Part 12

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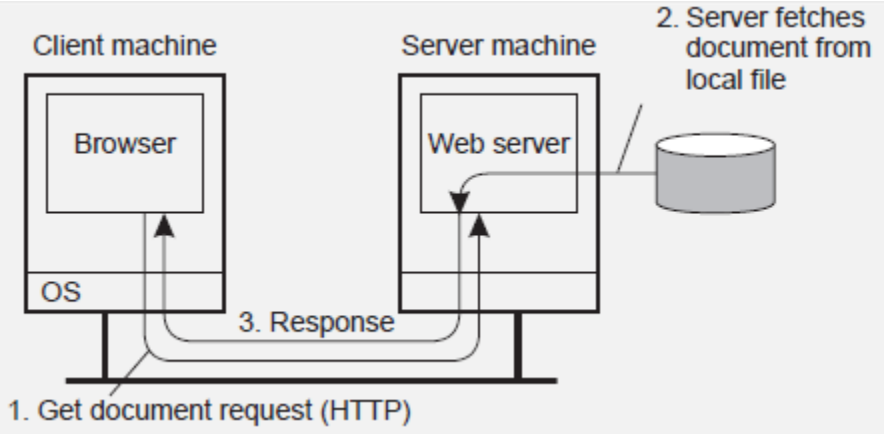
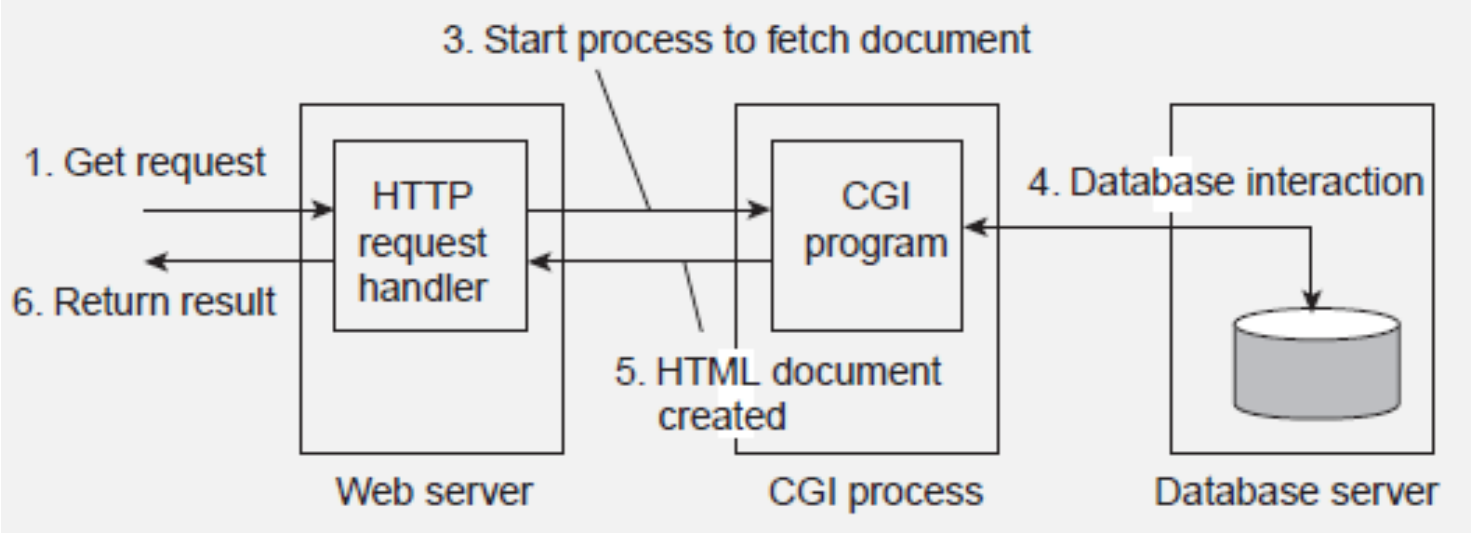
Distributed Web-based systems

- The WWW is a huge client-server system with millions of servers; each server hosting thousands of hyperlinked documents.
  - Documents are often represented in text (plain text, HTML, XML)
  - Alternative types: images, audio, video, applications (PDF, PS)
  - Documents may contain scripts, executed by client-side software



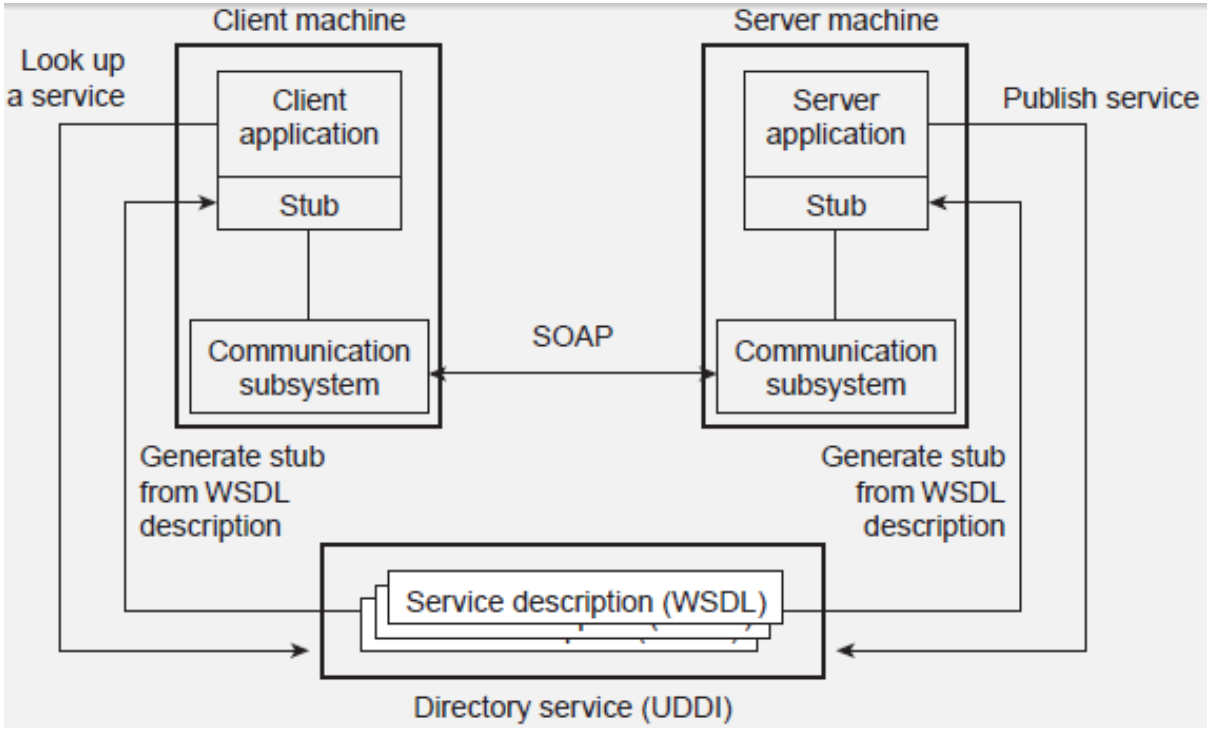
Multi-tiered architectures

- Already very soon, Web sites were organized into three tiers.



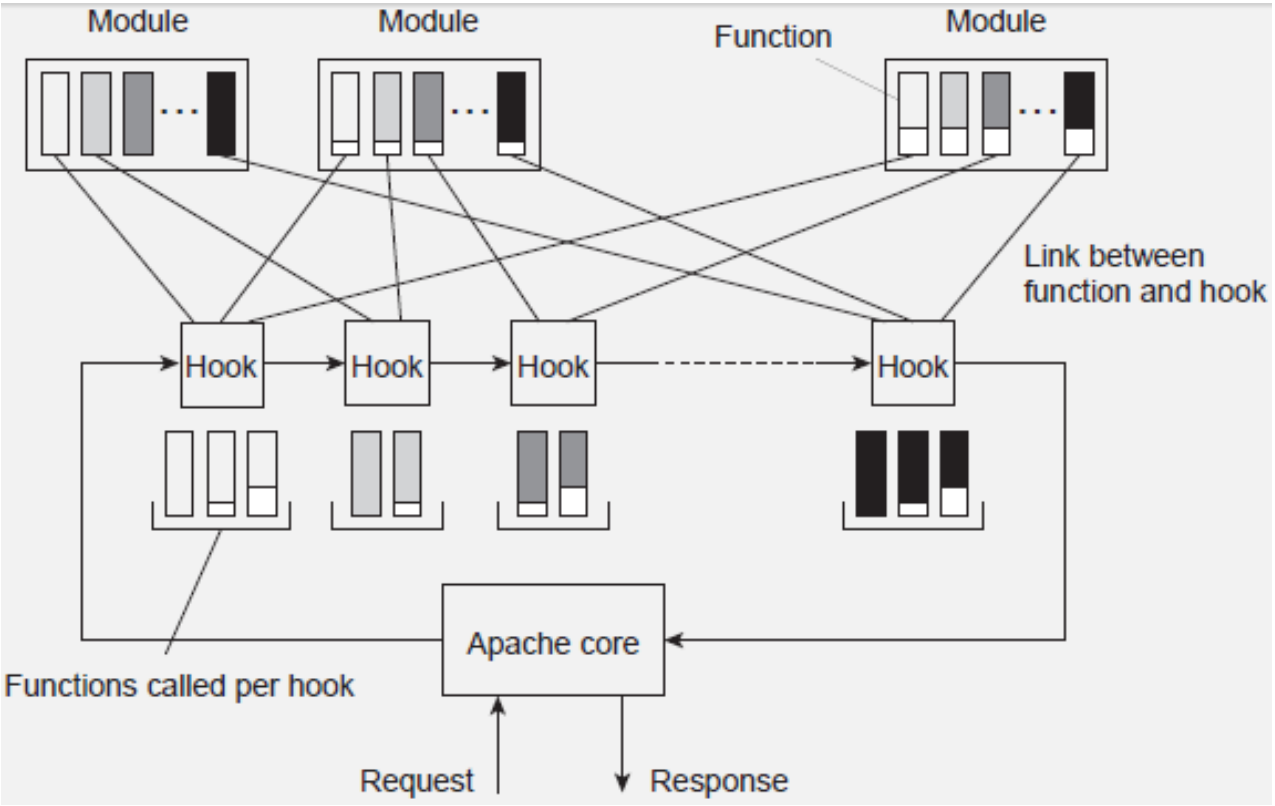
Web services

- At a certain point, people started recognizing that it is was more than just user ↔ site interaction: sites could offer services to other sites ⇒ standardization is then badly needed.



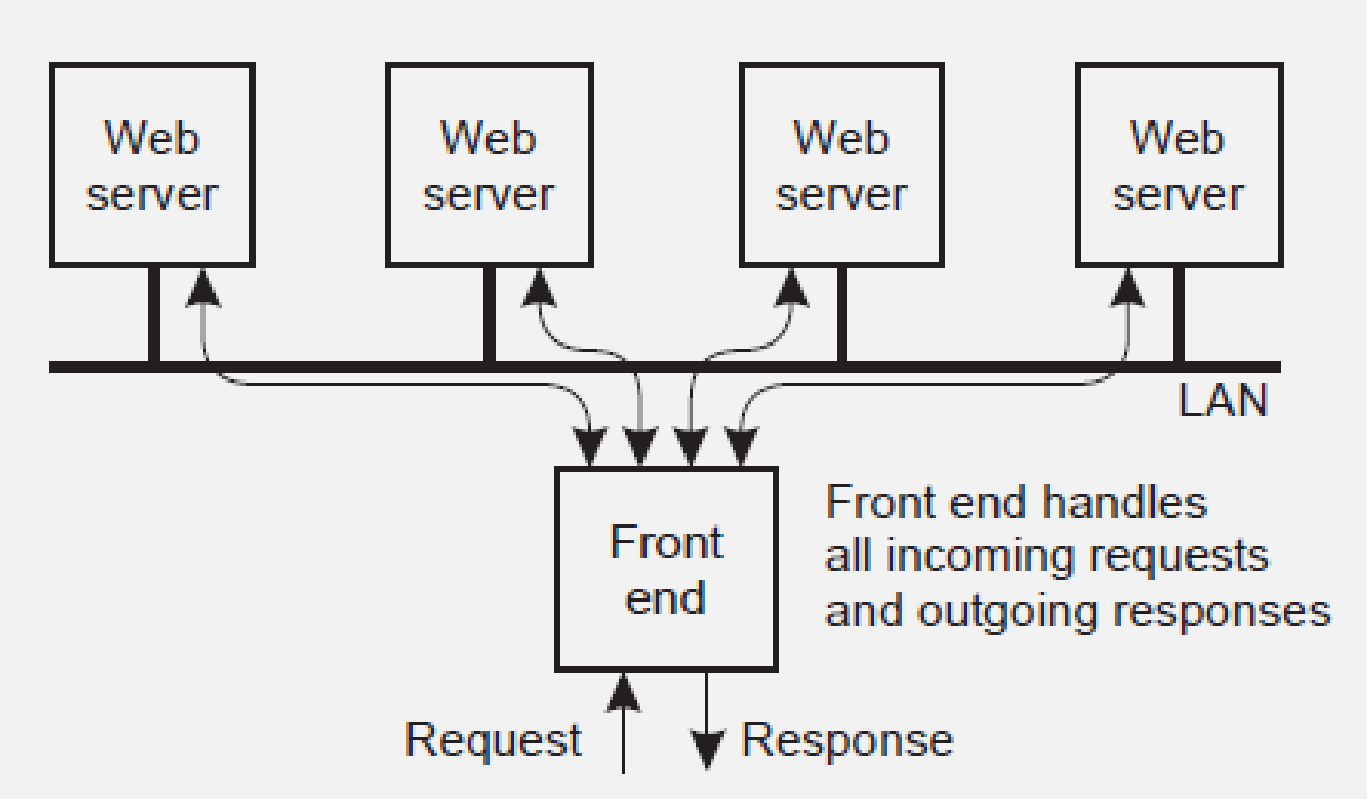
Apache Web server

- The server is internally organized more or less according to the steps needed to process an HTTP request.



Server clusters

- To improve performance and availability, WWW servers are often clustered in a way that is transparent to clients.

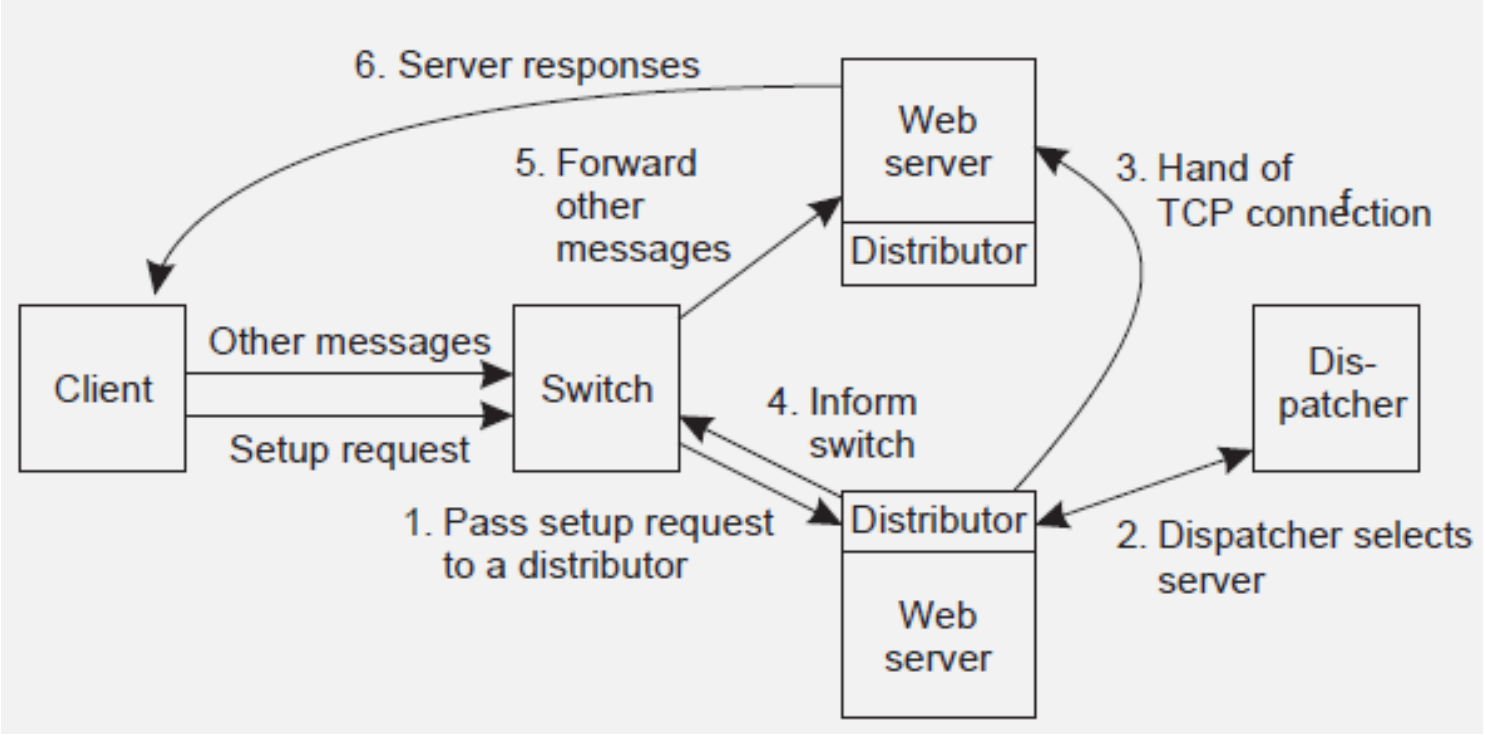


Server clusters

- Problem: The front end may easily get overloaded, so that special measures need to be taken.
  - Transport-layer switching: Front end simply passes the TCP request to one of the servers, taking some performance metric into account.
  - Content-aware distribution: Front end reads the content of the HTTP request and then selects the best server.

Server Clusters

- Question: Why can content-aware distribution be so much better?



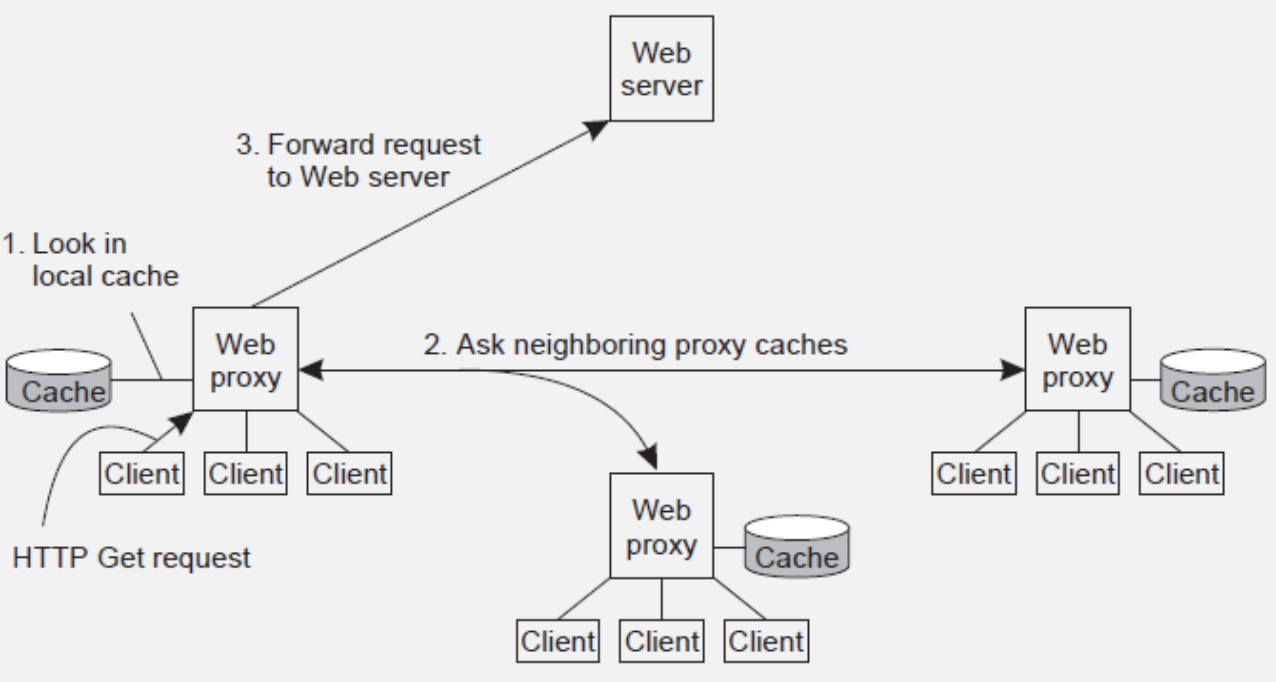
Web proxy caching

- Sites install a separate proxy server that handles all outgoing requests. Proxies subsequently cache incoming documents. Cache-consistency protocols:
  - Always verify validity by contacting server
  - Age-based consistency:

$$T_{expire} = \alpha \cdot \left(T_{cached} - T_{last_{modified}}\right) + T_{cached}$$

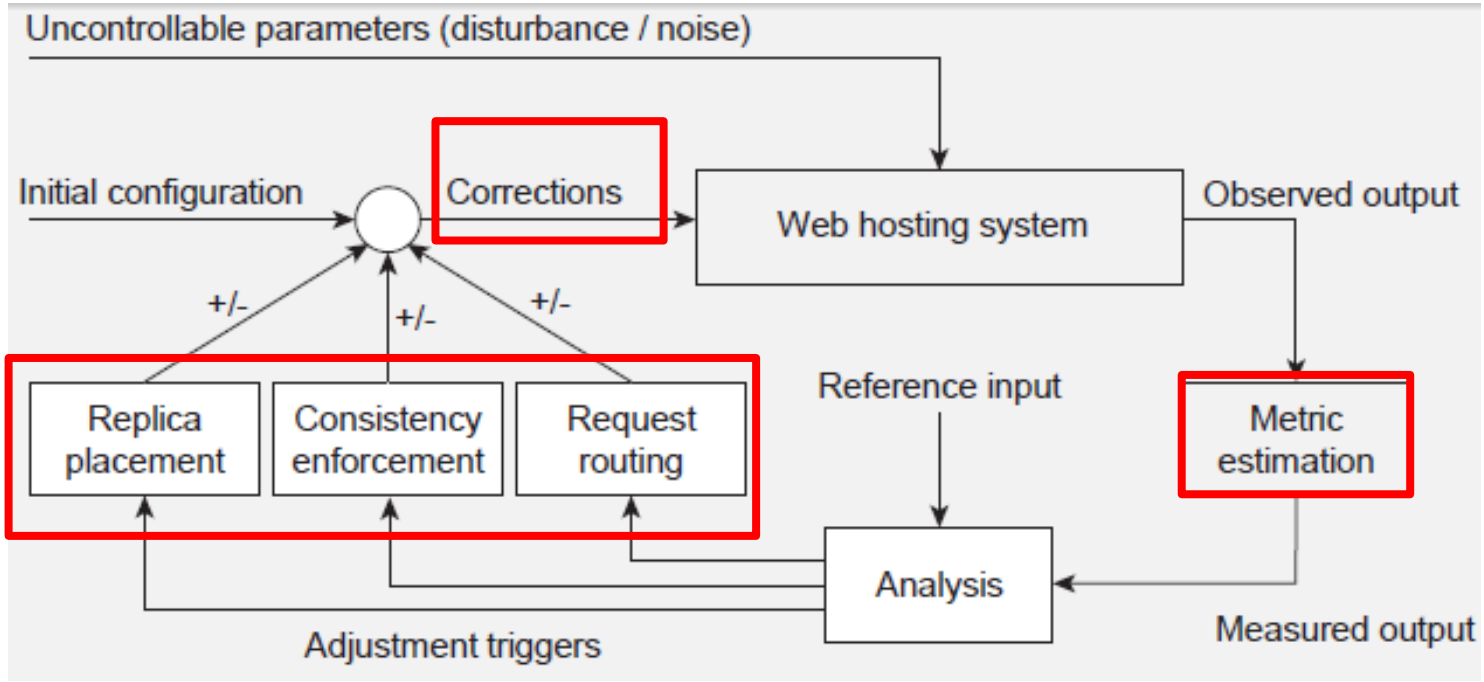
Web proxy caching

- Basic idea(cnt'd): Cooperative caching, by which you first check your neighbors on a cache miss



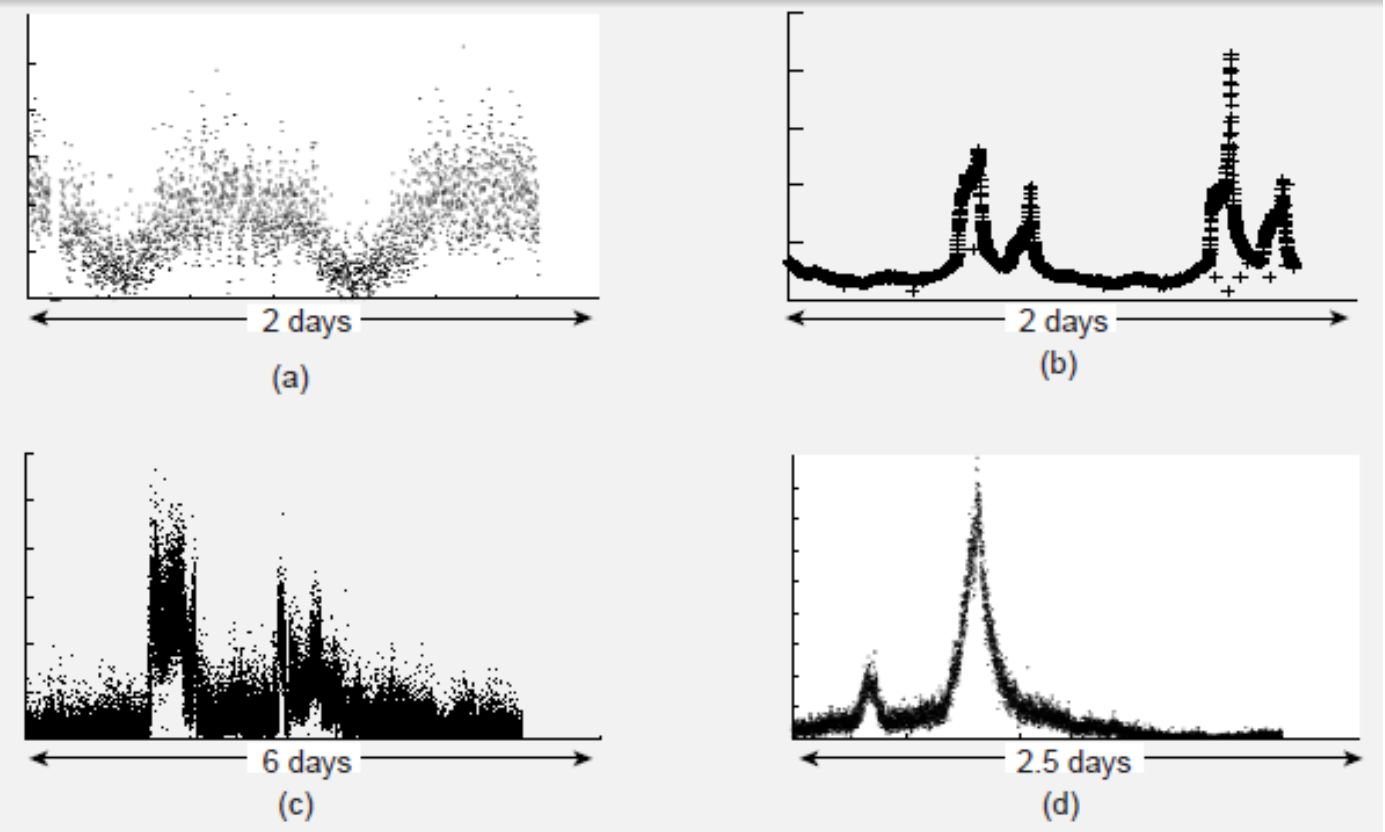
Replication in Web hosting systems

- By-and-large, Web hosting systems are adopting replication to increase performance. Much research is done to improve their organization. Follows the lines of self-managing systems.



Handling flash crowds

- We need dynamic adjustment to balance resource usage. Flash crowds introduce a serious problem.

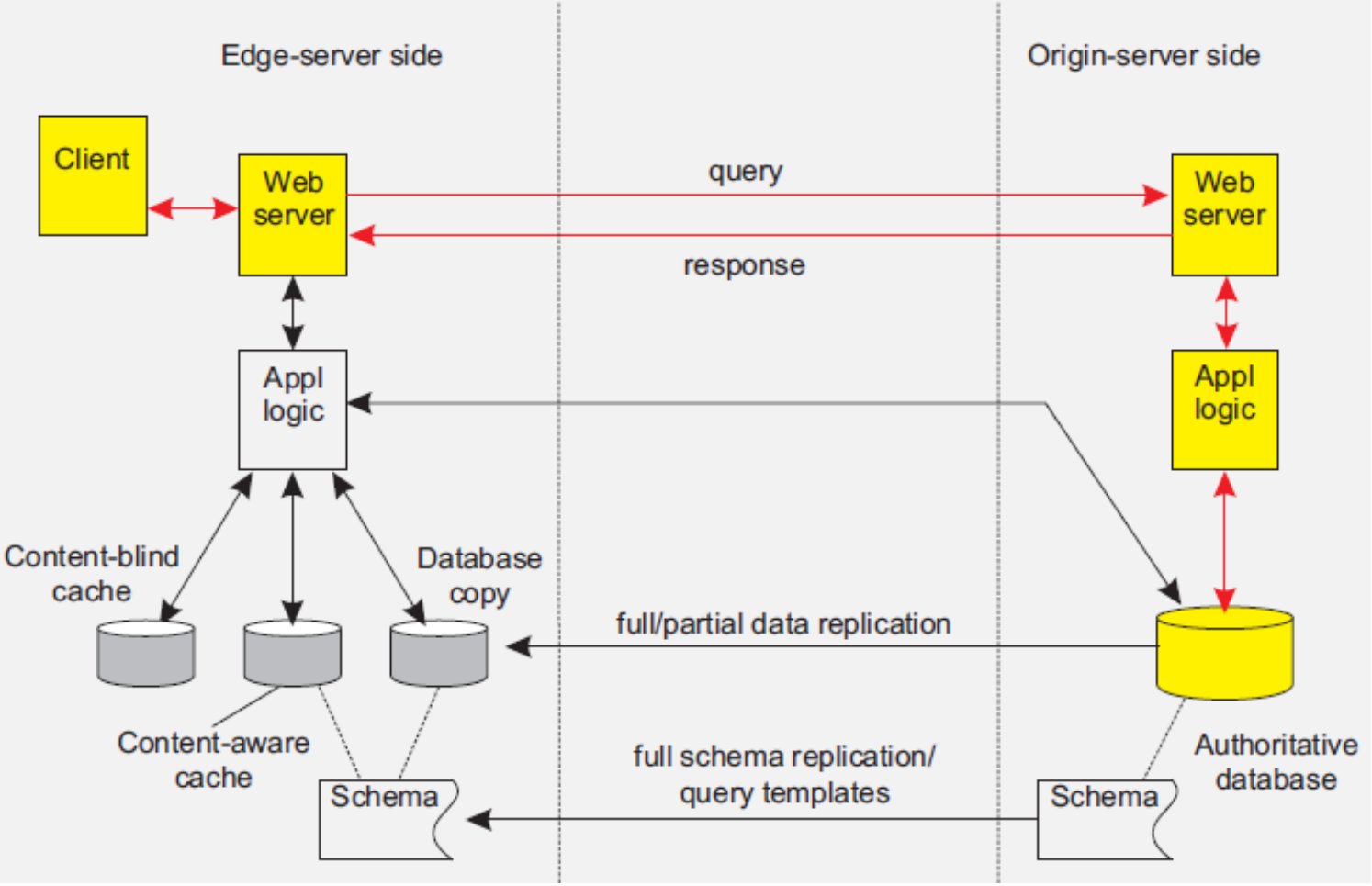


Replication of Web applications

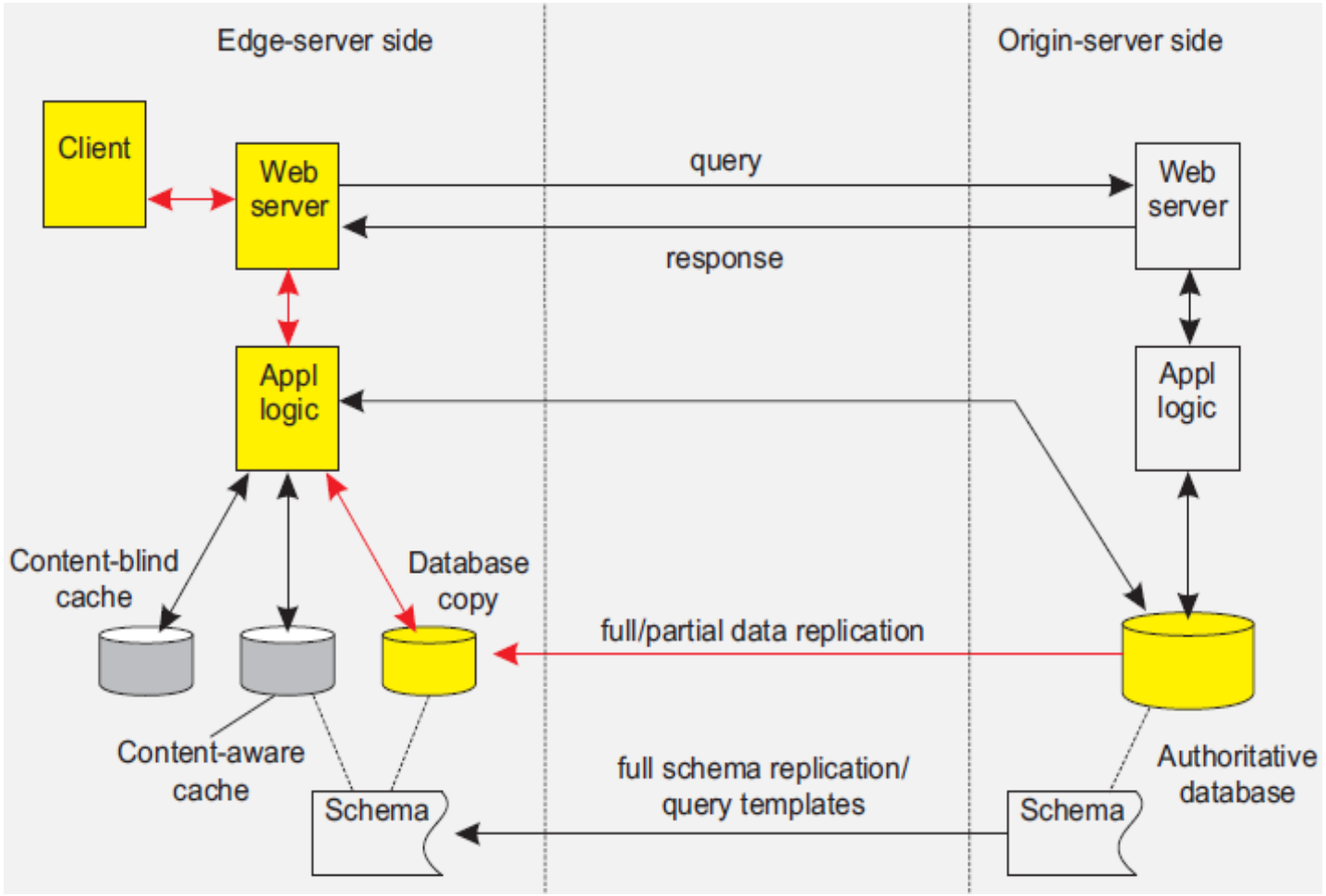
- Replication becomes more difficult when dealing with databases and such. No single best solution.

- Assumption: Updates are carried out at origin server, and propagated to edge servers.

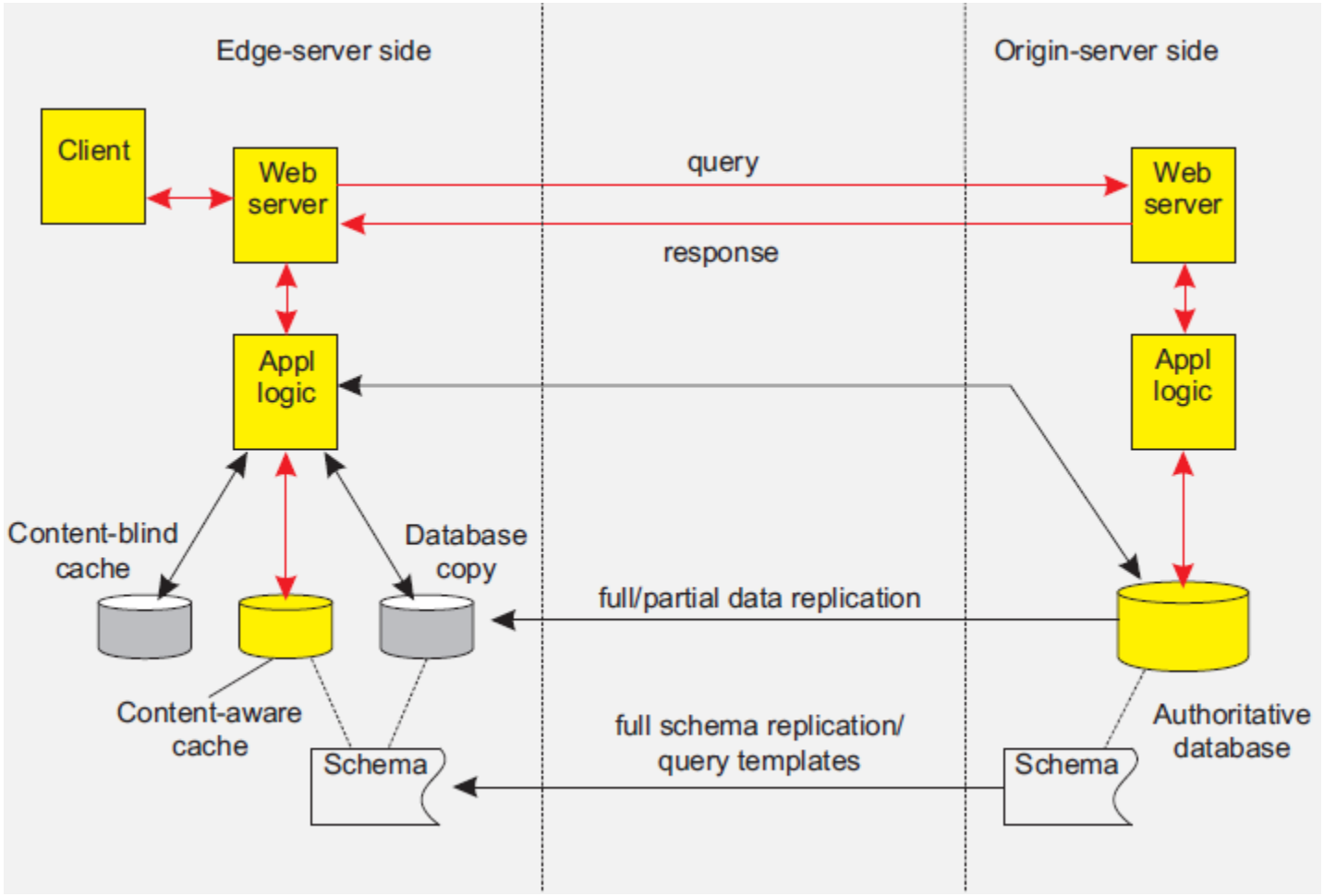
Replication of Web applications: normal



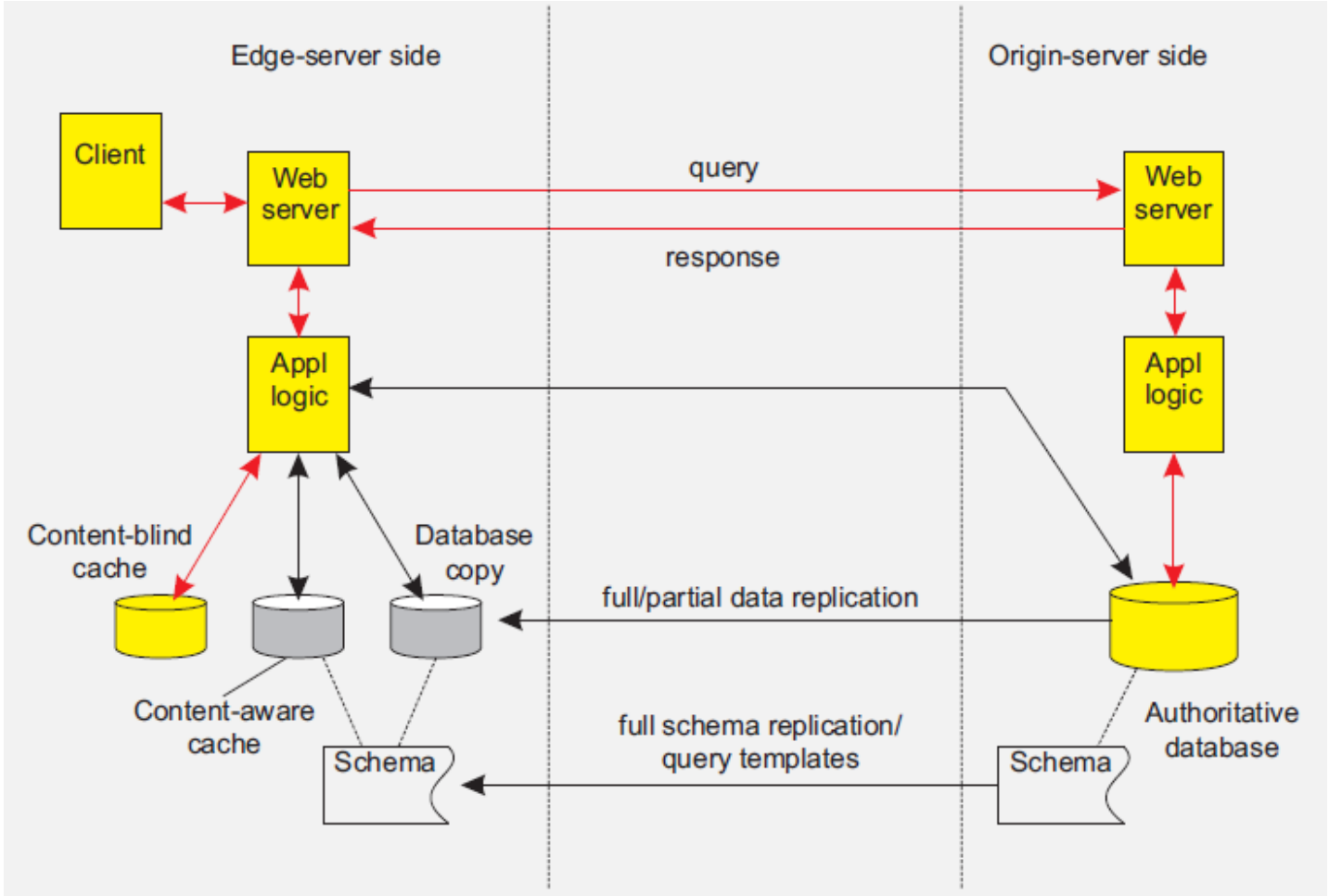
Replication Web apps.: full/partial replication



Replication Web apps.: content-aware caching



Replication Web apps.: content-blind caching



Replication of Web applications

- Full replication: high read/write ratio, often in combination with complex queries.
- Partial replication: high read/write ratio, but in combination with simple queries
- Content-aware caching: Check for queries at local database, and subscribe for invalidations at the server. Works good with range queries and complex queries.
- Content-blind caching: Simply cache the result of previous queries. Works great with simple queries that address unique results (e.g., no range queries).
- Question: What can be said about replication vs. performance?