Deploying Safety Technologies in Commercial Vehicles

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Table of Contents

Executive Summary.................................................................1
Introduction.................................................................................3
Methodology..............................................................................6
Major Findings.........................................................................9
Conclusion..............................................................................32
Deploying Safety Technologies in Comercial Vehicles

Executive Summary

This study by the University of Michigan Transportation Research Institute with funding from the Intelligent Transportation Systems of America (ITS America) measures the penetration of advanced safety technologies throughout the larger truck fleet as well as trying to understand the opportunities and challenges managers face as they decide whether to introduce the technologies.

A previous attempt to measure these technologies was funded by the Federal Highway Administration and performed by the University of Michigan Transportation Research Institute\(^1\). This study differs from the previous study because it focuses only on the larger carriers to find out what technologies they currently use and which they plan to use in the near future. The five main technologies include: lane departure warning or mitigation systems (LDWS), electronic stability control systems (ESC), forward collision warning or mitigation systems (FCWS), blind spot detection systems (BSDS), and vehicle communication systems (VCS). Using a census of carriers with at least 300 vehicles, with at least 50 percent tractors, the study provides estimates of current and future usage of each technology.

The analysis of the survey produced the following key findings:

1. These larger carriers are familiar with these advanced safety technologies.

The results of the survey indicate that carriers have high levels of familiarity with all of the technologies examined in this study. This contrasted with the 2009 study that showed much less familiarity with the technologies.

2. Penetration of onboard safety technologies, except for Vehicle Tracking Systems, is low compared to the number of companies that could be using them, but carriers expect significant increases over the next five years.

Current penetration for new trucks for LDWS is approximately 11 percent, 31 percent for ESC, 14 percent for FCWS, 4 percent for BSDS, and 67 percent for Tracking Systems. When looking at the technology five year forecast of penetration rates for the larger carriers, it is anticipated that there will be significant increases in penetration rates. LDWS are expected to increase to 36 percent penetration, ESC to 49 percent, FCWS to 41 percent, and BSDS to 24 percent. Vehicle communications systems are expected to have an overall penetration of about 72 percent in 5

\(^1\) Belzowski, B.M., Blower, D., Woodroffe, J., & Green, P.E. (2009). Tracking the Use of Onboard Safety Technologies Across the Truck Fleet. *Prepared for the Motor Carrier Safety Administration*
years. These systems differ from the others in that they can be deployed through the aftermarket as well as through the manufacturer.

3. Companies committed to LDWS, ESC/RSC, FCWS, or SCWS report significant safety improvements.

Reduced cost of accidents, an improved safety culture, proven safety benefits, and to a lesser extent reduced insurance premiums are considered the most important reasons for deploying these safety technologies. Carriers agree that these same reasons are also considered the main benefits of deploying these technologies. In terms of crash reductions and crash cost reductions, carriers report that all of the technologies helped reduce crashes and their costs. Carriers estimated that LDWS reduced crashes by 14 percent, ESC by 19 percent, FCWS by 14 percent, BSDS by 5 percent, and Vehicle Communications Systems by 9 percent.


Vehicle communication systems, the most prevalent system in the U.S. fleet, offer carriers both safety and business value. Carriers report that almost all the reasons for implementing vehicle communications systems are important, though they noted that improving on-time performance, optimizing fleet utilization, automating vehicle location, and reducing fuel consumption as a group are slightly more important. Carriers agree that the main benefits in deploying vehicle communications systems include improved on-time performance, improved communications with dispatchers, improved driver performance, optimized fleet utilization, reduced fuel consumption, and automated vehicle location. They also attribute a 14 percent reduction in vehicle theft, six percent reduction in the number of trailers needed, and 19 percent increase in business opportunities to their deployment of vehicle communication systems.

5. Carriers report significant challenges in introducing advanced safety technologies into their fleets.

Carriers report significant positive and negative effects of deploying the technologies in the study. The training and maintenance costs for each technology differs with the highest costs for vehicle communications systems and electronic stability control. In terms of return on investment (ROI), thirteen percent of carriers expect a ROI with 12 months, 40 percent within two years, 39 percent within three years, and only eight percent longer than three years. Carriers consider nearly all the possible incentives provided as potentially successful in increasing deployment of the advanced safety technologies. A number of interviewees see regulation as the main driver for increasing the penetration of these technologies.
6. Future directions include system integration, autonomous vehicles and V2X technologies, and retrofitting

Interviewees see system integration as the important next step in development. It will be used to sort out conflicts among the technologies in terms of warnings and mitigation, as well as weave the information from outside the vehicle from V2X technologies into complex vehicle safety decisions. Autonomous vehicle are not coming in the near term, but the advanced safety technologies discussed in this study will play the “mitigation/active safety” role in the transition to autonomous vehicles. Finally, retrofitting advanced safety technologies is seen as the key to deploying these technologies in the entire fleet in the shortest possible time.

**Introduction**

The introduction of advanced safety technologies into the heavy truck fleet offers the potential of reducing the number of accidents, thereby making highways safer. The challenge is how to introduce these technologies into the heavy truck fleet and measure the penetration of these technologies in the fleet. This study by the Automotive Futures group at the University of Michigan Transportation Research Institute with funding from ITS America measures the penetration of these technologies while trying to understand the opportunities and challenges managers face as they decide whether to introduce the technologies.

This study focused on five technologies: lane departure warning or mitigation systems (LDWS), electronic stability control systems (ESC), forward collision warning or mitigation systems (FCWS), blind spot detection systems (BSDS), and vehicle communication systems (VCS). Because the supporting technologies for these systems have improved dramatically in recent years and also because of their potential contribution to the growth of ITS technologies, ITS America wanted to find out the current and future penetration of these technologies.

Previous research on the penetration of these technologies in 2009 showed low penetration rates for most of the technologies except tracking systems (communications systems in this version of the study). ITS America thought now would be a good time to review where the industry is in its adoption of these technologies and what are the challenges to their greater adoption. The main areas of interest included:

- The carriers’ familiarity with these technologies
- Their current and future use of these technologies

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2 The technology definitions included “mitigation” in that the 2014 study as part of lane departure and forward collision systems. In 2009, there was little talk about the technologies doing anything other than warning drivers.
The reasons for implementing and the challenges they face when they implement these technologies.

Some of the gains carriers see from their use of the technologies.

Also, ITS America wanted to hear from the system suppliers that developed the current technologies about their future plans and the state Departments of Transportation about the role of government in the adoption of new technologies.

Methodology

Due to cost and time constraints, the current study was not able to replicate the 2009 study that used a stratified random sample to measure technology penetration across the entire fleet of U.S. carriers. Instead, this study focused on the larger carriers where researchers expected higher levels of technology adoption. Based on the 2009 study, larger companies, and especially those with 1,000 or more trucks were more likely to be familiar with and use the technologies.

To supplement the results of the survey, 12 qualitative interviews were conducted with six carriers, two system suppliers, and four state department of transportation participating. The goal of the interviews was to gather more detail about particular issues relating to deploying safety technologies such as when carriers began using the technologies, which ones they use, how satisfied they are with the reliability, safety results, cost savings, and maintenance needs, as well as their drivers’ views about the technology. Carriers were also asked about their future plans for installing other technologies and possible incentives to install other technologies. System suppliers were asked about marketing and technological challenges, as well as future directions, and state DOTs were asked about their ITS-related interactions with fleet operators, the regulatory environment, and planning processes.

The approach for this study focused on companies with 300 or more vehicles of which more than 50 percent were tractors. Using the U.S. Motor Carrier Management Information System (MCMIS) database that lists all the carriers in the U.S., researchers were able to identify 537 companies that met the criteria. Using the phone numbers and email addresses listed for each company, researchers contacted representatives from each of the companies over a period of two months using emails and phone calls to ask for their support in completing an online survey similar to the one used in 2009.

The response rate for the survey ranged from 14 percent (77 of 537) for carriers that answered the core questions of familiarity and usage of the technologies to 11 percent (60 of 537) that completed all the survey questions. Figure 1 shows the average number of trucks and trailers of the participating companies. These averages are inflated due to the largest fleets that reported 2000 to 7000 tractors.
Figure 1 – Average number of tractors, trailers, and straight trucks in the sample of participating companies

Participating companies were primarily For Hire businesses as shown in Figure 2

Figure 2 – The percentage of type of business conducted by participating companies.
Traditionally, large companies tend to turnover their tractors every 3 to 4 years, based on our interviews with these companies. This means that the companies need to receive a return on their investment within that time if they are to invest in new technologies that require additional costs. The companies in this study tend to hold on to their tractors longer, replacing them every six years on average, as seen in Figure 3. One interviewee noted that keeping his tractors longer because of the recession affected his purchasing cycle.

“During the recession, no one had freight. Now, we’re moving freight again, but the result is that fleet replacement cycles got delayed. The typical replacement cycle is 3-4 years. Holding on to trucks longer is more efficient, but the replacement pool of trucks is smaller and older. Old trucks are inefficient, have no safety technology, and the small market means they are more expensive.”

Another interviewee noted that regulations also affect the timing of new vehicle purchases which affects the introduction of new safety technologies.

“…regulation has driven up the cost of vehicles and prohibited the purchasing of new equipment. For example, EPA requirements that add costs have been a hindrance to buying vehicles with safety equipment.”

![Average Replacement Cycles](image)

**Figure 3 – Average replacement cycles for participating companies for tractors, straight trucks, and trailers**
Interviewees report that except for the vehicle communications technologies, all the installations are by manufacturers. Because these technologies are not available in the aftermarket, it makes the rollout of the technologies to the whole fleet slower because they can only be added to new trucks.

Interviewees also see the introduction of these technologies in the context of one of their major challenges: recruiting and retaining qualified drivers. As one interviewee noted,

“The profile of a new driver in the industry has changed due to people doing it out of necessity versus doing it as a career. The majority of people who are doing it now are doing it to make above average wages. No one has a dream of doing it. Ten-to-fifteen years ago, people chose the career. Recruiting experienced drivers or someone willing is diminishing.”

Major Findings

1. Representatives from the larger carriers are familiar with advanced safety technologies.

As expected, representatives of the larger companies that made up the sample for this study are familiar with these technologies, as shown in Figure 4. Their familiarity exceeds that of the largest companies in the 2009 study where the average score was slightly more than three for companies with 1000 or more trucks. This increase in familiarity is based most likely on the introduction of these technologies as options for new vehicle purchases for both passenger cars and heavy trucks. As with the previous study, surveyed company representatives are more familiar with vehicle communications systems. (These systems were called “tracking systems” in the previous study.)
2. Penetration of onboard safety technologies, except for Vehicle Tracking Systems, is low compared to the number of companies that could be using them, but carriers expect significant increases over the next five years.

Across the entire population of truck operators, the use of advanced safety technologies is low as shown in Figure 5, which displays the estimated percentage of companies using the technologies. For this sample of larger carriers, the average penetration of 11 percent for lane departure warning and mitigation systems, 31 percent for electronic stability control, 15 percent for forward collision warning and mitigation systems, and 4 percent for blind spot detection systems represents both the challenge and the opportunity for their deployment. System suppliers suggest that stability control is on 30 to 50 percent of new trucks, but a much lower percentage for collision technologies. The large number of companies not using these technologies offers the opportunity of considerable growth, while the challenge comes from trying to inform a large number of companies in the fleet of the value of deploying these technologies and the legislative or regulatory support that may be needed to increase their use in fleets.
Figure 5 – Average penetration of advanced safety technologies in large commercial fleets.

Vehicle communications technologies that include all forms of communication such as cell phones, tablets, computers, and cameras in the cabin showed the highest penetration: 67 percent. Figure 6 shows the penetration of the different communications technologies in the fleets. The main device used is a location identification device on the tractor. The other technologies include cell phones deployed for communication purposes and identification systems on tractors and trailers.
Figure 6 – The penetration of communication devices used by carriers

A direct comparison to the 2009 study is difficult because in 2009 the sample of companies surveyed was stratified into six groups with the two largest groups representing companies with 101 to 999 and 1000 or more trucks. The current study surveyed companies with 300 or more trucks. Figure 7 shows results in 2009 compared to the 2014 results.

- For lane departure warning and mitigation systems, the 2014 results are between the 2009 results for the two groups of trucks.

- For electronic stability control, the 2014 results exceed both of the average penetrations for the 2009 groups.

- For forward collision warning and mitigation systems, the 2014 penetration is similar to the largest group in 2009.

- Vehicle communications which was called “vehicle tracking” in the 2009 study showed a small increase in the penetration in the 2014 study.
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<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Lane Departure Warning or Mitigation Systems</td>
<td>N=227</td>
<td>N=85</td>
<td>N=77</td>
</tr>
<tr>
<td>Stability Control Systems</td>
<td>3%</td>
<td>21%</td>
<td>11%</td>
</tr>
<tr>
<td>Forward Collision Warning or Mitigation Systems</td>
<td>10%</td>
<td>19%</td>
<td>31%</td>
</tr>
<tr>
<td>Blind Spot Detection Systems</td>
<td>Not asked</td>
<td>Not asked</td>
<td>4%</td>
</tr>
<tr>
<td>Vehicle Communication Systems</td>
<td>60%</td>
<td>61%</td>
<td>67%</td>
</tr>
</tbody>
</table>

Figure 7 – 2009 and 2014 advanced technology average penetration by size of company

This apparent lack of progress in the use of lane departure warning or mitigation systems and forward collision warning or mitigation systems may be related to cost or the capability of the systems, but it is clear that these systems, along with blind spot detection systems with a 4 percent penetration, are not making a strong enough case for their installation with the major carriers.

Comparing the expected penetration of these technologies that was predicted in 2009 for the 2014 timeframe in Figure 8 also shows the disconnect between what companies thought would occur in five years and what has actually occurred in lane departure warning and forward collision warning systems, as well as the accurate predictions the companies in 2009 made about the penetration of electronic stability control and vehicle communications systems in 2014.

- For lane departure warning systems, the two largest groups of carriers expected this technology to have a 17 percent to 33 percent penetration compared to the current reported penetration of 11 percent.

- For stability control systems, companies were very accurate in their estimate of penetration in 2014 when the two largest groups of carriers reported that penetration would be between 26 and 28 percent compared to the current 31 percent.

- For forward collision or mitigation systems, the two largest groups of carriers in 2009 expected penetration between 17 and 34 percent compared to the current 15 percent.

- For vehicle communications systems, the 2009 groups predicted penetration would be 72 percent compared to the current 67 percent.
2009 Technology Penetration Levels in 5 Years and Current Technology Penetration

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</thead>
<tbody>
<tr>
<td><strong>Lane Departure Warning or Mitigation Systems</strong></td>
<td>17%</td>
<td>33%</td>
<td>11%</td>
</tr>
<tr>
<td><strong>Stability Control Systems</strong></td>
<td>26%</td>
<td>28%</td>
<td>31%</td>
</tr>
<tr>
<td><strong>Forward Collision Warning or Mitigation Systems</strong></td>
<td>17%</td>
<td>34%</td>
<td>15%</td>
</tr>
<tr>
<td><strong>Blind Spot Detection Systems</strong></td>
<td>Not asked</td>
<td>Not asked</td>
<td>4%</td>
</tr>
<tr>
<td><strong>Vehicle Communication Systems</strong></td>
<td>72%</td>
<td>72%</td>
<td>67%</td>
</tr>
</tbody>
</table>

**Figure 8 – 2009 predictions for penetration of technologies in 2014 and the actual penetration of the technologies in 2014**

For the 2014 survey, companies report the rate of penetration of advanced safety technologies will increase significantly over the next 5 years, as shown in Figure 9, except in vehicle communications technologies which are predicted to increase only slightly.

**Figure 9 – 2014 predictions for penetration of advanced safety technologies in 5 years**
Figure 10 shows the expected penetration for each technology and the percentage increases for each technology.

<table>
<thead>
<tr>
<th>Technology Penetration Level Increases in 5 Years</th>
<th>N=77</th>
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</thead>
<tbody>
<tr>
<td>Lane Departure Warning or Mitigation Systems</td>
<td>35% (+25%)</td>
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<tr>
<td>Stability Control Systems</td>
<td>49% (+18%)</td>
</tr>
<tr>
<td>Forward Collision Warning or Mitigation Systems</td>
<td>41% (+26%)</td>
</tr>
<tr>
<td>Blind Spot Detection Systems</td>
<td>24% (+20%)</td>
</tr>
<tr>
<td>Vehicle Communication Systems</td>
<td>72% (+5%)</td>
</tr>
</tbody>
</table>

Figure 10 – 2014 predictions for penetration and percentage increases of advanced safety technologies in 5 years

3. Companies committed to LDWS, ESC, FCWS, or BSDS report significant safety improvements.

The companies that are using advanced safety technologies report that the technologies provide benefits to their companies as displayed in Figure 11. Companies report the importance of these technologies due primarily to reducing the cost of accidents, the development of a safety culture in the company, and proven safety benefits. They do not consider financial incentives, an improved safety rating, required implementation, and driver recruitment and retention as important to implementing these technologies. One carrier described a key issue related to implementing advanced safety technologies: not being able to measure accidents avoided.

“All (the technologies) have met our expectations, most have exceeded. I shouldn’t say most, since it can sometimes be hard to tell which technologies are working the best - you don’t see the accidents you prevent. We measure results with an onboard suite of reporting tools that tell us driver behavior, but we can’t identify specifically which technologies avoided accidents.”
Survey respondents who deployed the technologies were also asked about their impression of the benefits of deploying the technologies after deploying them. Figure 12 shows that their impressions of the benefits of deploying the technologies were similar to their original reasons for deploying them, though their levels of agreement are somewhat higher than their levels of importance of implementing the technologies. This is most noticeable in the slight increases in the benefits of insurance, an improved safety rating, and improved recruitment and retention of drivers. The only area where there was a slight reduction in agreement was about the benefits of an improved safety culture compared to their original views of the importance of implementing the technologies.
Figure 12 – Perceived benefits of deploying advanced safety technologies

To measure the benefits of the advanced safety technologies companies can use the increase or decrease in accidents. But a reduction in accidents may be a product of a different set of drivers or driver improvement programs, so it is difficult for companies to directly measure the impact of the technologies. Figure 13 shows the percentage reduction of crashes reported by survey respondents due to each technology. According to survey respondents, electronic stability control reduces the most accidents, followed closely by lane departure warning or mitigation and forward collision warning or mitigation systems. As noted earlier, companies may be underreporting the gains from these technologies because they cannot verify how many crashes are avoided because of the technologies. Also, drivers, in general, will not report all the instances where the technologies kept them from crashing for fear of being labeled as a driving risk.
The reduction in the number of crashes also reduces the costs of those crashes. Figure 14 displays the percentage reduction of the costs of crashes as reported by the survey respondents. In general, they see the reduction on costs to be similar to the reduction of the crashes.
4. Companies report that Vehicle Communication Systems offer both safety and business benefits

Vehicle communications systems differ from the other technologies in the survey because they offer both safety and business benefits. Safety benefits in this case include improving the security of trucks and the assets they are moving and locating stolen vehicles quickly. The business benefits range from logistics-related benefits such as improved on-time performance, optimized fleet utilization, and reduced fuel consumption. The more business-related benefits focus on improving their competitive advantage while also aiming to improve their relationship with the drivers through improving driver recruitment and retention, as well as driver satisfaction and positive driver feedback by improving driver performance and communications with dispatchers. Figure 6 earlier in the report shows the variety of vehicle communication devices on the trucks.

Government interviewees all see vehicle communications as the low hanging fruit in terms of providing drivers with information about their shipments and their routes, but they also see them as potential links to support vehicle to vehicle and vehicle to infrastructure communications, including links to government authorities as they travel along their routes.

Figure 15 displays the reasons for initiating the installation of vehicle communications systems. All the reasons are considered at least moderately important though the major reasons for implementation include improving on-time performance, optimizing fleet utilization, automating vehicle location, and reducing fuel consumption. Not very far behind these reasons are gaining a competitive advantage and improving truck and asset security.
Figure 15 – Importance of implementing vehicle communications systems

Figure 16 examines the benefits of implementing vehicle communications systems. In this question survey respondents note their agreement with benefits that have accrued through the implementation of the systems. Improved on-time performance again is the highest rated item along with improved communications with dispatchers, improved driver performance, and optimized fleet utilization. Closely following the first set of benefits are reduced fuel consumption, automated vehicle location identification, and improved competitiveness. One issue reported by an interviewee was the ability to monitor driver speed using his vehicle communication system, “I can use the information to apply corrective action plans and change behavior. It allows me to monitor speed, for example, 365 days a year, which has been a huge help.”
Besides the nine percent reduction in crashes as shown in Figure 13 and the 12 percent reduction in the cost of crashes shown in Figure 14 attributed to vehicle communications systems, Figure 17 displays the advantages provided by the vehicle communications systems in terms of theft reduction, reduction in the number of trailers, and increased business opportunities.
5. Carriers report deployment challenges in introducing advanced safety technologies into their fleets.

Each of the technologies in this study generated positive and negative comments about their potential and their use. For land departure warning or mitigation systems some survey respondents reported that there were too many false positives and that the system was erratic when roads are snow covered, while others noted that the system works well in training drivers to improve their performance. One survey respondent sees the technology as a dramatic improvement for his company.

“This is a technology that will decrease accidents and their severity; it will modify driver behavior in a positive way, and will aid us in being a safer company, which means lower insurance cost, a lower Compliance, Safety, and Accountability score, a better safety rating, a more desireable carrier partner with our customers, and a company better able to attract top-tier Class A commercial drivers.”

Companies using electronic stability control report general satisfaction with the technology and expect to team it with a retro-fitted forward collision warning system. Survey respondents see forward collision warning or mitigation systems as one of the key safety technologies because it warns drivers about their vehicles following too closely which they see as one of the major issues.
with their drivers. The system logs have also mitigated erroneous claims about the cause of accidents. Blind spot detection is not used by many companies, but some of the carriers report that the technology helps prevent their most costly accidents.

The vehicle communication devices offer some of the most detailed analyses of driver behavior while also allowing electronic logs and better communication with dispatchers, as noted by one carrier:

“The system has all but eliminated phone calls and wasted time looking for loading information now that dispatchers send loading and unloading information through our email system. In addition, we are checking reports regularly regarding vehicle dynamics to improve our fuel economy and overall maintenance (hard stops and starts).”

Another interviewee reported the value of electronic logs: “We installed electronic logs, which would be a type of vehicle communication, and we have reduced our DOT reportable accidents by 50 percent.” But another carrier discussed the issue of reliability of the onboard computers for the vehicle communications system.

“Well that it seems that on any given day, 2-3 percent of the onboard computers are down for various reasons. That’s a frustration, I know. We’ve got 925 trucks now, and if we have 25 people who are down, that’s 2.7 percent and when that happens, they have to go back to paper. We pay by the hour for those electronic logs, but then we have to rely on paper for payroll. It’s an aggravation for the driver and the people here at corporate.”

Also, based on the interviews, it is not uncommon for drivers to tamper with the onboard technology by trying to turn off the GPS so they cannot be found, turning off the forward collision warning system because of too many false positives, or disabling cameras because they think it is an invasion of privacy.

Finally, one of the key challenges mentioned throughout the interviews was the need to continually recruit new drivers who are inexperienced.

“In terms of safety challenges, one of the top ones is the driver shortage, the capacity crunch in regard to new drivers. The issue for the industry is as older drivers retire, there are not as many drivers available to replace them. There can be a potential for lower safety, because the replacements are not as experienced.”
Training and Maintenance

Survey respondents reported training and maintenance costs for all the technologies in the survey. For training, Figure 18 shows the averages per unit reported on training to date for each of the technologies. There are significant differences within and among the technologies with stability control and vehicle communications systems with the most expensive training costs.

![Average Training Costs Per Unit]

**Figure 18 – Average training costs per unit for each technology**

In terms of maintenance, Figure 19 displays that electronic stability control and vehicle communications systems also have the highest maintenance costs per unit annually. Nearly all interviewees report that all the maintenance is done by their staffs after they are trained by the supplier.
Deploying Safety Technologies in Commercial Vehicles

Return on Investment

A common theme throughout the interviews was the need for a quick return on investment (ROI) by the carriers in order to justify deploying advanced safety technologies. Unlike efforts to improve fuel economy that show visible financial returns immediately, safety technologies must be seen as preventing future costs caused by accidents. The cost of accidents can be a large cost for a carrier, but they occur intermittently. Smaller carriers sometimes see this as a risk they must take because of the cost of implementing the new technology. Figure 20 shows the maximum acceptable ROI timeframe for the carriers in the study. They expect near term ROI from new technologies, primarily because they turnover their fleets often. They feel that if they do not receive a return within their ownership cycle, then the justification for deploying the new technology is not sufficient. What this thinking does not take into account are the accidents that were avoided because of the technologies.

Thirteen percent of carriers expect a ROI with 12 months, 40 percent within two years, 39 percent within three years, and only eight percent longer than three years. This is a difficult task for advanced safety technologies because their primary goal is to avoid accidents, which are difficult to measure.

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**Figure 19 – Average annual maintenance costs per unit for each technology**

<table>
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<th>Technology</th>
<th>Mean ($)</th>
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</thead>
<tbody>
<tr>
<td>Lane Departure Warning or Mitigation Systems (n=42)</td>
<td>$22</td>
</tr>
<tr>
<td>Stability Control Systems (n=44)</td>
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<td>Forward Collision Warning or Mitigation Systems (n=43)</td>
<td>$98</td>
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<tr>
<td>Blind Spot Detection Systems (n=42)</td>
<td>$5</td>
</tr>
<tr>
<td>Vehicle Communication Systems (n=45)</td>
<td>$221</td>
</tr>
</tbody>
</table>
Developing an ROI estimate for smaller fleets is considered by the interviewees as one of the biggest challenges for the adoption of advanced safety technologies.

“One of the challenges is if you’re a smaller fleet, why should you invest in stability control or a rollover system? It’s not cut and dry, like fuel reduction. If I buy something to increase fuel economy, then I’m going to see some direct benefit. Payback analysis takes time [with safety technologies]. Fleets are a low margin industry. They can’t buy things that don’t provide a payback. I don’t want to boil it all down to dollars and cents because safety does save money. You can’t put a safety technology on a truck and get a fast number, however, like you do with fuel economy. Payback is certainly a challenge. “

Finally, one interviewee sees ROI from a different perspective: one that values safety over ROI. This thinking assumes that by testing the technology a company can learn its value in terms of actual instances where it helped avoid accidents. Once an estimate of the number of accidents is known, then companies can decide if investing in the technology is practical.

“Safety is made our number one priority, and then we perform rigorous testing and piloting. Based on the results, we will make a
decision. I should mention that ROI is totally useless, mostly a squishy measure. It is better said that safety competes for capital.

Incentives

Carriers were asked to rate the level of potential success of increasing deployment of advanced safety technology via a variety of incentives. Figure 21 displays the optimism of the carriers concerning nearly all of the incentives. They consider regulatory mandates as having the most potential for success, followed by the maturation of the technology (such as the integration of sensors and systems), and reduced insurance premiums. Tax incentives, the awareness of the cost and benefits of the technologies and the awareness of the safety benefits of the technologies all are also considered possible successful incentives.

![Success of Possible Incentives](image)

**Figure 21 – Potential success of a variety of incentives**

Incentives all have their challenges in terms of implementation and timing. One interviewee sees the regulatory incentive as a slow process because the government tends to delay regulation until it has completed exhaustive studies about the effects of the regulations. They also discuss the issue of regulations from different government agencies creating a burden for the freight business with its low margins.

“They don’t always look at how one regulation impacts other regulations. I’m looking at environmental regulations that add $20
Some of the interviewees report that short of paying for all the systems, the cost of implementation is too much for them to consider in their business model. One interviewee spoke of an incentive that improves both company efficiency and safety.

“Vehicles deployed with this technology could be allowed to make less stops at ports of entry which increases operating efficiency. In the real world, it is one of logistics, of time, so if you can shave off time, this can get down to minutes and hours, and run against your competitors along long routes. So there are different ways to look at incentives.”

Finally, there are the “soft” incentives of “awareness”. These incentives have worked over the past five years as the larger carriers are more familiar with the advanced safety technologies than they were in the 2009 study. But in the trucking industry, these incentives are slow to penetrate the smaller carriers that make up the bulk of the companies making decisions about deploying safety technologies. One can see a costs and benefits awareness program aimed directly at these carriers as a potentially fruitful program. This program would discuss the efficiency and safety aspects of these technologies.

**Regulation**

When state DOT’s talk about the relationship among different transportation system partners, they consider a variety of federal agencies, all the different state DOTs and their different safety-related departments, industry manufacturers and suppliers, and carriers and trucking associations. All of these groups do not always have the same agendas. As one government interview noted, “They each have their own goals and things they want to get done. We all tend to operate in silos and don’t cross into looking at the transportation world as a whole.” One of the big differences they report is planning cycles,

“The government planning horizon is typically anywhere from 5-40 years. Most corporations do strategic planning once or twice a year. The transportation world is about 2 years. The transportation authorities need to better understand private sector needs and find ways to make government more adaptive to making changes. The government often plays catchup in regard to these technologies.”
Another issue is the varying laws among the states and their attempts to make the most out of their transportation endowment.

“At state and federal levels, and it is not an easy fix. Because of the way our government is – states’ rights – there are varying standards. When push comes to shove, each state wants to maintain their investments as long as possible, and many laws are incompatible.”

The state DOTs interviewed do not have metrics to measure the success of deployment of safety technologies, but they do see their states as test beds for government research in this area. As one interviewee stated, “We call it ‘R&D’, but we don’t call it Research and Development, we call it Research and Deployment. We want to make our state known for deployment.”

Other states are working on trying to improve the local economy while also increasing safety. One state government interviewee spoke about trying to meet this goal by “reducing friction” by dropping outmoded regulations while at the same time continuing to monitor and sanction carriers with poor safety records.

From a negotiating perspective one interviewee sees an opportunity in allowing carriers to drive larger, heavier trucks, which has been a request of theirs for a number of years, in exchange for requiring advanced safety technologies on all trucks. This is not trading off safety for efficiency because other countries have shown good safety records with larger, heavier trucks. And the increased number of trucks with advanced safety technologies would make the whole fleet safer.

But when system suppliers and state DOT interviewees look at the lack of progress in deploying these advanced safety technologies, they feel that the federal government will have to mandate them. In particular, this would deal with the issue of the smaller carriers not installing the technologies on their trucks. One state DOT interviewee sees this as inevitable because of the lack of leadership among the various transportation groups, “we haven’t figured out how to put mutual interests together to effect change within our own industry and sectors, so a lot of it ends up falling on Congress.” A system supplier interviewee sees government regulation coming primarily from the safety perspective.

“The National Highway Transportation Safety Administration (NHTSA) is coming out with a ruling on trucks and tractors in January. So I think that a lot could be regulated in the relatively short term. NHTSA’s goal is to reduce the 30,000 fatalities on our roads. I think you’re probably aware that the fatality rate started to really come down in 2006 in the heavy truck world, but since 2009 they started to creep back up. I think that the industry is not happy
with that and NHTSA is not happy with that, so that there will be some acceleration of regulation.”

6. **Future directions include system integration, autonomous vehicles and V2X technologies, and retrofitting**

*System integration*

In today’s safety technology, a number of interviewees report the need to have the advanced safety technologies link to the vehicle communications devices, so headquarters can tell if a driver is having near misses in any of the technologies. This could provide a measure of accidents averted by the technology, thus allowing companies to better see the advantages of the technologies.

System suppliers continue to think that eventually all the advanced safety technologies will work as one system. They mention Daimler as one manufacturer that is developing its own systems for its autonomous trucks. Integration is both a threat and opportunity for the system suppliers. If they cannot develop their own suite of advanced safety technologies, probably based on a fusion of radar/lidar, ultrasound, and cameras, the manufacturers will do it. One system supplier described an interesting information overload situation where a number of individual systems are providing warnings at the same time.

> “*What we need is an integrated approach. First of all, the OEMs don’t want to have a bunch of different independent systems on their vehicles. They want to have a system that is integrated that is going to give them the most safety effectiveness and functions. You can get all of these technologies from a different supplier, and that’s nice, but the reality is you’re coming up close on someone and you’re out of your lane and there is something in your blind spot – you can have a situation where you have a lot of distraction coming from different alerts for the driver. You want the most important alert first for your driver. You’re going to want to maximize the functionality, minimize distraction, and that is going to speak to an integrated approach.*”

System integration plays an even more important role when one considers the additional information that will be provided to drivers from outside the vehicle via V2X technologies.

> “*I think that in the future the fleets and the OEMs are going to focus on an integrated safety solution. That will become more important with V2V, because that can provide us additional*”
information to help the active safety system. But I think that it needs to be integrated to help prioritize information – you don’t want to create driver information overload.”

Autonomous vehicles and V2X technologies

System suppliers see autonomous vehicles in the distant future, but they see the advanced safety technologies of today playing an important role along the path to autonomous vehicles. The “mitigation” part of these advanced safety technologies will play the key role after the system decides that something must be done based on sensors on the vehicle and information gathered from external sources (V2X).

“On vehicle sensor technology, you can only take safety systems so far. You really need to have this connected V2X infrastructure in order to maximize the performance and optimize the performance of these systems. That, to me, is critical in terms of the future of safety technology. And it just ties into the fact that more information into the system means that the system can help out in more ways than can just be done with onboard sensor technology.”

A number of interviewees discussed the issue of rear end collisions and the need for “360 degree awareness” that can be provided by V2X technologies.

“Obviously, V2V is going to change the game a bit or maybe a significant amount, but that’s not near term. That will be gradual. The only way this will take off is assuming it is regulated. That’s certainly going to be a big of a game changer. 360 degree awareness can have a big influence on crash reduction.”

There seems to be some uncertainty in the minds of the carriers in the survey who responded to the question about the anticipated benefits of V2V and V2I technologies. Concerning the issues of reduced crashes, increased fuel economy, reduced congestion, and improved profit margins, the carriers reported that they were between “Agree” and “Neither Agree nor Disagree” on all of these issues.

Retrofitting

The issue of retrofitting technologies unto older vehicles came up a few times in the interviews. When one looks at the efforts to design aftermarket V2X technologies, one sees the opportunity to add thousands more vehicles into the fleet of active users. This is in contrast to the advanced safety technologies in this study where is seen as practically impossible to deploy these
technologies through the aftermarket. The exception to this are the vehicle communication devices that can be deployed after the vehicle is in service. As one interviewee noted, waiting for the fleet to include advanced safety technologies at its current rate on new trucks only will take a very long time to reach a high penetration.

“The last thing is the importance for the ability of technology to be retrofitted onto existing vehicles. And I think it is the insurance institute that said that it can take 15-25 years for regulation to take effect because of how long it takes to get old vehicles out and new vehicles into the fleet. So as we’re looking at these things in the future, we need to be able to retrofit these technologies onto older vehicles.”

Conclusions

The deployment of advanced safety technologies in commercial vehicles has increased over the past five years, but penetration rates for all the technologies other than vehicle communication systems are low. All the carriers in the study understand the benefits of deploying the technologies, but penetration is held back by a variety of issues including cost of deployment, difficulty in measuring the value of accidents avoided because of the technologies, uncertainty of meeting ROI timeline requirements due to fleet turnover, and waiting for all the technologies to mature and be packaged as one system instead of multiple systems.

Answers to some key questions will probably determine the path of deployment:

1. Will the efficiency of better and safer drivers because of advanced safety systems overcome pure ROI technology decisions?

2. Will advanced safety system suppliers develop integrated systems or will manufacturers do it themselves?

3. Will advanced safety technologies be able to replicate the aftermarket technology strategy being developed by V2X technologies?

4. Will states, trucking organizations, carriers, and manufacturers and suppliers work together to promote safety solutions that meet efficiency and safety goals or will the federal government take the lead and regulate the deployment without incentives?

As these questions are answered, the path to deployment will become clearer and our roads will become safer.