

The 700 MHz Band: Recent Developments and Future Plans

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Abstract

In the United States, terrestrial television broadcasters will switch from analog to digital by 17 February 2009. When this occurs, the lower bandwidth costs of digital television will free up 108 megahertz (MHz) of spectrum for other uses. This portion of spectrum, from 698 to 806 MHz, is collectively known as the 700 MHz band. This paper discusses the process by which licenses to use the soon-to-be vacated band are being auctioned off as well as currently announced plans for their future use.

Keywords

700 MHz, 700 megahertz, spectrum auction, auction 73, federal communications commission, FCC, public safety, digital television, UHF, long term evolution, LTE

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1. Introduction

The biggest news in mobile networking lately has been the 700 megahertz (MHz) spectrum auction. But what is the auction? What is the 700 MHz band?

The 700 MHz band is actually the set of frequencies between 698 and 806 MHz, which puts them in the Ultra High Frequency, or UHF, range of radio frequencies. In the United States, these were and are still used as television channels 52 through 69. On 17 February 2009, however, that will change as the long-used analog television channels go dark and are replaced with new digital ones. Because of the advantages gained from the switch to digital, channels 52-69 will no longer be needed and can be reused for other purposes. More technical details on the band itself as well as the changeover to digital television are discussed in section 2 of this paper.

One of the congressional directives during the formulation of this plan was that some of the freed space would be allocated for use by public safety agencies such as police departments, fire departments, and ambulance districts. Right now, these agencies use a myriad of frequencies with systems that are incompatible from region to region. The freed spectrum in the 700 MHz band will allow for the creation of a national broadband public safety network to enhance communication between agencies at all levels of government. The frequencies that are not being used by public safety are nearly finished being auctioned off to companies for their use. Most of these companies plan to drastically improve their mobile Internet and media capabilities by installing next generation networks for use in the 700 MHz band. The auction process and plans for the spectrum are discussed further in sections 3 and 4.

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2. Background

2.1 Technical Merits

The spectrum in the 700 MHz band is very highly desired, in particular because of the electromagnetic properties of its frequencies. In general, the frequencies in the band, between 698 and 806 MHz, travel farther and pass through walls and other obstacles much better than existing cell phone networks do, leading to a lower required number of cells to provide the same

amount of coverage. In addition, because of the lower frequency, it would require less power to run a mobile phone/Internet cell on the 700 MHz band than on the other common bands, which are at higher frequencies. Since the upper TV channels are moving lower on the spectrum, they too will use less power than before. The exact details for use of the spectrum, including range, power, and data speeds, will require more time to become known because many of the planned new networks on this band will use technologies that are still in development [[Rast05](#)].

2.2 Digital TV Changeover

The Public Safety Wireless Advisory Committee (PSWAC) was established by the United States Congress in 1993 to investigate the spectrum requirements of public safety groups and recommend future actions to make improvements if necessary [[Doumi06](#)]. At the end of 1996, they recommended augmenting the amount of spectrum devoted to public safety by approximately 100 MHz. One part of the spectrum with a lot of wasted space was UHF, the section with all television channels 13 and above. In particular, the high end of UHF was very sparsely populated.

The introduction of the Advanced Television Systems Committee's (ATSC's) digital television standard in 1998 provided an opportunity for change. Digital ATSC channels use approximately one-sixth the bandwidth as their analog National Television System Committee (NTSC) counterparts for a picture of similar resolution. Digital television will use higher resolution images, however, so the advantage will be slightly lessened. Because digital signals inherently interfere with each other less than analog signals, the channels can be closer together [[Rast05](#)]. The channels that were spread out between 2 and 69 will instead be compressed into the space currently occupied by channels 2 through 51. In addition, by auctioning off the newly freed spectrum, which would come to be known as the 700 MHz band, the federal government could make several billion dollars to go towards balancing the federal budget or reducing the national debt [[Doumi06](#)].

Congress originally set a transition date for the end of 2006, meaning that by the end of the year, all stations would switch off their analog broadcasts. The one caveat to this date was that 85% of U.S. households in each market had to have at least one television with an ATSC digital tuner, required to read the new digital broadcasts. By 2005, Congress realized that this was not going to happen - the adoption rate was still hovering around 1%. The transition date was then changed to 17 February 2009 [[Report07](#)]. After this date, the entire 700 MHz band will be available for use.

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3. FCC Licenses and Auctions

In the United States, the right to transmit on communications frequencies is restricted (with few exceptions) to those organizations that hold a broadcast license from the Federal Communications Commission (FCC). A license specifies many characteristics to which the broadcast signal must conform, including, among others, the carrier frequency, allocated bandwidth, and geographical location where broadcasting is allowed. When licenses are to be

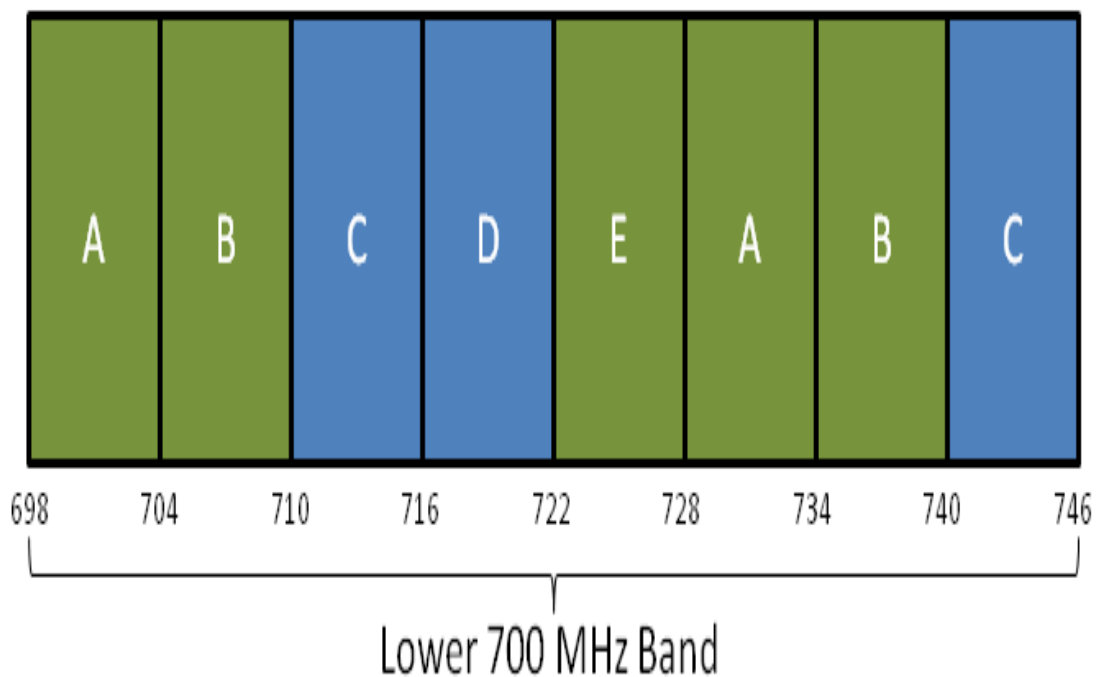
used for commercial usage, FCC policy requires the license to be auctioned to the highest bidder. This section details the structure of the licenses for the 700 MHz band and the auction processed used to distribute said licenses.

3.1 Bands and Blocks

The 700 MHz band is actually made up of two separate bands: the lower 700 MHz band (698-746 MHz) and the upper 700 MHz band (746-806 MHz).

3.1.1 Lower 700 MHz Band

The lower band is divided into five blocks as shown below in figure 1. The A, B, and C blocks are paired, which makes them useful for services that require two-way transmission, such as wireless Internet. The upper half of the pair is usually used to transmit from a tower to mobile devices while the lower half is usually used to transmit from devices back to the network; this ordering is prevalent because higher frequency transmissions require more power. The D and E blocks, to contrast, are unpaired, thus they only support one-way transmission.



 For commercial use - auctioned as part of Auction 73  For commercial use – previously auctioned

Figure 1: Lower 700 MHz Band

Block A consists of a pair of 6 MHz blocks licensed by Economic Area (EA), of which there are 176. The unpaired 6 MHz Block E is also broken up by EA. Blocks B and C each contain a pair of 6 MHz blocks, but unlike Block A these are licensed by Cellular Market Area (CMA). CMAs are smaller than EAs, thus there are 734 CMAs, each of which has a license for Block B and a license for Block C. Block D, which is an unpaired 6 MHz block, is licensed by the even larger Economic Area Grouping (EAG), of which there are six in the U.S. [Report07].

3.1.2 Upper 700 MHz Band

The upper band is a bit more interesting. It is also divided into five paired blocks as shown below, with A through D being auctioned for commercial use and the fifth being devoted to communication related to public safety.

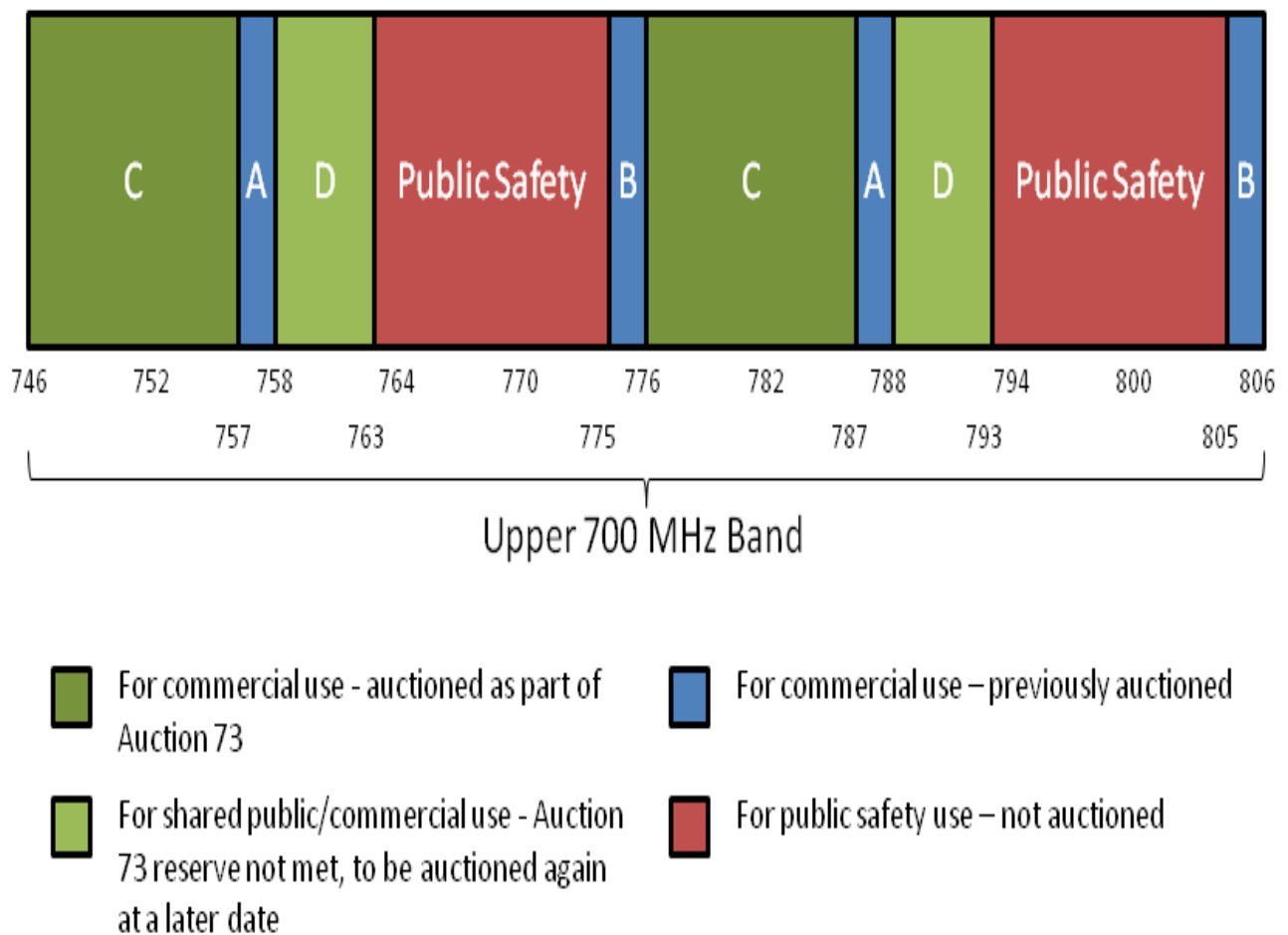


Figure 2: Upper 700 MHz Band

Blocks A and B were originally guard bands on either side of the public safety blocks, which meant that they had to conform to strict standards on reducing interference on neighboring frequencies. They were also not allowed to use a cell-based architecture. After a restructuring,

however, only the B block is subject to these requirements. Both of these blocks are licensed by Major Economic Areas (MEAs), of which there are 52.

Block C consists of paired 11 MHz blocks, giving it the largest bandwidth of any group up for auction. In addition, it is licensed as only twelve Regional Economic Area Groupings (REAGs), six of which combine to cover the entire continental United States; the other six are for Alaska, Hawaii, and outlying U.S. territories. The large bandwidth and simple geography made Block C one of the most coveted groups of licenses in the 700 MHz band.

Block D consists of paired 5 MHz blocks. It is unusual in that only one nationwide license is being given for the entire block. The caveat, however, is that all devices on this part of the band must support spectrum sharing with the public safety devices, as part of the 700 MHz Public/Private Partnership. In this sense, Block D acts somewhat as a guard between itself and the frequencies devoted solely to public safety [[Report07](#)].

3.2 Openness Requirements

On July 9, 2007, Eric Schmidt, the Chief Executive Officer of Google, Inc., sent an ex parte letter to the FCC Chairman, Kevin Martin. This letter requested that the FCC impose four openness requirements on the winner of the upper C block, the most desired piece of the spectrum to be auctioned. The four requirements were [[Google07](#)]:

- Open applications: Consumers should be able to download and utilize any software applications, content, or services they desire;
- Open devices: Consumers should be able to utilize a handheld communications device with whatever wireless network they prefer;
- Open services: Third parties (resellers) should be able to acquire wireless services from a 700 MHz licensee on a wholesale basis, based on reasonably nondiscriminatory commercial terms; and
- Open networks: Third parties (like internet service providers) should be able to interconnect at any technically feasible point in a 700 MHz licensee's wireless network.

On July 20, Google further encouraged the FCC by promising to bid at least the reserve price of \$4.6 billion, which meant that the C block would still generate enough revenue even if other companies were discouraged by the new requirements. In the end, the FCC agreed to enforce the open applications and open devices requirements, a move which Verizon Wireless strongly opposed [[Report07](#)].

3.3 Auctions and Results

The upper guard bands (blocks A and B) were auctioned off during FCC Auctions 33 and 38. The lower C and D blocks were auctioned off during FCC Auctions 44 and 49. The majority of the commercial licenses for the 700 MHz band were auctioned off by the FCC as part of Auction 73, including the lower A, B, and E blocks as well as the upper C and D blocks. Many companies got a piece of the pie, but a select few won a very large share.

3.3.1 Verizon Wireless

Verizon spent \$9.4 billion in Auction 73. They won the six of the twelve licenses in the upper C block, the ones covering the entire continental United States plus Hawaii. They also picked up some licenses in the lower A and B blocks. This means that they have 22 MHz of bandwidth nationwide (or close to nationwide) and 12 or 24 additional MHz in some areas where they have lower A and/or B licenses. This would enable them to roll out a nationwide network in the 700 MHz band, something which no other company can currently do. The upper C auction did meet its reserve price, however, so they will have to subscribe to the openness restrictions imposed by the FCC [[Brome08](#)].

3.3.2 AT&T

Before Auction 73 even began, AT&T owned a significant number of licenses in the 700 MHz band. They had recently purchased Aloha Partners, which owned most of the licenses in the lower C block sold in Auctions 44 and 49. In Auction 73, AT&T won parts of the lower B block as well. This leaves them with 12 or 24 MHz of bandwidth in most major markets, though there is still a large amount of relatively less populated areas where they do not have any licenses, thus preventing them from building a nationwide network comparable to the one Verizon will be building [[Brome08](#)].

3.3.3 Qualcomm

Qualcomm already owned all of the lower D block from Auctions 44 and 49, which they have already been using for their MediaFLO service (see section 4 below). In Auction 73, they also purchased some of the lower E licenses in key markets. Because the lower E block is unpaired spectrum, like the lower D block, they will likely just use the lower E licenses to increase bandwidth in those large markets. While Qualcomm does have a national network, its lower bandwidth and unpaired nature mean it too is not a competitor with Verizon [[Brome08](#)].

3.3.4 Google

Google bid on the upper C block as promised. Bidding records show that they were a driving force in increasing the price that Verizon had to pay. Ultimately, however, they came away with nothing from the auction [[Brome08](#)]. Based on their public statements, this is actually what they were hoping for; they wanted to increase the price of the upper C block so that the reserve price would be met and the open access requirements would be triggered [[Google08](#)].

3.3.5 Other

There were approximately 100 different companies and group that purchased licenses in Auction 73, thus Verizon, Qualcomm, and AT&T by no means control the entire band, though they do control a majority. Most of the other purchasers only obtained a few licenses for use in local and regional services. In addition, the upper D block, which requires cooperation with the public safety agencies, did not meet its reserve price so the FCC retains possession of it. It is believed

that the FCC will try to auction it again at a later date, but plans have not yet been announced [[Brome08](#)].

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4. Future Plans and Uses

Now that most of the 700 MHz band has been reallocated, the most significant questions going forward are how it will be used and when the new networks will be deployed.

4.1 Public Safety

One of the original goals of the reallocation of the 700 MHz band was to increase the amount of spectrum available for public safety [[Doumi06](#)]. As described above, 24 MHz of the band will be solely devoted to use by national, regional, and local agencies for public safety applications. Within each of the two 12 MHz blocks, the lower 5 MHz will be used for a nationally standardized broadband network. The upper 6 MHz of each block will be controlled by regional and local governments for narrowband applications, most likely voice and low-speed data communications similar to those currently in use. This leaves 1 MHz in the middle of each block as a guard band to prevent interference between the broadband and narrowband communications. In addition, the holder of the upper D block is required to participate in what is known as the 700 MHz Public/Private Partnership, meaning that both the D block commercial traffic and the broadband public safety traffic will share the same infrastructure. This even allows for public safety to use the D block in times of need [[Report07](#)].

The nationally controlled broadband network will fill a very large gap in current public safety networks: a network that can be used at the national, state, and local levels to coordinate public safety efforts. This need has been made evident several times after major incidents, in particular by the terrorist attacks of September 11, 2001. By creating a broadband network shared at all levels, something which has not existed to date, coordination of security and rescue operations can be made much easier and more productive [[Doumi06](#)].

4.2 Mobile Internet

While the government is happy to be expanding the bandwidth available for public safety applications, the industry's main plan for this spectrum is the improvement of mobile internet access. One of the important emerging technologies for the 700 MHz band is the Third Generation Partnership Project's Long Term Evolution (3GPP LTE). 3GPP LTE is the project which will produce a new, fourth generation (4G) compatible version of the Universal Mobile Telecommunications System (UMTS), which is the third generation (3G) successor to the second generation (2G) Global System for Mobile communications (GSM).

On April 3, 2008, the gag order regarding Auction 73 expired. At this point, the companies involved in the auction were able to begin discussing their plans for the licenses they won. In a press release on April 4, 2008, Verizon announced that it would use its purchases in the upper C

block as well as the lower A and B blocks to deploy an LTE-compatible network. They estimate that this network will be rolled out in 2010 [Verizon08]. On April 3, 2008, AT&T announced that they too would be using their 700 MHz licenses to create an LTE network, though they estimate completion in 2012 [Malik08]. AT&T chose to go with LTE because it is the successor to GSM, the platform on which their current networks are based, thus allowing for better backwards-compatibility [AT&T08].

4.3 Streaming Media

Another potential use for the 700 MHz spectrum, especially the unpaired blocks, is streaming media. Qualcomm acquired the majority of the lower D block through Auctions 44 and 49 and subsequently purchased the remainder of the licenses from their original owners. Since then, it has used this slice of spectrum to develop MediaFLO, a technology for broadcasting video and data streams to mobile devices. The "FLO" in the name stands for Forward Link Only, emphasizing the unidirectional nature of this service. This is necessary due to the unpaired nature of the D block. Because of the FLO connection, all required authentication must be done over a different network. Using this authentication information, a MediaFLO-compatible device can decode the broadcasted streams and give the user access to their content [Qualcomm04]. Qualcomm operates MediaFLO through a partnership with cell phone companies. MediaFLO's partners sell equipment and licenses to their customers on behalf of Qualcomm. Verizon was the first such partner, using MediaFLO as part of their VCAST media service [DailyWireless07]. AT&T has also recently announced plans to become a MediaFLO partner [Qualcomm07].

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5. Summary

The reallocation process for the 700 MHz band began over ten years ago with a desire to increase spectrum available for public safety agencies. This transition, however, has many benefits for all parties involved. The government gets more public safety communications and more money in the budget. The public gets use of the 700 MHz band for mobile multimedia and Internet applications, better public safety response, higher quality television signal, and increased openness in mobile communications. The corporations expand their services and make more money. The reallocation of frequencies leads to lower power consumption despite increased range and signal strength. In short, the reallocation of the 700 MHz band dramatically improves the mobile networking landscape and will likely lead to many new developments in the future.

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List of Acronyms and Abbreviations

- 2G - Second generation
- 3G - Third generation
- 3GPP - Third Generation Partnership Project
- 4G - Fourth generation
- ATSC - Advanced Television Systems Committee
- CMA - Cellular Market Area

- EA - Economic Area
- EAG - Economic Area Grouping
- FCC - Federal Communications Commission
- FLO - Forward Link Only
- GSM - Global System for Mobile communications
- LTE - Long Term Evolution
- MEA - Major Economic Area
- MHz - Megahertz
- NTSC - National Television System Committee
- PSWAC - Public Safety Wireless Advisory Committee
- REAG - Regional Economic Area Grouping
- UHF - Ultra High Frequency

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