A Cluster Formation Algorithm for Fog Architectures Based on Mobility Parameters at a Geographically LAN Perspective

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Agenda

1. **Introduction**
2. Related Works
3. Experimentation
   - 3.1 Environment
   - 3.2 Proposed Algorithm
4. Evaluation Results
5. Conclusions and Future Work

Introduction

- 1 trillion US$ IoT
- Location systems heavily rely on mobility patterns, which involve a set of variables like speed, direction and orientation
- Fog based architectures have been used, since they can process, compute and deliver information within the network, costing considerably less than cloud-only approaches
- Clusters as regions in indoor systems: location awareness
- Problem of manually set clusters: stakeholders unreliability
- **Is it possible to organize clusters based on geographical and location parameters?**
- Contributions:
  1. implemented algorithm to set up clusters using geographical parameters
  2. customized dataset of user mobility based on EUA dataset

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Related Works

	MANET	VANET	User-walk	Fog	Adaptive clusters	Location-based formation	Urban scenario
[1]	X		X		X	X	
[2]	X	X			X	X	
[8]					X	X	
[11]		X			X	X	X
[14]		X			X	X	X
[15]				X		X	
Our proposal			X	X		X	X

Table 1: Comparison of the proposed to the related works

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Experimentation - Proposed Algorithm (Overview)

- Based on accepted node range (ANR) and maximum nodes per cluster (MAX)

Input

.csv file based on EUA dataset format [1]

ID	Latitude	Longitude	Block	Level	Parent	State	Details
0	-27.600469	-48.5182707	0	0	-1	VIC	cloud
1	-27.6004237	-48.5183383	1	1	0	VIC	proxy
8	-27.6004051	-48.5182962	1	2	1	VIC	gateway

Table 2: Sample of an input file

[1] https://github.com/swinedge/eua-dataset

Experimentation - Algorithm (Initialization)

The developed code is responsible to parse the input file to the arrays

Algorithm 1: Proposed cluster formation algorithm

Input : Array containing fog coordinates
Output: Array containing fog coordinates and regions

$metersPerNode \leftarrow AREA/nodes;$
$range \leftarrow AREA/metersPerNode;$
$maxNodesPerCluster \leftarrow nodes/metersPerNode;$
$clusters \leftarrow null;$

Figure 1: Initialization part of the algorithm

Experimentation - Algorithm (Formation pt.1)

```
{FORMATION}
for node in nodes do
    if clusters.size() is null then
        adds node to clusters and sets responsible as 0
    else
        if responsible is null then
            tries to get responsible for node and breaks
        end if
        if responsible is still null then
            adds node to clusters
            sets responsible as clusters.size() - 1
            adds node to added array
        end if
    end if
```

Figure 2: First half of the Formation part of the algorithm

Experimentation - Algorithm (Formation pt.2)

```
    for node in nodes do
        if nextNode is equal to current then
            continue;
        end if
        if added contains current then
            continue;
        end if
        if the size of clusters[responsible] is less or equal to the maxNodesPerCluster then
            if distance between current and nextNode is within range then
                adds nextNode to clusters[responsible]
                adds nextNode to added array
            end if
        else
            if distance between current and nextNode is within range then
                adds node and nextNode to clusters with node as responsible
                adds node and nextNode to added array
            end if
        end if
    end for
end for
```

Figure 3: Second half of the Formation part of the algorithm

Experimentation - Algorithm (Optimization)

```
{OPTIMIZATION}
for responsible in clusters do
    if the size of clusters[responsible] has more than one node then
        adds group to selected array
    end if
end for
return selected
```

Figure 4: Optimization part of the algorithm

Experimentation - Algorithm - Output

Output

Array of fog coordinates and regions

ID	Latitude	Longitude	Block	Level	Parent	State	Details
0	-27.600469	-48.5182707	0	0	-1	VIC	Datacenter
1	-27.6004237	-48.5183383	1	1	0	VIC	Block 1 Proxy
8	-27.6004051	-48.5182962	1	2	1	VIC	GW 1

Table 3: Sample of an output file

Algorithm - Limitations

- Cluster omission
- Users still connected even distant than ANR
- User input dependency

Experimentation - Environment

- iFogSim v2
- 3-tiered cloud-fog-edge model
- Wi-fi based location system (WLAN)

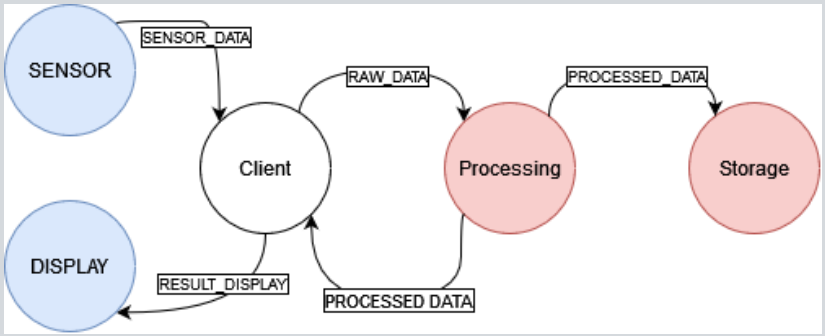

Figure 5: Application modules

Figure 6: QR Code to the repository

Experimentation - Clusters

- 130 nodes
- 12 clusters

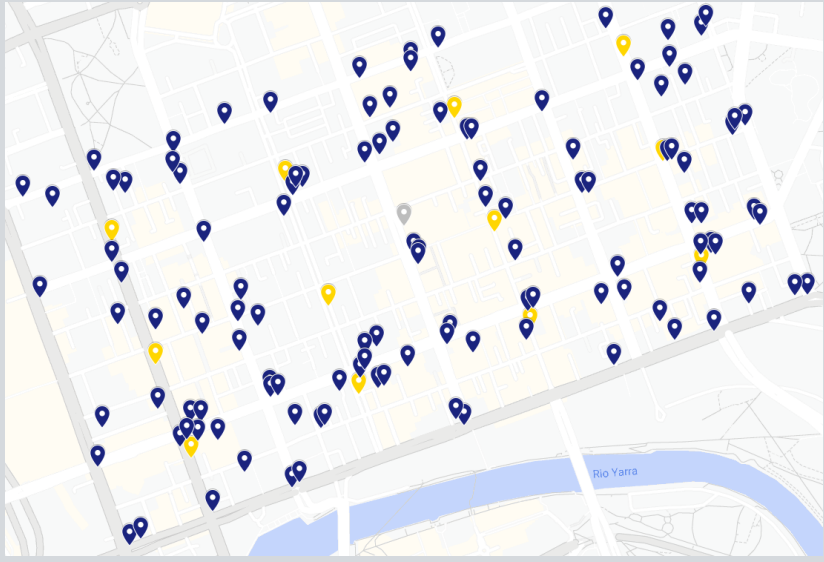

Figure 7: Original EUA clusters

- 128 nodes
- 28 clusters

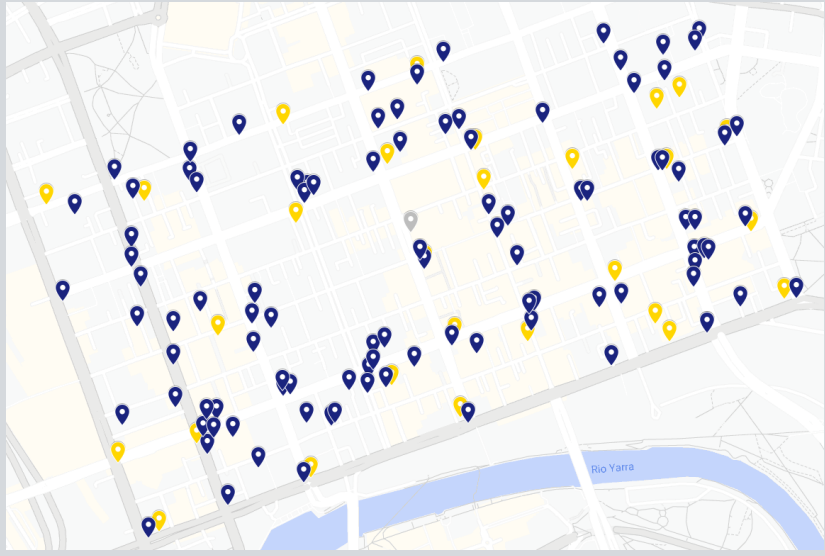

Figure 8: Generated clusters

Experimentation - Datasets

Two edge resource mobility datasets: randomized and directional

Randomized dataset

- Generated by the simulator
- Preordained max. distance
- 1, 5, 10 and 50 users

Directional dataset

- Street direction logic
- Real user walking
- 1, 5, 10 and 20 users

Each experiment was ran 10 times

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Evaluation Results - Migration Time

- Migration performance and specifically delayed by the application modules: mobility induced by user-walking

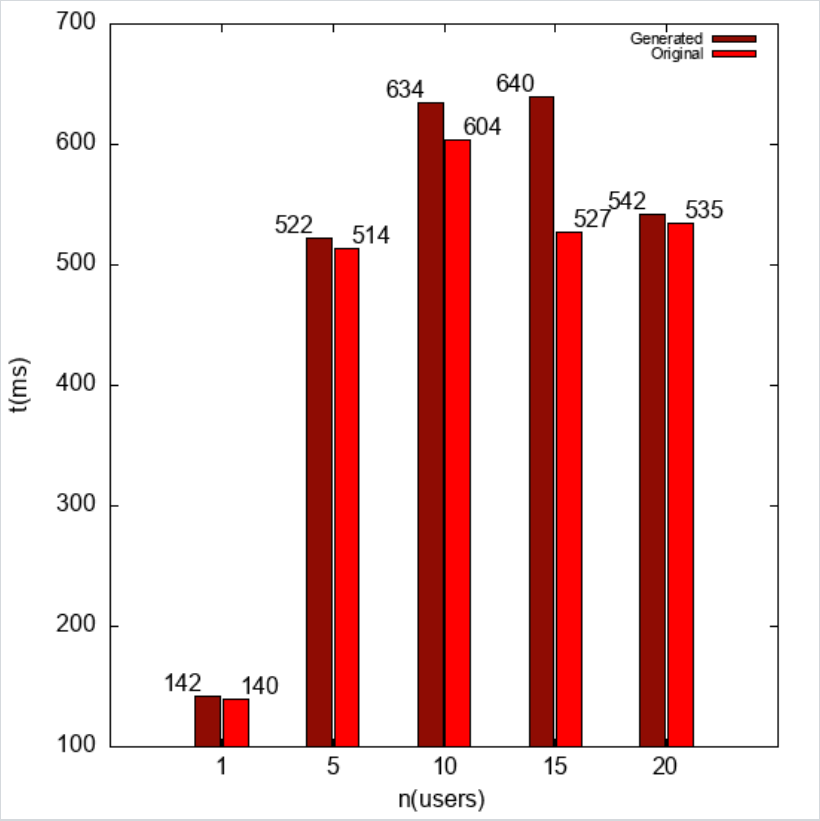

Figure 9: MT in original and generated clusters using directional dataset vs number of users

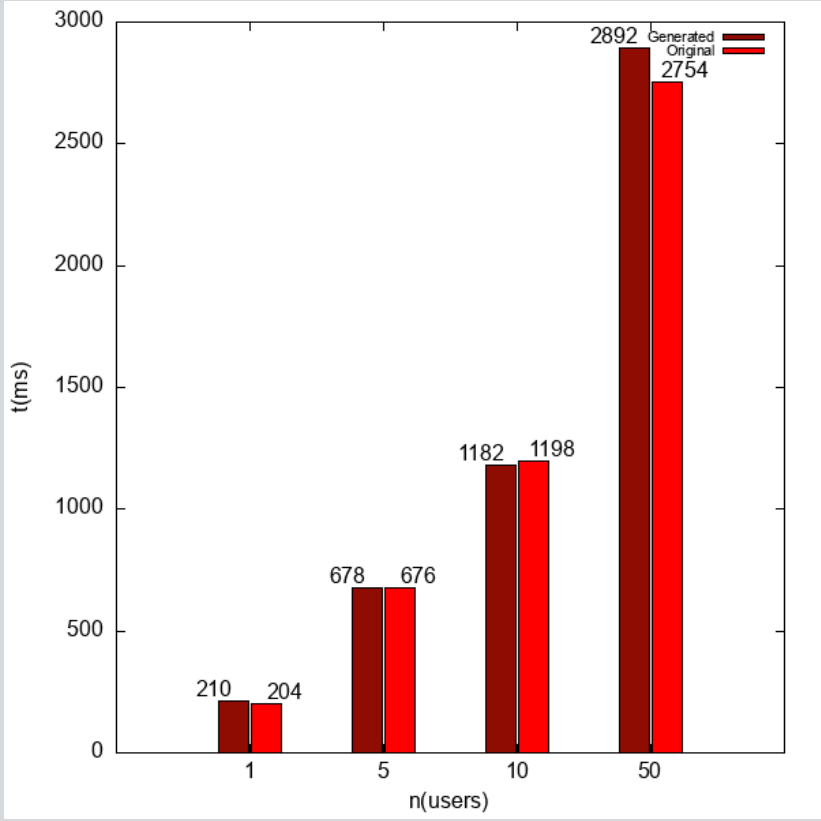

Figure 10: MT in original and generated clusters using randomized dataset vs number of users

Evaluation Results - Application Delay

- Performance time overall

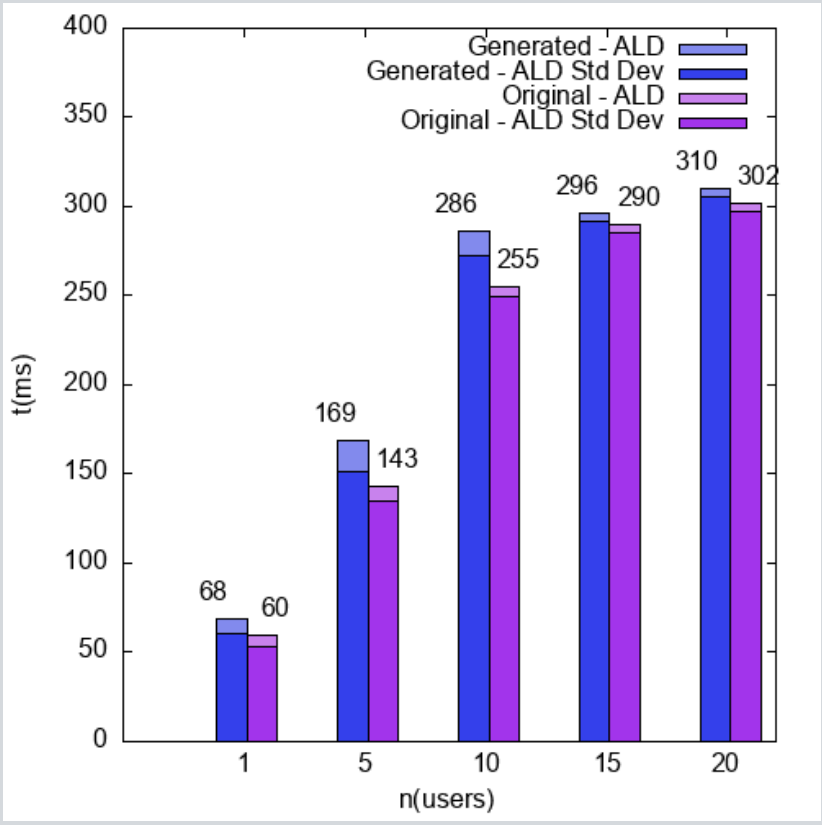

Figure 11: ALD in original and generated clusters using directional dataset vs number of users

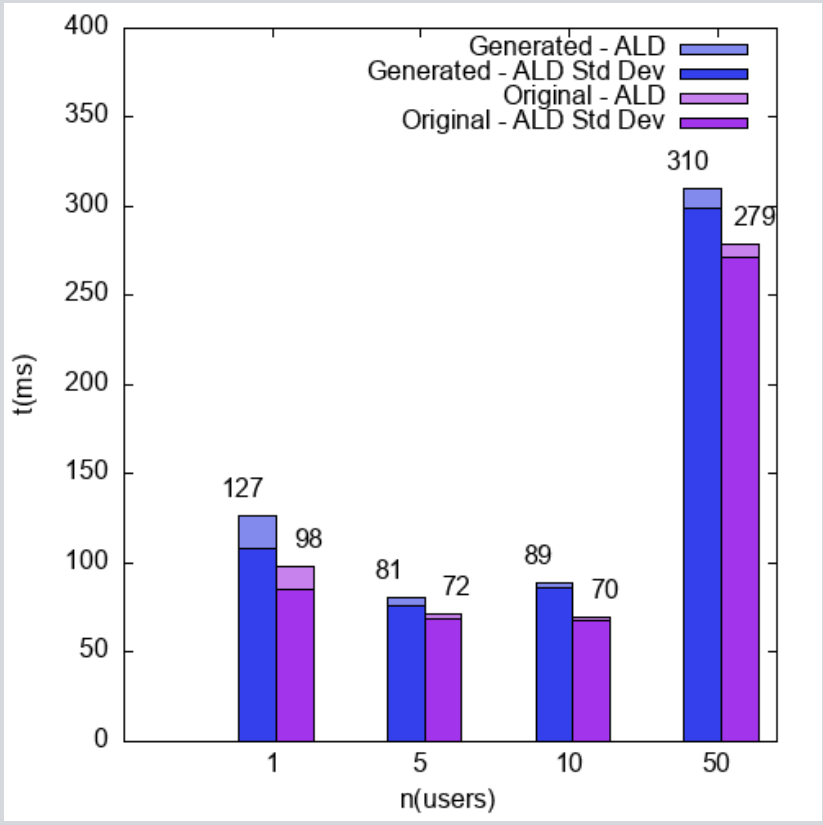

Figure 12: ALD in original and generated clusters using randomized dataset vs number of users

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Conclusions and Future Work

- Region-based approaches can enhance LBS increasing QoS and context-awareness, reducing computational and financial costs
- This study presented an algorithm that can help defining clusters through geographical parameters
- Using less nodes, our algorithm was capable of having similar performance when compared to the default dataset
- Future work: weight feature based on previous datasets to prioritize regions

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Thank you

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