

The Impact of the FCC's Position on Wireless E911

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1 Introduction

“She plunged off the road and into a canal. As the muck rose around her, she dialed 911. But where was she? She did not know....By the time the Florida Highway Patrol found the tire tracks in the mud, and by the time divers reached her BMW, 46 minutes had passed. Too late.” [45]

The Federal Communications Commission (FCC) has spent the past seven years promoting the implementation of Wireless Enhanced 911 (E911) services. During that time, the FCC has taken a neutral approach regarding the technology required to implement E911 and the cost recovery mechanisms for Public Safety Answering Points (PSAPs) and carriers. This neutral position stems from the FCC's belief that competitive market forces will generate the best solutions to meet their requirements. Recognizing that the deployment of E911 is in the public interest, our goal is to determine if this neutral position is hindering the deployment of Phase II E911. Our hypothesis maintains that in the public safety context, a natural incentive structure for a purely market driven solution does not exist. Therefore, the public interest would be best served if the FCC provides specific guidelines for the timely implementation of Phase II E911.

This paper explores the effects of the FCC's neutral position with regard to E911. Part 2 presents the background and definition of 9-1-1 emergency services. Part 3 defines the FCC's regulatory position. Part 4 presents a brief description of the main technologies, a chronology leading to the current position of the FCC, and a description of three possible alternative technical positions. Part 5 examines the FCC's position regarding cost recovery mechanisms beginning with a chronology of events that led to the current position, an analysis of market and incentive issues, and a description of three possible cost-recovery models. Part 6 concludes our paper.

2 Wireless E911 Foundations

The ability to simply dial the digits 9-1-1 and be connected to an emergency dispatching center, or PSAP, was first introduced in 1968 by AT&T [10,30]. Over time, wireline 9-1-1 services grew to include the ability of the carrier to transmit the phone number and location of the calling party, capabilities labeled “Enhanced 911” [11]. Since 9-1-1 was first implemented, wireless networks have proliferated and the use of wireless services has become widespread. Consequently, the number of wireless 9-1-1 calls has increased dramatically, from 5.9 million calls in 1990 to 43.3 million calls in

1999 [9,11], representing 50 – 70% of all 9-1-1 calls in some areas [45]. The wireless phone network can transmit a phone number for Automatic Number Identification (ANI), however is not designed to easily transmit the location for Automatic Location Identification (ALI), or to selectively route calls to the appropriate PSAP [11].

During the proceedings for the Personal Communications Systems licenses, the FCC recognized the critical importance of E911 to society and began a rulemaking proceeding focused exclusively on E911, in 1994 [10,11]. The FCC’s authority requiring wireless carriers to implement E911 is found in the Communications Act of 1934 (“the Act”) which mandates that the FCC “promot[e] safety of life and property through the use of wire and radio communication” and promote the public interest [2,3,11]. The Act also grants the FCC control over the use of spectrum through the issuance of licenses limited by “terms, conditions, and [time] periods” [4]. The FCC created two phases beyond requiring that all 9-1-1 calls be delivered to a PSAP: Phase I required the transmission of a caller’s ANI and the location of the cell site receiving the call by April 1998; and Phase II required the transmission of ALI, accurate to within 125 meters for 67 percent of the calls by October 2001 [11].

3 The FCC’s Regulatory Position

Over the past thirty years, the FCC has shifted its emphasis from a standards-setting body to a more market-based regulator [35]. Nevertheless, the FCC could have taken several different paths to promote E911 deployment. First, based on its power to license radio spectrum, the FCC could have mandated a technical solution, which may have led to quick deployment and relative ubiquity [4]. Second, the FCC could have mandated a technical solution and created a cost recovery mechanism on a national level. Third, technical solutions could have been developed through a negotiated rulemaking proceeding [11]; however, a successful resolution of this case would have depended upon excluding the E911 vendors, as their economic interests are incompatible with each other as well as with the carriers [19]. Finally, the FCC could have selected an entirely market-driven approach, leaving the specifics completely undefined.

The FCC did not directly choose any of these options. Instead, it defined the parameters that any technical solution must meet and the timelines for the deployment of these solutions [11]. With regard to cost recovery, the FCC required that PSAPs must have a mechanism in place before a carrier is obligated to meet a Phase I or II request [16]. Although the FCC issued a credible set of decisions in the E911 docket, it chose an indecisive technical path for a service that is not market-driven, and an indecisive cost recovery path when a consistent path would have kept all parties working towards the deployment of E911. The FCC’s neutral position effectively created an unfunded mandate [34]. The following sections will explore this position.

4 The FCC’s Position of Technical Neutrality

4.1 The Technologies

Network-based and handset-based solutions are the groups of technologies used for geolocation. Network-based solutions require the placement of radio receivers in each cell site to estimate the mobile’s position based on the measurement of the signal received by multiple base stations. Network-based solutions use angle of arrival (AOA) or time difference of arrival (TDOA)

technologies. AOA estimates the mobile's location by triangulating the line of bearing measurements from the mobile station to as few as two base stations [24]. TDOA calculates the mobile's position by intersecting the hyperbolic areas described by each difference-in-time-of-arrival measurement of the mobile's signal to at least three base stations [25]. Both methods exhibit poor performance in rural areas because triangulation is not feasible due to the linear orientation of the base stations along roads [22]. The advantages to network-based solutions include wide availability and arguably, efficient deployment due to its ability to overlay existing cellular networks without requiring considerable modifications to the mobile. This efficiency is contingent on lease agreements and zoning regulations [41]. Disadvantages include a low accuracy (150-200 meters on average) [19] and a considerable upfront investment in the network by carriers.

Handset-based solutions require the mobile to determine its position based on the signals it receives. Global Positioning System (GPS) is a popular solution in which a receiver in the mobile estimates its location by triangulating the measurements of the signals arriving from three or more satellites. GPS provides high accuracy in relatively open areas, yet low accuracy where urban canyons or in-building attenuation affects signals [40]. Another solution, Enhanced Observed Time Difference (E-OTD) uses the handset to calculate the mobile's position by comparing the difference in arrival times of signals from several base stations. This solution is less expensive than GPS [18]. The advantages of handset-based solutions include greater accuracy (5-50 meters on average) [19], smaller upfront investment by the carriers, and arguably, a more elegant solution [6]. Disadvantages include inefficient deployment due to the need to upgrade or replace handsets, current low handset availability, and a potential considerable upfront investment by consumers. Additionally, the success of GPS depends on reducing the cost of the receivers and their integration into standard small-size, low-power consumption mobiles [40].

More recently, vendors have developed hybrid technologies that combine network-based and GPS solutions to take advantage of the complementary coverage areas of the two technologies. In this solution, a location server collects the measurements from the GPS and the base station network, and combines them to determine the mobile's position [36].

In evaluating the technologies, it is clear the FCC faces a difficult task in determining what technological position they should take. This is especially true because the implementation of any of the geolocation solutions depends on the air interface employed by the carrier. For example, AMPS networks using network-based solutions comply with Phase II requirements. However, TDOA presents many challenges in CDMA networks because of the use of power control. In addition, E-OTD performs better in GSM networks [24]. Therefore, the FCC's neutral position reflected the idea that location technologies would continue to evolve and market forces would lead to an optimal solution.

4.2 History and Current Position

In the First Report and Order, the FCC initially laid out its technically neutral position stating that technology standards were better left to standards development bodies rather than to the government [11]. Yet, the FCC's Phase II timelines favored network-based solutions because the Commission felt there was not ample evidence to support the handset-based approach meeting

the timeline requirements. This is due to the fact that this solution involves a gradual replacement or upgrade of all current handsets.

However, as of September 15, 1999, the FCC fully supported the possibility of a handset solution in its Third Report and Order [15]. The Commission felt by this time there was substantial evidence to support an aggressive timeline for the deployment of such a handset-based solution. This timeline was, in fact, competitive with the deployment schedule for network-based solution: by March of 2001, carriers seeking to deploy a handset-based solution were to have the first handsets available on the market, and by October of 2001 fifty percent of all handsets activated were to be ALI capable [15].

The FCC's lofty goals were received by industry members with appreciation for the neutrality of the Commission, yet resistance to the timeline. As such, various companies with an economic interest submitted waivers to push back the timeline based on an array of defenses. Organizations such as the National Emergency Number Association (NENA) argued that these waivers were only serving to delay the deployment and diminish the ubiquity of wireless E911 [12]. Alternatively, vendors of handset solutions such as SnapTrack filed comments encouraging the Commission to accept such waivers for the benefit of the technology [13].

The FCC currently maintains its position of neutrality in defining which technology is appropriate for E911 implementation. To give equal precedence to the handset solution while recognizing the difficulties of deployment, the FCC is granting more flexibility in the scheduled implementation for those companies providing handset solutions.

4.3 Standardization Issues

Although the FCC did not mandate a particular technology, choosing a standard may have been a better option from the beginning. A characteristic that suggests government involvement may be beneficial is an "identifiable public policy externality that makes [a] unified standard desirable and makes timing urgent" [26]. In the case of E911, there is a public policy externality in that a social group will be served beyond those who own wireless phones. For instance, after a car accident, the benefits of E911 can extend beyond a wireless customer when that customer calls 9-1-1 for the victim. Additionally, the FCC's timeline inherently indicates there is a pressing need to expedite E911 deployment. Hence, standardization has justifiable merit in this case.

Some individuals in the E911 industry share the notion that a standard would have alleviated the problems plaguing E911 implementation. Interviews suggest that "public safety should not be left to the marketplace" [42], and therefore standards are beneficial where public safety is concerned. In addition, considering public safety is a non-lucrative market, companies are not motivated to participate in its development [8]. Therefore, if a technology had been mandated, participants may have developed and implemented a solution to the best of their abilities and for the lowest cost [38].

However, the FCC did not mandate a standard. Various carriers and industry consortia feel that any efforts to standardize would have stifled the development of a handset solution and interfered with the competitive forces that lead to innovation [14,41]. With the majority of carriers choosing the handset solution, there is evidence that had the FCC chosen to mandate a network solution early in

the process, a quality innovation that could ultimately become the *de facto* standard would have been abandoned. Therefore, the FCC's decision to stay technically neutral was perhaps the best decision for the development of a potentially superior technology.

Nevertheless, despite the FCC's goals, E911 has been delayed and the public is unlikely to see Phase II implementation on time [37]. Currently, only 16 of 129 carriers claim they will meet Phase II by the deadline [29]. Notably, major carriers such as AT&T, Nextel, Cingular, and Verizon are not part of the compliant group. Therefore, the question of what should now happen ensues.

4.4 Proposed Models

The FCC's neutral position is based on the hypothesis that promoting competition benefits the public by providing the best solution at the lowest price. The FCC could maintain this position and let standards evolve naturally. However, allowing industry committees to determine the standard can take a long time and might "produce an answer that will end up isolating vendors and fractionalizing the market rather than uniting them behind a standard" [26]. Therefore, other approaches the FCC could pursue may be more appropriate when the public interest is involved.

Following the approach taken in the case of Digital Television (DTV), the government could arrange a federal advisory committee, which would integrate all players, in order to study and make recommendations on the technical, economic, and public interest issues pertaining to the provision of E911 [39]. A critical issue for the advisory committee's success is to guarantee that all parties are equally represented so that results are not tailored by the interest of a particular group [27]. The Federal Advisory Committee Act outlines this methodology [1].

During the transition to DTV, the FCC was concerned that the adoption of the technology would be delayed and that multiple standards could have resulted in compatibility problems and consumer confusion [26]. These factors made the DTV case a good candidate for government participation. E911 presents a similar scenario. Phase I has been delayed and Phase II is expected to be delayed, in part due to hardware availability problems [41]. Manufacturers are not truly committed to developing products because of the variety of location technology options available, the uncertainty of which option is better, and the different air interfaces they can target [19]. An advisory committee could provide the necessary guidelines by bringing together all parties to develop a standard quickly.

Additionally, market-driven technologies could result in incompatible geolocation solutions that ultimately affect the public. In particular, roamers could be limited to Phase I accuracy because of these incompatibilities. Developing a unified standard, at least for some air interfaces, is critical. The advisory committee could aid this process by providing the structure required to join hundreds of technical experts to create an "ideal" solution, following the rules defined by the industry [27].

Alternatively, the FCC could adopt a more aggressive approach by selecting a solution. Choosing a standard is difficult because geolocation solutions present tradeoffs in accuracy, market availability, and operability with the different air interfaces. However, some solutions are gaining momentum: "terminal-centric solutions can be expected to achieve a greater market share" since many operators prefer the GPS solution due to its higher accuracy and potential for commercial services [18]. Indeed, as of November 2000 the majority of the 116 carriers are working with handset technologies [19].

Conversely, representatives from carriers and PSAPs consider that a hybrid solution will bring more benefits to consumers and providers. Field tests performed by Qualcomm with their gpsOneTM solution provided accuracy of 88 meters in 67% of the cases with two satellites and two base stations in sight [36]. Additionally, VoiceStream's hybrid solution initially permits a complete deployment of a network approach, which is then followed by full penetration of handset technology within two years – faster than the FCC's timetable [19]. The Commission could propose that all carriers deploy a hybrid solution in an appropriate time frame. However, carriers would not favor this decision because of their resistance to having regulators involved in their business decisions [26].

In the case of AM stereo, the FCC did not choose an air interface standard. In 1982, after five years of attempting to set a standard, the FCC left the market to select a technology. To this day, AM stereo has still not been widely deployed. Arguably, the lack of a standard prevented the widespread implementation by broadcasters and receiver manufacturers since no one wanted to invest in a technology that might end up second to a *de facto* standard, thus stranding an entire division of the market [28]. Considering the array of possible solutions for E911 and the uncertainties manufacturers are facing, mandating a hybrid solution could create the necessary stability for committed investment in geolocation technologies thereby avoiding the complications exhibited in the AM stereo case.

The lack of a technical standard has delayed E911 implementation and has had consequences contradicting public interest. However, the lack of guidelines in cost recovery mechanisms has arguable been a stronger factor in delaying the implementation of E911 [37].

5 The FCC's Position of Cost Recovery Neutrality

5.1 History and Current Position

In the First Report and Order, the FCC mandated that carriers provide E911 services only if “a mechanism for the recovery of costs relating to the provision of such services is in place” [11]. Wireless carriers argued that the FCC should provide guidance in addressing cost recovery mechanisms. However, the Commission did not find enough evidence for the need to prescribe a particular cost recovery methodology. Furthermore, it considered that “an inflexible Federal prescription would deny carriers and government officials the freedom to develop innovative cost recovery solutions” [11].

In December 1999, the Commission determined that its ambiguous mandate for cost recovery mechanisms was causing delays in Phase I and II deployment because implementing a methodology required a high level of coordination and cooperation between wireless carriers, PSAPs, LECs and the states. More than a year after the Phase I implementation deadline, less than 10 percent of the PSAPs around the country were compliant [7]. The main reasons were the lack of funds and the uncertainties surrounding implementation costs [5]. To address this problem, the FCC in its Second Memorandum and Order retained the requirement for PSAPs cost recovery to encourage local and state authorities in the funding of E911, yet removed the requirement for carriers since they are not subject to rate regulation [16]. According to the Commission, this position does not preclude states and localities from providing or adopting a cost recovery mechanism to support carriers and PSAPs [17].

Unfortunately, the revised rules motivated additional debates between carriers and PSAPs with regard to the network demarcation points separating the responsibilities for providing E911 components, referred to as the “King County Issue.” On August 16, 2000 the Commission issued a public notice seeking comments on whether clear demarcation points exist, whether they will vary according to the technology employed, and whether the wireline E911 implementation provides a rationale for a division of costs among carriers and PSAPs [46]. Implementation of Phase I in many counties is waiting for the resolution of this matter.

Although the FCC maintains that removing the cost recovery mechanisms for carriers will relieve the problems around delays, evidently there are still delays directly related to cost recovery issues. The FCC and many of the parties to this docket have declared their belief in the power of the competitive market to solve all of the issues. However, fundamentally the assumption that competitive forces can solve the problems around cost recovery is flawed because the E911 environment exhibits characteristics of market failure, in particular the existence of externalities.

5.2 Market Failure

The fact that there is intrinsic value of the E911 network to society confirms the existence of externalities. That is, the consumption of E911 services yields positive externalities because when a larger mass of the population connects to the E911 network, again, it is more likely that a third party will benefit in an emergency from assistance provided by a subscriber. Additionally, the FCC requires any non-service-initialized phones to have access to the E911 network [11].

An assumption that must hold true when evaluating a perfectly competitive market is that there is an absence of externalities and the only consideration for price setting involve private costs and private willingness to pay [23]. In the case of E911, this assumption does not hold.

Considering Figure 1, Demand₁ represents the private value of E911 to subscribers of wireless services, or the private willingness to pay (WTP). The supply curve represents the private cost of production of E911. Private welfare is maximized where Demand₁ crosses the supply curve at the point of market equilibrium (price = private marginal cost, or the price in which neither the seller or the consumer want to change his/her behavior). Q₁ represents the number of subscribers who have the capacity to call E911.

The existence of externalities in the E911 market pushes the demand curve up to reflect the value society as a whole places on the emergency service network. In this case, the social value of E911 is seen as Demand₂, the social WTP, or the externality. The point at which Demand₂ crosses the supply curve is the social market equilibrium given the E911 network and its externalities. P₂ is the price set by social demand and Q₂ is the number of people who benefit from E911 externalities. Yet, carriers cannot charge the price set by the externality (P₂) because the price cannot be estimated because Q₂ is non-quantifiable and private subscribers are not willing to pay the “social” price of demand. The gap between Q₁ and Q₂ demonstrates the effect of the externality. It is essentially a gap between the number of 911 calls that are placed with just private demand and the number of 911 calls that could be placed with social demand. Nevertheless, the FCC has required that carriers provide the social demand of E911. Therefore, carriers are forced to absorb the costs of the gap between P₁ and P₂.

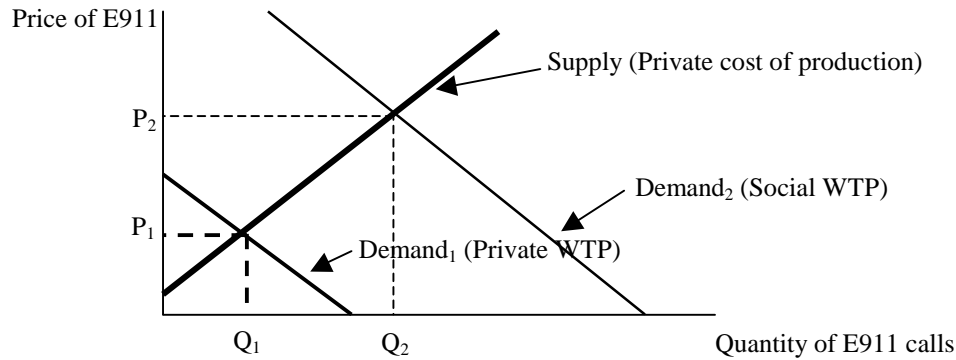


Figure 1

Under competitive forces, the market produces enough quantity to meet the private demand of the service. However, the market will not supply enough quantity to satisfy the demand of the social value, or the externality. As a result, there exists market failure:

Market failure...may occur when the production or consumption of an output exhibits significant externalities, that is, costs or benefits that consumers or producers are unable to fully incorporate into their decision-making processes [20].

The consequence of the market providing only at Q_1 , when society demands at Q_2 , is under-subscription to the network. The consequence of the FCC regulating with a reliance on market forces that fail, is under-funding of the network.

Given the value of human life, under-subscription to the E911 network resulting in death, can lead to enormous costs for society. In a life or death situation, the E911 externality could potentially save society massive amounts of money. For instance, Litigation Analytics Inc. estimates the economic value of life of a 30-year-old person is \$1,630,255 [21] based on estimated future earnings. Considering a conservative estimate, if E911 saves lives only 0.002% of the time (or 1000 times of 45 million calls annually), this is worth 1.6 billion dollars to society, not including pain and suffering costs. This example illustrates the immense benefits society could reap from E911 externalities.

Given that externalities lead to market failure and to high costs associated with under-subscription, there is justifiable need for government intervention if it is in the public interest to have a selected good ubiquitously distributed. In the E911 case, the fact that the FCC initiated Docket 94-102 indicates the government sees E911 as a benefit to the public and is willing to intervene. However, the FCC's neutral cost recovery position may not have been appropriate considering the cost burden of E911 ubiquity for both carriers and PSAPs, in a scenario of market failure.

5.3 Incentive Failure

As a result of the FCC's E911 rulings, location-based services (LBS) gained momentum and became a potential opportunity to recover the E911 implementation investment [6]. LBS will theoretically open the door to new commercial applications such as location-sensitive billing, concierge services, asset tracking, and traffic and weather information. This incentive approach has failed so far because,

within the regulatory environment, there is uncertainty about the technical solution that best satisfies the FCC requirements and that in turn supports these new services [6]. Additionally, privacy advocates are concerned about the implications of LBS intruding on the privacy rights of consumers. Therefore, a premature investment supporting these services would be expensive because LBS cannot achieve economies of scale at the volume of demand immediately expected [32]. According to Ovum projections, LBS will provide worldwide revenues up to \$20 billion by 2006, yet this amount will represent only 1% of the total revenue of the operators [33]. These services are not going to be the expected immediate “killer applications” [5,41].

Regarding emergency and concierge services as potential revenue opportunities for carriers, these market incentives fail as well. That is, due to the FCC mandate, emergency and concierge services such as OnStar provides at \$20 to \$30 a month [31] could become obsolete upon the advent of E911. This is because customers will not be willing to pay a high monthly fee when they can get E911 for close to free thereby crippling any type of business model that carriers could pursue with regard to charging money for emergency and concierge services [42].

5.4 Proposed Models

The FCC should retreat from its institutionalized faith in the market because an analysis of this industry reveals that sub-optimal conditions exist for carriers to recover their costs “naturally.” Funding for E911 service is necessary to ensure that carriers provide the service as soon as possible and that PSAPs have adequate systems to receive and process the information.

At the end of 2000, 15 states still did not have wireless funding [37]. Therefore, one regulatory model that the FCC could follow would be to encourage the States to continue implementing wireless E911 funds, such as the one outlined by XYPoint [43]. This model requires carriers to collect a statewide subscriber surcharge, implemented as a line item in the monthly bill and exempted from sales taxes, that could be used to achieve rapid, uniform, statewide deployment of E911. The state would be responsible for the enforcement and administration of the surcharge. The fund would reimburse carriers, PSAPs, and any other E911 equipment or service provider [43]. The main advantage of this method is that providers avoid pricing distortions caused by cross-subsidies.

Similar benefits could be gained if Congress created a national funding mechanism for E911. Such a fund could be beneficial since wireless carriers are essentially unable to receive Universal Service support at this time. The main advantages would include the aforementioned lack of price distortions, uniform nationwide contribution and distribution standards, and time savings gained by not having to negotiate the implementation of E911 funds in 50 different states. The potential disadvantages would be the inability to benefit from 50 different state experiments that might create a more efficient solution than one federal process might create, the forced application of federal rules onto states with varying E911 specifications, and the added difficulty of the FCC administering a new federal program. Although this is an economically elegant solution, it is not likely to be enacted by Congress since the general trend in U.S. government leans toward less involvement.

Another possible model would be for the FCC to leverage its influence through recommendations for carrier pricing. Although the FCC would be acting beyond its authority to regulate prices, a strong recommendation for E911 pricing would be within its authority. Most

carriers are unwilling to increase their rates or to introduce line items in bills to cover E911 costs because of customer backlash [41]. Therefore, if the FCC shouldered the responsibility of an added line item to a bill, carriers may feel more compelled to initiate the process of implementing this cost recovery mechanism and then move forward with the deployment process. This model would be relatively easy to implement and would provide a fast solution to expedite the process as compared to establishing a government-administered fund. A disadvantage to this mechanism would be the difficulty in determining the extent to which the FCC should be involved in the price-setting process.

6 Conclusion

A fundamental issue that affected how the FCC handled both the technical and cost recovery issues in the case of E911 is the underlying tension of whether the FCC has the ability to make the “right” decision, or whether the competitive market will arrive at the “right” solution. Further, the FCC appears especially concerned with choosing the “wrong” solution. Two observations are relevant: 1) the normative terms “right” and “wrong” imply that a binary choice between success and failure exists; and 2) the “right” choice is the most sound technological, economic, and political option, in perpetuity. In the E911 docket, the parties have sought a perfect solution to all of the difficult issues. However, the FCC should be expected to make technical, political and economic decisions to the best of its abilities and in conformance with existing law, even though modifications to that decision might be required in the future. In a case when public safety is at issue, the FCC should promote the rapid deployment of a “good” solution that can evolve into the “right” solution.

The FCC has stated a strong belief in the power of a competitive market to solve significant issues. However, in the case of E911, market externalities exist and therefore, there is market failure. Based on our analysis, the FCC’s neutral position has delayed the deployment of Phase II E911. Companies are still struggling to determine what the best solution is, and a standard has not yet evolved. Manufacturers still do not have a solid incentive to invest in producing technologies that have no clear potential as the market matures. Carriers have not found a clear economic incentive to invest in deploying a solution. There are continuing disputes between all parties due to a lack of clear cost recovery guidelines. Consequently, only 16 of the 129 carriers are going to comply with the Phase II deadlines. Therefore, the FCC’s choice to stay neutral was not necessarily appropriate considering the public safety and social interests involved, especially when there are justifiable reasons for standardization and government participation.

In 1934, an “expert agency” was created, in large part to handle issues related to spectrum management. Over time, that role has diminished as the belief in the marketplace has inserted itself in the place of standards setting of various types. However, the marketplace is not solving the E911 issues in a manner that comports with the FCC mandate to promote the safety of life and property through regulation of the airwaves. Thus, the Commission should retract from an unwavering commitment to the marketplace and take an active role in cases involving public safety.

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