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Conversion to Non-Halogenated Flame Retardants in Electronics

Bob Pfahl

NEPCON
Shanghai
April 22, 2009

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Outline

- Why Eliminate Halogenated Flame Retardants (HFR)
  - iNEMI 2009 Environmentally Conscious Electronics Roadmap
  - OEM input
- Current Status by Market
- Consortial Development Programs to Prepare for Conversion
  - EPA
  - HDPUG
  - iNEMI
- Expected Time Line
- Summary and Conclusions

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Why Eliminate Halogenated Flame Retardants

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2009 iNEMI Roadmap Trend Analysis

- **To produce environmentally-conscious electronics industry activities must continue to keep pace with:**
  - **Continuing emergence of material restrictions**
  - **Energy efficiency requirements and renewable energy**
  - **End-of life requirements**
  - **Holistic Eco-design requirements**
  - **Sustainable business practices**

- **As many of these issues are shared by industry, it's best to work together!**

Materials

Short Term Needs - Identified in 2009 iNEMI Roadmap

- **A strategy and action plan to facilitate low risk conversion of high-reliability applications to Pb-Free solders**
- **Prepare for possibility of additional substance restrictions under RoHS and/or REACH (HBCDD, phthalates)**
- **Proactive programs to facilitate low risk conversion to halogenated flame retardant (HFR) - free and PVC-free material alternatives**
  - **The environmental concerns with PCB's containing halogenated flame retardants is that toxic dioxins may be produced during burning.**

- Dell is committed to eliminating remaining uses of BFR and PVC – but has no set timeline
- Dell values projects such as the iNEMI BFR-free Leadership project – it is best for industry to collaborate on common solutions, reduces costs and burdens for all in industry
- Dell has committed resources to the BFR-free Leadership project and we would like to see key suppliers do the same.
- Dell emphasis on BFR and PVC-free is in client and consumer products, not enterprise products. Our preference is to focus on Notebook and Desktop products exclusively, or at least as the first priority.

Current Status and Growth Projections 增长的预测

MARKET AND GROWTH OF RIGID LAMINATE

Standard FR4

Area (Mm²)	2006	2007	2012	Value CAAGR ('07-'12)
FR 4 Total	256.8	284.4	430.3	8.6%
Mobile Phone		14.7	21.6	8.0%
Notebook		18.0	39.1	16.7%
Desktop		35.3	40.4	2.7%
Other (Server, consumer)		216.4	329.2	8.8%

HFR-free

Area (Mm²)	2006	2007	2012	Value CAAGR ('07-'12)
HFR-free FR 4 Total	11.4	20.9	60.9	23.9%
Mobile Phone		7.5	21.4	23.4%
Notebook		3.9	13.8	29.0%
Desktop		1.8	5.2	23.6%
Other (Server, consumer)		7.7	20.5	21.6%

CAAGR: Compound aggregate annual growth rate
年复合增长率

PRISMARK

If HFR-free supplants halogenated FR4, CAAGR grows to almost 70%

(assuming HF FR4 reaches FR4 volumes in '12)

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Consortial Development Programs

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Industry BFR/PVC-Free Projects

Project Title	Project Chair	Key Objectives	Link for More Information	Expected Completion Date
HDPUG – Reliability of BFR/PVC-Free Notebook PWBs	Dell Wistron ITRI	Supply chain assessment of 100% BFR/PVC-Free Notebook PWBs (board + components) and reliability assessment	www.hdpug.org	Results expected in late 2009
HDPUG – BFR/PVC-Free Cables	Dell	Assess a broad range of BFR/PVC-Free materials for different cable and wire applications.	www.hdpug.org	Results and publication expected by early 2010
IPC – Halogen-Free Subcommittee (J-Std 709)	Intel/Dell	Develop a new BFR/PVC-Free standard (define maximum concentration values for halogens across a variety of applications, not just PCBs)	www.ipc.com	Re-ballot in summer 2009
US EPA - Flame Retardants in Printed Circuit Boards	EPA	Identify and evaluate commercially available flame retardants in FR-4 printed circuit boards and their environmental, human health and safety and environmental fate aspects.	http://www.epa.gov/dfe/pubs/projects/pcb/index.htm	Finalize report and publicize results in mid-2009
iNEMI - HFR-Free PCB Material Evaluation	Intel	Identify technology readiness, supply capability and standards development opportunities for “halogen-free” alternatives to conventional printed wiring board materials	www.inemi.org	Project completed in 2008 and presented at SMTAI

Additional Projects in iNEMI HFR-Free Portfolio

Completed project (shown on previous foil)

- HFR-Free PCB Material Evaluation

Active projects

- **HFR-Free High Reliability PCB**

New initiatives

- **PVC Alternative Initiative**
- **HFR-Free Leadership Initiative**
  - **HFR-Free PCB Materials**
  - **HFR-Free Signal Integrity**

HFR-Free PCB Material Evaluation

Purpose: **Identify technology readiness, supply capability and standards development opportunities for "halogen-free" alternatives to conventional printed wiring board materials**

Goals of the Project:

- **Identify commercially viable materials**
- **Benchmark past work and identify critical knowledge gaps**
- **Design test vehicles and test methodologies**
- **Leveraging prior investigations, carry out the necessary testing to characterize viable materials**
- **Analyze results**
- **Publish recommendations**

Results and Benefits:

- **Determined the critical tests for evaluating halogen-free laminate materials**
- **Showed industry the general benefits and limitations of non-bromine based flame retardant laminates**
- **Participants obtained detailed knowledge of each laminate**

Material Selection Summary 材料选择小结

Mat'l	Dk	Df	H_2O Absorb	Tg	CTE	Flex	Td	T260/ Cu	T288/ Cu	Peel Strength	IST	CAF	UL94 V0	Shock	Vibe	Temp Cycle	Cold Ball Pull
A																	
B																	
C																	
D																	
E																	
F																	
G																	
H																	
I																	
J																	
K																	

Color Code

- Equal to or better than FR4 (No issue)
- Marginal vs FR4 (Issue not clear)
- Worse than FR4 (Clear Issue)
- No Data

Derived from iNEMI WG data

Material selection can matter!

HFR-Free PCB Material Evaluation Project Members

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BFR-Free High Reliability Project

Project Leader

Steve Tisdale,

Intel Corporation

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BFR-Free High Reliability Project

Purpose: **Identify technology readiness, supply capability and reliability characteristics for "BFR-free" alternatives to conventional printed wiring board materials and printed wiring board assemblies, based on the high-reliability market segment requirements (large, thick, boards).**

Goals of the Project:

- **Identify commercially viable materials**
- **Benchmark past work and identify critical knowledge gaps**
- **Build on industry knowledge and capability, including the iNEMI BFR-Free PCB Material Evaluation Project**
- **Design test vehicles and test methodologies**
- **Leveraging prior investigations, carry out the necessary testing to characterize viable materials**
- **Analyze results**
- **Publish recommendations**

Status:

- **Currently in the testing phase**
- **Completion of Project in Q1 2010**

BFR-Free High Reliability Project Members

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iNEMI PVC Alternatives Project

Project Leader

Scott O'Connell, Dell

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Background

- 7 of the top 10 global PC manufacturers have set goals to phase-out PVC, where viable alternatives are identified
  - These 7 manufacturers represent over 50% of the worldwide market share for PCs (per IDC WW Quarterly PC Tracker for Q1-2008)
- PVC alternatives project was proposed at the September 2008 iNEMI Sustainability Summit, approved by the Board of Directors
- The project will focus on 2 areas:
  - Phase 1 - Cradle-to-grave Life cycle assessment (LCA) comparing PVC versus PVC-free cables
  - Phase 2 - Technical evaluation of PVC alternatives – electrical, mechanical, safety

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HFR-Free Technology Leadership Program

Program Leader
Martin Rausch,
Intel Corporation

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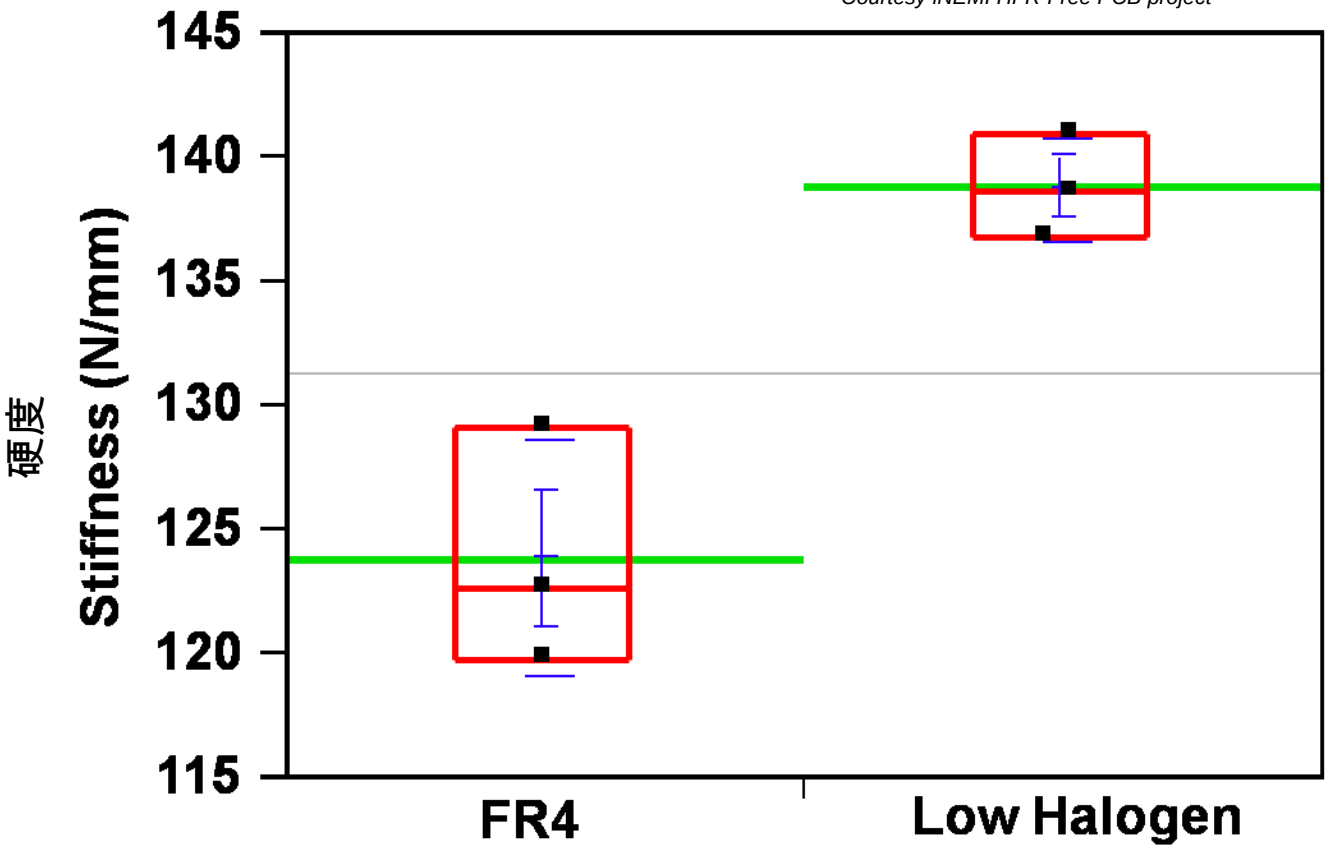
Firms Participating in the Program Development

Solder Joint Reliability (SJR, 焊接可靠性)

Courtesy iNEMI HFR-Free PCB project

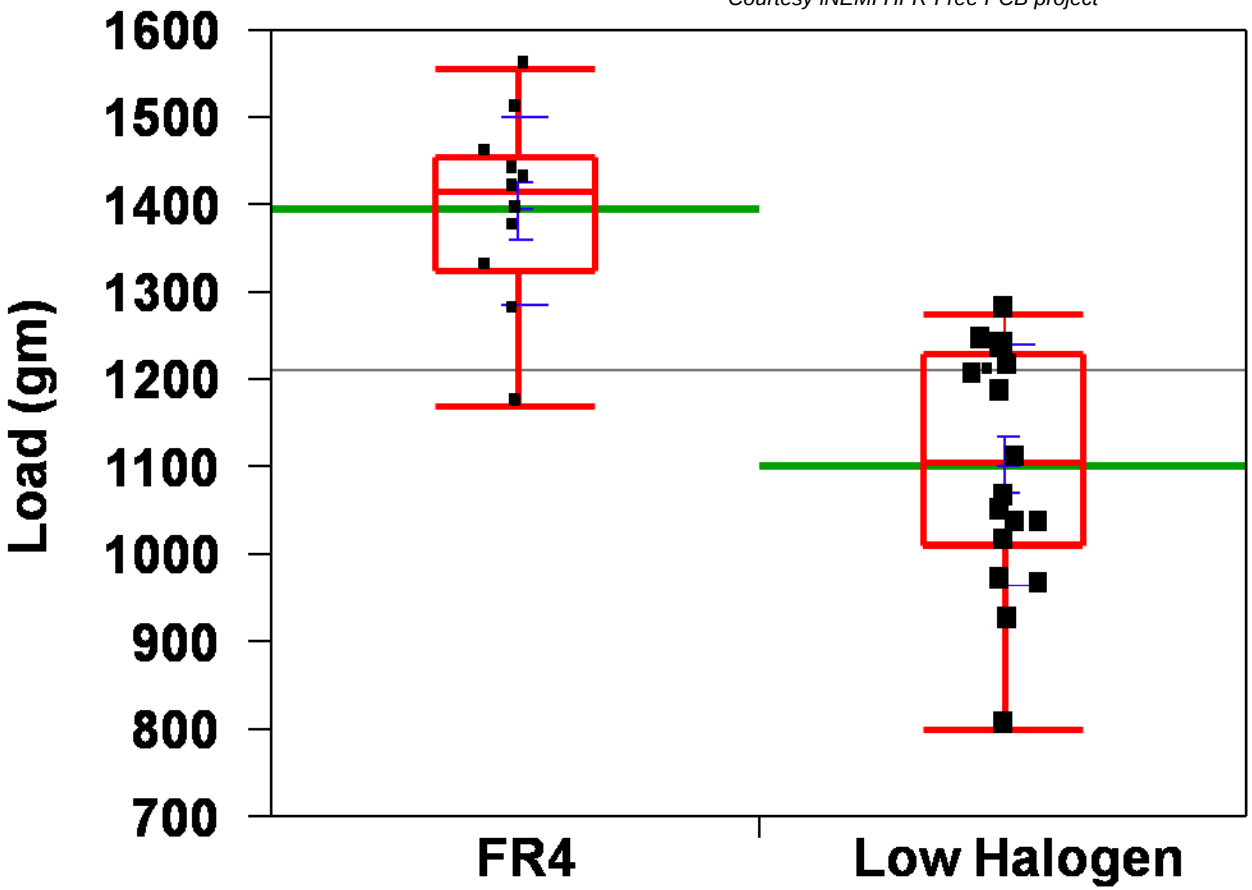


HF is ~10% stiffer
(8 layer .062” board)

Lower mech stress limits
(higher SJR risk)

Pad Crater Performance 焊盘剥落特性

Courtesy iNEMI HFR-Free PCB project

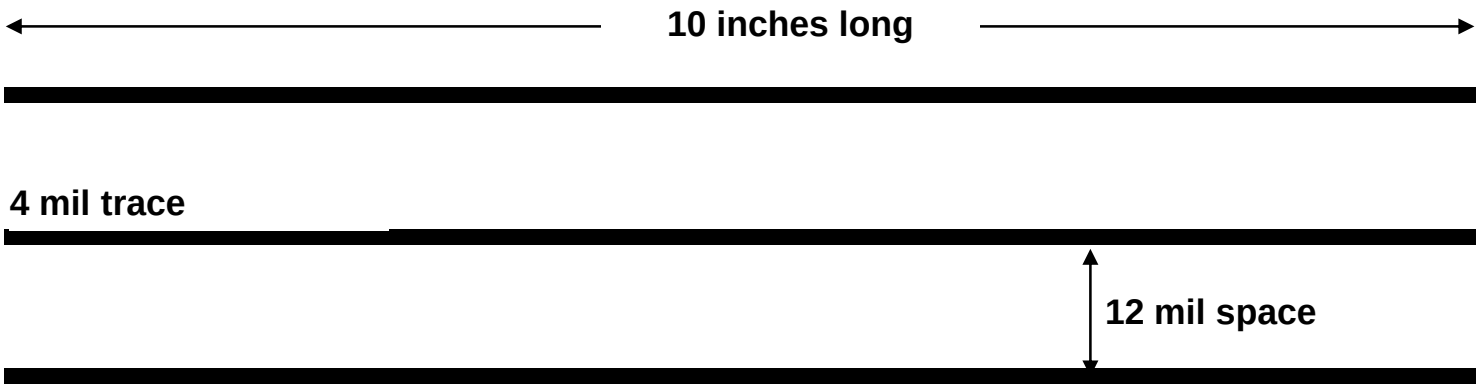


HF has ~20% worse cold ball pull performance

Increase pad cratering
(higher rework risk)

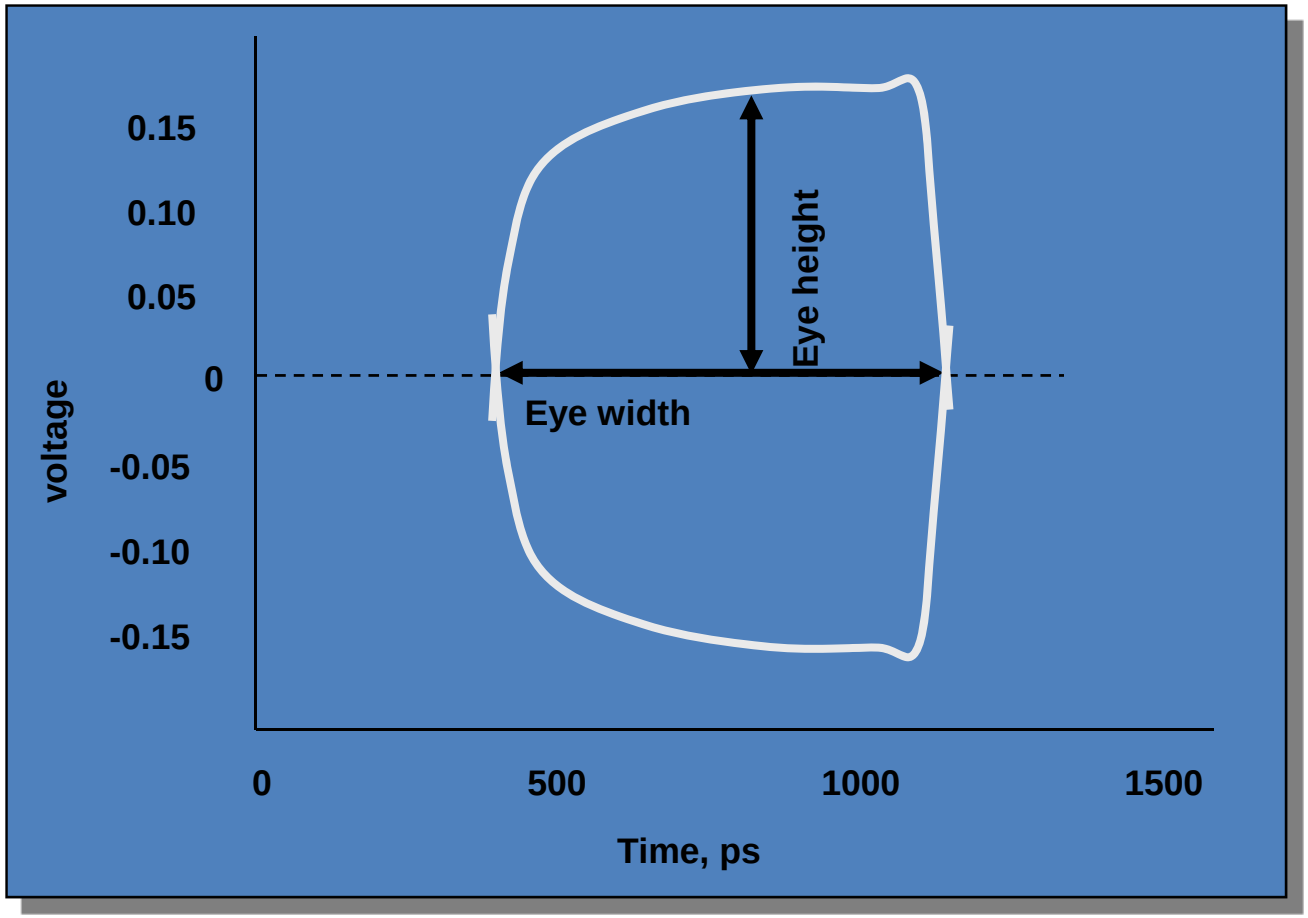
Some parameters will have less margin!

Dk Impact on High Speed Signaling 高速信号



- Simulation Conditions 模拟条件
  - 3 single ended traces
  - Constant impedance (50Ω)
  - No discontinuities (no vias, no connectors)

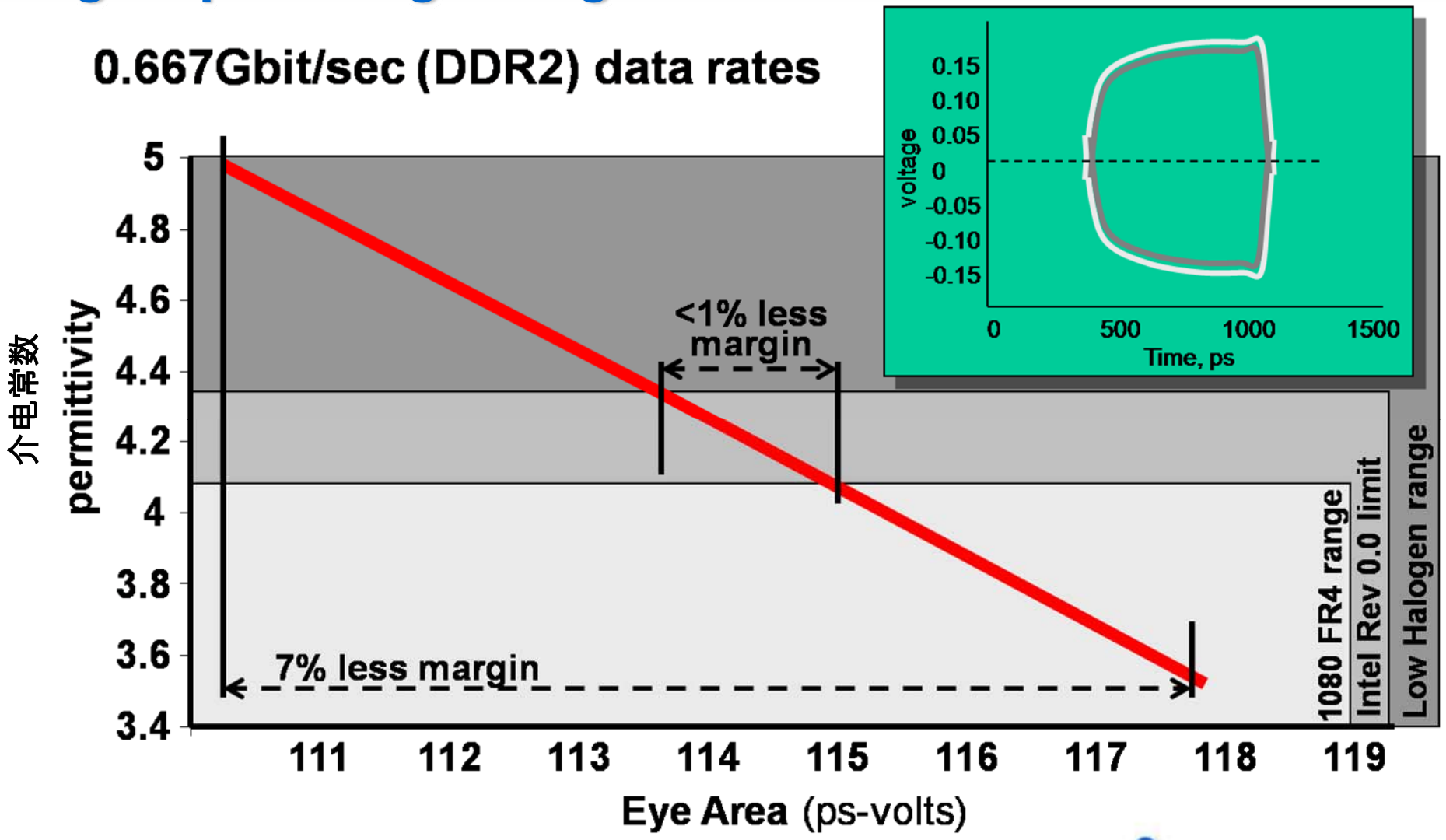
High Speed Signaling 高速信号



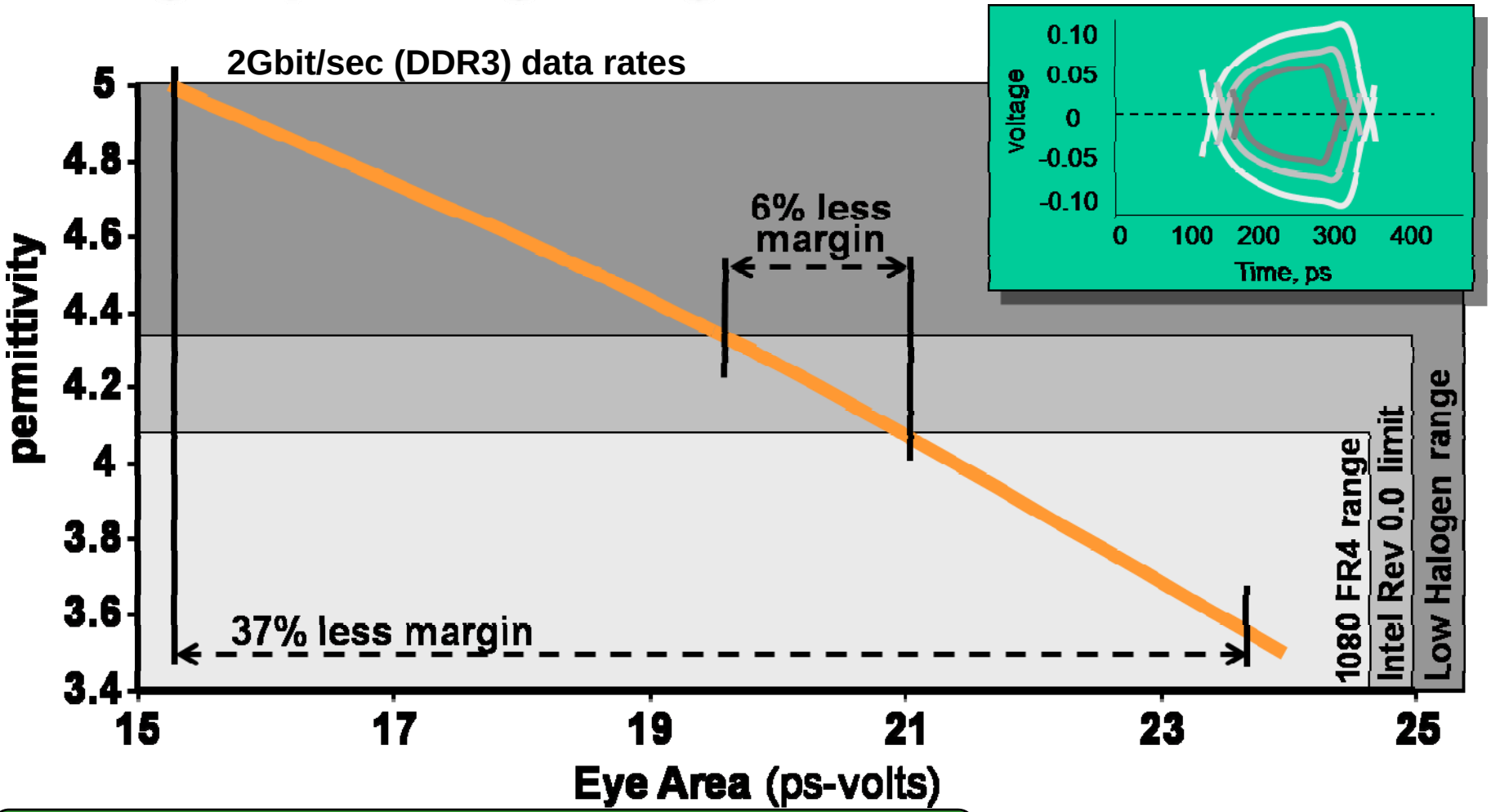
Eye Area = eye width x eye height

解释：眼图面积的大小表明有用信号和干扰及漂移的相对强弱

High Speed Signaling



High Speed Signaling



Emerging buses are more sensitive!
Timeline 2011-2012

新的总线要求更敏感

iNEMI HFR-Free Leadership Program Consortium Objectives 联盟目标

- **Identify technology readiness, supply chain capability, and reliability characteristics for "BFR-free" alternatives to conventional printed circuit board materials and assemblies 查看技术是否就绪，产业链的能力以及无溴化阻燃剂替代品在常规PCB材料和装配中的可靠性能**
  - **Spans electrical and mechanical properties包括电和机械属性**
  - **Includes assessing if board/system design modifications can overcome material property limitations 评估板/系统设计的修改是否能弥补材料属性的限制**
- **Define technology limits for BFR-free materials across all market segments 定义各产品门类对无BFR材料的技术性能的限制要求**
  - **Initial focus is on client platforms (desktop, notebook)**
  - **Goal is to drive laminate supplier slash sheet content**

Summary of Program: A Systems Approach

- A broad transition to halogen-free materials could become quite disruptive 大范围地转为无卤材料可能有破坏性的影响
- Existing halogen-free materials are worse than existing brominated FR4 on several key parameters 就几个关键参数而言，目前的无卤材料较溴化FR4差
- This effort is focused on driving tradeoffs across design, fabrication, and materials to derive solutions 该项目的重点是要使设计、生产和材料相互折衷互补来解决问题

HFR-Free Technology Leadership

EMS/ODM Participants

Company	Web Site	Type
Celestica	**www.celestica.com**	**EMS/ODM**
Compal Electronics	www.compal.com	EMS/ODM
Flextronics	**www.tw.flextronics.com**	**EMS/ODM**
Foxconn	**www.foxconn.com**	**EMS/ODM**
Inventec	www.inventec.com	EMS/ODM
Micro-Star International	www.msi.com.tw	EMS/ODM
Pegatron	www.pegatroncorp.com	EMS/ODM
Quanta Computer	www.quantatw.com	EMS/ODM
Sanmina-SCI	**www.sanmina-sci.com**	**EMS/ODM**
STATS ChipPAC	**www.statschippac.com**	**EMS/ODM**
Universal Scientific Industrial	www.usi.com.tw	EMS/ODM
Wistron	www.wistron.com	EMS/ODM

HFR-Free Technology Leadership

PCB Manufacturer Participants

Company	Web Site	Type
Compeq Mfg. Co.	www.compeq.com.tw	PCB
Elec & Eltek	www.eleceltek.com	PCB
Gold Circuit Electronics	www.gce.com.tw	PCB
HannStarBoard	www.hannstarboard.com	PCB
Ibiden	**www.ibiden.com**	**PCB**
NanYa PCB	www.nanyapcb.com.tw	PCB
Sanmina-SCI	**www.sanmina-sci.com**	**EMS/ODM**
Tripod Technology Corp.	www.tripod-tech.com	PCB
WUS Printed Circuit	www.wuspc.com	PCB

SANMINA-SCI

HFR-Free Technology Leadership

Laminate Supplier Participants

Company	Web Site	Type
Doosan Electro-Materials	**www.doosan.com**	**LAM**
Elite Material Co.	**www.emctw.com**	**LAM**
Grace T.H.W.	www.graceelectron.com	LAM
Hitachi Chemical Co.	www.hitachi-chemical.com	LAM
Isola	www.isola-group.com	LAM
ITEQ Corporation	**www.iteq.com.tw**	**LAM**
Nan Ya Plastics	**www.npc.com.tw**	**LAM**
Panasonic Electric Works	www.panasonic-denko.co.jp	LAM
Shengyi Sci. Tech Co.	**www.syst.com.cn**	**LAM**
TUC (Taiwan Union Technology Corp)	www.tuc.com.tw	LAM

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Time Line

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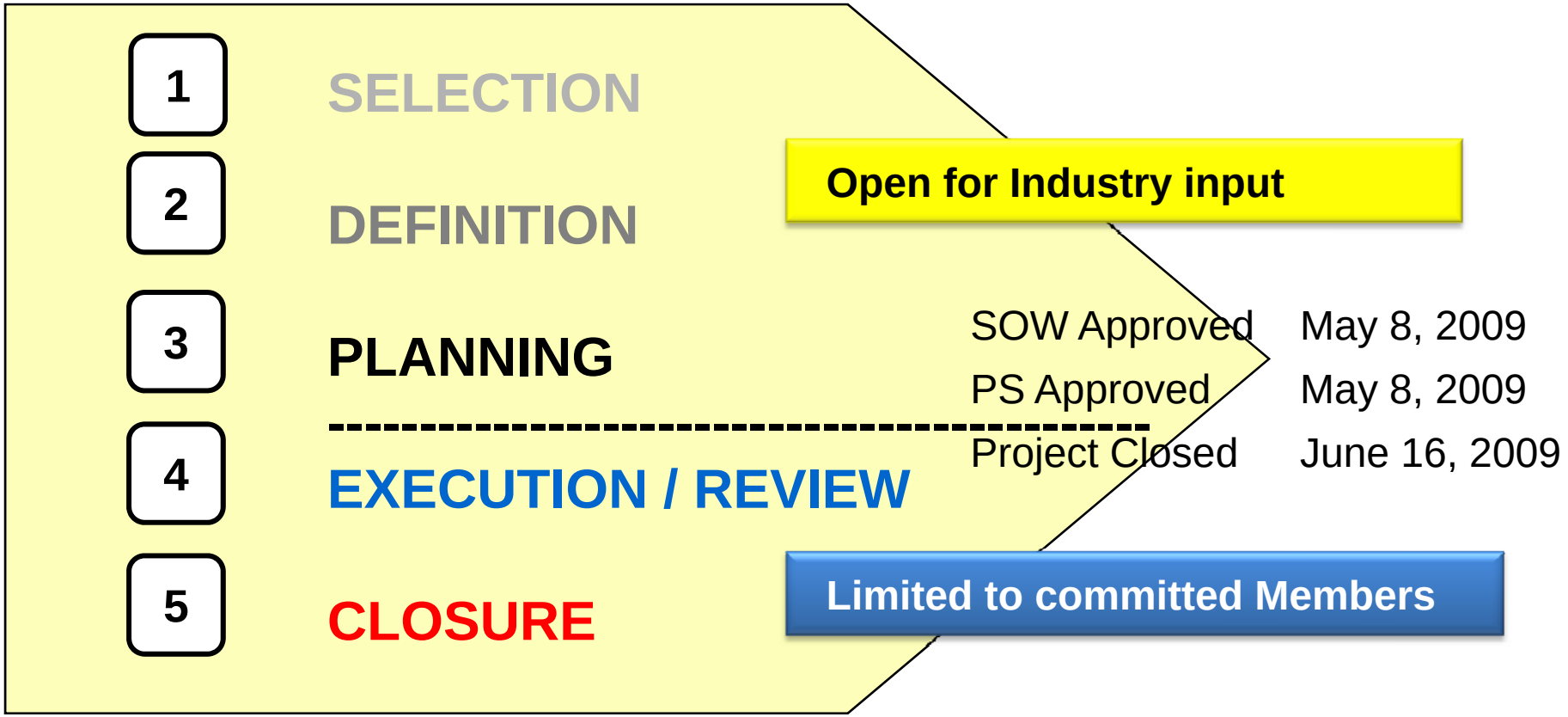
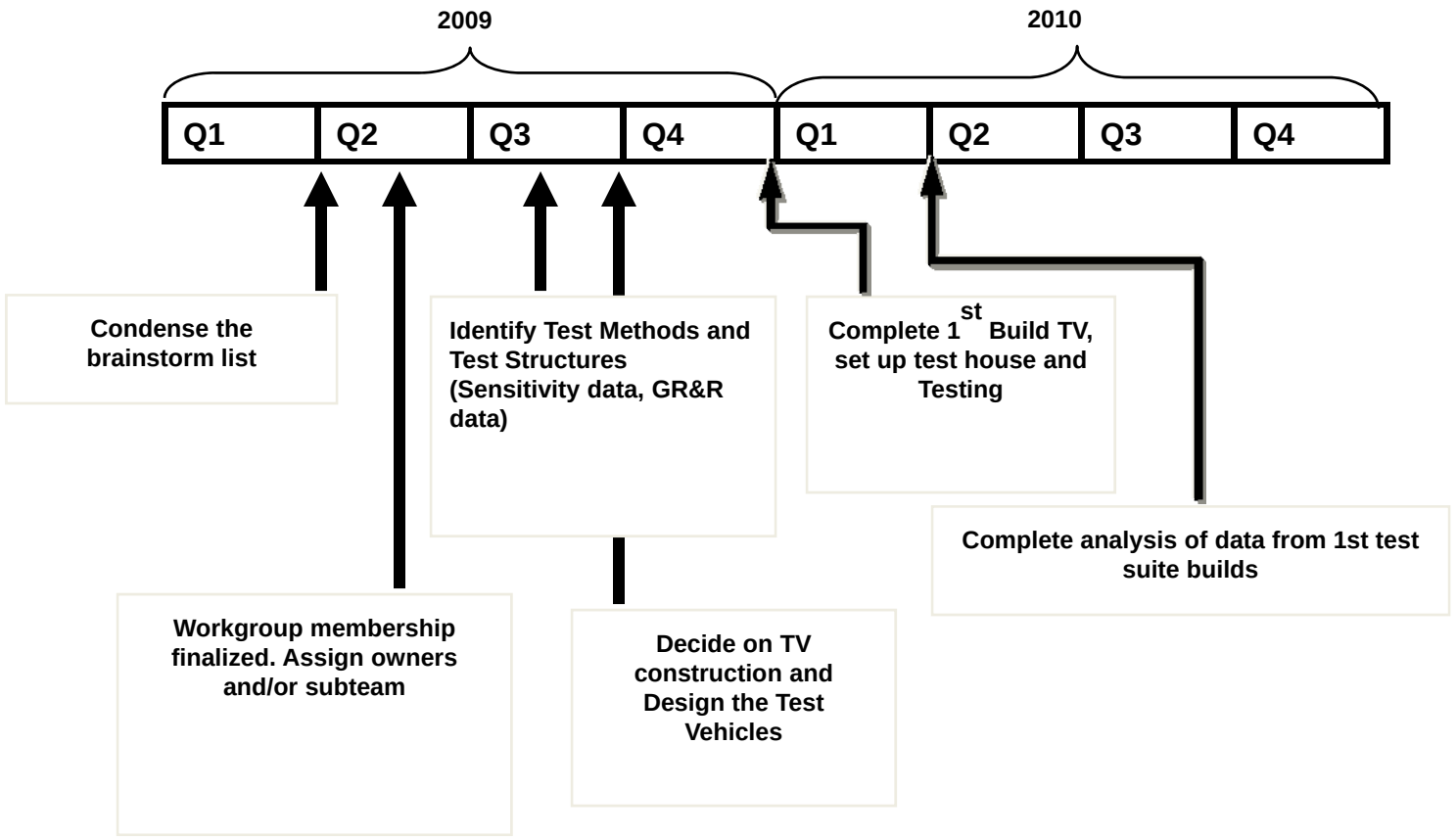
Starting Date for Program



Proposed Timeline for Program 时间表



Emerging buses are more sensitive!
Timeline 2011-2012

Closing Thoughts

- **Conversion to Pb-Free Solders has demonstrated:**
  - **The need to select and develop the technology and verify its reliability**
  - **The need for the entire supply chain to be involved**
    - **Segments driving the change**
    - **Segments that may be impacted by the change**
  - **The need to develop a conversion time line for each class of products**
- **The Voluntary adoption of HFR-Free Technology will require:**
  - **All of the above**
  - **Verifying the design and electrical performance**
  - **Each Class of Products working with its supply chain to insure successful planning and execution of the conversion**

www.inemi.org

Email contacts:

Jim McElroy

jmcelroy@inemi.org

Bob Pfahl

bob.pfahl@inemi.org

Haley Fu - Asia

haley.fu@inemi.org

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