From Object-Oriented Programming to Component Software

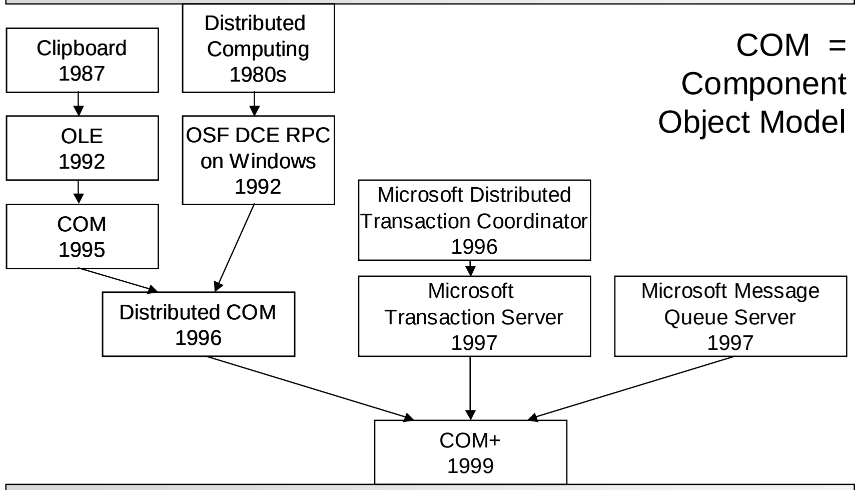
- OO Languages:
  - Ada, Smalltalk, Java, C++
- Class versus Object:
  - Express existence of objects directly in code
  - Code is more expressive, easier to develop, less costly to maintain
- Main Concepts:
  - Encapsulation – hiding of implementation details
  - Inheritance – reuse existing objects in creation of new objects
  - Polymorphism – exhibit multiple behavior depending on object used
- Reuse:
  - Code must be written in a general enough manner
  - Language-independent

Component Software

- Object-Oriented Analysis and Design:
  - Breakdown of a project in its logical components
- Components:
  - Reusable pieces of software in binary form
  - Interoperability
- Interfaces;
  - Semantically related set of methods
  - Strongly typed contract between software component and ist clients
  - Articulation of expected behavior
  - Reusable in a variety of contexts

Evolution of COM+

COM = Component Object Model


Clipboard 1987
Distributed Computing 1980s
OLE 1992
OSF DCE RPC on Windows 1992
COM 1995
Microsoft Distributed Transaction Coordinator 1996
Distributed COM 1996
Microsoft Transaction Server 1997
Microsoft Message Queue Server 1997
COM+ 1999

Problems of Complex Software

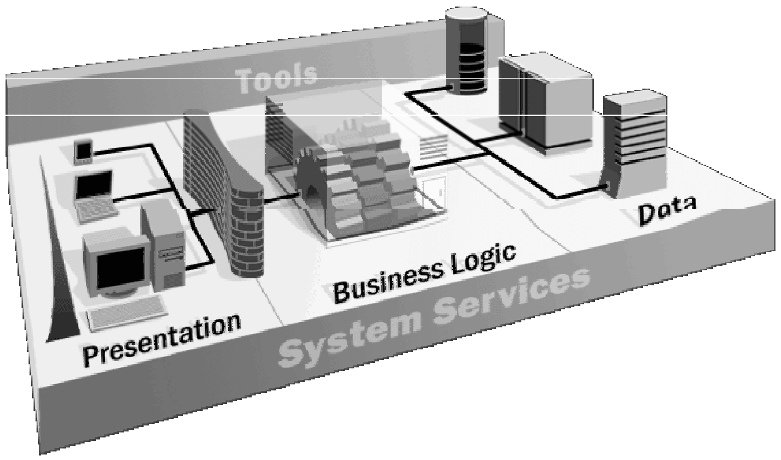
- Apps are large and complex:
  - Time consuming to develop, difficult and costly to maintain,
  - Risky to extend with additional funtionality
- Monolythic style:
  - Prepackaged with a range of static features
  - Add/remove/upgrade/replace features is difficult (impossible)
- Apps do not lend themselves to integration:
  - Neither data nor functionality is available to another program
- Programming models reflect provider‘s upbringing:
  - No location-transparency

COM Software can better meet these challenges.

COM and COM+

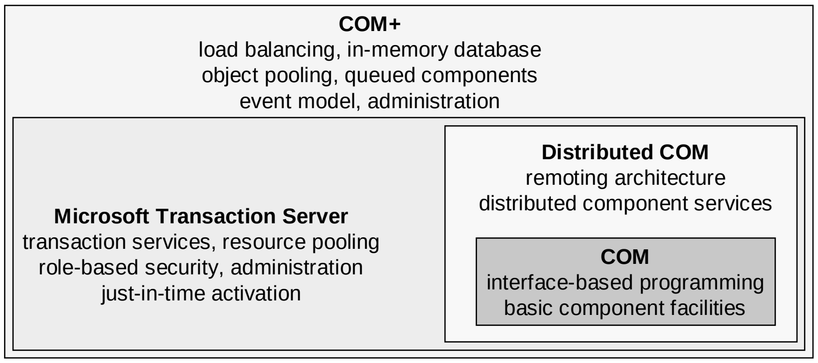
- **COM**: Fundamental programming architecture for building software components
  - Unconfigured components
- Plus (**+**) an integrated suite of component services with an associated runtime environment
  - Configured components
- Support for robust server-size systems
  - Threading, concurrency, security
  - Administration, robustness
  - Example: Microsoft SQL server

Windows DNA: a COM+-based three-tier architecture



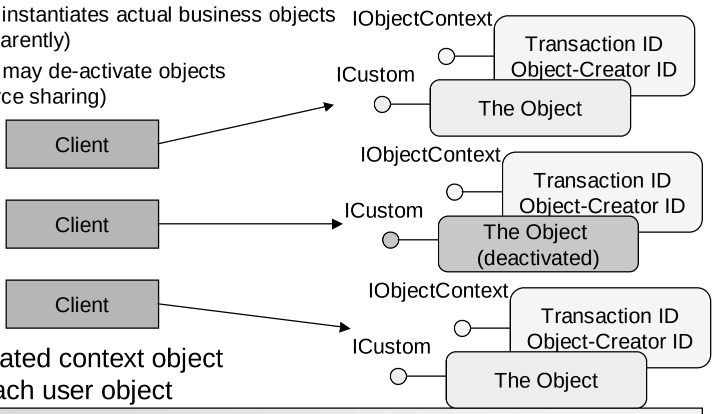
Evolution of Component Services

- Standard implementation of services that are frequently needed by component developers


COM+
load balancing, in-memory database
object pooling, queued components
event model, administration
Microsoft Transaction Server
transaction services, resource pooling
role-based security, administration
just-in-time activation
Distributed COM
remoting architecture
distributed component services
COM
interface-based programming
basic component facilities

Just-in-time activation

- Scalability of middle-tier components
  - Clients obtain references to context objects
  - COM+ instantiates actual business objects (transparently)
  - COM+ may de-activate objects (resource sharing)



System-created context object shadows each user object

Scalability Enhancements

Object Pooling

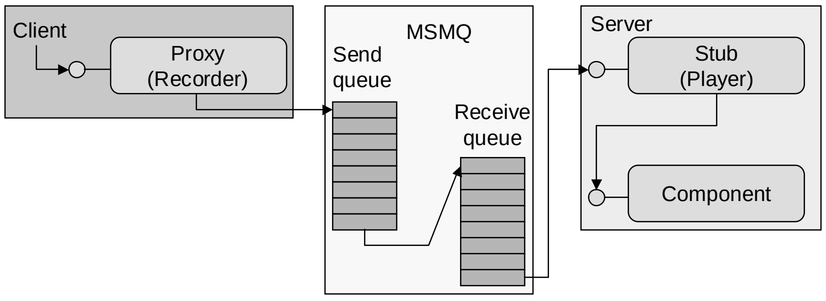
- COM+ may recycle objects for later reuse
  - Automatic instantiation of new objects when pools is empty
  - Useful technique when object creation is very expensive (time)

Load Balancing

- Client workload can be distributed among multiple servers in a network
  - Load balancing at component level
  - Clients contact load balancing router first
  - COM+ uses response-time analysis algorithm to determine server
  - Windows 2000 clustering service can be used to eliminate balancing router as single-point-of-failure

Queued Components

- Execute method calls against unavailable components
  - Based on Microsoft Message Queue Server (MSMQ – Windows 2000)



Transactions

- COM+ components may automatically participate in distributed transactions
- Implemented by Distributed Transaction Coordinator:
  - Object-oriented two-phase commit protocol based on COM (OLE Transaction specification: *ITransaction, ITransactionDispenser, ITransactionOptions, ITransactionOutcomeEvents* interfaces)
  - Support of the X/OPEN DTP XA standard (two-phase commit)
  - Originally bundled with SQL Server
- ACID properties of transactions:
  - **A**tomic, **C**onsistent, **I**solated, **D**urable
- Four levels of transaction support for components:
  - Requires/requires new/supports/<u>does not support</u> transactions

Security & Events

- Role-based Security:
  - Leverage Windows 2000 security model
  - Declarative and programmatic security
  - Security settings on component and interfacce basis
- Events:
  - Publisher/subscriber style of communication
  - External event model: publisher/subscriber do not need to execute simultaneously
  - Subscriptions are maintained outside of publisher/subscriber: *persistent subscriptions*
  - Subscriber is any component that implements a given class interface