SCTP Extension for EGPRS/WLAN Handover Data

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Abstract – Multistreaming and multihoming SCTP features give better performance than TCP for the transport of signaling in wired networks. More recently, some solutions have been defined for wireless environment [1]. Mobile SCTP (mSCTP) is a wireless extension that was proposed to take benefit from the multihoming feature for handoff. In this paper we use SCTP's multihoming feature and define a new type of control chunk in order to retrieve radio information from mobile and to use this information to improve the performance of SCTP in handoff situation. We propose modifications of the SCTP congestion control algorithms to take into account information sent by mobile to the network (GGSN) via QoS_Measurement_Chunk. This new mechanism is useful to perform inter RAT handover for data. The example studied here is between EGPRS and WLAN. The results obtained are compared with the standard SCTP and present an improvement of performance especially in terms of throughput.

***Keywords* – Data Handover, SCTP, Qos_Measurement_chunk, cwnd adaptation, cross layer.**

I. Introduction

One major TCP problem when using a radio link is its ability to detect packet losses due to transmission errors [2]. Indeed, TCP considers all the losses as caused by congestion problems, as it has been designed initially for a wired environment. Thus the risk to trigger slow start phase whereas the network isn't congested. TCP performance over wireless networks is affected by high link errors, low bandwidth and large delays.

A proposed solution considers that a transmission error occuring when sending datagrammes will not trigger congestion control mechanisms, at the transmitter end. At the receiver side, the idea is to mask the transmission to transport protocol by taking them again on layer 2 via a reliable ARQ mechanism (not always possible because of retransmission delays). Existing well established solutions like the Eifel algorithm [3]that requires both the sender and the receiver to support TCP's timestamp option.

In our approach we consider SCTP protocol for its reliability and interesting transmission features, which consists of creating a cross layer alternative based on chunk control aspect in SCTP. We propose a new control chunk named QoS_Measurement_chunk used to carry radio transmission conditions to transport layer in order to adapt congestion control parameter to the radio transmission conditions. This information will determine when to trigger change of SCTP address. The mobile node uses this chunk to inform GGSN about radio link quality (as PDCP frame error rate PDCP, maximum capacity supported by the radio link...). This chunk can also serve to inform the GGSN of any modification as the available radio link throughput (degradation of radio conditions, change of coding scheme...). This information is used by the GGSN to update the size of congestion window in the downlink according to the maximum bit rate tolerated by the activated coding scheme.

This chunk contains mainly the maximum available throughput for a PDP-Context established within an SCTP association. QoS_Measurement_chunk is exchanged at the establishment of the association to inform the network about the maximum capacity provided by the access network to the end user. The mobile sends QoS_Measurement_chunk each time its access parameters change. This information can be particularly useful for data handover, and especially in a multi RAT context. This work tackles data handover between EGPRS and WLAN access.

The paper is organized as follows. Section 2 details simulation scenarii and parameters. Section 3 describe the proposed contribution for the SCTP congestion control mechanism. Simulation results and interpretations related to EGPRS/EGPRS and EGPRS/WLAN handover are given by section 4. Finally, some conclusions are drawn.

II. Simulation context

We simulate two scenarii to study the improvement of our modification to the SCTP protocol. Firstly, we consider two EGPRS cells and we suppose that we have one mobile (it has a single IP address conserved for the lifetime of the PDP context), the correspondent scenario is given by figure 1. The handover is triggered by the BSS.

At PDP context setup, an SCTP association is established between MS and GGSN. SCTP association is multihomed on server IP side, and we activate one stream because we use a simple application FTP flow. The MS has only one IP address (it does not change during the PDP context lifetime). The primary address of SCTP association corresponds to the IP address located on the MS-SGSN network. This address can change if the mobile changes of SGSN. At level 2 (RLC/MAC) to reproduce link quality degradation by changing the coding scheme used to transmit RLC blocks (Errors uniformly distributed at RLC/MAC level with a 10^{-2} loss rate). Coding scheme can change from CS3 to CS1. The coding scheme used in the new cell is CS3 (just after the handover)

The window size can vary at the RLC/MAC level from 64 to 384 blocks. A TBF can use up to 3 PDCH in downlink and 1 PDCH in uplink.

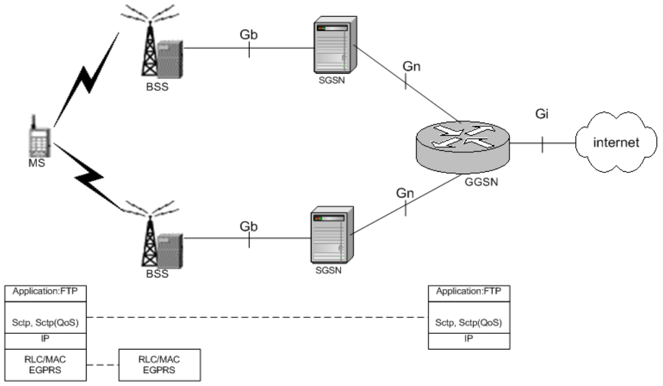

Figure 1.. Simulated Architecture

The degradation of throughput on the radio interface triggers the handover towards the new cell and then new radio conditions are taken into account for the alternate SCTP path. Table 1 gives the simulation parameters.

TABLE 1. SIMULATION PARAMETERS

Interface	Link	Rate	Propagation delay
Gb	duplex	64Kbps	100ms
Gi	duplex	5Mbps	100ms
GGSN-Fixed Host	duplex	5Mbps	100ms

The error model on the Gi interface, is uniformly distributed with a mean packet error rate of 1%. Qos_Measurement_Chunk functionality was added to the SCTP simulator developed by [4].

Secondly, we consider an inter RAT handover : data handover from EGPRS cell to WLAN (see figure 2). Parameters for EGPRS cell are the same as the previous studied scenario, we consider that the quality is decreased over the EGPRS cell, controlled by the BLER.

Over WLAN radio interface we consider a two ray ground propagation model that considers both the direct path and a ground reflection path. For the EGPRS/WLAN handover we consider a loose coupling approach that the WLAN gateway does not have any direct connection to EGPRS network elements. WLAN traffic would not go through EGPRS core network. We suppose that the fixed host is multihomed where each interface corresponds to different radio access technology. The Mobile host isn't multihomed.

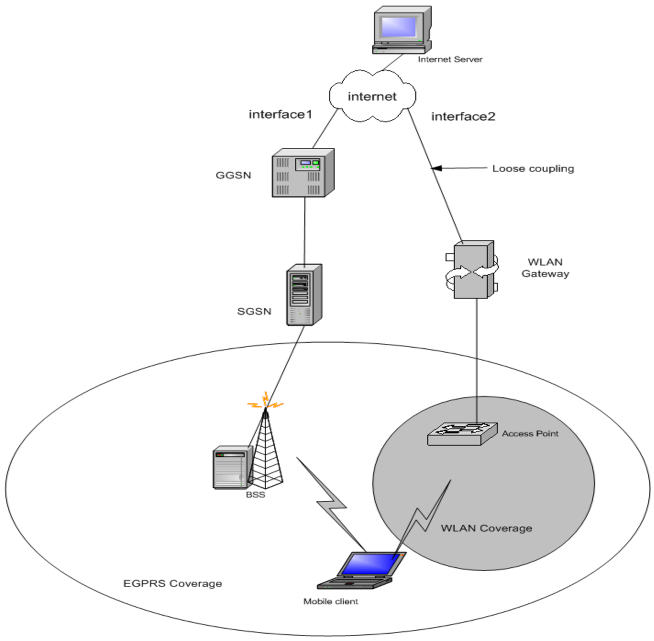

Figure 2.. Simulated Architecture for EGPRS/WLAN handover.

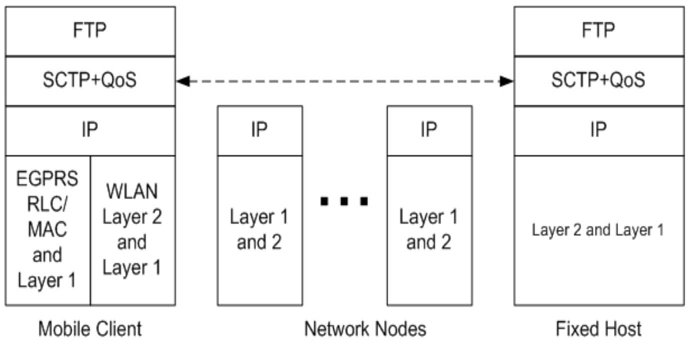

Figure 3.. Protocol Architecture.

III. QOS_MEASUREMENT PROCEDURE PERFORMANCE

At the establishment of the association, the mobile transmits to the GGSN (via the PDP context activation procedure) the attributes of the radio link, here we consider the maximum bit rate allowed on the radio interface (15.6kbps for cs3, 9.05kbps for cs1 ...). The reception of a Qos_Measurement_chunk containing the information about the coding scheme used in the downlink just after the handover, will cause an update of the cwnd in the new cell. The cwnd is performed as follows.

*cwnd(new_cell)=cwnd(old_cell)-C(Cs_old_cell)*RTT+C(Cs-new_cell)*RTT*, where

C(Cs_old_cell) is the throughput provided by the coding scheme used in the old cell just before handover and *C(Cs-new_cell)* is the throughput provided by the coding scheme used in the new cell just after the handover.

Modifications concern the fact that slow start is not systematically triggered when a handover occurs such as it is done in standard SCTP. In fact, ssthresh value which consist on keeping the old value of ssthresh of last cell for the ssthresh on the new cell. That means that if the mobile is in congestion avoidance phase in the old cell, it will stay in this phase in the new cell with an updated value of cwnd (just after the handover and if no transmission errors occur). If the mobile is in slow start phase in the old cell, it will stay in the slow start phase in the new cell but with a value equal to the *cwnd(new_cell) instead of one or two MTUs* (as in the standard SCTP) [5].

The proposed extension does not modify directly the congestion control algorithm in standard SCTP, it is rather an adaptation to the radio conditions. Indeed, the problem highlighted is the change of radio conditions and its impact on the flow transmission control at the transport layer. The losses on the radio interface are generally interpreted by transport protocol as congestion problems on the fixed part of the network. QoS_Measurement_Chunk is an approach that makes the possibility to informe the transport protocol about the transmission parameters on the radio interface. This makes it possible to adapt the flow of data transmission by an update of the parameters of congestion control mainly the size of the congestion window (cwnd) and the slow start threshold (ssthresh) (vs. Figure 4). The receiver side doesn't send an ACK after processing of a QoS_Measurement_Chunk, it is a measurement report.

The cwnd and ssthresh update is done according to their previous respective values and of the BDP of the radio link as it is described above. QoS_Measurement_Chunk is a control chunk independent of Heartbeat chunk. Its emission cannot be periodic as it is the case for the heartbeat chunks. This chunk allows an instantaneous control of the transmission flow.

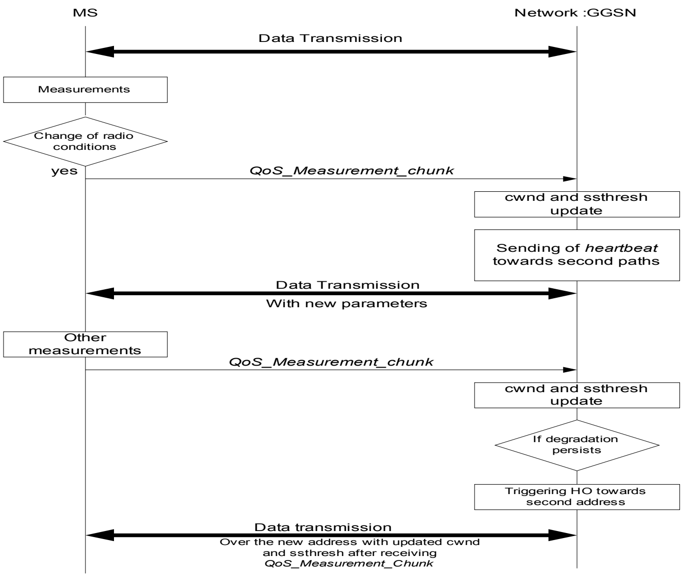

Figure 4. Qos_Measurement_chunk approach

IV. Simulations results

A. EGPRS/EGPRS Handover

Figure 5 shows the evolution of congestion window during PDP context, we notice that the evolution of cwnd is better for the proposed extension than standard SCTP. In fact, the throughput increases more rapidly for the proposed extension. The standard SCTP sets cwnd to one MTU for the slow start that follows the switching to the alternate path (see figure 5 at t=100s) whereas cwnd with QoS_Measurement_Chunk remains nearly unchanged and keeps growing after the handover. This is confirmed by the evolution of the TSN in figures 6 and 7.

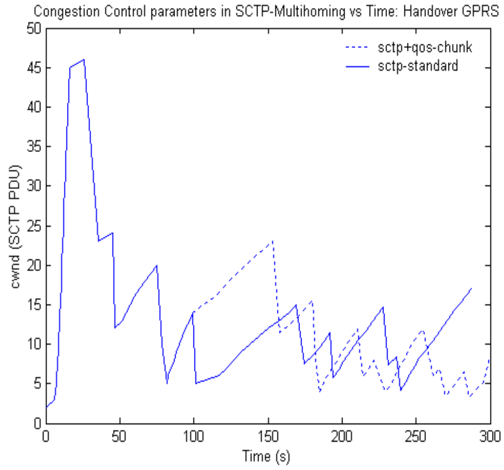

Figure 5. Congestion control window.

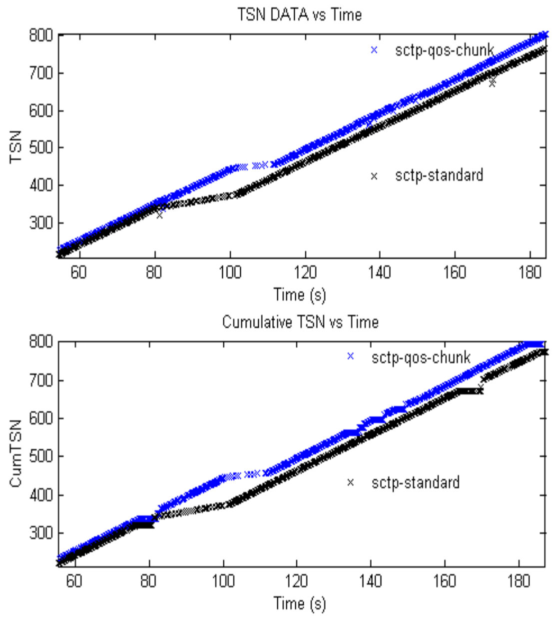

Figure 6. SCTP TSN variations.

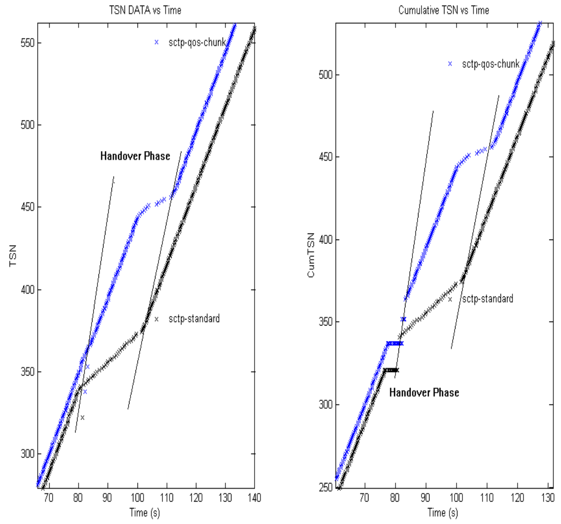

Figure 7. SCTP TSN variations (zoom).

Standard SCTP sets cwnd to one MTU for the slow start that follows the switching to the alternate path (see figure 6 at t=100s). The cwnd in the proposed extension remains unchanged and keeps growing after the handover. That explains that the evolution of cwnd is better for the proposed extension and that the throughput increases also more rapidly for the proposed extension (see figures 6and 7).

B. *EGPRS/WLAN Handover*

The IEEE 802.11 WLAN can offer high bandwidth user access, and is envisioned to interwork with EGPRS cellular network to provide better data services to mobile clients. Here we present the simulated results of data handover between EGPRS and WLAN with the proposed scheme compared to the standard SCTP. We consider that both the mobile client and the fixed host are assumed to implement SCTP with QoS_Measurement_Chunk. The mobile client supports both EGPRS and WLAN at the physical and data link layers. The fixed host is implementing SCTP multihoming feature that each interface corresponds to a type of radio access technology. The mobile is single homed during the overall communication, it provides only one IP address to support handover. The handover is initiated and controlled by the network. Figure 8 represents the evolution over time of the congestion control mechanism for the SCTP proposed extension compared to the standard SCTP. The results show that the proposed extension performs better at transport layer that after handover the cwnd increase continuously without restart with slow start as the case for standard SCTP witch supports the normal evolution of the communication and the improvement of the reception quality.

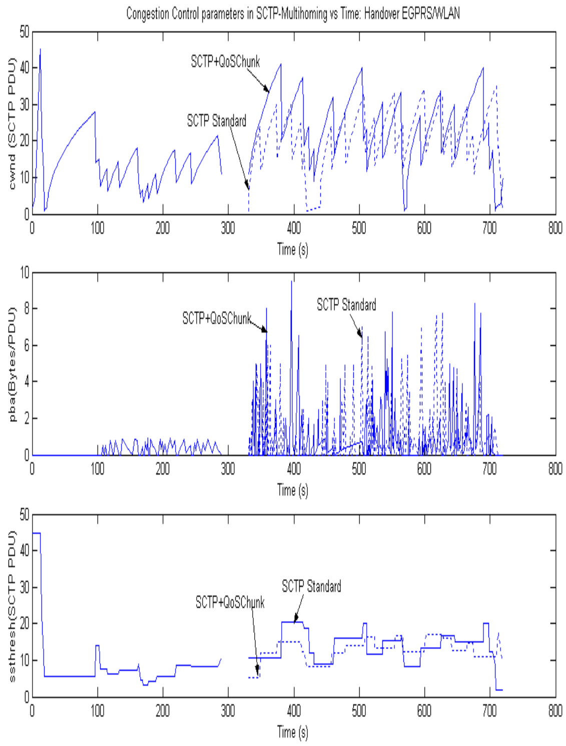

Figure 8. Congestion control parameters in the case of EGPRS/WLAN handover.

For the proposed extension the throughput increase more rapidly than the standard SCTP. The figure 9 shows the evolution of the transmission sequence number of the transmitted data chunks. We can see that SCTP with QoS_Measurement_Chunk performs better than the standard SCTP, it provides a higher throughput. Just after the link switching the standard SCTP trigger more retransmissions than the proposed extension in order to rebuild the gaps caused by the quality degradation over the EGPRS link and the setup of a slow start phase (see figure 10), the cumulative TSN curve shows the reception of duplicate TSNs which triggers a Timer expiration and so a setup of slow start phase (see figure 8at 415sec). In the case of SCTP with QoS_Measurement_Chunk, we have no timer expiration because the sender transmits continuously without losses and so the losses over wireless link is independent of congestion over the wired link.

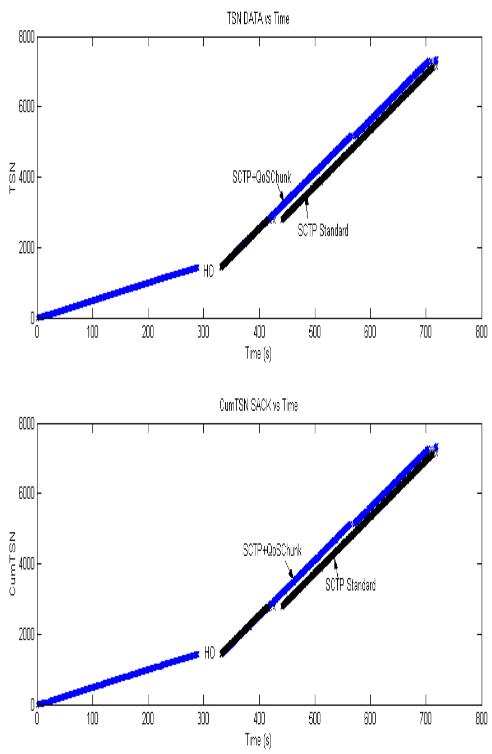

Figure 9. SCTP TSN variations.

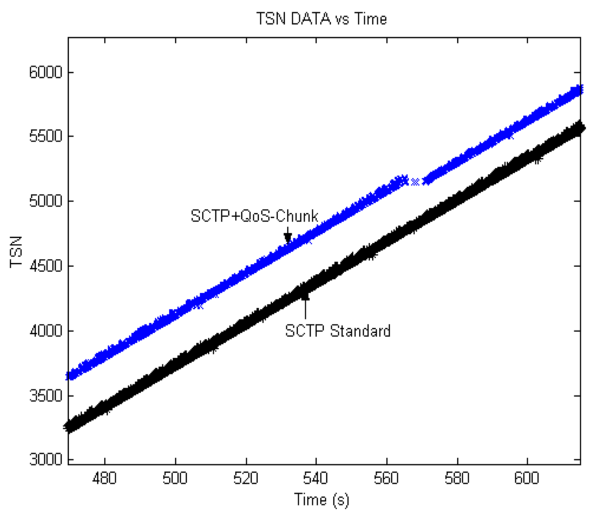

Figure 10. SCTP TSN data variations after Handover.

V. Conclusion

Simulation results show that SCTP with QoS_Measurement_Chunk performs better than standard SCTP. The modification proposed in this paper, is useful for an adaptation of the transport protocol to the radio environment. SCTP with its multihoming feature ensures data handover, with the addition of a new chunk type (QoS_Measurement_chunk control). This allows to adapt the variation of cwnd according to the radio conditions. The association does not execute slow start as the case of standard SCTP which slows down the transmission rate. The extension proposed allows handover data to be performed better than with ordinary transport protocols within an homogeneous radio access technology. This will be even more interesting in heterogeneous radio access technologies with different quality parameters as we have seen the results above. The introduced SCTP modification allows to perform data handover inter RAT in B3G networks.

References

[1] W Xing, H Karl, A Wolisz, H Mueller ,“M-SCTP: Design and prototypical implementation of an end-to-end mobility concept”,Proceedings of 5th Intl. Workshop The Internet Challenge: Technology and Applications, Berlin October 2002

[2] M Chang, M Lee, S Koh, “A Transport Layer Mobility Support Mechanism”, Information Networking: Networking Technologies for Broadband and Mobile Networks International Conference ICOIN 2004, Busan, Korea, February 18-20, 2004

[3] R.Ludwig and R.H.Katz,“the Eifel Algorithm : making Tcp Robust Against Spurious Retransmission“, ACM Computer Communications Review, vol.30, no.1, pp.30-36, January 2000.

[4] “SCTP patch of ns-2 simulator”, http://pel.cis.udel.edu

[5]R. Stewart, Q. Xie, K. Morneault, C. Sharp, H. Schwarzbauer, T. Taylor, I. Rytina, M. Kalla, L. Zhang, V. Paxson, “Stream Control Transmission Protocol”, RFC2960, October 2000