CODE STRUCTURE STANDARD FOR RF IDENTIFICATION OF ANIMALS

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Abstract: Radio Frequency Identification can be used to identify animals. In order to guarantee exchangeability of reader and transponders a standard is required. ISO standard 11784 defines the structure of the information content of the transponder. The 64 bits of code are split into: 16 bits for special purposes; 10 bits refering to the issuing country or the manufacturer of the transponder; and 38 bits of code containing a serial number. The combination of country/manufacturer's code and serial number form a world wide unique identification number of the animal. This number can be used to retrieve information on an individual animal.

Keywords: ISO, Standardisation, RFID, Electronic identification, Animal Identification, Code structure

1. INTRODUCTION

Radio frequency identification (RFID) is an effective method to identify animals (Hanton, 1974, Hurst, *et al.*, 1983, Kuip, 1987, Merks and Lambooij, 1990). It is based upon a micro-electronic device (transponder) connected to the animal and a reading device. The transponder is passive, which means that it does not have an internal power source. It is activated by an electromagnetic field transmitted by the reading device. Upon activation the transponder transmits a unique code. This code is received by the reading device and can be used to identify an animal. Because of its small size—the smallest one, the so called micro transponder, is cylindrical shaped with a length of 11 mm and a diameter of 2 mm—and the fact that no line of sight is necessary between the transponder and the reader, the transponder can subcutaneously be inserted into the animal (Lambooij, 1991). In this way it does not hamper the animal, it does not degrade its appearance and is highly resistant against fraud.

A number of different manufacturers sell RFID systems. Unfortunately these systems, up till now, were not interchangeable. A transponder of one make could not be read by the reader of another. This incompatibility of systems allowed RF identification of animals only in well defined small scale

applications, like zoo animals. To make it useful in applications like husbandry animals, systems needed to be interchangeable. This called for an international standardisation initiative, which was started in 1991 by ISO. A Working Group (WG3) under ISO-Technical Committee 23 (TC23), Sub-Committee 19 (SC19) was instituted to define a standard for RFID in agricultural applications.

To make transponders and readers interchangeable, the standard must first define how the information is stored in the transponder. Secondly it must be specified how reader and transponder can communicate to correctly transfer the information stored in the transponder to the reader.

In May 1994 the first edition of the standard on the code structure (ISO 11784, 1996) was published. Its field of application was the identification of agricultural animals. Other categories of animals (zoo animals, companion animals and laboratory animals) also had started to use RFID systems for identification and wanted to have standards. WG3 was asked to investigate if a uniform standard would be feasible. In February 1995 a revision of ISO 11784 was accepted as a Draft International Standard (DIS). An overwhelming majority of members countries have approved it. After some minor editorial changes the revised ISO 11784 will be published and come into force.

2. GENERAL

The standardised transponder can accommodate 64 binary bits of identification code. Apart from these 64 bits, additional bits—e.g. header, error detection, trailer—are needed to guarantee correct reception of the data. Since these bits are related to the technical concept they are described in the second standard (ISO 11785, 1996). Within the 64 identification bits a code must be stored that world-wide can identify an animal uniquely. If somebody finds an unknown animal the identification code must make it possible to obtain certain details of the animal, like the current owner, the history of the animal, etcetera. This means that the code must provide keys to retrieve this information. Consequently the 64 bits of code need to be split up into different fields, each with a well defined meaning.

In general it can be said that all proposals for code structures start off with fields for a country code, a manufacturers code, a species code, a race code, a year-of-birth code, a category code, a farm code, a gender code, etc. in combination with an individual number code. The code, however, can not be changed after application of the transponder. The meaning of fields must therefore be stable in time. For instance a category code (husbandry animal / companion animal / zoo animal / laboratory animal) is not a good component of a code because an animal can change categories (a laboratory guinea pig can become the companion animal of the caretakers child). Also, the meaning of a field must be uniform all over the world. Some animals are regarded to belong to one category in one country while they belong to another category in another country. Most importantly, fields in the code must make sense, must add functionality to the code.

Working Group 3 decided to define only those fields necessary to effectively retrieve the information. In the end it was concluded that a country or manufacturers code in combination with an individual identification code should suffice. The world-wide unique identification number of an animal comprises a 3 digit country code (10 bits) and a 12 digit individual identification code (38 bits). The rest of the bits have been used for administrative purposes or have been reserved for future use. These bits are not part of the identification code.

3. APPLICATION BIT — BIT 1

Working Group 3 foresees a future in which many objects in our direct surroundings are identified by means of radio frequency tags. These devices may very well be based on the same circuitry as is used in the animal

transponders. To prevent that a reader inadvertently reads the tag of a nearby object instead of the identification tag of the animal, WG3 assigned the first bit in the code to be a rudimentary application identifier. If the first bit of an RFID code is binary **1** the transponder identifies an animal; if it is binary **0** it is part of a different application.

WG3 realises that unilaterally defining an application identifier is not very effective. The new Sub-Committee 31 of ISO/JTC1 on Automatic Data Capture could undertake the task to define an application identifier code for different RFID applications.

4. RESERVED CODE — BITS 2–15

Fourteen bits have not been given a meaning. These bits are reserved for future use. Working Group 3 anticipated that in the near future certain legislative bodies might have need for additional means to include specific information in the transponder. Also a standard on application identifiers would need more than one bit. To be able to accommodate these needs, the bits 2–15 have been reserved.

The reserved code has been placed directly behind the applications bit to optimally be able to accommodate the application identifier. If the responsible committee would be willing to assign the code with bit 1 **1** and the rest of the bits **0** to the animal application, all transponders in conformance with ISO 11784 and used for animal identification would already be compatible with this system.

User groups have an urge to distinct themselves from the other applications. Having WG3 assign a bit of reserved code to their application is viewed as an effective way to make such a distinction. Up till now Working Group 3 has not done this for several reasons. It is usually not economical to make distinctions. With a distinction transponders are manufactured in smaller series, more series must be kept in stock and a more elaborate logistical system must be maintained to have the right transponders delivered to the right customers. And what happens if, inadvertently, the wrong type of transponder is injected in an animal? Most importantly, the world wide unique identification code comprises the country or manufacturers code and the individual identification code (bits 17–64). The reserved bits are *not* part of the identification code. By distinguishing only in the reserved code, two animals could have the same country or manufacturers code and individual identification code. There must also be a distinction within one of these codes. But in that case the distinction in the reserved code is not necessary anymore.

5. FLAG FOR ADDITIONAL DATA BLOCK BIT — 16

The current transponder is a read-only transponder. The user can not change the code. Already during the standardisation of these transponders, especially in industrial applications, transponders with extended possibilities became available. The Working Group took these future transponders into account by assigning one bit to flag for these types of transponders.

A transponder with the flag for additional data blocks **1** would have more memory space available. The reader must know in the first read that extra information, appended to the 64 bits can be expected, in order to correctly process this information.

6. COUNTRY CODE — BITS 17–26

The basic function of identification of animals is to retrieve the information of an unknown animal. The best way to achieve this would be to have one database in which all the identification codes of all the animals identified world wide would be stored, together with a reference to a database where the information can be found. WG3 did not think that this would be feasible. The Working Group therefore decided to introduce one field in the identification code,

which specifies the country in which the transponder was issued.

To distinguish between different countries ISO has defined a standard: ISO 3166 (ISO 3166, 1993). The three digit numerical code was chosen to specify the country in the identification code. This code can be coded in a field of 10 bits. The numerical codes are always smaller than 900. Individual users can assign a specific meaning to the codes above 900. The next section will describe the use of these codes in the animal identification application. A code of 999 has a very specific meaning: it signals that this transponder is a test transponder and that its identification code may not be unique.

7. MANUFACTURER'S CODE — BITS 17–26

The previously described country code works fine in countries that have a central database available to guard the uniqueness of the individual identification codes of the transponders issued, but, more importantly, that can fulfil the directory function if the information on a specific animals is to be retrieved. Unfortunately, at this point in time, such countries are rare. To overcome this problem Working Group 3 has accepted a proposal of the manufacturers to be able to exchange the country code for a code identifying the manufacturer of the transponder. A manufacturer is every individual organisation that can program the code in a transponder. When the manufacturer's code is used instead of the country code, the manufacturer has become responsible for the uniqueness of the code. The manufacturer must also maintain a database, accessible from outside, to redirect queries for information to the right sources.

Since country codes from 900 up are not used to identify countries, these codes can be used to identify manufacturers. To make this system work, some organisation must administer the codes. The International Committee for Animal Recording (ICAR) has volunteered to do so. A system is now operational with which a manufacturer of transponders conforming to the standards ISO 11784 and ISO 11785 can apply for a manufacturers code. The use of the code is governed by very specific rules.

The concept of a manufacturers code is meant to be temporary to overcome the transition period in which the national central databases were set up. As soon as a country has a logistical system in place with which it can guarantee the uniqueness of the individual identification codes and can redirect queries for information to the proper decentralised database, the use of manufacturers codes in that country should cease and the appropriate country code should be used.

8. INDIVIDUAL IDENTIFICATION CODE — BITS 27–64

The individual identification code has been devised to be a unique serial number within the country. The 38 bits constitutes a series of 274.877.906.944 combinations. Represented in decimal format it has 12 digits.

Working Group 3 has refrained from defining a structure within this number. Different countries can tailor the series to their own needs. WG3 anticipates that there will be countries that will allocate part of the series to certain species or categories of animals; other countries will split it up over organisations that maintain databases and/or issue identification numbers; whereas some countries may want to fall back on the database maintained by manufacturers and assign part of the series to specific manufacturers.

The size of the field was determined by estimating the number of animals to be identified in a large country, taking into consideration an average maximum lifetime of an animal of 30 years. This means that the series must be able to last for 30 years. Splitting the series up into smaller series will result in inefficiency in the use of the combinations. Some codes in a sub-series assigned to a small application will not be

used. Also, some animals may live longer that 30 years (turtles in a zoo). By the time the combinations in a country are exhausted a solution for long living animals must have been found. Although it can be expected that the technology described in the standards by then will have been replaced.

9. LOGISTICAL SYSTEMS

Identification of animals using RFID systems only make sense when information technology infra-structures are available. At the application level (e.g. a home, a veterinary practice, a zoo, a farm or a slaughterhouse) a database must be maintained in which the identification code of an animal is associated with information on that particular animal. The type of information and the amount will vary greatly between different applications. Normally one will see the most complete information stored at this level. Unfortunately, these databases will generally not be accessible from the outside.

The RFID system can be used to automate certain processes. On dairy farms automatic identification of the cows in the milking parlour makes it possible to monitor the individual production of the animals (Buck, *et al.*, 1987, Artmann, 1993). Feeding stations will supply individual rations to animals correlated with their individual production rate. Linked into the farm management system, interesting correlations can be made (Hansen, *et al.*, 1983). Cats with RFID transponders can have cat doors that will only open for the right cat. When animals get transported a stationary reader at the entrance of the van can administrate exactly which animals were loaded. The same reader can also monitor the unloading. All this information can be transferred to the right organisations by Electronic Data Interchange (EDI). Billing can thus be done automatically.

At an intermediate level (e.g. a breeders organisation or a milk recording organisation) very specific information will be stored. The most common reason for storing information at this level is to build histories of individual animals (e.g. heritage, ownership, production rates, etc.). In some countries these organisations may be authorised to issue transponders. The databases at this level will be accessible from the outside.

At the highest level (country or manufacturer) a master database must be available, in which all the individual identification codes issued so far are stored, together with a reference to a database in which basic information on the animal can be found.

When an animal gets found somewhere and the owner needs to be located, the identification code will be read. The code will be transferred to a computer. From the country or manufacturers code the computer can automatically be connected to the computer in which the master database is stored. Looking up the individual identification code in this database will provide an address of the computer with the intermediate database. After making the connection to this computer the name and address of the owner can be retrieved. This process can be automated completely and will take only seconds to complete.

10. DISCUSSION

Up till now, the system defined in ISO 11784 has only been used in small scale applications. Especially the logistical systems on a national or intermediate level have not been implemented yet. Much will depend on the discipline of the users of these systems. Information on important mutations in the status of individual animals must be reported to higher level recording organisations. This may be feasible in industrialised countries with a good logistical system and many checks along the way; it may prove impossible to attain in some less developed countries.

The RFID system defined in ISO 11784 and ISO 11785 have limited possibilities. The user can not change the contents of the transponders. The new types of transponders

will have additional code pages. Certain parts of these additional pages can be programmed by the user. In future transponders can also contain sensors to monitor certain parameters in the animals. To define a flexible structure for these new generations of transponders is the next work item of Working Group 3.

11. CONCLUSION

The code structure defined in ISO 11784 provides a suitable means to identify animals and to retrieve the information on an individual animal world wide. It does so with only one field that has a meaning combined with a serial number, thus maintaining optimal flexibility of the system. Different countries can devise a substructure in the serial number to suits their needs. Apart from the identification code of 48 bits, 16 additional bits have been defined. Two of them already have been given a specific meaning (animal application and extra data block); the remaining bits have been reserved for future use. If necessary these bits can be used for specific purposes. The 16 additional bits are not part of the identification code.

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