ROUTING DIAGRAM FOR THE TRANSPORT OF VIDEO TRAFFIC IN A WSN

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ABSTRACT

The technology "sensor networks" is currently training an emerging area of research and has been the subject of numerous studies in recent years. The wireless sensor networks (WSNs) raises fundamental problems for the scientific community. These problems, in addition to the problems encountered in ad hoc networks classics, are due to wireless communications, the density distribution of nodes, the constraints of resources (energy, processor, and memory), the low reliability of nodes, and the highly distributed nature of the application and supported the mobility of nodes. These features specific to sensor networks systems are unreliable and whose behaviour is hardly predictable.
Currently, sensors equipped with cameras have emerged which will undoubtedly strengthen the monitoring application in all areas. However, applications of multimedia transport in WSNs are in embryonic stage and very little work has been done so far. A multimedia stream is characterized primarily by its needs delivered in terms of bandwidth, a scarce resource in WSNs.

The rapid development of multimedia technology and the commercial interest of companies to popularize this type of application, the quality of service (QoS) a sector of great importance. In addition, ensure QoS in such networks is very delicate. However, the unexpected change of topology may affect the continuity of service and makes it extremely difficult if not impossible. It is therefore legitimate to consider the reliability of roads as the main constraint on QoS to be considered for the transmission of video streams. The mission of routing is to determine the best path between the source and destination in the network according to a certain performance criterion.

This article presents a solution that allows to extend the protocol AODV (AODV: Ad hoc On-demand Distance Vector) to ensure the quality of service in terms of bandwidth for the transmission of video streams. The improvement we make is to define a function that maximizes the chances of selecting the road more easily repairable and therefore whose deadlines reconstruction will lowest since involve a re-routing local. In this decision-making phase, we seek to maximize the parameters contained in messages connection request reached the destination. These parameters are, for each route, the number of nodes involved the average density and the number of bottlenecks. But use of these data is not obvious. In this context, we must choose the road with the following characteristics:

-- The number of nodes lowest.
-- The average density strongest possible.
-- The number of bottlenecks lowest.

A road is even more difficult to repair a partial re-routing it involves long chains of nodes around which the density is low. A topology which contains such sequences is regarded as somewhat interesting because its maintenance is complicated. The local re-routing in case of failure of a node on these roads will be carried not effective. It will therefore more often carry out a re-routing more greedy in time and bandwidth that a local re-routing.

Keywords: WSNs; Flow multimedia; AODV; global Re-routing; partial Re-routing; Density; availability; bandwidth estimate; road Notation.

1 - INTRODUCTION:

The progress made in recent decades in the fields of microelectronics, micromechanics, and wireless communication technologies have yielded with a reasonable cost component of a few cubic millimetres in volume. The latter are called sensor nodes, include: acquisition unit responsible for collecting physical quantities (heat, humidity, vibration, etc…) and transform them into digital quantities, a processing and data storage unit and a module for wireless transmission [1] [2] [3]. As a result, the sensor nodes are real embedded systems. The deployment of several of them, to collect and transmit environmental data to one or several collection points, in autonomous form a wireless sensors network (WSNs). This technology is currently training an emerging area of research and has been the subject of numerous studies in recent years. The WSNs raise fundamental problems for the scientific community. These problems, in addition to the problems encountered in ad hoc networks classics, are due to wireless communications, the density distribution of nodes, the constraints of resources (energy, processor, and memory), the low reliability of nodes, and the highly distributed nature of the application and supported the mobility of nodes. These features specific to sensor networks systems are unreliable and whose behaviour is hardly predictable.

Currently, sensors equipped with cameras have emerged which will undoubtedly strengthen the monitoring application in all areas. However, applications of multimedia transport in WSNs are in embryonic stage and very little work has been done so far. A multimedia stream is characterized primarily by its needs delivered in terms of bandwidth, a scarce resource in WSNs [4].

The rapid development of multimedia technology and the commercial interest of companies to popularize this type of application, the quality of service (QoS) a sector of great importance. In addition, ensure QoS in such networks is very delicate. However, the unexpected change of topology may affect the continuity of service and makes it extremely difficult if not impossible. It is therefore legitimate to consider the reliability of roads as the main constraint of QoS to be considered for the transmission of video streams. The routing is a method of delivery of packages to the correct destination through a network. The mission of routing is to determine the best path between the source and destination in the network according to a certain performance criterion. Because of the limitation of the scope of radio transmission, the packets in the network can be transported through multi-hops. The search for paths and routing become essential mechanisms to support multi-hops radio transmission. In addition to the change in the topology makes the problem of connectivity and routing true challenges.

The chosen orientation is to extend the protocol AODV to ensure the quality of service in terms of bandwidth for the transmission of a stream multimedia. How to build a path and while maintaining a satisfactory quality of service required by an application of multimedia in the context of WSNs? What metric considered for routing?

2 - WIRELESS VIDEO SENSORS NETWORK (WVSN):

One or more nodes is equipped with cameras, which runs east to capture a stream of multimedia from physical world. There are many applications that deal with audio or video and therefore imply that the challenges inherent in multimedia in terms of reliability and time constraints, among others. This explains the need that we have today to develop research on multimedia communication in sensor networks [4][5]:

- Monitoring and object recognition.
- Locating and tracking objects.
- Security
- Domotique

3 - PROBLEMS OF TRANSMISSION OF VIDEO WVSN [10] [11]:

- The amount of data to send is much greater than in traditional applications.
- Techniques such as the aggregation of data are difficult to use.
- The conventional compression algorithms are not applicable to WSNs.

4 - FACTORS INFLUENCING THE DESIGN OF VIDEO SENSOR NETWORKS:

The design of sensor network is influenced by several factors such as fault tolerance, adaptability, cost and operating environment, network topology, material constraints, media transmission and power consumption. On the other hand, multimedia applications have complementary factors that affect multimedia communication in WSNs as bandwidth demand ,multimedia coding techniques, specific requirements of applications (the delay, jitter and the error rate or losses,…) [4] [5] [6].

5 - ROUTING IN AD HOC NETWORKS:

The WSNs are considered as a special type of ad hoc networks. An ad hoc network is a set of mobile nodes that are dynamically and arbitrarily scattered where the interconnection between the nodes may change at any time. In most cases, the unit destination is not necessarily within the scope of the unit source implying that the exchange of data between any two nodes must be done by intermediate stations [13] [14] .

The routing strategy is used in order to discover the paths between nodes. The main purpose of such a strategy is the establishment of roads that are correct and effective between a pair of any units, which ensures the exchange of messages. Limitations of ad hoc networks, construction of roads must be made with a minimum of control and consumption of bandwidth. There are two large families of routing protocols: the protocols based on the state of links, and those based on distance vector.

Depending on the way of roads creation and maintenance during the delivery of data, routing protocols can be separated:

- Proactive: The protocols establish proactive roads in advance based on the periodic exchange of routing tables.
- Reactive (on demand): The protocols reagents seek roads at the request
- Hybrid: hybrid protocols define two areas where they combine proactive inside a zone and reactive between zones.

6 - ROUTING WITH QUALITY OF SERVICE:

In the field of networks, the concept of quality of services is referred to describe the network's capacity to provide a service. The performance of a network is a fundamental and necessary element for the use of applications, including multimedia applications [12].

The QoS level of a network is divided into five parameters:

- The flow commonly called "bandwidth" represents the resource occupied transmission or receiving a flood. The bandwidth management is an important element for ensuring the quality of service.
- Latency is defined by the transfer deadline end of a package of a flood. The interactive applications have a maximum tolerable latency. If a package is undergoing a significant delay, beyond the tolerable value, the data it contains become unnecessary for the application.
- The jitter is the variation of latency packages. The main cause of the outbreak of jitter in the waves comes from changes in intensity of traffic on the links output switches.
- Loss of package: It occurs when there are errors on data integrity. The packet loss occurs mainly when the intensity of traffic on the links output becomes greater than their capacity to flow. It is an indication of congestion
- Desequencing: This is a modification of the order of arrival of packages.

7 - THE INITIAL PROTOCOL:

It is the AODV routing protocol. We chose the AODV routing protocol because the protocol lends itself best to incorporate the improvement that we offer. Moreover, this choice has been strengthened by the fact that this protocol has been widely studied in the literature [13] [14].

The AODV is based on the use of two mechanisms «Discovered and reservation of roads and maintenance of the roads, in addition to routing node-by-node, the principle of sequence numbers and the periodic exchange of DSDV. The AODV uses the principles of sequence numbers in order to maintain consistency routing information. Because of the mobility of nodes in ad hoc networks, roads frequently change so that the roads maintained by some nodes, become disabled. The sequence numbers can use the roads in new or in other words, the more fresh roads. The AODV uses Road Request in order to create a path to a certain destination.

However, AODV maintains roads in a distributed manner keeping a routing table, at each node transit belonging to the path sought.

If a new road is necessary, or a road disappears, the updating of these tables is done through the exchange of three types of messages between nodes:

• Road Request (RREQ), a message asking Road.
• Road Reply (RREP), a reply message to a RREQ.
• Road Error (RERR), a message that signals the loss of a road.

7-1 Discovered and reservation of roads: With the reception of a request for connection for a destination given with a requirement of the quality of service expressed in term of band-width, the source initiates the process of routing. It sends to all its neighbours a request for connection towards the destination. The nodes which receive the message for the first time and which fulfils the requirements of band-width propagate the request with their vicinities. This message of connection is propagated thus in the network until the destination. When the destination receives the message of request for connection of the source, it sends a message of reservation and confirmation along the found road. As soon as the source receives this message of reservation, connection is established and the communication can start.

7-2 Maintenance of the roads: Because of mobility (failure) of the nodes responsible for the transmission for the data between source and destination, the risks of road rupture before the end of the communication are very important. In the event of problem of rupture of link or failure of node in the course of communication, there then exist two scenarios for the re-routing:

a) **A global re-routing** starting from the source of the communication. This re-routing is implemented in the majority of the protocols of routing, although it takes an important time and consumes much band-width.

b) **A partial re-routing** starting from the node where the failure took place. This partial re-routing is of the interest to be fast and to consume little band-width.

When a source wishes to send a package of data to a destination and that it have the road to reach it with the good constraints of QoS, it starts to send the packages to the next node identified in the table of routing recovered of the phase of detection of road. To the reception of a package, each intermediate node of the road sends to the preceding node a defendant of good reception then the retransmit with the following node of the road. If the link towards the following node is broken, the node initiates the phase of repair of road. This phase is based on a total or partial re-routing [15]. A rupture of link is detected by the node upstream broken link. Information on the rupture of link can be provided by protocols of sub-layer. For example, the protocol IEEE 802.11 of the connection layer can deal with this operation.

a- Global re-routing: If, at the time of the routing of a package of the source towards the destination, a problem of rupture of link appears, the node which detects it propagates an error message until the source. The source then initiates a new phase of discovered road towards the destination. This phase of re-routing presents the disadvantage of being long. This disadvantage is all the more awkward for a connection with requirements of QoS expressed in the form of maximum delay. The risk is then to exceed the maximum delay and thus not to more check the criterion defined at the time of the establishment of connection. Another disadvantage of the total re-routing is that it overloads the network with many messages of routing. It results from this a wasting from band-width prejudicial to the performance of the network.

b- Partial re-routing: The partial re-routing constitutes an alternative to the total re-routing. When a node detects an anomaly in the link, it systematically any more does not send an error message to the node source. It keeps in memory the package which it could send as well as the following packages only the source of the communication continues to send, in parallel, it takes care itself of the repair of the road then of the retransmission of the packages towards the new nodes integrated into the road. The principle is to find a road until the destination. One is inspired for that by the procedure by total re-routing. The node thus emits packages of search for road. The difference lies in the fact that, in this case, the re-routing is carried out more meadows of the destination. One can thus limit the surface of prospect ion and thus the number of re-emission of the packages of search for road. In addition this stage is faster than in the case of total re-routing because the node is near to the destination. In the event of rupture of road, a specific package of re-routing (Road Request: RReq) is thus diffused. The diffusion of this package is limited by a meter decremented on each arrival of the package of re-routing in a new node. When the meter passes to zero, the package is not repeated any more. The found way must fulfil the requirements of QoS. Once the node destination receives the RReq package and that it agrees to restore connection, it turns over a package of validation (Reply Road: RRep). Let us consider the case of the figure1 the case a) represents the road such as it is before the detection of the failure. With the case b) the node D detects a failure of the link between D and G. according to the local procedure of re-routing; the case c) D diffuses a RReq package. To the reception of this package, J turns over to D a RRep package. This package forwards by I, G and F.

when D receives it, the road is repaired and the communication can begin again. To decrease the default risks in the course of communication, one can choose to use the most reliable possible road, c' be-with-to say that for which the risks of rupture are tiny. Another solution however consists in selecting an easily reparable road, a road whose risk of rupture is not inevitably minimized but whose repair is easy. A road is easily reparable when it can be repaired by a local re-routing. The implementation of local repairs to the chances of success raised is ensured by the taking into account of a new parameter: density of the nodes along a given road.

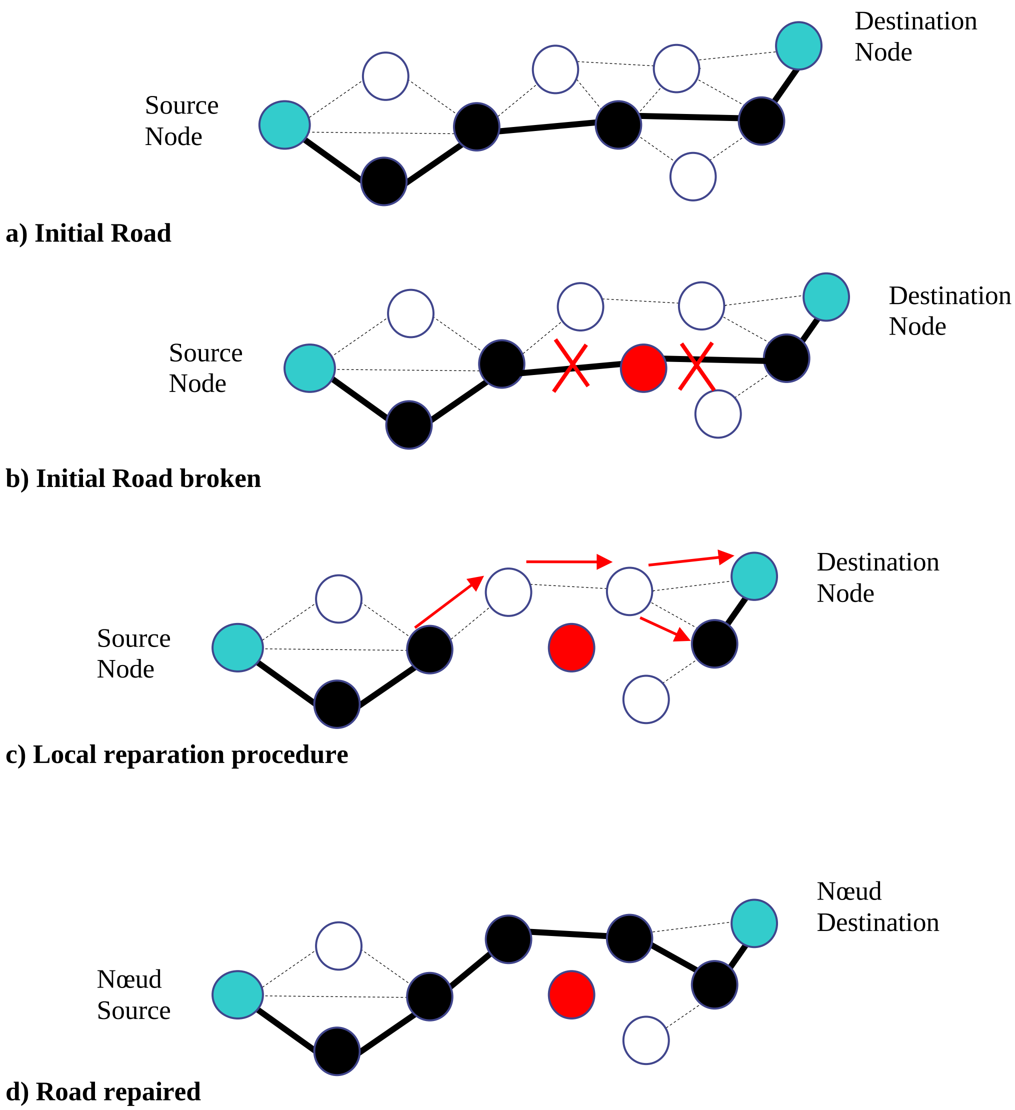

Figure 1: Restoration of road per partial re-routing

8- PROTOCOL IMPROVED OF DISCOVERED ROADS:

The objective of the made modifications is to ensure the selection of the road most easily reparable among those released at the time of the phase of discovered roads. To achieve this goal, one takes into account the nature of the vicinity of the nodes of the network, and in particular the density of nodes, like their availability. The repair of road in the event of failure of a node is carried out by the avoiding and implementation of a local procedure of re-routing, thus expensive complete re-routing in band-width and execution time, thus improving the deadlines of communication.

8-1 the availability: The problem is up to what point to determine a node belonging to a road between a given source and a destination and immediately neighbour to another node (radio range) can be replaced by this last if it would undergo a failure. It is necessary in particular that the node of replacement has channels of communication of sufficient band-width to ensure this new connection. One uses the parameter availability then to establish if such node is able to replace such other node. For summary, one can say that the availability corresponds to the free band-width on the level of a node on these channels of communication. So that each node has information on the availability of its neighbour nodes, it is necessary to envisage the regular exchange between neighbours of the data concerning their availability.

8-2 Estimate of the band-width: Two methods are possible to consider the band-width. The first consists to listen to the support of transmission and to consider the band-width as being the relationship between the lasting time which the medium is free and that lasting which the medium is occupied by using 802.11 MAC [14]. The second consists with the dissemination of information concerning the band-width of using the messages “Hello” and a node must calculate its band-width available while being based on the consumption of the band-width indicated in the messages “Hello”. The first method counts the band-width used but does not distinguish the cost from the band-width corresponding to each connection and consequently cannot release it what enormously affects the precision of the estimate of the band-width following a break of a road. One adopts the second method for the estimate of the band-width since she prevents the generation of the additional messages of control by using the messages “Hello” to disseminate the information of band-width and allows the release of the resources following breaks of roads or with the degradation of the requirements for quality of service. The regular emission of this information makes it possible to give an account of the evolution of the network, due to the appearance or the disappearance of roads, or the mobility of the nodes.

8-3 density: We define the density of a node, by the number of direct neighbours (the number of nodes in the zone of sound carried radio operator) whose band-width available is higher than that required by connection. The parameter density is specific to a node and a given connection (a given band-width). Thus, with the reception of a request of road, each node evaluates its density by deducting the number of neighbours of which the availability is higher than that required by connection. If the density is equal to one, no neighbour other than the transmitter of the request fulfils the requirements of QoS of connection. Continuous to diffuse the message of connection is useless since no node of the vicinity is in any event able to prolong the road towards the destination. One leads then to an anticipated detection of the imminent failure of discovered road passing by this node, while limiting the clogging of the network. If the density is equal to two, only one neighbour other than the transmitter of the request fulfils the requirements of QoS of connection. One can thus continue to diffuse the message of request of connection. It during, no node will be able to take over failing current node if the road would be used for the communication. This density is thus too low to ensure a local re-routing at the level of the current node. One speaks then about bottleneck. For a density higher than two, one can define the parameter redundancy starting from the density:

$$\text{Redundancy} = \text{density} - 2 \quad (1)$$

This parameter more intuitively gives an account of the facility of repair of the road in the event of failure of a node. Thus, for a density six, one obtains a redundancy equalizes to four. In other words, four nodes will be if required able to replace the failing node at the end of a phase of local re-routing, thus limiting the time of re-routing. The process of update of the data of availability of the close nodes can be summarized by the sequence illustrated on figure 2

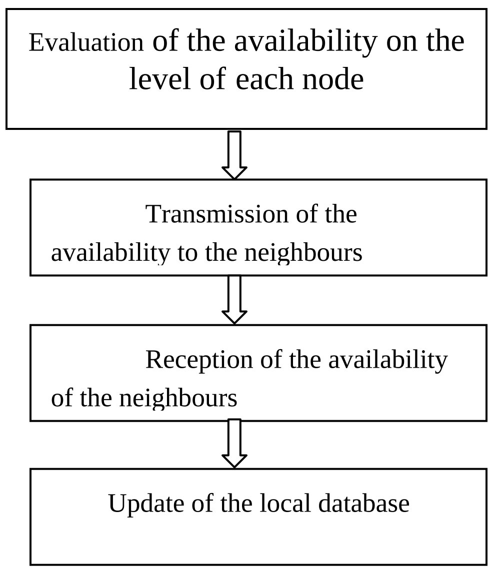

Figure 2: Diagram of update of the availability of the neighbour's nodes

8-4 Course of the phase of discovered roads: We take again the phase of discovered of road described in section 7.1 to which we add the taking into account of the parameters of density and availability. The source initiates the process of routing; it sends to all its neighbours a request for connection towards the destination [15]. The nodes which receive the message for the first time and which fulfils the requirements of QoS propagate the request with their vicinities after having:

- To increment number N of nodes of the road of a unit in the message of request of connection.
- To count the density of the neighbour's nodes suited, in term of band-width available, to take over connection in the event of failure of the central node.
- To update the fields average density and number of throttling of the road in construction in the RReq package in propagation towards the destination.

The update of the average density is carried out using the formula:

$$D_m = \frac{D_m * (n-1) + densit\acute{e}}{n} \qquad (2)$$

The request is propagated gradually towards the destination while following the same diagram of diffusion. Finally, the message of request for connection emitted to the level of the source arrives at the destination. This message comprises the following data:

- The number of nodes in the road.
- The average density along the road in construction.
- The number of bottlenecks along the road in construction.

The destination starts a countdown then and takes delivery of other messages of request for connection corresponding to as many roads detected between the point of rupture and the destination. In the term of the countdown and thanks to the data contained in the messages of request for connection, the destination selects the road whose repair is easiest, then propagates on this road a package of RRep confirmation to hold the essential resources.

8-5 Course of the phase of selection of road:

It is a question of defining a function which maximizes the chances to select the road most easily reparable and thus whose times of rebuilding will be weakest since involve a local re-routing. In this decisional phase, we seek to exploit to the maximum of the parameters contained in the messages of request for connection arrived at the destination. We recall that these parameters are, for each road, the number of implied nodes, the average density and the number of bottlenecks. But to exploit these data is not obvious [14] [15]. In this context, it is necessary to choose the road having the following characteristics:

- The lowest number of nodes.
- The average density strongest possible.
- The number of bottlenecks lowest.

A road is all the more difficult to repair by a partial re-routing which it utilizes long sequences of nodes around of which the density is low. A topology which contains such sequences is regarded as not very interesting because its maintenance is complicated. The local re-routing in the event of failure of a node on these roads will indeed not be effective. It will thus be necessary more often to proceed to a greedier re-routing in time and band-width that a local re-routing. We evaluate the time of average re-routing for an unspecified road and an unspecified specific failure.

N: number of node of this road; Ge: number of bottlenecks along this road.

a-Duration of a local re-routing: Let **t** the time to spread a message of notification from one node to another. Let $\mathbf{T_{rl,i}}$ the duration of the local re-routing to node **i**, where **i** indicates the distance between the source of the communication and the node which initiates the re-routing. Using Fig 2, we determine

$$\mathbf{T_{rl,i}=2t(n-i)} \qquad \mathbf{(3)}$$

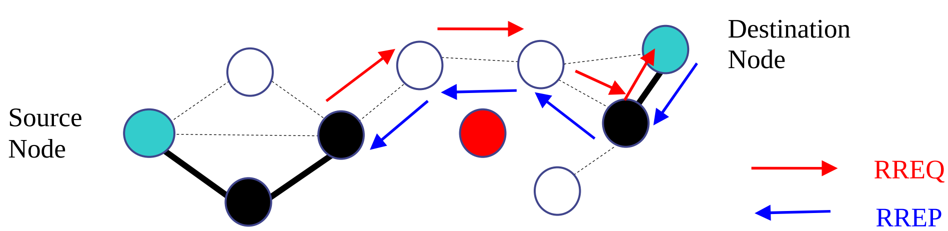

Fig 2: local Re-routage

b- Duration of a global re-routing Let $\mathbf{T_{rg,i}}$ the duration of the global re-routing to node **i**. using Fig 3, we determine

$$T_{rg,i}=t(i+2n) \quad (4)$$

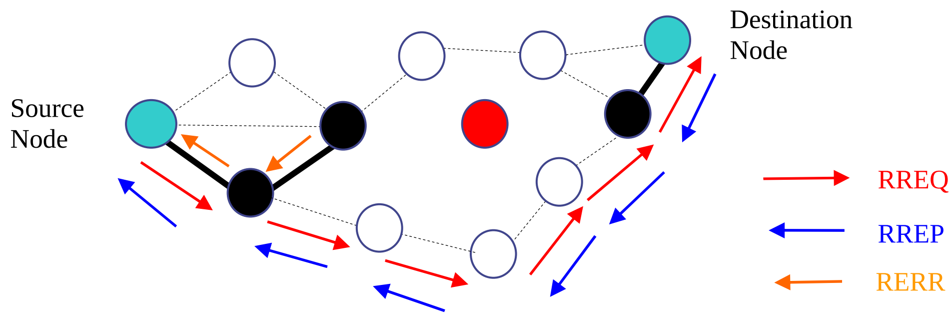

Fig 3: global Re-routage

c- Duration of a re-routing for a given node i: Either $\mathbf{T_i}$ duration of a re-routing to node **i** and $\mathbf{p_i}$ probability of success of a local re-routing on the level of node **i**. We have

$$p_i = 1 - \frac{Ge}{n} \quad (5)$$

Thus, the probability of success of a local re-routing decrease with the number of bottlenecks of the road but is independent of the position **i** from which the local re-routing is implemented. As we proceed initially systematically to a local re-routing then, if this last fails, we proceed a global re-routing, we deduce:

$$T_i = p_i * T_{rl,i} + (1-p_i)*[T_{rl,i} + T_{rg,i}] \quad (6)$$

d- Average duration of a re-routing: We consider that the probability of failure of a node is independent of its position on the road. That is to say **T** average duration of a re-routing. We have:

$$T = \frac{\sum_{i=0}^{n-1} T_i}{n} \quad (7)$$

Thus

$$T = \frac{t}{n}\sum_{i=0}^{n-1}\left[2(n-i) + \frac{Ge}{n}(i+2n)\right] \quad (8)$$

After simplification:

$$T = t\left[(n+1) + Ge\left(\frac{5}{2} - \frac{1}{2n}\right)\right] \quad (9)$$

As we could expect it, we notice that T believes with the number **Ge** of bottlenecks and length N of the road. The notation is inversely proportional to these parameters.

8-6 Notation of road: Our diagram of notation of road is a prelude to with the selection of the road most easily reparable, must be based on the various criteria mentioned above. The note takes account of the number of nodes N of the road: the higher it is, the more the note will be weak. It takes also account of the density $\mathbf{D_m}$ along the road expressed by:

$$D_m = \frac{\sum densité}{n} \qquad \textbf{(10)}$$

To finish, the note of the road takes account of the number of bottlenecks which it comprises. Let us recall that a throttling corresponds to a node of the road where the density is equal to two (node for which the redundancy is null). The more there are bottlenecks, the more difficult the road is to repair by a partial re-routing and thus more the allotted note is weak. That is to say **Ge** the number of bottlenecks. We can thus calculate the note of a road as follows:

$$Note = \frac{D_m}{n+1+Ge(5/2-1/2n)} \qquad \textbf{(11)}$$

It will be retained that the road most easily reparable is that whose notation is highest.

8.7. Choice and reservation of the road: Once a note was assigned to each road, the node destination determines that whose note is largest. It will be this road which will be used between the source and the destination for connection. If two roads have the same note, the selected road is that of which the message of request of connection arrived later at the destination. Indeed, the data contained in such a request reflect best the actual position of the network. As soon as the road was chosen, the destination sends a message of reservation and confirmation which is propagated along the road. Connection is established to the reception of this message by the source. The communication can start.

9- EXAMPLE OF IMPLEMENTATION:

The effectiveness of simulation resides in the capacity of the tool for simulation required precise measurements of relevant data from the point of view of the user. After having designed our algorithm of routing, we carry out his implementation now. As the complete development cycles of a protocol taking again all the specifications suggested can prove extremely long and move away us from our main objectives, we prefer to focus ourselves on a definite part of the work which allows, via a phase of tests, to validate the whole of work presented. Among the tools for simulation of existing WSNs in the literature, one can quote NS-2, Omnet++, Glomosim, SENSE and TOSSIM. But, for various reasons (complexity to implement new protocols and for certain software are not free and expensive), we developed our clean simulators We study through a detailed example in what the modifications made to the initial code affect the behaviour of the network. Let us take the case of figure represented on figure 4 (deployment of 19 node and Sink with one carried radio operator 8.5 cm).

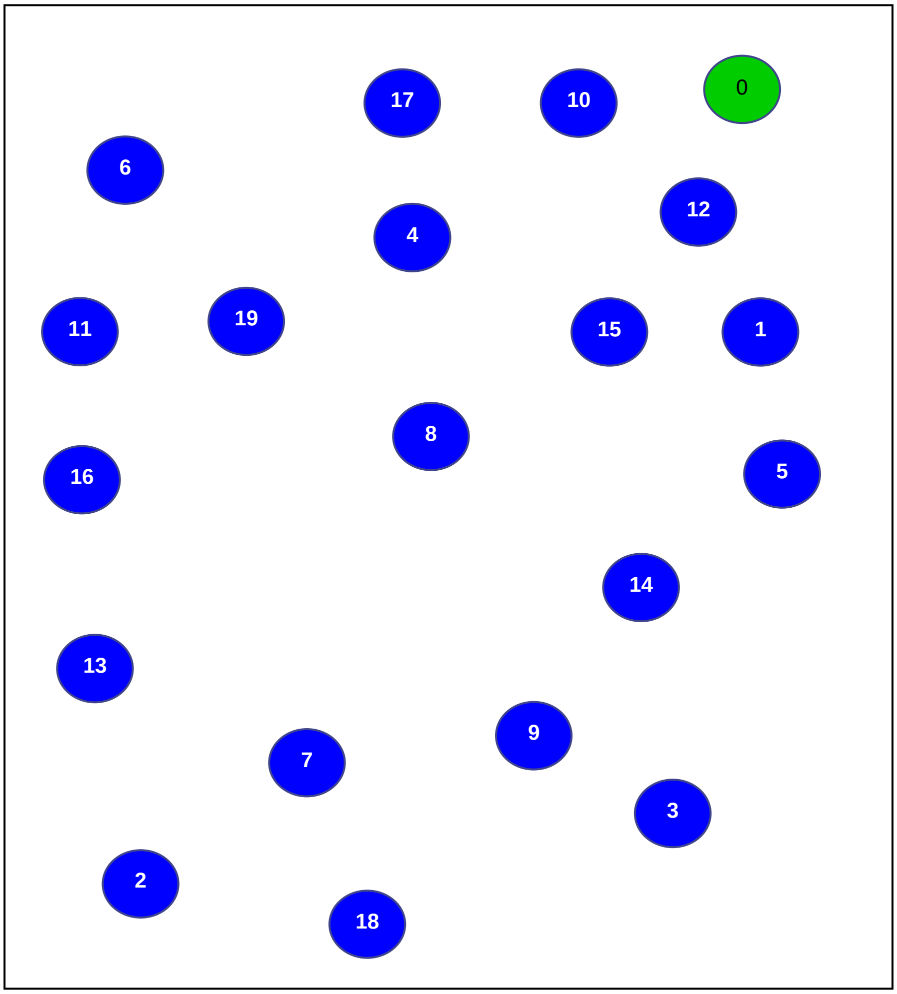

Figure 5: Space distribution of the nodes

9-1- Initial search for road: Node 18 (source) generates packages of data on the level application for an application of the node destination (Sink Node). To the level of the network layer of the source, the first package of data received is brought in file because no road for the destination is possible in the table of routing. The source thus starts the phase of search for road for the destination by diffusing a package RREQ with the field source (resp destination) affected to 18 (0 - Sink) and the fields average density and the number of affected bottlenecks according to its local density. The nodes which receive this package for the first time update their local database for the destination of address 0 (by recording in particular the identity of the next node) and repeat it after having updated the density average and incremented the number of bottlenecks according to their density room. The RREQs packages are propagated this manner along the network.

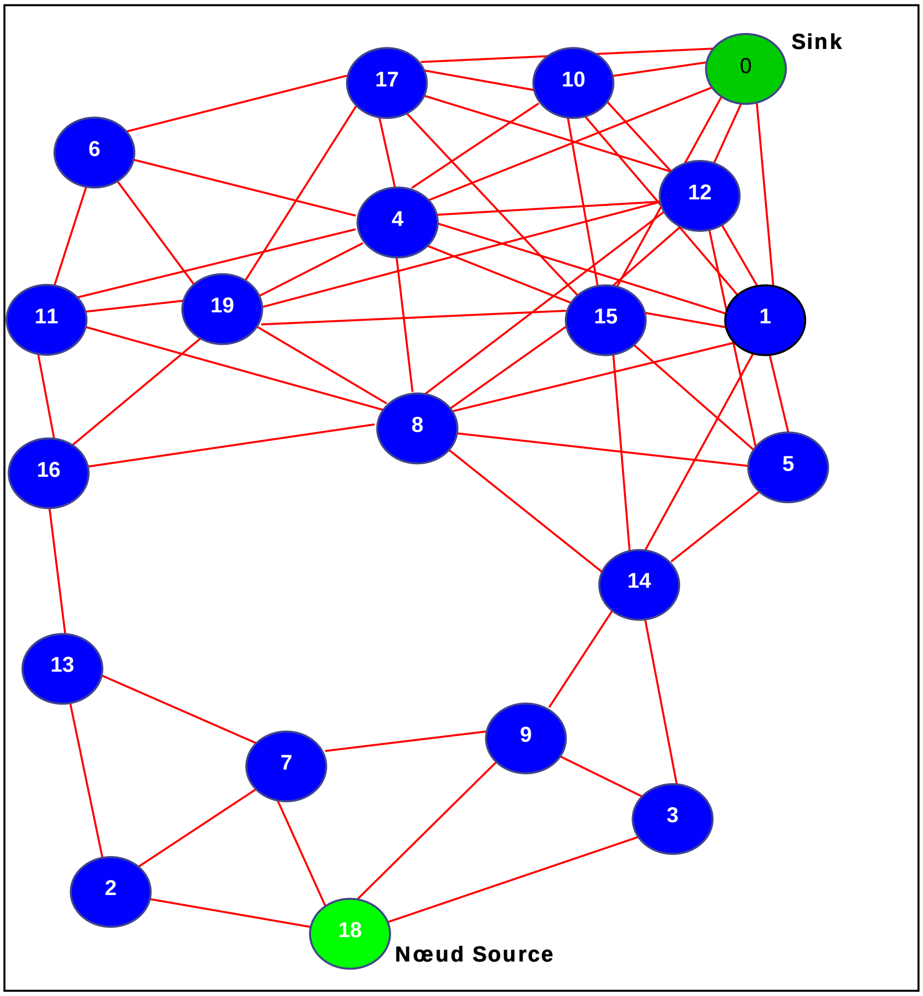

Fig 6 : Propagation of package RREQ

We consider in our simulation two cases

• Cas1: Traditional protocol AODV without taking into account of the parameter density and without local re-routing. It is acted in fact of the initial protocol deprived of its capacity of assumption of responsibility of local repairs of road.

• Case 2: Protocol AODV with assumption of responsibility parameter density and local re-routing according to the density (in particular, the local re-routing is prohibited when the density is lower than 3. It is about the improved protocol which we proposed.

Case 1: Traditional AODV The first package which arrives at the destination (Sink) is the package having forwarded by nodes 18,3,14 and 1. It is the selected way

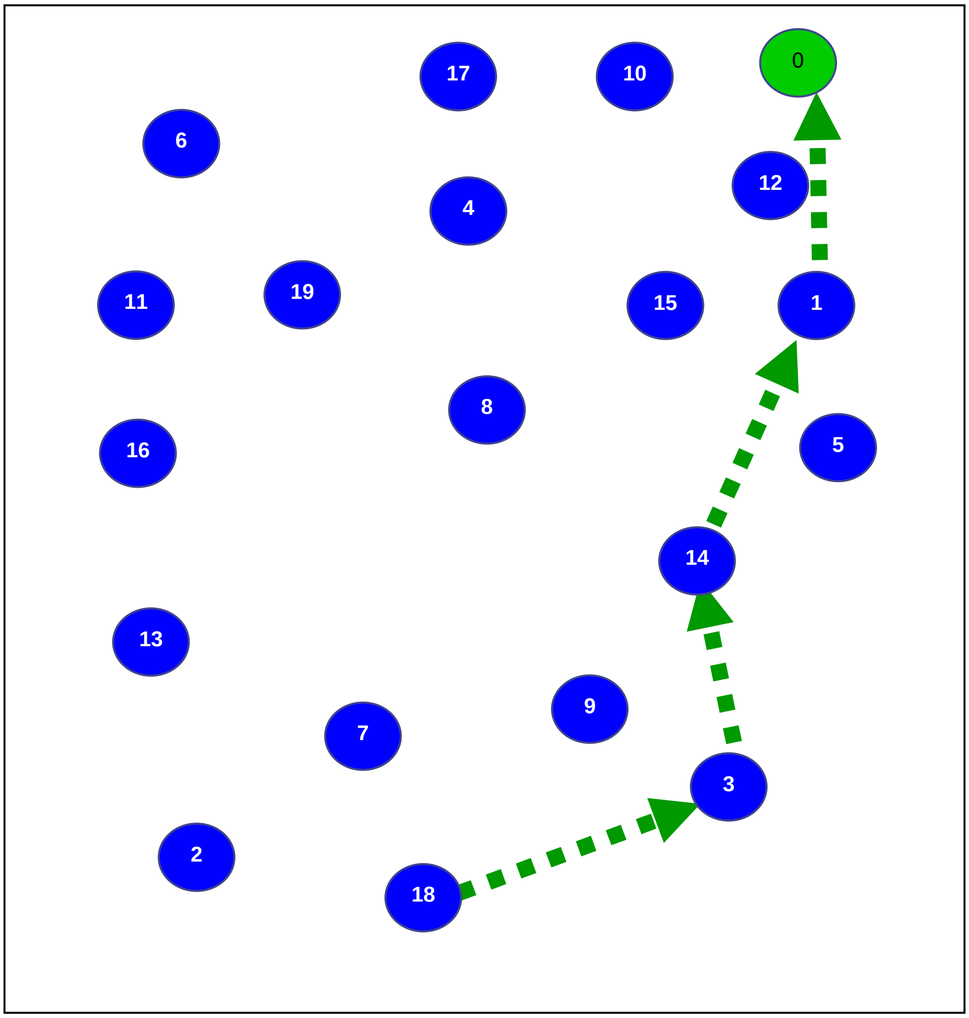

Figure 7: Road found by traditional AODV (Case 1)

Case 2: Modified AODV The first package which arrives at the destination (Sink) is the package having forwarded by nodes 18,3,14 and 15. A pointer on this package is stored in the first box of the table of the requests received. A time of guard (times-out equal to 6 second) whose value depends on the time put by the package to be propagated until the destination is launched at once. In this interval, the destination stores each package RREQ which reaches him in the successive following boxes of the table while following the same process. In the term of time-out, an interruption is generated. One determines then, among the notes stored in the table of the notes, which is highest. One identifies the number of arrival of package RREQ corresponding to this road. It is about number 1. The pointer stored in table of the requests received then allows the generation of the package RREP which will be turned over towards source 18. Each intermediate node which receives package RREP updates its local database towards the destination (Sink) by recording in particular the next node towards Sink. When package RREP arrives at source 18, the entry corresponding to the destination is unobtrusive. The packages of data put in file can be sent to the destination along this new road.

	Source	1st Jump	2nd Jump	3rd Jump	4th Jump	5th Jump	6th Jump	7th Jump	8th Jump	9th Jump
Road N°1	18	3	9	14	15	0	--	--	--	--
Road N°2	18	3	9	14	15	17	0	--	--	--
Road N°3	18	3	9	14	15	1	0	--	--	--
Road N°4	18	3	9	14	15	1	4	0	--	--
Road N°5	18	3	9	14	15	1	4	10	0	--
Road N°6	18	3	9	14	15	1	4	10	12	0

Table 1 : Lists found Roads

	Road N°1	Road N°2	Road N°3	Road N°4	Road N°5	Road N°6
Bottlenecks number	1	1	1	1	1	1
Average density	4.599	4.666	5	5.285	5.25	5.555
Note	0.541	0.491	0.526	0.503	0.456	0.444

Table 2: Notation of the found Roads

The selected Road is N° 1, that whose note is highest

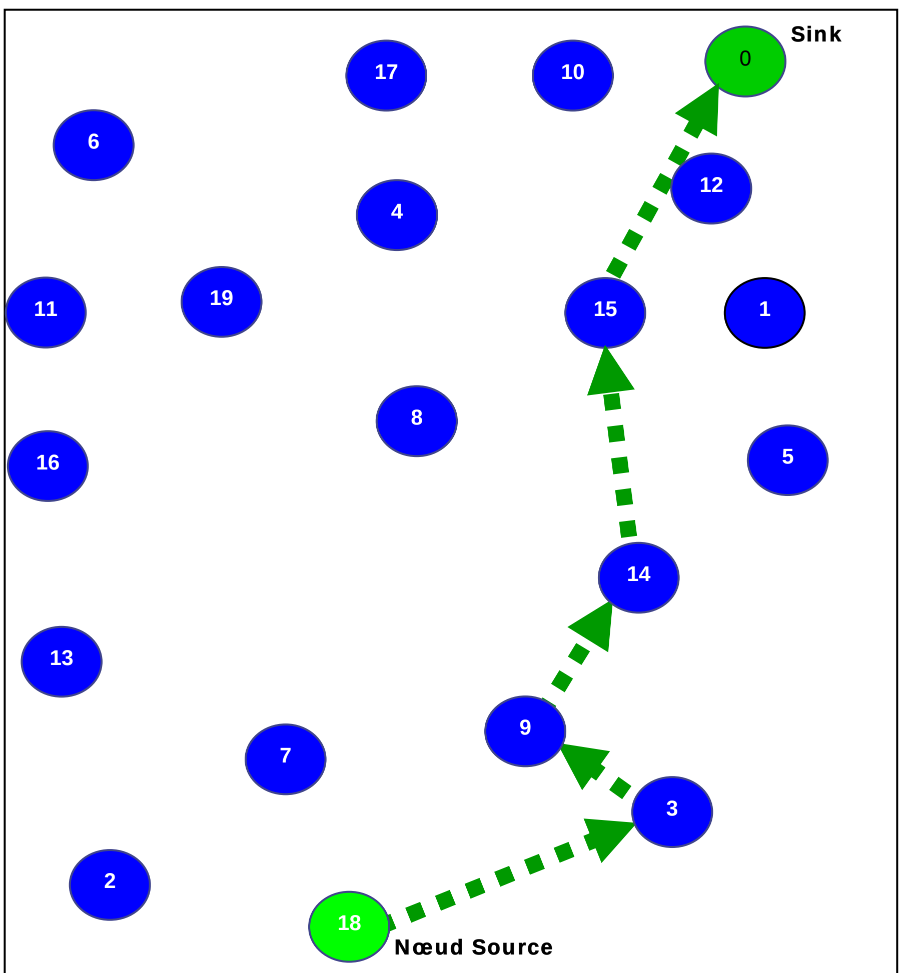

Fig 8: Better Road found by modified AODV (Case 2)

9-2- Repair of road:

Let us study how the repair of road in the event of disappearance of nodes 1 is carried out, node the 15 then nodes 14. 9-2-1 Disappearance of node 1

• In case 1, the node 14 detects that node 1 disappeared and turns over immediately a message RERR to node 18. This one starts an operation of total re-routing then. As it appears in table 4.4, this phase of re-routing lasts longer than the initial phase (0.018 S against 0.0092 s).

• In case 2, the packages take a way of which node 1 does not form part. We thus do not observe any change. The time remains unchanged before and after the departure of node 1. It established at 0.014 second. We note on the other hand that the search time of initial road is definitely longer than in the preceding case. We explain this observation by the fact that we await other RREQs on the level it Sink before turning over RREP.

		Cas1	Cas2
1	Time of initial routing (s)	0,0092	0,019729
2	Time of local repair (s)	0	0
3	Total time re-routing (s)	0,0181667	0
4	Average time before re-routing (s)	0,0095	0,014
5	Average time after re-routing (s)	0,016	0,014

Table 3: Summary table for the disappearance of node 1

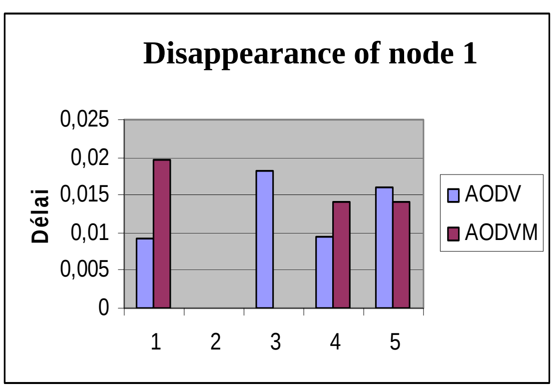

Fig 9 Comparison enters the two alternatives of AODV for the disappearance of node 1

9-2-2- Disappearance of node 15

• In the cas1 no re-routing is undertaken consequently with the departure of node 15. We can envisage it because node 15 does not form part of the road used in case 1.

• In case 2: In case disappearance of node 15. The node 14 which precedes it on the road detects its disappearance on the level lay down MAC when it does not receive an emanating acknowledgement of delivery of 15, following a sending of packages of data. A package NACK is then turned over to the network layer. The node 14 puts in file the package DATA corresponding and proceeds to an attempt at local repair. Indeed, its density is higher than two. It thus starts by passing the statute of the road towards node 18 (source), road in the course of repair so that the packages which will arrive later on are put in file. The node 14 envisages also an interruption to deal with the case where the local re-routing would not succeed. Then, it sends packages RREQ nodes 5 and 8 (its neighbours) according to the same principle as at the time of the initial routing, but with the notable difference which this time the Density_mode field is decontaminated in the RREQs packages sent. The packages are thus propagated in the network without taking into account the average density and the number of bottlenecks. The first package arrived at Sink immediately starts the generation of a RREP addressed to the node 14. This package is propagated until the node 14, the statute of the road passed by again with ACTIF and the stored packages can be sent to the destination along the new road. The packages stored during the phase of local re-routing can thus all be sent to the destination.

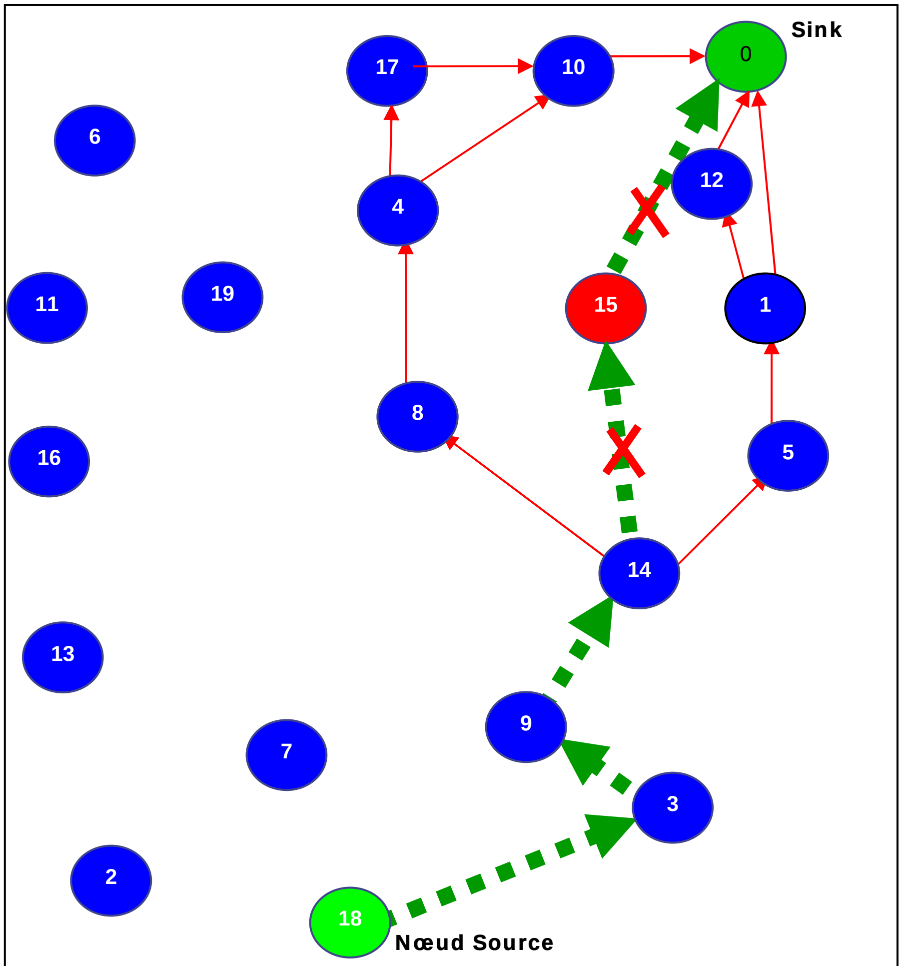

Fig 10: Disappearance of node 15 (Case 2)

We observe in table 4.5 that a local re-routing was undertaken successfully. We note that this local re-routing lasts 0.00782 second. This time of re-routing is compared with 0.018 seconds of the total re-routing obtained in case 1 for the disappearance of node 1.

		Cas1	Cas2
1	Time of initial routing (s)	0.00855	0.022013
2	Time of local repair (s)	0	0.00782
3	Total time re-routing (s)	0	0.00782
4	Average time before re-routing (s)	0,0095	0,014
5	Average time after re-routing (s)	0.0095	0.016

Table 4: Summary table for the disappearance of node 15

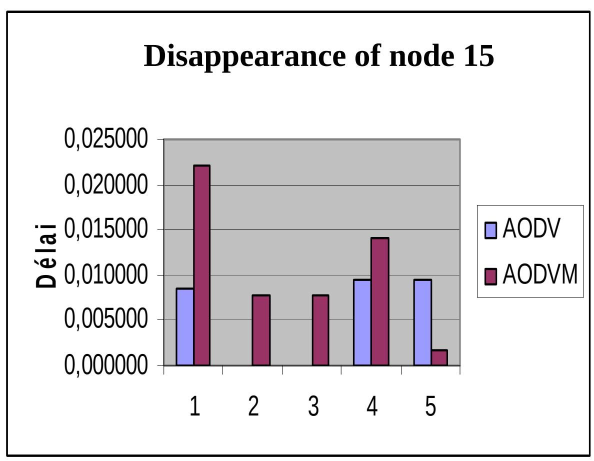

Fig 11: Comparison enters the two alternatives of AODV for the disappearance of node 15

9-2-3- Disappearance of the node 14

• In case 1, node 3 detects that the node 14 disappeared and turns over immediately a message RERR to node 18. This one starts an operation of total re-routing then.

• In case 2: The node 9 which precedes it on the road detects its disappearance on the level lay down MAC when it does not receive an emanating acknowledgement of delivery of 14, following a sending of packages of data. A package NACK is then turned over to the network layer. Indeed, its density is equal to two. It immediately turns over a message RERR to node 3 intended for node 18 (node source). This one starts an operation of total re-routing then.

9-2-4- Assessment of the disappearance of a node: We seek to extend our results obtained by the failure of all the nodes belonging to the selected road. We on the other hand do not consider the cases of failure of nodes 18 (node source) or Sink (their failure would be irremediable for the communication. We suppose that the failure of each node of the system is equiprobable. We classify the nodes in several groups according to the case to which we refer. We obtain the following distributions:

Cas1: The disappearance of node 1 is representative of the disappearance of nodes 14 and 3 Cas2: The disappearance of the node 14 is representative of the disappearance of nodes 9 and 3 We balance the various scenarios of disappearance to obtain the synthetic results presented to table 4.6.

		Cas1	Cas2
1	Time of initial routing (s)	0.00878	0.0205
2	Total time re-routing (s)	0.039	0.0058
3	Average time before re-routing (s)	0.0095	0.014
4	Average time after re-routing (s)	0.119	0.0146

Table 5 Results of comparison of 2 alternatives of AODV

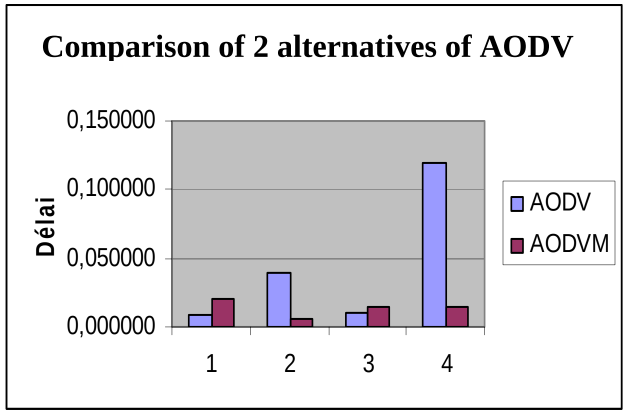

Fig 12 Comparison of 2 alternatives of AODV

We notice that the version of AODV provided with our improvement, makes it possible to avoid the loss of packages at the time of the failure of an unspecified node of the network. This result puts forward a marked improvement of the reliability of the protocol of routing compared to the cases where local repair is not implemented. We note however that the time of initial routing is systematically longer than in the case of initial protocol AODV. That is the principal disadvantage inherent in our improvement. But this longer waiting on the level of the phase of establishment of road is necessary to choose a better reparable road. This observation thus attests marked improvement of the assumption of responsibility of the quality of the service by the improved protocol suggested compared to the initial version. A weakness of our improvement is observed on the length level of the road. The road thus puts concerned more node and consequently, the probability so that a failure occurs increases on the road selected. We conclude from it that to this level there still our improvement brings a profit in term of management of quality of service in the event of failure.

10- CONCLUSION

The proposals presented in this article aim at improving management of quality of service by taking into account of the definite density as being the numbers of nodes available in the carried radio operator of nodes. We released two center:

- Introduction of a mechanism of choice of road.
- Anticipated forecast of the failure of a local re-routing. The mechanism of choice of road aims at selecting among several competitors that whose maintenance is easiest to realize.

We highlighted a situation in which an attempt at local re-routing is harmful: if the density is too low around the nodes which initiates the local re-routing, this one is dedicated to the failure. It is thus preferable to turn over directly a RERR to the source directly after having detected a rupture of bond. The principal limitation of our process of choice of road lies in waste of time in the initial routing. This waste of time is related to waiting of the reception of other RREQs coming from the source before selecting the best road within the meaning of the facility of repair. During the implementation of methods, as a contribution of the paper, we implemented our improvements in the AODV protocol and compared the results with those of simulation obtained for versions incorporate not our improvements. We get interesting results regarding the number of lost packets and the average repair time drive after the defiance of a node. So even if the duration of initial routing is automatically extended from the version of the protocol AODV incorporate not our improvement, the selection of the road more easily reparable is beneficial in terms of gain in the quality of service.

Another line of work would be to conduct a thorough performance study for distributions of nodes inspired plausible situations in real environments.

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