The invention concerns a method of providing an MMoIP communication service, and a MMoIP system to execute the said method. One or more MMoIP packet streams (Ti(x)) are transmitted via a connection (C(T1,T2)) established between a first and second endpoint (T1, T2) of an IP communication network (100). The one or more MMoIP packet streams (Ti(x)) comprise MMoIP payload data and/or control data. Control data directed to a processor (P) is inserted in at least one MMoIP packet stream (Ti(x)) of the one or more MMoIP packet streams (Ti(x)) at the first endpoint (T1) and/or the second endpoint (T2). The one or more MMoIP packet streams (Ti(x)) are transmitted via an MMoIP switch (S) of the IP communication network (100). The MMoIP switch (S) monitors the one or more MMoIP packet streams (Ti(x)). The MMoIP switch (S) detects the control data directed to the processor (P). The MMoIP switch (S) forwards the detected control data to the processor (P).
Method of providing an MMoIP communication service

Field of Invention

The invention concerns a method of providing an MMoIP communication service, and a MMoIP system to execute the said method (MMoIP = MM over IP; MM = Multimedia; IP = Internet Protocol).

Background

MMoIP refers to providing multiple services, such as text, still image, data, audio (e.g. voice, music), moving image (e.g. video), animation, and interactivity content forms, using the packet technology over an IP network.

TS 23.228 published by the 3GPP (= 3rd Generation Partnership Project) describes the IP Multimedia Subsystem (= IMS). IMS is an architectural framework for providing MMoIP solutions. However IMS has shortcomings, e.g. since, with the Cloud computing paradigm, carriers, ISPs and ASPs are stacked rather than separated in autonomous IP subnets, since the 3GPP has adopted a pure end-to-end protocol for signalling, cf. IETF SIP/RTP call architecture, or since multimedia telecommunication has been introduced as an additional Internet service overlay rather than being regarded at the same level as transport protocol level, e.g. TCP, UDP, SCTP (ISP = Internet Service Provider; ASP = Application Service Provider; IETF = Internet Engineering Task Force; SIP = Session Initiation Protocol; RTP = Real-Time Transport Protocol; TCP = Transmission Control Protocol; UDP = User Datagram Protocol; SCTP = Stream Control Transmission Protocol).
It is the object of the present invention to provide an improved MMoIP communication service.

**Summary**

The object of the present invention is achieved by a method of providing an MMoIP communication service, comprising the steps of transmitting one or more MMoIP packet streams via a connection established between a first endpoint of an IP communication network and a second endpoint of the IP communication network, whereby the one or more MMoIP packet streams comprise MMoIP payload data and/or control data; inserting control data directed to a processor in at least one MMoIP packet stream of the one or more MMoIP packet streams at the first endpoint and/or the second endpoint; transmitting the one or more MMoIP packet streams via an MMoIP switch of the IP communication network; monitoring, by the MMoIP switch, the one or more MMoIP packet streams; detecting, by the MMoIP switch, the control data directed to the processor; and forwarding, by the MMoIP switch, the detected control data to the processor. The object of the present invention is further achieved by a MMoIP system for providing an MMoIP communication service in an IP communication network, comprising a first endpoint and a second endpoint which are adapted to send one or more MMoIP packet streams via a connection established between the first endpoint and the second endpoint and to insert control data directed to a processor in at least one MMoIP packet stream of the one or more MMoIP packet streams, whereby the one or more MMoIP packet streams comprise MMoIP payload data and/or control data, and comprising an MMoIP switch adapted to monitor the one or more MMoIP packet streams which are transmitted via the MMoIP switch, detect the control data directed to the processor and forward the detected control data to the processor.

An endpoint according to the present invention is essentially equal to an IP endpoint, preferably as an unbound socket which can be identified and used
by any software running on the endpoint to send data into the MMolP system. A connection according to the present invention is a communication among two endpoints. A connection according to the present invention is not required to have a connection setup or teardown, e.g. TCP, but the information transmitted can be of ad-hoc connectivity, e.g. UDP. A stream according to the present invention is a unidirectional sequence of data originating from an endpoint which has an individual identifier regardless of the connection. A dialogue according to the present invention is two or more unidirectional streams from different endpoints, preferably forming a bidirectional session under a common stream identifier. TCP, UDP and SCTP are examples for transport layer protocols used for a transmission of streaming media data via a network.

An endpoint can multiplex connections. A connection can multiplex streams. A stream can switch between the underlying connections. A response stream to an initial stream uses the same identifier to be recognizable as a dialogue.

Embodiments of the present invention provide a permanent multimedia switching service available to Internet endpoints. This is achieved by introducing a switching element, called "MMolP switch", for a MMolP communication service in an IP communication network, e.g. a telecommunication architecture, which can identify endpoints, e.g. in and outside (so-called "external endpoint") the switching domain, connections, streams and dialogues.

The MMolP system provides interoperability with existing MMolP technologies by re-using existing protocols for bearer data. Through its design the MMolP system is adapted to achieve interoperability with a traditional bearer in existing MMolP solutions, e.g. in VoIP system, by placing system border elements which translate traditional call control signalling to the indications used by the proposed MMolP system (VoIP = Voice over IP). The invention also re-uses existing telecommunication service components. Thus the
The invention achieves a better integration with the existing Internet architecture than known MMolP systems. Further, the MMolP system is adapted to overlay the switching system according to embodiments of the present invention with the traditional call control signalling. However, it is to be noted that the present invention is not an overlay.

Rather than built on top of existing client/server-based services, the proposed MMolP system is tightly integrated into IP to provide a MMolP communication service in the way of end-to-end telecommunication, e.g. packet inspection is used for packet routing rather than a DNS overlay, signalling is inherently available among all processing elements without creating additional overhead (DNS = Domain Name System). The MMolP system builds upon characteristics of end-to-end communication by leveraging the IP end-to-end paradigm. For example, the invention tightly integrates telecommunication with packet-based end-to-end addressing and transport socket connections. Since the invention is integrated with IP addressing, it achieves a better terminal mobility than known MMolP systems.

The MMolP system provides information contexts such as network-context, stream-context and dialog-context information which is easily distinguishable in order to create clearly described state machines.

The MMolP system uses the flexibility for processing elements introduced by Cloud computing in order to overcome the telecommunication service silos. In particular, the MMolP system makes instantiation and use of telecommunication services, e.g. on-stream modifications or mixing, available. The invention provides an auto-configuration of services in a self-consistent state model for MM service applications.

The continuous, permanent availability of the MMolP communication service provided by the proposed method does not cause a disproportionately high OPEX (= Operational Expenditure). Only the use of the MMolP communication
service, i.e. the MMoIP transmission, requires provider resources. Therefore, the invention uses less resources, both computational and networking, for MMoIP bearer establishment and achieves a higher utilisation of resources than known MMoIP systems. Further the invention achieves a faster setup for MMoIP communication than known MMoIP systems.

Further advantages are achieved by embodiments of the invention indicated by the dependent claims.

According to an embodiment of the invention, the one or more MMoIP packet streams comply with the RTP protocol. Preferably the one or more MMoIP packet streams are RTP packet streams.

According to an embodiment of the invention, the method further comprises the step of inserting control data from the processor into at least one MMoIP packet stream of the one or more MMoIP packet streams.

According to an embodiment of the invention, the method further comprises the step of processing, by the processor, at least one MMoIP packet stream of the one or more MMoIP packet streams. With this embodiment it is preferred if the control data which are forwarded by the MMoIP switch to the processor control the processing of the at least one MMoIP packet stream of the one or more MMoIP packet streams by the processor.

According to an embodiment of the invention, monitoring by the MMoIP switch the one or more MMoIP packet streams comprises executing a packet inspection of the one or more MMoIP packet streams packet per packet, and distinguishing payload data and control data. The MMoIP system distinguishes signalling data, in particular best-effort data, and multimedia data, in particular real-time data, on a per-packet basis rather than creating complicated connection overlays for these two kinds of data.
According to an embodiment of the invention, the method further comprises the steps of inserting, at the first endpoint and/or the second endpoint, an indication in at least one MMoIP packet stream of the one or more MMoIP packet streams; detecting, by the MMoIP switch, the indication; triggered by the detected indication, setting up the processor for processing at least one MMoIP packet stream of the one or more MMoIP packet streams; and re-directing, by the MMoIP switch, the at least one MMoIP packet stream of the one or more MMoIP packet streams to the processor.

The MMoIP system is adapted to seamlessly add/remove processing elements to/from streams/dialogues, relocate processors, split and merge streams to/by dialogues across processing elements - either upon request or autonomously (i.e. "intelligently") - in order to achieve an optimal trade-off between a high quality of the MMoIP communication service provided and resource utilization in the IP communication network. Thus the MMoIP system provides an easy third party integration, e.g. as additional hardware in a node or as additional software upon IaaS (= Infrastructure as a Service).

According to an embodiment of the invention, the method further comprises the step of, if the MMoIP switch detects a failure of the processor, stopping, by the MMoIP switch, the forwarding of the control data to the processor. Thus failure of a processing element does not destroy the whole communication. The MMoIP system is capable of continuing telecommunication among endpoints, even if network elements, such as switching elements, stream processors or dialogue processors fail. The MMoIP system inherently provides failover techniques and thus provides a better reliability of IP communications than known MMoIP systems due to successive addition in a model which preserves setup and fallbacks without interruption.

In case of the MMoIP switch re-directing at least one MMoIP packet stream of the one or more MMoIP packet streams to the processor, it is preferred that the MMoIP switch, if the MMoIP switch detects a failure of the processor,
controls a fallback of the at least one MMolP packet stream on the connection without passing the processor.

According to an embodiment of the invention, the method further comprises the steps of indicating, by the processor, a need for an additional processor to the MMolP switch; triggered by the said indication received from the processor, instantiating, by the MMolP switch, the additional processor; redirecting, by the MMolP switch, the at least one MMolP packet stream to the additional processor; and sending, by the additional processor, its output of the at least one MMolP packet stream to the processor. The MMolP switch is adapted to react on indications sent by receiving endpoints to include processing elements, whereby a processing element can be a) a stream processor which operates on MMolP packet streams without being an endpoint itself and b) a dialogue processor which introduces itself to the exchange of the MMolP packet streams as a new endpoint.

According to another embodiment of the invention, the processor is a dialogue processor for processing a bidirectional dialogue between the first endpoint and the second endpoint.

**Brief Description of the Figures**

These as well as further features and advantages of the invention will be better appreciated by reading the following detailed description of exemplary embodiments taken in conjunction with accompanying drawings of which:

- Fig. 1 is a schematic block diagram of a connection between two endpoints of an IP communication network with a single stream;
- Fig. 2 is a schematic block diagram of the connection of Fig. 1 with multiple streams and signalling;
Fig. 3 is a schematic block diagram of a MMoIP system;

Fig. 4 is a schematic block diagram of a MMoIP system comprising a stream processor;

Fig. 5 is a schematic block diagram of a MMoIP system comprising a dialogue processor;

Fig. 6 is a schematic block diagram of a MMoIP system comprising a failed stream processor;

Fig. 7 is a schematic block diagram of a MMoIP system comprising a failed dialogue processor;

Fig. 8 is a schematic block diagram of a MMoIP system comprising a processor and an additional stream processor;

Fig. 9 is a schematic block diagram of a MMoIP system with a multi-party dialogue;

Fig. 10 is a schematic block diagram of a MMoIP system with dialogue processor multiplexing; and

Fig. 11 is a schematic block diagram of a MMoIP system with collaboration detection.

**Detailed Description of Embodiments**

Fig. 1 is a schematic block diagram of a connection between a first endpoint T1 and a second endpoint T2 of an IP communication network 100 with a single stream T1(x). The endpoints T1 and T2 may be UDP sockets or TCP sockets of telecommunication devices adapted to send and receive IP packets,
e.g. a computer connected via a fixed access (e.g. DSL) or a wireless access (e.g. WLAN) to the IP communication network, or a mobile phone connected via a mobile access (e.g. UMTS) to the IP communication network (DSL = Digital Subscriber Line; WLAN = Wireless LAN; LAN = Local Area Network; UMTS = Universal Mobile Telecommunications System). Each endpoint T1 and T2 is identified by a pair identifier consisting of an IP address and a port number: T1 = {IP address(T1), port (T1)}; T2 = {IP address(T2), port (T2)}.

A connection C, e.g. a UDP connection, a TCP connection or a SCTP channel, is established between the first endpoint T1 and the second endpoint T2. The connection C is identified by its endpoints T1 and T2: connection C = C(T1, T2).

A stream T1(x), e.g. a multimedia stream or a signalling stream, is transmitted via the connection C from a stream source, i.e. the first endpoint T1, to a stream sink, i.e. the second endpoint T2. The stream T1(x) is identified on the connection C by its stream source T1 and a stream identifier x: stream = T1(x).

A packet associated with the stream T1(x) and sent from the stream source T1 to the stream sink T2 comprises, on a first layer, RTP stream data in form of the synchronization source variable SSRC (= Synchronization Source; cf. RFC 1889). The SSRC variable is set to identify the stream: SSRC = T1(x). On a second layer, below the first layer, the packet comprises a UDP/TCP header which specifies the stream source T1 (src = UDP(T1)) and the stream destination T2 (dst = UDP(T2)) on this layer (src = source; dst = destination). On a third layer, below the second layer, the packet comprises an IP header which specifies the stream source T1 (src = IP(T1)) and the stream destination T2 (dst = IP(T2)) on this layer.

As mentioned before, both MMolP user data and signalling/control data associated with the MMolP user data are transmitted via the same connection C. Several methods exist for transmitting both MMolP user data and
signalling/control data associated with the MMoIP user data over a single connection between a first endpoint and a second endpoint, e.g. a single port connection, whereby the signalling/control data is used for establishing, maintaining and terminating a transmission connection.

A preferred "traffic separation" method for providing a real-time communication connection over an IP communication network between a first entity and a second entity is described in the following. The "traffic separation" method comprises the steps of fragmenting signalling traffic and/or control traffic and/or other non-real-time traffic associated with the real-time communication connection at the first entity; multiplexing the fragments of the signalling traffic and/or control traffic and/or other non-real-time traffic into a real-time traffic stream of the communication connection and generating a resulting data stream comprising the packets of the real-time traffic stream multiplexed with the fragments of the signalling traffic and/or control traffic and/or other non-real-time traffic at the first entity; transmitting said data stream via an IP-based real-time communication connection from the first entity to the second entity; de-multiplexing said data stream and obtaining the fragments of the signalling traffic and/or control traffic and/or other non-real-time traffic and the real-time traffic stream of the communication connection at the second entity; re-composing the fragments of the signalling traffic and/or control traffic and/or other non-real-time traffic and generating the original signalling traffic and/or control traffic and/or other non-real-time traffic at the second entity. The term multiplexing refers to the combination of two or more information channels onto a common transmission medium. The term interleaving denotes a special type of multiplexing which involves the re-sorting and the nesting of bits. Interleaving is a way to arrange data in a non-contiguous way to increase performance. Therefore the term multiplexing is meant to also comprise the process of interleaving. The preferred "traffic separation" method makes it possible that a complete media session can be easily forwarded to a new access point via simple IP forwarding. Preferably the signalling and control messages are multiplexed/interleaved with the real-time data using any
common and suitable transmission protocol. Preferred protocols for the transmission of the multiplexed stream are RTP, UDP, UDP lite, IP. For example, the fragments of the signalling and/or control traffic are multiplexed into the real-time traffic stream of the communication connection by generating separate data stream packets for the signalling and/or control traffic and the real-time traffic, whereby each data stream packet comprises an IP header, a UDP header, information about the type of the payload, namely signalling traffic, control traffic, or real-time traffic, a stream ID, a sequence number, information about the length of the payload, and the payload of the signalling traffic or control traffic or real-time traffic. Thus this preferred "traffic separation" method comprises a multiplexing of RTP and UDP in a one socket connection.

Another "traffic separation" method may use a marking of signalling/control data packets so that the signalling/control data packets can be distinguished from the MMolP user data packets, although both use a single port. For example, MMolP user data packets contain an (IP + UDP/TCP) header and RTP stream data, whereas signalling/control data packets contain a (IP+UDP/TCP) header, a two bit zero marking, i.e. a so-called "magic sequence", and signalling/control data.

Fig. 2 is a schematic block diagram based on Fig. 1 with multiple streams and signalling. The difference between Fig. 1 and Fig. 2 is that the connection shown in Fig. 2 comprises multiple streams whereas the connection shown in Fig. 1 comprises a single stream. The first endpoint T1 comprises a stream source module, a stream sink module, and a signalling module SIG. The second endpoint T2 comprises a stream source module, a stream sink module, and a signalling module SIG. A first MM stream T1(x) is transmitted via the connection C from the stream source module of the first endpoint T1 to the stream sink module 22 of the second endpoint T2. A second MM stream T2(x) is transmitted via the connection C from the stream source module of the second endpoint T2 to the stream sink module of the first endpoint T1. The two MM streams T1(x) and T2(x) are identified with the same MM stream identifier.
x and are transmitted between the endpoints T1 and T2 in opposite directions; therefore they represent a bi-directional or conversational MM dialogue \(D(x) = D(T1(x), T2(x))\).

A third MM stream \(T2(y)\) is transmitted via the connection \(C\) from the stream source module of the second endpoint T2 to the stream sink module of the first endpoint T1. The MM stream \(T2(y)\) is identified by the MM stream identifier y. This MM stream \(T2(y)\) has not (yet) a counterpart MM stream which is transmitted between the endpoints T1 and T2 in the opposite direction of the stream \(T2(y)\); therefore the MM stream \(T2(y)\) represents a uni-directional MM dialogue \(D(y) = T2(y)\).

A signalling stream \(T1(T2)\) is transmitted via the connection \(C\) from the signalling module \(SIG\) of the first endpoint T1 to the signalling module \(SIG\) of the second endpoint T2. A second signalling stream \(T2(T1)\) is transmitted via the connection \(C\) from the signalling module \(SIG\) of the second endpoint T2 to the signalling module \(SIG\) of the first endpoint T1. These two signalling streams \(T1(x)\) and \(T2(x)\) are transmitted between the endpoints T1 and T2 in opposite directions; therefore they represent a signalling dialogue \(D(T1, T2) = D(T1(T2), T2(T1))\). It is possible that the signalling dialogue \(D(T1, T2)\) is associated with the above mentioned conversational MM dialogue \(D(x) = D(T1(x), T2(x))\).

Fig. 3 is a schematic block diagram of a MMoIP system comprising a first endpoint T1 and a second endpoint T2 in an IP communication network 100, e.g. the Internet. The MMoIP system shown in Fig. 3 is similar to the IP communication network 100 shown in Fig. 1, except that the MMoIP system shown in Fig. 3 further comprises a node N wherein a MMoIP switch S is implemented, e.g. in form of an additional switching module. A MMoIP packet stream \(T1(x)\) sent from the first endpoint T1 of the IP communication network 100 to the second endpoint T2 of the IP communication network 100 is transmitted via a connection \(C(T1 , T2)\) established between the first endpoint
T1 and the second endpoint T2. The MMoIP packet stream T1(x) comprises MMoIP payload data and/or control data.

In a first step 1.a., a MMoIP packet stream T1(x) comprising MMoIP payload data and/or control data is sent under the Ethernet standard 802.3 from the stream source of the first endpoint T1 to the node N. A packet of the MMoIP packet stream T1(x) comprises, on a first layer, an RTP synchronization source variable SSRC: SSRC = T1(x). On a second, lower layer, the packet comprises a UDP/TCP header which specifies a port Port(T1) of the stream source endpoint T1 and a port Port(T2) of the stream sink endpoint T2. On a third, lower layer, the packet comprises an IPv4/v6 header which specifies an IP address IP(T1) of the stream source endpoint T1 and an IP address IP(T2) of the stream sink endpoint T2. Preferably, the IP address IP(T1) of the stream source endpoint T1 is a public IP address, thus including NAT cases (NAT = Network Address Translation). The connection C(T1,T2) is associated with the UDP/TCP header and the IPv4/v6 header.

Furthermore the packet is provided at the first endpoint T1, on a link layer, with a source MAC address MAC(T1) according to the Ethernet standard 802.3 associated with the stream source, i.e. the first endpoint T1, and a destination MAC address MAC(N) associated with the node N (MAC = Media Access Control). Using the MAC addresses, the packet is routed from the first endpoint T1 hop-by-hop across the IP communication network 100 to the node N by means of the MAC addresses: MAC(T1) → MAC(...) → MAC(N).

The MMoIP switch S is composed of one or several inter-linked computers, i.e. a hardware platform, a software platform basing on the hardware platform, and several application programs executed by the system platform formed by the software and hardware platform. The functionality of the MMoIP switch S is provided by the execution of these application programs. The application programs or a selected part of these application programs constitute a computer software product providing a switching service as described in the
following, when executed on the system platform. Further, such computer software product is constituted by a storage medium storing these application programs or said selected part of application programs.

The MMoIP switch S may be an extension to an Ethernet switch, preferably on top of 802.3 Ethernet, monitoring traffic suggested for further treatment in a processing element. Therefore the MMoIP switch S can be located at any location within the IP communication network in co-existence with existing switching equipment across the IP communication network. External endpoints only require a piece of software to benefit from a co-operation with the MMoIP switch S.

The switching of the IP packet via the MMoIP switch S can be based on traffic separation, examples of which are described above. Other solutions for switching of the IP packet via the switch S are encapsulation of the stream IP-IP tunnels, GRE tunnels, VLAN, MPLS, IP over ATM (GRE = Generic Routing Encapsulation; VLAN = Virtual LAN; MPLS = Multi-Protocol Label Switching; ATM = Asynchronous Transfer Mode).

In a second step 1.d., the MMoIP packet stream $T_1(x)$ is sent under the Ethernet standard 802.3 from the node N to the stream sink of the second endpoint T2. While the MMoIP switch S does not change the MMoIP packet stream $T_1(x)$ and the connection $C(T_1, T_2)$, the MMoIP switch S replaces the destination MAC address MAC(N) with the MAC address MAC(T2) associated with the second endpoint T2. Using the MAC addresses, the packets of the MMoIP packet stream $T_1(x)$ are routed from the node N hop-by-hop across the IP communication network 100 to the second endpoint T2 by means of the MAC addresses: $\text{MAC}(N) \rightarrow \text{MAC}(...) \rightarrow \text{MAC}(T2)$.

Since the UDP/TCP headers used in the "single-connection" (i.e. comprising payload data and signalling/control data) MMoIP stream packets are identical to UDP/TCP headers of "normal" (i.e. where payload data and
signalling/control data are transmitted on different channels/connections) traffic, the "single-connection" MMolP stream packets which belong to the connection C(T1, T2) must be identified. On connection initialization, this identification can, e.g., be provided by one of the following methods:

1. **Packet inspection:** With packet inspection, the first packet transmitted via a connection C(T1, T2) is inspected and identified so that subsequent packets transmitted via the connection can be treated using UDP/TCP connection tracking. For example, an RTP traffic detection can be achieved by a hashing over IP source and destination values present in the IP header and UDP source and destination values present in the UDP header (IPsrc + IPdst + UDPSrc + UDPdst) as connection identifier and further statistical valuation of the first bytes in the UDP payload on UDP connections to detect potential RTP headers.

2. **Explicit invitation:** An explicit invitation to classify a packet associated with a "single connection" is stated by a user, e.g. by using an additional signalling protocol.

3. **Residential Gateway:** A packets associated with a "single connection" is classified by a Residential Gateway, e.g. by configuration of a DSL router or by setting a DSCP value of the packet (ToS byte or class field in the IP header) to a certain value (DSCP = Differentiated Services Code Point; ToS = Type of Service).

Therefore, using, e.g., the aforementioned packet inspection approach, a packet associated with an RTP stream of a "single connection" could be identified by hashing over (IPsrc + IPdst + UDPSrc + UDPdst) and the RTP variable SSRC: IPsrc + IPdst + UDPSrc + UDPdst + SSRC.

Fig. 4 is a schematic block diagram of a MMolP system as illustrated in Fig. 3, further comprising a stream processor Ps. The seamless stream processor Ps may be added on behalf of the first endpoint T1, the second endpoint T2 or the MMolP switch S. The request to add a stream processor Ps may be indicated to the MMolP switch S by either the first endpoint T1 or the second endpoint.
T2 using the signalling stream T1(T2) or T2(T1) on the same connection C(T1, T2). The MMolP switch S may detect that processing is required, e.g. to perform services for a VoIP connection such as an echo cancellation, a stream synchronization in case of multiple streams T1(x), T1(y), a loudness adaptation, etc. Indications can also be received using H.248, MEGACO (= Media Gateway Control Protocol), SOAP/XML (SOAP = Simple Object Access Protocol; XML = Extensible Markup Language).

The first step 1.a. shown in Fig. 4 corresponds to the first step 1.a. shown in Fig. 3, i.e. a MMolP packet stream T1(x) comprising MMolP payload data and/or control data is sent under the Ethernet standard 802.3 from the stream source of the first endpoint T1 to the node N. The MMolP packet stream T1(x) comprises control data directed to the stream processor P_s. The control data have been inserted into the MMolP packet stream T1(x) at the first endpoint T1. The MMolP packet stream T1(x) is transmitted via the MMolP switch S of the IP communication network 100.

Triggered by a corresponding indication, the MMolP switch S switches the MMolP packet stream T1(x) directed to the stream processor Ps. The MMolP switch S changes the source MAC address and destination MAC address of the packets of the MMolP packet stream T1(x) which are directed to the stream processor Ps as follows: the source MAC address is the MAC address of the MMolP switch S: MAC(S); the destination MAC address is the MAC address of the stream processor P_s: MAC(P_s).

The MMolP switch S monitors the MMolP packet stream T1(x). If the MMolP switch S detects control data directed to the stream processor Ps, the MMolP switch S forwards the detected control data to the stream processor Ps. The MMolP switch S and the stream processor P_s are located on the same node N. The control data which are forwarded by the MMolP switch S to the stream processor P_s control the processing of the MMolP packet stream T1(x) by the stream processor P_s.
After processing the MMolP packet stream $T_1(x)$, the stream processor $P_s$ changes the source MAC address and destination MAC address of the packets of the MMolP packet stream $T_1(x)$ as follows: the source MAC address is the MAC address of the stream processor $P_s$: $\text{MAC}(Ps)$; the destination MAC address is the MAC address of the MMolP switch $S$: $\text{MAC}(S)$.

In a third step i.e., the processed MMolP packet stream $T_1(x)$ are transmitted back to the MMolP switch $S$.

In a fourth step 1.d., the packets of the MMolP packet stream $T_1(x)$ are sent from the node $N$ to the stream sink of the second endpoint $T_2$. The MMolP switch $S$ replaces the destination MAC address $\text{MAC}(S)$ with the MAC address $\text{MAC}(T2)$ associated with the second endpoint $T2$. Using the MAC addresses, the packets of the MMolP packet stream $T_1(x)$ are routed from the MMolP switch $S$ hop-by-hop across the IP communication network 100 to the second endpoint $T2$ by means of the MAC addresses: $\text{MAC}(S) \rightarrow \text{MAC}(...) \rightarrow \text{MAC}(T2)$.

Fig. 5 is a schematic block diagram of a MMolP system similar to the MMolP system illustrated in Fig. 4, with the difference that the processor of Fig. 5 is not a stream processor but a dialogue processor $P_D$.

In a first step 1., a MMolP packet stream $T_1(x)$ is transmitted via the connection $C(T1,T2)$. It is possible that there exist signalling streams $T1(T2)$ and $T2(T1)$, i.e. on dialogue $D(T1,T2)$. In a second step 2., an indication/request to include a processing, i.e. a processing service, is sent in a signalling stream $T2(T1)$ from the second endpoint $T2$. In a step 2.a., the signalling stream $T2(T1)$ comprises an indication of the second endpoint $T2$, in the direction of the first endpoint $T1$ to include a processing service. In a step 2.b., the MMolP switch $S$ which monitors the signalling stream $T2(T1)$ pre-empts the detected indication. If none of the nodes in the IP communication network 100 can pre-empt/service the indication, the first endpoint $T1$ can also
try to perform the processing. In a step 2.c., the MMolP switch S sets up a
dialogue processor service PD, e.g. according to the RTP protocol. The MMolP
switch S waits for a response from the dialogue processor service PD while
packet routing of the MMolP packet stream T1(x) is not affected. The MMolP
switch S and the dialogue processor PD are located on the same node N. In a
step 2.d., an indication created by the MMolP switch S is sent on the signalling
stream T2(T1) to send any further packets of the MMolP packet stream T1(x)
on an established connection C(T1,P_D) between the first endpoint T1 and the
dialogue processor PD.

In steps 3.a. to 3.d., further packets of the MMolP packet stream T1(x),
denoted as T1(x)', are sent by the first endpoint T1 on the connection C(T1,P_D)
to the dialogue processor PD and, after processing, are sent by the dialogue
processor PD on an established connection C(P_D,T2) between the dialogue
processor PD and the second endpoint T2. In a following step, signalling can
now be transmitted in the signalling dialogues D(T1,T2), D(T1,P_D) and
D(P_D,T1).

The processing of the MMolP packet streams T1(x) and T2(x), representing a
MM dialogue D(x), by the dialogue processor PD may comprise a modification
of the loudness or an echo cancellation of audio data of one or more of the
streams T1(x) and T2(x), a recording of one or more of the streams T1(x) and
T2(x), or an adding of additional data into one or more of the streams T1(x)
and T2(x), e.g. an input of music data.

Preferably, the receiver of a MMolP packet stream indicates the re-routing of
the stream. Additional signalling may trigger the receiver to send an indication.

Fig. 6 is a schematic block diagram of stream processor failover in a MMolP
system comprising a failed stream processor Ps. As a precondition, a stream
processor service Ps was added to a connection to handle the MMolP packet
stream T1(x). When the stream processor service Ps fails (step 1), the MMolP
switch S detects the failure (step 2), e.g. an Ethernet link or blade failure is detected by missing packets from the stream processor service Ps. After detecting the failure (step 2), the MMolP switch S stops the redirection of the MMolP packet stream T1(x) to the stream processor Ps, and indicates the failure of the stream processor Ps to the endpoints T1 and/or T2 (step 3).

Failure indication, created by the MMolP switch S, may be sent on the signalling dialogues D(x), D(y), etc. which are transmitted in the MMolP system. Then the MMolP packet stream T1(x) continues without a processing of the MMolP packet stream T1(x) by the stream processor Ps. The second endpoint T2 may request the same service again, which can then be performed by another node or processor.

A stream processing node failover where all the processor P is affected is a system operator failover where the packets of a MMolP packet stream T1(x) can be simply routed from the first endpoint T1 to the second endpoint T2 without implications. Also, the MMolP packet stream T1(x) can be handled by another MMolP switch and serviced by another processor Ps whereby the activated service is known to the system operator.

Fig. 7 is a schematic block diagram of stream processor failover in a MMolP system comprising a failed dialogue processor P_D. As a precondition, a dialogue processor service P_D was added to a connection to handle a MMolP packet stream dialogue D(x) comprising the MMolP packet stream T1(x). When the dialogue processor P_D fails (step 1), the MMolP switch S detects the failure (step 2), e.g. an Ethernet link or blade failure is detected by missing packets from the dialogue processor service P_D. The MMolP switch S indicates the failure of the dialogue processor P_D to the endpoints T1 and/or T2 (step 3). Then in step 4, the MMolP packet stream T1(x) falls back to the connection C(T1, T2) without a processing of the MMolP packet stream T1(x) by the dialogue processor P_D. The same procedure correspondingly applies to the MMolP packet stream T2(x) in the dialogue D(x) and also for other uni-directional and/or bi-directional dialogues D(x), D(y), etc. which are transmitted in the MMolP system.
A dialogue processing node failure where all the processor P is affected can be detected in one of the following ways a) to c). a) For a unidirectional MMolIP packet stream T1(x) on a connection C(T1,P1), a dialogue processing node failure can be detected when a stream source T1 receives an ICMP destination unreachable message (ICMP = Internet Control Message Protocol); b) For a unidirectional stream sink at a second endpoint T2 a dialogue processing node failure can be detected by using T2(PD) to ping, in case of suspended stream due to inactivity; c) Detection of network operator failover, i.e. the packets of a MMolIP packet stream T1(x) can be simply routed from the first endpoint T1 to the second endpoint T2 without implications. In case of a dialogue processing node failure, a failover can be a fall-back of all MMolIP packet streams Ta(x) in a dialogue D(x) to a connection C(Ta,TP) if an endpoint Tβ is in the dialogue D(x). Another failover would be re-instantiating the service on another MMolIP switch P_D' with an indication as described above with regard to the dialogue processing shown in Fig. 5.

Fig. 8 is a schematic block diagram of a MMolIP system comprising a processor and an additional stream processor on a single node N. As a precondition, a stream or dialogue processor service P₁ was added to the node N of a MMolIP system to handle the MMolIP packet stream T1(x) or a dialogue D(x). In step 1, the processor service P₁ sets up an additional stream processing service Ps,2 in the node N to service the MMolIP packet stream T1(x). In step 1a, the processor service P₁ indicates to the MMolIP switch S the need of an additional stream processing service Ps,2 on the MMolIP packet stream T1(x). In step 1b, the MMolIP switch S instantiates an additional stream processing service Ps,2 in the node N and configures the additional stream processing service Ps,2 to send its output to the processor service Pi. When the additional stream processing service Ps,2 signals ready, the MMolIP switch S redirects, in step 2, further data of the MMolIP packet stream T1(x) to the additional stream processing service Ps,2. The additional stream processing service Ps,2 sends its output to the processor service P₁. The processor
service P₁ sends its output back to the MMolP switch S for forwarding it to the second endpoint T₂.

The same method correspondingly applies for multiple MMolP packet streams T_j and collectively for a dialogue Dᵢ. The MMolP switch S chooses whether to instantiate a single processor or distribute the streams across multiple processors.

The instantiation of an additional dialogue processor substantially works in the same way as adding an additional stream processor describes above. In case of an additional dialogue processor however, the processor service P₁ uses the signalling stream Pᵢ(T₁) on the connection C(T₁,P₁) as described above with regard to the dialogue processing, shown in Fig. 5, to indicate a requirement of a dialogue service.

An additional dialogue service can be instantiated to add additional parties. This is reflected in the indication, as a requirement, to allow any MMolP switch on the way of the connection C(T₁,Pᵢ) to detect whether it is in a suitable location/condition to pre-empt/service the indication.

Accordingly, an indication works as the indication of an additional stream processor, except that the processor service P₁ indicates that it wants to defer multiple existing MMolP packet streams Tᵢ(x) of a dialogue D(x) to a dialogue processor. Any MMolP switch on the way of the connection C(T₁,Pᵢ) can choose whether it is in a suitable location/condition to pre-empt/service the indication.

Further, a dialogue processor P_A can use any existing signalling connection C(P_A,P_B) if the processor P_B is part of the dialogue D(x) to handover MMolP packet streams Tᵢ(x) of the dialogue D(x) that the a dialogue processor P_A currently multiplexes.
Fig. 9 is a schematic block diagram of a MMolP system with a multi-party dialogue, e.g. a telephone conference. Three parties, i.e. a first endpoint T1, a second endpoint T2 and a third endpoint T3, have switched from end-to-end communications between each other to use a dialogue processor PD in order to communicate in a multi-party dialogue D(x) with one stream each {T1(x), T2(x), T3(x)}. Dotted arrows refer to communication before the switch, solid arrows refer to communication after the switch to a dialogue processor PD. Fallbacks, e.g. C(T1,T3) are just inactive, indicated by the dotted arrows, but would be able to extract data if a stream packet with the respective MMolP packet stream arrives, e.g. a T3(x) packet at the connection C(T1,T3).

Fig. 10 is a schematic block diagram of a MMolP system with a dialogue processor multiplexing. A dialogue processor PD can multiplex MMolP packet stream data to combine MMolP packet streams, e.g. by audio/video/text mixing. For the dialogue processor stream PD(X) at the endpoints, corresponding fallback stream endpoints are available to switch to in case of a failure, e.g. a temporary unavailability.

Fig. 11 is a schematic block diagram of a MMolP system with a collaboration detection. In a first step 1.a., an activity detection AD at a stream source T1 is used, as in VAD (= Voice Activity Detection), to limit the number of stream packets transmitted to a stream sink T2. Preferably, in case of the activity detection AD detecting that there exist no MM data at the stream source T1 to be transmitted to the stream sink T2, no MMolP packets are generated. For example, in case of a VoIP telephone call, if a telephone caller associated with the first endpoint T1 does not speak, no VoIP packets are generated and sent from the first endpoint T1.

In a second step 1.b., the MMolP switch S measures the activity of an endpoint T1, T2 in collaboration with one or more other endpoints in terms of time during which a user associated with the endpoint T1, T2 has sent data in a MMolP packet stream, e.g. T1(x). Communication endpoints T1, T2 can be
classified by their IP address in the endpoint tuple $E_P$ to be either part of the switching system or external to the switching system. When the MMolIP switch $S$ holds a connection $C(X,Y)$ and either the endpoint $X$ or the endpoint $Y$ is a communication endpoint outside of the switching system, i.e. an external endpoint, the MMolIP switch $S$ preferably measures an activity of the external endpoint and reports it to a storage facility $ST$ for correlation.

Further, whenever the MMolIP switch $S$ pre-empts/services an indication to setup or remove a dialogue processor $P_D$, to add a MMolIP packet stream or remove a MMolIP packet stream from the dialogue processor $P_D$, it preferably stores associated time data and data associated with changes in the dialogue participation to the storage facility $ST$.

In a third step i.e., the MMolIP switch $S$ correlates the above mentioned data from the storage facility $ST$ to derive collaboration data of the endpoints $T_1$, $T_2$, e.g. a collaboration graph which indicates which endpoints are communicating and how actively.

In a fourth step i.d., the MMolIP switch $S$ derives the Pareto-optimal location of pre-empting/serving indications from an endpoint $T_1$, $T_2$ and targeted to an endpoint $T_1$, $T_2$ under consideration of a collaboration activity, processing resource availability and network resource availability.

The MMolIP system is adapted to measure an endpoint activity and a dialogue creation to eventually create a collaboration graph. First, the collaboration graph may be is used by the MMolIP system to self-optimize a resource utilization by the MMolIP system, e.g. by deriving Pareto-optimal locations for processing of streams and dialogues, by relocating processing elements and by routing MMolIP packet streams to reach a more efficient network/computational resource utilization. Second, the MMolIP system is adapted to provide segments of the collaboration graph to affiliated endpoints as information. Third, the MMolIP system is adapted to use the endpoint activity
and collaboration graph for accounting. The MMolIP system may use endpoint activity and collaboration data, such as collaboration traces, to self-optimize the utilization of resources. The MMolIP system leverages inter-endpoint collaboration activity for optimization of resource utilization.
**Claims**

1. A method of providing an MMoIP communication service, comprising the steps of:
   transmitting one or more MMoIP packet streams (T1(x)) via a connection (C(T1,T2)) established between a first endpoint (T1) of an IP communication network (100) and a second endpoint (T2) of the IP communication network (100), whereby the one or more MMoIP packet streams (T1(x)) comprise MMoIP payload data and/or control data;
   inserting control data directed to a processor (P) into at least one MMoIP packet stream (T1(x)) of the one or more MMoIP packet streams (T1(x)) at the first endpoint (T1) and/or the second endpoint (T2);
   transmitting the one or more MMoIP packet streams (T1(x)) via an MMoIP switch (S) of the IP communication network (100);
   monitoring, by the MMoIP switch (S), the one or more MMoIP packet streams (T1(x));
   detecting, by the MMoIP switch (S), the control data directed to the processor (P); and
   forwarding, by the MMoIP switch (S), the detected control data to the processor (P).

2. The method of claim 1, characterised in that the method further comprises the step of:
   inserting control data from the processor (P) into at least one MMoIP packet stream (T1(x)) of the one or more MMoIP packet streams (T1(x)).
3. The method of claim 1, characterised in
that the method further comprises the step of:
processing, by the processor (P), at least one MMolP packet stream
(T1(x)) of the one or more MMolP packet streams (T1(x)).

4. The method of claim 3, characterised in
that the control data which are forwarded by the MMolP switch (S) to
the processor (P) control the processing of the at least one MMolP
packet stream (T1(x)) of the one or more MMolP packet streams
(T1(x)) by the processor (P).

5. The method of claim 1, characterised in
that monitoring, by the MMolP switch (S), the one or more MMolP
packet streams (T1(x)) comprises:
executing a packet inspection of the one or more MMolP packet
streams (T1(x)) packet per packet; and
distinguishing payload data and control data.

6. The method of claim 1, characterised in
that the method further comprises the steps of:
inserting, at the first endpoint (T1) and/or the second endpoint (T2), an
indication in at least one MMolP packet stream (T1(x)) of the one or
more MMolP packet streams (T1(x));
detecting, by the MMolP switch (S), the indication;
triggered by the detected indication, setting up the processor (P) for
processing at least one MMolP packet stream (T1(x)) of the one or
more MMolP packet streams (T1(x)); and
re-directing, by the MMolP switch (S), the at least one MMolP packet stream (T1(x)) of the one or more MMolP packet streams (T1(x)) to the processor (P).

The method of claim 1,
characterised in
that the method further comprises the step of:
if the MMolP switch (S) detects a failure of the processor (P), stopping, by the MMolP switch (S), the forwarding of the control data to the processor (P).

The method of claim 1,
characterised in
that the method further comprises the steps of:
indicating, by the processor (P), a need for an additional processor (P2) to the MMolP switch (S);
triggered by the said indication received from the processor (P), instantiating, by the MMolP switch (S), the additional processor (P2);
re-directing, by the MMolP switch (S), the at least one MMolP packet stream (T1(x)) to the additional processor (P2); and
sending, by the additional processor (P2), its output of the at least one MMolP packet stream (T1(x)) to the processor (P).

The method of claim 1,
characterised in
that the method further comprises the steps of:
measuring, by the MMolP switch (S), an activity of at least one of the endpoints (T1, T2) in collaboration with one or more other endpoints (T1, T2) in terms of a time during which a user associated with the at least one endpoint (T1, T2) has sent MMolP data in at least one of the one or more MMolP packet streams (T1(x));
storing the measured activity data; and
correlating, by the MMoIP switch S, the stored activity data to derive collaboration data of the endpoints T₁, T₂.

10. A MMoIP system for providing an MMoIP communication service in an IP communication network (100), comprising a first endpoint (T₁) and a second endpoint (T₂) which are adapted to send one or more MMoIP packet streams (T₁(x)) via a connection (C(T₁, T₂)) established between the first endpoint (T₁) and the second endpoint (T₂) and to insert control data directed to a processor (P) in at least one MMoIP packet stream (T₁(x)) of the one or more MMoIP packet streams (T₁(x)), whereby the one or more MMoIP packet streams (T₁(x)) comprise MMoIP payload data and/or control data, and comprising an MMoIP switch (S) adapted to monitor the one or more MMoIP packet streams (T₁(x)) which are transmitted via the MMoIP switch (S), detect the control data directed to the processor (P) and forward the detected control data to the processor (P).

11. The MMoIP system of claim 10, characterised in

that the processor (P) is a stream processor (Ps) adapted to process at least one MMoIP packet stream of the one or more MMoIP packet streams (T₁(x)) and/or a dialogue processor (P_D) adapted to process a bidirectional dialogue between the first endpoint (T₁) and the second endpoint (T₂).

12. The MMoIP system of claim 10 or claim 11, characterised in

that the MMoIP system further comprises the processor (P).

13. The MMoIP system of claim 10, characterised in

that the MMoIP system further comprises a storage facility (ST)
adapted to receive data from the MMoIP switch (S) and store the received data.
FIG. 4
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04L12/26 H04L12/56 H04L29/06

ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic database consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
</table>

Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another document, or other special reason (as specified)

"O" document referring to oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"A" document member of the same patent family

Date of the actual completion of the international search
7 November 2011

Date of mailing of the international search report
14/11/2011

Name and mailing address of the ISA
European Patent Office, P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk
Tel. (+31-70) 340-2040, Fax. (+31-70) 340-3016

Authorized officer
Tous Fajardo, Juan

Form PCT/ISA/210 (second sheet) (April 2005)
<table>
<thead>
<tr>
<th>Patent document</th>
<th>Publication date</th>
<th>Patent family member(s)</th>
<th>Publication date</th>
</tr>
</thead>
<tbody>
<tr>
<td>US 2006209807</td>
<td>21-09-2006</td>
<td>NONE</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 2001298491 A</td>
<td>26-10-2001</td>
</tr>
</tbody>
</table>