Alcatel-Lucent India

Consultation Paper
IMT – Advanced
MOBILE WIRELESS BROADBAND SERVICES

Response to Telecom Regulatory Authority of India

20th September, 2011

1. Introduction

Alcatel-Lucent is pleased to provide the following response to the Telecom Regulatory Authority of India (TRAI) invitation to comment on the questions raised in the consultation paper, IMT – Advanced Mobile Wireless Broadband Services.

As one of the world's leading providers and developers of telecommunications networks and solutions, we are well qualified to offer a view on the issues raised in the consultation paper.

Wireless infrastructure is an important and complimentary component of the national telecommunications landscape and it is important that India plans appropriately to maximise the potential opportunities.

2. About Alcatel-Lucent

Alcatel-Lucent (Euronext Paris and NYSE: ALU) is the trusted transformation partner of service providers, enterprises, strategic industries such as defense, energy, healthcare, transportation, and governments worldwide, providing solutions to deliver voice, data and video communication services to end-users.

A leader in fixed, mobile and converged broadband networking, IP technologies, applications and services, Alcatel-Lucent leverages the unrivalled technical and scientific expertise of Bell Labs, one of the largest innovation powerhouses in the communications industry.

With operations in more than 130 countries and the most experienced global services organisation in the industry, Alcatel-Lucent is a local partner with a global reach.

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3. Comments on Selected Questions Raised

Question 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?

Alcatel-Lucent Response:

User Equipment (UE)

The international standard bodies, such-as ITU, 3GPP, IEEE and 3GPP2 have defined the architecture and user equipment specifications to a great level of specificity and with attention to nation-specific frequency allocations.

User terminals will be governed by underlying standards for LTE-A (i.e. 3GPP Release 10/11).

Market forces will help insure that India benefits from global ecosystems of parts suppliers and these same market forces support international roaming of Indian citizens while abroad. Market forces are most responsive to changing demands and emerging technologies, and tend to maximize the overall economic benefits by using resources such as spectrum and base station sites most efficiently.

System Architecture

The advanced performance enabling technologies of LTE-A, require architectural changes to today's RAN:

- Advanced MIMO – more radio and antenna elements
- CoMP and HetNet – fast inter BTS communication for coordination
- Small Cells – Plug and play access points and outdoor hot-spots
- High Peak Rates – All IP high bandwidth backhaul

The exact target architecture for each operator will vary depending on their specific factors (such as, spectrum bands, service offering, converged or mobile only operator, etc.). Therefore the implementation is a matter of design for the operators.

Alcatel-Lucent advocates technology neutral spectrum licensing to ensure current and future unforeseen market forces are not impeded.

Question 2:

Whether there is a minimal set of performance characteristics the UE 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 UE has already passed.

Alcatel-Lucent Response:

LTE-A UEs must meet minimum 3GPP standards for LTE-A and legacy technologies.

The performance category of the UE will depend on the operator's service strategy.

Consideration of pan-India and international roaming will dictate support of at least common 3G frequency bands for fall-back.

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Voice-centric, data-centric, smart terminals and emerging machine-to-machine communicating devices continue to evolve fast, so international standards also continue to evolve to enable new applications while protecting legacy services.

Question 3 and 4:

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?
What basic security frameworks should be mandated in all networks to protect customer?

Alcatel-Lucent Response:

Security issues to consider might include:

- Encryption of private information
- Lawful interception of information
- Guarding against interference to other services that may have national security implications.

Encryption security aspects specified for LTE will apply for LTE-Advanced from a service point of view.

The basic LTE security aspects should be maintained as defined in 3GPP TS 33.401 standard. The standard supports optional IPSec encryption on the S1-u interface that protects the privacy of the user plane data in backhaul which is often regulated by the national authorities.

Lawful interception continues to be a consideration of the LTE developing technology.

Adjacent services interference mitigation continues to be a focus of the 3GPP standardization with attention to nation-specific frequency allocations taking into consideration of local requirements.

Question 5:

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

Alcatel-Lucent Response:

LTE-A will operate in existing LTE bands, plus new bands being progressively introduced. For India we recommend to follow the strong APAC ecosystems in the following bands highlighted in the table below. We also provide our view of how the market will likely evolve the services and Access technologies in these bands.

Freq (MHz)	*Duplex*	*Service*	*Access*	*Evolves*	*Service*	*Access*
700 (APT)	*FDD*			->	*QoS Data/VoIP*	*LTE/LTE-A*
850/900	*FDD*	*Voice + Data*	*CDMA/GSM*	->	*Voice*	*WCDMA (+2G)*
1800	*FDD*	*Voice*	*GSM*	->	*QoS Data/VoIP*	*LTE/LTE-A*
2100	*FDD*	*Voice + Data*	*WCDMA*	->	*Voice*	*WCDMA*
2300	*TDD*			->	*QoS Data*	*LTE/LTE-A*
2600	*FDD and/or TDD*	*BWA*	*WiMAX*	->	*QoS Data*	*LTE/LTE-A*

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3500	FDD and/or TDD			->	Hot Spot Data	LTE/LTE-A

A comprehensive list of existing 3GPP standardised bands with a view of their legacy usage internationally is provided below.

Common Name	eUTRA Band	Uplink (UL) operating band UE Tx/BS Rx	Downlink (DL) operating band	Duplex Mode	Band-width	Duplex Spacing	GSM Band	WCDMA Band	CDMA Band	WiMAX Band	TV Band (DigDiv)
2100 IMT	1	1920 MHz – 1980 MHz	2110 MHz – 2170 MHz	FDD	60 + 60	190		Y	Y		
PCS-1900	2	1850 MHz – 1910 MHz	1930 MHz – 1990 MHz	FDD	60 + 60	80	Y	Y	Y		
DCS-1800	3	1710 MHz – 1785 MHz	1805 MHz – 1880 MHz	FDD	75 + 75	95	Y		Y		
AWS	4	1710 MHz – 1755 MHz	2110 MHz – 2155 MHz	FDD	45 + 45	400		Y	Y		
850MHz	5	824 MHz – 849 MHz	869 MHz – 894 MHz	FDD	25 + 25	45	Y	Y	Y		
2.6GHz IMT-E	7	2500 MHz – 2570 MHz	2620 MHz – 2690 MHz	FDD	70 + 70	120				Y	
E-GSM 900	8	880 MHz – 915 MHz	925 MHz – 960 MHz	FDD	35 + 35	45	Y	Y	Y		
1800 Japan	9	1749.9 MHz – 1784.9 MHz	1844.9 MHz – 1879.9 MHz	FDD	35 + 35	95		Y			
WCDMA USA	10	1710 MHz – 1770 MHz	2110 MHz – 2170 MHz	FDD	60 + 60	400		Y			
1500 Japan	11	1427.9 MHz – 1452.9 MHz	1475.9 MHz – 1500.9 MHz	FDD	25 + 25	48		Y			
Lower ABC 700 USA	12	698 MHz – 716 MHz	728 MHz – 746 MHz	FDD	18 + 18	30					Y
Upper C 700 USA	13	777 MHz – 787 MHz	746 MHz – 756 MHz	FDD	10 + 10	-31					Y
Public safety 700 USA	14	788 MHz – 798 MHz	758 MHz – 768 MHz	FDD	10 + 10	-30					Y
Lower BC 700 USA	17	704 MHz – 716 MHz	734 MHz – 746 MHz	FDD	12 + 12	30					Y
850 Japan	18	815 MHz – 830 MHz	860 MHz – 875 MHz	FDD	15 + 15	45			Y		
850 Japan	19	830 MHz – 845 MHz	875 MHz – 890 MHz	FDD	15 + 15	45		Y			
800 Europe DD (R9)	20	832 MHz – 862 MHz	791 MHz – 821 MHz	FDD	30 + 30	-41					Y
Ext 1500 Japan (R9)	21	1447.9 MHz – 1462.9 MHz	1495.9 MHz – 1510.9 MHz	FDD	15 + 15	48					
US L-Band ATC (R10)	24	1626.5 MHz – 1660.5 MHz	1525 MHz – 1559 MHz	FDD	34 + 34	-101					
	...										
2 GHz TDD	33	1900 MHz – 1920 MHz	1900 MHz – 1920 MHz	TDD	20	0					
IMT Centre Gap	34	2010 MHz – 2025 MHz	2010 MHz – 2025 MHz	TDD	15	0					
	35	1850 MHz – 1910 MHz	1850 MHz – 1910 MHz	TDD	60	0					
	36	1930 MHz – 1990 MHz	1930 MHz – 1990 MHz	TDD	60	0					
PCS Centre Gap	37	1910 MHz – 1930 MHz	1910 MHz – 1930 MHz	TDD	20	0					
IMT-E Centre Gap	38	2570 MHz – 2620 MHz	2570 MHz – 2620 MHz	TDD	50	0				Y	
	39	1880 MHz – 1920 MHz	1880 MHz – 1920 MHz	TDD	40	0					
2.3 GHz TDD	40	2300 MHz – 2400 MHz	2300 MHz – 2400 MHz	TDD	100	0				Y	
2.6 GHz TDD (R10)	41	2496 MHz – 2690 MHz	2496 MHz – 2690 MHz	TDD	194	0				Y	
3.5 GHz TDD (R10)	42	3400 MHz – 3600 MHz	3400 MHz – 3600 MHz	TDD	200	0				Y	
3.6 GHz TDD (R10)	43	3600 MHz – 3800 MHz	3600 MHz – 3800 MHz	TDD	200	0				Y	

Additional 3GPP work items will also add 700MHz and 800MHz FDD bands suitable for use in APAC in the next release.

Deployment of Public Safety Broadband services over LTE/LTE-A should also be considered in band planning. This technology will help in emergency scenarios where multi-media communications will help with situational awareness, response and co-ordination. With a requirement for ubiquitous coverage spectrum below 1GHz is desirable due to the propagation advantages. The new 700MHz and 800MHz bands are therefore suitable candidates for harmonised Public Safety Broadband.

To be effective in emergency scenarios where commercial networks get congested, a separate network and band allocation for security/emergency services will be required.

Question 6 and 7:

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

Alcatel-Lucent Response:

LTE and LTE-A employs OFDM modulation with flexible contiguous component carriers from 1.4, 3, 5, 10, 15 and 20MHz. LTE-A aims to allow carrier aggregation up to 100MHz.
Small channel bandwidths (<5MHz) are less efficient due to:

- Higher proportional signalling overheads
- Less OFDM frequency diversity
- Less trunking efficiency and hence less multi-user gain

When considering spectrum allocation for advanced mobile broadband, the dichotomies of coverage and capacity need to be considered. Coverage for less dense (Suburban, Rural) areas requires frequencies < 1GHz, but these bands tend to have smaller bandwidth channels. For dense (urban) areas, hot spots and small cells require higher bandwidths for capacity, but bands with larger bandwidth channels tend to be at higher frequencies. It is therefore considered that band pairing is advantageous for deploying comprehensive IMT services.

We recommended a typical allocation of 140MHz for an LTE-A operator, based on the following:

Purpose	*Coverage*	*Capacity Density*	*Hot-Spot*
Carrier Frequency	*< 1 GHz*	*1 GHz < < 3GHz*	*> 3 GHz*
Minimum Bandwidth	*10 + 10 MHz*	*20 + 20 MHz*	*40 + 40 MHz*

Question 8:

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

Alcatel-Lucent Response:

As mentioned in the response to Q6 & Q7, for comprehensive advanced mobile broadband services a suite of spectrum bandwidths is required. The maximum amount of spectrum per service provider is therefore a function of the total amount of spectrum available, and the competitive objectives of the regulator.

Question 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?

Alcatel-Lucent Response:

The recommend duplexing scheme/s per band is provided in the table in response to Q5. It should be noted that for the bands particularly suited for coverage (i.e. < 1GHz) a FDD duplexing scheme is recommended, due to its coverage advantage over TDD.

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For the 2600 and 3500 MHz band FDD/TDD or TDD only band plans are possible depending on the presence and migration plans for existing services. Where TDD (or FDD/TDD) band plans are allocated inter-system interference needs to be considered by the operators.

Adjacent operators can:

- Choose to synchronise (sub-frame schemes) their networks and therefore negate the need for guard-bands, or
- Based on their network design and deployment choose to allow appropriate guard-bands from within their spectrum allocation

Question 12 and 13:

Q12. Should there be any roll out obligations for spectrum given through auction? Should it be different in different bands?
Q13. Whether there should be any specific rollout obligations in respect of rural areas?

As mentioned in the response to Q6 & Q7 the deployment of services requires a suite of bands for coverage, capacity density and hot-spot access. The deployment across these bands depends on the operator's service objectives and target markets, so specific rollout coverage requirements would be hard to define.

Encouraging band use and preventing band 'hoarding' are important considerations, which can be addressed with usage obligations.

The economics of rolling out a new mobile service in less dense areas is always less favourable. Public initiatives such as USO funds are an effective way to promote rural services.

Question 15:

Using MIMO technology what can be the possible infrastructure sharing issues and what can be the probable solutions.

MIMO has no impact on RAN sharing, which is handled in the same way as without MIMO: if RF equipment supports several carriers, then each carrier can be assigned to a specific Operator or RAN sharing is handled like roaming by allowing UEs which do not belong to the primary Operator network to use it.

With LTE-A the extended use of MIMO technology (such as higher order MIMO up to 8x8 and Beamforming) will require a large number of radio and antenna elements at the site and UE.

Based on current rack mounted or RRH based radios, this puts pressure on physical infrastructure space (Tower and Housing), therefore the opportunities for sharing such space are reduced.

Question 16:

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

Alcatel-Lucent Response:

LTE and LTE-A are an all IP access technology. The standards are defined to support carrier grade Voice over IP (VoIP) with features such as: QoS control and scheduling, lower latency, optimal frame structure, header compression, and legacy network hand-over.

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Delivery of QoS controlled carrier grade VoIP (VoLTE) services can provide user grade of services inline with current expectations. Voice services on LTE-A through IMS will come under operator controlled Qos mechanisms and could follow voice regulations and mechanisms.

The best effort IP access bearers may also be used by users for over-the-top VoIP services such as Skype. These will not be under the operator controlled QoS mechanisms and therefore user grade of service will be difficult to predict.

Question 17:

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

Alcatel-Lucent Response:

LTE and LTE-A standards provide the mechanisms for Voice and Data interoperability with legacy technologies, including GSM/WCDMA and CDMA/EVDO.

Due to the fragmentation of global LTE frequencies, it is likely that the default standard for global roaming will remain for sometime as quad-band GSM, and tri-band WCDMA. Coupled with SIM based provisioning the user has the ability to move among networks.

Within India we encourage harmonisation to the frequency bands and technologies provided in the table in response to Q5.

The network interworking will depend on the operator's service strategy and partnerships in the market.

Question 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.

Alcatel-Lucent Response:

As mentioned in the response to Q16 if carrier grade voice services are deployed with VoLTE, the KPIs for such services can be engineered to meet current requirements.

For data the nature of advanced mobile broadband access is to move to service delivery, as apposed to all 'Best Effort' data access. In this regard QoS mechanisms are more advanced in LTE to differentiate services such as:

- Video calling
- Real-time Video
- Interactive
- Background transfer
- Machine-2-machine telemetry

The KPIs are associated with each service are unique to that service definition. They could for example be related to throughput, latency, error rate, depending on the service requirements. Difference services have different KPI requirements.

New services, and associated KPIs, will continue to be added based on market demand.

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

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Alcatel-Lucent Response:

Densification with small cells requires advanced SON and interference management features.

Femtocells can support a variety of user access approaches. In many cases femtocells used in home will have a closed user group, in other cases, often in the enterprise or outdoors, femtocells will be open or semi-open access. The choice of approach depends on the service being offered by the operator to the femtocell users. In all cases, however, only registered users of the relevant mobile network are permitted access, and the full authentication and security mechanisms typically used in mobile networks are applied.

In general Small Cells will improve coverage, capacity and therefore user experience in terms of dropped calls, throughput and battery life. In this way KPIs of user experience should improve.

Femtocells will operate and comply with existing spectrum license conditions, and therefore shouldn't specifically impact spectrum policy.

Infrastructure sharing is not something envisaged for Femtocells, as it is for common practice for Macrocells. However RAN sharing techniques could apply to Femto and Metrocells in open access mode.

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

Alcatel-Lucent Response:

Femtocells by their nature as low power 'personal' access points need to have regulatory policy suitable to allow mass deployment. Some principles to consider include:

- Self-install
    - As low power (defined by EiRP limit) access points they should not fall under the same policy requirements as a full Macro BTS would, i.e. they need to be classified as a CPE similar to a WiFi router, and treated as such for deploy, registration and licensing purposes.
- Operate and comply with existing spectrum license conditions
- Allow local area data breakout to offload core networks

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