———————————— MODULE *DisasterWarningAndResponse* ————————————

EXTENDS *Integers*, *Sequences*, *TLC*, *Naturals*

--**algorithm** *DisasterWarningandResponse*

variables
  SensorMode = "Inactive",
  SensorConnectivity = "NotConnected",
  SnSensedDisaster = FALSE,
  SnTransmittedDInfo = FALSE,
  GwReceivedDInfo = FALSE,
  GwRelayedDinfoToBS = FALSE,
  GwRelayedDinfoToActuator = FALSE,
  BsReceivedDData = FALSE,
  BsBroadcastDInfo = FALSE,
  DisasterDetected = FALSE,
    Actuator variables
  ActuatorMode = "Inactive",
  ActuatorConnectivity = "Connected",
  ActuatorReceivedDInfo = FALSE

process *Sensor* = "sensor"
begin
  sensor_loop:
  while TRUE **do**
      Non-deterministically set sensor mode
    either
      SensorMode := "Active"
    or
      SensorMode := "Inactive"
    end either ;
      Non-deterministically set sensor connectivity
    either
      SensorConnectivity := "Connected"
    or
      SensorConnectivity := "NotConnected"
    end either ;
      Set *SnSensedDisaster* based on mode
    if *SensorMode* = "Active" **then**
      either *SnSensedDisaster* := TRUE**or** *SnSensedDisaster* := FALSE**end either**
     else
      SnSensedDisaster := FALSE
    end if ;
      Transmit data if connected
    if *SensorConnectivity* = "Connected" **then**
      SnTransmittedDInfo := *SnSensedDisaster*

1

```
      else
        SnTransmittedDInfo := FALSE
      end if
    end while
end process

process Gateway = "gateway"
begin
  gateway_loop:
  while TRUE do
    GwReceivedDInfo := SnTransmittedDInfo ;
      Relay to both BaseStation and Actuator in parallel
    GwRelayedDinfoToBS := GwReceivedDInfo ;
    GwRelayedDinfoToActuator := GwReceivedDInfo
  end while
end process

process BaseStation = "basestation"
begin
  bs_loop:
  while TRUE do
    BsReceivedDData := GwRelayedDinfoToBS ;
    BsBroadcastDInfo := BsReceivedDData ;
    DisasterDetected   := BsBroadcastDInfo
  end while
end process

  New Actuator process
process Actuator = "actuator"
begin
  actuator_loop:
  while TRUE do
      Actuator is always connected to gateway
    ActuatorConnectivity := "Connected" ;
      Receive disaster info from gateway
    ActuatorReceivedDInfo := GwRelayedDinfoToActuator ;
      Set actuator mode based on received info
    if ActuatorReceivedDInfo = TRUE then
      ActuatorMode := "Active"
     else
      ActuatorMode := "Inactive"
    end if
  end while
end process

end algorithm   ;
```

VARIABLES $SensorMode$, $SensorConnectivity$, $SnSensedDisaster$,
$\qquad\quad SnTransmittedDInfo$, $GwReceivedDInfo$, $GwRelayedDinfoToBS$,
$\qquad\quad GwRelayedDinfoToActuator$, $BsReceivedDData$, $BsBroadcastDInfo$,
$\qquad\quad DisasterDetected$, $ActuatorMode$, $ActuatorConnectivity$,
$\qquad\quad ActuatorReceivedDInfo$

$vars \triangleq \langle SensorMode$, $SensorConnectivity$, $SnSensedDisaster$,
$\qquad\quad SnTransmittedDInfo$, $GwReceivedDInfo$, $GwRelayedDinfoToBS$,
$\qquad\quad GwRelayedDinfoToActuator$, $BsReceivedDData$, $BsBroadcastDInfo$,
$\qquad\quad DisasterDetected$, $ActuatorMode$, $ActuatorConnectivity$,
$\qquad\quad ActuatorReceivedDInfo\rangle$

$ProcSet \triangleq \{$"sensor"$\} \cup \{$"gateway"$\} \cup \{$"basestation"$\} \cup \{$"actuator"$\}$

$Init \triangleq$ Global variables
$\qquad\quad \land\ SensorMode =$ "Inactive"
$\qquad\quad \land\ SensorConnectivity =$ "NotConnected"
$\qquad\quad \land\ SnSensedDisaster =$ FALSE
$\qquad\quad \land\ SnTransmittedDInfo =$ FALSE
$\qquad\quad \land\ GwReceivedDInfo =$ FALSE
$\qquad\quad \land\ GwRelayedDinfoToBS =$ FALSE
$\qquad\quad \land\ GwRelayedDinfoToActuator =$ FALSE
$\qquad\quad \land\ BsReceivedDData =$ FALSE
$\qquad\quad \land\ BsBroadcastDInfo =$ FALSE
$\qquad\quad \land\ DisasterDetected\ \ =$ FALSE
$\qquad\quad \land\ ActuatorMode =$ "Inactive"
$\qquad\quad \land\ ActuatorConnectivity =$ "Connected"
$\qquad\quad \land\ ActuatorReceivedDInfo =$ FALSE

$Sensor \triangleq\ \land\ \lor\ \land\ SensorMode' =$ "Active"
$\qquad\qquad\qquad\ \lor\ \land\ SensorMode' =$ "Inactive"
$\qquad\qquad\ \land\ \lor\ \land\ SensorConnectivity' =$ "Connected"
$\qquad\qquad\qquad\ \lor\ \land\ SensorConnectivity' =$ "NotConnected"
$\qquad\qquad\ \land$ IF $SensorMode' =$ "Active"
$\qquad\qquad\qquad\quad$ THEN $\ \land\ \lor\ \land\ SnSensedDisaster' =$ TRUE
$\qquad\qquad\qquad\qquad\qquad\qquad\ \lor\ \land\ SnSensedDisaster' =$ FALSE
$\qquad\qquad\qquad\quad$ ELSE $\quad \land\ SnSensedDisaster' =$ FALSE
$\qquad\qquad\ \land$ IF $SensorConnectivity' =$ "Connected"
$\qquad\qquad\qquad\quad$ THEN $\ \land\ SnTransmittedDInfo' = SnSensedDisaster'$
$\qquad\qquad\qquad\quad$ ELSE $\quad \land\ SnTransmittedDInfo' =$ FALSE
$\qquad\qquad\ \land$ UNCHANGED $\langle GwReceivedDInfo$, $GwRelayedDinfoToBS$,
$\qquad\qquad\qquad\qquad\qquad\qquad GwRelayedDinfoToActuator$, $BsReceivedDData$,
$\qquad\qquad\qquad\qquad\qquad\qquad BsBroadcastDInfo$, $DisasterDetected$, $ActuatorMode$,
$\qquad\qquad\qquad\qquad\qquad\qquad ActuatorConnectivity$, $ActuatorReceivedDInfo\rangle$

3

$Gateway \triangleq \land GwReceivedDInfo' = SnTransmittedDInfo$
$\qquad\qquad\quad \land GwRelayedDinfoToBS' = GwReceivedDInfo'$
$\qquad\qquad\quad \land GwRelayedDinfoToActuator' = GwReceivedDInfo'$
$\qquad\qquad\quad \land \textsc{unchanged} \langle SensorMode, SensorConnectivity, SnSensedDisaster,$
$\qquad\qquad\qquad\qquad\qquad\qquad SnTransmittedDInfo, BsReceivedDData,$
$\qquad\qquad\qquad\qquad\qquad\qquad BsBroadcastDInfo, DisasterDetected, ActuatorMode,$
$\qquad\qquad\qquad\qquad\qquad\qquad ActuatorConnectivity, ActuatorReceivedDInfo \rangle$

$BaseStation \triangleq \land BsReceivedDData' = GwRelayedDinfoToBS$
$\qquad\qquad\qquad \land BsBroadcastDInfo' = BsReceivedDData'$
$\qquad\qquad\qquad \land DisasterDetected' = BsBroadcastDInfo'$
$\qquad\qquad\qquad \land \textsc{unchanged} \langle SensorMode, SensorConnectivity,$
$\qquad\qquad\qquad\qquad\qquad\qquad\quad SnSensedDisaster, SnTransmittedDInfo,$
$\qquad\qquad\qquad\qquad\qquad\qquad\quad GwReceivedDInfo, GwRelayedDinfoToBS,$
$\qquad\qquad\qquad\qquad\qquad\qquad\quad GwRelayedDinfoToActuator, ActuatorMode,$
$\qquad\qquad\qquad\qquad\qquad\qquad\quad ActuatorConnectivity, ActuatorReceivedDInfo \rangle$

$Actuator \triangleq \land ActuatorConnectivity' = \text{"Connected"}$
$\qquad\qquad\quad \land ActuatorReceivedDInfo' = GwRelayedDinfoToActuator$
$\qquad\qquad\quad \land \textsc{if } ActuatorReceivedDInfo' = \textsc{true}$
$\qquad\qquad\qquad\quad \textsc{then } \land ActuatorMode' = \text{"Active"}$
$\qquad\qquad\qquad\quad \textsc{else } \land ActuatorMode' = \text{"Inactive"}$
$\qquad\qquad\quad \land \textsc{unchanged} \langle SensorMode, SensorConnectivity, SnSensedDisaster,$
$\qquad\qquad\qquad\qquad\qquad\qquad SnTransmittedDInfo, GwReceivedDInfo,$
$\qquad\qquad\qquad\qquad\qquad\qquad GwRelayedDinfoToBS, GwRelayedDinfoToActuator,$
$\qquad\qquad\qquad\qquad\qquad\qquad BsReceivedDData, BsBroadcastDInfo,$
$\qquad\qquad\qquad\qquad\qquad\qquad DisasterDetected \rangle$

$Next \triangleq Sensor \lor Gateway \lor BaseStation \lor Actuator$

$Spec \triangleq Init \land \Box[Next]_{vars}$

END TRANSLATION

4