(54) Title: APPARATUS AND METHOD FOR PROVIDING GUARANTEED FRAME RATE SERVICE IN ATM SWITCH

(57) Abstract: A guaranteed frame rate (GFR) service providing apparatus and method for an ATM switch is provided. A cell conformance portion applies a test to each cell in an input frame with respect to generic cell rate algorithm (GCR), cell loss priority (CLP) bit, and maximum frame size (MFS), sets the conforming bit (CB) of each cell in the frame to a conforming value if all cells of the frame pass the test, and sets the CB of each cell in the frame to a non-conforming value if at least one cell of the frame does not pass the test. A buffer management portion allocates cells with CBs set a conforming value to a high priority queue, allocates cells with CBs set a non-conforming value to a low priority queue, transmits the cells allocated to the high priority queue with a minimum cell rate (MCR) guaranteed, and transmits the cells allocated to the low priority queue at a cell rate allowed by a bandwidth available in a network.
APPARATUS AND METHOD FOR PROVIDING GUARANTEED FRAME RATE SERVICE IN ATM SWITCH

BACKGROUND OF THE INVENTION

1. Field of the Invention
The present invention relates generally to an apparatus and method for providing guaranteed frame rate (GFR) service in an asynchronous transfer mode (ATM) switch.

2. Description of the Related Art
The guaranteed frame rate (GFR) service is intended to support non-real-time applications in the ATM network. It is designed for applications that may require a minimum rate guarantee and can benefit from accessing additional bandwidth dynamically available in the network. The GFR does not require adherence to a flow control protocol unlike the Available Bit Rate (ABR) service. The service guarantee is performed based on AAL-5 PDUs (ATM Adaptation Layer 5 Protocol Data Unit: frames). Here, a frame refers to a unit, which binds a plurality of cells, to be transmitted on a transmission line. While frame structure varies depending on at which AAL sub-layer a particular frame is used, a frame is typically comprised of a PDU header, a PDU payload, and a PDU trailer. Such a frame structure, however, can not be processed at the ATM layer. Accordingly, a frame is identified by marking the last cell of the frame with the payload type field PT of an ATM cell header.

Under congested conditions, the network discards cells at the frame level rather than at the cell level. Therefore, the guaranteed frame rate (GFR) service requires that user data cells are organized in the form of frames that can be delineated at the ATM layer. Upon establishment of a GFR connection, the end system specifies a peak cell rate (PCR) and a minimum cell rate (MCR) that is defined along with a maximum frame size (MFS), that is, a maximum number of cells per frame. The user may always send cells at a rate up to the peak cell rate (PCR), but the network only commits to carry cells in complete frames at the minimum cell rate (MCR). Traffic beyond the MCR will be delivered within the limits of available resources.
The above service guarantee implies that if the user sends frames that do not exceed the MCR, then the user should expect to see the frames delivered with minimum losses. The GFR service also allows the user to send in excess of the MCR, but the excess traffic will only be delivered within the limits of available resources. Furthermore, the service specifies that the excess traffic from each user should have access to a fair share of the available sources.

The user can send frames either unmarked or marked. An unmarked frame is one in which all cells have CLP (Cell Loss Priority)=0, and a marked frame is one in which all cells have CLP=1. By sending a frame marked, the user indicates to the network that such a frame is of lesser importance than an unmarked frame. The minimum cell rate (MCR) guarantee only applies to unmarked frames. The network is only allowed to tag cells in unmarked frames if the user has requested the tagging option, either via signaling (for Switched Virtual Channels: SVCs) or via subscription (for Permanent Virtual Channels: PVCs). A cell is called tagged when the network sets its CLP bit to 1. Otherwise, tagging by the network is not applicable. Currently, the GFR service category only applies to virtual channel connection as frame delineation is not generally visible in a virtual path connection.

There are two versions of guaranteed frame rate (GFR), GFR.1 and GFR.2. They differ with respect to the treatment of the Cell Loss Priority (CLP) bit based on a frame-based generic cell rate algorithm (F-GCRA) test. In GFR.1, the CLP bit is transparently conveyed by the network and the tagging is not allowed. In the GFR.2 version, the tagging is allowed and every cell conforms to the F-GCRA.

Details about the GFR service are available in the ATM Forum site over the Internet. For reference, see "Traffic Management Specification Draft Version 4.1".

If the network may tag frames that can not pass the F-GCRA test as in GFR.2 version, the network can delineate frames to be transmission-guaranteed by their CLP bits according to the states of the frames and the network. If such frame delineation is viable, there can be system implementation choices in terms of implementation simplicity and performance. However, in case the network is unable to tag as in GFR.1, the network should rely on the CLP bits marked by the user to delineate frames to be guaranteed. A cell is conforming if the cell conforms to a traffic contract preset by the network, and a cell is non-conforming if it does not conform to the traffic contract. Then, in the case that tagging is not allowed in the network, the non-
conforming cells may not be delineated, thus making it difficult to process the non-conforming cells.

**SUMMARY OF THE INVENTION**

It is, therefore, an object of the present invention to provide an apparatus and method for efficiently providing the GFR service in ATM according to the characteristic of a network by discriminating between a conforming cell and a non-conforming cell and storing them in different output buffered queues.

It is another object of the present invention to provide an apparatus and method for protecting unmarked cells received from a user as far as possible by checking the CLP bits of non-conforming cells.

The above objects can be achieved by providing a guaranteed frame rate (GFR) service providing apparatus in an ATM switch. A cell conformance portion applies a test to each cell in an input frame with respect to generic cell rate algorithm (GCRA), cell loss priority (CLP) bit, and maximum frame size (MFS); sets the conforming bit (CB) of each cell in the frame to a conforming value if all cells of the frame pass the test; and, sets the CB of each cell in the frame to a non-conforming value if at least one cell of the frame does not pass the test. A buffer management portion allocates cells with CBs set a conforming value to a high priority queue; allocates cells with CBs set a non-conforming value to a low priority queue; transmits the cells allocated to the high priority queue with a minimum cell rate (MCR) guaranteed; and, transmits the cells allocated to the low priority queue at a cell rate allowed by a bandwidth available in a network.

A method for providing GFR service in an ATM switch, comprising the steps of:

(a) applying a test to each cell in an input frame of a cell conformance portion for with respect to generic cell rate algorithm (GCRA), cell loss priority (CLP) bit, and maximum frame size (MFS);
(b) setting a conforming bit (CB) of each cell in the frame to a conforming value if all cells of the frame pass the test applied in step (a);
(c) setting the CB of each cell in the frame to a non-conforming value if at
least one cell of the frame does not pass the test applied in step (a);
   (d) allocating cells with CBs set at the conforming value to a high priority
    queue in a buffer management portion;
   (e) allocating cells with CBs set at the non-conforming value to a low priority
    queue in the buffer management portion;
   (f) transmitting the cells allocated to the high priority queue with a minimum
    cell rate (MCR) guaranteed; and,
   (g) transmitting the cells allocated to the low priority queue at a cell rate
   allowed by a bandwidth available in a network.

In a first aspect of the present invention, the test recited in step (a) includes
   testing
   each cell in the cell conformance portion by:
   (1) applying a conformance test with a cell conformance tester to each cell in
    the input frame with respect to GCRA, CLP bit and MFS, and then transmitting the
    cells through different paths according to test results, including:
    (i) transmitting cells that pass the cell conformance test to a conforming path;
    (ii) transmitting cells that do not pass the cell conformance test a non-
    conforming path for; and,
   the setting step recited in step (b) including:
   (i) setting one bit in a header error control (HEC) field of the header of each
    cell received from the conforming path with a CB setter to the conforming value;
    and
   (ii) setting one bit in the HEC field of the header of each cell received from the
    non-conforming path with the CB setter to the non-conforming value.

Another aspect of the present invention includes that the allocating cells in the
   buffer management portion recited in step (d) includes:
   (1) allocating the cells with the conforming value to the high priority queue and
    allocating the cells with the non-conforming value to the low priority queue by
    utilizing the cell allocator;
   (2) queuing the allocated cells under predetermined control by providing a
    buffered queue having the high priority queue and the low priority queue; and,
   (3) controlling the high priority queue and the low priority queue with a queue
    controller for transmitting the cells allocated to the high priority queue with the MCR
    guaranteed, and transmitting the cells allocated to the low priority queue at the cell
rate allowed by the bandwidth available in a network.

In yet another aspect of the GFR service providing method of the present invention, the controlling of the high priority and low priority queues by the queue controller recited in step (d)(3) includes:

(i) setting a predetermined congested queue depth for the low priority queue; and

(ii) discarding the cells in frames units when the queue value of the cells allocated to the low priority queue is greater than or equal to the congested queue depth.

Finally, in still another aspect of the present invention, the GFR service providing method includes having the queue controller immediately discard cells with CLP bits set in the low priority queue when the network is congested.

**BRIEF DESCRIPTION OF THE DRAWINGS**

The above and other objects, features, and advantages of the present invention will become more apparent from the following detailed description when taken in conjunction with the accompanying drawings in which:

FIG. 1 is a block diagram of an ATM GFR service providing apparatus according to the embodiment of the present invention;

FIG. 2 is a flowchart illustrating a cell conformance test procedure in the ATM GFR service providing apparatus according to the embodiment of the present invention; and,

FIG. 3 illustrates a conforming cell and a non-conforming cell in the ATM GFR service providing apparatus according to the embodiment of the present invention.

**DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT**
A preferred embodiment of the present invention will be described hereinbelow with reference to the accompanying drawings. For the purpose of clarity, well-known functions or constructions are not described in detail since they would obscure the invention in unnecessary detail.

FIG. 1 is a block diagram of an ATM guaranteed frame rate (GFR) service providing apparatus and method according to an embodiment of the present invention.

With reference to FIG. 1, the ATM GFR service providing apparatus and method of the present invention is comprised of a cell conformance portion 100 and a buffer management portion 110. The cell conformance portion 100 includes a cell conformance tester 101 and a conforming bit (CB) setter 102 connected to the cell conformance tester 101. The buffer management portion 110 includes a cell allocator 111 connected to the conforming bit setter 102, a buffered queue 113 connected to the cell allocator 111, and a queue controller 112 for controlling the buffered queue 113.

The cell conformance portion 100 applies a cell conformance test to each cell in the input frame of a GFR connection and sets a CLP bit for the cell.

The cell conformance tester 101 tests each cell in the input frame of a GFR connection on predetermined traffic parameters. For example, generic cell rate algorithm (GCRA), cell loss priority (CLP) bit, and maximum frame size (MFS) that will be later described. The concept of the cell conformance test is disclosed in the above-stated document “Traffic Management Specification Draft Version 4.1”.

For a clear understanding of the subject matter of the present invention, the cell conformance test will be described in detail with reference to FIG. 2. Traffic parameters and the algorithm used for the cell conformance test will be first described.

A traffic parameter describes an inherent characteristic of a traffic source. It may be quantitative or qualitative. Typical traffic parameters include peak cell rate (PCR), sustainable cell rate (SCR), minimum cell rate (MCR), and maximum frame size (MFS). A definition for PCR is a reciprocal of the minimum inter-arrival time of cells within a frame.

ATM layer functions (e.g., cell multiplexing) may alter the traffic
characteristics of connections by introducing cell delay variation. When cells from two or more connections are multiplexed, cells of a given connection may be delayed while cells of another connection are being inserted at the output of the multiplexer. Similarly, some cells may be delayed while physical layer overhead or OAM (Operation Administration and Management) cells are inserted. Consequently with respect to the peak emission interval T (i.e., the inverse of the contracted PCR), some randomness may affect the inter-arrival time between consecutive cells of a connection as monitored at the UNI (User Network Interface). The upper bound on the “clumping” measure is cell delay variation tolerance (CDVT).

The GCRA is used to define conformance with respect to the traffic contract. For each cell arrival, the GCRA determines whether the cell conforms to the traffic contract of the connection. The GCRA is a virtual scheduling algorithm or a continuous-state Leaky Bucket Algorithm which is well known in the art. The GCRA is used to define the relationship between peak cell rate (PCR) and cell delay variation tolerance (CDVT), and the relationship between SCR, and Burst Tolerance (BT). The GCRA is defined with two parameters: the increment (l) and the limit (L). The notion “GCRA (l, L)” means the generic cell rate algorithm with the value of the increment parameter set equal to l and the value of the limit parameter set equal to L.

The GFR conformance definition is based on the conformance of each cell of a frame with respect to the following conditions. A frame is conforming if all cells within the frame are conforming, but non-conforming if one or more of its cells are non-conforming.

A user generated cell is conforming if all of the following three conditions are met:

1. The cell conforms to GCRA(1/PCR, CDVT).
2. The CLP bit of the cell has the same value as the CLP bit of the first cell of the frame.
3. The cell either is the last cell of the frame or the number of cells in the frame up to and including this cell is less than MFS.

FIG. 2 is a flowchart illustrating a GFR cell conformance test of each cell in an input frame in the cell conformance tester 101 of FIG. 1.

With reference to FIG. 2, upon cell arrival, the cell conformance tester 101
tests the cell according to the GCRA in step 210 with the parameters 1/PCR and CDVT indicating the increment value and the limit value, respectively. Here, PCR is defined for a CLP=0+1 cell stream (i.e., a cell stream with CLP= 0 or 1). 1/PCR indicates an expected arrival time of the next cell and is updated upon every cell arrival of a frame. The CDVT specifies the upper and lower error limits for 1/PCR. If each cell arrives within the CDVT, the cell conforms to the GCRA. Then, the procedure goes to step 220.

If the cell is the first cell of the frame in step 220, the cell conformance tester 101 registers the CLP bit of the first cell in an inner register in step 221. If the cell is not the first cell of the frame in step 220, the cell conformance tester 101 determines whether the CLP bit of the cell has the same value as the CLP bit of the first cell registered in the inner register in step 222. If they are the same, the CLP bit of the cell is conforming and if they are different, the cell is non-conforming.

If the CLP bit of the cell is conforming in step 222, the cell conformance tester 101 determines whether the cell is the last cell of the frame in step 230. If the cell is not the last cell of the frame, the cell conformance tester 101 determines whether the number of cells received so far is less than MFS in step 231. Upon cell arrival, it is determined whether the number of cells received up to that time is less than the MFS, and if the cell number is less than the MFS, the cell conforms to the test of the MFS. If the cell number is greater than the MFS, the cell is not conforming to the MFS test. If the cell is the last cell of the frame, the cell is also conforming to the MFS.

When the cell meets all the above conditions, it is said that the cell is conforming in step 240. If at least one of the conditions is not satisfied in steps 210, 222, and 231, the cell is defined as non-conforming in step 241.

The GCRA test is applied to every cell. Therefore, even in case a cell arrives above a congested threshold value, the cell is protected as the other cells of the frame as long as the cell satisfies the above conditions.

Returning to FIG. 1, if each cell of the input frame passes the cell conformance test with respect to the algorithm and traffic parameters, the cell is fed to the conforming bit setter 102 through a conforming path 103. If the frame has at least one cell that has not pass the cell conformance test, the cells in the frame are fed to the
conforming bit setter 102 through a non-conforming path 104.

The conforming bit setter 102 sets the most significant bit (MSB) of a header error control (HEC) field in the header of each cell in the frame received through the conforming path 103 to CB (Conforming Bit)=0 (low). A cell with CB=0 is a conforming cell. The conforming bit setter 102 sets the MSB of the HEC field in the header of each cell in the frame received through the non-conforming path 104 to CB=1 (high). A cell with CB=1 is a non-conforming cell. Since the cell conformance test with respect to the traffic parameters of GCRA, CLP bit, and MFS is applied to each cell in a frame, CBs have the same value within one frame.

FIG. 3 illustrates a conforming cell and a non-conforming cell in the ATM GFR service providing apparatus according to the embodiment of the present invention. The MSB of the field HEC of a cell header represents a CB. If a cell has CB=0, it is a conforming cell. If a cell has CB=1, it is a non-conforming cell. The conforming bit setter 102 transmits each cell with its CB set to zero or one in a frame to the buffered queue 110.

The cell allocator 111 of the buffer management portion 110 allocates cells with CB=0 and cells with CB=1 to a high priority queue 114 and a low priority queue 115, respectively. In view of the same CB value in one frame, cells are allocated in units of frames to the high and low priority queues 114 and 115.

The queue controller 110 transmits the cells input to the high priority queue 114, providing an MCR service guarantee. The queue controller 110 sets a congested queue depth at which the network is congested. Unless the queue value of the cells allocated in the low priority queue 115 is greater than the congested queue depth, the queue controller 110 allows the cells to access a fair share of the available bandwidth in the network with other ATM service categories like ABR. In addition, the queue controller 110 transmits the cells allocated to the low priority queue 115 at a cell rate according to the available bandwidth of the network.

However, if the queue value of the cells allocated to the low priority queue 115 is greater than the congested queue depth, then all cells can not be transmitted at the cell rate allowed by the available bandwidth of the network. Accordingly, the queue controller 110 discards the cells at the frame level, thereby managing the
performance (transmission rate) of the network. A discarded cell in frames does not imply concurrent discarding of all cells in one frame, rather it determines a frame to be discarded and a selective discarding of the cells in the frame according to CLP bits. At traffic congestion in the network, the queue controller 110 first discards cells with CLP=1 and protects unmarked cells (CLP=0) as far as possible.

As described above, the present invention has the same effect as observed in GFR.2 where the network can tag using CB within the system. Besides, a cell conformance test is given to a cell input to the network even for GFR.1, which is characterized in that tagging not is allowed in the network, thus that the present invention can protect a cell that is against a connection contract of the network but unmarked by a user if cell is considered to be significant. The resulting traffic management enables the network to be protected against users who terminates or breaches the connection contract.

While the invention has been shown and described with reference to a certain preferred embodiment thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and the scope of the invention as defined by the appended claims.
WHAT IS CLAIMED IS:

1. A guaranteed frame rate (GFR) service providing apparatus in an Asynchronous Transfer Mode (ATM) switch, comprising:
   a cell conformance portion for applying a test to each cell in an input frame with respect to generic cell rate algorithm (GCRA), cell loss priority (CLP) bit, and maximum frame size (MFS), setting the conforming bit (CB) of each cell in the frame to a conforming value if all cells of the frame pass the test, and setting the CB of each cell in the frame to a non-conforming value if at least one cell of the frame does not pass the test; and
   a buffer management portion for allocating cells with CBs set at a conforming value to a high priority queue, allocating cells with CBs set at a non-conforming value to a low priority queue, transmitting the cells allocated to the high priority queue with a minimum cell rate (MCR) guaranteed, and transmitting the cells allocated to the low priority queue at a cell rate allowed by a bandwidth available in a network.

2. The GFR service providing apparatus of claim 1, wherein the cell conformance portion comprises:
   a cell conformance tester for applying a test to each cell in the input frame with respect to GCRA, CLP bit, and MFS and transmitting the cells through different paths according to test results;
   a conforming path for transmitting cells that pass the cell conformance test;
   a non-conforming path for transmitting cells that do not pass the cell conformance test; and
   a CB setter for setting one bit in a header error control (HEC) field of the header of each cell received from the conforming path to the conforming value and setting one bit in a HEC field of the header of each cell received from the non-conforming path to the non-conforming value.

3. The GFR service providing apparatus of claim 1, wherein the buffer management portion comprises:
   a cell allocator for allocating the cells with the conforming value to the high priority queue and the cells with the non-conforming value to the low priority queue;
   a buffered queue having the high priority queue and the low priority queue, for queuing the allocated cells under predetermined control; and
   a queue controller for controlling the high priority queue and the low priority queue, transmitting the cells allocated to the high priority queue with the MCR
guaranteed, and transmitting the cells allocated to the low priority queue at the cell rate allowed by the bandwidth available in a network.

4. The GFR service providing apparatus of claim 2, wherein the buffer management portion comprises:
   a cell allocator for allocating the cells with the conforming value to the high priority queue and the cells with the non-conforming value to the low priority queue;
   a buffered queue having the high priority queue and the low priority queue, for queuing the allocated cells under predetermined control; and,
   a queue controller for controlling the high priority queue and the low priority queue, transmitting the cells allocated to the high priority queue with the MCR guaranteed, and transmitting the cells allocated to the low priority queue at the cell rate allowed by the bandwidth available in a network.

5. The GFR service providing apparatus of claim 3, wherein the queue controller sets a predetermined congested queue depth for the low priority queue and discarding the cells in frames units if the queue value of the cells allocated to the low priority queue is greater than or equal to the congested queue depth.

6. The GFR service providing apparatus of claim 5, wherein the queue controller discards cells with CLP bits set in the low priority queue in the first place when the network is congested.

7. A method for providing a guaranteed frame rate (GFR) service in an Asynchronous Transfer Mode (ATM) switch, comprising the steps of:
   (a) applying a test to each cell in an input frame of a cell conformance portion for with respect to generic cell rate algorithm (GCRA), cell loss priority (CLP) bit, and maximum frame size (MFS);
   (b) setting a conforming bit (CB) of each cell in the frame to a conforming value
   if all cells of the frame pass the test applied in step (a);
   (c) setting the CB of each cell in the frame to a non-conforming value if at least one cell of the frame does not pass the test applied in step (a);
   (d) allocating cells with CBs set at the conforming value to a high priority queue in a buffer management portion;
   (e) allocating cells with CBs set at the non-conforming value to a low priority
queue in the buffer management portion;

(f) transmitting the cells allocated to the high priority queue with a minimum cell rate (MCR) guaranteed; and,

(g) transmitting the cells allocated to the low priority queue at a cell rate allowed by a bandwidth available in a network.

8. The GFR service method according to claim 7, wherein the test applied to each cell in the cell conformance portion recited in step (a) comprises:

(1) applying a conformance test with a cell conformance tester to each cell in the input frame with respect to GCRA, CLP bit and MFS, and then transmitting the cells through different paths according to test results, including:

(i) transmitting cells that pass the cell conformance test to a conforming path;

(ii) transmitting cells that do not pass the cell conformance test a non-conforming path for; and

the setting step recited in step (b) including:

(i) setting one bit in a header error control (HEC) field of the header of each cell received from the conforming path with a CB setter to the conforming value; and,

(ii) setting one bit in the HEC field of the header of each cell received from the non-conforming path with the CB setter to the non-conforming value.

9. The GFR service providing method according to claim 7, wherein the allocating cells recited in the buffer management portion recited in step (d) includes:

(1) allocating the cells with the conforming value to the high priority queue and allocating the cells with the non-conforming value to the low priority queue by utilizing the cell allocator;

(2) queuing the allocated cells under predetermined control by providing a buffered queue having the high priority queue and the low priority queue; and,

(3) controlling the high priority queue and the low priority queue with a queue controller for transmitting the cells allocated to the high priority queue with the MCR guaranteed, and transmitting the cells allocated to the low priority queue at the cell rate allowed by the bandwidth available in a network.

10. The GFR service providing method according to claim 8, wherein the allocating cells recited in the buffer management portion recited in step (d) includes:

(1) allocating the cells with the conforming value to the high priority queue and
allocating the cells with the non-conforming value to the low priority queue by utilizing the cell allocator;

(2) queuing the allocated cells under predetermined control by providing a buffered queue having the high priority queue and the low priority queue; and

(3) controlling the high priority queue and the low priority queue with a queue controller for transmitting the cells allocated to the high priority queue with the MCR guaranteed, and transmitting the cells allocated to the low priority queue at the cell rate allowed by the bandwidth available in a network.

11. The GFR service providing method according to claim 9, wherein the controlling of the high priority and low priority queues by the queue controller recited in step (d)(3) includes:

(i) setting a predetermined congested queue depth for the low priority queue; and

(ii) discarding the cells in frames units when the queue value of the cells allocated to the low priority queue is greater than or equal to the congested queue depth.

12. The GFR service providing method according to claim 11, wherein the discarding by the queue controller recited in (d)(3)(ii) includes immediately discarding cells with CLP bits set in the low priority queue when the network is congested.
\{ CB=0 \Rightarrow \text{CELL CONFORMING} \\
CB=1 \Rightarrow \text{CELL NOT CONFORMING} \}

**FIG. 3**
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

IPC7 H04L 12/28

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)

IPC7: H04L, H04Q

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

Korean Patents and Applications for Inventions since 1975
Korean Utility Models and Applications for Utility Models since 1975

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

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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>
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<tr>
<td>Y</td>
<td>&quot;Buffer management and scheduling for TCP/IP over ATM-GFR&quot;, Wu, D.; Chao H. J.</td>
<td>3-6, 11-12</td>
</tr>
<tr>
<td>A</td>
<td>US 6,002,667 : abstract, claim</td>
<td>1, 7</td>
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☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
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Date of the actual completion of the international search 21 FEBRUARY 2001 (21.02.2001)

Date of mailing of the international search report 22 FEBRUARY 2001 (22.02.2001)

Name and mailing address of the ISA/KR
Korean Industrial Property Office
Government Complex-Taejon, Dunsan-dong, So-ku, Taejon Metropolitan City 302-701, Republic of Korea
Facsimile No. 82-42-472-7140

Authorized officer
LEE, Saang Woong
Telephone No. 82-42-481-5714

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<table>
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