Incremental Design of Nano-Sensors Network

Khaldia BENAHMED [1]*, Mostefa BELARBI [2]*, Abdelhamid HARICHE [3]*, Benyamina Abou El Hassan [4]#
* LIM research laboratory,University of Tiaret,Algeria
# LAPECI research laboratory,University of Oran ES-SENIA; Algeria
1 benkhaldia@hotmail.fr
2 belarbimostefa@yahoo.fr
3 Haricheabdelhamid@gmail.com
4 benyanabou@yahoo.fr

Abstract

A general approach is to reduce the overall complexity by raising the level of abstraction of the design phase. On the context of this idea, we suggest to apply incremental formal approach in the context of nano-devices network and wireless body network (WBAN). The suggested research approach consists of constructing architectures based on NoC-FPGA (Network-on-Chip - field Programmable Gate Assembly). This research work includes the mapping of this kind of architecture on some special context like Wireless nano-sensors network. The methodology used the formal method based on validated B- event theories to generate the chosen context. The used theories are Noc Theory, wireless network theory, colored graph theory and the VHDL (Very High Speed Integrated Circuit Hardware Description Language) theory. Properties like reliability, fault tolerance will be crossed on the kind wireless nano- sensors network.

Key-words : Nano-sensor network, NoC, Formal methods,B-Event, Theory Concept, FPGA, VHDL, WBAN

1. Introduction

Several research works explore systems verification using formal technics in computer science but not all these works perform general methodology which integrates design flow of micro-electronic systems. This validation is more complex in the case of strong reconfigurable communicating architectures [1,14] using Nano metric scale [5,10,13] which don't consume energy, without interference and ultra wide band (UWB) based on impulsion [2,3,11,15,17]. Mac layers differs from traditional one [10] on which fair energy consuming, good synchronization precision and compatible with nanotechnologies. The liability and security of this kind of wireless sensors become important research study. [16]

The main requirements in the domain WBAN are low power consumption, low latency and high reliability communications [11,12]. The deployment of devices based on nanomaterials inside the human body correspond to various physiological parameters for example to monitor on a real-time manner the imbalance of cholesterol, the measurement of bone growth, etc

The most important characteristic in the WBANs which is variable over time is the stored energy of the nanomaterials. During communication cycles, the energy is dissipated and can be reconstituted using certain energy recovery techniques (rhythmic vibration of the heart, body movement, ..), resulting in an energy fluctuation node aware of the time. Therefore, the lifetime of this type of network is longer.

Our suggestion consists of suggesting a new approach of the design of sensors network using fault-tolerant platform [6,7] based on FPGA reconfigurable technology. This approach uses proved incremental refinement notion in order to improve validation phase (by reducing time and reaching certain reliability) of high level design. The purpose of the study is to suggest using an incremental manner a new flow design which will generate synthesizable architecture of fault tolerant sensors network using FPGA technology. This purpose will be possible by investigating formal proof using Rodin Tool associated to Event-B Language [8]. The micro-architecture will be composed by two parts: the first part consists of the nano-device [10] and the second part consists of the device constituted by SoC using FPGA technology [14]. This platform allows us to design and simulate wireless sensors using IPs (intellectual property) in order to develop advanced embedded applications like for example WBAN and nano sensor network

The important part of the study consists of representing the network using several theories like graph theory [6], colored graph [20], VHDL theory [21]. Event- B language helps us to represent this mapping. The mechanism of fault-tolerance will have enriched using the notion of refinement. [18]

The paper structure is as follows: section two presents base Event-B theories. This section shows how we can model self-organized network using colored graph theory, VHDL is also presented. Section three develops a part of incremental Design of Nano-FPGA architecture deployment using BAN context. We conclude with the main ideas which allow us to combine two parts: analogic (nano-sensor) and digital parts (network of FPGA nodes) in order to prove the properties of this kind network.

2. Generic Event-B models

Models in Event-B are specified by means of contexts (static properties of a model) and machines (dynamic properties of a model) and during the modeling of every system, the main benefit in this work is the use of models from theories already validated to reduce the time in the formal specification of any given system taking as target the NoC system after n-level of verified models, a theory (a new kind of Event-B component) is defined independently of any particular models. A theory component (Figure 1) has a name, a list of global type parameters (global to the theory), and an arbitrary number of definitions and rules: The Theory plug-in provides a mechanism to extend the Event-B mathematical language as well as the prover. The main purpose of this new feature was to validate systems with a way to extend the standard Event-B mathematical language by supporting operators, basic predicates and algebraic types. Along with these additional notations, it can also define new proof rules (proof extensions). A theory is used to hold mathematical extensions: data types, direct, recursive and axiomatic definitions of operators, and proof extensions polymorphic theorems, rewrite and inference rules. Theories are a helpful basis for the static checking and proof obligation generation which ensure that no compromise for the existing infrastructure of modeling, proof and any contributed extensions. In essence, the theory plug-in provides a systematic platform for defining, validating of the well-creation of embedded systems.

Theory name
type parameters T1, ..., Tn
{ _Predicate Operator Definition _
| _ Expression Operator Definition _
| _ Data Type Definition _
| _ Rewrite Rule _
| _ Inference Rule _ }

Figure 1. Theory in Event-B

This work proposes to validate very particular the wireless sensors network based on BAN systems (Figure.2.) which is composed of set of NoC switches using the NoC theory with the graph theory, the new strategy for recovering the set of faulty nodes in form of theory(WSNoC theory) to handle and manage the complexity of the multi-failure of sensors using the colored graph theory, the final step is to ensure that all the properties for this embedded system will applied correctly in the application environment by combining these previous theories with the VHDL. The last step will allow us to launch a set of scenarios to check all possible case for running correctly the BAN system.

In this paper we present some important points:

The benefit of using generic theories to model a BAN-Based wireless sensors network in incremental fashion to ensure the most valuable properties used in this kind of network.

The token case study is for analyze the reasons of collision during multiple sending of data and propose a mechanism to detect the failure and solved it using a set of theories that help in the final step to generate a VHDL code thanks to VHDL theory.

The carry out of some temporal properties in the modeling phase to make the proposed recovering strategy more convenient.

A quick view of the different validation steps of the BAN system designing, starting from the conception using Event-B generic theories that help to implement with vivado Environment to simulate and upload the perfect VHDL codes to the FPGA board.

2.1. NoC-based Wireless Network theory modeling using the Event-B

The creation of a very particular NoC system inspired from the model proposed [7] for a self-reconfigurable multi-node network, this net is composed of a set of self-organized wireless nodes. Each node is independent. This allows maintenance and operational reliability of the system in the case of failure.

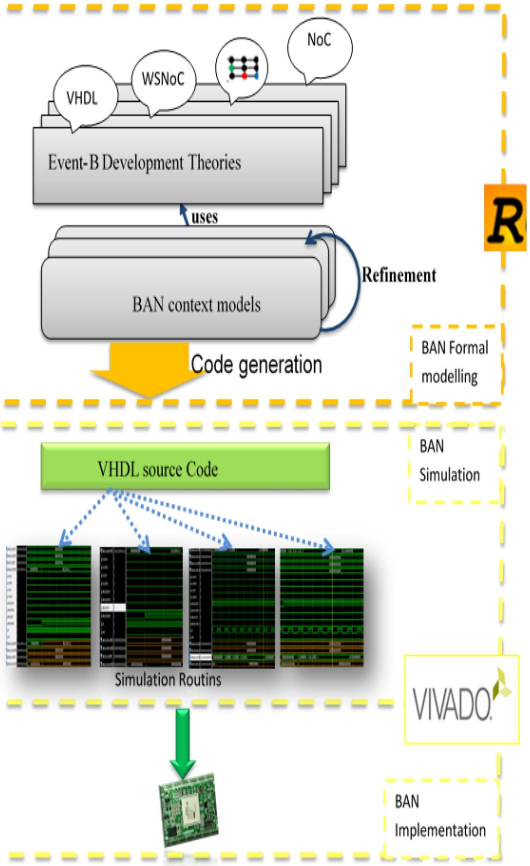


Figure 2. BAN system designing flow

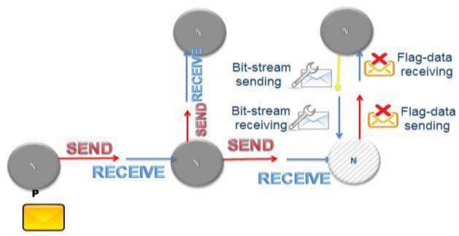


Figure 3. The Wireless network of NoC theory in Event-B

This network system is a system composed of several nodes which apply XY algorithm inside as described previously and communicate with each other through a communication channel, which can be a network, shared variables, messages, this allows us to consider our system like a distributed system which is often seen as a graph [20], where the vertices are the nodes and the edges, direct communication links between them.

During the modeling for this particular network (Figure 3.) used NoC, it must introduced the way of reconfiguration for any faulty node and for this new constraint it adds a new extension for the NoC theory, this new theory Wireless-NoC contains:

The new data-type “state” is used to represent the state of every node.

The next operators are used to clarify more the new theory that respects all the properties of reliabilities: WNocStat: to create a set of nodes with its state:

ocpy: mentions that the node is occupied by sending or receiving data. free: mentions that node is not occupy.

nodeState: this operator presents the state of specific node “nod”.

packet: to represent the new structure of data which contains a flag “flg” to specify the type of data in the case of node failure this flg will have the value 1.

Datatype *state* **constructors** *ocpy* *free*	**operator** WSnode **prefix** **args** s: state , nod: $\mathbb{P}(S)$ **condition** $any \in role$ $\wedge\ net \in node(any, nod)$ **definition** net	**operator** packet **prefix** **args** $flg: \mathbb{N}$ data: $\mathbb{P}(T)$ **condition** $flg \in 0..1$ **definition** data	**Operator** nodeState **prefix** **args** nod: $\mathbb{P}(S)$ **condition** $a \in role$ $\wedge\ net \in node(a, nod)$ $\wedge\ s \in state$ **definition** s

So it can present this particular NoC using Wirless-NoC theory definition like in follow:

Data sending

When a source Srcnod sends a packet (msg), the packet must have a value of 0 for the flg argument and the states of nodes Srcnod, Desnod must be changed with the value ocpy.

Data recieving

A packet is received by its destination, if the packet has reached the destination (node with a role equal to rcv Case 3 in predicate).This packet must have a value of 0 for the flg argument and the states of nodes Srcnod, Desnod must be changed with the value free.

Data forward

In the network, a packet (msg) transits from a node (Srcnod) to another node Desnod(node with a role equal to dst Case 2 in predicate).This packet must have a value of 0 for the flg argument and the state of the node Srcnod must be changed with the value free when the node Desnod will have the value ocpy.

Case 1: SEND

$Send=send \cup \{Srcnod \mapsto msg\} \wedge srcstate= ocpy \wedge Desstate= ocpy$

Case 2: FORWARD

$rcvd= rcvd \cup \{Desnod \mapsto msg\} \wedge srcstate= free \wedge Desstate= ocpy$

Case 3: RECIEVE

$rcvd= rcvd \cup \{Desnod \mapsto msg\} \wedge srcstate= free \wedge Desstate= free$

In the optimal case those last events could represent the communication between different nodes otherwise some nodes could be in failure state so they must inform the other nodes by sending a flagData with flg=1, (see Flag data sending).

Flag-data sending

In case of a node (Fnod) Failure which can’t receive a packet (msg), the packet FlagData with a value of 1 for the flg argument is sent if the faulty node Fnode still be occupied (value ocpy).When the flag data is received (see Flag-data receiving), one of the healthy nodes take the mission of reconfiguration (see Config-data receiving) for the faulty nodes after checking these following rules:Every node is not a faulty node, has the material resources to implement IP node, has the Bitstream packet of configuration IP and do not be occupied by a priority.

$\forall send, Fnod, FlagData \bullet FlagData \in packet(1, \mathbb{P}(T)) \wedge srcstate=Statenod(Srcnod)$
$\wedge failstate=Statenode(Fnod))$
$\Rightarrow$
$Send=send \cup \{Fnod \mapsto FlagData\} \wedge srcstate= ocpy \wedge Failstate= ocpy$

Flag-data recieving

A packet (FlagData) is received by switch (Srcnod), if it is sending from a faulty node (Fnod).

$rcvd = rcvd \cup \{Srcnod \mapsto FlagData\} \wedge srcstate=ocpy \wedge Failstate=ocpy$

Config-data sending

In the case of a node (Srcnod) can check the rules of reconfiguration ability (described before) it send a configuration data (Bitstream) to the faulty node (Fnod).

$\forall Bitetream, FlagData \bullet Bitsream \in packet(0, \mathbb{P}(T)) \wedge FlagData \in packet(1, \mathbb{P}(T))$
$\Rightarrow Send=send \cup \{Srcnod \mapsto Bitstream\} \wedge srcstate=free \wedge Failstate=ocpy$

Config-data recieving

A packet (FlagData) is received by switch (Srcnod), if it is sending from a faulty node (Fnod).

$rcvd = rcvd \setminus \{Fnod \mapsto Bitstream\} \wedge srcstate=free \wedge srcstate=free$

2.2. Vertex coloring theory modeling

In the reason of managing nodes failures and the way of the self-recovering, the graph theory helps to specify the Wireless reconfigurable WS-NoC (Figure 4.) using algorithms of colored graph principals [20] that include a part from Closure theory, the closure theory as in follow composed of operator cls and have so many properties of graph such as composition of sub-closures an transitivity

THEORY closure **OPERATORS** •**cls** : $cls(r : \mathbb{P}(S \times S))$ **direct definition** $cls(r : \mathbb{P}(S \times S)) \triangleq fix(\lambda s \cdot s \in \mathbb{P}(S \times S) \mid r \cup (s;r))$ **THEOREMS** $\forall r \cdot r \in \mathbb{P}(S \times S) \Rightarrow cls(r) = r \cup (cls(r);r)$ $\forall r \cdot r \in \mathbb{P}(S \times S) \Rightarrow r \subseteq cls(r)$ $\forall r \cdot r \in \mathbb{P}(S \times S) \Rightarrow cls(r);r \subseteq cls(r)$ $\forall r,x \cdot r \in \mathbb{P}(S \times S) \wedge r[x] \subseteq x \Rightarrow cls(r)[x] \subseteq x$, $\forall r,s \cdot r \in \mathbb{P}(S \times S) \wedge s \in \mathbb{P}(S \times S) \wedge r \subseteq s \wedge s;r \subseteq s \Rightarrow cls(r) \subseteq s$ $\forall r \cdot r \in \mathbb{P}(S \times S) \Rightarrow cls(r);cls(r) \subseteq cls(r)$		$\forall clr, count \bullet clr \in COLORS \wedge Count \in \mathbb{N}$ **Case 1 :colored_faulty** $\wedge count \leq 4$ **Case 2 :faulty_wait_to_be_colored** $\wedge count > 4$ **Case 1 :colored_faulty** *colored*= colored $\cup$ {Fnod} $\wedge$ colored(Desnod)=clr $\wedge$ count=count+1 $\wedge$ has_colored=has_colored $\cup$ {Fnod} **Case 2 :faulty_wait_to_be_colored** *wait_to_be_colored*= wait_to_be_colored $\cup$ {Fnod} $\wedge$ count=count+1 $\wedge$ colored(Desnod)=clr
Datatype *Colors* **constructors** *Yellow,Red,* *Green,Bleu ,none*	**Operator** Colorenode **prefix** **args** c:Colors , nod: $\mathbb{P}(S)$ **definition** nod	

The coloring graph algorithms [20] can be used to control a set of nodes: There may be two nodes that have the same job but two adjacent nodes cannot even fix the failed node at the same time [17].

Math extension is a standard library provides the closure as a theory which is almost similar to our Wireless NoC architecture but need to add the coloring rules in the context to cover all courant proprieties of our Graph Theory.

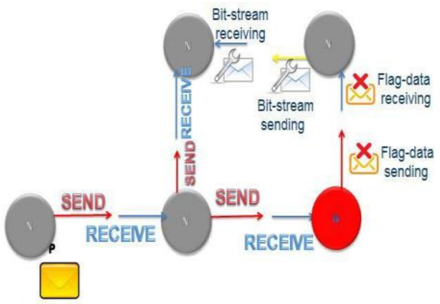


Figure 4. The colored graph theory application onto WSNoC system in Event-B

During the refinement events which are for the Application variables represented by a graph theory and their Execution environment variables must be handled in the same model by introducing the VHDL theory (see section 2.3) that could be used in every event Model as new VHDL variables represented with Event-B. So the coloration will cover all possible state for the events that nodes can do.

So any node that cannot send and receive data can be labelled with Blue ,Yellow, Green , Red and uncoloured even managed the multi-failure of nodes that overpass more than 4 nodes by counting it as node in waiting list to be in the next colored due to the available colour.

Flag-data sending

In case of a node (Fnod) Failure which can't receive a packet it must colore the node that sends a

FlagData with red.

Send=send∪{Fnod↦FlagData} ∧ colored(Fnod)=clr ∧ has_colored:=has_colored∪{Fnod }

Config-data sending

Bitstream-packet (Bitstream) is received by a faulty switch (Fnod), if it is sending from a reorganizer IP (Rfcgnod) in the buffer, then for that reason both nodes Fnod and Rcfgnod must be uncolored.

rcvd = rcvd \ {Fnod↦Bitstream }∧colored(Fnod)=none ∧has_colored:=has_colored\{Fnod }

2.3. The VHDL theory in Event-B

The Theory VHDL_th (Figure 5) used during this Self-Organized network Modelling is composed of an Entity and a set of architectures that contains a set of variables, the entity contains ports in direction in out or in_out, from that two operators are created (arch_decl and ports_decl) when one had a data type parameter (pio), in this VHDL case study, we had std_logic and the std_logic_vectors signals, the last one must have new theory could be used in the VHDL_th, it is a similar structure of array presented in[34].The variable in VHDL must have a type and in this structure for example the integer type is represented like an operator and ensure that couldn't be over int_max= and every operation that use that kind of variable must never overflow that value so the Proof obligation will ensure the non-overflow error for integer variables in the VHDL code. During the modelling of our VHDL theory that it will introduce into the Event-B model the set of operations created in our new theories and taking some cases like VHDL operations (+,*,-, /), or the assignment of variables in VHDL, also some proofs had to be discharged during this WSNoC modelling will be a good start for the code generation after ensuring the well definition of all the system.

THEORY VHDL_th **DATATYPES** pio≙I n , out, inout **OPERATORS** •**arch_decl :** arch_decl(s:ℙ(T)) **direct definition** arch_decl(s : ℙ(T)) ≙ s •**port_decl :** port_decl(p:pio,s: ℙ(T)) **direct definition** port_decl(p:pio,s : ℙ(T)) ≙ s •**std_logic :** std_logic **direct definition** std_logicl ≙ 0 ‥ 1	•**vector:** vector(s: ℙ(T)) **direct definition** vector(s : ℙ(T)) ≙ {n,f·n∈ℕ∧f∈0 ‥ (n−1)→s|f} •**std_logic_vector:** vector(length: ℕ,s: ℙ(T)) **well-definedness condition** **direct definition** std_logic_vector(length: ℕ,s : ℙ(T)) ≙ {v|v∈vector(s)∧card(s)=length}

Figure 5. The VHDL theory

3. Theories deployment and WBAN Context

To check the validity of the network designed in the context of WBAN, we rely on three theories: colored graph theory, theory NoC, the theory WSNoC. The wireless network BAN context type is based on the probabilistic model [10], which we have extracted several parameters such as packet rates, time of energy consumption, ... These parameters are injected into the machine -Event B BAN (see figure 6.a ,6.b.and 6.c.). The context of WBANs includes several types of collisions these collisions occur when a nano- device initiates its transmission in the interval when the noise of the molecular absorption is at its peak, or the receiver's power is low. Nano-devices are unavailable for certain duration. The two factors responsible for this type of collision are the behaviour of the channel, and the fluctuation of the receiver's power. The generic model presented in the previous sections incorporates nodes status. In this refining step we integrate the channel state when the transmitted packet does not undergo significant molecular noise absorption, and this packet can be detected at the receiver with a highest probability; by cons put it there's case the packet is lost due to the significant molecular noise absorption.

On this modelling we try to evaluate the state of receiver node during a multi-transmission of data using the following invariants:

p: The number of receiving data during a single emission

q: the non-received data number during a single emission

the node will take the state of a faulty node if the number of received data still less than the total data and the duration of the emission overpass the threshold of an ordinary emission task (model Ban_M0), though the faulty node will be colored using Colored graph theory(Ban_M1).

when the study that we have is about a multi nano-devices that send multiple symbols, so the failure of several nodes lead to the failure of the system, this is why we need to colored all faulty node till the recovery of the nodes by sending the bitstream data which is considered as the main properties covered by the WNoC theory, so every recovered node will be uncolored till the end of all the faulty nodes which are the waiting list(Ban_M2).

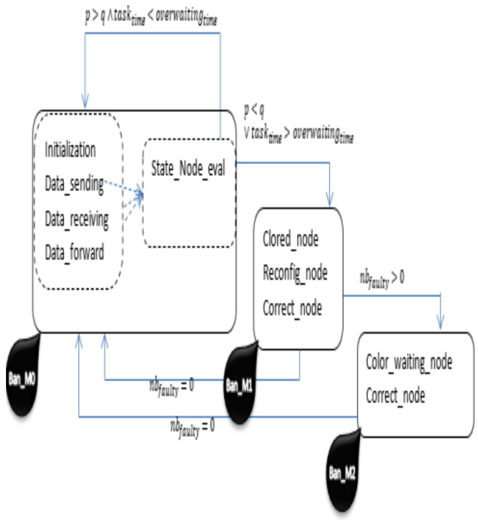
The flow of data must not be randomly, but it must follow four case to check the behavior of nodes respecting the WSNoC theory rules, NoC theory and especially the vertex colored graph theory, we can clearly observe this behavior using ProB Tool delivered in the Rodin toolset as a scenario of animation where multiple data must be received by a node:

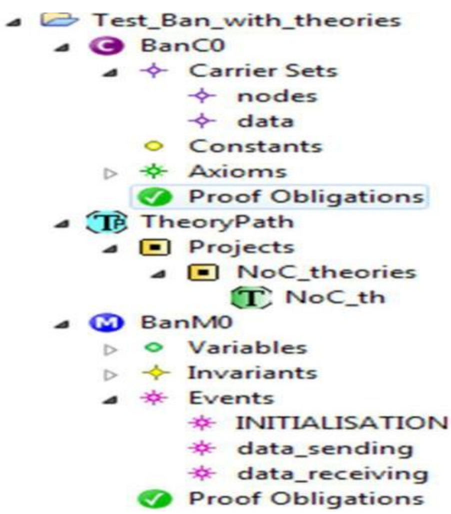
In the same time with a same rate (the arrival time to add for the Task_time will be the same even the time reserved for saving the data from a direction dir_buff_time).

In the same time with different rates (the arrival time to add for the Task_time will be the same and we will add different times reserved for saving the data from a direction dir_buff_time).

At different times with the same rate (the arrival time to add for the Task_time will be not the same but the time reserved for saving the data from a direction dir_buff_time will be the same).

At different times with different rates (the arrival time to add for the Task_time will be not the same even the time reserved for saving the data from a direction dir_buff_time).





(c)

```
MACHINE
    dftM0
SEES
    dftC0
VARIABLES
    sent            // p envoyé
    rcvd            // p reçu
    switchcontrol
    str
    gr
    Task_rate
    Emis_time
    Total_data
    Forward_time
    Rcvd_data
    Recp_task
    syst_state
EVENTS
    INITIALISATION  ≙
    STATUS
      ordinary
BEGIN
      act1   :  sent:=∅
      act2   :  rcvd:=∅
      act3   :  switchcontrol:=∅
      act4   :  str:=∅
      act5   :  gr:= g
      act6   :  Task_rate:=0
      act7   :  Emis_time:=2
      act8   :  Forward_time:= 3
      act9   :  Total_data:=0
      act10  :  Rcvd_data:=0
      act11  :  Recp_task:=∅
      act12  :  syst_state:=0
END

    SEND  ≙              //  l'envoi du p(sending data)
    STATUS
      ordinary
ANY
      p          //  paquet
      s          //  un noeud source
WHERE
      grd1   :  p∈PACKETS
      grd2   :  s∈NODES
      grd3   :  s=src(p)
THEN
      act1   :  sent:=sent∪{s↦p}
      act2   :  str:=str ∪{s↦p}        le réseau
      act3   :  Task_rate:=Task_rate+Emis_time
      act4   :  Total_data:=Total_data+1
END
END

    RECIEVE  ≙            //  la reception du p
    STATUS
      ordinary
ANY
      p
      d          //  dst
      s
WHERE
      grd1   :  p∈PACKETS
      grd2   :  d∈NODES
      grd3   :  s∈NODES
      grd4   :  s=src(p)
      grd5   :  d=dst(p)
      grd6   :  p∈ sent[{s}]
THEN
      act1   :  rcvd := rcvd ∪{d↦p}
      act2   :  str:=str\{d↦p}
      act3   :  Recp_task:=Recp_task∪{d↦Task_rate}
      act4   :  Rcvd_data:=Rcvd_data+1
END

    FORWARD  ≙
    STATUS
      ordinary
ANY
      n
      d
      m
      p
WHERE
      grd1   :  n∈NODES
      grd2   :  d∈NODES
      grd3   :  m∈NODES
      grd4   :  p∈PACKETS
      grd5   :  d=dst(p)
      grd6   :  n ↦ p ∈ switchcontrol
      grd7   :  n ↦m  ∈ cls(gr)
      grd8   :  m ↦ d ∈ cls(gr)
      grd9   :  str=str ∪{n↦p}          //  le p est mis ds le reasean
THEN
      act1   :  switchcontrol:=(switchcontrol\{n↦p})∪{m↦p}
      act2   :  Task_rate:=Task_rate+Forward_time
      act3   :  Rcvd_data:=Rcvd_data+1
END
    EVALUATE1  ≙
    STATUS
      ordinary
ANY
      p
      p2
WHERE
      grd1   :  p∈ℕ
      grd2   :  p2∈ℕ
      grd3   :  p2=Rcvd_data
      grd4   :  p=Total_data
      grd5   :  p−p2≥Total_data÷2
THEN
      act1   :  syst_state:=1
END
END
```

Figure 6. the BAN context modeling.
a. the modeling flow of BAN models.
b. the first BAN model(Ban_M0) and the used NoC theory
c. The BAN Machine Ban_M0

4. Experimental test and results

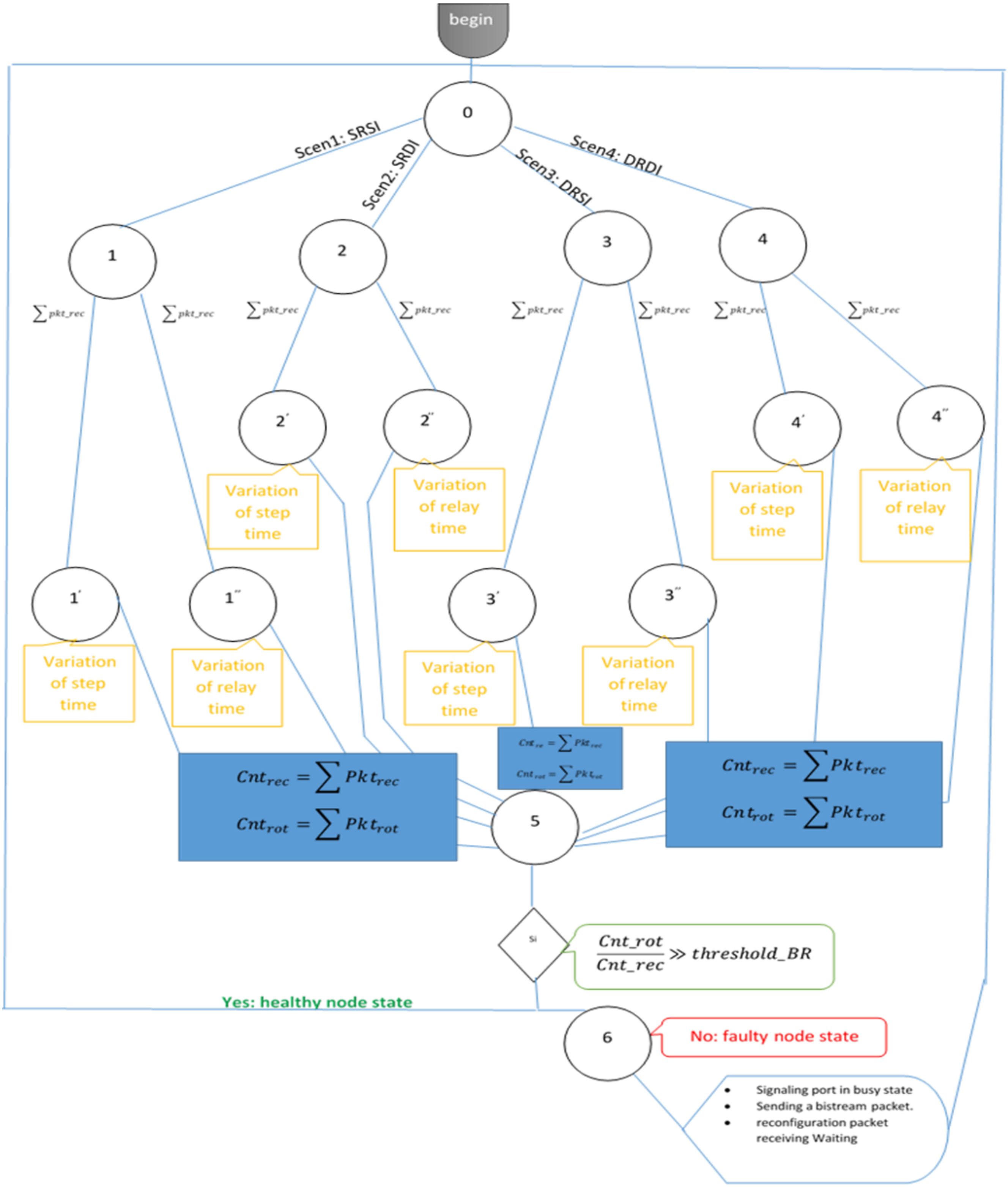


Figure 6 the simulation of BAN context on Xilinx vivado Environment.

It is important to coordinate concurrent transmissions from multiple nano-machines to realize the potential of multi-hop BAN network in the aim of answering this meaningful question: Does the process of sending different symbol rates by different bio-nano-devices invite any collision at the receiver?

We redefine "collision" in the context of BAN

networks. It includes not only sequential collision of symbols of a same packet but also the sequential collision of symbols from different packets.

We observe that two important factors are responsible for such type of collision: the instance for arrival of data, and the rate to make it received by a node.

Following the same line of argument just presented, we consider that the state of receiver node can be

Modeled using Event-B model that call the NoC theory, colored graph theory and VHDL theory, this model will also give the decision of how to give a recover signal to make the node in the state "faulty" become again a "healthy" node.

This model was interpreted to VHDL annotation thanks to the VHDL theory giving us the opportunity to created four axes of simulation where the sent data were received at:

same rate (speed associated to distance which corresponds in our case to direction) and same time instant. (or shortly SRSI see Figure 6).

same rate but different at time instants, (or shortly SRDI see Figure 6).

different rates at same time instant, (or shortly DRSI see Figure 6).

different rates and different time instant, (or shortly DRDI see Figure 6).

The variation of the two factors was to ensure the reason of collision as follow:

4.1. The Variation by Arrival Rate

The variation of the two factors was to ensure the reason of collision. Knowing that changing the rate of arrival data is to change the time scale that represent this reservation of time of data to ensure the passage from the Net interfaces to the buffers then to the next interfaces calculated.

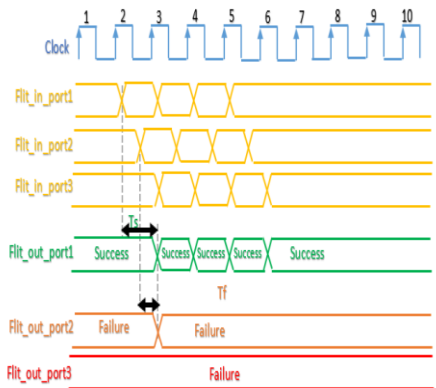


Figure 7 the rate variation meaning in BAN context

4.2. The Variation by Arrival Instance

The variation of the arrival instance was calculated by observing the escape time between the time of successful receiving data (Ts) in the net interfaces and the failure time (Tf).

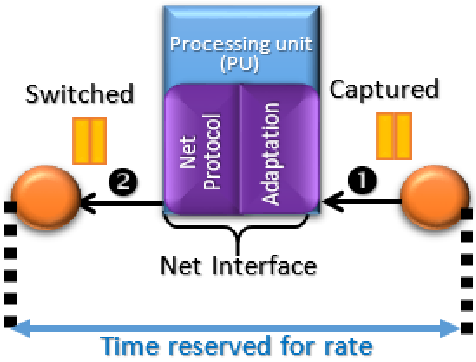


Figure 8 the time variation meaning in BAN context

5. Conclusion and future perspectives

This suggested new approach for fault-tolerant wireless network using FPGA base SoC (System-On-Chip). This approach exploits the notion of refinement and incrementality mechanisms and formal proof. It allows us to improve the reliability and decrease the design time of high level specification.

The strategy used during the study, well-defined graph theory, auto-self organization network using reconfigurable FPGA and well-defined nano-sensors theory. We can map theses nano-sensors theories with IP blocs. We show that our methodology can integrate several constraints like for example those associated to probabilistic model. Other concepts and technics associated to BAN network can be injected in future research such Multiple Input Output Orthogonal Frequency Demodulation Modulation MIMO-OFDM [11], as new step in the refinement process.

The methodology used the coupled tools, at one hand RODIN tool based Event-B language and at the other hand Simulation Xilinx environment [9] and VHDL language. Code generation and integration system will be performed in the last step of the methodology.

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