A demand responsive feeder bus system

An integrated flexible transit system

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(Flexible) MANY TO FEW

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(Flexible) FEW TO MANY

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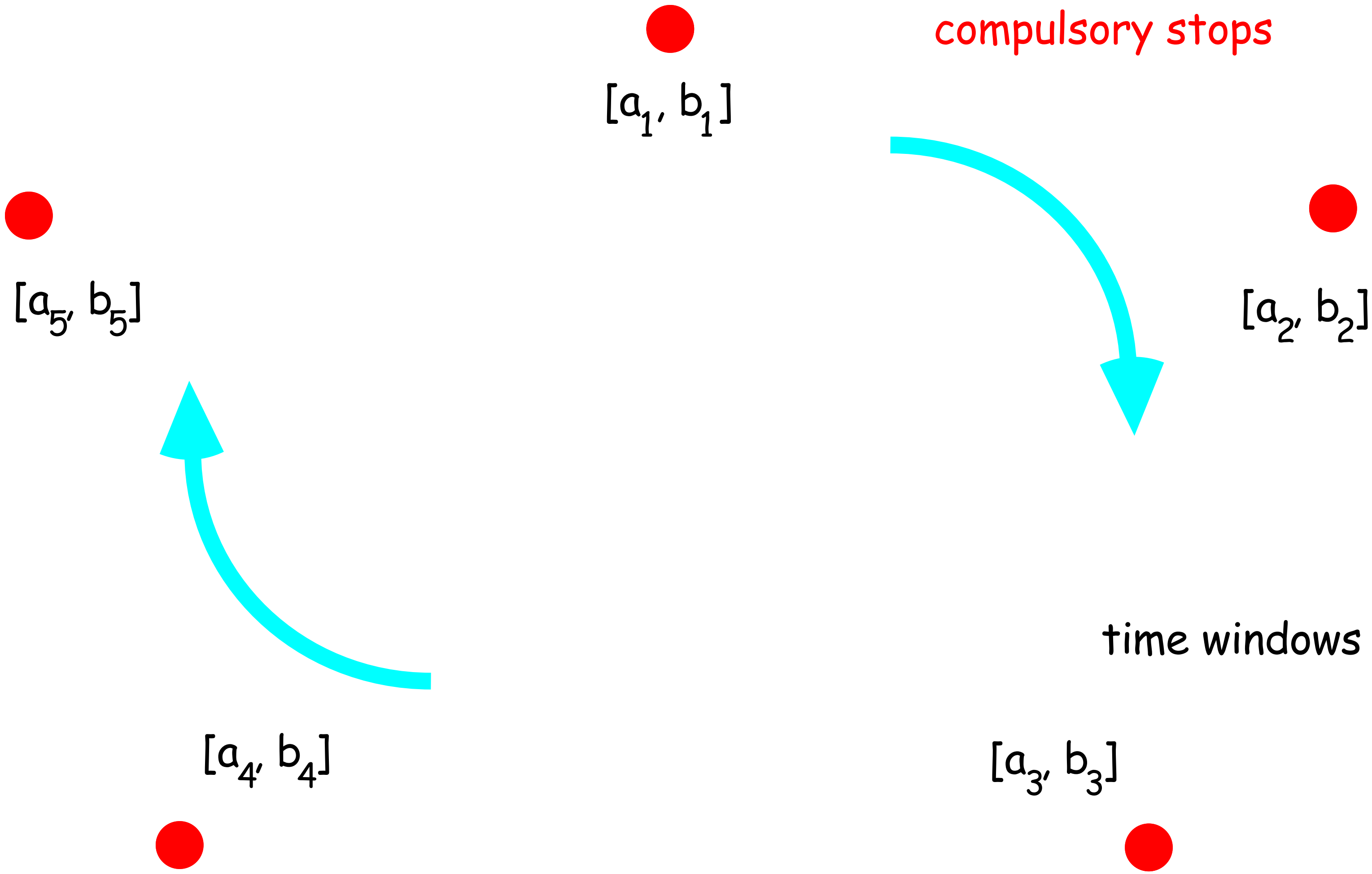
An almost "personalized" transportation system at the cost of a traditional fixed line system

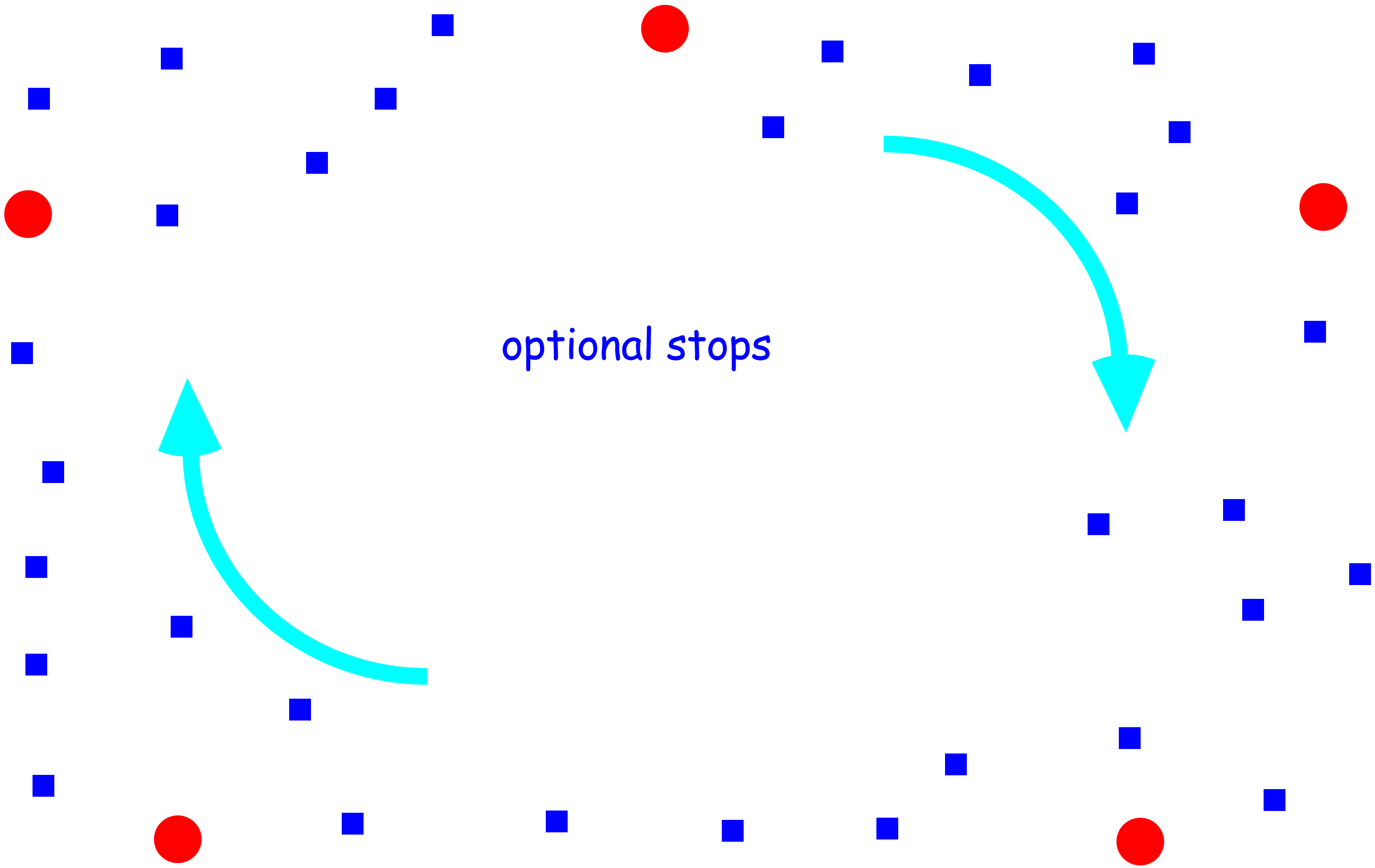
- the system assures also a traditional transportation service to users who do not reserve for the service

Building block: 1 flexible line



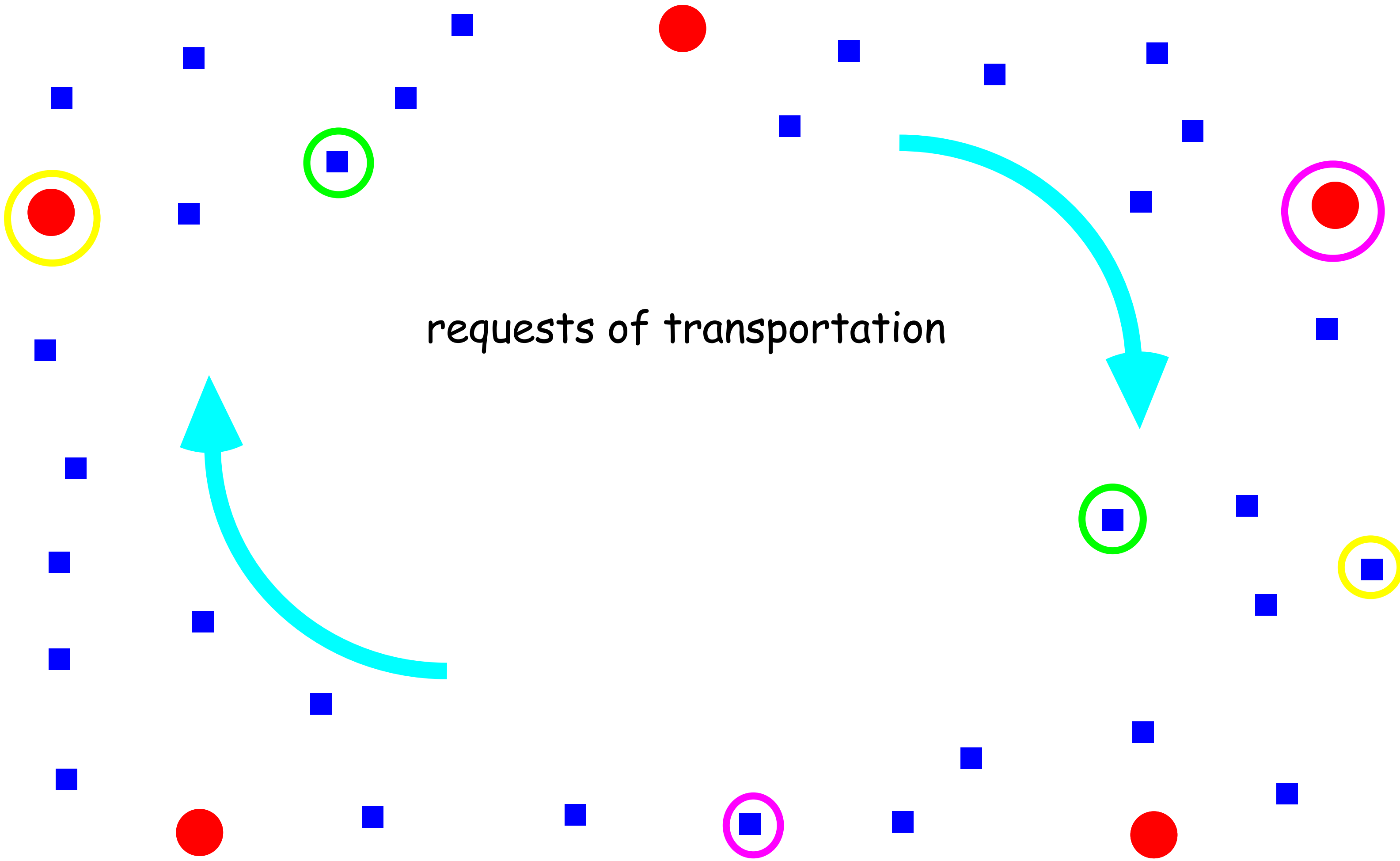
The bus pass by the compulsory stops following the sequence and within the specified time window

Building block: 1 flexible line



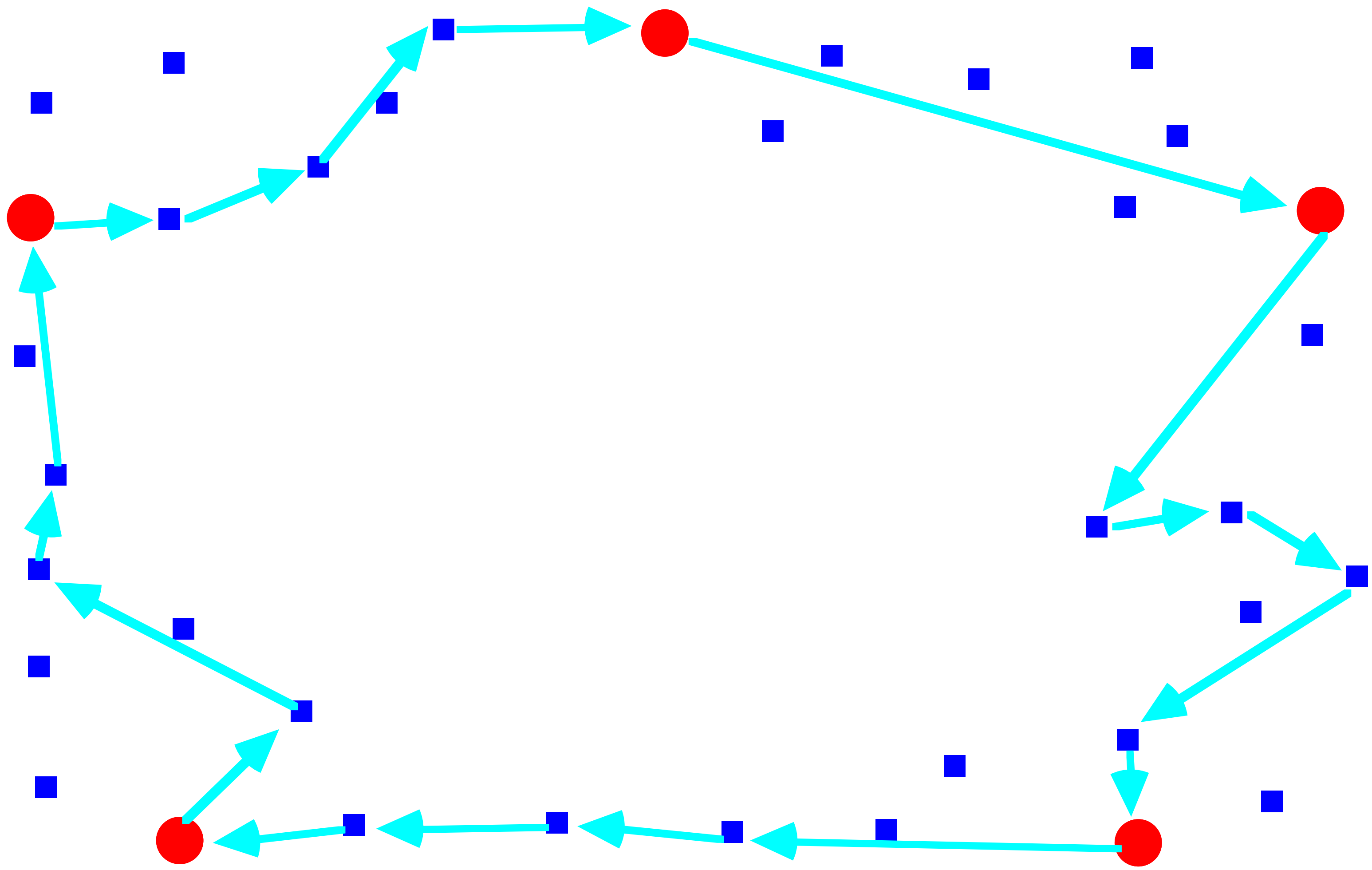
The bus pass by an optional stops if a user issues a request of transportation

Building block: 1 flexible line



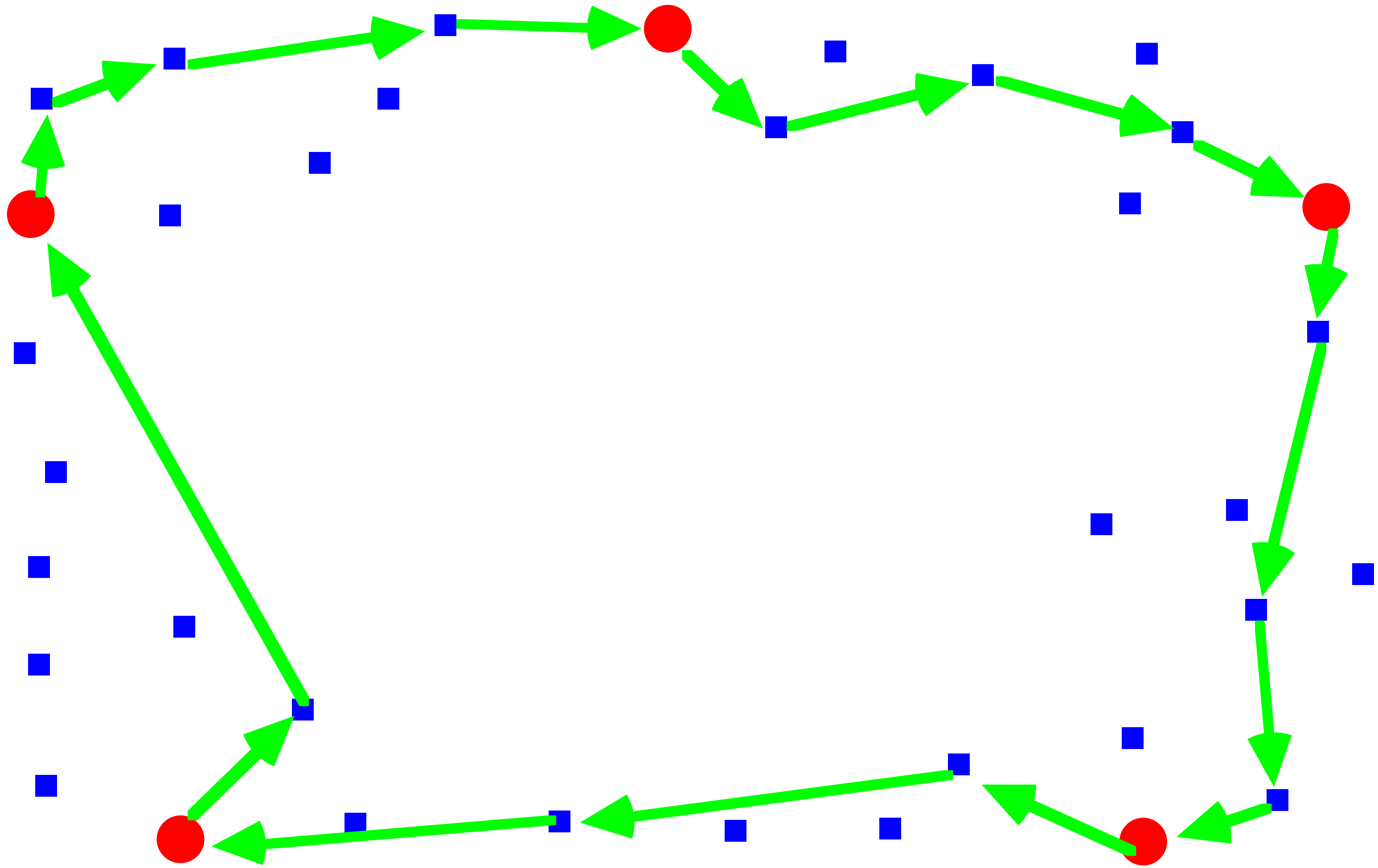
requests from optional to optional, from optional to compulsory, form compulsory to optional. A target time at the origin/destination is specified

Building block: 1 flexible line



The acceptation of requests induces detours in the vehicle basic itinerary

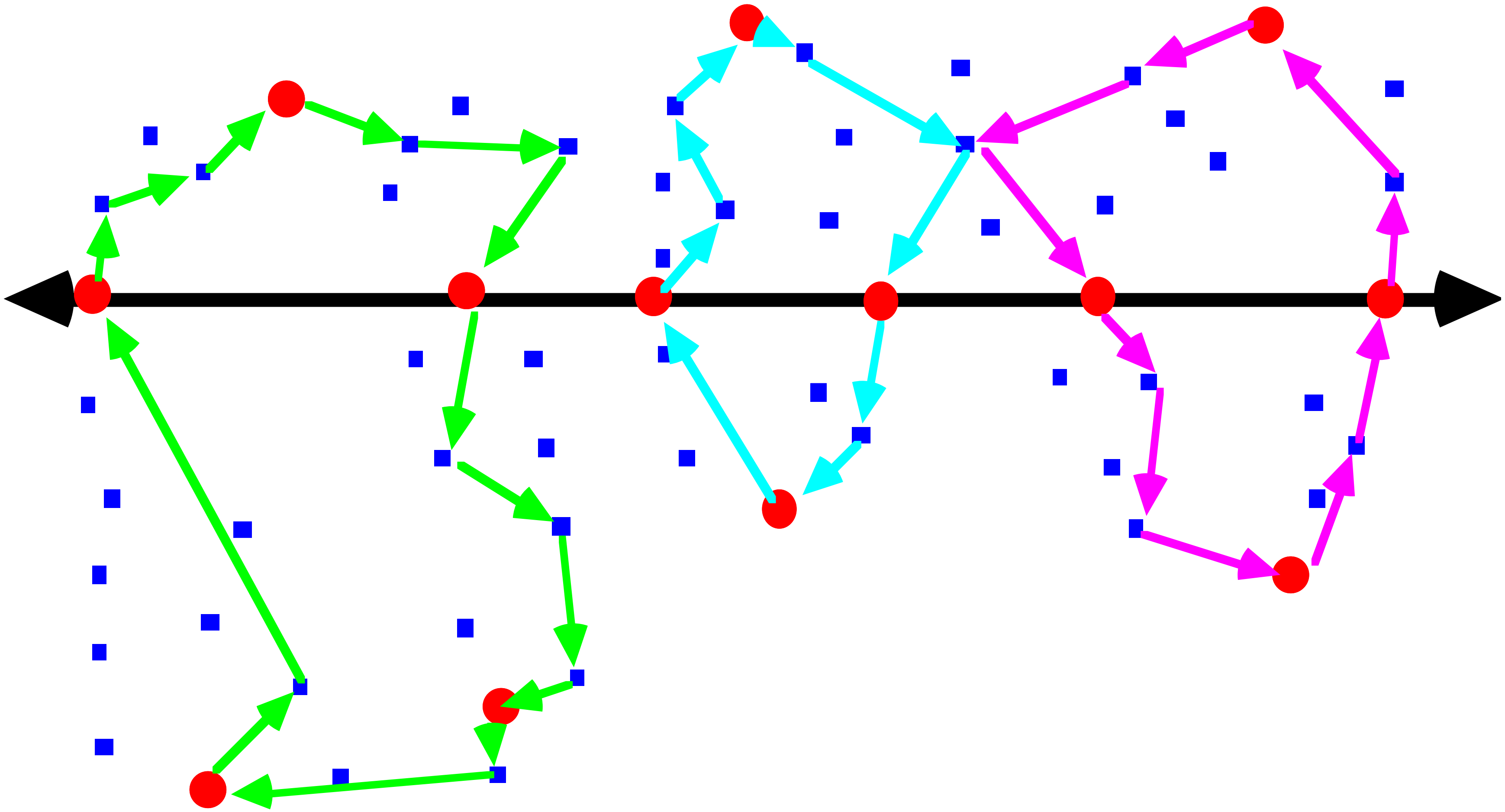
Building block: 1 flexible line



Multiple tours (or multiple vehicle in the same line)

An integrated system

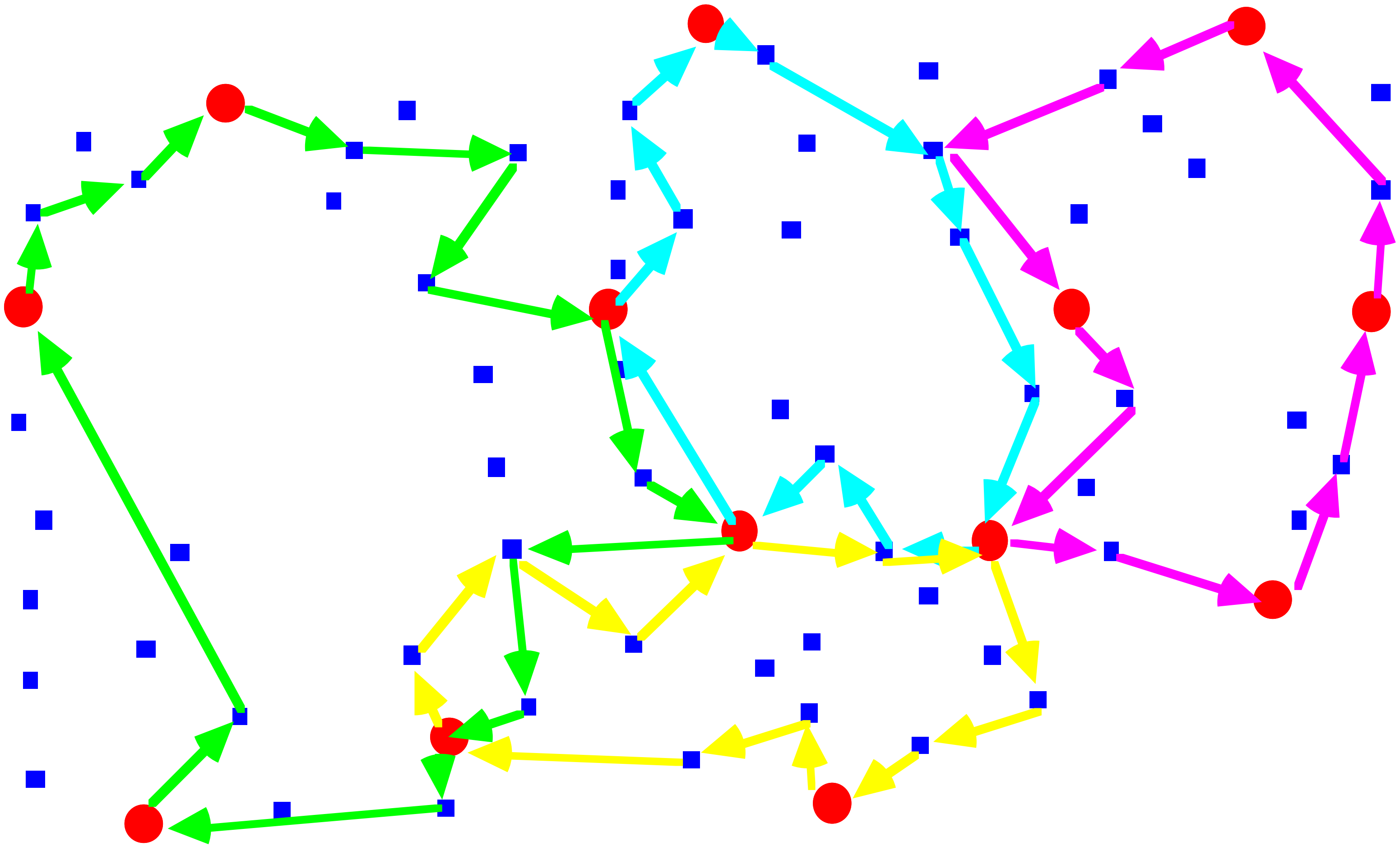
Flexible lines feeding a bearing swift line



the flexible lines serve passengers of residential and suburban areas

An integrated system

A set of intersecting and coordinated flexible lines



Main features of the integrated system

Vehicle synchronization (to guarantee the connections):

static or dynamic (on a reservation base)

Multiple classes of users (with different needs and fares):

express service, users with limited mobility, etc.

Additional flexibility (negotiation):

fare discount if displacement in time or in space occurs

Request management:

on line, off line

Integration with a Dial a Ride system

Technological aspects

Vehicle monitoring system: it is sufficient to keep track of the last visited compulsory stop.

Telecommunication system with the vehicles (in case of dynamic synchronization and on line management to enforce detours and delays).

Telecommunication system with the users (to confirm the reservation and the itinerary).

Decision support aspects

Decisions

user itinerary: when and where to pick up a user
when and where to make transfers

vehicle itinerary: which vehicle to board in each portion of a user trip

Constraints

- time windows in compulsory stops
- time windows of the users (depending on the class)
- trip characteristics (depending on the class of the user)
- vehicle synchronization (in the dynamic case)

Objective

Maximize the profit (minimize the "refused" requests)

Maximize the service level

Decision support aspects

Implicit constraints

- precedence between pick up and drop off
- fleet size
- synchronization (in the static case)

No capacity constraints (low demand, presence of "traditional users, medium sized busses)

Decomposition of the decision process

The problem can be decomposed in one problem for each line and each vehicle.

Each subproblem can be decomposed in one problem for each pairs of consecutive compulsory stops

Decision support aspects

Mathematical models to optimize the service from the user and the management point of view (in particular for the off line case): vehicles itinerary, passengers itinerary

Efficient algorithms

Planning of the service: localization of compulsory stops, localization of optional stops (service area), definition of frequencies, definition of the time windows

Conclusions

The proposed system provides a good flexibility maintaining the features of a traditional fixed line system: traditional users and users who ask explicitly for a ride may share the service.

Limited technological requirements.

Low costs

Efficient service if supported by suitable mathematical and algorithmic tools.

Additional information: http://www.elet.polimi.it/people/malucell