A New Procedure for Resource Reservation in Advance, Based on the Implementation of QoS NSLP Signaling

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ABSTRACT: *Providing QoS (Quality of Service) to mobile terminals in an all-IP environment is a very extensive research. In integrated services networks, the most of work seeking to extend RSVP to a mobile environment. In this case, the article describes a new procedure for resource reservation in the wireless environment. It is based on the application of QoS NSLP signaling [1], following the work of the IETF NSIS (Next Steps In Signaling) WG. This is based on a reservation MSpec object that determines the future locations of the terminal which is included in a mobility profile. In this way we can improve the QoS.*

Keywords: NSIS, Signaling, Handover, QOS, Mobility, MSpec

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1. Introduction

The IP world experienced a remarkable evolution and especially with demanding applications in terms of Quality of Service (QoS), with the introduction of signaling in this area several solutions which are seen as RSVP() [9], MPLS() and GMPLS() [5]. The diversity of signaling solutions pushes the IETF() in 2002 to launch a new working group to unify all his signaling solutions. This working group appointed as NSIS (Next Steps In Signaling). The NSIS protocol consists of two layers that are the NTLP() and NSLP() [6] the signaling layer (see Figure 1):

• NSLP (NSIS Signaling Layer Protocol) is the upper layer stack NSIS [3] [4] protocol. It is designed for a particular application signaling and has two main points of interaction. It acts on one side with NTLP, and the other with the appropriate application signaling, which is not actually a part of the NSIS protocol. In addition, NSLP can define such formats message: the message PDU (Protocol Data Units) Posts sequence, etc.. NSLP is application-specific signaling.

• NTLP (NSIS Transport Layer Protocol Protocol) is the lower layer stack NSIS protocol. It is designed to work with the IP layer and the different NSLPS. Its role is to transmit signaling messages sent by the NSLP layer between two adjacent nodes NSIS. In addition to these signaling messages NTLP allows the exchange of control information such as error messages and forwarding messages.

QoS-NSLP [1] must act with block traffic that the router and the operating model of QoS-NSLP are given in the diagram above.

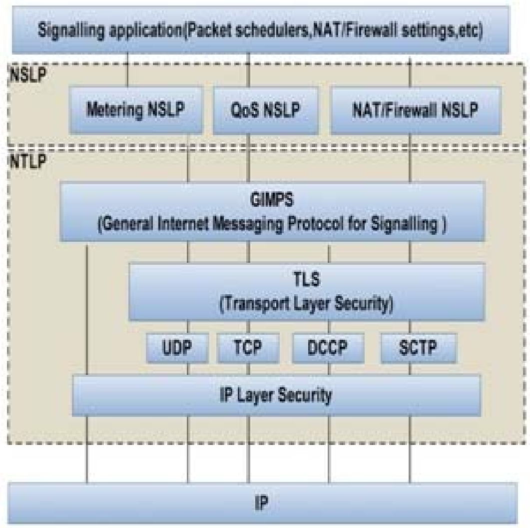


Figure 1. NSIS stack protocol

2. Applying QOS NSLP Signaling

The function of QoS-NSLP is essentially similar to the operation of Resource Reservation Protocol (RSVP) with a better representation. QoS-NSLP is not compatible with RSVP, but interoperability between the two protocols could be possible signaling passages.

QoS NSLP can generate a signal to provide a certain level of QoS, it is independent of the model used for QoS (DiffServ, IntServ...).

QoS NSLP generates four types of messages:

- **Reserve:** The only message that manipulates the state of the reservation (refresh, create, delete).
- **Response:** It can send a response to a previously received message.
- **Query:** This message is used to request information about the nodes in the path data, such as available resources.
- **Notification:** This type of message informs a node without advance request.

2.1 QoS NSLP Objects

QoS NSLP message includes a common header to all messages; it is followed by objects whose use is determined for each type of message. Among these objects there are: Response Request, Refresh Period, Session ID, Error SPEC, QSpec [2]. We are particularly interested in the subject QSpec because it allows you specify the QoS requested.

QSpec QoS NSLP is transparent; it can contain traffic characteristics (TSpecs RSVP), a description of the desired QoS (RSpec) and available resources (ADSPEC). QSpec corresponds to the three specified in RSVP objects.

2.2 Parameters of QSpec

The following parameters are available for QSpec [2].

1. QSpec ID
2. QSM Control Information

3. QoS Description: Traffic Descriptors, QoS Class QoS Characterization, Excess Treatment, Priority and Reliability, Service Schedule, Monitoring Requirements.

QoS NSLP relies on GIMPS for transporting signaling. Features such as the identification of adjacent NEQ, the detection of the last QNE, or a Session ID parameter as identified by GIMPS QoS NSLP and sent via an API [7] [8].

3. Profile of Mobility

3.1 Features of a Profile of Mobility

Improving QoS in a mobile IP network based on mobility profile of the user, which required reserve resources in advance for the mobile device only in cells which can be visited. This reservation is made after an observation phase of the terminal. [10] This improvement approach is validated in the project RNRT IP-SIG.

The profile of mobility by RNRT IP-SIG project is based on the behavior of the user to determine its future location. So locating space consists of N cells. The user profile after his behavior and movements follows m association with e system of N cells. Afterward, the modeling is with Markov chains. The system is a model that can evolve between n states defined by the set:

• $C = (C1, C2, Ci \text{........ ....} Cn)$

The system is in state i = the mobile terminal is in the cell Ci

• ***Pij*:** probability of transition of the cell Ci to cell Cj

• ***P* (*t*):** the probability that the mobile terminal is in the cell Ci at the instant t

The behavioral model of the user whose mobility profile is determined by following:

• A unique identifier for the user (*User_id*)

• User preferences (*User_P*)

• Matrix *M*

• Vector *V*

• Mspace (Mobility Specification)

• Decision of the handover

3.2 Resource Reservation in Advance with QoS NSLP

QoS NSLP messages are used to make reservations in advance. The reservation is made in a MSpec object included in a mobility profile. [11]

3.3 Format MSpec

The proposed MSpec the format is as follows:

• MSpec <MSpec ID> <Duration> <Cell ID>.

• MSpec ID: MSpec a unique identifier.

Duration: <Start Time>, <End Time>: this is the time interval during which it is possible to determine the future locations of the mobile terminal.

For resource reservation in advance, MAP passes both parameters Duration Service Schedule the QSpec.

• Cell ID: <cell ID1>, <cell ID2>, <cell ID3>... <cell IDn>.
This is a set of cell identifiers. It is assumed that each cell is identified by a unique identifier.

3.4 QoS NSLP

QoS NSLP is the procedure for resource reservation in advance with QoS NSLP in mobile environment. QoS NSLP operates in two modes: Sender Initiated Reservation and Receiver Initiated Reservation. In the first mode, the transmitter initiates the flow reservation (it sends the message RESERVE), in the second mode, the receiver initiates the flow reservation. The figure 2 shows the procedure for resource reservation in advance through the QoS NSLP messages.

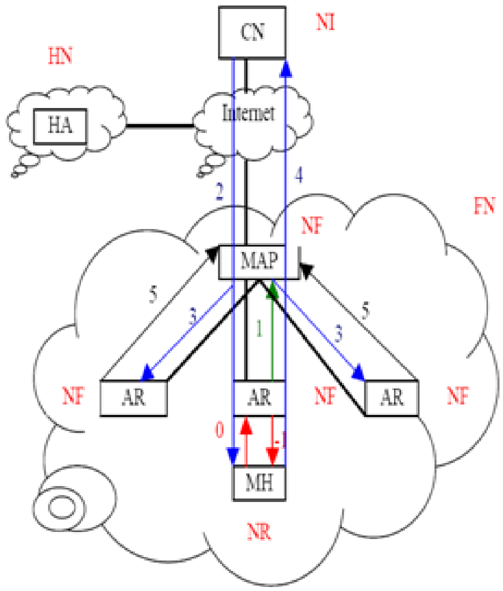


Figure 2. The procedure for advance reservation

MH : Mobile Host

AR : Access Router

HA : Home Agent

0: Router Advertisement message (MIPv6)

1 : Registration request message (MIPv6)

2 : NOTIFY message (QoS NSLP)

3 : RESERVE message (QoS NSLP)

4 : RESERVE message

5 : RESPONSE message (QoS NSLP)

6 : RESPONSE message

In the case of an approach Sender Initiated Reservation QoS NSLP, CN represents the NI (NSIS Initiator: it is the entity that initiates NSIS signaling protocol at the request of a signaling application.) MH represents NR (the last entity on the NSIS signaling pathway, which responds to the NI.) and each AR (Access Router) and the MAP (Mobility Anchor Point) represent a NF (the NSIS entity which propagates signaling between the NI and NR).

4. The Procedure of Handover

During the handover, the MH through the following steps:

a. Registration with the new AR (Mobile IPv6).

b. To minimize packet loss and before installing the new path, we propose to make a context transfer between the old and the new AR via the CTP (Context Transfer Protocol). In the case of a “Network controlled” mode, initiated by the nAR, messages following are used:

b1. The new AR sends the message CT Request to the old AR.

b2. Former AR answers using the message CTD (CTDR the message is optional).

c. Establishment of the new path and update the resource reservation:

c1. The new AR sends the message RESERVE MH (message 1 in Figure 3).

c2. MH responds with the RESPONSE message including the new MSpec (post 2 on Figure 3).

c3. After receiving the message RESPONSE, the new AR sends a NOTIFY message to the MAP including the new MSpec.

c4. The MAP tests the new MSpec, and performs the following actions:

- Guard reservation for the old cell if it belongs to the new MSpec, otherwise deletes the reservation.
- Made reservations in advance in the new cells that do not belong to the old MSpec
- Removes the reservation for the old cells that do not belong to the new MSpec but quite sour for the current cell.

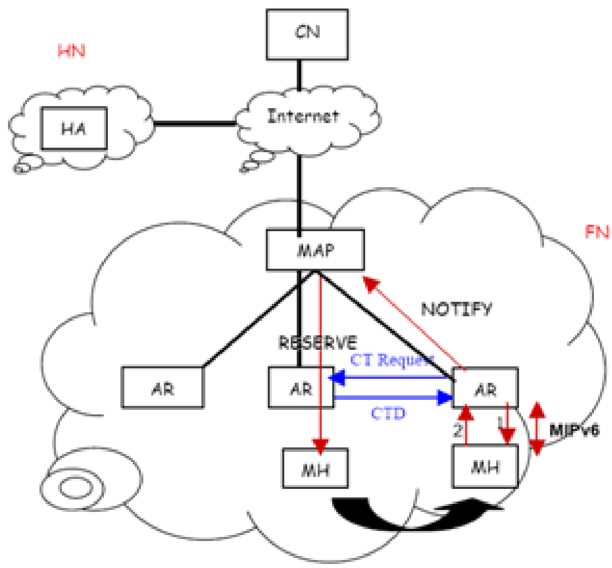


Figure 3. The procedure of handover

5. Mathematical Model

The objective of this simulation is to find the correct value of θ in order to simulate the system and consider the time required for the determination of *MSpec*. The key to resource reservation in advance is all *MSpec*. The *MSpec* is defined as follows:

$$MSpec\,(tr) = \{ Cj \,/\, Pj\,(tr+1) \geq \theta \}, (\, 0 \leq \theta \leq 1).$$

The choice of the value of θ is very important to build *MSpec*. More θ is large (close to 1), the more *MSpec* is reduced, if θ is small enough (close to 0), the set contains the entire *MSpec* neighborhood.

We define the following function *f* :

$$f\,(a_j, C_i) = \begin{cases} \{\} & si \quad a_i = 0 \\ \{\, C_i \,\} & si \quad a_i = 1 \end{cases}$$

The *MSpec* is defined by:

$$MSpec = \bigcup_{i=1}^{n} f\,(ai, Ci)$$

The following parameters are related to *MSpec* and are considered for simulation:

- Nb_cel_MSpec: the number of cells constituting the *MSpec*.
- T_Determination: time determining the MSpec by the mobile terminal.
- Failure rate: the failure rate for determining the MSpec.

  Nb_cel_MSpec: the number of cells constituting the MSpec.

Mathematical summary: We: $C = (C1, C2, Ci \ldots\ldots \ldots\ldots Cn)$: all the cells in the vicinity of the mobile terminal.
The MSpec is defined as follows:

$$MSpec\,(tr) = \{Cj \,/\, Pj\,(tr+1) \geq \theta\,\},\ (0 \leq \theta \leq 1).$$

If $\theta = 0$ then the *MSpec* = C (*MSpec* contains the entire neighborhood), and the number of cells constituting the *MSpec* is n.

If $\theta = 1$ then {} = *MSpec* (all MSpec is empty). In this case the number of cells constituting the *MSpec* was 0.

The function f is defined as follows:

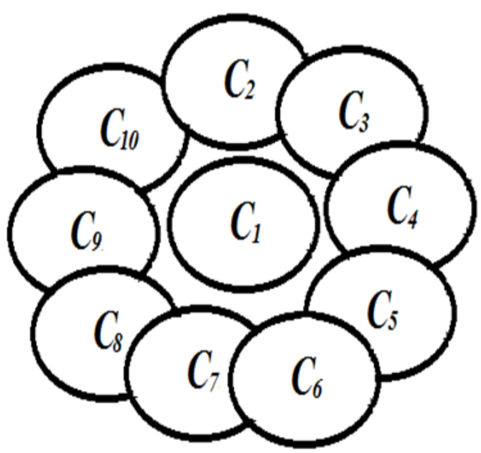
$$f\,(a_j, C_i) = \begin{cases} \{\} & si \quad a_i = 0 \\ \{\mathrm{C_i}\} & si \quad a_i = 1 \end{cases}$$

And thus, we can deduce the following formula:

$$MSpec = \bigcup_{i=1}^{n} f\,\big((1-\theta), Ci\big)$$

6. Simulation

The location of the cells relative to each other influences the transition probabilities. We consider the following cell location, provided that the vicinity of the user contains 10 cells.



Let $k\,(i)$ the number of times that the user logs in the cell *i* at time to. We obtain the following table:

k (1)	k (2)	k (3)	k (4)	k (5)	k (6)	k (7)	k (8)	k (9)	k (10)
0	5	7	8	0	12	0	8	0	0

Subsequently, the vector was $V = (P1\,(\text{to}), \ldots, P8\,(\text{to}))$, with Pi (to), it is calculated using the following formula :

$$Pi\,(to) = \frac{k\,(i)}{m}$$

We obtain

P1 (to)	P2 (to)	P3 (to)	P4 (to)	P5 (to)	P6 (to)	P7 (to)	P8 (to)	P9 (to)	P10 (to)
0	0.125	0.175	0.2	0	0.3	0.075	0.2	0	0

Before calculating the matrix M, we give the table $T[i, j]$ which contains the number of transitions of the cell i to cell j during 40 association of our system.

T[i, j]	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}
C_1	0	6	6	4	3	2	3	2	3	2
C_2	5	0	7	0	0	0	0	0	0	4
C_3	5	9	0	8	0	0	0	0	0	0
C_4	5	0	8	0	7	0	0	0	0	0
C_5	4	0	0	5	0	5	0	0	0	0
C_6	6	0	0	0	8	0	6	0	0	0
C_7	3	0	0	0	0	4	0	3	0	0
C_8	3	0	0	0	0	0	3	0	5	0
C_9	2	0	0	0	0	0	0	3	0	3
C_{10}	3	4	0	0	8	0	4	0	2	0

Now, We set $g(i)$ the number of transitions that have as starting point the cell i during the 40 associations. It is calculated as follows:

$$g(i) = \sum_{j=1}^{8} T[i, j],$$

And we obtain

g (1)	g (2)	g (3)	g (4)	g (5)	g (6)	g (7)	g (8)	g (9)	g (10)
31	16	22	20	14	20	10	11	8	9

The matrix is calculated using the formula

$$M[i, j] = \frac{T[i, j]}{g(i)}$$

The matrix $M[i, j]$ is the following

M[i,j]	1	2	3	4	5	6	7	8	9	10
1	0	0.1935	0.1935	0.1290	0.0968	0.0645	0.0968	0.0645	0.0968	0.0645
2	0.3125	0	0.4375	0	0	0	0	0	0	0.2500
3	0.2273	0.4091	0	0.3636	0	0	0	0	0	0
4	0.2500	0	0.4000	0	0.3500	0	0	0	0	0
5	0.2857	0	0	0.3571	0	0.3571	0	0	0	0
6	0.3000	0	0	0	0.4000	0	0.3000	0	0	0
7	0.3000	0	0	0	0	0.4000	0	0.3000	0	0
8	0.2727	0	0	0	0	0	0.2727	0	0.4545	0
9	0.2500	0	0	0	0	0	0	0.3750	0	0.3750
10	0.3333	0.4444	0	0	0	0	0	0	0.2222	0

After 30 associations with the system, the matrix $M[i, j]$ and the vector $V(i)$ are fixed. To calculate V_1, we use the following numerical scheme:

$$V_1 = \frac{V \times M + \frac{1}{2} V \times M^2}{\frac{3}{2}} \quad \text{And} \quad V^*_1 = V_1 \times \frac{N}{10}$$

In order to build the first *MSpec*1 for handover, where N is the number of cells. We build the others handover of the system by calculates the vector

$$V_i = \frac{V_{i-1} \times M + \frac{1}{2} \mathrm{V}_{i-1} \times M^2}{\frac{3}{2}} \quad \text{And} \quad V^*_i = V_i \times \frac{N}{10}$$

7. Results and Discussion

Using MATLAB[] and after 6 handovers, we have the following results:

$$V_1^* = [0.2488 \;\; 0.0884 \;\; 0.1264 \;\; 0.0931 \;\; 0.1429 \;\; 0.0478 \;\; 0.1052 \;\; 0.0317 \;\; 0.0717 \;\; 0.0440]$$

$$V_2^* = [0.2119 \;\; 0.1196 \;\; 0.1307 \;\; 0.1190 \;\; 0.0868 \;\; 0.0925 \;\; 0.0558 \;\; 0.0649 \;\; 0.0550 \;\; 0.0638]$$

$$V_3^* = [0.2181 \;\; 0.1247 \;\; 0.1401 \;\; 0.1089 \;\; 0.0945 \;\; 0.0700 \;\; 0.0624 \;\; 0.0533 \;\; 0.0623 \;\; 0.0658]$$

$$V_4^* = [0.2169 \;\; 0.1291 \;\; 0.1414 \;\; 0.1119 \;\; 0.0880 \;\; 0.0711 \;\; 0.0571 \;\; 0.0553 \;\; 0.0606 \;\; 0.0686]$$

$$V_5^* = [0.2171 \;\; 0.1306 \;\; 0.1433 \;\; 0.1111 \;\; 0.0881 \;\; 0.0684 \;\; 0.0570 \;\; 0.0540 \;\; 0.0612 \;\; 0.0692]$$

$$V_6^* = [0.2170 \;\; 0.1315 \;\; 0.1438 \;\; 0.1115 \;\; 0.0873 \;\; 0.0681 \;\; 0.0562 \;\; 0.0539 \;\; 0.0610 \;\; 0.0696]$$

$$V_{100}^* = [0.2170 \;\; 0.1322 \;\; 0.1445 \;\; 0.1116 \;\; 0.0870 \;\; 0.0674 \;\; 0.0558 \;\; 0.0536 \;\; 0.0609 \;\; 0.0699]$$

For the traditional method, we have

$$V_1 = [0.2712 \;\; 0.0700 \;\; 0.1350 \;\; 0.0665 \;\; 0.1900 \;\; 0 \;\; 0.1440 \;\; 0 \;\; 0.0920 \;\; 0.0313]$$

$$V_2 = [0.2015 \;\; 0.1193 \;\; 0.1089 \;\; 0.1558 \;\; 0.0504 \;\; 0.1404 \;\; 0.0271 \;\; 0.0940 \;\; 0.0343 \;\; 0.0683]$$

$$V_3 = [0.2217 \;\; 0.1119 \;\; 0.1531 \;\; 0.0873 \;\; 0.1308 \;\; 0.0406 \;\; 0.0876 \;\; 0.0331 \;\; 0.0791 \;\; 0.0548]$$

$$V_4 = [0.2147 \;\; 0.1275 \;\; 0.1263 \;\; 0.1350 \;\; 0.0689 \;\; 0.0941 \;\; 0.0433 \;\; 0.0693 \;\; 0.0500 \;\; 0.0709]$$

$$V_5 = [0.2176 \;\; 0.1225 \;\; 0.1509 \;\; 0.1022 \;\; 0.1064 \;\; 0.0543 \;\; 0.0684 \;\; 0.0446 \;\; 0.0696 \;\; 0.0635]$$

$$V_6 = [0.2159 \;\; 0.1296 \;\; 0.1361 \;\; 0.1250 \;\; 0.0792 \;\; 0.0777 \;\; 0.0501 \;\; 0.0597 \;\; 0.0569 \;\; 0.0698]$$

The graph below shows the impact value of θ on the number of cells constituting the MSpec.

We note that from the 0.28 value of θ, the *MSpec* is empty, so the values of θ above 0.28 are not interesting for the simulation. In the following and for the rest of the simulation, we will take $\theta = 0.1$

The study of the convergence and stability of our mathematical model which is based on the Taylor expansion we get a much improved model and the simulation results with MATLAB shows it all.

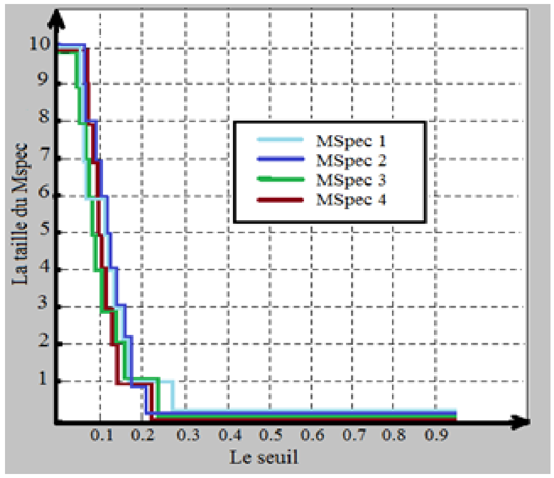


Figure 3. Impact θ value of the number of cells constituting the *MSpec*

8. Conclusion

We presented in this paper a new procedure for resource reservation in advance, based on the application of QoS NSLP signaling. This reservation is made by an MSpec object that determines the future locations of the mobile terminal. Our goal through this procedure is to minimize the degradation services during the handover. We have proposed a format for MSpec object that will be considered an extension of QoS NSLP messages. To increase the performance of the handover, we propose using a context transfer protocol (CTP).

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