## Amended Set of Claims

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

decoding a sub-picture timing supplemental enhancement information (SEI) message associated with a first decoding unit (DU) of an access unit (AU);

determining, from the decoded sub-picture timing SEI message, a duration between a coded picture buffer (CPB) removal time of a second DU of the AU in decoding order and a CPB removal time of the first DU in the sub-picture SEI message; and

deriving the CPB removal time of the first DU based at least in part on the determined duration.

2. The method of claim 1, further comprising:

decoding a sequence level flag to determine the presence of one or more sub-picture level CPB parameters either in the sub-picture timing SEI message or a picture timing SEI message associated with the first DU.

3. The method of claim 2, further comprising:

decoding the sub-picture level CPB parameters, wherein determining the CPB removal time of the first DU is further based at least in part on the sub-picture level CPB parameters.

4. The method of claim 3, wherein the sequence level flag indicates the sub-picture level CPB parameters are to be 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 first DU.

5. The method of claim 4, wherein the second DU is a last DU in the AU in decoding order, and wherein decoding the sub-picture SEI message comprises:

decoding the duration between a removal time of the last DU and the removal time of the first DU in the sub-picture timing SEI message.

6. The method of claim 1, wherein the second DU is a last DU in the AU in decoding order.

7. The method of claim 1, wherein the second DU is immediately subsequent to the first DU in the AU in decoding order.

8. The method of claim 1, wherein the first 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.

9. The method of claim 1, wherein determining the removal time of the first DU comprises determining the removal time of the first DU without decoding an initial CPB removal delay and offset.

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

decode a sub-picture timing supplemental enhancement information (SEI) message associated with a first decoding unit (DU) of an access unit (AU);

determine, from the decoded sub-picture timing SEI message, a duration between a coded picture buffer (CPB) removal time of a second DU of the AU in decoding order and a CPB removal time of the first DU in the sub-picture SEI message; and

derive the CPB removal time of the first DU based at least in part on the determined duration.

11. The video decoding device of claim 10, the video decoder further configured to decode a sequence level flag to determine the presence of one or more sub-picture level CPB parameters either in the sub-picture timing SEI message or a picture timing SEI message associated with the first DU.

12. The video decoding device of claim 11, the video decoder further configured to decode the sub-picture level CPB parameters, wherein determine the CPB removal time of the first DU is further based at least in part on the sub-picture level CPB parameters.

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

14. The video decoding device of claim 13, wherein the second DU is a last DU in the AU in decoding order, and wherein the video decoder is configured to decode the sub-picture SEI message comprises the video decoder is configured to decode the duration between a removal time of the last DU and the removal time of the first DU in the sub-picture timing SEI message.

15. The video decoding device of claim 10, wherein the second DU is a last DU in the AU in decoding order.

16. The video decoding device of claim 10, wherein the second DU is immediately subsequent to the first DU in the AU in decoding order.

17. The video decoding device of claim 10, wherein the first 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.

18. The video decoding device of claim 10, wherein the video decoder is configured to determine the removal time of the first DU further comprises the video decoder is configured to determine the removal time of the first DU without decoding an initial CPB removal delay and offset.

19. 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 sub-picture timing supplemental enhancement information (SEI) message associated with a first decoding unit (DU) of an access unit (AU);

determine, from the decoded sub-picture timing SEI message, a duration between a coded picture buffer (CPB) removal time of a second DU of the AU in decoding order and a CPB removal time of the first DU in the sub-picture SEI message; and

derive the CPB removal time of the first DU based at least in part on the determined duration.

20. The computer-readable storage medium of claim 19, the instructions, when executed, further causing a processor of a device for coding video data to:

decode a sequence level flag to determine the presence of one or more sub-picture level CPB parameters either in the sub-picture timing SEI message or a picture timing SEI message associated with the first DU.

21. The computer-readable storage medium of claim 20, the instructions, when executed, further causing a processor of a device for coding video data to:

decode the sub-picture level CPB parameters, wherein determine the CPB removal time of the first DU is further based at least in part on the sub-picture level CPB parameters.

22. The computer-readable storage medium of claim 19, wherein the sequence level flag indicates the sub-picture level CPB parameters are to be present in the sub-picture timing SEI message, and wherein decode the sub-picture level CPB parameters comprises decode the sub-picture timing SEI message associated with the first DU.

23. A video decoding device, comprising:

means for decoding a sub-picture timing supplemental enhancement information (SEI) message associated with a first decoding unit (DU) of an access unit (AU);

means for determining, from the decoded sub-picture timing SEI message, a duration between a coded picture buffer (CPB) removal time of a second DU of the AU in decoding order and a CPB removal time of the first DU in the sub-picture SEI message; and

means for deriving the CPB removal time of the first DU based at least in part on the determined duration.

24. The video decoding device of claim 23, further comprising:

means for decoding a sequence level flag to determine the presence of one or more sub-picture level CPB parameters either in the sub-picture timing SEI message or a picture timing SEI message associated with the first DU.

25. The video decoding device of claim 24, further comprising:

means for decoding the sub-picture level CPB parameters, wherein determining the CPB removal time of the first DU is further based at least in part on the sub-picture level CPB parameters.

26. The video decoding device of claim 25, wherein the sequence level flag indicates the sub-picture level CPB parameters are to be present in the sub-picture timing SEI message, and wherein means for decoding the sub-picture level CPB parameters comprises means for decoding the sub-picture timing SEI message associated with the first DU.

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

determining a duration between a coded picture buffer (CPB) removal time of a first decoding unit (DU) in an access unit (AU) and a CPB removal time of a second DU in the AU; and

encoding the duration in a sub-picture timing supplemental enhancement information (SEI) message associated with the AU.

28. The method of claim 27, further comprising encoding one or more sub-picture level CPB parameters.

29. The method of claim 28, further comprising:

encoding a sequence level flag to indicate the presence of the one or more sub-picture level CPB parameters in either the sub-picture timing SEI message or a picture timing SEI message associated with the first DU.

30. The method 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 encoding the one or more sub-picture level CPB parameters comprises encoding the sub-picture timing SEI message associated with the AU.

31. The method of claim 27, wherein the second DU is a last DU in the AU in decoding order.

32. The method of claim 27, wherein the second DU is immediately subsequent to the first DU in the AU in decoding order.

33. The method of claim 27, wherein the first 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.

34. The method of claim 27, wherein determining the duration comprises determining a removal time of the first DU without encoding an initial CPB removal delay and offset.

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

determine a duration between a coded picture buffer (CPB) removal time of a first decoding unit (DU) in an access unit (AU) and a CPB removal time of a second DU in the AU; and

encode the duration in a sub-picture timing supplemental enhancement information (SEI) message associated with the AU.

36. The video encoding device of claim 35, further comprising encode one or more sub-picture level CPB parameters.

37. The video encoding device of claim 36, the video encoder further configured to encode a sequence level flag to indicate the presence of the one or more sub-picture level CPB parameters in either the sub-picture timing SEI message or a picture timing SEI message associated with the first DU.

38. The video encoding device of claim 37, wherein the sequence level flag indicates the sub-picture level CPB parameters are present in the sub-picture timing SEI message, and wherein encode the one or more sub-picture level CPB parameters comprises encode the sub-picture timing SEI message associated with the AU.

39. The video encoding device of claim 35, wherein the second DU is a last DU in the AU in decoding order.

40. (Cancelled)

41. The video encoding device of claim 35, wherein the second DU is immediately subsequent to the first DU in the AU in decoding order.

42. The video encoding device of claim 35, wherein the first 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.

43. The video encoding device of claim 35, wherein the video encoder is configured to determine the duration further comprises the video encoder is configured to determine a removal time of the first DU without encoding an initial CPB removal delay and offset.

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

determine a duration between a coded picture buffer (CPB) removal time of a first decoding unit (DU) in an access unit (AU) and a CPB removal time of a second DU in the AU; and

encode the duration in a sub-picture timing supplemental enhancement information (SEI) message associated with the AU.

45. The computer-readable storage medium of claim 44, the instructions, when executed, further causing a processor of a device for coding video data to:

encode one or more sub-picture level CPB parameters.

46. The computer-readable storage medium of claim 45, the instructions, when executed, further causing a processor of a device for coding video data to:

encode a sequence level flag to indicate the presence of the one or more sub-picture level CPB parameters in either the sub-picture timing SEI message or a picture timing SEI message associated with the first DU.

47. The computer-readable storage medium of claim 46, wherein the sequence level flag indicates the sub-picture level CPB parameters are present in the sub-picture timing SEI message, and wherein encode the one or more sub-picture level CPB parameters comprises encode the sub-picture timing SEI message associated with the AU.


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## CLAIMS

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

decoding a sub-picture timing supplemental enhancement information (SEI) message that provides Coded Picture Buffer (CPB) removal delay information for a decoding unit (DU) associated with the sub-picture timing SEI message, the DU associated with the sub-picture timing SEI message consisting, in decoding order, of an SEI network abstraction layer (NAL) unit containing the sub-picture timing SEI message followed by one or more NAL units that do not contain sub-picture timing SEI messages, including all subsequent NAL units in an access unit (AU) up to but not including any subsequent SEI NAL unit containing an additional sub-picture timing SEI message;

determining, from the sub-picture timing SEI message, a duration between a CPB removal time of a last DU of the AU in decoding order and a CPB removal time of the DU associated with the sub-picture SEI message;

deriving the CPB removal time of the DU associated with the sub-picture timing SEI message based at least in part on the determined duration; and

at the CPB removal time of the DU associated with the sub-picture timing SEI message, decoding video data associated with the DU associated with the sub-picture timing SEI message.

2. The method of claim 1, further comprising:

decoding a sequence level flag to determine the presence of one or more sub-picture level CPB parameters either in the sub-picture timing SEI message or a picture timing SEI message associated with the DU associated with the sub-picture timing SEI message.

**3**. The method of claim **2**, further comprising:

decoding the sub-picture level CPB parameters, wherein determining the CPB removal time of the DU associated with the sub-picture timing SEI message is further based at least in part on the sub-picture level CPB parameters.

**4**. The method of claim **3**, wherein the sequence level flag indicates the sub-picture level CPB parameters are to be 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 associated with the sub-picture timing SEI message.

**5**. The method of claim **1**, wherein determining the removal time of the DU associated with the sub-picture timing SEI message comprises determining the removal time of the DU associated with the sub-picture timing SEI message without decoding an initial CPB removal delay and offset.

**6**. A video decoding device comprising:

a coded picture buffer; and

a video decoder comprising one or more processors configured to:

decode a sub-picture timing supplemental enhancement information (SEI) message that provides Coded Picture Buffer (CPB) removal delay information for a decoding unit (DU) associated with the sub-picture timing SEI message, the DU associated with the sub-picture timing SEI message consisting, in decoding order, of an SEI network abstraction layer (NAL) unit containing the sub-picture timing SEI message followed by one or more NAL units that do not contain sub-picture timing SEI messages, including all subsequent NAL units in an access unit (AU) up

to but not including any subsequent SEI NAL unit containing an additional sub-picture timing SEI message;

determine, from the sub-picture timing SEI message, a duration between the coded picture buffer (CPB) removal time of a last DU of the AU in decoding order and a CPB removal time of the DU associated with the sub-picture SEI message;

derive the CPB removal time of the DU associated with the sub-picture timing SEI message based at least in part on the determined duration; and

at the CPB removal time of the DU associated with the sub-picture timing SEI message, decode video data associated with the DU associated with the sub-picture timing SEI message.

**7**. The video decoding device of claim **6**, the video decoder further configured to decode a sequence level flag to determine the presence of one or more sub-picture level CPB parameters either in the sub-picture timing SEI message or a picture timing SEI message associated with the DU associated with the sub-picture timing SEI message.

**8**. The video decoding device of claim **7**, the video decoder further configured to decode the sub-picture level CPB parameters, wherein the video decoder is configured to determine the CPB removal time of the DU associated with the sub-picture timing SEI message based at least in part on the determined duration and the sub-picture level CPB parameters.

**9**. The video decoding device of claim **8**, wherein the sequence level flag indicates the sub-picture level CPB parameters are to be present in the sub-picture timing SEI message, and wherein the video decoder is configured such that, as part of decoding the sub-picture level CPB param-

eters, the video decoder decodes the sub-picture timing SEI message associated with the DU associated with the sub-picture timing SEI message.

**10**. The video decoding device of claim **6**, wherein the video decoder is configured such that the video decoder determines the removal time of the DU associated with the sub-picture timing SEI message without decoding an initial CPB removal delay and offset.

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

decode a sub-picture timing supplemental enhancement information (SEI) message that provides Coded Picture Buffer (CPB) removal delay information for a decoding unit (DU) associated with the sub-picture timing SEI message, the DU associated with the sub-picture timing SEI message consisting, in decoding order, of an SEI network abstraction layer (NAL) unit containing the sub-picture timing SEI message followed by one or more NAL units that do not contain sub-picture timing SEI messages, including all subsequent NAL units in an access unit (AU) up to but not including any subsequent SEI NAL unit containing an additional sub-picture timing SEI message;

determine, from the sub-picture timing SEI message, a duration between a coded picture buffer (CPB) removal time of a last DU of the AU in decoding order and a CPB removal time of the DU associated with the sub-picture SEI message;

derive the CPB removal time of the DU associated with the sub-picture timing SEI message based at least in part on the at least in part on the determined duration; and

at the CPB removal time of the DU associated with the sub-picture timing SEI message, decode video data associated with the DU associated with the sub-picture timing SEI message.

**12**. The computer-readable storage medium of claim **11**, the instructions, when executed, further causing the processor to:

decode a sequence level flag to determine the presence of one or more sub-picture level CPB parameters either in the sub-picture timing SEI message or a picture timing SEI message associated with the DU associated with the sub-picture timing SEI message.

**13**. The computer-readable storage medium claim **12**, the instructions, when executed, further causing the processor to:

decode the sub-picture level CPB parameters, wherein the instructions, when executed, cause the processor to determine the CPB removal time of the DU associated with the sub-picture timing SEI message based at least in part on the sub-picture level CPB parameters.

**14**. The computer-readable storage medium of claim **11**, wherein the sequence level flag indicates the sub-picture level CPB parameters are to be present in the sub-picture timing SEI message, and wherein as part of causing the processor to decode the sub-picture level CPB parameters, the instructions, when executed, cause the processor to decode the sub-picture timing SEI message associated with the DU associated with the sub-picture timing SEI message.

**15**. A video decoding device, comprising:

means for decoding a sub-picture timing supplemental enhancement information (SEI) message that provides Coded Picture Buffer (CPB) removal delay information for a decoding unit (DU) associated with the sub-

picture timing SEI message, the DU associated with the sub-picture timing SEI message consisting, in decoding order, of an SEI network abstraction layer (NAL) unit containing the sub-picture timing SEI message followed by one or more NAL units that do not contain sub-picture timing SEI messages, including all subsequent NAL units in an access unit (AU) up to but not including any subsequent SEI NAL unit containing an additional sub-picture timing SEI message;

means for determining, from the sub-picture timing SEI message, a duration between a coded picture buffer (CPB) removal time of a last DU of the AU in decoding order and a CPB removal time of the DU associated with the sub-picture SEI message;

means for deriving the CPB removal time of the DU associated with the sub-picture timing SEI message based at least in part on the determined duration; and

means for decoding, at the CPB removal time of the DU associated with the sub-picture timing SEI message, video data associated with the DU associated with the sub-picture timing SEI message.

**16**. The video decoding device of claim **15**, further comprising:

means for decoding a sequence level flag to determine the presence of one or more sub-picture level CPB parameters either in the sub-picture timing SEI message or a picture timing SEI message associated with the DU associated with the sub-picture timing SEI message.

**17**. The video decoding device claim **16**, further comprising:

means for decoding the sub-picture level CPB parameters, wherein determining the CPB removal time of the DU

associated with the sub-picture timing SEI message is further based at least in part on the sub-picture level CPB parameters.

**18**. The video decoding device of claim **17**, wherein the sequence level flag indicates the sub-picture level CPB parameters are to be present in the sub-picture timing SEI message, and wherein means for decoding the sub-picture level CPB parameters comprises means for decoding the sub-picture timing SEI message associated with the DU associated with the sub-picture timing SEI message.

**19**. A method for encoding video data, the method comprising:

determining a coded picture buffer (CPB) removal time of a first decoding unit (DU) in an access unit (AU);

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

encoding the first DU, the encoding of the first DU comprising encoding the duration in a sub-picture timing supplemental enhancement information (SEI) message associated with the AU,

wherein the first DU is in the AU and consists, in decoding order, of an SEI network abstraction layer (NAL) unit containing the sub-picture timing SEI message in which the duration is encoded followed by one or more NAL units that do not contain a sub-picture timing SEI message, including all subsequent NAL units in the AU up to but not including any subsequent SEI NAL unit containing an additional sub-picture timing SEI message.

**20**. The method of claim **19**, further comprising encoding one or more sub-picture level CPB parameters.

**21**. The method of claim **20**, further comprising:

encoding a sequence level flag to indicate the presence of

the one or more sub-picture level CPB parameters in either the sub-picture timing SEI message or a picture timing SEI message associated with the first DU.

**22**. The method of claim **21**, wherein the sequence level flag indicates the sub-picture level CPB parameters are present in the sub-picture timing SEI message, and wherein encoding the one or more sub-picture level CPB parameters comprises encoding the sub-picture timing SEI message associated with the AU.

**23**. The method of claim **19**, wherein the second DU is a last DU in the AU in decoding order.

**24**. The method of claim **19**, wherein the second DU is immediately subsequent to the first DU in the AU in decoding order.

**25**. The method of claim **19**, wherein determining the duration comprises determining a removal time of the first DU without encoding an initial CPB removal delay and offset.

**26**. A video encoding device comprising:

a coded picture buffer (CPB); and

a video encoder configured to:

determine a CPB removal time of a first decoding unit (DU) in an access unit (AU);

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

encode the first DU, the encoding of the first DU comprising encoding the duration in a sub-picture timing supplemental enhancement information (SEI) message associated with the AU,

wherein the first DU is in the AU and consists, in decoding order, of an SEI network abstraction layer (NAL) unit containing the sub-picture timing SEI

message in which the duration is encoded followed by one or more NAL units that do not contain a sub-picture timing SEI message, including all subsequent NAL units in the AU up to but not including any subsequent SEI NAL unit containing an additional sub-picture timing SEI message.

**27**. The video encoding device of claim **26**, the video encoder further configured to encode one or more sub-picture level CPB parameters.

**28**. The video encoding device of claim **27**, the video encoder further configured to encode a sequence level flag to indicate the presence of the one or more sub-picture level CPB parameters in either the sub-picture timing SEI message or a picture timing SEI message associated with the first DU.

**29**. The video encoding device of claim **28**, wherein the sequence level flag indicates the sub-picture level CPB parameters are present in the sub-picture timing SEI message, and wherein the video encoder is configured to encode the sub-picture timing SEI message associated with the AU.

**30**. The video encoding device of claim **26**, wherein the second DU is a last DU in the AU in decoding order.

**31**. The video encoding device of claim **26**, wherein the second DU is immediately subsequent to the first DU in the AU in decoding order.

**32**. The video encoding device of claim **26**, wherein the video encoder is configured to determine a removal time of the first DU without encoding an initial CPB removal delay and offset.

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

determine a coded picture buffer (CPB) removal time of

a first decoding unit (DU) in an access unit (AU);

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

encode the first DU, the encoding of the first DU comprising encoding the duration in a sub-picture timing supplemental enhancement information (SEI) message associated with the AU,

wherein the first DU is in the AU and consists, in decoding order, of an SEI network abstraction layer (NAL) unit containing the sub-picture timing SEI message in which the duration is encoded followed by one or more NAL units that do not contain a sub-picture timing SEI message, including all subsequent NAL units in the AU up to but not including any subsequent SEI NAL unit containing an additional sub-picture timing SEI message.

**34**. The computer-readable storage medium of claim **33**, the instructions, when executed, further causing the processor to:

encode one or more sub-picture level CPB parameters.

**35**. The computer-readable storage medium of claim **34**, the instructions, when executed, further causing the processor to:

encode a sequence level flag to indicate the presence of the one or more sub-picture level CPB parameters in either the sub-picture timing SEI message or a picture timing SEI message associated with the first DU.

**36**. The computer-readable storage medium of claim **35**, wherein the sequence level flag indicates the sub-picture level CPB parameters are present in the sub-picture timing SEI message, and wherein as part of causing the processor to encode the one or more sub-picture level CPB parameters,

the instructions cause the processor to encode the sub-picture timing SEI message associated with the AU.

**37**. The method of claim **1**, further comprising decoding pictures of the AU and outputting the decoded pictures to a display.

**38**. The video decoding device of claim **6**, further comprising a display, wherein the video decoder is configured to decode pictures of the AU and display the decoded pictures on the display.

**39**. The video decoding device of claim **6**, wherein the video decoding device comprises at least one of:

an integrated circuit;

a microprocessor; or

a wireless communication device.

**40**. The method of claim **1**, further comprising using the decoded duration to calculate an earliest possible time of arrival of the video data associated with the first DU into the CPB for a Hypothetical Stream Scheduler (HSS).

**41**. The video decoding device of claim **6**, wherein the video decoder is further configured to use the decoded duration to calculate an earliest possible time of arrival of the video data associated with the first DU into the CPB for a Hypothetical Stream Scheduler (HSS).

**42**. The method of claim **1**, wherein a Hypothetical Reference Decoder (HRD) is assumed to decode the video data associated with the first DU instantaneously.

**43**. The video decoding device of claim **6**, wherein a Hypothetical Reference Decoder (HRD) is assumed to decode the video data associated with the first DU instantaneously.

**44**. The non-transitory computer-readable storage medium of claim **11**, wherein a Hypothetical Reference Decoder (HRD) is assumed to decode the video data associated with the first DU instantaneously.

**45**. The video decoding device of claim **15**, wherein a Hypothetical Reference Decoder (HRD) is assumed to decode the video data associated with the first DU instantaneously.

**46**. The method of claim **1**, wherein deriving the CPB removal time of the DU associated with the sub-picture timing SEI message comprises:

based on a syntax element being equal to 0, setting a CPB removal delay variable to the determined duration, the syntax element being equal to 1 specifying that sub-picture level CPB removal delay parameters are present in picture timing SEI messages and no sub-picture timing SEI messages are present, the syntax element being equal to **0** specifying that sub-picture level CPB removal delay parameters are present in sub-picture timing SEI messages and picture timing SEI messages do not include sub-picture level CPB removal delay parameters;

based on the syntax element being equal to **0**, setting a nominal removal time of the DU associated with the sub-picture timing SEI message as

$$t_{r,n}(m)=t_{r,n}(n)-t_{c_sub}*CpbRemovalDelay(m)$$

where $t_{t,n}$ is the nominal removal time of the DU associated with the sub-picture timing SEI, $t_{r,n}(n)$ is a nominal removal time of the access unit, $t_{c_sub}$ is a sub-picture clock tick, and CpbRemovalDelay(m) is the CPB removal delay variable; and

based on the nominal removal time of the DU associated with the sub-picture timing SEI message being greater than or equal to a final arrival time of the decoding unit associated with the sub-picture timing SEI message, setting the CPB removal time of the DU associated

with the sub-picture timing SEI message equal to the nominal removal time of the DU associated with the sub-picture timing SEI message.

**47**. The video decoding device of claim **6**, wherein the video decoder is configured such that, as part of deriving the CPB removal time of the DU associated with the sub-picture timing SEI message, the video decoder:

based on a syntax element being equal to 0, sets a CPB removal delay variable to the determined duration, the syntax element being equal to 1 specifying that sub-picture level CPB removal delay parameters are present in picture timing SEI messages and no sub-picture timing SEI messages are present, the syntax element being equal to **0** specifying that sub-picture level CPB removal delay parameters are present in sub-picture timing SEI messages and picture timing SEI messages do not include sub-picture level CPB removal delay parameters;

based on the syntax element being equal to 0, sets a nominal removal time of the DU associated with the sub-picture timing SEI message as

$$t_{r,n}(m)=t_{r,n}(n)-t_{c_sub}*CpbRemovalDelay(m)$$

where $t_{t,n}$ is the nominal removal time of the DU associated with the sub-picture timing SEI, $t_{r,n}(n)$ is a nominal removal time of the access unit, $t_{c_sub}$ is a sub-picture clock tick, and CpbRemovalDelay(m) is the CPB removal delay variable; and

based on the nominal removal time of the DU associated with the sub-picture timing SEI message being greater than or equal to a final arrival time of the decoding unit associated with the sub-picture timing SEI message, sets the CPB removal time of the DU associated with the sub-picture timing SEI message equal to the nomi-

nal removal time of the DU associated with the sub-picture timing SEI message.

**48**. The non-transitory computer-readable storage medium of claim **11**, wherein as part of causing the processor to derive the CPB removal time of the DU associated with the sub-picture timing SEI message, the instructions cause the processor to:

based on a syntax element being equal to 0, set a CPB removal delay variable to the determined duration, the syntax element being equal to 1 specifying that sub-picture level CPB removal delay parameters are present in picture timing SEI messages and no sub-picture timing SEI messages are present, the syntax element being equal to 0 specifying that sub-picture level CPB removal delay parameters are present in sub-picture timing SEI messages and picture timing SEI messages do not include sub-picture level CPB removal delay parameters;

based on the syntax element being equal to 0, set a nominal removal time of the DU associated with the sub-picture timing SEI message as

$$t_{r,n}(m)=t_{r,n}(n)-t_{c_sub}*CpbRemovalDelay(m)$$

where $t_{t,n}$ is the nominal removal time of the DU associated with the sub-picture timing SEI, $t_{r,n}(n)$ is a nominal removal time of the access unit, $t_{c_sub}$ is a sub-picture clock tick, and CpbRemovalDelay(m) is the CPB removal delay variable; and

based on the nominal removal time of the DU associated with the sub-picture timing SEI message being greater than or equal to a final arrival time of the decoding unit associated with the sub-picture timing SEI message, set the CPB removal time of the DU associated with the sub-picture timing SEI message equal to the nominal removal time of the DU associated with the sub-picture timing SEI message.

**49**. The video decoding device of claim **15**, wherein the means for deriving the CPB removal time of the DU associated with the sub-picture timing SEI message comprises:

means for setting, based on a syntax element being equal to 0, a CPB removal delay variable to the determined duration, the syntax element being equal to 1 specifying that sub-picture level CPB removal delay parameters are present in picture timing SEI messages and no sub-picture timing SEI messages are present, the syntax element being equal to 0 specifying that sub-picture level CPB removal delay parameters are present in sub-picture timing SEI messages and picture timing SEI messages do not include sub-picture level CPB removal delay parameters;

means for setting, based on the syntax element being equal to 0, a nominal removal time of the DU associated with the sub-picture timing SEI message as

$$t_{r,n}(m)=t_{r,n}(n)-t_{c_sub}*CpbRemovalDelay(m)$$

where $t_{t,n}$ is the nominal removal time of the DU associated with the sub-picture timing SEI, $t_{r,n}(n)$ is a nominal removal time of the access unit, $t_{c_sub}$ is a sub-picture clock tick, and CpbRemovalDelay(m) is the CPB removal delay variable;

means for setting, based on the nominal removal time of the DU associated with the sub-picture timing SEI message being greater than or equal to a final arrival time of the decoding unit associated with the sub-picture timing SEI message, the CPB removal time of the DU associated with the sub-picture timing SEI message equal to the nominal removal time of the DU associated with the sub-picture timing SEI message.