Amended Set of Claims

1. A method for decoding video data, the method comprising:

decoding a sequence level flag to determine one location of two locations in which one or more sub-picture level coded picture buffer (CPB) parameters for a decoding unit (DU) of an access unit (AU) are present, wherein the two locations are: a picture timing supplemental enhancement information (SEI) message associated with the DU and a sub-picture timing SEI message associated with the DU; and

decoding the one or more sub-picture level CPB parameters from the picture timing SEI message or the sub-picture timing SEI message based on the sequence level flag.

2. The method of claim 1, wherein the one or more sub-picture level CPB parameters are present in only one of the picture timing SEI message or the sub-picture timing SEI message.

3. The method of claim 1, further comprising:

determining a CPB removal time of the DU based at least in part on the one or more sub-picture level CPB parameters.

4. The method of claim 3, wherein determining the CPB removal time of the DU comprises determining the CPB removal time of the DU without decoding an initial CPB removal delay and offset.

5. The method of claim 1, wherein the sequence level flag indicates the sub-picture level CPB parameters are present in the sub-picture timing SEI message, and wherein decoding the sub-picture level CPB parameters comprises decoding the sub-picture timing SEI message associated with the DU.

6. The method of claim 1, wherein the sequence level flag indicates the sub-picture level CPB parameters are present in the picture timing SEI message, and wherein decoding the sub-picture level CPB parameters comprises decoding the picture timing SEI message associated with the DU.

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7. The method of claim 1, wherein the DU is a first DU, the method further comprising:

deriving a CPB removal time of the first DU based at least in part on the sub-picture level CPB parameters;

decoding a duration between CPB removal time of a second DU of the AU in decoding order and the CPB removal time of the first DU; and

decoding video data of the first DU based at least in part on the CPB removal times.

8. The method of claim 7, wherein the second DU is either a last DU in the AU in decoding order or immediately subsequent to the first DU in the AU in decoding order.

9. The method of claim 1, wherein the DU comprises a non-video coding layer (VCL) network abstraction layer (NAL) unit with nal_unit_type equal to UNSPEC0, EOS_NUT, EOB_NUT, in the range of RSV_NVCL44 to RSV_NVCL47 or in the range of UNSPEC48 to UNSPEC12.

10. The method of claim 1, wherein the AU has a TemporalId equal to 0, the method further comprising:

decoding at least one of a buffering period SEI message or a recovery point SEI message associated with the AU.

11. The method of claim 1, further comprising:

deriving at least one of a CPB arrival time and a CPB nominal removal time for the AU at both an access unit level and a sub-picture level regardless of a value of a syntax element that defines whether the DU is the AU.

12. A video decoding device comprising a video decoder configured to:

decode a sequence level flag to determine one location of two locations in which one or more sub-picture level coded picture buffer (CPB) parameters for a decoding unit (DU) of an access unit (AU) are present, wherein the two locations are: picture timing supplemental enhancement information (SEI) message or a sub-picture timing SEI message associated with the DU; and

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decode the one or more sub-picture level CPB parameters from the picture timing SEI message or the sub-picture timing SEI message based on the sequence level flag.

13. The video decoding device of claim 12, wherein the one or more sub-picture level CPB parameters are present in only one of the picture timing SEI message or the sub-picture timing SEI message.

14. The video decoding device of claim 12, the video decoder further configured to determine a CPB removal time of the DU based at least in part on the one or more sub-picture level CPB parameters.

15. The video decoding device of claim 14, the video decoder being configured to determine the CPB removal time of the DU without decoding an initial CPB removal delay and offset.

16. The video decoding device of claim 12, wherein the sequence level flag indicates the sub-picture level CPB parameters are present in the sub-picture timing SEI message, the video decoder being configured to decode the sub-picture timing SEI message associated with the DU.

17. The video decoding device of claim 12, wherein the sequence level flag indicates the sub-picture level CPB parameters are present in the picture timing SEI message, and the video decoder being configured to decode the picture timing SEI message associated with the DU.

18. The video decoding device of claim 12, wherein the DU is a first DU, the video decoder being further configured to:

derive a CPB removal time of the first DU based at least in part on the sub-picture level CPB parameters;

decode a duration between CPB removal time of a second DU of the AU in decoding order and the CPB removal time of the first DU; and

decode video data of the first DU based at least in part on the CPB removal times.

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19. The video decoding device of claim 18, wherein the second DU is either a last DU in the AU in decoding order or immediately subsequent to the first DU in the AU in decoding order.

20. The video decoding device of claim 12, wherein the DU comprises a non-video coding layer (VCL) network abstraction layer (NAL) unit with nal_unit_type equal to UNSPEC0, EOS_NUT, EOB_NUT, in the range of RSV_NVCL44 to RSV_NVCL47 or in the range of UNSPEC48 to UNSPEC12.

21. The video decoding device of claim 12, wherein the AU has a TemporalId equal to 0, the video decoder being further configured to decode at least one of a buffering period SEI message or a recovery point SEI message associated with the AU.

22. The video decoding device of claim 12, the video decoder being further configured to derive at least one of a CPB arrival time and a CPB nominal removal time for the AU at both an access unit level and a sub-picture level regardless of a value of a syntax element that defines whether the DU is the AU.

23. A computer-readable storage medium having stored thereon instructions that, when executed, cause a processor of a device for coding video data to:

decode a sequence level flag to determine one location of two locations in which one or more sub-picture level coded picture buffer (CPB) parameters for a decoding unit (DU) of an access unit (AU) are present, wherein the two locations are: a picture timing supplemental enhancement information (SEI) message or a sub-picture timing SEI message associated with the DU; and

decode the one or more sub-picture level CPB parameters from the picture timing SEI message or the sub-picture timing SEI message based on the sequence level flag.

24. The computer-readable storage medium of claim 23, wherein the one or more sub-picture level CPB parameters are present in only one of the picture timing SEI message or the sub-picture timing SEI message.

25. The computer-readable storage medium of claim 23, the instructions, when executed, further causing the processor of the device for coding video data to determine a CPB removal time of the DU based at least in part on the one or more sub-picture level CPB parameters.

26. The computer-readable storage medium of claim 25, the instructions causing the processor to determine the CPB removal time of the DU without decoding an initial CPB removal delay and offset.

27. The computer-readable storage medium of claim 23, wherein the sequence level flag indicates the sub-picture level CPB parameters are present in the sub-picture timing SEI message, the instructions causing the processor to decode the sub-picture timing SEI message associated with the DU.

28. The computer-readable storage medium of claim 23, wherein the sequence level flag indicates the sub-picture level CPB parameters are present in the picture timing SEI message, and the instructions causing the processor to decode the picture timing SEI message associated with the DU.

29. A video decoding device, comprising:

means for decoding a sequence level flag to determine one location of two locations in which one or more sub-picture level coded picture buffer (CPB) parameters for a decoding unit (DU) of an access unit (AU) are present, wherein the two locations are: a picture timing supplemental enhancement information (SEI) message or a sub-picture timing SEI message associated with the DU; and

means for decoding the one or more sub-picture level CPB parameters from the picture timing SEI message or the sub-picture timing SEI message based on the sequence level flag.

30. The video decoding device of claim 29, wherein the one or more sub-picture level CPB parameters are present in only one of the picture timing SEI message or the sub-picture timing SEI message.

31. The video decoding device of claim 29, further comprising means for determining a CPB removal time of the DU based at least in part on the one or more sub-picture level CPB parameters.

32. The video decoding device of claim 31, wherein the means for determining the CPB removal time of the DU comprises means for determining the CPB removal time of the DU without decoding an initial CPB removal delay and offset.

33. The video decoding device of claim 29, wherein the sequence level flag indicates the sub-picture level CPB parameters are present in the sub-picture timing SEI message, and wherein the means for decoding the sub-picture level CPB parameters comprises means for decoding the sub-picture timing SEI message associated with the DU.

34. The video decoding device of claim 29, wherein the sequence level flag indicates the sub-picture level CPB parameters are present in the picture timing SEI message, and wherein the means for decoding the sub-picture level CPB parameters comprises means for decoding the picture timing SEI message associated with the DU.

35. A method for encoding video data, the method comprising:

encoding one or more sub-picture level coded picture buffer (CPB) parameters for a decoding unit (DU) of an access unit (AU) in either a picture timing SEI message or a sub-picture timing SEI message; and

encoding a sequence level flag to indicate one location of two locations in which one or more sub-picture level CPB parameters for a DU of an AU are present, wherein the two locations are: the picture timing SEI message or the sub-picture timing SEI message associated with the DU.

36. The method of claim 35, wherein encoding the one or more sub-picture level CPB parameters comprises encoding the one or more sub-picture level CPB parameters in only one of the picture timing SEI message or the sub-picture timing SEI message.

37. The method of claim 35, further comprising:

determining a CPB removal time of the DU based at least in part on the one or more sub-picture level CPB parameters.

38. The method of claim 37, wherein determining the CPB removal time of the DU comprises determining the CPB removal time of the DU without encoding an initial CPB removal delay and offset.

39. The method of claim 35, wherein encoding the one or more sub-picture level CPB parameters comprises encoding the one or more sub-picture level CPB parameters in the sub-picture timing SEI message associated with the DU, and wherein the sequence level flag indicates the sub-picture level CPB parameters are present in the sub-picture timing SEI message.

40. The method of claim 35, wherein encoding the one or more sub-picture level CPB parameters comprises encoding the one or more sub-picture level CPB parameters in the picture timing SEI message associated with the DU, and wherein the sequence level flag indicates the sub-picture level CPB parameters are present in the picture timing SEI message.

41. The method of claim 35, wherein the DU is a first DU, the method further comprising:

deriving a CPB removal time of the first DU based at least in part on the sub-picture level CPB parameters; and

encoding a duration between CPB removal time of a second DU of the AU in decoding order and the CPB removal time of the first DU.

42. The method of claim 41, wherein the second DU is either a last DU in the AU in decoding order or immediately subsequent to the first DU in the AU in decoding order.

43. The method of claim 35, wherein the DU comprises a non-video coding layer (VCL) network abstraction layer (NAL) unit with nal_unit_type equal to UNSPEC0, EOS_NUT, EOB_NUT, in the range of RSV_NVCL44 to RSV_NVCL47 or in the range of UNSPEC48 to UNSPEC12.

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44. The method of claim 35, wherein the AU has a TemporalId equal to 0, the method further comprising:

encoding at least one of a buffering period SEI message or a recovery point SEI message associated with the AU.

45. The method of claim 35, further comprising:

deriving at least one of a CPB arrival time and a CPB nominal removal time for the AU at both an access unit level and a sub-picture level regardless of a value of a syntax element that defines whether the first DU is the AU.

46. A video encoding device comprising a video encoder configured to:

encode one or more sub-picture level coded picture buffer (CPB) parameters for a decoding unit (DU) of an access unit (AU) in either a picture timing SEI message or a sub-picture timing SEI message; and

encode a sequence level flag to indicate one location of two locations in which one or more sub-picture level CPB parameters for a DU of an AU are present, wherein the two locations are: the picture timing SEI message or the sub-picture timing SEI message associated with the DU.

47. The video encoding device of claim 46, the video encoder being configured to encode the one or more sub-picture level CPB parameters in only one of the picture timing SEI message or the sub-picture timing SEI message.

48. The video encoding device of claim 46, the video encoder being further configured to determine a CPB removal time of the DU based at least in part on the one or more sub-picture level CPB parameters.

49. The video encoding device of claim 48, the video encoder being configured to determine the CPB removal time of the DU without encoding an initial CPB removal delay and offset.

50. The video encoding device of claim 46, the video encoder being further configured to encode the one or more sub-picture level CPB parameters in the sub-picture timing SEI message associated with the DU, and wherein the sequence level flag

indicates the sub-picture level CPB parameters are present in the sub-picture timing SEI message.

51. The video encoding device of claim 46, the video encoder being further configured to encode the one or more sub-picture level CPB parameters in the picture timing SEI message associated with the DU, and wherein the sequence level flag indicates the sub-picture level CPB parameters are present in the picture timing SEI message.

52. The video encoding device of claim 46, wherein the DU is a first DU, the video encoder being further configured to:

derive a CPB removal time of the first DU based at least in part on the sub-picture level CPB parameters;

encode a duration between CPB removal time of a second DU of the AU in decoding order and the CPB removal time of the first DU; and

encode video data of the first DU based at least in part on the CPB removal times.

53. The video encoding device of claim 52, wherein the second DU is either a last DU in the AU in decoding order or immediately subsequent to the first DU in the AU in decoding order.

54. The video encoding device of claim 46, wherein the DU comprises a non-video coding layer (VCL) network abstraction layer (NAL) unit with nal_unit_type equal to UNSPEC0, EOS_NUT, EOB_NUT, in the range of RSV_NVCL44 to RSV_NVCL47 or in the range of UNSPEC48 to UNSPEC12.

55. The video encoding device of claim 46, wherein the AU has a TemporalId equal to 0, the video encoder being further configured to encode at least one of a buffering period SEI message or a recovery point SEI message associated with the AU.

56. The video encoding device of claim 46, the video encoder being further configured to derive at least one of a CPB arrival time and a CPB nominal removal time

for the AU at both an access unit level and a sub-picture level regardless of a value of a syntax element that defines whether the DU is the AU.

57. A computer-readable storage medium having stored thereon instructions that, when executed, cause a processor of a device for coding video data to: encode one or more sub-picture level coded picture buffer (CPB) parameters for a decoding unit (DU) of an access unit (AU) in either a picture timing SEI message or a sub-picture timing SEI message; and

encode a sequence level flag to indicate one location of two locations in which one or more sub-picture level CPB parameters for a DU of an AU are present, wherein the two locations are: the picture timing SEI message or the sub-picture timing SEI message associated with the DU.

58. The computer-readable storage medium of claim 57, the instructions, when executed, causing the processor to encode the one or more sub-picture level CPB parameters in only one of the picture timing SEI message or the sub-picture timing SEI message.

59. The computer-readable storage medium of claim 57, the instructions, when executed, causing the processor of the device for coding video data to determine a CPB removal time of the DU based at least in part on the one or more sub-picture level CPB parameters.

60. The computer-readable storage medium of claim 59, the instructions, when executed, causing the processor to determine the CPB removal time of the DU without encoding an initial CPB removal delay and offset.

61. The computer-readable storage medium of claim 57, the instructions, when executed, causing the processor to encode the one or more sub-picture level CPB parameters in the sub-picture timing SEI message associated with the DU, and wherein the sequence level flag indicates the sub-picture level CPB parameters are present in the sub-picture timing SEI message.

62. The computer-readable storage medium of claim 57, the instructions, when executed, causing the processor to encode the one or more sub-picture level CPB parameters in the picture timing SEI message associated with the DU, and wherein the sequence level flag indicates the sub-picture level CPB parameters are present in the picture timing SEI message.

CLAIMS

1. A method for decoding video data, the method comprising:

receiving a bitstream that includes a sequence parameter set (SPS) that is active for a coded picture associated with a picture timing Supplemental Enhancement Information (SEI) message, the SPS including a Hypothetical Reference Decoder (HRD) parameters syntax structure;

obtaining, from the HRD parameters syntax structure of the SPS, a sequence level flag, the sequence level flag equal to 1 specifying that sub-picture level coded picture buffer (CPB) removal delay parameters are present in the picture timing SEI message and specifying no sub-picture timing SEI message is present, the sequence level flag equal to 0 specifying that sub-picture level CPB removal delay parameters are present in sub-picture timing SEI messages and specifying the picture timing SEI message does not include sub-picture level CPB removal delay parameters;

based on the sequence level flag being equal to 0:

obtaining, from a sub-picture timing SEI message, a sub-picture level CPB removal delay parameter for a decoding unit (DU) associated with the sub-picture timing SEI message, the DU being in an access unit; and

setting a nominal CPB removal time of the DU equal to a nominal removal time of the access unit minus a multiplication product of a sub-picture clock ticks parameter and the sub-picture level CPB removal delay parameter for the DU;

setting a CPB removal time of the DU to the nominal CPB removal time of the DU; and

at a time based on the CPB removal time of the DU, decoding video data associated with the DU.

2. The method of claim 1, wherein the CPB removal time of the DU is determined without decoding an initial CPB removal delay and offset.

3. The method of claim 1, wherein the DU is a first DU, the method further comprising:

decoding a duration between a CPB removal time of a second DU in decoding order and the CPB removal time of the first DU; and

decoding video data of the first DU based at least in part on the CPB removal times.

4. The method of claim 3, wherein the second DU is either a last DU in the AU in decoding order or immediately subsequent to the first DU in the AU in decoding order.

5. The method of claim 1, further comprising using the sub-picture level CBP removal delay parameter to calculate an earliest possible time of arrival of DU data into a CPB for a Hypothetical Stream Scheduler.

6. The method of claim 1, wherein when the DU associated with the sub-picture timing SEI message is the last DU in a current access unit, the value of the sub-picture level CPB removal delay parameter must be equal to 0.

7. A video decoding device comprising:

a coded picture buffer (CPB); and

a video decoder configured to:

receive a bitstream that includes a sequence parameter set (SPS) that is active for a coded picture associated with a picture timing Supplemental Enhancement Information (SEI) message, the SPS including a Hypothetical Reference Decoder (HRD) parameters syntax structure;

obtain, from the HRD parameters syntax structure of the SPS, a sequence level flag, the sequence level flag equal to 1 specifying that sub-picture level CPB removal delay parameters are present in the picture timing SEI message and specifying no sub-picture timing SEI message is present, the sequence level flag equal to 0 specifying that sub-picture level CPB removal delay parameters are present in sub-picture timing SEI messages and specifying the picture timing SEI message does not include sub-picture level CPB removal delay parameters;

based on the sequence level flag being equal to 0:

obtain, from a sub-picture timing SEI message, a sub-picture level CPB removal delay parameter for a decoding unit (DU) associated with the sub-picture timing SEI message, the DU being in an access unit; and

set a nominal CPB removal time of the DU equal to a nominal removal time of the access unit minus a multiplication product of a sub-picture clock ticks parameter and the sub-picture level CPB removal delay parameter for the DU;

set a CPB removal time of the DU to the nominal CPB removal time of the DU; and

at a time based on the CPB removal time of the DU, decode video data associated with the DU.

8. The video decoding device of claim 7, the video decoder being configured to determine the CPB removal time of the DU without decoding an initial CPB removal delay and offset.

9. The video decoding device of claim 7, wherein the DU is a first DU, the video decoder being further configured to:

decode a duration between a CPB removal time of a second DU in decoding order and the CPB removal time of the first DU; and

decode video data of the first DU based at least in part on the CPB removal times.

10. The video decoding device of claim 9, wherein the second DU is either a last DU in the AU in decoding order or immediately subsequent to the first DU in the AU in decoding order.

11. The video decoding device of claim 7, the video decoder further configured to use the sub-picture level CBP removal delay parameter to calculate an earliest possible time of arrival of DU data into the CPB for a Hypothetical Stream Scheduler.

12. The video decoding device of claim 7, wherein when the DU associated with the sub-picture timing SEI message is the last DU in a current access unit, the value of the sub-picture level CPB removal delay parameter must be equal to 0.

13. A non-transitory computer-readable storage medium having stored thereon instructions that, when executed, cause a processor of a device for coding video data to:

receive a bitstream that includes a sequence parameter set (SPS) that is active for a coded picture associated with a picture timing Supplemental Enhancement Information (SEI) message, the SPS including a Hypothetical Reference Decoder (HRD) parameters syntax structure;

obtain, from the HRD parameters syntax structure of the SPS, a sequence level flag, the sequence level flag equal to 1 specifying that sub-picture level coded picture buffer (CPB) removal delay parameters are present in the picture timing SEI message and specifying no sub-picture timing SEI message is present, the sequence level flag equal to 0 specifying that sub-picture level CPB removal delay parameters are present in sub-picture timing SEI messages and specifying the picture timing SEI message does not include sub-picture level CPB removal delay parameters;

based on the sequence level flag being equal to 0:

obtain, from a sub-picture timing SEI message, a sub-picture level CPB removal delay parameter for a decoding unit (DU) associated with the sub-picture timing SEI message, the DU being in an access unit; and

set a nominal CPB removal time of the DU equal to a nominal removal time of the access unit minus a multiplication product of a sub-picture clock ticks parameter and the sub-picture level CPB removal delay parameter for the DU;

set a CPB removal time of the DU to the nominal CPB removal time of the DU; and

at a time based on the CPB removal time of the DU, decode video data associated with the DU.

14. The non-transitory computer-readable storage medium of claim 13, the instructions causing the processor to determine the CPB removal time of the DU without decoding an initial CPB removal delay and offset.

15. The non-transitory computer-readable storage medium of claim 13, wherein the instructions, when executed, cause the processor to use the sub-picture level CBP removal delay parameter to calculate an earliest possible time of arrival of DU data into a CPB for a Hypothetical Stream Scheduler.

16. The non-transitory computer-readable storage medium of claim 13, wherein when the DU associated with the sub-picture timing SEI message is the last DU in a current access unit, the value of the sub-picture level CPB removal delay parameter must be equal to 0.

17. A video decoding device, comprising:

means for receiving a bitstream that includes a sequence parameter set (SPS) that is active for a coded picture associated with a picture timing Supplemental Enhancement Information (SEI) message, the SPS including a Hypothetical Reference Decoder (HRD) parameters syntax structure;

means for obtaining, from the HRD parameters syntax structure of the SPS, a sequence level flag, the sequence level flag equal to 1 specifying that sub-picture level coded picture buffer (CPB) removal delay parameters are present in the picture timing SEI message and specifying no sub-picture timing SEI message is present, the sequence level flag equal to 0 specifying that sub-picture level CPB removal delay parameters are present in sub-picture timing SEI messages and specifying the picture timing SEI message does not include sub-picture level CPB removal delay parameters;

means for obtaining, based on the sequence level flag being equal to 0, from a sub-picture timing SEI message, a sub-picture level CPB removal delay parameter for a decoding unit (DU) associated with the sub-picture timing SEI message, the DU being in an access unit; and

means for setting, based on the sequence level flag being equal to 0, a nominal CPB removal time of the DU equal to a nominal removal time of the access unit minus a multiplication product of a sub-picture clock ticks parameter and the sub-picture level CPB removal delay parameter for the DU;

means for setting a CPB removal time of the DU to the nominal CPB removal time of the DU; and

means for decoding, at a time based on the CPB removal time of the DU, video data associated with the DU.

18. The video decoding device of claim 17, wherein the CPB removal time of the DU is determined without decoding an initial CPB removal delay and offset.

19. The video decoding device of claim 17, further comprising means for using the sub-picture level CBP removal delay parameter to calculate an earliest possible time of arrival of DU data into a CPB for a Hypothetical Stream Scheduler.

20. The video decoding device of claim 17, wherein when the DU associated with the sub-picture timing SEI message is the last DU in a current access unit, the value of the sub-picture level CPB removal delay parameter must be equal to 0.

21. A method for encoding video data, the method comprising:

encoding, in a sequence parameter set (SPS) that is active for a coded picture associated with a picture timing Supplemental Enhancement Information (SEI) message, a Hypothetical Reference Decoder (HRD) parameters syntax structure that includes a sequence level flag, the sequence level flag equal to 1 specifying that sub-picture level Coded Picture Buffer (CPB) removal delay parameters are present in the picture timing SEI message and specifying no sub-picture timing SEI message is present, the sequence level flag equal to 0 specifying that sub-picture level CPB removal delay parameters are present in sub-picture timing SEI messages and specifying the picture timing SEI message does not include sub-picture level CPB removal delay parameters; and

based on the sequence level flag being equal 0, encoding, in a sub-picture timing SEI message, a sub-picture level CPB removal data parameter for a decoding unit (DU) associated with the sub-picture timing SEI message.

22. The method of claim 21, wherein the DU is in an access unit, the method further comprising:

based on the sequence level flag being equal to 0, setting a nominal CPB removal time of the DU equal to a nominal removal time of the access unit minus a multiplication product of a sub-picture clock ticks parameter and the sub-picture level CPB removal delay parameter for the DU;

setting a CPB removal time of the DU to the nominal CPB removal time of the DU.

23. The method of claim 22, wherein the CPB removal time of the DU is determined without encoding an initial CPB removal delay and offset.

24. The method of claim 22, wherein the DU is a first DU, the method further comprising:

encoding a duration between a CPB removal time of a second DU of the AU in decoding order and the CPB removal time of the first DU.

25. A video encoding device comprising:

a data storage medium that is configured to store encoded video data; and

a video encoder configured to:

encode, in a sequence parameter set (SPS) that is active for a coded picture associated with a picture timing SEI message, a Hypothetical Reference Decoder (HRD) parameters syntax structure that includes a sequence level flag, the sequence level flag equal to 1 specifying that sub-picture level CPB removal delay parameters are present in the picture timing Supplemental Enhancement Information (SEI) message and specifying no sub-picture timing SEI message is present, the sequence level flag equal to 0 specifying that sub-picture level Coded Picture Buffer (CPB) removal delay parameters are present in sub-picture timing SEI messages and specifying the picture timing SEI message does not include sub-picture level CPB removal delay parameters; and

based on the sequence level flag being equal 0, encode, in a sub-picture timing SEI message, a sub-picture level of CPB removal delay parameter for a decoding unit (DU) associated with the sub-picture timing SEI message.

26. The video encoding device of claim 25, wherein the DU is in an access unit, the video encoder being further configured to:

based on the sequence level flag being equal to 0, set a nominal CPB removal time of the DU equal to a nominal removal time of the access unit minus a multiplication product of a sub-picture clock ticks parameter and the sub-picture level CPB removal delay parameter for the DU;

set a CPB removal time of the DU to the nominal CPB removal time of the DU.

27. The video encoding device of claim 26, the video encoder being configured to determine the CPB removal time of the DU without encoding an initial CPB removal delay and offset.

28. The video encoding device of claim 26, wherein the DU is a first DU, the video encoder being further configured to:

encode a duration between a CPB removal time of a second DU of the AU in decoding order and the CPB removal time of the first DU.

29. A non-transitory computer-readable storage medium having stored thereon instructions that, when executed, cause a processor of a device for coding video data to:

encode, in a sequence parameter set (SPS) that is active for a coded picture associated with a picture timing SEI message, a Hypothetical Reference Decoder (HRD) parameters syntax structure that includes a sequence level flag, the sequence level flag equal to 1 specifying that sub-picture level CPB removal delay parameters are present in the picture timing Supplemental Enhancement Information (SEI) message and specifying no sub-picture timing SEI message is present, the sequence level flag equal to 0 specifying that sub-picture level Coded Picture Buffer (CPB) removal delay parameters are present in sub-picture timing SEI messages and specifying the picture timing SEI message does not include sub-picture level CPB removal delay parameters; and

based on the sequence level flag being equal 0, encode, in a sub-picture timing SEI message, a sub-picture level CPB removal delay parameter for a decoding unit (DU) associated with the sub-picture timing SEI message.

30. The computer-readable storage medium of claim 29, wherein the DU is in an access unit, the instructions, when executed, causing the processor of the device for coding video data to:

based on the sequence level flag being equal to 0, set a nominal CPB removal time of the DU equal to a nominal removal time of the access unit minus a multiplication product of a sub-picture clock ticks parameter and the sub-picture level CPB removal delay parameter for the DU; and

set a CPB removal time of the DU to the nominal CPB removal time of the DU.

31. The computer-readable storage medium of claim 30, the instructions, when executed, causing the processor to determine the CPB removal time of the DU without encoding an initial CPB removal delay and offset.