

# **KODAK: Storage and the 21st Century**

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**Fairfax VA 22043**

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# Presentation Topics

- **Kodak Storage Technology and Products**
- **Applications driving technology and standards**
- **Technology Roadmap for Optical Storage**
- **Enabling Technologies**
- **Alternative Technologies**
- **Conclusions**



# Kodak: A Leader in the Digital Imaging Business

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- **KODAK develops and manufactures a variety of digital imaging products serving many market segments**

**Digital & Advanced Photo System Film Cameras**

**CD Based and Large Format Optical Storage Systems**

**High Speed Document & Color Pictorial Scanners**

**Digital Printers and Inkjet Media**

**Digital Imaging Workstations**

# Kodak's Storage History

- **Historical Focus**
  - Recording Materials & Recording Physics (“HMI”)
- **Current Storage Technologies**
  - Write Once Optical Recording Media
    - » Phase Change Media
    - » Proprietary Organic/Metallic Media CD-R2 / DVD - R
    - » Dye Based CD-R / DVD-R Media
  - Re-Writable Superlattice CoPt MO media
  - High Performance Optical Heads & Actuators
  - Magnetic Recording Heads and “Magnetics on Film” Media
  - Micrographics



# Kodak Storage Products

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- **Writable CD Media with “Infoguard”**
- **PCD 600 6X Writer and Autoloader**
- **CD 144 ADL (CD-ROM & CD-R Drives)**
- **OD System 2000E Automated Disk Library**
- **OD System 2000E Media (25GB)**
- **Micrographic Media and Equipment**



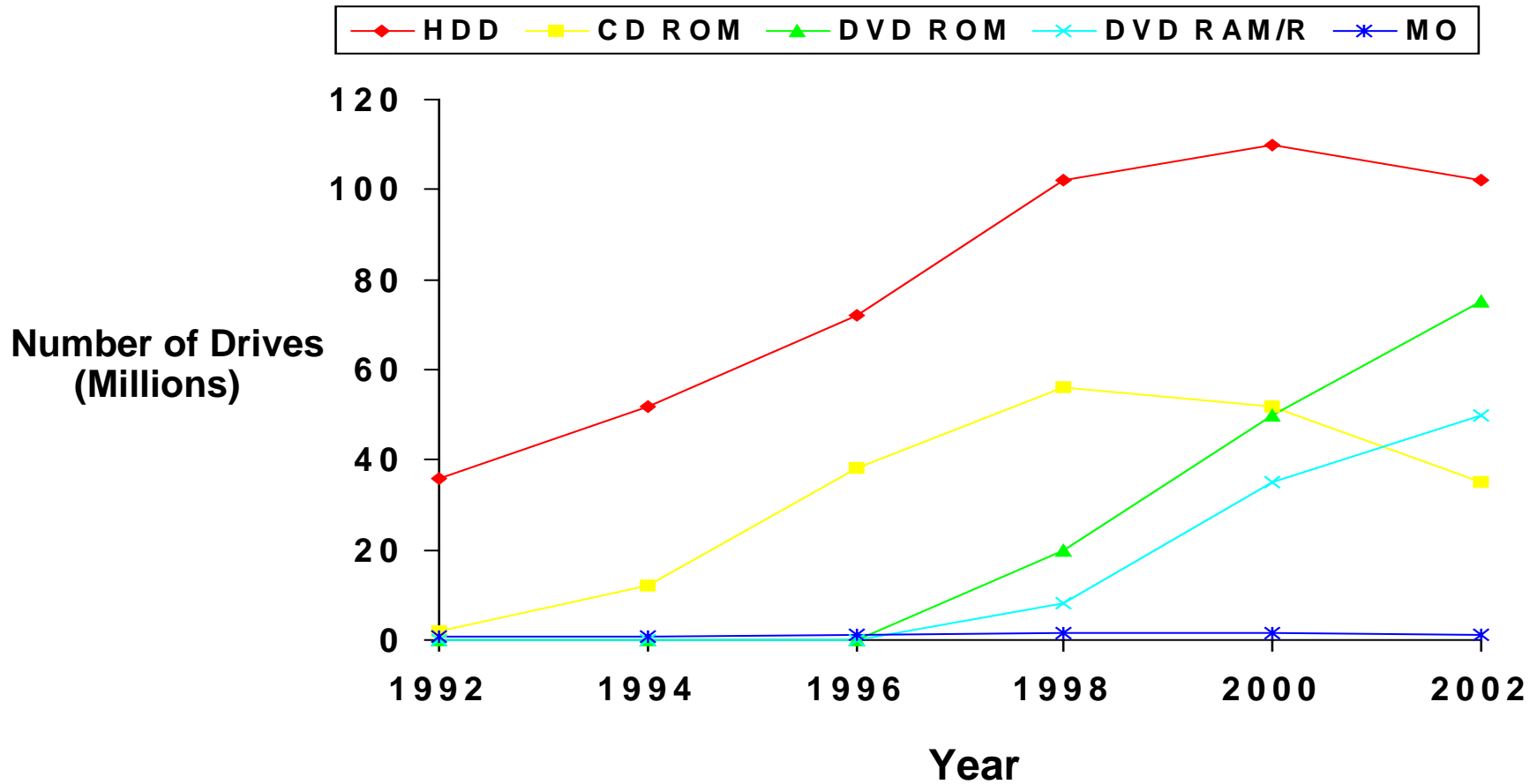
# Applications and Markets

TECHNOLOGY	APPLICATION	1996 MARKET	MARKET TREND
CD-Audio	Prerecorded digital audio	\$ 1B	Increasing at 20%/yr
CD-ROM	Prerecorded computer software	\$ 4B	DVD-ROM will replace in 2-5 years
CD-R	SW publishing and document/data distribution	\$0.4B	Growing popularity due to low cost drives and authoring SW
CD-E	Personal Storage	\$0.0	Will compete with DVD-RAM in 1998
WORM	Archival computer data storage	\$ 0.7B	Projected 200 Gbytes by 2000 (AGR = 40+%)
Rewriteable Optical Drives	Archival storage of large volumes of data	\$ 1B	Reduced volumes due to magnetic disks advances
Magnetic Hard Drives	Used for on line & archival storage of data	\$ 25B	Improving density and lowering costs (AGR = 60%)

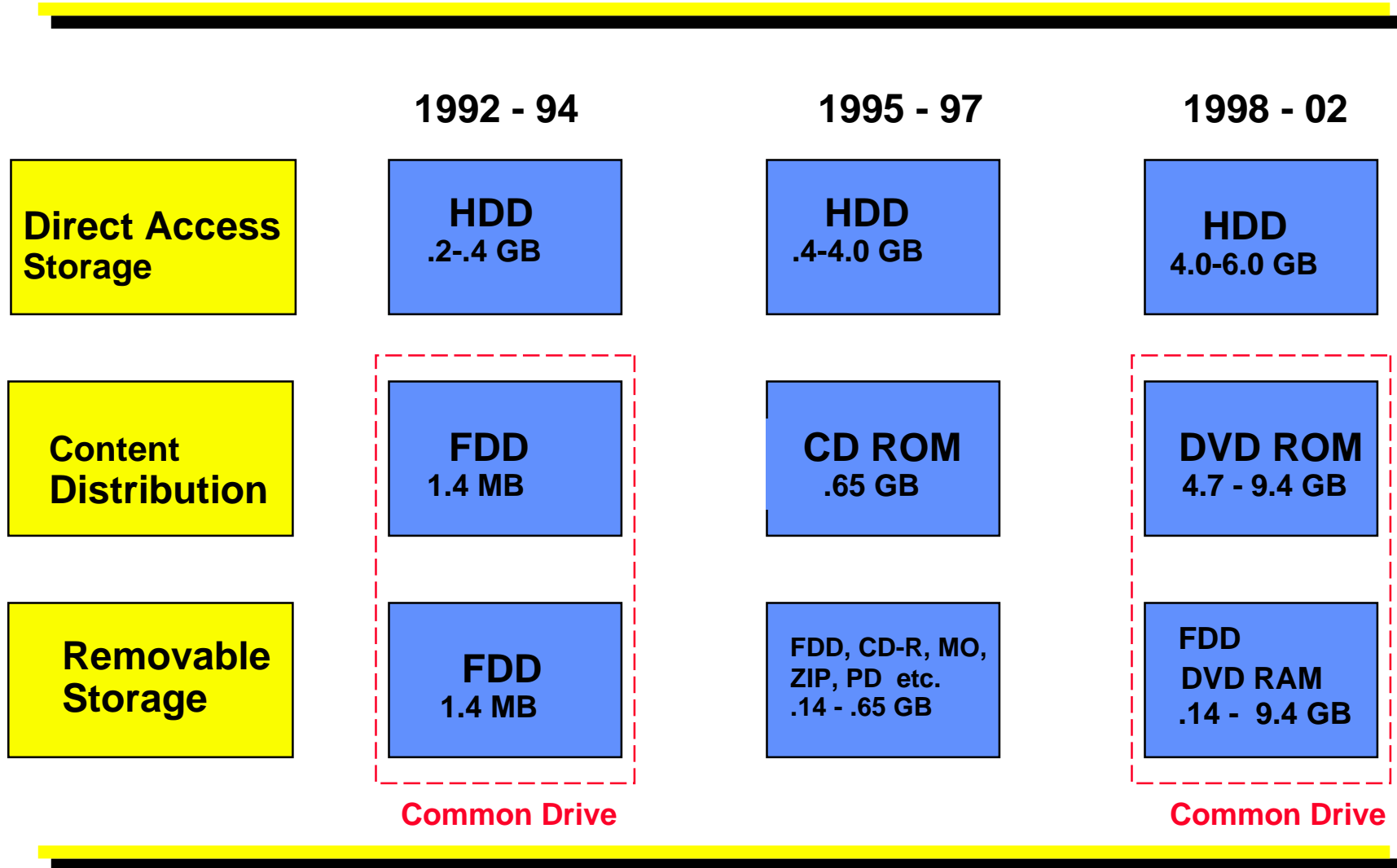
# Emerging Applications DVD

TECHNOLOGY	APPLICATION	MARKET TREND
DVD-ROM	Prerecorded movies and computer SW	Available in 1997 with 4.7 GB capacity. Will replace CD-ROM
DVD-R (Write-Once)	SW publishing. Insufficient capacity for DVD video	Projected for late 1997 with 3.9 GB capacity.
DVD-RAM (Rewritable)	Transport/duplicate data and multimedia content	Projected for late 1998 with 2.6 GB capacity

# Desktop Drive Trends



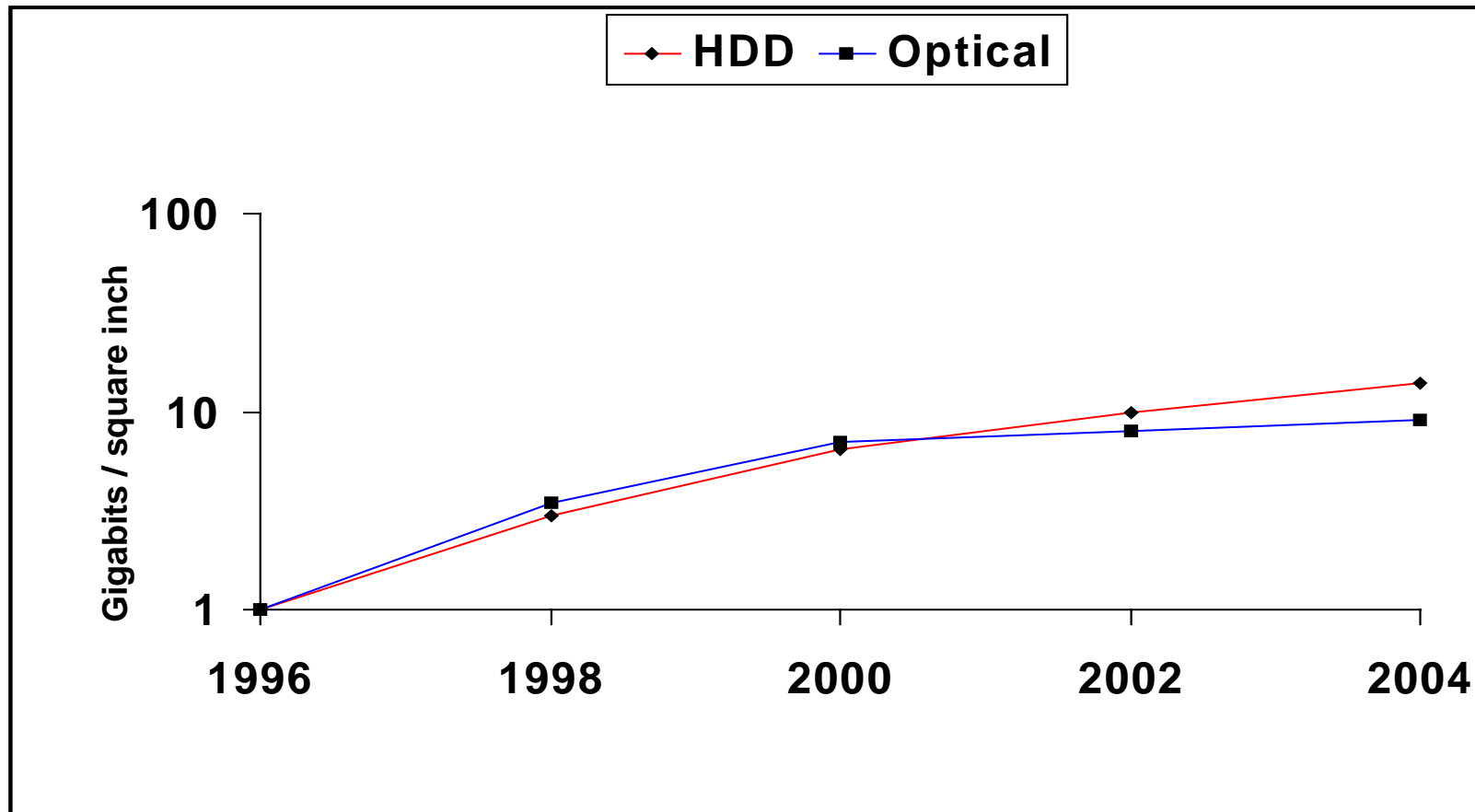
# Desktop Storage Trends



# Applications Driving Capacity

- **“Motion Rich” Multimedia Content**
  - 1 page of ASCII Text 3 KB
  - Professional Color Photographic Image (JPEG) 4 MB
  - 1 min CD Audio 10 MB
  - 1 min MPEG II Video 35 MB
  - 30 sec Motion Picture Sequence 25 GB
- **Internet and On Line Imaging Services (e.g. Digital Photofinishing, Video on Demand)**
- **Convergence to digital form in commercial and professional markets**
  - Electronic media is less expensive than hard copy
  - Availability of authoring tools and standard playback platforms ( CD-ROM)

# Aerial Density Trends





# Key Enabling Technologies for Storage

- **Aerial density limits for magnetic and optical storage are comparable approaching 36 Gb/ sq inch**
- **Optical Storage**
  - Shorter wavelength high power lasers
  - Optical Heads (objective optics with  $NA > .6$ , solid immersion lenses, hologram / grating beam splitters, active tilt control, improved actuators)
  - Advances in media (multilayer, panchromatic)
- **Magnetic HDD Storage**
  - Advances in media performance (thermal stability, high anisotropy, smaller grain size)
  - Advances in head performance ( MR vs Inductive, higher switching frequencies, flying with sub micron gaps)

# Projected Laser Development

		Type	1997	1998	1999	2000	2001	2002
<b>Wavelength</b>	375	GaN				2mW		30mW
	420	GaN				2mW		30mW
	420	SHG	2mW	5mW	10mW	20mW		
	490	ZnSe				2mW		30mW
	520	ZnSe			2mW		30mW	
	635	InGaAlP	<5mW		40mW			
	650	InGaAlP	<20mW		60mW			
	670	InGaAlP	<60mW	100mW				

**Available   Lab Demo   Predicted**

# Optical Media Technology

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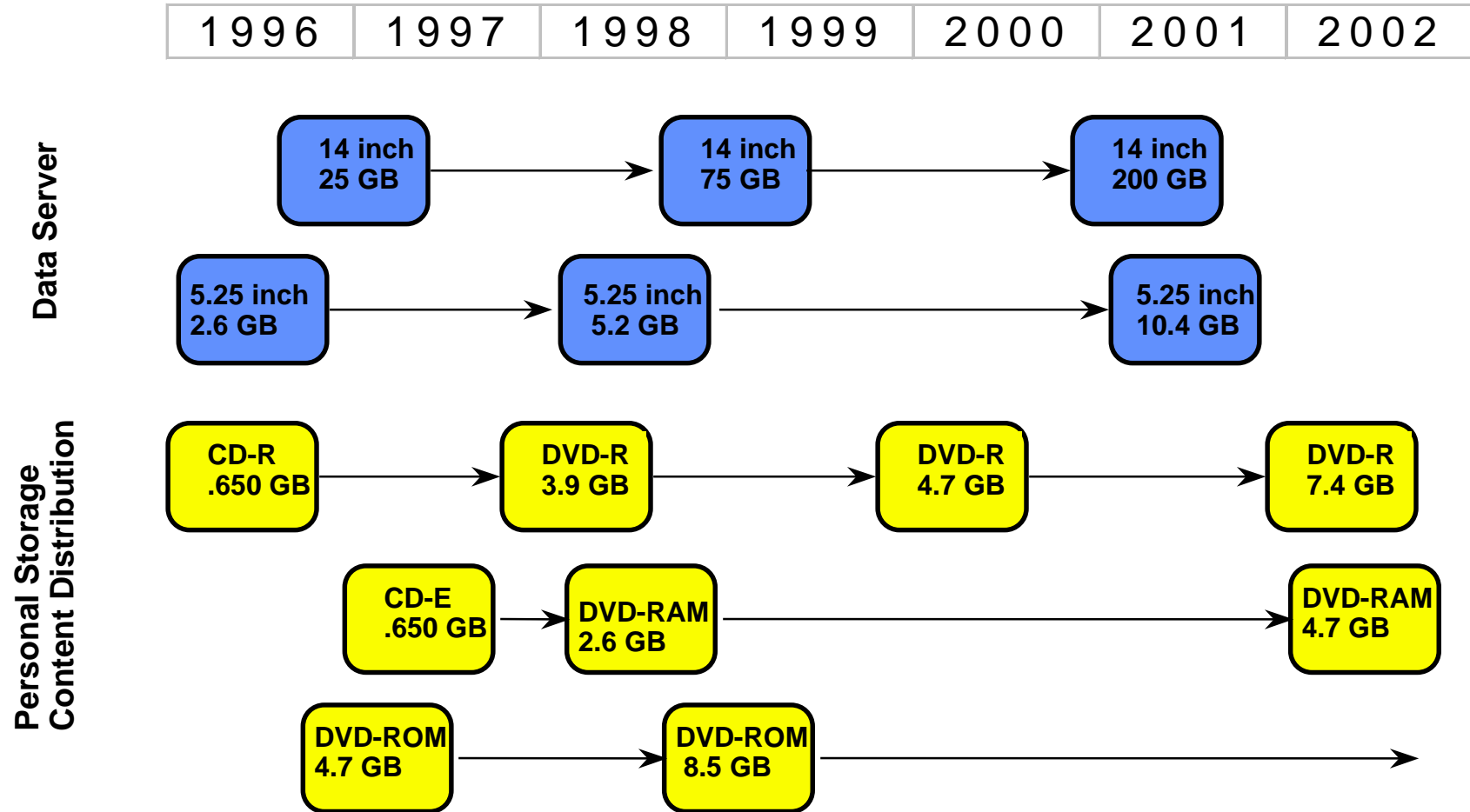
- **Greater precision in mastering**
- **Improved precision and uniformity of molding**
- **Improved tracking and servo formats to increase radial track density**
- **New/Improved thin film semi transparent recording layers**
- **Pan sensitive recording layers**

# Alternative Technologies

- **Optical Tape**
  - **Risks: Lack of standards and disorganized marketplace**
- **Near Field recording (NFR)**
  - **Technical Risks: Low cost solid immersion lens, media performance**
- **Holographic Storage**
  - **Technical Risks: recording layer materials , tailored light sources, high performance optics**
- **Electron Trapping Optical Memory (ETOM)**
  - **Technical risks: Substrate materials, thin film deposition**
- **Persistent Spectral Hole Burning (PSHB)**
  - **Technical risks: Cryogenic temperatures, data permanence**



# Optical Storage Technology Roadmap



# Conclusions

- **“Image Rich” applications will drive the need for increased capacity**
- **Magnetic Technology (HDD, tape) will continue to have an advantage in performance and volumetric density**
- **Optical Disk Technology will maintain its advantage in removability, interchangeability and replication / distribution costs**
- **Magnetic and Optical Disk products will coexist and compliment each other**
- **Near Field Recording, Optical Tape and Holographic recording appear to be the most promising emerging storage technologies**

# KODAK Approach

- **Focus on Imaging Applications**
- **Drive product leadership through R&D**
- **Support Standards**
  - Active participation in:
    - » ANSI X3, ECMA TC31, ISO/IEC JTC 1/SC23
- **Industry and Government Partnerships**
  - Active participant in:
    - » NSIC, OIDA, OSTA, SIGCAT, DVD Working Groups 6,7
  - Federal Government Sponsored R&D
    - » NIST - Advanced Technology Programs
    - » DOD - IR&D

# Kodak - Going Forward

- **Kodak will continue to provide digital storage products that emphasize:**
  - **Best-Value**
  - **High Productivity**
  - **Customer Investment Protection**
    - » **Data Integrity, Data Protection**
    - » **Open Standards**
    - » **Backward Compatibility**
    - » **Forward Migration Path**