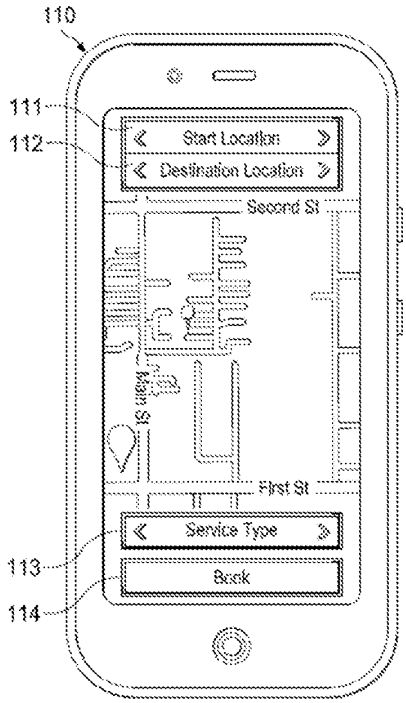

110
111
112
Start Location
Destination Location
Second St
Main St
First St
113
Service Type
114
Book

FIG. 1

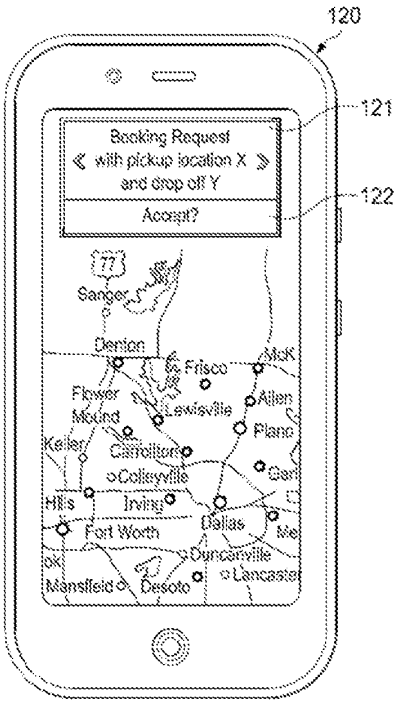

120
121
Booking Request
with pickup location X
and drop off Y
122
Accept?
77
Sanger
Denton
Frisco
McK
Flower Mound
Lewisville
Allen
Plano
Keller
Carrollton
Colleyville
Irving
Dallas
Fort Worth
Duncanville
Mansfield
Desoto
Lancaster

FIG. 2

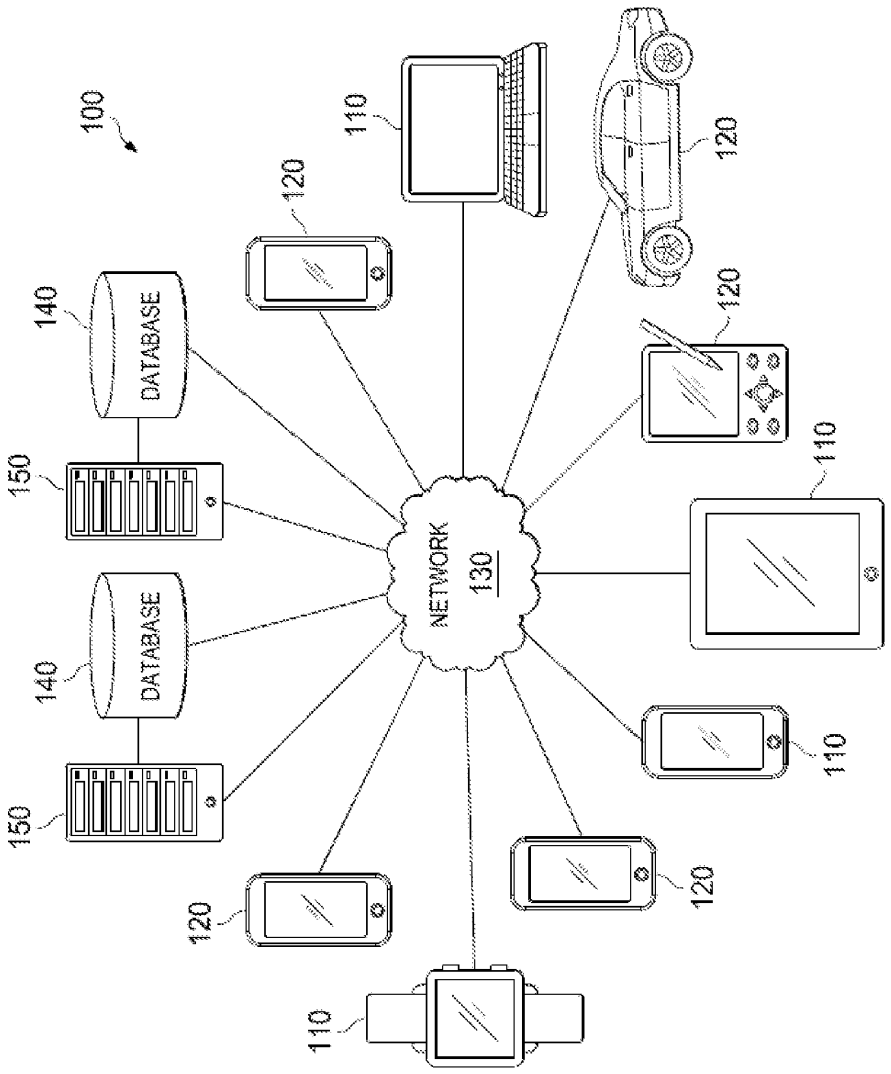
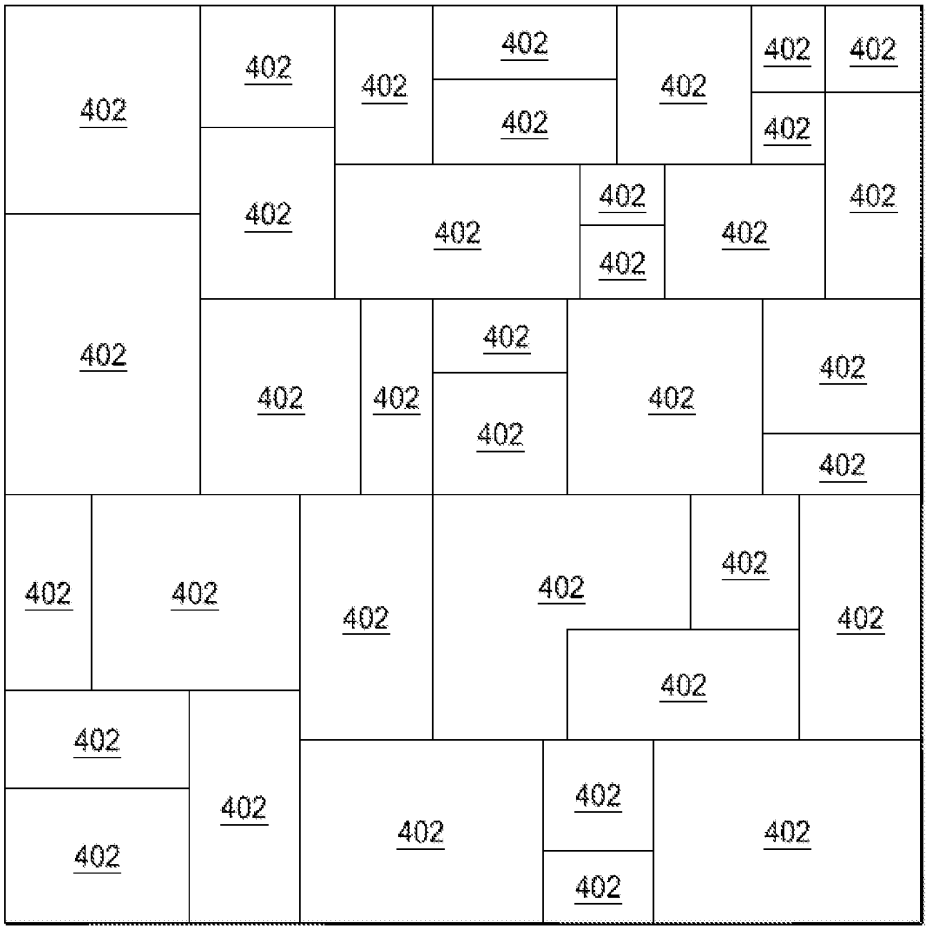

100
110
120
120
120
140
DATABASE
150
NETWORK
130
110
140
DATABASE
150
110
120
120
110

FIG. 3

402k	402l	402m	402n	402o
402f	402g	402h	402i	402j
402a	402b	402c	402d	402e

FIG. 4A


402
402
402

OVER-DEMAND STATE 402k	NORMAL STATE 402l	NORMAL STATE 402m	NORMAL STATE 402n
OVER-SUPPLY STATE 402f	NORMAL STATE 402g	OVER-DEMAND STATE 402h	NORMAL STATE 402i
OVER-SUPPLY STATE 402a	NORMAL STATE 402b	NORMAL STATE 402c	NORMAL STATE 402d
NORMAL STATE 402p	NORMAL STATE 402q	NORMAL STATE 402r	OVER-DEMAND STATE 402s

FIG. 4C

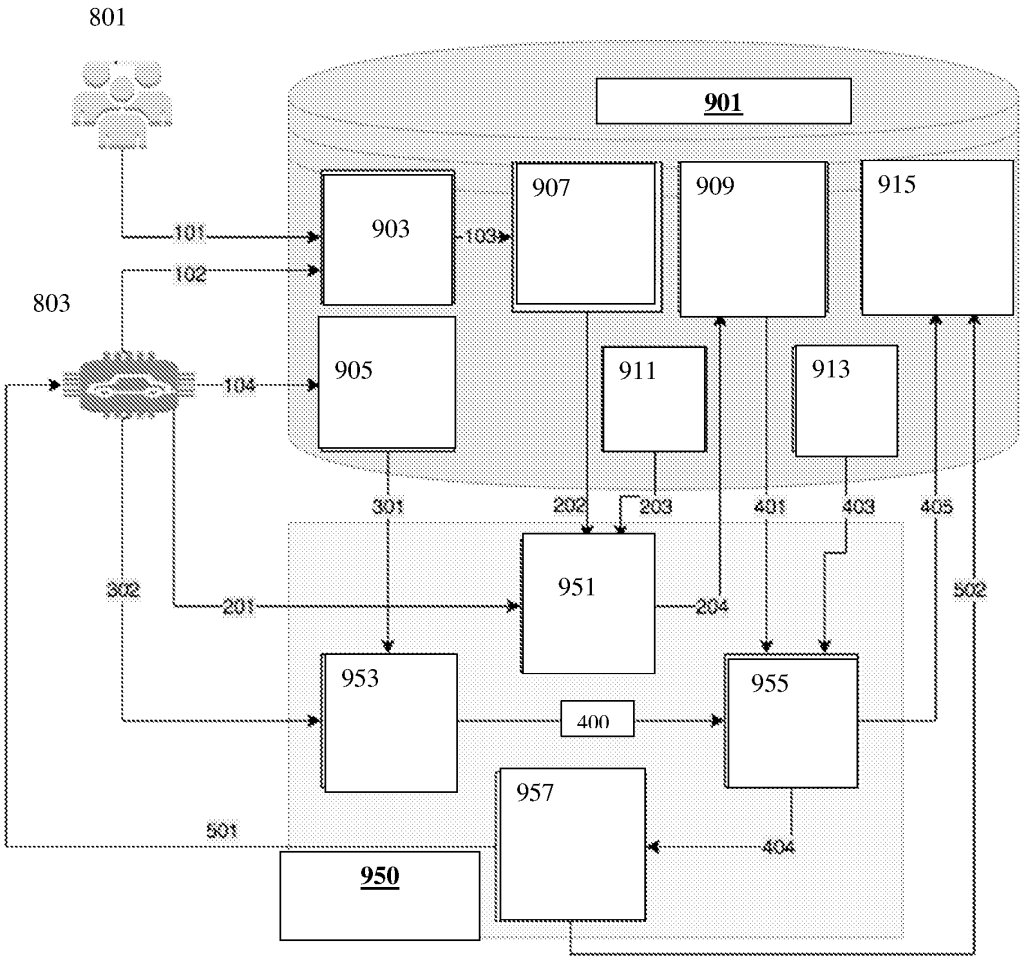

801
803
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903
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905
911
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202
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403
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404
501
502

FIGURE 5

Figure 6. Example of historical spatial temporal demand supply data

area	Start_time	End_time	demand	supply
CBD	2018-06-01 04:30:00	2018-06-01 04:45:00	50	30
CBD	2018-06-01 04:45:00	2018-06-01 05:00:00	60	35
…	…	…	…	…
Clementi	2018-06-01 04:30:00	2018-06-01 04:45:00	10	25
Clementi	2018-06-01 04:45:00	2018-06-01 05:00:00	8	15

Figure 7. Example of service provider profile data

	Provider ID	time	A C R	Is taxi driver	Age on platform	Avg online hour	Avg ride per week
A	1111	2018-06-01	18%	t	30 weeks	8 hr	60
B	203	2018-06-01	85%	f	20 days	3 hr	15
C	884	2018-06-01	46%	f	8 months	6 hr	40
D	1842	2018-06-01	15%	t	3 years	10 hr	80
	...	...	...	...	...	...	...

Figure 8A Example of service requests data

User_id	Request_id	request_time	Pickup	Dropoff	…
1	1-a	2018-06-01 05:01:00	(1.443, 103.802)	(1.278,103.843)	…
2	2-b	2018-06-01 05:00:23	(1.123, 103.451)	(1.318,102.984)	…
…	…	…	…	…	…

Figure 8B. Example of real time service provider status data

ID	time	lat	lon	Is online	Is available	destination	Time to destination	Time since last notification
1111	2018-06-01 05:00:00	1.315	133.298	t	f	Orchard	20 sec	28 min
203	2018-06-01 05:00:00	1.362	132.874	f	f	NULL	NULL	18 hours
884	2018-06-01 05:00:00	1.322	129.950	t	t	NULL	NULL	3 hours
1842	2018-06-01 05:00:00	1.348	135.874	t	t	NULL	NULL	17 min
…	…	…	…	…	…	…	…	…

Figure 9. Example of real time third party data

area	Start_time	End_time	rain	MRT breakdown	Events
CBD	2018-06-01 05:00:00	2018-06-01 05:15:00	Medium	NA	NA
CBD	2018-06-01 05:15:00	2018-06-01 05:30:00	Heavy	NA	NA
…	…	…	…	…	
Stadium	2018-06-01 05:00:00	2018-06-01 05:15:00	Medium	NA	concert
Stadium	2018-06-01 05:15:00	2018-06-01 05:30:00	Medium	NA	concert

Figure 10. Example of forecasted spatial temporal demand supply data

area	Start_time	End_time	Forecasted demand	Forecasted supply
CBD	2018-06-01 05:15:00	2018-06-01 05:30:00	58	32
CBD	2018-06-01 05:30:00	2018-06-01 05:45:00	62	31
…	…	…	…	…
Clementi	2018-06-01 05:15:00	2018-06-01 05:30:00	12	20
Clementi	2018-06-01 05:30:00	2018-06-01 05:45:00	10	16

Figure 11A Example of real time service provider status data

ID	time	lat	lon	area	Is available	Eligible for notification
1111	2018-06-01 05:00:00	1.315	133.298	CBD	f	f
203	2018-06-01 05:00:00	1.362	132.874	CLEMENTI	f	t
884	2018-06-01 05:00:00	1.322	129.950	STADIUM	t	t
1842	2018-06-01 05:00:00	1.348	135.874	TAMPINES	t	f
...	...	...	...		...	...

Figure 11B. Example of candidate service provider data

ID	time	lat	lon	area	Is available	Eligible for notification
203	2018-06-01 05:00:00	1.362	132.874	CLEMENTI	f	t
884	2018-06-01 05:00:00	1.322	129.950	STADIUM	t	t

Figure 12. Example of Historical aggregated temporal-spatial data

area	Start_time	End_time	Avg prob next job	Avg multiplier	AVG Fare
CBD	2018-06-01 05:00:00	2018-06-01 05:15:00	0.9	2.8	30
CLEMENTI	2018-06-01 05:00:00	2018-06-01 05:15:00	0.7	1.4	15
Orchard	2018-06-01 05:00:00	2018-06-01 05:15:00	0.8	2.0	25
…	…	…	…	…	

Figure 13. Example of optimization result

ID	time	lat	lon	From area	To area	moving distance
1111	2018-06-01 05:00:00	1.315	133.298	CBD	NA	0
203	2018-06-01 05:00:00	1.362	132.874	CLEMENTI	JURONG EAST	2.3 km
884	2018-06-01 05:00:00	1.322	129.950	STADIUM	ORCHARD	2.6 km
1842	2018-06-01 05:00:00	1.348	135.874	TAMPINES	NA	0
...	...	...	...		...	...

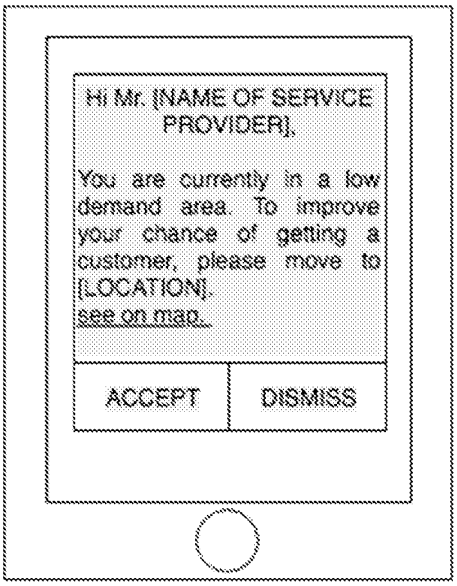


Figure 14

Figure 15. Example of message

Message ID	Broadcast time	Service provider ID	From area	To area	message
1	2018-06-01 05:00:00	203	CLEMENTI	JURONG EAST	***
2	2018-06-01 05:00:00	884	STADIUM	ORCHARD	***
...	...	...	...	...	...

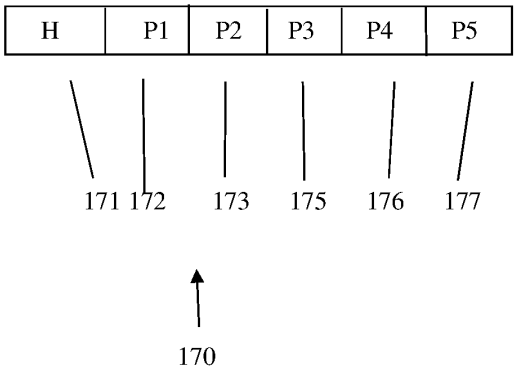


Figure 16