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ASTC HDD Roadmap Process

Roadmap Planning Committee: J. Best, G. Bertero, R. New, T. Chang

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Roadmap Goals

- Provide a likely direction to member companies and associates on the industry path for achieving higher areal densities in HDD products

- Early identification of major technology gaps to roadmap closure and sponsoring of the necessary research and development to eliminate them

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Roadmap Approach

- Develop strawman system roadmaps for major technology alternatives
  - Likely first product introduction time and density
  - Subsequent generations to 4X density (>= 4 Tb/sq in)
  - Sufficient detail for discussion with component groups to evaluate technical alternatives and identify major technical barriers
- Develop roadmaps for fundamental technologies to support the system roadmaps
  - Include tools as well as heads, disks, tribology, servo, signal processing

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Roadmap Taxonomy

- Overall
  - Areal density vs. time
  - Range of fundamental parameters: tpi, bpi, spacing, datarate
  - Summary outlook for solid state memory density/cost vs. time
- System Technologies
  - PMR w/ & w/o SMR
  - BPMR
  - HAMR
  - TDMR
  - MAMR
- Core Technologies

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Roadmap Activity Organization

- Overall guidance to be provided by roadmap co-leaders
  - J. Best, G, Bertero, R. New, T. Chang
- System strawman roadmaps
  - Systems leaders and modelers
    - PMR: T. Chang*, R. Wood, E. Champion
    - BPR: T. Albrecht*, B. Clark, R. van de Veerdonk, R. Victora, S. Greaves
    - HAMR: M. Gibbons*, T. Rausch, B. Stipe, J. Thiele, J. Zhu
    - TDMR: F. Erden*, R. Wood,
    - MAMR: M. Mallary*, P. van der Heijden ,J. Zhu
- Technology elements roadmap
  - Selected company functional leads to coordinate efforts (all need to pitch in)
    - Head: Tim Rausch, Disk: Dieter Weller, Signal processing: Greg Burd, Servo: Guaoxiao Guo, Head Disk Interface: Yiao-Tee Hsia

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DRAFT: to be defined by PMR system leads

PMR

- Extendibility
  - What is consensus view on density limit?
  - With and without shingled write
    - Is shingled write short term solutions, or will it be carried to all future technologies
      - Two classes of drives?
  - TDMR option?

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DRAFT: to be defined by TDMR system leads

TDMR

- PMR option only, or for BPM and/or HAMR?
- How much ultimate areal density benefit does TDMR provide?
- What is effective native block size for TDMR device as a function of areal density and time?
  - HDD architecture implications
  - HDD application shift to primarily archive, backup, streaming, data access, with reduced performance requirements on random write?
  - Flash on drive? Flash on system with HDD?

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DRAFT: to be defined by BPMR system leads

BPMR

- At what density and time frame can it realistically be introduced into products?
- How far can patterning density go without self-assembly?
- Basic technology and tool strategies for:
  - Master generation
  - Self assembly resolution enhancement
  - Pattern transfer – imprint
  - Etch
  - Planarization
- Density limits of various technology options
- Media magnetic material requirements

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DRAFT: to be defined by HAMR system leads

HAMR

- At what density and time frame can it realistically be introduced into products?
- Disk magnetic material options vs. density limits
- Roadmap for small grain HAMR material
  - Known roadmap vs. breakthroughs required
- Roadmap for light generation
- Roadmap for light delivery
  - Density vs. spot size vs. efficiency
  - Basic design and fabrication approach
- System reliability/Head Disk Interface

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DRAFT: to be defined by systems and head function leads

Heads

- Roadmap for lithography
  - Tools and basic process for head vs. density
  - Tools and basic process for HAMR NFT vs. density
- Sensitivity, noise roadmap
- Basic technology roadmap to support read parameters
  - Limits of TMR
  - CPP GMR
    - Materials structure roadmap
  - Other architectures
  - Requirements for depositions systems
- Fly height control roadmap

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Other Technology Elements

- Disk, Signal Processing, Tribology, Servo
  - Systems and Functional leaders to develop list of key questions and roadmap elements for each area

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Timetable

2/1/2011	Roadmap Kickoff
	Strawman proposal development Functional outline and question development
3/15/2011	Strawman System Proposal Drafts Complete
	Functional details development Revise and update strawman system roadmaps
4/30/2011	Functional Groups Drafts Complete
6/30/2011	Final Roadmap Report Complete
1/31/2012	Kickoff annual update
3/31/2012	Complete update

Multiple conference calls and one or two physical meetings to communicate and refine system proposals, function details, and final draft

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