

Claims

1. A first agent device (100) for message routing with content passing and reference passing for a distributed system (500) with a plurality of interacting agent devices (100, 201, 202, 203, 300) wherein the interaction between the interacting agent devices occurs through exchange of messages, an exchanged message including a content portion (CP) and a reference identifier (RI) associated with a particular agent device, the reference identifier (RI) enabling any other agent device to establish a communication with the particular agent device, the content portion (CP) having a type which is either a content sub-type or a message-set sub-type, wherein the message-set sub-type allows to include a set of messages or aggregate message sets in the content portion of the message, the first agent device (100) comprising:

a first interface component (110) configured to load a first agent class specification (152) defining a first finite state machine (FSM1) which is configured to control the function of the first agent device (100) when executed by a process execution engine (121);

a second interface component (120) configured to retrieve at least a subset of a plurality of messages (M2_1, M2_2, M2_3) from a message buffer (151), the plurality of buffered messages (M2_1, M2_2, M2_3) originating from a plurality of multi-agent devices (201, 202, 203) linked to a second agent class specification defining a second finite state machine (FSM2) wherein the first finite state machine (FSM1) and the second finite state machine (FSM2) enable the interaction of the first agent device (100) with the plurality of multi-agent devices (201, 202, 203);

at least one processor component (130) configured to run the process execution engine (121) and, in accordance with the first finite state machine (FSM1), to process retrieved buffered messages (M2_1, M2_2, M2_3), to generate an aggregate message (M3) including at least a subset of the buffered messages (M2_1, M2_2, M2_3) in the aggregate message content portion (CP) having the message-set sub-type, and to provide, in accordance with the first finite state machine, the aggregate message (M3) for further processing to a further agent device (300), or to another agent operating the first agent device (100).

2. The agent device of claim 1, wherein the process execution engine configured to provide the aggregate message for further processing includes that the process execution engine is configured to send the aggregate message (M3) to at least a second agent device (300).

3. The agent device of claim 1 or 2, wherein the first finite state machine (FSM1) is configured to send a first message (M1) to the plurality of multi-agent devices (201, 202, 203), the first message (M1) configured to trigger the generation of the plurality of messages (M2_1, M2_2, M2_3) by the plurality of multi-agent devices (201, 202, 203) according to the second finite state machine (FSM2).
4. The agent device of any one of the previous claims, wherein the messages (M2_1, M2_2, M2_3) are received asynchronously.
5. The agent device of any one of the previous claims, wherein the agent devices included in the plurality of multi-agent devices (201, 202, 203) are configured to interact with the first agent device (100) in an equivalent manner in accordance with the plurality of multi-agent devices (201, 202, 203).
6. The agent device of any one of the previous claims, wherein the process execution engine (121) is further configured to check the retrieved plurality of messages (M2_1, M2_2, M2_3) based on a pre-defined condition and to provide the aggregate message for further processing only in case the pre-defined condition is fulfilled.
7. The agent device of any one of the previous claims, wherein the reference identifier (RI) of a particular retrieved message is associated with the multi-agent device from which the particular retrieved message originates.
8. The agent device of any one of the previous claims, wherein the agent device (100) is a multi-agent device out of a further plurality of agent devices linked to the first agent class specification (152).
9. A computer-implemented method for message routing with content passing and reference passing for a distributed system (500) with a plurality of interacting agent devices (100, 201, 202, 203, 300) wherein the interaction between the interacting agent devices occurs through exchange of messages, an exchanged message including a content portion (CP) and a reference identifier (RI) associated with a particular agent device, the reference identifier (RI) enabling any other agent device to establish a communication with the particular agent device, the content portion (CP) having a type which is either a content sub-type or a message-set sub-type wherein the message-set sub-type allows to include a set of messages or aggregate message sets in the content portion of the message, the method comprising:

loading (1100), by a first agent device, a first agent class specification (152) defining a first finite state machine (FSM1) which is configured to control the function of the first agent device (100) when executed by a process execution engine (121);

retrieving (1400) from a message buffer (151), by the first agent device, at least a subset of buffered messages (M2_1, M2_2, M2_3), the buffered messages (M2_1, M2_2, M2_3) originating from a plurality of multi-agent devices (201, 202, 203) linked to a second agent class specification defining a second finite state machine (FSM2) wherein the first finite state machine (FSM1) and the second finite state machine (FSM2) enable the interaction of the first agent device (100) with the plurality of multi-agent devices (201, 202, 203);

processing (1500), by the a first agent device in accordance with the first finite state machine (FSM1), the retrieved buffered messages (M2_1, M2_2, M2_3);

generating (1600) an aggregate message (M3) including at least a subset of the buffered messages (M2_1, M2_2, M2_3) in the aggregate message content portion (CP) having the message-set sub-type; and

providing (1700), in accordance with the first finite state machine, the aggregate message (M3) for further processing to a further agent device (300), or to another agent operating the first agent device (100).

10. The method of claim 9, wherein the retrieved buffered messages (M2_1, M2_2, M2_3) are of the same message type.

11. The method of claim 9 or 10, further comprising:

prior to retrieving, sending (1200), from the first agent device, a first message (M1) to the plurality of multi-agent devices (201, 202, 203), the first message (M1) configured to trigger the generation of the plurality of messages (M2_1, M2_2, M2_3) by the plurality of multi-agent devices (201, 202, 203) according to the second finite state machine (FSM2).

12. The method of any one of the claims 9 to 11, wherein the buffered plurality of messages (M2_1, M2_2, M2_3) are asynchronously received (1300) from the plurality of multi-agent devices (201, 202, 203) by the message buffer.

13. The method of any one of the claims 9 to 12, wherein processing (1500) comprises checking (1550) the retrieved plurality of messages (M2_1, M2_2, M2_3) based on a pre-defined condition; and generating (1600) the aggregate message (M3) in case the pre-defined condition is fulfilled.

14. The method of any one of the claims 9 to 13, wherein the agent device (100) is a multi-agent device out of a further plurality of multi-agent devices linked to the first agent class

specification (152), and wherein providing (1700) the aggregate message (M3) for further processing includes sending (1750) the aggregate message to a second agent device, further comprising:

retrieving (1810) from a further buffer, by the second agent device (300), a plurality of aggregate messages (M3) from the further plurality of multi-agent devices;

processing (1820), by the a second agent device in accordance with a third finite state machine (FSM3), the retrieved aggregate messages (M3);

generating (1830) a further aggregate message including at least a subset of the aggregate messages (M3) in the content portion (CP) of the further aggregate message; and

providing (1840) the further aggregate message for further processing.

15. A computer program product that when loaded into a memory of a computing device and executed by at least one processor of the computing device executes the steps of the computer-implemented method according to any one of the claims 9 to 13.