gb/s."
- Next Generation of SATA at 6Gb/s is to be referenced as either "SATA Revision 3.0" or "SATA 6Gb/s."
The move to SATA 6 Gb/s

Goals

- Backward compatible with 3Gb/s and 1.5Gb/s
- Same cables as 3Gb/s
- Same connectors as 3Gb/s
- Double the speed

Currently under review

- Many comments
- Release date: First half of 2009
The move to 6 Gb/s: SATA Revision 3.0

History

- Started October, 2006 – Lags SAS by ~6 mo.

Goals

- 6 Gb/s speed
- Copper channel

Key Differences from SAS

- No Equalization
- No Pre-emphasis

Attenuation effects means SATA is useable for only short (<=1m) distances
SATA Revision 3.0: New Features

- Protocol-Layer Features
  - Data streaming
  - Better power management

- Physical Layer (PHY) Features
  - 6 Gb/s speed
  - Low cost interface

- Most 6 Gb/s issues will be Physical Layer
What we’ve seen...

- **SATA**: Short maximum distance (1 meter) causes issues when using test equipment

- **Recommendation**:
  - Know your test equipment’s connection methods well
  - Understanding of the tighter tolerances at 6 Gb/s
  - Shorter Cables
Test equipment challenges at 6 Gb/s
6G SATA’s Physical Layer Challenges

Carrying high frequency signals over copper cables tests the limits of signaling technology

*Tighter tolerances*

*SATA_6Gb/s signals have increased sensitivity to attenuation and jitter.*

Signal Integrity is majorly impacted by
- Attenuation
- Jitter
High-Speed Channel (Physical) Issues

1. Attenuation
   - High freq.'s attenuate faster than low freq. over distance
   - High freq.'s are more susceptible to jitter

2. Jitter
   - Source
   - Destination
But...

Inserting Test Equipment adds distance and (may) induce jitter!

This can adversely affect signal integrity.

What can you do?
Know your connection methods

1. Analog Passthrough
   - From Dev. A
   - To Dev. B
   - To Tester

2. Digital Retiming
   - From Dev. A
   - To Dev. B
   - To Tester

3. Re-amplification
   - From Dev. A
   - To Dev. B
   - To Tester
Analog Passthrough

- Signal passes through solid-state switch

**Pros**
- Lowest impact to signal
- Little induced jitter

**Cons**
- Attenuates signal
- Creates a discontinuity in the link to the effect using a connector splice to join two cables
Digital Retiming

- Equipment acts as a device (Source and Target); Traffic decoded, re-encoded, and resent

**Pros**
- Longest cables
- Low jitter

**Cons**
- Adds latency
- Changes Link-Layer traffic as tester drops or adds ALIGN characters to maintain clock alignment with the devices under test
- Can mask Physical Layer issues

- Most commonly used connection for SATA’s short cable lengths
Re-amplification

Traffic re-amplified within equipment

Pros

- Allows longer cables
- Best signal integrity in terms of amplitude, i.e., decreased attenuation

Cons

- Induces jitter and thus may be unacceptable
- Can mask channel issues; for example reflections
What we’ve seen...

- Many customers are unaware that their test equipment has different connection methods that can help them with channel issues

- ... unaware that their test equipment can mask issues occurring at the physical layer

**Recommendation:** Know what your test equipment can/cannot do for your channel
Test Coverage using development tools
Xgig: Providing Enterprise-Level Test

Single unified platform for multi-protocol and multifunction analysis and test

10G iSCSI, FC, & FCoE
8G Fibre Channel
6G SAS/SATA

Expert Analysis
Traffic Generation
Jammer / BERT
Analyzer

- Provides line rate monitoring
- Non-Intrusive
  - Analog Pass-through
  - Digital Re-time
- Out-of-Band (OOB) sequences
  - Graphically to quickly identify OOB Errors
  - Captures timing of every Data Burst and D.C. Idle on both sides of OOB, speed negotiations, as well as automatically detecting OOB signaling patterns
Analyzer – Enhanced Capabilities

What to look out for in a good Analyzer

- Multi-protocol support
- Correlation of data
- Largest trace buffers
- Memory segmentation to allow multiple trace captures

Expert Analysis
- Topology of the link under test
- Detects and reports link errors, protocol violations, potential problems and other info
- Performance metrics

Traffic Summary View
- OOB signaling, primitives, error and event types
- Frames, connections, and transactions
- navigation between each counter and associated events

Analysis of multiplexed traces
- Triggering and filtering across all logical ports
Jammer

- Should be able to Inject Error for complex error path analysis
- Ability to Inject Errors for simulating physical layer problems
- Bit Errors
- Frame/Packet Errors
- Protocol Errors
- Easily synchronized with the Xgig Analyzer

By using the above capabilities one can create exercise the entire state machine for the protocol and Device’s capability from Error handling and Recovery.
Generation

- Should be able to generate arbitrary SAS/SATA protocol traffic
- Operate at all possible speeds of 1.5, 3.0, and 6.0 Gb/s for SAS and SATA protocols.
- Provide an API to create extensive test scenarios.
- Ability to execute multi-step or repeated command sequences.
- **Hardware Compare**: should allow data read from a target device to be verified against expected data without imposing a performance penalty on the data transfer.
- **Speed Negotiation Control**: should allow setting link speeds using the specified SAS and SATA speed negotiation.
- **“Loss of Sync” Insertion**: should be able optionally force a “Loss of Sync” either by temporarily changing clock rate, or by sending constant disparity and/or code violation errors.
Generator + Analyzer Topology

Solid lines show single port connection

Dashed lines show dual port connection

Legend

- "Wide" Connection (x4)
- Generator Connection
- Analyzer Connection
- Unused (Can only be Generator)

Device Under Test

Xgig-KL6400C

Double “Wide” Blade (2 x4)
Generator + Jammer + Analyzer

- Generate a known pattern
- Inject an Error on the pattern being generated
- Analyze using the Analyzer as to how the device is responding to the error.
- With the Generator, Jammer and Analyzer working in conjunction.
  - Check Performance
  - Devices Error Handling
  - Adherence to the protocol specs
  - Cross triggering as across
Medusa Test Tools: I/O Generation

- Bit-for-bit data integrity checking at benchmark speeds
- Provides wealth of data patterns designed to find hardware weaknesses (signal integrity)
- Ability to automatically trigger protocol analyzer for root cause analysis when anomalies are discovered
- Complete I/O control (queue depth, I/O size, file size, I/O direction)

- Medusa also provides protocol education course through DSI (Singapore)
Conclusions

1. Adhere to specification – more than ever
2. Know your equipments’ connection methods
3. Know the tools available for test and development
Thank you

Any Questions/Comments?

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