

MainGUI
<p>-FXML_VIEW: String  +windowWidth: int  +windowHeight: int  -borderPaneContainer: BorderPane  -simulationHeader: HBox  -bottomLogArea: TitledPane</p> <p>+start(primaryStage: Stage): void  +main(args: String[]): void</p>

MainController
<p>@FXML -topHbox: HBox  @FXML -leftControlPanel: ScrollPane  @FXML -rootStackPane: StackPane  @FXML -startButton: Button  @FXML -pauseButton: Button  @FXML -stepButton: Button  @FXML -vehicleIdField: TextField  @FXML -routeIdField: TextField  @FXML -injectVehicleButton: Button  @FXML -setVehicleSpeedButton: Button  @FXML -vehicleSpeedField: TextField  @FXML -setVehicleColorButton: Button  @FXML -vehicleColorField: TextField  @FXML -trafficLightIdField: TextField  @FXML -setRedPhaseButton: Button  @FXML -setGreenPhaseButton: Button  @FXML -resumeAutoButton: Button  @FXML -setPhaseDurationButton: Button  @FXML -phaseDurationField: TextField  @FXML -adaptiveTrafficCheck: CheckBox  @FXML -filterColorField: TextField  @FXML -filterMinSpeedField: TextField  @FXML -filterEdgeField: TextField  @FXML -applyFilterButton: Button  @FXML -clearFilterButton: Button  @FXML -stressEdgeField: TextField  @FXML -stressCountField: TextField  @FXML -stressTestButton: Button  @FXML -pathToSumocfgFile: TextField  @FXML -pathToSumoGui: TextField  @FXML -insertSumocfgButton: Button  @FXML -startSumoGuiButton: Button  @FXML -simStepLabel: Label  @FXML -vehicleCountLabel: Label  @FXML -avgSpeedLabel: Label  @FXML -avgTravelTimeLabel: Label  @FXML -congestionLabel: Label  @FXML -showChartsButton: Button  @FXML -exportFilterCheck: CheckBox  @FXML -exportCsvButton: Button  @FXML -exportPdfButton: Button  @FXML -mapAnchorPane: AnchorPane  @FXML -rightMapStackPane: StackPane  @FXML -rightMapPaneGroup: Group  @FXML -vehiclePane: Pane  @FXML -baseMapPane: Pane  @FXML -lanePane: Pane  @FXML -junctionPane: Pane  @FXML -routePane: Pane  @FXML -carPane: Pane  @FXML -busPane: Pane</p>





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@FXML -busPane: Pane
@FXML -truckPane: Pane
@FXML -bikePane: Pane
@FXML -logLabel: Label
@FXML -zoomInButton: Button
@FXML -zoomOutButton: Button
@FXML -resetViewButton: Button
@FXML -toggle3DButton: ToggleButton
@FXML -bottomLogArea: TitledPane
-simManager: SimulationManager
-renderer: Renderer
-converter: CoordinateConverter
-uiLoop: AnimationTimer
-threadPool: ExecutorService
-NUMBER_OF_THREADS: int
-isSimulationRunning: boolean
-vehicleVisuals: Map<String, Shape>
-mapContentGroup: Group
-mapInteractionHandler: MapInteractionHandler
-PADDING: double

+MainController()
+main(args: String[]): void
@FXML +initialize(): void
@FXML -startSimulation(): void
-startUiLoop(): void
-updateView(): void
-log(message: String): void
+stopSimulation(): void
@FXML -pauseSimulation(): void
@FXML -stepSimulation(): void
@FXML -injectVehicle(): void
@FXML -startSumoGUI(): void
@FXML -insertSumoConfigFile(): void
@FXML -applyFilter(): void
@FXML -clearFilter(): void
@FXML -runStressTest(): void

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-sumoPath: String
-sumoConfigFileName:
-sumoConfigFilePath:
-stepLength: String
-sumoConnection: Su
-stateLock: Object
-activeVehicles: vol
-activeTrafficlights: vo
-statisticsManager: St
-reportManager: Repc
-sumoMap: MapMang
-vehicleManager: Veh
-trafficlightManager: T
-currentStep: volatile i
-isRunning: volatile bo

+SimulationManager()
+startConnection(): bo
-setupPaths(): boolean
+runSimulationLoop()
+step(): void
+stopSimulation(): voi
+getActiveVehicles():
+getStatisticsManage
+getReportManager()
+getCurrentStep(): int
+getConnection(): Sui
+getSumoMap(): Map

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**StatisticsManager**

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-averageSpeed: double
-totalVehicles: int

+StatisticsManager()
+updateStatistics(statistics)

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**ReportManager**

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+ field: type

+exportToCSV(statistics)

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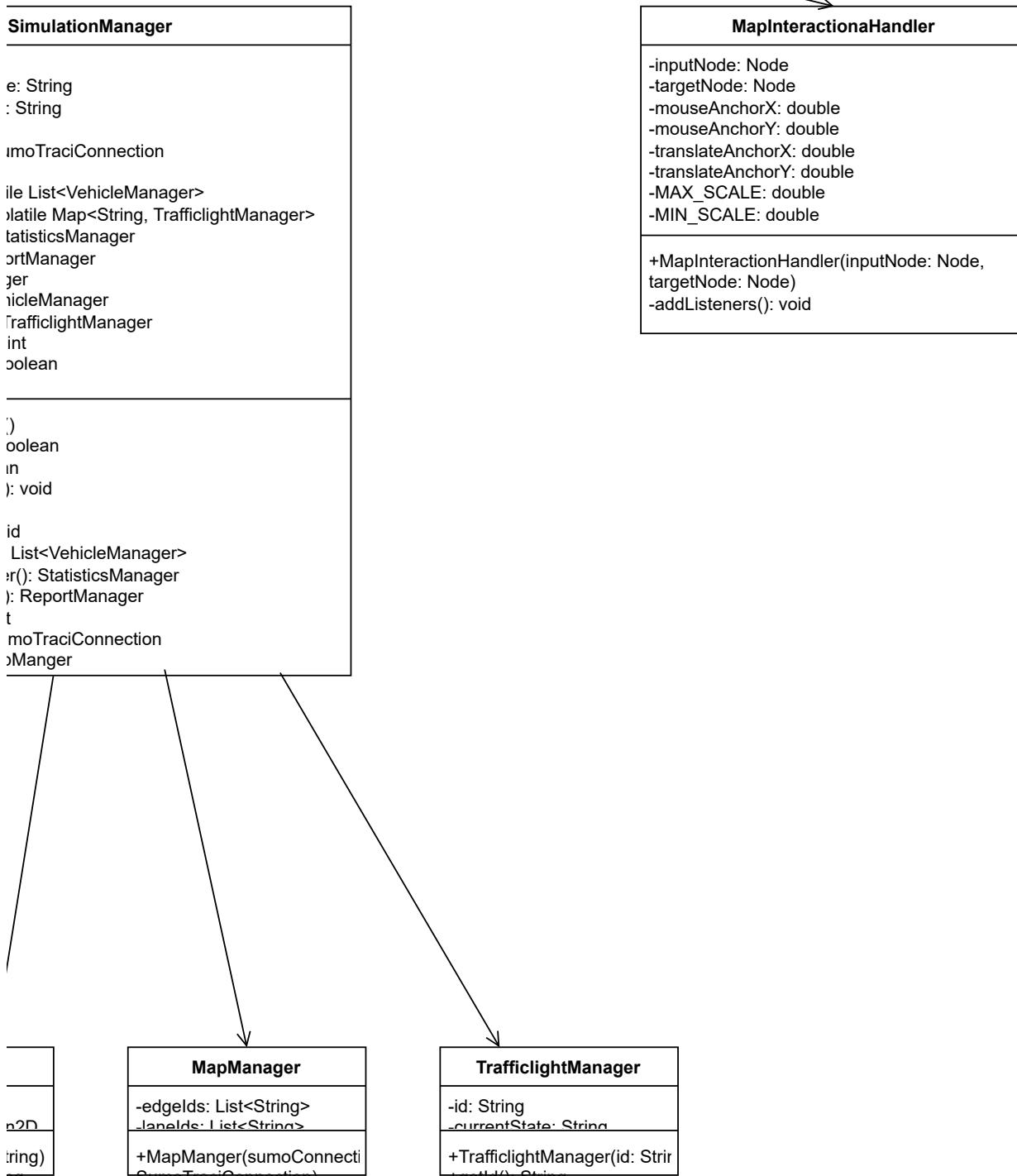
**VehicleManager**

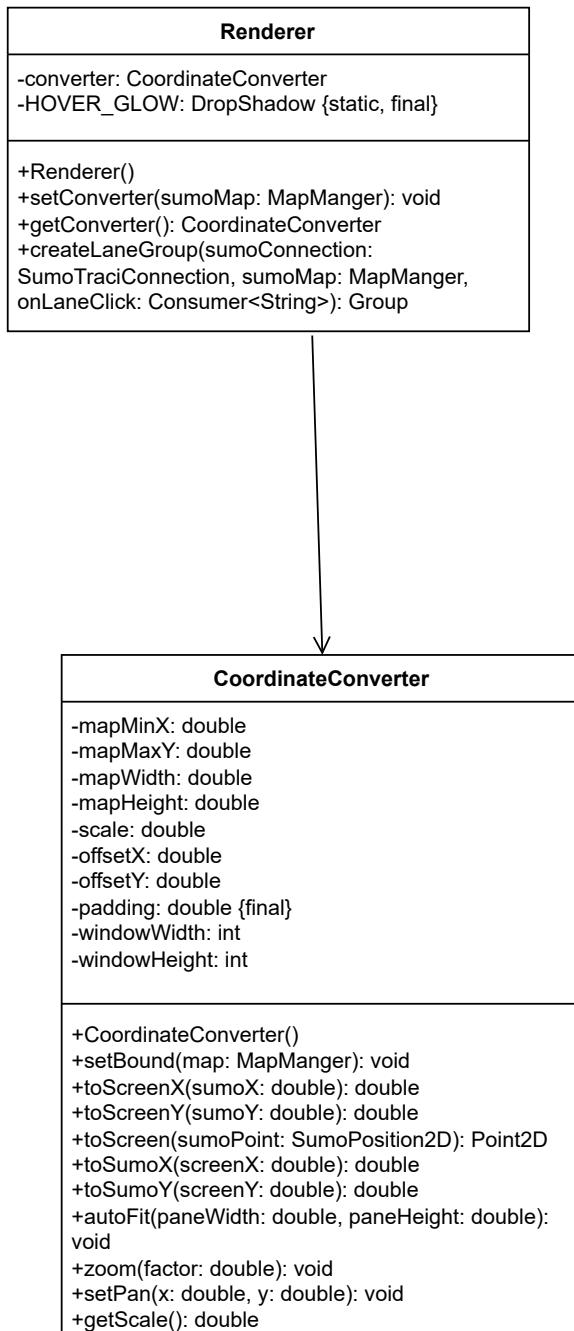
```

#id: String
#position: SumoPosition

+VehicleManager(id: String, position: SumoPosition)
+startVehicle(id: String)
+stopVehicle(id: String)

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// --- FXML UI Elements: Map & Log ---
[FXML] - leftControlPanel: ScrollPane
[FXML] - mapScrollPane: ScrollPane
[FXML] - mapPane: Pane
[FXML] - logLabel: Label
[FXML] - mapControlsContainer: StackPane
[FXML] - mapControlsVBox: VBox
[FXML] - zoomInButton: Button
[FXML] - zoomOutButton: Button
[FXML] - resetViewButton: Button
[FXML] - toggle3DButton: ToggleButton
// --- FXML UI Elements: Sim Control ---
[FXML] - startButton: Button
[FXML] - pauseButton: Button
[FXML] - stepButton: Button
// --- FXML UI Elements: Vehicle Actions ---
[FXML] - vehicleIdField: TextField
[FXML] - routeIdField: TextField
[FXML] - injectVehicleButton: Button
[FXML] - setVehicleSpeedButton: Button
[FXML] - vehicleSpeedField: TextField
[FXML] - setVehicleColorButton: Button
[FXML] - vehicleColorField: TextField
// --- FXML UI Elements: Traffic Light Actions ---
[FXML] - trafficLightIdField: TextField
[FXML] - setRedPhaseButton: Button
[FXML] - setGreenPhaseButton: Button
[FXML] - resumeAutoButton: Button
[FXML] - setPhaseDurationButton: Button
[FXML] - phaseDurationField: TextField
[FXML] - adaptiveTrafficCheck: CheckBox
// --- FXML UI Elements: Vehicle Filtering ---
[FXML] - filterColorField: TextField
[FXML] - filterSpeedField: TextField
[FXML] - filterEdgeField: TextField
[FXML] - applyFilterButton: Button
[FXML] - clearFilterButton: Button
// --- FXML UI Elements: Stress Testing ---
[FXML] - stressEdgeField: TextField
[FXML] - stressCountField: TextField
[FXML] - stressTestButton: Button
// --- FXML UI Elements: Statistics ---
[FXML] - simStepLabel: Label
[FXML] - vehicleCountLabel: Label
[FXML] - avgSpeedLabel: Label
[FXML] - avgTravelTimeLabel: Label
[FXML] - congestionLabel: Label
[FXML] - showChartsButton: Button
// --- FXML UI Elements: Data Export ---
[FXML] - exportFilterCheck: CheckBox
[FXML] - exportCsvButton: Button
[FXML] - exportPdfButton: Button
```