

Today

- Architectures for distributed systems (*Chapter 2*)
 - Centralized, decentralized, hybrid
 - Middleware
 - Self-managing systems

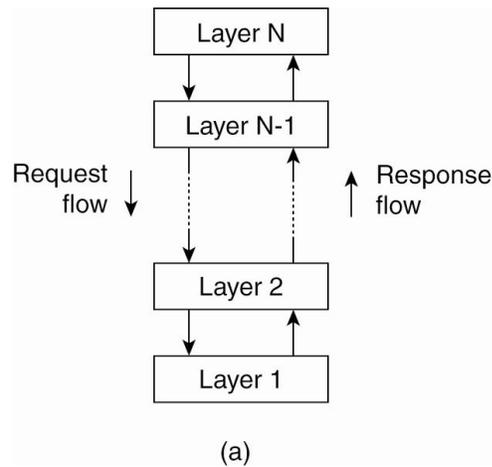


Architectural Styles

- Important styles of architecture for distributed systems
 - Layered architectures
 - Object-based architectures
 - Data-centered architectures
 - Event-based architectures



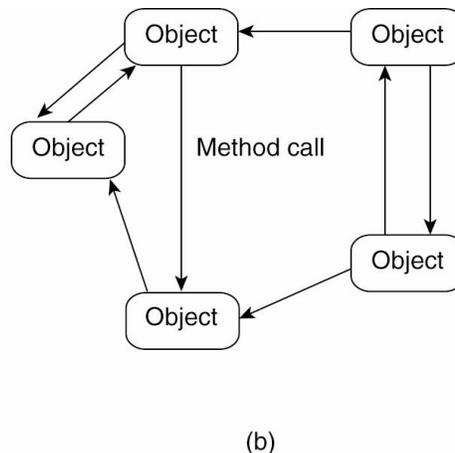
Layered Design



- Each layer uses previous layer to implement new functionality that is exported to the layer above
- Example: Multi-tier web apps



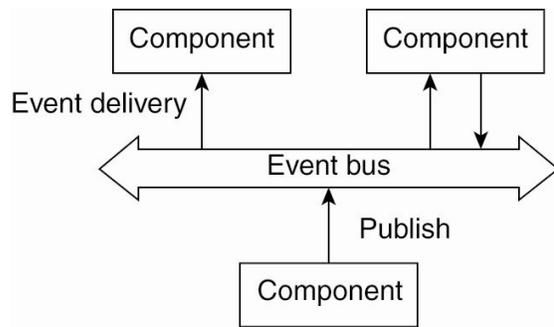
Object-based Style



- Each object corresponds to a component
- Components interact via remote procedure calls
 - Popular in client-server systems



Event-based architecture

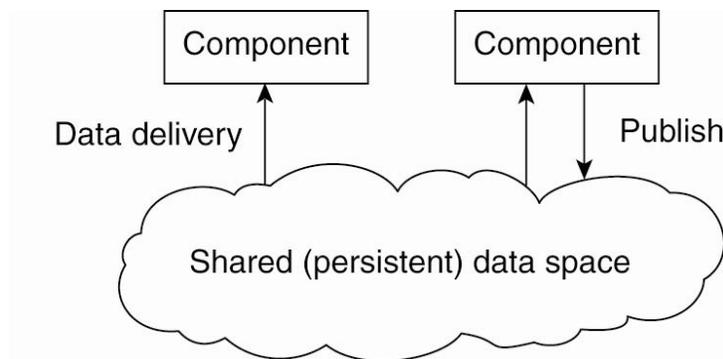


(a)

- Communicate via a common repository
 - Use a publish-subscribe paradigm
 - Consumers subscribe to types of events
 - Events are delivered once published by any publisher



Shared data-space

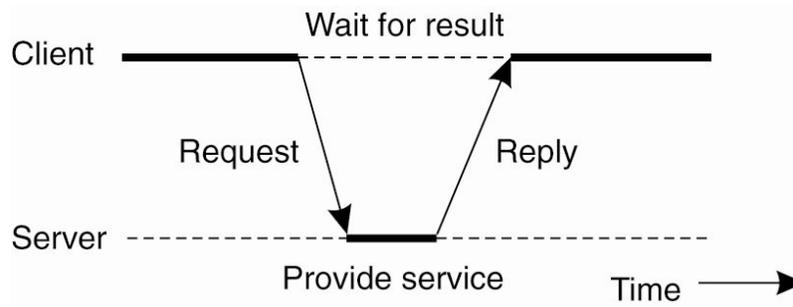


(b)

- “Bulletin-board” architecture
 - Decoupled in space and time
 - Post items to shared space; consumers pick up at a later time



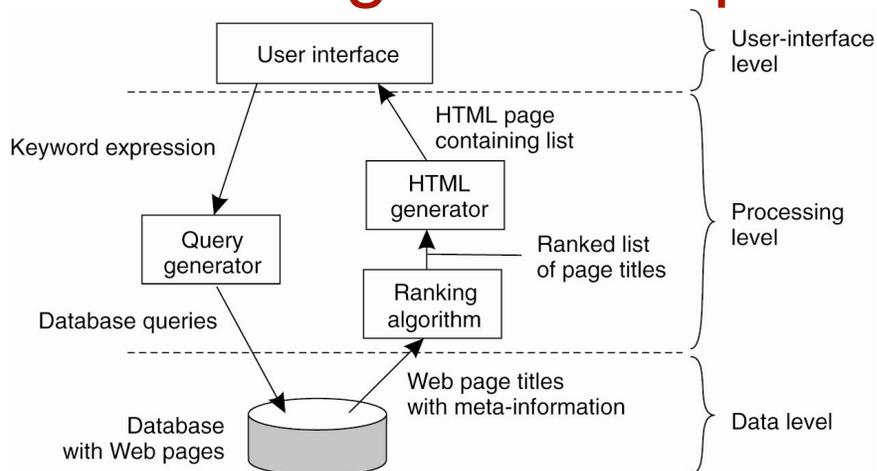
Client-Server Architectures



- Most common style: client-server architecture
- Application layering
 - User-interface level
 - Processing level
 - Data level



Search Engine Example



- Search engine architecture with 3 layers



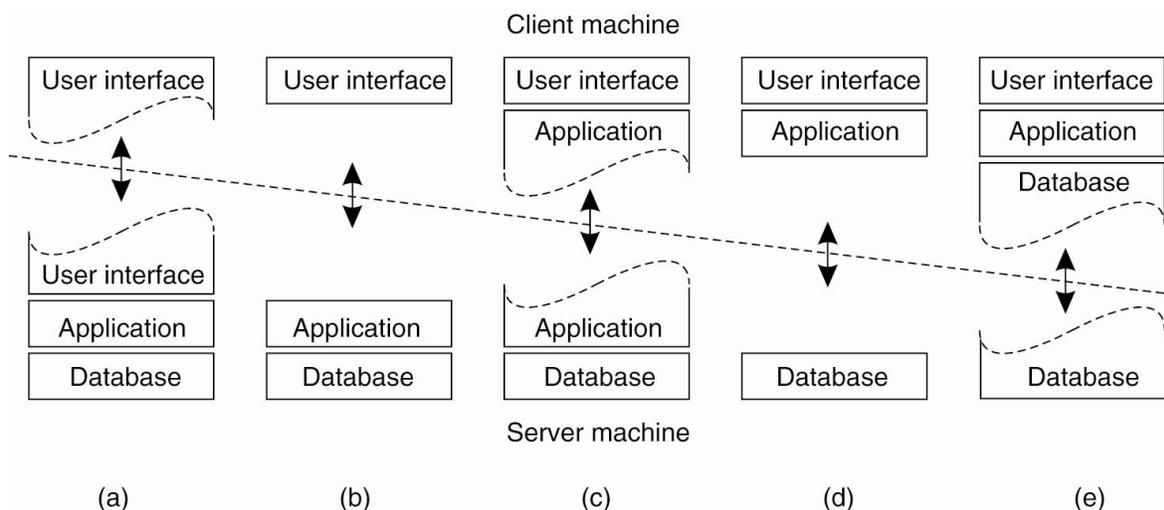
Multitiered Architectures

- The simplest organization is to have only two types of machines:
- A client machine containing only the programs implementing (part of) the user-interface level
- A server machine containing the rest,
 - the programs implementing the processing and data level

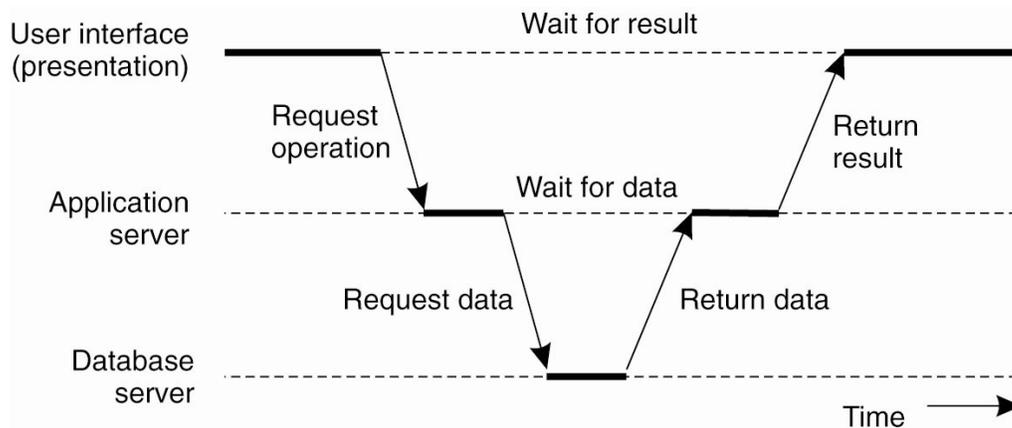


A Spectrum of Choices

- From browser-based to phone-based to desktop apps



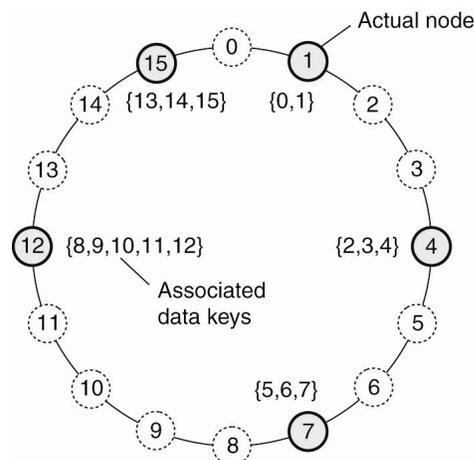
Three-tier Web Applications



- Server itself uses a “client-server” architecture
- 3 tiers: HTTP, J2EE and database
 - Very common in most web-based applications



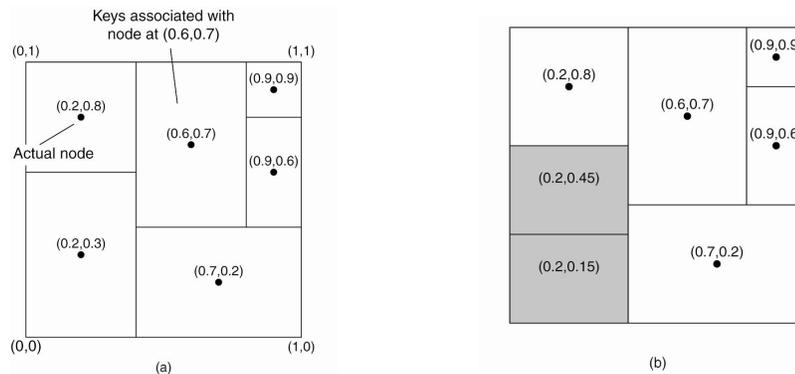
Decentralized Architectures



- Peer-to-peer systems
 - Removes distinction between a client and a server
 - Overlay network of nodes
- Chord: structured peer-to-peer system
 - Use a distributed hash table to locate objects
 - Data item with key k -> smallest node with $id \geq k$



Content Addressable Network (CAN)



- CAN: d-dimensional coordinate system
 - Partitioned among all nodes in the system
 - Example: $[0,1] \times [0,1]$ space across 6 nodes
 - Every data item maps to a point
 - Join: pick a random point, split with node for that point
 - Leave: harder, since a merge may not give symmetric partitions

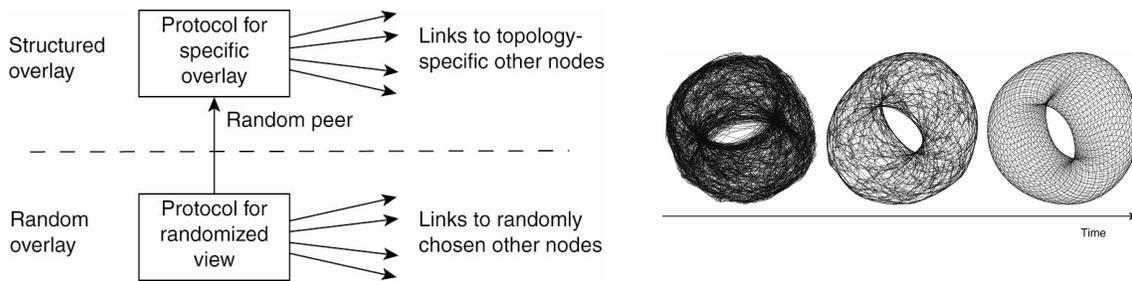


Unstructured P2P Systems

- Topology based on randomized algorithms
 - Each node pick a random set of nodes and becomes their neighbors
 - Gnutella
 - Choice of degree impacts network dynamics



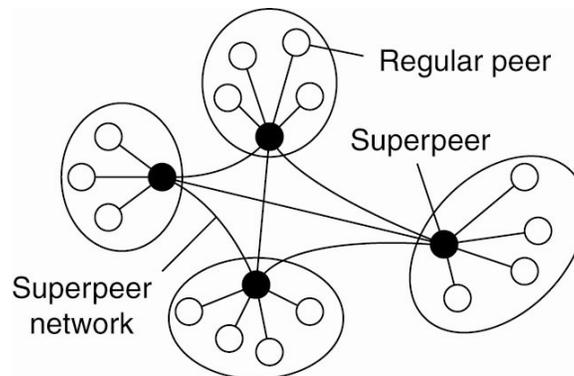
Structured and Unstructured P2P



- Can move from one to another
 - Carefully exchange and select entries from partial views



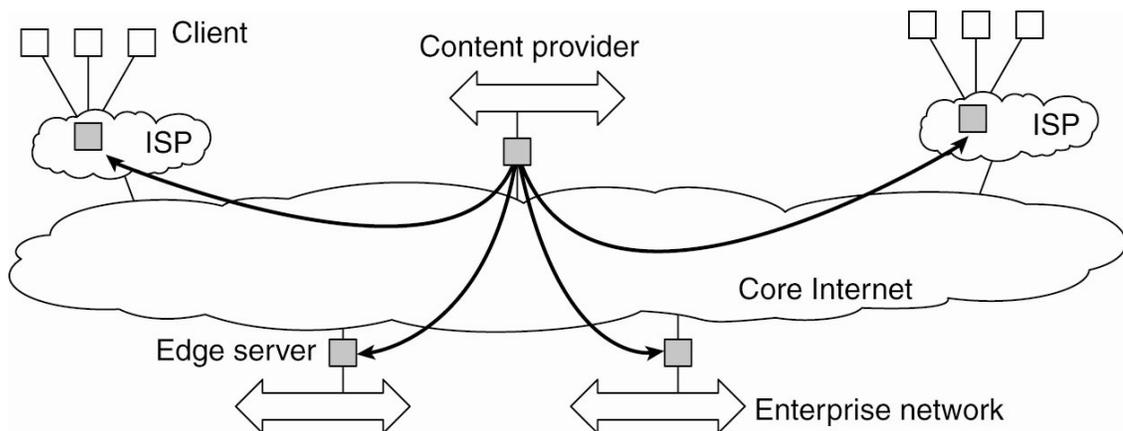
SuperPeers



- Some nodes become “distinguished”
 - Take on more responsibilities (need to have or be willing to donate more resources)
 - Example: Skype super-peer



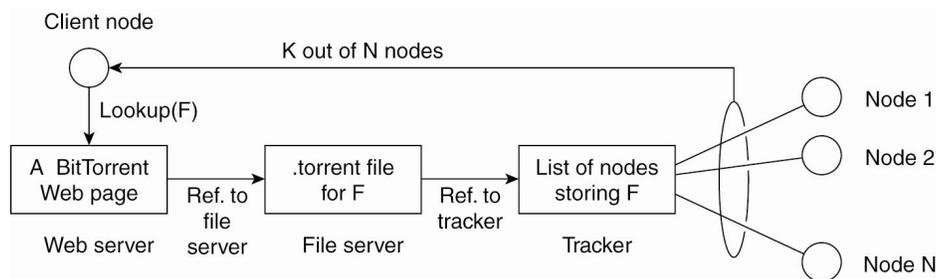
Edge-Server Systems



- Edge servers: from client-server to client-proxy-server
- Content distribution networks: proxies cache web content near the edge



Collaborative Distributed Systems

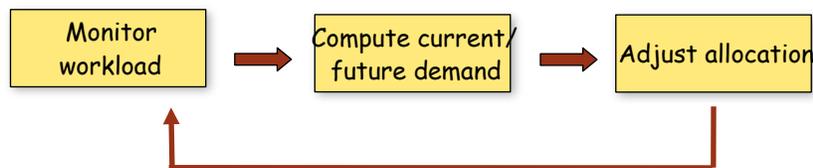


- BitTorrent: Collaborative P2P downloads
 - Download chunks of a file from multiple peers
 - Reassemble file after downloading
 - Use a global directory (web-site) and download a .torrent
 - .torrent contains info about the file
 - Tracker: server that maintains active nodes that have requested chunks
 - Force altruism:
 - » If P sees Q downloads more than uploads, reduce rate of sending to Q

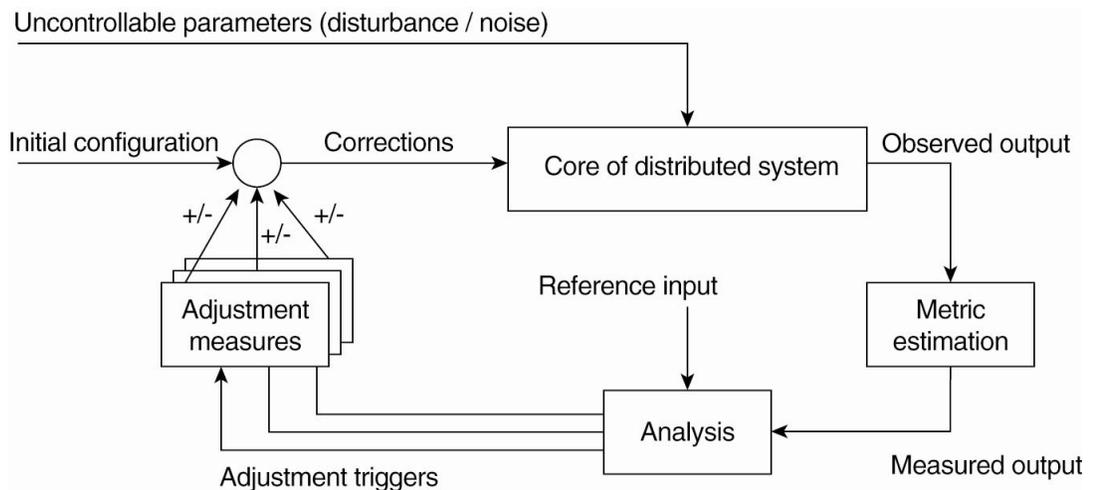


Self-Managing Systems

- System is adaptive
 - Monitors itself and takes action autonomously when needed
 - Autonomic computing, self-managing systems
- Self-*: self-managing, self-healing
- Example: automatic capacity provisioning
 - Vary capacity of a web server based on demand



Feedback Control Model



- Use feedback and control theory to design a self-managing system

