

1 *For BIS Use Only*

2 *Draft Indian Standard*

3 **REQUIRMENTS FOR LIGHT ELECTRIC VEHICLES (LEV) BATTERY SWAP**
4 **SYSTEMS (BSS)**

5
6 **(Part 3)**

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Last date for receipt
of comments is - 25 September 2022

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Draft Indian Standard

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Central Management System

17

(Part 3)

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20 Electrotechnology in Mobility Sectional Committee, ETD-51**21 FOREWORD**

22

23 India is gaining momentum in Electric Vehicles adoptions through newer technologies available
24 through the world and by innovating in various domains. A faster adoption to EVs is seemingly
25 difficult due to higher cost of EVs, particularly with batteries responsible for about half the cost of
26 the vehicle. Swapping of batteries offer a viable alternative for solving the affordability problem
27 where vehicles can be topped up with the batteries as we regularly fuel the conventional vehicles
28 with diesel and petrol. This will also ensure that electric vehicle charging does not take more time
29 than fueling the conventional vehicles.

30

31 The battery swapping mechanism allows the sale and registration of electric vehicles without any
32 batteries and these batteries are considered as separate entities. The complete liability of these
33 batteries is with battery as a service provide (aka BaaS provider). Therefore, battery swapping
34 offers a lot of benefits for vehicle owners and business providers.

35

36 This battery swapping systems also helps in addressing the problem of insufficient charging
37 infrastructure which is a major concern associated with conventional charging methods. Battery
38 swapping allows an easy exchange of discharged batteries with the fully charged ones quickly and
39 the users are charged based on consumption. Therefore, battery swapping technology can help to
40 develop a successful EV ecosystem in India and can help contribute to the shift to electric mobility.

41

42 For the benefit of the end user, it is important to make the assets used in swapping infrastructure
43 interoperable. This standard covers the Central Management System (CMS) for Swap Battery
44 Packs and provides the backend management essentials to maintain the functionality of the
45 guidelines that are offered in following standards.

46

47

48

1. Part 4/Sec 1 Light Electric Vehicle- Guidelines and Pack Dimensions
2. Part 4/Sec 2 Light Electric Vehicle- Connection System
3. Part 4/Sec 3 Light Electric Vehicle- Communication protocol.

Draft Indian Standard
Central Management System
(Part 3)

1 SCOPE

- 1.1 This part of standard, which is Central Management System, allows an efficient communication between the different entities of the battery charging infrastructure. The Central Management System is an interconnection point for the subsystems in the ecosystem to ensure interoperability between all these subsystems. Central Management System involves collecting meaningful attributes from swapping infrastructure components and consolidating all the operational information at one common platform. Some of these meaningful attributes such as available battery and location of the battery swap station would be accessible to authorities and swappable battery users.
- 1.2 The aspects covered in this standard include
- a) Functionalities of central management system
 - b) Functionalities of user application that helps users to access swapping infrastructure
 - c) Requirements of BaaS operator platform for maintaining all records

2 REFERENCES

The standards listed below contain provisions, which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed below:

<i>IS No</i>	<i>Title</i>
AIS 065:2005	Statutory Plates and Inscriptions for Motor Vehicles, their Location and Method of attachment – Vehicle Identification Numbering System

3 TERMINOLOGIES

For the purposes of this standard, the following terms and definitions shall apply.

3.1 AIO (Asset Inter-Operability)

The physical entities maintained by a Battery as a Service operator that are enrolled into its infrastructure

3.2 BaaS (Battery as a Service)

Battery is used as a service by the operator to provide a charged battery to the user in exchange of the discharged battery

3.3 BSS (Battery Swap Station)

Device that can store more than one SBS and support battery swap for EVs

86 **3.4 B-AIO (Battery Asset Inter-Operability)**

87 The batteries of different makes and models that are inter-operatable with BSS and EVs in
88 the network

89 **3.5 BOP (BaaS Operator Platform)**

90 The web portal managed by the operator that provides battery swap services to the users

91 **3.6 EV (Electric Vehicle)**

92 Vehicle propelled by an electric motor drawing current from a rechargeable storage battery
93 or from other portable energy storage devices (rechargeable, using energy from a source
94 off the vehicle, such as residential or public electric service), which is manufactured
95 primarily for use on public streets, roads or highways

96 **3.7 I-NIO (Intra-Operator Network Inter-Operability)**

97 A network of BSS and SBS that is managed by an Operator that can be used and
98 recognized within an Operator's zone of service

99 **3.7 SBS (Swappable Battery System)**

100 Battery system that can be moved or removed from an EV by hand or with assistance of
101 mechanical device

102 **3.8 SS-AIO (Swap Station Asset Inter-Operability)**

103 The BSS in the network that provide services to users through UAP(User Application) for
104 battery swapping and also charges the batteries

105 **3.9 SSN (Single Station Network)**

106 Typically, setup by an Operator whose network allows swappable batteries, battery swap
107 stations, and user to recognize and interact with each other

108 **3.10 State Of charge (SOC)**

109 Available capacity in a battery pack or system expressed as a percentage of rated capacity

110 **3.11 State of health (SOH)**

111 Parameter that indicates health of the battery in terms of percentage or residual lifecycles

112 **3.12 SON (Swap Operator Network)**

113 Network of all SSN in the infrastructure set up by the BaaS operator

114 **3.13 T-NIO (Inter-Operator Network Interoperability)**

115 Interoperability between two or more SON

116 **3.14 UAP (User Application)**

117 Mobile user application for users enrolled with BaaS operator to access swapping infrastructure
118 and avail swapping services

119 **3.15 VCU (Vehicle Control Unit)**

120 VCU is a supervisory controller in EV that acts as a telematics device (or integrated with a
121 telematics device) for fetching driving data of SBS and sending back to CMS by Telecom/Wi-fi
122 technology.

123 **4 SYMBOLS AND ABBREVIATIONS (TBD)**

124 For the purpose of this standard, the following letter symbols and abbreviations have the
125 meaning indicated against each, other symbols used in this standard have been explained at
126 appropriate places.

127 C-rate capacity, expressed in ampere-hours (A·h)

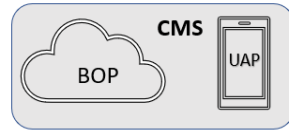
128 CAN Control Area Network

129 SOC state of charge

130 % Percentage

131 **5. CENTRAL MANAGEMENT SYSTEM**

132 Central management system is a platform to maintain and manage all operations of battery
 133 swapping infrastructure to provide seamless services to beneficiaries enrolled with BaaS
 134 operator. CMS is owned and maintained by the BaaS operator. The CMS platform comprises of
 135 two modules namely BaaS operator platform (BOP) and User app (UAP).



136
 137 Figure 1: CMS composition
 138

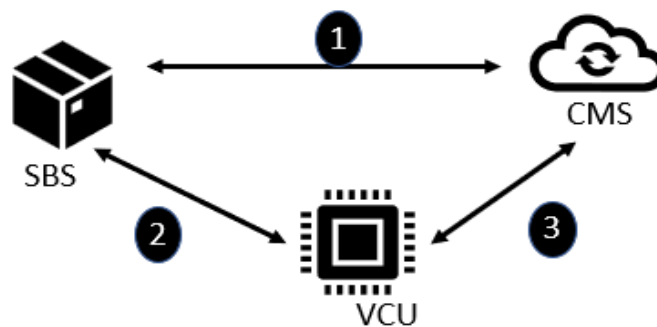
139 **5.1 COMMUNICATION INTERFACES BETWEEN CMS AND MANAGING ENTITIES**

140 To fulfil the purpose of CMS, the data from all sub systems involved in the battery infrastructure
 141 needs to be brought to the CMS. For LEV battery swap system, the system and sub systems
 142 involved in the infrastructure are provided in the system overview defined in standard IS17018
 143 Part 4 Section1. To link these entities to CMS, the interfaces or say communication links
 144 between each of these entities and CMS need to be established.

145 All communication interfaces including BOP and UAP should comply with the National data
 146 privacy policy.

147
 148 **5.1.1 Interface Between SBS And CMS during Discharging Mode**

149 An SBS may communicate to CMS in two different ways during discharging. Communication of
 150 the SBS data during discharging mode of SBS shall happen either directly through Telecom /
 151 Wi-Fi or through the medium such as VCU in the vehicle, any telematics device, or App as
 152 required.



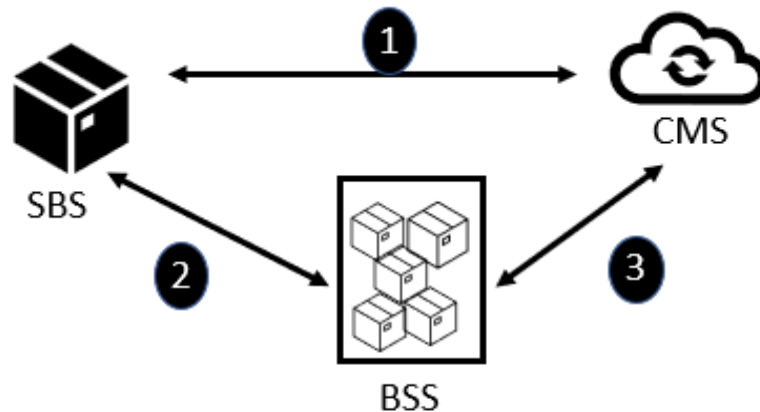
Key-Description: Mode of communication
 1- Link between SBS and CMS : 2G/3G/4G/5G
 2- SBS to VCU : CAN
 3- VCU to CMS: Telecom Network / Wi-Fi

154
 155 Figure 2: Interface between SBS and CMS in Discharging Mode

156

157 5.1.2 Interface between SBS and CMS during charging mode

158 An SBS may communicate to CMS in two different ways during charging. Communication of
 159 the SBS data during charging mode of SBS shall happen either directly through Telecom/Wi-Fi
 160 or through the BSS.



Key-Description: Mode of communication

1- Link between SBS and CMS : Telecom / Wi-Fi

2- SBS to BSS : CAN

3- BSS to CMS: Telecom / LAN/Wi-Fi

161

162

163

Figure 3: Interface between SBS and CMS in Charging Mode

164

165 5.1.3 Interface between BSS and CMS

166 BSS may communicate to CMS using any of the wired and wireless communication media.

167 Example of wired communication is Ethernet. Examples of wireless media that may be used are
 168 2G/3G/4G/5G

169

170 5.1.4 Interface between VCU and CMS

171 Communication between VCU and CMS shall always happen through a continuous link on
 172 wireless media, example 2G/3G/4G/5G.

173

174 5.2 ENTITIES MANAGED IN CMS

175 The entities that shall be managed by CMS are electric vehicles (EVs), swappable battery system
 176 (SBS) and battery swap station (BSS). For managing these entities, relationship of each entity with
 177 another shall be established. To establish relation between entities, each entity should be
 178 uniquely identified in the CMS.

179

180 **5.2.1 Vehicle Identification Number – VIN**

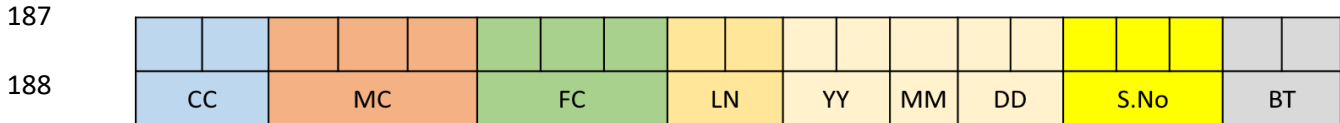
181 Each EV is identified with its uniquely defined vehicle identification number.

182 Format of VIN is detailed in AIS-065.

183 **5.2.2 Battery Identification Number – BIN**

184 Battery is uniquely identified by battery identification number (BIN). The format of BIN is
 185 defined below.

- 186 • BIN Components – 20 Digits



190 Table 1: BIN Components description

#	Components	Abbreviation	Description	Reference	Digits
1	Country code	CC	To identify the country	ISD country codes can be used Ref: https://countrycode.org/	2
2	Manufacturer Code	MC	To identify the manufacturer	To be assigned by some regulatory authority to identify different manufacturers. E.g. EXI – Exide, AMR-Amara raja	3
3	Factory code of the manufacturer	FC	To identify the factory code where the battery manufacturing is done	This could be manufacturer specific data to identify the factory	3

4	Line Number in the factory	LN	To identify the line number in the factory	This could be manufacturer specific data to identify the factory	2
5	Production Date	YYMMDD	Year, Month and date of production	Year: Offset to be 2017. E.g. 1 indicates 2017, 2 indicates 2018 and so on up to 99 Month: A-Jan, B-Feb, C-Mar.... J-Nov, K-Dec Date: 01, 02, 03... 30, 31.	2+1+2=5
6	Serial Number	S.No	Serial number of the battery	Three-digit serial number of the battery ranging from 1 to 4095(0X01H to 0xFFH)	3
7	Battery Type	BT	Battery chemistry type	01H: lead acid battery; 02H: nickel hydrogen battery; 03H: lithium iron phosphate battery; 04H: lithium manganite battery; 05H: cobalt based lithium battery; 06H: ternary material battery; 07H: polymer lithium-ion battery; 08H: lithium ion battery; 09H: NMC (Lithium Nickel Manganese Cobalt Oxide)0AH: NCA (Lithium Nickel Cobalt Aluminum Oxide)0BH: Lithium titanate oxide (LTO)0CH: Lithium	2

				Nickel cobalt manganese FFH: other batteries	
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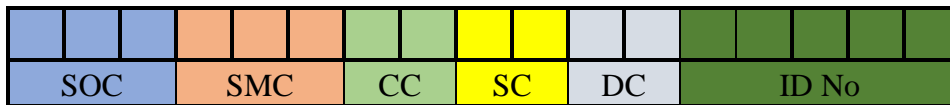
191

192

193 **5.2.3 Battery Swap Station Number – BSSN**

194 Each BSS is uniquely identified with its battery swap station number (BSSN). The format of
195 BSSN is as given below.

- 196 • BSSN – 14 Digits



197

198 Table 2: BSSN components description

#	Components	Abbreviation	Description	Reference	Digits/Bytes
1	Swap Operator Code	SOC	To identify the BaaS operator who deploys the BSS in the infrastructure	Can be taken from first 3 letters of the entity / abbreviation of BaaS	3
2	Station Manufacturer code	SMC	To identify the manufacturer of the BSS	Can be taken from first 3 letters of the entity / abbreviation of BSS Manufacturer	3
3	Country Code	CC	To identify the country	ISD country codes can be used. Ref: https://countrycode.org/	2
4	State code	SC	To identify the state in which the BCS is present. State codes used in vehicle number plate can be taken as reference. CMS will have list of state code. This would be captured during registration of SO with CMS and generated based on user's selection of location	Ref: https://en.wikipedia.org/wiki/Vehicle_registration_plates_of_India#Current_codes	2

5	District Code	DC	<p>To identify the district of respective state in which the BCS is present.</p> <p>CMS will have list of state-wise district code. This would be captured during registration of SO with CMS and generated based on user's selection of location</p>	<p>Ref:https://en.wikipedia.org/wiki/List_of_districts_in_India</p>	2
6	ID Number	ID No.	<p>5-digit number to identify the BCS</p>	<p>Unique 5-digit ID from CMS upon successful registration</p>	5

199

200

201 **6 INTEROPERABILITY CLASSIFICATION**

202

203 A BaaS shall manage the assets and the BaaS communication network. With respect to the BaaS
204 operator, the interoperability is categorized into Asset Interoperability and Network
205 Interoperability. Two assets for BaaS operator to manage in the infrastructure are batteries and
206 swap stations. The two networks for BaaS operator to manage are intra-operator network and inter-
207 operator network.

208 **6.1 ASSETS INTEROPERABILITY (AIO)**

209

210 All the components of the network should be connected and should communicate with each other.
211 The assets of all different manufacturers, makes and models should be compatible to rest of the
212 assets of AIO. The two major components of AIO are batteries and swap stations.

213

214 **6.1.1 Battery Asset Interoperability (B-AIO)**

215

216 The battery is considered as a separate entity and all the batteries in their respective segment say
217 LEV or e-Bus under IS-17018 should be connected with the swap station irrespective of their make
218 and model. These batteries should be compatible with the standard defined under different sections
219 of IS-17018, for example for ratings, safety and physical attributes, battery should comply to IS-
220 17018 Part-4 Section-1; for connector the battery should follow IS-17018 Part-4 Section-2 and for
221 communication with vehicle or swap station the battery should follow IS-17018 Part-4 Section-3
222 under LEV segment.

223 **6.1.2 Swap Station Asset Interoperability Network (SS-AIO)**

224 N number of BSS can take part in this system and can communicate with each other. They can
225 share the information about the availability of batteries and location of the station and all this
226 information will be stored on CMS through a wired / wireless media.

227 These BSS should be compatible with the standard defined under different sections of IS-17018,
228 for example for ratings, safety and physical attributes, BSS should comply to IS-17018 Part-4
229 Section-1; for connector the BSS should follow IS-17018 Part-4 Section-2 and for communication
230 with SBS, it should follow IS-17018 Part-4 Section-3 under LEV segment.

231

232

233 **6.2 NETWORK INPEROPERABILITY (NIO)**

234 For the communications under CMS, interoperability for BaaS operator shall be obtained using
235 following two classifications.

- 236 i. Intra-operator Network Interoperability (I-NIO)
- 237 ii. Inter-operator Network Interoperability (T-NIO)

238

239 **6.2.1 Intra-Operator Network Interoperability (i-NIO)**

240

241 This connection allows a swapping of a standard swap battery at any standard swap station of
242 one operator. The operator is responsible for setting up complete infrastructure of a swap
243 station and the information related to different swap stations on his network should be
244 conveyed to the user through an app. The user can check the location of the swap station,
245 availability of the batteries, battery compatibility information, reservation status, cancellation
246 option, etc.

247

248 At the swap station, the user can exchange the discharged battery with the charged one and
249 can pay per swap through the digital payment like BHIM UPI. The tariffs and scheme can be
250 decided by the operator.

251 I-NIO is obtained through single station network (SSN) that manages b-AIO and ss-AIO,
252 and swap operator network (SON)

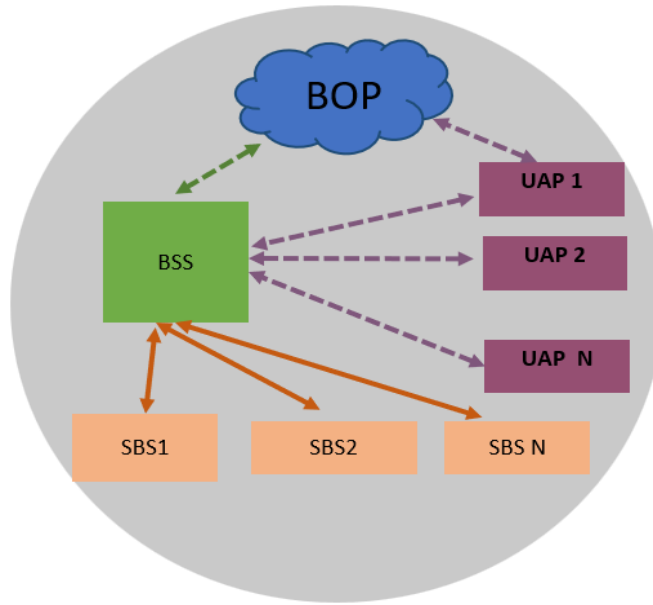
253 **6.2.1.1 Single Station Network (SSN)**

254 The status from different SBS can be shared with every single BSS of a particular
255 BaaS operator. BSS interacts with all authenticated / registered users of the operator and
256 controls the issuance of SBS to the user. SSN ensures B-AIO and SS-AIO.

257 SSN prime functions are

- 258 i. user verification
- 259 ii. battery verification
- 260 iii. battery charging
- 261 iv. battery data transfer to CMS.

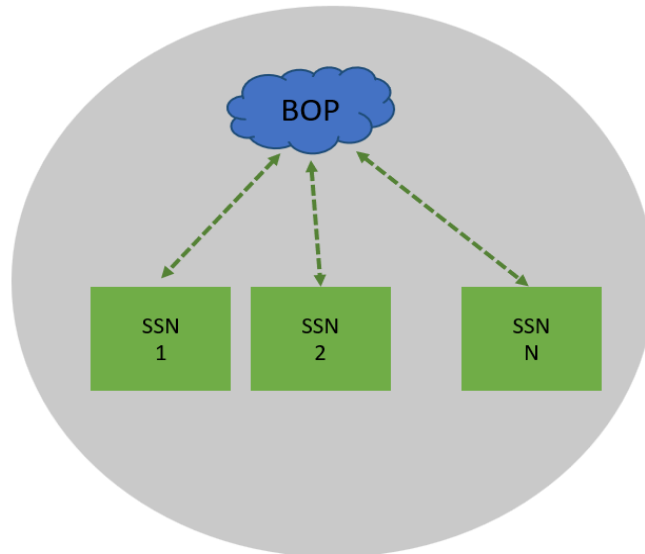
262



263
264 Figure 3: SSN Network for management of b-AIO and ss-AIO and interfacing with BOP and
265 UAP for CMS communication
266

267 **6.2.1.2 Swap Operator Network (SON)**

268 All different SSN can interact with each other and information from each of the SSN shall be all
269 time available with CMS.



270
271 Figure 4: SON through interoperability between all SSN networks
272

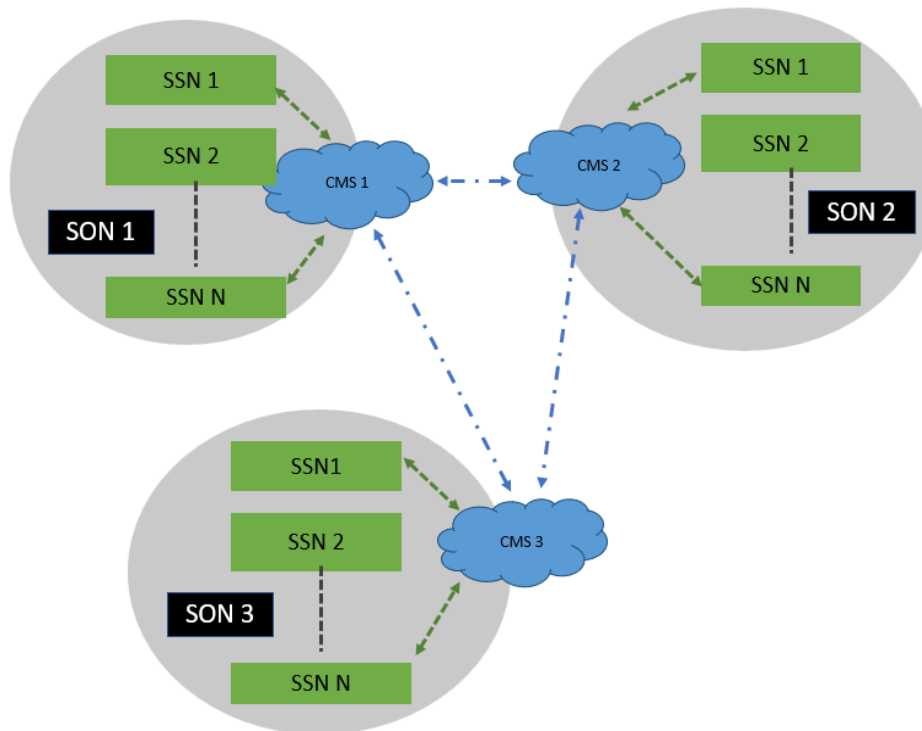
273 All SSN under SON shall be geographically independent and can be spread across a small
 274 region or across the nation. BOP shall maintain all records and transactions related to all SSN
 275 under the SON. The requirements of records maintenance by BOP are listed in section 7.2.

276

277 **6.3 INTER-OPERATOR NETWORK INTEROPERABILITY (t-NIO)**

278 Operators are allowed to exchange their APIs / keys / operational data among each other for
 279 providing seamless services to their users. Definitions of APIs / exchange of required
 280 information among the operators to make the systems interoperable is left to the operators
 281 based on their specific business requirements.

282



283

284

285

Figure5: t-NIO Representation

286 The SON with which a user gets registered becomes the Home Network (HN). After the SON 1
 287 or say HN signs an inter-operability agreement with another BaaS operator or say SON2, this
 288 SON2 becomes Guest Network (GN) for a particular user.

289 The user should be able to seamlessly access GN. The transactions between HN and GN should
 290 be transparent to the user. A single UAP of HN should be able to offer services from SSN under
 291 HN and GN to the user.

292 **6.3.1 t-NIO Interoperability Process**

293 One operator should be able to extend his services to his registered users through GN. All BaaS
294 operators should be able to collaborate to each other by means of exchanging their APIs or plug-
295 in to provide integrated services to users. HN and GN signing up should happen between two
296 operators when required by the operator, however the definition of API and the formats are left
297 open and not mandated under this standard due to nascency of the market and to enable faster
298 adoption of the remaining standard under IS17018. The optional sign-up process is defined as
299 below.

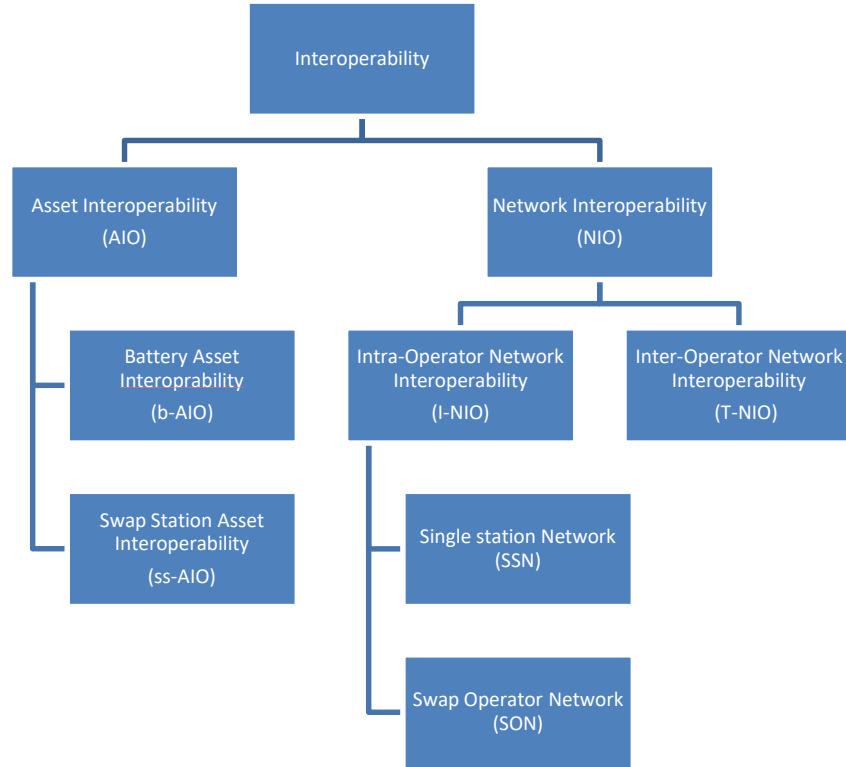
- 300 a. Signup with GN- API exchange and integration between two or more BaaS operators
- 301 b. On boarding of GN- integration with UAP and BOP of HN
- 302 c. Services to User- HN to offer aggregated network of HN and GN on a common platform
- 303 to user

304 Except for the user information that resides with the HN, all the parameters listed in Table 4
305 under section 7.1 should be shared by GN for the purpose of interoperability.

306 **6.4 SUMMARY OF INTEROPERABILITY**

307 The classification of interoperability is summarized in Figure 6.

308



309

310 Figure 6: Summary of Classification for Interoperability

311

312 **6.4.1 Achieving Interoperability**

313

314 Table 3: Interoperability Mandates

AIO	b-AIO	Mandated
	ss-AIO	Mandated
NIO	i-NIO	Mandated
	SSN	Mandated
	SON	Mandated
	t-NIO	Flexible

315

316 **7. FUNCTIONALITY AND DATA MANAGEMENT REQUIREMENTS**

317 **7.1 REQUIREMENTS FOR UAP**

318 The UAP is an interface between users and BaaS provider to enable the user to come to one of
 319 the BSS in their SON to swap the battery. The BaaS operator should provide mandated features
 320 in the user app to enable swapping transaction. These features are tabulated in Table 1.

321

322
323**Table 4 – Features provided in User App by BaaS operator**

Sr.No	Features	Mandate	Description
1	Location of BSS	Yes	Lat, Long display on screen
2	Availability of Charged batteries	Yes	Indication on screen on availability
3	User Identification	Yes	To uniquely identify the user
4	User authentication	Optional	Operator to validate to provide the service to user or not based on payment history
5	Vehicle category (2W/3W/others)	Yes	The category of vehicle served by the BSS
6	Number of Batteries needed by User	Yes	Person to book the number of batteries for every transaction or during registration
7	Station Identification	Yes	To initiate transaction with the swap station
8	Reserve, cancel battery	Optional	User may reach the station and perform transaction or may reserve the battery
9	Payments and billings	Yes	BHIM/UPI and others digital payment mechanisms. Billing through SMS/email/Mobile App etc. optional
10	Capacity of the issued battery	Yes	SoC% indicating capacity of battery issued
11	Rating of the swap station	Optional	Input from user to rate the swap station based on the experience
12	Report feature	Optional	Report/feedback about swapping station
13	Notification feature	Mandate	Notifications <ol style="list-style-type: none"> 1. Addition / Deletion of the BSS – Mandate 2. Non-operational BSS- Mandate 3. Reservation / Cancellation updates – optional 4. Payment / Tariffs related notifications – Mandate 5. Others- optional as business of BaaS operator

324
325
326**7.2 REQUIREMENTS FOR BOP**

Sr.No	Features	Description
1	Records of BSS tagged with BSSN	<ol style="list-style-type: none"> 1. Numbers of BSS setup in BaaS infrastructure 2. Location and address details of all BSS being operated

2	Records of SBS tagged with BIN	<ol style="list-style-type: none"> 1. All SBS floated in BaaS infrastructure with date and time of introduction in the infrastructure 2. Numbers of SBS associated with each SBS at any given point in time
3	Records of Users	<ol style="list-style-type: none"> 1. Details of all users who are availing services of the BaaS operator
4	Records of vehicles tagged with VIN	<ol style="list-style-type: none"> 1. Details of Vehicle onboarded for services with BaaS
5	Digital Payment support to App	<ol style="list-style-type: none"> 1. BHIM/UPI Mandated and others optional payment gateway integration for supporting users to make payments through App
6	Swap Records	<ol style="list-style-type: none"> 1. All swaps done with time stamps to be maintained

327
328
329
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331
332

8. MONITORED PARAMETERS

8.1 BSS Parameters monitored at BOP

Sr.No	Features	Description
1	BSSN	BSS Identification
2	Bootup Notification	Notification from BSS to BOP to indicate/ BSSN / number of slots/ HW Version / Firmware Version/Date/time
3	BSS Operational Status	Overall status of BSS: In-Operation / Under maintenance
4	Connector operational status	Operational status of each connector: Functional / Non-functional / Disabled for usage based on server request etc.
5	Slot periodic update	BIN with SoC of battery being charged in that slot
6	Slot occupancy status	Slot occupancy status: Occupied / Free / Disabled based on server request
7	Charging Completion Status	Update of charging completion status
8	Total number of batteries swapped	Swap record mapping BSS with BIN, Date and Time
9	Downtime	Records of Service downtime including failure time of each BSS and each slot.
10	Total number of Users served	Number of users served by the Baas operator in each category of vehicle (2W / 3W)

333
334
335
336

8.2 SBS Parameters monitored on BOP

Sr. No	SBS Parameter	Description
--------	---------------	-------------

1	BIN	Identification of Battery
2	Rating	Voltage, Current (Ah rating)
3	BCS	As per A.4.2.5.3. in IS 17018 Part 4 Section 3
4	BUT	As per A.4.2.5.3. in IS 17018 Part 4 Section 3
5	BUC	As per A.4.2.5.3. in IS 17018 Part 4 Section 3

337

338

9. CERTIFICATION MANDATE

339

Any BaaS operator should produce its BOP and UAP for certification to the authorized organizations. Certification shall be done against the following.

340

341

1. Records maintenance for Identities as specified in Section 5.2.

342

2. Features validation on UAP as per section 7.1.

343

3. Features validation in BOP as per section 7.2.

344

4. Parameters available on BOP as per section 8.

345

Data demonstration at Certification agency with either a battery and swap station connected at certification agency or through a remotely connected test site through a video conference to validate the live swapping status.

346

347

348

350 **Bureau of Indian Standards**

351
352 BIS is a statutory institution established under the *Bureau of Indian Standards Act, 2016* to
353 promote harmonious development of the activities of standardization, marking and quality
354 certification of goods and attending to connected matters in the country.

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362
363 **Review of Indian Standards**

364
365 Amendments are issued to standards as the need arises on the basis of comments. Standards are
366 also reviewed periodically; a standard along with amendments is reaffirmed when such review
367 indicates that no changes are needed; if the review indicates that changes are needed, it is taken up
368 for revision. Users of Indian Standards should ascertain that they are in possession of the latest
369 amendments or edition by referring to the latest issue of ‘BIS Catalogue’ and ‘Standards: Monthly
370 Additions’.

371
372 This Indian Standard has been developed from Doc No.: ETD 51 (XXXX) Part 6.1.

373
374 **Amendments Issued Since Publication**

Amend No.	Date of Issue	Text Affected