

Amended Set of Claims

1. A method of coding video data, the method comprising:
storing one or more decoding units of video data in a picture buffer;
obtaining a respective buffer removal time for the one or more decoding units,
wherein the one or more decoding units comprise sub-pictures of a common picture, and
wherein obtaining the respective buffer removal time comprises receiving a respective
signaled value indicative of the respective buffer removal time for each of a plurality of
the sub-pictures of the common picture;
removing the one or more decoding units from the picture buffer in accordance
with the obtained buffer removal time for each of the decoding units; and
coding video data corresponding to the one or more decoding units, wherein
coding the video data comprises decoding the one or more decoding units.
2. The method of claim 1, wherein each of the one or more decoding units of video
data is either an access unit or a subset of an access unit.
3. The method of claim 1, further comprising storing the one or more decoding
units of video data in a continuous decoding order in the picture buffer.
4. The method of claim 3, further comprising receiving the one or more decoding
units of video data in the continuous decoding order prior to storing the one or more
decoding units.
5. The method of claim 1, wherein the picture buffer is a coded picture buffer.
6. The method of claim 5, the method further comprising removing a first decoding
unit of the decoding units from the coded picture buffer prior to removing a second
decoding unit of the decoding units from the coded picture buffer, wherein the first
decoding unit and the second decoding unit comprise respective subsets of a common
access unit.

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7. The method of claim 1, wherein the signaled value indicative of the buffer removal time for the at least one of the decoding units comprises a signaled value indicative of a number of network abstraction layer (NAL) units comprised by the at least one of the decoding units.
8. The method of claim 1, wherein receiving the respective signaled value indicative of the respective buffer removal time for each of the plurality of the sub-pictures of the common picture comprises receiving a respective signaled value indicative of the buffer removal time for each of the sub-pictures of the common picture.
9. The method of claim 8, wherein the picture buffer is a coded picture buffer (CPB), and wherein receiving the respective signaled value indicative of the buffer removal time for each of the sub-pictures of the common picture comprises receiving respective signaled values indicative of an initial CPB removal delay at access unit level, an initial CPB removal delay offset at access unit level, an initial CPB removal delay at sub-picture level, and an initial CPB removal delay offset at sub-picture level.
10. The method of claim 8, wherein the respective signaled value indicative of the buffer removal time for each of the sub-pictures of the common picture is comprised in a picture timing supplemental enhancement information (SEI) message applicable to the common picture.
11. The method of claim 8, wherein the respective signaled value indicative of the buffer removal time for each of the sub-pictures of the common picture is comprised in a supplemental enhancement information (SEI) message applicable to a respective sub-picture.
12. The method of claim 1, wherein coding the video data comprises encoding video data to form at least one of the decoding units, and wherein obtaining the buffer removal time comprises determining a value indicative of the buffer removal time.

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13. The method of claim 1, wherein removing the decoding units of video data from the picture buffer in accordance with the obtained buffer removal time comprises removing at least one of the decoding units from the picture buffer after the obtained buffer removal time has passed since the storing of at least one of the decoding units in the picture buffer.

14. (Canceled)

15. The method of claim 1, further comprising receiving a signaled value indicative of a byte alignment of at least one of the sub-pictures within a larger set of the video data.

16. The method of claim 15, wherein the larger set of the video data comprises an access unit, a subset of an access unit, a picture, a frame, a slice, a wave, or a tile.

17. The method of claim 1, wherein the sub-pictures correspond to at least one of one or more sequences of blocks of video data, one or more slices, one or more waves, one or more tiles, or one or more network abstraction layer (NAL) units.

18. The method of claim 1, wherein obtaining the respective buffer removal time for a respective decoding unit of the decoding units comprises:

if the respective decoding unit comprises an ordinal first decoding unit of the video data, determining that the buffer removal time comprises a coded picture buffer removal delay value specified in a buffering period supplemental enhancement information (SEI) message associated with an access unit that comprises the respective decoding unit; and

if the respective decoding unit is not the ordinal first decoding unit of the video data, wherein the respective decoding unit comprises an ordinal i^{th} decoding unit where $i > 0$, determining that the buffer removal time comprises a decoding unit coded picture buffer removal delay[i] as specified in the picture timing SEI message associated with the access unit that comprises the respective decoding unit.

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19. The method of claim 1, wherein obtaining the respective buffer removal time for a respective decoding unit of the decoding units comprises:

if the respective decoding unit comprises an ordinal first decoding unit of an access unit of the video data, determining that a nominal removal time for the decoding unit comprises an initial coded picture buffer removal delay value divided by 90000; and

if the respective decoding unit is not the ordinal first decoding unit of the access unit, wherein the decoding unit comprises an ordinal m^{th} decoding unit where $m > 0$ of the access unit, determining that a nominal removal time for the decoding unit comprises a nominal removal time of an ordinal first decoding unit of a previous buffering period plus a clock tick times a coded picture buffer removal delay associated with the ordinal m^{th} decoding unit.

20. The method of claim 1, wherein at least two of the decoding units include different numbers of coding blocks, and coding the video data corresponding to the removed decoding units comprises coding the different numbers of coding blocks in the at least two decoding units.

21. The method of claim 1, wherein at least two of the decoding units include different numbers of bits, and coding the video data corresponding to the removed decoding units comprises coding the different numbers of bits in the at least two decoding units.

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22. A device for coding video data, the device comprising a video coder configured to:
- store one or more decoding units of video data in a picture buffer;
 - obtain a respective buffer removal time for the one or more decoding units,
- wherein the one or more decoding units comprise sub-pictures of a common picture, and wherein obtaining the respective buffer removal time comprises receiving a respective signaled value indicative of the respective buffer removal time for each of a plurality of the sub-pictures of the common picture;
- remove the one or more decoding units from the picture buffer in accordance with the obtained buffer removal time for each of the decoding units; and
 - code video data corresponding to the one or more decoding units, wherein coding the video data comprises decoding the one or more decoding units.
23. The device of claim 22, wherein each of the one or more decoding units of video data is either an access unit or a subset of an access unit.
24. The device of claim 22, wherein the video coder is further configured to store the one or more decoding units of video data in a continuous decoding order in the picture buffer.
25. The device of claim 24, wherein the video coder is further configured to receive the one or more decoding units of video data in the continuous decoding order prior to storing the one or more decoding units.
26. The device of claim 22, wherein the picture buffer is a coded picture buffer.
27. The device of claim 26, wherein the video coder is further configured to remove a first decoding unit of the decoding units from the coded picture buffer prior to removing a second decoding unit of the decoding units from the coded picture buffer, wherein the first decoding unit and the second decoding unit comprise respective subsets of a common access unit.

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28. The device of claim 22, wherein the signaled value indicative of the buffer removal time for the at least one of the decoding units comprises a signaled value indicative of a number of network abstraction layer (NAL) units comprised by the at least one of the decoding units.

29. The device of claim 22, wherein receiving the respective signaled value indicative of the respective buffer removal time for each of the plurality of the sub-pictures of the common picture comprises receiving a respective signaled value indicative of the buffer removal time for each of the sub-pictures of the common picture.

30. The device of claim 29, wherein the picture buffer is a coded picture buffer (CPB), and wherein receiving the respective signaled value indicative of the buffer removal time for each of the sub-pictures of the common picture comprises receiving respective signaled values indicative of an initial CPB removal delay at access unit level, an initial CPB removal delay offset at access unit level, an initial CPB removal delay at sub-picture level, and an initial CPB removal delay offset at sub-picture level.

31. The device of claim 29, wherein the respective signaled value indicative of the buffer removal time for each of the sub-pictures of the common picture is comprised in a picture timing supplemental enhancement information (SEI) message applicable to the common picture.

32. The device of claim 29, wherein the respective signaled value indicative of the buffer removal time for each of the sub-pictures of the common picture is comprised in a supplemental enhancement information (SEI) message applicable to a respective sub-picture.

33. The device of claim 22, wherein to code the video data, the video coder is further configured to encode the video data to form at least one of the decoding units, and wherein to obtain the buffer removal time, the video coder is further configured to determine a value indicative of the buffer removal time.

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34. The device of claim 22, wherein to remove the decoding units of video data from the picture buffer in accordance with the obtained buffer removal time, the video coder is further configured to remove at least one of the decoding units from the picture buffer after the obtained buffer removal time has passed since the storing of at least one of the decoding units in the picture buffer.

35. (Canceled)

36. The device of claim 22, wherein the video coder is further configured to receive a signaled value indicative of a byte alignment of at least one of the sub-pictures within a larger set of the video data.

37. The device of claim 36, wherein the larger set of the video data comprises an access unit, a subset of an access unit, a picture, a frame, a slice, a wave, or a tile.

38. The device of claim 22, wherein the sub-pictures correspond to at least one of one or more sequences of blocks of video data, one or more slices, one or more waves, one or more tiles, or one or more network abstraction layer (NAL) units.

39. The device of claim 22, wherein to obtain the respective buffer removal time for a respective decoding unit of the decoding units, the video coder is further configured to:

determine, if the respective decoding unit comprises an ordinal first decoding unit of the video data, that the buffer removal time comprises a coded picture buffer removal delay value specified in a buffering period supplemental enhancement information (SEI) message associated with an access unit that comprises the respective decoding unit; and

determine, if the respective decoding unit is not the ordinal first decoding unit of the video data, wherein the respective decoding unit comprises an ordinal i^{th} decoding unit where $i > 0$, that the buffer removal time comprises a decoding unit coded picture buffer removal delay[i] as specified in the picture timing SEI message associated with the access unit that comprises the respective decoding unit.

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40. The device of claim 22, wherein to obtain the respective buffer removal time for a respective decoding unit of the decoding units, the video coder is further configured to:

determine, if the respective decoding unit comprises an ordinal first decoding unit of an access unit of the video data, that a nominal removal time for the decoding unit comprises an initial coded picture buffer removal delay value divided by 90000; and

determine, if the respective decoding unit is not the ordinal first decoding unit of the access unit, wherein the decoding unit comprises an ordinal m^{th} decoding unit where $m > 0$ of the access unit, that a nominal removal time for the decoding unit comprises a nominal removal time of an ordinal first decoding unit of a previous buffering period plus a clock tick times a coded picture buffer removal delay associated with the ordinal m^{th} decoding unit.

41. The device of claim 22, wherein at least two of the decoding units include different numbers of coding blocks, and coding the video data corresponding to the removed decoding units comprises coding the different numbers of coding blocks in the at least two decoding units.

42. The device of claim 22, wherein at least two of the decoding units include different numbers of bits, and coding the video data corresponding to the removed decoding units comprises coding the different numbers of bits in the at least two decoding units.

43. The device of claim 22, wherein the device comprises at least one of:
one or more integrated circuits;
one or more microprocessors; and
a wireless communication device that includes the video coder.

44. The device of claim 22, wherein, to code the video data corresponding to the removed decoding units, the video coder is further configured to decode the video data.

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45. The device of claim 22, wherein the picture buffer is a coded picture buffer, and the device further comprises a memory configured to store one or more decoded pictures in a decoded picture buffer.

46. The device of claim 22, wherein the picture buffer is a coded picture buffer, and the device further comprises a memory configured to store coded video data in the coded picture buffer.

47. The device of claim 22, wherein the picture buffer is a coded picture buffer, and the device further comprises a stream scheduling unit configured to store coded video data to the coded picture buffer.

48. An apparatus for coding video data, the apparatus comprising:
means for storing one or more decoding units of video data in a picture buffer;
means for obtaining a respective buffer removal time for the one or more decoding units, wherein the one or more decoding units comprise sub-pictures of a common picture, and wherein obtaining the respective buffer removal time comprises receiving a respective signaled value indicative of the respective buffer removal time for each of a plurality of the sub-pictures of the common picture;
means for removing the one or more decoding units from the picture buffer in accordance with the obtained buffer removal time for each of the decoding units; and
means for coding video data corresponding to the one or more decoding units, wherein coding the video data comprises decoding the one or more decoding units.

49. The apparatus of claim 48, wherein each of the one or more decoding units of video data is either an access unit or a subset of an access unit.

50. The apparatus of claim 48, further comprising means for storing the one or more decoding units of video data in a continuous decoding order in the picture buffer.

51. The apparatus of claim 50, further comprising receiving the one or more decoding units of video data in the continuous decoding order prior to storing the one or more decoding units.

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52. The apparatus of claim 48, wherein the picture buffer is a coded picture buffer.

53. The apparatus of claim 52, further comprising means for removing a first decoding unit of the decoding units from the coded picture buffer prior to removing a second decoding unit of the decoding units from the coded picture buffer, wherein the first decoding unit and the second decoding unit comprise respective subsets of a common access unit.

54. The apparatus of claim 48, wherein the signaled value indicative of the buffer removal time for the at least one of the decoding units comprises a signaled value indicative of a number of network abstraction layer (NAL) units comprised by the at least one of the decoding units.

55. The apparatus of claim 48, wherein receiving the respective signaled value indicative of the respective buffer removal time for the each of the plurality of the sub-pictures of the common picture comprises receiving a respective signaled value indicative of the buffer removal time for each of the sub-pictures of the common picture.

56. The apparatus of claim 55, wherein the picture buffer is a coded picture buffer (CPB), and wherein the means for receiving the respective signaled value indicative of the buffer removal time for each of the sub-pictures of the common picture comprises means for receiving respective signaled values indicative of an initial CPB removal delay at access unit level, an initial CPB removal delay offset at access unit level, an initial CPB removal delay at sub-picture level, and an initial CPB removal delay offset at sub-picture level.

57. The apparatus of claim 55, wherein the respective signaled value indicative of the buffer removal time for each of the sub-pictures of the common picture is comprised in a picture timing supplemental enhancement information (SEI) message applicable to the common picture.

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58. The apparatus of claim 55, wherein the respective signaled value indicative of the buffer removal time for each of the sub-pictures of the common picture is comprised in a supplemental enhancement information (SEI) message applicable to a respective sub-picture.

59. The apparatus of claim 48, wherein the means for coding the video data comprises encoding video data to form at least one of the decoding units, and wherein the means for obtaining the buffer removal time comprises means for determining a value indicative of the buffer removal time.

60. The apparatus of claim 48, wherein the means for removing the decoding units of video data from the picture buffer in accordance with the obtained buffer removal time comprises means for removing at least one of the decoding units from the picture buffer after the obtained buffer removal time has passed since the storing of at least one of the decoding units in the picture buffer.

61. (Canceled)

62. The apparatus of claim 48, further comprising means for receiving a signaled value indicative of a byte alignment of at least one of the sub-pictures within a larger set of the video data.

63. The apparatus of claim 62, wherein the larger set of the video data comprises an access unit, a subset of an access unit, a picture, a frame, a slice, a wave, or a tile.

64. The apparatus of claim 48, wherein the sub-pictures correspond to at least one of one or more sequences of blocks of video data, one or more slices, one or more waves, one or more tiles, or one or more network abstraction layer (NAL) units.

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65. The apparatus of claim 48, wherein the means for obtaining the respective buffer removal time for a respective decoding unit of the decoding units comprises:

means for determining, if the respective decoding unit comprises an ordinal first decoding unit of the video data, that the buffer removal time comprises a coded picture buffer removal delay value specified in a buffering period supplemental enhancement information (SEI) message associated with an access unit that comprises the respective decoding unit; and

means for determining, if the respective decoding unit is not the ordinal first decoding unit of the video data, wherein the respective decoding unit comprises an ordinal i^{th} decoding unit where $i > 0$, that the buffer removal time comprises a decoding unit coded picture buffer removal delay $[i]$ as specified in the picture timing SEI message associated with the access unit that comprises the respective decoding unit.

66. The apparatus of claim 48, wherein the means for obtaining the respective buffer removal time for a respective decoding unit of the decoding units comprises:

means for determining, if the respective decoding unit comprises an ordinal first decoding unit of an access unit of the video data, that a nominal removal time for the decoding unit comprises an initial coded picture buffer removal delay value divided by 90000; and

means for determining, if the respective decoding unit is not the ordinal first decoding unit of the access unit, wherein the decoding unit comprises an ordinal m^{th} decoding unit where $m > 0$ of the access unit, that a nominal removal time for the decoding unit comprises a nominal removal time of an ordinal first decoding unit of a previous buffering period plus a clock tick times a coded picture buffer removal delay associated with the ordinal m^{th} decoding unit.

67. The apparatus of claim 48, wherein at least two of the decoding units include different numbers of coding blocks, and coding the video data corresponding to the removed decoding units comprises coding the different numbers of coding blocks in the at least two decoding units.

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68. The apparatus of claim 48, wherein at least two of the decoding units include different numbers of bits, and coding the video data corresponding to the removed decoding units comprises coding the different numbers of bits in the at least two decoding units.

69. The apparatus of claim 48, wherein the apparatus comprises at least one of:
one or more integrated circuits;
one or more microprocessors; and
a wireless communication device that includes a video coding device.

70. A computer program product comprising a computer-readable storage medium comprising instructions stored thereon that, if executed, cause a processor to:
store one or more decoding units of video data in a picture buffer;
obtain a respective buffer removal time for the one or more decoding units,
wherein the one or more decoding units comprise sub-pictures of a common picture, and
wherein obtaining the respective buffer removal time comprises receiving a respective signaled value indicative of the respective buffer removal time for each of a plurality of the sub-pictures of the common picture;
remove the one or more decoding units from the picture buffer in accordance with the obtained buffer removal time for each of the decoding units; and
code video data corresponding to the one or more decoding units, wherein coding the video data comprises decoding the one or more decoding units.

71. The computer program product of claim 70, wherein each of the one or more decoding units of video data is either an access unit or a subset of an access unit.

72. The computer program product of claim 70, wherein the instructions further cause the processor to store the one or more decoding units of video data in a continuous decoding order in the picture buffer.

73. The computer program product of claim 72, further comprising receiving the one or more decoding units of video data in the continuous decoding order prior to storing the one or more decoding units.

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74. The computer program product of claim 70, wherein the picture buffer is a coded picture buffer.

75. The computer program product of claim 74, the method further comprising removing a first decoding unit of the decoding units from the coded picture buffer prior to removing a second decoding unit of the decoding units from the coded picture buffer, wherein the first decoding unit and the second decoding unit comprise respective subsets of a common access unit.

76. The computer program product of claim 70, wherein the signaled value indicative of the buffer removal time for the at least one of the decoding units comprises a signaled value indicative of a number of network abstraction layer (NAL) units comprised by the at least one of the decoding units.

77. The computer program product of claim 70, wherein receiving the respective signaled value indicative of the respective buffer removal time for each of the plurality of the sub-pictures of the common picture comprises receiving a respective signaled value indicative of the buffer removal time for each of the sub-pictures of the common picture.

78. The computer program product of claim 77, wherein the picture buffer is a coded picture buffer (CPB), and wherein receiving the respective signaled value indicative of the buffer removal time for each of the sub-pictures of the common picture comprises receiving respective signaled values indicative of an initial CPB removal delay at access unit level, an initial CPB removal delay offset at access unit level, an initial CPB removal delay at sub-picture level, and an initial CPB removal delay offset at sub-picture level.

79. The computer program product of claim 77, wherein the respective signaled value indicative of the buffer removal time for each of the sub-pictures of the common picture is comprised in a picture timing supplemental enhancement information (SEI) message applicable to the common picture.

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80. The computer program product of claim 77, wherein the respective signaled value indicative of the buffer removal time for each of the sub-pictures of the common picture is comprised in a supplemental enhancement information (SEI) message applicable to a respective sub-picture.

81. The computer program product of claim 70, wherein coding the video data comprises encoding video data to form at least one of the decoding units, and wherein obtaining the buffer removal time comprises determining a value indicative of the buffer removal time.

82. The computer program product of claim 70, wherein removing the decoding units of video data from the picture buffer in accordance with the obtained buffer removal time comprises removing at least one of the decoding units from the picture buffer after the obtained buffer removal time has passed since the storing of at least one of the decoding units in the picture buffer.

83. (Canceled)

84. The computer program product of claim 70, wherein the instructions further cause the processor to receive a signaled value indicative of a byte alignment of at least one of the sub-pictures within a larger set of the video data.

85. The computer program product of claim 84, wherein the larger set of the video data comprises an access unit, a subset of an access unit, a picture, a frame, a slice, a wave, or a tile.

86. The computer program product of claim 70, wherein the sub-pictures correspond to at least one of one or more sequences of blocks of video data, one or more slices, one or more waves, one or more tiles, or one or more network abstraction layer (NAL) units.

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87. The computer program product of claim 70, wherein obtaining the respective buffer removal time for a respective decoding unit of the decoding units comprises:

if the respective decoding unit comprises an ordinal first decoding unit of the video data, determining that the buffer removal time comprises a coded picture buffer removal delay value specified in a buffering period supplemental enhancement information (SEI) message associated with an access unit that comprises the respective decoding unit; and

if the respective decoding unit is not the ordinal first decoding unit of the video data, wherein the respective decoding unit comprises an ordinal i^{th} decoding unit where $i > 0$, determining that the buffer removal time comprises a decoding unit coded picture buffer removal delay $[i]$ as specified in the picture timing SEI message associated with the access unit that comprises the respective decoding unit.

88. The computer program product of claim 70, wherein obtaining the respective buffer removal time for a respective decoding unit of the decoding units comprises:

if the respective decoding unit comprises an ordinal first decoding unit of an access unit of the video data, determining that a nominal removal time for the decoding unit comprises an initial coded picture buffer removal delay value divided by 90000; and

if the respective decoding unit is not the ordinal first decoding unit of the access unit, wherein the decoding unit comprises an ordinal m^{th} decoding unit where $m > 0$ of the access unit, determining that a nominal removal time for the decoding unit comprises a nominal removal time of an ordinal first decoding unit of a previous buffering period plus a clock tick times a coded picture buffer removal delay associated with the ordinal m^{th} decoding unit.

89. The computer program product of claim 70, wherein at least two of the decoding units include different numbers of coding blocks, and coding the video data corresponding to the removed decoding units comprises coding the different numbers of coding blocks in the at least two decoding units.

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90. The computer program product of claim 70, wherein at least two of the decoding units include different numbers of bits, and coding the video data corresponding to the removed decoding units comprises coding the different numbers of bits in the at least two decoding units.

91. A method of processing video data, the method comprising:

- processing video data in accordance with at least one of a plurality of video usability information (VUI) parameters including:
 - a sub-picture coded picture buffer (CPB) parameters present flag (sub_pic_cpb_params_present_flag) that indicates a presence of sub-picture CPB parameters,
 - a first supplemental enhancement information (SEI) message including at least one of a syntax element indicating a delay for a SchedSelIdx-th CPB between a time of arrival in a coded picture buffer (CPB) of a first bit of coded data associated with a first decoding unit in an access unit associated with a buffering period SEI message, and a time of removal from the CPB of the coded data associated with the first decoding unit, for the first buffering period after hypothetical reference decoder (HRD) initialization (initial_du_cpb_removal_delay), and a syntax element indicating, in combination with a syntax element indicating a CPB removal delay (cpb_removal_delay), an offset for the SchedSelIdx-th CPB to specify an initial delivery time of the first decoding unit to the CPB (initial_du_cpb_removal_delay_offset), and
 - a second SEI message including at least one syntax element indicating a number of network access layer (NAL) units in a corresponding i-th decoding unit of the access unit with which the picture timing SEI message is associated (num_nalus_in_du_minus1), and a syntax element that specifies a number of clock ticks to wait after removal from the CPB of the first decoding unit in the access unit associated with the most recent buffering period SEI message in a preceding access unit before removing from the CPB the corresponding i-th decoding unit in the access unit associated with the picture timing SEI message (du_cpb_removal_delay),
- wherein processing the video data comprises removing, in response to the sub-picture CPB parameters present flag, decoding units from a coded picture buffer in accordance with at least one of the first SEI message or the second SEI message.

CLAIMS

1. An invention not claimed in any divisional application.