

# An Intelligent Multi-Agent Elevator System

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The multi-agent intelligent elevator system consists of ordinary elevator hardware, an agent for each elevator car and a blackboard shared among the agents. The car agents communicate through the blackboard and directly with each another using an agent communication language.

## 1 Normal Hours Schedule

**Request Elevator.** A passenger can request an elevator from a floor by pressing one of the up or down buttons. All the buttons on the same floor with the same direction are illuminated. The request is posted with the Blackboard (a singleton).

Car agents can retrieve and update these requests asynchronously. In particular, a moving car agent consults the blackboard whenever it approaches a floor. If there is a pending request of the same direction, the car agent instructs the elevator to stop at the floor and open the door. The floor button light is turned off.

The elevator then waits at the floor to unload and load passengers. When this is done, the elevator door is closed if the elevator has waited for more than three seconds or the close (door) button on the elevator panel is pressed. When the door is securely closed, the elevator travels to its next destination.

Passengers in an elevator can push any of the numbered buttons to enter a destination request. All the destination requests are maintained by the car agent and used to instruct the elevator to stop at a floor if the floor is on the list. It also instructs the elevator to open the door and turn off the panel button light.

When an elevator reaches its final destination and there is no pending requests from the final destina-

tion floor, the car agent checks if it is during the rush hour. If so, the agent consults the blackboard and travels to a destination floor as appropriate; otherwise, the agent reads the blackboard and contact the other elevator car agents to identify its next destination. The agent will go to serve a floor if and only if the following conditions hold:

- There is a pending request from the floor.
- There is no elevator closer to the floor and either traveling toward that floor or standing by.

If the elevator decides to go to serve a floor, then the associated elevator request posted with the blackboard is updated to indicate that the request is being served.

If no floor needs to be served, the elevator enters the stand-by state and sleeps for one minute. When it wakes up, it repeats above process and goes to sleep again if no request needs to be served.

## 2 Rush Hours Schedule

Early morning, late afternoon and lunch time are rush hours. The demand for service has a bell shape during each of these rush hours. In particular, people are heading up from the first floor during the morning rush hour and heading down to the first floor during the afternoon rush hour. During lunch time, people are heading down to the first floor before lunch and heading up from the first floor after lunch. While the up requests from the first floor during the morning rush hour and after lunch are pretty much the same, the down requests during the afternoon rush

hour and before lunch differ from floor to floor and may change from time to time.

The rush hour schedule is stored with the blackboard and periodically updated by an intelligent service log (ISL). The ISL uses data mining techniques to discover new demand patterns from its service log and computes the up-to-date rush hour schedule. The ISL does this once a while. The frequency is adaptive and adjusts to one that will provide the most suitable rush hour schedule.

During a rush hour, the car agents direct their respective elevators to rush to floors whose demands have not been completely satisfied. This can be achieved by requiring that the car agents monitors the weights or number of passengers carried away from a floor during a particular rush hour and reports this information to the ISL and posts it with the blackboard. The ISL uses this information to compute the anticipated rush hour demand for each floor. The car agents use the anticipated rush hour demand and the demand that has been served to approximately determine how much demand remains to be served. This in turn can be used to determine how many more trips are needed.

When an elevator reaches its final destination during a rush hour, it rushes to serve floors according to the demands pattern as follows. If it is during the morning rush hour or after lunch rush hour, it rushes to the first floor. If it is during the other rush hours, it checks the schedule at the blackboard for floors with anticipated rush hour demands remain to be served. If such floors are found, then it contacts other car agents to learn their status and goes to a floor that is most appropriate. In all cases, it updates the blackboard to inform the other agents of its move. If all anticipated demands have been taken care of, the elevator goes to sleep for a preset time period.

### 3 Idle Hours Schedule

During idle hours some elevators are turned off to conserve energy improve efficiency. It is assumed that only one third or half of the elevators will be in service during idle hours. Which elevator is turned off during idle hours are determined by the first come first get

policy until the preset percentage is reached.

The elevator car agent will periodically check the blackboard and interact with other car agents while its associated elevator is turned off. If there are elevator requests that are outstanding for longer than a preset threshold and no other elevator seems to be at a better position to serve that request, the car agent in question will turn on the elevator and instruct it to go to serve that request. After all such requests are served the elevator is turned off again if the idle hour has not expired.