

Reply to comments on a proposed semantics for BMSCs

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We thank the editor for giving us the opportunity to reply to the comments of Ladkin and Leue. We will start with a brief explanation of the context and history of our work. (This information was not in our paper, because it is not directly relevant to the subject.)

Our paper in *The Computer Journal* [MR94a] is one of the results of a project which dates back to February 1992 and started with the question posed at Philips Research Laboratories Eindhoven “What is the meaning of an Interworking?”. We provided a formal semantics based on process algebra [MvWW92a] and derived a prototype tool set [MW93]. The main difference between Interworkings and MSCs is that Interworkings consider synchronous communication. The CCITT (recently renamed into ITU-T) rapporteur for MSCs asked us to present our work at their 1992 November meeting in Geneva [MvWW92b, MvWW92c]. In that meeting, three other approaches were presented, amongst which the approach from Ladkin and Leue. During the next meeting in October 1993 it was decided that the “algebraic semantics will serve as the canonical model for MSCs”. The current situation is that the MSC experts have agreed on the proposal and that in March 1995 the recommendation will be effective [IT94a]. The current proposal includes the complete MSC-language, except that the composition of MSCs is not covered. The reason is that it is recognized by the MSC-experts that the MSC language should be extended with explicit composition operators and that the discussion on the meaning of so-called *conditions* is still open.

Our paper in *The Computer Journal* must be considered as an explanation of the process algebra approach towards the definition of the semantics of MSC-like languages. We have restricted our discussion to Basic Message Sequence Charts, since these are the features shared by most comparable languages. The semantics of the complete MSC language (without composition) can be found in [MR94b, IT94a].

We now comment in detail on the remarks of Ladkin and Leue.

- “the textual definition does not suffice to describe BMSCs.”
They motivate this by referring to two (semantically) different BMSCs with the same textual notation. The example boils down to the problem that overloading of message names in a graphically represented MSC leads to ambiguities on the level of textual MSCs. However, this ambiguity is completely solved in Recommendation Z.120 [IT94b] by requiring that “the correspondence between message outputs and message inputs has to be defined uniquely” (Section 4.3). So-called message instance names are used for this purpose.

The BNF grammar from Z.120 can be considered as a formal way to express the textual representation of MSCs. It contains all semantically relevant information. The graph grammar from Z.120 is much more informal. Ladkin and Leue don’t even use this informal graph grammar in their definition of the semantics. They simply give a translation of MSC graphs in English prose into their notion of Ne/sig graphs.

- “What do Mauw and Reniers consider the meaning of a BMSC?”
Recommendation Z.120 states: “A Message Sequence Chart (...) imposes a partial ordering on the set of events being contained.” It contains an informal description of this partial ordering, including several examples. Ladkin and Leue give in their comments on our paper

yet another informal explanation of what was already explained in the standard. (In their words: "Just define the global state as the collection of positions of the program counters of the processes". Note that there are no program counters in MSCs and that they are not easy to define in the presence of so-called coregions). Our aim was to formalize this common understanding. The formal meaning of an MSC is in our approach an equivalence class of process graphs, as is stated clearly in our paper.

- "Mauw and Reniers prefer to define process algebra (...) axioms and use these axioms to calculate a term. Why?"
We consider process algebra a convenient method to define formal semantics of parallel languages. We needed 24 axioms (most of which are very standard in process algebra literature) in order to define the semantics of BMSCs. This compares favourably with the definitions in [LL92].
- "The size of the resulting term appears to be of similar complexity as the entire state-transition calculations itself."
We think that the size of the resulting term is not relevant for the applicability of the semantics. First of all we also give an operational semantics, for which the size of the expression needed is comparable to the size of the MSC specification. And secondly we present a representation theorem, which states that for BMSCs the resulting term is completely characterized by one single completed trace (which has size also proportional to the BMSC specification).
- "However, there is no such object as a moment of choice in an MSC"
For a discussion on the usefulness of the notion of *moment of choice* and *deadlock* refer to the literature on these subjects (e.g. [vG90]). In the trace model of process algebra it is not possible to express the moment of choice, while in the bisimulation model it is. In a forthcoming paper [BM95] it is explained that for the composition of MSCs, it is useful to consider the moment of choice.
- "There is no indication that representing traces by a process algebra term has an advantage over compactification schemes"
It has never been our intention to provide a compact representation of the global state space. As indicated before, the representation theorem stated in our paper enables a compact representation by means of a single trace. Furthermore, one can consider the process algebra term before normalization as a compact representation of the state space. For the example in section 5.3 of our paper it consists of four events, two occurrences of the merge operator and one occurrence of the state operator (i.e. seven tokens). In general it is proportional to the size of the BMSC-specification.
- "Mauw and Reniers claim a complete algebraic semantics for MSCs."
We agree that in [MR94b] we do not give a semantics for composition of MSCs. Although conditions are part of Recommendation Z.120, we think that they don't play a rôle in the semantics (and in our semantics they are treated accordingly as having no dynamic meaning). However, conditions play an important rôle in putting restrictions on the way in which MSCs may be composed. Therefore they are treated in the static requirements, currently in preparation [Ren94].
- "[LL92] defines a composition of MSCs"
"Mauw and Reniers may not have understood what we (Ladkin and Leue) have done (in our work)"
In [LL92] Ladkin and Leue do not explicitly state which sub-language of MSCs they give a semantics to. It turns out that they don't consider: local actions, timers, environments, coregions and refinement (which are all covered in [MR94b, IT94a]). However, they treat a small class of conditions (global start/end conditions) in a very interesting way.

It is true that we have not completely understood [LL92]. We shall contact the authors in order to clarify some of the problems we encountered.

- “We became aware of the work of Mauw and Reniers in early 1994.”
At the ITU-T meeting in November 1992 we presented the formal semantics of synchronous Interworkings which basically contains all ideas expressed in our article in *The Computer Journal* (be it in a synchronous setting). At this meeting our papers were distributed and accepted as input as Delayed Contributions D. 96-X/3 and D. 95-X/3. (Note that the only officially distributed documents at ITU study group meetings are contributions, delayed contributions and temporary documents.) Leue and Ladkin’s document WD-3-13, although accepted as Working Document, is not on the official list of documents (TD X/3-2).

Ladkin and Leue have attended this meeting, so they were aware of our work. However, we notice, that none of their papers that we have seen contains any reference to our work or to proposals for other semantics for MSCs, which were also presented at the CCITT meeting in Geneva 1992 [dM93, GGR93]

We thank Ladkin and Leue for their interest in our work. We think that their research on the meaning of conditions is of value when studying the extension of MSCs with compositional operators.

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