Mobile Network Sharing Between Operators: A Demand Trace-Driven Study

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Outline

• Introduction.
• Data.
• Correlation (time and space).
• Effectiveness of network sharing.
• Conclusion & future works.
Network sharing to reduce CAPEX and OPEX.

When does resource sharing make sense?

How to assess the effectiveness of network sharing?
Data Available

Data made available by two operators: Meteor & O2

- Transmitters’ location spread throughout the Republic of Ireland (> 20,000).
- Coverage (approx.) & sectorization information.
- Detailed call records & data sessions (many million).
- Long observation time (weeks).
- Information on mobile device types usage (TAC codes > 3,000).

Limitations:

- Partial mobility information.
- Users precise location is unknown.
- Datasets have been collected at different time frame.
GSM coverage

MNO₁

MNO₂
3G coverage

MNO\textsubscript{1}

MNO\textsubscript{2}
Mobile Network Sharing Between Operators

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Data Available
Data Coverage
Correlation
Time
Space
Assessing the effectiveness
Results
Conclusion & Future Works

Autocorrelation

Voice traffic

Autocorrelation

MNO1 – Aggregated
MNO2 – Aggregated
MNO1 – Busiest sector
MNO2 – Busiest sector
MNO1 – Median sector
MNO2 – Median sector

Hours [h]
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Hours [h]

0 20 40 60 80 100 120 140 160

0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8

-1

-1 0 20 40 60 80 100 120 140 160

0 20 40 60 80 100 120 140 160
Space correlation (1)

Global (Moran’s Index):

\[
\frac{1}{S_0} \sum_{i=1}^{n} \sum_{j=1, j \neq i}^{n} w_{i,j} (x_i - \bar{X})(x_j - \bar{X}) \frac{1}{n} \sum_{i=1}^{n} (x_i - \bar{X})^2
\]

\[
w_{i,j} = \frac{|A_i \cap A_j|}{|A_i \cup A_j|}
\]
Local:
It allows to label transmitters as: outlier (hot, cold), cluster (hot, cold)

$$\frac{x_i - \bar{X}}{s_i^2} \sum_{j=1, j \neq i}^n w_{i,j} (x_j - \bar{X})$$

$$w_{i,j} = \frac{|A_i \cap A_j|}{|A_i \cup A_j|}$$
Hot Spots in Dublin - 24h timelapse
Wrapping up the results

<table>
<thead>
<tr>
<th></th>
<th>Operator</th>
<th>Ireland</th>
<th>Urban</th>
<th>Rural</th>
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</thead>
<tbody>
<tr>
<td><strong>Deployment density</strong> [sectors/km²]</td>
<td>MNO₁</td>
<td>0.080</td>
<td>4.488</td>
<td>0.040</td>
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<tr>
<td></td>
<td>MNO₂</td>
<td>0.095</td>
<td>5.615</td>
<td>0.042</td>
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<td><strong>Space correlation</strong> [Moran’s Index]</td>
<td>WE</td>
<td>MNO₁</td>
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<td>WD</td>
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<td><strong>hot spot reduction</strong></td>
<td>WE</td>
<td>MNO₁</td>
<td>-55%</td>
<td>-38%</td>
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<tr>
<td></td>
<td>MNO₂</td>
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<td>-35%</td>
<td>-50%</td>
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<tr>
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<td>WD</td>
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<td>-46%</td>
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<tr>
<td></td>
<td>MNO₂</td>
<td>-54%</td>
<td>-44%</td>
<td>-93%</td>
</tr>
</tbody>
</table>
Future works

- Combine demand data with census data publicly available.
- Propose actual mechanisms for effecting network sharing.
- Energy efficiency, cost reduction, through network sharing.
Thank You