CHALMERS

Distributed frequency allocation algorithms for cellular networks:

Trade-offs and tuning strategies

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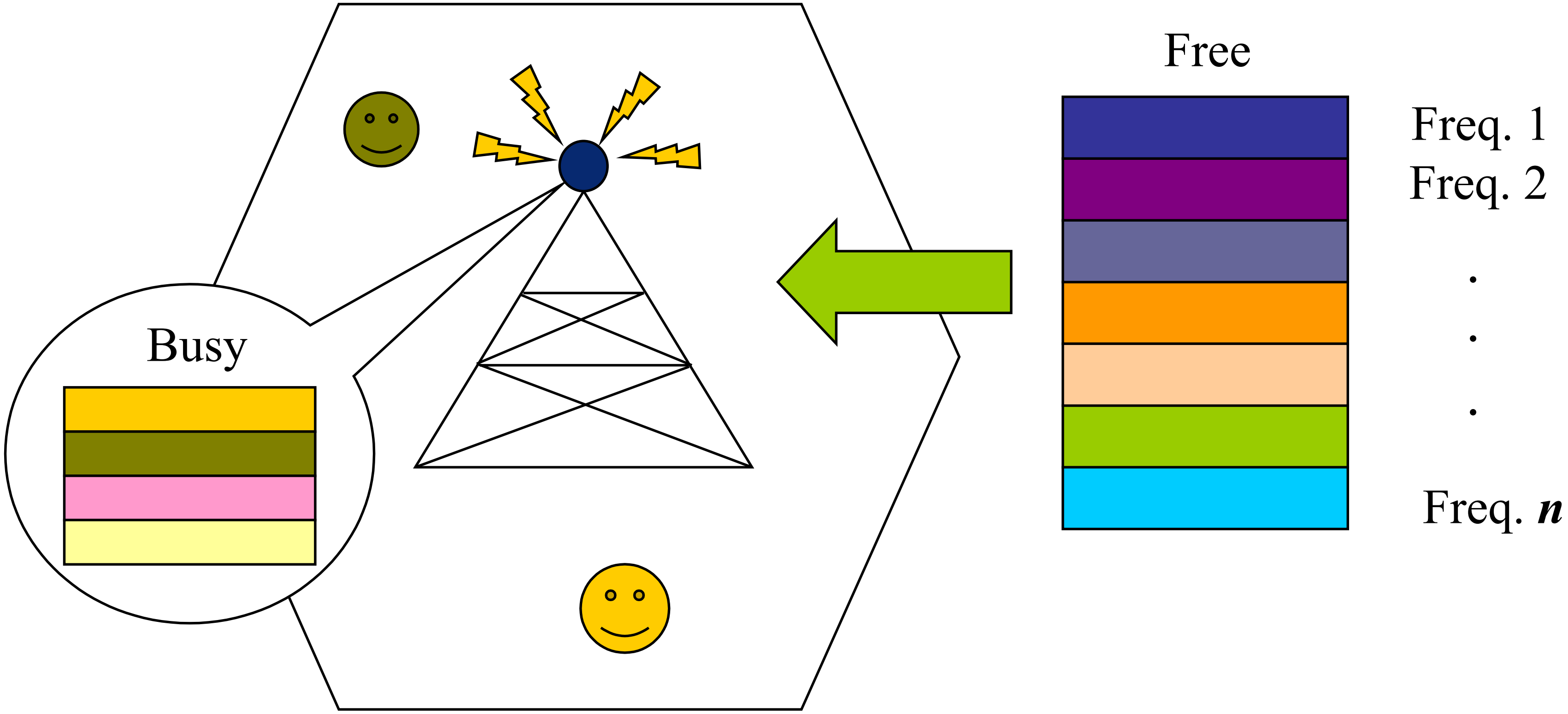
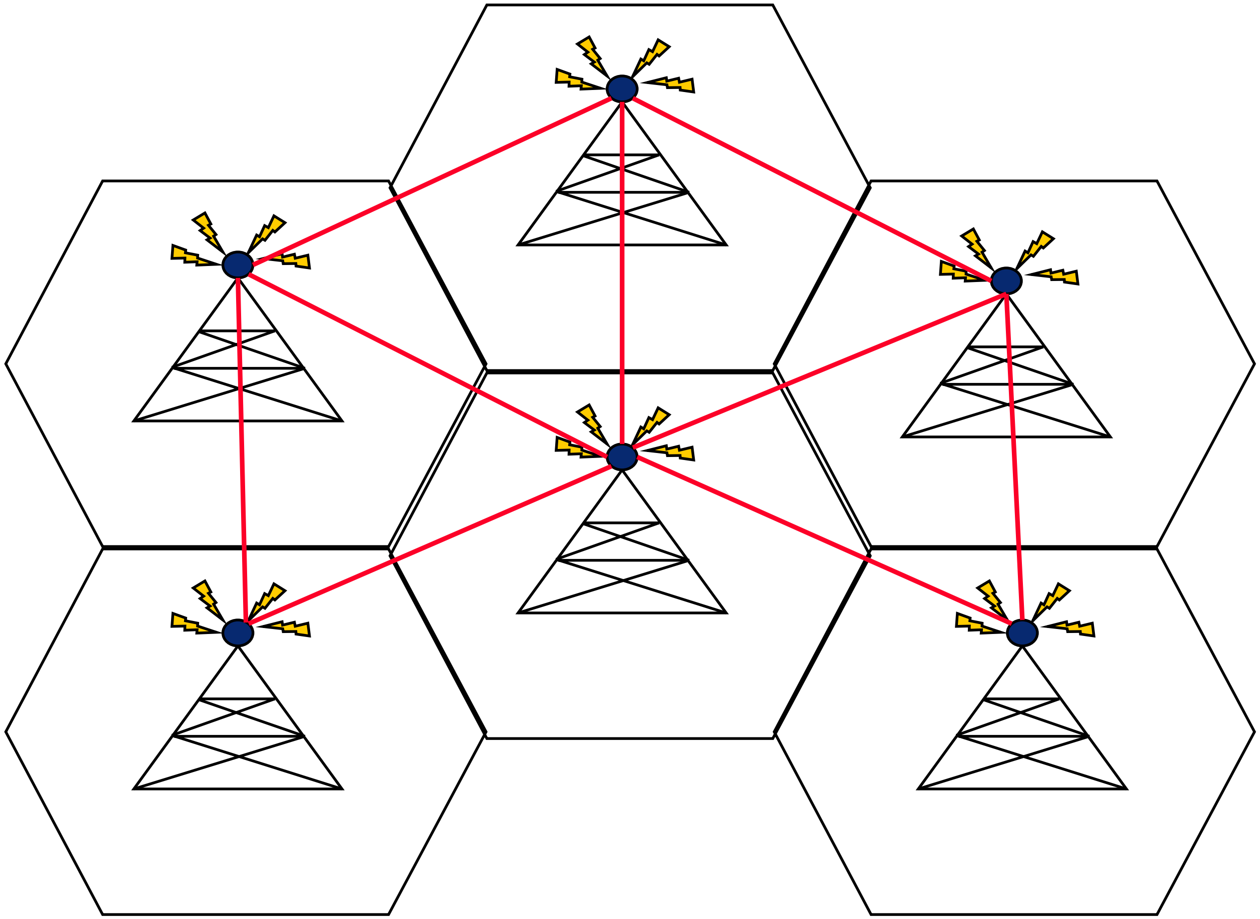
What did we do ?

- Frequency Allocation in cellular networks
- Distributed solutions:
  - How do they perform in practice ?
  - How can we tune them ?
  - What are the trade-offs ?
  - What happens when the load is dynamic and non uniform ?
  - What happens if there are failures in the network ?

Base station

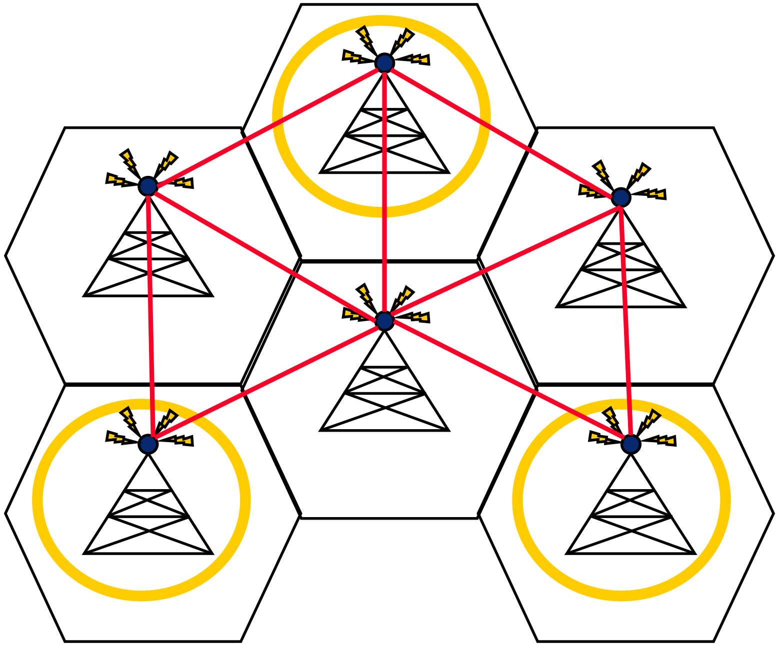


Cellular Network



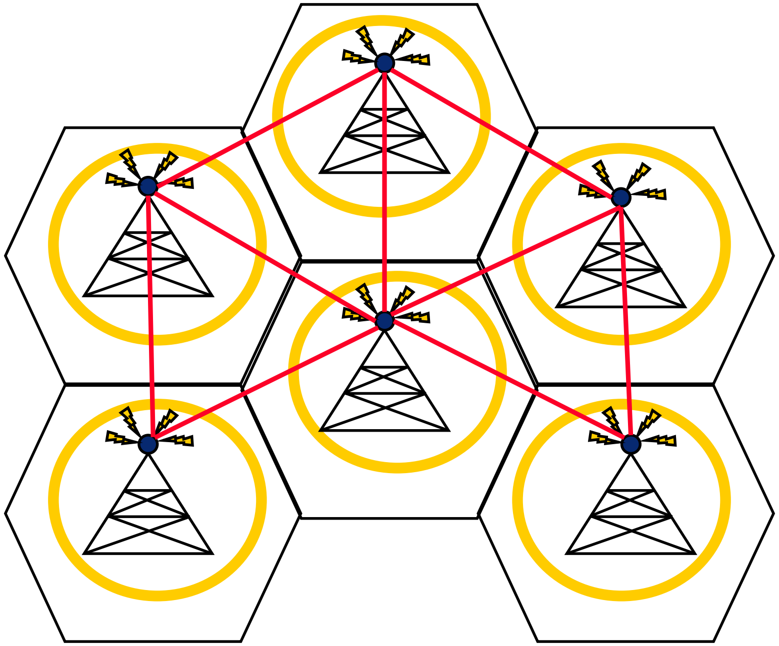
Deterministic Distributed List Colouring (DET_DLC)

- Based on vertex-colouring by Alon & Tarsi and advanced mutual exclusion due to Choy & Singh.
- Introduced by Garg, Papatriantafilou and Tsigas.



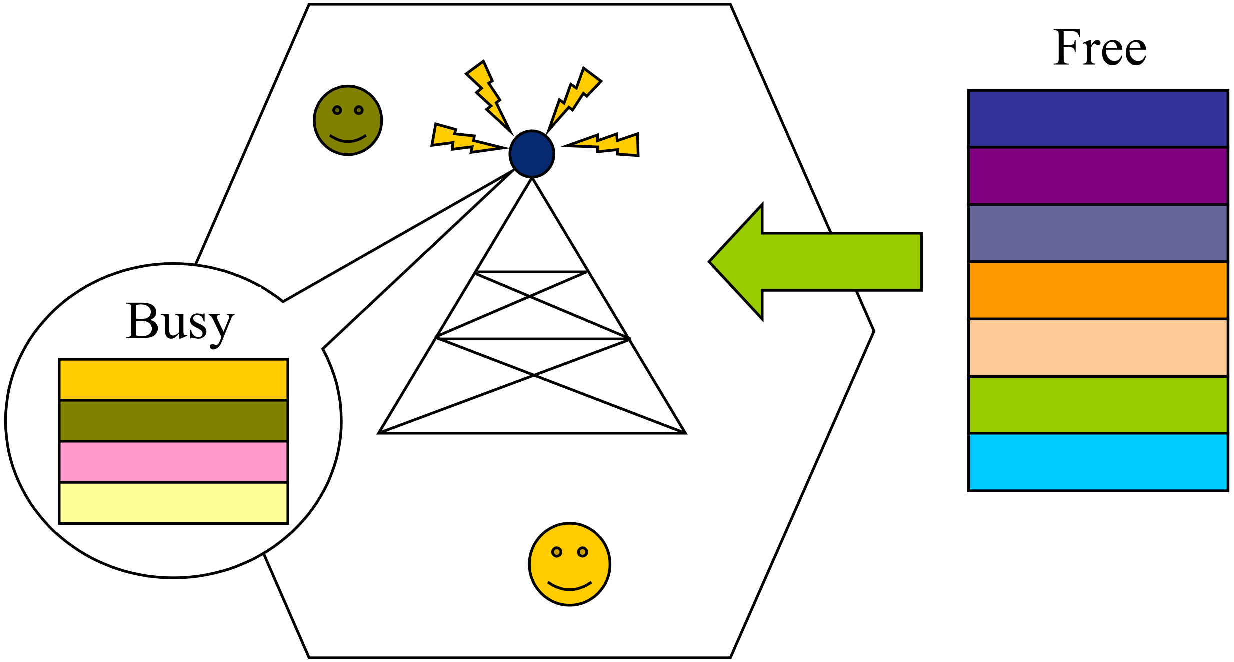
Randomised Distributed List Colouring (RAND_DLC)

- Avoids sychronisation by randomising the frequencies that are chosen by a base station.
- Also introduced by Garg, Papatriantafilou and Tsigas.



Tuning Strategies

- Dynamically determining the number of frequencies to acquire, and retain.



Tuning Strategies

Little's Law:

- Mean number of requests at a base station ($\lambda_i T$)
- LittlesLawStrategy = $\lambda_i T - |Busy_i|$

QueueRatio:

- $min\_ratio = min(\lambda_i T) \neq 0$
- $QueueRatio = r_i(1+1/\Delta))(1-free\_ratio)$
- QueueRatio Strategy = $max(QueueRatio, min\_ratio)$

Experiment Design

- Network size: 49 cells
- Spectrum size: 500 frequencies
- Arrival rate: Poisson distribution. Hot-cells $\lambda = 85$/min, normal cells $\lambda = 45$/min, cold cells $\lambda = 20$/min
- Total number of requests: 100,000
- Failures: Up to 3 crash failures at arbitrary stations.
- Network load: based on *hot-cell configurations* that are changed during the experiment execution.

The Trade-offs…

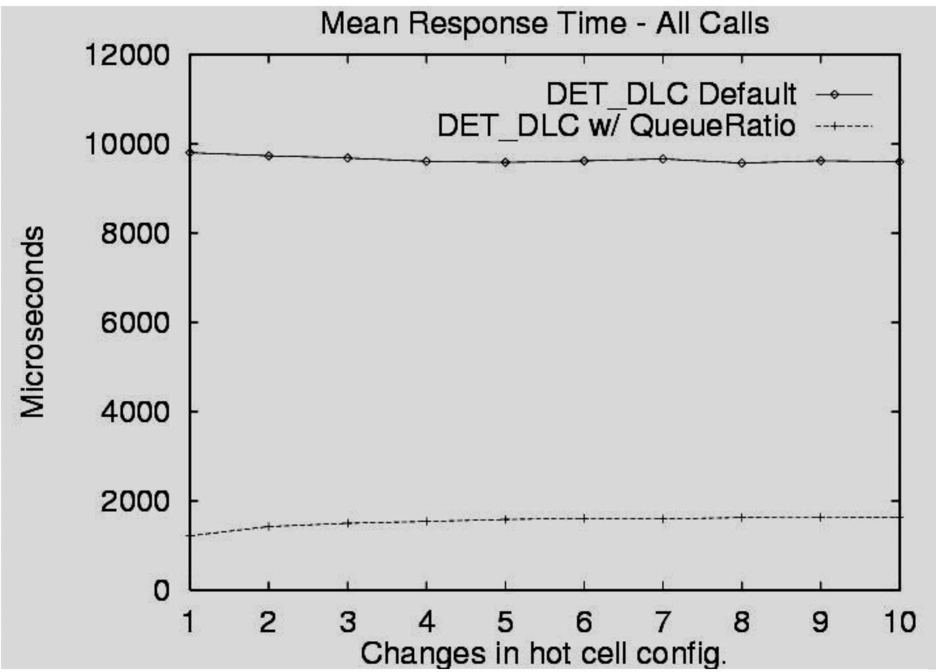
Response Time

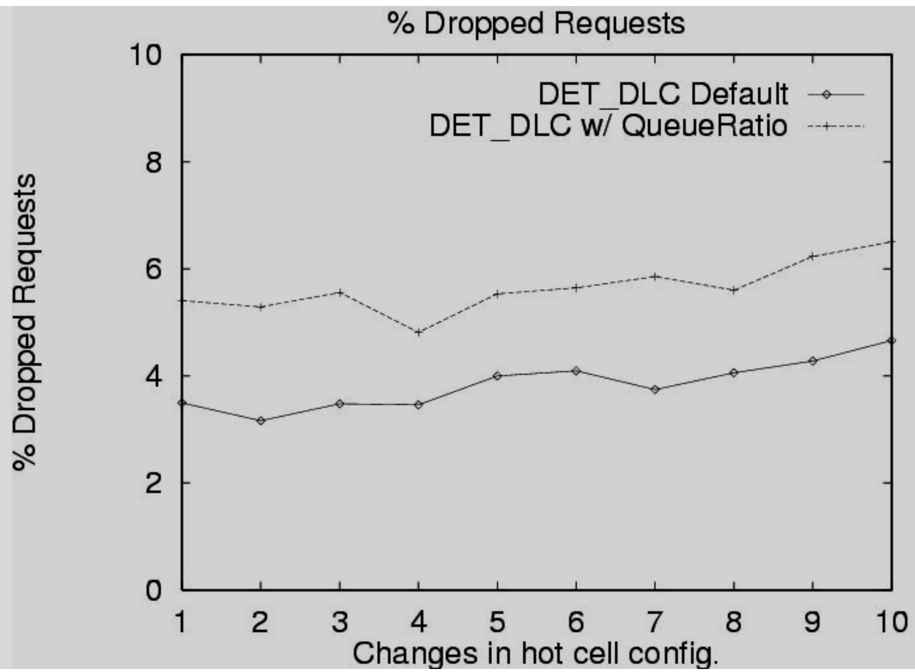
Dropped Calls

Total Messages

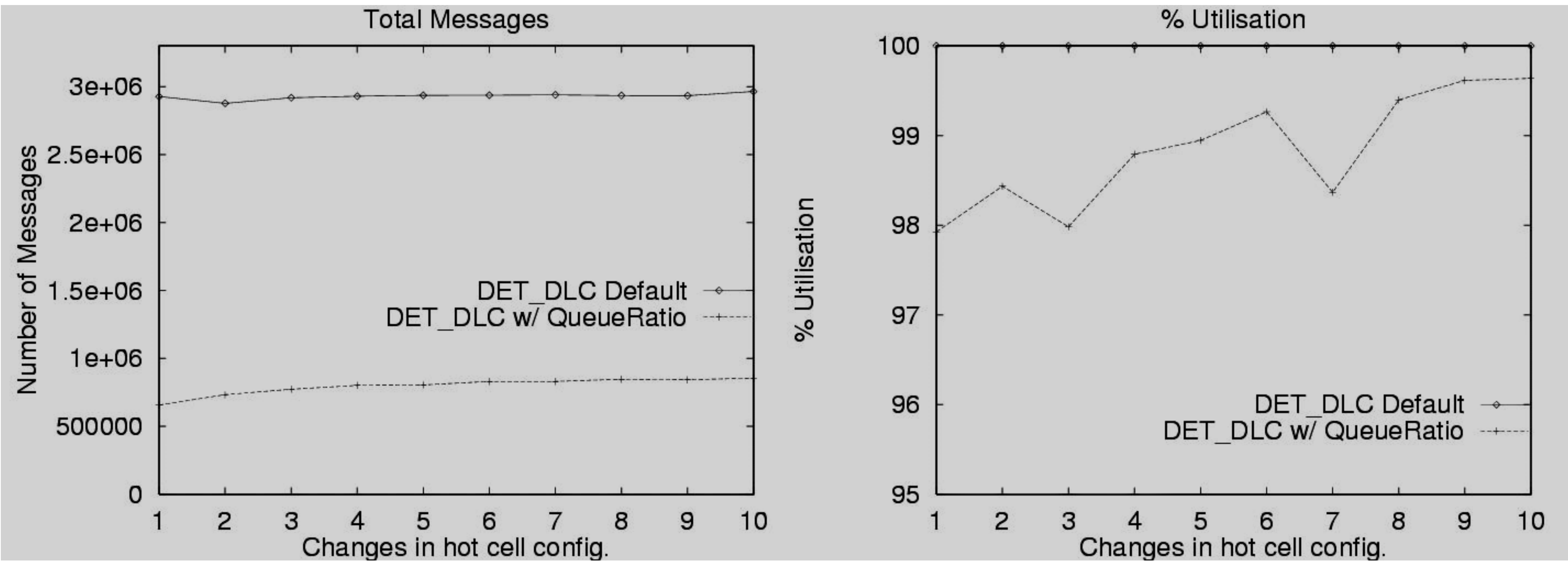
Bandwidth Utilisation

Response Time vs Dropped Requests





Total Messages vs Utilisation



Conclusions

- By designing appropriate tuning strategies, we can balance the trade-offs so that the performance gains can be substantial, while the losses are small.

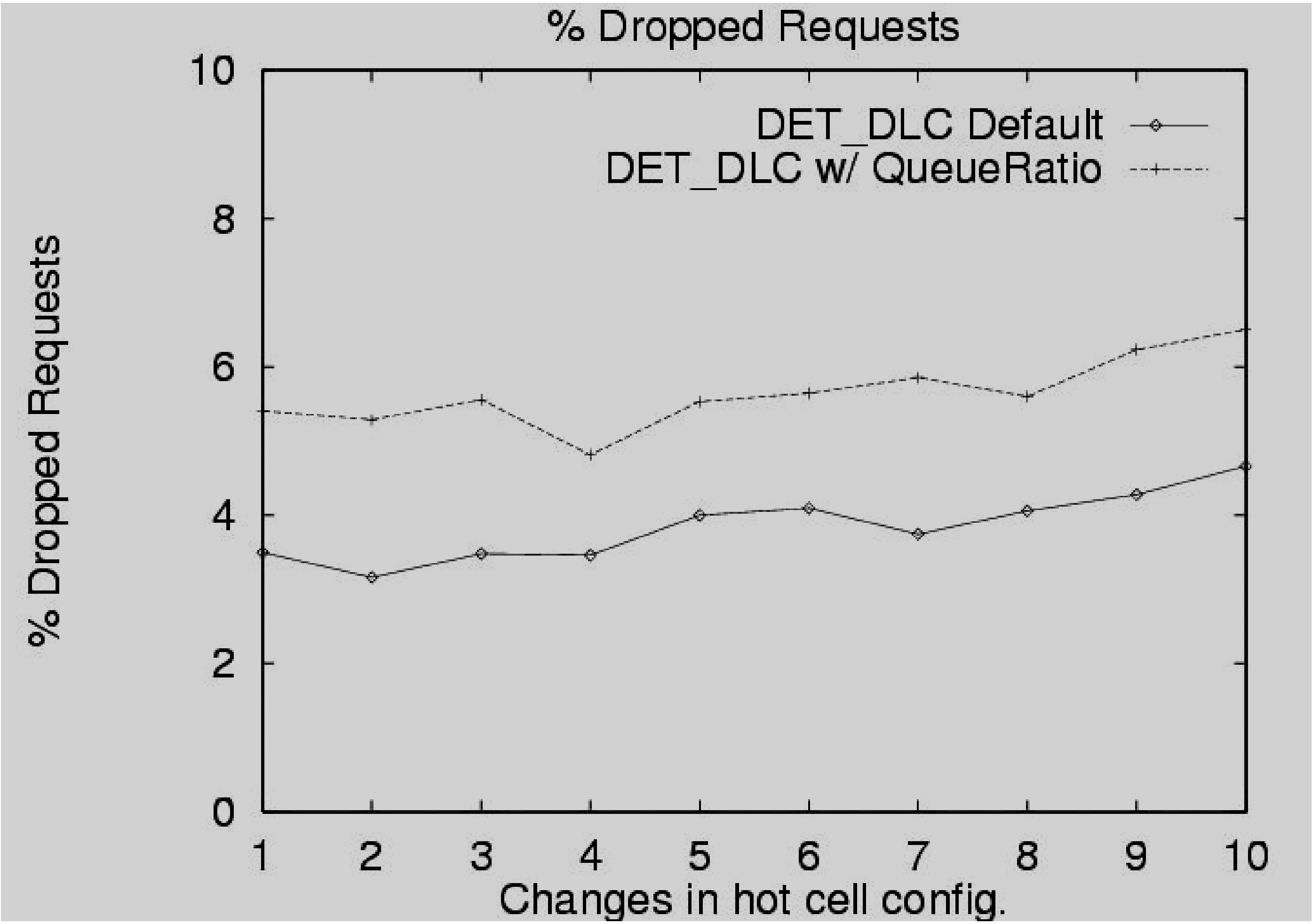
- Fault tolerance: our results confirm the theoretic results. Also, the tuning strategies actually *improve* the performance of the algorithms in some respects.

Future Work

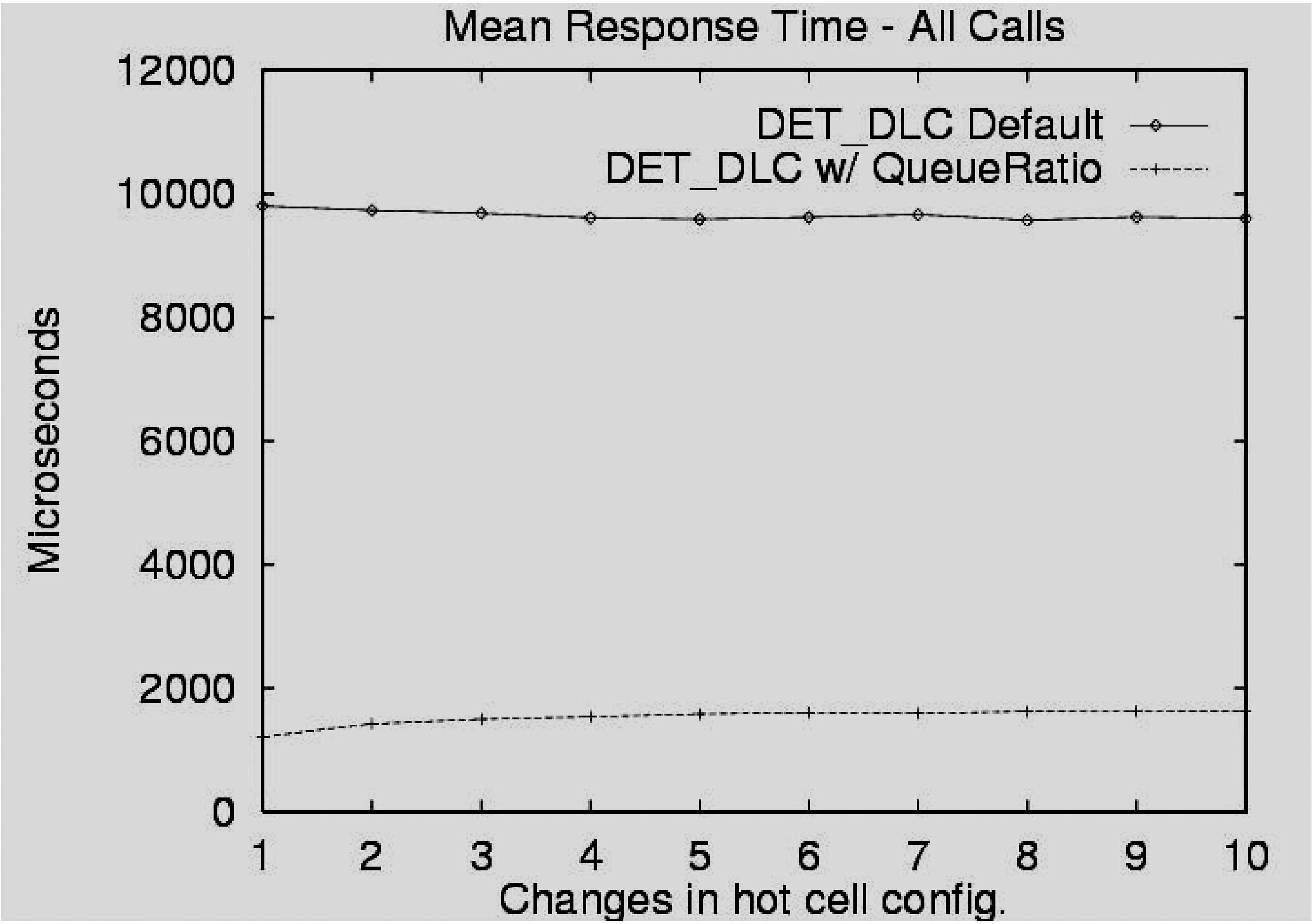
- To develop algorithms that can make use of the frequency reuse information, while maintaining the performance and fault tolerant properties of the previous solutions.

- Continuing the current study, looking at priority schemes, frequency reservation schemes (for hand-offs), etc.

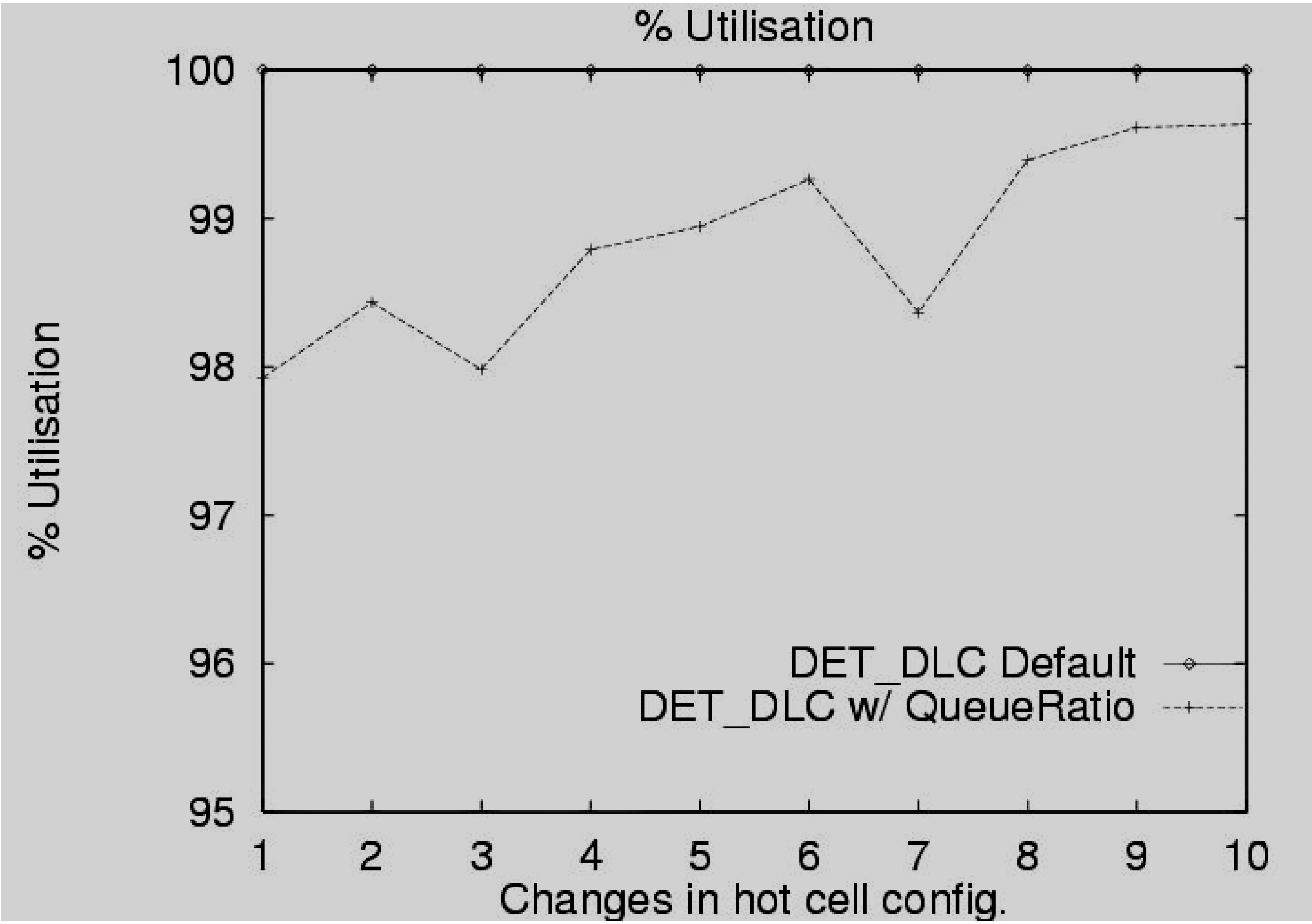
Dropped Requests



Response Time



Bandwidth Utilisation



Total Messages