AUMOVIO India Private limited (Previously Continental Automotive Components India private Limited) Comments for

TRAI Consultation paper on Regulatory Framework on V2X

There are 4 major comments from Aumovio India Private Limited on the TRAI Consultation paper on Regulatory Framework on V2X, which are addressed below.

These 4 major concerns are followed by specific answers to question which are asked with TRAI consultation paper on Regulatory Frame work for V2X

1. **Use cases of V2X**
    a. **Under "CHAPTER II: V2X TECHNOLOGIES AND GLOBAL PRACT" Section B** Use cases were discussed in detail with Task force meetings and "Final Report of ITS Task Force" has use cases prioritised based on safety criticality needs of V2X system.

    Some of the very important use cases Mentioned in "Final Report of ITS Task Force" under "Day-0" is recommended, these use cases reduce causalities on public roads based on V2V Communication (Vehicle to vehicle communication), So these use cases should have been part of "B. Use cases of V2X, (1) Vehicle to Vehicle Communication" in "TRAI Consultation paper on Regulation Framework on V2X" along with existing use cases mention in the "TRAI Consultation paper on Regulation Framework on V2X"

    "Day-0 Use cases in Final Report of ITS Task Force" based on direct V2V Communication to improve the safety on public roads,

        i. Emergency Electronic Brake Light (EEBL)
        ii. Forward Collision Warning (FCW)
        iii. Hit from Behind Warning
        iv. Intersection Movement Assist (IMA)
        v. Queue Warning - (V2V)

    b. Further if the objective in "TRAI consultation paper on Regulatory Framework on V2X" is to have broader spectrum of use cases possibilities, we would recommend to take reference from Use case description according to Report "ITU-R M.2534-0 (09/2023) Connected automated vehicles" TABLE 4, as described below

Day-0 (Note: Since recommendation from Task Force as published in "Final Report of ITS Task Force"V2X with EU based ETSI standard for V2X in India, in below table ETSI-DENM, ETSU-CAM, ETSI VAM, ISO MAPEM, ISO SPaTEM, ETSI IVI (In vehicle information), would be applicable message set other message set are from North America base SAE Standard and china based CSAE Standard

Use Case	Description	Message Set	Type of Communication	Transmission interval in Hz (min/max/static or dynamic)	Message Size in Bytes	Service Level Latency In ms
collision avoidance	Collision avoidance assistance when a vehicle ahead stops or decelerates suddenly –> Informs all the road users on the emergency braking done by any vehicle travelling in front -> Helps in avoiding the pile up of vehicles in accidents	ETSI-DENM, SAE-BSM, CSAE-BSM,	V2V	1/10/static	1000/1300/11500	10
	Collision avoidance assistance by using hazard information -> Warning the broken-down vehicle / stopped vehicle information to the vehicles in travelling in same direction and lane	ETSI-DENM, SAE-BSM, CSAE-BSM,	V2V	1/10/static	1000/1300/11500	10
	Collision avoidance assistance with provision of blind spot information -> vehicles in blind spot approach information	ETSI-CAM, SAE-BSM, CSAE-BSM,	V2V	1/10/dynamic	1000/1300/11500	10
	Collision avoidance assistance at intersections -> Collision in intersection possibility information	ETSI-CAM, SAE-BSM, CSAE-BSM,	V2V V2I	1/10/dynamic	1000/1300/11500	10
	Collision avoidance assistance by warning in two lane roads to alert the vehicle with vehicle coming in adjacent lane in opposite direction -> Do not overtake warning	ETSI-CAM, SAE-BSM, CSAE-BSM,	V2V	1/10/dynamic	1000/1300/11500	10
emergency vehicle notification	Driving assistance/ Driver alert based on emergency vehicle information, coming from behind in which lane or coming from opposite direction	ETSI-CAM, DENM, SAE-BSM, CSAE-BSM,	V2V V2I	10/static	1000 1000/1900/1450	100
Vulnerable Road User protection	Integration of Vulnerable Road Users into V2X radiocommunication Pedestrians and Bicycles	ETSI VAM, SAE PSM, CSAE PSM	P2V, P2I, V2I, V2V	10/10/dynamic	45/100/ P2V, P2I 100/12000/500 (V2I)	100
Lookahead information	Bad Road / Roadworks warning -> Road under construction ahead information	ETSI-DENM, SAE-BSM, CSAE-BSM,	V2I	10/10/static	1000/1300/11500	100
	Disaster Zone communication -> Landslides, Slippery road due to rain/ Snow, Low visibility due to fog/ smog conditions, Loose Stones warning	ETSI-DENM, SAE-BSM, CSAE-BSM,	V2N	10/10/static	1000/1300/11500	100
	by notification of wrong-way vehicles	ETSI-CAM, DENM, SAE-BSM, CSAE-BSM,	V2V V2I	10/10/static	1000/1300/11500	100
Traffic signal information	Driving assistance by using traffic signal information	ISO SPaTEM, SAE SPAT, CCSA SPAT, ISO MAPEM, SAE MAP ETSI IVI (In vehicle information)	V2I	2/10/static	1200	100
	Optimisation of Traffic for Emergency vehicle and VIP vehicles – Green Corridor		V2I, V2N	2/10/static	1200	100

Day-1

Use Case	Description	Message Set	Type of Communication	Transmission interval in Hz (min/max/static or dynamic)	Message Size in Bytes	Service Level Latency In ms
Driving Assistance	Driving assistance based on intersection information and general crash avoidance between all (powered) vehicle types	ETSI CAM, SAE BSM, CCSA BSM, CSAE SSM ETSI CPM SAE SDSM	V2V	1/10/dynamic	400/700/550	100
	Driving assistance by notification of abnormal vehicles Driving assistance by notification of wrong-way vehicles Driving assistance based on traffic congestion information Traffic congestion assistance at branches and exits Driving assistance based on hazard information	CCSA RSM, ETSI DENM, ETSI IVI ETSI CPM SAE SDSM	V2I	10/static	1000/1300/1150	10
	Driving assistance based on emergency vehicle information	ETSI DENM, ETSI CPM, SAE BSM, SAE SDSM, CCSA BSM, CCSA RSM, CSAE SSM	V2V V2I	10/static	1000 1000/1900/1450	100
Smart Traffic Management	Automated Traffic management System with Data collected from V2X messages and Traffic signals are adjusted as per the density of vehicles Collection of information to optimize the traffic flow and control of Traffic signals based on the data points collected (Integration with existing camera based system to make traffic management more advanced)	ETSI CAM, SAE BSM, CCSA BSM, CSAE SSM, ETSI DENM, CPM	V2I			

Day-2:

Use Case	Description	Message Set	Type of Communication	Transmission interval in Hz (min/max/static or dynamic)	Message Size in Bytes	Service Level Latency In ms
Platooning/ adaptive cruise control	Platooning of driverless follower vehicles by electronic towbar Adaptive cruise control and manned platooning of following vehicles using adaptive cruise control	ETSI PCM, SAE CCM, CSAE CLPMM, ETSI CAM	V2V	20/50	400/1400	10
Autonomous Driving Assistance	V2X acts as a additional sensor along with Cameras, Radar, Lidar, Ultrasonic Sensor to support L3/ L4 ADAS systems to assist the systems with, - Automated Intersection collision braking (can be part of Automated emergency braking, -					
	- Overtake Assist for ADAS with V2X					
	- Right Turn Assist for ADAS with V2X					
	- Lane Change Assist for ADAS with V2X					
	- Terrain Assist for ADAS with V2X by road condition infomration					
	Safety Extension for ADAS L3/ L4 driving					
Merging/ lane change assistance	Merging assistance by • preliminary acceleration and deceleration • targeting the gap on the main lane Cooperative merging assistance with vehicles on the main lane by roadside control	ETSI MCM, SAE MSCM, CSAE, VIR	V2I	10/static	1000/1300/ 1150	10
	Merging assistance based on negotiations between vehicles/Decentral path coordination and decision between multiple CAV Lane change assistance when the traffic is heavy Entry assistance from non-priority roads to priority roads during traffic congestion	ETSI MCM, SAE MSCM, CSAE, VIR	V2V	1/10/dynamic	1000/1300/ 1150	10
Smart Traffic Management	Update and automatic generation of maps Distribution of dynamic map information	ISO MAPEM, SAE MAP, CCSA MAP	V2N	2/10/static	1200	100

These use cases could be added on top of “Table 2.1: Different types of V2X Communications to support vehicular applications” in “TRAI Consultation paper on Regulation Framework on V2X”

2. **Safeguarding V2X communication 5875MHz to 5925Mhz from Interference:**
   OBU's and RSU's spectrum interference to neighboring bands has been described in the "TRAI Consultation paper on Regulation" with out of band emission limits for OBUs and RSUs in "Table 3.1" in "TRAI Consultation paper on Regulation" but interference from neighboring spectrum to V2X has been observed in field studies and Safeguarding V2X communication from Spectrum Interference from use of low power and very low power Wireless Access System including Radio Local Area Network in lower 6 GHz band (5925 – 6425 MHz band) is very essential as V2X has primary aim of reducing accidents and saving human lives.

   There are several alternative possibilities that may help ensuring a better coexistence of V2X and low power devices without having interference in the operation of safety critical V2X Technology as mentioned below, we would recommend to hence include Interference to V2X spectrum limitation possibilities in the "TRAI Consultation paper on Regulation" as specifically mentioned in section 2.2 of "TRAI Consultation paper on Regulation" that "

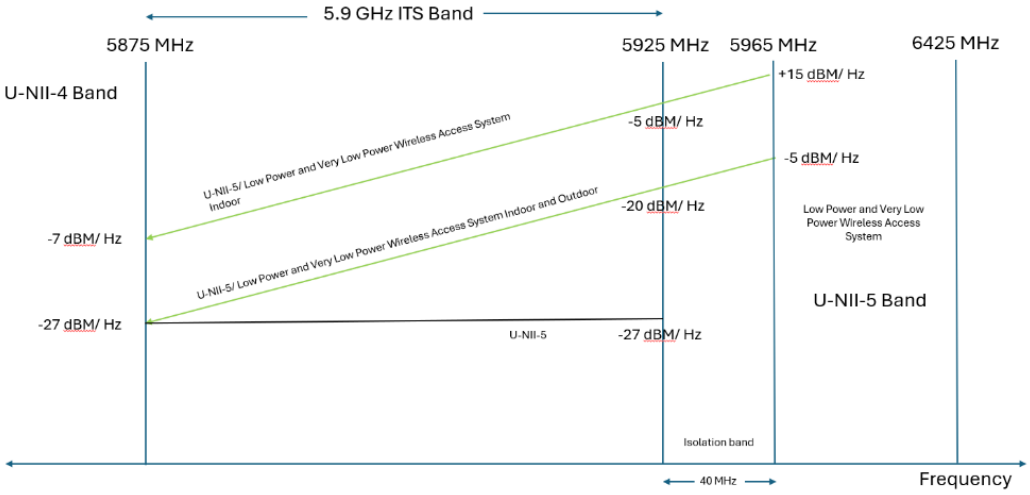
   A combination of 1, 2 and 3 is recommended based on feasibility in Indian context by TRAI:

   1.
      a) The low power transmission is not allowed at all.
      b) Or low power devices are only allowed with less transmission power e.g. -20dBm/MHz between (5925 – 6425 MHz band)
      c) Or low power devices are only allowed to use small bandwidth e.g. 10 Mhz (this will translate in stricter OOB - out of band emissions requirements too)
      d) Or low power devices need to detect V2X transmissions OOB emissions (e.g. by their OOB – out of Band emissions) and in case they detect V2X signals they must use the channels above 5965 MHz
         In the frequency range (5925 – 6425 MHz band)
         (Similar to 5.1 to 5.4 GHz Radar Detection possibility for RLAN. reference: DFS Dynamic Frequency selection. Reference: ITU-R M.1652-1, Annex 1 and ETSI EN 303 893)

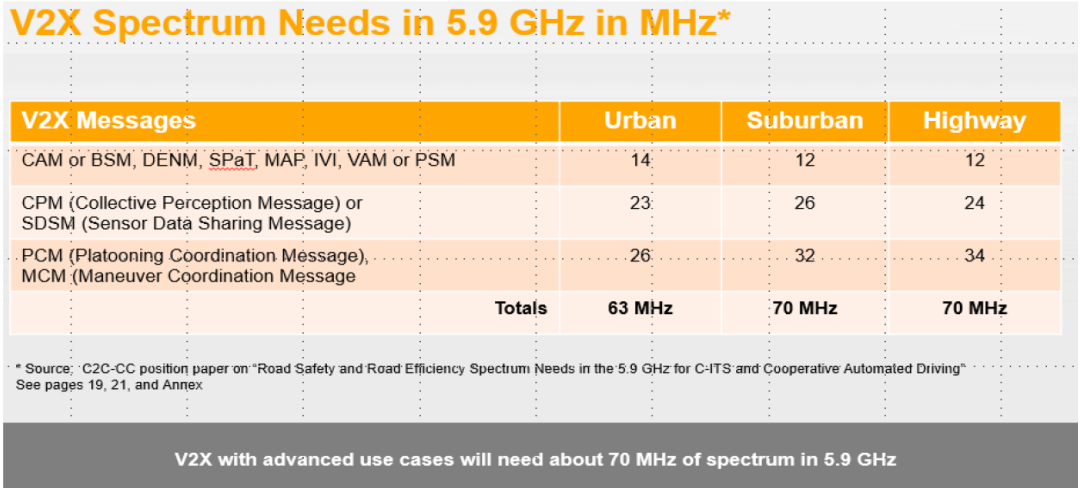
      RECOMMENDATION ITU-R M.1652-1 - Dynamic frequency selection* in wireless access systems including radio local area networks for the purpose of protecting the radiodetermination service in the 5 GHz band

      https://www.etsi.org/deliver/etsi_en/301800_301899/301893/02.02.01_60/en_301893v020201p.pdf
   2. Require lower OOB - out of band emissions from the low power devices general band 5925 to 6425 MHz (e.g. <-27dBm/MHz, better suppression of the signal at the band boundaries, etc) starting at band edge of 5925 MHz

3. Add a maximum duty cycle requirement for every low-power device e.g. 5%. Meaning only 5% of the time the band is utilized and 95% of the time no transmission per station.



3. **Additional Spectrum needs of 50 MHz to 70 MHz for advance maneuverability and platooning as part ITS global objectives.**
    a. Additional 20 MHz is needed from 5925 to 5945 MHz on top of 5875 to 5925MHz would be necessary, if use cases for platooning and maneuvering assist functions for ADAS integration needs to be realized in the future to better realise ITS Goals.
    Reference: CAR 2 CAR-Communication Consortium "Road Safety and Road Efficiency Spectrum Needs in the 5.9 GHz for C-ITS and Cooperative Automated Driving"
    CAR 2 CAR Communication Consortium.
    Annex A 5.9 GHz C-ITS and cooperative automated driving spectrum requirement calculations, Europe. Figure 10 to Figure 16 Annex B 5.9 GHz C-ITS and cooperative automated driving spectrum requirement calculations, USA, Figure 17 to Figure 2



These above recommendation are on top of "Section 13.3 other allied frequency requirements for V2X India" referred in" "TRAI Consultation paper on Regulation Framework on V2X"

4. **V2I Communication:**
    V2I Communication within the range of 5875 MHz to 5925MHz is recommended to be reserved for safety critical application and messages between OBUs and RSUs, which are of broadcast in nature and since they help in reducing the fatalities in road accidents and improving the road safety, 5875MHz to 5925NHz spectrum usage by OBUs and RSUs needs to be exempt spectrum charges, as followed the Europe Standards. ETSI Standard has already been recommended by Task Force in "Final Report of ITS Task Force".

    Non safety critical convenience messages or application and commercial messages and applications should be restricted to the outside 5875MHz to 5925 MHz.

Answer to Questions of "TRAI Consultation paper on Regulation Framework on V2X"

Q1: Whether there is a need to introduce an authorisation for vehicle-to-infrastructure (V2I) communication service under Section 3(1)(a) of the Telecommunications Act, 2023? If yes, please provide input with respect to the following aspects:

(a) Eligibility conditions for the authorization.

(b) Period of validity of the authorisation and conditions for its renewal.

(c) Service area of the authorization.

(d) Scope of service of the authorization.

(e) Technical, operating, security related conditions etc. of the authorization.

(f) Any other related aspect. Kindly provide a detailed response with justification

Q2: In case your reply to Q1 is no, what should be the mechanism for enabling, facilitating and regulating vehicle-to-infrastructure (V2I) communication service in India? Kindly provide a detailed response with justification

Q3: Any other suggestions relevant to the authorization for vehicle-to-infrastructure (V2I) communication service may be submitted with proper explanation and justification.

Aumovio Answer for Q1, Q2 and Q3:

No. All V2X messages and applications which are safety Critical and result in reducing road accidents and human fatality are recommended to be part of 5875 MHz to 5925 MHz (Direct Short Range Communication in V2X) frequency spectrum, which is recommended to be authorized and regulated like OBUs, for RSUs for interoperability of all devices in ITS following regulation and having authorization to transmit.

Since EU stack has been considered EU regulations and administration methods can be used for India

Commercial and non-safety critical messages which are recommended to be using frequency spectrum outside 5875 MHz to 5925 MHz, Commercial and non-safety critical messages could need Authorization and condition for renewal, service area authorization, security related condition and regulations would be needed

Q4: Whether a specific technology (such as LTE-based C-V2X, NR-based C-V2X etc.) should be prescribed for the implementation of C-V2X in India? If yes, which technology should be adopted for the implementation of C-V2X? If no, in what manner, the issues related to inter-operability between different technologies should be addressed? Kindly provide a detailed response with justification

Aumovio Answer to Q4:

Single radio technology for short range communication to be used specifically for Direct Short-Range Communication with all layers properly defined to make sure the interoperability. LTE based C-V2X or NR based C-V2X could be decision of TRAI based on technology availability and technology implementation of technology which would be available for V2X in India.

It is very essential to define and regulate the safety critical Direct short range_V2X communication for Day-0 V2V use cases and applications as recommended by Task force in "Final Report of ITS Task Force for V2X in India", to achieve the objective of increasing the road safety for road users and decreasing the fatalities on India roads which are objective and priority with which V2X technology is being discussed for Indian Region.

Q5: Whether there is a need to bring road-side units (RSUs) and on-board units (OBUs) under the regime of Mandatory Testing Certification of Telecom Equipment (MTCTE)? If no, in what manner, Electromagnetic Interference (EMI), Electromagnetic Compatibility (EMC), safety, technical and security requirements prescribed by TEC/ DoT may be ensured? Kindly provide a detailed response with justification

Aumovio Answer to Q5:

Yes mandatory certification and testing is important by regulatory body for EMI, EMC and interoperability of OBUs and RSUs is necessary. As these devices adhering to the regulation and transmitting and receiving the messages in the RF spectrum as per the regulation is very important, if certification and testing for EMI, EMC and interoperability is not one, it will adversely impact in achieving the overall objective of ITS and safety.

Q6: To ensure inter-operability among different RSUs/ OBUs, whether there is a need to standardize the layered communication framework (stack) for higher layers (other than the access layer in which C-V2X will be used) of Intelligent Transportation System (ITS)? If yes, which standard for ITS stack and security should be adopted? Specifically, whether the ETSI standard for ITS stack and security, as recommended by the Task Force on Intelligent Transportation System for the use of 5.9 GHz (mentioned at para 3.5 of this consultation paper) should be adopted? If no, in what manner, inter-operability among different RSUs/ OBUs can be ensured? Kindly provide a detailed response with justification

Aumovio Answer to Q6:

Yes standardization if all communication layers is important with profiling of application standards for interoperability of systems developed by different manufacturers.

Aumovio recommends ETSI standards for V2X as discussed and recommended by major stakeholders at Task Force on Intelligent Transportation System and as per "Final Report of ITS Task Force for V2X in India"

ETSI is recommended for the following reasons,

1. **Better Safety:** dynamic message transfer rate or frequency possibility for DENM (Dynamic Event Notification Messages) of safety critical messages which enables not only deterministic but also faster delivery and processing of safety critical messages which will help in reducing road fatalities
2. **India specific Customization:** India specific inclusion of data within the message structure to handle India specific environment scenarios is very necessary which can be better accommodated in ETSI due to its structure
3. **Future expansion Scope:** Future expansion capabilities into advanced maneuvering and platooning possibilities
4. **Better Handling of channel load and message density due to high number of vehicles**

V2X in IEEE and ETSI Comparison

› Message definitions similar but different (BSM – CAM+DENM / SPAT+Map / etc.)	
› IEEE: fixed TX rate (10 Hz)	ETSI: urgency dependent TX rate (2-10 Hz)
› IEEE: single hop communication	ETSI: multi hop communication
› IEEE: no addressing of nodes	ETSI: addressing geographical regions
› IEEE: using US security standards	ETSI: using EU security standards
› IEEE: no message prioritization	ETSI: fine grained priorities for messages/UCs
› IEEE: limited number of cause codes	ETSI: large and growing number of cause/sub-cause codes

› IEEE: V2X radio = DSRC (similar to ITS-G5) ETSI: V2X radio = C-V2X PC5 or ITS-G5

Dynamic Messages brings lot of advantages for safety critical messages which needs less latency and deterministic transmission (with high probability of success in transmission and reception)

For security on direct communication, the adopted stack should rely on globally recognized V2X security mechanisms, including IEEE 1609.2-based certificate and message security frameworks as profiled by ETSI

Note: the term "uu" is used in this document to refer to common, long-range cellular communications using the cellular network infrastructure. In contrast, the term "direct short range V2X communication" is used to refer to V2V and V2I communication that does not require cellular network infrastructure. Some examples of "direct short range V2X communication" are LTE-V2X PC5 and NR-V2X PC5.

Q7: Whether there is a need for prescribing a security framework for ITS/ C-V2X in India? If yes,

(a) What should be the security framework for ITS/ C-V2X?

(b) Which agency [such as Controller of Certifying Authorities (CCA), Ministry of Electronics & Information Technology (MeitY)] should implement the Public Key Infrastructure (PKI) framework for ITS/ C-V2X in India

(c) How to ensure coexistence of V2X PKI certificates with the legacy PKI mechanism in India i.e. based on X.509, operated by Root Certifying Authority of India (RCAI)?

Please provide a detailed response with justifications.

Aumovio Answer to Q7:

Yes security framework needs to be defined for India for V2X,
For security on direct communication, the adopted stack should rely on globally recognized V2X security mechanisms, including IEEE 1609.2-based certificate and message security frameworks as profiled by ETSI
IEEE 1609.2 PKI security framework can be used agencies such as CCA/ MeitY can be controlling body of Root Certificates in India. India can either go with root of separate PKI infrastructure of Initial Root Certificate signing using X.509 and subsequent certificates Intermediate certificate and pseudonym certificate using standard PKI mechanism one Root Certificate is authorized and converted to standard PKI mechanism

Q8: What should be the regulatory framework for the assignment of frequency spectrum to the entities holding the proposed V2I communication service authorisation? Specifically,

(a) Whether there is a need for partitioning the 30 MHz spectrum (5,875-5,905 MHz) for specific applications such as "safety applications" and "operational applications (non-safety applications)"?

(b) In case more than one authorised entity has to operate in the same geographical area, what should be the mechanism for simultaneous use of the spectrum? Specifically, whether the spectrum should be divided amongst the authorised entities in an exclusive manner, or should the authorised entities utilize the spectrum in a shared manner?

(c) If your response to part (b) is "in an exclusive manner", what should be the minimum quantity of spectrum to be assigned to each entity holding the proposed V2I communication

service authorisation? If your response to part (b) is "in a shared manner", whether there is a need to prescribe a mechanism for interference management?

(d) For interference management, whether there is a need to prescribe –

(i) minimum directionality of road-side unit (RSU), or

(ii) protection distance between the RSUs, or

(iii) maximum antenna height for RSUs?

If yes, what should be such parameter(s)?

(e)

Whether there is need to mandate a mechanism for obtaining prior approval (analogous to SACFA clearance) for the establishment of RSUs by the entities holding the proposed V2I communication service authorisation? If no, in what manner, the establishment of RSUs should be regulated?

(f)

For avoiding (i) interference between RSUs, (ii) interference between RSUs and OBUs, and (iii) interference between OBUs, whether the radiated power limits for OBUs and RSUs and OOBE limits, recommended by the Task Force on Intelligent Transportation System for the use of 5.9 GHz (mentioned at para 3.4 of this consultation paper) should be adopted? If no, what should be the radiated power limits for OBUs and RSUs and OOBE limits?

(g)

What should be the maximum period of assignment of spectrum to the entities holding the proposed V2I communication service authorisation?

(h)

Whether there is a need to prescribe roll-out obligations associated with the assignment of spectrum to the entities holding the proposed V2I communication service authorisation?

(i)

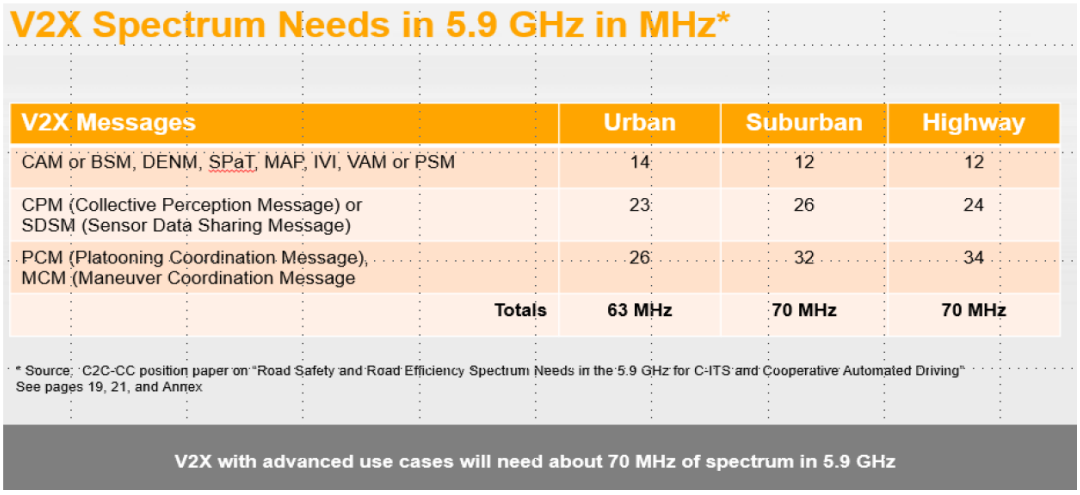
Whether there is a need to introduce a provision for the

surrender of frequency spectrum?

Kindly provide a detailed response with justification.

Aumovio Answer to Q8 :

a) The entire spectrum from 5875 Mhz to 5925 Mhz is necessary for road safety related application and messages to improve the road safety and decrease the road accident fatalities in India. As per research based paper from Car to Car "C2C consortium" on "Road Safety and Road efficiency Spectrum needs in 5.9 GHz for C-ITS and cooperative automated driving" reference from page 19, 20 and annex (Image shown below) clearly shows that minimum of 63 MHz to 70 Mhz of spectrum needs for Direct Short range V2X communication, currently accommodated spectrum in India at 5.9 GHz is only 50 Mhz and hence complete 50 MHz of spectrum from 5875 Mhz to 5925 Mhz is required for safety applications,
operational and non-safety applications need to be moved out of 5875 MHz to 5925 MHz (one example could be long range uu communication link)



V2X Spectrum Needs in 5.9 GHz in MHz*

V2X Messages	Urban	Suburban	Highway
CAM or BSM, DENM, SPaT, MAP, IVI, VAM or PSM	14	12	12
CPM (Collective Perception Message) or SDSM (Sensor Data Sharing Message)	23	26	24
PCM (Platooning Coordination Message), MCM (Maneuver Coordination Message	26	32	34
Totals	**63 MHz**	**70 MHz**	**70 MHz**

* Source: C2C-CC position paper on "Road Safety and Road Efficiency Spectrum Needs in the 5.9 GHz for C-ITS and Cooperative Automated Driving" See pages 19, 21, and Annex

V2X with advanced use cases will need about 70 MHz of spectrum in 5.9 GHz

Note: the term "uu" is used in this document to refer to common, long-range cellular communications using the cellular network infrastructure. In contrast, the term "direct short range V2X communication" is used to refer to V2V and V2I communication that does not require

cellular network infrastructure. Some examples of “direct short range V2X communication” are LTE-V2X PC5 and NR-V2X PC5.

b) ETSI standards clearly defines usage of all safety critical and safety relevant messages in 5.9 GHz ITS band in its IEEE 1609 standard, where are messages defined inside like CAM, DENM, SPaT, MAO, IVI, VAM/ PSM, Collective Perception Message, Sensor Data Sharing Message, Platooning Coordination Message and Advanced Maneuver Messages handling of spectrum and priorities are well defined, these messages will be using spectrum in shared manner
c) Simultaneous use of spectrum and sharing of spectrum is defined in ETSI IEEE Standards hence same can be carried forward into Indian standards as well
d) ETSI EN 302 571 specifies EIRP limits (~23 dBm/MHz class) and spectrum masks, providing a comparable and proven baseline.
e) RSU Registration and certification should be sufficient to handle the regulation part. V2X security mechanisms, including IEEE 1609.2-based certificate and message security frameworks as profiled by ETSI for - EN Security Standard IEEE 1609.2 should manage all the V2X and V2I service authorization
f) Yes recommended by the Task Force on Intelligent Transportation System for the use of 5.9 GHz (mentioned at para 3.4 of this consultation paper) should be adopted along with below recommendation for neighboring devices operating below 5875 MHz and above 5925 Mhz

   A combination of 1, 2 and 3 is recommended based on feasibility in Indian context by TRAI:

   1.

      e) The low power transmission is not allowed at all.
      f) Or low power devices are only allowed with less transmission power e.g. -20dBm/MHz between (5925 – 6425 MHz band)
      g) Or low power devices are only allowed to use small bandwidth e.g. 10 Mhz (this will translate in stricter OOB - out of band emissions requirements too)
      h) Or low power devices need to detect V2X transmissions OOB emissions (e.g. by their OOB – out of Band emissions) and in case they detect V2X signals they must use the channels above 5965 MHz
         In the frequency range (5925 – 6425 MHz band)
         (Similar to 5.1 to 5.4 GHz Radar Detection possibility for RLAN. reference: DFS Dynamic Frequency selection. Reference: ITU-R M.1652-1, Annex 1 and ETSI EN 303 893)

RECOMMENDATION ITU-R M.1652-1 - Dynamic frequency selection* in wireless access systems including radio local area networks for the purpose of protecting the radiodetermination service in the 5 GHz band

https://www.etsi.org/deliver/etsi_en/301800_301899/301893/02.02.01_60/en_301893v020201p.pdf

2. Require lower OOB - out of band emissions from the low power devices general band 5925 to 6425 MHz (e.g. <-27dBm/MHz, better suppression of the signal at the band boundaries, etc) starting at band edge of 5925 MHz

3. Add a maximum duty cycle requirement for every low-power device e.g. 5%. Meaning only 5% of the time the band is utilized and 95% of the time no transmission per station.

g) All V2V and V2I messages which are safety critical application and messages, and which specifically contribute in reducing the road fatalities and emergency response of the special vehicles needs to be part of 5875 to 5925 Mhz which is direct short range V2X communication. All non safety, operational, informational application and messages which contribute towards convenience and smart mobility could be part long range cellular communication outside 5875 Mhz to 5925 MHz frequency (Example: uu Communication)
Above 2 steps will make sure that spectrum is efficiently used by all devices. Radiation power can be defined for direct short range V2X communication and uu communication to make sure the interference is minimum but major isolation is needed with the neighboring bands as explained in point 2 above “Safeguarding V2X communication 5875MHz to 5925Mhz from Interference:”

Note: the term “uu” is used in this document to refer to common, long-range cellular communications using the cellular network infrastructure. In contrast, the term “direct short range V2X communication” is used to refer to V2V and V2I communication that does not require cellular network infrastructure. Some examples of “direct short range V2X communication” are LTE-V2X PC5 and NR-V2X PC5.

h) Yes approval and certification for both OBUs and RSUs would be needed to make sure all the parameters and standards are followed to make sure there is no interference as well as there is interoperability between all devices
i) No Authorized entities should use the spectrum on the shared manner and prioritization for safety critical messages and applications must be done

Q9: Whether there is a need for prescribing timelines for processing the applications for the assignment of spectrum to the entities holding the proposed V2I communication service authorization? Kindly provide a detailed response with justification.

Aumovio Answer : ETSI specification of security authorization using IEEE 1609.2 can be followed to make entities who is authorized is only using the spectrum and for the defined time

Q10: Whether there are any other suggestions related to assignment of spectrum to the entities holding the proposed V2I communication service authorization? Please provide a detailed response with justification.

Aumovio Answer :

Yes All V2V and V2I messages which are safety critical applications and messages, and which specifically contribute in reducing the road fatalities and emergency response of the special vehicles needs to be part of 5875 to 5925 Mhz which is Direct short range V2X communication.

All non safety, operational, informational application and messages which contribute towards convenience and smart mobility could be part uu Communication from 3GPP.

Above 2 steps will make sure that spectrum is efficiently used by all devices. Radiation power can be defined for direct short range V2X communication and uu communication to make sure the interference is minimum but major isolation is needed with the neighboring bands as explained in point 2 above “Safeguarding V2X communication 5875MHz to 5925Mhz from Interference:”

Along with this implementation of ETSI based IEEE 1609.2 provides proper authorization for the OBUs and RSUs for using being active participants in the 5.9 Ghz spectrum thus solving the authorization issues, kindly note there is provision to revoke the authorization of the entities also defined in IEEE 1609.2. ETSI specification further also takes care of congestion management of the spectrum.

Q11: Any other issues/suggestions relevant to the regulatory framework for V2X communication may be submitted with proper explanation and justification.

Aumovio Answer:

Yes there are 2 Topics,

1. **Safeguarding V2X communication 5875MHz to 5925Mhz from Interference** (Justification mentioned Below)
2. **Additional Spectrum needs of 50 MHz to 70 MHz for advance maneuverability and platooning as part ITS global objectives** (Justification mentioned Below)

Justification for : "Safeguarding V2X communication 5875MHz to 5925Mhz from Interference:"

OBU's and RSU's spectrum interference to neighboring bands has been described in the "TRAI Consultation paper on Regulation" with out of band emission limits for OBUs and RSUs in "Table 3.1" in "TRAI Consultation paper on Regulation" but interference from neighboring spectrum to V2X has been observed in field studies and Safeguarding V2X communication from Spectrum Interference from use of low power and very low power Wireless Access System including Radio Local Area Network in lower 6 GHz band (5925 – 6425 MHz band) is very essential as V2X has primary aim of reducing accidents and saving human lives.

There are several alternative possibilities that may help ensuring a better coexistence of V2X and low power devices without having interference in the operation of safety critical V2X Technology as mentioned below, we would recommend to hence include Interference to V2X spectrum limitation possibilities in the "TRAI Consultation paper on Regulation" as specifically mentioned in section 2.2 of "TRAI Consultation paper on Regulation" that "

A combination of 1, 2 and 3 is recommended based on feasibility in Indian context by TRAI:

1.
   i) The low power transmission is not allowed at all.
   j) Or low power devices are only allowed with less transmission power e.g. -20dBm/MHz between (5925 – 6425 MHz band)
   k) Or low power devices are only allowed to use small bandwidth e.g. 10 Mhz (this will translate in stricter OOB - out of band emissions requirements too)
   l) Or low power devices need to detect V2X transmissions OOB emissions (e.g. by their OOB – out of Band emissions) and in case they detect V2X signals they must use the channels above 5965 MHz
   In the frequency range (5925 – 6425 MHz band)

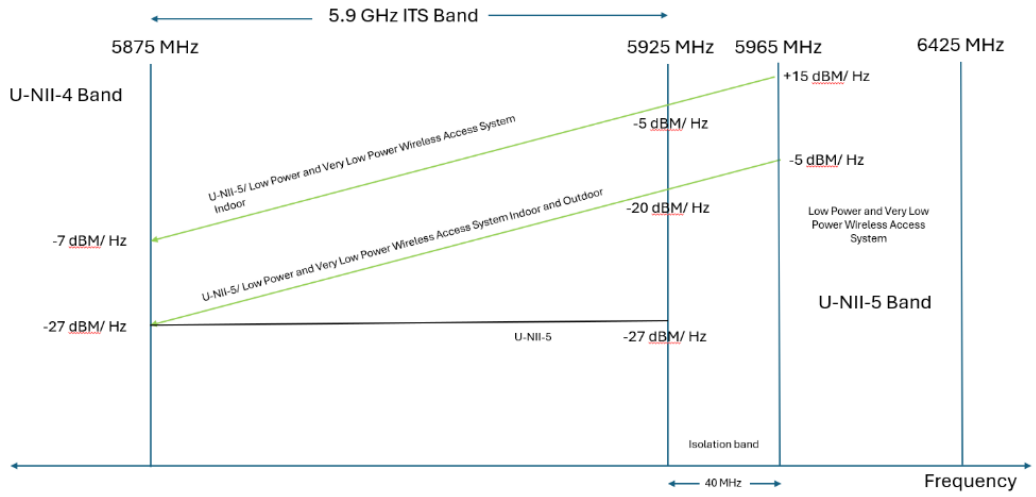
(Similar to 5.1 to 5.4 GHz Radar Detection possibility for RLAN. reference: DFS Dynamic Frequency selection. Reference: ITU-R M.1652-1, Annex 1 and ETSI EN 303 893)

RECOMMENDATION ITU-R M.1652-1 - Dynamic frequency selection* in wireless access systems including radio local area networks for the purpose of protecting the radiodetermination service in the 5 GHz band

https://www.etsi.org/deliver/etsi_en/301800_301899/301893/02.02.01_60/en_301893v020201p.pdf

2. Require lower OOB - out of band emissions from the low power devices general band 5925 to 6425 MHz (e.g. <-27dBm/MHz, better suppression of the signal at the band boundaries, etc) starting at band edge of 5925 MHz

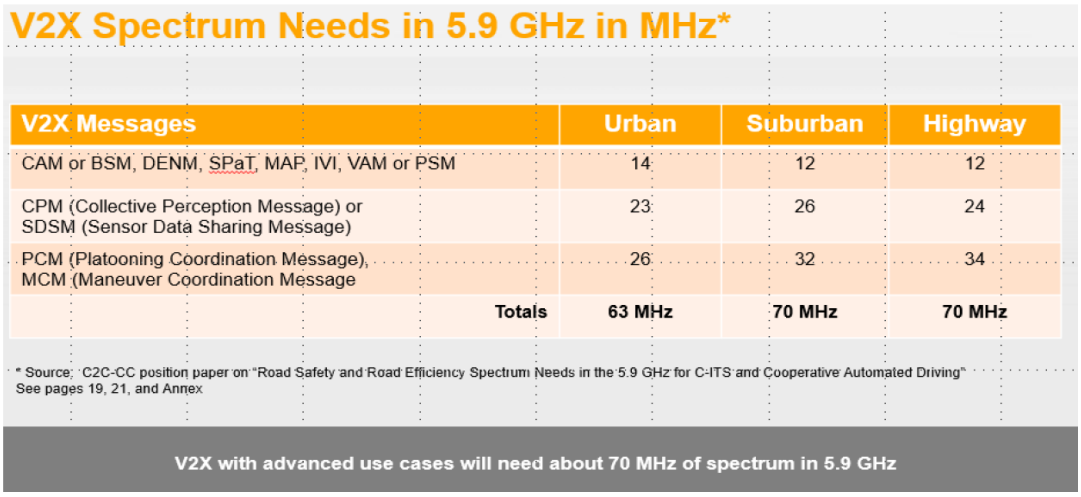
3. Add a maximum duty cycle requirement for every low-power device e.g. 5%. Meaning only 5% of the time the band is utilized and 95% of the time no transmission per station.



Justification for : "Additional Spectrum needs of 50 MHz to 70 MHz for advance maneuverability and platooning as part ITS global objectives."

a. Additional 20 MHz is needed from 5925 to 5945 MHz on top of 5875 to 5925MHz would be necessary, if use cases for platooning and manoeuvring assist functions for ADAS integration needs to be realized in the future to better realise ITS Goals.
Reference: CAR 2 CAR-Communication Consortium "Road Safety and Road Efficiency Spectrum Needs in the 5.9 GHz for C-ITS and Cooperative Automated Driving"
CAR 2 CAR Communication Consortium.

Annex A 5.9 GHz C-ITS and cooperative automated driving spectrum requirement calculations, Europe. Figure 10 to Figure 16 Annex B 5.9 GHz C-ITS and cooperative automated driving spectrum requirement calculations, USA, Figure 17 to Figure 2



These above recommendation is on top of "Section 13.3 other allied frequency requirements for V2X India" referred in" "TRAI Consultation paper on Regulation Framework on V2X"

Q12: In view of the public welfare-oriented nature of V2X applications and the need to encourage the deployment of such infrastructure and services, should there be spectrum charges levied on spectrum assigned to the V2I communication service authorized entities under the proposed V2I communication service authorization? Please provide detailed justification in support of your response.

Aumovio Answer:

Spectrum 5875 MHz to 5925 MHz for V2V and V2I needs to be License exempt / general authorization for safety and emergency related V2I and V2V applications and messages which will help in reducing the road fatalities as in Europe.

For Non-Safety and commercial applications, messages, frequency spectrum outside 5875 MHz to 5925 Mhz needs to be used (Example: uu communication), There is no comment from Aumovio on the spectrum charge for uu communication spectrum, this kind of balance will help to develop the infrastructure which is needed for safety applications along with better spectrum commercial utilization.

Note: the term "uu" is used in this document to refer to common, long-range cellular communications using the cellular network infrastructure. In contrast, the term "direct short range V2X communication" is used to refer to V2V and V2I communication that does not require cellular network infrastructure. Some examples of "direct short range V2X communication" are LTE-V2X PC5 and NR-V2X PC5.

Q13: If answer to Q12 is affirmative, whether the spectrum charges for the V2I communication service authorized entities under the proposed V2I communication service authorization should be determined based on the spectrum charging methodology prescribed by the Department of Telecommunications (DoT) vide its order dated 11.12.2023? If yes, then which of the radiocommunication services specified in the said order, should be taken as basis for calculation of spectrum Charges? Please provide detailed justification in support of your response.

Aumovio Answer:

Direct short range V2X communication spectrum usage should be reserved for safety critical and emergency applications/ messages and hence should not be part of spectrum charges as it is very important to reduce the fatalities on Indian Roads, this needs to be done in the view of increasing the public safety of citizens of India.

Non safety critical and non-emergency applications which could operate in the uu spectrum which is outside 5875 MHz to 5925 MHz and this could be on spectrum usage chargeable basis but decision is up to TRAI for uu Spectrum usage by RSU's

Note: the term "uu" is used in this document to refer to common, long-range cellular communications using the cellular network infrastructure. In contrast, the term "direct short range V2X communication" is used to refer to V2V and V2I communication that does not require cellular network infrastructure. Some examples of "direct short range V2X communication" are LTE-V2X PC5 and NR-V2X PC5.

Q14: If answer to Q12 is affirmative, whether the spectrum charges for the V2I communication service authorized entities under the proposed V2I communication service authorization should be levied as a percentage of Adjusted Gross Revenue (AGR)? If yes, are there any specific operational/ non-operational revenue items that should be included in/ excluded from AGR for the purpose of determination of spectrum charges? Please provide your response with detailed justification.

Aumovio Answer:

Direct short range V2X communication should not be part of spectrum charges.

Non safety critical and commercial messages using uu spectrum there is no opinion on charges from Aumovio it is up to TRAI to make decision for uu communication charges for the RSU's

Q15: If response to questions 13 and 14 is negative, then what should be the appropriate methodology for determination of spectrum charges for the V2I communication service authorized entities under the proposed V2I communication service authorization? Please provide detailed justification in support of your response.

Aumovio Answer:

Direct short range V2X communication should not be part of spectrum charges.

Non safety critical and commercial messages which could be outside 5875 MHz to 5925 MHz spectrum (Example: uu spectrum), there is no opinion on charges from Aumovio .

Justification is V2X being very important technology to improve the safety of road users and decrease the fatalities on Indian Roads is a technology which is very important from Indian High density vehicle movement infrastructure nature and hence since public safety and improvement of safety is the direct outcome spectrum charges specifically for direct side link communication using PC 5 is not recommended.

Note: the term “uu” is used in this document to refer to common, long-range cellular communications using the cellular network infrastructure. In contrast, the term “direct short range V2X communication” is used to refer to V2V and V2I communication that does not require cellular network infrastructure. Some examples of “direct short range V2X communication” are LTE-V2X PC5 and NR-V2X PC5.

Q16: For spectrum assigned to the V2I communication service authorized entities under the proposed V2I communication service authorization, what should be the appropriate payment terms for spectrum charges, if any? Please provide your response with detailed justification.

Aumovio Answer:

Further Authorization could be handled by ETSI IEEE 1609.2 standard where certificates are issues only for certified and authorized RSU entities and OBU’s. with provision to revoke the certificate and hence disable those entities from being part of active ITS participant.

Direct short range V2X communication should not be part of spectrum charges.

Non safety critical and commercial messages using Spectrum outside of 5875 MHz to 5925 Mhz (example: uu spectrum) there is no opinion on charges from Aumovio

Note: the term “uu” is used in this document to refer to common, long-range cellular communications using the cellular network infrastructure. In contrast, the term “direct short

range V2X communication" is used to refer to V2V and V2I communication that does not require cellular network infrastructure. Some examples of "direct short range V2X communication" are LTE-V2X PC5 and NR-V2X PC5.

Q17: What are the potential sources of revenue, if any, for an V2I communication service authorized entity under the proposed V2I communication service authorization? Please provide your response with detailed justification.

Aumovio Answer:

Direct short range V2X communication should not be part of spectrum charges.

Non safety critical and commercial messages using frequency outside 5875 MHz to 5925 MHz (Example: uu spectrum) there is no opinion on charges from Aumovio

Note: the term "uu" is used in this document to refer to common, long-range cellular communications using the cellular network infrastructure. In contrast, the term "direct short range V2X communication" is used to refer to V2V and V2I communication that does not require cellular network infrastructure. Some examples of "direct short range V2X communication" are LTE-V2X PC5 and NR-V2X PC5.

Q18: What should be the definitions of Gross Revenue (GR), Applicable Gross Revenue (ApGR), and Adjusted Gross Revenue (AGR) for V2I communication service authorized entity under the proposed V2I communication service authorization? Further, what should be the relevant items of revenue, exclusions and deductions and consequent definitions of GR, AGR and ApGR? Please provide your response with detailed justification.

Aumovio Answer:

No Comments

Q19: What revenue components should be included in, or excluded from, the computation of Gross Revenue (GR), Applicable Gross Revenue (ApGR) and Adjusted Gross Revenue (AGR) for the purpose of determining authorization fees or spectrum charges for the proposed V2I communication service authorization? Please provide your response with detailed justification

Aumovio Answer:

No Comments

Q20: Whether revenue derived from safety-related V2X services under the proposed V2I communication service authorization should be excluded from the computation of AGR, in view of their public interest and non-commercial nature? Please provide your response with detailed justification.

Aumovio Answer:

Yes. Justification: As it is important to have RSU infrastructure developed and as in general RSU would also support the direct short range V2X communication which would mainly be focusing on safety critical and emergency applications and messages, hence to improve the coverage and penetration of RSU is V2X system any exclusions of license charges would help in improving the coverage and safety of all road users and hence any exclusions in RSU commercial spectrum usage in uu band would help improve road safety in India

Q21: What should be the appropriate entry fee for V2I communication service authorized entities under the proposed V2I communication service authorization? Please provide detailed justification in support of your response.

Aumovio Answer:

No comments

Q22: What should be the appropriate terms and conditions for bank guarantees for the proposed V2I communication service authorization? Please provide detailed justification in support of your response.

Aumovio Answer:

Service Authorization could be based on certification similar to ETSI IEEE 1609.2 could be done which enables the RSU's and OBU's to be active participants in the ITS network, with provision of revocation in case of unauthorized use of spectrum or misbehaviors observed.

Q23: What should be the applicable minimum equity and minimum net worth requirements for authorized entities under the proposed V2I communication service authorization? Please provide detailed justification in support of your response.

Aumovio Answer:

No comments

Q24: What should be the applicable application processing fee for the proposed V2I communication service authorization? Please provide detailed justification in support of your response.

Aumovio Answer:

No comments

Q25: What should be the applicable rate of authorization fee for proposed V2I communication service authorization? Please provide detailed justification in support of your response.

Aumovio Answer:

No comments

Q26: Apart from the financial provisions discussed earlier, are there any other financial terms and conditions that should be made applicable for the proposed V2I communication service authorization? Please provide detailed justification in support of your response.

Aumovio Answer:

No comments