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Information technology — Real-time locating systems (RTLS) —

Part 2:
2,4 GHz air interface protocol

Technologies de l'information — Systèmes de localisation en temps réel —

Partie 2: Protocole d'interface d'air à 2.4 GHz

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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of the joint technical committee is to prepare International Standards. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights.

ISO/IEC 24730-2 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 31, *Automatic identification and data capture techniques*.

ISO/IEC 24730 consists of the following parts, under the general title *Information technology — Real-time locating systems (RTLS)*:

— *Part 1: Application program interface (API)*

— *Part 2: 2,4 GHz air interface protocol*

Introduction

ISO/IEC 24730 defines two air interface protocols and a single application program interface (API) for real-time locating systems (RTLS) for use in asset management and is intended to allow for compatibility and to encourage interoperability of products for the growing RTLS market.

This part of ISO/IEC 24730, the 2,4 GHz air interface protocol, establishes a technical standard for real-time locating systems that operate at an internationally available 2,4 GHz frequency band and that are intended to provide approximate location with frequent updates (for example, several times a minute). In order to be compliant with this standard, compliance with this part of ISO/IEC 24730 and ISO/IEC 24730-1 is required.

Real time locating systems are wireless systems with the ability to locate the position of an item anywhere in a defined space (local/campus, wide area/regional, global) at a point in time that is, or is close to, real time. Position is derived by measurements of the physical properties of the radio link.

This part of ISO/IEC 24730 specifies the air interface for a system that locates an asset in a controlled area, e.g. warehouse, campus, airport (area of interest is instrumented) - accuracy to 3 m.

There are a further two methods of locating an object which are really RFID rather than RTLS:

— Locating an asset by virtue of the fact that the asset has passed point A at a certain time and has not passed point B.

— Locating an asset by virtue of providing a homing beacon whereby a person with a handheld can find an asset.

The method of location is through identification and location, generally through multi-lateration. The different types are

— Time of Flight Ranging Systems,

— Amplitude Triangulation,

— Time Difference of Arrival (TDOA),

— Angle of Arrival.

This part of ISO/IEC 24730 defines the air interface protocol needed for the creation of an RTLS system. There are many types of location algorithms that could be used. An example of a location algorithm is given in Annex A.

Information technology — Real-time locating systems (RTLS) —

Part 2:
2,4 GHz air interface protocol

1 Scope

This part of ISO/IEC 24730 defines a networked location system that provides X-Y coordinates and data telemetry. The system utilizes RTLS transmitters that autonomously generate a direct-sequence spread spectrum radio frequency beacon. These devices may be field programmable and support an optional exciter mode that allows modification of the rate of location update and location of the RTLS device. ISO/IEC 24730 also defines these modes, but does not define the means by which they are accomplished.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 24730-1, *Information technology — Real-time locating systems (RTLS) — Part 1: Application program interface (API)*

ISO/IEC 18000-4, *Information technology — Radio frequency identification for item management — Part 4: Parameters for air interface communications at 2,45 GHz*

ISO/IEC 19762-1, *Information technology — Automatic identification and data capture (AIDC) techniques — Harmonized vocabulary — Part 1: General terms relating to AIDC*

ISO/IEC 19762-3, *Information technology — Automatic identification and data capture (AIDC) techniques — Harmonized vocabulary — Part 3: Radio frequency identification (RFID)*

ISO/IEC 15963, *Information technology — Radio frequency identification for item management — Unique identification for RF tags*

ISO/IEC 8802-11:2005, *Information technology — Telecommunications and information exchange between systems — Local and metropolitan area networks — Specific requirements — Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 19762-1, ISO/IEC 19762-3 and the following apply.

3.1
air interface
wireless communications protocol and signal structure used to communicate data between RTLS transmitters and other RTLS devices

3.2
corporate LAN
customer-provided network such as Ethernet or wireless LAN

3.3
host applications
customer's management information systems

3.4
RTLS infrastructure
system components existing between the air interface protocol and the RTLS server API

3.5
real-time locating system
set of radio frequency receivers and associated computing equipment used to determine the position of a transmitting device relative to the placement of the aforementioned receivers that is capable of reporting that position within several minutes of the transmission used for determining the position of the transmission

Note: Refer to Figure 1 for clarity regarding elements of RTLS infrastructure.

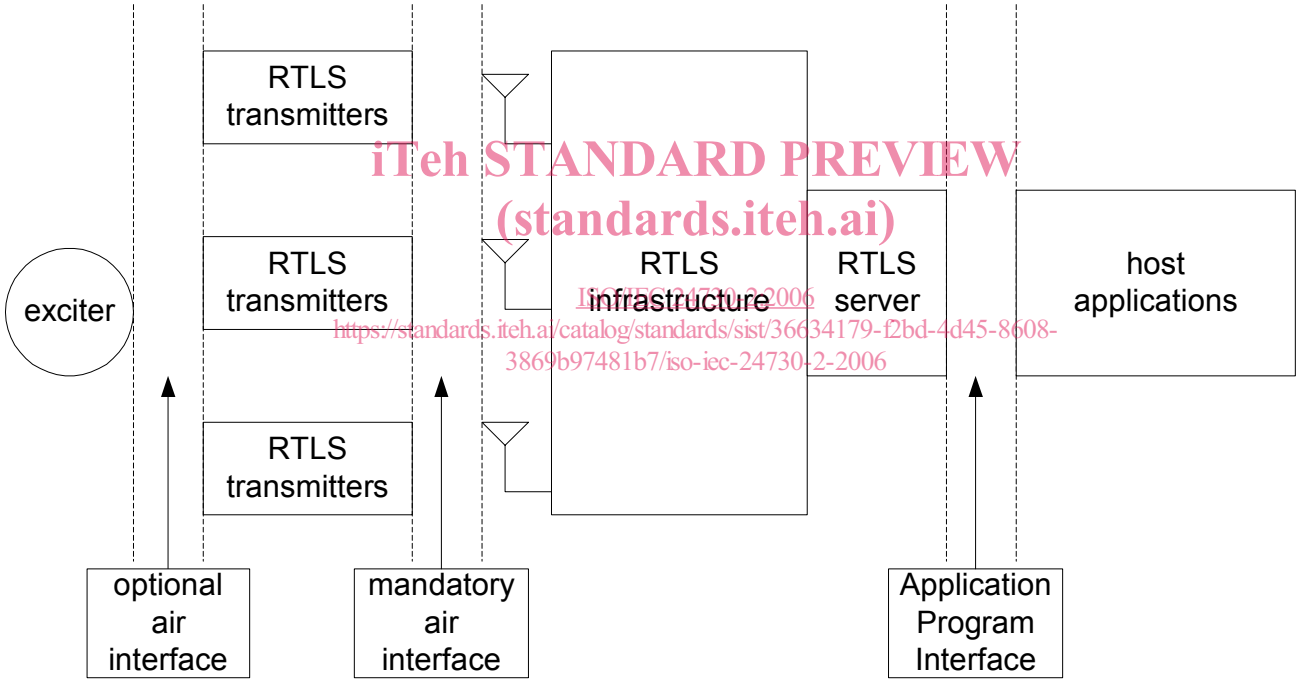

Figure 1 — Elements of RTLS infrastructure

3.6
RTLS server
computing device that aggregates data from the readers and determines location of transmitters

3.7
RTLS transmitter
battery powered radio devices that utilize the protocols specified in ISO/IEC 24730

3.8
RTLS reader
device that receives signals from an RTLS transmitter

3.9
open field
path from transmitter to receiver is LOS (line of sight)

[ANS T1.523-2001]

3.10
exciter
device that transmits a signal that alters the behaviour of an RTLS transmitter

3.11
upconvert
change a baseband signal to a higher frequency signal

3.12
tag blink
radio frequency transmission(s) from an RTLS transmitter that may consist of one or multiple duplicate messages

3.13
sub-blink
message that is transmitted one or multiple times in a “blink”

4 Symbols and abbreviated terms

For the purposes of this document, the symbols and abbreviated terms given in ISO/IEC 19762-1, ISO/IEC 19762-3 and the following apply.

DSSS Direct Sequence Spread Spectrum

EB Event Blink

EXB EXciter Blink

RTLS Real Time Locating System

TIB Timed Interval Blink

5 Requirements

5.1 Frequency range

This part of ISO/IEC 24730 addresses real-time locating systems (RTLS) operating in the 2,400 GHz to 2,4835 GHz frequencies.

5.2 2,4 GHz spread spectrum air interface attributes

The minimum feature set shall include the following.

— RTLS transmitters shall autonomously generate a direct sequence spread spectrum radio frequency beacon.

— Transmission shall be at a power level that can facilitate reception at ranges of 300 m open-field separation between the transmitter and receiver when operating within the parameters described in Table 1.

— RTLS transmitters shall be fully compliant with local regulatory requirements.

— Class 1 RF transmissions are low power and electro-magnetically compatible with and shall not interfere (not cause any measurable difference in throughput) and co-exist with existing standardized ISO/IEC 8802-11 wireless communication networks. They are also systems that co-exist with ISO/IEC 18000-4, and shall not exceed the maximum power requirements of the local regulatory agencies.

— Class II RF transmissions shall not exceed the maximum power requirements of the local regulatory agencies.

5.3 Compliance requirements

The beacon transmitters specified in this part of ISO/IEC 24730 shall transmit at a power level that can facilitate reception at ranges of at least 300 m LOS separation between the transmitter and receiver. Such RTLS transmitters shall be fully compliant with local radio frequency regulatory requirements. Each receiver shall be capable of receiving and processing data from a minimum of 120 beacon transmissions per second. The nominal location data provided by the RTLS shall be within a 3 m radius of the actual location of the RTLS transmitter. The RF transmissions are low power, compatible with, and shall not interfere with existing standardized ISO/IEC 8802-11 wireless communication networks, and systems compliant with ISO/IEC 18000-4.

To be fully compliant with this part of ISO/IEC 24730, RTLS shall also comply with ISO/IEC 24730-1.

5.4 Manufacturer tag ID

The manufacturer's tag identification number identifies a particular manufacturer and consists of 16 bits. A manufacturer may have more than one ID number. As reported from the RTLS Server to the API, the first 16 bits are designated for the manufacturer's identification number. As reported from the Data Link Layer to the API, the remaining 16 bits establish a numbering system made unique by the initial manufacturer ID number. The manufacturer's identification number is a registration in accordance with ISO/IEC 15963. The 16-bit manufacturer's identification number shall be assigned in accordance with ISO/IEC 15963, under Allocation Class 16h.

5.5 Physical layer parameters

The parameter definitions given in Table 1 apply. These parameters are referenced by parameter name. These operating parameters are to be defined for the temperature range of –30 degrees Celsius to 50 degrees Celsius.

Table 2 and Table 3 specify the parameters for the optional air interfaces that may be implemented.

Table 1 — RTLS transmitter DSSS link parameters

Parameter name	Description
Operating frequency range	2400 MHz – 2483,50 MHz
Operating frequency accuracy	± 25 ppm maximum
Centre frequency	2441,750 MHz
Occupied channel bandwidth	60 MHz
Transmit power	Class 1: 10 dBm EIRP max. Class 2: Maximum in accordance with local regulations.
Spurious emission, out of band	The device shall transmit in conformance with spurious emissions requirements defined by the country's regulatory authority within which the system is operated.

Parameter name	Description
Modulation	BPSK Direct Sequence Spread Spectrum (DSSS)
Data encoding	Differentially encoded
Data bit rate	59,7 kb/s
Bit error rate	0,001%
PN chip rate	30,521875 MHz ± 25 ppm
PN code length	511
PN spread code	0x1CB
Data packet lengths	Option 1: 56 bits Option 2: 72 bits Option 3: 88 bits Option 4: 152 bits
Message CRC polynomial	$G(x)=X^{12} + X^{11} + X^3 + X^2 + X + 1$
CRC polynomial initialized value	0x001
Blink interval	Programmable, 5 s minimum
Blink interval randomization	± 638 ms maximum
Number of sub-blinks	Programmable, 1 - 8
Sub-blink interval randomization	125 ms ± 16 ms maximum
Maximum Frequency Drift	< ± 2 ppm over the duration of the entire message
Phase Accuracy	< 0,50 radians within any 33 μs period
Phase Noise	< 15 degrees when the noise is integrated from 100 Hz to 100 kHz

Table 2 — RTLS transmitter OOK link parameters

Parameter Number	Parameter Name	Description
O 1a	Carrier frequency	2400 MHz – 2483,5 MHz
O 1b	Operating frequency accuracy	± 25 ppm maximum
O 1c	Centre frequency	2441,750 MHz
O 2a	Data encoding	Differentially encoded
O 2b	Data packet lengths	Option 1: 88 bits Option 2: 184 bits
O 2c	Message CRC polynomial	$G(x) = X^{16} + X^{12} + X^5 + 1$
O 2d	CRC polynomial initialized value	0x0001
O 3	Transmit power	Class 1: 10 dBm EIRP max. Class 2: Max. per local radio regulations
O 4	Transmit spurious emissions, out of band	Within local radio regulations
O 5	Modulation	OOK/FSK, using 2 tones @ 376,8 kHz /535,5 kHz
O 5a	Logic “0”	19 cycles at a 377 kHz rate of 2,44652 GHz on/off

Parameter Number	Parameter Name	Description
O 5b	Logic “1”	27 cycles at a 535 kHz rate of 2,44652 GHz on/off
O 6	Data rate	19,83 kb/s
O 7	Duty cycle	50%
O 8	Data error rate	0,001% max.

Table 3 — RTLS transmitter magnetic link parameters

Parameter Number	Parameter Name	Description
M 1	Signalling frequencies	114,688 kHz and 126,976 kHz
M 2	Field strength	Regulatory/application dependent
M 3	Bit data rate	2,048 kb/s
M 4	Symbol period	244,14 ms
M 5	Data error rate	0,001%
M 6	Start sync	3 symbol periods @ 114,688 kHz followed by 3 symbol periods @ 126,976 kHz
M 7	End sync	3 symbol periods @ 126,976 kHz followed by 3 symbol periods @ 114,688 kHz
M 8	Data bit 0	1 symbol period @ 126,976 kHz followed by 1 symbol period @ 114,688 kHz
M 9	Data bit 1	1 symbol period @ 114,688 kHz followed by 1 symbol period @ 126,976 kHz
M 10a	Programmer packet lengths	Option 1: 10 bits Option 2: 48 bits Option 3: 64 bits Option 4: 68 bits Option 5: 144 bits Option 6: 160 bits
M 10b	Exciter packet lengths	Option 1: 10 bits Option 2: 28 bits Option 3: 44 bits Option 4: 144 bits
M 11	Data encoding	Manchester encoding
M 12a	Programmer message CRC polynomial	$G(X) = X^{12} + X^{11} + X^3 + X^2 + X^1 + 1$
M 12b	28 bit exciter CRC polynomial	$G(X) = X^8 + X^4 + X^3 + X^2 + 1$
M 12c	44 bit exciter CRC polynomial	$G(X) = X^{12} + X^{11} + X^3 + X^2 + X^1 + 1$
M 12d	10 bit programmer / exciter CRC polynomial	$G(X) = X^4 + X^1 + 1$