

ASSESSING THE ECONOMIC VALUE OF UNLICENSED USE OF THE 6 GHZ BAND IN INDIA

Raúl L. Katz



Telecom Advisory Services LLC

New York — Buenos Aires — Madrid — Bogotá — Quito

THE ECONOMIC VALUE OF WI-FI IS DRIVEN BY THE INTRINSIC VALUE OF UNLICENSED SPECTRUM

- Factor of production
- Complementary technology
 - A technology that enables the production of another one by lowering manufacturing and distribution costs
 - A technology that addresses bottlenecks in the diffusion and adoption of a second one
- Unlicensed spectrum provides the required environment to enable the development and introduction of innovations, rendering irrelevant any barriers to innovation caused by the need to use licensed spectrum
- Supports the development of innovative business models
- Address the digital divide in broadband coverage

THE ECONOMIC VALUE OF WI-FI FOR INDIA HAS BEEN ASSESSED WITHIN THREE AREAS -- GDP CONTRIBUTION, PRODUCER SURPLUS AND CONSUMER BENEFIT

AREAS OF VALUE

1. **GDP Contribution:** economic growth enabled by Wi-Fi, strictly considering the revenues added “above and beyond” what would have occurred had the Wi-Fi spectrum been licensed.
2. **Producer surplus:** economic profit producers earn by relying on Wi-Fi
3. **Consumer benefit:** amount consumers would be willing to pay to use the Wi-Fi service, compared to what they actually pay

SOURCES OF VALUE

1. **Free Wi-Fi:** public Wi-Fi Internet access offered for free
2. **Residential Wi-Fi:** support of device connectivity at home
3. **Enterprise Wi-Fi:** support of device connectivity in enterprises
4. **ISPs:** public Wi-Fi sold for a fee and savings from Wi-Fi routing of cellular traffic
5. **Wi-Fi ecosystem:** profits from production of Wi-Fi enabled equipment

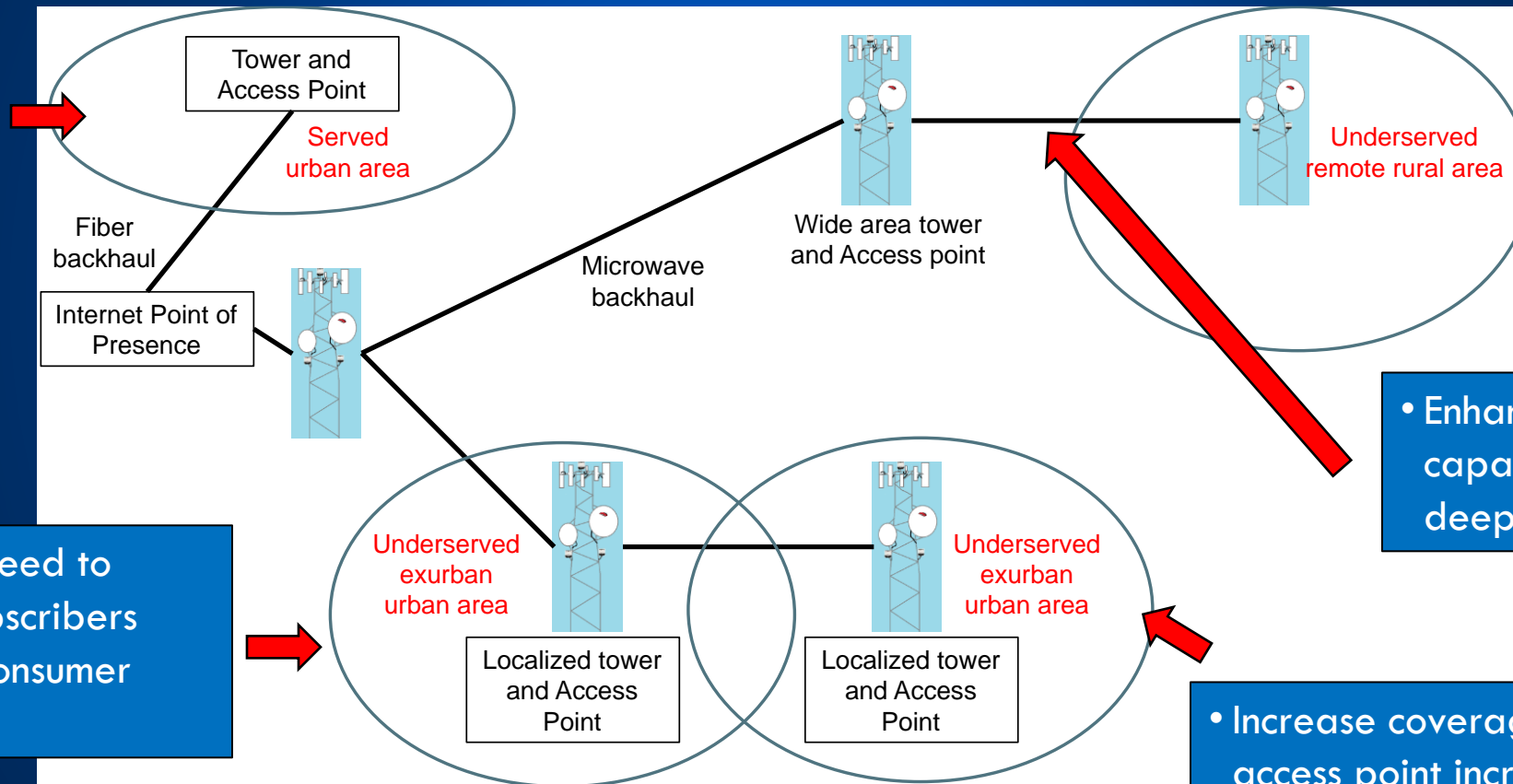
EACH SOURCE OF VALUE HAS BEEN STUDIED ALONG MULTIPLE EFFECTS

Free Wi-Fi	<ul style="list-style-type: none">• Benefits to consumers from free Wi-Fi Hot spots (Municipality, schools, retail)
Residential Wi-Fi	<ul style="list-style-type: none">• Economic impact and consumer benefit from increased speed by reducing Wi-Fi congestion
Enterprise Wi-Fi	<ul style="list-style-type: none">• Reduction of enterprise wireless costs• Wide deployment of IoT• CAPEX reduction due to Wi-Fi off-loading• Economic effect of Augmented Reality/Virtual Reality
ISPs	<ul style="list-style-type: none">• Enhanced coverage and improve affordability through WISPs
Wi-Fi ecosystem	<ul style="list-style-type: none">• Consumer benefits and profits from production of Wi-Fi enabled equipment

THE 6 GHz BAND IS A TECHNOLOGY ENABLER OF WIRELESS ISPs TO CONTINUE TACKLING THE DIGITAL DIVIDE

IMPACT OF SPECTRUM ALLOCATION ON A WISP NETWORK

- Higher capacity per access point allows for more line sharing



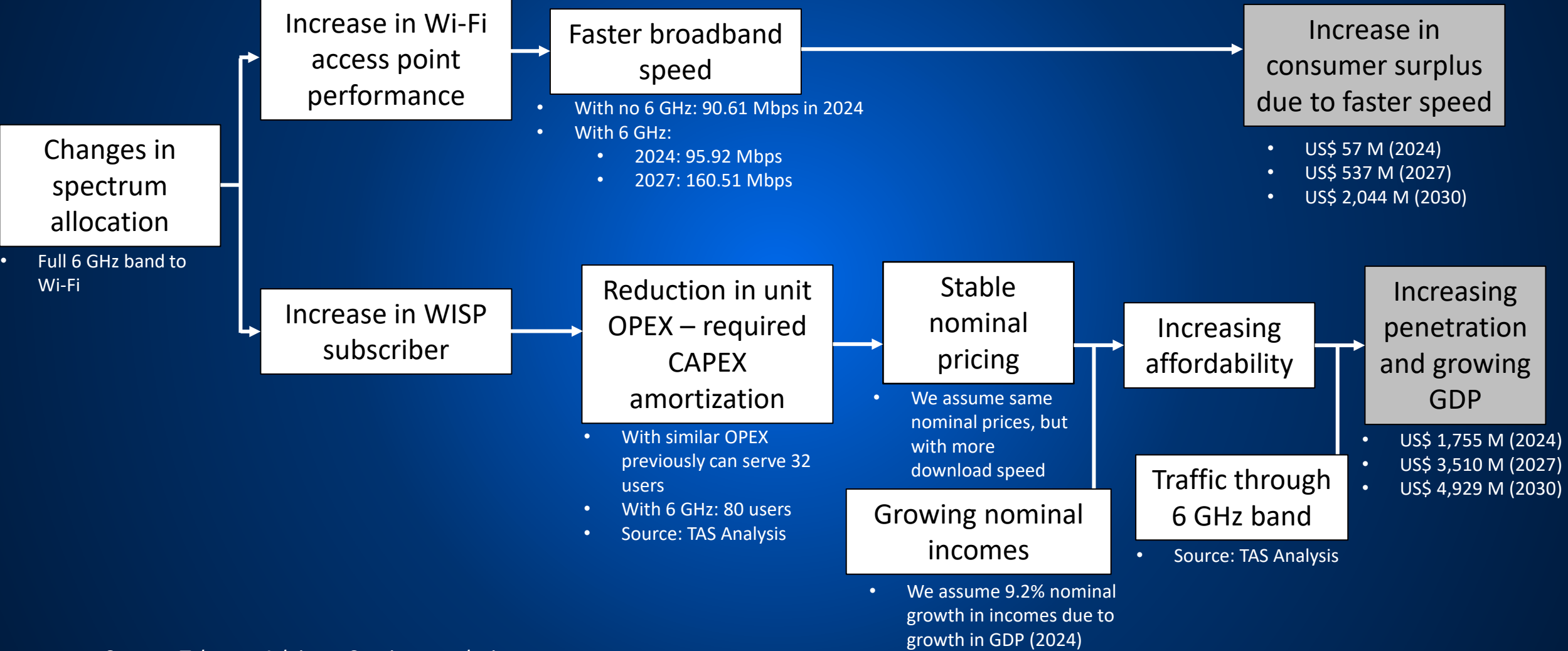
- Enhanced backhaul capacity allows for deeper rural penetration

- Increase speed to existing subscribers enhances consumer surplus

- Increase coverage per access point increases affordability

Source: Telecom Advisory Services

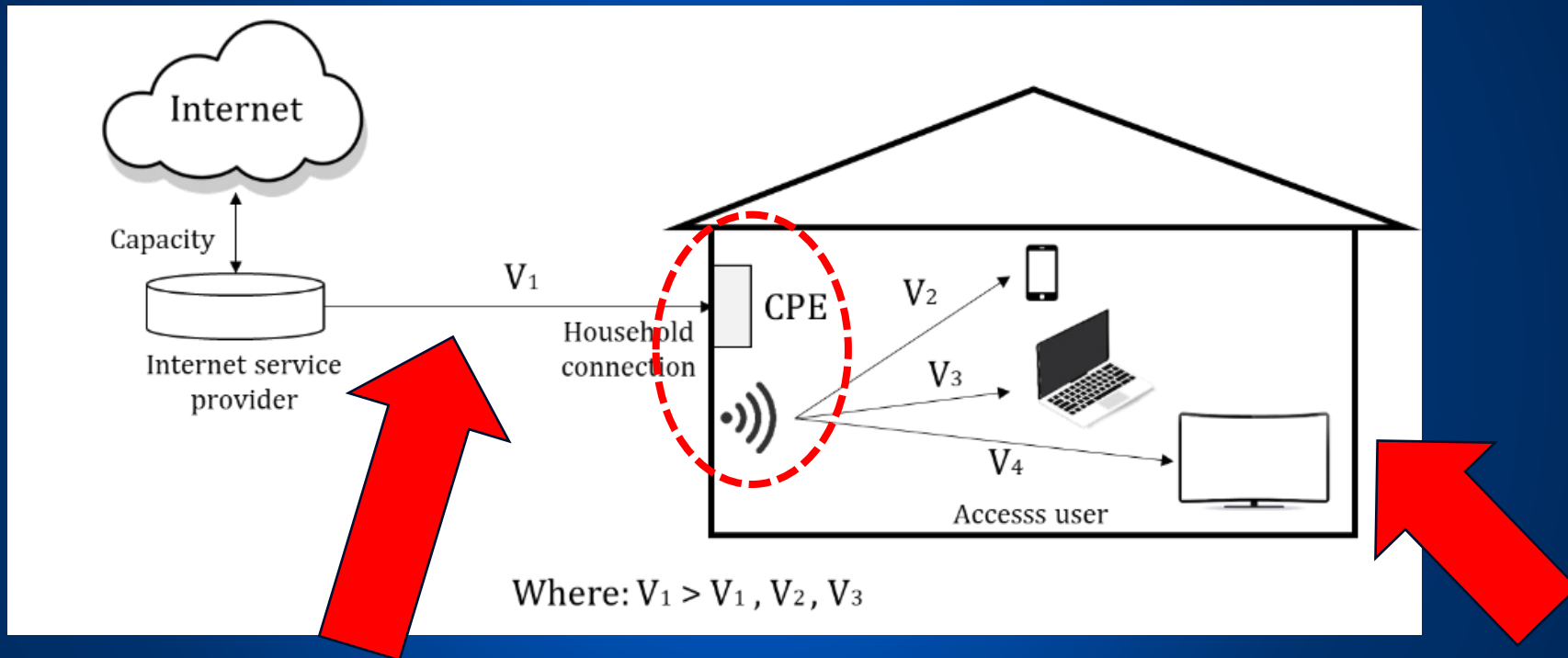
THE 6 GHz BAND WILL ACCELERATE FIXED BROADBAND SPEEDS AND WILL INCREASE WIRELESS ISPs SUBSCRIBERS – BOTH EFFECTS HAVE AN IMPACT ON THE INDIAN GDP



Source: Telecom Advisory Services analysis

CONSIDERING THE DRAMATIC INCREASE IN FIXED BROADBAND LINES AND THE NUMBER OF IN-HOME DEVICES, THE ROUTER BECOMES A CRITICAL NETWORK COMPONENT

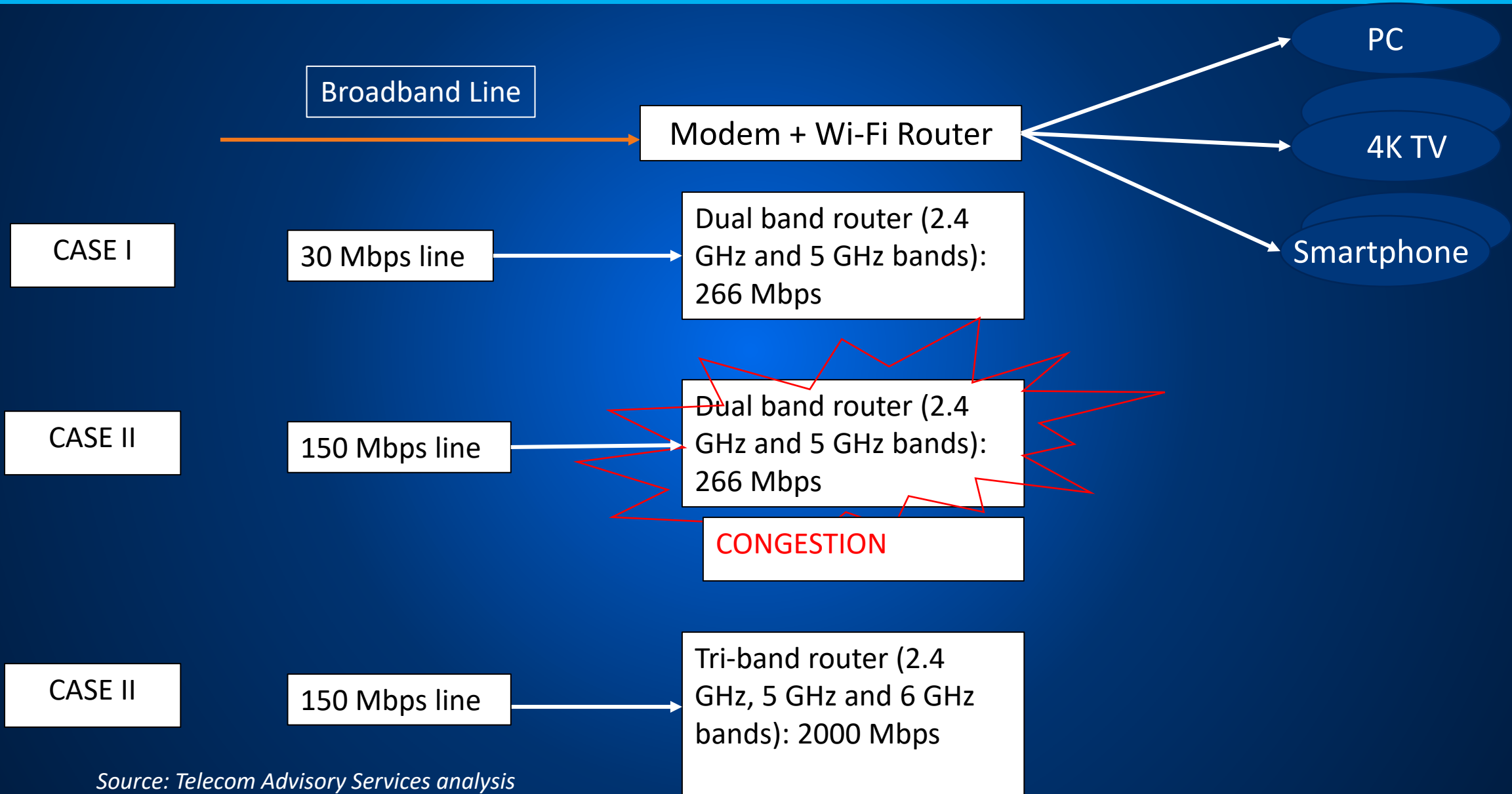
DRIVER OF RESIDENTIAL Wi-Fi VALUE



The faster the fixed broadband connection, the more valuable becomes the Wi-Fi CPE (router) that interconnects with user devices

The more user devices that require interconnection, the more valuable becomes the Wi-Fi CPE (router)

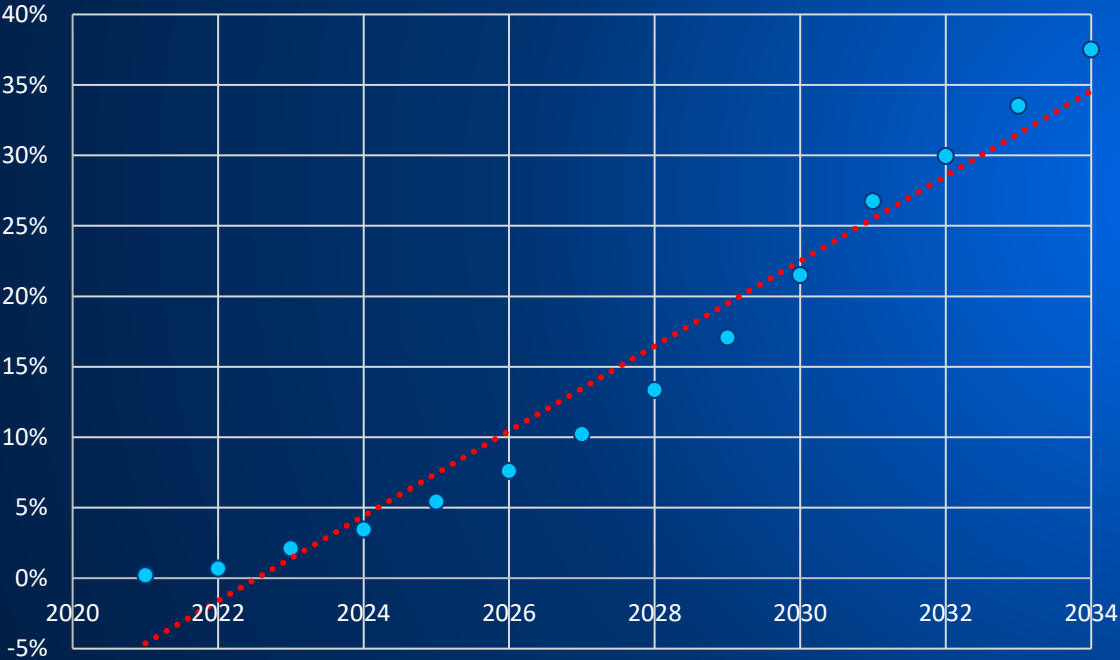
IN THIS CONTEXT, WI-FI 6 IS ALSO A GOOD APPROACH TO DEAL WITH RESIDENTIAL BROADBAND SERVICE CONGESTION



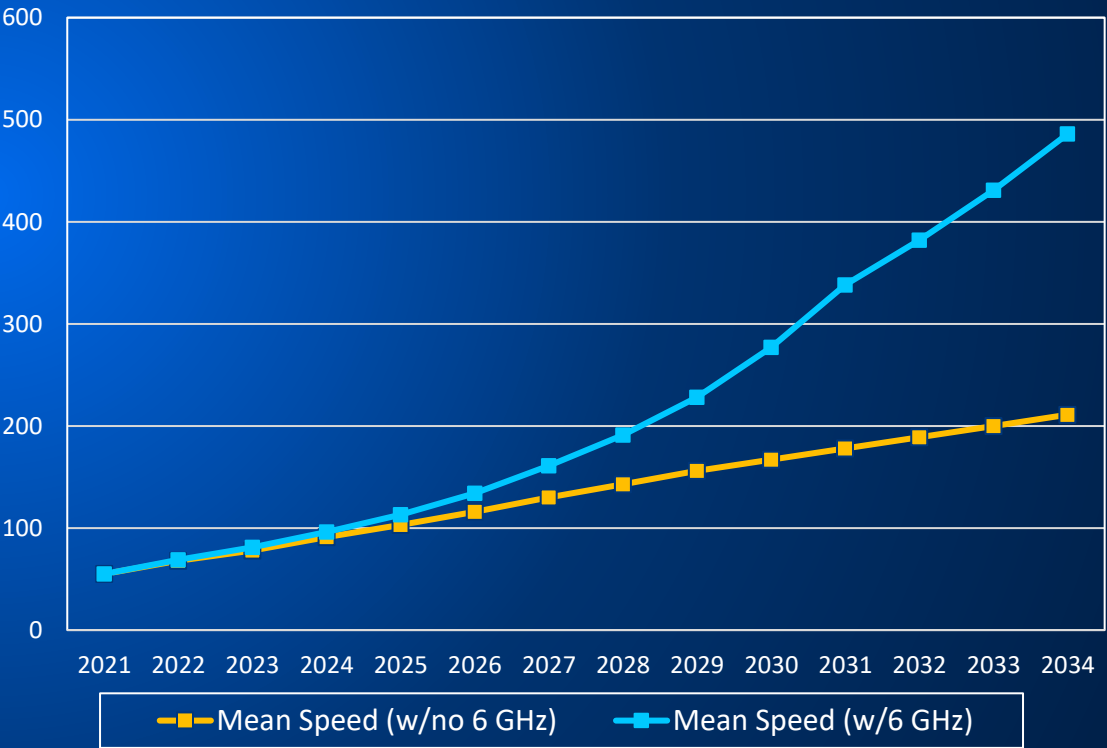
Source: Telecom Advisory Services analysis

THE IMPORTANCE OF 6 GHz BAND INCREASES DUE TO GROWTH OF THE NUMBER OF FIXED BROADBAND LINES HIGHER THAN 150 MBPS AND, CONSEQUENTLY, THE AVERAGE SPEED

INDIA: PERCENT OF FIXED BROADBAND LINES > 150 MBPS (2021-2034)



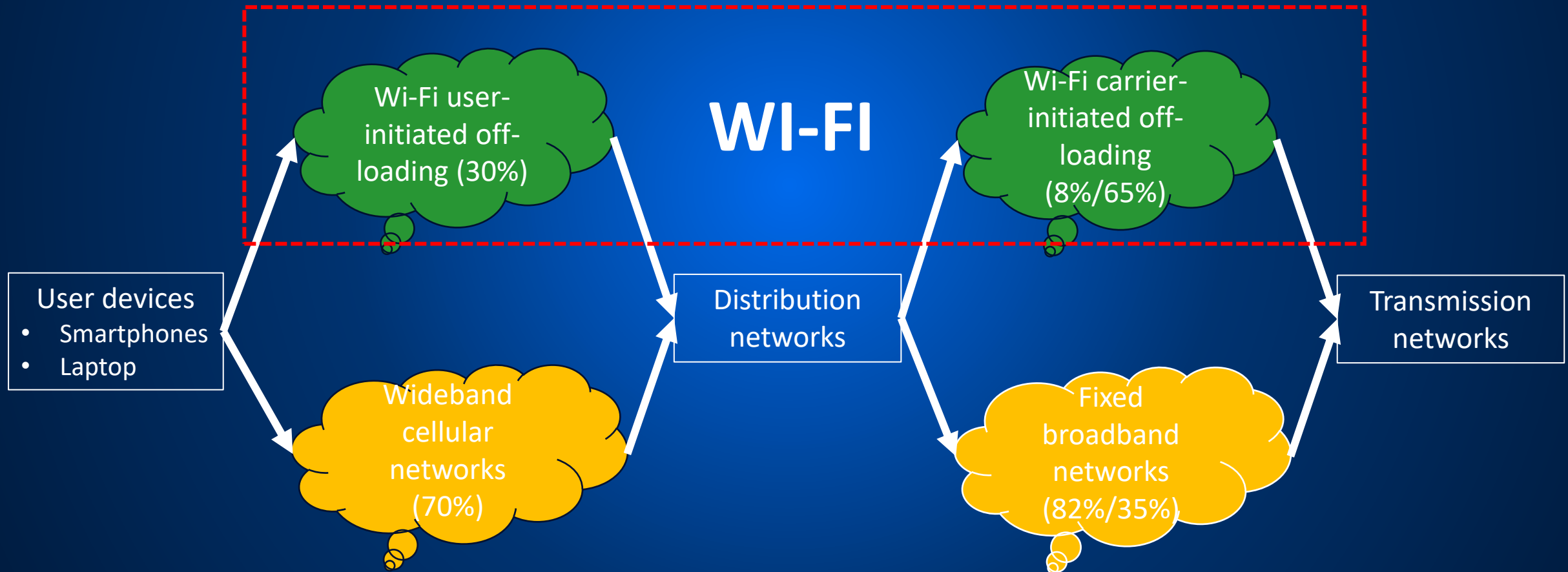
INDIA: MEAN DOWNLOAD SPEED OF FIXED BROADBAND (2021-2034)



Source: Telecom Advisory Services analysis based on CISCO and Ookla data

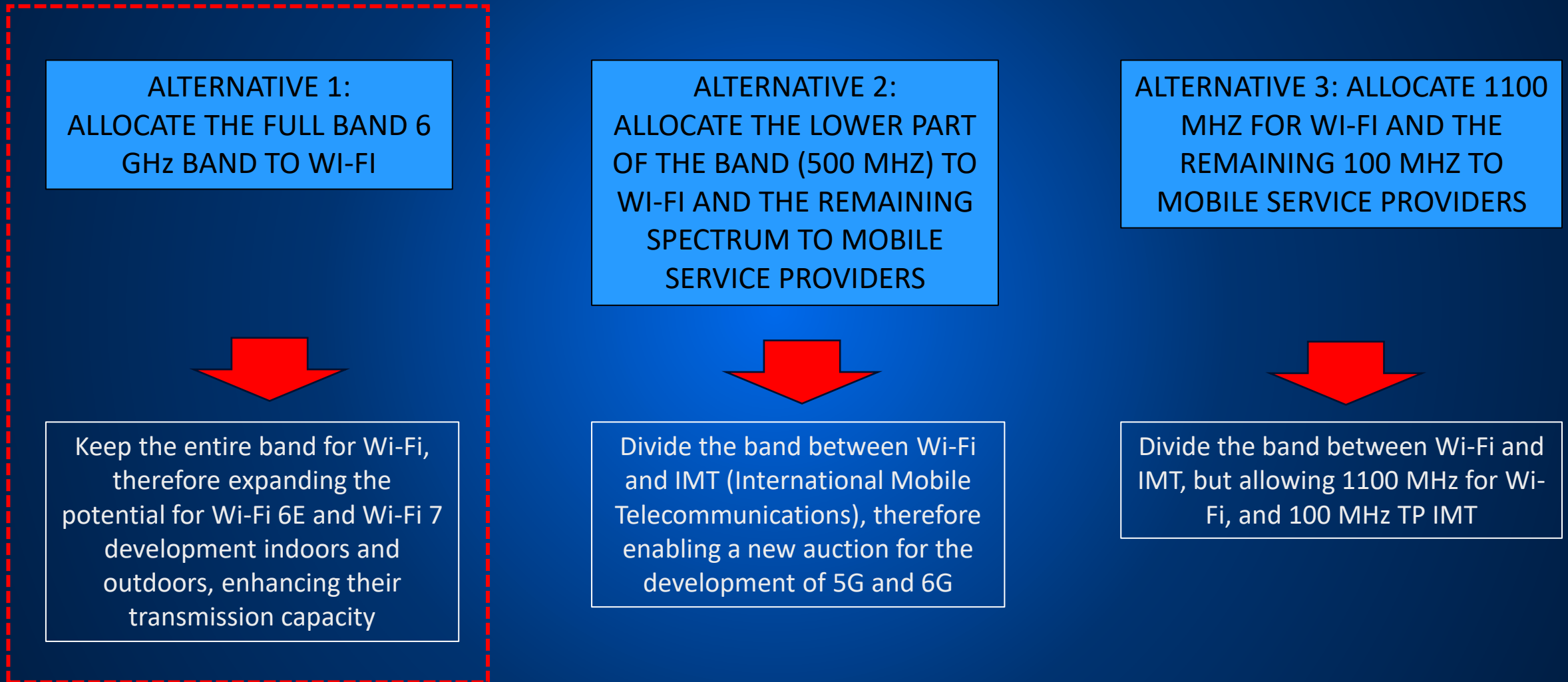
COINCIDENTALLY, WI-FI IS BECOMING A CRITICAL COMPONENT OF TELECOMMUNICATIONS NETWORK ARCHITECTURES

INDIA: WI-FI OFFLOADING RATIOS



Sources: IO by HFCL; Jain, R. (2021). The Economic Value of Wi-Fi Spectrum for India.

WE DEVELOPED AN ESTIMATION OF THE ECONOMIC VALUE OF WI-FI IN INDIA UNDER THREE POTENTIAL SCENARIOS OF ALLOCATING THE 6 GHz BAND



Source: Telecom Advisory Services analysis

THE AGGREGATE ECONOMIC VALUE OF WI-FI IS BASED ON CALCULATING INDEPENDENTLY EACH SOURCE OF VALUE AND AGGREGATING THEM WITHIN A SINGLE ESTIMATE

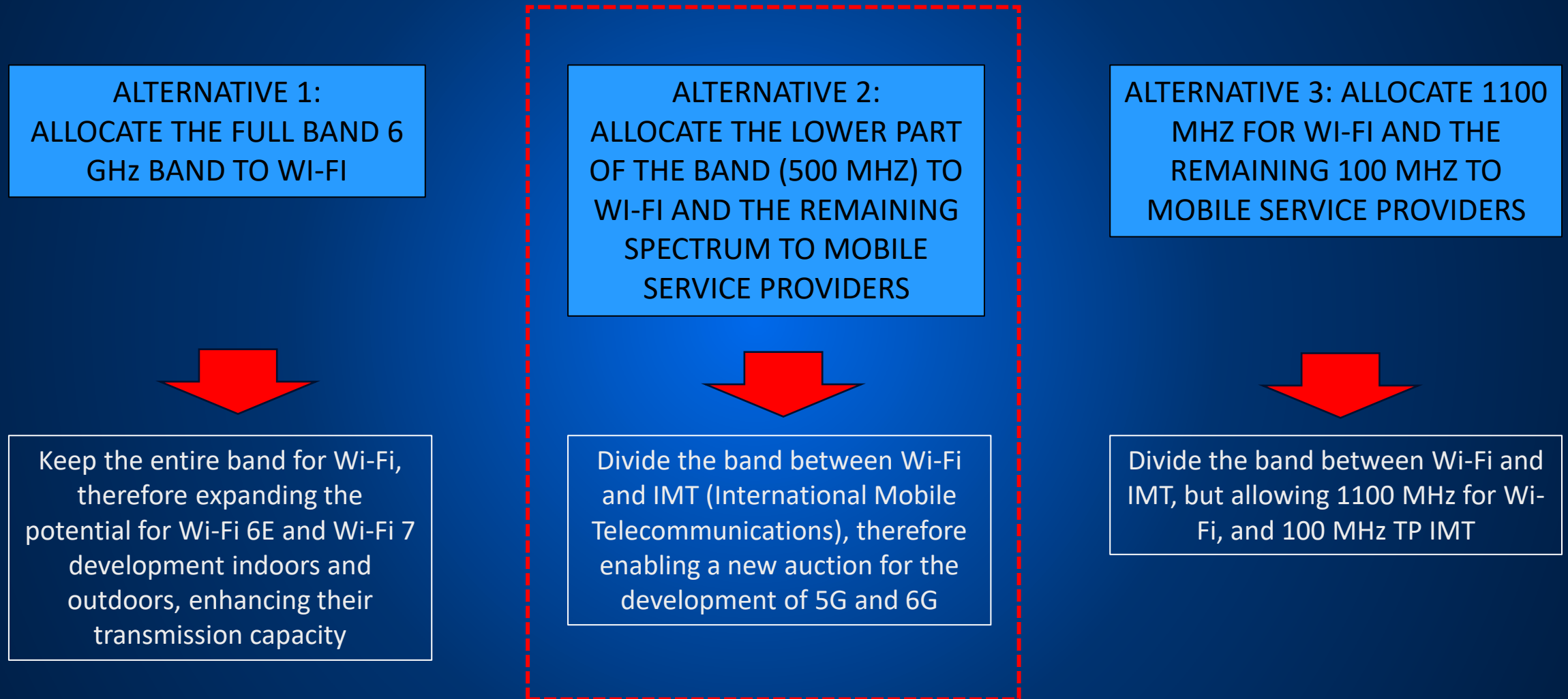
	WI-FI AGGREGATE VALUE (2024-2034)	Consumer surplus	Producer surplus	GDP contribution
1. FREE WI-FI	1.1. Savings incurred by consumers by accessing free Wi-Fi in public sites			
	1.2. Free Wi-Fi service supporting the needs of the broadband unserved population			
	1.3. Benefit to consumers enjoying higher speed from free Wi-Fi under Wi-Fi 6E, and Wi-Fi 7			
	1.4. Benefit to consumers relying on Wi-Fi in educational institutions			
	1.5. Use of Wi-Fi in highly dense heterogeneous environments			
2. RESIDENTIAL WI-FI	2.1. Home internet access for devices that lack an Ethernet port			
	2.2. Avoidance of inside wiring investment			
	2.3. Consumer benefit derived from faster broadband speed			
	2.4. Consumer benefit generated by use of residential Wi-Fi devices and equipment			
	2.5. Bridging the digital divide: use of Wi-Fi to increase coverage in rural and isolated areas			
3. ENTERPRISE WI-FI	3.1. Savings in business Internet traffic transmitted through Wi-Fi			
	3.2. Avoidance of enterprise building inside wiring			
	3.3. Benefits derived from an increase in average speed			
	3.4. Benefits derived from reduced latency			
	3.5. Enhanced IoT deployment			
	3.6. Deployment of Augmented Reality/Virtual Reality solutions			
4. ISPs	4.1. Cellular networks CAPEX savings by off-loading traffic to Wi-Fi			
	4.2. Revenues of Wi-Fi based Public Internet Service Providers			
	4.3. Revenues of Wi-Fi based Wireless Internet service Providers			
5. WI-FI ECOSYSTEM	5.1. Manufacturing of Wi-Fi devices and equipment for residential use			
	5.2. Manufacturing of enterprise Wi-Fi devices and equipment			
	5.3. Benefits of Firms in the IoT ecosystem			
	5.4. Benefits of firms in the AR/VR ecosystem			
		TOTAL	TOTAL	TOTAL

FULL BAND TO WI-FI: THE ECONOMIC VALUE AMOUNTS TO US\$ 3,544 B IN GDP CONTRIBUTION, US\$ 158 B IN PRODUCER SURPLUS, AND US\$ 329 B IN SURPLUS TO CONSUMERS UP TO 2034

	WI-FI AGGREGATE VALUE (2024-2034) (in USD millions)	Consumer surplus	Producer surplus	GDP contribution
1. FREE WI-FI	1.1. Savings incurred by consumers by accessing free Wi-Fi in public sites	\$ 674		
	1.2. Free Wi-Fi service supporting the needs of the broadband unserved population			\$ 329,353
	1.3. Benefit to consumers enjoying higher speed from free Wi-Fi under Wi-Fi 6E, and Wi-Fi 7	\$ 2,828		
	1.4. Benefit to consumers relying on Wi-Fi in educational institutions	\$ 215,592		
	1.5. Use of Wi-Fi in highly dense heterogeneous environments	\$ 49		
2. RESIDENTIAL WI-FI	2.1. Home internet access for devices that lack an Ethernet port	\$ 63,768		
	2.2. Avoidance of inside wiring investment	\$ 6,833		
	2.3. Consumer benefit derived from faster broadband speed	\$ 19,141		
	2.4. Consumer benefit generated by use of residential Wi-Fi devices and equipment	\$ 19,824		
	2.5. Bridging the digital divide: use of Wi-Fi to increase coverage in rural and isolated areas			\$ 159,698
3. ENTERPRISE WI-FI	3.1. Savings in business Internet traffic transmitted through Wi-Fi		\$ 16,565	
	3.2. Avoidance of enterprise building inside wiring		\$ 421	
	3.3. Benefits derived from an increase in average speed			\$ 993,114
	3.4. Benefits derived from reduced latency			\$ 1,277,606
	3.5. Enhanced IoT deployment			\$ 772,904
	3.6. Deployment of Augmented Reality/Virtual Reality solutions			\$ 9,007
4. ISPs	4.1. Cellular networks CAPEX savings by off-loading traffic to Wi-Fi		\$ 7,911	
	4.2. Revenues of Wi-Fi based Public Internet Service Providers			\$ 809
	4.3. Revenues of Wi-Fi based Wireless Internet service Providers			\$ 1,128
5. WI-FI ECOSYSTEM	5.1. Manufacturing of Wi-Fi devices and equipment for residential use		\$ 6,707	
	5.2. Manufacturing of enterprise Wi-Fi devices and equipment		\$ 4,652	
	5.3. Benefits of Firms in the IoT ecosystem		\$ 115,933	
	5.4. Benefits of firms in the AR/VR ecosystem		\$ 5,480	
		\$ 328.7 B	157.7 B	3,543.6 B

Source: Telecom Advisory Services analysis

THE SECOND SCENARIO STIPULATES ALLOCATING ONLY 500 MHz RATHER THAN 1200 MHz OF THE 6 GHz BAND TO WI-FI AND AUCTIONING THE REMAINING SPECTRUM AMONG IMT



Source: Telecom Advisory Services analysis

500 MHz TO WI-FI: THE ALLOCATION ON ONLY 500 MHz RATHER THAN 1200 MHz OF THE 6 GHz BAND HAS SIGNIFICANT IMPLICATIONS ON WI-FI PERFORMANCE AND, CONSEQUENTLY, ITS ECONOMIC VALUE

1. IMPACT ON FREE WI-FI

- The total number of devices that a Wi-Fi hotspot site can support simultaneously depends on the allocated bandwidth, the usage and traffic demand profile of the average user and the number of devices connected at the simultaneously
- Considering wireless internet usage statistics for India, the number of users that can be handled by a free hotspot under the 500 MHz frequency allocation will be reduced by 41.18% relative to allocating the full 1200 MHz.

2. IMPACT ON RESIDENTIAL USE

- Within a residential use, if the frequencies allocated for unlicensed use in the 6 GHz band are reduced from 1200 MHz to 500 MHz, this has an impact on the number of resource units assigned for transmission, and consequently the maximum speed at the device level.

3. IMPACT ON WISPs

- The increase in subscribers that can be handled by Wireless ISPs relying on Wi-Fi technology depends on the number of outdoor channels. Considering that the 500 MHz alternative supports 25 20 MHz channels, compared to 42 under the full 6 GHz band, the maximum number of users with 242 Resource Units decreases by 40.48%

4. IMPACT ON IoT

- An allocation of 500 MHz of the 6 GHz band rather than 1200 MHz would decrease the number of IoT sensors that can be connected by 58.33%

5. IMPACT ON AR/VR

- A simulation of AR/VR use in a school setting indicates that when considering a 1200 MHz allocation of the 6 GHz band, Wi-Fi can support 22 headsets; the number of headsets diminishes to 4 if only 500 MHz spectrum is allocated in the same band

500 MHz TO WI-FI: THE DECREASE IN ECONOMIC VALUE FROM THE FULL ALLOCATION OF THE 6 GHz BAND IS DUE TO THE FOLLOWING EFFECTS

1. IMPACT ON FREE WI-FI

- 41.18% of Wi-Fi outdoor accessibility provided by free hot spots is limited due to their access points restricted access to the 6GHz band and a lower reduction in latency

2. IMPACT ON RESIDENTIAL USE

- Wi-Fi indoor speed is restricted by 50%, which means that residential broadband access undergoes a bottleneck for lines in excess of 600 Mbps

3. IMPACT ON WISPS

- 40.48% of Wi-Fi outdoor accessibility provided by WISPs is limited due to their access points restricted access to the 6GHz band and a lower reduction in latency

4. IMPACT ON IoT

- More than half of IoT devices undergoes a limit in their indoor and outdoor access

5. IMPACT ON AR/VR

- 81.82% of the AR/VR devices supported in indoor environments is restricted by limits in terms of their ability to operate

500 MHz TO WI-FI: THE ECONOMIC VALUE AMOUNTS TO US\$ 2,513 B IN GDP CONTRIBUTION, US\$ 84 B IN PRODUCER SURPLUS, AND US\$ 321 B IN CONSUMER SURPLUS (A REDUCTION OF US\$ 1,112 BILLION)

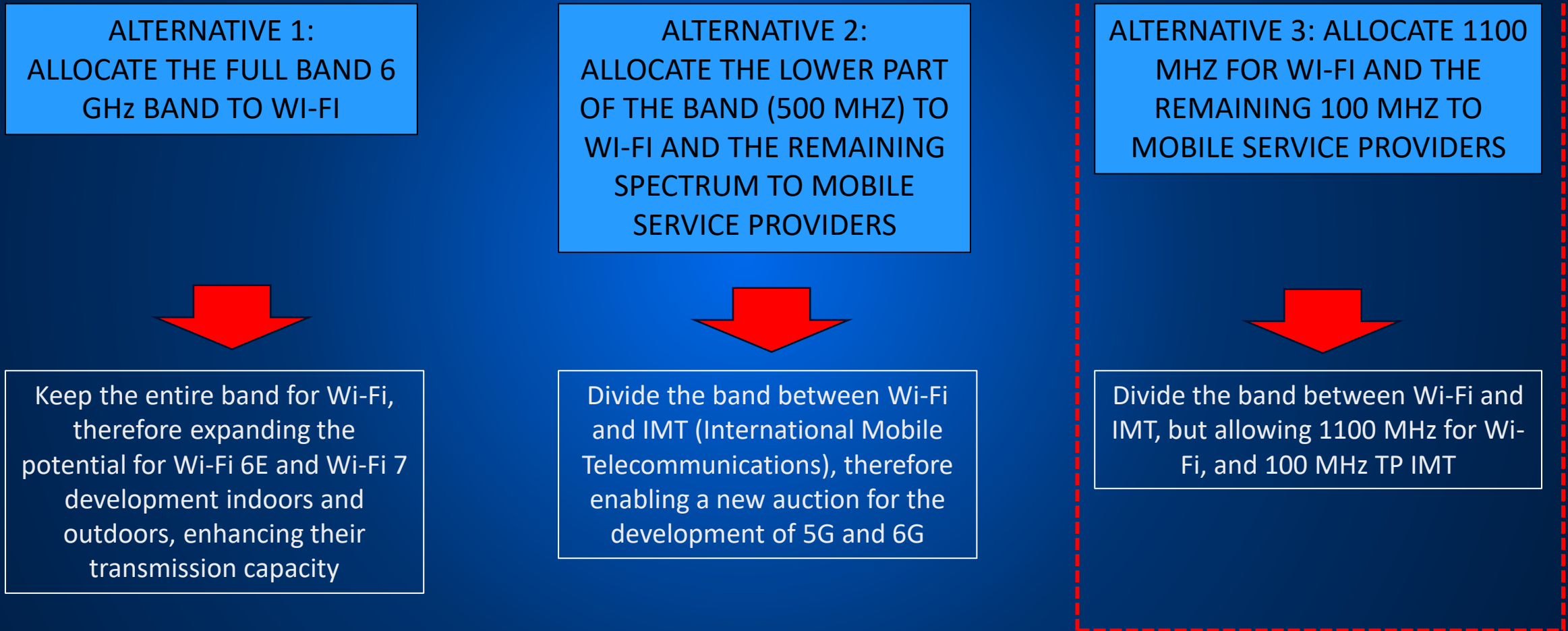
	WI-FI AGGREGATE VALUE (2024-2034) (in USD millions)	Consumer surplus	Producer surplus	GDP contribution
1. FREE WI-FI	1.1. Savings incurred by consumers by accessing free Wi-Fi in public sites	\$ 674		
	1.2. Free Wi-Fi service supporting the needs of the broadband unserved population			\$ 270,620
	1.3. Benefit to consumers enjoying higher speed from free Wi-Fi under Wi-Fi 6E, and Wi-Fi 7	\$ 1,663		
	1.4. Benefit to consumers relying on Wi-Fi in educational institutions	\$ 215,592		
	1.5. Use of Wi-Fi in highly dense heterogeneous environments	\$ 49		
2. RESIDENTIAL WI-FI	2.1. Home internet access for devices that lack an Ethernet port	\$ 63,768		
	2.2. Avoidance of inside wiring investment	\$ 6,833		
	2.3. Consumer benefit derived from faster broadband speed	\$ 13,607		
	2.4. Consumer benefit generated by use of residential Wi-Fi devices and equipment	\$ 19,071		
	2.5. Bridging the digital divide: use of Wi-Fi to increase coverage in rural and isolated areas			\$ 138,060
3. ENTERPRISE WI-FI	3.1. Savings in business Internet traffic transmitted through Wi-Fi		\$ 14,686	
	3.2. Avoidance of enterprise building inside wiring		\$ 421	
	3.3. Benefits derived from an increase in average speed			\$ 661,572
	3.4. Benefits derived from reduced latency			\$ 1,224,392
	3.5. Enhanced IoT deployment			\$ 363,605
	3.6. Deployment of Augmented Reality/Virtual Reality solutions			\$ 3,119
4. ISPs	4.1. Cellular networks CAPEX savings by off-loading traffic to Wi-Fi		\$ 1,342	
	4.2. Revenues of Wi-Fi based Public Internet Service Providers			\$ 667
	4.3. Revenues of Wi-Fi based Wireless Internet service Providers			\$ 1,037
5. WI-FI ECOSYSTEM	5.1. Manufacturing of Wi-Fi devices and equipment for residential use		\$ 6,282	
	5.2. Manufacturing of enterprise Wi-Fi devices and equipment		\$ 4,308	
	5.3. Benefits of Firms in the IoT ecosystem		\$ 54,144	
	5.4. Benefits of firms in the AR/VR ecosystem		\$ 2,449	
		\$ 321.3 B	\$ 83.6 B	\$ 2,513.1 B

Source: Telecom Advisory Services analysis

500 MHz TO WI-FI: PART OF THE NEGATIVE ECONOMIC IMPACT OF LIMITING ACCESS OF THE 6 GHz BAND FOR WI-FI IS MITIGATED BY THE BENEFITS RESULTING FROM ALLOCATING 700 MHz TO FOR USE BY IMT

- The GSMA estimates that the allocation of mid bands to IMT in Asia and Pacific would generate a GDP contribution of US\$ 285 billion in 2030 (Source: GSMA, “The Socio-Economic Benefits of Mid-Band 5G Services”, February 2022), from where US\$ 30 billion can be interpolated for India
- Prorating this value to the 700 MHz in the 6 GHz band yields a total GDP contribution between 2024 and 2034 of US\$ 83 billion
- Additionally, by gaining access to 700 MHz, wireless service providers could generate US\$ 26 billion in producer surplus (primarily driven by IoT deployment) and US\$ 139 billion in consumer surplus
- Finally, it is estimated that auction proceeds for 700 MHz in the 6 GHz band could generate US\$ 6 billion (an extrapolation of the price per MHz of the 2014 auction)

THE THIRD SCENARIO STIPULATES ALLOCATING 1100 MHZ OF THE 6 GHz BAND TO WI-FI AND AUCTIONING THE REMAINING 100 MHZ SPECTRUM AMONG IMT



Source: Telecom Advisory Services analysis

1100 MHz TO WI-FI: WHILE THE ECONOMIC VALUE OF THIS ALTERNATIVE IS HIGHER THAN ALLOCATING 500 MHz TO WI-FI, IT STILL DENOTES SOME DECREASE FROM ALLOCATING THE FULL BAND

1. IMPACT ON FREE WI-FI

Considering internet usage statistics for India, the number of users that can be handled by a free hotspot under 1100 MHz frequency allocation will be reduced by 5.88% from the 1200 MHz alternative.

2. IMPACT ON WISPS

The increase in subscribers that can be handled by Wireless ISPs relying on Wi-Fi technology depends on the number of outdoor channels. Considering that a 1100 MHz alternative supports fewer channels compared to 42 under the full 6 GHz band, the maximum number of users with 242 Resource Units decreases 4.76%.

3. IMPACT ON IoT

An allocation of 1100 MHz of the 6 GHz band rather than 1200 MHz would decrease the number of IoT sensors that can be connected by 8.33%

4. IMPACT ON AR/VR

A simulation of AR/VR use in a school setting indicates that when considering a 1200 MHz allocation of the 6 GHz band, Wi-Fi can support 22 headsets; the number of headsets diminishes by 60% if only 1100 MHz spectrum is allocated in the same band

1100 MHz TO WI-FI: THE ECONOMIC VALUE AMOUNTS TO US\$ 3,469 B IN GDP CONTRIBUTION, US\$ 146 B IN PRODUCER SURPLUS, AND US\$ 329 B IN SURPLUS TO CONSUMERS UP TO 2034

	WI-FI AGGREGATE VALUE (2024-2034) (in USD millions)	Consumer surplus	Producer surplus	GDP contribution
1. FREE WI-FI	1.1. Savings incurred by consumers by accessing free Wi-Fi in public sites	\$ 674		
	1.2. Free Wi-Fi service supporting the needs of the broadband unserved population			\$ 320,967
	1.3. Benefit to consumers enjoying higher speed from free Wi-Fi under Wi-Fi 6E, and Wi-Fi 7	\$ 2,661		
	1.4. Benefit to consumers relying on Wi-Fi in educational institutions	\$ 215,592		
	1.5. Use of Wi-Fi in highly dense heterogeneous environments	\$ 49		
2. RESIDENTIAL WI-FI	2.1. Home internet access for devices that lack an Ethernet port	\$ 63,768		
	2.2. Avoidance of inside wiring investment	\$ 6,833		
	2.3. Consumer benefit derived from faster broadband speed	\$ 19,141		
	2.4. Consumer benefit generated by use of residential Wi-Fi devices and equipment	\$ 19,824		
	2.5. Bridging the digital divide: use of Wi-Fi to increase coverage in rural and isolated areas			\$ 157,154
3. ENTERPRISE WI-FI	3.1. Savings in business Internet traffic transmitted through Wi-Fi		\$ 16,565	
	3.2. Avoidance of enterprise building inside wiring		\$ 421	
	3.3. Benefits derived from an increase in average speed			\$ 993,114
	3.4. Benefits derived from reduced latency			\$ 1,277,606
	3.5. Enhanced IoT deployment			\$ 714,453
	3.6. Deployment of Augmented Reality/Virtual Reality solutions			\$ 3,892
4. ISPs	4.1. Cellular networks CAPEX savings by off-loading traffic to Wi-Fi		\$ 6,889	
	4.2. Revenues of Wi-Fi based Public Internet Service Providers			\$ 809
	4.3. Revenues of Wi-Fi based Wireless Internet service Providers			\$ 1,117
5. WI-FI ECOSYSTEM	5.1. Manufacturing of Wi-Fi devices and equipment for residential use		\$ 6,707	
	5.2. Manufacturing of enterprise Wi-Fi devices and equipment		\$ 4,652	
	5.3. Benefits of Firms in the IoT ecosystem		\$ 107,109	
	5.4. Benefits of firms in the AR/VR ecosystem		\$ 3,257	
		\$ 328.5 B	\$ 145.6 B	\$ 3,469.1 B

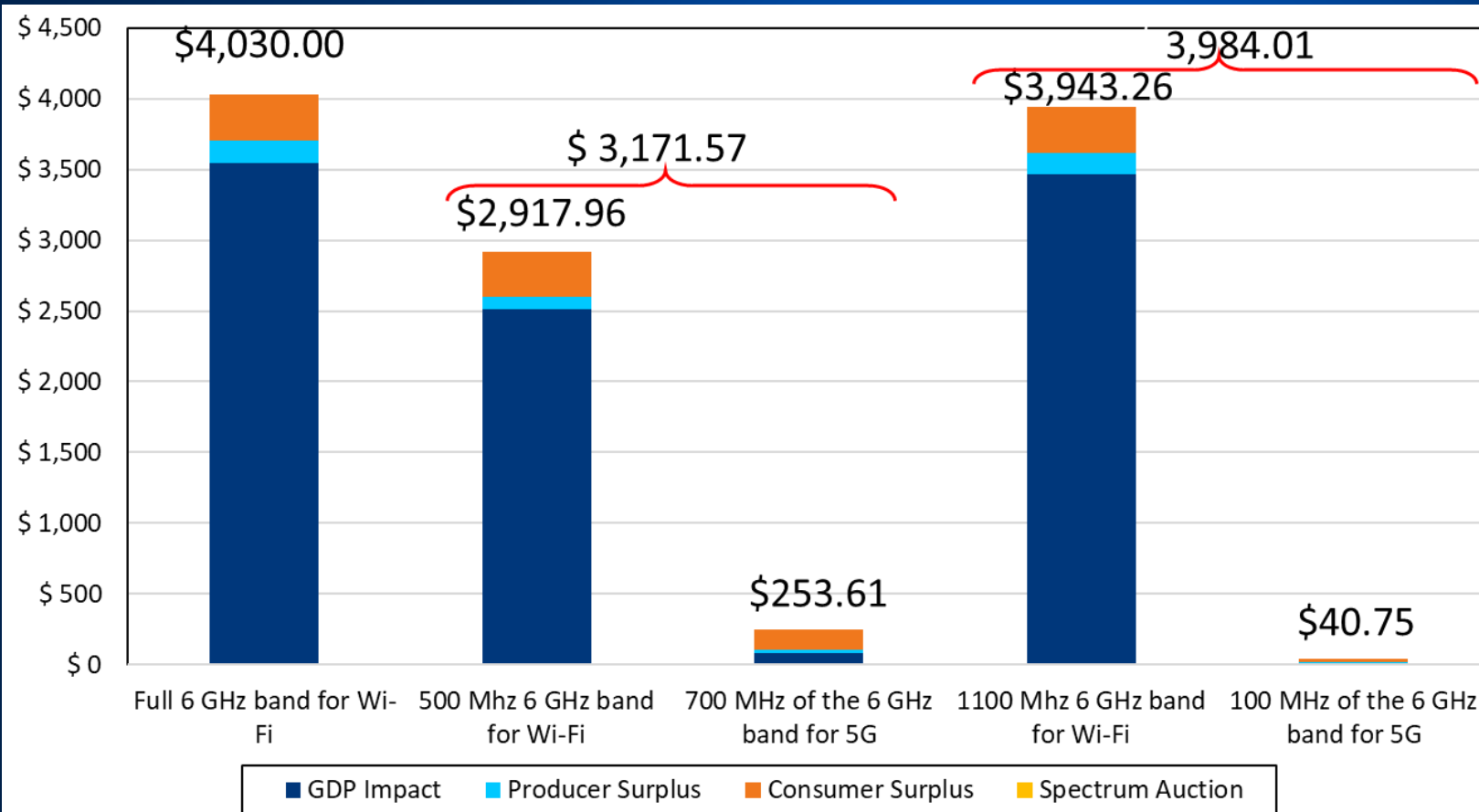
Source: Telecom Advisory Services analysis

1100 MHz TO WI-FI: IN THIS CASE, THERE IS ALSO A DECREASE IN ECONOMIC VALUE OF WI-FI WITH RESPECT TO THE ALLOCATION OF THE FULL 6 GHz BAND (US\$ 87 BILLION)

- Prorating the GDP contribution estimated by GSMA to the case of 100 MHz in the 6 GHz band yields a total GDP contribution between 2024 and 2034 of US\$ 12 billion
- Additionally, by gaining access to 100 MHz, wireless service providers could generate US\$ 4 billion in producer surplus (primarily driven by IoT deployment) and US\$ 24 billion in consumer surplus
- Finally, it is estimated that auction proceeds for 100 MHz in the 6 GHz band could generate US\$ 1 billion.

IN CONCLUSION, THE LARGEST ECONOMIC IMPACT IS ASSOCIATED WITH FULLY ALLOCATING THE 6 GHz BAND FOR UNLICENSED USE

INDIA: ECONOMIC VALUE OF WI-FI (2024-2034) (in USD millions)



- The difference between full and partial allocation of 6 GHz for Wi-Fi is larger than the expected effects of partial allocation for 5G
- Wi-Fi has the advantage of generating immediate economic impact and presents larger potential to increase coverage in rural areas
- This advantage occurs, even without considering the costs to IMT generated by spectrum refarming



For more information, contact:

Raul Katz, raul.katz@teleadvs.com, +1 (845) 868-1653

**Telecom Advisory Services LLC
139 West 82nd Street, Suite 6D
New York, New York 12581 USA**