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(54) **WIRELESS DEVICE, SYSTEM AND METHOD FOR DISCRIMINATING RADAR TRANSMISSIONS FROM WIRELESS NETWORK TRANSMISSIONS AND WIRELESS NETWORK HAVING RADAR-AVOIDANCE CAPABILITY**

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This patent is subject to a terminal disclaimer.

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H04Q 7/20 (2006.01)

(52) **U.S. Cl.** **455/454**; 455/424; 455/67.13;
342/162; 342/159; 340/571

(58) **Field of Classification Search** 455/454, 455/424, 67.13, 69, 442; 342/162, 159; 340/571
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,697,013	B2 *	2/2004	McFarland et al.	342/159
2002/0086691	A1 *	7/2002	Kostic et al.	455/503
2003/0107512	A1	6/2003	McFarland et al.	
2003/0214430	A1	11/2003	Husted et al.	
2005/0032524	A1	2/2005	Kruys et al.	

FOREIGN PATENT DOCUMENTS

EP 1248477 A1 10/2002

OTHER PUBLICATIONS

"Joint Rapporteur Group 8A-9B—Working Document Towards a Preliminary Draft New Recommendation on Dynamic Frequency Selection in 5GHz RLANS"; IEEE P802 Radio Regulations 01/026r2, Nov. 2001, 42 Pgs. XP-002304581.

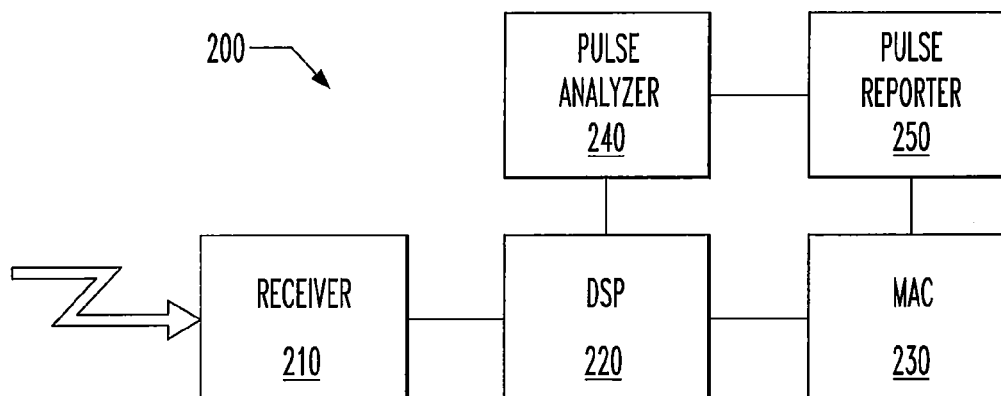
* cited by examiner

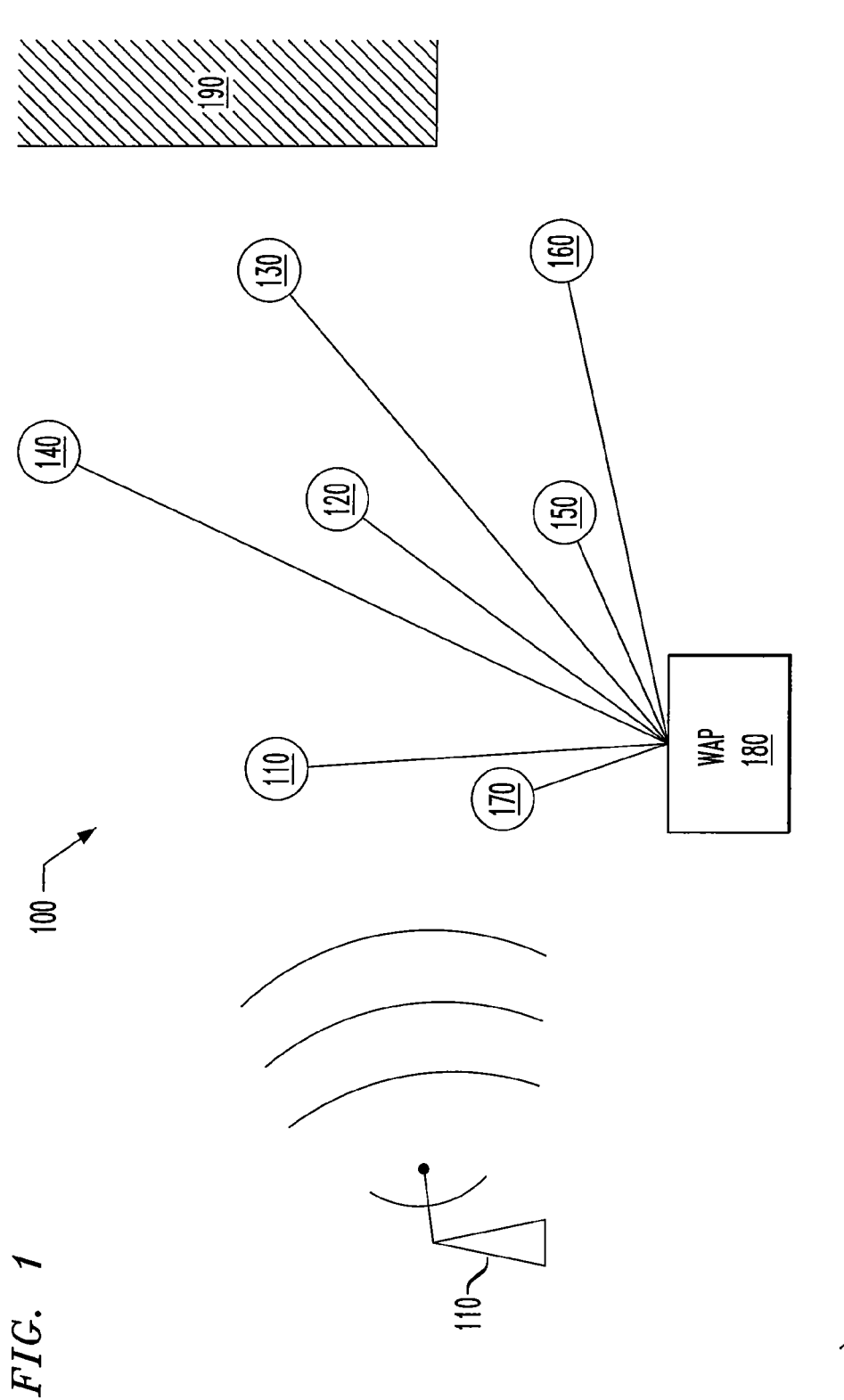
Primary Examiner — Danh Le

(57) **ABSTRACT**

The disclosure provides a wireless device for use in a wireless network, systems and methods for identifying radar signals and for giving the wireless network a radar-avoidance capability. In one embodiment, the wireless device includes: (1) a pulse analyzer configured to make a determination whether a received pulse is a radar pulse and not a wireless network pulse and (2) a pulse reporter coupled to the pulse analyzer and configured to generate, if the determination is positive, a report thereof for transmission over the wireless network to a central aggregation node thereof.

19 Claims, 4 Drawing Sheets





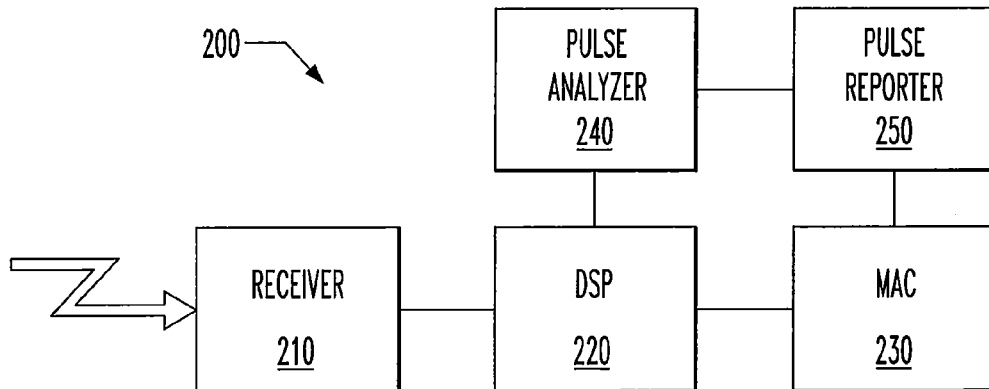


FIG. 2

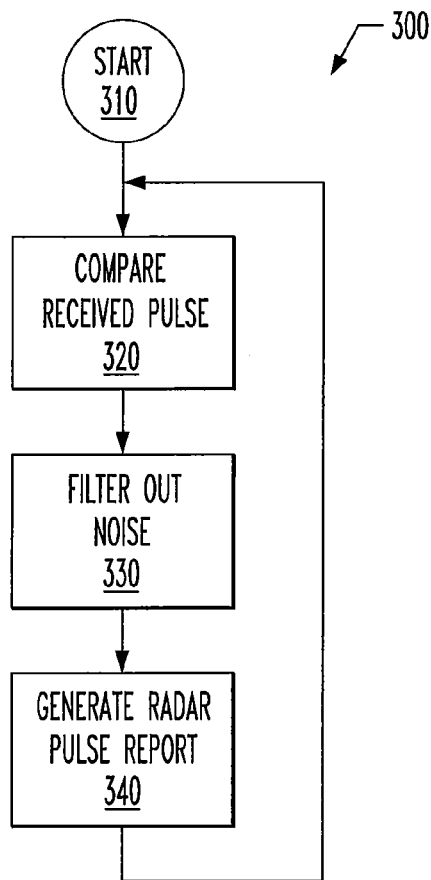


FIG. 3

FIG. 4

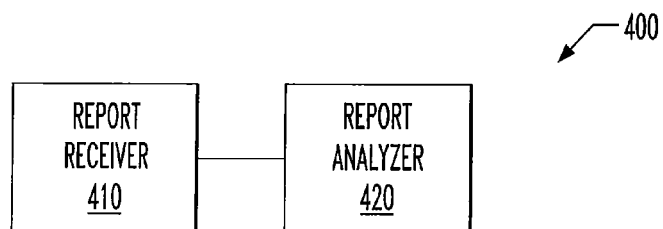


FIG. 5A

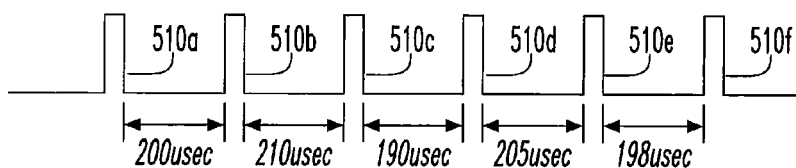


FIG. 5B

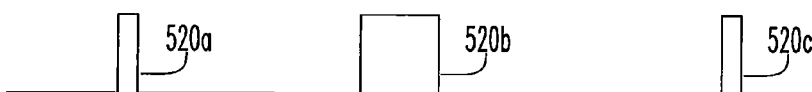


FIG. 5C

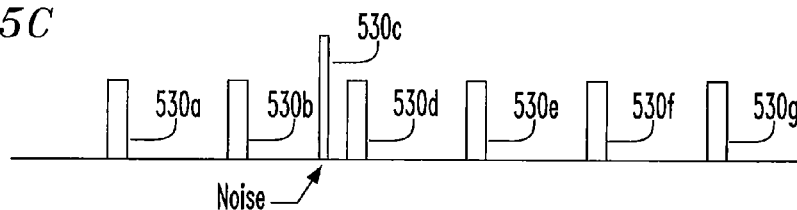


FIG. 5D

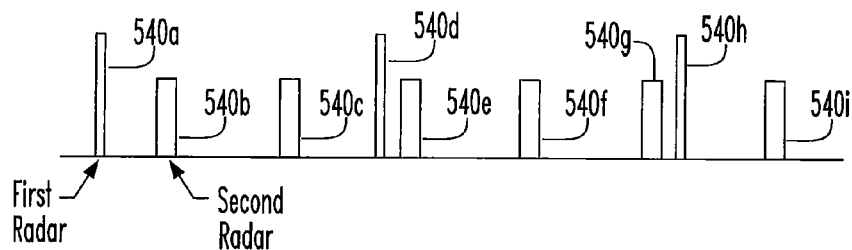
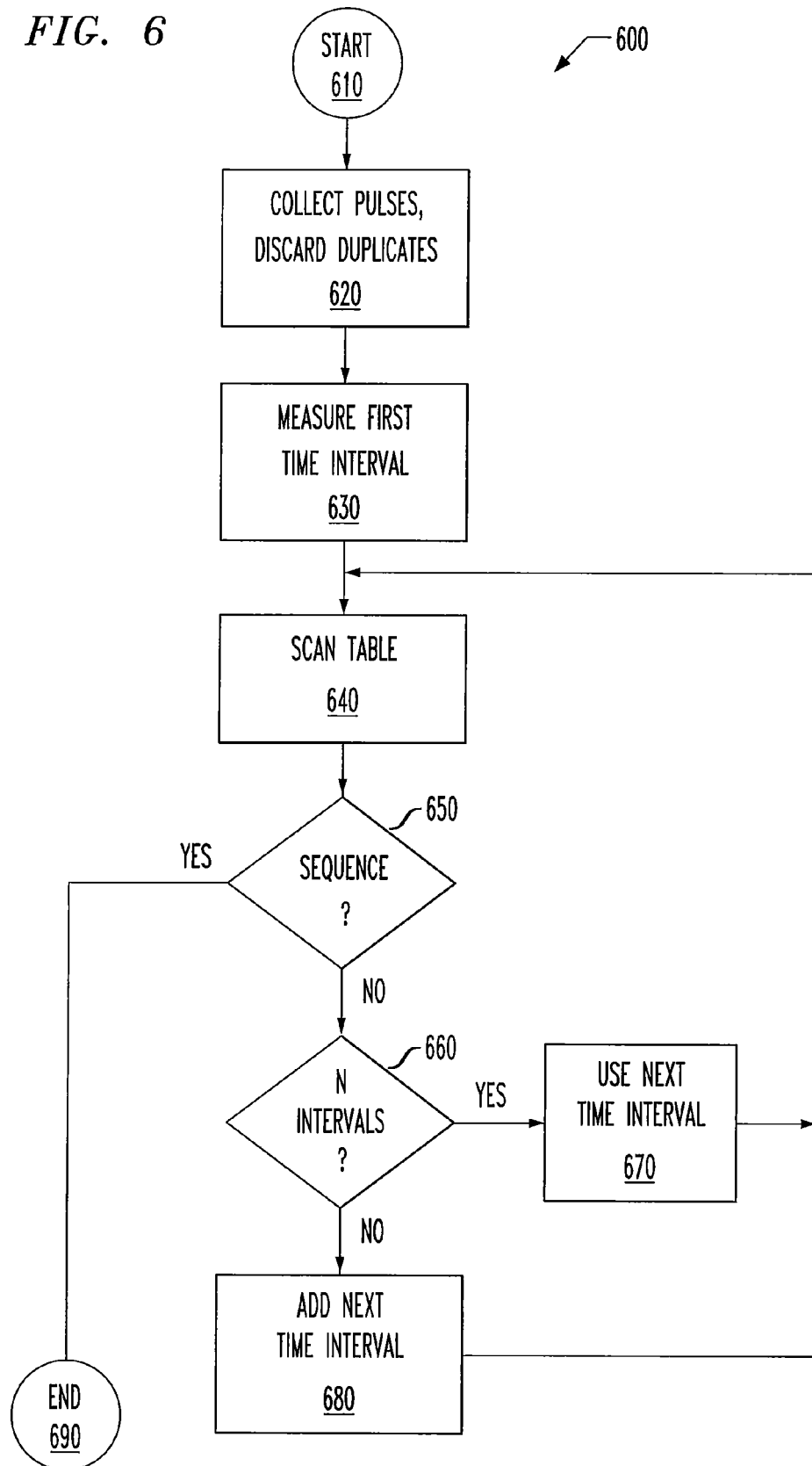


FIG. 5E



FIG. 6



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WIRELESS DEVICE, SYSTEM AND METHOD FOR DISCRIMINATING RADAR TRANSMISSIONS FROM WIRELESS NETWORK TRANSMISSIONS AND WIRELESS NETWORK HAVING RADAR-AVOIDANCE CAPABILITY

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. patent application Ser. No. 10/636,429, to Jan P. Kruys, entitled "SYSTEM AND METHOD FOR DISCRIMINATING RADAR TRANSMISSIONS FROM WIRELESS NETWORK TRANSMISSIONS AND WIRELESS NETWORK HAVING RADAR-AVOIDANCE CAPABILITY," filed on Aug. 7, 2003 now U.S. Pat. No. 8,014,787 currently allowed. The above-listed application is commonly assigned with the present invention and is incorporated herein by reference as if reproduced herein in its entirety.

TECHNICAL FIELD OF THE INVENTION

The present invention is directed, in general, to wireless networking and, more specifically, to a system and method for discriminating radar transmissions from wireless network transmissions and wireless network having radar-avoidance capability.

BACKGROUND OF THE INVENTION

One of the fastest growing technologies over the last few years has been wireless local area network (WLAN) devices based on the Institute of Electrical and Electronic Engineers (IEEE) 802.11b standard, commonly known as "Wi-Fi." The 802.11b standard uses the 2.4 GHz frequency of the electromagnetic spectrum and allows users to transfer data at speeds up to 11 Mbit/sec.

However, a complementary WLAN standard (IEEE 802.11a) is now available that specifies how WLAN equipment has to operate on frequencies between 5 GHz and 6 GHz (the "5 GHz band"). The 802.11a standard significantly expands the capacity of WLANs, allowing data to be exchanged at even faster rates (up to 54 Mbit/sec), but at a shorter operating range than 802.11b.

Unfortunately, the Department of Defense (DOD) operates a large number of radar systems in the 5 GHz band. The DOD has become concerned that the increasing adoption of 802.11a wireless devices will, as time goes on, cause increasing interference between the pulses that make up the signals produced by the radar systems and the pulses produced by the wireless devices. Its concern is particularly acute in today's security-conscious environment.

To accommodate both radar and 802.11a WLAN wireless devices in the same 5 GHz band, the WLAN industry developed a concept called "dynamic frequency selection," or DFS. DFS calls for wireless devices to detect the presence of radar signals. When a radar signal is detected on a particular channel, the wireless devices are to switch automatically to another channel to avoid interfering with the radar signal. DFS would appear in theory to yield an acceptable sharing of the 5 GHz band.

However, several problems have arisen in prior art implementations of DFS. First, switching sensitivity is a serious issue. If a particular implementation of DFS provides good noise rejection, switching may occur too slowly in response to a real radar transmission, resulting in undue interference.

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However, if the noise rejection is reduced, switching may occur in response to noise that appears to be a real radar transmission. The resulting needless channel switch reduces the efficiency with which user data is transmitted through the WLAN, and therefore reduces its effective bandwidth.

Second, DFS can only be undertaken in a wireless device when it is receiving, not when it is transmitting, since its receiver is effectively disabled during that time. Therefore, radar signals will almost certainly go undetected when the wireless device is transmitting, increasing the risk of unwanted interference to radar systems.

Fourth, some radar systems transmit the pulses of their radar signals at a low rate. If a wireless device misses detecting even one pulse, the time interval between the two adjacent pulses may be too great for the wireless device properly to identify the radar transmissions. Again, the radar transmissions may go undetected.

Finally, the position of the 802.11a wireless device with respect to the radar may be such that radar transmissions received by the wireless device are of enhanced or diminished amplitude. The transmissions may therefore be misinterpreted as noise and ignored. In a similar vein, multipath interference may transform the pulses of the radar transmission, rendering them unrecognizable as such by the 802.11a wireless device. Again, the extent to which noise is rejected has some bearing on noninterpretation or misinterpretation of radar transmissions. In either case, the risk is that channels would not be switched quickly enough, and interference results.

While the IEEE does, in 802.11h, provide a protocol that allows radar-monitoring data to be collected from wireless devices, it sets forth no method for actually monitoring radar transmissions, nor does it specify how the radar-monitoring data should be analyzed to determine whether a radar is in operation. What is needed in the art is a comprehensive, practical DFS implementation that effectively rejects noise, but quickly and correctly identifies true radar transmissions. What is further needed in the art is a DFS implementation that is operable even when a particular wireless device is transmitting.

SUMMARY OF THE INVENTION

To address the above-discussed deficiencies of the prior art, the present invention provides for use in a wireless network (of which a WLAN is one type), a wireless device, systems and methods for identifying radar signals and for giving the wireless network a radar-avoidance capability.

In one aspect, a wireless device for operating in a wireless network is disclosed. In one embodiment, the wireless device includes: (1) a pulse analyzer configured to make a determination whether a received pulse is a radar pulse and not a wireless network pulse and (2) a pulse reporter coupled to the pulse analyzer and configured to generate, if the determination is positive, a report thereof for transmission over the wireless network to a central aggregation node thereof.

In another aspect, a method of identifying radar signals is disclosed. In one embodiment, the method includes: (1) making, at a wireless device in the wireless network, a determination whether a received pulse is a radar pulse and not a wireless network pulse and (2) generating, if the determination is positive, a report thereof for transmission over the wireless network.

In yet another aspect, a system for giving the wireless network a radar-avoidance capability is disclosed. In one embodiment, the system includes: (1) a report receiver configured to receive reports via the wireless network from wire-

less devices thereof and (2) a report analyzer, associated with the report receiver, configured to analyze relationships among the reports to make a determination whether a sequence of radar pulses exists and, if the determination is positive, generate a radar transmission alert.

Therefore, the present invention introduces the broad concept of employing the wireless network as a whole (or at least a number of its wireless devices) to gather radar pulse data and using a node in the wireless network to analyze the data centrally. Using multiple wireless devices overcomes the many problems described above (e.g., transmit blackout, multipath interference, noise and amplitude variation) that result when only one wireless device is used. Once it has been determined that radar transmissions are present on the wireless network's frequency, the wireless network responds by changing frequency to avoid the radar.

The foregoing has outlined, rather broadly, preferred and alternative features of the present invention so that those skilled in the art may better understand the detailed description of the invention that follows. Additional features of the invention will be described hereinafter that form the subject of the claims of the invention. Those skilled in the art should appreciate that they can readily use the disclosed conception and specific embodiment as a basis for designing or modifying other structures for carrying out the same purposes of the present invention. Those skilled in the art should also realize that such equivalent constructions do not depart from the spirit and scope of the invention in its broadest form.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present invention, reference is now made to the following descriptions taken in conjunction with the accompanying drawings, in which:

FIG. 1 illustrates a schematic diagram of a WLAN operating in an environment in which a radar system is also operating;

FIG. 2 illustrates a block diagram of one embodiment of a system for identifying radar signals constructed according to the principles of the present invention;

FIG. 3 illustrates a flow diagram of one embodiment of a method of identifying radar signals carried out according to the principles of the present invention;

FIG. 4 illustrates a block diagram of one embodiment of a system for giving the WLAN of FIG. 1 a radar-avoidance capability constructed according to the principles of the present invention;

FIG. 5A through 5E illustrate exemplary graphical representations of pulses that the system of FIG. 4 can analyze to identify radar pulse sequences; and

FIG. 6 illustrates a flow diagram of one embodiment of a method of giving the WLAN of FIG. 1 a radar-avoidance capability carried out according to the principles of the present invention.

DETAILED DESCRIPTION

Referring initially to FIG. 1, illustrated is a schematic diagram of a WLAN, generally designated 100, operating in an environment in which a radar system 110 is also operating. The WLAN 100 includes a plurality of wireless devices 120, 130, 140, 150, 160, 170. The WLAN 100 is further illustrated as including a Wireless Access Point (WAP) 180 that provides a bridge between the various wireless devices 120, 130, 140, 150, 160, 160 of the WLAN 100 and an external network (not

shown), such as the Internet. Finally, a reflective surface 190 is schematically shown for a purpose that will soon become evident.

During operation of the WLAN 100, the wireless devices 120, 130, 140, 150, 160, 170 transmit and receive packets of user and control data. Since the wireless devices 120, 130, 140, 150, 160, 170 conform to the IEEE 802.11a standard, the packets are transmitted between the wireless devices 120, 130, 140, 150, 160, 170 and the WAP 180 using coded Orthogonal Frequency Division Multiplexing (OFDM) symbols that take the form of pulses that, in turn, modulate a carrier wave of a certain frequency. The frequency of the carrier wave defines the channel at which the wireless devices 120, 130, 140, 150, 160, 170 are operating.

From the perspective of the Open Systems Interconnect (OSI) network model, the OFDM symbols are coded, transmitted, received and decoded at the physical, or "PHY," layer. All other data manipulation occurs at higher layers.

For purposes of illustration, it is now assumed that the radar system 110 begins to transmit at a frequency that approximates the frequency of the channel at which the WLAN 100 is operating. Radar pulses emanate from the radar system 110 and begin to traverse the WLAN's space. The result, as amply described in the Background of the Invention section above, is that the continued operation of the WLAN 100 on its current channel begins to interfere with the receiver of the radar system 110.

The challenge at this point for the WLAN 100 is to detect and correctly identify the radar pulses and switch channels to halt further interference. Each of the wireless devices 120, 130, 140, 150, 160, 170 could try to detect and identify the radar pulses independently but, as described above, significant barriers exist to this approach.

To illustrate by way of example, the wireless device 170 is relatively close to the radar system 110. Radar pulses may appear enhanced in amplitude or distorted by virtue of their relative power. In contrast, the wireless device 160 is relatively far from the radar system 110. Radar pulses may appear diminished in amplitude and be subject to being treated as noise. Still further in contrast, the wireless device 130 is proximate the reflective surface 190. Not only does the wireless device 130 receive radar pulses directly from the radar system 110, it also receives delayed, attenuated and probably distorted reflections of the radar pulses by virtue of their interaction with the reflective surface 190. It would be quite difficult to provide a common set of known characteristics (e.g., time interval, pulsewidth or amplitude) to the wireless devices 120, 130, 140, 150, 160, 170 that would allow them each reliably to distinguish numbers of radar pulses from wireless network pulses sufficient to reach a reliable determination, since their perceptions of the radar pulses differ.

Compounding the challenge is that the wireless devices 120, 130, 140, 150, 160, 170 are unable to detect radar pulses while they are transmitting, so the wireless devices 170, 160, 130 cannot be assumed to have complete data from which to make their respective determinations.

As stated above, the present invention takes a different approach, calling for the various wireless devices 120, 130, 140, 150, 160, 170 to identify as many radar pulses as reasonably possible given their circumstances and to pool their findings such that a more comprehensive analysis can be performed centrally on a larger body of collective data. Embodiments of the present invention will now be described to describe this process in greater detail.

Turning now to FIG. 2, illustrated is a block diagram of one embodiment of a system, generally designated 200, for identifying radar signals constructed according to the principles

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of the present invention. The illustrated embodiment of the system **200** embodied in each of the wireless devices **120**, **130**, **140**, **150**, **160**, **170**. As such, the system **200** has access to and employs a receiver **210**, a digital signal processor (DSP) **220** and a media access controller (MAC) **230** already existing in each of the wireless devices **120**, **130**, **140**, **150**, **160**, **170**. Those skilled in the pertinent art understand that, as conventional OFDM symbols are received into a particular wireless device, its receiver amplifies, demodulates and filters the received symbols; its DSP decodes the symbols to yield a bitstream; and its MAC applies protocols to and buffers the bitstream so it can be transferred to the remainder of the wireless device.

The system **200** includes a pulse analyzer **240**. The pulse analyzer **240** is configured to make a determination whether a received pulse is a radar pulse and not a wireless network pulse. As such, the pulse analyzer **240** compares the received pulse to at least one known characteristic. In the illustrated embodiment, the pulse analyzer **240** is embodied as a sequence of instructions executable in the DSP **220** and employs programmable characteristics that distinguish the radar pulse, the wireless network pulse and noise from one another.

If the pulse analyzer **240** determines that the received pulse is noise, it causes the received pulse to be filtered out. If the pulse analyzer **240** determines that the received pulse is a wireless network pulse, it causes the received pulse to be decoded in the DSP **220** and passed on to the MAC **230** for standard processing. If the pulse analyzer **240** makes a determination that the received pulse is a radar pulse, it signals a pulse reporter **250**.

The pulse reporter **250** is coupled to the pulse analyzer **240** and is configured to generate, if the determination is positive, a report thereof for transmission over the WLAN (**100** of FIG. **1**). More specific to the illustrated embodiment, the pulse reporter **250** is embodied in the MAC **230**, allowing it to generate a packet of proper protocol containing the report. One such a packet may contain one or more of these reports.

The report includes at least a timestamp derived from a common timebase. The fact that the MAC **230** already has a real time clock synchronized with other real time clocks in the WLAN (**100** of FIG. **1**) advantageously allows it to provide the timestamp. In the illustrated embodiment, the timestamp indicates the onset (arrival) time of the pulse. The report of the illustrated embodiment further includes a pulsewidth which may prove useful in later analysis. The report can also include pulse amplitude, frequency, phase or any other characteristic that may be deemed useful in a particular implementation of the present invention.

Accordingly, the MAC **230**, under control of the pulse reporter **250**, generates the report and causes the report to be destined for a "central aggregation node" in the WLAN (**100** of FIG. **1**). A number of these reports may be combined and transmitted in one transmission. In the illustrated embodiment, the central aggregation node is the WAP **180** of FIG. **1**. Those skilled in the art will readily realize, however, that this need not be the case.

Turning now to FIG. **3**, illustrated is a flow diagram of one embodiment of a method, generally designated **300**, of identifying radar signals carried out according to the principles of the present invention. The method **300** begins in a start step **310**, wherein it is desired to monitor pulses to determine whether they may indicate the presence of a radar system on the channel being used.

The method proceeds to a determination of whether a received pulse is a radar pulse and not a wireless network pulse (and perhaps not noise either). Accordingly, in a step

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320, the received pulse is compared to at least one known characteristic (e.g., time interval, pulsewidth or amplitude). In the illustrated embodiment, time interval and pulsewidth are the employed characteristics and are programmable such that the sensitivity of the WLAN (**100** of FIG. **1**) can be altered. If the received pulse is determined to be noise, the received pulse is filtered out in a step **330**.

Next, in a step **340**, if the determination that the received pulse is a radar pulse and not a wireless network pulse is positive, a report of that fact is generated for transmission over the WLAN (**100** of FIG. **1**). In the illustrated embodiment, the report is sent to the WAP (**180** of FIG. **1**), which serves as a central aggregation node for reports from all wireless devices of the WLAN (**100** of FIG. **1**). Those skilled in the pertinent art will recognize that the report sent to the WAP (**180** of FIG. **1**) may be aggregated with other reports into a single message over the WLAN (**100** of FIG. **1**). At this point, it is assumed that monitoring of received pulses continues, subject to periods during which the wireless device is transmitting data. Accordingly, the method **300** doubles back to the step **310**.

Turning back briefly to FIG. **1**, it should be assumed at this point that, given that the radar system **110** of FIG. **1** is active on their channel, the various wireless devices **120**, **130**, **140**, **150**, **160**, **170** are transmitting various reports to the WAP **180** concerning suspected radar pulses they have received therefrom. The term "suspected" is used, because the wireless devices **120**, **130**, **140**, **150**, **160**, **170** may have incorrectly determined some noise to be radar pulses and caused spurious reports to have been transmitted. Nonetheless, such spurious reports will be dealt with in a manner that will become apparent.

Turning now to FIG. **4**, illustrated is a block diagram of one embodiment of a system, generally designated **400**, for giving the WLAN of FIG. **1** a radar-avoidance capability constructed according to the principles of the present invention. The illustrated embodiment of the system **400** is embodied as a sequence of software instructions executable in a general purpose processor associated with the WAP **180**. Those skilled in the pertinent art will understand that other embodiments and locations for the system **400** fall within the broad scope of the present invention.

The system **400** includes a report receiver **410**. The report receiver **410** is configured to receive reports of received radar pulses via the WLAN (**100** of FIG. **1**) from wireless devices thereof, (e.g., the wireless devices **120**, **130**, **140**, **150**, **160**, **170**). The illustrated embodiment of the report receiver **410** assembles the data contained in the reports into a table (not shown, but represented schematically in FIGS. **5A** through **5E**) in timestamp order to facilitate analysis.

The system **400** further includes a report analyzer **420**. The report analyzer **420** is associated with the report receiver **410** and is configured to analyze relationships among the reports to make a determination whether a sequence of radar pulses exists. If the determination is positive, the report analyzer **420** generates a radar transmission alert to be employed by the WLAN (**100** of FIG. **1**) in switching channels to avoid the radar system (**110** of FIG. **1**). Upon receiving the radar transmission alert, the WLAN (**100** of FIG. **1**) responds by ordering a channel switch, and the wireless devices (e.g., the wireless devices **120**, **130**, **140**, **150**, **160**, **170** of FIG. **1**) respond to effect the switch.

As described above, the reports of the illustrated embodiment include timestamps derived from a common timebase and widths of the radar pulses (pulsewidths). Accordingly, the

illustrated embodiment of the report analyzer **420** analyzes time intervals between ones of the radar pulses and further analyzes the pulsewidths.

More specifically, the report analyzer identifies X successive repetitions of a given time interval between ones of the radar pulses subject to a maximum of Y missing radar pulses and within a tolerance of Z microseconds, where X, Y and Z are programmable variables provided to the system **400**. Thus X, Y and Z together determine the sensitivity of the system **400**. Those skilled in the pertinent art will understand that other or further variables may be employed to advantage to identify radar signals.

Moreover, the report analyzer **420** identifies a maximum of N time intervals between ones of the radar pulses, where N is a programmable variable. N thus determines how thorough the search for like time intervals is to be before calling the search off and beginning to search for wholly different time intervals.

Some details regarding the analysis of specific radar pulses will now be illustrated. FIG. 5A through 5E illustrate exemplary graphical representations of pulses that the system **400** of FIG. 4 can analyze to identify radar pulse sequences.

FIG. 5A illustrates six pulses **510a**, **510b**, **510c**, **510d**, **510e**, **510f** of substantially constant width and periodicity, but with some variation. (Keep in mind that these pulses **510a**, **510b**, **510c**, **510d**, **510e**, **510f** may have been collected from various and even multiple wireless devices.) As FIG. 5A indicates, the interval between pulses **510a** and **510b** is 200 μ sec. The interval between pulses **510b** and **510c** is 210 μ sec. The interval between pulses **510c** and **510d** is 190 μ sec. The interval between pulses **510d** and **510e** is 205 μ sec. Finally, the interval between pulses **510e** and **510f** is 198 μ sec. If the given time interval is 200 μ sec and the tolerance Z is 10 μ sec, the report analyzer **420** will regard the six pulses **510a**, **510b**, **510c**, **510d**, **510e**, **510f** as belonging to a sequence of radar pulses. The report analyzer **420** may not regard the sequence as complete, however, if X, the number of successive repetitions of a given time interval required to constitute a valid radar pulse sequence, is greater than six.

FIG. 5B illustrates three pulses **520a**, **520b**, **520c** separated by arguably similar time intervals. However, the pulse **520b** is quite evidently wider than the pulses **520a**, **520c**. In the illustrated embodiment, the pulse **520b** would be disregarded as noise. A programmable variable W may achieve the purpose of defining the maximum width variation tolerance.

FIG. 5C illustrates seven pulses **530a**, **530b**, **530c**, **530d**, **530e**, **530f**, **530g**. The pulse **530c** stands out from the rest as being the only one of its amplitude. In the illustrated embodiment, the pulse **530c** would be disregarded as noise. A programmable variable A may achieve the purpose of defining the maximum amplitude variation tolerance.

FIG. 5D illustrates nine pulses **540a**, **540b**, **540c**, **540d**, **540e**, **540f**, **540g**, **540h**, **540i**. It is apparent that the pulses **540a**, **540d**, **540h** potentially belong (subject to X, Y and Z) to a first sequence of radar pulses (emanating from what appears to be a first radar system) and the remainder of the pulses **540b**, **540c**, **540e**, **540f**, **540g**, **540i** potentially belong (subject again to X, Y and Z) to a second sequence of radar pulses (emanating from what appears to be a second radar system). FIG. 5D illustrates the ability of the report analyzer **420** to discern multiple radar pulse sequences, subject to N.

FIG. 5E illustrates the consequence of Y. Five pulses **550a**, **550b**, **550c**, **550d**, **550e** are evident, but the time interval separating the pulses **550b** and **550c** appears to be twice those separating the others. Assuming that Y is set to at least one, the double time interval will be assumed to be missing a pulse,

and the five pulses **550a**, **550b**, **550c**, **550d**, **550e** actually in evidence will be candidates (subject to X and Z) for a potential sequence of radar pulses.

Turning now to FIG. 6, illustrated is a flow diagram of one embodiment of a method, generally designated **600**, of giving the WLAN **100** of FIG. 1 a radar-avoidance capability carried out according to the principles of the present invention. The method **600** begins in a start step **610**, wherein it is desired to collect up and centrally analyze pulses in an effort to detect radar signals.

The method **600** proceeds to a step **620**, in which data pertaining to pulses determined by various wireless devices to be radar pulses are collected into a table and pulses that are apparent duplicates (the same pulse determined by multiple wireless devices) are discarded. Next, in a step **630**, the first time interval in the table is measured.

Then, in a step **640**, the table is scanned to find a sequence of at least X successive repetitions of the time interval. A sequence is still considered to be valid even if Y pulses are missing. When comparing time intervals, a tolerance of Z μ sec is allowed.

Next, in a decisional step **650**, it is determined whether a sequence has been found in the table. If YES, then the method **600** ends in an end step **690**. If NO, the method **600** proceeds to a decisional step **660** in which it is determined whether N such time intervals have been found. If YES, the search for like time intervals ceases, and the next time interval in the table is measured in a step **670**. Processing then continues in the step **640**. If NO, the method proceeds to a step **680** in which the time interval in the table is incremented. Processing then continues in the step **640**.

Although the present invention has been described in detail, those skilled in the art should understand that they can make various changes, substitutions and alterations herein without departing from the spirit and scope of the invention in its broadest form.

What is claimed is:

1. A wireless device for operating in a wireless network, comprising:
 - a pulse analyzer configured to make a determination whether a pulse received at said wireless device is a suspected radar pulse and not a wireless network pulse; and
 - a pulse reporter, coupled to said pulse analyzer, configured to generate a report of said suspected radar pulse based on said determination for transmission over said wireless network to a central aggregation node of said wireless network, wherein said central aggregation node employs said report to determine if said suspected radar pulse is a radar pulse and transmits an alert to said wireless network based upon determining said suspected radar pulse is a radar pulse.
2. The wireless device as recited in claim 1 wherein said pulse analyzer filters out said received pulse if said pulse analyzer determines that said received pulse is noise.
3. The wireless device as recited in claim 1 wherein said pulse analyzer makes said determination by comparing said received pulse to a known characteristic.
4. The wireless device as recited in claim 1 wherein said pulse analyzer is embodied in a digital signal processor and employs programmable characteristics that distinguish said radar pulse, said wireless network pulse and noise.
5. The wireless device as recited in claim 1 wherein said pulse reporter is embodied in a MAC and said report includes a timestamp derived from a common timebase that indicates the arrival time of said received pulse and includes a pulse-width of said received pulse.

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6. The wireless device as recited in claim 1 wherein said received pulse is received on a channel of said wireless network and said report is transmitted over said channel to said central aggregation node.

7. The wireless device as recited in claim 1 wherein said wireless network pulse is an OFDM pulse conforming to IEEE 802.11a and said radar pulse is in a 5 GHz band.

8. For use in a wireless network, a method of identifying radar signals, comprising:

making, at a wireless device in said wireless network, a determination whether a received pulse is a suspected radar pulse and not a wireless network pulse;

generating a report of said suspected radar pulse based on said determination for transmission over said wireless network to a central aggregation node of said network;

analyzing, at said central aggregation node, a relationship between said report with other suspected radar reports from other wireless devices in said wireless network to determine whether a sequence of radar pulses exists; and transmitting an alert based on said analyzing to said wireless network.

9. The method as recited in claim 8 further comprising filtering out said received pulse if said received pulse is determined to be noise.

10. The method as recited in claim 8 wherein said making comprises making said determination by comparing said received pulse to a known characteristic.

11. The method as recited in claim 8 wherein said making is carried out in a digital signal processor and comprises employing programmable characteristics that distinguish said radar pulse, said wireless network pulse and noise.

12. The method as recited in claim 8 wherein said generating is carried out in a MAC and said report includes a timestamp derived from a common timebase.

13. The method as recited in claim 8 wherein said wireless network pulse is an OFDM pulse conforming to IEEE 802.11a and said radar pulse is in a 5 GHz band.

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14. A system for giving a wireless network a radar-avoidance capability, comprising:

a plurality of wireless devices, each of said wireless devices including:

a pulse analyzer configured to make a determination whether a pulse received at said wireless device is a suspected radar pulse and not a wireless network pulse; and

a pulse reporter, coupled to said pulse analyzer, configured to generate a report, if said received pulse is said suspected radar pulse, for transmission over said wireless network; and

a central aggregation node configured to receive said reports of received radar pulses via said wireless network from said plurality of wireless devices and analyze relationships among said reports to make a determination whether a sequence of radar pulses exists and, if said determination is positive, generate and transmit a radar transmission alert to said wireless network.

15. The system as recited in claim 14 wherein said reports include timestamps derived from a common time base and said report analyzer analyzes time intervals between ones of said radar pulses.

16. The system as recited in claim 14 wherein said reports include widths of said radar pulses and said report analyzer analyzes widths of ones of said radar pulses.

17. The system as recited in claim 14 wherein said central aggregation node is Wireless Access Point.

18. The system as recited in claim 14 wherein said report analyzer filters out said received pulse if said pulse analyzer determines that said received pulse is noise.

19. The system as recited in claim 14 wherein said pulse analyzer makes said determination by comparing said received pulse to a known characteristic.

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