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Public Interest Comment¹ on

The National Highway Traffic Safety Administration's Advance Notice of Proposed
Rulemaking:

Federal Motor Vehicle Safety Standards: Vehicle-to-Vehicle (V2V) Communications

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The George Washington University Regulatory Studies Center strives to improve regulatory policy through research, education, and outreach. As part of the Center's mission, Center scholars conduct careful and independent analyses to assess rulemaking proposals from the perspective of the public interest. This comment on the National Highway Traffic Safety Administration's preliminary proposal to create a new Federal Motor Vehicle Safety Standard (FMVSS No. 150) requiring vehicle-to-vehicle (V2V) communication capabilities does not represent the views of any particular affected party or special interest, but is designed to evaluate the effect of NHTSA's proposal on overall social welfare.

¹ This comment reflects the views of the authors, and does not represent an official position of the GW Regulatory Studies Center or the George Washington University. The Center's policy on research integrity is available at <http://regulatorystudies.columbian.gwu.edu/policy-research-integrity>.

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Introduction

In August 2014, the National Highway Traffic Safety Administration (NHTSA) issued an Advanced Notice of Proposed Rulemaking (ANPRM) and an accompanying technical report to initiate the rulemaking process to establish a new Federal Motor Vehicle Safety Standard (FMVSS No. 150) that would require vehicle-to-vehicle (V2V) communication capabilities in new passenger cars and light truck vehicles. NHTSA believes that requiring such capabilities will “facilitate the development and introduction of a number of advanced safety applications...[that would] warn drivers of possible safety risks in situations where other technologies have less capability.”³ NHTSA asserts that V2V technology has the potential to address some of “the most deadly crashes that U.S. drivers currently face,” but that manufacturers will not have the incentive to develop V2V capabilities absent regulation.⁴

We appreciate the opportunity to respond to some of the questions raised by NHTSA in its ANPRM, as well as comment on our concerns relating to the assertion of market failure and the ability to effectively create anticipatory technological standards. We also offer a number of suggestions for strengthening the cost-benefit analysis so that it more accurately captures the full costs and benefits of a potential V2V mandate. In this comment we make three arguments:

1. The market failure that requires regulation has not been clearly demonstrated.
2. It is impossible to predict the future course of technology with enough confidence to prescribe a specific detailed standard that will remain in effect for many years.
3. The cost-benefit analysis appears to underestimate some costs and overestimate some benefits.

I. Network effects do not necessarily constitute market failure.

President Clinton’s Executive Order 12866 established a federal regulatory philosophy and outlined several regulatory principles to which executive branch agencies are required to adhere when “deciding whether and how to regulate.”⁵ The first of the regulatory principles specified in E.O. 12866 directs agencies to identify the problem that justifies government action through regulation:

Each agency shall identify the problem that it intends to address (including, where applicable, the failures of private markets or public institutions that warrant new agency action) as well as assess the significance of that problem.⁶

³ 79 FR 49270.

⁴ 79 FR 49270.

⁵ Exec. Order No. 12866, *Regulatory Planning and Review*, 58 FR 51735 (1993).

⁶ Exec. Order No. 12866, *Regulatory Planning and Review*, 58 FR 51735 (1993).

This step is crucial to the formulation of any policy. Without knowledge of the problem that the agency is trying to address, the public cannot assess whether the policy or regulation at hand will have the intended effect, which is key in evaluating whether the regulation should be adopted.

In the context of NHTSA's proposal to establish a new Federal Motor Vehicle Safety Standard (FMVSS) requiring V2V communication capabilities in passenger cars and light truck vehicles, the agency identifies the "significant number of annual crashes... that could potentially be addressed through expanded use of more advanced crash avoidance technologies" as the key problem that justifies regulatory action.⁷ Specifically, NHTSA estimates that there are approximately 5,355,000 unimpaired light-vehicle crashes in the U.S. per year that result in injuries, fatalities, and attendant property damage.⁸ Of those crashes, the agency believes that 81 percent, representing 22 pre-crash scenarios, could potentially be addressed by a "fully mature" V2V system.⁹

Consistent with the first regulatory principle described above, NHTSA has identified market failure as the overarching problem it is seeking to address. More specifically, NHTSA believes:

No single manufacturer would have the incentive to build vehicles able to "talk" to other vehicles, if there are no other vehicles to talk to—leading to likely market failure without the creation of a mandate to induce collective action.¹⁰

NHTSA does not explain in detail why it believes that such a market failure would exist but notes that the proposed V2V technology is a network good and appears to assume that network goods should be expected to result in market failure. In the following paragraphs, we show why this is a problematic assumption. In addition to outlining key theoretical principles based on the network effects literature, we provide several technologically relevant examples to illustrate the range of potential outcomes that can occur depending on market factors and other mitigation strategies.

Network goods do require special attention during the start-up phase, but do not necessarily lead to market failure. In the early 1970's AT&T introduced Picturephone service based on an innovative technology for carrying video images over ordinary telephone wires. The service failed to attract many subscribers and was soon withdrawn. AT&T had given little attention to the problem of establishing the new service, which was substantially more expensive than regular telephone service and could only be used to communicate with other Picturephone subscribers.

⁷ National Highway Traffic Safety Administration, *Vehicle-to-Vehicle Communications: Readiness of V2V Technology for Application*, 2014, xiii, <http://www.nhtsa.gov/About+NHTSA/Press+Releases/NHTSA-issues-advanced-notice-of-proposed-rulemaking-on-V2V-communications>.

⁸ National Highway Traffic Safety Administration, *Vehicle-to-Vehicle Communications*, 19.

⁹ National Highway Traffic Safety Administration, *Vehicle-to-Vehicle Communications*, 18.

¹⁰ 79 FR 49270.

In order to clarify the economic issues that contributed to the Picturephone failure, then Bell Labs economist Jeffrey Rohlfs published the first of many articles on network effects in which an individual's valuation of a product depends on the number of other users.¹¹ A general finding of network effects models is that a critical mass of users is necessary to make the product viable; therefore, specific efforts (such as subsidizing early adopters) must be made in order to reach the critical mass. Although AT&T's failure to take sufficient account of network effects in its introduction of Picturephone service contributed to the fiasco, the high price of Picturephone compared to ordinary telephone service would have limited demand even in the absence of network effects. In a retrospective analysis, Rohlfs wrote:

A product such as Picturephone, which is not that good, may still succeed if the supplier successfully undertakes a campaign to solve the start-up problem. Such a campaign is, however, both costly and risky. The expected returns may not justify these costs and risks – in addition to all the other costs and risks associated with introducing a new product. In that case, the product should not be brought to market at all.¹²

Network effects such as those associated with the old Picturephone service or with the proposed V2V communication can generate market failure but do not necessarily do so. Stanley Liebowitz and Stephen Margolis have cautioned against interpreting network effects as market failure. They observe that network effects are widespread in the economy, but that many ordinary market processes exist to compensate for those effects and allow the markets to function adequately. They write:

The representative network externality problem is this: Some action would be socially wealth-increasing if enough people joined in, but each agent finds that independent action is unattractive.... A clear implication of the network externalities literature is that often we cannot move from one technology to a superior one, from one standard to a better one, from one kind of network to a better one.... A transition to a standard or technology that offers benefits greater than costs will constitute a profit opportunity for entrepreneurial activities that can arrange the transition and appropriate some of the benefits.... Given the march of technological progress, claims that wrong choices were made, or that superior options were not implemented in a timely fashion require a fairly high standard of countervailing evidence.¹³

¹¹ Jeffrey Rohlfs, "A Theory of Interdependent Demand for a Communications Service," *Bell Journal of Economics* 5.1 (1974): 16-37.

¹² Jeffrey Rohlfs, *Bandwagon Effects in High-Technology Industries* (Cambridge, Mass. The MIT Press, 2001).

¹³ Stanley Liebowitz and Stephen Margolis, "Network Externality: An Uncommon Tragedy," *Journal of Economic Perspectives* 8.2 (1994): 133-150 at 144-146.

Several factors allow markets to function adequately even with the presence of network effects. First, if a small number of users have substantial demand for communication among themselves, they may constitute a viable network that will then grow over time. For example, the telephone developed as a private enterprise to connect small groups of individuals or businesses, and government efforts to promote universal service only began much later after the telephone had become routine. Many other networks have developed in a similar way: groups of high value users constitute the initial subscribers to a network because it provides sufficient value to them to justify the cost. Eventually, potential subscribers with lower values find it worthwhile to join the network, causing it to grow. Nicholas Economides and Charles Himmelberg studied the growth of the market for facsimile machines between 1979 and 1992 with the aid of a theoretical model of network effects. They concluded that network effects were a significant factor that contributed to the rapid growth phase of that market in the late 1980's, in addition to the price declines that promoted growth.¹⁴ However, neither the rapid growth in the facsimile market, nor its later decline, were induced by government action. Rather, high value users created the initial small network even with high equipment prices and limited nodes, network effects contributed to later growth, and new technology in the form of document transmission over the Internet contributed to the decline. With high demand, a government mandate might accelerate the growth of the market but would not be necessary for the market to function.

Second, if the demand for the product is low, the market may fail even if the network effects are overcome. It seems likely that this was the case for Picturephone service. The cost of the product was high in relationship to the value it provided over substitute products. With low demand, a government mandate will create social losses because it requires people to purchase a product for which they would not voluntarily pay the full cost of production even when everyone else subscribes to the product. The demand for a particular product is dependent on the substitutes available and may change over time. For example, in the late 1980's the demand for facsimile services was high enough to generate rapid growth, but now the demand is much lower due to the ease of transmitting documents by email. A mandate to purchase facsimile machines would have accelerated the early growth by compensating for the network effects but would have created negative effects as demand declined.

Third, the actions of one or more large firms may overcome network effects. The negative predictions of network effects models assume that individuals are making independent decisions without coordination. However, there are many administrative forms of coordination. For example, employees of large corporations do not need to guess about the likely software choices of other employees in order to achieve compatibility because the software to be used is typically specified by the company. If there was adequate demand for mature Picturephone service, AT&T could have overcome the start-up problem by subsidizing early users and targeting sales to

¹⁴ Nicholas Economides and Charles Himmelberg, "Critical Mass and Network Evolution in Telecommunications" in Gerald Brock, ed. *Toward a Competitive Telecommunication Industry: Selected Papers from the 1994 Telecommunications Policy Research Conference* (Mahwah, New Jersey, Lawrence Erlbaum, 1995).

networks of people who communicated frequently.¹⁵ Large firms that are not monopolies may provide administrative coordination to overcome network effects through negotiation. The introduction of compact disc (CD) players provides an example. The purchase of a compact disc player was only desirable if there was sufficient music available in the proper format, but music companies did not want to invest in compact disc music unless there was adequate demand from owners of players. Philips and Sony were developing incompatible players but agreed to combine their technology into a single standard that was then made available to others. They then negotiated with CBS Records and other music producers to arrange a modest library of CD music that would be available at the same time as the initial players.¹⁶ The arrangements were successful in overcoming the start-up problem that could have led to market failure if all decisions were made independently.

In the context of the current V2V proposal, NHTSA appears to underestimate the ongoing industry-led effort to develop many of the vehicle safety technologies, including V2V communication capabilities, outlined in its technical report. For instance, General Motors recently announced that its 2017 Cadillac CTS Sedan will feature V2V technology, while a second unspecified Cadillac 2017 model will incorporate hands-off “Super Cruise” technology that will have the ability to “take control of steering, acceleration and braking at highway speeds of 70 miles per hour or in stop-and-go congested traffic.”¹⁷ BMW and Mercedes-Benz have also indicated that they are in the process of developing V2V technology for their vehicles, with BMW placing a special emphasis on left turn assist (LTA) capabilities—one of the key applications NHTSA discusses in its report.¹⁸ Meanwhile, Ford is developing state-of-the-art obstacle avoidance and lane-keeping systems, and already offers vehicles featuring its blind spot information system (with cross-traffic alert), adaptive cruise control, and collision warning with automated brake support.¹⁹

While these early stage efforts may not yet be equivalent to the comprehensive V2V system NHTSA envisions in its technical report, they are indicative of both auto manufacturers’

¹⁵ In the actual case of Picturephone of the 1970’s, rate-of-return regulation limited AT&T’s ability to subsidize early users and recoup the losses from later users but in general a company can use promotional pricing to initiate a new product subject to network effects.

¹⁶ Rohlfs, *Bandwagon Effects*, chapter 9.

¹⁷ Keith Naughton, “2017 Cadillac CTS to be first with talking car capability,” *Chicago Tribune*, September 8, 2014, <http://www.chicagotribune.com/classified/automotive/sns-wp-blm-news-bc-gm-cadillac07-20140907-story.html>.

¹⁸ Chris Weiss, “BMW Making Roads Safer with Left Turn Assist,” *Motor Authority*, May 18, 2011, http://www.motorauthority.com/news/1060086_bmw-making-roads-safer-with-left-turn-assist. Viknesh Vijayenthiran, “2011 Geneva Motor Show Preview: BMW Vision Connected Drive Concept,” *Motor Authority*, February 10, 2011, http://www.motorauthority.com/news/1055163_2011-geneva-motor-show-preview-bmw-vision-connecteddrive-concept. Mercedes-Benz, “Car-To-X Communication,” <http://www5.mercedes-benz.com/en/innovation/car-to-x-communication-dialogue-on-the-road-increases-safety-comfort-efficiency/>.

¹⁹ Jamie Lendino, “Testing Ford’s New Driver Assist Technologies,” *PC Mag*, December 13, 2013, <http://www.pcmag.com/article2/0%2c2817%2c2428336%2c00.asp>.

awareness of the safety need and their desire to develop and integrate advanced safety technologies into their vehicles with or without a government mandate. Their efforts also reflect consumer demand for more advanced safety features, at least within the context of the luxury vehicle market. Moreover, given the rapid rate at which the private sector is developing intelligent and driverless vehicle technologies, it seems possible, as transportation economists Clifford Winston and Fred Mannering have suggested, that these innovations will “effectively leapfrog most of the existing technologies that the public sector could but has [thus far] failed to implement.”²⁰

If either the voluntary V2V technology currently planned for luxury models diffuses throughout the fleet or if substantial deployment of intelligent vehicles provides an alternative route to the benefits expected from V2V technology, then there will not be a market failure requiring a government mandate. We cannot predict the future course of technological developments, but the rapid advancement in technologies currently being tested suggests that NHTSA should tread cautiously as it considers whether to mandate a specific technology whose large-scale benefits would not be realized until 2036, if at all.

II. It is impossible to predict the future course of technology with enough confidence to prescribe a specific detailed standard that will remain in effect for many years.

Question 6 of the ANPRM asks: “How can NHTSA be sure that V2V is the most cost effective technology available?” Our answer is that NHTSA cannot be sure that V2V is the most cost effective technology available. It is impossible to forecast the future course of technological development with enough accuracy to ensure that any particular technology will be the winner of later competitive battles.

There are multiple possible technologies for increasing safety in addition to the V2V structure described in the ANPRM and the associated technical report. Currently known alternatives include technologies for automating the awareness of vehicles to their surroundings (smart cars and driverless cars) and vehicle-to-vehicle communication using existing platforms such as smartphones. It is impossible to predict the future developments of these or other competitive technologies that may be developed in the future. This is not a problem that can be solved with more analysis or consultation with a wider range of experts. Thus, the appropriate course is not to attempt to refine predictions of the technology, but to recognize that any technological prediction is subject to a wide range of error and to construct a policy that can be easily adapted to future technological developments. Economic historian Douglass North concluded that

²⁰ Clifford Winston and Fred Mannering, “Implementing Technology to Improve Public Highway Performance: A Leapfrog Technology from the Private Sector is Going to be Necessary,” *Economics of Transportation* (2014): 7, <http://www.brookings.edu/~media/research/files/papers/2014/02/improving%20highway%20performance%20winston/improving%20highway%20performance%20winston>.

adaptive efficiency is more significant for economic success than allocative efficiency.²¹ That is, the ability to adapt to new circumstances and new technology is more important than the standard kind of economic efficiency generated by a competitive market system. It is important that any new technological requirements be structured with enough flexibility that they can be modified in light of future events.

While some long run trends are clear, such as the continually declining price of semiconductor components for electronic products, the technological implications of those trends are not clear because they depend on innovations in design and marketing. We do not simply see lower costs for long established products but see new classes of products. Twenty years ago, it would have been safe to forecast improved price-performance characteristics for desktop and laptop computers but difficult to predict the extensive development of smart phones and tablet computers that has occurred in recent years. The two examples below—data communications and television—illustrate the difficulty of choosing the best technology in a rapidly changing market. In both cases, the government selected and at one point mandated a particular technology, only to reverse the mandate after observing later developments.

Data Communications²²

By the mid-1970's, a number of data communications networks were planned, under construction, or in operation. Data communications networks were recognized as an important future technology that straddled previous boundaries between regulated communication services and unregulated data processing services, and a number of different standards were proposed for the new services. IBM (the then dominant computer company) introduced its proprietary standard Systems Network Architecture (SNA) in 1974 to provide data communications among IBM computers. Soon after, other computer companies released their own proprietary protocols. The telephone companies in several countries were concerned that IBM's dominance of the computer industry could cause SNA to become the defacto data communications standard and sought a formal public standard for data communications. Representatives of the telephone companies in Canada, France, and Great Britain took the lead in developing a standard protocol for data communications networks and their work resulted in the X.25 standard that was formally adopted as a CCITT standard in late 1976.²³

Several countries adopted the X.25 protocol as the basis for their domestic data communications networks provided by the monopoly telephone carrier. IBM and other computer manufacturers

²¹ Douglass North, "Economic Performance through Time," *American Economic Review* 84.3 (1994): 359-368.

²² See Andrew Russell, *Open Standards and the Digital Age: History, Ideology, and Networks* (New York: Cambridge University Press, 2014). Janet Abbate, *Inventing the Internet* (Cambridge, Mass. The MIT Press, 1999).

²³ The CCITT (now known as ITU-T) is a part of the International Telecommunications Union (ITU), an agency of the United Nations. It issues technical standards to harmonize the operation of international telecommunications systems.

began offering software to allow their computers to be used in X.25 networks. However, neither the U.S. nor many other countries required compliance with X.25, allowing the opportunity for network providers to experiment with other protocols.

Two separate efforts sought to develop data communications in a more “open” manner by providing ways to interconnect disparate networks without using the proprietary IBM SNA or the telecommunication companies’ X.25 protocols. One of those efforts was developed under the auspices of the International Organization for Standardization (ISO) and its various national committees (ANSI in the U.S.). In 1977, ISO created a new subcommittee on Open Systems Interconnection (OSI) and assigned the lead role (the “secretariat”) to the U.S. The U.S. group designed a system that was conceptually similar to IBM’s SNA but incompatible with it and non-proprietary. After extensive meetings and negotiations, the ISO approved the work as a formal standard in 1983 as “ISO 7498: The Basic Reference Model for Open System Interconnection.” ISO 7498 did not provide full implementation details but left some of those to the implementing group. In the U.S., the National Bureau of Standards created the Government Open Systems Interconnection Profile (GOSIP) and made GOSIP a Federal Information Processing Standard in 1988, with a requirement that all federal agencies procure GOSIP-compliant products after August 1990.

The alternative open effort was developed informally outside of the formal standards process. The TCP/IP protocol was developed by academic computer scientists with U.S. military support and a goal of interconnecting disparate networks with differing levels of reliability. It was particularly influenced by the early experience with the U.S. Arpanet and the French Cyclades network. The main ideas for the protocol were developed at a Stanford conference in 1973, published in 1974, and after revisions based on early efforts to implement, it was successfully used to connect different types of networks in 1977. ARPA supported efforts to implement TCP/IP in Unix and other operating systems, and at the beginning of 1983, the Arpanet was converted from its original protocol to TCP/IP (an event that is generally considered the beginning of the Internet). The Internet expanded rapidly during the 1980’s with the addition of the NSFNET connecting many universities, the development of applications for mail and file transfer, and the support of companies supplying relevant equipment. Detailed standards and their implementation were developed through an informal process of the Internet Engineering Task Force (IETF) without the formal committees and votes of the established standards bodies. “Internet Architect” David Clark summarized the Internet approach, stating, “We believe in rough consensus and running code.” The emphasis on “running code” was meant to separate the Internet emphasis on considering proposals for standards only after they had been implemented from the OSI process of specifying a framework for protocols that had not yet been implemented.

Despite the federal procurement requirement, GOSIP compliant products developed slowly while Internet protocol products proliferated. Federal agencies found it difficult to comply with

the GOSIP mandate and the mandate was rescinded in 1995. Agencies were then given a choice of data communication standards and Internet protocols were most commonly chosen. Two decades passed between the early development of data communication protocols in the mid-1970's until the Internet became dominant in the mid-1990's. No one could have reasonably predicted that outcome in the 1970's. As late as 1991, data communications pioneer Louis Pouzin observed that TCP/IP networks were growing rapidly despite the protocol having never been formally adopted as an international standard but predicted that OSI would displace it within a few years. Yet the OSI model was never widely implemented even though it remained an important conceptual model for data communications. According to Andrew Russell, "Rather than becoming a model of international cooperation, contemporaries believed that OSI demonstrated the pitfalls of 'anticipatory standardization,' a term they coined to describe projects that try to shape new technologies instead of codifying existing practice."²⁴

Television²⁵

U.S. black and white television broadcasting began in 1941 and attention soon turned to the introduction of color television. RCA (the then leading manufacturer of television sets and the owner of the NBC network) was developing an electronic color system while CBS (the top network) was developing a mechanical color system. When the FCC held a test of the two systems, the CBS system performed better and the FCC adopted the CBS system as the official color standard in 1950. Despite government support, however, the CBS color system failed. Color broadcasts could not be received on black and white television sets, forcing CBS to choose between broadcasting in color to a very small set of customers who owned color sets and broadcasting in black and white to most television customers. Meanwhile, RCA continued to develop its alternative unapproved electronic color system which was backward compatible. That is, the RCA color broadcast could be received in color by those who had color sets and in black and white by those who did not, while the CBS color broadcast simply left black and white sets blank. In late 1953, the FCC reversed its earlier decision and adopted the RCA system as the color television standard.

Japan led in the development of high definition television to provide substantially higher quality picture and sound compared to the early television standards. In a coordinated government and industry effort, Japan developed the analog "Muse" high definition system and began broadcasting on it during the 1980's. However, the early Japanese high definition television sets were extremely expensive and the system developed slowly while leading technology changed from analog to digital, eventually leading to the abandonment of the Muse system. Similarly, Europe developed the analog high definition "HD-MAC" system with a combination of European Commission funding and the efforts of the major European electronics companies and

²⁴ Russell, *Open Standards and the Digital Age*, 226.

²⁵ See Carl Shapiro and Hal Varian, *Information Rules: A Strategic Guide to the Network Economy* (Boston: Harvard Business School Press, 1999), chapter 7.

that was also abandoned. The U.S. effort to develop high definition television was inspired by the fear that Japan's early lead in high definition television would allow it to dominate the U.S. market in the absence of a vigorous U.S. response, but the U.S. moved more slowly than either Japan or Europe toward high definition television. When the U.S. sought high definition standards proposals for testing in 1991, technology had advanced to the point that it was feasible to consider digital broadcasting instead of analog. The possibility of digital television sets reduced the distinction between television sets and computer monitors and brought the computer companies into the conversation. Eventually in 1996, the FCC adopted a flexible set of standards that gave enough guidance to ensure compatibility between broadcast signals and television sets²⁶ but left considerable room for choices to accommodate changing technology and multiple kinds of users. The U.S. process was messy and slow compared to the more tightly integrated Japanese and European processes, but the flexible standard designed to satisfy many interests and changing technology has been more durable than the earlier Japanese and European efforts. It has also been more successful than the early U.S. establishment of a color television standard that was not feasible to implement and had to be reversed.

As the data communications and television examples discussed above demonstrate, no matter how well intentioned a government mandate may be, it is impossible to predict the future course of technology with enough confidence to prescribe a specific detailed standard that will remain in effect for many years. Thus, we recommend that NHTSA avoid anticipatory standardization and exercise restraint as it seeks to identify the "best" technological solution for improving vehicle safety and reducing crashes.

III. The cost-benefit analysis appears to underestimate some costs and overestimate some benefits.

Once an agency has determined that regulation is indeed necessary to address the identified problem, the agency must then consider a variety of factors, including incentives for innovation, distributive impacts, and equity. It must also assess the costs and benefits of the regulation, consistent with the E.O. 12866 regulatory principles below:

- a. When an agency determines that a regulation is the best available method of achieving the regulatory objective, it shall design its regulations in the most cost-effective manner to achieve the regulatory objective. In doing so, each agency shall consider incentives for innovation, consistency, predictability, the costs of enforcement and compliance (to the government, regulated entities, and the public), flexibility, distributive impacts, and equity.

²⁶ The standard contained multiple options and the manufacturers agreed to build sets that could operate under any of the approved options. That approach would have been unreasonably expensive in an earlier era when electronic components were expensive but the reduced cost of electronic components made it feasible to use a more flexible standard.

- b. Each agency shall assess both the costs and the benefits of the intended regulation and, recognizing that some costs and benefits are difficult to quantify, propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs.²⁷

Many of the costs and benefits described in the ANPRM are necessarily uncertain at this point because the system does not yet exist and the computations are based on very limited data from experiments, simulations, and manufacturer data submissions. In this section we suggest some additional issues that should be considered as NHTSA refines its cost-benefit analysis.

Costs

According to NHTSA, implementing the proposed V2V system would cost an estimated \$300 million to \$2.1 billion per year in 2020, the first year of implementation. Total annual costs are then predicted to peak as high as \$6.4 billion between 2022 and 2024 before decreasing to an annual cost ranging from \$1.1 to \$4.6 billion. These costs fall into four categories: vehicle equipment, fuel economy impact, communications costs, and the security credentials management system (SCMS). Taken together, these costs would translate to a per vehicle cost to consumers of approximately \$341 to \$350 in 2020. According to NHTSA's predictions, manufacturer learning would likely cause costs to decrease to between \$209 and \$227 by 2058.²⁸

While NHTSA notes that the estimated costs of V2V equipment “are less than some of the more notable safety equipment” (such as airbags and antilock brakes which cost \$496 and \$424, respectively),²⁹ this comparison is over-simplistic for two reasons. First and most importantly, unlike airbags and antilock brakes, which produce measurable safety benefits for those who purchase the equipment regardless of other vehicles' equipment status, V2V technology will not provide significant benefits to individual consumers until a large proportion of the fleet is equipped with the technology. Based on NHTSA's estimates, early adopters could be waiting longer than many buyers will own their car before even minimal safety benefits are realized. Second, while airbags automatically produce benefits to those involved in a vehicle crash regardless of a passenger's ability to respond, the effectiveness of V2V technology is wholly dependent on the extent to which a driver can quickly respond to and act on the system's commands. This suggests that the benefits of V2V technology will be dramatically diminished if drivers fail to respond due to distraction, or otherwise choose to ignore or disable the warnings.

The issues described above raise important questions about the distribution of benefits among early and late adopters of V2V technology. While the additional per vehicle cost of V2V technology is significant regardless of when consumers purchase a new V2V-equipped vehicle,

²⁷ Exec. Order No. 12866, *Regulatory Planning and Review*, 58 FR 51735 (1993).

²⁸ National Highway Traffic Safety Administration, *Vehicle-to-Vehicle Communications*, 216.

²⁹ National Highway Traffic Safety Administration, *Vehicle-to-Vehicle Communications*, 135.

early adopters will be at a clear disadvantage both in terms of what they will spend and the benefits they will receive. Consider, for example, a consumer who purchases a new V2V-equipped vehicle in 2020, the year in which the mandate is proposed to take effect. If it takes “up to 20 years for the entire U.S. vehicle fleet to turn over,” as one automobile manufacturer suggested in an interview with the GAO,³⁰ early adopters may well replace their first V2V-equipped vehicle long before the technology penetrates a sufficient proportion of the fleet to realize benefits. Therefore, unless retrofit devices or some other incentive hastens the deployment of V2V technology, early adopters could likely view V2V equipment as an additional cost without a perceivable benefit.

In addition to carefully considering the distributive impacts of a V2V mandate as it will affect early versus late adopters, we hope NHTSA will closely evaluate the ways in which a vehicle cost increase of this magnitude will disproportionately impact low-income individuals and households. The fixed cost per vehicle will be a greater proportion of the vehicle cost for low-end vehicles than for high-end vehicles. If low-income price sensitive consumers who are planning to purchase an inexpensive automobile in the early 2020’s are required to pay an additional several hundred dollars for a V2V system that is unlikely to provide any personal benefit to them, the fairness and political sustainability of the program may be questioned. We urge NHTSA to consider ways to lessen the adverse distributive impact of the cost burden on early adopters and low-income individuals.

We believe that real or perceived risks relating to privacy and cybersecurity could also pose major challenges to consumer acceptance, and thus, should be taken very seriously. With regards to data privacy, it seems unlikely that, in light of recent revelations about the scope of U.S. government surveillance activities, consumers will view the public transmittal of their vehicle’s location, speed, and other driving data as inconsequential. Senator John Hoeven of North Dakota, a co-sponsor of the Drivers Privacy Act, emphasized this point in a January 2014 interview with the *New York Times*, stating, “we’ve got real privacy concerns on the part of the public... People are very concerned about their personal privacy, especially as technology continues to advance.”³¹ Expressing similar concern, Senator Al Franken requested a GAO study to assess the privacy implications of in-car location based services. As summarized by the same *New York Times* article, the GAO report found that:

The 10 automakers, navigation device manufacturers and application developers surveyed did not make owners aware of all the risks of the data collection, like

³⁰ United States Government Accountability Office, *Intelligent Transportation Systems: Vehicle-to-Vehicle Technologies Expected to Offer Safety Benefits, but a Variety of Deployment Challenges Exist*, GAO 14-13, (Washington, DC, 2013), <http://www.gao.gov/assets/660/658709.pdf>.

³¹ Jaclyn Trop, “The Next Data Privacy Battle May Be Waged Inside Your Car,” *New York Times*, January 10, 2014, http://www.nytimes.com/2014/01/11/business/the-next-privacy-battle-may-be-waged-inside-your-car.html?_r=0.

allowing third parties to track their location or gather sensitive information such as their religious and political activities and preferences.³²

While we recognize that the privacy analysis in the ANPRM and associated technical report is preliminary and will be supplemented by a later report, we think it is unlikely that anything NHTSA says will convince consumers that a government requirement to broadcast their speed and location at all times will not lead to monitoring of those broadcasts by police and other parties. Thus, privacy concerns should be considered a cost of the proposed system and could seriously undermine consumer acceptance. Likewise, while NHTSA concedes in its technical report that “cyber-attacks across the entire vehicle fleet have been considered but not yet addressed,”³³ given the multitude of cyber security risks associated with greater connectivity—and consumers’ increased awareness of such risks—we urge NHTSA also to address this issue.

The costs presented in the ANPRM are dominated by the expected costs of the initial equipment planned for installation in new automobiles with minimal costs projected for managing the complex security certificate program, distributing frequent updates from the central authority to large numbers of moving vehicles, creating and updating the application software, or maintenance of the original in-vehicle equipment. It seems likely that NHTSA has underestimated the costs of transforming radio equipment installed in vehicles into a secure functioning distributed communications system. NHTSA estimates the total cost of the Security Credential Management System (SCMS) at an average of \$60 million per year. For comparison, Neustar is the current FCC-approved contractor to manage the North American Numbering Plan and the number portability databases that allow consumers to keep the same telephone number when they switch carriers. Neustar was paid approximately \$435 million for those services in 2013³⁴ and it seems likely that the proposed SCMS will be more complex and difficult to manage effectively than the telephone number portability system.

Similarly, NHTSA proposes that the security updates should be distributed through a new system of vehicle radios and road-side equipment based on an assumption that it would be both cheaper and more secure than using the established cellular communications network at current commercial prices. It seems unlikely that a new nationwide mobile infrastructure can be created more cheaply than using the existing infrastructure, and we question whether the full costs of the proposed roadside equipment (including obtaining site permission, installation, and maintenance) have been taken into account. We urge NHTSA to recognize that the full costs of existing communications systems are far higher than the costs of the original equipment and that is likely to be true for the proposed V2V system as well.

³² Ibid. See also United States Government Accountability Office, *In-Car Location-Based Services: Companies Are Taking Steps to Protect Privacy, but Some Risks May Not Be Clear to Consumers*, GAO-14-81 (Washington, DC, 2013), <http://www.gao.gov/products/GAO-14-81>.

³³ National Highway Traffic Safety Administration, *Vehicle-to-Vehicle Communications*, 240.

³⁴ Neustar, *2013 Annual Report*, <http://www.neustar.biz/about-us/investor-relations/financials>.

Finally, an additional potential cost of the proposed system is a reduction in adaptive efficiency. As noted above, the ability to adapt to changing circumstances is a critical component of an efficient economy. In this case, a mandated implementation of a specific safety technology may limit the freedom to adopt new technologies that become available. The innovative Japanese HDTV technology of the 1980's that generated predictions of long-term Japanese dominance of consumer electronics soon became obsolescent when new possibilities for digital television became available. Similarly, the innovative V2V design of today is unlikely to appear innovative after a long lag while the technology is gradually installed on new vehicles, but specific standards embedded in rules may be difficult to adapt to the new circumstances of that time.

Benefits

As noted by the Government Accountability Office (GAO) in its November 2013 report on V2V technologies, “the potential benefits of V2V technologies are dependent upon a number of factors including their deployment levels, how drivers respond to warning messages, and the deployment of other safety technologies that can provide similar benefits.”³⁵ We agree with the GAO's assessment and, as outlined below, encourage NHTSA to give each of these issues specific consideration when calculating final benefit estimates.

(a.) Deployment levels

NHTSA should carefully consider whether consumer acceptance issues, such as privacy concerns, will undermine consumer demand by causing consumers to disable the V2V device that comes with their new vehicle, which would further slow implementation even beyond the rate at which vehicles are replaced. Significant benefits in the medium term are dependent upon voluntary retrofitting of V2V devices in cars purchased before the proposed 2020 mandatory installation. NHTSA should assess whether there is any realistic scenario in which a substantial number of consumers will purchase aftermarket V2V devices in the absence of an aftermarket mandate. While this demand is difficult to gauge with certainty, results from a 2014 Accenture survey on connected vehicle services found that while 50 percent of U.S. survey participants “would like to use” vehicle-to-vehicle communication technology, 43 percent are “not interested in it.” Moreover, of the eleven driver support technologies included in the interest assessment portion of the survey, respondents expressed the lowest interest in V2V communication.³⁶

³⁵ United States Government Accountability Office, *Intelligent Transportation Systems: Vehicle-to-Vehicle Technologies Expected to Offer Safety Benefits, but a Variety of Deployment Challenges Exist*, GAO 14-13, (Washington, DC, 2013): 10, <http://www.gao.gov/assets/660/658709.pdf>.

³⁶ Accenture, *Reach Out and Touch the Future: Accenture Connected Vehicle Services*, 2014, http://www.accenture.com/us-en/landing-pages/products/Documents/ivi/pdfs/ACC_CV_US.pdf#zoom=50.

(b.) Driver response to warning messages

The second issue that could impact the effectiveness of V2V technology is driver response to warning messages. Even if the technology were to be widely deployed, the effectiveness of a V2V communications system would still depend on whether drivers respond to warning messages appropriately. In this context, responding *appropriately* would mean that a driver would both internalize and respond to the message in a timely fashion *and* do so in a way that is consistent with the warning message. If drivers find the warnings to be annoying, too frequent, or inaccurate due to a high number of error messages or false positives, they may consciously or subconsciously tune them out, or even decide to disable the system.

Considerable attention will need to be given to developing a warning system that attracts attention and causes drivers to respond appropriately in an emergency situation. The cost estimates assume a simple five-light display with a light for each type of warning, and an associated cost of \$7.24 per vehicle.³⁷ Such a display, however, would be easy to ignore or to confuse one type of warning with another by not correctly perceiving which warning light is flashing. Thus, there is a danger that drivers could miss the warning and fail to take appropriate action or even misunderstand the warning and take inappropriate action that increases the probability of an accident. More sophisticated warning systems are possible and presumably will be developed and deployed over time, but they are likely to also increase the cost. If outdated software causes message inaccuracies, but updating it is either too time-consuming or expensive, a consumer may decide to disable or ignore the warnings. We hope the agency will more thoroughly evaluate potential driver responses to V2V warnings as it continues to assess the potential benefits of a V2V mandate.

(c.) Other safety technologies that provide the same benefits

NHTSA's benefit estimates start with recent data on the number of crashes and proceed to estimate the fraction of those crashes that could be prevented with V2V technology under various scenarios. Thus the benefit estimates implicitly assume that the number of crashes would remain constant in the absence of V2V technology. Yet NHTSA observes that the number of crashes has been declining as cars have become safer. In the absence of a V2V mandate, the number of crashes should continue to decline as new technologies are developed and installed in the ongoing efforts to develop safer and more automated vehicles. Thus, the appropriate comparison is not what fraction of current crashes might be prevented by V2V technology twenty-five years from now as is done in the ANPRM. Instead, NHTSA should be evaluating what fraction of the crashes that would occur in the automotive fleet of twenty-five years from now could be prevented by the proposed V2V technology. That is more difficult because it requires projecting the likely number of crashes in future years as new technology is installed in

³⁷ National Highway Traffic Safety Administration, *Vehicle-to-Vehicle Communications*, 222.

cars in the absence of a V2V mandate, but it is more accurate than simply assuming that the number of crashes would remain constant in the absence of V2V technology.

Assuming that non-V2V technological advances will lead to greater safety, the ANPRM overestimates the benefits of V2V technology by not considering other methods of reducing crashes. To use a well-known historical example, the C&O canal was originally conceived as a critical link in the transportation network and would have been far more valuable if the B&O railroad had not begun construction of an alternative transportation technology over essentially the same route at the same time as the canal was being built. Both the canal and the railroad remained viable for many years but the value of the canal in later years was measured in relationship to the railroad that existed at that time, not in relationship to the transportation available in 1825 when the federal government granted the canal company a charter. Similarly, the value of V2V technology twenty-five years from now will be the incremental safety it can add to the cars of that time with all of their reasonably expected technological improvements.

Conclusion

As we have emphasized throughout this comment, we believe NHTSA should proceed with extreme caution as it decides whether to move forward with a costly, highly prescriptive V2V communication mandate for which benefits are far too dependent on unpredictable variables. In assessing NHTSA's ANPRM and associated technical report, we identified several areas that require further analysis and possible reevaluation. Specifically, we argued:

1. The market failure that requires regulation has not been clearly demonstrated.

While NHTSA implies that network goods, such as V2V communication, require government intervention to induce collective action and avoid market failure, we provided examples such as the Picturephone, facsimile, and compact disc player, to demonstrate that several factors allow markets to function adequately despite the presence of network effects. First, if a small number of users have substantial demand for communication among themselves, they may constitute a viable network that will grow over time. Second, if demand for the product is low, the market may fail even if network effects are overcome. Finally, one or more large firms may overcome network effects through administrative forms of coordination. We hope NHTSA will take these principles into account as it continues to evaluate whether a market failure is indeed present.

2. It is impossible to predict the future course of technology with enough confidence to prescribe a specific detailed standard that will remain in effect for many years.

To illustrate this concern, we described the U.S. government's previous experience attempting to predict and standardize what it perceived as the "best" technology in the realms of data

communications and television. As we demonstrated, despite expertise and significant research, it is far too difficult to accurately forecast the ways in which technology and markets will develop long-term. Thus, anticipatory standardization should be avoided whenever possible. When new technological requirements are necessary, however, they should be developed with sufficient flexibility to allow modification in light of future innovation and events.

3. The cost-benefit analysis appears to underestimate some costs and overestimate some benefits.

Specifically, after evaluating NHTSA's cost and benefit estimates against the regulatory principles set forth in Executive Order 12866, we believe that the agency failed to take sufficient account of the adverse distributive impact a mandate would have on early adopters and low income individuals. We also believe that the agency should place greater weight on consumer acceptance costs, such as privacy and cyber security risks. Finally, we hope the agency will reassess the accuracy of its estimates relating to the development and maintenance of the proposed security and communications systems, specific safety applications, and roadside equipment. With respect to benefits, we urge the agency to more thoroughly evaluate the extent to which after-market deployment levels, driver response to warning messages, and the future availability of substitute technologies will impact the realization of V2V's potential benefits.