

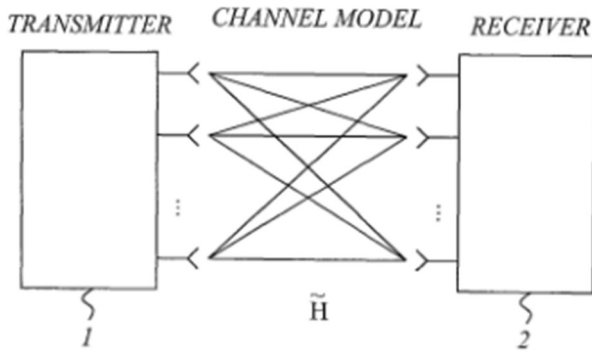
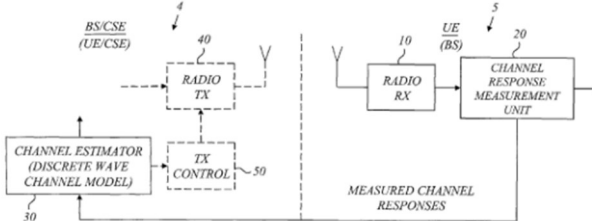
DEFENDANTS' INVALIDITY CONTENTIONS FOR U.S. PAT. 8,891,347

EXHIBIT A2: US20140010274A1 ("Medbo")

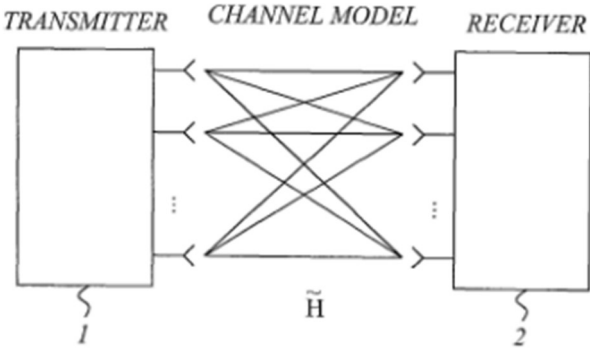
As demonstrated in the claim charts below, the claims of U.S. Patent No. 8,891,347 ("the '347 patent") are invalid (a) under one or more sections of 35 U.S.C. § 102 as anticipated by Medbo and (b) under 35 U.S.C. § 103(a) as obvious over Medbo standing alone and as set forth herein, and/or combined with the knowledge of a person of ordinary skill in the art, Applicant's Admitted Prior Art, and/or the additional prior art references identified in Defendant's Preliminary Invalidity Contentions, the contents of which are hereby incorporated by reference into this chart. One of ordinary skill in the art, as of the priority date of the '347 patent, would have known to combine the prior art elements disclosed by the foregoing references using known methods, and to use these elements according to their established functions in order to achieve a known and predictable result.

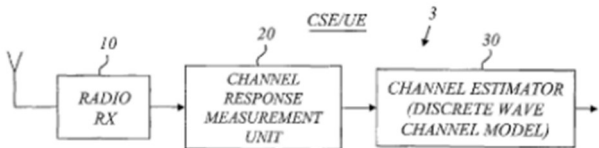
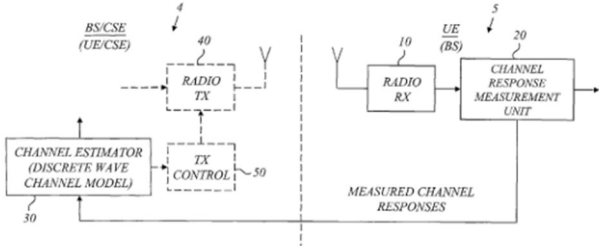
Defendant has conducted the invalidity analysis herein based at least in part and in some instance entirely upon Plaintiff's apparent application of the claims of the '347 patent. By charting the prior art against the claims and elements herein, Defendant is not admitting or agreeing to Plaintiff's application of the claims at issue in this case, and these charts should not be interpreted as an admission or concession by Defendant that any particular construction or application of any claim element by Plaintiff is correct or proper. Additionally, these charts provide representative examples of portions of the charted references that disclose the indicated elements of the claims; additional portions of these references other than the representative examples provided herein may also disclose the indicated element(s). For example, where a particular figure is cited, the citation should be understood to encompass the caption and description of the figure as well as any text relating to or describing the figure. Conversely, where particular text referring to a figure is cited, the citation should be understood to include the figure as well.

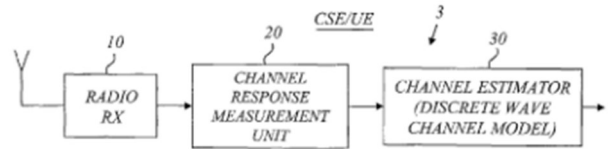
Claim Element	Exemplary Citations to Medbo
19[pre] A wireless device for performing wireless communication with a base station with a transmitter via a plurality of propagation paths, the wireless device comprising:	By providing this disclosure, Defendant does not take a position on whether the preamble is a claim limitation. Medbo discloses or renders obvious "[a] wireless device for performing wireless communication with a base station with a transmitter via a plurality of propagation paths." For example: Medbo at Abstract The present technology relates to a channel estimator configured to operate based on a discrete wave channel model and measured channel responses between a transmitter having at least one transmit antenna and a receiver having at least one receive antenna. The channel estimator comprises a windowed likelihood determiner and a maximization processor. The windowed likelihood determiner is configured to determine a windowed likelihood function based on the measured channel responses, a selected window function, and modeled channel responses defined based on a number of discrete waves according to the discrete wave channel model. The maximization processor is configured to perform maximization of the windowed likelihood function, using initial input in the form of at least one of predetermined wave propagation delay(s) and predetermined wave propagation direction(s) for at least one of the discrete waves, to extract the wave parameters of the discrete waves.

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	Medbo at Figure 1  <i>Fig. 1</i> Medbo at Figure 2B  <i>Fig. 2B</i> Medbo at [0037]–[0038] FIG. 1A schematically illustrates an example of a radio channel, where a transmitter 1 has one or more transmit antennas and a receiver 2 has one or more receive antennas. In matrix form, the channel can be expressed as: [Equation] where y is the received signal vector, H is a complex channel matrix, x is the transmitted signal vector, σ is a vector representation of noise. The elements of the complex channel matrix H can be written as H_{mn}, which represents the “channel” between transmit antenna m and receive antenna n. The number N_{tx} of transmit antennas can vary from 1 and up, and the number N_{rx} of receive antennas can also vary from 1 and up. Expressed mathematically: $N_{tx} \geq 1$, and $N_{rx} \geq 1$. The following

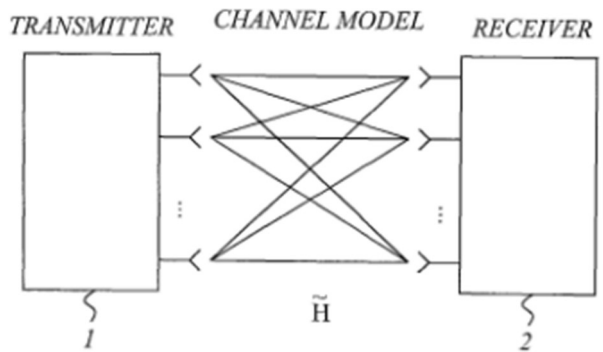
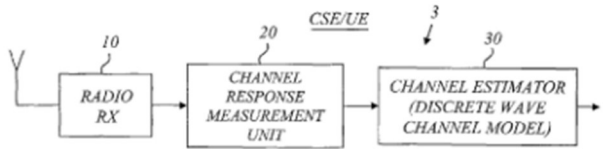
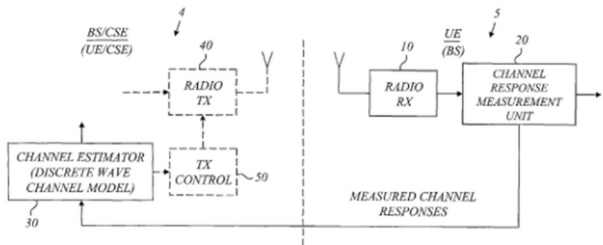
Claim Element	Exemplary Citations to Medbo
	methodology is thus valid for Single-Input Single-Output (SISO), Single-Input Multiple-Output (SIMO), Multiple-Input Single-Output (MISO) and Multiple-Input Multiple-Output (MIMO) antenna cases. Medbo at [0042] FIG. 2B is a schematic diagram illustrating an example of a unit having a channel estimator operating based on a discrete wave channel model, using measured channel responses obtained from one or more other units. For example, the unit 4 may be a base station (BS) or a channel sounding equipment (CSE), and the unit 5 may be a user equipment. Alternatively, the unit 4 may be a user equipment, and the unit 5 may be a base station, or both units 4 and 5 may be channel sounding equipment. The unit 4 basically comprises a channel estimator 30 operating based on a discrete wave channel model. The channel estimator 30 also operates based on measured channel responses obtained from one or more other units such as unit 5. The unit 5 comprises at least a radio receiver (RX) 10 and a channel response measurement unit 20, and can transfer the measured channel responses to the unit 4, e.g. via a radio control interface. The unit 4 can then receive the measured channel responses, e.g. via the radio control interface. Medbo at [0048] FIG. 3 is a schematic flow diagram illustrating an example of a method of channel estimation according to an embodiment. The method is based on a discrete wave channel model and measured channel responses between a transmitter having at least one transmit antenna and a receiver having at least one receive antenna. Step S1 includes determining a windowed likelihood function based on the measured channel responses, a selected window function, and modeled channel responses defined based on a number of discrete waves according to the discrete wave channel model. Each one of the discrete waves is associated with wave parameters to be determined including at least one of wave propagation direction(s) and wave propagation delay. Step S2 includes performing maximization of the windowed likelihood function, using initial input in the form of at least one of predetermined wave propagation delay(s) and predetermined wave propagation direction(s) for at least one of the discrete waves, to determine the wave parameters of the discrete waves. Medbo at [0049] The use of a windowed likelihood function enables a more efficient and accurate estimation of the wave parameters. The window function is preferably designed such that waves being separated by a certain distance in at least one of wave propagation delay and wave propagation direction are substantially decoupled. Decoupled waves implies that the waves have no or low correlation and/or no or low power overlap. The windowing thus makes it possible to find independent or decoupled groups of waves, which is beneficial with respect to both accuracy and computational efficiency.

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	To the extent this element is not disclosed by Medbo, it would have been obvious to one of ordinary skill in the art to combine, with the teachings of Medbo, those elements, as known to them or as disclosed by other prior art identified in the cover pleading.
[19.a] a receiver;	Medbo discloses or renders obvious “a receiver.” For example: Medbo at Abstract The present technology relates to a channel estimator configured to operate based on a discrete wave channel model and measured channel responses between a transmitter having at least one transmit antenna and a receiver having at least one receive antenna. The channel estimator comprises a windowed likelihood determiner and a maximization processor. The windowed likelihood determiner is configured to determine a windowed likelihood function based on the measured channel responses, a selected window function, and modeled channel responses defined based on a number of discrete waves according to the discrete wave channel model. The maximization processor is configured to perform maximization of the windowed likelihood function, using initial input in the form of at least one of predetermined wave propagation delay(s) and predetermined wave propagation direction(s) for at least one of the discrete waves, to extract the wave parameters of the discrete waves. Medbo at Figure 1  <i>Fig. 1</i>

Claim Element	Exemplary Citations to Medbo
	Medbo at Figure 2A  Fig. 2A Medbo at Figure 2B  Fig. 2B Medbo at [0037]–[0038] FIG. 1A schematically illustrates an example of a radio channel, where a transmitter 1 has one or more transmit antennas and a receiver 2 has one or more receive antennas. In matrix form, the channel can be expressed as: [Equation] where y is the received signal vector, H is a complex channel matrix, x is the transmitted signal vector, σ is a vector representation of noise. The elements of the complex channel matrix H can be written as H_{mn}, which represents the “channel” between transmit antenna m and receive antenna n. The number N_{tx} of transmit antennas can vary from 1 and up, and the number N_{rx} of receive antennas can also vary from 1 and up. Expressed mathematically: $N_{tx} \geq 1$, and $N_{rx} \geq 1$. The following methodology is thus valid for Single-Input Single-Output (SISO), Single-Input Multiple-Output (SIMO), Multiple-Input Single-Output (MISO) and Multiple-Input Multiple-Output (MIMO) antenna cases. Medbo at [0041] FIG. 2A is a schematic diagram illustrating an example of a unit having a channel estimator operating based on a discrete wave channel model, using measured channel responses obtained by the unit itself. In this particular example, the unit 3 comprises, among other standard radio components, a standard radio receiver (RX) 10, a channel response measurement unit 20, and a channel estimator 30 operating based on a discrete wave channel model. The channel response measurement unit 20 is sometimes also referred to

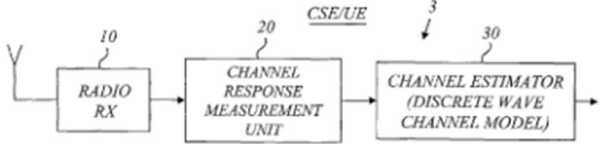
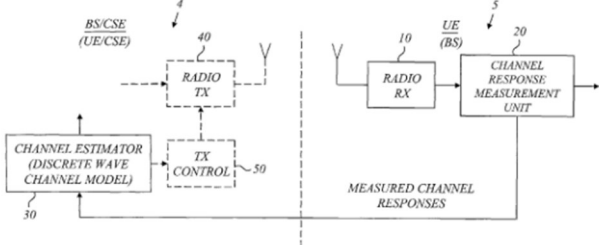
Claim Element	Exemplary Citations to Medbo
	as a channel estimator, but, compared to the channel estimator 30, the channel response measurement unit 20 normally only operates to more or less directly provide measured channel responses based on known reference symbols. The measured channel responses can for example be represented in frequency, time/delay, code and/or space. The channel estimator 30, however, operates based on a discrete wave channel model and makes use of the measured channel responses from the channel response measurement unit 20 to determine wave parameters associated with a number of discrete waves. The unit 3 may for example be a channel sounding equipment (CSE) or a user equipment (UE). Medbo at [0042] FIG. 2B is a schematic diagram illustrating an example of a unit having a channel estimator operating based on a discrete wave channel model, using measured channel responses obtained from one or more other units. For example, the unit 4 may be a base station (BS) or a channel sounding equipment (CSE), and the unit 5 may be a user equipment. Alternatively, the unit 4 may be a user equipment, and the unit 5 may be a base station, or both units 4 and 5 may be channel sounding equipment. The unit 4 basically comprises a channel estimator 30 operating based on a discrete wave channel model. The channel estimator 30 also operates based on measured channel responses obtained from one or more other units such as unit 5. The unit 5 comprises at least a radio receiver (RX) 10 and a channel response measurement unit 20, and can transfer the measured channel responses to the unit 4, e.g. via a radio control interface. The unit 4 can then receive the measured channel responses, e.g. via the radio control interface. To the extent this element is not disclosed by Medbo, it would have been obvious to one of ordinary skill in the art to combine, with the teachings of Medbo, those elements, as known to them or as disclosed by other prior art identified in the cover pleading.
[19b] a computing device; and	Medbo discloses or renders obvious “a computing device.” For example: Medbo at Figure 2A  Fig. 2A Medbo at [0041] FIG. 2A is a schematic diagram illustrating an example of a unit having a channel estimator operating

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	based on a discrete wave channel model, using measured channel responses obtained by the unit itself. In this particular example, the unit 3 comprises, among other standard radio components, a standard radio receiver (RX) 10, a channel response measurement unit 20, and a channel estimator 30 operating based on a discrete wave channel model. The channel response measurement unit 20 is sometimes also referred to as a channel estimator, but, compared to the channel estimator 30, the channel response measurement unit 20 normally only operates to more or less directly provide measured channel responses based on known reference symbols. The measured channel responses can for example be represented in frequency, time/delay, code and/or space. The channel estimator 30, however, operates based on a discrete wave channel model and makes use of the measured channel responses from the channel response measurement unit 20 to determine wave parameters associated with a number of discrete waves. The unit 3 may for example be a channel sounding equipment (CSE) or a user equipment (UE). To the extent this element is not disclosed by Medbo, it would have been obvious to one of ordinary skill in the art to combine, with the teachings of Medbo, those elements, as known to them or as disclosed by other prior art identified in the cover pleading.
[19c] a computer-readable storage medium having computer-executable instructions stored thereon that are executable by the computing device to perform operations comprising:	Medbo discloses or renders obvious “a computer-readable storage medium having computer-executable instructions stored thereon that are executable by the computing device to perform operations.” For example: To the extent this element is not disclosed by Medbo, it would have been obvious to one of ordinary skill in the art to combine, with the teachings of Medbo, those elements, as known to them or as disclosed by other prior art identified in the cover pleading.
[19d] receiving a first signal at the receiver via a first propagation path of the plurality of propagation paths;	Medbo discloses or renders obvious “receiving a first signal at the receiver via a first propagation path of the plurality of propagation paths.” For example: Medbo at Abstract The present technology relates to a channel estimator configured to operate based on a discrete wave channel model and measured channel responses between a transmitter having at least one transmit antenna and a receiver having at least one receive antenna. The channel estimator comprises a windowed likelihood determiner and a maximization processor. The windowed likelihood determiner is configured to determine a windowed likelihood function based on the measured channel responses, a selected window function, and modeled channel responses defined based on a number of discrete waves according to the discrete wave channel model. The maximization processor is configured to perform maximization of the windowed likelihood function, using initial input in the form of at least one of predetermined wave

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	propagation delay(s) and predetermined wave propagation direction(s) for at least one of the discrete waves, to extract the wave parameters of the discrete waves. Medbo at Figure 1  <i>Fig. 1</i> Medbo at Figure 2A  <i>Fig. 2A</i> Medbo at Figure 2B  <i>Fig. 2B</i>

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	Medbo at [0037]–[0038] FIG. 1A schematically illustrates an example of a radio channel, where a transmitter 1 has one or more transmit antennas and a receiver 2 has one or more receive antennas. In matrix form, the channel can be expressed as: [Equation] where y is the received signal vector, H is a complex channel matrix, x is the transmitted signal vector, σ is a vector representation of noise. The elements of the complex channel matrix H can be written as H_{mn}, which represents the “channel” between transmit antenna m and receive antenna n. The number N_{tx} of transmit antennas can vary from 1 and up, and the number N_{rx} of receive antennas can also vary from 1 and up. Expressed mathematically: $N_{tx} \geq 1$, and $N_{rx} \geq 1$. The following methodology is thus valid for Single-Input Single-Output (SISO), Single-Input Multiple-Output (SIMO), Multiple-Input Single-Output (MISO) and Multiple-Input Multiple-Output (MIMO) antenna cases. Medbo at [0041] FIG. 2A is a schematic diagram illustrating an example of a unit having a channel estimator operating based on a discrete wave channel model, using measured channel responses obtained by the unit itself. In this particular example, the unit 3 comprises, among other standard radio components, a standard radio receiver (RX) 10, a channel response measurement unit 20, and a channel estimator 30 operating based on a discrete wave channel model. The channel response measurement unit 20 is sometimes also referred to as a channel estimator, but, compared to the channel estimator 30, the channel response measurement unit 20 normally only operates to more or less directly provide measured channel responses based on known reference symbols. The measured channel responses can for example be represented in frequency, time/delay, code and/or space. The channel estimator 30, however, operates based on a discrete wave channel model and makes use of the measured channel responses from the channel response measurement unit 20 to determine wave parameters associated with a number of discrete waves. The unit 3 may for example be a channel sounding equipment (CSE) or a user equipment (UE). Medbo at [0042] FIG. 2B is a schematic diagram illustrating an example of a unit having a channel estimator operating based on a discrete wave channel model, using measured channel responses obtained from one or more other units. For example, the unit 4 may be a base station (BS) or a channel sounding equipment (CSE), and the unit 5 may be a user equipment. Alternatively, the unit 4 may be a user equipment, and the unit 5 may be a base station, or both units 4 and 5 may be channel sounding equipment. The unit 4 basically comprises a channel estimator 30 operating based on a discrete wave channel model. The channel estimator 30 also operates based on measured channel responses obtained from one or more other units such as unit 5. The unit 5 comprises at least a radio receiver (RX) 10 and a channel response measurement

Claim Element	Exemplary Citations to Medbo
	unit 20, and can transfer the measured channel responses to the unit 4, e.g. via a radio control interface. The unit 4 can then receive the measured channel responses, e.g. via the radio control interface. Medbo at [0048] FIG. 3 is a schematic flow diagram illustrating an example of a method of channel estimation according to an embodiment. The method is based on a discrete wave channel model and measured channel responses between a transmitter having at least one transmit antenna and a receiver having at least one receive antenna. Step S1 includes determining a windowed likelihood function based on the measured channel responses, a selected window function, and modeled channel responses defined based on a number of discrete waves according to the discrete wave channel model. Each one of the discrete waves is associated with wave parameters to be determined including at least one of wave propagation direction(s) and wave propagation delay. Step S2 includes performing maximization of the windowed likelihood function, using initial input in the form of at least one of predetermined wave propagation delay(s) and predetermined wave propagation direction(s) for at least one of the discrete waves, to determine the wave parameters of the discrete waves. Medbo at [0049] The use of a windowed likelihood function enables a more efficient and accurate estimation of the wave parameters. The window function is preferably designed such that waves being separated by a certain distance in at least one of wave propagation delay and wave propagation direction are substantially decoupled. Decoupled waves implies that the waves have no or low correlation and/or no or low power overlap. The windowing thus makes it possible to find independent or decoupled groups of waves, which is beneficial with respect to both accuracy and computational efficiency. To the extent this element is not disclosed by Medbo, it would have been obvious to one of ordinary skill in the art to combine, with the teachings of Medbo, those elements, as known to them or as disclosed by other prior art identified in the cover pleading.
[19e] performing a channel estimation based on the first signal to obtain path parameter information of the first propagation path;	Medbo discloses or renders obvious “performing a channel estimation based on the first signal to obtain path parameter information of the first propagation path.” For example: Medbo at Abstract The present technology relates to a channel estimator configured to operate based on a discrete wave channel model and measured channel responses between a transmitter having at least one transmit antenna and a receiver having at least one receive antenna. The channel estimator comprises a windowed likelihood determiner and a maximization processor. The windowed likelihood determiner is configured to determine a windowed likelihood function based on the measured channel responses, a selected

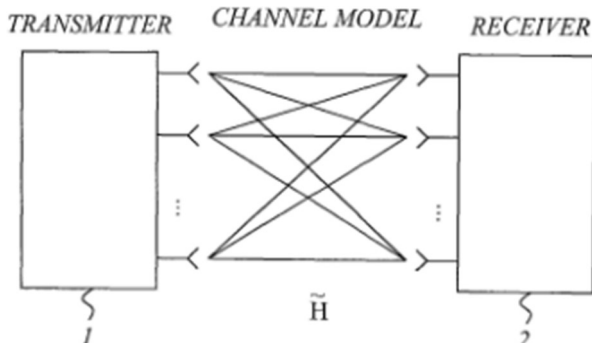
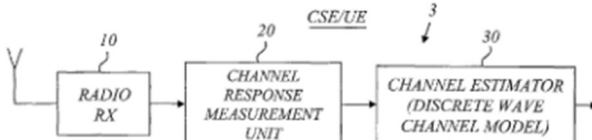
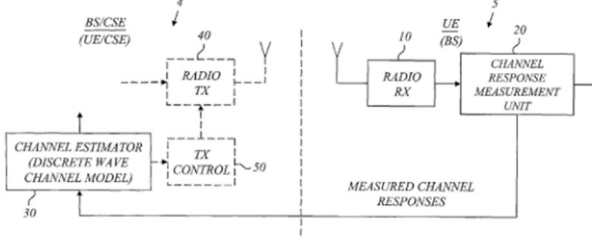
Claim Element	Exemplary Citations to Medbo
	window function, and modeled channel responses defined based on a number of discrete waves according to the discrete wave channel model. The maximization processor is configured to perform maximization of the windowed likelihood function, using initial input in the form of at least one of predetermined wave propagation delay(s) and predetermined wave propagation direction(s) for at least one of the discrete waves, to extract the wave parameters of the discrete waves. Medbo at Figure 2A  Fig. 2A Medbo at Figure 2B  Fig. 2B Medbo at [0010] In a first aspect, there is provided a method of channel estimation based on a discrete wave channel model and measured channel responses between a transmitter having at least one transmit antenna and a receiver having at least one receive antenna. A basic idea is to determine a windowed likelihood function based on the measured channel responses, a selected window function, and modeled channel responses defined based on a number of discrete waves according to the discrete wave channel model. Each one of the discrete waves is associated with wave parameters to be determined including at least one of wave propagation direction(s) and wave propagation delay. Subsequently, maximization of the windowed likelihood function is performed, using initial input in the form of at least one of predetermined wave

Claim Element	Exemplary Citations to Medbo
	propagation delay(s) and predetermined wave propagation direction(s) for at least one of the discrete waves, to determine the wave parameters of the discrete waves. Medbo at [0041] FIG. 2A is a schematic diagram illustrating an example of a unit having a channel estimator operating based on a discrete wave channel model, using measured channel responses obtained by the unit itself. In this particular example, the unit 3 comprises, among other standard radio components, a standard radio receiver (RX) 10, a channel response measurement unit 20, and a channel estimator 30 operating based on a discrete wave channel model. The channel response measurement unit 20 is sometimes also referred to as a channel estimator, but, compared to the channel estimator 30, the channel response measurement unit 20 normally only operates to more or less directly provide measured channel responses based on known reference symbols. The measured channel responses can for example be represented in frequency, time/delay, code and/or space. The channel estimator 30, however, operates based on a discrete wave channel model and makes use of the measured channel responses from the channel response measurement unit 20 to determine wave parameters associated with a number of discrete waves. The unit 3 may for example be a channel sounding equipment (CSE) or a user equipment (UE). Medbo at [0042] FIG. 2B is a schematic diagram illustrating an example of a unit having a channel estimator operating based on a discrete wave channel model, using measured channel responses obtained from one or more other units. For example, the unit 4 may be a base station (BS) or a channel sounding equipment (CSE), and the unit 5 may be a user equipment. Alternatively, the unit 4 may be a user equipment, and the unit 5 may be a base station, or both units 4 and 5 may be channel sounding equipment. The unit 4 basically comprises a channel estimator 30 operating based on a discrete wave channel model. The channel estimator 30 also operates based on measured channel responses obtained from one or more other units such as unit 5. The unit 5 comprises at least a radio receiver (RX) 10 and a channel response measurement unit 20, and can transfer the measured channel responses to the unit 4, e.g. via a radio control interface. The unit 4 can then receive the measured channel responses, e.g. via the radio control interface. Medbo at [0048] FIG. 3 is a schematic flow diagram illustrating an example of a method of channel estimation according to an embodiment. The method is based on a discrete wave channel model and measured channel responses between a transmitter having at least one transmit antenna and a receiver having at least one receive antenna. Step S1 includes determining a windowed likelihood function based on the measured channel responses, a selected window function, and modeled channel responses defined based on a number of discrete waves according to the discrete wave channel model. Each one of the discrete waves is associated

Claim Element	Exemplary Citations to Medbo
	with wave parameters to be determined including at least one of wave propagation direction(s) and wave propagation delay. Step S2 includes performing maximization of the windowed likelihood function, using initial input in the form of at least one of predetermined wave propagation delay(s) and predetermined wave propagation direction(s) for at least one of the discrete waves, to determine the wave parameters of the discrete waves. Medbo at [0049] The use of a windowed likelihood function enables a more efficient and accurate estimation of the wave parameters. The window function is preferably designed such that waves being separated by a certain distance in at least one of wave propagation delay and wave propagation direction are substantially decoupled. Decoupled waves implies that the waves have no or low correlation and/or no or low power overlap. The windowing thus makes it possible to find independent or decoupled groups of waves, which is beneficial with respect to both accuracy and computational efficiency. Medbo at [0060] FIG. 4 is a schematic flow diagram illustrating an example of a method of channel estimation according to another embodiment. In this example, the measured channel responses are windowed according to the window function to produce windowed measured channel responses in step S11. The initial input in the form of at least one of predetermined wave propagation delay(s) and predetermined wave propagation direction(s) for at least one of the discrete waves is determined based on the windowed measured channel responses in step S12. In the discrete wave channel model, the channel responses are also windowed according to the window function to produce windowed modeled channel responses, and the windowed likelihood function is determined in step S13 based on the windowed measured channel responses and the windowed modeled channel responses. The windowing of the modeled channel responses can be seen as part of the determining of the windowed likelihood function in step S13. Subsequently, maximization of the windowed likelihood function is performed to determine wave parameters of the discrete waves in step S14. Medbo at [0062] FIG. 5 is a schematic flow diagram illustrating an example of a method of channel estimation according to yet another embodiment. In this example, the measured channel responses are windowed according to the window function to produce windowed measured channel responses in step S21. In step S22, samples of the windowed measured channel responses are clipped to produce remaining windowed measured channel responses. The initial input in the form of at least one of predetermined wave propagation delay(s) and predetermined wave propagation direction(s) for at least one of the discrete waves is determined based on the remaining windowed measured channel responses in step S23. In the model, the channel responses are

Claim Element	Exemplary Citations to Medbo
	also windowed according to the window function to produce windowed modeled channel responses, and the windowed likelihood function is determined in step S24 based on the remaining windowed measured channel responses and windowed modeled channel responses corresponding to the remaining windowed measured channel responses. The windowing of the modeled channel responses can be seen as part of the determining of the windowed likelihood function in step S24. It should also be understood that only windowed modeled channel responses corresponding to the remaining windowed measured channel response are needed to be defined in the windowed likelihood function. Subsequently, maximization of the windowed likelihood function is performed to determine wave parameters of the discrete waves in step S25. Medbo at [0076] FIG. 6 is a schematic block diagram illustrating an example of a channel estimator according to an embodiment. The channel estimator 100 is configured to operate based on a discrete wave channel model and measured channel responses between a transmitter having at least one transmit antenna and a receiver having at least one receive antenna. The channel estimator 100 basically comprises a windowed likelihood determiner 120 and a maximization processor 130. The windowed likelihood determiner 120 is configured to determine a windowed likelihood function based on the measured channel responses, a selected window function, and modeled channel responses defined based on a number of discrete waves according to the discrete wave channel model. Each one of the discrete waves is associated with wave parameters to be determined including at least one of wave propagation direction(s) and wave propagation delay. The maximization processor 130 is configured to perform maximization of the windowed likelihood function, using initial input in the form of at least one of predetermined wave propagation delay(s) and predetermined wave propagation direction(s) for at least one of the discrete waves, to extract the wave parameters of the discrete waves. Medbo at [0080] FIG. 7 is a schematic block diagram illustrating an example of a channel estimator according to another embodiment. The channel estimator 100 of FIG. 7 basically comprises a windower 112, a windowed likelihood determiner 120, an initializer 125 and a maximization processor 130. The windower 112 is configured to window the measured channel responses according to the window function to produce windowed measured channel responses, and the initializer 125 is configured to determine the initial input in the form of at least one of predetermined wave propagation delay(s) and predetermined wave propagation direction(s) for at least one of the discrete waves based on the windowed measured channel responses.

Claim Element	Exemplary Citations to Medbo
	Medbo at [0082] FIG. 8 is a schematic block diagram illustrating an example of a channel estimator according to yet another embodiment. The channel estimator 100 of FIG. 8 basically comprises a windower 112, a clipper 114, a windowed likelihood determiner 120, an initializer 125 and a maximization processor 130. The windower 112 is configured to window the measured channel responses according to the window function to produce windowed measured channel responses. The clipper 114 is configured for clipping samples of the windowed measured channel responses to produce remaining windowed measured channel responses. The initializer 125 is configured to determine the initial input in the form of at least one of predetermined wave propagation delay(s) and predetermined wave propagation direction(s) for at least one of the discrete waves based on the remaining windowed measured channel responses. The windowed likelihood determiner 120 is configured to window modeled channel responses according to the window function to produce windowed modeled channel responses, and to determine the windowed likelihood function based on the remaining windowed measured channel responses and windowed modeled channel responses corresponding to the remaining windowed measured channel responses. It should be understood that only windowed modeled channel responses corresponding to the remaining windowed measured channel response are needed to be defined in the windowed likelihood function. To the extent this element is not disclosed by Medbo, it would have been obvious to one of ordinary skill in the art to combine, with the teachings of Medbo, those elements, as known to them or as disclosed by other prior art identified in the cover pleading.
[19f] sending the channel estimation that includes the path parameter information to the transmitter; and	Medbo discloses or renders obvious “sending the channel estimation that includes the path parameter information to the transmitter.” For example: Medbo at Abstract The present technology relates to a channel estimator configured to operate based on a discrete wave channel model and measured channel responses between a transmitter having at least one transmit antenna and a receiver having at least one receive antenna. The channel estimator comprises a windowed likelihood determiner and a maximization processor. The windowed likelihood determiner is configured to determine a windowed likelihood function based on the measured channel responses, a selected window function, and modeled channel responses defined based on a number of discrete waves according to the discrete wave channel model. The maximization processor is configured to perform maximization of the windowed likelihood function, using initial input in the form of at least one of predetermined wave propagation delay(s) and predetermined wave propagation direction(s) for at least one of the discrete waves, to extract the wave parameters of the discrete waves.

Claim Element	Exemplary Citations to Medbo
	Medbo at Figure 1  <i>Fig. 1</i> Medbo at Figure 2A  <i>Fig. 2A</i> Medbo at Figure 2B  <i>Fig. 2B</i> Medbo at [0037]–[0038] FIG. 1A schematically illustrates an example of a radio channel, where a transmitter 1 has one or more

Claim Element	Exemplary Citations to Medbo
	transmit antennas and a receiver 2 has one or more receive antennas. In matrix form, the channel can be expressed as: [Equation] where y is the received signal vector, H is a complex channel matrix, x is the transmitted signal vector, σ is a vector representation of noise. The elements of the complex channel matrix H can be written as H_{mn}, which represents the “channel” between transmit antenna m and receive antenna n. The number N_{tx} of transmit antennas can vary from 1 and up, and the number N_{rx} of receive antennas can also vary from 1 and up. Expressed mathematically: $N_{tx} \geq 1$, and $N_{rx} \geq 1$. The following methodology is thus valid for Single-Input Single-Output (SISO), Single-Input Multiple-Output (SIMO), Multiple-Input Single-Output (MISO) and Multiple-Input Multiple-Output (MIMO) antenna cases. Medbo at [0041] FIG. 2A is a schematic diagram illustrating an example of a unit having a channel estimator operating based on a discrete wave channel model, using measured channel responses obtained by the unit itself. In this particular example, the unit 3 comprises, among other standard radio components, a standard radio receiver (RX) 10, a channel response measurement unit 20, and a channel estimator 30 operating based on a discrete wave channel model. The channel response measurement unit 20 is sometimes also referred to as a channel estimator, but, compared to the channel estimator 30, the channel response measurement unit 20 normally only operates to more or less directly provide measured channel responses based on known reference symbols. The measured channel responses can for example be represented in frequency, time/delay, code and/or space. The channel estimator 30, however, operates based on a discrete wave channel model and makes use of the measured channel responses from the channel response measurement unit 20 to determine wave parameters associated with a number of discrete waves. The unit 3 may for example be a channel sounding equipment (CSE) or a user equipment (UE). Medbo at [0042] FIG. 2B is a schematic diagram illustrating an example of a unit having a channel estimator operating based on a discrete wave channel model, using measured channel responses obtained from one or more other units. For example, the unit 4 may be a base station (BS) or a channel sounding equipment (CSE), and the unit 5 may be a user equipment. Alternatively, the unit 4 may be a user equipment, and the unit 5 may be a base station, or both units 4 and 5 may be channel sounding equipment. The unit 4 basically comprises a channel estimator 30 operating based on a discrete wave channel model. The channel estimator 30 also operates based on measured channel responses obtained from one or more other units such as unit 5. The unit 5 comprises at least a radio receiver (RX) 10 and a channel response measurement unit 20, and can transfer the measured channel responses to the unit 4, e.g. via a radio control interface. The unit 4 can then receive the measured channel responses, e.g. via the radio control interface.

Claim Element	Exemplary Citations to Medbo
	Medbo at [0048] FIG. 3 is a schematic flow diagram illustrating an example of a method of channel estimation according to an embodiment. The method is based on a discrete wave channel model and measured channel responses between a transmitter having at least one transmit antenna and a receiver having at least one receive antenna. Step S1 includes determining a windowed likelihood function based on the measured channel responses, a selected window function, and modeled channel responses defined based on a number of discrete waves according to the discrete wave channel model. Each one of the discrete waves is associated with wave parameters to be determined including at least one of wave propagation direction(s) and wave propagation delay. Step S2 includes performing maximization of the windowed likelihood function, using initial input in the form of at least one of predetermined wave propagation delay(s) and predetermined wave propagation direction(s) for at least one of the discrete waves, to determine the wave parameters of the discrete waves. Medbo at [0060] FIG. 4 is a schematic flow diagram illustrating an example of a method of channel estimation according to another embodiment. In this example, the measured channel responses are windowed according to the window function to produce windowed measured channel responses in step S11. The initial input in the form of at least one of predetermined wave propagation delay(s) and predetermined wave propagation direction(s) for at least one of the discrete waves is determined based on the windowed measured channel responses in step S12. In the discrete wave channel model, the channel responses are also windowed according to the window function to produce windowed modeled channel responses, and the windowed likelihood function is determined in step S13 based on the windowed measured channel responses and the windowed modeled channel responses. The windowing of the modeled channel responses can be seen as part of the determining of the windowed likelihood function in step S13. Subsequently, maximization of the windowed likelihood function is performed to determine wave parameters of the discrete waves in step S14. Medbo at [0062] FIG. 5 is a schematic flow diagram illustrating an example of a method of channel estimation according to yet another embodiment. In this example, the measured channel responses are windowed according to the window function to produce windowed measured channel responses in step S21. In step S22, samples of the windowed measured channel responses are clipped to produce remaining windowed measured channel responses. The initial input in the form of at least one of predetermined wave propagation delay(s) and predetermined wave propagation direction(s) for at least one of the discrete waves is determined based on the remaining windowed measured channel responses in step S23. In the model, the channel responses are

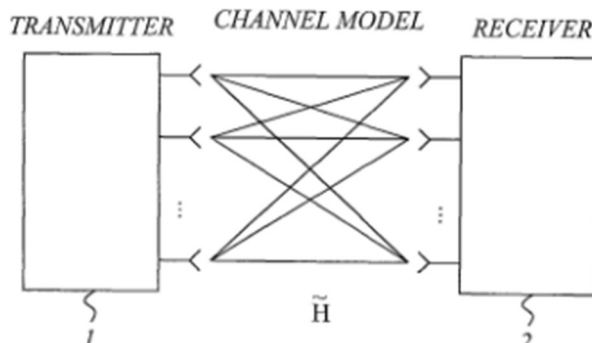
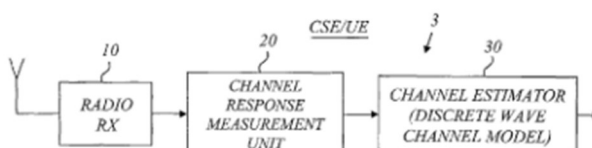
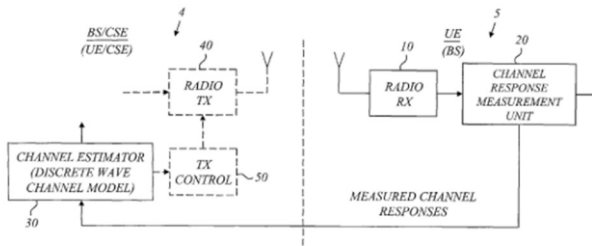
Claim Element	Exemplary Citations to Medbo
	also windowed according to the window function to produce windowed modeled channel responses, and the windowed likelihood function is determined in step S24 based on the remaining windowed measured channel responses and windowed modeled channel responses corresponding to the remaining windowed measured channel responses. The windowing of the modeled channel responses can be seen as part of the determining of the windowed likelihood function in step S24. It should also be understood that only windowed modeled channel responses corresponding to the remaining windowed measured channel response are needed to be defined in the windowed likelihood function. Subsequently, maximization of the windowed likelihood function is performed to determine wave parameters of the discrete waves in step S25. Medbo at [0076] FIG. 6 is a schematic block diagram illustrating an example of a channel estimator according to an embodiment. The channel estimator 100 is configured to operate based on a discrete wave channel model and measured channel responses between a transmitter having at least one transmit antenna and a receiver having at least one receive antenna. The channel estimator 100 basically comprises a windowed likelihood determiner 120 and a maximization processor 130. The windowed likelihood determiner 120 is configured to determine a windowed likelihood function based on the measured channel responses, a selected window function, and modeled channel responses defined based on a number of discrete waves according to the discrete wave channel model. Each one of the discrete waves is associated with wave parameters to be determined including at least one of wave propagation direction(s) and wave propagation delay. The maximization processor 130 is configured to perform maximization of the windowed likelihood function, using initial input in the form of at least one of predetermined wave propagation delay(s) and predetermined wave propagation direction(s) for at least one of the discrete waves, to extract the wave parameters of the discrete waves. Medbo at [0080] FIG. 7 is a schematic block diagram illustrating an example of a channel estimator according to another embodiment. The channel estimator 100 of FIG. 7 basically comprises a windower 112, a windowed likelihood determiner 120, an initializer 125 and a maximization processor 130. The windower 112 is configured to window the measured channel responses according to the window function to produce windowed measured channel responses, and the initializer 125 is configured to determine the initial input in the form of at least one of predetermined wave propagation delay(s) and predetermined wave propagation direction(s) for at least one of the discrete waves based on the windowed measured channel responses.

Claim Element	Exemplary Citations to Medbo
	Medbo at [0082] FIG. 8 is a schematic block diagram illustrating an example of a channel estimator according to yet another embodiment. The channel estimator 100 of FIG. 8 basically comprises a windower 112, a clipper 114, a windowed likelihood determiner 120, an initializer 125 and a maximization processor 130. The windower 112 is configured to window the measured channel responses according to the window function to produce windowed measured channel responses. The clipper 114 is configured for clipping samples of the windowed measured channel responses to produce remaining windowed measured channel responses. The initializer 125 is configured to determine the initial input in the form of at least one of predetermined wave propagation delay(s) and predetermined wave propagation direction(s) for at least one of the discrete waves based on the remaining windowed measured channel responses. The windowed likelihood determiner 120 is configured to window modeled channel responses according to the window function to produce windowed modeled channel responses, and to determine the windowed likelihood function based on the remaining windowed measured channel responses and windowed modeled channel responses corresponding to the remaining windowed measured channel responses. It should be understood that only windowed modeled channel responses corresponding to the remaining windowed measured channel response are needed to be defined in the windowed likelihood function. To the extent this element is not disclosed by Medbo, it would have been obvious to one of ordinary skill in the art to combine, with the teachings of Medbo, those elements, as known to them or as disclosed by other prior art identified in the cover pleading.
[19g] receiving a second signal via the first propagation path, the second signal predistorted in a time domain, a frequency domain, and a spatial domain according to the channel estimation based on the first signal.	Medbo discloses or renders obvious “receiving a second signal via the first propagation path, the second signal predistorted in a time domain, a frequency domain, and a spatial domain according to the channel estimation based on the first signal.” For example:

Claim Element	Exemplary Citations to Medbo
	Medbo at Figure 1 The diagram illustrates a radio channel model. On the left, a rectangular block labeled 'TRANSMITTER' is connected to a central 'CHANNEL MODEL' block. The transmitter is labeled with a '1' and a squiggly line below it. The channel model is represented by a matrix of connections between the transmitter and receiver antennas. On the right, a rectangular block labeled 'RECEIVER' is connected to the channel model. The receiver is labeled with a '2' and a squiggly line below it. The channel model is labeled with 'H-tilde' below it. The connections between the transmitter and receiver are shown as a series of lines forming a matrix, with a '3' and a squiggly line below the transmitter, and a '3' and a squiggly line below the receiver, indicating multiple antennas. <i>Fig. 1</i> Medbo at [0037]–[0038] FIG. 1A schematically illustrates an example of a radio channel, where a transmitter 1 has one or more transmit antennas and a receiver 2 has one or more receive antennas. In matrix form, the channel can be expressed as: [Equation] where y is the received signal vector, H is a complex channel matrix, x is the transmitted signal vector, σ is a vector representation of noise. The elements of the complex channel matrix H can be written as H_{mn}, which represents the “channel” between transmit antenna m and receive antenna n. The number N_{tx} of transmit antennas can vary from 1 and up, and the number N_{rx} of receive antennas can also vary from 1 and up. Expressed mathematically: $N_{tx} \geq 1$, and $N_{rx} \geq 1$. The following methodology is thus valid for Single-Input Single-Output (SISO), Single-Input Multiple-Output (SIMO), Multiple-Input Single-Output (MISO) and Multiple-Input Multiple-Output (MIMO) antenna cases. Medbo at [0048] FIG. 3 is a schematic flow diagram illustrating an example of a method of channel estimation according to an embodiment. The method is based on a discrete wave channel model and measured channel responses between a transmitter having at least one transmit antenna and a receiver having at least one receive antenna. Step S1 includes determining a windowed likelihood function based on the measured channel responses, a selected window function, and modeled channel responses defined based on a number of discrete waves according to the discrete wave channel model. Each one of the discrete waves is associated with wave parameters to be determined including at least one of wave propagation direction(s) and wave propagation delay. Step S2 includes performing maximization of the windowed likelihood function, using

Claim Element	Exemplary Citations to Medbo
	initial input in the form of at least one of predetermined wave propagation delay(s) and predetermined wave propagation direction(s) for at least one of the discrete waves, to determine the wave parameters of the discrete waves. Medbo at [0049] The use of a windowed likelihood function enables a more efficient and accurate estimation of the wave parameters. The window function is preferably designed such that waves being separated by a certain distance in at least one of wave propagation delay and wave propagation direction are substantially decoupled. Decoupled waves implies that the waves have no or low correlation and/or no or low power overlap. The windowing thus makes it possible to find independent or decoupled groups of waves, which is beneficial with respect to both accuracy and computational efficiency. Medbo at [0064] For example, the windowed measured channel responses may be represented in the frequency domain and transformed from the frequency domain into the delay domain, and the clipping in step S22 may be performed in the delay domain, and the remaining windowed measured channel responses may be transformed from the delay domain back to the frequency domain. Medbo at [0065] In another example, the windowed measured channel responses may be represented in the space domain and transformed from the space domain into the direction domain, and the clipping in step S22 may be performed in the direction domain, and the remaining windowed measured channel responses may be transformed from the direction domain back to the space domain. Medbo at [0156] The possibility to remove dependencies between waves which are separated in some degree of freedom, of the data set, suggests that the data set size may be reduced by clipping. Data which correspond to uncorrelated waves are removed by clipping, e.g. in the delay domain and/or the angle/direction domain. Since the computational complexity is proportional to the size of the data set, clipping constitutes an additional means for increasing the efficiency of parameter estimation. Medbo at [0157] As an example the clipping in delay domain may be performed as follows. The data consist of N=1000 equidistant samples in frequency domain. Transformation (e.g. Fourier transformation) is used to provide delay domain data. First the maximum of the peak at the distance 400 m is identified (see FIGS. 13A-B). In this particular example, Hanning windowing, given by (40), has been used.

Claim Element	Exemplary Citations to Medbo
	Medbo at [0169] In order to keep high computational efficiency, a good guess of the initial parameter values is desirable. For this purpose any rough estimation technique can be used. For example, beamforming (corresponds to Discrete Fourier Transformation in the frequency domain) is performed providing an angle/direction power function. In step S32, a number of maxima in angle/direction are found at delay that corresponds to the maximum of the power delay profile previously found in step S31. Alternatively, if a maximum in the windowed power angle/direction profile was previously found in step S31, a delay power function is now defined and a number of maxima in delay are found in step S32. Each local maximum of this function, which is above the noise level, corresponds to an initial wave. In this stage the measured channel is windowed also for the domains (space and/or frequency) which are not clipped in order to avoid fake initial waves. However, this windowing is not applied in any other steps. Medbo at claim 8 8. The method of claim 7, wherein said windowed measured channel responses are transformed from the frequency domain into the delay domain, and said clipping is performed in the delay domain, and said remaining windowed measured channel responses are transformed from the delay domain back to the frequency domain. Medbo at claim 9 9. The method of claim 7, wherein said windowed measured channel responses are transformed from the space domain into the direction domain, and said clipping is performed in the direction domain, and said remaining windowed measured channel responses are transformed from the direction domain back to the space domain. To the extent this element is not disclosed by Medbo, it would have been obvious to one of ordinary skill in the art to combine, with the teachings of Medbo, those elements, as known to them or as disclosed by other prior art identified in the cover pleading.
20. The wireless device of claim 19, wherein the path parameter information of the first propagation path includes at least one of an estimation of a delay, an estimation of a Doppler frequency, an estimation of a direction of arrival, an estimation of a direction	Medbo discloses or renders obvious “[t]he wireless device of claim 19, wherein the path parameter information of the first propagation path includes at least one of an estimation of a delay, an estimation of a Doppler frequency, an estimation of a direction of arrival, an estimation of a direction of departure, and an estimation of a complex amplitude of the first propagation path.” For example:

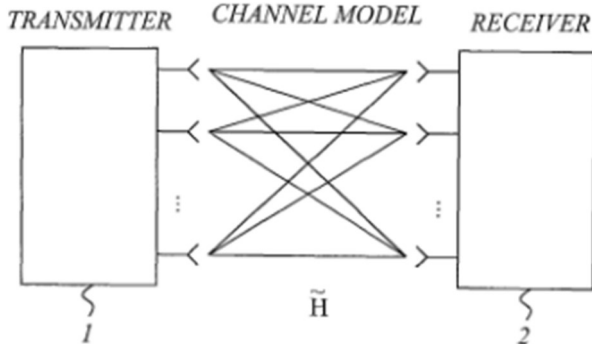
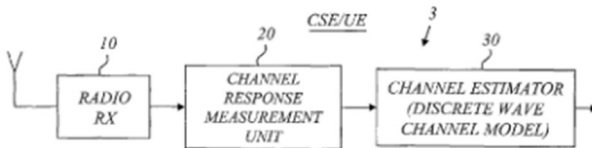
Claim Element	Exemplary Citations to Medbo
of departure, and an estimation of a complex amplitude of the first propagation path.	Medbo at Figure 1  <i>Fig. 1</i> Medbo at Figure 2A  <i>Fig. 2A</i> Medbo at Figure 2B  <i>Fig. 2B</i> Medbo at [0037]–[0038] FIG. 1A schematically illustrates an example of a radio channel, where a transmitter 1 has one or more

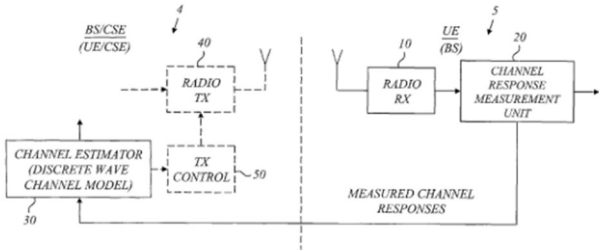
Claim Element	Exemplary Citations to Medbo
	transmit antennas and a receiver 2 has one or more receive antennas. In matrix form, the channel can be expressed as: [Equation] where y is the received signal vector, H is a complex channel matrix, x is the transmitted signal vector, σ is a vector representation of noise. The elements of the complex channel matrix H can be written as H_{mn}, which represents the “channel” between transmit antenna m and receive antenna n. The number N_{tx} of transmit antennas can vary from 1 and up, and the number N_{rx} of receive antennas can also vary from 1 and up. Expressed mathematically: $N_{tx} \geq 1$, and $N_{rx} \geq 1$. The following methodology is thus valid for Single-Input Single-Output (SISO), Single-Input Multiple-Output (SIMO), Multiple-Input Single-Output (MISO) and Multiple-Input Multiple-Output (MIMO) antenna cases. Medbo at [0041] FIG. 2A is a schematic diagram illustrating an example of a unit having a channel estimator operating based on a discrete wave channel model, using measured channel responses obtained by the unit itself. In this particular example, the unit 3 comprises, among other standard radio components, a standard radio receiver (RX) 10, a channel response measurement unit 20, and a channel estimator 30 operating based on a discrete wave channel model. The channel response measurement unit 20 is sometimes also referred to as a channel estimator, but, compared to the channel estimator 30, the channel response measurement unit 20 normally only operates to more or less directly provide measured channel responses based on known reference symbols. The measured channel responses can for example be represented in frequency, time/delay, code and/or space. The channel estimator 30, however, operates based on a discrete wave channel model and makes use of the measured channel responses from the channel response measurement unit 20 to determine wave parameters associated with a number of discrete waves. The unit 3 may for example be a channel sounding equipment (CSE) or a user equipment (UE). Medbo at [0042] FIG. 2B is a schematic diagram illustrating an example of a unit having a channel estimator operating based on a discrete wave channel model, using measured channel responses obtained from one or more other units. For example, the unit 4 may be a base station (BS) or a channel sounding equipment (CSE), and the unit 5 may be a user equipment. Alternatively, the unit 4 may be a user equipment, and the unit 5 may be a base station, or both units 4 and 5 may be channel sounding equipment. The unit 4 basically comprises a channel estimator 30 operating based on a discrete wave channel model. The channel estimator 30 also operates based on measured channel responses obtained from one or more other units such as unit 5. The unit 5 comprises at least a radio receiver (RX) 10 and a channel response measurement unit 20, and can transfer the measured channel responses to the unit 4, e.g. via a radio control interface. The unit 4 can then receive the measured channel responses, e.g. via the radio control interface.

Claim Element	Exemplary Citations to Medbo
	Medbo at [0048] FIG. 3 is a schematic flow diagram illustrating an example of a method of channel estimation according to an embodiment. The method is based on a discrete wave channel model and measured channel responses between a transmitter having at least one transmit antenna and a receiver having at least one receive antenna. Step S1 includes determining a windowed likelihood function based on the measured channel responses, a selected window function, and modeled channel responses defined based on a number of discrete waves according to the discrete wave channel model. Each one of the discrete waves is associated with wave parameters to be determined including at least one of wave propagation direction(s) and wave propagation delay. Step S2 includes performing maximization of the windowed likelihood function, using initial input in the form of at least one of predetermined wave propagation delay(s) and predetermined wave propagation direction(s) for at least one of the discrete waves, to determine the wave parameters of the discrete waves. Medbo at [0049] The use of a windowed likelihood function enables a more efficient and accurate estimation of the wave parameters. The window function is preferably designed such that waves being separated by a certain distance in at least one of wave propagation delay and wave propagation direction are substantially decoupled. Decoupled waves implies that the waves have no or low correlation and/or no or low power overlap. The windowing thus makes it possible to find independent or decoupled groups of waves, which is beneficial with respect to both accuracy and computational efficiency. Medbo at [0057] In general, it is desirable to determine the number of discrete waves and at least one of the wave propagation direction(s) and wave propagation delay of each of these waves. Preferably, the complex amplitudes, described by a complex polarimetric amplitude matrix, for each of the discrete waves should also be determined. Medbo at [0060] FIG. 4 is a schematic flow diagram illustrating an example of a method of channel estimation according to another embodiment. In this example, the measured channel responses are windowed according to the window function to produce windowed measured channel responses in step S11. The initial input in the form of at least one of predetermined wave propagation delay(s) and predetermined wave propagation direction(s) for at least one of the discrete waves is determined based on the windowed measured channel responses in step S12. In the discrete wave channel model, the channel responses are also windowed according to the window function to produce windowed modeled channel responses, and the windowed likelihood function is determined in step S13 based on the windowed measured channel responses and the

Claim Element	Exemplary Citations to Medbo
	windowed modeled channel responses. The windowing of the modeled channel responses can be seen as part of the determining of the windowed likelihood function in step S13. Subsequently, maximization of the windowed likelihood function is performed to determine wave parameters of the discrete waves in step S14. Medbo at [0062] FIG. 5 is a schematic flow diagram illustrating an example of a method of channel estimation according to yet another embodiment. In this example, the measured channel responses are windowed according to the window function to produce windowed measured channel responses in step S21. In step S22, samples of the windowed measured channel responses are clipped to produce remaining windowed measured channel responses. The initial input in the form of at least one of predetermined wave propagation delay(s) and predetermined wave propagation direction(s) for at least one of the discrete waves is determined based on the remaining windowed measured channel responses in step S23. In the model, the channel responses are also windowed according to the window function to produce windowed modeled channel responses, and the windowed likelihood function is determined in step S24 based on the remaining windowed measured channel responses and windowed modeled channel responses corresponding to the remaining windowed measured channel responses. The windowing of the modeled channel responses can be seen as part of the determining of the windowed likelihood function in step S24. It should also be understood that only windowed modeled channel responses corresponding to the remaining windowed measured channel response are needed to be defined in the windowed likelihood function. Subsequently, maximization of the windowed likelihood function is performed to determine wave parameters of the discrete waves in step S25. Medbo at [0076] FIG. 6 is a schematic block diagram illustrating an example of a channel estimator according to an embodiment. The channel estimator 100 is configured to operate based on a discrete wave channel model and measured channel responses between a transmitter having at least one transmit antenna and a receiver having at least one receive antenna. The channel estimator 100 basically comprises a windowed likelihood determiner 120 and a maximization processor 130. The windowed likelihood determiner 120 is configured to determine a windowed likelihood function based on the measured channel responses, a selected window function, and modeled channel responses defined based on a number of discrete waves according to the discrete wave channel model. Each one of the discrete waves is associated with wave parameters to be determined including at least one of wave propagation direction(s) and wave propagation delay. The maximization processor 130 is configured to perform maximization of the windowed likelihood function, using initial input in the form of at least one of predetermined wave propagation

Claim Element	Exemplary Citations to Medbo
	delay(s) and predetermined wave propagation direction(s) for at least one of the discrete waves, to extract the wave parameters of the discrete waves. Medbo at [0080] FIG. 7 is a schematic block diagram illustrating an example of a channel estimator according to another embodiment. The channel estimator 100 of FIG. 7 basically comprises a windower 112, a windowed likelihood determiner 120, an initializer 125 and a maximization processor 130. The windower 112 is configured to window the measured channel responses according to the window function to produce windowed measured channel responses, and the initializer 125 is configured to determine the initial input in the form of at least one of predetermined wave propagation delay(s) and predetermined wave propagation direction(s) for at least one of the discrete waves based on the windowed measured channel responses. Medbo at [0082] FIG. 8 is a schematic block diagram illustrating an example of a channel estimator according to yet another embodiment. The channel estimator 100 of FIG. 8 basically comprises a windower 112, a clipper 114, a windowed likelihood determiner 120, an initializer 125 and a maximization processor 130. The windower 112 is configured to window the measured channel responses according to the window function to produce windowed measured channel responses. The clipper 114 is configured for clipping samples of the windowed measured channel responses to produce remaining windowed measured channel responses. The initializer 125 is configured to determine the initial input in the form of at least one of predetermined wave propagation delay(s) and predetermined wave propagation direction(s) for at least one of the discrete waves based on the remaining windowed measured channel responses. The windowed likelihood determiner 120 is configured to window modeled channel responses according to the window function to produce windowed modeled channel responses, and to determine the windowed likelihood function based on the remaining windowed measured channel responses and windowed modeled channel responses corresponding to the remaining windowed measured channel responses. It should be understood that only windowed modeled channel responses corresponding to the remaining windowed measured channel response are needed to be defined in the windowed likelihood function. To the extent this element is not disclosed by Medbo, it would have been obvious to one of ordinary skill in the art to combine, with the teachings of Medbo, those elements, as known to them or as disclosed by other prior art identified in the cover pleading.

Claim Element	Exemplary Citations to Medbo
21. The wireless device of claim 20, wherein the path parameter information of the first propagation path further includes an estimation of a polarization status of the first propagation path.	Medbo discloses or renders obvious “[t]he wireless device of claim 20, wherein the path parameter information of the first propagation path further includes an estimation of a polarization status of the first propagation path.” For example: Medbo at Figure 1  <i>Fig. 1</i> Medbo at Figure 2A  <i>Fig. 2A</i>

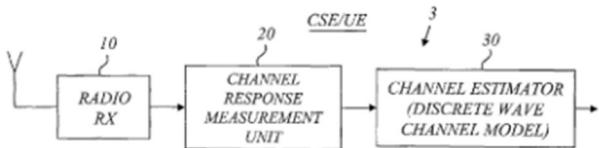
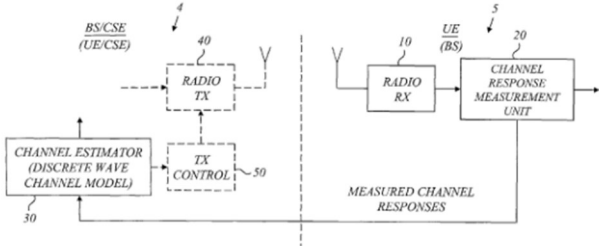
Claim Element	Exemplary Citations to Medbo
	Medbo at Figure 2B  Fig. 2B Medbo at [0037]–[0038] FIG. 1A schematically illustrates an example of a radio channel, where a transmitter 1 has one or more transmit antennas and a receiver 2 has one or more receive antennas. In matrix form, the channel can be expressed as: [Equation] where y is the received signal vector, H is a complex channel matrix, x is the transmitted signal vector, σ is a vector representation of noise. The elements of the complex channel matrix H can be written as H_{mn}, which represents the “channel” between transmit antenna m and receive antenna n. The number N_{tx} of transmit antennas can vary from 1 and up, and the number N_{rx} of receive antennas can also vary from 1 and up. Expressed mathematically: $N_{tx} \geq 1$, and $N_{rx} \geq 1$. The following methodology is thus valid for Single-Input Single-Output (SISO), Single-Input Multiple-Output (SIMO), Multiple-Input Single-Output (MISO) and Multiple-Input Multiple-Output (MIMO) antenna cases. Medbo at [0041] FIG. 2A is a schematic diagram illustrating an example of a unit having a channel estimator operating based on a discrete wave channel model, using measured channel responses obtained by the unit itself. In this particular example, the unit 3 comprises, among other standard radio components, a standard radio receiver (RX) 10, a channel response measurement unit 20, and a channel estimator 30 operating based on a discrete wave channel model. The channel response measurement unit 20 is sometimes also referred to as a channel estimator, but, compared to the channel estimator 30, the channel response measurement unit 20 normally only operates to more or less directly provide measured channel responses based on known reference symbols. The measured channel responses can for example be represented in frequency, time/delay, code and/or space. The channel estimator 30, however, operates based on a discrete wave channel model and makes use of the measured channel responses from the channel response measurement unit 20 to determine wave parameters associated with a number of discrete waves. The unit 3 may for example be a channel sounding equipment (CSE) or a user equipment (UE).

Claim Element	Exemplary Citations to Medbo
	Medbo at [0042] FIG. 2B is a schematic diagram illustrating an example of a unit having a channel estimator operating based on a discrete wave channel model, using measured channel responses obtained from one or more other units. For example, the unit 4 may be a base station (BS) or a channel sounding equipment (CSE), and the unit 5 may be a user equipment. Alternatively, the unit 4 may be a user equipment, and the unit 5 may be a base station, or both units 4 and 5 may be channel sounding equipment. The unit 4 basically comprises a channel estimator 30 operating based on a discrete wave channel model. The channel estimator 30 also operates based on measured channel responses obtained from one or more other units such as unit 5. The unit 5 comprises at least a radio receiver (RX) 10 and a channel response measurement unit 20, and can transfer the measured channel responses to the unit 4, e.g. via a radio control interface. The unit 4 can then receive the measured channel responses, e.g. via the radio control interface. Medbo at [0048] FIG. 3 is a schematic flow diagram illustrating an example of a method of channel estimation according to an embodiment. The method is based on a discrete wave channel model and measured channel responses between a transmitter having at least one transmit antenna and a receiver having at least one receive antenna. Step S1 includes determining a windowed likelihood function based on the measured channel responses, a selected window function, and modeled channel responses defined based on a number of discrete waves according to the discrete wave channel model. Each one of the discrete waves is associated with wave parameters to be determined including at least one of wave propagation direction(s) and wave propagation delay. Step S2 includes performing maximization of the windowed likelihood function, using initial input in the form of at least one of predetermined wave propagation delay(s) and predetermined wave propagation direction(s) for at least one of the discrete waves, to determine the wave parameters of the discrete waves. Medbo at [0049] The use of a windowed likelihood function enables a more efficient and accurate estimation of the wave parameters. The window function is preferably designed such that waves being separated by a certain distance in at least one of wave propagation delay and wave propagation direction are substantially decoupled. Decoupled waves implies that the waves have no or low correlation and/or no or low power overlap. The windowing thus makes it possible to find independent or decoupled groups of waves, which is beneficial with respect to both accuracy and computational efficiency. Medbo at [0060] FIG. 4 is a schematic flow diagram illustrating an example of a method of channel estimation according to another embodiment. In this example, the measured channel responses are windowed according to the

Claim Element	Exemplary Citations to Medbo
	window function to produce windowed measured channel responses in step S11. The initial input in the form of at least one of predetermined wave propagation delay(s) and predetermined wave propagation direction(s) for at least one of the discrete waves is determined based on the windowed measured channel responses in step S12. In the discrete wave channel model, the channel responses are also windowed according to the window function to produce windowed modeled channel responses, and the windowed likelihood function is determined in step S13 based on the windowed measured channel responses and the windowed modeled channel responses. The windowing of the modeled channel responses can be seen as part of the determining of the windowed likelihood function in step S13. Subsequently, maximization of the windowed likelihood function is performed to determine wave parameters of the discrete waves in step S14. Medbo at [0062] FIG. 5 is a schematic flow diagram illustrating an example of a method of channel estimation according to yet another embodiment. In this example, the measured channel responses are windowed according to the window function to produce windowed measured channel responses in step S21. In step S22, samples of the windowed measured channel responses are clipped to produce remaining windowed measured channel responses. The initial input in the form of at least one of predetermined wave propagation delay(s) and predetermined wave propagation direction(s) for at least one of the discrete waves is determined based on the remaining windowed measured channel responses in step S23. In the model, the channel responses are also windowed according to the window function to produce windowed modeled channel responses, and the windowed likelihood function is determined in step S24 based on the remaining windowed measured channel responses and windowed modeled channel responses corresponding to the remaining windowed measured channel responses. The windowing of the modeled channel responses can be seen as part of the determining of the windowed likelihood function in step S24. It should also be understood that only windowed modeled channel responses corresponding to the remaining windowed measured channel response are needed to be defined in the windowed likelihood function. Subsequently, maximization of the windowed likelihood function is performed to determine wave parameters of the discrete waves in step S25. Medbo at [0076] FIG. 6 is a schematic block diagram illustrating an example of a channel estimator according to an embodiment. The channel estimator 100 is configured to operate based on a discrete wave channel model and measured channel responses between a transmitter having at least one transmit antenna and a receiver having at least one receive antenna. The channel estimator 100 basically comprises a windowed likelihood determiner 120 and a maximization processor 130. The windowed likelihood determiner 120 is

Claim Element	Exemplary Citations to Medbo
	configured to determine a windowed likelihood function based on the measured channel responses, a selected window function, and modeled channel responses defined based on a number of discrete waves according to the discrete wave channel model. Each one of the discrete waves is associated with wave parameters to be determined including at least one of wave propagation direction(s) and wave propagation delay. The maximization processor 130 is configured to perform maximization of the windowed likelihood function, using initial input in the form of at least one of predetermined wave propagation delay(s) and predetermined wave propagation direction(s) for at least one of the discrete waves, to extract the wave parameters of the discrete waves. Medbo at [0080] FIG. 7 is a schematic block diagram illustrating an example of a channel estimator according to another embodiment. The channel estimator 100 of FIG. 7 basically comprises a windower 112, a windowed likelihood determiner 120, an initializer 125 and a maximization processor 130. The windower 112 is configured to window the measured channel responses according to the window function to produce windowed measured channel responses, and the initializer 125 is configured to determine the initial input in the form of at least one of predetermined wave propagation delay(s) and predetermined wave propagation direction(s) for at least one of the discrete waves based on the windowed measured channel responses. Medbo at [0082] FIG. 8 is a schematic block diagram illustrating an example of a channel estimator according to yet another embodiment. The channel estimator 100 of FIG. 8 basically comprises a windower 112, a clipper 114, a windowed likelihood determiner 120, an initializer 125 and a maximization processor 130. The windower 112 is configured to window the measured channel responses according to the window function to produce windowed measured channel responses. The clipper 114 is configured for clipping samples of the windowed measured channel responses to produce remaining windowed measured channel responses. The initializer 125 is configured to determine the initial input in the form of at least one of predetermined wave propagation delay(s) and predetermined wave propagation direction(s) for at least one of the discrete waves based on the remaining windowed measured channel responses. The windowed likelihood determiner 120 is configured to window modeled channel responses according to the window function to produce windowed modeled channel responses, and to determine the windowed likelihood function based on the remaining windowed measured channel responses and windowed modeled channel responses corresponding to the remaining windowed measured channel responses. It should be understood that only windowed modeled channel responses corresponding to the remaining windowed measured channel response are needed to be defined in the windowed likelihood function.

Claim Element	Exemplary Citations to Medbo
	Medbo at [0120]–[0123] In order to achieve positive definite $\mathbf{CH}^H\mathbf{C}$ the antennas used must account for the full polarization matrix. If this is not the case, the channel corresponding to the actual antenna polarizations may be used. It should be noted that different amplitudes A'_{jl} corresponding to different antenna elements may not be orthogonal [Equation] The expression corresponding to (13) is [Equation] which may be vectorized in the same manner as above. It should be noted that (13) and (19) are in practice identical when A'_{jl} corresponds to orthogonal antenna polarizations. To the extent this element is not disclosed by Medbo, it would have been obvious to one of ordinary skill in the art to combine, with the teachings of Medbo, those elements, as known to them or as disclosed by other prior art identified in the cover pleading.
22. The wireless device of claim 19, wherein the path parameter information is obtained by at least one estimation technique of the group consisting of a maximum likelihood estimation algorithm, periodogram, correlatorgram, spectral-based methods, Bartlett beamformers, Capon beamformers, subspace-based techniques, MUSIC (Multiple Signal Classification), ESPRIT (Estimation of Signal Parameters via Rotational Invariance Techniques), approximation of the maximum-likelihood method based on iterative schemes, SAGE (Space-Alternating Generalized Expectation-maximization), RiMAX (Richter's Maximum Likelihood method), maximum-a-posteriori based methods, Evidence Framework, Bayesian	Medbo discloses or renders obvious “[t]he wireless device of claim 19, wherein the path parameter information is obtained by at least one estimation technique of the group consisting of a maximum likelihood estimation algorithm, periodogram, correlatorgram, spectral-based methods, Bartlett beamformers, Capon beamformers, subspace-based techniques, MUSIC (Multiple Signal Classification), ESPRIT (Estimation of Signal Parameters via Rotational Invariance Techniques), approximation of the maximum-likelihood method based on iterative schemes, SAGE (Space-Alternating Generalized Expectation-maximization), RiMAX (Richter's Maximum Likelihood method), maximum-a-posteriori based methods, Evidence Framework, Bayesian techniques, tracking algorithms, Kalman filtering techniques, enhanced Kalman filtering techniques, particle filtering techniques, and least-square-error methods.” For example: Medbo at Abstract The present technology relates to a channel estimator configured to operate based on a discrete wave channel model and measured channel responses between a transmitter having at least one transmit antenna and a receiver having at least one receive antenna. The channel estimator comprises a windowed likelihood determiner and a maximization processor. The windowed likelihood determiner is configured to determine a windowed likelihood function based on the measured channel responses, a selected window function, and modeled channel responses defined based on a number of discrete waves according to the discrete wave channel model. The maximization processor is configured to perform maximization of the windowed likelihood function, using initial input in the form of at least one of predetermined wave propagation delay(s) and predetermined wave propagation direction(s) for at least one of the discrete waves, to extract the wave parameters of the discrete waves.

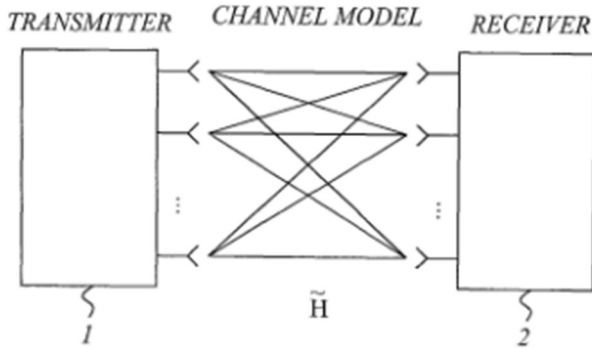
Claim Element	Exemplary Citations to Medbo
techniques, tracking algorithms, Kalman filtering techniques, enhanced Kalman filtering techniques, particle filtering techniques, and least-square-error methods.	Medbo at Figure 2A  Fig. 2A Medbo at Figure 2B  Fig. 2B Medbo at [0003] An advanced approach for channel estimation is based on discrete wave channel modeling involving a number of discrete waves, combined with Maximum Likelihood (ML) parameter estimation. Medbo at [0004] It is well known that Maximum Likelihood in principle is one of the most accurate methods available. It suffers however from considerable computational complexity. The basic problem is that maximization is not feasible with respect to all waves and the corresponding parameters simultaneously. Different methods have previously been proposed for complexity reduction like Space Alternating Generalized Expectation (SAGE) maximization, and a maximum likelihood framework called RIMAX [1]. The problem with SAGE is that the convergence is very slow when the estimated parameters are dependent on each other. This problem is to a large extent solved with RIMAX which uses a gradient based method to find a local maximum. The problem with RIMAX is however that all parameters in principle have to be estimated simultaneously. Though the convergence is much faster it is still not feasible to handle the number of waves which in most practical cases may be several hundreds. For RIMAX this is solved by identifying groups of uncoupled waves and performing sequential maximization for parameters within

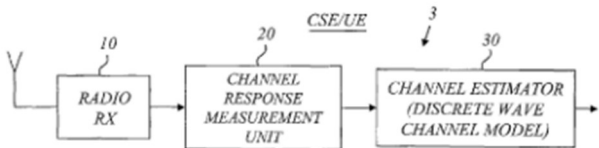
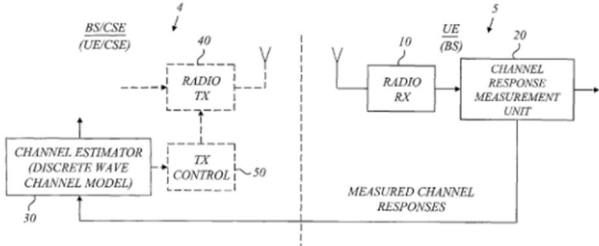
Claim Element	Exemplary Citations to Medbo
	these groups. It is however difficult, and often not even possible, to find uncoupled groups of waves, i.e. groups of waves with no or low correlation and/or with no or low power overlap. Medbo at [0010] In a first aspect, there is provided a method of channel estimation based on a discrete wave channel model and measured channel responses between a transmitter having at least one transmit antenna and a receiver having at least one receive antenna. A basic idea is to determine a windowed likelihood function based on the measured channel responses, a selected window function, and modeled channel responses defined based on a number of discrete waves according to the discrete wave channel model. Each one of the discrete waves is associated with wave parameters to be determined including at least one of wave propagation direction(s) and wave propagation delay. Subsequently, maximization of the windowed likelihood function is performed, using initial input in the form of at least one of predetermined wave propagation delay(s) and predetermined wave propagation direction(s) for at least one of the discrete waves, to determine the wave parameters of the discrete waves. Medbo at [0041] FIG. 2A is a schematic diagram illustrating an example of a unit having a channel estimator operating based on a discrete wave channel model, using measured channel responses obtained by the unit itself. In this particular example, the unit 3 comprises, among other standard radio components, a standard radio receiver (RX) 10, a channel response measurement unit 20, and a channel estimator 30 operating based on a discrete wave channel model. The channel response measurement unit 20 is sometimes also referred to as a channel estimator, but, compared to the channel estimator 30, the channel response measurement unit 20 normally only operates to more or less directly provide measured channel responses based on known reference symbols. The measured channel responses can for example be represented in frequency, time/delay, code and/or space. The channel estimator 30, however, operates based on a discrete wave channel model and makes use of the measured channel responses from the channel response measurement unit 20 to determine wave parameters associated with a number of discrete waves. The unit 3 may for example be a channel sounding equipment (CSE) or a user equipment (UE). Medbo at [0042] FIG. 2B is a schematic diagram illustrating an example of a unit having a channel estimator operating based on a discrete wave channel model, using measured channel responses obtained from one or more other units. For example, the unit 4 may be a base station (BS) or a channel sounding equipment (CSE), and the unit 5 may be a user equipment. Alternatively, the unit 4 may be a user equipment, and the unit 5 may be a base station, or both units 4 and 5 may be channel sounding equipment. The unit 4 basically comprises a channel estimator 30 operating based on a discrete wave channel model. The channel

Claim Element	Exemplary Citations to Medbo
	estimator 30 also operates based on measured channel responses obtained from one or more other units such as unit 5. The unit 5 comprises at least a radio receiver (RX) 10 and a channel response measurement unit 20, and can transfer the measured channel responses to the unit 4, e.g. via a radio control interface. The unit 4 can then receive the measured channel responses, e.g. via the radio control interface. Medbo at [0046] General information on channel estimation based on a discrete wave channel model using Maximum Likelihood techniques can be found in reference [1]. A review of radio channel sounding techniques can also be found in reference [2]. It is also well known that the corresponding computational complexity is huge. The complexity problem has been treated before and partly solved by methods like SAGE and RIMAX [1]. Medbo at [0048] FIG. 3 is a schematic flow diagram illustrating an example of a method of channel estimation according to an embodiment. The method is based on a discrete wave channel model and measured channel responses between a transmitter having at least one transmit antenna and a receiver having at least one receive antenna. Step S1 includes determining a windowed likelihood function based on the measured channel responses, a selected window function, and modeled channel responses defined based on a number of discrete waves according to the discrete wave channel model. Each one of the discrete waves is associated with wave parameters to be determined including at least one of wave propagation direction(s) and wave propagation delay. Step S2 includes performing maximization of the windowed likelihood function, using initial input in the form of at least one of predetermined wave propagation delay(s) and predetermined wave propagation direction(s) for at least one of the discrete waves, to determine the wave parameters of the discrete waves. Medbo at [0049] The use of a windowed likelihood function enables a more efficient and accurate estimation of the wave parameters. The window function is preferably designed such that waves being separated by a certain distance in at least one of wave propagation delay and wave propagation direction are substantially decoupled. Decoupled waves implies that the waves have no or low correlation and/or no or low power overlap. The windowing thus makes it possible to find independent or decoupled groups of waves, which is beneficial with respect to both accuracy and computational efficiency. Medbo at [0060] FIG. 4 is a schematic flow diagram illustrating an example of a method of channel estimation according to another embodiment. In this example, the measured channel responses are windowed according to the

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	window function to produce windowed measured channel responses in step S11. The initial input in the form of at least one of predetermined wave propagation delay(s) and predetermined wave propagation direction(s) for at least one of the discrete waves is determined based on the windowed measured channel responses in step S12. In the discrete wave channel model, the channel responses are also windowed according to the window function to produce windowed modeled channel responses, and the windowed likelihood function is determined in step S13 based on the windowed measured channel responses and the windowed modeled channel responses. The windowing of the modeled channel responses can be seen as part of the determining of the windowed likelihood function in step S13. Subsequently, maximization of the windowed likelihood function is performed to determine wave parameters of the discrete waves in step S14. Medbo at [0062] FIG. 5 is a schematic flow diagram illustrating an example of a method of channel estimation according to yet another embodiment. In this example, the measured channel responses are windowed according to the window function to produce windowed measured channel responses in step S21. In step S22, samples of the windowed measured channel responses are clipped to produce remaining windowed measured channel responses. The initial input in the form of at least one of predetermined wave propagation delay(s) and predetermined wave propagation direction(s) for at least one of the discrete waves is determined based on the remaining windowed measured channel responses in step S23. In the model, the channel responses are also windowed according to the window function to produce windowed modeled channel responses, and the windowed likelihood function is determined in step S24 based on the remaining windowed measured channel responses and windowed modeled channel responses corresponding to the remaining windowed measured channel responses. The windowing of the modeled channel responses can be seen as part of the determining of the windowed likelihood function in step S24. It should also be understood that only windowed modeled channel responses corresponding to the remaining windowed measured channel response are needed to be defined in the windowed likelihood function. Subsequently, maximization of the windowed likelihood function is performed to determine wave parameters of the discrete waves in step S25. Medbo at [0076] FIG. 6 is a schematic block diagram illustrating an example of a channel estimator according to an embodiment. The channel estimator 100 is configured to operate based on a discrete wave channel model and measured channel responses between a transmitter having at least one transmit antenna and a receiver having at least one receive antenna. The channel estimator 100 basically comprises a windowed likelihood determiner 120 and a maximization processor 130. The windowed likelihood determiner 120 is

Claim Element	Exemplary Citations to Medbo
	configured to determine a windowed likelihood function based on the measured channel responses, a selected window function, and modeled channel responses defined based on a number of discrete waves according to the discrete wave channel model. Each one of the discrete waves is associated with wave parameters to be determined including at least one of wave propagation direction(s) and wave propagation delay. The maximization processor 130 is configured to perform maximization of the windowed likelihood function, using initial input in the form of at least one of predetermined wave propagation delay(s) and predetermined wave propagation direction(s) for at least one of the discrete waves, to extract the wave parameters of the discrete waves. Medbo at [0080] FIG. 7 is a schematic block diagram illustrating an example of a channel estimator according to another embodiment. The channel estimator 100 of FIG. 7 basically comprises a windower 112, a windowed likelihood determiner 120, an initializer 125 and a maximization processor 130. The windower 112 is configured to window the measured channel responses according to the window function to produce windowed measured channel responses, and the initializer 125 is configured to determine the initial input in the form of at least one of predetermined wave propagation delay(s) and predetermined wave propagation direction(s) for at least one of the discrete waves based on the windowed measured channel responses. Medbo at [0082] FIG. 8 is a schematic block diagram illustrating an example of a channel estimator according to yet another embodiment. The channel estimator 100 of FIG. 8 basically comprises a windower 112, a clipper 114, a windowed likelihood determiner 120, an initializer 125 and a maximization processor 130. The windower 112 is configured to window the measured channel responses according to the window function to produce windowed measured channel responses. The clipper 114 is configured for clipping samples of the windowed measured channel responses to produce remaining windowed measured channel responses. The initializer 125 is configured to determine the initial input in the form of at least one of predetermined wave propagation delay(s) and predetermined wave propagation direction(s) for at least one of the discrete waves based on the remaining windowed measured channel responses. The windowed likelihood determiner 120 is configured to window modeled channel responses according to the window function to produce windowed modeled channel responses, and to determine the windowed likelihood function based on the remaining windowed measured channel responses and windowed modeled channel responses corresponding to the remaining windowed measured channel responses. It should be understood that only windowed modeled channel responses corresponding to the remaining windowed measured channel response are needed to be defined in the windowed likelihood function.

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	To the extent this element is not disclosed by Medbo, it would have been obvious to one of ordinary skill in the art to combine, with the teachings of Medbo, those elements, as known to them or as disclosed by other prior art identified in the cover pleading.
23. The wireless device of claim 19, wherein the receiver comprises multiple antennas in a multiple-input and multiple-output (MIMO) wireless communication system or a single antenna in a single-input and single-output (SISO) wireless communication system.	Medbo discloses or renders obvious “[t]he wireless device of claim 19, wherein the receiver comprises multiple antennas in a multiple-input and multiple-output (MIMO) wireless communication system or a single antenna in a single-input and single-output (SISO) wireless communication system.” For example: Medbo at Abstract The present technology relates to a channel estimator configured to operate based on a discrete wave channel model and measured channel responses between a transmitter having at least one transmit antenna and a receiver having at least one receive antenna. The channel estimator comprises a windowed likelihood determiner and a maximization processor. The windowed likelihood determiner is configured to determine a windowed likelihood function based on the measured channel responses, a selected window function, and modeled channel responses defined based on a number of discrete waves according to the discrete wave channel model. The maximization processor is configured to perform maximization of the windowed likelihood function, using initial input in the form of at least one of predetermined wave propagation delay(s) and predetermined wave propagation direction(s) for at least one of the discrete waves, to extract the wave parameters of the discrete waves. Medbo at Figure 1  <i>Fig. 1</i>

Claim Element	Exemplary Citations to Medbo
	Medbo at Figure 2A  Fig. 2A Medbo at Figure 2B  Fig. 2B Medbo at [0037]–[0038] FIG. 1A schematically illustrates an example of a radio channel, where a transmitter 1 has one or more transmit antennas and a receiver 2 has one or more receive antennas. In matrix form, the channel can be expressed as: [Equation] where y is the received signal vector, H is a complex channel matrix, x is the transmitted signal vector, σ is a vector representation of noise. The elements of the complex channel matrix H can be written as H_{mn}, which represents the “channel” between transmit antenna m and receive antenna n. The number N_{tx} of transmit antennas can vary from 1 and up, and the number N_{rx} of receive antennas can also vary from 1 and up. Expressed mathematically: $N_{tx} \geq 1$, and $N_{rx} \geq 1$. The following methodology is thus valid for Single-Input Single-Output (SISO), Single-Input Multiple-Output (SIMO), Multiple-Input Single-Output (MISO) and Multiple-Input Multiple-Output (MIMO) antenna cases. Medbo at [0041] FIG. 2A is a schematic diagram illustrating an example of a unit having a channel estimator operating based on a discrete wave channel model, using measured channel responses obtained by the unit itself. In this particular example, the unit 3 comprises, among other standard radio components, a standard radio receiver (RX) 10, a channel response measurement unit 20, and a channel estimator 30 operating based on a discrete wave channel model. The channel response measurement unit 20 is sometimes also referred to

Claim Element	Exemplary Citations to Medbo
	as a channel estimator, but, compared to the channel estimator 30, the channel response measurement unit 20 normally only operates to more or less directly provide measured channel responses based on known reference symbols. The measured channel responses can for example be represented in frequency, time/delay, code and/or space. The channel estimator 30, however, operates based on a discrete wave channel model and makes use of the measured channel responses from the channel response measurement unit 20 to determine wave parameters associated with a number of discrete waves. The unit 3 may for example be a channel sounding equipment (CSE) or a user equipment (UE). Medbo at [0042] FIG. 2B is a schematic diagram illustrating an example of a unit having a channel estimator operating based on a discrete wave channel model, using measured channel responses obtained from one or more other units. For example, the unit 4 may be a base station (BS) or a channel sounding equipment (CSE), and the unit 5 may be a user equipment. Alternatively, the unit 4 may be a user equipment, and the unit 5 may be a base station, or both units 4 and 5 may be channel sounding equipment. The unit 4 basically comprises a channel estimator 30 operating based on a discrete wave channel model. The channel estimator 30 also operates based on measured channel responses obtained from one or more other units such as unit 5. The unit 5 comprises at least a radio receiver (RX) 10 and a channel response measurement unit 20, and can transfer the measured channel responses to the unit 4, e.g. via a radio control interface. The unit 4 can then receive the measured channel responses, e.g. via the radio control interface. Medbo at [0103] The number Ntx of transmit antennas can vary from 1 and up, and the number Nr_x of receive antennas can also vary from 1 and up: $N_{tx} \geq 1$, and $N_{rx} \geq 1$. The methodology is thus valid for Single-Input Single-Output (SISO), Single-Input Multiple-Output (SIMO), Multiple-Input Single-Output (MISO) and Multiple-Input Multiple-Output (MIMO) antenna cases. To the extent this element is not disclosed by Medbo, it would have been obvious to one of ordinary skill in the art to combine, with the teachings of Medbo, those elements, as known to them or as disclosed by other prior art identified in the cover pleading.