UNIVERSITÄT BERN

Forschungsseminar, Institut für Telematik, KIT

Service-Centric Networking

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Overview

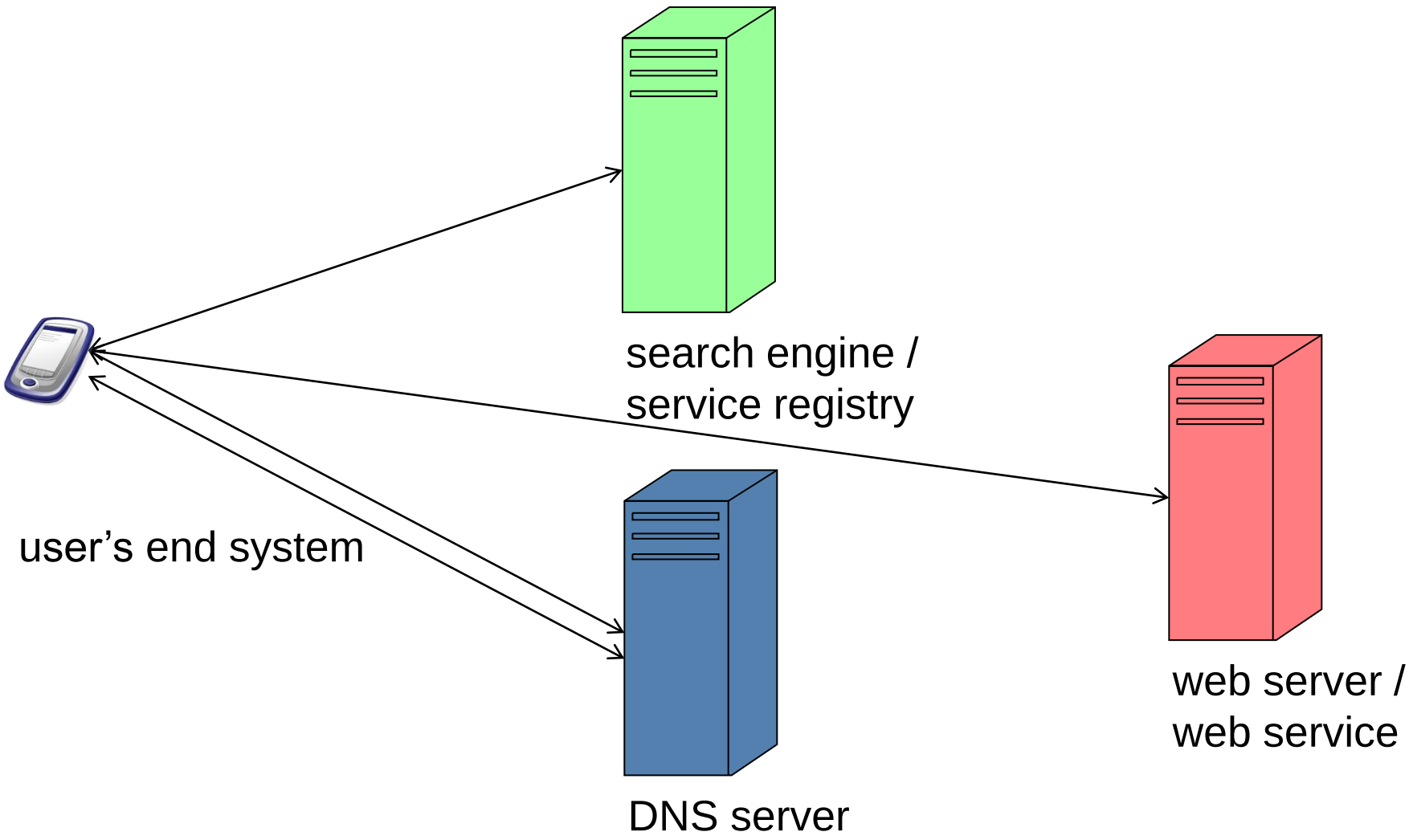
- Introduction
- Content-Centric Networking
- Service-Centric Networking
- Conclusions and Outlook

Motivation for Content-Centric Networking

- Today's network traffic is dominated by information retrieval rather than point-to-point communication between machines or humans.
- Circuit communication model is not considered as appropriate any more.
- Future communication architecture should focus on information objects instead of nodes.
- Today, wires and memories solve complimentary aspects of the same problem:
  - Wires move information in space.
  - Memories move information in time.
- Future communications architecture should unify both issues.

[modification of slides on CCN from NDN and CCNx projects]

Traditional Web Retrieval / Web Services



Related Work

- Peer-to-Peer Networks
  - Construction of overlay networks
  - Content / service discovery,
    e.g., using distributed hash tables, flooding, random walks, etc.
- Web Caching
  - Providing content for local users
- Content Distribution Networks
  - Routing and redirection of HTTP requests
  - Cache management

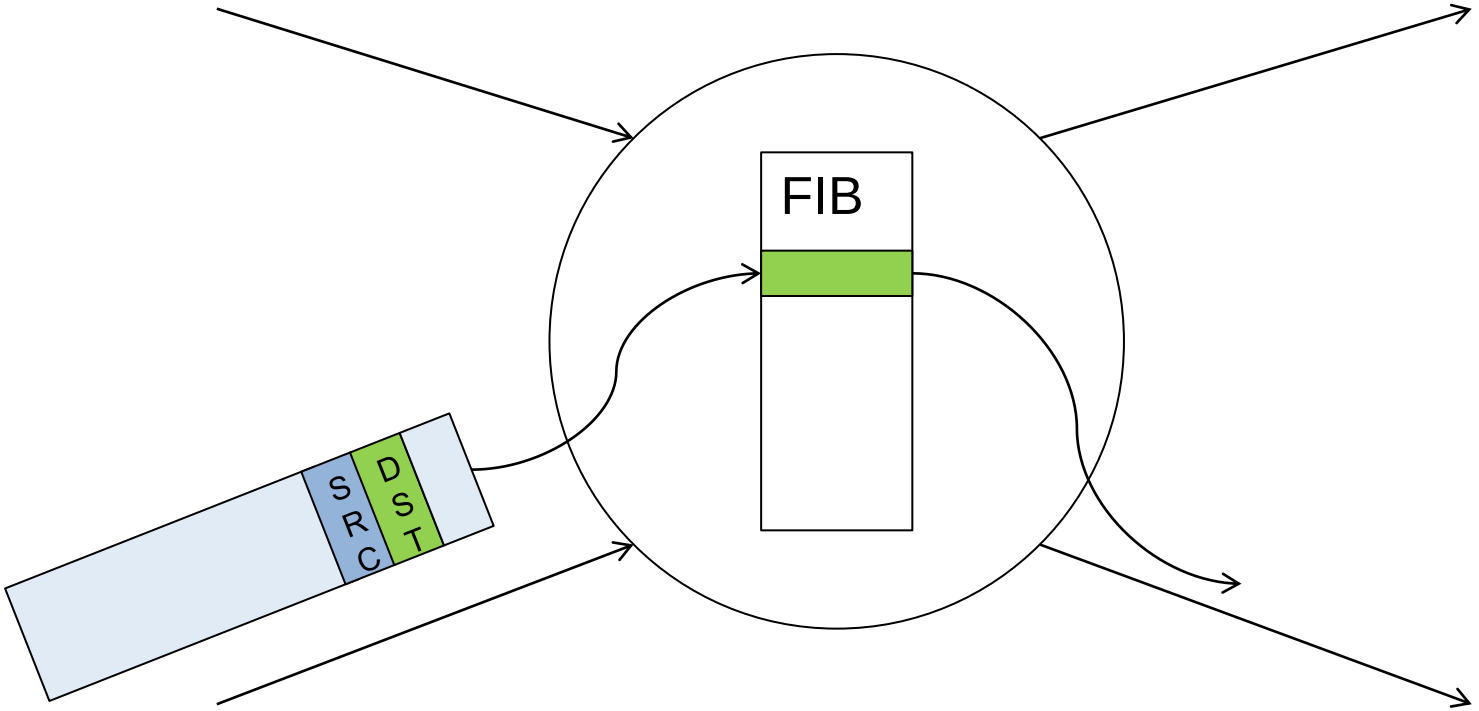
Content-Centric Networking (CCN)

- [Jacobson et al., ACM CONEXT, December 2009]
- Combination of content lookup and message routing
- Idea: describe the users' interests in the message header, but not where to get it.
- Messages (using XML encoding)
  - ***Interest:*** content name, selector
  - ***Data:*** content name, signature (info), data
- Hierarchical content names
  - Example: /unibe.ch/braun/lecture/20100405

Related Projects

- NDN = Named Data Networking, www.named-data.net
- CCNx = Open Source Core Software Project for Content-Centric Networking, www.ccnx.org
- Scalable and Adaptive Internet Solutions (SAIL), www.sail-project.eu

IP Model

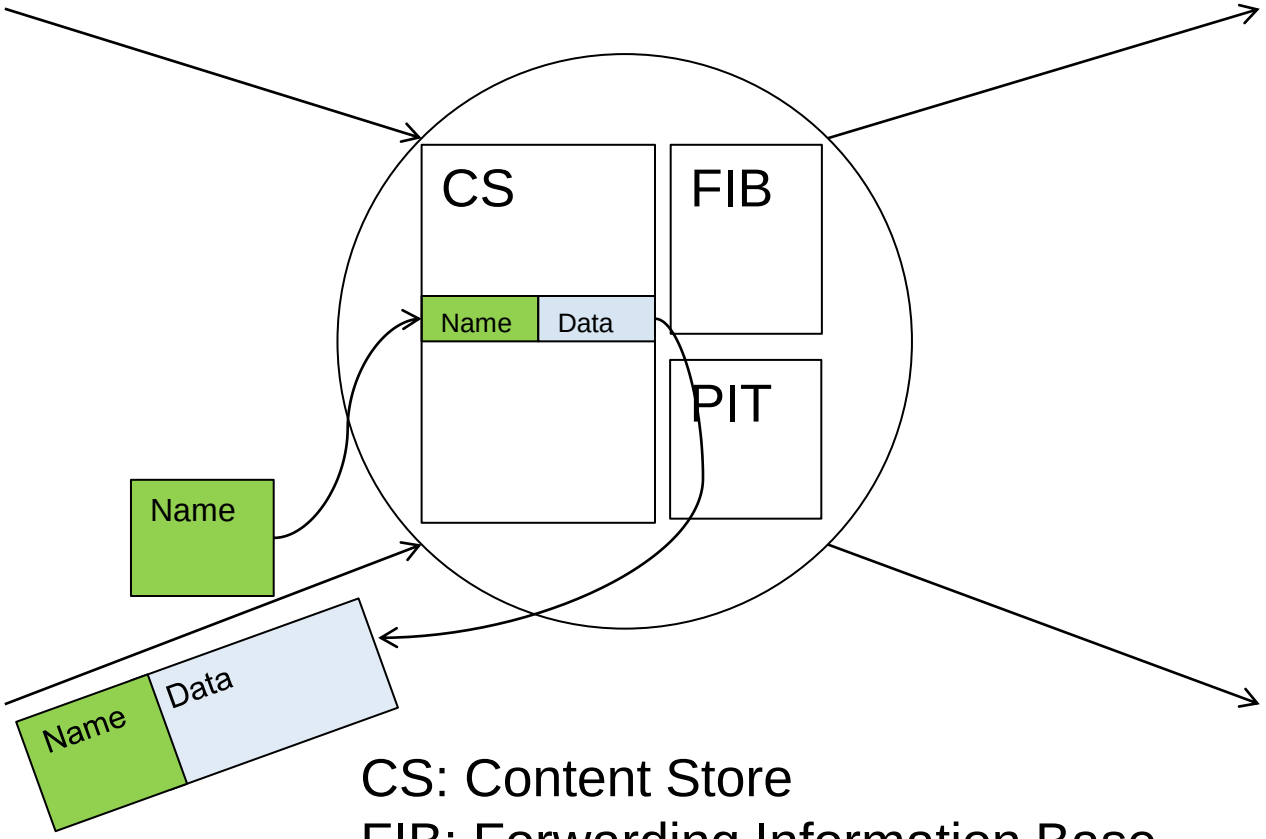


FIB: Forwarding Information Base

Processing of Interest Message in CCN

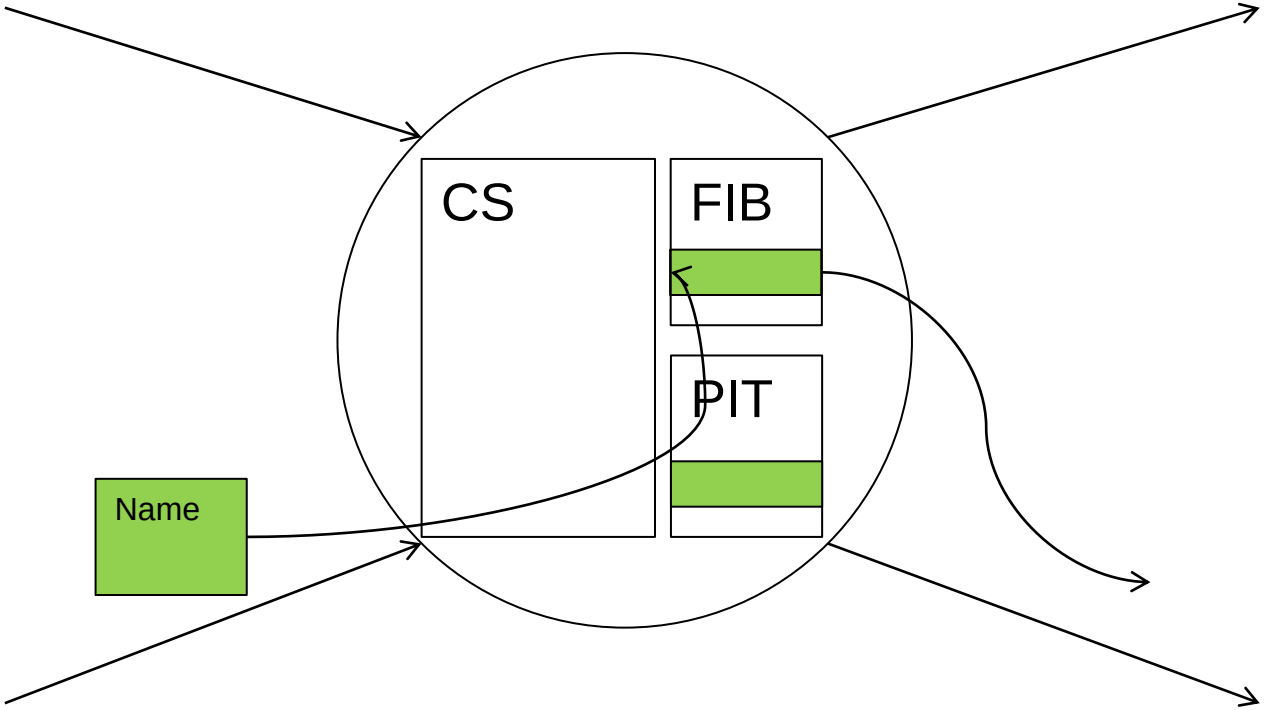
1. Longest prefix match on content name in ***Content Store (CS)***: returning data and discarding Interest
2. ***Pending Interest Table (PIT)*** match: adding request to PIT and discarding Interest
3. ***Forwarding Information Base (FIB)*** match: forwarding of Interest towards data
   - FIB population by announcements of content availability)

CCN Model: Match in Content Store



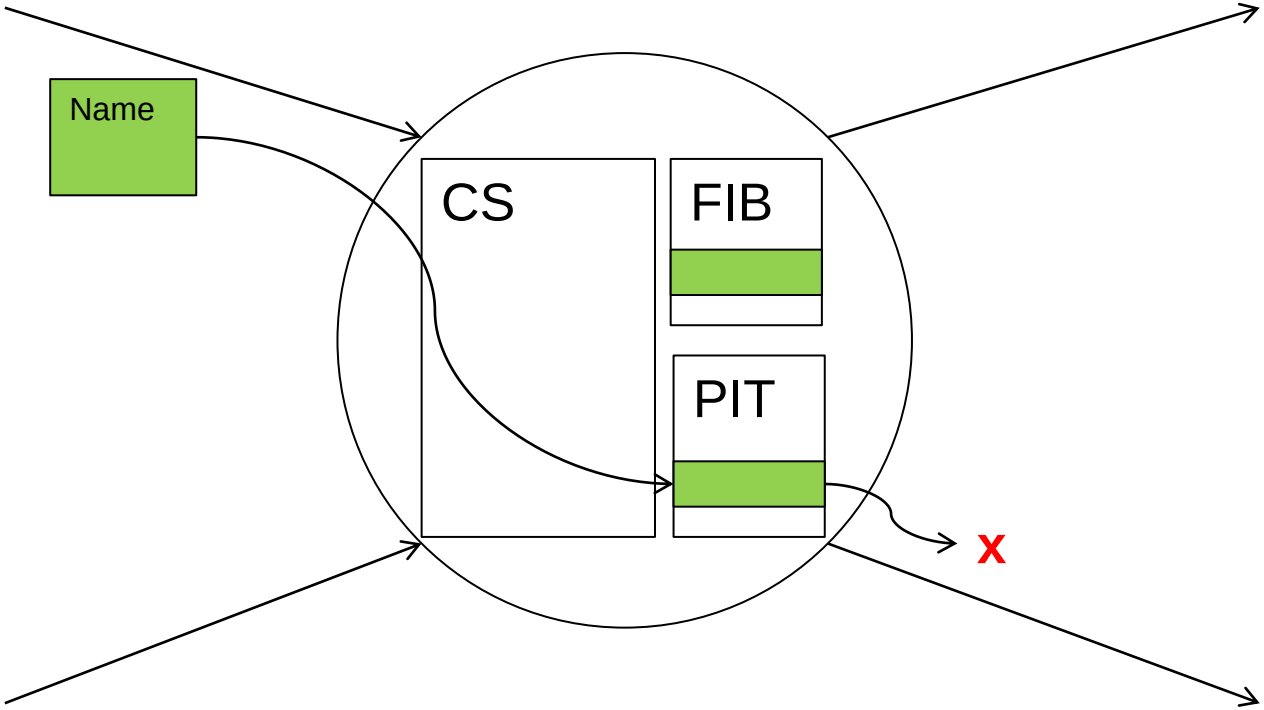
CS: Content Store
FIB: Forwarding Information Base
PIT: Pending Interest Table

CCN Model: Match in Forwarding Information Base



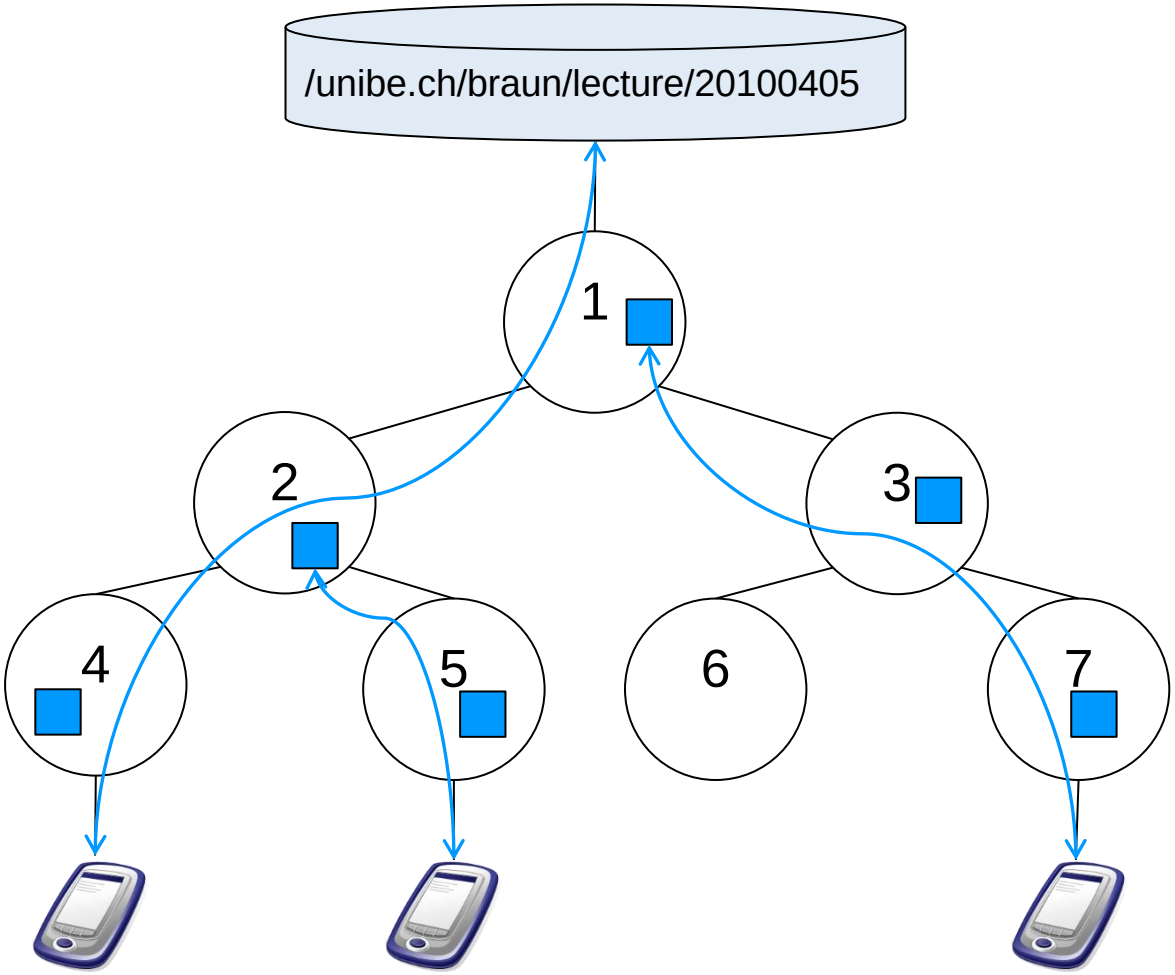
CS: Content Store
FIB: Forwarding Information Base
PIT: Pending Interest Table

CCN Model: Match in Pending Interest Table



CS: Content Store
FIB: Forwarding Information Base
PIT: Pending Interest Table

Content Distribution



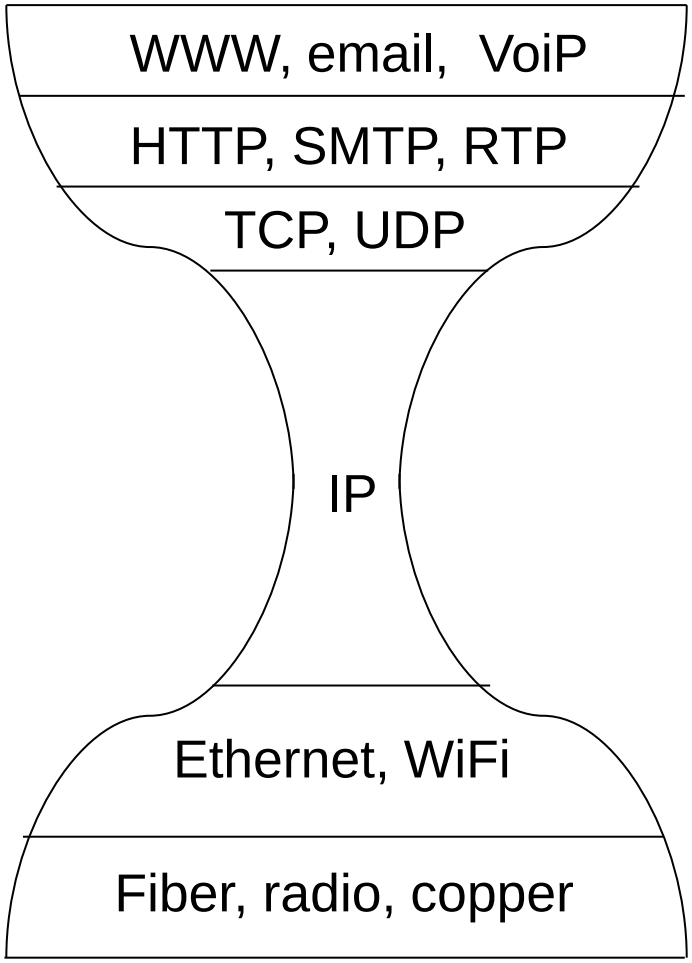
Naming

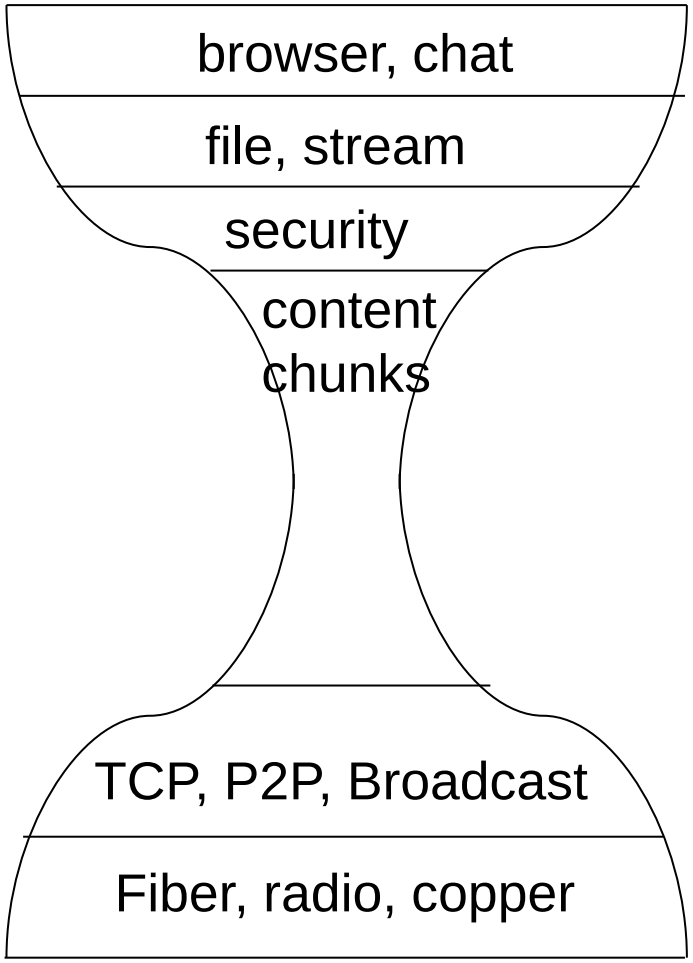
- Any kind of names are possible → flexible naming
- Examples
  - /unibe.ch/braun/lecture/20100405
  - /kit.edu/Zirkel2/SR367/Projector
- Support for simple operations
  - %C1.org.ccnx.frobnicate~1~37
  - command in the namespace org.ccnx
  - operation is frobnicate, which takes 1 and 37 as arguments

Routing

- Longest Prefix Match Routing (as in IP)
- But: different FIB entry semantics
  - IP: IP address prefix ***can be reached*** via an outgoing interface for an existing FIB entry
  - CCN: content name prefix ***might be reached*** via an outgoing interface for an existing FIB entry
- FIB entries should be populated proactively for known content.
- Alternatively, searching for content, e.g., using broadcasting

Hour-Glass Models





Content-Centric Networking

- Advantages
  - Automatic content distribution
  - < 1 round-trip-time
  - Minimization of latency
  - Minimization of bandwidth
  - Local congestion control
  - Built-in security
- Drawbacks
  - Routing as open issue
  - Lacking support of flexible services

Service-Centric Networking (SCN)

- CCN is content-centric and encodes a few operations on content as extensions of names.
- Proposal: Service-Centric Networking
  - Extension of content-centric networking to support services, possibly operating on content.
  - Description of a service using content naming scheme, e.g., /google.com/file-service
  - Service request to invoke a service in Interest message
  - Service response in Data message
- Services
  - Infrastructure services, e.g., cloud computing services
  - Client-oriented services, e.g., web services
  - Continuous content retrieval and streaming services, e.g., A/V conferencing, streaming

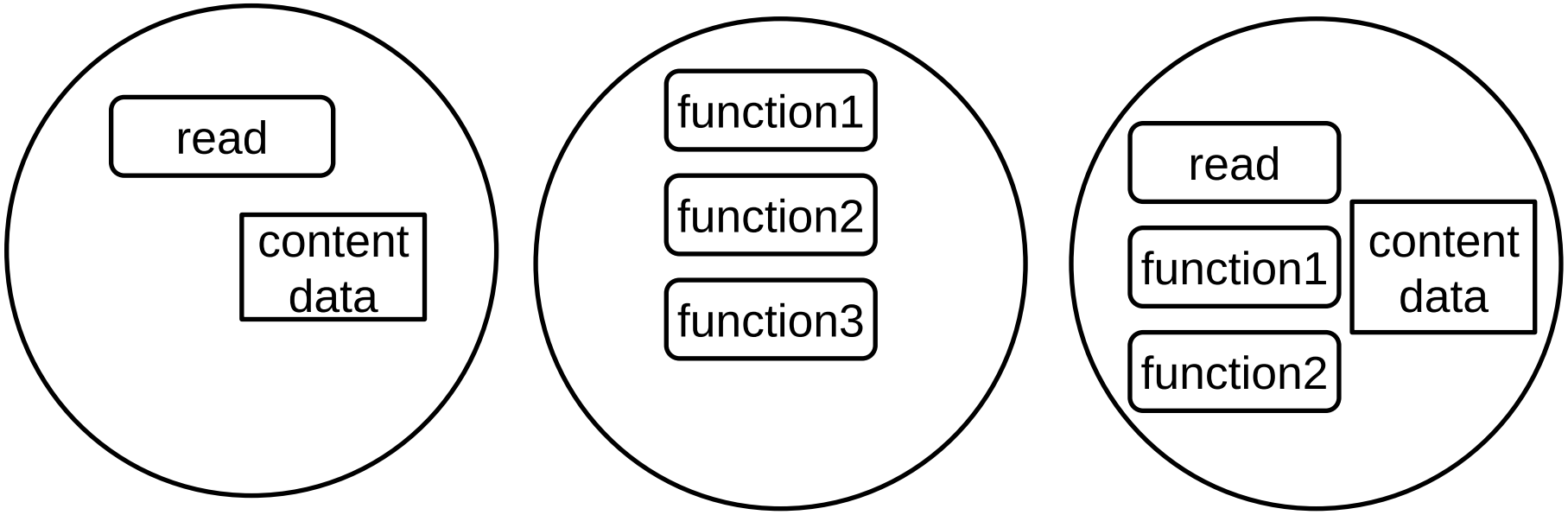
Advantages of SCN

- No service lookup and service registry
- Caching of service data; extended caching of multimedia data (transcoding)
- Location-based services
- Optimized service selection

Uniform Naming for Services (Functions) and Content (Data)

- Services perform (data) processing and are represented by *functions* to be invoked. Content stores for *data*.
- Service-centric networking should support both data and functions.
- Object-orientated programming paradigm integrates both functions and data into objects.
  Method calls among objects to invoke functions.
- Proposal: Object names for both services (functions) and content (data), e.g.,
  - /youtube.com/rendering
  - /unibe.ch/braun/lecture/20100405
- Advantages of object-oriented approach
  - Uniform naming
  - Services can be implemented as a set of cooperating objects

SCN Object Types

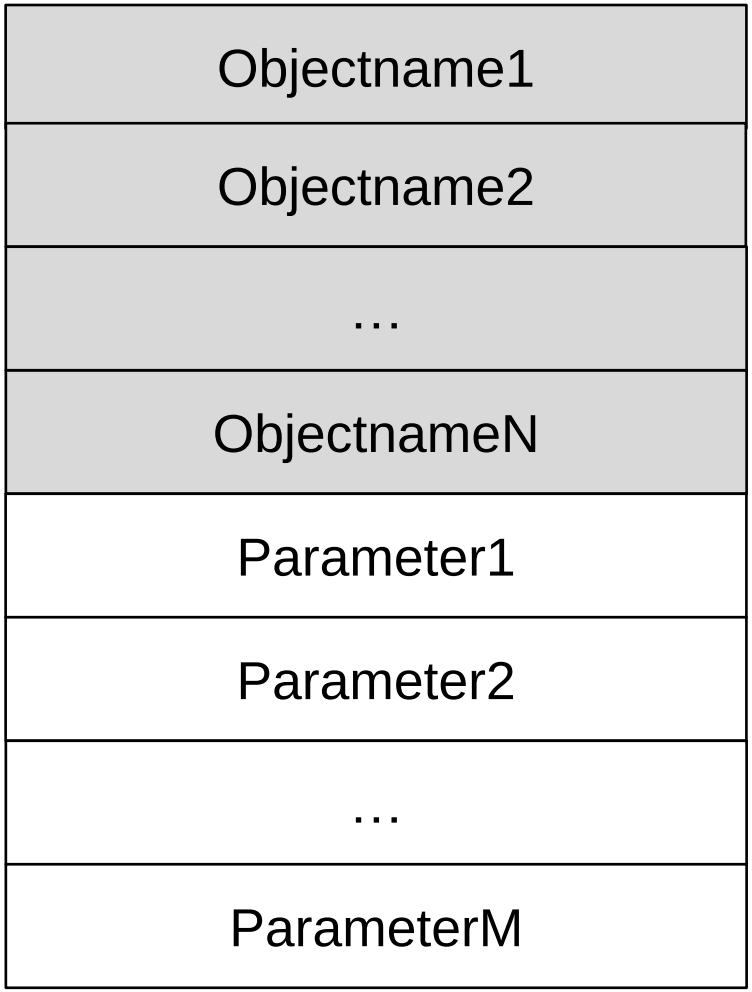


1: Content Object

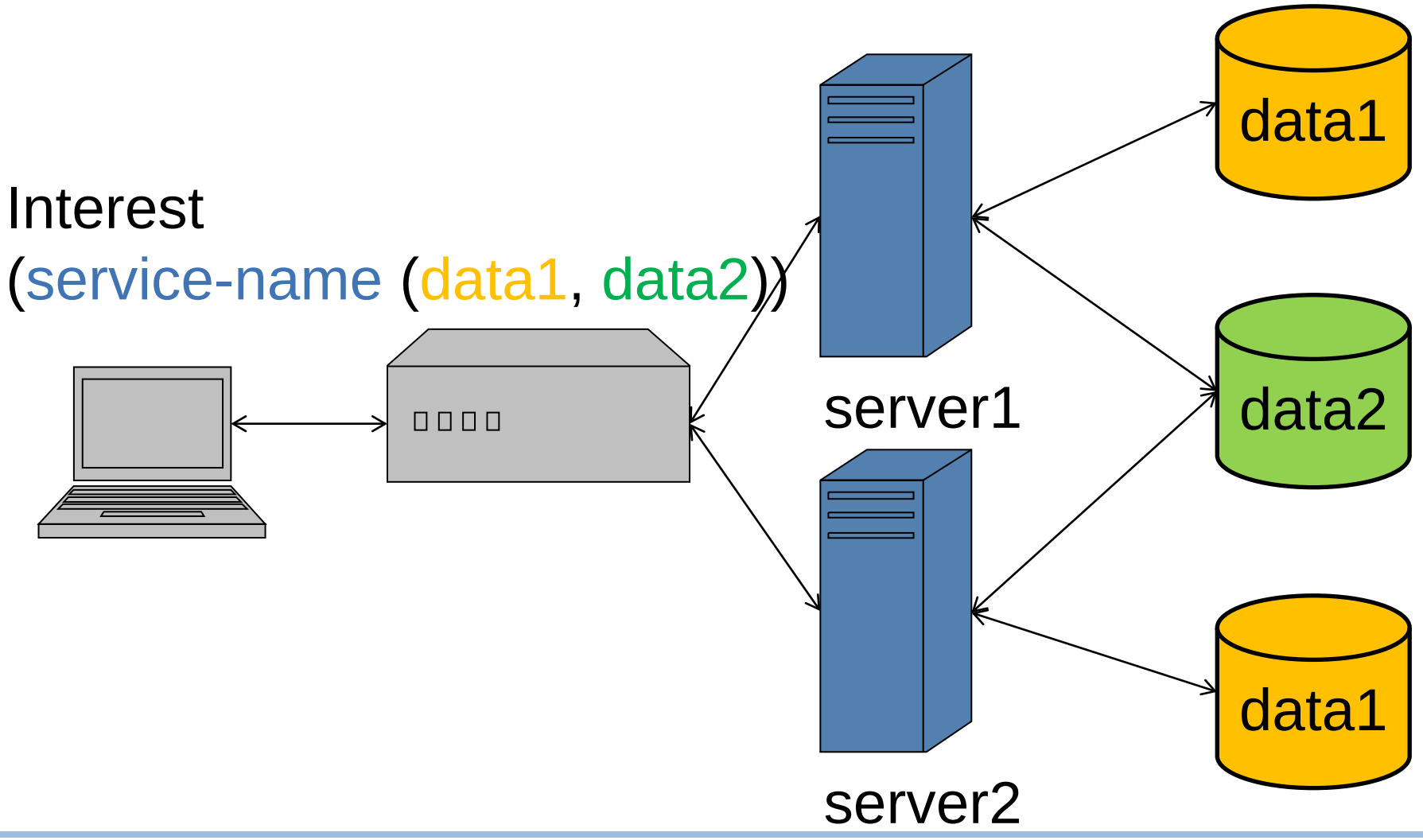
2: Service Object

3: Content/Service Object

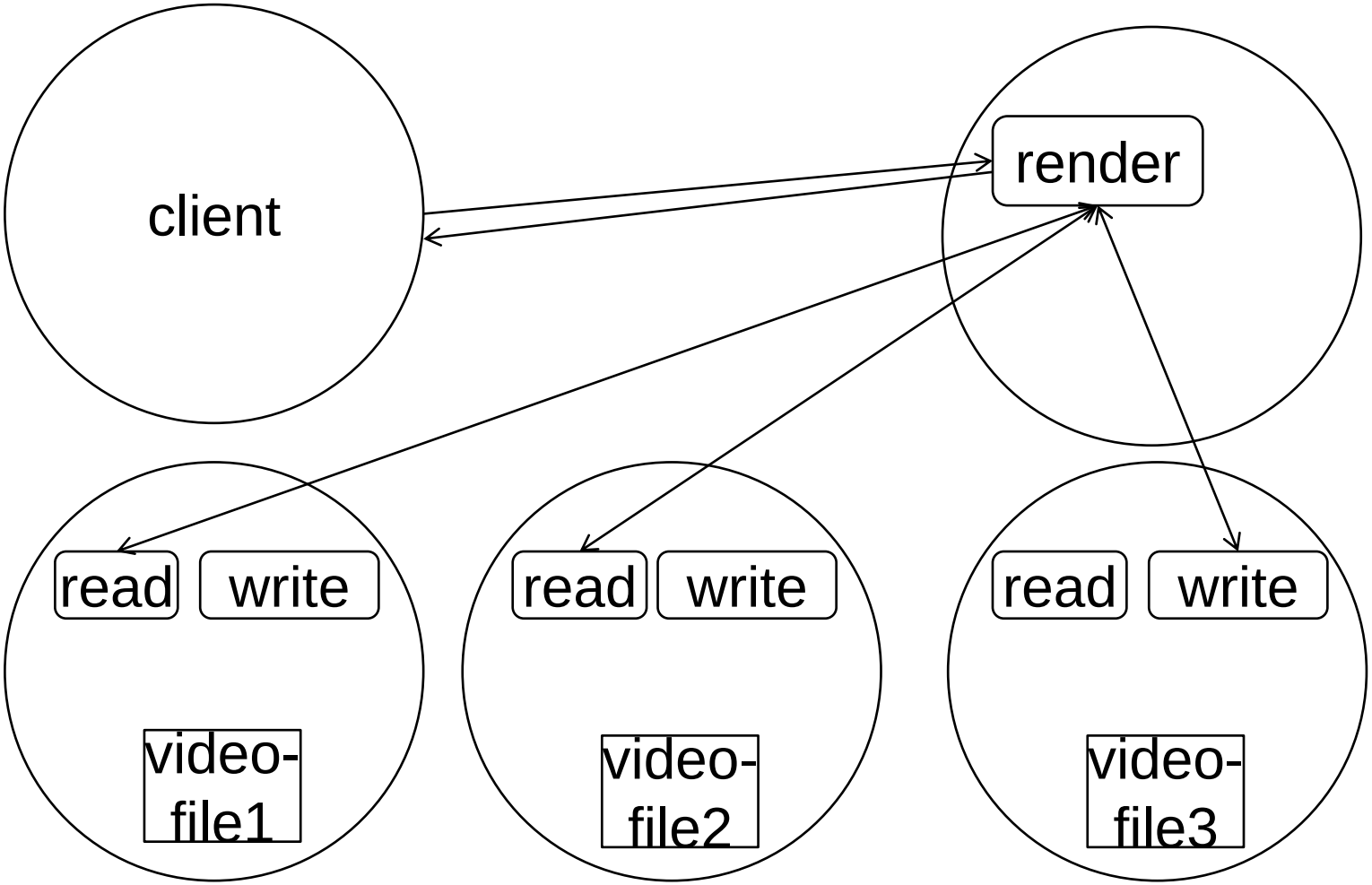
Addressing Multiple Objects for Composed Services



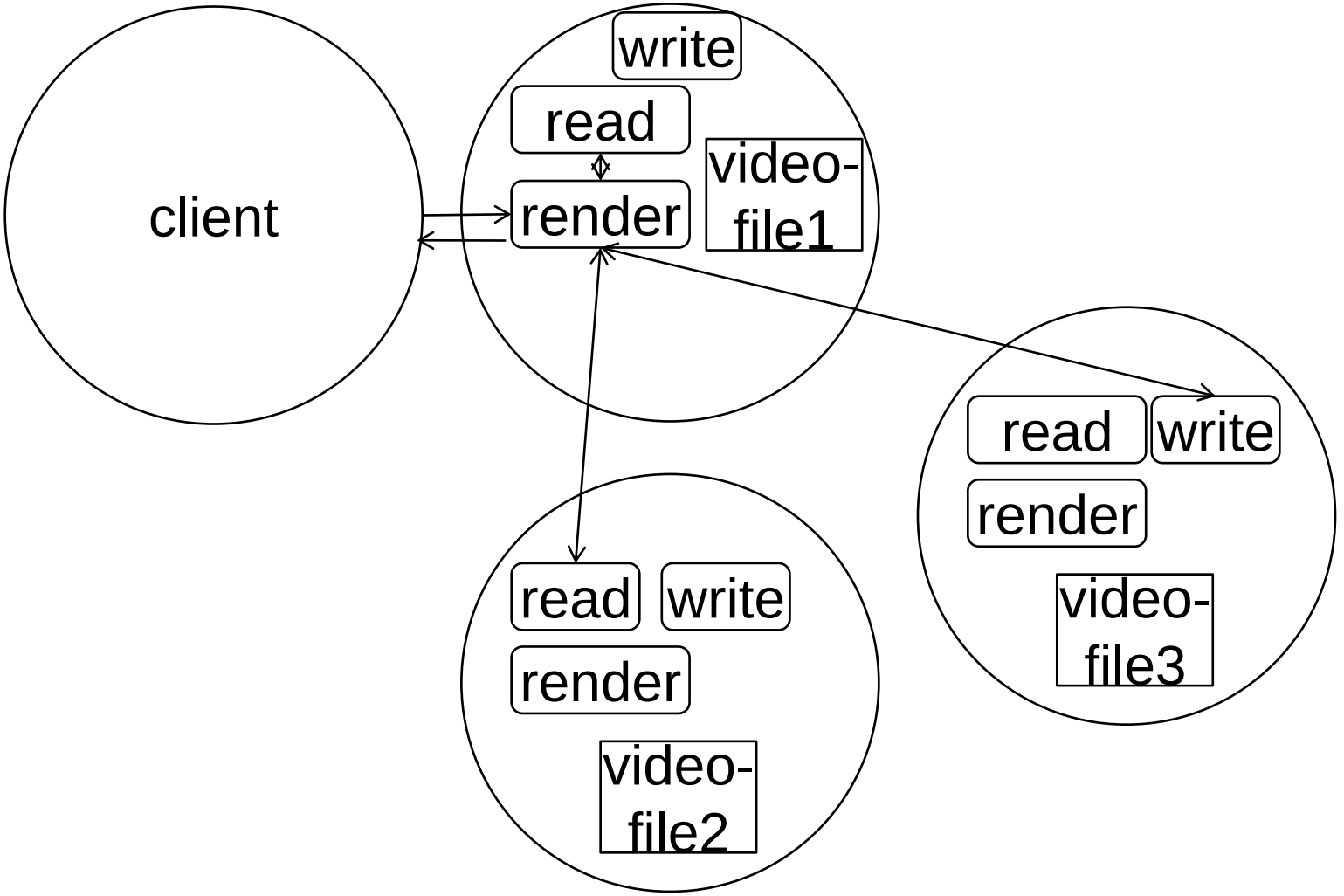
Optimization of Service Execution



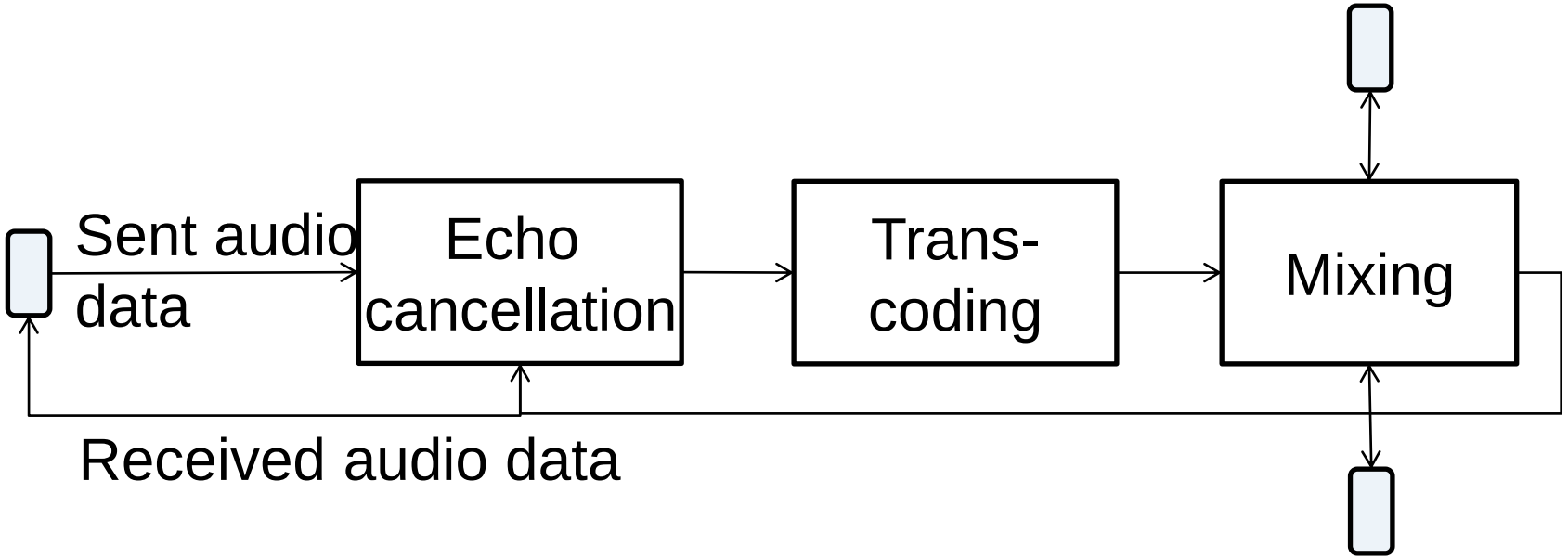
Example: Video Rendering I



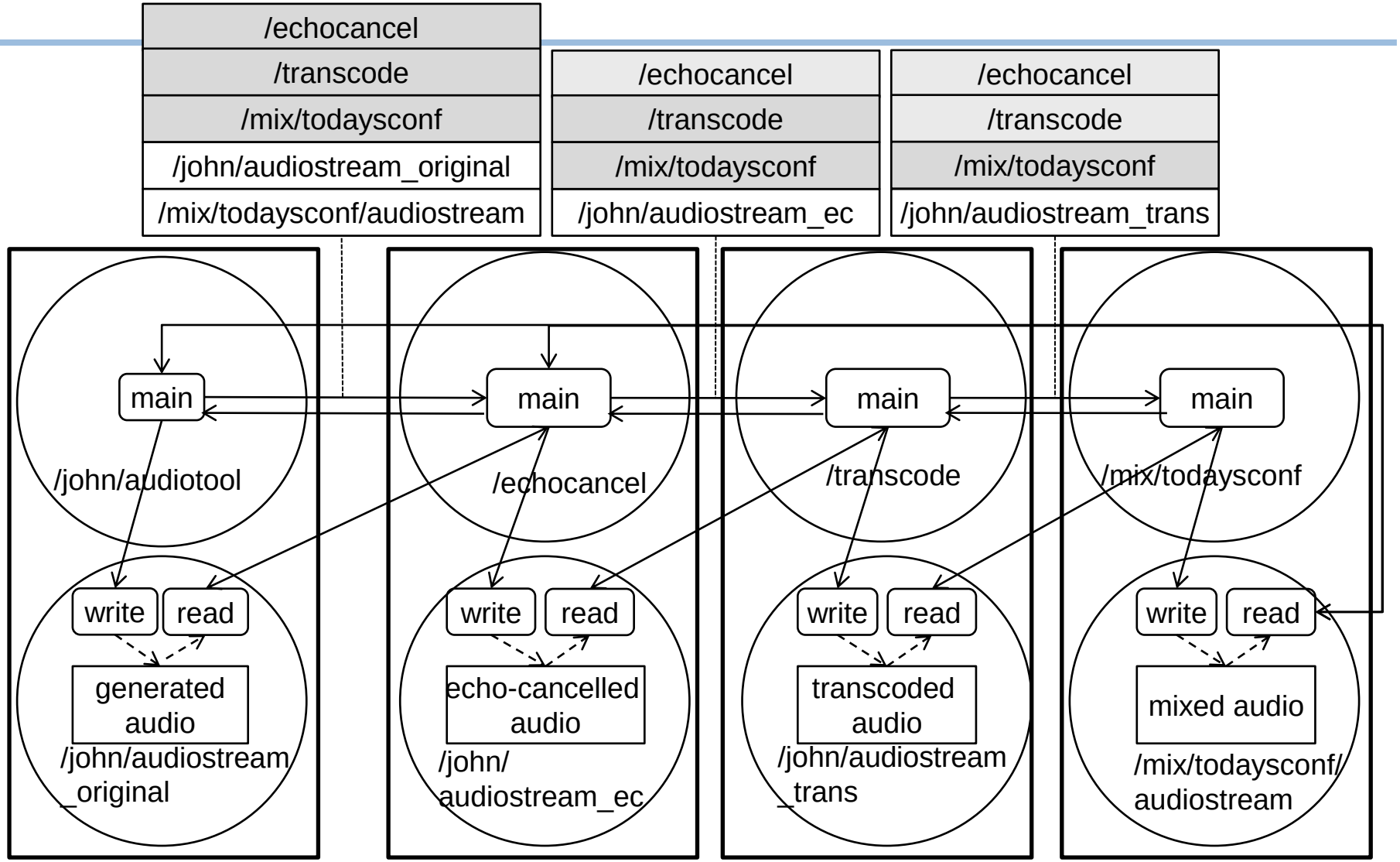
Example: Video Rendering II



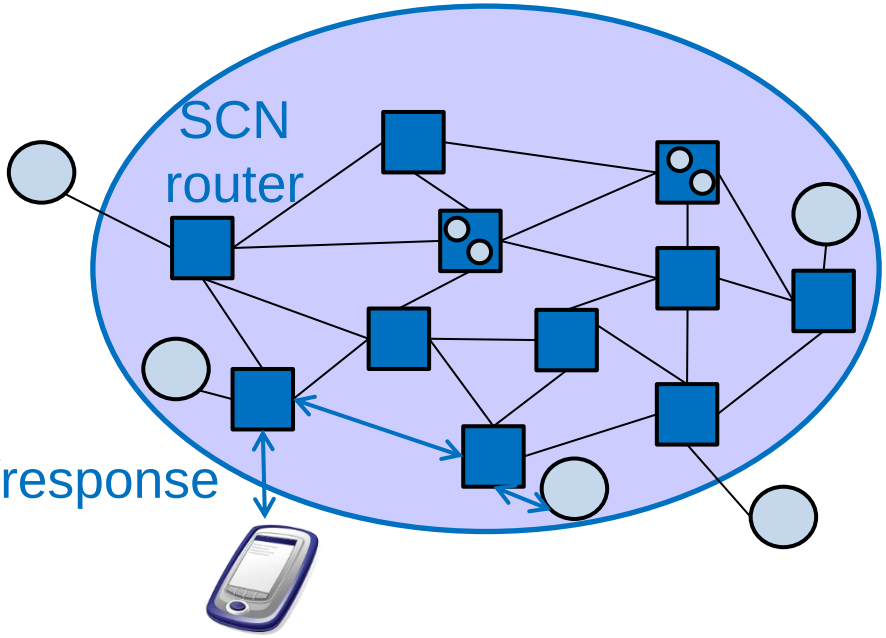
Example: Real-time Audio Conferencing



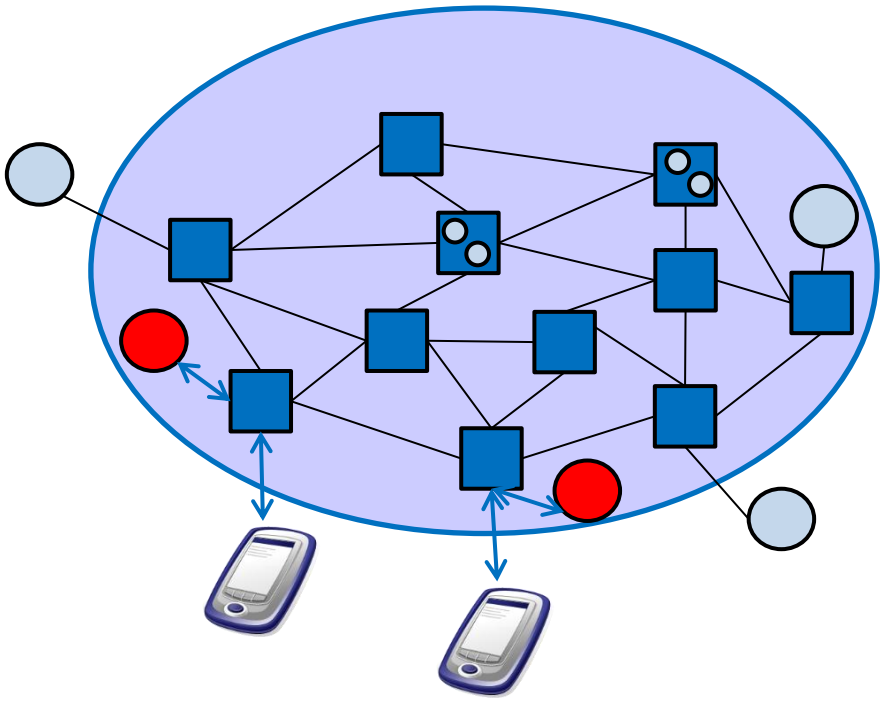
Real-Time Audio Conferencing Service



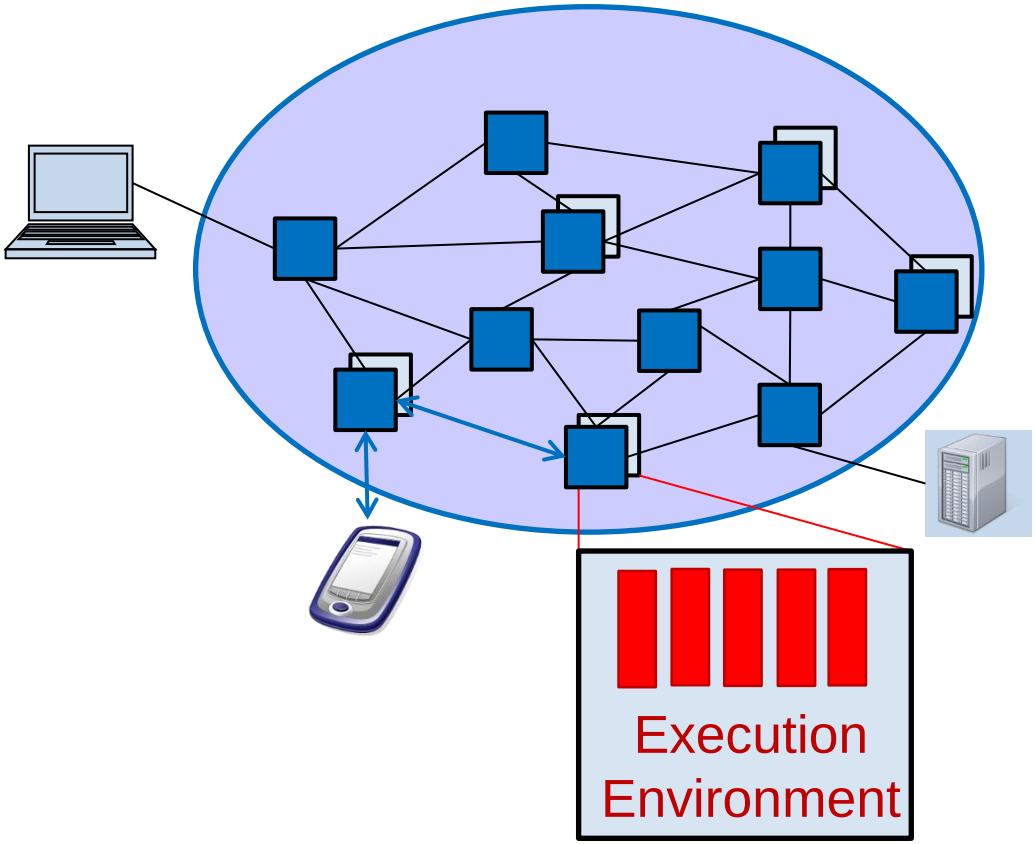
Service-Centric Network



Location-Based Services



Service-Centric Networking and Cloud Computing



Session Support

- CCN Interest messages must be continuously submitted for continuous data flow, e.g., VoIP, streaming, and single chunks

- Option: establishment of flows / sessions between service users and service providers,
  e.g., using OpenFlow, cf. SCAFFOLD (Princeton)

Conclusions and Outlook

- Service-Centric Networking as a new paradigm extending content-centric networking using an object-oriented naming concept
- Open Issues
  - Implementation architectures
  - Service management
  - Service composition
  - Routing
  - Parameter support
  - Charging
  - Security
  - Wireless ad-hoc networks
  - Delay-/Disruption-tolerant networks
  - …

Thanks for your attention !

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> rvs.unibe.ch/research