

BIF Response to TRAI CP on Rating of Buildings or Areas for Digital Connectivity

New ecosystem to create DCI

Q.1. How can an ecosystem be created to design, deploy and evaluate DCI with good connectivity in a cohesive and timely manner? What would be the typical role and responsibilities of actors of the ecosystem? Please justify your response with rationale and suitable examples, if any.

BIF RESPONSE

Traditionally, Infrastructure Providers (also termed as IP1s) have been responsible for building the requisite Digital Communications Infrastructure (DCI) across the length and breadth of the country. The IP1s are responsible, empowered and technically well suited to meet the requirements of the consumers for provisioning of Digital Communications Infrastructure. The IP1s also provide the requisite infrastructure for in-building solutions to cater to the needs of the consumers inside the buildings. All kinds of buildings are covered in their scope viz. Multi-storeyed Buildings, Bungalows, Condominiums, Apartments, Government Buildings, Office Complexes, etc. This model has worked very well until now.

However, in the case of In-Building Connectivity, it has been felt that QoS needs to be improved. Though there are no clear benchmarks to measure QoS inside the buildings and often there are call drops /session drops that consumers encounter inside the residences, there is an overall perception of the need to improve the QoS indoors.

Also with the changing scenario where most of the data consumption and data sessions now happening indoors or inside the buildings, the increased emphasis of in-building connectivity can be well understood.

While the IP1s of today are quite competent & capable of designing & deploying DCI, it is felt that involvement of the end user must be there during the stages of design, deployment and monitoring the quality of the digital connectivity.

However, it must be noted that in actual reality today, most of the end users today are either not interested or are simply not competent or capable to get involved in this highly technical ecosystem of building, monitoring and upgrading quality of DCI and would rather like to be only recipients of DCI and enjoy its benefits and not want to be part of the ecosystem in providing the same. Hence it must be understood that the new ecosystem being envisaged, for it to be accepted and adopted by all stakeholders may be an uphill task.

The new ecosystem being envisaged propagates the concept of co-creation and co-designing of the in-building DCI network in a collaborative manner between the telecom professionals (viz. Infrastructure Providers and other experts) and the Real Estate, and empowers end users and involves them in the provisioning of DCI right from the design stage. It may not be a workable idea till the end users viz. builders, architects, building owners, RWAs, take sufficient interest in this exercise.

Broadband inside buildings is not a luxury but a necessity, like electricity or water. Therefore, basic infra inside building must include planning and construction of in-building digital

infrastructure that can be made available to users inside the building. It should be mandated in building laws, the way it is being done for water and electricity. Provision of ducts, space for antennae/access points and other basic infra can be mandated and certified when building is complete. The concept of building owner (in case of public buildings) having right to unilaterally determine commercial terms as it may deem fit, needs to be discouraged & prevented. A building owner providing good quality DCI as per bye-laws should be allowed to charge to IP-1s/TSS on non-discriminatory basis, the charge should be reasonable and fair and should be suitably capped. On the other hand, a public building having no DCI infra, the provider should be mandated to provide access to all IP-1s/TSPs without any charge.

A. Role of IP1s:

- (i) need to play a key role in assuring that a good quality network is available inside the building as envisaged at the design and deployment stage.
- (ii) need to create mechanisms that ensure that in-building network is plugged with appropriate backhaul connectivity from all TSPs present in that area. –behave as a ‘neutral host’ IP1.
- (iii) be fully geared up to ensure that infrastructure so created inside a building/ in an area, are ready/upgradable to adopt any new/futuristic technology, which may emerge during course of time and may be required/useful to the end users.
- (iv) Since the IP1s have responsibilities towards TSPs for ensuring necessary QoS, the builders should engage with IP1s to create neutral infrastructure to cater to multi TSP services viz. BMS, IoT, etc. Also, it is suggested to have a single rollout done for multi operator service environment (Neutral host). This will avoid repetition, bring efficiencies and better network utilisation.
- (v) It may be noted that the TSPs and IP1s who are the current licensed entities have the necessary competency and capability and hence should also be permitted to design, implement & evaluate along with this new breed of professionals/entities in the envisaged ecosystem. However, it may be noted that since the IP1s are already registered with DoT, there may be no need for any certification in their case.
- (vi) The creation of new eco-system should not dismantle the current effective system.
- (vii) The IP-1s of today are quite competent & capable of designing & deploying Digital Communication Infrastructure (DCI) in the country as they have the necessary competency and capability and hence should also be permitted to design, implement & evaluate the DCI along with the new entities envisaged in the new framework

Building a network inside buildings is a complex and multi-dimensional process. This can be effectively addressed only by a **coordinated effort between a multitude of agencies such as TSPs, infrastructure providers, property managers, real estate developers, RWAs, authorities granting permissions or facilitating utility infrastructures.** This collaborative engagement at an early stage of the building project would enable co-designing and co-creation of the networks.

B. Roles & Responsibilities of All Actors in the New Ecosystem:

- a. **Real estate developers** can

- (i) take care of requirements of digital connectivity right from the planning stage with the help of this ecosystem so as to meet the expectations of the end users in a rapidly changing environment.
- (ii) Further, such ecosystem will ensure that real estate developers account for good digital connectivity requirements in the beginning.
- (iii) Also, such an ecosystem can have mechanisms to get infrastructure updated to meet futuristic requirements.
- b. **Role of the National Building Code of India and Building Bye Laws** should be more to give legal backing to the ecosystem required for digital connectivity including associated requirements such as developing solutions using certified products and tools, deploying solutions by certified professionals and evaluation of the network by empanelled or certified agencies.
- c. **Role of TEC:** TEC approved products are available and TEC is also undertaking mandatory Testing & Certification of all Telecom Products, creating a separate system for certification may not be necessary. As regards QoS, standardisation of equipment should be ensured for consistent Quality of Experience to end consumers. It may be advisable to hold the TSP/IP1s responsible, as they are anyways required to ensure QoS.
- d. **Role of Property Managers:** There is a need to create an ecosystem which will help property managers to design and deploy and evaluate Digital Connectivity Infrastructure (DCI) in such a manner that the deployed infrastructure, if integrated with TSPs' network, is ready for service delivery on non-discriminatory basis, and it also meets the expectations of the end users. While this is desirable, it is highly dependent on regulations in terms of sharing the active equipment by different TSPs as well as for localized IT solutions (BMS, Camera, etc.).

Roles of other entities would be as given below:

- e. **Property Manager** would be responsible for the Digital Communications Infrastructure (DCI) for the building. It may consist of maintenance agencies, RWAs, Builders and come with different capabilities, core expertise and sizes. For a Property Manager to develop in-house DCI planning, deploying and maintaining capabilities may not be possible or feasible. Currently, since the IP1s have the required competence and capabilities, besides the capacity and willingness to invest, create networks using a 'neutral host' and ensure QoS, it may be advisable to maintain status quo and they may continue to hold proxy for the Property Manager's responsibilities in this regard.
- f. **DCI Designers** are certified professionals who have competence and possess desired qualifications to design networks for in-building solutions. Such professionals may directly take up the work or there may be firms who hire such professionals to carry out the work. Currently, it may be noted, that this competence is available with the Infrastructure Providers (IP1s).
- g. **DCI Engineers** are certified professionals who have competence and possess desired qualifications to implement the solutions designed for in-buildings. Such professionals may provide services directly or there may be firms who can hire such professionals to carry out the work. Currently, it may be noted, that this competence is available with the Infrastructure Providers (IP1s).

- h. **DCI Evaluators or Auditors** are empanelled agencies to measure and evaluate quality of network inside buildings. These agencies may have their own platforms, or they may be required to take services of a designated platform built for the purpose.
- i. **Role of Digital Tools & Platforms**
In addition to new entities, digital tools and platforms offering solutions to non-telecom professionals to get network designed may play an important role in decoupling activities related to realization of digital connectivity inside the buildings. It would enable property managers to get network designed as per the requirements of the users of the buildings. There are tools which help in deciding take-off quantity of the material and equipment that would be required to build the solution. Such tools may also provide estimated cost for various options. However, **given the fact that these tools need to be operated by trained professionals, it should be left to designers, engineers, evaluators, IP1s and TSPs. Establishing digital platforms which may enable collaborative working among stakeholders would help in faster roll out of digital connectivity.**

Q.2. How would the ecosystem proposed in response to Question no.1 ensure that created infrastructure does not get monopolized? Please justify your response with rationale and suitable examples, if any.

BIF RESPONSE

BIF upholds the primary need for inducing sufficient, free and fair competition amongst the service providers. Some measures to ensure creation of sufficient competition are:

- (i) It should be ensured that the TSPs/IP-Is should permit 'open access' to all and no restriction of access to any TSP. Indulgence in such practices, through either formal or informal arrangement, should not be encouraged.
- (ii) A system (time bound) may be developed, which may, inter-alia, include
 - a. The seeker-TSP i.e. who wishes to access the Cables/IBS installed by an existing IP-I (provider), should place its requirement in writing to such provider.
 - b. The provider shall respond in writing within 60 days' time. In case of denial of request to access the infrastructure, the provider shall give reasons and justification for denial (Right of First Refusal by the 'neutral host').
- (iii) Commercial terms for sharing of the in-building telecom infrastructure system, may be decided by the provider. However, the same shall be done in transparent, fair and non-discriminatory manner.
- (iv) DoT should take up the matter with the Ministry of Housing and Urban Affairs to ensure that suitable provision for the creation of Common Telecom Infrastructure (CTI) - both passive and active (by the 'neutral host') inside the newly constructed public places like Airports, commercial complexes, Government buildings, Medical & Educational campuses and residential complexes, should form part of the Model Building Bye-Laws.
- (v) Government should ensure that the essential requirement for telecom installations and the associated cabling is part of National Building Code of India (NBC), being amended by Bureau of Indian Standards (BIS).

- (vi) "Commercial terms for sharing of the in-building telecom infrastructure system, may be offered by the IBS service provider. The same shall be done in a transparent, fair and non-discriminatory manner and in case of public buildings, the provider should be obliged to issue a reference offer, a copy of which may be filed with an authority (e.g. TRAI)." The concept of public buildings should be defined in an inclusive manner to include all buildings like offices, schools, hospitals, multi storey apartments, malls, commercial complexes etc.

To check the issue of monopolization certain enabling provisions have been included in the Addendum to the Model Building Bye – laws 2016 issued in March 2022. Relevant provisions are stated below

As part of the Building Bye-laws the Builder/RWA should be mandated to ensure the following:

1. Access to building as well as CTI facilities inside the buildings should be available on a fair, transparent and non-discriminatory manner for all Service providers/IP-1s.
2. The service providers/IP1s should have unrestricted access for maintenance work.
3. Charges (rentals/power rates etc.) levied to the TSPs/IP1s should be fair, transparent and non-discriminatory and should be on residential rates.

It is felt that incorporation of these in State/UT Building Byelaws will go a long way towards checking monopolisation.

Q.3. How would the ecosystem proposed in response to Question no.1 enable DCI Designers to factor in the digital connectivity requirements of the existing and/or prospective users of the network? How can such requirements be gathered at the stage of construction of a new building or at the time of upgradation or expansion in case of pre-existing DCI? Please justify your response with rationale and suitable examples, if any.

BIF RESPONSE

It is envisaged that Digital Platforms be made available which shall enable all stakeholders and particularly the user community (including present & prospective users) to continuously provide feedback while construction of new building or re-calibration of pre-existing DCI. Like electricity, Gas and water, the market dynamics will create templates for the categories of the building (Residential/Commercial/Office Complex), size and price segment, and there need to be standard requirements (that will keep upgrading based on technological upgradations and customer need).

Q.4. How would the ecosystem proposed in response to Question no.1 enable DCI Evaluators to get requisite information to evaluate and ensure that the designed or deployed network would meet the requirements of end users? Please justify your response with rationale and suitable examples, if any.

BIF RESPONSE

Establishing digital platforms which may enable collaborative working among stakeholders would help in faster roll out of digital connectivity. Collaborative tools may help in co-

designing of the network by telecom professionals and real estate together. The proposed platform shall enable a continuous monitoring and evaluation process; this will ensure that continuous feedback from the users or prospective users are taken into account while construction of new building or re-calibration of pre-existing DCI. Like electricity, Gas and water, the market dynamics will create templates for the categories of the building (Residential/Commercial/Office Complex), size and price segment, and there need to be standard requirements (that will keep upgrading based on technological upgradations and customer need).

Q.5. How would the ecosystem proposed in response to Question no.1 ensure that upgrades and expansion of the DCI are done from time to time and continue to meet rising demands? Please justify your response with rationale and suitable examples, if any.

BIF RESPONSE

The proposed framework should mandate review of the DCI Rating from time to time –both periodically as well as after expiry of validity period of current certification or after change in requirements arising due to Traffic demand, change in technology, change in spectrum, user needs, etc.

Q.6. How would the ecosystem proposed in response to Question no.1 ensure that the TSPs' networks are planned, designed, deployed, and upgraded to serve the DCI requirements in a timely manner? Please justify your response with rationale and suitable examples, if any.

BIF RESPONSE

Since the TSPs have their networks periodically as well as randomly assessed for QoS, so any gaps/deficiencies perceived by the Certifying Agency/Regulator in meeting the desired KPIs and standards would need to be corrected. This way, the IP1s who provide the necessary passive infrastructure are obligated to provide and ensure that their networks are upgraded to meet the desired QoS levels.

Capacity Building of skilled Professionals

Q.7. How can an ecosystem be created to build capacity requirements of skilled professionals such as DCI Designers, DCI Engineers, DCI Evaluators? What would be the typical role and responsibilities of actors of the ecosystem? Please justify your response with rationale and suitable examples, if any.

BIF RESPONSE

To build capacity for these new breed of skilled professionals, support of accredited skilling agencies viz. TSSC & NSDC may be utilised who can impart telecom training skills. Besides one could also take the support of Government polytechnics & ITIs (Industrial Training Institutes). In telecom domain, there are various training and certification courses to plan, design and deploy DCI. List of some of such courses are offered by various organizations such as BICSI, TSSC, iNARTE, CTNS, etc. Some of these courses might be accredited in present form or may

be required to be customized for specific requirements. Availability of such courses in the country and affordability may also be required to be seen. The present training infrastructure available in the telecom sector may be utilized to offer such courses.

Roles & Responsibilities of these new entities viz. DCI Engineers, Designers & Evaluators are dealt with in great detail in Response to Q1 above.

Q.8. How would the ecosystem proposed in response to Question no.7 ensure that relevant training courses are available in the country? Please justify your response with rationale and suitable examples, if any.

BIF RESPONSE

As mentioned in our response to Q7 above, to build capacity for these new breed of skilled professionals, support of accredited skilling agencies viz. TSSC & NSDC may be utilised who can impart telecom training skills. Besides one could also take the support of Govt. polytechnics & ITIs (Industrial Training Institutes). In telecom domain, there are various training and certification courses to plan, design and deploy DCI. List of some of such courses are offered by various organizations such as BICSI, TSSC, iNARTE, CTNS, etc. Some of these courses might be accredited in their present form or may be required to be customized for specific requirements. The present training infrastructure available in the telecom sector may be utilized to offer such courses.

A similar approach as is being followed in the case of Architects must also be followed in the case of this new breed of telecom professionals viz. of recognizing the registration of professionals for Architects under the Architects Act 1972, which also lays down minimum qualifications for an Architect and the Council of Architecture has the responsibility to regulate the education and practice of profession throughout India besides maintaining the register of architects.

Q.9. Whether the training courses proposed in response to Question no. 8 are already being offered by any organisation or institution that can be recognized for the purpose? If yes, please provide a list of organisations offering such courses. If not, how specialized courses can be designed to meet the requirements? Please justify your response with rationale and suitable examples, if any.

BIF RESPONSE

Yes. There are ongoing programs being conducted by specialised telecom skilling organisations viz. TSSC, NSDC besides Government run polytechnics and ITIs –all of which are already recognised. Besides Nasscom and other Government & private agencies are also running skilling programs for upgradation of skills both in the IT & Telecom sector. The present training infrastructure available in the telecom sector may be utilized to offer such courses.

Q.10. Is there a need to establish a council on the lines of "Council of Architecture" (CoA) to regulate minimum qualifications, additional specialized courses and practice of DCI

profession in the country? Please justify your response with rationale and suitable examples, if any.

BIF RESPONSE

Yes. A similar approach of recognizing the registration of professionals as is being followed for Architects under the Architects Act 1972 should also be initiated in the case of telecom for certifying the new breed of professionals being envisaged. The Architects Act 1972 also lays down minimum qualifications for an Architect and the Council of Architecture has the responsibility to regulate the education and practice of profession throughout India besides maintaining the register of architects.

Q.11. Whether the requirements of additional specialized courses and practices of profession would vary depending upon the size of work or kind of work involved in a particular DCI project? Please justify your response with rationale and suitable examples, if any.

BIF RESPONSE

Yes. Specialised courses to cater to specific user needs and specific to a particular kind and size of building maybe required to perform the function of Rating of a Building or Area for DCI

Creation of Digital Platform to hire services of professionals and procure products

Q.12. Whether creation of a digital platform to hire services of professionals would help Property Managers in creation of DCI? Should there be a feedback mechanism to assess quality of services delivered by professionals? Please justify your response with rationale and suitable examples, if any.

BIF RESPONSE

Yes. Creation of a Digital Platform to hire services of this new breed of professionals would help create capacity and availability of certified professionals whose help and support can be taken for creation of DCI. The Platform must provide feedback mechanism for consumers/users to provide their assessment of the quality of service, processes and the quality of the work done by these new breed of professionals.

Q.13. Whether creation of a digital platform for procurement of certified products would help Property Managers in creation of DCI? How would the certified products for the purpose of DCI be identified and updated on the platform? Please justify your response with rationale and suitable examples, if any. DCI ownership and upkeep models

BIF RESPONSE

No. This is not required because most of the equipment used in the telecom and in-building solutions are either tested or certified by TEC or BIS. Need for separate certifying agencies for products may not be required as almost all the products used are based on global or Indian standards and have already undergone certification.

Q.14. What may be the possible models of DCI ownership and its upkeep? Whether co-ownership models would help in aligning incentives in realising connectivity that would meet expectations of the end users from time to time? Should there be a need to specify terms and conditions for entities owning and responsible for upkeep of DCI to function in a fair, transparent and non-discriminatory manner? Please justify your response with rationale and suitable examples, if any.

BIF RESPONSE

It is suggested that co-ownership models which involve joint and collective responsibility of all stakeholders including the end consumer, the property owner, the service provider of DCI and the government, besides the civic/municipal authorities, would perhaps be the most optimal approach of DCI ownership, responsibility of its upkeep and upgradation requirements from time to time. Going forward it may be a good idea to encourage creation of an independent platform which may not essentially have sensitive information (like CAD designs or proprietary information which belongs to the infra provider viz. IP1) but will have clear roles and responsibilities of each co-owner and clear terms and conditions under which each of them will operate.

One model that's currently being given a great deal of consideration, and is already being used successfully within large venues such as shopping malls and stadiums, is the employment of a neutral host management provider (IP-1 in our case). It also addresses the issues regarding ownership/monopolization.

In such cases, the ownership of the system is shifted from the carrier to the third-party service provider (IP-1) who then assumes all financial, regulatory, legal and technical responsibility for deploying, installing and maintaining the system. Access to the system is leased to one or more operators which, as well as generating more revenue, ensures that more tenants and visitors are able to access their carrier's network without the need to roam.

It's likely that building owners would be willing to adopt this model, as it's flexible and delivers a tangible return on investment, but its success would depend on the size and nature of the venue itself. The larger the venue, for example, the more people could be concentrated in a given area, making it more attractive for the neutral host and the operators involved.

Building owners who may be tempted to replicate this neutral host model themselves should be aware that maintaining it requires a specific skillset on an ongoing basis/lifetime. Established neutral host providers(IP-1s) know the financial models needed to make it profitable, and how it needs to work; they know the formulas. It is their core competency, after all.

Enabling new Ecosystem by Technical requirement specifications for DCI in Building Codes (NBC)

Q.15. As one solution might not be suitable for all types of buildings, whether current requirements stipulated in the National Building Code of India, 2016 would be required to

**be evolved and prescribed ab initio to make it more appropriate for DCI requirements?
Please justify your response with rationale and suitable examples, if any.**

BIF RESPONSE.

Yes-we agree for changes to be made in the National Building Code of India 2016. The current provisions in the National Building Code of India 2016 is inadequate to meet the challenging and growing needs for transformation of DCI in-buildings due to humungous data traffic being generated and consumed within the close confines of a building. The telecom provisions need to be completely reviewed and revised. BIF had written to MoHUA in this regard in 2021 and a copy of its letter to MoHUA along with the suggested provisions of a complete chapter to be inserted in the NBC of India, are attached herewith for reference. A copy of BIF's proposed inputs to the Addendum to Model Building Bye Laws - 2016 and Provisions for in-Building solutions for Telecom Infrastructure is also enclosed herewith.

Buildings can be specifically classified for digital connectivity infrastructure on the basis of various factors like area, height, density, type of construction and type of use.

Since design of the proposed collaborative approach to digital infrastructure is expected to be evolutionary as it requires the property manager's participation in the process of creation of DCI, the requirements and provisions in the NBCI would perhaps be required to be developed ab initio to make it more appropriate for DCI requirements

In view of the importance of Digital Infrastructure (DCI), digital connectivity infrastructure requires a separate classification. Also, design of the proposed collaborative approach to digital infrastructure is evolutionary and it requires the property manager's participation in the process of creation of DCI. As such, there is requirement for incorporating necessary provisions in NBC for creating a system for defining qualifications of professionals for provision of digital connectivity infrastructure and their registration processes, etc. NBC can assign some specialized agency for this purpose. NBC provisions can be further incorporated in various Building Bye Laws and Guidelines published by Ministry of Housing and Urban Affairs and/or State/UT Governments.

Additional Inputs:

- a. Role of the National Building Code of India and Building Bye Laws will be more to give legal backing to the ecosystem required for digital connectivity
- b. One size doesn't fit all Solutions must be specifically designed for the case. For example, the requirements would be very different in each of these cases: (i) a tall, multi-storeyed residential building; (ii) a mall; (iii) a cluster of row houses; and (iv) an office complex or building. E.g.: An antenna system on ground-based (external) towers may be adequate for row houses but fail to reach the higher floors of a tall building. A mall may require good coverage for supporting voice calls, but not nearly the same bandwidth for data connectivity as an office of equivalent floor-area.
- c. In a work-from-home scenario, where adults and children alike need stable and high bandwidth connectivity everywhere, nothing but a network engineered to suit the flat might deliver the needed experience.

Q.16. Whether NBC needs to prescribe a separate classification of buildings for the purpose of DCI? If yes, which factors should be considered to make such a classification? If not, how to accommodate DCI specific requirements in the existing classification of buildings by the NBC? Please justify your response with rationale and suitable examples, if any.

BIF RESPONSE

Yes-In view of the importance of Digital Infrastructure (DCI), digital connectivity infrastructure requires a separate classification in the NBC.

Following new provisions are required to be incorporated in the NBC viz.

- (i) Creating a system for defining qualifications of professionals for provision of digital connectivity infrastructure and their registration processes, etc. NBC can assign some specialized agency for this purpose.
- (ii) NBC provisions can be further incorporated in various Building Bye Laws and Guidelines published by Ministry of Housing and Urban Affairs and/or State/UT Governments.
- (iii) Reference to the specific standards of telecom and ICT and Best Current Practices (BCPs),
- (iv) Develop more detailed guidelines on Planning and designing of digital connectivity infrastructure, apart from technical parameters, will need consideration of other parameters such as aesthetics, safety, value engineering, etc. Such parameters can vary according to the types and size of the buildings, and service requirements of occupants. This may also impact the design and deployment of the systems.
- (v) Buildings can be specifically classified for digital connectivity infrastructure on the basis of various factors like area, height, density, type of construction and type of use.
- (vi) It will be very useful to define general parameters for different classes of buildings for digital connectivity infrastructure.

As Model Building Byelaws 2016, issued by Ministry of Housing and Urban Affairs (MoHUA) classify buildings based on use of premises or activity, design or height, features, safety due to maintenance level. Same could be used for DCI.

Q.17. Whether there is a need to include DCI Professionals as Persons on Record as typically done in building bye laws or development regulations? Or registration with the Council proposed in Question no. 10 would suffice to practice profession across the country as followed in the case of Architects? Please justify your response with rationale and suitable examples, if any.

BIF RESPONSE

- A. Yes. There is a need to recognise and register professionals for digital connectivity infrastructure and specify qualifications and other aspects for such professionals. Volume II Part 8 of NBC 2016 on Building Services specifies qualifications and competence of the architects, various engineers, designers and the contractors for utility services, but does not specify any qualification for professional experts for DCI. Telecom and IT infrastructure in the buildings is becoming critical in the light of Industry 4.0 and

new technologies like artificial intelligence (AI), augmented reality (AR)/virtual reality (VR), robotics, machine to machine (M2M) communications, etc. being increasingly used at the workplace and even at home for home automation, etc., in light of the evolution to 'smart homes'.

- B. Hence, there is a need to recognise certified professionals for digital connectivity infrastructure without any delay. NBC enables government to stipulate eligible requirements for registering professionals for building works and services under Building Services part of the Code. They may take into account practices being followed by national professional bodies dealing with specialist engineering services for arriving at the conclusion to recommend such professionals for digital connectivity infrastructure, if required by a law as had been done in case of other technical professionals connected with construction.
- C. The responsibilities of Individual Persons on Record (PoR) for professionals of Architect, Engineer, Structural Engineer, etc. are mentioned in The Comprehensive General Development Control Regulations - 2017 notified by Urban Development and Urban Housing Department, Government of Gujarat. For a good DCI within the building or area, it is important to engage qualified professionals for the entire period of the DCI project for an integrated approach.
- D. However, professionals referred in NBC for telecom or ICT planning and installations are only Electrical Engineers, with the competency in LV (Low Voltage) systems. They are not experts in telecom or ICT and more specifically, they may not be qualified to handle radio networks covering 2G, 3G, 4G and upcoming 5G mobile network systems. Further, in wireless systems, installing antennas at buildings or boundary walls or street poles might be required, and such requirements need engagement of telecom or ICT design professionals. Designing wireless systems requires in depth knowledge of radio propagation models, capacity calculation on air interface, and hands-on experience on coverage prediction tools, drive or walk test tools, etc. **Hence, it is absolutely necessary to create a new category of professionals to handle increasingly complex subject of digital connectivity infrastructure.**

Q.18. How can the clearances or approvals required for DCI at various stages of construction of building may be incorporated in building bye laws? In typical building bye laws, there are provisions for getting clearances from central government e.g., in case of civil aviation, defense and telecom being a central subject, what role can be played by the central government in giving such clearances or granting such approvals? Please justify your response with rationale and suitable examples, if any.

BIF RESPONSE

Keeping in view the complexity of the subject, handling of varieties of building types and rapid changes on supply and demand side, it would be better to have standards which are open and ready to accommodate futuristic standards evolving from time to time. Accordingly, standardisation body created either under the broad ambit of NBC or through any other agency, as deemed fit, should keep enough provisions in standards to take care of innovative solutions offered by the network designers. However, it may be useful to give legal backing to such requirements by appropriately amending various related laws, bye-laws and regulations. Amendments may also be required in the state and central laws and related regulations.

Such separate standards for DCI would be helpful in allowing participation of relevant stakeholders in the design and implementation of digital connectivity infrastructure. Such standards will be required to be made applicable to special areas and organisations like Railways, Defence estates, Cantonment areas, etc.

In such ecosystem, NBC and Building Bye Laws may be required to be amended, so as to recognise the DCI professionals and standardisation body, to provide legal backing which is entrusted with formulation of standards including specifications, guidelines and processes.

Need to introduce a special class of Infrastructure Providers

Q.19. Is there a need to introduce a special class of Infrastructure Providers to create, operate and maintain DCI for a building or cluster of buildings in ownership models suggested in response to Question No. 14? What should be the terms and conditions for such special Infrastructure Providers? Should such terms and conditions vary depending upon type, size and usage of buildings? Please justify your response with rationale and suitable examples, if any.

BIF RESPONSE

No. The IP1 Registrants are sufficient to take care of needs to create, operate and maintain the DCI. The scope of IP1s may be increased to include active infrastructure viz. DAS, FTTH, etc. besides passive infrastructure viz. towers and fiber.

Infrastructure providers are well able and capable for the creation, operation and maintenance of Digital connectivity infrastructure (DCI) for a building or cluster of buildings, there is no need to introduce a special class of Infrastructure providers exclusively with a limited charter. Rather, as mentioned in the **National Digital Communications Policy (NDCP-2018)** there is a need to *'Encourage and facilitate sharing of active infrastructure by enhancing the scope of Infrastructure Providers (IP) and promoting and incentivizing deployment of common sharable, passive as well as active, infrastructure'*. IPs-1 are most suited to ensure Quality of Service(QoS), adherence to SLA conditions, coverage and ownership issues.

Introduce rating of building from a DCI perspective- Voluntary scheme

Q.20. What are the initiatives or practices being taken in other jurisdictions outside India with regard to rating of buildings from a DCI perspective? Please share details and suggest how similar processes can be created in India?

BIF RESPONSE

As per international best practices, in a few countries, rating of buildings has already started or are in advanced stages of being introduced. However, these initiatives are taken by private organizations or by consortium of telecom industry or by building councils. Some of such initiatives based on global best practices are given below:

International examples of Ratings in Buildings

<u>S.No.</u>	<u>Country</u>	<u>Model or Framework followed</u>
1-5		

	USA, Canada, Australia, UK, and Europe	¹ WiredScore a global organization that owns and operates WiredScore Certification provides digital connectivity certification. It rates quality and resilience of digital infrastructure in the buildings.
6	USA	² Underwriters Laboratory (UL) and the Telecommunications Industry Association (TIA) recently announced that they would provide a joint program for assessing smart buildings. The SPIRE Smart Building Program will offer both self-certification programs as well as Verified Assessment Ratings completed jointly by UL and TIA that measures the effectiveness and security of smart buildings based on six primary criteria of life and property safety, health and well-being, connectivity, power and energy, cybersecurity and sustainability. The SPIRE Self-Assessment online tool can evaluate building intelligence and performance based on an expertly curated, objective and holistic framework across these six criteria
7	BRAZIL	³ Over the last year, they have seen a 30 per cent increase in the use of the Leadership in Energy and Environmental Design (LEED) green building rating system, which has been boosting Brazil's green and sustainable building design, construction, and operations, enabling businesses and politicians to attract new foreign investment and increase real estate portfolio competition
8	EU	⁴ The potential of smart technologies in the building sector was heavily emphasized in the 2018 revision of the European Energy Performance of Buildings Directive (EPBD) and the concept of a Smart Readiness Indicator (SRI) was introduced. This indicator allows for rating the smart readiness of buildings, i.e. the capability of buildings (or building units) to adapt their operation to the needs of the occupant, also optimizing energy efficiency and overall performance, and to adapt their operation in reaction to signals from the grid (energy flexibility). The smart readiness indicator will raise awareness amongst building owners and occupants of the value behind building automation and electronic monitoring of technical building systems and should give confidence to occupants about the actual savings of those new enhanced functionalities.

9	Germany	<p>⁵The DGNB System for Buildings In Use like other DGNB certification systems grades buildings by using performance indice. The total performance index is calculated from grading individual criteria. The platinum certificate is the most prestigious award issued by the DGNB.</p> <p>The building receives the DGNB bronze certificate from a total performance index of 35%. The DGNB silver certificate is awarded from 50%. The project must reach 65% for the DGNB gold certificate and 80% for the DGNB platinum certificate.</p> <p>Buildings that are already operating carbon-neutrally receive the Climate Positive award in addition to the DGNB certificate. This is a recognition of their contributing positively to achieving climate-protection goals.</p>
10.	Singapore	<p>⁶Among the ASEAN nations, Singapore is at the forefront of green building development. The country's Green Mark Scheme was the first green building rating system to be designed specifically for the tropical climate and has been widely adopted in other ASEAN countries. Because it is a net oil importer with limited natural resources, Singapore has been proactive in trying to increase the energy efficiency of its buildings. Buildings account for nearly 40% of the city state's total electricity consumption and over 20% of its greenhouse gas (GHG) emissions.</p>

Key Outcomes of International initiatives on Ratings of buildings.

TRAI may consider working towards formulating technical and advocacy reports taking relevant inputs from all the relevant Ministry responsible for provisioning of various services inside buildings which encapsulates the requirements of Digital Communication Infrastructure inside buildings and energy efficiency of such buildings. The report may cover the requirements of formulating the methodology of ratings, identify key stakeholders involved for ensuring hassle-free connectivity inside buildings, monitoring and security, along with including the critical elements involved in a building to ensure ubiquitous digital connectivity inside buildings in a technology agnostic manner and should also support the fact that user-experience and feedback is an important factor that may be identified for critically analyzing the overall ratings of a building.

1. <https://wiredscore.com/>; TRAI CP on Rating of Buildings or Areas for Digital Connectivity.
2. <https://www.prnewswire.com/news-releases/ul-and-the-telecommunications-industry-association-announce-spire-smart-building-verifications-now-available-301414212.html>

3. <https://www.un-page.org/brazil-building-green-economy-infrastructure-whilst-maintaining-natural-resources-and-biodiversity>
4. <https://smartreadinessindicator.eu/>
5. <https://www.dgnb-system.de/en/buildings/in-use/index.php>
6. <https://research.hktdc.com/en/article/NDI2MDUyMjk4#:~:text=Among%20the%20ASEAN%20nations%2C%20Singapore%20is%20at%20the,has%20been%20widely%20adopted%20in%20other%20ASEAN%20countries.>

In India GRIHA system is used. GRIHA is an acronym for Green Rating for Integrated Habitat Assessment. GRIHA is a Sanskrit word meaning – ‘Abode’. Human Habitats (buildings) interact with the environment in various ways. Throughout their life cycles, from construction to operation and then demolition, they consume resources in the form of energy, water, materials, etc. and emit wastes either directly in the form of municipal wastes or indirectly as emissions from electricity generation. GRIHA attempts to minimize a building’s resource consumption, waste generation, and overall ecological impact to within certain nationally acceptable limits / benchmarks.

GRIHA attempts to quantify aspects such as energy consumption, waste generation, renewable energy adoption, etc. so as to manage, control and reduce the same to the best possible extent.

GRIHA is a rating tool that helps people assesses the performance of their building against certain nationally acceptable benchmarks. It evaluates the environmental performance of a building holistically over its entire life cycle, thereby providing a definitive standard for what constitutes a ‘green building’. The rating system, based on accepted energy and environmental principles, will seek to strike a balance between the established practices and emerging concepts, both national and international. The GRIHA council conducts various courses for training professionals working in the green building industry.

Q.21. Is there a need to introduce Rating of buildings from the perspective of DCI that may help in nudging the Property Managers to strive for collaboration with other stakeholders to meet the digital connectivity expectations of the users of the building? Please justify your response with rationale and suitable examples, if any.

BIF RESPONSE

Yes. Introduction of rating systems for digital connectivity experience is expected to bring benefits to **the property managers** to strive for collaboration with other stakeholders to meet the digital connectivity needs/requirements of the users.

During the pandemic and thereafter, good digital connectivity inside a building has become an essential requirement with the need to work from remote locations or work from anywhere becoming a norm. Good connectivity would most likely result in increasing the value of the property including rental value as it increases productivity, improves satisfaction, and boosts commercial activity making the property more attractive.

Rating mechanism would nudge property managers to improve connectivity. Rating would provide information transparency about quality of DCI in the buildings. In case of new buildings where infrastructure is to be built and property managers can clearly see business model of providing good connectivity, they would be willing to invest. Even property managers of existing buildings and areas used for business related activities such as enterprise workplaces, shopping malls, industrial estates, restaurants, cafeterias, etc., would be willing to invest and build good connectivity. Even in case of existing residential buildings, residents may push to get better rating when they will realize that they are empowered to influence the property managers (viz. RWAs). **It is also expected that likely commercial benefits of good connectivity would automatically push property managers to get their buildings rated.**

Rating of digital connectivity experience of the buildings would create an environment that can cause competition among property managers to achieve best quality in their buildings. This is quite likely to happen as positive externalities of rating of digital connectivity will impact the commercial decision of buyers and prospective tenants. If end users and property managers are enabled and empowered to design, deploy and operate DCI under an ecosystem of designers, engineers and evaluators on one hand; and property managers and rating agencies on the other hand; then market forces may start working in a manner that might address the issues and concerns of the end users.

Introduction of Rating of buildings from the perspective of DCI in terms of NBC, 2016 should help the end users to judge and take decision whether particular building will be able to cater to their digital connectivity requirements or not. The ratings will definitively provide an advocacy for having the updated and best DCI in the buildings to have the best of experience in digital connectivity for the end users.

Q.22. In case, rating is introduced as a voluntary scheme, is there a need to monitor the progress? If progress is not satisfactory, would there be a need to launch campaigns and awareness drive to encourage Property Managers to come forward for rating? Please justify your response with rationale and suitable examples, if any.

BIF RESPONSE

Yes. Good Digital Connectivity inside the buildings is a perennial need and not a one-time requirement. Due to a number of factors, Digital Connectivity's effectiveness changes constantly and hence needs to be continuously monitored, reassessed and corrected from time to time. Property Managers or Building Owners of Residential and Commercial Buildings must constantly assess the rating, get their buildings or properties rated from time to time. Such steps or measures, if taken, would help increase the saleable / rental value of their properties. There would be need to launch educational and marketing campaigns /drives to encourage Property Managers/Builders to come forward for getting their buildings rated for DCI.

- We would also like to mention and emphasize here that awarding the rating will itself be big incentive and will attract the end users.
- There will be a need to monitor the progress during the incubation period.
- The awareness campaigns are needed more for the end users to create demand which will automatically encourage the need for proper rating of the building.

Q.23. Should the voluntary scheme of rating be extended to cover cities, towns and villages and even states? Would such a scheme help in encouraging local and state authorities to facilitate TSPs in creation or in improving outdoor as well as indoor DCI? Please justify your response with rationale and suitable examples, if any.

BIF RESPONSE

Yes. We are of the view that DCI Rating must be extended not just to residential or commercial spaces, but to all areas including cities, towns and villages. As the saying goes, what cannot be monitored and measured, can never be improved. So, to improve digital connectivity across the country in a ubiquitous manner, the rating must be extended to every nook and corner of the country. Such a measurement index would serve as a benchmark for need for improvement in a collective and collaborative manner by all stakeholders viz. Local, State and Central Governments, the Service Providers, the Property or Area Managers as well as the general consumers.

Q.24. If in response to the Question No. 23 answer is yes then what framework should be introduced to rate cities, towns, villages and states, and how weightages can be assigned to different aspects of indoor and outdoor connectivity? Please justify your response with rationale and suitable examples, if any.

BIF RESPONSE

Yes, there is a prime need to have a new regulatory framework that assigns a bigger role to property managers/building owners. If new responsibilities are to be given to the property managers, then there is a need to make necessary changes in the legal, licensing and regulatory requirements to recognize them as one of the responsible stakeholders in the eco-system. For example, if we want to create DCI in accordance with the regulatory framework developed, property managers may be required to be recognized as an entity under the Indian Telegraph Act 1885, and the Indian Wireless Act 1933. In the new proposed ecosystem, the ownership and the management of the solution in case of buildings may be shifted towards property managers. They may be responsible for all financial, regulatory, legal and technical aspects of designing, deploying, installing and maintaining the system. Property managers with onus of ensuring good quality network inside the building or area, can get tailored solutions for their buildings and provide the same to the end users. The property managers will have liberty to build DCI designed and deployed by the certified firms or professionals by using certified products. The network solutions so developed can be evaluated by independent DCI evaluators.

DCI makes a very small part of the total cost of building. It requires very specific expertise available and viable with limited agencies. The Government of India has created, with a futuristic vision, different type of licences that also put lot of obligations on the license holder. In the proposed framework, we may look at the accountability frame work for the license holder, who also invests in the capex for DCI. So, the builder can be given the responsibility to ensure DCI, but making them invest for it and making them responsible for its ownership, will on one hand burden them in terms of cost, and on the other hand will make the RWAs (with very limited experience and expertise) run for maintenance of DCI thru life cycle.

New ecosystem may enable market forces to drive QoS requirements for a building. Defining baseline requirements of quality of service for IP1s like mandatory use of ITU-T G.657.A2/b3 bend insensitive fibre with fire and safety rated cable, may address the issue. However, in this case, the following points are to be kept in mind:

- a) All buildings are not of the same type and it is almost impossible to define general requirements that serve the purpose in all circumstances.
- b) In wireless, there are multiple solutions including those for connecting a building from outside to achieve the same result of intended DCI. Ideally, while the builders should be responsible for creation of DCI, they should not be forced to own the DCI.

If an ecosystem is developed, then an in-building solution would get deployed that would meet general requirements of the users. Such ecosystem may also offer options to consumers to get customized premium quality network built. However, just having regulatory framework that defines new entities, lists out processes and creates a marketplace, may not be adequate to meet the desired objectives. To reach a level of enhanced customer experience, a mechanism may be required to be introduced that would **nudge property managers** to come forward and implement the solutions accordingly. There is a need to **rate digital connectivity experience in the building**.

A building can be categorized based on assessment of quality of digital connectivity and suitable rating can be awarded to the buildings. Such rating can bring value addition to the concerned building. This will also draw attention of all stakeholders, especially end users. If ratings are poor, then property managers and other stakeholders will be required to improve such ratings for the benefit of the users. For example, cleanliness rating of the cities by the government has drawn attention of all stakeholders towards improving rating of their cities.

Rating as a mandatory requirement for specific classes of buildings

Q.25. Is there a need to make rating a mandatory requirement for specific classes of buildings such as public transport hubs, government buildings or any building of public importance etc.? If yes, which type of buildings should be covered under this category? Please justify your response with rationale and suitable examples, if any.

BIF RESPONSE

Yes. There may be a need to make rating a mandatory requirement for specific classes of buildings such as public transport hubs, government buildings or any building of public importance etc. The main reason is to ensure better connectivity for end users and meet the ever rising footfall in these places.

The type of buildings which should be covered under this category are:

1. Buildings with public offices having high footfalls of citizens
2. Buildings with public offices having responsibility of handling citizens' grievances
3. Buildings with public offices with servers for websites having heavy e-traffic.

There is a need to make necessary provisions in the law to introduce a system of rating. It would be pertinent to note that rating in general would nudge property managers to get their buildings evaluated on quality of DCI available in the building. Rating may not be made mandatory for all buildings. The market forces may push property managers to act in the direction of improving quality inside buildings and add values to their properties, to make a business case. It is expected that once a successful model emerges, various stakeholders would start adopting it.

However, in some cases, it may be required to make it mandatory, especially in the cases in which end-users don't have any ownership or have not rented any space. In such cases, many users of the buildings might be prospective owners or tenants or daily visitors as working employees/citizens availing facilities created in the building. Examples of such buildings can be airports, ports, railway stations, public transport stations, bus stands, major rail routes and highways, large shopping complexes, industrial estates, major market areas, office or workplaces, government buildings, government residential colonies and any other building of public importance. In such cases it may be required to make rating mandatory. Rating may also be made mandatory for large or high-rise residential buildings.

In case of important buildings where rating is made mandatory, designating a nodal official may help other stakeholders involved in quality assessment of DCI. Such an official may play a significant role in reaching out to the concerned stakeholders, coordinating activities and getting digital connectivity rated.

Q.26. What should be the time plan to rate buildings falling under the mandatory category and is there a need to prioritize some buildings within the mandatory category to make it more effective? Whether existing buildings falling under such classes are required to be dealt differently? Please justify your response with rationale and suitable examples, if any.

BIF RESPONSE

In some cases, it may be required to make it mandatory for rating of certain buildings, especially in the cases in which end-users don't have any ownership or have not rented any space. In such cases, many users of the buildings might be prospective owners or tenants or daily visitors as working employees/citizens availing facilities created in the building. Examples of such buildings can be airports, ports, railway stations, public transport stations, bus stands, major rail routes and highways, large shopping complexes, industrial estates, major market areas, office or workplaces, government buildings, government residential colonies and any other building of public importance. In such cases it may be required to make rating mandatory. Rating may also be made mandatory for large or high-rise residential buildings.

In case of important buildings where rating is made mandatory, designating a nodal official may help other stakeholders involved in quality assessment of DCI. Such an official may play a significant role in reaching out to the concerned stakeholders, coordinating activities and getting digital connectivity rated.

Q.27. Is there a need to designate a nodal official for building(s) falling under the mandatory category to comply with the rating related requirements? What actions are proposed to be taken in case of noncompliance? Please justify your response with rationale and suitable examples, if any.

BIF RESPONSE

Yes. In case of important buildings where rating is made mandatory, designating a nodal official may help other stakeholders involved in quality assessment of DCI. Such an official may play a significant role in reaching out to the concerned stakeholders, coordinating activities and getting digital connectivity rated.

However, IP-1s have the technology, knowledge & knowhow to design, deploy and evaluate the DCI with good connectivity. The IP-1s of today are quite competent & capable of designing & deploying Digital Communication Infrastructure (DCI) in the country and to comply with the rating related requirements. Perhaps the compliance with NBC, 2016 could be treated as sufficient, being mandatory in nature.

Changes required in laws dealing with the development of areas or construction of buildings

Q.28. Is there a need to amend legal provisions under various laws, bye laws dealing with development of land and buildings or areas including forest areas, cantonment areas, port areas, panchayat areas, municipal areas etc. to facilitate creation of DCI and ratings of the buildings or areas? Please justify your response with rationale and suitable examples, if any.
Role of Regulator in New ecosystem

BIF RESPONSE

Yes. Possible Changes required in law would include the following

- (i) It may be required to create a legal framework to enforce voluntary and mandatory requirements of ratings. The relevant laws including the Indian Telegraph Act, the Indian Wireless Act and other relevant acts are to be aligned to recognize property managers as legal stakeholders in providing DCI in the buildings.
- (ii) For buildings where option to get rated is mandatory, a clear road map is to be developed to rate such buildings which may be in large numbers. New ecosystem would also require TSPs, property managers and other stakeholders to participate in co-design, co-creation and co-deployment. In order to ensure that end-users are empowered to influence the decisions and force property managers to act in their interest, it is required to introduce appropriate legal provisions. Legal provisions are also required to support the stakeholders in getting necessary permissions from the concerned authorities in a time bound manner. These legal provisions may be either in the Indian Telegraph Act, Indian Wireless Act or other relevant laws related to Building Bye Laws, National Building Code, Real Estate Acts, Urban and Regional Development Plans Formulations and Guidelines, and also in other relevant acts related to development activities taken up in Railways, Cantonment Boards, Forests, etc.

- (iii) The laws and guidelines are required to be reviewed periodically so as to facilitate market growth continually in smooth manner.

Regulator may play an important role in introduction of ratings. The initiatives for building ratings have been introduced mainly in advanced countries and are mostly led by industry. In a country like India where in the past one and half decades, communication network expansion has seen exponential growth with introduction of new technologies, especially in the wireless segment - serving more than 1200 million customers and its readiness to launch 5G soon, it is essential to create a well-defined system to ensure availability of reliable and robust digital connectivity infrastructure in every building. Further, even if such ecosystem of rating gets introduced, it will require adoption at an accelerated rate and therefore, to extend the benefits of such ecosystem of rating, regulator may be required to play an important role. It is well acknowledged that private players and industry may play very important role in creation of ecosystem and run it. However, establishment of an institutional mechanism backed by regulations may help in implementation as well as protecting the interests of all stakeholders, including end-users.

There is a need to amend legal provisions under various laws, bye laws dealing with development of land and buildings or areas including forest areas, cantonment areas, port areas, panchayat areas, municipal areas etc. to facilitate creation of DCI and ratings of the buildings or areas. The reasons for the same are:

1. The powers and functions related to land and buildings are vested with states as seventh schedule. This lead to complicated interpretation for provisioning of digital connectivity inside buildings.
2. Areas such as forest areas, cantonment areas, port areas, panchayat areas, municipal areas etc. are governed by important Acts of parliament/ State legislature. There is always a need to provide for enabling provisions in these acts as well as in Acts/ rules governing the DCI.

Q.29. In case a voluntary scheme for rating is to be introduced or rating is notified as mandatory for specific classes of buildings then what should be the role of TRAI or DoT? Please justify your response with rationale and suitable examples, if any.

BIF RESPONSE

For certain classes of buildings viz. Government Buildings, etc. DCI must be mandated and TRAI or DoT could be the overarching regulator to regulate the proposed new legal & regulatory framework to govern the sector.

To begin with rating of buildings could be introduced for government buildings, the new Parliament complex is at an advanced stage of construction and is supposed to be equipped with state of the art wired and wireless communication systems. **Commencing the rating system with the rating of new parliament building would be an ideal start to the process.**

While DoT may not have much role to play in the system of rating, TRAI will form an important entity. The scope of tests such as drive tests should specifically need to be enhanced to include

the buildings. Use of drone technology may be considered. This will also work as an audit of DCI Evaluators. TRAI needs to come out with specific guidelines on the same.

Q.30. Whether creation of "Regulatory Sandbox" to carry out experiments or demonstrate capabilities of innovative solutions to improve digital connectivity would be helpful to make changes in existing policies, laws or regulations? What should be the terms and conditions to establish a regulatory sandbox? Please justify your response with rationale and suitable examples, if any.

BIF RESPONSE

Yes. The concept of Regulatory Sandbox as mooted by TRAI in its Consultation Paper is extremely useful for testing and maturing new and innovative solutions as well as checking their feasibility from their efficacy in the policy, regulatory & law making aspects. There is a need to take a relook at existing regulatory provisions and make them flexible to allow innovations in in-building solutions.

A Regulatory Sandbox approach may help in demonstrating capabilities of innovative solutions before relevant stakeholders. Based on feedback, necessary changes in the laws or regulations may be required. Changes may be related to a variety of aspects covering technical specifications/standards such as limits of maximum output power in case of smart antennas, changes in approval processes, new business models introducing new entities and assigning role and responsibilities in new context and any out of box solution.

The Regulatory Sandbox may also bring different types of stakeholders together to demonstrate their capabilities in the fields of planning, designing, procurement, deployment, and evaluation in the new ecosystem. New concepts with necessary proven-ness of the product and features may help in bringing acceptance of the solution by the property managers. For example, better way of camouflaging and aesthetic blending of digital infrastructure. Such solutions may also be demonstrated as a part of the Regulatory Sandbox.

Operationalization of rating framework

Q.31. Is there a need to establish a Certificate Issuing Authority to award ratings to buildings from DCI perspective? If yes, what should be the structure of such an authority? If not, who can be assigned the role to perform this function? Please justify your response with rationale and suitable examples, if any.

BIF RESPONSE

YES. The following framework for certification of ratings of buildings could possibly be conceived viz.

- A. As large number of buildings may be required to be rated or there may be voluntarily options for rating, the volume of work may be huge and will require considerable amount of time and resources. In addition, these buildings would be spread across the country. It may not be possible to carry out this work unless an elaborate ecosystem is

created which allows, promotes and encourages participation of private sector and active role of state governments and local bodies.

- B. Identification of agencies who can carry out such work of rating and create an institutional mechanism that assigns role and responsibilities of such agencies is crucial. These agencies may be hired by property managers for evaluation to be done by using objective and other methods. These agencies will also be required to follow certain well-defined guidelines so that their evaluations remain reliable and trustworthy. DCI evaluators may carry out such functions and their reports may be used to rate the buildings.
- C. DCI evaluators may operate in a particular region and may also develop expertise in particular type of buildings. There may be a need to maintain a data base of such evaluators and the works performed. Such readily available pool of information will help property managers in selecting and hiring an appropriate DCI evaluator for rating his/her building.
- D. It may be appropriate to develop a platform, the service of which can be used by the DCI evaluators. The advantage of having such a platform is that it would allow standards to be established based on the learnings of such evaluators, and improve the same from time to time to take care of futuristic requirements.
- E. It is also required to be examined whether there may be a single platform or multiple platforms. In case of multiple platforms, there may be requirements to establish a synergy between platforms for common types of evaluations. Ownership of these platforms may be with the regulator and/or any agency authorized for the purpose. Or it may also be run by private entities with detailed terms and conditions defined by an appropriate regulation in this regard.

Introduce certification and certificate issuing authority

- (i) On the basis of the measurements and evaluation details provided by the DCI evaluators, a certificate of rating will be required to be issued to the property manager for his/her building being rated. For discussion and deliberations, such entities issuing such certificates may be referred to as Certificate Issuing Authorities. Ratings may be awarded in terms of numerical values and there may be a standard form to present it in form of stars. This certificate should be usable for all legal purposes and may allow rating of digital connectivity to be used for various marketing purposes. Due provisions may be required in regulations to deal with any misuse of methods of rating. When rating awarded earlier is withdrawn or becomes time barred, provisions may be required so that the old rating is not used again.
- (ii) Such certificate can have associated terms and conditions for its use, with a validity period. It may also provide conditions under which it may be required to be renewed or may also describe conditions under which it may be withdrawn. For example, performance quality of same DCI may degrade because of change in average traffic demand or expectations may get changed because of availability of new technology networks, spectrum bands. In case additional capabilities are introduced in DCI and renewal of rating is requested, only incremental assessment might be required to be done.
- (iii) There may be requirement of identifying and delegating power to issue certificates and reviewing the same periodically for continued compliances. Also, there is need

to maintain a data base of such awards on a platform accessible to the relevant authorities for verifications and further auditing, as the case may be.

- (iv) **Appellate Authority:** There may be instances of disagreement of the Property Manager with the rating assigned to his building based on the measurement and the evaluation done. There is need for the provisions in the new framework for revaluation of the rating assigned, where the property manager can prefer appeal against the decision of the Certificate Issuing authority, for review and reconsideration, within certain time frame of receiving the communication of rating assigned. The appeal so preferred is also required to be disposed in timely manner for maintaining fairness and transparency in the system. The scope of the Telecom Appellate Authority viz. TDSAT may be expanded to include resolution of disputes arising out of this sector in addition to their existing roles & responsibilities.

Q.32. Whether the authority suggested in response to Question no. 31 may use reports from DCI evaluators to award ratings? To ensure reliability of reports from DCI Evaluators, should Certificate Issuing Authority need to conduct periodic audits of DCI evaluators? Please justify your response with rationale and suitable examples, if any.

BIF RESPONSE

Yes. On the basis of the measurements and evaluation details provided by the DCI evaluators, a certificate of rating will be required to be issued by the Certifying Authority to the property manager for his/her building being rated. Identification of agencies viz. DCI evaluators who can carry out such work of DCI rating is crucial. DCI Evaluators will also be required to follow certain well-defined guidelines so that their evaluations remain reliable and trustworthy.

It may be appropriate to develop a platform, the service of which can be used by the DCI evaluators. The advantage of having such a platform is that it would allow standards to be established based on the learnings of such evaluators, and improve the same from time to time to take care of futuristic requirements. Ownership of these platforms may be with the regulator and/or any agency authorized for the purpose. Or it may also be run by private entities with detailed terms and conditions defined by an appropriate regulation in this regard.

There may be requirement of identifying and delegating power to issue certificates and reviewing the same periodically for continued compliances. This may involve the need to conduct periodic audits of the DCI evaluators.

Terms and conditions for using awarded ratings including provisions for its renewal, revocation & penal provisions in case of misuse

Q.33. What should be the terms and conditions for using ratings awarded to a building(s) from a DCI perspective? What should be the validity period of awarded ratings? Do you envisage any situations under which an awardee of ratings might be required to get the ratings renewed before the validity period? Please justify your response with rationale and suitable examples, if any.

BIF RESPONSE

On the basis of the measurements and evaluation details provided by the DCI evaluators, a certificate of rating will be required to be issued to the property manager for his/her building being rated. Ratings may be awarded in terms of numerical values and there may be a standard form to present it in form of stars. This certificate should be usable for all legal purposes and may allow rating of digital connectivity to be used for various marketing purposes. Due provisions may be required in regulations to deal with any misuse of methods of rating. When rating awarded earlier is withdrawn or becomes time barred, provisions may be required so that the old rating is not used again.

Such certificate can have associated terms and conditions for its use, with a validity period of say three years. It may also provide conditions under which it may be required to be renewed or may also describe conditions under which it may be withdrawn. For example, performance quality of same DCI may degrade because of change in average traffic demand or expectations may get changed because of availability of new technology networks, spectrum bands. In case additional capabilities are introduced in DCI and renewal of rating is requested, only incremental assessment might be required to be done.

Q.34. Whether in the initial stages of introduction of the rating system, validity should be for a shorter time period, and later it may be increased as evaluation system matures? Should the validity period be dependent on the type of buildings? Please justify your response with rationale and suitable examples, if any.

BIF RESPONSE

Yes, this may be considered. Accordingly, perhaps initial period of Validity may be kept as 3 years which as the system matures can be progressively increased to 5 or even 10 years Validity period may be needed to be reviewed in the light of new technology networks, spectrum bands, change in traffic patterns or traffic demand or due to changed expectations/needs of the users.

Q.35. Whether the process of renewal of rating should be the same as the process defined to get rated first time or it may be incremental? Or renewal process may be dependent upon the grounds on which it is being renewed e.g. expiry of validity period, introduction of new technology, introduction of new spectrum band(s), introduction of new services(s) etc.? Please justify your response with rationale and suitable examples, if any.

BIF RESPONSE

Process of renewal of rating to assess additional capabilities introduced in DCI, may be done on an incremental basis. If assessment is required to be done in the light of introduction of new technology, new spectrum bands, introduction of new services, etc., then perhaps the entire process may be required to be repeated as applicable for fresh licenses

Q.36. Whether the provisions to make an appeal should be introduced to give an opportunity to the applicant to make representation against the decisions of the Certificate Issuing Authority? What should be the time frame for preferring the appeal in case of disagreement

with the rating assigned and its disposal? Please justify your response with rationale and suitable examples, if any.

BIF RESPONSE

Yes. Provision to appeal against the Certifying Authority must be there in the proposed new Framework. There may be instances of disagreement of the Property Manager with the rating assigned to his building based on the measurement and the evaluation done. There is need for the provisions in the new framework for revaluation of the rating assigned, where the property manager can prefer appeal against the decision of the Certificate Issuing authority, for review and reconsideration, within certain time frame of receiving the communication of rating assigned. The appeal so preferred is also required to be disposed in timely manner (say in 4-6 weeks) for maintaining fairness and transparency in the system.

Q.37. If somebody is found to be using ratings in an unauthorized manner, what legal actions are proposed to be taken against such entities? Please justify your response with rationale and suitable examples, if any.

BIF RESPONSE

Penal provisions must be made in the proposed new legal framework to ensure that the Ratings for DCI are standardised, uniform, and are granted by the Authority after due verification of the procedure & processes followed or laid down for the DCI evaluation by the proposed DCI evaluators. Also the accreditation of the DCI Evaluators must be thoroughly examined before the certification is duly granted. Any violation of the process or procedures must attract due penalties including up to cancellation of the license/certificate.

Adoption of Digital Tools & Platforms, AI/ML Models to co-design and co-create DCI

Q.38. Whether creation of a digital platform that allows stakeholders to co-design and co-create DCI would be helpful to realise better, faster and cheaper solutions? Whether technologies and tools such as AI, ML would be helpful in achieving this objective? Please justify your response with rationale and suitable examples, if any.

BIF RESPONSE

Yes-as has been mentioned earlier, Digital Platforms that permit all stakeholders (including the consumers/users) to collaborate and co-design and co-create DCI Ratings would be very helpful in creating the proposed new framework.

Since Assessment of quality by measuring network and service related KPIs involves complexities on two counts, measurement as well as evaluation, it is felt that by taking resort to new technologies & tools that use AI, ML & other emerging technologies shall be extremely useful.

A short summary of the complexities involved as regards measurement & evaluation is given below.

(i) On measurement part, it requires:

- a) measurement of numerous parameters of network and service KPIs,
 - b) collection of samples for huge number of spots, and
 - c) collection of samples for each spot during different time bands and on different types of days.
- (ii) On evaluation part it is complex, as it is not a simple addition of measured values. Also, it requires discovery of value of weights to be assigned to:
- a) values observed for various network KPIs
 - b) values observed for various service KPIs
 - c) values measured at different locations
 - d) values measured during different time bands or days
- (iii) Multi-dimensionality of parameter measurements and evaluation gets further complicated because of the dynamic nature of performance of wireless networks. In practice, measurements done earlier may not remain valid for a long period, as quality also gets impacted due to various network related activities such as network optimization, expansion and upgradation. Variations in traffic demand also impacts quality of service.
- (iv) The designing and creation of DCI requires high degree of specialization. As IP1s are well versed and skilled in the process, the creation of DCI will be done a timely manner to support the rising demand.
- (v) The IP1s are responsible, empowered and technically well suited to meet the requirements of the consumers for the provisioning of Digital Communications Infrastructure as they are ready to upgrade/adopt any new/futuristic technology as the demand comes in.
- (vi) The IP1s also provide the requisite infrastructure for in-building solutions to cater to the needs of the consumers inside the buildings by creating mechanisms that ensure that in-building network is plugged with appropriate backhaul connectivity from all TSPs present in that area.
- (vii) The IP1s of today are quite competent & capable of designing & deploying Digital Communication Infrastructure (DCI) in the country as they have the necessary competency and capability and hence should also be permitted to design, implement & evaluate the DCI.

Typical processes involved in rating of a building

Q.39. What should be the typical process to rate a building? Whether terminologies and steps involved in the rating process need to be standardized? Please justify your response with rationale and suitable examples, if any.

BIF RESPONSE

Yes-all terminologies, processes and procedures for rating need to be standardised. For assessment of quality, various types of services are to be considered. Services which are required to be assessed may vary even within the same areas to be rated for Digital Connectivity. For example, video conferencing may be a very important service to be used from an apartment but may not be that important in the basement area for a residential apartment society. Internet of Things (IoT) or M2M (Machine to Machine) may be of high importance in parking and basement area.

Some type of Services that may be required to be evaluated may include –

- i. Conversational services such as voice/video calls,
- ii. Streaming services such as audio/video podcasts,
- iii. Interactive services such as chat, text/multi-media messaging, audio clips or video clips,
- iv. Background services such as file transfer, web browsing and email, etc.
- v. Services when using collaborative tools such as working on a shared document, presentation typically used for office working
- vi. Services when doing group tasks such as group singing when persons are located at different places
- vii. Certain scenarios to capture digital connectivity experience.

A list of services out of consolidated list of services that would be more appropriate to be evaluated in a particular part of area, may be required to be prepared. Some of the key parameters to be considered are, while fixing the process or procedure would include:

Consumption Profile: To assess quality, consumption patterns of various services may be important for deciding and applying weightages for evaluation of various services. Consumption of services may vary at aggregated level and at individual level from apartment to apartment and from individual to individual. Depending upon an individual, for someone, quality of entertainment services may be more important than quality of web browsing. For another person, requirement might be opposite of this. Importance of various services can be assessed from the consumption patterns. Different profiles may require different weights for evaluation. Weightage assignment may be related to variations in consumption pattern and variation in location. For example, in case of apartments, consumption pattern changes significantly in different parts of the apartment such as drawing room, balcony, kitchen, etc. Evaluation methodologies will require to evolve to reduce the gap between the measured quality and quality perceived by the users. Desired accuracy in the quality evaluation would decide requirement of level of granularity in measurements and assessments.

Building Profile: For assessment of quality, context in which digital connectivity would be used is very important. Context may significantly change from one type of building to another type of building. Models of evaluation of quality would evolve over a period with better understanding of the context. In practice, there may be variants or sub-modules of the models which may be best suited for evaluation for a particular type of building. It would be important to classify buildings from the point of view of digital connectivity experience. As discussed earlier, National Building Code of India and Development Regulations may introduce classifications of the buildings from a digital connectivity perspective. Wherever required, sub-classification may also be done to focus on specifics.

Applications to be Considered: Similar to the list of services to be considered, a list of applications with a popularity index in an ARC would also be required to predict the experience. Similarly, the profile of ARC in terms of typical devices along with their models, etc. would also be required to be generated for better assessment of the experience. Predicted experience needs to be derived from network performance parameters, application performance in an ARC, Services to be Considered, Consumption Profile, Device Profile, etc.

Rating of Digital Connectivity Experience (REx): REx may require composite assessment of all values measured and evaluated after assigning due weightages to the measured values as discussed in previous paras. Sources of inputs from which data and information may be required to be combined are network performance reports, field measurement reports, crowd source data and data provided by prediction tools. Prediction tools may play an important role in assessment even when the building has not come up or the network has not been put in place and users are not present. However, accuracy and reliability of prediction tools would depend upon quality and quantity of data and would also depend upon algorithms used to make predictions.

Typical steps for evaluation of quality of experience would involve Combining all kinds of inputs for overall assessment. Digital connectivity quality assessment may start from a particular spot for a variety of services to be measured at that spot. Assessment of quality in an apartment may be composed of a number of such spots. Further assessment at building level may or may not be aggregation at floor level depending upon closeness of the variations across apartments on the same floor or across floor on the same side of the tower.

Taking the note from "GRIHA Rating", the following Rating Process can be suggested:

1. **Online registration:** The project team can initiate the registration process by filling the EOI Form available on the website. The process of registration is completed after the successful payment of registration fees by the project team.
2. **Orientation workshop:** The registration is followed by an orientation workshop conducted by officials, which intends to provide detailed information of the rating along with an elaborate explanation to all the criteria, and post addressing project-specific queries of the teams.
3. **Due diligence I:** The site visit should be conducted by officials to validate sustainable measures adopted during the construction phase. It will be scheduled when the project is carrying out above plinth level work such as column and slab construction.
4. **Due diligence II:** The second site visit may be conducted by the officials to validate internal finishes, electrical, plumbing, and mechanical components installed during the construction phase. It is scheduled post completion of the building structure work.
5. **Submission of documents:** As the project is nearing completion, the project proponent will upload the documents for all criteria on the online panel using the username and password provided at the time of registration.
6. **Preliminary evaluation:** Preliminary evaluation is carried out by a team of professionals from rating agency and external evaluators, who are experts in their respective fields recognized by agency.
7. **Final due diligence:** The final site visit should be conducted by the rating officials to verify the submitted documentation with on-site implementation. The visit is done once the project is complete and all equipment and systems are installed and commissioned.
8. **Final evaluation:** The rating officials along with external evaluators shall then evaluate the final round of submitted documentation and the final site visit report in response to the preliminary evaluation. The final rating may be awarded based on the final evaluation and should be valid up to 5-10 years.
9. **Additional due diligence DCI awareness drive:** The officials may conduct an additional due diligence visit post the final rating, for green awareness and education amongst

project occupants. This visit aims to impart basic knowledge and understanding on green buildings and their way of working.

Q.40. Whether the process of rating would vary based on the types of buildings? If yes, then what factors or aspects of a building would matter or impact the outcome of rating? Please justify your response with rationale and suitable examples, if any.

BIF RESPONSE

Yes-The rating should be in alignment with national standards and guidelines such as the National Building Code of India 2016 (NBC), together with other relevant regulations pertaining to specific topics.

Building Profile: For assessment of quality, context in which digital connectivity would be used is very important. Context may significantly change from one type of building to another type of building. Models of evaluation of quality would evolve over a period with better understanding of the context. In practice, there may be variants or sub-modules of the models which may be best suited for evaluation for a particular type of building. It would be important to classify buildings from the point of view of digital connectivity experience. As discussed earlier, National Building Code of India and Development Regulations may introduce classifications of the buildings from a digital connectivity perspective. Wherever required, sub-classification may also be done to focus on specifics.

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Q.41. Which objective methods should be used to evaluate the DCI? How can various aspects of performance to evaluate the quality can be combined together? Please justify your response with rationale and suitable examples, if any.

BIF RESPONSE

Typical steps for evaluation of quality of experience would involve Combining all kinds of inputs for overall assessment. Digital connectivity quality assessment may start from a particular spot for a variety of services to be measured at that spot. Assessment of quality in an apartment may be composed of a number of such spots. Further assessment at building level may or may not be aggregation at floor level depending upon closeness of the variations across apartments on the same floor or across floor on the same side of the tower.

Q.42. Which subjective methods should be used to evaluate perceived quality of DCI? Whether survey techniques can be improved considering penetration of smartphones? Whether improved techniques can help in providing insights and actionable items to improve DCI? Please justify your response with rationale and suitable examples, if any.

BIF RESPONSE

Given that there are many emerging digital technologies and predictive tools that are available for doing RF mapping, DCI quality, etc., subjective methods should preferably be avoided. Survey techniques including Drive Tests that are conducted for determining QoS parameters in outdoor locations anyways use smartphones. Smartphones could also be deployed in indoor locations too to assess signal levels and QoS.

Yes, we believe use of new and emerging Digital Tools & Techniques should be predominantly used for determining and improving DCI Ratings.

Q.43. Would combining the parametric values or results of objective and subjective methods be helpful in assessing digital connectivity that is closer to the perceived quality of experience? Please justify your response with rationale and suitable examples, if any.

BIF RESPONSE

Yes. This could be possibly done to achieve a near real time assessment of the actual & perceived QoS at the consumer end and also of DCI Rating thereof.

Traditionally, the telecommunications industry has relied on QoS as the principal descriptor of the overall performance of their network services. QoS has been defined from a system perspective subordinating the user's response entirely to the influence of the telecommunication system. Even though the 'network-centric' approach for QoS has allowed mobile operators to deploy their network infrastructure and guarantee acceptable service levels, the correlation between network performance and good user experience is not direct.

This is because QoS deals only with technical aspects, ignoring the other elements impacting users' perception. Meanwhile, the goal of QoE is to interpret and understand end-to-end quality

including human users' point of view. According to the Qualinet project, QoE can be defined as *'the degree of delight or annoyance of the user of an application or service. It results from the fulfilment of his or her expectations with respect to the utility and/or enjoyment of the application or service in the light of the user's personality and current state'*. This definition remarks that QoE in communications services is influenced by content, network, device, application, user expectations, and context of use. For perceived quality of DCI there would be need to deliberate upon defining QoE parameters.

Q.44. How advanced technologies such as Artificial Intelligence (AI), Machine Learning (ML) etc. might be useful to make the evaluation process more nuanced and suitable for the purpose? How can AI/ML models evolve from the inputs of measurement and evaluation being carried out in other parts of the city, state or Country? Please justify your response with rationale and suitable examples, if any.

BIF RESPONSE

Rating may be a complex task but can be achieved. With the advancements in digital tools and availability of advanced techniques such as Artificial Intelligence (AI) and Machine Learning (ML), rating can be achieved in a more reliable and authentic manner. With these techniques and tools, contexts may be understood in a better way and may also be considered at the stage of evaluation.

Digital tools to predict network quality - Digital tools may help in providing data points by precisely predicting through simulations. Precision may come via better algorithms and availability of detailed information related to building. This may be crucial for making predictions about wireless signals inside building. Availability of building related information in digital form makes it easier to share and factor-in while making evaluation.

Digital tools to conduct survey that captures precise information –Digital tools may also help in engaging end-users to participate in the surveys and provide more precise information about the quality of experience. User interfaces developed considering capabilities of new devices and using building related information may make it much easier for an end-user to participate in the surveys. User interfaces may be much more interactive and intuitive and may help in capturing relevant information and avoiding unnecessary details.

AI/ML may help in combining information from multiple sources such as network reports, field measurement reports, crowd source apps, prediction tools, survey reports etc. Creating the picture of quality inside building after considering multiple sources and both objective as well as subjective assessments, may be much more reliable and closer to the perceived quality. However, process of combining of data may be context specific and there may be large number of variants, each one developed or evolved suiting to the context in which it is to be applied. Classification of buildings from digital connectivity perspective would help in this process.

Digital tools, AI/ML may help in dealing with such large number of variants. Digital platforms created for this specific purpose may help in learning of this model from the data collected from different parts of city or state or country. Prediction tools which may predict quality of service considering network configurations and building and other clutter related information are very

useful for evaluation of the quality. These digital tools with simulation mechanisms can predict network performance in a reliable and granular manner.

Digital tools used by the real estate sector –Technological advancement is continually happening in digital tools used in the real estate sector. Earlier, building information was generated via AutoCAD which was a drafting tool and provided information as 2D geometry. Subsequently, Building Information Modelling (BIM) software was developed for Architects, Structural Engineers, Contractors (AEC) and Mechanical, Electrical and Plumbing (MEP) Engineers and Designers. The software allows users to design a building, its structure and components in 3D, annotate the model with 2D drafting elements and access building information from the building's model database. 3D visualizations allow consumers to see historic preservation and site context with respect to the new project.

New dimensions are being added and 4D designs have added time dimension i.e., project phasing and construction sequencing to the model. Other dimensions in this model are cost and maintenance. It can be automated for quantity take-offs and cost estimating, including relationships between quantities, costs and locations.

Construction Operations Building Information Exchange (COBIE) is an information exchange format to capture the information created during design, construction and commissioning and it allows this information to be passed directly to the building operator into the owner's facility management program.

Some of the examples of BIM software include AutoDesk Revit, ArchiCAD, Allplan, CYPE and ACCA software. Similar types of capabilities in BIM tools, as in the case of AEC or MEP to plan, design, build and manage, are evolving to take care of telecom requirements in the buildings. For example, these tools or add-on software applications may figure out quantities and coordinate locations of telecommunication outlets with the Electrical Engineer for rough-ins and ensure that there is power adjacent to the outlet.

Most platforms, for the development of BIM projects in the cloud, have a mobile application giving real-time notifications of modifications made to the project. Advancements in technologies such as Augmented Reality (AR) are also being used to work with a virtual model in order to know the exact position of the elements. There may be applications or software which are specially designed for planning, designing, building and managing digital connectivity inside the buildings. Even for the existing buildings which might not be having building information in BIM format, there are some tools which carry out surveys of the building with use of special software and generate BIM required for the purpose of digital connectivity.

Digital Twin: The latest innovation related to building information is creation of Digital Twin. Quantity take-offs are a detailed measurement of materials and labour needed to complete a construction project. To make a rough or unfinished version of something, such as a design, as the first step in creating the finished version of the building. BIM focuses on design and construction whereas a Digital Twin models how people interact with the built environment. They create robust data models about all the aspects of the building. It may capture more

context about the built environment and behaviour pattern of the people including space design to achieve better outcomes through enhanced analytical and predictive capabilities.

3D models of clutter environment - Advanced Unmanned Aerial Vehicles (UAVs) with tilt photography and computing technologies to analyse images, facilitates generation of 3D models of reliefs, terrain textures, clutter, etc. through much faster processes and at a lower cost. These are required to predict radio propagation in a more precise manner. Such models may be used not only to improve accuracy but also to save time.

With more detailed and accurate information about building and clutter environment, and that too in a digital format that is interoperable, would be of great help for tools predicting quality of services inside the building. However, acquiring such information or getting it generated for single purpose like digital connectivity infrastructure may be a costly proposition. But such information may be useful for variety of purposes and if digital repository of such information is maintained by city or state or concerned authorities and made available to design and evaluate digital connectivity infrastructure, then it might be a feasible option.

Q.45. Any other issue which is relevant to this subject? Please justify your response with rationale and suitable examples, if any.

BIF RESPONSE

Human safety factors shall be given highest priorities, that include Fire Safety requirement and Electrical Safety requirement. In case of fire emergency, human lives are mainly at risk due to fast fire propagation through different cables deployed and hazardous gas emitted. So, there shall be regulation by law which ensure/bind the TSP/IP that the infrastructure to be deployed in any building/premises shall have the minimum fire safety requirement like fire propagation, smoke measurement and emission of hazardous gases as per IEC standards. EU and LATAM countries follow CPR and UL rated products to ensure fire safety in their premises. Also, when multiple cables are installed together in the same duct, TSP/IP shall ensure that the heat generated by electrical conductors should not exceed the maximum allowed temperature specified for the cable element materials.

Electrical safety is another area of concern as there is high risk/threat to Human Lives. Electrical safety norms shall be followed wherever there is any metallic wire/cable is running within the building or terminated in building.

Flame Standard adoptions for Data Communications Cables to be aligned as listed below as per application need:

- (i) IEC 60332-1
- (ii) IEC 60332-3A
- (iii) IEC 60332-3B

In the past decade, PoE and PoE+ has helped in creating a simple and convenient recourse for powering devices. Evolving structured and converged cabling techniques are being used to support devices which even exceed the PoE+ standards. As the ecosystem of powered devices continues to grow, power delivery and heating characteristics will soon join other traditional

cable performance parameters as a factor in the selection of cabling. Cabling must be able to ensure the delivery of increasing power and data speeds in adverse conditions over its expected lifetime. To maximize the capabilities and efficiencies of tomorrow's system, the correct cabling infrastructure will need to be implemented. Selecting a higher grade of cabling, or cabling with a larger conductor, will reduce heat generation within the cabling infrastructure, minimize the impact to IP traffic traversing the network and reduce the aging effect that heat can have on insulating materials. Over time, as more devices are connected and powered over the network infrastructure, the selected solution employed in the network will have a growing impact on network performance. Cables with temperature listings of at least 70-75°C will be better suited to resist the aging impacts of elevated ambient temperatures over time. Cat 6A onward can successfully transmit data better across the full 100 m channel, and not only provides an extra margin of performance, but also supports a wider range of data center and network configurations. Category 6A typically offers less cable heating under high-power Power over Ethernet applications. The trend toward higher access speeds and more pervasive, higher power PoE delivery makes a compelling case for Category 6A in any new installation preparing for the future. Standard guidelines TSB-184-A, ISO/IEC 29125 to be followed for PoE++ new installations.

QoE would be dependent on the quality of equipment used for Digital Connectivity. Quality of Fiber used must be preferably based on the latest state-of-the-art. For example, ITU-T G.657.A2 Fiber addresses rapidly rising demands for better QoS in indoor cabling and has the ability to be routed in very tight spaces –all without any data loss. This cable is far superior as compared to the archaic ITU-T G.652 B and the later version viz. ITU.G652.D