An Adaptive Hierarchical Extension of DSR: The Cluster Source Routing

Farid Jaddi[†] Béatrice Paillassa[†]

[†] IRIT-ENSEEIHT
2, Rue Camichel
Toulouse, France

May 19, 2005

Topic

Objective

- Improving the DSR scalability.

Originality

- Adaptive use of our full-compatible extension according to network conditions.

Outline

1. Research context
   - Proposal
   - Principle
2. Adaptive Routing
   - Adaptation criteria
   - Criteria estimation
3. Our proposal
   - CSR model
   - CSR Route Discovery
   - Architecture
   - Routing mode switching
4. Conclusion

Previous work

1^{st} generation: (1997)

- Flat (DSR, AODV)
- Overhead minimization on low-density networks
- Flooding-based Route Discovery on high-density networks

2^{nd} generation: (2002)

- Hierarchical Routing (OLSR, ARC)
- Overhead minimization on high-density networks
- Architecture set up and maintenance on low-density and/or high-mobility networks

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Proposal

Motivations

- Scalability limitations of DSR
- Different performance domains for each kind of solutions

Our proposal

- Hierarchical extension for DSR: CSR
- Adaptive extension: *DSR* $\leftrightarrow$ *CSR*
  - ☞ DSR (low-density, high-mobility networks)
  - ☞ CSR (high-density, low-mobility networks)

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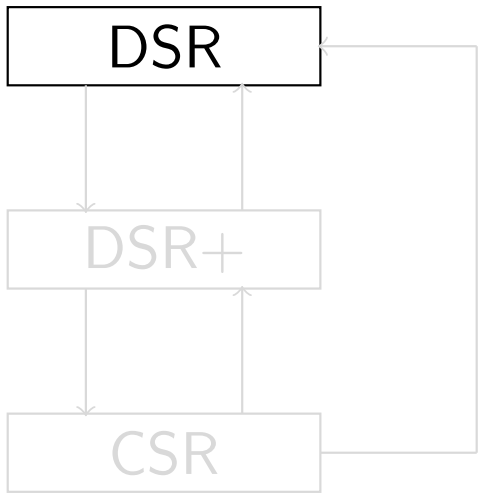
Principle of our proposal

Stages

- Init: DSR mode (DSR routing)
- If suitable {density, mobility} :
  - Set up of the CSR scheme
  - DSR routing
- operational CSR mode :
  - CSR routing



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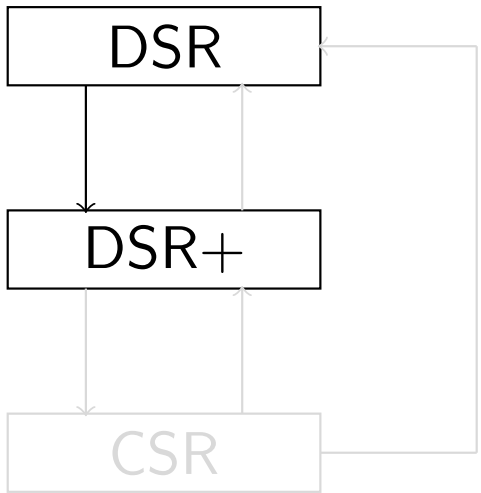

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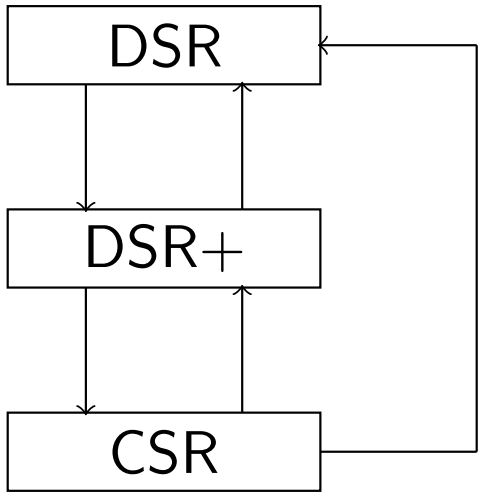

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Adaptation criteria

How to evaluate suitable {density, mobility} conditions ?

Key criteria

- Density
- Mobility

Estimation

- Routing level

Criteria estimation

Periodic Hello for each node

- Local mobility: Link duration between neighbors
- Density: number of neighbors

Routing information

- Local mobility: Link duration estimation from Route cache
- Density: number of neighbors (Route cache)
- Global mobility: Route cache and control traffic

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Adaptation criteria utility

Mode switching between DSR and CSR

Global mobility + density

Timers adjustment

Local mobility

Election criterion of Cluster Heads

Local mobility + density

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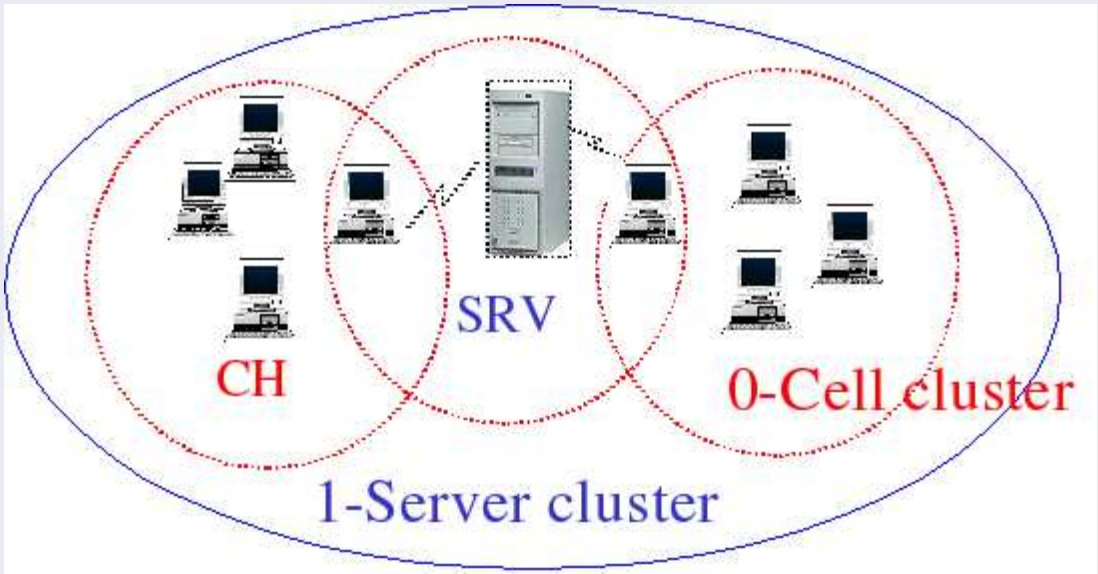
CSR model

2-level hierarchy

- 0-Cell cluster
- 1-Server cluster



CSR principles

Optimized Routing

- CSR Route Discovery

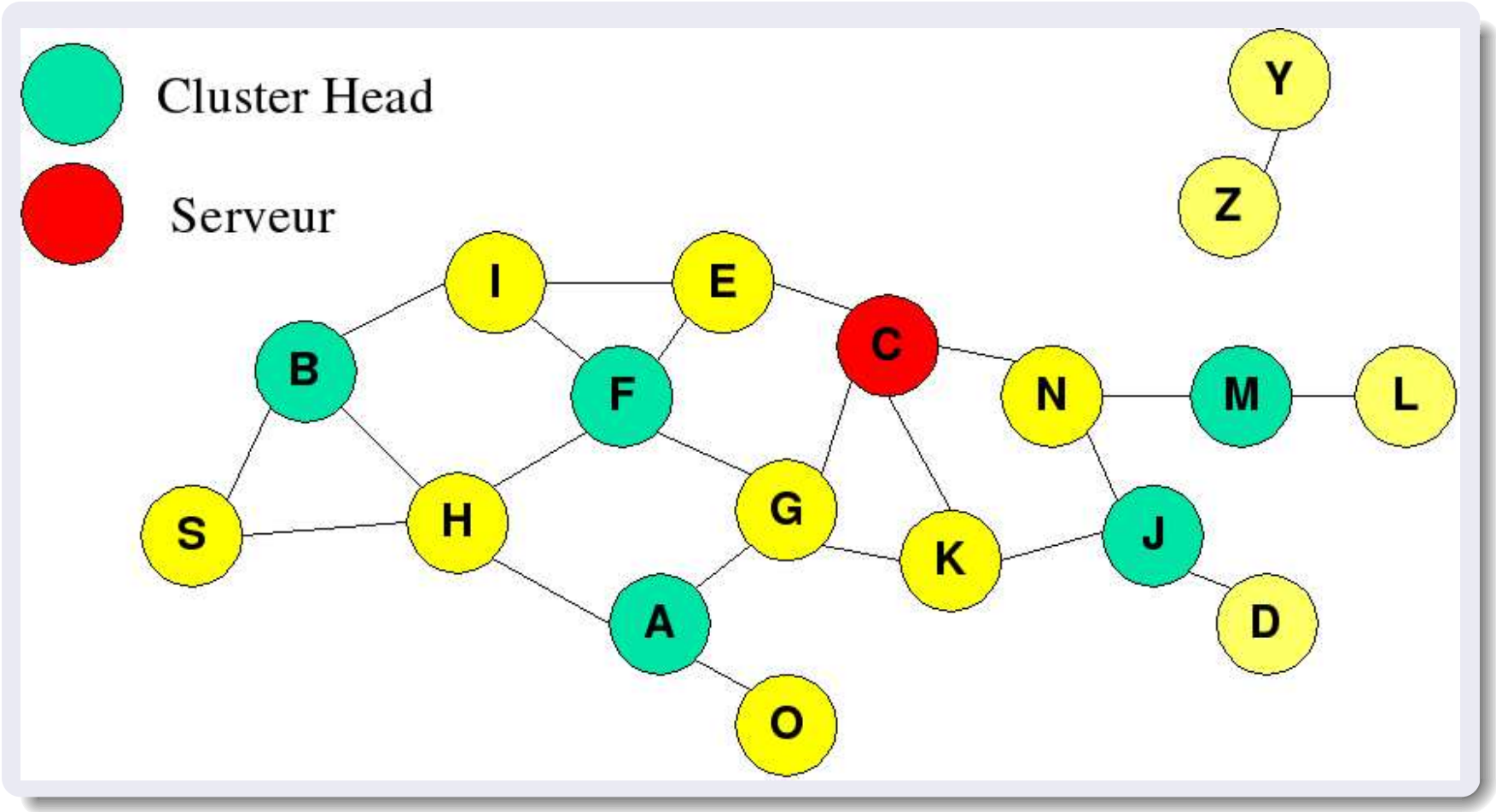
Hierarchical architecture

- Clusters set up
- Clusters maintenance

Adaptation wrt mobility and density

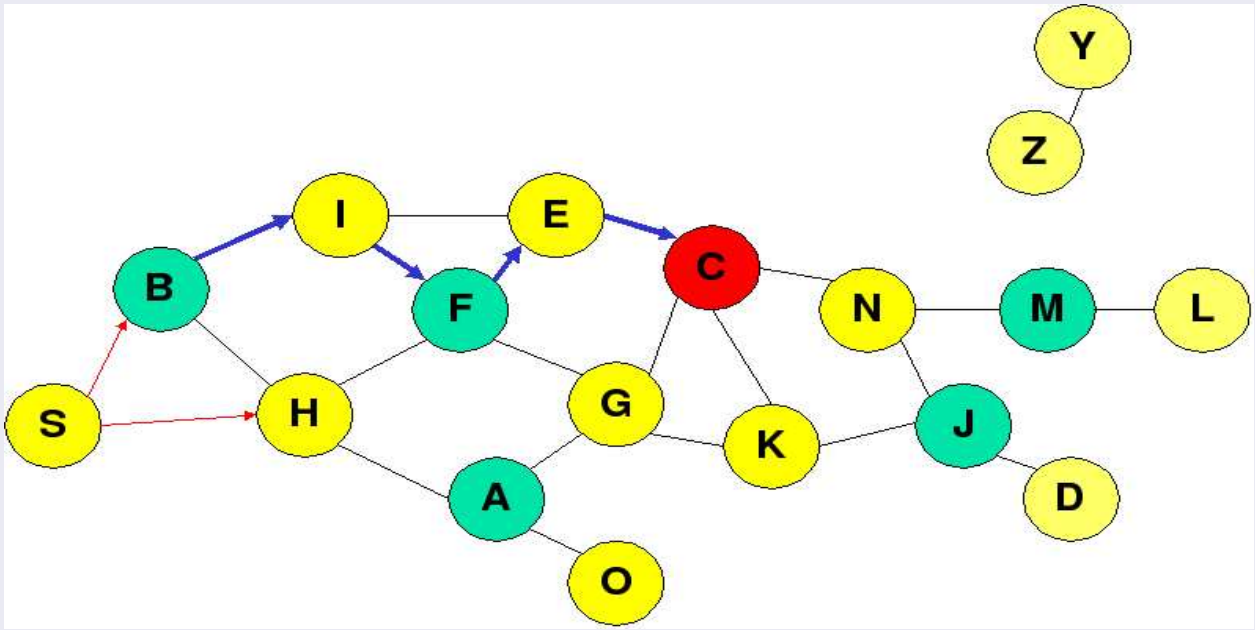
- mode switching $DSR \leftrightarrow CSR$

CSR Route Discovery (1)



CSR Route Discovery (2)

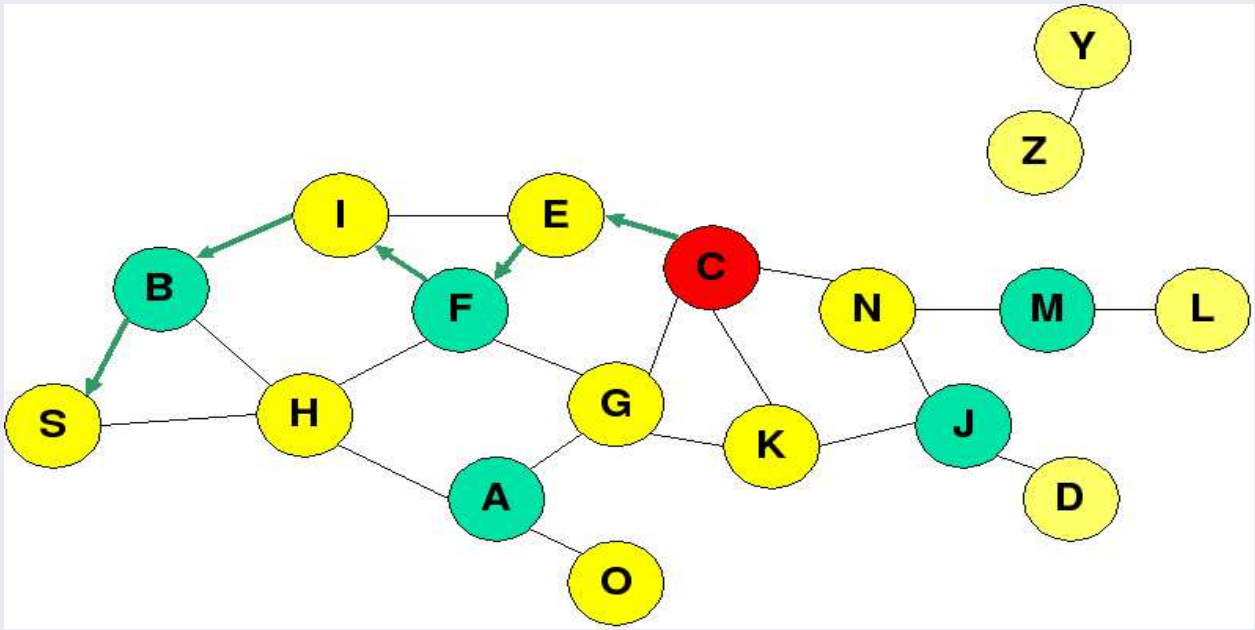
- Local broadcast
- Route Request forwarding to Server



CSR Route Discovery (3)

Route already in Server Cache

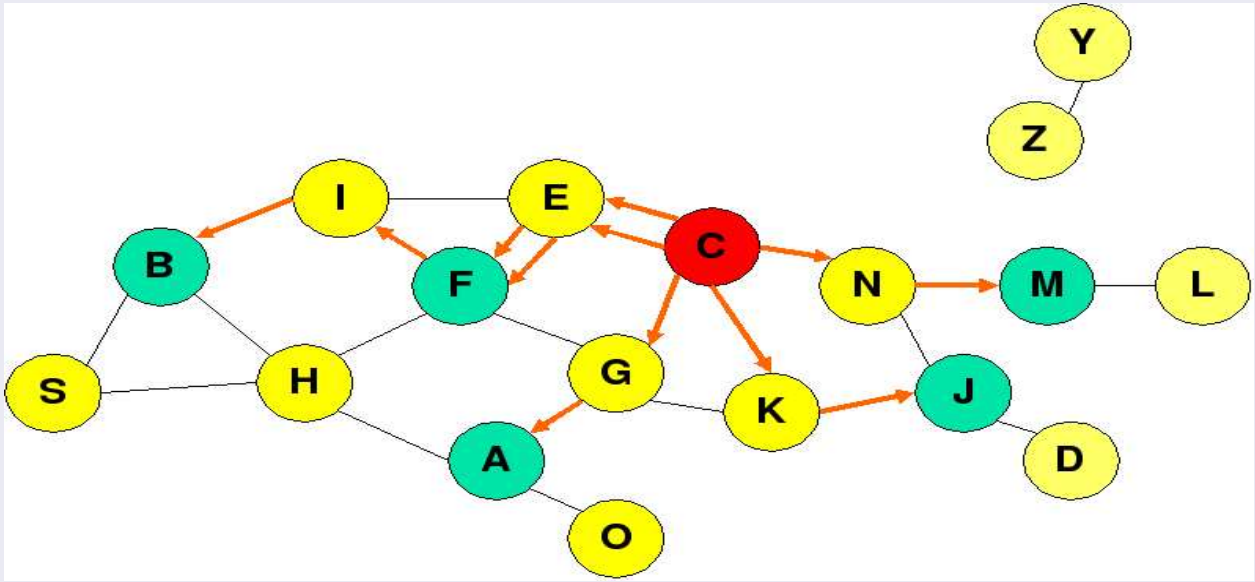
- Server Route Reply



CSR Route Discovery (4)

No route in Server Cache

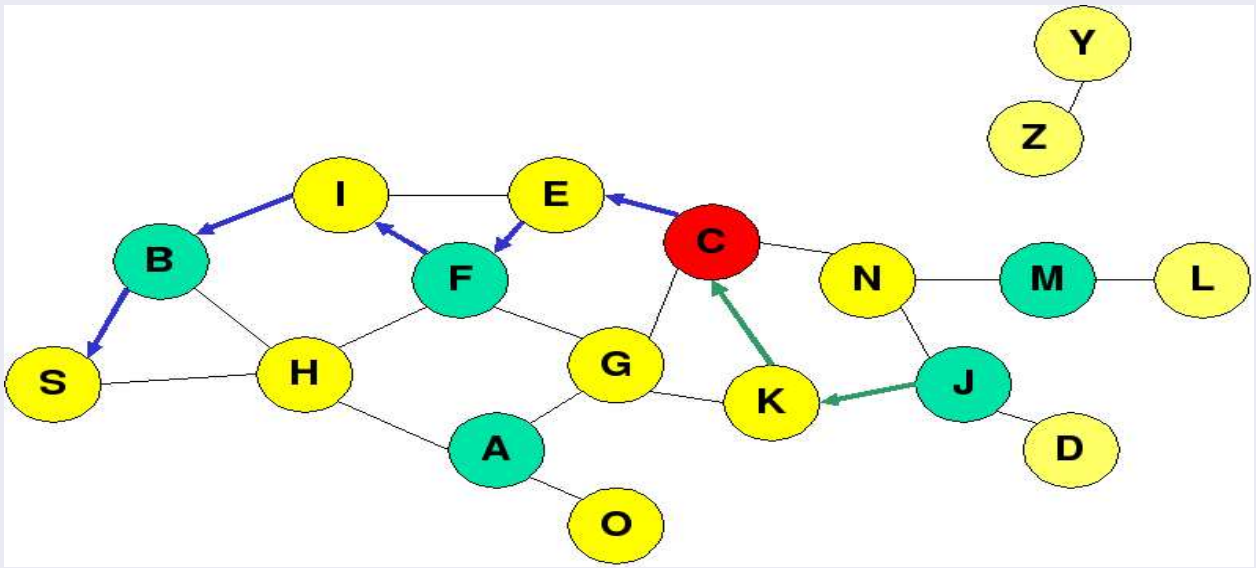
- Cluster Heads questioning to localize the destination



CSR Route Discovery (5)

Destination localized

- Cluster Head(s) Reply to the Server
- Server Reply to the source of the Request



Global evaluation

Objective

- Comparison of DSR and CSR Route Discoveries

Parameters

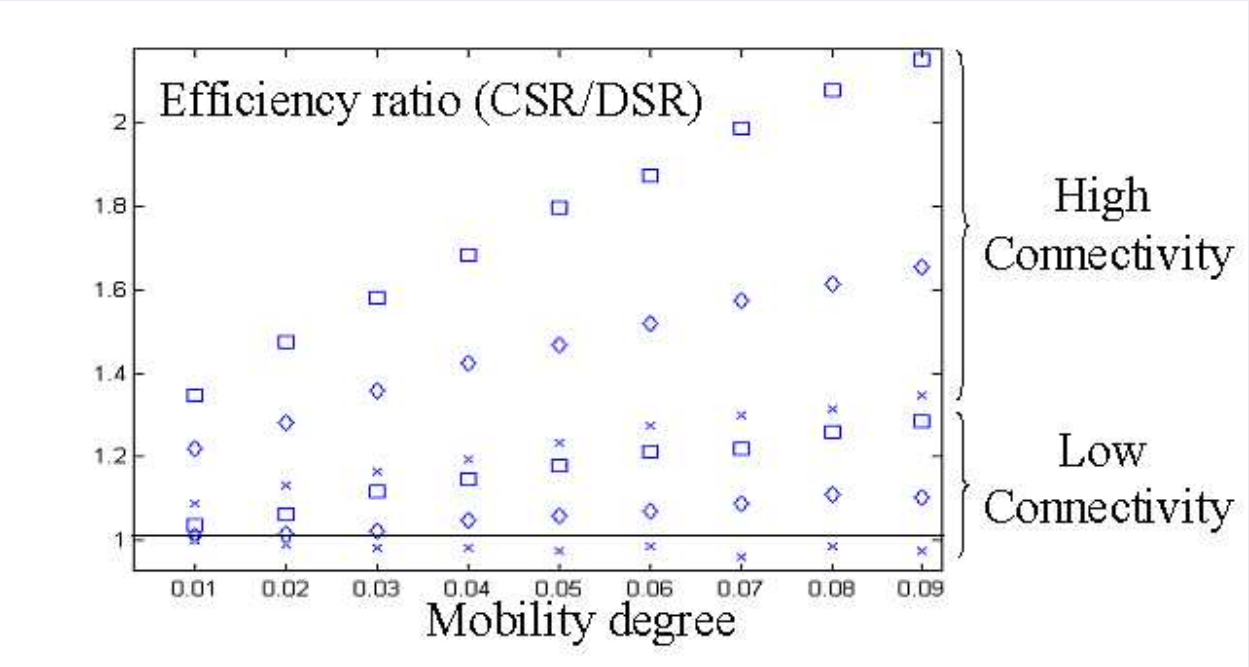
- Mobility degree
- Node density
- Connectivity degree

Metric

- Efficiency: $\frac{Data}{Data+Overhead}$

Global evaluation (2)

Efficiency ratio on 2 topologies for 3 node densities



node density: $\times \leq \Diamond \leq \square$

0-Cell cluster

Set up

- Cluster Head election.
- Criterion = local mobility + density.
- Mechanism :
  - local broadcast in the 1-hop neighborhood.

Maintenance

- Each CH periodically broadcasts a Maintenance packet.
- If absent CH, a Node initiates a CH election.

1-Server cluster

Set up

- Cluster Heads registration to Server
- If absent Server, CH initiate a Server election
- Server is selected among Cluster Heads

Maintenance

- Cluster Heads periodically indicate their position
- Server updates its routing information

Detailed evaluation

Objective

- CSR procedures implementation

Simulation tool

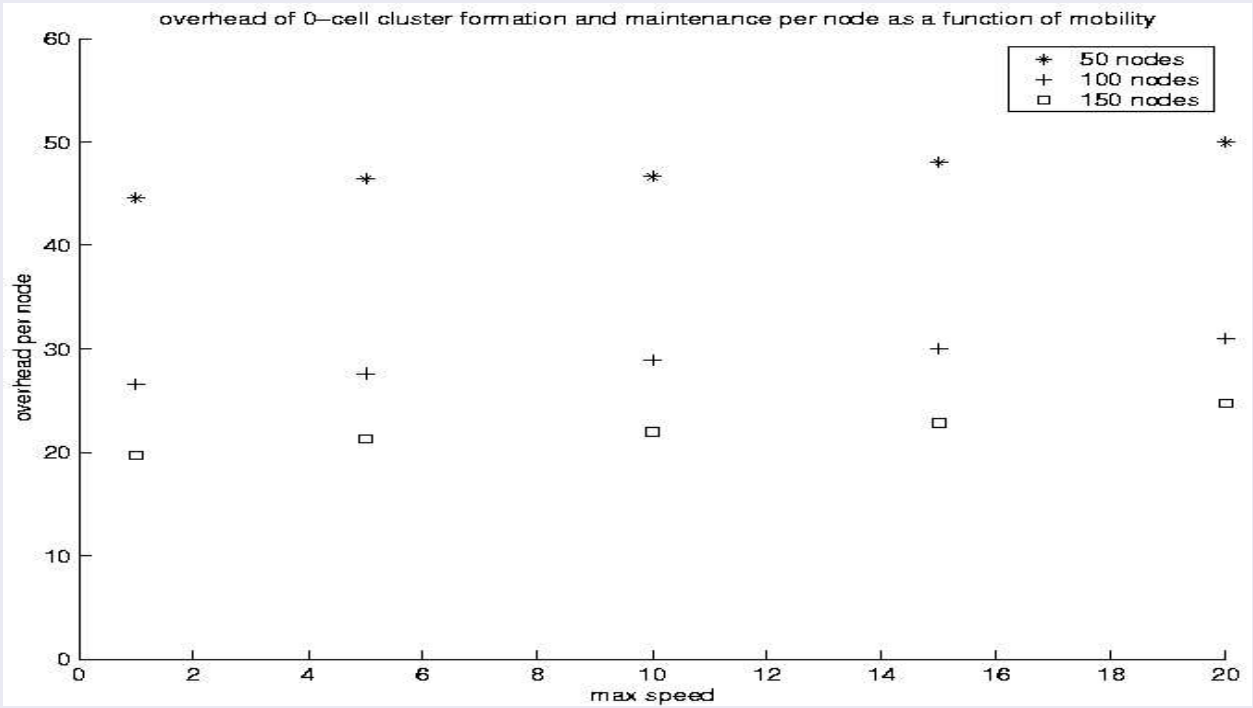
- NS2

Parameters

- Simulation area: $1000m * 1000m$
- Density: $\{50,100,150\}$ nodes
- Mobility model (Random Waypoint):
  - $Vmax = [1, 20]$: node speed is chosen in [0,Vmax]
  - $Pausetime = 30s$

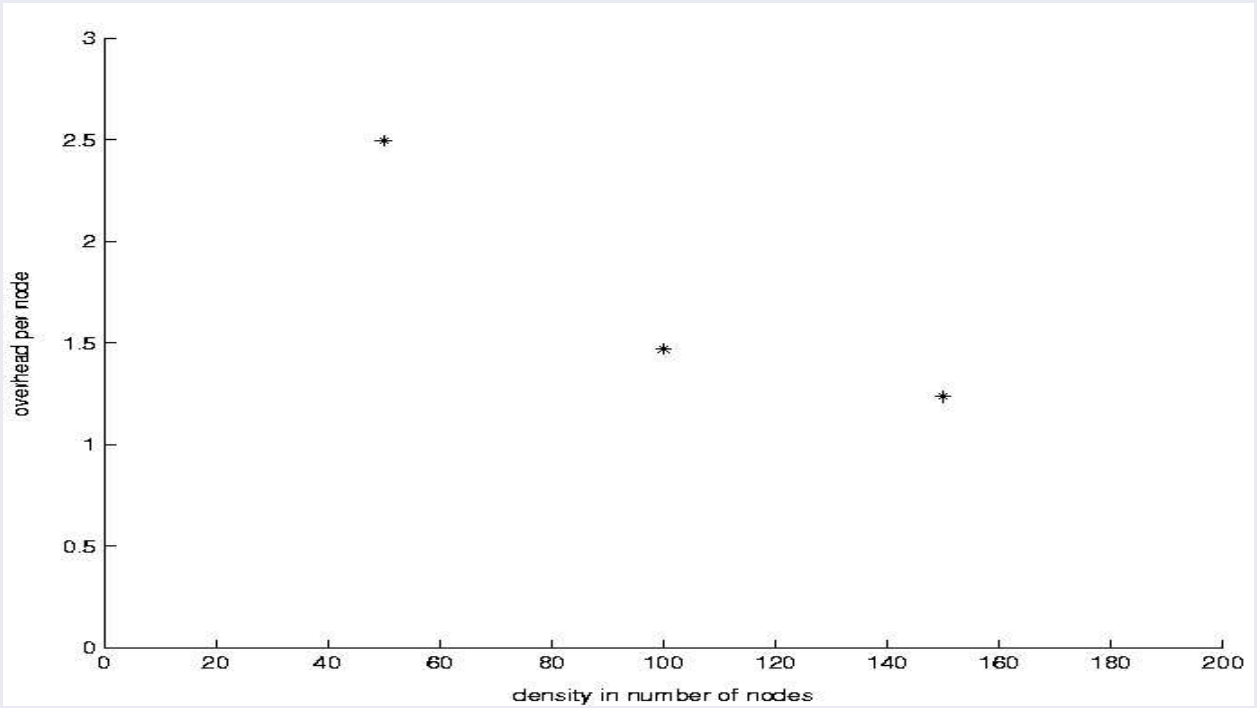
Detailed evaluation (2)

Overhead per node for *0-cell* procedures



Detailed evaluation (3)

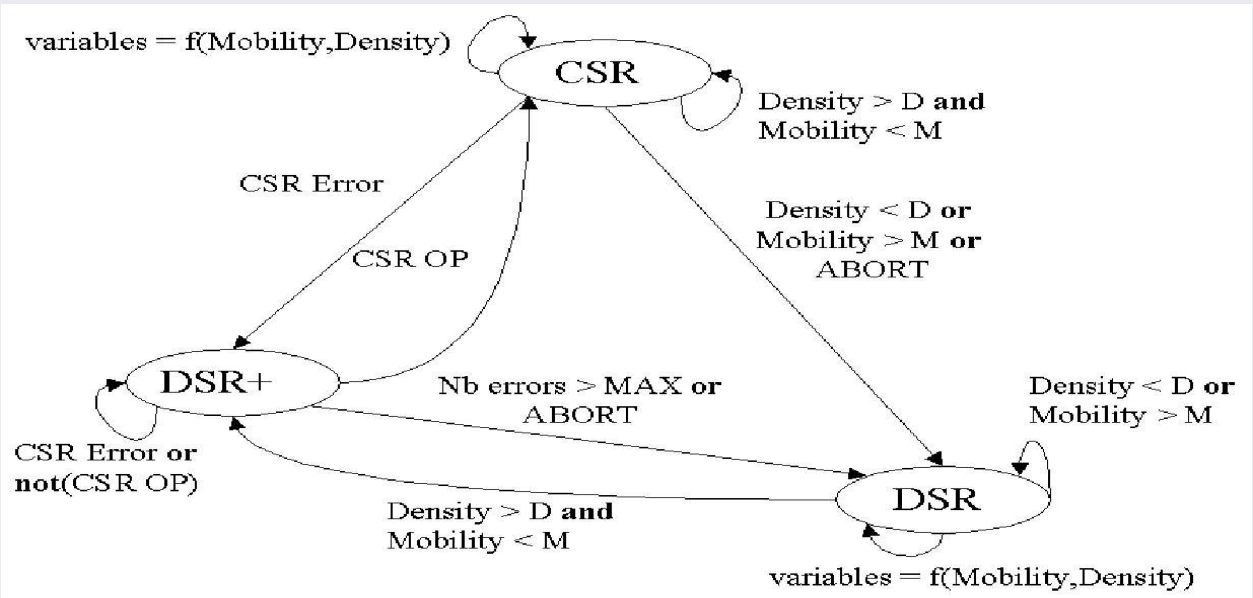
Overhead per node during a Server election



Routing mode switching : *DSR* ↔ *CSR*

Each node could experience 3 states

- DSR: DSR Route Discovery
- DSR+: DSR Route Discovery + clustering procedures
- CSR: CSR Route Discovery + clustering procedures



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Future work

Completed work

- Procedures specification and implementation.
- Optimization principles validated by simulation.
- Adaptation criteria definition (mobility and density)

Prospects

- Full comparison of DSR and CSR modes on NS
- Adaptation criteria evaluation
- Mode switching thresholds computation $\rightarrow$ {Mobility,Density}

Conclusion

- We propose a hierarchical extension of DSR
- Benefits:
  - DSR scalability is improved
  - Full compatibility with native DSR → adaptation
  - Can be used for QoS issues (load balancing, multi path)