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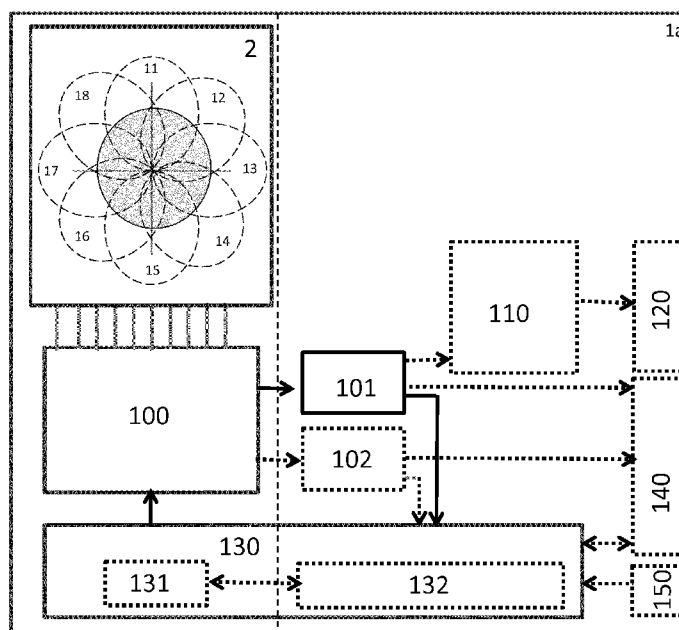


Figure 3a

(57) Abstract: A method for operating a digital signal receiver is disclosed. A salient idea of the present principles is to use a smart antenna system embedded in a digital signal receiver, the smart antenna system being operable in an omnidirectional mode and in a plurality of directional modes, the smart antenna system being further associated with a two steps installation method of the digital signal receiver. The first step of the installation method comprises determining an indoor location for positioning the digital signal receiver based on measuring the signal strength of the available RF channels received through an omnidirectional radiation pattern of the smart antenna system. The second step of the installation method comprises configuring the smart antenna system, located at the determined location by the selection of a directional mode for each channel, based on a signal quality such as a signal to noise ratio, a bit error rate or any combination thereof. The smart antenna system can also be advantageously leveraged by a further optional step of



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METHOD AND APPARATUS FOR OPERATING A DIGITAL SIGNAL RECEIVER

1. TECHNICAL FIELD

5 The technical field of the disclosed method, system and apparatus is related to the indoor reception of digital television signals.

2. BACKGROUND ART

10 Digital Terrestrial Television (DTT) distribution is popular all around the world. Traditionally DTT receivers use an outdoor antenna located on the roof of buildings for ensuring a good reception quality. Using small size indoor antenna rather than roof-top antenna would improve the user experience by simplifying the product, reducing the wiring and making the installation easier in the building. However using small size indoor antennas for receiving DTT
15 signals raises at least three challenges. First, receiving DTT signals using a small size antenna for example integrated to the product, in comparison with using roof top antenna gives rise to a drastic signal attenuation. Signal losses result from the antenna height loss due to the reflection from ground and the clearance of the Fresnel zone, the building penetration loss and the antenna
20 gain loss due to the limited size of the indoor/integrated antenna. The total extra-loss may vary from typically 20 dB up to 40 dB or more depending on the height, the type of building and the orientation regarding the broadcast tower. Second the exposure of the receiver to interferences from different broadcast towers is increased due to the use of small size antenna. Third, the
25 multipath issue is accentuated in an indoor context. Since there is often no direct line-of-sight signal path from the transmitter, indoor reception is further deteriorated by a large amount of multipath as the signal reflects on surrounding objects such as walls, ceilings and nearby buildings, and by dynamic multipath caused by moving objects such as vehicles and human
30 bodies. Furthermore, the frequency selective multipath fading worsen the signal strength and interferences issues. It is generally not easy for a user to find the best place for the localization of the product/antenna within the home,

in particular when taking into account the above issues. A method for automatic antenna/product installation within the home is therefore needed.

3. SUMMARY

5 A salient idea of the present principles is to use a smart antenna system embedded in a digital signal receiver, the smart antenna system being operable in an omnidirectional mode and in a plurality of directional modes, the smart antenna system being further associated with a two steps installation method of the digital signal receiver. The first step of the
10 installation method comprises determining an indoor location for positioning the digital signal receiver based on measuring the Received Signal Strength (RSS) of the available RF channels received through an omnidirectional radiation pattern of the smart antenna system. The second step of the installation method comprises configuring the smart antenna system, located
15 at the determined location by the selection of a directional mode for each channel, based on a signal quality such as a signal to noise ratio, a bit error rate or any combination thereof. The smart antenna system can also be advantageously leveraged by a further optional step of dynamic optimization of the signal quality in order to take into account dynamic changes of the
20 propagation conditions.

To that end a digital signal receiver device comprising an antenna operable in an omnidirectional mode and in a plurality of directional modes is disclosed. The digital signal receiver comprises a processor configured to:

- 25
- set the antenna in the omnidirectional mode for measuring a first RSS (Received Signal Strength) for a set of channels at various locations;
 - determine a location responsive to the first RSS measured at the location for the set of channels;
 - set the antenna in a directional mode selected for each channel based
30 on a first signal quality measured for each channel of the set of channels at the determined location.

According to a particularly advantageous variant, the processor is further configured to measure the first signal quality of each channel for each directional mode of the antenna.

5 According to another particularly advantageous variant, the digital signal receiver further comprises a first RF receiver connected to the antenna via a selector, the selector being adapted to configure the antenna in a first mode associated with the first RF receiver, the first mode being among the omnidirectional mode and the plurality of directional modes.

10 According to another particularly advantageous variant, the digital signal receiver further comprises a second RF receiver connected to the antenna via the selector, the selector being further adapted to configure the antenna in a second mode associated with the second RF receiver, in parallel of the first mode associated with the first RF receiver, the second mode being among the omnidirectional mode and the plurality of directional modes.

15 According to another particularly advantageous variant, the first RSS is measured for a first channel by the first receiver in parallel of a second RSS being measured by the second receiver for a second channel.

20 According to another particularly advantageous variant, the first signal quality is measured for a first channel by the first receiver in parallel of a second signal quality being measured by the second receiver for a second channel.

25 According to another particularly advantageous variant, the first RF receiver is configured to receive a TV program from the antenna, being configured in a first directional mode corresponding to a channel of the TV program, the second RF receiver being configured to sequentially configure the antenna in other directional modes and to measure the second signal quality of the channel of the TV program for each other directional mode.

According to a particularly advantageous variant, the processor is further configured to set the antenna in a second directional mode in case the

second signal quality measured by the second RF receiver as the second directional mode is set, is of higher quality than the first signal quality.

According to another particularly advantageous variant, the first and the second signal quality comprise a signal to noise ratio value.

5 According to another particularly advantageous variant, the first and the second signal quality comprise a bit error rate value.

According to another particularly advantageous variant, the set of channels corresponds to a subset of available channels, and is configurable by a user.

10

In a second aspect an antenna adapted to a digital signal reception is also disclosed. The antenna is operable in an omnidirectional mode and in a plurality of directional modes, the omnidirectional mode being used for measuring a received signal strength for a set of channels at various locations
15 so as to determine a location, a directional mode of the antenna being determined for each channel of the set of channels based on measuring a signal quality of each channel at the determined location.

In a third aspect a method for operating a digital signal receiver is also
20 disclosed. The digital signal receiver comprises an antenna operable in an omnidirectional mode and in a plurality of directional modes. The method comprises:

- measuring a first RSS (Received Signal Strength) for a set of channels at various locations;
- 25 - determining a location responsive to the first RSS measured at the location for the set of channels;
- determining a directional mode of the antenna at the determined location based on measuring a signal quality of each channel of the set of channels.

30

According to a particularly advantageous variant, the method further comprises:

- receiving a TV program from the antenna, being set in a first directional mode corresponding to a channel of the TV program,
- 5 - sequentially setting the antenna in other directional modes and measuring a second signal quality of the channel for each other directional mode.

10 In a fourth aspect, a computer program for operating a digital signal receiver comprising an antenna operable in an omnidirectional mode and in a plurality of directional modes is also disclosed. The computer program comprises program code instructions executable by at least one processor for:

- setting the antenna in the omnidirectional mode for measuring a first RSS (Received Signal Strength) for a set of channels at various
15 locations;
- determining a location responsive to the first RSS measured at the location for the set of channels;
- setting the antenna in a directional mode selected for each channel based on a first signal quality measured for each channel of the set of
20 channels at the determined location.

In a fifth aspect, the disclosed principles are directed to a computer program product comprising instructions of program code for execution by at least one processor to perform the disclosed method.

25

In a sixth aspect, a non-transitory computer-readable storage medium storing computer-executable program code instructions to operate a digital signal receiver comprising an antenna operable in an omnidirectional mode and in a plurality of directional modes is also disclosed. The program code
30 instructions are executable by at least one processor for:

- setting the antenna in the omnidirectional mode for measuring a first RSS (Received Signal Strength) for a set of channels at various locations;

- determining a location responsive to the first RSS measured at the location for the set of channels;
- setting the antenna in a directional mode selected for each channel based on a first signal quality measured for each channel of the set of channels at the determined location.

In a sixth aspect, a digital signal receiver device comprising an antenna operable in an omnidirectional mode and in a plurality of directional modes is disclosed. The digital signal receiver comprises a processor configured to:

- select a location based on a set of Received Signal Strength RSS values measured for a set of channels at different locations, with the antenna configured in the omnidirectional mode, the selected location corresponding to RSS values measured at that location for at least a part of the set of channels and meeting a first criterion;
- set the antenna in a directional mode selected for each channel, wherein a first signal quality of each channel of the set of channels is obtained for each directional mode at the selected location, the selected directional mode corresponding to the highest first signal quality of each channel of the set of channels.

According to a particularly advantageous variant, the processor is further configured to further select the location based on a set of quality indicator values determined for the set of channels at the different locations, with the antenna configured in the omnidirectional mode, the selected location corresponding to quality indicator values determined for that location for the at least part of the set of channels and meeting a second criterion, wherein a quality indicator value is determined for a given channel of the set of channels, by dividing a RSS value measured for the given channel of the set of channels by an average of a set of noise levels determined for a subset of the set of channels.

According to a particularly advantageous variant, a noise level of the set of noise levels is determined for each channel of the subset of the set of

channels by dividing a measured RSS value of the channel by a signal quality of the channel.

According to a particularly advantageous variant, wherein the signal quality belongs to a set at least comprising a Signal to Noise Ratio, SNR, and
5 Modulation Error Ratio, MER.

According to a particularly advantageous variant, the set of noise levels is determined for the subset of the set of channels prior to measuring the RSS value of the given channel.

According to a particularly advantageous variant, the given channel is
10 not included in the subset of the set of channels.

According to a particularly advantageous variant, the digital signal receiver further comprises a first RF receiver connected to the antenna via a selector, the selector being adapted to configure the antenna in a first mode associated with the first RF receiver, the first mode being among the
15 omnidirectional mode and the plurality of directional modes.

According to a particularly advantageous variant, the digital signal receiver further comprises a second RF receiver connected to the antenna via the selector, the selector being further adapted to configure the antenna in a second mode associated with the second RF receiver, in parallel of the first
20 mode associated with the first RF receiver, the second mode being among the omnidirectional mode and the plurality of directional modes.

According to a particularly advantageous variant, the set of RSS values for the set of channels are obtained by measuring a first RSS value for a first channel by the first RF receiver in parallel of measuring a second RSS value
25 by the second RF receiver for a second channel.

According to a particularly advantageous variant, the first signal quality of a first channel is obtained by the first RF receiver in parallel of a second signal quality of a second channel being obtained by the second RF receiver.

According to a particularly advantageous variant, the set of noise levels for the set of channels is obtained by measuring a first RSS and obtaining a first signal quality of a first channel by the first RF receiver in parallel of measuring a second RSS and obtaining a second signal quality of a second channel by the second RF receiver.

According to a particularly advantageous variant, the set of noise levels for the set of channels is obtained by measuring a first RSS and obtaining a first signal quality of a first channel by the first RF receiver in parallel of measuring a second RSS and obtaining a second signal quality of a second channel by the second RF receiver.

According to another particularly advantageous variant, the first RF receiver is configured to receive a TV program from the antenna, being configured in a first directional mode corresponding to a channel of the TV program, the second RF receiver being configured to sequentially configure the antenna in other directional modes and to obtain the second signal quality of the channel of the TV program for each other directional mode.

According to another particularly advantageous variant, the processor is further configured to set the antenna in a second directional mode in case the second signal quality obtained for the second RF receiver as the second directional mode is set, is of higher quality than the first signal quality.

According to another particularly advantageous variant, the first and the second signal quality belong to a set at least comprising a signal to noise ratio value and a bit error rate value.

According to another particularly advantageous variant, the set of channels corresponds to a subset of available channels, and is configurable by a user.

In a seventh aspect, a further digital signal receiver device is disclosed. The digital signal receiver comprises:

- a RF receiver;
- a processor configured to
 - o tune the RF receiver to a given channel;

- determine a quality indicator of the given channel, by dividing a RSS value measured for the given channel by an average of a set of noise levels determined for a plurality of channels;
- display the quality indicator of the given channel with an indication of whether the quality indicator meets a second criterion.

In an eighth aspect, a method for operating a digital signal receiver comprising an antenna operable in an omnidirectional mode and in a plurality of directional modes is disclosed. The method comprises:

- selecting a location based on a set of Received Signal Strength RSS values measured for a set of channels at different locations, with the antenna configured in the omnidirectional mode, the selected location corresponding to RSS values measured at that location for at least a part of the set of channels and meeting a first criterion;
- for each channel of the set of channels, determining a directional mode of the antenna for operating at the selected location, wherein a signal quality of each channel of the set of channels is obtained for each directional mode at the selected location, the determined directional mode of the channel corresponding to the highest first signal quality of the channel.

In a ninth aspect, a computer program product for operating a digital signal receiver comprising an antenna operable in an omnidirectional mode and in a plurality of directional modes is disclosed. The method comprises program code instructions executable by at least one processor for:

- selecting a location based on a set of Received Signal Strength RSS values measured for a set of channels at different locations, with the antenna configured in the omnidirectional mode, the selected location corresponding to RSS values measured at that location for at least a part of the set of channels and meeting a first criterion;
- setting the antenna in a directional mode selected for each channel, wherein a first signal quality of each channel of the set of channels is

obtained for each directional mode at the selected location, the selected directional mode corresponding to the highest first signal quality of each channel of the set of channels.

While not explicitly described, the present embodiments may be employed in any combination or sub-combination. For example, the present principles are not limited to the described variants, and any arrangement of variants and embodiments of a smart antenna system can be used. Moreover the present principles are not limited to the described omnidirectional and directional beam examples. The present principles are not further limited to the described signal quality metrics, and any other signal quality metric (measured or estimated from measured parameters are compatible with the disclosed principles. The present principles are not further limited to the described receivers comprising an integrated antenna and are applicable to any other receivers connected to an external indoor antenna.

Besides, any characteristic, variant or embodiment described for the digital signal receiver device is compatible with the further digital signal receiver device, the antenna, the smart antenna system the method for operating the digital signal receiver device, a computer program product comprising program code instructions and with a non-transitory computer-readable storage medium storing program instructions for performing the method in any variant.

4. BRIEF DESCRIPTION OF THE DRAWINGS

- **Figure 1a** describes a method for operating a digital signal receiver comprising an antenna operable in an omnidirectional mode and in a plurality of directional modes, according to a specific and non-limiting embodiment of the disclosed principles;
- **Figure 1b** details a step of the method of Figure 1a, according to a specific and non-limiting embodiment of the disclosed principles;
- **Figure 2** details another step of the method of Figure 1a, according to a specific and non-limiting embodiment of the disclosed principles;

- **Figure 3a** describes a processing device comprising an antenna operable in an omnidirectional mode and in a plurality of directional modes, according to a specific and non-limiting embodiment of the disclosed principles;
- 5 - **Figure 3b** describes a processing device for displaying a quality indicator of a given channel, according to a specific and non-limiting embodiment of the disclosed principles;
- **Figure 4a** describes an antenna operable in an omnidirectional mode and in a plurality of directional modes, according to a specific and non-limiting embodiment of the disclosed principles;
- 10 - **Figure 4b** represents an exemplary architecture of the processing device of figure 3 according to a specific and non-limiting embodiment of the present principles.

15 5. DESCRIPTION OF EMBODIMENTS

Figure 1a describes a method for operating a digital signal receiver comprising an antenna operable in an omnidirectional mode and in a plurality of directional modes, according to a specific and non-limiting embodiment of the disclosed principles. The digital signal receiver is for example a Digital
20 Terrestrial Television receiver, but any kind of receiver adapted to receive wireless digital signals from a set of radio frequency channels is compatible with the disclosed principles. The term channel is used throughout the description aiming at designating a Radio Frequency (RF) channel. Digital Terrestrial Television is for example compliant with the American ATSC
25 (Advanced Television Systems Committee) standard in any of its version, particularly the ATSC 3.0 version based on the OFDM (Orthogonal Frequency Division Multiplexing) technology. In another example, Digital Terrestrial Television is compliant with the DVB-T (Digital Video Broadcast – Terrestrial) standard in any of its version.

30 According to a specific and non-limiting embodiment of the disclosed principles, the antenna is integrated in the digital signal receiver, for example as a part of the main printed circuit board of the digital signal receiver and

does not need to be positioned independently from the digital signal receiver. According to this specific and non-limiting embodiment, the digital signal receiver further comprises a network interface for connection to a home network such as for example and without limitation an Ethernet, WiFi, or Powerline network. The network interface is for example configured to transmit over the home network a received television program to another device connected to the home network. There may be a large set of potential locations in a home for such kind of network devices, as they do not need to be located closed to a display device. For example, such digital signal receivers may be advantageously located in the attic of the home, being remotely configured from the network interface and benefiting of some more height (because being closer to the roof, but remaining protected from bad weather conditions). As mentioned above, DTT indoor reception, being sensitive to multipath, is highly depending on a location of the antenna. Identifying an indoor location with a good reception is of primary importance. Given the important number of potential locations and channels to test, the time response and the overall search time must be minimized and an adequate interface should be provided to the user, to facilitate his installation. Furthermore, for a given geographic location, there are generally several broadcast towers located in different directions and it not practical for the user to orientate the antenna/product at multiple directions. And even if this would have been feasible (using an adequate tool), it is not granted at all to find an orientation that allows the best reception for all the desired channels.

A salient idea is to associate a smart antenna system to a multi-step method comprising a first S1 and a second S2 step of installation of the digital signal receiver, wherein the smart antenna system is operable in an omnidirectional mode and in a plurality of directional modes. The smart antenna system is further configurable to operate several modes sequentially. For example, the smart antenna system is configurable for operating first in the omnidirectional mode, as described in the step S1, and then in a plurality of directional modes, as described in the step S2. The smart antenna system is further configurable to operate at least two modes in parallel, and to direct the received power corresponding to each mode towards a dedicated output.

For example, the smart antenna system is configurable to operate the omnidirectional mode twice in parallel, or to operate several different directional modes in parallel. The method further comprises an optional third step S3 of dynamically improving a signal quality of the digital signal receiver.

5 ***Step S1: Determining a best location for positioning the digital signal receiver in the home***

The idea is to use the power level of the RF channel received through the omnidirectional radiation mode of the antenna as an indicator of the average received signal strength of that channel at a given location within the home. To that end, a Received Signal Strength (RSS) is measured from the antenna operated in the omnidirectional mode, for a set of channels at various indoor locations. Using the omnidirectional mode advantageously allows the reception of all the existing channels from all broadcast towers with equal antenna gain, making thus possible to fairly compare all the various locations without orientation discrimination. Unlike more sophisticated signal quality measurements such as SNR (Signal to Noise Ratio) or BER (Bit Error Rate), which take some time required for the demodulation of the channel, the level of the received RF power is advantageously deducible from the value of the AGC (Automatic Gain control) available at the tuner/demodulator interface. A high value of the AGC implies low signal power while a low value implies a high signal power at the tuner stage. Modern tuners provide high dynamic ranges (typically over 80dB) of the AGC with settling time of the AGC of few tens of milliseconds. Although not always explicitly mentioned, the antenna is configured in the omnidirectional mode all along the step 1.

25 According to a specific and non-limiting embodiment a displayable user interface is used so as to assist a user in the installation step S1. The user for example triggers received signal strength measurements from the user interface of the digital signal receiver at each location among a set of candidate locations around the home. The displayable user interface provides a feedback to the user with regards to the measured values of received signal strength for the channels at the candidate locations. For example, bar graphs are used to instantaneously display average power information of the set of

channels at a candidate location. In a variant, a threshold value is determined by the digital signal receiver and is used by the user interface to change the color of a bar graph, depending on whether the measured received signal strength is above the threshold value (i.e. display the bar in green) or below the threshold value (i.e. display the bar in red). The threshold value is for example determined to take into account the minimum required signal level at the antenna input for proper reception. In another example, the threshold value takes into account the fact that the omnidirectional mode input is followed by a power splitter for feeding two parallel tuner/demodulator chains.

Also average improvement brought by the use of a directional mode of the antenna (i.e. antenna directional mode gain as well as multipath and interferences rejection gain), are taken into account for the estimation of this threshold value.

In an advantageous variant, the set of channels on which the received signal strength is measured by the digital signal receiver at various candidate locations, is a subset of the available channels and corresponds to a list of preferred channels. The list of preferred channels is for example determined from a list of preferred TV programs configured by a user from the user interface. Taking the United States as an example, a channel of 6 MHz includes between 1 and 6 programs with an average of 3 programs per channel. A channel comprising a preferred program as configured by the user is determined as a preferred channel. Optionally a priority order is also configured by the user for the preferred programs / channels via the user interface. There may be situations, where it is unlikely that an integrated small size antenna, even according to the disclosed principles could receive all the channels available with a good reception quality, for all homes, in a given location. Configuring a list of preferred TV programs with an optional priority order is advantageous as it allows displaying the measured received signal strength according to the priority as configured by the user, assisting the user in deciding what is the location fitting the greatest number of preferred channels / programs.

A location is determined by the digital signal receiver, wherein an acceptable RSS value has been measured, at that location, for at least a subset of the channels. The subset of the channels is for example a list of preferred channels corresponding to a list of preferred TV programs. In a first variant, after having triggered a measurement of RSS values of a set of channels on the digital signal receiver positioned at different candidate locations, the user completes the installation process by positioning the digital signal receiver in the location for which an acceptable RSS value has been measured, for example thanks to the display of the bar graphs described above in any of the variants. In that variant, the location is determined as the location at which, for example, the installation process is terminated from the user interface.

In a second variant, after various measurements of RSS values of a set of channels have been triggered on the digital signal receiver positioned at different candidate locations, the digital signal receiver automatically determines a location among the candidate locations based on the RSS values measured at the different candidate locations for at least a subset of the channels. For example, a location is selected if the RSS values measured at that location meet a first criterion for at least the subset of channels. More precisely, the location, also called best location, is determined for example from a metric calculated from the RSS values measured for the channels at the different candidate locations. There is for example a RSS value for each channel measured at each candidate location. In addition, a priority is associated with each channel. The priority is for example an integer, being 0, 1 or any value in an interval of values. Setting all the priorities to 1 represents considering all the available channels in the metric calculation. Setting the priority to 1 for some channels and to zero to other channels represents considering a set of preferred channels in the metric calculation. Setting the priority of the channels to a value greater than 1 for the preferred channels represents allocating a further prioritization among the preferred channels in the metric calculation. The metric for selecting the best channel is for example a weighted sum of the RSS values, wherein the weights are the priorities in any of their variants. In that example, the location corresponding to the

highest metric is selected as the best location. In another example, the fact that a RSS value is above a threshold value is further taken into account. For example the location for which the greatest number of preferred channels have a measured RSS value above a threshold value is selected as the best
5 location. Any combination of the previous examples and more generally any technique for automatically selecting a best location among candidate locations from RSS values measured at the different candidate locations for at least a subset of the channels is compatible with the disclosed principles. In that second variant, the selected location is for example suggested to the user
10 and validated by the user via the user interface.

More generally a location is selected based on a set of RSS values measured for a set of channels at different locations, with the antenna configured in the omnidirectional mode. More precisely, at each location among candidate locations, a set of local RSS values is obtained, one local
15 RSS value per channel of the set of channels at a given location. The location is selected among the candidate locations according to a first criterion, that is met by at least a subset of the set of local RSS values measured at that location for at least a subset of the channels. The first criterion does not need to be met by all the channels (i.e. all the values) but only for the RSS values
20 corresponding to the subset of the channels. The variants previously described are possible examples of such first criterion. Possible criteria to be met by the subset of local RSS values for a location to be selected, include without limitation: all local RSS values of the subset to be above a first value, at least a given number of local RSS values to be above the value, a weighted
25 sum of the local RSS values of the subset to be above a second value (the sum being weighted by channel priorities), no local RSS value to be below a third value, no more than another given number of local RSS values to be below the third value, ...

Considering the example of ATSC broadcast reception in the United
30 States, a typical number of seventy-five programs corresponds to typically twenty-five RF channels. Considering an AGC setting time of thirty milliseconds, the refreshment period of scanning all the RF channels is equal

for example to seven hundred fifty milliseconds leading to almost instantaneous assessment (at least in less than one second) of each location within the home. In an advantageous variant, a first RF receiver is used in parallel to a second RF receiver, each RF receiver comprising a RF tuner and a demodulator. This allows to divide by two the time needed for measuring a RSS for all the available channels, or for the preferred channels. More precisely, the first RF receiver measures the first RSS of a first subset of channels in parallel to the second RF receiver measuring a second RSS of a second subset of channels, the aggregation of the first and the second subsets of channels, corresponding to all the available channels, or all the preferred channels.

Figure 1b describes the step S1 of the method of Figure 1a, according to a specific and non-limiting embodiment of the disclosed principles. As previously mentioned, measuring RSS values with the antenna configured in the omnidirectional mode allows to quickly determine an amount of energy received at a given location, so as to fairly compare received amounts of energy at various locations without orientation discrimination. However, in some situations, measuring only the RSS value for a set of channels is not sufficient to assess a quality of reception as it may not be sufficiently representative of reception conditions at various locations. For example, in presence of a nearby interfering transmitter, excessive signal level, including out of band signal may induce significant in-band noise due mainly to amplifier/tuner non-linearity. In such a case, despite of a high RSS value, the reception conditions, due to interference may be very bad. Also, out of band emissions of an increasing number of licensed and unlicensed devices operating in the White Spaces may increase the noise floor, in particular in indoor conditions as they might be within few meters from the receiver. A salient idea is to determine, for the set of channels at various locations, in addition to the set of RSS values, a set of quality indicator values, that are more representative of reception conditions, while remaining efficient (i.e. fast) to determine. Similarly, to the RSS values measurement, the quality indicator values are determined in a short time compared to a more sophisticated signal quality as described in steps S2 and/or S3. Some signal quality metrics

such as for example and without limitation a Signal to Noise Ratio (SNR) or a Modulation Error Ratio (MER) are more representative of a reception condition than only the RSS. The SNR is a measure that compares the level of a desired signal to the level of background noise (SNR is noted C/N , C representing the signal level, N representing the background noise). The MER is a measure used to quantify the performance of a digital transmitter or receiver in a communications system using digital modulation, it is often noted $C/(N+I)$, C being the signal level, N the background noise and I the Interference level. A MER is a bit more complicated to determine than a SNR, but is also more realistic (because taking the Interferences into account). The signal quality metrics (SNR, MER) can be measured for a channel, but requires more time than only measuring a RSS value. To that end a background noise is estimated by performing a few noise measurements at the beginning of the process in a few channels, followed by an estimation of the signal quality (SNR or MER) of other channels based on only a measured RSS value and the estimated background noise. Estimating the signal quality for the other channels, based only the RSS and background noise is advantageous as it is faster than measuring the signal quality for every channel of the set of channels. The background noise is estimated by measuring a RSS value and obtaining a signal quality value in each channel of a subset of channels, for example comprising 3 channels, by determining and averaging noise levels. Considering using three RF receivers in parallel for estimating noise levels in each of the three channels in parallel would make the estimation of the background noise not longer than measuring a single signal quality. According to different variants, in each channel of the subset of channel, the quality signal is measured or estimated from other measured metrics. The SNR or the MER may either be directly measured by a RF receiver, or estimated from other measured metric such as for example and without limitations a number of uncorrected packets (calculable from a packet error rate), or a measured EVM (Error Vector Magnitude)

More formally and taking the SNR as an exemplary signal quality, the estimated SNR of a channel is determined by dividing a measured RSS value for that channel by the estimated background noise, and is noted

$(\text{SNR})_e = (\text{RSSI})_m / (N)_e$, where the “e” refers to “estimated”, and “m” refers to “measured”, “o” for obtained (being either measured or estimated).

The estimated background noise $(N)_e$ is obtained by averaging a set of noise levels determined for a subset of channels, wherein a noise level of the set of noise levels is determined for each channel of the subset of channels by dividing a measured RSS value of the channel by a SNR value obtained (measured or calculated) for the channel, as represented by the following formula:

$$(N)_e = (\sum_{i=1}^k [(\text{RSSI})_m / (\text{SNR})_o]_i) / k; k \text{ being the number of channels}$$

Advantageously, noise levels of different channels are determined in parallel by obtaining SNR and RSS values for different channels by different RF receivers in parallel. For example, the set of noise levels for the set of channels is obtained by measuring a first RSS value and obtaining a first signal quality value for a first channel by the first RF receiver in parallel of measuring a second RSS value and obtaining a second signal quality value by the second RF receiver for a second channel. A first noise level of the set of noise levels is then obtained by dividing the measured first RSS value by the obtained first signal quality value. Similarly, a second noise level of the set of noise levels is then obtained by dividing the measured second RSS value by the obtained second signal quality value. The disclosed principles are not limited to two RF receivers in parallel, and advantageously the number of noise levels determined in parallel corresponds to the number of RF receivers available in parallel in the digital receiver.

Referring to Figure 1b, in the sub-step S12, a location is selected among a set of candidate locations based on a set of Received Signal Strength RSS values measured for a set of channels at different locations of the set of candidate locations, with the antenna configured in the omnidirectional mode. A location is selected if the RSS values measured at that location for at least a part of the set of channels meet a first criterion, according to any variant described above.

In a following and optional sub-step S14, the location is further selected based on a set of quality indicator values determined for the set of channels at the different locations, with the antenna still configured in the omnidirectional mode. A location is selected if the quality indicator values determined for that location and for the at least part of the set of channels meet a second criterion.

For the sake of clarity, the set of quality indicator values are described below as a set of estimated SNR values, but any other type of indicator value such as for example an estimated MER is compatible with the disclosed principles. At each location of candidate locations, a set of local SNR values are estimated, one estimated local SNR value per channel of the set of channels at a given location. Advantageously, the set of noise levels is determined for the subset of the set of channels and the background noise is estimated prior to measuring the RSS value of a given channel for estimating the local SNR value of that given channel. Advantageously, the given channel is not comprised in the subset of the set of channels (on which the background noise estimation is based). Indeed, for channels belonging to the subset of channels, the local SNR value is measured and does not need to be estimated.

The location is selected among the candidate locations according to a second criterion, to be met by at least a subset of the set of local SNR values estimated for that location and for at least a subset of the channels. The second criterion does not need to be met by all the channels (i.e. all the values) but only for the estimated SNR values corresponding to the subset of the channels. The variants previously described are possible example of such first criterion. Possible criteria to be met by the subset of estimated local SNR values for a location to be selected, include without limitation: all estimated local SNR values of the subset to be above a first value, at least a given number of estimated local SNR values to be above the value, a weighted sum of the estimated local SNR values of the subset to be above a second value (the sum being weighted by channel priorities), no estimated local SNR value

to be below a third value, no more that another given number of estimated local SNR values to be below the third value, ...

5 In a concrete example, a reception threshold may be defined, and indicate that a channel for which the estimated SNR is above the threshold is very likely to be received in good conditions by the digital signal receiver. The second criterion may also be based on a number of channels among the preferred channels for which the estimated SNR is above the threshold, that number being required to be above a given number or ratio. In a variant, the same criterion may be used based on number of received programs instead of
10 the number of channels (considering each channel comprises a plurality of programs). According to this specific and non-limiting embodiment, both the first and the second criteria need to be met for a location to be selected.

Step S2: Fine tuning antenna configuration

15 Measuring a RSS using an omnidirectional antenna, while allowing a practical and quick identification of a good place for the localization of the digital signal receiver within the home, does not guarantee the best reception quality, in particular in presence of multipath and interferers. For example, an interfering signal or a multipath could improve the received signal power while
20 it might degrade the reception quality. A directional radiation pattern, even moderate helps improving the desired signal level, reducing interferences and multipath, therefore leading to better overall performances, sometimes even with lower received power.

25 For the sake of clarity and without loss of generality the method is described with signal quality being measured, although the disclosed principles are also applicable to signal quality being estimated based on other measured metrics such as for example and without limitation a number of uncorrected packets (calculable from a packet error rate), or a measured EVM (Error Vector Magnitude)

In the step S2, once the location of the digital signal receiver within the home is determined, a directional mode of the antenna is determined responsive to measuring a first signal quality of each channel of the set of channels at the determined location. In a variant, the set of channels is a subset of the available channels and correspond to a list of preferred channels as described above. More precisely, the first signal quality is measured by a first RF receiver for each channel and for each directional mode of the antenna. The first RF receiver comprises a tuner and a demodulator including AGC adjustment, Intermediate Frequency amplification, interferences rejection, multipath cancellation and Forward Error Correction, leading to an optimal SNR (Signal to Noise Ratio (SNR) and/or BER (Bit Error Rate).

In a first variant the first signal quality comprises a SNR. The directional mode of the antenna for a given channel is selected based on the SNR measured among the directional modes for that given channel. In a first example the directional mode of the antenna for a given channel is selected as the directional mode for which the highest SNR has been measured among the other directional modes for that given channel. In a second example the directional mode for a given channel is selected as a directional mode for which the SNR has been measured above a value for that channel.

In a second variant the first signal quality comprises a BER. The directional mode of the antenna for a given channel is selected based on the BER measured among the directional modes for that given channel. In a first example the directional mode of the antenna for a given channel is selected as the directional mode for which the lowest BER has been measured among the other directional modes for that given channel. In a second example the directional mode for a given channel is selected as a directional mode for which the BER has been measured below a value for that channel.

In yet another variant, any combination of the first and second variants is compatible with the disclosed principles. More generally, any technique for selecting a directional mode for a channel based on the measured SNR and/or BER values for other directional modes for that channel are compatible with the disclosed principles.

Advantageously the first signal quality, in any of its variant, is measured for a first channel by the first RF receiver in parallel of a second signal quality being measured by a second RF receiver for a second channel. Any variant for the second signal quality similar to the variants of first signal quality is
5 compatible with the disclosed principles.

Measuring a SNR for a channel takes a few hundred of milliseconds (typically two hundred of milliseconds), while measuring a BER for a channel takes a few seconds (typically three seconds). Considering twenty five channels and eight directional modes, the duration time of the step S2 of the
10 installation, using a single RF receiver is about:

- forty seconds, with a first signal quality based on a SNR only
- ten minutes, with a first signal quality level based on a BER only.

These durations are advantageously divided by two thanks to the use of the two RF receivers in parallel which finally leads to a typical duration for
15 the installation of all the channels of about twenty seconds (respectively five minutes) when using SNR (respectively BER) as first (and second) signal quality.

Step S3 (optional): Dynamic improvement of the received signal

Due to the well-known frequency selective multipath fading
20 encountered in indoor environments, even after fine tuning the antenna configuration as described in step S2, the received signal may suffer from variations/fading due to time-varying multiple reflections from moving vehicles such as planes or cars or the movement of people/objects around the digital signal receiver. To that end an optional step S3 of antenna diversity
25 advantageously leverages a second optional RF receiver in order to improve the stability of the reception of the first RF receiver.

In the sub-step S30, a TV program is received from the antenna and the first receiver, the antenna being set in a first directional mode corresponding to a channel of the TV program. Optionally the received TV

program is further transmitted to another device of the home via a network interface.

In the sub-step S32, the antenna is sequentially set in other directional modes and a second signal quality of the channel is measured for each other
5 directional mode by a second RF receiver, so as to identify another directional mode associated to a second signal quality of higher quality than the first signal quality for that TV program.

Figure 2 describes the sub-step S32 of the method of Figure 1 with
10 more details, according to a specific and non-limiting embodiment of the disclosed principles. In Figure 2, the first signal quality is denoted SQ1, the second signal quality is denoted SQ2, and directional modes are denoted by the letter p designating for example numbers, and corresponding to the selected directional beam 11, 12, 13, 14, 15, 16, 17, 18 for a given directional
15 mode, as described later in Figure 4a. Any variant described in the disclosed principles for the first and second signal quality are applicable to SQ1 and SQ2

The sub-step S32 comprises two distinct loops operating simultaneously. The first loop S321, S322, S323, S324 also called receiving
20 mode is based on the first RF receiver and is devoted to the decoding of the channel/program to be rendered to a user, the antenna 2 being set to a first directional mode, also denoted current mode in Figure 2. The first directional mode is for example the directional mode that was determined for that channel during the installation step S2 previously described. In another
25 example, the first directional mode is the directional mode that was used the last time the same channel was received by the digital signal receiver. The second loop S326, also called scanning mode is based on the second RF receiver and is devoted to the scanning of all remaining directional modes, in order for the digital signal receiver to switch to the best one when required,
30 the objective being to maintain the optimum reception quality.

As a change of program is requested by a user via a user interface, in the sub-step S320, the corresponding configuration, including the RF channel and the first directional mode (i.e. current mode) is retrieved. The antenna 2 and the first RF receiver are configured according to the current mode. The first signal quality metric SQ1 of the current mode is continuously tracked in the sub-step S321, and is denoted SQ1. In the sub-step S322, SQ1 is evaluated against a predetermined level denoted Threshold depending on the variant of signal quality (SNR, BER, any combination). Threshold is determined so as to preserve a good audio/video decoding even in case of a reasonable degradation of a reception quality. For the sake of clarity and without limitation Threshold represents a quality level, wherein the higher the Threshold, the higher the quality of the link. If the first signal quality SQ1 is of higher quality than the predetermined level, the current mode selected for program decoding is kept.

In parallel of the first loop, all directional modes except the current mode are scanned by the second RF receiver in the second loop S326. Scanning these directional modes comprises setting the antenna 2 in one of these directional modes, measuring a second signal quality of the channel for that that directional mode, storing in memory the measured second signal quality associated with that directional mode and repeating the process (set, measure, store) with another directional mode.

In the sub-step S323, when the first signal quality SQ1 is of lower quality than the predetermined level, the first signal quality SQ1 is further evaluated against the second signal quality SQ2(p) corresponding to other directional modes p, and measured by the second RF receiver. In case there is a directional mode p for which the second signal quality SQ2(p) is of higher quality than the first signal quality SQ1, the current mode is switched to the directional mode p for which the measured second signal quality SQ2(p) is of higher quality than the first signal quality SQ1. For example the current mode is switched to the directional mode corresponding to the highest signal quality. In case there is no directional mode p for which the second signal quality SQ2(p) is of higher quality than the first signal quality SQ1, the current mode

is kept, and the first signal quality SQ1 is further measured in the sub-step S321.

Evaluating the first signal quality against a predetermined level in the sub-step S322 before evaluating the first signal quality against the second signal quality of other directional modes in the sub-step 323 is advantageous as it allows keeping the current mode is case the first signal quality is at least corresponding to the predetermined level, and to avoid frequent switching between directional modes. Indeed in case of frequent switching between different directional modes of similar performance, the risk of experiencing micro cut in the overall signal decoding significantly increases.

Figure 3a describes a processing device 1 as a digital signal receiver, according to a specific and non-limiting embodiment of the disclosed principles. The processing device 1 is for example a Digital Terrestrial Television receiver, but as mentioned above any kind of receiver adapted to receive wireless digital signals is compatible with the disclosed principles.

The processing device 1 comprises an antenna 2 operable in an omnidirectional mode and in a plurality of directional modes. More precisely, the antenna 2 comprises a reconfigurable radiating system, i.e. an antenna capable of modifying dynamically its radiation properties in a controlled and reversible manner. The antenna for example comprises inner mechanisms (such as RF switches, varactors, etc...) and/or tunable materials that enable controllable redistribution of the RF currents over the antenna surface and produce reversible modifications over its radiation patterns. For the sake of clarity and without loss of generality, these reversible modifications of the antenna radiation properties are further described as the omnidirectional mode and the plurality of directional modes. According to a specific and non-limiting embodiment illustrated in **Figure 4a**, the omnidirectional mode corresponds to an omnidirectional radiation pattern 10, adapted to receive an equivalent power from all directions. According to the specific and non-limiting embodiment illustrated in **Figure 4a**, the antenna 2 is further operable in eight

different directional modes, each directional mode corresponding to a moderately directional beam 11, 12, 13, 14, 15, 16, 17, 18. Directional beams 11, 12, 13, 14, 15, 16, 17, 18 are determined in such a way that each directional beam 11, 12, 13, 14, 15, 16, 17, 18 corresponds to a different direction for receiving a greater amount of power, and that all directions are covered by a juxtaposition of all the directional beams 11, 12, 13, 14, 15, 16, 17, 18 as illustrated in **Figure 4a**. The disclosed principles are described with eight different directional beams but any number of directional beams, corresponding to a same number of directional modes, is compatible with the disclosed principles. An antenna operable in an omnidirectional mode in addition to a plurality of directional modes is advantageous over an antenna operable only in a plurality of directional modes as it allows to fairly and quickly compare a set of various locations by evaluating the received power of a set of channels from all broadcast towers with an equal antenna gain at each location. The comparison is fair as the omnidirectional antenna allows measuring the received power without orientation discrimination. The comparison is fast as based on a RSS which can be measured in a very short period of time compared to other more sophisticated signal quality measurements.

The processing device 1 further comprises a selector 100 adapted to configure the antenna 2 in a mode among the omnidirectional mode and the plurality of directional modes. When the antenna 2 is configured in the omnidirectional mode, its radiating system is reconfigured so as to receive equivalent power from all directions via the omnidirectional radiation pattern 10. When the antenna 2 is configured in a directional mode, its radiating system receives greater power from a specific direction corresponding to a direction of the directional beam 11, 12, 13, 14, 15, 16, 17, 18. The selector 100 further comprises at least one switch, for example a single pole multiple throw (SPMT) switch, connected to the antenna 2. The switch is capable of switching at least one input connected to the antenna 2 to a first output. According to a specific and non-limiting embodiment, the switch comprises eight inputs, and one output, each input corresponding to a directional mode of the antenna 2. In a variant, one of the eight inputs also corresponds to the

omnidirectional mode of the antenna. In another variant (not represented), the switch comprises at least one additional input corresponding to the omnidirectional mode. In any variant, the switch is configurable to switch any of the inputs corresponding to any of the antenna 2 modes to the first input. A
5 combination of at least the antenna 2 and the selector 100 are an example of a smart antenna system.

The processing device 1 further comprises a first RF receiver 101 connected to the antenna 2 via the first output of the selector 100, the selector 100 being adapted to configure the antenna 2 in a first mode associated with
10 the first RF receiver 101, the first mode being among the omnidirectional mode and the plurality of directional modes. The first RF receiver 101 comprises a first tuner and a first demodulator including AGC adjustment, Intermediate Frequency amplification, interferences rejection, multipath
cancellation and Forward Error Correction, leading to an optimal SNR (Signal
15 to Noise Ratio (SNR) and/or BER (Bit Error Rate)).

Optionally, the processing device 1 further comprises a second RF receiver 102 connected to the antenna 2 via a second output of the selector 100, the selector 100 being further adapted to configure the antenna 2 in a
20 second mode associated with the second RF receiver 102, in parallel of the first mode associated with the first RF receiver 101, the second mode being also among the omnidirectional mode and the plurality of directional modes. Similarly to the first RF receiver 101, the second RF receiver 102 comprises a
second tuner and a second demodulator including AGC adjustment, Intermediate Frequency amplification, interferences rejection, multipath
25 cancellation and Forward Error Correction, leading to an optimal SNR (Signal to Noise Ratio (SNR) and/or BER (Bit Error Rate)).

In a first example both the first and second antenna modes are the omnidirectional mode. A configurable power splitter, included in either the selector 100 or in the antenna 2, is configured by the processing module 130
30 so as to split the power received from the omnidirectional radiation pattern 10 towards both the first and the second outputs of the selector 100. In a second example both the first and second antenna modes are a different directional

mode, each mode respectively corresponding to a first and a second directional beam 11, 12, 13, 14, 15, 16, 17, 18. In that second example, the selector 100 is configured by the processing module 130 to direct the power received from the first directional beam to the first output and the power
5 received from the second directional beam to the second output in parallel. In a third example, the first antenna mode is the omnidirectional mode and the second antenna mode is a directional mode corresponding to a directional beam 11, 12, 13, 14, 15, 16, 17, 18. In that third example, the selector 100 is configured by the processing module 130 to direct the power received from
10 the omnidirectional radiation pattern 10 towards the first output in parallel of directing the power received from the directional beam to the second output. The third example is for example advantageous for further parallelizing the steps S1 and S2.

In an advantageous variant, a first RSS and/or a first signal quality is
15 measured for a first channel by the first receiver in parallel of a second RSS and/or a second signal quality being measured by the second receiver for a second channel.

The processing device 1 further comprises a processing module 130, for example a processor, configured to set the antenna 2 in at least a mode
20 among the omnidirectional mode and the plurality of directional modes. The antenna mode selection is done by the processing module 130 sending a control signal to the selector 100 further appropriately reconfiguring the antenna 2. The processing module 130 is configured to set the antenna 2 in the omnidirectional mode for measuring a first RSS for a set of channels at
25 various indoor locations so as to determine a location. The processing module 130 is further configured to set the antenna 2 in a directional mode selected for each channel based on a first signal quality measured for each channel of the set of channels at the determined location. According to a specific and non-limiting embodiment the processing module 130 is further configured for
30 measuring the first (and/or second) signal quality of each channel for each directional mode of the antenna.

According to a specific and non-limiting embodiment, the processing module 130 is further optionally configured to set the antenna 2 in the omnidirectional mode for measuring a second RSS for a second subset of channels at various indoor locations in parallel to measuring the first RSS for a first subset of channels at the various indoor locations, so as to determine a location. The processing module is further optionally configured to set the antenna 2 in a directional mode selected for each channel based on a first signal quality measured for each channel of a first subset of channels at the determined location, in parallel of a second signal quality measured for each channel of a second subset of channels at the determined location.

According to a specific and non-limiting embodiment the processing module 130 is further optionally configured for measuring the first (and/or second) signal quality of each channel for each directional mode of the antenna, the selected directional mode for a channel corresponding to the highest quality of the first and/or second quality factor being measured for the channel et for each directional mode.

According to a specific and non-limiting embodiment the processing module 130 is further optionally configured to configure the first RF receiver 101 to receive a TV program from the antenna, being configured in a first directional mode corresponding to a channel of the TV program. The processing module 130 is further configured to configure the second RF receiver 102 to sequentially configure the antenna in other directional modes and to measure the second signal quality of the channel of the TV program for each other directional mode. The processing module 130 is further configured to switch the antenna 2 from a first directional mode to a second directional mode and the associate the second directional mode of antenna 2 with the first RF receiver 101 for receiving the channel in case the second signal quality measured by the second receiver 102 for the channel as the second directional mode is configured, is of higher quality than the first signal quality being measured for the channel by the first RF receiver 101 as the first directional mode was configured.

According to a specific and non-limiting embodiment, the first RSS and/or the first signal quality, in any of its variant are permanently measured by the first RF receiver 101, and are accessible to the processing module 130 on request. For example, the level of the received signal strength is deducible from the value of the AGC (Automatic Gain control) available at the tuner and/or demodulator interface. According to another specific and non-limiting embodiment, the first received signal strength and/or the first signal quality in any of its variant are measured by the first RF receiver 101 based on a request sent by the processing module 130. Similarly measured second RSS and/or second signal quality are compatible with the disclosed principles.

The processing device 1 further comprises an optional input 150 to receive user data from a user. User data comprise trigger data generated from a user interface in order to trigger RSS measurements by the processing module 130, as the processing device 1 is located at various candidate locations. User data also comprise validation data generated from a user interface so that, for example, the processing module 130 determines the location for positioning the processing device 1. The input 150 belongs to a set comprising:

- a touch screen sensor and its accompanying controller based firmware able generate trigger data and validation data from a locally displayed user interface;
- A keyboard, a key pad or a set of keys able generate trigger data and validation data in relation with a user interface displayed on a local or remote display mean;
- Any other hardware adapted to enable a user to communicate user data to the processing module in relation to a user interface.

The processing device 1 further comprises an optional network interface 140 coupled in signal communication to the processing module 130, the first RF receiver 101 and the optional second receiver 102. The network interface 140 is for example configured to transmit a TV program received from and demodulated by the first 101 or the second 102 RF receiver to another network device over a network. The network interface 140 is also for

example configured to receive user data from a remote device displaying a remote user interface to the user, and to send them to the processing module 130. According to different embodiments of the disclosed principles, the network interface 140 is a local area network interface and belongs to a set

5 comprising:

- An Ethernet interface, or any network interface compatible with the IEEE 802 family of wired standards;
- A WiFi network interface in any of its variants, or more generally any networking standard compatible with the IEEE 802.11 family
- 10 of standards;
- Bluetooth in any of its variants;
- MoCA;
- A power line interface in any of its variants.

More generally any networking interface allowing send and receive data
15 to/from a home network is compatible with the disclosed principles.

The processing device 1 further comprises an optional audio video decoder 110 coupled in signal communication to the processing module 130 and the first RF receiver 101. The audio video decoder 110 receives TV programs from the first RF receiver 101. The audio video decoder 110 is
20 further configured to decode the TV program and send the decoded data to an optional audio video output 120 such as an audio video rendering means. According to a particular embodiment the audio video rendering means is external to the device and the output 120 sends the decoded data to render to an external rendering means. According to different embodiments of the
25 disclosed principles, the rendering means, internal or external, belongs to a set comprising:

- a personal computer;
- a TV;
- a tablet;
- 30 - a smartphone.

More generally any rendering means allowing to display a decoded audio video data is compatible with the disclosed principles.

According to a specific and non-limiting embodiment, the processing module 130 comprises a first processor 131 coupled in signal communication to a second processor 132. The first processor 131 is advantageously further connected to the selector 100 and the antenna, while the second processor 132 is further connected to the first receiver 101, and to the optional second receiver 102, input 150, network interface 140, decoder 101 and output 120. Two independent processors 131 and 132 allow to implement an antenna 2 separated from the processing device, i.e. not necessarily integrated in the digital signal receiver.

According to a specific and non-limiting embodiment, the antenna 2 is a frequency tunable antenna. In a first variant, the antenna 2 is frequency tunable between the UHF (Ultra High Frequency) band, typically 470-700MHz, and the VHF (Very High Frequency) band, typically 174-216MHz. In a second variant the antenna 2 is frequency tunable for each RF channel of both bands. A frequency tunable antenna advantageously improves the performances of a small size antenna in dedicated frequency bands. According to this specific and non-limiting embodiment, and in any of its variant, the processing module 130 is further configured to tune the frequency of the antenna, for operating in a RF channel, operating in a RF channel comprising any operation mentioned on the steps S1, S2 and S3 of the disclosed principles.

The disclosed principles are also applicable to devices directly connected to a display means or integrating a display means such as digital TVs. Indeed the disclosed principles allow to assist a user in the installation of the device by identifying a best location among candidate locations and by appropriately configuring the antenna in the best location.

Figure 3b depicts a processing device 1b for displaying a quality indicator of a given channel.

According to a specific and non-limiting embodiment, the processing device 1b comprises an RF receiver 10 configured to receive digital TV signal from a broadcast network interface such a digital terrestrial network interface. The RF receiver 10 comprises an antenna, internal or external to the

processing device 1b, as well as a tuner a demodulator including AGC adjustment, similar to the RF receiver 101 of the processing device 1 of figure 1a. Optionally, the processing device comprises a second RF receiver (not represented), connected to the same antenna as the RF receiver 10, and able to receive the same signal in parallel.

The input 10 is linked to a processing module 14 configured to tune the RF receiver to a given channel, to determine a quality indicator of the given channel, by dividing a RSS value measured for the given channel by an average of a set of noise levels determined for a plurality of channels, and to send for display to the output 18 such as a display means, the quality indicator of the given channel with an indication of whether the quality indicator meets a second criterion. Any variant for the second criterion and for computation of the quality indicator (including the parallel measurement using at least two RF receivers in parallel) described in figure 1b are compatible with the processing device 1b. According to a particular embodiment the display means is external to the device and the output 18 sends the data to display to an external display means. According to different embodiments of the principle, the display means, internal or external, belongs to a set comprising:

- a personal computer screen;
- a TV screen;
- a tablet;
- a smartphone screen.

More generally any display means allowing to display a quality indicator of a given channel with an indication of whether the quality indicator meets a criterion, is compatible with the disclosed principles.

According to a specific and non-limiting embodiment of the disclosed principles, the processing module is further configured to scan a set of channels. More precisely, the processing module is configured, for each channel of the set of channels, to tune to the channel, to determine a quality indicator of the channel, by dividing a RSS value measured for the channel by an average of a set of noise levels determined for a plurality of channels, and to display the quality indicators of the channels together with indications of whether the quality indicators meet a second criterion. All the variants for

displaying indications according to the user interface described in Figure 1 are compatible with the processing device 1b. Displaying these indications are advantageous as a user is able to quickly determine whether a candidate location will provide good reception conditions or not.

5

Figure 4b represents an exemplary architecture of the processing device 1, 1b according to a specific and non-limiting embodiment. The processing device 1 comprises one or more processor(s) 410, which is (are), for example, a CPU, a GPU and/or a DSP (English acronym of Digital Signal Processor), along with internal memory 420 (e.g. RAM, ROM, EPROM). The processing device 1, 1b comprises one or several Input/Output interface(s) 430 adapted to send to display output information and/or to allow a user to enter commands and/or data (e.g. a keyboard, a mouse, a touchpad, a webcam, a display), and/or to send / receive data over a network interface; and a power source 440 which may be external to the processing device 1, 1b.

According to an exemplary and non-limiting embodiment, the processing device 1 further comprises a computer program stored in the memory 420. The computer program comprises instructions which, when executed by the processing device 1, 1b, in particular by the processor 410, make the processing device 1 carry out the processing method described with reference to figures 1a and 1b. According to a variant, the computer program is stored externally to the processing device 1, 1b on a non-transitory digital data support, e.g. on an external storage medium such as a SD Card, HDD, CD-ROM, DVD, a read-only and/or DVD drive and/or a DVD Read/Write drive, all known in the art. The processing device 1, 1b thus comprises an interface to read the computer program. Further, the processing device 1, 1b could access one or more Universal Serial Bus (USB)-type storage devices (e.g., "memory sticks.") through corresponding USB ports (not shown).

According to exemplary and non-limiting embodiments, the processing device 1 is a device, which belongs to a set comprising:

- a digital terrestrial TV receiver;
- a set top box device;
- a TV device;

- a digital media player device;
- an Internet gateway device;
- a communication device.

Claims

1. A digital signal receiver, comprising:

- an antenna (2) operable in an omnidirectional mode and in a plurality of directional modes;
- a processor (130, 410) configured to:
 - o select a location based on a set of Received Signal Strength RSS values measured for a set of channels at different locations, with the antenna configured in the omnidirectional mode, the selected location corresponding to RSS values measured at that location for at least a part of the set of channels and meeting a first criterion; ;
 - o set the antenna (2) in a directional mode selected for each channel, wherein a first signal quality of each channel of the set of channels is obtained for each directional mode at the selected location, the selected directional mode corresponding to the highest first signal quality of each channel of the set of channels.

2. The digital signal receiver of claim 1, wherein the processor is further configured to further select the location based on a set of quality indicator values determined for the set of channels at the different locations, with the antenna configured in the omnidirectional mode, the selected location corresponding to quality indicator values determined for that location for the at least part of the set of channels and meeting a second criterion, wherein a quality indicator value is determined for a given channel of the set of channels, by dividing a RSS value measured for the given channel of the set of channels by an average of a set of noise levels determined for a subset of the set of channels.

3. The digital signal receiver of claim 2, wherein a noise level of the set of noise levels is determined for each channel of the subset of the set of channels by dividing a measured RSS value of the channel by a signal quality of the channel.

4. The digital signal receiver of claim 3, wherein the signal quality belongs to a set at least comprising a Signal to Noise Ratio, SNR, and Modulation Error Ratio, MER.
- 5 5. The digital signal receiver of any of claims 2 to 4, wherein the set of noise levels is determined for the subset of the set of channels prior to measuring the RSS value of the given channel.
6. The digital signal receiver of any of claims 2 to 5, wherein the given channel
10 is not included in the subset of the set of channels.
7. The digital signal receiver of any of claims 2 to 6, further comprising a first RF receiver (101) connected to the antenna (2) via a selector (100), the selector (100) being adapted to configure the antenna (2) in a first mode
15 associated with the first RF receiver (101), the first mode being among the omnidirectional mode and the plurality of directional modes.
8. The digital signal receiver of claim 7, further comprising a second RF receiver (102) connected to the antenna (2) via the selector (100), the selector
20 (100) being further adapted to configure the antenna (2) in a second mode associated with the second RF receiver (102), in parallel of the first mode associated with the first RF receiver (101), the second mode being among the omnidirectional mode and the plurality of directional modes.
- 25 9. The digital signal receiver of claim 8, wherein the set of RSS values for the set of channels are obtained by measuring a first RSS value for a first channel by the first RF receiver (101) in parallel of measuring a second RSS value by the second RF receiver (102) for a second channel.
- 30 10. The digital signal receiver of claim 8, wherein the first signal quality of a first channel is obtained by the first RF receiver (101) in parallel of a second signal quality of a second channel being obtained by the second RF receiver (102).

11. The digital signal receiver of claim 8, wherein the set of noise levels for the set of channels is obtained by measuring a first RSS and obtaining a first signal quality of a first channel by the first RF receiver (101) in parallel of measuring a second RSS and obtaining a second signal quality of a second channel by the second RF receiver (102).

12. The digital signal receiver of claim 8, wherein:

- the first RF receiver (101) is configured to receive a TV program from the antenna (2), being configured in a first directional mode corresponding to a channel of the TV program;
- the second RF receiver (102) is configured to sequentially configure the antenna (2) in other directional modes and to obtain the second signal quality of the channel of the TV program for each other directional mode.

13. The digital signal receiver of claim 12, wherein the processor (130, 410) is further configured to set the antenna (2) in a second directional mode in case the second signal quality obtained for the second RF receiver (102) as the second directional mode is set, is of higher quality than the first signal quality.

14. The digital signal receiver of any claims 1 to 13, wherein the first and the second signal quality belong to a set at least comprising a signal to noise ratio value and a bit error rate value.

15. The digital signal receiver of any claims 1 to 14, wherein the set of channels corresponds to a subset of available channels, and is configurable by a user.

16. A digital signal receiver (1b), comprising

- a RF receiver (10);
- a processor (14, 410) configured to
 - o tune the RF receiver to a given channel;

- determine a quality indicator of the given channel, by dividing a RSS value measured for the given channel by an average of a set of noise levels determined for a plurality of channels;
- display the quality indicator of the given channel with an indication of whether the quality indicator meets a second criterion.

17. A method for operating a digital signal receiver comprising an antenna (2) operable in an omnidirectional mode and in a plurality of directional modes, the method comprising:

- selecting (S12) a location based on a set of Received Signal Strength RSS values measured for a set of channels at different locations, with the antenna configured in the omnidirectional mode, the selected location corresponding to RSS values measured at that location for at least a part of the set of channels and meeting a first criterion;
- for each channel of the set of channels, determining (S2) a directional mode of the antenna (2) for operating at the selected location, wherein a signal quality of each channel of the set of channels is obtained for each directional mode at the selected location, the determined directional mode of the channel corresponding to the highest first signal quality of the channel.

18. A computer program product for operating a digital signal receiver comprising an antenna (2) operable in an omnidirectional mode and in a plurality of directional modes, said computer program comprising program code instructions executable by at least one processor for:

- selecting a location based on a set of Received Signal Strength RSS values measured for a set of channels at different locations, with the antenna configured in the omnidirectional mode, the selected location corresponding to RSS values measured at that location for at least a part of the set of channels and meeting a first criterion;
- setting the antenna (2) in a directional mode selected for each channel, wherein a first signal quality of each channel of the set of channels is obtained for each directional mode at the selected location, the

selected directional mode corresponding to the highest first signal quality of each channel of the set of channels.

1/5

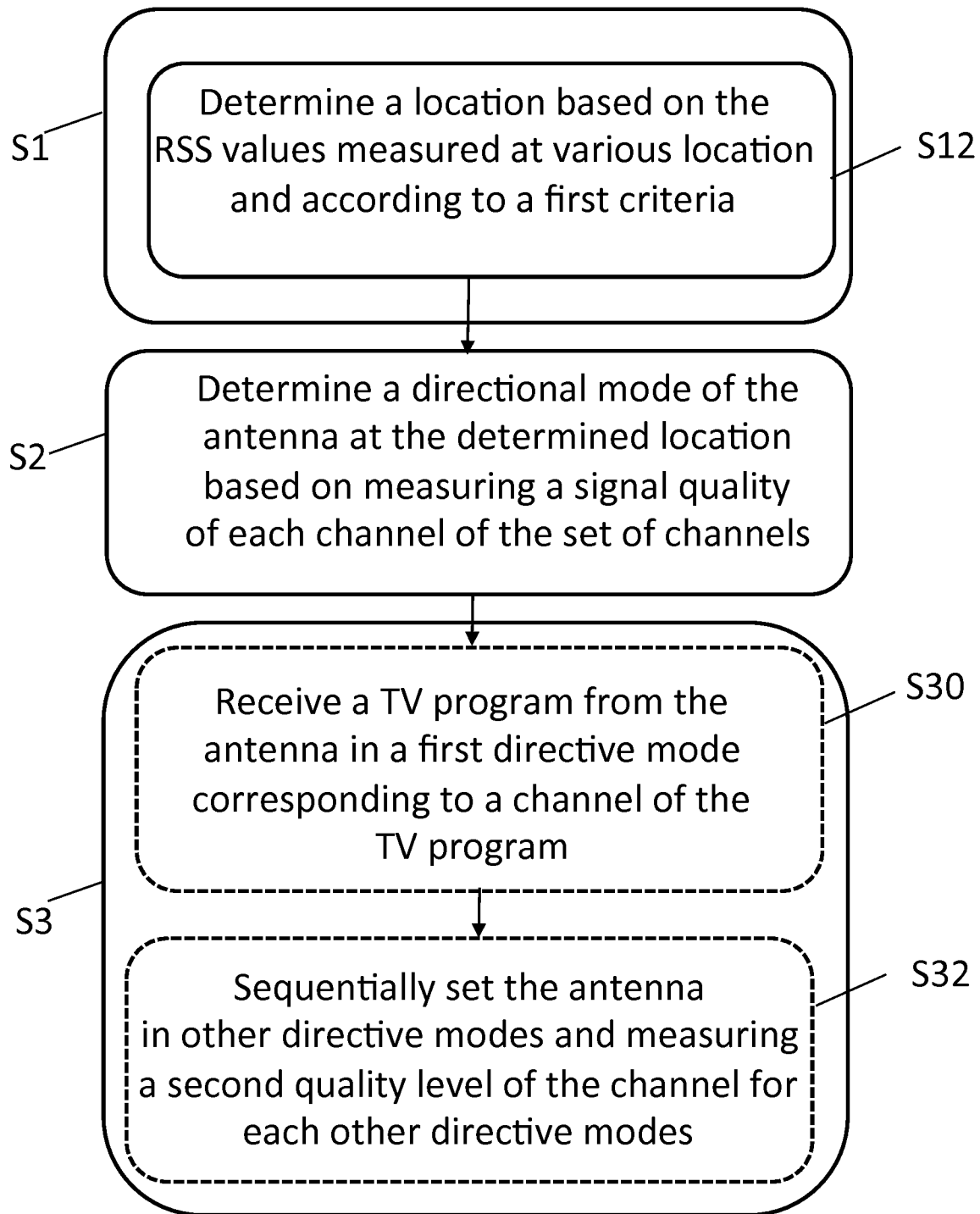


Figure 1a

2/5

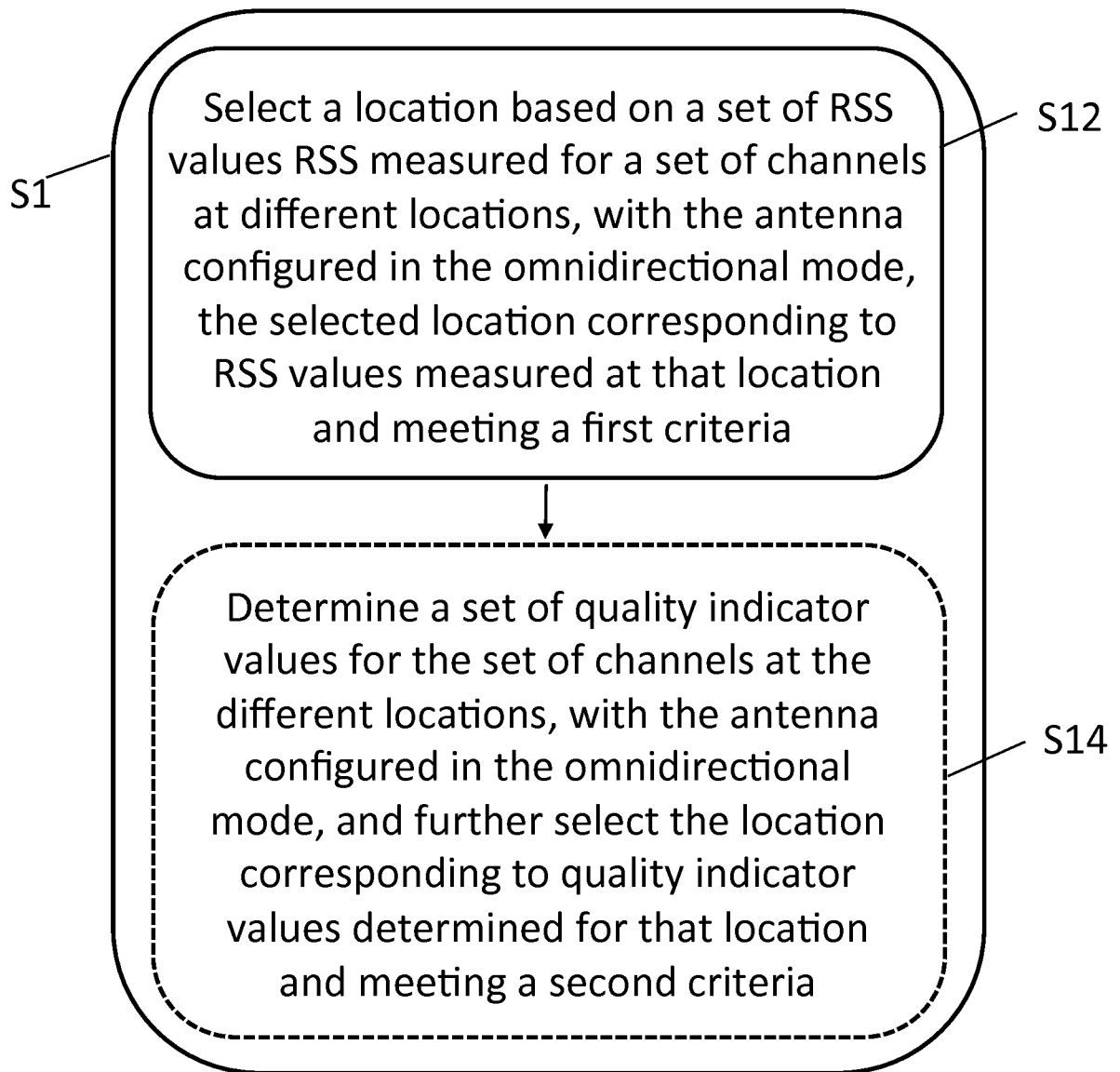


Figure 1b

3/5

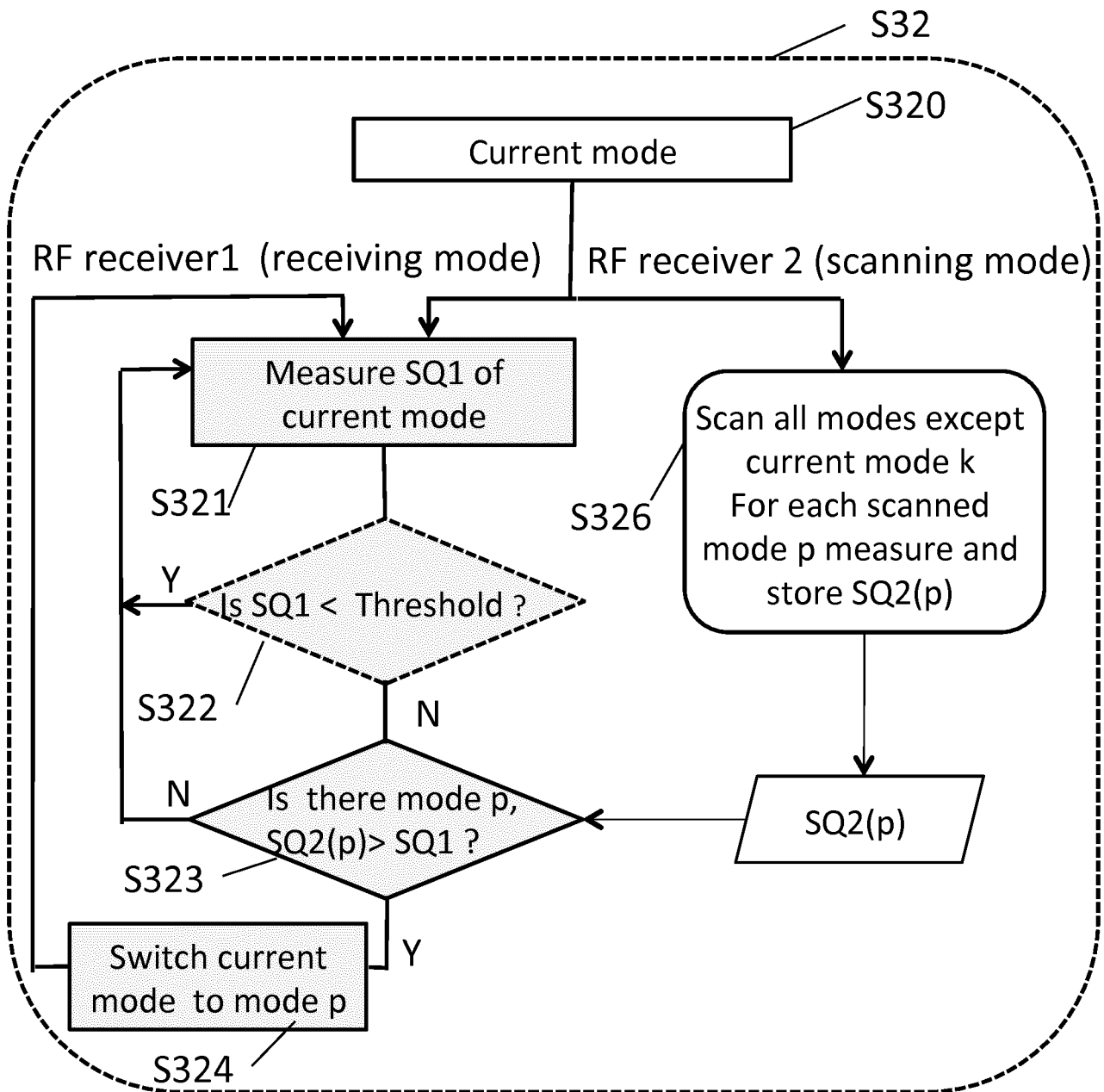


Figure 2

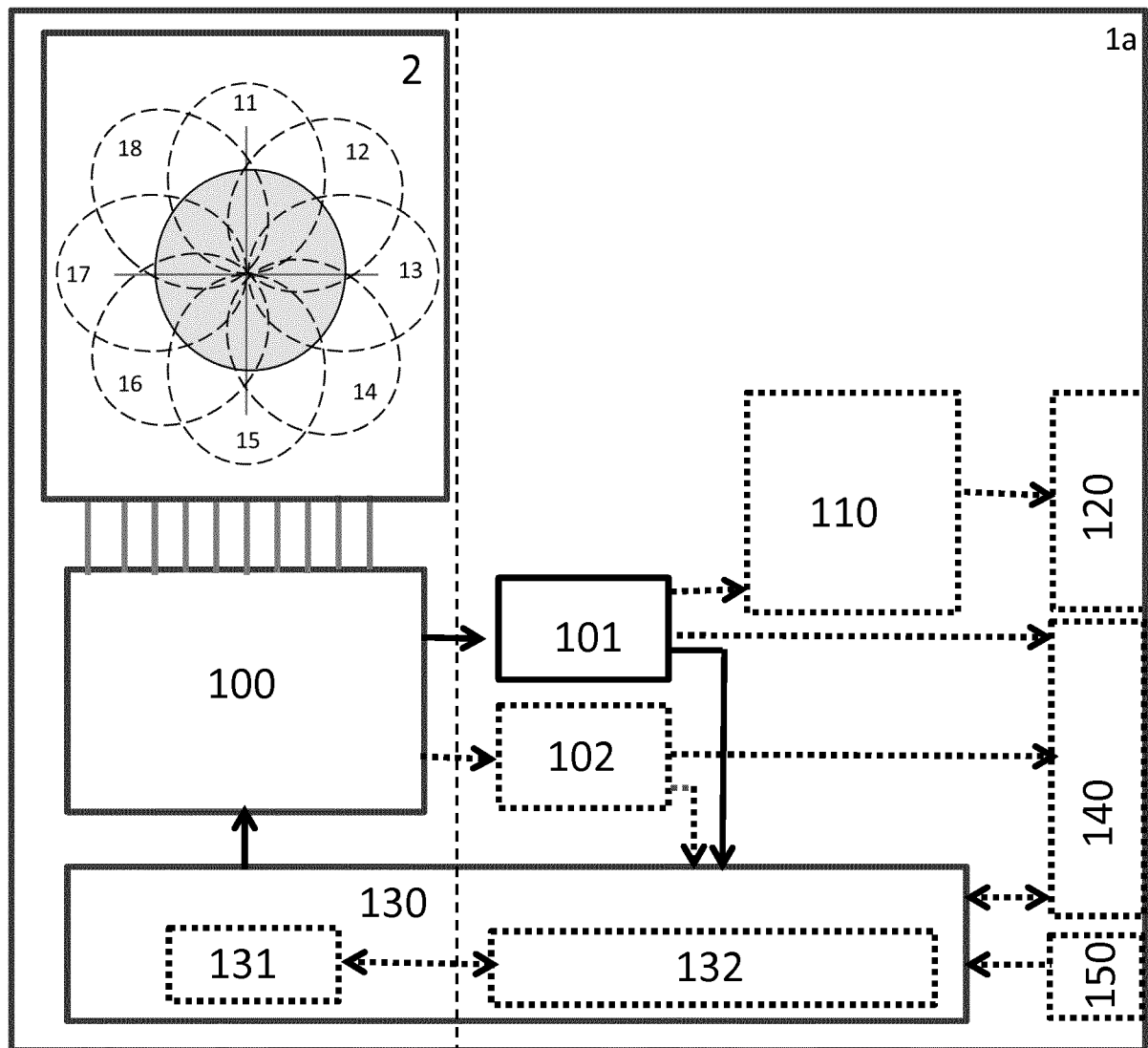


Figure 3a

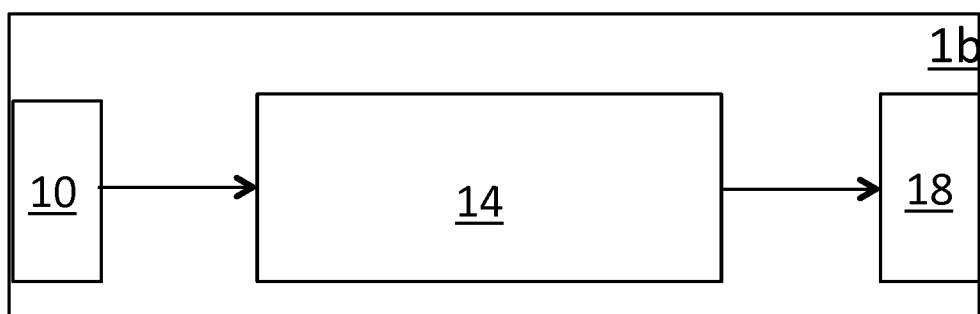


Figure 3b

5/5

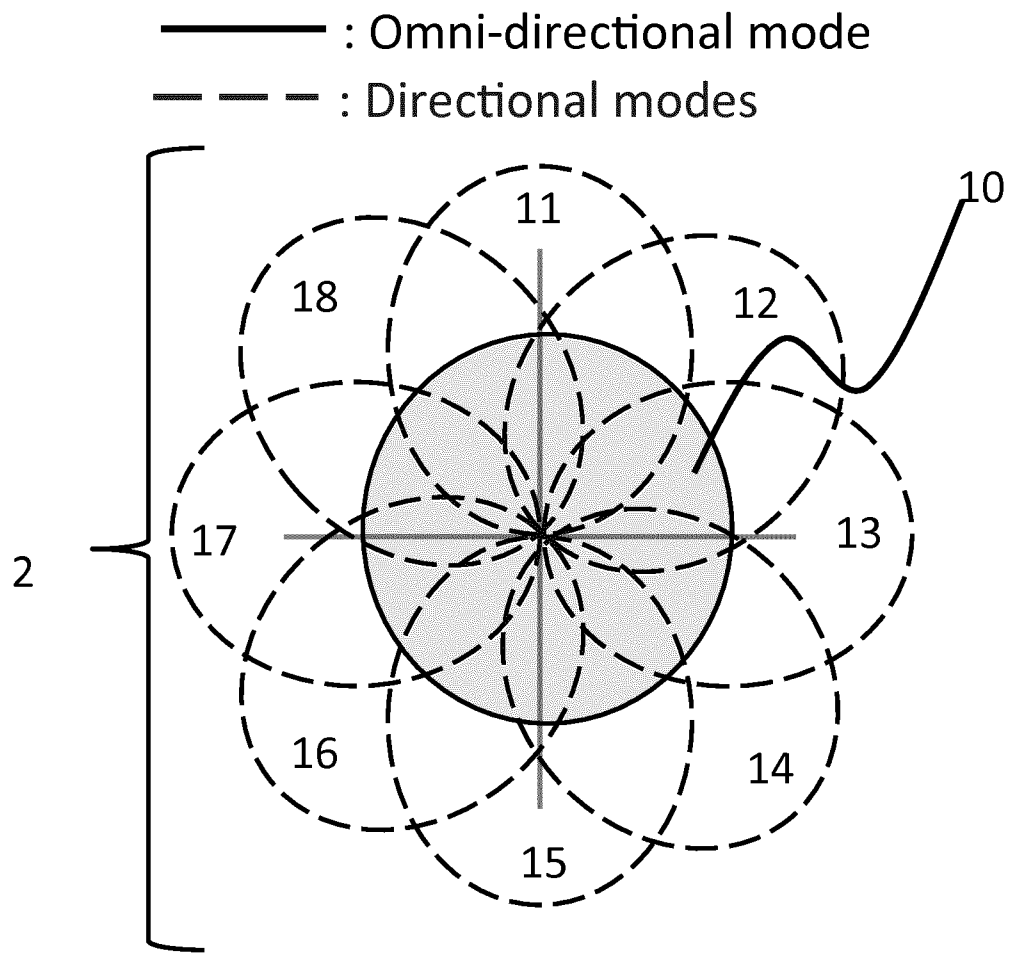


Figure 4a

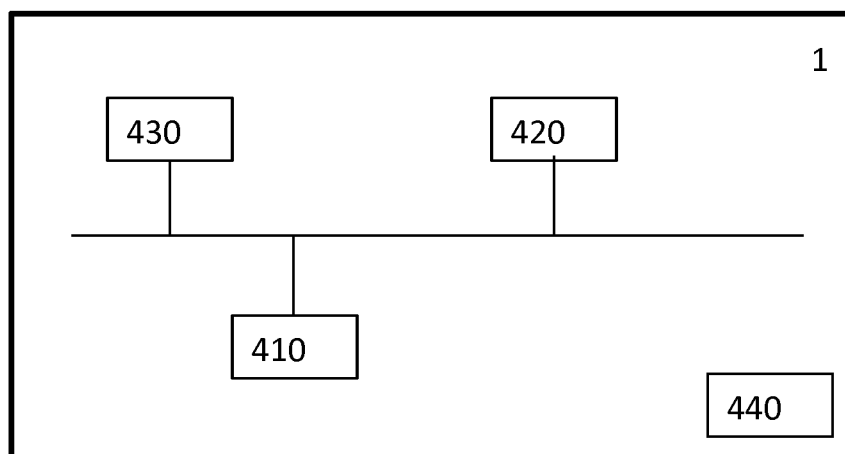


Figure 4b

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2018/076361

A. CLASSIFICATION OF SUBJECT MATTER

INV. H04B17/309 H04N5/44 H04N21/438 H04N21/61 H04N5/50
H01Q21/00 H04N21/426

ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04B H04N H01Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 2 963 834 A1 (FUNAI ELECTRIC CO [JP]) 6 January 2016 (2016-01-06) the whole document paragraph [0036] - paragraph [0061]; figures 1,5-7	16
Y	US 2005/289609 A1 (TAKAGI TOSHIHIRO [JP] ET AL) 29 December 2005 (2005-12-29) the whole document paragraph [0007] - paragraph [0007]; figure 4 paragraph [0027] - paragraph [0054]; figures 2,4 ----- -/--	1-15,17, 18

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

11 October 2018

Date of mailing of the international search report

24/10/2018

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Schneiderlin, Jean

INTERNATIONAL SEARCH REPORT

International application No.
PCT/EP2018/076361

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☒ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2018/076361

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	DVB ORGANIZATION: "a_74-2010.pdf", DVB, DIGITAL VIDEO BROADCASTING, C/O EBU - 17A ANCIENNE ROUTE - CH-1218 GRAND SACONNEX, GENEVA - SWITZERLAND, 9 April 2010 (2010-04-09), XP017846665, paragraph [05.7] -----	1-15,17, 18

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2018/076361

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 2963834	A1	06-01-2016	EP 2963834 A1 06-01-2016
			JP 6379746 B2 29-08-2018
			JP 2016015594 A 28-01-2016
			US 2016006972 A1 07-01-2016

US 2005289609	A1	29-12-2005	JP 4470611 B2 02-06-2010
			JP 2006014061 A 12-01-2006
			US 2005289609 A1 29-12-2005

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-18

select location and direction of an antenna.

1.1. claim: 16

display quality indicator with second criteria.
