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OF ITU

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SERIES I: INTEGRATED SERVICES DIGITAL NETWORK

B-ISDN equipment aspects – Multiplexing aspects

Inverse multiplexing for ATM (IMA)

ITU-T Recommendation I.761

(Formerly CCITT Recommendation)

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ITU-T Recommendation I.761

Inverse multiplexing for ATM (IMA)

Summary

This ITU-T Recommendation defines a protocol for inverse multiplexing of an ATM cell stream over multiple physical links, and to retrieve the original stream at the far-end from these links. Multiplexing of the ATM cell stream is performed on a cell-by-cell basis across the multiple links.

Source

ITU-T Recommendation I.761 was prepared by ITU-T Study Group 13 (1997-2000) and approved under the WTSC Resolution 1 procedure on 10 March 2000.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Conference (WTSC), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSC Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

CONTENTS

ITU-T Recommendation I.761

Inverse multiplexing for ATM (IMA)

1 Scope

This ITU-T Recommendation defines a protocol for inverse multiplexing of an ATM cell stream over multiple physical links, and to retrieve the original stream at the far-end from these links. Multiplexing of the ATM cell stream is performed on a cell-by-cell basis across the multiple links.

The Inverse Multiplexing for ATM (IMA) protocol provides a modular bandwidth for user access to ATM networks at rates between those used for UNI as defined in ITU-T Recommendation I.432 series [1], and for connection between ATM network elements at rates other than those defined by existing digital hierarchies. The introduction of ATM Inverse Multiplexers provides an effective method of combining the transport bandwidths of multiple links grouped to collectively provide higher intermediate rates.

This ITU-T Recommendation defines a new sublayer located between the Physical Layer Transmission Convergence (TC) sublayer and the ATM layer. This sublayer is called the IMA sublayer. This ITU-T Recommendation also defines modifications to the TC sublayer over which IMA is implemented.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; all users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published.

[1] ITU-T Recommendation I.432-series (1993), *B-ISDN User-Network Interface – Physical Layer Specification*.

[2] ATM Forum af-phy-0086.001 (1999), *Inverse Multiplexing for ATM (IMA) Specification 1.1*.

[3] ITU-T Recommendation I.361 (1999), *B-ISDN ATM layer specification*.

3 Definitions

This ITU-T Recommendation defines the following terms:

3.1 filler cell: This cell is used to fill in the IMA frame when no cells are available at the ATM layer.

3.2 ICP cell: This cell is used to carry information to establish the IMA protocol between two IMA units.

3.3 IMA frame: The IMA frame is used as the unit of control in the IMA protocol. It is a logical frame defined as M consecutive cells, numbered 0 to M-l, transmitted on each of the N links in an IMA group.

3.4 IMA group: Group of links at one end used to establish an IMA virtual link to other end.

3.5 IMA sublayer: Sublayer part of the Physical layer and located between the interface specific Transmission Convergence (TC) sublayer and the ATM layer.

3.6 IMA virtual link: Virtual link established between two IMA units over a number of physical links (IMA group).

4 Abbreviations

This ITU-T Recommendation uses the following abbreviations:

CDV	Cell Delay Variation
HEC	Header Error Check
ICP cell	IMA Control Protocol cell
IMA	Inverse Multiplexing for ATM
LCD	Loss of Cell Delineation
LIF	Loss of IMA Frame defect
LODS	Link Out of Delay Synchronization defect
OIF	Out of IMA Frame anomaly
PHY	Physical Layer
PMD	Physical Medium Dependent
RDI	Remote Defect Indication
TC	Transmission Convergence

5 Overview of Inverse Multiplexing for ATM (IMA)

The ATM inverse multiplexing technique involves inverse multiplexing and de-multiplexing of ATM cells in a cyclical fashion among links grouped to form a higher bandwidth logical link whose rate is approximately the sum of the link rates. This is referred to as an IMA group.

Figure 1 provides an illustration of the ATM Inverse Multiplexing technique for unidirectional connection. For bidirectional connections, the same technique applies.

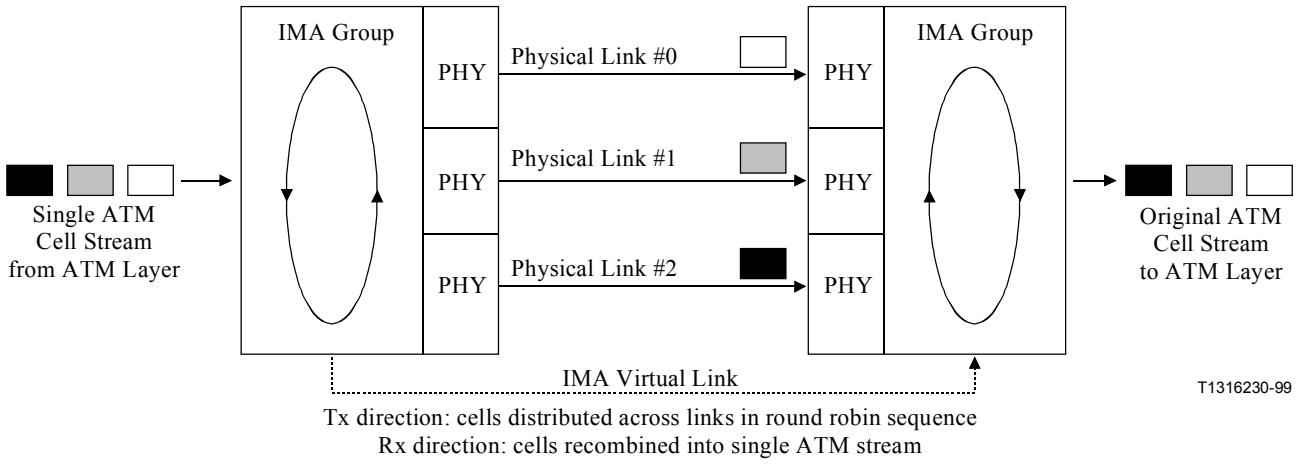

Figure 1/I.761 – Inverse multiplexing and de-multiplexing of ATM cells via IMA groups

IMA groups terminate at each end of the IMA virtual link. In the transmit direction, the ATM cell stream received from the ATM layer is distributed on a cell-by-cell basis, across the multiple links within the IMA group. At the far-end, the receiving side of the IMA virtual link recombines the cells from each physical link, on a cell-by-cell basis, recreating the original ATM cell stream. The aggregate cell stream is then passed to the ATM layer.

The transmitting side of the IMA virtual link periodically transmits special cells that contain information that permits reconstruction of the ATM cell stream at the receiving side of the IMA virtual link after accounting for the link differential delays, smoothing Cell Delay Variation (CDV) introduced by the control cells, etc. These cells, defined as IMA Control Protocol (ICP) cells, provide the definition of an IMA frame. The transmitter must align the transmission of IMA frames on all links (shown in Figure 2). This allows the receiver to adjust for differential link delays among the constituent physical links. Based on this required behaviour, the receiver can detect the differential delays by measuring the arrival times of the IMA frames on each link.

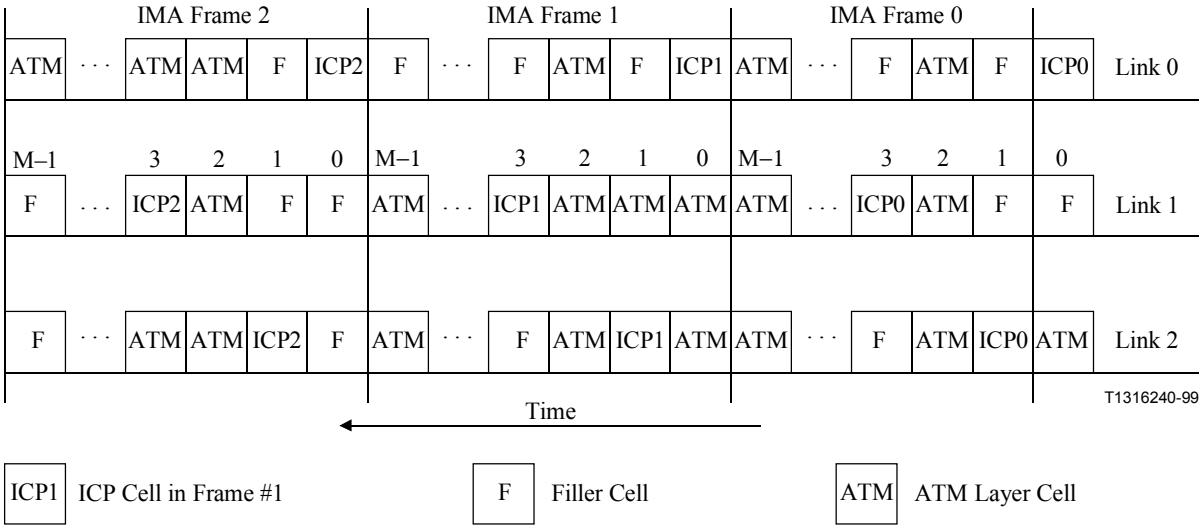

Figure 2/I.761 – Illustration of IMA frames

At the transmitting end, the cells are transmitted continuously. If there are no ATM layer cells to be sent between ICP cells within an IMA frame, then the transmitting side of the IMA virtual link sends Filler cells to maintain a continuous stream of cells at the physical layer. The insertion of filler cells provide cell rate decoupling at the IMA sublayer. The filler cells should be discarded by the receiving side of the IMA virtual link.

A new OAM cell is defined for use by the IMA protocol. This cell has codes in its payload that define it as an ICP or filler cell (refer to ITU-T Recommendation I.361 [3]).

The IMA sublayer is part of the physical layer. It is located between the Transmission Convergence sublayer and the ATM layer. Figure 3 shows the location of the IMA sublayer in the layer reference model and the main functions of the IMA sublayer. The shaded areas of Figure 3 represent an overview of the IMA functions within the scope of this ITU-T Recommendation.

<table>
<tr><th></th><th></th><th>User plane functions</th><th>Layer management functions</th><th>Plane management functions</th></tr>
<tr><td>ATM layer</td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="4">Physical layer</td><td>IMA-specific transmission convergence sublayer</td><td>• ATM cell stream splitting and reconstruction
• ICP cell insertion/removal
• Cell rate decoupling
• IMA frame synchronization
• Stuffing
• Discarding of cells with bad HEC</td><td>• IMA connectivity
• ICP cell errors (OIF)
• LIF/LODS/RDI-IMA defect processing
• RDI-IMA alarm generation
• Tx/Rx IMA link state report</td><td>• IMA group configuration
• Link addition/deletion
• ATM cell rate change
• IMA group failure notification
• IMA statistics</td></tr>
<tr><td rowspan="2">Interface-specific transmission convergence sublayer</td><td>• No cell discarding
• No cell rate decoupling</td><td></td><td></td></tr>
<tr><td>• Cell delineation, cell scrambling and descrambling (if required)
• Header error correction (if required)
• HEC generation/verification</td><td>• HEC error indication
• LCD-RDI alarm generation (if required)</td><td>• LCD failure notification
• TC statistics</td></tr>
<tr><td>Physical medium dependent sublayer</td><td>• Bit timing
• Line coding
• Physical medium</td><td>• Local alarm processing
• RDI alarm's generation</td><td>• Link failure notification
• PMD state</td></tr>
</table>

Figure 3/I.761 – IMA sublayer in layer reference model

6 Detailed requirements

The detailed requirements and protocols for the IMA sublayer shall be in accordance with ATM Forum af-phy-0086.001, "Inverse Multiplexing for ATM (IMA) Specification Version 1.1", March 1999 [2].

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