DISTRIBUTED SYSTEMS
Principles and Paradigms
Second Edition
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MAARTEN VAN STEEN

Chapter 2
ARCHITECTURES

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Architectural Styles (1)

Important styles of architecture for distributed systems

- Layered architectures
- Object-based architectures
- Data-centered architectures
- Event-based architectures

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Architectural Styles (2)

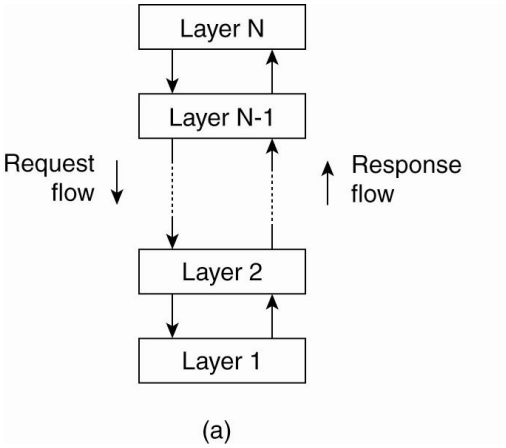

Figure 2-1. The (a) layered architectural style and …

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Architectural Styles (3)

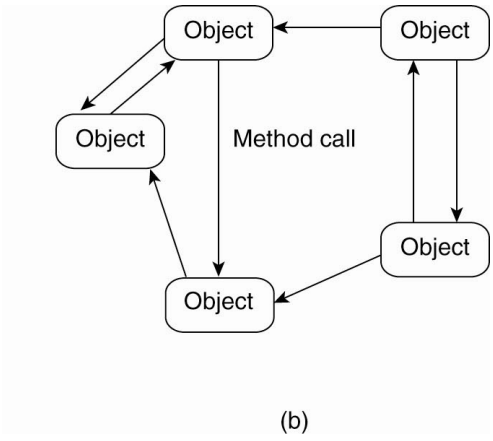

Figure 2-1. (b) The object-based architectural style.

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Architectural Styles (4)

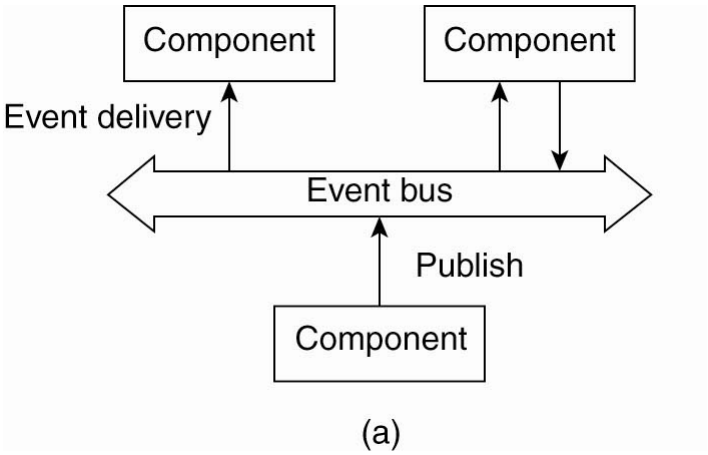

Figure 2-2. (a) The event-based architectural style and …

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Architectural Styles (5)

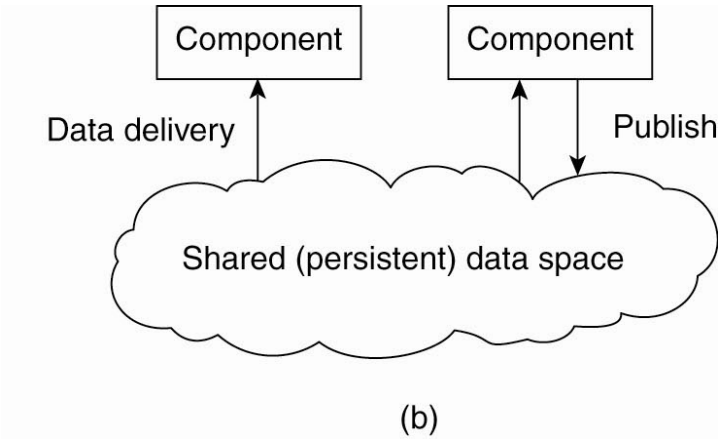

Figure 2-2. (b) The shared data-space architectural style.

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Centralized Architectures

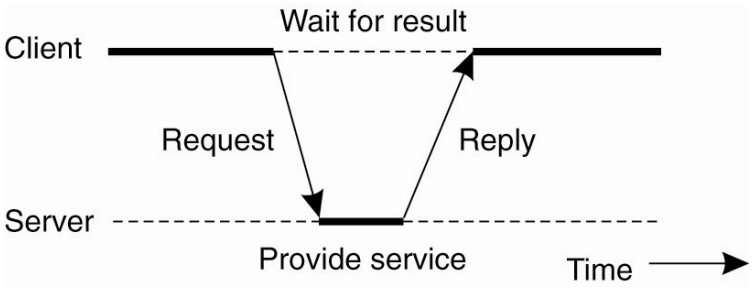

Figure 2-3. General interaction between a client and a server.

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Application Layering (1)

Recall previously mentioned layers of architectural style

- The user-interface level
- The processing level
- The data level

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Application Layering (2)

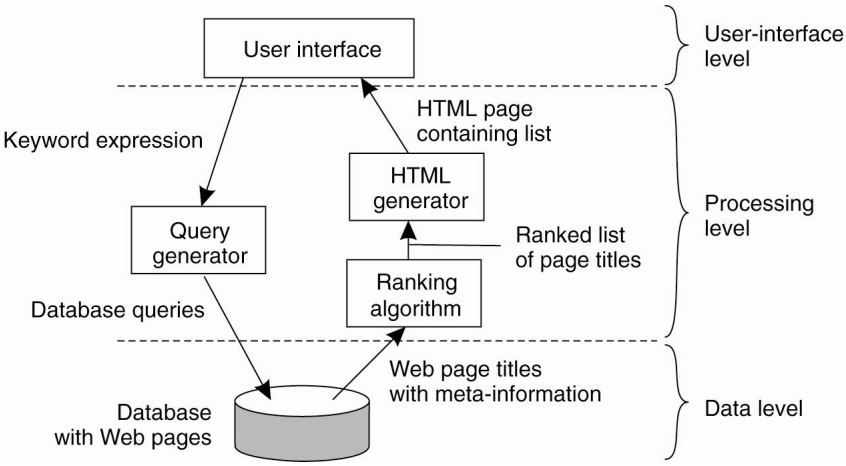

Figure 2-4. The simplified organization of an Internet search engine into three different layers.

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Multitiered Architectures (1)

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

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Multitiered Architectures (2)

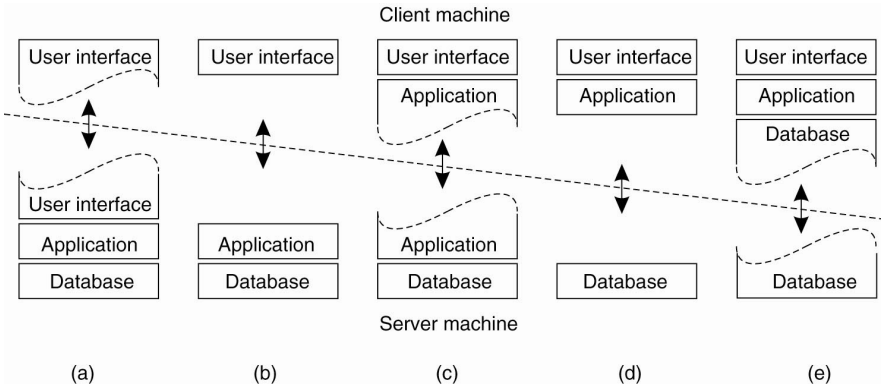

Figure 2-5. Alternative client-server organizations (a)–(e).

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Multitiered Architectures (3)

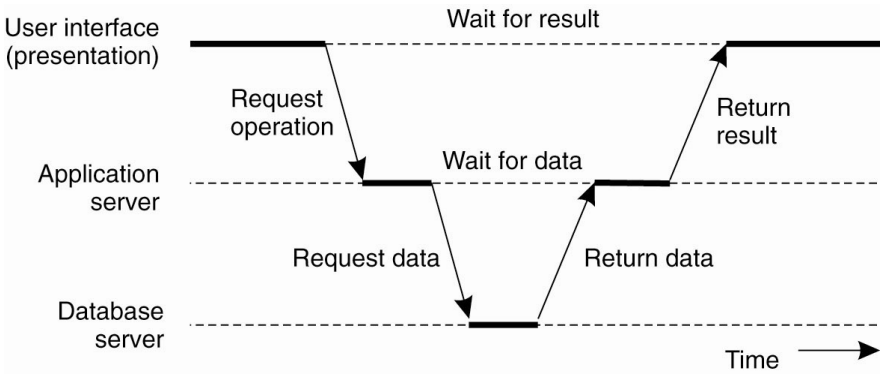

Figure 2-6. An example of a server acting as client.

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Structured Peer-to-Peer Architectures (1)

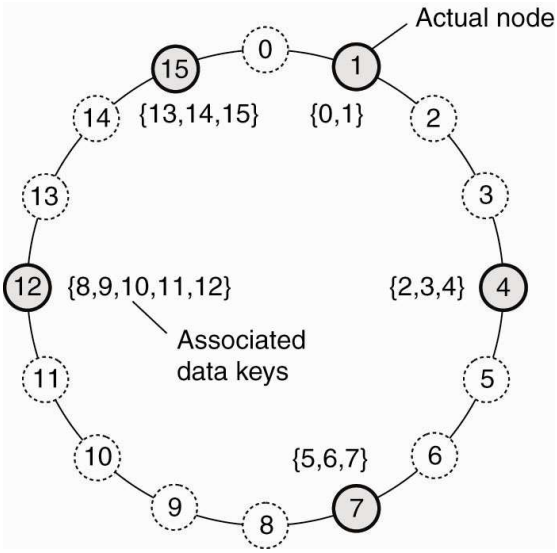

Figure 2-7. The mapping of data items onto nodes in Chord.

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Structured Peer-to-Peer Architectures (2)

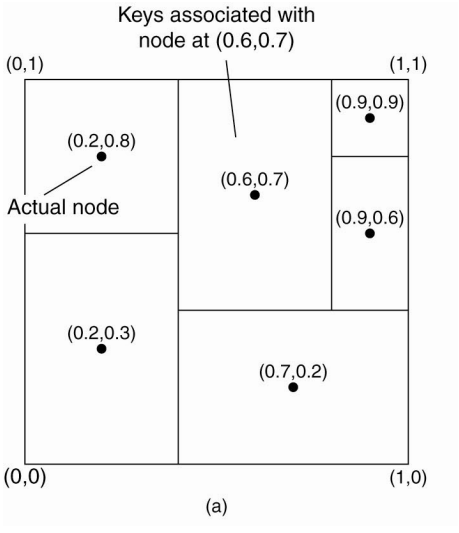

Figure 2-8. (a) The mapping of data items onto nodes in CAN.

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Structured Peer-to-Peer Architectures (3)

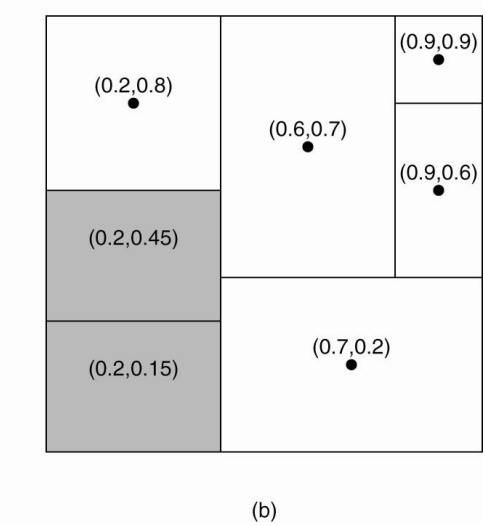

Figure 2-8. (b) Splitting a region when a node joins.

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Unstructured Peer-to-Peer Architectures (1)

Actions by active thread (periodically repeated):

```
select a peer P from the current partial view;
if PUSH_MODE {
    mybuffer = [(MyAddress, 0)];
    permute partial view;
    move H oldest entries to the end;
    append first c/2 entries to mybuffer;
    send mybuffer to P;
} else {
    send trigger to P;
}
if PULL_MODE {
    receive P's buffer;
}
construct a new partial view from the current one and P's buffer;
increment the age of every entry in the new partial view;
```

(a)

Figure 2-9. (a) The steps taken by the active thread.

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Unstructured Peer-to-Peer Architectures (2)

Actions by passive thread:

```
receive buffer from any process Q;
if PULL_MODE {
    mybuffer = [(MyAddress, 0)];
    permute partial view;
    move H oldest entries to the end;
    append first c/2 entries to mybuffer;
    send mybuffer to P;
}
construct a new partial view from the current one and P's buffer;
increment the age of every entry in the new partial view;
```

(b)

Figure 2-9. (b) The steps take by the passive thread

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Topology Management of Overlay Networks (1)

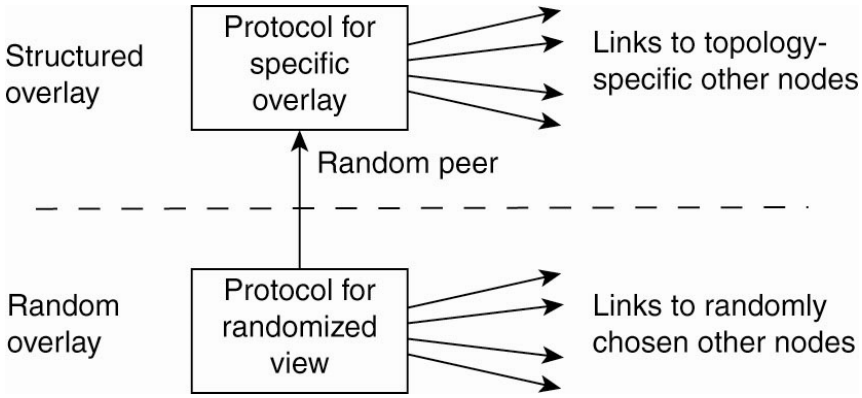

Figure 2-10. A two-layered approach for constructing and maintaining specific overlay topologies using techniques from unstructured peer-to-peer systems.

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Topology Management of Overlay Networks (2)

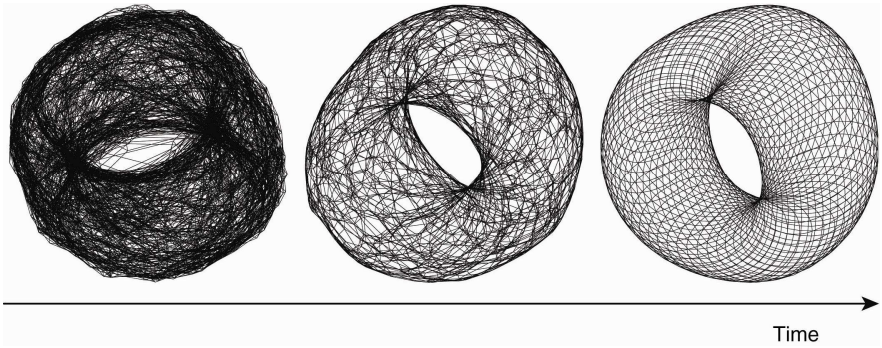

Figure 2-11. Generating a specific overlay network using a two-layered unstructured peer-to-peer system [adapted with permission from Jelasity and Babaoglu (2005)].

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Superpeers

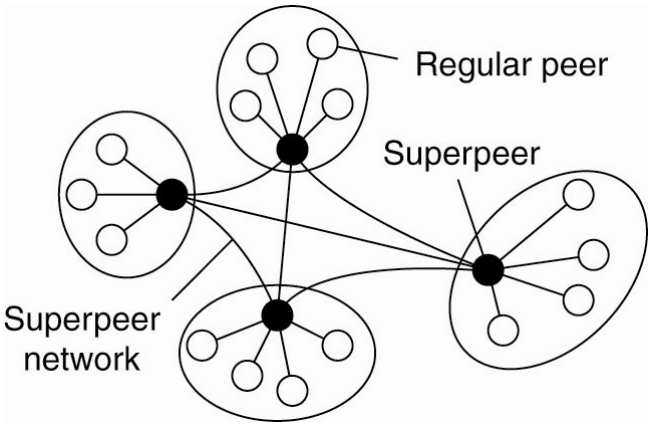

Figure 2-12. A hierarchical organization of nodes into a superpeer network.

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Edge-Server Systems

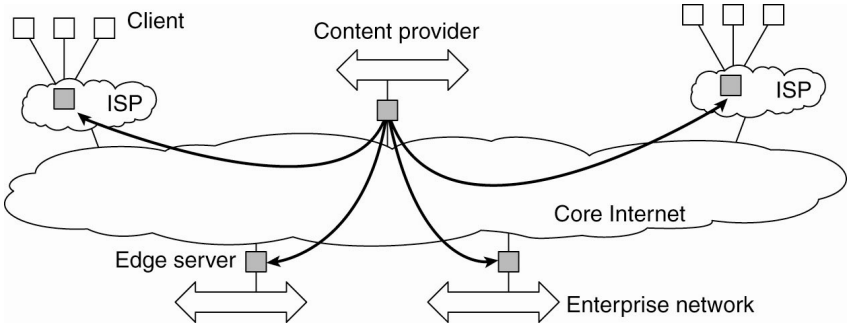

Figure 2-13. Viewing the Internet as consisting of a collection of edge servers.

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Collaborative Distributed Systems (1)

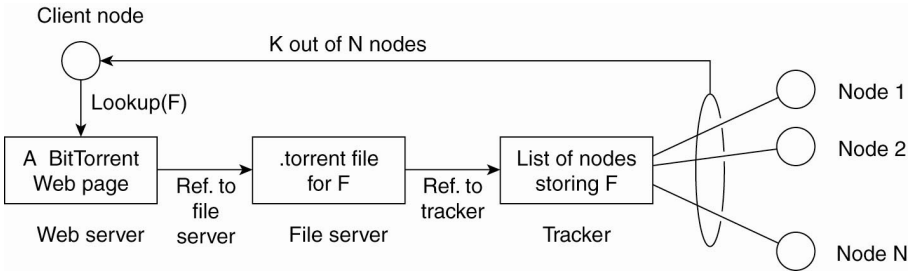

Figure 2-14. The principal working of BitTorrent [adapted with permission from Pouwelse et al. (2004)].

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Collaborative Distributed Systems (2)

Components of Globule collaborative content distribution network:

- A component that can redirect client requests to other servers.
- A component for analyzing access patterns.
- A component for managing the replication of Web pages.

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Interceptors

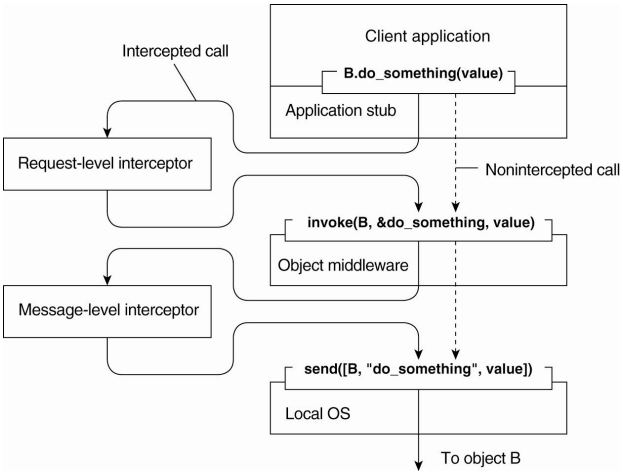

Figure 2-15. Using interceptors to handle remote-object invocations.

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General Approaches to Adaptive Software

Three basic approaches to adaptive software:

- Separation of concerns
- Computational reflection
- Component-based design

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The Feedback Control Model

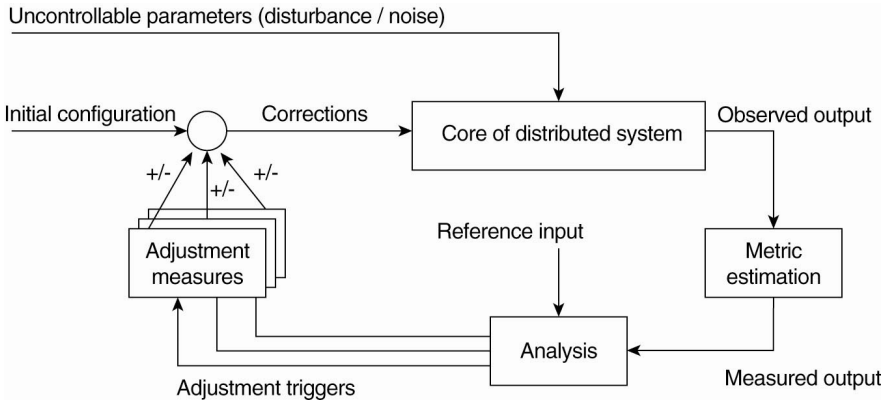

Figure 2-16. The logical organization of a feedback control system.

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Example: Systems Monitoring with Astrolabe

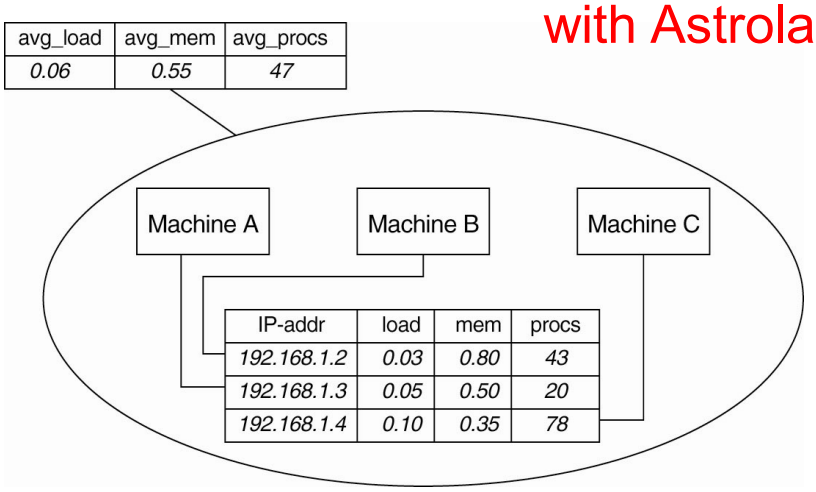

Figure 2-17. Data collection and information aggregation in Astrolabe.

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Example: Differentiating Replication Strategies in Globule (1)

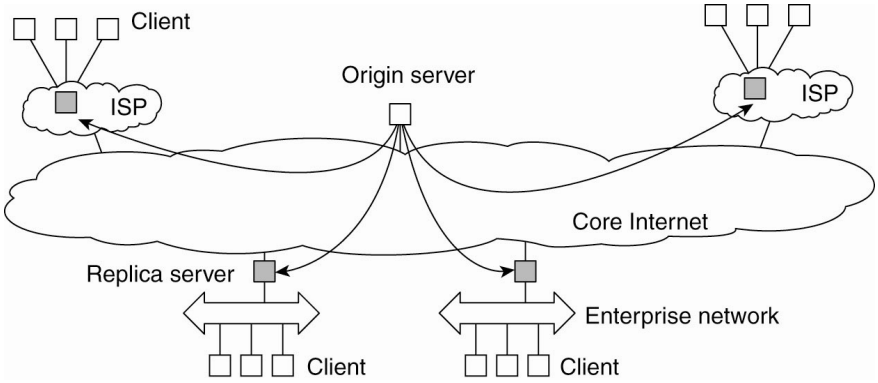

Figure 2-18. The edge-server model assumed by Globule.

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Example: Differentiating Replication Strategies in Globule (2)

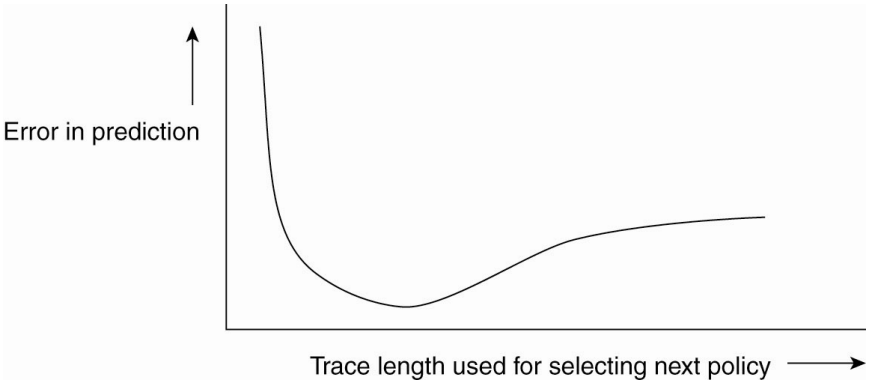

Figure 2-19. The dependency between prediction accuracy and trace length.

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Example: Automatic Component Repair Management in Jade

Steps required in a repair procedure:

- Terminate every binding between a component on a nonfaulty node, and a component on the node that just failed.
- Request the node manager to start and add a new node to the domain.
- Configure the new node with exactly the same components as those on the crashed node.
- Re-establish all the bindings that were previously terminated.

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