A view from inside a distributed Internet coordinate system.

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A view from inside a distributed Internet coordinate system.

- Why studying Internet coordinate systems?
- How does an Internet coordinate system work?
  - Vivaldi
- Experimentation scenario
- Simulation scenario
- Our clustering algorithm
- Experimental results
- Conclusion and Future work

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Why studying Internet coordinate systems?

- Recently, a new approach has emerged for Internet positioning having the main advantage of providing estimates for network delays between machines at a low measurement cost (ICS).

- Can coordinates then be an efficient way for a light-weight network diagnosis that does not require the deployment of a complex monitoring infrastructure?.

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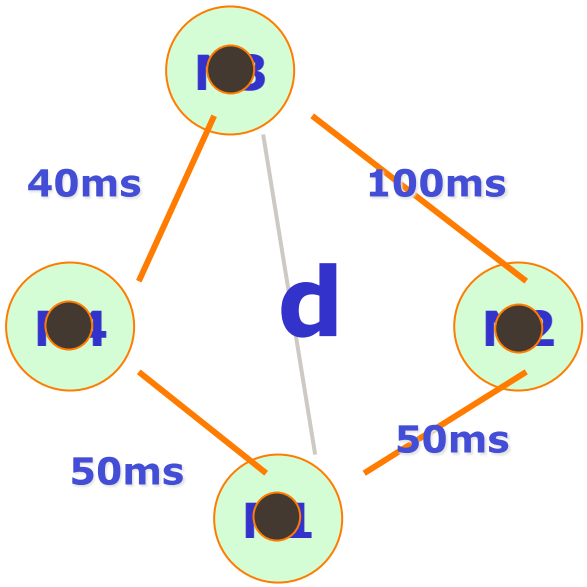
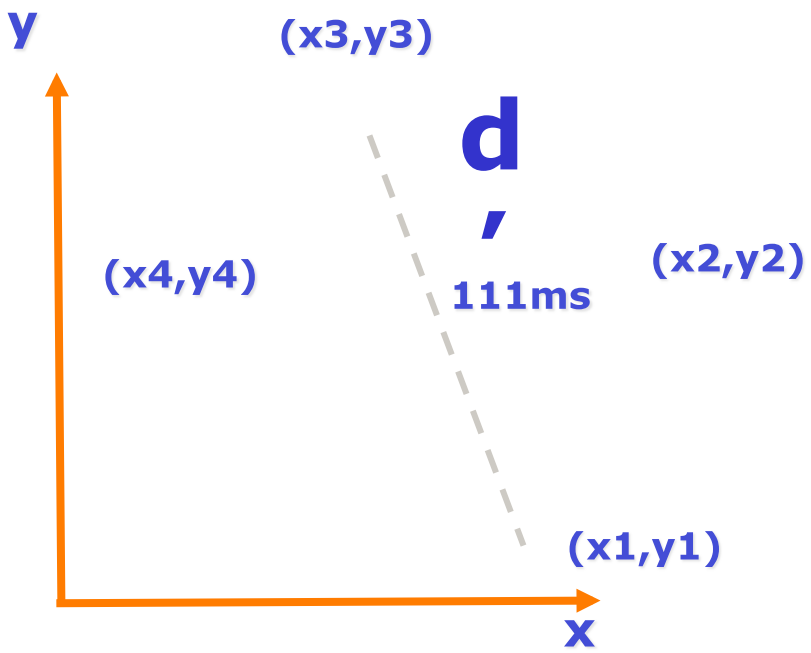
How does an Internet coordinate system work?

- ICS (Internet Coordinate Systems):
  - Embed RTTs into geometric spaces
  - The network delay between any two nodes can be approximated by the geometric distance separating them.





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Vivaldi : A decentralized Internet coordinate system

- Fully distributed, light-weight and efficient algorithm
- No fixed network infrastructure and no distinguished nodes.
- It is able to estimate network delays accurately while minimizing the load on the network.

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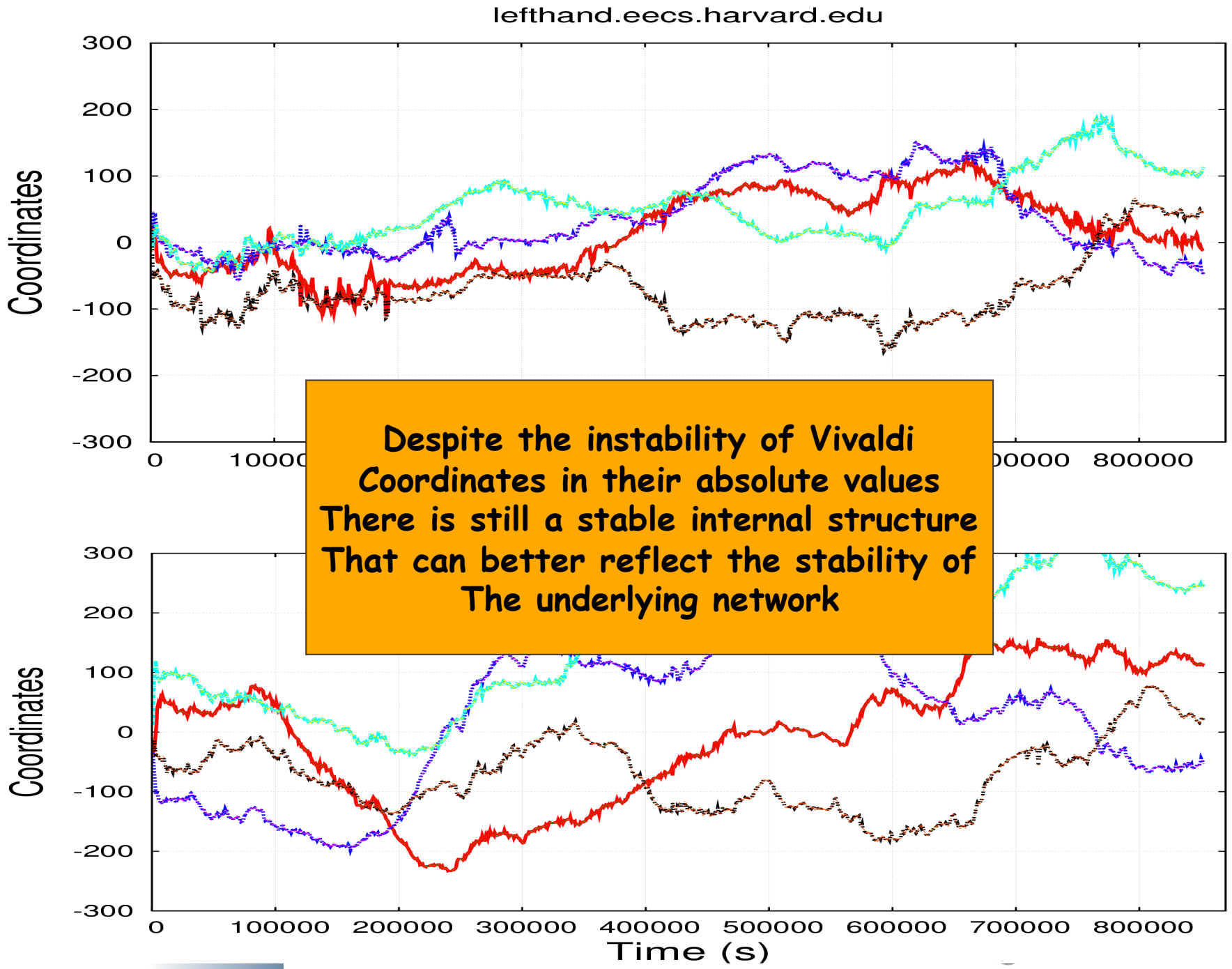
The basic idea of Vivaldi

- Every node has an estimation of its coordinate.
- It picks a random node and asks for its coordinate estimation.
- It computes the Euclidean distance between itself and this selected node and compare it to the network delay between them.
- It computes the stretch of the path and decides on the change to introduce into its coordinate.
- All nodes keep applying this algorithm in a decentralized manner until the whole system stabilizes.


lefthand.eecs.harvard.edu
Coordinates
300
200
100
0
-100
-200
-300
0
800000
Despite the instability of Vivaldi
Coordinates in their absolute values
There is still a stable internal structure
That can better reflect the stability of
The underlying network
Coordinates
300
200
100
0
-100
-200
-300
0
100000
200000
300000
400000
500000
600000
700000
800000
Time (s)

Experimentation scenario

- Pyxida implementation of Vivaldi (from Harvard, in java)
- 145 nodes
- 32 neighbors per node
- Four dimensions + height
- Applicative ping (UDP)
- One ping every 10 seconds
  - Approximately one tour every 320 seconds
- Measure coordinates every 10 seconds

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Simulation scenario

- For flexibility purposes, we also resort to simulations.
- To be close to reality, we simulate a real topology of PlanetLab provided by the iPlane infrastructure.
  - 200 nodes
- We fix the duration of all simulations to 30000 seconds as the convergence time of coordinates is around 2000 seconds.

Clustering algorithm [1]

- Cluster: A set of nodes that are stable with respect to each other.
- ε: This is the threshold of allowed variations of Euclidean distances (expressed in ms).
- Error : an error occurs between two nodes *i* and *j* at time interval *t* when the shift of the Euclidean distance between them is larger then the threshold ε.
- *C*, or the confidence level, allows **1-*C*** distance error between two nodes.
- I: Number of past time intervals of 10s to be considered for the clustering. After trying several values for I, we specify it to 100 in this work.

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Clustering algorithm [2]

- First, we calculate the number of violations from each node to all other.
- We sort nodes by their decreasing number of violations.
- The algorithm here starts with all nodes in the same cluster.

- To find the first cluster, we exclude the node with the largest number of violations, then we recalculate the number of violations for the remaining nodes. We continue excluding nodes with large number of violations until there is no violation between the nodes of the cluster.

- We repeat the above steps to form a second cluster with the excluded nodes.

- We stop the algorithm when we are left without any excluded node.

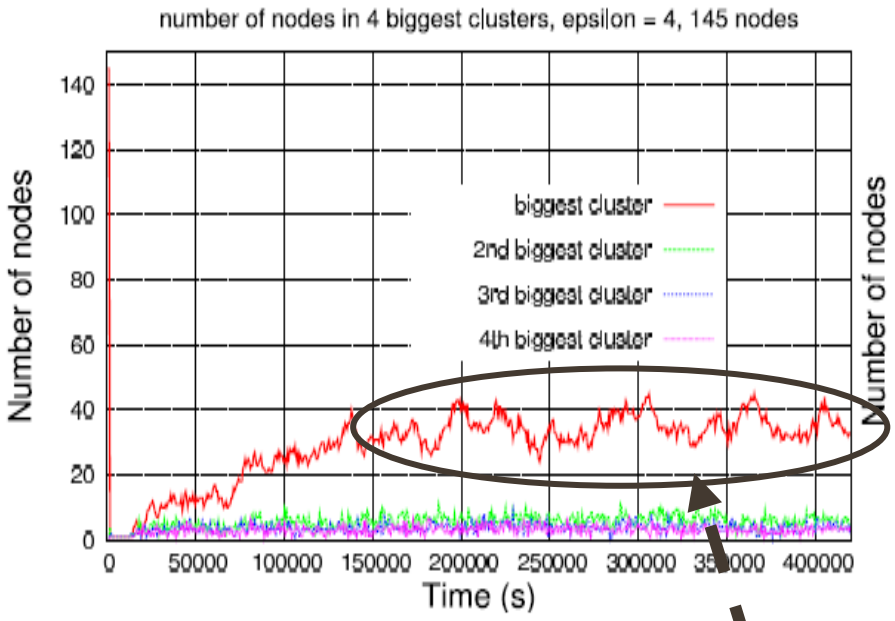


Fig.3(a) (ϵ = 4ms)

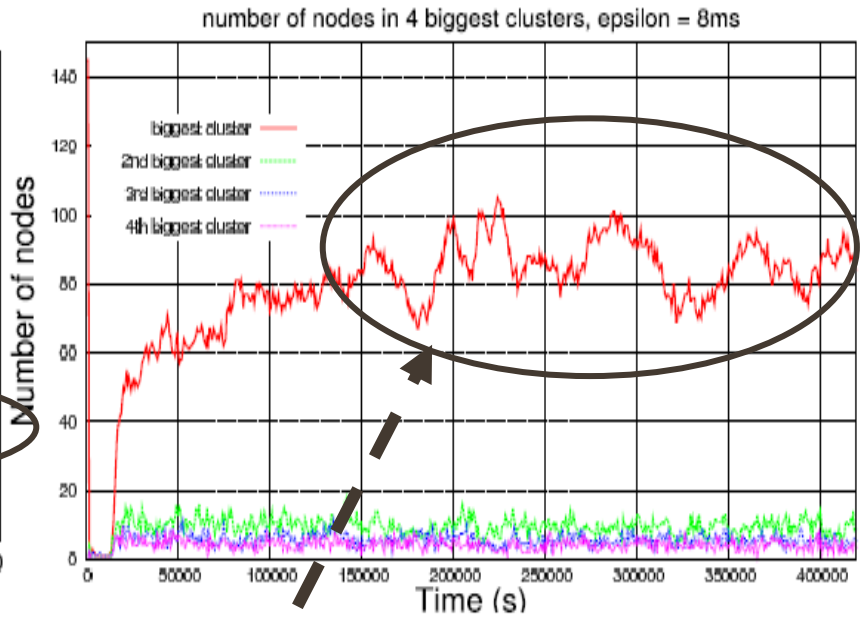


Fig.3(b) (ϵ = 8ms)

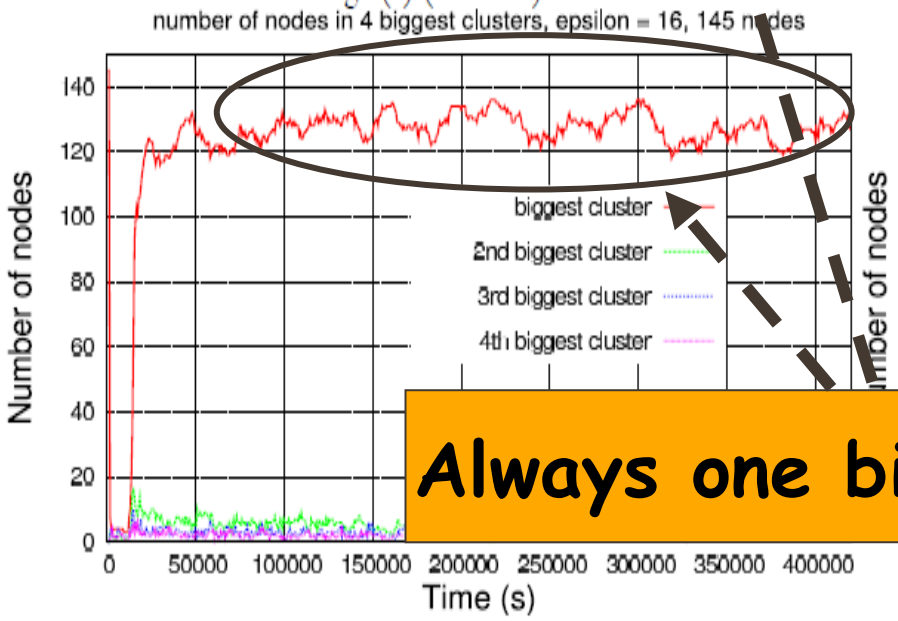


Fig.3(c) (ϵ = 16ms)

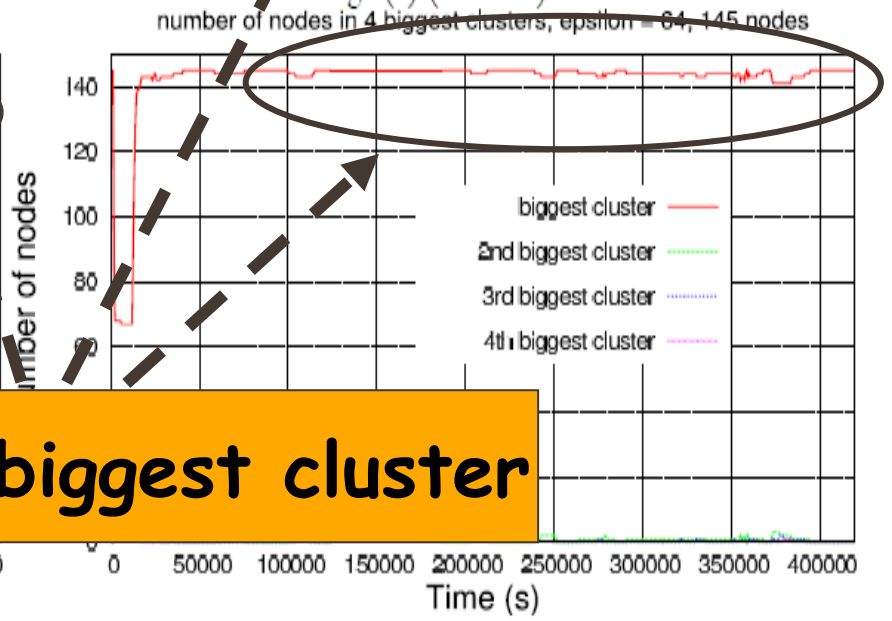
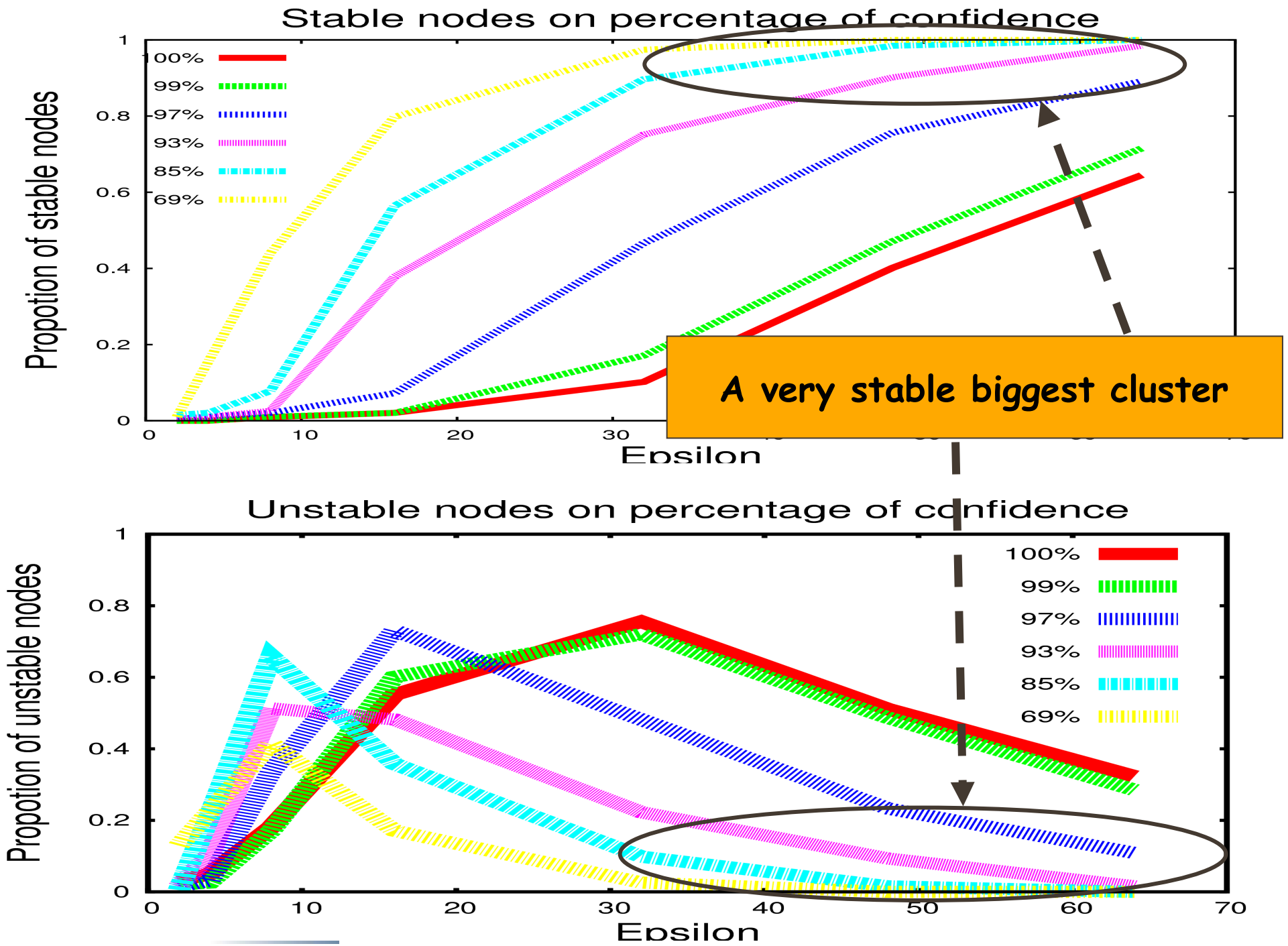
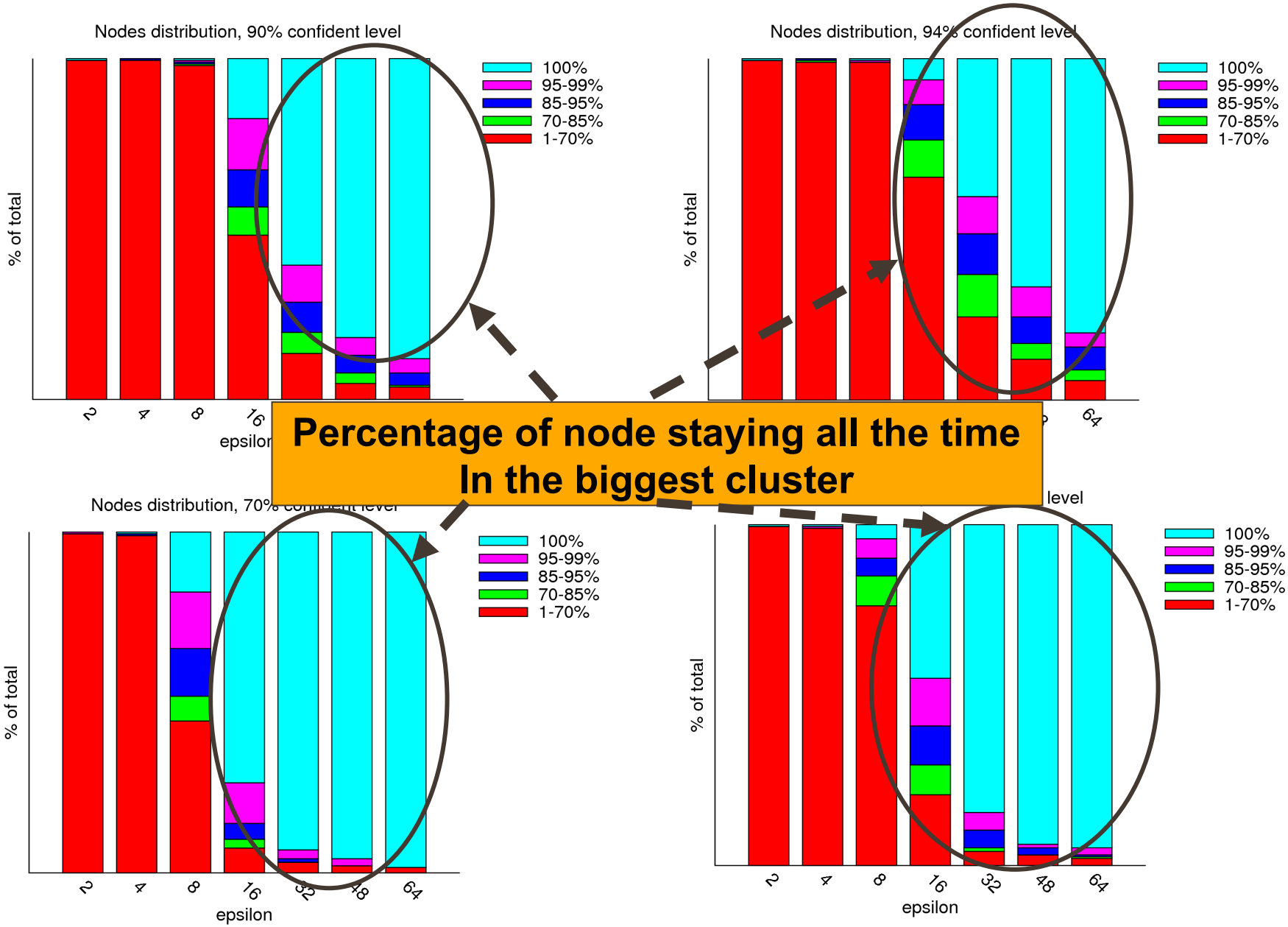


Fig.3(d) (ϵ = 64ms)

Always one biggest cluster


Stable nodes on percentage of confidence
Propotion of stable nodes
Epsilon
100%
99%
97%
93%
85%
69%
A very stable biggest cluster
Unstable nodes on percentage of confidence
Propotion of unstable nodes
Epsilon
100%
99%
97%
93%
85%
69%



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Conclusion

- We studied the Vivaldi coordinate system from inside and we showed that despite the instability of these coordinates, there is still a stable core of nodes that can be used to track network changes.
  - The amount of changes to detect and the confidence level of tracking can be set by the network administrator.
- We developed a new clustering algorithm that permitted us to group the stable nodes together following the amount of variations of their coordinates.

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Future work

- An exhaustive experimental study to validate the performance of such protocol by considering a large set of scenarios for changing network delays.

- Designing a distributed protocol for machine clustering and for the detection and localization of network delay anomalies, by the help of Vivaldi coordinates.

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Thank You

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