Virtual Enterprises meet the Internet

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Quick Outline

- **Background**
  - » The networked Virtual Enterprise
  - » Traditional CAD/CAM/PDM meets Internet Technology
- **Emerging Issues and Hot Topics**
  - » Engineering Services, Object Technologies, Smart Catalogs
  - » Agents, agents, everywhere….
- **Assesment and Prospectus**
  - » Costs, business issues, practical considerations
- **Conclusions and Questions**
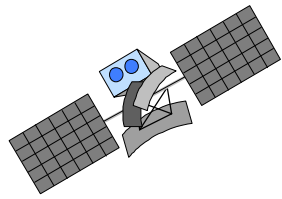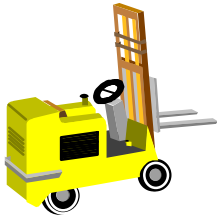
Future Information Networks
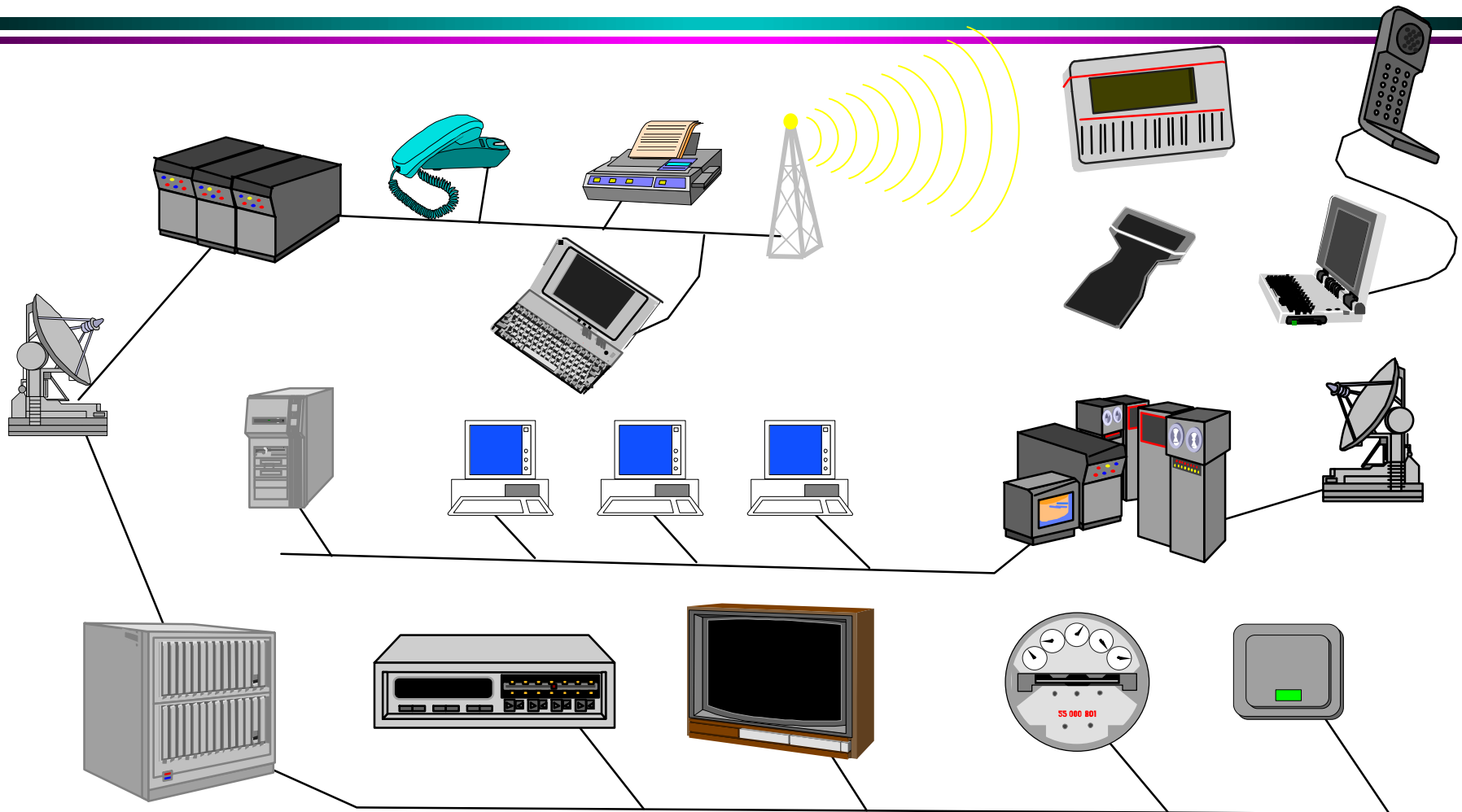
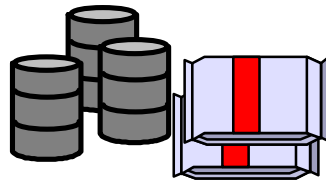# The Business Model
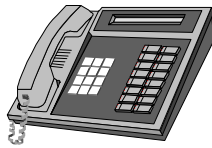
Sales

Engineering

Accounting

Manufacturing

Shipping/ Receiving

Inventory
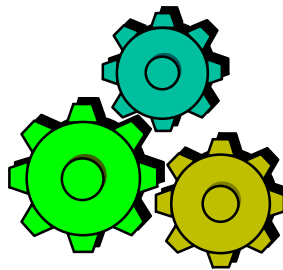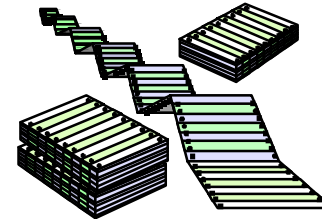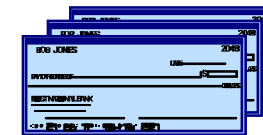
Payables/ Receivables

- Every piece of software is part of your enterprise
- Every partner is part of your enterprise

"Traditional" CAE

- Computer-Aided Design
- Computer-Aided Manufacturing
- Product Data Management
- Visualization
- Simulation
- Analysis
- Prototyping
- Life-cycle support
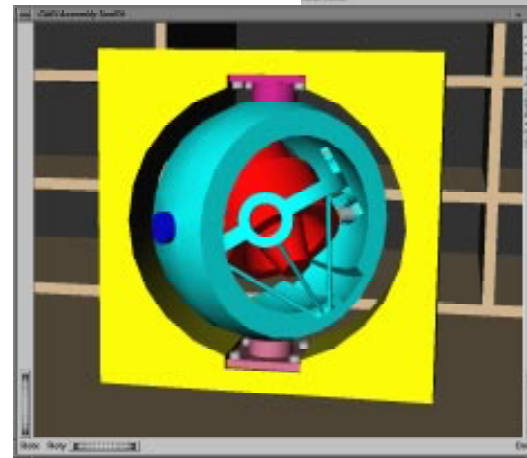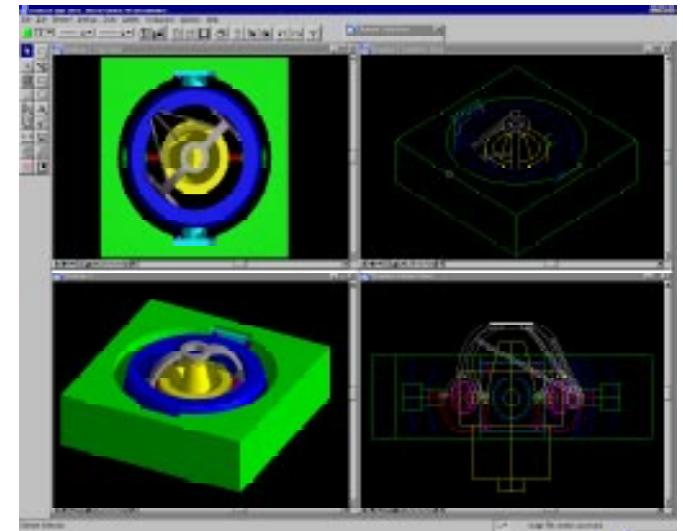
Internet Technology

- **Information Access**
  - » Sophisticated hardware
  - » communication protocols (TCP/IP, FTP, ATM...)
- **Active Information**
  - » Higher-level protocols (X Windows, HTTP, SMTP...)
  - » Complex/interactive systems (MBONE…)
- **Internet integrated with the desktop**
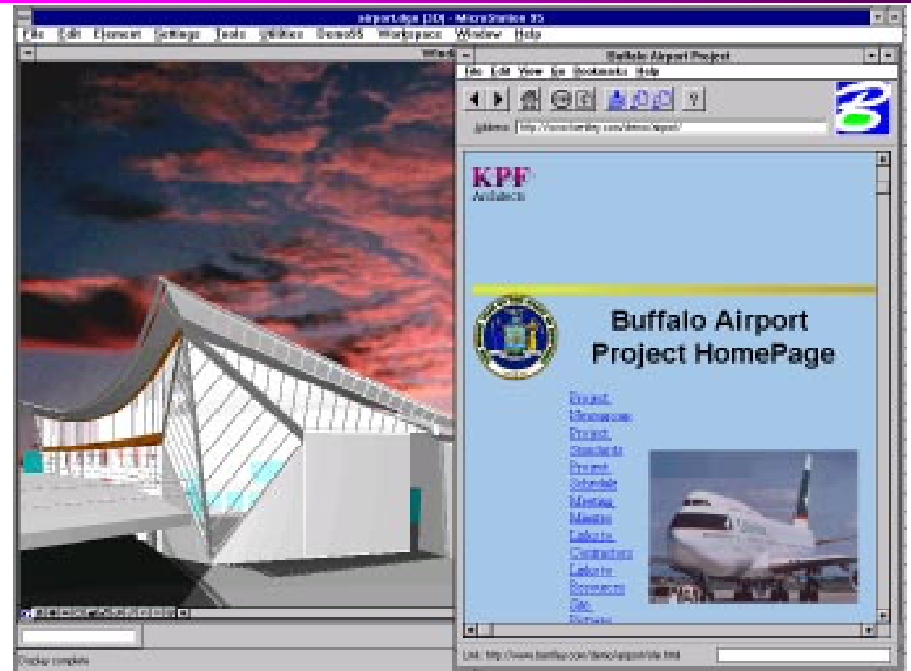
Scenarios for Virtual Organizations

- **Scenario #1: Small-Mid size manufacturer**
  - » sharing data with manufacturing partners
  - » component catalogs
  - » digital procurements
  - » electronic bids
  - » partner selection
  - » customization
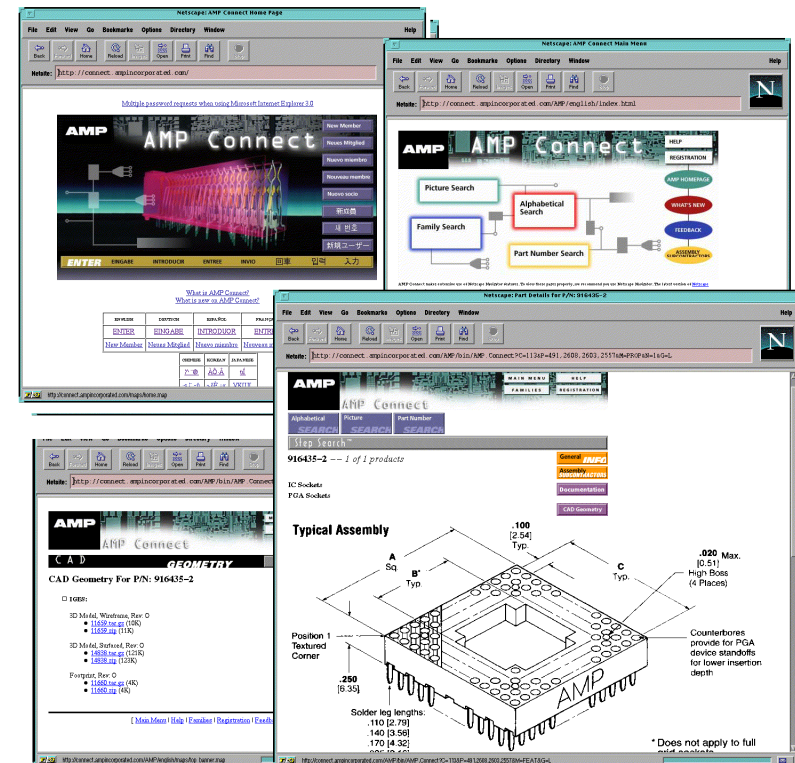
Scenarios for Virtual Organizations

- ● Scenario #2: a construction project
  - » multiple organizations

    Architect, contractors, city/state, regulators, neighbors

  - » Open expertise hidden inside individual organizations

  - » Provide controlled

    access intellectual property

  - » Share tools and experience

  - » Record collective project

    history
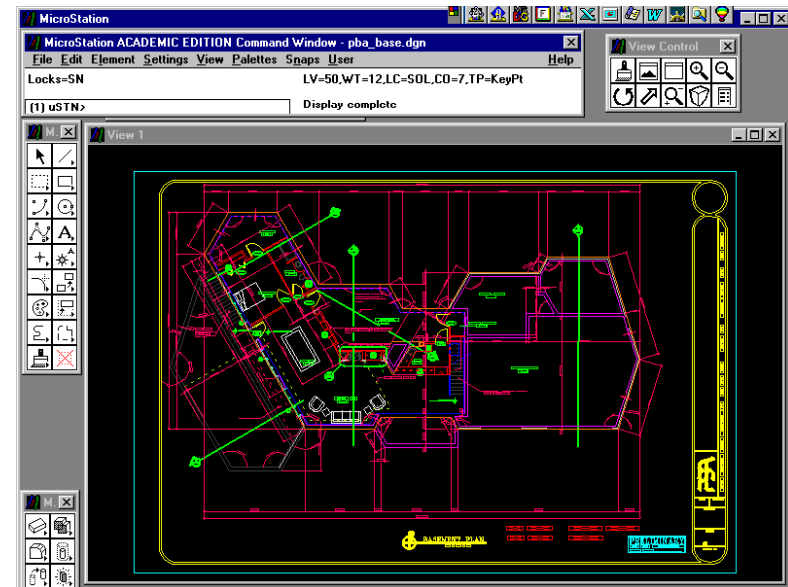
Benefits of **Internet-Enabled** Engineering

- Communication of information
  - » within an office
  - » across virtual organizations
  - » to suppliers and customers
- Access to services
  - » human expertise
  - » software agents
- Collaboration
- Vast reductions in communication overhead

Information

Services

Collaboration
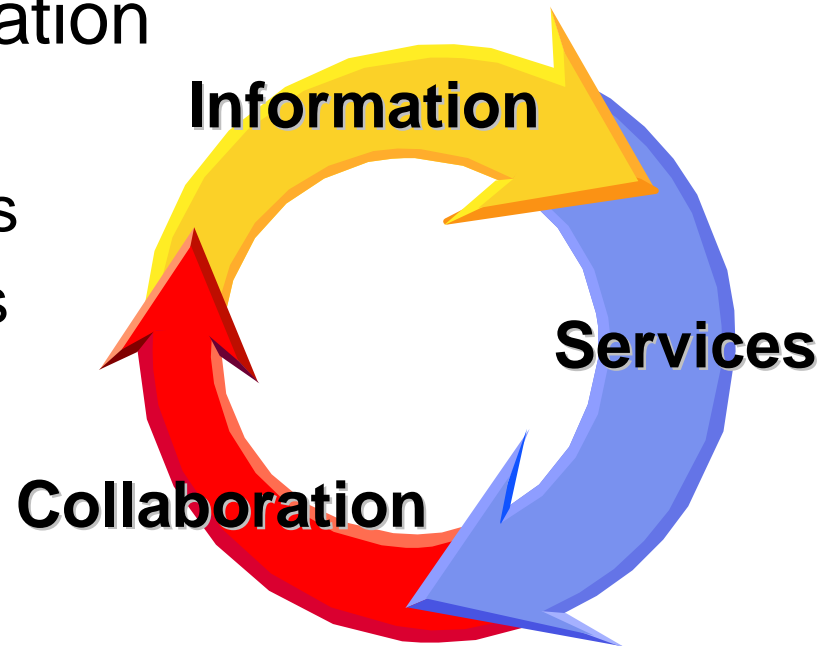
Issues for Virtual Organizations

- Major issues of **Security** and **Trust**
- Many competing and immature technologies
- Many technologies require radical changes in
  - » Vendor business practices and models
  - » User business practices
- Lots of gadgets and tools with flash

  hard to find the substance...
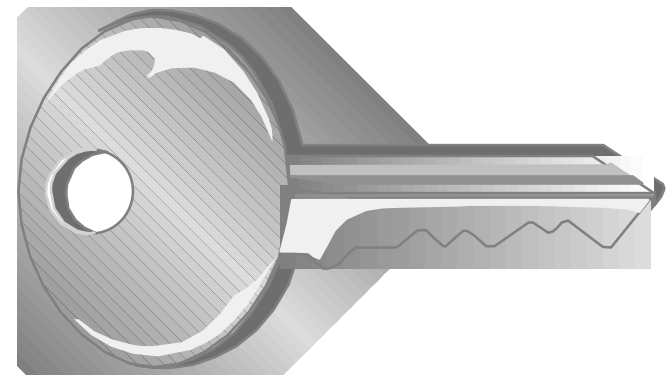
Technology Trends

- **Engineering groupware**
- **Object Technology**
- **Engineering Services**
- **Agents**
- **Integration of Internet, Computing and Telecommunications**
  - » The **Information-based Manufacturing Testbed** at Carnegie Mellon and Drexel Universities

Convergence
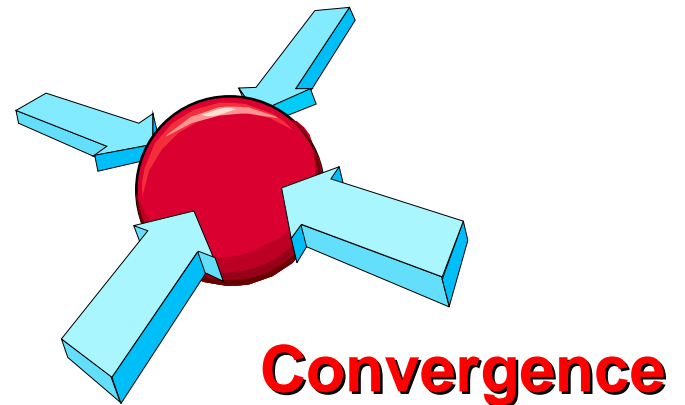
Engineering Groupware

- **CAD Viewers**
  - » many appearing in Java
- **Redline and markup tools**
- **Embedded browsers**
- **CAD "servers"**
- **Integrating Internet and Product Data Management**
  - » COTSS: Metaphase, PM, ...
  - » Leveraging the WWW
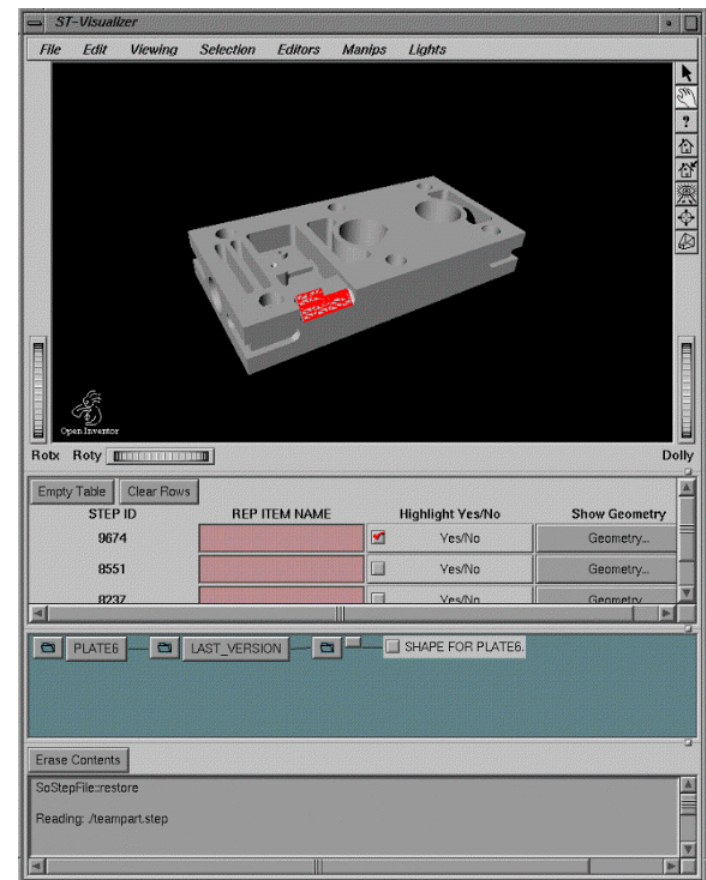
Object Technology

- Microsoft's **Common Object Model** (COM, also known as ActiveX/OLE)

- The Object Management Group's **CORBA**, the Common Object Request Broker Architecture

- **Java** (Sun Microsystems)

- **OpenDOC** (IBM/Apple) (Deceased….)

These technologies are radically changing the way computing is done…...

Microsoft's OLE

Now called ActiveX

Component Object Model (COM)

1994 and beyond

1993

1991

Future Microsoft OS Services
Distributed OLE, OFS, *even better* OLE Documents, etc...

OLE Industry Solutions
3rd Party Efforts to solve industry problems
by defining standards based on OLE

OLE Controls
Programmable Components
(Includes some new generic services)

Generic services
(COM, OLE Automation, UDT, ...)

better
OLE Documents

OLE Documents
(OLE 1.0)

Under the COM/OLE hood...

CORBA Architecture
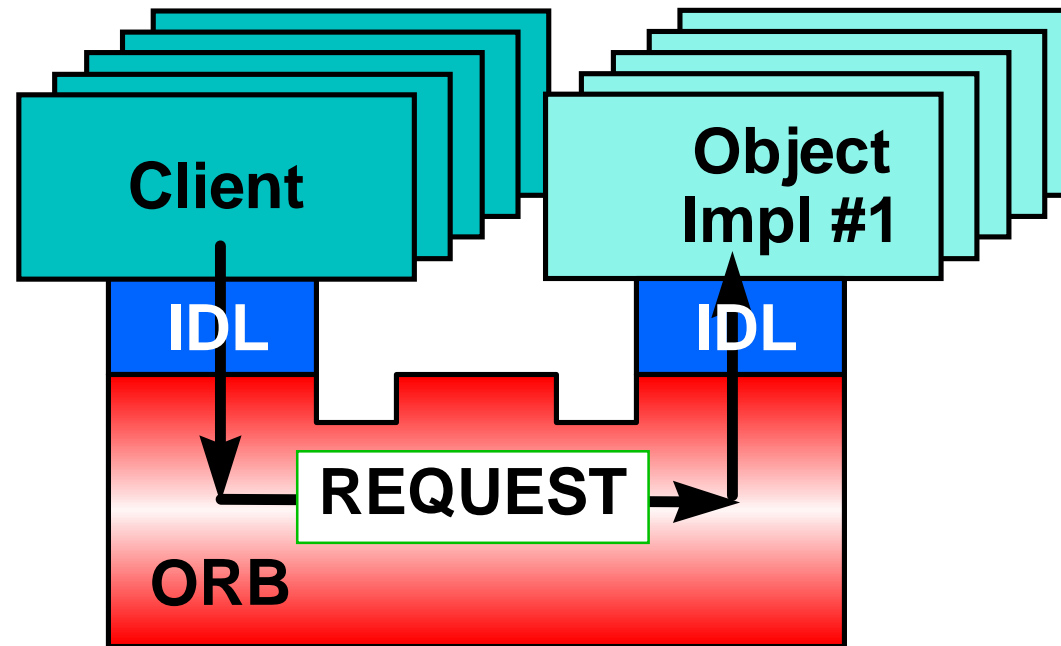
An Object Request Broker relays the Invocation from Client to Object Implementation, and the result back to the Client.

CORBA: A Common Foundation

- Enable interoperability and Portability based on an object-oriented foundation which specifies:
    - » A single terminology for object-orientation.
    - » A common abstract framework or object model.
    - » A common reference model or architecture.
    - » Common interfaces & protocols

Application Objects   Common Facilities

Object Request Broker

Object Services

- Heterogeneous platforms, OS, languages, and systems.
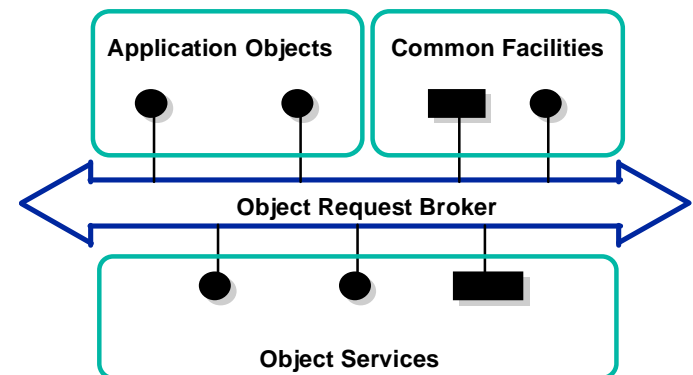
Application Frameworks

Non-standardized application-specific interfaces

Vertical domain-specific interfaces

Horizontal facility interfaces

Application Objects

Domain Objects

CORBA facilities

Object Request Broker

CORBA services

General service interfaces
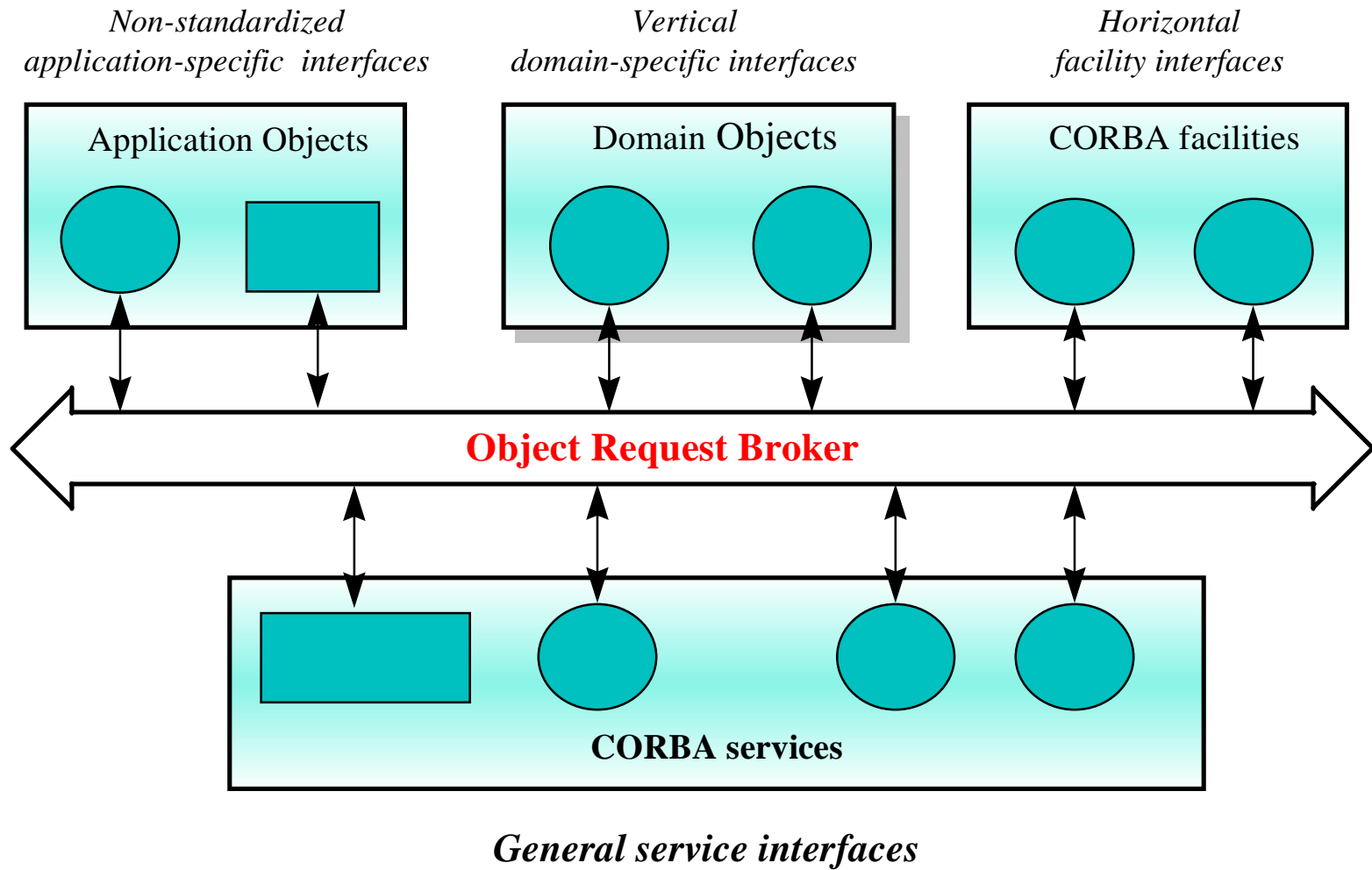
Sun's Java Language

- 1990 - Started by James Gosling
- 1991 - Consumer Electronics
- 1993 - Interactive TV
- 1995 - Internet and HotJava

- Object Oriented
- C/C++ Syntax
- Platform-independent compiled bytecode executable
- Executable over WWW as embedded Applets
- Emerging as bridge to legacy systems
- The **right** technology, the **right** place, the **right** time...
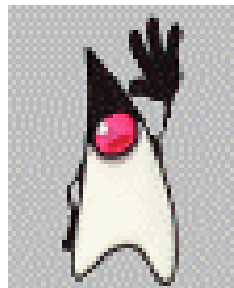
Engineering Services

- **On-line Catalogs**
- **Human Consultants**
- **Software Services**
- **Prototyping**
- **Fabrication**
- **Data Translators**
- **Agents**

Agents

- Autonomous software modules
- Intelligent (?)
- Can vary in size and scope
    - » light/small agents, fine granularity
    - » heavy/large agents, coarse granularity
- Encapsulate legacy systems
- Mediate among systems and enterprises
    - » partner selection
- Java is an implementation language of choice

Various Types of Agents

Engineering Design

Design Repository Services
Wide-area Product Data Management (PDM)
Manufacturing Process Selection
Cost Estima ti on
 Engineering Experience

Broker

Manufacturing Partner Selection
Manufacturing Process Modeling Agents
Information search and retrieval
Data tracking and network management

Manufacturing Facility

 Machining Services
 Solid Free-FormFabrication Services
 Sheet Metal Bending
 Robotic Assembly Manipulators
 Human Assembly

- Linking engineers with highly focused tools
- Navigating among competing partners
- Modeling the tools and capacity of individual facilities

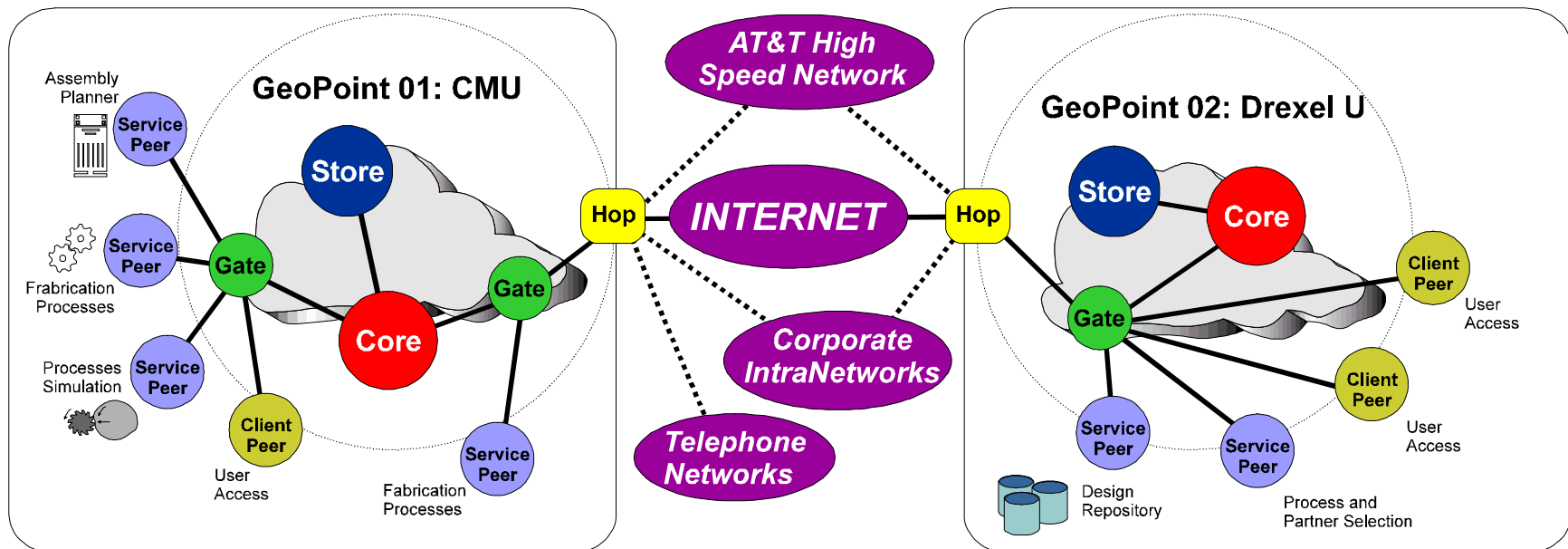# CMU/Drexel Information-based Manufacturing Testbed

- Explore information infrastructural issues
- Deploy agent-based engineering architectures
- Allied Signal, AT&T, Bentley, SDRC, State of PA

Internet-Aided Engineering Vision

A networked set of integrated engineering software services accessible via the telecommunications infrastructure (e.g. The Internet).

- Includes the latest sophisticated engineering software

- Availability of smart catalogs, libraries, and repositories

- Highly inter-networked distributed software and hardware

- Seamless integration

- Access to advanced manufacturing services
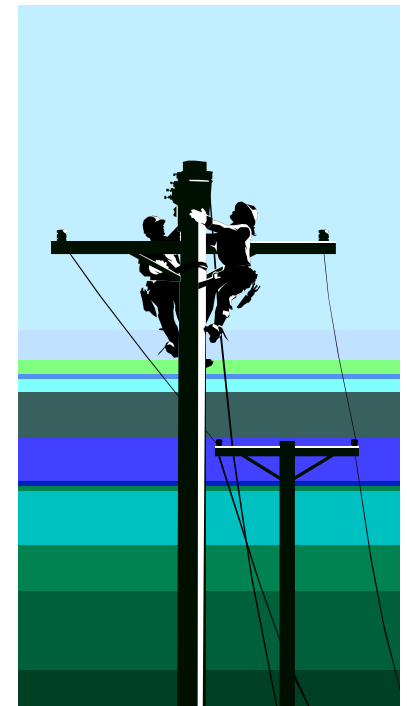
Conclusions

- **Three basic types of VM**
- Design Centered VM
  - » plan based manufacturabilty evaluation of designs
- Some Challenges
  - » developing robust and reliable systems
  - » modifing the corporate culture
  - » support for conceptual and process-independent design

Success Stories

- **Catalog Services**
  - » IndustryNet/NETS Inc., PartNet, AMP Inc.
- **Collaborative Engineering**
- **Agent-based Engineering**
  - » PACT: the Palo Alto Collaborative Testbed
  - » CyberCut
- **Corporate Intranets and Virtual Intranets**
  - » SUN's design of the Ultra workstation
  - » Boeing 777

Current Trends

- ● **Access to human expertise**
  - » Software as consultancy
- ● **Smarter Objects**
  - » uniting data and methods
- ● ***A la carte*** **software**
  - » (rental, pay-per-use)
- ● **Agents, agents everywhere**
  - » Analysis, feedback, cost estimation

Developments to Watch

- **Microsoft's "Distributed COM" (DCOM)**
  - » due out in late 1997
  - » will lack some of the functionality present in other Object Technologies

- **NIIIP Consortium and Open Standards**
  - » National Industrial Information Infrastructure Protocols
  - » Led by IBM, includes many software companies and manufacturers, large and small
  - » CORBA-based integration frameworks
  - » Recent announcements by Netscape, Sun, IBM, and Oracle

- **Where are the serious Java applications?**

Some of the Cot for VM

- **Internet Access**
  - » T1/T3== $1000s/month, covers many users
  - » Dialup== <$20, for home business
  - » Network cards, modems, etc. ($200-300)
- **Software tools and support**
- **Training**
- **Developing new management techniques**

Technology/Research Issues

- Many competing/immature technologies
- **Security** a major issue
- ***Open* Standards** are needed
- Technologies require radical changes in
  - » Vendor business practices and models
  - » User business practices
- Lots of gadgets and tools with flash, hard to find the substance
- Enabling Dynamic Object/Agent Interoperability

Virtual Factories

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ISR
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Institute for Systems Research
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Who We Are

- **Ten years experience**
  - » Concurrent Engineering: IMACS, EDAPS, SIPS/EFHA
  - » Systems Engineering: EXTRA, OSPAM
  - » Production Operations: DPS, HPMS, BBOR
  - » Logistics: Inventory, Distribution, Supply Chain Management
- **Sponsors and Partners**
  - » *Government:* DARPA, ARO, ONR, NIST, NSF, US Army TACOM, Wright Patterson AFB
  - » *Industry:* Allied Signal, Bentley Systems, Harris Semiconductor, IBM, Kopflex Inc., LAI, Lockheed Martin, Northrop Grumman, Pangborne Corp., Pepco, Raytheon, Simmons Mattress, SDRC, Spatial Technologies, Texas Instruments, Washington Aluminum, Westinghouse