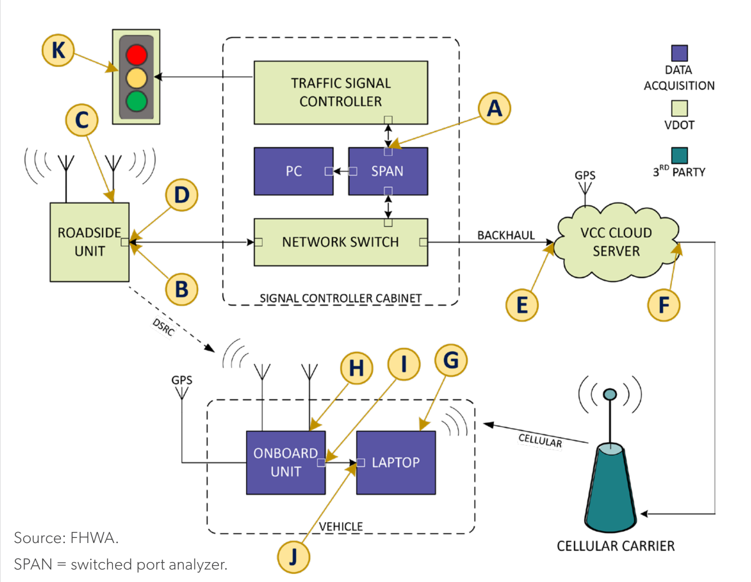
FEASIBILITY STUDY AND ASSESSMENT OF COMMUNICATIONS APPROACHES FOR REAL-TIME TRAFFIC SIGNAL APPLICATIONS

Connected vehicle (CV) technology is expected to significantly improve transportation systems due to the mobility, safety, and environmental benefits gained from connectivity between different vehicles and with infrastructure. Connectivity to real-time traffic signal data is a key component of CV applications and is enabled by wireless communications.

Latency in wireless communications is defined as the amount of time taken for a transmitted packet to reach a receiver (analogous to delay). This study analyzed the latency differences between two wireless communications approaches—dedicated short-range communications (DSRC) and cellular (3rd Generation Partnership Project 4G/long-term evolution [LTE])—to assess the feasibility of using these methods for various CV applications.

Data Collection

Operated by the Virginia Department of Transportation (VDOT) and Virginia Tech Transportation Institute, the Virginia Connected Corridor (VCC) served as the testbed for this study. The VCC is a cluster of more than 60 intersections in northern Virginia that are equipped with roadside units (RSUs). These RSUs provide traffic signal phase and timing (SPaT) data to end users via DSRC and cellular technology to support the early deployment of CV applications.



Source: FHWA.
SPAN = switched port analyzer.

Figure 1. Data collection in the northern Virginia CV system

The study collected data at three points:

- C: SPaT messages broadcasted from the RSU antenna interface via DSRC.
- H: SPaT messages received on the onboard unit (OBU) via DSRC.
- G: SPaT messages received on the laptop via the VCC Cloud (cellular networks).

Two data delivery paths were explored:

- Cellular – **C** RSU →VCC Cloud →**G** Laptop
- DSRC – **C** RSU →**H** OBU.

The study selected three separate sites within the VCC based on their differing characteristics—Virginia Route 7 (VA-7) and Springhill Road (urban), Virginia State Route 650 (Route 650) and Yorktowne Center (suburban), and U.S. Route 50 (US 50) corridor (suburban).

Results

The collected data were compared based on latency and distance coverage. In particular, the analysis considered the difference in time when the same SPaT message was received at the OBU through DSRC and on the laptop through cellular. The range was determined by calculating the distance between the RSU and the furthest location at which a SPaT message was received. Table 1 shows the results.

Table 1. Summary of latencies and ranges using DSRC and cellular

	Latency (milliseconds)			Range (meters)	
Type	Min.	Median	Max.	Min.	Max.
DSRC	0.80	1.10	1.50	430.53	1,365.50
Cellular	7.70	36.46	68.00	1,171.00	3,751.00

Source: FHWA.

An initial comparison shows that DSRC has a shorter range but very low latency (less than 2 milliseconds), whereas cellular has a longer range but higher latency (greater than 40 milliseconds).

Feasibility Analysis

An analysis was conducted to assess the impact of latency and coverage on the feasibility of supporting various safety and non-safety applications, including Glidepath, traffic optimization for signalized corridors (TOSCo), transit signal priority (TSP), and red-light violation warning (RLVW). Table 2 provides a summary of the results.

Table 2. Feasibility of applications using DSRC and cellular

Application	DSRC	Cellular	Hybrid (DSRC and Cellular)
Glidepath	Yes	Yes	Yes
TOSCo	Yes	Yes	Yes
TSP	Yes	No*	Yes
RLVW	Yes	No	Yes

Source: FHWA.
*Cellular may be acceptable for TSP at speeds ≤50 miles per hour.

The findings suggest that for applications such as Glidepath and TOSCo, receiving SPaT data over cellular might enhance the performance of the system, as the delay induced by cellular may be negated by the message being received over a wider distance. However, applications such as TSP (if the speed limit is greater than 50 miles per hour) and RLVW, which require low latency, may not be supported by the cellular network.

Conclusion

Both DSRC and cellular LTE demonstrate strengths and weaknesses in supporting applications in terms of timing and communications range requirements. The results of this study will be disseminated to other agencies that are considering real-time traffic signal data distribution and aim to help developers and deployers in improving the safety and performance of the nation's roadways. Opportunities for further work include the study of other performance metrics, such as accuracy and reliability, and of alternate communications methods.

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