IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SAMSUNG ELECTRONICS CO., LTD.,

SAMSUNG ELECTRONICS AMERICA, INC.

Petitioners,

v.

XIFI NETWORKS R&D, INC.

Patent Owner.

Case No. IPR2025-01203

U.S. Patent No. 11,849,337

PETITION FOR *INTER PARTES* REVIEW

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EXHIBIT LIST

Exhibit	Description
EX1001	U.S. Patent No. 11,849,337 ("the '337 patent")
EX1002	Declaration of Kevin Almeroth, Ph.D.
EX1003	12/19/2023 Certificate of Correction
EX1004	File History of U.S. Patent No. 11,849,337
EX1005	WO 2013/126859 ("Chincholi")
EX1006	Published U.S. Patent Application 2011/0320625 ("Riggert")
EX1007	U.S. Patent Application 2009/0141691 ("Jain")
EX1008	U.S. Patent 9,379,868 ("Wang")
EX1009	U.S. Patent 9,055,592 ("Clegg")
EX1010	U.S. Patent 10,567,147 ("DiFazio")
EX1011	Curriculum Vitae of Kevin Almeroth Ph.D.
EX1012	PO's District Court Infringement Contentions Cover Pleading
EX1013	PO's District Court Infringement Chart for U.S. Patent No. 11,849,337
EX1014	U.S. Patent 5,345,599 ("Paulraj")
EX1015	Gerard J. Foschini, "Layered Space-Time Architecture" (Foschini, Bell Labs Technical Journal, 1(2), 41-59) (1996)
EX1016	Exhibit Intentionally Omitted
EX1017	File History of U.S. Patent No. 11,818,591

LIST OF CHALLENGED CLAIMS

Claim	Limitation
1[pre]	A method of improving the performance of a wireless networking device, comprising the steps of:
1[a]	connecting an application interface to a processing interface, the application interface being associated with a first application, the first application providing, when the wireless networking device is being used, a first data stream and having a first wireless bandwidth requirement;
1[b]	connecting first and second actual MAC interfaces to the processing interface;
1[c]	connecting first and second actual PHY interfaces respectively to the first and second actual MAC interfaces;
1[d]	respectively associating first and second wireless transceivers with the first and second actual PHY interfaces, wherein each of the first and second wireless transceivers (i) is suitable for use in a wireless local area network, (ii) has a first and second bandwidth availability up to first and second actual bandwidths, and (iii) is adapted to emit radio waves in first and second different bands of frequencies;
1[e]	forming in the processing interface (i) at least one virtual MAC interface and (ii) first and second virtual PHY interfaces that, during operation of the wireless networking device, feed information regarding the bandwidth availabilities of the first and second wireless transceivers back to the at least one virtual MAC interface;
1[f]	wherein the processing interface is configured to, when the wireless networking device is being used in a manner transparent to any layer of the wireless networking device above the processing interface,
1[g]	(i) identify at least one portion of each one of the first and second actual bandwidths of the first and second wireless transceivers that are available for communication,
1[h]	(ii) select one transceiver of the first and second transceivers which has the most bandwidth available, (iii) prepare the first data stream for transmission to a recipient from the selected wireless transceiver using a specific subset of frequencies corresponding to the identified at least one portion of its available bandwidth, and

Claim	Limitation
	(iv) cause the prepared first data stream to be transmitted from the selected wireless transceiver to thereby at least partially satisfy the first wireless bandwidth requirement of the first application;
1[i]	wherein, if the unselected wireless transceiver has more bandwidth availability than the selected transceiver during use of the wireless networking device, the processing interface is adapted to, as a result of the increased bandwidth availability and in a manner transparent to any layer of the wireless networking device above the processing interface, (i) identify at least one portion of the bandwidth of the unselected transceiver that is available for communication and select the unselected transceiver, (ii) prepare the first data stream, without requiring the disassociation of the recipient from the actual MAC and PHY interfaces of any wireless transceiver, for transmission to the recipient from the unselected transceiver using a specific subset of frequencies corresponding to its identified at least one portion of available bandwidth, and (iii) cause the prepared first data stream to be transmitted to the recipient from the unselected transceiver, without requiring the disassociation of the recipient from the actual MAC and PHY interfaces of any wireless transceiver, to thereby continue to at least partially satisfy the first wireless bandwidth requirement of the first application; and
1[j]	wherein the wireless networking device's utilization of the available bandwidth of the selected and unselected transceivers does not prevent other wireless networking device from utilizing a range of frequencies corresponding to the remaining portion of the bandwidth availabilities of the selected and unselected wireless transceivers for data transmission purposes at the same time that processed data is being sent from the selected and unselected wireless transceivers.
2	The method of claim 1,
2[a]	wherein the application interface is associated with a second application, the second application providing, when the wireless networking device is being used, a second data stream and having a second wireless bandwidth requirement;
2[b]	wherein the processing interface is configured to, when the wireless networking device is being used in a manner transparent to any layer of the wireless networking device above the

Claim	Limitation
	processing interface, (i) prepare the first and second data streams for simultaneous transmission to the recipient from the selected wireless transceivers using a specific subset of frequencies corresponding to the identified at least one portion of its available bandwidth, and
2[c]	(ii) cause the prepared first and second data streams to be simultaneously transmitted from the selected wireless transceivers to thereby at least partially satisfy the first and second wireless bandwidth requirements of the first and second applications.
3	The method of claim 2,
3[a]	wherein, if the identified at least one portion of the bandwidth of the first wireless transceiver becomes unavailable during use of the wireless networking device or if it has an unidentified portion of bandwidth availability that is greater than its identified at least one portion of bandwidth availability during use of the wireless networking device, the processing interface is configured to, as a result of the unavailability or the increased bandwidth availability and in a manner transparent to any layer of the wireless networking device above the processing interface, (i) identify at least one new portion of the bandwidth of the first wireless transceiver that is available for communication and then select that wireless transceiver,
3[b]	(ii) prepare the first and second data streams, without requiring the disassociation of the recipient from the actual MAC and PHY interfaces associated with any wireless transceiver, for transmission to the recipient from the first wireless transceiver using a specific subset of frequencies corresponding to its newly identified at least one portion of available bandwidth, and
3[c]	(iii) cause the prepared first and second data streams to be transmitted to the recipient from the first transceiver, without requiring the disassociation of the recipient from the actual MAC and PHY interfaces of any wireless transceiver, to thereby continue to at least partially satisfy the first and second wireless bandwidth requirements of the first and second applications.
4	The method of claim 3,
4[a]	wherein, if the identified at least one portion of the bandwidth of the second wireless transceiver becomes unavailable during use of the wireless networking

Claim	Limitation
	device or if it has an unidentified portion of bandwidth availability that is greater than its identified at least one portion of bandwidth availability during use of the wireless networking device, the processing interface is configured to, as a result of the unavailability or the increased bandwidth availability and in a manner transparent to any layer of the wireless networking device above the processing interface, (i) identify at least one new portion of the bandwidth of the second wireless transceiver that is available for communication and then select that wireless transceiver,
4[b]	(ii) prepare the first and second data streams, without requiring the disassociation of the recipient from the actual MAC and PHY interfaces associated with any wireless transceiver, for transmission to the recipient from the second wireless transceiver using a specific subset of frequencies corresponding to its newly identified at least one portion of available bandwidth, and
4[c]	(iii) cause the prepared first and second data streams to be transmitted to the recipient from the second transceiver, without requiring the disassociation of the recipient from the actual MAC and PHY interfaces of any wireless transceiver, to thereby continue to at least partially satisfy the first and second wireless bandwidth requirements of the first and second applications.
5	The method of claim 4,
5[a]	wherein the processing interface is configured to, when the wireless networking device is being used, in a manner transparent to any layer of the wireless networking device above the processing interface, evaluate the identified bandwidth availabilities of the first and second wireless transceivers with respect to the first and second bandwidth requirements of the first and second applications; and
5[b]	wherein, if, during operation of the wireless networking device, the first and second bandwidth requirements of the first and second applications are at least partially satisfied by the bandwidth availability of the selected transceiver, preparing the first and second data streams for simultaneous transmission to the recipient from both of the first and second wireless transceivers using a specific subset of frequencies corresponding to the identified at least one portion of their available bandwidth and causing the prepared first data stream to be transmitted from the first and

Claim	Limitation
	second wireless transceivers to thereby at least partially satisfy the first and second wireless bandwidth requirements of the first and second applications.
6	The method of claim 4, further comprising the steps of:
6[a]	connecting a third actual MAC interface to the processing interface; connecting a third actual PHY interface to the third actual MAC interface; associating a third wireless transceiver with the third actual PHY interface, wherein the third wireless transceiver (i) is suitable for use in a wireless local area network, (ii) has a third bandwidth availability up to a third actual bandwidth, and (iii) is adapted to emit radio waves in a third band of frequencies;
6[b]	forming in the processing interface a third virtual PHY interface that is configured to, during operation of the wireless networking device, feed information regarding the bandwidth availability of the third wireless transceiver back to the at least one virtual MAC interface;
6[c]	wherein the processing interface is configured to, when the wireless networking device is being used in a manner transparent to any layer of the wireless networking device above the processing interface, request or create a third association between the recipient and the third actual MAC and PHY interfaces;
6[d]	wherein the selected transceiver comprises one of the first, second and third wireless transceivers and the unselected transceivers comprise the remaining two transceivers of the first, second and third transceivers;
6[e]	wherein, if one of the unselected wireless transceivers has more bandwidth availability than the selected transceiver during use of the wireless networking device, the processing interface is adapted to, as a result of the increased bandwidth availability and in a manner transparent to any layer of the wireless networking device above the processing interface, (i) identify at least one portion of the bandwidth of at least of the one of the unselected wireless transceivers that has more bandwidth availability than the selected transceiver and select that new transceiver,
6[f]	(ii) prepare the first and second data streams, without requiring the disassociation of the recipient from the actual MAC and PHY interfaces of any wireless transceiver, for transmission to the

Claim	Limitation
	recipient from the new transceiver using a specific subset of frequencies corresponding to its identified at least one portion of available bandwidth, and
6[g]	(iv) cause the prepared first and second data streams to be transmitted to the recipient from the new transceiver, without requiring the disassociation of the recipient from the actual MAC and PHY interfaces of any wireless transceiver, to thereby continue to at least partially satisfy the first and second bandwidth requirements of the first and second applications; and
6[h]	wherein the wireless networking device's utilization of the available bandwidth of the first, second and third wireless transceivers does not prevent other wireless networking devices from utilizing a range of frequencies corresponding to the remaining portion of the bandwidth availability of the first, second and third wireless transceivers for data transmission purposes at the same time that processed data is being sent from one or more of the first, second and third wireless transceivers.
7	The method of claim 6, wherein the at least one portion of the third bandwidth of the first transceiver comprises a single portion.
8	The method of claim 6, wherein the at least one portion of the third bandwidth of the third transceiver is contiguous.
9	The method of claim 6, wherein the third virtual PHY interface is not contiguous with the virtual MAC interface.
10	The method of claim 6 further comprising the step of coupling first and second buffer memories respectively to the first and second actual PHY layers, the first and second buffer memories being configured to, during use of the wireless networking device, store data prior to its actual transmission to the recipient via the first and second actual PHY layers, the capacity of the first and second buffer memories being programmable.
11	The method of claim 10, wherein each of the first and second buffer memories comprises a programmable register.
12	The method of claim 10, further comprising the steps of:
12[a]	connecting a fourth actual MAC interface to the processing interface; connecting a fourth actual PHY interface to the fourth actual MAC interface; associating a fourth wireless transceiver with the actual PHY interface, wherein the fourth wireless transceiver (i) is suitable for use in a wireless local area network,

Claim	Limitation
	(ii) has a fourth bandwidth availability up to a fourth actual bandwidth, and (iii) is adapted to emit radio waves in a fourth band of frequencies; and
12[b]	forming in the processing interface a fourth virtual PHY interface that is configured to, during operation of the wireless networking device, feed information regarding the bandwidth availability of the fourth wireless transceiver back to the at least one virtual MAC interface.
13	The method of claim 12, wherein the processing interface is configured to, when the wireless networking device is being used in a manner transparent to any layer of the wireless networking device above the processing interface, request or create a fourth association between the recipient and the fourth actual MAC and PHY interfaces; and wherein the selected transceiver comprises one of the first, second, third and fourth wireless transceivers and the unselected transceivers comprise the remaining three transceivers of the first, second, third and fourth transceivers.
14	The method of claim 12, wherein the fourth virtual PHY interface is not contiguous with the virtual MAC interface.
15	The method of claim 1, wherein the wireless networking device comprises a wireless access point.
16	The method of claim 1, wherein the wireless networking device comprises a handheld computing device.
17	The method of claim 1, wherein each one of the first and second frequency bands are specified in at least one member of the family of IEEE 802.11 standards.
18	The method of claim 17, wherein the at least one member of the family of IEEE 802.11 standards was in existence as of Oct. 30, 2013.
19	The method of claim 1, wherein the virtual MAC interface includes a decision block.
20	The method of claim 1, wherein the virtual MAC interface includes a processing block.
21	The method of claim 1, wherein the virtual MAC interface includes an ultra-streaming block.
22	The method of claim 1, wherein each of the virtual PHY interfaces includes an RF block.

Claim	Limitation
23	The method of claim 1, wherein the at least one portion of the first bandwidth of the first transceiver comprises a single portion.
24	The method of claim 1, wherein the at least one portion of the first bandwidth of the first transceiver is contiguous.
25	The method of claim 1, wherein the at least one portion of the second bandwidth of the second transceiver comprises a single portion.
26	The method of claim 1, wherein the at least one portion of the second bandwidth of the second transceiver is contiguous.
27	The method of claim 1, wherein the first virtual PHY of: layer is not contiguous with the virtual MAC interface.
28	The method of claim 1, wherein the second virtual PHY layer is not contiguous with the virtual MAC interface.
29	The method of claim 1, wherein the processing interface comprises multiple virtual MAC interfaces.
30	The method of claim 1, wherein the processing interface includes a bandwidth allocator.

I. INTRODUCTION

Petitioners, Samsung Electronics Co., Ltd. and Samsung Electronics America, LLC ("Petitioners") request *Inter Partes* Review of claims 1-30 of U.S. Patent No. 11,849,337 ("'337 patent") assigned to XiFi Networks R&D, Inc. ("Patent Owner"). The '337 patent is directed to a "wireless networking system" with multiple wireless transceivers and a processing layer to allocate bandwidth based on a bandwidth requirement. (EX1001, Abstract.) This basic architecture involving multi-transceiver devices was ubiquitous in the prior art, and the '337 patent claims no non-obvious features.

II. MANDATORY NOTICES

A. Real Party-in-Interest (37 C.F.R. § 42.8(b)(1))

Real parties-in-interest for Petitioner are Samsung Electronics Co., Ltd. and Samsung Electronics America, Inc.

B. Related Matters (37 C.F.R. § 42.8(b)(2))

1. Related Patent Office Proceedings

The '337 patent is in the same family as U.S. Patents 11,818,591 ("'591 patent"), 11,856,414 ("'414 patent"), 11,974,143 ("'143 patent"), 11,950,105 ("'105 patent"), 12,003,976 ("'976 patent"), 12,015,933 ("'933 patent"), 12,114,177 ("'177 patent"), 12,169,756 ("'756 patent"), 12,190,198 ("'198 patent"), and 12,250,564 ("'564 patent"). Petitioner is concurrently filing IPR petitions against the first six patents.

2. Related Litigation

Patent Owner is currently asserting the ’337 patent against Petitioner in *XiFi Networks R&D, Inc. v Samsung Electronics Co., Ltd. and Samsung Electronics America, Inc.*, Case No. 2:24-cv-01057-JRG (E.D. Tex.).

C. Lead and Backup Counsel and Service Information (37 C.F.R. §§ 42.8(b)(3)-(4))

Electronic service may be made on the email addresses identified below and in the accompanying Power of Attorney.

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D. Payment of Fees (37 C.F.R. § 42.15(a))

The Office is authorized to charge the fee required for this Petition (and any additional fees) to Deposit Account No. 50-5708.

E. Requirements For *Inter Partes* Review (37 C.F.R. §§ 42.101(A)-(C), 42.104(A), AND 42.018)

Petitioner certifies that the ’337 patent is available for *inter partes* review, that Petitioner is not barred or estopped from challenging the ’337 claims on the grounds identified herein, and that the prohibitions of 35 U.S.C. §§ 315(a)-(b) are inapplicable.

III. STATEMENT OF RELIEF REQUESTED AND IDENTIFICATION OF CHALLENGE (37 C.F.R. § 42.104(B))

Petitioner respectfully requests that *inter partes* review of claims 1-30 (“Challenged Claims”) on the following grounds:

Ground	Basis	References	Claims
1	§103	WO 2013/126859 (“Chincholi”) in combination with US 2011/0320625 (“Riggert”)	1-30

IV. BACKGROUND

A. ’337 Patent (EX1002, ¶¶43-51)

1. Earliest Priority Date

The ’337 patent is a post-AIA patent whose earliest possible priority date is October 30, 2013, via Provisional Application Nos. 61/897,216 and 61/897,219.

2. Specification

The ’337 patent relates to evaluating wireless bandwidth requirements of applications and bandwidth availabilities of transceiver resources, and allocating bandwidth of the transceivers to satisfy the bandwidth requirements of the applications. (EX1001, Abstract.)

The architecture described in the ’337 patent “includes an application layer, actual MAC and PHY layers, and a processing layer between the actual MAC and PHY layers.” *Id.*, 2:47-50. The processing layer may comprise “virtual MAC and PHY layers” that “enable simultaneous allocation of multiple PHY resources for different signal types associated with different applications.” *Id.*, 3:42-44.

For example, in the embodiment of Figure 6, the wireless networking device is stated to use the virtual MAC and PHY layers to configure the resources of two separate transceivers to each handle the bandwidth requirement of a respective application for a single recipient device using asymmetric transmit and receive cycles. *Id.*, 5:37-56.

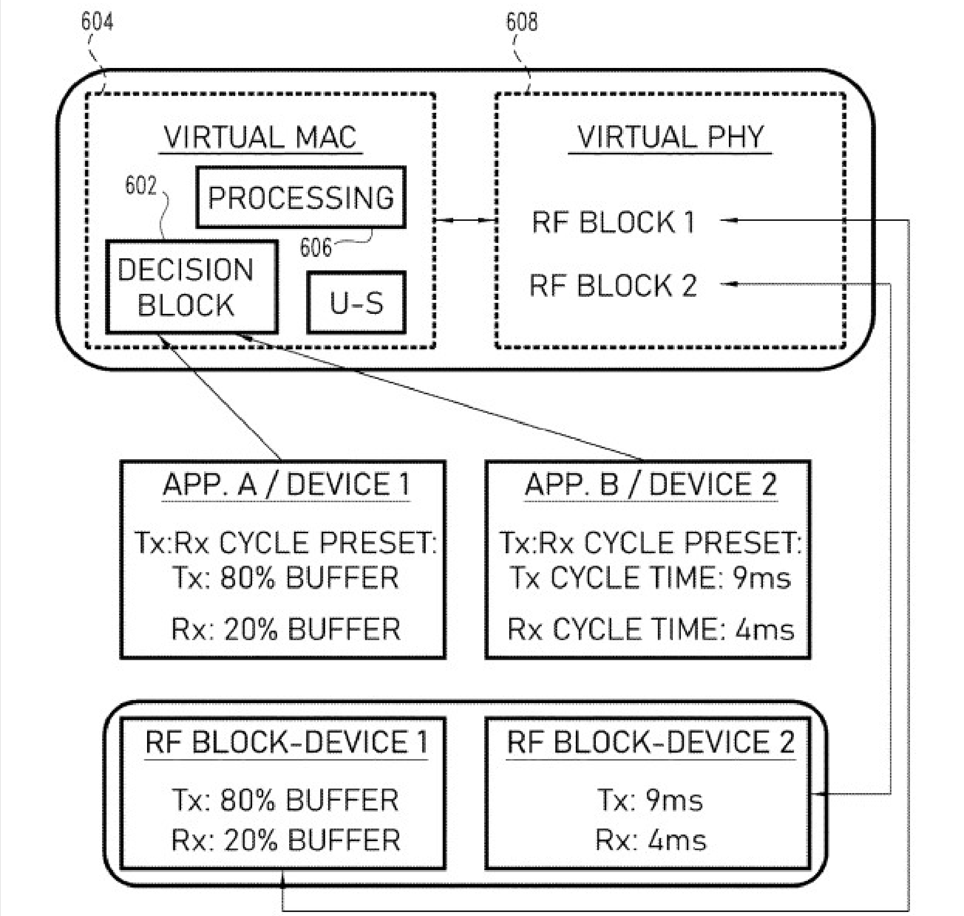

Fig. 6

3. Prosecution History (EX1004)

The '337 patent was filed on August 11, 2023, as application 18/448,281, which was a continuation of application 17/468,509 now US Patent 11,818,591 ("'591 patent"). The applicant requested Track One status, which was granted on September 18, 2023. During prosecution, the Examiner issued a single non-final rejection on October 3, 2023, asserting double patenting as to certain claims in light of the '509 application. In response, applicant filed a terminal disclaimer. The

Examiner issued a notice of allowance on October 30, 2023. A post-issuance certificate of correction was filed. (EX1003.)

B. Asserted Prior Art (EX1002, ¶¶60-67)

1. Chincholi (EX1005)

WO 2013/126859 ("Chincholi") has an international filing date of February 24, 2013, and was published on August 29, 2013. It is prior art under §§102(a)(1) and 102(a)(2).

Chincholi discloses systems "to manage multiple radio access technology (RAT) interfaces to enable opportunistic RAT selection and aggregation for sending data traffic over the RAT interfaces." (EX1005, [0003].) In one embodiment, Chincholi discloses a network terminal, such as an "access point," that "may be configured to work in an infrastructure mode or an adhoc mode … in an IEEE 802.11 based Wi-Fi system." (*Id.*, [0115].) An 802.11 access point configured according to Chincholi enables "multiple RATs simultaneously [to] provide increased bandwidth and/or increased reliability for an application." (*Id.*, [0194].)

Chincholi discloses an "Opportunistic Multiple-Medium Access Control (MAC) Aggregation (OMMA) layer," (*id.*, [0003]), which is a "single thin software layer" that "may enable one RAT to operate over industrial scientific medical (ISM) and another RAT to operate over a TVWS band for the same IP flow," (*id.*, [0120]). An exemplary OMMA layer enabling a dual-RAT aggregation device in an 802.11n network is shown in Figure 5:

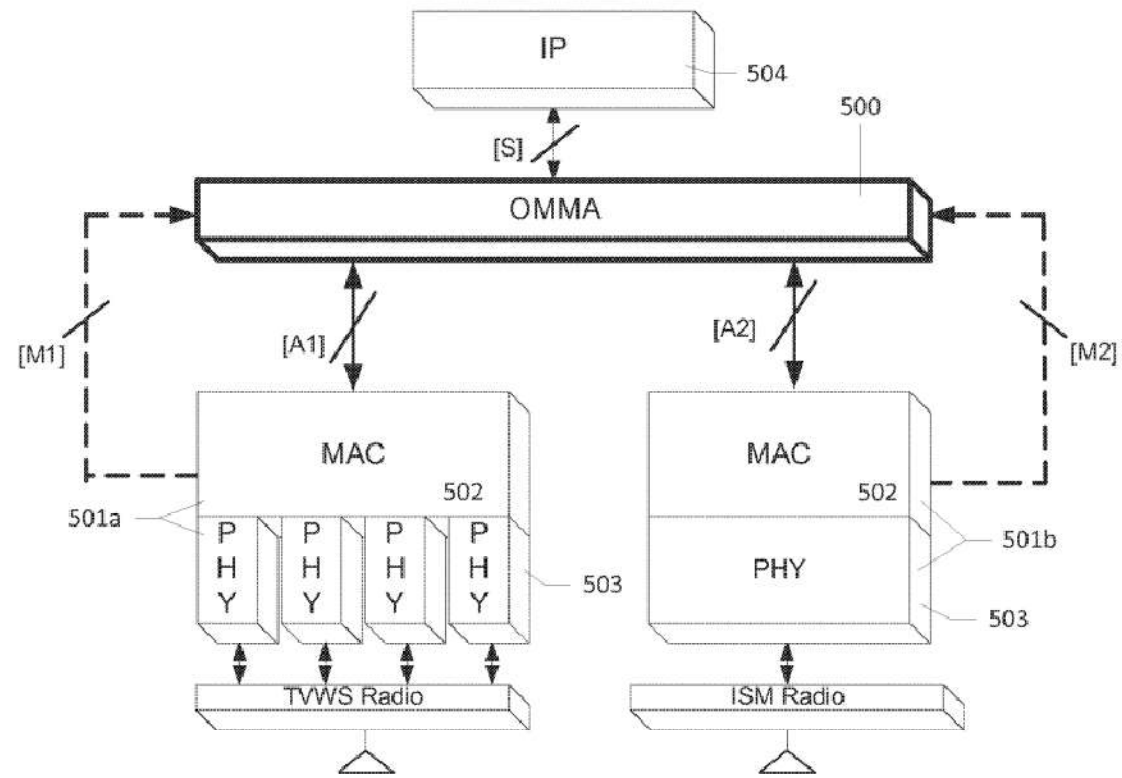

FIG. 5

The OMMA layer processes single or multiple IP flows (*i.e.*, application data streams) and uses feedback from each RAT to best allocate transceiver resources to meet the bandwidth requirement of the IP flows. The OMMA layer may "aggregate" available bandwidth of multiple transceivers, enabling communication paths between network devices using one or more RATs. (*Id.*, [0383].) For example, first and second packets of a single IP flow may be scheduled for simultaneous transmission to a recipient across the first and second RAT. (*Id.*, [0385].)

Chincholi was not before the examiner during prosecution of the ’337 patent.

2. Riggert (EX1006)

Published U.S. Patent Application 2011/0320625 (“Riggert”) was filed on June 28, 2010, and published on December 29, 2011. It is prior art under §§102(a)(1) and 102(a)(2).

Riggert is directed to techniques for improving bandwidth efficiency and throughput in a multi-transceiver wireless communication network. (EX1006, [0004].) Riggert teaches that “by identifying multiple physical interfaces” in a multi-transceiver network “and combining them together into one physical interface (*i.e.*, bondable ***virtual interface***), data throughput may be improved.” (*Id.*, [0049].) An important benefit of the “bondable virtual interface” is that it may be used generically in the framework, allowing easy substitution of one virtual interface with another without changing interface requirements. (*Id.*, [0065].) As an example, Riggert describes a virtual interface pairing together two 802.11g wireless interfaces. (*Id.*, [0057].)

Riggert was not before the examiner during prosecution of the ’337 patent.

V. PERSON OF ORDINARY SKILL

A person of ordinary skill in the art at the time of the ’337 patent (“POSITA”) had at least a Bachelor of Science in electrical engineering, computer engineering, or similar fields and at least two years of practical experience in the field of computer networks and wireless communication applications. More education can supplement for less practical experience, and vice versa. (EX1002, ¶54.)

Petitioner's expert, Dr. Almeroth, met this level by the priority date. (*Id.*, ¶55.)

VI. CLAIM CONSTRUCTION

No express constructions are required to find the '337 patent claims invalid. To the extent relevant, Petitioner addresses the plain meaning of certain terms in the analysis for the presented Ground. (EX1002, ¶56.) The challenged claims have not been construed in other proceedings.

VII. GROUND: Chincholi In Combination With Riggert Renders Claims 1-30 Obvious[1]

A. Overview and Motivation to Combine

As discussed in more detail below, Chincholi teaches the same architecture as the '337 patent, including a wireless networking device with multiple transceivers, each having actual MAC and PHY interfaces. (EX1002, ¶¶68-75.) Chincholi uses a single "Opportunistic Multiple-Medium Access Control (MAC) Aggregation layer," positioned above the actual MAC-PHY layers of each transceiver, to receive feedback information available bandwidth portions to efficiently meet the

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[1] Unless noted otherwise, all emphases in quotes and annotations to figures from prior art references are added.

requirements of data streams from one or more applications. (EX1005, [0122-0123].)

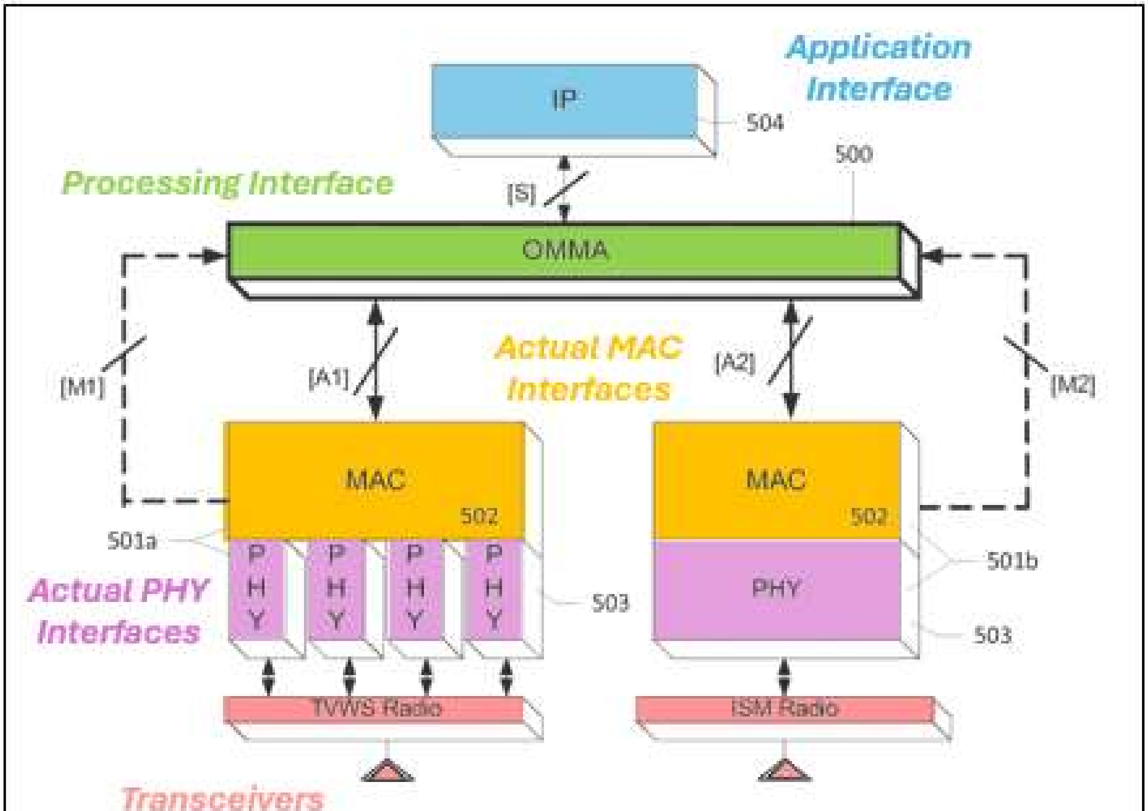


FIG. 5

Chincholi expressly discloses receiving, at the OMMA layer, feedback information regarding bandwidth availability on a per-transceiver basis and feeding that information back to the OMMA layer's virtual MAC function. (EX1002, ¶69; EX1005, [0137].) Because Chincholi already discloses a partial virtualization of the MAC function at the OMMA layer, a POSITA would have been motivated to leverage this virtualization at the OMMA/transceiver interfaces to further increase flexibility in the system. (EX1002, ¶69.) Specifically, rather than implement static (and limited) interfaces between Chincholi's OMMA layer and each RAT, a POSITA would have recognized the opportunity to implement "virtual PHY" interfaces. (*Id*.)

Providing a "virtualized" PHY interface between the OMMA layer and the RATs in Chincholi would have been particularly beneficial in implementing an 802.11 system. This is because implementing virtualized PHY interfaces would allow the system to accommodate communication channels with wireless devices that may operate using various different generations of the 802.11 standards. (EX1002, ¶70; EX1005, [0134] (teaching that "[a] Wi-Fi RAT may be a IEEE802.11n RAT, a IEEE802.11ac RAT, a IEEE802.11af RAT, etc.").) Virtualization of the physical interface for this purpose is taught, for example, in U.S. Patent Application 2009/0141691 ("Jain"). (EX1007, [0034-0037]); (EX1002, ¶70.) A POSITA would have recognized that virtualizing the interfaces between Chincholi's OMMA layer and individual RATs would result in a flexible and "reconfigurable" PHY interface that could be used to match the different needs of potential recipient devices and networks. (EX1002, ¶70; EX1007, [0033].)

A POSITA would have understood that one way of implementing virtualized PHY interfaces to further enhance Chincholi is taught in Riggert. (EX1002, ¶71.) Riggert teaches a "bondable virtual interface" which provides a virtualized, flexible interface to the actual PHY interfaces that can be used generically and thus easily substituted across differently configured PHY interfaces in the system. (EX1007, [0065]; EX1002, ¶71.)

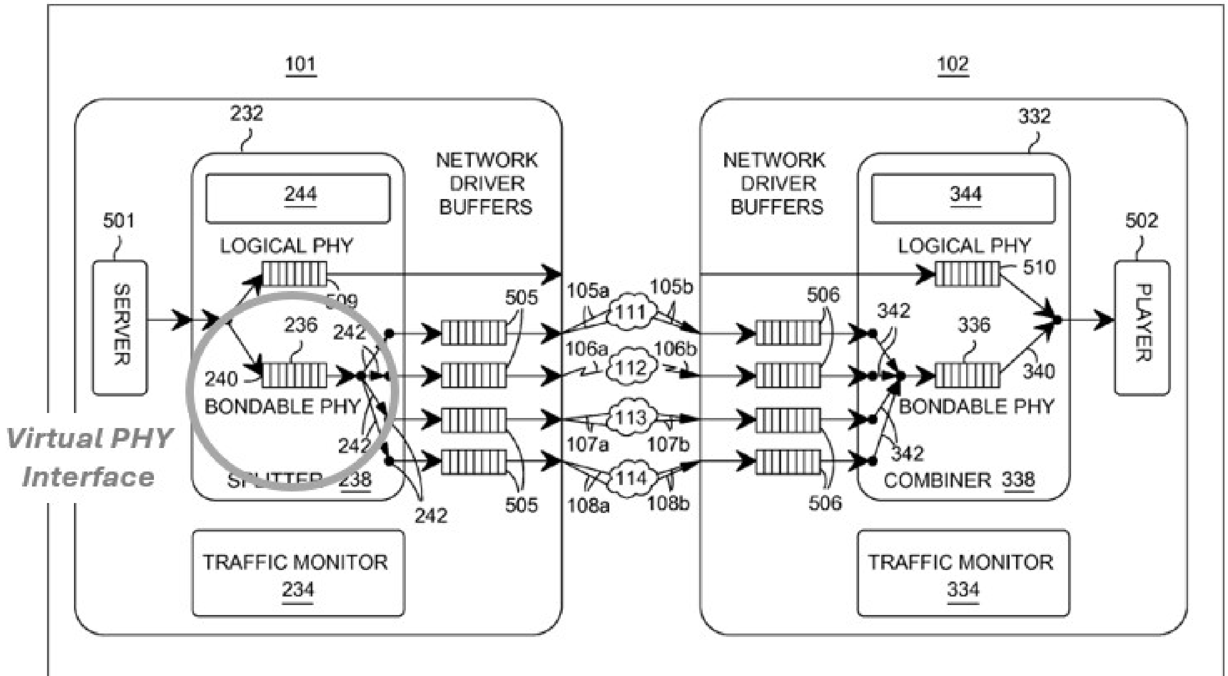


FIG. 5

A POSITA would have been motivated to modify Chincholi according to the teachings of Riggert's "virtual PHY" to improve the system of Chincholi. (EX1002, ¶72.) The references both arise in the same field of endeavor and are similarly addressed to increasing bandwidth efficiency and throughput in multi-transceiver, wireless communication networks. (EX1005, [0002] ("Wireless technologies have been demanding higher data throughput rates and lower latencies"); EX1006, [0004] ("In the field of data streaming in a network, there is a problem in that data streaming from a sending endpoint to a recipient endpoint may be detrimentally affected by limited network bandwidth . . . .").) Both references address 802.11 type systems specifically. (EX1005, [0138]; EX1006, [0057].)

Riggert's "bondable virtual interface" would improve the system of Chincholi by providing a flexible, universal interface between the OMMA layer and the actual transceiver resources. (EX1002, ¶73; EX1006, [0065] ("The bondable virtual interfaces 236 and 336 conform to an interface, which allows them to be used generically in the framework.").) The combined system would improve Chincholi by providing a universal interface between the OMMA controller and sets of potentially differently configured RATs, a benefit that cannot be achieved alone by Chincholi's system. (EX1002, ¶73.) This combination would allow Chincholi's system to operate seamlessly with a wider variety of recipient devices operating on different versions of the 802.11 standards. (*Id.*)

Implementing Riggert's virtualized PHY interfaces into Chincholi would be straight-forward, requiring no more than the exercise of ordinary skill in the art, given that Chincholi already contemplates a virtualization of the MAC function at the OMMA layer. (EX1002, ¶74.) Based on the above, a POSITA would have recognized that the combination could be accomplished with a reasonable expectation of success. (*Id.*)

In the analysis below, the combined prior art system is referred to as Chincholi/Riggert.

B. Limitation-By-Limitation Analysis

1. Claim 1

a) 1[pre]: A method of improving the performance of a wireless networking device, comprising the steps of:

Chincholi discloses "[s]ystems, ***methods***, and instrumentalities . . . for managing multiple radio access technology (RAT) interfaces to enable opportunistic RAT selection and aggregation for sending data traffic over the multiple RAT interfaces." (EX1005, Abstract; [0003]; EX1002, ¶¶76-78.)

Chincholi discloses that its systems and methods may be implemented in connection with the RAT interfaces of a ("NT"), such as an access point, or a wireless transmit/receive unit ("WTRU"). These terminals "may be configured to work in an infrastructure mode or an adhoc mode … in an IEEE802.11 based Wi-Fi system." (*Id.*, [0115].) Each is a "***wireless networking device***." (EX1002, ¶77.)

Chincholi's methods ***improve the performance*** of the disclosed wireless networking device, for example, by enabling dynamic selection and aggregation of wireless interfaces (*id.*, [0003]), which enhances throughput and reduces latency (*id.*, [0002]; EX1002, ¶78.). As discussed in the below limitations, Chincholi/Riggert discloses a method of improving the performance of a wireless networking device, as claimed. (*Id.*)

b) 1[a]: connecting an application interface to a processing interface, the application interface being associated with a first application, the first application providing, when the wireless networking device is being used, a first data stream and having a first wireless bandwidth requirement;

"a first application . . . ": Chincholi discloses that "[u]sing multiple RATs simultaneously may provide the benefit of increased bandwidth for an ***application*** (*e.g.*, an IP flow) as well as increased reliability." (EX1005, [0191]; EX1002, ¶¶79-85.)

"providing, when the wireless networking device is being used, a first data stream . . . ": The first data stream of a first application is referred to as an "IP flow." (EX1005, [0132] ("A single IP flow may refer to a stream of IP packets belong[ing] to a particular application."); EX1002, ¶81.)

"application interface being associated with [the] first application": In an 802.11 embodiment (Figure 5), IP packets associated with the application data stream come from or are destined to an IP layer 504. Thus, the IP flow (*i.e.,* the ***first data stream***) is provided by the application when the wireless networking device is being used. (EX1005, [0138], Table 1 ("S" interface is for "Incoming/Outgoing IP Packets").) The interface from the IP layer for the IP stream "[S]" is therefore an ***application interface associated with a first application.*** (EX1002, ¶82.)

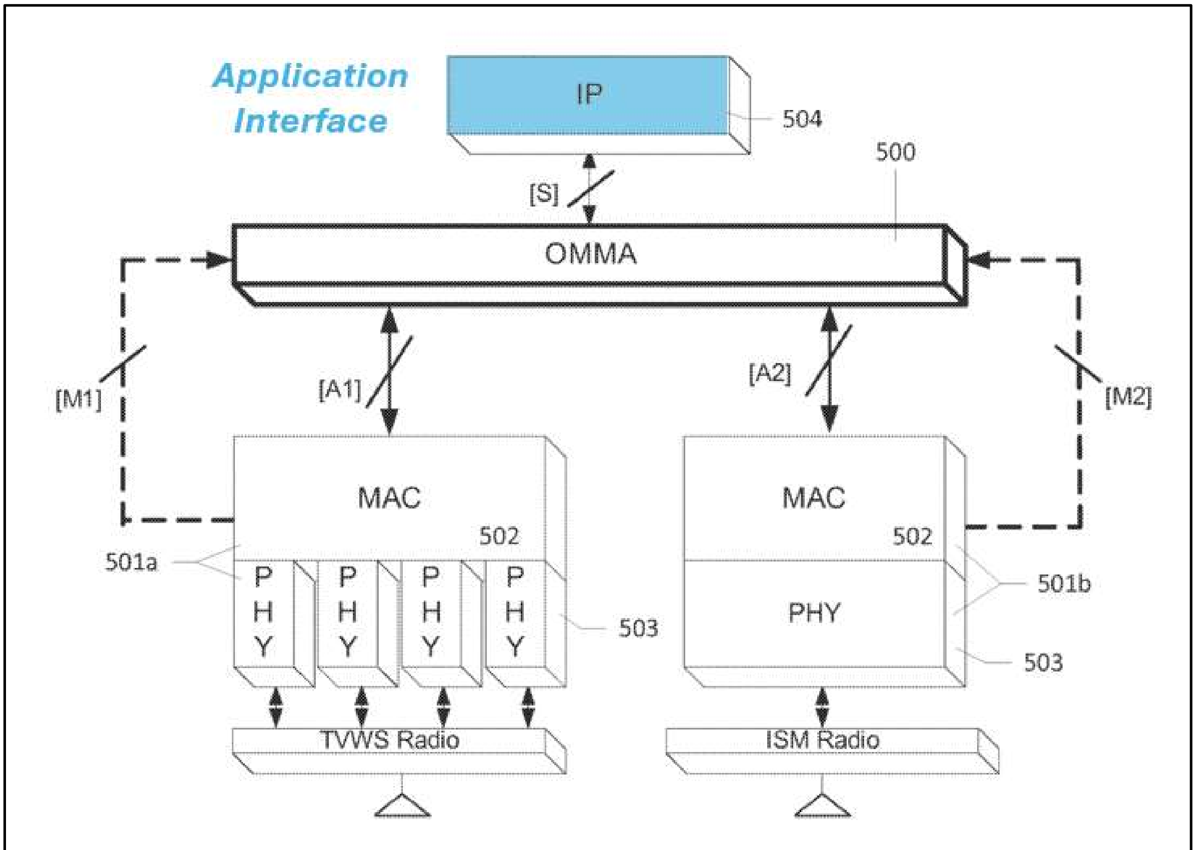


FIG. 5

"***connecting an application interface to a processing interface*"*:** Chincholi teaches an "***Opportunistic Multiple-Medium Access Control (MAC) Aggregation (OMMA) layer***." (EX1005, [0003]; EX1002, ¶83.) A POSITA would have understood that the plain meanings of "interface" and "layer" in the context of the '337 patent are congruent, which is underscored by the specification describing layers having the same functionality as the claimed interfaces, and the prosecution history of the prior related '591 patent, where Applicant interchangeably used the terms "layer" and "interface" to describe Figure 1. (EX1002, ¶83; EX1017, Aug. 8, 2023 Applicant Remarks; Sep. 28, 2023 Applicant Remarks.) The OMMA layer is a common layer/module between the IP layer/module and the multiple RAT layers/modules. (EX1005, [0137]; [0120] ("[T]he single thin software layer may enable one RAT to operate over industrial scientific medical (ISM) and another RAT to operate over a TVWS band for the same IP flow.").) An exemplary OMMA layer enabling a dual-RAT aggregation device in an 802.11n network is shown in Figure 5:

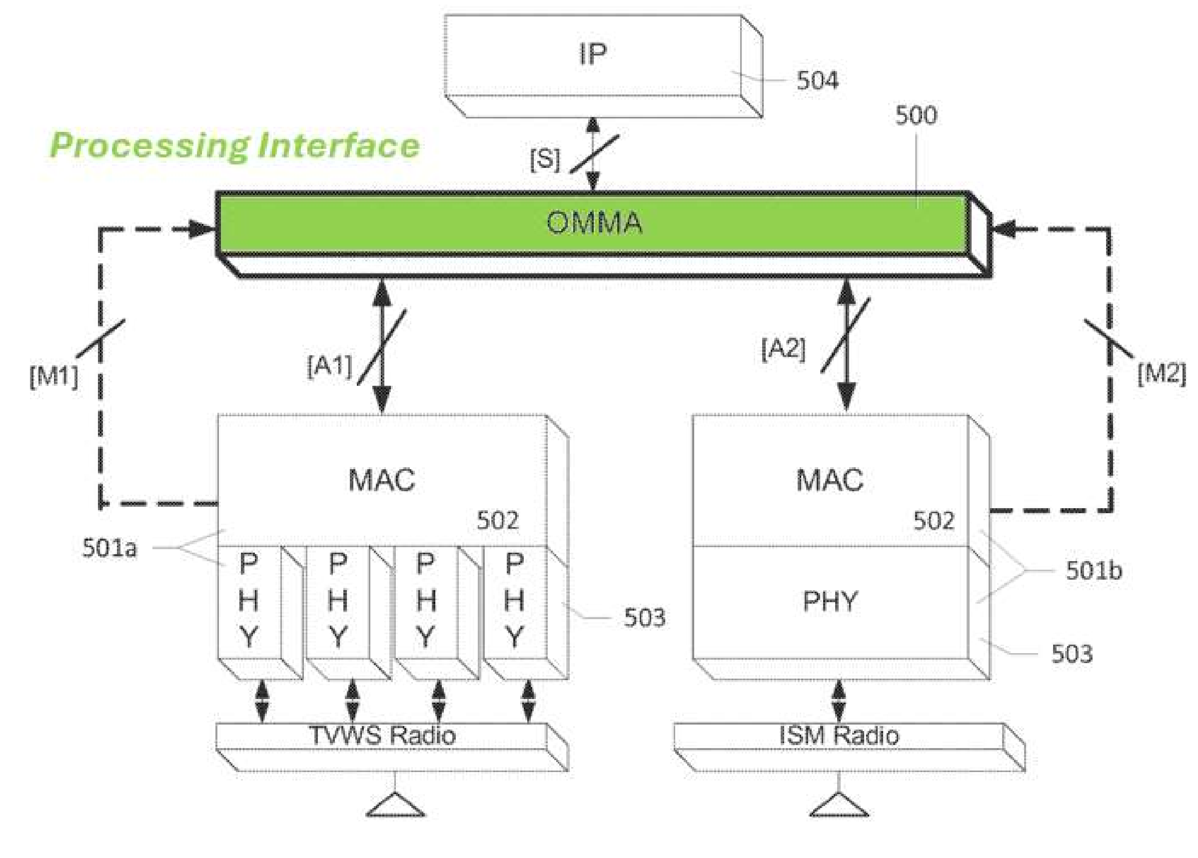


FIG. 5

The IP layer interface (*i.e.*, the ***application interface***) is connected to the OMMA layer and provides IP packets that the OMMA layer processes. (EX1005,

[0137]); (EX1002, ¶84.) The OMMA "may allow for enhanced throughput and reduced latency for a single IP flow." (EX1005, [0120].) The OMMA layer therefore processes IP packets and provides an ***interface*** between the IP layer interface (the ***application interface***) and the actual MAC interfaces, *i.e.*, a ***processing interface***. (EX1002, ¶84.)

"first application . . . having a first wireless bandwidth requirement":

Chincholi teaches "a bandwidth requirement for an IP flow." (EX1005, [0260].) It thus teaches that the first application has a first bandwidth requirement. (EX1002, ¶85.)

c) 1[b]: connecting first and second actual MAC interfaces to the processing interface;

Chincholi discloses ***connecting first and second actual MAC interfaces to the processing interface*** (*i.e.*, the common OMMA layer). (EX1002, ¶¶86-87.) Figure 5, for example, depicts a "dual-RAT aggregation" with the common OMMA layer existing above and connected to two RATs 501a and 501b, which comprise first and second actual MAC interfaces 502, respectively. (EX1005, [0138] ("The RATs 501a, 501b may comprise a MAC layer/module 502 and one or more physical layers/modules 503.").)

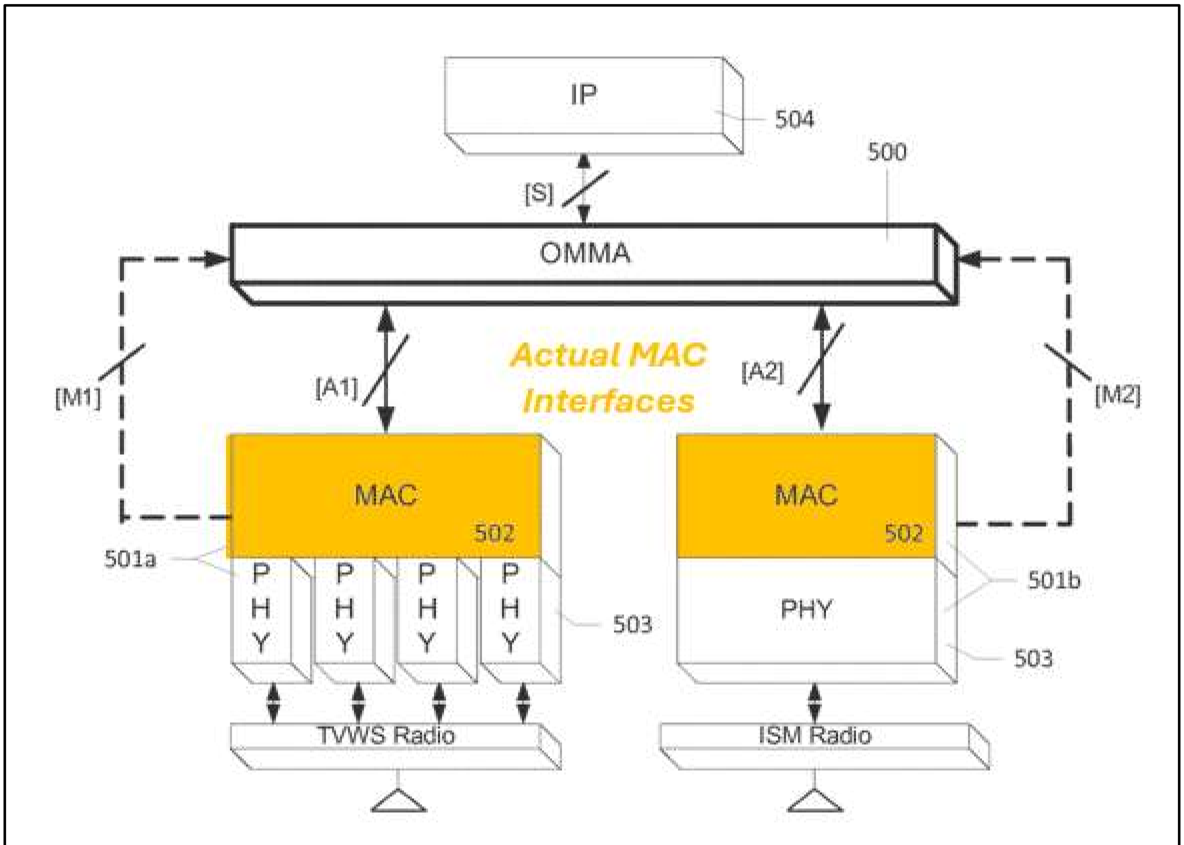


FIG. 5

Consistent with Figure 5, Chincholi explains that a given RAT can comprise a "PHY/MAC," *i.e.,* includes an actual MAC interface. (EX1005, [0135].) A POSITA would have understood that in a typical 802.11 implementation, each RAT would have actual MAC and PHY interfaces. (EX1002, ¶87.)

d) 1[c]: connecting first and second actual PHY interfaces respectively to the first and second actual MAC interfaces;

Chincholi explains that each RAT comprises ***one or more physical layers***, each of which corresponds to a claimed ***actual PHY interface***. (EX1002, ¶88; EX1005 [0138] ("The RATs 501a, 501b may comprise a MAC layer/module 502 and ***one or more physical layers/modules 503***.").) As shown in Figure 5 below, Chincholi discloses connecting the first and second actual PHY interfaces (503) to the actual MAC interfaces (502):

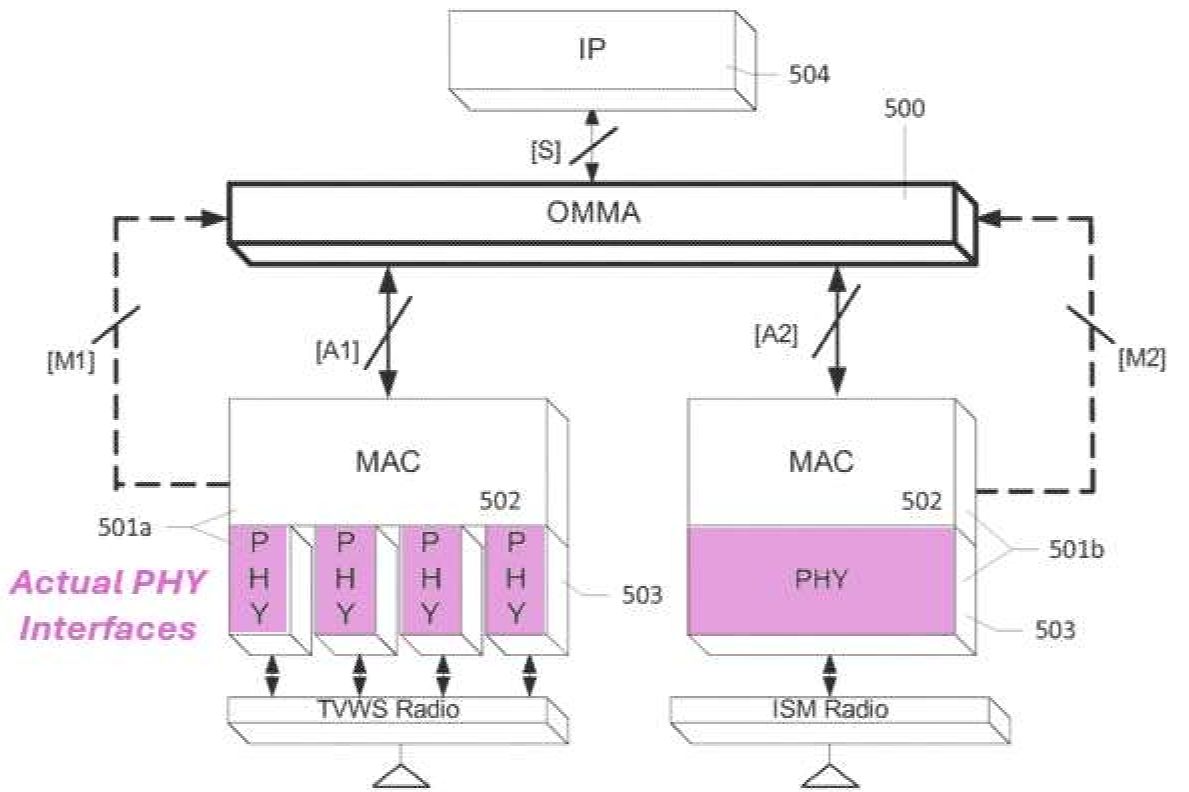


FIG. 5

e) **1[d]: respectively associating first and second wireless transceivers with the first and second actual PHY interfaces, wherein each of the first and second wireless transceivers (i) is suitable for use in a wireless local area network, (ii) has a first and second bandwidth availability up to first and second actual bandwidths, and (iii) is adapted to emit radio waves in first and second different bands of frequencies;**

"respectively associating first and second wireless transceivers with the first

and second actual PHY interfaces … suitable for use in a wireless local area network": The system shown in annotated Figure 5 associates each actual PHY interface of each RAT with an ***antenna/radio frequency (RF) front-end pair***. (EX1005, [0133]; EX1002, ¶¶89-98.)

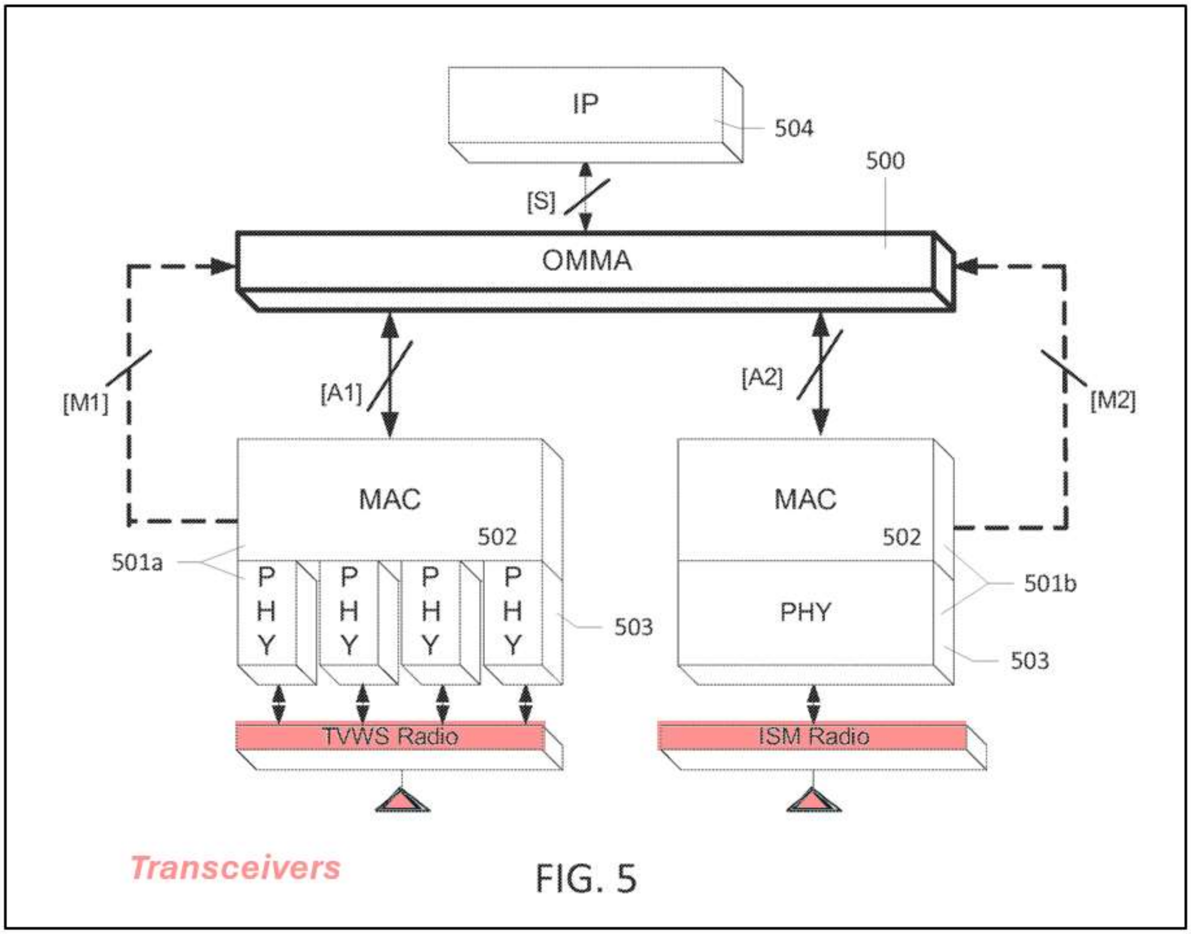


FIG. 5

The ***antenna/radio frequency (RF) front-end pairs*** in Figure 5 include first and second transceivers. (EX1002, ¶91.) A POSITA would have understood that a "transceiver" is a physical device that can both transmit and receive information. (*Id.*) Thus, each of Chincholi's disclosed "antenna/RF front-end pairs" is a wireless transceiver because each operates according to wireless protocols for transmitting and receiving data, such as IEEE802.11, IEEE802.11ac, IEEE802.11af, LTE, WCDMA, etc. (EX1005, [0134].) A POSITA would have further understood that the transceivers in Figure 5 are associated with the actual PHY layer of each respective RAT, because the PHY layer is understood to be the physical connection between a transceiver and the rest of the RAT. (EX1002, ¶91.)

Chincholi also teaches that each RAT may be implemented as a Wi-Fi RAT, and thus their associated transceivers are suitable for use in a wireless local area network. (Ex. 1005 [0134]; EX1002, ¶92.)

"each of the first and second wireless transceivers … has a first and second bandwidth availability up to first and second actual bandwidths": The plain meaning of this limitation is that each of the wireless transceivers has at least two bandwidth availabilities and two respective actual bandwidths. However, Patent Owner has alleged in the parallel litigation that this limitation may be met by each of the two wireless transceivers having one respective bandwidth availability up to an actual bandwidth. (EX1012; EX1013, 19-20.) Regardless, Chincholi discloses or renders obvious this limitation under either interpretation.

Consistent with PO's infringement contentions, a POSITA would have recognized that each transceiver has an "actual" bandwidth (*i.e.*, total bandwidth of the transceiver) with a "bandwidth availability" that may be a subset of the actual bandwidth (*i.e.*, sub-portions of the total bandwidth that are available for use). (EX1002, ¶94.) Indeed, as Chincholi teaches, the RATs associated with each transceiver provide "meta-data feedback" allowing the OMMA layer to split IP packets amongst the RATs based on their available bandwidth. (EX1005, [0138]; [0161] (listing "Channel bandwidth(s)" sent by the PHY layer as an example of "feedback metric[] used by an OMMA layer"); [0167] ("At startup, the OMMA layer may receive the ***available bandwidth of each of the one or more RATs***.").) Thus, Chincholi discloses that each of the two transceivers has a bandwidth availability up to an actual bandwidth.

Chincholi also discloses that there are multiple available bandwidths for each transceiver, specifically that a transceiver's feedback metrics include available "[c]hannel bandwidth(s)" in the form of a "Vector/list of elements which are multiple of 0.5 MHz." (EX1005, [0161], Table 2.) A POSITA would have understood a "vector" or "list" data structure is a data structure for transferring multiple data elements of indeterminate count, and would therefore have understood that the number of available "channel bandwidths" stored in the vector could and would exceed two. (EX1002, ¶95.)

"***each of the first and second wireless transceivers … is adapted to emit radio waves in first and second different bands of frequencies***": The plain meaning of this limitation is that each of the transceivers emit radio waves in the same two frequency bands. (EX1002, ¶96.) Patent Owner, however, has read this limitation to only require that each transceiver emit on a single, mutually exclusive frequency band. For example, in its infringement contentions, Patent Owner alleges that this limitation is met by implementation of the Wi-Fi 7 Draft Standard where "[t]he first transceiver is the 2.4 GHz transceiver," the second is "one of the 5 GHz and 6 GHz transceivers." (EX1012; EX1013, 19-20.) Regardless, Chincholi discloses or renders obvious this limitation under either interpretation. (EX1002, ¶96.)

The transceivers of each RAT are adapted to emit radio waves in respective different bands of frequencies, consistent with PO's infringement contentions. In the context of Figure 4, Chincholi discloses that "[f]or multiple RATs 401, ***each RAT 401 may be operating on a specific band***. For example, a 802.11n PHY/MAC operating over 2.4GHz ISM band, a 802.11af PHY/MAC operating over 512 MHz-698 MHz TVWS band, an LTE RAT operating of a licensed band (*e.g.*, 700 MHz band), a Bluetooth RAT operating on 2.4 GHz ISM band, *etc.*" (EX1005, [0135].) Thus, a POSITA would have understood that Chincholi discloses this limitation under PO's interpretation. (EX1002, ¶97.)

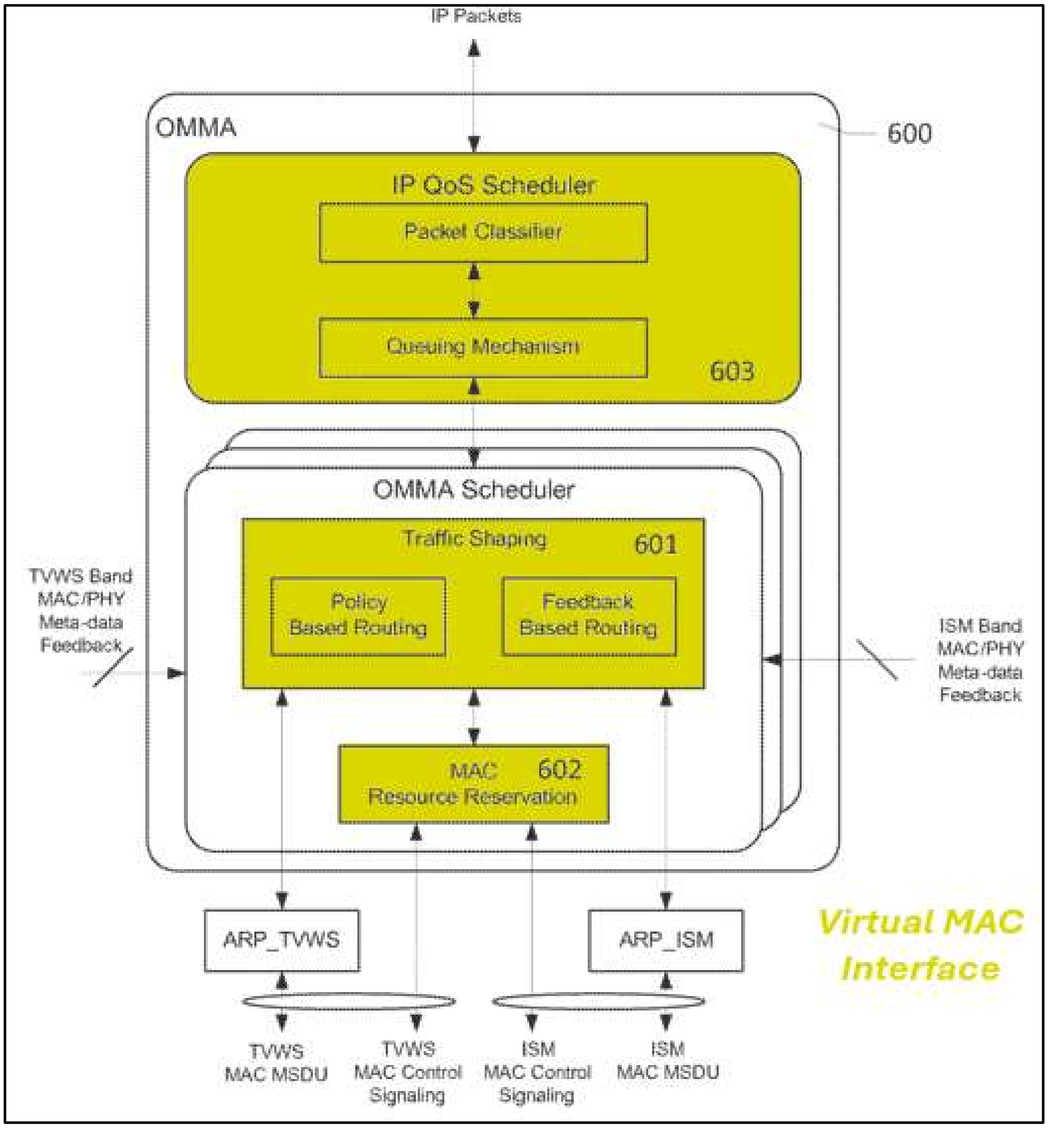
Chincholi also discloses that each transceiver can emit radio waves within all of the at least two frequency bands. For example, Chincholi describes that an NT and WTRU "may communicate with each other over a single radio frequency (RF) spectral band" such as "2.4 GHz ISM band, ***or*** 5 GHz ISM band," even when the devices are "multi-RAT capable devices," *i.e.* comprising multiple transceivers. (EX1005, [0118].) Chincholi further describes that the frequency band is comprised of "multiple contiguous or noncontiguous channels" within the band over which the devices communicate. *Id.* Accordingly, a POSITA would have understood that each transceiver operating on the 2.4 GHz ISM band is adapted to emit radio waves in any one of two contiguous channels, *i.e.,* the first and second different bands of frequencies, and thus satisfies the claim limitation under the alternative interpretation. (EX1002, ¶98.)

f) 1[e]: forming in the processing interface (i) at least one virtual MAC interface and (ii) first and second virtual PHY interfaces that, during operation of the wireless networking device, feed information regarding the bandwidth availabilities of the first and second wireless transceivers back to the at least one virtual MAC interface;

According to the '337 patent, the claimed virtual MAC and PHY layers "enable simultaneous allocation of multiple PHY resources for different signal types associated with different applications." (EX1001, 3:41-47.) The patent states that the virtual MAC layer comprises the functionality of "decision," "processing," and "ultra-streaming" blocks, while the virtual PHY layer may comprise one or more "RF blocks." (EX1001, 4:39-44.) The virtual PHY layer may include multiple RF blocks, each representing the virtual use of some set of allocated transceiver resources. (*Id.,* 4:41-44; Fig. 3 (depicting two RF blocks associated with "two sets" of transceiver resources).) "By employing a virtual MAC and virtual PHY between an application layer and an actual MAC and PHY layer, wireless transceiver resources may be allocated more efficiently to handle various data bandwidth requirements from different applications." (EX1001, 5:60-64.)

First, Chincholi discloses that the OMMA "the processing interface") includes the claimed "***virtual MAC interface***." (EX1002, ¶¶99-108.) Indeed, "OMMA" is an abbreviation for "opportunistic multi-medium access control ***(MAC) aggregation***," which refers to the fact that the OMMA layer aggregates multiple MAC interfaces, as depicted in Figure 5. (EX1005, [0120].) The OMMA layer includes an interface acting as a "virtual MAC interface" because it transparently "distributes and/or combines" packets between the IP layer and the RATs. (EX1005, [0192].) A POSITA would have recognized that this "virtualizes" a MAC interface because the OMMA would effectively appear to the IP layer as a single interface for exchanging packets that are ultimately sent or received by the actual MAC-PHY pairs. (EX1002, ¶100.)

Chincholi's OMMA layer also includes all of the functionality that the '337 patent associates with the "virtual MAC interface." (*Id.,* ¶101.) Specifically, Figure 6 of Chincholi is a block diagram of an OMMA layer, comprising an IP QoS Scheduler 603, a MAC Resource Reservation module 602, and a Traffic Shaping Module 601. (EX1005, [0139].)



The IP QoS Scheduler classifies incoming packets of a packet stream and may segregate them into distinct IP QoS streams (EX1005, [0143]), which a POSITA would have recognized as the functionality of the "decision block" of the '337 patent's "virtual MAC interface" (EX1002, ¶102; EX1001, 3:21-24). The MAC Resource Reservation module determines the time duration or spectral fragment/bandwidth required by a packet or set of packets (EX1005, [0142]), which a POSITA would have recognized as the functionality of the "processing block" of the '337 patent's "virtual MAC interface" (EX1002, ¶102; EX1001, 3:24-26). Finally, the Traffic Shaping module determines the way packets are routed across RATs using either policy based routing or feedback based routing (EX1005, [0139]), which a POSITA would have recognized as the functionality of the "ultra-streaming block" of the '337 patent's "virtual MAC interface" (EX1002, ¶102; EX1001, 3:26-30). Thus, a POSITA would have recognized that Chincholi's OMMA layer includes a "***virtual MAC interface***." (EX1002, ¶102.)

<u>*Second*</u>, Chincholi discloses that its processing interface comprises "***first and second virtual PHY interfaces that, during operation of the wireless networking device, feed information regarding the bandwidth availabilities of the first and second wireless transceivers back to the at least one virtual MAC interface.***" (*Id.*, ¶103.) Chincholi discloses that the traffic shaping module of the OMMA (*i.e.*, part of the "virtual MAC interface") may determine packet routing using "feedback based routing." (EX1005, [0139].) In feedback based routing, "the OMMA transmitter may use measurement metrics fed back from each RAT," which include "channel quality metrics and the ***number of available resources on the medium***." (EX1005, [0161].)

Figures 28 and 29 and their associated descriptions describe how Chincholi collects feedback from each RAT for the traffic shaping module. Figure 28 illustrates how the OMMA layer includes an OMMA Controller, which interfaces with each RAT to collect metrics regarding the channel quality and number of resources available on the medium. Specifically, using interface "A2" in Figure 28, "[a] RAT (*e.g.*, ***each RAT***) may provide feedback metrics (*e.g.*, a vector comprising a value of serving rate, jitter, packet delay, and packet loss rate on its MAC) to the OMMA Controller 2900 ***per device (e.g., WTRU or NT) per access category supported at that RAT***." (EX1005, [0205].) It would have been obvious to a POSITA to incorporate first and second virtual PHY interfaces into the OMMA Controller of Chincholi to collect the disclosed feedback metrics from each RAT over the "A2" interface and feed them back to the virtual MAC interface. (EX1002, ¶104.)

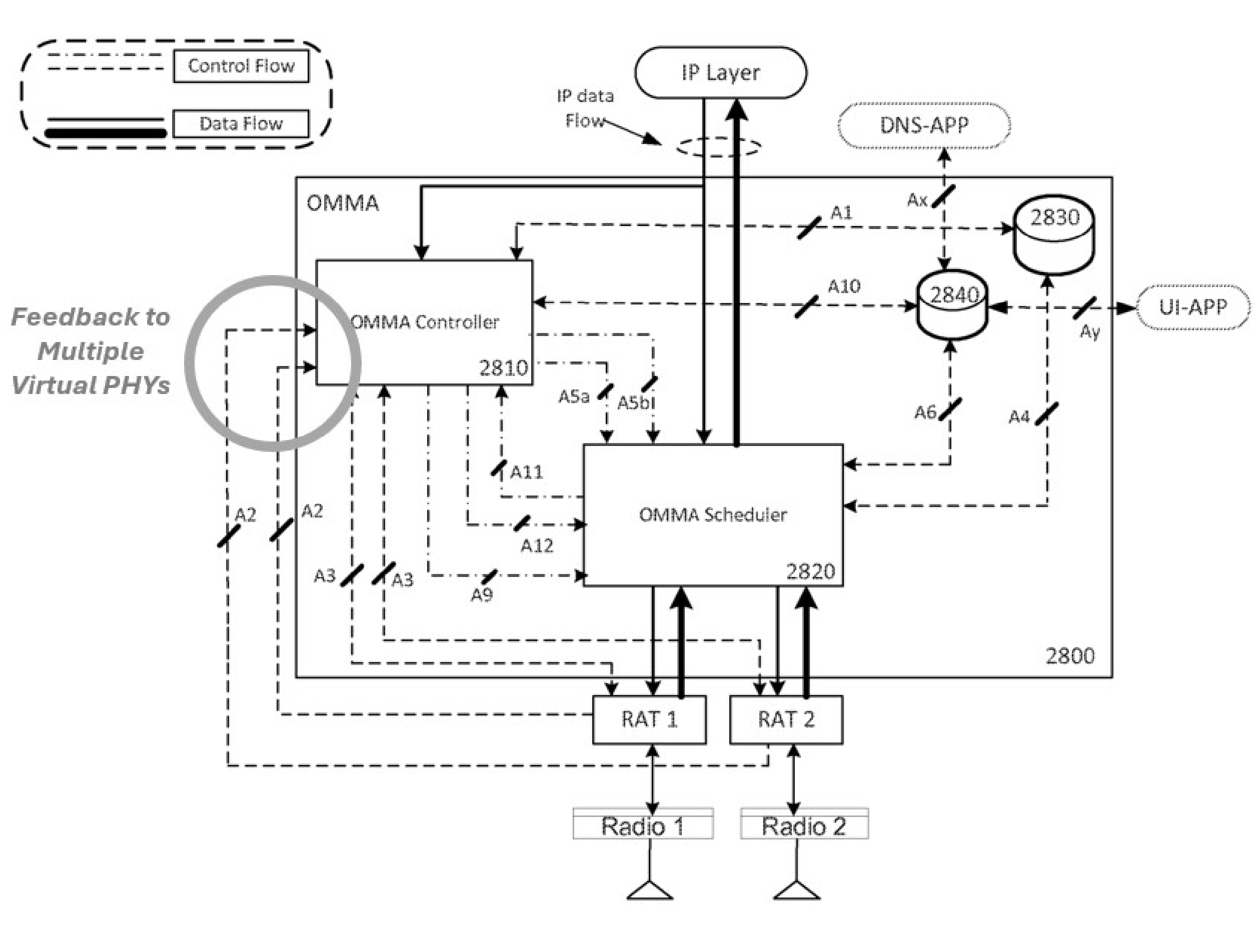


FIG. 28

Further details regarding the implementation of virtual PHY interfaces are disclosed by Riggert. As discussed above, *supra* Section IV.B.2, Riggert teaches a "bondable virtual interface" that provides one or more virtualized physical interfaces to the actual PHY layers of the communication channels, allowing for easy substitution of the interface throughout the system. (EX1006, [0065].) Providing this sort of virtualized physical interface for transceivers in an 802.11 system is particularly beneficial as it allows an access point to accommodate communication channels with wireless devices that may operate using various different generations of the 802.11 standards. (EX1002, ¶105.) Virtualization of the physical interface for this purpose is taught, for example, in background reference U.S. Patent Application 2009/0141691 ("Jain"). (EX1007, [0034-0037]); EX1002, ¶105.)

Figure 5 of Riggert teaches the basic architecture for implementing "bondable physical interfaces" in the wireless network devices of a multi-channel network:

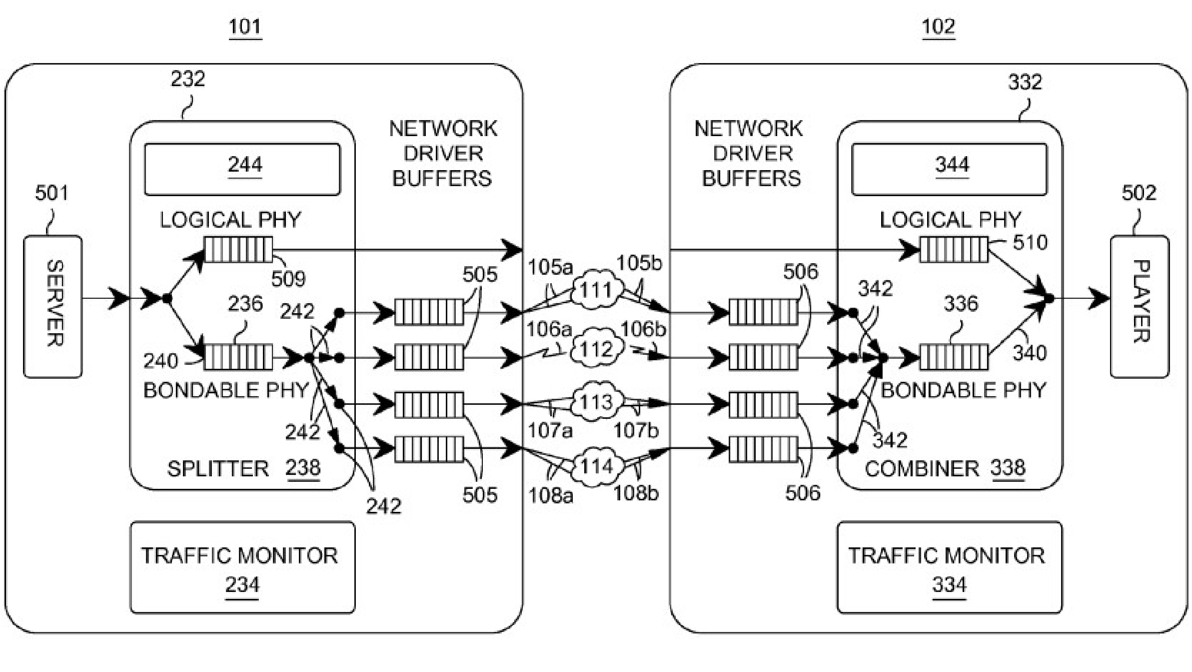


FIG. 5

The "bondable virtual interface" in Figure 5 on the server side is denoted as a "bondable PHY" (240). While the exemplary architecture depicts only a single "bondable virtual interface" associated with four actual transceiver resources, Riggert teaches that ***multiple*** physical bondable interfaces are possible in a single device. (EX1002, ¶107.) For example, each network endpoint may comprise a "plurality of bondable virtual interface connectors 244 and 344, respectively," each one of which may be associated with specific bondable virtual interface. (EX1006, [0069].)

For the reasons discussed above, *see* Section VII.A, a POSITA would have been motivated to combine Riggert's implementation of virtual PHY interfaces into the OMMA Controller of Chincholi for the purposes of receiving the feedback statistics over the "A2" interfaces and passing that feedback data to Chincholi's traffic shaping module. The resulting combination would implement one or more bondable virtual PHY interfaces into Chincholi's OMMA controller, each associated with one or more actual MAC-PHY pairs, thus increasing flexibility in the system. (EX1002, ¶108.)

g) 1[f]: wherein the processing interface is configured to, when the wireless network device is being used in a manner transparent to any layer of the wireless networking device above the processing interface,

Chincholi discloses that its OMMA layer ("processing interface") is configured to operate in a manner transparent to any higher layer. (EX1002, ¶109.) For example, Chincholi discloses that "[t]he OMMA layer ***may be transparent*** in that it distributes and/or combines packets from different RATs and forwards the packets to the IP layer." (EX1005, [0192], [0126].) This is as opposed to a "non-transparent" configuration in which the OMMA layer would "add[] additional headers [] at the transmitter, and read and/or remove the headers at the receiver." (*Id.*)

h) 1[g]: (i) identify at least one portion of each one of the first and second actual bandwidths of the first and second wireless transceivers that are available for communication,

Chincholi teaches that NTs and WTRUs communicate with one another over "channels," which are portions of a transceiver's bandwidth availability. (EX1002, ¶¶110-12.) Specifically, "[t]he NT and WTRU may communicate with each other over a single radio frequency (RF) spectral band… ***using a channel within the band or aggregating multiple contiguous or noncontiguous channels***." (EX1005, [0118]; [0121] ("An 802.11 based system may operate in a time division duplexing (TDD) mode …***on a band over a single 20/40MHz channel in the case of ISM band or a single 5/10/20 MHz channel in television white space (TVWS) band*** using contiguous/non-contiguous carrier aggregation.").)

Chincholi also discloses identifying available bandwidth channels for communication. The OMMA layer receives various feedback information from each RAT. (EX1005, [0123].) For example, "the OMMA transmitter may use measurement metrics fed back from each RAT," which include "channel quality metrics and the ***number of available resources on the medium***." (EX1005, [0161].) Amongst the available resources provided as part of the feedback information are the "number of channels" and "channel bandwidth." (*Id.*)

A POSITA would have understood that the ability of Chincholi's OMMA layer to receive from each RAT a number of channels and channel bandwidths is an identification of "at least one portion" (*i.e.*, at least one available channel, or an aggregation of multiple contiguous or non-contiguous channels) of the first and second actual bandwidths of the first and second wireless transceivers that are available for communication. (EX1002, ¶112.)

i) 1[h] (ii) select one transceiver of the first and second transceivers which has the most bandwidth available, (iii) prepare the first data stream for transmission to a recipient from the selected wireless transceiver using a specific subset of frequencies corresponding to the identified at least one portion of its available bandwidth, and (iv) cause the prepared first data stream to be transmitted from the selected wireless transceiver to thereby at least partially satisfy the first wireless bandwidth requirement of the first application;

Based on its evaluation of transceiver bandwidth availability with respect to the application bandwidth requirement, Chincholi discloses selecting one transceiver having the most bandwidth available, preparing the first data stream for transmission using a subset of the available bandwidth on that transceiver, and causing the transmission to thereby at least partially satisfy the first application's bandwidth requirement. (EX1002, ¶¶113-18.)

First, Chincholi discloses that the OMMA layer uses feedback metrics indicating the amount of available bandwidth on each RAT to select between the first and second transceivers. (*Id.*, ¶114.) For example, in a "cold start" phase, Chincholi teaches how the OMMA layer "may request the individual RATs to transmit the total channel bandwidths supported by them." (EX1005, [0163].) Thus, the distribution of IP packets across two separate RATs, operating on two different frequency bands, may be calculated as the simple ratio of available bandwidth on the two RATs:

$$BW_{ISM} : \sum_{k=1}^{N} BW_{TVWS}^{k}$$

(EX1005, [0163].) Chincholi also discloses more sophisticated algorithms for allocating packets based on *both* available bandwidth and link quality for a "ramp-up phase" and a "steady state phase." (EX1005, [0164]-[0165].)

A POSITA would have understood from these calculations that a higher ratio of IP packets will be allocated to the transceiver with more available bandwidth. (EX1002, ¶115.) Further, where the available bandwidth of the first transceiver is substantially better than that of the second transceiver, a POSITA would have understood the capability to transmit the *entire* first data stream using only the first transceiver. (*Id.*) Thus, Chincholi teaches a selection of the transceiver with the most available bandwidth for preparation and transmission of the first data stream. (*Id.*)

Second, after selecting the transceiver, Chincholi discloses that the OMMA layer ***prepares the data stream for transmission*** using available spectral fragments (i.e., portions of the transceiver's available bandwidth allocated for transmission).

For example, Chincholi teaches that its MAC Resource Reservation module "may determine an amount of time duration and/or spectral fragment/bandwidth required by a packet or a set of packets." (EX1005, [0142].) A POSITA would have understood that these spectral fragments correspond to the claimed "subset of frequencies" of the transceiver's available bandwidth. (EX1002, ¶116.) Once bandwidth and spectral fragments have been allocated, preparing the data stream for transmission further includes segmenting the data, mapping the data stream to the allocated bandwidth resources, applying appropriate modulation and coding schemes, and generating the physical-layer signals for transmission over the selected transceiver. (*Id.*)

Third, Chincholi further discloses causing the prepared first data stream to be transmitted from the selected transceiver, thereby at least ***partially satisfying the application's bandwidth requirement***. As Chincholi explains, "[u]sing multiple RATs simultaneously may provide increased bandwidth and/or increased reliability for an application." (EX1005, [0194].)

Finally, Chincholi discloses that this selection, preparation, and transmission is performed by the OMMA layer in a manner transparent to higher layers: "[t]he OMMA layer ***may be transparent***…" (EX1005, [0192], [0126].)

j) 1[i]: wherein, if the unselected wireless transceiver has more bandwidth availability than the selected transceiver during use of the wireless networking device, the processing interface is adapted to, as a result of the increased bandwidth availability and in a manner transparent to any layer of the wireless networking device above the processing interface, (i) identify at least one portion of the bandwidth of the unselected transceiver that is available for communication and select the unselected transceiver,

Chincholi teaches that the OMMA layer dynamically monitors bandwidth availability and may select a transceiver with greater bandwidth availability as conditions change. (EX1002, ¶¶119-21.) Chincholi explains that the OMMA layer may "continuously update . . . the available RAT capability of a device . . . based on feedback metrics from each RAT." (EX1005, [0235].) These feedback metrics include both channel quality and the number of available resources on the medium. (EX1005, [0161].)

Chincholi further discloses that the processing interface (i.e., the OMMA layer) is adapted to identify a bandwidth portion of an unselected transceiver and select an unselected transceiver if its bandwidth availability exceeds that of the selected transceiver during use of the wireless networking device. Chincholi teaches that "[a]s the channel quality/availability of RATs 1301a, 1301b changes, the best RAT may be selected which may be different from the one previously used." (EX1005, [0154].) A POSITA would have understood that this includes situations where bandwidth availability (i.e., the amount of available spectrum or channel resources on a RAT) increases relative to the previously selected transceiver, prompting the OMMA layer to switch and select the RAT with more bandwidth availability. (EX1002, ¶120.)

Finally, Chincholi discloses that this selection of an unselected transceiver is performed by the OMMA layer in a manner transparent to higher layers: "[t]he OMMA layer may be transparent…" (EX1005, [0192], [0126].) Accordingly, a POSITA would have understood that the OMMA's transparent routing of packets across RATs allows the switching to occur without requiring disassociation and reassociation at the MAC/PHY level. (EX1002, ¶121.)

k) (ii) prepare the first data stream, without requiring the disassociation of the recipient from the actual MAC and PHY interfaces of any wireless transceiver, for transmission to the recipient from the unselected transceiver using a specific subset of frequencies corresponding to its identified at least one portion of available bandwidth, and

After selecting the unselected transceiver, Chincholi discloses that the OMMA layer prepares the first data stream for transmission to the recipient from the transceiver using a specific subset of frequencies corresponding to its identified at least one portion of available bandwidth. (EX1002, ¶¶122-25.) For example, Chincholi teaches that the MAC Resource Reservation module "may determine an amount of time duration and/or spectral fragment/bandwidth required by a packet or a set of packets." (EX1005, [0142].) A POSITA would have understood that, once bandwidth and spectral fragments have been allocated, preparing the data stream for transmission further includes segmenting the data, mapping the data stream to the allocated bandwidth resources, applying appropriate modulation and coding schemes, and generating the physical-layer signals for transmission over the selected transceiver. (EX1002, ¶122.)

Additionally, Chincholi does not "require" disassociation of recipient WTRUs from actual MAC and PHY interfaces of any wireless transceiver during operation, including during preparation of the first data stream for transmission and transmission by a newly selected transceiver. (*Id.,* ¶123.)

Indeed, a POSITA would have also recognized the desirability of implementing Chincholi combined with the teachings of Riggert to transmit the first data stream to the recipient without requiring "disassociation" of the recipient from either or both of the first and second actual MAC and PHY interfaces. For example, in the field of 802.11 systems—where each associated terminal is assigned a unique association identifier ("AID")—it was well-known that avoiding disassociation after initial association was desirable, as repeatedly re-forming associations was inefficient and disruptive. (EX1002, ¶124; EX1008 (U.S. Patent 9,379,868) ("Wang"), 24:42-43 ("This approach is undesirable, can be blunt and can disrupt the on-going services (e.g., requires disassociation), 24:57-62 ("The lack of update/change of the AID values . . . after an initial AID assignment is inherently inflexible and can prevent the realization power saving, among other considerations, that an update/change of the AID values can provide.") Indeed, recognizing this issue, background prior art reference Wang described techniques in a multiple transceiver/MIMO system for effectuating an update to a recipient's unique association identifier ("AID") through various interactions with the system without requiring a disassociation of a wireless device from an access point. (EX1008, 24:63-25:57.)

In light of this background art, a POSITA would have recognized that in implementing the Chincholi/Riggert combination, it would be desirable implement known dynamic AID reassignment techniques to avoid disassociation of recipients from the actual MAC and PHY interfaces of any wireless transceiver during operation including throughout any process of reallocating transceiver, channel, and/or bandwidth resources to a recipient. (EX1002, ¶125.)

l) (iii) cause the prepared first data stream to be transmitted to the recipient from the unselected transceiver, without requiring the disassociation of the recipient from the actual MAC and PHY interfaces of any wireless transceiver, to thereby continue to at least partially satisfy the first wireless bandwidth requirement of the first application; and

Chincholi further discloses causing the prepared first data stream to be transmitted from the newly selected transceiver, thereby continuing to at least partially satisfy the application's bandwidth requirement. (EX1002, ¶¶126-27.) As Chincholi explains, "[u]sing multiple RATs simultaneously may provide increased bandwidth and/or increased reliability for an application." (EX1005, [0194].)

As discussed above in the prior limitation, Chincholi does not require disassociation of the recipient from the actual MAC and PHY interfaces of any wireless transceiver during operation including throughout any process of reallocating transceiver, channel, and/or bandwidth resources to a recipient. (EX1002, ¶127.)

m) 1[j]: wherein the wireless networking device's utilization of the available bandwidth of the selected and unselected transceivers does not prevent other wireless networking device from utilizing a range of frequencies corresponding to the remaining portion of the bandwidth availabilities of the selected and unselected wireless transceivers for data transmission purposes at the same time that processed data is being sent from the selected and unselected wireless transceivers.

Chincholi discloses examples of "***multi-WTRU*** multi-IP flow cases." (EX1005, [0328]; EX1002, ¶¶128-31.) For example, "[a] system may comprise ***multiple WTRUs***, a single NT, and multiple IP flows from the NT to one or more WTRUs." (EX1005, [0328].) This is disclosed, for example in Figure 3.

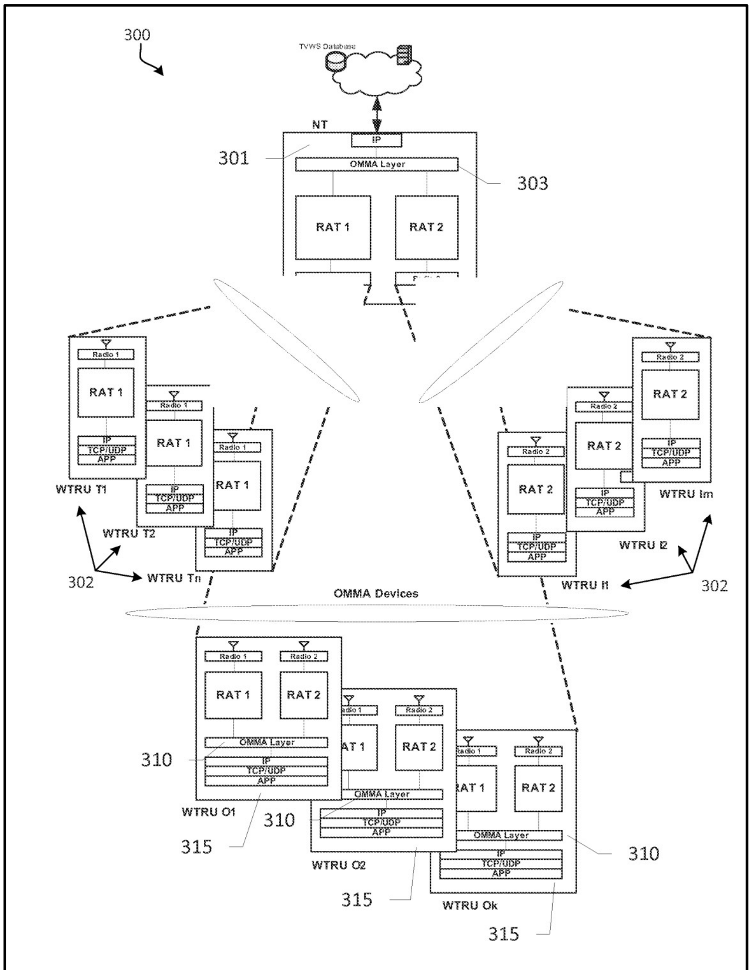


FIG. 3

To manage data flows for multiple WTRUs, Chincholi teaches techniques for queuing packets according to their access categories and/or WTRU addresses and optimizing the distribution of packets of multiple streams for multiple WTRUs across multiple RATs. (EX1005, [0351]-[0356].) For example, Chincholi discloses a MAC layer of a given transceiver may implement multiple transmission buffers, denoted Q_{ik}, where "i" refers to the WTRU for which a group of packets is designated and "k" refers to the IP flow associated with the group of packets. (EX1005, [352].)

Chincholi further discloses how utilization of the available transceiver bandwidth for one WTRU does not prevent other WTRUs from utilizing a range of frequencies corresponding to the remaining transceiver bandwidth at the same time. As discussed above, Chincholi's OMMA layer receives feedback metrics from each RAT. (EX1005, [0161].) Amongst the feedback metrics are the "MAC Type," for example "OFDMA." (EX1005, [0161] & Table 2.) OFDMA stands for "Orthogonal Frequency Division Multiple Access," which was a known wireless communication technique for dividing an available bandwidth into smaller subcarriers (*i.e.* frequency ranges) which are then allocated to different users. (EX1002, ¶130.) These subcarriers are described as orthogonal because they do not interfere with each other when simultaneously transmitted. A POSITA would have recognized that OFDMA techniques would allow multiple WTRUs to access different channels of the transceiver resources simultaneously and without interference. (*Id.*)

Because Chincholi's RATs may provide feedback to the OMMA indicating that they are operating as an OFDMA MAC Type, a POSITA would have recognized that Chincholi discloses the capability to allow multiple WTRUs to simultaneously utilize different portions of the bandwidth availabilities of the selected and unselected transceivers. (*Id.*, ¶131.)

2. Claim 2: The method of claim 1,

a) wherein the application interface is associated with a second application, the second application providing, when the wireless networking device is being used, a second data stream and having a second wireless bandwidth requirement;

Chincholi discloses that a "single IP flow may refer to a stream of IP packets belong[ing] to a particular application." (EX1005, [0132]; EX1002, ¶¶132-40.) Moreover, Chincholi discloses "multi-WTRU ***multi-IP flow*** cases." (EX1005, [0328], [0349].) For example, "[a] system may comprise multiple WTRUs, a single NT, and ***multiple IP flows*** from the NT to one or more WTRUs." (EX1005, [0328].)

Chincholi teaches techniques for queuing packets according to their access categories and/or WTRU addresses and optimizing the distribution of packets of multiple streams for multiple WTRUs across multiple RATs. (EX1005, [0351]-[0356].) For example, Chincholi discloses that a MAC layer of a given transceiver may implement multiple transmission buffers, denoted Q_{ik}, where "i" refers to the WTRU for which a group of packets is designated and "k" refers to the IP flow associated with the group of packets. (EX1005, [0352].)

b) wherein the processing interface is configured to, when the wireless networking device is being used in a manner transparent to any layer of the wireless networking device above the processing interface, (i) prepare the first and second data streams for simultaneous transmission to the recipient from the selected wireless transceivers using a specific subset of frequencies corresponding to the identified at least one portion of its available bandwidth, and

A POSITA would have understood that Chincholi discloses that the OMMA layer evaluates the identified channel availabilities and selects amongst available transceivers with respect to *both* the first bandwidth requirement of the first application and the second bandwidth of the second application. (EX1002, ¶¶134-37.) As discussed *re* limitation 2[a], Chincholi teaches the use of transmission buffers Q_{ik} to store data destined for WTRU "i" from IP flow (*i.e.*, application "k"). (EX1005, [0352].) Chincholi then discloses various feedback metrics for "multi WTRU multi IP flow (QoS) cases" along with algorithms for optimizing the distribution of packets in this scenario across multiple RATs. (EX1005, [0353]-[0356].)

After selecting between first and second transceivers with respect to both first and second applications, Chincholi discloses that its MAC Resource Reservation module "may determine an amount of time duration and/or spectral fragment/bandwidth required by a packet or a set of packets." (EX1005, [0142].) A POSITA would have understood that in the multi-IP flow scenario, this would involve reserving a specific subset of frequencies from one of the first or second transceivers for *each* of the first and second applications. (EX1002, ¶135.)

A POSITA would have further understood that, once bandwidth resources across the transceivers are allocated for each of the first and second application, Chincholi would prepare the first and second data streams, including by segmenting the data, mapping the data streams to the allocated resources, and applying modulation, encoding, and physical layer processing for transmission. (*Id*.)

Finally, Chincholi discloses that this selection, preparation, and transmission of the two data streams is performed by the OMMA layer in a manner transparent to higher layers: "[t]he OMMA layer ***may be transparent***… " (EX1005, [0192], [0126].)

c) (ii) cause the prepared first and second data streams to be simultaneously transmitted from the selected wireless transceivers to thereby at least partially satisfy the first and second wireless bandwidth requirements of the first and second applications.

Chincholi discloses the use of buffers at the MAC layer of each transceiver to independently queue data streams from multiple IP flows. (EX1005, [0352]; EX1002, ¶¶138-40.) Further, as discussed above, Chincholi discloses that each transceiver may operate in an OFDMA fashion, with different portions of their bandwidth availability allocated for separate, independent transmissions. (EX1005, [0161]; Table 2.) A POSITA would have recognized that Chincholi's OFDMA techniques enable each transceiver to simultaneously transmit IP packets from multiple IP flows. (EX1002, ¶138.)

Additionally, Chincholi discloses preparing and transmitting a data stream across multiple transceivers simultaneously, for example in a multiplexing mode. (EX1005, [0152].) Chincholi further discloses the use of feedback metrics for optimizing distribution of packets across multiple transceivers in a multi-IP flow (QoS) case. (*Id.*, [0353]-[0356].)

Thus, a POSITA would have understood that Chincholi discloses the capability to prepare and transmit both first and second data streams for simultaneous transmission to the recipient from selected wireless transceivers using specific subsets of frequencies corresponding to the identified portions of their available bandwidth, to thereby at least partially satisfy the bandwidth requirements of both applications. (EX1002, ¶140.)

3. Claim 3: The method of claim 2,

a) wherein, if the identified at least one portion of the bandwidth of the first wireless transceiver becomes unavailable during use of the wireless networking device or if it has an unidentified portion of bandwidth availability that is greater than its identified at least one portion of bandwidth availability during use of the wireless networking device, the processing interface is configured to, as a result of the unavailability or the increased bandwidth availability and in a manner transparent to any layer of the wireless networking device above the processing interface, (i) identify at least one new portion of the bandwidth of the first wireless transceiver that is available for communication and then select that wireless transceiver,

Chincholi teaches that the OMMA layer continuously monitors the availability and quality of bandwidth for each transceiver.: the OMMA layer may "continuously update . . . the available RAT capability of a device . . . based on feedback metrics from each RAT." (EX1005, [0235]; EX1002, ¶¶141-46.) These feedback metrics include both channel quality and the number of available resources on the medium. (EX1005, [0161].)

Chincholi further discloses that the OMMA layer may dynamically select a new bandwidth portion of the first transceiver upon the originally identified bandwidth portion becoming unavailable or a new portion with greater bandwidth availability becoming available. (EX1002, ¶142.) Chincholi discloses that for a given data stream, its MAC Resource Reservation module "may determine an amount of time duration and/or spectral fragment/bandwidth required by ***a packet or a set of packets***." (EX1005, [0142].) A POSITA would have understood that Chincholi discloses the capability to reserve a new spectral fragment for a given data stream in response to changes in bandwidth availability, and thus discloses identifying at least one new portion of bandwidth of the first transceiver, as claimed. (EX1002, ¶142.)

Chincholi discloses that this selection, preparation, and transmission of the two data streams is performed by the OMMA layer in a manner transparent to higher layers: "[t]he OMMA layer ***may be transparent***…" (EX1005, [0192], [0126].) Accordingly, a POSITA would have understood that Chincholi allows for switching bandwidth portions in a manner transparent to higher layers. (EX1002, ¶143.) A POSITA would have understood that the plain meaning of resource "unavailability" in the context of the '337 patent broadly includes resources that are partially or completely unavailable or that have less bandwidth availability than another resource. Indeed, during prosecution of the prior related '591 patent, the applicant expressly stated in arguing patentability to overcome a prior art rejection that "[i]t is applicant's intention that these words ["unavailable" and "unavailability"] refer to, for example, a partial or complete loss of certain transceiver resources as well as a situation where a different band than the one currently in use provides more bandwidth available for transmission." (EX1002, ¶143; EX1017, Aug. 8, 2023

Applicant Remarks.)

b) (ii) prepare the first and second data streams, without requiring the disassociation of the recipient from the actual MAC and PHY interfaces associated with any wireless transceiver, for transmission to the recipient from the first wireless transceiver using a specific subset of frequencies corresponding to its newly identified at least one portion of available bandwidth, and

After selecting a new bandwidth portion, Chincholi discloses that the OMMA layer's processor may prepare both first and second data streams for transmission using a specific subset of frequencies corresponding to the newly identified portion of the available bandwidth. (EX1002, ¶144.) As discussed above (2[b]), a POSITA would have understood that in the multi-IP flow scenario, Chincholi's MAC Resource Reservation module would reserve a specific subset of frequencies from the selected transceiver for *each* of the first and second applications. (*Id.*) Preparing the data streams includes segmenting the data, mapping the data streams to the allocated resources, and applying modulation, encoding, and physical layer processing for transmission. (*Id.*)

Additionally, as discussed above (1[k]), Chincholi does not "require" disassociation of recipient WTRUs from actual MAC and PHY interfaces of any wireless transceiver during operation, including during preparation of first and second data streams for transmission using a newly identified bandwidth portion. (*Id.,* ¶145.) A POSITA would have recognized that it would be desirable to avoid disassociation of recipients from the actual MAC and PHY interfaces of any wireless transceiver during operation including throughout any process of reallocating transceiver, channel, and/or bandwidth resources to a recipient. (*Id*.)

c) (iii) cause the prepared first and second data streams to be transmitted to the recipient from the first transceiver, without requiring the disassociation of the recipient from the actual MAC and PHY interfaces of any wireless transceiver, to thereby continue to at least partially satisfy the first and second wireless bandwidth requirements of the first and second applications.

As discussed above (2[c]), Chincholi discloses that prepared first and second data streams are transmitted to the recipient from a selected transceiver using the bandwidth resources reserved by the MAC Resource Reservation Module, thereby continuing to at least partially satisfy both applications' bandwidth requirements. (EX1005, [0194]; EX1002, ¶146.) As discussed above (3[b]), Chincholi does not require disassociation of the recipient from the actual MAC and PHY interfaces of any wireless transceiver during its reallocation of transceiver, bandwidth, or channel operations.

4. Claim 4: The method of claim 3,

a) wherein, if the identified at least one portion of the bandwidth of the second wireless transceiver becomes unavailable during use of the wireless networking device or if it has an unidentified portion of bandwidth availability that is greater than its identified at least one portion of bandwidth availability during use of the wireless networking device, the processing interface is configured to, as a result of the unavailability or the increased bandwidth availability and in a manner transparent to any layer of the wireless networking device above the processing interface, (i) identify at least one new portion of the bandwidth of the second wireless transceiver that is available for communication and then select that wireless transceiver,

Just as Chincholi discloses the ability to dynamically identify a new bandwidth portion of the first transceiver in response to changes in availability, (see above 3[a]), Chincholi also discloses this ability with respect to the second wireless transceiver. (EX1002, ¶147.)

b) (ii) prepare the first and second data streams, without requiring the disassociation of the recipient from the actual MAC and PHY interfaces associated with any wireless transceiver, for transmission to the recipient from the second wireless transceiver using a specific subset of frequencies corresponding to its newly identified at least one portion of available bandwidth, and

Just as Chincholi discloses the ability to prepare the first and second data streams, without requiring disassociation of the recipient, for transmission using frequencies of the newly identified bandwidth portion, (see above 3[b]), Chincholi also discloses this ability with respect to the second wireless transceiver. (EX1002, ¶148.)

c) (iii) cause the prepared first and second data streams to be transmitted to the recipient from the second transceiver, without requiring the disassociation of the recipient from the actual MAC and PHY interfaces of any wireless transceiver, to thereby continue to at least partially satisfy the first and second wireless bandwidth requirements of the first and second applications.

Just as Chincholi discloses the ability to cause the first and second data streams to be transmitted to the recipient from the first transceiver, without requiring disassociation of the recipient, (see above 3[c]), Chincholi also discloses this ability with respect to the second wireless transceiver. (EX1002, ¶149.)

5. Claim 5: The method of claim 4,

a) wherein the processing interface is configured to, when the wireless networking device is being used, in a manner transparent to any layer of the wireless networking device above the processing interface, evaluate the identified bandwidth availabilities of the first and second wireless transceivers with respect to the first and second bandwidth requirements of the first and second applications; and

As discussed above (claim 2), Chincholi discloses that a "single IP flow may refer to a stream of IP packets belong[ing] to a particular application." (EX1005, [0132]; EX1002, ¶¶150-55.) Chincholi further discloses scenarios involving multiple WTRUs and multiple IP flows. (EX1005, [0328].) For example, "[a] system may comprise multiple WTRUs, a single NT, and multiple IP flows from the NT to one or more WTRUs." (*Id.*)

Chincholi teaches the use of transmission buffers (Q_{ik}) to store data from multiple IP flows for each WTRU. (*Id.*, [0352].) The OMMA layer receives feedback metrics from each RAT, including bandwidth availability and channel quality metrics. (*Id.*, [0161], [0353]-[0356].) A POSITA would have understood that this allows the OMMA layer to evaluate the bandwidth availabilities of both transceivers with respect to the bandwidth requirements of both applications. (EX1002, ¶151.)

Finally, Chincholi discloses that this evaluation of bandwidth availabilities with respect to application requirements is performed by the OMMA layer in a manner transparent to higher layers: "[t]he OMMA layer ***may be transparent***… " (EX1005, [0192], [0126].) Accordingly, a POSITA would have understood that Chincholi allows for evaluating the bandwidth availabilities of multiple transceivers for multiple applications in a manner transparent to higher level layers. (EX1002, ¶152.)

b) wherein, if, during operation of the wireless networking device, the first and second bandwidth requirements of the first and second applications are at least partially satisfied by the bandwidth availability of the selected transceiver, preparing the first and second data streams for simultaneous transmission to the recipient from both of the first and second wireless transceivers using a specific subset of frequencies corresponding to the identified at least one portion of their available bandwidth and causing the prepared first data stream to be transmitted from the first and second wireless transceivers to thereby at least partially satisfy the first and second wireless bandwidth requirements of the first and second applications.

Chincholi discloses that if sufficient bandwidth is available across both transceivers, the OMMA layer may prepare the first and second data streams for simultaneous transmission using subsets of the available frequencies. For example, Chincholi's MAC Resource Reservation module "may determine an amount of time duration and/or spectral fragment/bandwidth required by a packet or a set of packets" for transmission. (EX1005, [0142].) A POSITA would have understood that preparing the data streams includes segmenting the data, mapping each stream to allocated bandwidth resources, applying modulation and coding, and generating the signals for physical transmission. (EX1002, ¶153.)

Further, Chincholi discloses that the RATs may operate using OFDMA, allowing available bandwidth to be divided into separate, non-overlapping subcarriers for simultaneous transmission of different data streams without interference. (EX1005, [0161], Table 2.) A POSITA would have understood that Chincholi's OFDMA-based transmission allows simultaneous use of bandwidth portions on both transceivers to transmit data streams from both applications. (EX1002, ¶154.)

Chincholi also discloses multiplexing modes where data streams may be distributed across RATs based on link quality and bandwidth availability. (EX1005, [0152], [0353]-[0356].) From these disclosures, a POSITA would have recognized that Chincholi discloses preparing and transmitting both first and second data streams for simultaneous transmission from both transceivers using subsets of their available bandwidth, thereby at least partially satisfying both bandwidth requirements. (EX1002, ¶155.)

6. Claim 6: The method of claim 4, further comprising the steps of:

a) connecting a third actual MAC interface to the processing interface; connecting a third actual PHY interface to the third actual MAC interface; associating a third wireless transceiver with the third actual PHY interface, wherein the third wireless transceiver (i) is suitable for use in a wireless local area network, (ii) has a third bandwidth availability up to a third actual bandwidth, and (iii) is adapted to emit radio waves in a third band of frequencies;

Chincholi discloses multi-RAT aggregation that may include RATs comprising an actual MAC interface, actual PHY interface, and transceivers. It teaches a "multi-RAT aggregation" (Figure 4), including RATs operating on different frequency bands (e.g., 2.4 GHz, 5 GHz, TVWS, LTE bands, etc.). (EX1005, [0132]–[0135]; Figs. 4 and 5.) In an 802.11 system, each RAT in Figure 4 corresponds to an actual MAC-PHY pair, thus disclosing first, second, and third actual PHY interfaces connected to corresponding MAC interfaces. (EX1005, [0135]); (EX1002, ¶¶156-71.)

Chincholi discloses that in an 802.11 device, its OMMA layer connects to the actual MAC and PHY interfaces of each RAT and receives bandwidth feedback metrics from each transceiver. (EX1005, [0138], [0205]; Fig. 28.) Thus, Chincholi contemplates that adding a third transceiver entails connecting a third actual MAC to the processing interface, a third actual PHY interface to the MAC, and the third transceiver to the PHY. (EX1002, ¶157.)

A third transceiver would be suitable for use in a wireless LAN, have a bandwidth availability up to a third actual bandwidth, and would be adapted to emit radio waves in a third band of frequencies. (*Id.*, ¶158.)

b) forming in the processing interface a third virtual PHY interface that is configured to, during operation of the wireless networking device, feed information regarding the bandwidth availability of the third wireless transceiver back to the at least one virtual MAC interface;

As discussed above (1[e]), a POSITA would have understood from Riggert that virtual PHY interfaces may provide a logical abstraction layer between the

OMMA layer and the actual MAC and PHY interfaces. (EX1002, ¶159.) A POSITA would have understood that adding a third RAT/transceiver could entail adding a third virtualized interface (a "virtual PHY") to accommodate its interface to the OMMA layer. (*Id.*)

A POSITA would have further understood that Chincholi's OMMA architecture readily extends to a third transceiver in an 802.11 network by adding third actual MAC and PHY interfaces and forming a corresponding virtual PHY interface to manage feedback metrics. (*Id.*, ¶160.)

c) wherein the processing interface is configured to, when the wireless networking device is being used in a manner transparent to any layer of the wireless networking device above the processing interface, request or create a third association between the recipient and the third actual MAC and PHY interfaces;

Chincholi describes modifying association request/response frames to include OMMA-specific discovery parameters (EX1005, [0127].) A POSITA would have understood that incorporating a third RAT/transceiver would enable creation of a corresponding association between the recipient and the third MAC/PHY interfaces. (EX1002, ¶161.)

Chincholi discloses that such associations are created by the OMMA layer in a manner transparent to higher layers: "[t]he OMMA layer ***may be transparent***…" (EX1005, [0192], [0126].) A POSITA would have understood that Chincholi permits forming these associations between an actual MAC/PHY pair and a recipient in a manner transparent to higher layers. (EX1002, ¶162.)

d) wherein the selected transceiver comprises one of the first, second and third wireless transceivers and the unselected transceivers comprise the remaining two transceivers of the first, second and third transceivers;

A POSITA would have recognized that Chincholi's multi-RAT capabilities, such as monitoring bandwidth and selecting transceivers accordingly, (EX1005, [0235], [0154], [0161], [0235]), could be readily extended to a three-transceiver system, one selected and the remaining two unselected. (EX1002, ¶163.) Chincholi's layered architecture accommodates this. (EX1005, [0138], [0205]; Fig. 28; EX1002, ¶163)

e) wherein, if one of the unselected wireless transceivers has more bandwidth availability than the selected transceiver during use of the wireless networking device, the processing interface is adapted to, as a result of the increased bandwidth availability and in a manner transparent to any layer of the wireless networking device above the processing interface, (i) identify at least one portion of the bandwidth of at least of the one of the unselected wireless transceivers that has more bandwidth availability than the selected transceiver and select that new transceiver,

As discussed above (1[i]), Chincholi teaches dynamic bandwidth monitoring and transceiver selection. A POSITA would have understood that this extends to a three-transceiver device. (EX1002, ¶164.)

Chincholi teaches: "[a]s the channel quality/availability of RATs 1301a, 1301b changes, the best RAT may be selected which may be different from the one previously used." (EX1005, [0154].) A POSITA would have understood this includes selection based on increased bandwidth availability. (EX1002, ¶165.)

This transceiver switching is performed transparently by the OMMA layer. (EX1005, [0192], [0126].) Thus, a POSITA would have understood that switching may occur without disassociation or reassociation. (EX1002, ¶166.)

f) (ii) prepare the first and second data streams, without requiring the disassociation of the recipient from the actual MAC and PHY interfaces of any wireless transceiver, for transmission to the recipient from the new transceiver using a specific subset of frequencies corresponding to its identified at least one portion of available bandwidth, and

As discussed above (1[k]), Chincholi teaches that once a new transceiver is selected, the OMMA layer prepares the stream for transmission over a specific frequency subset. Chincholi's MAC Resource Reservation module "may determine an amount of time duration and/or spectral fragment/bandwidth required by a packet or a set of packets." (EX1005, [0142].) A POSITA would have understood this includes segmenting, mapping, and generating physical-layer signals. (EX1002, ¶167.) Chincholi does not require disassociation during such preparation or transmission. (*Id.*, ¶168.)

g) (iv) cause the prepared first and second data streams to be transmitted to the recipient from the new transceiver, without requiring the disassociation of the recipient from the actual MAC and PHY interfaces of any wireless transceiver, to thereby continue to at least partially satisfy the first and second bandwidth requirements of the first and second applications; and

Chincholi teaches that: "[u]sing multiple RATs simultaneously may provide increased bandwidth and/or increased reliability for an application." (EX1005, [0194].)

As discussed above, this operation, including switching and transmitting, does not require disassociation. (EX1002, ¶¶169-70.)

h) wherein the wireless networking device's utilization of the available bandwidth of the first, second and third wireless transceivers does not prevent other wireless networking devices from utilizing a range of frequencies corresponding to the remaining portion of the bandwidth availability of the first, second and third wireless transceivers for data transmission purposes at the same time that processed data is being sent from one or more of the first, second and third wireless transceivers.

As discussed above (1[j]), Chincholi discloses "***multi-WTRU*** multi-IP flow cases." (EX1005, [0328].) For example, "[a] system may comprise ***multiple WTRUs***, a single NT, and multiple IP flows from the NT to one or more WTRUs." (EX1005, [0328].) Chincholi discloses OFDMA techniques that enable simultaneous bandwidth sharing. (EX1005, [0161]; Table 2; EX1002, ¶171.)

7. Claim 7: The method of claim 6, wherein the at least one portion of the third bandwidth of the first transceiver comprises a single portion.

Chincholi discloses that a "NT and WTRU may communicate with each other over a single radio frequency (RF) spectral band … using ***a channel within the band*** or aggregating multiple contiguous or noncontiguous channels." (EX1005, [0118].) A POSITA would have understood each "channel" within Chincholi as a "single portion" and where Chincholi identifies a single channel within the bandwidth of a transceiver, that portion comprises a single portion. (EX1002, ¶172.)

8. Claim 8: The method of claim 6, wherein the at least one portion of the third bandwidth of the third transceiver is contiguous.

Chincholi discloses that a "NT and WTRU may communicate with each other over a single radio frequency (RF) spectral band … using a channel within the band ***or aggregating multiple contiguous or noncontiguous channels***." (EX1005, [0118].) A POSITA would have understood that where Chincholi identifies multiple contiguous channels within the bandwidth of a transceiver as the at least one portion, that portion is contiguous. (EX1002, ¶173.)

9. Claim 9: The method of claim 6, wherein the third virtual PHY interface is not contiguous with the virtual MAC interface.

As discussed above (1[e]), Chincholi/Riggert renders obvious multiple virtual PHY interfaces in Chincholi's OMMA Controller, and the OMMA Scheduler comprises the "virtual MAC interface." (EX1002, ¶174.)

As shown in Figure 28, the OMMA Controller and Scheduler are distinct modules that communicate via control flow interfaces. A POSITA would have understood that, as modified by Riggert's teachings, Chincholi's OMMA Controller comprises the virtual PHY interface and the Scheduler comprises the virtual MAC interface. (EX1002, ¶175.) Accordingly, a POSITA would have understood that the third virtual PHY interface is not contiguous with the virtual MAC interface. (*Id.*)

10. Claim 10: The method of claim 6 further comprising the step of coupling first and second buffer memories respectively to the first and second actual PHY layers, the first and second buffer memories being configured to, during use of the wireless networking device, store data prior to its actual transmission to the recipient via the first and second actual PHY layers, the capacity of the first and second buffer memories being programmable.

Chincholi teaches that the MAC layer of each RAT may implement multiple transmission buffers, denoted Q_{ik}, which store data destined for WTRU *i* for IP flow *k* (or access category *k*). (EX1005, [0352]; EX1002, ¶¶176-78.) Because multiple transmission queues are implemented to handle multiple WTRUs and multiple IP flows, each queue Q_{ik} operates independently for the corresponding WTRU and flow. (*Id.*)

A POSITA would have understood that these buffers store data prior to its transmission via the PHY layer, as data processed by the MAC queues is passed to the PHY interface for physical layer transmission. (EX1002, ¶177.) A POSITA would have further understood that the buffer memories are coupled to the respective PHY interfaces to hold data prior to modulation and radio transmission. (*Id.*)

A POSITA also would have understood that such buffers may be implemented using hardware or software memory resources, including programmable registers or dynamically allocated memory, to support varying queue capacities based on system needs, application demands, or QoS requirements. (*Id.*, ¶178.)

11. Claim 11: The method of claim 10, wherein each of the first and second buffer memories comprises a programmable register.

As discussed above (claim 10), Chincholi teaches that data is queued prior to transmission using transmission buffers Q_{ik} for each WTRU and IP flow. (EX1005, [0352]; EX1002, ¶¶179-80.)

A POSITA would have understood that such transmission buffers may be implemented in hardware or software, and that a common way to configure or control the capacity, address pointers, and storage management for such buffers is by using programmable registers or register-based control structures. (EX1002, ¶180.) Thus, a POSITA would have recognized that Chincholi discloses or renders obvious the use of programmable registers to manage the buffer memories. (*Id.*)

12. Claim 12: The method of claim 10, further comprising the steps of:

a) connecting a fourth actual MAC interface to the processing interface; connecting a fourth actual PHY interface to the fourth actual MAC interface; associating a fourth wireless transceiver with the actual PHY interface, wherein the fourth wireless transceiver (i) is suitable for use in a wireless local area network, (ii) has a fourth bandwidth availability up to a fourth actual bandwidth, and (iii) is adapted to emit radio waves in a fourth band of frequencies; and

As discussed above (claim 6), Chincholi discloses multi-RAT aggregation, e.g., in Figure 4, including any number (up to "n") RATs operating on potentially different frequency bands (e.g., 2.4 GHz, 5 GHz, TVWS, LTE bands, etc.). (EX1005, [0132]–[0135]; Figs. 4 and 5; EX1002, ¶¶181-85.)

Chincholi discloses that in 802.11 devices, its OMMA layer connects to the actual MAC and PHY interfaces of each RAT and receives bandwidth feedback metrics from each transceiver. (EX1005, [0138], [0205]; Fig. 28.) Thus, Chincholi contemplates that adding a fourth transceiver entails connecting a fourth actual MAC to the processing interface, a fourth actual PHY interface to the fourth actual MAC interface, and the fourth transceiver to the fourth actual PHY interface. (EX1002, ¶182.) A fourth transceiver would be suitable for use in a wireless LAN, have a fourth bandwidth availability up to a fourth actual bandwidth, and would be adapted to emit radio waves in a fourth band of frequencies. (*Id.*)

b) forming in the processing interface a fourth virtual PHY interface that is configured to, during operation of the wireless networking device, feed information regarding the bandwidth availability of the fourth wireless transceiver back to the at least one virtual MAC interface.

As also discussed above (1[e]), a POSITA would have understood from Riggert that virtual PHY interfaces may be implemented to provide a logical abstraction layer between the OMMA layer and the actual MAC and PHY interfaces for each RAT. (EX1002, ¶183.) A POSITA would have understood that adding a fourth RAT/transceiver could entail adding a fourth virtualized interface (a "virtual PHY") to accommodate its interface to the OMMA layer. (*Id.*, ¶184)

A POSITA would have further understood that Chincholi's OMMA architecture readily extends to adding a fourth transceiver in an 802.11 wireless network by adding fourth actual MAC and PHY interfaces and forming a corresponding fourth virtual PHY interface to collect and manage feedback metrics for the newly added fourth transceiver. (*Id.*, ¶185.)

13. Claim 13: The method of claim 12, wherein the processing interface is configured to, when the wireless networking device is being used in a manner transparent to any layer of the wireless networking device above the processing interface, request or create a fourth association between the recipient and the fourth actual MAC and PHY interfaces; and wherein the selected transceiver comprises one of the first, second, third and fourth wireless transceivers and the unselected transceivers comprise the remaining three transceivers of the first, second, third and fourth transceivers.

As discussed above (claim 12), Chincholi teaches that its OMMA layer enables multi-RAT aggregation, where multiple transceivers operate simultaneously on potentially different frequency bands. (EX1005, [0132]–[0135]; Fig. 4; EX1002, ¶¶186-88.) Further, Chincholi describes modifying association request/response frames to include OMMA-specific discovery parameters (EX1005, [0127].) A POSITA would have understood that incorporating a fourth RAT/transceiver into Chincholi's system would enable a corresponding association between the recipient and the actual MAC and PHY interfaces for the fourth transceiver. (EX1002, ¶186.)

Chincholi discloses that creation of associations between MAC and PHY interfaces and a recipient is performed by the OMMA layer transparently to higher layers: "[t]he OMMA layer ***may be transparent***…" (EX1005, [0192], [0126].) Accordingly, a POSITA would have understood that Chincholi allows for forming such associations transparently to higher layers. (EX1002, ¶187.)

A POSITA would have further recognized that Chincholi's multi-RAT capabilities, such as continuously monitoring bandwidth and selecting RATs accordingly, (EX1005, [0235], [0154], [0161], [0235]), could readily extend to a four-transceiver system in which one transceiver is selected and the others remain unselected. (EX1002, ¶188.) The OMMA architecture readily accommodates additional RATs through its layered structure. (EX1005, [0138], [0205]; Fig. 28.)

14. Claim 14: The method of claim 12, wherein the fourth virtual PHY interface is not contiguous with the virtual MAC interface.

As discussed above (1[e] and claim 9), Riggert teaches virtual PHY interfaces separate from the virtual MAC interface, and Chincholi discloses that the OMMA Controller and virtual MAC function are separate modules that communicate via control interfaces. (EX1005, Fig. 28; [0201], [0205]; EX1006; EX1002, ¶189.) A POSITA would have understood that the fourth virtual PHY interface likewise would not be contiguous with the virtual MAC interface. (EX1002, ¶189.)

15. Claim 15: The method of claim 1, wherein the wireless networking device comprises a wireless access point.

Chincholi teaches wireless communication between a network terminal (NT) and a wireless transmit/receive unit (WTRU). (EX1005, [0002]; EX1002, ¶190.) An NT may be an "***access point***" (*id.*) and a "WiFi access point" may be a node on Chincholi's wireless communication network (*id.*, [0115]).

16. Claim 16: The method of claim 1, wherein the wireless networking device comprises a handheld computing device.

The OMMA layer of Chincholi may be implemented in NTs and WTRUs: in "an IEEE 802.11 based Wi-Fi system, the NT ***and/or a WTRU*** may be configured to work in the infrastructure mode of the adhoc mode." (EX1005, [0121]; [0122]; EX1002, ¶191.) Thus, a WTRU may be the wireless networking device of claim 1.

Chincholi discloses that a WTRU may be a "user equipment (UE), a mobile station, a fixed or mobile subscriber unit, a ***pager***, a ***cellular telephone***, a ***personal digital assistant (PDA)***, a ***smartphone***, a laptop, a netbook, a personal computer, a wireless sensor, consumer electronics, and the like." (EX1005, [0074].) Thus, a POSITA would have recognized that Chincholi discloses that the wireless networking device of claim 1 comprises a handheld computing device. (EX1002, ¶192.)

17. Claim 17: The method of claim 1, wherein each one of the first and second frequency bands are specified in at least one member of the family of IEEE 802.11 standards.

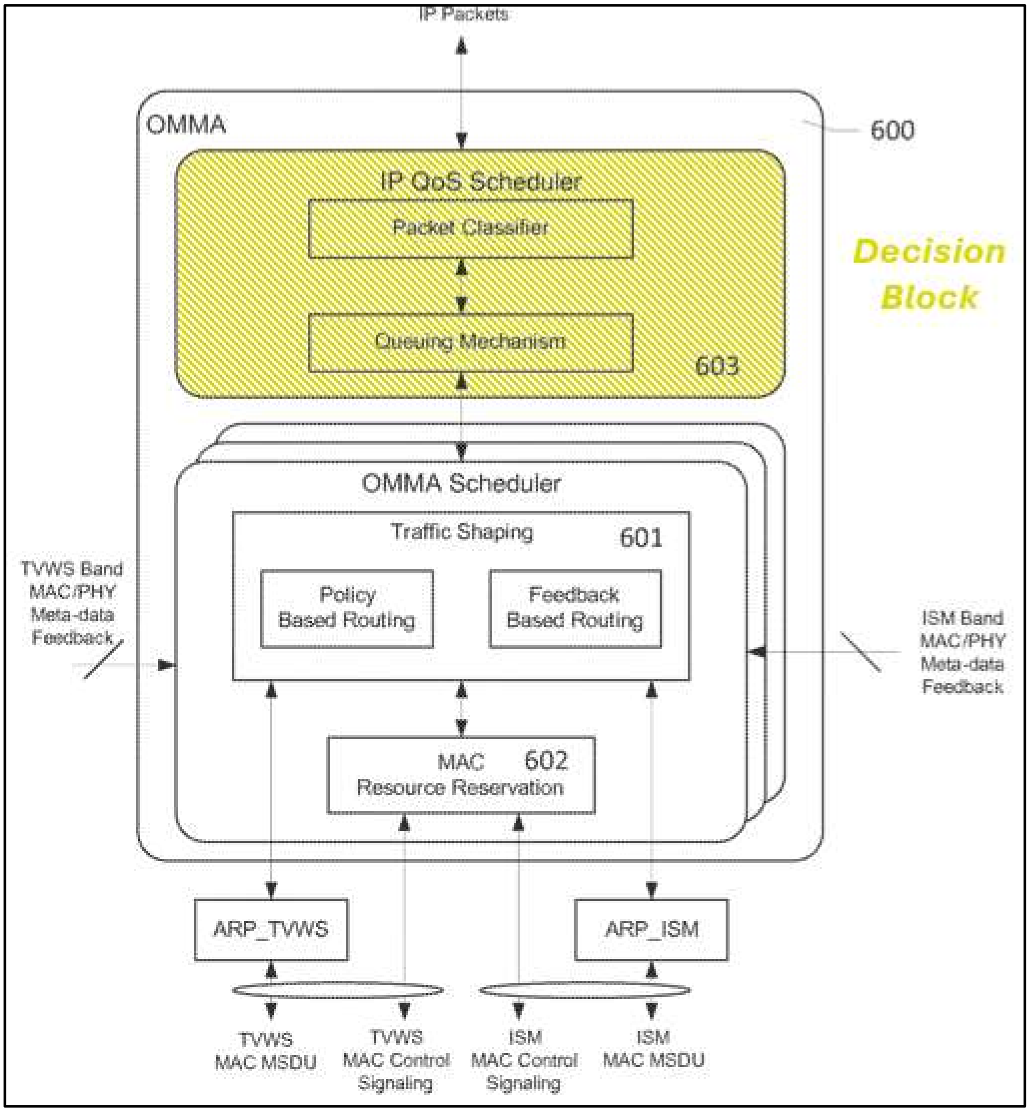
Chincholi teaches that its techniques support implementing an IEEE 802.11-based Wi-Fi system. (EX1005, [0121]; EX1002, ¶193.) Thus, "[t]he NT 201 may operate using one flavor of the 802.11 system (*e.g.*, 11a/b/g/n) at any given time over a specific band (*e.g.*, 2.4GHz or 5GHz) when communicating with a WTRU." (EX1005, [0121].)

18. Claim 18: The method of claim 17, wherein the at least one member of the family of IEEE 802.11 standards was in existence as of Oct. 30, 2013.

Chincholi expressly discloses 802.11 standards ("11a/b/g/n") that were in existence as of October 30, 2013. (EX1005, [0121]; EX1002, ¶194.)

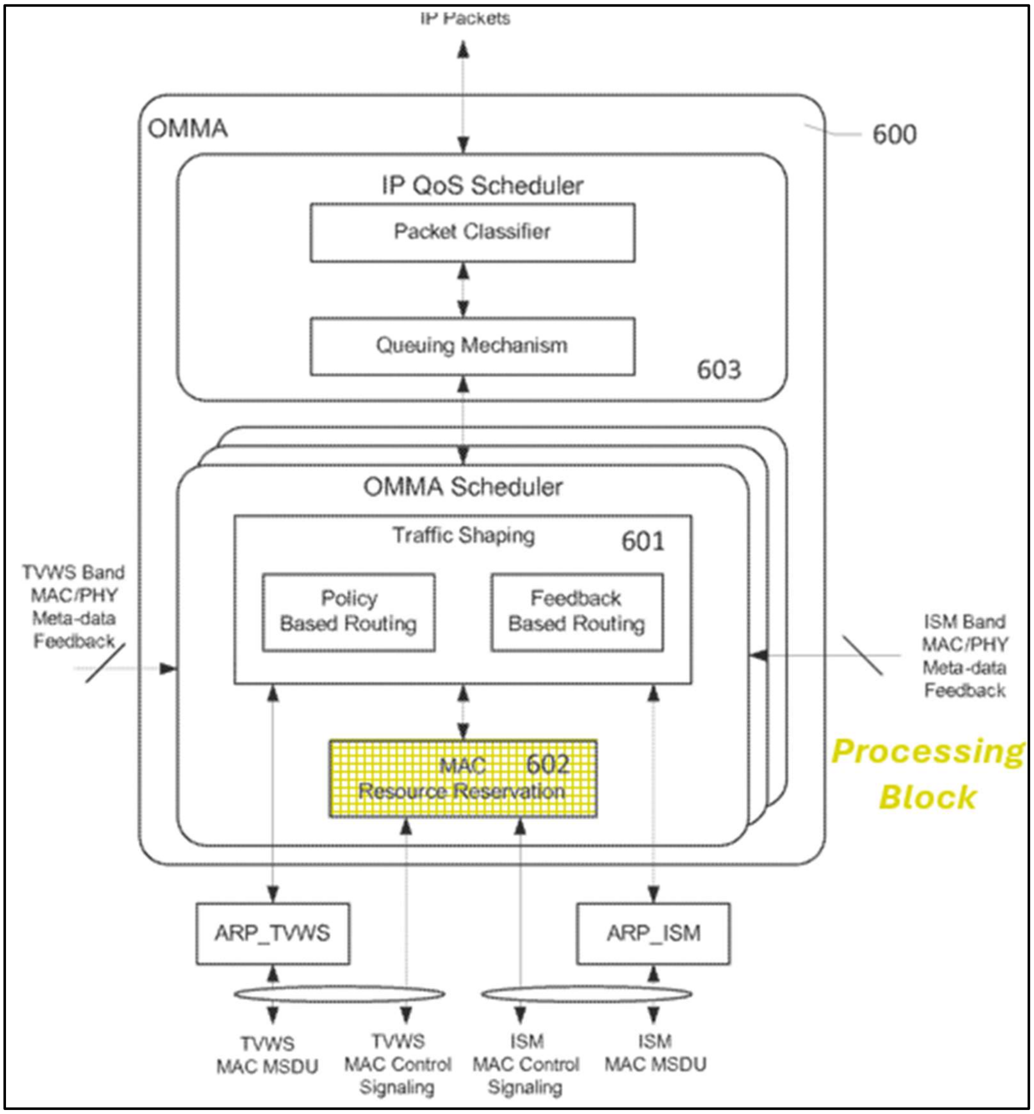
19. Claim 19: The method of claim 1, wherein the virtual MAC interface includes a decision block.

The '337 patent states that the ***decision block*** "determines the size and type of data stream being received, and the type of processing necessary to put the stream in a format where it is capable of being transmitted." (EX1001, 3:21-24.) Chincholi discloses this same functionality in the IP QoS Scheduler module: "[t]he IP QoS Scheduler 603 may segregate single IP packet stream comprising multiple IP QoS types into distinct IP QoS streams… so that the traffic shaping module 601 may treat each IP QoS stream independently and satisfy the specific QoS requirements when routing IP packets." (EX1005, [0143]; EX1002, ¶195.)



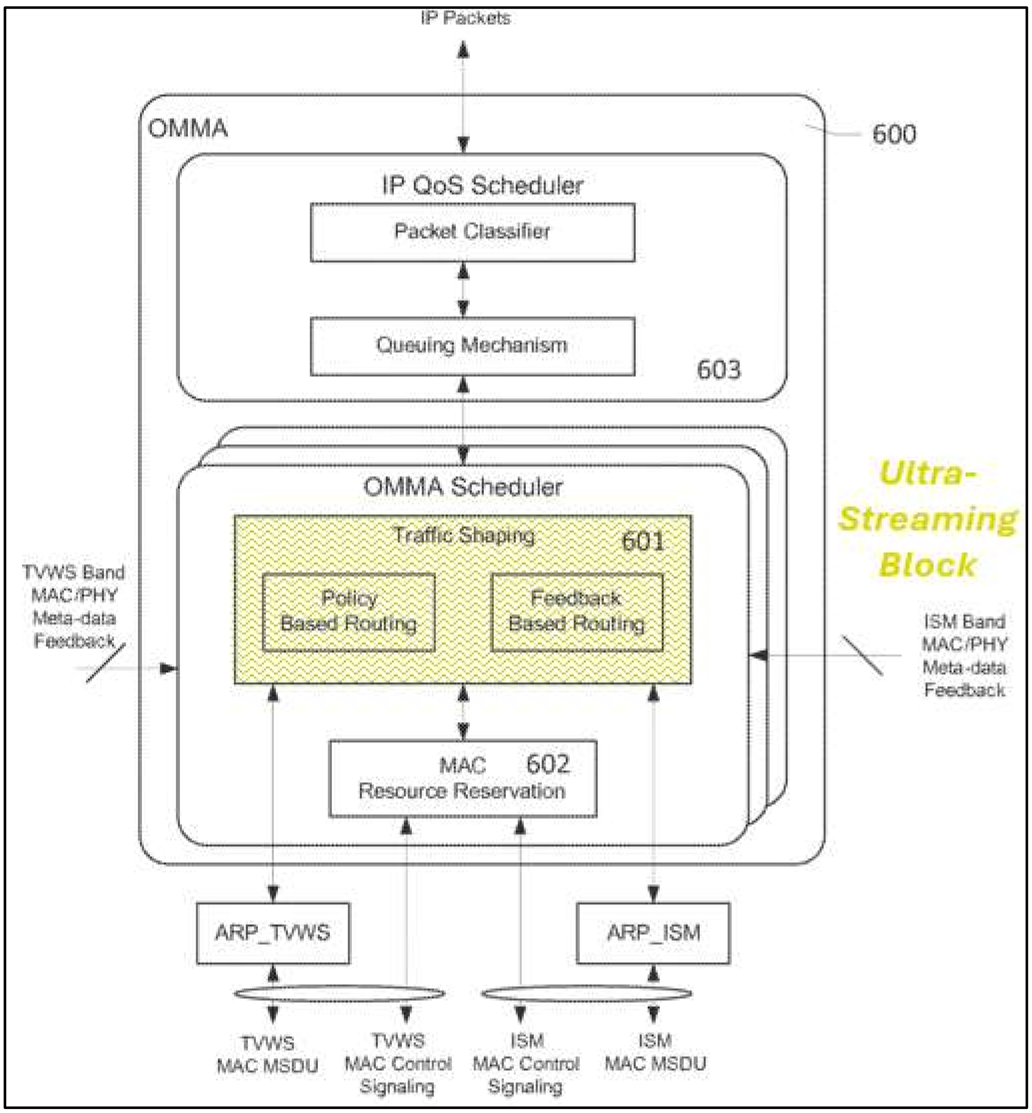
20. Claim 20: The method of claim 1, wherein the virtual MAC interface includes a processing block.

The ’337 patent states that the ***processing block*** “processes the data stream as determined by the decision block, and couples to an ultra-streaming block.” (EX1001, 3:24-26.) Chincholi discloses this same functionality in the MAC Resource Reservation module. (EX1002, ¶196.) As Chincholi teaches, “[t]he MAC Resource Reservation module 602 may determine an amount of time duration and/or spectral fragment/bandwidth required by a packet or a set of packets. This module may transmit specific requests to the RATs over the A1/A2 interface." (EX1005, [0142].)



21. Claim 21: The method of claim 1, wherein the virtual MAC interface includes an ultra-streaming block.

The '337 patent states that the claimed ***ultra-streaming block*** "manages the processing of signal streams or sub-streams given the available resources (memory, processing speed, number of available radios, etc.), and packetizes sufficient processed streams or sub-streams." (EX1001 at 3:26-30.) Chincholi discloses this same functionality in the form of the ***Traffic Shaping Module***. (EX1002, ¶197.) As Chincholi teaches, "[t]he ***traffic shaping module 601*** may [be] responsible for determining the way packets are routed across RATs," for example by "using policy based routing or feedback based routing." (EX1005, [0139].)



22. Claim 22: The method of claim 1, wherein each of the virtual PHY interfaces includes an RF block.

The '337 patent states that the "the RF block" may "form[] a virtual PHY layer," (EX1001 at 8:26) and that a virtual PHY layer may comprise multiple RF blocks "denot[ing] the virtual use of two sets of allocated transceiver resources." (EX1001 at 4:41-44.) The RF block may communicate with the ultra-streaming block "about actual resource availability" or alternatively may communicate directly with the virtual MAC decision block and/or processing block. (EX1001 at 4:44-50.) Thus, a POSITA would have understood the claimed "RF block" to be a component of a virtual PHY capable of receiving and reporting information about the availability of RF resources. (EX1002, ¶198.)

As discussed above (1[e]), Chincholi discloses that the OMMA Controller receives feedback metrics regarding resource availability from RATs over the "A2" interface. A POSITA would have found it obvious in view of Riggert to implement virtual PHY interfaces in the OMMA Controller to receive this feedback on a per RAT basis and provide the information to Chincholi's "traffic shaping module" (*i.e.*, the "ultra-streaming" block). Thus, a POSITA would have recognized that Chincholi/Riggert discloses that each virtual PHY includes an RF block capable of receiving and reporting RF resource availability. (EX1002, ¶199.)

23. Claim 23: The method of claim 1, wherein the at least one portion of the first bandwidth of the first transceiver comprises a single portion.

Chincholi discloses that a "NT and WTRU may communicate with each other over a single radio frequency (RF) spectral band … using ***a channel within the band*** or aggregating multiple contiguous or noncontiguous channels." (EX1005, [0118].) A POSITA would have understood each "channel" within Chincholi as a "single portion" and where Chincholi identifies a single channel within the bandwidth of the first transceiver as the at least one portion of the first bandwidth, that portion comprises a single portion. (EX1002, ¶200.)

24. Claim 24: The method of claim 1, wherein the at least one portion of the first bandwidth of the first transceiver is contiguous.

Chincholi discloses that a "NT and WTRU may communicate with each other over a single radio frequency (RF) spectral band … using a channel within the band ***or aggregating multiple contiguous or noncontiguous channels***." (EX1005, [0118].) A POSITA would have understood that where Chincholi identifies multiple contiguous channels within the bandwidth of the first transceiver as the at least one portion of the first bandwidth, that portion is contiguous. (EX1002, ¶201.)

25. Claim 25: The method of claim 1, wherein the at least one portion of the second bandwidth of the second transceiver comprises a single portion.

Chincholi discloses that a "NT and WTRU may communicate with each other over ***a single radio frequency (RF) spectral band*** … using ***a channel within the band*** or aggregating multiple contiguous or noncontiguous channels." (EX1005, [0118].) A POSITA would have understood each "channel" within Chincholi as a "single portion" and where Chincholi identifies a single channel within the bandwidth of the second transceiver as the at least one portion of the second bandwidth, that portion comprises a single portion. (EX1002, ¶202.)

26. Claim 26: The method of claim 1, wherein the at least one portion of the second bandwidth of the second transceiver is contiguous.

Chincholi discloses that a "NT and WTRU may communicate with each other over a single radio frequency (RF) spectral band … using a channel within the band ***or aggregating multiple contiguous or noncontiguous channels***." (EX1005, [0118].) A POSITA would have understood that where Chincholi identifies multiple contiguous channels within the bandwidth of the second transceiver as the at least one portion of the second bandwidth, that portion is contiguous. (EX1002, ¶203.)

27. Claim 27: The method of claim 1, wherein the first virtual PHY layer is not contiguous with the virtual MAC interface.

As discussed above(limitation 1[e]), Chincholi/Riggert renders obvious the implementation of multiple virtual PHY interfaces in Chincholi's OMMA controller and the OMMA Scheduler comprises the "virtual MAC interface." (EX1002, ¶204.)

As shown in Figure 28, the OMMA Controller and the OMMA Scheduler are distinct blocks that communicate via control flow interfaces. A POSITA would have understood that the first virtual PHY layer is not contiguous with the virtual MAC interface. (*Id.*, ¶205.)

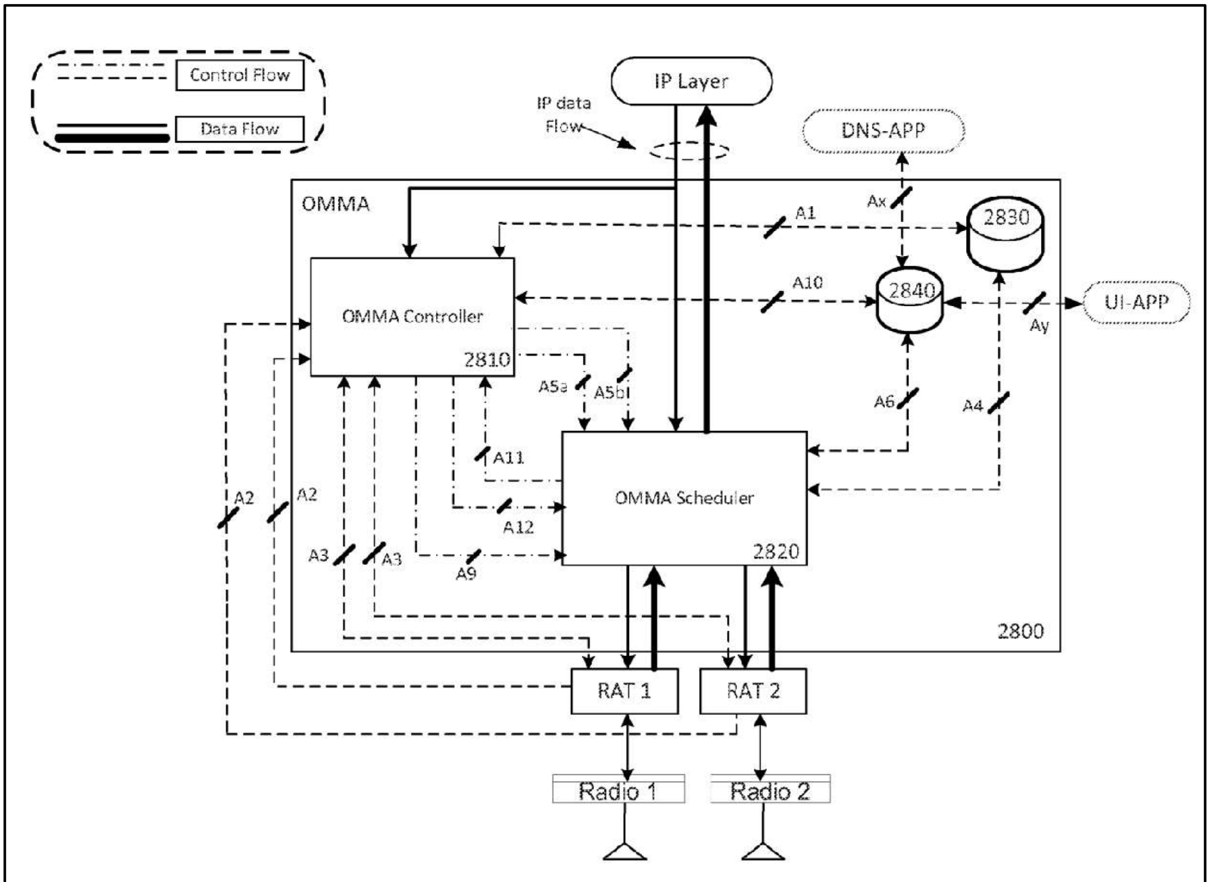


FIG. 28

28. Claim 28: The method of claim 1, wherein the second virtual PHY layer is not contiguous with the virtual MAC interface.

As discussed above (claim 27), Chincholi discloses that the virtual PHY interfaces in the OMMA Controller and the virtual MAC interface in the OMMA Scheduler are distinct blocks that communicate via control flow interfaces. A

POSITA would have understood that the second virtual PHY layer is not contiguous with the virtual MAC interface. (EX1002, ¶206.)

29. Claim 29: The method of claim 1, wherein the processing interface comprises multiple virtual MAC interfaces.

In addition to an OMMA layer in the context of a single NT communicating with WTRUs, Chincholi discloses other wireless communication architectures involving multiple base stations in a radio access network (RAN) that communicate with wireless devices through a multiple input, multiple output (MIMO) architecture. (EX1005, [0109], Figure 1E; EX1002, ¶¶207-208.)

A POSITA would have recognized that each base station in Figure 1E comprised its own OMMA layer (*i.e.*, virtual MAC interface) and that an obvious implementation would have been combining the multiple virtual MAC interfaces of the system in Figure 1E into a single wireless communication device. (EX1002, ¶208.) Combining this functionality into a single device could, for example, leverage common hardware and increase device efficiency. (*Id.*)

30. Claim 30: The method of claim 1, wherein the processing interface includes a bandwidth allocator.

The ’337 patent does not describe any additional functionality performed by the claimed “bandwidth allocator.” A POSITA would have understood a ***bandwidth allocator*** to refer to a processing layer capable of allocating the bandwidth availabilities of multiple transceivers to meet the bandwidth requirement of one or more data streams. (EX1002, ¶¶209-11.)

Chincholi discloses this functionality. (*Id.*) It teaches that "the traffic shaping module may determine how a packet is routed using policy based routing ***or feedback based routing***." (EX1005, [0139].) In feedback-based routing, "the OMMA transmitter may use measurement metrics fed back from each RAT," including "channel quality metrics and the ***number of available resources on the medium***." (EX1005, [0161].) Using this feedback, the "OMMA layer may intelligently manage data traffic across multiple RATs as a function of the link quality of each RAT." (EX1005, [0194].) The OMMA layer can also "readjust the assigned medium resources to a WTRU on each RAT … based on global knowledge of resource assignment on other RATs." (EX1005, [0196].) Thus, the "OMMA layer may utilize MAC resource reservation to achieve ***globally optimal resource allocation across RATs***." (*Id.*)

A POSITA would therefore have recognized that Chincholi discloses a processing layer capable of allocating the bandwidth availabilities of multiple transceivers to meet the bandwidth requirement of one or more data streams. (EX1002, ¶211.) Chincholi thus discloses a "bandwidth allocator." (*Id.*)

VIII. CONCLUSION

For at least the foregoing reasons, this Petition should be instituted.

Respectfully submitted,

Date: July 3, 2025

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CERTIFICATION UNDER 37 C.F.R. § 42.24

Under the provisions of 37 C.F.R. § 42.24, the undersigned hereby certifies that the word count for the foregoing Petition for *inter partes* review (excluding the table of contents, table of authorities, mandatory notices, certificate of service or word count, and appendix of exhibits or claim listing) totals 13,957 words, which is within the word limit allowed under 37 C.F.R. § 42.24(a)(i).

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CERTIFICATE OF SERVICE

Pursuant to 37 C.F.R. §§ 42.6(e), 42.105(a), the undersigned hereby certifies service on the Patent Owner of a copy of this Petition and its respective exhibits at the official correspondence address for the attorneys of record for the '337 patent as shown in USPTO PAIR via FedEx:

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