Deployment of an Distributed Strategic Material Flow Control for Automated Material Flow Systems Consisting of Autonomous Modules

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Modularized Automated Material Flow Systems (aMFSs)

Conventional aMFSs
- There are no standardized components or modules for aMFSs, so there is a great variety of heterogeneous modules on the market.
- aMFSs are mostly operated by a specialized control software and changes due to new demands require a high manual effort.
- New demands arise from:
  - Changed manufacturing or logistics processes caused by new products
  - Fluctuating production volume
  - Modification of the layout in the production process due to new machinery

Convertible aMFSs
- Convertible aMFSs are characterized by providing flexibility beyond predefined limits.
- Convertible aMFSs can be realized by dividing the monolithic software usually implemented on a single PLC in independent automated material flow modules (aMFMs).
- An aMFMs is defined as an encapsulated unit that performs predefined logistical functions, such as transporting or buffering.
- An aMFM possesses all the necessary knowledge and software to control its hardware and to communicate with other aMFMs or superior systems.

Buffer Selection Strategies
- Every aMFM can act as buffer.
- The maximum and available buffer capacity have to be communicated to the coordinator.
- The destination aMFMs strategically selects a buffer set with one or more buffer aMFMs and requests an update for the set of buffers from the coordinator.

Buffer Selection Strategy
1. Select the buffer which is closest to the start:
   The TU arrives within a short transport time at the buffer and the majority of the transport is not accomplished yet.
2. Select a buffer which is closest to the destination:
   The TU already accomplishes the majority of the transport to the destination.
3. Select the buffer which is closest to the current position:
   The TU only has a short transport to the next buffer.
4. Select a buffer in dependence of the system layout and utilisation of the aMFMs:
   In order to evaluate the qualification of an aMFMs to act as a buffer, an indicator is introduced which favours the scenarios shown on the right.

Results of the Simulation Study
- The strategy to select buffers with the introduced indicator showed the best results.
- Combination of the quality indicator with the buffer position.
- The strategy solely selecting buffers after the quality indicator showed the best results.

<table>
<thead>
<tr>
<th>Buffer Strategy</th>
<th>Buffer Quality</th>
<th>Quality Sinks</th>
<th>Quality Sources</th>
<th>Quality Position</th>
<th>All Strategies</th>
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