



**Recommendation ITU-R M.1890-1**  
**(01/2019)**

**Operational radiocommunication objectives  
and requirements for advanced  
Intelligent Transport Systems**

**M Series**  
**Mobile, radiodetermination, amateur  
and related satellite services**

## Foreword

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Series	Title
<b>BO</b>	Satellite delivery
<b>BR</b>	Recording for production, archival and play-out; film for television
<b>BS</b>	Broadcasting service (sound)
<b>BT</b>	Broadcasting service (television)
<b>F</b>	Fixed service
<b>M</b>	<b>Mobile, radiodetermination, amateur and related satellite services</b>
<b>P</b>	Radiowave propagation
<b>RA</b>	Radio astronomy
<b>RS</b>	Remote sensing systems
<b>S</b>	Fixed-satellite service
<b>SA</b>	Space applications and meteorology
<b>SF</b>	Frequency sharing and coordination between fixed-satellite and fixed service systems
<b>SM</b>	Spectrum management
<b>SNG</b>	Satellite news gathering
<b>TF</b>	Time signals and frequency standards emissions
<b>V</b>	Vocabulary and related subjects

*Note: This ITU-R Recommendation was approved in English under the procedure detailed in Resolution ITU-R 1.*

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## RECOMMENDATION ITU-R M.1890-1

**Operational radiocommunication objectives and requirements for advanced Intelligent Transport Systems**

(Question ITU-R 205-5/5)

(2015-2019)

**Scope**

This Recommendation provides operational radiocommunication objectives and requirements for intelligent transport systems (ITS), including evolving ITS. ITS utilize a combination of technologies such as computers, telecommunications, positioning, and automation to improve the safety, management, efficiency, usability and environmental sustainability of terrestrial transportation systems.

**Keywords**

Intelligent Transport Systems (ITS)

**Abbreviations**

AVL	Automated vehicle location
DARC	Data radio channel
FM	Frequency modulation
GNSS	Global navigation satellite systems
IMT-2000	International Mobile Telecommunications-2000
IMT-Advanced	International Mobile Telecommunications-Advanced
ISO	International Organization for Standardization
ITS	Intelligent transport systems
ITS-G5	Access technology to be used in frequency bands dedicated for European intelligent transport System (ITS)
LAN	Local area network
RF	Radio frequency
RDS	Radio data system
V2X	Vehicle-to-everything

**Related ITU-R Recommendations and Reports**

Recommendation ITU-R M.1452 – Millimetre wave radiocommunication systems for intelligent transport systems applications

Recommendation ITU-R M.1453 – Intelligent transport systems – Dedicated short range communications at 5.8 GHz

Recommendation ITU-R M.1797 – Vocabulary of terms for the land mobile service

Recommendation ITU-R M.2084 – Radio interface standards of vehicle-to-vehicle and vehicle-to-infrastructure communications for Intelligent Transport System applications

Recommendation ITU-R M.2120 – Harmonisation of frequency bands for Intelligent Transport Systems in the mobile service

Report ITU-R M.2228 – Advanced intelligent transport systems (ITS) radiocommunications

Report ITU-R M.2441 – Emerging usage of the terrestrial component of International Mobile Telecommunication (IMT)

Report ITU-R M.2445 – Intelligent transport systems (ITS) usage in ITU Member States

The ITU Radiocommunication Assembly,

*considering*

- a) that there is a need to integrate various technologies including radiocommunications into land transportation systems;
- b) that many new land transportation systems use intelligence in land vehicles coupled with advanced vehicle, advanced traffic management, advanced traveller information, advanced public transportation, and advanced fleet management systems to improve traffic management;
- c) that ITS are being planned and implemented in various Regions by administrations;
- d) that a wide variety of applications and services are defined;
- e) that international standards would facilitate worldwide application of ITS and provide for economies of scale in bringing ITS equipment and services to the public;
- f) that worldwide compatibility of ITS may be dependent on harmonized radio spectrum allocations;
- g) that the ISO is standardizing ITS (non-radio aspects) in ISO/TC204 including applications for “cooperative systems” which require vehicle-to-vehicle and vehicle-to-infrastructure radiocommunications;
- h) that next generation vehicular radiocommunication technologies and ITS broadcast systems are emerging;
- i) that ITS applications can be classified as safety-related ITS and non-safety related ITS applications; and their corresponding objectives and requirements are different,

*recognizing*

- a) that Recommendation ITU-R M.1452 provides low power short-range vehicular radar equipment at 60 GHz and 76 GHz, and technical characteristics of millimetre wave radiocommunication systems for data communications for vehicle-to-vehicle and vehicle-to - infrastructure communications;
- b) that outlines of technologies and characteristics for dedicated short-range communications at 5.8 GHz are described in Recommendation ITU-R M.1453;
- c) that Recommendation ITU-R M.1797 provides terminology on ITS;
- d) that the land mobile Handbook (Volume 4 on ITS) contains information on ITS radiocommunication;
- e) that some administrations in each of the three Regions have deployed radio local area networks (RLANs) in the frequency band 5 725-5 825 MHz, which is also identified for industrial, scientific and medical (ISM) applications;
- f) that Report ITU-R M.2228 defines “Advanced ITS”;
- g) that studies and feasibility tests on advanced ITS radiocommunications have been actively conducted towards the realization of traffic safety and a reduction of environmental impact as described in Report ITU-R M.2228;

- h) that radio interface standards of vehicle-to-vehicle and vehicle-to-infrastructure communications for ITS applications are described in Recommendation ITU-R M.2084;
- i) that Report ITU-R M.2445 addresses the usages of ITS radiocommunication applications, such as vehicle-to-infrastructure, vehicle-to-vehicle, vehicle to pedestrian communications for traffic safety related and traffic efficiency applications as well as electronic tolling systems and automotive radars for collision avoidance in ITU Member States;
- j) that Report ITU-R M.2441 provides information on the usage of IMT systems for emerging applications, including ITS,

*recommends*

that the operational radiocommunication objectives and requirements described in the Annex should be used for the further deployment of ITS.

## Annex

### Operational radiocommunication objectives and requirements for advanced ITS

#### 1 Elements of ITS

Based on major services required for ITS, the elements of ITS and the associated RF interfaces are listed in the following sections. For rural area applications, it may be necessary to appropriately tailor these technologies to meet the operational requirements. In the following sections, the term “vehicle-to-infrastructure” refers to both radiocommunication originating from vehicles and radiocommunication originating from infrastructure.

##### 1.1 Advanced vehicle control systems

Advanced vehicle control systems are oriented to complementing major portions of the driving task.

Elements	Radiocommunication options
<i>Longitudinal collision avoidance:</i> helps to prevent head-on, rear-end or backing collision between vehicles, vehicles to objects or pedestrians	Short-range vehicle-to-vehicle, short-range radar, high-resolution short-range radar, millimetre-wave communications
<i>Lateral collision avoidance:</i> helps prevent collisions when vehicles leave their lane of travel	Short-range vehicle-to-vehicle, short-range radar, high-resolution short-range radar, millimetre-wave communications
<i>Intersection collision avoidance:</i> helps prevent collisions at intersections	Short-range vehicle-to-vehicle, vehicle-to-infrastructure communication, millimetre-wave communications, short-range radar
<i>Vision enhancement systems:</i> improves driver’s ability to see the roadway and objects on or along the roadway	Forward looking infrared radar, high-resolution short-range radar (short-range radar)
<i>Pre-crash restraint deployment:</i> anticipates an imminent collision and activates passenger safety systems before the collision occurs earlier than is currently feasible	Short-range vehicle-to-vehicle, short-range radar, high-resolution short-range radar

Elements	Radiocommunication options
<i>Automated road systems</i>	Short-range vehicle-to-vehicle communication, short-range radar, short-range vehicle-to-infrastructure communication
<i>Safety readiness: provides warnings about the condition of the driver, the vehicle and the roadway</i>	Short-range vehicle-to-vehicle, short-range vehicle-to-infrastructure communication, wide area communication, millimetre-wave communications

## 1.2 Advanced traffic management systems

Advanced traffic management systems are intended to improve traffic flow and result in more efficient use of the road systems.

Elements	Radiocommunication options
<i>Traffic network monitoring and control: manages the movement of traffic on streets and highways</i>	Radar, short-range vehicle-to-infrastructure communication, broadcast, wide area communications
<i>Travel demand management: supports policies and regulations designed to mitigate the environmental and social impacts of traffic congestion</i>	Short-range vehicle-to-infrastructure communication, broadcast, wide area communication
<i>Incident detection and management: helps public and private organizations quickly identify incidents and implement a response to minimize their effects on traffic</i>	Radar, short-range vehicle-to-infrastructure communication, broadcast, wide area communication
<i>Emissions testing and mitigation: provides information for monitoring air quality and developing air quality improvement strategies</i>	Wide area communication
<i>Parking management: provides information of parking lots or manages the entry and exit of vehicles</i>	Radar, short-range vehicle-to-infrastructure communication, broadcast, wide area communication

## 1.3 Advanced traveller information systems

Advanced traveller information systems are intended to assist travellers in trip planning and with route navigation and traffic conditions.

Elements	Radiocommunication options
<i>Pre-trip travel information: provides information for selecting the best transportation mode, departure time and route</i>	Broadcast, wide area communication
<i>En-route driver information: provides driver advisory and in-vehicle signing for convenience and safety during travel</i>	Broadcast, wide area communication, short-range vehicle-to-infrastructure communication
<i>En-route transit information: provides information to travellers using public transportation after the start of the trip</i>	Broadcast, wide area communication, short-range vehicle-to-infrastructure communication

Elements	Radiocommunication options
<i>Route guidance</i> : provides travellers with simple instruction on how to best reach their destinations	Broadcast, wide area communication, short-range vehicle-to-infrastructure communication
<i>Ride matching and reservation</i> : makes ride sharing easier and more convenient	Wide area communication

#### 1.4 Advanced public transportation systems

Advanced public transportation systems are designed to improve the efficiency of public transportation and make it more desirable by providing real-time scheduling and rider information.

Elements	Radiocommunication options
<i>Public transportation management</i> : automates operations, planning and management functions of public transit systems	Wide area communication, GNSS (AVL)
<i>Personalized public transportation</i> : offers flexibly routed transit vehicles for more convenient service to customers	Wide area communication, GNSS (AVL)

GNSS: Global navigation satellite system (GPS, GALILEO, GLONASS, etc.) including satellite-based augmentation system.

AVL: Automated vehicle location.

#### 1.5 Advanced fleet management systems

Advanced fleet management systems are intended to improve efficiency and productivity of commercial vehicle operations.

Elements	Radiocommunication options
<i>Vehicle administration</i> : provides electronic purchasing of credentials and automated mileage and fuel reporting and auditing	Wide area communication
<i>Safety monitoring and tracking</i> : senses the safety status of a commercial vehicle, cargo and driver	Wide area communication, short-range vehicle-to-infrastructure communication, GNSS
<i>Fleet management</i>	Wide area communication, GNSS
<i>Vehicle preclearance</i> : facilitates domestic and international border clearance, minimizing stops	Short-range vehicle-to-infrastructure communication
<i>Automated roadside safety inspections</i> : facilitates roadside inspections	Short-range vehicle-to-infrastructure communication
<i>Hazardous material incident response</i> : provides immediate description of hazardous materials to emergency responders	Wide area communication, GNSS

#### 1.6 Emergency management systems

Emergency management systems are intended to improve the response times of emergency vehicles involving transportation and other emergency related incidents.

Elements	Radiocommunication options
<i>Emergency notification and personal security</i> : provides immediate notification of an incident and an immediate request for assistance	Short-range vehicle-to-infrastructure communication, short-range vehicle-to-vehicle communication, wide area communication, short-range radar, high resolution short-range radar
<i>Public travel security</i> : creates a secure environment for public transportation operators	
<i>Emergency vehicle management</i> : reduces the time it takes emergency vehicles to respond to an incident	

### 1.7 Electronic payment services

Elements	Radiocommunication options
<i>Electronic payment services</i> : allows travellers to pay for transportation services electronically based on short-range vehicle-to-infrastructure communication	Short-range vehicle-to-infrastructure communication
<i>Electronic payment services</i> : allows travellers to pay for transportation services electronically based on GNSS and wide area communication	Wide area communication, GNSS

### 1.8 Pedestrian supporting systems

Pedestrian supporting systems are intended to assist pedestrians in traffic situations such as crossing intersections.

Elements	Radiocommunication options
<i>Pedestrians route guidance</i> : helps pedestrians to find appropriate directions to go to destinations	Wide area communication, short-range vehicle-to-infrastructure communication, GNSS
<i>Vehicle-pedestrian accident avoidance</i> : detects dangerous situations, and to provide necessary alarm both for pedestrians and drives	Short-range vehicle-to-infrastructure communication, radio frequency identification, high-resolution short-range radar

## 2 ITS radio service objectives

### 2.1 Radiocommunication options

Different ITS applications have specific requirements for radiocommunication options. ITS functions will be most effectively achieved through the single or combined use of the following radiocommunication options:

- *Broadcast*.
- *Point-to-point*: two way transmission from one specific node to another specific node.
- *Short-range radiocommunications*: vehicle-to-infrastructure radiocommunication (e.g. DSRC, WAVE, digital cellular mobile telecommunication systems (GSM, etc.), IMT-2000, IMT-Advanced (including LTE based V2X), ITS Connect).



- *Short-range radiocommunications*: vehicle-to-vehicle radiocommunications (e.g. WAVE, ITS-G5, Wireless LAN, LTE based V2X, ITS Connect).
- *Millimetre wave communications*.
- *Short-range radar*.
- *High-resolution short-range radar*.
- *Wide area radiocommunication*: including mobile two-way communications using networks of terrestrial base stations (e.g. cellular) or using satellites.
- *GNSS*: for location-based services such as AVL one way communication.

## **2.2 Service objectives**

Tables 1 and 2 provide ITS radio interface technology for communication and radio determination. Table 3 provides ITS service objectives for radiocommunication.

TABLE 1

**ITS Radio interface technology – Communication**

<b>Radiocommunication option</b>	<b>Coverage area</b>	<b>Network configuration</b>	<b>Radiocommunication interface technology examples</b>
Short-range vehicle-to-vehicle radiocommunication	Small coverage area	Broadcast	ITS-G5 WAVE Wireless LAN IMT-Advanced (including LTE based V2X) ITS Connect
		Point-to-point	ITS-G5 WAVE Wireless LAN Digital cellular mobile telecommunication systems (GSM, etc.) IMT-2000 IMT-Advanced Millimetre wave communications
Short-range vehicle-to-infrastructure radiocommunication	Small coverage area	Broadcast	ITS-G5 WAVE Wireless LAN IMT-Advanced (including LTE based V2X) ITS Connect
		Point-to-point	DSRC ITS-G5 WAVE Wireless LAN Digital cellular mobile telecommunication systems (GSM, etc.) IMT-2000 IMT-Advanced (including LTE based V2X) Millimetre wave communications

TABLE 1 (end)

Radiocommunication option	Coverage area	Network configuration	Radiocommunication interface technology examples
Wide area radiocommunication	Large coverage area including underground car park tunnels and rural areas	Broadcast	Digital TV Multimedia broadcast Digital radio FM multiplex broadcasting (DARC, RDS, etc.) Wireless LAN IMT-Advanced (including LTE based V2X)
		Point-to-point	Digital cellular mobile telecommunication systems (GSM, etc.) IMT-2000 IMT-Advanced (including LTE based V2X) Wireless LAN

TABLE 2

**ITS Radio interface technology – Radio determination**

Radio determination		Coverage area	Range resolution	Velocity resolution
Radar	Short-range radar	Small coverage area	Less than 3% of the detection distance or less than 1 m	Less than 3% of the vehicle speed or less than 1 km/h.
	High-resolution short-range radar	Small coverage area: tens of metres	Less than 20 cm detection distance	N/A
Global navigation satellite systems		Nearly ubiquitous coverage	N/A	N/A

## ITS Service objectives for radiocommunication

<b>Application</b>	<b>Data Rate</b>	<b>Data integrity</b>	<b>Transmission latency</b>	<b>Radio Interface Technology Radio determinations</b>
Safety	middle	Less than one undetected message error per 100 messages	very low	Short-range vehicle-to-infrastructure communication Short-range vehicle-to-vehicle communication Global navigation satellite systems Short-range radar High-resolution short-range radar Millimetre wave communications
Payment	middle to high	Less than one undetected message error per 1 000 messages to less than one detected message error per one million messages (ratio of undetected message error per one million messages should be negligibly small)	low	Short-range vehicle-to-infrastructure communication Global navigation satellite systems Wide area communication
Data broadcasting	high	Very high: low probability of undetected error	middle	Short-range vehicle-to-infrastructure communication Wide area radiocommunication Broadcast

### **3 International standardization**

For safety reasons international standardization of ITS is desirable in respect to the short-range vehicle-to-vehicle or vehicle-to-infrastructure radiocommunications and any short-range radar employing cooperative techniques.

From a user's perspective, international standardization is also highly desirable, at a minimum on a regional basis, for the convenience of users moving within that region and for the broadcast and short-range vehicle-to-vehicle or vehicle-to-infrastructure radiocommunications.

### **4 Interconnection requirements**

The largest data capacity needs will probably be required for the purpose of data collection from roadside sensors. Other services include control of signals and variable message signs, distribution of data between traffic authorities, service providers and fleet managers and for distribution of data to/from broadcast and roadside communications facilities. A mix of dedicated and switched connections is anticipated. Multipoint distribution will benefit from the use of packet mode communications.

### **5 Use of evolving mobile telecommunication services**

It is expected that the evolving mobile telecommunication will be able to support the ITS applications requiring terrestrial, two-way, wide area communications, particularly when combined with the GNSS.

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