

[0011] Fragmentation can happen at various layers of the Open Systems Interconnection (OSI) model protocol stack when the protocol data unit (PDU) size of a layer is less than that of the upper layer. For example, if an IP packet size is greater than the maximum transport unit (MTU) size, the IP packet needs to be fragmented. Examples include IP fragmentation in IP-based networks, Radio Link Control (RLC) layer fragmentation in the wireless networks, and application-layer fragmentation. Fragmentation at the application layer is preferred to IP-fragmentation.

[0012] Application-layer fragmentation was addressed for the real-time transport of compressed video bit streams. For example, Internet Engineering Task Force (IETF) Request for Comments (RFC) 3984 defines fragmentation rules and the corresponding syntax when the compressed video bit stream of a H.264 NAL unit needs to be fragmented into multiple RTP packets.

[0013] Currently, there are no solutions focusing particularly on the fragmentation of XML content and information necessary to aid in error recovery and error concealment at the client when one or more of these fragments are lost during transmission. The most recent version of the Mobile Open Rich-media Environment (MORE) proposal in the 3GPP SA4 forum defines a primitive form of fragmentation. It borrows many concepts from IETF RFC 3984, however it does not consider special structure of SVG content (XML syntax) in defining the fragmentation rules.

[0014] Certain conventional systems, such as that described in "Structured documents: Searching XML documents via XML fragments" by Carmel et al. exist that extend the vector space model for the purpose of querying XML collections via XML fragments and ranking results by relevance. However, in such systems, the purpose for utilizing XML fragments is to allow a type of free text querying used to access documents expressed in free text, where XML can be used to formulate queries to search relevant XML documents. Document similarity and relevance is performed by extending the vector space information retrieval algorithm based on XPath model, and corresponding documents are retrieved. Thus, the information to be queried is expressed as XML snippets, called XML "fragments."

[0015] Still other prior art systems such as that described in "XML query processing: Query processing of streamed XML data" by Bose et al. focus on processing continuous XML streams, where a server broadcasts XML data concurrently. The server may disseminate XML fragments from multiple documents in the same stream. Clients use a light-weight in-memory database to cache stream data and physical algorithms based on XML algebra to evaluate the XML queries against these data. The focus of such a prior art system is on caching and reconstructing parts of the original XML data just enough for evaluating XML queries against these data. Also, each fragment corresponds to just one XML element from a transmitted document. The server prunes fragments from the XML document tree and has holes in the document for references to the fragments that need to be filled. In addition, the structure of the transmitted XML document is also sent to the client to aid in formulating query grammar for efficient parsing of the partially reconstructed XML content at the client.

[0016] U.S. Patent Publication No. 2005/0267909, entitled, "Storing Multipart XML Documents," incorporated herein by reference in its entirety, describes a method of storing XML documents, by decomposing the XML docu-

ment into a hierarchy of nodes and creating an index of the nodes. This structure facilitates an indexed-based search for XML content. However, this invention does not consider the problem of fragmenting XML content for streaming purposes, nor any mechanisms for helping the client in error recovery if one or more fragments are lost during transmission.

[0017] U.S. Patent Publication No. 2005/0203957, entitled, "Streaming XML data retrieval using XPath," incorporated herein by reference in its entirety, describes an XML Extractor that can selectively extract a portion of an XML document using XPath-based XML data retrieval. A receiver receives streaming input that represents XML data and a set of XPaths with associated content handler instances for registration. The receiver then evaluates events from the stream-based parser against the registered XPaths and determines whether the received streaming input includes an XPath that matches the registered XPath. Although this process involves the extraction and evaluation of XML data from streamed input, it does not address XML fragmentation and information concerning the transmission of these fragments to enable error recovery.

SUMMARY OF THE INVENTION

[0018] Various embodiments of the present invention provide a system and method for fragmenting XML-based content, encapsulating the content fragments in RTP transport packets, transmitting the RTP transport packets to a receiver, and defining various ways of reconstructing the XML-based content from the fragments to create streamed media. Various rules and options are defined and adhered to by the various embodiments of the present invention when fragmenting XML-based content. The XML-based content can be partitioned into fragments without taking into account any syntactic structure of the XML-based content. Alternatively, various embodiments of the present invention can partition XML-based content in a manner that preserves any underlying syntactic structure or format. In both cases, the XML fragments are extracted and associated with certain relevant fragment information, all of which is transmitted in the RTP transport packet. Upon receipt of the RTP transport packets at the receiver, various methods of reconstructing the XML-based content from the fragments, retransmitting lost packets, and/or performing error concealment can be utilized.

[0019] The various embodiments of the present invention provide a method of fragmentation that is not limited simply to, for example, each XML element in a tree hierarchy, but that is driven by permissible transport packet size and optimality to address different needs and applications. In addition, the relevant fragment information transmitted with the fragments can be used to aid in error recovery and error concealment of the XML-based content sample at the receiver end in the event that packets are lost during transmission.

[0020] These and other advantages and features of the invention, together with the organization and manner of operation thereof, will become apparent from the following detailed description when taken in conjunction with the