Optimal Closed-loop Control of Timed-Event Graphs in Dioids

Carlos A. Maia * [1]

Departamento de Engenharia Elétrica, Universidade Federal de Minas Gerais , Av. Antônio Carlos 6627, Pampulha, 31270-010, Belo Horizonte, MG, Brazil,
e–mail : andrey@dca.fee.unicamp.br

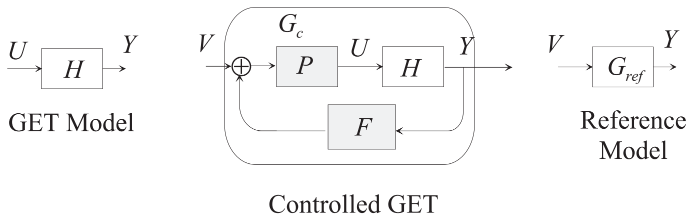
Laurent Hardouin

Laboratoire d'Ingénierie des Systèmes Automatisés, Université d'Angers, 62, avenue Notre-Dame du Lac, Angers, 49000, France,
e–mail : laurent.hardouin@istia.univ-angers.fr

Rafael Santos-Mendes

Faculdade de Engenharia Elétrica e de Computação , Universidade Estadual de Campinas , P.O Box 6101, 13083-970, Campinas, Brazil,
e–mail : rafael@dca.fee.unicamp.br

This paper proposes a new approach for the model-reference control of timed event graphs (TEG), based on the simultaneous utilization of a precompensator and a feedback controller. Let H be the plant transfer function, written in dioid formalism, and G_{ref} be the reference model. If P and F are respectively the precompensator and the feedback controller, then the closed-loop transfer function between the output signal (Y) and a reference signal (V) is $G_c = (HPF)^*HP = HP(FHP)^*$. Similarly the transfer function between the input signal U and the reference signal V is $G_{uv} = P(FHP)^*$. This is illustrated in the figure below.



The control problem is, as usually [2], stated in a just-in-time context, i.e. find matrices P and F such that G_{uv} is maximal and $G_c \preceq G_{ref}$. This guarantees that a closed loop specification (G_{ref}) is satisfied while delaying as much as possible the entrance of products to be processed. The paper shows that the solution for this problem is:

$$P_{op} = \frac{G_{ref}}{H}. \tag{1}$$

$$F_{op} = (HP_{op}) \backslash\!\!\circ (HP_{op}) /\!\!\circ (HP_{op}). \tag{2}$$

The paper proves also that this control strategy leads to the greatest possible control law for any chosen reference model and that the closed loop transfer function is as close as possible to the reference model.

Finally the paper provides sufficient conditions for the stability of the closed-loop system. These conditions can be translated into an appropriate choice of the reference model. One should remark, on one hand, that the feedback strategies previously presented in the literature [1] can guarantee stability, under similar conditions, but optimality is restricted to some choices of the reference model. On the other hand, precompensation strategies [3] can guarantee optimality but not stability. The control strategy herein proposed can guarantee optimality for any chosen reference model and stability under appropriate conditions.

[1] Supported by CAPES-BRAZIL.

[1] B. Cottenceau, L. Hardouin, J.-L. Boimond, and J.-L. Ferrier. *Model Reference Control for Timed Event Graphs in Dioid.* Automatica, 37:1451–1458 2001.

[2] G. Cohen, P. Moller, J.P. Quadrat, and M. Viot. *Algebraic Tools for the Performance Evaluation of Discrete Event Systems.* IEEE Proceedings: Special issue on Discrete Event Systems, 77(1):39–58, January 1989.

[3] L. Hardouin, E. Menguy, J.-L. Boimond and J.-L. Ferrier. *S.I.S.O. Discrete Event Systems Control in Dioid Algebra.* Journal Européen des Systèmes Automatisés, 31: 433–452, 1997.

Index