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(54) Title: RECORDING MEDIUM WITH SEGMENT INFORMATION THEREON AND APPARATUS AND METHODS FOR FORMING, RECORDING, AND REPRODUCING THE RECORDING MEDIUM

	Sector in each PAC	Data Byte Position	Description
Common Header for all PACs	0	D ₀ to D ₃	PAC_ID
	0	D ₄ to D ₇	Reserved
	0	D ₈ to D ₁₁	Unknown PAC Rules
	0	D ₁₂ to D ₁₃	Reserved
	0	D ₁₄	Entire Disc Flag
	0	D ₁₅	Number of Segments
	0	D ₁₆ to D ₂₃	Segment_0
	0	D ₂₄ to D ₃₁	Segment_1
	0	...	...
	0	D ₂₆₄ to D ₂₇₁	Segment_31
PAC specific information	0	D ₂₇₂ to D ₃₈₃	Reserved(not used)
	0	D ₃₈₄ to D ₂₀₄₇	Reserved for Specific PAC
	1 to 31	D ₀ to D ₂₀₄₇	Reserved for Specific PAC

(57) Abstract: A recording medium, such as a high-density and/or optical recording medium including segment information recorded thereon, and apparatus and methods for recording to and reproducing from the recording medium, in order to improve data protection, data management and/or reproduction compatibility.



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RECORDING MEDIUM WITH SEGMENT INFORMATION THEREON AND
APPARATUS AND METHODS FOR FORMING, RECORDING, AND
REPRODUCING THE RECORDING MEDIUM

The present invention relates to managing physical access control (PAC) and recording data, media containing PAC and recording data (for example, high density optical discs, such as Blu-ray Disc) and apparatus and methods for recording and/or reproducing data to and/or from the media.

Media, for example, optical discs may be used for recording a large quantity of data. Of the optical discs available, a new high density optical media (HD-DVD), for example, the Blu-ray Disc (hereafter called as “BD”) is under development, which enables increased recording and/or storing of high definition video and/or audio data.

BD further includes a rewritable Blu-ray disc (BD-RE), Blu-ray disc writable once (BD-WO), and Blu-ray disc read only (BD-ROM).

Currently, one problem with existing systems is the potential incompatibility between drives of different versions, for example a drive of a previous version with a previous set of capabilities may have difficulty interacting with a medium that has interacted with a drive

including at least one capability from a subsequent set of capabilities.

Disclosure of Invention

Example embodiments of the present invention provide a PAC including segment information
5 on a medium, such as a high density optical disc, and apparatus and methods for recording
data to and reproducing data from the medium using a PAC including segment information.

Example embodiments of the present invention provide physical access control (PAC)
including segment information recorded thereon, in order to improve data protection,
improve data management, improve reproduction compatibility, avoid destruction of data,
10 and/or reduce unnecessary, repetitive operations.

Example embodiments of the present invention provide a medium, such as a high density
optical disc, and apparatus and methods for managing a PAC including segment information.

In an example embodiment, the present invention is directed to a recording medium having a
data structure for managing a data area of a recording medium including at least one physical
15 access control (PAC) cluster, the at least one PAC cluster including information for managing
recording to and/or reproducing from the recording medium, each PAC cluster including a
PAC header, common to each PAC cluster and a PAC specific information area, including
information specific to each PAC cluster, wherein the PAC header includes segment number
information identifying a number of segments and a segment list area identifying each of the
20 segments in a user data area of the recording medium.

In an example embodiment, the present invention is directed to a method of recording or reproducing on a recording medium including recording or reproducing at least one physical access control (PAC) cluster, the at least one PAC cluster including information for managing recording to and/or reproducing from the recording medium, each PAC cluster including
5 segment number information and a segment entry list and if a PAC cluster is unknown one and the segment number information identifies at least one segment in a user data area of the recording medium, recording to and/or reproducing from the user data area for the at least one segment.

In an example embodiment, the present invention is directed to a method of reproducing from
10 a recording medium including reproducing a user data area recorded on the recording medium based on at least one physical access control (PAC) cluster, each of the at least one PAC clusters including a number of segments in the user data area, wherein if the number of segments indicates zero, said reproducing is performed for the whole user data area, and otherwise, said reproducing is performed for each of the number of segments.

15 In an example embodiment, the present invention is directed to an apparatus for recording to and/or reproducing from a recording medium including a driver for driving an optical recording device to record data on the recording medium or reproduce data from the recording medium and a controller for controlling the driver to record or reproduce the data based on at least one physical access control (PAC) zone including at least one physical
20 access control (PAC) cluster, the at least one PAC cluster including information for managing

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recording to and/or reproducing from the recording medium, each PAC cluster including segment number information and a segment entry list, said controller recording to and/or reproducing from the user data area for the at least one segment if a PAC cluster is unknown and the segment number information identifies at least one segment in a user data area of the recording medium.

In an example embodiment, the present invention is directed to an apparatus for reproducing from a recording medium including a driver for driving an optical recording device to reproduce data from the recording medium and a controller for controlling the device to reproduce the data based on at least one physical access control (PAC) zone including at least one physical access control (PAC) cluster, the at least one PAC cluster including information for managing recording to and/or reproducing from the recording medium, each PAC cluster including segment number information and a segment entry list, said controller reproducing a user data area recorded on the recording medium based on the at least one physical access control (PAC) cluster, each of the at least one PAC clusters including a number of segments in the user data area, said controller reproducing the entire user data area if the number of segments indicates zero and reproducing each of the number of segments if the number of segments does not indicate zero.

In one aspect there is provided a recording medium comprising:

- a user data area including a plurality of segment regions; and
- a control data area storing access control information for controlling access to the recording medium and specifying the segment regions to which the access control information applies, the access control information including:
 - an unknown rule defining a read/write controllability of an area of the recording medium for a drive that cannot recognize the access control information; and
 - segment information including a segment number information indicating the total number of the segment regions specified by the access control information and a segment list indicating the addresses of the segment regions.

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In another aspect there is provided a method of recording data on a recording medium, the method comprising:

recording, on the recording medium, access control information for controlling access to the recording medium and specifying a plurality of segment regions to which the access control information applies in a user data area of the recording medium, the access control information including:

segment information including segment number information indicating the total number of the segment regions specified by the access control information and a segment list indicating the addresses of the segment regions; and

an unknown rule defining a read/write controllability of an area of the recording medium for a drive that cannot recognize the access control information; and

recording data on the segment regions according to the access control information.

In another aspect there is provided a method of reproducing data from a recording medium, the method comprising:

reading access control information for controlling access to the recording medium and specifying segment regions to which the access control information applies in a user data area of the recording medium, the access control information including:

segment information including a segment number information indicating the total number of the segment regions specified by the access control information and a segment list indicating the addresses of the segment regions; and

an unknown rule defining a read/write controllability of an area of the recording medium for a drive that cannot recognize the access control information; and

reproducing data recorded on the recording medium based on the access control information.

In another aspect there is provided an apparatus for recording data on a recording medium, the apparatus comprising:

an optical device configured to write data on the recording medium; and
a controller configured to control the optical device to:

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record, on the recording medium, access control information for controlling access to the recording medium and specifying a plurality of segment regions to which the access control information applies in a user data area of the recording medium, the access control information including:

5 segment information including a segment number information indicating the total number of the segment regions specified by the access control information and a segment list indicating the addresses of the segment regions; and

10 an unknown rule defining a read/write controllability of an area of the recording medium for a drive that cannot recognize the access control information, and

record data on the segment regions based on the access control information.

15 In another aspect there is provided an apparatus for reproducing data from a recording medium, the apparatus comprising:

an optical device configured to read data from the recording medium; and
a controller configured to control the optical device to:

20 read access control information for controlling access to the recording medium and specifying a plurality of segment regions to which the access control information applies in a user data area, the access control information including:

segment information including a segment number information indicating the total number of the segment regions specified by the access control information and a segment list indicating the addresses of the segment regions; and

25 an unknown rule defining a read/write controllability of an area of the recording medium for a drive that cannot recognize the access control information, and

reproduce data from the segment regions based on the access control information.

30

It is to be understood that both the foregoing general description and the following detailed description of the present invention are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

Brief Description of Drawings

The accompanying drawings, which are included to provide a further understanding of example embodiments of the invention and are incorporated in and constitute a part of this application, illustrate example embodiment(s) of the invention where,

FIG. 1 illustrates a diagram showing PAC zones on a high density optical disc in accordance with an example embodiment of the present invention;

FIG. 2 illustrates a diagram showing configurations of INFO2 zone and INFO1 zone on a high density optical disc in accordance with an example embodiment of the present invention;

FIG. 3 illustrates a PAC recorded on a high density optical disc in accordance with an example embodiment of the present invention;

FIG. 4 illustrates a PAC on a high density optical disc in accordance with an example embodiment of the present invention;

FIG. 5 illustrates an "Unknown PAC Rules" field in accordance with an example embodiment of the present invention;

FIG. 6 illustrates segment zones on a high density optical disc in accordance with an example embodiment of the present invention;

FIG. 7 illustrates a PAC on a high density optical disc in accordance with another example embodiment of the present invention;

FIG. 8 illustrates a PAC on a high density optical disc in accordance with another example embodiment of the present invention;

FIG. 9 illustrates a PAC on a high density optical disc in accordance with another example embodiment of the present invention;

5 FIG. 10 illustrates control information on a segment area on a high density optical disc in accordance with an example embodiment of the present invention;

FIG. 11 illustrates control information on a segment area on a high density optical disc in accordance with another example embodiment of the present invention;

FIG. 12 illustrates a block diagram of an optical recording and reproducing apparatus in
10 accordance with an example embodiment of the present invention.

Best Mode for Carrying Out the Invention

Reference will now be made in detail to example embodiments of the present invention, illustrated in the accompanying drawings. Wherever possible, the same reference numbers
15 will be used throughout the drawings to refer to the same or like parts.

FIG. 1 illustrates PAC zones on a high density optical disc in accordance with an example embodiment of the present invention.

Referring to FIG. 1, the high density optical disc may be partitioned from an inner circumference to an outer circumference, into a lead-in zone, a data zone, and a lead-out zone.

20 The lead-in zone may be further partitioned into an INFO2 zone and an INFO1 zone for

recording various kinds of information thereon. The INFO2 zone and an INFO1 zone may include PAC (Physical Access Control) zones.

For convenience, a PAC zone assigned to the INFO2 zone is labeled a PAC2 zone and the PAC zone assigned to the INFO1 zone is labeled a PAC1 zone. One of the PAC2 zone and the
5 PAC1 zone may have an original PAC recorded thereon and the other one may have a back up zone for recording a copy of the original PAC. If a writing direction is from the inner circumference to the outer circumference of the disc, it may be advantageous that the original PAC is recorded on the PACII zone and the backup PAC is recorded on the PACI zone.

The PAC zone may be provided to handle problems that may occur when an older version of
10 a drive apparatus cannot detect functions on a disc added having functions compatible with a newer version of a drive apparatus. The PAC zone may handle compatibility problems using one or more an "unknown rules".

An "unknown rule" may be used to control predictable operations of the disc, for example, basic control of read, write, etc., linear replacement of a defective zone, logical overwrite, etc.

15 An area may also be provided on the disc, indicating where the "unknown rule" is applicable, for example, segments for defining the entire disc or a certain portion of the disc, which is described later in more detail.

Thus, by defining an area of the disc, an older version drive apparatus is able to access by using the "unknown rule", a newer version of the disc reduces unnecessary access operation
20 of the older version drive apparatus.

Moreover, by defining an accessible area on a physical area of the disc for an older version drive apparatus to access by using the PAC, a data area containing user data recorded thereon can be protected more robustly and/or unauthorized access (for example, hacking) of the disc may be prevented or reduced.

- 5 The INFO2 zone and the INFO1 zone having the PACII and I zones therein in the lead-in zone may be reviewed in view of writable characteristics of the high density optical disc.

FIG. 2 illustrates a diagram showing configurations of the INFO2 zone and the INFO1 zone on a high density optical disc in accordance with an example embodiment of the present invention.

- 10 Referring to FIG. 2, for an example BD-RE high density optical disc, the INFO2 zone may have 256 clusters including 32 clusters of PACII zone, 32 clusters of DMA (Defect Management Area) 2 zone for management of defects, 32 clusters of CD (Control Data) 2 zone having control information recorded thereon, and/or 32 clusters of BZ (Buffer Zone) 3 zone of a buffer zone.

- 15 The INFO1 zone may include 32 clusters of BZ2 zone of a buffer area, 32 clusters of drive area which may be a drive area for storing information specific to a drive, 32 clusters of DMA1 zone for managing defects, 32 clusters of CD1 zone for recording control information, and/or a BZ1-PACI zone utilizable as the PAC zone.

For a write once high density optical disc (BD-R), the INFO2 zone may have 256 clusters

- 20 including a PACII zone, a DMA 2 zone, a CD 2 zone, and a BZ 3 zone, each with 32 clusters,

and the INFO1 zone includes a BZ2 zone, a DMA1 zone, a CD1 zone, and/or a BZ1-PACI zone, each with 32 clusters, and 128 clusters of drive area.

For a read only high density optical disc (BD-ROM), the INFO2 zone may have 256 clusters including a PACII zone, a CD 2 zone, and a BZ 3 zone, each with 32 clusters, and the INFO1
5 zone 256 clusters including a CD1 zone, and/or a BZ1-PACI zone, each with 32 clusters.

The PAC zones of example embodiments of the present invention may be assigned to the INFO2 zone and/or the INFO1 zone in the lead-in zone in 32 clusters each, according to rewritable characteristics of the high density optical disc.

In the PAC zone of 32 clusters, one PAC may have one cluster, for recording a plurality of
10 valid PACs. An example structure in which one PAC is recorded as one cluster is described with reference to FIG. 3.

FIG. 3 illustrates a PAC recorded on a high density optical disc in accordance with an example embodiment of the present invention.

Referring to FIG. 3, one PAC of one cluster size (32 sectors) may include a header zone and a
15 specific information zone, specific to a particular disc drive (for example, optical disc drive).

The PAC header zone may have 384 bytes allocated to a first sector of the PAC, for recording various kinds of PAC information, such as information on an "unknown PAC rule" and segments, and another area of the PAC zone may have information specific to the (optical) disc drive may be referred to as "known rules" recorded thereon.

20 An example structure of a PAC recorded in above structure is described with reference to FIG.

4. For convenience, in the description, particular fields of the PAC that require more detailed description will refer to drawings that illustrate the particular fields.

5 FIG. 4 illustrates a PAC on a high density optical disc in accordance with an example embodiment of the present invention.

Referring to FIG. 4, the PAC may include a header portion applicable to all PACs and an area having information specific to the drive, recorded thereon.

An example header portion may include 4 bytes of "PAC_ID", 4 bytes of "Unknown PAC Rules", 1 byte of "Entire Disc Flag", 1 byte of "Number of Segments", and/or 32 "segments Segment_0 ~ Segment_31 each with 8 bytes.

10 The "PAC_ID" may provide the present PAC status and identification codes, for example, if the "PAC_ID" contains '00 00 00 00' bits, the "PAC_ID" indicates that the present PAC is not used, if the "PAC_ID" contains 'FF FF FF FE' bits, the "PAC_ID" indicates that the present PAC zone is not available for use due to defects or something similar, and if the "PAC_ID" contains 'FF FF FF FF' bits, the "PAC_ID" indicates that the present PAC zone is
15 available for use again even if the PAC zone has been used previously.

By recording the "PAC_ID" in predetermined bits, such as '54 53 54 00' bits, the "PAC_ID" may be used as a code for determining if the disc is a disc for which a present drive can have free access to. That is, if the present drive does not recognize the "PAC_ID" applied thereto (possibly a case where the present drive can not recognize the present PAC due to version
20 mismatch or similar problem), the '54 53 54 00' bits may be used as code to refer to

information recorded in the "Unknown PAC Rules" field.

As described, the "Unknown PAC Rules" field may be used as a field that designates an operation range of a drive that can not recognize the present PAC, which will be described further with reference to FIG. 5.

5 FIG. 5 illustrates an "Unknown PAC Rules" field in accordance with an example embodiment of the present invention.

Referring to FIG. 5, a degree of controllability of various areas on the disc may be enabled by the "Unknown PAC Rules". In this example, the "Area" column in Fig. 5 represents the controllable areas on the disc, the "Control" column represents control types, such as
10 read/write etc., and "Number of bits" column represents a number of bits required for control. The additional bits in the "Number of bits" column may represent cases of dual layer disc with two recording/reproduction sides.

For example, in the "Area" column in Fig. 5, read/write controllability of the PAC zone can be represented with "PAC zones 1, 2" fields, and write controllability of a defect management
15 zone can be represented with "DMA Zone 1, 2" fields. Write controllability of a replacement area for a defective area can be represented with "Replacement Clusters" field, read/write controllability of a data zone can be represent with a "Data Zone" field, and logical overwrite controllability can be represented with a "Logical Overwrite" field.

Write controllability is applicable only to re-writable discs BD-RE and BD-R and the write
20 controllability of a replacement area for a defective area is also applicable to the re-writable

discs BD-RE and BD-R. As a result, various example features of the present invention may depend on the re-writable characteristics of the high density (optical) disc.

Using the above technique, the "Unknown PAC Rules" field enables designation of a controllable area on the disc for a drive with a version mismatch. Moreover, the above
5 technique may also be applicable to control access to a particular physical area on a disc at a user's option.

Returning to Fig. 4, the "Entire Disc Flag" field may be used as a field for indicating that the PAC is applicable to an entire area of the disc and the "Number of Segments" field is a field that may represent a number of segment areas to which the PAC is applicable.

10 In an example embodiment, a maximum number of segments may be allocatable to one PAC.

In an example embodiment, a maximum number of 32 segments can be allocated to one PAC and information on the allocated segments may be written in "Segment_0" to "Segment_31" fields, each including 8 bytes. Each of the "Segment_0~31" fields may include the first physical sector number (PSN) and the last PSN of the allocated segment area
15 recorded thereon.

Segments are described in more detail below. FIG. 6 illustrates segment zones on a high density optical disc in accordance with an example embodiment of the present invention.

Referring to FIG. 6, if required, there may be a maximum number (for example, 32) of segment areas on the high density optical disc, for applying the PAC thereto. The maximum
20 number of segment area may start from "segment 0".

In an example, positions of the segment areas may be identified by an optical disc drive by writing the first PSN, which may indicate a starting position of the allocated segment area and the last PSN which may indicate the last position of the allocated segment area on "Segment" fields of PACII and PACI zones.

- 5 In an example arrangement, none of the plurality of allocated segments need overlap and the starting and ending positions may be designated at boundaries of clusters.

Thus, in example embodiments, the present invention may provide a plurality of PACs, to manage a number (for example, 32) segment areas, which are described in more detail below.

- FIG. 7 illustrates a PAC zone on a high density optical disc in accordance with an example
10 embodiment of the present invention.

Referring to FIG. 7, a plurality of valid PACs, each with a common cluster size, may be written in one PAC zone (for example, the PAC zone of INFO2 or INFO1) of 32 clusters.

- In an example embodiment, the header portion may include 4 bytes of "PAC_ID", 4 bytes of "Unknown PAC Rules", 1 byte of "PAC Header Tag", 1 byte of "Entire_disc_flag", 1 byte of
15 "Number of Segments defined", and/or 32 "segments Segment_0 ~ Segment_31" each with, for example, 8 bytes.

The "PAC Header Tag" may be used for connecting to clusters each having a specific PAC having information specific to a drive. The "PAC Header Tag" may be incremented by one starting from (01) whenever a new PAC is added.

- 20 In this example, if the bits are FF, this indicates that no new PAC is added, and if the bits are

00, this indicates that the "PAC Header Tag" is not used.

FIG. 8 illustrates a PAC on a high density optical disc in accordance with another example embodiment of the present invention.

Referring to FIG. 8, a PAC in accordance with another example embodiment of the present invention may include a header portion and an area having specific information specific to
5 the drive, and the header portion may further include 4 bytes of "PAC_ID", 4 bytes of "Unknown PAC Rules", 1 byte of "PAC Header Tag", 1 byte of "Entire_disc_flag", 2 bytes of "Byte address for the set of Segments", 2 bytes of "Number of Segments defined in the Set", and/or a "Reserved for Segment" field which is reserved for 32 Segments each with 8 bytes.

10 A PAC structure in accordance with another example embodiment of the present invention may include a Byte address for a segment set. That is, for areas reserved for Segments, a number of defined segment areas may be indicated in the "Number of Segments defined in the Set (N_Segs)" field and a byte address of a starting position may be indicated in the "Byte address for the Set of Segments" field. In this example, it may be advantageous to use the
15 defined segments continuously.

FIG. 9 illustrates a PAC on a high density optical disc in accordance with another example embodiment of the present invention.

Referring to FIG. 9, a PAC in accordance with another example embodiment of the present invention may include a header portion and an area having specific information specific to
20 the drive, and the header portion may further include 4 bytes of "PAC_ID", 4 bytes of

“Unknown PAC Rules”, 1 byte of “PAC Header Tag”, 1 byte of “Entire_disc_flag”, 2 bytes of “Byte address for the Main set of Segments”, 2 bytes of “Number of Segments defined in the Main Set (N_M_Segs)”, 2 bytes of “Byte address for the Additional set of Segments”, 2 bytes of “Number of Segments defined in the Additional Set (N_A_Segs)”, and/or an “Unused Part
5 in the specific PAC” field in a specific information area specific to a particular drive.

The PAC structure in accordance with another example embodiment of the present invention may include a Main segment set and an Additional segment set. Segment areas may be allocated additionally, for use in a case when it is intended to allocate more segment areas to the 32 segment areas.

10 In an example, a number of the main segments defined by the “Number of Segments defined in the Main Set (N_M_Segs)” is recorded and a starting position thereof may be recorded on the “Byte address for the main Set of Segments” field. That is, the information recorded on the “Byte address for the main Set of Segments” field may serve as a pointer to the defined main segment area.

15 The defined additional number of segments may be recorded using the “Number of Segments defined in the Additional Set (N_A_Segs)” and a starting position thereof may be recorded on the “Byte address for the Additional Set of Segments” field.

In this example, the additional segment area may be provided with an unused part in the specific PAC in one PAC zone of 1 cluster size, may be allocated to the N_A_Segs.

20 The above example PAC structures enable management of additional segment areas, in

addition to the 32 segment areas.

Example embodiments of the present invention are directed to recording control information on an entire disc area, an entire allocated segment area, or respective allocated segment areas by using the designated PAC, as described below.

5 FIG. 10 illustrates control information on a segment area on a high density optical disc in accordance with an example embodiment of the present invention.

Referring to FIG. 10, an allocated segment may be represented with an 8 byte entry, wherein the first Physical Sector Number of the segment area may have a 32 byte size and the last Physical Sector Number may have a 32 byte size. Therefore, an optical disc drive can
10 obtain position information on the allocated segment area through the segment information of the recorded PAC.

In this example, as described above, a number of segment areas (one or greater) may be managed by one or more PACs. If at least one segment area is allocated, the optical disc drive may determine the number of the allocated segment areas through the "Number of
15 Segment" field and determine controllability, such as read, write, and/or other similar operations, on the area through "Data Zone" field of the "Unknown PAC Rule".

If no segment is allocated and the "Entire_disc_flag" field indicating that the PAC is applicable to entire disc area is recorded, as described above, though the "Data Zone" field of the "Unknown PAC Rule" is used a field indicating accessibility to the data area on the
20 optical disc, such as read, write, and/or other similar operations, if the segment area is

allocated, to write the "Number of Segment" field, the "Data Zone" field of the "Unknown PAC Rule" may be used as a field indicating accessibility to the allocated entire segment areas.

In an example embodiment of the present invention, there may be information on control of
5 the segment area other than the position information, as information recorded on the "Segment" field, which will be described below.

FIG. 11 illustrates control information on a segment area on a high density optical disc in accordance with another example embodiment of the present invention.

One segment may be represented with one entry and include a "Status 1" field and a "Status
10 2" field for indicating controllability of a relevant segment area, a "The first PSN" field for representing the first Physical Sector Number of the segment area, and/or a "The last PSN" field for representing the last Physical Sector Number of the segment area.

The "Status 1" field may be represented with four bit control information, for indicating controllability of a relevant segment area; for an example, "0000" of the "Status 1" field may
15 indicate that access to the segment area for reproduction or recording is not possible, "0001" of the "Status 1" field may indicate that access to the segment area for read only is possible, "0010" of the "Status 1" field may indicate that access to the segment area for write only is possible, and "0011" of the "Status 1" field may indicate that access to the segment area is possible.

20 Therefore, by determining accessibility to a relevant segment area using the "Status 1" field

and "Status 2" field, unnecessary access operations to the segment area can be reduced, and in a case a plurality of segment areas are allocated, access to each of the segments can be controlled.

In this example, because the "Status 2" field may be a reserved field for future use and not in use presently, in an example, the "Status 2" field is recorded in "0000" bit.

When the segment area is allocated, the control of each of the segment areas may not be consistent with the controllability on the segment area defined at the "Data Zone" field of the "Unknown PAC Rules".

That is, for an example, despite all types of access, such as read and write to entire segment areas is possible in the "Data Zone", only reading of a relevant segment area may be possible in the "Segment" field.

In this example, read only control of the segment area the "Segment" field indicates is possible. That is, depending on the controllability of the "Data Zone", the control of the segment area may be made possible using an "AND" condition with the "Segment" field.

Accordingly, if the "Data Zone" field indicates that access to entire segment areas allocated to the "Data Zone" field for read or write not possible, access to the entire segment areas will become impossible regardless of controllability on the "Segment" field, and even the "Data Zone" field is set such that access to entire segment areas is possible, if it is set that access to individual segment areas is impossible, access to the segment area is impossible.

As described, with regard to a PAC of a high density optical disc, a writing control portion

thereof may be applicable to a physically writable high density optical disc BD-R, and BD-RE, and may depend on the writable characteristics of the high density optical disc.

By recording a first physical sector number of a relevant segment area on the "The first PSN" field of FIG. 11 and a last physical sector number of a relevant segment area on the "The last PSN" field of FIG. 11, a position of the segment area on the disc can be indicated.

FIG. 12 illustrates a block diagram of an optical recording/reproducing apparatus in accordance with an example embodiment of the present invention.

Referring to FIG. 12, the optical recording/reproducing apparatus may include a recording/reproducing device 10 for performing recording/reproduction on the optical disc and a host, or controller 20 for controlling the recording/reproducing device 10. In an example embodiment, the recording/reproducing device 10 may act as the "optical disc drive" discussed above in conjunction with many example embodiments of the present invention.

In an example embodiment, the host 20 gives a writing or reproduction instruction to write to or reproduce from a particular area of the optical disc to the recording/reproducing device 10, and the recording/reproducing device 10 performs the recording/reproduction to/from the particular area in response to the instruction from the host 20.

The recording/reproducing device 10 may further include an interface part 12 for performing communication, such as exchange of data and instructions with the host 20, a pickup part 11 for writing/reading a data to/from the optical disc directly, a data processor 13 for receiving a

signal from the pickup part 11 and recovering a desired signal value or modulating a signal to be written into a signal able to be written on the optical disc, , a servo part 14 for controlling the pickup part 11 to read a signal from the optical disc accurately or to write a signal on the optical disc accurately, a memory 15 for temporary storage of various kinds of information
5 including management information and data, and a microcomputer 16 for controlling various parts of the recording/reproducing device 10.

An example method for recording a PAC on a high density writable optical disc using the example optical recording/reproducing apparatus will be described below.

Upon inserting the optical disc into the optical recording/reproducing apparatus, management
10 information may be read from the optical disc and stored in the memory 15 of the recording/reproducing device 10, for use at the time of recording/reproduction of the optical disc.

In this state, if the user desires to write on a particular area of the optical disc, the host 20, taking this as a writing instruction, provides information on a desired writing position to the
15 recording/reproducing device 10, together with a data to be written.

The microcomputer 16 in the recording/reproducing device 10 may receive the writing instruction, determine if the area of the optical disc the host 20 desires to write is a defective area or not from the management information stored in the memory 15, and/or perform data writing according to the writing instruction from the host 20 on an area which is not a
20 defective area.

- If it is determined that writing on an entire disc or on a particular area of the disc includes new features which a previous version of the recording/reproducing device is not provided with, leading the previous version of the recording/reproducing device to fail to sense, or if it is intended to restrict functions, such as writing or reproducing to/from a particular area of the disc according to restriction set by the user, the microcomputer 16 of the recording/reproducing device 10 may write control information of the area in the PAC zone on the disc as an "Unknown PAC rule". The microcomputer 16 of the recording/reproducing device 10 may also write PAC information, such as the PAC_ID for a written state, and segment information which is control information on the particular area of the disc.
- 10 In this example, if the recorded PAC includes control information for entire disc area, the "Entire Disc Flag" field may be recorded, and if at least one segment area is allocated on an area of the disc, to control access to the entire area, a number of the allocated segment areas is recorded on the "Number of Segment" field, and control information, such as accessibility and/or other relevant information, may be recorded on the "Data Zone" field of the "Unknown PAC Rule". If it is desired to individually control the segment areas, control and
- 15 position information of the segment may be recorded on the "Segment" field.
- A PAC may be recorded on the PAC2 zone of the INFO2 zone at one cluster size and the PAC and a copy PAC of the PAC may be recorded on the PAC1 zone of the INFO1 zone as a backup.
- 20 The microcomputer 16 may provide position information of the area the data is written

thereon, or the PAC zone, and the data to the servo 14 and the data processor 13, so that the writing is finished at a desired position on the optical disc through the pickup part 11.

Additionally, a method for recording/reproducing the high density optical disc having PAC information written by the above example method will be described below.

- 5 Upon inserting an optical disc into the optical recording/reproducing apparatus, management information may be read from the optical disc and stored in the memory 15 of the recording and reproducing device 10, for use at the time of recording and reproduction of the optical disc.

The information in the memory 10 may include position information of various zones
10 included in the PAC zone on the disc. Particularly, positions of valid PACs in the PAC zone may be known from disc definition structure (DDS) information. After positions of the valid PACs are known, a PAC_ID field of the PAC may be examined, for verifying if the PAC_ID is an identifiable PAC_ID.

If the PAC_ID is identifiable, the method determines that a recording and reproducing device
15 having written the data on the disc has a version identical to a version of the present recording and reproducing device or there are no separate writing/reproduction restrictions, and the recording/reproduction is performed according to the instruction from the host 20.

If the PAC_ID is not identifiable, the method determines that the recording and reproducing device having written the data on the disc has a version different from the version of the
20 present recording and reproducing device, and the recording/reproduction is preformed

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according to the instruction from the host with reference to recording/reproduction restriction areas on the disc including the "Unknown PAC rule" and the "segment".

Accordingly, the microcomputer 16 provides the location information and data according to the instruction from the host to the servo 14 and the data-processor 13, so that the

5 recording/reproduction is finished at a desired location on the optical disc through the pickup part 11.

As described above, the methods and apparatus for recording and reproducing in a high density optical write-once disc according to example embodiments of the present invention may have one or more of the following advantages.

10 First, the definition of an accessible area of a disc of a different version drive by using PACs may permit more robust protection of a data area having user data recorded thereon, for example, to prevent or reduce unauthorized access (for example, hacking).

Second, effective recording data to and/or reproducing data from a high density optical disc is improved by using a PAC which manages the entire data area or a part of the data

15 area of the disc.

It will be apparent to those skilled in the art that various modifications and variations can be made to the example embodiments of the present invention described above without departing from the spirit or scope of the invention. Thus, it is intended that the present

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invention covers the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

Throughout this specification and the claims which follow, unless the context requires
5 otherwise, the word "comprise", and variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated integer or step or group of integers or steps but not the exclusion of any other integer or step or group of integers or steps.

The reference in this specification to any prior publication (or information derived from it),
10 or to any matter which is known, is not, and should not be taken as, an acknowledgement or admission or any form of suggestion that that prior publication (or information derived from it) or known matter forms part of the common general knowledge in the field of endeavour to which this specification relates.

The claims defining the invention are as follows:

1. A recording medium comprising:
a user data area including a plurality of segment regions; and
5 a control data area storing access control information for controlling access to the recording medium and specifying the segment regions to which the access control information applies, the access control information including:
an unknown rule defining a read/write controllability of an area of the recording medium for a drive that cannot recognize the access control information;
10 and
segment information including a segment number information indicating the total number of the segment regions specified by the access control information and a segment list indicating the addresses of the segment regions.
- 15 2. The recording medium of claim 1, wherein the number of the segment regions is less or equal to a predetermined value.
3. The recording medium of claim 1, wherein the access control information carries out controlling reading data from and/or writing data to the segment regions.
- 20 4. The recording medium of claim 1, wherein a serial number of the segment regions are from zero to a desired number.
5. The recording medium of claim 1, wherein the access control information
25 recorded in a recording unit of the recording medium.
6. The recording medium of claim 1, wherein the unknown rule includes data zone bits for the segment regions, the data zone bits indicating actions available for the segment regions, wherein the actions include reading and/or writing.
- 30 7. The recording medium of claim 6, wherein the data zone bits indicate whether data in the segment regions is recordable and/or reproducible.
8. The recording medium of claim 1, wherein the access control information

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includes:

a header portion including the segment information, and

a specific information portion including information specific to the access control information.

5

9. The recording medium of claim 8, wherein the header portion includes a segment pointer identifying a set of segment regions in the user data area of the recording medium.

10. The recording medium of claim 8, wherein the header portion includes a main set segment pointer identifying the number of main set segment regions and a subset segment pointer identifying the number of subset segment regions in the user data area of the recording medium.

11. The recording medium of claim 1, wherein the recording medium is a rewritable recording medium.

12. The recording medium of claim 1, wherein the recording medium is a write once recording medium.

13. The recording medium of claim 1, wherein the recording medium is a read-only recording medium.

14. A method of recording data on a recording medium, the method comprising:
recording, on the recording medium, access control information for controlling access to the recording medium and specifying a plurality of segment regions to which the access control information applies in a user data area of the recording medium, the access control information including:

segment information including segment number information indicating the total number of the segment regions specified by the access control information and a segment list indicating the addresses of the segment regions; and

an unknown rule defining a read/write controllability of an area of the recording medium for a drive that cannot recognize the access control information; and

recording data on the segment regions according to the access control information.

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15. The method of claim 14, wherein the number of the segment regions is less or equal to a predetermined value.

5 16. The method of claim 14, further comprising:
identifying segment regions according to the segment number information and segment list of the access control information.

10 17. The method of claim 14, wherein the access control information includes:
a header portion including the segment information, and
a specific information portion including information specific to the access control information.

15 18. A method of reproducing data from a recording medium, the method comprising:

reading access control information for controlling access to the recording medium and specifying segment regions to which the access control information applies in a user data area of the recording medium, the access control information including:

20 segment information including a segment number information indicating the total number of the segment regions specified by the access control information and a segment list indicating the addresses of the segment regions; and

an unknown rule defining a read/write controllability of an area of the recording medium for a drive that cannot recognize the access control information; and

25 reproducing data recorded on the recording medium based on the access control information.

19. The method of claim 18, wherein the number of the segment regions is less or equal to a predetermined value.

30 20. The method of claim 18, wherein if the segment number indicates zero, the reproducing is performed for the whole user data area.

21. The method of claim 18, wherein the access control information includes:

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a header portion including the segment information, and
a specific information portion including information specific to the access control information.

5 22. An apparatus for recording data on a recording medium, the apparatus comprising:

an optical device configured to write data on the recording medium; and
a controller configured to control the optical device to:

10 record, on the recording medium, access control information for
controlling access to the recording medium and specifying a plurality of segment
regions to which the access control information applies in a user data area of the
recording medium, the access control information including:

15 segment information including a segment number information
indicating the total number of the segment regions specified by the access
control information and a segment list indicating the addresses of the
segment regions; and

an unknown rule defining a read/write controllability of an area of
the recording medium for a drive that cannot recognize the access control
information, and

20 record data on the segment regions based on the access control information.

23. The apparatus of claim 22, wherein the number of the segment regions is
less or equal to a predetermined value.

25 24. The apparatus of claim 22, wherein the controller controls access to the whole
user data area, if the segment number is zero.

25. The apparatus of claim 22, wherein the access control information includes:

30 a header portion including the segment information, and
a specific information portion including information specific to the access control
information.

26. An apparatus for reproducing data from a recording medium, the apparatus
comprising:

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an optical device configured to read data from the recording medium; and
a controller configured to control the optical device to:

read access control information for controlling access to the recording
medium and specifying a plurality of segment regions to which the access control
5 information applies in a user data area, the access control information including:

segment information including a segment number information
indicating the total number of the segment regions specified by the access
control information and a segment list indicating the addresses of the
segment regions; and

10 an unknown rule defining a read/write controllability of an area of
the recording medium for a drive that cannot recognize the access control
information, and

reproduce data from the segment regions based on the access control
information.

15 27. The apparatus of claim 26, wherein the number of the segment regions is
less or equal to a predetermined value.

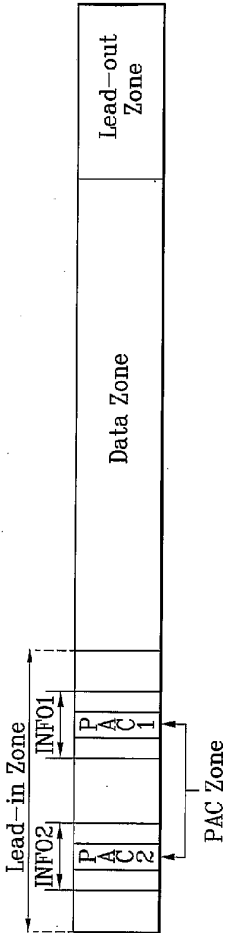
28. The apparatus of claim 26, wherein the controller controls access to the
20 segment regions according to the access control information.

29. The apparatus of claim 26, wherein the controller controls access to the whole
user data area, if the segment number is zero.

25 30. The apparatus of claim 26, wherein the access control information includes:
a header portion including the segment information, and
a specific information portion including information specific to the access control
information.

30 31. A recording medium, a method of recording data on a recording medium, a
method of reproducing data from a recording medium, an apparatus for recording data on a
recording medium, or an apparatus for reproducing data from a recording medium, being
substantially hereinbefore described with reference to the accompanying drawings.

FIG. 1

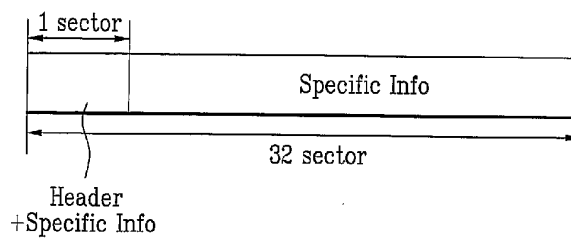


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FIG. 2

		BD-RE	BD-R	BD-ROM
INFO2	Reserved	128	128	160
	PAC 2	32	32	32
	DMA2	32	32	
	CD2	32	32	32
	BZ3	32	32	32
INFO1	BZ2	32	32	192
	Drive Area	32	128	
	Reserved	96		
	DMA1	32	32	
	CD1	32	32	32
	BZ1-PAC1	32	32	32

FIG. 3



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FIG. 4

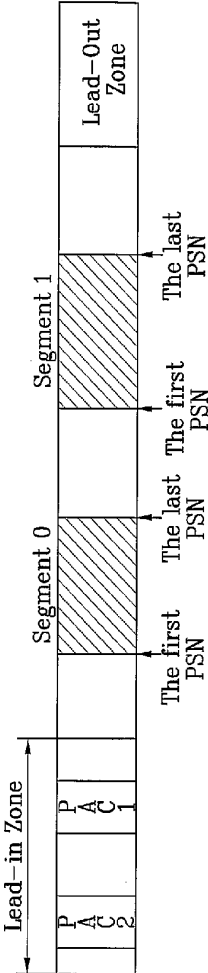
	Sector in each PAC	Data Byte Position	Description
Common Header for all PACs	0	D ₀ to D ₃	PAC_ID
	0	D ₄ to D ₇	Reserved
	0	D ₈ to D ₁₁	Unknown PAC Rules
	0	D ₁₂ to D ₁₃	Reserved
	0	D ₁₄	Entire Disc Flag
	0	D ₁₅	Number of Segments
	0	D ₁₆ to D ₂₃	Segment_0
	0	D ₂₄ to D ₃₁	Segment_1
	0	...	...
	0	D ₂₈₄ to D ₂₇₁	Segment_31
	0	D ₂₇₂ to D ₃₈₃	Reserved(not used)
	0	D ₃₈₄ to D ₂₀₄₇	Reserved for Specific PAC
	1 to 31	D ₀ to D ₂₀₄₇	Reserved for Specific PAC
PAC specific information			

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FIG. 5

Area	Control		Number of bits
	Read	Write	
PAC zones 1,2	Yes	Yes	$2 \cdot 10$
Individual PACs	Yes	Yes	2
Control Data zones 1,2	Yes	Yes	2
DMA zones 1,2	No	Yes	1
Replacement clusters	No	Yes	1
Data Zone	Yes	Yes	2
Logical Overwrite	No	Yes	1
Reserved Area	Yes	Yes	$2 \cdot 10$
Buffer zone 3	Yes	Yes	$2 \cdot 0$
Buffer zone 2	Yes	Yes	$2 \cdot 0$
Drive Area	No	No	0
Reserved Area	Yes	Yes	$2 \cdot 6$
Buffer Zone 1	Yes	Yes	$2 \cdot 0$
Reserved for future areas			$11 \cdot 6$

FIG. 6



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FIG. 7

	Sector in each PAC	Data Byte Position	Description
Common Header for all PACs	0	D ₀ to D ₃	PAC_ID
	0	D ₄ to D ₇	Unknown PAC Rules
	0	D ₈	PAC Header Tag
	0	D ₉	Entire_disc_flag
	0	D ₁₀	Number of Segments
	0	D ₁₁ to D ₁₅	Reserved
	0	D ₁₆ to D ₂₃	Segment_0
	0	D ₂₄ to D ₃₁	Segment_1
	0	...	...
	0	D ₂₈₄ to D ₂₇₁	Segment_31
	0	D ₂₇₂ to D ₃₈₃	Recorder_ID
PAC specific information	0	D ₃₈₄ to D ₂₀₄₇	Reserved for Specific PAC
	1 to 31	D ₀ to D ₂₀₄₇	Reserved for Specific PAC

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FIG. 8

	Sector in each PAC	Data Byte Position	Description	
			Description	
Common Header for all PACs	0	D ₀ to D ₃	PAC_ID	
	0	D ₄ to D ₇	Unknown PAC Rules	
	0	D ₈	PAC Header Tag	
	0	D ₉	Entire_disc_flag	
	0	D ₁₀ to D ₁₁	Byte address for the Set of Segments	
	0	D ₁₂ to D ₁₃	Number of segments defined in the Set(N_Segs)	
	0	D ₁₄ to D ₂₁	Reserved for Segment	
	0	D ₂₂ to D ₂₉	Reserved for Segment	
	0	...	...
	0	D ₂₆₂ to D ₂₈₉	Reserved for Segment	
PAC specific information	0	D ₂₇₀ to D ₃₈₁	Reserved_ID	
	0	D ₃₈₂ to D ₂₀₄₇	Reserved for Specific PAC	
	1 to 31	D ₀ to D ₂₀₄₇	Reserved for Specific PAC	

N_Segs

FIG. 9

	Sector in each PAC	Data Byte Position	Description	
Common Header for all PACs	0	D ₀ to D ₃	PAC_ID	
	0	D ₄ to D ₇	Unknown PAC Rules	
	0	D ₈	PAC Header Tag	
	0	D ₉	Entire_disc_flag	
	0	D ₁₀ to D ₁₁	Byte address for the Main Set of Segments	
	0	D ₁₂ to D ₁₃	Number of segments defined in the Main Set(N_M_Segs)	
	0	D ₁₄ to D ₁₅	Byte address for the Additional Set of Segments	
	0	D ₁₆ to D ₁₇	Number of segments defined in the Additional Set(N_A_Segs)	
	0	D ₁₈ to D ₂₅	Reserved for Main Set of Segmentst	N_M_Segs
	0	...	...
PAC specific information	0	D ₂₆₆ to D ₂₇₃	Reserved for Main Set of Segmentst	N_A_Segs
	0	D ₂₇₄ to D ₂₈₅	Reserved_ID	
	0	D ₂₈₆ to D ₂₉₇	Reserved for Specific PAC	
	1 ~	D ₀ ~	Reserved for Specific PAC	
	~ 31	~ D ₂₀₄₇	Unused part in the specific PAC	

FIG. 10

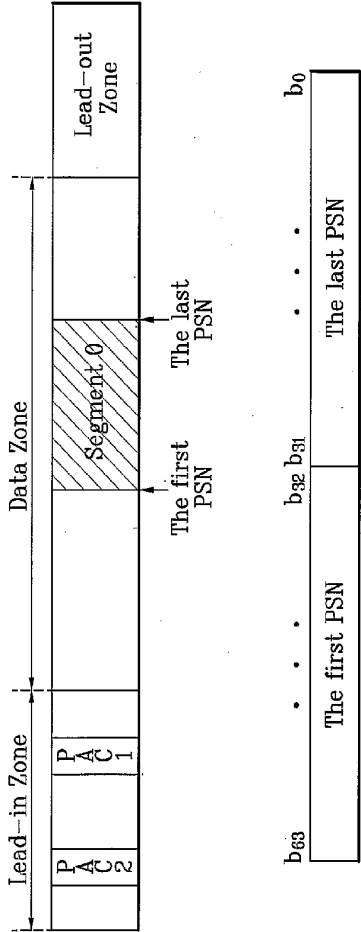
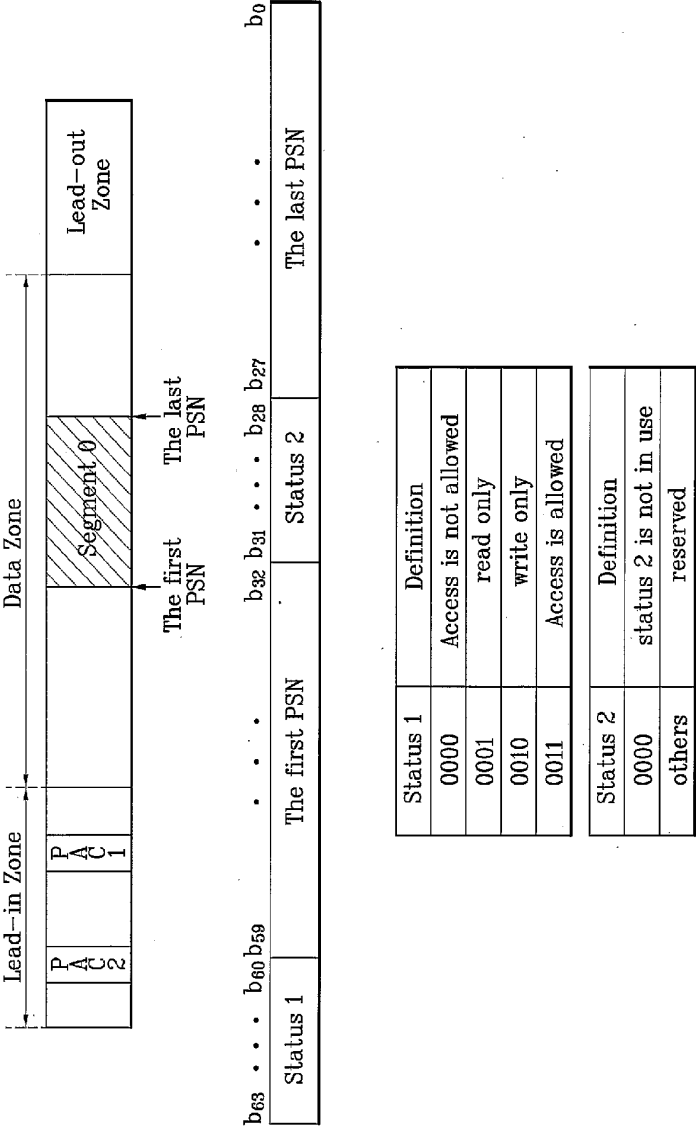


FIG. 11



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FIG. 12

