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Autonomous Transportation System Traffic Semantic Representation Language Part 1: General Definitions

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preface

This document is drafted in accordance with GB/T 1.1—2020 "Guidelines for Standardization Work Part 1: Structure and Drafting Rules of Standardization Documents".

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This document is proposed and overseen by the China Intelligent Transportation Industry Alliance (C-ITS).

The primary drafting institutions for this document include: Beijing Jiaotong University, Beijing University of Posts and Telecommunications, the Ministry of Transport's Highway Research Institute, Hualu Yiyun Technology Co., Ltd., China Unicom Smart Network Technology Co., Ltd., Beihang University, Zhuzhou CRRC Times Electric Co., Ltd., and the Ministry of Transport's Water Transport Research Institute.

The primary drafters of this document are: Dong Honghui, Wang Jiajia, Li Wei, Yuan Quan, Li Jinglin, Ren Yilong, Yu Haiyang, Li Zhenhua, She Hongyan, Xin Liang, Yu Chaoyang, Ou Fan, Niu Yajie, Wang Quandong, Pan Xiaoxi, Zhou Yucheng, Chen Yi, Hong Yipeng, Liu Junlan, Zhou Weijie, Wu Hao, Ni Jiaying, Feng Jiarui, Jiang Peiyuan, Lan Zhengxing, Gu Huinan, Ma Panke, and Lin Jun.

Autonomous Transportation Systems Traffic Semantics Representation Language Part 1: General Definitions

1 scope

This document defines the general representation of the autonomous traffic system traffic semantic representation language, and gives the core terms of the traffic semantic representation in road traffic mode, rail traffic mode and water transport mode.

This document applies to transportation entities with varying degrees of autonomy, including but not limited to people, transport equipment, infrastructure, and traffic management.

2 Normative reference documents

The content of the following documents forms the essential provisions of this document through their normative references. For dated references, only the version corresponding to that date applies to this document; for undated references, their latest version (including all amendments) applies to this document.

GB/T 29100—2012 Road traffic information service Traffic event classification and coding

GB/T 32590.1—2024 Rail Transit: Management and Command/Control Systems for Urban Rail and City Rail Transport Part 1: System Principles and Basic Concepts

GB/T 7727.1-2008 General terms for ships Part 1: General

JTS 165-2013 General Design Code for Ports

DB21/T 3915—2024 Technical Specification for Urban Rail Transit Operation Management

T/ITS 0292-2025 Model of Interoperability Mechanism for Autonomous Transport Systems

3 Terms and Definitions

The terms and definitions defined in T/ITS 0292-2025 and the following apply to this document.

3.1

autonomous transportation system

It is a highly intelligent and highly autonomous traffic system characterized by autonomous perception, autonomous decision-making and autonomous execution.

[Source: T/ITS 0292-2025]

Autonomous traffic agent

Autonomous traffic agent is a traffic intelligent agent which can realize the closed loop of perception, cognition, decision-making and control in the complex traffic environment and achieve the predetermined traffic task.

3.2

Traffic Semantic Representation Language

Traffic semantic representation language is a formal language to describe traffic content accurately, which has the abilities of semantic representation, semantic understanding, semantic interaction, logical reasoning and interoperability.

3.3

Terminology Database for Traffic Semantic Representation Languages

Based on the definition of traffic semantic representation language, it is a concept set used to store, manage and retrieve the specialized terms and related information in the field of traffic.

4 General Definition of Traffic Semantic Representation Language

4.1 Common Naming Conventions for Traffic Semantic Representation Languages

The general naming convention for traffic semantic representation languages is as follows:

a) Module names, category names, and entity names follow the camel case naming convention, such as TrafficLib, RoadSys, and Vehicle.

b) Attribute names, relationship names, and action names follow the camel case naming convention, such as HasSpeed and Distance.

c) The constants use camel case naming with numbers and underscores, e.g., Car_1, Road.

d) Variables and functions follow snake naming conventions, using lowercase letters and underscores to separate words, such as speed (Car_1), ego(vehicle), x, y.

4.2 General Definition of Traffic Semantic Representation Language Classification

The general definition of traffic semantic representation language is divided into entity, category, attribute, relation and action, and the specific definition is as follows:

a) Entity: Entity name_Identifier. For example: Car_V001 represents the car entity with ID V001;

b) Category: Is predicate (parameter 1, parameter 2,..., parameter n). For example: IsTrafficLight(x), indicating x is a traffic light;

c) Property: Has predicate (parameter 1, parameter 2,..., parameter n). For example: HasSpeed(Vehicle, Speed), indicating that the vehicle Vehicle has speed Speed.

d) Relation: Relation name (parameter 1, parameter 2,..., parameter n). For example: On (Vehicle, Line), indicating that the vehicle Vehicle is on lane Line;

e) Action: Let event name (parameter 1, parameter 2,..., parameter n). For example: LetAcceleration (Vehicle, Value), indicating that the vehicle Vehicle has executed the acceleration event.

4.3 Definition of the Terminology Library for Traffic Semantic Representation Language

Traffic semantic representation language (TSRL) is a standardized set of concepts, which includes a series of semantic information related to traffic.

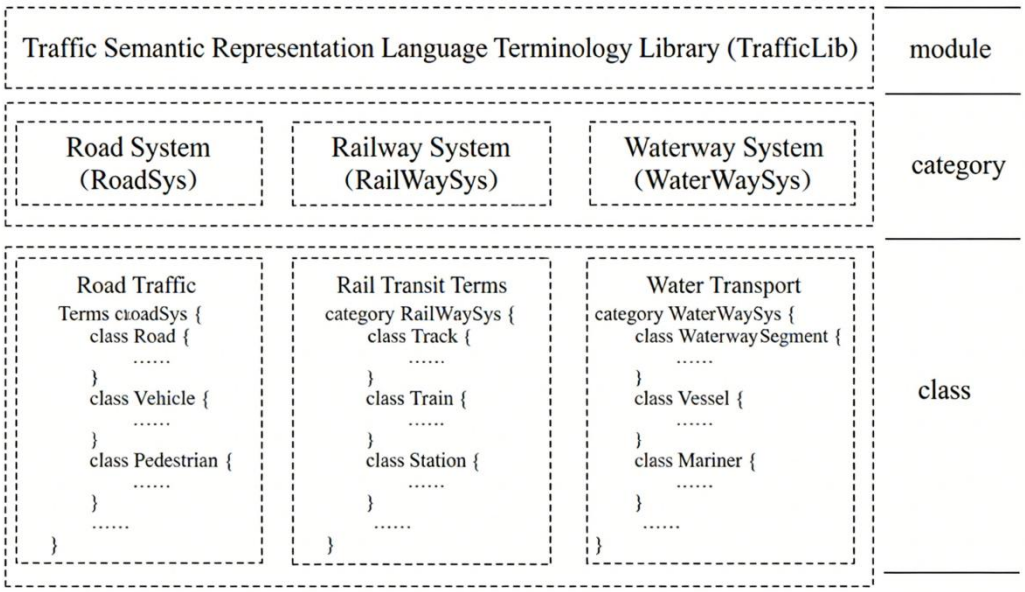

Figure 1 The Overall Architecture of the Traffic Semantic Representation Language Terminology Bank

a) The specification defines the traffic semantics representation language's terminology library' TrafficLib 'using the keyword' module', with the following format:

【 code 】

```
module TrafficLib{
    ......
}
```

b) Within the TrafficLib terminology library, the keyword "category" defines three categories: "RoadSys", "RailWaySys", and "WaterWaySys", representing road, rail, and water transport systems respectively, as follows:

【 code 】

```
module TrafficLib{
        category RoadSys {
    ......
    }
        category RailWaySys {
    ......
    }
        category WaterWaySys {
    ......
    }
}
```

c) In each transportation system category, the keyword "class" defines the corresponding traffic entities. For example, in road traffic systems, entities like roads and vehicles are defined as follows:

【 code 】

```
    category RoadSys {
            class Road {
            ......
      }
      class Vehicle {
            ......
      }
      class Pedestrian {
            ......
      }
}
```


5 Definition of Traffic Semantic Representation Terms

5.1 Road traffic participants

For road traffic participants (i.e., individuals involved in road traffic activities), the information primarily includes pedestrians and personnel directly operating transport equipment, as specified in GB/T 29100-2012. The following semantic representation language is adopted:

a) IsPedestrian(x) indicates that individual x is a pedestrian.

b) HasPedestrianID(x, id), indicating that pedestrian x's unique identifier is id.

c) HasPedestrianPosition(x, position), indicating that pedestrian x's location is position.

d) HasPedestrianSpeed(x, speed), indicating that pedestrian x's speed is speed.

e) HasPedestrianAcceleration(x, acceleration), indicating that pedestrian x's acceleration is acceleration.

f) HasPedestrianStatus(x, status), indicating that pedestrian x's status is status.

g) IsDriver(x) indicates that individual x is a driver.

h) HasDriverID(x, id), indicating that driver x's unique identifier is id.

i) IsBicycleRider(x) indicates that individual x is a cyclist.

j) HasBicycleRiderID(x, id) indicates that rider x's unique identifier is id.

k) HasBicycleRiderPosition(x, position) indicates that cyclist x's location is position.

l) HasBicycleRiderSpeed(x, speed) indicates that cyclist x's speed is speed.

m) HasBicycleRiderAcceleration(x, acceleration) indicates that cyclist x's acceleration is acceleration.

n) HasBicycleRiderStatus(x, status) indicates that cyclist x's status is status.

o) IsMotorcycleRrider(x) indicates that individual x is a motorcycle rider.

p) HasMotorcycleRiderID(x, id) indicates that rider x's unique identifier is id.

q) HasMotorcycleRriderPosition(x, position), indicating that rider x's position is position.

r) HasMotorcycleRriderSpeed(x, speed) indicates that rider x's speed is speed.

s) HasMotorcycleRriderAcceleration(x, acceleration), indicating that rider x's acceleration is acceleration.

t) HasMotorcycleRriderStatus(x, status) indicates that rider x's status is status.

u) IsElectricBicycleRider(x) denotes that individual x is an electric bicycle rider.

v) HasElectricBicycleRiderID(x, id) indicates that the unique identifier for electric bike rider x is id.

w) HasElectricBicycleRider(x, position) indicates that electric bike rider x is at position position.

x) HasElectricBicycleRider(x, speed) indicates that electric bike rider x's speed is speed.

y) HasElectricBicycleRider(x, acceleration) indicates that the electric bicycle rider x has an acceleration of acceleration.

z) HasElectricBicycleRider(x, status) indicates that the electric bike rider x is in status.

aa) IsTrafficManager(x) indicates that individual x is a traffic manager.

5.2 Road traffic carriers

For various road traffic carriers, the following semantic representation language is defined in accordance with the relevant provisions of GB/T 29100-2012, which mainly includes information about vehicles carrying people or goods and moving on roads.

a) IsCar(x) indicates that individual x is a passenger car.

b) HasCarID(x, id) indicates that the unique identifier for passenger car x is id.

c) HasCarModel(x, model) indicates that passenger car x is of model.

d) HasCarPosition(x, position), indicating that car x's position is position;

e) HasCarSpeed(x, speed) indicates that car x's speed is speed.

f) HasCarAcceleration(x, acceleration) indicates that the acceleration of car x is acceleration.

g) IsBus(x) indicates that individual x is a bus.

h) HasBusID(x, id) indicates that bus x has the unique identifier id.

i) HasBusModel(x, model) indicates that bus x belongs to the model x.

j) HasBusPosition(x, position) indicates that bus x is at position position.

k) HasBusSpeed(x, speed) indicates that bus x has a speed of speed.

l) HasBusAcceleration(x, acceleration) indicates that bus x has an acceleration of acceleration.

m) HasBusCapacity(x, c) denotes that bus x has a rated passenger capacity of c.

n) IsMotorcycle(x) indicates that individual x is a motorcycle.

o) HasMotorcycleID(x, id) indicates that motorcycle x has the unique identifier id.

p) HasMotorcycleModel(x, model) indicates that motorcycle x belongs to model.

q) HasMotorcyclePosition(x, position), indicating that motorcycle x's position is position.

r) HasMotorcycleSpeed(x, speed), indicating that motorcycle x's speed is speed.

s) HasMotorcycleAcceleration(x, acceleration), indicating that motorcycle x's acceleration is acceleration.

t) IsBicycle(x) indicates that individual x is a bicycle.

u) HasBicycleID(x, id) indicates that bicycle x has a unique identifier id.

v) HasBicycleModel(x, model), indicating that bicycle x belongs to model;

w) HasBicyclePosition(x, position), indicating that bicycle x's position is position;

x) HasBicycleSpeed(x, speed) indicates that bicycle x's speed is speed.

y) HasBicycleAcceleration(x, acceleration) indicates that bicycle x's acceleration is acceleration.

z) IsElectricBicycle(x) indicates that individual x is an electric bicycle.

aa) HasElectricBicycleID(x, id) indicates that the unique identifier for electric bicycle x is id.

ab) HasElectricBicyclePosition(x, position), indicating that the electric bicycle x is at position position.

ac) HasElectricBicycleSpeed(x, speed) indicates that the electric bicycle x has a speed of speed.

ad) HasElectricBicycleAcceleration(x, acceleration) indicates that the electric bicycle x has an acceleration of acceleration.

ae) IsTruck(x) indicates that individual x is a truck.

af) HasTruckID(x, id) indicates that truck x has the unique identifier id.

ag) HasTruckPosition(x, position), indicating that truck x is at position position.

ah) HasTruckSpeed(x, speed) indicates that truck x's speed is speed.

ai) HasTruckAcceleration(x, acceleration) indicates that truck x has an acceleration of acceleration.

aj) HasTruckCapacity(x, c) indicates that truck x has a capacity of c.

5.3 Road traffic infrastructure

For road traffic infrastructure, in accordance with the relevant provisions of GB/T 29100-2012, it mainly includes road network, traffic facilities and their topological structure, etc. The traffic semantic representation language is defined as follows:

a) IsTrafficSignal(x) indicates that x is a traffic light.

b) HasTrafficSignalPhase(x, phase) indicates that the current phase of traffic light x is phase.

c) HasRemainingPhaseTime(x, remaining_time) indicates the remaining phase time of signal x, where remaining_time is the duration.

d) IsTrafficSign(x) indicates that x is a traffic sign.

e) IsParkingFacility(x) indicates that x is a parking facility.

f) IsTrafficCamera(x) indicates that x is a traffic camera.

g) IsBusStop(x) indicates that x is a bus stop.

h) IsPedestrianCrossing(x) indicates that x is a pedestrian crossing.

i) IsLane(x) indicates that x is a lane.

j) HasLaneType(x, type), indicating that lane x is of type (e.g., motor vehicle lane, bus lane, emergency lane, ramp, left-turn lane, straight lane, right-turn lane, etc.);

k) HasLaneDirection(x, direction), indicating the lane x's driving direction (e.g., straight, left turn, U-turn, etc.).

l) HasLaneMarking(x, marking_type) indicates the lane x's boundary type (e.g., solid line, dashed line, double yellow line, etc.).

m) HasLaneSpeedLimit(x, limitspeed) indicates that lane x has a speed limit of limitspeed.

n) IsIntersection(x) indicates that x is an intersection;

o) Connect(x, y) indicates that roads x and y are connected.

p) HasRoadType(x, type), indicating that road x is of type type;

q) HasRoadStatus(x, status) indicates the road x's status (e.g., normal, congested, closed, etc.).

r) HasRoadWidth(x, width) indicates that the width of road x is width.

s) HasRoadDirection(x, direction), indicating whether the road x is one-way or two-way.

t) HasIntersectionType(x, type), indicating that intersection x is of type (crossroads, roundabouts, etc.).

5.4 Traffic control and management

For road traffic control information, in accordance with the relevant provisions of GB/T 29100-2012, it mainly includes rules, equipment and systems used for traffic management and control, defined as follows using traffic semantic representation language:

a) IsTrafficControlDevice(x) indicates that x is a traffic control device.

b) IsTrafficSensor(x) indicates that x is a traffic sensor.

c) IsElectronicDisplay(x) indicates that x is an electronic display screen.

d) HasTrafficRule(x, rule), indicating that x follows the traffic rule specified by rule.

e) NoEntrySign(x) indicates a no-entry sign at location x.

f) HasSpeedLimit(x, limit) indicates that the speed limit rule at position x is limit.

g) RightTurnOnRed(x) indicates that right turns are permitted at red lights at position x.

h) HasTrafficControlDecision(x, decision) indicates that traffic control measures (e.g., traffic restrictions or prohibitions) are implemented at location x.

i) HasRouteChoiceDecision(x, decision) indicates the route selection decision at position x, such as choosing the shortest or fastest path.

j) HasPriorityRule(x, Rule), indicating the traffic priority rule at position x (e.g., priority road, yield rule, etc.).

k) IsAlertTrigger(x) indicates that x is an alert trigger message.

l) HasAlertType(x,Alert) indicates that x is an Alert type.

m) IsActionRecommendation(x) indicates that x is an action suggestion.

n) HasRouteRecommendation(x, Recommendation) indicates that route suggestion Recommendation is available at location x.

o) HasPedestrianCrossingAdvice(x, Advice) indicates that there is a pedestrian crossing advisory (Advice) at location x.

6 Definition of the Terminology for Semantic Representation of Rail Transit

6.1 Participants in rail transit

For rail transit participants, that is, the personnel involved in rail transit activities, referring to the relevant provisions of GB/T 32590.1-2024 and DB21/T 3915-2024, mainly including passengers, personnel directly operating carrying equipment and other information, the traffic semantic representation language is defined as follows:

a) IsPassenger(x) indicates that individual x is a passenger.

b) HasPassengerPosition(x, position), indicating that passenger x's location is position.

c) HasPassengerDeparture(x, departure) indicates that passenger x's destination is departure.

d) HasPassengerDestination(x, destination), indicating that passenger x's destination is destination.

e) IsOperationControlCentre(x) indicates that individual x is an operational control center.

f) IsOperationStaff(x) indicates that individual x is a track operator.

g) IsStationAttendant(x) indicates that individual x is a station attendant.

h) IsTrainOperator(x) indicates that individual x is a train driver.

i) IsMaintenanceWorker(x) indicates that individual x is a maintenance worker.

j) HasMaintenanceWorkerTask(x, task), indicating that maintenance worker x's task is task.

6.2 Railway transportation carriers

For rail transit carriers, referring to the relevant provisions of GB/T 32590.1-2024 and DB21/T 3915-2024, it mainly includes information such as vehicles used to carry people or goods and move on roads, and is defined as follows using traffic semantic representation language:

a) IsTrain(x) indicates that individual x is a train.

b) HasTrainPosition(x, position), indicating that train x is at position position.

a) HasTrainMission(x, mission) indicates that train x's journey is mission.

c) HasTrainSpeed(x, speed) indicates that train x's speed is speed.

d) HasTrainAcceleration(x, acceleration), indicating that train x's acceleration is acceleration.

e) HasTrainCapacity(x, capacity) indicates that train x has a capacity of capacity.

f) HasTrainStop(x, stop) indicates that train x has stop as its terminal station.

g) IsMetro(x) indicates that individual x is a subway.

h) IsLightRail(x) indicates that individual x is a light rail.

i) IsTram(x) indicates that individual x is a tram.

j) IsHighSpeedTrain(x) indicates that individual x is a high-speed train.

k) IsCommonSlowTrain(x) indicates that individual x is a conventional-speed train.

l) IsHeavyHaulTrain(x) indicates that individual x is a heavy-haul train

m) IsMaglevTrain(x) indicates that individual x is a maglev train.

6.3 Railway infrastructure

For rail transit infrastructure, referring to the relevant provisions of GB/T 32590.1-2024 and DB21/T 3915-2024, it mainly includes information such as railway network, traffic facilities and their topology, and is defined as follows using traffic semantic representation language:

a) IsSignal(x) indicates that individual x is a signal device.

b) IsWaysideEquipment(x) indicates that individual x is a roadside equipment.

c) IsTrainControlEquipment(x) indicates that individual x is a train control device.

d) IsStation(x) indicates that individual x is a station.

e) HasStationName(x, name) indicates that station x is named name.

f) HasStationPosition(x, position) indicates that station x is located at position position.

g) IsLineSegment(y) indicates whether individual y is a line segment.

h） HasLineSegmentLength(y, length), indicating that the length of line segment y is length.

i） IsTrack(z) indicates that individual z is a track.

j） HasTrackType(z, type) indicates the track type z (e.g., single track, double track, etc.).

k） IsSwitch(w) indicates that individual w is a turnout.

l） HasSwitchType(w, type) indicates the type of switch w (e.g., single or double open switches).

6.4 Rail transit control

For rail transit control, referring to the relevant provisions of GB/T 32590.1-2024 and DB21/T 3915-2024, it mainly includes rules, equipment and systems used for management and control of traffic operation, which are defined as follows using traffic semantic representation language:

a） IsRailTrafficControlCenter(x) indicates that x is the rail transit control center.

b） IsDispatcher(x) indicates that individual x is a dispatcher.

c） HasControlZone(center, zone) indicates that the control center (center) manages the scheduling area (zone).

d） HasTrainSchedule(train, schedule), indicating that the train's planned timetable is schedule.

e） HasActualTimetable (train, timetable) indicates that the actual train schedule is timetable.

f） LetDispatchingCommand (train, command) indicates that the dispatcher has issued dispatch instructions (e.g., acceleration, avoid, or route change) to the train.

g） IsRailTrafficIncidentArea(x) indicates that location x is an accident zone in rail transit.

h） IsRailEmergencyResponseUnit(x) indicates that x is a rail transit emergency response unit.

i） HasEmergencyResponsePlan(x, plan), indicating that the emergency response plan for location x is plan.

j） HasRailTrafficRestriction(x, restriction) indicates that traffic restriction exists at location x.

7 Definition of semantic representation terms for water transport

7.1 Participants in water transport

For water transport participants, that is, the personnel involved in water transport activities, referring to the relevant provisions of GB/T 7727.1-2008 and JTS 165-2013, mainly including pedestrian, personnel directly operating carrying equipment and other information, the traffic semantic representation language is defined as follows:

a） IsMariner(m) indicates that individual m is a crew member.

b） HasMarinerRole (m, role), indicating that crew member m holds the role (e.g., captain, first mate, sailor, etc.).

c) IsPassenger(p) indicates that individual p is a passenger.

d) IsPortWorker(x) indicates that individual x is a port worker.

e) IsCustomsOfficer (c) indicates that individual c is a customs officer.

f) IsPilot(p) denotes that individual p is a pilot.

g) IsDispatcher(d) indicates that individual d is a port dispatcher;

h) HasOfficerDuty (co, duty) indicates that the customs officer's duty (e.g., cargo inspection, vessel dispatch, etc.) is the official responsibility.

7.2 The carrier of water transportation

For water transport carriers, that is, vehicles used to carry people or goods and move on the road, refer to the relevant provisions of GB/T 7727.1-2008 and JTS 165-2013, the traffic semantic representation language is described as follows:

a) IsVessel(v), indicating that individual v is a vessel;

b) HasVesselType(v, type), indicating the vessel type of v (e.g., container ship, passenger ship, oil tanker, bulk carrier, roll-on/roll-off ship, refrigerated ship, etc.);

c) HasVesselCapacity (v, capacity) indicates the cargo or passenger capacity of vessel v, where 'capacity' refers to the vessel's total carrying capacity.

d) HasVesselPosition(v, position), where 'position' indicates the vessel v's location.

e) HasVesselSpeed (v, speed), where 'speed' denotes the vessel's velocity (v).

f) HasVesselCourse (v, course) indicates that vessel v is on course.

7.3 Water transport infrastructure

For water transport infrastructure, referring to the relevant provisions of GB/T 7727.1-2008 and JTS 165-2013, it mainly includes information such as water transport network, traffic facilities and their topology, and is defined as follows using traffic semantic representation language:

a) IsPort(x) indicates that x is a port.

b) IsDock(x) indicates that x is a dock.

c) IsNavigationMark(x) indicates that x is a navigation beacon.

d) IsLock(x) indicates that x is a lock.

e) IsBreakwater(x) indicates that x is a breakwater.

f) IsAnchorage(x) indicates that x is an anchorage.

g) IsWaterwaySegment(w) indicates that individual w is a waterway segment.

h) HasSegmentDepth(w,depth) indicates that the water depth at segment w is depth;

i) IsWaterwayNode(w) indicates that individual w is a waterway node.

j) HasTidalImpact (w, impact) indicates the tidal impact level of waterway segment w.

k） HasSegmentType(w, type), indicating that the waterway segment w is of type (e.g., river, canal, strait, etc.);

l） HasSegmentNavigability (w, navigability), indicating the navigability status of waterway segment w (e.g., year-round navigable, seasonal navigable, etc.).

7.4 Water transport traffic control

For water transport traffic control, referring to the relevant provisions of GB/T 7727.1-2008 and JTS 165-2013, it mainly includes rules, equipment and systems used for management and control of traffic operation. The traffic semantic representation language is defined as follows:

a） IsWaterTrafficControlDevice(x) indicates that x is a water transport traffic control device.

b） HasWaterTrafficRule(x, rule), indicating that x follows the water traffic rule specified as rule.

c） NoEntryZone(x) indicates a restricted access zone at position x.

d） HasSpeedLimit(x, limit) indicates that the speed limit rule at position x is limit.

e） HasTrafficControlDecision(x, decision) indicates that the traffic control decision at location x is decision.

f） HasRouteChoiceDecision(x, decision) indicates that the route selection decision at position x is decision.

g） x is the Emergency Management Center, indicating that x is the emergency management center for water transport.

h） HasNavigationAdvice(x, advice), indicating that the navigation suggestion provided at location x is advice.

i） HasWeatherWarning(x, warning) indicates that the weather alert issued at location x is of warning level.

j） IsTrafficCongestionArea(x) indicates that location x is a congested area for water transport.

Appendix A

(informative annex)

Semantic representation of road traffic scenarios

A.1 Description of road traffic scenarios

The traffic semantic representation language is used to describe the traffic scene of the vehicle changing lane on the highway.

Vehicles traveling on highways may need to change lanes to meet various driving needs, such as overtaking, exiting the highway, or yielding to slower-moving vehicles. When changing lanes, drivers must consider the position and speed of surrounding vehicles to ensure safe passage. Additionally, lane changes may be affected by factors like minimum/maximum speed limits and exit locations, requiring appropriate driving strategies based on specific conditions. In this scenario, drivers must adhere to traffic rules and make informed decisions according to traffic conditions and road conditions to ensure safe travel on highways.

A.2 Terminology for road traffic scenarios

a) IsVehicle(x): Indicates a vehicle.

b) IsLane(x): indicates lane.

c) IsHighway(x): indicates a highway.

d) IsHighwayExit(x): indicates a highway exit.

e) LetLaneChange(vehicle, t): indicates that the vehicle initiates lane change at time t.

f) MaintainSafeDistance (vehicle, t): indicates whether the vehicle maintained a safe distance at time t.

g) AdjustSpeed(vehicle, t): indicates whether the vehicle adjusted its speed at time t.

h) HasVehicleSpeed(x, speed): indicates the current speed of the vehicle.

i) OnLane (vehicle, t): indicates the lane the vehicle is currently in.

j) HasDistanceToExit (vehicle, distance): indicates the distance from the vehicle to the highway exit.

Appendix B

(informative annex)

Semantic representation of rail transit scenarios

B.1 Description of the rail transit scenario

The scenario of train conflict resolution based on turnout in urban rail transit is selected, and the decision-making process of rail transit dispatching is described by traffic semantic representation language.

In the urban rail transit system, there is a main railway line equipped with multiple switches along its route. Trains must navigate these switches to reach different destinations. Each switch is fitted with signal lights and crossing gates to control train passage. At a specific switch, two trains are simultaneously approaching and attempting to cross. The dispatching system at the track control center detects that the two trains are about to create a path conflict within the switch section.

Train A: A passenger train is approaching the turnout and preparing to turn right onto the next track.

Train B: A freight train approaching the same turnout from another track, intending to proceed straight through.

The system predicts potential path conflicts by analyzing real-time train position, speed, planned routes, and occupancy status of switches and track sections. It automatically generates dispatch plans based on train type, priority, and current timetable execution. In this scenario, the decision prioritizes Train A's passage while instructing Train B to stop and wait before proceeding. The system translates this decision into specific control commands: locking the switch to Train A's required position, disabling Train B's entry signal, and sending a stop recommendation or command to Train B. It continuously monitors Train B's deceleration and stopping status, as well as Train A's smooth passage, until the conflict risk is fully resolved.

B.2 Terminology for Rail Transit Scenarios

a) IsTrain(x): Checks if x is a train.

b) IsSwitch(x): indicates that x is a turnout;

c) IsTrackSegment(x): indicates that x is a track segment.

d) IsControlCenter(x): indicates that x is a control center.

e) HasPathConflict(Train1, Train2, Location, t): Indicates a path conflict between Train1 and Train2 at time t and location location.

f) HasTravelPriority (train1, priority): indicates that train1 has priority level priority.

g) LetDispatchingCommandIssued(center,train,command,t): indicates that control center center issued dispatch command command to train train at time t.

Appendix C

(informative annex)

Semantic representation of water transportation scenarios

C.1 Description of water transportation scenarios

The water traffic scene is selected, and the two ships meeting in the waterway is considered. The traffic semantic representation language is used to describe the rail traffic scene.

A waterway refers to designated navigation channels in oceans, rivers, or other water bodies. When vessels A and B follow their respective routes along such channels, they may intersect at certain points. Given the limited space in these channels, such encounters pose potential collision risks. Therefore, appropriate navigation rules and safety measures must be implemented during vessel encounters to ensure safe passage. Throughout this process, the speed, course, and position of vessels are dynamically changing, and the distance between them varies over time. Navigation decisions during vessel encounters must consider multiple factors, including navigation regulations, vessel dynamics, and maritime traffic conditions, to minimize collision risks and ensure the safety and efficiency of water transport.

C.2 Terms used to describe water transport scenarios

a) IsVessel(x) indicates that individual x is a vessel.

b) IsChannel(x): indicates that x is a channel;

c) Encounter (IsVessel(A), IsVessel(B)): indicates whether vessel A and vessel B are in collision on the waterway.

d) HasVesselPosition(x, position): indicates the vessel's current location;

e) HasVesselSpeed(x, speed): indicates the vessel's current speed.

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