Master Purchase Order

DO NOT INVOICE TO THIS ADDRESS		Workday™ Supplier Contract No.	SC-00005877
City & County of Denver		Date: 7/12/2021	Revision No.
Purchasing Division		Payment Terms	Net 30 — Resolution (as applicable):
201 West Colfax Avenue, Dept. 304		Freight Terms	FOB DESTINATION
Denver, CO 80202		Ship Via	Best Way
United States		Analyst:	Joseph Furman
Phone: 720-913-8100 Fax: 720-913-8101		Phone:	720-913-8110

Workday Supplier ID: SUP-00004621 Phone: 408-758-1720 Email: Jozsef.kovacs@commsignia.com

Commsignia, Inc
5201 Great America Pkwy
Suite 320
Santa Clara, CA 95054
Attn: Jozsef Kovacs
Colorado Secretary of State ID: 20191942059
U.S. Federal SAM Registry Verification Date: 04/21/2021

Ship To: 5440 Roslyn St
Denver, CO 80216

Bill To: As Specified By Agency

1. **Goods/Services:**
Commsignia, Inc., a corporation in the State of Delaware, ("Vendor") shall provide the goods, and any services related thereto, identified and described on attached **Exhibit A**, to the City and County of Denver, a Colorado municipal corporation (the "City"), all in accordance with the terms and conditions of this Master Purchase Order.
2. **Ordering:**
The City shall purchase one or more of the goods/services by issuing a written purchase order(s) or similar appropriate written document ("Order"), each of which will be deemed incorporated into this Agreement for purposes of such Order only.
3. **Pricing:**
The pricing/rates for the goods/services is contained on **Exhibit A** and shall be held firm for the term of this Master Purchase Order.
4. **Term/Renewal:**
The term of this Agreement shall be from date of City signature to and including 2/28/2024. The City and the vendor may mutually agree to renew and continue this agreement for additional periods at the same pricing structure, terms and conditions. However, no renewal shall surpass 2/28/2026.
5. **Non-Exclusive**:
This Master Purchase Order is non-exclusive. City does not guarantee any minimum purchase other than as provided herein.
6. **Inspection and Acceptance:**
Vendor shall perform any services in accordance with the standard of care exercised by highly competent vendors who perform like or similar services. City may inspect all goods/services prior to acceptance. Payment does not constitute acceptance. Vendor shall bear the cost of any inspection/testing that reveal goods/services that are defective or do not meet specifications. City's failure to accept or reject goods/services shall not relieve Vendor from its responsibility for such goods/services that are defective or do not meet specifications nor impose liability on City for such goods/services. If any part of the goods/services are not acceptable to City, City may, in addition to any other rights it may have at law or in equity: (1) make a warranty claim; (2) or reject and return the goods at Vendor's cost and/or reject the services at Vendor's expense for full credit. Any rejected goods/services are not to be replaced without written authorization from City, and any such replacement shall be on the same terms and conditions contained in this Purchase Order.
7. **Shipping, Taxes and Other Credits and Charges:**
All pricing is F.O.B. destination unless otherwise specified. Shipments must be marked with Vendor's name, the Master Purchase Order number, and contain a delivery or packing slip. Vendor shall not impose any charges for boxing, crating, parcel post, insurance, handling, freight, express or other similar charges or fees. Vendor shall notify City in writing of any price decreases immediately, and City shall receive the benefit thereof on all unshipped items. Vendor shall comply with any additional delivery terms specified herein. Vendor shall be responsible for the cleanup and reporting of any contamination (environmental or otherwise) or spillage resulting from the delivery and/or unloading of goods within twenty-four (24) hours of the contamination or spillage or sooner if required by law. Vendor shall procure all permits and licenses; pay all charges, taxes and fees; and give all notices

necessary and incidental to the fulfillment of this Master Purchase Order and all cost thereof have been included in the prices contained herein. City shall not be liable for the payment of taxes, late charges or penalties of any nature, except as required by D.R.M.C. § 20-107, et seq. The price of all goods/services shall reflect all applicable tax exemptions. City's Federal Registration No. is 84-6000580 and its State Registration No. is 98-02890. Vendor shall pay all sales and use taxes levied by City on any tangible personal property built into the goods/services. Vendor shall obtain a Certificate of Exemption from the State of Colorado Department of Revenue prior to the purchase of any materials to be built into the goods/services and provide a copy of the Certificate to City prior to final payment.

8. **Risk of Loss:**
   Vendor shall bear the risk of loss, injury or destruction of goods prior to delivery to City. Loss, injury or destruction shall not release Vendor from any obligation hereunder.
9. **Invoice:**
   Each invoice shall include: (i) the Purchase Order number; (ii) individual itemization of the goods/services; (iii) per unit price, extended and totaled; (iv) quantity ordered, back ordered and shipped; (v) an invoice number and date; (vi) ordering department's name and "ship to" address; and (vii) agreed upon payment terms set forth herein.
10. **Payment:**
    Payment shall be subject to City's Prompt Payment Ordinance D.R.M.C. § 20-107, et-seq. after City accepts the goods/services. Any other provision of this Agreement notwithstanding, in no event shall the City be liable for aggregate payments under this Master Purchase Order in excess of **Four Hundred Twenty-Five Thousand Dollars ($425,000)**. The Vendor acknowledges that any goods/services provided beyond those specifically described in **Exhibit A** are performed at Contractor's risk and without authorization from the City. City's payment obligations hereunder, whether direct or contingent, shall extend only to funds appropriated by the Denver City Council for the purpose of this Master Purchase Order, encumbered by the City after receipt of Vendor's invoice and paid into the Treasury of City. Vendor acknowledges that: (i) City does not by this Master Purchase Order, irrevocably pledge present cash reserves for payments in future fiscal years; and (ii) this Master Purchase Order is not intended to create a multiple-fiscal year direct or indirect debt or financial obligation of City. City may setoff against any payments due to Vendor any claims and/or credits it may have against Vendor under this Master Purchase Order.
11. **Amendments/Changes:**
    Only the Executive Director of General Services or his/her delegate is authorized to change or amend this Master Purchase Order by a formal written change order. Any change or amendment that would cause the aggregate payable under this Master Purchase Order to exceed the amount appropriated and encumbered for this Master Purchase Order is expressly prohibited and of no effect. Vendor shall verify that the amount appropriated and encumbered is sufficient to cover any increase in cost due to changes or amendments. Goods/services provided without such verification are provided at Vendor's risk. The Vendor has no authority to bind City on any contractual matters.
12. **Warranty**:
    Vendor warrants and guarantees to City that all hardware furnished under this Purchase Order are free from defects in workmanship and materials, are merchantable, and fit for the purposes for which they are to be used.

    This warranty does not apply to: (i) cosmetic damage, such as scratches, nicks and dents; (ii) consumable parts, such as batteries, unless product damage has occurred due to a defect in materials or workmanship; (iii) damage caused by accident, abuse, misuse, water, flood, fire, or other acts of nature or external causes; (iv) damage caused by service performed by anyone who is not an authorized service person of Vendor; or (v) damage to a product that has been modified or altered (including hardware and software) without the written permission of Vendor. In addition, Vendor reserves the right to refuse warranty claims against products or services that are obtained and/or used in contravention of the laws of any country.

    Vendor warrants that software (whether part of a hardware product or licensed standalone) will be conformant with agreed written specifications and will contain agreed features and functions.

    For any goods furnished under this Purchase Order which become defective within twelve (12) months (unless otherwise specified) after date of receipt by City, Vendor shall either, at City's election and to City's satisfaction, remedy any and all defects or replace the defective goods at no expense to City within seven (7) days of receipt of the defective goods or accept the defective goods for full credit and payment of any return shipping charges. Vendor shall be fully responsible for any and all warranty work, regardless of third-party warranty coverage. Vendor shall furnish additional or replacement parts at the same prices, conditions and specifications delineated herein

    No other warranty of any kind, express, implied, or statutory, including, but not limited to, implied warranties is given by Vendor. The sole remedy provided by vendor is the warranty provided as stated above."
13. **Indemnification/Limitation of Liability:**

Vendor shall indemnify and hold harmless City (including but not limited to its employees, elected and appointed officials, agents and representatives) against any and all losses (including without limitation, loss of use and costs of cover), liability, damage, claims, demands, actions and/or proceedings and all costs and expenses connected therewith (including without limitation attorneys' fees) that arise out of or relate to any claim of infringement of patent, trademark, copyright, trade secret or other intellectual property right related to this Purchase Order or that are caused by or the result of any act or omission of Vendor, its agents, suppliers, employees, or representatives. Vendor's obligation shall not apply to any liability or damages which result solely from the negligence of City. Liability for claims for injuries to persons or property arising from the acts, omissions, or negligence of the City, their departments, boards, commissions committees, bureaus, offices, employees and officials shall be controlled and limited by the provisions of the Colorado Governmental Immunity Act, Colorado Revised Statutes § 24-10-101, et seq; the Federal Tort Claims Act, 28 U.S.C. Pt. VI, Ch. 171 and 28 U.S.C. 1346(b); and the City's limitation on liability for torts, Denver Revised Municipal Code § 1.1.7.

Furthermore in no case shall Vendor be liable for (i) any claim relating to the use of third party products or customer products in combination with Vendor products, services or software or (ii) for claims regarding specifications or instructions given by City, or (iii) for any loss of profit, business or goodwill, loss of or corruption of confidential or other information or data, for business interruption, for loss of use of equipment, for loss of privacy or (iv) consequential, incidental, indirect, special, reliance, or punitive damages or for any lost profits or revenues, regardless of the legal theory under which such liability is asserted.

Vendor shall not be liable for operating microwave radio modules in Vendor communication equipment outside the national and international regulatory rules. All radio modules are, therefore, shipped disabled.

14. Termination:

City may terminate this Master Purchase Order, in whole or in part, at any time and for any reason immediately upon written notice to Vendor. In the event of such a termination, City's sole liability shall be limited to payment of the amount due for the goods/services ordered by City. Vendor acknowledges the risks inherent in this termination for convenience and expressly accepts them. Termination by City shall not constitute a waiver of any claims City may have against Vendor.

15. Interference:

Vendor shall notify the Director of Purchasing immediately of any condition that may interfere with the performance of Vendor's obligations under this Master Purchase Order and confirm such notification in writing within twenty-four (24) hours. City's failure to respond to any such notice shall in no way act as a waiver of any rights or remedies City may possess.

16. Venue, Choice of Law and Disputes:

Venue for all legal actions shall lie in the District Court in and for City and County of Denver, State of Colorado, and shall be governed by the laws of the State of Colorado as well as the Charter and Revised Municipal Code, rules, regulations, Executive Orders, and fiscal rules of City. All disputes shall be resolved by administrative hearing, pursuant to the procedure established by D.R.M.C.§ 56-106. Director of Purchasing shall render the final determination.

17. Assignment/No Third Party Beneficiary:

Vendor shall not assign or subcontract any of its rights or obligations under this Master Purchase Order without the written consent of City. In the event City permits an assignment or subcontract, Vendor shall continue to be liable under this Master Purchase Order and any permitted assignee or subcontractor shall be bound by the terms and conditions contained herein. This Master Purchase Order is intended solely for the benefit of City and Vendor with no third party beneficiaries

18. Notice:

Notices shall be made by Vendor to the Director of Purchasing and by City to Vendor at the addresses provided herein, in writing sent registered, return receipt requested.

19. Compliance With Laws:

Vendor shall observe and comply with all federal, state, county, city and other laws, codes, ordinances, rules, regulations and executive orders related to its performance under this Master Purchase Order. City may immediately terminate this Master Purchase Order, in whole or in part, if Vendor or an employee is convicted, plead nolo contendre, or admits culpability to a criminal offense of bribery, kickbacks, collusive bidding, bid-rigging, antitrust, fraud, undue influence, theft, racketeering, extortion or any offense of a similar nature.

20. Insurance:

Vendor shall secure, before delivery of any goods/services, the following insurance covering all operations, goods and services provided to City. Vendor shall keep the required insurance coverage in force at all times during the term of the Master Purchase Order, or any extension thereof, during any warranty period, and for three (3) years after termination of this Master Purchase Order. The required insurance shall be underwritten by an insurer licensed to do business in Colorado and rated by A.M. Best Company as "A-"VIII or better. If such written notice is unavailable from the insurer, contractor shall provide written notice of cancellation, non-renewal and any reduction in coverage to the parties identified in the Notices section by certified mail, return receipt requested within three (3) business days of such notice by its insurer(s) and referencing the City's contract number. If any policy is in excess

of a deductible or self-insured retention, City must be notified by Vendor. Vendor shall be responsible for the payment of any deductible or self-insured retention. The insurance coverages specified in this Master Purchase Order are the minimum requirements, and these requirements do not lessen or limit the liability of Vendor. Risk Management reserves the right to require additional policies and/or limits based on agreement scope of work. Vendor shall provide a copy of this Master Purchase Order to its insurance agent or broker. Vendor may not commence services or work relating to the Master Purchase Order prior to placement of coverage. Contractor certifies that the attached certificate of insurance attached to the Master Purchase Order documents, preferably an ACORD certificate, complies with all insurance requirements of this Master Purchase Order. The City's acceptance of a certificate of insurance or other proof of insurance that does not comply with all insurance requirements set forth in this Master Purchase Order shall not act as a waiver of Vendor's breach of this Master Purchase Order or any of the City's rights or remedies under this Agreement. The City's Risk Management Office may require additional proof of insurance, including but not limited to policies and endorsements. For Worker's Compensation Insurance, Vendor shall maintain the coverage as required by statute for each work location and shall maintain Employer's Liability insurance with limits of $100,000 for each bodily injury occurrence claim, $100,000 for each bodily injury caused by disease claim, and $500,000 aggregate for all bodily injuries caused by disease claims. Vendor expressly represents to City, as a material representation upon which City is relying, that none of the Vendor's officers or employees who may be eligible under any statute or law to reject Workers' Compensation Insurance shall effect such rejection during any part of the term of this Master Purchase Order, and that any such rejections previously effected, have been revoked. Vendor shall maintain Commercial General Liability coverage with limits of $1,000,000 for each occurrence, $1,000,000 for each personal and advertising injury claim, $2,000,000 products and completed operations aggregate, and $2,000,000 policy aggregate. Vendor shall maintain Business Auto Liability coverage with limits of $1,000,000 combined single limit applicable to all owned, hired and non-hired vehicles used in performing services under this Master Purchase Order. For claims-made coverage, the retroactive date must be on or before the first date when any goods or services were provided to City. Vendor must advise the City in the event any general aggregate or other aggregate limits are reduced below the required per occurrence limits. At their own expense, and where such general aggregate or other aggregate limits have been reduced below the required per occurrence limit, the Vendor will procure such per occurrence limits and furnish a new certificate of insurance showing such coverage is in force

21. **Severability:**
If any provision of this Master Purchase Order, except for the provisions requiring appropriation and encumbering of funds and limiting the total amount payable by City, is held to be invalid, illegal or unenforceable by a court of competent jurisdiction, the validity of the remaining portions or provisions shall not be affected if the intent of City and Vendor can be fulfilled.

22. **Survival:**
All terms and conditions of this Master Purchase Order which by their nature must survive termination/expiration shall so survive. Without limiting the foregoing, Vendor's insurance, warranty and indemnity obligations shall survive for the relevant warranty or statutes of limitation period plus the time necessary to fully resolve any claims, matters or actions begun within that period.

23. **No Construction Against Drafting Party:**
No provision of this Master Purchase Order shall be construed against the drafter.

24. **Status of Vendor/Ownership of Work Product:**
Vendor is an independent contractor retained on a contractual basis to perform services for a limited period of time as described in Section 9.1.1E(x) of the Charter of City. Vendor and its employees are not employees or officers of City under Chapter 18 of the D.R.M.C. for any purpose whatsoever. All goods, deliverables, hardware, plans, drawings, reports, submittals and all other documents or things furnished to City by Vendor shall become and are the property of City, without restriction. Ownership rights shall include, but not be limited to the right to copy, publish, display, transfer, prepare derivative works, or otherwise use materials. Software licenses terms may be incorporated herein by an End User License Agreement signed by the Director of Purchasing. Any 'click-wrap' electronic acceptance or other terms and conditions not agreed to in writing by the Director of Purchasing are of no force and effect. **Records and Audits:**
Vendor shall maintain for three (3) years after final payment hereunder, all pertinent books, documents, papers and records of Vendor involving transactions related to this Master Purchase Order, and City shall have the right to inspect and copy the same.

25. **Remedies/Waiver:**
No remedy specified herein shall limit any other rights and remedies of City at law or in equity. No waiver of any breach shall be construed as a waiver of any other breach.

26. **No Discrimination in Employment:**
In connection with the performance of work under this Master Purchase Order, the Vendor may not refuse to hire, discharge, promote or demote, or discriminate in matters of compensation against any person otherwise qualified, solely because of race, color, religion, national origin, gender, age, military status, sexual orientation, gender identity or gender expression, marital status, or physical or mental disability. The Vendor shall insert the foregoing provision in all subcontracts.

27. Use, Possession or Sale of Alcohol or Drugs:
Vendor shall cooperate and comply with the provisions of Executive Order 94. Violation may result in City terminating this Master Purchase Order or barring Vendor from City facilities or from participating in City operations.

28. Conflict of Interest:
No employee of City shall have any personal or beneficial interest in the goods/services described in this Master Purchase Order; and Vendor shall not hire or contract for services any employee or officer of City which would be in violation of City's Code of Ethics, D.R.M.C. §2-51, et seq. or the Charter §§ 1.2.8, 1.2.9, and 1.2.12.

29. Advertising and Public Disclosure:
The Vendor shall not include any reference to the Master Purchase Order or to services performed or goods purchased pursuant to the Master Purchase Order in any of the Vendor's advertising or public relations materials without first obtaining the written approval of the Director of Purchasing.

30. No Employment of Illegal Aliens to Perform Work Under The Agreement:

a. This Agreement is subject to Division 5 of Article IV of Chapter 20 of the Denver Revised Municipal Code, and any amendments (the "Certification Ordinance").

b. The Vendor certifies that:

(1) At the time of its execution of this Agreement, it does not knowingly employ or contract with an illegal alien who will perform work under this Agreement.

(2) It will participate in the E-Verify Program, as defined in § 8-17.5-101(3.7), C.R.S., to confirm the employment eligibility of all employees who are newly hired for employment to perform work under this Agreement.

c. The Vendor also agrees and represents that:

(1) It shall not knowingly employ or contract with an illegal alien to perform work under the Agreement.

(2) It shall not enter into a contract with a subconsultant or subcontractor that fails to certify to the Contractor that it shall not knowingly employ or contract with an illegal alien to perform work under the Agreement.

(3) It has confirmed the employment eligibility of all employees who are newly hired for employment to perform work under this Agreement, through participation in the E-Verify Program.

(4) It is prohibited from using the E-Verify Program procedures to undertake pre-employment screening of job applicants while performing its obligations under the Agreement, and that otherwise requires the Vendor to comply with any and all federal requirements related to use of the E-Verify Program including, by way of example, all program requirements related to employee notification and preservation of employee rights.

(5) If it obtains actual knowledge that a subconsultant or subcontractor performing work under the Agreement knowingly employs or contracts with an illegal alien, it will notify such subconsultant or subcontractor and the City within three (3) days. The Vendor will also then terminate such subconsultant or subcontractor if within three (3) days after such notice the subconsultant or subcontractor does not stop employing or contracting with the illegal alien, unless during such three-day period the subconsultant or subcontractor provides information to establish that the subconsultant or subcontractor has not knowingly employed or contracted with an illegal alien.

(6) It will comply with any reasonable request made in the course of an investigation by the Colorado Department of Labor and Employment under authority of § 8-17.5-102(5), C.R.S, or the City Auditor, under authority of D.R.M.C. 20-90.3.

d. The Contractor is liable for any violations as provided in the Certification Ordinance. If Contractor violates any provision

of this section or the Certification Ordinance, the City may terminate this Agreement for a breach of the Agreement. If the Agreement is so terminated, the Contractor shall be liable for actual and consequential damages to the City. Any such termination of a contract due to a violation of this section or the Certification Ordinance may also, at the discretion of the City, constitute grounds for disqualifying Contractor from submitting bids or proposals for future contracts with the City.

31. FEDERAL PROVISIONS:

Where the source of the funds, directly or indirectly for this Purchase Order is the Federal Government, the Vendor agrees to the applicable provisions set out below. The Vendor shall be responsible for determining which terms are applicable to its products and/or services.

EQUAL EMPLOYMENT OPPORTUNITY COMPLIANCE Vendor agrees to comply with Executive Order 11246 of September 24, 1965, entitled "Equal Employment Opportunity," as amended by Executive Order 11375 of October 13, 1967, and as supplemented in Department of Labor regulations (41 CFR Part 60).
DAVIS-BACON ACT COMPLIANCE Vendor agrees to comply with the Davis-Bacon Act (40 U.S.C. 3148 to 3148) as supplemented by Department of Labor regulations (29 CFR part 5). **ANTI-KICKBACK ACT COMPLIANCE** Vendor agrees to comply with the Copeland "Anti-Kickback" Act (18 U.S.C. 874) as supplemented in Department of Labor regulations (29 CFR Part 3). **CONTRACT WORK HOURS AND SAFETY STANDARDS** Vendor agrees to comply with Sections 102 and 107 of the Contract Work Hours and Safety Standards Act (40 U.S.C. 327-333), as supplemented by Department of Labor regulations (29 CFR part 5) **RIGHTS TO INVENTIONS MADE UNDER A CONTRACT OR AGREEMENT** Vendor agrees to comply with 37 CFR part 401, "Rights to Inventions Made by Nonprofit Organizations and Small Business Firms Under Government Grants, Contracts and Cooperative Agreements," and any implementing regulations issued by the awarding agency. **CLEAN AIR AND WATER REQUIREMENTS** Vendor agrees to comply with all applicable standards, orders, or requirements issued under the Clean Air Act (42 U.S.C. 7401 et. seq.), and the Clean Water Act (33 U.S.C. 1251 et. seq.). Vendor agrees to report each violation of these requirements to the City and understands and agrees that the City will, in turn, report each violation as required to the appropriate EPA regional office. **ENERGY CONSERVATION REQUIREMENTS** The Vendor agrees to comply with mandatory standards and policies relating to energy efficiency which are contained in the state energy conservation plan issued in compliance with the Energy Policy and Conservation Act. (42 U.S.C. 6201) **NO SUSPENSION OR DEBARMENT** Vendor certifies that neither it nor its Principals or any of its subcontractors is presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation in this Agreement by any Federal department or agency. **BYRD ANTI-LOBBYING**. If the Maximum Contract Amount exceeds $100,000, the Vendor must complete and submit to the City a required certification form provided by the City certifying that it will not and has not used Federal appropriated funds to pay any person or organization for influencing or attempting to influence an officer or employee of any agency, a member of Congress in connection with obtaining any Federal contract grant of any other award covered by 31 U.S.C. 1352. Vendor must also disclose any lobbying with non-Federal funds that takes place in connection with obtaining any Federal award.

This Master Purchase Order is acknowledged and agreed to by:

		City & County of Denver, Purchasing Division
Vendor Name:	Commsignia, Inc.	
	(Company Name)	
By: By:	DocuSigned by: 402BBCB4A82E45B... (Authorized Signature)	Joseph Furman
Print Name: Print Name:	Jozsef Kovacs	Joseph Furman
Title: Title:	CEO	Sr. Procurement Analyst
Date: Date:	7/15/2021	7/15/2021

Supervisor Initial: Romero, Michael P. - Purchasing Digitally signed by Romero, Michael P. - Purchasing Date: 2021.07.13 06:59:57 -06'00'

EXHIBIT "A"

Supplier: Commsignia, Inc.
Solicitation/ Award Title: Dual Roadside and Onboard Units
Solicitation No. /Internal File Reference Location: RFP # 11047

It is recommended that you use your Supplier Contract No SC-00005877 in all future correspondence and/or other communications.

Description of the goods, and services related thereto, being purchased and pricing:

There are three Connected Vehicle (CV) projects in the ATCMTD Program, the City and County of Denver (CCD) hopes to improve congestion, safety, data collection, and communication. To achieve these objectives, new or modified capabilities, functions, processes, and interfaces are being introduced within the traffic equipment. As such, CCD is focused on purchasing Dual **Dedicated Short-Range Communications (DSRC) / Cellular-Vehicle to Everything (C-V2X) Dual Roadside (RSU) and Onboard Units (OBU) with** the following CV applications:

- Freight and Snowplow Signal Priority
- Basic Safety Messages (BSMs) to TMC
- Pedestrian in Signalized Crosswalk Warning

Supporting these applications and the general CV environment consisting of roadside, onboard, and back-end infrastructure, are core services that will allow safe, secure, and reliable operations of each system.

The RSU's will be installed on traffic intersections pre-identified for the ATCMTD Program.

The OBU's will be installed on a variety of vehicles in the City and County of Denver Fleet.

Current requirements estimate no more than 300 Dual Units total.

SCOPE OF WORK:

A.1.a **Roadside Systems Scope**

Roadside Systems to be provided and quoted are:

- Roadside Unit with DSRC (Dedicated Short-Range Communication) and C-V2X (Cellular Vehicle to Everything) communication compatibility and an interface to a GUI (Graphical User Interface) with interoperability to existing ITS equipment deployed by City and County and Denver
- GPS, DSRC, C-V2X Antennas A.1.b **Vehicle Systems Scope:**

Vehicle Systems to be provided and quoted are:

- On-Board Unit with DSRC and C-V2X communication compatibility and accessible using a Human Machine Interface (HMI) (Android Tablet)

- GPS, DSRC and C-V2X Antennas

The figure below shows the Scope of Work, which consists of Roadside System and Vehicle System:

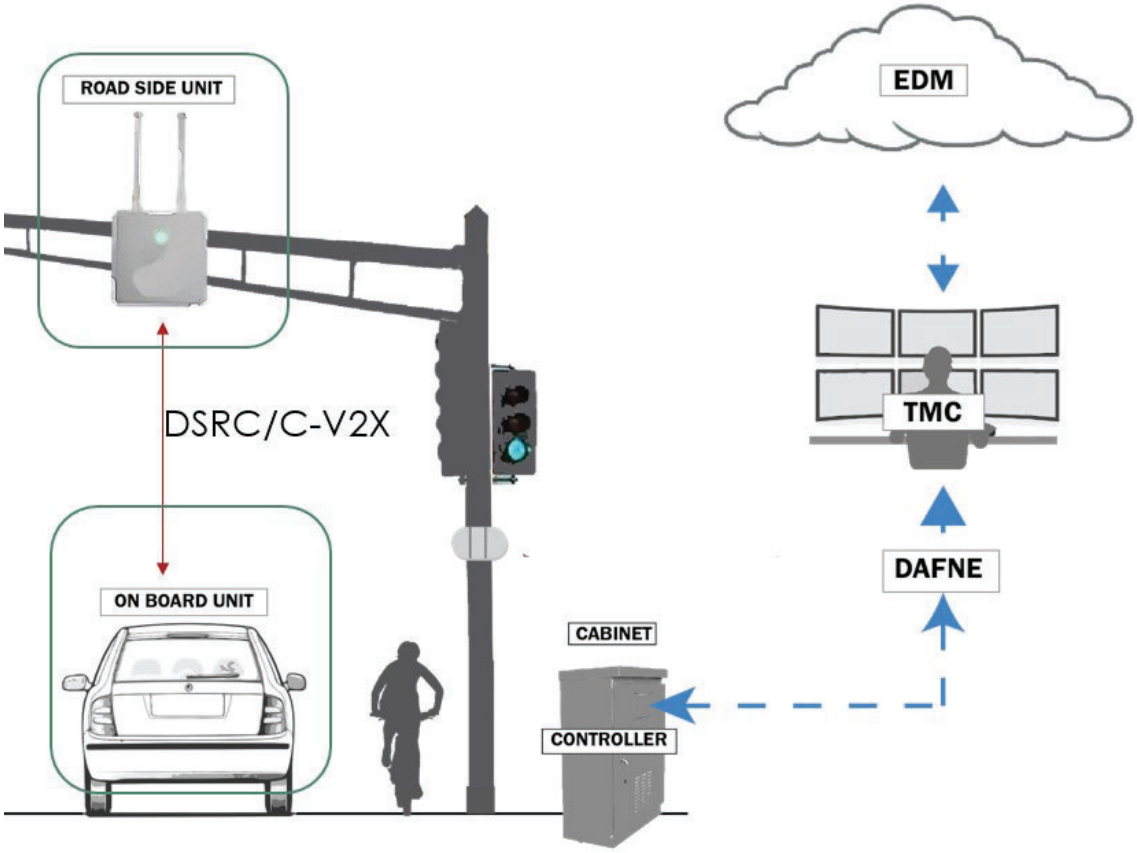


Figure 1: Connected Vehicle Systems Scope

VENDOR PERFORMANCE MANAGEMENT:

The Purchasing Department may administer a vendor performance management program as part this proposal and resulting contract. The purpose of this program is to create a method for documenting and advising the Purchasing Department of exceptional performance or any problems related to the purchased goods and services.

Propose as part of your response specific performance measures that may be used to develop a vendor performance management report card. Also provide any other data, criterion or methods that would be effective in measuring vendor performance over the life of this contract.

NON-OBSOLESCENCE:

Once product is designated as approaching end of life and a new product is identified, the City expects the supplier to provide the replacement product at the price proposed and for it to have all the same functionality and capabilities as the product it replaced. Such designations are to be communicated to the buyer within fourteen (14) calendar days of the date of notification. This includes when current models are discontinued or upgraded.

FREIGHT:

NO ADDITIONAL SHIPPING CHARGES AND/OR SURCHARGE will be paid by the City. All shipping charges are to be included in the bid prices. In the event the market price on any item is reduced during the period of the contract, the supplier shall reduce the proposal price to the City accordingly.

WARRANTY GUARANTEE:

Supplier shall be fully responsible for any and all warranty work, regardless of whether or not manufacturers of equipment, and/or its component parts, provide the actual warranty coverage.

FAILURE TO DELIVER:

In the event of failure of an awarded supplier to deliver the goods in accordance with the contract terms and conditions, the City may immediately terminate the contract.

3 SECTION C: PRICING PROPOSAL

3.1 Exhibit B - Pricing Matrix

Pricing Matrix	Commsignia Inc.									
ITEM DESCRIPTION	Part #	QTY	UOM	Unit Cost	Cost Year 1	Cost Year 2	Cost Year 3	Cost Year 4	Cost Year 5	Supplier Explanations and Assumptions (if any)
Onboard Unit with applications and interface to the Human Machine Interace (HMI) (Android Tablet)		300	EA	$ 2 490,00	$ 747 000,00					
DSRC/C-V2X Dual Roadside Unit		300	EA	$ 2 784,30	$ 835 290,00					
GPS, DSRC, and C-V2X Antennas		300	EA	$ 187,50	$ 56 250,00					
Ancillary Supporting Equipment (*)		1	ONE TIME	$ 189 000,00	$ 189 000,00					
Device Configuration		600	EA	$ 187,50	$ 112 500,00					
General Support and Maintenance		1	YEAR	$ 58 932,00	$ 58 932,00	$ 58 932,00	$ 58 932,00	$ 58 932,00	$ 58 932,00	General Support and Maintenance consists of Commsignia's Premium Support and Mainline Maintenance packages. Price for the maintenance part is calculated for 300 + 300 units - in case of partial order the price may be reduced. See Section 3 - Pricing Proposal part in the document for Support and Maintenance Package descriptions.
Warranty Extension										Price of the warranty extension is calculated for 300 + 300 units.
1 + 2 years	N/A	1	YEAR	$ 137 529,00	$ -	$ 137 529,00	$ 137 529,00			1st year cost is included in the Hardware prices. If 'Cost Year 2' and 'Cost Year 3' is paid upfront in 'Cost Year 1' then additional 10 % discount applies.
1 + 4 years	N/A	1	YEAR	$ 103 146,75	$ -	$ 103 146,75	$ 103 146,75	$ 103 146,75	$ 103 146,75	1st year cost is included in the Hardware prices. If 'Cost Year 2', 'Cost Year 3' 'Cost Year 4', 'Cost Year 5' is paid upfront in 'Cost Year 1' then additional 10 % discount applies.
Subtotal					**$ 1 998 972,00**	**$ 58 932,00**	**$ 58 932,00**	**$ 58 932,00**	**$ 58 932,00**	
Total	$ 2 234 700,00									

(*) Supplier shall provide itemized list, complete with unit costs and quantities, of any ancillary supporting equipment required

(*) Ancillary Supporting Equipment details:

SCMS/PKI integration, enrollment and hardening: **$378 USD / unit**

Total number: **300 OBUs + 300 RSUs**

Roadside Systems Scope

Dual Mode ITS-RS4 Road Side Unit

Product code: ITS-RS4-M ver:D-SGLB

Designed for Cooperative ITS deployment, the fourth generation ITS-RS4 from Commsignia is the ultimate V2X communication solution for roadside applications and future edge computing solutions. The platform combines a high performance application CPU with real-time V2X software stack and radio interfaces with the ability to connect it with sensors along the road. Enhanced security solutions, IP66/IP67 enclosure and Industrial grade design offers a professional solution for equipment operators and makes TMC integration easy and secure.

Figure: ITS4-RS4 Roadside Unit

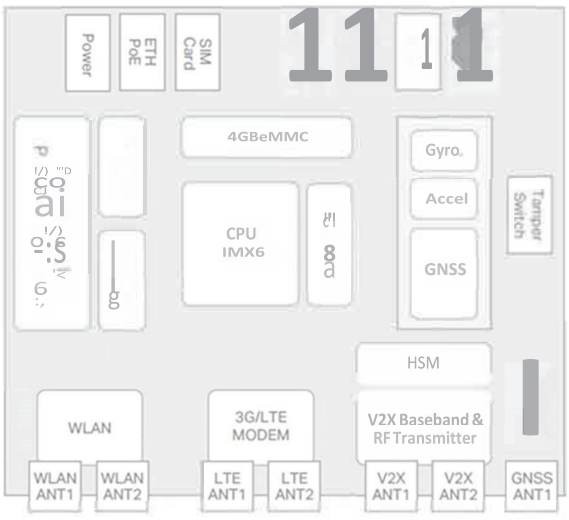


Figure: ITS4-RS4 Roadside Unit Software Architecture

CORE FEATURES	
CPU	800 MHz Freescale/NXP i.MX 6
OS	Linux / RTOS fV2X)
RAM	2 GB DDR3 SDRAM
FLASH	4 GBeMMc
STORAGE	Dual micro SD Card slot
ETHERNET	10/100/1000 Mbps Ethernet PoE
EXTERNAL 1/0	Dual USB 2.0, GPIO
SUPERVISOR	Yes
POWER SUPPLY	8-32 VOe / PoE (surge and reverse polarity protected)
BACKUP POWER	Yes (10s Store & Shutdown) (optional)
POSITIONING	Advanced GNSS
WIFI	Dual band a/b/g/n Mini PCIe slot #1 only (optional)
BLUETOOTH	Yes foptional)
CELLULAR	3G / LTE (M1Mo) Mini PCIe slot #2 only
IMU	3 axis gyroscope BOSCH 3 axis accelerometer BMI 160 3 axis magnetometer BMM150

CONNECTORS	
ANTENNA - dimensions	2 x V2X, 2 x Wifi, 2 x LTE/3G1 x GNSS DSRC/I.TE/C-V2X/WiR:178mmx022mm GPS dome antenna: 64mm x 055mm
DATA	1 x ETH, 2 x USB, 1 x CAN, 1 x OBD-11
OTHER	Power connector2 x Bicolor LEDs
EXTENSION	2 x M1n1 PCIe slots

ENCLOSURE
Protection: NEMA4X -IP67, vibration proofwaterproof outdoor enclosure
Mount: pole and wall mountable
Dimensions: (Wx H xD) 227mm x 90mm x 257mm

AVAILABLE V2X RADIO/ARJANTS
Autotalks Seeton
NXP TEF5100 (Rf Transceiver) & SAF5100 fBaseband)
Marvell SDIO (88W8987PA)
Qualcomm 9150

SECURITY
Hardware Security Module (HSM) SLI97
ECDSA verification(> 2000verifications) ECDSA encryption(< 50 usec signing delay)
NIST and Brainpool verification, encryption
Secure boot. encrypted storage, tamper proof system
EAL6+ certified and available with up to 1 MBof secure SOLJD FLASH
ARM TrustZone including the TZ architecture

Traffic light controller integration and support

The Commsignia RSU platform software contains a built-in configuration interface for certain traffic light controllers. Currently the following controllers are supported for SPaT broadcasting purposes:

- Trafficware
- Econolite
- Intelight

TrafficWare signal controllers (US based company) are used in the Las Vegas deployment project for the CES autonomous shuttle bus / Lyft self-driving taxi real-life projects in January 2018.

The below standards are supported by the Commsignia ITS-RS4-M which could be used with different traffic light controller models:
- Immediate Forwarding -
Battelle SpaT

More advanced integration with bi-directional communication enables V2X application integration as well such as Traffic Signal Priority (TSP). Currently it is available with the following controllers:

- Trafficware
- Intelight

We are working on further integrations with our partners and additional traffic signal controller integrations are possible project based.

Pedestrian Detection

Pedestrian Safety Messages can be triggered by the Commsignia RSUs based on the detected location of pedestrians so that vehicles can be notified about possible danger. This and similar features are part of Commsignia fusion platform which goal is to speed up the transition phase of V2X deployments while the penetration level is not sufficient. This way non V2X enabled participants of the transportation and traffic can be involved into the V2X ecosystem.

The Commsignia fusion platform enables smart sensors to be integrated in a smooth way, merging detection data coming from the sensors with data coming from the V2X system. Commsignia already demonstrated integrated solutions for truck detection with a SmartMicro smart radar connected with the Commsignia RSU. Smart cameras and lidars can also be connected and integrated to provide pedestrian detection data for generating PSM messages at the RSU and broadcast them around the intersection.

The integration effort for adding a smart camera solution for pedestrian detection and automatic PSM generation is not part of our current offer. Commsignia needs to know the selected smart sensor vendor and receive the interface description documents for the selected sensor model first to estimate the amount of work required for full integration.

RSU Management Solutions

Commsignia RSUs units are providing two different operation modes. The standalone mode assumes a single RSU without any kind of remote connection. Standalone RSUs broadcast pre-defined messages or perform local integration with a traffic light controller. Connected RSUs are installed in a network environment where each node is accessible from a central location.

The Commsignia RSUs can be integrated into 3rd party RSU management platforms on a project basis, but Commsignia also has its own Centralized Software Solution for RSU monitoring, remote management including configuration and software upgrades.

For further information please read the "Centralized Software Solution Package" chapter in this document.

Remote management of Standalone RSUs

The Commsignia RSU software has flexible remote management capabilities including the below features: CLI management (SSH Client)
Web dashboard
Web based system configuration
Managed remote firmware upgrade

This approach can be applied if no central RSU management solution is deployed. This way single RSUs can be accessed via the network and they provide a user-friendly GUI for status check and configuration.

Web Based interface of the Commsignia RSU:

FHWA RSU 4.1 compliance

On Behalf of US DOT FHWA maintains an RSU specification which most important goal is to define universal behavioral and interface requirements for RSU vendors to make the work of integrators easier. Commsignia recommends using its own API while it provides higher level integration, but we understood the importance of universality from integrators point of view.
The most important RSU 4.1 requirements are available as core features of Commsignia RSU products such as:

SNMP interface

Store and Repeat function

Immediate Forward function

WSA management

DSRC data forwarding

Operation Modes

And in addition to the above listed RSU 4.1 - specific features the core stack fulfills by default the essential RSU 4.1 requirements:

HSM-secured security (IEEE 1609.2)

Network, transport and facility layer protocol conformance (IEEE 1609.3, 4, 12 & SAE DSRC)

SCMS integration

.Linux Operating System for Commsignia ITS-RS4

The device is running a Linux operating system and can be accessed by the console through a serial connection or SSH and also through a graphical user interface from a web browser.
The network management possibilities of its own RSU units that enables the user to set IP networking, DNS, DynDNS settings, routing, firewall, NAT, VPN and many more network related options. Support for wireless and cellular network configuration as also included.

Secure Host Platform

Due to requirements for increasing levels of security and robustness, Commsignia implemented the following features to support a fully integrated secure host platform including:

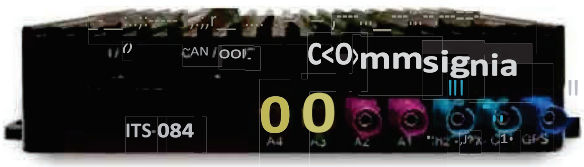
- Secure Boot
- Failover (Dual-Bank) Firmware Upgrade Management
- Encrypted Storage
- Encrypted Upgrades
- Tamper Detection
- Process Supervisor Framework

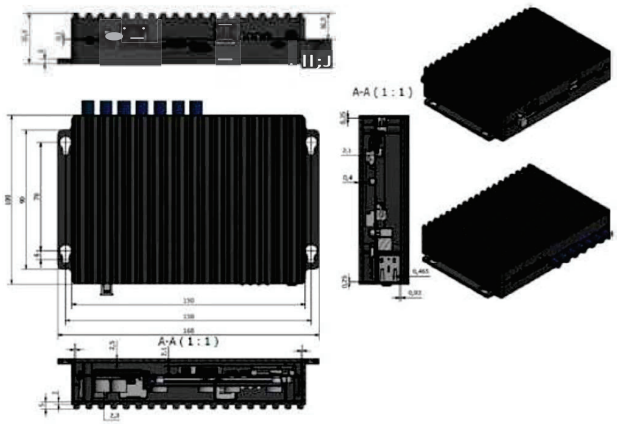
Securing the host platform of each deployed RSU is required by SCMS providers to ensure these devices are tamper proof and secure from cybersecurity attacks. SCMS enrolment of the RSUs can be done after these security hardening steps which must be carried out during the production phase in a secured environment.

Vehicle Systems Scope

Dual Mode V2X Onboard Unit

Product code: ITS-0B4-M ver:D-W-S-S1
The fourth generation of Commsignia's vehicular connectivity system offers superior performance coupled with V2X Software stack. The unit provides low-cost and easy OEM / aftermarket integration, offering built in Tamper-proof Hardware Security Module, CAN, high range V2X radio and easy HMI integration. By combining the benefits of automotive grade design, high performance application CPU and dual channel V2X radio performance, the ITS-OB4 offers a professional, complete and future proof solution.





Commsignia ITS-0B4

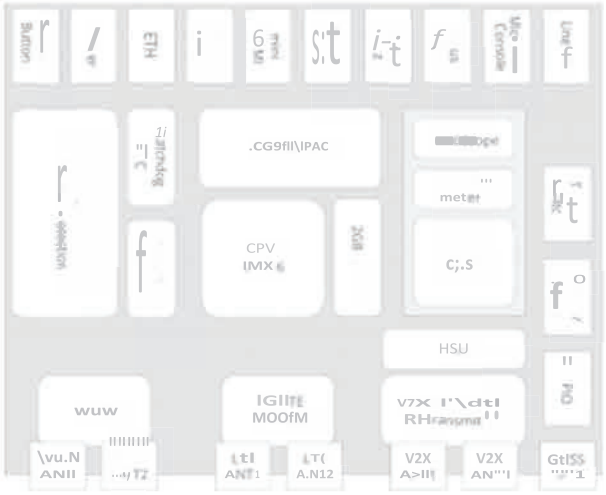


Figure: V2X Onboard UnitSoftware Architecture

CORE FEATURES	
CPU	800 MHz Freescale/NXP i.MX 6
OS	Linux/ RTOS(V2X)
RAM	2G BDDR3 SDRAM
FLASH	4GBeMMc
STORAGE	Dual micro SD Card slot
ETHERNET	10/100/1000 Mbps Ethernet
EXTERNAL 1/0	Dual USB 2.0, GPIO
SUPERVISOR	Yes
POWER SUPPLY	8-32 voe, PoE (surge and reverse polarity protected)
BACKUP POWER	Yes(10s Store & Shutdown)(optional)
POSITIONING	Advanced GNSS
WIFI	Dual band a/b/g/n Mini PCIe slot #1 only(optional)
BLUETOOTH	Yes(optional)
CELLULAR	3G ILTE(MiMo) Mm1 PCIe slot #2 only
IMU	3 axis gyroscope BOSCH 3 axis accelerometer BMI 160 3 axis magnetometer BMM150

CONNECTORS	
ANTENNA	2 xV2X, 2 x WiFi, 2 x LTE/3G, 1 xGNSS
DATA	1 xETH ,2 xUSB, 1 xCAN, 1 xOBD-11
OTHER	Power connector Reset button 4 x81color LEDs
EXTENSION	2 xMini PCIe slots
VIDEO	HDMI 1.4a
LINE OUT	3.5 mmJack

DIMENSIONS
(W xH xD) 168x32.2x109mm/ 6.61 x1.26 x4.29 inches

AVAILABLEV2X RADIO VARIANTS
Autotalks Seeton
NXP TEF5100(RF Transceiver) & SAF5100 (Baseband)
Marvell SDIO (88W8987PA)
Qualcomm 9150

SECURITY
Hardware Security Module(HSM) SLI97
ECDSA verification(> 2000 verifications), ECDSA encryption(< 50 usec signing delay)
NIST and Brainpool verification, encryption
Secure boot. encrypted storage, tamper proof system
EAL6+ certified and available with up to 1MB of secure SOLID FLASH
ARM TrustZone including the TZ architecture

ENVIRONMENTAL
Operation humidity: 10o/o-95o/o
Storage humidity: max95%
Temperature range: -40C -+85C
Vibration proof

Mounting

The OBU can be mounted in any direction thanks to the mounting holes on the enclosure, double sided tape might be used as well.

Standard compliance of the V2X Communication Software (RSU, OBU)

Full ID	Region Radio	Layer	Title
ETSI EN 302 571-V2.1.1	EU G5	Access	Radiocommunications equipment operating in the 5 855 MHz to 5 925 MHz frequency band; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU
ETSI EN 302 663-V1.2.1	EU G5	Access	Access layer specification for Intelligent Transport Systems operating in the 5 GHz frequency band
ETSI TS 103 613 V1.1.1	EU LTE	Access	Access layer specification for Intelligent Transport Systems using LTE Vehicle to everything communication in the 5,9 GHz frequency band
ETSI EN 302 636-4-1-V1.3.1	EU G5	Network	GeoNetworking; Geographical addressing and forwarding for point-to-point and point-to-multipoint communications; Media-Independent Functionality
ETSI EN 302 931-V1.1.1	EU G5+LTE	Network	Geographical Area Definition
ETSI EN 302 636-1-V1.2.1	EU G5+LTE	Network	GeoNetworking; Requirements
ETSI EN 302 636-2-V1.2.1	EU G5+LTE	Network	GeoNetworking; Scenarios
ETSI EN 302 636-3-V1.2.1	EU	Network	GeoNetworking; Network Architecture
ETSI EN 302 636-5-1-V2.1.1	EU G5	Network	GeoNetworking; Transport Protocols; Basic Transport Protocol
ETSI TS 102 731 V1.1.1	EU G5+LTE	Security	Security; Security Services and Architecture
ETSI TS 102 940 V1.3.1	EU G5+LTE	Security	Security; ITS communications security architecture and security management
ETSI TS 103 097-V1.3.1	EU G5+LTE	Security	Security; Security header and certificate formats
ETSI TS 102 941-V1.3.1	EU G5+LTE	Security	Security; Trust and Privacy Management
ETSI TR 103 415 V1.1.1	EU G5	Pseudonymity	Security; **Pre-standardization study** on pseudonym change management
ETSI TS 102 942 V1.1.1	EU G5+LTE	Security	Security; Access Control
ETSI TS 102 943 V1.1.1	EU G5+LTE	Security	Security; Access Control
ETSI TS 102 894-1 V1.1.1	EU G5+LTE	Facilities	Users and applications requirements; Part 1: Facility layer structure, functional requirements and specifications
ETSI EN 302 637-2-V1.4.0	EU G5+LTE	Facilities	Basic Set of Applications; Specification of Cooperative Awareness Basic Service
ETSI EN 302 637-3-V1.3.0	EU G5+LTE	Facilities	Basic Set of Applications; Specifications of Decentralized Environmental Notification Basic Service
ETSI TS 102 894-2-V1.3.1	EU G5+LTE	Facilities	Users and applications requirements; Applications and facilities layer common data dictionary
ETSI TS 103 301-V1.2.1	EU G5+LTE	Facilities	Basic Set of Applications; Facilities layer protocols and communication requirements for infrastructure services
CEN ISO TS 19321-2015	EU G5+LTE	Facilities	Cooperative ITS - Dictionary of in-vehicle information (IVI) data structures
CEN ISO TS 19091-2017	EU G5+LTE	Facilities	Cooperative ITS - Using V2I and I2V communications for applications related to signalized intersections
ISO 14823-2017	EU G5+LTE	Facilities	Graphic data dictionary
SAE J2735-201509	EU G5+LTE	Facilities	Dedicated Short Range Communications (DSRC) Message Set Dictionary Note: Referenced by the obsolete ISO 19091
IEEE 1609.2-2016	US DSRC+CV2X	Security	IEEE Standard for Wireless Access in Vehicular Environments - Security Services for Applications and Management Messages
IEEE 1609.2a-2017	US DSRC+CV2X	Security	IEEE Standard for Wireless Access in Vehicular Environments - Security Services for Applications and Management Messages - Amendment 1

IEEE **1609.3-2016**	US DSRC+CV2X	Network	**FHWA-JPO-17-589-4.1-DSRC**	US	DSRC **US DOT** System **revs**
IEEE 1609.4-2016	US DSRC	Access	IEEE Standard for Wireless Access in Vehicular Environments 0/VAVE) - Networking Services IEEE		
IEEE **1609.12-2016**	US DSRC+CV2X	Facilities	Standard for Wireless Access in Vehicular Environments 0/VAVE) - Multi-Channel Operation IEEE Standard for Wireless Access in Vehicular Environments 0/VAVE) - Identifier Allocations		
SAE J2735-201603	US DSRC+CV2X	Facilities	Dedicated Short Range Communications (DSRC) Message Set Dictionary		
SAE J3067-201408	US DSRC+CV2X	Facilities	Candidate Improvements to Dedicated Short Range Communications (DSRC) Message Set Dictionary [SAE J2735j Using Systems Engineering Methods		
SAE J2945/1-201603	US	Facilities	On-Board System Requirements for V2V Safety Communications Dedicated Short-Range Communications Roadside Unit Specifications (typically referred as RSU **4.1)**		

4

Linux Operating System for Commsignia ITS-OB4 and ITS-RS4

The device is running a Linux operating system and can be accessed by the console through a serial connection or SSH and also through a graphical user interface from a web browser.

The network management possibilities of its own RSU units that enables the user to set IP networking, DNS, DynDNS settings, routing, firewall, NAT, VPN and many more network related options. Support for wireless and cellular network configuration as also included.

3

OBU V2X Communication Software Description

The Commsignia V2X Software Stack is a flexible embedded C-ITS solution that is developed based on the specification of the ISO/ ETSI/ IEEE/ C2C-CC communication architecture, providing a modular framework for various target platforms, supporting Linux and RTOS operating systems

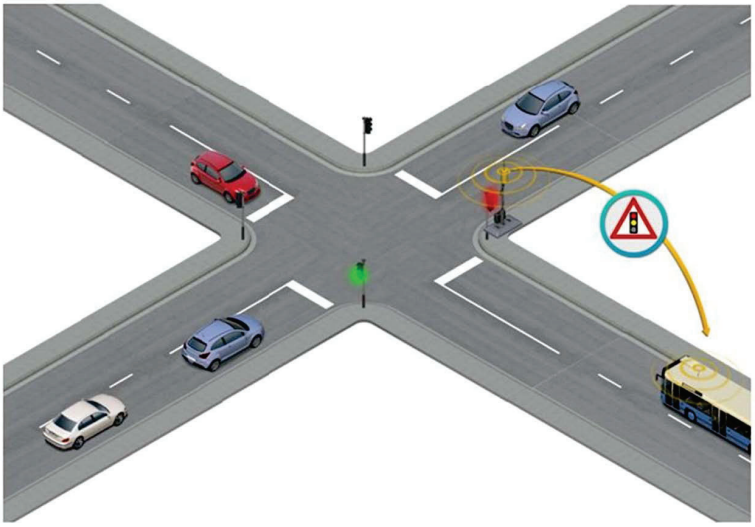
The V2X Software Stack follows strict coding guidelines and cutting-edge automotive standards (MISRA C:2012) for a reliable and portable embedded software solution. Strict build and test processes assure ISO quality standard release packages.

The V2X Communication Software Stack features an industry leading security software stack. The security stack has been developed solely by Commsignia and is not relying on any 3rd-party dependencies. It is providing a future proof, high-performance layer to enable signed and secured radio communication. Unlike our competitors, Commsignia utilizes a hardware accelerator component to handle up to 2000 packets per second.

Commsignia is not only able to provide the communication software for DSRC and C-V2X radios but we have created various connected vehicle safety applications (Day 1 Apps), utilizing the messages of our communication software stack. These applications are available, utilizing real-time performance and low-delay processing.

OBU CV Applications

Freight and Snow Plow Signal Priority (TSP)



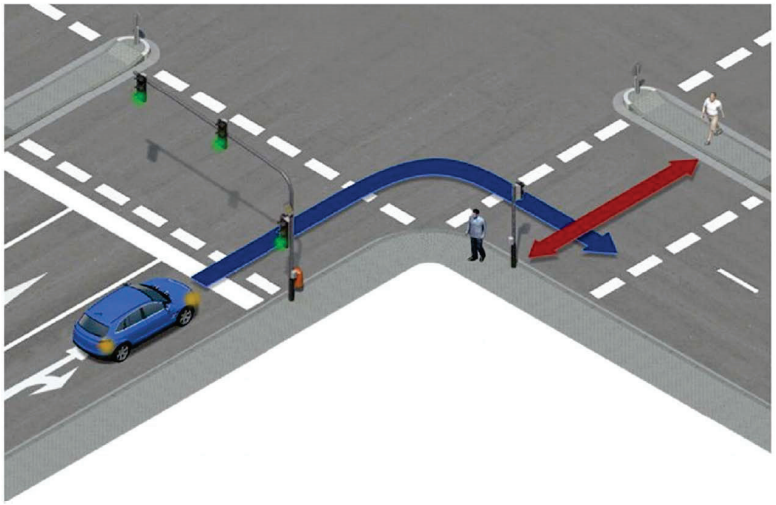
The Transit Signal Priority (TSP) is a use case of the Signal Request Management (SRM) processor, which is an 12V communication-based feature that lets public transportation vehicles request priority for green traffic signals in their lane.

TSP can be triggered manually or automatically based on the lane matching information of the vehicle and the Signal Phase and Timing (SPaT) signal received from the Roadside Unit (RSU) at the intersection.

After the Onboard Unit (OBU) of the vehicle sends a TSP it is received by the RSU at the intersection and its SRM processor handles and validates the request. The RSU then communicates with the connected Traffic Light Controller (TLC) if the traffic signals are to be changed. An acknowledgment is then forwarded back to the OBU through the RSU to notify the requesting vehicle.

This application is compliant and relies on the US (WAVE) standards.

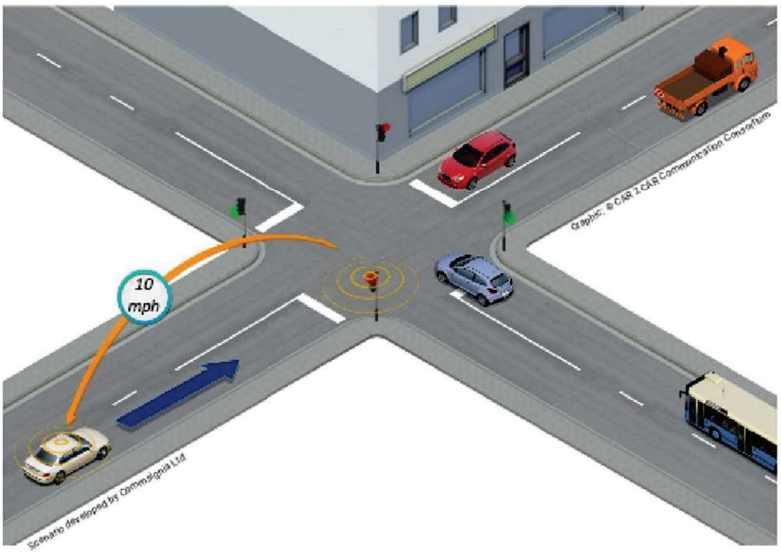
Pedestrian in Signalized Crosswalk Warning (PED-X/PCW)



Application's goal is to avoid pedestrian - vehicle conflicts. Commsignia has already been able to integrate different sensor technologies, allowing V2X enabled vehicles to detect pedestrians. The Commsignia OBUs are able to display the SAE J2735 based standard PSM messages on the Foresight application's map view. The Pedestrian Collision Warning application will be triggered once the vehicle's projected path is colliding with the position of PSM message.

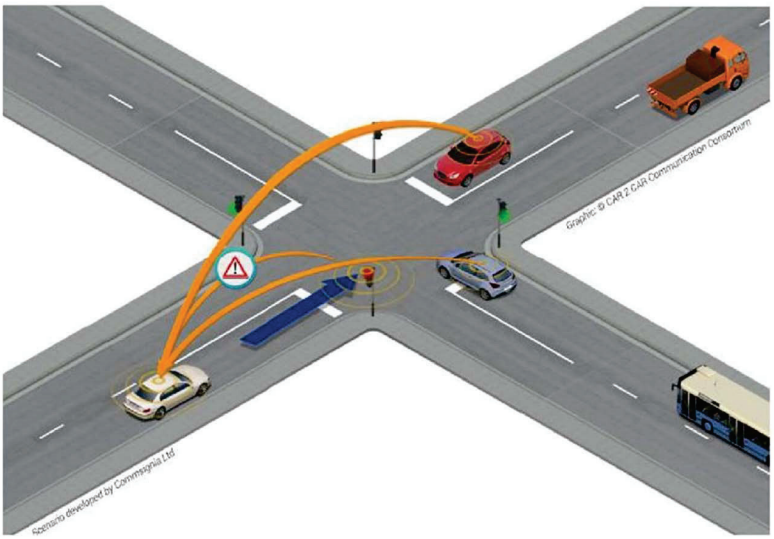
The Commsignia RSU can generate PSM (Pedestrian Safety Message) based on external input. This input can be received from smart sensors (e.g. smart camera) which can detect pedestrians with the use of AI aided technology and send digital information to the RSU describing the detected position of pedestrians and/or other VRU objects such as cyclists or motorbikes. The selected smart sensor must be integrated with the Commsignia RSU in order to use its data inputs for PSM generation.

Green Light Optimized Speed Advisory (GL0SA)



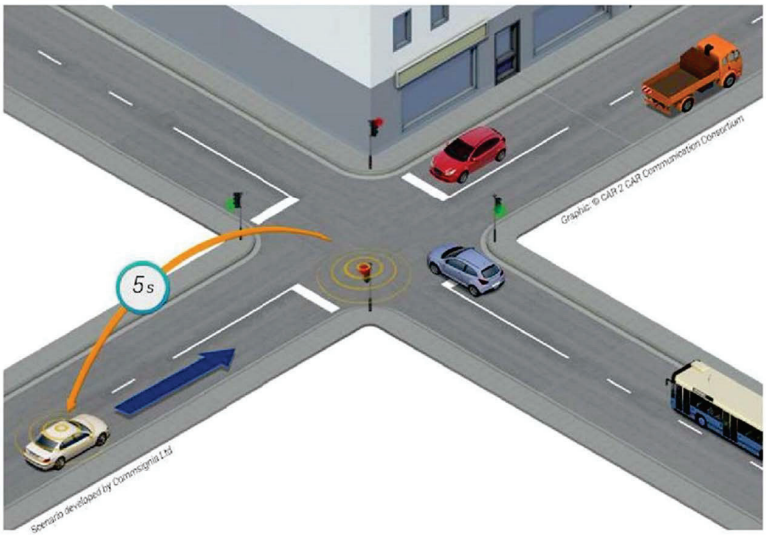
The Green Light Optimized Speed Advise (GLOSA) is a use case for the Traffic Signal Information (TSI) safety application, which is an 12V communication-based safety feature that suggests a calculated speed to the driver of the host vehicle, allowing them to pass through an intersection during the green signal interval. This information is calculated based on the received Traffic Signal Information and the current speed and location of the host vehicle. GLOSA will help drivers in avoiding or mitigating delays as a result of stop-and-go motions through intersections, optimizing fuel efficiency and reducing traffic congestion. This application is compliant and relies on to the European (ETSI GS) and the US (WAVE) standards

Red Light Violation (RLV)



The RLV application provides traffic light state and changes information towards approaching vehicles. Warns the driver if the vehicle's path prediction enters into the intersection when the light is red.

Time To Green (TTG)



The TTG application provides traffic light state and changes information towards approaching vehicles. Time To Green warning uses infrastructure-to-vehicle communication to notify the driver about the remaining time to green traffic signals. TTG reduces fuel consumption and reduces time spent at the red light by increasing traffic flow efficiency.

Basic Safety Messages (BSMs) to TMC

The Commsignia OBU has a separate software module for BSM generation which works automatically and starts after the device is powered up and GPS fix is acquired by the GPS subsystem in the device. BSMs are generated according to the latest SAE J2735 standards (see supported standards list).

To deliver these messages to a TMC (Traffic Management Center) the deployed RSUs must receive these BSMs and forward them to a specific network endpoint.

The highly modular software stack of Commsignia can provide data streams of multiple abstraction levels.
- RAW network payload including, Commsignia's debugging header information
- Received and sent J2735 payloads (filters can be defined to forward only the BSM messages)
- APIs to access any received objects

Unlike the previous use cases this functionality does not require a separate application to run on the OBU, but it works automatically on the OBU side. BSM collection and forwarding should be configured at the infrastructure side.

Documentation and Technical Support

Commsignia have been working with the City and County of Denver regarding On-Board Unit and Roadside Unit integration and installation for the last few years already. Therefore Commsignia have tremendous knowledge and hands-on experience on the systems the City is using. Commsignia has provided all the documentation and technical support plans which are scalable and can be continued during the current project.

Commsignia offers complete support and maintenance packages. Package description can be found in the pricing section.

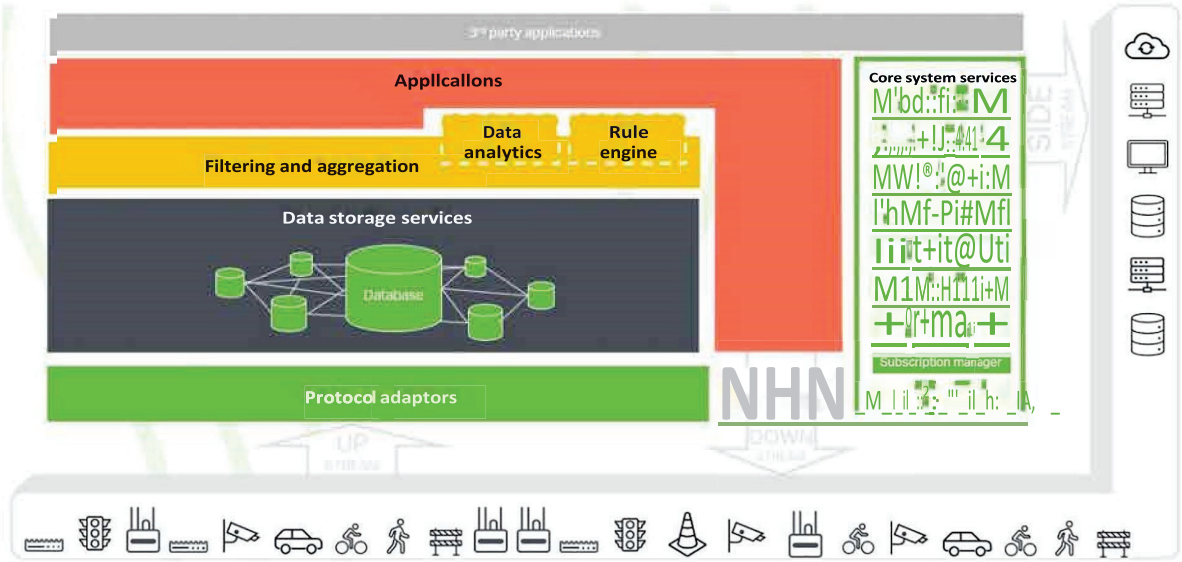
Planning for centralized software solution package

Cost

Modules		Annual plan
CORE FUNCTIONALITY / ADDITIONAL PLUGINS	COMMITMENT LENGTH	1 year of access purchased
	BILLING CYCLE	Yearly
	TOTAL PRICE	$ 100 / device / month*
	ADD DEVICE	Any time for additional cost
	REMOVE DEVICE	When renewing annual contract
	CANCELLATION	Annual commitment (even if canceled during yearly cycle)
MAINTENANCE SERVICE		*The license price is allowing access to the latest version of the platform*
SUPPORT SERVICE		*Based on a separate agreement, support services can be purchased*
OPERATION SERVICE		*The platform can be deployed on-premise or in the Commsignia cloud. In case of on-premise operation mode then the customer is fully responsible for the operation.*

*The above pricing is indicative. The Central Solution is not in the Scope of the current RFP we reserve the right to change the content of the above table. Licence packages are available e.g. for 25, 50, 100 etc. licences.

Planned Architecture



3rd party interfaces and applications

The platform is and open architecture, meaning it was designed with flexibility and expandability in mind. A rich set of APIs are provided allowing 3rd party applications and integrations.

Application layer

- Asset monitoring
- Asset management
- Asset log management
- Data visualization
- System automations
- Information disseminator
- V2X message creation
- V2X message deployment
- Edge service management

The application layer hosts the different services that are

- utilizing upstream data and providing Information to the users, or
- Processing, enriching and transforming the data and disseminating towards devices and users (downstream) or to other services (sidestream)

Core system services

- User manager
- Database manager
- Authentication
- User Access Control
- Audit/ System log
- System settings
- Modern GUI
- Subscription manager
- API management

The core system services provide a modern, scalable framework for the applications

Adaptor layer

- NTCIP/ SNMP adaptor
- REST adaptor
- DATEX/ AMQP adaptor
- OCIT adaptor
- MQTT adaptor
- + Custom adaptors

The adaptor layer provides a flexible, expandable set of protocols allowing smooth integration with

- field devices (e.g Commsignia RS4 or 3rd party RSUs),
- other services on the network, and
- the cloud

Database layer

- Distributed NoSQL database
- SQL database

The database layer is responsible for storing

- low frequency relational data or
- streaming time series information in a scalable way.

Filtering layer

- Filtering and aggregation o Data analytics o Rule engine

The filtering and aggregation layer is responsible for providing the necessary input data for the different applications, analytics, visualizations and dashboards

Estimated timeline of Centralized Solution development

2020 Q4

- First release
- Basic V2X message management
- Basic device config management
- Central ITS integration

2021 H1

- Enhanced V2X message management
- Enhanced device config management
- Inventory management
- User management
- Basic data management
- Alerting

2021 H2

- Enhanced user access right management
- Data analytics and visualization
- Data rule engine

Scope of work

- Delivery of 300 Roadside Units.
- Delivery of 300 OBU units
- 1 Enhanced Commsignia Software stack o Custom US SCMS client o OBU/RSU ports' access control
  - Vehicle signal integration (CAM/BSM) - customizable Vehicle signal integration using CAN bus.

Integrating all the signals which are required (mandatory) for CAM and/or BSM generation.

Implementation will be done according to CAMP CAN protocol. Integration is distributed in source code format and customizable by the customer. CAN data processing can be dynamically changed by C code generation from dbc file. The handling of each field (after re-generation) needs to be changed manually.

- Application fine-tuning

  Fine tuning applications based on client's requirements. New configuration options, new corner cases, etc. Applications: TSP, PED-X/PCW.

- Quick Boot Mode for OBU (OPTIONAL)

  OBU should be equipped with supercapacitor based backup power and the controlling MCU (microcontroller unit) software should be refined to enable deep sleep mode with minimal consumption and wake up on ignition.

- SCMS / PKI enrollment 600 units
- Android Tablet HMI application

Out of Scope Elements

- Simultaneous CV2X and DSRC broadcasting
- Integration of SCMS / PKI client to the customer hardware or plant
- RSU onsite physical installation and assembly
- Vehicle signal integration which are not included in the CAMP CAN specifiation into the part II section of BSM messages.
- Vehicle signal integration for messages beyond BSM, CAM.

Assumptions:

- The system includes the following Day1 infrastructure-to-vehicle applications:
  - Freight and Snow Plow Signal Priority (TSP
  - Pedestrian in Signalized Crosswalk Warning (PED-X/PCW) o Green Light Optimized Speed Advise (GLOSA) o Time To Green (TTG) o Red Light Violation (RL V)
- Provided applications are based on Commsignia internal requirements. Commsignia works on a wide application-level compatibility with other vendors, but minor differences in message construction (beyond the scope which is defined by standards and profiles) may be possible. • All Commsignia software is built for the Linux operating system, which is not a Real Time Operating System. As a consequence, accurate latency and jitter requirements cannot be met, and Commsignia software provided as-is with these metrics. Commsignia is responsible for the below listed metric only, and only if the system CPU load is not greater than 50%.
  - Meet the CAM (ETSI EN 302 637-2) and BSM (SAE J2945/1) scheduling and latency requirements
  - Keep scheduling for all the other messages with 100 ms as lowest repetition interval if the total number of non-CAM and non-BSM messages to be transmitted is below 50
  - Jitter of message transmission is not greater than 50 ms
  - Any application which is based on the Remote API of the Commsignia stack (including applications developed by Commsignia or 3rd-party) may have higher latency and jitter, and the Commsignia team does not guarantee anything in terms of these metrics.
- The system is compliant with the following US standards:
  - IEEE 1609.2-2016: IEEE Standard for Wireless Access in Vehicular Environments - Security Services for Applications and Management Messages o IEEE 1609.2a-2017: IEEE Standard for Wireless Access in Vehicular Environments - Security Services for Applications and Management Messages - Amendment 1 o IEEE 1609.3-2016: IEEE Standard for Wireless Access in Vehicular Environments (WAVE) - Networking Services o IEEE 1609.4-2016: IEEE Standard for Wireless Access in Vehicular Environments (WAVE) - Multi-Channel Operation o IEEE 1609.12-2016: IEEE Standard for Wireless Access in Vehicular Environments (WAVE) - Identifier Allocations o SAE J2735-201603: Dedicated Short Range Communications (DSRC) Message Set

Dictionary o SAE J3067-201408: Candidate Improvements to Dedicated Short Range Communications (DSRC) Message Set Dictionary [SAE J2735] Using Systems Engineering Methods

o SAE J2945-201712: Engineering Process Guidance for SAE J2945/X Documents and Common Design Concepts o SAE J2945/1-201603: On-Board System Requirements for V2V Safety Communications o SAE J2945/9-201703: Vulnerable Road User Safety Message Minimum Performance Requirements

- Support of above listed standards means that Commsignia has implemented the requirements and features from the standard which is commonly used/considered as a best practice in the industry, meaning that this is widely adopted and required for interoperability testing (Plugtests, Plugfests) and V2X compliance testing/certifications (OmniAir, similar).
- The SCMS / PKI system provides a communication interface with standard (IEEE 1609.2 + CAMP or ETSI TS 103 097) message-format. The OSI layers may be custom including the application (HTTP), the network-transport (IP) and physical (DSRC / Ethernet). All the required protocols need to be supported by the solution (BSP or stack).
- Only the USB ports and SD card reader are included in the configurable access control, since these were the main points in the requirement description. Access control for WI-Fl and Ethernet can be done via firewall configuration.
- Vehicle signal integration assumptions o All the required vehicle signals are available on the interface. o Combining-generating values upon other fields is not necessary, only unit-conversions need to be applied.

Project Requirements

Client Responsibilities

- For the custom US SCMS Client Commsignia requires a clear and complete API description including the message formats, protocols. It is also required to have access to the SCMS test system.
- Providing security profile and/or final list of PSIDs to be able to setup security and enroll devices
- Vehicle signal (CAN Integration) inputs
  - Clear definition of all the required signals
  - CAN signals in valid dbc file format.
  - Software and/or hardware tools together with sample data to replay / simulate signals for testing purposes. As minimum, a text file is required with separate CAN messages per line, each message (line) must have a timestamp, CAN message ID and data..
- Application fine tuning needs detailed requirements for the application behavior.

Discounts on the devices

The applied discounts from the list prices are as follows. These discounts are already applied in the above price offering (Pricing Matrix).

Item Description	Applied discounts
Onboard Unit with applications and interface to the Human Machine Interace (HMI) (Android Tablet)	44,67 %
DSRC/C-V2X Dual Roadside Unit	28,59 %
GPS, DSRC, and C-V2X Antennas	25%
Ancillary Supporting Equipment (*)	50 %
Device Configuration	25 %
General Support and Maintenance	23,50%
Warranty Extension 1 + 2 years	30%
Warranty Extension 1 + 4 years	30%

Commsignia's goal is to utilize its existing hardware and software products (as a homogenous package) to meet project requirements in order to ease maintenance. In some cases, to achieve ATCMTD Program objectives, Commsignia reserves the right to provide different hardware and software variants of the Commsignia products considering the requested CV application, variety of vehicles and other circumstances.

Commsignia has a stock of the items mentioned in the 'Vehicle Systems' and ready to deliver the requested quantities (depending on the final quantities and timeline at once or continuously, in multiple parts).

Hardware delivery lead time is up to 8-12 weeks after receiving a binding PO depending on the ordered quantity and delivery batches. SCMS enrollment requirement is highly affecting the manufacturing process, delivery timeline is to be defined separately. All shipping charges are included in the prices.

Commsignia is going to be able to accept the City's authorized Procurement Card as a method of payment without any price changes or additional fee(s).
Commsignia will gladly collaborate with the City to introduce and maintain specific Catalog Items in the City and County of Denver's system to ease the procurement processes.

Software Support

Commsignia provides 1 year of software support for the supplied devices. Software support extensions can be separately purchased as indicated in the pricing as part of the General Support and Maintenance line. General Support and Maintenance line indicated in the pricing refers to Commsignia Premium Support

Package.

Premium Support Package Description:

Support Features	Basic how-to and trouble shooting assistance
Maximum response time for Severity Level 1 issues	Status update frequency
Technical support coverage (product level based)	Online forums, documents and Knowledge Base
Maximum non charged support engineer hours per month	Premium Support 8-hours

Mon-Fri 8 am - 6 pm US EST	TRUE
16	TRUE
Once per week	

Phone support	TRUE
Email support	TRUE
Chat support	TRUE
Conference service (e.g. Webex)	TRUE
On-site support	not included
Direct access to senior support engineers	TRUE
Designated Customer Success Manager	TRUE
Faster response times, escalation and resolution	TRUE
Proactive product information updates and knowledge sharing	TRUE
Onboarding assislance, enablement and product adoption	TRUE

Software Maintenance

Commsignia provides 1 year of software maintenance for the supplied devices. Software maintenance extensions can be separately purchased as indicated in the pricing as part of General Support and Maintenance line. General Support and Maintenance line indicated in the pricing refers to Commsignia Mainline Software Maintenance Package.

Mainline Software Maintenance Package Description:

Features	Mainline maintenance package
Release content	Corrective and preventive maintenance in addition to continuous feature upgrade following the Commsignia mainline. Entitled to access Commsignia releases according to the regular release roadmap, releases on a quarterly basis
Modules covered	All purchased software modules and variants
Backward compatibility	Not guaranteed
Backward compatibility scope	Not guaranteed
Source branch	Mainline branch
Release frequency	Quarterly
Latest software/firmware upgrades	Included
Availability	Can be ordered anytime
New product features	Included
Vendor Related Issue Resolution	
Critical Priority	Next release (if report accepted 2 weeks before the release at latest) Urgency may be requested twice a year. In this case resolution within 2 weeks.
High Priority	Next release (if report accepted 4 weeks before the release at latest) Urgency may be requested twice a year. In this case resolution within 4 weeks
Medium Priority	Next release (if report accepted 6 weeks before the release at latest)
Low priority	One of the next two releases

Warranty

Commsignia provides 1 year of warranty for the supplied devices. The warranty applies to the units only, unmounting from vehicle, shipment and re-mounting are the Customer's responsibility. Warranty extensions can be separately purchased as indicated in the pricing.

Additional items to consider

SCMS / PKI integration

Integration and product enrollment of the previously purchased units with the selected SCMS / PKI system.

Item	Qty	Price/ Unit	Total price
Any ancillary supporting equipment - SCMS / PKI integration - SCMS / PKI enrollment - Security hardening	109	$500	$54,500

2.7 Exhibit A - DSRC/CV2X RSU and OBU Requirements

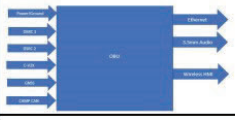
Supplier Name: Commsignia Inc.

Exhibit A: DSRC/CV2X RSU and OBU Requirements
Dual units refer to both RSUs and OBUs

ID	Requirement	Add'l Comments	Priority	Offeror Response
CCD_Req_1	Dual Units shall be Dedicated Short-Range Communication (DSRC) and Cellular Vehicle to Everything (CV2X) communication compatible.		Must Have	Compliant
CCD_Req_2	Dual units shall have GPS, DSRC, CV2X antennas		Must Have	Compliant
CCD_Req_3	Dual units shall have the capacity for central management of the devices.		Must Have	Compliant NOTE: Dual mode OBUs must have an additional external 4G dongle (USB) for connecting with a central management entity. Commsignia provides a compatible 4G dongle together with the OBU
CCD_Req_4	Vendor shall include planning for centralized software solution package	Cost, technical specifications, timelines for maintenance and support of the software	Must Have	Compliant
CCD_Req_5	Dual units shall have a Graphical User Interface for programming		Must Have	Compliant
CCD_Req_6	Dual units shall come with the latest software/firmware at the time of delivery	Please share your release management process, version details and capabilities. Also share if CCD will receive unlimited SW and Firmware updates, what updates CCD will receive as a part of this contract and what is the time length.	Must Have	Compliant NOTE: SW maintenance service is incuded in our offer.
CCD_Req_7	Dual units shall have all technical documentation necessary for setup,operation and maintanence		Must Have	Compliant
CCD_Req_8	Vendor shall provide technical support for dual units integration with the existing ITS infrastructure if needed	Once the device has been selected, detailed procedures needs to provide and assist the technicians at the City and County of Denver set up the device and have	Must Have	Compliant NOTE: On-line support service is incuded in our offer.

		available support with any troubleshooting efforts during the configuration		
CCD_Req_9	CCD Prefers the Dual Units to be Omni Air Certified	Please provide information whether your units are Omni Air Certified	Should Have	Compliant NOTE: DSRC RSU and OBU are already OmniAir certified which covers their SW part. CV2X and Dual mode units have the same V2X stack softvare. Commsignia applied for the certification of the C-V2X interface extension but the test framework is not finalized at OmniAir yet. Commsignia will be among the first players to be certified with C-V2X.
CCD_Req_10	Vendor shall offer a Software stack that is capable of transit signal priority	Priority, pre-emption etc.	Must Have	Compliant
RSU Specific requirements				
CCD_Req_11	RSU shall be compliant with USDOT RSU v4.1 Specifications	Include a test report from an accredited test facility with regards to compliance with these requirements	Must Have	Compliant. NOTE: RSU v4.1 requirements are covered by the OmniAir certificate.
CCD_Req_12	Vendor response shall provide information on the frequency bands that dual RSU is capable of utilizing		Must Have	Compliant
CCD_Req_13	Vendor response shall provide information regarding capabilities of DSRC and CV2X communication	Provide documentataion regarding the switching between DSRC and C-V2X communication and also mention whether it involves a hardware change or software change or both.	Must Have	Compliant NOTE: Mode scwitch between DSRC and C-V2X can be done via a standard software change procedure.
CCD_Req_14	RSU shall include DSRC antenna connectors		Must Have	Compliant
CCD_Req_15	RSU shall include GNSS antenna connectors		Must Have	Compliant
CCD_Req_16	RSU shall include Cellular anenna connectors		Must Have	Compliant
CCD_Req_17	RSU shall have the capability to integrate with SCMS (City is using Blackberry)	Store and issue security certificates	Must Have	Compliant NOTE: Blackberry SCSMS integration is assumed which is part of our offer.
SECURITY Requirements				
CCD_Req_18	Access to RSU shall be restricted with login credentials		Must Have	Compliant

CCD_Req_19	All communication ports shall have acess control e.g. configurable firewalls and Access Control Lists		Must Have	Compliant NOTE: the only interface which is available is the PoE (Ethernet) that is essential for central connectivity. The rest of the ports are internal (within the box) and cannot be accessed without opening the enclosure due to tamper protection. This is part of our offer. In case of customization the requirements are up to negotiation.
CCD_Req_20	The RSU shall provide evidence to detect tampering (e.g. opening of the case) through tamper-evident seals. Unused ports should include plastic caps.		Must Have	Compliant
OBU Specific Requirements				
CCD_Req_21	OBU shall document compliance with SAE J2945/1 On System Requirements for V2V Communications	Include a test report from an accredited test facility with regards to compliant with these requirements	Must Have	Compliant. NOTE: SAE J2945/1 requirements are covered by the OmniAir certificate.
CCD_Req_22	Packaging envelope of the OBU should not exceed 9" L X 3" H X 8" W	Other dimensions will be considered	Should Have	Compliant
CCD_Req_23	The OBU should be able to be mounted in any orientation	Mounting tabs, holes, grooves or notches integrated into the OBU body are preferable but Velcro or double-sided tape might be used as well. The OBUs will be mounted away and hidden from the view of the vehicle's users. The spaces used for mounting might include but are not limited to glove box, behind the glove box, under the dash, front kick panels, trunk, spare tire compartment and lift jack compartment. Temperatures in these compartments might reach extremes and air circulation might be limited.	Must Have	Compliant NOTE: Operating temperature range must be within the following limits: -40 … +75 C
CCD_Req_24	OBU shall have DSRC antenna FAKRA connectors		Must Have	Compliant

CCD_Req_25	OBU shall have Cellular-V2X (FAKRA) antenna connectors		Must Have	Compliant
CCD_Req_26	OBU shall have GNSS antenna FAKRA connector		Must Have	Compliant
CCD_Req_27	OBU shall have Vehicle power connections (lock-in connector)		Must Have	Compliant
CCD_Req_28	OBU shall have wireless HMI capability		Must Have	Compliant
CCD_Req_30	OBU should have audio Output (3.5mm connector preferred)		Should Have	Compliant
CCD_Req_31	OBU shall have CAN interface (CAMP Standard)		Must Have	Compliant NOTE: The OBU has a CAN interface for vehicle integration. CAMP CAN intergation is included in our offer.
CCD_Req_32	OBU should have Internal Battery and/or capacitor for quick boot capability		Should Have	Compliant NOTE: The OBU has an internal supercapacitor for graceful shutdown in case of sudden power loss. This could also be used to implement quick boot capability although it is not yet available. The OBU boot time should be below 60 seconds. The OBU can be connected to the main battery of any vehicle. It has an intelligent power supply unit which controls efficiently the power consumption and may provide quick boot option.
CCD_Req_33	OBU should have general purpose inputs(GPIO) (0-12V) for additional vehicle wiring		Should Have	Compliant NOTE: The OBU have 3 switched outputs, 5 isolated inputs
CCD_Req_34	OBU shall have USB/data port for diagnostic features and quick modifications		Must Have	Compliant NOTE: The OBU has a CNSL (debug console) port with micro USB connector.
CCD_Req_35	OBU should have SD Card/internal HDD for future data logging considerations		Should Have	Compliant NOTE: The OBU has a n SD card reader slot.
CCD_Req_36	The OBU shall not be adversely affected and maintain operation during shock and vibration levels as specified in SAE J1211 as typical for motor vehicles, nor be adversely affected by shock and vibration from shipping		Must Have	Compliant
CCD_Req_37	The unit must be CISPR 25 compliant and shall withstand electromagnetic interference (EMI) from external sources and electrical distribution.		Must Have	Compliant
CCD_Req_38	The onboard equipment device and any removable components shall be protected from electrical transients as specified in SAE J1113 Immunity to Conducted Transients on Power Leads. The		Must Have	Compliant

	OBU shall not affected by reverse or double battery connection.			
CCD_Req_39	Communicate BSM Part 1 and Part 2 is an important aspect of this deployment		Must Have	Compliant
CCD_Req_40	The OBU is to be powered from a vehicle power source, and shall not exceed an average of 2 amps in the System On mode. The OBU is to be powered from a vehicle power source, and shall not exceed 50mA in Sleep or off state		Must Have	Compliant
CCD_Req_41	Sudden loss of vehicle power is to be expected as well as significant operating voltage variations which requires that the OBU operation not be adversely affected by these voltage events. Upon power loss and restoration, the OBU performs a secure boot checking the integrity and authenticity of the installed software before executing it. Note: the OBU may have a provision for optional battery or capacitor		Must Have	Compliant NOTE: The OBU includes a supercapacitor for graceful shutdown in case of sudden power loss.
CCD_Req_42	HMI interface for visual display for the driver is required.	Some fleet vehicles may not require an active HMI but others might.	Must Have	Compliant NOTE: Commsignia provides an android based HMI application. Custom HMI development is also possible basid on the Commsignia application notification API.
OBU SECURITY				
CCD_Req_43	All communication access ports (e.g. USB/data, etc.) shall maintain access control (e.g. configurable firewalls and Access Control Lists). Access to the OBU should be restricted so that vehicle operators can't use the open input ports nor the SD Card slot.		Must Have	Compliant NOTE: USB and SD card slots can be disabled from device configuration, the WiFi and Ethernet ports can be controlled by firewall rules.
CCD_Req_44	The OBU equipment shall be able to detect when there are any new connections or insertions into the USB port, CAN interface, SD Card slot or any other data port. If the OBU is so notified it shall record the date, time, and location of the event in an append-only log on the internal memory.		Must Have	Compliant NOTE: These events are reported in the system log which is maintained in the system memory and can also be saved on an external USB drive with the logrotate feature.
CCD_Req_45	OBU shall be able to validate SCMS OBU Psuedonym Certificates		Must Have	Compliant
Other Requirements				
CCD_Req_46	Vendor shall have at least one deployment in Unites States of America (U.S.A.)	Please provide information on when and where	Must Have	Compliant