Semantically Enhanced Interactions for Peer Communities

Xi Bai

Centre for Intelligent Systems and their Application

School of Informatics, University of Edinburgh, UK

Outline

- **Peer Interaction Model (IM) in LCC**
- **Semantically Enhanced IM**
- **Peer-to-Peer Community Formation**
- **Distributed Storage of Peer Profiles**
- **Linking IM Elements to the LOD**
- **IM & Collaborator Discovery**
- **IM Consumption & Qualification Verification**
- **Case Study & Experiments**
- **OpenKnowledge Communicating Layer Redesign**
- **Future Work & Conclusions**

Service Choreography and LCC

- **Lightweight Coordination Calculus (LCC) is a lightweight and compact but expressive choreography description language.**

- **Semantic service orchestration description languages:**
  - **OWL-S, WSDL-S, SAWSDL, etc.**
  - **Matchmakers: OWLS-MX, SAWSDL-MX, etc.**

- **Service choreography description languages:**
  - **WS-CDL, WSMO.**

- **LCC can be replaced with any choreography description languages.**

Peer Interaction Model (IM) in LCC

```
r(client, initial, 1, 1)
r(shop, necessary, 1)


a(client(PC, CC), C)::
buy(PC, CC) =>a (shop, S) ← payby(CC) & lookup(S) then
receipt(R) <= a(shop, S)


a(shop, S)::
buy(PC, CC) <= a(client(_),C) then
receipt(R) => a(client(_), C) ← enough_credit(CC, PC) &
                                complete_order(PC, CC, R)
```

- **LCC is not a typed language and variables can mean anything in this IM.**

Semantically Enhanced IM

```
<html
xmlns=''http://www.w3.org/1999/xhtml''
xmlns:openk=''http://homepages.inf.ed.ac.uk/s0896253/openk.owl#''
xmlns:dbpedia=''http://dbpedia.org/resource/''
>
...
<div typeof=''openk:InteractionModel''>
 <span property=''openk:has_declaration''>r(client, initial, 1, 1)
 </span><br/>
 <span property=''openk:has_declaration''>r(shop, necessary, 1)</span>
 <div rel=''openk:has_role''>
  <div typeof=''openk:Role'' property=''openk:has_roletype''
  content=''initial''>a(<span property= ''openk:has_name''>client
  </span>(<span rel=''openk:has_arg'' typeof=''openk:Argument
  dbpedia:Universal_Product_Code''>
  <span property=''openk:has_name''>PC</span></span>), C)::<br/>
  <span rel=''openk:sendout''>
   <span typeof=''openk:Message''>
    <span property= ''openk:has_name''>buy</span>(
    <span rel=''openk:has_arg''>
     <span typeof=''openk:Argument dbpedia:Universal_Product_Code''>
      <span property=''openk:has_name''>PC</span></span>,
     <span typeof=''openk:Argument dbpedia:Credit_card''>
      <span property=''openk:has_name''>CC</span></span>)
...
```

Peer-to-Peer Community Formation

- **OKBook is an on-line community which allows peers to publish, discover and subscribe/unsubscribe to IMs.**
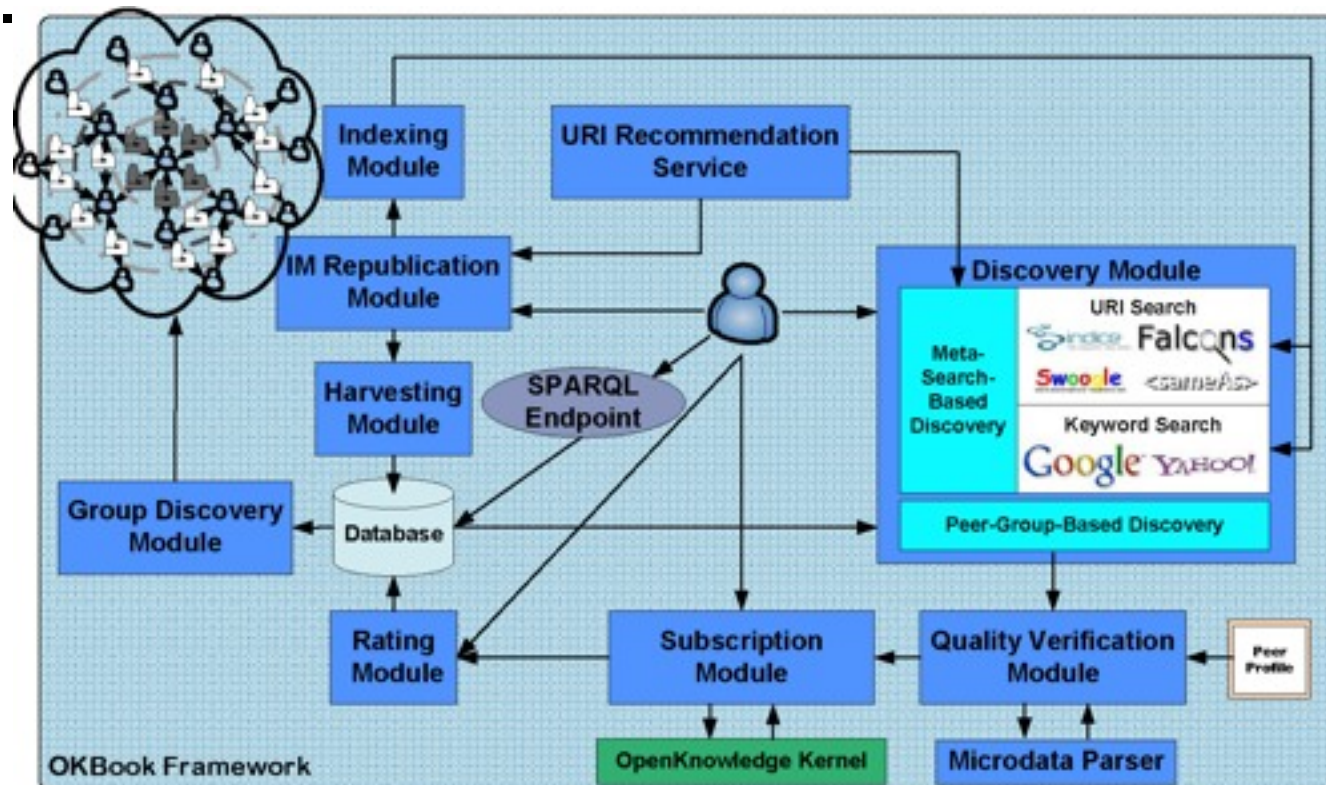
Distributed Storage of Peer Profiles

- **In RDF or RDFa format.**

- **Only the peer itself has the right to revise its profile.**

- **A peer can have accounts on different OKBook servers, each of which holds a copy of its profile.**

- **Profile content:**
  - Peer capabilities (OpenKnowledge Components (OKCs)).
  - Peer accounts.
  - Historical interactions.
  - IM authorization.
  - Followers/followees.

- **OKBook supports the OpenID standard.**

Linking IM Elements to the LOD

- IMs are annotated by publishers using URIs.

- URIs can be discovered based on DBpedia Lookup service APIs.

- URIs can be discovered based on search engines or on-line services.

- A URI is minted for each IM which can be linked to other resources.

- Triples embedded in IMs are harvested using the ARC2 RDF system and exposed to other potential developers via a SPARQL endpoint.
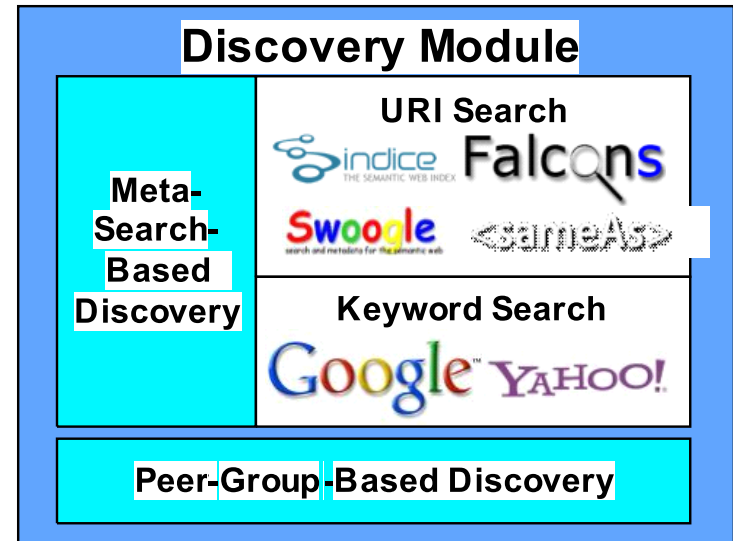
Peer Profile Management
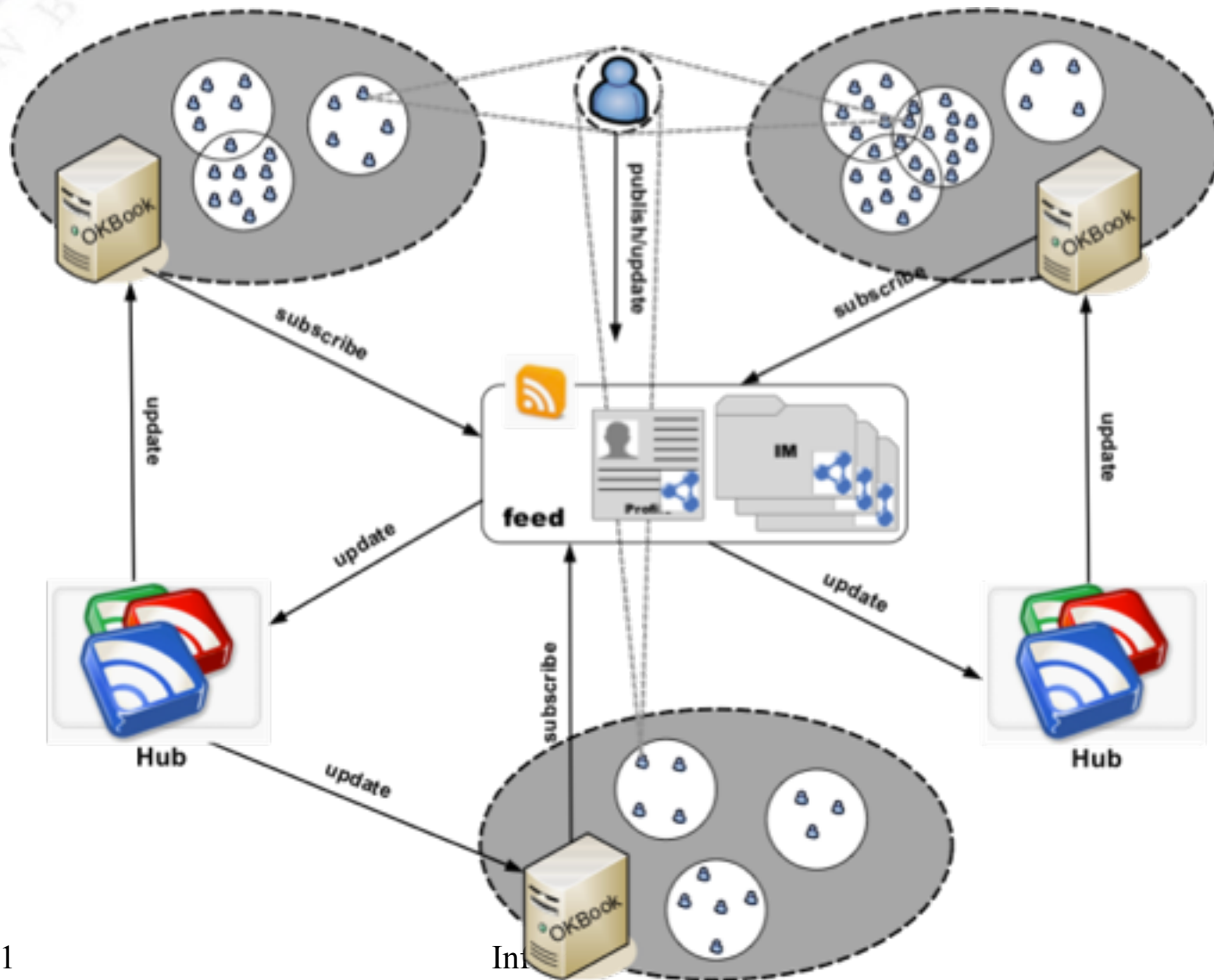
IM & Collaborator Discovery

- **Meta-Search-Based Discovery**
  - **Semantic Web search engines**
    E.g., Sindice, Falcons, Swoogle
  - **General search engines**
    E.g., Google, Yahoo!Search
  - **Co-reference search engine**
    E.g., sameAs
  - **Query phrase recommendation**
  - **Aggregated ranking:**

$$rank(U, Q) = \frac{\sum_{i=0}^{N} \chi_i \times rank_{S_i}(U, Q)}{N}$$

Suggestions on Query phrases

- **DBpedia Lookup service.**
  - **Pros.**
    - » **Ontology mapping work can be alleviated to some extend.**
    - » **Each URI has a human-readable comments from Wikipedia.**
    - » **URIs are curated and updated friendly.**
  - **Cons.**
    - » **IM publishers have to use URIs curated by DBpedia (Centralized)**
    - » **Concepts on Wikipedia are very general and not domain specific.**

- **More lookup services may be integrated (e.g., OpenLink lookup service).**
  - **Challenges.**
    - » **This needs URI mapping.**

IM & Collaborator Discovery

- **Group-Based Discovery**
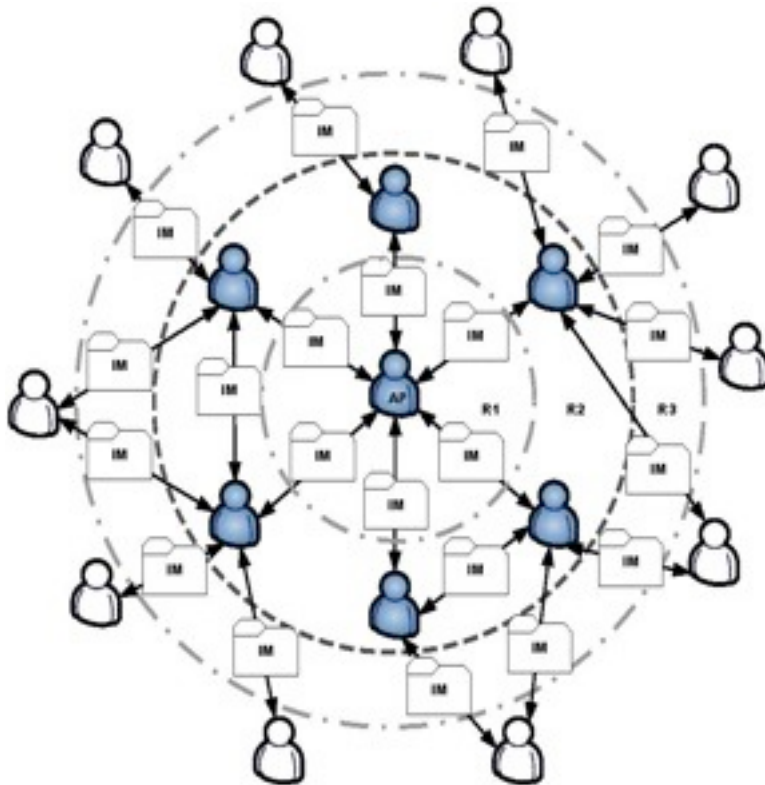
Input: the URI of current authorized peer, $apeer\_uri$ and the historical interaction record, $record$.
Output: URIs of group members, $fpeer\_uris$ and URIs of IMs these members were involved in, im_uris.

```
begin
    IM_URIs = getInvolvingIMs (apeer_uri, record);
    for each im_uri ∈ IM_URIs do
        partner_peer_uris = getInvolvedPeerURIs(im_exec);
        for each peer_uri ∈ partner_peer_uris do
            if apeer_uri equals peer_uri then
            |   continue;
            end
            else
                fpeers = fpeers ∪ {peer_uri};
                IM_URIs' = getInvolvingIMs(peer_uri, record);
                for each im_uri' ∈ IM_URIs' do
                    if im_uri' ∈ im_uris then
                    |   continue;
                    end
                    else
                    |   im_uris = im_uris ∪ {im_uri'};
                    end
                end
            end
        end
    end
end
```

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Extended Open Graph Protocol (EOGP)

- **On Facebook, Flicker and eBay etc., people are not only connected by links but also connected by things. On OKBook, peers are also connected by interactions in the form of IMs.**
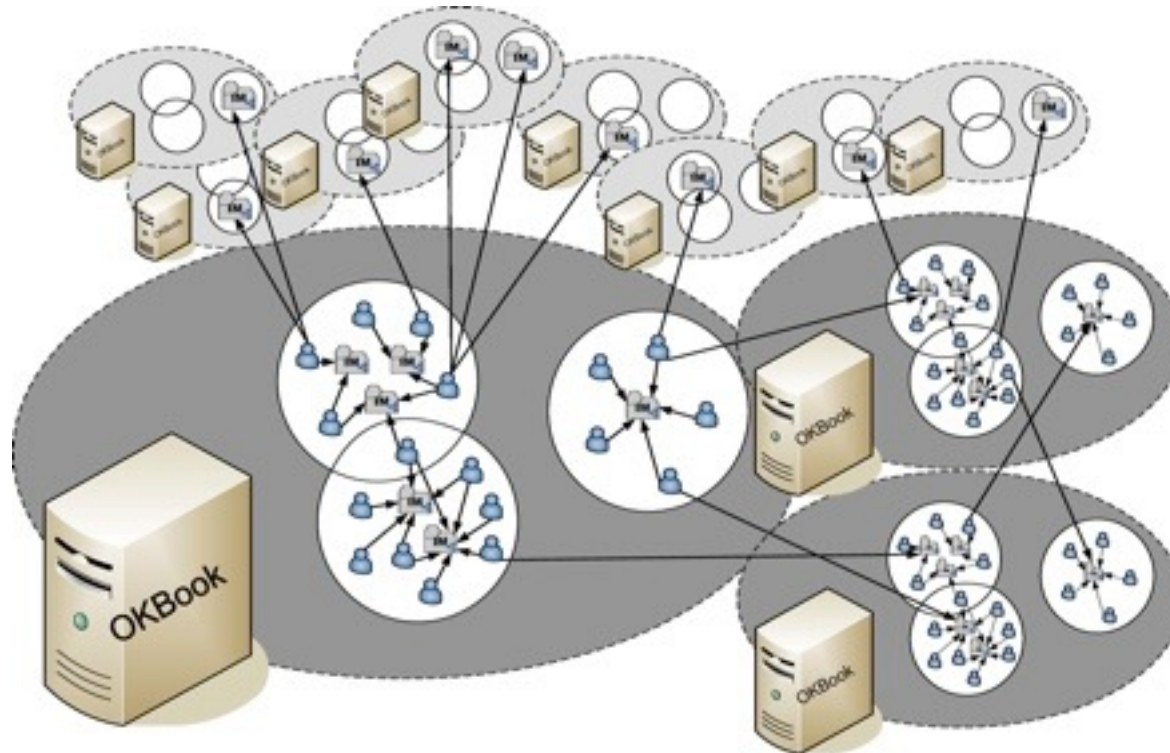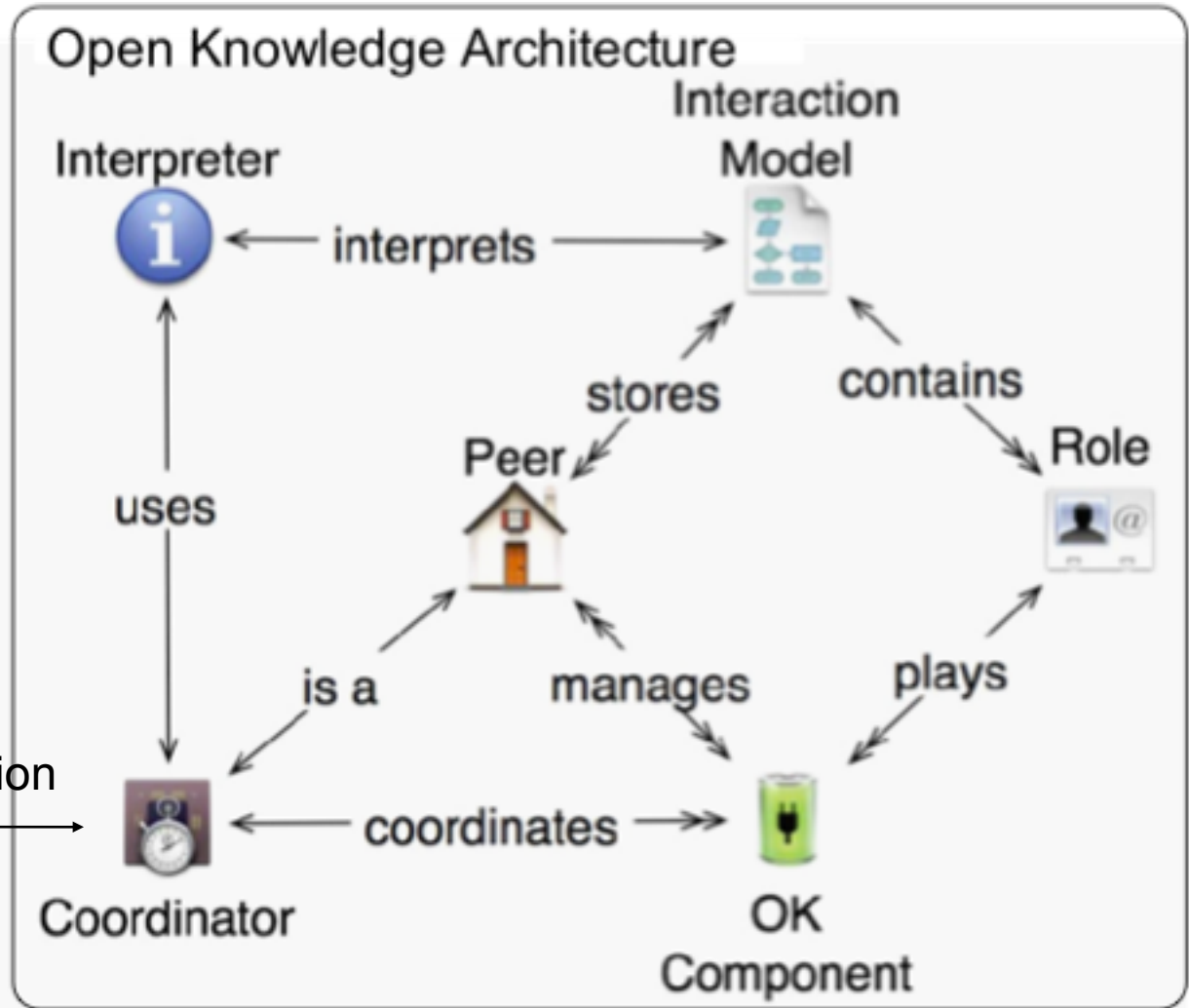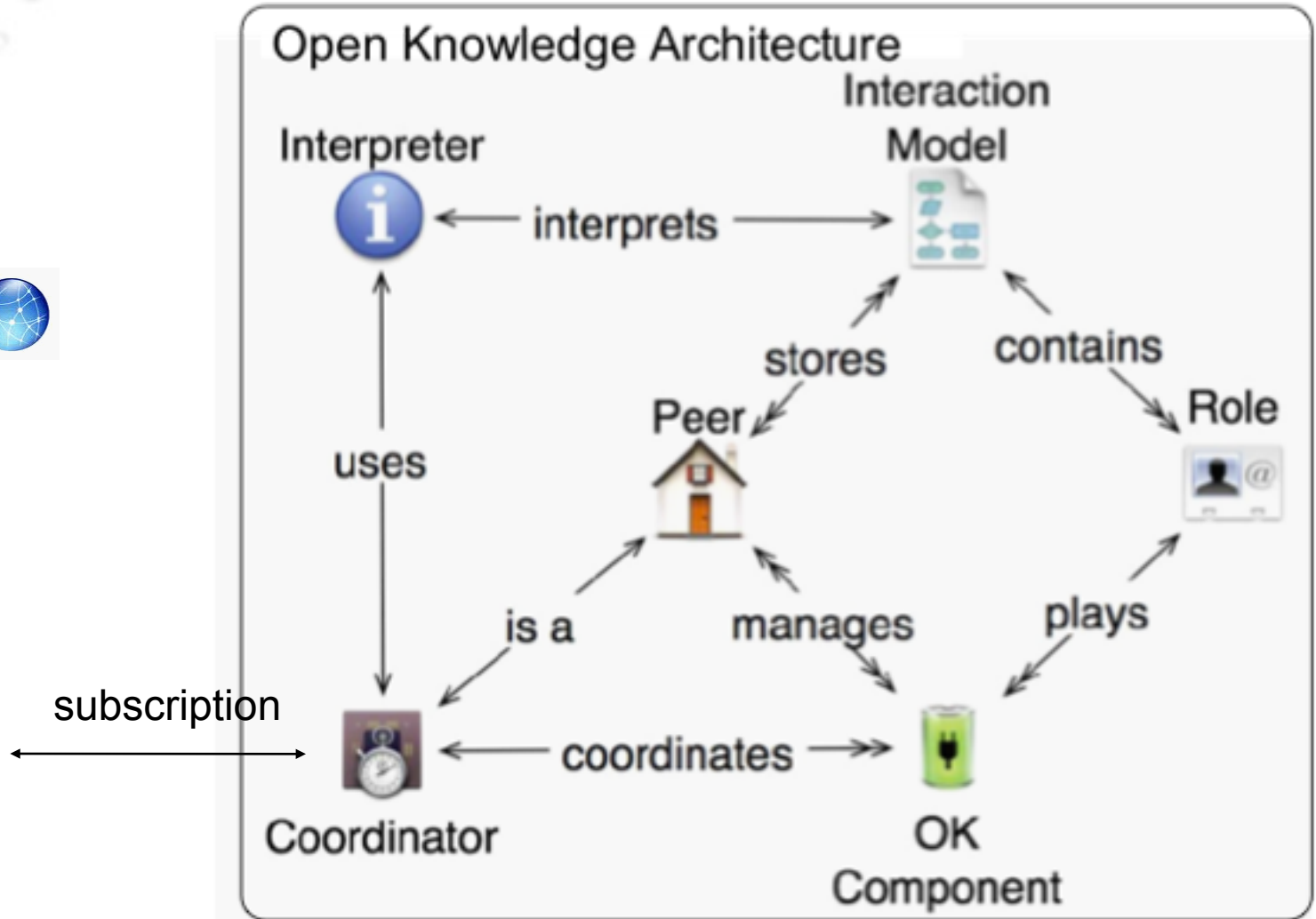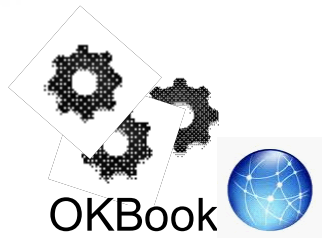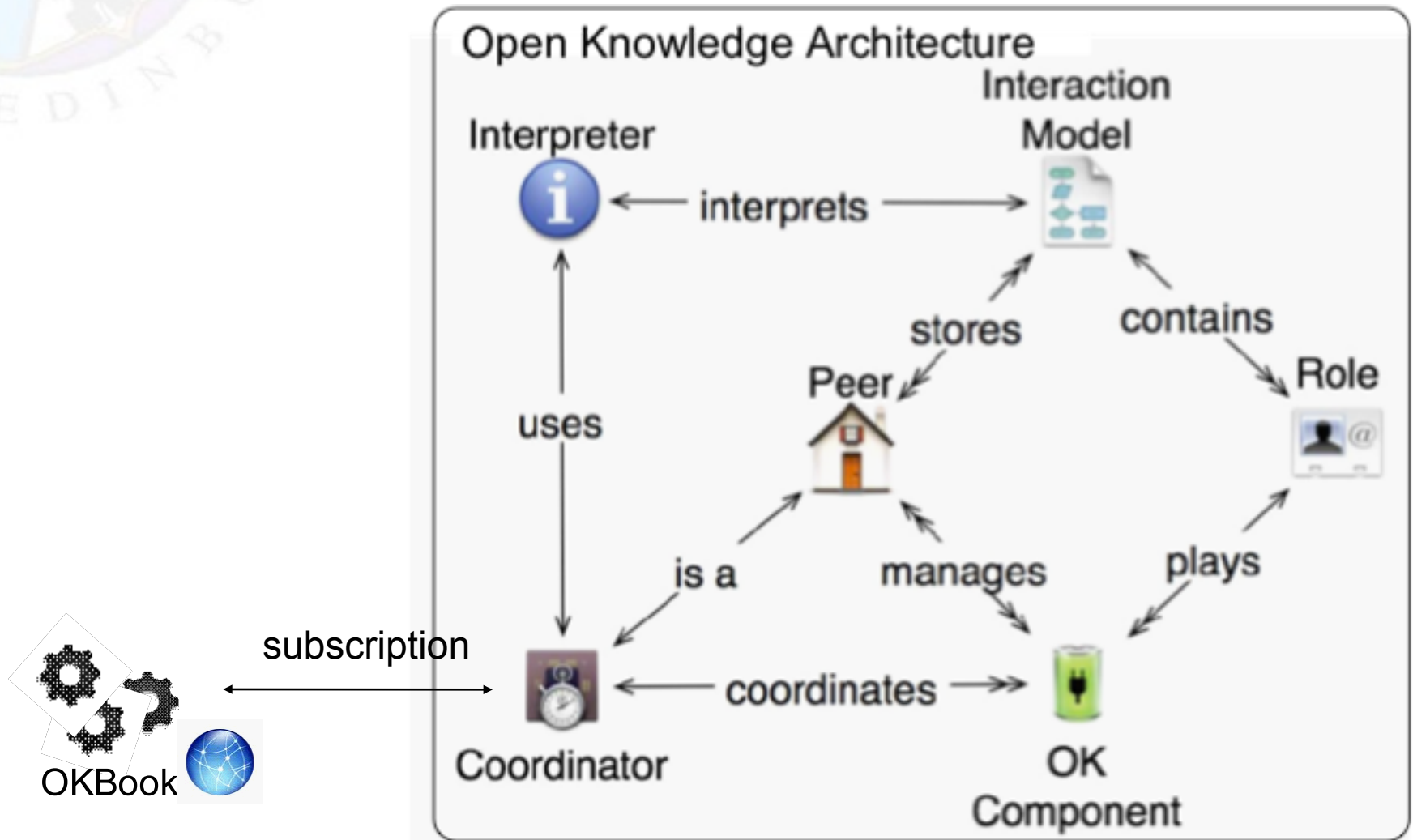
Submission & Feedback

OKBook

DDS

Open Knowledge Architecture

Interpreter ← interprets → Interaction Model

uses

stores

contains

Peer

Role

is a

manages

plays

Coordinator ← coordinates → OK Component

Submission & Feedback

Open Knowledge Architecture

Submission & Feedback

Open Knowledge Architecture
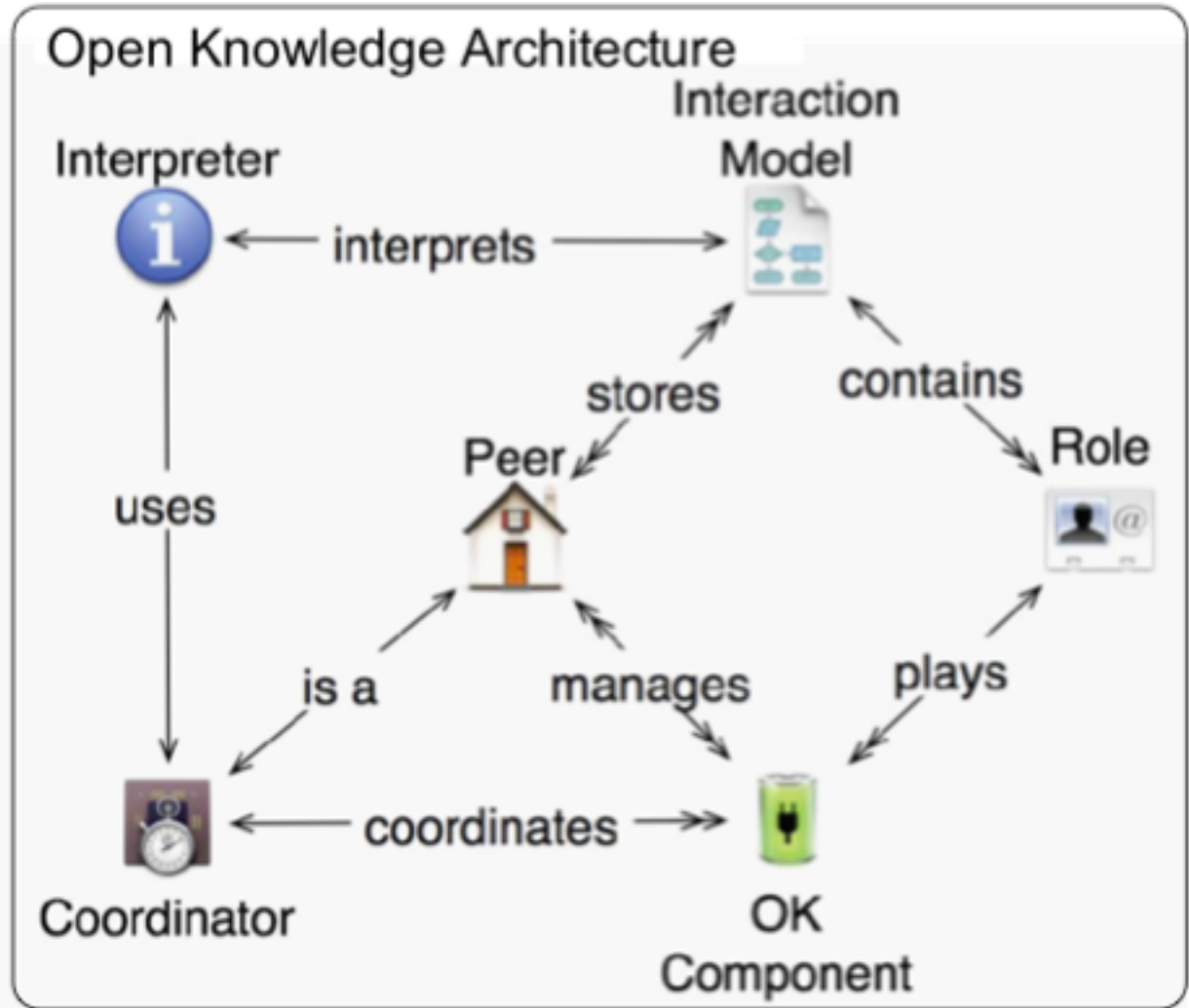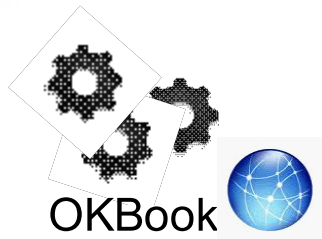
OKBook

Submission & Feedback

Group-Driven Interaction
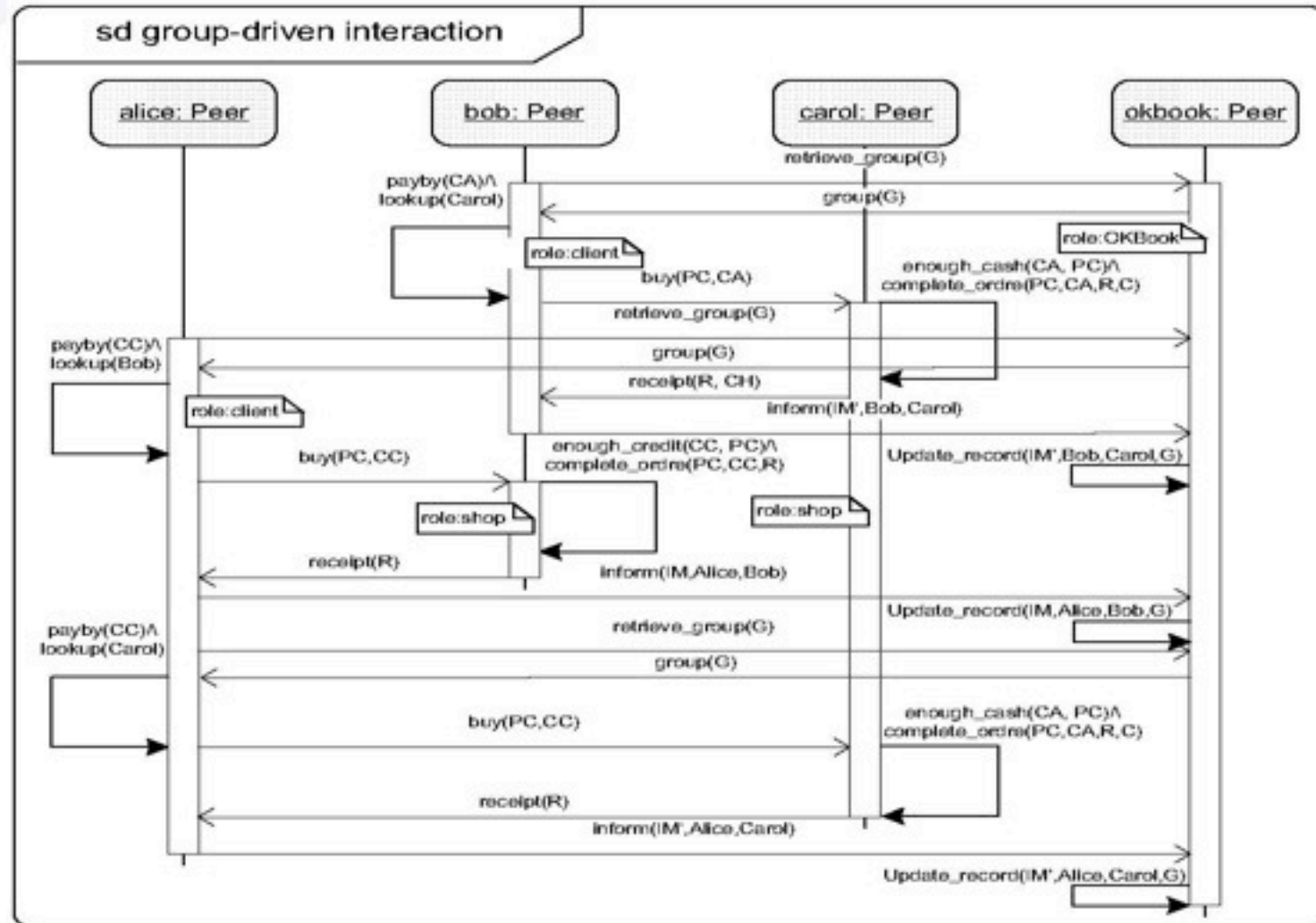
Experiment 1

- **100,000 peers and 10 IMs.**

- **Each IM has two roles.**

- **80,000 interactions in total.**

- **Winning Proportion (WP):**
  - The percentage of peers which found desired IMs from their group members.

- **1,000 runs**

- **WP = 38.99% (two roles)**

- **More than one third of peers do not have to use the OKBook meta search engine.**

Experiment 2

- **Three elements may influence the WP:**
  - **The number of peers**
  - **The number of IMs**
  - **The number of interactions.**

- **Fix two elements and just change another one each time.**

  - **WP change with peers**
  - **WP change with IMs**
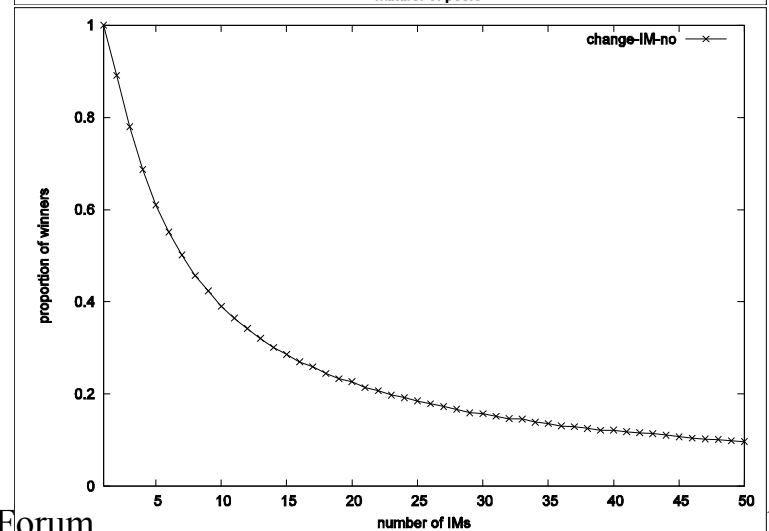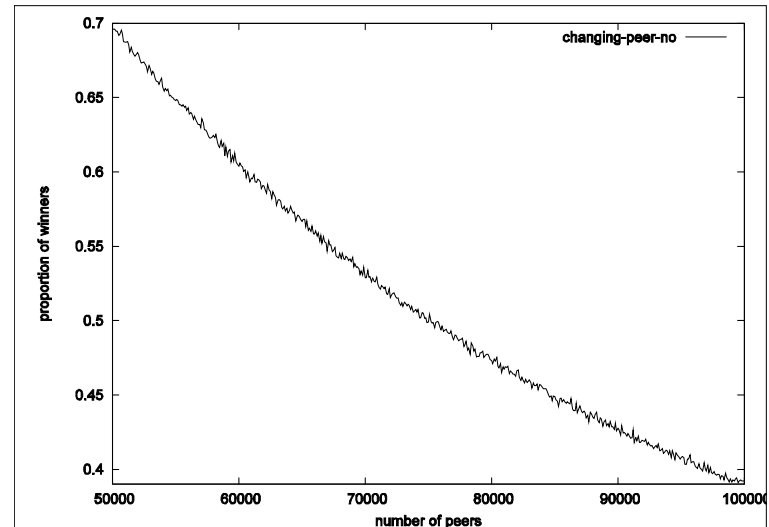
Experiment 2

- **Three elements may influence the WP:**
  - The number of peers
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  - The number of interactions.
- **Fix two elements and just change another one each time.**

  - WP change with interactions
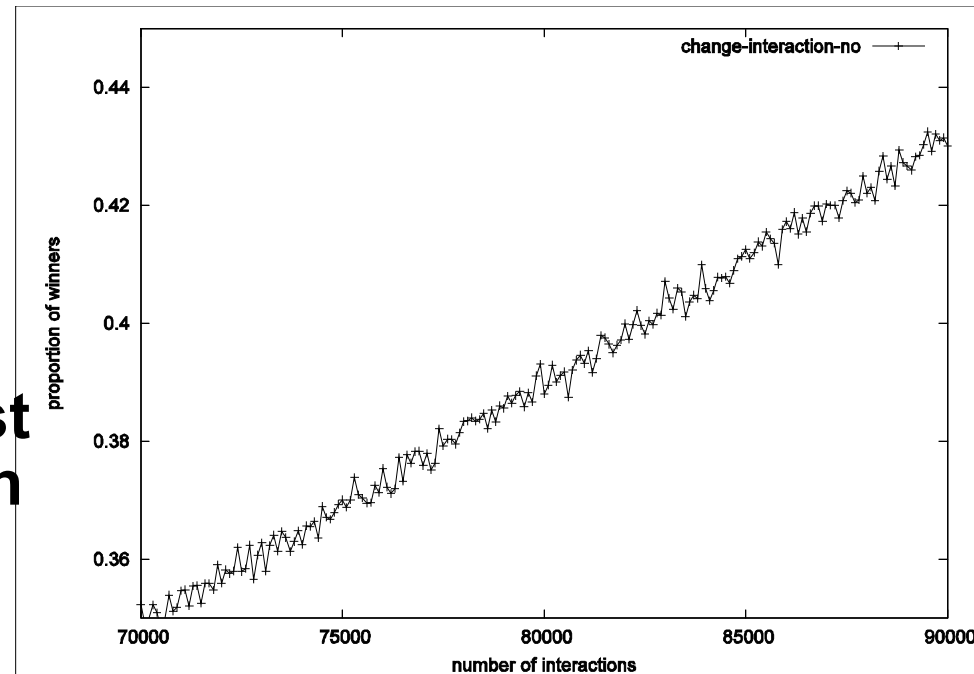
MORE INTERACTIONS!!!

Experiment 3

- **IMs with three or four roles**

- **100,000 peers, 10 IMs and 80,000 interactions**

- **200 runs**

  - **WP = 72% (three roles)**
  - **WP = 91.43% (four roles)**
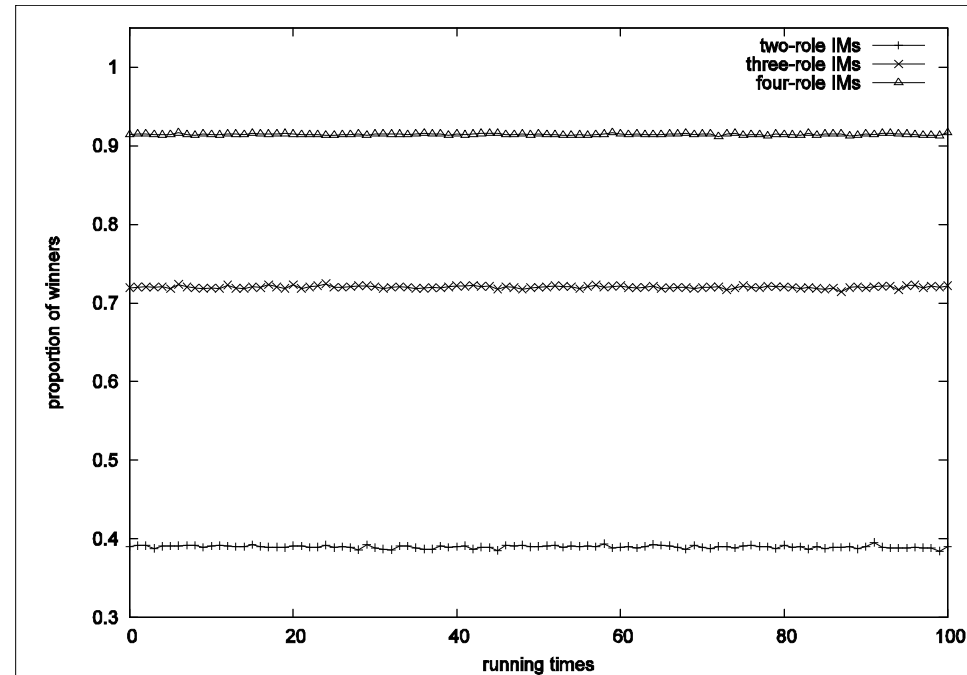
MORE COLLABORATORS!!!

IM Consumption


```
SELECT ?role ?community
FROM ⟨IM⟩
FROM NAMED ⟨IM_{triples}⟩
WHERE {
    GRAPH ⟨IM_{triples}⟩ {?P a openk:Peer. ?role a openk:
        Role. ?P openk:can_play ?role.}
    ?community a openk:P2PCommunity.
    ⟨im_uri⟩ openk:has_role ?role.
    ⟨im_uri⟩ openk:belongs_to ?community.
}
```

OpenKnowledge Communicating Layer Redesign

- **The OK system has been designed to handle peer interactions via coordinators.**

- **Central handling can mitigate the burden on other peers.**

- **Central handling does not make good use of computational resources provided by other peers.**

- **Central handling is not convincing because peers are usually autonomous and egocentric.**

- **A more direct interacting method needs to be found and current communicating layer needs redesign.**

Architecture of Communicating Layer
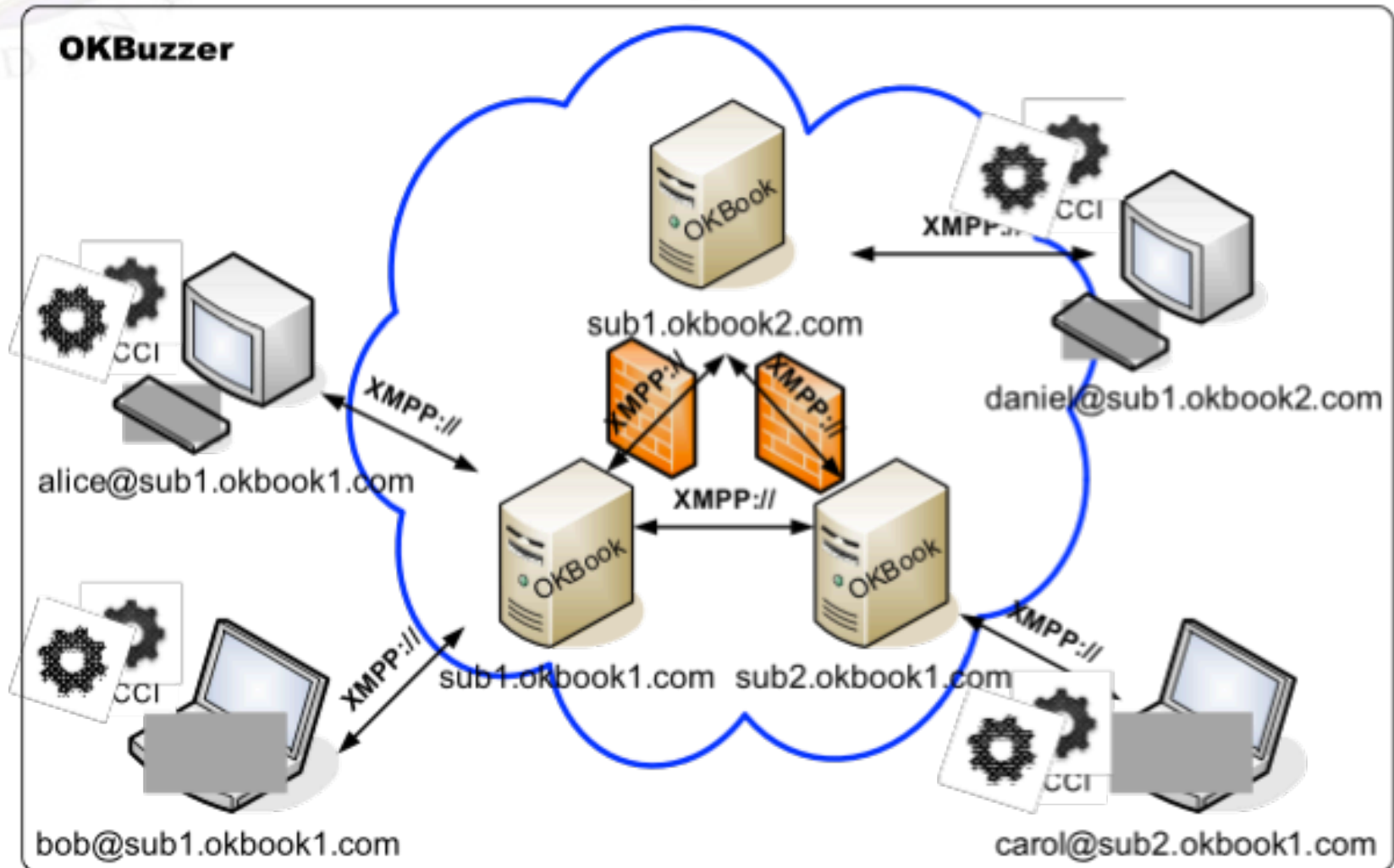
Messages in Peer Interaction

- **IM document**
  - **Header**
    - **InvolvedPeers**
      - **JID**   **string**
      - **Role**   **string**
      - **RoleType**   **string**
      - **OKCs**   **string[]**
  - **Body**
    - **Clauses (LCC)**

- **Message**

```
<message from="alice@okbook.inf.ed.ac.uk" to="bob@okbook.inf.ed.ac.uk" type="chat" id="_12345">
    <body>
        {"name" : "msg", value : "undefined", params : [{"name" : "X", value : "100", params : []}, …]}
    </body>
</message>
```

Future Work

- **Cache the group discovery result.**

- **Peer ranking.**

- **Make further use of the directed peer relationships.**
  - This may benefit the IM discovery.
  - This may evolve the peer community.

- **Integrate and aggregate URI lookup services.**

- **Participants and benchmarks are needed to comprehensively experiment with the system.**

Conclusions

- **OKBook provides peers with a platform for sharing choreographies.**

- **IM publication complies with the Linked Data principles.**

- **IM discovery is relatively flexible either via our meta-search engine or via detected peer groups.**

- **In the near future, we will not search for services but services will find us in one way or another.**

- **OKBook is a prototype trying to achieve this goal via the distributed knowledge sharing environment.**

Thank you!

Questions?