RFC 2 - Boolean Value Encoding in Transmission Protocol

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Contents

1 Introduction

We would like to find a way to encode a binary value in each transmission along with the UID. The encoding must not interfere with our current collision detection work and should not require a massive overhall of the transmission protocol as it currently stands.

2   Background

Patrick has requested that we look into adding the ability for a transmitter to broadcast some additional detail about the crab it is paired with. Specifically, Patrick is interested in attaching accelerometers to the tagged crabs so that we can determine if a given crab is "inert," perhaps because it has molted its shell or because it has died. We would encode this as an additional binary value in the transmission signal.

Patrick has stated that this is a highly desirable feature, but not absolutely critical to the end product.

3   Requirements and Concerns

We want to be able to encode both a UID and some binary value in each transmission without losing the work we've done to ensure that all collisions are detectable. Additionally, in the event that we decide not to include this feature in the final product, the changes made to the iCRAB protocol must not interfere with our original goals. That is, if we scrap this requirement, it should cost little or no extra work to continue on our original path.

We have already created a protocol that will encode a UID and is robust against collisions (that is, they are detectable). For more information on how this works, see RFC 1 Section 4.4. Some methods for adding binary encoding may interfere with the this collision detection work, and we would prefer that such solutions be avoided. In other words, collisions should still be detectable, at least in most cases, even if addition information is encoded in the signal.

4   Potential Solutions

In the case that the given boolean value that we wish to express is **false**, we may broadcast the original signal with no adjustments. We next propose alterations we could make in the case that the given boolean value we with to express is **true**.

4.1   Add Additional Ping

In this solution, a single UTP would be represented as a sequence such as P_P_P where P is a ping and $\_$ is a delay.

While this would work in the general case, it adds some additional complexity to the receiver's detection code. Worse, it may cause collisions to be undetectable under certain circumstances. We will not discuss these situations, but they are easily discoverable and therefore left as an exercise to the interested reader. (Hint: if a collision occurs such that the first or third ping is affected, the receiver may reasonably assume that it detected two collision-free pings and would therefore report a standard, non-inert transmissions.)

4.2 Adjust Duration of Both Pings

One variation of this is essentially double the number of IDs we can encode. Half of the IDs are unchanged. The other half of IDs (eg the larger IDs, or the even-numbered IDs, or something along those lines) are reserved for transmitters to use when their boolean value has become TRUE.

For example, suppose we have 500 unique IDs, but choose to only assign the even-numbered IDs. The odd-numbered IDs could then be used for existing transmitters when their boolean value B is TRUE. Then transmitter 42, for example, would transmit the number 42 while b was false. Once b becomes true, that transmitter will start transmitting the value 43. Since 43 is an odd number, the receiver could easily deduce that transmitter 42's b value was TRUE.

Alternatively, suppose we have, for example, 500 IDs, and we assign 0-499 to transmitters. We then use values in the range 500-999 only when b is TRUE. That is, transmitter 42 would transmit 42 when $b =$ FALSE and 500+42=542 when $b =$ TRUE.

4.2.1 Benefits

This method requires very little adjustment to the encoding protocol. Instead, it would require only a small adjustment to how we interpret ID values as they are detected.

4.2.2 Drawbacks

Unfortunately, this method does double the number of IDs we need to be able to encode, which means that the max UTP duration will be much higher. This could potentially lead to more collisions. This solution is also potentially confusing, as the encoding is not obvious and it relies to some degree on magic numbers.

4.3 Adjust Duration of Only One Ping

In this scenario, we would make the length of one ping considerably larger than the other ping in a UTP. This long tone (herein referred to as an **inert tone**), like the delay and second ping, would encode the UID of the transmitter (that is, its length would be determined by the UID). However, it would also indicate that the given transmitter was in the inert state, as it would be longer than a standard ping for that UID. See Figure 1 for an illustration.
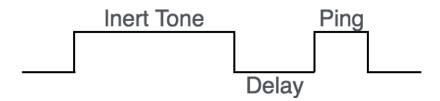

Figure 1: An example of a UTP with an "inert tone" in place of the first ping.

In this solution, we would still be able to detect collisions because the pings and delay would have mathematically-determined values, and any collision could cause one or more of those values to be altered, meaning that they would no longer be copacetic.

4.3.1 Benefits

This method does not require a change to *standard* UTP formatting, and removal of the boolean value encoding requirement would not affect previous work.

This method is resistant to collisions, so long as the appropriate restrictions are placed on the duration of each inert tone.

A UTP with an inert tone is clearly distinguishable from a standard UTP. This means that there is no arbitrarily-defined distinction between standard and inert UTPs. For instance, a simple visual inspection of a given UTP could quickly and easily determine if a UTP came from an inert transmitter or not.

Because the inert tone is considerably longer than most other transmissions, this method may cause the battery in the transmitter to die sooner. Since there is no need to repeatedly record the location of a transmitter that does not move, this may conveniently lead to the inert transmitter ceasing its transmissions earlier than it otherwise would. This is speculation and will depend on the actual hardware performance, though, so it is only a small consideration.

4.3.2 Drawbacks

The total duration of a UTP with an inert tone would be considerably longer than a standard UTP, which means we may have more collisions.

This method will also require additional processing and calculations by the receiver, though the same may be said of *almost* any other alternative.