

International Telecommunication Union

**ITU-T**

TELECOMMUNICATION  
STANDARDIZATION SECTOR  
OF ITU

**F.921**

(08/2018)

SERIES F: NON-TELEPHONE TELECOMMUNICATION  
SERVICES

Accessibility and human factors

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**Audio-based indoor and outdoor network  
navigation system for persons with vision  
impairment**

Recommendation ITU-T F.921



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## Recommendation ITU-T F.921

### Audio-based indoor and outdoor network navigation system for persons with vision impairment

#### Summary

Recommendation ITU-T F.921 specifies how audio-based network navigation systems can be designed to ensure that they are inclusive and meet the needs of persons with visual impairments. Recommendation ITU-T F.921 adopts a technology neutral approach by specifying the functional characteristics of the system. The aim is to give designers of audio-based network navigation systems the information they need at the initial stages of development to anticipate and overcome any restrictions and barriers that prevent users with visual impairments from making full and independent use of the built environment. Recommendation ITU-T F.921 explains how to accommodate users' experience of audio-based network navigation systems and ensure the interoperability of those systems. Recommendation ITU-T F.921 recognizes that by meeting the user needs of persons with visual impairments, audio-based network navigation systems may also benefit persons with other disabilities, age-related conditions and specific needs, as well as the general public.

This revision provides updates based on feedback received from field use of this Recommendation, as well as other text clarifications and corrections.

#### History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T F.921	2017-03-01	16	<a href="http://handle.itu.int/11.1002/1000/13185">11.1002/1000/13185</a>
2.0	ITU-T F.921 (V2)	2018-08-29	16	<a href="http://handle.itu.int/11.1002/1000/13662">11.1002/1000/13662</a>

#### Keywords

Accessibility, audio-based, network navigation system, persons with disabilities.

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\* To access the Recommendation, type the URL <http://handle.itu.int/> in the address field of your web browser, followed by the Recommendation's unique ID. For example, <http://handle.itu.int/11.1002/1000/11830-en>.

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## **Introduction**

This Recommendation specifies how audio-based network navigation systems can be designed to ensure they are inclusive and meet the needs of persons with visual impairments. This Recommendation adopts a technology neutral approach by specifying the functional characteristics of the system.

The aim is to give designers of audio-based navigation system the information they need at the initial conception stage to anticipate and overcome any restrictions and barriers that prevent users from making full and independent use of the built environment. Whilst existing audio-based network navigation systems have utilized mobile technologies to provide users with efficient, effective and satisfying wayfinding and hardware, compatibility and interoperability standards for mobile technologies may provide a useful basis for promoting audio-based navigation, this Recommendation explains how to accommodate the users' experience of inclusive audio-based network navigation systems (IABNNSs) and ensure their interoperability. This Recommendation recognizes that, by meeting the user needs of persons with visual impairments, IABNNSs can also benefit persons with other disabilities, age-related conditions and specific needs, as well as the general public. This Recommendation can be applied to IABNNSs in a variety of built environments, including those in urban or rural settings.

NOTE – This Recommendation on audio-based network navigation systems does not consider the specialized requirements of people who are deaf or with impaired hearing.

# Recommendation ITU-T F.921

## Audio-based indoor and outdoor network navigation system for persons with vision impairment

### 1 Scope

This Recommendation specifies requirements for the design of inclusive audio-based network navigation systems (IABNNSs) to accommodate users with vision impairment as well as users with a wide range of characteristics and capabilities. This Recommendation aims to help design professionals to achieve an inclusive environment through IABNNSs that augment the physical environment by the provision of aural information about environments for users. This Recommendation does not consider the specialized requirements of people who are deaf or with impaired hearing.

In addition, while this Recommendation recognizes the necessity to provide audio-based network navigation outputs in languages determined by the user, provision of specific solutions is beyond scope of this Recommendation. Implementers are encouraged to ensure that the instructions are accessible to and understood by as many users as possible and are encouraged to provide for the use of a wide range of languages. Future work aims, among other things, to address this issue, and will explore the use of meta-coding for providing a flexible user-centric translation system.

### 2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ISO 23599:2012] ISO 23599:2012, *Assistive products for blind and vision-impaired persons – Tactile walking surface indicators*.

### 3 Definitions

#### 3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

**3.1.1 accessibility** [b-ITU-T F.791]: The degree to which a product, device, service or environment (virtual or real) is available to as many people as possible.

**3.1.2 disability** [b-ITU-T F.791]: Any restriction or inability to perform a function or activity in the manner or the range considered average or accepted functionality, resulting from an impairment or reduction of ability, than can be either permanent or temporary.

**3.1.3 impairment** [b-ITU-T F.791]: Any loss or abnormality of psychological, physiological, or anatomical structure or function.

**3.1.4 persons with age related disabilities** [b-ITU-T F.791]: Persons when they age, often develop cognitive and physical disabilities that are caused by the aging process itself. Examples are diminished eyesight, deafness in varying degrees, reduced mobility, or cognitive abilities.

**3.1.5 persons with specific needs** [b-ITU-T F.791]: Includes persons with disabilities (PWD), persons who are not literate, those with learning disabilities, children, indigenous people, older persons with age related disabilities, and anyone who has a temporary disability.

**3.1.6 platform accessibility features** [b-ITU-T F.791]: Accessibility functionality provided as standard on a particular hardware/software platform.

## **3.2 Terms defined in this Recommendation**

This Recommendation defines the following terms:

**3.2.1 audio alert:** Aural signal designed to precede audio instructions.

**3.2.2 audio instruction:** Aural message to provide wayfinding instructions and directions for users of audio-based network navigation systems (IABNNSs).

**3.2.3 cardinal coordinates:** Means of communicating general directions to a user based on points of a compass where "North" is straight ahead.

**3.2.4 clock face directions:** Means of communicating general directions to a user by reference to the positions of the hours on an analogue clock with 12 o'clock being straight ahead.

**3.2.5 countable delimiter:** Word or phrase that uses numbers to communicate directions, e.g., the first (corridor).

**3.2.6 decision point:** Crossing or intersection of a pathway, e.g., a route to a railway station ticket gate for departing passengers and the gate for arriving passengers.

**3.2.7 degree directions:** Means of communicating general directions to a user by reference to the degrees of a circle, with 0° being straight ahead.

**3.2.8 descriptive delimiter:** Word or phrase that describes an object or an environmental feature to communicate directions, e.g., the lower (concourse).

**3.2.9 directional delimiter:** Word or phrase that usually follows a verb and communicates direction, e.g., left.

**3.2.10 egocentric frame of reference:** Reference frame in which the spatial layout and orientation are communicated based on the individual's current location and viewpoint.

**3.2.11 inclusive audio-based network navigation system (IABNNS):** Technologies used to augment the physical environment by the provision of an audio version of that environment for users.

**3.2.12 journey completed notification alert:** A sequence of short three-note rising pitch sounds of equal duration provided when the scheduled journey is complete. They are different to mobile device operating system alerts.

**3.2.13 landmark:** Feature in the physical environment, e.g., an isolated column.

**3.2.14 notification alert:** A sequence of short two-note sounds of equal duration provided just before audio alerts and audio instructions to notify the user of an impending audio alert or audio instruction. This is different to a mobile device operating system alert.

**3.2.15 object:** Small feature in the physical environment, e.g., a lift control button.

**3.2.16 orthogonal:** Means of communicating general directions to a user that is different from the 'degree' approach and uses directions based on 90° angles from a direction straight ahead.

**3.2.17 pathway:** A route allowing passage from one point to another, examples include a corridor, ramp, tunnel, subway, escalator, stair or lift (elevator), footway or road crossing.



**3.2.18 person with a disability:** person who has a physical or mental impairment that has a substantial and long-term adverse effect on her or his ability to carry out normal day-to-day activities.

NOTE – [b-UNCRPD] covers the rights of people with disabilities.

**3.2.19 platform:** A boarding facility to provide access to rail-mounted vehicles.

**3.2.20 proportional directions:** Means of communicating general directions to a user that is different to the "clock face" or "degree" approach and uses terms like "straight", "ahead", "left" and "right".

**3.2.21 segment:** Distinctive area in an environment, e.g., a railway station forecourt.

**3.2.22 sequential delimiter:** Word or phrase that limits the relationship of one object to communicate directions, e.g., after (the gates).

**3.2.23 vision impairment:** A vision loss that cannot be corrected by the use of glasses, refractive correction, medication or surgery. The vision loss may affect visual acuity, central or peripheral visual field defects, or reduced contrast sensitivity.

## **4 Abbreviations and acronyms**

This Recommendation uses the following abbreviations and acronyms:

IABNNS      Inclusive Audio-Based Network Navigation System

PWD          Person With Disabilities

## **5 Conventions**

The following conventions are used in this Recommendation. The word "should" indicates an essential requirement in order to conform to this Recommendation. The word "may" indicates a recommendation with which it is not essential to comply in order to conform to this Recommendation.

## **6 Design principles**

The principles for the design and interoperability of an IABNNS should involve users in the design, development and validation process, in a real environment. Users should help to identify the location of the main points of interest, key features and routes that are safe and convenient. The route should have defined segments and landmarks and be the most accessible. The content, terminology and classification used in the audio instructions are shown in clause 9.

## **7 Validation principles**

The principles for the validation and interoperability of an IABNNS should include the testing of the installation, configuration, usability and accessibility.

## **8 Directions**

Directions should be provided through the use of an egocentric frame of reference that communicates general directions and alerts based on a clock face, degree, proportional or orthogonal approach, as defined in clause 3.2. The most accessible route should be used.

NOTE – An allocentric frame of reference, which communicates general directions and alerts based on cardinal coordinates ([b-Chen, 2015]; [b-Kalia, 2010]) (as defined in clause 3.2.3), may be used.

## **9 Audio instructions**

Audio instructions and audio alerts should be clear, unambiguous, effective and safe ([b-Allen, 2000]; [b-Kulyukin, 2008]). The piloting or chaining of routes should allow instructions to be related to particular segments of the route. The most accessible route should be used.

### **9.1 Components of an audio instruction**

An audio instruction should contain the elements specified in 9.1.1 to 9.1.3.

NOTE – Two examples of an audio instruction using the elements included in this clause are shown in Appendix I.

#### **9.1.1 Verbs**

Verbs are used to communicate the action required, e.g., "walk".

#### **9.1.2 Orientation information**

Orientation information is used to communicate users' current location in relationship to their surroundings, e.g., "you are approaching". Orientation information should make reference to features of the physical environment and the route. These include segments (3.2.21), pathways (3.2.17), decision points (3.2.6), landmark (3.2.13) and objects (3.2.15).

#### **9.1.3 Direction information**

Direction information is used to communicate directions to the user. Direction information should use directional delimiters (3.2.9), countable delimiters (3.2.5), sequential delimiters (3.2.22) and descriptive delimiters (3.2.8).

### **9.2 Audio instructions – Classification**

Audio instructions are classified [b-Gaunet, 2005] as in 9.2.1 to 9.2.8.

#### **9.2.1 Route starting instructions**

Define the starting point of the route, the type of environment and identify the orientation of the user, e.g., "Welcome to Central Station. You are now on the main concourse. For your train, walk forward to the ticket barriers".

#### **9.2.2 Route ending instructions**

Define the ending point of the route, inform users they have reached their destination and that audio instructions are ending, e.g., "You have exited Central station. You are now on the east side of Alpha High Street facing the Town Hall".

#### **9.2.3 Progression direction instructions**

Define the direction to the next segment, pathway, decision point, landmark or object e.g., "At the bottom of the stairs, turn left and walk forward to the ticket gates".

#### **9.2.4 Reassurance progression direction instructions**

Reassure users that they are following a route that is communicated by audio instructions, e.g., "Keep walking forward" and should be provided every 10 m on routes where there are no changes of direction or decision points and where the user of an IABNNS has not configured their system to receive such notifications less frequently.

#### **9.2.5 Orientation progression direction instructions**

Communicate a change in direction prior to reaching an environmental feature, e.g., "At the next tactile paving intersection, follow the tactile paving route to the left".

### **9.2.6 Alerts of the location of the next environmental feature**

Communicate information about the location of the next environmental feature, e.g., "The down escalator is the one on the left."

### **9.2.7 Alert to an environmental feature**

Communicate information about an environmental feature that is close to the user, e.g., "You are approaching the escalators"; "You are approaching the stairs".

### **9.2.8 Alert to current location**

Communicate information about the spatial layout of a location and the position of the user.

## **10 Specific features, landmarks and objects**

This clause includes a range of decision points, landmarks and objects where particular instructions and alerts should be provided. Audio instruction directions should utilize the most accessible routes.

### **10.1 Entrances and exits**

The audio instruction communications from an IABNNS should:

- utilize the most accessible entrance and exit;
- allow users to choose their entrance and exit;
- provide information about the type, size and opening configuration of doors;
- provide information about the position and type of door opening furniture and operating controls.

### **10.2 Pathways**

The audio instruction communications from an IABNNS should:

- utilize the most accessible pathway;
- allow users to choose their pathway;
- provide information about the type and size of the pathway;
- inform users of any curve in the pathway;
- where appropriate, advise users to keep on the side of the pathway that is best for the direction in which they are travelling when on a route where people are moving in both directions.

### **10.3 Decision points**

The audio instruction communications from the IABNNS should:

- be provided at all decision points;
- utilize the most accessible decision points;
- allow users to choose their decision points;
- provide information about the type, size and configuration of decision points.

### **10.4 Tactile walking surface indicators**

There are two different types of tactile walking surface indicators [ISO 23599:2012], namely warning and directional indicators.

#### **10.4.1 Warning walking surface indicators**

These indicators are used to warn of pedestrian hazards.

#### **10.4.2 Directional walking surface indicators**

These indicators are used to provide direction information.

The audio instruction communications from an IABNNS should:

- be provided for all walking surface indicators;
- utilize the most accessible route of walking surface indicators;
- provide information about the type, size and configuration of the walking surface indicators.

NOTE – Some tactile walking surface indicators indicate the proximity of platforms.

#### **10.5 Escalators**

The audio instruction communications from an IABNNS should:

- enable the user to locate the escalator;
- describe the proximity of the escalator;
- describe the moving direction of the escalator;
- describe the numbers of escalators in any group;
- describe the moving direction of each escalator in a group;
- describe the location of the handrail;
- where appropriate, state the side of the escalator where travellers stand;
- describe the relative width/length of the escalator;
- describe the next direction of the route when leaving the escalator.

The proximity of an escalator should be given in an audio instruction  $6 \pm 1$  m from the escalator.

#### **10.6 Stairs**

The audio instruction communications from an IABNNS should:

- enable the user to locate the stairs;
- describe the proximity of the stairs;
- describe the direction of the stairs;
- describe the numbers of steps;
- describe the location of a landing within a flight of stairs;
- describe the location of handrails;
- where appropriate, state the side of the stairs travellers use to move up and down;
- describe the relative width/length of the stairs;
- describe the next direction of the route when leaving the stairs;
- where appropriate, announce the presence of an open riser staircase.

NOTE – Only describe the number of steps when less than 12.

The proximity of a staircase should be given in an audio instruction  $6 \pm 1$  m from the first step.

#### **10.7 Lifts**

The audio instruction communications from an IABNNS should:

- enable the user to locate the lift;
- describe the proximity of the lift;
- describe the numbers of lifts;

- describe the location of call buttons outside the lift;
- describe the size of the lift;
- describe the location of call buttons inside the lift;
- indicate which button to operate to get to different levels;
- describe the next direction of the route when leaving the lift.

The proximity of a lift should be given in an audio instruction  $6 \pm 1$  m from the lift.

The audible announcements generated by lifts e.g., the next lift to arrive, the travel direction of the lift, the entry and exit floor, and the position of the opening doors should supplement the audio instruction communications from the IABNNS.

## **10.8 Ticket control gates and barriers**

The audio instruction communications from an IABNNS should:

- enable the user to locate the gates and barriers appropriate to the direction of travel;
- describe the proximity of the gates and barriers;
- describe the numbers of gates and barriers;
- describe the size of the gates and barriers;
- describe the next direction of the route when leaving the gates and barriers.

The proximity of gates and barriers should be given in an audio instruction  $6 \pm 1$  m from the gate or barrier.

All users, including those with guide dogs, should be directed to the widest accessible gate.

The use of gates and barriers for arriving or departing travellers should be clearly described.

NOTE – The terminology around ticket control gates and barriers can vary between countries. In this Recommendation, the term "gate" refers to wide, accessible gates and the term "barrier" refers to an accessible route that is controlled to permit ingress and egress.

## **10.9 Platforms**

The audio instruction communications from an IABNNS should:

- enable the user to locate the platform appropriate to the direction of travel;
- enable the user to orientate themselves in relation to the direction of travel of trains;
- enable the user to orientate themselves in relation to their position on the platform;
- describe the proximity of the platform;
- describe the type of platform;
- describe the numbers of platforms;
- describe the size of the platform;
- describe the size of the gap between the platform edge and the rail-mounted vehicle;
- describe any difference between the length of the rail-mounted vehicle and the platform;
- describe the next direction of the route before leaving the platform;
- indicate whether the platform is part of a pedestrian route to/from other platforms.

The proximity of a platform should be given in an audio instruction  $6 \pm 1$  m from the platform.

NOTE – Platforms are a hazard because of the risk of falls.

## **11 Railway stations**

This specific type of built environment includes a range of segments, decision points, landmarks and objects where particular instructions and alerts should be provided, see clause 9.2. Audio instruction directions should utilize the most accessible routes. The segments described in this clause are the forecourt, interchange to other forms of transport, concourse, retail areas and platforms.

The audio instruction communications from an IABNNS that relates to segments should:

- describe the start of a segment;
- enable the location of the segments;
- describe the location of the segments;
- describe the proximity of adjoining segments;
- describe the type of segment;
- describe the size of the segment;
- describe the next direction of the route when leaving the segment.

## **12 Mobile app features**

The mobile app features specific to the IABNNS for the built environment should provide instructions and alerts that are accessible, simple, clear, concise, consistent, understandable and safe.

The audio instruction communications from an IABNNS that are delivered through a mobile app should:

- use a notification alert before an alert or instruction;
- provide user preview;
- enable user replay;
- enable user search by dictation;
- use a journey completed notification alert.

NOTE 1 – A single action button should be utilized for user replay.

NOTE 2 – User replay can mask current instructions.

## Appendix I

### Examples of an audio instruction

(This appendix does not form an integral part of this Recommendation.)

This appendix gives two examples of an audio instruction using the elements included in clause 9.

#### Audio instruction

##### *Example 1*

"Turn left and take the escalator down to the platforms.

The down escalator is the one on the left."

The instruction comprises the following elements:

Verb (i.e., "turn"), directional delimiter (i.e., "left"), verb (i.e., "take"), environmental feature is the pathway (i.e., "the escalator"), directional delimiter (i.e., "down"), directional delimiter (i.e., "to"), environmental feature is the area/segment (i.e., "the platforms"), directional delimiter (i.e., "the down"), environmental feature is the pathway (i.e., "escalator"), state-of-being verb (i.e., "is"), directional delimiter (i.e., "the one on the left").

##### *Example 2*

"At the bottom of the stairs, turn right and walk forward to the platform."

The instruction comprises the following elements:

Sequential delimiter (i.e., "at the bottom"), environmental feature is the pathway (i.e., "the stairs"), verb (i.e., "turn"), directional delimiter (i.e., "right"), verb (i.e., "walk"), directional delimiter (i.e., "forward"), directional delimiter (i.e., "to"), environmental feature is the segment (i.e., "the platform").

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Series T	Terminals for telematic services
Series U	Telegraph switching
Series V	Data communication over the telephone network
Series X	Data networks, open system communications and security
Series Y	Global information infrastructure, Internet protocol aspects, next-generation networks, Internet of Things and smart cities
Series Z	Languages and general software aspects for telecommunication systems