ERICSSON



APT700

A TRULY GLOBAL LTE BAND

Starting in Asia, Ericsson has led the development and championed widespread acceptance of the APT700 band, creating a global LTE ecosystem opportunity, benefiting consumers and operators.

The superior propagation characteristics of digital dividend spectrum, made available through the re-farming and re-stacking of terrestrial broadcast TV spectrum, is gaining widespread attention and momentum across the world, specifically in Asia, Oceania and Latin America. This global band is already proving to be a key pillar in mobile operators' strategies to enhance both rural coverage and metro capacity.

August 2013

INTRODUCTION

Consumer perspective

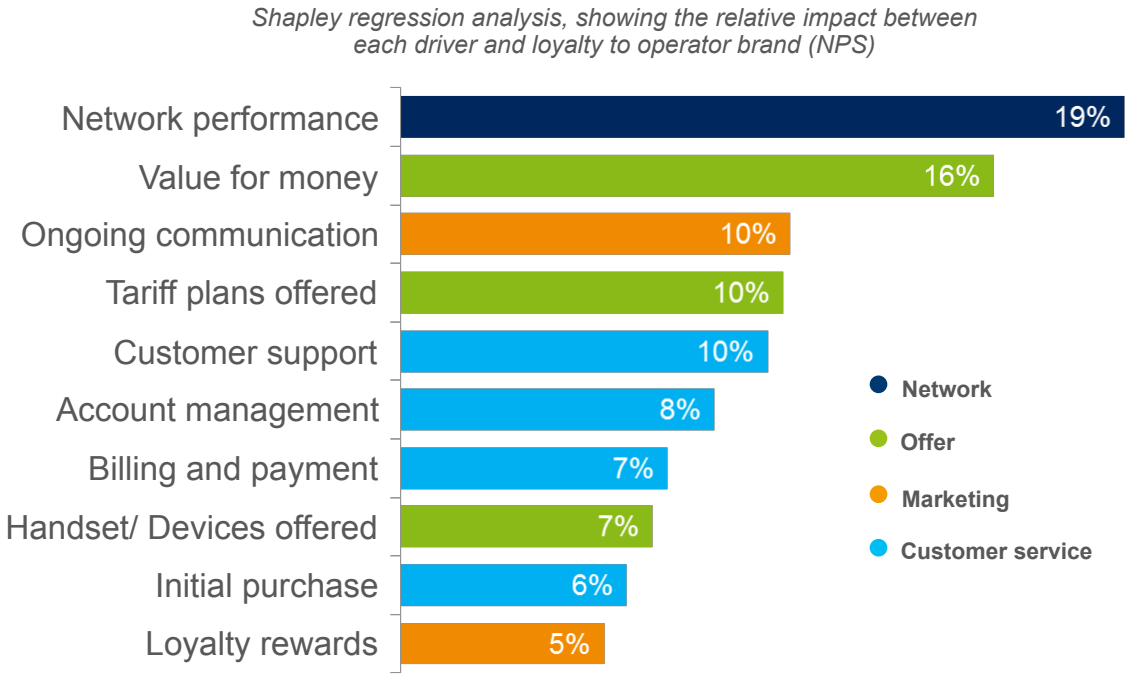
Across the globe, demand for connected devices continues to grow, including smartphones with ever-larger screens, tablets in a wide variety of shapes and sizes, as well as laptops and an expanding range of new devices - such as connected cameras, portable WiFi hotspots and machine-to-machine applications - all of which require connectivity to deliver services to consumers. Today, mobile broadband is an integral part of life in the Networked Society, where access to information and services anywhere, anytime is a natural extension of society's working and personal lives.

As enterprises and individuals invest in an increasing number of connected devices for the purpose of increased productivity or enhanced personal communications, the expectations on operator networks to deliver high performance - whether indoors, outdoors, city, suburban or in rural areas - are also becoming the norm.

Recent Ericsson ConsumerLab research[1] into customer loyalty investigated the relative impact of individual drivers and their relative contribution operator brand loyalty. The results, as shown in Figure 1, indicate that network performance is currently the principal driver behind subscribers' loyalty to mobile operators, followed by value for money. In fact, addressing network performance has twice the impact on customer loyalty compared to improving customer support, and is four times more effective than loyalty rewards schemes.

Further, considering the fact that approximately 75% of the time spent using a smartphone today is for non-voice related activities, the importance that users place on network performance is greater than ever before.

Figure 1 – Drivers of Operator Loyalty



Operator perspective

The need for exceptional mobile broadband coverage has never been greater, as users expect their services and apps to work virtually anywhere. Additionally, with mobile broadband adoption continuing at an exponential rate, operators must find ways of handling this traffic growth, cost effectively. Latest Ericsson forecasts show that global traffic is expected to grow by a factor 12 between 2012 and 2018.[2] Furthermore, traffic generated by specific devices is also expected to increase significantly over the coming years, as illustrated in the following figure.

Figure 2 - Traffic per month per device type, 2012 to 2018[2]

Traffic per month	2012	2018
Smartphone	0.45 GB	2 GB
Tablet	0.60 GB	3.1 GB
Mobile PC	2.5 GB	11 GB

A combination of approaches will be required to deal with this expected growth – including evolution to highly efficient radio technologies, such as Long Term Evolution (LTE), multi-path antennas (MIMO), new network architectures including Heterogeneous Networks and small cells, as well as spectrum re-farming and securing of additional spectrum bands.

Of course, any regionally harmonised spectrum is valuable for dealing with capacity growth; however, low-frequency spectrum is particularly desirable due to its ability to provide excellent in-building coverage, as well as deliver wide area coverage in regional & rural areas. With superior network performance proving to be a key differentiator for operators, digital dividend spectrum represents a rare opportunity for operators to cost-effectively enhance mobile coverage and end-user experience, whilst at the same time maximising the re-use of existing mobile sites.

A UNIQUE OPPORTUNITY

Golden opportunity

The global migration of terrestrial TV broadcasting from analogue to digital enables much more efficient use of Ultra High Frequency (UHF) spectrum, thereby creating a digital dividend. For reasons described earlier, this spectrum is ideally suited for mobile broadband. The International Telecommunication Union (ITU) has defined three regions globally for mobile telecommunications, due to regional differences in UHF spectrum allocation and broadcasting technologies that have been in place for many years. These three regions are broadly defined as Region 1 (Europe, Middle East & Africa), Region 2 (Americas) and Region 3 (Asia Pacific).

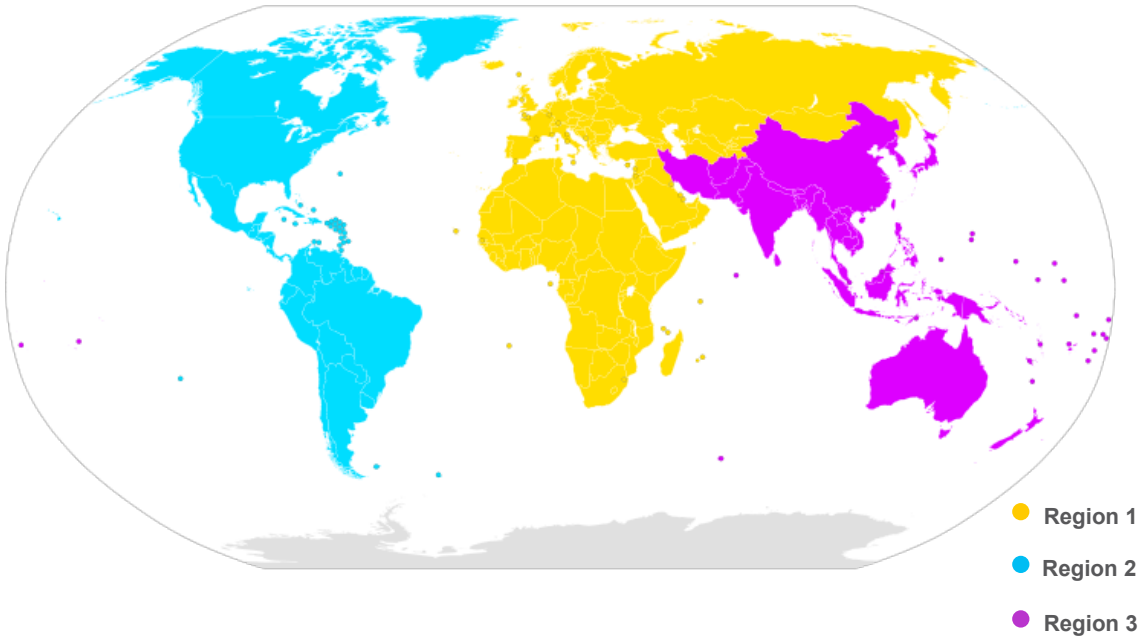
In Region 3 (Asia-Pacific) the UHF-band has primary allocation to mobile along with broadcasting, and in International Telecommunication Union (ITU) World Radiocommunication Conference 2007 (WRC-07) the frequency band 698-862 MHz was also identified for International Mobile Telecommunications (IMT) in the ITU Radio Regulations for some countries.

Figure 3 – ITU Region definition[3]

Following on from this decision, the 700MHz digital dividend band was acknowledged by APT as a candidate for regional harmonisation, which subsequently developed a regulatory framework for the 694/698-806 MHz for two proposed spectrum arrangements and was finalized 2011 – known as APT700. The 3GPP used this framework to specify two bandplans being Band 28 for Frequency Division Duplex (FDD) and Band 44 for Time Division Duplex (TDD), which was concluded in June 2012. The FDD variant (Band 28) in particular has gained the attention of regulators and operators across Asia, Oceania and the Americas.

This report focusses on the current and immediate implementation of the APT700 plan, being the FDD 2 x 45MHz arrangement which has been so widely adopted globally. It should be noted that a TDD variant also exists, and that that both versions are specified in regulatory and 3GPP specifications.

More recently, standardisation has focussed on alignment of the European (Region 1) second digital dividend to the lower duplexer of the APT700 plan, providing even greater economies of scale for device and infrastructure manufacturers. This is illustrated in Figure 8 later in this report.



Quantifying the opportunity

Numerous studies have been undertaken which attempt to quantify the economic and social benefits of allocating digital dividend spectrum to mobile broadband. Some of these highlights include:

- Increase of US$1 trillion in additional GDP by 2020, attributed to digital dividend allocation across the Asia Pacific region ; additionally
- Tax revenue growth of US$215 billion
- Creation of 1.4 million new businesses and
- Creation of 2.7 million new jobs

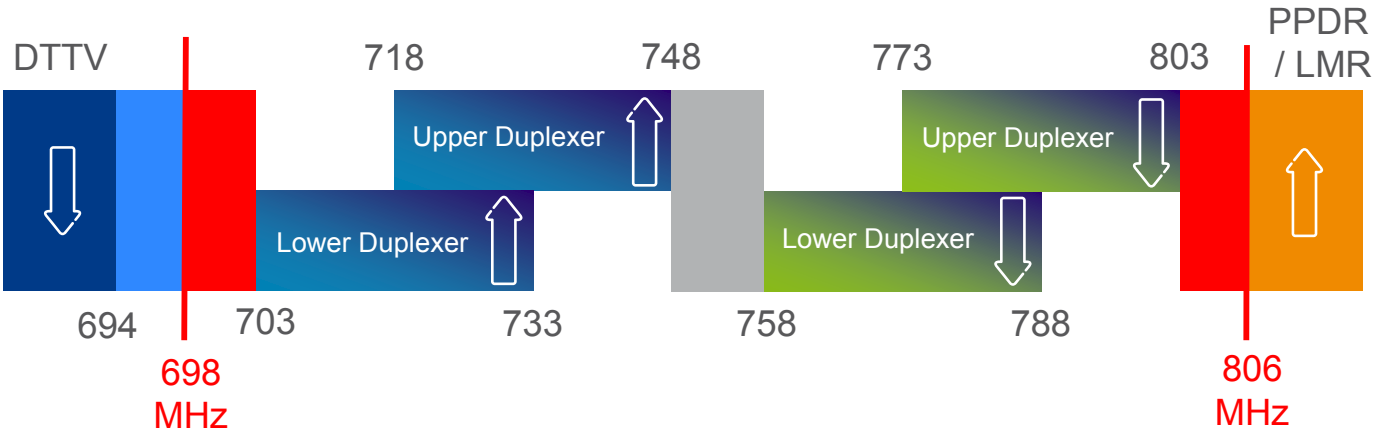
Additionally, research into impact of broadband in general also demonstrates strong social and economic benefits, including:

- For every additional 1000 broadband subscribers, around 80 new jobs are created[5]
- A 10% increase in broadband penetration results in a GDP increase of 1%[6]
- Doubling the broadband speed for an OECD economy increases GDP by 0.3%[7]

REAL GDP GROWTH

Based on a study of 33 OECD countries, doubling of broadband speed increases GDP by 0.3%, equating to USD126 Billion, due to direct, indirect and induced effects.

Figure 4 – Asia Pacific Telecom (APT) 700 MHz, 2 x 45MHz FDD plan (Band 28)



CREATING A GLOBAL BAND

A global band in the making…
APT700 was originally identified as a key opportunity due to the planned transition of terrestrial broadcasting from analogue to digital, being driven by a lesser quantum of spectrum and lower power required compared to analogue transmission.

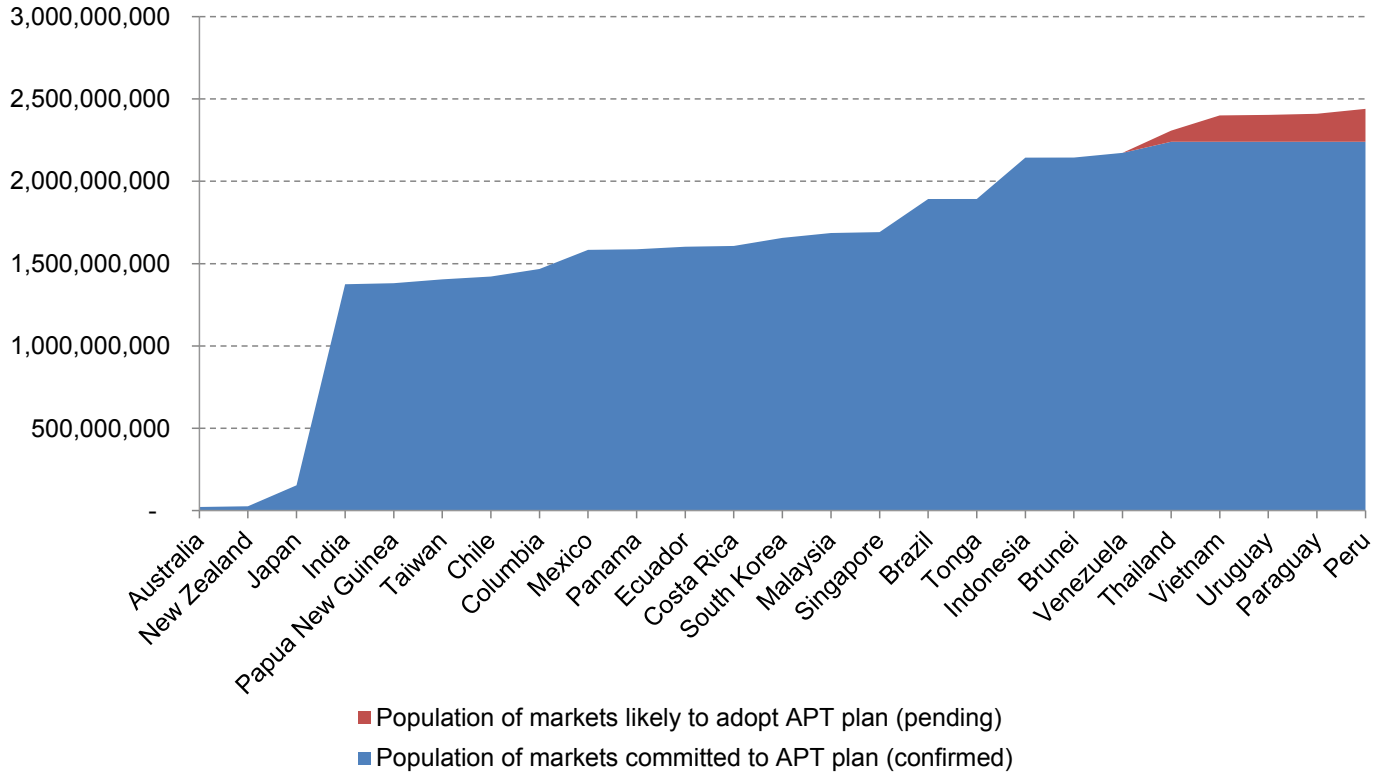
Despite the fact that a multitude of terrestrial broadcasting standards exist within Region 3 (including DVB-T, ATSC, ISDB-T, DMB-T), it was widely acknowledged by APT members that a regionally harmonised digital dividend would create significant economies of scale, thereby driving down cost of mobile devices, as well as provide excellent wide area coverage and in-building penetration.

Since APT700 was identified as a key Region 3 band, Ericsson has taken a driving role in the regulatory and standardization development in close collaboration with operators Telstra and Telecom New Zealand, amongst others.

Ericsson also acknowledges the leading role played by the Australian Communications and Media Authority (ACMA), the New Zealand Ministry of Business, Innovation and Employment (formerly the Ministry of Economic Development) and other regulatory bodies in driving the regional and global adoption of this band.

With the strong endorsement from these two operators, Australia and New Zealand became the first two countries in the region to adopt the APT700 plan, with many countries following since, not only across APAC but also extending to Latin America. Ericsson also adopted a driving role in Japan, together with other major suppliers and industry players to change the already planned Japan-specific frequency allocation covering 700MHz and 900MHz bands to be aligned with APT700. Japan became the first market to license part of the 700MHz digital-dividend band to mobile operators, in accordance with APT700.

Figure 5 - APT700 adoption globally by addressable population[8]



Steady adoption creating global momentum

The adoption of the APT700 Band 28 has been steady over the past few years and in recent times has grown rapidly. Markets that have adopted or endorsed the APT700 plan include:

- Asia-Pacific: Australia, New Zealand, Japan, India, Papua New Guinea, Taiwan, South Korea, Tonga, Brunei, Indonesia, Malaysia and Singapore
- Americas: Brazil, Costa-Rica, Colombia, Chile, Mexico, Ecuador, Panama and Venezuela

Furthermore, countries that are likely to endorse the APT700 plan in the near future include Thailand, Vietnam, Uruguay, Paraguay and Peru, and is illustrated in Figure 5.

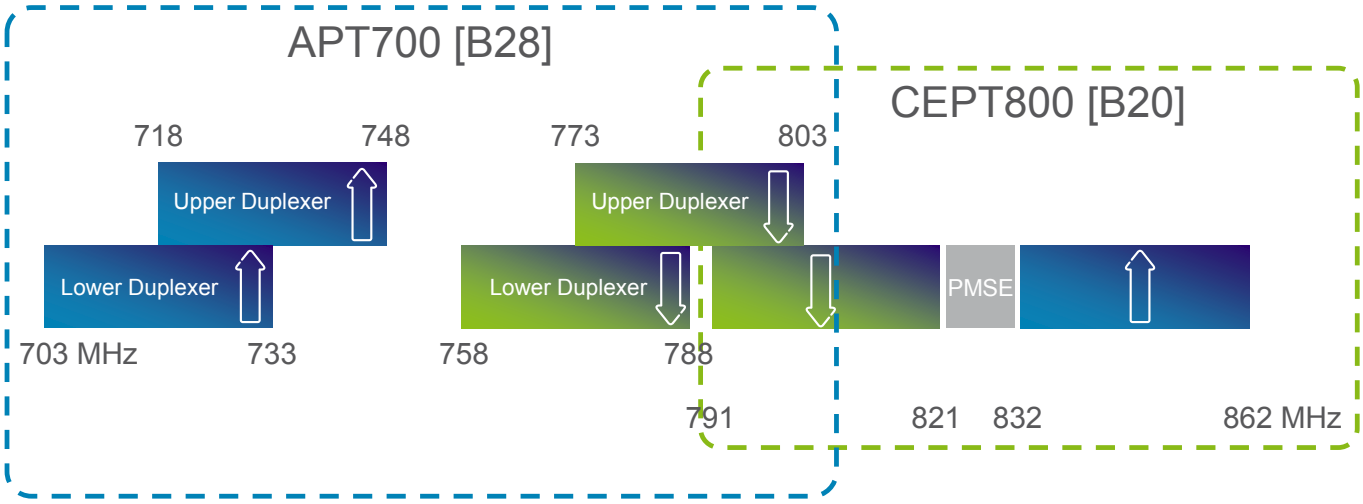
Of strategic importance to Latin America's rapid and widespread adoption of the APT700 plan was Mexico's formal adoption of this plan during 2012. With a population of over 116 million people, this was at the time the third most populous country to adopt the plan after India and Japan. Of even greater significance was Mexico's decision to deviate from what could have been considered by many as the 'default' choice to adopt the US700 (Region 2) band, primarily due to the superior characteristics and greater economies of scale that the APT700 plan will deliver.

GLOBAL IMPACT AND MOMENTUM

Adjacent ecosystem development
Accepting that the APT700 plan has now been widely adopted within Asia Pacific (Region 3), as well as a large and growing number of countries within the Americas (Region 2), the band is also proving to be of growing interest within Europe, the Middle East and Africa (Region 1).

During World Radiocommunication Conference 2012 (WRC-12), it was decided that ITU Region 1 (Europe, Middle East and Africa) should allocate the 694 – 790 MHz band to mobile on a co-primary basis with broadcasting. This band is also known as the 'second digital dividend,' (DD2) as the first digital dividend is already defined and in use, known as CEPT800 or Band 20 (832-862 MHz / 791-821 MHz). This allocation is expected to take place directly after the WRC-15 conference, and may result in further synergies with the APT700 market, due to the APT700 Lower Duplexer overlapping with the CEPT DD2 band.

Figure 6 – APT700 [B28] Lower Duplexer (30MHz) alignment with Region 1 (EMEA) DD2 spectrum

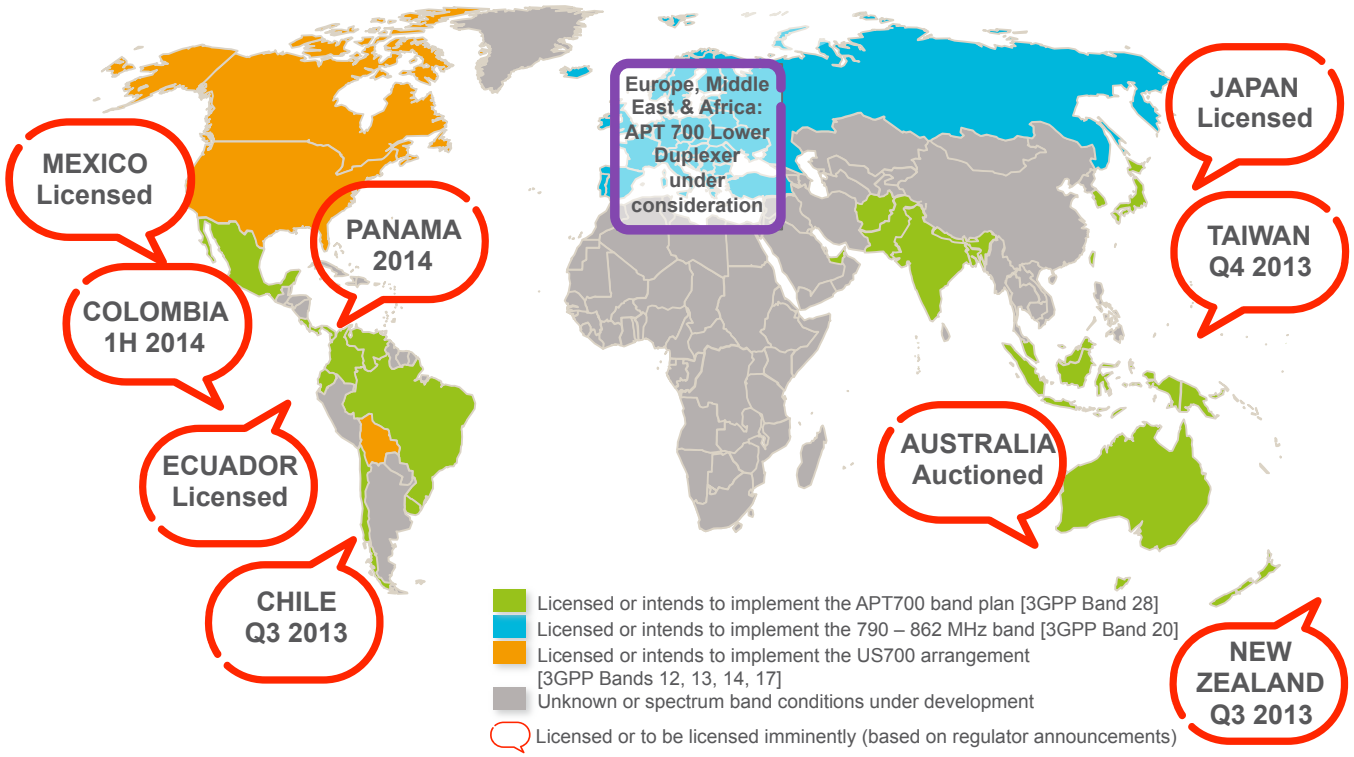


More recently (Q2 2013), the United Arab Emirates has allocated the combined Region 1 CEPT (CEPT) digital dividend and Lower Duplexer of the Region 3 APT700 band [B28] to mobile, thereby being the first country to adopt a plan that will support two out of the 3 global ITU Regions. This is illustrated in Figure 6 below, and elaborated further in Figure 8.

Global UHF band allocation

The following figure shows the global allocation status of the UHF band, demonstrating the scale of adoption of Region 3 APT700 band within and outside of Asia Pacific.

Figure 7 – Allocation of UHF band by market[9]



UHF OPTIONS: ADVANTAGE APT

The bigger picture

For some countries who were early to adopt the APT700 plan, including Australia, New Zealand and Japan, regulators and operators were required to take a 'leap of faith' in the ongoing adoption of this plan as well as ecosystem development. These pioneering regulators and operators were faced with the very real choice of adopting the existing US700 plan, with network equipment and devices under development, versus the future prospect of a plan with continuous 2 x 45MHz spectrum blocks and with a potentially much larger global footprint.

Considerations included the total quantum of spectrum available, the maximum channel size, interference protection, duplexer design – including alignment potential to future UHF bands and also ability to cover the entire band, maturity of the current vs future anticipated ecosystem and finally, the addressable market size for the device ecosystem.

The following figure illustrates the digital dividend band plans available or under standardisation, including APT700, CEPT800 and US700. For the purposes of this paper, a comparison is made only between APT700 and US700 due to the fact that the bands are closely aligned in frequency allocation, whereas the CEPT800 digital dividend has a different frequency allocation.

It should also be noted that despite some of the challenges associated with the US700 MHz plan, its widespread and rapid adoption in the US market has created strong momentum for the supply of many LTE devices to that market, including smartphones, tablets, routers and MiFi. This initial momentum, from such a large and mature LTE market, will also have a positive impact on future devices in many other global bands, including APT700, 1800MHz and 2600MHz bands, to name a few.

Figure 8 – Comparing global mainstream digital dividend band allocations[10]

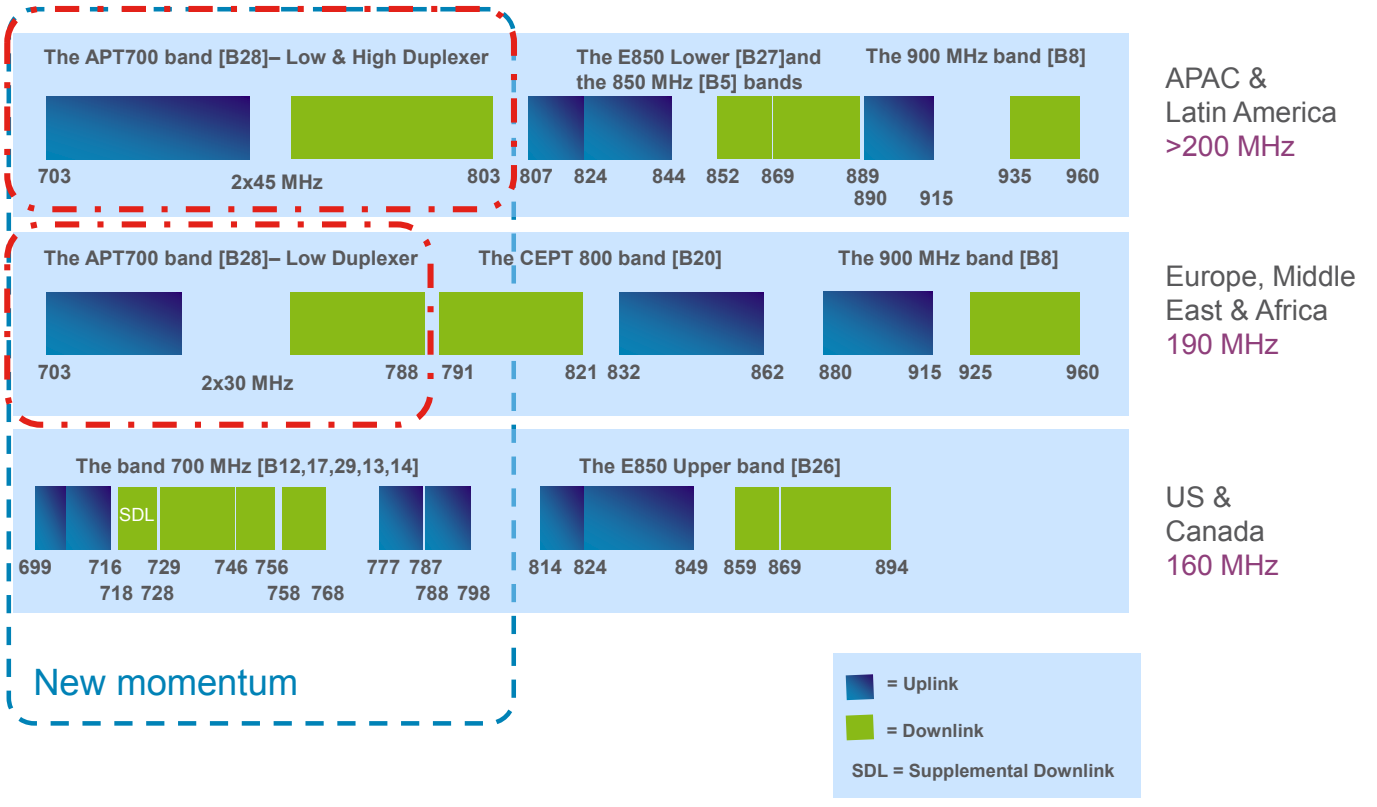


Figure 9 – Comparison of APT700 and US700 band plans and characteristics

Characteristic	APT700	US700	Implication
Total spectrum available	90MHz contiguous band allocation	84MHz non-contiguous band allocation	APT700: delivers increased band carrying capacity; greater mobile broadband capacity and/ or competition
Maximum channel size (bandwidth)	Up to 2 x 20MHz	Up to 2 x 12MHz (of which 2 x 10 usable for LTE)	APT700: wider bandwidths available for greater data capacity per network and/ or higher performance
Interference protection	High – upper & lower + centre guard bands	Varied due to irregular band gaps & guard bands	APT700: Simplified device filters, greater standardisation
Duplexer alignment to other region band plans	Lower Duplexer aligns to EMEA digital dividend (Band 20)	No alignment to EMEA or APAC UHF digital dividend 1 or 2	APT700: Expanded ecosystem, improved roaming capability
Dual duplexers covering entire band	Uniform duplex arrangements across entire band	Non-uniform duplex arrangements; reverse duplex	APT700: Full device interoperability / support across entire band; maximise economies of scale; maximum consumer choice for network provider
Ecosystem maturity	Yet to be established; likely scale to commence 2014/2015	Established since Q4 2010; significant momentum & device variety since 2011/2012	US700: Current scale advantage (short-term), however scale will be rapidly overtaken by APT700 ecosystem due to size of addressable market
Addressable population / market size	>2.1 billion people	>300 million people	APT700: Larger ecosystem to drive greater consumer choice & lower device cost

CONCLUSION

Consumer demand for connected devices continues at a rapid pace in virtually all markets across the globe today, driven by economic and social benefits that are well documented. A key challenge for operators and regulators is to secure and make available new spectrum bands to continue to unleash this potential. With customer loyalty driven primarily by network performance, low-frequency UHF spectrum is particularly attractive to operators seeking to improve both wide-area coverage, as well as boosting network performance in urban and indoor areas through the use of existing macro cell sites supplemented by small cell deployments.

Looking beyond today's business and consumer mobile broadband, a further benefit of UHF spectrum is the fact that it is well suited to machine-to-machine applications, such as smart grids, and has broad applicability in the enablement of Smart City ICT solutions, where connected devices may be located in any number of indoor or outdoor locations.

The pace and scale of adoption of the APT700 plan makes this highly attractive to operators and regulators alike across all three ITU Regions, which is a deciding factor in the ongoing endorsement of this plan in all Regions. Furthermore, the proposal of a second 'digital dividend' in Europe, Middle East & Africa (Region 1), with technical alignment to the APT700 plan, makes the choice clear for even wider adoption.

Finally, the large addressable market for APT700, which currently stands at over 2.1 billion people and growing, creates certainty for both network infrastructure providers and device manufacturers to prioritize this band for inclusion in network equipment as well as devices. For device manufacturers, large economies of scale ultimately drive greater variety and also lower prices for consumers and enterprises, benefiting both people and society.

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4 Boston Consulting Group, The Economic Benefits of Early Harmonisation of the Digital Dividend Spectrum & the Cost of Fragmentation in Asia-Pacific, May 2012

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8 Ericsson and consolidated regulator announcements

9 Ericsson and regulator announcements

10 Ericsson

APPENDIX – APT700 GLOBAL STATUS

Figure 10 – Global APT700 band adoption and status

Market	APT	Digital Dividend	Band Plan (APT700)	Status	Population
Australia	2011	694 – 820 MHz	2 x 45	Auctioned 2 x 30, April 2013	22,262,501
New Zealand	2011	698 – 806 MHz	2 x 45	Auction Q3 2013	4,365,113
Japan	2012	718 – 806MHz	2 x 30 (remaining unallocated)	Awarded June 2012	127,253,075
India	2012	698 - 806MHz	2 x 30 (remaining TBA)	Auction 2014-15	1,220,800,359
Papua New Guinea	2012	698 - 806MHz	2 x 45	Allocated 2 x 22.5	6,431,902
Taiwan	2012	694 - 806	2 x 45	Allocation 2012	23,299,716
Chile	2012	698 – 806 MHz	2 x 45	Allocation by end 2013	17,216,945
Colombia	2012	698 – 806 MHz	2 x 45	Allocation by end 2013	45,745,783
Mexico	2012	698 – 806 MHz	2 x 45	Allocated 2013	116,220,947
Panama	2012	698 – 806 MHz	2 x 45	Allocation 2014	3,559,408
Ecuador	2012	698 – 806 MHz	2 x 45	Licensed	15,439,429
Costa Rica	2012			TBA	4,695,942
South Korea	2012	698 – 806 MHz	2 x 20 (remainder pending)	TBA	48,955,203
Malaysia	2013	698 - 806MHz	2 x 45	TBA	29,628,392
Singapore	2013	698 - 806MHz	2 x 45	TBA	5,460,302
Brazil	2013	TBA	2 x 45	TBA	201,009,622
Tonga	2013	TBA	2 x 45	Allocated 2 x 15	106,322
Indonesia	2013	TBA	TBA	TBA	251,160,124
Brunei	2013	TBA	TBA	TBA	415,717
Venezuela	2013	TBA	TBA	TBA	28,459,085
				Subtotal - adopted	**2,172,485,887**
Thailand	TBA	TBA	TBA	TBA	67,448,120
Vietnam	TBA	TBA	TBA	TBA	92,477,857
Uruguay	TBA	TBA	TBA	TBA	3,324,460
Paraguay	TBA	TBA	TBA	TBA	6,623,252
Peru	TBA	TBA	TBA	TBA	29,849,303
				Subtotal - pending	**199,722,992**

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