Summary of available patent families

Our ref	Title	Patent family reference	Patent Family
IP-1	Carrier-phase difference detection and tracking in multipoint broadcast channels	US8837525	US, CN
IP-2	Maximum-likelihood MIMO demodulation for frequency-selective channels	US8705647	US
IP-3	Carrier-phase difference detection with mismatched transmitter and receiver delays	US8792372	US, CN
IP-4	Phase synchronization of base stations via mobile feedback in multipoint broadcasting	US8478203	US, CN
IP-5	Wideband analog channel information feedback	US8644265	US, CN
IP-6	Heterogeneous pilots	US9137077	US, CN
IP-7	Channel feedback in OFDM systems	US8908587	US, CN
IP-8	Channel estimation by time-domain parameter extraction	US9571305	US, CN
IP-9	Sparse channel detection, estimation, and feedback	US9031169	US, CN
IP-10	Coordinated multi-point transmission and multi-user MIMO	US9125074	US, CN

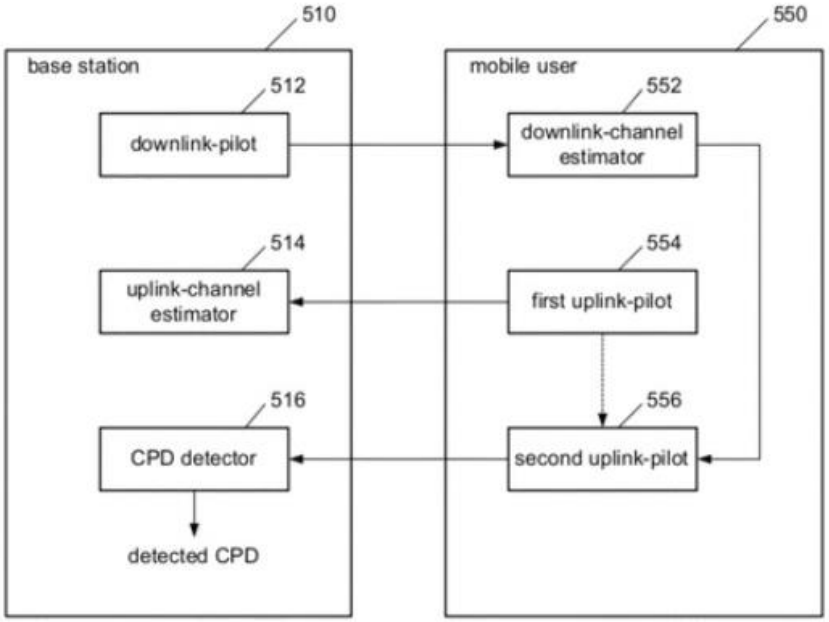
IP-1, US8837525: Carrier-phase difference detection and tracking in multipoint broadcast channels

An invention:
The downlink channel information can be derived from uplink channel information, when the Carrier-phase difference (CPD) is known.

A need for the invention:
As the number of channels is high in multipoint broadcasting the feedback overhead on uplink channel diminishes uplink capacity (especially in a TDD environment).

A patent family:
Granted US and CN patents

Links to patent publications:
Espacenet patent database
US8837525
CN102546491B



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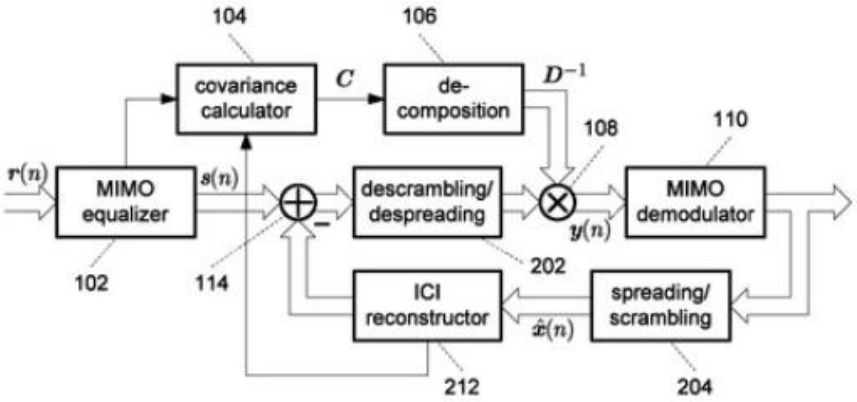
IP-2, US8705647: Maximum-likelihood MIMO demodulation for frequency-selective channels

An invention:
The invention is using maximum-likelihood (ML) demodulation in wideband MIMO systems where equalization has to be performed first to suppress the inter-symbol interference (ISI) or inter-chip interference (ICI). To apply ML or near-ML demodulation on the equalized signal, an equivalent MIMO channel matrix and a noise covariance matrix of the equalizer output will be constructed. Noise de-correlation is then applied to the equalized signal. Much improved performance can be achieved by optimum ML or near-ML demodulations after de-correlation.

A need for the invention:
A need to improve the performance of a wideband MIMO receiver.

A patent family:
Granted US patent

Links to patent publications:
Espacenet patent database
US8705647



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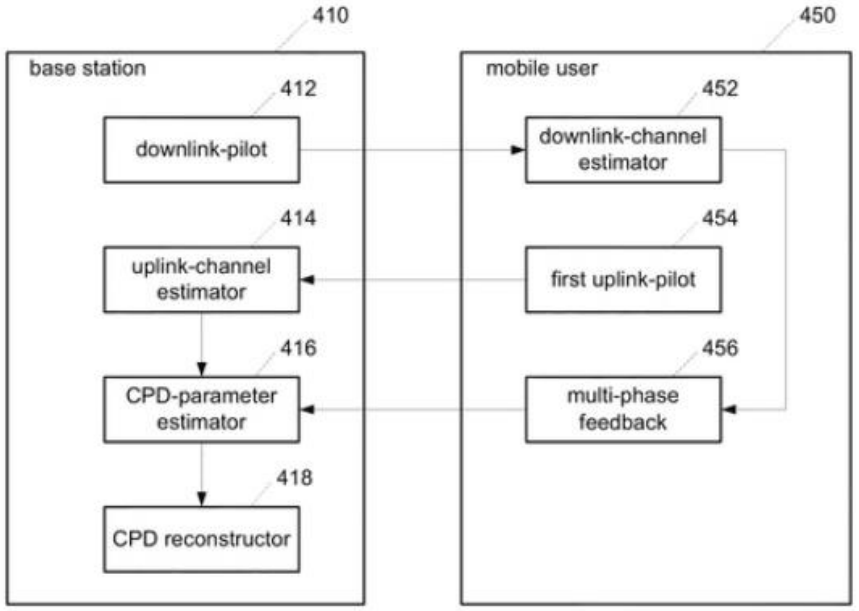
IP-3, US8792372: Carrier-phase difference (CPD) detection with mismatched transmitter and receiver delays

An invention:
How to determine a CPD.

A need for the invention:
CPD determination is needed for feedback overhead reduction on uplink channel (especially in TDD environment)

A patent family:
Granted US and CN patents

Links to patent publications:
Espacenet patent database
US8792372
CN102685042B



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IP-4, US8478203: Phase synchronization of base stations via mobile feedback in multipoint broadcasting

An invention:
How the phase synchronization of base stations can be made independent of multipoint-broadcast sessions and by utilizing the determined CPD.

A need for the invention:
In some aspects of the subject disclosure, the base-station set in a multipoint-broadcast session relies on only one mobile user for downlink-channel phase feedback. The base-station set uses the feedback from the mobile user to detect the CPDs, and then uses the detected CPDs to achieve phase synchronization in the sense that each base station in the set has the knowledge of the relative phases between any base-station pair in the base-station set. Such knowledge, together with the pilots in downlink transmissions as phase references for mobile users, is sufficient for the base stations to determine the pre-coding matrix for multipoint broadcasting. As a result, the feedback overhead in resource domain is greatly reduced.

A patent family:
Granted US and CN patents

Links to patent publications:
Espacenet patent database
US8478203
CN102917454B

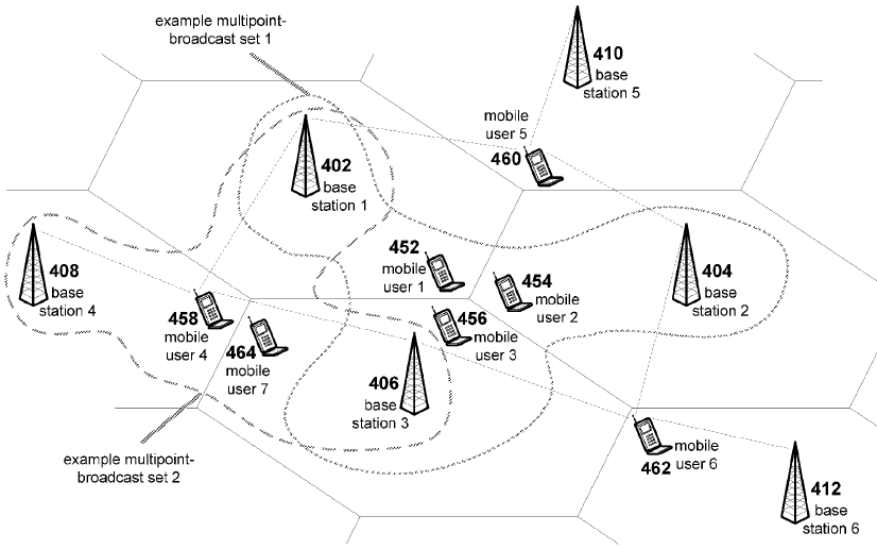

FIG. 4

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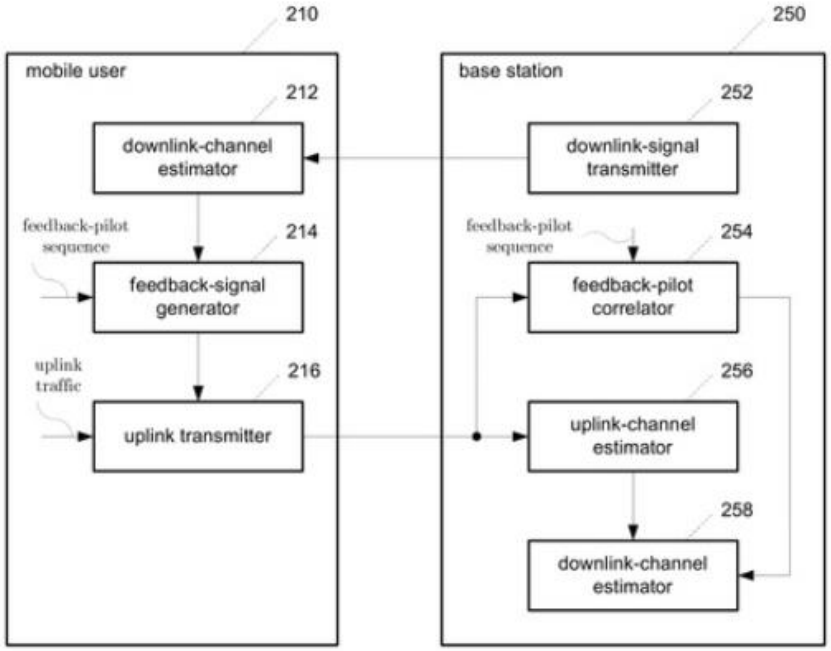
IP-5, US8644265: Wideband analog channel information feedback

An invention:
The downlink channel information can be fed back by analog channel from a mobile device to a base station.

A need for the invention:
Feedback overhead reduction in a FDD environment.

A patent family:
Granted US and CN patents

Links to patent publications:
Espacenet patent database
US8644265
CN102843222B



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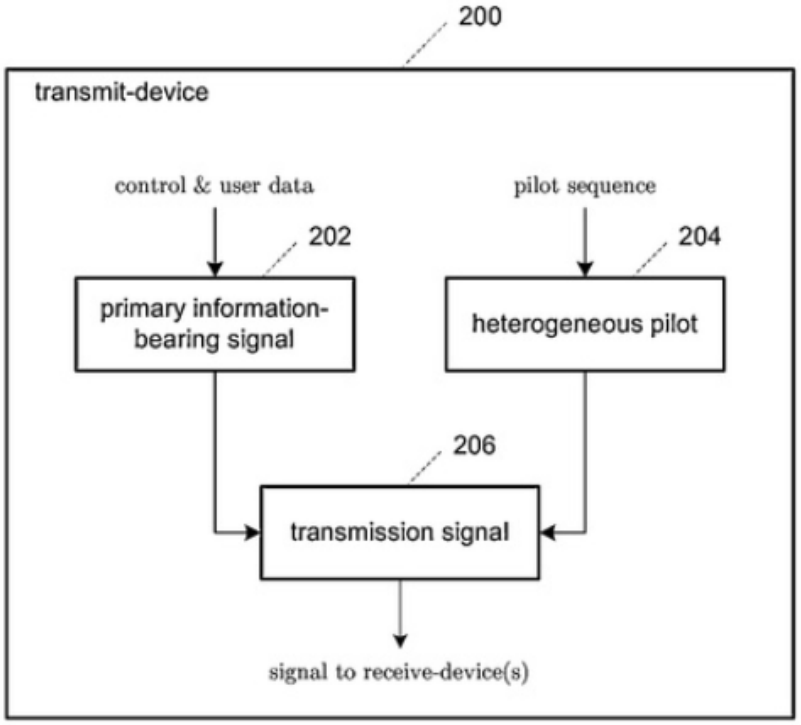
IP-6, US9137077: Heterogeneous pilots

An invention:
A heterogeneous pilot is a signal that has different signal structures and/or characteristics from that of the primary information-bearing signal (e.g. OFDM vs. CDMA). A heterogeneous pilot thus does not use any resources of the primary information-bearing signal.

A need for the invention:
There are need for several types of reference signals and minimized usage of network resources.

A patent family:
Granted US and CN patents

Links to patent publications:
Espacenet patent database
US9137077
CN102916782B



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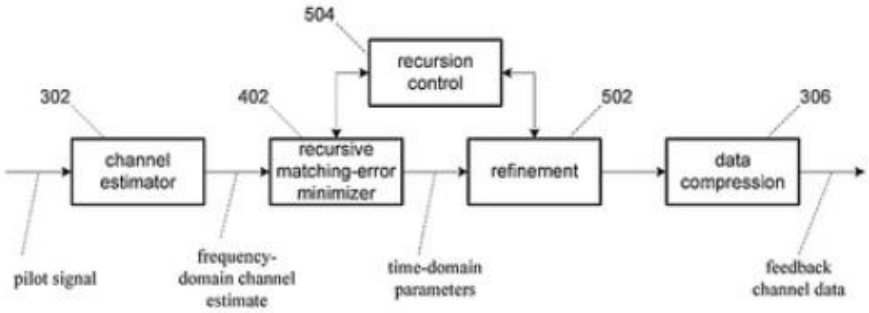
IP-7, US8908587: Channel feedback in OFDM systems

An invention:
Based on a continuous time-domain channel model, the time-domain parameters are derived from the frequency-domain channel samples. The time-domain parameters in the continuous time domain include the number of multipaths, multipath delays, and multipath amplitudes. The time-domain parameters require a much smaller data size to describe than the frequency-domain channel samples, regardless of the delay spread of the channel, thereby incurring a much smaller feedback overhead.

A need for the invention:
Overhead reduction in a FDD domain.

A patent family:
Granted US and CN patents

Links to patent publications:
Espacenet patent database
US8908587
CN103067134B



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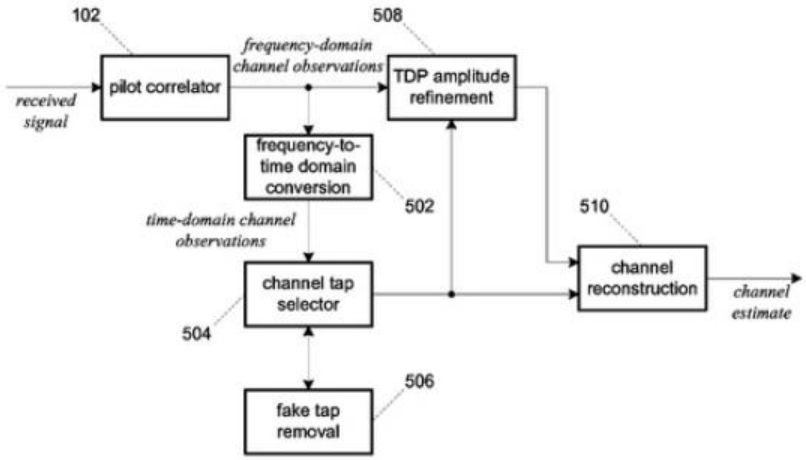
IP-8, US9571305: Channel estimation by time-domain parameter extraction

An invention:
The subject disclosure provides for improved channel estimation by extracting the time-domain parameters (TDP) of the channel from the channel observations. The TDPs can be considered as the time-domain representation of the channel estimation. The reconstructed channel from the extracted TDPs is more accurate than the channel observations that were used as the channel estimations in prior art.

A need for the invention:
An Improved channel estimation is needed as the quality of the channel estimation directly influences the receiver performance in terms of bit error rate and/or block error rate.

A patent family:
Granted US patent and pending CN application

Links to patent publications:
Espacenet patent database
US9571305
CN103716262A



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IP-9, US9031169: Sparse channel detection, estimation, and feedback

An invention:
Various detection variables can be used for sparse channel detection, including the relative captured channel energy, the relative captured total energy, and the matching error.

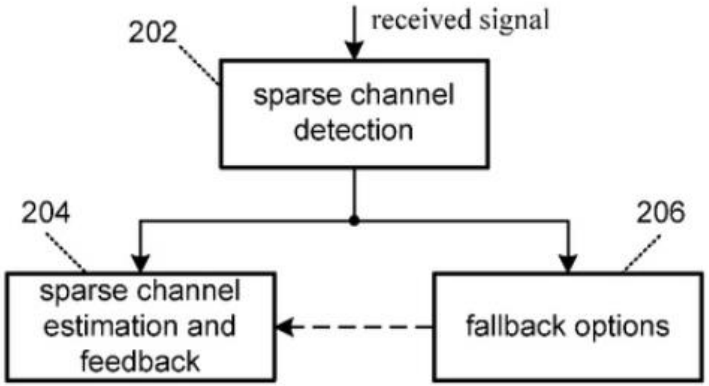
In some other aspects of the subject disclosure, continuous time domain parameter (TDP (CTDP)) extraction is used for channel estimation and feedback.

In yet other aspects of the subject disclosure, various fallback options for channel estimation and feedback can be selected when the channel is determined to be non-sparse.

A need for the invention:
Sparse channel detection is performed typically on the received signal. This ensures the high estimation quality and low feedback overhead when sparse channel-based algorithms are used on channels that are determined to be sparse.

A patent family:
Granted US and CN patents

Links to patent publications:
Espacenet patent database
US9031169
CN103997470B



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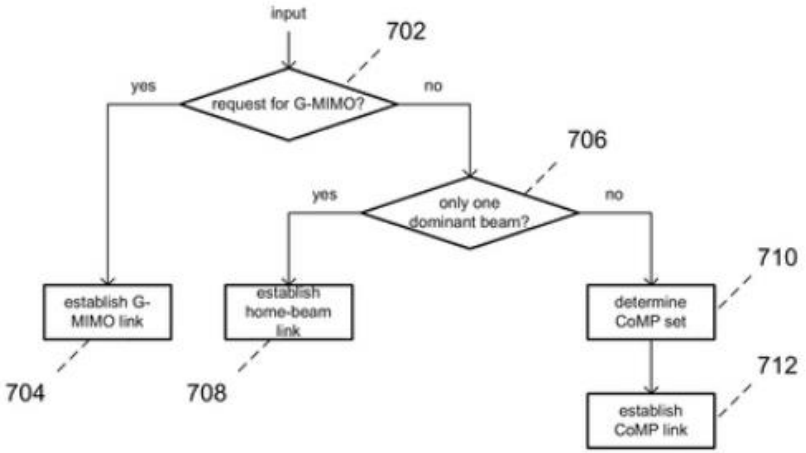
IP-10, US9125074: Coordinated multi-point transmission and multi-user (MU) MIMO

An invention:
In some aspects of the subject disclosure, a scheme called reference-signal grid of beam (RS-GOB) is used to distribute the effective antennas of a base station among multiple beams, which significantly reduces the number of downlink channels that have to be fed back, thereby significantly reducing the channel feedback overhead.

A need for the invention:
Channel feedback overhead reduction in coordinated multi-point transmission (CoMP) is needed and achieved by providing a flexible spatial structure on MU-MIMO beams, and yet allowing high-throughput mobile users to achieve their maximum throughput.

A patent family:
Granted US and CN patents

Links to patent publications:
Espacenet patent database
US9125074
CN104079332B



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