



# The Connected Bus

## 8 Technologies for the Next Generation School Bus



# The Connected Bus

Buses don't necessarily have a reputation as the most innovative transit option around. But thanks to new advances in technology, all that is changing. With features like onboard Wi-Fi, Global Positioning System (GPS), telematics, cameras, enhanced driver support tools, and a greater focus on the passenger experience, next-generation fleets are changing perceptions about bus transit in cities across the country.

In many of these cities, a decline in ridership has forced public transit systems to take a closer look at how they operate so that they can be more efficient and better meet passenger expectations in today's connected world. While some of the motivating factors may be different for school transportation directors, you likely have similar goals as you explore ways to enhance your bus systems.

## IMPLEMENTING THE NEXT-GENERATION SCHOOL BUS

Across the country, increasing safety and security remains a top priority for school buses, along with other important objectives like improved maintenance and efficiency, optimized bus routes, enhanced driver tracking, and simplified communications with parents. At the same time, more and more school systems are also focused on what's happening on the bus itself. This includes not only managing disruptive behavior but also leveraging students' time on board more productively.

Like your counterparts at mass transit systems, you're probably turning to technology to help solve these challenges. Onboard Wi-Fi, for example, allows districts to "extend the classroom" so that students can get school work done while on the bus. Identification (ID) cards allow parents and administration to track student whereabouts. Stop-arm notifications help identify violators, and cameras provide enhanced security both inside and outside the vehicle, while telematics monitor bus status and help maintain the fleet.

"There is seemingly no limit to the reach of Wi-Fi, as seen by the increasing number of connected school bus garages."

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**Ryan Gray**

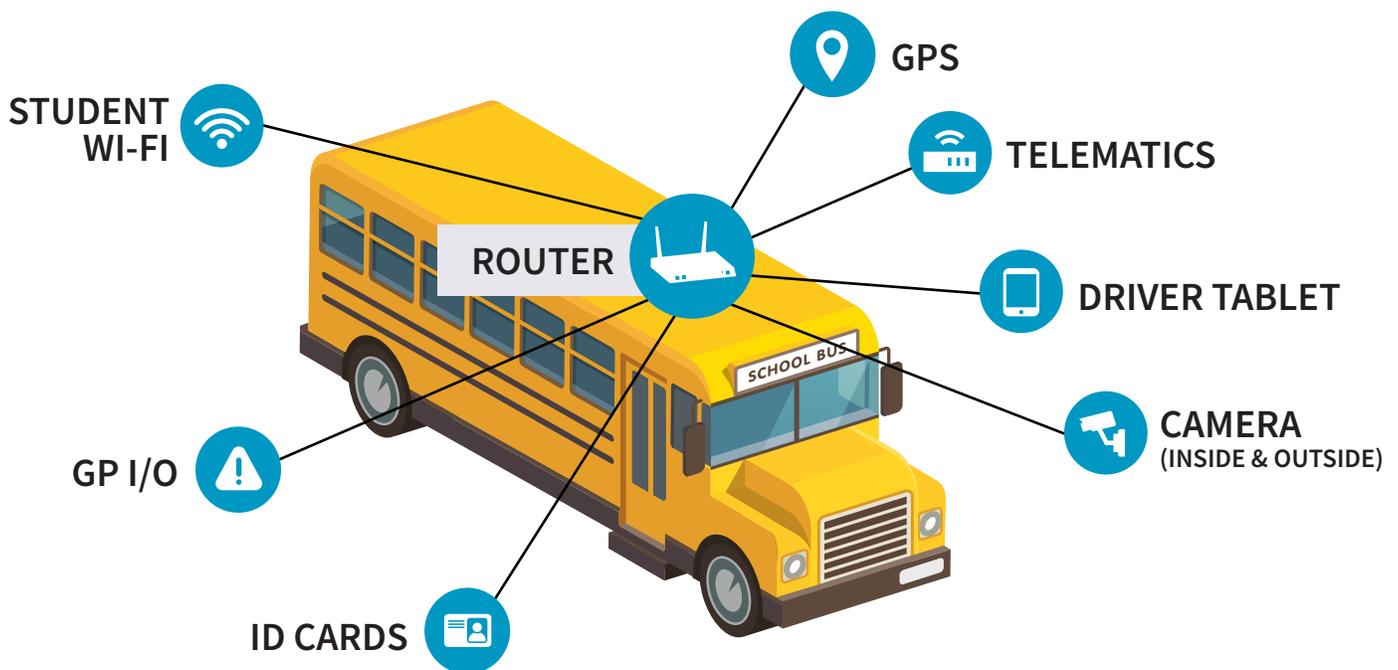
*School Transportation News*

With all of these Internet-enabled options now available — and more always on the horizon — it's beginning to seem like the sky's the limit. Technology is giving us powerful new ways to automate, optimize, and enhance all aspects of school bus operations. But in practice, it's not always so simple. In fact, many school transportation directors now face a new challenge: How do you coordinate and connect all these different technologies, tools, and suppliers, especially when your budgets are anything but unlimited?

### You need a centralized device that can bring it all together.

As school buses become well-connected vehicles, with telematics to GPS and everything in between, there needs to be a factor that ties all of the technology together. And that connecting piece is Internet access. With Wi-Fi on the school bus, districts get the access they need to keep moving forward in the connected world while saving money and expanding their capabilities to integrate any Wi-Fi enabled solutions.

Let's take a look at some of the different types of technologies available to the connected school bus, and how you can use them to meet your efficiency, safety, and educational goals.



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# Router

A router provides the bus with Wi-Fi connectivity, similar to the setup of any non-mobile Internet network. But specific routers need to be used to work effectively in the unique environment of a passenger vehicle and to meet the specific requirements of a connected school bus.

## Ruggedized Cellular Router

Ruggedized routers with the latest LTE Advanced capabilities, 3-in-1 or 5-in-1 antennas aggregate multiple bands and provide GPS while managing a local Wi-Fi and Gigabit Ethernet network. At their core, these are the same kind of routers used in police and first responder vehicles and utility and service vans, with the added capability of supporting up to 128 simultaneous Wi-Fi clients.

## SmartBus With Dual Connect™

Network strength varies by location, so Kajeet provides districts the ability to choose two wireless carriers and switch between networks based on coverage needs. If one network is stronger than another in certain areas of the district, the router will switch to the stronger network.

U.S. students spend an estimated **520 million school days** on buses each year.

## How Much Time Does An Average Student Spend on a Bus?





# Student Wi-Fi

As more school districts implement digital learning initiatives requiring students to complete online assignments outside the classroom, millions of students who lack Internet access at home find themselves caught in the Homework Gap. At the same time, it is estimated that U.S. students spend a staggering 520 million school days on buses each year, according to the [American School Bus Council](#). Why not give students the opportunity to use that travel time to work productively on school assignments?

The [Kajeet SmartBus™](#) extends the classroom to the school bus with safe, CIPA-compliant Internet access for students. [Kajeet Education Broadband](#) equips school buses with 4G LTE connectivity pre-configured with CIPA-compliant, education-only filters, keeping students focused on schoolwork and not on distractions. [Kajeet Sentinel®](#), our innovative cloud platform, controls all filtering, data management, and routers.

## Student Wi-Fi

With plans designed to fit the unique needs of individual schools and districts, Kajeet Education Broadband is compatible with all industry-standard, Wi-Fi capable devices across all operating systems.

## CIPA-Compliant Customized Filters

The Kajeet Sentinel cloud portal analyzes and categorizes millions of new URLs every day and provides customizable filtered Internet access to keep students focused on homework. This means schools and districts can filter out both inappropriate and non-educational content and reduce unnecessary use of bandwidth, which drives down costs for the entire program.

## Usage And Data Reporting

Sentinel provides detailed views into usage, destinations, and management of student limits or bandwidth. You can also run or schedule reports that allow you to view data usage totals and web traffic activity for your devices.

## Who's On Board With Wi-Fi?

**7%** of districts currently provide Wi-Fi on Buses

**37%** of districts considering Wi-Fi in the next 1-2+ years

Source: "Extend the Classroom with Wi-Fi on Your Buses," Kajeet, October 2016.

## Top 5 Educational Sites Visited by Students

coolmath-games.com

hoodamath.com

abcya.com

pbskids.org

starfall.com

Source: Data pulled from a sampling of Kajeet customers.

## Four 4G LTE Networks Available

Kajeet offers reliable nationwide coverage on four of the largest 4G LTE wireless networks in the U.S., which provide download speeds up to 300Mbps.

## Pool And Share Data Among Buses

Districts can purchase data in bulk through Kajeet. The data is then pooled and placed in the account, available for use across all buses. Data does not expire and rolls forward each month. Additional data can be added to the account at any time.

## Kajeet Data On The Bus

Kajeet Education Broadband keeps students focused on schoolwork and not distracted by social and entertainment content on the Internet.

- **Allowed vs. Denied Websites:** Select from URL categories to allow or block websites. Allowed and blocked lists set rules on specific destinations or keywords to local specifications.
- **Types Of Denied Websites:** Blocked websites include age-inappropriate content (e.g., adult images/pornography, gambling, alcohol, drugs, hate speech, etc.); high-bandwidth (entertainment, non-educational games, Pandora, Hulu, Netflix, and streaming media) and popular consumer sites and app traffic (Internet radio, TV, celebrity news/gossip, non-educational games, text/pic/video chat sites, etc.); social networks; and various protocol and security risks.
- **Student Usage:** Manage data consumption limits per bus and per fleet. Time-of-day management and access controls allow you to further customize, monitor, and control student usage.
- **More Than Just Web Filtering:** Blocks other protocols, applications, and security features such as intrusion detection and threat prevention.

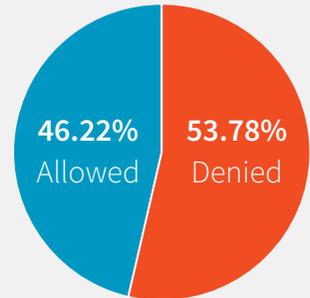
## Driver Wi-Fi

Bus drivers can use Wi-Fi when the bus is stopped—for example, during field trips or sporting events. They can also connect a driver-specific tablet to Wi-Fi.

(See **page 6** for more information about driver tablets.)

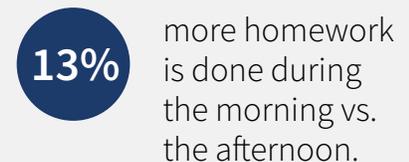
## Keep Students on Task

Allowed vs. Denied Sites



Source: Data pulled from a sampling of Kajeet customers.

## When is Homework Getting Done?



Source: Data pulled from sample of Kajeet customers.



# Global Positioning System (GPS) and Routing

Global Positioning System (GPS) technology has become standard equipment in many passenger vehicles today, but it's still relatively new within the school transportation industry. That's quickly changing as districts discover the variety of ways GPS technology can improve bus safety, security, and tracking.

While most of us think of GPS in terms of directional navigation, that's just one of many benefits it offers school buses. GPS technology allows districts to track a bus's location in real time and analyze historical data to optimize routes and improve on-time records. It also gives staff and parents reliable information about the location and route of a bus at any given moment. That increased accuracy means fewer children are left standing in the elements waiting on a delayed bus.

## GPS

GPS provides school administrators with valuable data they can use to keep tabs on the fleet and improve overall efficiencies.

### Individual and/or Fleet Current Location

Track and monitor the movements and locations of every bus in your fleet.

### Individual And/or Fleet Historic Location

Easily analyze and identify suggested route changes based on historic route and location data of every bus in your fleet. Data can support route optimization studies to cut down on fuel costs, saving school districts money.

“Adding cameras and GPS makes our buses safer and more efficient. They help us achieve our goal of getting students to and from school safely and on time.”

**Ken Nance**

[Director of Transportation](#)

*New Hanover County  
Schools (NC)*

## Routing

Routing software can encompass a number of different solutions for monitoring and optimizing route and fleet efficiency and improving overall safety.

### Routing (Planned vs. Actual)

With GPS data analysis routing software, school administrators can ensure that their drivers are following pre-designated optimal and safe routes. Many services also include in-vehicle maps of planned routes so the drivers can access the most accurate maps of your plan.

### Real-Time Location

Real-time tracking of school buses helps school administrators monitor drivers and the routes they take, know where their buses are, improve safety, and provide better service. With sharing apps and services, parents can also stay informed of bus locations. Many services include email and push notifications that alert parents to arrival times, schedule delays, and emergencies. There are also options that alert parents when their children enter and exit the bus.

### Telematics

With advanced telematics systems, administrators can monitor actual driver behavior: Did the bus stop where it was supposed to? For how long? With that information in hand, they can then address any issues or inefficiencies.

See **page 8** for more information about telematics.





# Driver Tablet

School bus drivers typically have to juggle a variety of materials and information as part of the job. The challenge is making that data easy to access while minimizing potentially risky distractions for the driver.

In-vehicle tablets help districts increase driver accountability, safety, and efficiency. As a key component of next-generation fleet management, these mobile data devices and terminals allow drivers to streamline their daily tasks while providing dispatch with insight into what's happening (or not) on the road. They also [replace the need for drivers to rely on their cell phones](#) to access maps, routing, and student information.

While regulations vary by state, some states have specific guidelines that dictate where devices must be mounted. Some states also mandate that screens must go “dark” when the bus is in motion to eliminate driver distraction.

## Turn-by-Turn Directions

Driver tablet software typically includes detailed maps with highlighted routes and audible turn-by-turn instructions to the next scheduled stop. Depending on the system, drivers may be able to manually change the route as needed, and alternate routes can be suggested if a driver encounters unanticipated road closures or misses a stop. Any changes are then immediately available to the fleet manager.



“Our drivers were literally using printed-out directions and three-ring binders to keep track of student names, bus assignments, everything. Now, everything will be in the tablet so our drivers can pay attention to the road and not a stack of papers sitting nearby.”

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**Cheryl Dalton**

[Director of Transportation](#)

*Saratoga Springs  
School District (NY)*

## Clock In/Out

With full time clock capabilities integrated into a bus-mounted device, the tablet can replace outdated time keeping software. Drivers can log in and out without delay, and that means the district doesn't have to pay for unnecessary downtime. By capturing time and attendance data, these systems also make it easier to track employees and streamline reporting.

## Vehicle Inspections

Some systems include software that requires drivers to log in to the terminal to access step-by-step pre-trip inspection instructions and log results for remote viewing by fleet managers. Drivers can use the terminal to conduct their post-trip inspections as well.

## Backup Camera View

If the software is installed, the driver tablet can also mirror the backup camera for added safety.

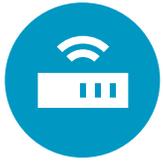
## Ridership Tracking

Once at the bus stop, the driver can visually confirm assigned riders at their individual embark and disembark points. The driver can also use the tablet to manually enter the student's data in instances where the ID card is left at home.

Maryland requires each of their 9,000 school buses to be inspected three times a year. Through a mobile device, electronic records indicate whether each bus has passed inspection or requires additional follow up.

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[Maryland Department of Transportation Motor Vehicle Administration](#)



# Telematics

School transportation directors have to stay on top of a range of issues that affect bus safety, performance, and reliability, from monitoring driver habits and determining the safest drop-off and pick-up points, to keeping tabs on vehicle status and knowing when a part needs to be repaired or replaced. Managing these disparate tasks can be a complex, time-consuming, and, ultimately, expensive process.

Advanced telematics, which connect to all electronics on the bus and allow for the transmission of vehicle data back to the fleet manager, automate and enhance many of these manual or disconnected tasks. Considered [an essential aspect of any good fleet maintenance system](#) today, telematics have the potential to make school buses more efficient, safer, and easier to maintain than ever before, leading to a lower total cost of ownership.

They also allow school transportation directors to monitor driver behavior and gather data on unsafe habits so they can correct and prevent problems while rewarding and reinforcing good habits.

Pre- and post-trip inspection monitoring allows fleet managers to track critical data points such as:

## Start/Stop Events

Collect and analyze data about start/stop events (i.e. hard breaking or fast starts) to identify and reduce harmful driving behaviors that could endanger students.

## Engine Diagnostics

Make informed service decisions within minutes of an engine or after-treatment fault event so that you only service vehicles when needed, increasing vehicle uptime.

## Fuel Consumption

Track fuel efficiency to detect potential unsafe driver behaviors. For example, speeding and sharp acceleration are detrimental to the vehicle's fuel efficiency

“These innovations not only increase efficiency, but also save fuel, mileage, and wear and tear for unneeded stops. Once adopted within a fleet, the opportunities to boost operational efficiency as well as safety are limitless.”

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**Mike Stotler**

[Thomas Built Buses](#)

*School Transportation News*

**TIP:** Rather than having your students connected to the same local area network (LAN) as your engine diagnostics (and exposing the system to possible hacks), use a virtual local area network (VLAN) for telematics.

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## Preventative Maintenance Alerts

Diagnose and resolve maintenance issues before they become significant problems.

## Engine Idle Time

Reduce fuel costs, emissions, and engine wear-and-tear with systems that automatically record excessive idle time, send alerts to dispatch and fleet managers, and provide fleet managers with necessary data to evaluate driver performance.

## Tire Pressure

Get real-time alerts to manage one of your fleet's biggest consumable items and ensure buses operate safely. In addition to pressure monitoring, automatic tire inflation systems can inflate tires whenever the detected pressure is below the target, reducing bus inoperable time.

## Impact Sensors

Get immediate notification of an emergency – such as an accident, fire, or other incident – so that appropriate measures can be initiated as quickly as possible.



## Vehicle Speeds

In addition to monitoring speeds, new speed-limiting technology can use GPS to automatically limit vehicle speed in real time according to posted speed limits.



A fleet with 10 vehicles can lose over \$14,000 to idle time in just a year.

[Green Fleet Magazine](#)



# Camera

## (Inside & Outside)

When administrators get complaints about student bullying or inappropriate driver behavior, it's not always easy to reconstruct what actually happened on the bus. Likewise, many incidents of illegal passing are never reported because bus drivers don't have the evidence to prove a violation and police officers might not be there to catch the motorist in the act.

By capturing audio and video of what's happening in and around the bus, cameras help promote driver and student accountability as well as compliance with traffic laws – all of which are critical to keeping students safe.

Camera systems today not only monitor student behavior and driver performance inside the vehicle, they can also be used to record what's going on outside the bus, providing all-around enhanced safety and security. Here are a few of the features a typical school bus camera system offers:

### Archived Storage/Digital Video Recorder (DVR)

Depending on the system, a mobile DVR can capture and store footage of both the internal and external environment as well as signals from the bus, including braking, turning, warning lights, and stop-arm deployment. With archived video footage, administrators have well-documented evidence for identifying problematic student behavior and investigating incidents without having to rely solely on personal accounts.

### Real-Time Access

Closed-circuit television systems have been used by buses for years, but one feature they can't easily offer is the ability to review video footage in real time. A bus equipped with a wireless IP video system allows for real-time access with remote reviewing, essential in the case of an emergency when an immediate response is critical.

“It's not a he-said/she-said situation. We have proof of what happened. If we get an accusation against a driver, we can pull up the video and see exactly what happened.”

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**Joey Simon**

Transportation Coordinator

*Lafayette Parish  
School System (LA)*

## Illegal Passing Record

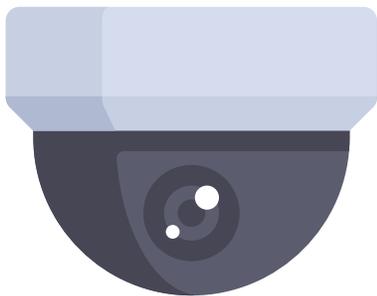
At least 15 states already have school bus stop-arm camera laws designed to catch and punish traffic violators by allowing cameras to record illegal passing. High-resolution surveillance cameras are pointed outside the bus, and [the camera system is automatically activated when the stop arm is extended](#), capturing video footage of all vehicles passing the stopped bus. Typically, images are then sent to a processing center, matched with motor vehicle registration information, and forwarded on to the police.

## Automatic Video Download

Camera systems can be programmed to automatically download video via Wi-Fi for review and processing when the bus returns to the yard.

## Out-of-Band Management (OOBM)

Out-of-band access provides the option to manage the camera via a secondary Ethernet connection to eliminate downtime and disruption. With OOBM, you will still be able to handle basic camera actions such as turning it in a different direction or turning it off, even if the primary network goes down.



Over a fifth of the nation's school bus drivers reported nearly 78,000 incidents of motorists illegally passing stopped school buses during one-day counts earlier this year, equating to 14 million violations over a 180-day school year.

### [National Association of State Directors of Pupil Transportation Services Survey](#)

[School Transportation News](#)

*August 2017*



# Student ID Cards

While the [National Transportation Safety Board](#) notes that children are much safer traveling in school buses than in any other vehicle, school districts still have to be able to track where students are and make sure they're getting on the right buses and getting off at the right stops. As more and more school districts employ [smart ID card systems](#) to increase security, they're now bringing that technology onto the bus to improve safety, efficiency, and peace of mind for parents, drivers, administrators, and students alike.

[Special bus cards](#) are typically embedded with microchips that use radio frequency identification device (RFID) technology or near field communication (NFC) to log when and where a student boards and exits the bus.

## Hardware And Scanner

Whether it uses RFID or NFC technology, the ID card is scanned when the student gets on and off the bus. Typically, the scanner is mounted near the driver and beeps to indicate that the card has been read correctly.

## On/Off Bus

In addition to tracking when students board and exit the bus, the systems monitor where a student is in real time so that parents or administrators can identify the child's location at any given moment. Some systems include software that sends a text to parents so they don't have to wonder whether their child got on the right bus or off at the right stop. And in accidents where the driver is hurt or unresponsive, such systems provide administrators with a way of knowing who is supposed to be on the bus.

“This addresses safety issues that we have with students: whether they're on the right bus, getting off at the correct stop. We have some students that are unable to speak their name clearly enough for the driver to understand, and you can imagine the stress that puts on a driver. ‘Where does this student go?’ That's a big concern.”

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**[Becky Reier](#)**

[Director of Transportation](#)

*Kearney Public Schools (NE)*

## Bus Stop Parental Notifications

A huge benefit to parents is the ability to receive notifications about the bus's expected arrival time at the bus stop and that their child has made it to school or home safely. Software can send parents a text to let them know when their child got on or off the bus — and that they're on the right bus. (Note: Requires routing software.)

## Who Is On The Bus?

Student ID systems give bus drivers instant, accurate counts of actual student ridership versus planned ridership. Some systems also alert the driver when a student boards the wrong bus or is missing. Students can also be quickly and efficiently reassigned to a bus in case of an emergency, such as a [gas leak that closed a neighborhood school](#).

## Student Stop Notification

Systems can notify students by text (SMS) that their stop is coming up and/or interrupt their current Wi-Fi session with a pop-up reminder.

## Time On Bus And Drop-Off Logging

Log drop-offs and time on the bus for special education or medical reporting requirements to secure accurate reimbursements.





# General Purpose Input/Output (GP I/O)

Technology is revolutionizing all aspects of fleet management and on-board safety. Today's school bus systems can leverage a variety of devices and sensors to improve child safety and optimize response time in an emergency.

## Stop-Arm Notification

In addition to the camera that records illegal passing, infrared devices and multi-sensor camera systems can capture and synchronize license plate imagery with bus speed, stop arm deployment, other vehicle sensors, date, time, and driver identification.

## Door-Open Notification

Open/closed door sensors can prevent students from getting caught in school doors.

## Child-Left-On-Bus Alert

New artificial-intelligence-powered devices are hitting the market that use a variety of sensors to detect any movement in a powered-down vehicle. If a child is detected on the bus after it's been parked, the device will alert the driver and fleet operator via telematics notification. Alarms can also be installed to remind the driver to check each seat at the end of the route.

## Top Hatch

An emergency exit monitor system can include one or more sensors that provide both audible and visual signals to the driver when an emergency exit hatch is open.

## Fire/Smoke Detection

When there's a fire on a bus, every second counts. Smoke and fire detection systems quickly alert the driver so that the students can be evacuated and the fire can be extinguished before it spreads, saving lives and stemming property loss.

California law requires "all school buses to be equipped with child-check reminder alarm systems and for bus drivers to be trained on those systems."

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**Nicole Schlosser**

*School Bus Fleet*

## Cabin Temperature

The latest climate control systems available for school buses are lightweight and less obtrusive while more efficient, responsive, and accurate in controlling on-board temperature. Programmable pre-heating systems help save on heating, maintenance, and labor costs while reducing idling time and emissions.

## Side Windows

Similar to roof hatch sensors, side window sensors provide alerts when side window emergency exits are unlatched.

## Lift Activation

Advanced technologies can also track and monitor functions like wheelchair-lift activation, providing transportation directors and technicians with real-time information and alerts when there's an issue.

“To get children to school on time and safely, a safe and reliable vehicle is a must...The reliability of the vehicle can only be guaranteed if the issue is fixed before it becomes an issue.”

**GP Singh**

*School Bus Fleet*



# Driving Your Unique Outcomes

Advances in technology are rapidly transforming the traditional school bus, and new innovations seem to hit the market daily. As these systems work together to keep students safe, enhance the rider and bus driver experience, and improve overall bus safety, efficiency, and total cost-of-ownership, the key to getting the best return on your investment is understanding how to bring it all together to meet your specific needs.

## We can help.

All of the aforementioned technologies, and those that haven't been developed yet, rely on a robust, enterprise-grade IT network and Internet access. The Kajeet SmartBus with the cellular router at its core provides the connecting piece, managing academic and operational traffic along with all communication off the bus to commercial and private networks.

No two school districts share the same off-campus Internet connectivity needs; each one has its own specific challenges, budget limitations, and staff constraints. Get in touch with us today to discuss optimal strategies for rolling out next-generation, connected school buses in your district.

“What happens on the bus has a large impact on the rest of a student’s school day. We tend to look at buses only as vehicles, but they are always an extension of the classroom and the school environment.”

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### **Gary Lambert**

Director of 21<sup>st</sup>  
Century Learning

*Beekmantown Central  
School District (NY)*

# Acknowledgements

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Kajeet, Inc.  
7901 Jones Branch Drive  
Suite 350  
McLean, VA 22102  
240.482.3500  
www.kajeet.com  
marketing@kajeet.com

## About Kajeet®

Kajeet, the industry leader for safe, mobile student Internet connectivity, is closing the Homework Gap in school districts across the country. Kajeet provides an affordable mobile broadband solution that connects low-income students to the resources needed to complete homework. The Kajeet SmartSpot® (a portable Wi-Fi hotspot), and the Kajeet SmartBus™ (school bus Wi-Fi) solutions combined with the innovative Sentinel® cloud portal, enables administrators and teachers to provide CIPA-compliant, customizable filtered Internet access that keeps students focused on school work and provides mobile Internet connectivity for education without worry of data abuse. Kajeet products and services, which operates on four U.S. wireless carriers, are protected by the following issued U.S. patents: 9,237,433; 9,137,389; 9,137,386; 9,125,057; 8,995,952; 8,929,857; 8,918,080; 8,774,755; 8,774,754; 8,755,768; 8,731,517; 8,725,109; 8,712,371; 8,706,079; 8,667,559; 8,644,796; 8,639,216; 8,634,803; 8,634,802; 8,634,801; 8,630,612; 8,611,885; 8,600,348; 8,594,619; 8,588,735; 8,285,249; 8,078,140; 7,945,238; 7,899,438; 7,881,697. Other patents are pending. For more information, please visit us at [kajeet.com](http://kajeet.com).