

Electronic Product Failure

A Case Study

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PHM = Risk Insurance

- PHM Cannot Prevent Product Defects.
- PHM Can Help Identify Conditions Leading to, or Resulting From, Defects.
- Without PHM, Defects May Be Identified Only After Large Field Failures.
- Delayed Defect Discovery Is Extremely Costly.
- PHM is Similar to Insurance:
 - You Hope Nothing Unexpected Will Occur;
 - You Don't Think Too Much About It;
 - You Hate to Pay for It; but
 - It Can Save You from Financial Run.

Cast of Characters

Consumers

H-P, Apple, Dell, Asus, Samsung, Toshiba, Fujitsu, Sony

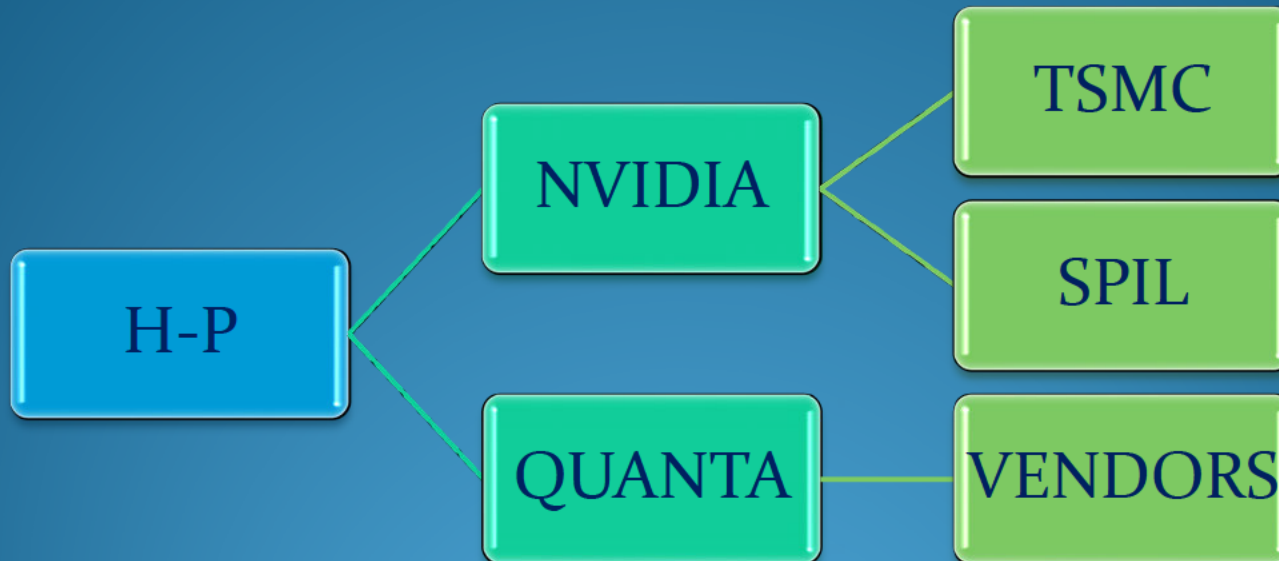
Quanta, Wistron, Compal

Nvidia

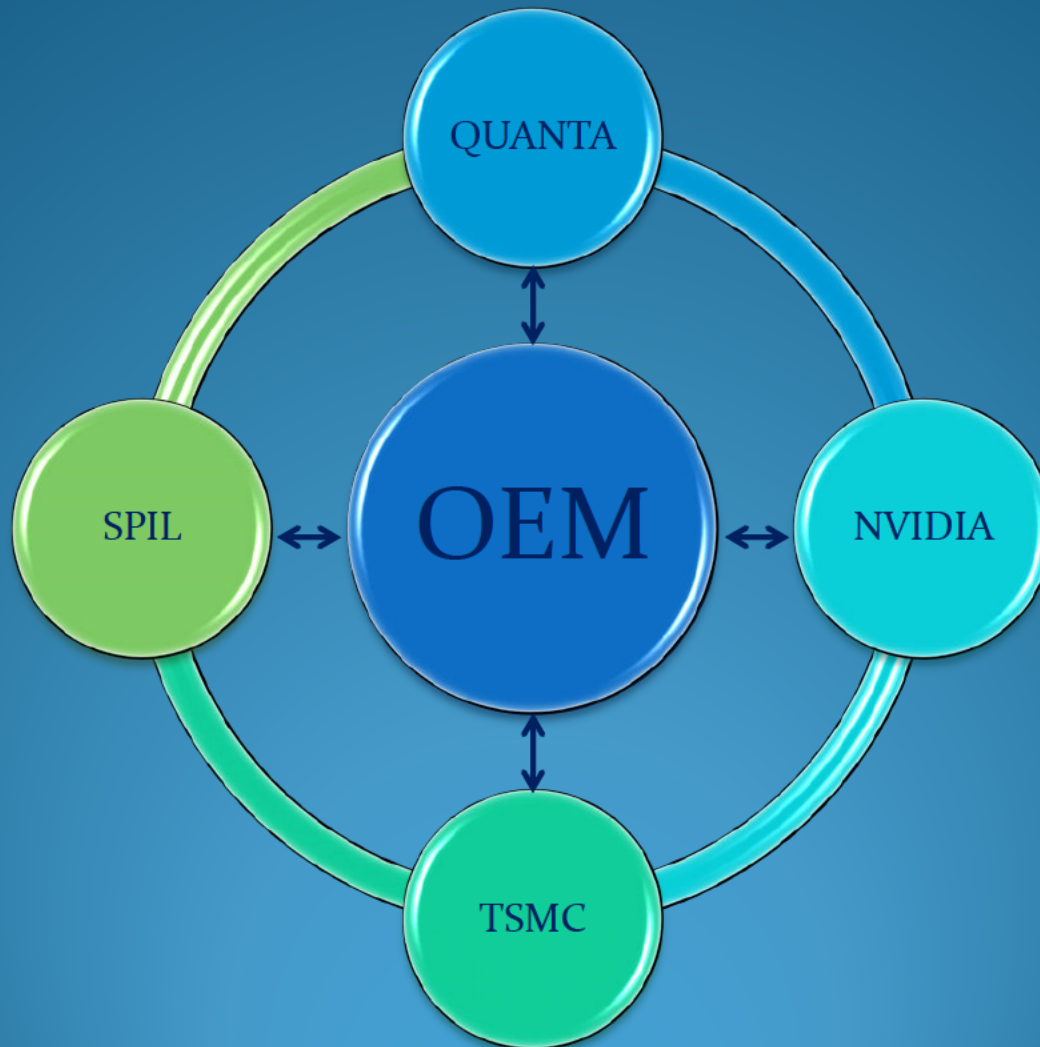
SPIL, ASE

TSMC

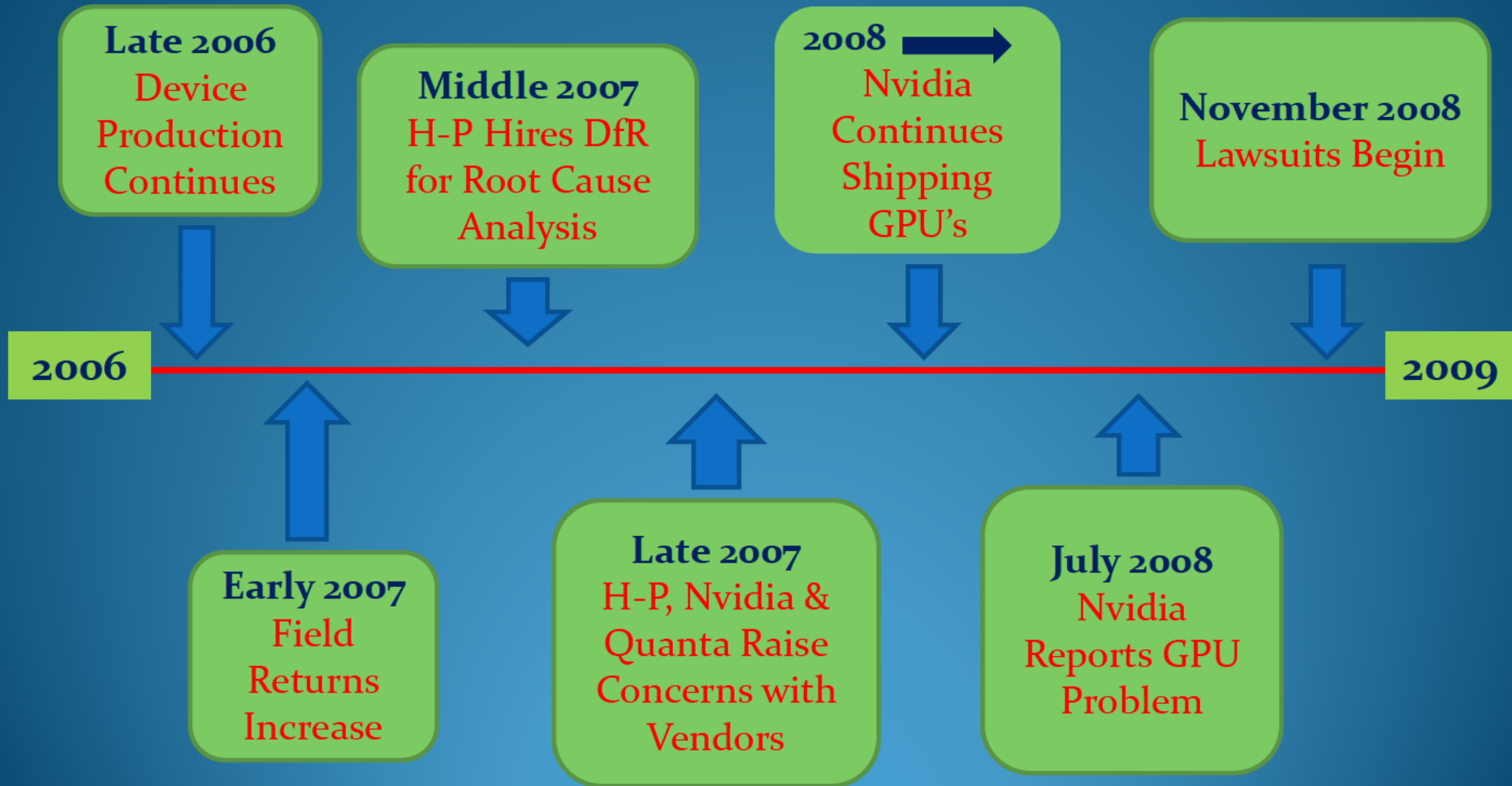
Production Dialogue



Proposed PHM Dialogue



Time Line of Events



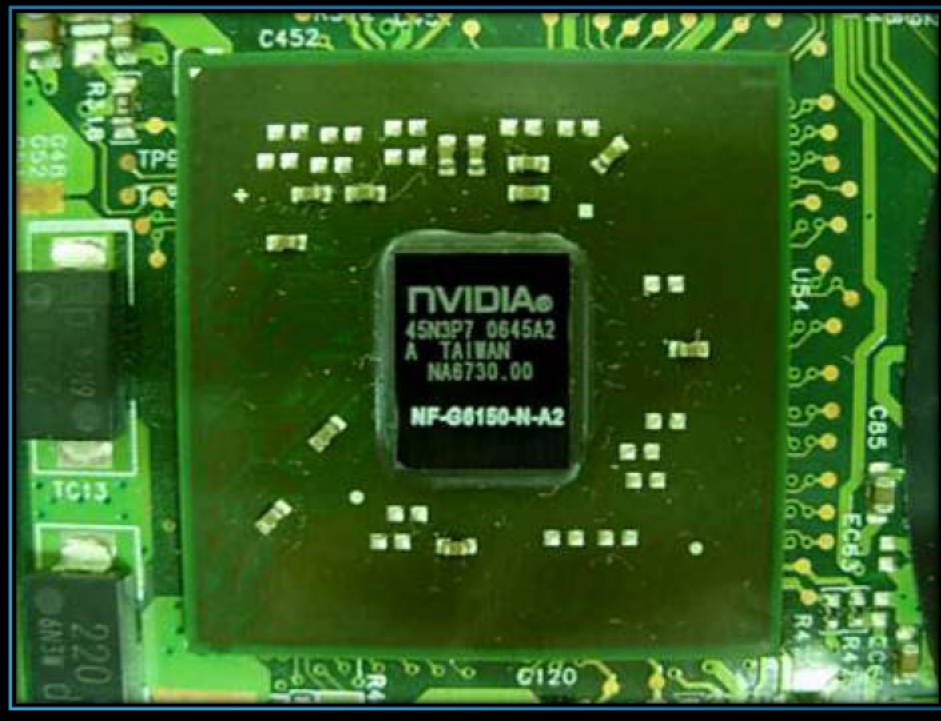
Failure Symptoms

No Video	Sudden Shut-Downs
Failure to Reboot	Random Characters
Vertical & Horizontal Lines	No Wireless Connection
No Power	LED Light Failures
Multiple Images	Excessive Heat

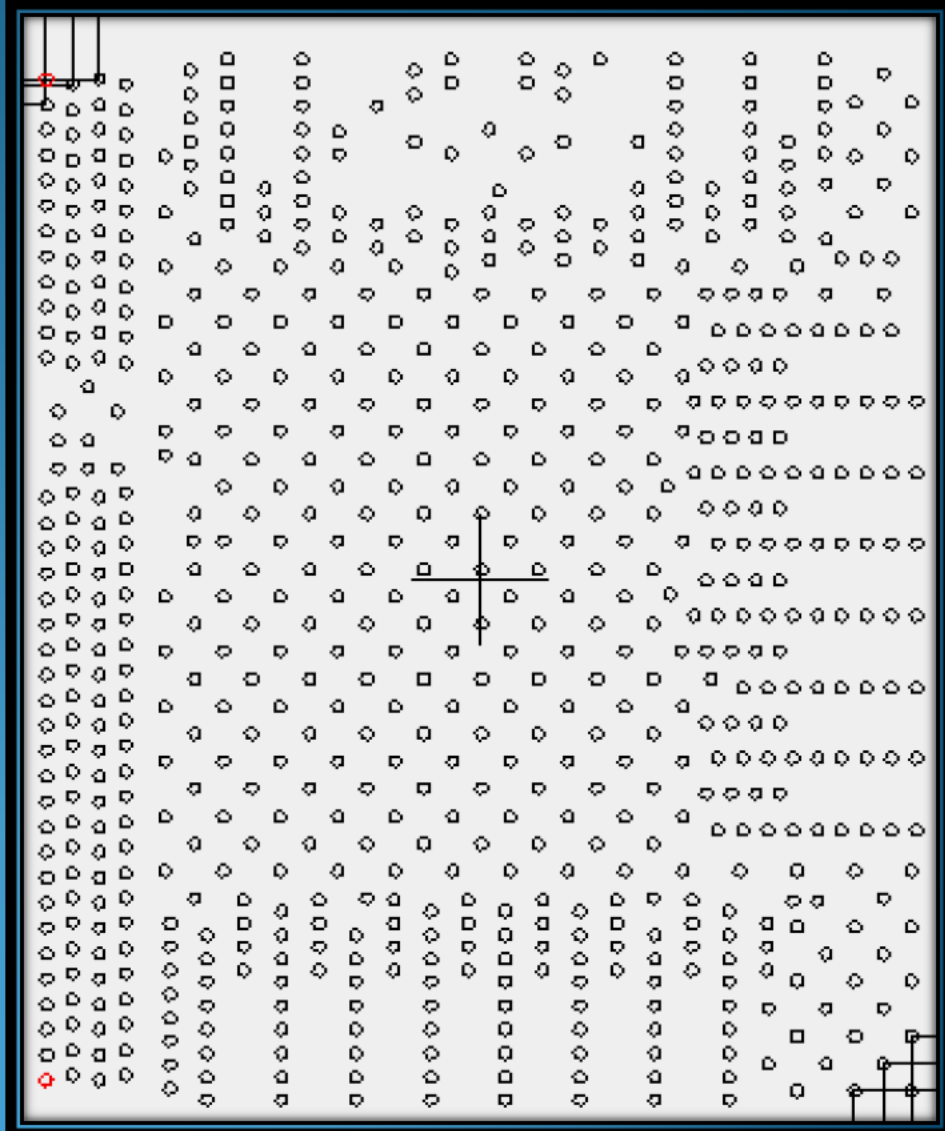
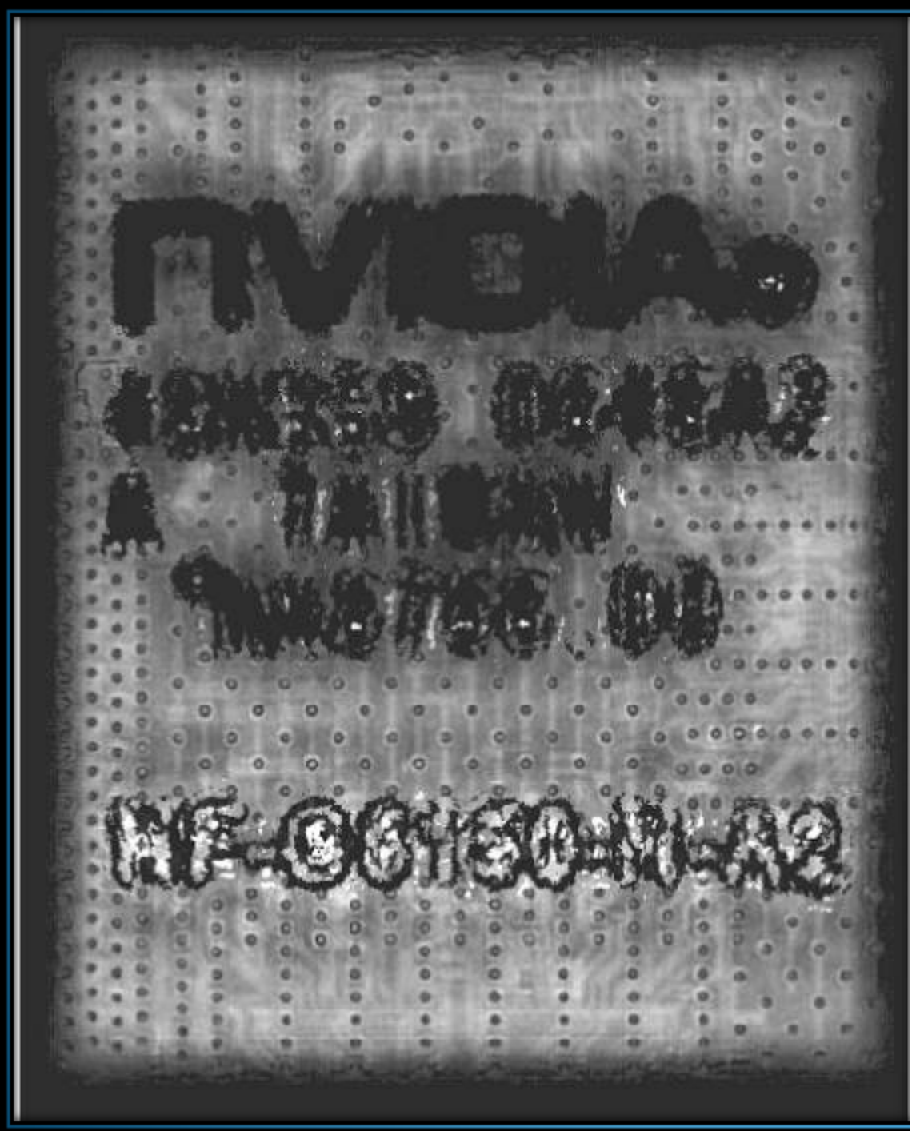
The Problem Chips

GF-G07900-GSHN-A2 [G71]	GF-G07950-GTXHN-A2 [G71]	GF-G07950-GTXHN-A2 [G71]
QDFX-2500M-HN-A2 [G71]	QDFX-3500M-HN-A2 [G71]	QD-NVS-110M-N-A3 [G72]
GF-G07200-N-A3 [G72]	GF-G07400-N-A3 [G72]	GF-G07600-H-N-B1 [G73]
GF-G07600-N-A2 [G73]	G84-602-A2 [G84]	G86-630-A2 [G86]
G86-620-A2 [G86]	G86-770-A2 [G86]	G86-920-A2 [G86]
G86-730-A2 [G86]	MCP67M-A2 [N067]	MCP67MV-A2 [N067]
NF-GSPP-100-N-A2 [NF04 (C51)]	NF-G6150-N-A2 [NF04 (C51)]	NF-G6100-N-A2 [NF04 (C51)]
NF-G6100LE-N-A2 [NF04 (C51)]	NV42	MCP67

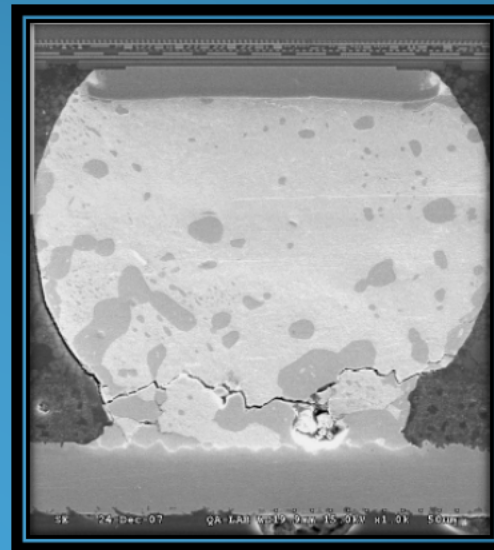
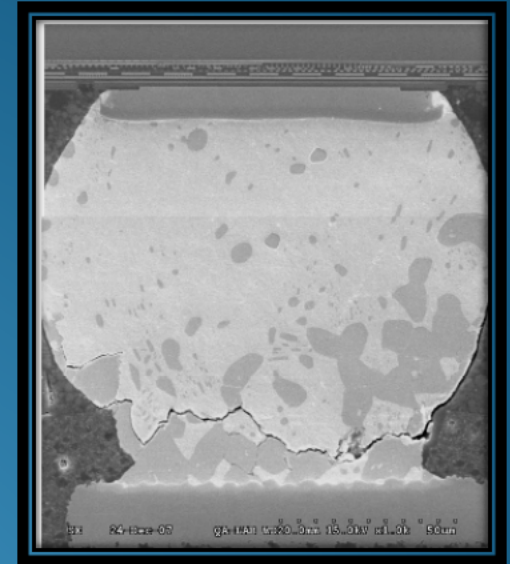
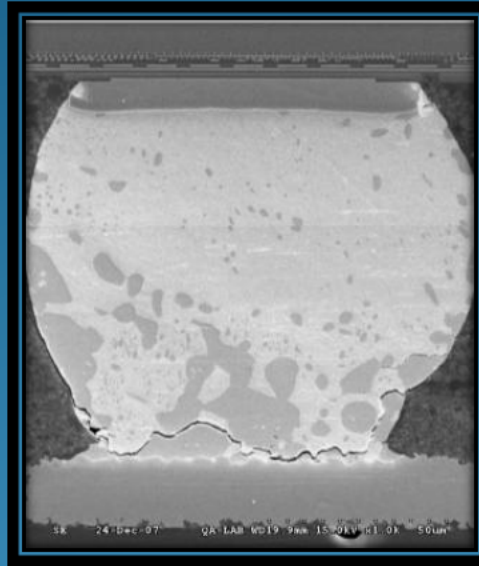
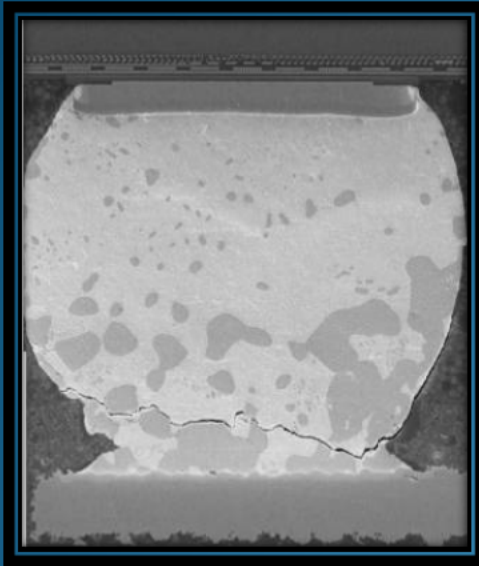
Board & Chip View



Bump Diagram



Typical Bump Cracks



Root Cause ?

“While we have not been able to determine with certainty a root cause for these failures, testing suggests –

- A weak material set of die/package combination;
- System thermal management designs; and
- Customer use patterns are contributing factors.”

Nvidia 10-Q dated November 19, 2009

Note: Since mid-2007 H-P, Quanta and Nvidia have worked with consultant DfR and Craig Hillman, Ph.D to identify the root cause – apparently without success.

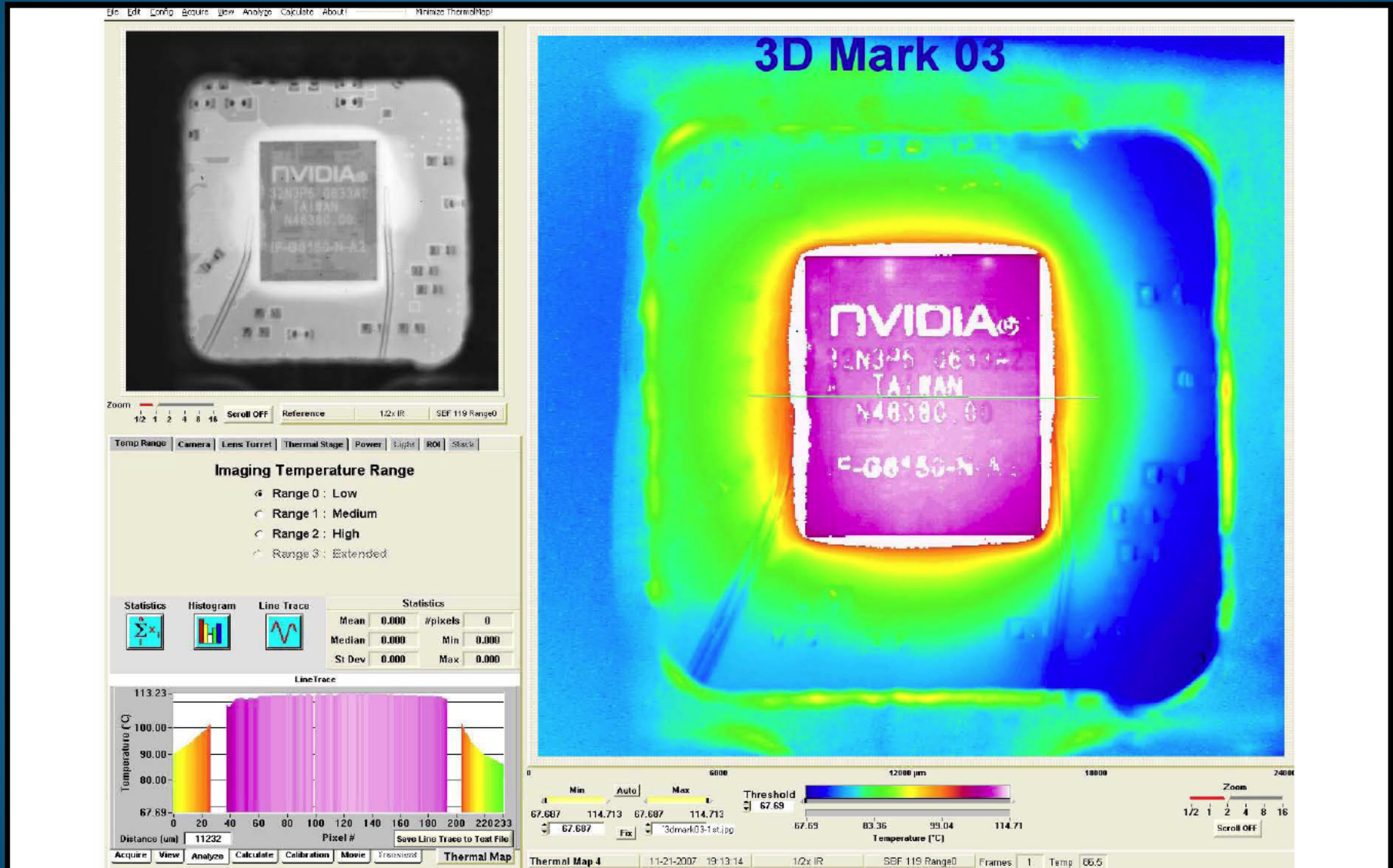
One Failure Issue

Thermal Stress

<u>Nvidia GPU Qualification Specs</u>	<u>Result</u>
TCT: -40 – 125 deg. C	Pass
HTST: 150 deg. C / 1000 hrs	Pass
HAST: 110 deg. C / 85% / 96 hrs	Pass

<u>GPU Operating Temp Rating</u>	<u>Actual</u>
90 deg. C Maximum	110+ deg. C

GPU Case Temperature



Thermal Data Collection

GPU Temp	CPU Temp	Ramp Rates
Fan On / Off	Fan Speed	Dwell Times
	Cycles	

Based On Thermal Data –

Review, Adapt & Modify as Necessary

Bump Material	Underfill	Heatsinks
BIOS	Board Design	Fan
Substrate	Heat Pipe	Materials

Claims & Lawsuits

OEM's vs. Nvidia

Consumers vs. OEM's

Consumers vs. Nvidia

Shareholders vs. Nvidia

Insurance Company vs. Nvidia

Direct Financial Impact

<u>Event / Date</u>	<u>US Dollar Cost</u>
Nvidia 8-K / July 2, 2008	196 million
Nvidia 10-Q / Nov. 19, 2009	164.5 million
TOTAL REPORTED	360.5 million

These charges reflect only Nvidia's cost of settling with and supporting its customers' extended warranty programs to manage the product returns caused by the defective GPU's.

Indirect Financial Impact

<u>Event</u>	<u>US Dollar Cost (Est.)</u>
Attorneys' Fees & Costs	10 million
Consumer Litigation	100 million
Shareholder Litigation	100 million
TOTAL (Est.)	210 million
GRAND TOTAL	570.5 MILLION

The Consumer and Shareholder Litigation is ongoing, but the parties are engaged in settlement discussions. The above estimates are conservative. Insurance recoveries have offset some of Nvidia's costs.

Conclusions

- ❖ PHM Permits Accelerated “Failure Analysis”
- ❖ Early Detection Leads To Early Solution
- ❖ Effective PHM Reduces Scale Of Epidemic Failure
- ❖ Cost of PHM Is Outweighed By Risk Reduction Benefit

THANK YOU