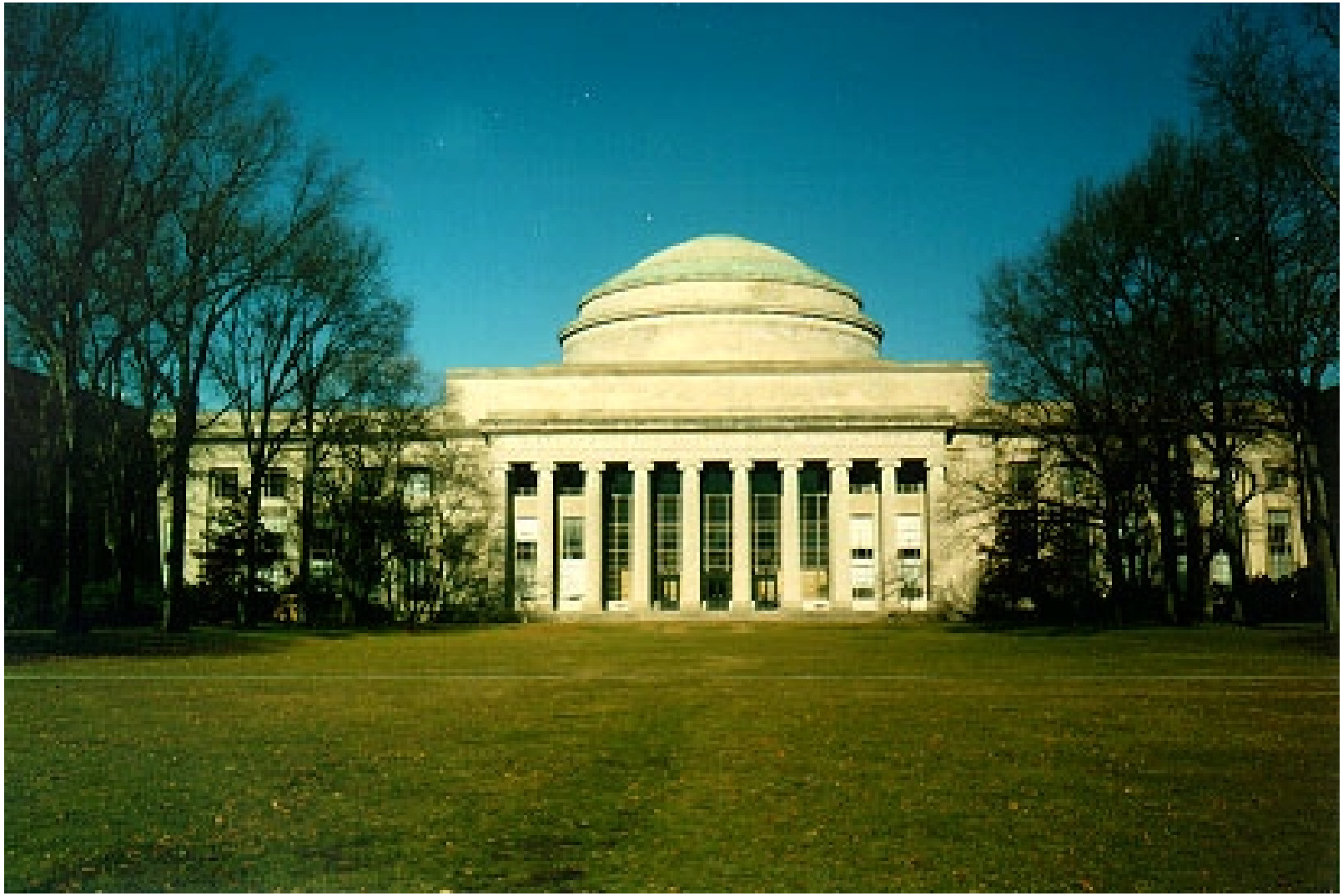
NTT-MIT Research Collaboration

http://www.ai.mit.edu/projects/ntt

Outline of Talk

- MIT - research partnerships
- MIT - structure, LCS/AI
- LCS/AI as labs
- Why we think it is a good idea for MIT
- Why we think it is a good idea for NTT
- Seventeen NTT-MIT projects
- Web site
- Some highlights
- Oxygen
- Summary

MIT-- Constant but Changing

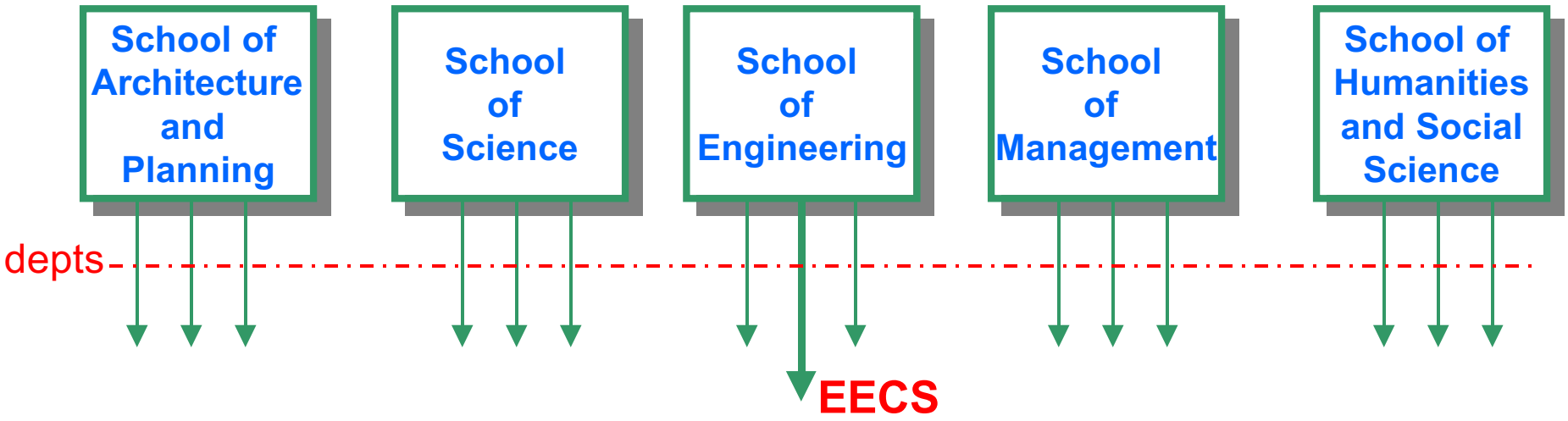


MIT Research Collaborations

Amgen	Bio-tech
Ford	Automobiles
Merck	Pharmaceuticals
Merrill-Lynch	Finance
Microsoft	Software
NTT	Telecommunications

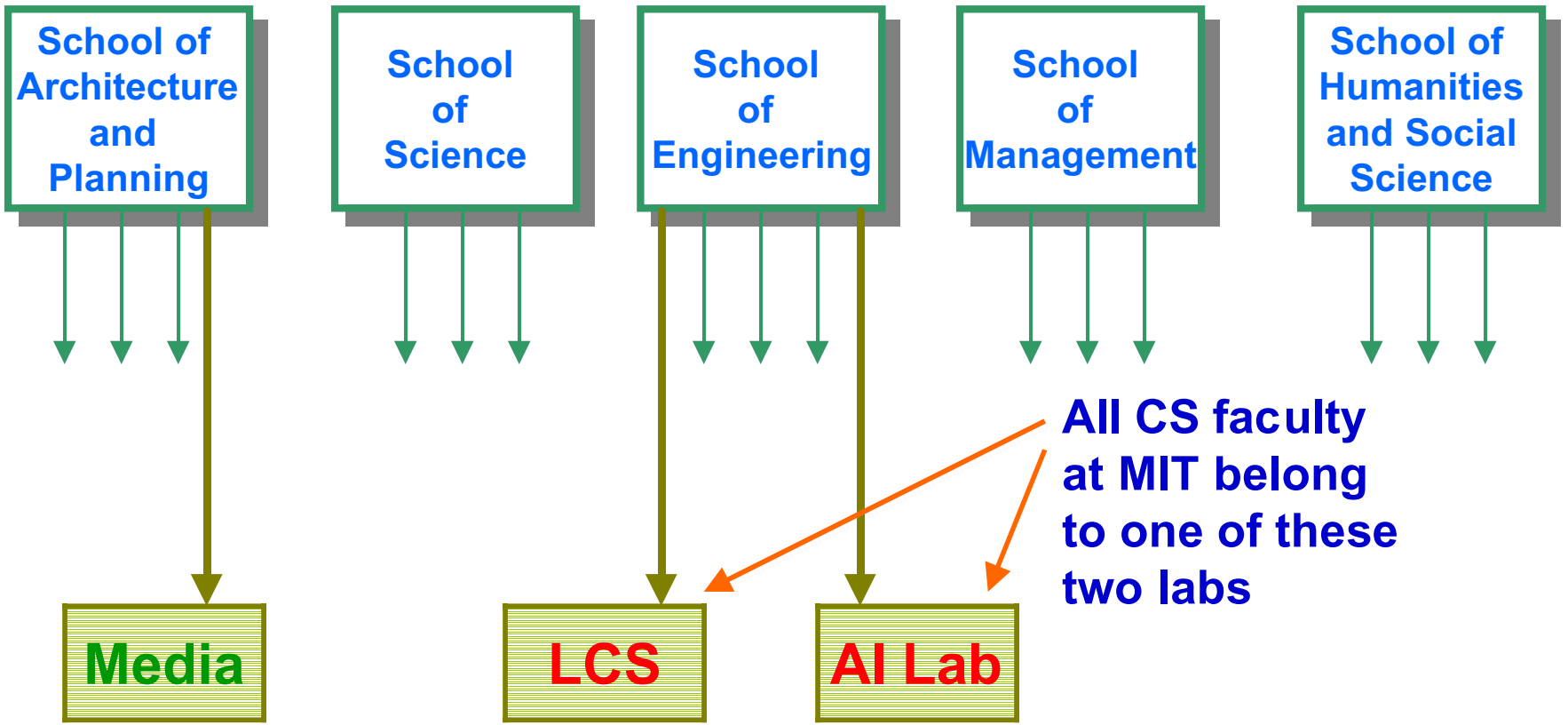
All are five year projects with multiple faculty involved

MIT--Organized in Five Schools



- School of Engineering is about 2/3 of MIT students
  - has eight departments and two divisions
- Department of Electrical Engineering and Computer Science (EECS) has about 1/3 of all MIT students
- CS now has more than half of the EECS students

The Research Happens In Labs



LCS and AI

- AI Lab founded in 1959, LCS in 1963 (as project MAC)
- AI Lab: 225 people, LCS: 500 people

AI occupies top 3 floors

LCS occupies bottom 6 floors

June 23, 1997 -- US Research Labs

LCS #2

AI #9

Media #10

THE TOP 20 U.S. RESEARCH LABORATORIES

	RANK	STAFF SIZE	FACULTY MEMBERS OR PhDs (%)	RESEARCH HONORS	PATENTS
STANFORD UNIVERSITY Where many researchers want to work	1	230	13	10	.004
CARNEGIE MELLON UNIVERSITY (CMU) COMPUTER SCIENCE Creating new centers to pursue key technologies	2	263	20	9	N.A.
MIT LABORATORY FOR COMPUTER SCIENCE Long a hotbed for new startups	2	254	12	13	0.08
AT&T LABS Tied with Bell Labs, though only one-tenth as big	4	2,500	95	11	N.A.
BELL LABS (Lucent Technologies) King-sized lab is awarded an average of three patents a day	4	24,000	17	40	0.2
UNIVERSITY OF CALIFORNIA-BERKELEY Closing the gap with traditional leaders	6	230	13	10	N.A.
IBM RESEARCH Big Blue remains a research bulwark	7	2,300	52	75	0.7
XEROX PARC Now generating startups, too	8	230	60	34	1.0
MIT ARTIFICIAL INTELLIGENCE LAB Has spun off 20 startup companies	9	165	12	5	0.3
MIT MEDIA LAB Keeps on making news—and waves	10	400	5	N.A.	0.06
MICROSOFT RESEARCH A five-year-old newcomer leaps ahead	11	205	70	46	N.A.
CMU ROBOTICS INSTITUTE Its robots aren't just for factories	12	220	20	5	N.A.
SANTA FE INSTITUTE Very strong in complexity research	13	40	100	10	0.01
UNIVERSITY OF ILLINOIS-URBANA Mosaic and Netscape started here	14	356	10	2	0.1
UNIVERSITY OF SOUTHERN CALIFORNIA Its Information Sciences Institute is a star	14	374	29	5	0.08
UNIVERSITY OF MICHIGAN Good marks in artificial intelligence	16	283	14	2	0.2
UNIVERSITY OF WASHINGTON Rapid rise in standing since 1970s	16	175	17	4	N.A.
GEORGIA INSTITUTE OF TECHNOLOGY Has new Advanced Telecommunications Center	18	685	40	3	0.5
CALIFORNIA INSTITUTE OF TECHNOLOGY Leader of a new program in quantum computing	19	2,713	N.A.	104	0.09
CORNELL UNIVERSITY An Ivy League computer pioneer	19	101	50	4	N.A.

Some LCS Innovators

Ward
Workstation/ NuBus

Clark
Internet

Metcalf
Ethernet

Dertouzos
Information Marketplace

Berners-Lee
WWW

Rivest
RSA Encryption

Zue
Speech Interfaces

Corbato
Time Sharing

Frankston
SpreadSheet

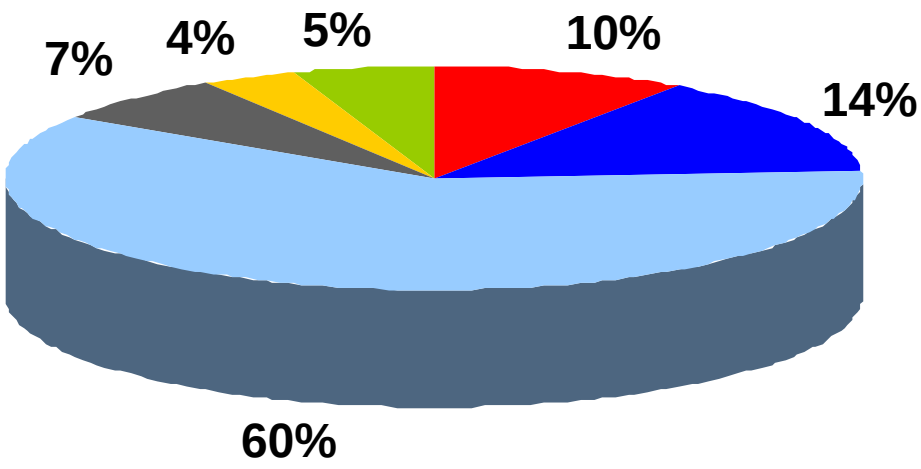
Szolovits
Guardian Angel

Some AI Lab Innovations

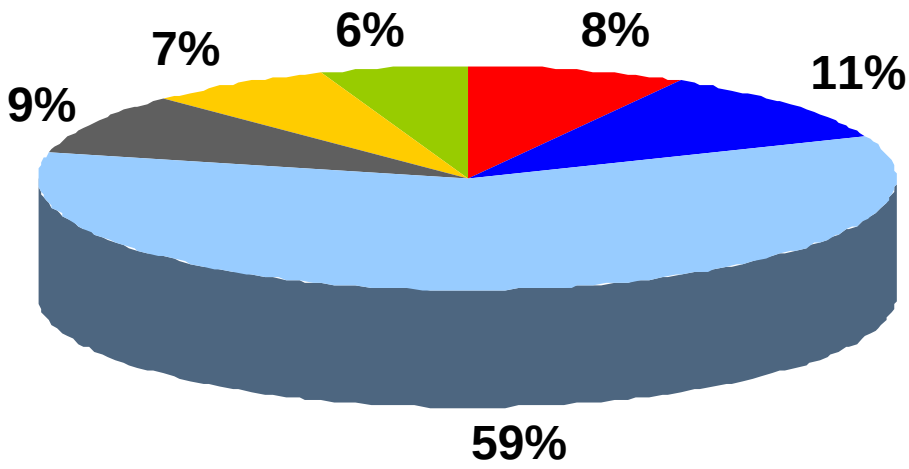
- 1959 LISP -- first computer language with
  - conditional expressions
  - storage management
- 1965 MacHack -- first tournament level chess program
  - all major features found today in Deep Blue
  - first real implementation of alpha-beta search
- 1967 First megabyte memory
- 1968 Macsymma -- first widely available computer algebra system
- 1972 First RAM-based bit-mapped display
- 1972 VICARM -- prototype of first commercial electric robot arm
- 1972 SHRDLU -- first natural language interface to a computer
- 1973 Actors -- precursor to object oriented programming
- 1975 Chess machine -- special purpose computer
- 1976 Chaosnet -- concurrent with first ethernet
- 1976 Lisp machine -- first personal workstations
- 1979 First special purpose vision chip
- 1982 Digital Orrerey -- first supercomputer in a box
- 1982 Connection Machine
- 1988 Small mobile robots -- direct precursor to 1997 Mars mission
- 1993 White House publication system
- 1993 PHANTOM -- first commercial haptic interface system
- 1997 Daily image guided brain surgery

Distribution of People - 1999

People



People



- Faculty
- Researchers
- Students
- Support Staff
- Visitors
- Others

- Faculty
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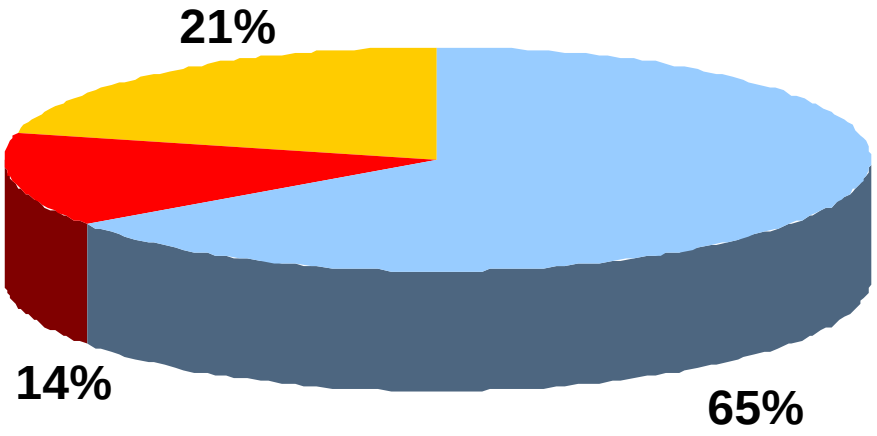
- Others

ai lab @ MIT

L C S

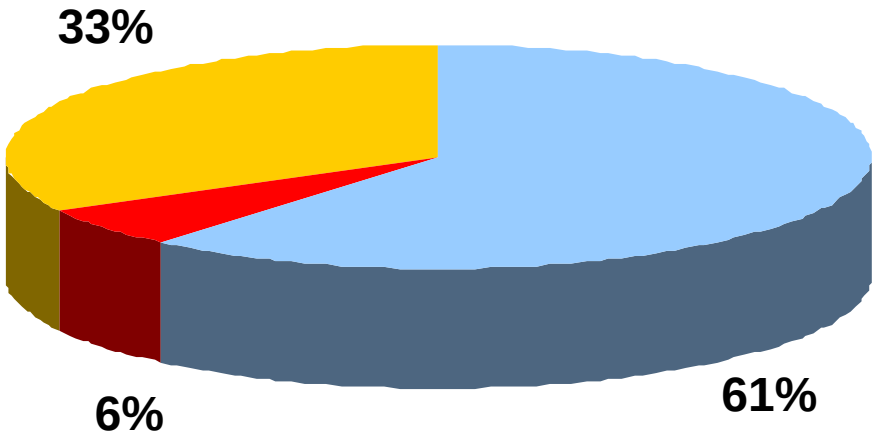
Research Sponsorship - 1999

Funding



- DARPA
- Government (Other)
- Industry

Funding



- DARPA
- Government (Other)
- Industry

Why MIT Likes Working with NTT

- MIT Computer Science has been driven since the 1960's by the needs of US defense
- The world situation has changed over the last few years
- We believe that it is important for us to be driven by a more commercial set of fundamental issues

- NTT is a large scale player in telecommunications and multi-media
- It has a culture of understanding the importance of basic research

Why We Think it's Beneficial to NTT

- In the US the model of innovation into large companies has been augmented
  - large companies still have good internal research labs (Microsoft, Compaq, IBM, AT&T, Lucent, Xerox, etc.)
  - but, they also buy many small companies
- Small companies are a major source of innovation
  - there is a much stronger tradition of entrepreneurial small companies in the US than in Japan or Europe
  - but, it may be hard for foreign companies to absorb small US companies into their main stream
- But where does the innovation come from?
  - largely it is from research students coming out of the major research universities: MIT, CMU, Stanford & Berkeley

- NTT gets direct access to these students and their ideas at the pre-competitive stage

The Collaboration

- **Began July 1st, 1998**
  - **first year had seven projects**
  - **MIT faculty and NTT researchers**
    - **many visits to NTT from MIT faculty**
    - **many visits to MIT from NTT researchers (for varying lengths of time)**
  - **all projects were renewed for a second year**

- **Second year began July 1st, 1999**
  - **ten new projects**
  - **each project has NTT collaborators**

First Year Projects; 1998-2000

- WIND: Wireless Networks of Devices
  - Hari Balakrishnan and John V. Guttag; Minoru Katayama
- Multilingual Conversational Speech Research
  - James Glass and Stephanie Seneff; Kiyoaki Aikawa
- Research in Cryptography, Info Security and Algorithm Dev.
  - Shafi Goldwasser, Ronald L. Rivest, and Mike Sipser; Tatsuaki Okamoto
- Self-updating Software
  - Barbara Liskov and Daniel Jackson; Minoru Kubota
- Variable Viewpoint Reality
  - Paul Viola and Eric Grimson; Ken'ichiro Ishii
- Image Database Retrieval
  - Paul Viola; Tsutomu Horikoshi
- Interactive Sculpting of Virtual 3D Materials
  - Julie Dorsey and Leonard McMillian; Tsutomu Horikoshi

Second Year Projects(1); 1999-2000

- **Malleable Architectures for Adaptive Computing**
  - **Arvind, Larry Rudolph, and Srinivas Devadas; Hiroshi Sawada**
- **A Framework for Automation Using Networked Information Appliances**
  - **Srinivas Devadas and Larry Rudolph; Satoshi Ono**
- **Haystack: Per-User Information Environments**
  - **David Karger and Lynn Andrea Stein; Kazuhiro Kuwabara**
- **Learning Rich, Tractable Models of the Real World**
  - **Leslie Pack Kaelbling; Shigeru Katagiri**
- **Digital Control and Communication in Living Cells**
  - **Tom Knight and Gerry Sussman; Hitoshi Hemmi**

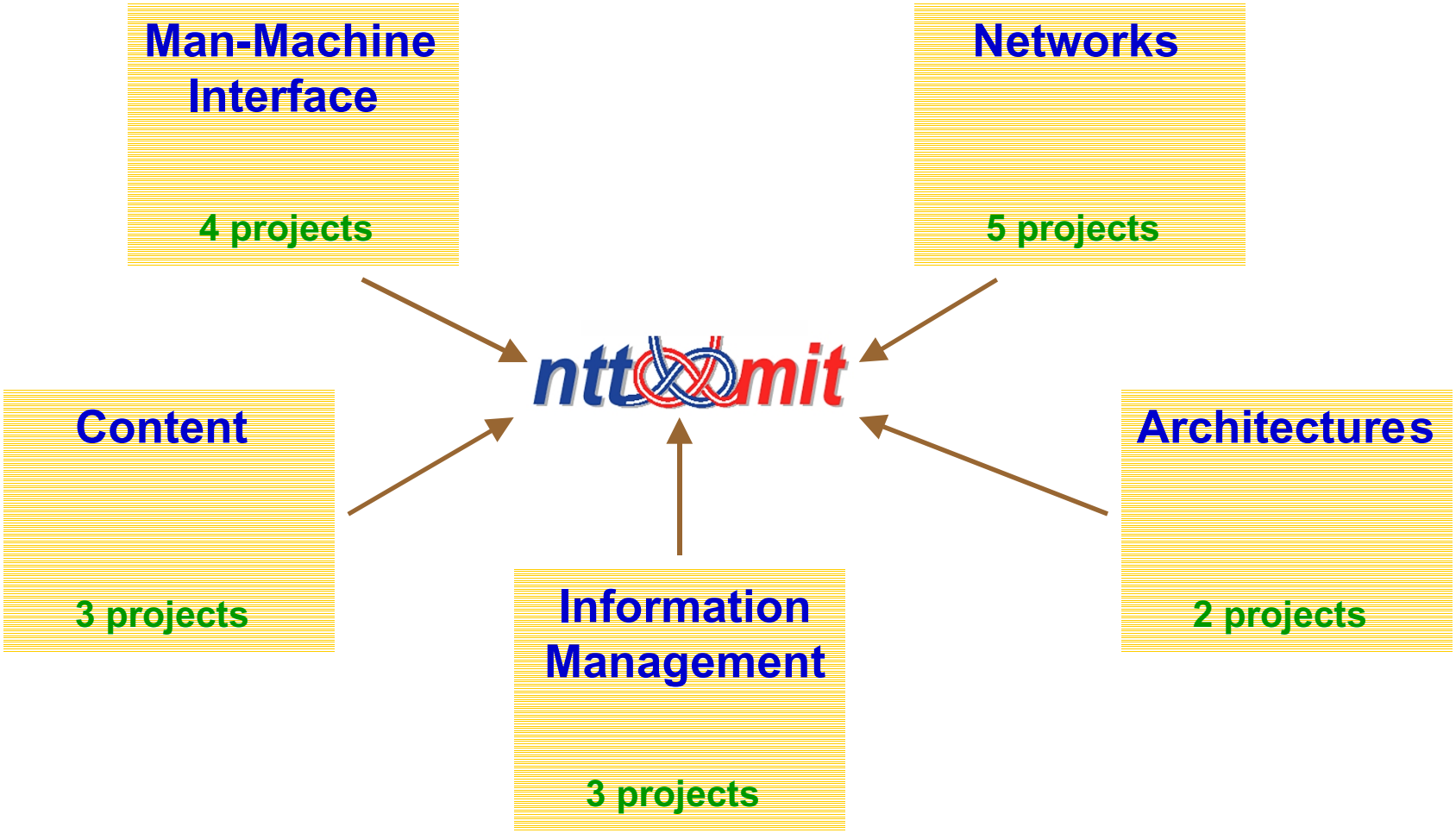
Second Year Projects(2); 1999-2000

- **Building Blocks for High-Performance, Fault-Tolerant Distributed Systems**
  - **Nancy Lynch and Idit Keidar; Kiyoshi Kogure**
- **A Synthetic-Aperture Camera Array**
  - **Leonard McMillian and Julie Dorsey; Hiroshi Murase**
- **Adaptive Man-Machine Interfaces**
  - **Tomaso Poggio; Norihiro Hagita**
- **High Resolution Mapping and Modeling of Multi-Floor Architectural Interiors**
  - **Seth Teller; Tsutomu Horikoshi**
- **Human-Robot Dynamic Social Interaction**
  - **Rodney Brooks; Katsunori Shimohara**

Current Status

- 17 projects
- 28 MIT faculty members

17 Projects in 5 Broad Areas



Areas of Research (1)

- **Man-machine interface**
  - u **Multilingual Conversational Speech Research**
  - Y **Adaptive Man-Machine Interfaces**
  - – **Interactive Sculpting of Virtual 3D Materials**
  - Y **Human-Robot Dynamic Social Interaction**

- **Networks**
  - u **WIND: Wireless Networks of Devices**
  - – **Self-updating Software**
  - – **Cryptography, Info Security and Algorithm Development**
  - – **Automation Using Networked Information Appliances**
  - – **High-Performance, Fault-Tolerant Distributed Systems**

Areas of Research (2)

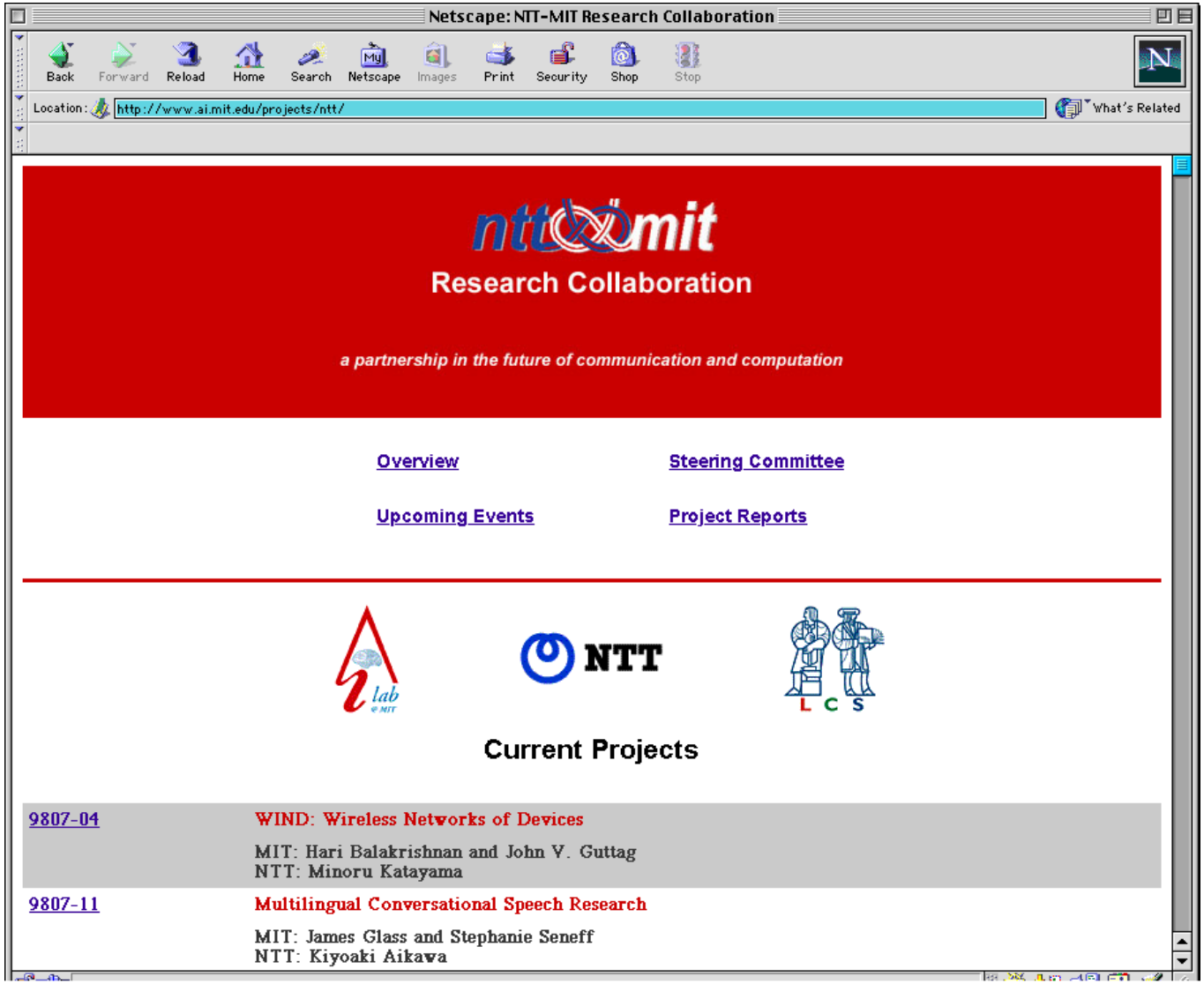
- **Content**
  - Mapping and Modeling of Architectural Interiors
  - A Synthetic-Aperture Camera Array
  - Variable Viewpoint Reality
- **Architectures**
  - Malleable Architectures for Adaptive Computing
  - Digital Control and Communication in Living Cells
- **Information Management**
  - Image Database Retrieval
  - Haystack: Per-User Information Environments
  - Learning Rich, Tractable Models of the Real World

Collaboration Web Site

- http://www.ai.mit.edu/projects/ntt
  - username: NTTMIT
  - password: collaboration

- information on all the current projects
  - project overviews
  - recent updates and breaking news
  - presentations, online papers
  - progress reports
  - links to related research
  - scripts for NTT and MIT researchers to add
    - comments
    - content

NTT-MIT Collaboration Page



A Page for Each Project

Netscape: NTT-MIT: 9807-28 Variable Viewpoint Reality

Back Forward Reload Home Search Netscape Images Print Security Shop Stop

Location: http://www.ai.mit.edu/projects/ntt/projects/9807-28/ What's Related

Research Projects

Variable Viewpoint Reality

9807-28

Start date: 07/98

Paul Viola and Eric Grimson
MIT AI Lab

Ken'ichiro Ishii
NTT

Project summary

This work synthesizes information from many different cameras to produce arbitrary viewpoints of sporting or entertainment events.

Project description

In the foreseeable future, sporting events will be recorded in super high fidelity from hundreds or even thousands of cameras. Currently the nature of television broadcasting demands that only a single viewpoint be shown, at any particular time. This viewpoint is necessarily a compromise and is typically designed to displease the fewest number of viewers.

In this project we are creating a new viewing paradigm which will take advantage of recent and emerging methods in computer vision, virtual reality and computer graphics technology, together with the computational capabilities likely to be available on next generation machines and networks. This new paradigm will allow each viewer the ability to view the field from any arbitrary viewpoint -- from the point of view of the ball headed toward the soccer goal; or from that of the goalie defending the goal; as the quarterback dropping back to pass; or as a hitter waiting for a pitch.

In this way, the viewer can observe exactly those portions of the game which most interest him, and from the viewpoint that most interests him (e.g. some fans may want to have the best view of Michael Jordan as he sails toward the basket; others may want to see the world from his point of view).

Demos, movies and other examples

Our current system consists of a set of cameras, distributed around an open working area. These cameras can automatically self calibrate, so that their input can be coordinated.

The OXYGEN Project

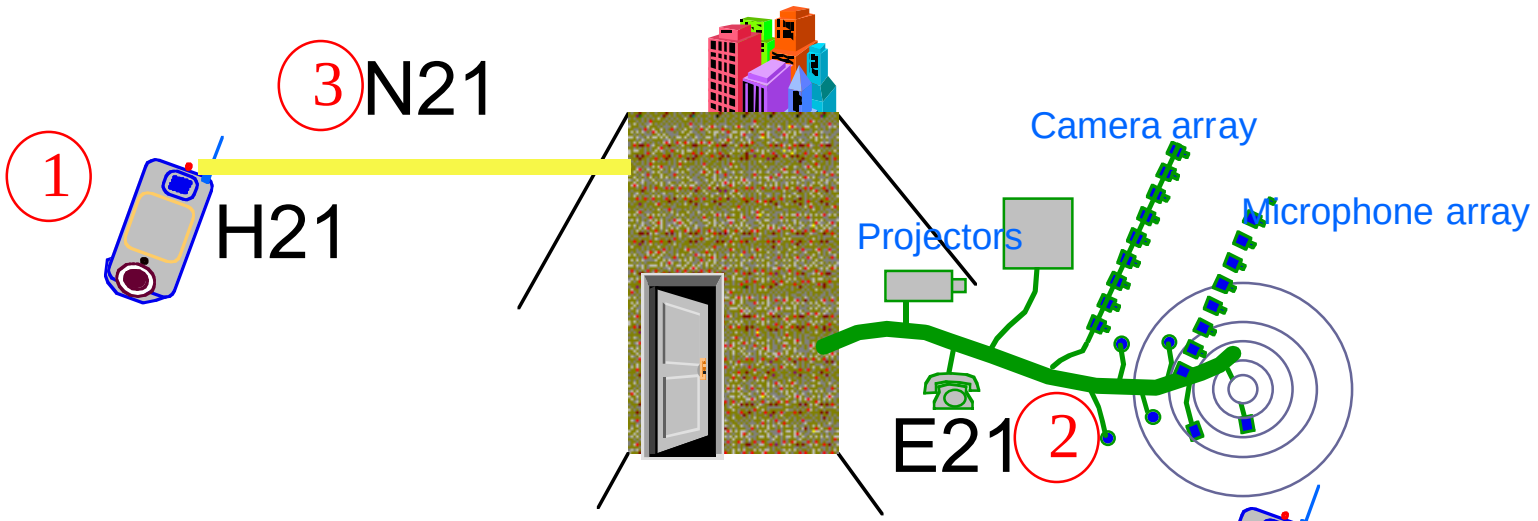
- A new project started in AI and LCS in mid-1999
- We expect it to grow to cover approximately one third of our two laboratories
- We view our new building as a target of opportunity for building the Oxygen project on a very large scale

Oxygen: Goals and Vision

- **Goal : Help people "do more by doing less"**
  - **bring information technology to people**
  - **increase ease of use**
  - **increase human productivity, 300% possible**

- **Vision: To bring an abundance of computation and communication within easy reach of humans**
  - **through natural perceptual interfaces of speech and vision**
  - **so computation blends into peoples' lives**
  - **enabling them to easily do tasks they want to do -**
    - **collaborate, access knowledge, automate, and customize**

Translating the vision...Oxygen System



4 Speech and vision

5 Automation & 6 customization

7 Individualized knowledge acces

8 Collaboration

Physical systems

Software Env

User technologies

Whose World?

- **That was then:**
  - people enter the computational world, they go to a computer
    - more recently they lug it around
    - it doesn't care, nor is aware, whether they are even there
  - virtual reality makes this even worse…
- **This is now:**
  - Computation to enter the human world, and understand the goals, intentions, and desires of people
  - To be freely available everywhere, like batteries and power sockets

Oxygen Funding

- US Government
- Negotiating with European Union

- Setting up an industrial consortium
  - speaking actively to many companies
  - these companies will come from a spectrum of different interests (e.g., chip manufacturers, computers, software, etc.)
  - companies will contribute research funds
  - companies benefit by being part of the research

- Of course, NTT is already such a close collaborator, that NTT is a member by virtue of our existing arrangement

Summary

- We are 18.5 months into a five year collaboration
- The collaboration has established many relationships between NTT and MIT researchers
- Visits between the groups are commonplace

- MIT is very interested in finding new research challenges that are driven by NTT's strategic needs
- MIT is very grateful for close intellectual interactions

- LCS and AI are strong advocates for NTT and feel very fortunate to be working with such a strong group