An Architectural Prototype for Certificate-based Authentication and Authorization

- Sal Gurnani - University of California
  - Project Scope
  - Design Considerations
  - University of California Certificate Authority and UC Directory
- David Millman - Columbia University
  - Columbia University Certificate Authority and CU Directory
  - Transaction Process
  - Open Issues
  - Next Steps

Project Scope

- Tests an authentication protocol and operational model for using digital certificates for authentication
- Tests a directory service to serve user attributes to determine the level of authorized access to licensed online materials
- Does not address any issues involved in generating and distributing certificates by the institution.

Participants

- Digital Library Federation
- Columbia University
- University of California Office of the President
- JSTOR
- OCLC

Design Considerations - Localization of Information

- Must be able to allow the user to decide and convey if the transaction should be anonymous/stateless or unique/persistent.
- In a degraded condition where authorization is not available, an alternate level of service is provided.
- Only the institution (university, college, campus, etc.) can determine the affiliation and eligibility of each of its members to use each licensed publication, based on the license terms.

Design Considerations - Localization of Information

- Each eligible member will be assigned to (at least) one "class of service." The available classes are negotiated as part of the license agreement. For some publishers, there may be only a single class of service, for others there may be several.
- Only the publisher can determine the precise set of access permissions corresponding to a particular class of service, as specified in the license agreement with a particular institution.
- Allow for dynamic changes in user attributes. E.g., a person's status at an institution may change before the expiration date of their digital certificate from that institution.

Design Considerations - Privacy

- The institution should not be required to reveal information that can be used to identify a particular individual in order to allow that individual access to a licensed resource.
- Minimize the interface: only information strictly necessary to authenticate an individual and to authorize access should be exchanged as part of the transaction.
- Maximize reusability by minimizing the amount of institution-specific information that the publisher must keep, and the amount of publisher-specific information that the institution must keep.

Assumptions

- Each institution has its own certificate authority (CA) which is explicitly trusted by the publisher. Thus, the "Issuer" field in the certificate is sufficient to identify the institution.
- The institution must have a directory server which, given some information from the certificate, the publisher can query for user attributes and determine eligibility for the service.
- The full authentication and authorization process is performed infrequently (e.g., once per "session") so that minimizing the transaction cost is less critical.

University of California Certificate Contents

http://www.ucop.edu/irc/auth/auth-wg/CURRENT/UC-Architecture-033099/UC-Architecture-033099.pdf

x509v3 Extensions (relevant subset)

⌘ **NetID***	Required	UC assigned unique ID for an individual
⌘ **Strength Value***	Required	Certificate Issuance Identity Check Method/Strength for Individual
⌘ **Campus Affiliation**	Required	String value from set {OP, BK, DV, IR, LA, RV, SB, SC, SD, SF}
⌘ **Auth. Pointer Type**	Optional	String, ex. “URL”
⌘ **Auth. Pointer Value**	Optional	String, ex. “ldaps://attributes.ucop.edu/query”

* This field must be specified in order for the certificate to be a personal identity certificate. If the extension is not specified or missing, the certificate becomes an attribute certificate (see CPS).

University of California Directory Attributes

Affiliation	optional	Faculty, staff, student
Campus	optional	String value from set {OP, BK,DV,IR,LA, RV, SB, SC, SD, SF}
Serviceclass Object		
Publisher	required	String value defined by Publisher {jstor.org, oclc.org}
Service	required	String value defined by publisher *{Null,* FirstSearch}
Class of Service	required	String value defined by publisher {berkeley.edu, 100053231}

New Requirements

- OID 1.2.840.114006: CLIR
- OID 1.2.840.114006.1000: "Digital Library Authentication and Authorization Architecture”
- OID 1.2.840.114006.1000.1: query URL (this is the X509v3 extension)

Columbia University Certificate Contents

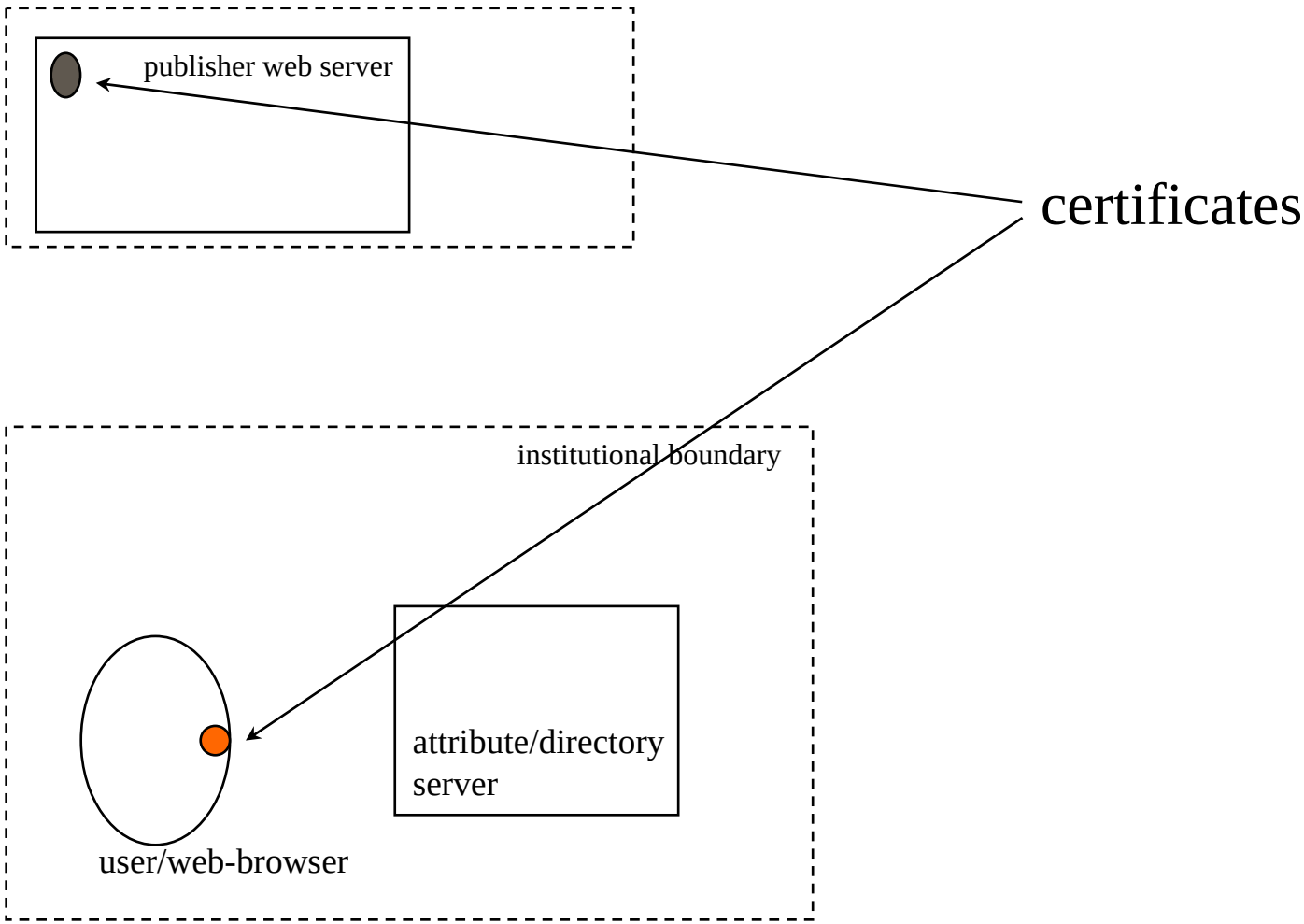
```
Certificate:
    Data:
        Version: 3 (0x2)
        Serial Number:
            03:6f:7f:bc:38
        Signature Algorithm: md5WithRSAEncryption
        Issuer: C=US, ST=New York, L=New York City, O=Columbia University, OU=AcIS R&D, CN=AcIS Pilot
    Project CA
        Validity
            Not Before: Mar 23 20:07:22 1999 GMT
            Not After : Oct  9 20:07:22 1999 GMT
        Subject: C=US, ST=New York, L=New York City, O=Columbia University, OU=AcIS R&D Pilot Project,
    CN=5b5495da786f5977ff373d1ccf23341b
        Subject Public Key Info:
            Public Key Algorithm: rsaEncryption
            RSA Public Key: (1024 bit)
                Modulus (1024 bit):
                    {Key Data}
                Exponent: 65537 (0x10001)
        X509v3 extensions:
            1.2.840.114006.1000.1:
                ldaps://xsamd.cc.columbia.edu/ou=AcIS R&D Pilot Project,o=Columbia
    University,c=US?serviceClass?sub?(tempid=5b5495da786f5977ff373d1ccf23341b)
    Signature Algorithm: md5WithRSAEncryption
        {Signature Data}
```

Columbia University Directory Content

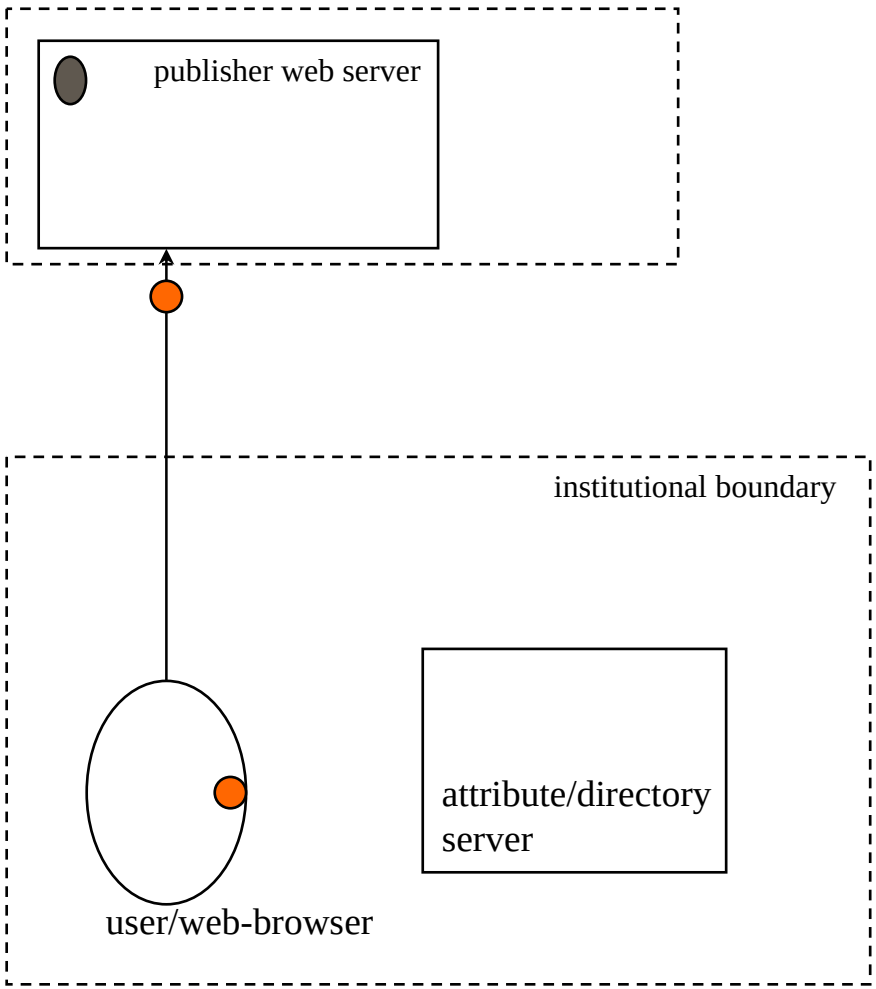
* **dn**: other=922908404, ou=PilotPerson, ou=AcIS R&D Pilot Project, o=Columbia University, c=US
  other: 922908404
* **objectclass**: pilotPerson
  cn: HOLLY GOTHAM
  sn: GOTHAM
  uni: hbg27
  krbName: hbg27@CC.COLUMBIA.EDU
* **tempid**: 5467a891a6fba9dcc8286d140cfacf65
* **serviceclass**::MCIECG9jbGMub3JnBAtGaXJzdFNlYXJjaAQJMTAwMDUzMjMx
* **serviceclass**::MCAECWpzdG9yLm9yZwQFanN0b3IEDGNvbHVtYmlhLmVkdQ==
  description: acis pilot project data

- Only '*' fields are visible to publishers
- dn is "opaque"
- tempid is used for local certificate issuing method
- serviceclasses in this format are b64 encoded of asn1 der-encoding. decoded, they are:
  - serviceclass:: **oclc.org FirstSearch 100053231**
  - serviceclass:: **jstor.org jstor columbia.edu**

Transaction Protocol



Transaction Protocol



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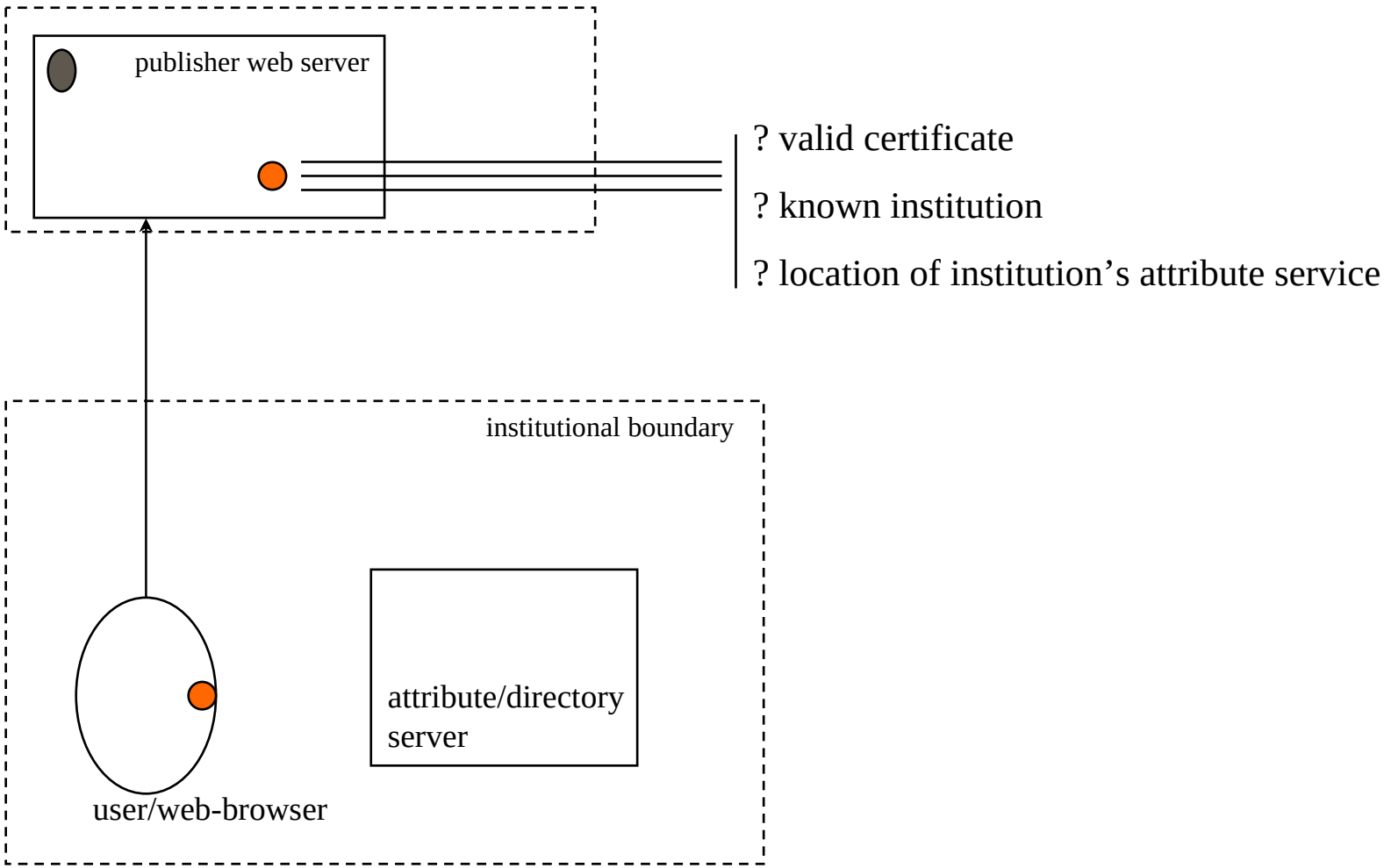

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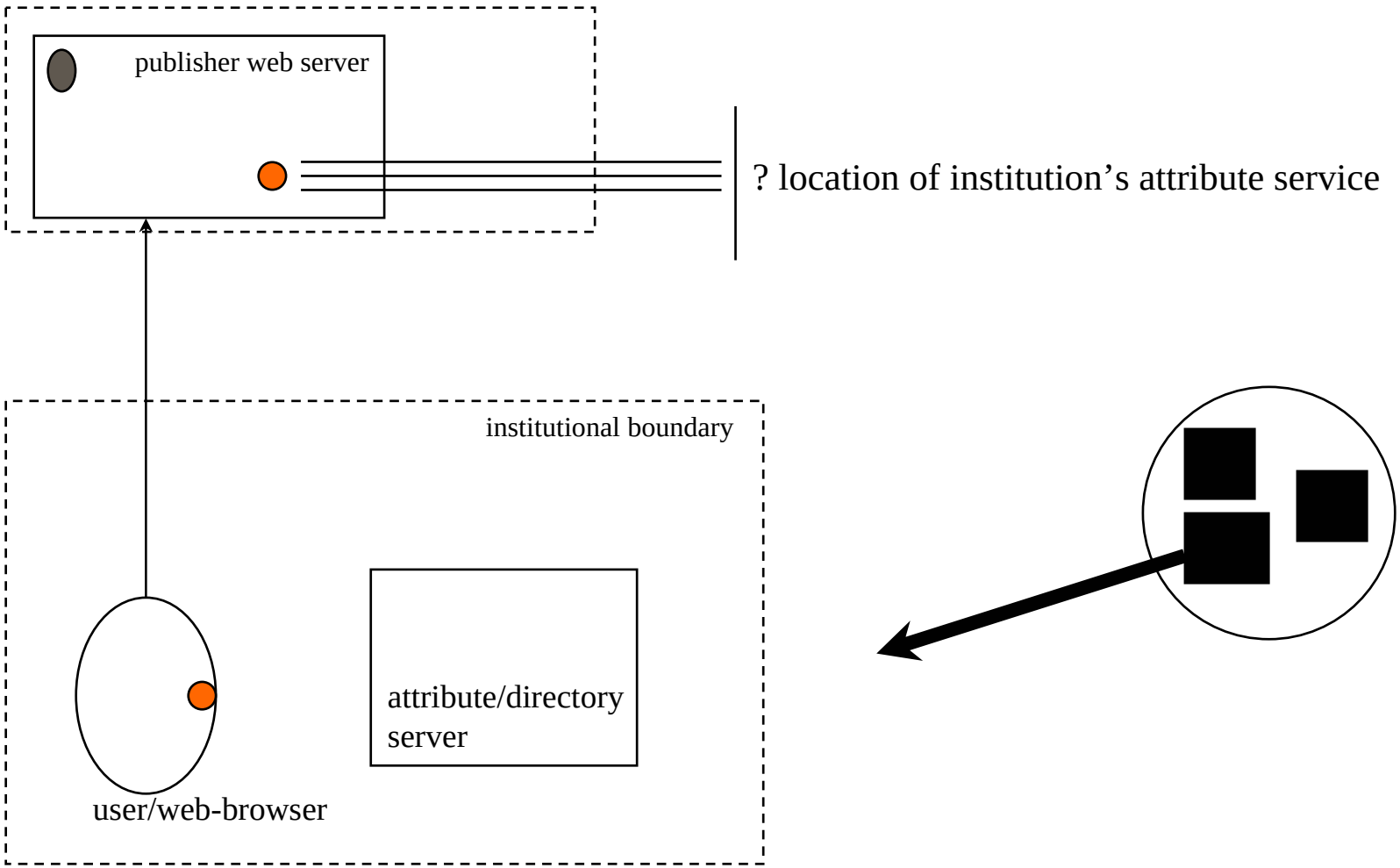

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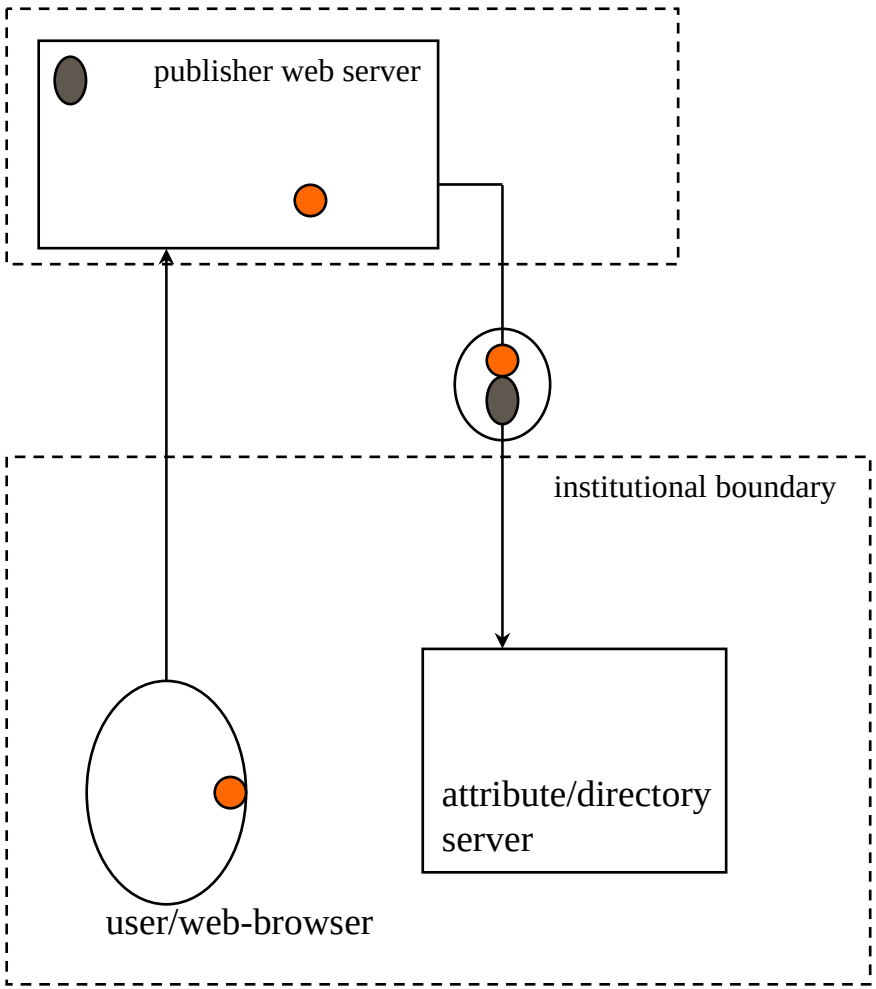

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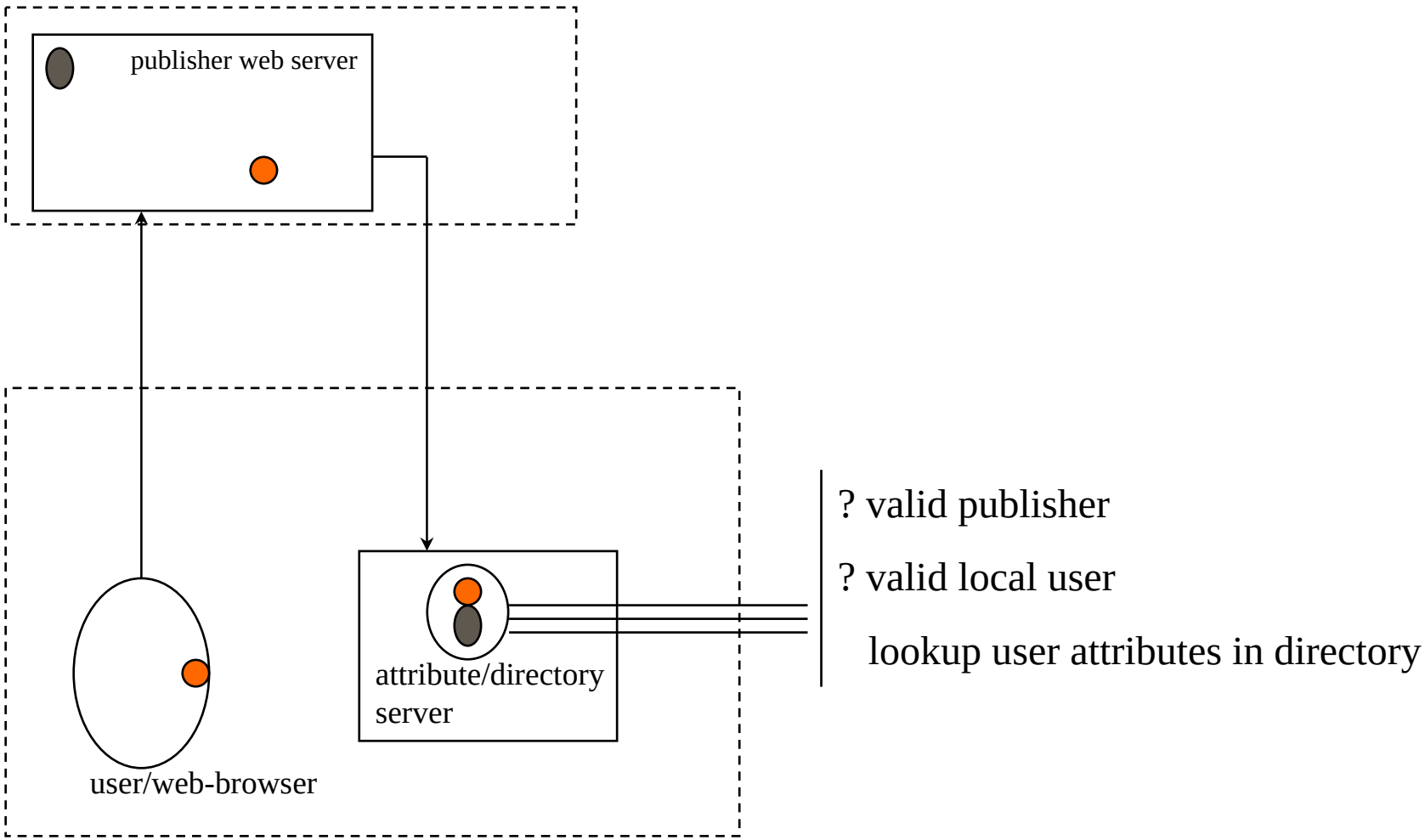
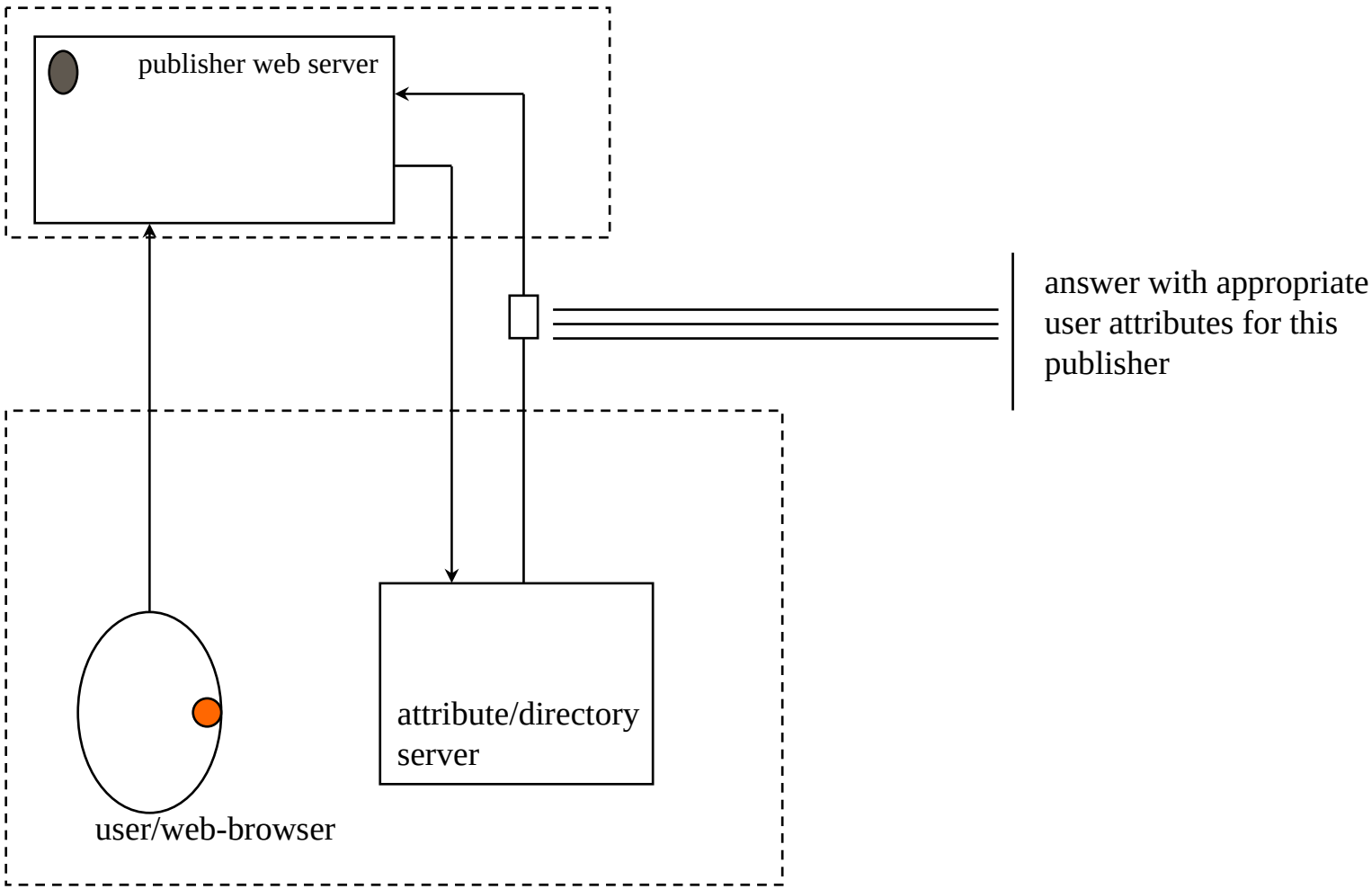
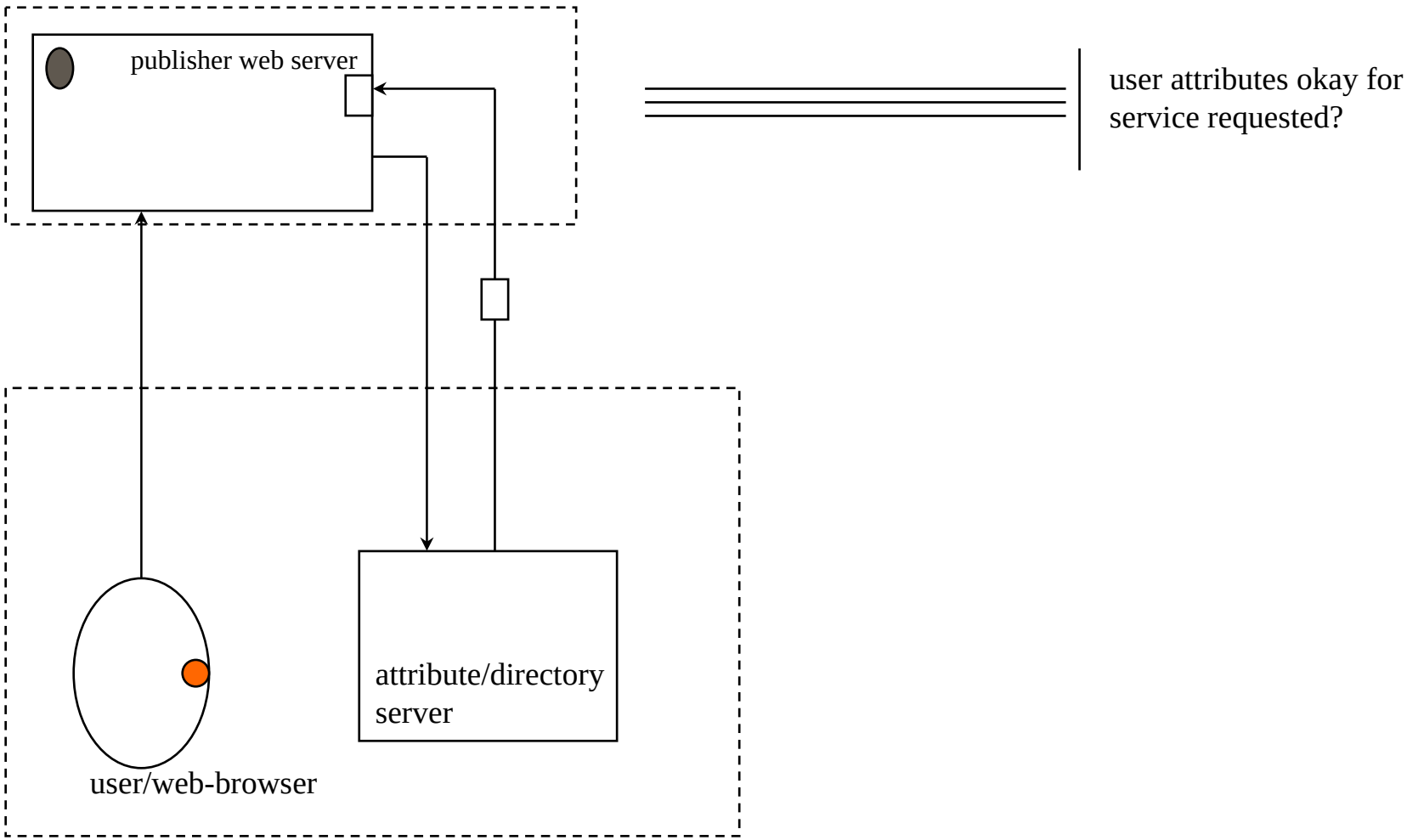


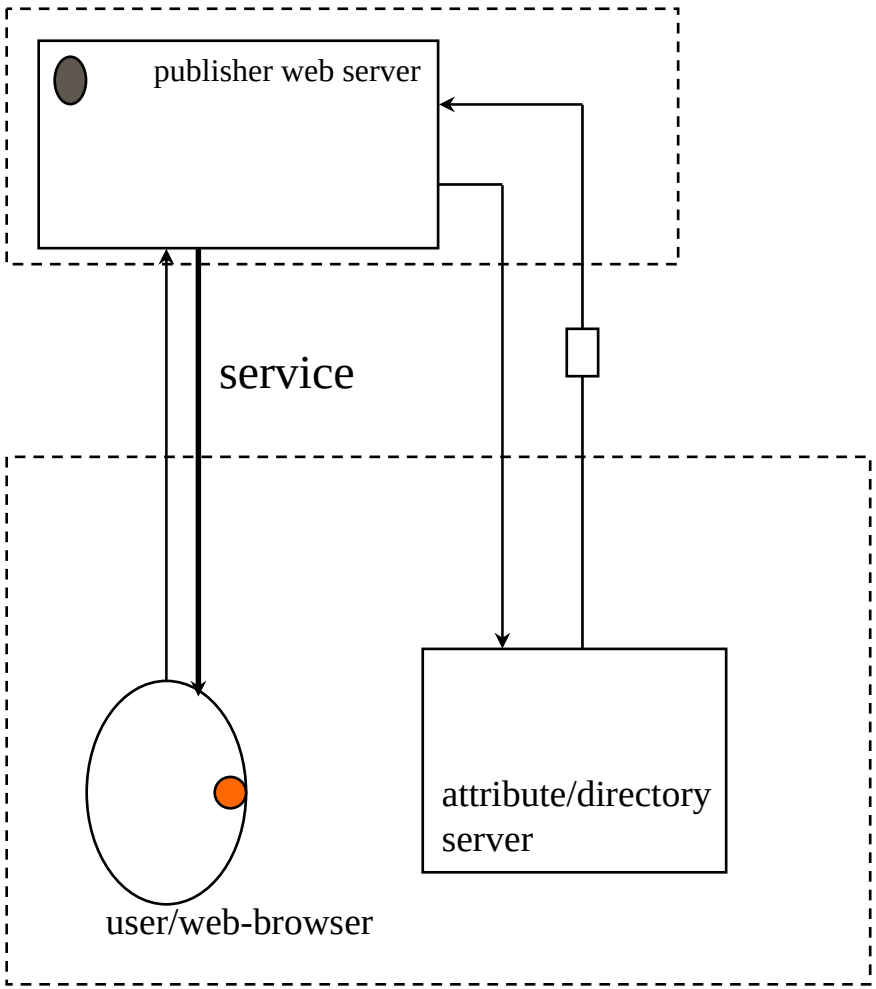
Transaction Protocol



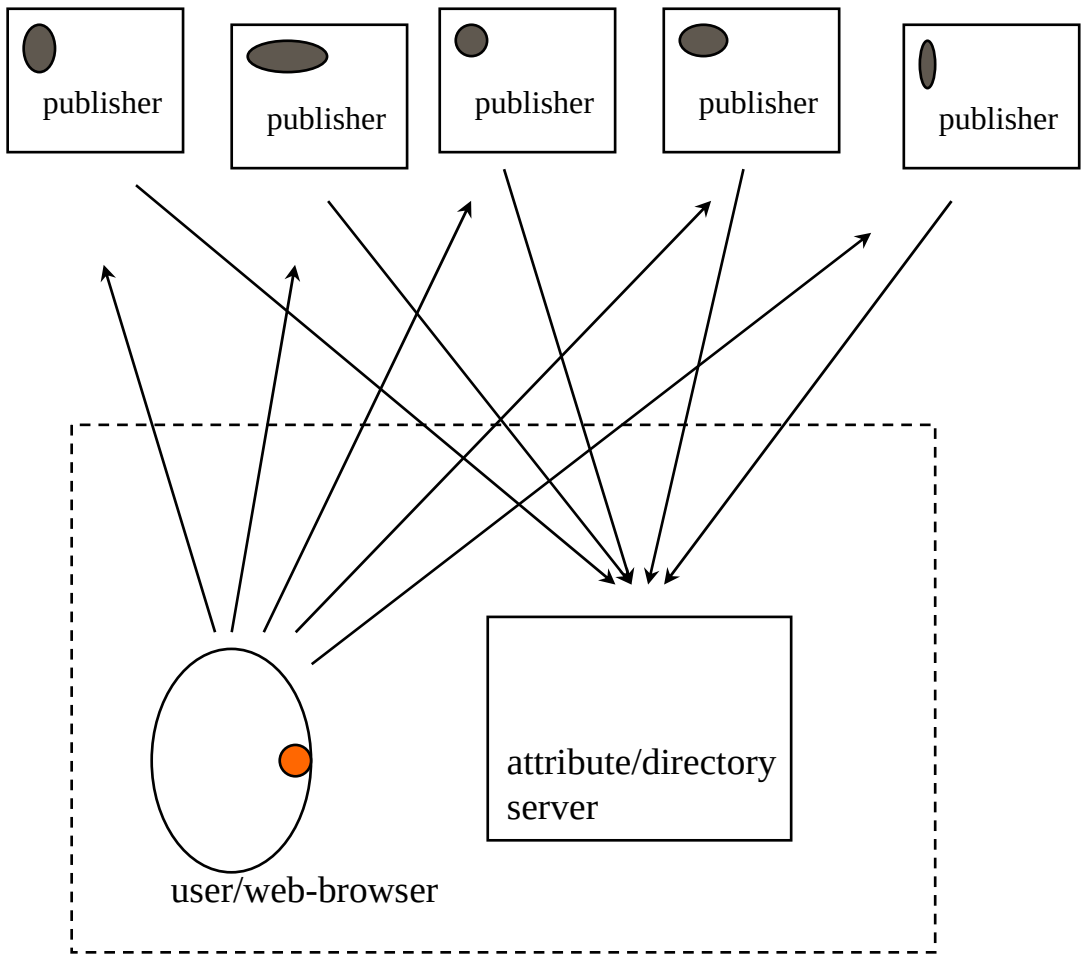
Transaction Protocol



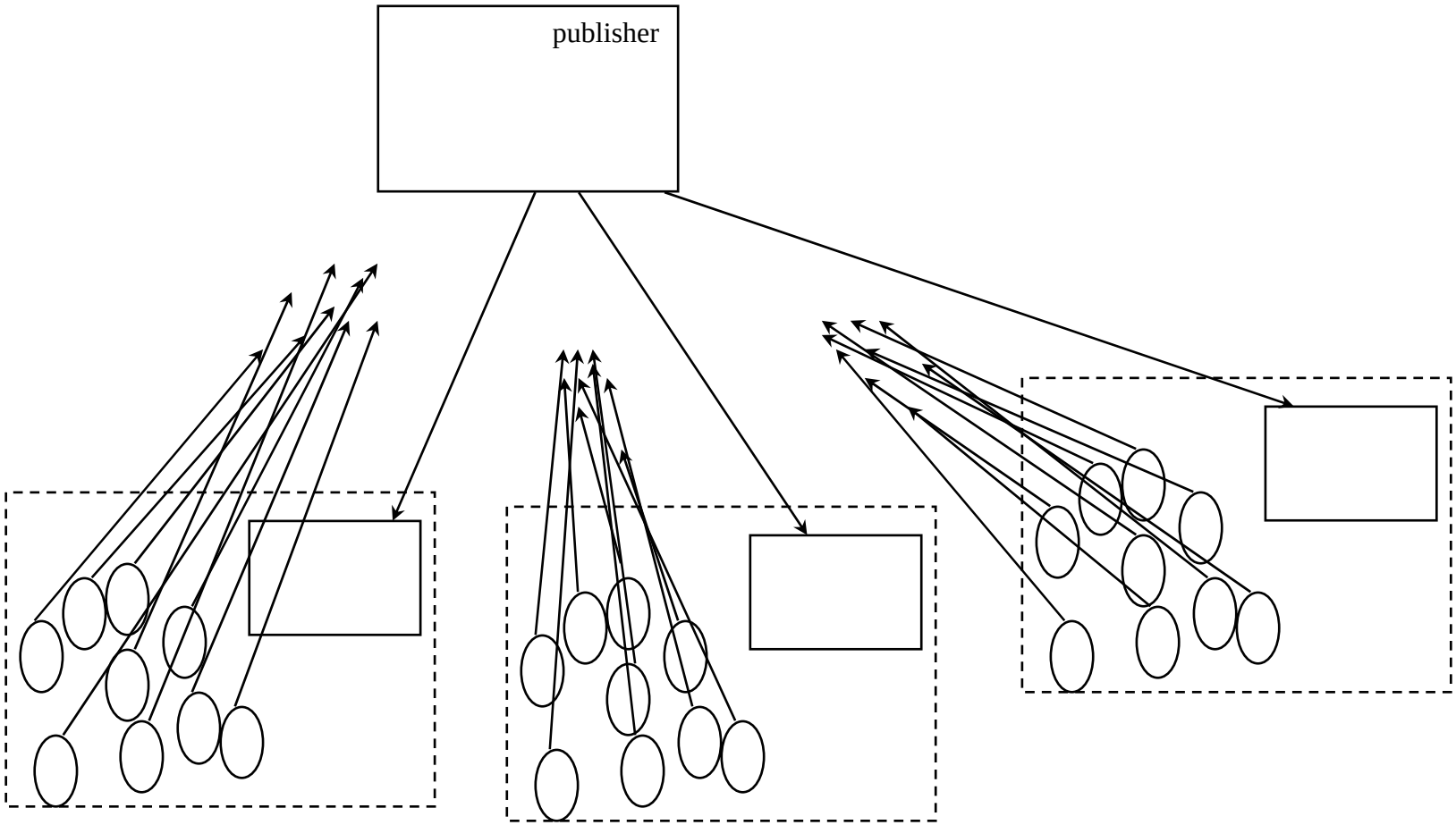
Transaction Protocol



Transaction Protocol Scales



Transaction Protocol Scales



Open Issues

- **Persistence of User Identity**
  - LDAP protocol always returns the distinguished name field
  - Methods for dissociating distinguished name from the user
  - Certificate Portability - mobile users, public workstation issues
- **Anonymous or “Attribute” Certificates**
  - different certificate distribution possibilities
  - not yet a stable standard
- **Hierarchical Certificate Authorities**
  - Certificate Authority chains of length > 1

Implementation Issues

- Attribute maintenance for each license
  - Individuals with multiple roles
- Directory service architecture and maintenance
  - **Centralized vs. distributed directories (meta-directory with pointers)**
- Attribute service unavailable - failover to a minimum level of service (contract specific)

Next Steps

- The architecture will need to be extended to handle the case in which the institution is not also the CA, possibly by requiring that the institution be identified in the "Subject" field.
- Expand the testbed to include three more educational institutions and three more publishers.
- Determine the ability of this model to support the delivery of use statistics specified by the International Consortium of Library Consortia in, "Guidelines for Statistical Measures of Usage of Web-based Resources," November 1998, http://www.library.yale.edu/consortia/webstats.html.
- Incorporate Transport Layer Security (TLS), in addition to Secure Socket Layer (SSL), as that standard becomes finalized.