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>> Editor Comments

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>> Editor

>> Comments to the Author:

>> (There are no comments. Please check to see if comments were included as a file attachment with this e-mail or as an attachment in your Author Center.)

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>> Reviewers' Comments

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>> Please note that some reviewers may have included additional comments in a separate file. If a review contains the note "see the attached file" under Section III A - Public Comments, you will need to log on to ScholarOne Manuscripts to view the file. After logging in, select the Author Center, click on the "Manuscripts with Decisions" queue and then clicking on the "view decision letter" link for this manuscript. You must scroll down to the very bottom of the letter to see the file(s), if any. This will open the file that the reviewer(s) or the Associate Editor included for you along with their review.

>> Reviewer: 1

>> Recommendation: Reject

>> Comments:

>> This paper presents the DiVE platform for virtual environments. DiVe is extensible and has an event-driven architecture based on regions.

>> Overall, the architecture seems completely sound and reasonable, but it is unclear what the research contribution is.

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## That is true, what we do is not really new.

**We will not modify according to this comment**

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The region approach the paper focuses on is a reasonable engineering decision, but it is not novel. The claim that any-to-any event subscriptions requires O(N^2) operations isn't correct; an intelligent spatial index structure, or even a basic one like an R-Tree, would reduce this to a problem of density and not overall world size.

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## Not sure what he means. But without doing anything, what we did is correct: the very primitive way is o^2

**We will not modify according to this comment**

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How are regions different than the mechanisms used in Second Life/OpenSim? In these cases the regions are sims. An object is subscribed to events from its sim as well as adjacent sims, with an additional distance filter as needed.

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## In openSim, when you change region you have a loading time. THIS IS NOT NEGLIGIBLE

The transition between region in our case is smooth, it is not at all the same as a SIM in OPENSIM

TODO: explain diff between region and openSim region

DONE : find in paper “DiVE and OpenSim are using 'regions' differently”

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>>

>> When there are significant existing systems, then it's necessary to evaluate the techniques in contrast to existing ones.Right now, the paper describes a technique and justifies it with some good reasoning. But existing systems use more refined and efficient mechanisms; to demonstrate that the idea is valuable, it needs to be evaluated against existing systems to quantitatively demonstrate the benefit.

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## That is true, but few of the systems are open source

**We will not modify according to this comment**

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A future, much stronger version of this paper would present existing techniques in detail, explained how the region approach is different and superior to the state of the art, and evaluated it to verify the explanation quantitatively. There's clearly been a lot of good engineering, but unfortunately the potential research contributions aren't clear.

>>

>> Additional Questions:

>> 1. Which category describes this manuscript?: Research/Technology

>> 2. How relevant is this manuscript to the readers of this periodical? Please explain your rating under Public Comments below. Interesting - but not very relevant

>> 1. Please explain how this manuscript advances this field of research and/or contributes something new to the literature: The paper proposes a region technique with a two-step interest diameter, with the goal of reducing oscillations when entities move back and forth.

>> 2. Is the manuscript technically sound? Please explain your answer under Public Comments below. : Yes

>> 1. Are the title, abstract, and keywords appropriate? Please explain under Public Comments below.: Yes

>> 2. Does the manuscript contain sufficient and appropriate references? Please explain under Public Comments below.: Important references are missing; more references are needed

>> 3. Does the introduction state the objectives of the manuscript in terms that encourage the reader to read on? Please explain your answer under Public Comments below.: Could be improved

>> 4. How would you rate the organization of the manuscript? Is it focused? Is the length appropriate for the topic? Please explain under Public Comments below.: Satisfactory

>> 5. Please rate the readability of the manuscript. Explain your rating under Public Comments below.: Easy to read

>> 6. Should the supplemental material be included? (Click on the Supplementary Files icon to view files): No, it should not be included at all

>> 7. If yes to 6, should it be accepted: As is

>> Please rate the manuscript. Please explain your choice.: Poor

>> Reviewer: 2

>> Recommendation: Author Should Prepare A Major Revision For A Second Review

>> Comments:

>> The paper is well written and well organized. The strength of the paper is the region-based AOI algorithm that is designed and implemented to address the scalability challenge of message passing in distributed VEs. In addition, the architecture built based on the region-based AOI algorithm, DiVE, has been applied in several virtual world applications and validated its effectives in supporting those applications.

>> The concerns that the reviewer has are as follows:

>> 1.Claiming DiVE to be a generic platform for distributed virtual environments is too broad.

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## Might be true, but how to emphasis the multi-usage of Dive ?

**We will not modify according to this comment**

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>> DiVE is a networking framework, rather than a complete generic platform, and it seems to support a certain types of VE applications: multi-user 3D games, in which users mainly control an entity (avatar of vehicle), and the content of the VE can are preloaded at each client machine and do not change during the game plays. The major updates in these games are position updates of the entities, and in general no concurrent controls of the same entity (hence avoiding consistency challenges)

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## True, but still a certain consistency should be kept or it would be noticed by players

We do not mean consistency as objects being manipulated by different users

DONE: DiVE does focus on making it possible to share quickly and efficiently some network properties among defined network objects. It maintains a consistency between users in a multiuser environment. It does not allow to create or modify network objects (class)dynamically, and spread them accross the network

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would happen. In addition, the games that DiVE supported seems were running with LAN networking setup, hence networking delay

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## I disagree with it. It is true that we had good network setup, but if we see bad performances in a good network, then we know the problem comes from us. If we see bad performances in a bad network, we can then blame the network.

Will you blame google it it was slow, using a 56k modem ?

X

**Shall we address this ?**

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was not a big issue. Such games make it possible that simulations happen on the client machines, and servers only collects and disseminates position updates in time.

>> However, there are many types of distributed VEs than the type discussed above. For instance, there are VEs in which the simulation is not only the movements of avatars or vehicles, but also complex simulations of object behaviors. There are also VEs that client machines are not trusted for running simulations, VEs that need to support clients globally, and VEs with user-created content that is hard to be pre-loaded, etc.

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## This is true, we are mostly sharing properties among objects already shared, and defined on every clients

Add something about this into the paper, about the dll

DONE: “This also means every clients must have the custom class on their machine before the simulation starts.”

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>> There are several limitations of DiVE. First, DiVE handles the simulation scalability problem by running simulation on client machines and letting each client simulating its own entity’s movement. This puts requirements on client machines to have adequate compute capabilities,

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## True, we are not clouding everything, but i would say, Nowaday, the bottleneck is more the network than the computer.

DONE

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which limit the types of VE applications that DiVE can support. Second, DiVE does not address the consistency of distributed simulation, which makes it not a choice for VE applications that need consistency maintenance. For instance, DiVE does not seem to be adequate for VEs in which multiple simulation engines (script engine, physics engine, and user operations) may operate on the same entity (think of Second Life and OpenSimulator VEs).

Third, with distributed simulation across the client machines, network delays would be a big concern if the clients are located in different geo locations. The applications that DiVE supported seemed to run in the same LAN, and hence the network delay issue was not addressed. For many distributed VEs, however, client machines at different geo locations would be the norm and network delays need to be addressed.

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## same comment as before

X

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>> In summary, DiVE addresses the scalability of message passing across the distributed nodes in distributed VEs and can be applied to certain type(s) of VE applications. It does not include support for other scalability challenges in distributed VEs, such as consistency maintenance in a VE where an entity could be operated by various simulation engines concurrently, scalability of simulation/computation, the challenge of network delays in VEs that need to support global accesses, etc. The authors should adequately discuss what types of VEs that DiVE is adequate to support, and what types of VEs are beyond DiVE’s scope.

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### I see the point better, He says one open problem is the weakness to network latency, therefore, our solution could be innovative by being robust to network issues.

That is a good point, but dive is not adressing it. This is another topic, and in our case, i even wonder if the correction should be on client or server side.

DONE We are assessing the ability of DiVE to spread

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>> 2.Comments of some details in the paper:

>> • The double areas of interest idea, discussed in Section 3.1, does not provide details on how to choose the size of the outer area. For the example given in Fig.4, one can easily argue that given different moving speeds, an entity still ma

y subscribe/unsubscribe many times even if it has an outer area (case b), if the outer area size is not configured to accommodate the moving speed of this entity. The real usefulness of the idea is how to configure the outer area, less the idea itself.

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## This is true, i wanted to think a bit about it but did not do it. We could maybe give a simple rule to set it, depending mainly on the maximum speed of one entity

OK

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>> • The types of movement patterns used in choosing the appropriate regions size (section 3.2) are rather limited. If the types of VEs supported b DiVE mainly exhibits the two types of movement patterns, it’s fine, but the paper should clearly state that. Otherwise, it would be a more thorough study to include a few more movement patterns that are common in the VEs supported by DiVEs, and give instructions on what region sizes to configure given what movement patterns (or given the main movement pattern in an VE).

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## It is true we could have included more move patterns, but honnestly, I thought it was covering most of the case.

In most of the games, or simulation I have seen, it is either 'exploration', so you move pseudo randomly. Or quest, or race oriented, in this case you have 'checkpoints'.

One problem we did not adress clearly is maybe how many clients can we have in the same region. (what is the limit). I guess the limit is the one we had with 'global' area of interest.

Adding something about the maximum clients into the same region

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>> Additional Questions:

>> 1. Which category describes this manuscript?: Research/Technology

>> 2. How relevant is this manuscript to the readers of this periodical? Please explain your rating under Public Comments below.: Relevant

>> 1. Please explain how this manuscript advances this field of research and/or contributes something new to the literature : This paper addresses the scalability challenge in disseminating updates in multi-user virtual environments (VEs) and proposes a region-base area of interest (AOI) technique to control the number of updates transmitted over the network. Althoughthe idea of region-based AOI is not new, this paper evaluate costs and benefits of different region sizes and proposes heuristics on choosing an appropriate region size given the AOI size and some movement patterns of users in the VEs. It also presents the DiVE communication architecture based on the proposed region-based AOI technique. The DiVE architecture is actually the networking framework that has been applied in several transportation related VEs. In other words, it is work that has been applied to practical usages.

>> 2. Is the manuscript technically sound? Please explain your answer under Public Comments below. : Partially

>> 1. Are the title, abstract, and keywords appropriate? Please explain under Public Comments below.: No

>> 2. Does the manuscript contain sufficient and appropriate references? Please explain under Public Comments below.: References are sufficient and appropriate

>> 3. Does the introduction state the objectives of the manuscript in terms that encourage the reader to read on? Please explain your answer under Public Comments below.: Could be improved

>> 4. How would you rate the organization of the manuscript? Is it focused? Is the length appropriate for the topic? Please explain under Public Comments below.: Satisfactory

>> 5. Please rate the readability of the manuscript. Explain your rating under Public Comments below.: Easy to read

>> 6. Should the supplemental material be included? (Click on the Supplementary Files icon to view files): Does not apply, no supplementary files included

>> 7. If yes to 6, should it be accepted:

>> Please rate the manuscript. Please explain your choice.: Good

>> Reviewer: 3

>>

>> Recommendation: Revise And Resubmit As “New”

>> Comments:

>> This work has some potential to be interesting, but, as is, the paper has two major problems:

>> 1) Region-based partioning is not new -- it is used is a large number of virtual worlds. Region-based partitioning with variable client interest range is also not new. OpenSim / Second Life do it -- the client tells the server its "draw distance", and the server sends updates accordingly. The authors don't seem to be aware of this, even though they are knowledgeable of work in the area. The stated contribution of the paper is, therefore, in question. At the very least the authors need to differentiate their approach from that used in OpenSim / Second Life much better. I can see this work being an interesting analysis of the impact of different interest ranges, but the author need to focus the paper on that and frame the work much better in the context of all that already exists.

======

## I agree with the comment. What we propose is a kind of simple way to set a region based method, with a protocol:

- First you decide the view range of your client

- then you set AOI to this value

- then you set region\_size = AOI\_size\*2

Insist on the difference between opensim and dive, we are not having sim, and what we are exchanging is some predefinite objects (entities)

DONE

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>> 2) The Matlab graphs in Section 3 throw a veil of confusion over the entire work. The authors need to either remove that part altogether, replacing it with a theoretical complexity analysis, or improve the Matlab code and its analysis considerably. If the latter, the Matlab code should be part of the paper as an appendix, as it is critical for the reader to understand what is being compared.

======

## I think he thinks the code given is the one to get the graph, which is not true.

However, it could be than some optimization are needed.

Apply code optimization if needed

DONE: modified code reference position

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>> 3) The test conditions in section 5 are poorly explained and, again, throw a veil of confusion about what exactly is being compared.

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## I take note of this comment, maybe we should explain better the test conditions

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>>

>> Detailed comments follow.

>> COMMENT 1

>> Figure 3 (mislabeled Fig. 4 in page 5, line 25) is meant to provide the basic motivation for region-based interest manage

ment, but as is it throws a veil of suspicion over the value proposition of the work. The execution time -- the chosen independent variable -- is sensitive to implementation details. I looked at the Matlab code in order to understand the results (thank you for making it available!). The authors are showing us the comparison between an unfairly bad implementation of distance-based interest management with an ok implementation of fixed space partioning. Additionally, the code has some issues that makes me doubt its relation to Figure 3. Here are the problems:

>> 1) The pause of 50ms in each iteration of the loop has the potential for hiding any computational differences between interest management algorithms. 50ms is an enormous amount of computational time! Updating 1500 entities, no matter how badly that is done, will be several orders of magnitude smaller than 50ms in any decent programming language. Furthermore, 50ms\*10000 iterations = 500s. That means that at the very minimum, all points in that graph should have a runtime of 500s. As such,the graph shown in Figure 3 is impossible to obtain with the provided programs.

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## The pause has been added for the sake of visualization, and was removed during the test

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>> 2) The range in entity-based program is 3; that number is 2 (smaller) in the region-based program.

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## it could be, but still, with a region based you see more than your 'RANGE' as defined in the paper.

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>> 3) The rendering code is being done differently: in the case of entity-based, the axis properties are being set for every entity at every iteration of the loop. In the region-based program, it's being done only once per loop iteration. This willhave an impact.

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## No rendering code when we computed the chart !!!

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>> 4) Ignoring the issues above, the authors perform a simplistic n^2 scan of entities in entity-based, as opposed to using a more suitable data structure for these kinds of clusters. Even without a better data structure, a simple optimization might yield a completely different result:

>> Instead of doing this:

>>

>> %% AREA OF INTEREST ALGORITHM

>> for j=1:number\_entity

>> if (i~=j)

>> dist\_x = abs(all\_entity(i).positionx - all\_entity(j).positionx);

>> dist\_y = abs(all\_entity(i).positiony - all\_entity(j).positiony);

>> if ((dist\_x < range) && (dist\_y < range))

>> % entity in area of interest detected

>> all\_entity(i).nearby = [all\_entity(i).nearby j];

>> end

>> end

>> end

>>

>> Do this:

>>

>> %% AREA OF INTEREST ALGORITHM

>> for j=1:number\_entity

>> if (i~=j) && all\_entity(i).nearby does not contain j % <-------

>> dist\_x = abs(all\_entity(i).positionx - all\_entity(j).positionx);

>> dist\_y = abs(all\_entity(i).positiony - all\_entity(j).positiony);

>> if ((dist\_x < range) && (dist\_y < range))

>> % entity in area of interest detected

>> all\_entity(i).nearby = [all\_entity(i).nearby j];

>> all\_entity(j).nearby = [all\_entity(j).nearby i]; % <---------

>> end

>> end

>> end

>> But anyone doing an entity-based, distance-based interest management would simply use a much better data structure.

======

### This looks like the comment from reviewer 1.I may not be aware of such 'data structures'

=======

>> 5) The region-based program still has an O(N^2) (specifically O(N^2/16) component to it:

>> %% AREA OF INTEREST ALGORITHM PART 2

>> for i=1:number\_entity % <------------------------------------------------------

>> % finding what region the entity sees (what region intersect its

>> % area of interest

>> matrice = region\_seen(all\_entity(i),range,MAP);

>> size\_mat = size(matrice);

>> nb\_region= size\_mat(1);

>> if (nb\_region > 0)

>> % for each region the entity sees, we get update from the

>> % entities of these regions

>> for j=1:nb\_region

>> corX = matrice(j,1);

>> corY = matrice(j,2);

>> if ((corX ~= 0) && (corY ~=0))

>> len = length(cell2mat(region\_map(matrice(j,1), matrice(j,2))));

>> if (len ~= 0)

>> list\_entities = region\_map(matrice(j,1), matrice(j,2));

>> for k=1:length(list\_entities) % <-------------------------------------here

>> all\_entity(i).nearby = [all\_entity(i).nearby list\_entities(k)];

>> end

>> end

>> end

>> end

>> end

>> end

>> As the number of entities grows, so does the number of entities in each region -- assuming 16 regions, the growth is by a factor of N/16. As such, the algorithm is still quadratic, especially when implemented in this simplistic manner. Yet, we don't see it in Figure 3. One more reason to suspect that Figure 3 does not reflect the code.

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### It DOES NOT reflect the code, indeed

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>> Bottom line: this analysis throws a veil of suspicion over the entire work. Instead of running Matlab programs and measuring runtimes of specific implementations, the authors should perform a theoretical complexity analysis of their algorithms. In doing so, they would very likely come to the conclusion that the region-based interest management algorithm is still quadratic in nature, but with a much lower growth rate. If I'm wrong, the authors should show it in their analysis.

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### This sounds weird to me, maybe by pushing more the matlab code we can see the region approach as quadratic, but i doubt it.

It may be quadratic with the number of regions, but not with number of entities.

This comment gives me a doubt.

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>> COMMENT 2

>> In section 5.2.3, the definitions of AOI are unclear. 1x1 area of interest is << than 60x60, the size of each region. How do the clients in "Local AOI" "see only what's in their region"? Do they see all entities in their region? Or only the entities in their region that fall within their 1x1 range?

======

### we should make it clear, they see their region

DONE, and NOT DONE, the text : “we use a `local' area of interest, 1m$\times$1m.\footnote{Note that the client can still see the whole region where the AOI is located in.} This size is smaller than the region size, so the clients basically see only what is in their region.” Seems clear

======

>> 1x1 range seems really small, given the max of 350 clients of the experiment. It would be important to know the average number of clients per region and the average number of other clients per client interest range.

======

### that is a good point, it may just sound a bit disapointing because we have quite a lot of regions. Still, with the checkpoint approach, the clients may be pretty concentrated aroung points

DONE: Limit of client in one region = limit of client with global AOI

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>> More importantly, I would expect to see an analysis of the size of the interest range, and that's not what this study shows. The authors need to do a better job at explaining what the results in section 5 show. Or better yet, show a study of the effect of the size of the interest range.

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### For this comment, I would say we need a starting point. In our case we started with the range, saying "we decide view range will be X, what is then the good region size.

I thought this approach was more pragmatic than saying, this is the region size, then what is a good view range.

OK

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>> Minor details:

>> pg 2, lines 15, 16: wrong grammar

>> pg 2, lines 37-50: mischaracterization of both the Hypergrid and multi-simulator opensim/SL grids

>> pg 3, lines 32-34: OpenSim offers a plugin API too

>> Additional Questions:

>> 1. Which category describes this manuscript?: Research/Technology

>> 2. How relevant is this manuscript to the readers of this periodical? Please explain your rating under Public Comments below.: Relevant

>> 1. Please explain how this manuscript advances this field of research and/or contributes something new to the literature: This paper has the potential to contribute a performance analysis of interest management in fixed space partitioning virtual environments. But the current paper has so many problems that the potential contribution is mute.

>> 2. Is the manuscript technically sound? Please explain your answer under Public Comments below. : No

>> 1. Are the title, abstract, and keywords appropriate? Please explain under Public Comments below.: Yes

>> 2. Does the manuscript contain sufficient and appropriate references? Please explain under Public Comments below.: References are sufficient and appropriate

>> 3. Does the introduction state the objectives of the manuscript in terms that encourage the reader to read on? Please explain your answer under Public Comments below.: No

>> 4. How would you rate the organization of the manuscript? Is it focused? Is the length appropriate for the topic? Please explain under Public Comments below.: Satisfactory

>> 5. Please rate the readability of the manuscript. Explain your rating under Public Comments below.: Easy to read

>> 6. Should the supplemental material be included? (Click on the Supplementary Files icon to view files): Yes, as part of the main paper if accepted (cannot exceed the strict page limit)

>> 7. If yes to 6, should it be accepted: After revisions. Please include explanation under Public Comments below.

>> Please rate the manuscript. Please explain your choice.: Poor