IV. CURRENT STATUS OF SOFTWARE COMPONENTS

Currently, the transporter software is functional and it is developed in 4diac, accordingly to the new IEC61499 standard. Fig. 5 shows the functional blocks of the program.

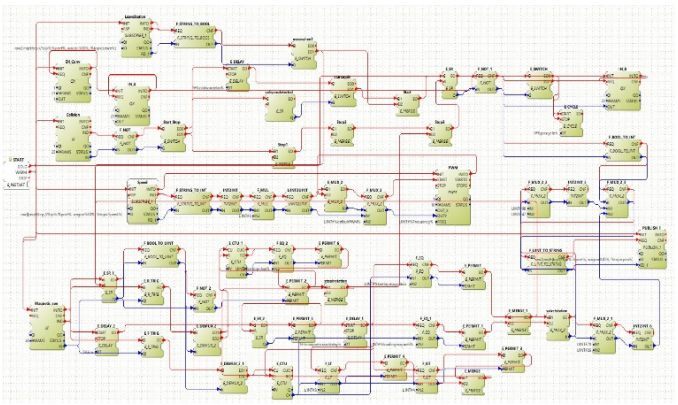

Fig. 5 4diac implementation of transporting unit

Interaction between each instance of the wagon and agents is achieved using messages. By far, the most important message is the "Speed" parameter, which is controlling the motion flow for each wagon. When the wagons are in motion to a specific point, the distances between each other are monitored constantly as a safety measure to avoid collisions. Considering a more client-oriented approach with customization enabled, the system allows to select one of the two levels of speed for wagons movement (normal mode or fast). Start of the transportation sequence will be fired up from the order interface and sent by the central system. Also, the order will be sent with the level of customization, which will select the level of speed of the wagons. After that command, motion is triggered and the actual position of the wagon is approximated taking into consideration two factors: if distance measured in front if the wagon is under safety distance or if a station is reached. If one of these two conditions are met, the stop motion command will be triggered. If the safety distance is reached, then the wagon will remain still until the safety mode is deactivated and the motion is being restarted until a station is reached. A more detailed explanation of the transporter system can be found in [13].

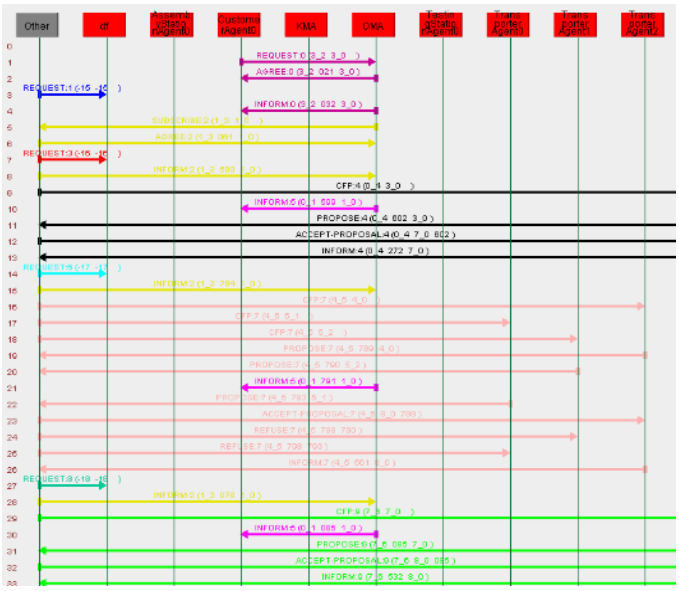

Fig. 6 Multi-agent interaction diagram in Jade

The MAS is currently developed up the simulation stage – the interfaces to the low-level controller that interacts with the hardware are missing. This simulation includes the following agents: OMA, KMA, Assembly Station, Transporter, Customer, Warehouse and Testing. The agents are using Fipa ACL messages to communicate among them. In Fig. 6 it can be seen an example of the sequence of messages exchanged in the MAS when an order is placed by a customer. Fig. 6 shows only the first messages because the completion of an order would generate, in average, about 200 exchanged messages.

V. CONCLUSION

This article presents a proposal of a distributed control architecture based on two layers of control, applicable to Industry 4.0. This architecture has been briefly explained, from software, hardware and human interaction point of view. Even if the physical system presented here is not a complex one, it is still a starting point for learning the stages of developing a real distributed system, with high complexity, where the only viable solution is the distributed control approach.

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