Modular Modeling of SMIL Documents with Complex Termination Events

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Abstract. In order to design and analyse complex real time systems, we improve the communication mechanism of Time Recursive Petri Net model that we have proposed in previous works. We have used our extended model, named Time $ERPN^+$, to check the temporal coherence of SMIL documents. This paper presents on-going work where special attention is given to the **termination events** between objects having distinct time references.

This paper summarises and extends some previous results of our work aiming at controlling the temporal coherence of SMIL documents by using models based on Time Recursive Petri net (Time RPN) [1]. This latter is an extension of Recursive Petri net (RPN) with time by proposing a formal methodology for the design and validation of component-based real-time systems with dynamic structure, namely Time RPN. The modularity is inherent in Time RPN without any extended notation. Afterwards, we have refined Time RPN model by improving the communication mechanism between threads; the proposed version is called Time $ERPN^+$. In Time RPN, each thread has its own local execution context (local place marking). No communication between threads is possible, except birth and death relationship. When a thread T terminates, it aborts its whole descent of threads. Only T may return results to its father-thread (which gave birth to T). Therefore, all aborted threads have a silent death, except T. Whereas in Time $ERPN^+$, communications between threads are enriched by means of shared context (global places). Furthermore, any thread has the ability to report its death, contrary to Time RPN, where some threads have silent death. Moreover, finitude, accessibility and boundness of Time $ERPN^+$ are decidable.

A multimedia document SMIL is a collection of media. A media may be (i) basic as an image, a video, a text or an hyper-link, or (ii) composite as a *par* (resp. *seq*) object which plays in parallel (resp. seq) a set of media, considered as its children. The temporal behaviour of a media is described by a set of temporal attributes. For instance, *begin* and *end* attributes define respectively the beginning and ending times of a media; it can be a known value or a synchronisation

event (e.g. $end(media1) = end(media2)$ means that $media1$ must terminate when $media2$ terminates). Author, who is in charge of creating such document, can incrementally add, modify or remove any temporal relation. Therefore, his document may become incoherent. Research in the field of temporal consistency verification of multimedia documents covers several aspects : verification at authoring stage, designing schedulers which handle synchronisation at player level and so on. Our approach focuses on temporal consistency verification of multimedia documents at authoring stage [2].

A SMIL document is translated into a Time $ERPN^+$, used to check its temporal coherence. To each SMIL media (basic or composite), a time *sub-*$ERPN^+$ is associated as a simulation support. Furthermore, the transitions of the sub-net are constrained by temporal intervals which are deduced from the temporal attributes of the media. Also an abstract transition is attached to the media and viewed as its interface. A firing of the media interface allows to launch one media simulation occurrence by creating a thread which will play such a simulation. In a previous work [2], we have modeled *simple* synchronisation **event** between children of a same parent media. For this purpose, local places are used within the sub-net associated with the parent media. Furthermore a simple synchronisation **event** is played by the parent thread and no need to global places. In second time, we have tackled media having distinct parents but we have only considered relations such as $begin(media1) = begin(media2) + t$ or $begin(media1) = end(media2) + t$. We have shown that the time $ERPN^+$ model is more suitable for such a synchronisation, characterized as complex, in fact it allows to maintain the compactness of our modeling [3]. In this paper, we consider terminate events such as $end(media1) = begin(media2) + t$ or (ii) $end(media1) = end(media2) + t$ and explain briefly its modeling. It consists in adding a time *sub-*$ERPN^+$ which is played by the initial thread. The parent thread of $media2$ puts a token in a global place as soon as $media2$ (i) starts or (ii) terminates. After t time units, the initial thread marks a second global place which will force the end of the thread playing $media1$. Thanks to global places and the new communication concept of time $ERPN^+$, our modeling is modular and reflects the structure of a SMIL document.

References

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