



AUSPI's Response to the TRAI Consultation Paper No. 6/2011 on IMT Advanced Mobile Wireless Broadband Services

Responses to the various queries raised by TRAI in the above mentioned consultation paper are provided below:

1. Whether there is a need to define a particular user equipment or architecture to be used by the vendors or this may be left to the market forces?

It is important to permit multiple user equipment vendors in order to deliver significantly better value to end consumers at competitive prices. Architecture and specifications of user equipment have been defined to a great level of specificity and with attention to nation-specific frequency allocations by international bodies, like ITU, 3GPP and IEEE etc.

However, it is ideal that the user equipment meets certain basic performance characteristics such as inter-operability, protocol conformance and emission tests. The interface should be compatible with existing networks. Shifting from one network to another network should be a seamless transition for users. This would require their user equipment is enabled to work on other networks also.

Apart from the requirements mentioned above, it is recommended that user equipment should be standards specific; however, the choice of both vendor and technology should be left to market forces. Market forces will ensure that India benefits from global ecosystems of parts suppliers; this will also support subscribers who travel to international destinations as well as international in-roamers.

Similarly, the architecture to be used by the vendors should also be left to the market forces. It is pertinent to note that with multiple operators having pan India presence, there is already an intense competition in the Indian market, which will automatically force the operators to deploy the most efficient architecture available to them.

In a competitive device market as it exists today, market players are usually better prepared to adapt to changing demands and emerging technologies, and hence tend to introduce technologies which look at maximizing economic benefits by using resources such as spectrum and base station sites most efficiently. Market players with their international coverage and experience, would be able to better determine performance characteristics of user equipment which can ensure a coherent user experience and would find favor with its user base; eventually shaping the market dynamics as well as technical landscape.

In a competitive market, it is in the interest of the operator, that the product conforms to certain set international norms and standards as they have to ensure product reliability, quality of service percolating to customer satisfaction.

Summary: It is recommended that market forces should decide upon user equipment and/or architecture as per accepted international best practices, which ensures benefits to the end-consumer.



- 2. Whether there is a minimal set of performance characteristics the user equipment has to meet before it is permitted to enter a network? These characteristics are over and above the inter-operability, protocol conformance and emission tests which presumably the user equipment has already passed.**

We expect IMT Advanced business model to deliver user experience which creates value from higher data rates delivered cost efficiently with significantly lower power consumption. The user equipment should not be an impediment in allowing higher data throughput and optimal network performance.

Another desirable feature for the UE would be its ability for seamless transition between advanced and legacy networks. Also, as the spectrum allocation for IMT Advanced is likely to be in different bands across countries, it is imperative that the device supports multiple bands

Given the current state of competitiveness in the global and Indian UE market, these attributes, which are minimum performance characteristics, are likely to be covered by various players. In a competitive market, the development and evolution of UE is likely to be significantly above the highlighted characteristics. An example of this evolution is well illustrated by the smartphones, which over the last few years have seen significant innovation, making it a data centric lifestyle device, with customized applications being built to cater to lifestyle needs of end users.

As discussed above, market forces would look to ensure that user equipment in the network would comply with the minimal set of performance characteristics set by the industry associations such as IEEE/3GPP to ensure product reliability, quality of service and hence adequate customer satisfaction.

Summary: It is recommended that market forces should decide upon user equipment and/or architecture as per accepted international best practices, which ensures benefits to the end-consumer.

- 3. In addition to what has been described above, what can be the other security issues in IMT-Advanced services? How these security issues can be addressed?**
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- 4. What basic security frameworks should be mandated in all networks to protect customer?**

Protections from unauthorized access, denial of service, malicious attacks affecting performance as well as theft of service are some of the issues which could be possibly encountered. To ensure data protection, integrity and privacy, mutual authentication of base station as well as mobile station would be required.

In addition, IMT Advanced is expected to make extensive use of user installed Femto cells; security and privacy in such networks is required at various levels which include:

- Air interface
- Operator's internal network
- Inter-operator links

In order to ensure that network security is not compromised, given the nature of services to be provided by IMT-A, network should be made secure from both outside attacks as well as inside



attacks. 3GPP recognizes this and has defined security standards which are likely to resolve the underlying issues in the network architecture.

Thus, the security measures have to be technology-independent, meaning that they will be applied in a top-down nature and be overlaid upon the entire system, not necessarily one of the specific networks. It is considered to be inefficient to secure applications through overlay technologies, which is why previous systems have enforced security through device measures¹.

In addition to the points highlighted above, IMT Advanced systems will be required to protect its resources from attacks as well as misuse. Mutual authentication of base station as well as mobile station is required for data protection, integrity and privacy. An end to end security system will be implemented by using different levels of security across various architecture layers. The following steps could be considered for basic security frameworks across different layers of the IMT Advanced architecture:

- Mutual Authentication
- Authentication / Credentials of user or device
- Data confidentiality
- Message Integrity and Origin authentication
- Maintain security association across networks without losing connection
- Protection against replay attacks
- Privacy and Integrity

The above issues are covered by 3GPP security framework which covers multiple layers of the network architecture and defines standards by five security feature groups:

- **Network access security:** the set of security features that provide users with secure access to services, and which in particular protect against attacks on the (radio) access link.
- **Network domain security:** the set of security features that enable nodes to securely exchange signalling data, user data, and protect against attacks on the wireline network.
- **User domain security:** the set of security features that secure access to mobile stations.
- **Application domain security:** the set of security features that enable applications in the user and in the provider domain to securely exchange messages.

Visibility and configurability of security: the set of features that enables the user to inform himself whether a security feature is in operation or not and whether the use and provision of services should depend on the security feature.

The following points need to be considered while defining the security framework:

a) Customer education: The customer should be clearly explained the operational model and possible exposures to this most advanced network. They should be made aware of the security risks associated with such advanced networks and advised suitably to take the actions required at their end to mitigate these risks.

b) Minimum UE authentication related aspects should be taken care of by the service providers.



c) Sharing of passive and active infrastructure should ensure that such sharing does not result in enhanced risks.

d) Licensor has to revisit the interception capacity and the quality/type of interception required for such networks.

Further, it is submitted that since the licenses are technologically neutral, operators will be free to deploy any of the technologies namely LTE-Adv or IEEE 802.16m (Wireless MAN - Advanced) or any other alternate technologies, and hence any mandate for specific framework may favor some of the technologies and this should be avoided.

Summary: It is recommended that we may adopt the security framework covered as part of 3GPP standards

5. Which spectrum bands should be identified for the IMT-Services in India?

Internationally, the following bands have been identified for IMT and IMT advanced for public telecommunication services: 450 MHz; 585-806 MHz; 800 MHz; 900 MHz; 1800 MHz; 1900 MHz; 2010-2025 MHz; 2.1GHz; 2.3-2.4 GHz; 2.5-2.69 GHz; 3.3-3.4 GHz and 3.4-3.6GHz.

In India, as per the National Frequency Allocation Plan 2011 the following bands have been identified for IMT

- 450 MHz (450.5 – 457.5 MHz paired with 460.5 MHz – 467.5 MHz) (IND – 35)
- 698 – 806 MHz (IND 38)
- 1920-1980 MHz paired with 2110-2170 MHz (FDD mode) (IND 59)
- 2010-2025 MHz (TDD Mode) (IND 59)
- 2300-2400 MHz (IND 61)
- 2535-2655 MHz (IND 63)
- 3400-3600 MHz (IND 66)

A comparison of these bands is given in the table below:

Band	Current Use (in India)	Implications for IMT	International Deployments
700 MHz	Defence, Broadcasting services, Captive Users	<ul style="list-style-type: none"> • Good propagation characteristics • Can help reach out to rural areas • Relatively lower power requirements (especially important for data usage) 	United States
900 MHz	2G services, incumbent GSM operators	<ul style="list-style-type: none"> • Good propagation characteristics • Can help reach out to rural areas • Relatively lower power requirements (especially important for data usage) 	



Band	Current Use (in India)	Implications for IMT	International Deployments
2.3-2.4 GHz	BWA services, Captive users, Government agencies	<ul style="list-style-type: none"> • Poor propagation characteristics (8-10 times cell sites needed for coverage as compared to 700 MHz) • Expensive to deploy 	
2.5 – 2.69 GHz	Government agencies, BSNL / MTNL – BWA	<ul style="list-style-type: none"> • Poor propagation characteristics (8-10 times cell sites needed for coverage as compared to 700 MHz) • Internationally harmonized • Expensive to deploy 	Germany, Sweden, Norway
3.4 – 3.6 GHz	Television reception	<ul style="list-style-type: none"> • Poor propagation characteristics • Likely to have poor global ecosystem 	

From technical point of view, low frequencies bands are better for signal propagation hence deployment friendly (especially in rural areas). It is recommended that the 700 MHz spectrum band should be used for IMT services in India. This frequency is appropriate both from the perspective of capacity and coverage. The low frequency is efficient and allows for a network that does not require a dense build-out and provides better in-building penetration than higher frequency bands. The propagation characteristics could facilitate the deployment of networks reaching sparsely populated areas that are uneconomic to cover with networks operating at higher bands. The benefits of using this frequency would mean that fewer base stations which would lower the capital investment as well as significantly lower operational expenditure. This will help government meet its broadband penetration objectives.

A further advantage of identifying this band for IMT-A services in India is that it is likely to have an established global ecosystem of network equipment as well as devices which is critical for the success of technology.

It is recommended that considering the economy of scale, support for international roaming, ease of availability of UEs, propagation characteristics and availability of spectrum bandwidth to provide the high speed data services through IMT Advanced technologies the 700 MHz band seems to be appropriate band for IMT-A Services in India.

It needs to be noted that TRAI has already recommended that 700 MHz band be earmarked for IMT applications. The draft NTP'2011 also aims to make available globally harmonized bands for commercial mobile services, which will be a key driver for success of – IMT Advanced services in India

Since the required spectrum requirement may not be entirely met through 700 MHz, Government may have to consider spectrum in at-least one more band. Another important band for deployment in India could be 2.5 – 2.69 MHz. While it does not have good propagation characteristics (as compared to 700 MHz), it is likely to have good global ecosystem which provides it an



edge over other bands (except 700 MHz). In addition, 800 MHz and 900 MHz spectrum bands may be evolved towards for IMT– Advanced services.

6. What should be the block size of spectrum to be put on auction? How many blocks of spectrum should be allocated/ auctioned per service area?

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7. What is the minimum spectrum block size for effective use of 4G technologies?

While the technology allows combining multiple smaller blocks of spectrum, larger the contiguous block of spectrum, better is the spectral efficiency (using statistical multiplexing) and higher the cell throughput. Hence, it may not be advisable to divide the available spectrum up into smaller blocks that do not fulfil the licensed entity’s requirements nor the end user’s requirements or expectations of high speed/quality of broadband services. IMT-A achieves higher data rates and requires wider radio channels, such as 10 MHz wide channels. To deliver very high data rate, the system must minimize interference.

It should be noted that moving towards more advanced standards, (e.g. LTE 3GPP rel 10) there is inherent support for larger bandwidth to gain larger throughput. All IMT Advanced technologies would require wider contiguous channels (10 MHz or more) to provide the desired services and level of performance required of IMT Advanced services which include enhanced data rates, value added services and various data centric applications.

Spectral efficiencies of IMT Advanced technologies typically find synergy when larger bandwidths are available with the operator. Internationally, 10-20 MHz of spectrum has been allocated to operators for rolling out IMT Advanced networks.

For example, in USA when FCC auctioned the 700 MHz spectrum, it divided the spectrum into 5 blocks as below:

Block	Description	Bandwidth (MHz)	Reserve price (Per MHz – USD Mn)	Highest Bid (Per MHz – USD Mn)
A	176 “economic area” licences for 2 × 6MHz	12	150.6	330.1
B	734 “cellular market area” licences for 2 × 6MHz	12	114.5	762
C	12 “regional economic area grouping” licences for 2 × 11MHz, with "open platform" conditions	22	210.8	215.8
D (unsold)	Single national licence for 2 × 5MHz, with conditions requiring a public/private partnership to create a public safety broadband network	10	133	47.2
E	176 economic area licences for 6MHz (unpaired)	6	150.6	211.1



In the case of Germany, 360 MHz spectrum was auctioned across 4 different frequency bands viz., 800 MHz, 1.8 GHz, 2 GHz & 2.6 GHz. The spectrum was won by 4 players:

Player	Quantum of Spectrum
Telekom	95 MHz
Vodafone	95 MHz
E-Plus	70 MHz
Telefonica O2	99 MHz

A geography based division of spectrum (within a circle) may not be feasible in India; it can be seen from US example that spectrum auctioned was in the range of 2 X 6 to 2 X 11 MHz. The spectrum in the 2 X 5 MHz was not taken up by any bidder. From the case of Germany, it is evident that operators would need large quantum of spectrum.

Hence, minimum block size for effective deployment of IMT Advanced networks should be 2 X 10MHz. A 10 MHz bandwidth in FDD and 1x20 MHz in TDD per operator should be auctioned to achieve better efficiency and throughput. It is preferred to utilize more diversity gain considering high traffic demand.

Ideally 6 blocks should be auctioned in every service area as this would protect consumer interest. These blocks may be identified across multiple bands. The number of blocks auctioned should ideally be equal to the number of potential bidders minus 1 to ensure that the Government realizes the true value of the spectrum and at the same time successful bidders do not face a “winners curse”.

Another important aspect is that of service area; as envisaged in NTP’2011 the future services should embrace the ‘one-nation’ concept which implies that the service area may be considered as ‘one-nation’ i.e. whole of India

Summary: It is recommended that the block size of spectrum for deployment of IMT Advanced should be 2 X 10MHz in FDD and 1X20MHz in TDD mode. The number of blocks ideally to be auctioned could be 6 (Pan-India basis) to enable development of a fair market for end consumers in multiple band. These blocks could be identified across spectrum bands. This will allow fair amount of competition and would also provide for required bandwidth to deliver quality services to subscribers. Also, this allocation may be at India level where the service area is treated as Pan-India.

8. What should be the maximum amount of spectrum which a service provider can be allocated through auction?

The maximum amount of spectrum per service provider should ideally be a function of the total amount of spectrum available, and the competitive objectives of the regulator. Once the initial number of players has been determined (through number of blocks of spectrum to be auctioned) and a start-up spectrum is allocated, any further, allocation may be through auction or any other criteria as deemed appropriate by the authority.



Additional spectrum in the long run may be required by operators who have attained the maximum utilization level for the current allocated block and any curbs may affect the provisioning of quality service to customers.

The draft NTP'11 envisages an environment where spectrum pooling, sharing and trading will be allowed for optimal and efficient utilization of spectrum. In such a scenario, any capping on the spectrum loses significance as the operator needing additional spectrum may still be able to get the required spectrum

However, in order to ensure that adequate competitiveness exists in the market, government may consider putting a cap on the number of blocks being awarded to a player as part of the initial auction process. The government may consider putting a cap of '1 blocks (of 2 X 10 MHz each for FDD)' and 1X20 for TDD MHz per player for ensuring fair level of competition. This will prevent a monopolistic situation and will ensure desired number of players get the start-up spectrum

Summary: At the initial auction, the number of spectrum blocks may be capped at 1 (2 X 10 each for FDD) and 1X20 for TDD. However, there may not be any long-term capping on the maximum amount of spectrum which a service provider can be allocated.

9. Whether there is a need to specify the use of particular duplexing scheme based on the band in which spectrum allocation is done? If yes, in the case of TDD, is it required to specify further the frame duration, mandate frame synchronization using one of a specified set of timing sources and a permissible set of Uplink/Downlink sub-frame schemes compatible with the IMT-A standards?

2G and 3G technologies that use FDD are prevalent in the Indian market. Technologies that use TDD are expected to start operations soon. Also, duplexing is a function of type of spectrum available (for e.g. TDD was already allocated in 2.3 GHz for BWA). Given this context, it is quite apparent that there will be a co-existence of FDD and TDD based technologies in the Indian operation and it may not be appropriate to recommend any one Duplexing for IMT-A. However, it is necessary to have a harmonized approach of duplexing for each band to get advantage of economies of scale and ensure efficient use of the spectrum.

In the event of TRAI deciding to agree for both FDD and TDD for the IMT-A services, it will have to specify, in the case of TDD, the frame duration, to mandate frame synchronization using one of a specified set of timing sources and a permissible set of Uplink/Downlink sub-frame schemes compatible with the IMT-A standards. Such an arrangement will have to ensure the necessary guard bands and the mechanism for minimizing the interference.

In our opinion, it should be technology neutral; both FDD and TDD should be allowed and offered.

10. What should be the reserve price per MHz in different spectrum bands?

While auction reserve price is an indication of the inherent value of the asset, competitive forces determine the real asset value in the market. Nominal reserve price may attract several players to the auction thereby extending the auction period and delaying the actual value realisation for the



auctioneer as market forces aim to reach the optimal value based on the underlying valuation factors. Alternatively, setting a reserve price closer to the real value quickens the value realisation which could be high enough to keep out weaker players while leaving enough room for value adjustment based on the estimates of the bidders.

However, while reserve price may not have too high a bearing on the actual revenue realisation for the government, it is nevertheless a lever to control the auction behaviour in terms of number of bidders, auction duration, etc. To this end, certain key parameters need to be borne into consideration while fixing the reserve price, some of which could be as given below:

- **Spectrum availability**
- **Technological considerations**
- **Market sentiments.**
- **Reserve price of prior auction:**

Summary: Reserve price primarily serves to provide an indication of the inherent value of the asset being auctioned, while the actual revenue realisation is market determined and conditioned by other aspects of the auction process such as sealed bid or increasing bid auction method, etc. As such it does not seem to have too high a bearing on the market valuation of the spectrum. Nonetheless, to arrive at a reasonable estimate for the same, certain key factors such as spectrum availability, technological aspects of the spectrum band being auctioned and their cost implications, market sentiments, reserve price of prior auction of a similar asset etc., could be taken into consideration. Thus, it is recommended that government may determine the appropriate reserve price based on the prevalent conditions at the time of auction and this may be done through a consultation process involving various stakeholders.

11. What should be the eligibility conditions for bidding for spectrum?

Eligibility criteria should aim to arrive at a balance between policy objectives, market realities and consumer benefit. While the government may aim at stimulating competition in the sector in the hope of providing meaningful services to the consumer at affordable prices, the same may not be viable from a market sustainability perspective as consolidation would eventually happen in an overly fragmented market.

Policy objectives such as providing advanced communication services to all residents through the length and breadth of the country and promoting rollout of advanced communication network infrastructure to augment national productivity could be incorporated into the eligibility criteria through levers such as prior experience in providing such services and financial strength to implement projects of such scale. There could be other parameters as well that could have a bearing on more intricate issues of national interest and security and hence, could be incorporated into the eligibility conditions.



The 2008, 700 MHz spectrum auctions in USA, also throws light on a hybrid model tried by the FCC which helped broader ecosystem players to participate in the auctions apart from established telecom operators. In an effort to encourage network neutrality, Google asked that the spectrum be free to lease wholesale and the devices operating under the spectrum be open. Google's specific requests were the adoption of certain policies such as open applications, open devices, open services and open networks. Currently many providers such as Verizon and AT&T use technological measures to block external applications. In return, Google guaranteed a minimum bid of \$4.6 billion. However, this model of broader eco-system players playing a part in spectrum auctions has not seen significant success, with Google in this instance not winning any licenses. Even if regulator wants to keep the market open for non-telecom players, broader eco-system players can participate through M&As which are likely to be permitted under the new telecom policy.

From coverage and 'provisioning of advanced communication services to all' perspective, and the viewpoint of continued delivery of the same to all consumers through the foreseeable future, certain key eligibility conditions could be mandated by the regulatory authority. These could include the following:

- **Financial strength:**
- **Implementation capability:**
- **Concrete rollout plans:**

Eligibility criteria could be:

- a) The bidder should hold a UAS licence as per the current regime or**
- b) Unified license as per the envisaged future licensing regime**

**11. Should there be any roll out obligations for spectrum given through auction?
Should it be different in different bands?**

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12. Whether there should be any specific rollout obligations in respect of rural areas?

Ideally, since the spectrum is being acquired through market price discovery, there should not be any roll out obligations since the acquirer pays for the spectrum based on its business case. The roll out obligations should normally be imposed only when the spectrum is made available below the market pricing.

With the new NTP looking to delink spectrum from licenses and allow spectrum trading, it is critical to impose rollout obligations to prevent speculators from bidding for the spectrum and trading them later. Specific lock in provisions tied to the rollout obligations too is needed to prevent such speculation and trading activity and provide for the most efficient use of spectrum. Since the reserve price as well as the final price would take into account rollout obligations and the limitations of each band, rollout obligations need not differentiate between bands.

In order to ensure that the available scarce resource is put to most efficient use and also fulfils the service penetration targets of the licensor in line with the national objectives, spectrum roll out obligations for IMT-A services can be specified as applicable for 3G spectrum.



14. What should be the spectrum usages charges? Should it be based on revenue share or be a fixed charge?

Telecom subscribers pay a significant component of their bills as taxes and levies which include spectrum charges. To provide affordable services and to meet the projected penetration targets, spectrum usage charges should not be enforced.

Once the spectrum is auctioned and the winning bidder has paid the stipulated market price, there should not be any extra charge levied on the service provider. For spectrum acquired through the auction process, the value of spectrum gets realized upfront; hence, there is no merit in levying any additional fees on the same resource.

It is recommended that the regulator may not impose any revenue linked OR fixed spectrum usage charges on the operator.

15. Using MIMO technologies what can be the possible infrastructure sharing issues and what can be the possible solutions

MIMO utilizes several antennas at the base station and devices to achieve higher data rates by better utilizing independent channels in space. Infrastructure sharing issues with MIMO technologies may arise due to varying requirements of operators for antenna utilization due to the MIMO technology adopted (Beamforming, Spatial Multiplexing), transmit power requirements, etc.

However, operators are in a better position to develop sharing agreements to collaboratively operate and reduce costs through sharing mechanisms similar to passive infrastructure sharing in India prevalent today.

3GPP has standards, specified architectures and interface details for network sharing that may be followed.

16. What regulatory mechanisms are to be provided for delivery of voice services over IMT-A systems?

Existing basic regulations on voice such as Legal intercept for security purposes, provisioning for emergency services may continue to apply for IMT-A systems for voice services. It may help to have clearly articulated policies on intra and inter-circle roaming and allowing for Voice over IP services since IMT-A systems are primarily on IP networks.

IMT-A systems are all IP based systems. It is submitted that IP telephony is presently permitted from IP device to another IP device and not to PSTN/PLMN. If DOT/TRAI proposes to liberalize this, level playing field issues vis s vis UASL operators need to be taken care of who have paid large entry-fee for offering voice services.

17. Should the interoperability of services to legacy 2G/3G systems be left to market forces?

As pointed out by TRAI, at present in India there is widespread use and penetration of voice based mobile services where as data and broadband services are in early growth stage. IMT-A adoption is expected to be gradual and driven by market demand for data and broadband



services. It is expected that IMT Advanced service providers will ramp up coverage across the country in a phased manner.

Thus, in the initial rollout of IMT Advanced services, interoperability will be more of a necessity.

18. What are the QoS measurements that can be reported on IMT-A systems? Suggest the appropriate KPI for data and voice services to guarantee customer satisfaction.

The types of services available on broadband high speed networks will evolve over time primarily driven by demand from customers and be determined through a thorough consultation paper involving all stakeholders by TRAI.

19. In view of the likely deployment of scenarios where the cell radius is scalable to much smaller levels using the concepts of femto and pico cells:

a. What will be the impact of femto cells/SoN architecture on KPI?

In general, smaller cells will improve coverage, capacity and therefore end user experience in terms of dropped calls, throughput, battery life, etc since they are targeted for specific areas in the network. Femto cells are not likely to impact the macro network

b. What will be the impact of Relays/femto cells on spectrum policy?

Similar to macro cells, Femto/Pico cells should operate, comply with existing license conditions but they will not impact spectrum policy. Macro cells always have higher power as compared to femto's. Possibilities for out-of-band interference are absent.

c. What will be the impact on infrastructure sharing?

At this stage, no impact on the infrastructure sharing is anticipated due to use of femto cells

d. What policy guidelines are required to encourage low emission low energy and high capacity architecture like femto cells overlaid over macro cells?

Regulator should encourage active infrastructure sharing to reduce cost to serve the end customer. Sharing may be allowed and enabled through virtual sharing in the base band processor of the femto as per the operator requirements.
