

SINCRONIZAÇÃO DE REDES DE TRANSPORTES PÚBLICOS

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FCT
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e a Tecnologia

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de Desenvolvimento Regional

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TÓPICOS

- 1) Contexto
- 2) **Estimação de Destinos e Identificação de Transbordos em registos AFC com informação apenas de embarque**
 - a) Algoritmo Trip Chaining Method (TCM) para estimar os destinos de cada segmento de viagem
 - b) Critérios para identificar transbordos e agregar segmentos de viagem em viagens completas
- 3) **Identificação de Ligações de Transbordo Relevantes**
- 4) **Identificação de Redes de Sincronização**

1. CONTEXTO

Sistema de Transportes Públicos do Porto

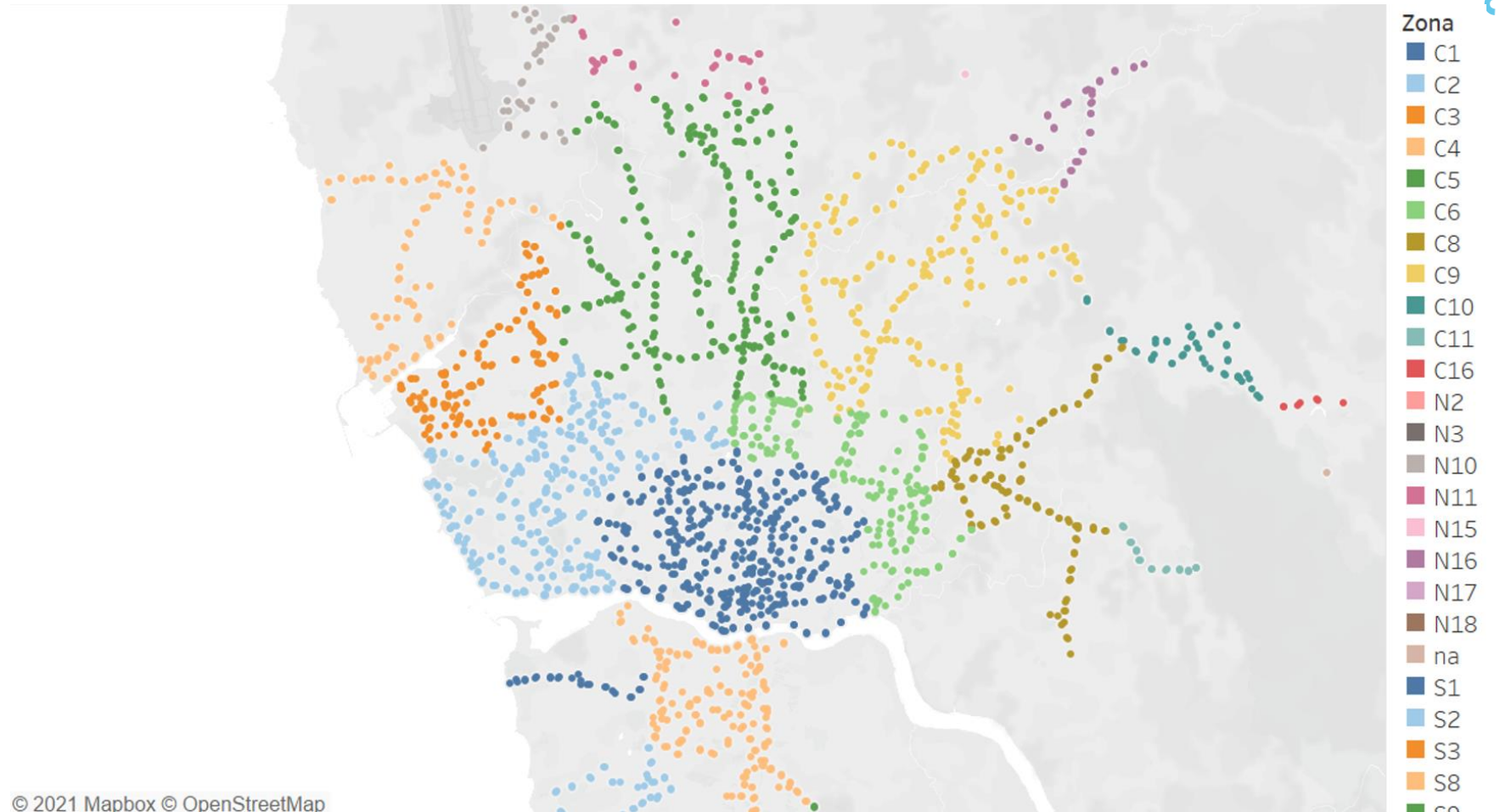
- 156 rotas direcionais (cada sentido é considerado separadamente)
- 2673 paragens



1. CONTEXTO

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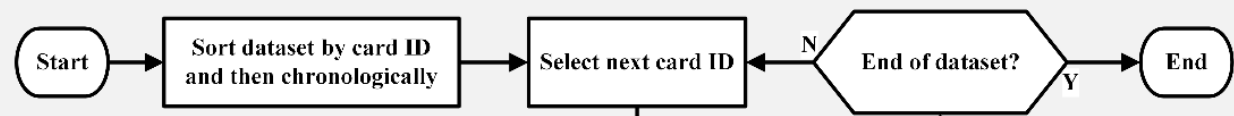
Registos AFC (validações) na cidade do Porto

- Cada registo no sistema AFC é associado a um segmento de viagem
- **Cada registo AFC contém a seguinte informação sobre o embarque:**
 - Autocarro e eléctrico: rota, sentido, paragem, data e hora.
 - Metro: estação, data e hora.

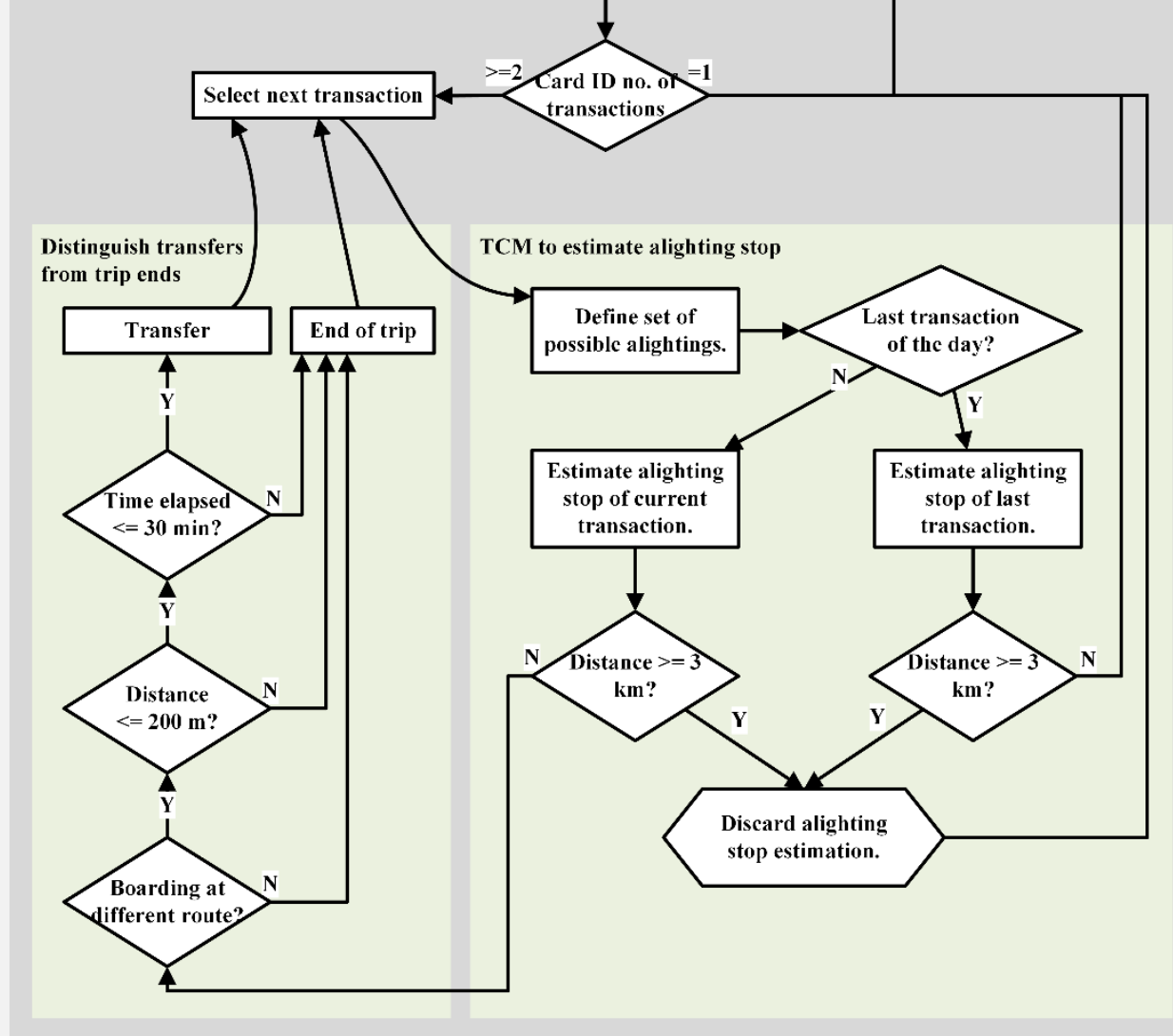
2. ESTIMAÇÃO DE DESTINOS E IDENTIFICAÇÃO DE TRANSBORDOS

ALGORITMO

For each day



For each card ID



2. ESTIMAÇÃO DE DESTINOS E IDENTIFICAÇÃO DE TRANSBORDOS

PRESSUPOSTOS

Table 3.10: Assumptions adopted to estimate alighting-stops using the TCM.

No.	Description
Assumption 3.1	The majority of passengers will start the next trip-leg at or near the alighting-stop of their previous trip-leg
Assumption 3.4	The majority of passengers end the last trip-leg of the day at or near the boarding-stop of the first trip-leg of the day
Assumption 3.7	By default, passengers travel within the Public Transport system
Assumption 3.9	Passengers travel outside the Public Transport system when the walking-distance between consecutive trip-legs exceeds a specified threshold
Assumption 3.8	Passengers travel outside the Public Transport system when there is a single trip-leg in the day
Assumption 3.10	When an alighting-stop cannot be estimated, the corresponding trip-leg is discarded
Assumption 3.13	Passengers can only alight in the sequence of stops not yet traveled by the directed-route boarded
Assumption 3.19	The alighting-time is not estimated

Table 3.11: Assumptions adopted to identify transfers.

No.	Description
Assumption 3.20	Passengers do not walk more than a specified distance to transfer
Assumption 3.22	Passengers do not wait more than a specified time to transfer
Assumption 3.25	A transfer occurs between consecutive trip-legs
Assumption 3.26	A transfer occurs between trip-legs on the same smart card
Assumption 3.27	Passengers do not transfer to the same route
Assumption 3.28	When passengers travel out of the Public Transport system, the next trip-leg starts a new full-trip

Table 3.12: Assumptions adopted to build full-trips.

No.	Description
3.30	A full-trip starts at a boarding-stop and ends at an alighting-stop
3.31	A full-trip containing transfers starts at the boarding-stop of the first trip-leg, and ends at the alighting-stop of the last trip-leg
3.32	The boarding-stop of the first trip-leg of the day starts a full-trip
3.33	The alighting-stop of the last trip-leg of the day ends a full-trip

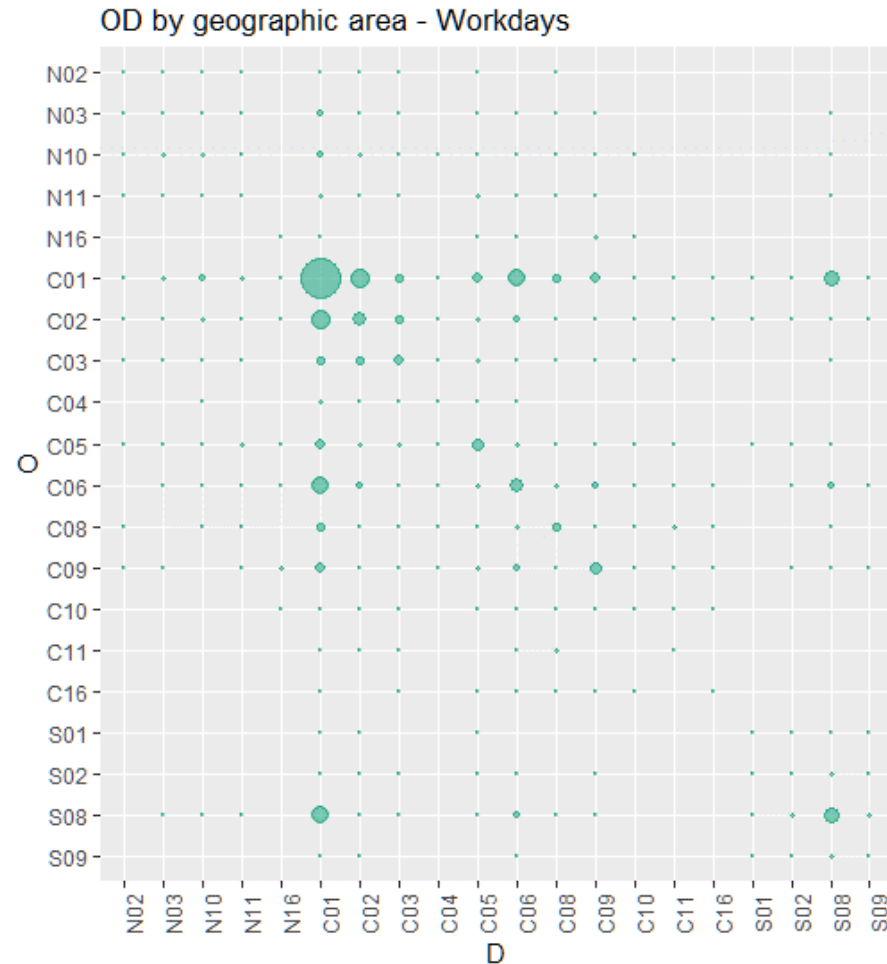
2. ESTIMAÇÃO DE DESTINOS E IDENTIFICAÇÃO DE TRANSBORDOS



RESULTADOS

Table 3.14: Summary of the segmentation by type of day: workdays vs. Sundays and Holidays vs. Saturdays. Proportions calculated on the total number of full-trips (i.e., 621,666).

Category	Days/year	full-trips/day	full-trips/year	
	No.	Average No.	No.	%
Workdays	251	2,100	526,998	84.77
Sun. & Hol.	63	665	41,921	6.74
Saturdays	51	1,034	52,747	8.48



2. ESTIMAÇÃO DE DESTINOS E IDENTIFICAÇÃO DE TRANSBORDOS

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Foram consideradas os registos realizados por 4000 cartões de viagens durante o ano de 2013, seleccionados aleatoriamente. O número de registos AFC realizados por estes 4000 cartões é de 191,938.

Table 4.5: Summary of the application of the methodology to the case study of Porto, discriminated by month. All proportions were calculated with reference to the total number of AFC records analyzed (i.e., 191,938 records).

Month	All records		Single daily record		Ass. 3.9 (3km)		Transfers	
	No.	%	No.	%	No.	%	No.	%
1	16,783	8.74	1,458	0.76	447	0.23	1,830	0.95
2	15,080	7.86	1,243	0.65	417	0.22	1,632	0.85
3	15,965	8.32	1,452	0.76	409	0.21	1,664	0.87
4	17,160	8.94	1,481	0.77	475	0.25	1,866	0.97
5	18,460	9.62	1,607	0.84	494	0.26	2,076	1.08
6	15,088	7.86	1,434	0.75	428	0.22	1,668	0.87
7	16,349	8.52	1,465	0.76	404	0.21	1,864	0.97
8	12,891	6.72	1,091	0.57	357	0.19	1,479	0.77
9	15,232	7.94	1,327	0.69	381	0.20	1,677	0.87
10	17,851	9.30	1,449	0.75	464	0.24	1,912	1.00
11	16,360	8.52	1,363	0.71	450	0.23	1,587	0.83
12	14,719	7.67	1,311	0.68	458	0.24	1,337	0.70
Sum	191,938	100.00	16,681	8.69	5,184	2.70	20,592	10.73

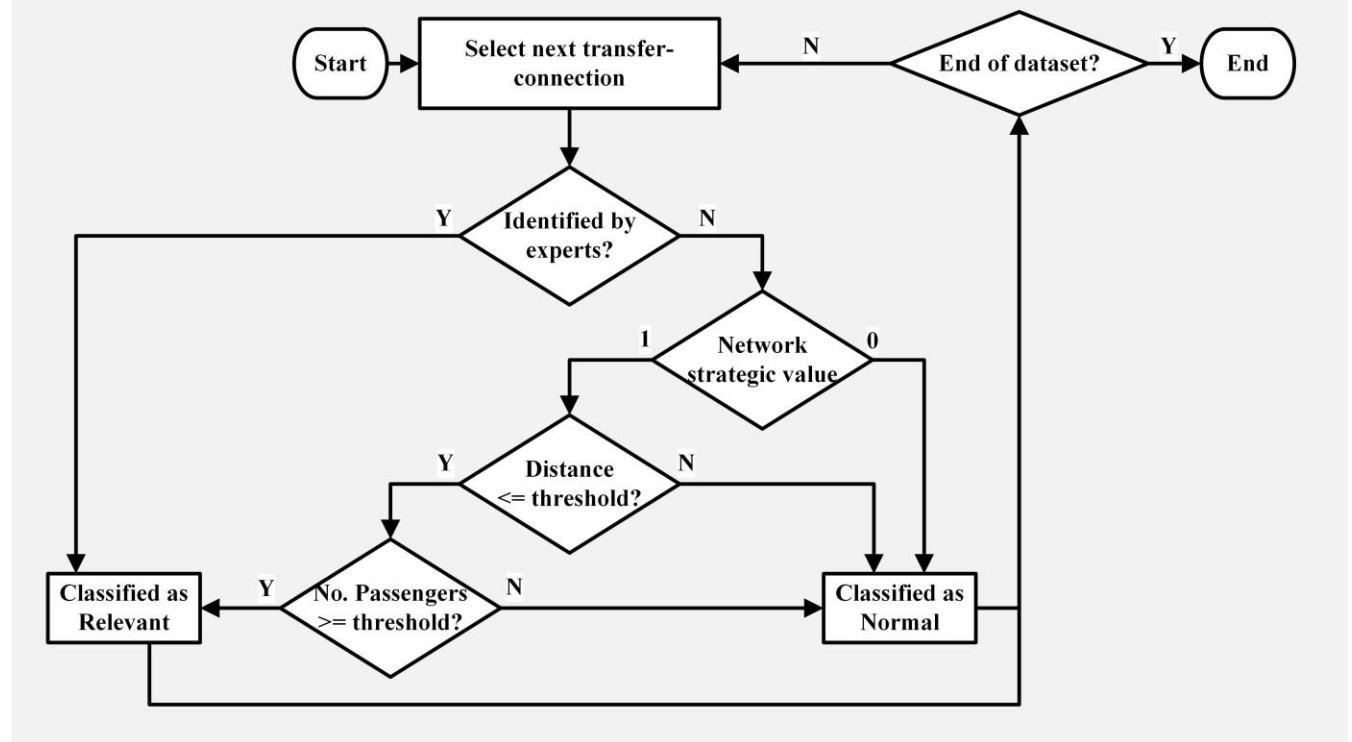
3. IDENTIFICAÇÃO DE LIGAÇÕES DE TRANSBORDO RELEVANTES

METODOLOGIA

Table 4.4: Set of assumptions chosen to identify transfer-connections relevant to be synchronized.

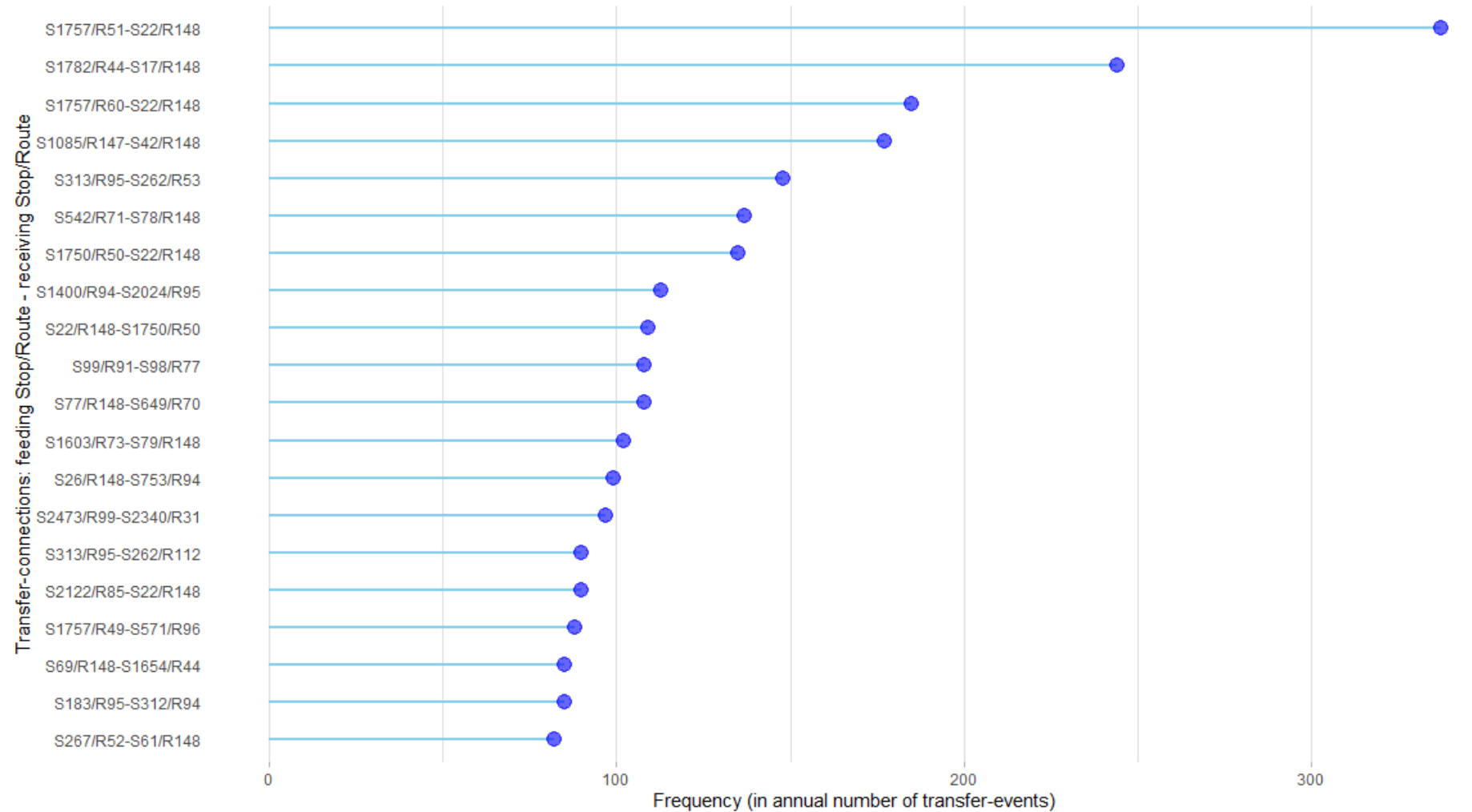
No.	Description
4.1	A transfer-connection is relevant for synchronization when identified as such by experts, considering social, historical, and service quality aspects
4.2	When two directed-routes have shared path segments, favor the selection of transfer-connections at their merging and splitting transfer-nodes
4.3	A transfer-connection must comply with a specified transfer walking-distance maximum threshold
4.4	Select transfer-connections whose constituent directed-routes are of Low-Frequency
4.5	Select the transfer-connections with the highest demand (i.e., with high transfer-flows)

For each Uniform Demand Period (UDP)



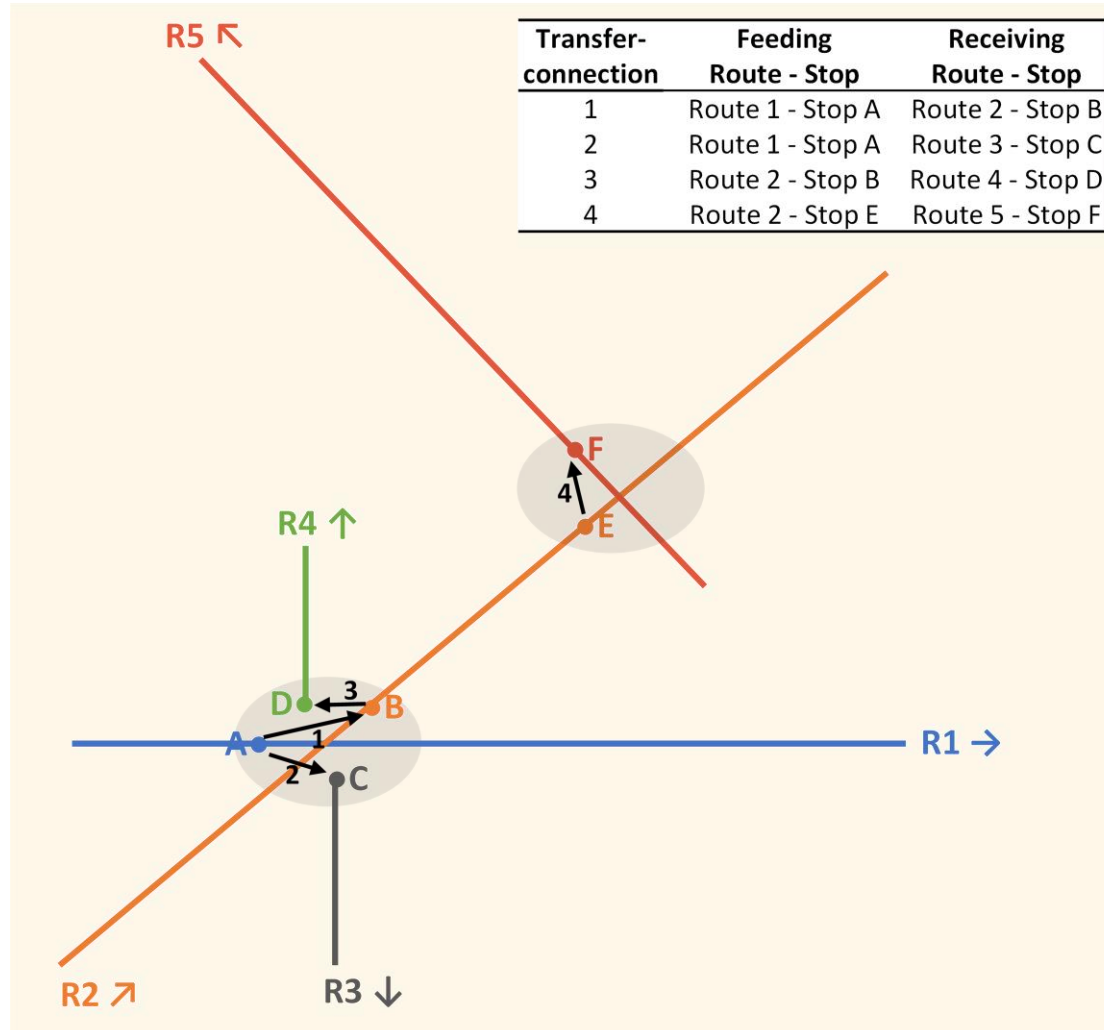
3. IDENTIFICAÇÃO DE LIGAÇÕES DE TRANSBORDO RELEVANTES

RESULTADOS



4. IDENTIFICAÇÃO DE REDES DE SINCRONIZAÇÃO

METODOLOGIA



Transfer-nodes are identified by grouping the transfer-connections (previously identified as relevant to synchronize) whenever they share at least one common *route/stop* pair. This grouping process considers the *route/stop* pairs of the transfer-connections regardless of their direction in the transfer (i.e., feeding or receiving).

The analysis of all transfer-nodes will then allow determining the networks to synchronize. When two or more transfer-nodes share the same route, one possibility is to join those transfer-nodes into the same network. However, when the resulting network is too large, decision-makers may split it by discarding one or more relevant transfer-connections. These decisions are made on a case-by-case basis.

4. IDENTIFICAÇÃO DE REDES DE SINCRONIZAÇÃO

RESULTADOS

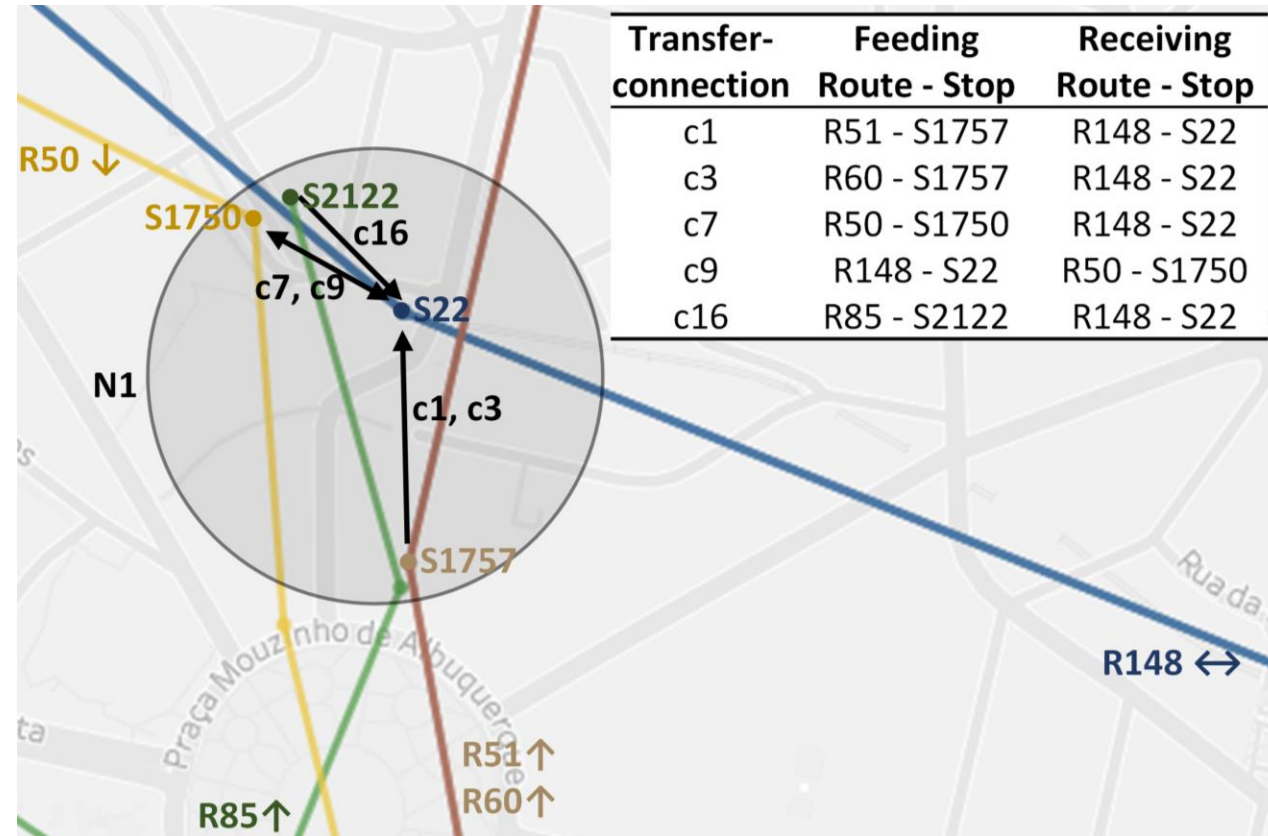


Figure A.1: Transfer-node 1, visualization with detail of transfer-connections 1, 3, 7, 9, and 16. R50 corresponds to route 204 direction *Foz*, R51 to route 204 direction *São João*, R60 to route 209 direction *Prelada*, R80 to route 504 direction *Casa da Música*, and R148 to all metro routes as a whole (i.e., A, B, C, D, E, and F) in any direction.

4. IDENTIFICAÇÃO DE REDES DE SINCRONIZAÇÃO

RESULTADOS

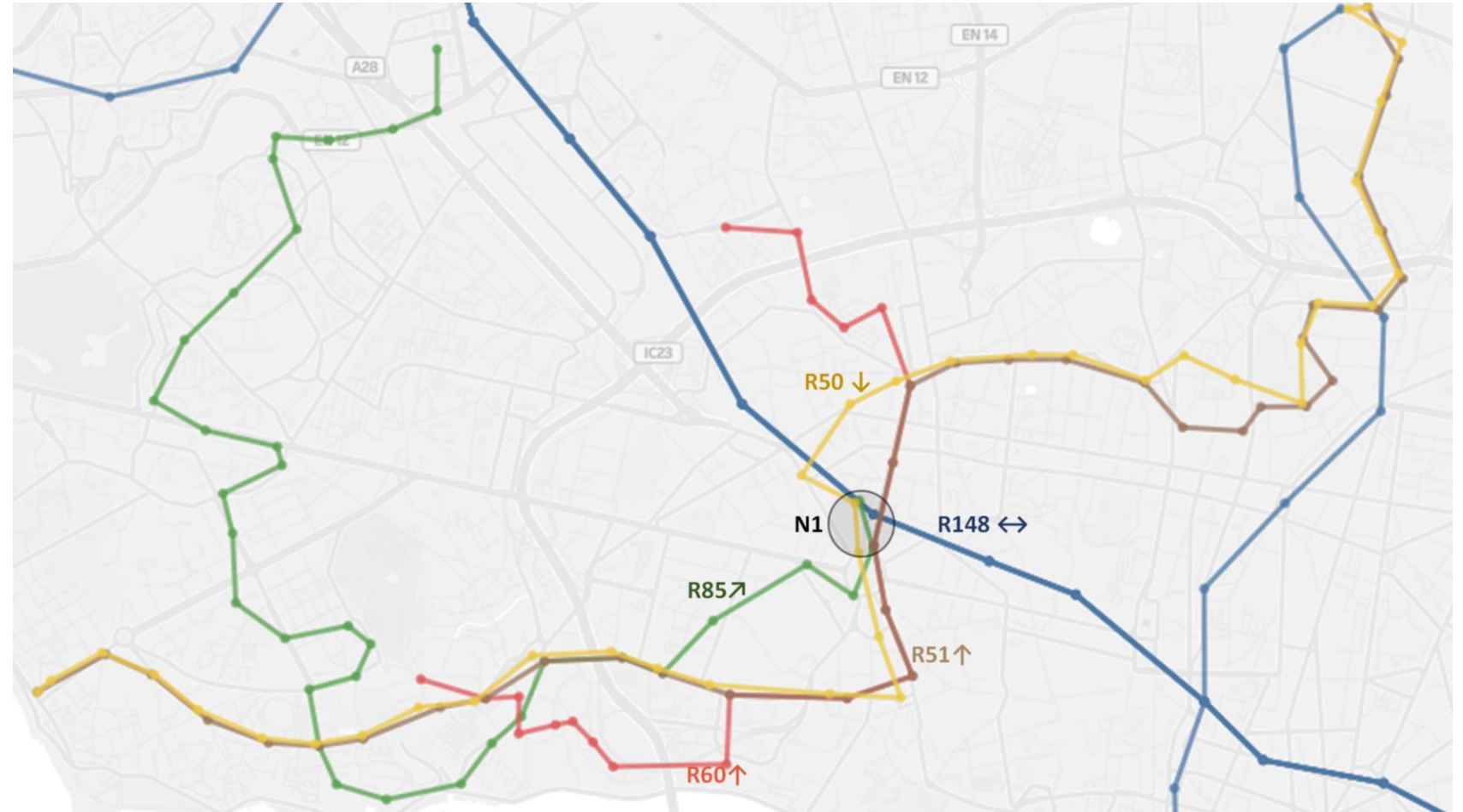


Figure A.2: Transfer-node 1, perspective view of routes. R50 corresponds to route 204 direction *Foz*, R51 to route 204 direction *São João*, R60 to route 209 direction *Prelada*, R80 to route 504 direction *Casa da Música*, and R148 to all metro routes as a whole (i.e., A, B, C, D, E, and F) in any direction.

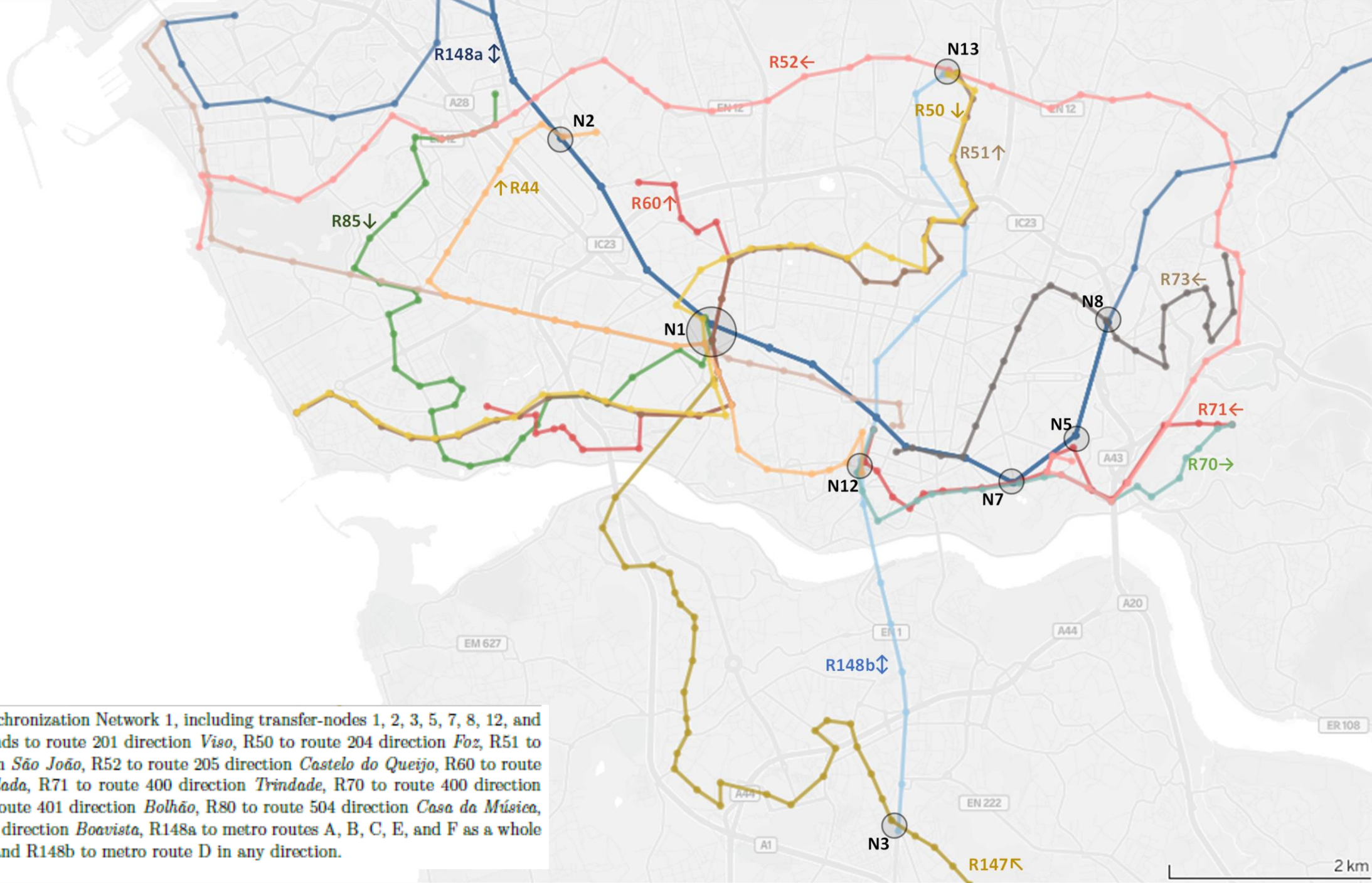


Figure B.1: Synchronization Network 1, including transfer-nodes 1, 2, 3, 5, 7, 8, 12, and 13. R44 corresponds to route 201 direction *Viso*, R50 to route 204 direction *Foz*, R51 to route 204 direction *São João*, R52 to route 205 direction *Castelo do Queijo*, R60 to route 209 direction *Prelada*, R71 to route 400 direction *Trindade*, R70 to route 400 direction *Azevedo*, R73 to route 401 direction *Bolhão*, R80 to route 504 direction *Casa da Música*, R147 to route 907 direction *Boavista*, R148a to metro routes A, B, C, E, and F as a whole in any direction, and R148b to metro route D in any direction.

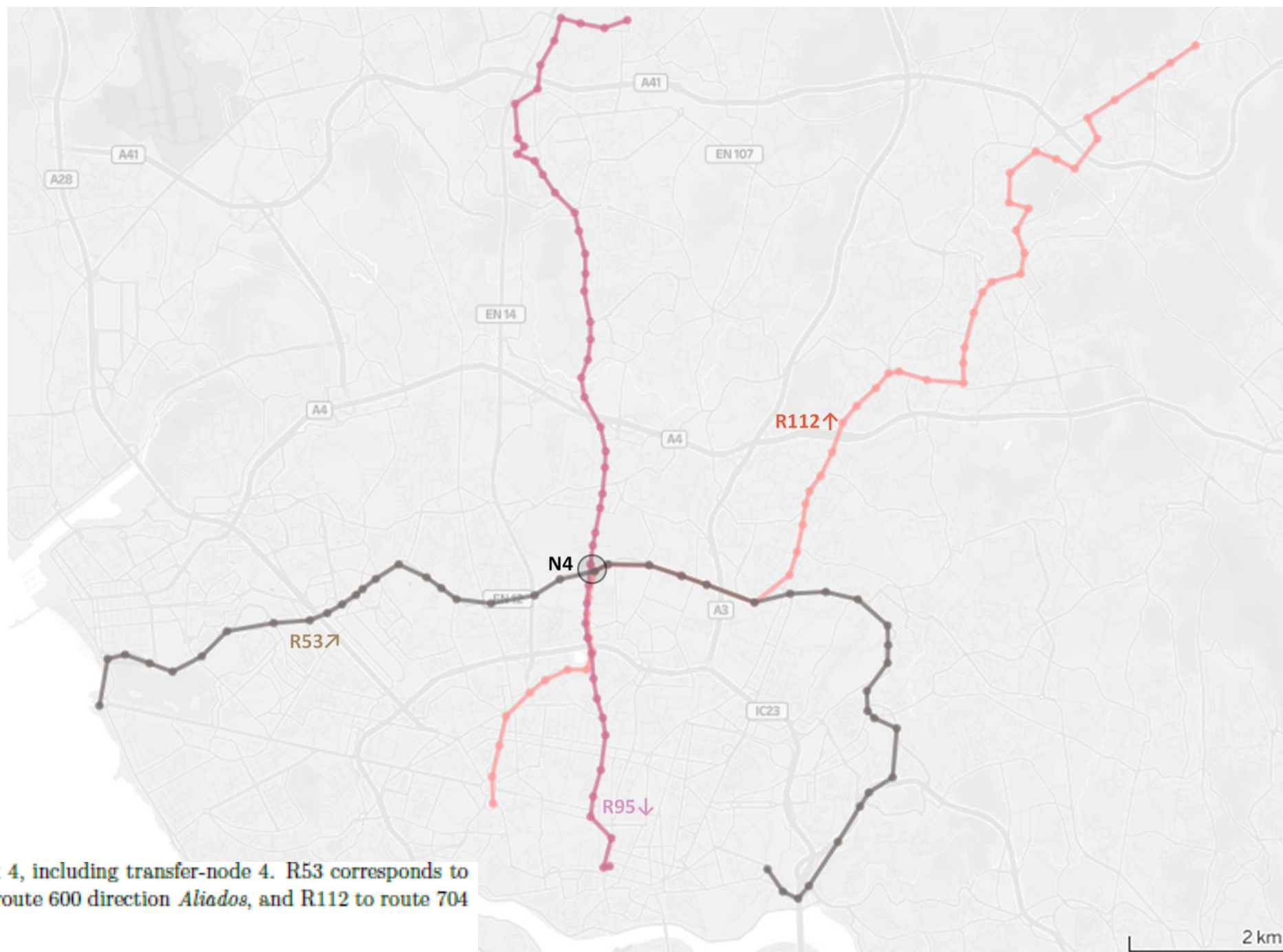


Figure B.4: Synchronization Network 4, including transfer-node 4. R53 corresponds to route 205 direction *Campanhã*, R95 to route 600 direction *Aliados*, and R112 to route 704 direction *Largo da Codiceira*.

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