



National Urban Innovation Stack (NUIS)

DIGITAL BLUEPRINT

(Principles, Approach, Reference Architecture & Key Building Blocks)

Message



Shri Durga Shanker Mishra
Secretary
Ministry of Housing and Urban Affairs

The importance of urban India is difficult to overstate. Urban areas will be home to 40 percent of India's population by 2030, and account for 70 percent or more of our GDP. In the words of Hon'ble PM Modi, "India will experience the largest wave of urbanization in the world in the next two decades. It is a challenge, but also a huge responsibility and opportunity."

MoHUA has been laying the groundwork to accomplish its Vision 2024 of ease of living, responsive governance, clean and sustainable environment, rapid inclusive economic growth, and livelihood opportunities for all citizens. Efforts for transforming the urban landscape can be seen in various programs such as Swachh Bharat Mission - Urban (SBM-U), Pradhan Mantri Awas Yojana - Urban (PMAY-U), National Urban Livelihoods Mission (NULM), Atal Mission for Rejuvenation and Urban Transformation (AMRUT), and Smart Cities Mission (SCM).

The growth of our cities has also amplified the challenges of urban governance. As we aim for citizen-centric governance, the need of the hour is to ensure reliable channels of information and improved access for citizens. We need to strengthen the capacity of the urban ecosystem, across the quadruple helix of society, government, academia and industry. In order to transform the urban sector at scale and speed, MoHUA published a strategy and approach paper on the National Urban Innovation Stack (NUIS), which lays a digital pathway to India's urban future. Envisioned to create a cross-cutting digital infrastructure, NUIS will be a public good that enables all stakeholders in the urban sector to collaborate and co-create local solutions for local challenges.

MoHUA and NIUA have launched the Centre for Digital Governance (CDG) to serve as the anchor institution for operationalizing the NUIS strategy. This digital blueprint is a key milestone, detailing out the NUIS strategy into a reference guideline for anyone wishing to create NUIS-aligned solutions. This document will act as a common reference point, driving creation of interoperable solutions which can be leveraged by the urban ecosystem. MoHUA itself is among the first to adopt this blueprint, for programs such as Citizen-Centric Smart Governance (CCSG) and National Urban Learning Platform (NULP).

Even the pandemic has put a spotlight on the urban sector. As eyes are now on the sector with expectations to drive holistic economic growth post-COVID, the digital infrastructure for urban governance holds even more importance than ever. My wholehearted appreciation goes to the officers at Smart Cities Mission and the National Institute of Urban Affairs for their leadership, initiative, and teamwork during these challenging times. My special thanks to the esteemed members of the Technical Advisory Committee for their guidance and support in designing this robust blueprint.

I am sure that the NUIS digital blueprint would bring about a paradigm shift, towards open governance and multi-sector coordination for urban development. I urge each one of us to work together to implement the envisioned changes to realize this vision of efficient and citizen-centric governance in every city and town.

Message



Shri Kunal Kumar

Joint Secretary
(Mission Director Smart Cities)
Ministry of Housing and Urban Affairs

Indian cities are home to innovative startups, SMEs, academic institutions, and social impact organizations. To leverage the true potential of this remarkable ecosystem of actors across government, industry, academia, and civil society, Smart Cities Mission envisions developing 100 Indian cities as lighthouses, or models to inspire and lead other cities and towns. These smart cities in their roles as lighthouses will act as laboratories, enabling new solutions and initiatives which can be replicated across the country.

As per Census 2011, close to 500 cities / urban agglomerations have a population larger than 1 lakh. Once we step beyond these cities, there is a "long tail of small cities" where challenges such as inadequate infrastructure, insufficient capacity, and lack of the right tools hamper their ability to deliver effective and citizen-centric governance. The National Urban Innovation Stack (NUIS) as a strategy, Centre for Digital Governance (CDG) at NIUA as an anchoring institution, and Citizen-Centric Smart Governance (CCSG) as a lead NUIS program are calibrated towards accelerating the transformative journey of these cities to bring about a digital revolution in urban India.

Anchored by CDG, the first phase of CCSG is focused on efficient, equitable and transparent delivery of municipal services in all 4400+ ULBs by 2024. The second phase will re-imagine cities as a "one government" experience for citizens, by breaking the silos and enabling integrated functioning of multiple line departments and parastatal agencies.

Developing robust digital infrastructure will be the key to improve capacity of urban local bodies which in turn is critical for India's economic growth, especially as the pandemic reshapes how we live and work. To these ends, the digital blueprint is developed as a primary and practical source of guidance for ecosystem actors as they innovate solutions that can remain widely interoperable even as they solve context-specific problems. To address the complex and nuanced nature of problems, this blueprint provides a roadmap to balance scale, interoperability, and extensibility. The future of India is unified not uniform - hence the minimalism of the blueprint enables unification through standardization while also encouraging local innovation.

My hearty congratulations to the CDG team for the publication and a sincere thanks to the members of the Technical Advisory Committee for their guidance. I invite the reader to use this digital blueprint to participate in the co-creation of the urban solutions, and join our efforts to develop a best-in-class digital public good for urban India.

Foreword



Hitesh Vaidya
Director
National Institute of Urban Affairs

The Sustainable Development Agenda 2030 focuses on 'making cities inclusive, safe, resilient and sustainable', which require enabling the cities to design and implement well-articulated strategies that support India's growth innovations and initiatives at scale. Sustainable, inclusive and timely urban development is a prime imperative for India. In recent years, urban governance in India has moved towards the adoption of an ecosystem mindset to drive the delivery of excellent service to citizens. Key to this piece has been the upskilling, training and re-training of state and city government officials and administrators to rise up to this ambitious challenge.

MoHUA's transformational National Urban Innovation Stack is one of the focal initiatives that will enable the use of digital technology to drive essential programs; while addressing the needs of capacity building by utilising urban data, co-creating with actors across the spectrum and enabling responsive, citizen-centric governance.

The National Institute of Urban Affairs has always been geared towards pioneering innovative approaches, that will not only allow Indian cities to meet the challenges of the future, but also thrive through sustainable and inclusive development. Launched in 2020, the Centre for Digital Governance serves as the anchor institution for NUIS with the goal to facilitate adoption of technology as the core for digital transformation. As part of the CDG and NIUA's continuous efforts to translate policy into action, I am pleased to present the NUIS Digital Blueprint which will energise urban governance and harness the power of the virtual ecosystem to deliver the best-in-class solutions to our cities and citizens.

Through the Digital Blueprint, we hope that urban governments will envision and enact a platform on which they can interact, connect, and collaborate with ease with citizens, industry and government by automating routine tasks and facilitating data-based decision making to drive urban governance and policymaking, thus revolutionising every aspect of day-to-day governance in India.

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GLOSSARY

Centre for Digital Governance (CDG)	Launched on 25th June 2020, the Centre for Digital Governance at NIUA serves as the institutional home for all programs and platforms under NUIS.
Citizen-Centric Smart Governance (CCSG) Program	Citizen-Centric Smart Governance is one of 7 focus areas identified in the NUIS Strategy and Approach. The CCSG Program, as one of the flagship programs of the CDG, will identify or create a number of the building blocks and governance mechanisms envisaged by NUIS.
Domain Working Group	In order to devise standards on a given domain, programs under NUIS will create working groups. These groups will include members from government, industry, academia, and civil society, and work in a collaborative manner to come up with standards that should have wide acceptability among persons working on that specific domain. "Domain" refers to a certain area of work; in the context of the CCSG program, for instance, the domains will be municipal services - e.g. property tax, water and sewerage, trade licences etc.
National Institute of Urban Affairs (NIUA)	The National Institute of Urban Affairs is India's leading national think tank on urban planning and development. As a hub for the generation and dissemination of cutting-edge research in the urban sector, NIUA seeks to provide innovative solutions to address the challenges of a fast urbanising India, and pave the way for more inclusive and sustainable cities of the future. NIUA has been appointed as the "anchor institution" for NUIS by the Ministry of Housing and Urban Affairs, and has launched the Centre for Digital Governance to consolidate these programs.
National Urban Innovation Stack (NUIS)	The National Urban Innovation Stack is a digital blueprint for creating a common digital infrastructure for urban India. The NUIS Strategy and Approach explains the guiding principles, layers, key components, and the role of standards and certifications in creating the Stack.
Platform and Platform Architecture	In the context of NUIS, a platform refers specifically to an open digital platform. This is a collection of software components ("building blocks"), which are created as microservices and interact through the use of APIs. A complex software system, which can perform multiple functions, is deconstructed into a digital platform by following the principle of unbundling. "Platform architecture" is an abstract description of the components of a digital platform and how they are related to each other.
Program	A program is an initiative undertaken by a given actor or group of actors to achieve a defined mission or goal. A program can have multiple activities, outputs, and outcomes which it pursues as part of its mission. For programs created in the context of NUIS, one of these outcomes will be the creation of open digital platforms or their building blocks. While such work will tend to take place at a central level, these platforms and programs can further support the establishment of state-level programs that adopt and align with the mission or goals of the central-level program.
Solution (and Reference Solution)	A solution can be defined in the abstract as any method or process to address a problem. In the context of NUIS, solutions will take the form of a software application; such applications are said to run "on top of" a platform, leveraging the various microservices and capabilities provided by the platform. Platforms developed in keeping with NUIS will include certain "reference solutions", which are intended to illustrate to the ecosystem how such solutions/applications could function. A reference solution may not be directly used, but can form the basis for an actual operational solution with relatively little effort.
Urban Local Body (ULB)	Urban Local Bodies are the Constitutionally-mandated third tier of government for urban areas. They are responsible for the 18 areas of work described in the 12th Schedule. Depending on the size of the city, the ULB can be a Municipal Corporation (population above 10 lakhs), Municipal Council (population between 1-10 lakhs), or Nagar Panchayat (population below 1 lakh). Most ULBs in India are Nagar Panchayats.

Context

By 2030, India's urban population is expected to grow to 600 million, i.e. 40% of the national population. Given the concentration of trade and commerce, knowledge-based industries, and a vast informal sector in the cities, urban India has become the fulcrum of India's growth, with 70% of the national GDP expected to come from urban areas.

Urban governance involves a variety of social, economic and governance priorities, interacting through a wide range of institutions, across multiple levels of government, as well as industries, citizens' groups, and civil society institutions. With the 74th Amendment to the Constitution, the responsibility for coordinating across these various stakeholders to ensure development, management, and maintenance of cities is placed upon the Urban Local Body (ULB).

Most ULBs are severely constrained to fulfil these responsibilities, given the legacy of gaps in infrastructure and shortages in human resources and financing. The urban sector in India is in urgent need of whole-of-system innovation, focused on identifying and removing systemic bottlenecks and inefficiencies.

At the same time, ULBs in India are spread across a vast geography, with more than 4000 cities spanning the diverse geographical and cultural contexts of India's states and union territories. This diversity means that no single solution can be identified or scaled across the country; rather, it is necessary to rapidly scale up ULBs' intrinsic capacity to solve local problems, meet local needs, and deliver services to their residents in an effective, efficient, and equitable manner.

In order to address the need for scale and speed, it is essential to use the transformational force of digitisation in all aspects of the urban sector. Recognizing this need, MoHUA released the National Urban Innovation Stack (NUIS) Strategy and Approach in February 2019. NUIS is envisioned to act as a digital public good, in the form of a set of APIs or building blocks for all stakeholders across the "quadruple helix" of government, industry, academia, and civil society and citizens' groups in urban India.

These building blocks will enable different stakeholders to collaboratively design, implement, and refine innovative solutions to local problems. While traditional approaches to innovation focus on identifying and scaling solutions, NUIS aims one step higher: to build local, distributed, and decentralised capacity to solve, and to do so at speed and scale. NUIS adopts a stack approach to provide both adaptability and ease of adoption, envisioning a fractal pattern of platforms, each of which is further made up of reusable and modular building blocks, arranged in various configurations as per the needs of each use case.

The Centre for Digital Governance (CDG) has been created at the National Institute of Urban Affairs (NIUA) to anchor and operationalize the NUIS Strategy and Approach. CDG will set standards and policies relevant to the NUIS, host the National Reference Platforms developed or identified as part of NUIS, orchestrate the urban ecosystem, and provide advisory support to states and ULBs as they engage in digitally-enabled transformation of urban systems.

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Objective of this Document

The objective of this document is to provide an overview of the NUIS stack approach, and to illustrate how the different components of the stack contribute to meeting the twin requirements of adaptability and ease of use. Specifically, this document will:

- Summarise key aspects of NUIS - stack approach, design principles, standards, platform architecture layers, and building blocks.
- Provide a framework to assess participating platforms/ solutions against NUIS requirements.
- Provide an approach to governance for the programs, platforms, and data that will be created or identified in keeping with the NUIS strategy.



Stack Approach

A. Why is a Stack approach needed in the urban domain?

India has more than 4400 ULBs, ranging from some of the world's largest cities - with populations in the tens of lakhs - to small statutory towns with fewer than a lakh residents. The challenges that these cities face are **diverse** in nature, related not only to their size or density but also their geographic, climatic, and socio-economic conditions. These challenges are often **complex**, having persisted despite years or even decades of efforts to address them. They are also **dynamic**, interacting with each other and with emerging circumstances in unanticipated ways.

In order to address these diverse, complex, and dynamic challenges - both persistent and newly-emerging ones - it is necessary to avoid indexing too heavily on any one solution. Instead, what is needed is to rapidly enhance the local capacity to solve such challenges in every ULB. This can be achieved through a stack approach, which, by its very nature is:

Extensible: the core components or building blocks can, with relatively little effort, be modified to meet additional requirements, corresponding to specific local needs.

- **Evolvable:** the governance of the stack is designed to incentivise and incorporate innovations, and to enable updating of components to keep pace with evolving circumstances or needs.
- **Scalable:** the modular nature of the stack makes it easy to replicate or reuse core components, so that multiple users can leverage a relatively minimal set of capabilities swiftly & easily.
- Able to **catalyse collaboration:** the stack promotes openness and interoperability, with multiple avenues for stakeholders across the quadruple helix to contribute as per their own capabilities, expertise, and interests.

B. How does NUIS adopt the Stack Approach?

NUIS is made up of multiple building blocks, which can be shared & combined into a number of platforms and applications. The design and interaction of these building blocks, from the smallest component up to an entire platform, are governed by the NUIS Design Principles, as well as the standards and specifications that will be developed to correspond to specific platforms and use cases.

NUIS embodies the stack approach by:

- Unbundling complex challenges into smaller, more manageable chunks ("micro problems");
- Arranging micro problems into multiple layers, based on the extent to which they vary from context to context (i.e. from context-invariant to context-specific);
- Enabling the creation of specific solutions to these micro problems ("microservices"); and ensuring these microservices are reusable;
- Speeding up the solutioning process, and expanding the range of challenges that can be rapidly addressed, by leveraging other existing stacks, frameworks, policies, and processes (e.g. IndEA, IndiaStack, OpenAPI Policy, NDSAP, the Data Protection Report, other open stacks in relevant domains, etc.);
- Maintaining consistency, compatibility, and reusability across components and layers by defining principles, standards, and specifications, which enable the participation of multiple stakeholders/ecosystem actors in this process of developing, aggregating, and contextualising micro-service-based solutions.

By applying this approach, NUIS envisions the creation of multiple reusable and extensible building blocks, each developed to solve specific problems but reasonably easy to repurpose or reassemble in a wide range of use cases. This also sets the stage for multi-sectoral collaboration, with various stakeholders and solution providers contributing

as per their skills and capabilities - the stack approach provides the ability to aggregate these local and micro-solutions into coherent, flexible, and scalable solutions.

C. Illustration of stack approach

This section will provide a simple and non-comprehensive illustration of the stack approach, using the Property Tax service provided by a ULB as an example. The Property Tax service provides a way for property owners to get their properties assessed, for the ULB or other concerned departments to review such assessments if they wish to, and for payments to be made against these assessments.

Note: The lists in 1-4 below are illustrative, not exhaustive. There could be other micro-problems identified, and additional micro-solutions / building blocks created or leveraged in each layer.

Applying the high-level steps described above to this use case:

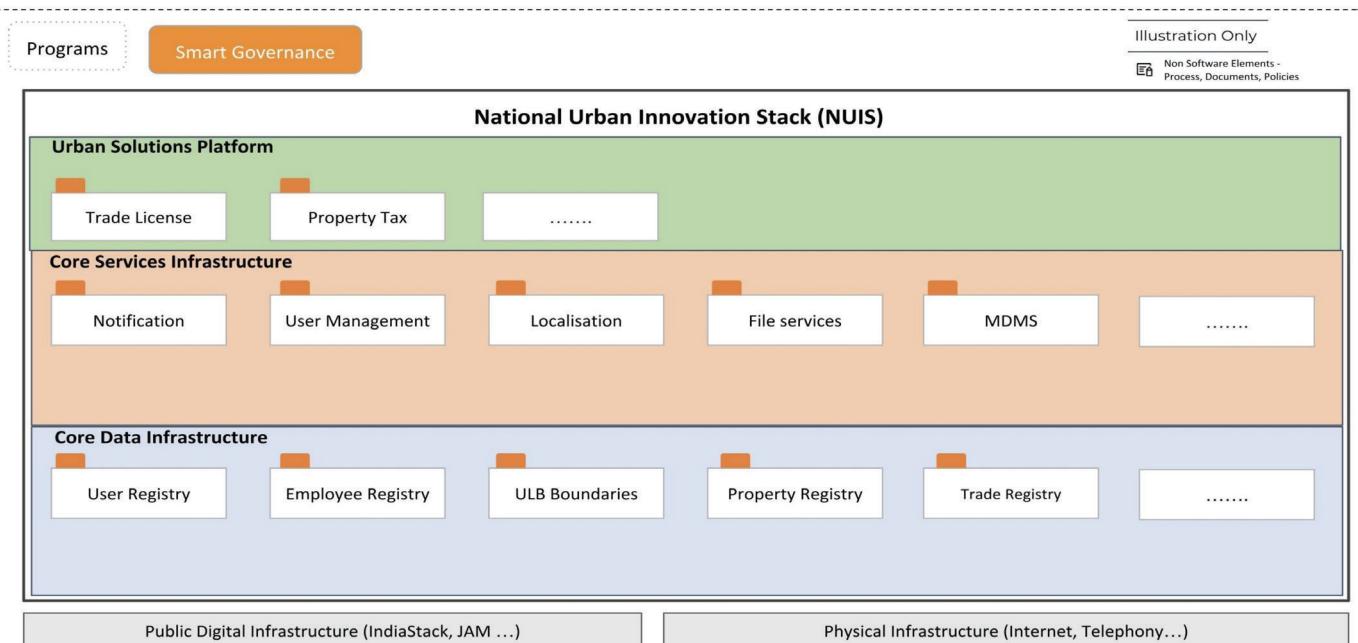
1. Unbundling the challenge into micro problems such as:
 - a. Need records of property data and its changes over the years
 - b. Need to be able to match owners and relevant employees to properties to conduct the assessment process
 - c. Need records of previous assessments
 - d. Need the ability to store and track reference metadata on properties and assessment, e.g.
 - i. Taxonomies (Property types, Usage Types, Structure types)
 - ii. Calculation method(s)/formulas
 - iii. Values of constants in the formula like slab rates, taxes, surcharges
 - iv. Location related data - city, locality, special features of location
 - e. Need to be able to identify location of the property
 - f. Need to be able to create and run assessment-related workflows - e.g. self assessment, assisted assessment, assessment verification, ratification, etc.
 - g. Need the ability to accept, verify and store supporting documents
 - h. Need to be able to calculate the tax amount, given details on the property, time period, etc.
 - i. Need to be able to raise demands / issue bills
 - j. Need to be able to notify various parties (e.g. about status of assessment, any reviews needed, that a bill has been raised, payments received etc.)
 - k. Need to be able to receive payments, or to record payments made through any authorised means
 - l. Need to be able to raise grievances/challenges in case an assessment is believed to be incorrect
 - m. Need to ensure personally identifiable information (PII) is stored and processed safely, and access to

such data is controlled, authorised, audited etc.

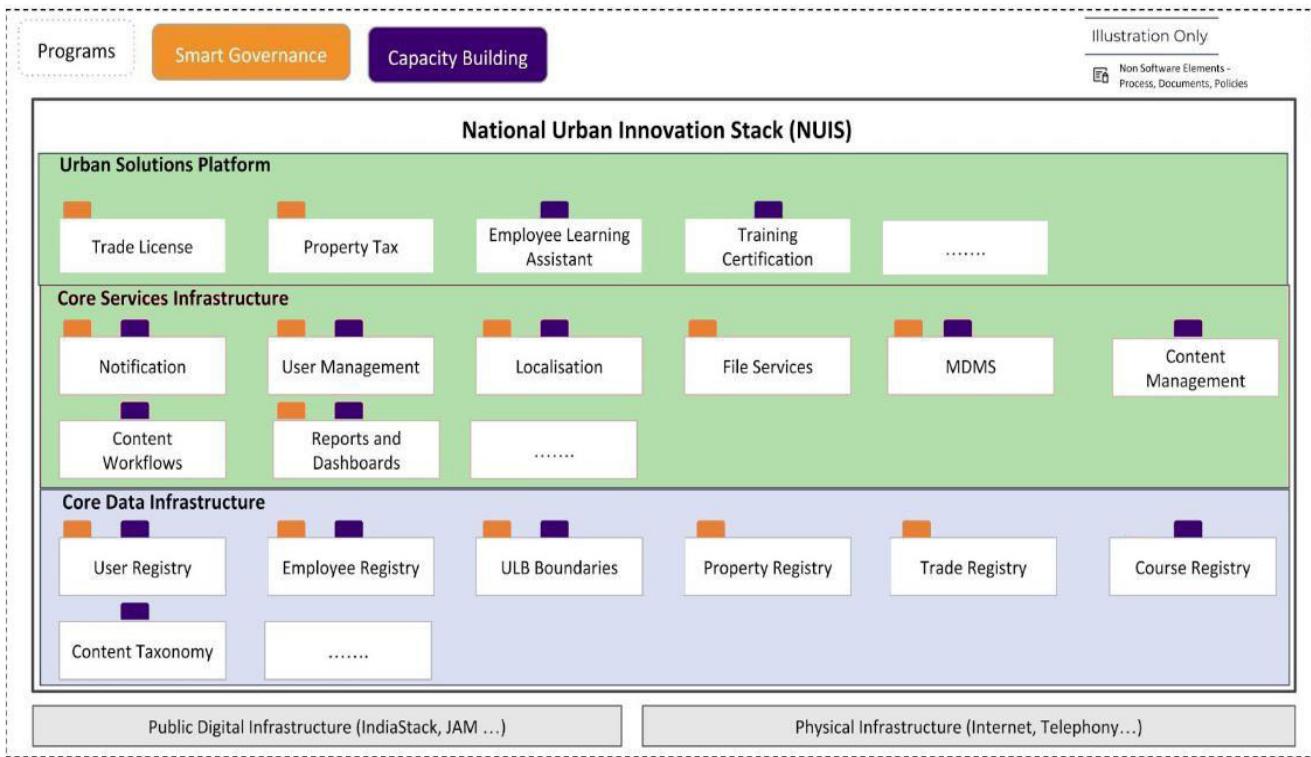
- n. Need to be able to generate basic reports (i.e. display status of property tax charged and collected in that ULB)
2. Arranging the micro problems in various layers, based on how context-specific they are, and identifying micro-solutions for each.
 - a. Data Infrastructure Layer (broad tasks, not context-specific)
 - i. Data specifications and taxonomies for - Property, Assessment, Location, Assessee (owner), Administrator, Demand, Bills, Receipts, Documents, etc.
 - ii. Registries/Store support for - Property, Assessment, Assessee, ULBs, Administrators, etc.
 - iii. Reference Master Data Management infrastructure for metadata
 - iv. Data signing and encryption for data privacy and security
 - v. Template engine for Bills, Receipts, Notices, Notifications, etc.
 - b. Core Services Layer (well-defined tasks, used across multiple contexts)
 - i. Authentication of users, employees, etc.
 - ii. Authorisation of specific actions in the workflow
 - iii. Billing (demand, bill and receipt generation)
 - iv. File management
 - v. Grievance management
 - vi. Localisation
 - vii. Notifications
 - viii. Reporting
 - ix. Telemetry to measure the interactions between stakeholders
 - x. Urban GIS
 - xi. User management
 - xii. Workflow/Application management
 - c. Urban Solutions Layer (context-specific - with the specific domain here being property tax.)
 - i. Context-specific extension to data models or APIs
 - ii. Assessment service, to apply domain-specific checks
 - iii. Tax calculation service
 - iv. Assessment-specific workflow, including triggers for other services such as notification, external payment gateways, etc.
 - v. Any custom logic that is specific to the domain, e.g. custom reports in a city where property tax assessment operates on a unique time period, etc.
3. Identifying building blocks from existing stacks which can be leveraged here:
 - a. Authentication may build on top of Aadhar

- b. Employee part of user registry can leverage existing systems like LGD
 - c. Payment part can leverage UPI and other payment gateways
 - d. Assessments and receipt can be stored at DigiLocker
 - e. BBPS may be leveraged for bill distribution and payment recognition
 - f. Existing GIS can be used for location awareness
 - g. ESign may be leveraged for tax receipt signing
4. Use of principles, standards and specs
- a. Key design principles provide basic guard rails for the design of each of these components and their interactions with others

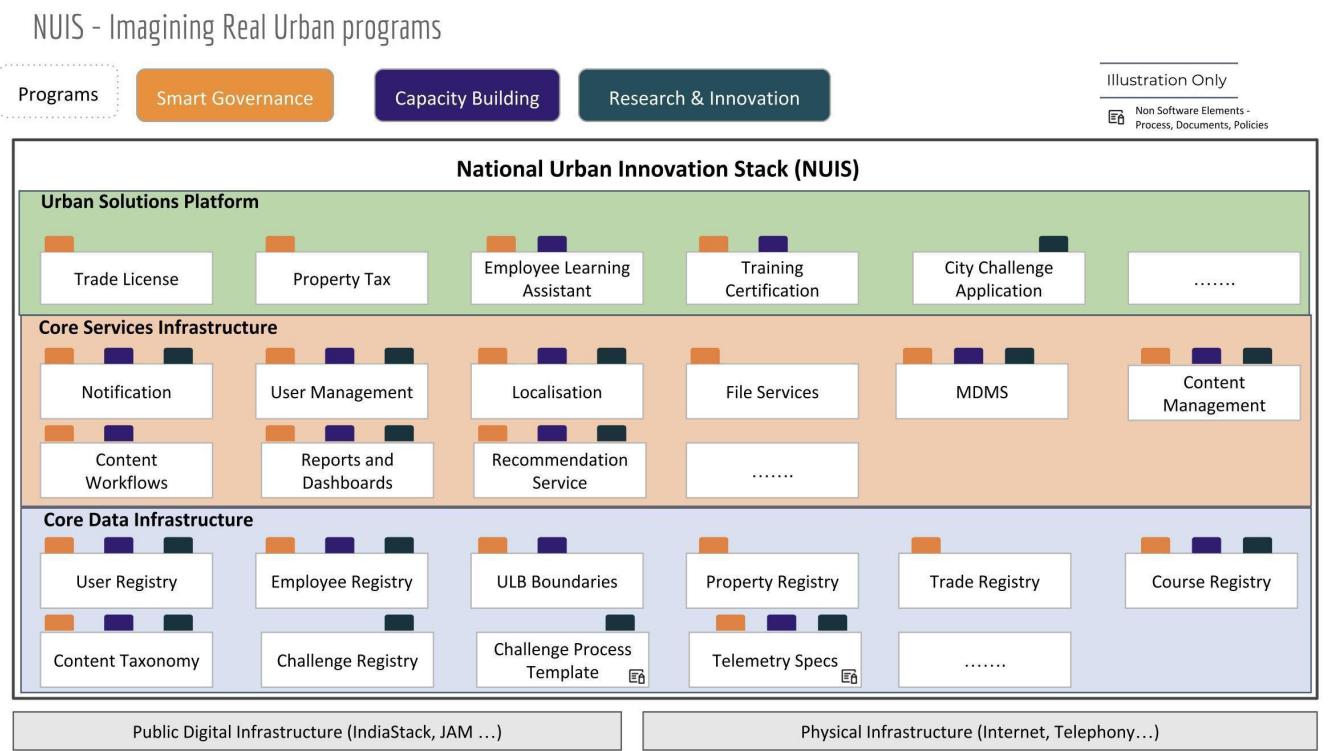
Snapshot 1: As an illustration, let us assume the Smart Governance Program - as the first platform developed under NUIS - adds digital solutions in the urban solutions layer. These include solutions for Trade Licenses and Property Tax, among others.



Snapshot 2: In the second illustration, the Capacity Building Program could then add an Employee Learning Assistant and Training Certification to the urban solutions layer (indicated in dark blue). These solutions re-used pre-existing core services such as notification, user management, localisation etc. (indicated in both orange and dark blue), while also creating or identifying new core services—Content Management, Content Workflows (indicated in dark blue). The solely orange ones are being used only by Smart Governance solutions. The solely blue ones are being used only by Capacity Building program; the ones with both tabs (blue and orange) are being used by solutions in both programmes. This evolving nature of layered implementation can also be noticed in the data infrastructure layer with the addition of Course Registry and Content Taxonomy, and the integration of previously implemented modules for new services and solutions.



Snapshot 3: The Research & Innovation Program (Grey) could then add City Challenge Application (CCA) to the solution platform layer. CCA was built using multiple pre-existing core services and data infrastructure. For its own implementation, CCA also added the 'recommendation service' to the core services layer which was picked up by previous solutions (as indicated by orange and blue along with grey). This evolving nature of layered implementation can also be noticed in the data infrastructure layer with Telemetry Specs. It must also be noted that new implementations will not always be integrated with previous solutions. Here, core implementations such as the Challenge Registry and Challenge Process Template which don't enhance functionality are only marked with grey, showing that they only support the CCA solution.



Key Components of NUIS

NUIS is designed to ensure ease of adoption across varied urban contexts, both present and future. These features are reinforced at every step of its design, including:

- Design Principles
- Standards and Specifications - which ensure interoperability of building blocks
- Architecture, its layers and their key building blocks - i.e. how the different layers are organised, and indicative lists of components / microservices in each layer, which can be reassembled and extended to form context-specific solutions.

A. Design Principles

In this section, we focus on the digital infrastructure aspects of NUIS by specifying the underlying design principles. As platforms “distribute the ability to solve” to ecosystem actors, they need guidance in the form of basic principles and best practices for each such actor to create useful and relevant solutions.

Principles, in turn, enable the creation of necessary Standards, Specifications, and Certifications, which can be developed across three contexts:

- People (Roles, Actions, Capabilities, etc),
- Process (Policy standards, working methodologies, Process standards, compliance certificates, etc), and
- Platforms, i.e. the underlying digital infrastructure (Open standards, Open APIs, Open reference applications, etc).

These principles serve as guardrails, ensuring that the variety of efforts that leverage and contribute to NUIS platforms are widely aligned to each other, as well as to the IndEA principles. (Appendix 1 maps NUIS and IndEA approaches to demonstrate this alignment.)

Federated Architecture

To resolve for scale the ability to solve must be distributed, providing stakeholders with the power to overcome the

challenges they face. Hence platforms are federated by design. Most population-scale systems today are distributed systems hence allowing for replication to achieve scale and data exchange to function as a unit if needed.

Interoperability through Open APIs and Open Standards

Interoperability is essential for NUIS to be able to support a large number of diverse use cases and foster innovation. NUIS must be built using open standards, avoid dependence on specific platforms or software frameworks that may prevent ecosystem participation. In addition, the components of the stack should be loosely coupled using open interfaces (APIs). Adoption of open APIs and open standards; where prudent, choosing open source frameworks and components over proprietary ones; and creating vendor-neutral API's, will help achieve the goal of interoperability. NUIS will integrate with all relevant open platforms of the government, including Aadhar, GSTN, UPI, BBPS, and BharatQR.

Privacy and Security by Design

Managing security and privacy of data is important and thus will be a critical part of the design of the stack. All data access must be through API calls to ensure appropriate security controls. NUIS will require programs and organisations working under its ambit to provide standards and certification for data privacy and security. Except Open data, direct access to data will be prohibited and use of APIs will be mandated. NUIS-compliant programs, platforms, and solutions will ensure privacy, data encryption, and data integrity; they will disseminate data only to authenticated and authorised stakeholders (both internal and external) through applicable data fiduciaries.

Ensuring Extensibility through the use of Layered Design

The design of NUIS will be modular: there will be a clear separation of concerns for data storage, software services and APIs. Components will be minimalistic and independently replaceable and extensible. This will allow different components to be loosely coupled when building

applications which will enable application diversity. Different instances of the stack will be able to customise and create contextual solutions to serve their specific purpose, make changes to them with appropriate change management process.

Designing for Evolvability and Scale

The Stack must be able to scale horizontally to hundreds of millions of users in the urban ecosystem and to handle trillions of data records. All components including computer, network and storage resources must be capable of scaling horizontally: it should be possible to add new resources as and when needed to achieve required scale. Being cloud-ready and using commodity hardware will ensure that capital investments on the Stack will be minimal. This will also give a choice of infrastructure to the implementers and enable systems to evolve heterogeneously.

Transparency and Accountability through Data

The verified registry of all the entities and the non-repudiable transaction trails shall lead to higher trust and stronger accountability. NUIS will be data-driven and will use data generated through transactions for reporting and analysis. Public Open Data shall be made available via APIs for transparency. The access to open data will ensure high-quality analytics, accurate fraud detection, shorter cycles for system improvement and, most importantly, high responsiveness to user needs.

Multi-Channel Access

With the rapid growth of net connectivity and the variety of electronic devices available in the market, it is important that end users' access points and their access interfaces are kept in mind while enabling access channels (Citizen Service Centres, PCs, Tablets, Smartphones, Offline) and ensuring an engaging user experience on all of these channels to enable rapid adoption by the end users.

Inclusive

Different instances of NUIS should be able to configure, extend or customise applications to cater to their specific needs as long it meets the Open Standards and Specifications laid out by NUIS.

Domain Modeling

Since NUIS must balance between abstraction for wider adaptability, and specific solutions, the data specifications should remain generic without making concrete assumptions about the purpose for which the data is used. The data specifications should be extensible, allowing programs to model their own domain by adding new data attributes on top of available specifications.

Minimalistic

The goal of the stack is to enable inclusion; hence, it is important that stack remains minimal and allows innovative

solutions to emerge rather than forcing a particular type of solution. A given program or platform may provide reference implementations to seed the imagination, but should remain minimalistic to allow the ecosystem to thrive on it.

Ecosystem-Driven

The success of any platform is its ecosystem. Linux, Android, iOS, Apache - all these platforms have been successful because they could foster vibrant ecosystem of players from commercial to non-commercial, from product to service providers, from big companies to a single developer.

Unbundling

Platforms achieve scale and ecosystem by unbundling complex challenges into micro solutions/services and allowing for rebundling them for the needed context. These micro services – which can be seen as akin to Lego blocks – are arranged in layers, going from context-invariant bottom layers to more context-sensitive layers at the top. Unbundling promotes reusability, lowers the barrier for new solutions and enhances participation by abstracting complexity under simple interfaces.

Non-Repudiable

The platform should enable a means of ensuring accountability. For collaboration and interaction within the ecosystem to thrive on the platform, building trust by ensuring accountability is very important. This accountability will take the form of non-repudiability of any access or changes to data, ensured through the platform's own design and audit mechanisms.

B. Standards

In keeping with the NUIS design principles and the principles of **Data, Integration, and Security reference model from IndEA**, the various building blocks that make up the stack should be developed and operate in compliance with the standards and specifications developed and published by NUIS. Certification processes and bodies can also be identified, so that existing or new building blocks can be assessed to ensure they qualify as compliant with these standards and specifications.

Why Standards?

In the context of the NUIS, a standard is a collection of minimal requirements and definitions which helps solutions to:

- Coexist and interoperate correctly with each other
- Speed up time to market
- Meet the necessary regulations/policies
- Help compare applicability of competing solutions
- Allow solution providers the choice of technology

The provision of standards, in turn, can bring the following benefits to key stakeholders:

Industry

- Build customer confidence that products are safe and reliable
- Meet regulation requirements, at a lower cost
- Reduce costs across all aspects of business (for which standards are specified)
- Gain market access across geographies (wherever the standards are being followed)

Citizens and Civil Society

- Assure quality and reliability of services
- Ensure consistency in services, irrespective of the vendor / provider involved
- Enable choice (and fair competition, which further enhances choice)
- Provide transparency in production information
- Guide towards suitability of products for vulnerable populations
- Support consumer protection and rights, e.g. data privacy etc.

Policy Makers / Government

- Open up innovation by expanding participation from ecosystem players
- Improve the efficiency of products and solutions
- Stimulate solutions to national and regional issues, e.g. disaster mitigation, energy efficiency, trade promotion etc.
- Save money, through providing much of the technical detail and safety requirements needed for effective policy
- Take in a wide range of views and expertise, and ensure buy-in from many stakeholder groups, thus lowering barriers to policy adoption by the ecosystem

Development Principles

In order to ensure that these standards act as a common foundation for the ecosystem, driving greater levels of participation and innovation, NUIS proposes certain principles to guide their design, development, and prioritisation:

- **Standards respond to a need in the market** - Instead of choosing the priority areas at its will, the working group that is developing a standard needs to respond to the needs of the ecosystem and apply appropriate prioritization criteria. Working groups should also leverage existing work in the applicable field, rather than seeking to redo that work.
- **Standards are based on expert opinion** - Standards should be developed by groups of experts from all sectors of the ecosystem, who should be convened in

the relevant domain working groups or sub-committees thereof. These experts negotiate all aspects of the standard, including its scope, key definitions, and content.

- **Standards are developed through a multi-stakeholder process** - The working groups should have a broad composition, complementing the perspectives of experts from relevant domains with participation from other relevant actors across government, civil society, industry, and academia.
- **Standards are consensus-based** - The approach to developing standards should be consensus-based, wherein comments from all stakeholders are taken into account.

Design Principles Applicable to Standards Development

In keeping with the logic of a stack approach, the standards and specifications will derive from and be compliant with the relevant design principles. In turn, by ensuring compliance with the standards, the developers of any component / building block will be able to assert that it is compliant with the design principles. Key principles are:

- **Openness:** standards are open so as to support technology & vendor neutrality; they are typically published under the most unrestricted licence - e.g. MIT or Creative Commons (see also, MEITY Policy on Open Standards for e-Governance)
- **Evolvability:** standards are designed to be evolvable over time so as to accommodate changing needs / requirements
- **Extensibility:** standards are designed to be extendable, so that ecosystem actors can leverage them when innovating in a specific context
- **Minimalism:** standards are designed to be minimal, so as to enable and support innovation, rather than stifling it, while still ensuring interoperability
- **Balancing data privacy and security with data empowerment:** standards are designed to provide mechanisms to keep data secure and private, while still allowing for its exchange and processing with suitable consent or authorisation
- **Non-repudiability:** standards ensure mechanisms to view and verify attribute trails - i.e. who accessed or edited data - e.g. digital signatures
- **Unbundling:** standards aim to break down complex areas and mechanisms into smaller and simpler pieces, which can be solved and reassembled in modular ways

Recommended Standards

NUIS follows the design principle of minimalism when creating standards to ensure that they enable interoperability without stifling the ecosystem's ability to drive innovation. In order to facilitate this, NUIS will mainly focus on following standards in each of its programs:

- Data Specifications and Taxonomies, to ensure semantic and syntactic (content) interoperability
- Data Models and APIs, to ensure technical interoperability
- Data Privacy and Security standards (including requirements specified by law)
- Lists of key building blocks for each domain, wherein these building blocks may implement, augment, or replace the more context-invariant building blocks developed by the NUIS platforms

Additional Considerations for Technical Interoperability Standards

- Support multi-tenancy by design
- Provide standard Open APIs to perform, at a minimum, the following five functions on each domain entity:
 - Create
 - Update
 - Search
 - Delete
 - Cancel
- Reuse, leverage or extend existing national/international standards in the relevant area e.g. schema.org for entity definitions, Open311 for service definitions, LCBS for land classification etc.
- Support multiple transport protocols to be future ready for things like IoT and sensors, allow flexibility in data exchange etc.
- Use standard definition specification like OpenAPI 3.0 (recommended)
- Support evolution of standards by adopting standard versioning schemes - e.g. SemVer2.0 (recommended).

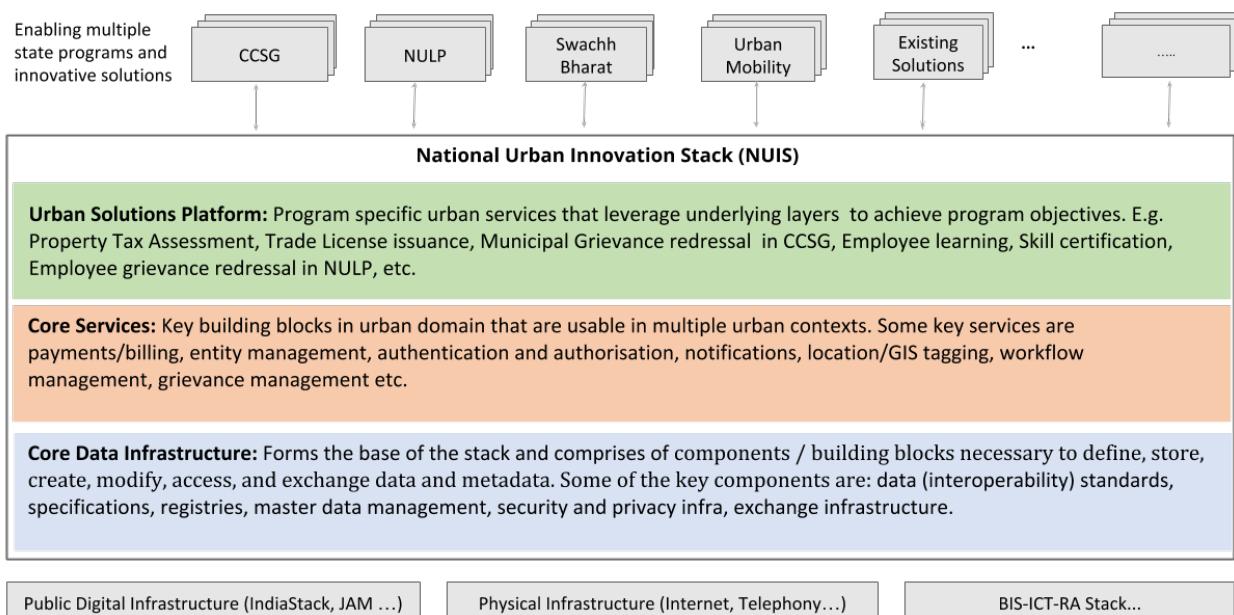
- Clearly specify authentication, authorization, and validation criterion
- Develop using open collaboration tools like GitHub

C. Architecture (Layers and their Key Building Blocks)

In keeping with the design principles, NUIS adopts an architectural model that enables solutions - the topmost layer of the stack - to build upon the underlying layers in consistent and reliable ways. The layered design of this architecture supports both, reusability of specific components across contexts and use cases, and use of shared infrastructure through multi-tenancy. As described in Appendix 1, it aligns with principles of **Application, Technology, and Architecture Governance Reference Model** from IndEA.

The idea of "building blocks" is central to the stack approach. Each of the design principles finds expression in the design of the building blocks themselves, the manner in which the blocks interact with each other, and the ability to reassemble or reconfigure these building blocks to address various contexts and use cases.

Building blocks can be understood as **self-contained and reusable** units of functionality (microservices, or micro-solutions to micro-problems). Each such block is **interoperable** with other building blocks, with both the building blocks and their interfaces designed based on / in **compliance with standards** (as discussed in section 3C, immediately above). These **interfaces are reasonably stable**, so that interoperability between the blocks can be stably maintained.



Finally, building blocks are designed for **scalability and evolution**, both in terms of flexibility to extend the block for a particular use case, and the ability to reassemble sets of building blocks into new configurations.

The following section enumerates a few key building blocks in each layer of the stack¹.

Core Data Infrastructure Layer

This layer consists of the various components / building blocks necessary to define, store, create, modify, access, and exchange data and metadata.

Types of Data

Data in NUIS can mainly be categorized as follows:

- Master data - Metadata about entities in the system aka Registry.
 - a. Entity Master Data - Data that describes the entity
 - b. Reference Master Data - Data about qualifiers of main entities like categories, types, sub-types etc.
- Transaction data - Transactional data like assessments, applications, payments, expenses, workflows etc.
- Stream data - Interaction events, sensor data, Telemetry Data, Alerts, Messages, Commands etc. and consists of both live data streams as well as their archived records
- Derived data - Computed from raw stream feeds or other derived data by analytics pipelines using chaining of data products (microservices for data processing)

Mechanisms of Handling Data

Data in the first three categories typically enters a NUIS-compliant platform or solution through APIs. NUIS requires its participating platforms and solutions to provide capabilities for injecting, storing, processing and accessing the data in conjunction with higher layers of the stack. All data should be made available through APIs or exhausts. Based on the nature of output data these APIs/exhaust may be access controlled.

In line with the microservice architecture, the data architecture should allow development of new data products and assembling them for higher order insights. Data solutioning exercise is about understanding the user's concerns, mapping it to a data product (available out of the box, or a new one), and defining the behavior of that data product based on telemetry and other available data.

Data products will usually be stream processors or batch processors that take incoming data and process it to derive data/metrics. They can range from simple processors like validators, de-duplicator, de-normalisers etc. to higher order ones like summarisers.

Data Security and Privacy

Following the principle of Privacy and Security by Design, participating programs, platforms, and solutions should:

- Follow all relevant laws and policies, e.g. the Personal Data Protection Bill (once adopted as an Act).
- Ensure that sensitive data either remains anonymous, or use virtual profiles (across both master data and transaction data).
- Ensure that no unnecessary sensitive or personally identifiable data is captured.
- Store sensitive details like email or phone number, where these are legitimately captured (e.g. in User Profile for password reset), in encrypted form.
- Enable dissemination of data only to authenticated and authorised stakeholders, both internal and external.
 - a. They can adopt mechanisms for user consent, as described in the Electronic Consent Framework of the Ministry of Electronics and Information Technology (MeITY), to enable applications to share data about users in a safe and consent-based manner. An example of this is the Data Empowerment & Protection Architecture (DEPA) as proposed by NITI Aayog, once these are developed to the point of being usable.
- Define their own data manifesto, including their policies around data gathering, usage, and sharing, against which compliance or breaches can be assessed. These can be based upon policy guidance issued by relevant government bodies, e.g. the City Data Policy once issued by MoHUA.
- Provide tools to enable audit and breach investigations, based on the data manifesto described above.

Registries - Fundamental Source of Truth for all Platform-based Solutions

Digital Registries solve for reliable, secure, and easily-accessible master data. They serve as a "single source of truth" across departments and organisations, and are built relying on shared data standards and taxonomies so as to be widely interoperable.

Guiding principles of digital registries are:

- Self-maintainability of each registry
- Non-repudiability of any operations conducted on data (including access/views)
- Data provenance is recorded with the data itself
- Provide incentives for key actors to participate
- Extensible and flexible schemas to enable incorporation of data into more context-specific processes / use cases

¹This list is not exhaustive, and subject to change over time: new building blocks can be created, existing blocks can be updated or extended, and some blocks may be permitted to expire if they are found to not be in use - for instance, if a better means of providing the same microservice is developed.

- Accessible through Open APIs, which are themselves standardised
- Data visibility can be controlled (e.g. based on credentials or authentication)
- Compatible with mechanisms for consented data sharing

Building Blocks in Core Data Infrastructure

Data Specifications infrastructure

Data specification infrastructure includes:

- Domain Specifications - Taxonomies, Models, API definitions,
- Telemetry specifications
- Message structures, processing standards etc

Common Registry Infrastructure

Digital infrastructure to achieve usable basic registries that take care of data security, privacy and consented access based on simple data specifications and configurations. These registries may extend existing registries (e.g. Aadhar, LGD) or can be extended by creating new registries.

Key aspects of this infrastructure would be:

- Ability to define a registry using simple JSON specifications, e.g. OpenAPI 3.0
- Ability to configure data security parameters for registry attributes
- Ability to create data in registries
- Ability to sign and encrypt the data for security and tamper proofing purposes
- Ability to perform controlled and consented access to registry data based on basic parameters

Following key registries are envisioned at this time:

- User registry
 - a. Citizen registry - may be linked to existing registries like Aadhar
 - b. Employee registry
- Property - Fundamental to most other use cases for Urban
- Urban Assets - Movable and immovable urban assets
- Complaint - Necessary for citizen services
- Associated reference master data registries for each of the above

Data Encryption and Signing Infrastructure

Extendable infrastructure to provide software and hardware encryption and signing capabilities to assist with data security, tamper proofing, privacy etc.

Data Exchange Infrastructure

Infrastructure to catalogue, discover and share the data (and its derived insights). NUIS aims to leverage Indian

Urban Data Exchange Platform (one of the platforms under NUIS umbrella) to facilitate the exchange of data.

(For additional details on how NUIS recommends approaching these issues, see the "Data Governance" section below.)

Core Services Layer

The Core Services layer houses broadly context-invariant services which can be leveraged to build urban solutions. These can be API-driven digital services or their enabling counterparts (research services, training services, compliance services etc). Some key services that form part of this layer are discussed in the "key building blocks" section below.

Building Blocks in Core Services Layer

These are context-invariant services and libraries that are needed by multiple urban contexts. NUIS will try to leverage existing building blocks in the ecosystem by providing a layer of standardisation around them. (E.g. Aadhaar for Authentication, BBPS for Billing, DigiLocker for documents, UPI for payments etc.) While respective domain working groups will decide domain specific building blocks of the participating platforms/solutions, a few of the **key building blocks currently envisioned in this layer are:**

- Authentication
- Authorisation
- Billing (demand and receipt generation)
- File management
- Grievance management
- Localisation
- Notifications
- Reporting
- Telemetry
- Urban GIS
- User management
- Workflow management

Urban Solutions Layer

This layer is where the context-sensitive components required to implement specific urban programs are located. These can be existing components that have evolved themselves, or they may be new components that are developed to leverage underlying layers of the stack.

Building Blocks in Urban Solutions layer

Building blocks in the Urban Solutions layer will ideally be developed by ecosystem players in their respective domains of expertise. Specific programs under NUIS are already underway to build a number of components of the stack; these programs may further decide to provide reference solutions for certain priority domains.

These reference solutions will demonstrate how the platform can provide value for ULBs and other stakeholders; they are intended to seed the imagination of the ecosystem, rather than to serve as mandatory or default applications. (Imagine these as equivalent to BHIM for UPI, or stock apps on iOS/Android.)

Programs under NUIS will aim to facilitate a wide range of solutions by on-boarding available solutions from the ecosystem which follow the principles of NUIS. Each program will in turn describe how it will leverage the NUIS approach to create a platform and solutions that are NUIS-compliant.

The following programs are currently developing platforms and solutions for NUIS:

- Citizen Centric Smart Governance (CCSG)
- National Urban Learning Platform (NULP)
- Indian Urban Data Exchange (IUDX)

Leveraging Public Digital Infrastructure, IndiaStack, and other Open Stacks

As noted above, NUIS proposes to leverage components / building blocks from existing stacks, as well as any

reusable digital artefacts as may already be available in the ecosystem. Among others, NUIS will leverage IndiaStack and other existing stacks like the internet, cloud platforms, telephony, GPS etc.

Building Blocks from IndiaStack

NUIS proposes to leverage existing building blocks from various layers of IndiaStack

- Presence-less: Identification, KYC through Aadhaar
- Paper-less: eSign, DigiLocker
- Cashless: Digital payments through UPI
- Consent: Data privacy

Building Blocks from other existing stacks

NUIS will also leverage other existing stacks wherever available/applicable, such as:

- GIS - location related services and infrastructure
- Telephony - communication related services and infrastructure
- Public, Private and Hybrid cloud - Cloud infrastructure
- BBPS - Billing and Collection of taxes and charges
- iGOT - Training infrastructures for government employees
- BIS ICT-RA - ICT Reference architecture for smart cities

5

Governance

Governance in NUIS can be categorised into the following areas:

- Overall program governance
- Digital platform / artefacts governance
- Data governance

A. Overall Program Governance

NIUA has created the Centre for Digital Governance (CDG) to serve as the anchor institution for NUIS, and to provide an institutional home for the various programs that will develop components of the stack. Currently, the two programs being operationalised through CDG are Citizen-Centric Smart Governance (CCSG) and the National Urban Learning Platform (NULP); a third program - the India Urban Data Exchange - is also underway as a partnership between MoHUA and the Indian Institute of Science (IISc).

CDG will help define the priorities and roadmap for NUIS and its programs, and support states and ULBs along their journey of digitally-enabled urban governance transformation. In particular, programs developed in keeping with NUIS may consider developing policies, frameworks, and mechanisms to ensure governance of the following areas:

- Ensuring compliance of the program (and platforms and solutions it develops or identifies) with the NUIS digital blueprint
- Managing the creation and publication of standards, specifications and assessment frameworks
- Managing the creation and provision of open digital platforms and reference solutions

B. Digital Platform/Artefacts Governance

This category refers to governance around standards, specifications, architectural blueprints, key building blocks, and reference solutions developed through the various programs undertaken in keeping with NUIS. The objectives of this governance area are to:

- Facilitate creation of specifications, standards, and certifications, in compliance with the GoI Policy on Open Standards for e-Governance, for chosen domains;
- Provide a framework for assessment, which states/ULBs can apply to assess the extent to which platforms, building blocks, and solutions that they are considering or already using are in compliance with the NUIS Digital Blueprint and relevant domain standards;
- Identify, prioritise, and optionally provide critical elements of the digital infrastructure for the program(s) such as key building blocks, standard operating procedures, and reference solutions.

In particular, programs under NUIS may provide for the creation and dissemination of standards for the particular domains where they aim to provide or identify solutions. (For additional guidelines on standards development, see the "Standards development principles" section above.)

C. Data Governance

Data is fundamental to the effectiveness of digital systems. Effective data governance ensures that data is consistent, trustworthy and doesn't get misused. It helps generate trust in underlying data, break down data silos, enable innovation and ensure compliance with laws. This is increasingly critical as urban stakeholders rely more and more on data analytics to help optimize operations and drive policy decision making.

NUIS provides the blueprint for technology capabilities for data governance through its principles, standards, architecture and key building blocks like rMDMS, Data security and data exchange infrastructure. Microservices based layered and federated architecture of NUIS also allows its participating platforms/solutions to come up with needed arrangements for data exchange between different programs/institutions while providing necessary privacy and security. These capabilities can further facilitate insight generation, learning, and innovation by sharing non critical/non PII data like:

- Telemetry streams
- Aggregates defined in domain standards
- Anonymised transaction data

A good data governance framework goes beyond such technical capabilities; it consists of the policies, rules, processes, organizational structures and technologies

that are put in place as part of a governance program. To ensure robust data governance, NUIS expects participating programs/institutions to take responsibility for the data they collect or create, and to establish the necessary policies, rules, processes, and organizational structures to provide effective data governance in their own contexts.

6

Framework for assessment of compliance with NUIS Digital Blueprint

It is envisioned that multiple programs will leverage NUIS, each facilitated by underlying solutions platforms and other layers of the stack. This section provides a framework to assess the alignment of the proposed platforms and/or solutions with NUIS core requirements. Participating programs and organisations/institutions may further add or modify this framework to create assessment templates specific to their needs.

A. Purpose

The purpose of this framework for assessment is to:

- Help MoHUA in creating guardrails in nudging the ecosystem towards the needed objectives.
- Help platform and solution providers in understanding and complying with the principles and standards of NUIS.
- Help procurement authorities in states/ULBs in understanding the compliance of platforms and solutions with respect to NUIS and make informed decisions in selecting as per their need.

B. Key Tenets of the Framework

1. Assessment criteria can be divided into

- a. **Core requirements:** These are requirements that assess the adherence to overall principles, standards, and architecture of NUIS. These requirements will mainly cover adherence to:
 - i. Design principles
 - ii. Architectural considerations
 - iii. Prescribed standards and specifications, namely:

- ▶ Taxonomies
 - ▶ Data Models
 - ▶ APIs
 - ▶ Data Security and Privacy specifications
- iv. Key building blocks

b. **Domain-specific requirements:** These are requirements that will be decided by relevant domain working groups constituted for each domain as the need emerges.

2. Each category will be scored on a scale of 1-100.
3. Some categories will carry a minimal score for qualification. Failing to attain the minimal score in these requirements will lead to disqualification of the overall submission.
4. Overall score of a submission will be the sum total of scores on all core and domain-specific categories.
5. Each domain/subdomain may add further core and domain-specific categories and/or requirements as per its needs, in keeping with the scoring philosophy described in #2, #3, and #4 above.

C. Core Requirements (CRs)

This section details the key requirements that should be addressed by all participating platforms/solutions. As NUIS platforms/solutions are used by the urban ecosystem, these core requirements can evolve based on a combination of feedback from the ecosystem, the TAC, and any other relevant sources.

Appendix 2 provides an assessment matrix with minimal needed score on each of the core requirements. **These**

core requirements are sorted into 7 categories:

1. Interoperability
 - a. Taxonomies are available for the key domain entities/registries
 - b. Data specifications/models are available for domain entities
 - c. Open APIs are available for following key functionalities for the domain entities
 - i. Create
 - ii. Update
 - iii. Search
 - iv. Cancel
 - v. Delete
 - d. Above artefacts comply to prescribed domain standards where defined, or leverage existing national/international standards, or are self-published as open standards
2. Data Privacy and Security by design
 - a. Data privacy capabilities are available to mark and protect sensitive data
 - b. Appropriate access controls can be defined in the APIs to ensure authorised access to sensitive data
 - c. Encryption requirements can be defined and adhered for storage of sensitive data
 - d. Mechanisms to allow consented access can be defined and adhered to.
3. Transparency and Accountability through data
 - a. Provides capability to define registries, preferably through standard specifications like OpenAPI 3.0
 - b. Provides capability to configure registry attributes for security, and protects as per the configuration
 - c. Registry data can be tamper-proofed using digital signing
 - d. Provides mechanisms to verify data and its provenance through audit logs (access and change logs), preferably through APIs
 - e. Provides ability to gather secure telemetry to help observability
4. Reusability and Extensibility
 - a. Requirements are unbundled into their fundamental units - micro services / solutions - and layered in order of context awareness, as defined in the layers of the NUIS architecture
 - b. Allows extension of data models to include contextual attributes
 - c. Allows extension of existing capabilities without needing architectural interventions
 - d. Supports single-instance multi-tenancy to enable sharing of underlying infrastructure
5. Evolvability and Scale
 - a. New capabilities can be added without needing overall system re-architecture
 - b. Individual components can evolve separately to enable heterogeneous evolution of the system
 - c. Uses standard versioning schemes like SemVer 2.0 for its APIs and components
 - d. Can be scaled horizontally to handle change in request volumes
 - e. Can work on any infrastructure, from commodity hardware to commercial clouds, including hybrid deployment models
 - f. Individual components can be scaled independent of each other, to enable efficient resource utilisation
6. Multi-channel access
 - a. Allows multiple channels of solution delivery - mobile, tablets, PCs, IVRS etc
 - b. Ability to support different access policies for different channels
7. Ecosystem-driven
 - a. Leverages open source technologies to reduce cost of solutions
 - b. Leverages or Integrates with or Extends existing platforms/stacks like IndiaStack, IUDX, ICTRA infrastructure etc
 - c. Provide capability to gather feedback from ecosystem in digital manner

D. Domain-Specific Requirements (DSRs)

These are envisioned to be finalized by domain working groups constituted to develop standards under NUIS, whether by CDG or through whatever other mechanism. It is recommended that the framework provided for assessing compliance with core requirements is extended to domain-specific requirements, wherein

- Domain working groups list down the domain-specific requirements
- Scoring is done against each such domain-specific requirement
- Domain-specific requirements are prioritised *inter se*, by marking higher minimum scores against high-priority requirements
- In addition to the above, specific domains / sub-domains may choose to extend even the core requirements, by including additional core requirements relevant to that domain.

Appendix 1

Mapping IndEA principles with NUIS

This section lists the most important principles as defined in the IndEA document and how NUIS aligns with them.

1. **SDG Linkage** - NUIS chooses the principles of being "**Ecosystem Driven**", "**Domain modelling**" and "**Extensibility**", hence it does not take any strong opinionated view on any particular business use case or goal. It focuses on enabling the ecosystem to choose programs relevant to its need and leverage underlying building blocks to achieve the intended outcome. In a direct manner NUIS will support the achievement of SDG 11 "Make cities and human settlements inclusive, safe, resilient and sustainable" and SDG 17 "Strengthen the means of implementation and revitalise the global partnership for sustainable development". As states and cities leverage platforms developed in keeping with NUIS, they can further contribute to SDG 1 ("end poverty"), SDG 2 ("end hunger"), SDG 3 ("ensure healthy lives and promote well-being"), SDG 4 ("ensure inclusive and equitable quality education"), SDG 6 ("sustainable management of water and sanitation"), SDG 8 ("decent work"), and SDG 16 ("effective, accountable and inclusive institutions").
2. **Integrated Services** - Through the principle of "**Interoperability through Open APIs and Open Standards**" one of the key focus of NUIS is to enable integrations with relevant components, systems stacks to enable smooth exchange of information wherever needed. It also aims to enhance the trust in the information by choosing the principles of "**Privacy and Security by Design**", "**Transparency and Accountability through Data**" and "**Non-Repudiability**".
3. **Sharing and Reusability** - Through its principles of "**Unbundling**", "**Minimalistic**", "**Extensibility through use of layered design**" and "**Inclusive**", NUIS puts emphasis on creating reusable building blocks that can be leveraged in diverse contexts.

4. **Technology Independence** - NUIS places emphasis on Technology Independence by being "**Inclusive**" and requiring the ecosystem to only adhere to "**Open APIs and Standards**" without needing to commit itself to any particular technology. NUIS tries to go a step further by choosing the principles of being "**Minimalistic**" and "**Extendable**" even in its Standard and APIs.
5. **Data sharing** - NUIS places special emphasis on data - its creation, storage, maintenance, processing and sharing through its principles of "**Open APIs and Open Standards**", "**Privacy and Security by design**", "**Transparency and Accountability through Data**" and "**Non-repudiability**". Importance of data sharing in NUIS can be gauged by its dedication of one of the layers to data, its definition and handling that helps enable data sharing with right controls and confidence.
6. **Cloud first** - NUIS takes the modern micro services driven approach to addressing the challenges. By requiring its underlying components and resulting platforms to adhere to principles of "**Open API and Open Standards**" driven "**Unbundled**" components that are "**Extensible through the use of layered design**" NUIS pushes the deployment neutrality of its components - thereby also deployable in cloud environments.
7. **Mobile first** - NUIS' principle of "**Multi Channel Access**" is aimed at ensuring that its components and offering support the current and evolving channels that are conducive to its end users in a given context.
8. **Federated Orchestration** - NUIS requires "**Federated Architecture**" for scale and ensures agency by distributing ability to solve to its multiple stakeholders.
9. **Primacy of Principles** - Given the complexity of the challenges and diversity of ecosystem, NUIS takes principles first approach and requires all its further artefacts to be grounded in its principles. As evident, It also aligns with principles of relevant reference models from IndEA wherever applicable.

Appendix 2

Sample Assessment Matrix

This matrix can serve as a tool for assessing any given platform or solution against the NUIS CRs, and against such requirements DSRs as may be specified for a given service or use case. While programs or institutions adopting this matrix may contextualise it to their specific needs, it is strongly recommended to follow the indicated scores closely. In case any modifications are made, the rationale for the same should be communicated to CDG.

- To qualify against this matrix, a given platform or solution would have to attain the minimum score against all categories.
- Totalscore provides the overall comparative alignments of various platforms/solutions against the categories assessed in this matrix.
- Users should also specify domain-specific requirements, along with minimum scores in the same, as relevant to their specific use case.
- The CR numbers in this matrix refer to the requirements listed in the "Core Requirements" section above.

Category	Requirement	Minimum Score (out of 100)	Score achieved
CR	Interoperability (1.a - 1.d)	100	
CR	Data Privacy and Security by Design (2.a - 2.d)	90	
CR	Transparency and Accountability through data (3.a - 3.g)	70	
CR	Reusability and Extensibility (4.a - 4.f)	80	
CR	Evolvability and Scale (5.a - 5.g)	70	
CR	Multi-Channel Access (6.a - 6.b)	80	
CR	Ecosystem Driven (7.a - 7.c)	60	
DSR	a.x - a.y	nn	
DSR	b.x - b.y	nn	



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