

# A remark on the decentralized diagnosis of labeled Petri nets

Maria Paola Cabasino, Alessandro Giua, Andrea Paoli, Carla Seatzu \*

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## Abstract

A remark related to our recent paper [1] is made. Using a counterexample we show that we need more strict assumptions with respect to those used in [1] to prove that if a system is diagnosable in a decentralized setting, then it is also diagnosable in a centralized one. Specifically we require that the central diagnoser sees all the events that can be seen by all the local diagnosers, and that the central diagnoser can distinguish all observable events that the local diagnosers can distinguish on their own.

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\*M.P. Cabasino, A. Giua and C. Seatzu are with the Department of Electrical and Electronic Engineering, University of Cagliari, Piazza D’Armi, 09123 Cagliari, Italy. (E-mail: {cabasino,giua,seatzu}@diee.unica.it). Alessandro Giua is also with Aix-Marseille University, LSIS, France.

A. Paoli is with the Department of Electronic, Computer Science and Systems, University of Bologna, Italy. (E-mail: andrea.paoli@unibo.it).

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In [1] we have presented an approach to the diagnosis of Petri nets in a decentralized setting that combines the decentralized scheme for automata presented by Debouk *et al.* in [3] with the diagnosis approach for Petri nets based on the notion of basis markings and justifications presented by some of us in [2]. The decentralized architecture that we used is composed by a set of sites communicating their diagnosis information with a coordinator that is responsible for detecting the occurrence of failures in the system. Moreover we have studied how decentralized diagnosability is related to centralized diagnosability. In particular, we have presented the following result.

**Corollary 8** [1] *If a system is diagnosable in the decentralized setting (regardless of the used protocol), then it is also diagnosable in the centralized setting.* ■

In order for this result to hold, we need to guarantee that everything that can be distinguished by the decentralized system can be distinguished by the centralized system as well. This is surely true under the following assumption on the decentralized system:

(A6) If a site observes a transition labeled  $e$ , then it also observes all other transitions labeled  $e$ .

The following counterexample clarifies this.

Let us consider the Petri net system in Fig. 1, where  $t_1$  and  $t_2$  are observable transitions, while transition  $t_f$  is an unobservable and fault transition. If transitions  $t_1$  and  $t_2$  are both labeled with label  $a$ , i.e.,  $\mathcal{L}(t_1) = \mathcal{L}(t_2) = a$ , then the centralized system is not diagnosable. To show this consider a faulty sequence  $t_f t_2^q$  of arbitrary length after the fault. Such a sequence produces an observation  $a^q$  that can also be explained by the fault-free sequence  $t_1^q$ . On the other hand, let us consider a decentralized setting with two sites: Site 1 observes transition  $t_1$ , while Site 2 observes transition  $t_2$ , and both transitions are labeled  $a$ , as in the centralized case. Regardless of the protocol used by the two sites to communicate information to the coordinator, this system is diagnosable in a decentralized framework. In fact, as soon as Site 2 observes a label  $a$  it can infer that  $t_2$  has fired thus diagnosing the fault.

Therefore in [1] assumption A6 needs to be added and Corollary 8 in [1] needs to be substituted by the following Corollary 8'.

**Corollary 8'** *Let assumption A6 hold. If a system is diagnosable in the decentralized setting (regardless of the used protocol), then it is also diagnosable in the centralized setting.*

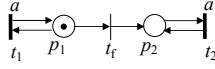


Figure 1: The PN system that shows the necessity of assumption A6.

*Proof:* Assumption A6 guarantees that everything that can be distinguished by the decentralized system can be distinguished by the centralized system as well, thus proving the statement.  $\square$

Finally, since in our framework the set of locally observable transitions of each site  $T_{o,j}$  is a subset of the set of observable transitions for the centralized system  $T_o$ , i.e.,  $T_{o,j} \subseteq T_o$ , the reverse does not hold.

## References

- [1] M.P. Cabasino, A. Giua, A. Paoli, and C. Seatzu. Decentralized Diagnosis of Discrete-Event Systems Using Labeled Petri Nets. *IEEE Trans. Systems, Man and Cybernetics: Systems*, 43(6):1477–1485, November 2013.
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- [3] R. Debouk, S. Lafortune, and D. Teneketzis. Coordinated decentralized protocols for failure diagnosis of discrete-event systems. *Discrete Events Dynamic Systems*, 10(1):33–86, 2000.