UCLouvain

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LINFO2146
Mobile and embedded project

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Value	Signification
0	Sensor
1	Coordinator
2	Border

Table 1: Values for Node field

Value	Signification
0	Discovery
1	Message
2	Synchro

Table 2: Values for Msg field

1 MESSAGE FORMAT

We consider two possible formats.

1.1 Default

```
    2      2        12              32
+------+------+-----------+--------------------+
| Node | Msg  |  Payload  |       Clock        |
+------+------+-----------+--------------------+
```

The `node` is on two bits. The value indicates which type of node the sender is. The `msg` is also on two bits. The value indicates the type of the message that is sent. The considered values are summarized in the tables 1 and 2.

Discovery messages are used for building a tree.

Synchro messages exchange clocks between the border and coordinators, communicate slots to the coordinators and signal the death of a parent to the children.

As for the *Message* type, it is used for exchanging data counts (by the children to send the data, or by the coordinator/sensor parents to ask children their data count)

1.2 Extended

```
    2      2        12              32                  32
+------+------+-----------+--------------------+--------------------+
| Node | Msg  |  Payload  |       Duration     |       Clock        |
+------+------+-----------+--------------------+--------------------+
```

An extended message format was considered for when the border sends slots to coordinators. This extended format allows us to transmit, at the same time, the slot assigned (in the payload field), the duration (an additional field of 32 bits), as well as the network clock. Given those 3 elements, the coordinator can then schedule its cycle for the next period.

2 ROUTING

2.1 Coordinator and border

The border broadcasts a discovery message to signal its presence. The coordinators respond to it with a unicast discovery message. The border then adds the responding coordinators to its list of children. At the end of a period, it forwards a unicast SYNCHRO message to each of the coordinators it discovered.

The duration of the slot is halved when it is too high given the number of coordinators. This check is performed whenever a new coordinator responds to the discovery broadcast of the border. The adapted duration is later used at the end of the period when scheduling slots for the next period. Note that the additional nodes do not receive a slot for the current period, preventing overlaps.

The duration of the slot is not increased when coordinators fail. We assumed the number of coordinators would not be decreased in the long term so that it is acceptable for the application at hand.

2.2 Coordinator and sensor

Sensors send broadcast discovery messages to find a parent. Sensors and coordinators that have a parent (i.e. a way to the border) respond with a unicast discovery message. During a period, it considers the different responding candidates and keeps the best according to 2 criteria: the type of the node (first criterion), and the strength of the signal (second criterion). And finally, send a unicast discovery to the chosen parent to indicate his choice.

2.3 Failures from parent

The children (coordinators and children) should receive a message from their parents during each period. So, a process periodically checks the time since the last message was received from the sender. If this time exceeds some threshold (5 periods), the parent is considered to have failed and the node will look for a new parent. Before doing so, it advertises its children from the connectivity loss, so that they don't remain connected to a node that cannot forward messages to the border. To do so, the parent broadcast a *SYNCHRO* message with a special value as payload.

When a child receive that kind of message from his parent, it also informs his children of the loss.

2.4 Failures from children

To detect failures from children, a parent node stores, for each child, a clock representing the time of the last message of the child. As messages should be exchanged every period, we detect a child as failed if it has not sent any message for more than a certain amount of periods. This amount was fixed to 10 to prevent erroneous detections.

3 COORDINATION

3.1 Between coordinators

Border periodically gives a specific slot and the network clock to each coordinator, so that they don't overlap when retrieving/sending data counts.

The network clock is synchronized using an implementation of the Berkeley Time Synchronization Algorithm. Coordinators provide their updated network clock when responding to the broadcast discovery message (they do so only after they have joined the network and been previously given a slot so that they already received a network clock).

The network clock is updated periodically. The period was therefore fixed to 5 seconds (statement: "The elapsed time between two runs of the algorithm must not be more than 5 seconds.")

3.2 Between sensors

Polling was implemented: a coordinator/sensor parent iterates on its children in a round-robin fashion. Before requesting data count from a child, the parent checks whether it has enough time for the next network round trip. Some margin was implemented to prevent overlap when the coordinator responds to the border/

4 PRACTICALS

We brought two updates to the default environment :

- We modified the docker run command to open port 60001 for the Python server to be able to read the content written on the serial socket.
- We updated the constant `CSMA_MAX_NEIGHBOR_QUEUES` defined in *os/net/mac/csma/csma-output.c* to 8 instead of 2 so that we can send a sequence of unicast packets for distributing the slot on the border.