

Graceful Degradation:

Component failures should reduce functionality rather than cause system failure

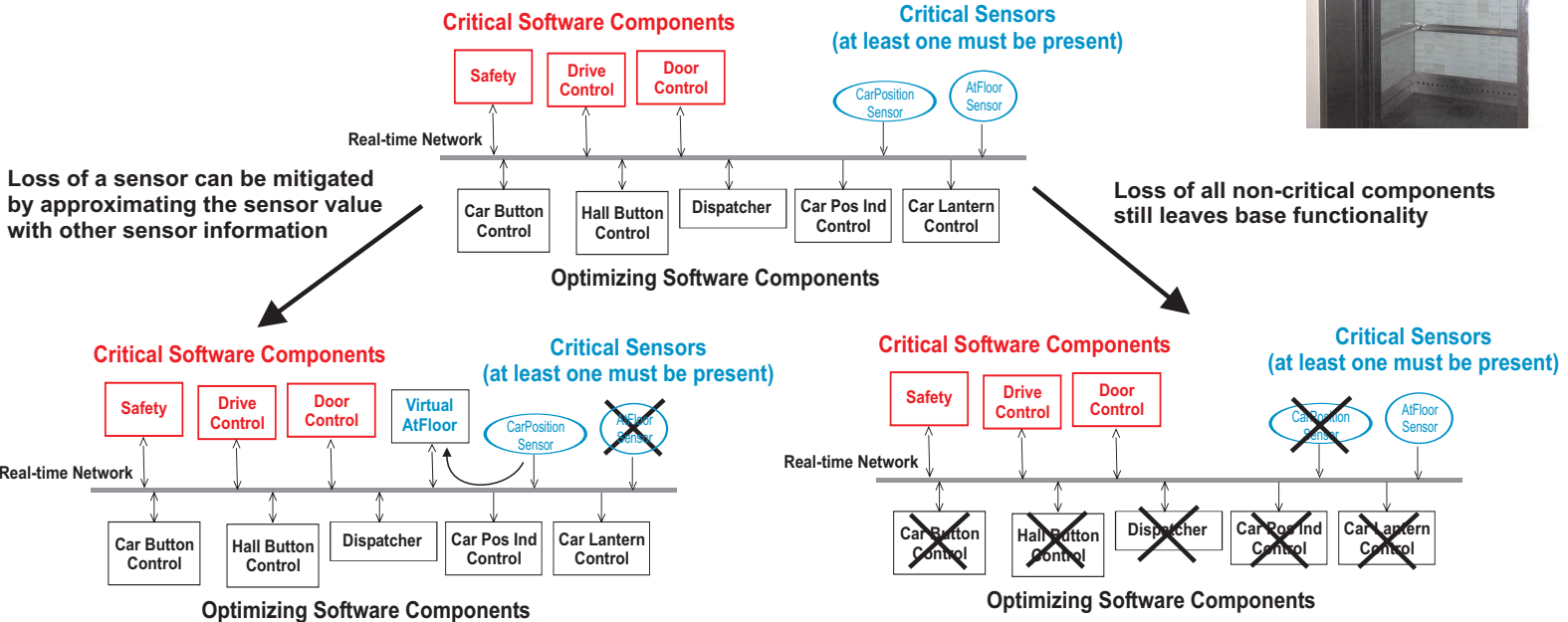
Desirable Architectural Objectives:

- Build a fine-grained distributed system to decouple components
- Partition the system into critical and non-critical components
- Construct well-defined component interface definitions
- Design components to be semi-autonomous (provide some functionality when inputs are lost)

Proof of Concept:

Model an elevator control system with these architectural objectives

- Simulate the physical elevator system and build the software control system
- Inject component failures to determine how well it performs graceful degradation



Simulate workloads of passengers using the elevator and inject component failures.

- Functionality metric based on performance: best, average and worst case passenger delivery times.
- System works even in the presence of multiple component failures.

Components Failed	All Passenger Delivery Times in Seconds Test 1: 14 Passengers						
	best time		average time		worst time		
	mean	stddev	mean	stddev	mean	stddev	
0	25.00	N/A	108.55	N/A	190.00	N/A	
1 (Car Position Indicator (CPI))	27.00	N/A	119.41	N/A	204.00	N/A	
3 (CPI and Lanterns broken) 4 combinations	41.00	18.96	180.84	36.19	327.75	119.10	
7 (One third of the Car and Hall Buttons) 10 combinations	22.20	5.05	150.26	26.37	362.30	61.75	
10 (Half of the Car and Hall Buttons) 10 combinations	28.80	8.73	161.76	10.51	387.20	23.06	
13 (Two thirds of the Car and Hall Buttons) 10 combinations	23.10	11.75	178.77	22.43	305.10	51.97	
20 (Everything except CPI, Lanterns, and Critical Components)	17.00	N/A	139.19	N/A	340.00	N/A	
23 (Everything except Critical Components) 4 combinations	47.50	57.00	195.10	28.13	339.75	34.60	
24 (Everything including Car Position Sensor, except Critical Components)	33.00	N/A	311.41	N/A	718.00	N/A	

Components Failed	Test 2: 50 Passengers						
	best time		average time		worst time		
	mean	stddev	mean	stddev	mean	stddev	
0	15.00	N/A	87.89	N/A	163.00	N/A	
1 (Car Position Indicator (CPI))	24.00	N/A	98.41	N/A	193.00	N/A	
3 (CPI and Lanterns broken) 4 combinations	26.50	18.07	161.93	104.24	355.25	271.64	
7 (One third of the Car and Hall Buttons) 10 combinations	26.20	8.48	255.03	108.30	884.20	623.34	
10 (Half of the Car and Hall Buttons) 10 combinations	28.90	6.90	269.71	100.18	811.90	435.42	
13 (Two thirds of the Car and Hall Buttons) 10 combinations	28.90	6.98	399.23	289.69	1345.70	1254.51	
20 (Everything except CPI, Lanterns, and Critical Components)	20.00	N/A	173.47	N/A	590.00	N/A	
23 (Everything except Critical Components) 4 combinations	70.50	33.35	332.05	53.60	922.25	289.38	
24 (Everything including Car Position Sensor, except Critical Components)	145.00	N/A	723.45	N/A	1436.00	N/A	

