# Computer Supported Collaborative Knowledge building : P2P Semantic Wikis Approach


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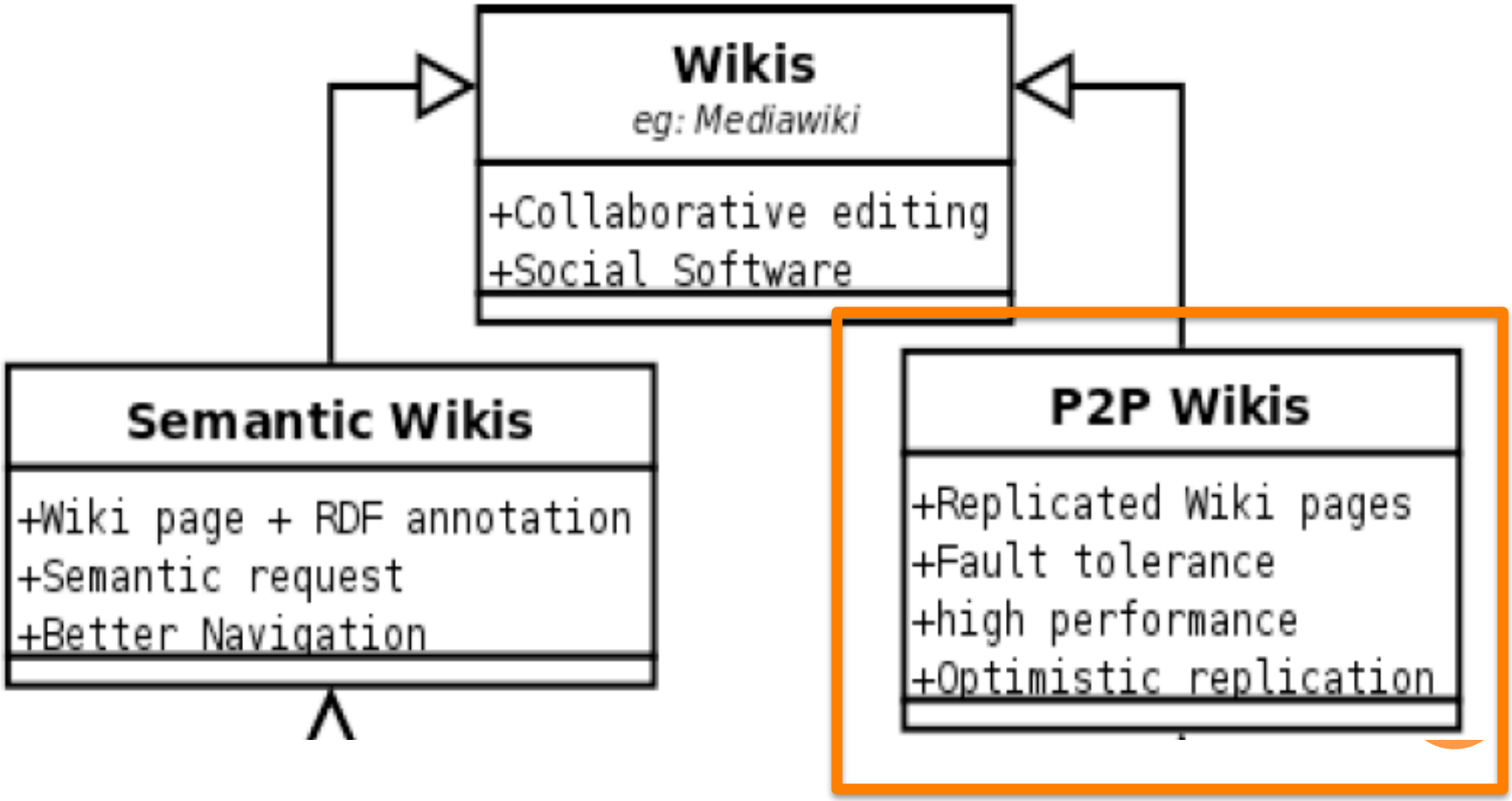
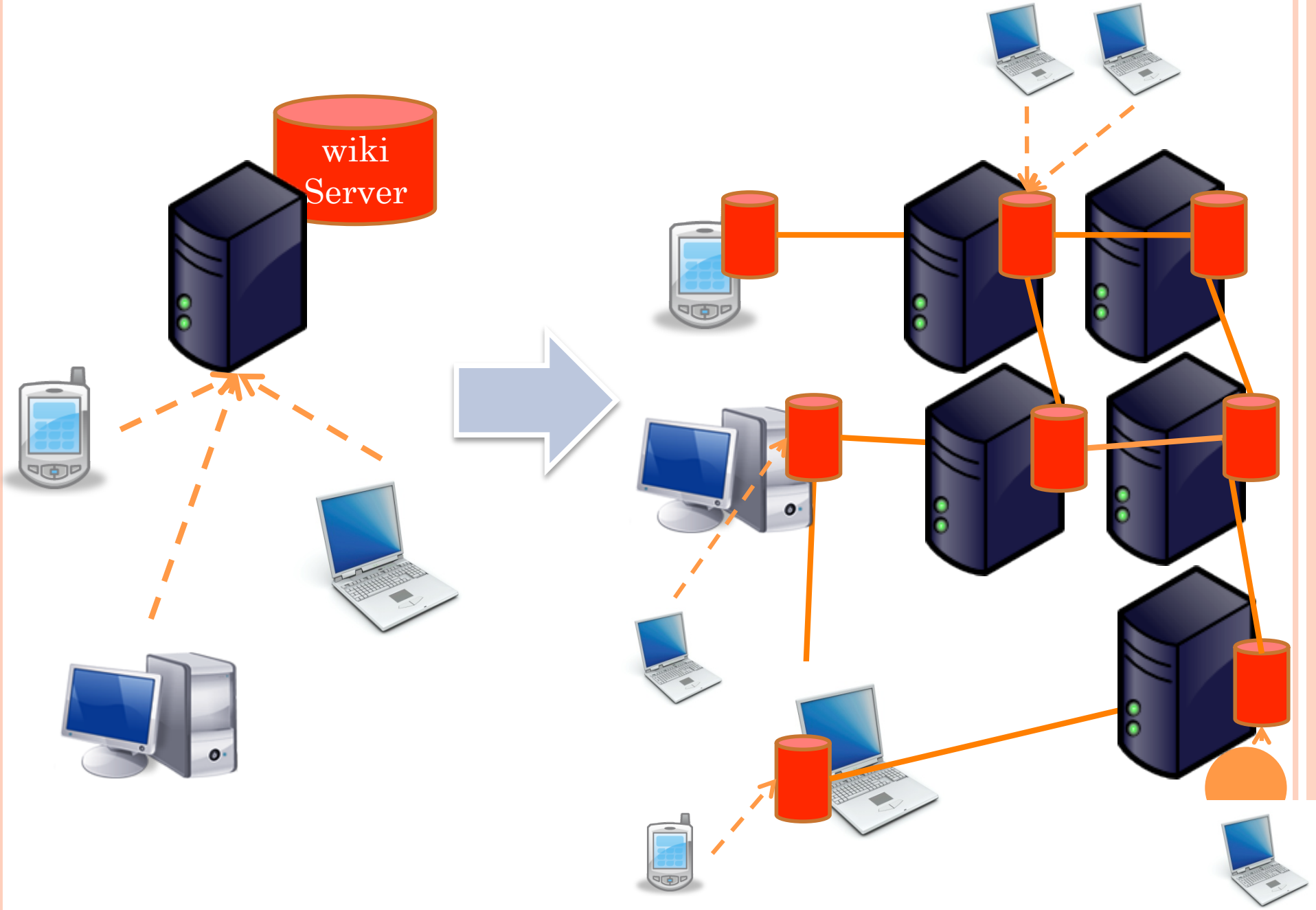
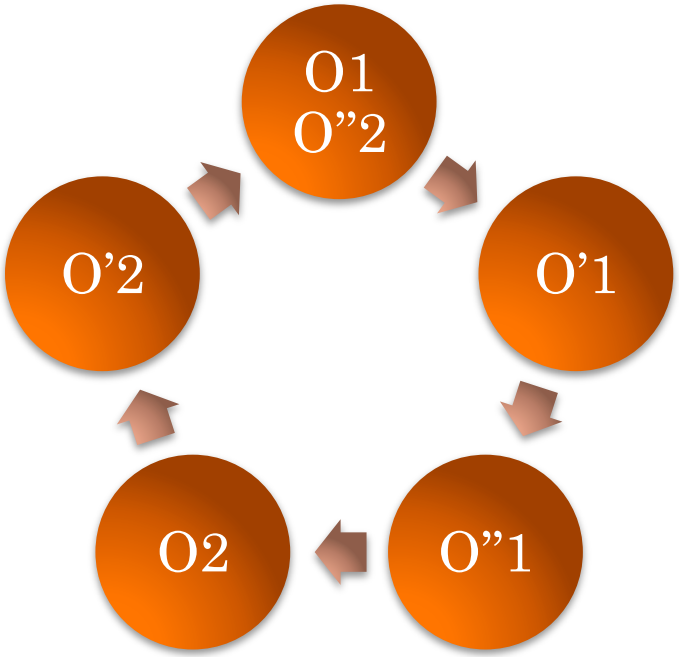
# Wikis Evolutions



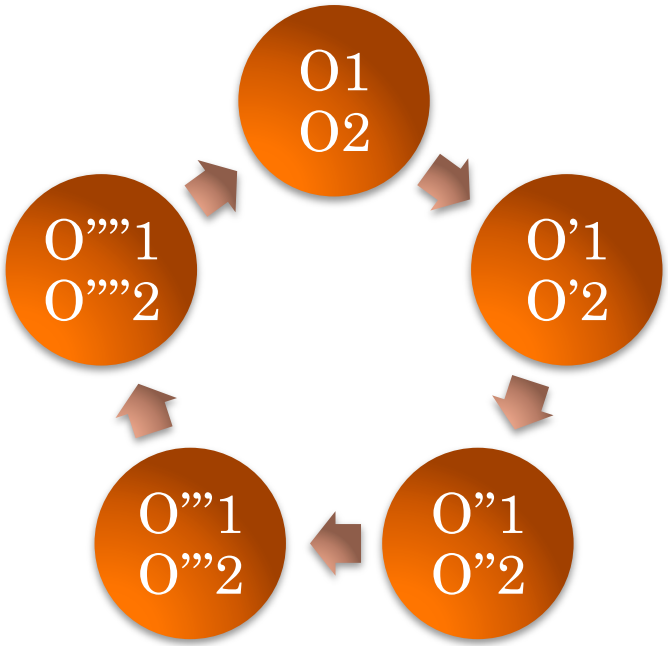

wiki
Server

# Peer to peer Wikis

- Every peer  acts as a client and a server
- Wikis pages are replicated on the peers
  - Partially or totally




O1 has 3 replicas,
O2 has 3 replicas




Number of replicas =  number of peers

# P2P Wikiks

- Advantages
  - Better performance and availability
  - Fault-tolerance
  - Load-balancing
- In all cases (partial or total) rely on **optimistic replication approach**

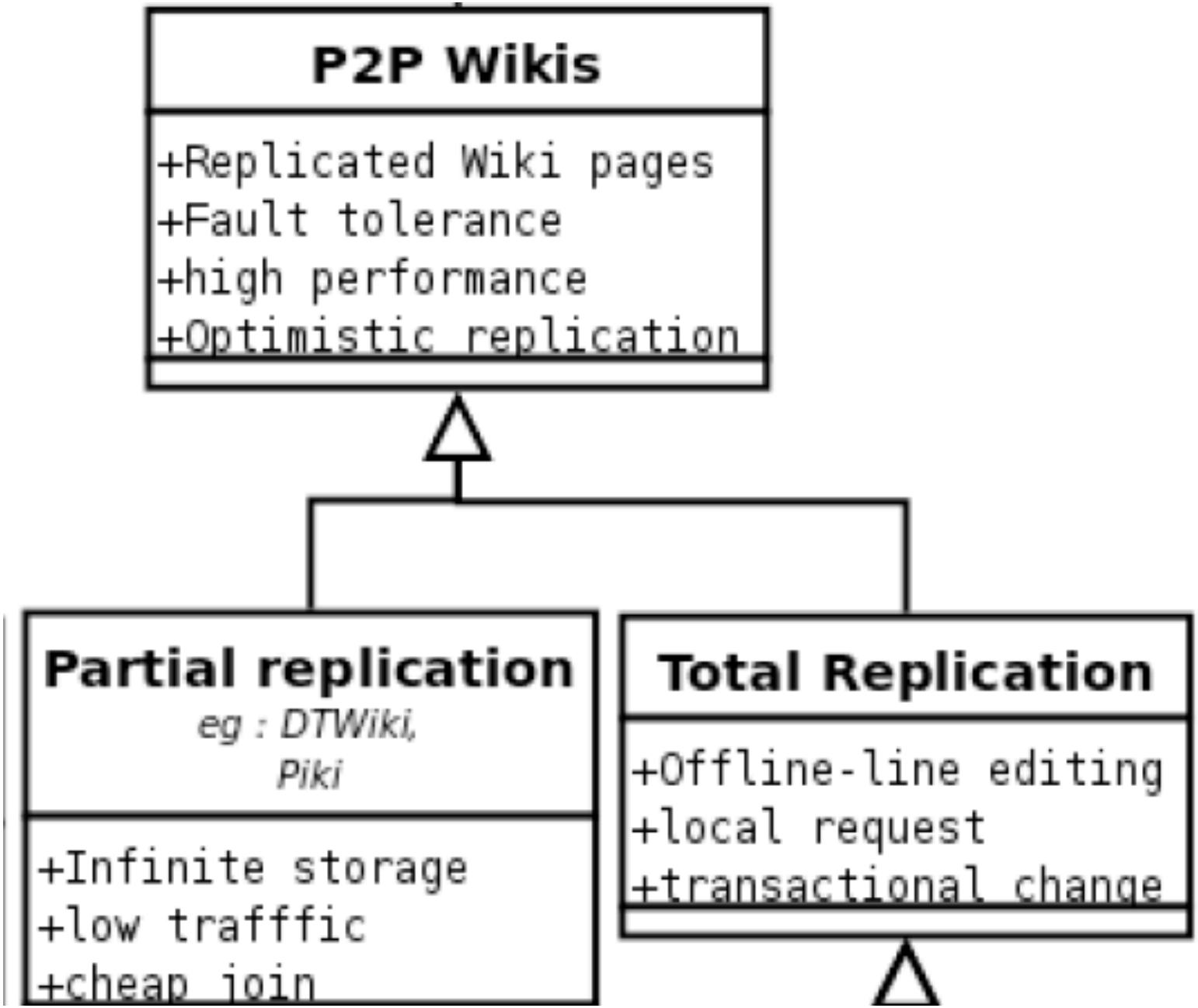
# General model of optimistic replication Approach

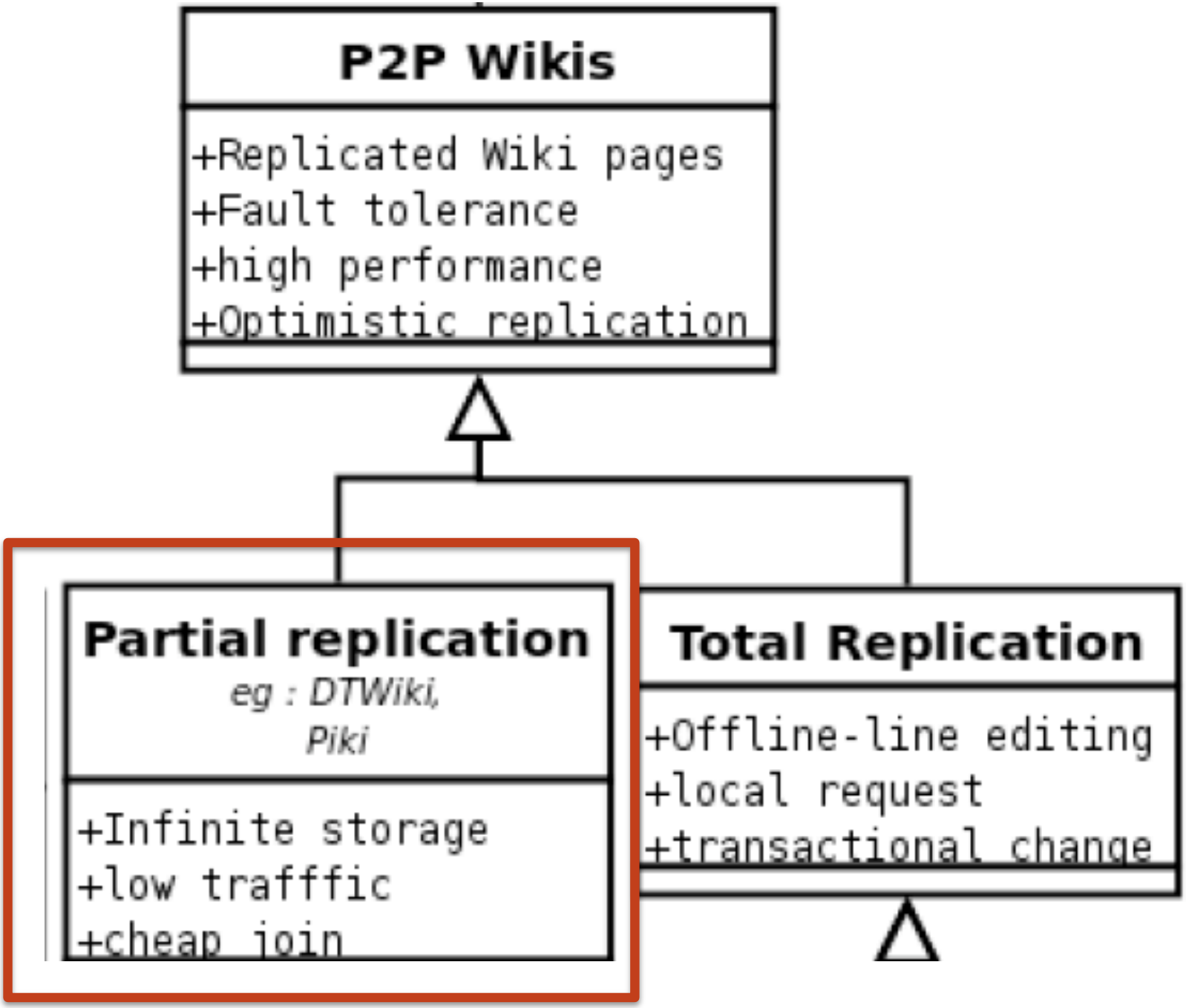
- An operation is generated on  one site and executed immediately
  - without any locking, any communication with another site
- Operation is broadcasted to other sites
  - Hypothesis: the operation will eventually arrive on all sites (not so easy…)
- When a site receives a remote operation
  - The operation is re-executed
- The system is correct if it ensures a consistency criteria such as Causal Consistency, Eventual Consistency, CCI consistency etc…

# Consistency Levels

- **Causal Consistency** : dependent operations are executed in the same order in all servers
- **Eventual consistency**: all copies are identical when the system is idle
- **CCI consistency:** Causal consistency + Eventual consistency + Intention preservation
  - **Intention preservation:** The effect observed at generation time is observed on all sites whatever any concurrent operation.

Sun and et al. Achieving Convergence, Causality Preservation, and Intention Preservation in Real-Time Cooperative Editing Systems, *ACM Transactions on Computer-Human Interaction*, 5(1), 1998.


P2P Wikis
+Replicated Wiki pages
+Fault tolerance
+high performance
+Optimistic replication
Partial replication
eg : DTWiki,
Piki
+Infinite storage
+low trafffic
+cheap join
Total Replication
+Offline-line editing
+local request
+transactional change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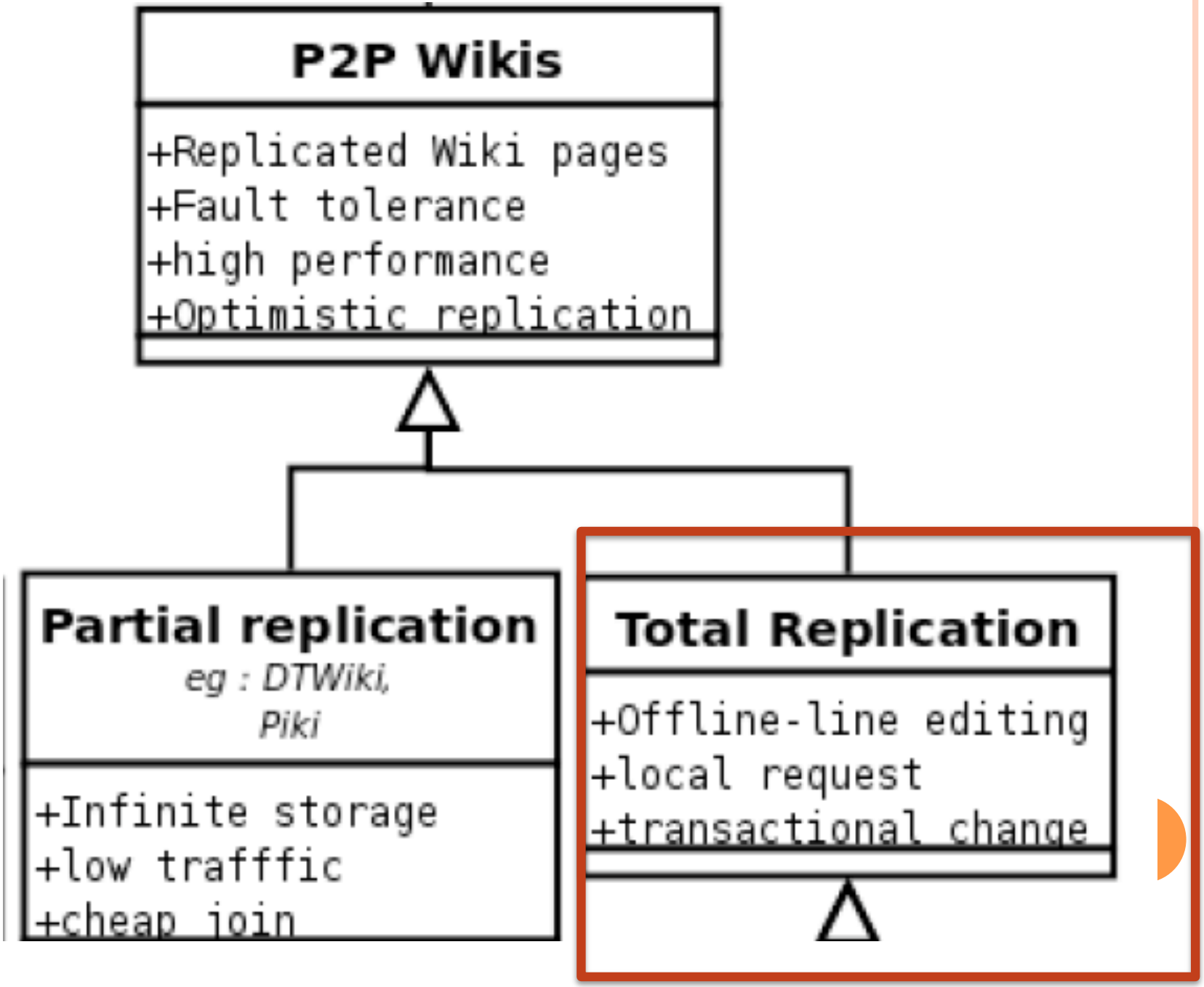
# Partialy replicated P2P Wikis

- Based on Structured P2P network
  - Distributed Hash Table (DHT) networks
  - Efficient resource discovery
- Wiki pages are replicated on a number of *replicas peers*
- A limit number of replicas of every page.
- Examples:
  - DistiWiki, DTWiki, Piki

Morris. DistriWiki: a distributed peer-to-peer wiki network, international symposium on Wikis (WikiSym), 2007.
Du et al. DTWiki: a disconnection and intermittency tolerant wiki, 17th international conference on World Wide Web (WWW), 2008.
Mukherjee et al. Piki - A Peer-to-Peer based Wiki Engine. Eighth International Conference on Peer-to-Peer Computing (P2P08), 2008.

# Partialy Replicated P2P Wikis

- Advantages:
  - Infinite storage capacity
  - Low traffic : operation on a page is just propagated to few peer, not at all peers…
  - Joining the P2P network is cheap : may require to transfer few pages on join
- Drawbacks:
  - Do not ensure the CCI correction model (DistriWiki,Piki, DTWiki)
    - User-based merge and manual resolution of conflicts
  - Cannot process a request locally
  - Do not support offline work
  - Do not enable transactional changes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+transactional change

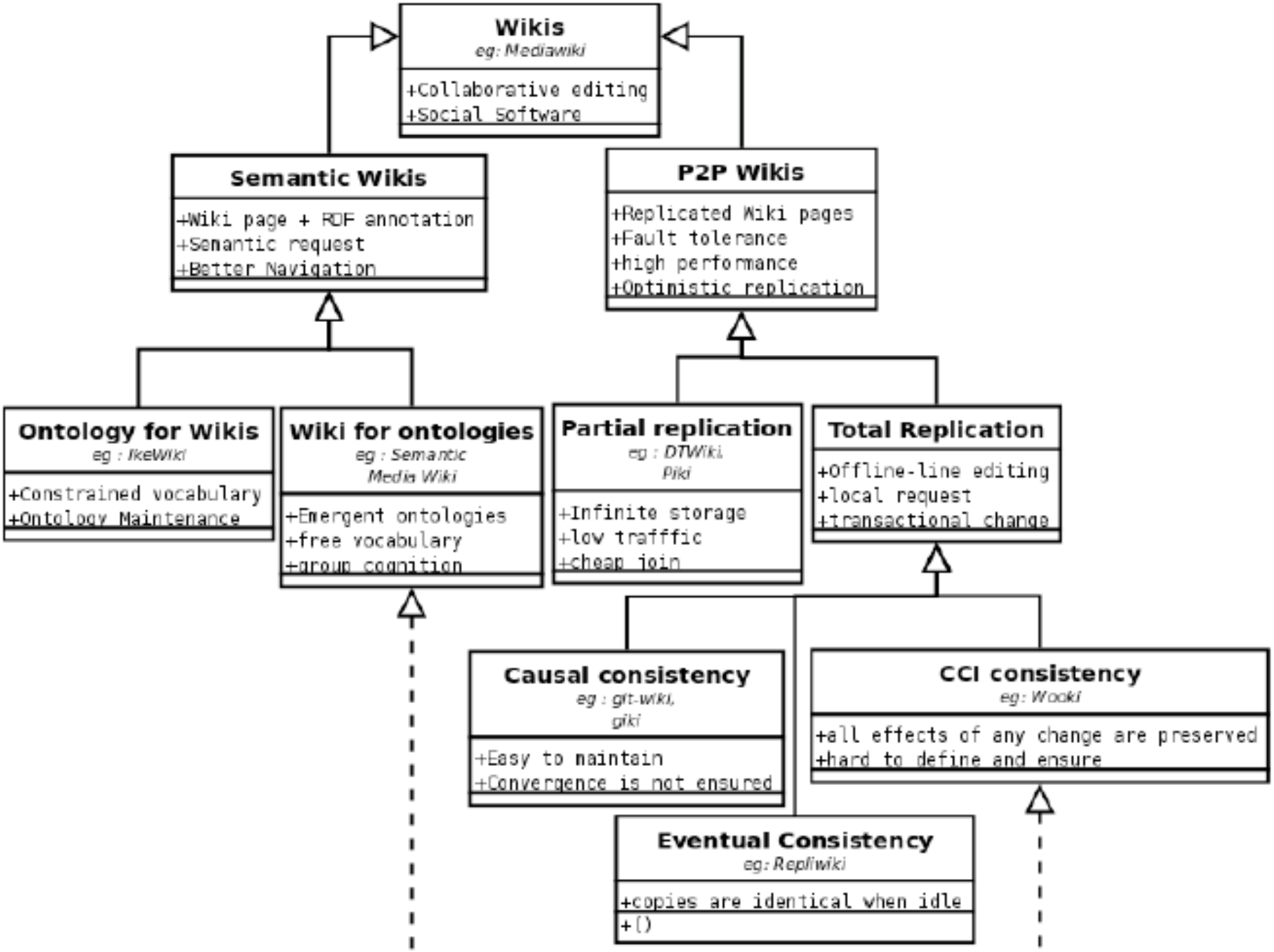
# Totally Replicated P2P wikis

- Each wiki server hosts a copy of the set of wiki pages.
- Number of replicas is equal to the number of the servers
- Examples:
  - Git-wiki (http://atonie.org/2008/02/git-wiki)
    - Causal Consistency
  - RepliWiki:
    - Eventual Consistency
  - Wooki:
    - CCI Consistency (Woot Algorithm)

Weiss et al. Wooki: a P2P Wiki-based Collaborative Writing Tool, Web Information Systems Engineering (WISE), 2007

# Totally Replicated P2P Wikis

- Advantages:
  - Scalability with user number
  - WOOKI ensures CCI consistency
  - Local queries
  - Support offline work
  - Enable transactional changes
- Drawbacks:
  - Joining the P2P network is expensive : state transfer
  - High traffic : operation on a page is propagated all peers…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+Collaborative editing
+Social Software
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+Wiki page + RDF annotation
+Semantic request
+Better Navigation
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eg : IkeWiki
+Constrained vocabulary
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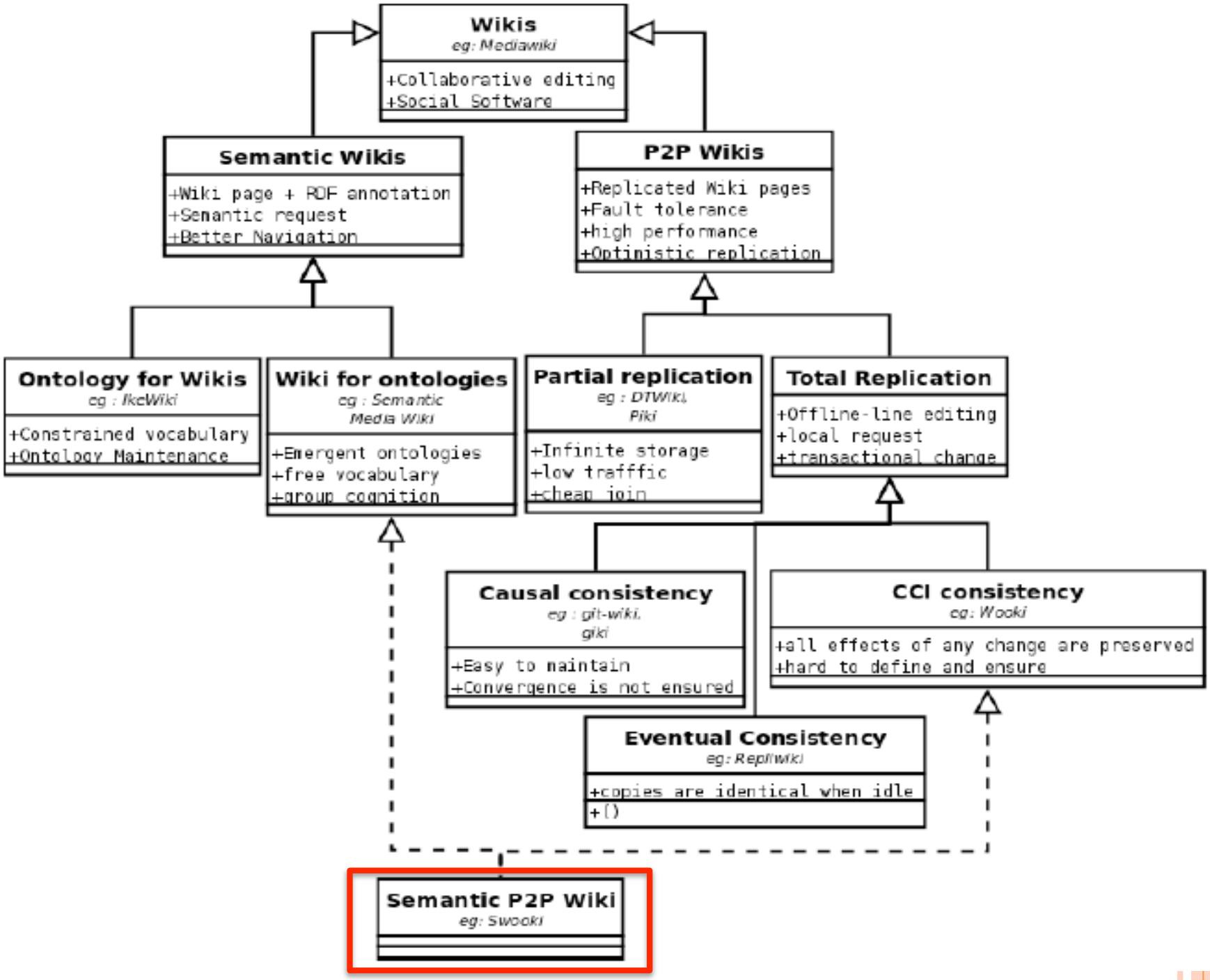
+Easy to maintain
+Convergence is not ensured
CCI consistency
eg: Wooki
+all effects of any change are preserved
+hard to define and ensure
Eventual Consistency
eg: Repliwiki
+copies are identical when idle
+()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Ontology for Wikis
eg : IkeWiki
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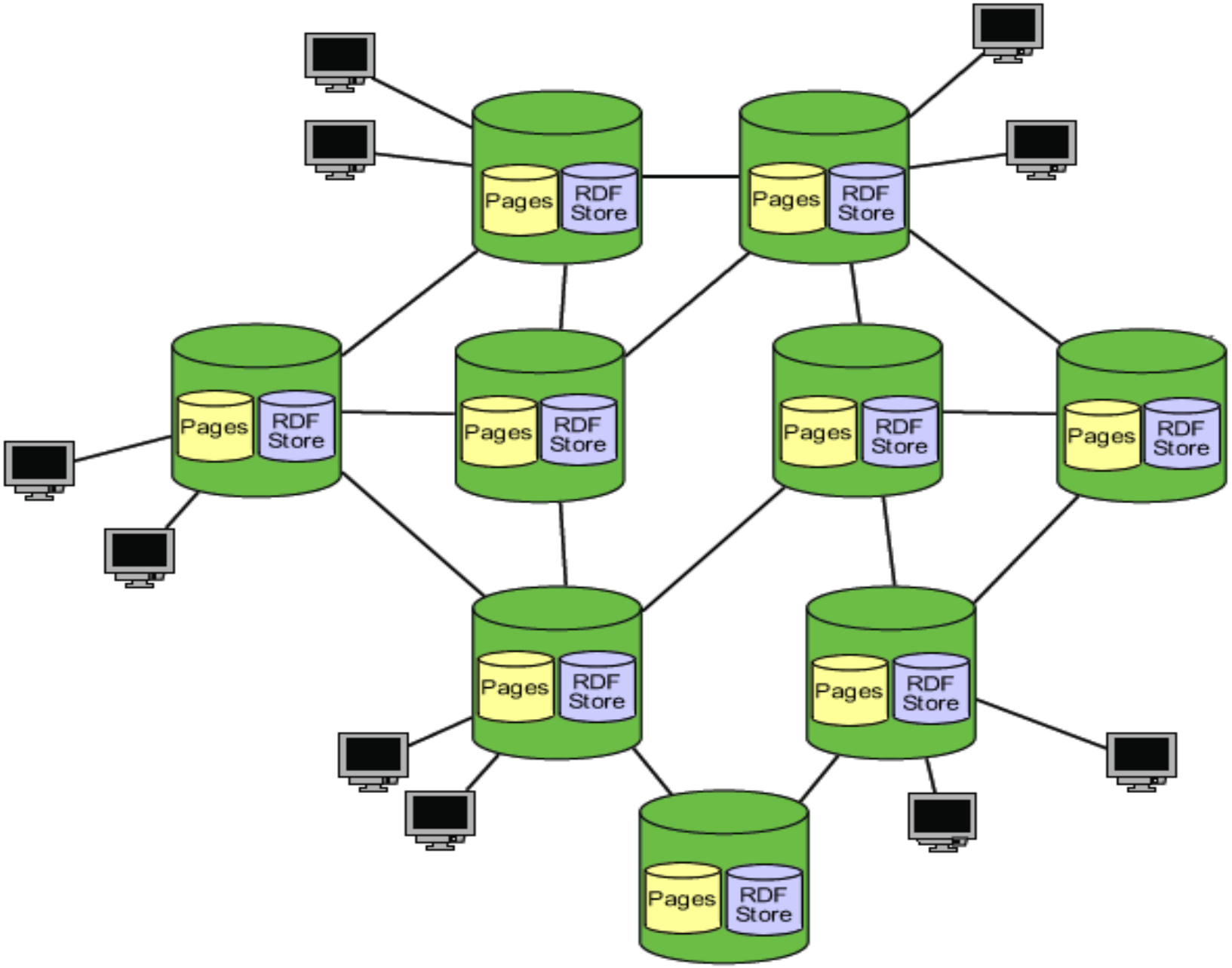
Semantic P2P Wiki
eg: Swooki

# SWOOKI: P2P SEMANTIC WIKIS

- Integrate advantages of :
  - P2P Wikis based on total replication
  - With CCI consistency
- And
  - Semantic wiki based on the approach “wiki for ontologies”


Pages
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# SWOOKI

- Why wiki for ontologies:
  - We are interested in ontology emergence
- Why total replication ?
  - Queries can be executed locally
  - Offline work
  - Transactional changes i.e.
- Modifying a semantic wiki like Semantic Media Wiki requires to change many pages (one subject per page) If no transactional change :
  - Visibility of intermediate result is confusing for other users
  - Requests view intermediate results

# Challenges

- New data Type
  - Text and semantic data
- Editing operations
- Optimistic replication algorithm
  - Adapted to the new data model
  - Adapted to P2P constraints
  - Ensures CCI Consistency

# Data Model

- A wiki Page is a sequence of lines
- Lines contain text and semantic data

France is located in [located In::Europe]

The capital of France is [has Capital::Paris]

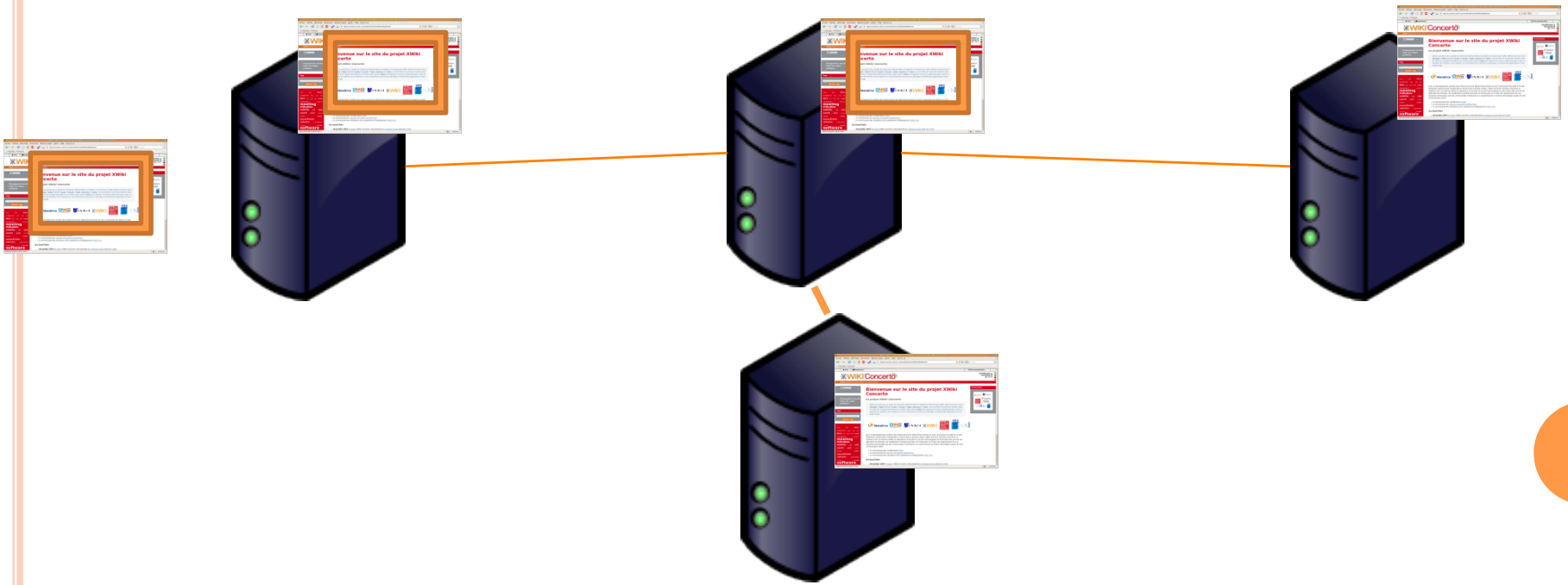
- Two editing operations
  - Insert a new line
  - Delete an existing line
  - Update = Delete + Insert

# CCI Model for SWOOKI

- Convergence for text (by WOOT) and semantic data (??)
- Causality same as  WOOKI
  - SWOOKI do not introduce new editing operations
  - Pre-conditions on editing operation
- Intention preservation:
  - Intention: text (insert (lp < l < ln)), semantic data (?)
  - Preservation: text (WOOT), semantic data(?)

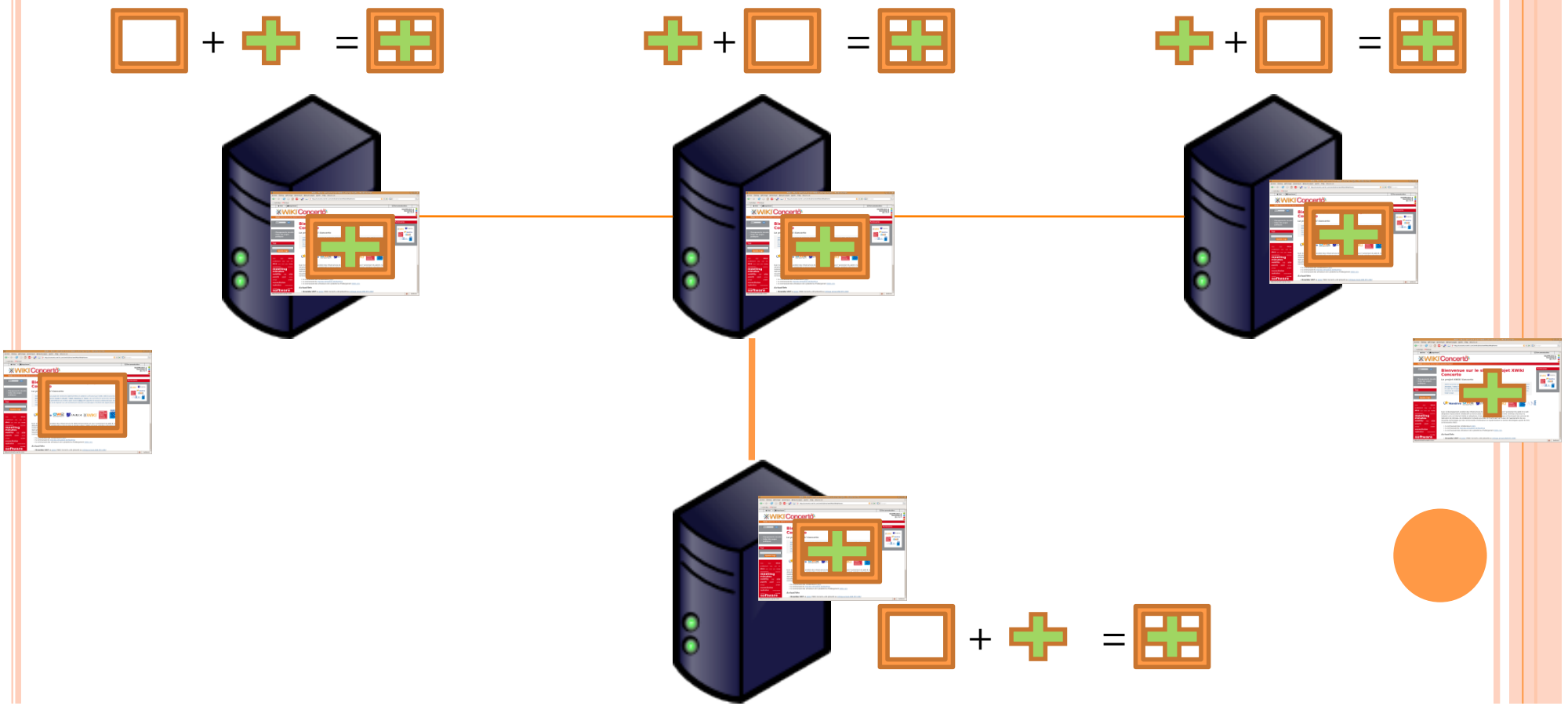
# WOOT Approach

- A change is immediatly applied, broadcast to others (epidemic), integrated by remote (optimistic replication).



# Optimistic replication and concurrent changes

- Automatic merge must be executed by servers when receiving remote changes…



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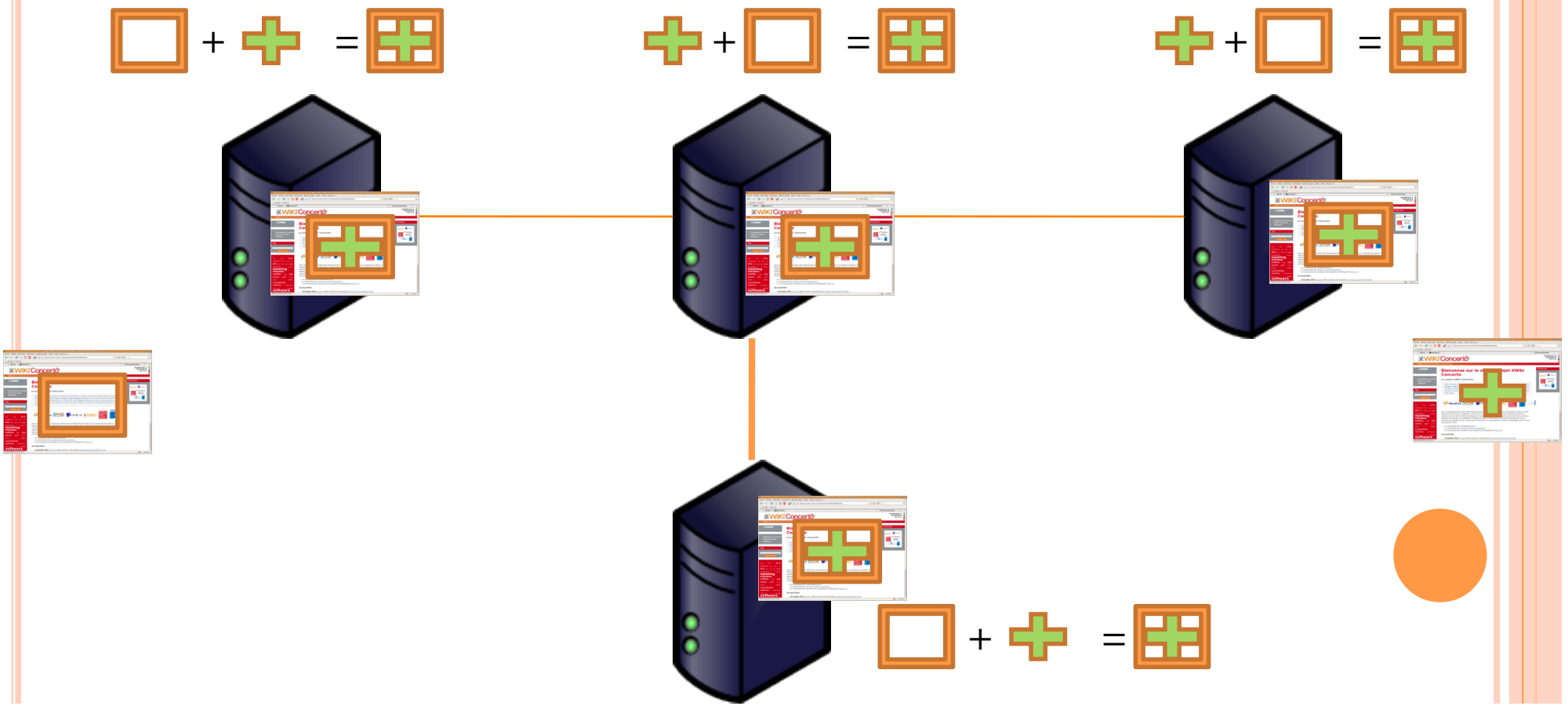


# Optimistic replication for RDF Model

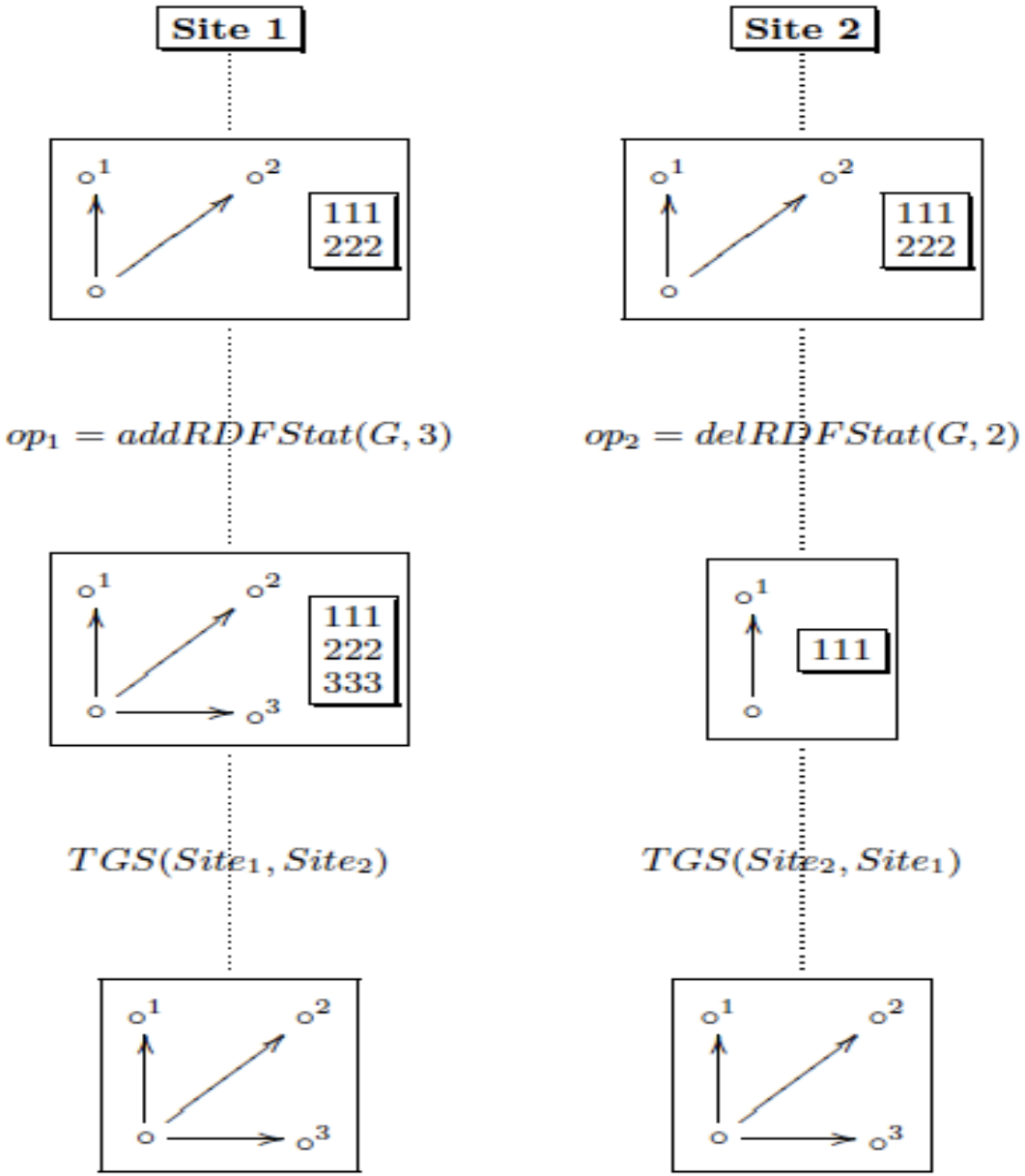
- RDFPeers
  - Partial replication to ensure fault tolerance
  - Each RDF Triple is stored in 3 places
- Problems:
  - Sharing immutable semantic data
  - Concurrent updates are not managed
- RDFGrowth and Publish/Subscribe Networks

Cai et al. RDFPeers: A Scalable Distributed RDF Repository based on a Structured Peer-to-Peer Network. 13 international conference on World Wide Web (WWW), 2004.
Chirita et al. Publish/Subscribe for RDF-based P2P Networks. The Semantic Web: Research and Applications, First European Semantic Web Symposium, ESWS 2004, LNCS 3053

# Optimistic replication for RDF Model

- RDFSync: Synchronize a source and a target of RDF data
  - Decompose RDF graphs into Minimal Self Contained Graphs (MSGs)
  - Ordered list of identifiers (hashs)
- Convergence but does not preserve intention on delete

Morbidoni et al. Rdfsync: Efficient Remote Synchronisation of RDF models. 6th International Semantic Web Conference, ISWC, 2007.




Convergence but does not preserve intention on delete

# Optimistic replication for RDF Model

- Edutella RDF-based metadata infrastructure for P2P applications.
  - Querying distributed RDF metadata
  - Replication service :
    - metadata persistence / availability
    - workload balancing
    - maintaining metadata integrity and consistency
  - Do not mention how to replicate and synchronize metadata

Nejdl et al. Edutella: A P2P networking infrastucture based on RDF. 11th international conference on World Wide Web (WWW), 2002.

# Summary

- P2P Semantic Web replication algorithm
  - Sharing immutable RDF meta-data
  - Concurrent updates not handled
  - Do not ensure CCI Model

# CCI Model for SWOOKI

- Causality same as WOOKI
  - Pre-conditions on editing operation
  - SWOOKI does not introduce new editing operations
- Convergence for text (by WOOT) and semantic data (??)
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  - Intention: text (insert ($lp < l < ln$)), semantic data (?)
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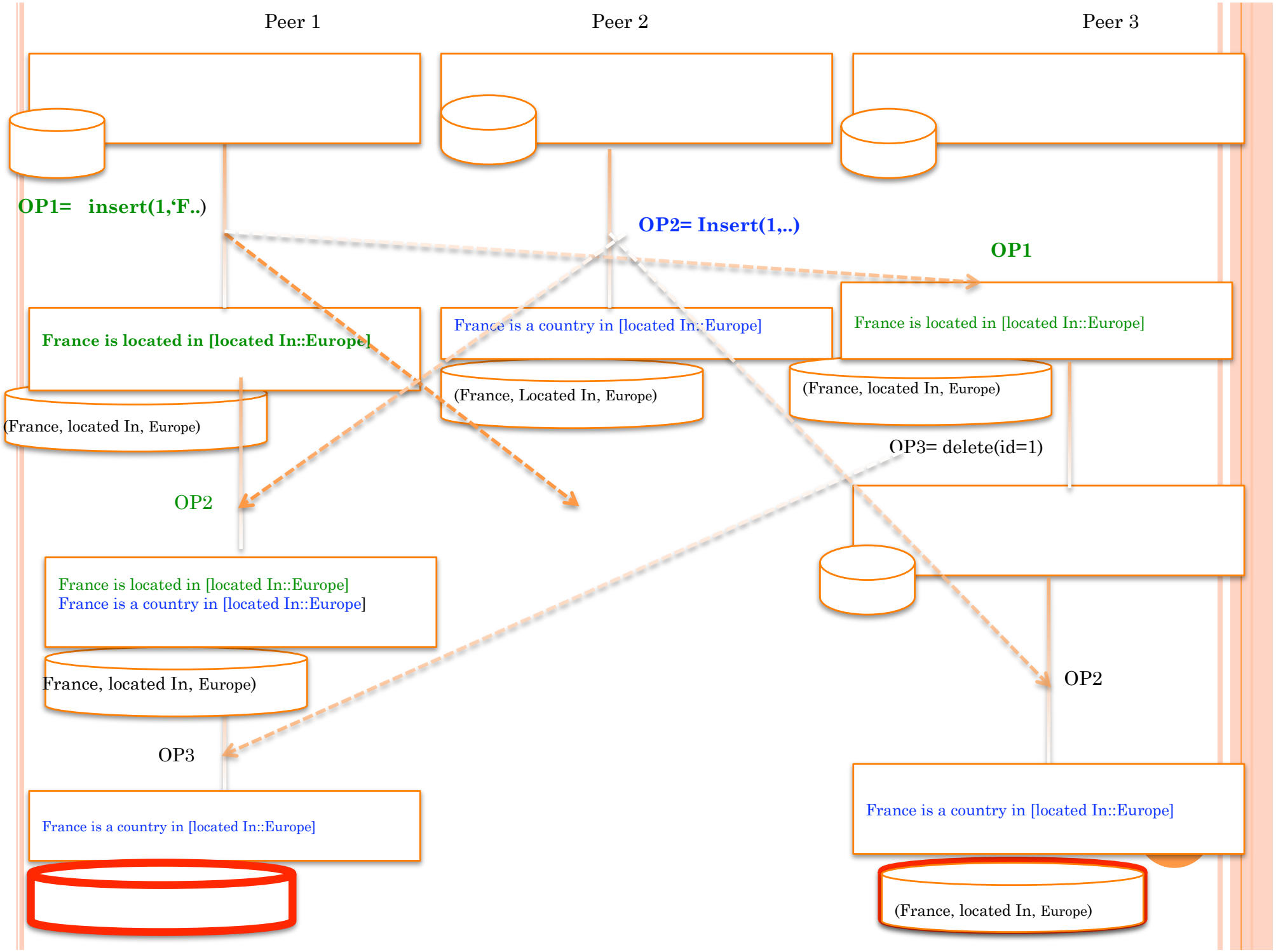

Peer 1
Peer 2
Peer 3
OP1= insert(1,'F..)
OP2= Insert(1,..)
OP1
France is located in [located In::Europe]
France is a country in [located In::Europe]
France is located in [located In::Europe]
(France, located In, Europe)
(France, Located In, Europe)
(France, located In, Europe)
OP3= delete(id=1)
OP2
France is located in [located In::Europe]
France is a country in [located In::Europe]
France, located In, Europe)
OP2
OP3
France is a country in [located In::Europe]
France is a country in [located In::Europe]
(France, located In, Europe)

# Intention Violation

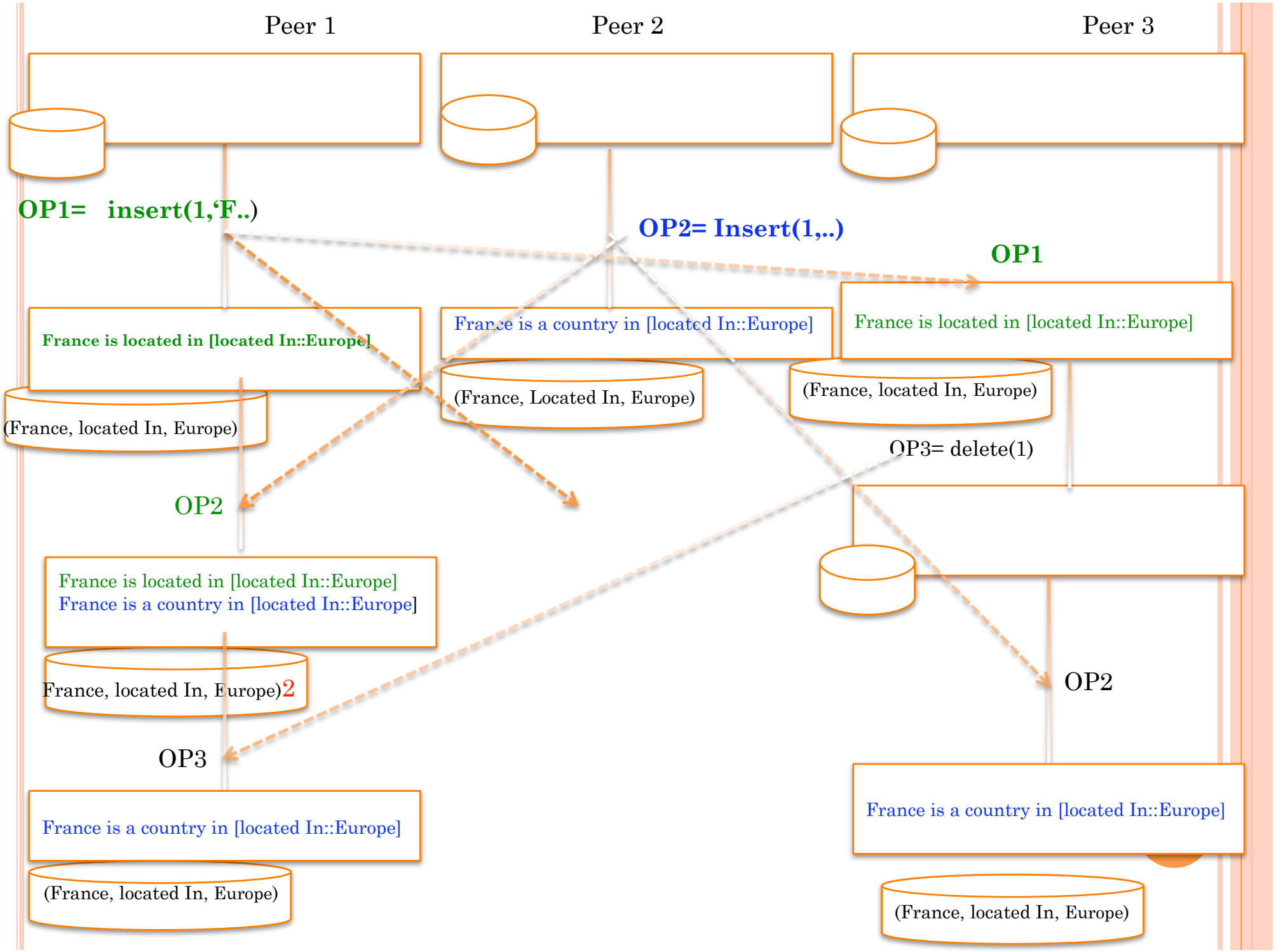
- The effects of the insertion of a triple in a RDF repository is not visible because of concurrent delete
  - The effects of every delete must be visible in RDF repository
  - The effects of every insert must be visible in RDF repository
- Transform RDF repository into multi-set repository

# Insert Intention

$$
\begin{aligned}
\exists i \quad & \wedge \\
& \wedge \exists\, i_P < i \; LineID(Page'[i_P]) = p \\
& \wedge \exists\, i_N \leq i \; LineID(Page'[i_N]) = n \\
& \wedge Page'[i] = newline \\
& \wedge \forall j < i \; Page'[j] = Page[j] \\
& \wedge \forall j \geq i \; Page'[j] = Page[j-1] \\
& \wedge R' \leftarrow R \uplus T
\end{aligned}
$$

# Delete Intention

$$\exists i \ \wedge PageID(Page'[i]) = l$$
$$\wedge \ visibility(Page'[i]) \leftarrow false$$
$$\wedge \ R' \leftarrow R - T$$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(France, located In, Europe)
(France, Located In, Europe)
(France, located In, Europe)
OP3= delete(1)
OP2
France is located in [located In::Europe]
France is a country in [located In::Europe]
France, located In, Europe)2
OP2
OP3
France is a country in [located In::Europe]
(France, located In, Europe)
France is a country in [located In::Europe]
(France, located In, Europe)

# Algorithms

```
1  Upon Save(page, oldPage) :-
2      let P ← Diff(page, oldPage)
3   for each op ∈ P do
4      Receive(op)
5   endfor
6  Broadcast(P)
```

```
7  Upon Receive(op) :-
8   if isExecutable(op) then
9      if type(op) = insert then
10       IntegrateIns(op)
11     if type(op) = delete then
12       IntegrateDel(op)
13  else
14       waitingLog ← waitingLog ⋃ {op}
15  endif
```

# Integration

```
37  IntegrateIns(PageID, line, l_P , l_N) :-
38      IntegratedInsT(PageID, line, l_P , l_N)
39      IntegrateInsRDF(line)
```

# Text Integration

```
41  IntegrateInsT(PageID, line, l_P , l_N) :−
42  let S'  ← subseq(Page[PageID]), l_P, l_N)
43  if S    = ∅ then
44    insert(PageID, line, l_N)
45  else
46          let i   ← 0
47          let   d_min ← min(degree(S'))
48          let F ← filter(S', degree = d_min)
49          while (i < |F| − 1) and (F[i] <_id l) do
50              i   ← i +1
51           IntegrateInsT(PageID, line, F[i−1], F[i])
```

# Integration the insertion of RDF data

```
52 IntegrateInsRDF(line) :−
53 let   S ← ExtractRDF(line)
54 if  S ≠ ∅ then
55   for each  triple  ∈ S do
56      if   Contains(triple)  then
57           triple .counter++
58      else
59          insertRDF(R,triple)
60      endif
61  endif
```

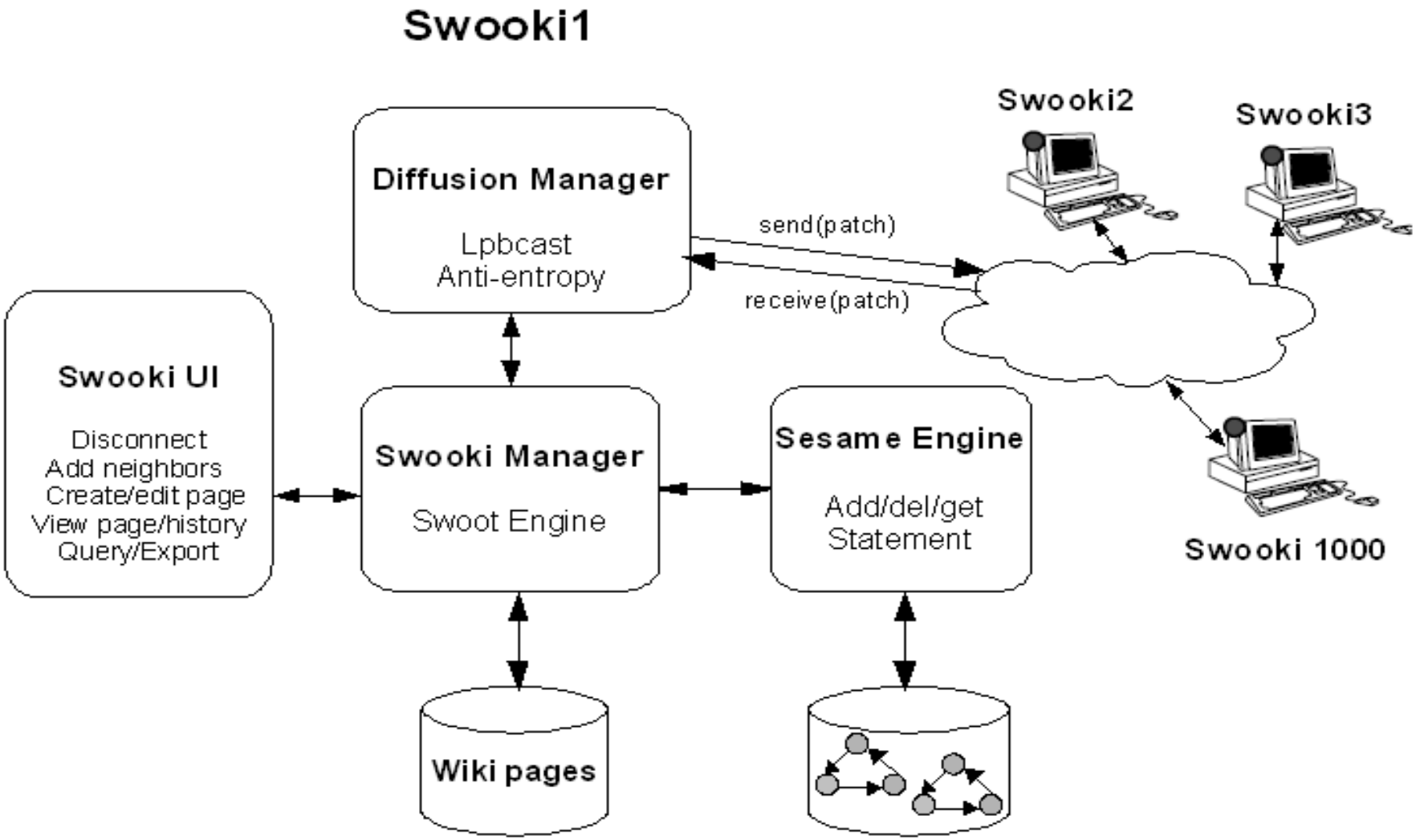
# Integration of delete operation

```
23 IntegrateDel(LineID) :−
24     IntegrateDelT(LineID)
25     IntegrateDelRDF(LineID)
```

```
26 IntegrateDelT(LineID) :−
27     Page[LineID]. visibility    ← false
```

```
28 IntegrateDelRDF(LineID) :−
29 let   S ← ExtractRDF(LineID)
30 if  S ≠ ∅ then
31  for each  triple  ∈ S do
32        triple .counter−−
33      if    triple .counter == 0 then
34        deleteRDF(R,triple)
35      endif
36 endif
```

# SWOOKI ARCHITECTURE




格Woo-Ki氣
http://wooki.loria.fr/wooki2
Menu
Home
Create Page
Site status
Disconnect Wooki
Log
Neighbors table
2 neighbors
Pages List
Home
France
Italy
SPARQL Query
SPARQL query
RDF
RDF Search
Skin
Blue
Ubuntu
Red
France
[View] [Edit] [Source] [History] [Log] [RDFGraph]
France is located in Europe
The capital of France is Paris
Facts
locatedIn : Europe
hasCapital : Paris
Export RDF
Wooki © 2006 - ECOO Team - LORIA
Semantic Query

# Query

```
Select ?s ?p ?v where { ?s ?p ?v.
Filter(regex(str(?s),\
request.getParameter("search")+"\") ||
regex(str(?p),\""+request.getParameter("search")
+"\")" ||
regex(str(?v), \""+request.getParameter("search")
+"\"))}
```

# Conclusion

- SWOOKI is the first P2P Semantic Wikis
- SMW + WOOKI
- CCI Model for SWOOKI data type
- New collaborative modes
  - Off-line work
  - Transactional changes
  - Collborative knowledge building

# Conclusion

- Availability, fault-tolerance, load-balancing
  - Locality transparency
- Performance
  - Execution query: local execution
  - Messages delivery: LpbCast , one round, WOOT does need extra messages
- Data synchronization:
  - Convergence in one round, no extra messages for integration
  - Complexity : $O(n2)$

# Open Issues and Perspectives

- Security
  - In wikis security policies presented as attribute of the page
  - Replicate security policies
  - Use the same approach to hand this new data type (operations, CCI Model)
- Distributed queries to reduce the load and share cost
- SMW + partial replication (reduce traffics, infinite storage)
- IkeWiki + WOOKI
- IkeWiki + partial replication