Telecom Regulatory Authority of India

Recommendations

on

Allocation and Pricing of Microwave Access (MWA) and Microwave Backbone (MWB) RF carriers

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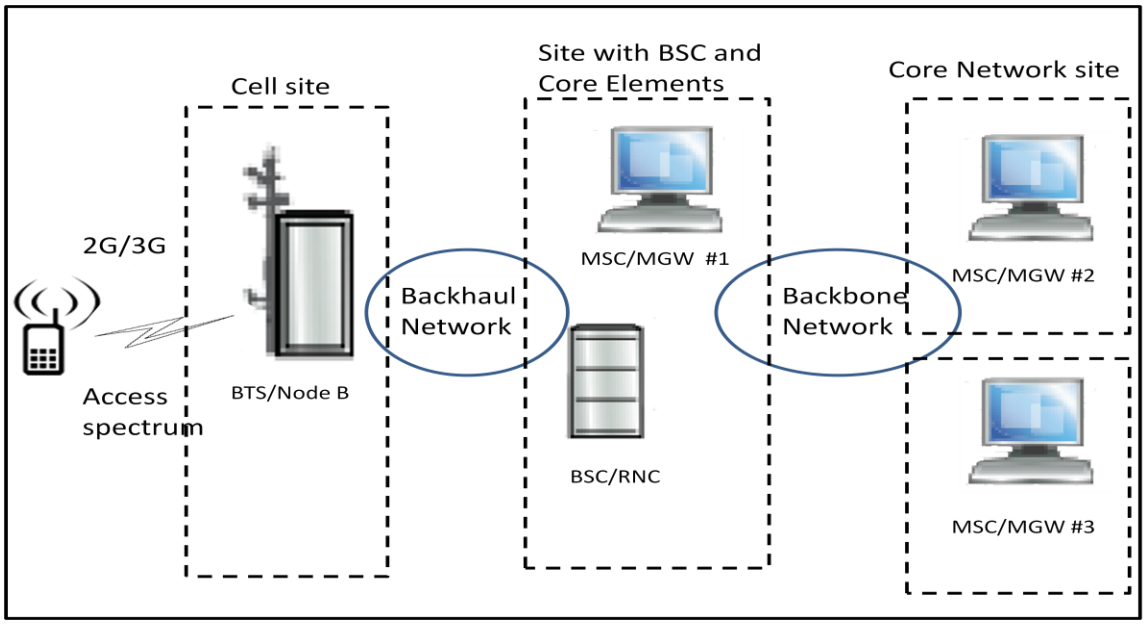
CHAPTER I: INTRODUCTION

1.1 The mobile network can be visualized as connectivity from mobile handsets to cell site (BTSs/Node Bs)[1] through access spectrum, cell site to BSCs/RNCs[2] thorough backhaul network and the interconnection of MSCs/MGWs[3] and other core elements through backbone network (Fig 1.1). Microwave (MW) point to point (PtP) links plays an important role in backhaul as well as backbone network, each of which is discussed in the subsequent paras.

Fig 1.1



Mobile Backhaul Network

1.2 The mobile backhaul is an integral part of the network which connects cell site BTSs with BSCs. From an implementation point of view, the backhaul architecture can be further divided into two parts (Fig. 1.2):

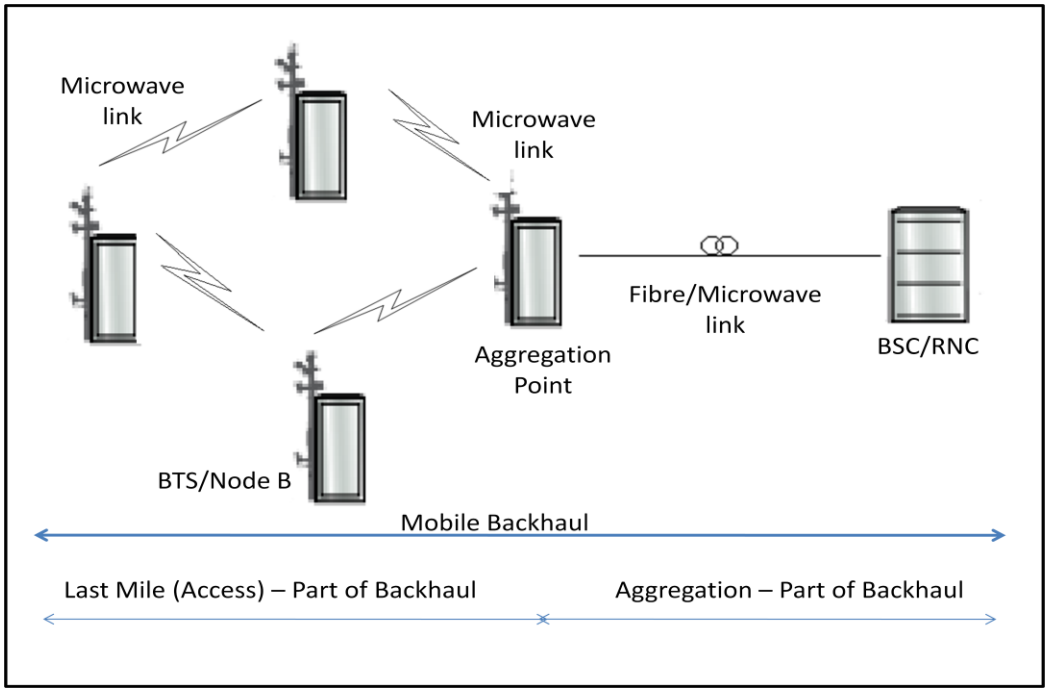
- Last Mile (Access) part of backhaul - It provides last mile backhaul connectivity to BTS from the aggregation point. It aggregates traffic

[1] BTS- Base Transceiver, Node B- It is a term used in Universal Mobile Telecommunications System (UMTS) and is equivalent to the BTS
[2] BSC-Base Station Controller, RNC-Radio Network Controller, AGW-Access Gateway
[3] MSC- Mobile Switching Centre, MGW- Media gateway

from a number of BTSs sites and feeds it into the aggregating network. It can be called pre-aggregation segment also.

- Aggregation part of backhaul: It aggregates traffic from different access parts and backhauls it to BSC/RNC.

Fig. 1.2



1.3 Depending on an operator's strategy and availability at the site, one or a combination of various available physical link technologies (MW, copper and fiber) can be used in this part. Each type of backhaul link has got certain advantages and disadvantages. Links provided on copper suffer from its limited capacity support and inability to scale in a cost efficient manner. Therefore, it is not very useful for technologies like 3G or LTE which require higher data capacity. OFC provides practically unlimited capacity. However, it is costly and requires time for deployment. Pulling Fiber to every cell site is practically not feasible due to cost and logistical challenges. Though MW does not have the matching capacity of fiber, it is cheaper, scalable and a highly reliable option and can be deployed quickly. Therefore, it is the dominating backhaul technology in the majority of cell sites in the pre-aggregation segment of backhaul. In

certain rural and remote locations, MW is the only practical high-capacity backhaul solution available. Reducing inter-site distances have also helped in MW links becoming so popular. However, aggregation part of the backhaul network mainly relies on OFC considering its higher bandwidth requirement. However, MW can also be used in places of lesser bandwidth requirements.

1.4 Due to the increasing use of newer multimedia and other data centric applications, the proliferation of third and fourth generation wireless mobile systems is increasing and, therefore, the requirement of mobile backhaul capacity is expected to grow rapidly in future.

Mobile Backbone Network

1.5 Mobile backbone network refers to the interconnection of core elements situated at separate geographic locations. As the requirement of bandwidth is large, typically, OFC is used in the backbone network. However, MW is also sometimes used in the backbone network, particularly in those areas where laying fibre is not a feasible option due to difficult terrain, time constraints or economic viability.

Types of MW RF Carriers

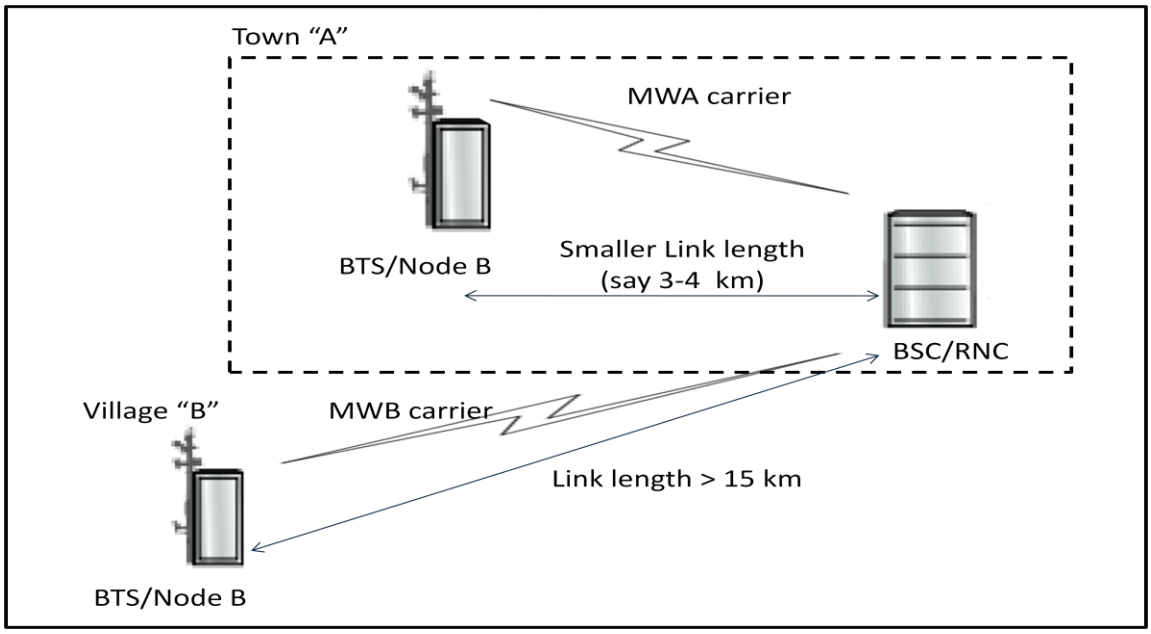
1.6 For PtP links, MW frequencies are generally assigned in chunks of 2x28 MHz, known as MW carriers. There are two types of MW carrier viz. **M**icro**w**ave **A**ccess (MWA) carriers and **M**icro**w**ave **B**ackbone (MWB) carriers.

1.7 MWA carriers refer to the MW carriers in the frequency bands of 10 GHz and beyond. These are assigned for short-haul systems which are used to carry traffic through relatively shorter distances. MWA carriers are typically used in the mobile backhaul networks (mainly in the pre-aggregation part). In India, currently 13 GHz (12.750-13.250 GHz), 15

GHz (14.5-15.5 GHz), 18 GHz (17.7-19.7 GHz) and 21 GHz (21.2-23.6 GHz) bands are used for the assignment of frequencies for MWA carriers.

1.8 MWB carriers are assigned for relatively longer links. These are assigned for a minimum link length of 15 Km. However, in the hilly terrains (including Assam, North-East, Himachal Pradesh and Jammu and Kashmir LSAs), MWB carriers are assigned for a minimum link length of 10 Km[4]. Normally carriers in the frequency bands below 10 GHz are assigned for MWB carriers. In India, currently 6 GHz (5.925-6.425 GHz) and 7 GHz (7.425-7.725 GHz) bands are used for the assignment of frequencies for MWB carriers. MWB carriers are generally used in the backbone networks of the cellular network. These can also be used in backhaul section if the distance of link length is more (Fig 1.3).

Fig 1.3



WHY IS HIGH-CAPACITY BACKHAUL REQUIRED?

1.9 The world is moving rapidly to the use of data centric applications from mobile devices. The explosive data growth in mobile data traffic is being driven by the growing popularity of mobile broadband-enabled devices

[4] WPC order dated 23.03.2005

such as smart-phones, tablets etc. These devices, coupled with bandwidth intensive applications are generating very high level of traffic across mobile networks and are driving the adoption of new access technologies and increase in the number of cells (macro/small/femto etc). This has resulted in the need for greater capacity in the mobile microwave backhaul networks.

1.10 As the experience of customers in accessing mobile broadband improves, demand for newer and content rich applications will grow even further. This trend in growth is likely to continue and is forcing the Telecom Service Providers (TSPs) to deploy IMT/IMT advanced access technologies. However, this shift to higher technologies is not possible without complementary support in the form of higher capacity of mobile backhaul. Mobile broadband service requires a major upgradation in the capacity of mobile backhaul.

1.11 For 2G and 3G technologies, average base station capacity is 2-30 Mbps, but the capacity required for deployment of 4G technologies is comparatively high (Table 1.1). According to the ITU, IMT mobile networks are defined as providing at least 100 Mbps peak capacity for high mobility applications, and 1 Gbps for stationary applications. This massive jump in performance definitions from 3G to 4G is one of the key drivers for enhanced backhaul capacity needs. It is expected that cell site backhaul will inevitably grow to 150- 200 Mbps per cell site in the foreseeable future, and multiple Gbps in the aggregation networks.

Table-1.1
Backhaul Requirement for different Access Technologies[5]

Access Technology	**Backhaul Capacity per BTS**
2G	Typically 2 Mbps to 4 Mbps required. Very large urban BTSs could require up to 12 Mbps.
3G	HSPA will require 12 Mbps – 30 Mbps for typical macro-base station deployments.
LTE	LTE macro-base stations will require between 30 – 120 Mbps, with very large urban base stations requiring up to 240 Mbps backhaul capacity.

[5] OFCOM:Future Options for Efficient Backhaul, 23rd January 2007

1.12 The importance of MW in the backhaul was emphasized in the previous section. Today, MW connections currently account for over 50% of mobile backhaul access connections for macro cell sites worldwide[6]. As per one estimate, nearly 80 per cent of cell sites in India have a MW-based backhaul link. Moving forward, it is expected to play an increasingly important role in providing backhaul connectivity where fiber or copper-based access is either not available or economically unviable to deploy. Therefore, its assignment criteria cannot be locked in time when the requirement of backhaul was limited to 2G technologies; it needs to be looked afresh.

DoT's reference and its background

1.13 Through its letter dated 26th November 2012 **(Annexure 1.1)**, the Department of Telecommunications (DoT) sought TRAI's recommendations, under clause 11 (1) (a) of TRAI Act 1997 as amended, on the following issues:

a. Methodology for Allocation and Pricing of MW Access and Backbone (MWA / MWB) carriers for new service providers and the existing service providers for initial and additional allocations of MW Access and MW backbone carriers.

b. Criteria for withdrawal of excess allocation of MWA and MWB carriers from existing service providers.

c. Annual spectrum usages charges and criteria for pricing for different bands of MWA and MWB carriers including any upfront charges, along with date of applicability.

1.14 Presently, in India, the assignment of MW backhaul carriers is made administratively, subject to availability of spectrum. Regarding the assignment of carriers for MW access and backbone networks, the order

[6] Infonetics Research, Macrocell Mobile Backhaul Equipment and Services, 2012

of 18th April 2002 issued by the Wireless Planning and Coordination (WPC) wing of the DoT stated that-

"Assignment of frequencies for MW access and MW backbone networks for cellular operations would continue to be considered on the basis of full justification on the requirements and availability of the spectrum on case-to case and link-to-link basis after taking into consideration the interest of the other users with a view to ensure electromagnetic compatibility etc. The complete technical analysis and all related aspects of frequency assignments, including efficient use of spectrum will apply before assigning frequencies for various MW access/backbone links. There will be no obligations on the part of the Government to assign frequencies for such purposes".

1.15 In November 2006, WPC issued another order for the assignment and charging methodology to be followed for MW carriers for GSM and CDMA based TSPs, which substantially increased the spectrum charges. Regarding the assignment criteria for MW carriers, it stated that:

- The first microwave access carrier can be allotted for the complete service area; subsequently carriers shall be allotted based on justification and for cities/districts where it is found to be essential.
- Assignment of frequencies for MW access and MW backbone networks for GSM and CDMA based telecom networks would continue to be considered on the basis of full justification of the requirements and availability of the spectrum, on case-to-case and link-to-link basis, after taking into consideration the spectrum requirement of the other users with a view to ensuring electromagnetic compatibility etc. The complete technical analysis and all related aspects of frequency assignments, including efficient use of spectrum, will apply before assigning frequencies for various MW access and MW backbone links. There will be no obligation on the part of the Government to assign frequencies for such purposes.
- The assignment of MW access and MW backbone frequencies shall not be exclusive for any service provider and will be shared with other services / users.

1.16 Aggrieved by this order of November 2006, cellular Operators under the umbrella of their association (COAI) filed a petition (petition No. 122) in TDSAT in 2007. The petitioner *inter alia* prayed that:

(a) strike down the said impugned order dated 03.11.2006 issued by the Respondents unilaterally increasing the spectrum charges for Microwave (MW) Access and MW Backbone networks GSM based telecom service providers, as being unfair, unjust, unreasonable, unwarranted, violative of the terms of the Licence Agreement, unilateral, violative of the contract between the Cellular Operators and the Government and otherwise illegal.

(b) direct the Respondents not to unilaterally vary / change the mutually agreed contract between the Cellular Operators and the Government with respect to the spectrum charges for Microwave (MW) Access and MW Backbone networks;

1.17 Telecom operators, providing services using CDMA technology, filed a petition (petition No. 116 of 2007) through Association of Unified Telecom Service Providers of India (AUSPI) in Hon'ble TDSAT on 11th May, 2007. The petitioners inter alia prayed for the following relief:

"Hold and declare that the action of the Respondents in not extending the benefit of uniform charging methodology to the CDMA operators at par with the GSM operators from November 2003 onwards is discriminatory, arbitrary, illegal and violative of Article 14 of the Constitution of India"

1.18 On 22.04.2010, Hon'ble TDSAT set aside the WPC order dated November 2006. However, in its judgment dated 18.07.2011 on the petition filed by AUSPI, Hon'ble TDSAT upheld the position of the DoT. On the petition filed by AUSPI, part of the judgment order by Hon'ble TDSAT states that *".....we, therefore are of the opinion that the impugned order dated 3rd November 2006 cannot be struck down, as being discriminatory or violative of the National Telecom Policy."*

1.19 The Government filed an appeal in 2010 before the Hon'ble Supreme Court against the TDSAT judgment dated 22.04.2010 and the matter now is sub-judice.

1.20 In December 2010, a Committee was constituted by the DoT under the chairmanship of DDG (Radio), Telecommunication Engineering Centre (TEC), to determine the actual requirement of MW access carriers for different services. In its report dated 7th October 2011, which is a part of the DoT's reference to the Authority, the Committee recommended that MWA carriers (each of 28 MHz paired bandwidth) may be allocated as per the following Table:

Table 1.2
Recommendations of the Committee on MWA's assignment

Service	**Metro and A circle**	**B circle**	**C circle**	**Remarks**
2G	3-4	2-3	2	
3G	One additional RF pair in each category compared to 2G			
BWA	4-6	3-4	3	This is the requirement for a standalone BWA operator as well as for an operator having 2G and 3G services in a service area.

1.21 On 16th March 2012, the DoT issued guidelines for allocation of Microwave Access RF carriers for BWA services as an interim measure (annexed as part of the DoT's reference[7]). As per these guidelines, a total of 4 MW Access carriers in Metros and 'A' circles and 3 in 'B' and 'C' circles respectively may be allotted to new BWA operators as well as existing 2G/3G operators offering BWA services (including their present assignment of MW Access carriers) on their request. Allotment will be considered in the frequency bands as per the channeling plan provisioned in the National Frequency Allocation Plan -2011 amended from time to time, subject to availability and execution of a legally vetted frequency agreement. The DoT's order further stated that additional MW

[7] These guidelines were issued as an interim measure for the assignment of MWA carriers to TSPs who acquired are standalone BWA operators and acquired the BWA spectrum through 2010 auctions.

access spectrum beyond 4 carriers in Metros and A circles and 3 in B circles may be considered by the Government after formulation of necessary criteria.

1.22 In this backdrop, the DoT has sent the reference dated 26th November 2012 to the TRAI seeking its recommendations on the various issues related to the assignment and pricing of MWA/MWB carriers. Subsequent to the reference, TRAI sought certain information on the subject from the DoT. The DoT provided some information in June 2013 and remaining information in August 2014. Taking into consideration the information given in June 2013, TRAI issued a Consultation Paper (CP) on 28th March 2014, raising specific issues for consideration of stakeholders. The key issues raised in the CP were (i) the number of MW carriers required to be assigned to TSPs in case of 2G, 3G and BWA technologies, (ii) the preferred mechanism of assignment of MWA/MWB carriers to TSPs i.e. 'exclusive basis assignment' or 'link-to-link based assignment, administrative assignment or assignment through auction, (iii) criteria for allocation of additional carriers, (iv) pricing mechanism for assigned carriers, (v) exploration of options for assignment of MWA carriers in all the spectrum bands in 6-42 GHz range and (vi) assignment of MWA carriers in higher frequency bands viz. E-band and V-band[8].

1.23 In response to the CP, TRAI received comments and counter comments from stakeholders. These were placed on the TRAI website www.trai.gov.in. An Open House Discussion (OHD) with stakeholders was organised on 19th June 2014. After analyzing the various issues involved and also considering the comments received from stakeholders in their written responses and during the OHD, the Authority has finalized these recommendations.

[8] The frequency range 71-76 GHz /81-86 GHz is known as E-Band and frequency range 57-66 GHz is known as V-Band. These frequencies are called *millimeter waves* and are used as backhauling solution in some of the countries.

1.24 Chapter –II discusses backhaul requirements in different technology scenarios and the assessment of number of MW carriers required in the initial stage of roll-out and in the later period. The chapter also deals with the availability status of carriers in 13GHz/15GHz/18GHz/21GHz bands and the need to explore the possibility of allocation in other internationally harmonized bands in 6-42 GHz range viz. 26 GHz, 28 GHz, 32 GHz, 38 GHz and 42 GHz. Chapter –III discusses the pricing mechanism and the criteria for determination of annual spectrum charges for MWA and MWB carriers in sub-42 GHz band - percentage of AGR or 'link-to-link' basis or a combination of the two. Various issues regarding adoption in case of E-band and V –Band for MW carriers, the licensing framework, allocation and charging criteria etc. are discussed in the Chapter-IV. The last chapter summarizes the Recommendations.

CHAPTER-II: ASSESSMENT OF THE REQUIREMENT OF MWA/MWB R.F. CARRIERS

Requirement of MWA/MWB Carriers

2.1 Mobile broadband services require a quantum increase in the capacity of mobile access as well as backhaul network. The access technologies has evolved over a period of time which has resulted in better use of access spectrum in terms of improved spectral efficiencies and increased capacity. However, the higher data carrying capacity of access technologies can be effective in providing mobile broadband services to the customers only if these are complemented by an equally supportive and capable backhauls.

2.2 Based on the access technology deployed, the access service providers can be categorized in to various groups: (a) TSPs deploying only 2G technologies; (b) TSPs providing services using both 2G and 3G technologies; (c) TSPs deploying BWA technologies alone; and (d) TSPs providing 2G, 3G and BWA technologies.

2.3 The requirement of backhaul depends on many factors including the technology deployed by a TSP, the number of nodes to be connected to a hub site, the number of OFC PoPs and, to some extent, on the network topology adopted by the TSP. Further, the requirement of mobile backhaul carriers by a TSP may be less at the time of rolling-out of its network. However, with the increase in traffic in its access network, there will be a requirement for additional MW access carriers, particularly in dense urban or urban areas where there is no further scope for reducing inter-BTS distances and the reuse of already assigned carriers is not possible because of the possibility of interference.

2.4 In the CP, stakeholders were requested to give their views on the requirement of MWA/MWB carriers for a TSP deploying various services

viz. 2G only, 3G only, BWA only, 2G and 3G only, 2G and BWA only and 2G, 3G and BWA only.

2.5 Many stakeholders responded that this is not as simple as it sounds. There are various factors that affect the requirement of MWA carriers and, therefore, planning an exact requirement for MW spots and suggesting a simple number would be difficult. In their view, it will be a fairly complex exercise that involves interplay of various technical and locational factors and involves calculation of number of frequency spots depending on capacity requirement, fiber availability, geography (terrain, area), threshold degradation, equipment deployed in network, number of network nodes to be connected, traffic capacity to be supported by the network, network topology etc.

2.6 One stakeholder suggested that as India is moving towards a technology neutral regulatory regime, it would not be correct to allocate MW spectrum on the basis of technology deployed or to be deployed. The line between various technologies is thin and, therefore, MW spectrum allocation on the basis of technology would result in disputes and unnecessary litigation.

2.7 Another stakeholder suggested that, as the factors determining the requirement vary from operator to operator, specifying an assignment by operator type/technology (2G only, 3G only etc.) will invariably result in insufficient MW capacity for some, and excess carriers for others. As per the stakeholder, given the adequate availability of MWA carriers and availability of carriers in other new bands such as 26GHz, 28GHz, 32GHz, 38GHz, 42GHz, etc, that are being used in other countries, there is no need to a priori limit the number of MWA carriers that should be assigned per TSP. On the other hand, one stakeholder stated that MW spectrum should be used diligently so as to meet the present/future requirements of higher data usage and some spectrum cap should apply to avoid any excess allocation to any set of TSPs. The stakeholder

proposed a cap of 6-8 MW carriers (including 2 carriers for MWB) to a TSP irrespective of the technologies used. In its opinion, placing a ceiling will also lead to usage/laying of fibre backbone network where the demand is higher. In case a TSP needs additional carriers above the cap of 6-8 carriers, then those should be allocated in the higher spectrum bands.

2.8 A few stakeholders stated that they were in agreement with the recommendations of TEC regarding allocation of MWA/MWB carriers for various services. A few stakeholders, mainly the dual technology operators, were of the view that since the CDMA and GSM networks of dual technology operators are altogether different and independent from each other having independent requirements, MW carriers should be allocated for both networks separately. One suggestion was that for the 2G technology, technically the allocation should be linked to access spectrum allocation and the number of BTSs required for coverage of the town/city.

2.9 Many stakeholders have given their own assessment of the requirement of MWA carriers. A gist of that is given below:

Table 2.1

Service	**Metro**	**A Circle**	**B Circle**	**C Circle**
2G only	4-5	3-5	2-4	2-3
3G only	5/8	5/6	4-5	4-5
BWA only	6-9	6-8	4-6	4-6
2G + 3G only	6/8	6	4-5	4-5
2G + BWA only	7-9/8-10	7-9/8-10	5-7/6-8	5-7/6-8
2G+3G+ BWA only	8-10	8-10	5-8	5-8

2.10 Some stakeholders have suggested that MWA carriers should be assigned on an equitable basis to all TSPs (i.e. TSPs should be assigned carriers across all bands i.e. 13 GHz, 15 GHz, 18 GHz and 21 GHz band).

2.11 On the issue of MWB RF carriers, a few stakeholders suggested that there should be at least 2 MWB carriers per TSP on an exclusive basis to take care of the basic minimum requirements for interference-free networks. However, some TSPs have submitted that one MWB carrier would be sufficient since inter-city traffic is carried mainly through OFC due to high volume.

2.12 One TSP submitted that, at present, the assignment of MW backbone carriers is done on link-to-link basis, considering full justification of the requirements and availability of spectrum. It recommended that the present allocation methodology in respect of MW backbone links may be continued in future.

Analysis

2.13 The Authority has examined the comments received from all stakeholders. The stakeholders have rightly brought out that the requirement of MW carriers is dependent upon a number of factors including the technology deployed by a TSP, the number of nodes to be connected to a hub site, the number of OFC PoPs and, to some extent, on the network topology adopted by the TSP. Therefore, the requirement of every operator may not be the same. The Authority is also aware that the exact carrier requirement can be determined by carrying out the simulation of the entire network and then performing the interference analysis. However, as it is not practical to go for simulation of the network each time, it is essential to frame general guidelines for assignment of MW spectrum.

2.14 The Authority noted that, in its report to the DoT, the TEC has recommended that MWA carriers (each of 28 MHz paired bandwidth) be allocated as per Table 2.2 below.

Table 2.2

Service	**Metro and A circle**	**B circle**	**C circle**	**Remarks**
2G	3-4	2-3	2	
3G	One additional RF pair in each category compared to 2G			
BWA	4-6	3-4	3	This is requirement for a standalone BWA operator as well as for an operator having 2G and 3G services in a service area.

2.15 The Authority observed that the data carrying requirement of a site and its density are important factors that affect the requirement of MWA carriers. Backhaul capacity requirement per BTS for 2G access technologies is about 2 to 4 Mbps, while it is around 6 to 30 Mbps for 3G technologies such as HSPA/HSPA+. Typical backhaul requirement of a LTE base station is around 100 Mbps. However, the data capacity of a node also depends on the quantum of access spectrum being used in that site. Therefore, it cannot be said that the technology deployed alone can be a guiding factor for assessing the requirement of MWA carriers. The same technology can be deployed using different quantum of spectrum e.g. LTE carrier size varies from 1.4 MHz up to 20 MHz. Similarly, TSPs may use 1 carrier or more to deploy 3G networks.

2.16 The access spectrum presently being assigned through auction is technology independent. The TSP is free to use any technology permitted within the framework of the operating licence and it is safe to assume that the TSPs will deploy the most efficient access technology. As discussed earlier, quantum of access spectrum, that a TSP has, directly impacts the capacity of its access network and, therefore, the requirement of backhaul capacity. Therefore, the Authority is of the view that, instead of technology used in the access network, the quantum of access spectrum that a TSP possesses should be used as a benchmark to assess the requirement of MWA carriers.

2.17 Other factors such as topology used by the TSPs, technology deployed in the backhaul network, number of OFC PoPs present in the network etc are in the TSP's control and they are expected to design their networks to ensure optimal use of MW spectrum. Therefore, the Authority is of the view that instead of assessing the impact of each of these factors separately on the requirement of MWA carriers, a ceiling on the number of MWA carriers that can be assigned to a TSP should be defined. Within the ceiling, it should be left to the TSP to decide the number of carriers it wants to deploy.

2.18 The availability of MWA carriers is another important aspect which needs to be seen before deciding the ceiling on the number of MWA carriers that can be assigned to a TSP. In India, MW Access carriers are assigned in 13 GHz, 15 GHz, 18 GHz and 21 GHz spectrum bands. As per the data provided by WPC, all available carriers (15 carriers in each LSA) in the 15 GHz band have already been assigned to the TSPs; there is no carrier available in this band. However, many carriers are available in other bands. The availability of carriers in other bands is given in Table 2.3 and Table 2.4. Overall, out of total 2090 carriers in these 4 bands, 810 carriers have been assigned and 1280 carriers are available with the WPC. Moreover, there are other spectrum bands viz. 26 GHz, 28 GHz, 32 GHz, 38 GHz and 42 GHz which are used in other countries for the assignment of MW fixed links. Further, there are E-band (71-76 GHz/81-86 GHz and V-band (57-64 GHz) which can also be used for providing high-speed short distance MW links.

Table 2.3

Availability status of MW Access carriers

Sl. No.	Service Area	Number of carriers in 13 GHz			Number of carriers in 18 GHz			Number of carriers in 21GHz		
		Total	Allotted	Balance	Total	Allotted	Balance	Total	Allotted	Balance
1	Delhi	8	4	4	32	14	18	40	8	32
2	Mumbai	8	4	4	32	21	11	40	12	28
3	Kolkata	8	8	0	32	14	18	40	4	36

4	Maharashtra	8	8	0	32	15	17	40	5	35
5	Gujarat	8	8	0	32	14	18	40	4	36
6	A.P.	8	3	5	32	13	19	40	8	32
7	Karnataka	8	5	3	32	12	20	40	9	31
8	Tamilnadu	8	5	3	32	14	18	40	7	33
9	Kerala	8	3	5	32	10	22	40	7	33
10	Punjab	8	3	5	32	12	20	40	6	34
11	Haryana	8	3	5	32	10	22	40	5	35
12	UP(West)	8	6	2	32	11	21	40	5	35
13	UP(East)	8	6	2	32	11	21	40	5	35
14	Rajasthan	8	6	2	32	12	20	40	4	36
15	M.P.	8	3	5	32	9	23	40	4	36
16	West Bengal	8	3	5	32	8	24	40	4	36
17	H.P.	8	8	0	32	7	25	40	4	36
18	Bihar	8	7	1	32	9	23	40	5	35
19	Orissa	8	3	5	32	9	23	40	3	37
20	Assam	8	5	3	32	7	25	40	5	35
21	North East	8	5	3	32	7	25	40	5	35
22	J&K	8	3	5	32	8	24	40	5	35
	Total	**176**	**109**	**67**	**704**	**247**	**457**	**880**	**124**	**756**

Table 2.4

Summary of availability of MW Access carriers

S. No.	Service Area	Availability status of MW Access carriers		
		13/15/18/21 GHz Bands		
		Total number of carriers available	Total allotted carriers	Balance available carriers
1	Delhi	95	41	54
2	Mumbai	95	52	43
3	Kolkata	95	41	54
4	Maharashtra	95	43	52
5	Gujarat	95	41	54
6	A.P.	95	39	56
7	Karnataka	95	41	54
8	Tamilnadu	95	41	54
9	Kerala	95	35	60
10	Punjab	95	36	59
11	Haryana	95	33	62
12	UP(West)	95	37	58
13	UP(East)	95	37	58
14	Rajasthan	95	37	58
15	M.P.	95	31	64
16	West Bengal	95	30	65
17	H.P.	95	34	61
18	Bihar	95	36	59
19	Orissa	95	30	65
20	Assam	95	32	63

S. No.	Service Area	Availability status of MW Access carriers		
		13/15/18/21 GHz Bands		
		Total number of carriers available	Total allotted carriers	Balance available carriers
21	North East	95	32	63
22	J&K	95	31	64
	Total	**2090**	**810**	**1280**

2.19 From the above discussion, it can be concluded that, at present, there is no shortage in the availability of MWA carriers. Nevertheless, spectrum itself is a scarce resource. Availability of sufficient MW carriers alone does not justify assignment of more carriers than what are actually required. Assignment of only the required number of carriers will ensure that these are put to optimal and efficient use. Moreover, this situation of supply being higher than the demand may not sustain for long keeping in view that deployment of new technologies like LTE, LTE-Advanced etc will put a lot of stress on backhaul capacity and significantly more number of MW carriers will be required. Therefore, the Authority is of the view that MWA carriers should be assigned in an optimal manner to the TSPs.

2.20 The Authority is of the view that it is necessary to have some minimum number of MWA carriers for a TSP to roll-out the network. Therefore, a green field TSP with less than 2.5 MHz (paired) access spectrum in any band should be permitted to get an assignment of 3 MWA carriers for Metro/Cat A circles and 2 MWA carriers for Cat B/C circles. The TSP shall be eligible for more MWA carriers, if it possesses access spectrum beyond 2.5 MHz. In general, requirement of additional carriers should be linked with the quantum of access spectrum available with the TSP. The ceiling limit on MWA carriers in Metro/Cat 'A' circles will be comparatively higher to the higher population density.

2.21 As far as MWB carriers are concerned, they are assigned on a link-to-link basis. In the latter part of these recommendations, the Authority is

recommending that the present assignment methodology in respect of MWB carriers may be continued in future also. Therefore, the issue of assessing the requirement of MWB carriers is not required.

2.22 Considering all the above factors including the TEC's report and the present availability of MWA carriers, **the Authority recommends that TSPs should be assigned MWA carriers as per their requirement. However, it will be subject to a ceiling on the number of MWA carriers that can be assigned to a TSP as given in Table 2.5 below.**

Table 2.5

Maximum No. of MWA carriers that can be assigned to a TSP

Quantum of Access Spectrum that a Licensee has in a LSA	Metro/Cat 'A' Circles	Cat 'B' Circles	Cat 'C' Circles
Less than 2.5 MHz	3	2	2
2.5 MHz or more but < 5 MHz	4	3	2
5 MHz or more but < 10 MHz	5	4	3
10 MHz or more but < 15 MHz	6	5	4
15 MHz or more but < 20 MHz	7	6	5
20 MHz or more but < 30 MHz	8	7	6
30 MHz or but <40 MHz	9	8	7
40 MHz or more	10	9	8

Note:

1. **If any TSP requires carriers in addition to what have been recommended above, it may be examined by the DoT on a case-to-case basis.**
2. **It has been assumed that each carrier is of size 2x28 MHz. Carrier of 2x56 MHz and 2x112 MHz should be counted as 2 and 4 carries respectively when applying the above ceiling.**
3. **Access spectrum indicated in this table is a paired spectrum. Therefore, unpaired access spectrum shall be counted as half for the purpose of applying the above ceilings e.g. 20 MHz of unpaired spectrum in the 2300 MHz band shall be considered as equivalent to 10 MHz (paired).**
4. **The above ceilings may be reviewed periodically.**

No. of MW carriers at the start of service

2.23 Considering the fact that, at the start of their services, the requirement of MW carriers may be less, stakeholders were asked to comment on the number of MWA/MWB carriers to be assigned to TSPs providing 2G, 3G and/or BWA services at the start of services. Stakeholders were also requested to comment on the assignment criteria for allocation of additional carriers.

2.24 On the issue of the requirement of MWA and MWB carriers at the time of start of services, a few stakeholders submitted that start-up TSPs should be assigned 4 MWA carriers in Metros/Cat A circles and 2-3 carriers in B/C category circles along with 1 MWB carrier. One stakeholder submitted that 3-4 carriers (including 1 carrier for MWB) may be allotted initially with access spectrum to enable the TSP to roll-out its network. Any allocation above the initial allocation should be based on justification of the additional carrier requirement and availability on a case-to-case basis. One stakeholder proposed that that the new TSPs can be allocated MWA carriers based on the recommendations of the DoT Committee report dated 7th Oct, 2011.

2.25 One stakeholder suggested that 2 MWA carriers in 15/18 GHz and 1 MWB carrier should be allocated right in the beginning bundled with the initial allocation of access spectrum irrespective of technology. Another stakeholder submitted that, in the beginning, it may be possible to plan the network with 1 carrier of 28 MHz bandwidth in 13/15/18 GHz bands and 1 carrier of 56 MHz bandwidth in 21/26/28 GHz bands. Subsequently 1 carrier of 112 MHz bandwidth in 32/42 GHz band and 1 carrier of 250 MHz bandwidth in 60/80 GHz bandwidth can be assigned to meet growing traffic. Further, as the network and traffic grows, suitable additional carriers can be assigned, based on justification.

2.26 Another suggestion was that, at the beginning of the service, TSPs may be allocated MWA/MWB carriers as demanded by them up to the

eligibility limits, as different TSPs may have their own business plan for commercial launch of services and may require different numbers of MWA and MWB carriers at the beginning for roll-out of services.

2.27 Another stakeholder submitted that for standalone BWA networks, a minimum of six MWA carriers in Metro and A circles and a minimum of four MWA carriers in B and C circles needed to be allotted initially with the provision to increase them to eight and six respectively depending on network architecture deployed and network capacity enhancements. It further proposed that, for BWA networks with 900/1800 MHz spectrum, a minimum of eight MWA carriers in Metro and A circles and a minimum of six MWA carriers in B and C circles needed to be allotted initially with the provision to increase them to ten and eight respectively depending on network architecture deployed and network capacity enhancements to cater to the increased data traffic capacity requirements of LTE networks operating in both 2300 MHz and 900/1800 MHz spectrum bands.

2.28 Many stakeholders opined that assignment of additional MWA carriers should be based on the justification for additional requirement. Various factors proposed by them for the evaluation are network architecture and network size in terms of cell site density, loading of existing carriers, amount of access spectrum being used for 3G and 4G/LTE, services offered, existing subscriber base, number of hub sites and MW links emanating and planned network capacity enhancements. They were of the view that multiple spots allocation using mixed band would enable better network planning and, hence, the need for additional carriers could get postponed.

Analysis

2.29 The Authority has considered the comments of all the stakeholders. Each operator designs its network in its own way. Accordingly, their requirement of MWA carriers varies. Presently, annual spectrum charges are levied on revenue (AGR) share basis and the applicable percentage of

AGR increases with the number of carriers that a licensee holds. The Authority, in a later section, is recommending the continuance of spectrum charges based on revenue share for the assignment of MWA carriers. Escalation of revenue share with the number of MWA carriers assigned to a TSP will ensure that a TSP will ask for the assignment of only those MWA carriers it actually needs. As presently there is no shortage of MWA carriers, there is no incentive for the TSP to grab more carriers. In Para 2.22, the Authority has already recommended that TSPs should be assigned MWA carriers as per their requirement subject to a ceiling mentioned therein. It is of the view that within this ceiling limit, it should be left up to the TSP to decide the number of MWA carriers it requires at a particular point of time. Accordingly, **the Authority recommends that the TSP should be assigned MW carriers as per their request as long as it is within the ceiling limit recommended in Para 2.22.**

2.30 As discussed in the preceding section, MWB carriers are assigned on a link-to-link basis. In the latter part of these recommendations, the Authority is recommending that the present assignment methodology in respect of MWB carriers may be continued in future. Therefore, the issue of assessing the requirement of MWB carriers at different stages of roll-out of the network is irrelevant.

Surrender of Excess MW Carriers

2.31 The preceding section discussed the requirement of MWA carriers for the deployment in 2G, 3G and BWA networks. It is possible that existing assignment to TSPs may be more than the ceiling being recommended by the Authority in these recommendations. In that case, the question that arises is how to align existing assignments with the ceiling being recommended. In this context, stakeholders were asked to comment on whether the excess MW spectrum be withdrawn from TSPs. They were

also asked to respond to the question that if excess carriers are to be withdrawn, what should be the criteria for their withdrawal.

2.32 One set of stakeholders were against the idea of withdrawal of carriers. They argued that all existing allocations of MW have been done after giving full justification and as per prevailing guidelines. Therefore, according to these stakeholders, there is no excess of MW carriers assigned. Moreover, MW spectrum has been fully utilized to carry out extensive roll-outs and any withdrawal of MW spectrum will adversely impact roll-out and quality of services and will also require either re-tuning of installed equipments to the desired sub-band or replacing this equipment, all of which will result in a huge cost impact while also requiring extensive effort and time. They further submitted that, going forward, there is a growing proliferation of broadband services which entail higher capacities and additional MWA carriers. There will be a requirement to further augment rather than restrict the MWA allocations. One of these stakeholders submitted that the allocated MW carriers are being paid for as additional percentage of AGR and there is no incentive for any operator to hoard excess MW carriers. So far, out of the available 2190 carriers, only 810 MW carriers have been allocated to existing TSPs and 1280 MW access carriers are still available with the DoT in the bands 13, 15, 18 and 21 GHz bands. Thus, there seems to be no immediate case for withdrawal of MWA carriers from existing TSPs. One stakeholder submitted that the charges for existing allocations and, thereby, the allocations themselves, are governed/ protected by the order of TDSAT that had set aside the DoT's orders dated November 2006. Although the DoT has challenged this order before the Hon'ble Supreme Court and the Court has admitted the matter, but no stay has been granted.

2.33 Another set of stakeholders were in favour of withdrawing excess carriers from TSPs. According to them, spectrum being a scarce resource it should be assigned judiciously taking into account the future

requirement and efficient utilization by TSPs. Withdrawing excess spectrum and its reallocation to operators having a fewer number of carriers would ensure efficient utilization of MW bands by all operators.

2.34 A few stakeholders suggested that, a maximum of one or two MWA carriers should be assigned in 15 GHz bands and carriers assigned in excess may be withdrawn and should be replaced by carriers in higher bands. One stakeholder proposed that existing TSPs can be asked to re-plan their network with some MW access carriers in higher bands of 21/26/28 GHz; 32/42 GHz and/or 60/80 GHz bands. For shorter routes, it may be possible to use higher bands and release carriers in lower bands of 13/ 15/18 GHz. Another stakeholder suggested that at least one carrier should be allocated in 15 GHz band to all TSPs with a ceiling of 3 carriers in any band.

2.35 One stakeholder submitted that TSPs may be provided with a maximum time limit of one year to vacate the excess carriers allocated to them. Another stakeholder was of the view that instead of withdrawing MW carriers, a higher SUC may be levied on those carriers.

Analysis

2.36 The Authority has carefully gone through all the comments. There are some cases, where the assigned MWA carriers are more than justified as per the criteria recommended in Para 2.22. There is no denying the fact that these carriers, which are being rendered as excess, were assigned following the then prevailing guidelines and TSPs have designed their network accordingly. It is also true that, at present, there is no shortage in the availability of MWA carriers. However, as discussed earlier also, spectrum itself is a scarce resource. Availability of sufficient MWA carriers does not justify the assignment of more carriers than what is actually required. Assignment of only the required number of carriers will

ensure that these are put to optimal use and the sufficient carriers are available for future.

2.37 If TSPs are asked to vacate these carriers, they will have to re-tune their backhaul network which will have attendant time and cost implications. However, these TSPs cannot be permitted to hold on to the excess MWA carriers forever. The Authority is of the view that such TSPs should be given sufficient time to redesign their backhaul network and one year should be a reasonable time period for this purpose. Therefore, TSPs should be given one year period to surrender their excess MWA carriers.

2.38 Para 2.22 also states that if any TSP requires carriers in addition to what have been recommended, it may be examined by the DoT on case-to-case basis. On the similar lines, in the case the assigned carriers are more than the criteria recommended, TSP may continue to retain them if it is able to justify the need of additional carriers to the satisfaction of the DoT.

2.39 As the Authority has linked the ceiling limit on the MWA carriers with the quantum of access spectrum available with a TSP (Para 2.22), it is necessary to consider the fact that the Government has given *in-principle* approval for spectrum trading and the Authority has given its recommendations on the working guidelines for spectrum trading on 28th January 2014. Once a decision is taken by the Government on the recommendations of the Authority, there is a possibility that TSPs may sell some of their access spectrum holding through spectrum trading. In such cases, it is quite likely that TSPs will be left with excess MWA carriers. In such a scenario, they cannot be given one year period for surrendering the excess MW carriers. Such TSPs will have to surrender additional carrier(s) within three months of the effective date of trade.

2.40 In view of the above, **the Authority recommends that TSPs, holding MWA carriers in excess of the maximum number of carriers recommended by the Authority in Para 2.22, should be asked to**

surrender the excess MWA carriers in one year's time period with effect from the date the new guidelines come into force. However, in case TSP is left with excess MWA carriers as a result of trading of spectrum, it will have to surrender the excess MW carriers within three months of the effective date of trade. In case TSP wants to retain them, it should be permitted to do so, only if it is able to justify the need of additional carriers to the satisfaction of the DoT.

2.41 The Authority noted that a number of stakeholders requested for an equitable distribution of MWA carriers in the lower frequency bands such as 13GHz/15GHz as lower frequency waves travel comparatively longer distances. It is true that propagation characteristics of lower frequencies are better when compared to higher frequency bands. The Authority is in favour of the proposition that each TSP should have access to lower frequency bands. Therefore, in future, no TSP should be assigned more than 4 MWA carriers in the 13/15 GHz band. In other bands too, there should be an equitable distribution of carriers as far as possible.

2.42 However, if any re-arrangement of MWA carriers is mandated, TSPs will be required to redesign their network which will require them to incur costs. As these carriers were assigned to them as per the prevailing norms, the Authority is <u>not</u> in favour of imposing any such measure on them. However, it would like to incentivize it by way of differential annual spectrum charges between lower and higher band frequencies. The issue of spectrum charges is discussed in detail in Chapter III.

2.43 In view of above, **the Authority recommends that, in future, no TSP should be assigned more than 4 MWA carriers in the 13/15 GHz band. In other bands too, there should be equitable distribution of carriers as far as possible. However, this would not have any impact on existing assignments. This is because of the fact that any re-arrangement of MWA carriers already assigned to TSPs will force**

them to redesign their network which will require them to incur significant costs.

Methodology for the Assignment of Microwave Carriers

2.44 As discussed in Chapter-I (Para 1.14 to 1.21), presently, in India, the assignment of microwave carriers is done administratively, based on justification of the requirement and availability of spectrum. Earlier, WPC issued order in 18th April 2002 regarding the assignment of carriers for MW access and backbone networks. Subsequently, in November 2006, WPC issued another order on the subject, which was set aside by Hon'ble TDSAT on 22nd April 2010 on a petition of GSM telecom service providers and their association (COAI) on the issue of modification in the spectrum charges. The Government filed an appeal before the Hon'ble Supreme Court against the TDSAT judgment and the matter now is sub-judice.

2.45 As an interim measure, the DoT issued guidelines for administrative allocation of MWA carriers for BWA services in March 2012. Subsequently, in November 2012, it sought TRAI's recommendations on the various issues related to the assignment and pricing of MWA/MWB carriers.

2.46 As discussed above, MW carriers have been assigned administratively so far. However, if the assignment of carriers is to be done on an exclusive basis, auctions could be another possible approach. Auction provides a transparent mechanism for assignment of any natural resource particularly when the demand is more than the supply.

2.47 With this background, the stakeholders were requested to comment on the preferred basis of assignment of MWA/MWB carriers i.e. 'exclusive basis assignment' or 'link-to-link based assignment'. The stakeholders were requested to indicate that in case 'exclusive basis' assignment is preferred, whether MWA and MWB carriers should be assigned

administratively or through auction. In case 'link-to-link' basis assignment is preferred, how should the carrier assignment for different links be carried out to ensure interference free operation was another linked issue on which suggestions of stakeholders were sought.

2.48 On the issue of preferred mechanism for assignment of MWA/MWB carriers to TSPs, the majority of the stakeholders have proposed that assignment of MWA carriers to TSPs should be made on an exclusive basis. As per them, exclusive allotment is simpler, easier to implement and also gives flexibility to the TSP to plan and manage its network. It not only helps the TSP to use the MW spectrum without any interference but also reduces the WPC effort of coordination while allotting carriers on link-to-link basis. These stakeholders further commented that only if the allocation is on exclusive basis, it is possible for an operator to manage and properly control link engineering and interference at the individual TSP level. The ordering of equipment also gets simplified. Further, approvals for the Standing Advisory Committee on Frequency Allocations (SACFA) require lesser time. Some of these stakeholders argued that considering the prevailing arrangement and large scale deployments of MW links, link-to-link assignment is not a feasible or practical option today.

2.49 A few stakeholders proposed that carrier allocation in new MWA bands (26GHz/28GHz/38GHz/42GHz) can be done on a link-to-link basis under full regulation of WPC.

2.50 Regarding the assignment of MWB carriers, a number of stakeholders submitted that presently the assignment is done on a link-to-link basis and this should be continued in the future. Some of these stakeholders stated that the available number of MWB carriers and the links deployed are fewer in numbers and are mostly being used for inter-city traffic. Thus, as per these stakeholders, the coordination for interference and subsequent assignment to various operators by WPC is relatively easy.

However, some stakeholders proposed that MWB carriers should be assigned on an exclusive basis, citing the same reasons which they gave for proposing the assignment of MWA carriers on an exclusive basis.

2.51 On the issue of the preferred mechanism of assignment of MW carriers (i.e. administratively or through auctions), most stakeholders were of the view that assignment of MWA/MWB carriers should be done administratively as these are only supporting infra resources for already auctioned radio access spectrum (2G, 3G and LTE). They were of the view that auctions are the preferred mechanism only when demand is expected to exceed supply. However, presently MWA carriers are available in abundance for allocation to TSPs. In case of MWB, although the spectrum availability is limited, these allocations are made on a non-exclusive basis. Some of these stakeholders argued that there is no additional revenue generation because of MWA/MWB carriers. Some of them were of the view that administrative assignment is a long proven process being followed not only in India but in most countries worldwide.

2.52 One TSP submitted that the requirement of backhaul carriers will keep on changing with an increase in the number of customers and associated traffic which makes it very difficult for any operator to ascertain its backhaul carrier requirement in advance for the long-term. One argument given against the adoption of assignment mechanism through auction was that new operators will be hesitant to participate in the access spectrum auction if there is no certainty about availability of backhaul spectrum.

2.53 One stakeholder has proposed an alternate practice for allocation of backhaul spectrum through 'Band Managers'. In this arrangement for allocation of backhaul spectrum in the primary market, the government auctions spectrum in large blocks (at least 10 carriers) to "Band Managers" for an entire circle. The band managers then lease the

spectrum to individual TSPs in the secondary market in the most efficient manner to maximize utility.

Analysis

2.54 The Authority has examined the comments and suggestions of all the stakeholders. On the issue whether the assignment of MW carriers should be done on a link-to-link basis or on an exclusive basis, the Authority noted that most stakeholders were of the view that MWA carriers should be assigned on exclusive basis only. For the assignment of MWB carriers, some stakeholders were of the view that it should also be done on an exclusive basis while most of the others were in favour of continuing with the present practice of assignment on a link-to-link basis.

2.55 Ideally, the assignment of MW spectrum for fixed point-to-point links should be on a link-to-link basis as it is the most optimal solution. In a number of countries, the assignment of MW carriers for fixed links is done on a link-to-link basis only. However, this puts the onus of interference management amongst MW carriers assigned to different links on the administrator (WPC in our case). This would require an extensive interference analysis with the existing operating links of other TSPs, requiring simulation tools, the geo-coordinates of the connected sites, complete details of all links (viz. antenna height, antenna gain, antenna radiation pattern power transmitted etc) and other details like nearby buildings, terrain etc.

2.56 The number of TSPs in India (7 to 13 licensees in each LSA) is large as compared to most other countries. They have established MW links in large numbers. Therefore, the assignment of MW carriers on a link-to-link basis will be a huge challenge for the WPC and, at present, WPC may not be equipped with the necessary planning tools and requisite expertise to deal with it. The Authority is of the view that considering the large number of TSPs, huge number of MW links and ever increasing

demand of MW links, continuing with the assignment on an exclusive basis seems to be the practical way forward for assignment of MWA carriers.

2.57 As far as MWB carriers are concerned, their assignment is presently done on a link-to-link basis. MWB carriers are assigned in 6 GHz and 7 GHz bands. As per the information provided by the WPC, there are 8 carriers in 6 GHz and 5 carriers in 7 GHz. WPC also informed that all the carriers available in these bands have been assigned for MW links in all the LSAs. However, as the carriers are not assigned on an exclusive basis to any TSP, additional assignment for MWB links can be done after ensuring compatibility with existing links. Moreover, the use of MWB carriers is mainly for inter-city links. Therefore, there are not enough carriers available in 6 GHz and 7 GHz bands that can be assigned on exclusive basis nor it is required to do so. Moreover, MWB links are less in number and assignment of MWB carriers on a link-to-link basis is a manageable affair. Therefore, the Authority is in favour of continuing with the present methodology of assignment of MWB carriers on link-to-link basis.

2.58 In view of the above, **the Authority recommends that the assignment of MWA carriers should be done on an exclusive basis for the various spectrum bands in 13-42 GHz range whereas the assignment of MWB carriers should be done on a link-to-link basis.**

2.59 If the assignment of MWA carriers is to be done on an exclusive basis then it can be done either administratively or through an auction. The Authority noted that unlike access spectrum which is assigned mostly by auction, the assignment of MW carriers is done administratively in most countries. There are only a very few examples worldwide where the auction route was tried for the assignment of MW carriers **(Annexure 2.1)**. The practice followed in some countries for the assignment of spectrum for fixed MW links has been discussed in **Annexure 2.2**

2.60 As mentioned earlier, in India, MWA carriers are assigned in 13 GHz, 15 GHz, 18 GHz and 21 GHz spectrum bands. The availability of carriers in these bands is given in Table 2.3 and Table 2.4. Overall, out of total 2090 carriers in these 4 bands, 810 carriers have been assigned and 1280 carriers are available with the WPC. Moreover, there are other spectrum bands in higher frequency range which can be used for providing MW links. This implies that there are sufficient MWA carriers available.

2.61 The Authority is in agreement with the stakeholders' view that MW carriers are essential for the roll-out of the network. Therefore, its availability should be ensured for all TSPs who acquire access spectrum. The Authority concludes that (a) the assignment of spectrum for MW fixed point-to-point links is done administratively in most countries; (b) there is no shortage of MWA/MWB carriers; (c) MW carriers are essential for the roll-out of network; and, (d) since the access spectrum is being assigned through auction, there seems to be no justification for another auction for the assignment of MW carriers as these will be used by only those TSPs who have got the access spectrum. Therefore, the Authority is of the view that the assignment of MWA and MWB carriers should continue to be done administratively.

2.62 Accordingly, **the Authority recommends that the assignment of MWA and MWB carriers should continue to be done administratively.**

2.63 In the OHD and subsequent submissions, some TSPs brought out the issue of partial assignment of MWA carriers. As per the WPC order of 2006, the first MWA carrier is allotted for the complete service area; subsequently carriers are allotted based on justification and for cities/districts where it is found to be essential. According to these TSPs, the assignment of MWA carriers on city basis (instead of LSA basis) is causing a lot of problems. In many LSAs, the second and third MWA carriers have been assigned only in select cities. They submitted that their requests for assignment of MWA carriers for the remaining cities

have been pending with the WPC for many years despite timely submission of the need and justification. One TSP informed that its request for assignment of carriers in other parts of LSA is pending since 2009. These TSPs have submitted that non-availability of assignment throughout the LSA is not only a hindrance in meeting roll-out obligations and Quality-of-Service (QoS) norms but also creates a non-level playing field vis-à-vis other TSPs that were assigned MWA carriers on a pan-LSA basis.

2.64 Some TSPs have also drawn the attention of the Authority on the inordinate delay in the assignment of both access spectrum, acquired through auction, as well as MW carriers. Some TSPs submitted that after the delay in the assignment of access spectrum, non-assignment of MWA carriers further delay the roll-out. These TSPs requested that as the MW carriers are a support infrastructure for radio spectrum, the Government should aim for their timely allocation. The situation becomes critical for a green field TSP as in the absence of MW resources, it is simply not feasible to roll-out the network and meet the roll-out obligations. One TSP pointed out that Notice Inviting Applications (NIAs) issued for recently held auctions and the Unified Licence (UL) do not recognize the need of MW to meet the roll-out obligations and as such are contradictory to the above stated requirement.[9]

2.65 One TSP, that acquired the access spectrum in some LSAs in March 2013 auctions after its licences were quashed, submitted that it is still waiting for the reassignment of MW frequencies. In the absence of MW frequencies, the TSP is not in a position to import any MW equipment for expansion or upgradation of the network. Another TSP informed that it has acquired the access spectrum in Assam through February 2014

[9] UL Agreement Clause 42.7: Allotment of spectrum for individual point-to-point fixed links i.e. Microwave Backhaul Spectrum shall be subject to separate application to WPC Wing and the allotment of the same is not linked to the compliance of roll-out obligations where prescribed. The allotment of backhaul spectrum is subject to availability, usual processes and terms and conditions. Separate charges as prescribed from time to time shall be payable for microwave backhaul spectrum.

auctions, but is still waiting for both access spectrum and the MW carriers. Therefore, being a new operator in that LSA, it is not in a position to roll-out its network.

Analysis

2.66 On the issue of assignment of carriers on city basis, the Authority is of the view since the assignment of MWA carriers is being done on an exclusive basis, restricting it to city-based assignment instead of pan-LSA serves no meaningful purpose. On the contrary, it leads to avoidable administrative delays as is evident from the submissions made by various TSPs in the previous para. It would be a hindrance for faster network roll-outs by the TSPs. In any case, TSPs are liable to pay the annual spectrum charges on the revenue share basis and the revenue of the entire LSA is counted for that purpose.

2.67 The Authority is in agreement with the TSPs that there should not be any delay in the assignment of access spectrum after the receipt of payment from any TSP that has acquired the spectrum through auction. The Authority also agrees with the contentions of the stakeholders that MW spectrum is an essential component for quick roll-out of any network. MW resources are a must, if access spectrum is assigned to any TSP. This, in turn, also affects the revenues of the Government in terms of Licence Fee, Spectrum Usage Charges etc. Moreover, when the MWA carriers are available in abundance, it is explicable why a few carriers cannot be assigned to a TSP which has made huge payments to acquire the access spectrum. This delay in assigning the access spectrum after taking the money from the TSPs borders on negligence and apathy on part of the officers. The Authority strongly believe that assignment of <u>both</u> access spectrum and MWA carriers should be done simultaneously within a period of one month from the date the TSP makes the payment for access spectrum, failing which, the TSP should be paid compensation

at the SBI PLR rate of the amount it had already paid[10] to acquire the access spectrum.

2.68 The requirement of MWA carriers is critical for a green-field operator. If the access spectrum is assigned to a green-field TSP without the assignment of MWA carriers, it can neither meet the roll-out obligations nor start commercial services. Therefore, in case of delay in the assignment of MWA carriers for a new TSP in a LSA, the effective date of access spectrum assignment may be taken as the date of assignment of the first MWA carriers.

2.69 Accordingly, **the Authority recommends that**

i. **The assignment of MWA carriers should be done for the entire LSA.**

ii. **Assignment of both access spectrum and MWA carriers should be done simultaneously within a period of one month from the date the TSP makes the payment for access spectrum, failing which TSP should be paid compensation at the SBI PLR rate of the amount it had already paid to acquire the access spectrum.**

iii. **In case of delay in the assignment of MWA carriers for a new TSP in a LSA, the effective date of access spectrum assignment may be taken as the date of assignment of the first MWA carrier**.

Other Spectrum Bands in 6-42 GHz Range (26 GHz, 28 GHz, 32 GHz, 38 GHz and 42 GHz)

2.70 Presently, in India, allotment of carriers for MW point-to-point links is done in the 6 GHz, 7 GHz, 13 GHz, 15 GHz, 18 GHz and 21 GHz bands. Frequencies in the 6 GHz and 7 GHz bands are earmarked for the MWB carriers and only 13 GHz, 15 GHz, 18 GHz and 21 GHz are being used

[10] Under the deferred payment option, a successful bidder has to make a part upfront payment and rest amount is to be paid in installments. Therefore, only the amount already paid by it is to be considered to determine the compensation.

for MWA carriers. As the mobile broadband network traffic is continuously growing, demand for point-to-point fixed links will also increase. It is quite likely that demand for fixed links cannot be met from the existing bands in future. Therefore, there is a requirement to explore the usage of new bands. Apart from these bands, there are other frequency bands in the 6-42 GHz range, which are used for MW point-to-point links by a number of countries. These bands are 26 GHz, 32 GHz, 38 GHz and 42 GHz. With this background, the stakeholders were requested to comment on whether the option of assignment of MWA carriers in all the spectrum bands in 6-42 GHz range should be explored in line with other countries. The stakeholders were also requested to comment on the likely issues in its assignment MWA carriers in these additional spectrum bands.

2.71 Most stakeholders were of the view that MWA carrier assignments in other spectrum bands in 6-42 GHz range should be explored in line with other countries. The existing bands may get exhausted with the passage of time due to exponential growth in demand for mobile broadband services, which is driving operators to upgrade their radio networks to offer enhanced throughput to users. In their opinion, the availability of additional bands for assignment would facilitate roll-out of high-speed telecommunications services.

2.72 A stakeholder has suggested that some of the bands could be in use for satellite communication which should be carefully considered before opening up of these bands. One stakeholder has opined that the allocation in sub-42 GHz bands may be considered after exhausting existing bands.

2.73 Some stakeholders stated that because of range limitation, higher frequency band carriers are traditionally less preferred for deployment of MW links. However, TSPs can be encouraged to utilize these bands by compensating them by way of levying favorable charges. A few

stakeholders have recommended increasing carrier bandwidth to 2x56 MHz per channel to support higher bandwidth required for high capacity Radio Access Networks (RAN). This will also reduce the demand for exclusive MWA carriers in existing bands.

Analysis

2.74 Currently, MWA carriers are assigned from 13 GHz, 15 GHz, 18 GHz and 21 GHz bands. As per the channeling plan[11], the number of carriers in each of these bands is given in Table 2.6 below.

Table 2.6

Sl No.	Band Name	Frequency range	Carrier Size (MHz)	Number of carriers as per channeling plan
1.	13 GHz	12.750-13.250 GHz	28	8
2.	15 GHz	14.5-15.5 GHz	28	15
			14	30
			7	60
			3.5	120
3.	18 GHz	17.7-19.7 GHz	13.75	69
			28	32[12]
4.	21 GHz	21.2-23.6 GHz	28	40
			14	80
			7	180

2.75 It can be seen from the above table that there are only 95 carriers of 28 MHz (paired) available in 13 GHz, 15 GHz, 18 GHz and 21 GHz bands. With the increase in demand for backhaul capacity and MW being the preferred choice for the TSPs, there will be a requirement for more carriers in the future. With the proliferation of LTE and higher bandwidth services and use of small cells, use of higher frequency MW carriers, which are suitable for short-haul applications and have greater capacities, will be more relevant. A number of countries have already

[11] As per National Frequency Allocation Plan (NFAP) -2011.
[12] As per information provided by the WPC.

opened up higher frequency bands viz. 26 GHz, 28 GHz, 32 GHz, 38 GHz and 42 GHz for the assignment of fixed point-to-point links.

2.76 ECC's[13] report on "Fixed Service in Europe- Current use and future trends post 2011" published in March 2012, presents information on the number of fixed links in each band used in CEPT countries. The report highlights the fact that some of the bands have already started to show a rapid growth in terms of number of links while others are still preparing to take off.

Table 2.7

Band	**Band Frequency**	**No. of active links**	**Number of countries**
26 GHz	24.5-26.5	37000	30
28 GHz	27.5-29.5	2600	31
32 GHz	31.8-33.4	8000	31
38 GHz	37.0-39.5	136000	31
42 GHz	40.5-43.5	100	12

2.77 ITU has specified channel plan for these bands as given in Table below.

Table 2.8

Band Name		**26 GHz**	**28 GHz**	**32 GHz**	**38 GHz**	**42 GHz**
Standards		ITU-R F.748-4		ITU-R F.1520-3	ITU-R F.749	ITU R F.2005
Frequency Range (GHz)		24.5-26.5	27.5-29.5	31.8-33.4	37.0 -39.5	40.5- 43.5
Channel Bandwidth (MHz)		3.5,7,14, 28,56,112	3.5,7,14,28 56,112	3.5,7,14,28, 56,112	3.5,7,14, 28,56, 112	7,14,28, 56,112
Number of Channels	**3.5 MHz**	256	256	216	320	--
	7 MHz	128	128	108	160	202
	14 MHz	64	64	54	80	101

[13] Electronic Communications Committee of CEPT (European Conference of Postal and Telecommunications Administrations)

	28 MHz	32	32	27	40	50
	56 MHz	16	16	12	20	25
	112 MHz	8	8	6	10	12

2.78 It can be seen that these bands, in general, offer a larger bandwidth and therefore, a greater number of channels. The ITU channeling plan permits the use of bigger carrier sizes of 56 and 112 MHz in all these bands. Even in the lower frequency bands (15 GHz, 18 GHz and 21 GHz), ITU channeling plan permits the use of larger size carriers as can be seen from Table below:

Table 2.9

Band Name		**13 GHz**	**15 GHz**	**18 GHz**	**21 GHz**
Standards		ITU-R F.497-7	ITU-R F.636-4	ITU-R F.595-10	ITU-R F.637-4
Frequency Range (GHz)		12.75-13.25	14.5-15.35	17.7-19.7	21.2-23.6
Channel Size (MHz)		3.5,7,14,28	3.5,7,14,28,56	13.75,27.5,55, 110	3.5,7,14,28, 56,112
Number of Channels	**3.5 MHz**	64	120	--	320
	7 MHz	32	60	--	160
	14 MHz	16	30	69 (Channel size 13.5 MHz)	80
	28 MHz	8	15	34 (Channel size 27.5 MHz)	40
	56 MHz	--	7	17 (Channel size 55 MHz)	20
	112 MHz	--	--	8 (Channel size 110 MHz)	10

2.79 Apart from the above discussed international trends, the Authority has also examined the comments of the stakeholders. It has concluded that there is a definite need of opening up carriers in other bands in harmonisation with the international trend. Also channel plan and carrier size need to be kept in consonance with ITU-R recommendations

and international practices. Therefore, the Authority is of the view that the higher frequency bands viz. 26 GHz, 28 GHz, 32 GHz, 38 GHz and 42 GHz should be earmarked for fixed point-to point MW carriers and the channeling plan should be in line with ITU-R recommendations. The Authority is also of the view that larger carriers of size 56 MHz (paired) and 112 MHz (paired) should also be assigned to the TSPs in these bands. As can be seen from Table 2.3, the number of assignments made in the 21 GHz band is quite small, the DoT may also examine the feasibility of assigning a larger carrier size in this band.

2.80 In view of the above, **the Authority recommends that the higher frequency bands viz. 26 GHz, 28 GHz, 32 GHz, 38 GHz and 42 GHz should be earmarked for fixed point-to-point MW carriers and the channeling plan should be kept in line with the ITU-R recommendations. The Authority is also of the view that larger carriers of size 56 MHz (paired) and 112 MHz (paired) should also be assigned to the TSPs in these bands. As the number of assignments made in the 21 GHz band is quite small, the DoT may also examine the feasibility of assigning larger carrier sizes in this band.**

CHAPTER-III: PRICING OF MW ACCESS/BACKBONE CARRIERS

3.1 The present pricing methodology for MWA/MWB carriers is based on the revenue share model and is applied as a percentage of the AGR of the TSP. The slab of revenue share is linked only to the number of MW carriers but not with number of links that a TSP establishes through the LSA. As such, the present pricing mechanism does not encourage usage of OFC in the network by the TSP. In view of the above, stakeholders were requested to comment on the charging mechanism so as to ensure that spectrum carriers assigned are used optimally and TSPs are encouraged to move towards replacing MW with OFC.

3.2 A few stakeholders suggested that to encourage laying of OFC, there should be uniform governing guidelines from the DoT on the subject to facilitate fast clearances and reasonable Right of Way (RoW) charges across India. RoW permissions are presently regulated by multiple local agencies and there are huge variations in cost, making OFC laying extremely expensive or non-viable in many urban areas. One stakeholder submitted that the pace of fiberisation will depend on the ease of getting RoW, rationalization of high RoW costs (over Rs 85 lakhs per Km in Mumbai) and the support of local municipal bodies in executing OFC work.

3.3 Some stakeholders pointed out that although OFCs have near unlimited bandwidth capability, deployment of OFC is suitable only in those areas where there is high density of customers. They were of the view that extending OFCs into sparsely populated areas with limited business potential would be an unwanted and avoidable financial burden on TSPs and, in turn, on the end users. These stakeholders submitted that MW being an operationally manageable and financially viable option, TSPs roll-out fiber wherever it is economically justified and feasible.

3.4 Since commercial viability is the prime concern for shifting from MW to OFCs, many stakeholders were of the view that significant incentives will be required to counter the high cost of laying optical OFCs. Some stakeholders pointed out that besides high cost of laying the OFC network, there are many challenges in expanding OFC network such as difficult terrain, higher time for deployment, logistical challenges, cumbersome approval procedures etc which hinders its deployment.

3.5 To encourage operators to move towards OFC deployment, some stakeholders have suggested that there should be a single-window for according time-bound RoW clearances and RoW charges should be regulated. One suggestion was that a dedicated corridor for laying OFC be provided in all cities and important highways to ensure safety of the laid OFC. Another stakeholder suggested that introduction of formal obligation and liability on the part of infrastructure developers would help improve reliability of OFCs as this would avoid infrastructure developers and the utility providers from undertaking digging unmindful of the presence of buried OFCs. Another suggestion was that the bandwidth charges (leased line) paid to other operators should be allowed as pass-through charges in AGR.

3.6 Some stakeholders believe that the present pricing methodology of microwave resources, based on a percentage of AGR, is sufficient to encourage an operator to replace MW links with OFC network. As the AGR of an operator increases, the payment liability of the TSP increases. Also, if an operator uses more number of carriers, it needs to pay spectrum usage charges as per the higher slab rate which also increases its liability.

3.7 The Authority has carefully considered and examined the comments of all stakeholders. The Authority is in agreement with stakeholders' views that getting RoW at reasonable prices as well as in a reasonable period of time is a pre-requisite to laying OFC. The local authorities generally take

a long time in granting permission for RoW and, in a number of cases, TSPs have to approach multiple agencies for obtaining RoW clearance. It is also seen that there is lack of uniformity in the decision making processes.

3.8 The Authority had dealt with the issue of RoW in its earlier recommendations also. In its recommendation on 'National Broadband Plan' dated 8th December 2010, the Authority had recommended that "*Government may fix and notify the charges for Right of Way in consultation with the State Governments on priority basis and ensure time bound availability of RoW to telecom service providers after due intimation to the agency concern.*"

3.9 The Authority is aware that the RoW procedure, including streamlining/rationalizing RoW cost, is a State subject and, therefore, the Central Government cannot issue instructions unilaterally. However, considering the importance of the issue, **the Authority recommends that:**

a) The Central Government should take up the issue of RoW with the State Governments on top priority to emphasise the need to bring simplification and uniformity in the process of according RoW permissions and to bring the RoW charges to a realistic level.

b) The Central Government may mandate various agencies, responsible for making intra- and inter-city roads/highways, to provide infrastructure utility ducts along the roads/highways which can be used by companies providing utility services like telecom, power etc. for laying cables.

3.10 Prior to 2002, the annual royalty charges for MW links for cellular mobile systems were calculated on a link-to-link basis and were based on a mathematical formula accounting for the number of R.F. channels used,

adjacent channel separation etc. In April 2002, WPC modified the calculation methodology for spectrum charges for MW access and MW backbone networks of GSM based cellular networks from link-to-link basis to an AGR based regime as explained below:

For MW access networks

- For spectrum bandwidth up to 112 MHz in any of the circles, or 224 MHz in any of the 4 metros, spectrum charges shall be levied @ 0.25% of AGR per annum; and
- For every additional 28 MHz or part thereof (if justified and assigned) in circles or 56 MHz or part thereof in any of 4 metro areas, additional spectrum charges shall be levied @ 0.05% of AGR per annum.
- These would also include the royalty charges for spectrum usages and license fee for the fixed stations in the MW access links.

For MW backbone networks

- For spectrum bandwidth up to 56 MHz, spectrum charges shall be levied @ 0.10% of AGR per annum; and
- For every additional 28 MHz or part thereof (if justified and assigned), additional spectrum charges shall be laid read @ 0.05% of AGR per annum.
- These would also include the royalty charges for spectrum usages and license fee for the fixed stations in the MW backbone links.

3.11 Through its order of 03.11.2006 and its subsequent amendments dated 10.11.2008 and 19.02.2009, WPC amended the AGR based charges for MWA and MW carriers of GSM based cellular networks and also made them applicable for CDMA based networks, which hitherto were determined on a link-to-link basis. The revised share percentage(s) for assignment of MWA carriers were prescribed as given below[14]:

[14] Charges for Seventh carrier and beyond were prescribed by WPC in November 2008.

Table 3.1

MWA/MWB Spectrum Charges as per WPC Order of 2006/2008

Spectrum Bandwidth	Spectrum charges as percentage of AGR	Cumulative spectrum charges as percentage of AGR
First carrier	0.15 %	0.15%
Second carrier	0.20%	0.35%
Third carrier	0.20 %	0.55 %
Fourth carrier	0.25 %	0.80 %
Fifth carrier	0.30 %	1.10 %
Sixth carrier	0.35 %	1.45 %
Seventh carrier	0.40%	1.85%
Eighth carrier	0.45%	2.30%
Ninth carrier	0.50%	2.80%
Tenth carrier	0.55%	3.35%
Eleventh carrier	0.60%	3.95%

Remark: Each carrier denotes paired spectrum of 28 MHz.

3.12 The revenue share is based on the AGR for the complete LSA. These charges include royalty charges for spectrum usage and the licence fee for the fixed stations in the MWA and MWB links. Presently, there is no upfront charge payable for the assignment of MWA/MWB carriers. As mentioned earlier, the WPC order of 2006 was set aside by the Hon'ble TDSAT judgment dated 22.04.2010. The matter is now sub-judice and is before the Hon'ble Supreme Court.

3.13 With this background, the stakeholders were asked to comment on whether the annual spectrum charges for MWA and MWB carriers should be levied as a percentage of AGR or on a link-to-link basis or a combination of the two. The stakeholders were also asked to give their views on whether an upfront charge should also be levied on the assignment of MWA or MWB carriers, apart from the annual spectrum charges. The stakeholders were also requested to suggest whether there is any need to change the existing slabs prescribed by the DoT in 2006 and 2008.

3.14 Almost all stakeholders opposed the proposal for levying upfront charges at the time of assignment of MWA and MWB carriers. Most TSPs believe that MWA and MWB are essential for rollout of networks. One stakeholder, who favoured the idea of putting upfront charges, said that in case of exclusive assignment of carriers, a reasonable upfront charge along with annual charges would ensure optimal use of the carriers. It further suggested that the upfront charge for the second and subsequent MWA carriers in 13/15/18 GHz bands should be increasingly higher than the first carrier to ensure that the operator uses the available carriers to the full capacity.

3.15 A few TSPs have suggested that the spectrum charges should only cover the costs of administration and regulation of this resource; otherwise these should continue to be levied on an AGR basis.

Analysis

3.16 The Authority has examined the comments of all stakeholders. The Authority noted that a majority of stakeholders opined that no upfront charge should be levied on the assignment of MWA or MWB carriers. The Authority agrees with the view of stakeholders that MWA and MWB are essential resources for any licensee having access spectrum. The TSPs can roll-out their networks only if they have backhaul MW carriers. Now, access spectrum has been delinked from the licence and it can only be acquired by paying a market determined price. Having acquired access spectrum through auction and having paid the market price, there is no rationale for placing upfront charges for the assignment of MWA/MWB carriers.

3.17 Accordingly, **the Authority recommends that there should not be any upfront charges for the assignment of MWA and MWB carriers.**

3.18 On the issue of whether the existing AGR based charging mechanism should be continued or should be replaced by a link-to-link method,

most stakeholders strongly urged that the existing pricing mechanism - AGR based- is appropriate. Some of these stakeholders have stated that this AGR based pricing is simple in implementation whereas link-to-link basis charging may create complexity for the Government as well as the operators, in verifying and tallying the number of links, which vary in a dynamic manner, with new links coming up with new BTSs and other network elements as well as some links being shifted to OFC.

3.19 One stakeholder stated that in the presently allocated bands i.e. 6 GHz /7 GHz/13 GHz/15 GHz/18 GHz/21 GHz, the pricing should continue to be on the basis of percentage of AGR. Any change in the charging methodology from the present AGR basis per carrier to a link-to-link basis may pose a lot of operational and administrative difficulties because huge rollouts have been carried out by TSPs on MW links. However, as per the stakeholder, for the new bands that the DoT intends to explore and open in future for allocation of MW carriers, the pricing may be done on a link-to-link basis.

3.20 One stakeholder submitted that annual spectrum charges for MWA and MWB carriers should be levied on link-to-link basis but the existing formula for calculating charges for MW links needs to be modified. It further stated that for a TSP procuring MWA/MWB under the captive category, an AGR based model is justified only if the annual spectrum charges are applied to AGR directly arising from the use of MW spectrum, i.e. excluding any AGR arising as a result of use of any other transmission medium. Another stakeholder suggested that present pricing leads to inefficient utilization of MWA/MWB carriers because less efficient operators will have lower payout obligations and efficient operators will pay more. Thus, there is a need to devise a mechanism which would act as a deterrent to inefficient utilization or hoarding of a national resource like this. According to the stakeholder, one mechanism can be to prescribe a “presumptive AGR” as minimum charges to be paid which should be adequate enough to deter any person from just holding

on to carriers and not undertaking any operations or generating any revenue from the allocated MW spots.

Analysis

3.21 The Authority has examined the comments of all the stakeholders. The Authority has noted that a number of countries have adopted charging of MW links on link-to-link basis **(Annexure 2.2 and Annexure 3.1)**. The Authority also noted that, prior to 2002, the pricing for all types of MW RF links was being done on link-to-link basis only. In 2002, the pricing mechanism for MWA/MWB carriers used in cellular based networks was modified to AGR based charging, whereas for all other terrestrial MW links, the formula based on link-to-link charging is continuing till date.

3.22 The Authority is conscious of the fact that charging on a link-to-link basis may lead to better utilisation of MW spectrum as TSPs will use the carrier frequencies judiciously because they have to pay based on the number of links. However, it will add to complexity in the sense that charges for each and every link will need to be determined. Also, the charges payable are dependent on the number of links, the manner in which the new links are accounted for, etc which changes dynamically. This will create a potential bone of contention between the licensor and the licensee.

3.23 The present pricing methodology is simple and has in-built elasticity for future revenues on the basis of growth in AGR. The current charging of MW carriers on an AGR basis, which increases with the increase in number of carriers, incentivizes operators to opt for the least number of MW carriers that are required for running the network. Huge rollouts have been carried out by TSPs on the basis of allocated carriers. Any change in charging methodology from the present AGR basis per carrier to a link-to-link basis will pose operational and administrative difficulties and will be a challenge both for the TSP as well as the WPC. Moreover, as the Authority has recommended that the assignment of MWA carriers be

done on exclusive basis for the entire LSA, charging on the basis of AGR for the entire LSA seems logical.

3.24 In contrast, MW backbones, which mainly cater inter-city traffic, are limited in number. Therefore, adoption of charging on a link-to-link basis for MWB carriers is relatively easier. Moreover, the assignment of MWB carriers is not done on an exclusive basis. Therefore, charging MWB carriers on the basis of AGR of the entire LSA does not seem justified.

3.25 In view of ongoing discussion, **the Authority recommends that the AGR based spectrum charging mechanism for MWA carriers should be continued. However, for MWB carriers, the charging should be done on a link-to-link basis as is being done for all other terrestrial MW links.**

Charging slabs for MWA Carriers

3.26 Is there any need to change the existing slabs prescribed by the DoT in 2006 and 2008? Most stakeholders were of the view that the DoT Order of 2002 laid down a most appropriate and reasonable manner of ensuring allocation and charging for MW spectrum. The subsequent DoT orders of 2006 and 2008, unjustly aimed at converting the MW allocation into a revenue enhancing exercise. Higher rates would have a significant adverse impact on the operations of the TSPs. Therefore, in view of these stakeholders, the DoT should stick to the 2002 rates.

3.27 A few stakeholders submitted that the percentage of AGR as prescribed by the DoT in 2006 and 2008 is quite high and does not take into account the fact that MWA/MWB carriers are only a supporting infrastructure for mobile backhaul and should be made available as cheap as possible to facilitate cost-effective spread of mobile services

3.28 Some stakeholders submitted that TDSAT has already quashed the 2006/2008 policy in 2010 and, as on date, the 2002 policy is the

applicable policy. Therefore, in the opinion of these stakeholders, it is surprising that DoT/WPC is insisting on charging on the basis of the 2006 policy even in 2010 and thereafter. These stakeholders further argued that, firstly, the 2006 policy was without a specific recommendation of TRAI, and, secondly, when the 2006 policy itself has been quashed, then the DoT/WPC should not unnecessarily burden industry with additional costs.

3.29 One stakeholder suggested that for the quantum of spectrum holdings recommended by TEC, the existing pricing mechanism (based on a percentage of AGR) may be followed. However, for additional allotments beyond TEC prescribed limits, a considerably higher percentage may be levied and, for every additional allotment, the applicable percentage should increase sharply.

3.30 A few stakeholders were of the view that that the spectrum charges should only cover the costs of administration and regulation of this resource. A stakeholder suggested a modified version of the slab rate wherein the slab increment for additional carriers up to the requisite numbers of carriers should be fixed at 0.15% per carrier; subsequently, the slab increment should be 0.5%. One stakeholder was of the view that a uniform rate of 0.05% of AGR per carrier of 28 MHz bandwidth (paired) can be prescribed for both MWA and MWB carriers. Another stakeholder suggested that that for both MWB and MWA, a flat rate of 0.1% of AGR should be charged as annual spectrum charges for the first and second carrier. However, optimal and efficient utilization of MW carriers should be enforced through an audit mechanism and this should form the basis for future allocation.

3.31 One stakeholder submitted that the existing slab-wise rates may be revised downwards; however, the frequency spots assigned in lower bands may be charged at a relatively higher rate than the spots assigned in higher bands. Another stakeholder was of the view that spectrum

charges and other regulatory fees should be stable for a long period of time as this allows investors to confidently make long-term investment decisions.

Analysis

3.32 The Authority would first like to place on record that the issue of spectrum charging for MW backhaul carriers is currently sub-judice before the Hon'ble Supreme Court. However, that should not prevent the Authority from looking at the matter of charges for MW carriers afresh. After all, as and when the Hon'ble Supreme Court rules on the matter, liabilities up to that point will continue to be determined by either the WPC Order of 2006 or in terms of the earlier WPC Order of April, 2002. In contrast, any recommendations the Authority makes would have only prospective effect; and, should these recommendations be accepted and implemented before the ruling of the Hon'ble Supreme Court is available, it will not materially affect the revenue liabilities of the TSPs up till the point of time when the new regime kicks in.

3.33 The Authority has examined the views and suggestions of all stakeholders. It has been noted that most stakeholders are in favour of continuing spectrum charges as per the WPC order of 2002. Almost all stakeholders are of the view that these charges should be kept at a nominal level.

3.34 As stated earlier, MWA and MWB carriers are essential for the roll-out of any mobile network. The access service providers can only roll-out their network if they have MWA carriers. Now, access spectrum can only be acquired through spectrum auction/trading. Having paid the market price, there seems to be no justification for high annual spectrum charges for the assignment and subsequent use of MW carriers. Since MW carriers are an essential requirement for an access service provider, the Authority has already recommended that the assignment of MWA carriers should be done along with the assignment of access spectrum.

The Authority has also recommended that no upfront charges be levied for the assignment of MWA carriers. Because of the very same reasons, the Authority is not in favour of substantially higher spectrum charges for the use of MWA carriers. However, it is of the view that as assignments are to be made administratively, the applicable percentage of AGR needs to be hiked with the assignments of additional carriers to ensure that TSPs make optimal and efficient use of MW carriers and seek assignment of additional MWA carriers only when it is essential for them.

3.35 By the orders of 2006 and 2008, there has been a substantial rise in the spectrum charges for MWA as shown in Table 3.2 below.

Table 3.2
Spectrum Charges for MWA carriers as percentage of AGR

No. of MWA carriers assigned to a TSP	WPC Order of April 2002		WPC Order of Nov 2006/2008
	Non-Metro LSAs	Metro LSAs	
1	0.25%	0.25%	0.15%
2	0.25%	0.25%	0.35%
3	0.35%	0.25%	0.55%
4	0.45%	0.25%	0.80%
5	0.55%	0.30%	1.10%
6	0.65%	0.35%	1.45%
7	0.75%	0.40%	1.85%
8	0.85%	0.45%	2.30%
9	0.95%	0.50%	2.80%
10	1.05%	0.55%	3.35%
11	1.15%	0.60%	3.95%

3.36 As per the rates notified by the DoT in 2002, for the first two MWA carriers in non-metro LSAs and four MWA carriers in metro LSAs, the same percentage of AGR was applicable as spectrum charges. Subsequently, there was a provision of uniform increase in the spectrum charges as percentage of AGR with the increase in the number of MWA carriers assigned. As per the modified rates of 2006, there is a non-linear increase in slab rates with the assignment of each carrier. The Authority is of the view that the non-uniform and substantial hike in the applicable

percentage with the assignment of each MW carrier is simply not justified. The Authority is of the view that there should be a uniform and reasonable increase in the applicable slab with the assignment of each MW carrier. And, there are other ways to ensure that spectrum is not hoarded. (Please see the recommendations of the Authority on pricing issue in the subsequent paras.)

3.37 The choice of frequency band is also an important factor as lower frequency bands possess better propagation characteristics, whereas higher frequency bands suffer more losses. Therefore, link lengths for lower frequency bands are longer as compared to higher frequency bands. A number of stakeholders have also submitted that carriers in the lower frequency bands should be made available on an equitable basis.

3.38 Internationally, some administrations have used the frequency band as one of the factors in deriving the spectrum price for point to point MW link in a linear fashion. Frequency-factor/band-factor as specified by the South African Regulator (The Independent Communications Authority of South Africa-ICASA) and UK's regulator (OFCOM) are given in Tables 3.3 and 3.4 below.

Table 3.3

Frequency-factors specified by ICASA

Frequency Range		**Frequency Factor**
From	**To**	
30 MHz	174 MHz	1.00
174 MHz	880 MHz	0.75
880 MHz	1.8 GHz	0.50
1.8 GHz	5 GHz	0.40
5 GHz	10 GHz	0.30
10 GHz	17 GHz	0.20
17 GHz	23 GHz	0.15
23 GHz	30 GHz	0.10
30 GHz	above	0.05

Table 3.4

Band-factors specified by OFCOM

Frequency Range		Band Factor
From	To	
5.925 GHz	6.425 GHz	0.74
6.425 GHz	7.125 GHz	0.74
7.425 GHz	7.900 GHz	0.74
12.750 GHz	13.250 GHz	0.43
14.500 GHz	15.350 GHz	0.43
17.700 GHz	19.700 GHz	0.30
21.200 GHz	23.600 GHz	0.30
24.500 GHz	26.500 GHz	0.26
27.828 GHz	29.060 GHz	0.26
31.800 GHz	33.400 GHz	0.26
37.000 GHz	39.500 GHz	0.26

The band-factor/frequency factor are affecting the MW prices linearly, it is resulting in lesser prices for the MW spectrum in the higher frequency bands.

3.39 The Authority too is of the view that propagation characteristics of frequency bands need to be incorporated in the charging mechanism being framed for MWA charges. It would discourage TSPs from hoarding lower frequency MWA carriers and would encourage them to opt for higher frequency MWA carriers to reduce spectrum charges. It may also result in vacation of a few lower frequency MWA carriers that may be assigned to TSPs who do not have any MWA carrier in the 13 GHz/15 GHz range. Therefore, it would also help in achieving the objective of equitable assignment of MWA carriers. Accordingly, based on the two formulations given in Table 3.3 and 3.4, the Authority is of the view that the following band factors may be applied to determine the spectrum charges for higher frequency bands.

Table 3.5

Sl. No.	Frequency band	Frequency Factor
1.	13/15 GHz	1.4
2.	18/21 GHz	1
3.	26/28/32 GHz	0.8
4.	38/42 GHz	0.6

3.40 Keeping in view the stakeholders comments, the WPC orders of 2002 and the policy that charges for MW links should be reasonable, the Authority has concluded that a uniform rate of 0.12% of AGR per carrier of 28 MHz bandwidth (paired) can be prescribed for MWA carriers in the 18 GHz/21 GHz bands both for metro as well as for non-metro LSAs. Applicable rates for other bands have been calculated after taking into account the frequency factors as mentioned above in Table 3.6 which comes out to be 0.17% of AGR per carriers in the 13/15 GHz band, 0.1% of AGR per carrier in the 26/28/32 GHz band and 0.07% of AGR per carrier in the 38/42 GHz bands.[15] Accordingly, **the Authority recommends that the following spectrum charges for MWA carriers (28 MHz paired) should be made applicable for access service providers.**

Table 3.6

No. of MWA carriers assigned to a TSP	Applicable Percentage of AGR as spectrum charge for MWA carriers			
	13/15 GHz	18/21 GHz	26/28/32	38/42 GHz
1	0.17%	0.12%	0.10%	0.07%
2	0.34%	0.24%	0.20%	0.14%
3	0.51%	0.36%	0.30%	0.21%
4	0.68%	0.48%	0.40%	0.28%
5	0.85%	0.60%	0.50%	0.35%

Note: For larger carrier sizes, spectrum charges shall increase proportionately. i.e. if the TSP has two carriers of 2x56 MHz of carriers in 18/21 GHz band, it shall be charged at 0.48% of AGR.

3.41 As an illustration of the above recommendation, consider a TSP that has been assigned 2 carriers in 15 GHz band, 2 carriers in 18 GHz band and 1 carrier in 26 GHz band and each carrier assigned is of 2x28 MHz size. In this case, the TSP will be liable to pay spectrum charges @0.68% of AGR as detailed below:

- @0.34% of AGR for 2 carriers in 15 GHz band
- @0.24% of AGR for 2 carriers in 18 GHz band, and
- @0.1% of AGR for 1 carrier in 16 GHz band.

[15] After round off.

3.42 In Chapter-II, the Authority had recommended that TSPs, holding MWA carriers in excess of the maximum number of carriers recommended by the Authority in Table 2.5, should be asked to surrender the excess MWA carriers in one year's time period with effect from the date the new guidelines come into force. However, in case the TSP is left with excess MWA carriers as a result of trading of spectrum, it will have to surrender the excess MW carriers within three months of the effective date of trade. The Authority has also recommended that in case TSP wants to retain them, it should be permitted to do so, only if it is able to justify the need of additional carriers to the satisfaction of the DoT. The Authority is of the view that if the WPC is not satisfied with the justification and the TSP does not surrender the excess spectrum within the specified time limits (i.e. either one year or three months as the case may be), it shall be liable to pay an additional 25% of total MWA spectrum charges that the TSP is otherwise liable to pay for the period in excess of permissible period. Accordingly, **the Authority recommends that if a TSP, holding MWA carriers in excess of the maximum number of carriers recommended by the Authority in Para 2.22, fails to justify the retention of additional carriers to the DoT and does not surrender the excess MWA carriers within the specified time limits (i.e. either one year or three months as the case may be), it shall be liable to pay an additional 25% of total MWA spectrum charges that the TSP is otherwise liable to pay for the period in excess of permissible period.**

Charging of MWB links

3.43 In case link-to-link based charging mechanism is adopted, what factors should appear in the formula? Only a few stakeholders have commented on the issue. Most stakeholders have refrained from commenting saying that they prefer the existing charging mechanism based on revenue share.

3.44 One stakeholder has suggested that since carriers in the higher bands have lower propagation characteristics than lower bands, carriers at higher frequencies should be progressively lower charged. It has suggested different band factor values for different frequency ranges, e.g. the stakeholder has suggested band factor values of (a) 0.5 for frequency bands > 6 GHz and <= 10 GHz, (b) 0.3 for frequency bands > 10 GHz and <= 20 GHz (c) 0.2 for frequency bands > 20 GHz and <= 30 GHz and (d) 0.1 for frequency bands, and > 30 GHz and <= 42 GHz. The stakeholder has also suggested that along with the usual factors such as end-to-end distance, channel bandwidth and the number of carriers, the formula should also consider demographic and geographic factors. Thinly populated rural areas should attract relatively lower charges as against dense urban and suburban areas. It has suggested that geographical factor of 1 for Metro circles, 0.5 for A/B Circles, and 0.25 for C Circles.

3.45 One stakeholder commented that, in most cases, a multiplier that reflects availability and usability of the spectrum should be applied in the formula. The Multiplier is higher for lower frequencies since the re-use of frequency is limited (wide beams and longer propagation distance). Another stakeholder suggested that because of widely different propagation characteristics, spectrum bands may be grouped for the purpose of spectrum charging as (a) 6/7 GHz bands together (mostly for MW backbone network); (b) 13/15/18 GHz bands (for relatively longer range MW access links); (c) 21/26/28 GHz bands (for relatively medium range MW access links); (d) 32/42 GHz bands (for relatively short range MW access links); and (e) 60/80 GHz (for very short range MW access links).

Analysis

3.46 In India, prior to 2002, the pricing for all types of MW RF links was done on a link-to-link basis only, in conformity with the WPC's order dated 20th July 1995. In 2002, the pricing mechanism for MWA/MWB carriers

used in cellular based networks was modified to AGR-based charging. In 2006, the WPC revised spectrum charges for MWB carriers as given in Table 3.7 below.

Table 3.7

Spectrum Charges for MWB carriers as percentage of AGR

No. of MWB carriers assigned to a TSP	WPC Order of April 2002	WPC Order of Nov 2006/2008
1	0.10%	0.15%
2	0.20%	0.35%
3	0.30%	0.55%
4	0.40%	0.80%
5	0.50%	1.10%
6	0.60%	1.45%
7	0.70%	1.85%
8	0.80%	2.30%
9	0.90%	2.80%
10	1.00%	3.35%
11	1.10%	3.95%

3.47 Prior to migration to AGR based charging, the charging for microwave backhaul carriers was on link to link basis based on the following formula:-

Annual Royalty (R) = M x W x C, where;

i. M (Constant Multiplier) = 4800 for GSM Standard CMTS MW Networks within a city/town/service area and point-to-multipoint network;

M= 4800 for point to point MW link(s) with end-to-end distance less than or equal to 60 Km.

M= 9000 for point to point MW link(s) with end-to-end distance greater than 60 Km but less than or equal to 120 Km.

M= 15000 for point to point MW link(s) with end-to-end distance greater than 120Km but less than or equal to 500 Km.

M= 20000 for point to point MW link(s) with end-to-end distance greater than or equal to 500 Km.

ii. Weighing Factor 'W' which is decided by the adjacent channel separation of the R.F channelling plan deployed where:

W = 30 for adjacent channel separation up to 2 MHz.

W = 60 for adjacent channel separation greater than 2 MHz but less than or equal to 7 MHz.

W = 120 for adjacent separation greater than 7 MHz but less than or equal to 28 MHz.

W = 0.15 X Number of equivalent voice channels that can be accommodated within the adjacent channel separation greater than 28 MHz.

iii. Number of R.F. Channels used (equal to twice the number of duplex R.F. channel pairs) represented by 'C';

3.48 As the assignment of MWB carriers is not done on an exclusive basis in an LSA but on a link-to-link basis, the Authority had earlier recommended that charging on MWB carriers should also be done on a link-to-link basis as is being done in a number of countries.

3.49 To arrive at a formula for link-to-link basis charging, the Authority has tried to understand the rationale for assigning values to the three parameters viz. M, W and C in the above formula (para 3.47). However, as per the information available, reasons for assigning values are not apparent.

3.50 In view of the above, the Authority has decided to use the cost of laying/leasing a fibre for the backhaul as a proxy for arriving at the spectrum charges which a TSP should pay for a microwave link.

3.51 Through its Telecom Tariff (57th Amendment) Order dated 14th July 2014, TRAI has notified revised ceiling tariffs for domestic leased circuits for E1 (2Mbps), DS-2 (45 Mbps), STM-1 (155 Mbps) and STM-4 (622 Mbps) capacities. It is proposed to determine the link charges for MWB carriers using the ceiling tariffs for domestic leased circuits for STM-1 (155 Mbps) as TSPs, generally, are deploying STM-1 systems on the 2x28 MHz MWB carrier.

3.52 If the two alternatives of either installing a MW link or taking bandwidth on OFC leased circuits are compared then surely (a) OFC provides better quality and reliable connectivity and scalable bandwidth, (b) the TSP is not required to incur any capital/O&M expenditure if it chooses to take

the circuit on lease basis, (c) the leasing option is quick to implement whereas MW links installation take some time in processes like assignment of MWB carriers, SACFA clearance etc. The Authority recognizes that while it is not easy to quantify the relationship between OFC costs and the corresponding MWB costs, some of the factors that need to be considered in arriving at a reasonable level of MWB costs are: (a) Backhaul is an essential facility for rollout of services; (b) The high ROW costs that render the costs of the alternative to MWB (viz., OFC) unreasonably high as already explained at para 3.9 above; and (c) the need to incentivize the provision of MWB links till such time the Authority's recommendations in favour of rationalizing the RoW charges are acted upon. The Authority is of the view that in this overall context, it would be reasonable to allow a decrement of about 50% on the corresponding OFC costs for arriving at the MWB costs. Therefore, the Authority considers that a factor of 0.5 may be used on the ceiling tariff of DLC to compensate for above advantages of fibre over microwave and also to account for Return on Capital (RoC) and Licence Fee of the DLC providers. Therefore, the Authority has decided to apply the factor of 0.5 to the ceiling tariff. Thereafter, the annualized capital cost and O&M charges, that a TSP will have to incur, have been deducted to determine spectrum charges for MW link.

3.53 It has been assumed that a MW backbone link would be typically of 30 KM length without the need of a repeater. Therefore, ceiling tariffs for 30 KM distance have been used to calculate the MW link charges.

3.54 In the TTO (57th amendment), the first slab for ceiling tariffs notified by TRAI is for a 'distance <50 KM'. Using the formulation used by TRAI to arrive at the cost, tariff has been determined for slabs of distance 30 KM. which comes out to be Rs. 1,057,262 per annum.

3.55 After applying the factor of 0.5 to the ceiling tariff and adjusting the annualized MW capital cost[16] and O&M charges (10% of terminal cost, i.e., Rs 30,000), remaining amount has been considered as the spectrum charges for 30 KM MWB link which comes out to be Rs. 4,16,131 only as detailed in Table 3.8 below:

Table 3.8

Item	Amount
(A) Ceiling Tariff (per annum) for 30 KM distance	Rs, 1,057,262
(B) After applying factor of 0.5	Rs. 528,631
(C) Terminal costs and O&M charges	Rs. 112,500
(D) Spectrum Charge for 30 KM MWB link (B-C) per annum	Rs. 416,131

3.56 The above charges are for 30 KM MWB link which implies that spectrum charges using MWB carrier will be Rs. 13871 per annum i.e. Rs. 13,900 per KM per annum (after rounding off).

3.57 In view of above, **the Authority recommends that spectrum charges for MWB link shall be Rs. 13,900 per KM per annum.**

Spectrum Charges for other Terrestrial Point-to-Point MW links

3.58 As mentioned above, In India, prior to 2002, the pricing for all types of MW RF links was done on a link-to-link basis only. In 2002, the pricing mechanism for MWA/MWB carriers used in cellular based networks was modified to AGR-based charging. However, spectrum charges for other Terrestrial Point-to-Point MW links continue to be determined on link-to-link basis and are calculated based on a formula. Through its order of March 2012 **(Annexure 3.2)**, the WPC has notified fresh charges for such links. The charges are 250% of the earlier charges for most of the slabs.

[16] Capital costs taken as Rs. 3 lakh for terminal both the ends. Applying 15% ROCE and 12.5% of depreciation, annualized capital cost comes out to be Rs. 82500.

3.59 Spectrum charges for point-to-point MW link of 2x28 MHz of carrier calculated as per WPC's order of March 2012, for different distance slabs are given in Table 3.9 below.

Table 3.9
Spectrum charges for point-to-point MW link of 2x28 MHz of carrier

Distance Slab	Unit	Spectrum Charge (in Lakh)
>2 to 5	Km	7.2
>5 to 25	Km	14.4
>25 to 60	Km	28.8
>60 to 120	Km	54
>120 to 500	Km	90
> 500	Km	120

3.60 The Authority is of the view that the above charges are very high. As MW links are being used by not only TSPs (ISPs, NLD,ILD etc) but also by other organizations such as Railways, ONGC, NTPC etc for their operational needs, therefore, these charges should be rationalized. In hilly and remote areas, MW links are, in some cases, the only way to provide connectivity. Therefore, the Authority is of the view that these charges should be the same as have been recommended for MWB links. Accordingly, **the Authority recommends that present spectrum charges for terrestrial Point-to-Point MW links (other than MWB links used in cellular network) should be rationalized and should be the same as have been recommended for MWB links.**

CHAPTER IV: ADOPTION OF E-BAND AND V-BAND

4.1. With the increasing adaption of smart phones and tablets, more and more users are turning towards mobile broadband as their primary means for accessing the internet and content-based applications. As a result, mobile data traffic is growing at a rapid speed and is expected to further increase exponentially in the coming years. To cater to the bandwidth hungry applications, new services mainly data centric -3G, 4G, LTE, LTE advanced - have been launched in recent years. As a result the average speed of wireless data connection has leapt to the level of multiple of Mbps from a few Kbps.

4.2. The Government has a plan to work on the establishment of 100 new 'SMART' cities. These cities would use smart technologies with state-of–the–art infrastructure. Typically, in a smart city, sensors will provide real-time inputs to a control centre on clean water, energy, public transport, public safety, education, and healthcare. Intelligent communication tools will let administrators manage and respond to emergencies quickly as well as provide residents with constant real-time inputs. There will be supporting machine-to-machine (M2M) and machine-to-machine-to-human (M2M2H) communications in the SMART cities with high Internet access across wireline and wireless networks. This will also increase the requirement of high speed internet access.

4.3. To cater to this high speed in the access network, there will be continuous need to deploy more backhaul transmission capacity both in the form of more links for new radio sites and additional capacity to support high bandwidth services on the radio sites.

4.4. Worldwide TSPs are looking for an alternative, high capacity backhaul solution. One such solution is to deploy backhaul network in V-band and E-band. The use of V-band and E-band by TSPs, ISPs and enterprise customers is growing even in fibre rich countries like Japan

and Korea. LTE networks and high speed Wi-Fi standards have increased the use of E-band and V-band.

E-Band

4.5. E-band's frequencies are point-to-point, line of sight, radio waves in the frequency range of 71 to 86 GHz bands (71-76 GHz paired with 81-86 GHz), which are also called "millimeter waves". The unique transmission properties of very high frequency millimeter-waves enable much simpler frequency coordination, interference mitigation and path planning compared to lower frequency bands. The antennas used in E-band frequencies are highly directional. Together with the propagation limitations, wireless systems operating at the E-band frequencies are highly focused, point-to-point "pencil beam" links allowing a much higher reuse of the same frequency in a given area. These millimeter waves are able to support more capacity per backhaul link at a comparatively low cost to meet broadband demand.

4.6. E-Band, with two 5 GHz blocks of spectrum allocated at 71-76 GHz and 81-86 GHz, benefits from the large channel bandwidth available in this frequency. (typical channel bandwidth of 250 MHz). The equipment supports both duplexing methods i.e. Time Division Duplexing (TDD) and Frequency Division Duplexing (FDD). E-band spectrum with a short range up to 1Km in India (which is high intensity rain zone, though in most of the western world it is up to 2.5 Km), the high spectral reuse in dense urban areas, and low cost equipment, make it suitable for last mile deployments in urban areas.

4.7. ITU in its recommendation No. ITU-R F.2006 and CEPT in its recommendation ECC/ REC / (05/07) have provided a detailed channel plan for this band. In FDD case there are 19 channels of 250 MHz each with a duplex separation of 10 GHz between them along with separation between the blocks by 5 GHz. The channel sizes in E-band are sufficiently higher than conventional microwave spectrum

for fixed links which creates the capability to transfer very high data rates of 1 Gbps and above.

4.8. Presently, almost 40 countries have released the license plan for E-Band. In India, as per National Frequency Allocation Table (NFAP) 2011[17]:

'The use of high capacity dense network may be considered in the frequency bands 71-76 GHz and 81-86 GHz on FDD and TDD basis subject to their co-existence'.

V-Band

4.9. The V-band (57-64 GHz) is also used for high capacity terrestrial millimeter wave communications systems. In addition to the high-data rates that can be accomplished in this spectrum, energy propagation in the 60 GHz band has unique characteristics that make possible many other benefits such as excellent immunity to interference, high security, and frequency re-use. The antennas used in V-band frequencies are also highly directional and together with the propagation limitations, wireless systems operating at the V-band frequencies are also highly focused, point-to-point "pencil beam" links allowing a much higher reuse of the same frequency in a given area.

4.10. V-band is available for license-exempt applications in USA and Canada. In Japan, wireless personal area network (WPAN) systems are being implemented in the 60 GHz range for short-range, high speed multimedia data services to terminals located in rooms or office space. In Europe, several bands above 57 GHz are currently being considered for fixed wireless systems. In the United Kingdom, the 57-64 GHz band is available for license-exempt, fixed services, point-to-point applications.

[17] Footnote IND 81

4.11. On V-band, the National Frequency Allocation Plan (NFAP) - 2011[18] table states that

"Requirements of high capacity dense network may be considered in the frequency bands 31.8-33.4, 37-40 GHz, 40.5-43.5, 51.4-52.6 GHz, 55.78-59 GHz and 64-66 GHz".

4.12. Opening the E-band and V-band can be useful for catering to backhaul requirements of TSPs having 3G/4G/LTE networks or planning to launch the same. These can be used where deploying high capacity fiber is not feasible. Regarding appropriate timing of assignment of E-band and V-band the issue was placed for the comments of stakeholders in the Consultation Paper (CP).

4.13. In their comments to the CP, most stakeholders have suggested that E- band and V- band are already in use in multiple countries and in the light of deployment of new mobile technologies, it is right time to allocate the same in India to ensure good quality of service, high throughput, high network availability for new bandwidth hungry applications and excellent customer experience and customer satisfaction. As soon as the rules for these bands are clear, telecom operators can start to incorporate microwave backhaul into their network planning (and business planning and fundraising) activities. Given the shortage in access spectrum in India, these frequencies can play an important role in backhauling Wi-Fi and offloading the networks.

4.14. One of the stakeholders has suggested that since E-band V-band have different propagation characteristics, the bands should be allocated under a separate category i.e. Microwave - Very Short Haul (MWVSH).

[18] Footnote IND 80

Analysis

4.15. With increase in 3G services penetration and with rolling out of 4G (LTE) services there will be a rapid increase in data traffic. TSPs will be requiring significantly high capacity data throughput per cell site(s). The common preferred architecture is ring based to ensure the high availability of the network. The WiFi/3G/4G/LTE traffic will require high capacity rings which can be met by V-band and E-band frequencies, because traditional legacy MWA carriers with smaller carrier size will not be able to cater for such large backhaul capacity requirements. MWA carriers in E-band and V-band with large carrier size will be required to ensure good quality of service, high throughput, and high network availability for new bandwidth hungry applications.

4.16. The opening of E and V-bands would help to decongest the network over very short distances, while 15/18/21 GHz and other bands will continue to be used over relatively longer distances. These new bands can be used for providing rapid and economical deployment for dense urban routes as last mile solutions because these frequency bands are expected to decrease CAPEX, OPEX for service providers, interference between the mobile sites and reduce pressure on fiber based services to provide backhaul solutions.

4.17. Accordingly, **the Authority recommends that in order to increase broadband penetration in India, the usage of high capacity backhaul E-band (71-76 / 81-86 GHz) and V-band (57-64MHz) may be explored for allocation to the telecom service providers.**

Licensing Mechanism for E-band and V-band

4.18. A connected issue is about licensing/regulation of these bands. These bands can either be fully regulated/licensed or lightly

regulated/licensed. The CEPT[19] describes a light licensing regime as: *"Light licensing regime, where the position and characteristics of the stations are recorded on a database on a first-come first-served basis, with responsibility for subsequent users to ensure the compatibility with previously notified stations"*. In the CP, stakeholders were requested to comment on whether these bands should be fully regulated or lightly regulated.

4.19. In response many stakeholders suggested link-to-link assignment of carriers in E-band with "light-touch" regulation. Some stakeholders have suggested that apart from light-touch regulation for E-band deployment and usage, WPC should coordinate allocation of E-band frequencies and specify technical assignment criteria for Channel Plan, Power, and Antenna Gain etc.

4.20. Some stakeholders has suggested that the carriers allocated in E/V bands should be "full regulated" as is being done with other spectrum currently. The co-ordination in these bands is necessary to ensure that services neither suffer from, nor cause, interference.

4.21. On V-band licensing, many stakeholders commented that many countries in the world had adopted the V-band and kept it as un-licensed band. Therefore, it should be kept as an un-licensed band in India too. They suggested that while keeping it under unlicensed category, reporting requirements can be mandated with details of location, spot frequency uses, antenna gain etc. for the purpose of maintaining records in WPC.

Analysis

4.22. There are pros and cons of having unlicensed, lightly licensed and fully licensed (regulated) bands. In fully regulated bands though there are

[19] European Conference of Postal and Telecommunications Administrations (CEPT) is a regional organisation dealing with postal and telecommunications issues and presently has members from 48 Countries.

fewer problems of interference but there can be considerable delay in their assignment. In the case of unlicensed bands, though the related devices are quick to deploy and no license fee is charged from operators, there are chances of interference between the links. Light touch license/regulation lies in between the fully licensed/regulated and unlicensed regimes where it takes little time for allocation of frequencies, a smaller amount of License Fee, and reduced probability of interference between the links.

4.23. Internationally there are different licensing regimes in different countries for these bands. Countries like Finland, Switzerland, Estonia and Ireland have adopted "fully licensed /regulated" regime in allocation of carriers in 71-76 and 81-86 GHz bands. FCC in USA has adopted a flexible and innovative regulatory framework in which rights with regard to specific links are established based upon the date and time of link registration. A first – in – time criterion is adopted in order to protect the first-in-time registered or incumbent links. All licencees are required to obtain and submit and interference analyses to a third party database manager as a part of link registration.

4.24. In order to minimize the risk of interference when operating in this band, many regulators worldwide adopted a new, 'light licensing' regime. In UK, OFCOM opened E-band frequencies in March 2007, after a considerable public consultation, under a "light licensed" process. The applicant first applies to the regulator to become a nationwide licensee, and can then apply for any number of individual link licenses. A form containing equipment parameters and site information is submitted to OFCOM for each individual link. Responsibly for interference analysis rests with the licensee, who needs to check OFCOM's link database prior to link registration (links are protected on a "first come, first served" basis). This self-coordination significantly reduces OFCOM's administration costs.

The annual cost per E-band license is £50 per year, and link licenses are approved within 7 days of receipt.

4.25. Australian Communications and Media Authority (ACMA) opened the 71-76 and 81-86 GHz bands for point-to-point fixed service in Australia in 2007 with the provision of 125 MHz guard bands at the top and bottom of each 5 GHz block. The carriers are allocated on link-to- link basis using RADCOM[20] database for registration system. To avoid possible spectrum hoarding due to low cost fee structure, ACMA recommended 12 month roll-out time for achieving the roll-out goal. Russia, Canada, Germany and some other European countries have also adopted a similar approach of "light licensing".

4.26. In a fully regulated/licensed regime, in case link-to-link assignment is considered for allocation of carriers in E-band, there would be a huge task of database management, interference analysis and coordination for solving the interference issues, which will require putting up additional resources to accomplish the link management process.

4.27. In India, in view of the large geographical area, 22 License Service Areas (LSAs) and a large number of TSPs, it would be impractical for the DoT/WPC to allocate links in E-band and V-band in 'full- licensed' mode. There could be several thousand links registered in one LSA itself. Managing such a huge database could be a complex and difficult task. An 'exclusive-basis' assignment is also not a practical solution; this could lead to the hoarding and underutilization.

4.28. Though there is a demand for keeping V-band as unlicensed band, however, there are two factors which require considerations:

- The effects of atmospheric attenuation (rain and oxygen absorption) are severe in this band, and rain or humidity can

[20] RADCOM is a database used by Australian Communications and Media Authority (ACMA) for creating and managing radiocommunications site information and licensing data online.

cause a significant reduction in signal strength even over short distances.

- The license-exempt approach may not provide operators with the reliability they require for their backhaul networks. While the high atmospheric absorption that typifies the band mitigates the risk of interference from other users, the possibility of interference between co-channels, co-located systems cannot be eliminated.

Further, in case the band is kept as unlicensed it would be difficult to administer (if needed) it at a later stage in case of interference.

4.29. In view of the above, the most practical and productive approach would be to assign these bands on "link-to-link" basis with 'light-licensing' regulation. It would be the responsibility of the operator to address issues of interference etc.

4.30. To facilitate the link registration and maintain the database, WPC/DoT should make arrangements for an online web portal that should have a form containing equipment parameters, site information (latitude, longitude) and any other relevant information which needs to be submitted by the applicant for each individual link to the WPC. Responsibility for interference analysis should rest with the licensee, who needs to check the WPC link database prior to link registration (links should be protected on a "first come, first served" basis). This self-coordination will significantly reduce administration costs. WPC should maintain a waiting list for the same spot, coordinate allocation of E-band and V-band frequencies and specify technical assignment criteria for Channel Plan, Power, and Antenna Gain etc.

4.31. **In view of the foregoing, the Authority recommends that both E-band and V-band should be opened with 'light touch regulation' and allotment should be on a 'link to link basis'. The responsibility for registration and database management should lie with WPC wing of DoT. For this purpose, WPC should make**

necessary arrangements for an online registration process by developing a suitable web portal. Responsibility for interference analysis should rest with the licensee, who needs to check the WPC link database prior to link registration (links should be protected on a "first come, first served" basis). WPC can also maintain a waiting list for the same spot.

Channeling plan of E-band and V-band

E-band

4.32. Regarding the Radio-frequency channel and block arrangements for fixed wireless systems operating in the 71-76 and 81-86 GHz bands ITU-R Recommendation F.2006[21] (03/2012) has recommended several combinations with channel bandwidth of 250MHz and guard band of 125MHz at the top and bottom of each 5 GHz band. With this arrangement it is possible to have 19 basic channels of 250MHz each within the bands 71-76 GHz and 81-86 GHz. For requirement of higher bit rate and high system gain applications where wider channels are needed, a flexible number of consecutive 250 MHz channels may be aggregated. A similar arrangement has been recommended by CEPT and OFCOM.

4.33. Some countries like the US and Australia have elected not to allocate channels, assuming that since this frequency band has high frequency re-use, area based licensing will enable flexible usage of the spectrum. Other countries (mainly Europe) have selected the ETSI/CEPT[22] 250MHz channel plan, although they allow unlimited aggregation of any number of channels, and also charge a flat rate for the use of the E-Band on a per link basis.

[21] https://www.itu.int/rec/R-REC-F.2006-0-201203-I/en
[22] http://www.erodocdb.dk/docs/doc98/official/pdf/REC0507.pdf

4.34. During the consultation process most stakeholders who submitted their comments on this issue, also preferred to have 250MHz channel size for E-band allocation.

V-band

4.35. Elementary slot arrangement in V-band (57-64 GHz) as defined by ITU is in multiples of 50 MHz[23]. The initial two slots are reserved as guard bands and any channel size can be defined in multiples of 50 MHz. Bands limits are as per Table 4.1

Table 4.1

Bands limits (GHz) →	**57-59**							**59-63**					**63-64**		
50 MHz Slot number	1	2	3	4	.....	39	40	41	42	.....	119	120	121	.....	140
	Guard Band				.....					.....				.....	

4.36. In the upper band edge, there is no need for a guard band (GB) because the same system may also operate in the adjacent 64 - 66 GHz band. The same arrangement has been done in CEPT[24] wherein it is recommended [Recommendation Number (09)01] to assign pre-defined 50 MHz slots or their multiple aggregation, either paired or unpaired, with a maximum aggregated bandwidth up to 2500 MHz.

4.37. In view of the ITU recommendations, practices in other countries, stakeholders preferences and in-house analysis **the Authority recommends that:**

(a) Channel bandwidth for E-band (71-76 GHz and 81-86 GHz) should be 250MHz with a guard band of 125MHz at the top and bottom of

[23] http://www.itu.int/dms_pubrec/itu-r/rec/f/R-REC-F.1497-2-201402-I!!PDF-E.pdf
[24] http://www.erodocdb.dk/docs/doc98/official/pdf/Rec0901.pdf

each 5 GHz band. More than one channel can be allowed and allocated for aggregation.

(b) Channel bandwidth for V-band (57-64 GHz) should be 50MHz with a 100MHz guard band at the beginning of the band. More than one channel can be allowed and allocated for aggregation.

Pricing of E-band and V-band

4.38. Pricing of services is an important element to encourage the utilization of any frequency/band. E-band and V-bands are by and large unutilized at this point of time. Economic viability of using links in these higher frequency bands poses a challenge and, therefore, suitable charging methodology has to be worked out to encourage the utilization of these bands. The present charging mechanism of MW based on revenue share arrangement may not be suitable and/or commercially viable for the operators. It may discourage the usage of these bands with a resultant loss due to non-utilisation.

4.39. The issue of charging/ pricing of E-band and V-band links have been raised in CP for the comments of stakeholders. The near unanimous view of stakeholders is that in view of the different characteristics of millimeter–waves, the pricing of these links should be kept minimal only to cover administrative costs.

4.40. One stakeholder opined that once Authority decides to open these band carriers for allotment, it would be highly desirable to deliberate upon the pricing mechanism that suits the overall socio-economic model of the country and ensure efficient utilization of natural resources.

4.41. It has been suggested by some stakeholders that to attract TSPs to use this band, the initial pricing of the band should be kept as low as possible to incentivize the use of these bands. Also automatic SACFA clearance should be permitted. Some other stakeholders have

suggested for allocation of the whole V-band (57-64GHz) as unlicensed bands free of charge. A divergent view has been suggested by one stakeholder that these bands will have much bigger channel size therefore spectrum should be charged at the same rate specified for sub-21 GHz bands.

4.42. Some stakeholders propose that light licensing and nominal spectrum charges of maximum Rs 10000/- per link should be adopted at the earliest in line with the objective of NTP-2012 for making available affordable and effective communication for the citizens.

4.43. One stakeholder has suggested that pricing could be determined on per link policy where each 2X250MHz channel ("spot") will be around Rs 1,500 annually. During a 5 year transition period:

- First 2 years during which frequency will be charged at 80% discount.
- Further 3 years during which the operators will receive 50% discount.

4.44. Two stakeholders have suggested two pricing models[25] based on:

(a) Carrier Value Perspective [bits/Hz/area] wherein they have suggested price for 2 X 250 MHz E-band channel as 33 times lower than a 2 X 28MHz microwave channel and

(b) Fees as per Area covered/ affected by link wherein they have suggested a price of Rs750/- for 2x250MHz E-band.

Analysis

4.45. Backhaul spectrum is complementary to access spectrum. Government revenues, quality of service and efficient utilization of access spectrum can be better ensured if backhaul spectrum is

[25] Details are available on TRAI website www.trai.gov.in under section of stakeholder's comments on the CP.

allocated timely and adequately to cater to the voice and data needs and is priced properly. In case of E-band and V-band pricing, the Authority is inclined to agree with one of the stakeholder's suggestion that the current pricing model (based on AGR) cannot be applied to these bands considering the quantum of available spectrum and the different characteristics of these bands.

4.46. In case of E-band, the pricing followed in some countries is as given in the Table 4.2.

Table 4.2

Country	**E-Band License Structure**	**Typical E-Band License Fee**
USA	On-line Light License	$75 for 10 year license
UK	Light License	£50 per year (around $100)
Czech Republic, Hongkong	Unlicensed	Free of charge
Russia	Light License	Minimal registration fee
Australia	Light License	AU$187 per year
UAE	Traditional PTP	$1200
Ireland	Full licensed	$ 1500

4.47. Based on the study of international trends, the usefulness of the bands in accelerating the growth of mobile data segment, and overall growth in ICT and in view of the fact that it is almost a greenfield area for short distance backhaul, the Authority has reached the conclusion that the price of carriers in E-band and V-band should be kept low so as to leverage technology. 'Light licensing' will facilitate the speedy allocation of the carriers and low pricing would enable operators to roll out the technology faster with lower CAPEX and OPEX. Spectrum in access segment is scarce and acquired through a market based mechanism. The efficiency of the access spectrum can be improved if sufficient high capacity backhaul network is available at an affordable

price so that India can harness the fruits of the latest technologies which support high bandwidth applications.

4.48. For India, we may put a price of Rs. 10000/- (Rs. Ten Thousand) per annum per carrier of 250MHz each in E-band. In order to promote this band an initial promotional discount of 50% for three years from the date of allocation of first carrier in this band can be given. Similarly in case of V-band since there are limitations in this band due to the factors enumerated in para 4.28, it can be charged at Rs. 1000 (Rs. One Thousand) per annum per carrier of 50MHz each. Further, there should be initial promotional discount of 50% for three years from the date of allocation of first carrier in this band. These prices can be reviewed after a period of five years based on deployment and usage of the links.

4.49. To avoid spectrum hoarding which may be possible by the low fee structure, a rollout obligation should be attached to the licenses and a 12 month time limit for achieving the rollout goal may be given to the licensee in this band failing which the spectrum for that particular TSP may be taken back and assigned to next in the waiting list.

4.50. Accordingly, **the Authority recommends that:**

(a) E-band carrier should be charged at Rs. 10,000/- (Rs. Ten Thousand) per annum per carrier of 250 MHz each. More than one channel can be allocated and allowed for aggregation. There should be initial promotional discount of 50% for three years from the date of allocation of first carrier in this band.

(b) In case of charging of V-band carriers since there are limitations in this band due to the factors enumerated in para 4.278, it should be charged for Rs. 1000 (Rs. One Thousand) per annum per carrier of 50MHz each. More than one channel can be allocated and allowed for aggregation. There should be initial promotional discount of

50% for three years from the date of allocation of first carrier in this band.

(c) To avoid spectrum hoarding which may be possible by the low fee structure, a rollout obligation should be attached to the licenses and a 12 month time limit for achieving the rollout goal may be given to the licensee failing which the spectrum for that particular spot may be taken back and assigned to next in the waiting list.

(d) The prices mentioned for E-band and V-band has to be reviewed after 5 years based on deployment and usage of the links.

CHAPTER-V: SUMMARY OF RECOMMENDATIONS

5.1 The Authority recommends that TSPs should be assigned MWA carriers as per their requirement. However, it will be subject to a ceiling on the number of MWA carriers that can be assigned to a TSP as given in Table 2.5 below.

Table 2.5

Maximum No. of MWA carriers that can be assigned to a TSP

Quantum of Access Spectrum that a Licensee has in a LSA	Metro/Cat 'A' Circles	Cat 'B' Circles	Cat 'C' Circles
Less than 2.5 MHz	3	2	2
2.5 MHz or more but < 5 MHz	4	3	2
5 MHz or more but < 10 MHz	5	4	3
10 MHz or more but < 15 MHz	6	5	4
15 MHz or more but < 20 MHz	7	6	5
20 MHz or more but < 30 MHz	8	7	6
30 MHz or but <40 MHz	9	8	7
40 MHz or more	10	9	8

Note:

1. **If any TSP requires carriers in addition to what have been recommended above, it may be examined by the DoT on a case-to-case basis.**
2. **It has been assumed that each carrier is of size 2x28 MHz. Carrier of 2x56 MHz and 2x112 MHz should be counted as 2 and 4 carries respectively when applying the above ceiling.**
3. **Access spectrum indicated in this table is a paired spectrum. Therefore, unpaired access spectrum shall be counted as half for the purpose of applying the above ceilings e.g. 20 MHz of unpaired spectrum in the 2300 MHz band shall be considered as equivalent to 10 MHz (paired).**
4. **The above ceilings may be reviewed periodically.**

(Para 2.22)

5.2 The Authority recommends that the TSP should be assigned MW carriers as per their request as long as it is within the ceiling limit recommended in Para 2.22. (Para 2.29)

5.3 The Authority recommends that TSPs, holding MWA carriers in excess of the maximum number of carriers recommended by the Authority in Para 2.22, should be asked to surrender the excess MWA carriers in one year's time period with effect from the date the new guidelines come into force. However, in case TSP is left with excess MWA carriers as a result of trading of spectrum, it will have to surrender the excess MW carriers within three months of the effective date of trade. In case TSP wants to retain them, it should be permitted to do so, only if it is able to justify the need of additional carriers to the satisfaction of the DoT. (Para 2.40)

5.4 The Authority recommends that, in future, no TSP should be assigned more than 4 MWA carriers in the 13/15 GHz band. In other bands too, there should be equitable distribution of carriers as far as possible. However, this would not have any impact on existing assignments. This is because of the fact that any re-arrangement of MWA carriers already assigned to TSPs will force them to redesign their network which will require them to incur significant costs. (Para 2.43)

5.5 The Authority recommends that the assignment of MWA carriers should be done on an exclusive basis for the various spectrum bands in 13-42 GHz range whereas the assignment of MWB carriers should be done on a link-to-link basis. (Para 2.58)

5.6 The Authority recommends that the assignment of MWA and MWB carriers should continue to be done administratively. (Para 2.62)

5.7 The Authority recommends that

i. The assignment of MWA carriers should be done for the entire LSA.

ii. Assignment of both access spectrum and MWA carriers should be done simultaneously within a period of one month from the date the TSP makes the payment for access spectrum, failing

which TSP should be paid compensation at the SBI PLR rate of the amount it had already paid to acquire the access spectrum.

iii. In case of delay in the assignment of MWA carriers for a new TSP in a LSA, the effective date of access spectrum assignment may be taken as the date of assignment of the first MWA carrier.

(Para 2.69)

5.8 The Authority recommends that the higher frequency bands viz. 26 GHz, 28 GHz, 32 GHz, 38 GHz and 42 GHz should be earmarked for fixed point-to-point MW carriers and the channeling plan should be kept in line with the ITU-R recommendations. The Authority is also of the view that larger carriers of size 56 MHz (paired) and 112 MHz (paired) should also be assigned to the TSPs in these bands. As the number of assignments made in the 21 GHz band is quite small, the DoT may also examine the feasibility of assigning larger carrier sizes in this band. (Para 2.80)

5.9 The Authority recommends that:

a) The Central Government should take up the issue of RoW with the State Governments on top priority to emphasise the need to bring simplification and uniformity in the process of according RoW permissions and to bring the RoW charges to a realistic level.

b) The Central Government may mandate various agencies, responsible for making intra- and inter-city roads/highways, to provide infrastructure utility ducts along the roads/highways which can be used by companies providing utility services like telecom, power etc. for laying cables.

(Para 3.9)

5.10 The Authority recommends that there should not be any upfront charges for the assignment of MWA and MWB carriers. (Para 3.17)

5.11 The Authority recommends that the AGR based spectrum charging mechanism for MWA carriers should be continued. However, for MWB carriers, the charging should be done on a link-to-link basis as is being done for all other terrestrial MW links. (Para 3.25)

5.12 The Authority recommends that the following spectrum charges for MWA carriers (28 MHz paired) should be made applicable for access service providers.

Table 3.7

No. of MWA carriers assigned to a TSP	Applicable Percentage of AGR as spectrum charge for MWA carriers			
	13/15 GHz	18/21 GHz	26/28/32	38/42 GHz
1	0.17%	0.12%	0.10%	0.07%
2	0.34%	0.24%	0.20%	0.14%
3	0.51%	0.36%	0.30%	0.21%
4	0.68%	0.48%	0.40%	0.28%
5	0.85%	0.60%	0.50%	0.35%

Note: For larger carrier sizes, spectrum charges shall increase proportionately. i.e. if the TSP has two carriers of 2x56 MHz of carriers in 18/21 GHz band, it shall be charged at 0.48% of AGR.

(Para 3.40)

5.13 The Authority recommends that if a TSP, holding MWA carriers in excess of the maximum number of carriers recommended by the Authority in Para 2.22, fails to justify the retention of additional carriers to the DoT and does not surrender the excess MWA carriers within the specified time limits (i.e. either one year or three months as the case may be), it shall be liable to pay an additional 25% of total MWA spectrum charges that the TSP is otherwise liable to pay for the period in excess of permissible period. (Para 3.42)

5.14 The Authority recommends that spectrum charges for MWB link shall be Rs. 13,900 per KM per annum. (Para 3.57)

5.15 The Authority recommends that present spectrum charges for terrestrial Point-to-Point MW links (other than MWB links used in

cellular network) should be rationalized and should be the same as have been recommended for MWB links. (Para 3.60)

5.16 The Authority recommends that in order to increase broadband penetration in India, the usage of high capacity backhaul E-band (71-76 / 81-86 GHz) and V-band (57-64MHz) may be explored for allocation to the telecom service providers. (Para 4.17)

5.17 The Authority recommends that both E-band and V-band should be opened with 'light touch regulation' and allotment should be on a 'link to link basis'. The responsibility for registration and database management should lie with WPC wing of DoT. For this purpose, WPC should make necessary arrangements for an online registration process by developing a suitable web portal. Responsibility for interference analysis should rest with the licensee, who needs to check the WPC link database prior to link registration (links should be protected on a "first come, first served" basis). WPC can also maintain a waiting list for the same spot. (Para 4.31)

5.18 The Authority recommends that:

(a) Channel bandwidth for E-band (71-76 GHz and 81-86 GHz) should be 250MHz with a guard band of 125MHz at the top and bottom of each 5 GHz band. More than one channel can be allowed and allocated for aggregation.

(b) Channel bandwidth for V-band (57-64 GHz) should be 50MHz with a 100MHz guard band at the beginning of the band. More than one channel can be allowed and allocated for aggregation.

(Para 4.37)

5.19 The Authority recommends that:

(a) E-band carrier should be charged at Rs. 10,000/- (Rs. Ten Thousand) per annum per carrier of 250 MHz each. More than one channel can be allocated and allowed for aggregation. There should

be initial promotional discount of 50% for three years from the date of allocation of first carrier in this band.

(b) In case of charging of V-band carriers since there are limitations in this band due to the factors enumerated in para 4.278, it should be charged for Rs. 1000 (Rs. One Thousand) per annum per carrier of 50MHz each. More than one channel can be allocated and allowed for aggregation. There should be initial promotional discount of 50% for three years from the date of allocation of first carrier in this band.

(c) To avoid spectrum hoarding which may be possible by the low fee structure, a rollout obligation should be attached to the licenses and a 12 month time limit for achieving the rollout goal may be given to the licensee failing which the spectrum for that particular spot may be taken back and assigned to next in the waiting list.

(d) The prices mentioned for E-band and V-band has to be reviewed after 5 years based on deployment and usage of the links.

(Para 4.50)

Abbreviations

S.No.	Abbreviation	Expansion
1.	2G	Second Generation
2.	3G	Third Generation
3.	4G	Fourth Generation
4.	ACMA	Australian Communications and Media Authority
5.	AGR	Adjusted Gross Revenue
6.	AUSPI	Association of Unified Telecom Service Providers of India
7.	BSC	Base Station Controller
8.	BTS	Base Transceiver Station
9.	BWA	Broadband Wireless Access
10.	CAPEX	Capital Expenditure
11.	CDMA	Code Division Multiple Access
12.	CEPT	European Conference of Postal and Telecommunications Administrations
13.	CMTS	Cellular Mobile Telephone System
14.	COAI	Cellular Operators Association of India
15.	CP	Consultation Paper
16.	DLC	Domestic Leased Circuits
17.	DoT	Department of Telecommunications
18.	ECC	Electronic Communications Committee
19.	ETSI	European Telecommunications Standards Institute
20.	FBO	Facilities Based Operators
21.	FCC	Federal Communications Commission
22.	FDD	Frequency Division Duplexing
23.	FNA	Federal Network Agency
24.	Gbps	Gigabits Per Second
25.	GHz	Gigahertz
26.	GSM	Global System for Mobile Communications
27.	HSPA	High Speed Packet Access

S.No.	Abbreviation	Expansion
28.	HSPA+	Evolved HSPA
29.	ICASA	The Independent Communications Authority of South Africa
30.	ICT	Information and Communication Technology
31.	IDA	Infocomm Development Authority of Singapore
32.	ILD	International Long Distance
33.	IMT	International Mobile Telecommunications
34.	ISP	Internet Service Provider
35.	ITU	International Telecommunication Union
36.	ITU-R	ITU Radiocommunication Sector
37.	LSA	Licence Service Area
38.	LTE	Long Term Evolution
39.	M2M	machine-to-machine
40.	M2M2H	machine-to-machine-to-human
41.	Mbps	Megabits Per Second
42.	MGW	Media Gateway
43.	MHz	Megahertz
44.	MSC	Mobile Switching Centre
45.	MW	Microwave
46.	MWA	Microwave Access
47.	MWB	Microwave Backbone
48.	MWVSH	Microwave – Very Short Haul
49.	NFAP	National Frequency Allocation Plan
50.	NIA	Notice Inviting Applications
51.	NLD	National Long Distance
52.	NTP	National Telecom Policy
53.	NTPC	National Thermal Power Corporation Limited
54.	O&M	Operations & Maintenance
55.	OFC	Optical Fiber Cable
56.	OFCOM	UK's Regulator

S.No.	Abbreviation	Expansion
57.	OFTA	Office of the Telecommunications Authority of Hong Kong
58.	OHD	Open House Discussion
59.	ONGC	Oil and Natural Gas Corporation Limited
60.	OPEX	Operating Expenditure
61.	PoP	Point of Presence
62.	PtP	Point to Point
63.	QoS	Quality of Service
64.	RADCOM	Radiocommunication database of ACMA
65.	RAN	Radio Access Networks
66.	RF	Radio Frequency
67.	RNC	Radio Network Controller
68.	RoC	Return on Capital
69.	RoW	Right of Way
70.	SACFA	Standing Advisory Committee on Radio Frequency Allocation
71.	SBI PLR	State Bank of India – Prime Lending Rate
72.	SUC	Spectrum Usage Charge
73.	TDD	Time Division Duplexing
74.	TDSAT	Telecom Dispute Settlement Appellate Tribunal
75.	TEC	Telecommunication Engineering Centre
76.	TSP	Telecom Service Provider
77.	UL	Unified Licence
78.	UMTS	Universal Mobile Telecommunication System
79.	WiFi	Wireless Fidelity
80.	WPC	Wireless Planning & Coordination

Annexure 1.1

SL No- 19(I)

Government of India
Ministry of Communication & Information Technology
Department of Telecommunications
(WPC Wing)

F. No. L-14035/19/2010-BWA

Dated, the 26th November, 2012

To,

The Secretary,
Telecom Regulatory Authority of India,
MTNL Doorsanchar Bhawan,
Jawahar Lal Nehru Marg,
New Delhi-110002

Subject : Recommendation for allocation and pricing of Microwave Access (MWA) and Microwave Backbone (MWB) RF carriers.

Sir,

Presently, the charging of Microwave Access & Backbone (MWA/MWB) carriers is regulated as per the AGR based annual spectrum usage charges mentioned in this Ministry's orders No.J-14025/20(11)/06-NT dated 03.11.2006, its amendments dated 10.11.2008 and 19.02.2009 respectively as may be modified by the Govt. from time to time (copy enclosed) and allotment, as provisioned in National Frequency Allocation Plan, subject to availability of spectrum. The above spectrum charging orders were challenged in Hon'ble court of TDSAT by GSM telecom service providers and their association (COAI) vide petition no. 122 of 2007. *These orders were set aside vide Hon'ble TDSAT judgment dated 22.04.2010.* The orders are now subjudice in view of a Civil appeal no.D29714 of 2010 filed by the Government before Hon'ble Supreme Court against the above TDSAT judgment.

2. It may be mentioned that in another judgment dated 18.07.2011 passed by Hon'ble TDSAT i.r.o. petition no.116 of 2007 filed by AUSPI and other CDMA operators v/s Union of India, part of the judgment order states that "*.....we, therefore, are of the opinion that the impugned order dated 3rd November, 2006 can not be struck down, as being discriminatory or violative of the National Telecom Policy.*" The same has been placed before Hon'ble Supreme Court in case of Civil Appeal No.D29714 of 2010. The appeal has been admitted on 07.09.2012 and the hearing is to take place.

3. In 2010 timeframe, pending decision of Hon'ble Supreme Court on the above spectrum charging orders, Telecom Commission in its meeting held on 29.10.2010 decided to allot two(2) nos. of MW Carriers to new operators offering 3G/BWA services to ensure timely roll out of their services. The TC also directed to conduct a technical study for actual requirement of MW Access carriers for different services (2G/3G/BWA).

4. Accordingly, two MW Access carriers were allotted to new BWA operators, after executing the legally vetted Frequency Agreement (copy enclosed). It may be mentioned that MW Backbone carriers are being allotted in the bands 6/7GHz and MW Access carriers above 10GHz bands, in general, usually with the bandwidths of 28MHz, 14 MHz, 7MHz (paired). (Ref. Annexure-I)

5. The Government constituted a committee under chairmanship of DDG (Radio), TEC, DOT which submitted its report to determine the actual requirement of MW Access Carriers for different services on 07.10.2011 (copy enclosed). The committee made the following recommendations:

i) The service providers should lay more fibers so as to reduce dependence on the RF pairs to the extent possible.

ii) E-band radios should be used for increased capacities and additional availability of RF carries. Similarly, other bands may also be explored for this purpose

iii) The following table may be referred for allocation of RF carriers:

Service	Metro & A circle	B Circle	C Circle	Remarks
2G	3-4	2-3	2	
3G	One additional RF pair in each category compared to 2G.			
BWA	4-6	3-4	3	This is the requirement for a standalone BWA operator as well as for an operator having 2G & 3G services in a service area

Note : Each MW Access RF Carrier refers to 28 MHz paired bandwidth.

6. The above Recommendations were submitted and it was considered that the recommendations of the committee may be accepted for reference for allotment of MW Access carrier to various 2G/3G/BWA service providers subject to the operators abiding to pay by the methodology and MW Carriers spectrum usage charges mentioned in order No.J-14025/20(11)/06-NT dated 03.11.2006, its amendments dated 10.11.2008 and 19.02.2009 as may be modified by the Government from time to time.

7. Following were taken into consideration :

7.1 After considering many factors viz. technical facts and considering recommendations of the committee, AGR based charging method of MW Access Carrier, requirement of the BWA operators, also the spectrum availability and keeping in view of the relevant NIA provisions, a total of 4 MW Access Carriers in Metros & A circles and 3 in B & C circles respectively may be allotted initially, to the BWA operators as well as existing 2G/3G operators offering BWA services on their request, as per channeling plan provisioned in National Frequency Allocation Plan amended from time to time subject to availability of spectrum and only after execution of a legally vetted Frequency Agreement by the operators.

7.2 There is a clause in the Frequency Agreement for MWA Network under ISP-BWA License that "The Licensee hereby agrees that as and when the rates for Microwave Access are revised by a rule or regulation made under the Telegraph Act, the Licensee will be bound by the said revised rates and hereby agrees and undertake to pay the said rates as and when revised." (Clause 4).

7.3 Beyond the above initial allotment of MW Access Carrier for BWA services, the further allotment would be subject to roll out, growth and generation of AGR from the service and other criteria, if any, to be decided by the competent authority. Accordingly, additional MW Access spectrum beyond 4 MW Carriers in Metros & A circles and 3 in B circles may be considered by the Government after formulation of necessary criteria.

7.4 In this regard, it may be mentioned that as per provision under NIA clause 2.3, subject to the usual processes, terms and conditions, and applicable charges, the Government shall make available spectrum for these purposes under the prevailing terms and conditions (specified by the WPC), subject to availability. However, it must be noted that these frequencies are not part of the Auctions, are not bundled with the 3G spectrum or the BWA spectrum and payment of the Successful Bid Amount does not grant usage rights to such backhaul spectrum. Separate charges, as applicable, are payable for backhaul spectrum.

7.5 To impose charges on all the operators in respect of all their existing and future MW Access carrier allotments. These charges may include charges as a percentage of presumptive AGR wherever the actual AGR is NIL or delayed, from the date of allotment of MW carriers besides the spectrum usage charges as per AGR based annual spectrum charges mentioned in orders dated 03.11.06, 10.11.08 & 19.02.09.

7.6 Existing 2G/3G operators having MW carriers more than the limits as described in Para 5(iii) above, may have to surrender the excess, as it was observed that most of the existing 2G GSM/CDMA & 3G operators are having MW Access carriers either comparable or more than that recommended by the committee. It may be mentioned that all 3G service providers are existing 2G operators, and are operational as on date. Further, in some cases of the existing 2G/3G operators, the implementation of recommendations of the committee may also require consideration of allotment of additional MW carriers, wherever the existing allocation is less than the minimum recommended numbers. Since, the spectrum charging orders of MW carriers have been challenged by existing 2G/3G operators and are subjudice before the Hon'ble Supreme Court, and the immediate withdrawal of carriers in concerned cases might result into revenue loss to the Government, the decision in the matter of 2G/3G services may be taken separately after consulting TRAI.

7.7 Keeping in view the recommendations of CANR (Committee on Allocation of Natural Resources), the necessary criteria for allocation and pricing of MW Access and Backbone carriers (MWA/MWB) for all the new service providers and the existing service providers needs to be decided by the Government in consultation with TRAI. Further, the necessary criteria for allotment of additional MW Access carriers beyond the initial allocation and the charges to be levied as mentioned above in respect of all operators also needs to be decided by the Government in consultation with TRAI.

8. Based on above considerations, and until the consultation process with TRAI are completed and a final decision is taken by the Government after receiving the necessary TRAI recommendations in this regard, guidelines have been issued as an interim measure i.r.o. allotment of MWA carriers for BWA services vide L-14035/19/2010-BWA dated 16th March, 2012 (copy enclosed). WPC Wing has initiated the process of assignment of MW Access carriers to the operators offering BWA services, only after execution of legally vetted Frequency Agreement.

9. In view of above and to regulate allocation and pricing of MW Access and Backbone carriers in an efficient manner, recommendations are sought on the following issues :

a. Methodology for Allocation & Pricing of Microwave Access & Backbone (MWA / MWB) carriers for new service providers and the existing service providers for initial and additional allocations of MW Access and MW backbone carries.

b. Criteria for withdrawal of excess allocation of MWA & MWB carriers from existing service providers.

c. Annual spectrum usages charges & criteria for pricing for different bands of MWA & MWB carriers including any upfront charges, alongwith date of applicability.

10. TRAI is requested to furnish their recommendations on above in terms of clause 11 (1)(a) of TRAI Act 1997 as amended by TRAI Amendment Act 2000.

This issues with the approval of Secretary (T).

(R.K. Saxena)
Deputy Wireless Adviser to Govt. of India
Tel : 23359561

Enclosures :

(i) Spectrum Charging Orders.
(ii) Frequency Agreement.
(iii) Committee Recommendation i.r.o. MW Access carriers.
(iv) Guide lines dated 16th March, 2012.
(v) Copies of Hon'ble TDSAT judgment dated 22.04.2010 i.r.o. petition no. 122 of 2007 and judgement dated 18.07.2011 i.r.o. petition no.116 of 2007.
(vi) Annexure-I .

NOTE

The Enclosures mentioned in this letter are part of the Consultation Paper dated 28th March 2014 (at pages 43 to 155) which may be referred to. The consultation paper is available in the TRAI website www.trai.gov.in

Annexure 2.1

Summary of auctions held for backhaul spectrum bands

Country	Date	Frequency Bands	Winning Bids
Ireland	June 2008	26 GHz band, each block is 2x 28 MHz for national use	€70,000 per 2x28 MHz One bidder paid an additional €30,679 per block and another paid an additional €39,609 per block to secure their preferred blocks
UK	February 2008	10 GHz band, 28 GHz, 32 GHz and 40 GHz bands	Prices for national blocks range from £60-975/MHz
USA	July 2004	880 licenses of 80 MHz in the band of 24 GHz in a range of geographic areas	Only 7 licenses sold prices ranged from $13,000 to $62,400 depending on the area.

Source: Study of radio Spectrum pricing System: A report for OFTA by PLUM, December 2009

Annexure-2.2

International Practices

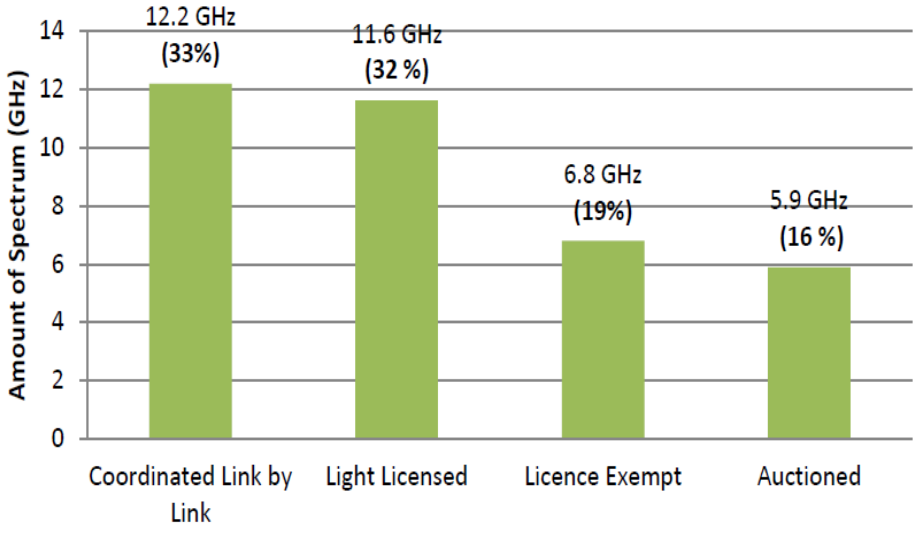
UNITED KINGDOM

1. UK regulator, Ofcom assigns and regulates the assignment of spectrum for fixed MW point-to-point links to Telecom Service Providers (TSP). Approximately 37 GHz of spectrum in the bands ranging from 1.4 GHz to 86 GHz is available in the UK for fixed terrestrial point to point links and the majority of fixed links in the UK is used to provide backhaul for cellular networks. OFCOM has adopted different approach for assignment of spectrum for point to point links. On the basis of assignment, the spectrum available for fixed links can be distinguished into four types: - (i) OFCOM coordinated, (ii) Light Licenced, (iii) Licence exempted and (iv) Auctioned/Block Licenced Spectrum.

Chart 1

Current Management Approach for Spectrum available for fixed links in the UK

(as a percentage of the total spectrum available for fixed point to point links)



2. Ofcom coordinated spectrum is fully licensed and technically coordinated on a link by link basis by Ofcom. Ofcom sets the technical assignment criteria in consultation with stakeholders and use this to coordinate the links to prevent interference. All of these fixed link bands are assigned on first-come-first-basis and consist of a pair of carriers. The pricing of wireless fixed links is done as per the spectrum pricing algorithm given

in the 2005 Wireless Telegraphy License Fees Regulations[26]. There is around 12 GHz of spectrum in this category spread across fourteen separate bands between 1.4 GHz and 60 GHz.

3. In Auctioned/Block licensed category Ofcom packages the spectrum into blocks (typically, on a regional or UK-wide basis) that are licensed to a single licensee via an auction process. The licensee is then responsible for micro-management of any assignments within its licensed block and can use the spectrum either for its own use (e.g. backhaul for its own mobile network) or for provision of spectrum access services to others (third party band management).[27] There have been two auctions of this type of spectrum: the 28GHz auction in 2000 by the Radio Authority and the 10-40 GHz auction by Ofcom in 2008. The 10-40 GHz auction included frequencies in the 10 GHz, 28 GHz, 32 GHz and 40 GHz bands; and some national as well as some regional licences were issued. Summary of results of "10-40 GHz" auction of 2008 is given below[28]:

Table 1

Band	**10 GHz National**	**28 GHz National**	**28 GHz Sub National 1**	**28 GHz Sub National 2**	**28 GHz Sub National 3**	**32 GHz National**	**40 GHz National**
Number of Lots	10	2	1	1	1	6	6
Size of each lot	2 × 10 MHz	2 × 112 MHz	2 × 112 MHz	2 × 112 MHz	2 × 112 MHz	2 × 126 MHz	2 × 250 MHz
Minimum price per lot	£10,000	£60,000	£20,000	£10,000	£30,000	£60,000	£30,000
Final price per lot	£69,000	£707,000	£97,000	£37,000	£130,000	£594,000	£151,000

4. In Light licensed category, individual link licenses are issued by Ofcom, but the licensees take their own responsibility for coordinating these links. Ofcom does not generally specify the channel arrangements in these bands and licensees have the freedom to choose the channel size. Links are registered on Ofcom's wireless telegraphy register and are given

[26] http://licensing.ofcom.org.uk/binaries/spectrum/fixed-terrestrial-links/guidance-for-licensees/FeeCalcDoc.pdf
[27] http://stakeholders.ofcom.org.uk/binaries/consultations/spectrum-review/update.pdf
[28] http://www.cramton.umd.edu/papers2005-2009/cramton-review-of-10-40-ghz-auction.pdf

priority in the band on a 'date of registration' basis, which can be referred if an interference case arises. There is approximately 12 GHz of spectrum in this category located between 64 GHz and 86 GHz. Ofcom has decided to review the light licensing self coordinated approach and to consider a number of possible options that are likely to deliver the best outcome considering the urgent requirement to establish the way forward with respect to facilitating 4G infrastructure rollout.

5. Unlicensed spectrum can also be used for backhaul purposes. In License Exempt category, users of licence do not need to inform Ofcom of their planned use or coordinate among themselves for operation. However they have to follow general conditions agreed to prevent interference. There is approx. 7 GHz of license exempt spectrum available in 57 - 64 GHz.

SINGAPORE

6. Infocomm Development Authority (IDA) of Singapore assigns frequencies for MW backhaul links to Facilities Based Operators (FBO) to provide backbone links between major exchanges and also as links for their local access networks. IDA generally assigns frequencies for point-to-point fixed service links on a shared-use basis. Use of exclusive frequency assignment is discouraged. For the request for exclusive frequency assignment, applicant is required to provide justifications and only usage that warrant such assignment is approved by the IDA.

7. IDA encourages the use of hot standby and space diversity for backbone links to improve the service availability. To ensure the efficient usage of frequency, frequency diversity is generally not permitted. To ensure the efficient use of lower frequency band, which have better propagation characteristics, IDA decides the choice of frequency band based on the path length of the fixed service link. As a general rule, the request for a frequency in any band should satisfy the minimum path length as stipulated in Table below:

Table 2

Frequency Range	Channelling Plan	Channel Width (MHz)	Minimum Path Length
5925-6425 MHz	ITU-R F.383-8	29.65	20 Km
6425-7125 MHz	ITU-R F.384-10	20	20 Km
7125-7725 MHz	ITU-R F.385-9	7	20 Km
7725-8500 MHz	ITU-R F.386-8	29.65	20 Km
10.5-10.68 GHz	ITU-R F.747-0	7/14	15 Km
10.7-11.7 GHz	ITU-R F.387-11	20	15 Km
12.2-12.7 GHz	ITU-R F.746-9	20	15 Km
12.75-13.25 GHz	ITU-R F 497-7	28	15 Km
14.4-15.35 GHz	ITU-R F.636-3	7/14/28	10 Km
17.7-19.7 GHz	ITU-R F.595-9	27.5/55	5 Km
21.2-23.6 GHz	ITU-R F.637-3	3.5/7/14/28	2 Km

8. IDA does not guarantee the availability of the frequencies for any length of time. Usage of each frequency is renewed on an annual basis. However, taking into account the need for continued operation of the service and lead time required for migration, IDA endeavours to give notice as early as possible if there is a change in the spectrum plans.

9. Two types of charges are levied on the FBOs for the assignment of MW backhaul links. One part of the charge is application and processing Fees. It is a one-time charge. Another spectrum charge is frequency management fees, which is charged annually. Application and processing fee and the frequency management fee are given in Table below: [29]

Table 3

Radio Frequency Spectrum	Application and Processing Fee Payable Per Frequency
25 KHz or less	$290
25 KHz < Bandwidth < 500 KHz	$450
500 KHz <= Bandwidth < 1 MHz	$ 1,350
1 MHz <= Bandwidth < 20 MHz	$ 2,700
Bandwidth >= 20 MHz	$ 4,650

[29] Singapore Management Handbook, 2014 by IDA Singapore (http://www.ida.gov.sg,)

Table 4

Radio Frequency Spectrum	**Fee Payable per frequency per annum**
Frequencies for Networks and Systems – (a) Exclusive use – (i) Bandwidth of 1 MHz or more	$12,000 for the first MHz of occupied bandwidth and $300 per subsequent MHz of occupied bandwidth or part thereof.
(b) Shared use – (i) Bandwidth of 300 KHz or more but less than 20 MHz. (ii) Bandwidth of 20 MHz or more	 $3,500 $6,200

GERMANY

10. The Federal Network Agency (FNA), as per Telecommunications Act 2004, is the central body for planning, coordinating and assigning frequencies for fixed radio relay links. While assigning spectrum bands, FNA ensures that the spectrum available for fixed links is used as efficiently and effectively as possible and that all interested users have an easy access to such links. Frequency assignment for the operation of MW backhaul is generally done in spectrum bands of 6, 7, 13, 15, 18, 23, 26, 28, 32 and 38 GHz. However, FNA is also considering opening of frequency bands above 50 GHz for MW wireless backhaul. For assignment of frequencies for point-to-point backhaul, service providers have to apply at the Federal Network Agency. The calculation of spectrum fees is done by Federal Network Agency on the basis of fixed link algorithm for point-to-point links. Applicants do not have a legal right to particular transmitting frequencies, but may state their preference. During the assignment procedure the Agency checks whether or not the preferred or other frequencies are available and can be coordinated (compatibility with other fixed links already operated, and coordination with military users, where appropriate). The Federal Network Agency does not do any general technical, radio hop or radio relay system planning work in connection with frequency assignment. These tasks need to be carried out, or outsourced, by the fixed link operators themselves.

AUSTRALIA

11. Australian Communications and Media Authority (ACMA) takes care of the assignment of the spectrum for fixed point-to-point links under the apparatus license system. Apparatus licences can be issued for any period up to a maximum of five years and may be renewed on expiry. There are two types of fees applicable to apparatus licences: administrative charges to recover the direct costs of spectrum management, and annual taxes to recover the indirect costs of spectrum management.

12. The annual licence tax is applied to each chargeable 'spectrum access' of an assigned licence. The annual licence tax is determined by multiplying the following factors: -

(i) Normalisation Factor: - The constant converts the relative spectrum values provided by the rest of the formula to an actual dollar figure. It is updated by CPI adjustments every year to keep licence taxes constant in real terms.

(ii) Bandwidth: - Taxes also vary depending on the bandwidth within which a service is licensed to operate.

(iii) Power: - The power factor allows a reduced tax for low-power spectrum accesses, which deny spectrum to other users over a small area. Spectrum accesses that are not low power have a power factor of one. However, the low-power factor does not apply to point-to-point link as there is weak correlation between the power level and the area over which spectrum is denied to other users.

(iv) Location Weighting: - There are 65 combinations of spectrum and geographic locations, which have each been assigned a location weighting. The location combinations reflect the density of services and demand for spectrum at different frequencies and geographic areas. Higher taxes in locations of higher density and demand encourage efficient spectrum use.

(v) Adjustment Factor: - Adjustment factors are used to modify the tax levels of some licensing options which introduce the flexibility to vary taxes according to parameters that are not included in the tax formula. E.g. for fixed point-to-point below 960 MHz and above 960 MHz, the adjustment factor is 18.4841 and 0.4369 respectively.

13. Apart from annual charges, there are also administrative charges which are of three kinds: issue, renewal and instalment charges. Charges apply per spectrum access for assigned licences, and per licence for non-assigned licences.

(i) Issue Charges: - cover the direct costs incurred by the ACMA in issuing the licence (the major cost of which is the frequency assignment task). The issue charge is also payable when the ACMA carries out the assessment for a spectrum access, but does not issue it. This may occur when there is no suitable frequency available at the site nominated by the applicant. An accredited person may also perform the frequency assignment task and provide a client with a frequency assignment certificate. The ACMA will then issue a licence. This incurs a smaller issue charge.

(ii) Renewal Charges: - a renewal charge of $4.00 is payable for each chargeable spectrum access. If a renewal request for an assigned licence is not received by 60 days after the expiry of the old licence, the frequency assignment and call sign become available for assignment to other services.

(iii) Instalment Charges: - Where a licence is taken out for more than a year, a licensee can choose to pay the tax by annual instalment.

14. It is not necessary for licensees to use the tax formula to calculate their annual tax, as the 'annual licence tax ($ per kHz)' tables display the results of the formula for each licence type at every spectrum/geographic location, and include the normalisation factor. This means that licensees only need to refer to the tables in the applicable division, multiply the

relevant figure by the bandwidth of their spectrum access (per kHz) and apply the low-power discount if necessary. E.g. License Charges ($ per KHz) for Fixed Point-to-Point Licences[30] for (a) >8.5 to 14.5 GHz and (b) >14.5 to 31.3 GHz frequency range are given below:

Table 5

Spectrum Location	**Geographic Location**				
	Australia-wide	**High Density**	**Medium Density**	**Low Density**	**Remote Density**
>8.5 to 14.5 GHz	0.3999	0.1439	0.0340	0.0025	0.0011
>14.5 to 31.3 GHz	0.3999	0.1064	0.0234	0.0025	0.0011

This is subject to a minimum tax of $36.17. In addition, the licensee shall have to pay (a) Issue Charges - $493 and (b) Renewal/ Instalment Charges - $4 as administrative charges.

[30] Apparatus License Fee Schedule dated 15th August, 2012

Annexure 3.1

Pricing Formula applicable for Point to Point Fixed RF links

Countries	Pricing Formula	Factors
UK[31]	**As = Sp x Bwf x Bf x Plf x Avf (x CCDP Discount x Directional Discount)** Where – – 'As' means the sum to be calculated. – 'Sp' is the spectrum price, being a sum set at £88 per 2 x 1 MHz for each bidirectional link. – 'Bwf' means the value of actual system bandwidth (MHz). – 'Bf' means the band factor which is determined by the actual frequency band. – 'Plf' is the path length factor which is determined from the actual path length and the minimum path length which is specified in Interface. – 'Avf' means the availability factor which is determined from the required system availability.	**Element Range:** Spectrum Price: Set at £88 per 2 × 1 MHz. Bandwidth Factor: Minimum = 1 MHz but any actual value above this with an observed maximum of 135 MHz. Band Factor: Any value between 0.00 and 1.00 is possible. However the current active range is 1.0 to 0.17 (decreasing with frequency band). Path Length Factor: 1 or the minimum between √(Minimum Path Length /Actual Link Path) Availability Factor: Between 0.7 and 1.45. CCDP Discount: For 2nd link operating co-channel cross polar to the 1st link along a common path the value is 0.5 otherwise it equals 1. Directional Discount: For uni-directional links the value is 0.75 otherwise it equals 1.
Australia[32]	**At = K × B × P × Adj × LW**	'At' is the annual spectrum fees. 'K': Every year all apparatus licence taxes are increased by CPI. This is to ensure that the desired outcomes of the tax, efficient use of spectrum and indirect cost recovery, are not eroded by the effects of inflation. 'B' is Bandwidth (in KHz). 'P' is the power factor which allows a reduced tax for low-power spectrum accesses which deny spectrum to other users over a small area. Spectrum accesses that are not low power have a power factor of one. 'Adj' is the adjustment factors for particular sets of licensing options such as premium to reflect the higher demand for mobile spectrum or a discount to reflect the frequency reuse possible with fixed links. This gives flexibility to adjust values according to parameters not included in the formula and to make adjustments to correct historic anomalies. 'LW' is a weight related to the spectrum location and the geographic location (Australia wide, high density, medium density, low density and remote density) of the license.

[31] Fixed Link Licence Fee Algorithm (Ofcom) - http://licensing.ofcom.org.uk/binaries/spectrum/fixed-terrestrial-links/guidance-for-licensees/FeeCalcDoc.pdf

[32] http://www.acma.gov.au/webwr/_assets/main/lib410241/apparatus_licence_fee_schedule-27aug2012.pdf

<table>
<tr>
<td>Kenya[33]</td>
<td>F (in Kenyan Shilling) per transmitter = (RFBW/ 8.5 kHz) × K1 x Unit fee x FZ</td>
<td>Where,
Unit fee = 574.10, as Kenyan Shilling for an 8.5 kHz band.
K1 is the band factor,
= 0.9 for frequency band ≤ 1GHz
= 0.3 for frequency band > 1 GHz and ≤ 10 GHz
= 0.21 for frequency band > 10 GHz and ≤ 20 GHz
= 0.15 for frequency band > 20 GHz and ≤ 30 GHz
= 0.1 for frequency band > 30GHz
RFBW is RF bandwidth in KHz or 500KHz, whichever is higher
FZ Frequency Zone Factor
= 1 for Zone A (High Congestion Zone)
= 0.5 for Zone B (Low Congestion Zone)</td>
</tr>
<tr>
<td>UAE[34]</td>
<td>Annual Spectrum Fee for each fixed point to point link above 2 GHz shall be calculated as follows:
Spectrum Fee = F x 2000 + BW x 1000
Where:
F = Frequency range factor
BW = Bandwidth Factor</td>
<td>
<table>
<tr><td>Frequency Range</td><td>F factor</td></tr>
<tr><td>2GHz - 3GHz</td><td>4</td></tr>
<tr><td>>3 GHz - 14 GHz</td><td>3</td></tr>
<tr><td>> 14 GHz - 40 GHz</td><td>2</td></tr>
<tr><td>Above 40 GHz</td><td>1</td></tr>
</table>
<table>
<tr><td>Bandwidth</td><td>BW factor</td></tr>
<tr><td>7 MHz or less</td><td>1</td></tr>
<tr><td>> 7MHz - 28 MHz</td><td>2</td></tr>
<tr><td>> 28 MHz - 56 MHz</td><td>3</td></tr>
<tr><td>More than 56 MHz</td><td>4</td></tr>
</table>
</td>
</tr>
<tr>
<td>South Africa[35]</td>
<td>Spectrum fees = Unit×BW×FREQ×CG×GEO×SHR×HOPMINI×UNIBI
Where:
UNIT - Cost per MHz
BW - Bandwidth
FREQ - Frequency Band
CG - Congestion
GEO - Geographical Factor
SHR - Sharing
HOPMINI - Minimum Hop Length
ASTER - Area Sterlisation
UNIBI - Uni- or bi-directional</td>
<td>Factors:
UNIT – Annual Basic price per MHz.
BW - The Bandwidth used (BW) is the number of MHz assigned.
FREQ - Different frequencies have different propagation characteristics. Higher frequency Bands are assigned lower factors.
CG - The Congestion Factor indicates if the band is congested or not. For Congested Band this factor is 1.50 and for Not Congested Band it is 1.00.
GEO - The Geographical factor depends on where in the country the spectrum is to be used. For High Density Area it is 1 and for low density area it is 0.1.
SHR - Spectrum can be assigned in 'Exclusive' and 'Shared' use. When exclusive use of spectrum is assigned then, the regulator (ICASA) is responsible for making sure, as far as possible, that no interference occurs. When spectrum is shared, then sharing parties are responsible for coordinating amongst themselves to avoid interference. It is '1' for exclusive use or '0.5' for shared use.
UNIBI - The Unidirectional factor (UNIBI) takes into account inefficiencies inherent in only making unidirectional use of spectrum. For Point-to-Point uses it is '0.75' for unidirectional use and '1.00' for Bidirectional use.
ASTER - Only applies to Point to Multipoint uses of spectrum.
HOPMINI = √ (MINIMUM PATH LENGTH / ACTUAL PATH LENGTH). This factor takes in to account the optimal use of the frequency band.</td>
</tr>
</table>

[33] http://www.cck.go.ke/licensing/spectrum/downloads/Frequency_fee_schedule_-_effective_1st_July_2012.pdf

[34] http://www.tra.gov.ae/spectrum-policies-regulations.php

[35] http://www.ellipsis.co.za/wp-content/uploads/2012/02/5-Spectrum-Fees-20120305a.pdf

Government of India
Ministry of Communications & IT
Department of Telecommunication
Wireless Planning & Co-ordination (WPC) Wing

Sanchar Bhavan,
20, Ashoka Road,
New Delhi-110 001

No. P-11014/34/2009-PP (II) Date: 22nd March, 2012

ORDER

Subject: Royalty charges for Assignments of Frequencies to 'Captive Users' (users being charged on formula basis) including all Government Users, involving **Multi Channel** Operations for Fixed/ Land/ Land Mobile Stations.

In pursuance of Power conferred by section 4 of the Indian Telegraph Act, 1885(13 of 1885) and in supersession of this Ministry's Orders No. R-11014/26/2002-LR dated 06.05.2003, No. R-11014/26/2002-LR dated 01.04.2003, No. R-11014/4/87-LR (pt.) dated 20.07.1995 and No. R-11014/4/87-LR dated 09.12.1987, the Central Government has decided the following Royalty charges for Assignments of Frequencies to 'Captive Users' (users being charged on formula basis) including all Government Users, involving **Multi Channel** Operations for Fixed/ Land/ Land Mobile Stations:-

2. *Annual Royalty* is calculated as per the following formula and rules:

$$\textit{Annual Royalty (in Rupees)} = \sum_{i=1}^{n} M_i \, x \, W, \textbf{ where n = no. of carriers.}$$

i. The Basic Royalty (M) given below is for *one* carrier frequency in a *Basic Link* (simplex) of 2 Fixed/ Land/ Land Mobile stations (1 station for broadcasting).

ii. Duplex circuits (with two central frequencies) and Semi-duplex circuits shall be charged at twice the rate of simplex (single central frequency) circuits.

iii. For multi-frequency circuits, even if operating in simplex mode, the Basic Royalty shall be charged for each frequency separately.

iv. For the purpose of charging Royalty under Table-B, the *Bandwidth Factor W* shall be as per *Table-C*, given below.

v. For all carrier frequencies, the chargeable bandwidth shall include the *Guard Bands* required to be provided as per *ITUs*.

vi. The rates of Royalty apply to the specified *polarization(s)* of the assigned frequencies.

vii. In addition to above, the explanatory "Notes" on the applicability of royalty charges, are as following:

- To determine the "Maximum Distance" slab applicable to a case, the 'maximum power rating/ assigned' of the transmission equipment be considered, and expressly recorded in the assignment instrument Decision Letter, Agreement-in-Principle, or Wireless Operating License (DL/ AIP/ WOL).

- The *duration* of a radio frequency assignment will normally be one or two years. If an applicant desires, and frequencies are available, the duration of assignment may be fixed as three or four or five years.
- Before issuing any DL/ AIP/ WOL, full amounts of Royalty shall be submitted by the applicant in advance for the entire duration of the DL/ AIP/ WOL.
- For all assignments of frequencies, all applicants or users shall pay the applicable Royalty, License Fee, etc. **at the rates and terms in force from time to time, all previously paid amounts being adjusted on pro-rata basis.**

Table-B For The 'M' Factor

Distance Cat.	"Maximum Distance (KM) Over Which the F/L/LM Network would operate"	Royalty Charges (in Rs.) for of the Basic Link.
		M
I	<= 2	*1500*
II	<= 5	*3000*
III	> 5 <= 25	*6000*
IV	> 25 <= 60	*12000*
V	> 60 <= 120	*22500*
VI	> 120 <= 500	*37500*
VII	> 500	*50000*

Table-C for The 'W' Factor

Slabs of Adjacent Channel Separation (BW), in MHz	Values of W
Up to and including 2	30
More than 2 but < = 3.5	40
More than 3.5 but < = 7	60
More than 7 but < = 14	90
More than 14 but < = 28	120
> 28	120+30 x (Excess bandwidth to 28 MHz / 7) @

@: That is, in steps of 7 MHz or part thereof.

viii. Any "single channel service" that uses a channel bandwidth in excess of 375 KHz shall be covered by Charging Table-C above, where the Bandwidth Factor "W" is used from the lowest value of 30 onwards.

3. For Charging of "Licence fee and other fees, Surcharge/ late fee and Charging Methodologies for Royalty / licence fees, Order No. No. P-11014/34/2009-PP (IV) dated 22nd March, 2012 shall be applicable

4. This issues with the concurrence of the Wireless Finance Division, vide this Dy. No.482/Sr.DDG(WPF), dated 19/3/12.

5. This Order shall come into force from 1st April 2012.

(Viresh Goel)
Deputy Wireless Advisor
to the Government of India

Copy to:

1. All concerned
2. Wireless Finance Division
3. Wireless Monitoring Organisation
4. Director, IT DoT for uploading on DoT website
5. DWA(ASMS) for uploading on WPC Wing website