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An Introduction to Common RAID Disk Data Format (DDF) Standard

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Agenda

- Abstract
- Overall Problem to Be Solved
- DDF Overview
  - What DDF Is
  - What DDF Is Not
  - What Part of the Overall Problem Does DDF Solve
- Use Cases
- Specification Development Status

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Abstract

- Introduction to Common RAID Disk Data Format (DDF) Standard
  - This session is intended to be an introduction to the Common RAID Disk Data Format (DDF) standard. The standard was created to increase interoperability between RAID solutions by enabling data-in-place migration. The tutorial describes the various problems the DDF standard addresses. It also describes the technical implementation of the DDF structure. The tutorial presents several examples of problems the DDF solves. It also gives the status of specification development and the certification test program.
  - The session is appropriate for both developers and end users of RAID products.

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Information on the Institute and an online version of the tutorial cross reference is available at http://www.snia.org/tech_center/institute/

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How many RAID solutions do you have?

- Software (SW)
  - Server O/S or Application
- Hardware (HW)
  - Embedded RAID – **R**AID **O**n **M**other**B**oard (ROMB)
  - RAID Controller – Raid on Ancillary Board
    - PCI-X, PCI-E, Other?
- Intelligent Storage Array
  - Modular or Monolithic
  - RAID functionality built into storage controllers

Are you feeling these pains?

- Disk drives typically can't be moved between dissimilar RAID solutions without migrating data (typically tape backup/restore)
  - SW ⇔ HW , ROMB ⇔ Raid Controller, SW ⇔ SW, ROMB ⇔ ROMB, Raid Controller ⇔ Raid Controller, Present RAID ⇔ Future Raid (Disk Based Backup)
- Extensive server/application or DR restoration times due to added complexity of data restoration/migration
  - When extended HW outage requires use of a different server to restore application/service
  - Is the same RAID solution available on the new resource?

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Are you feeling these pains?

- Limited scalability of smaller server systems
  - Performance or growth forces DATA repository from inside server to external JBOD configuration
  - Drives moving from SW or ROMB to Raid Controller solution
- Reusable resources discarded due to TCO impact of required re-initialization, setup, formatting and data migration steps
  - Difficult to remove serviceable RAID disks from retired/dead hardware and reuse in different/newer configurations without significant touch labor

End User Pain Points

- *If you migrate your disks from one RAID vendor to another the format/disks will be unrecognized and perceived blank!*
  - Disk signatures may be written to disk destroying the data
  - Administrators may inadvertently create a new RAID array over existing data
  - Result: Data Loss could occur

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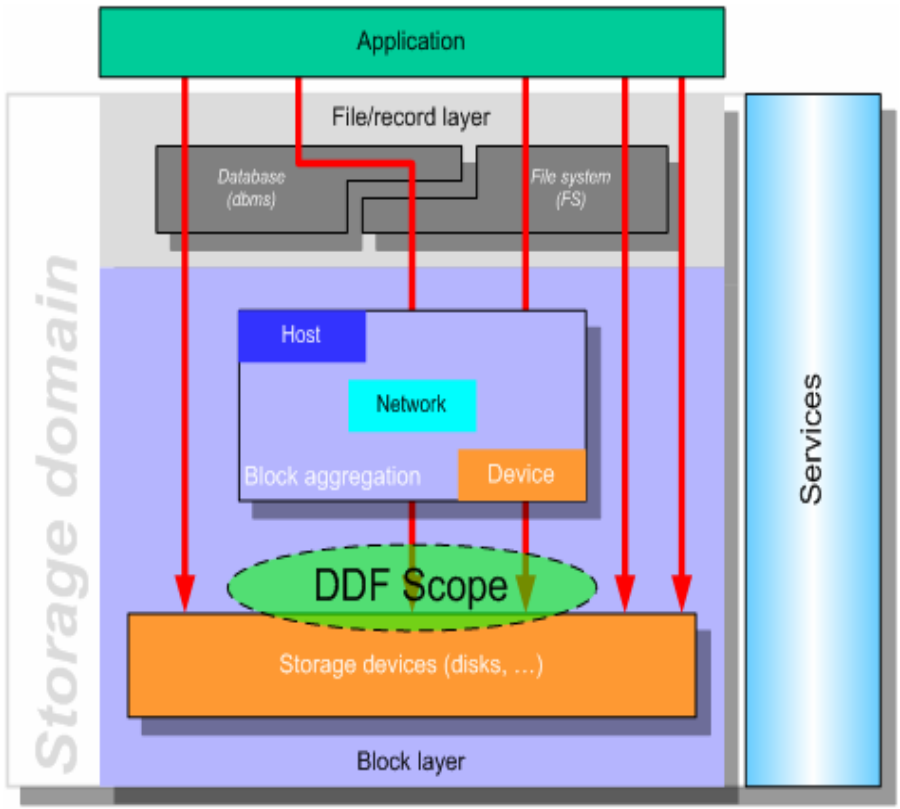
The Common RAID Data Disk Format (DDF) is:

- A data structure describing RAID configuration
  - Stored on each disk in a RAID group
  - Describes how data is distributed in a RAID group
  - Allows detection of non-compatible configurations
- Targeted at server based RAID, HW and SW
  - May not be appropriate for high-end external RAID solutions
- Benefits:
  - Increases interoperability
  - Decreases development time
  - Decreases cost
  - Decreases complexity
  - Increases choice
- Under development in the SNIA's DDF Technical Working Group

Scope

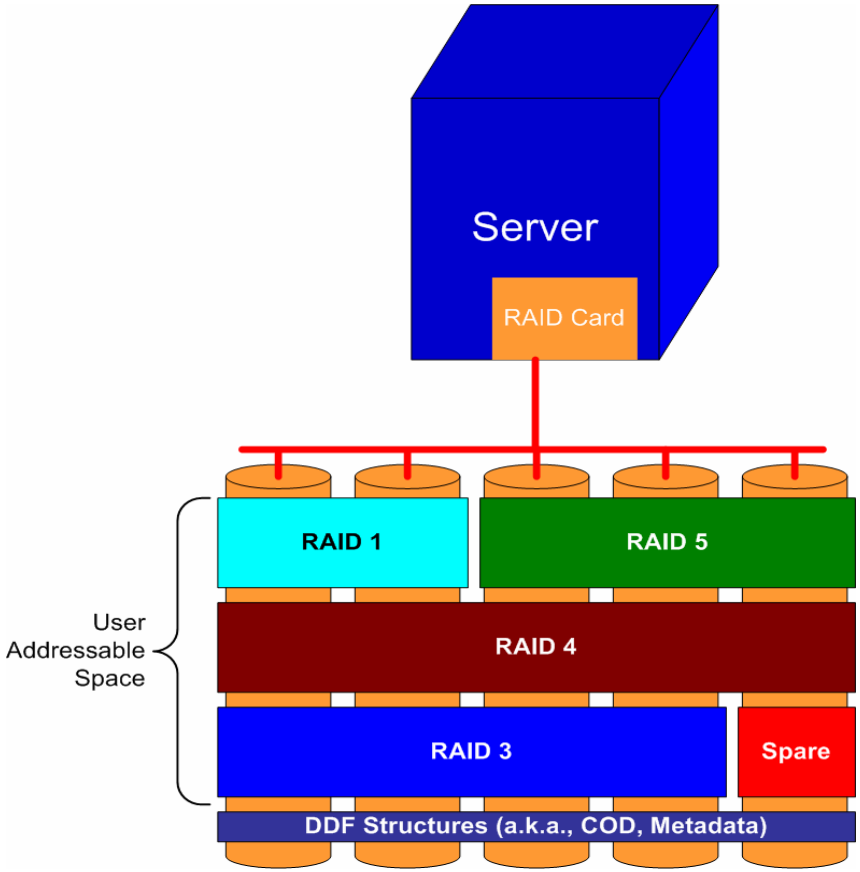
- DDF - Data structures describing how data is distributed across the drives in a RAID array
- Scope limited to interface between Block Aggregation implementation and Storage Devices
- Does not standardize operating system/RAID controller interface or create a single driver



SNIA Shared Storage Model

Example

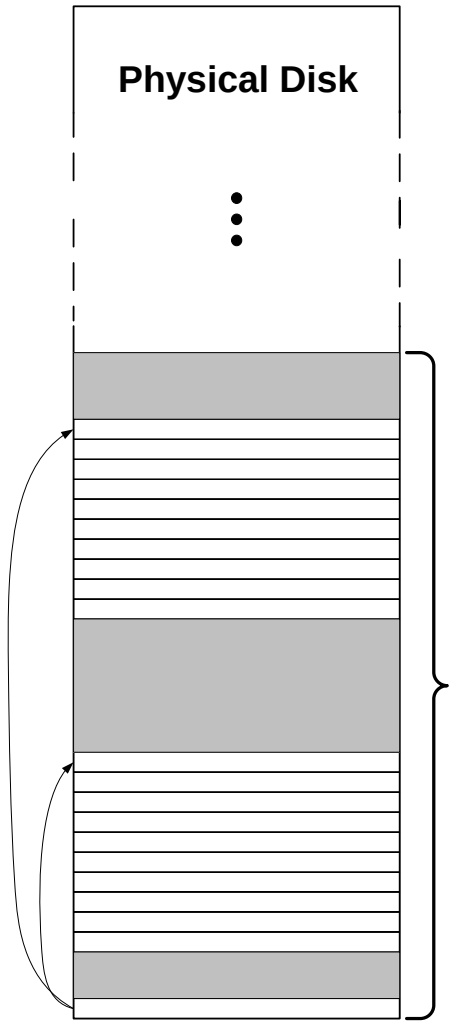
- DDF – Disk Data Format
  - A.k.a. Configuration on Disk (COD)
  - A.k.a. Metadata
- DDF structures reside on every disk behind a RAID controller
- Collectively, the DDF structures on the disks define how data is distributed in a RAID array



Note: Hardware colors and shapes defined by SNIA Shared Storage Model

DDF Described Features

- Controller Data
- Physical Drive Data (e.g., Online state)
- Virtual Drive Data (e.g., Initialization state)
- Virtual Drive Configuration
  - RAID Level (e.g., 0, 1, 3, 4, 5)
  - Secondary RAID Level (e.g., 10, 50, 51, etc.)
  - Participating drives
  - Stripe size
  - Cache policy
  - etc.
- Spare Assignments
- Bad Block Management
- Vendor Specific Logs
- Other features



DDF RAID Levels

Primary RAID Levels

Name	Description
RAID-0	Striped array with no parity
RAID-1	Mirrored array.
RAID-3	Striped array with typically non-rotating parity, optimized for long, single-threaded transfers
RAID-4	Striped array with typically non-rotating parity, optimized for short, multi-threaded transfers
RAID-5	Striped array with typically rotating parity, optimized for short, multi-threaded transfers
RAID-1E	>2 disk RAID-1, similar to RAID-10 but with striping integrated into array
JBOD	Single, non-arrayed disk
Concatenation	Physical disks combined head to tail
RAID-5E	RAID-5 with hot space at end of array
RAID-5EE	RAID-5 with hot space integrated into array

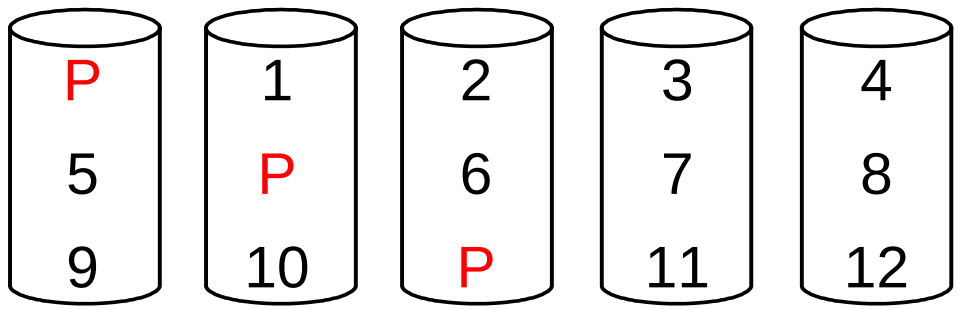
Secondary RAID Levels

Name	Description
Striped	Data is striped across Basic VDs. First strip stored on first BVD and next on next BVD. **Note:** BVD sequence is determined by the Secondary_Element_Seq field in the Virtual Disk Configuration Record (Section 5.8.1).
Mirrored	Data is mirrored across Basic VDs.
Concatenated	Basic VDs combined head to tail.
Spanned	A combination of stripping and concatenations involving Basic VDs of different sizes. **Note:** BVD sequence is determined by the Secondary_Element_Seq field in the Virtual Disk Configuration Record (Section 5.8.1).

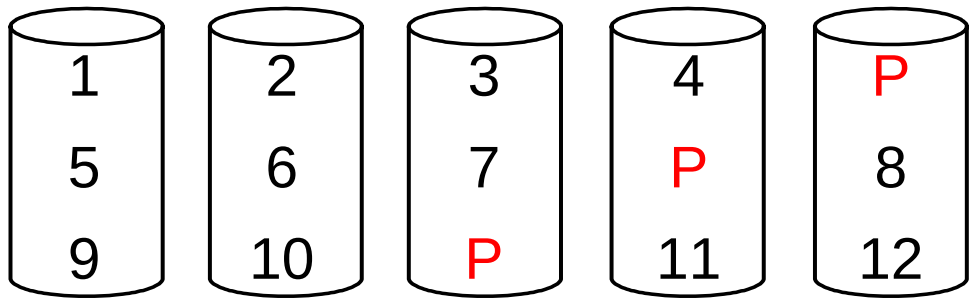
RAID Level Definitions

- The DDF Specification had to give detailed definitions of the RAID levels supported. Including:
  - Mathematical formulas of data layouts
  - Method of parity calculation
- Example: Different types of RAID 5

RAID 5
Rotating Parity 0
with Data Restart



RAID 5
Rotating Parity N
with Data Restart



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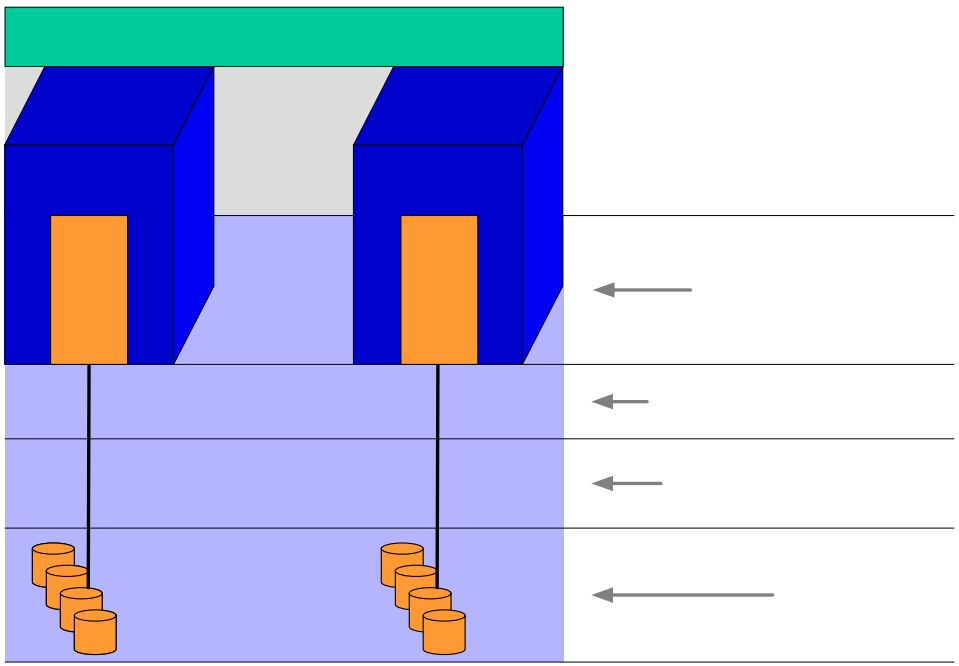
What DDF Is Not

- DDF is necessary for interoperability. DDF does **NOT** equal interoperability
- Simple example:



- User wishes to replace RAID card X with RAID card Y
- RAID card X only supports RAID 5
- RAID card Y only supports RAID 1
- Both are DDF compliant
- Data is not migratable from X to Y

What DDF Is Not

- DDF does not specify mandatory features like:
  - Supported RAID levels (primary or secondary)
  - Drives per RAID array
  - Sparing type (dedicated/global)
  - Maximum drives
  - Cache policies
  - RAID level/strip size migration
  - Etc.
- DDF does specify how to represent these features if supported
- Why doesn't DDF specify mandatory features?
  - Features vary greatly between classes of storage
  - Examples:
    - Chipset RAID may only support RAID 1
    - PCI RAID may support RAID 0, 1, 5, 10, 50
    - We still want to migrate from chipset RAID to PCI RAID

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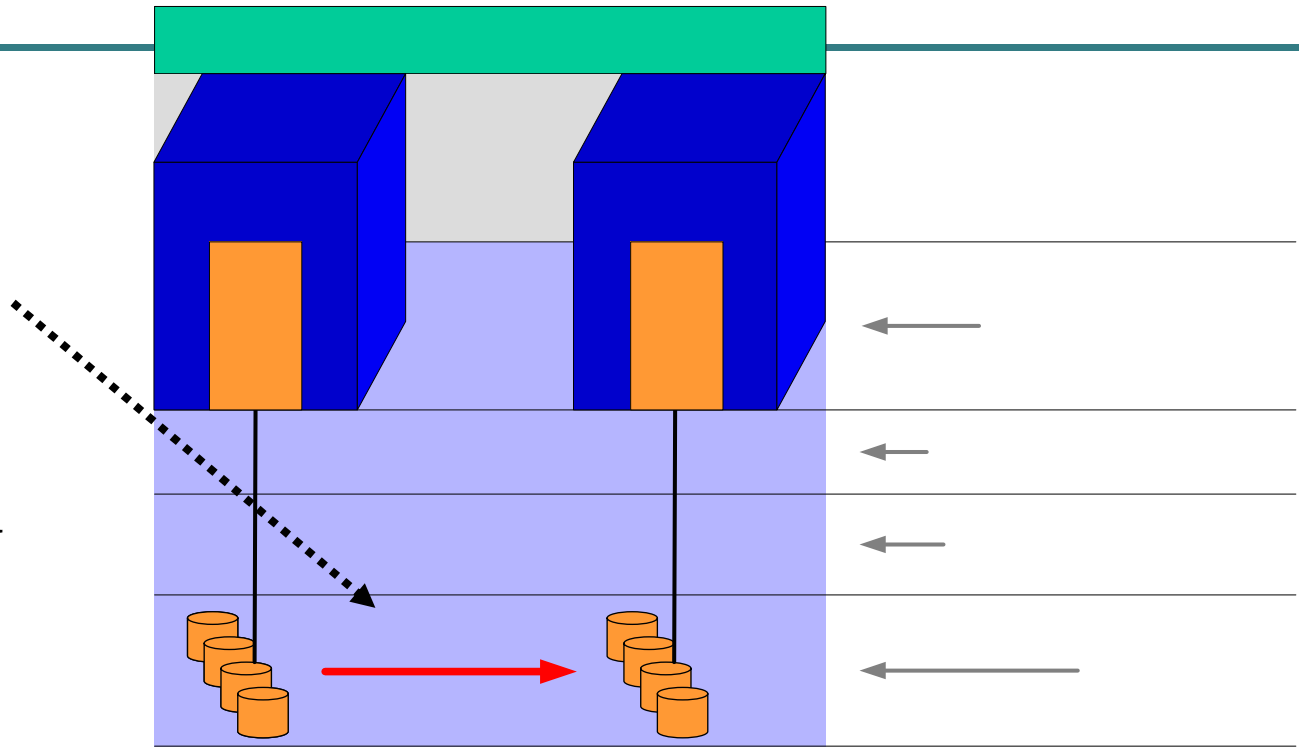
DDF Solves:

Disk movement behind RAID solutions **WITH** data in place



- Provided both RAID solutions support the particular RAID formats stored on the disks
- If a RAID format is not supported by a solution:
  - The solution can identify the non-migratable volumes
  - Notify the administrator

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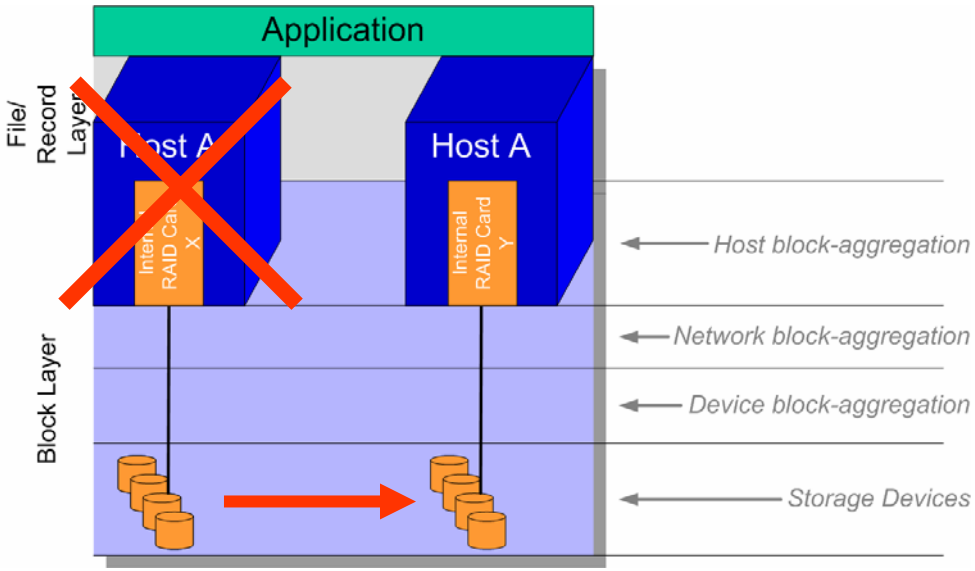
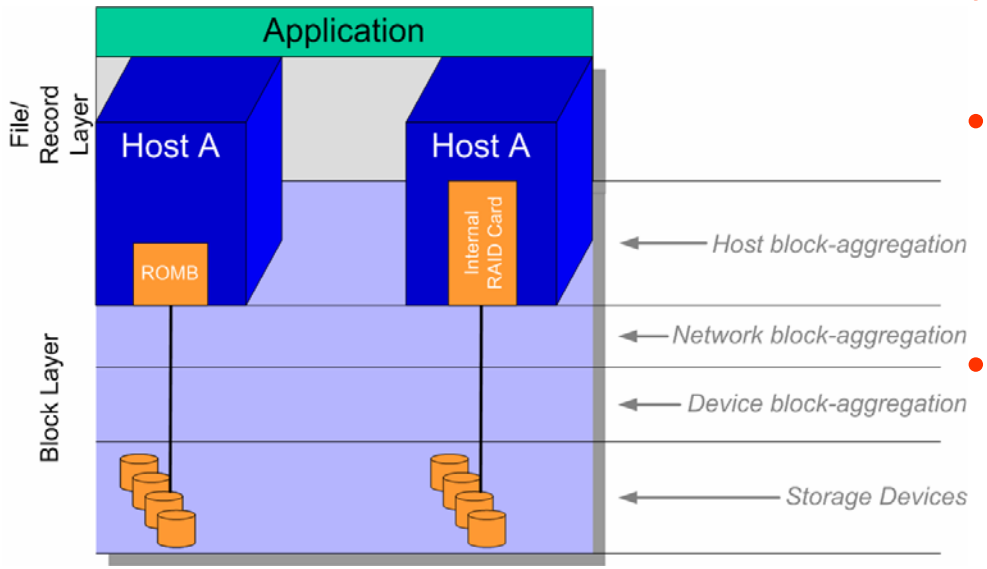
Disaster Recovery



- Problem: Failed host replaced with new host and RAID card.
- Today's Solution: Move disks to new system. Restore data from tape.
- DDF Solution: Move disks with data in place.

RAID Upgrade



- Problem: Data set outgrows current RAID capacity.
- Today's Solution: Backup data to tape. Move disks to new RAID implementation. Restore data from tape.
- DDF Solution: Move disks with data in place.

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DDF Status

- Specification Timeline
  - DDF TWG proposed to SNIA – 4/13/2003
  - DDF TWG created – 5/29/2003
  - DDF Specification completes 60 day trial-use/public comment release – 5/15/2004
  - SNIA and INCITS update
- DDF TWG Membership
  - 60 people registered on DDF TWG webpage
  - 29 companies and organizations
- Whitepaper Available

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DDF Status – What's Next

- DDF TWG working on DDF profiles
  - A profile describes a collection of supported features and configurations.
  - If two solutions support the same profile, data-in-place migration is enabled.
  - Several profiles will be completed by the end of 2004.
- DDF TWG developing Certification Test Program
  - The DDF TWG is working with the SNIA CTP to develop certification tests showing support for DDF TWG registered profiles.

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Q&A / Feedback

- Please send any questions or comments on this presentation to SNIA: ddftwg@snia.org

Many thanks to the following individuals for their contributions to this tutorial.

SNIA Education Committee

Matt Brisse **Ahmad Ali**