Consistency Management of Replicas in Wireless Grid Environment

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Abstract

In a wireless network, an user has the possibility of remaining link while moving in a more or less spread geographical perimeter, it is the reason for which they intend to sometimes speak about "mobility". The wireless Grid represent a new type of network of distribution of means linking up mobile phones and other implements of edge some with the others with different access points. In this article, we offer a service allowing to manage the consistency of the replicas of data in such environment where the users can move at any time. Offered service combines between optimistic and pessimistic approaches. We go shown with the aid of several results of experimentation which our proposal allows to reduce in a remarkable manner the number of divergences and conflicts between replicas of the same data in environment Wireless Grid.

Keywords: *Wireless Grid, Replication, Consistency, Optimistic approach, Pessimistic approach.*

1. Introduction

The management of replicas in a distributed system allows to augment its robustness and to balance workload on all the available nodes. If data are stocked in an only place, his control is simplified there, but its availability is that of the node that it accommodates it. Also it is preferable to replica data on several node to be sure of being able to dispose one of at least. The implementation of the techniques of replication for the management of consistency between replicas in mobile environments is a complex problem and this by their characteristics. Mobile networks are rapidly developing due to their interfaces who allow to an user to change places easily in a firm. Communication is directly made or by means of basic stations. Mobile or wireless networks can be classified in two classes: networks with facilities and networks without facilities. What differentiate the second type in comparison with the first type is because networks ad hoc are competitive for networks of small sizes. Our objective consists in offering a service allowing controlling the management of the consistency in Wireless Grid. To assess and position our proposal, we are going to compare the results of a point of view quality of replicas by measuring the degree of divergences and conflicts of the replicas of our proposal and that of optimistic approach and our. This paper is structured as follows. The section 2 introduces an introduction to wireless environments with infrastructure (Wireless Grid). The section 3 fixes the objectives of replication as well as the consistency. The section 4 represents the approach offered for the management of the consistency of replicas as well as its process of sequence. We reserved section 5 to present some algorithms describing the principle of our approach suggested for the consistency management in Wireless Grid. The section 6 allows introducing some results acquired from experimentation by our simulator accomplished for this purpose. Finally we end this paper by a conclusion and some perspectives for future work.

2. Wireless Grid

This section is articulated around the presentation of the model Wireless Grid, its infrastructure which is made up of three basic levels to be known: technologies and policies of the physical coat, infrastructure in networks and a middleware for communications.

2.1. Definition of Wireless Grid

Wireless Grid marks a new stage in the evolution of architectures of wireless firm. Wireless Grid benefits from advantages of the previous generations of architecture and answer numerous problems which affect deployments of firms (performance, expense of installation). Therefore an architecture Wireless Grid allows to envisage performances, to control the expenses of deployment and to postpone the obsolescence of wireless infrastructure \cite{ref1,ref6}. A description of the Wireless Grid is an increase of a grid which makes easier the exchange of information and correlation between the heterogeneous wireless apparatuses. A grid is material and software infrastructure providing a consistent, dependable access, in well brought up and cheap rate of penetration \cite{ref7}. The infrastructure of the Wireless Grid is made up of three basic levels \cite{ref1}:

- Technologies and policies of physical coat the physical coat of which contains the ghost on which the wireless apparatuses can work and communicate.
- Infrastructure in networks.
- A middleware to provide communications between the heterogeneous implements.

The mobility real-time plays a very important role in such environment; it is one of the keys of vault of the optimization of the performances of microcells. Mobility must be real-time taken into account and should not corrupt performances. The customers move in effect more often in the case of Wireless Grid than in another type of infrastructure. In this type of environment, a centralized management system must be inserted, which regroups all the information linked to a customer including of keys of encryption. All events of quick mobility, such as those of a structure Wireless Grid are fast taken into account and in a transparent way within WLAN. The complex definitions of parameters linked to a quick roaming and the linked updating are not necessary any more. The point of entrance in a network of a customer which moves remains the same and the network neighborhood of the customer remains unchanged if the customer moves on the same site. Ethernet networks gave foreseeable performances thanks to technology commuted Ethernet, what brought back the risk of collision to the single user. Wireless Grid adopts this approach by creating microcells around every GP (Grid Points) and a perimeter of signs RF (Radio frequencies) restrains. Every demarcation GP is used by a restricted number of wireless customers to minimize the risk of collision and to consolidate the levels of performances. Every customer can so use a demarcation GP located at a weak distance and a competitive and clear sign RF. \\Wireless Grid leans on a methodology structured for the deployment of wireless technologies in firm. Subjacent concepts draw inspiration from successes of the model structure of architecture of wired networks. It is the fourth generation of existent architecture of wiring.

2.2. Wireless Grid model

The model Wireless grid is a model at two levels introduced on the 1 which models a grid, being characterized by the mobility of nodes. The first level (level 0) represents a group of regions, a region is a group of mobile nodes, and the second level (level 1) represents the fixed points among which each manages and supervises one under group of mobile nodes being in his range.

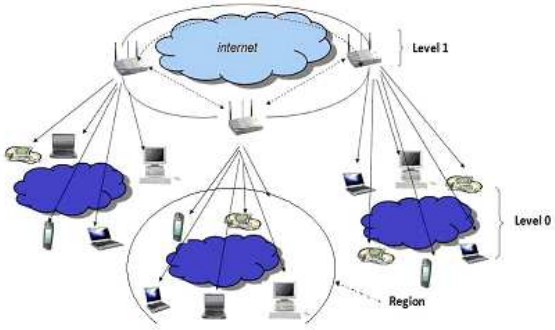

Figure 1: Wireless Grid model

3. Replication and consistency

Replication is the capacity to support in day an object on several machines linked up in network, by copying out in regular spaces fragments or entirety of the object from a machine to the other one. The main objective of replication is to make easier the access to data while augmenting availability \cite{ref2}. As protocols of replication, we quote : Active, passive and semi-active replication \cite{ref3}. The management of the consistency can be defined as being the control of accesses with a view to providing a vision which forgets replication, distribution and competition of accesses to shared data \cite{Gra96}.

The protocols of consistency can be classified according to two approaches \cite{ref5}: Pessimistic approach: Pessimistic approach \cite{ref4,ref5} forbids any access to a replica provided that it is in day, what gives illusion to the user to have the single substantial copy. It is a strong consistency; it does not support mobility and passage in the ladder. We can name as protocol ROWA, ROWAA \cite{ref3,Goe05,ref5}. Optimistic approach: Optimistic approach \cite{ref4,ref5} is in priori more adapted to network P2P. As part of an optimistic replication, copies can diverge. At given instant, an user can therefore notice copies of the same object with different stocks. Updating will be spread, for the period of the repose of the system, that is to say, when all requests of the customers were treated.

4. Management Service for Wireless Grid consistency

Our job aims at guaranteeing the consistency of the replicas of data in environment Wireless Grid, for it, we offer a service of management of consistency from a hybrid step which uses at the same time, the consistency of the replicas of data within carried by a fixed point, we shall speak therefore of a consistency intra-region, and a consistency between the fixed points, that we call the consistency inter-regions. The service of management of consistency offered for Wireless Grid is structured of several modules which collaborate between them in a purpose to make converge the replicas of the same group of data and by

consequence to reduce divergences and conflicts between replicas. The Figure 2 shows the different main modules of management of consistency as well as their correlations.

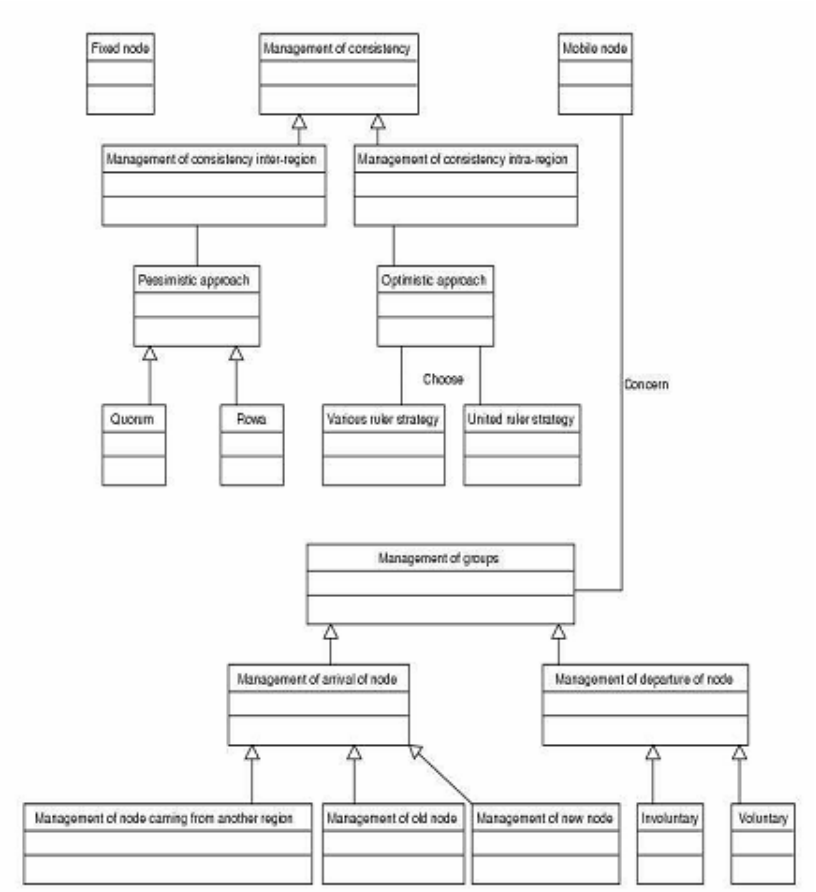

Figure 2: Global architecture of the proposed approach

This service is composed in most cases of:

- Under service of management of the group allows treating arrival and departure of the members of every region through the fixed point (the mobility of nodes).
- Under service of management of requests (Figure 3) allows to perform the treatment of requests.
- Under service of management of consistency intra-region (where nodes are in the same zone) consists in accomplishing the spread of the updating of the most recent replica in other nodes within the same region.
- Under service of management of consistency inter-regions (where the fixed points collaborate between them) will be triggered off further to a disability of some

metric. The launching of this consistency draws away a communication between all fixed points to find the most correct updating in environment Wireless Grid.

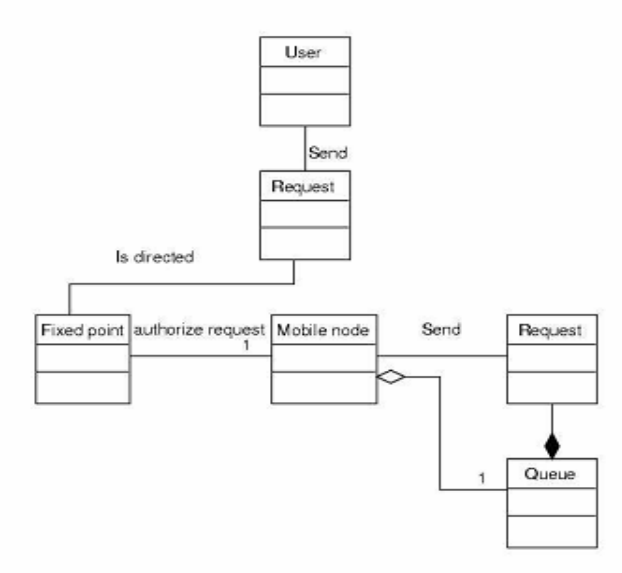

Figure 3: Management of requests for Wireless Grid

4.1. Sub management service of intra-region consistency

The management of the consistency intra-region is a process which is triggered off by the fixed point. The Figure 4 introduces this sequence. This management is made when the point fixes remark that there are no more requests of requests, this last which has a hut containing the address of the node having the most correct replica which is defined as being the one who is the most recent in time, sends in this node a request of spread of updating. This last broadcasts a Hello message in the region where he is to know the nodes which are linked. Later, it makes a broadcasting of the updating of its replica in all these present nodes in its region.

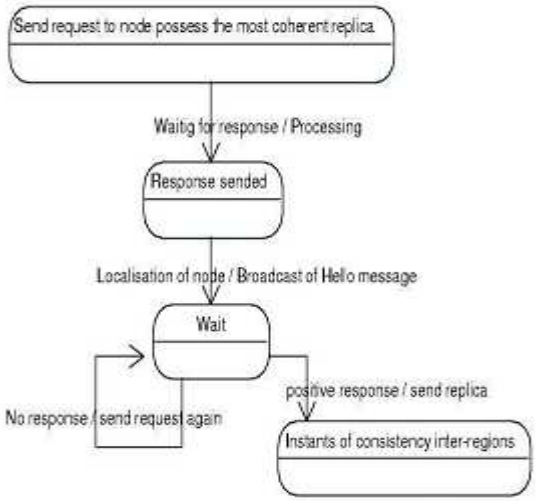

Figure 4: Management of intra-region consistency in Wireless Grid

4.2. Instants of launching of inter-regions

To trigger off inter-regions under service of management of consistency, we offered several situations, as it is define in the Figure 5. We sum up these situations as follows:

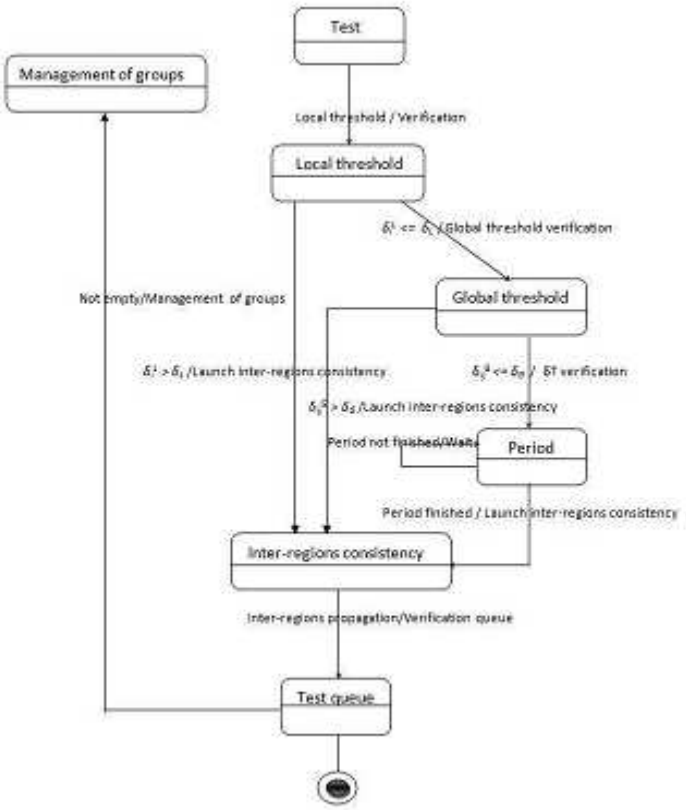

Figure 5: Instants of launching of inter-regions consistency

4.3. Sub management service of inter-regions consistency

The communication between the fixed points procreates not homogeneous regions of a point of view of replicas, what requires a launching of under service of consistency inter-regions. According to the Figure 6, the fixed nodes communicate to find the address of the node having the replica of the most recent data. The fixed point broadcasts this replica in other fixed points of the wireless grid and each of them spreads the updating to the nodes of its region.

The purpose of the consistency inter-regions is to find the most correct replica and broadcast it to nodes linked in this wireless grid. Approach crosses design between the intra consistency and the inter regions with the intention of guaranteeing a cohesion between the different copies of data, as we quoted it before, the first one is triggered off by the fixed point when he points out there is not more

requests of sends requests, the second is to manage by all fixed points of the wireless grid and it is triggered off when one of the metric of launching of the inter-regions consistency is not proved.

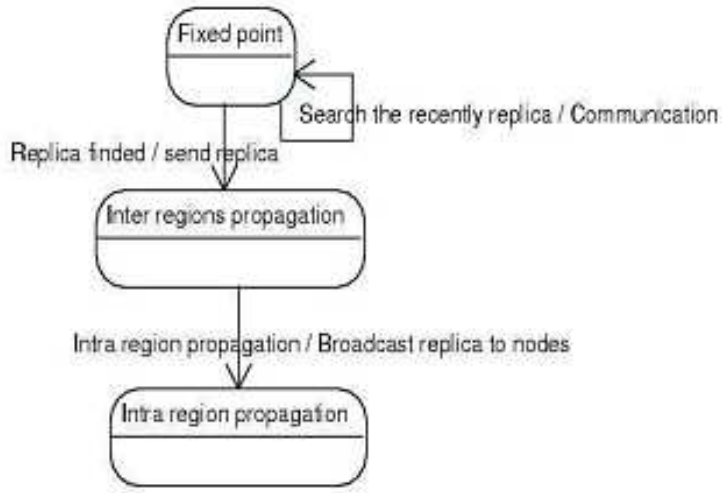

Figure 6: Management of inter-regions consistency in Wireless Grid

5. Algorithms for service of consistency in Wireless Grid

The fixed point is responsible for consistency management of nodes inside the area and he collaborated with other fixed points, to ensure inter-regional coherence. It represents an important role in Wireless Grid environments, its job is to manage the arrival and departure of nodes, manage the demands of requests and the time of sending the update.

The fixed point triggers Algorithm 1 when there is a request to send a request, the fixed point must give its approval to the node in question to send his request. This allows to manage the nodes in a region. Line 6 of the algorithm, expressed that if a node wants to send a request to another node, it must pass through the fixed point, to ask for permission. if a positive response, the request for reading or writing will be addressed is what is shown in line 9. Line 11 shows the loss of messages.

	Algorithm 1 MANAGER OF FIXED POINT
1	Demand_request = { True , False }
2	To_allow = { True , False }
3	Answer = {Positive , Not Answer }
4	**WHILE** (demand_request = True) **do**
5	Management_group();
6	To send answer asks to nodes;
7	To_allow = True;
8	**IF** (Answer = Positive) **then**
9	To treat Request ();
10	**else**

```
11              Transmit demand;
12        ENDIF
13    ENDWHILE
```

The algorithm Management-group (see Algorithm 2) presents, the treatment carried out, during management of the arrival and the departure of the nodes. Line 3 of the algorithm shows that, if the queue of the treatment of the nodes (the arrival or the departure of a node) is no empty, this management will be carried out. Line 4 of the algorithm is a significant stage to know, if it is an arrival or a departure of a mobile node.

```
      Algorithm 2 MANAGEMENT-GROUP
1     Type_treatment = { Departure , Arrived }
2     Treatment-Arrival_departure node = { vide , non vide }
3     WHILE (Treatment-Arrival-departure node ≠ ∅ ) do
4        IF  (type_treatment = Arrival)  then
5              Arrival-Node();\\
6        else
7             Departure-Node();
8        ENDIF
9     ENDWHILE
```

The function *Arrival-Node()* presents the treatment carried out, during the management of the arrival of the nodes. If it is about an old node which reappears, this management consists in restoring all information which relates to it and connects it with the other members of the group. In the case of a node, coming from another group, the treatment carried out consists in associating the node in question with the members of its new area, like with the fixed point concerned.

The function *Departure- node()* presents the treatment carried out in the case of the departure of the nodes. When departure is of the voluntary type and short duration, this last can be due to a disconnection or to a problem of battery. That involves a safeguard of information, which connects the node to the members of its area. For a voluntary and final departure, node in question informs its fixed point which it will leave its area in a permanent way. The treatment carried out consists, to remove all information which connects this node with the members of its area and its fixed point. For the involuntary departure, its fixed point seeks the existence of the node with a communication between fixed points. If this last is found in an area other than his, the fixed point concerned deduced, than the node changed group, consequently, this last removes information which associates it its area. If the node is not found after the communication, the fixed point keeps a trace of data (various counterparts) of this last.

The algorithm Treatment-Request (see Algorithm 3) presents the management of the requests. Line 4 of the algorithm makes it possible to treat the requests of writing and reading as long as the queue of the requests is not empty.

```
      ALGORITHM 3 TREATMENT-REQUEST
1     queue-request = { empty , not empty }
2     IF (To_allow = True) then
3        WHILE ( queue-request ≠ ∅ )  do
```

```
4              Treatment-Type-request();
5          ENDWHILE
6          Intra-region Consistency();
7          Moment of inter-regions Consistency()
8        else
9          Moment of inter-regions Consistency();
10   ENDIF
```

The algorithm intra-region consistency (see Algorithm 4) presents the management of consistency of intra-region. Line 2 of the algorithm describes the treatment of the node concerned with the update, this management concerns sends it requests for update to the other nodes. Line 4 of the algorithm expresses the made treatment, in order to have a consistency region.

ALGORITHM 4 INTRA-REGION CONSISTENCY

```
1   Answer = { Positive , Not Answer }
2   To diffuse the request for update to nodes;
3   WHILE ( type-answer = Positive ) do
4       To propagate the update;
5   ENDWHILE
6   IF ( type-answer = Not Answer) then
7     To send request back;
8   ENDIF
```

The algorithm of the moment of inter-regions consistency (see Algorithm 5), presents metric release of inter-regions consistency. Line 9 of the algorithm, described the treatment to make when the duration is not reached yet. If the three metric ones of release of inter-regions consistency are not checked, the treatment consists in returning to the management of the group, in order to treat the departure and the arrival of the nodes.

ALGORITHM 5 MOMENT OF INTER-REGIONS CONSISTENCY

```
1   \*  δG  : the total threshold   */
2   \*  δL   : the local threshold  */
3   \*  δ  : period to check local threshold */
4   IF (δL >=δi^L ) then
5           /* To check total threshold */
6          IF ( δG >=δij^G )  then
7           /* To check if the period of release of coherence inter-regions is reached*/
8              IF  (δτ >=  est non finie )  then
9                        Management-group();
10             else
11                        Inter-regions consistency();
12             ENDIF
13         else
14          Inter-regions consistency();
15       ENDIF
16  else
```

```
17        Inter-regions consistency();
18    ENDIF
```

6. Experimentation and interpretation

We accomplished a simulator to study the behaviour of the service of management of consistency offered. In this present job, we preferred to introduce some results of experimentation acquired from our simulator. In the first series of simulation, we chose 30 regions, 100 nodes by region, 5 data, every data are 100 times replicated distributed in environment Wireless Grid with a threshold of equal mobility 5, that is to say, 5 nodes can move, and we made vary the number of requests from 100 to 500 by step of 100.

The Figure 7 introduces simulation for the time of response according to the number of requests: Optimist Vs Hybrid. From this figure, we point out that the distance between optimistic and hybrid approach so acquired is always constant in spite of increase among requests. We can conclude that even though our service triggers off the consistency inter-regions its evolution remains constant and it follows the same paces as the curve of optimistic approach.

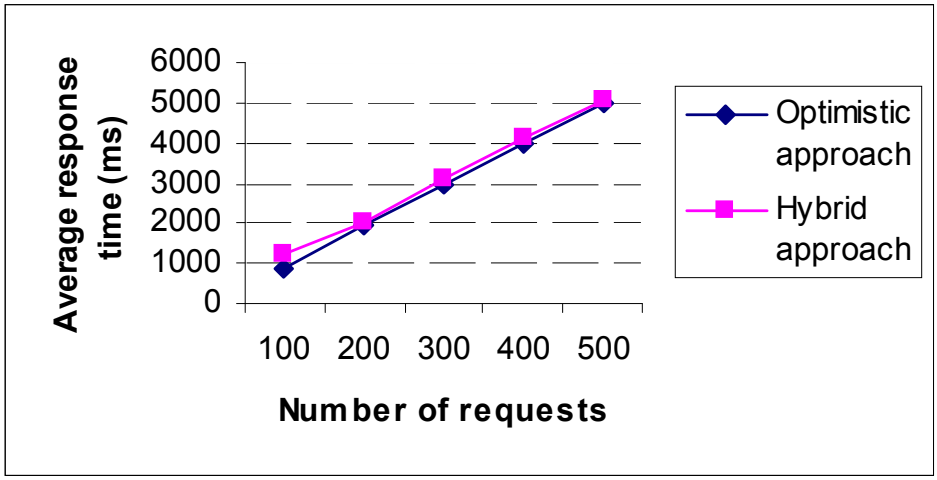

Figure 7: Evaluation for the time of response according to the number of requests

The Figure 8 introduces simulation for the time of response according to the number of replicas: Optimist Vs Hybrid. We can note that our approach reduces the medium time of response faster than optimistic approach. We note that in 130 replicas, both curves strive towards almost the same point.

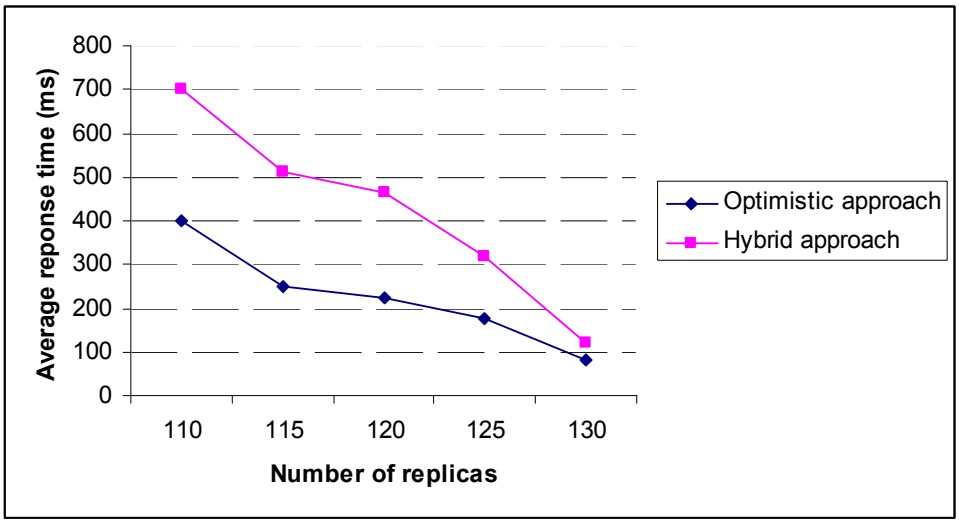

Figure 8: Evaluation for the time of response according to the number of replicas

The Figure 9 introduces the result of simulation to show the medium number of divergences by period, this simulation is made on 100 requests and concerns the single region among all regions of Wireless Grid. According to this face, we point out that with optimistic approach, the number of divergences augments very fast, on the contrary for our offered service, the number of differences is very small regardless of the period. We can conclude, that offered service allows to converge replicas and as a result, to reduce divergences and conflicts among replicas of even set of data.

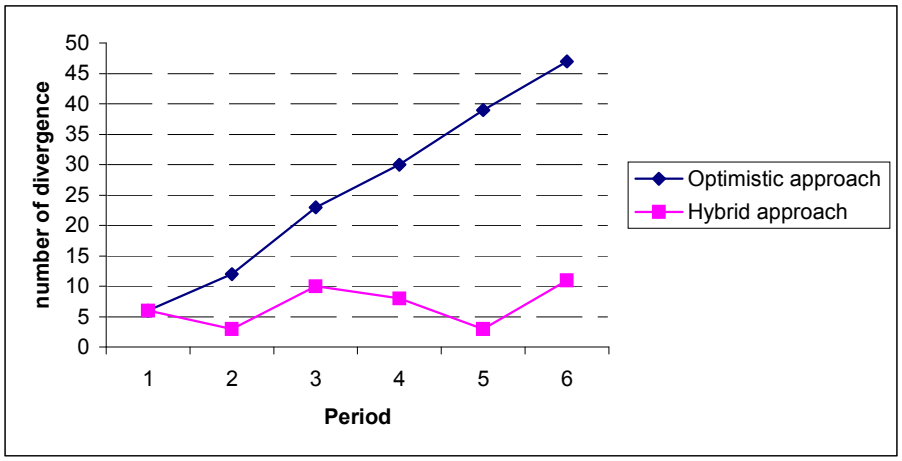

Figure 9: Evaluation for the number of divergences by period

7. Conclusion and future work

The technology of replication is very used for the management of data in the domains of the distributed systems and of grid computing to assure availability and tolerate breakdowns.

However the use of this last poses a problem of assertion of consistency of replicas. In this job, we offered a service for the assertion of the consistency in environments Wireless Grid. Offered service is composed in most cases of one under service which is made responsible for making converge replicas inside a region and under service inter-regions. This last has main responsibility to manage the consistency in the Wireless Grid environment. Acquired results show a better behaviour of our approach in comparison with the optimistic approach of a point of view performance and especially from point of view quality of replicas by reducing divergences and conflicts. We can envisage in future work as extension of this proposal: the taking care of the balancing of expenses in Wireless Grid and the catch of the semantics of replicas and to insert this service into a middleware of grid computing.

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