This chapter discusses the results obtained from various phases of experiments conducted for static environment. The experiments have been carried out in different phases to evaluate the performance of algorithms discussed in fifth chapter. The performance is evaluated on the parameters – successful deliveries, average minimum hop counts and flooding ratio. The experiments in static network are conducted in the following five phases that form the basis of this chapter.

- Basic Algorithms
- First hop routing
- Multi-hop routing
- Multi-hop routing using dominating set
- Geocasting

In the first phase the results of basic algorithms have been obtained to make strong foundation for rest of the work. Second phase obtains the results of proposed algorithms for single (first) hop routing only, i.e. the original source marks its neighbor at first hop only to forward message. In phase three results of multi-hop routing to check connectivity between a source and destination are achieved. Fourth phase the same algorithms are tested for multi-hop routing using the concept of dominating sets to reduce flooding. In the fifth phase algorithms are tested for geocasting.

7.1 Basic Algorithms

In this phase basic algorithms GEDIR, MFR, DIR, R-DIR, DREAM, and LAR are tested for static environment for single destination without circle (expected zone) around the destination. The aim of this phase is to compare the results of basic
algorithms with SP and evaluate their performance. This phase is important since it makes the basis for developing and implementing other proposed algorithms. The results of each of the parameter for performance evaluation are discussed below.

**Percentage of Successful Deliveries:** The results of GEDIR, MFR, DIR, R-DIR, DREAM, and LAR are compared with SP algorithms. Since all pairs of source and destination are connected therefore the SP algorithms gives 100% success rate. From figure 7.1, given below, we find that DREAM algorithm gives zero percent success. The reason is that when no circle is drawn around the destination, the radius of the circle becomes zero. Consequently the angle made by tangents drawn on both sides of the circle also becomes zero and the tangents overlap each other. Therefore, the angular request zone made in DREAM is a straight line, and does not contain any other node. Thus DREAM is not suitable when the mobility of node is zero.

![Percentage of successful deliveries vs degree of network](image)

**Figure 7.1:** Successful deliveries Vs Degree

The success rate of LAR2 is best among all algorithms and LAR1 gives least success rate. All algorithms except LAR1 have almost same success rate for K>10. It implies that for large degree of network algorithms do not make any significant difference. Success rate GEDIR, MFR, DIR, and R-DIR are almost same for all values of K. At K=5, algorithms GEDIR, MFR, DIR, and R-DIR have only 50% success rate of SP but the success rate improves for higher values of K and for K>=10 the success rate is same as of SP.
**Average Minimum Hop Counts:** Figures 7.2 (given below), shows the average minimum hop counts for successful deliveries corresponding to figures 7.1. DREAM has almost zero hop counts for zero percent of success rate. From the figures given below it can be observed that algorithms GEDIR, MFR, DIR, LAR1, and LAR2 have same hop counts as of SP for K >=10 since the success rate is nearer to 100% as of SP at K>=10. For K=5, 6 the hop counts of all algorithms are less than SP since the success rate is also less than SP. GEDIR and MFR have very closer hop counts and success rate since both algorithms are based on distance i.e. they select their next hops that are closer to the destination [47].

Algorithms R-DIR and DIR have marginally higher hop counts than SP for K>=10 where all algorithms have nearly 100 % success rate. It may be due to the selection of longer route since direction based algorithms have tendency to select a longer route than SP [47].

![Figure 7.2: Hop Counts Vs Degree](image)

**Flooding Ratio:** From figure 7.3 (given below), it is observed that LAR1 and LAR2 have exceptionally very high flooding rate than all other algorithms. LAR1 floods the message in a request zone and in LAR2 messages are forwarded to all neighbors that are closer to destination than source. Therefore LAR1 and LAR2 have higher flooding ratio. DREAM gives zero percent flooding ratio since its request zone is null. All other algorithms GEDIR, MFR, R-DIR, DIR, and SP have very low (less than 5%) flooding ratio for all values of K.
Conclusion: From the above discussion it is concluded that considering all parameters of evaluation in totality GEDIR, MFR, R-DIR, and DIR are better than DREAM, LAR1 and LAR2. GEDIR and MFR have almost same results. It is also confirmed in paper [47]. LAR2 has good success rate but also very high flooding ratio therefore it can be considered as the best algorithm.

7.2 First Hop Counting

In this phase the algorithms VD-GEDIR, CH-MFR, R-DIR, DIR-16, DREAM, and LAR1 and LAR2 are tested in static environment for single destination with circle around the destination. The results are computed for different nodes marked at first hop only i.e. a data message is transmitted to how many different nodes for further transmission by a source that is outside the circle in the beginning. The data of this phase has been significant for understanding the results obtained in other phases. The results of this phase showed the behavior of algorithms from the beginning. Percentage of marked neighbors for retransmission is measured when source is outside of circle containing destination. Tables given below show the percentage of marked nodes for different values of P.
### Table 7.1: Marked neighbors (%) at first hop for P=10%

<table>
<thead>
<tr>
<th>Algo / K-&gt;</th>
<th>5</th>
<th>7</th>
<th>10</th>
<th>15</th>
<th>20</th>
<th>25</th>
<th>50</th>
</tr>
</thead>
<tbody>
<tr>
<td>VD-GEDIR</td>
<td>0.887</td>
<td>0.866</td>
<td>0.882</td>
<td>0.933</td>
<td>1.006</td>
<td>1.06</td>
<td>1.131</td>
</tr>
<tr>
<td>CH-MFR</td>
<td>0.825</td>
<td>0.849</td>
<td>0.909</td>
<td>0.953</td>
<td>0.991</td>
<td>1.043</td>
<td>1.119</td>
</tr>
<tr>
<td>R-DIR</td>
<td>0.913</td>
<td>1.022</td>
<td>1.208</td>
<td>1.464</td>
<td>1.742</td>
<td>2.051</td>
<td>3.126</td>
</tr>
<tr>
<td>DREAM</td>
<td>0.421</td>
<td>0.466</td>
<td>0.740</td>
<td>0.911</td>
<td>1.178</td>
<td>1.505</td>
<td>2.576</td>
</tr>
<tr>
<td>LAR1</td>
<td>1.091</td>
<td>1.353</td>
<td>1.846</td>
<td>2.672</td>
<td>3.461</td>
<td>4.303</td>
<td>7.804</td>
</tr>
<tr>
<td>LAR2</td>
<td>1.430</td>
<td>1.867</td>
<td>2.621</td>
<td>3.757</td>
<td>4.978</td>
<td>6.195</td>
<td>11.830</td>
</tr>
<tr>
<td>DIR-16</td>
<td>0.958</td>
<td>1.028</td>
<td>1.193</td>
<td>1.444</td>
<td>1.706</td>
<td>1.971</td>
<td>2.832</td>
</tr>
</tbody>
</table>

### Table 7.2: Marked neighbors (%) at first hop for P=20%

<table>
<thead>
<tr>
<th>Algo / K-&gt;</th>
<th>5</th>
<th>7</th>
<th>10</th>
<th>15</th>
<th>20</th>
<th>25</th>
<th>50</th>
</tr>
</thead>
<tbody>
<tr>
<td>VD-GEDIR</td>
<td>1.055</td>
<td>1.122</td>
<td>1.223</td>
<td>1.323</td>
<td>1.402</td>
<td>1.454</td>
<td>1.732</td>
</tr>
<tr>
<td>CH-MFR</td>
<td>1.009</td>
<td>1.083</td>
<td>1.180</td>
<td>1.258</td>
<td>1.312</td>
<td>1.356</td>
<td>1.526</td>
</tr>
<tr>
<td>R-DIR</td>
<td>1.110</td>
<td>1.288</td>
<td>1.573</td>
<td>1.977</td>
<td>2.484</td>
<td>2.805</td>
<td>4.716</td>
</tr>
<tr>
<td>DREAM</td>
<td>0.601</td>
<td>0.720</td>
<td>0.976</td>
<td>1.356</td>
<td>1.836</td>
<td>2.202</td>
<td>4.103</td>
</tr>
<tr>
<td>LAR1</td>
<td>1.338</td>
<td>1.700</td>
<td>2.319</td>
<td>3.383</td>
<td>4.442</td>
<td>5.274</td>
<td>9.855</td>
</tr>
<tr>
<td>LAR2</td>
<td>1.590</td>
<td>2.088</td>
<td>2.905</td>
<td>4.275</td>
<td>5.681</td>
<td>6.899</td>
<td>13.217</td>
</tr>
<tr>
<td>DIR-16</td>
<td>1.193</td>
<td>1.346</td>
<td>1.587</td>
<td>1.937</td>
<td>2.381</td>
<td>2.634</td>
<td>3.999</td>
</tr>
</tbody>
</table>

### Table 7.3: Marked neighbors (%) at first hop for P=30%

<table>
<thead>
<tr>
<th>Algo / K-&gt;</th>
<th>5</th>
<th>7</th>
<th>10</th>
<th>15</th>
<th>20</th>
<th>25</th>
<th>50</th>
</tr>
</thead>
<tbody>
<tr>
<td>VD-GEDIR</td>
<td>1.291</td>
<td>1.363</td>
<td>1.501</td>
<td>1.642</td>
<td>1.751</td>
<td>1.846</td>
<td>2.218</td>
</tr>
<tr>
<td>CH-MFR</td>
<td>1.228</td>
<td>1.319</td>
<td>1.452</td>
<td>1.561</td>
<td>1.643</td>
<td>1.698</td>
<td>1.951</td>
</tr>
<tr>
<td>R-DIR</td>
<td>1.331</td>
<td>1.632</td>
<td>1.993</td>
<td>2.563</td>
<td>3.140</td>
<td>3.741</td>
<td>6.275</td>
</tr>
<tr>
<td>DREAM</td>
<td>0.780</td>
<td>1.006</td>
<td>1.333</td>
<td>1.885</td>
<td>2.441</td>
<td>3.038</td>
<td>5.565</td>
</tr>
<tr>
<td>LAR1</td>
<td>1.596</td>
<td>2.103</td>
<td>2.861</td>
<td>4.044</td>
<td>5.268</td>
<td>6.441</td>
<td>11.968</td>
</tr>
<tr>
<td>LAR2</td>
<td>1.787</td>
<td>2.447</td>
<td>3.319</td>
<td>4.790</td>
<td>6.332</td>
<td>7.875</td>
<td>15.126</td>
</tr>
<tr>
<td>DIR-16</td>
<td>1.439</td>
<td>1.684</td>
<td>1.981</td>
<td>2.471</td>
<td>2.957</td>
<td>3.391</td>
<td>4.920</td>
</tr>
</tbody>
</table>
From the above tables it can be observed that LARI and LAR2 have high percentage of marked neighbors among all algorithms from the beginning. DREAM starts with low percentage of marked nodes at K=0, but this percentage increases rapidly as K increases (up to 6-8 time).

7.3 Multi-hop Routing

In this phase algorithms VD-GEDIR, CH-MFR, DIR-16, R-DIR, DREAM, LAR1, LAR2 and SP are tested for multi-hop routing in static environment for single destination with circle drawn around the destination. Destination is assumed to be the center of the circle. The routing process of marking nodes continues till the destination is found. The results are computed on the same parameters as in earlier previous phases. In our experiments we have considered that the number of nodes inside the circle determines the size of the circle which is denoted by P. Number of nodes inside the circle are taken as 10%, 20%, and 30%.

Percentage of Successful Deliveries: The results obtained for success rate are given in tables A.1, A.2 and A.3 (see appendix A) for different values of P = 10%, 20%, and 30% respectively. Figures 7.4, 7.5, and 7.6 show the graphs of success rate for the corresponding tables A.1, A.2 and A.3 respectively.

Figure 7.4: Successful deliveries for P=10%
From figure 7.4 it is observed that SP gives 100% success rate for all values of K since all the selected pairs of source and destination were connected. SP sets a standard benchmark for comparing the success rate of all algorithms. DREAM has very low success rate especially for K<=15 in comparison to other algorithms. However the success rate reaches up to 100% for K=50. VD-GEDIR and DIR-16 have very closer success rate to each other. VD-GEDIR and DIR-16 also have higher success rate among all other algorithms. At k>=10 almost all algorithms except DREAM have 100% (approximately) success rate. Therefore, for large degree of network the algorithms do not make any difference.
Chapter 7

As the value of $P$ increases from 10% to 30%, the success rate of all algorithms, except LAR2, increases since the larger value of $P$ implies the large circle size and consequently large request zone. Large request zone selects more neighbors hence increases the success rate. For $P=30\%$ GEDIR and DIR-16 have more than 88% (approximately) success rate comparable to SP for all values of $K$. CH-MFR and R-DIR are next to GE-DIR and DIR-16. In case of LAR2 the success rate remains almost same for all values of $P$ since the request zone in LAR2 is independent of the size of circle, and number of nodes inside the request are same for all values of $P$. Therefore the process of marking of neighbors for forwarding a message is independent of the circle size. DREAM has significant improvement in success rate for $P=30\%$.

**Average Minimum Hop Counts**: The results of average minimum hop counts for $P=10\%$, 20%, and 30% are shown in the figures 7.7, 7.8, and 7.9 corresponding to tables A.4, A.5, and A.6 (see appendix A) given below respectively. Figure 7.7 shows that hop counts in DREAM are very low for $K<20$ since its success rate is also low. However, for $K\geq20$ hop counts are almost equal to SP. All algorithms have almost same hop counts for $K\geq7$. At $K=5$ there is a variation of 1 to 3 hop counts in all algorithms since the success rate also varies for this value $K$. SP has maximum hop counts for $K=5$ since it also has maximum success rate (100%) at $K=5$. SP algorithm sets a standard benchmark for comparing the Hop counts of all algorithms since SP has 100% success rate for all values of $K$.

![Average Minimum Hop Counts](image)

Figure 7.7: Hop Counts for $P=10\%$
As the value of $P$ increases from 10% to 30% hop counts of DREAM improves significantly since its success rate also improves significantly. Hop counts of all algorithms come closer to SP as $P$ increases since success rate also approaches to 100% as of SP.

**Flooding Ratio**: Flooding ratio for $P=10\%$, $20\%$, and $30\%$ is shown in the following figures 7.10, 7.11, and 7.12 corresponding to tables A.7, A.8, and A.9 (see appendix A) respectively. From figure 7.10, it is observed that LAR2 and SP are at two extreme points. LAR2 produces maximum flooding ratio (up to 63%) among all algorithms and SP gives minimum flooding ratio (less than 5%). The flooding ratio in LAR2...
increases drastically as the value of $K$ increases. This may be due to the reason that LAR2 does not make any explicit request zone, it forwards data message to all of its neighbors that are closer to destination than the source itself. Therefore, when $K$ is large LAR2 marks more neighbors to forward the message that results into higher flooding ratio. LAR1 has the second highest flooding ratio. LAR1 defines a request zone and it floods the message in the request zone. As the value of $K$ increases the size of request zone also increases. Therefore the flooding ratio also increases for large value of $K$.

![Figure 7.10: Flooding Ratio for $P=10\%$](image)

![Figure 7.11: Flooding Ratio for $P=20\%$](image)
Other algorithms VD-GEDIR, CH-MFR, DIR-16, R-DIR, and DREAM have very low flooding ratio in comparison to LAR1 and LAR2. VD-GEDIR, CH-MFR, DIR-16, R-DIR, and DREAM have maximum up to 22% (approximately) flooding ratio for any value of K and P. DREAM has lowest flooding ratio for small value of K but increases significantly as K increases. Reason for this behavior is that for small values of K, DREAM algorithm finds very few neighbors in request zone and hence results for low flooding ratio. For large values of K, DREAM finds number of neighbors in the request zone that results into more flooding ratio. R-DIR maintains higher flooding ratio than DREAM since R-DIR also selects one or two suitable neighbors from outside the request zone. This increases the success rate as well as flooding ratio in R-DIR. VD-GEDIR and CH-MFR have very closer flooding ratio for any value of K and P and maintains very low flooding ratio (<10% approximately). The significant observation in case VD-GEDIR and CH-MFR, is that as K increases the flooding ratio starts decreasing after attaining a particular level. This may happen since VD-GEDIR and CH-MFR are distance-based algorithms and marks only few neighbors that is closer to destination for any possible position of destination inside the circle. VD-GEDIR and CH-MFR do not blindly flood a message inside the request zone. Hence these algorithms reduce the flooding ratio. DIR-16 gives higher flooding ratio than VD-GEDIR and CH-MFR since direction-based algorithms some times take longer route than distance based algorithms [47]. Since DIR-16 is direction-based
algorithm therefore, DIR-16 results into more flooding ratio than VD-GEDIR and CH-MFR.

Conclusion: Form the above discussion it is concluded that VD-GEDIR, CH-MFR, R-DIR, and DIR-16 outperformed DREAM, LAR1 and LAR2. Considering the results of all three parameters we find that VD-GEDIR is most efficient algorithm and is followed by CH-MFR, DIR-16, R-DIR. More findings from experiments are elaborated in the following points:

- The percentage of successful deliveries is directly proportional to the average degree of network. So for large value of degree of network, algorithms do not make any difference in success rate.
- GEDIR and DIR-16 have the maximum success rate among all algorithms discussed in this phase after SP. DREAM has lowest success rate.
- Minimum hop count is inversely proportional to the average degree of the network. As degree of the network increases the hop counts reduces.
- Almost all algorithms have same hop counts for large degree of network.
- Flooding ratio of LAR2, LAR1 R-DIR, and DREAM grows rapidly with increase in $K$. In case DIR-16 the flooding ratio remains constant after reaching a particular level. These protocols, in terms of flooding ratio give very poor performance in comparison to SP, VD-GEDIR, and CH-MFR.
- VD-GEDIR and CH-MFR are more suitable to control flooding in a network. But to some extent DIR-16 is also suitable for controlling the flooding.
- At low degree of network, DREAM and LAR fail to deliver message frequently, while at higher degrees they flood the network considerably to achieve high success rate.
- Taking the holistic view, among all algorithms discussed in this phase only GEDIR and MFR are somehow comparable with SP on all performance metrics.
7.4 Multi-hop Routing using Dominating Sets

In this phase algorithms VD-GEDIR, CH-MFR, DIR-16, R-DIR, DREAM, LAR1, LAR2 and SP are tested using the concept of dominating sets for multi-hop routing for single destination with expected zone. Destination is assumed to be the center of the circle. The routing process of marking nodes continues until destination is found. In this phase, the results were observed with the following expectations:

- How much flooding ratio gets reduced using the concept of dominating sets in routing algorithms discussed in phase-3.
- VD-GEDIR, CH-MFR, R-DIR and DIR-16 should have better more reduction in flooding ration than DREAM and LAR after applying dominating sets.

Percentage of Successful Deliveries: The results obtained are shown in the following figures 7.13, 7.14 and 7.15, and corresponding data is given in tables A.10, A.11, and A.12 (see appendix A) for different values of $P = 10\%$, $20\%$, and $30\%$ respectively. If we compare the figure 7.13 with figure 7.4, we find that success rate of DREAM has been drastically reduced. The success rate of LAR1 is also reduced significantly. VD-GEDIR and DIR-16 maintain the same success rate (as of before applying dominating sets, fig. 7.4) while there is marginal reduction in case of CH-MFR, R-DIR and LAR2. The reason for significant drop in success rate in case of DREAM and LAR1 is unavailability of gateway nodes to forward the message in a small request zone. As $P$ increases (see figures 7.14 and 7.15) there is considerable improvement in success rate of DREAM and LAR. Other algorithms also perform better for large values of $P$. For $K >= 15$ (see in figures 7.13, 7.14, 7.15) VD-GEDIR, CH-MFR, DIR-16, R-DIR and LAR2 give more than 98% success rate except LAR1 and DREAM. SP gives exactly 100% success rate for all values of $K$ and $P$ since we had selected connected pairs of source and destination.
Figure 7.13: Successful deliveries for $P=10\%$

Figure 7.14: Successful deliveries for $P=20\%$

Figure 7.15: Successful deliveries for $P=30\%$
Average Minimum Hop Counts: The results of average minimum hop counts for 
P=10%, 20%, and 30% are shown in figures 7.16, 7.17, and 7.18 respectively, and 
corresponding data is given in tables A.13, A.14, and A.15 (see appendix A). The 
equivalents results of these figures before applying dominating sets are shown in 
figures 7.7, 7.8, and 7.9. Figure 7.16 shows that hop counts in DREAM are very low 
since its success rate is low except for K=50. However as P increases (see fig. 7.17 
and 7.18) hop counts of DREAM also increases and come closer to SP. All 
algorithms have almost same hop counts for K>=10. At K=5 and 7 there is a variation 
of 1 to 4 hop counts in algorithms since success rate also varies for these values of K. 
This difference reduces as P increases. SP has maximum hop counts for K=5 since it 
also has maximum success rate (100%) at K=5. SP algorithm sets a standard 
benchmark for comparing the Hop counts of all algorithms since SP has 100% 
success rate for all values of K. Another important observation for all these 
algorithms is that there is a decrement of one hop count (approximately) for K=5 and 
7 since the success rate is also low for these values of K. For K>=10 there is minor 
increment in hop counts. At this level the success rate is almost same and algorithms 
might have taken longer routes to find connectivity with destination since only 
gateway nodes are participating in routing.

![Average Minimum Hop Counts](image)

Figure 7.16: Hop Counts for P=10%
Flooding Ratio: Flooding ratio for $P=10\%, 20\%$, and $30\%$ is shown in the following figures 7.19, 7.20, 7.21 respectively and corresponding data is given in tables A.16, A.17, and A.18 (see appendix A). The equivalents results of these figures before applying dominating sets are given in figures 7.10, 7.11, and 7.12. From figure 7.19, it is observed that there is sharp decline in flooding ratio of LAR2 and LAR1 in comparison to fig. 7.10. There is a reduction of 80-85% flooding ratio in case of LAR2 after applying dominating sets. But still LAR2 produces maximum flooding ratio (up to 10-11%) among all algorithms. DREAM is producing minimum flooding ratio (less than 3%) for all values of $K$ and $P$. In other algorithms except SP, there is a significant drop of 40%-75% in flooding ratio after using dominating sets. The reason
for reduction in flooding ratio is due to elimination of non gateway nodes from routing. Only gateway nodes except source and destination participate in routing that results into a smaller subset of nodes. Hence the flooding is reduced. There is almost no change in flooding ratio of SP before and after applying dominating sets.

Another important observation is that almost all algorithms (except DREAM) follow same pattern (see figures 7.19, 7.20, and 7.21). The flooding ratio grows up to a certain level for \( K \leq 10 \) and then starts declining as value of \( K \) increases. This is due to reduction in size of dominating sets for large values of \( K \) that results into low flooding ratio. Therefore dominating sets are useful in controlling flooding ratio in a dense network.

Figure 7.19: Flooding Ratio for \( P=10\% \)

Figure 7.20: Flooding Ratio for \( P=20\% \)
Conclusion: In this phase dominating sets are applied in VD-GEDIR, CH-MFR, DIR-16, R-DIR, DREAM, LAR1, LAR2 and SP algorithms. The findings of this phase are described as follows:

- We found that dominating sets based routing is a promising approach to control flooding in a network especially for large dense network.
- VD-GEDIR, CH-MFR, DIR-16, and R-DIR perform better than DREAM and LAR before and after applying dominating sets.
- The flooding ratio in shortest path (Dijkstra's) algorithm is not affected before and after applying dominating sets since shortest path between any two nodes does not include any non gateway nodes as an intermediate node [57].
- Application of dominating sets in LAR2 reduced flooding ratio up to 80%-85%.
- In other algorithms VD-GEDIR, CH-MFR, DIR-16, R-DIR, DREAM, and LAR1 there is reduction of 40-75% in flooding ratio after using dominating sets.
- LAR2 and DREAM generates minimum flooding ratio in a network.
Chapter 7

7.5 Geocasting

In this phase algorithms VD-GEDIR, CH-MFR, DIR-16, R-DIR, DREAM and LARI are tested for geocasting in static environment. The difference between routing and geocasting is that in geocasting the message should reach to all nodes inside the circle drawn around destination instead of to the center of the circle. The success rate is measured differently in geocasting than routing. In routing success is assumed when source and destination are connected. While in geocasting the success rate is measured as the percentage of nodes inside the circle that receive the message. Here we call this measure as delivery rate. The flooding ratio remains same as discussed in phase-3 since in routing we have considered marked nodes that are outside the circle for calculating flooding ratio. The same process is followed for generating flooding ratio in geocasting. We have not computed average minimum hop counts for geocasting but definitely hop counts in geocasting would be lesser than the hop counts computed for routing in phase-3. The rationale for lesser hop counts is that in geocasting the hop counts is sum of the nodes in a route used to deliver a message up to the circle while in routing hop counts are considered up to the final destination. In our experiments we have considered that the number of nodes inside the circle determines the size of the circle which is denoted by P. Number of nodes inside the circle are taken as 10%, 20%, and 30%.

Delivery Rate: The results obtained for different values of P = 10%, 20%, and 30% are given in the following tables A.19, A.20, and A.21. The corresponding graphs for these tables are drawn in figures 7.22, 7.23 and 7.24 respectively. From figure 7.22 we observe that delivery rate of DREAM is very low in comparison to other algorithms. However, the delivery rate of DREAM increases for higher values of K and P, and goes up to 100% (approximately) for K=50 and P=30%. The reason may be attributed to large request zone for higher value of P. Therefore, for higher values of K and P, DREAM may find more suitable neighbors in request zone to forward a message that results into high deliver rate. VD-GEDIR and DIR-16 have highest delivery rate among all algorithms for all values of K and P. VD-GEDIR and DIR-16
are followed by CH-MFR and R-DIR. All algorithms generate almost 100% delivery rate for \( K \geq 15 \).

![Delivery Rate in Geocasting](image)

**Figure 7.22:** Delivery Rate for \( P=10\% \)

![Delivery Rate in Geocasting](image)

**Figure 7.23:** Delivery Rate for \( P=20\% \)

![Delivery Rate in Geocasting](image)

**Figure 7.24:** Delivery Rate for \( P=30\% \)

Results and Discussions - Static Network
From the above data tables and graphs of geocasting and routing (discussed in phase-3) for P=10%, 20%, and 30%, we found that for low values of K (say K=5) there is significant reduction in delivery rate in geocasting than routing. However for K>=15, the delivery rate of all algorithms is same in geocasting and routing. Low delivery rate in geocasting for low values of K may be due to the following reasons:

1. The probability of finding a route up to circle is low for small values of K.
2. The nodes may not be connected with each other inside the circle for low values of K.

Conclusion: From the above discussion the following conclusions may be drawn:

- VD-GEDIR and DIR-16 are the better geocasting algorithms than DREAM and LAR.
- VD-GEDIR and DIR-16 are followed by CH-MFR and R-DIR.
- For large degree of networks the delivery rate is almost same in geocasting and routing.

7.6 Conclusion of the Chapter

The results derived from experiments carried out in different phases can be summarized as follows:

- VD-GEDIR, DIR-16, CH-MFR and R-DIR are better routing algorithms than DREAM and LAR in terms of success rate, hop counts and flooding ratio.
- DREAM performs very poor by generating lowest success rate and LAR2 performs very poor by generating maximum flooding ratio.
- For higher degree on network routing algorithms do not make any significant difference in success rate and hop counts. However flooding ratio makes a significant difference for each algorithm.
- Dominating sets is a promising approach to reduce flooding especially in dense network.
- Dominating sets reduces flooding ratio in a network up to 40-80%.
• VD-GEDIR, DIR-16, CH-MFR and R-DIR are superior to DREAM and LAR after using dominating sets.
• VD-GEDIR, DIR-16, CH-MFR and R-DIR are better geocasting algorithms than DREAM and LAR in terms of success rate, hop counts and flooding ratio.
• For higher degree of network geocasting algorithms do not make any significant difference from routing for success rate.