

Multi Shaft Elevator System – Requirements Document

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This document presents the requirements for a multi shaft elevator system as shown in Figure 1.

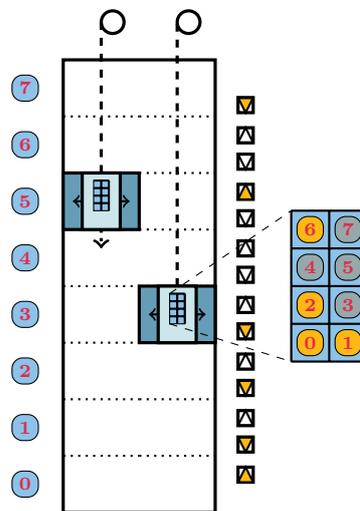


Fig. 1. Multi Shaft Elevator System

The system manages multiple elevators with a single cabin in each shaft. Each elevator cabin can be stationary on a floor or moving up and down in a building with a fixed number of floors, where the lobby is floor 0. The elevator cabins are numbered from 0 to $e-1$ where e is the number of elevator shafts in the building. The number of elevators must be less than the number of floors in the building.

REQ 1	There is a fixed number of floors starting at 0
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REQ 2	Each elevator shaft has exactly one elevator cabin
REQ 3	The number of elevators is less than the number of floors
REQ 4	Each elevator has a number starting at 0
REQ 5	Each elevator can be either stationary at a floor or moving either up or down

Each elevator cabin has buttons corresponding to all the building floors. Each elevator is responsible to serve the floor requests initiated by passengers pressing floor buttons inside its cabin. Each floor, except the top and bottom floors, has two buttons UP and DOWN to indicate the desired direction of movement. The top floor has only a DOWN button, while the bottom floor (floor 0) has only an UP button. Floor requests are controlled by a central controller, which assigns the request to one elevator. Once the floor request is assigned to an elevator it is treated as an internal request similar to its cabin requests. Internal requests are served, once an elevator arrives to one of the requested floors. Requests are dealt with sequentially, i.e., if the direction is up lower floors are served first, while upper floors are served first if the direction is down.

REQ 6	There are two types of floor requests internal and external
REQ 7	Internal floor requests are requests inside the cabin and are dealt with locally
REQ 8	External requests are floor requests outside cabins, they are assigned by a central controller to one elevator

REQ 9	Once an external request is assigned to an elevator, it is treated similar to internal requests
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REQ 10	Internal requests are served sequentially, when the elevator arrives at one of the requested floors
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External requests are assigned by the central controller to the nearest serving cabin. The central controller determines the nearest serving cabin according to the calculated figure of suitability (FS). The floor will be assigned to the elevator with the highest FS.

The figure of suitability depends on the distance to the floor, the direction of movement and the direction of call. FS is calculated according to the following cases where d is the distance between the cabin and the floor, and N is the number of floors (excluding 0).

- If the elevator cabin is moving towards the floor and the request is in the same direction: $FS = N + 2 - d$
- If the elevator cabin is moving towards the floor and the request is in the opposite direction: $FS = N + 1 - d$
- If the elevator cabin is moving away from the floor: $FS = 1$
- If the elevator is stationary: $FS = N + 1 - d$

If more than one elevator has the same FS, the controller will assign the call to the smallest indexed elevator.

REQ 11	The central controller will assign external floor requests to the nearest elevator
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REQ 12	The nearest elevator is determined by the figure of suitability which depends on the direction of the elevator, the direction of the call and the distance to the floor
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REQ 13	Requests are assigned to the lowest indexed elevator if more than one elevator has the same figure of suitability
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The elevator is driven by a motor. The cabin moves up when the motor is winding and moves down when the motor is unwinding. The cabin stops at a floor when the motor stops. (We will ignore the details that the cabin can be between floors)

REQ 14	The elevator is driven by a motor which can be either <i>WINDING</i> , <i>UNWINDING</i> , or <i>STOPPED</i> .
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REQ 15	If not at the top floor, the cabin moves up one floor if the motor is <i>WINDING</i>
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REQ 16	If not at the bottom floor, the cabin moves down one floor if the motor is <i>UNWINDING</i>
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The cabin has a door which can be *OPEN*, *HALF*, or *CLOSED*. To protect the elevator's users, the cabin door must be closed while the elevator is moving. (We omit other details of the system such as the cabin door motor, the doors on each floor and their motors.)

REQ 17	The cabin has a door which can be <i>OPEN</i> , <i>HALF</i> , or <i>CLOSED</i> .
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SAF 18	While the cabin is moving, its door must be closed.
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The users indicate their requests by pressing different buttons. On each floor except the top one, there is an *up* button to request the elevator to go up from the current floor. Similarly, on each floor except the bottom one, there is a *down* button to request the elevator to go down from the current floor. Once inside the cabin, the user presses the button corresponding to the floor to which the user wants to go.

REQ 19	On each floor except the top one, there is an "up" button.
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REQ 20	On each floor except the bottom one, there is a “down” button.
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REQ 21	Inside the cabin, there are floor buttons, one for each floor.
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The elevator can only stop at a floor and open its door if there are *some requests to serve* at that floor. The requests are cleared once the door is fully open. The elevator can leave a floor (to go up or down) only if there are no requests to serve at that floor. If there are no requests, the elevator should stay stationary at a floor with the door closed. An elevator can only change direction, if there are no requests to serve in its direction, but there are other requests in the opposite direction.

REQ 22	The cabin stops at a particular floor and open the door if there is a request to serve at that particular floor.
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REQ 23	The requests at one floor are cleared once the door is fully open.
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REQ 24	The elevator should not move to leave a floor if there are requests to serve at that floor
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REQ 25	The elevator should stay stationary at a floor when there are no requests
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REQ 26	The elevator can only change direction if it has no requests in the same direction, but has some requests in the opposite direction
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