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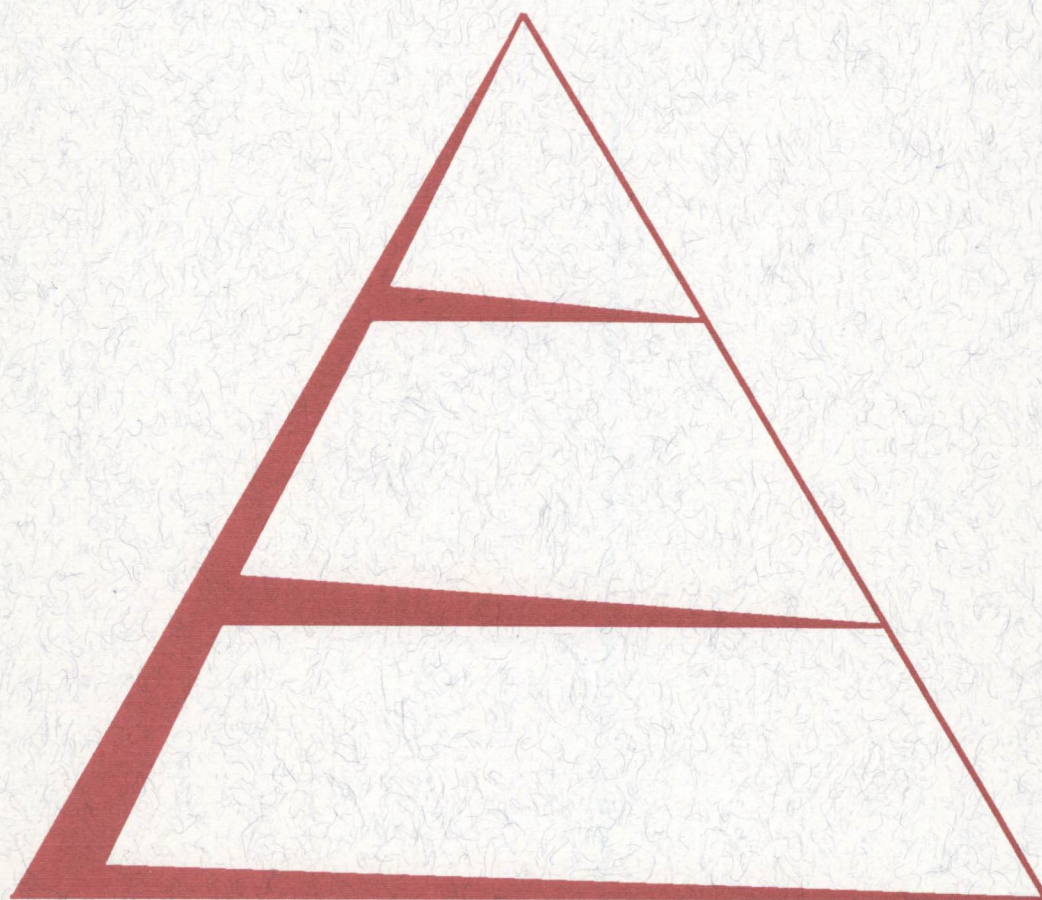
Record Group/Collection: George H.W. Bush Presidential Records
Collection/Office of Origin: Science and Technology Policy, Office of (OSTP)
Series: Publications
Subseries: Reports and Publications Files

OA/ID Number: 62110
Folder ID Number: 62110-004

Folder Title:
National Laboratories

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National Laboratories

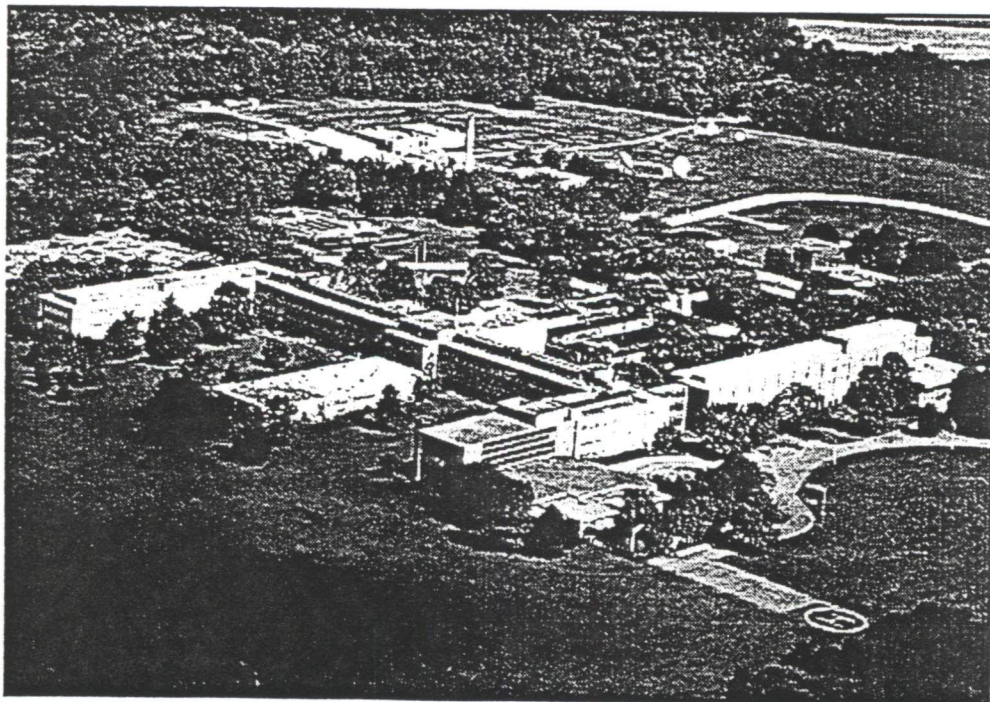


Introduction to the David Sarnoff Research Center

Sarnoff

AA1

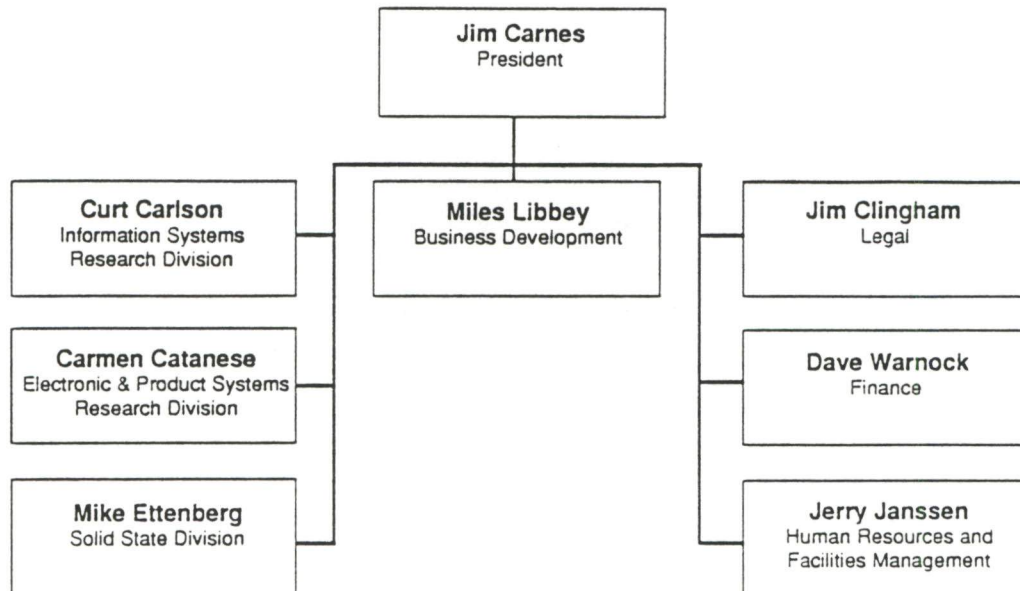
The David Sarnoff Research Center



Sarnoff

AA2

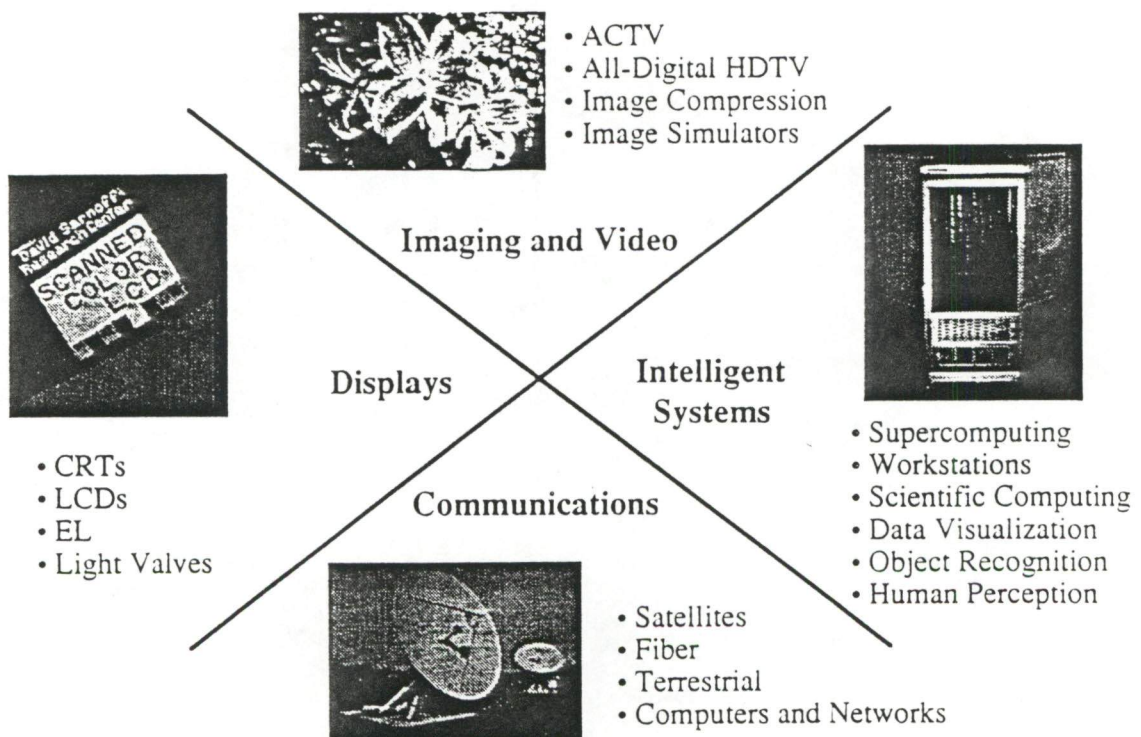
The David Sarnoff Research Center



Sarnoff

AA3

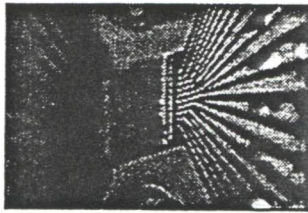
Information Systems



Sarnoff

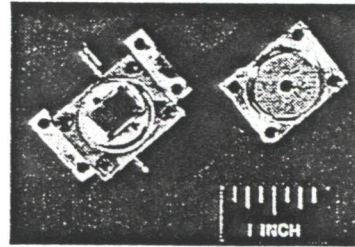
AA4

Solid State



Optoelectronics

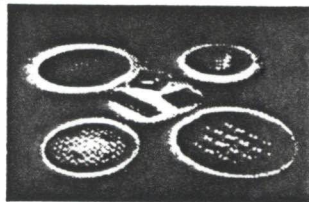
- Lasers
- Fiber Optics
- Optical Recording
- Imagers
- Photodetectors



Microwave

- Power Amplifiers
- Sensors
- Receivers
- MIMICs/OEICs
- Superconducting Filters
- CAD/CAM

Integrated Circuits



- Sub-Micron
- Rad hard
- Analog-Digital
- GaAs on Sil
- Smart Sensors
- Smart Power

Sarnoff

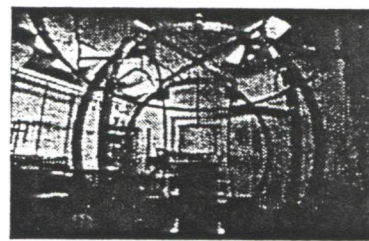
AA5

Materials and Manufacturing



Materials

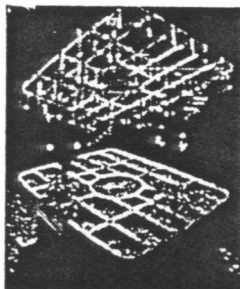
- SOS
- Ceramics
- Diamonds
- Luminescence
- Superconductivity
- Analysis
- Characterization



Systems & Processes

- Display Systems
- Display Manufacturing
- Integrated Process & Control
 - AI
 - Vision
 - System Modelling

Automation



- Electromechanical
- Manufacturing Equipment
- Electronic Packaging
- Prototypes

Sarnoff

AA6

Pioneering Contributions

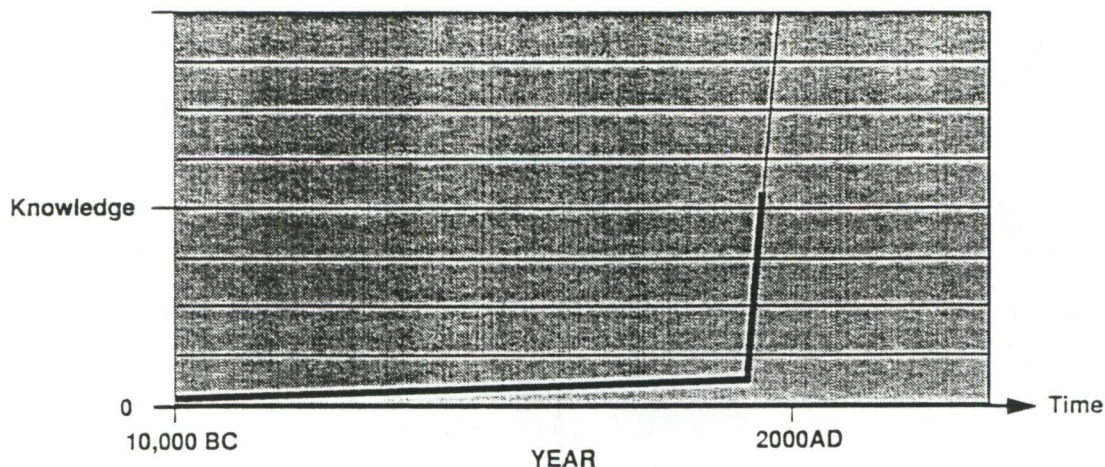
1943	Image Orthicon Camera Tube	1975	CMOS Microprocessor
1946	All-Electronic Color TV System	1976	All-Electronic TV Tuning System
1949	Magnetic Core Memory	1976	Just-Noticeable Difference Analysis
1949	Vidicon Camera Tube	1977	Silicon-on-Sapphire ICs
1950	Shadow Mask Color Picture Tube	1977	Amorphous Silicon Solar Cells
1953	Transistor Complementary Symmetry Principle	1977	CCD Comb Filter
1953	Magnetic Tape Recording (B&W and Color)	1982	Laser Diode Optical Recording
1954	Electrofax	1982	Coty-29 Picture Tube System
1955	Alloy-Junction Drift Transistor	1982	GaAs FET Microwave Amps (SSPAs)
1956	Transistor Temperature Compensation	1982	Pyramid-Based Image Processing
1963	Metal Oxide Semiconductor (MOS)	1984	CCD Broadcast Camera
1964	CMOS	1986	Grating Surface Emitting Laser
1966	Vapor-Phase-Growth for Gallium Arsenide	1986	Stereo Broadcast Television
1968	Liquid Crystal Display Technology	1987	DVI Technology
1968	Heterojunction AlGaAs Laser	1987	ACTV System
1968	Negative Electron Affinity Emitters	1988	Princeton Engine
1974	CCD Image Sensor	1989	Superconducting Microwave Filter
1974	ColorTrak TV Receiver	1990	High-Power Laser-Activated Switch
		1991	All Digital HDTV: ADTV
		1991	DARPA DMD HDTV Projector
		1992	DARPA High Res Workstation

Sarnoff

AA7

The Information Explosion

... approximately 90% of all knowledge was generated in the past 35 years: It will double again in the next 10 - 15 years ...



Source D.B. Merrifield: U.S. Department of Commerce

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AA8

The Importance of Images

... one of the keys for managing the information explosion ...

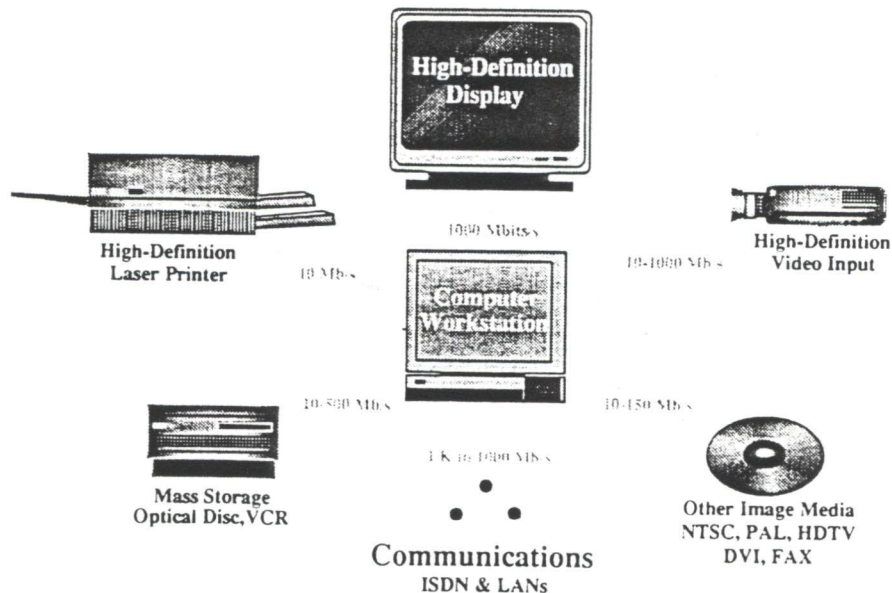
- Our most important sense
 - 10^9 bits/sec for vision
 - 10^5 bits/sec for hearing
- Often the best (only) means of analyzing complex data
- Images are "interesting" and "compelling"
- But
 - Resolution must match the eye
 - Moving images contain 10-100 times more information
- Requires
 - Communication rates that match the human visual system
 - Computer power that rivals the human brain

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AA9

Office Environment of the Late 1990's

... the office will heavily exploit imaging technology ...



Sarnoff

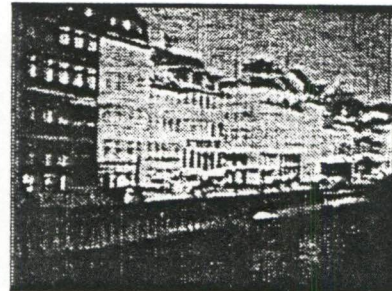
AA10

HDTV

... the key is extremely high-performance image compression ...



HDTV



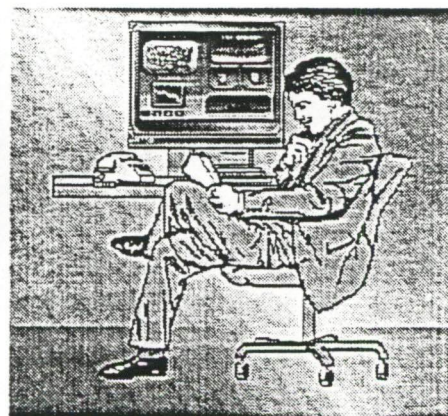
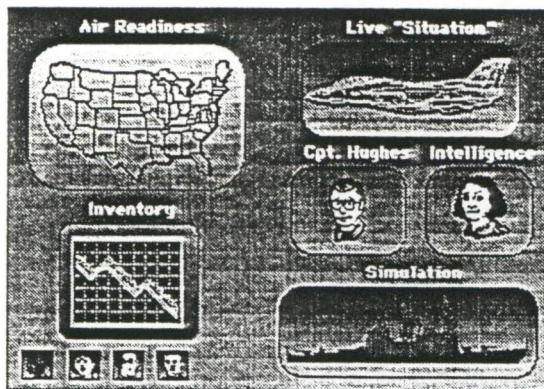
NTSC

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AA11

High-Resolution Video Workstations

... will have multiple video and graphics windows ...



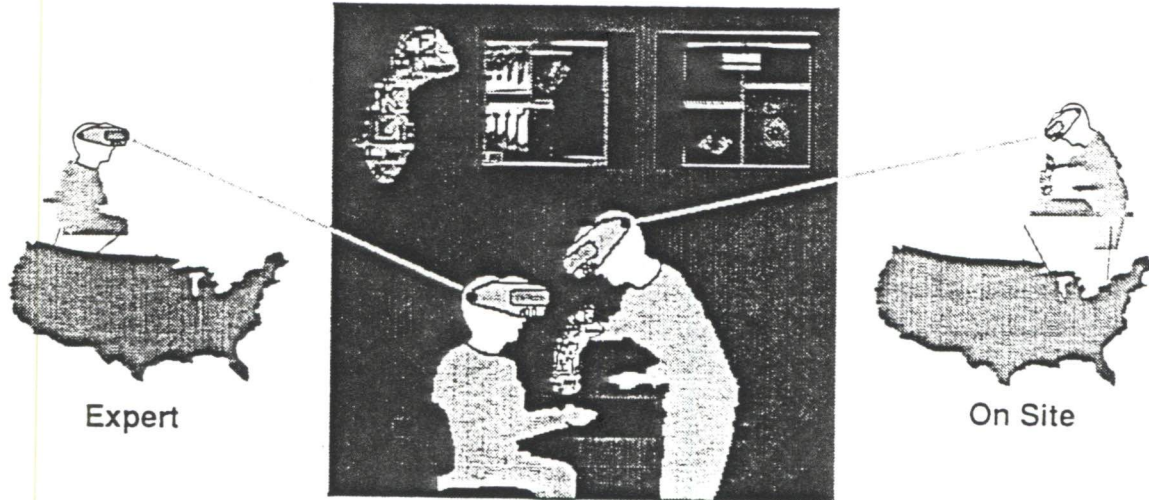
Sarnoff

AA12

Virtual Reality

... creating real-time, high-resolution, 3D synthetic environments ...

Collaborative Workplace

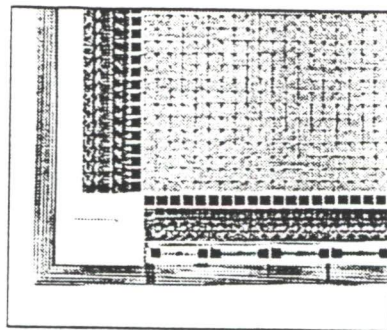
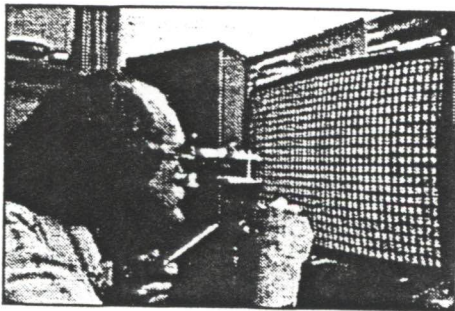


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AA13

Display Technologies

... large, uniform, high-resolution, bright displays ...



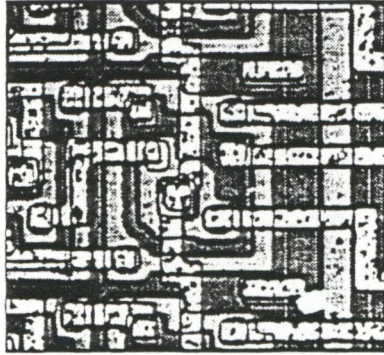
Sarnoff

AA14

What's the Difference? - Not Much

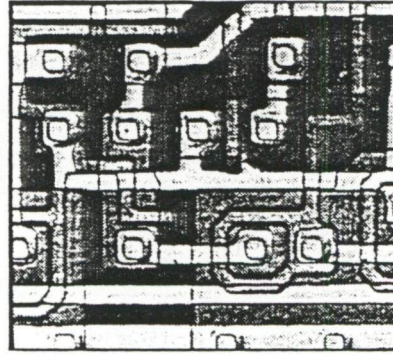
... future displays will include massively parallel computation capabilities ...

RCA 1802 Microprocessor
(5 μ m IC Technology)



CMOS Microprocessor
on Si (circa 1972)

Sarnoff's 6" x 8" LCD Display
(5 μ m IC Technology)



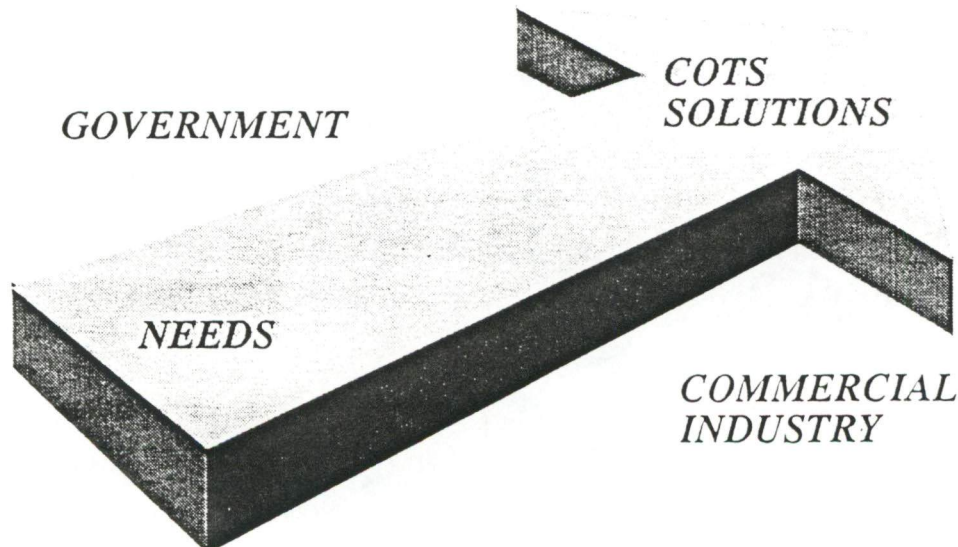
Si LCD Driving Circuitry
on Glass (circa 1991)

Sarnoff

AA15

David Sarnoff Research Center

... leveraging government and commercial resources to develop COTS solutions ...



Sarnoff

AA16



The National Laboratory Concept

BB1



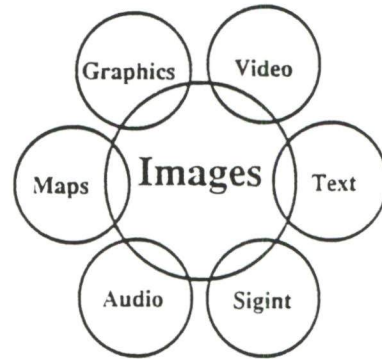
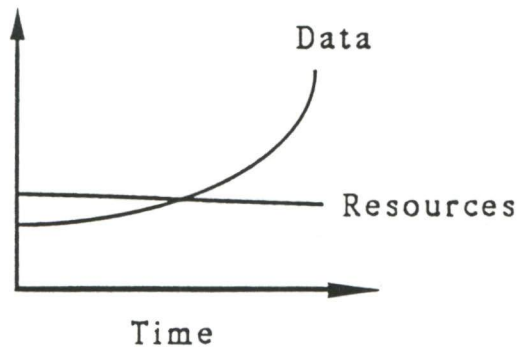
Introduction

- National Technical Centers of Excellence
 - New business model for R & D
 - Serving IC and its industrial base
- National Media Laboratory (Since 1989)
 - Media and Recording Systems
 - Hosted by 3M
 - Director: Dr. William Mularie
- National Information Display Laboratory (Since 1990)
 - Softcopy and Display Technologies
 - Hosted by David Sarnoff Research Center
 - Director: Dr. Curtis Carlson
- Sponsored by:
 - Government Partners
 - Combined with leveraged investment from Industry

BB2

Government Information Needs

... rapidly exploiting and disseminating all critical information ...

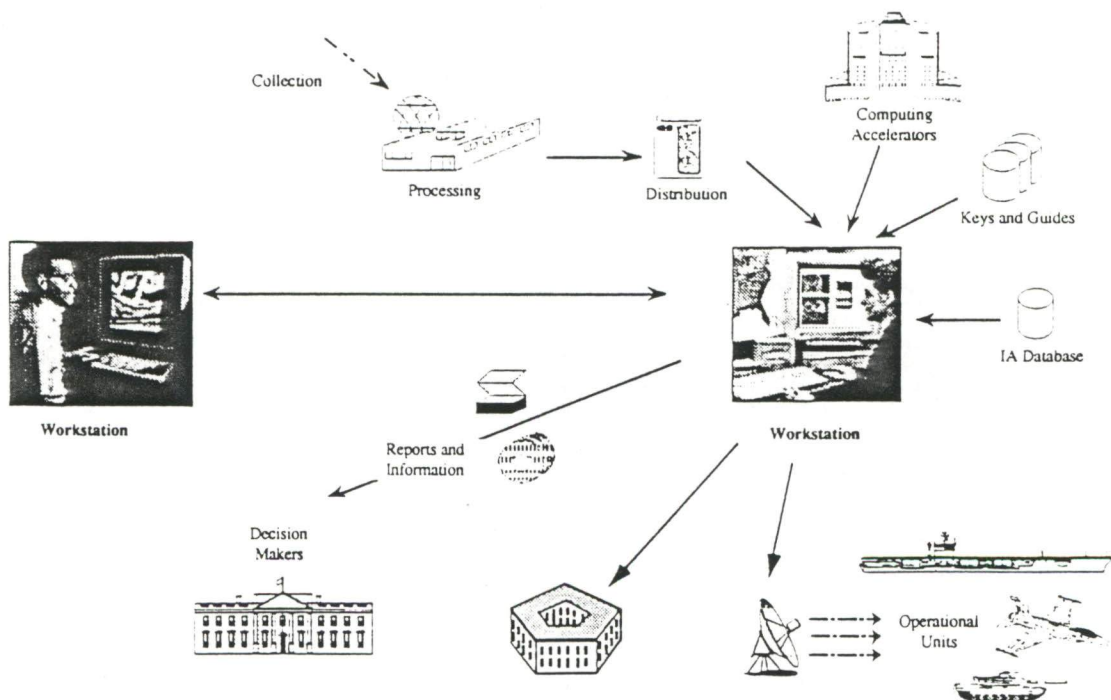


- Rapidly changing roles and responsibilities
- Increasingly diverse users
- Increasing data types

BB3

System Data Flow

... putting the User in control ...

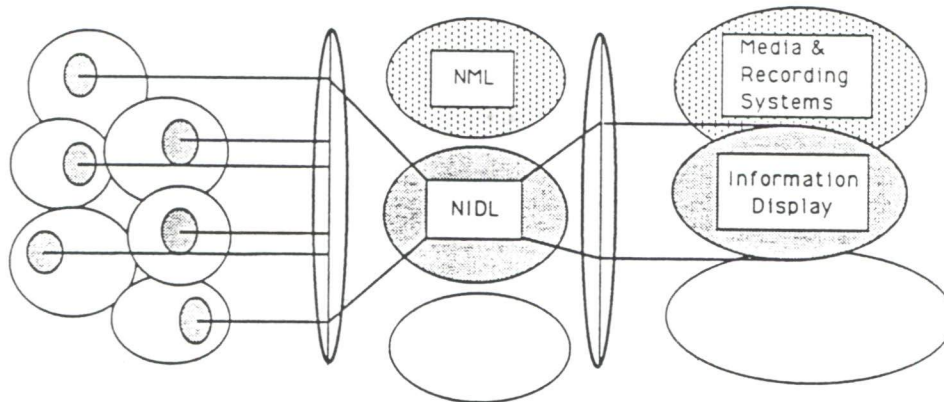


BB4

The Center of Excellence Concept



... focusing the resources of Industry onto User's needs ...



Government Users

- Users & Developers of Technology
 - Program Offices
 - R&D Groups
- Core technologies, essential to success of program

Centers of Excellence

- Focus
- Leverage
- Standards
- Continuity
- User Support

Industry

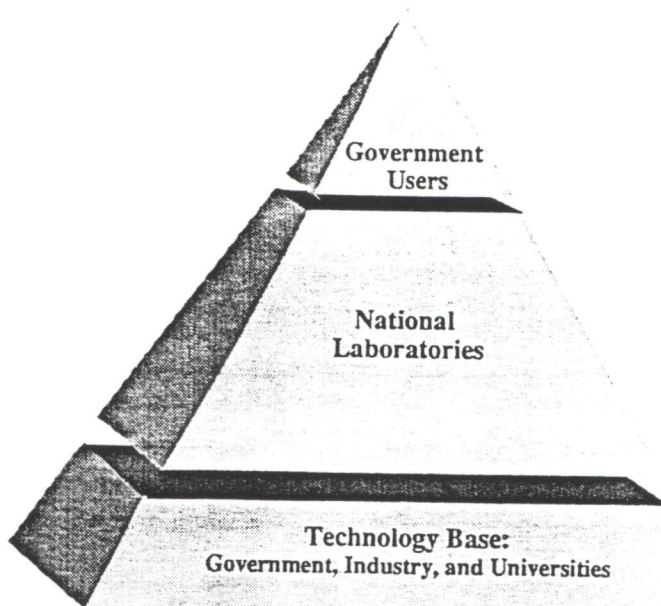
- Commercial Manufacturers
- R&D Centers
- System Developers
- Universities

BB5

National Laboratories



... Centers of Excellence ...



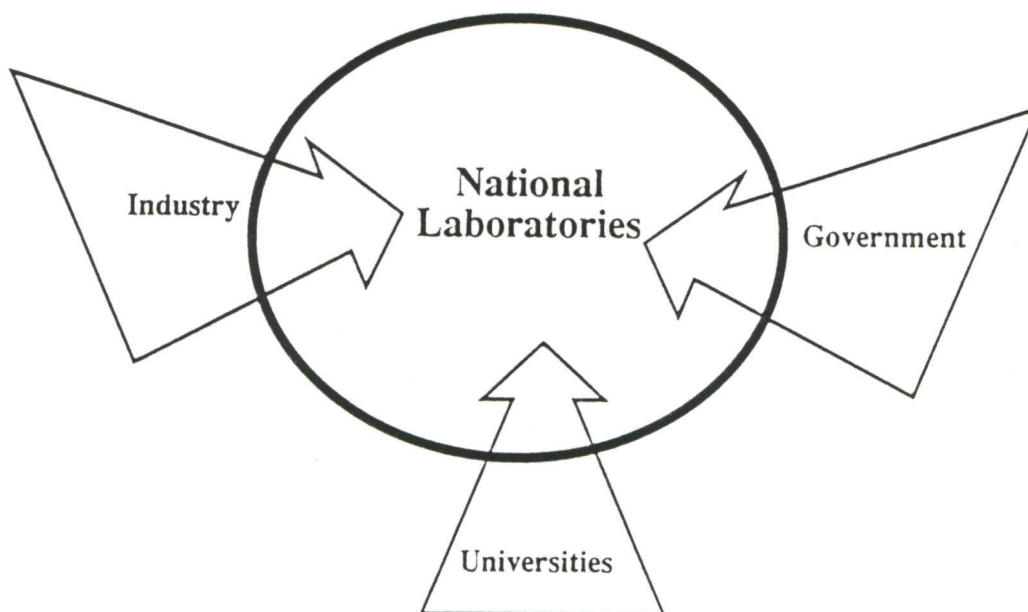
- User Support:
 - Operational Site Support
 - Evaluation
 - Quality Control
- R&D:
 - Technologies and Systems
 - Advanced Tools and Process
- Technology Transfer/Commercialization

BB6



“Distributed” Laboratories

... combining resources of Government, Industry and Academia ...



BB7



National Laboratories

... a new business model to address Government and Industry needs ...

- Government Needs
 - Reduced program cost
 - Sustained user support
 - Increased quality of product
 - Faster development of standards
 - Improved interoperability, interconnectability
 - Advancement and promotion of critical technologies
 - Broad insertion of COTS technology

BB8



National Laboratories

... a new business model to address Government and Industry needs ...

- U.S. Industry Needs
 - Access to Government requirements
 - Development of industry standards
 - Cost sharing in developing base technologies
 - Promotion of exchange of technology across industry
 - Improvement of US global competitiveness

BB9



Selecting a Technology

- Broad critical government application/need
- Large industry and commercial base
- Government requirements ahead of commercial product performance
- Emphasis on new science

BB10



Selecting a Lab Host

- Broad resource base
- Industry leader (capital invested, record of quality, projected IR&D, manufacturing technology)
- Management philosophy – independent, innovative
- Pro-active team leader
- National and/or world recognition of excellence
- Government and commercial base established

BB11



Partner

- Common technology interest (current or planned)
- Joint investment (dollars or resources)
- Help establish government requirements
- Part “ownership”
- Part control
- Long term relationship

BB12



User

- Government or industry
- Common technology interest
- Application level of technological research
- Base for OPS analysis
- Requirement source
- Test and evaluation participation

BB13



National Lab Business Strategy

... developing programs with overwhelming value ...

- Work with users to determine needs
- Begin “seed” program
- Seek partners with world leading capabilities
 - Government, Industry and Universities
- Develop programs that provide:
 - User satisfaction
 - State-of-the-art or revolutionary improvements
 - Path to commercialization

BB14



Unique Government Assets

... maximizing ROI and ROA for the benefit of the government...

- Continuously-interactive user involvement
- Leading-edge and paradigm-shifting research
- Fair and equitable expert advice
- Proactive, open communications
- Consolidation and leveraging of core resources with strategically aligned partners
- Aggressive commercialization



INTRODUCTION

to the

National Information Display Laboratory

Dr. Curtis R. Carlson
Director, NIDL

CC1



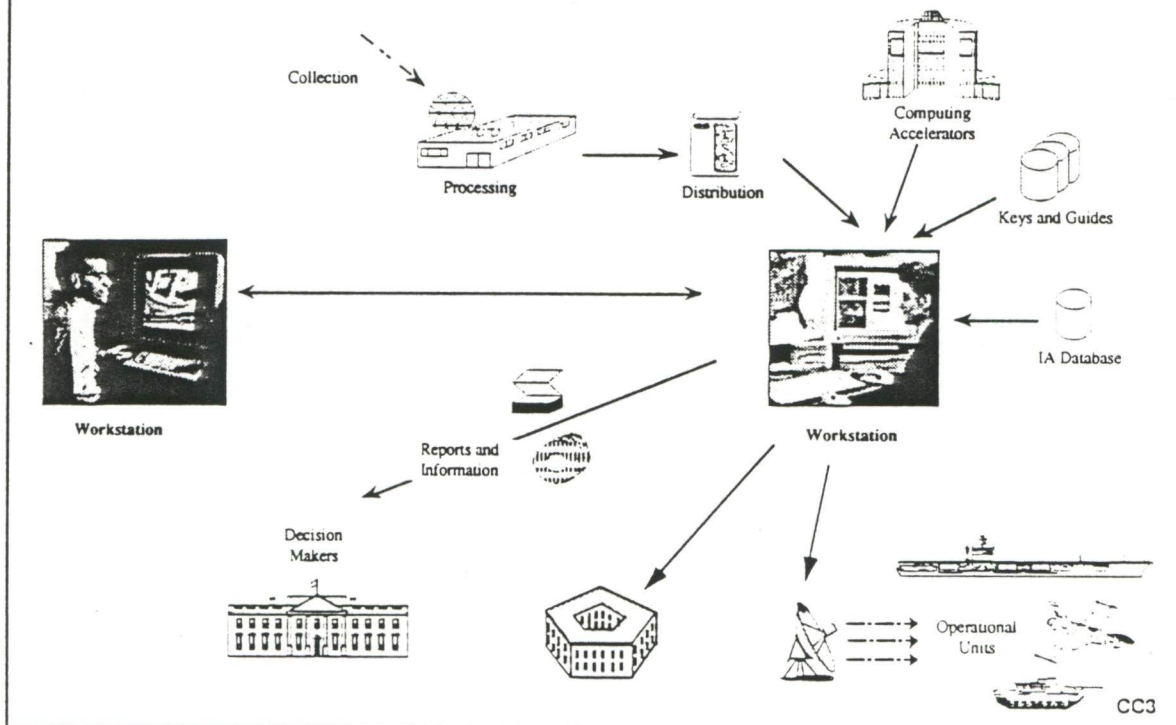
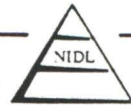
“The ability of the United States to acquire and effectively use information, while denying accurate information to adversaries, can help compensate for planned reductions in U.S. force structure and forward deployed assets ...”

Department of Defense
Critical Technologies Plan
1 May 1991

CC2

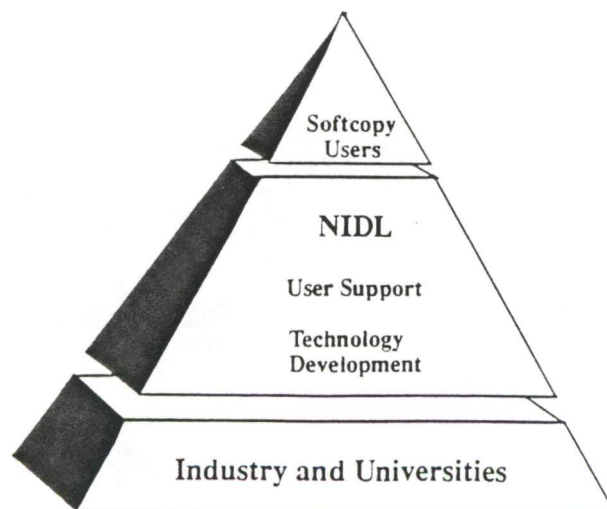
The User's Softcopy Environment

... putting the User in control ...



National Information Display Laboratory

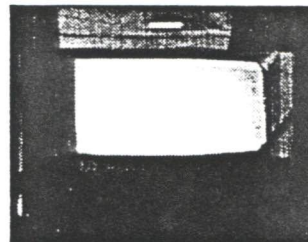
... a Center of Excellence for Softcopy technology ...



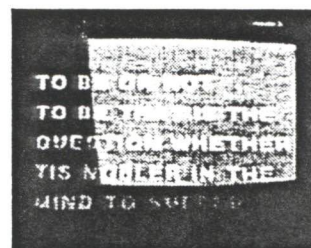
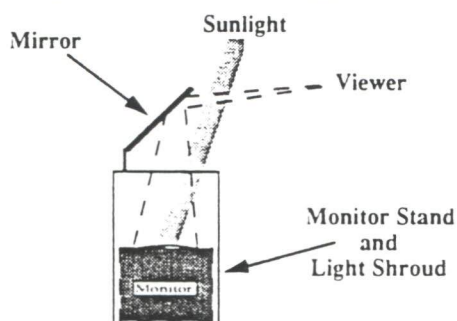


User Support

*... President's teleprompter:
timely response to a user's need ...*



Old



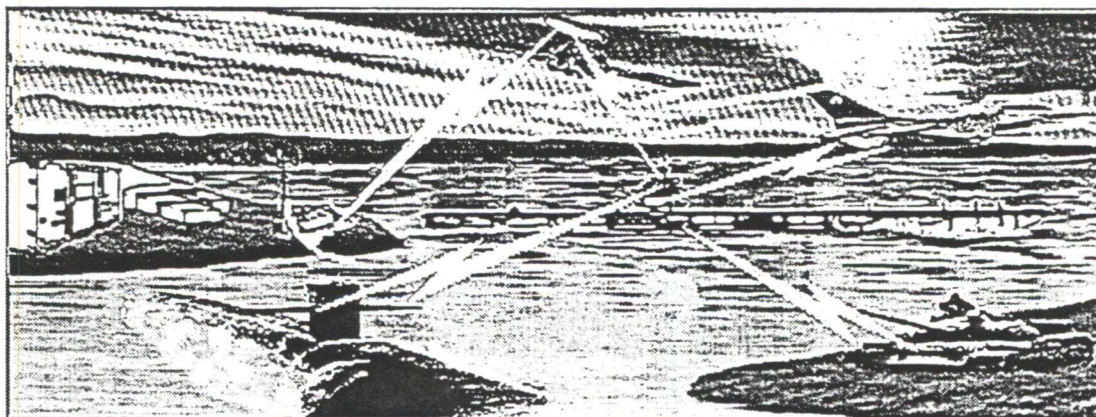
NIDL
Improved

CC5



User Support

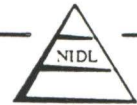
... providing Navy support for the Copernicus program ...



"We began our work together last fall and since then both labs have provided valuable services including user support at operational sites, pre-procurement consulting on large system acquisitions, and some very compelling advanced technology research. The Navy has realized substantial cost savings, as well as improved operational performance as a direct result of these labs."

Vice Admiral Jerry O. Tuttle, U.S. Navy

CC6



NIDL Themes

... helping put Users in control of their environments ...

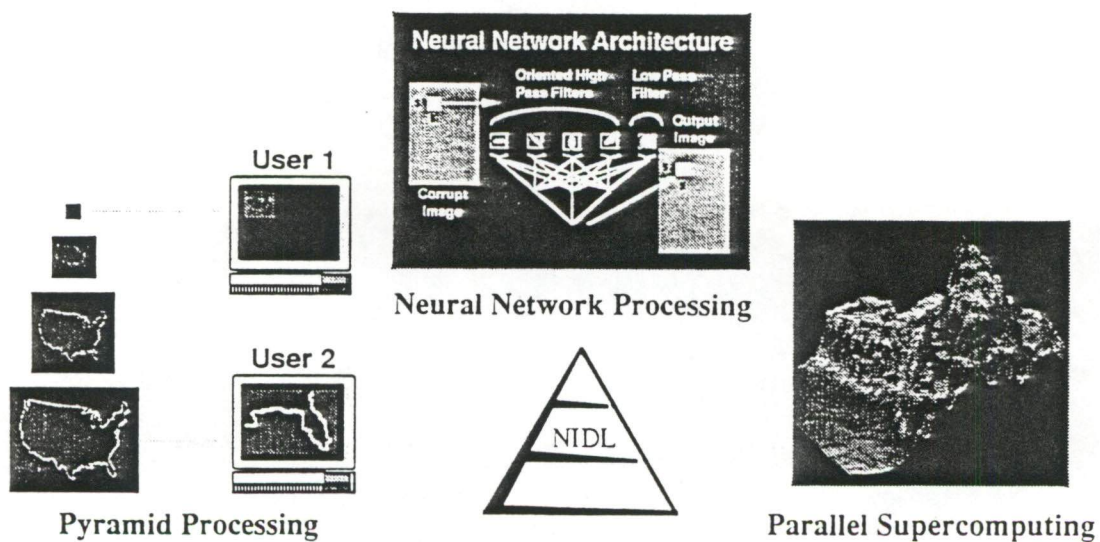
Augment Users:	Develop powerful tools that augment, not replace, the User
Visualize Data:	Exploit the User's most powerful sense: Vision
Leverage Knowledge:	Leverage User's knowledge and skill through software tools that complement their visual paradigms
Control of Environments:	Provide interactive, real-time tools to provide control
Reduce Cost:	Accelerate available COTS systems and technology

CC7



Strategic Technologies

... focus of NIDL Softcopy Tools & Technology ...



CC7a



Strategic Technologies

... focus of NIDL Softcopy Tools & Technology ...

Neural Network Processing

- Neural Network Tools and Applications
- Real-time Training
- Signals from Noise



Pyramid Processing

- Change Detection
- Keys & Guides: Interactive Search
- Efficient Multispectral Data Access
- Analysis & Visualization of Collateral Data
- Interactive Performance Visualization

Parallel Super Computing

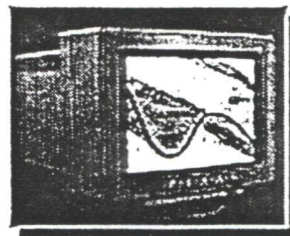
- Massively Parallel Production Front End
- Algorithm Understanding Lab
- Realistic Rendering

CC8

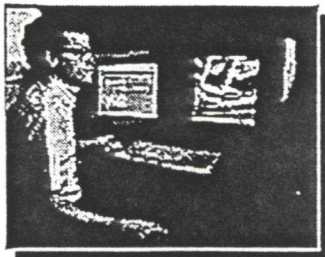


Strategic Technologies

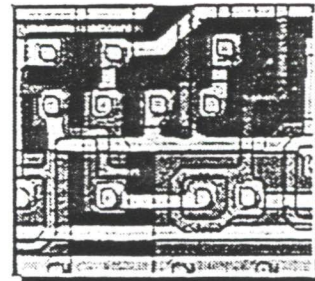
... focus of NIDL Display Technology ...



Display Systems



Display Systems Simulation



Integrated Circuit Technology

CC9



Strategic Technologies

... focus of NIDL Display Technology ...

Display Systems

- High-Resolution High-Brightness CRT Monitor
- Tiling for Wall-sized Flat Displays
- Display Evaluation & Certification
- Softcopy Quality Control



Display Systems Simulation

- Display System Simulator
- Visual Modeling
- LCD/EL/CRT/Tiling/Paper-like
- Display Evaluation & Certification

Integrated Circuit Technology

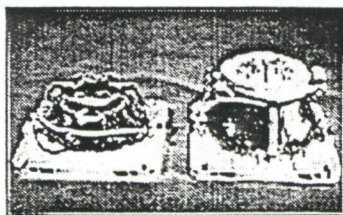
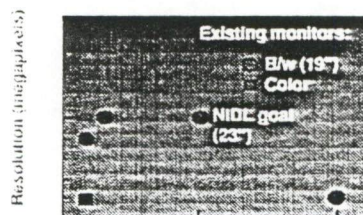
- LCD
- EL
- Paper-like Displays

CC9a

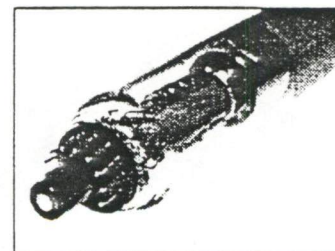


Technology

... working closely with an NIDL Partner to develop a new high-brightness, high-resolution CRT monitor ...



Yoke



Electron Gun

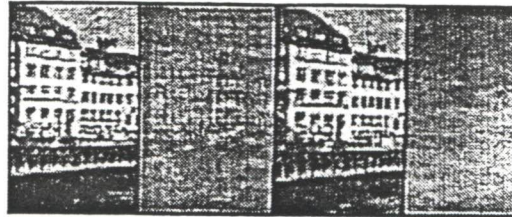
CC10



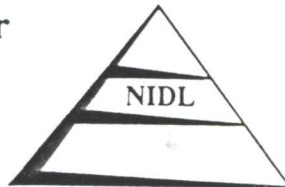
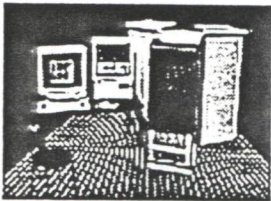
Algorithm Understanding Laboratory

*... interactively visualizing the development
of new algorithms and systems ...*

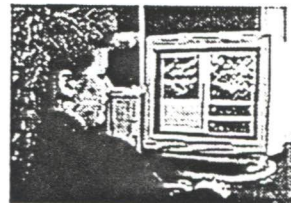
Visualization



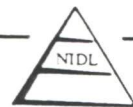
Computational Power



Interactivity

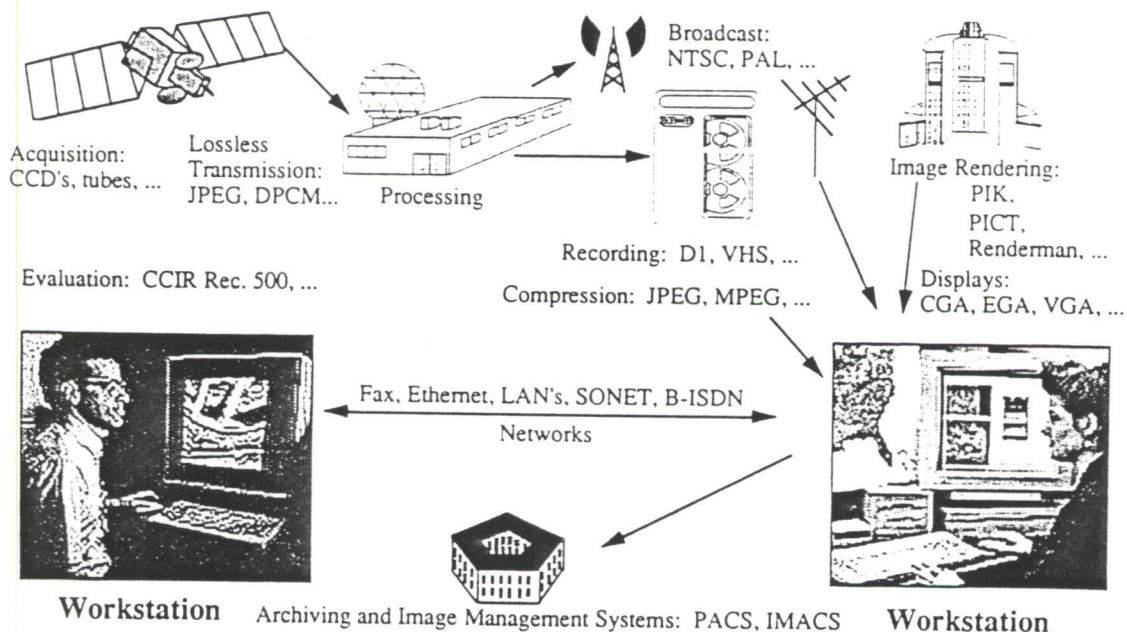


CC11



The World of Imaging Standards

... standards are needed wherever image data is used ...



CC12



Communications

... reaching out to both the Government and Industry ...

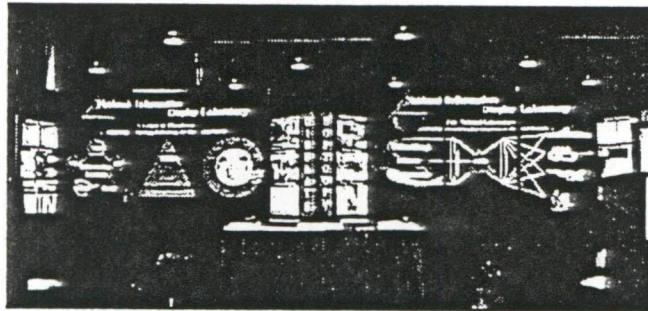
- Government

- IPWG
- NASA
- JNIDS
- NEL
- DNI
- DARPA

- ORD
- OSTP
- FAA
- IRDC
- DCA staff
- Navy Op 94

- Industry

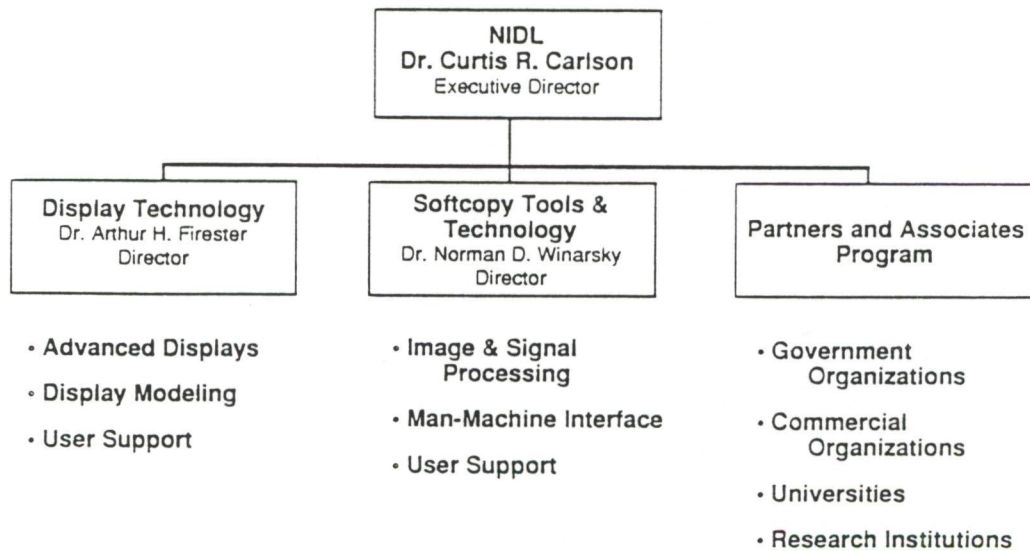
- Int'l. Display Conference Keynote
- SID Plenary Presentation
- SID Standards activities
- SID Display Booth
- JTEC
- Many other individual companies



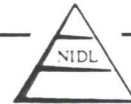
CC13



NIDL Organization



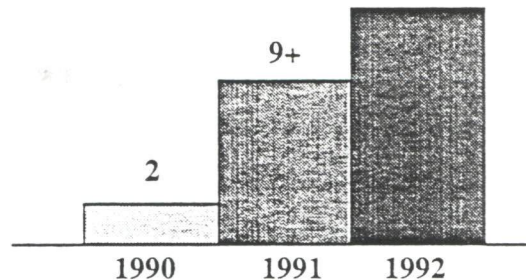
CC14



Partners and Users

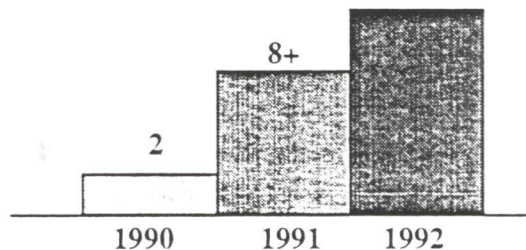
- Government Partners and Users

- Air Force
- Navy OP 94
- USGS
- JNIDS
- OSTP
- NEL



- Industry & Academia Partners

- Princeton University
- MIT
- Texas Tech
- Planar
- RCA/TCE
- DTI -AVP/MegaScan



CC15



Conclusions

... a new model for Government/Industry collaboration ...

- NIDL is a Center of Excellence in Softcopy Technology
- Goal: develop bold new way to satisfy the needs of Government Users through both:
 - Aggressive User support
 - Advanced technology
- Focus key softcopy and display technology on the interface to Users, to make them much more productive
- NIDL is a "Distributed Laboratory" with world-leading partners
- For additional information, call NIDL at 609-951-0150

CC16



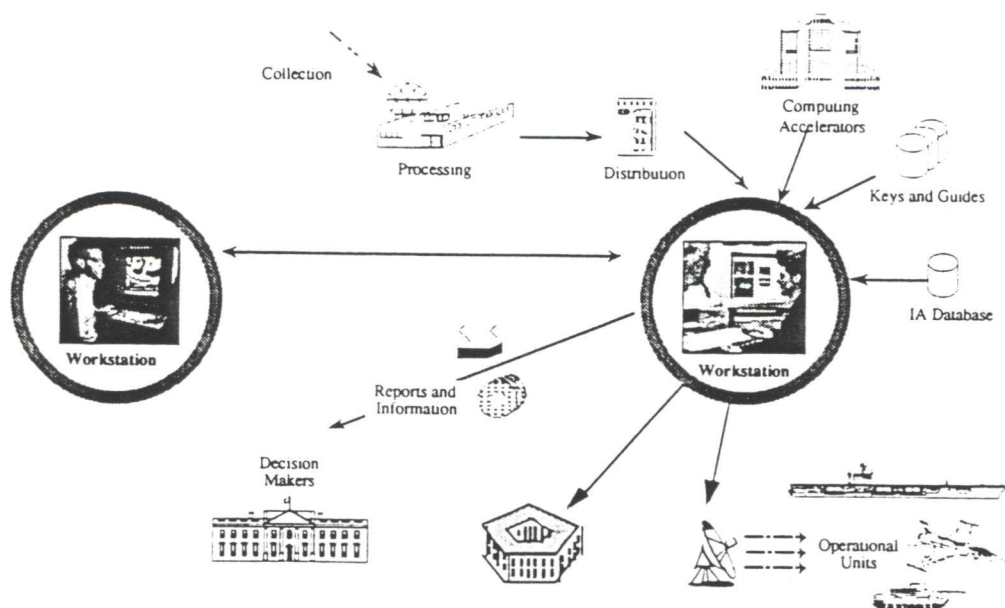
Softcopy Technology and User Support

Dr. Norman D. Winarsky
Director, Softcopy Technology

EE1



The Analyst's Softcopy Environment *... putting the Analyst in control ...*

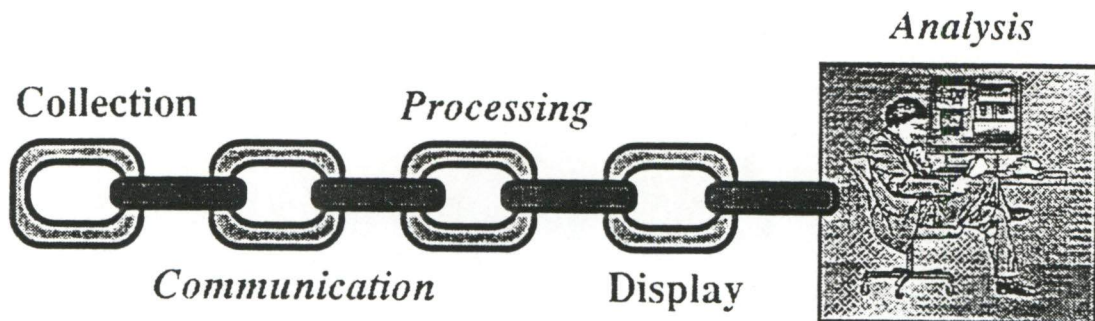


EE2



Information Flow

... maximizing return on collection resources ...



EE3



Information Flow Issues

... fundamental to making softcopy practical for the user ...

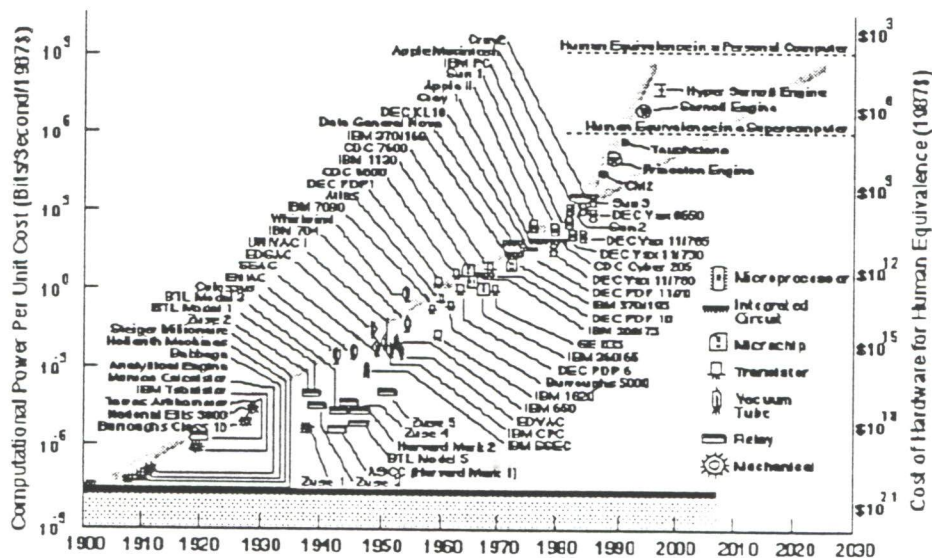
- Information Search
 - Finding the needle in a haystack
 - Computationally efficient approaches
- Algorithm Development
 - Proliferation
 - Prototyping
- Communications
 - Bandwidth
 - Smart interactive compression
- Parallel Computing
 - Computer power that rivals the human brain at reasonable cost
 - Real-time desktop image processor
- Virtual Reality

EE4



Computing in the 1990s

... emergence of a new power trend ...



EE5



NIDL Softcopy Technology Programs

User Support & Commercialization

- Algorithm Understanding Laboratory
- Softcopy User Support
- Data Central Archival Facility
- NTCS-A LAN

Applied Research & Development

- Collateral Data Analysis & Visualization
- Interactive Performance Visualization
- Keys & Guides: Interactive Search
- Visual Modeling
- Massively Parallel Production Front-end for Remote Sensing
- Efficient Multispectral Data Access

Advanced Research & Development

- Neural Network Tools and Applications
- Fast Model-based Volume Rendering
- Change Detection

- Air Force
- Navy
- NEL
- USGS
- Princeton
- Texas Tech
- General Dynamics
- TCE
- Michigan
- Phoenix

- Air Force
- USMC
- JNIDS
- CIA
- ORD
- NEL
- USGS
- NASA
- DARPA
- MIT

- Iterated Systems
- Silicon Graphics
- Greenville
- TCE
- SRI

- Air Force
- USGS
- DARPA
- US Park Service
- Princeton
- TCE

EE6

User Support



*... supporting the user and providing a foundation
for new technology development ...*

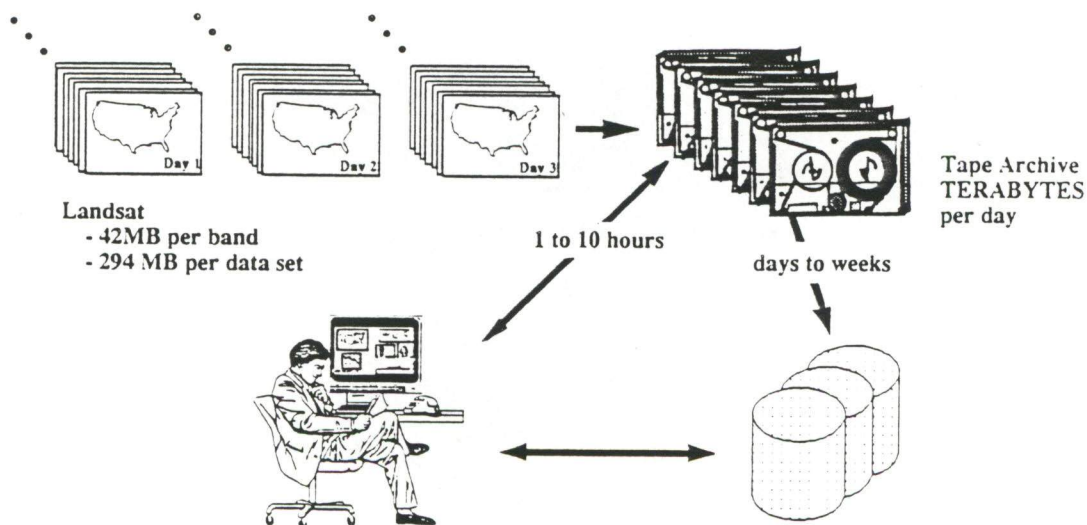
White House Communications Agency	Sunlight Teleprompter
Air Force	Data visualization for collection resource management
Air Force	Commercial technology assessment
USGS EROS Data Center	Investigate data access, compression, and visualization
DSPO	Diagnostic testing analysis
Navy	Copernicus Architecture Technology Program
Navy	FIST printer improvement

EE7

Image Search



*... finding critical data scattered in time, space,
and multiple spectral dimensions ...*

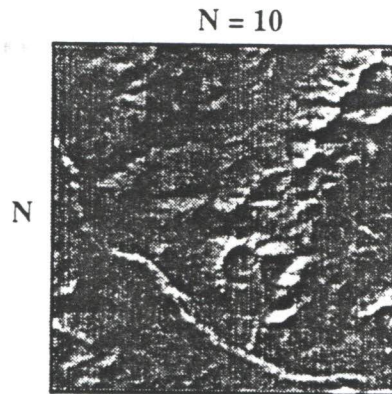
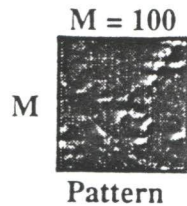


EE8



Content Based Search: Why is it a Problem?

... it can be computationally costly ...



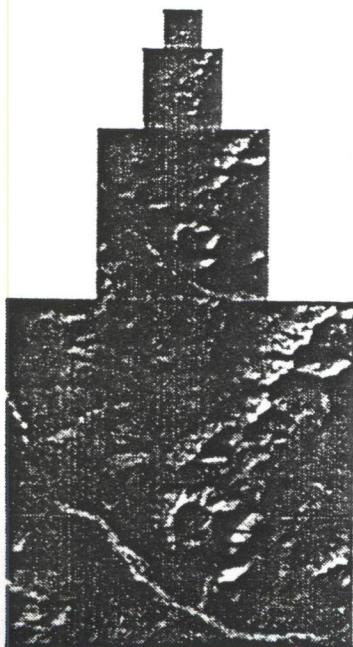
- For translation, rotation and scale: computational cost on the order of 10^{16} (proportional to N^2M^4)
- Conclusion: need a very computationally efficient approach

EE9



Achieving Computational Efficiency

... pyramid representation -- a necessary ingredient for success ...



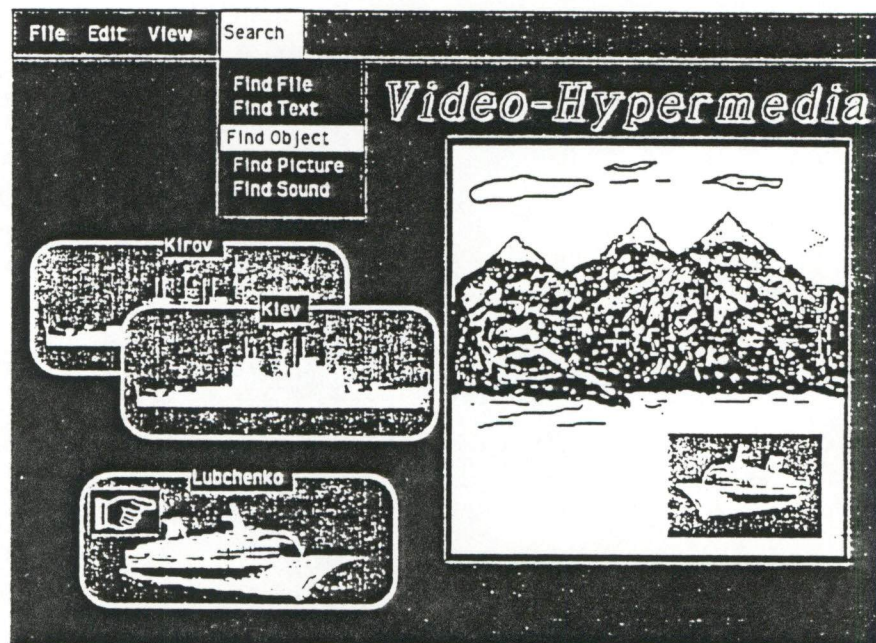
- Search efficiency
 - Work at the lowest resolution possible
 - Restrict areas of search
 - Match simple image features
- Provides computer savings of two orders of magnitude per pyramid level

EE10



Softcopy Keys & Guides

*... increasing the scope and power of what
can be done with images ...*

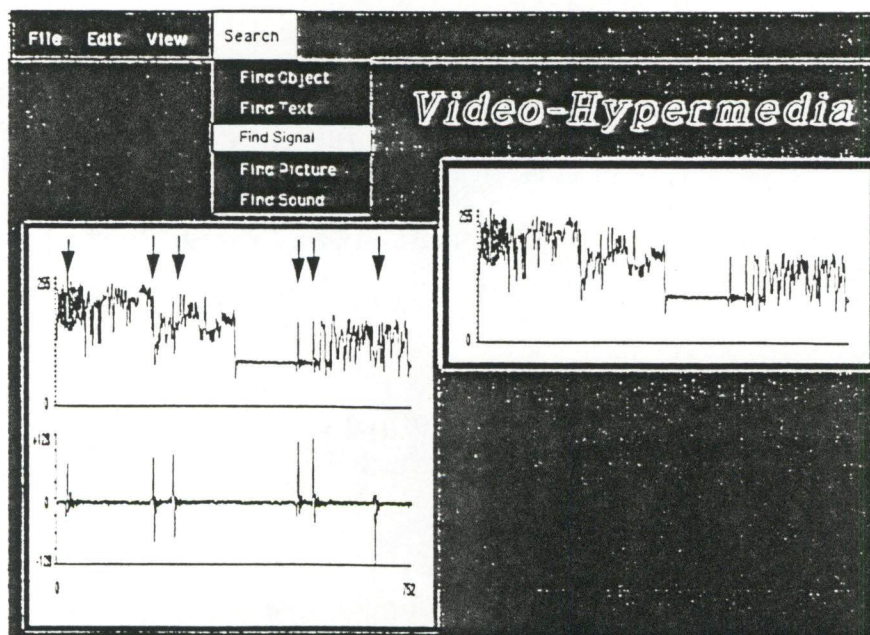


EE11



Softcopy Keys & Guides

*... increasing the scope and power of what
can be done with signals ...*



EE12

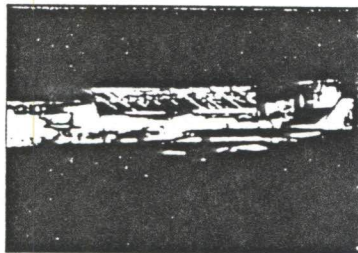


Sensor Fusion

... gaining maximal information from all sensors ...

Multiresolution approach:

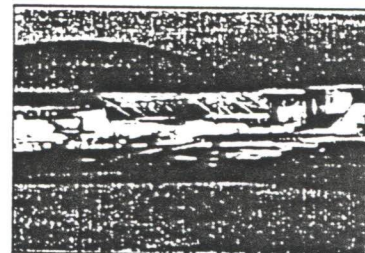
- Preserve essential image information
- Interactively select important structure
- Automatically select salient structure from each image



Visible Image



Infrared Image



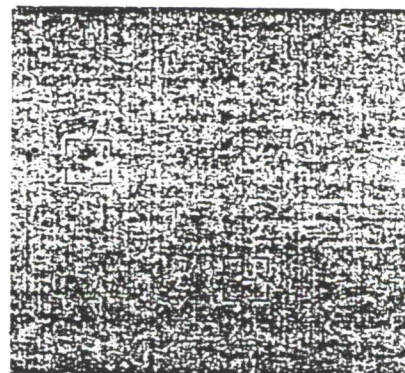
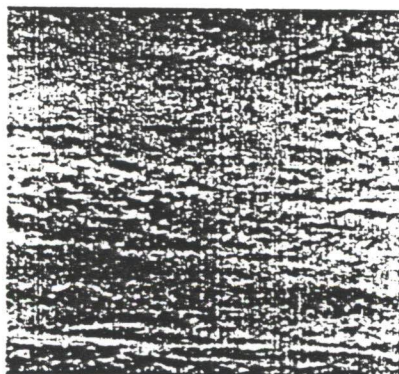
Automatically
Fused Image

EE13



Moving Target Detection

... using pyramid processing to pull targets from clutter ...

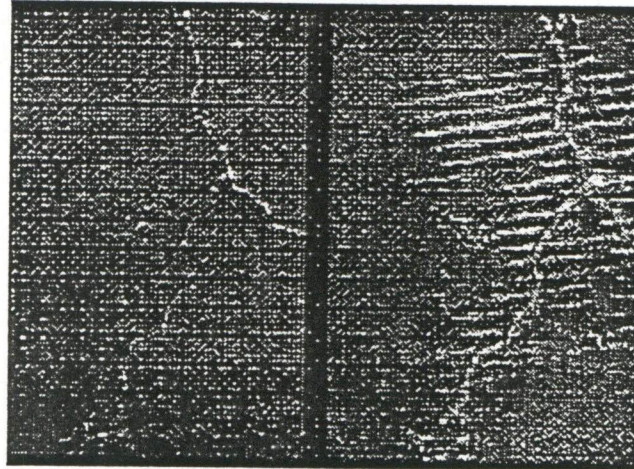


- Timescale of few seconds
- Small objects, highly localized (few pixels)
- Registration needed
- Limited variation in illumination and other factors

EE14

Deforestation Studies

... Brazilian Rainforest ...



Landsat MSS Image
June 19, 1975

Landsat MSS Image
August 1, 1986

- Timescale of years
- Changes somewhat localized
- Registration needed
- Other changes significant--e.g., illumination, ground cover

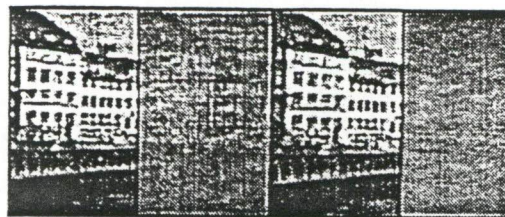
EE15

Algorithm Understanding Laboratory

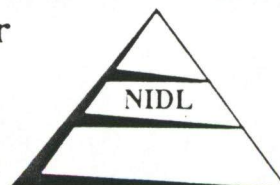
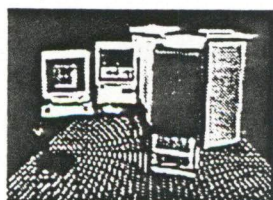
... interactively visualizing the development
of new algorithms and systems ...



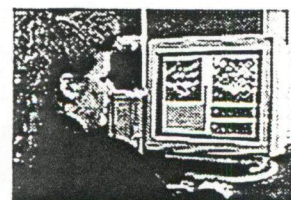
Visualization



Computational Power



Interactivity

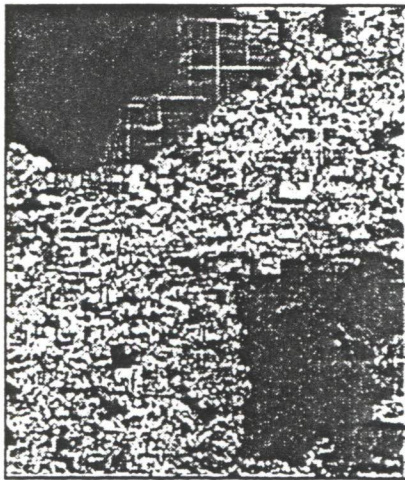


EE16

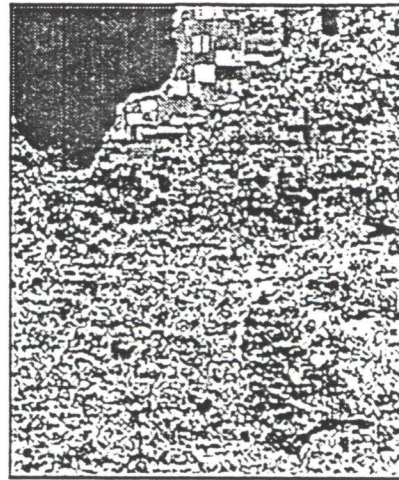


Multispectral

... sponsors use it ...



Original Image



Terrain Characterized Image

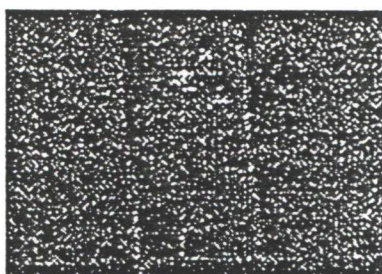
Interactivity aids algorithm understanding

EE17

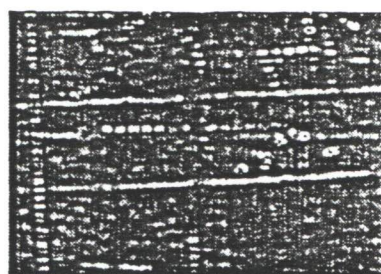


SAR

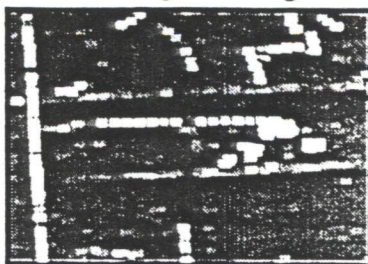
... contractors use it ...



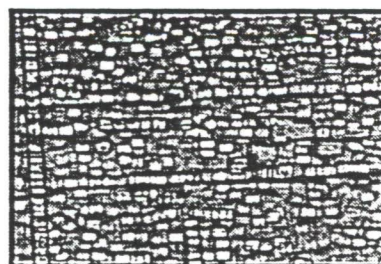
Original Image



Feature 1



Feature 2



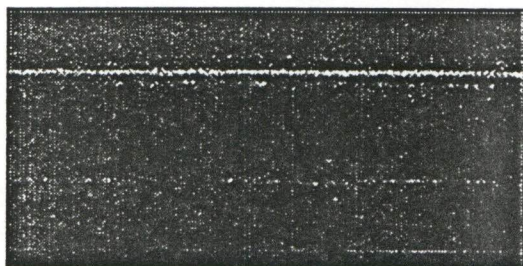
Feature 3

Visualization aids algorithm understanding

EE18

Neural Networks

... we use it ...

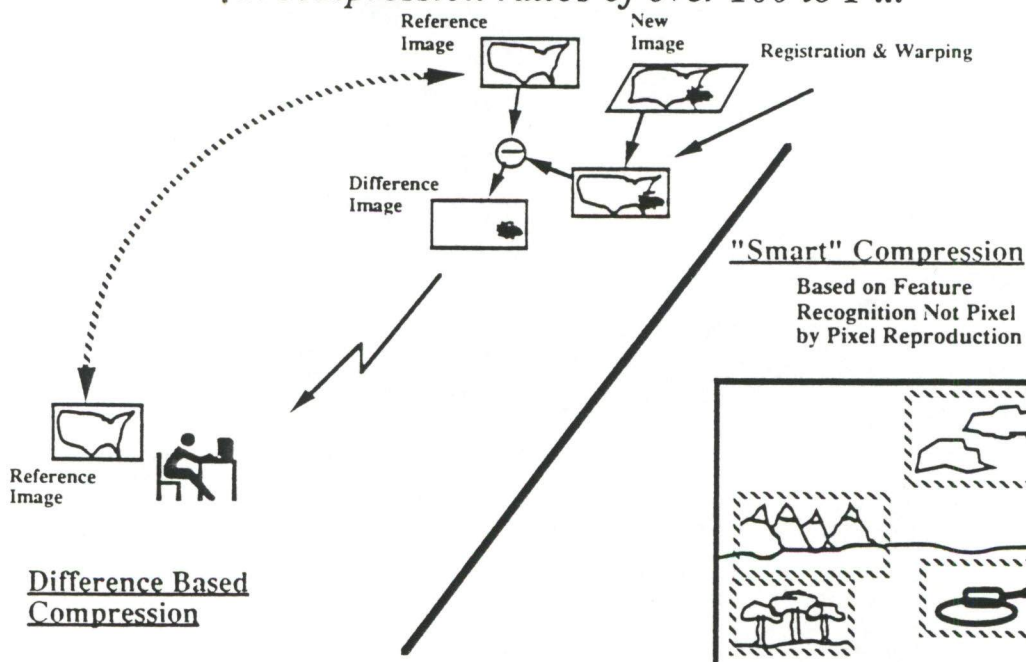


Computational power aids algorithm understanding

EE19

Paradigm Breaking Compression Schemes

... compression ratios of over 100 to 1 ...

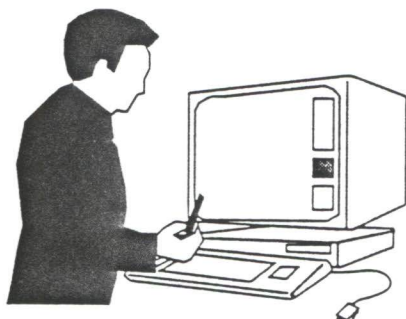


EE20



Desktop Supercomputer

*... putting the needed processing power
at the user's fingertips ...*



- Massively parallel accelerator board
- For COTS workstations
- Up to 300 to 1 acceleration
- UNIX, C, Fortran 90

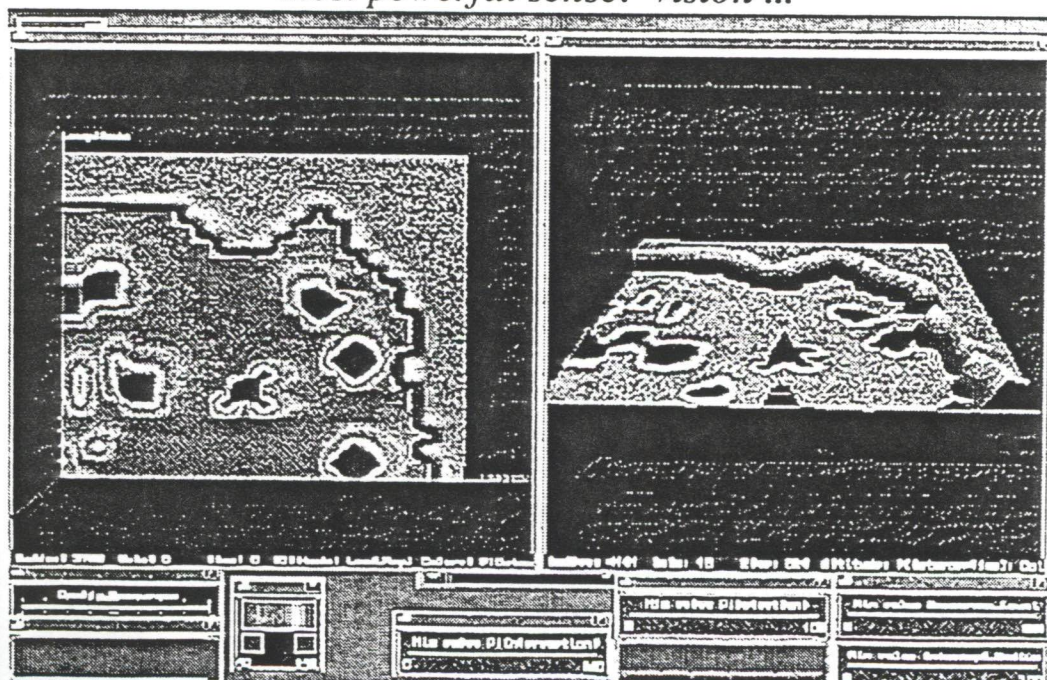
Applying massively parallel computer technology,
available submicron IC's, and multichip module packaging
to provide a cost effective, 3200 MIPS, accelerator.

EE21



Data Analysis and Visualization

*... presenting complex information to the user's
most powerful sense: vision ...*

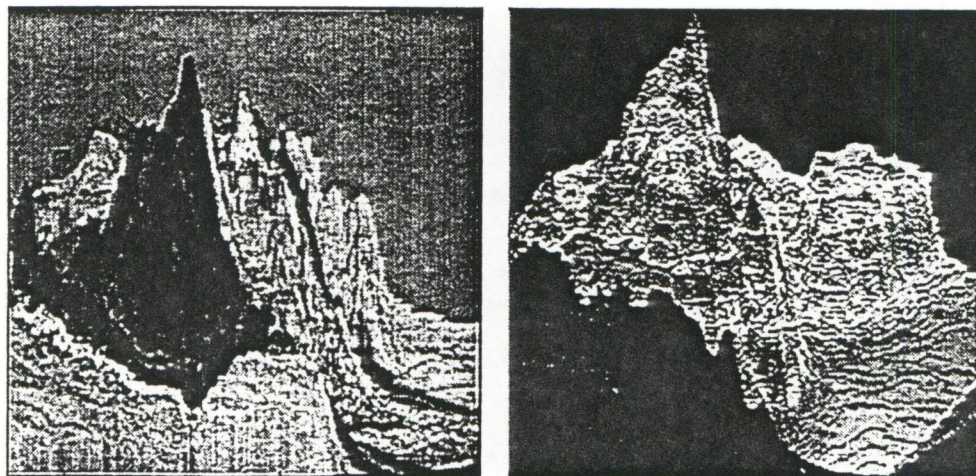


EE22



Parallel Terrain Rendering

... future directions in realistic scene rendering ...

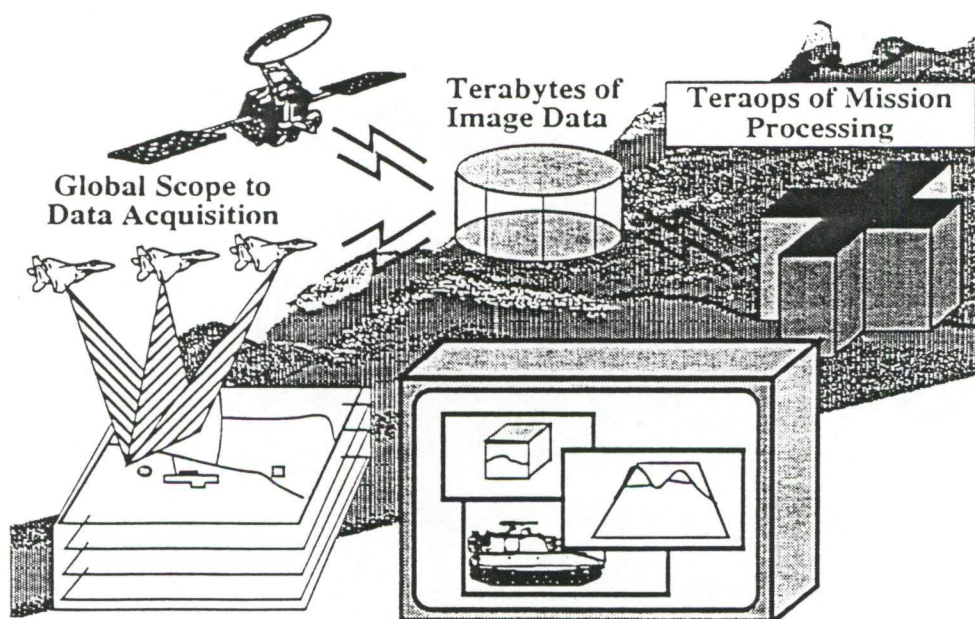


EE23



Virtual Reality

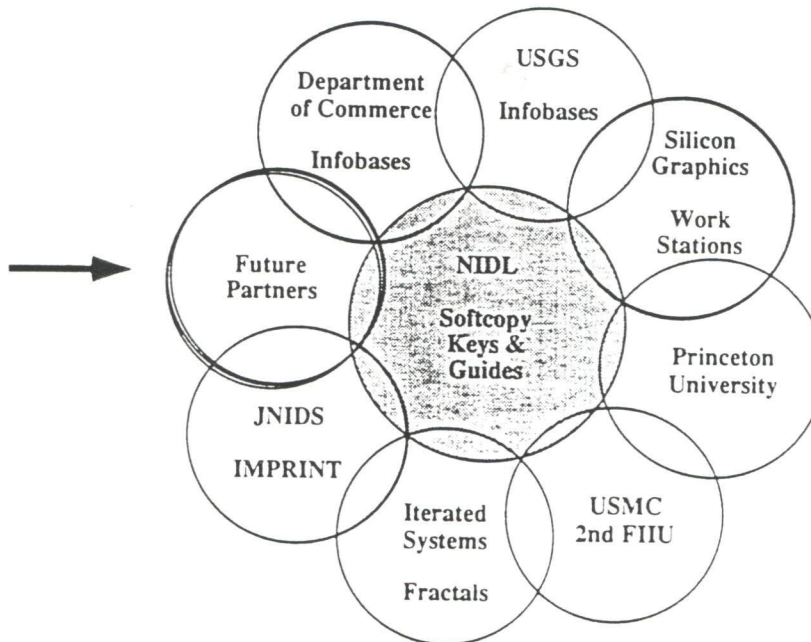
... immersing the user in information ...



EE24

Softcopy Keys & Guides

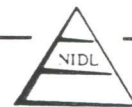
*... providing leverage with government, industry
and academic partnerships ...*



EE24a

JNIDS/NIDL IMPRINT

... an IMagery PRototyping INiTiative ...



- JNIDS Charter
 - Accelerate, extend and deepen the intelligence analyst's cognitive abilities through rapid application of advanced technology
- USMC 2nd FIU Mission
 - Derive intelligence information from aerial imagery produced from thermal infra-red (IR) sensors, side looking airborne radar (SLAR), and conventional photography
- Fundamental User Need
 - Assistance in the process of exploiting aerial imagery

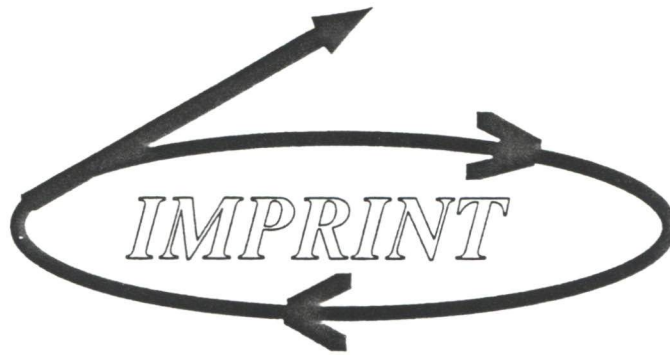
EE25



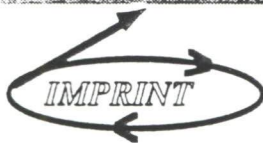
Summary

... the model is working ...

- Softcopy technology is undergoing simultaneous evolution and revolution
- NIDL technology and user support programs are in place to address government user needs of today and the future
- NIDL continuously seeks additional users and partners to steer and implement these programs



IMAGERY PROTOTYPE INITIATIVE



OBJECTIVE

**"CREATE THE NEXT GENERATION
OF IMAGERY TOOLS... TODAY"**



BACKGROUND

- Fully funded cooperative effort between NIDL & JNIDS
- Approved by MIB as FY92 initiative
- Operational testbed at 2nd FIIU



CURRENT STATUS

- PHASE 0: COMPLETE
- PHASE 1: UNDERWAY
- 1ST DELIVERY: JUNE 92





Display Technology and User Support

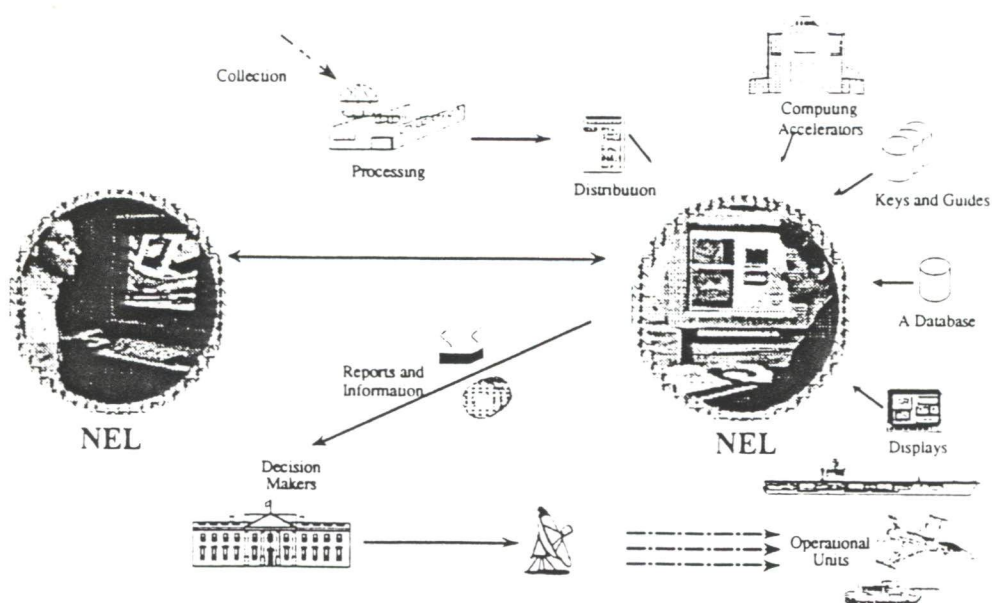
Arthur H. Firester
Director, Display Technology

DD1

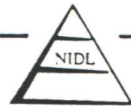


The Analyst's Softcopy Environment

... putting the Analyst in control ...

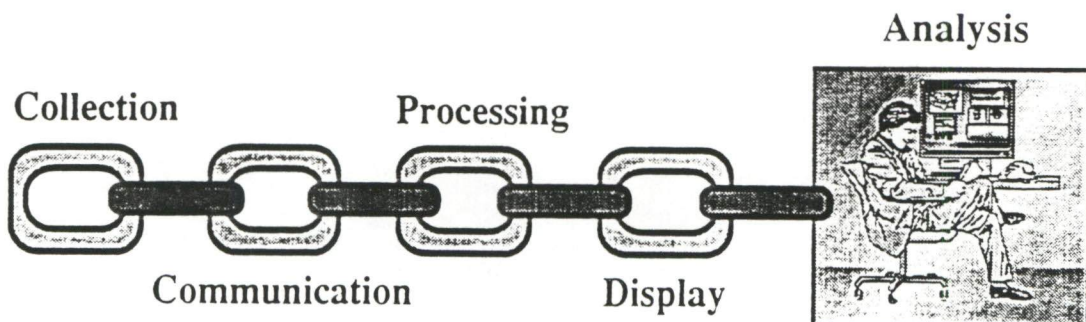


DD2



The Display

*... the last link in the information chain
to the Analyst ...*

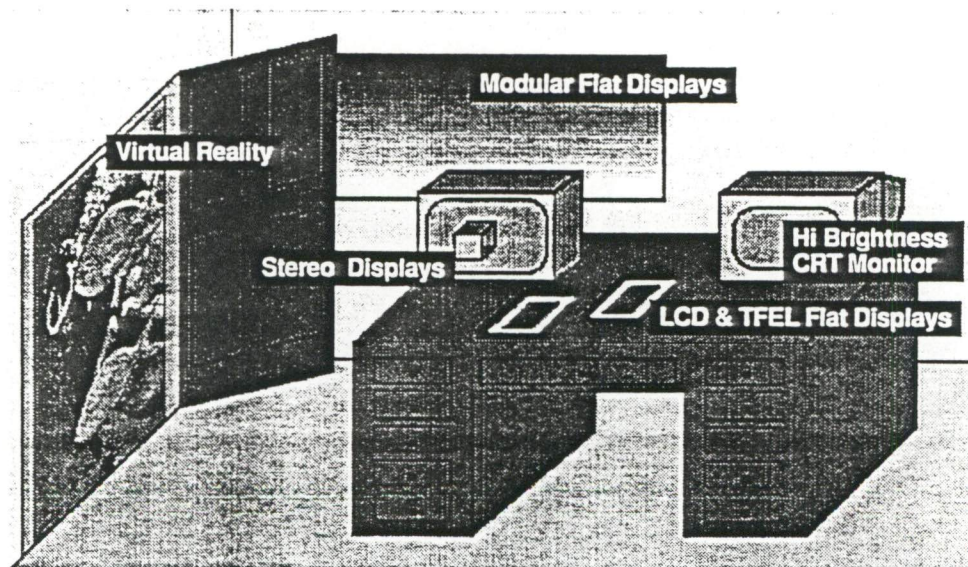


DD3



Advanced Displays

*... breadth of user needs drives a multiplicity of
display technologies ...*

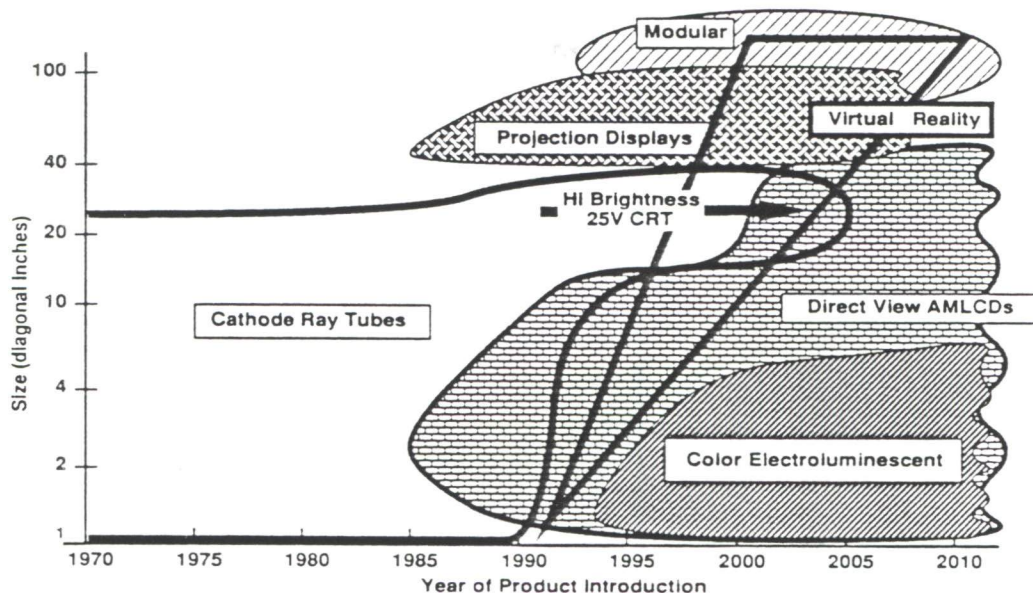


DD4



Technology Trends

*... medium size CRTs will remain dominant
for at least 10 more years ...*



Display Issues

*... differing display needs drive simultaneous
development of many display technologies ...*

CRT

- Resolution vs. Brightness vs. Color compromise driven by basic physics

LCD

- Manufacturability
- Size and resolution
- System Reliability/Integration

EL

- Color
- Brightness

Tiling

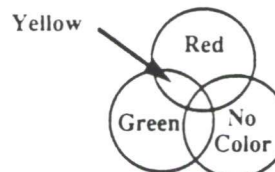
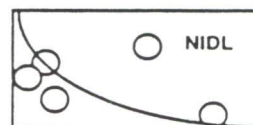
- Invisible Seams

Electronic Paper

- Basic electrically addressed display phenomena
- Reflected brightness and angular viewability

Virtual Reality

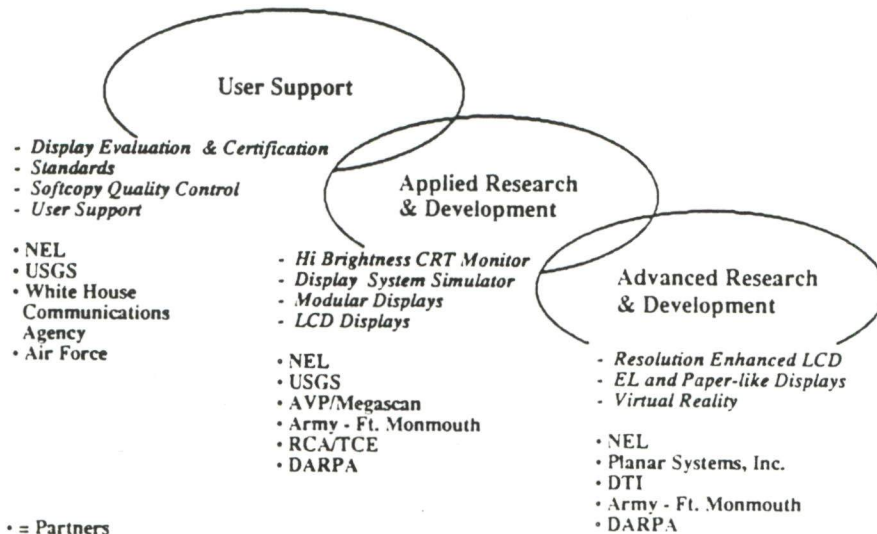
- Resolution matched to human eye
- Display goggles





NIDL Display Programs

... a technology spectrum supporting user's current and future needs ...



DD7



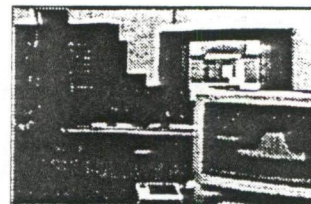
Display Evaluation and Certification

... helping the government user make the right monitor selection ...

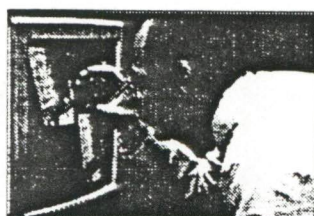
Measurement Procedures



Measurement Laboratory



Task Dependent Evaluations



Reports



DD8



Display Measurement Standards

... to enable leveraging of technology, markets, and to broaden involvement ...

- Version 1.0 and 2.0 disseminated to users, manufacturers, and technical communities
- Version 3.0 in preparation for review by SID-EIA



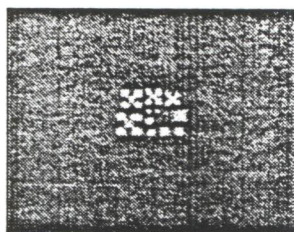
Measurement Procedures

DD9

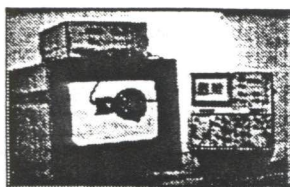


Softcopy Quality Control

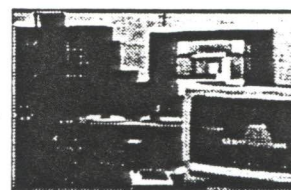
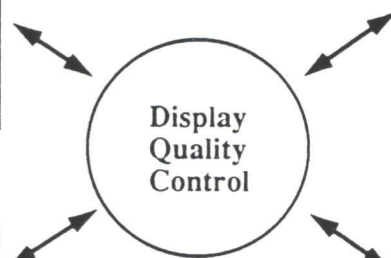
... on-site display performance evaluation to ensure user-specific softcopy quality control ...



User Test Software



User Test Hardware



Display Evaluation & Certification



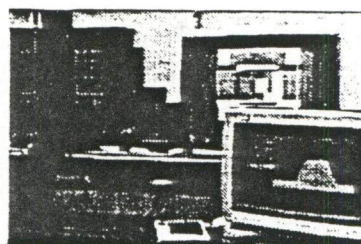
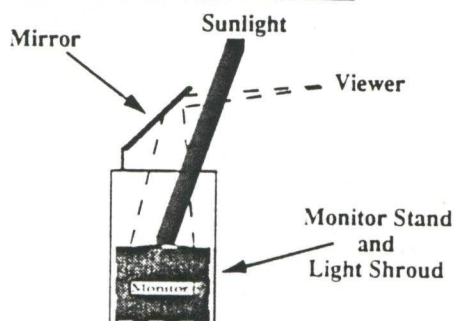
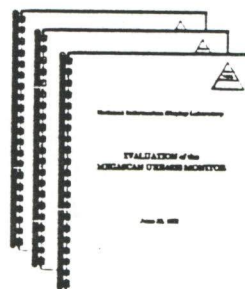
Display Simulator

DD10



User Support

... timely response to user needs ...

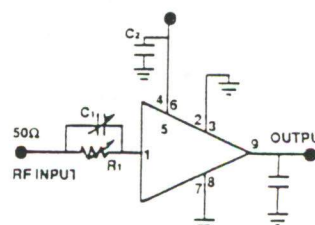
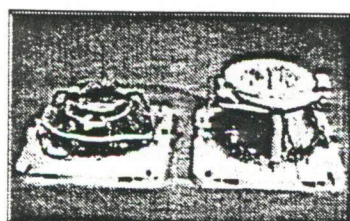
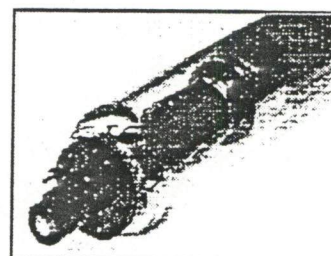
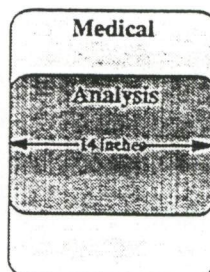
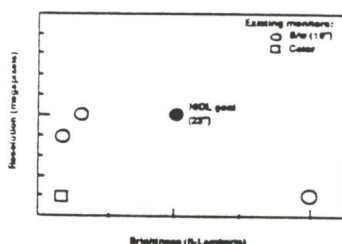


DD11



High Brightness, High Resolution CRT Monitor

... high brightness, uniform resolution, large screen COTS monitors are needed but not available ...

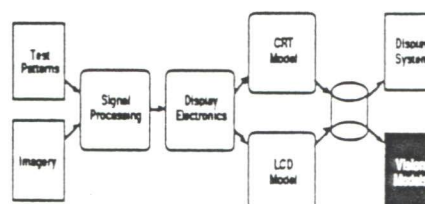
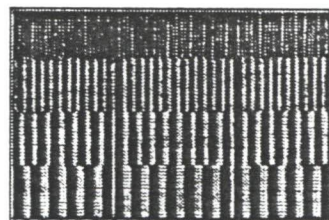
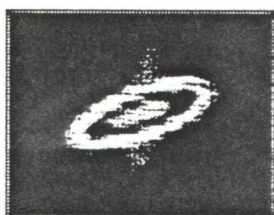
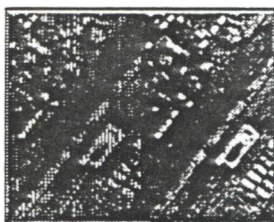


DD12



Display System Simulation

*... simulation enables rapid display system specification
and eliminates extensive, costly, slow prototyping ...*



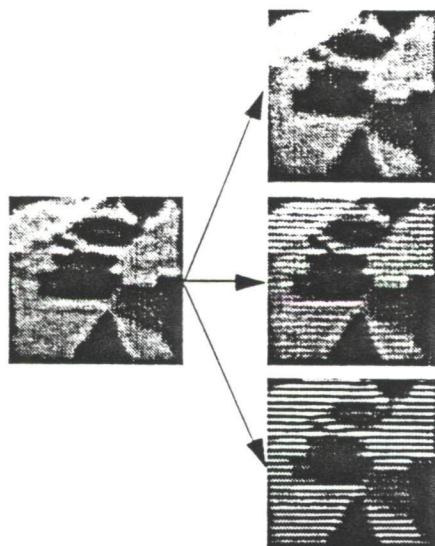
Data Flow Design Paradigm

DD13

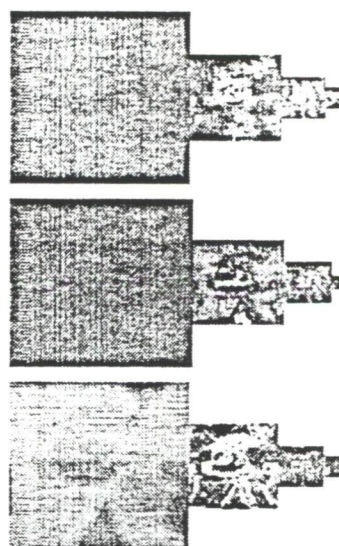


Human Visual Modeling

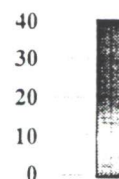
*... using a model of the human mind to
help design new imaging systems ...*



Simulated Images



Non-oriented Discriminability Maps



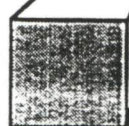
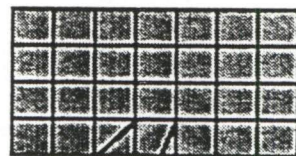
DD14



Modular Displays

... wall displays built cost effectively by seamless tiling of individual units ...

- Determine psychophysical requirements for invisible seams
- Evaluate tiling concepts through modeling and simulation
- Evaluate and prioritize technologies
- Develop approach satisfying requirements



Example
14-inch diagonal
1024 x 768 pixels
0.28 mm/pixel

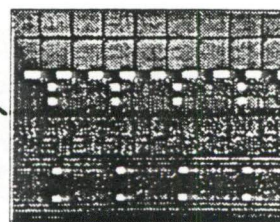
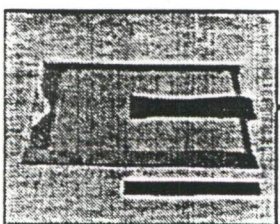
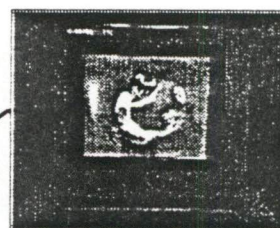
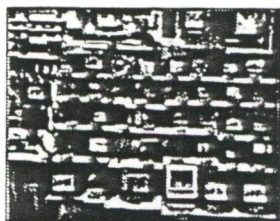


DD15



Active Matrix LCDs

... active matrix liquid crystal displays are becoming the dominant display technology ...



Applications
Technology
Availability

DD16

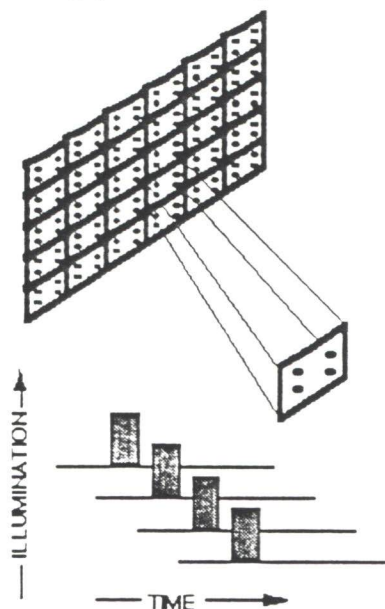


Resolution Enhanced LCDs

... multiplying resolution without reducing production yields ...

Dimension Technologies Inc.

- Demonstrate 4X enhanced resolution through subpixel sequential illumination
- Explore engineering issues
- January '92 contract start



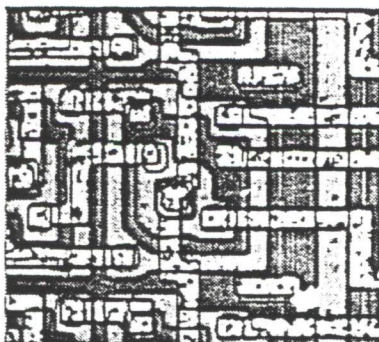
DD17



What's the Difference? - Not Much

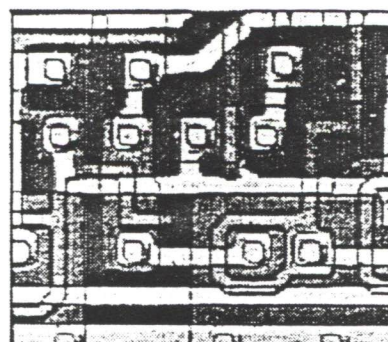
... future displays will include massively parallel computation capabilities ...

RCA 1802 Microprocessor
(5 μ m IC Technology)



CMOS Microprocessor
on Si (circa 1972)

Sarnoff's 6" x 8" LCD Display
(5 μ m IC Technology)



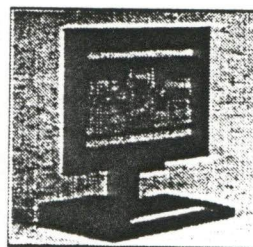
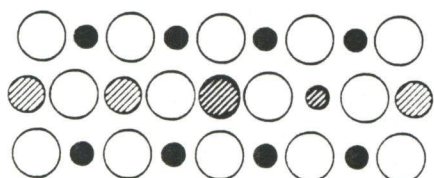
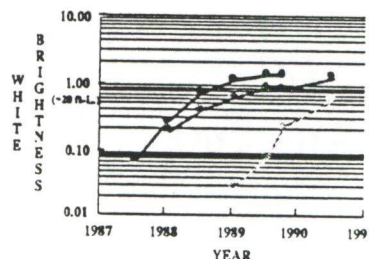
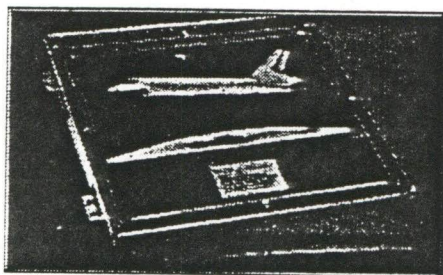
Si LCD Driving Circuitry
on Glass (circa 1991)

DD18



Color EL Display Development

... lack of an efficient blue phosphor is technology bottleneck ...



A full partnership program with Planar Systems, Inc.

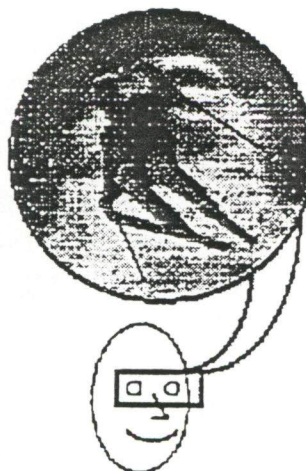
DD19



Virtual Reality

... head-mounted displays demonstrate the most promise for near-term development ...

- Active Matrix LCD
 - 1500 lines/inch
 - integrated drivers
 - full color now
- Active Matrix EL
 - 1000 lines/inch
 - integrated drivers
 - full color soon
 - fully solid state
- Deformable Mirror Device
 - 1500 lines/inch
 - integrated drivers
 - full color now
 - very accurate grayscale



DD19a



Summary

- Display technology is undergoing simultaneous evolution and revolution
- NIDL technology and user support programs are in place to address government user needs of today and the future
- NIDL continuously seeks additional and partners to steer and implement these programs



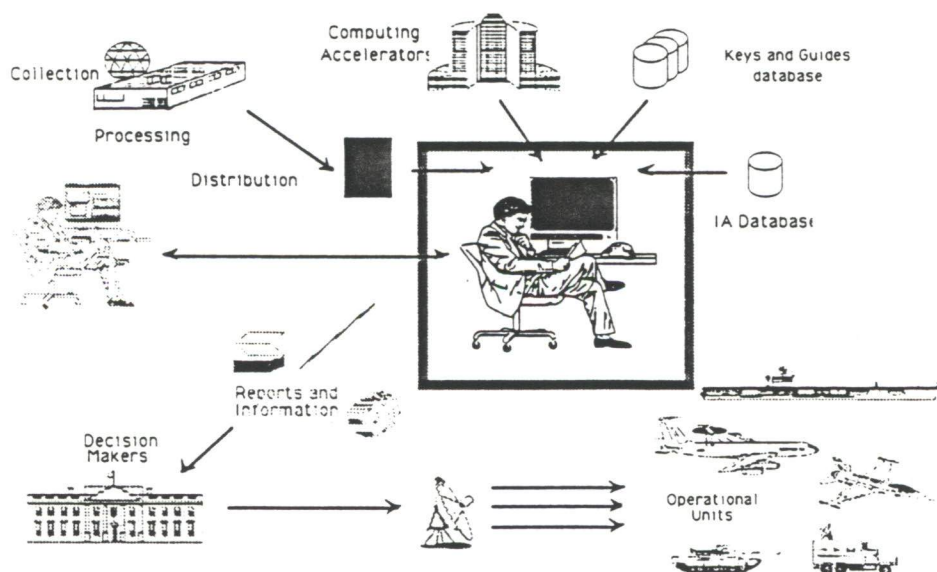
Future Directions

FF1

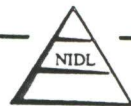


The World of Softcopy Today

... providing the user with initial softcopy tools ...

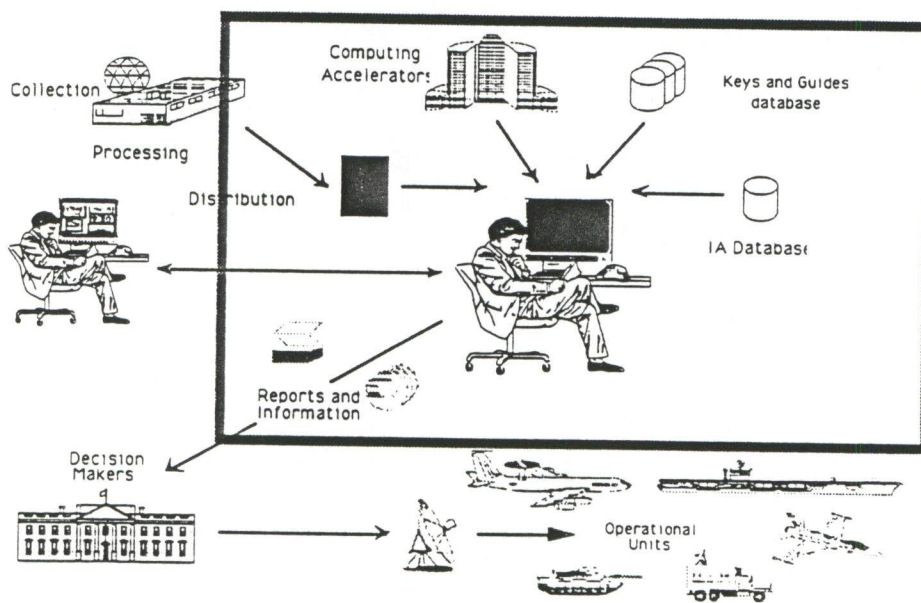


FF2



The World of Softcopy Tomorrow

... giving users control of their environment ...

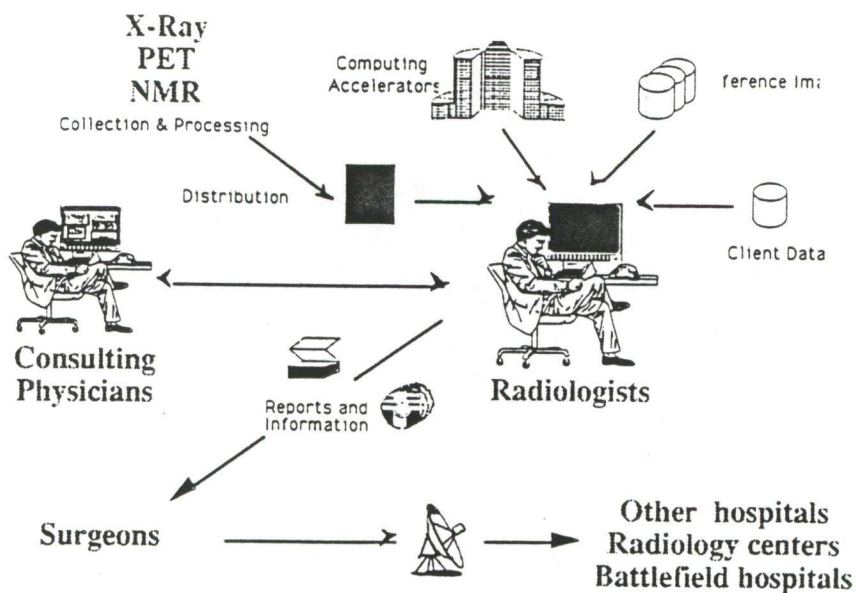


FF3



Medical Softcopy Environment

... emerging opportunities to leverage other industries ...



FF4



Next Steps

... the National Laboratories are established and ready to help ...



1988



1989



1990



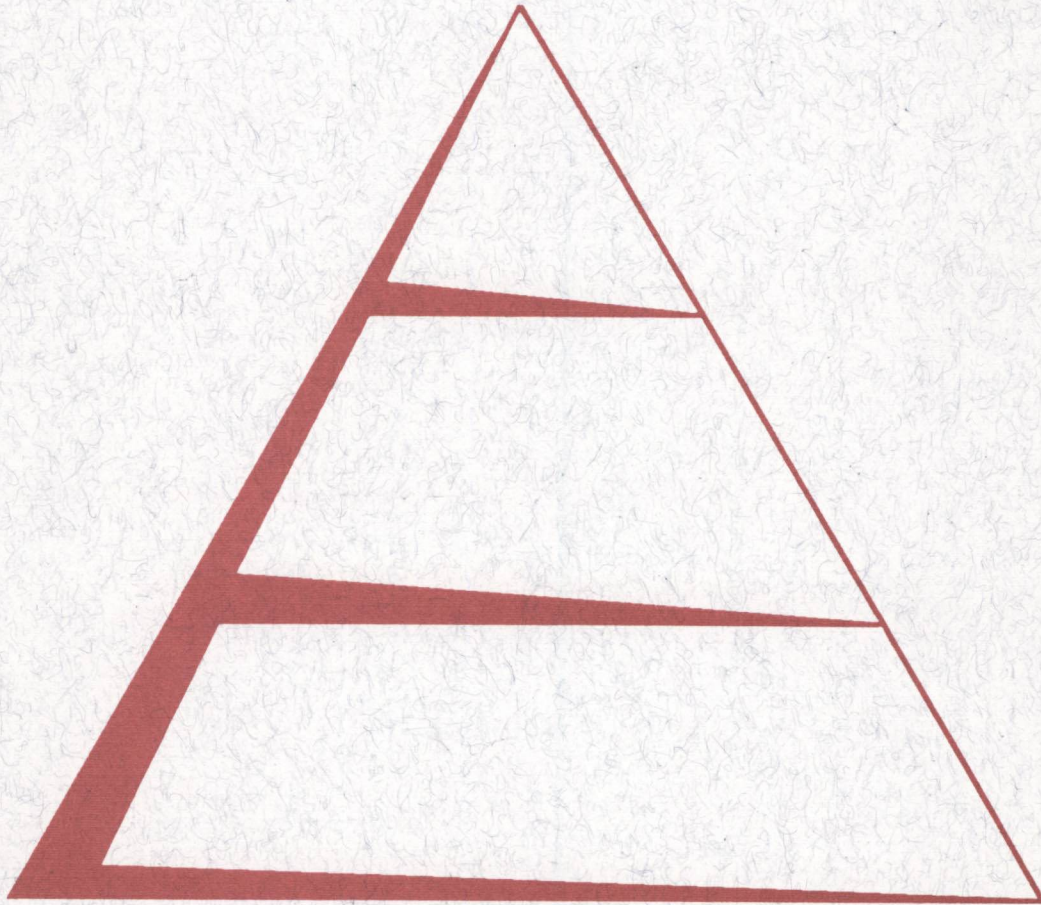
1991



1992

FF5

National Laboratories



**House Permanent Select
Committee on Intelligence
(HPSCI)**

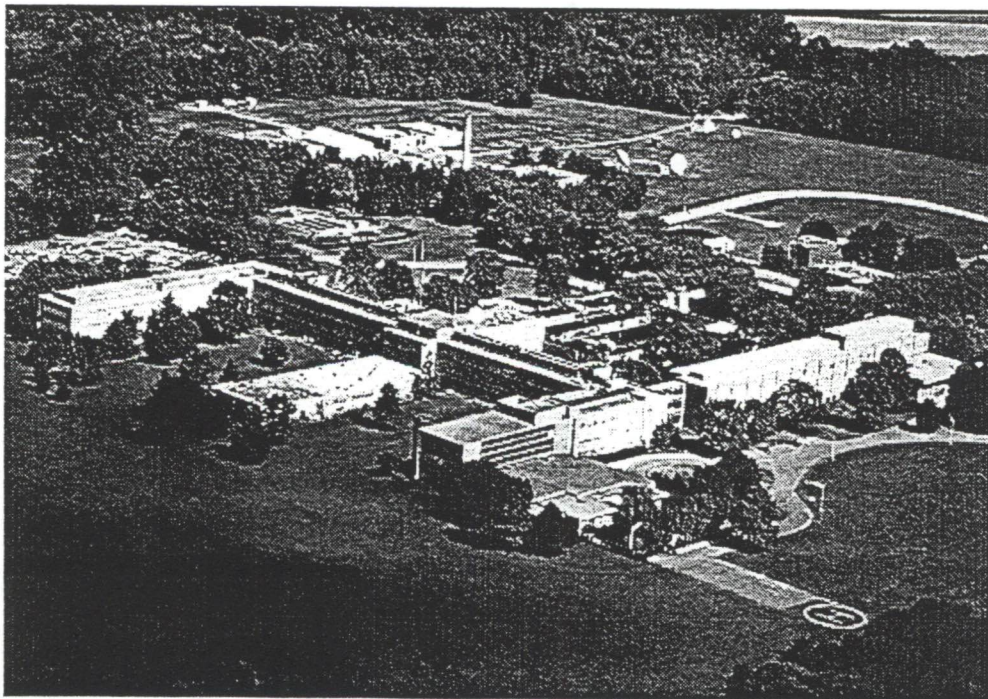
February 10, 1992

Introduction to the David Sarnoff Research Center

Sarnoff

AA1

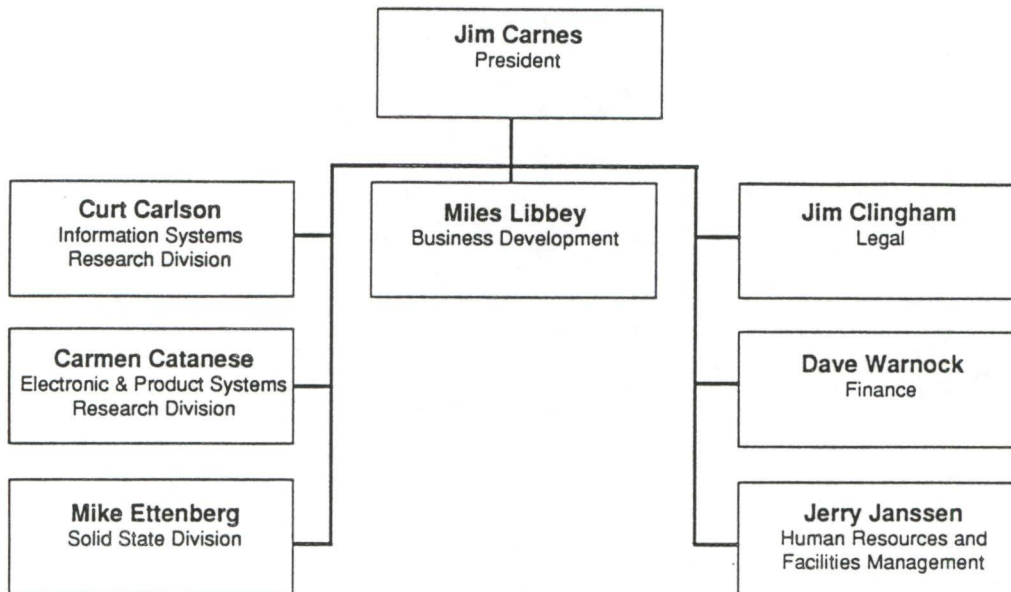
The David Sarnoff Research Center



Sarnoff

AA2

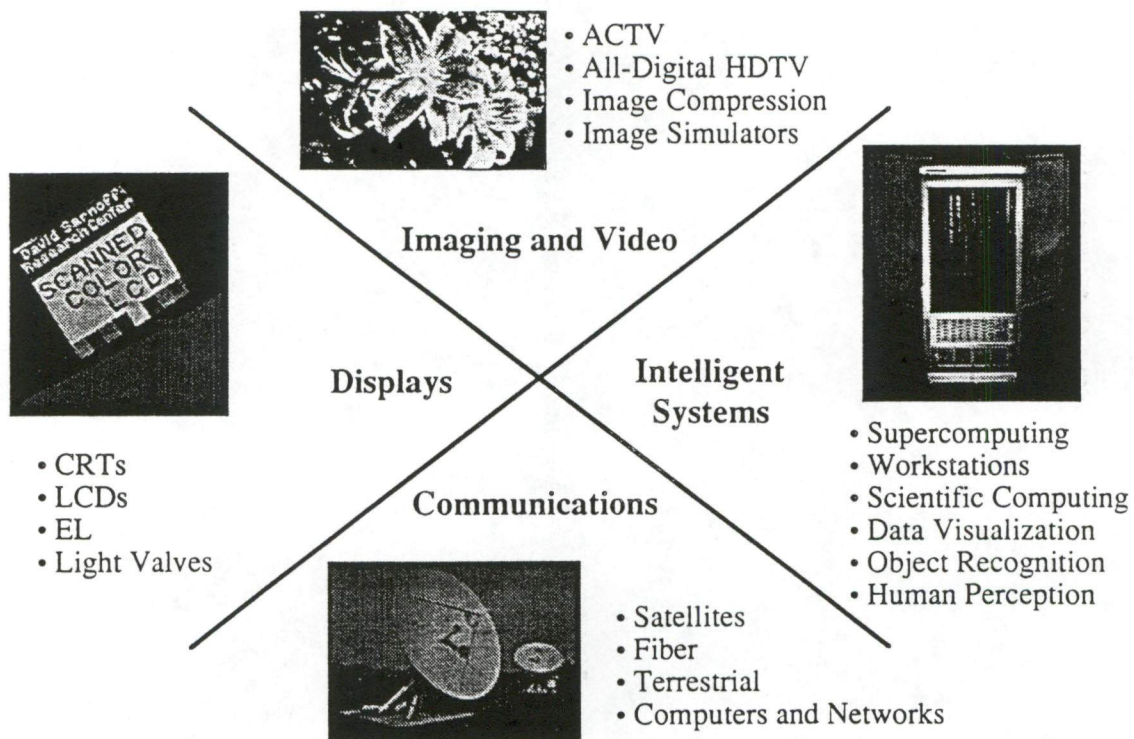
The David Sarnoff Research Center



Sarnoff

AA3

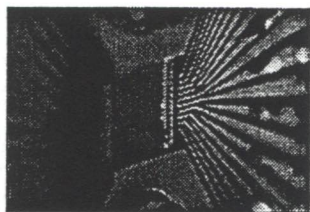
Information Systems



Sarnoff

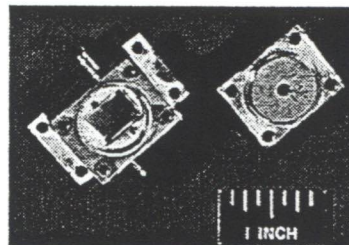
AA4

Solid State



Optoelectronics

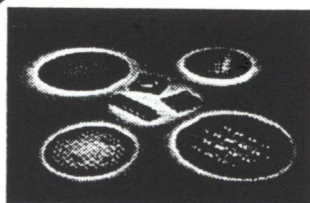
- Lasers
- Fiber Optics
- Optical Recording
- Imagers
- Photodetectors



Microwave

- Power Amplifiers
- Sensors
- Receivers
- MIMICs/OEICs
- Superconducting Filters
- CAD/CAM

Integrated Circuits

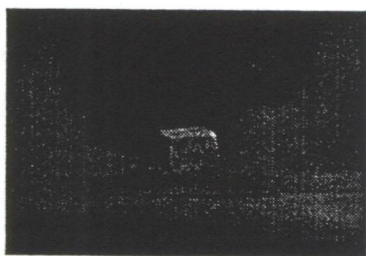


- Sub-Micron
- Rad hard
- Analog-Digital
- GaAs on Sil
- Smart Sensors
- Smart Power

Sarnoff

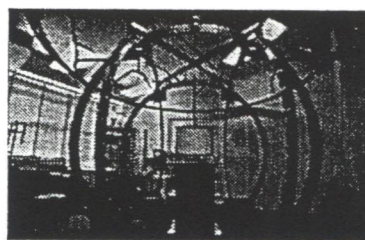
AA5

Materials and Manufacturing



Materials

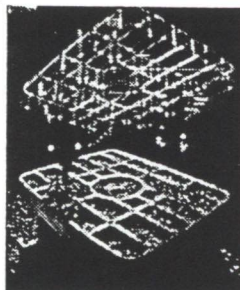
- SOS
- Ceramics
- Diamonds
- Luminescence
- Superconductivity
- Analysis
- Characterization



Systems & Processes

- Display Systems
- Display Manufacturing
- Integrated Process & Control
 - AI
 - Vision
 - System Modelling

Automation



- Electromechanical
- Manufacturing Equipment
- Electronic Packaging
- Prototypes

Sarnoff

AA6

Pioneering Contributions

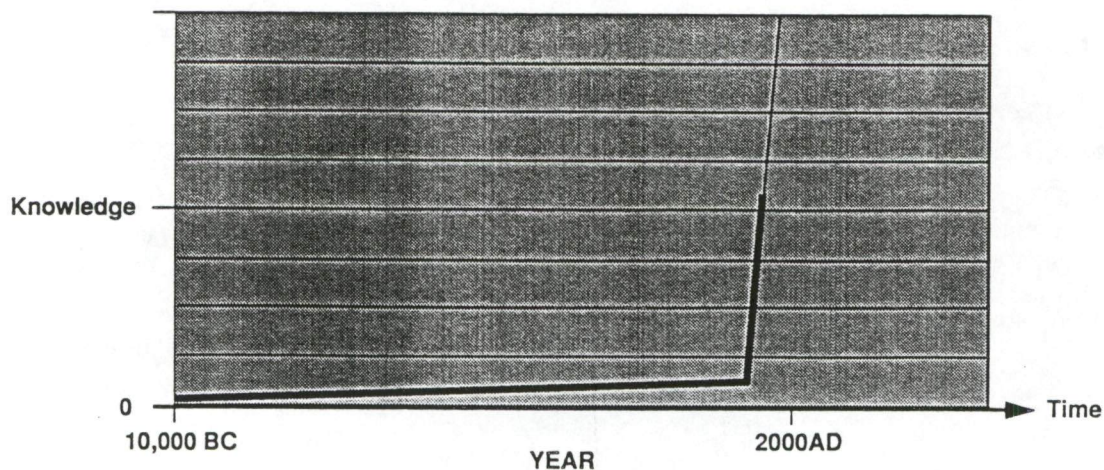
1943	Image Orthicon Camera Tube	1975	CMOS Microprocessor
1946	All-Electronic Color TV System	1976	All-Electronic TV Tuning System
1949	Magnetic Core Memory	1976	Just-Noticeable Difference Analysis
1949	Vidicon Camera Tube	1977	Silicon-on-Sapphire ICs
1950	Shadow Mask Color Picture Tube	1977	Amorphous Silicon Solar Cells
1953	Transistor Complementary Symmetry Principle	1977	CCD Comb Filter
1953	Magnetic Tape Recording (B&W and Color)	1982	Laser Diode Optical Recording
1954	Electrofax	1982	Coty-29 Picture Tube System
1955	Alloy-Junction Drift Transistor	1982	GaAs FET Microwave Amps (SSPAs)
1956	Transistor Temperature Compensation	1982	Pyramid-Based Image Processing
1963	Metal Oxide Semiconductor (MOS)	1984	CCD Broadcast Camera
1964	CMOS	1986	Grating Surface Emitting Laser
1966	Vapor-Phase-Growth for Gallium Arsenide	1986	Stereo Broadcast Television
1968	Liquid Crystal Display Technology	1987	DVI Technology
1968	Heterojunction AlGaAs Laser	1987	ACTV System
1968	Negative Electron Affinity Emitters	1988	Princeton Engine
1974	CCD Image Sensor	1989	Superconducting Microwave Filter
1974	ColorTrak TV Receiver	1990	High-Power Laser-Activated Switch
		1991	All Digital HDTV: ADTV
		1991	DARPA DMD HDTV Projector
		1992	DARPA High Res Workstation

Sarnoff

AA7

The Information Explosion

... approximately 90% of all knowledge was generated in the past 35 years: It will double again in the next 10 - 15 years ...



Source D.B. Merrifield: U.S. Department of Commerce

Sarnoff

AA8

The Importance of Images

... one of the keys for managing the information explosion ...

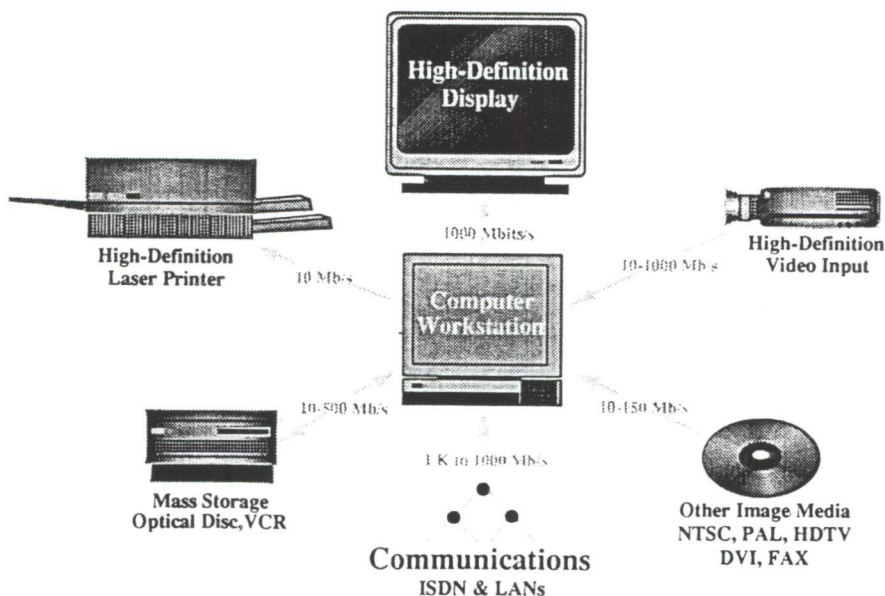
- Our most important sense
 - 10^9 bits/sec for vision
 - 10^5 bits/sec for hearing
- Often the best (only) means of analyzing complex data
- Images are "interesting" and "compelling"
- But
 - Resolution must match the eye
 - Moving images contain 10-100 times more information
- Requires
 - Communication rates that match the human visual system
 - Computer power that rivals the human brain

Sarnoff

AA9

Office Environment of the Late 1990's

... the office will heavily exploit imaging technology ...



Sarnoff

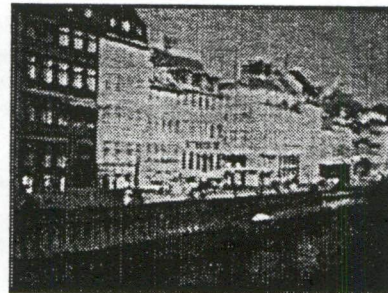
AA10

HDTV

... the key is extremely high-performance image compression ...



HDTV



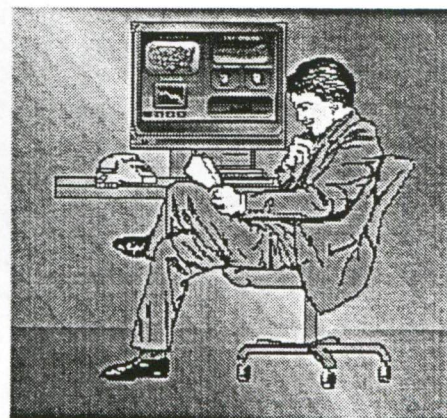
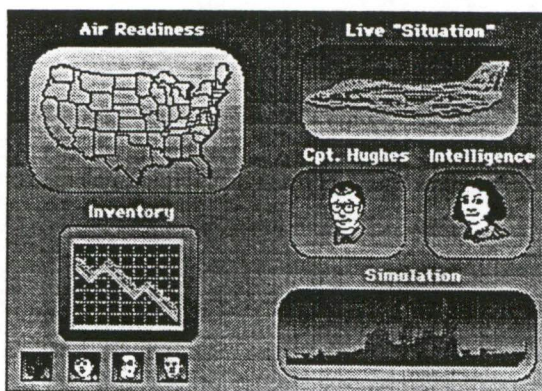
NTSC

Sarnoff

AA11

High-Resolution Video Workstations

... will have multiple video and graphics windows ...



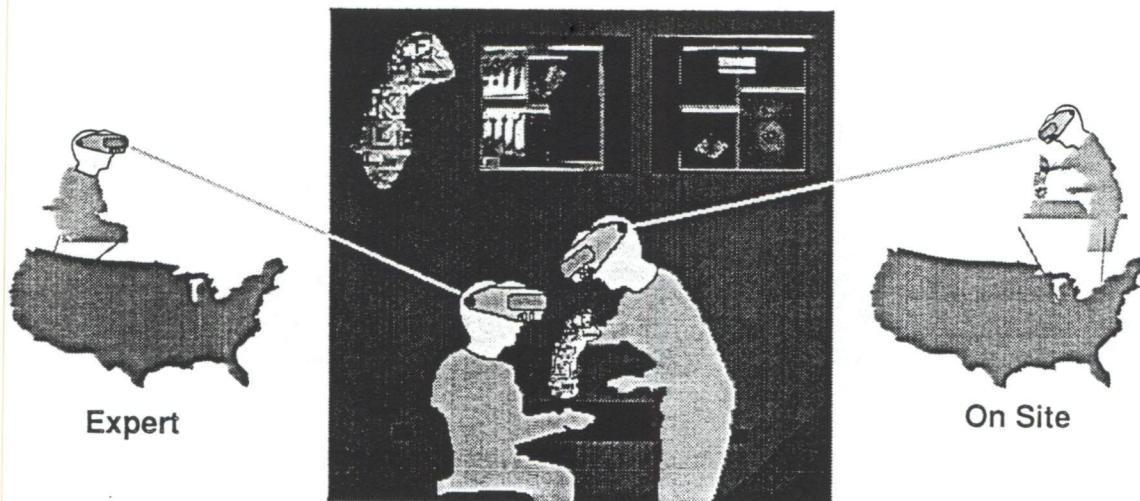
Sarnoff

AA12

Virtual Reality

... creating real-time, high-resolution, 3D synthetic environments ...

Collaborative Workplace

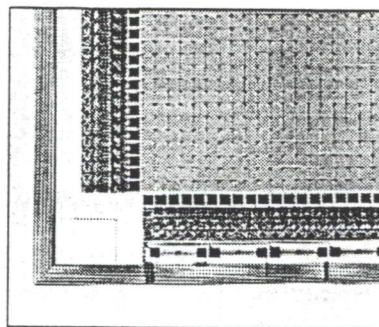
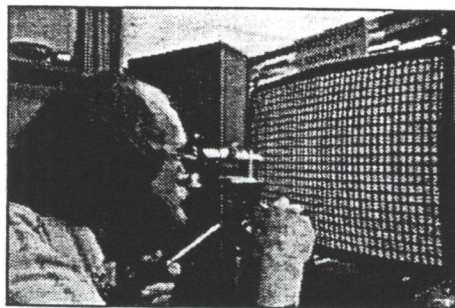


Sarnoff

AA13

Display Technologies

... large, uniform, high-resolution, bright displays ...



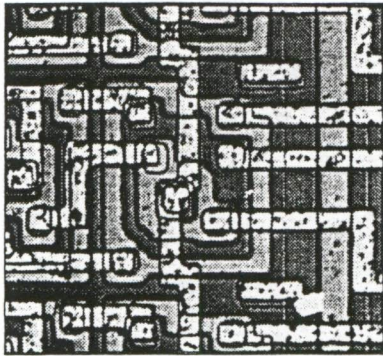
Sarnoff

AA14

What's the Difference? - Not Much

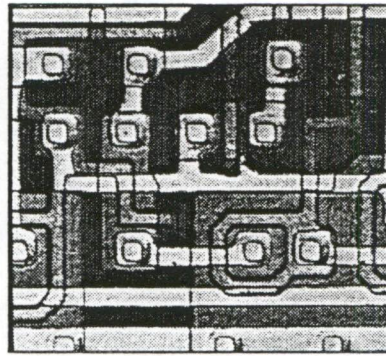
... future displays will include massively parallel computation capabilities ...

RCA 1802 Microprocessor
(5 μ m IC Technology)



CMOS Microprocessor
on Si (circa 1972)

Sarnoff's 6" x 8" LCD Display
(5 μ m IC Technology)



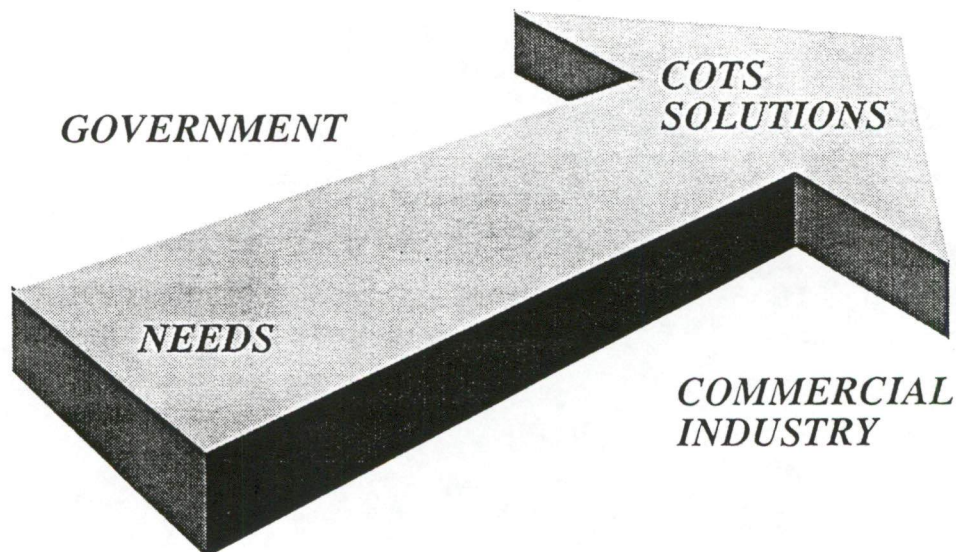
Si LCD Driving Circuitry
on Glass (circa 1991)

Sarnoff

AA15

David Sarnoff Research Center

... leveraging government and commercial resources to develop COTS solutions ...



Sarnoff

AA16



The National Laboratory Concept

BB1



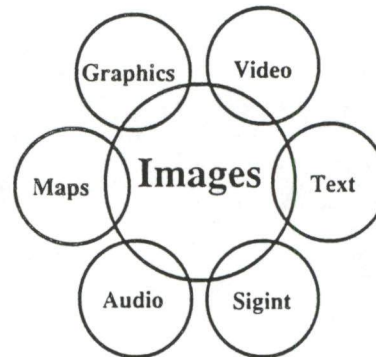
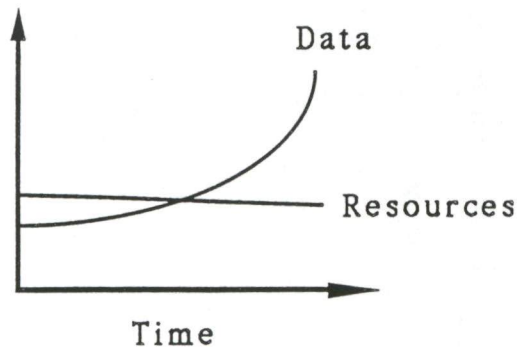
Introduction

- National Technical Centers of Excellence
 - New business model for R & D
 - Serving IC and its industrial base
- National Media Laboratory (Since 1989)
 - Media and Recording Systems
 - Hosted by 3M
 - Director: Dr. William Mularie
- National Information Display Laboratory (Since 1990)
 - Softcopy and Display Technologies
 - Hosted by David Sarnoff Research Center
 - Director: Dr. Curtis Carlson
- Sponsored by:
 - Government Partners
 - Combined with leveraged investment from Industry

BB2

Government Information Needs

... rapidly exploiting and disseminating all critical information ...

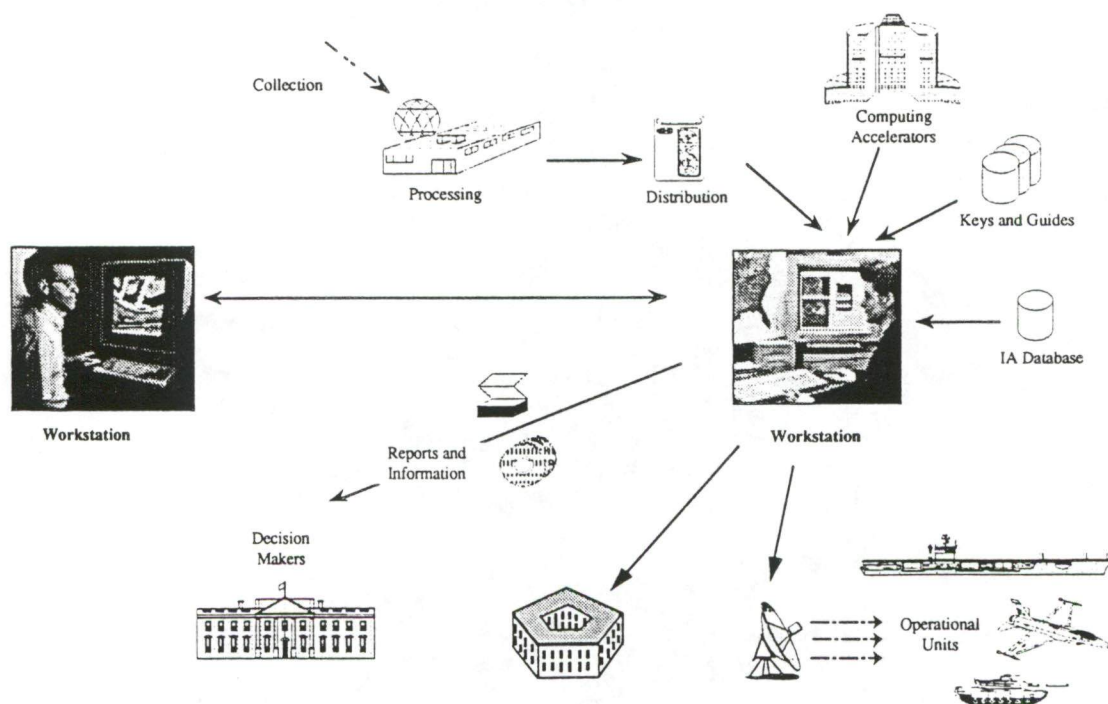


- Rapidly changing roles and responsibilities
- Increasingly diverse users
- Increasing data types

BB3

System Data Flow

... putting the User in control ...

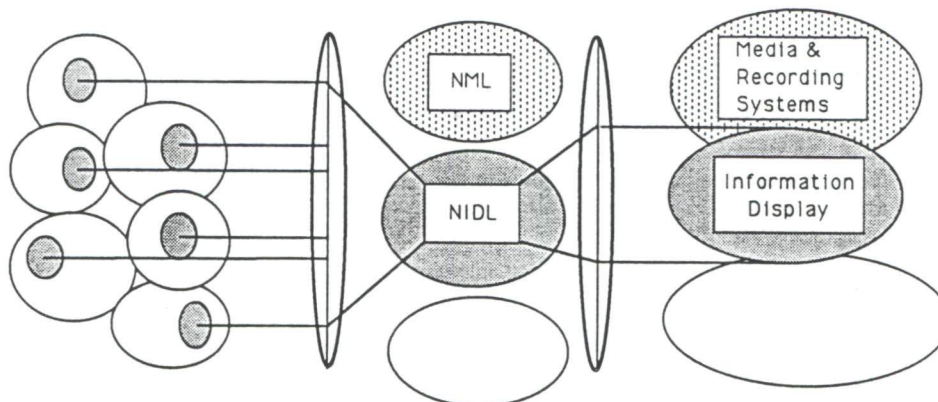


BB4

The Center of Excellence Concept



... focusing the resources of Industry onto User's needs ...



Government Users

- Users & Developers of Technology
 - Program Offices
 - R&D Groups
- Core technologies, essential to success of program

Centers of Excellence

- Focus
- Leverage
- Standards
- Continuity
- User Support

Industry

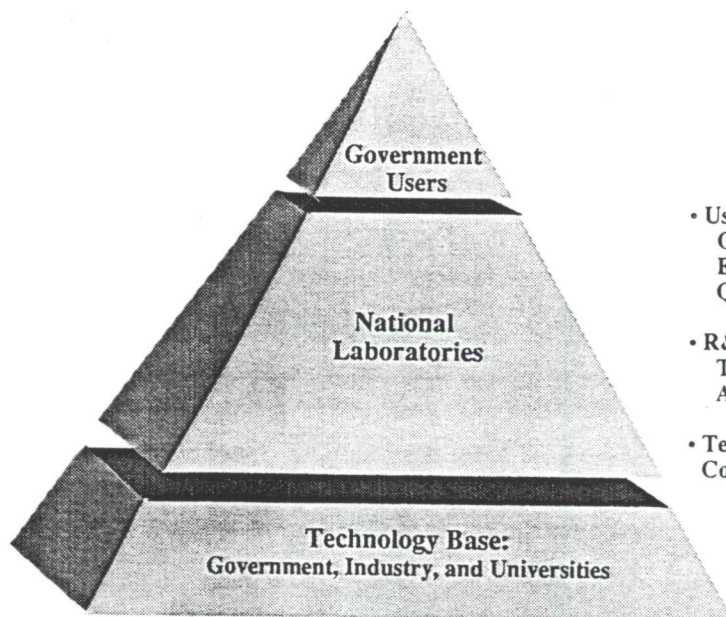
- Commercial Manufacturers
- R&D Centers
- System Developers
- Universities

BB5

National Laboratories



... Centers of Excellence ...

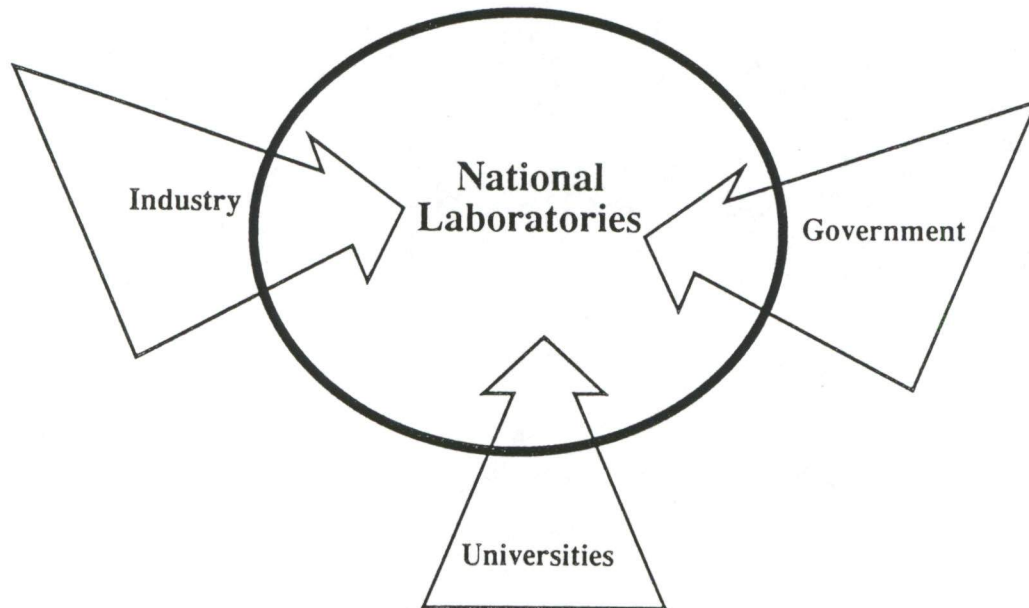


- User Support:
 - Operational Site Support
 - Evaluation
 - Quality Control
- R&D:
 - Technologies and Systems
 - Advanced Tools and Process
- Technology Transfer/Commercialization

BB6

“Distributed” Laboratories

... combining resources of Government, Industry and Academia ...



BB7

National Laboratories

... a new business model to address Government and Industry needs ...



- Government Needs
 - Reduced program cost
 - Sustained user support
 - Increased quality of product
 - Faster development of standards
 - Improved interoperability, interconnectability
 - Advancement and promotion of critical technologies
 - Broad insertion of COTS technology

BB8



National Laboratories

... a new business model to address Government and Industry needs ...

- U.S. Industry Needs
 - Access to Government requirements
 - Development of industry standards
 - Cost sharing in developing base technologies
 - Promotion of exchange of technology across industry
 - Improvement of US global competitiveness

BB9



Selecting a Technology

- Broad critical government application/need
- Large industry and commercial base
- Government requirements ahead of commercial product performance
- Emphasis on new science

BB10



Selecting a Lab Host

- Broad resource base
- Industry leader (capital invested, record of quality, projected IR&D, manufacturing technology)
- Management philosophy – independent, innovative
- Pro-active team leader
- National and/or world recognition of excellence
- Government and commercial base established

BB11



Partner

- Common technology interest (current or planned)
- Joint investment (dollars or resources)
- Help establish government requirements
- Part “ownership”
- Part control
- Long term relationship

BB12



User

- Government or industry
- Common technology interest
- Application level of technological research
- Base for OPS analysis
- Requirement source
- Test and evaluation participation

BB13



National Lab Business Strategy

... developing programs with overwhelming value ...

- Work with users to determine needs
- Begin “seed” program
- Seek partners with world leading capabilities
 - Government, Industry and Universities
- Develop programs that provide:
 - User satisfaction
 - State-of-the-art or revolutionary improvements
 - Path to commercialization

BB14

Unique Government Assets



... maximizing ROI and ROA for the benefit of the government...

- Continuously-interactive user involvement
- Leading-edge and paradigm-shifting research
- Fair and equitable expert advice
- Proactive, open communications
- Consolidation and leveraging of core resources with strategically aligned partners
- Aggressive commercialization



INTRODUCTION

to the

National Information Display Laboratory

Dr. Curtis R. Carlson
Director, NIDL

CC1



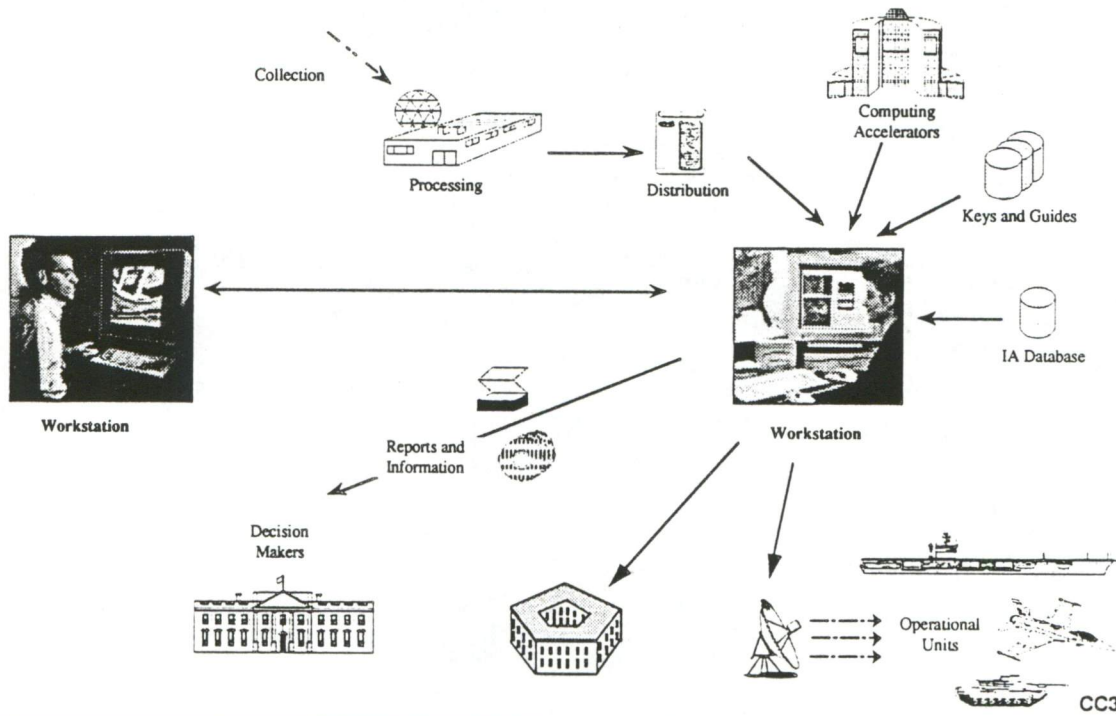
“The ability of the United States to acquire and effectively use information, while denying accurate information to adversaries, can help compensate for planned reductions in U.S. force structure and forward deployed assets ...”

Department of Defense
Critical Technologies Plan
1 May 1991

CC2

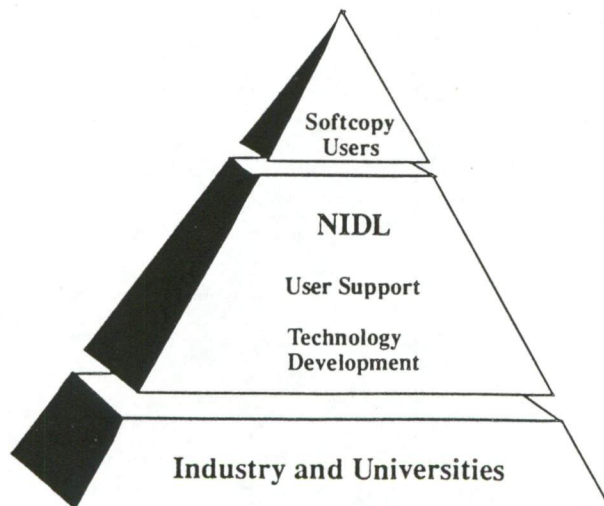
The User's Softcopy Environment

... putting the User in control ...



National Information Display Laboratory

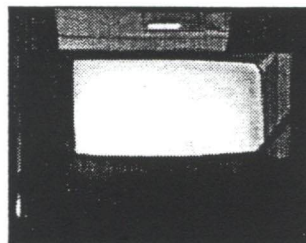
... a Center of Excellence for Softcopy technology ...



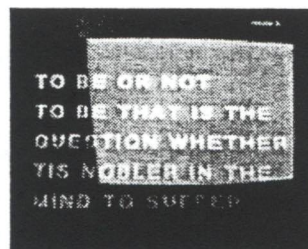
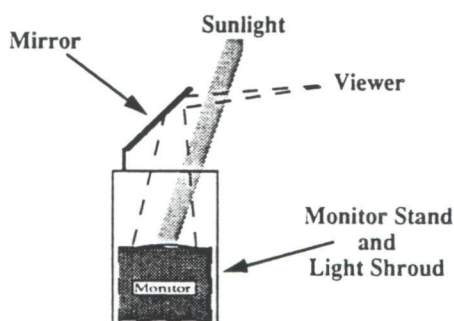


User Support

*... President's teleprompter:
timely response to a user's need ...*



Old



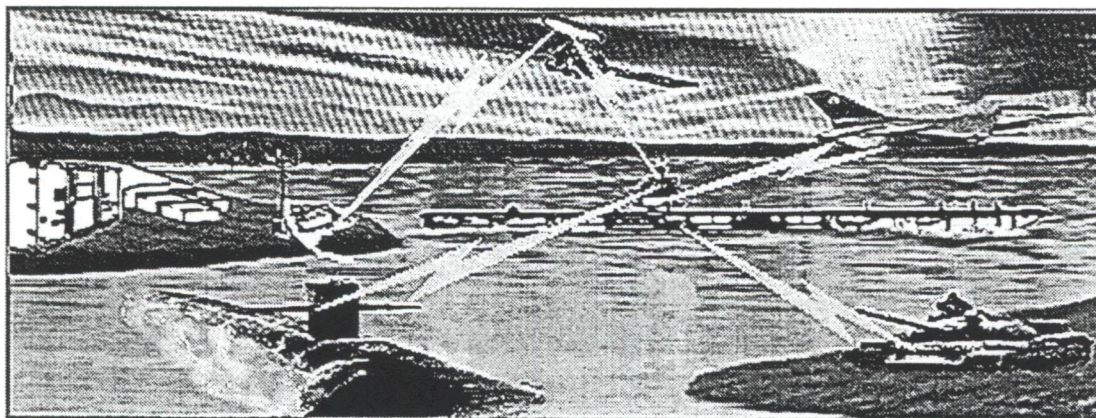
NIDL
Improved

CC5



User Support

... providing Navy support for the Copernicus program ...



"We began our work together last fall and since then both labs have provided valuable services including user support at operational sites, pre-procurement consulting on large system acquisitions, and some very compelling advanced technology research. The Navy has realized substantial cost savings, as well as improved operational performance as a direct result of these labs."

Vice Admiral Jerry O. Tuttle, U.S. Navy

CC6



NIDL Themes

... helping put Users in control of their environments ...

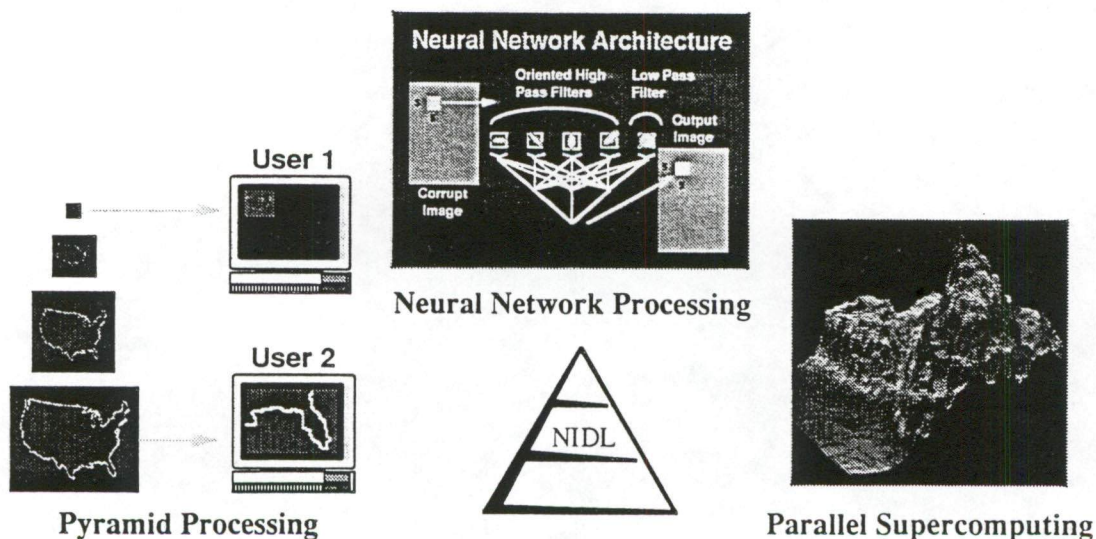
Augment Users:	Develop powerful tools that augment, not replace, the User
Visualize Data:	Exploit the User's most powerful sense: Vision
Leverage Knowledge:	Leverage User's knowledge and skill through software tools that complement their visual paradigms
Control of Environments:	Provide interactive, real-time tools to provide control
Reduce Cost:	Accelerate available COTS systems and technology

CC7



Strategic Technologies

... focus of NIDL Softcopy Tools & Technology ...



CC7a



Strategic Technologies

... focus of NIDL Softcopy Tools & Technology ...

Neural Network Processing

- Neural Network Tools and Applications
- Real-time Training
- Signals from Noise



Pyramid Processing

- Change Detection
- Keys & Guides: Interactive Search
- Efficient Multispectral Data Access
- Analysis & Visualization of Collateral Data
- Interactive Performance Visualization

Parallel Super Computing

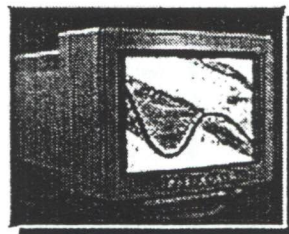
- Massively Parallel Production Front End
- Algorithm Understanding Lab
- Realistic Rendering

CC8

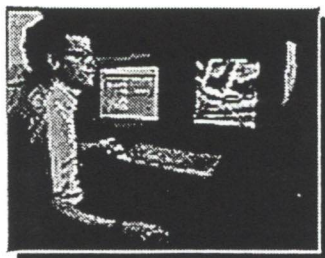
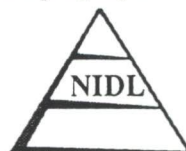


Strategic Technologies

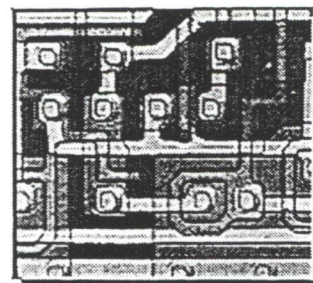
... focus of NIDL Display Technology ...



Display Systems

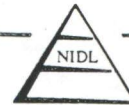


Display Systems Simulation



Integrated Circuit Technology

CC9



Strategic Technologies

... focus of NIDL Display Technology ...

Display Systems

- High-Resolution High-Brightness CRT Monitor
- Tiling for Wall-sized Flat Displays
- Display Evaluation & Certification
- Softcopy Quality Control



Display Systems Simulation

- Display System Simulator
- Visual Modeling
- LCD/EL/CRT/Tiling/Paper-like
- Display Evaluation & Certification

Integrated Circuit Technology

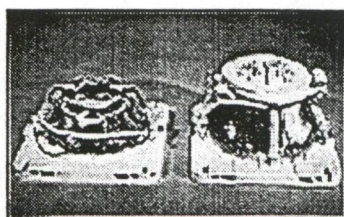
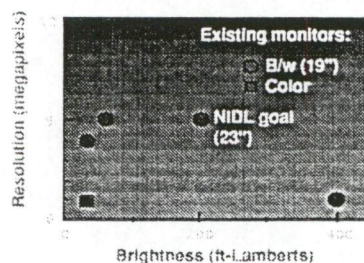
- LCD
- EL
- Paper-like Displays

CC9a

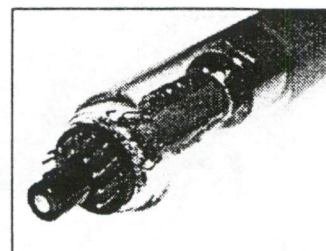


Technology

... working closely with an NIDL Partner to develop a new high-brightness, high-resolution CRT monitor ...



Yoke



Electron Gun

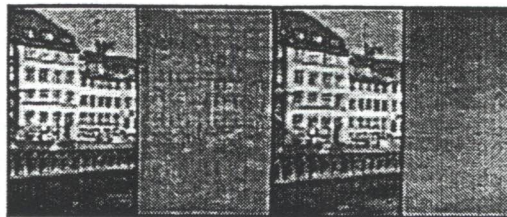
CC10



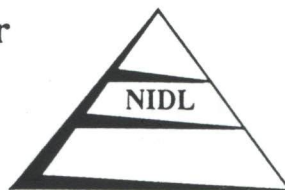
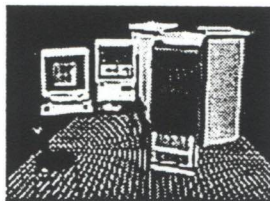
Algorithm Understanding Laboratory

*... interactively visualizing the development
of new algorithms and systems ...*

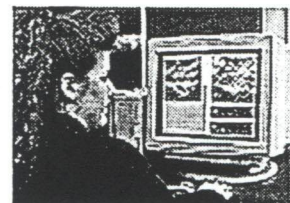
Visualization



Computational Power



Interactivity

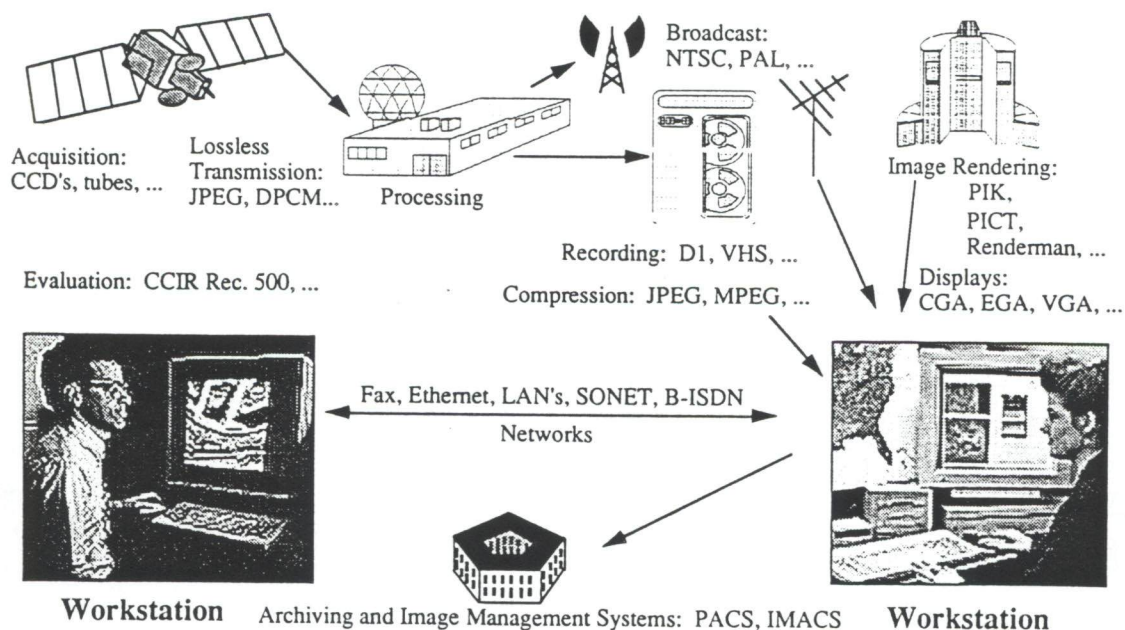


CC11



The World of Imaging Standards

... standards are needed wherever image data is used ...



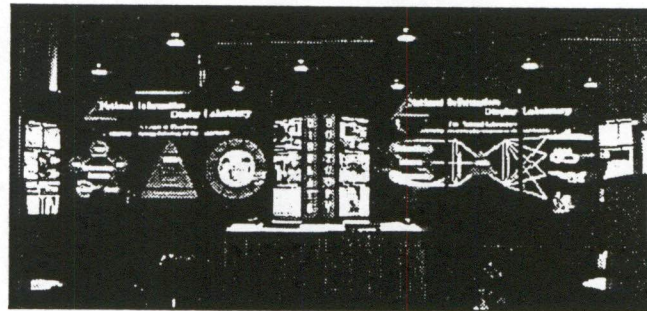
CC12



Communications

... reaching out to both the Government and Industry ...

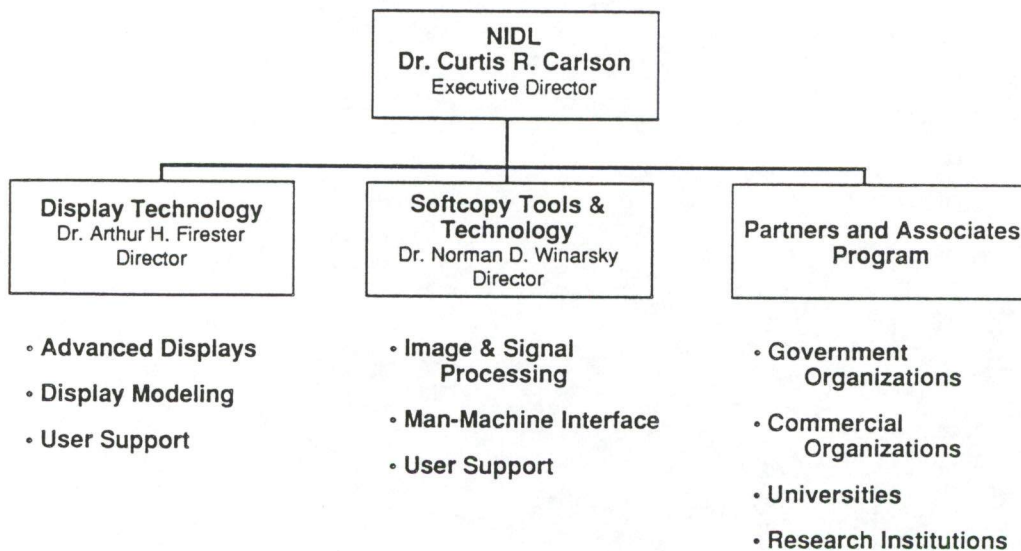
- Government
 - IPWG
 - NASA
 - JNIDS
 - NEL
 - DNI
 - DARPA
- Industry
 - ORD
 - OSTP
 - FAA
 - IRDC
 - DCA staff
 - Navy Op 94
- Industry
 - Int'l. Display Conference Keynote
 - SID Plenary Presentation
 - SID Standards activities
 - SID Display Booth
 - JTEC
 - Many other individual companies



CC13



NIDL Organization



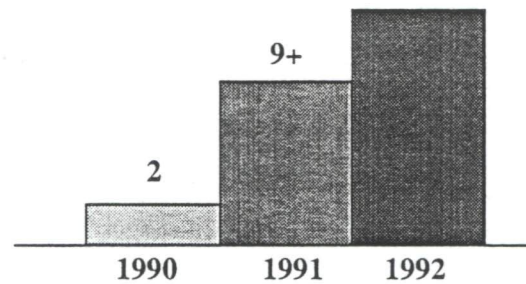
CC14



Partners and Users

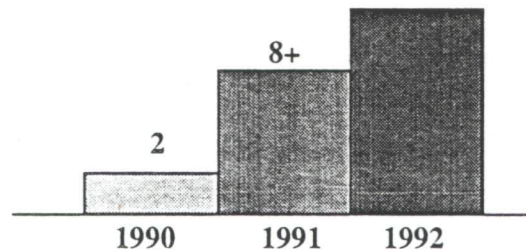
- Government Partners and Users

- Air Force
- Navy OP 94
- USGS
- JNIDS
- OSTP
- NEL

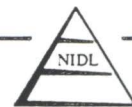


- Industry & Academia Partners

- Princeton University
- MIT
- Texas Tech
- Planar
- RCA/TCE
- DTI -AVP/MegaScan



CC15



Conclusions

... a new model for Government/Industry collaboration ...

- NIDL is a Center of Excellence in Softcopy Technology
- Goal: develop bold new way to satisfy the needs of Government Users through both:
 - Aggressive User support
 - Advanced technology
- Focus key softcopy and display technology on the interface to Users, to make them much more productive
- NIDL is a "Distributed Laboratory" with world-leading partners
- For additional information, call NIDL at 609-951-0150

CC16



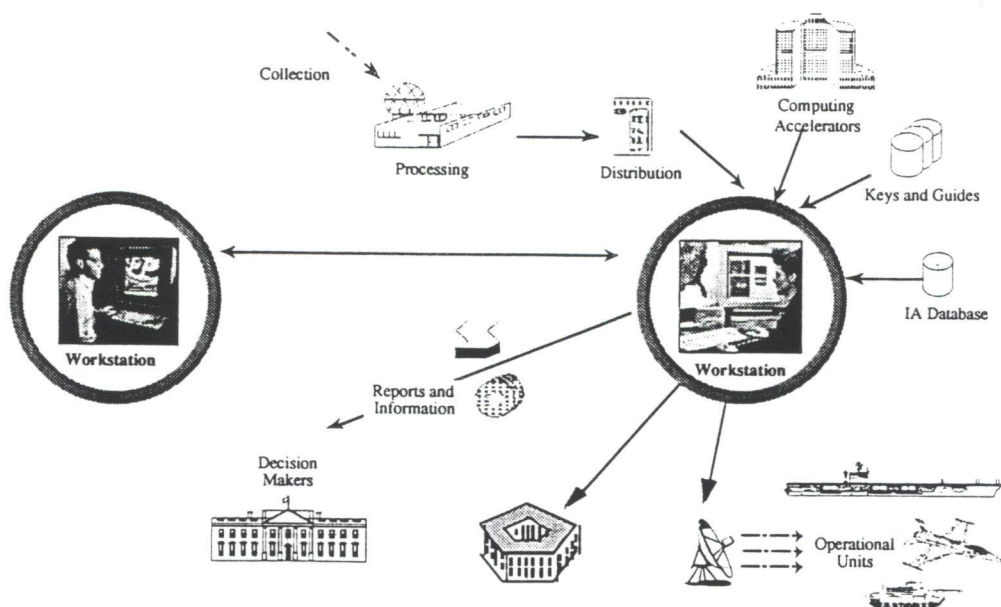
Softcopy Technology and User Support

Dr. Norman D. Winarsky
Director, Softcopy Technology

EE1



The Analyst's Softcopy Environment *... putting the Analyst in control ...*

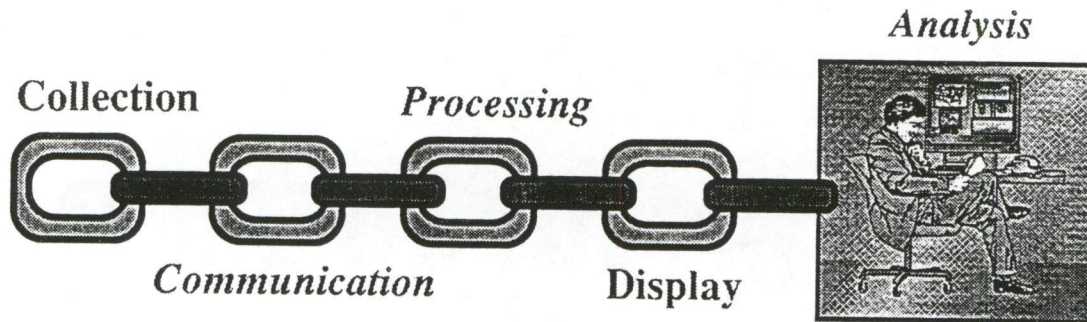


EE2



Information Flow

... maximizing return on collection resources ...



EE3



Information Flow Issues

... fundamental to making softcopy practical for the user ...

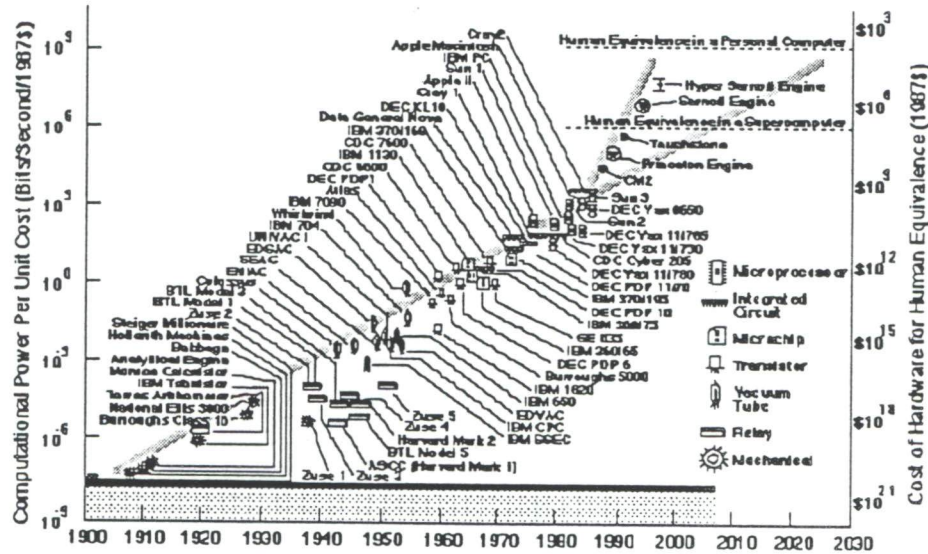
- Information Search
 - Finding the needle in a haystack
 - Computationally efficient approaches
- Algorithm Development
 - Proliferation
 - Prototyping
- Communications
 - Bandwidth
 - Smart interactive compression
- Parallel Computing
 - Computer power that rivals the human brain at reasonable cost
 - Real-time desktop image processor
- Virtual Reality

EE4



Computing in the 1990s

... emergence of a new power trend ...



EE5



NIDL Softcopy Technology Programs

User Support & Commercialization

- Algorithm Understanding Laboratory
- Softcopy User Support
- Data Central Archival Facility
- NTCS-A LAN

- Air Force
- Navy
- NEL
- USGS
- Princeton
- Texas Tech
- General Dynamics
- TCE
- Michigan
- Phoenix

Applied Research & Development

- Collateral Data Analysis & Visualization
- Interactive Performance Visualization
- Keys & Guides: Interactive Search
- Visual Modeling
- Massively Parallel Production Front-end for Remote Sensing
- Efficient Multispectral Data Access

- Air Force
- USMC
- JNIDS
- CIA
- ORD
- NEL
- USGS
- NASA
- DARPA
- MIT
- Iterated Systems
- Silicon Graphics
- Greenville
- TCE
- SRI

Advanced Research & Development

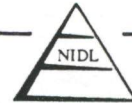
- Neural Network Tools and Applications
- Fast Model-based Volume Rendering
- Change Detection

- Air Force
- USGS
- DARPA
- US Park Service
- Princeton
- TCE

EE6

User Support

*... supporting the user and providing a foundation
for new technology development ...*



White House
Communications Agency

Sunlight Teleprompter

Air Force

Data visualization for collection
resource management

Air Force

Commercial technology assessment

USGS EROS Data Center

Investigate data access, compression,
and visualization

DSPO

Diagnostic testing analysis

Navy

Copernicus Architecture
Technology Program

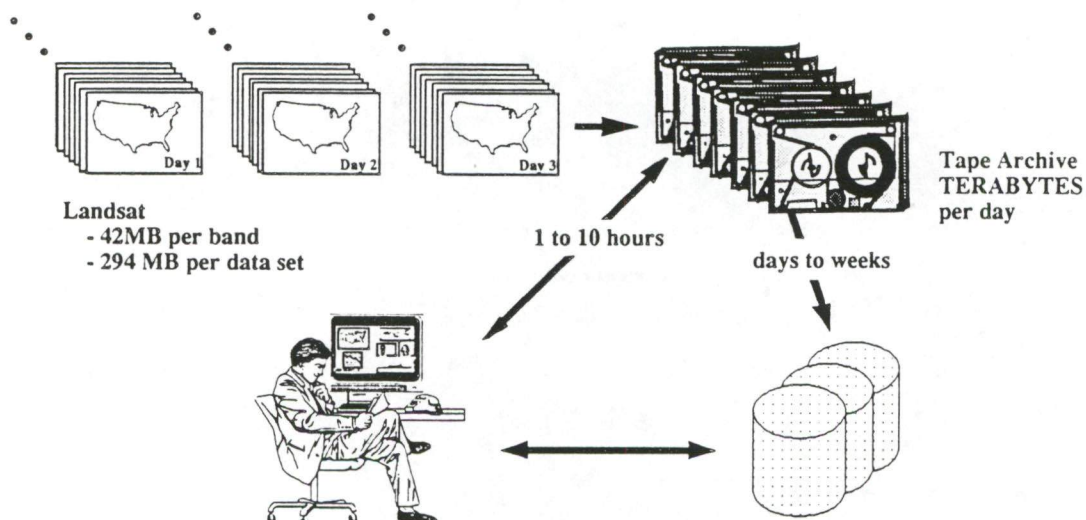
Navy

FIST printer improvement

EE7

Image Search

*... finding critical data scattered in time, space,
and multiple spectral dimensions ...*

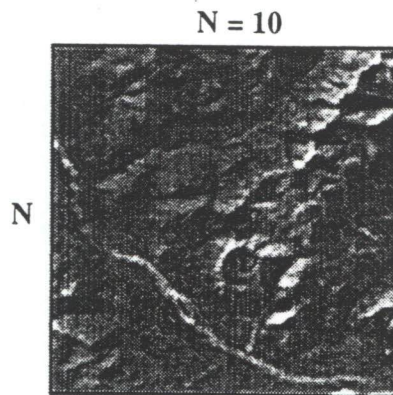
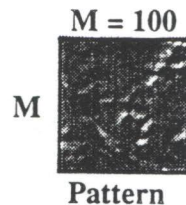


EE8



Content Based Search: Why is it a Problem?

... it can be computationally costly ...



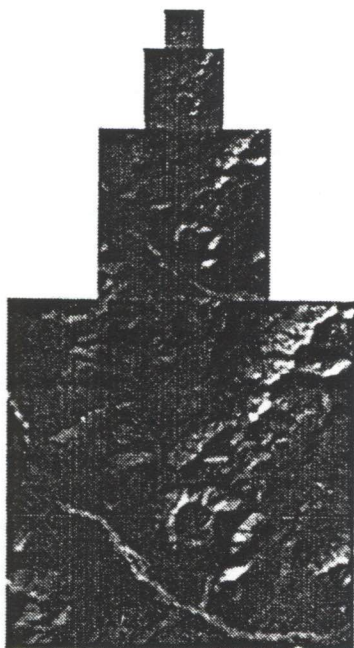
- For translation, rotation and scale: computational cost on the order of 10^{16} (proportional to N^2M^4)
- Conclusion: need a very computationally efficient approach

EE9



Achieving Computational Efficiency

... pyramid representation -- a necessary ingredient for success ...



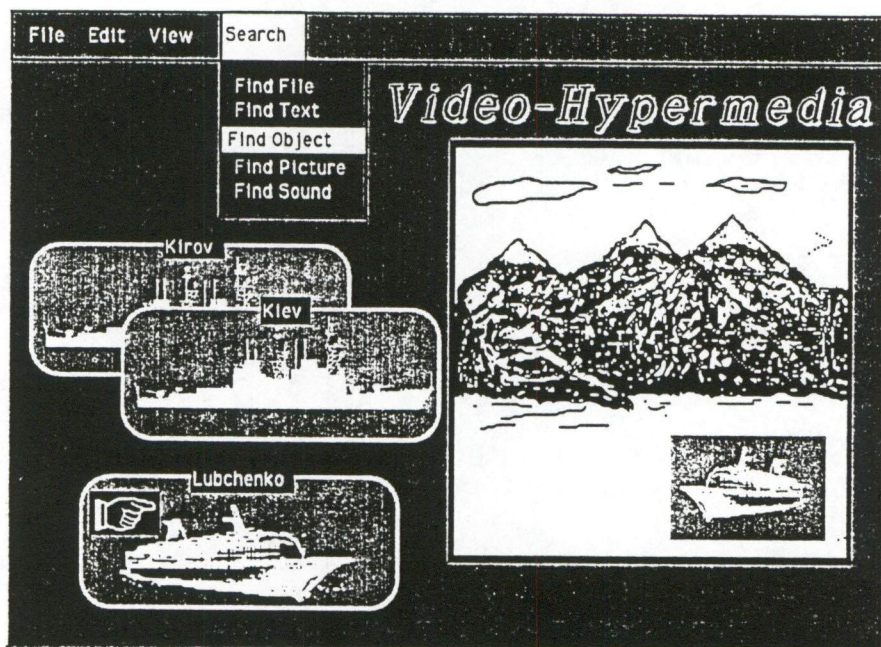
- Search efficiency
 - Work at the lowest resolution possible
 - Restrict areas of search
 - Match simple image features
- Provides computer savings of two orders of magnitude per pyramid level

EE10



Softcopy Keys & Guides

*... increasing the scope and power of what
can be done with images ...*

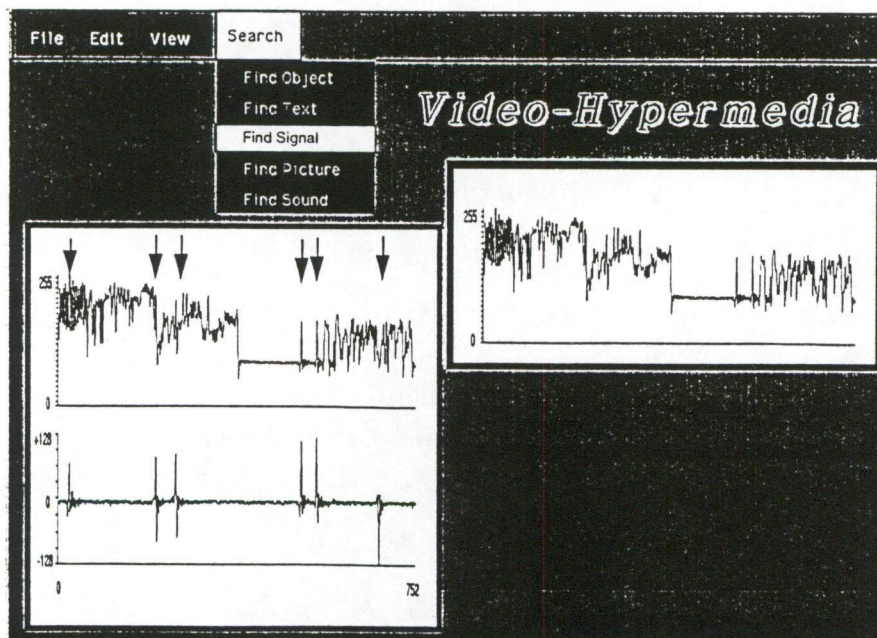


EE11



Softcopy Keys & Guides

*... increasing the scope and power of what
can be done with signals ...*



EE12

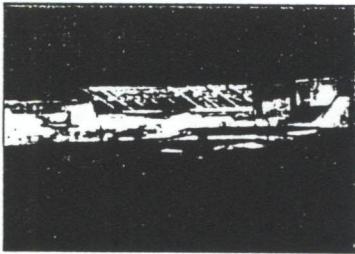


Sensor Fusion

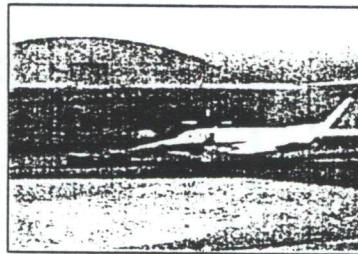
... gaining maximal information from all sensors ...

Multiresolution approach:

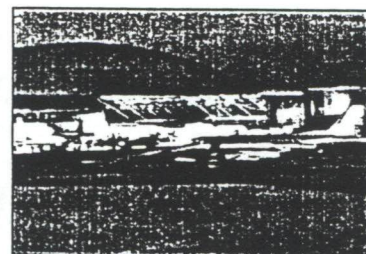
- Preserve essential image information
- Interactively select important structure
- Automatically select salient structure from each image



Visible Image



Infrared Image



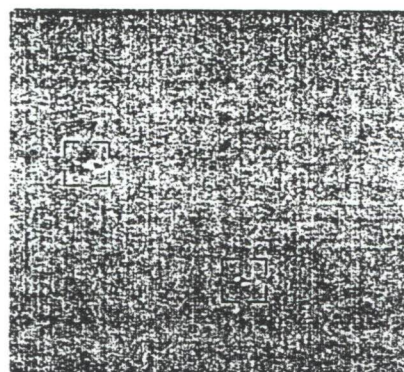
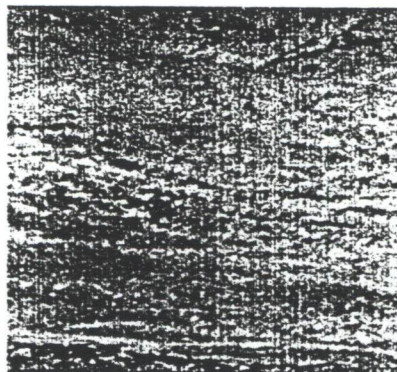
Automatically
Fused Image

EE13



Moving Target Detection

... using pyramid processing to pull targets from clutter ...

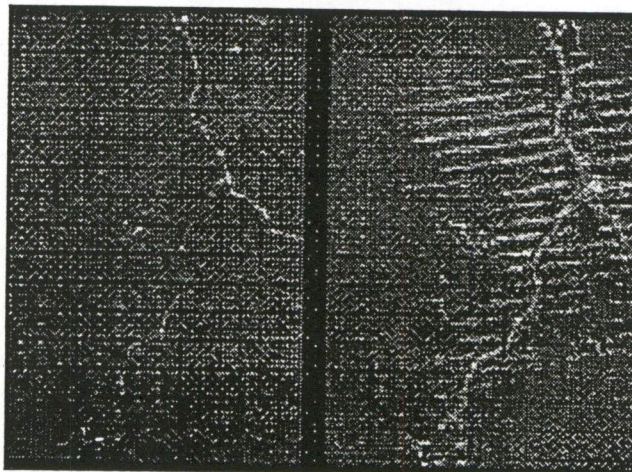


- Timescale of few seconds
- Small objects, highly localized (few pixels)
- Registration needed
- Limited variation in illumination and other factors

EE14

Deforestation Studies

... Brazilian Rainforest ...



Landsat MSS Image
June 19, 1975

Landsat MSS Image
August 1, 1986

- Timescale of years
- Changes somewhat localized
- Registration needed
- Other changes significant--e.g., illumination, ground cover

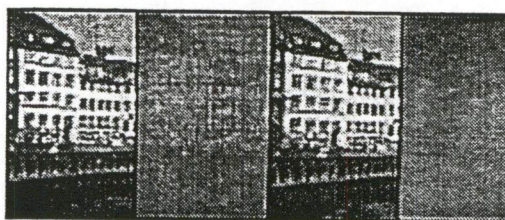
EE15

Algorithm Understanding Laboratory

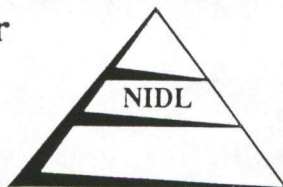
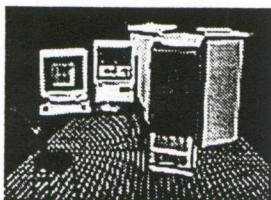
*... interactively visualizing the development
of new algorithms and systems ...*



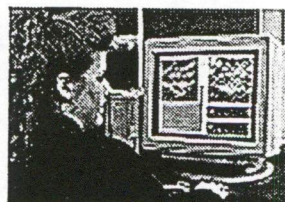
Visualization



Computational Power



Interactivity

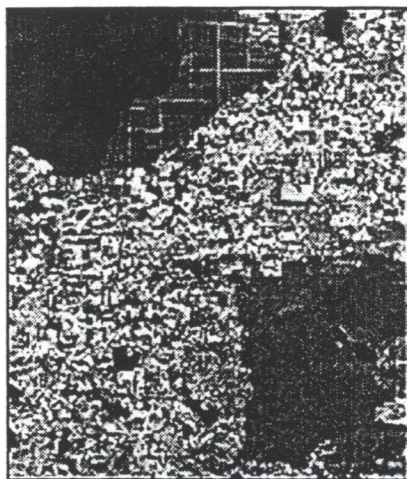


EE16

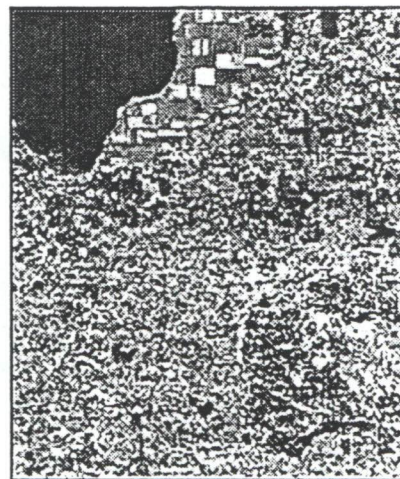


Multispectral

... sponsors use it ...



Original Image



Terrain Characterized Image

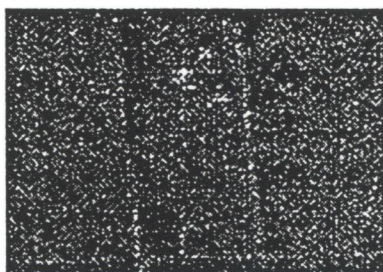
Interactivity aids algorithm understanding

EE17

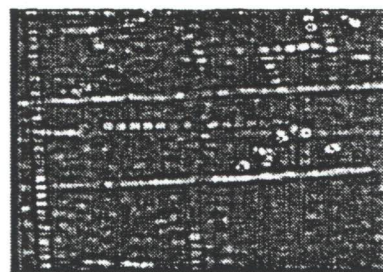


SAR

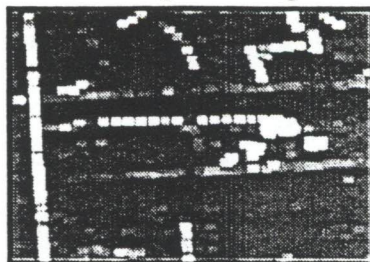
... contractors use it ...



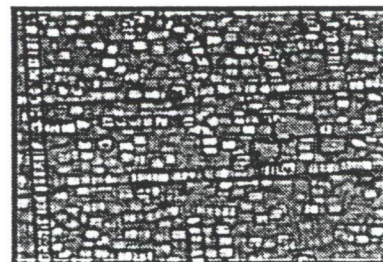
Original Image



Feature 1



Feature 2



Feature 3

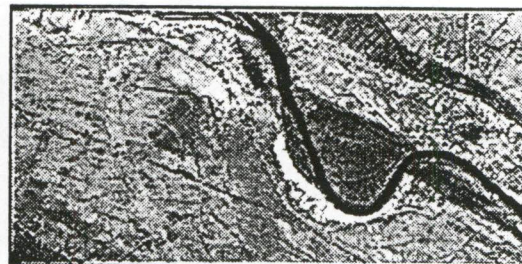
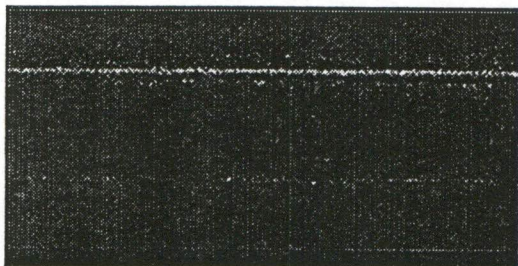
Visualization aids algorithm understanding

EE18



Neural Networks

... we use it ...



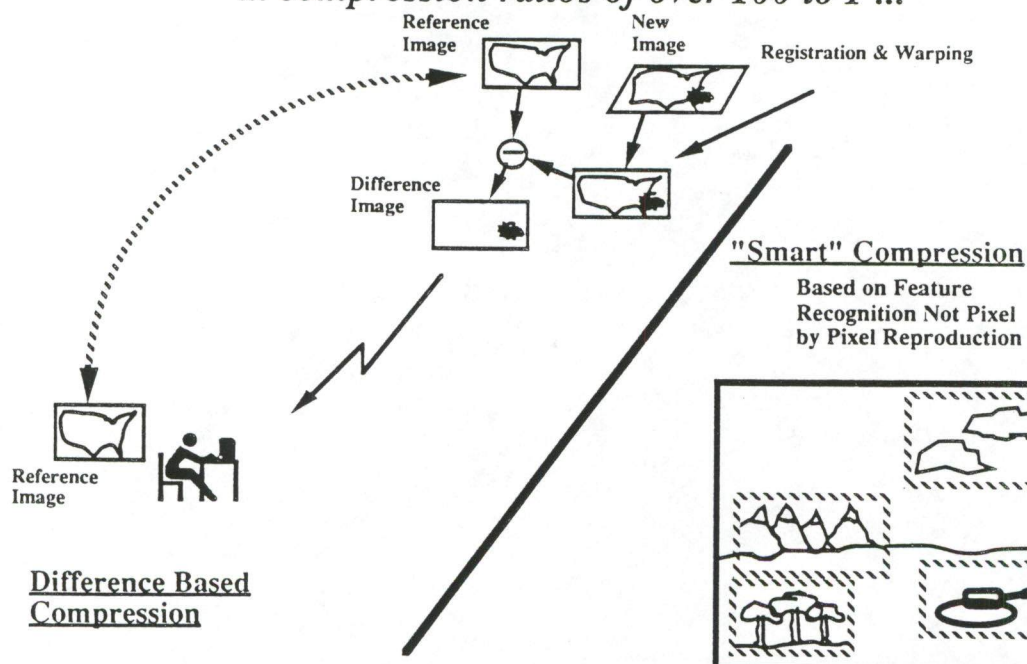
Computational power aids algorithm understanding

EE19



Paradigm Breaking Compression Schemes

... compression ratios of over 100 to 1 ...



EE20



Desktop Supercomputer

*... putting the needed processing power
at the user's fingertips ...*



- Massively parallel accelerator board
- For COTS workstations
- Up to 300 to 1 acceleration
- UNIX, C, Fortran 90

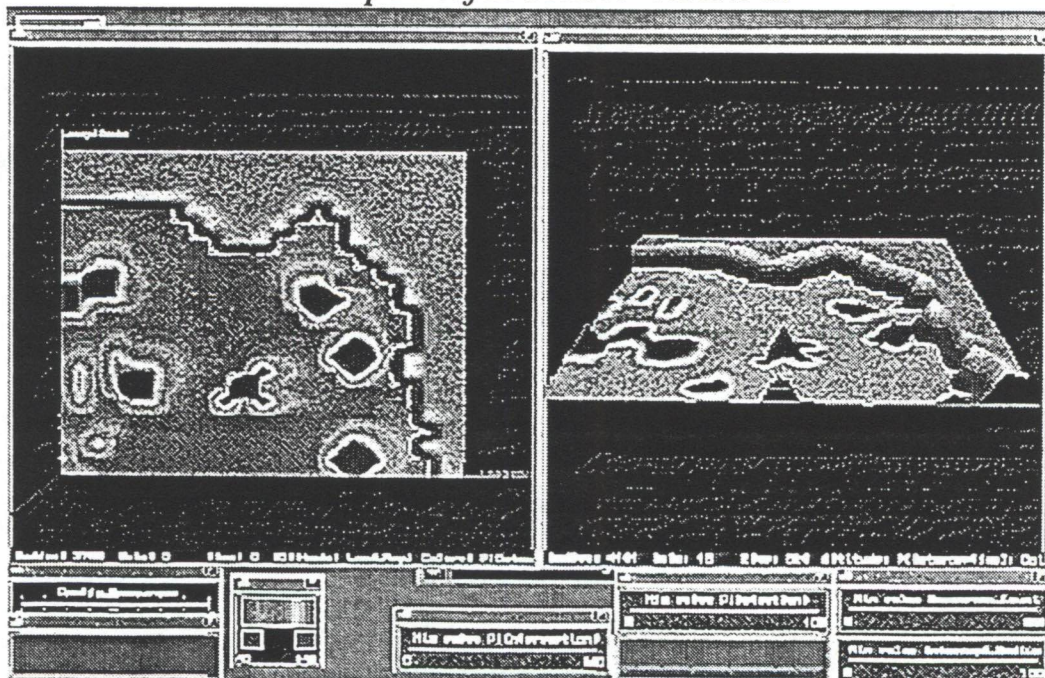
Applying massively parallel computer technology,
available submicron IC's, and multichip module packaging
to provide a cost effective, 3200 MIPS, accelerator.

EE21



Data Analysis and Visualization

*... presenting complex information to the user's
most powerful sense: vision ...*

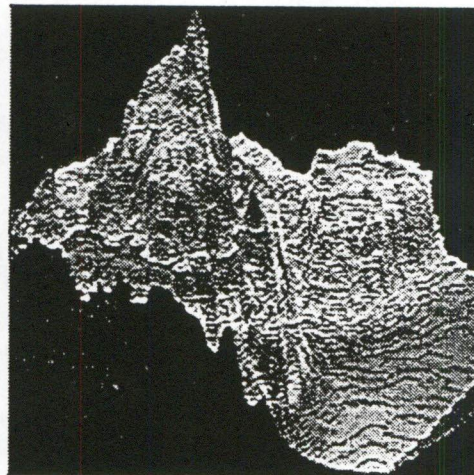
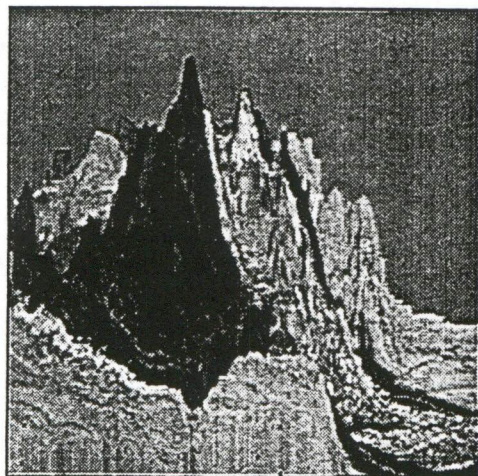


EE22



Parallel Terrain Rendering

... future directions in realistic scene rendering ...

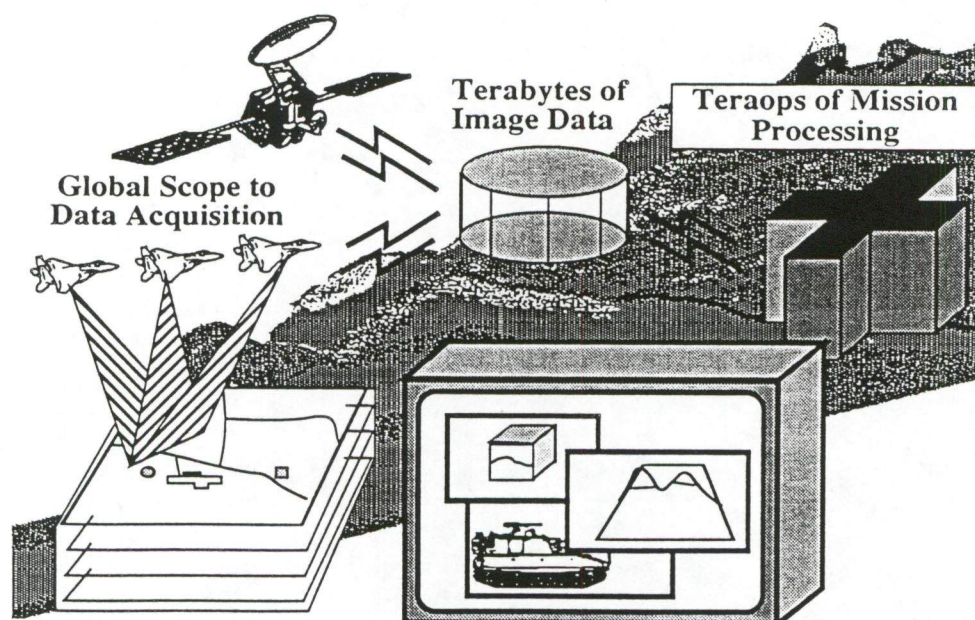


EE23



Virtual Reality

... immersing the user in information ...

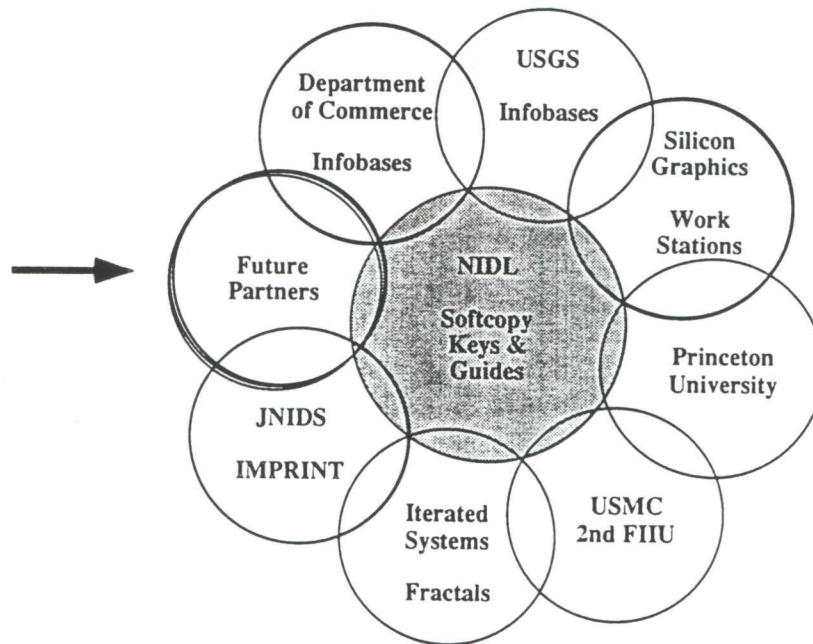


EE24



Softcopy Keys & Guides

*... providing leverage with government, industry
and academic partnerships ...*



EE24a



JNIDS/NIDL IMPRINT

... an IMagery PRototyping INiTiative ...

- JNIDS Charter
 - Accelerate, extend and deepen the intelligence analyst's cognitive abilities through rapid application of advanced technology
- USMC 2nd FIU Mission
 - Derive intelligence information from aerial imagery produced from thermal infra-red (IR) sensors, side looking airborne radar (SLAR), and conventional photography
- Fundamental User Need
 - Assistance in the process of exploiting aerial imagery

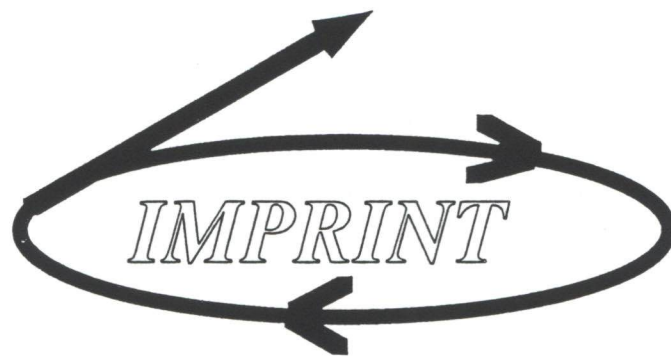
EE25



Summary

... the model is working ...

- Softcopy technology is undergoing simultaneous evolution and revolution
- NIDL technology and user support programs are in place to address government user needs of today and the future
- NIDL continuously seeks additional users and partners to steer and implement these programs



IMAGERY PROTOTYPE INITIATIVE



OBJECTIVE

**"CREATE THE NEXT GENERATION
OF IMAGERY TOOLS... TODAY"**



BACKGROUND

- Fully funded cooperative effort between NIDL & JNIDS
- Approved by MIB as FY92 initiative
- Operational testbed at 2nd FIU



CURRENT STATUS

- PHASE 0: COMPLETE
- PHASE 1: UNDERWAY
- 1ST DELIVERY: JUNE 92





Display Technology and User Support

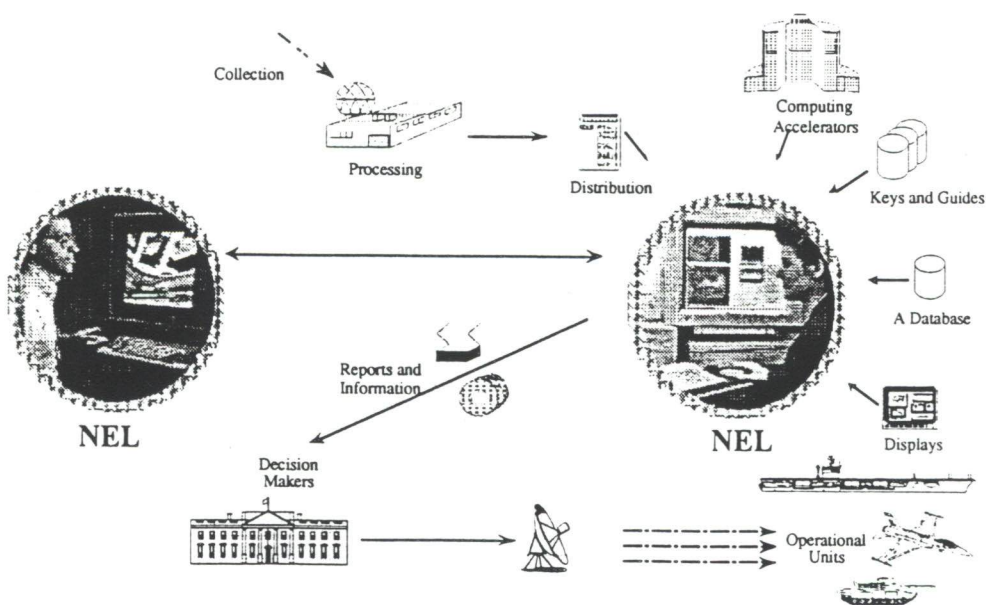
Arthur H. Firester
Director, Display Technology

DD1



The Analyst's Softcopy Environment

... putting the Analyst in control ...

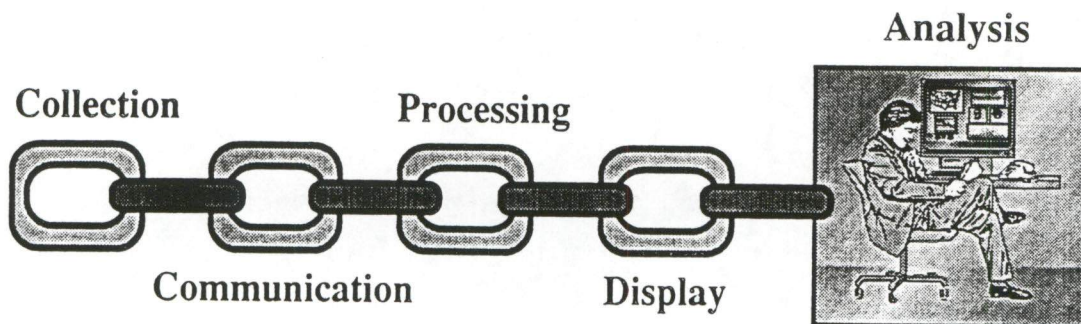


DD2



The Display

*... the last link in the information chain
to the Analyst ...*

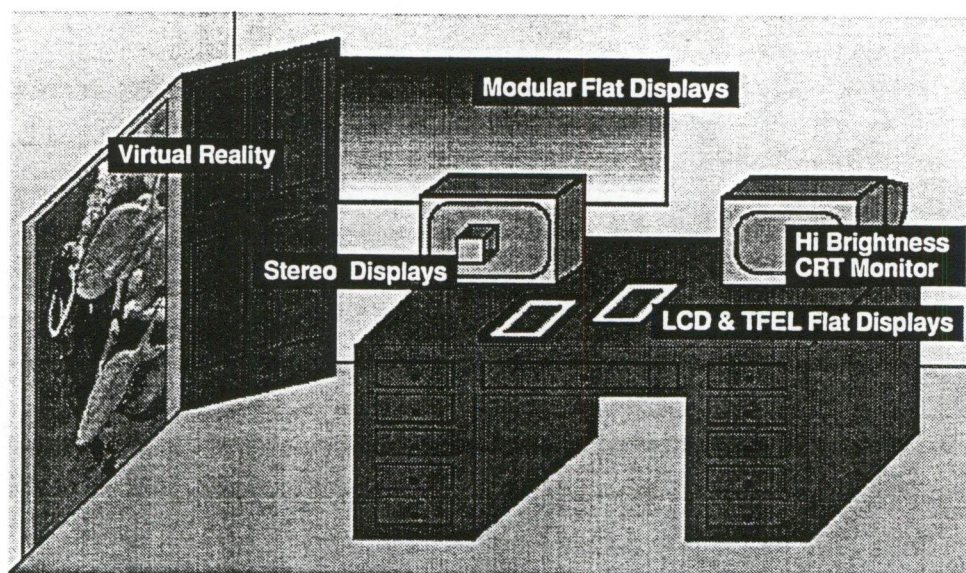


DD3



Advanced Displays

*... breadth of user needs drives a multiplicity of
display technologies ...*

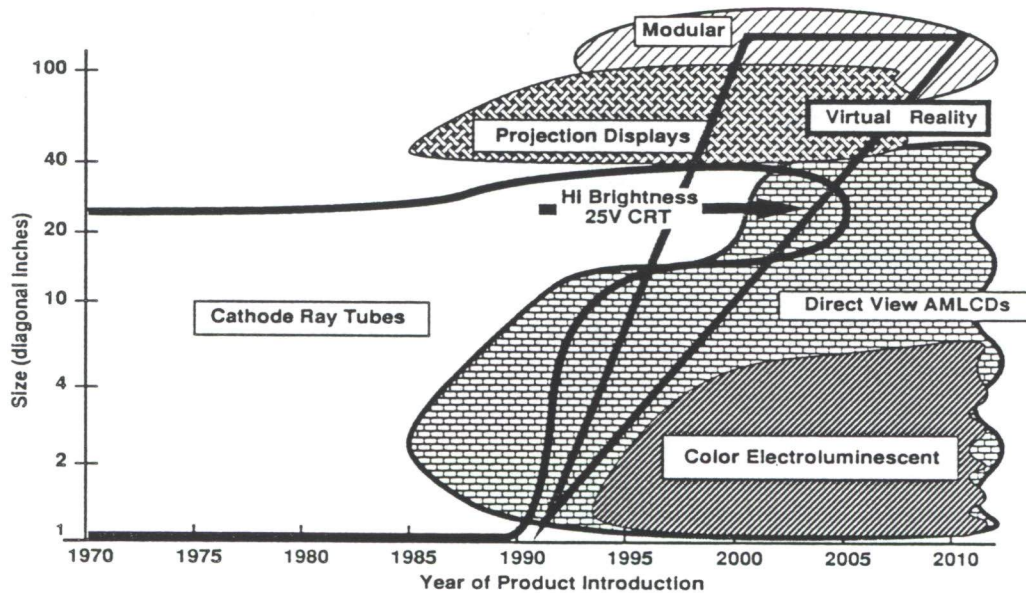


DD4



Technology Trends

... medium size CRTs will remain dominant for at least 10 more years ...



DD5



Display Issues

... differing display needs drive simultaneous development of many display technologies ...

CRT

- Resolution vs. Brightness vs. Color compromise driven by basic physics

LCD

- Manufacturability
- Size and resolution
- System Reliability/Integration

EL

- Color
- Brightness

Tiling

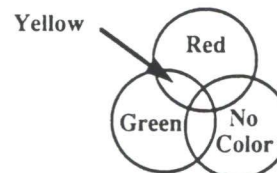
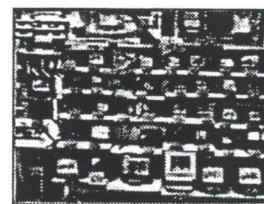
- Invisible Seams

Electronic Paper

- Basic electrically addressed display phenomena
- Reflected brightness and angular viewability

Virtual Reality

- Resolution matched to human eye
- Display goggles

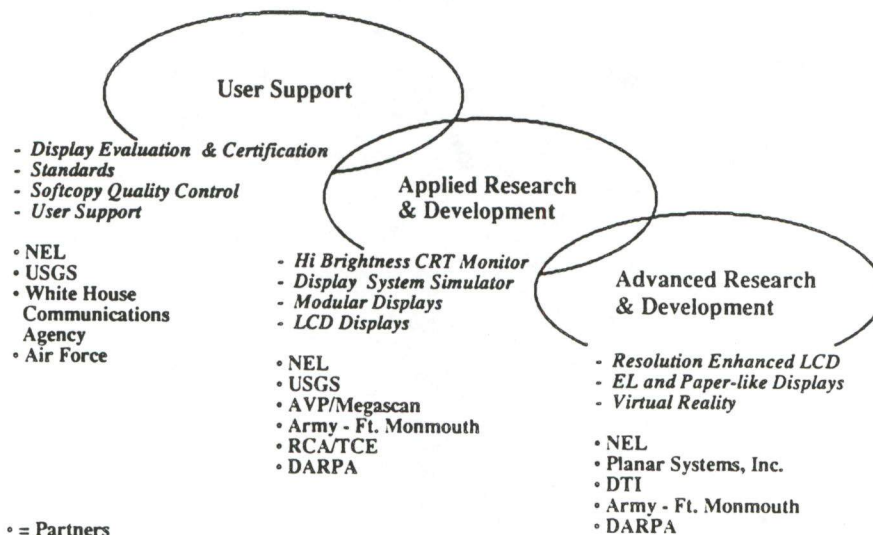


DD6



NIDL Display Programs

... a technology spectrum supporting user's current and future needs ...



DD7



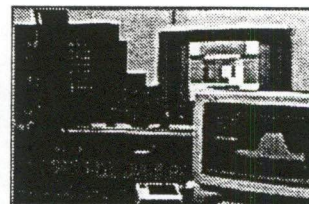
Display Evaluation and Certification

... helping the government user make the right monitor selection ...

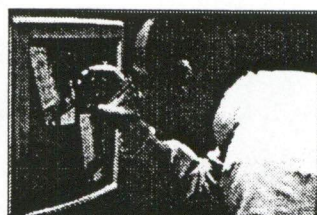
Measurement
Procedures



Measurement
Laboratory



Task Dependent
Evaluations



Reports



DD8



Display Measurement Standards

... to enable leveraging of technology, markets, and to broaden involvement ...

- Version 1.0 and 2.0 disseminated to users, manufacturers, and technical communities
- Version 3.0 in preparation for review by SID-EIA



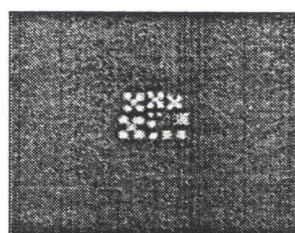
Measurement
Procedures

DD9

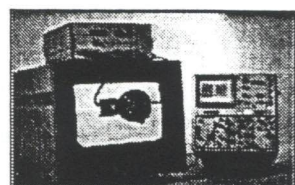


Softcopy Quality Control

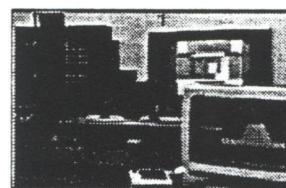
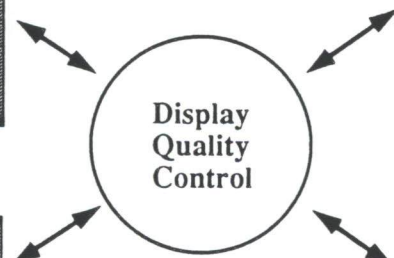
... on-site display performance evaluation to ensure user-specific softcopy quality control ...



User Test Software



User Test Hardware



Display Evaluation
& Certification



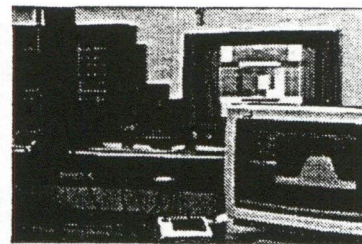
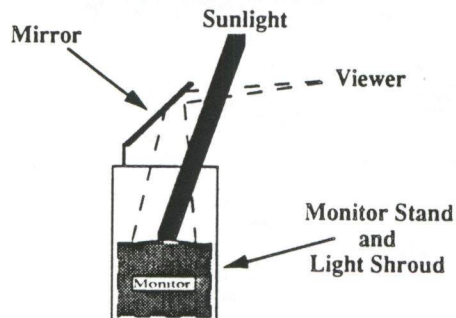
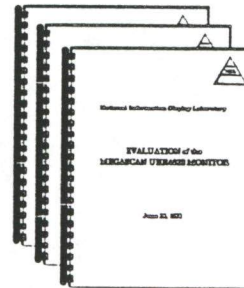
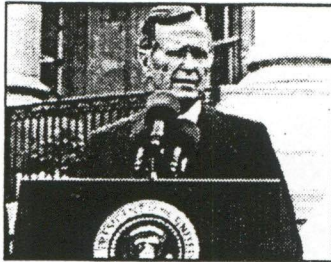
Display Simulator

DD10



User Support

... timely response to user needs ...

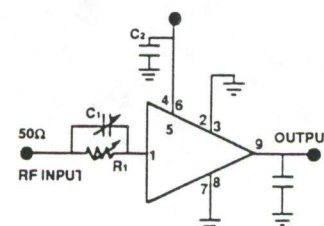
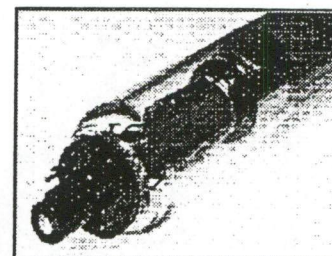
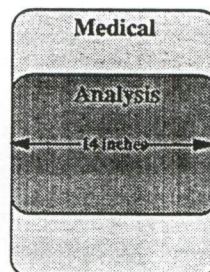
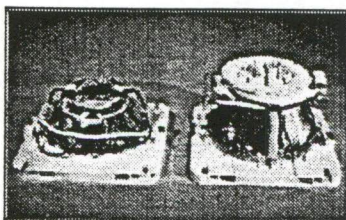
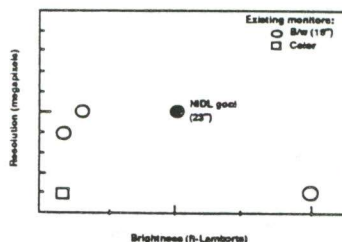


DD11



High Brightness, High Resolution CRT Monitor

... high brightness, uniform resolution, large screen COTS monitors are needed but not available ...

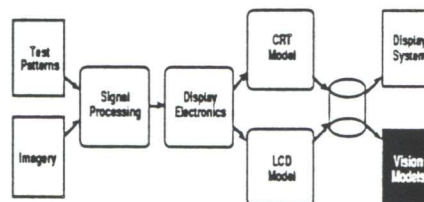
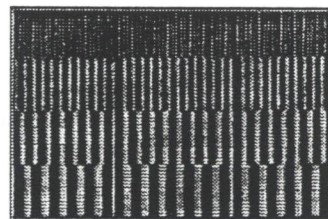
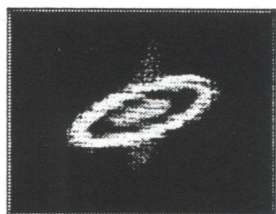
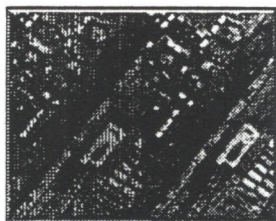


DD12



Display System Simulation

*... simulation enables rapid display system specification
and eliminates extensive, costly, slow prototyping ...*



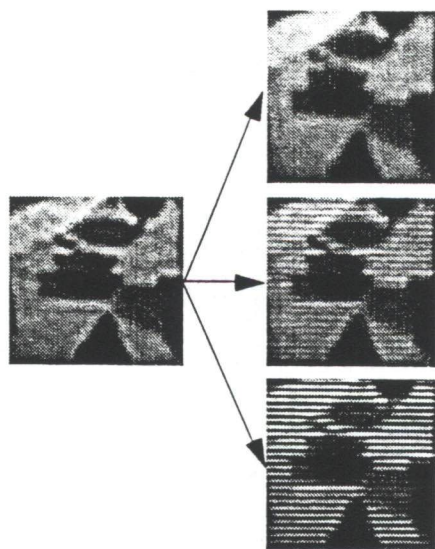
Data Flow Design Paradigm

DD13

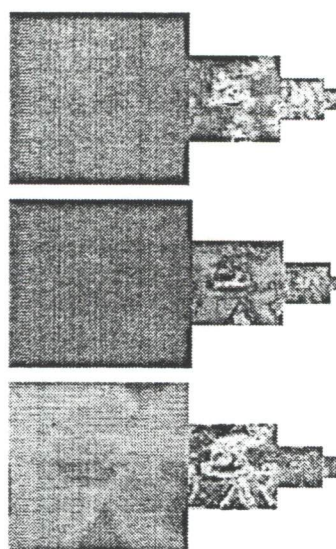


Human Visual Modeling

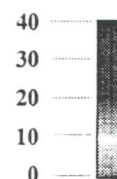
*... using a model of the human mind to
help design new imaging systems ...*



Simulated Images



Non-oriented Discriminability Maps



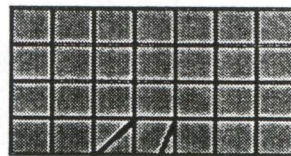
DD14



Modular Displays

... wall displays built cost effectively by seamless tiling of individual units ...

- Determine psychophysical requirements for invisible seams
- Evaluate tiling concepts through modeling and simulation
- Evaluate and prioritize technologies
- Develop approach satisfying requirements



Example
14-inch diagonal
1024 x 768 pixels
0.28 mm/pixel

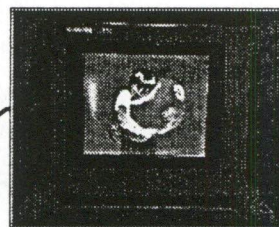
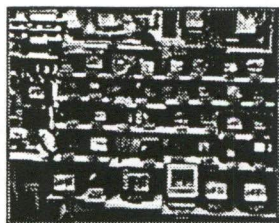


DD15

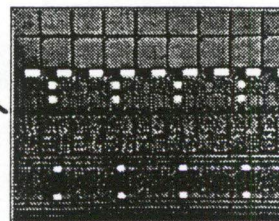
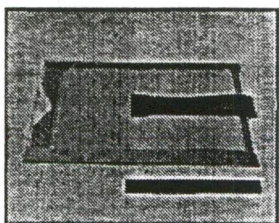


Active Matrix LCDs

... active matrix liquid crystal displays are becoming the dominant display technology ...



Applications
Technology
Availability



DD16

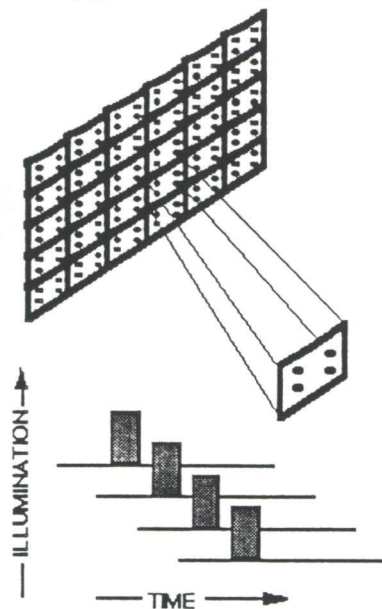


Resolution Enhanced LCDs

... multiplying resolution without reducing production yields ...

Dimension Technologies Inc.

- Demonstrate 4X enhanced resolution through subpixel sequential illumination
- Explore engineering issues
- January '92 contract start



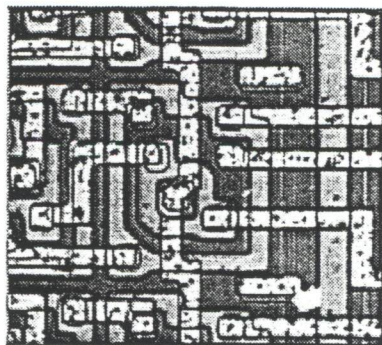
DD17



What's the Difference? - Not Much

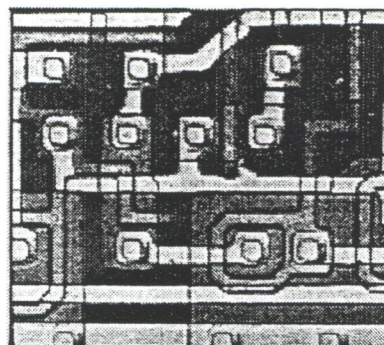
... future displays will include massively parallel computation capabilities ...

RCA 1802 Microprocessor
(5 μ m IC Technology)



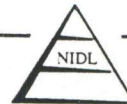
CMOS Microprocessor
on Si (circa 1972)

Sarnoff's 6" x 8" LCD Display
(5 μ m IC Technology)



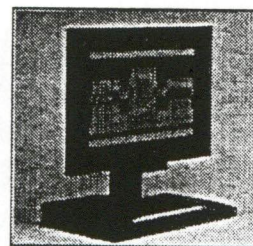
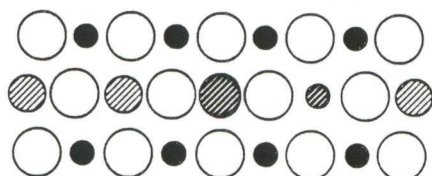
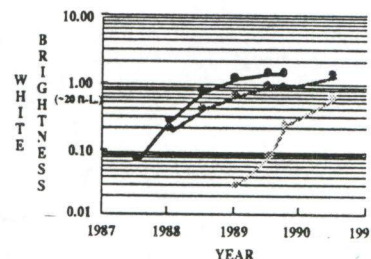
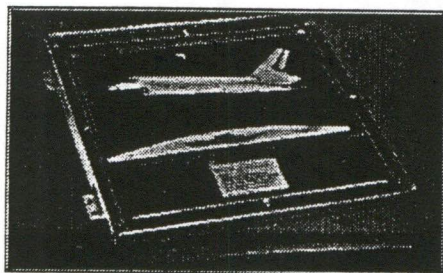
Si LCD Driving Circuitry
on Glass (circa 1991)

DD18



Color EL Display Development

... lack of an efficient blue phosphor is technology bottleneck ...



A full partnership program with Planar Systems, Inc.

DD19



Virtual Reality

... head-mounted displays demonstrate the most promise for near-term development ...

- Active Matrix LCD
 - 1500 lines/inch
 - integrated drivers
 - full color now
- Active Matrix EL
 - 1000 lines/inch
 - integrated drivers
 - full color soon
 - fully solid state
- Deformable Mirror Device
 - 1500 lines/inch
 - integrated drivers
 - full color now
 - very accurate grayscale



DD19a



Summary

- Display technology is undergoing simultaneous evolution and revolution
- NIDL technology and user support programs are in place to address government user needs of today and the future
- NIDL continuously seeks additional and partners to steer and implement these programs



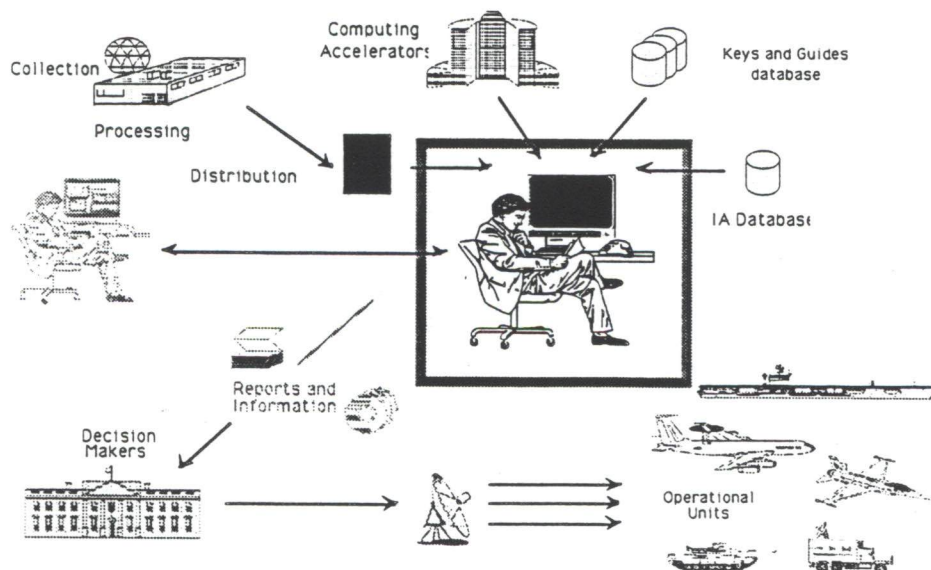
Future Directions

FF1



The World of Softcopy Today

... providing the user with initial softcopy tools ...

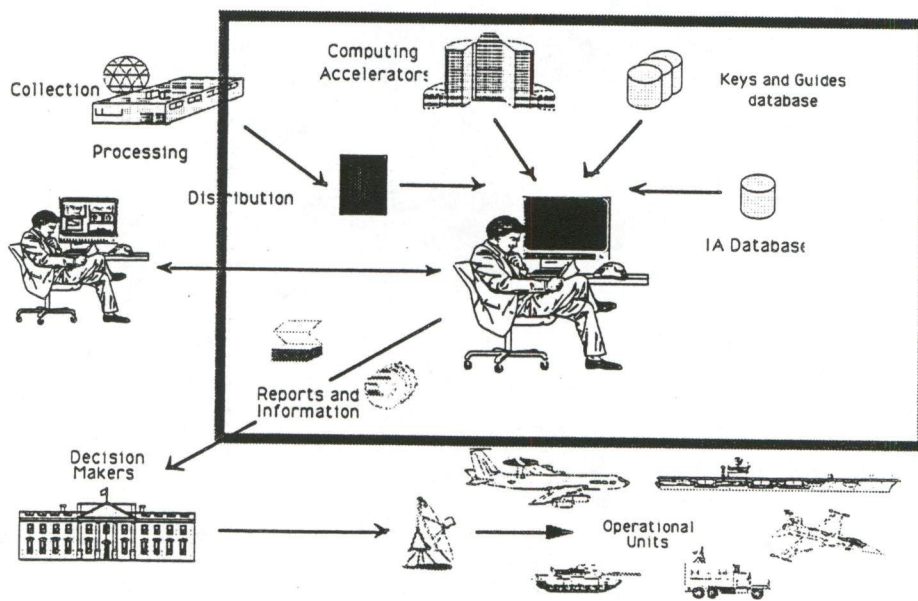


FF2



The World of Softcopy Tomorrow

... giving users control of their environment ...

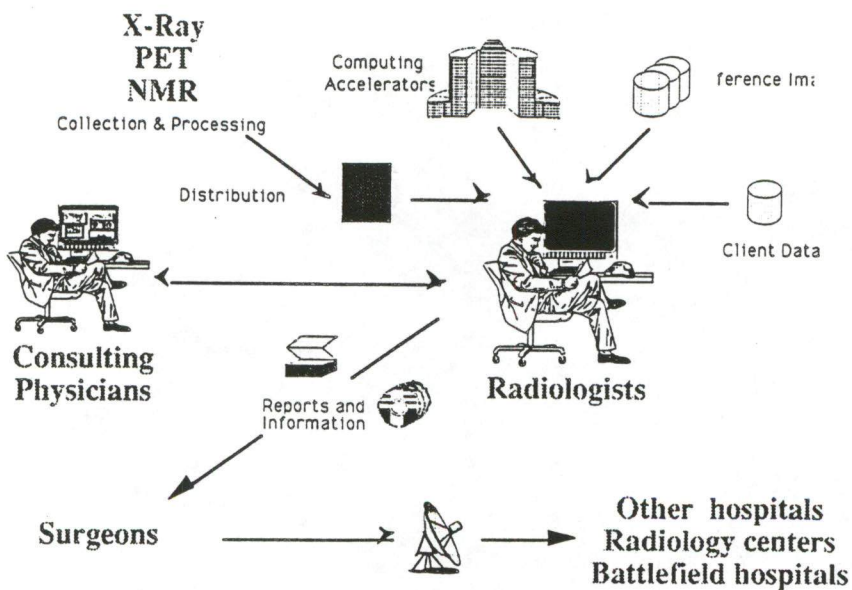


FF3



Medical Softcopy Environment

... emerging opportunities to leverage other industries ...



FF4



Next Steps

... the National Laboratories are established and ready to help ...



1988



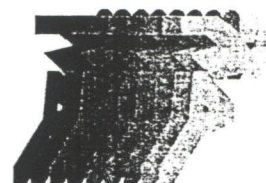
1989



1990



1991



1992

FF5

