TriMet Light Rail Simulation Study for Operational Playbook Development

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Topics of Discussion

- History of TriMet System Expansion in Portland, OR
- Full Network Simulation Model of TriMet's MAX
  - Calibration and Results for Existing Network
- Purpose and Need for Controller Playbook
- Development of Playbook Scenarios
- Analysis of Strategies for each Scenario
  - Assumptions, Methodology, and Simulation
 - Sample Scenario Playbook Page
- Conclusions

Expansion of the MAX System
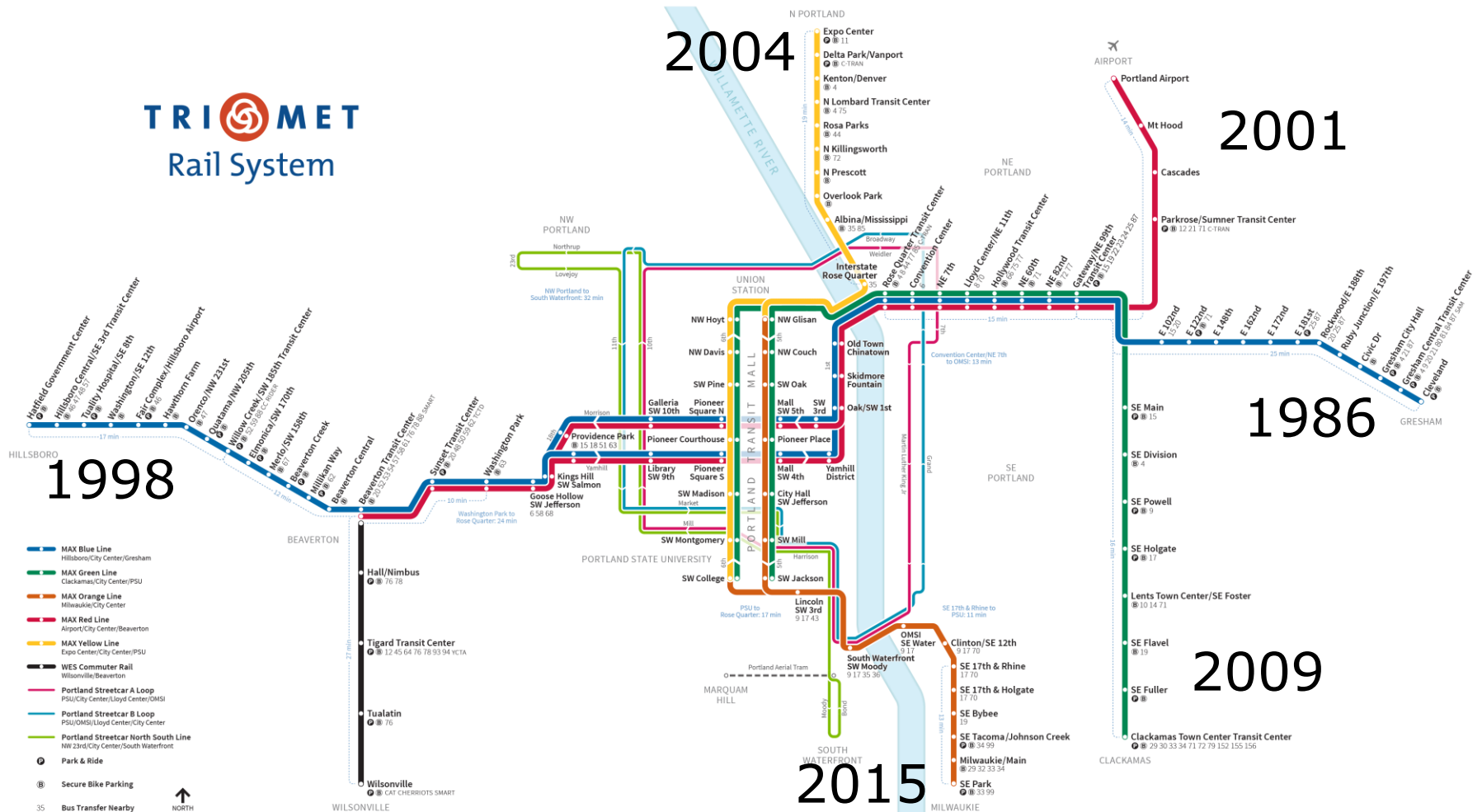
TrainOps® Simulation Model of MAX
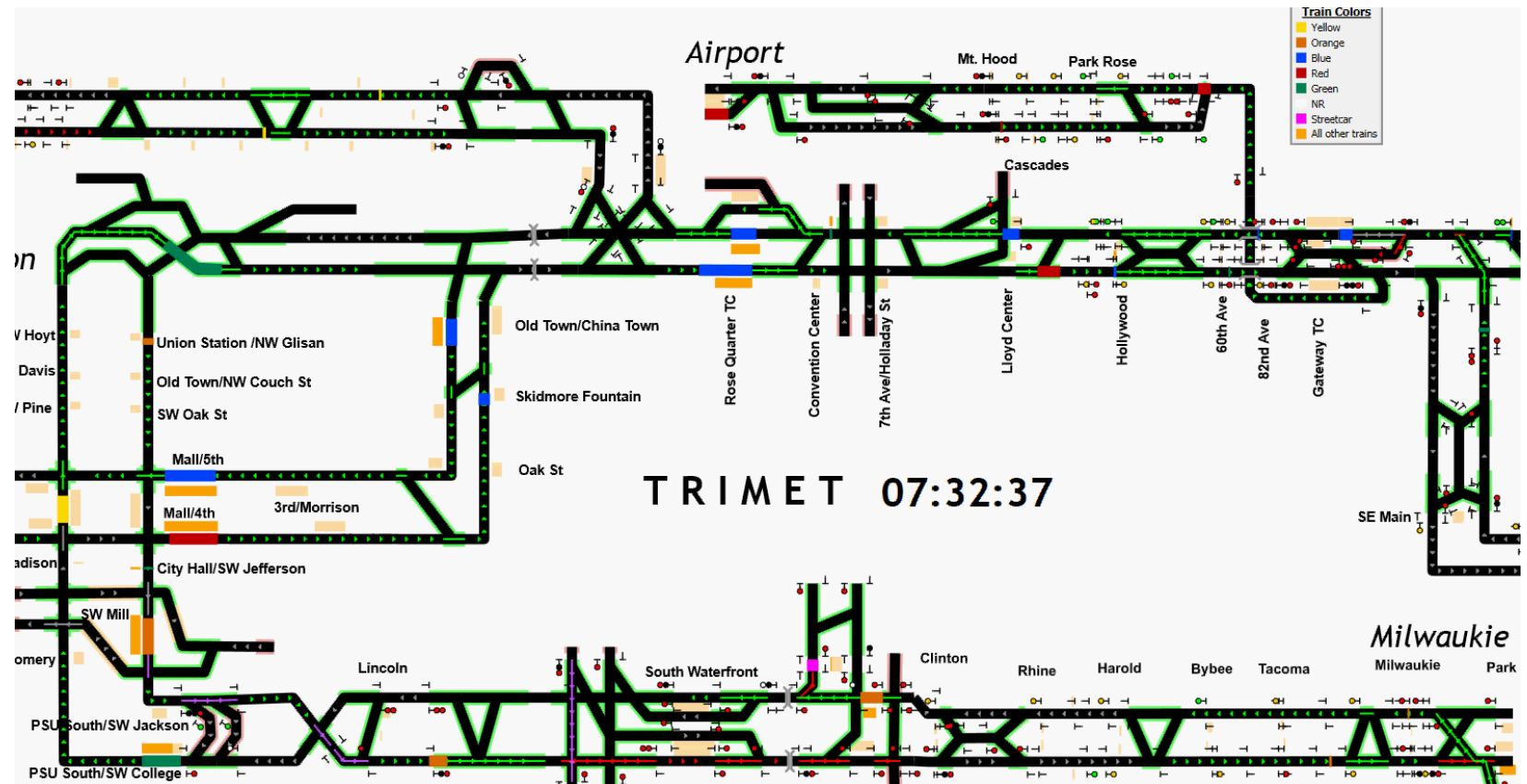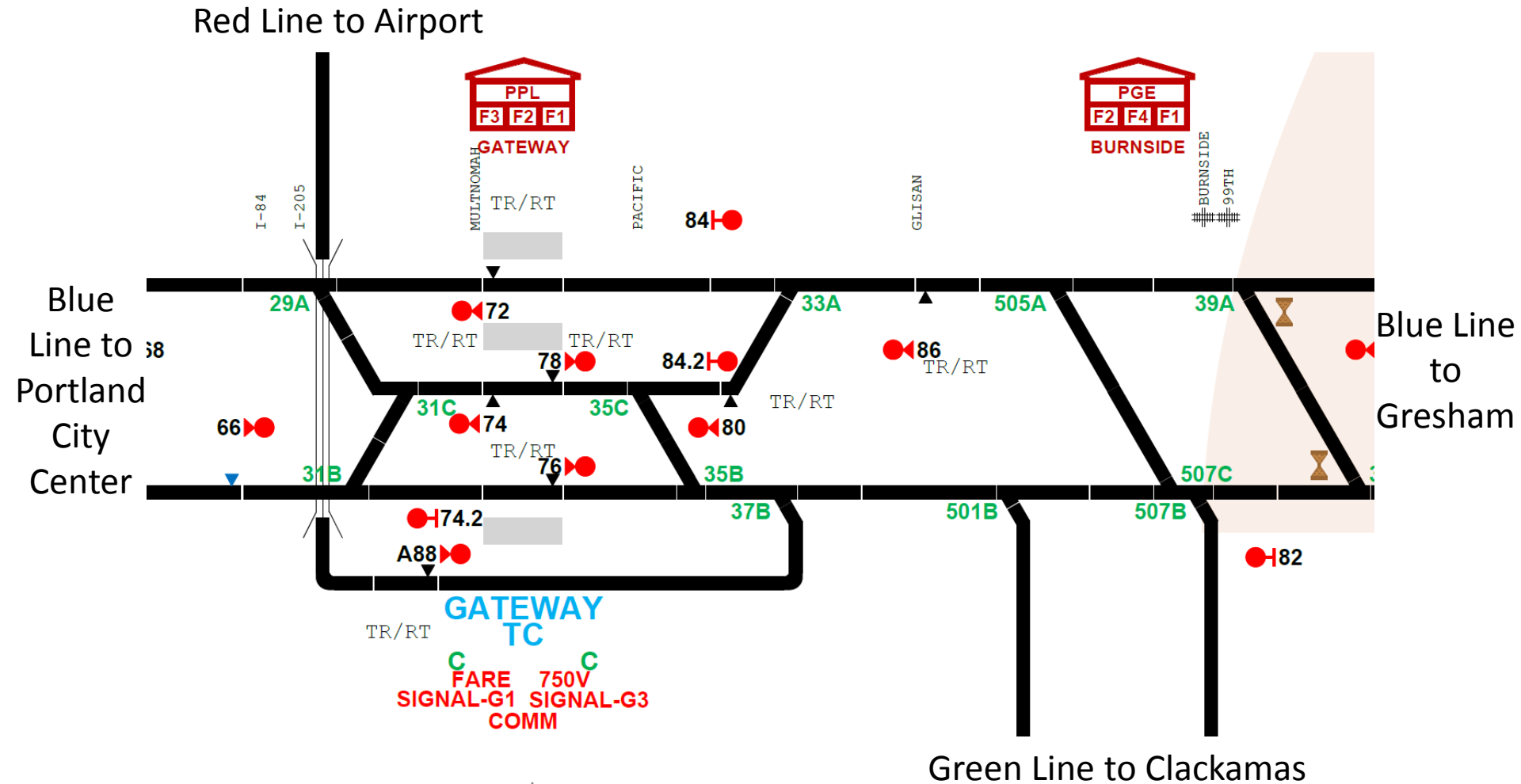
Gateway Interlocking Controller Playbook

- Gateway Interlocking is critical for MAX system reliability

- Develop a Playbook for Controllers to improve responses to incidents

- Playbook includes incidents at Gateway and the optimal relief strategy
  - Controllers reference Playbook when incident arises

- Optimal strategies determined from simulation
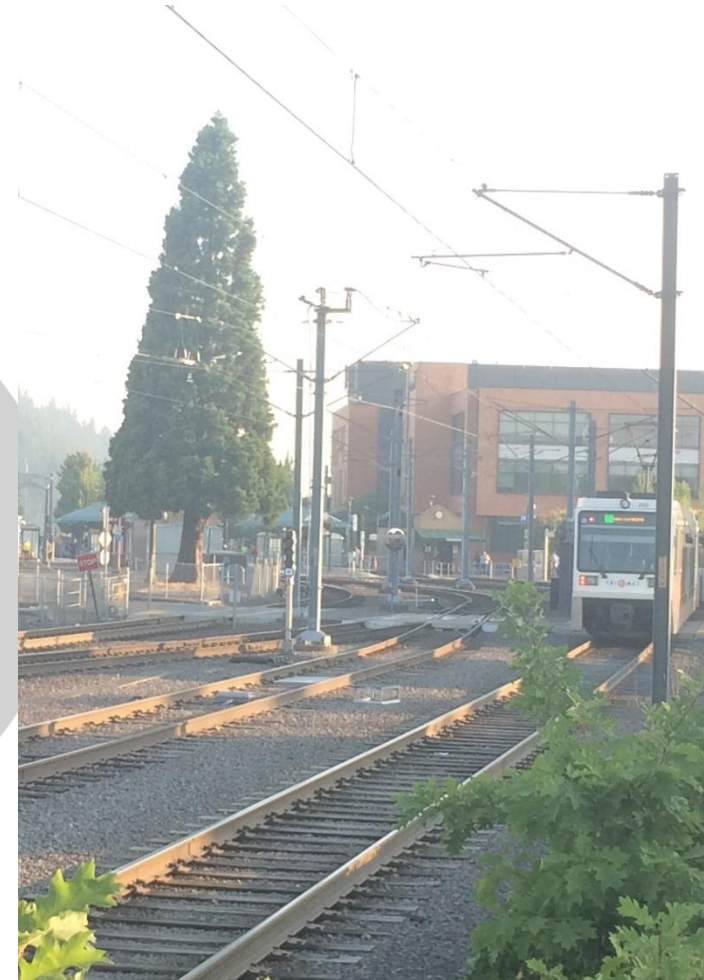
Gateway Interlocking

Controller Engagement

- TriMet Light Rail Controllers were engaged at every step
- Meetings to identify common incidents at Gateway
  - Strategies that Controllers implement to address them.
- Analysts toured Gateway Interlocking and Control Center
- Controller buy-in to the process is essential for success

Simulation and Analysis Methodology

- Develop a simulation of each Scenario in TrainOps
  - Baseline system response is a default scenario
- Each controller-suggested Strategy is modeled with specific variations to the simulation
- Iterative adjustments create the most efficient version of each Strategy
- Results are generated for each Strategy
- Results are compared to determine the optimal Strategy for handling each Scenario.

Sample Gateway Playbook Scenario

Switch 507 out of correspondence
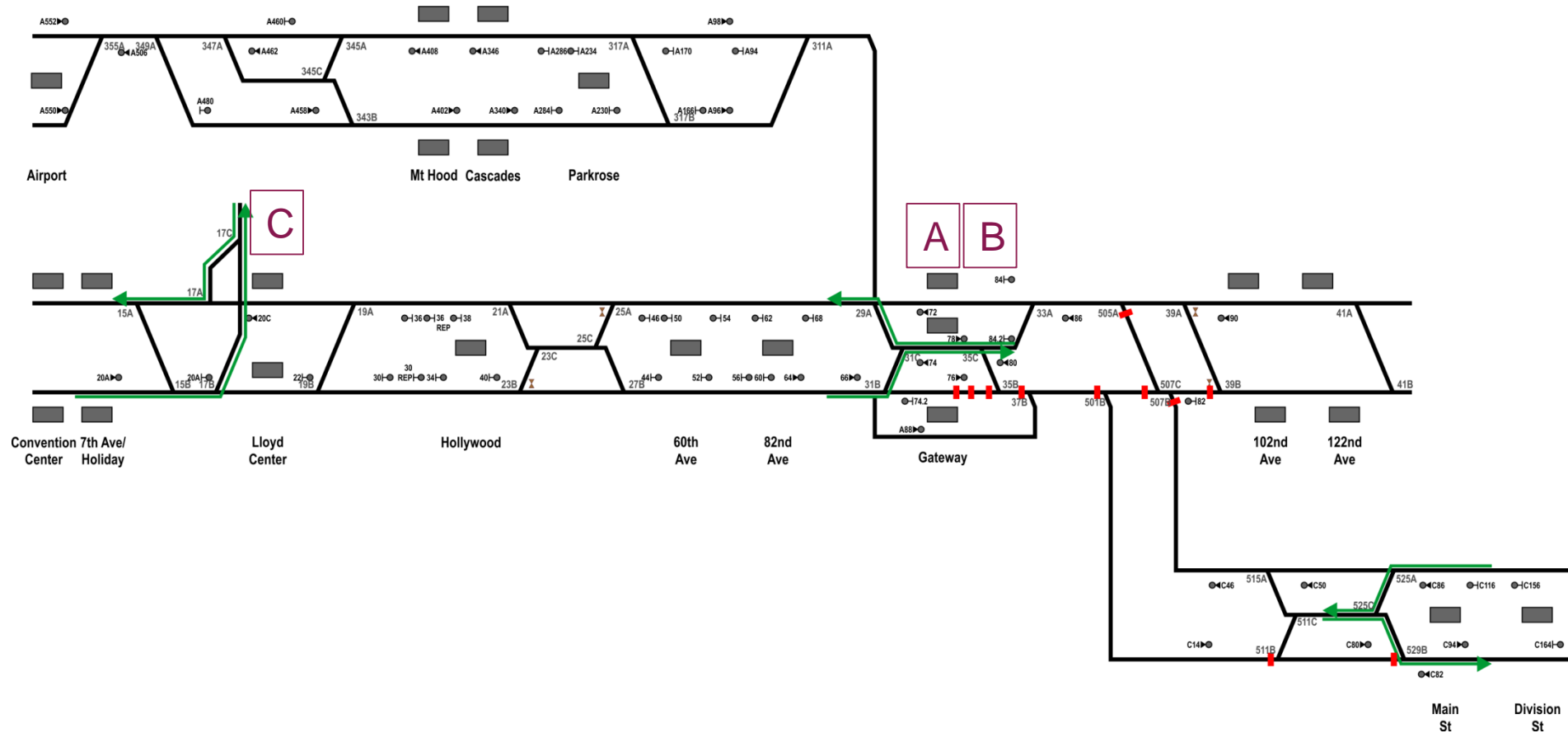
Sample Scenario Strategy Simulation
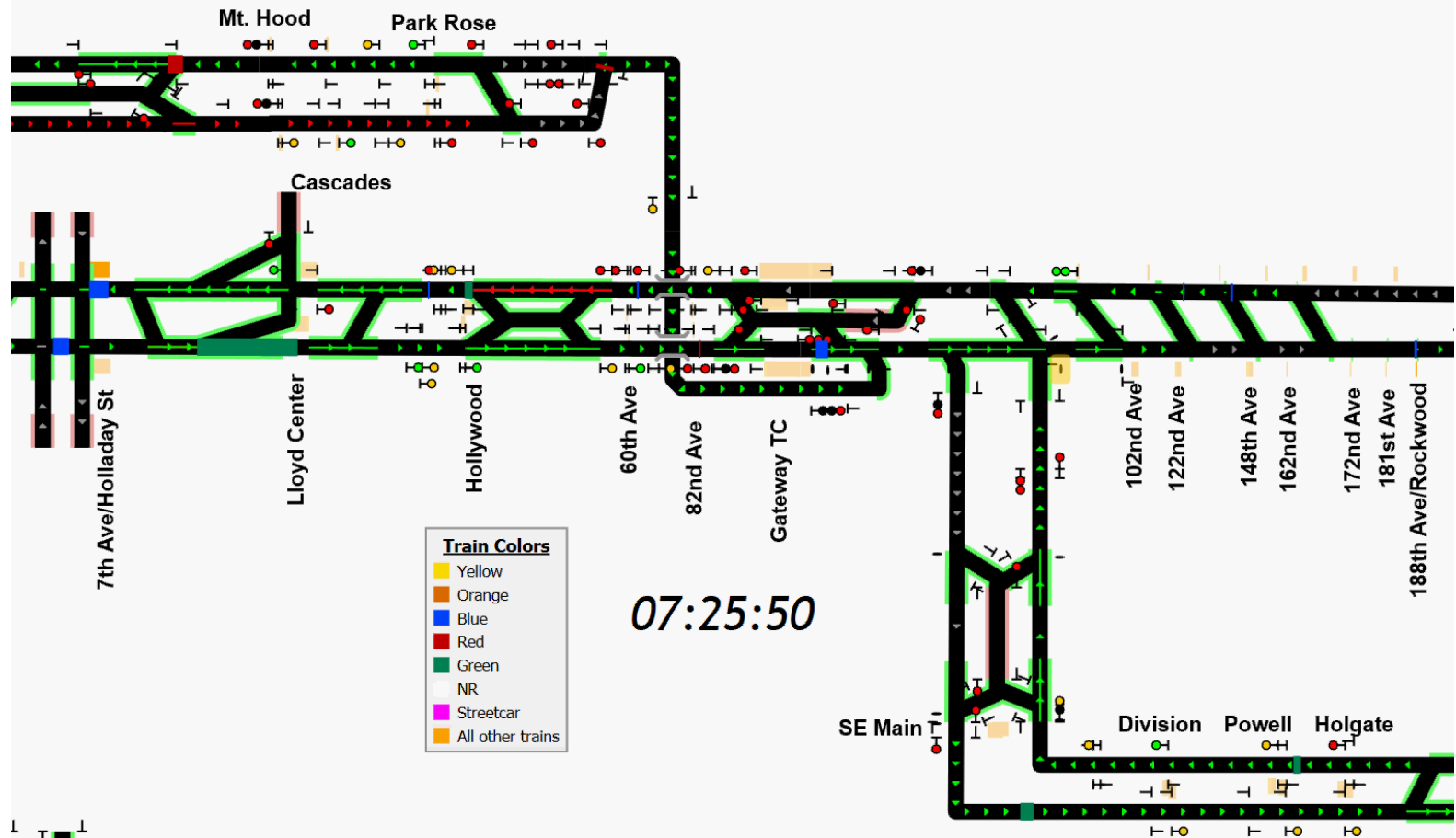
Handling Unexpected Outcomes

- Consist Allocation
  - Green Line severing may leave an unbalanced consist distribution
  - Response: Split a consist, or operate over Switch 507
- Green Line Short Turn
  - Some strategies create an unexpectedly late consist
  - Response: short-turn the consist to get it back on schedule
- Controllers were engaged in iterative analysis process
  - Confirmed analyst suggested responses, or
  - Presented responses from experience

Selecting Preferred Strategy

- Operations
  - On-Time Performance (OTP)
 - Stopped delay per distance traveled

- Passenger Impact
  - Average passenger travel time on Green Line (through affected area)
  - Number of passenger transfers
  - Number of station stops skipped
  - Green Line service headways

- Resources
  - Number of Controller radio calls required
  - Supervisor and Bus Driver person-hours
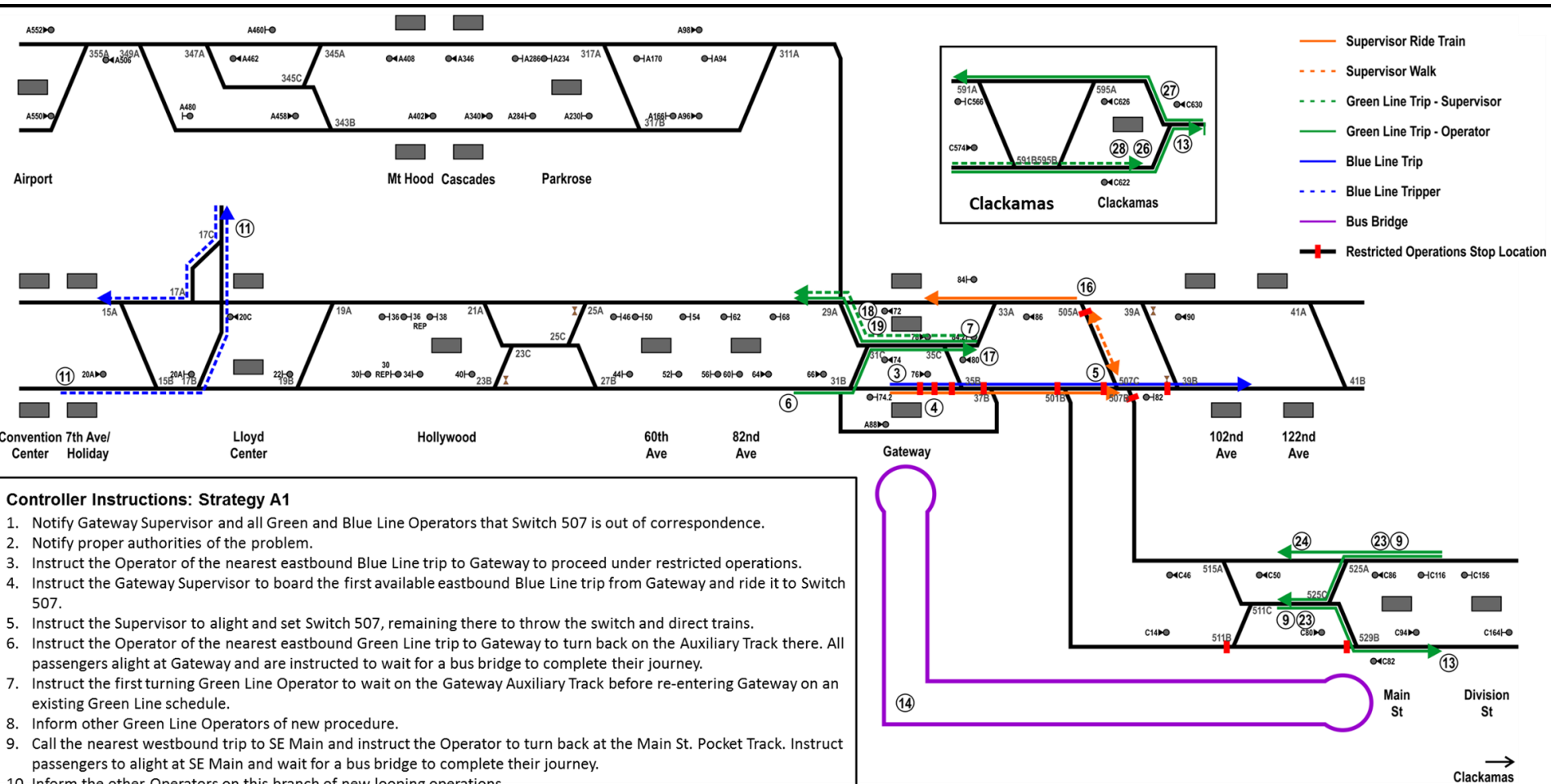 - Activity through affected area

Selecting Preferred Strategy
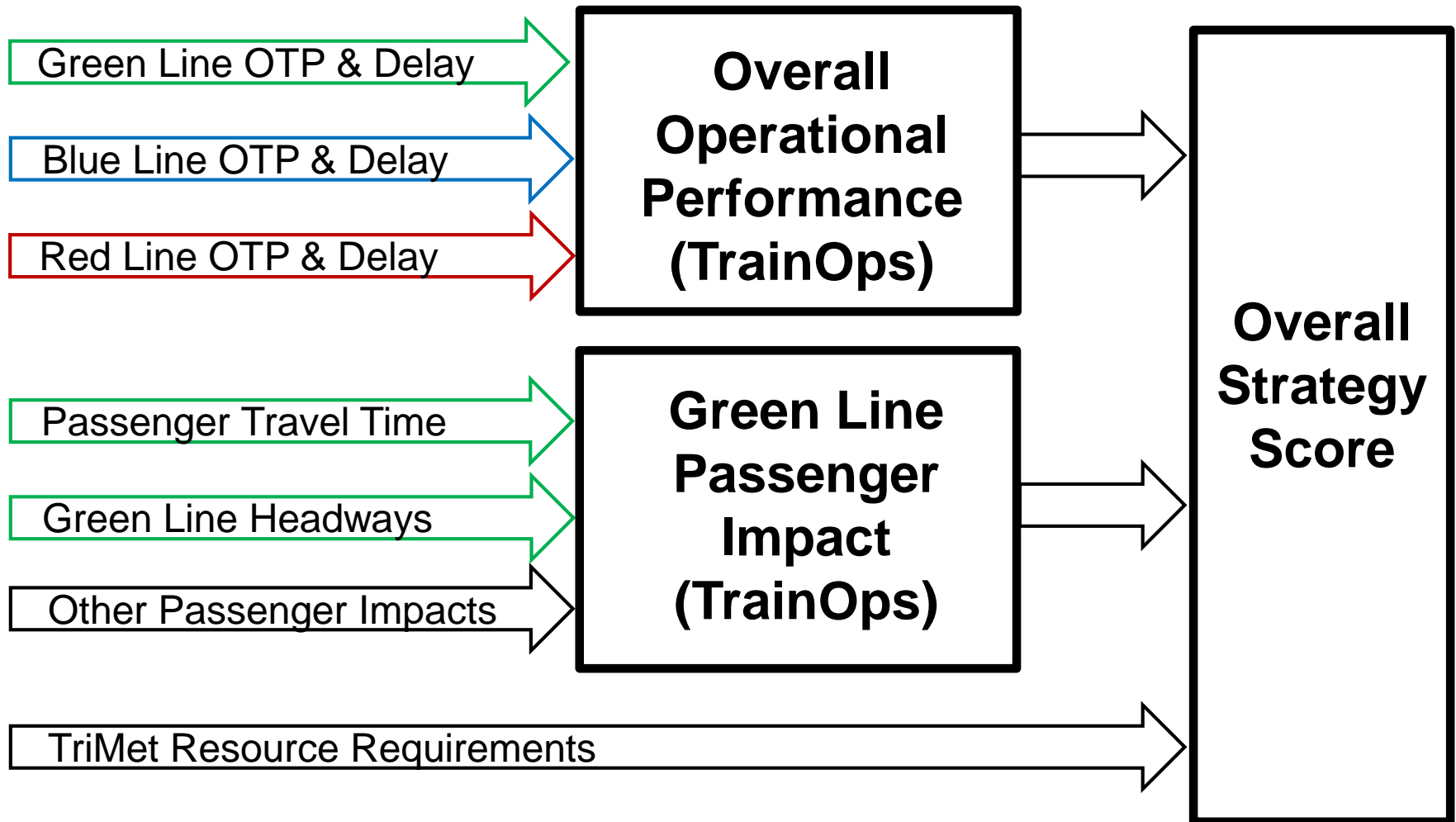
Results

Gateway Playbook Scenario 1 (Switch 507 Out of Correspondence) Results and Scoring

		Default	Strategy A: Gateway Aux	Strategy B: Gateway Mid	Strategy C: Double Tree	Strategy A0: Adjust Sup.	Strategy A1: Split Consist
Operations	Overall OTP	85.1%	87.6%	86.2%	81.7%	87.6	88.6
	Blue OTP	82.8%	83.5%	83.2%	81.3%	83.52	84.51
	Red OTP	86.4%	91.4%	87.3%	77.8%	91.4	91.4
	Green OTP	81.1%	90.4%	85.9%	76.8%	90.35	93.75
	Stopped Delay per 100mi	0:11:50	0:07:48	0:12:04	0:07:24	0:07:48	0:07:55
	Blue Delay (per 100mi)	0:09:23	0:05:34	0:08:47	0:05:17	0:05:32	0:05:56
	Red Delay (per 100mi)	0:17:12	0:10:42	0:23:46	0:10:56	0:10:42	0:11:00
	Green Delay (per 100mi)	0:18:52	0:13:24	0:15:16	0:11:59	0:13:30	0:12:48
	Operations Scores	**31.3%**	**95.7%**	**38.1%**	**50.0%**	**88.4%**	**94.5%**
Passenger Impact	Passenger travel time: 7th Ave. to Division	0:26:11	0:33:53	0:34:50	0:35:56	0:33:54	0:33:25
	Bus Bridge Length (minutes)	NA	10	10	10	10	10
	Passenger Transfers: Green Line Outbound	0	2	2	3	2	2
	Total Station Stops Skipped	0	28	18	640	28	50
	Resulting Green Line Service Headways at Gateway	0:15:00	0:15:00	0:15:00	7:55:12	0:15:00	0:16:00
	Resulting Green Line Service Headways at Rose Quarter	0:15:00	0:15:00	0:15:00	0:15:00	0:15:00	0:16:00
	Passenger Impact Scores	**80.0%**	**50.0%**	**48.4%**	**20.0%**	**50.0%**	**50.2%**
Resources	Number of Controller Radio Calls per hour	12	4	4	4	4	4
	Additional Man Hours: Supervisors and Bus Drivers	8	40	40	40	40	40
	Activity Through at risk area	1	0.1	0.1	0	0.1	0
	Resources Scores	**33.3%**	**63.3%**	**63.3%**	**66.7%**	**63.3%**	**66.7%**
	Overall Scores (Out of 100%)	**48.2%**	**69.7%**	**49.9%**	**45.6%**	**67.2%**	**70.5%**

Legend:
- Supervisor Ride Train
- Supervisor Walk
- Green Line Trip - Supervisor
- Green Line Trip - Operator
- Blue Line Trip
- Blue Line Tripper
- Bus Bridge
- Restricted Operations Stop Location

Stations: Airport, Mt Hood, Cascades, Parkrose, Convention Center, 7th Ave/Holliday, Lloyd Center, Hollywood, 60th Ave, 82nd Ave, Gateway, 102nd Ave, 122nd Ave, Clackamas, Clackamas, Main St, Division St, Clackamas

Controller Instructions: Strategy A1

1. Notify Gateway Supervisor and all Green and Blue Line Operators that Switch 507 is out of correspondence.
2. Notify proper authorities of the problem.
3. Instruct the Operator of the nearest eastbound Blue Line trip to Gateway to proceed under restricted operations.
4. Instruct the Gateway Supervisor to board the first available eastbound Blue Line trip from Gateway and ride it to Switch 507.
5. Instruct the Supervisor to alight and set Switch 507, remaining there to throw the switch and direct trains.
6. Instruct the Operator of the nearest eastbound Green Line trip to Gateway to turn back on the Auxiliary Track there. All passengers alight at Gateway and are instructed to wait for a bus bridge to complete their journey.
7. Instruct the first turning Green Line Operator to wait on the Gateway Auxiliary Track before re-entering Gateway on an existing Green Line schedule.
8. Inform other Green Line Operators of new procedure.
9. Call the nearest westbound trip to SE Main and instruct the Operator to turn back at the Main St. Pocket Track. Instruct passengers to alight at SE Main and wait for a bus bridge to complete their journey.
10. Inform the other Operators on this branch of new looping operations.
11. Instruct Blue Line tripper Operators to turn back at Double Tree. All passengers alight at 7th Ave./Holladay and are instructed to board a Red, Green or Blue Line trip to complete their journey.
12. Inform all Blue Line Operators of restricted operations east from Gateway.
13. If there were four consists on the Clackamas Branch at the time of the outage, instruct the Operator of the first trip to turn at the Main St. Pocket Track to proceed to the Clackamas Tail Track and layup there.
14. Set up a bus bridge between Gateway and SE Main. Four buses are required. Instruct drivers to wait for a Green Line train to arrive before departing.
15. Notify the public of the service disruption.
16. Instruct the Supervisor to return to Gateway as soon as maintenance of way workers arrive at Switch 507.

| March 2018 | TriMet | Dwg | A1 – 1 of 2 | 1 |
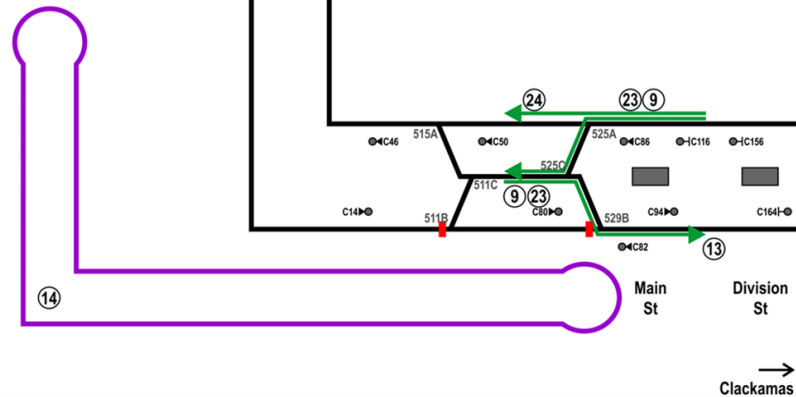
Gateway Emergency Playbook
Scenario 1
Switch 507 Out of Correspondence

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Conclusions

- Thoroughly vetted playbook has support of Controllers
  - Careful and comprehensive simulation analysis ensures successful strategies
- Playbook is dual-use for Controllers
  - Controllers consult playbook to respond to incidents in real time
  - Controllers utilize playbook as training material to plan responses to specific incidents.
- Upon completion, TriMet intends to implement the Gateway Playbook in its Control Center
- Playbook creation is applicable to other locations and rail networks
  - TriMet has interest in using this strategy at other MAX locations
  - The process is flexible and could be implemented on any rail network