CLAIMS

What is claimed is:

1. A method of decoding implemented by a video decoder, comprising:

receiving, by the video decoder, a coded video bitstream including a current picture;

deriving, by the video decoder, a first reference picture list and a second reference picture list for each slice of the current picture;

determining, by the video decoder, that the current picture is a clean random access (CRA) picture, the CRA picture signifying that there shall be no picture referred to by an entry in the first reference picture list or the second reference picture list that precedes, in an output order or a decoding order, any preceding intra random access point (IRAP) picture in the decoding order; and

decoding, by the video decoder, each slice of the CRA picture based on one or both of the first reference picture list and the second reference picture list.

2. The method of claim 1, wherein the preceding IRAP picture precedes the CRA picture in the output order or the decoding order.

3. The method of any of claims 1-2, wherein the preceding IRAP picture starts a coded video sequence (CVS) that contains the CRA picture.

4. The method of any of claims 1-3, wherein the CRA picture is decoded using intra prediction.

5. The method of any of claims 1-4, wherein one or more pictures following the CRA picture in the decoding order are decoded using inter prediction.

6. The method of any of claims 1-5, wherein the first reference picture list is designated RefPicList[0] and the second reference picture list is designated RefPicList[1].

~~7. The method of any of claims 1-6, further comprising displaying, on a display of the video decoder, an image generated based on the CRA picture.~~

7~~8~~. A method of encoding implemented by a video encoder, the method comprising:

deriving, by the video encoder, a first reference picture list and a second reference picture list when a current picture is a clean random access (CRA) picture, wherein there shall be no picture referred to by an entry in the first reference picture list or the second reference picture list that precedes, in an output order or a decoding order, any preceding intra random access point (IRAP) picture in the decoding order;

encoding, by the video encoder, the CRA picture and one or both of the first reference picture list and the second reference picture list into a video bitstream; and

storing, by the video encoder, the video bitstream pending transmission toward a video decoder.

9~~8~~. The method of claim ~~8~~7, wherein the preceding IRAP picture precedes the CRA picture in the output order or the decoding order.

10~~9~~. The method of any of claims ~~8-9~~7-8, wherein the preceding IRAP picture starts a coded video sequence (CVS) that contains the CRA picture.

11~~10~~. The method of any of claims ~~8-10~~7-9, wherein the CRA picture is encoded using intra prediction.

12~~11~~. The method of any of claims ~~8-11~~7-10, further comprising encoding one or more pictures following the CRA picture in the decoding order using inter prediction.

~~13. The method of any of claims 8-12, wherein the first reference picture list is designated RefPicList[0] and the second reference picture list is designated RefPicList[1].~~

~~14. The method of any of claims 8-13, further comprising transmitting the video bitstream toward the video decoder.~~

15~~12~~. A decoding device, comprising:

a receiver configured to receive a coded video bitstream including a current picture;

a memory coupled to the receiver, the memory storing instructions; and

a processor coupled to the memory, the processor configured to execute the instructions to cause the decoding device to:

derive a first reference picture list and a second reference picture list for each slice of the current picture;

determine that the current picture is a clean random access (CRA) picture, the CRA picture signifying that there shall be no picture referred to by an entry in the first reference picture list or the second reference picture list that precedes, in an output order or a decoding order, any preceding intra random access point (IRAP) picture in the decoding order; and

decode each slice of the CRA picture based on one or both of the first reference picture list and the second reference picture list.

~~16~~13. The decoding device of claim ~~15~~12, wherein the preceding IRAP picture precedes the CRA picture in the output order or the decoding order.

~~17~~14. The decoding device of any of claims ~~15-16~~12-13, wherein the preceding IRAP picture starts a coded video sequence (CVS) that contains the CRA picture, the CRA picture is decoded using intra prediction, and one or more pictures following the CRA picture in the decoding order are decoded using inter prediction.

~~18. The decoding device of any of claims 15-17, further comprising a display configured to display an image based on the CRA picture as decoded.~~

~~19~~15. An encoding device, comprising:

a memory containing instructions;

a processor coupled to the memory, the processor configured to implement the instructions to cause the encoding device to:

derive a first reference picture list and a second reference picture list when a current picture comprises a clean random access (CRA) picture, wherein there shall be no picture referred to by an entry in the first reference picture list or the second reference picture list that precedes, in an output order or a decoding order, any preceding intra random access point (IRAP) picture in the decoding order;

encode the CRA picture and one or both of the first reference picture list and the second reference picture list into a video bitstream; and

a transmitter coupled to the processor, the transmitter configured to transmit the video bitstream toward a video decoder.

~~20~~16. The encoding device of claim ~~19~~15, wherein the preceding IRAP picture precedes the CRA picture in the output order or the decoding order.

~~21~~17. The encoding device of any of claims ~~19-20~~15-16, wherein the preceding IRAP picture precedes the CRA picture in the output order or the decoding order, the CRA picture is encoded using intra prediction, and one or more pictures following the CRA picture in the decoding order are encoded using inter prediction.

~~22. The encoding device of any of claims 19-21, wherein the memory stores the video bitstream prior to the transmitter transmitting the bitstream toward the video decoder.~~

~~23~~18. A method of decoding implemented by a video decoder, comprising:

receiving, by the video decoder, a coded video bitstream including a current picture;

deriving, by the video decoder, a first reference picture list and a second reference picture list for each slice of the current picture;

determining, by the video decoder, that the current picture is a trailing picture ~~that follows, in both decoding order and output order, one or more leading pictures associated with a same intra random access point (IRAP) picture~~, the trailing picture signifying that there shall be no picture referred to by an entry in the first reference picture list or the second reference picture list that was generated by a decoding process for generating unavailable reference pictures for a same intra random access point (IRAP)~~the IRAP~~ picture associated with the current picture; and

decoding, by the video decoder, each slice of the trailing picture based on one or both of the first reference picture list and the second reference picture list.

~~24~~19. The method of claim ~~23~~18, wherein the decoding process for generating unavailable reference pictures is invoked once per coded picture for a clean random access (CRA) picture with a NoOutPutBeforeRecoveryFlag equal to one or a gradual decoding refresh (GDR) picture with the NoOutPutBeforeRecoveryFlag equal to one.

~~25~~20. The method of any of claims ~~23-24~~18-19, wherein the same IRAP picture starts a coded video sequence (CVS) that contains the trailing picture and the one or more leading pictures.

~~26~~21. The method of any of claims ~~23-25~~18-20, wherein the same IRAP picture is decoded using intra prediction, and wherein the trailing picture and the one or more leading pictures are decoded using inter prediction.

~~27~~22. A method of encoding implemented by a video encoder, the method comprising:

deriving, by the video encoder, a first reference picture list and a second reference picture list when a current picture is a trailing picture ~~that follows, in both decoding order and output order, one or more leading pictures associated with a same intra random access point (IRAP) picture~~, wherein there shall be no picture referred to by an entry in the first reference picture list or the second reference picture list that was generated by a decoding process for generating unavailable reference pictures for a same intra random access point (IRAP)~~the IRAP~~ picture associated with the current picture;

encoding, by the video encoder, the trailing picture and one or both of the first reference picture list and the second reference picture list into the video bitstream; and

storing, by the video encoder, the video bitstream pending transmission toward a video decoder.

~~28~~23. The method of claim ~~27~~22, wherein the decoding process for generating unavailable reference pictures is invoked once per coded picture for a clean random access (CRA) picture with a NoOutPutBeforeRecoveryFlag equal to one or a gradual decoding refresh (GDR) picture with the NoOutPutBeforeRecoveryFlag equal to one.

~~29~~24. The method of any of claims ~~27-28~~22-23, wherein the same IRAP picture starts a coded video sequence (CVS) that contains the trailing picture and the one or more leading pictures.

~~30~~25. The method of any of claims ~~27-29~~22-24, wherein the same IRAP picture is encoded into the video bitstream using intra prediction, and wherein the trailing picture and the one or more leading pictures are encoded using inter prediction.

~~31. The method of any of claims 27-30, further comprising transmitting the video bitstream toward the video decoder.~~

~~32~~26. A decoding device, comprising:

a receiver configured to receive a coded video bitstream including a current picture;

a memory coupled to the receiver, the memory storing instructions; and

a processor coupled to the memory, the processor configured to execute the instructions to cause the decoding device to:

derive a first reference picture list and a second reference picture list for each slice of the current picture;

determine that the current picture is a trailing picture ~~that follows, in both decoding order and output order, one or more leading pictures associated with a same intra random access point (IRAP) picture~~, the trailing picture signifying that there shall be no picture referred to by an entry in the first reference picture list or the second reference picture list that was generated by a decoding process for generating unavailable reference pictures for a same intra random access point (IRAP)~~the IRAP~~ picture associated with the current picture; and

decode each slice of the trailing picture based on one or both of the first reference picture list and the second reference picture list.

~~33~~27. The decoding device of claim ~~32~~26, wherein the decoding process for generating unavailable reference pictures is invoked once per coded picture for a clean random access (CRA) picture with a NoOutPutBeforeRecoveryFlag equal to one or a gradual decoding refresh (GDR) picture with the NoOutPutBeforeRecoveryFlag equal to one.

~~34~~28. The decoding device of any of claims ~~32-33~~26-27, wherein the same IRAP picture starts a coded video sequence (CVS) that contains the trailing picture and the one or more leading pictures.

~~35~~29. The decoding device of any of claims ~~32-34~~26-28, wherein the same IRAP picture is decoded using intra prediction, and wherein the trailing picture and the one or more leading pictures are decoded using inter prediction.

~~36~~30. An encoding device, comprising:

a memory containing instructions;

a processor coupled to the memory, the processor configured to implement the instructions to cause the encoding device to:

derive a first reference picture list and a second reference picture list when a current picture is a trailing picture ~~that follows, in both decoding order and output order, one or more leading pictures associated with a same intra random access point (IRAP) picture~~, wherein there shall be no picture referred to by an entry in the first reference picture list or the second reference picture list that was generated by a decoding process for generating unavailable reference pictures for a same intra random access point (IRAP)~~the IRAP~~ picture associated with the current picture;

encode the trailing picture and one or both of the first reference picture list and the second reference picture list into a video bitstream; and

a transmitter coupled to the processor, the transmitter configured to transmit the video bitstream toward a video decoder.

~~37~~31. The encoding device of claim ~~36~~30, wherein the decoding process for generating unavailable reference pictures is invoked once per coded picture for a clean random access (CRA) picture with a NoOutPutBeforeRecoveryFlag equal to one or a gradual decoding refresh (GDR) picture with the NoOutPutBeforeRecoveryFlag equal to one.

~~38~~32. The encoding device of any of claims ~~36-37~~30-31, wherein the same IRAP picture starts a coded video sequence (CVS) that contains the trailing picture and the one or more leading pictures.

~~39~~33. The encoding device of any of claims ~~36-38~~30-32, wherein the same IRAP picture is encoded into the video bitstream using intra prediction, and wherein the trailing picture and the one or more leading pictures are encoded using inter prediction.

~~40. The encoding device of any of claims 36-39, wherein the memory stores the video bitstream prior to the transmitter transmitting the bitstream toward the video decoder.~~

~~41~~34. A method of decoding implemented by a video decoder, comprising:

receiving, by the video decoder, a coded video bitstream including a current picture;

deriving, by the video decoder, a first reference picture list and a second reference picture list for each slice of the current picture;

determining, by the video decoder, that the current picture is a trailing picture ~~that follows, in both decoding order and output order, one or more leading pictures associated with a same intra random access point (IRAP) picture~~, the trailing picture signifying that there shall be no picture referred to by an entry in the first reference picture list or the second reference picture list that precedes a same intra random access point (IRAP)~~the same IRAP~~ picture in the output order or the decoding order; and

decoding, by the video decoder, each slice of the trailing picture based on one or both of the first reference picture list and the second reference picture list.

~~42~~35. The method of claim ~~41~~34, wherein the same IRAP picture starts a coded video sequence (CVS) that contains the trailing picture and the one or more leading pictures.

~~43~~36. The method of any of claims ~~41-42~~34-35, wherein the same IRAP picture is decoded using intra prediction, and wherein the trailing picture and the one or more leading pictures are decoded using inter prediction.

~~44~~37. A method of encoding implemented by a video encoder, the method comprising:

deriving, by the video encoder, a first reference picture list and a second reference picture list when a current picture is a trailing picture ~~that follows, in both decoding order and output order, one or more leading pictures associated with a same intra random access point (IRAP) picture~~, wherein there shall be no picture referred to by an entry in the first reference picture list or the second reference picture list that precedes a same intra random access point (IRAP)~~the same IRAP~~ picture in the output order or the decoding order;

encoding, by the video encoder, the trailing picture and one or both of the first reference picture list and the second reference picture list into the video bitstream; and

storing, by the video encoder, the video bitstream pending transmission toward a video decoder.

~~45~~38. The method of claim ~~44~~37, wherein the same IRAP picture starts a coded video sequence (CVS) that contains the trailing picture and the one or more leading pictures.

~~46~~39. The method of any of claims ~~44-45~~37-38, wherein the same IRAP picture is encoded into the video bitstream using intra prediction, and wherein the trailing picture and the one or more leading pictures are encoded using inter prediction.

~~47. The method of any of claims 44-46, further comprising transmitting the video bitstream toward the video decoder.~~

~~48~~40. A decoding device, comprising:

a receiver configured to receive a coded video bitstream including a current picture;

a memory coupled to the receiver, the memory storing instructions; and

a processor coupled to the memory, the processor configured to execute the instructions to cause the decoding device to:

derive a first reference picture list and a second reference picture list for each slice of the current picture;

determine that the current picture is a trailing picture ~~that follows, in both decoding order and output order, one or more leading pictures associated with a same intra random access point (IRAP) picture~~, the trailing picture signifying that there shall be no picture referred to by an entry in the first reference picture list or the second reference picture list that precedes a same intra random access point (IRAP)~~the same IRAP~~ picture in the output order or the decoding order; and

decode each slice of the trailing picture based on one or both of the first reference picture list and the second reference picture list.

~~49~~41. The decoding device of claim ~~48~~40, wherein the same IRAP picture starts a coded video sequence (CVS) that contains the trailing picture and the one or more leading pictures.

~~50~~42. The decoding device of any of claims ~~48-49~~40-41, wherein the same IRAP picture is decoded using intra prediction, and wherein the trailing picture and the one or more leading pictures are decoded using inter prediction.

~~51~~43. An encoding device, comprising:

a memory containing instructions;

a processor coupled to the memory, the processor configured to implement the instructions to cause the encoding device to:

derive a first reference picture list and a second reference picture list when a current picture is a trailing picture ~~that follows, in both decoding order and output order, one or more leading pictures associated with a same intra random access point (IRAP)~~

~~picture~~, wherein there shall be no picture referred to by an entry in the first reference picture list or the second reference picture list that precedes a same intra random access point (IRAP)~~the same IRAP~~ picture in the output order or the decoding order; and

encode the trailing picture and one or both of the first reference picture list and the second reference picture list into a video bitstream; and

a transmitter coupled to the processor, the transmitter configured to transmit the video bitstream toward a video decoder.

~~52~~44. The encoding device of claim ~~51~~43, wherein the same IRAP picture starts a coded video sequence (CVS) that contains the trailing picture and the one or more leading pictures.

~~53~~45. The encoding device of any of claims ~~51-52~~43-44, wherein the same IRAP picture is encoded into the video bitstream using intra prediction, and wherein the trailing picture and the one or more leading pictures are encoded using inter prediction.

~~54. The encoding device of any of claims 51-53, wherein the memory stores the video bitstream prior to the transmitter transmitting the bitstream toward the video decoder.~~

~~55~~46. A method of decoding implemented by a video decoder, comprising:

receiving, by the video decoder, a coded video bitstream including a current picture;

deriving, by the video decoder, a first reference picture list and a second reference picture list for each slice of the current picture;

determining, by the video decoder, that the current picture is a random access decodable leading (RADL) picture, the RADL picture signifying that there shall be no active entry in the first reference picture list or the second reference picture list that is any of the following:

a random access skipped leading (RASL) picture;

a picture generated by a decoding process for generating unavailable reference pictures; and

a picture that precedes an associated intra random access point (IRAP) picture in decoding order; and

decoding, by the video decoder, each slice of the RADL picture based on one or both of the first reference picture list and the second reference picture list.

~~56~~47. The method of claim ~~55~~46, wherein the decoding process for generating unavailable reference pictures is invoked once per coded picture for a clean random access (CRA) picture with a NoOutPutBeforeRecoveryFlag equal to one or a gradual decoding refresh (GDR) picture with the NoOutPutBeforeRecoveryFlag equal to one.

~~57~~48. A method of encoding implemented by a video encoder, the method comprising:

deriving, by the video encoder, a first reference picture list and a second reference picture list when a current picture is a random access decodable leading (RADL) picture, wherein there shall be no active entry in the first reference picture list or the second reference picture list that is any of the following:

a random access skipped leading (RASL) picture;

a picture generated by a decoding process for generating unavailable reference pictures; and

a picture that precedes an associated intra random access point (IRAP) picture in decoding order; and

encoding, by the video encoder, the RADL picture and one or both of the first reference picture list and the second reference picture list into a video bitstream; and

storing, by the video encoder, the video bitstream pending transmission toward a video decoder.

~~58~~49. The method of claim ~~57~~48, wherein the decoding process for generating unavailable reference pictures is invoked once per coded picture for a clean random access (CRA) picture with a NoOutPutBeforeRecoveryFlag equal to one or a gradual decoding refresh (GDR) picture with the NoOutPutBeforeRecoveryFlag equal to one.

~~59~~50. A decoding device, comprising:

a receiver configured to receive a coded video bitstream including a current picture;

a memory coupled to the receiver, the memory storing instructions; and

a processor coupled to the memory, the processor configured to execute the instructions to cause the decoding device to:

derive a first reference picture list and a second reference picture list for each slice of the current picture;

determine that the current picture is a random access decodable leading (RADL) picture, the RADL picture signifying that there shall be no active entry in the

first reference picture list or the second reference picture list that is any of the following:

a random access skipped leading (RASL) picture;

a picture generated by a decoding process for generating unavailable reference pictures; and

a picture that precedes an associated intra random access point (IRAP) picture in decoding order; and

decode each slice of the RADL picture based on one or both of the first reference picture list and the second reference picture list.

~~60~~51. The decoding device of claim ~~59~~50, wherein the decoding process for generating unavailable reference pictures is invoked once per coded picture for a clean random access (CRA) picture with a NoOutPutBeforeRecoveryFlag equal to one or a gradual decoding refresh (GDR) picture with the NoOutPutBeforeRecoveryFlag equal to one.

~~61~~52. An encoding device, comprising:

a memory containing instructions;

a processor coupled to the memory, the processor configured to implement the instructions to cause the encoding device to:

derive a first reference picture list and a second reference picture list when a current picture is a random access decodable leading (RADL) picture, wherein there shall be no active entry in the first reference picture list or the second reference picture list that is any of the following:

a random access skipped leading (RASL) picture;

a picture generated by a decoding process for generating unavailable reference pictures; and

a picture that precedes an associated intra random access point (IRAP) picture in decoding order; and

encode the RADL picture and one or both of the first reference picture list and the second reference picture list into a video bitstream; and

a transmitter coupled to the processor, the transmitter configured to transmit the video bitstream toward a video decoder.

~~62~~53. The encoding device of claim ~~61~~52, wherein the decoding process for generating unavailable reference pictures is invoked once per coded picture for a clean random access (CRA) picture with a NoOutPutBeforeRecoveryFlag equal to one or a gradual decoding refresh (GDR) picture with the NoOutPutBeforeRecoveryFlag equal to one.

~~63. A coding apparatus, comprising:~~

~~a receiver configured to receive a picture to encode or to receive a bitstream to decode;~~

~~a transmitter coupled to the receiver, the transmitter configured to transmit the bitstream to a decoder or to transmit a decoded image to a display;~~

~~a memory coupled to at least one of the receiver or the transmitter, the memory configured to store instructions; and~~

~~a processor coupled to the memory, the processor configured to execute the instructions stored in the memory to perform the method in any of claims 1-7, 23-26, 41-43, and 55-56 and any of claims 8-14, 27-31, 44-47, and 57-58.~~

~~64. The coding apparatus of claim 63, further comprising a display configured to display an image.~~

~~65~~54. A system, comprising:

an encoder; and

a decoder in communication with the encoder, wherein the encoder or the decoder includes the decoding device, or the encoding device~~, or the coding apparatus~~ of any of claims ~~15-22~~12-17, ~~32-39~~26-33, ~~48-54~~40-45, and ~~59-64~~50-53.

~~66~~55. A means for coding, comprising:

receiving means configured to receive a picture to encode or to receive a bitstream to decode;

transmission means coupled to the receiving means, the transmission means configured to transmit the bitstream to a decoding means or to transmit a decoded image to a display means;

storage means coupled to at least one of the receiving means or the transmission means, the storage means configured to store instructions; and

processing means coupled to the storage means, the processing means configured to execute the instructions stored in the storage means to perform the method in any of claims 1-

~~7~~6, ~~23-26~~18-21, ~~41-43~~34-36, and ~~55-56~~46-47 and any of claims ~~8-14~~7-11, ~~27-31~~22-25, ~~44-47~~37-39, and ~~57-58~~48-49.

56. A storage medium storing a bitstream which is obtained by using a decoding/encoding method that using the method of any of claims 1-6, 18-21, 34-36, and 46-47 and any of claims 7-11, 22-25, 37-39, and 48-49.

57. A computer-readable storage medium, wherein the computer-readable storage medium stores a computer program that can be executed by a processor, and when the computer program is executed by the processor, the processor performs the method according to any of claims 1-6, 18-21, 34-36, and 46-47 and any of claims 7-11, 22-25, 37-39, and 48-49.

58. A computer program product comprising instructions which, when the program is executed by a computer, cause the computer to carry out the method according to any of claims 1-6, 18-21, 34-36, and 46-47 and any of claims 7-11, 22-25, 37-39, and 48-49.