(12) UK Patent Application (19) GB (11) 2 379 358 (13) A

(43) Date of A Publication 05.03.2003

(21) Application No 0120837.0

(22) Date of Filing 28.08.2001

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(51) INT CL[7]
H04Q 7/38

(52) UK CL (Edition V)
H4L LRRMR

(56) Documents Cited
GB 2342255 A
JP 070143548 A
US 5974036 A
WO 2000/069186 A1
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(58) Field of Search
UK CL (Edition T) H4L LDGR LECTY LRRMR LRRMT LRRMX
INT CL[7] H04L 12/28 12/56 29/00 29/06, H04Q 7/28 7/38
Other:

(54) Abstract Title
Channel selection based on quality of signal

(57) The invention relates to a wide personal area network (WPAN) such as Bluetooth (RTM) with a decentralised, distributed topology, e.g a piconet. Devices in the system scan and monitor the channel quality (e.g. RSSI, segment error rate, segment failure rate, carrier to interference ratio). The devices are polled to return the signal quality information. If it is determined that the quality of signal (QOS) exceeds or falls below a comparison value, a channel re-evaluation is carried out in an attempt to identify an alternative channel which is better. A switch is then made to the alternative channel. The new channel is then communicated to other devices in the network, so that all devices can hand-over and communicate on the new channel.

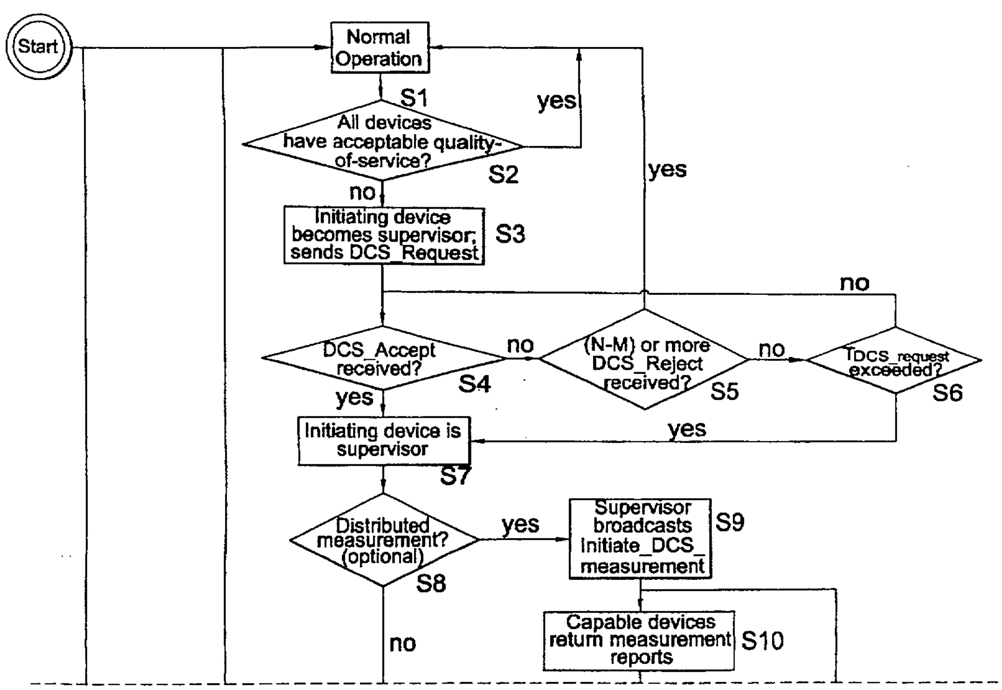

Fig. 2

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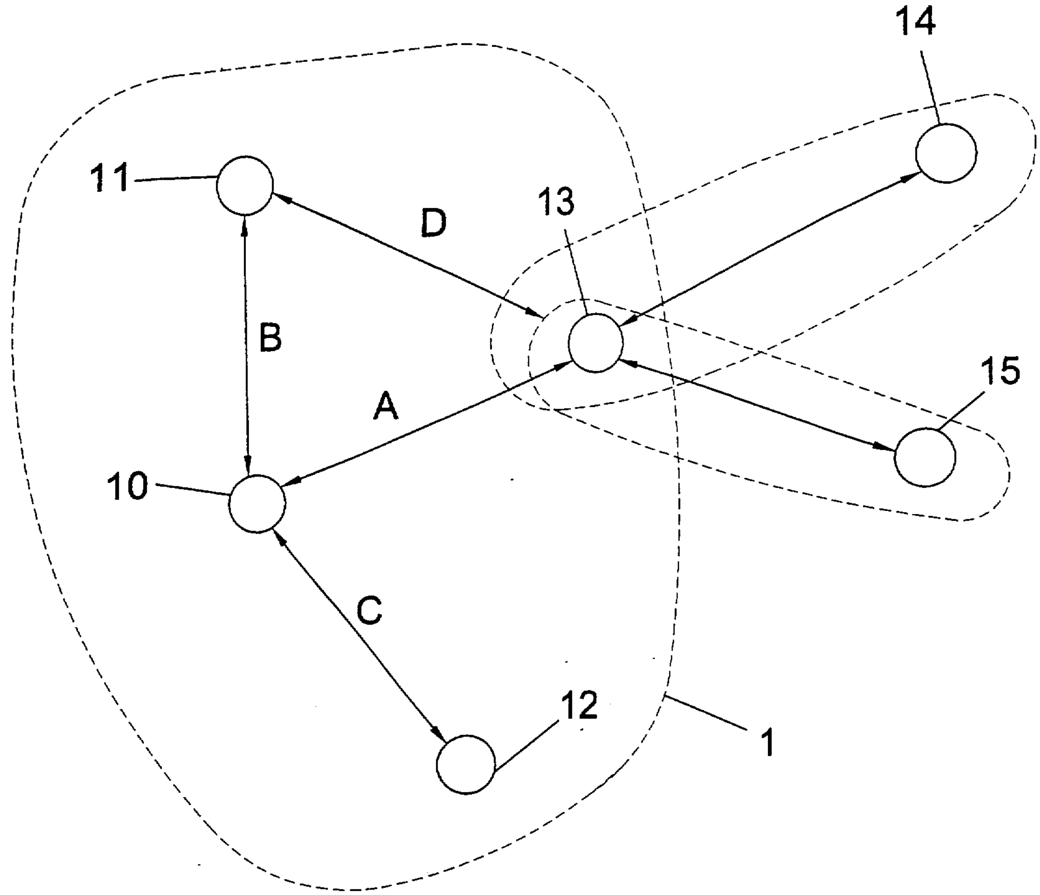


Fig. 1

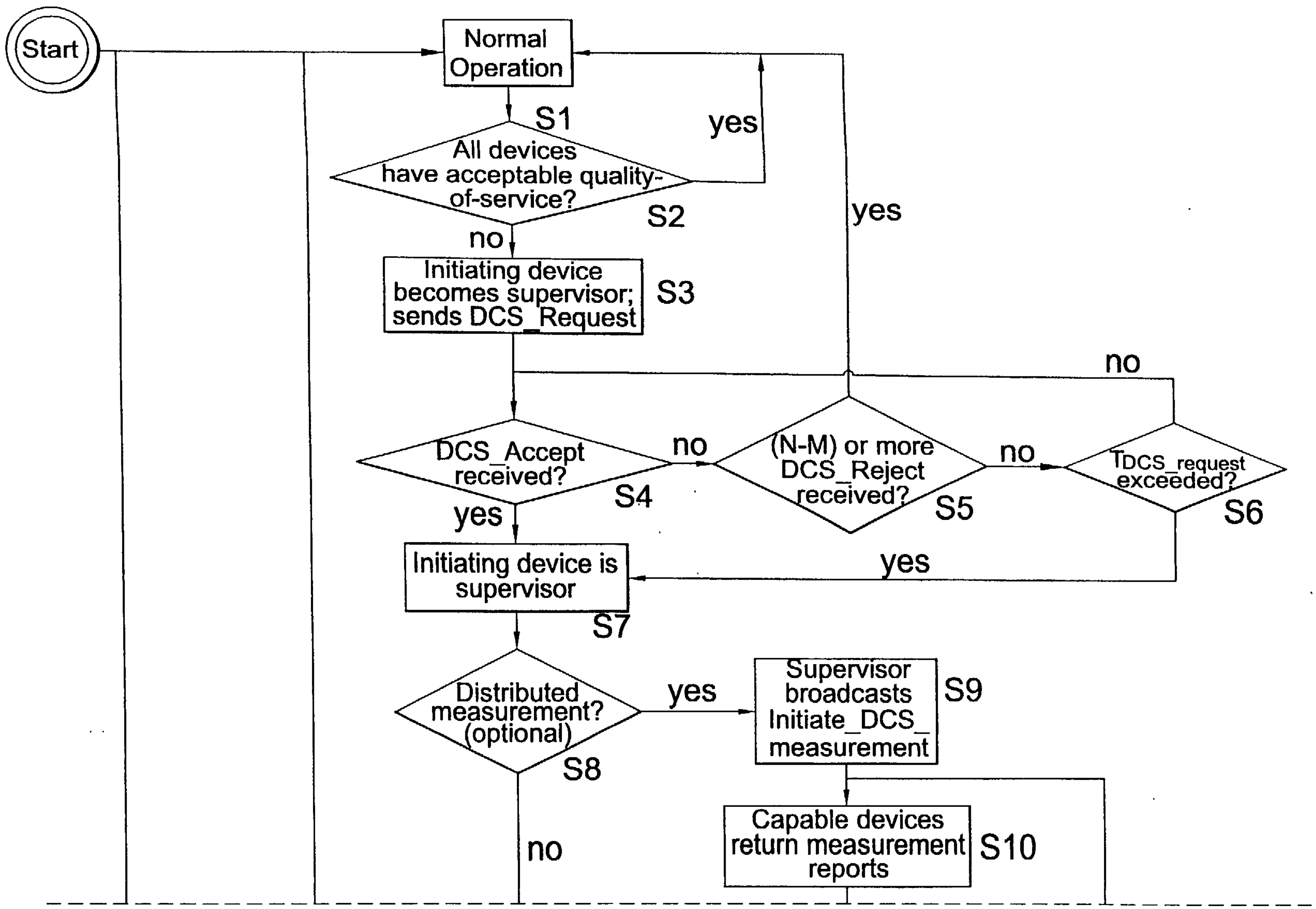
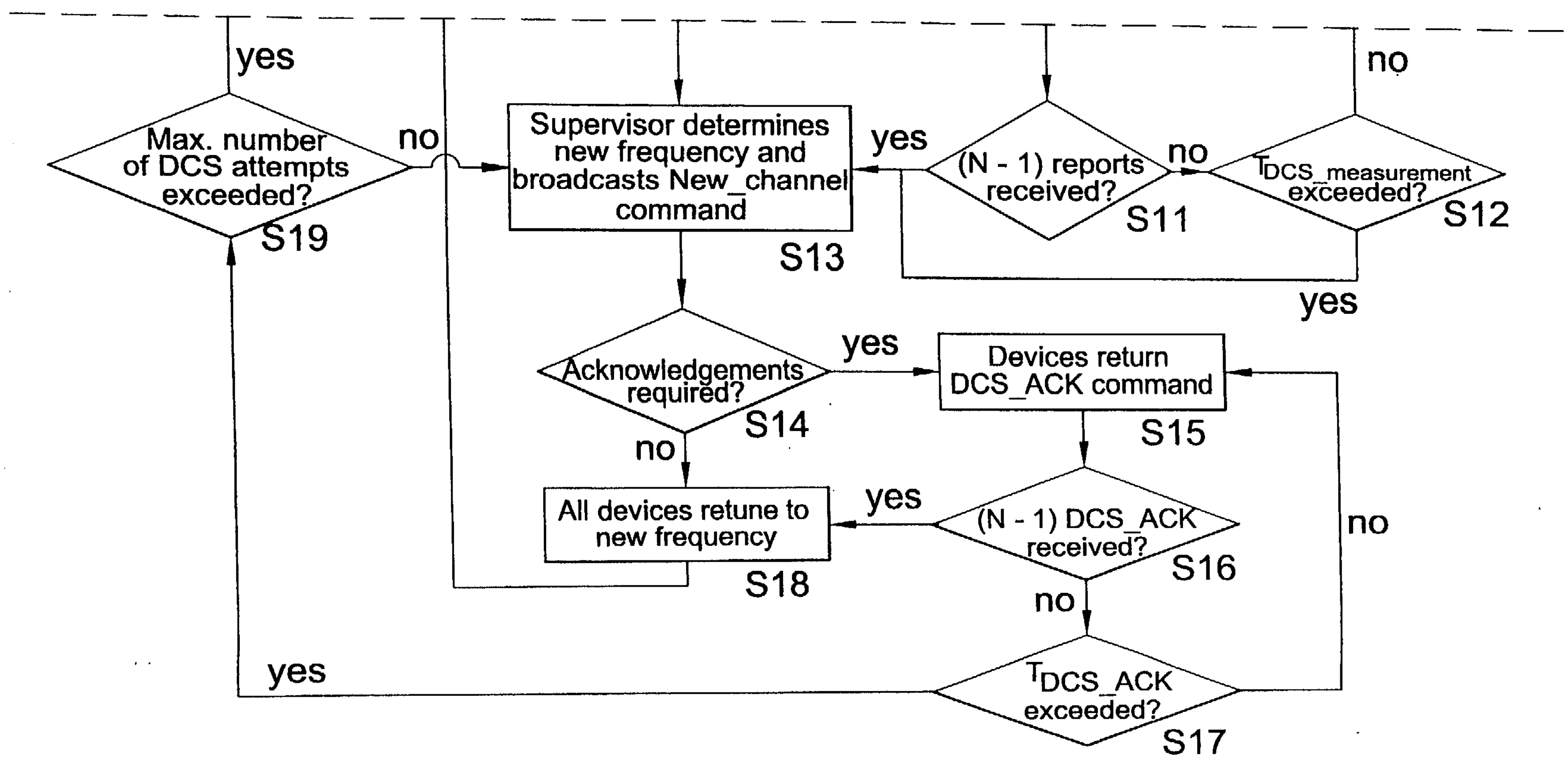

Start
Normal Operation
S1
All devices have acceptable quality-of-service?
S2
yes
no
Initiating device becomes supervisor; sends DCS_Request
S3
yes
no
DCS_Accept received?
S4
no
(N-M) or more DCS_Reject received?
S5
no
$T_{DCS\_request}$ exceeded?
S6
yes
yes
Initiating device is supervisor
S7
Distributed measurement? (optional)
S8
yes
Supervisor broadcasts Initiate_DCS_measurement
S9
no
Capable devices return measurement reports
S10

Fig. 2



Max. number of DCS attempts exceeded?
S19
yes
no
Supervisor determines new frequency and broadcasts New_channel command
S13
yes
(N - 1) reports received?
S11
no
T DCS_measurement exceeded?
S12
no
yes
Acknowledgements required?
S14
yes
no
Devices return DCS_ACK command
S15
All devices retune to new frequency
S18
yes
(N - 1) DCS_ACK received?
S16
no
no
T DCS_ACK exceeded?
S17
yes

Fig. 2(cont'd)

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Channel Adaptation in a Communication Network

The present invention relates to dynamic selection of channels for communication between devices, particularly for use in wireless personal area networks such as Bluetooth.

There have been a number of short-range wireless communication systems developed; one of the most recent is known as 'Bluetooth'. This system was initially developed with the intention of replacing the cables between computers and peripheral devices, e.g. a keyboard, to allow such devices to become mobile within a short-range of the device by introducing a lower power radio link. This technology developed to encompass a large number of applications in the field of wireless communications, including laptop computers, mobile phones and other mobile devices.

The current technology allows two or more such devices to form a wireless 'piconet', a short-range communication cell, to allow them to communicate with one another. Such wireless devices currently employ a frequency hopping spread spectrum system to mitigate the effects of unknown and unpredictable interference, or 'noise'. Some systems do employ fixed frequency links that can be switched in use to an alternative frequency on instruction from a fixed access point. However, these systems are generally dictated by a single device and have crude and unreliable methods for assessing the relative quality of alternative channels. Furthermore, relying on a centralised topology such as this removes much of the flexibility of a distributed structure.

Therefore according to the present invention there is provided a communication device for communication with one or more other communication devices comprising: means for measuring the signal quality of a communication channel; comparison means for determining if the measured signal quality exceeds a predetermined value; channel reselection means responsive to said comparison means for determining a reselection channel for further communication based upon channel quality information; and switching means for switching communication to said reselection channel.

Since there is no one specific master device which controls channel reselection and initial selection, use can be made of the distributed topology. Thus if the channel quality is poor in one part of the network area, a device in that area can initiate and complete channel reselection even if the original channel is acceptable everywhere else in the network area.

Preferably, the device comprises update means for transmitting a signal indicating the reselection channel which is received by the other communication devices. They can then retune to the new channel as well.

In addition, because the device can complete the reselection without reference to any other device, reselection can be carried out rapidly without delays which may occur due to all the devices forming a consensus.

The channel quality information can be obtained from a channel scanning means for scanning some or all of the available channels. It is not necessary to scan all channels. For example, only one channel in a certain band will be scanned if it is likely that interference is likely to extend across such a band. Therefore, where interference of a certain bandwidth is known to be present, channels may be scanned at intervals corresponding to the interference bandwidth.

The channel scanning means may determine the channel quality information in response to said comparison means determining that the quality is insufficient or alternatively, it may rely on information already collected prior to determining that the quality is insufficient. This clearly reduces the time overhead of scanning channels after it has been determined to reselect the channel. Furthermore, the pre-existing information may be updated after reselection has been determined to be necessary.

The devices preferably include polling means for transmitting a polling signal to be received by one or more other communication devices. In response to such a polling signal, the devices can provide channel information back to the original device. This allows any lack of homogeneity in the network to be compensated for by getting a picture of the channel status at different locations. Again the information provided may be pre-existing information or collected in response to the polling. If pre-existing information is available at one device, this can avoid the need for the supervisor device which initiated the reselection to carry out a scan of the spectrum.

There are a number of factors which can be used when determining the signal quality of the existing channel to ascertain whether the quality is below a desired level. This can include measuring at least one of: the segment error rate; the segment failure rate; the received signal strength; and the carrier to interference ratio.

Similarly there are a number of factors which can be used when determining the quality of a potential new channel to ascertain whether the channel can be used as the reselection channel. This can include measuring for each channel at least one of: the interference signal strength; the carrier to interference ratio; and the packet error rate.

The devices preferably include control means for receiving a polling signal from another communication device, producing local channel quality information and transmitting said local channel quality information for reception by said another communication device. This allows a device to act as a slave for providing information as well as a supervisor for carrying out reselection. In this way when a device is not in supervisor mode, it can still assist another device by providing local channel quality information in response to a polling signal.

The present invention provides both a device as indicated above but also a collection of two or more devices acting as a network.

Similarly, the present invention provides a method for operating a communication network comprising monitoring the quality of a communication channel at a communication device, and determining if the quality is below a predetermined level and if so: producing channel quality information for a plurality of candidate channels;

determining a reselection channel for communication based upon said channel quality information; and switching the communication channel.

The present invention will now be described in more detail with reference to the attached drawings in which:

Figure 1 shows a representation of a network to which the present invention can be applied; and

Figure 2 is a flow diagram showing how an embodiment of the present invention operates.

The present invention relates to a system for enhancing the communication between devices operating in a network over a communication channel. The following embodiment is described in relation to a piconet operating using a radio frequency communication link as part of a wireless personal area network (WPAN), e.g. Bluetooth.

A typical network includes a number of devices, which want to communicate with each other. Such an arrangement is shown in figure 1. These devices may be part of one or more networks with some devices connecting to more than one of these networks. For example, one network might include a laptop computer 10, a printer 11, a scanner 12 and a mobile phone 13. Another network may be formed between the mobile phone 13 and a personal digital assistant 14 and a further network may be formed between the mobile phone 13 and another PC 15.

Considering the network formed between the PC 10, printer 11, scanner 12 and mobile phone 13, when operating as in the context of a high rate Bluetooth system, it is assumed that a high rate (HR) subnet has been set up as a low rate (LR) Bluetooth piconet.

Whilst basic communication is carried using the LR piconet using a broadband system, HR communication is carried out using narrowband techniques. This allows for the higher data communication rate but is much more susceptible to narrowband fading, interference in the band and time dispersion.

The subnet 1 shown in figure 1 comprises four links A-D providing HR communications between the four devices. During normal operation data is transferred between the devices. However, if the quality of the communication channel being used deteriorates then it may be necessary to reselect an alternative channel for communication. The channel may deteriorate for a number of reasons such as the devices have moved into a different environment, moved relative to each other, another interfering source has moved closer to the devices and so on. The result is that satisfactory communication on the current channel is no longer possible.

In order to prevent loss of communication over the channel it is necessary to monitor the channel to determine when quality has fallen below a predetermined level, so that channel reselection can be carried out. Once it has been determined that channel reselection is required then it is necessary to determine an alternative channel to use. These two steps will be described in more detail below. In addition during start up it is also necessary to determine a suitable channel for use.

When multiple devices are present, if the devices are outside the coherence distance in the environment then narrowband and wideband fading will be uncorrelated between the different links A-D. For example, the link D may be deeply faded but links A-C have good received signal power. Consequently not all the devices would determine that reselection was required. Therefore, several and possibly all of the devices in the subnet monitor the channel. If one of the devices determines that the signal quality of the channel falls below a certain level then it initiates reselection as a supervisor. Some or all of the devices may initiate reselection and if so they become the supervisor. Thus any one of such devices can begin the reselection process without having to use a decentralised system where a consensus must be reached by all the devices. This is also more convenient that having a permanent master device for controlling the channel because this restricts the operability of this type of network because it means that all devices must be able to communicate with the master. The master must always be available and cannot move away from the other devices or vice versa.

As mentioned above, this dynamic channel selection process can be applied to deal with a number problems which may restrict signal quality, including (i) interference in the band; (ii) narrowband fading; and (iii) time dispersion. These problems are somewhat linked. A high RMS delay spread is likely to be experienced when the instantaneous narrowband channel attenuation is large. Furthermore, deep fade in the band will exacerbate problems of interference. Preferably, averaging of the measurements would be carried out to remove the impact of fast fading on the interference measurement. In addition, because interference may not be homogenous throughout the piconet such that different interferers dominate in different parts of the piconet then several measurements can be taken for an optimal solution.

Figure 2 shows a flow chart representing the steps to be carried out for monitoring and reselecting a channel. In S1 normal communication takes place. At S2 a check is carried out to determine whether all devices have quality of service above a predetermined level.

The quality of service can be measured in a number of ways. However, the most favoured option is monitoring the segment failure or segment error rate whilst in the most robust mode available (BPSK mode in the case of Bluetooth). The specific segment error rate required to trigger a reselection of the channel will be based on the required quality of service for the link. Other parameters that may be used are the received signal strength (RSSI) and the carrier to interference ratio (C/I) or combinations of any of these.

The regularity at which the quality of service is monitored depends on a number of factors. The most import of these is the rate at which interferers join or leave the vicinity of the devices and the multipath fading (due to the wireless channel) which is experienced on the desired and interfering links. In most situations, the rate of change due to multipath fading (as characterised by the Doppler frequency) will dominate the birth/death process of interferers. This is not a problem where the measurement is taken and then immediately acted upon such that there is little time between the measurement being taken and being acted upon. However, where the measurement is taken, for example during an idle period, and then stored for use subsequently, such as for reselection initiated by another device, then there is a danger that the measurements may be 'stale', i.e. out of date. This can be avoided by taking the measurements at a rate that is faster than the rate of change of the environment (dominated by the Doppler frequency as described above). This can be determined by the device itself based upon examining the difference between subsequent measurements or broadcast across the subnet by one or the other or the devices. Alternatively less frequent measurements may be tolerated by classifying the measurements taken according to their age. Newer measurements can be allocated a higher weighting value that is decreased with time as they become increasingly out of date. The quantisation of these weighting values could be related to the number of frames/packets since the measurement was taken or otherwise. Then when the measurements are taken into account, those which are older can be arranged to have less weight than more recent measurements.

Once it is determined by one of the devices at S2 that the quality of service is below the predetermined level, then the initiating device is assigned temporary supervisor status. Similarly a device initiating a new HR link is assigned temporary supervisor status. It then sends a dynamic channel selection request (DCS_Request) to the other devices in the subnet, step S3. It is assumed that there are N devices on the subnet and that the subnet is arranged such that M devices must accept a DCS_Request before it is accepted. Preferably M=N-1 meaning that all other devices on the subnet must accept the DCS_Request to ensure a robust implementation. The process may be speeded up by allowing M to be less than N-1.

At S4, it is determined whether the required M acceptances (DCS_Accept) have been received. If not, a check is carried out, at S5, to determine if the maximum (N-M) number of explicit rejections (DCS_Reject) has been received. If so, normal operation is resumed and DCS does not take place. Otherwise, the process continues on to step S6 where a check to see if the a maximum time (T_{DCS}) has expired. If some of the devices have not responded within this time, then the process continues without their response and they are effectively assumed to have accepted the request for DCS. If the time has not yet expired then operation reverts to step S4 and so on.

At step S7 the initiating device is established as the supervisor. As such, it is responsible for determining the new channel and for updating the other devices with the new channel information.

The simplest way of determining the new channel is for the supervisor to determine the status of the alternative channels itself and make the appropriate selection. However, where the subnet environment is not homogenous, the supervisor may select a channel which appears to be satisfactory to the supervisor but which is not ideal for another device of the subnet. Therefore, the supervisor may additionally incorporate information from some of the other devices on the subnet or even from another source which is able to provide local channel information.

Where measurement is to take place during the reselection process, it is possible that considerable latency would be introduced. For example, to carry out a full measurement of the entire band takes the following time: -

number of channels x (switching time + measurement time)

For a Bluetooth implementation, the settling time is likely to be of the order of 200μs and a measurement time of 1μs. With a Bluetooth device performing measurements at 1MHz, the time taken for an entire sweep is around 16ms. An HR device could scan at 4MHz and so perform the same measurement in 4ms. Whilst these figures are pessimistic (times of approximately 50% may be more realistic) they do not include additional time for averaging of channel variations which may be required.

Consequently, it is preferable if the supervisor can obtain channel data from other sources as well as or even in place of its own measurements (e.g. because it is unable to make a measurement in the time available or measurement would put undue demands on the power requirements of the device). Obtaining information from other capable devices helps to ensure that the lack of homogeneity across the subnet is accounted for. The supervisor collates measurement reports from capable devices. The reports contain a list of the most suitable and/or the least suitable channels. The supervisor can then combine the gathered information to determine the suitability of each channel as a candidate for the new channel. The significance of the data from each device or within a single report can be weighted according to various factors such as accuracy or to rank the frequencies in order of suitability.

The information used may be collated in advance. If information is already available then this reduces the delay in developing the measurement information during the dynamic channel selection process. For example, if an LR and an HR net is co-ordinated and the LR piconet reports on current channel conditions, then this information may be used. Alternatively, one or more of the devices in the HR subnet may be designated as monitoring devices and regularly rescan the entire band to maintain an up to date set of channel status data. This could be done when the device is idle. In this way when a device is idle, it can update its channel status information. The ideal situation is where every device on the piconet would have its own model of the channel, interference and environment. Therefore, the combination of the information from such devices would be able to provide a comprehensive picture of the overall parameters and status of the band.

Ideally the supervisor will have sufficient pre-measured information available to determine the new channel. However, if this is not the case then again the supervisor may utilise one or more other devices to carry out measurements for it. Such units are referred to as designated monitoring units. Such units may be in active, sniff or park modes. Ideally devices in park mode are used since the scanning operation does not affect their performance. Where they are in active mode, such scanning operation may prevent normal operation, which is undesirable. Obviously, power consumption needs to be considered, particularly in portable devices, as it is undesirable to have excessive power consumption due to scanning activities when the device is in park mode, i.e. not carrying out its normal functions.

When the decision to begin dynamic channel selection is made, the supervisor is generally in one of three positions: full knowledge of the channels (e.g. through pre-measurement); not in possession of full channel information but with sufficient time and capability to measure channels; and unable to measure channels. The selection of the algorithm for determining the channel depends upon which of these positions apply.

With full knowledge of a channel, in the case of a single link with a single measurement, the channel with lowest interference should be selected. With multiple links and hence multiple measurements, it is necessary to carry out optimisation (as described above) based upon the information from the various devices. Where the entire band is scanned and no suitable channel can be determined then a switch to low-rate (LR) or a disconnection is initiated.

Under the second condition, where information is not available but there is sufficient time to determine the information then it is possible to conduct a sequential search across the available frequencies, i.e. sweeping the entire band. Alternatively, the channels can be scanned randomly. However, by considering the bandwidth of potential interferers, subsequent channel measurements can be performed separated by this bandwidth or greater. In this way the possibility of wasting time scanning several channels which are all adversely affected by the same interferer is avoided, hence improving the scanning rate. For example, if the likely interferer has a 20MHz bandwidth (e.g.802.11b wireless LAN) it should be ensured that the next channel scanned is more than 20 MHz away. Additionally, where the calculation is based on a joint optimisation of carrier and interference power, then it is desirable to ensure that the gap between subsequent channels scanned exceeds the coherence bandwidth.

Also, it is generally not essential to search the entire band but simply scan until a channel that meets a minimum requirement is identified. Again if the entire band has been scanned and no suitable candidate has been identified then a drop back to LR or disconnection should be initiated.

Finally, where insufficient pre-measured information is available and where there is insufficient time to initiate a full scan then a random selection pattern can be implemented. The number of measurements that can be carried out will be determined by the latency permitted by the logical channel(s) quality of service requirements. The worst case and hence the fastest is where a random channel is selected without prior measurement. One further option is to return to the best hop frequency in the set or remain at the last one measured.

The number of times that channel reselection is initiated (and the overall channel quality) can be used to control the switch back to LR mode. In this way, if re-selection is continually taking place, for example because the entire band is poor a return to LR is initiated.

In order to determine the best channel, the channels need to be compared based on one or more parameters as a guide to their likely quality of service. Interference Signal strength indicator (ISSI) is the main factor in assessing each channel, although it does not reflect the degree of fading the desired channel(s) will experience and therefore the resulting quality. Other parameters are the carrier to interference ratio (C/I). This requires probing the band with a transmitted signal. If this is applied to all bands, it requires n^2 measurements (for n channels) as compared to n measurements for the interference only estimate. The C/I can be calculated by looking at the deviation of the known sequence from desired values or by taking separate measurements of received signal strength during reception and ISSI during guard intervals or gaps in transmission. Due to the significant processing and hence power consumption, C/I indication is preferable for a small number of devices such as a single link between two devices.

A further parameter is to measure the packet error rate for the associated LR piconet. The above parameters may be combined or used in isolation depending upon the arrangement, environment, etc.

Referring back to figure 2, at step S13 the supervisor determines the new frequency channel. This may be with information obtained from other devices by following the optional steps S8-S12. In these steps, the supervisor issues a request to other devices. Capable devices return their reports on the channel's status. When all the reports have been returned or after a predetermined time, $T_{DCSmeasurement}$, the process continues to step S13 where the supervisor determines the new channel. The supervisor broadcasts the new channel to the other devices. If an acknowledgement is required then it is necessary to wait for all the devices to acknowledge the change of channel (S15-S17). If all the devices have not acknowledged the change of channel within a predetermined period of time, T_{DCS_ACK}, then the supervisor resends the change of channel command.

This is repeated a number of times (S19) after which the change of channel is aborted and the system returns to 'Normal operation'. Once all the devices have acknowledged, all devices switch to the new channel.

It is preferable to avoid waiting for acknowledgement from all devices, as it is possible this may delay or inhibit changing of channel if one of any of the devices fails to respond. Instead, if no acknowledgement is required, those devices which receive the channel change information make the switch and those that don't are no longer able to communicate and so drop down to the LR mode. The LR master is updated with the new HR channel so that new devices can be directed to the right frequency and so that devices which have lost track and have dropped down to LR mode can return to HR mode.

The present invention has been described above in relation to a WPAN such as Bluetooth. However, this invention can be applied to any kind of network where a distributed topology is used, to allow decentralised control for allocation and switching of a communication channel. This allows devices to move freely in and out of a network coverage area as no device is necessary to the operation, i.e. as a master, of the network. Similarly, any device can join a network and reselect the channel if the current channel is not providing sufficient quality. Other advantages include the ability to obtain a picture of the channel environment across the network area when selecting a new channel rather than simply selecting a channel which is of good quality in the vicinity of the master or supervisor.

CLAIMS:

1. A communication device for communication with one or more other communication devices comprising:
means for measuring the signal quality of a communication channel;
comparison means for determining if the measured signal quality exceeds a predetermined value;
channel reselection means responsive to said comparison means for determining a reselection channel for further communication based upon channel quality information; and
switching means for switching communication to said reselection channel.

2. A communication device according to claim 1, further comprising update means for transmitting a signal, for reception by other communication devices, indicating the reselection channel.

3. A communication device according to claim 1 or 2, wherein at least some of said channel quality information is obtained from a channel scanning means.

4. A communication device according to claim 3, wherein said channel scanning means determines said channel quality information in response to said comparison means.

5. A communication device according to any one of the preceding claims, further comprising polling means for transmitting a polling signal for reception by one or more other communication devices and for receiving external channel quality information from at least one of said other communication devices to provide at least some of said channel quality information.

6. A communication device according to any one of the preceding claims, wherein the means for measuring the signal quality measures at least one of: the segment error

rate; the segment failure rate; the received signal strength; and the carrier to interference ratio.

7. A communication device according to any one of the preceding claims, wherein the channel reselection means determines a reselection channel based upon one or more of: the interference signal strength; the carrier to interference ratio; and the packet error rate, of each channel.

8. A communication device according to any one of the preceding claims, further comprising:

control means for receiving a polling signal from another communication device, producing local channel quality information and transmitting said local channel quality information for reception by said another communication device.

9. A communication device according to claim 8 wherein said control means produces said local channel quality information in response to said polling signal.

10. A communication device according to claim 8 wherein said control means produces said local channel quality information based on previously stored local channel quality information.

11. A communication device for communication with one or more other communication devices comprising:

control means for receiving a polling signal from another communication device, producing local channel quality information and transmitting said local channel quality information for reception by said another communication device.

12. A communication device according to claim 11 further comprising switching means for receiving reselection channel information and switching the current communication channel to the reselection channel.

13. A communication network comprising a plurality of communication devices according to any one of the preceding claims.

14. A communication network comprising a plurality of communication devices, each device comprising:
means for measuring the signal quality of a communication channel;
comparison means for determining if the measured signal quality exceeds a predetermined value;
channel reselection means responsive to said comparison means for determining a reselection channel for further communication based upon channel quality information;
means for transmitting information on said reselection channel for reception by the other devices; and
switching means for switching communication to said reselection channel.

15. A communication network according to claim 14 wherein said switching means is responsive to reselection channel information, transmitted by the transmitting means of another device, to switch to communicating on the reselection channel.

16. A method for operating a communication network comprising:
monitoring the quality of a communication channel at a communication device, and determining if the quality is below a predetermined level and if so:
producing channel quality information for a plurality of candidate channels;
determining a reselection channel for communication based upon said channel quality information; and
switching the communication channel.

17. A method according to claim 16, further comprising transmitting a signal, for reception by other communication devices, indicating the reselection channel.

18. A method according to claim 16 or 17, further comprising scanning candidate channels to provide said channel quality information.

19. A method according to claim 16, 17 or 18, further comprising wherein said channel quality information is determined in response to said comparison means determining that the quality is below a predetermined level.

20. A method according to any one of claims 16 to 19, further comprising transmitting a polling signal for reception by one or more communication devices and receiving external channel quality information from at least one of said other communication devices in response to said polling signal to provide at least some of said channel quality information.

21. A method according to any one of claims 16 to 20, wherein the monitoring of the quality of a communication channel includes measuring at least one of: the segment error rate; the segment failure rate; the received signal strength; and the carrier to interference ratio.

22. A method according to any one of claims 16 to 21, wherein determining of said reselection channel includes measuring at least one of: interference signal strength; the carrier to interference ratio; and the packet error rate, of each channel.

23. A method according to any one of claims 16 to 22, further comprising producing localised channel quality information in a communication device in response to receiving a polling signal from another communication device, and transmitting said local channel quality information for reception by said another communication device.

24. A method according to claim 23 wherein said local channel quality information is produced in after said polling signal is received.

25. A method according to claim 23 wherein said local channel quality information is produced based on previously stored local channel quality information.

26. A communication device substantially as described herein with reference to the attached drawings.

27. A method of controlling a communication network substantially as described herein with reference to the attached drawings.

28. A communication system substantially as described herein with reference to the attached drawings.

The Patent Office

INVESTOR IN PEOPLE

Application No:	GB 0120837.0	**Examiner:**	Dr Jan Miasik
Claims searched:	1, 14 & 16	**Date of search:**	15 April 2002

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.T): H4L(LDGR, LECTY, LRRMT, LRRMR, LRRMX)

Int Cl (Ed.7): H04L12/(28, 56), H04L29/(00, 06), H04Q7/28, H04Q7/38

Other: Online: EPODOC, WPI, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB 2342255 A	(NEC Corporation): see whole document	1-4, 7, 14-19
X	WO 00/69186 A1	(Telefonaktiebolaget LM Ericsson): see whole document, particularly p.16, lines 8-14	1-6, 11, 12, 14-18
X	US 5974036	(NEC USA, Inc.): see whole document, particularly col. 4, line 66 to col. 5, line 32	1-9
X	US 5491717	(Motorola, Inc.): see whole document, particularly fig. 5	1,3, 4, 6, 7
X	JP 070143548 A	(Matsushita Electric Ind. Co. Ltd.): 02.06.95 (see WPI abstract Accession No. 1995-236204 [31]	1

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
		E	Patent document published on or after, but with priority date earlier than, the filing date of this application.
&	Member of the same patent family		