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Synthesis of asynchronous circuits

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In a series of papers [**5**, **6**, **7**] we have reorganized the theory of asynchronous circuits originated by the staffs of Digital Computer Laboratory, Univ. of Illinois [**1**, **2**, **3**, **4**]. The aim of our previous papers was not to examine appropriateness of the fundamental concepts of the theory but to settle the theory on the security base by considering a mathematical system constructed over relations.

In the theory of asynchronous circuits the synthesis is one of the fundamental problems. Using our new formulation of the theory, we supply in this paper a synthesis procedure for binary, finite charts. Terminology of the paper relies heavily on the aforementioned series of papers [**5**, **6**, **7**].

In § 1 a congruence or equivalence relation, to be called a synthetic relation, is defined for given chart. There may be many synthetic relations for given chart, so that the definition is made implicitly by specifying their properties rather than explicitly stating the relation itself. In fact, it turns out in 1.6 Theorem that to define a synthetic relation for a chart is equivalent to give a synthesis procedure for that chart. Let (V, h) be a finite chart with a set J of nodes. A synthetic relation for (V, h) may be obtained from the synthetic relations for all $(V, h)|\{i, j\}$ and $(V, h)|\{i\}$, where i, j are distinct nodes. Therefore it is enough if we give a synthesis procedure for each (V, h) having at most two nodes. We distinguish in 1.9 four possible situations A, B, C and D for charts with at most two nodes.

In § 2 Lemmas are established for characterizing the situations. The characterization is of the type that it makes possible to define some congruences which turn out later in § 3 to be synthetic relations.

The synthesis procedure described in § 3 for each situation consists in adding new nodes in such a way that a congruence thereby introduced into the chart constitutes a synthetic relation for the chart. Except for the situation D the synthesis procedures are rather trivial, although proofs for the situations B and C are not so simple. In the last part § 4 of the paper an example is given.

For the further development of the theory the following problems would