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(71) Applicant *(for all designated States except US)*: **QUALCOMM Incorporated** [US/US]; Attn: International IP Administration, 5775 Morehouse Drive, San Diego, California 92121 (US).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: **GUPTA, Binita** [IN/US]; 5775 Morehouse Drive, San Diego, California 92121 (US).

(74) Agent: **EKWUEME, Kristine, U.**; Attn: International IP Administration, 5775 Morehouse Drive, San Diego, California 92121 (US).

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(54) Title: METHODS AND APPARATUS FOR RF HANDOFF IN A MULTI-FREQUENCY NETWORK

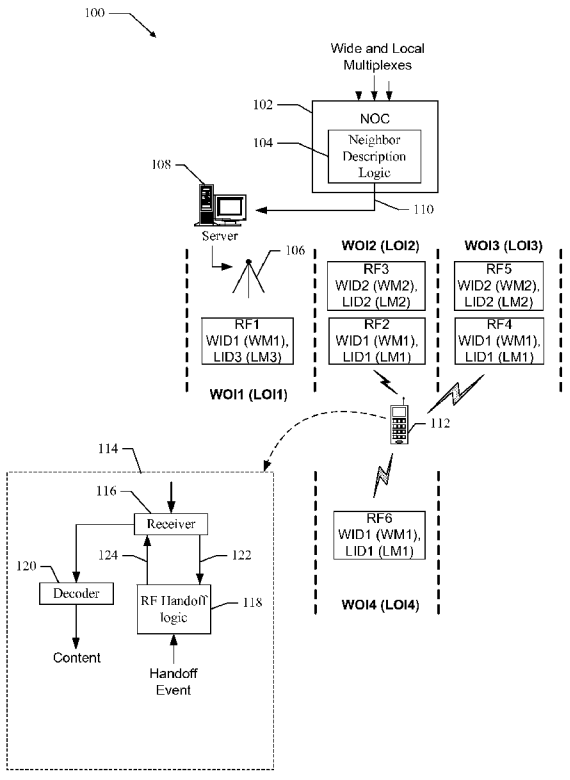


FIG. 1

(57) Abstract: Methods and apparatus for RF handoff in a multi-frequency network. In an aspect, a method includes generating a content preserving handoff table that includes a current LOI and neighboring LOIs carrying at least the same wide and local content multiplexes as the current LOI, and determining that handoff conditions are met for a content preserving handoff, selecting a selected LOI from the content preserving handoff table and a selected RF channel associated with the selected LOI, and performing a handoff to the selected RF channel in the selected LOI if the selected LOI is different than the current LOI. An apparatus includes means for generating a content preserving handoff table, means for determining that handoff conditions are met for a content preserving handoff, means for selecting a selected LOI and a selected RF channel, and means for performing a handoff to the selected RF channel in the selected LOI.

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METHODS AND APPARATUS FOR RF HANDOFF IN A MULTI-FREQUENCY NETWORK

Claim of Priority under 35 U.S.C. §119

[0001] The present Application for Patent is a Continuation-in-Part and claims priority to Patent Application No. 12/051,758, entitled "Methods and Apparatus for RF Handoff in a Multi-Frequency Network", filed 03/19/2008, and to Provisional Application No. 60/945,292, entitled "Methods and Apparatus for Providing Handoff in a Multiple Frequency Network," filed 06/20/2007, both assigned to the assignee hereof and hereby expressly incorporated by reference herein.

BACKGROUND

Field

[0002] The present application relates generally to the operation of data networks, and more particularly, to methods and apparatus for RF channel selection in a multi-frequency network.

Background

[0003] Data networks, such as wireless communication networks, have to trade off between services customized for a single terminal and services provided to a large number of terminals. For example, the distribution of multimedia content to a large number of resource limited portable devices (subscribers) is a complicated problem. Therefore, it is important for network operators, content retailers, and service providers to have a way to distribute content and/or other network services in a fast and efficient manner and in such a way as to increase bandwidth utilization and power efficiency.

[0004] A multi-frequency network (MFN) is a network in which multiple radio frequencies (RFs) (or RF channels) are used to transmit media content. One type of MFN is a horizontal multi-frequency network (HMFN) where a distribution waveform is transmitted over different RF channels in different local areas. The same or different content may be transmitted as part of distribution waveform carried over different RF channels in such local areas. Another type of MFN is a vertical multi-frequency network (MFN) in which multiple radio frequency (RF) channels are used in a given

local area to transmit independent distribution waveforms with an aim to increase the capacity of the network (in terms of the ability to deliver more content to a device/end user). An MFN deployment may also consist of VMFN in certain areas and HMFN in certain other areas.

[0005] In a typical HMFN, a local operations infrastructure (LOI) comprises transmitting sites that operate to transmit a single distribution waveform over an RF channel in a selected geographic area. In a typical VMFN, a local operations infrastructure (LOI) comprises transmitting sites that operate to transmit multiple distribution waveforms over multiple RF channels in a selected geographic area. Each distribution waveform may comprise one or more content flows that can be selected at a receiving device for rendering. Adjacent LOIs may utilize the same or different RF channels.

[0006] During operation, a receiving device may perform an RF handoff as a result of data acquisition failures for desired content. For example, acquisition failures can happen due to varying channel conditions as a result of device mobility. Typically, the device may handoff to any available RF channel that carries the desired content. However, if the device randomly hands off to any RF channel that carries the desired content, the LOI associated with the selected RF channel may not carry other content that is in common with the current LOI. Also, the LOI associated with the selected RF channel may not carry any additional content that is not available in the current LOI. For example, the LOI associated with the selected RF channel may carry less common content (with the current LOI) than LOIs associated with other available RF channels carrying the desired content. This situation may result in the device not having access to common and additional content after an RF handoff, which will adversely impact the user experience.

[0007] Therefore, it is desirable to have a handoff mechanism that operates to allow a device to perform a handoff in a multi-frequency network in a fast and efficient manner and to maximize common and additional content for an enhanced user experience.

SUMMARY

[0008] In one or more aspects, a handoff system, comprising methods and apparatus, is provided that operates to provide handoff in a multi-frequency network.

For example, when a handoff event is detected, the handoff system determines a new RF channel to which a device may tune to receive desired content. The handoff system operates to consider a plurality of factors, including but not limited to, signal strength, content availability, and other factors to determine the new RF channel. After the switch to the new RF channel, the device can receive the desired content and has the ability to switch to additional content that may be available on other RF channels in the associated LOI in a fast and efficient manner.

[0009] In an aspect, a method is provided for RF channel handoff in a multi-frequency network. The method comprises generating a content preserving handoff table, wherein the content preserving handoff table comprises a current LOI and neighboring LOIs carrying at least the same wide and local content multiplexes as the current LOI, and determining that handoff conditions are met for a content preserving handoff. The method also comprises selecting a selected LOI from the content preserving handoff table and a selected RF channel associated with the selected LOI, and performing a handoff to the selected RF channel in the selected LOI if the selected LOI is different than the current LOI.

[0010] In an aspect, an apparatus is provided for RF channel handoff in a multi-frequency network. The apparatus comprises processing logic configured to generate a content preserving handoff table, wherein the content preserving handoff table comprises a current LOI and neighboring LOIs carrying at least the same wide and local content multiplexes as the current LOI, determine that handoff conditions are met for a content preserving handoff, and select a selected LOI from the content preserving handoff table and a selected RF channel associated with the selected LOI. The apparatus also comprises channel switch logic configured to perform a handoff to the selected RF channel in the selected LOI if the selected LOI is different than the current LOI.

[0011] In an aspect, an apparatus is provided for RF channel handoff in a multi-frequency network. The apparatus comprises means for generating a content preserving handoff table, wherein the content preserving handoff table comprises a current LOI and neighboring LOIs carrying at least the same wide and local content multiplexes as the current LOI, and means for determining that handoff conditions are met for a content preserving handoff. The apparatus also comprises means for selecting a selected LOI from the content preserving handoff table and a selected RF channel associated with the

selected LOI, and means for performing a handoff to the selected RF channel in the selected LOI if the selected LOI is different than the current LOI.

[0012] In an aspect, a computer program product is provided for RF channel handoff in a multi-frequency network. The computer program product comprises a machine-readable medium that comprises a first set of codes for causing a computer to generate a content preserving handoff table, wherein the content preserving handoff table comprises a current LOI and neighboring LOIs carrying at least the same wide and local content multiplexes as the current LOI, and a second set of codes for causing a computer to determine that handoff conditions are met for a content preserving handoff. The machine readable medium also comprises a third set of codes for causing a computer to select a selected LOI from the content preserving handoff table and a selected RF channel associated with the selected LOI, and a fourth set of codes for causing a computer to perform a handoff to the selected RF channel in the selected LOI if the selected LOI is different than the current LOI.

[0013] In an aspect, at least one integrated circuit is provided that is configured for RF channel handoff in a multi-frequency network. The at least one integrated circuit comprises a first module configured to generate a content preserving handoff table, wherein the content preserving handoff table comprises a current LOI and neighboring LOIs carrying at least the same wide and local content multiplexes as the current LOI, and a second module configured to determine that handoff conditions are met for a content preserving handoff. The at least one integrated circuit also comprises a third module configured to select a selected LOI from the content preserving handoff table and a selected RF channel associated with the selected LOI, and a fourth module configured to perform a handoff to the selected RF channel in the selected LOI if the selected LOI is different than the current LOI.

[0014] Other aspects will become apparent after review of the hereinafter set forth Brief Description of the Drawings, Description, and the Claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] The foregoing aspects described herein will become more readily apparent by reference to the following Description when taken in conjunction with the accompanying drawings wherein:

[0016] **FIG. 1** shows a network that illustrates the operation of aspects of a handoff system for use in multi-frequency network;

[0017] **FIG. 2** shows a transmission frame and neighbor description information for use in aspects of a handoff system;

[0018] **FIG. 3** shows RF channel selection logic for use in aspects of a selection system;

[0019] **FIG. 4** shows an exemplary seamless handoff table applicable for use as a wide or local seamless handoff table in aspects of a handoff system;

[0020] **FIG. 5** shows an exemplary seamless handoff table applicable for use as a wide+local seamless handoff in aspects of a handoff system;

[0021] **FIG. 6** shows an exemplary partially seamless handoff table applicable for use as a wide, local, or wide+local partially seamless handoff table in aspects of a handoff system;

[0022] **FIG. 7** shows a method for performing a handoff for use in aspects of a handoff system;

[0023] **FIG. 8** shows a method for performing a handoff procedure for use in aspects of a handoff system;

[0024] **FIG. 9** shows a method for providing a handoff event trigger for activated flows for use in aspects of a handoff system;

[0025] **FIG. 10** shows a method for providing a handoff event trigger for activated flows for use in aspects of a handoff system;

[0026] **FIG. 11** shows a method for providing a handoff event trigger for registered flows for use in aspects of a handoff system;

[0027] **FIG. 12** shows a method for providing a handoff event trigger for registered flows for use in aspects of a handoff system;

[0028] **FIG. 13** shows examples of seamless handoff tables for use in aspects of a handoff system;

[0029] **FIG. 14** shows examples of partially seamless handoff tables for use in aspects of a handoff system;

[0030] **FIG. 15** shows RF handoff logic for use in aspects of a handoff system;

[0031] **FIG. 16** shows an exemplary content preserving handoff table applicable for use in aspects of a handoff system;

[0032] **FIG. 17** shows an exemplary method for providing a content preserving handoff for use in aspects of a handoff system; and

[0033] **FIG. 18** shows handoff logic for use in aspects of a handoff system.

DESCRIPTION

[0034] In one or more aspects, a handoff system is provided that operates at a device to determine an RF channel in a multi-frequency network to which a handoff may be performed so that desired content can be received. In an aspect, the handoff system assembles information related to neighboring RF channels and the content they carry. This information is assembled into seamless and partially seamless handoff tables. A handoff event is initiated when data acquisition fails for desired content. When a handoff event is detected, the handoff system operates to process the generated handoff tables to determine a new RF channel to which the device can switch to receive desired content.

[0035] The system is well suited for use in wireless network environments, but may be used in any type of network environment, including but not limited to, communication networks, public networks, such as the Internet, private networks, such as virtual private networks (VPN), local area networks, wide area networks, long haul networks, or any other type of data network.

Definitions

[0036] The following definitions are used herein to describe aspects of a selection system.

1. Local Area – Refers to a local geographic area such as a building, group of buildings, community, city, county or other local region in which services may be broadcast.
2. Wide Area – Refers to a wide geographic area such as a county, state, multiple states, country, multiple countries or other wide region in which services may be broadcast.
3. Multiplex – Refers to a grouping of content flows.
4. Wide Area Multiplex – Refers to a grouping of content flows that are broadcasted over at least one wide area.

5. Local Area Multiplex – Refers to grouping of content flows that are broadcasted over at least one local area.
6. Wide Area Operations Infrastructure (WOI) – Refers to a grouping of transmitters and associated systems that operate to transmit content flows over a wide area. A WOI maps to the smallest geographical wide area which can carry a wide area multiplex. A wide area multiplex may be broadcasted over one or more WOIs.
7. Local Area Operations Infrastructure (LOI) – Refers to a grouping of transmitters and associated systems that operate to transmit content flows over a local area. A LOI maps to the smallest geographical local area which can carry a local area multiplex. A local area multiplex may be broadcasted over one or more LOIs.
8. RF Channel – Refers to an RF frequency that is used to convey a content distribution waveform over a selected LOI.
9. Content Channel – Refers to selected content flows within a particular distribution waveform. For example, a distribution waveform may comprise multiple content channels and each content channel may comprise one or more content flows.

Acronyms

[0037] The following acronyms are used herein to describe aspects of a selection system.

LM – Local Area Multiplex

WM – Wide Area Multiplex

NOC – Network Operations Center

WOI - Wide Area Operations Infrastructure

LOI – Local Area Operations Infrastructure

NDM – Neighbor Description Message

WID – Wide Area Descrambling Identifier

LID – Local Area Descrambling Identifier

OIS – Overhead Information Symbols

CC – Control Channel

[0038] **FIG. 1** shows a network **100** that illustrates the operation of aspects of a handoff system to provide RF channel selection in multi-frequency network. For example, the network **100** comprises four WOIs (WOI1, WOI2, WOI3, and WOI4) each comprising one LOI (LOI1, LOI2, LOI3, and LOI4, respectively) of a multi-frequency network. Within each LOI, one or more RF channels are used to transmit content. LOI2 and LOI3 have a vertical MFN with two RF channels in each of these LOIs. LOI1 and LOI4 carry only one RF channel. Each RF channel has an associated WID/LID that identifies descrambling sequences that can be used to descramble content transmitted on that RF channel. LOI1, LOI2, LOI3, and LOI4 are neighboring LOIs as shown in the network **100**. The LOI1 has LOI2 as its neighbor, the LOI2 has LOI1, LOI3 and LOI4 as its neighbors, the LOI3 has LOI2 as its neighbor and LOI4 has LOI2 as its neighbor.

[0039] The network **100** comprises a network operations center (NOC) **102** that operates to receive wide and local content multiplexes for distribution over selected wide and local areas of a multi-frequency network. The NOC **102** also operates to configure the multi-frequency network to distribute that content. To accomplish this, the NOC **102** is aware of the geographic regions of the network that are covered by the LOIs, the RF channels used in each region, and any other network information that may be needed to configure the network and distribute the wide and local area content multiplexes. It should be noted that the network **100** may comprise any number of LOIs.

[0040] In an aspect, the NOC **102** comprises neighbor description logic **104**. The neighbor description logic **104** operates to assemble information relating to the list of neighboring LOIs for each LOI and the WID/LID descrambling identifiers that are associated with the RF channels in each LOI. For example, the wide and local area content multiplexes are scrambled with wide area and local area scrambling sequences before transmission over the network **100**. In an aspect, the neighbor description logic **104** operates to generate neighbor description messages (NDMs) that are configured to provide a list of neighboring LOIs associated with a particular LOI and WID/LID identifiers that identify descrambling sequences associated with RF channels of the particular LOI and its neighboring LOIs. In another aspect, the NDM messages are configured to provide a list of neighboring LOIs and WID/LID identifiers associated with RF channels for any selected group of LOIs. A more detailed description of the

NDM messages generated by the neighbor description logic **104** is provided in another section of this document.

[0041] The NOC **102** operates to transmit the wide and local area multiplexes and the generated NDMs to the LOIs in the network **100**. It should be noted that although only four LOIs are shown, the NOC **102** may transmit the multiplexes and associated NDMs to any number of LOIs.

[0042] In an aspect, the LOI1, LOI2, LOI3, and LOI4 comprise one or more transmitter sites. For example, the LOI1 comprises transmitter site **106**. Each transmitter site operates to transmit a distribution waveform on a selected RF channel over its respective LOI. It should be noted that each transmitter site comprises one or more servers as illustrated at **108**.

[0043] In an aspect, the NOC **102** operates to transmit the content multiplexes and the NDMs to the transmitter sites using any suitable transport mechanism. For example, the content multiplexes and the NDMs are transmitted to servers associated with each transmitter site, as illustrated at **110**. In an aspect, the NOC **102** transmits the content multiplexes and the NDM messages to the transmitter sites using an MPEG-2 transport mechanism. In this configuration, the multiplexes and NDM messages are assigned MPEG-2 transport identifiers so that servers at each transmitter site can detect and receive selected content multiplexes and an NDM message which are directed to them, respectively.

[0044] The servers at the transmitter sites use the transport identifiers to determine which multiplexes and NDM message are intended for them to distribute over their respective LOIs. The servers then operate to pack their respective multiplexes and the NDM message into transmission frames for transmission over selected RF channels. The servers utilize any suitable physical layer process to pack the multiplexes and the NDM message into the transmission frames for transmission. By using the transport identifiers to determine the multiplexes and the NDM message intended for transmission over their respective LOIs, the servers at the transmitter sites need not decode any of the multiplexes or NDM messages. The servers simply detect the appropriate transport identifiers and then pack the identified multiplexes and the NDM message into the transmission frames according to the physical layer process.

[0045] The transmission frames comprise content flows associated with the wide and local area multiplexes and the NDM message generated by the neighbor description

logic **104**. In an aspect, the transmission frames comprise wide and local data partitions that are used to convey the wide and local area content flows, respectively. In addition, the wide and local partitions comprise wide and local control channels. In an aspect, the local control channel is used to distribute the NDM message generated by the neighbor description logic **104** to the devices in each LOI.

[0046] In an aspect, the transmitter sites transmit transmission frames over their respective LOIs using the designated RF channels. By using multiple RF channels in LOIs for transmitting transmission frames, the network **100** is able to transmit more content flows over such LOIs. It should be noted that the transmitter sites within a LOI may be co-located or separated by any desired distance. It should also be noted that the NDMs distributed over each LOI may be different because each LOI may have a different set of neighbor LOIs and each neighbor LOI may be associated with different RF channels and associated descrambling sequences with which to descramble the transmitted content.

[0047] Within each LOI, descrambling sequence identifiers are associated with each RF channel. The descrambling sequence identifiers comprise wide area descrambling sequence identifiers (WID) and local area descrambling sequence identifiers (LID). The descrambling sequence identifiers identify descrambling sequences that can be used to descramble content received in a particular LOI on a particular RF channel. The descrambling sequence identifiers also identify content multiplexes carried on a particular RF channel. For example, in LOI2 there are two RF channels (i.e., RF2, RF3) and each RF channel is associated with descrambling sequence identifiers that identify descrambling sequences that can be used to descramble associated wide area and local area content multiplexes. For example, RF2 is associated with WID1 and LID1 and carries wide multiplex WM1 and local multiplex LM1; and RF3 is associated with WID2 and LID2 and carries wide multiplex WM2 and local multiplex LM2. WID1, LID1, WID2 and LID2 identify multiplexes WM1, LM1, WM2 and LM2 respectively.

[0048] A device **112** operating in the LOI2 is tuned to receive wide area content on channel RF2 that can be descrambled with a descrambling sequence identified by WID1. Details of the device **112** are shown at **114**. The device **112** comprises a receiver **116** that operates to tune to a selected RF channel to receive transmission frames. For example, the receiver **116** is tuned to RF2 in LOI2 to receive transmission frames. The transmission frames that are received comprise a local control channel that

conveys neighbor description information in one or more NDMs. For example, the NDMs are generated by the neighbor description logic **104** and distributed to the LOIs shown in **FIG. 1**. In an aspect, an NDM comprises the list of neighboring LOIs for a device's current LOI (i.e. LOI2 for device **112**) and WID/LID descrambling identifiers that identify descrambling sequences that are associated with RF channels in the current LOI (i.e., LOI2) and its neighboring LOIs (i.e., LOI1, LOI3 and LOI4).

[0049] The receiver **116** passes the neighbor description information received in an NDM (or the NDM itself) to RF handoff logic **118**, as illustrated at **122**. The receiver **116** also descrambles the received content using the correct WID/LID identifiers associated with RF2 in LOI2 and passes the descrambled content to a decoder **120** that operates to render the content for the device user.

[0050] The RF handoff logic **118** operates to receive the NDM at **122.** The NDM specifies a list of neighboring LOIs for a given LOI and WID/LID identifiers for RF channels in the given LOI and its neighboring LOIs. From this information, the RF handoff logic **118** operates to generate seamless handoff tables and partially seamless handoff tables for content multiplexes carried in device's current LOI. The seamless and partially seamless handoff tables for a given content multiplex carried in the current LOI provide a list of neighboring RFs which can be switched to acquire the given content multiplex. The seamless and partially seamless handoff tables are computed separately for wide and local content multiplexes. For example, a neighboring RF channel has an entry in the wide seamless handoff table associated with a given wide content multiplex carried in the current LOI if that neighboring RF channel carries the given wide content multiplex and if the LOI associated with the neighboring RF channel carries the same set or a superset of wide content multiplexes as the device's current LOI. A neighboring RF channel has an entry in the wide partially seamless handoff table associated with a given wide content multiplex carried in the current LOI if that neighboring RF channel carries the given wide content multiplex and if the LOI associated with the neighboring RF channel does not carry the same set or a superset of wide content multiplexes as the device's current LOI.

[0051] In an aspect, an RF handoff may be desired due to one or more handoff events. A handoff event causes the handoff logic **118** to determine a new RF channel and to send a request **124** to the receiver **116** to tune to the new RF channel. The handoff events are events that cause the device **112** to switch from one RF channel to

another RF channel to receive a desired content flow. In an aspect, a handoff event can be triggered by or be performed as a result of content acquisition failures associated with desired content (e.g. failures due to varying channel conditions because of device mobility).

[0052] In an aspect, content acquisition failures associated with device mobility occur when the device **112** moves from a region covered by LOI2 to a region covered by one or more neighboring LOIs. For example, the device receiver **116** is tuned to receive a desired content flow on a particular RF channel in LOI2. The RF handoff logic **118** operates to determine an RF channel in a neighboring LOI that the receiver **116** can tune to in order to continue to receive the desired content flow when a content acquisition failure is detected as the device **112** moves outside the coverage area of LOI2.

[0053] To determine a new RF channel carrying the desired content flow, the RF handoff logic **118** operates to perform one or more of the following functions in aspects of the handoff system.

1. Determine (from received neighbor description information) a list of available RF channels in neighboring LOIs that carry the desired content flow so that a smooth transition can be performed from the content acquisition perspective.
2. Monitor signal strength of neighboring RF channels.
3. Generate seamless and partially seamless handoff tables for desired content. These tables comprise entries based on the list of available RF channels and the content available in LOIs associated with these RF channels.
4. Rank the RF channels within the seamless and partially seamless tables.
5. Select a selected RF channel from the seamless handoff table based on rank, wherein the selected RF channel meets RF selection criteria.
6. Select the selected RF channel from the partially seamless handoff table based on rank wherein the selected RF channel meets RF selection criteria, if selection from the seamless handoff table fails.

[0054] Once the RF channel is determined, the RF handoff logic **118** outputs an RF channel switch message **124** to the receiver **116** to implement the RF handoff. The RF channel switch message contains the correct WID/LID identifiers for the selected RF channel so that the desired content flow can be descrambled by the receiver **116**. The

receiver **116** performs an RF channel switch to the selected RF channel and descrambles content using the WID/LID received in the channel switch message.

[0055] Therefore, in various aspects, the handoff system operates to determine which of the available RF channels in a multi-frequency network is to be selected for handoff so that the reception of desired content can continue after content acquisition failures are detected for the desired content. The handoff system determined the selected RF channel based on seamless and partially seamless handoff tables that are used to rank the available RF channels. Thus, the handoff system operations to select an available RF channel with the highest ranking which meets RF selection criteria. The RF selection criteria ensure that the selected RF channel has a large enough received signal strength indicator (RSSI) value and also meets RF handoff criteria. Details of RF handoff criteria are provided in other sections of this document.

[0056] **FIG. 2** shows a diagram of a transmission frame **200** for use in aspects of a handoff system. For example, the transmission frame **200** may be packed with wide and local content multiplexes and transmitted over the RF channels in the LOIs shown in **FIG. 1**.

[0057] The transmission frame **200** comprises four sub-frames, shown generally at **202**, that are used to convey wide and local content. For example, each sub-frame **202** comprises a wide area partition **204** that is packed with wide area content, and a local area partition **206** that is packed with local area content.

[0058] Included in the wide area partition **204** is a wide area control channel **208**. The wide area control channel **208** operates to convey messages pertaining to wide area content multiplexes. Included in the local area partition **206** is a local area control channel **210**. The local area control channel **210** operates to convey messages pertaining to local area content multiplexes. In an aspect, the local area control channel is used to convey neighbor description information as part of the NDM message for use in aspects of a handoff system.

[0059] At the start of the transmission frame **200** are overhead information symbols (OIS) **212** that provide overhead information that is used to locate the wide area control channel, the local area control channel, and the wide and local content that is packed into the sub-frames **202**. The OIS **212** comprises wide overhead information symbols (WOIS) and local overhead information symbols (LOIS).

[0060] In an aspect, content flows are transmitted using Media Logical Channels (MLCs) inside the sub-frames **202**. A single MLC may be used to carry one or more content flows. Content flow data can be successfully acquired even if all packets in an MLC are not received correctly because of redundancy added in the data transmitted as part of the MLC. Data acquisition fails for a content flow if MLC packet erasures exceed the allowed error threshold based on added redundancy in the data transmitted as part of the MLC.

[0061] In an aspect, neighbor description information contained in the NDM message is generated separately for each LOI and is configured to provide a list of RF channels associated with a selected LOI and its neighboring LOIs. In another aspect, a NDM message is generated for a selected group of LOIs (which may or may not be neighbors), and includes all neighboring LOIs for each of the LOI within the selected group of LOIs. Each of the RF channels described in the neighbor description information is associated with WID/LID descrambling identifiers.

[0062] In an aspect, the NDM message is distributed over a LOI using a local control channel that is part of the transmission frames transmitted by the RF channels in that LOI. It should be noted that the neighbor description information carried in the NDM may be formatted in any suitable format, encoded or encrypted, and/or reorganized or divided into two or more message components.

[0063] A table **214** illustrates how parameters provided in the NDM message may be organized and stored at a device. The table **214** comprises a LOI identifier **216** that identifies the device's current LOI (i.e., LOI2). The table **214** also includes a Neighbor LOI List **218** that identifies neighboring LOIs of the device's current LOI plus the current LOI itself. The table **214** also includes RF channel identifiers **220**, which indicate identifiers that may be used to reference to particular RF channels of the current LOI in other control channel messages. Note that the RF channel identifiers **220** are only provided for the current LOI (i.e., LOI2).

[0064] The table **214** also comprises RF Frequency identifiers **222** that identify RF frequencies associated with each LOI identified in the Neighbor LOI List **218**. The table **214** also comprises WID/LID Identifiers **224** that identify WID/LID descrambling sequence identifiers associated with each RF Frequency **222**. Thus, the table **214** may be created and stored at a receiving device and used during operation of the handoff system.

[0065] **FIG. 3** shows RF handoff logic **300** for use in aspects of a handoff system. For example, the RF handoff logic **300** is suitable for use as the RF handoff logic **118** shown in **FIG. 1**. The RF handoff logic **300** comprises processing logic **302**, message decoder **304**, channel switch logic **310**, and overhead input logic **306** all coupled to a data bus **308**.

[0066] The overhead input logic **306** comprises at least one of a CPU, processor, gate array, hardware logic, memory elements, and/or hardware executing software. The overhead input logic **306** operates to receive OIS and control channel data over an RF channel to which a device is currently tuned. The overhead input logic **306** passes the received CC data to the message decoder **304**. For example, the overhead input logic **306** operates to receive an NDM message that is transmitted over a local control channel as illustrated in **FIG. 2**.

[0067] The message decoder **304** comprises at least one of a CPU, processor, gate array, hardware logic, memory elements, and/or hardware executing software. In an aspect, the message decoder **304** operates to decode an NDM message received by the control channel input logic **306**. For example, the message decoder **304** operates to decode the received NDM message to determine available RF channels associated with the current LOI and its neighboring LOIs. The message decoder **304** decodes the received NDM message to determine WID/LID descrambling sequence identifiers associated with each RF channel in the device's current LOI and its neighboring LOIs. For example, the information received in the NDM message is organized and stored as illustrated in **FIG. 2** to provide the WID/LID descrambling identifiers associated with RF channels in the device's current LOI and its neighboring LOIs.

[0068] The processing logic **302** comprises at least one of a CPU, processor, gate array, hardware logic, memory elements, and/or hardware executing software. In an aspect, the processing logic **302** operates to receive a handoff event which indicates that an RF handoff is desired because of data acquisition failures associated with desired content due to changing network conditions (e.g. due to device mobility) or other reasons. In such a case, it may be necessary to perform a handoff to switch to an RF channel in a neighboring LOI which carries the desired content to continue to receive the desired content.

[0069] The processing logic **302** operates to process information received in the NDM to generate seamless and partially seamless handoff tables for desired content. In

an aspect, the processing logic **302** assembles the handoff tables to comprise those RF channels in neighboring LOIs that are associated with the WID/LID of the desired content. In an aspect, neighboring RF channels associated with same WID carry same wide area content and neighboring RF channels associated with same LID carry same local area content. In an aspect, handoff tables comprise wide, local, and wide+local seamless and partially seamless handoff tables.

[0070] Once the RF channels in the handoff tables are determined, the processing logic **302** operates to determine signal strength information related to those RF channels. For example, the processing logic **302** operates to perform RF monitoring for neighboring RFs to receive signal strength parameters associated with RF channels identified in the seamless and partially seamless handoff tables. For example, in an aspect, this information is obtained from a device receiver, such as the receiver **116** shown in **FIG. 1**.

[0071] The processing logic **302** also operates to determine information about the content available in the LOIs associated with each RF channel in the handoff tables. For example, the content information comprises the number of available common multiplexes with the current LOI and the total number of available multiplexes in each identified LOI. The processing logic **302** operates to use the content information to rank RF channels in the seamless and partially seamless handoff tables.

[0072] The processing logic **302** operates to receive a handoff event. The handoff event indicates that a handoff to another RF channel is needed to continue to acquire the desired content. For example, the handoff event may indicate that a handoff is desired because of content acquisition failures for the desired content e.g. due to changing network conditions.

[0073] Once the handoff event is detected for desired content, the processing logic **302** operates to process RF channels in the seamless handoff table associated with the desired content to determine a selected RF channel for handoff. If there are no RF channels in the associated seamless handoff table or if none of the RF channels in the associated seamless handoff table meet RF selection criteria, then the processing logic **302** processes RF channels in the partially seamless handoff table associated with the desired content to determine the selected RF channel for handoff. The processing logic **302** operates to process RF channels in the seamless handoff table and the partially seamless handoff table in their ranking order. Once the selected RF channel is

determined, the processing logic **302** passes the identity of this RF channel to the channel switch logic **310**. A more detailed description of the operation of the processing logic **302** to select the selected RF channel from the handoff tables and details of RF selection criteria is provided in another section of this document.

[0074] The channel switch logic **310** comprises at least one of a CPU, processor, gate array, hardware logic, memory elements, and/or hardware executing software. The channel switch logic **310** operates to generate an RF channel switch message that comprises the identity of the selected RF channel and its WID/LID descrambling sequence identifiers. The RF channel switch message is sent to the device receiver **116**. With this information, the receiver **116** can quickly switch to the selected RF channel and use the received WID/LID descrambling sequences to receive the desired content. Thus, during a handoff, an RF channel can be selected that provides the desired content, meets the RF selection criteria, and is ranked highest from the perspective of common content (with current LOI) and additional content carried in the associated LOI for an enhanced user experience.

[0075] In an aspect, the handoff system comprises a computer program product having one or more program instructions ("instructions") or sets of "codes" stored or embodied on a machine-readable medium, which when executed by at least one processor, for instance, a processor at the processing logic **302**, causes a computer to provide the functions described herein. For example, the sets of codes may be loaded into the RF handoff logic **300** from a machine-readable medium, such as a floppy disk, CDROM, memory card, FLASH memory device, RAM, ROM, or any other type of memory device or machine-readable medium that interfaces to the RF handoff logic **300**. In another aspect, the sets of codes may be downloaded into the RF handoff logic **300** from an external device or network resource. The sets of codes, when executed, cause a computer to provide aspects of a handoff system as described herein.

RF Channel Monitoring

[0076] In an aspect, the handoff system at the device operates to perform monitoring of RF channels carried in the device's current and neighboring LOIs to maintain information related to signal strength for these RF channels. For example, the processing logic **302** operates to obtain a received signal strength indicator (RSSI) for RF channels in the current LOI and neighboring LOIs. For each available RF channel,

the processing logic **302** may also maintain timestamps associated with RSSI measurements. The timestamps associated with RSSI measurements can be used to invalidate old RSSI entries. The processing logic **302** operates to maintain tables of RF channel monitoring information in a local memory. During handoff, the processing logic **302** utilizes information collected during RF channel monitoring to select an RF channel for handoff purposes. For example, signal strength information is used to evaluate RF channels in seamless and partially seamless handoff tables for handoff purposes.

Wide and Local Content Handoff

[0077] In an aspect, the handoff system operates to initiate RF handoff based on handoff events. The RF handoff can be initiated for wide content flows and/or local content flows. In an aspect, if a device is attempting to decode only desired wide content flows and content acquisition failures are detected, a wide content RF handoff will be initiated. In an aspect, if device is attempting to decode only desired local content flows and content a acquisition failures are detected, a local content RF handoff will be initiated. In another aspect, if device is attempting to decode both desired wide and local flows and content acquisition failures are detected, a wide+local content RF handoff will be initiated. A wide content RF handoff is targeted to handoff to an RF which carries at least the desired wide content. A local content RF handoff is targeted to handoff to an RF which carries at least the desired local content and a wide+local content RF handoff is targeted to handoff to an RF which carries both the desired wide and local content. A specific RF handoff type (wide, local or wide+local) will initiate a handoff to an RF channel in an associated seamless or partially seamless handoff table. For example, a wide content RF handoff will initiate a handoff to an RF channel in the seamless or partially seamless handoff table associated with the desired wide content.

Real Time and Non Real Time Content Handoff

[0078] A handoff event can be initiated when a device is attempting to acquire real time content flows and content acquisition failures occur. A handoff event can also be initiated when the device is attempting to acquire non real time content flows and content acquisition failures occur. Real time flows are also referred to as activated flows and non real time flows are also referred to as registered flows. A data

acquisition procedure to capture data for these flows can be performed in a variety of ways. For example, one data acquisition procedure to capture data for activated (real time) and registered (non real time) flows is provided in the above referenced application (Provisional Application No. 60/910,191, entitled "Methods and Apparatus for Providing Flow Data Acquisition Priority Scheme in a Multiple Frequency Network," filed 04/04/2007, and to Provisional Application No. 60/945,317, entitled "Methods And Apparatus for Providing Flow Data Acquisition Priority Scheme in a Multiple Frequency Network," filed 06/20/2007). The handoff process to execute RF handoff is same for both activated and registered flows, although the handoff process may operate for different timer periods for activated and registered flows. A detailed description of the handoff process for activated and registered flows is captured in other sections of this document.

Handoff Event Trigger Criteria

[0079] In an aspect, a handoff event is triggered by certain criteria related to activated and registered flows. Handoff event trigger criteria are evaluated separately for activated and registered flows. If both activated and registered flows are being decoded, then handoff event trigger criteria are evaluated for activated flows only. This is because activated flows (i.e. real time flows) are given higher priority than registered flows (i.e. non real time flows). The failure to acquire an appropriate set of overhead information which includes OIS and control channel (CC) will trigger a handoff event for both activated and registered flows. The overhead information is used to acquire flow data for activated and registered flows.

[0080] In various aspects, one or more of the following conditions trigger a handoff event for activated flows.

1. Acquisition of the appropriate OIS and control channel (CC) (if required) fail for desired wide and/or local activated flows. For example if only wide activated flows are being decoded, then WOIS and wide CC fail on the current RF.
2. Data acquisition fails for all activated flows on the current RF.
3. Acquisition of local OIS and local CC (if required) fail if both wide and local activated flows are being decoded on current RF channel.
4. Data acquisition fails for a subset of activated flows on the current RF.

[0081] For the acquisition of registered flows, the device determines a selected flow group (FG) and attempts to decode registered flows associated with that selected FG. For example, in an aspect, a flow group comprises a grouping of non real time data flows that are grouped together based on selected criteria, such as priority. An example of various types of flow groups is provided in the above referenced application (Provisional Application No. 60/910,191, entitled "methods and Apparatus for Providing Flow Data Acquisition Priority Scheme in a Multiple Frequency Network," filed 04/04/2007, and to Provisional Application No. 60/945,317, entitled "Methods And Apparatus for Providing Flow Data Acquisition Priority Scheme in a Multiple Frequency Network," filed 06/20/2007). The device also attempts to decode any other registered flows carried by the same RF channel as the selected FG. In various aspects, one or more of the following conditions trigger a handoff event for registered flows:

1. Acquisition of appropriate OIS and CC (if required) fail for wide and/or local registered flows in the selected flow group (FG). For example if selected FG has only wide registered flows, then WOIS and wide CC fail.
2. Data acquisition fails for all registered flows in selected FG.
3. Acquisition of local OIS and local CC (if required) fails if selected FG includes both wide and local registered flows.
4. Data acquisition fails for a subset of registered flows in selected FG.

Seamless Handoff Tables

[0082] In an aspect, the handoff system operates to generate and maintain seamless handoff tables for wide and local content multiplexes carried on RF channels in the current LOI. In an aspect, a seamless handoff table for a given wide or local content multiplex includes neighboring RF channels that carry the same given wide or local content multiplex, respectively, and the LOI associated with the neighboring RF channel carries the same set or a superset of wide or local content multiplexes, respectively, as carried in the current LOI. In an aspect, a seamless handoff table for a given combination of wide+local multiplexes includes neighboring RF channels that carry the same combination of wide+local content multiplexes and the LOI associated with the neighboring RF carries the same set or a superset of wide and local content multiplexes as carried in the current LOI. The neighboring RFs included in a given

seamless handoff table are referred to as seamless RFs for the associated content multiplex(es).

[0083] The following types of seamless handoff tables are maintained:

a. Wide seamless handoff table: A separate wide seamless handoff table is generated and maintained for each wide content multiplex carried in the current LOI. This table identifies neighboring RF channels that carry the same wide content multiplex and their associated LOI carries same set or a superset of wide content multiplexes as the current LOI.

b. Local seamless handoff table: A separate local seamless handoff table is generated and maintained for each local content multiplex carried in the current LOI. This table identifies neighboring RF channels that carry the same local content multiplex and their associated LOI carry same set or a superset of local content multiplexes as the current LOI.

c. Wide+Local seamless handoff table: A separate wide+local seamless handoff table is generated and maintained for each combination of wide+local content multiplexes carried on a single RF in the current LOI. This table identifies neighboring RF channels that carry the same combination of wide+local content multiplexes and their associated LOI carries same set or a superset of wide+local content multiplexes as the current LOI.

[0084] Depending on the content carried by neighboring RFs, seamless handoff tables may be empty for one or more of the content multiplexes (wide, local or wide+local) carried in current LOI. In an aspect, the seamless handoff table maintains information for each seamless RF channel related to: i) total number of wide and local content multiplexes that are common between the LOI associated with that seamless RF channel and the device's current LOI; and ii) overall total number of content multiplexes carried in the LOI associated with that seamless RF channel. The information (i) and (ii) maintained for seamless RF channels is used to rank these RF channels for the purpose of executing RF handoff.

[0085] **FIG. 4** shows an exemplary seamless handoff table **400** applicable for use as a wide or local seamless handoff table in aspects of a handoff system. In an aspect, the seamless handoff table **400** is generated by the processing logic **302**. The seamless handoff table **400** comprises a content multiplex identifier **402** which identifies the wide or local content multiplex for which this seamless handoff table is generated. The

seamless handoff table **400** also comprises a {RF, LOI} Identifier **404** that identifies an RF frequency and associated neighboring LOI that carries the wide or local content multiplex identified by the content multiplex identifier **402**. The seamless handoff table **400** also comprises an overall number of common multiplexes indicator **406** that indicates the total number of multiplexes that are common between the LOI associated with the identified seamless RF and the current LOI. The seamless handoff table **400** also comprises a total number of multiplexes indicator **408** that indicates the total number of multiplexes available in the LOI associated with the identified seamless RF.

[0086] **FIG. 5** shows an exemplary wide+local seamless handoff table **500** applicable for use in a wide+local seamless handoff in aspects of a handoff system. In an aspect, the wide+local seamless handoff table **500** is generated by the processing logic **302**. The wide+local seamless handoff table **500** comprises a content multiplex identifier **502** which identifies the combination of wide+local content multiplexes for which this seamless handoff table is generated. The wide+local seamless handoff table **500** also comprises a {RF, LOI} Identifier **504** that identifies an RF frequency and associated neighboring LOI that carry the wide+local content multiplexes identified by the content multiplex identifier **502.** The seamless handoff table **500** also comprises a total number of multiplexes indicator **506** that indicates the total number of multiplexes available in the LOI associated with the identified seamless RF.

Partially Seamless Handoff Tables

[0087] In an aspect, the handoff system operates to generate and maintain partially seamless handoff tables for wide and local content multiplexes carried on RF channels in the current LOI. In an aspect, a partially seamless handoff table for a given wide or local content multiplex includes neighboring RF channels that carry the same given wide or local content multiplex respectively, and the LOI associated with the neighboring RF does not carry the same set or a superset of wide or local content multiplexes respectively, as carried in the current LOI. In an aspect, a partially seamless handoff table for a given combination of wide+local multiplexes includes neighboring RF channels that carry the same combination of wide+local content multiplexes and the LOI associated with the neighboring RF does not carry the same set or a superset of wide and local content multiplexes as carried in the current LOI. The neighboring RFs included in a given partially seamless handoff table are referred to as

partially seamless RFs for the associated content multiplex(es). As per the definition, the sets of seamless RFs and partially seamless RFs for a given content multiplex are disjoint.

[0088] In various aspects, the following types of partially seamless handoff tables are maintained.

a. Wide partially seamless handoff table: A separate wide partially seamless handoff table is generated and maintained for each wide content multiplex carried in the current LOI. This table identifies neighboring RF channels that carry the same wide content multiplex and their associated LOI does not carry same set or a superset of wide content multiplexes as the current LOI.

b. Local partially seamless handoff table: A separate local partially seamless handoff table is generated and maintained for each local content multiplex carried in the current LOI. This table identifies neighboring RF channels that carry the same local content multiplex and their associated LOI does not carry same set or a superset of local content multiplexes as the current LOI.

c. Wide+Local partially seamless handoff tables: A separate wide+local partially seamless handoff table is generated and maintained for each combination of wide+local content multiplexes carried on a single RF in the current LOI. This table identifies neighboring RF channels that carry the same combination of wide+local content multiplexes and their associated LOI does not carry same set or a superset of wide+local content multiplexes as the current LOI.

[0089] Depending on the content carried by neighboring RFs, partially seamless handoff tables may be empty for one or more of the content multiplexes (wide, local or wide+local) carried in current LOI. In an aspect, the partially seamless handoff table maintains information for each partially seamless RF channel related to: i) total number of wide and local content multiplexes that are common between the LOI associated with that partially seamless RF channel and the device's current LOI; and ii) overall total number of content multiplexes carried in LOI associated with that partially seamless RF channel. The information (i) and (ii) maintained for partially seamless RF channels is used to rank these RF channels for the purpose of executing RF handoff.

[0090] **FIG. 6** shows an exemplary partially seamless handoff table **600** applicable for use as a wide, local, or wide+local partially seamless handoff table for use in aspects of a handoff system. In an aspect, the partially seamless handoff table **600** is generated

by the processing logic **302**. The partially seamless handoff table **600** comprises a content multiplex identifier **602** which identifies the wide, local or wide+local content multiplexes for which this partially seamless handoff table is generated. The partially seamless handoff table **600** also comprises a {RF, LOI} Identifier **604** that identifies an RF frequency and associated neighboring LOI that carries the wide, local or wide+local content multiplexes identified by the content multiplex identifier **602**.

[0091] The partially seamless handoff table **600** also comprises an overall number of common multiplexes indicator **606** that indicates the total number of multiplexes that are common between the LOI associated with the identified partially seamless RF and the current LOI. The partially seamless handoff table **600** also comprises a total number of multiplexes indicator **608** that indicates the total number of multiplexes available in the LOI associated with the identified partially seamless RF.

Handoff Table Examples

[0092] **FIG. 13** shows examples of seamless handoff tables **1300** for use in aspects of a handoff system. For example, it will be assumed that the device **112** is currently located in LOI2 and is operable to receive content multiplexes associated with WID1, WID2, LID1, LID2 that are transmitted on RF2 or RF3 in LOI2. Thus, the seamless handoff tables **1300** reflect the distribution of content in the network configuration illustrated in **FIG. 1** as it relates to the device **112** operating in the LOI2.

[0093] Wide seamless handoff tables associated with wide content in LOI2 are shown at **1302** and **1304**. The wide seamless handoff table **1302** is associated with a wide content multiplex identified by WID1 and includes seamless RF channel RF4 in LOI3, which carries the same wide content multiplex. In addition, the table **1302** shows that LOI3 has four (4) multiplexes in common with LOI2 and that the total number of multiplexes carried in LOI3 is four (4).

[0094] The wide seamless handoff table **1304** is associated with a wide content multiplex identified by WID2 and includes seamless RF channel RF5 in LOI3, which carries the same wide content multiplex. In addition, the table **1304** shows that LOI3 has four (4) multiplexes in common with LOI2 and that the total number of multiplexes carried in LOI3 is four (4).

[0095] Local seamless handoff tables are shown at **1306** and **1308**. The local seamless handoff table **1306** is associated with a local content multiplex identified by

LID1 and includes seamless RF channel RF4 in LOI3 which carries the same local content multiplex. In addition, the table **1306** shows that LOI3 has four (4) multiplexes in common with LOI2 and that the total number of multiplexes in LOI3 is four (4).

[0096] The local seamless handoff table **1308** is associated with a local content multiplex identified by LID2 and includes seamless RF channel RF5 in LOI3 which carries the same local content multiplex. In addition, the table **1308** shows that LOI3 has four (4) multiplexes in common with LOI2 and that the total number of multiplexes in LOI3 is four (4).

[0097] Wide+local seamless handoff tables are shown at **1310** and **1312**. The wide+local seamless handoff table **1310** is associated with a combination of wide+local content multiplexes identified by WID1+LID1 and includes seamless RF channel RF4 in LOI3, which carries the same combination of wide+local content multiplexes. In addition, the table **1310** shows that the total number of multiplexes in LOI3 is four (4).

[0098] The wide+local seamless handoff table **1312** includes is associated with a combination of wide+local content multiplexes identified by WID2+LID2 and includes seamless RF channel RF5 in LOI3 which, carries the same combination of wide+local content multiplexes. In addition, the table **1308** shows that the total number of multiplexes in LOI3 is four (4).

[0099] Thus, the seamless handoff tables **1300** identify wide and/or local content multiplexes in LOI2, seamless RF channels and their associated LOI identifiers for these content multiplexes, and multiplex information for LOIs associated with seamless RFs for use in aspects of a handoff system.

[00100] **FIG. 14** shows examples of partially seamless handoff tables **1400** for use in aspects of a handoff system. For example, it will be assumed that the device **112** is currently located in LOI2 and is operable to receive content multiplexes associated with WID1, WID2, LID1, LID2 that are transmitted on RF2 or RF3 in LOI2. Thus, the partially seamless handoff tables **1400** reflect the distribution of content in the network configuration illustrated in **FIG. 1** as it relates to the device **112** operating in the LOI2.

[00101] A wide partially seamless handoff table is shown at **1402**. The wide partially seamless handoff table **1402** is associated with a wide content multiplex identified by WID1 and includes partially seamless RF channels RF1 in LOI1, and RF6 in LOI4, which carry the same wide content multiplex. For LOI1, the table **1402** shows that it has one (1) multiplex in common with LOI2 and that the total number of multiplexes in

LOI1 is two (2). For LOI4, the table **1402** shows that it has two (2) multiplexes in common with LOI2 and that the total number of multiplexes in LOI4 is two (2).

[00102] A local partially seamless handoff table is shown at **1404**. The local partially seamless handoff table **1404** is associated with a local content multiplex identified by LID1 and includes partially seamless RF channel RF6 in LOI4, which carries the same local content multiplex. In addition, the table **1404** shows that LOI4 has two (2) multiplexes in common with LOI2 and that the total number of multiplexes in LOI4 is two (2).

[00103] A wide+local partially seamless handoff table is shown at **1406**. The wide+local partially seamless handoff table **1406** is associated with a combination of wide+local content multiplexes identified by WID1+LID1 and includes seamless RF channel RF6 in LOI4, which carries the same combination of wide+local content multiplexes. In addition, the table **1406** shows that LOI4 has two (2) multiplexes in common with LOI2 and that the total number of multiplexes in LOI4 is two (2). It should be noted that partially seamless handoff tables for WID2, LID2 and WID2+LID2 are empty and therefore not shown.

[00104] Thus the partially seamless handoff tables **1400** identify wide and/or local content multiplexes in LOI2, partially seamless RF channels and their associated LOI identifiers for these content multiplexes, and multiplex information for LOIs associated with partially seamless RFs for use in aspects of a handoff system.

RF Channel Ranking

[00105] In an aspect, RF channels in seamless and partially seamless handoff tables are ranked based on information maintained in these tables. Neighboring RF channels included in seamless and partially seamless handoff tables are ranked to achieve: i) Maximizing number of wide and/or local content multiplexes that are common between LOI associated with neighboring RF channel and device's current LOI; and ii) Maximizing overall total number of content multiplexes in LOI associated with neighboring RF channel. The neighboring seamless and partially seamless RF channels are evaluated in their ranking order for handoff execution to provide enhanced user experience. In various aspects, neighboring RF channels in wide or local seamless handoff table are ranked as follows.

1. The RF channel with more number of common multiplexes (with device's current LOI) in associated LOI is assigned higher rank.
2. Among RF channels with same number of common multiplexes with device's current LOI, RF channel with more number of overall multiplexes in associated LOI is assigned higher rank.
3. Among RF channels with same number of overall multiplexes, RF channels can be assigned ranking in any random order.

[00106] In various aspects, neighboring RF channels in wide+local seamless handoff table are ranked as follows.

1. The RF channel with more number of overall multiplexes in associated LOI is assigned higher rank.
2. Among RF channels with same number of overall multiplexes, RF channels can be assigned ranking in any random order.

[00107] In various aspects, neighboring RF channels in wide, local and wide+local partially seamless handoff tables are ranked as follows.

1. RF channel with more number of common multiplexes (with current LOI) in associated LOI is assigned higher rank.
2. Among RF channels with same number of common multiplexes in associated LOI, RF channel with more number of overall multiplexes is assigned higher rank.
3. Among RF channels with same number of overall multiplexes in associated LOI, RF channels can be assigned ranking in any random order.

[00108] In another aspect, RSSI values (if available) for RF channels carrying common wide and/or local content multiplexes in associated LOIs can also be used to rank seamless and partially seamless RF channels. The seamless and partially seamless RF channels which have higher RSSI values associated with RF channels carrying common wide and/or local content multiplexes in associated LOIs can be assigned higher rank. This will provide better availability of common multiplexes in the new LOI after handoff. The seamless and partially seamless RF channels are evaluated in their ranking order for executing an RF handoff. In an aspect, a seamless or a partially seamless RF channel is considered for a handoff only if it meets a signal strength criteria where RSSI for the RF channel is greater than a defined threshold.

Handoff Overview

[00109] An RF handoff to an RF channel in a neighboring LOI is initiated whenever a handoff event (i.e., content acquisition failures) is detected for desired content. The RF channels in seamless and partially seamless handoff tables associated with desired content are considered for performing the handoff. A handoff RF list is generated by combining seamless and partially seamless RF channels associated with desired content. Seamless RF channels are listed higher than partially seamless RF channels in the handoff RF list. Also, individual set of seamless and partially seamless RF channels are listed in their respective rank order in the handoff RF list. The RFs in the handoff RF list are evaluated for handoff in their listed order.

[00110] A Handoff_Trigger_RF parameter is maintained which specifies the current RF channel when the handoff event was first initiated. To perform a handoff to a particular neighboring RF, that neighboring RF should meet RF selection criteria. Meeting the RF selection criteria involves meeting a signal strength criterion where the RSSI of the selected RF channel should be greater than a defined threshold and meeting a handoff criterion. The handoff criterion is evaluated with respect to the Handoff_Trigger_RF. In an aspect, a neighboring RF meets the handoff criterion if the following holds true.

RSSI of neighboring RF>=RSSI of Handoff_Trigger_RF + RSSI_Hystersis **(1)**

[00111] The RSSI_Hysteresis is used to minimize ping ponging between the neighboring RF and the Handoff_Trigger_RF. The Handoff_Trigger_RF parameter gets set to the neighboring RF if the WOIS is acquired successfully on that neighboring RF.

[00112] The handoff to RFs in the set of neighboring seamless and partially seamless RFs for the desired content is attempted for a finite time period. A handoff timer is maintained to specify the time duration for which handoff should be executed. The handoff timer may be set to different values for activated and registered flows. For example, the handoff timer can be set to a larger value for activated flows as compared to registered flows because of real time nature of activated flows. If desired content can not be acquired after the handoff timer expires, the system gives up attempting to acquire the desire content. The device behavior for activated and registered flows after the handoff timer expires is captured in another section in this document.

[00113] **FIG. 7** shows a method **700** for performing a handoff for use in aspects of a handoff system. For clarity, the method **700** is described herein with reference to the handoff logic **300** shown in **FIG. 3**. For example, in an aspect, the processing logic **302** executes one or more sets of codes to control the handoff logic **300** to perform the functions described below.

[00114] At block **702**, neighbor description information is received as part of the NDM. For example, the neighbor description information identifies neighboring LOIs of the device's current LOI, their associated RF channels, and the multiplexes carried on those RF channels (identified by WID and LID information). In an aspect, the neighbor description information is received over a control channel by the control channel logic **306** and passed to the message decoder **304** where the information is decoded for use by the processing logic **302**.

[00115] At block **704**, the RF channels in the current LOI and its neighboring LOIs are monitored to measure signal strengths (RSSI) for these RF channels. In an aspect, the processing logic **302** operates to request and receive signal strength parameters related to the RFs in the current and neighboring LOIs.

[00116] At block **706**, seamless handoff tables are generated and maintained. In an aspect, the processing logic **302** operates to generate and maintain seamless handoff tables based on the received neighbor description information. For example, for each multiplex in the current LOI, wide and local seamless handoff tables are formatted as illustrated in **FIG 4**, and wide+local seamless handoff tables are formatted as illustrated in **FIG. 5**.

[00117] At block **708**, partially seamless handoff tables are generated and maintained. In an aspect, the processing logic **302** operates to generate and maintain partially seamless handoff tables based on the received neighbor description information. For example, for each multiplex in the current LOI, wide, local, and wide+local partially seamless handoff tables are formatted as illustrated in **FIG 6**.

[00118] At block **710**, a determination is made as to whether a handoff event for desired content has been detected. In an aspect, the processing logic **302** operates to detect a handoff event. In an aspect, a handoff event is triggered as the result of acquisition failures associated with desired content. For example acquisition failures may occur due to device mobility. If a handoff event is not detected, the handoff method ends. If a handoff event is detected, the method proceeds to block **712**.

[00119] At block **712**, a determination is made as to whether there are any RF channels in the seamless handoff table associated with the desired content. In an aspect, the processing logic **302** makes this determination based on set of seamless handoff tables maintained. If there are any RF channels in the seamless handoff table associated with the desired content, the method proceeds to block **714**. If there are no RF channels in the seamless handoff table associated with the desired content, the method proceeds to block **732**.

[00120] At block **714**, the RF channels in the seamless handoff table associated with the desired content are sorted by increasing rank. In an aspect, the processing logic **302** operates to perform this sorting according to the ranking algorithms described above.

[00121] At bloc **716**, a determination is made as to whether there are any RF channels in the partially seamless handoff table associated with the desired content. In an aspect, the processing logic **302** makes this determination based on the set of partially seamless handoff tables maintained. If there are RF channels available in the partially seamless handoff table associated with the desired content, the method proceeds to block **718**. If there are no RF channels in the partially seamless handoff table associated with the desired content, the method proceeds to block **722**.

[00122] At block **718**, the RF channels in the partially seamless handoff table associated with the desired content are sorted by increasing rank. In an aspect, the processing logic **302** operates to perform this sorting according to the ranking algorithms described above.

[00123] At block **720**, a handoff RF list is generated that comprises the sorted seamless RF channels followed by the sorted partially seamless RF channels. In an aspect, the processing logic **302** operates to generate the handoff RF list.

[00124] At block **722**, a handoff RF list is generated that comprises the sorted seamless RF channels. In an aspect, the processing logic **302** operates to generate the handoff RF list.

[00125] At block **724**, a determination is made as to whether the detected handoff trigger event is based on one of the first or second handoff trigger conditions out of the four handoff trigger conditions described above. In an aspect, the processing logic **302** makes this determination. If the handoff event is based on the first or second trigger condition, the method proceeds to block **728**. If the handoff event is not based on either of the first or second trigger conditions, the method proceeds to block **726**.

[00126] At block **726**, the Handoff_Trigger_RF is assigned to the current RF channel. In an aspect, the processing logic **302** makes this assignment.

[00127] At block **728**, a handoff timer is started. In an aspect, the handoff timer is maintained by the processing logic **302**, which operates to start the timer. In an aspect, the handoff timer parameter may be set to different values for handoffs initiated for activated and registered flows.

[00128] At block **730**, a handoff procedure is executed based on the current handoff RF list. In an aspect, the handoff procedure is provided by the method **800** shown in **FIG. 8**.

[00129] At block **732**, a determination is made as to whether there are any RF channels in the partially seamless handoff table associated with the desired content. In an aspect, the processing logic **302** makes this determination based on set of partially seamless handoff tables maintained. If there are any RF channels in the partially seamless handoff table associated with the desired content, the method proceeds to block **734**. If there are no RF channels in the partially seamless handoff table associated with the desired content, the method proceeds to block **738**.

[00130] At block **734**, the RF channels in the partially seamless handoff table associated with the desired content are sorted by increasing rank. In an aspect, the processing logic **302** operates to perform this sorting according to the ranking algorithms described above.

[00131] At block **736**, a handoff RF list is generated that comprises the sorted partially seamless RF channels. In an aspect, the processing logic **302** operates to generate the handoff RF list.

[00132] At block **738**, a determination is made as to whether the handoff type is a wide+local handoff. In an aspect, the processing logic **302** makes this determination. If the handoff is a wide+local handoff, the method proceeds to block **742**. If the handoff is not a wide+local handoff, the method proceeds to block **740**.

[00133] At block **740**, an attempt is made to acquire the desired content on an RF channel in the current LOI. This is because at this point in the method 700, it has been determined that there are no seamless or partially seamless RF channels available for the desired content.

[00134] At block **742**, the handoff type is wide+local and no seamless or partially seamless RF channels are available for the desired wide+local content. As a result, an

attempt is made to perform a wide handoff for the desired wide content. If the wide handoff fails, an attempt is made to perform a local handoff for the desired local content.

[00135] Thus, the method **700** operates to perform a handoff for use in aspects of a handoff system. It should be noted that the method **700** represents just one implementation and that other implementations are possible within the scope of the aspects.

[00136] **FIG. 8** shows a method **800** for performing a handoff procedure for use in aspects of a handoff system. For example, the method **800** is suitable for use at block **730** of the method **700.** For clarity, the method **800** is described herein with reference to the handoff logic **300** shown in **FIG. 3**. For example, in an aspect, the processing logic **302** executes one or more sets of codes to control the handoff logic **300** to perform the functions described below.

[00137] At block **802**, an Acquisition RF list is set to be equivalent to the current handoff RF list. In an aspect, the handoff RF list is determined by the processing logic **302** as discussed above with reference to the method **700**.

[00138] At block **804**, RF channels in the Acquisition RF list are monitored to measure signal strength (RSSI) for these RF channels.. In an aspect, the processing logic **302** operates to communicate with receiving logic at the device to request the RF signal strength characteristic of RFs in the Acquisition RF list.

[00139] At block **806**, a determination is made as to whether the signal strength of all RFs in the Acquisition RF list is less than a selected signal strength threshold. In an aspect, the processing logic **302** operates to compare the signal strength characteristics of all RFs in the Acquisition RF list to a selected threshold value to make this determination. If the signal strength of all RFs in the Acquisition RF list is less than or equal to the threshold, the method proceeds to block **808**. If there are any RFs in the Acquisition RF list that have a signal strength greater than the selected threshold, the method proceeds to block **814**.

[00140] At block **808**, a determination is made as to whether a handoff timer has expired. In an aspect, the processing logic **302** maintains the handoff timer (at block **728**) as discussed with reference to the method **700**. The processing logic **302** determines if the handoff timer has expired and if so, the method proceeds to block **812**. If the handoff timer has not expired, the method proceeds to block **810**.

[00141] At block **812**, a handoff failure is declared. In an aspect, because all RFs in the Acquisition RF list that have a signal strength that is less than or equal to the selected threshold and the handoff timer has expired, the processing logic **302** determines that the attempted handoff has failed.

[00142] At block **810**, the Acquisition RF list is set to be equivalent to the current handoff RF list. In an aspect, the handoff RF list is determined by the processing logic **302** as discussed above with reference to the method **700**.

[00143] At block **814**, the first RF channel with RSSI>Threshold is selected in the ordered Acquisition RF list. Then an evaluation is performed to evaluate the handoff criterion for the selected RF channel. The handoff criterion is evaluated as described by equation (1) above. In an aspect, the processing logic **302** makes the RF selection and handoff criteria evaluation.

[00144] At block **816**, a determination is made to determine if the handoff criterion evaluated at block **814** is satisfied for the selected RF channel. In an aspect, the processing logic **302** makes this determination. If the handoff criteria are satisfied for the selected RF channel in the Acquisition RF list, the method proceeds to block **818**. If the handoff criterion is not satisfied, the method proceeds to block **820**.

[00145] At block **820**, the selected RF channel is removed from the Acquisition RF list. In an aspect, the processing logic **302** removes the selected RF from the Acquisition RF list because this RF failed to meet the handoff criteria as determined at block **816** or because the OIS could not be successfully acquired on selected RF as determined at block **830** or because acquisition for CC (if required) fails on the selected RF as determined at block **838** or because no MLC could be decoded successfully as determined at block **842**.

[00146] At block **822**, a determination is made as to whether a handoff timer has expired. In an aspect, the processing logic **302** maintains the handoff timer as discussed with reference to the method **700**. The processing logic **302** determines if the handoff timer has expired and if so, the method proceeds to block **824**. If the handoff timer has not expired, the method proceeds to block **826**.

[00147] At block **824**, a handoff failure is declared. In an aspect, because the handoff timer has expired, the processing logic **302** determines that the attempted handoff has failed.

[00148] At block **826**, if the Acquisition RF list is empty, the Acquisition RF list is reset to be equivalent to the handoff RF list. In an aspect, the processing logic **302** determines if the Acquisition RF list is empty, and if so, resets it to the handoff RF list.

[00149] At block **818**, a switch to the selected RF is performed using the WID/LID associated with the RF. In an aspect, the processing logic **302** controls the channel switch logic **310** to switch to the selected RF and use the associated WID/LID to descramble content on that RF.

[00150] At block **828**, an attempt is made to acquire the OIS on the selected RF channel. In an aspect, the OIS is acquired by the overhead input logic **306**.

[00151] At block **830**, a determination is made as to whether the OIS was acquired successfully on the selected RF. In an aspect, the processing logic **302** makes this determination. If the OIS was not acquired successfully, the method proceeds to block **832**. If the OIS was acquired successfully, the method proceeds to block **834**.

[00152] At block **832**, a switch is made to the Handoff_Trigger_RF. In an aspect, the processing logic **302** controls the channel switch logic **310** to switch back to the Handoff_Trigger_RF because the OIS acquisition failed on the selected RF.

[00153] At block **834**, a Handoff_Trigger_RF is set to the current RF. In an aspect, the processing logic **302** performs this operation.

[00154] At block **836**, an attempt is made to acquire the appropriate control channel if needed. In an aspect, the overhead input logic **306** performs this operation.

[00155] At block **838**, a determination is made as to whether the control channel was acquired successfully. In an aspect, the processing logic **302** makes this determination. If the control channel was not acquired successfully, the method proceeds to block **820**. If the control channel was acquired successfully, the method proceeds to block **840**.

[00156] At block **840**, an attempt is made to decode media logical channels (MLCs) from the current RF. In an aspect, receiving logic at the device attempts to decode the MLCs and reports the results to the processing logic **302**.

[00157] At block **842**, a determination is made as to whether at least one MLC associated with desired content was decoded successfully. In an aspect, the processing logic **302** makes this determination. If at least one MLC associated with desired content was not decoded successfully, the method proceeds to block **820**. If at least one MLC associated with desired content was decoded successfully, the method proceeds to block **844**.

[00158] At block **844**, the handoff is determined to be successful and the handoff procedure ends. In an aspect, the processing logic **302** makes this determination because at least one MLC associated with desired content was successfully decoded.

[00159] Thus, the method **800** operates to perform a handoff for use in aspects of a handoff system. It should be noted that the method **800** represents just one implementation and that other implementations are possible within the scope of the aspects.

[00160] **FIG. 9** shows a method **900** for providing a handoff event trigger for activated flows for use in aspects of a handoff system. For clarity, the method **900** is described herein with reference to the handoff logic **300** shown in **FIG. 3**. For example, in an aspect, the processing logic **302** executes one or more sets of codes to control the handoff logic **300** to perform the functions described below.

[00161] At block **902**, one or more real time flows are successfully activated. In an aspect, applications at the device attempt to acquire one or more real time flows.

[00162] At block **904**, a determination is made as to whether required control channel information is locally stored. In an aspect, the processing logic **302** operates to determine if the required control channel information is locally stored. If the control channel data is locally stored, the method proceeds to block **906**. If the control channel data is not locally stored, the method proceeds to block **908**.

[00163] At block **906**, a switch is performed (if needed) to switch to the RF channel carrying the newly activated flows. In an aspect, the processing logic **302** controls the channel switch logic **310** to switch to the RF channel carrying the newly activated flows. An RF switch will not be required if the device's current RF is the RF carrying newly activated flows.

[00164] At block **908**, at attempt is made to acquire the appropriate set of OIS and control channel information from the new RF channel. In an aspect, the overhead input logic **306** obtains the OIS and control channel information from the new RF channel.

[00165] At block **910**, a determination is made as to whether the appropriate set of OIS and control channel information was successfully acquired. In an aspect, the processing logic **302** operates to make this determination. If the OIS and control channel data was not successfully acquired, the method proceeds to block **914**. If the OIS and control channel data was successfully acquired, the method proceeds to block **912**.

[00166] At block **912**, the newly activated flows are decoded on the new RF. In an aspect, receiving logic at the device operates to decode the newly activated flows.

[00167] At block **914**, a handoff procedure is executed in an attempt to acquire the activated flows on a neighboring RF channel. In an aspect, the processing logic **302** operates to execute the handoff procedure because the OIS and CC acquisition fails on the RF channel carrying activated flows in current LOI. In an aspect, the handoff procedure is described above with reference to **FIG. 8**.

[00168] At block **916**, a determination is made as to whether the handoff was successful. In an aspect, the processing logic **302** makes this determination. If the handoff was successful, the method proceeds to block **912**. If the handoff was not successful, the method proceeds to block **918**.

[00169] At block **918**, the handoff has failed and all activated flows are deactivated. In an aspect, the processing logic **302** operates to deactivate all the activated flows.

[00170] At block **920**, system acquisition logic is executed. In an aspect, the processing logic **302** operates to initiate system acquisition logic to acquire the system because the handoff failed.

[00171] Thus, the method **900** operates to perform providing a handoff event trigger for activated flows for use in aspects of a handoff system. It should be noted that the method **900** represents just one implementation and that other implementations are possible within the scope of the aspects.

[00172] **FIG. 10** shows a method **1000** for providing a handoff event trigger for activated flows for use in aspects of a handoff system. For clarity, the method **1000** is described herein with reference to the handoff logic **300** shown in **FIG. 3**. For example, in an aspect, the processing logic **302** executes one or more sets of codes to control the handoff logic **300** to perform the functions described below.

[00173] At block **1002**, a device is currently decoding activated flows on a current RF channel.

[00174] At block **1004**, a determination is made to determine whether data acquisition for all MLCs associated with activated flows failed or OIS acquisition failed on the current RF channel. In an aspect, the processing logic **302** makes this determination. If there are no MLCs and OIS failures, the method proceeds to block **1002**. If there is either the failure of all MLCs associated with activated flows or the failure of OIS acquisition, then the method proceeds to block **1006**.

[00175] At block **1006**, a handoff procedure for activated flows is executed. For example, the handoff procedure described in **FIG. 8** is executed to hand off to a new neighboring RF channel to successfully acquire OIS and activated flows.

[00176] At block **1008**, a determination is made as to whether the handoff was successful. In an aspect, the processing logic **302** makes this determination. If the handoff was successful, the method proceeds to block **1010**. If the handoff was not successful, the method proceeds to block **1012**.

[00177] At block **1010**, the activated flows are decoded from the new RF channel. In an aspect, the device has handed off to a new RF channel and is able to acquire the activated flows from that RF channel.

[00178] At block **1012**, handoff has failed and all the activated flows are deactivated. In an aspect, the processing logic **302** operates to deactivate the activated flow because the handoff to a different RF channel was unsuccessful.

[00179] At block **1014**, system acquisition logic is executed. In an aspect, the processing logic **302** operates to initiate system acquisition logic to acquire the system because the handoff failed.

[00180] Thus, the method **1000** operates to perform providing a handoff event trigger for activated flows for use in aspects of a handoff system. It should be noted that the method **1000** represents just one implementation and that other implementations are possible within the scope of the aspects.

[00181] **FIG. 11** shows a method **1100** for providing a handoff trigger event for registered flows for use in aspects of a handoff system. In an aspect, the method **1100** initiates a handoff in the event of data acquisition failure with respect to registered flows. It should be noted that a detailed description of a data acquisition procedure (DAP) for registered flows is not presented and specific embodiments of such a data acquisition procedure are not essential to the operation of the methods and apparatus of the various embodiments described herein. However, an example of a data acquisition procedure for registered flows can be found in the above referenced application (Provisional Application No. 60/910,191, entitled "methods and Apparatus for Providing Flow Data Acquisition Priority Scheme in a Multiple Frequency Network," filed 04/04/2007, and to Provisional Application No. 60/945,317, entitled "Methods And Apparatus for Providing Flow Data Acquisition Priority Scheme in a Multiple Frequency Network," filed 06/20/2007). In an aspect, the processing logic **302** executes

one or more sets of codes to control the handoff logic **300** to perform the functions described below.

[00182] At block **1102**, a determination is made as to whether required control channel information is locally stored. In an aspect, the processing logic **302** operates to make this determination. If the required control channel information is locally stored, the method proceeds to block **1104**. If the control channel information is not locally stored, the method proceeds to block **1108**.

[00183] At block **1104**, flow groups (FGs) comprising registered flows for which data is to be acquired are stored in the DAP_FG[..] list in their rank order. The highest rank FG (DAP_FG[0]) is selected for acquiring registered flow data. In an aspect, the processing logic **302** operates to perform these operations. The processing logic **302** operates to attempt to acquire flow data for registered flows in the selected FG plus other registered flows carried on the same RF channel.

[00184] At block **1106**, a switch (if required) is performed to the RF carrying the selected flow group. In an aspect, the processing logic **302** controls the channel switch logic **310** to switch to the RF channel carrying the selected FG. An RF switch will not be required if device current RF is the RF carrying the selected FG.

[00185] At block **1108**, at attempt is made to acquire appropriate set of the OIS and control channel information on the new RF channel. In an aspect, the overhead input logic **306** obtains the OIS and control channel information from the new RF channel.

[00186] At block **1110**, a determination is made as to whether the acquisition of the OIS and the control channel information succeeded. In an aspect, if the acquisition of the OIS and control channel information was successful, the method proceeds to block **1112**. If the acquisition of the OIS and control channel information was not successful, the method proceeds to block **1114**.

[00187] At block **1112**, the execution of the DAP procedure continues to acquire data associated with registered flows. In an aspect, the processing logic **302** operates to continue executing the DAP procedure.

[00188] At block **1114**, a handoff procedure for registered flows in selected FG is executed. For example, the handoff procedure described in **FIG. 8** is executed to hand off to a new neighboring RF channel in an attempt to obtain data for the registered flows in the selected FG.

[00189] At block **1116**, a determination is made as to whether the handoff was successful. If the handoff was successful, the method proceeds to block **1112**. If the handoff was not successful, the method proceeds to block **1118**.

[00190] At block **1118**, all the flow groups carried on the current RF channel are removed from the DAP flow group list. In an aspect, the processing logic **302** operates to remove FGs from the DAP flow group list.

[00191] At block **1120**, a determination is made as to whether there are any more flow groups left in the DAP flow group list. In an aspect, the processing logic **302** operates to make this determination. In an aspect, if there are more flow groups left in the DAP flow group list, the method proceeds to block **1104**. If there are no more flow groups left in the DAP flow group list, the method proceeds to block **1122**.

[00192] At block **1122**, the DAP flow group list is reset to all computed flow groups. In an aspect, the processing logic **302** operates to reset the DAP flow group list.

[00193] At block **1124**, monitoring of OIS information is scheduled so that acquisition for OIS, CC and flow data for FGs can be attempted again after a selected time interval.

[00194] Thus, the method **1100** operates to provide a handoff event trigger for registered flows for use in aspects of a handoff system. It should be noted that the method **1100** represents just one implementation and that other implementations are possible within the scope of the aspects.

[00195] **FIG. 12** shows a method **1200** for providing a handoff trigger event for registered flows for use in aspects of a handoff system. In an aspect, the method **1200** initiates a handoff in the event of data acquisition failure with respect to registered flows. In an aspect, the processing logic **302** executes one or more sets of codes to control the handoff logic **300** to perform the functions described below.

[00196] At block **1202**, a device is currently decoding registered flows associated with a selected flow group on a current RF. The device also decodes registered flows associated with other FGs carried on the current RF.

[00197] At block **1204**, a determination is made to determine whether data acquisition for all MLCs associated with registered flows in the Selected FG failed or OIS acquisition failed on the current RF. In an aspect, the processing logic **302** makes this determination. If there are no MLCs and OIS failures, the method proceeds to

block **1202**. If there is either failure of all MLCs associated with registered flows in the Selected FG or the failure of OIS acquisition, then the method proceeds to block **1206**.

[00198] At block **1206**, a handoff procedure for the registered flows in the selected FG is executed. For example, the handoff procedure described in **FIG. 8** is executed to hand off to a new neighboring RF channel to successfully acquire OIS and registered flows in the selected FG.

[00199] At block **1208**, a determination is made as to whether the handoff was successful. In an aspect, the processing logic **302** makes this determination. If the handoff was successful, the method proceeds to block **1210**. If the handoff was not successful, the method proceeds to block **1212**.

[00200] At block **1212**, all the flow groups carried on the current RF channel are removed from the DAP flow group list. In an aspect, the processing logic **302** operates to remove FGs from the DAP flow group list.

[00201] At block **1214**, a determination is made as to whether there are more flow groups left in the DAP flow group list. In an aspect, the processing logic **302** operates to make this determination. If there are more flow groups left, the method proceeds to block **1216** to start executing a DAP procedure. If there are no more flow groups left in the DAP flow group list, the method proceeds to block **1218**.

[00202] At block **1216**, a DAP procedure is executed to acquired data for additional flow groups that are left in the DAP flow group list.

[00203] At block **1218**, the DAP flow group list is reset to list all computed flow groups. In an aspect, the processing logic **302** operates to reset the DAP flow group list.

[00204] At block **1220**, monitoring of OIS information is scheduled so that acquisition for OIS, CC and flow data for FGs can be attempted again after a selected time interval.

[00205] Thus, the method **1200** operates to provide a handoff event trigger for registered flows for use in aspects of a handoff system. It should be noted that the method **1200** represents just one implementation and that other implementations are possible within the scope of the aspects.

[00206] **FIG. 15** shows handoff logic **1500** for use in aspects of a handoff system. For example, the handoff logic **1500** is suitable for use as the handoff logic **300** shown in **FIG. 3**. In an aspect, the handoff logic **1500** is implemented by at least one integrated circuit comprising one or more modules configured to provide aspects of a

handoff system as described herein. For example, in an aspect, each module comprises hardware and/or hardware executing software.

[00207] The handoff logic **1500** comprises a first module comprising means (**1502**) for generating seamless handoff tables and partially seamless handoff tables for multiplexes carried in a current LOI, wherein the seamless and partially seamless handoff tables comprise neighboring RF channels carrying one or more of the multiplexes in the current LOI, which in an aspect comprises the processing logic **302**. The handoff logic **1500** also comprises a second module comprising means (**1504**) for detecting a handoff event initiated by acquisition failures on a current RF, which in an aspect comprises the processing logic **302**. The handoff logic **1500** also comprises a third module comprising means (**1506**) for selecting a selected RF channel from the seamless and partially seamless handoff tables, which in an aspect comprises the processing logic **302**. The handoff logic **1500** also comprises a fourth module comprising means (**1508**) for performing a handoff to the selected RF channel, which in an aspect comprises the channel switch logic **310**.

Content Preserving Handoff

[00208] In an aspect, a content preserving handoff is provided wherein the handoff system operates to hand off to a horizontal RF in a neighboring LOI carrying the same set or a superset of multiplexes as carried in a current LOI. After a content preserving handoff, content is preserved in the sense that the content available in the old LOI is also available in the new LOI. For example, a Wide+Local seamless handoff is a special case of a content preserving handoff where the LOI associated with a new RF carries at least same set of wide and local content multiplexes as the old LOI. The content preserving handoff allows a device to move to a neighboring LOI which carries at least the same content as the current LOI and provide better signal strength for RF channels carried in the new LOI. This provides an overall improved success probability for content data acquisition in the multi-frequency network.

[00209] In an aspect, the handoff system performs a content preserving handoff if the following handoff conditions are met at the device:

1. Device has one or more flows registered from an upper layer over one or more RFs.
2. Device does not have any activated real time flows.

3. Device is not actively decoding any registered flows (i.e., all of the registered flows are not being broadcast currently).
4. Device has at least one good RF (RF for which OIS acquisition was successful)) in the current LOI.
5. Device has at least one bad RF in the current LOI (RF for which OIS acquisition failed) or has at least one good RF (RF for which OIS acquisition was successful) with an RSSI that is below a selected good RF threshold (Good_RF_Thresh).

[00210] In an aspect, the handoff system maintains a list of neighboring LOIs which can provide a content preserving handoff. The content preserving (CP) LOIs are those LOIs which carry at least same set of content as the device's current LOI. In an aspect, the handoff system performs the content preserving handoff if the set of RFs carrying the same content (as current LOI) in a CP LOI have overall better signal strength than RFs in the current LOI. In another aspect, the handoff system performs the content preserving handoff only if the broadcast of any of the registered flow data is not starting before a selected time window duration from a current time. This ensures that if the registered flow data broadcast is starting within the selected time window duration, it does not get interrupted by the content preserving handoff. If no appropriate CP neighboring LOI exists, the content preserving handoff is not performed. By providing the content preserving handoff, the handoff system operates to provide the following features.

1. Increase in the success probability for overall flow data acquisition for registered & active flows because RFs in the new LOI have an overall better signal strength than RFs in the current LOI.
2. If the current LOI has good RFs with RSSI below the Good_RF_Thresh, a content preserving handoff may improve the probability of successful data reception for these RFs.
3. If the current LOI has bad RFs for which OIS acquisition failed, a content preserving handoff may improve the probability of successful data reception for these bad RFs.

[00211] **FIG. 16** shows an exemplary content preserving handoff table **1600** applicable for use in aspects of a handoff system. In an aspect, the content preserving

handoff table **1600** is generated by the processing logic **302**. The content preserving handoff table contains data related to neighboring CP LOIs for the device's current LOI. The content preserving handoff table **1600** comprises a LOI identifier **1602** which identifies particular CP LOIs for the device's current LOI in the multi-frequency network. The content preserving handoff table **1600** also comprises a sum of weights identifier **1604** that indicates an overall weight value associated with RFs in a particular CP LOI identified by a LOI identifier **1602**. The content preserving handoff table **1600** also comprises a total number of multiplexes indicator **1606** that indicates the total number of wide and local multiplexes available in a particular CP LOI identified by a LOI identifier **1602**. It should be noted that the table **1600** is designed to include information associated with the current LOI as well. The information associated with the current LOI is used to determine if a content preserving handoff should be performed.

[00212] In an aspect, the RFs carrying the same multiplex (as the current LOI) in the each CP LOI identified in the content preserving table **1600** are assigned weights as follows:

1. For a selected RF, if the RSSI>Good_RF_Thresh, the weight is set equal to one, else the weight is set equal to zero;
2. Weights are assigned separately for wide and local multiplexes. Thus an RF with RSSI>Good_RF_Thresh in a CP LOI and which carries the same wide and local content multiplexes as the current LOI is assigned a weight equal to two (one for wide multiplex and one for local multiplex).

[00213] The sum of weights identifier **1604** is computed for a particular CP LOI by adding together weights assigned to each RF which carries same content multiplexes (as current LOI) in the CP LOI.

[00214] The content preserving LOIs are assigned ranks based on information included in the content preserving handoff table **1600.** It should be noted that the device's current LOI also has an entry in the content preserving handoff table and is assigned a rank as other CP LOIs. The content preserving LOIs are examined in their rank order for performing a content preserving handoff. In an aspect, the handoff system assigns ranks to CP LOIs and current LOI based on following criteria.

1. A LOI with a higher total sum of weights is assigned a higher rank.

2. Multiple LOIs with the same total weights are assigned ranks based on the total number of wide and local multiplexes carried in those LOIs. A LOI carrying more total number of multiplexes is assigned a higher rank.

[00215] In an aspect, the handoff system operates to determine a LOI to which a content preserving handoff is performed based on the rank order of LOIs identified in the table **1600**. A content preserving handoff is performed if it is determined that a neighboring CP LOI has a higher rank than the current LOI. The handoff system starts a content preserving handoff attempt with the neighboring CP LOI having the highest rank. The content preserving handoff is performed to the seamless RF in the selected CP LOI which is carrying same wide and/or local content multiplexes as the current RF in the current LOI. It should be noted that depending on the multiplexes available in neighboring LOIs, table **1600** may not include any CP LOIs. This will happen if no neighboring LOI carries same set of wide and local multiplexes as the current LOI. In this case, no content preserving handoff will be performed.

[00216] **FIG. 17** shows an exemplary method **1700** for providing a content preserving handoff for use in aspects of a handoff system. In an aspect, the processing logic **302** executes one or more sets of codes to control the handoff logic **300** to perform the functions described below.

[00217] At block **1702**, a determination is made as to whether selected content preserving handoff conditions have been met. In an aspect, the selected content preserving handoff conditions are as described above. If the content preserving handoff conditions have been met, the method proceeds to block **1704**. If not, the method ends.

[00218] At block **1704**, the RFs associated with current and neighboring CP LOIs are monitored to determine their signal strength (i.e., RSSI) for inclusion in the content preserving handoff table **1600**. The handoff system uses the signal strength values to compute information for current and CP LOIs in the content preserving handoff table **1600.** In an aspect, the processing logic **302** controls a receiver at the device to perform this function.

[00219] At block **1706**, a LOI with the next highest rank is selected from the content preserving handoff table **1600**. In an aspect, the processing logic **302** performs this function.

[00220] At block **1708**, a determination is made as to whether the selected LOI is different than the current LOI. If the selected LOI is different from the current LOI, the

method proceeds to block **1710**. If the selected LOI is not different from the current LOI, the method proceeds to block **1712**.

[00221] At block **1710**, a destination RF is set to an RF in the selected LOI carrying at least the same wide content multiplex as the current RF. If an RF exists in the selected LOI which carries same wide and local content multiplexes as the current RF, the destination RF is set that RF.

[00222] At block **1712**, the content preserving handoff is not performed and the method ends.

[00223] At block **1714**, a switch to the destination RF is performed. In an aspect, the processing logic **302** controls a device receiver to perform this function.

[00224] At block **1716**, a wide and local system acquisition procedure is performed. Based on the results of the acquisition procedure, a path is selected from three paths beginning at blocks **1718**, **1720**, and **1722**.

[00225] At block **1718**, the acquisition of the WOIS has failed and the method proceeds to block **1706**.

[00226] At block **1720**, the acquisition of the WOIS is successful and the acquisition of the LOIS has failed. The method then proceeds to block **1724**.

[00227] At block **1724**, a determination is made as to whether a content preserving handoff type parameter is set to "wide." A more detailed description of the handoff type parameter is provided below. If the handoff type parameter is set to "wide" the method proceeds to block **1726**. If the handoff type parameter is not set to "wide" the method proceeds to block **1706**.

[00228] At block **1722**, the acquisition of the WOIS and LOIS are successful and the method proceeds to block **1726**.

[00229] At block **1726**, control channel data on the new RF channel is acquired. The method then ends.

[00230] Thus, the method **1700** operates to provide a content preserving handoff for use in aspects of a handoff system. It should be noted that the method **1700** represents just one implementation and that other implementations are possible within the scope of the aspects.

CP Handoff Type Determination

[00231] In various aspects, a content preserving handoff type (CP_handoff_type) parameter is determined based on the type of registered flows at the device. In an aspect, the handoff system sets the CP_handoff_type to "wide" if only wide flows are currently registered from the upper layer. In another aspect, the handoff system sets the CP_handoff_type to "local" if only local flows are currently registered from the upper layer. In still another aspect, the handoff system sets the CP_handoff_type to "wide+local" if both wide and local flows are currently registered flows from the upper layer.

[00232] **FIG. 18** shows handoff logic **1800** for use in aspects of a handoff system. For example, the handoff logic **1800** is suitable for use as the handoff logic **300** shown in **FIG. 3**. In an aspect, the handoff logic **1800** is implemented by at least one integrated circuit comprising one or more modules configured to provide aspects of a handoff system as described herein. For example, in an aspect, each module comprises hardware and/or hardware executing software.

[00233] The handoff logic **1800** comprises a first module comprising means (**1802**) for generating a content preserving handoff table, wherein the content preserving handoff table comprises a current local operations infrastructure (LOI) and neighboring LOIs carrying at least the same wide and local content multiplexes as the current LOI, which in an aspect comprises the processing logic **302**. The handoff logic **1800** also comprises a second module comprising means (**1804**) for determining that handoff conditions are met for a content preserving handoff, which in an aspect comprises the processing logic **302**. The handoff logic **1800** also comprises a third module comprising means (**1806**) for selecting a selected LOI from the content preserving handoff table and a selected RF channel associated with the selected LOI, which in an aspect comprises the processing logic **302**. The handoff logic **1800** also comprises a fourth module comprising means (**1808**) for performing a handoff to the selected RF channel in the selected LOI if the selected LOI is different than the current LOI, which in an aspect comprises the channel switch logic **310**.

[00234] Thus, the various illustrative logics, logical blocks, modules, and circuits described in connection with the aspects disclosed herein may be implemented or performed with a general purpose processor, a digital signal processor (DSP), an application specific integrated circuit (ASIC), a field programmable gate array (FPGA)

or other programmable logic device, discrete gate or transistor logic, discrete hardware components, or any combination thereof designed to perform the functions described herein. A general-purpose processor may be a microprocessor, but, in the alternative, the processor may be any conventional processor, controller, microcontroller, or state machine. A processor may also be implemented as a combination of computing devices, e.g., a combination of a DSP and a microprocessor, a plurality of microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration.

[00235] The steps of a method or algorithm described in connection with the aspects disclosed herein may be embodied directly in hardware, in a software module executed by a processor, or in a combination of the two. A software module may reside in RAM memory, flash memory, ROM memory, EPROM memory, EEPROM memory, registers, a hard disk, a removable disk, a CD-ROM, or any other form of storage medium known in the art. An exemplary storage medium is coupled to the processor, such that the processor can read information from, and write information to, the storage medium. In the alternative, the storage medium may be integral to the processor. The processor and the storage medium may reside in an ASIC. The ASIC may reside in a user terminal. In the alternative, the processor and the storage medium may reside as discrete components in a user terminal.

[00236] The description of the disclosed aspects is provided to enable any person skilled in the art to make or use the present invention. Various modifications to these aspects may be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other aspects, e.g., in an instant messaging service or any general wireless data communication applications, without departing from the spirit or scope of the invention. Thus, the present invention is not intended to be limited to the aspects shown herein but is to be accorded the widest scope consistent with the principles and novel features disclosed herein. The word "exemplary" is used exclusively herein to mean "serving as an example, instance, or illustration." Any aspect described herein as "exemplary" is not necessarily to be construed as preferred or advantageous over other aspects.

[00237] Accordingly, while aspects of a handoff system have been illustrated and described herein, it will be appreciated that various changes can be made to the aspects without departing from their spirit or essential characteristics. Therefore, the

disclosures and descriptions herein are intended to be illustrative, but not limiting, of the scope of the invention, which is set forth in the following claims.

CLAIMS

WHAT IS CLAIMED IS:

1. A method for RF channel handoff in a multi-frequency network, the method comprising:

generating a content preserving handoff table, wherein the content preserving handoff table comprises a current local operations infrastructure (LOI) and neighboring LOIs carrying at least the same wide and local content multiplexes as the current LOI;

determining that handoff conditions are met for a content preserving handoff;

selecting a selected LOI from the content preserving handoff table and a selected RF channel associated with the selected LOI; and

performing a handoff to the selected RF channel in the selected LOI if the selected LOI is different than the current LOI.

2. The method of claim 1, wherein said determining comprises determining that the content preserving handoff conditions are met if:

one or more flows are registered;

no real time flows are currently active;

no registered flows are being decoded currently;

there is at least one good RF in the current LOI;

there is at least one bad RF in the current LOI or there is at least one good RF in the current LOI with signal strength below a selected good RF threshold; and

broadcast of content for no registered flows is to start before a selected time window from a current time.

3. The method of claim 1, wherein said selecting comprises:

ranking the current LOI and the neighboring LOIs based on RF signal strength and total number of multiplexes in each LOIs; and

selecting the selected LOI to be a LOI with the highest rank.

4. The method of claim 1, wherein said selecting comprises selecting the selected RF channel to be an RF channel in the selected LOI that carries at least the same wide multiplex as a current RF channel in the current LOI.

5. The method of claim 1, wherein said selecting comprises selecting the selected RF channel to be an RF channel in the selected LOI that carries the same wide and local content multiplexes as a current RF channel in the current LOI.

6. The method of claim 3, further comprising:

performing following operations once for each LOI with rank higher than the current LOI in the content preserving handoff table until a successful content preserving handoff occurs:

selecting the selected LOI to be a LOI with next highest rank and a selected RF channel associated with the selected LOI; and

performing a handoff to the selected RF channel in the selected LOI.

7. The method of claim 3, wherein said ranking further comprises:

assigning weight one to an RF channel if its signal strength is above a selected threshold;

assigning weight zero to the RF channel if its signal strength is not above a selected threshold;

determining a 'sum of weights' for a LOI by adding together weights assigned to RF channels in that LOI which carry the same content multiplexes as the current LOI;

assigning a higher rank to a LOI which has higher sum of weights; and

assigning a higher rank to a LOI with a higher total number of wide and local content multiplexes among LOIs with a same 'sum of weights'

8. The method of claim 7, further comprising assigning separate weights to an RF channel for wide and local content multiplexes, respectively.

9. An apparatus for RF channel handoff in a multi-frequency network, the apparatus comprising:

processing logic configured to:

generate a content preserving handoff table, wherein the content preserving handoff table comprises a current local operations infrastructure

(LOI) and neighboring LOIs carrying at least the same wide and local content multiplexes as the current LOI;

determine that handoff conditions are met for a content preserving handoff; and

select a selected LOI from the content preserving handoff table and a selected RF channel associated with the selected LOI; and

channel switch logic configured to perform a handoff to the selected RF channel in the selected LOI if the selected LOI is different than the current LOI.

10. The apparatus of claim 9, wherein said processing logic is configured to determine that the content preserving handoff conditions are met if:

one or more flows are registered;

no real time flows are currently active;

no registered flows are being decoded currently;

there is at least one good RF in the current LOI;

there is at least one bad RF in the current LOI or there is at least one good RF in the current LOI with signal strength below a selected good RF threshold; and

broadcast of content for no registered flows is to start before a selected time window from a current time.

11. The apparatus of claim 9, wherein said processing logic is configured to:

rank the current LOI and the neighboring LOIs based on RF signal strength and total number of multiplexes in each LOIs; and

select the selected LOI to be a LOI with the highest rank.

12. The apparatus of claim 9, wherein said processing logic is configured to select the selected RF channel to be an RF channel in the selected LOI that carries at least the same wide multiplex as a current RF channel in the current LOI.

13. The apparatus of claim 11, wherein said processing logic is configured to:

perform following operations once for each LOI with rank higher than the current LOI in the content preserving handoff table until a successful content preserving handoff occurs:

select the selected LOI to be a LOI with next highest rank and a selected RF channel associated with the selected LOI; and

perform a handoff to the selected RF channel in the selected LOI.

14. The apparatus of claim 11, wherein said processing logic is configured to:

assign weight one to an RF channel if its signal strength is above a selected threshold;

assign weight zero to the RF channel if its signal strength is not above a selected threshold;

determine a 'sum of weights' for a LOI by adding together weights assigned to RF channels in that LOI which carry the same content multiplexes as the current LOI;

assign a higher rank to a LOI which has higher sum of weights; and

assign a higher rank to a LOI with a higher total number of wide and local content multiplexes among LOIs with a same 'sum of weights'

15. An apparatus for RF channel handoff in a multi-frequency network, the apparatus comprising:

means for generating a content preserving handoff table, wherein the content preserving handoff table comprises a current local operations infrastructure (LOI) and neighboring LOIs carrying at least the same wide and local content multiplexes as the current LOI;

means for determining that handoff conditions are met for a content preserving handoff;

means for selecting a selected LOI from the content preserving handoff table and a selected RF channel associated with the selected LOI; and

means for performing a handoff to the selected RF channel in the selected LOI if the selected LOI is different than the current LOI.

16. The apparatus of claim 15, wherein said means for determining comprises means for determining that the content preserving handoff conditions are met if:

one or more flows are registered;

no real time flows are currently active;

no registered flows are being decoded currently;

there is at least one good RF in the current LOI;

there is at least one bad RF in the current LOI or there is at least one good RF in the current LOI with signal strength below a selected good RF threshold; and

broadcast of content for no registered flows is to start before a selected time window from a current time.

17. The apparatus of claim 15, wherein said means for selecting comprises:

means for ranking the current LOI and the neighboring LOIs based on RF signal strength and total number of multiplexes in each LOIs; and

means for selecting the selected LOI to be a LOI with the highest rank.

18. The apparatus of claim 15, wherein said means for selecting comprises means for selecting the selected RF channel to be an RF channel in the selected LOI that carries at least the same wide multiplex as a current RF channel in the current LOI.

19. The apparatus of claim 17, further comprising:

means for performing following operations once for each LOI with rank higher than the current LOI in the content preserving handoff table until a successful content preserving handoff occurs:

selecting the selected LOI to be a LOI with next highest rank and a selected RF channel associated with the selected LOI; and

performing a handoff to the selected RF channel in the selected LOI.

20. The method of claim 17, wherein said means for ranking further comprises:

means for assigning weight one to an RF channel if its signal strength is above a selected threshold;

means for assigning weight zero to the RF channel if its signal strength is not above a selected threshold;

means for determining a 'sum of weights' for a LOI by adding together weights assigned to RF channels in that LOI which carry the same content multiplexes as the current LOI;

means for assigning a higher rank to a LOI which has higher sum of weights; and

means for assigning a higher rank to a LOI with a higher total number of wide and local content multiplexes among LOIs with a same 'sum of weights'

21. A computer program product for RF channel handoff in a multi-frequency network, the computer program product comprising:

a machine-readable medium comprising:

a first set of codes for causing a computer to generate a content preserving handoff table, wherein the content preserving handoff table comprises a current local operations infrastructure (LOI) and neighboring LOIs carrying at least the same wide and local content multiplexes as the current LOI;

a second set of codes for causing a computer to determine that handoff conditions are met for a content preserving handoff;

a third set of codes for causing a computer to select a selected LOI from the content preserving handoff table and a selected RF channel associated with the selected LOI; and

a fourth set of codes for causing a computer to perform a handoff to the selected RF channel in the selected LOI if the selected LOI is different than the current LOI.

22. The machine-readable medium of claim 21, wherein said second set of codes are configured to cause the computer to determine that the content preserving handoff conditions are met if:

one or more flows are registered;

no real time flows are currently active;

no registered flows are being decoded currently;

there is at least one good RF in the current LOI;

there is at least one bad RF in the current LOI or there is at least one good RF in the current LOI with signal strength below a selected good RF threshold; and

broadcast of content for no registered flows is to start before a selected time window from a current time.

23. The machine-readable medium of claim 21, wherein said third set of codes further comprise:

a fifth set of codes for causing the computer to rank the current LOI and the neighboring LOIs based on RF signal strength and total number of multiplexes in each LOIs; and

a sixth set of codes for causing the computer to select the selected LOI to be a LOI with the highest rank.

24. The machine-readable medium of claim 21, wherein said third set of codes are configured to cause the computer to select the selected RF channel to be an RF channel in the selected LOI that carries at least the same wide multiplex as a current RF channel in the current LOI.

25. The machine-readable medium of claim 23, further comprising:

a seventh set of codes configured to cause the computer to perform following operations once for each LOI with rank higher than the current LOI in the content preserving handoff table until a successful content preserving handoff occurs:

select the selected LOI to be a LOI with next highest rank and a selected RF channel associated with the selected LOI; and

perform a handoff to the selected RF channel in the selected LOI.

26. The machine-readable medium of claim 23, wherein said fifth set of codes are configured to cause the computer to:

assign weight one to an RF channel if its signal strength is above a selected threshold;

assign weight zero to the RF channel if its signal strength is not above a selected threshold;

determine a 'sum of weights' for a LOI by adding together weights assigned to RF channels in that LOI which carry the same content multiplexes as the current LOI;

assign a higher rank to a LOI which has higher sum of weights; and

assign a higher rank to a LOI with a higher total number of wide and local content multiplexes among LOIs with a same 'sum of weights'

27. At least one integrated circuit configured for RF channel handoff in a multi-frequency network, the at least one integrated circuit comprising:

a first module configured to generate a content preserving handoff table, wherein the content preserving handoff table comprises a current local operations infrastructure (LOI) and neighboring LOIs carrying at least the same wide and local content multiplexes as the current LOI;

a second module configured to determine that handoff conditions are met for a content preserving handoff;

a third module configured to select a selected LOI from the content preserving handoff table and a selected RF channel associated with the selected LOI; and

a fourth module configured to perform a handoff to the selected RF channel in the selected LOI if the selected LOI is different than the current LOI.

28. The at least one integrated circuit of claim 27, wherein said second module is configured to determine that the content preserving handoff conditions are met if:

one or more flows are registered;

no real time flows are currently active;

no registered flows are being decoded currently;

there is at least one good RF in the current LOI;

there is at least one bad RF in the current LOI or there is at least one good RF in the current LOI with signal strength below a selected good RF threshold; and

broadcast of content for no registered flows is to start before a selected time window from a current time.

29. The at least one integrated circuit of claim 27, further comprising:

a fifth module configured to rank the current LOI and the neighboring LOIs based on RF signal strength and total number of multiplexes in each LOIs; and

a sixth module configured to select the selected LOI to be a LOI with the highest rank.

30. The at least one integrated circuit of claim 27, wherein said third module is configured to select the selected RF channel to be an RF channel in the selected LOI that carries at least the same wide multiplex as a current RF channel in the current LOI.

31. The at least one integrated circuit of claim 29, further comprising:

a seventh module configured to perform following operations once for each LOI with rank higher than the current LOI in the content preserving handoff table until a successful content preserving handoff occurs:

select the selected LOI to be a LOI with next highest rank and a selected RF channel associated with the selected LOI; and

perform a handoff to the selected RF channel in the selected LOI.

32. The at least one integrated circuit of claim 29, wherein said fifth module is configured to:

assign weight one to an RF channel if its signal strength is above a selected threshold;

assign weight zero to the RF channel if its signal strength is not above a selected threshold;

determine a 'sum of weights' for a LOI by adding together weights assigned to RF channels in that LOI which carry the same content multiplexes as the current LOI;

assign a higher rank to a LOI which has higher sum of weights; and

assign a higher rank to a LOI with a higher total number of wide and local content multiplexes among LOIs with a same 'sum of weights'

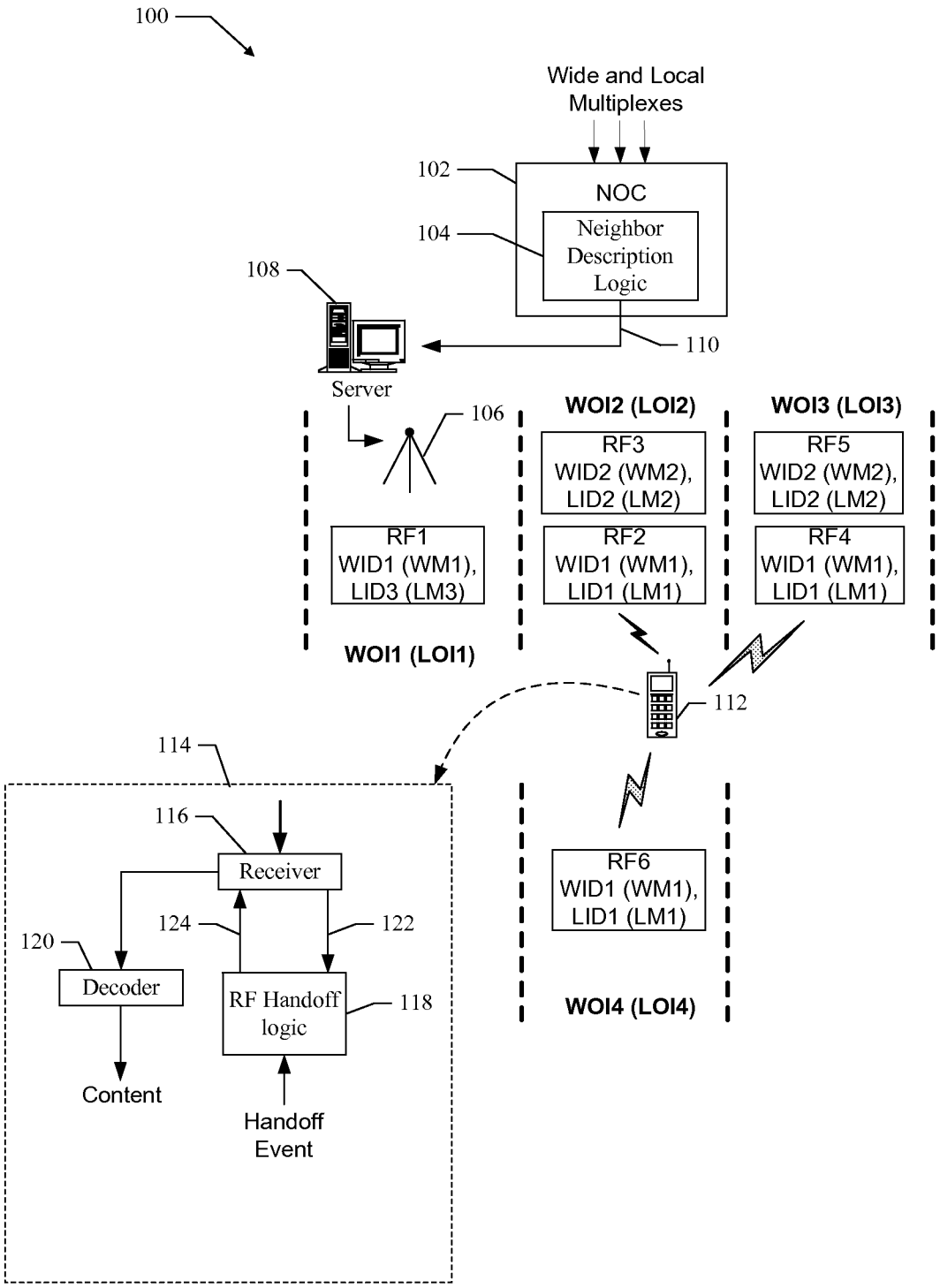
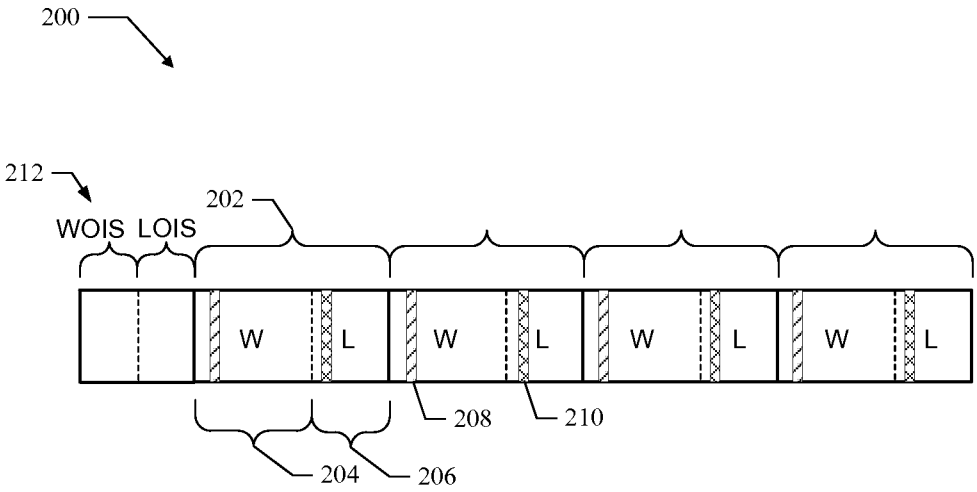

100
Wide and Local Multiplexes
102
NOC
104
Neighbor Description Logic
108
110
Server
106
WOI2 (LOI2)
WOI3 (LOI3)
RF3 WID2 (WM2), LID2 (LM2)
RF5 WID2 (WM2), LID2 (LM2)
RF1 WID1 (WM1), LID3 (LM3)
RF2 WID1 (WM1), LID1 (LM1)
RF4 WID1 (WM1), LID1 (LM1)
WOI1 (LOI1)
112
114
116
Receiver
124
122
120
Decoder
RF Handoff logic
118
Content
Handoff Event
RF6 WID1 (WM1), LID1 (LM1)
WOI4 (LOI4)

FIG. 1



214

216 LOI ID	218 Neighbor LOI List	220 RF Channel ID	222 RF Frequency	224 (WID, LID) Identifiers
LOI2	LOI1	NA	RF1	WID1, LID3
	LOI2	RF channel 0	RF3	WID2, LID2
		RF channel 1	RF2	WID1, LID1
	LOI3	NA	RF5	WID2, LID2
		NA	RF4	WID1, LID1
	LOI4	NA	RF6	WID1, LID1

FIG. 2

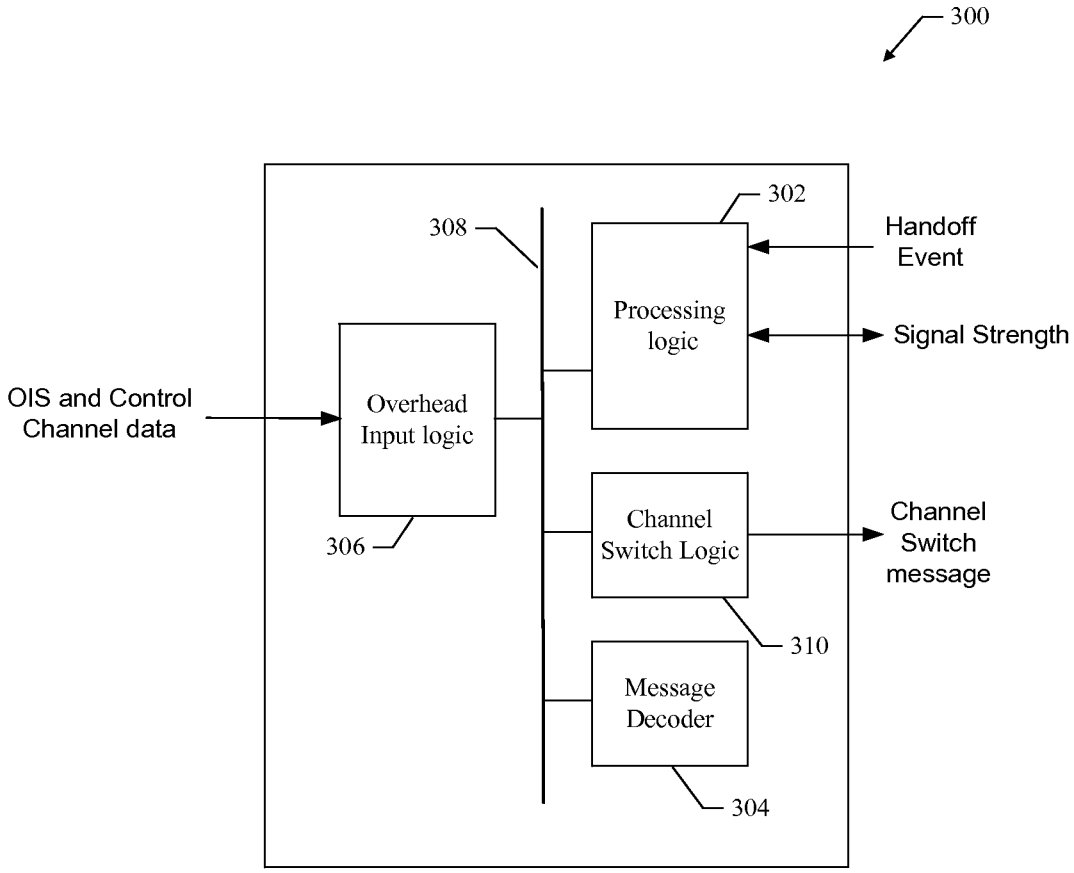
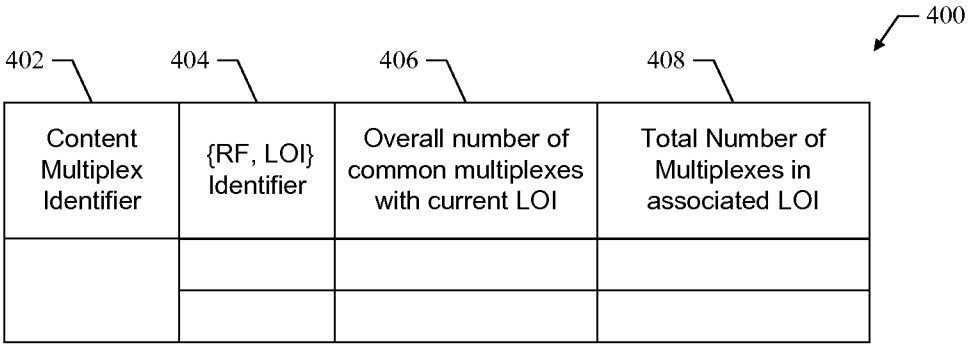
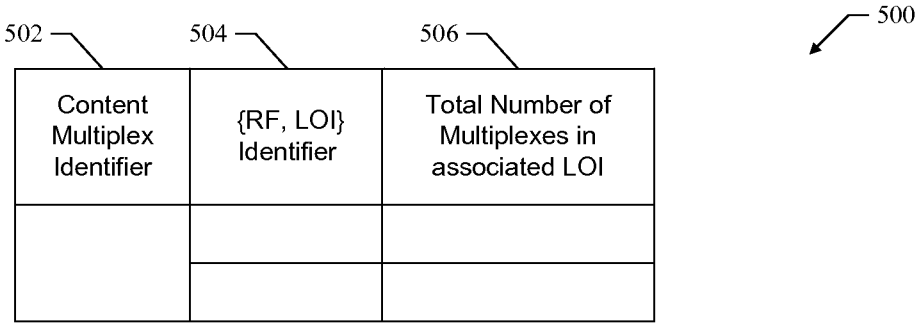

300
302
308
Handoff Event
Processing logic
Signal Strength
OIS and Control Channel data
Overhead Input logic
306
Channel Switch Logic
Channel Switch message
310
Message Decoder
304

FIG. 3



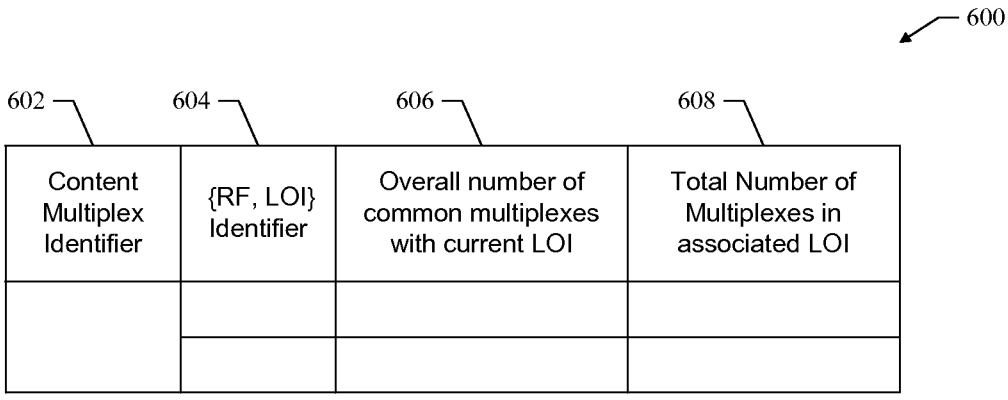
Wide or Local Seamless Handoff Table

FIG. 4



Wide+Local Seamless Handoff Table

FIG. 5



Wide/Local/Wide+Local Partially Seamless Handoff Table

FIG. 6

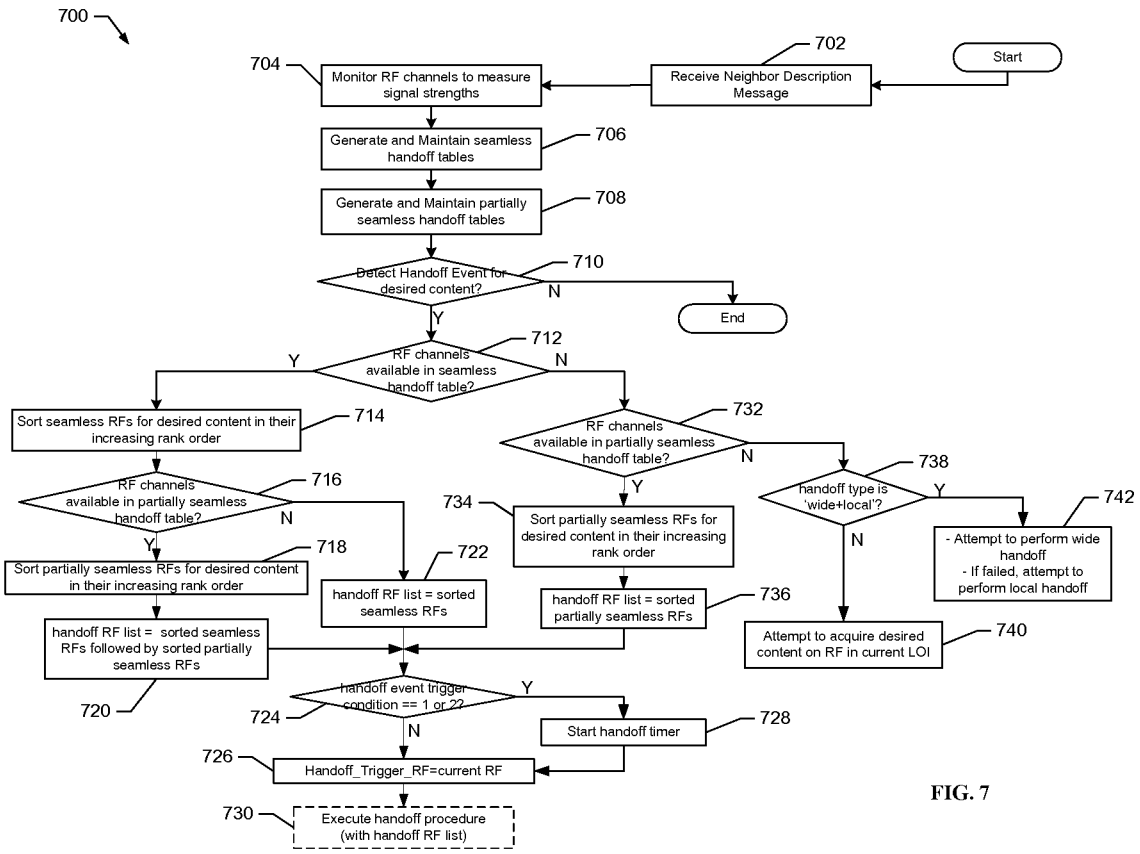

700
Start
702
Receive Neighbor Description Message
704
Monitor RF channels to measure signal strengths
706
Generate and Maintain seamless handoff tables
708
Generate and Maintain partially seamless handoff tables
710
Detect Handoff Event for desired content?
N
End
Y
712
RF channels available in seamless handoff table?
Y
N
714
Sort seamless RFs for desired content in their increasing rank order
716
RF channels available in partially seamless handoff table?
N
Y
718
Sort partially seamless RFs for desired content in their increasing rank order
720
handoff RF list = sorted seamless RFs followed by sorted partially seamless RFs
722
handoff RF list = sorted seamless RFs
724
handoff event trigger condition == 1 or 2?
Y
N
726
Handoff_Trigger_RF=current RF
728
Start handoff timer
730
Execute handoff procedure (with handoff RF list)
732
RF channels available in partially seamless handoff table?
N
Y
734
Sort partially seamless RFs for desired content in their increasing rank order
736
handoff RF list = sorted partially seamless RFs
738
handoff type is 'wide+local'?
Y
N
740
Attempt to acquire desired content on RF in current LOI
742
- Attempt to perform wide handoff
- If failed, attempt to perform local handoff

FIG. 7

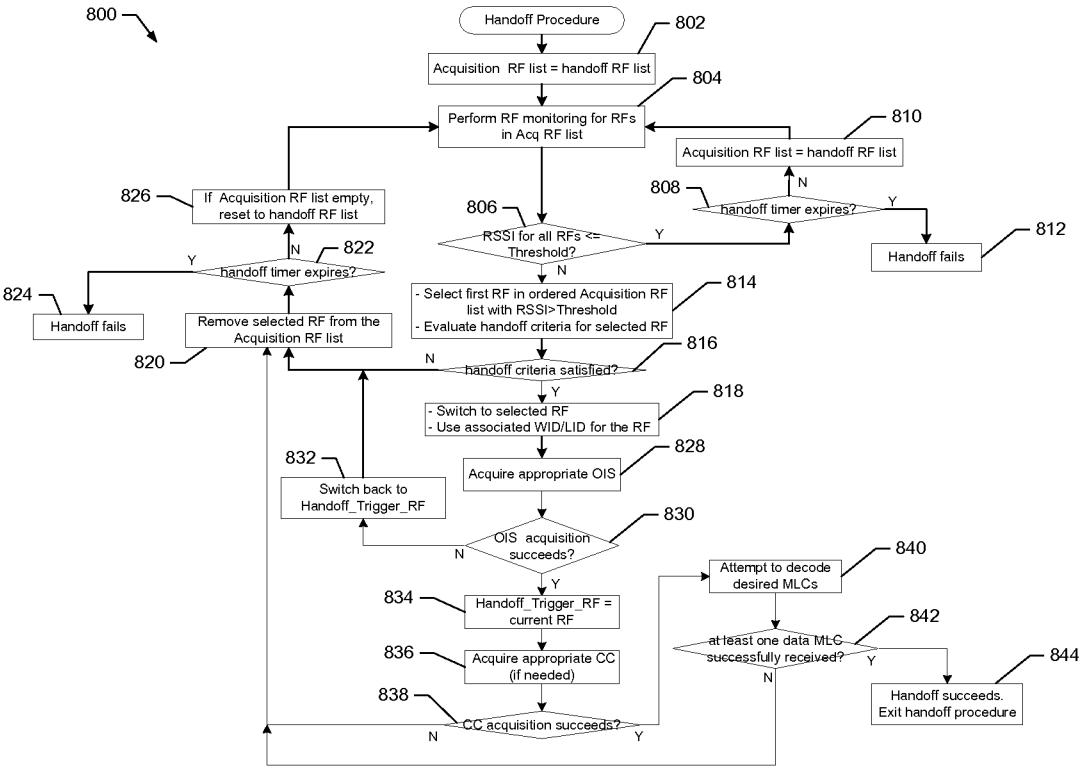

800
Handoff Procedure
802
Acquisition RF list = handoff RF list
804
Perform RF monitoring for RFs in Acq RF list
810
Acquisition RF list = handoff RF list
808
handoff timer expires?
N
Y
812
Handoff fails
806
RSSI for all RFs <= Threshold?
Y
N
814
- Select first RF in ordered Acquisition RF list with RSSI>Threshold
- Evaluate handoff criteria for selected RF
816
handoff criteria satisfied?
N
Y
818
- Switch to selected RF
- Use associated WID/LID for the RF
828
Acquire appropriate OIS
830
OIS acquisition succeeds?
N
Y
832
Switch back to Handoff_Trigger_RF
834
Handoff_Trigger_RF = current RF
836
Acquire appropriate CC (if needed)
838
CC acquisition succeeds?
N
Y
840
Attempt to decode desired MLCs
842
at least one data MLC successfully received?
N
Y
844
Handoff succeeds. Exit handoff procedure
826
If Acquisition RF list empty, reset to handoff RF list
822
handoff timer expires?
Y
N
824
Handoff fails
820
Remove selected RF from the Acquisition RF list

FIG. 8

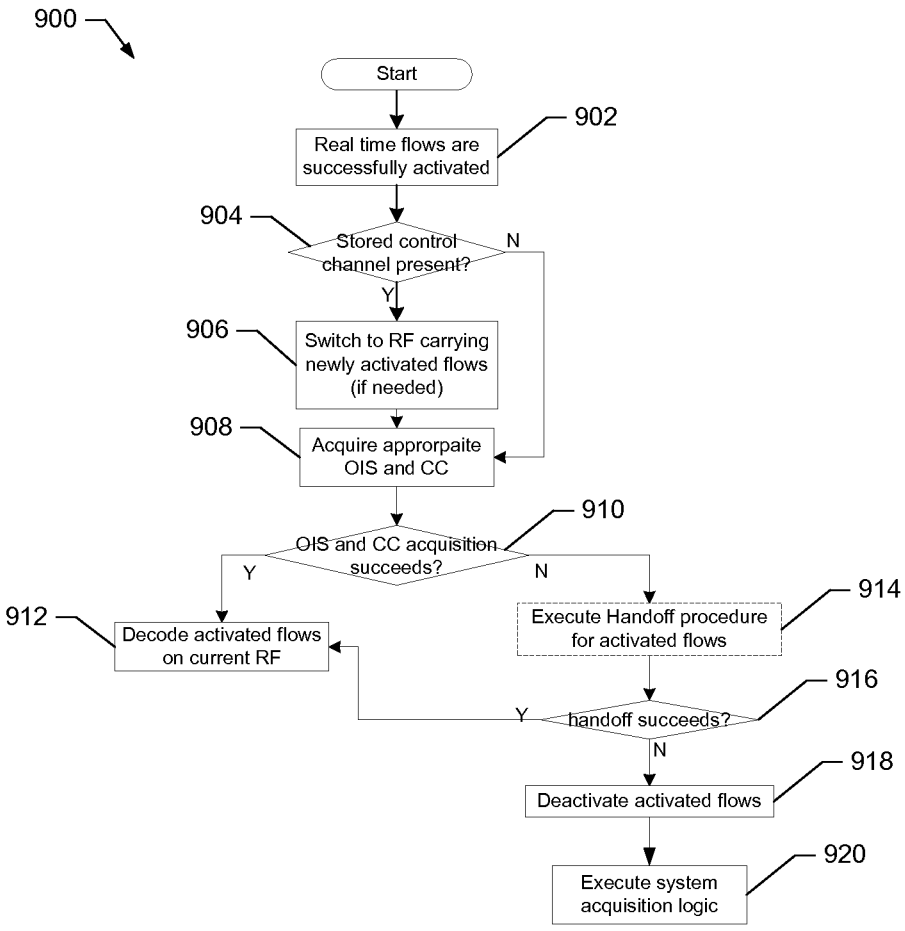

900
Start
902
Real time flows are successfully activated
904
Stored control channel present?
N
Y
906
Switch to RF carrying newly activated flows (if needed)
908
Acquire approrpaite OIS and CC
910
OIS and CC acquisition succeeds?
Y
N
912
Decode activated flows on current RF
914
Execute Handoff procedure for activated flows
916
handoff succeeds?
Y
N
918
Deactivate activated flows
920
Execute system acquisition logic

FIG. 9

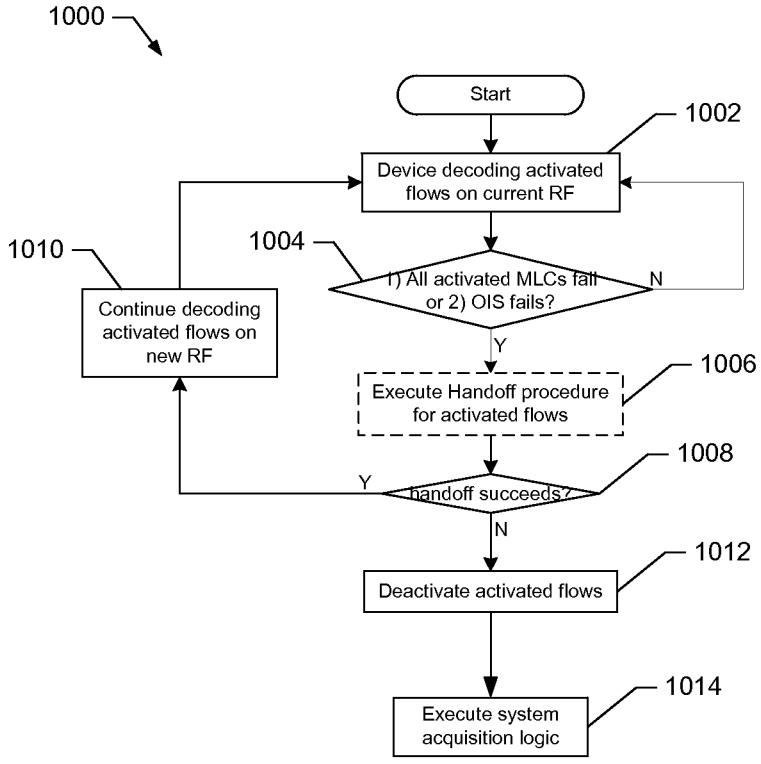

1000
Start
1002
Device decoding activated flows on current RF
1004
1) All activated MLCs fail or 2) OIS fails?
N
Y
1010
Continue decoding activated flows on new RF
1006
Execute Handoff procedure for activated flows
1008
Handoff succeeds?
Y
N
1012
Deactivate activated flows
1014
Execute system acquisition logic

FIG. 10

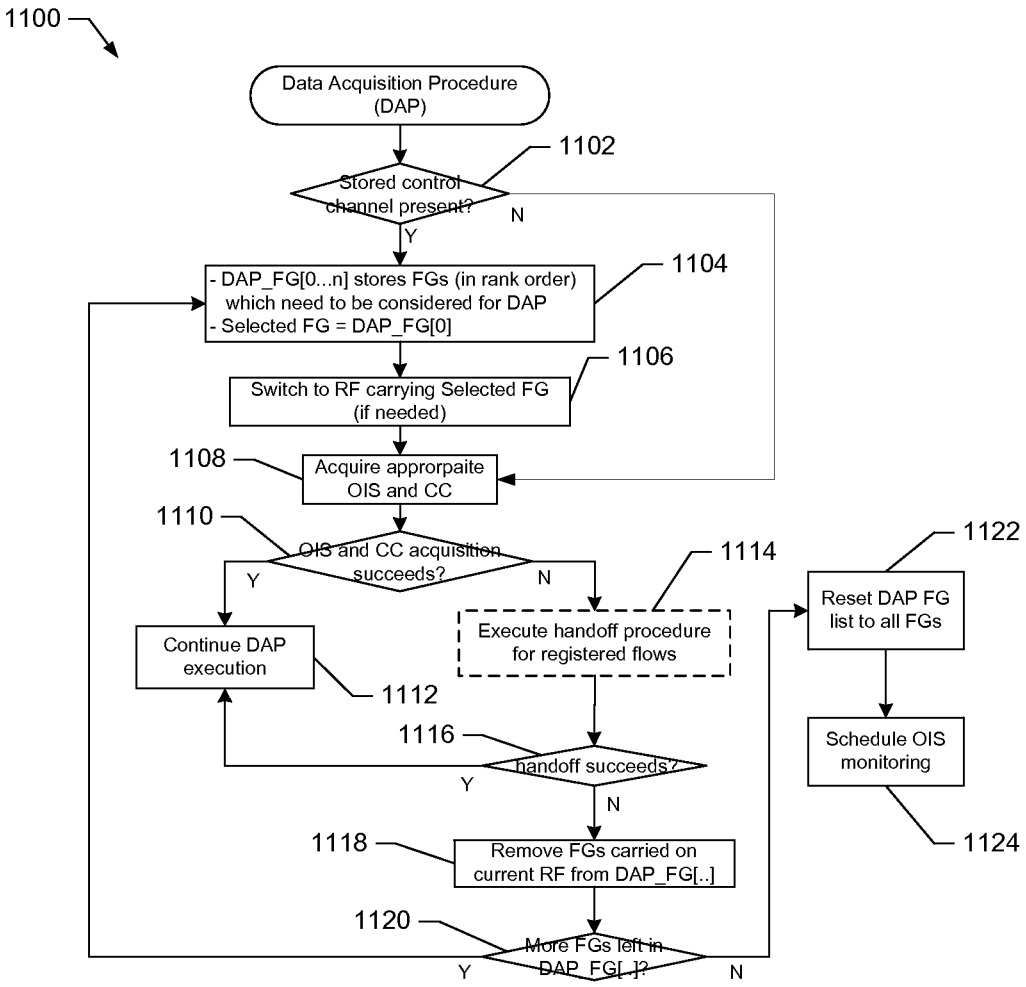

1100
Data Acquisition Procedure (DAP)
1102
Stored control channel present?
N
Y
1104
- DAP_FG[0...n] stores FGs (in rank order) which need to be considered for DAP
- Selected FG = DAP_FG[0]
1106
Switch to RF carrying Selected FG (if needed)
1108
Acquire approrpaite OIS and CC
1110
OIS and CC acquisition succeeds?
Y
N
1114
Execute handoff procedure for registered flows
1122
Reset DAP FG list to all FGs
Continue DAP execution
1112
1116
handoff succeeds?
Y
N
Schedule OIS monitoring
1124
1118
Remove FGs carried on current RF from DAP_FG[..]
1120
More FGs left in DAP_FG[_]?
Y
N

FIG. 11

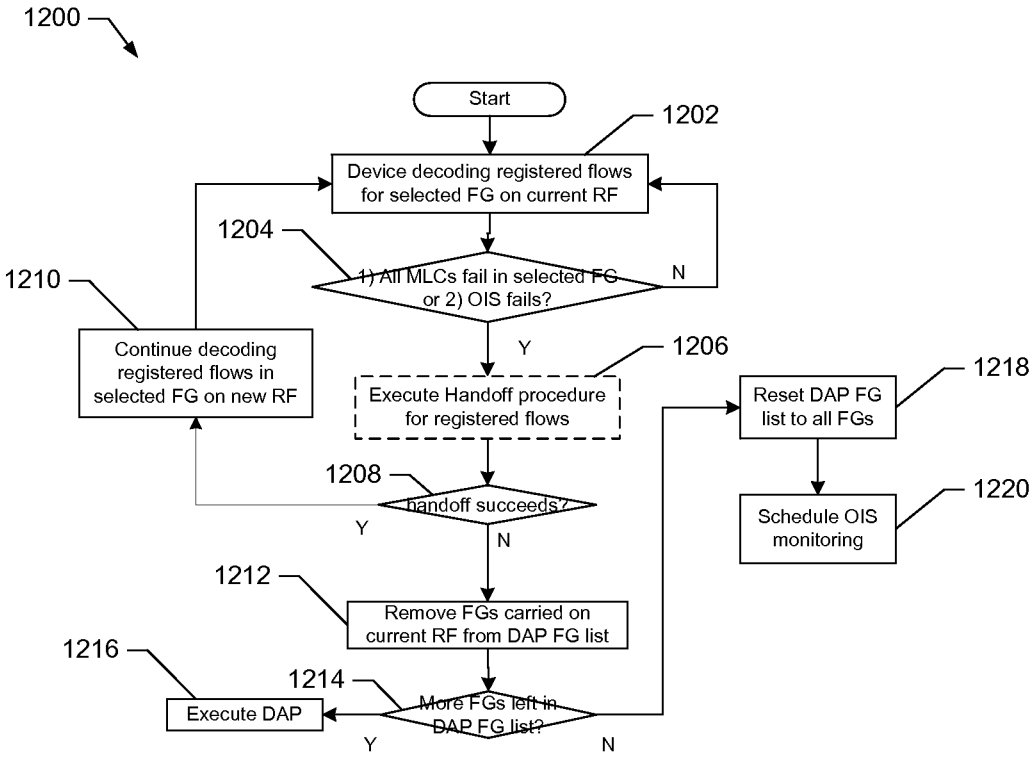
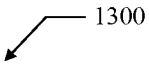

1200
Start
1202
Device decoding registered flows for selected FG on current RF
1204
1) All MLCs fail in selected FG or 2) OIS fails?
N
Y
1210
Continue decoding registered flows in selected FG on new RF
1206
Execute Handoff procedure for registered flows
1208
handoff succeeds?
Y
N
1212
Remove FGs carried on current RF from DAP FG list
1216
1214
Execute DAP
More FGs left in DAP FG list?
Y
N
1218
Reset DAP FG list to all FGs
1220
Schedule OIS monitoring

FIG. 12



1302

Content Multiplex Identifier	{RF, LOI} Identifier	Overall number of common multiplexes with current LOI	Total Number of Multiplexes in associated LOI
WID1	{RF4, LOI3}	4	4

1304

Content Multiplex Identifier	{RF, LOI} Identifier	Overall number of common multiplexes with current LOI	Total Number of Multiplexes in associated LOI
WID2	{RF5, LOI3}	4	4

1306

Content Multiplex Identifier	{RF, LOI} Identifier	Overall number of common multiplexes with current LOI	Total Number of Multiplexes in associated LOI
LID1	{RF4, LOI3}	4	4

1308

Content Multiplex Identifier	{RF, LOI} Identifier	Overall number of common multiplexes with current LOI	Total Number of Multiplexes in associated LOI
LID2	{RF5, LOI3}	4	4

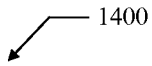
1310

Content Multiplex Identifier	{RF, LOI} Identifier	Total Number of Multiplexes in associated LOI
WID1+LID1	{RF4, LOI3}	4

1312

Content Multiplex Identifier	{RF, LOI} Identifier	Total Number of Multiplexes in associated LOI
WID2+LID2	{RF5, LOI3}	4

FIG. 13



1402

Content Multiplex Identifier	{RF, LOI} Identifier	Overall number of common multiplexes with current LOI	Total Number of Multiplexes in associated LOI
WID1	{RF6, LOI4}	2	2
	{RF1, LOI1}	1	2

1404

Content Multiplex Identifier	{RF, LOI} Identifier	Overall number of common multiplexes with current LOI	Total Number of Multiplexes in associated LOI
LID1	{RF6, LOI4}	2	2

1406

Content Multiplex Identifier	{RF, LOI} Identifier	Overall number of common multiplexes with current LOI	Total Number of Multiplexes in associated LOI
WID1+LID1	{RF6, LOI4}	2	2

FIG. 14

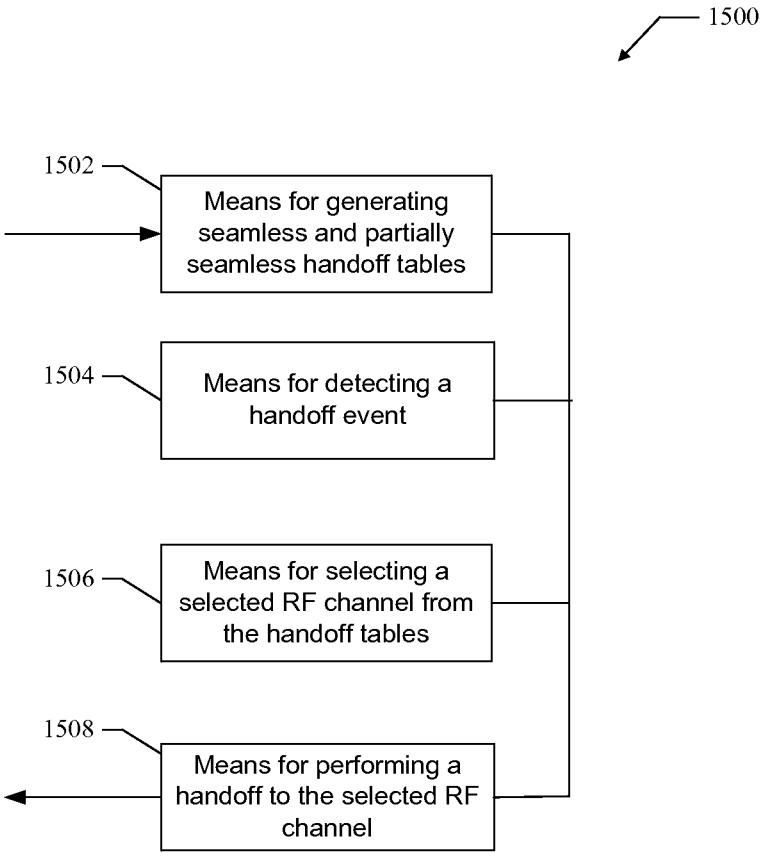

1500
1502
Means for generating seamless and partially seamless handoff tables
1504
Means for detecting a handoff event
1506
Means for selecting a selected RF channel from the handoff tables
1508
Means for performing a handoff to the selected RF channel

FIG. 15

1600

1602 Content Preserving LOI identifier	1604 Total Sum of Weights for RFs carrying the same content	1606 Total Number of Multiplexes in Content Preserving LOI

FIG. 16

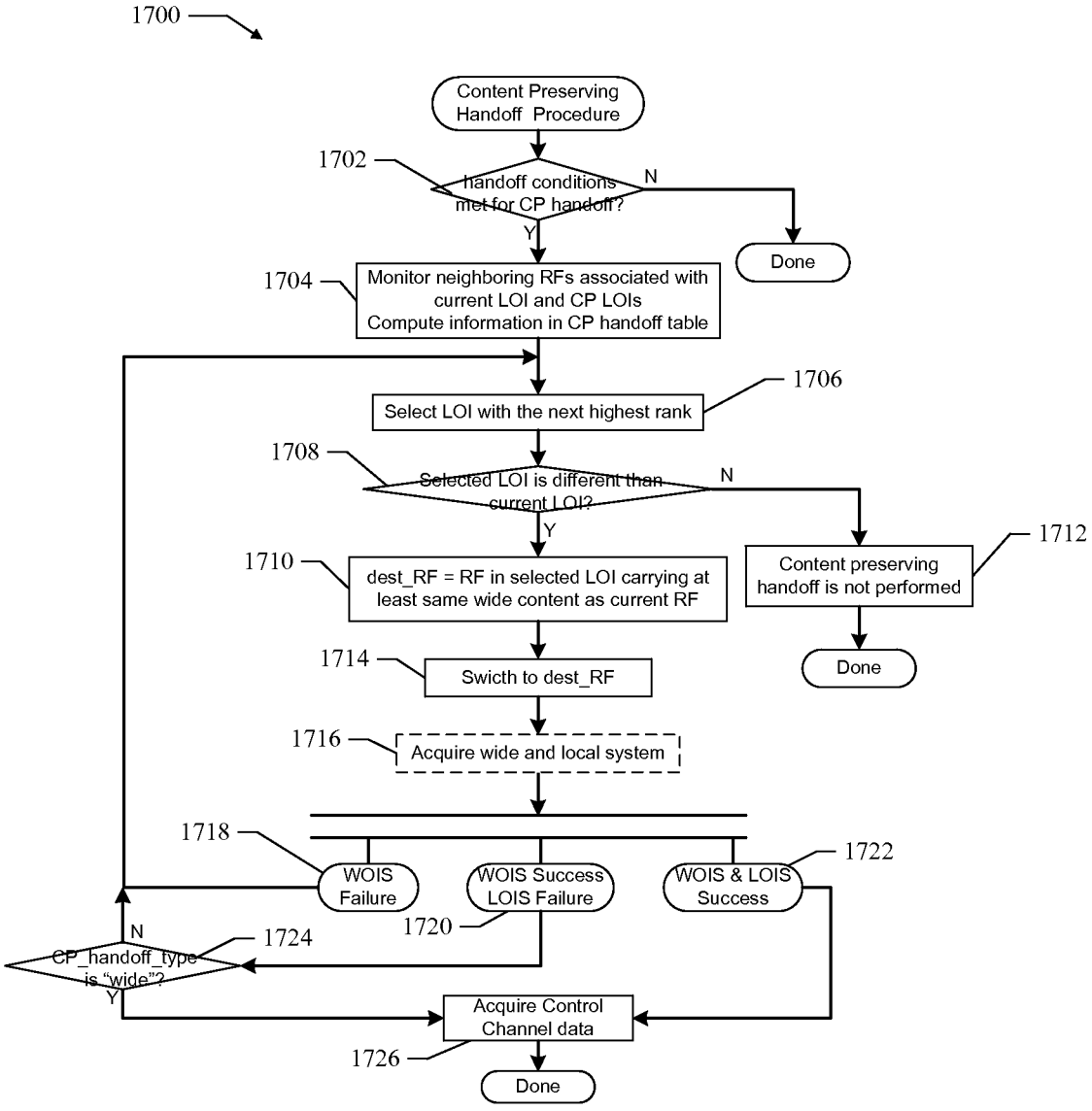


FIG. 17

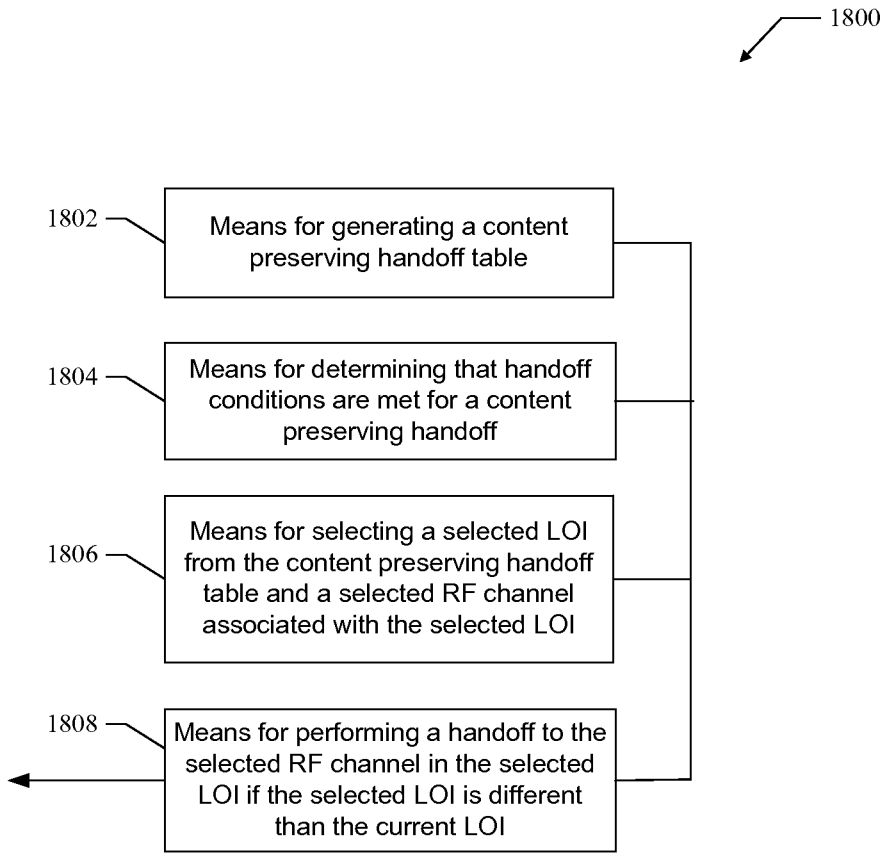

1800
1802
Means for generating a content preserving handoff table
1804
Means for determining that handoff conditions are met for a content preserving handoff
1806
Means for selecting a selected LOI from the content preserving handoff table and a selected RF channel associated with the selected LOI
1808
Means for performing a handoff to the selected RF channel in the selected LOI if the selected LOI is different than the current LOI

FIG. 18