Revision History

Version	Date	Comment
0.0.1	24 April 06	Initial Draft
0.0.2	12 July 2006	Added items from several sources including B. Wells, F. Perry, L. Armstrong, J. Rinchiuso, and L. Sitbor.

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1. Purpose

The purpose of this document is to detail the requirements for Dedicated Short Range Communication (DSRC) to be implemented in the Vehicle Infrastructure Integration (VII) domain.

2. Scope

This document contains high level numbered requirements for DSRC that are utilized by key sub-systems, namely: the On Board Unit (OBU), and the Road Side Unit (RSU). It does not, however, provide detailed or low level requirements for these sub-systems.

This is a draft which is a collection of requirements previously documented in several forms including Word documents, PowerPoint presentations and Excel spreadsheets over the past 5 years. Duplicate requirements from these documents have been consolidated.

3. Acronyms and Abbreviations

Table 3-1 gives the list of acronyms and abbreviations used in this document.

Table 3-1 Acronyms and Abbreviations

Acronym	Expansion
API	Application Programming Interface
DB	Database
DSRC	Dedicated Short Range Communication
DTC	Diagnostic Trouble Code
GIS	Geographical Information System
GPS	Global Positioning System
ID	Identifier
OBD	On-board Diagnostics
OBU	On Board Unit
OC	Operations Center
RSS	Road Side Server
RSU	Road Side Unit
UDP	User Datagram Protocol
UI	User Interface
VC	Vehicle Client
VII	Vehicle Infrastructure Integration

4. References

- Use Case Document
-

5. Introduction

DSRC / VII is a highway management system that will facilitate: Department of Transportation (DOT), Automotive Original Equipment Manufacturers (OEMs) and other third-party Content/Service Providers to:

- Monitor road conditions
- Manage traffic and intersections for incident reporting
- Control traffic on roads
- Deliver commercial, internet-based services to vehicles remotely

Figure 1 shows the key components of the system.

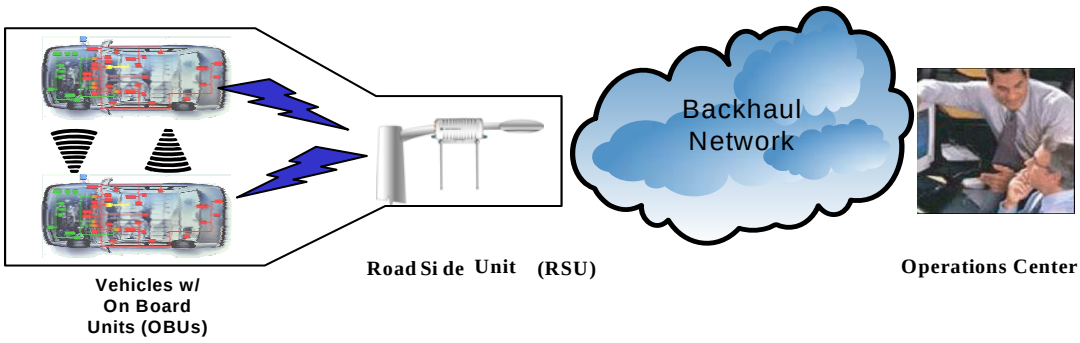

Figure 1 System Components

6. Numbered Requirements

The following sub-sections detail numbered requirements for supporting wireless communication in the DSRC band. The requirements are specifically written for the purpose of supporting the following forms of wireless communication:

- Between Road Side Unit and On Board unit
- Between On Board Units.

Functional Requirements

Notes:

1. 5.9GHz_Concept_Brf_AR+_APPLICATION_DIAGRAMS_w_LINK-BUDGETS_+_REQUIREMENTS_Expanded.PPT contains several application specific requirements with different parameters per applications that must be reviewed for worst case conditions and inserted into this document.
2.

System Requirements

Table 6-1 lists the functional requirements for the system.

Table 6-1 System Functional Requirements

Requirement #	Requirement Description	Use Case Traceability	Status	Source
SYS-REQ-1	Wireless DSRC devices must be interoperable across North America.	UC-		Cash[1]
SYS-REQ-2	Wireless DSRC devices must satisfy FCC, Industry Canada, and Mexican government regulations	UC-		Cash
SYS-REQ-3	Two-way wireless peer to peer communication shall be supported between roadside and vehicle units.	UC-		Cash
SYS-REQ-4	Two-way wireless peer to peer communication shall be supported between vehicle units.	UC-		Cash & Rinchiuso[2]
SYS-REQ-5	One-way point-to-multi-point communication shall be supported amongst wireless DSRC devices.	UC-		Cash & Rinchiuso
SYS-REQ-6	The DSRC devices must have high reliability / MTBF.	UC-	Needs to be quantified	Cash
SYS-REQ-7	The DSRC devices must have a low MTTR.	UC-	Needs to be quantified	Cash
SYS-REQ-8	The DSRC devices must support multimodal (road and rail) operation.	UC-		Cash
SYS-REQ-9	Non-interference with 915 MHz systems.	UC-	Review for need	Cash
SYS-REQ-10	The ISO L1 and L2 must be able to handle a large number of units in the communication zone. On the order of 50 to 100. The system must not collapse if this number is exceeded.	UC-		Cash
SYS-REQ-11	Transaction Size -- 500 Bits to 100 Mbytes or more	UC-		Cash

Requirement #	Requirement Description	Use Case Traceability	Status	Source
SYS-REQ-12	Minimum Beacon Separation -- 3 m (10 ft)	UC-	Beacon is a 802.11a term, that may be replaced.	Cash
SYS-REQ-13	Minimum Application Separation -- 15 m (50 ft) - Enable non-interference between neighboring DSRC applications	UC-	Can we justify the need	Cash
SYS-REQ-14	Traffic Speed -- 0 to 200 km/h (0 to 120 mph)	UC-	Sufficient?	Cash & Cash2[3]
SYS-REQ-15	Enable licensed operation	UC-	Is this a requirement or a policy	Cash
SYS-REQ-16	Implement vehicle location	UC-		Cash
SYS-REQ-17	DSRC devices (OBU and RSU) shall, on a regular basis, transmit data regarding their position to other DSRC devices that are within range.	UC-		Rinchiuso*
SYS-REQ-18	Implement lane discrimination (implies specification on antenna type and mounting).	UC-		Cash
SYS-REQ-19	Implement a high density of applications.	UC-	Not sure what this implies? Recommend replacing it with the following: "DSRC devices shall support simulations sessions."	Cash
SYS-REQ-20	Support multiple overlapping communication zones	UC-		Cash
SYS-REQ-21	Communication Zones shall be variable from 2 to 1000m			
SYS-REQ-22	Wireless DSRC devices must support an entry level - low cost – device.	UC-		Cash
SYS-REQ-23	Does not require usage fees	UC-	Policy rather than requirement?	Cash
SYS-REQ-24	Max. Speed - 200 km/h		Shouldn't this be Min. Speed	Cash
SYS-REQ-25	1000 m range must support 1 Mbps	UC-	1000m is covered elsewhere, do we want to place a limit on throughput here.	Cash
SYS-REQ-26	The DSRC devices must support connection and connectionless oriented services.	UC-	Changed "dedicated service" to connection and connectionless	Cash & Rinchiuso

Requirement #	Requirement Description	Use Case Traceability	Status	Source
			oriented services	
SYS-REQ-27	The DSRC devices must provide prioritized media access. Note: Safety applications should be given priority over non-safety applications.	UC-		Cash
SYS-REQ-28	High priority applications may pre-empt lower priority applications	UC-	Source?	
SYS-REQ-29	Must be able to support protected operation	UC-	Assuming protect means secure, it is cover elsewhere.	Cash
SYS-REQ-30	Implement a tier of device types to scale device capability from the lowest to highest raw data rate - 2 to 27/54 Mbps and 15 to 1000 m range to match application requirements to device complexity	UC-	Have a requirement that states DSCR must support similar data rates as 802.11a	Cash
SYS-REQ-31	Wireless DSRC devices must operate between 5.850 & 5.925 GHz	UC-		FCC
SYS-REQ-32	DSRC devices must support accurate location / ranging.	UC-		
SYS-REQ-33	DSRC devices must have a long (20 year) service life.	UC-		
SYS-REQ-34	DSRC devices must support a wide temperature range of operation.	UC-		Cash &
SYS-REQ-35	DSRC devices must support a high vibration tolerance.	UC-		
SYS-REQ-36	Prioritize safety/public safety applications	UC-		FCC R&O - paragraph 15
SYS-REQ-37	Protect safety/public safety applications against interference and unacceptable latency caused by non-safety applications	UC-		FCC R&O - paragraph 15
SYS-REQ-38	Ensure non-safety application use does not degrade the safety/public safety applications	UC-		FCC R&O - paragraph 15
SYS-REQ-39	Efficiently share available bandwidth between safety and non-safety applications	UC-		FCC R&O - paragraph 16
SYS-REQ-40	Control Channel protocol must implement the priority given to public safety communications through a priority interruption capability	UC-		FCC R&O - paragraph 30

Requirement #	Requirement Description	Use Case Traceability	Status	Source
SYS-REQ-41	Communications involving Safety of Life must have access priority over all other DSRC communications	UC-		FCC R&O - paragraph 32
SYS-REQ-42	Public Safety applications have access priority over all DSRC communications except Safety of Life	UC-		FCC R&O - paragraph 33
SYS-REQ-43	Control Channel protocol permitted to prioritize channel 172 for safety communications that involve vehicle safety and other high priority applications	UC-		FCC R&O - paragraph 34
SYS-REQ-44	Control Channel protocol permitted to prioritize channel 184 for high power public safety and intersection collision applications	UC-		FCC R&O - paragraph 34
SYS-REQ-45	Ensure scalability of the system from the initial penetration rate of 5%-10% up to 90% in the future	UC-		Lothar Stibor
SYS-REQ-46	Implement area encoding schema for location based services, e.g. Zone of relevance	UC-		Lothar Stibor
SYS-REQ-47	Support QoS for non-safety applications	UC-		Lothar Stibor
SYS-REQ-48				

Ad Hoc and Infrastructure Networking Requirements

Table 6-2 lists Road Side Server requirements.

Table 6-2 Ad Hoc Networking Functional Requirements

Requirement #	Requirement Description	Use Case Traceability	Implementation Status	Source
NET-REQ-1.	DSRC wireless devices must support IPv6.			
NET-REQ-2.	DSRC wireless devices shall be able to detect IP networks.			
NET-REQ-3.	DSRC wireless devices must support peer to peer /ad hoc communication.			
NET-REQ-4.	DSRC devices must be able support communication with infrastructure devices when present.			
NET-REQ-5.	DSRC devices must be able to seamlessly communicate between ad hoc devices as well as to infrastructure (stationary) devices.			
NET-REQ-6.	DSRC devices must be able to optimize communication paths to peer devices.			
NET-REQ-7.				
NET-REQ-8.				
NET-REQ-9.				

Security Requirements

Table 6-3 lists Road Side Server requirements.

Table 6-3 Security Functional Requirements

Requirement #	Requirement Description	Use Case Traceability	Implementation Status	Source
SEC-REQ-1.	Wireless DSRC devices must support authentication and access controls (Layers 1 and 2 must support security controls)			Cash
SEC-REQ-2.	DSRC data must be authenticated and must not facilitate tracking.			
SEC-REQ-3.	DSRC devices must be able to authenticate with a very short delay interval.			
SEC-REQ-4.	DSRC device must support anonymity.			
SEC-REQ-5.	DSRC devices must support data confidentiality			
SEC-REQ-6.	Must support a manageable and scalable security solution to handle large number DSRC devices.			
SEC-REQ-7.	Cryptographic algorithms and architectures must be chosen to limit impact on performance.			

Performance Requirements

Table 6-4 lists Road Side Server requirements.

Table 6-4 Performance Functional Requirements

Requirement #	Requirement Description	Use Case Traceability	Implementation Status	Source
PER-REQ-1.	Must have a robust service discovery mechanism.			
PER-REQ-2.	Must support 802.11a like data rates.	UC-		
PER-REQ-3.	Must have high multi-path tolerance.			
PER-REQ-4.	Must have high fade tolerance.			
PER-REQ-5.	The DSRC devices must not disrupt incumbent (primary allocation) 5.9 GHz systems	UC-		Cash
PER-REQ-6.	The DSRC devices must minimize interference with secondary allocation 5.9 GHz systems			Cash

PER-REQ-7.	The DSRC devices must be tolerant of inadvertent interference from incumbent 5.9 GHz systems			Cash
PER-REQ-8.	Messages transfer to and from vehicles at speeds of 85 mph with a Packet Error Rate (PER) of less than 10 % for PSDU lengths of 1000bytes.	UC-		ASTM
PER-REQ-9.	Messages transfer to and from vehicles at speeds of 120 mph with a Packet Error Rate of less than 10 % for PSDU lengths of 64bytes.	UC-		ASTM
PER-REQ-10.	Vehicle closing speed of 170 mph with a PER of less than 10 percent for PSDU lengths of 64bytes.	UC-		ASTM
PER-REQ-11.	Line of sight communication support up to 1000m.	UC-		
PER-REQ-12.	System acquisition less than 100 milliseconds.	UC-		
PER-REQ-13.	Traffic Flow Rate -- 3000 v/h/l - (1 to 8 lanes)			
PER-REQ-14.	DSRC devices must support fast channel detection.			
PER-REQ-15.	Must meet the DSRC-D emission mask.			
PER-REQ-16.	DSRC devices must maintain a high level degree of synchronized accuracy.			
PER-REQ-17.				

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Mobility Requirements

Table 6-5 lists Road Side Server requirements.

Table 6-5 Mobility Functional Requirements

Requirement #	Requirement Description	Use Case Traceability	Implementation Status	Source
MOB-REQ-1.	DSRC devices must support seamless layer 2 mobility.			
MOB-REQ-2.	DSRC devices must support seamless layer 3 mobility.			
MOB-REQ-3.	DSRC devices must support link quality metric.			
MOB-REQ-4.	DSRC devices must support low latency handoff in the order of milliseconds.			
MOB-REQ-5.	DSRC devices must be able to detect communication zones			
MOB-REQ-6.				
MOB-REQ-7.				

On Board Unit Requirements

Table 6-6 lists the On Board Unit Requirements.

Table 6-6 On Board Unit Requirements

Requirement #	Requirement Description	Use Case Traceability	Status	Source
OBU-REQ-1	The OBU shall be able to transmit and receive messages to and from surrounding OBUs and RSUs.			
OBU-REQ-2	OBU must support preemption.			
OBU-REQ-3	The OBU shall have ability of queuing messages to and from other OBUs and RSUs.			
OBU-REQ-4	Broadcast Reception Range for all On-board Equipment -- 325 m (1100 ft) at a standard selected RSE power output			
OBU-REQ-5	The OBE must be able to negotiate the frequency of operation			Cash
OBU-REQ-6	OBU must be configurable and programmable			ISO[4]
OBU-REQ-7	The OBU shall be able to receive periodic GPS data.			
OBU-REQ-8	Implement OBUs with store and forward functionality, so parked cars can be used as pseudo-RSUs	UC-		Lothar Stibor
OBU-REQ-9	Implement ad-hoc mode for OBUs working without a RSU			Lothar Stibor
OBU-REQ-10				

Road Side Unit Requirements

Table 6-7 lists Road Side Unit requirements

Table 6-7 Road Side Unit Requirements

Requirement #	Requirement Description	Use Case Traceability	Status	Source
RSU-REQ-1	The RSU shall be able to transmit and receive messages to and from surrounding OBUs and RSUs.			
RSU-REQ-2	RSU must support preemption.			
RSU-REQ-3	The RSU shall have ability of queuing messages to and from to other OBUs and RSUs.			
RSU-REQ-4	RSU Separation Distance in ft.			Cash2
RSU-REQ-5	Longitudinal RSU Separation Distance in ft.			Cash2
RSU-REQ-6	Lateral RSU Separation Distance in ft.			Cash2
RSU-REQ-7	RSU Density			Cash2
RSU-REQ-8	The RSU shall be able to receive periodic GPS data.			Cash2
RSU-REQ-9				
RSU-REQ-10				

Road Side Server Requirements

Table 6-8 lists Road Side Server requirements.

Table 6-9 RSS Functional Requirements

Requirement #	Requirement Description	Use Case Traceability	Implementation Status	Source
RSS-REQ-1.		UC-1		
RSS-REQ-2.		UC-1		
RSS-REQ-3.				
RSS-REQ-4.				

Communication Requirements

Table 6-9 lists the Communication requirements.

Table 6-9 Communication Requirements

Requirement #	Requirement Description	Use Case Traceability	Implementation Status	Source
COM-REQ-1	Communication Zones shall be variable from 2 to 1000m (7 to 3000 ft); i.e. Two-way Range for all devices -- 15 m (50 ft) • Two-way Range for some devices -- 30 m (100 ft) • Two-way Range for some devices -- 300 m (1000 ft) • Two-way Range for some devices -- 1000 m (3000 ft) • Transaction Success Rate -- 99.0 to 99.995 %		Do not understand this requirement??	
COM-REQ-2	BST Repetition Rate (related to Access Time)		????	
COM-REQ-3	Transaction Time Limit		????	
COM-REQ-4	Message Sequence Time Limit		????	
COM-REQ-5	Message sequence and packet sizes OR Transaction Size		????	
COM-REQ-6	Max. Range in ft.		???	
COM-REQ-7	Communication zone size in ft.		???	
COM-REQ-8	Introduce multi-hop communication to enlarge the communication zone, e.g. to enlarge the transaction time with the next RSU.			Lothar Stibor
COM-REQ-9	Add neighbourhood awareness, which is needed by both safety and non-safety applications based on vehicle-to-vehicle communications.			Lothar Stibor

Requirement #	Requirement Description	Use Case Traceability	Implementation Status	Source
COM-REQ-10	Dynamic network topology control based on neighbour vehicle density, transmission power and application requirements.			

Operations Center Requirements

Table 6-10 lists the Operations Center Requirements.

Table 6-10 Operations Center Requirements

Requirement #	Requirement Description	Use Case Traceability	Status	Source
OC-REQ-1	Remote software download to vehicle client.			
OC-REQ-2				
OC-REQ-3				
OC-REQ-4				

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* Check with Joe as to origin

[1] Word document titled “5-9GHz_Issues_Paper_2002a.doc” (Supplied by Broady Cash)

[2] Word document titled “5-9GHz_Issues_Paper_2002a.doc” (Supplied by Broady Cash & modified by Joe Rinchiuso)

[3] PowerPoint document titled “5-9GHz _Concept_Brf_AR+_APPLICATION_DIAGARMS_w_LINK_BUDGETS_+_REQUIREMENTS_Expanded.ppt” (Supplied by Broady Cash)

[4] Word document titled “Oiso204w16-21215-n0058 Requirements Specification for CALM M5-V2.0.doc” (Supplied by Knut Evensen)