
5G USE CASES LAB FOR BANKING AND FINANCIAL SERVICES

Project Proposal by IDRBT

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**Institute for Development and Research in
Banking Technology**

(Established by Reserve Bank of India)

Road No.1, Castle Hills, Masab Tank, Hyderabad 500057, Telangana

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Executive Summary

5G Services are expected to be available in India from 2020 onwards. Department of Telecommunications (DoT), Telecommunication Engineering Center (TEC) and members of Telecommunications Standards Development Society, India (TSDSI) are working with international researchers, industry and other key stakeholders to ensure India specific requirements are part of 5G specifications. It is expected that 5G availability with India specific use cases would be happening during the same time as the rest of the developed markets. To promote 5G research and identify use cases across various sectors, DoT is facilitating setting up of 5G Use Cases Labs for identified industry verticals with the guidance of TEC and TSDSI and others. Use cases of 5G are expected to address some of the current problems of existing technologies and extend to future advancements in Digital India. The 5G use cases will increase and change as the technology implementation gets enhanced and widely adopted.

IDRBT (Institute of Development and Research in Banking Technology) established by the Reserve Bank of India (RBI) is identified to establish the 5G Use Case Lab for Banking and Financial Services of India (BFSI) after discussions with DoT, TEC, TSDSI, RBI, NABARD and stakeholders from banking, insurance and capital markets. The document provides some of the use cases identified in consultation with researchers (IIT-Hyderabad, IIT-Madras, IISc-Bangalore and IIT-Delhi), telecom equipment manufacturers (Ericsson, Huawei, Intel, Qualcomm, Samsung) and service providers (BSNL, Airtel, Jio, Reliance Communications, Wipro) and most importantly banking and financial services user group (SBI, Andhra Bank, Central Bank of India, Federal Bank, Axis Bank, Yes Bank, IndusInd, Cholamandalam Finance, General Insurance Corporation, NABARD and LIC). Based on the inputs, IDRBT will set-up the 5G use case lab for Banking and Financial Services leveraging and extending the existing research centers facilities for use case development. The document provides an initial list of 5G Use Cases of Banking and Financial Services, an understanding of basic hardware, software and people requirements to fund 5G use case lab. The project has a proposed funding requirement of Rs. 22.1 Crores for a period of 3 years and would be implemented as Phase I (1st Year) and Phase II (2nd and 3rd year). IDRBT will fund about Rs. 1.6 Crores, IDRBT will work with Banks and Financial Services organizations to have their IT officers deputed to work on the project (the expected expense would be about 3 Crores for 3 years) and the remaining Rs.17.5 Crores is expected to be funded by DoT for next 3 years. Bank of Baroda and Union Bank of India have already identified IT officers to be deputed to work at IDRBT on 5G Use Cases from July 2019. The set-up of IDRBT 5G use case lab for banking and financial services can be used beyond 3 years and will get strengthened with increasing 5G penetration and technology upgrade in banking and financial sector.

1. Project Background

1.1 Project Title

5G Use Cases Lab for Banking and Financial Services

The project will identify and prototype India specific use cases of 5G in Banking and Financial Services sector. The project is expected to support Indian Banks, Insurance, Capital Markets



and FinTechs to implement 5G technologies on par with developed countries. IDRBT will guide and support FinTechs, Banking and Financial Services to scale and commercialize the prototypes. Considering that India has 2nd largest mobile penetration in the world and has a diverse digital divide, the security gaps in 5G technologies and services would also be identified along with 5G use cases.

1.2 Project Scope

- i. Identifying Use Cases of 5G for Banking and Financial Services to address current challenges and futuristic needs. The sectors would include organizations managed by DFS, regulated by Reserve Bank of India (RBI), National Bank for Agriculture and Rural Development (NABARD), Insurance Regulatory and Development Authority (IRDA), Securities and Exchange Board of India (SEBI) and others under finance ministry.
- ii. Prototype and demonstrate use cases for Banking and Financial Services
- iii. Collaborate with Banks, FinTech and Startup community to take prototypes to market/industry
- iv. Identifying detailed Bill of Materials required for building use case lab
- v. Procure and setup use case lab using the procured equipment and developed software

1.3 Project Type

1.3.1 Roll-out

The proposed project contains 2 phases. In Phase I, the initial scope of use cases and the related bill of materials will be finalized. Building a demonstration of initial use cases with 5G simulation will also be part of Phase I. Phase II consists of strengthening the use cases for banking services followed by demonstrations of Insurance and Capital Markets use cases.

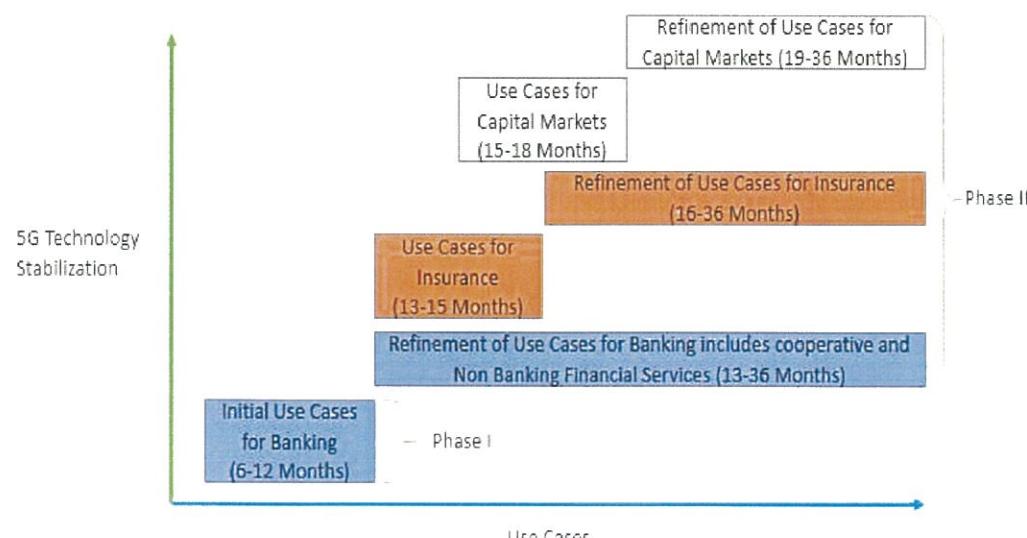


Figure 1:
Roll-out Plan for 5G Use Cases for Banking and Financial Services



1.3.2 Pilot

IDRBT will have officers from Banks, Insurance and Capital Markets as part of the 5G team so that adoption and pilot run in those organizations can be planned accordingly. On an ongoing basis, IDRBT will provide technical guidance, thought leadership and feature demonstrations to banks and other financial services including startups to develop 5G applications.

1.4 Initiator Details

The requirement of 5G for Banking and Financial Services was discussed on 26th March 2018 meeting hosted at RBI, Mumbai. The meeting had participation from the Department of Financial Services (DFS), TSDSI, ReBIT, NPCI, LIC, NABARD and others. Based on the interactions by DoT with DFS, IDRBT has been requested to set-up 5G Use Case Lab for Banking and Financial Services. Subsequently, IDRBT had conversations on 5G use cases with Andhra Bank and State Bank of India from public sector and Axis Bank from private sector to validate the need for 5G Use Case Lab. A workshop was also conducted with Banks (IndusInd, Federal Bank, Central Bank of India and others), OEM (Intel, Keysight), SI (Wipro) and Service Providers (BSNL and Reliance) that further strengthened the need for use case lab considering some of the challenges in 4G and opportunities with 5G

The project would have Prof V N Sastry, Lalit Mohan Sanagavarapu, Abhishek Kumar Thakur and N P Dhavale as the investigators.

Professor V N Sastry

Educational Qualifications - Ph.D. and Master's Degree from the Indian Institute of Technology (IIT), Kharagpur, India in 1994 & 1987 respectively. Obtained Bachelor's Degree with Honours from the University of Calcutta, Kolkata in 1985.

Professional Experience -

Chaired the ECMG (Expert Committee on Mobile Governance) of MEITY and Submitted the Mobile Governance Standard report in 2017.

Co-Founder of the Mobile Payment Forum of India (MPFI in 2007) and Serving as Executive Secretary.

Set up The Centre for Mobile Banking (CMB) at IDRBT in 2012 and Serving as Head.

Served as Faculty at NIT-Tiruchirappalli (1993-1999) and presently as Professor at IDRBT (since 1999).

Guided 9 Ph.D. and over 100 Projects of Graduate and PG Students. Published over 100 Research Papers and Articles in reputed Journals and Conferences in India and abroad.

Contributed as Reviewer, Examiner, Board of Studies Member, Ph.D. Coordinator, M.Tech. Co-ordinator, Co-ordinator of PGDBT, Consultant to Banks and as Senate Member of IIITDM.



Research Interests - Mobile Computing, Mobile Security and Quality of Service; Mobile Payments; Mobile Governance, Mobile Cloud; Wireless Sensor & IoT Applications; Security and Access Control Models; Network Optimization; Operations Research; Multi-Objective Fuzzy Optimization and Fuzzy Control; Financial Engineering; Asset Liability Management; Portfolio Optimization.

Personal page - <http://www.idrbt.ac.in/vnsastry.html>

S Lalit Mohan

Education Qualifications – Pursuing Ph.D. at IIIT Hyderabad. Completed Post Graduate Diploma in Cyber Laws and Intellectual Property Rights from the University of Hyderabad. Bachelor's in Technology from JNTU Hyderabad in 1997.

Professional Experience – Lalit has 20+ years of IT experience. Worked at Infosys Technologies Ltd, Wells Fargo India Solutions Pvt Ltd, Institute for Development and Research in Banking Technology. Executed IT projects for Microsoft, Aetna Inc, World Bank, Marsh Canada. Established the first Community Cloud for Banking sector using Open source technologies.

Research Interests - Cloud Computing, Software Engineering, Wireless Technologies, Information Retrieval, Information Security, Education Technologies

LinkedIn profile - <https://www.linkedin.com/in/slalitm/>

Abhishek Kumar Thakur

Educational Qualifications – Ph.D. from BITS Pilani, Hyderabad Campus. M.S. in Information Technology from Capella University, Minneapolis, USA in 2004. B.E. in Computer Science and Technology from University of Roorkee, India in 1997.

Professional Experience –

- Assistant Professor, IDRBT
- Worked as Visiting Faculty in BITS-Pilani, Hyderabad Campus from February 2011 to December 2017 and July 2018-December 2018
- Worked as Senior Software Engineer at Microsoft India Development Center, Hyderabad from March 2009 to February 2011
- Worked as Principal Engineer at Motorola Global Software Group, Bangalore from December 2005 to March 2009
- Worked as Principal Engineer at Motorola Inc. at Horsham, PA, USA from July 2004 to December 2005
- Worked as Sr. Engineer at Motorola Inc. San Jose, CA, USA from February 2000 to July 2004
- Worked as Sr. Engineer at Wipro Global R&D, Bangalore from July 1997 to February 2000.



Research Interests – Computer Networks, Multimedia Systems and Mobile Applications

Personal page: <http://www.idrbt.ac.in/abhishek.html>

N P Dhavale

Educational Qualifications – Doctorate in Management - Fellow of IIM Calcutta, M.Tech. in Aircraft Production Engineering, IIT Madras, B.E. in Computer Engineering with Honours, University of Bombay.

Professional Experience

- Associate Professor, IDRBT, at present
- Research Fellow, IIM Calcutta, till July 2000
- Deputy Manager, Hindustan Aeronautics Ltd, till June 1995

Research Interests – Payment Systems, IT Infrastructure, Mobile Security, Mobile Usability, 5G Security

Personal page: <http://idrbt.ac.in/npd.html>

1.5 Project Locations

1.5.1 Pilot Implementation Locations

The 5G Use case lab set-up will be at, IDRBT, Hyderabad. Banks as Bank of Baroda, Union Bank of India, Bank of India, Punjab National Bank, Canara Bank, State Bank of India, Andhra Bank, Axis Bank and Yes Bank have expressed interest to work with IDRBT on this 5G Use Case initiative. They have branches and operations in remote and urban areas representing Indian demographics. IDRBT will guide banks and financial services in piloting identified use cases to improve financial inclusion and enhance user experience. Locations of Banks and financial services' pilot would be decided after the feasibility study, and the readiness of Use Cases are identified. The use case lab will leverage test beds being deployed at IITs and other institutions. Pilots and deployment of use cases will align with the test bed features deployment and availability.

1.5.2 Readiness for pilot implementation

This scope will be part of Phase II of the project. We will collaborate with the start-up community to take forward the new ideas and the prototypes to the market. IDRBT has recently started a FinTech Forum with members from Banking and FinTech Community. IDRBT plans to become a "GOTO" for Banks and FinTech firms on operating procedures, technology and idea assessment. FinTech Forum will be leveraged by 5G Use Case Lab members to promote and commercialize 5G use cases for Banking and Financial Services.

1.5.3 Full implementation Locations

This scope will be part of Phase II of the project. IDRBT based on the advice and inputs of Steering Committee will hand over the prototypes and guidance to FinTechs, Banking and Financial Services organizations for full implementation.



1.5.4 Implementations Alternatives

IDRBT will seek support of RBI to facilitate Cooperative Banks and other small banks including NBFCs for piloting 5G technology. They would get support from SIs and FinTechs that would work with IDRBT in the 5G Use Case Lab.

2. Project Overview

2.1 Project Charter

2.1.1 Key Stakeholders

- a) Public and Private Sector Banks
- b) Cooperative Banks
- c) Non-Banking Financial Services
- d) Insurance Sector – Non-Life, Life (includes Medical and Pharmacy)
- e) Capital Markets
- f) 5G OEMs, ATM, PoS and Service Providers
- g) System Integrators
- h) Startup and FinTechs
- i) Test Bed providers and Institutions such as IITs and IISc
- j) DFS, RBI
- k) DoT, TEC, TSDSI
- l) IDRBT and other research organizations

2.1.2 Problems and Issues to be addressed

The use cases are identified from the interactions with stakeholders. These use cases would enhance user experience and also expected to make banking and financial services more affordable. The features of high bandwidth availability, low latency (less than 3 ms), large number of connected devices would make 5G more usable and useful to banking and financial services. The network slicing feature is expected to provide improved levels of QoS and better security.

- 1 **Financial Inclusion** - Banks have branches in remote areas. The services available in these locations have low reliability despite trying with VSAT, 3G/4G and wired connections. Existing solutions are expensive and provide less bandwidth; banks are challenged with creating bare minimum services and had to delay their transaction (lending and deposits) processing leading to customer backtracking and relying on alternate methods (pawn brokers, MFIs, hand loans, etc.) for meeting banking needs. 5G reliability and higher bandwidth will improve connection reliability and provide rich customer experience. This would enhance the rollout of newer branches and digital channels (mobile and internet) sooner and faster. This is also a dire situation for cooperative banks, agricultural cooperative societies and other banking related organizations that cannot afford



- dedicated optical fibre/leased lines but are expected to provide rich customer experiences like commercial and other urban banks with presence in towns and cities. This use case is supported by Enhanced Mobile Broadband (eMBB) and Ultra-reliable and Low-latency communication (uRLLC) features of 5G.
- 2 **Branch Efficiency** – Bank branches often face connectivity issues such as wired connection cuts due to unplanned road and other civil work activities. This continues to be a serious ongoing problem with expanding and modernization of cities, towns and villages. 5G connection at branch level with low latency, high reliability and more devices connection can mitigate/resolve civil work impact, thus improve branch operations. Ultra-reliable and Low-latency communication (uRLLC) feature of 5G is expected to reduce the impact of these challenges.
 - 3 **ATM Usage** - Employing security guards to protect ATMs in the cities and remote areas has been an expensive proposition and reliability of the guards has always been a concern for the banks. CC TV monitoring happens on low bandwidth and most times the recordings are kept in the ATM due to bandwidth issues, these situations are exploited by fraudsters. With improved image recognition techniques, online processing of ATM operations would help in raising alarms and protecting ATMs better. This would also expedite deployment of ATMs with more features. 5G implementation countrywide is going to be successful and fast, only if multiple stakeholders of different verticals besides service providers participate in a co-operative environment. Hence, it is proposed that the Banking System may play an active role by utilizing the existing infrastructure of more than 2 lakh ATMs in India with onsite and offsite booths by deploying 5G BTS (Base Trans receiver System) services to cover density, scale, distance and VAS. It would not only help in meeting the ATM Booth operational cost such as power, cash replenishment, cleanliness, security guard etc but gain by providing multiple 5G services such as Virtual Reality (VR) with Headset so that one can see and interact in their own native language with the bank representatives live without going to the branch. This would be a boon for rural Indian population to get varied financial services efficiently and securely. In the future, ATMS with BTS can act as access points to connect with neighbourhood home TV to provide IoT services. Ultra-reliable and Low-latency communication (uRLLC), Enhanced Mobile Broadband (eMBB) and Massive Machine Type Communication (mMTC) features of 5G is expected to enhance ATM usage and provide better fraud detection.
 - 4 **Biometric Authentication** - Customer authentication in remote areas and at home has been through password and OTP. While two-factor authentication have certainly reduced frauds, there have been growing concerns on SIM duplication and the user experience is not that great considering that every user needs to carry and be alert with mobile phone all the time. Biometric based access will resolve the existing concerns, and this can happen only if there is reliability and faster bandwidth (eMBB) that 5G promises. Voice Instruction based services in the native language and voice-based authentication for financial services would be a reality due to massive machine connectivity (mMTC) and ultra-low latency (uRLCC) of 5G, thereby meeting human perception limits of voice communication and verification.



- 5 **Fraud Monitoring** - Fraudsters have become extremely smart and have a better understanding of customer whereabouts. Banks require better algorithms and faster processing for identifying transaction patterns to identify potential frauds. Due to lack of good connectivity to customers and bank branches, 360° view of customer operations has not been happening. With 5G high bandwidth (eMBB) and low latency (uRLCC), banks can get better view of customer operations across channels on a near real-time basis. Some of the recent cyber frauds have been related to the delayed reconciliation process, the primary root cause being connectivity and bandwidth.
- 6 **Near DC** - Banks are expected to have near data center so that RPO and RTO for disaster situations are reduced. In most cases, large banks have set-up dark fibres to a near site; however, cooperative and smaller banks are finding it exorbitantly expensive to do this set-up. With <1 ms latency and high reliability leveraging features of eMBB and uRLCC, 5G can be an alternate for managing near DC or without a near DC with lower RTO and RPO.
- 7 **Security Issues** – According to a report, one in three 4G networks tested were found to be at risk of telecom fraud. Some of the security issues on the 4G connection are
 - I. Hackers can re-route users to scam websites
 - II. Data Integrity including manipulating location (traceability hole)
 - III. Carrier dependent for message encryption

Some of the related references on 4G security are included in the footnote¹. We expect some of these issues will be addressed as part of 5G so that Banks using mobile technologies will be able to provide more secured services. IDRBT would investigate and propose the design, framework and implementation of 5G network slicing to Banks and Financial Services which would provide secured and reliable communication; this would be similar to INFINET (INdian FINancial NETwork) set up by IDRBT for the entire banking sector of the country.

Following use cases will enable in planning futuristic banking

- 1) **Drones Usage** - Field officers have a hard time inspecting the usage of loan money. Also, there have been concerns about the data collected and fed into the systems. Using approved Drones, banks can get a near real-time data of farm fields and other properties for which loans have been given without invading privacy and depending on a person. The image data can be processed for validating the due amount paid or potential issues. This can also be used for identifying early warnings to potential NPAs and device mechanisms for better recovery. Edge Computing with IoTs and Sensors can also be deployed at customer location for better tracking on loan usage and insurance claims exploiting the uRLCC, eMBB and mMTC features of 5G.
- 2) **AR, VR and Video Banking** - Urban citizens and the future generations visit to branches has reduced tremendously. In developed markets, branches have been removed

¹ 1) A Survey of Security Threats on 4G Networks by Yongsuk Park and Taejoon Park

2) LTE/SAE Security Issues on 4G Wireless Networks by Anastasios N. Bikos and Nicolas Sklavos

3) <https://thehackernews.com/2018/06/4g-lte-network-hacking.html>

4) <https://www.livemint.com/Technology/VoLcRNy2sLKgZ2HZE2Jy4K/Security-flaws-in-4G-can-lead-to-mobile-phone-hacking.html>



considering the increasing footprint of digital channels. The cost of operation for withdrawals and other basic operations is expensive for the bank as well. There are banking operations that require specialists and advisors; these officers may not be available in every branch. With virtual reality, augmented reality and video banking that gets enhanced with eMBB, uRLCC and mMTC features of 5G, specialists can be better used across branches. Also, customers can have better clarifications to some of the basic queries without visiting branches, standing in long queues and/or losing their productive office schedule. AR, VR and Video Banking can also expedite KYC and improve efficiency of DBT and pension schemes.

- 3) **Omni Channels** - While there are computing capabilities and algorithms, implementation of Omni channels so that customer can start a transaction on Mobile, do some processing on internet and then finish at ATM/Branch is still far-fetched. Keeping a track of movements and bringing the data into the bank for processing has been a challenge, 5G can mitigate some of these issues with faster upload/download (eMBB) bandwidth. This would also help in tracking fraudsters with the intent of performing spear phishing and other attacks.
- 4) **AI and Analytics** - Small banks cannot afford to deploy Analytics. They typically would like to depend on a cloud service provider for processing the data. However, due to low bandwidth (expensive high bandwidth), small banks are not benefitting from the advantages of AI/data science and/or analytics. As India would be part of 5G specifications, the pricing of devices is expected to be in the range that most citizens can afford. This would help small banks (one branch bank) to leverage AI supported by faster bandwidth (eMBB) and compete with traditional banks in providing personalized services to customers.
- 5) **Virtual Assistants** - With ability to gather streaming data of customer, happenings on the web and in the bank, Banks can also deploy Virtual Assistants and Chatbots for providing better customer service. The assistants can also be available as an App on customer mobile phone so that they can be assisted in their spending patterns, this enhanced customer experience use case is possible with high bandwidth (eMBB) and massive machine connectivity (mMTC) features of 5G
- 6) **Micro-Payments** - Edge computing and IoTs can also enhance customer service with micropayments, delivering household articles, pay bills with little or zero customer intervention based on their spending patterns. Wearable devices with the flexibility to make micropayments could become a reality due to application of mMTC, eMBB and uRLCC. This would require us to review existing payment gateways (IMPS/NFS, UPI, SFMS - NEFT/RTGS) and prototype a new payment gateway to take care of micropayments.
- 7) **Locker** - With better tracking of customer presence in the locker room and biometric access, futuristic lockers need not have bank officer assistance during its operation.
- 8) **P2P lending** on mobile platforms with improved customer user experience and quicker access to funds due to availability of ultra reliable, low latency (uRLCC) and high bandwidth (eMBB).



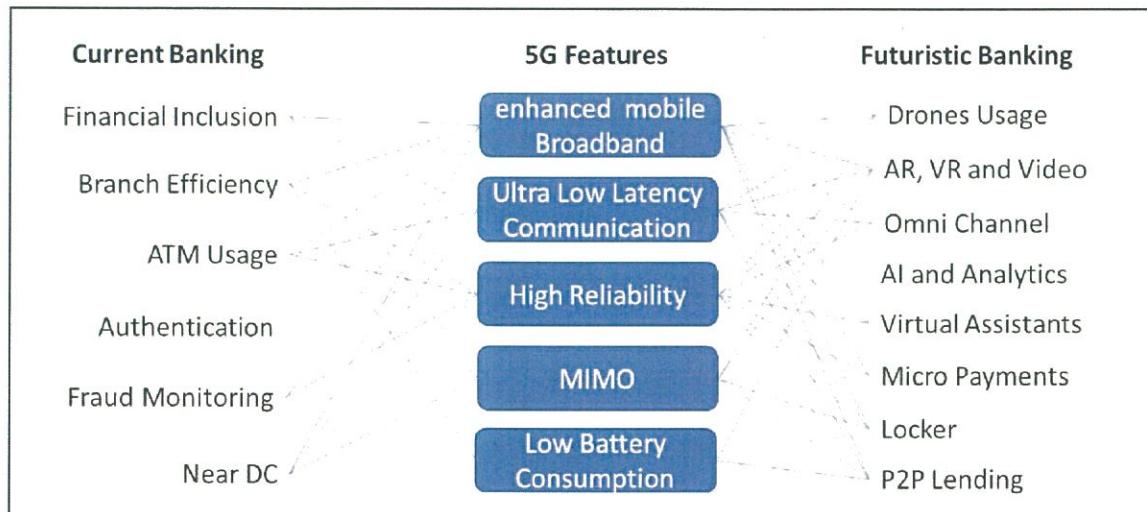


Figure 2: Mapping 5G Features to Use Cases

Use Cases for insurance and capital markets

The use cases for Insurance would be refined with increased involvement of user base and IDRBT understanding of 5G specifications and business domain. Following are some of the high-level use cases for these sectors

- I. Management of vehicle, asset and medical insurance. Monitor driving patterns, capturing weather patterns, mileage-based car insurance, etc. can take the benefits of uRLCC, mMTC and eMBB features of 5G.
- II. KYC for policy issuance and withdrawal using VR techniques taking the advantage of eMBB and uRLCC.
- III. Ease of Insurance coverage and the flexibility to monitor the issuance of insurance for expensive items at home will become reality with mMTC
- IV. Mobile and Algorithmic trading would provide citizens to participate beyond financial inclusion. The 5G features such as eMBB, uRLCC and mMTC are going to be vital for mobile trading to be successful.
- V. Unified Communications that reduces travel needs for a meeting will enhance productivity of organizations. Employees can operate from their home seamlessly with reliable (uRLCC) and high bandwidth (eMBB) network.
- VI. Fraud detection of Insurance Claims has been an area of concern for insurance providers. The lag between incident and reporting time is misused for falsifying claims. With eMBB and uRLCC features, insurance providers can get near real time information of incident and process the right claim.

2.1.3 Objectives to Interventions

2.1.3.1 Current Problems and Issues

- 1) With 4G technologies, India has become one of the largest market for mobile data consumption with 38% of mobile subscriptions moving to LTE and mobile broadband



contributing to more than 50% of the subscription². The quantum of data consumed on smartphones was reported to be highest for India at 9.8 GB / month.

Yet there is significant lag in data rates for urban vs. rural areas, across the world. FCC's broadband progress report for 2016³ for the United States of America, showed almost ten times difference between urban and rural broadband penetration (4% for rural areas vs. 39% for urban areas). Similar results are documented for other developed countries⁴. Closer home, IAMAI report for Internet penetration in India for December 2017⁵ shows more than three times lower penetration for Internet mobile connectivity in rural India. Anecdotal evidence suggests that rural mobile Internet connectivity is not suitable for broadband usage in many areas.

2) Besides the lack of bandwidth penetration, there have been challenges in 4G networks to ensure guaranteed availability of bandwidth or to discover the available network resources. Often when the communication spans across service providers, despite physical vicinity, for mobile devices, triangulation of mobile-IP leads to higher latency in the communication⁶.

3) Though encryption at end point can be used to secure communication over 4G networks, it is still possible to impact availability using denial of service on 4G networks⁷. Besides tools like LTE-Inspector have shown vulnerabilities in some of the implementation of LTE⁸.

4) Further 4G was designed primarily with human as an end-point and relied on developed countries to drive the specifications. With 5G, India can contribute with technologies that enable local use cases, like rural connectivity at an affordable cost⁹.

² <https://www.ericsson.com/en/mobility-report/reports/june-2019>

³ Federal Communications Commission and Federal Communications Commission, 2016. *Broadband progress report*. Washington, DC: Federal Communications Commission

⁴ Williams, F., Philip, L.J., Farrington, J. and Fairhurst, G., 2015. *University of Aberdeen, Dot. Rural Written Evidence to the Commons Select Committee Rural Broadband and Digital-only Services Inquiry for Environment, Food and Rural Affairs (EFRA)*

⁵ Vikram, K. (2018). Wide gap in Internet use in urban, rural India. [online] The New Indian Express. Available at: <http://www.newindianexpress.com/thesundaystandard/2018/mar/03/wide-gap-in-internet-use-in-urban-rural-india-1781640.html> [Accessed 26 Feb. 2019]

⁶ Silva, F.S.D., Neto, A.V., Maciel, D., Castillo-Lema, J., Silva, F., Froisi, P. and Cerqueira, E., 2016. An innovative software-defined WiNeMO architecture for advanced QoS-guaranteed mobile service transport. *Computer Networks*, 107, pp.270-291.

⁷ Xie, T., Li, C.Y., Tang, J. and Tu, G.H., 2018, May. How Voice Service Threatens Cellular-Connected IoT Devices in the Operational 4G LTE Networks. In 2018 IEEE International Conference on Communications (ICC) (pp. 1-6). IEEE.

⁸ Hussain, S., Chowdhury, O., Mehnaz, S. and Bertino, E., 2018, February. LTEInspector: A systematic approach for adversarial testing of 4G LTE. In Network and Distributed Systems Security (NDSS) Symposium 2018.

⁹ Chiaraviglio, L., Blefari-Melazzi, N., Liu, W., Gutiérrez, J.A., van de Beek, J., Birke, R., Chen, L., Idzikowski, F., Kilper, D., Monti, P. and Bagula, A., 2017. Bringing 5G into rural and low-income areas: Is it feasible?. *IEEE Communications Standards Magazine*, 1(3), pp.50-57.



Further, the 4G and prior network deployments did not have flexibility to handle varied vertical use cases¹⁰ and interoperability across various access technologies¹¹.

2.1.3.2 Causes and effects of the problems/issues

- 1) Lower rural connectivity and lack of high bandwidth implied that some of the banking and financial services had to be force fit on existing technologies. This adversely impacts the financial inclusion initiatives. In many cases, if the first digital transaction for the end user fails, they end up doubting the technology forever. E.g. report of "High Level Committee on Deepening of Digital Payments"¹² states that "as new users come into the digital payment systems, they expect to have a good experience for them to continue to use these systems. Any failures will result in a poor experience and will set back adoption."
- 2) Additional redundancy and duplication of data has to be done to ensure better quality for banking applications. Wired connectivity for branches and ATMs are expensive investments and reduce the ability of banks to be nimble and agile in their product offerings. In many scenarios, lack of ability to discover the network capabilities, imply that the application has to assume the worst, hence offering a significantly lower user experience.
- 3) If cost efficient connectivity with ATM and bank branches are available, some of the fraud incidents like mugging of users at unmanned ATM etc. can be reduced by live analysis of video feeds.

2.1.3.3 Category of services

With 5G architecture, we could have a dedicated platform to offer Mobile Services for Banking, Insurance and Capital Markets taking advantages of uRLCC, eMBB and mMTC features of 5G. Usage of IoT Based equipment¹³ (e.g. in ATM, cash delivery vans, equipment as loan collateral etc.) will allow delivery of better services to banking and financial services sector. This will allow reliable and trust worthy operations taking advantages of uRLCC, eMBB and mMTC features of 5G. ATM services, with much more feature rich ATM kiosks¹⁴ taking advantages of uRLCC, and eMBB features of 5G.

¹⁰ Elayoubi, S.E., Fallgren, M., Spapis, P., Zimmermann, G., Martín-Sacristán, D., Yang, C., Jeux, S., Agyapong, P., Campoy, L., Qi, Y. and Singh, S., 2016, June. 5G service requirements and operational use cases: Analysis and METIS II vision. In 2016 European Conference on Networks and Communications (EuCNC) (pp. 158-162). IEEE.

¹¹ Liolis, Konstantinos, Alexander Geurtz, Ray Sperber, Detlef Schulz, Simon Watts, Georgia Poziopoulou, Barry Evans et al. "Use cases and scenarios of 5G integrated satellite-terrestrial networks for enhanced mobile broadband: The SaT5G approach." International Journal of Satellite Communications and Networking 37, no. 2 (2019): 91-112.

¹² Report of the High Level Committee on Deepening of Digital Payments
<https://rbi.org.in/Scripts/PublicationReportDetails.aspx?UrlPage=&ID=922>

¹³ Li, S., Da Xu, L. and Zhao, S., 2018. 5G Internet of Things: A survey. Journal of Industrial Information Integration, 10, pp.1-9.

¹⁴ Imran, M. and Hussaan, A.M., 2018, March. Adaptive & dynamic interfaces for automated teller machines using clusters. In 2018 International Conference on Computing, Mathematics and Engineering Technologies (iCoMET) (pp. 1-6). IEEE.



Remote Branch Banking including with usage of Videos, VR and AR will be another use case that will be enabled by 5G¹⁵. Banking and Financial Services will be able to improve the Operational/Technology Risk Management, using features of network slice, eMBB and uRLCC in 5G¹⁶.

2.2 Envisaged solutions and Improvements

Current understanding is that the gaps in AR/VR/Video/near-DC will leverage the higher bandwidth and edge computing capabilities; Financial inclusion and rural scenarios will leverage beamforming, device-to-device D2D communication and low mobility large cell (LMLC) features of 5G; IoT and ATM scenarios will leverage massive M2M features.

Security for 5G has not matured yet, as the deployment architectures and standardization is an ongoing activity. Though network slicing at lower layers will provide for isolation and MEC will reduce the impact of denial-of-service; the softwarization of the 5G network opens a whole set of new challenges. These security challenges are still evolving for 5G¹⁷.

Improvements

Prototype of Banking solution and a mock branch with reliable connectivity using 5G will be enabled by a combination of URLLC, eMBB (for AR/VR) and network slicing (for security). Feature rich Mobile banking and ATM services will rely on mMTC (for IoT / camera feeds, biometrics etc.) and network slicing for security. Enhanced models for fraud monitoring on ATM and other digital channels would be possible on account of converged collaborative 5G deployments¹⁸ and privacy preservation through network slicing. Prototype Mobile Banking applications with enhanced security using network slicing, network capability exposure and mobile edge computing. Enhanced security and safety for cash transfer vans and ATM refill solutions will be primarily enabled by IoT capabilities (mMTC), coupled with video analytics (mobile edge computing) and other cognitive abilities of 5G network. Financial inclusion of rural and bottom of pyramid will be possible because of low mobility large cell (LMLC)¹⁹ deployments. Network capability exposure, multi-tenant 5G networks²⁰ and convergence of

¹⁵ Katsigiannis, S., Ahmad, W. and Ramzan, N., 2019. 5G: Disruption in Media and Entertainment. Enabling 5G Communication Systems to Support Vertical Industries.

¹⁶ Li, X., Samaka, M., Chan, H.A., Bhamare, D., Gupta, L., Guo, C. and Jain, R., 2017. Network slicing for 5G: Challenges and opportunities. *IEEE Internet Computing*, 21(5), pp.20-27.

¹⁷ Ahmad, I., Shahabuddin, S., Kumar, T., Okwuibe, J., Gurto, A. and Ylianttila, M., 2019. Security for 5G and Beyond. *IEEE Communications Surveys & Tutorials*.

¹⁸ Han, T., Ge, X., Wang, L., Kwak, K.S., Han, Y. and Liu, X., 2017. 5G converged cell-less communications in smart cities. *IEEE Communications Magazine*, 55(3), pp.44-50.

¹⁹ India will embrace 5G & be a leader in early, pervasive & cost-effective deployment: Mr. N Sivasailam, DoT Special Secretary <https://indiaeducationdiary.in/india-will-embrace-5g-leader-early-pervasive-cost-effective-deployment-mr-n-sivasailam-dot-special-secretary/>

²⁰ Rost, P., Banchs, A., Berberana, I., Breitbach, M., Doll, M., Droste, H., Mannweiler, C., Puente, M.A., Samdanis, K. and Sayadi, B., 2016. Mobile network architecture evolution toward 5G. *IEEE Communications Magazine*, 54(5), pp.84-91.



terrestrial and mobile networks with 5G's support of heterogeneous network²¹ will also ensure pervasive coverage.

Futuristic

AR and VR Mobile App for Banking and Insurance will simplify the capture of collateral for loans or damage for insurance. Usage of 5G enabled IoT and Drones will usher in smart banking, wherein survey, monitoring and tracking can be automated by such elements connected on 5G networks. With machines participating in financial transactions, prototype of Payment Gateway to handle micropayments is another use case that can be efficiently realized in future.

2.3 Past experience and lesson learned

IDRBT has been futuristic and technology enabler for banking community irrespective of size and nature of banks.

- I. IDRBT has been involved in setting up National Financial Switch (NFS) for settlement and clearing of ATM transactions across the country. This initiative was further scaled to set-up National Payments Corporation of India (NPCI) in 2009. Currently, NPCI manages NFS and this is extended to provide retail payment services such as IMPS, AEPS, UPI and others.
- II. IDRBT has successfully implemented INFINET, a secured network for connecting banks and other approved financial institutions with RBI. This network is used for NEFT, RTGS and other interactions between banks and RBI.
- III. To reduce the interbank transaction fee and strengthen make in India initiatives, a structured financial messaging system (SFMS) is also set-up and managed by IDRBT. SFMS is the backbone for NEFT, RTGS and other secured messaging related services.
- IV. Recently, considering the increasing use cases of Cloud Computing. IDRBT has established Indian Banking Community Cloud (IBCC), the first community cloud for the banking sector in the world. The set-up is being used for hosting core banking solution and other related interfaces for cooperative banks. Large commercial (public and private) banks are also using the services to host their newer applications that need wide area access. SFMS is now made available on IBCC that has provided impetus to small and cooperative banks to leverage NEFT and RTGS at a very less operational expense.

INFINET, SFMS and IBCC are now being managed by Indian Financial Technology Services, a subsidiary of IDRBT.

- V. IDRBT is a Certification Authority (CA) and provides digital certificates for Payment infrastructure to Banks and other financial services.

²¹ NetWorld2020's-SatCom, W.G., 2014. The role of satellites in 5G. white paper.



VI. IDRBT is also running IB-CART, a Centre for Analysis of Risks and Threats for Indian Banking community. This is focused on cyber-attacks, vulnerabilities, threats, etc.

The implementations of these services have been successful only because of continued support from Banking and Financial services organizations. Some of the key factors for IDRBT's ability to deliver are

- a) Banks provided officers with banking and IT experience to work on newer initiatives with IDRBT team. The avenues to collaborate have been through interactions held in Chief Information Security Officers Forum, Chief Information Officers/IT-Head Forum, Chief Analytics Forum and others. IDRBT also works with various industry verticals (beyond Banking and Financial Services) on a need basis.
- b) Collaboration with Banks and SIs to suggest, develop and strengthen use cases. The white paper on "5G Applications for banking and financial sector in India (April 2019)" is a product of such collaboration.
- c) IDRBT's faculty, with their bent for applied research has helped to table use cases and initiatives to create unique features. IDRBT faculty work closely with Banks providing technology consultancy and executive training programs.
- d) Well-oiled team for prototyping systems that can be scaled by other organizations.

NFS, now NPCI

- Had officers support from RBI and SBI
- Is owned by a group of Public and Private Sector Banks
- Banks are part of the Board
- Banks are part of various committees including Technology Advisory Committee

IFTAS

- SFMS - Had officers investment by RBI. Banks such as Indian Bank sent their officers on deputation. Banks pay for usage of SFMS
- INFINET - Had investment of officers from SBI
- Indian Banking Community Cloud - Banks are part of Technology Advisory committee. Banks pay for the usage. Andhra Bank, Syndicate Bank, Allahabad Bank and Bank of India came forward for the piloting of Community Cloud

CA and IB-CART

- CA - Banks are sending their officers on deputation. Banks pay for the usage
- IB-CART - Banks are investing time and money to develop and use the application on Annual Basis
- Development of various best practices, guidelines and white papers such as Cloud Security Framework, Information Security Framework, Cyber Insurance, Digital Banking, Data Quality and others

2.4 Project activities and timelines



The project would be implemented in two phases. Phase I would be for 1 year to finalize use cases list, bill of material and demonstrate an initial prototype. Phase II – will have enhanced use cases with obtained software and hardware infrastructure for banking, insurance and capital markets. Post-funding approval, Phase I would be for a period of 1 year and phase II for 2 years after completion of Phase I. The project will have facilities (people, hardware and software) that can continue beyond 3 years for newer use cases and newer mobile technologies.



Figure 3: Detail Plan for Phase I

IDRBT needs a dedicated team and support from industry partners to enhance 5G knowledge and build a use case lab for banking and financial services organizations. Having a dedicated team would get a better understanding of the intricacies involved in finalizing the use cases and bill of material for the lab. As 5G is an upcoming technology, getting experienced resources might be challenging and flexibility to explore different models for hiring the best talent. Following are the activities that are planned in phase I –

- 1) Interact with 5G providers, researchers, OEMs, Test Bed Institutions to understand the 5G features, challenges, infrastructure constituents and requirements.
- 2) Interact with Banks and financial services to explain benefits, identify and refine use cases.
- 3) Hire skilled resources at Senior Architect and Developers level on 5G technology and application development.
- 4) Prepare a bill of materials with costs and timeline for Lab Infrastructure halfway through the timeline. The hired team can focus on finalizing the bill of materials for the use case lab and be involved in the initial prototypes.
- 5) Alignment of deliverables with the schedule of testbeds at IITs and other research labs.
- 6) Forming and regular Interactions with technology Advisory Group for scoping, reviewing and guiding Phase 2 plan.
- 7) Prototype/demonstration of AR and VR related 5G use cases will be developed.

3. Financial Overview

3.1 Summary of Total Project Cost

The total funding requirements for the project are 17.5 Crores for setting up and running a 5G use cases lab for 3 years. In addition to the requested funding, IDRBT will be providing a senior researcher and 2 research scholars for setting up the lab, this is 35 Lakhs INR per annum



(1.05 Crores INR for 3 years). IDRBT will also provide space, network, servers and other available hardware which is equivalent to 0.55 Crores. IDRBT will coordinate with public sector banks, insurance and capital market companies to depute 4 capable personnel to support in building prototypes and deployment, this would be approximately 1 Crore INR per year (3 Crores INR for 3 years).

Phase I

The budgetary requirement for 1st Year is Rs. 3.5 Crores (1.5 Crores INR for OpEx and 2 Crores for initial Infrastructure set-up). Apart from this IDRBT would make infrastructure and people investment of upto Rs.1.75 Crores (including people deputed by banks). The funding schedule for Phase I would be 115 Lakhs (0-3 months), 115 Lakhs (4-6 months) and 150 Lakhs (7-12 months) as shown in figure 4.1.

People - Operational Expenses would be to hire on contract two 5G skilled resource persons from Industry and/or research labs, one system administrator and four developers on AR, VR, SDN and wireless technologies. A senior faculty with expertise in networking and wireless technologies would be available from IDRBT. At least two research scholars with research focus on 5G and related technologies would also be available for exploring research areas. IDRBT will liaise with banks and other financial institutions for making available four (4) Innovation, Digital and mobile banking IT officers from interested Banking and Financial services.

Software and Hardware – Based on the initial discussions/interactions/study from service providers, OEMs, researchers – an initial Bill of Materials for 5G simulation, application software and hardware are prepared. The hardware for the first year would be to build prototypes and demonstrate 5G relevance for Banking and Financial Services. Three rack servers, a 5G simulator, mobile devices, AR and VR equipment, banking related software and eleven laptops would be procured. The cost estimates for the 5G simulator is obtained from the interactions with service providers. The cost estimates for servers, application software and other equipment are based on our past procurement data and interactions with industry. A contingency plan of 10% is included in all the estimates for factoring any aberrations in the guestimates.

Meetings and Workshops – They would be planned and conducted at IDRBT and at other places on 5G for strengthening use case lab. Participation would be supported for travel, attending/presenting research outcomes. A workshop would be conducted with participants from Banking and Financial Services, FinTechs, stakeholders from DOT, DFS, OEMs and other in the first 6-9 months after the project start date so that the importance of the initiative can be showcased. Principal Investigators of this project may also have to travel to international/national conferences to have a better understanding of the trends and challenges in 5G.



Phase I (First Year Expenses in Lakhs)							
	Category	IDRBT		Banking and Financial Services		Funding Request	
		Expense Type	Expenses	Role	Expenses	Role	
OpEx	People	1 Senior Researcher - Salary	25	2 Officers from Networking and Mobile Banking	50	Expert / Technologist on Network Slicing and Security	
		2 Research Scholars - Stipend	7.7	2 Officers from CBS and Payment Systems	50	Architect on 5G Standards, Simulation and Testing	
						2 Prototype Developers - AR, VR and other relevant 5G use cases	
						2 Prototype Developers - SDN and Security	
		Admin & Accounting Support personnel	1.3			1 System Administrator	
	Travel	Sub-Total	34		100	130.0	
		Travel to Delhi	1			Travel to Conferences / workshops / Seminars / Meetings (2 trips * 2 people including registration) 4.5	
						Stationery and 5G related publications subscription 0.5	
						Contingency (10%) 15.0	
OpEx Total		35		100		150	
CapEx							
CapEx	Category	IDRBT	Expenses	Banking and Financial Services	Expenses	Funding Request	
	Hardware					3 Rack Servers (Latest Xeon Processor, 4 Socket Hexa Core, 4 TB Storage, 512 GB RAM and 8 GB GPU, 4 * 10 Gigabit Ports - 4 Embedded + Quad Port NIC) 45.0	
		2 * 32 GB, 1 Socket, 1 TB rack servers	4				
	Space	20 * 20 Sqft area including HVAC and furniture	5			5G Simulation measurement appliance for beamforming experimental setup 90.0	
	Mobile	3G Android Devices	0.5			VR and Augmented Reality Equipment (HoloLens, Oculus, Google Cardboard and other related equipment) 7.0	
		Network Connectivity	2.5			Mobile Devices (4G) 0.5	
	Network	Router and Firewall	5.5			2 Drones with camera 1.5	
		Network Switches	1			ATM 4.5	
	Software	3 Laptops	1.5			Humanoid 11.0	
		Usage of existing Virtualization and Cloud Software licenses (Approx Current software cost considering Depreciation)	20			Laptops for 11 people (includes 4 IT officers from Banking and Financial Services) 5.5	
Sub Total		40				180	
						Contingency (10%) 20	
CapEx Total		40				200	
		Total	75		100	350	

Figure 4: Break-up of OpEx and CapEx for Phase I

Based on the deliverables and the progress for Phase I, the expected payment schedule is shown in Figure 4.1



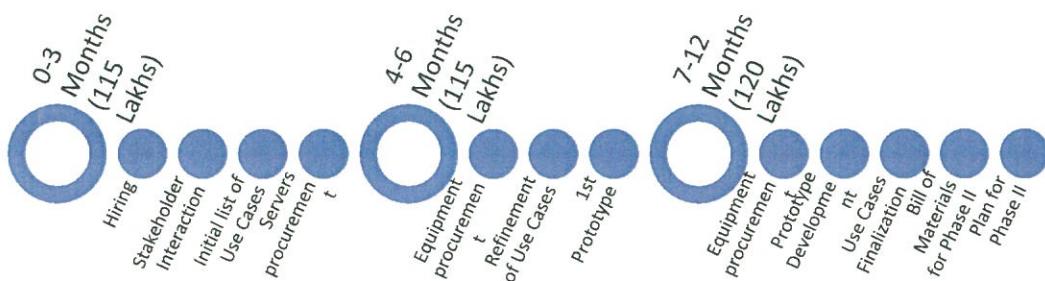
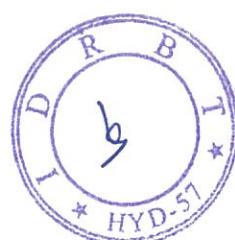


Figure 4.1: Payment Schedule for Phase I

Phase II

Based on the information gathered, we guesstimate that the expenses are **~14 Crores INR** (CapEx → 2nd Year – 4 Crores and 3rd Year – 6 Crores; OpEx – 2nd Year - 2 Crores and 3rd Year – 2 Crores) for setting up the lab including the people cost for 2 years. In addition to this, Banks, Insurance and Capital Markets segment would invest approximately 2 Crores and IDRBT would invest 0.85 Crores during Phase II of the project. The cost on resources (OpEx) are expected to increase for this phase, since we start implementing the use-cases. The lab infrastructure would contain servers, basic 5G infrastructure with base stations with antennas and interference measurement instruments, 5G ready mobile phones, application development toolkits. Some basic 5G simulation infrastructure is also planned in Phase 2 as the scale of testing and understanding will increase though the effort and plan would be to use existing testbeds of IITs, research labs and other institutions. These are guesstimate and we will have a better clarity of this estimate and bill of materials after getting a dedicated team on board during Phase I. A contingency plan of 10% is included in all the estimates for factoring any aberrations in the guesstimates. The lab would be extended to industry partners, academicians, FinTechs apart from Banking and Financial services organizations to have a 5G ecosystem. The lab can be used as a testbed/sandboxing environment by banks, startups and other stakeholders for exploring and promoting 5G in the country with a focus on futuristic banking. The estimates for funding request will be finalized after 1st year of due diligence and finalizing the schedule aligning with testbed deliverables. The estimates on 5G software, devices and simulation appliances are based on interactions with OEMs, academicians and CEWiT. The deliverables and payment schedule for Phase II would be finalized by the end of Phase I.



Phase II (2nd Year Expenses in Lakhs)							
					Guestimates		
	Category	IDRBT	Banking and Financial Services		Funding Request		
	OpEx	Expense Type	Expenses	Role	Expenses	Role	
People		1 Senior Researcher - Salary	25	2 Officers expertise in Networking and Mobile Banking	50	Expert / Technologist on Network Slicing and Security	
		2 Research Scholars - Stipend	7.7	1 Officers expertise in CBS and Payment Systems	25	Architect on 5G Standards, Simulation and Testing	
				1 Officer expertise in Insurance	25	4 Prototype Developers - AR, VR, Payment Gateway and other 5G use case technologies	
		Admin & Accounting Support personnel	2.3			2 Prototype Developers - SDN and Security	
		Sub-Total	35		100	1 System Administrator	
Travel						Travel to Conferences / workshops / Seminars / Meetings (3 trips * 2 people including registration)	
						Stationery and 5G related publications	
						Contingency (10%)	
		OpEx Total	35		100	200	
	Category	IDRBT	Expenses	Banking and Financial Services	Expenses	Funding Request	
	CapEx					IoT Sensors (approximately 1000 sensors) and 2 Gateways	
Space		Space	20 * 20 Sqft area including HVAC and furniture	5		Web Application Firewall - 2 and 2*10G Network Switches	
						White Goods - Smart Fridge, Smart TV, etc	
						Mobile Devices (5G)	
						2 Rack Servers (Latest Xeon Processor, 4 Socket Hexa Core, 4 TB Storage, 256 GB RAM and 8 GB GPU, 4 * 10 Gigabit Ports - 4 Embedded + Quad Port NIC)	
						Core Banking Software on Cloud	
						Payment Gateway Software	
						Fraud Detection Software	
						Laptop for 2 Additional people	
						Pico-cell level experiments 3G/4G using one or more of Open-Cellular / OpenLTE / Telecom-infra-project setup	
		Sub Total	7.5			158	
		CapEx Total	7.5			30	
		Grand Total	42.5		100	9	
						20	
						360.0	
						40.0	
						400	
						600	

Figure 5: Break-up of OpEx and CapEx for Phase II (Year 2)



Phase II (3rd Year Expenses in Lakhs)						
					Guestimates	
	Category	IDRBT	Banking and Financial Services		Funding Request	
OpEx	People	Expense Type	Expenses	Role	Expenses	
		1 Senior Researcher - Salary	25	1 Officers expertise in Networking and Mobile Banking	25	Expert / Technologist on Network Slicing and Security
		2 Research Scholars - Stipend	7.7	1 Officers expertise in CBS and Payment Systems	25	Architect on 5G Standards, Simulation and Testing
						4 Prototype Developers - AR, VR, Payment Gateway and other 5G use case technologies
				1 Officer expertise in Insurance	25	2 Prototype Developers - SDN and Security
	Admin & Accounting Support personnel	2.3		1 Officer expertise in capital markets	25	1 System Administrator
	Travel	Sub-Total	35		100	Travel to Conferences / workshops / Seminars / Meetings (3 trips * 2 people including registration)
						Stationery and Books
						Contingency (10%)
	OpEx Total		35		100	200
CapEx	Category	IDRBT	Expenses	Banking and Financial Services	Expenses	
	Space	20 * 20 Sqft area	5			Micropayments gateway hardware (Hardware servers)
						Extending Pico-cell level experimental setup to 5G and adding other pico cells
						Extending network slicing and beamforming. Work on SDN (Hardware and related Software)
						Mobile Devices (5G) of all grades
						Core Banking Software on Cloud
						Payment Gateway Software
		Network	2.5			Fraud Detection Software
		Sub Total	7.5			Annual Maintenance of Previous Year Hardware @ 10%
	CapEx Total		7.5			40
	Total		42.5		100	540
						60
						600
						800

Figure 6: Break-up of OpEx and CapEx for Phase II (Year 3)

IDRBT would be spending about 7.24% (i.e. 160 Lakhs INR) of the project expenses. IDRBT would coordinate with public sector Banking and Financial Services organizations to depute IT officers, the cost of deputed IT officers effort is about 300 Lakhs INR (13.57%), this combined effort and expenses is about 21% of the project spend. The remaining 79.19% that is equivalent to **17.5 Crores INR** is requested to be funded by DoT. The summary of the total expenses and funding request is

Year	Commitment from IDRBT and Support from BFS organizations (Coordinated by IDRBT) in Lakhs				Funding Request in Lakhs	
	IDRBT		Banking & Financial Services			
	OpEx	CapEx	OpEx	CapEx	OpEx	CapEx
Year 1	35	40	100	0	150	200
Year 2	35	7.5	100	0	200	400
Year 3	35	7.5	100	0	200	600
Total	105	55	300	0	550	1200
IDRBT		160	BFS	300 Fund Req		1750

Figure 7: Summary of OpEx and CapEx for Phase I and Phase II



The technical (Software and Hardware) requirements for this project would be

Banking and Financial Services Software required for validating use cases

1. Core Banking Solution
2. Mobile Banking App
3. Internet Banking
4. Fraud Monitoring software
5. ATM with required connectivity to test switches

Software and Devices for demonstrating use cases

1. AR and VR devices such as Oculus, Google Cardboard, HoloLens.
2. Chatbot software like DeepQA, Alexa, Cortana, etc.
3. Futuristic and smart White goods/sensors/thermostats/smoke detectors
4. New Payment Gateway for micropayments
5. Multiple sensors and IoT devices
6. Gateway software for processing IoT data
7. Low height flying Drones
8. TVs/Monitors with webcams for experimenting video banking
9. Big data software and related servers for processing the data
 - a. CCTV and related software for image processing
 - b. AI and modeling software such as Octave and/or R
10. Payment gateway and software for micropayments
11. Software for processing GPS APIs
12. Possibly, Humanoids
13. Security Testing - Static code and VAPT software
14. Servers (5 * 256GB RAM, 4 Sockets Hexa Core, 2 TB storage with Xeon processors)
15. App Servers, Web Servers, Database
16. Application software such as Java, .NET, Unity, OSVR, etc
17. 5G/4G/3G Devices to test prototypes and interoperability

Existing 5G testbeds established at IIT Hyderabad and/or IIT Madras would be used for emulation and simulation of 5G features. The deliverables such as prototypes and demonstrations will align with testbeds readiness at IITs and other research labs. The existing NKN connection at IDRBT would be used for connecting to 5G test bed at IIT Hyderabad or IIT Madras or IIT-Delhi or IISc-Bengaluru (<https://tsdsi.in/wp-content/uploads/2019/02/Rajiv-Sinha-Day-2-1st-Session.pdf>). Following is the list for the set-up that simulates/generates 5G specifications. This would be required if 5G test beds are not available for usage. However, two 5G simulators would be required so that dependency is reduced on test beds for basic testing.



1. Basic implementation of LTE L1 downlink and uplink chains
2. L2 MAC (Medium Access Layer), RLC (Radio Link Control) and a thin layer of PDCP (Packet Data Convergence Protocol)
3. Both eNodeB and UE implementations
4. Baseband level interface between eNodeB and UE using Hyperlink Hi-speed cable
5. End-to-end IP application flow both in DL, UL and simultaneous DL & UL

Hardware

6. Two EVMs (Evaluation Model) are used for setup, one is for UE and another for eNodeB. The EVMs are connected through Hyperlink cable.
7. System on Chip (SoC) used in EVM is TI's TMS320TCI6614 Communications Infrastructure SoC or newer. SoC has the following features - 4 DSP Cores, one ARM Core. DSP and ARM runs at 1.2GHz.
8. Hardware accelerators for LTE PHY bit level processing, for DFT, for decoding convolutional encoded data and turbo encoded data.
9. Gigabit Ethernet for interfacing with the application
10. Antenna Interface peripheral to transfer/receive analog IQ samples to/from RF device/card. It supports interfaces like CPRI and OBSAI
11. Hardware accelerators for LTE PHY bit level processing, for DFT, for decoding convolutional encoded data and turbo encoded data.
12. Gigabit Ethernet for interfacing with the application
13. Antenna Interface peripheral to transfer/receive analog IQ samples to/from RF device/card with support for CPRI and OBSAI.
14. Oscilloscope, Signal Analyzer, Signal Generator, Vector Signal Generators, Millimeter-wave converter, Routers, Modems

Software

15. LTE PHY stacks for eNodeB and UE
16. Supports 3GPP Release 8 specifications
17. Supports up to 10 MHz bandwidth and can be extended to 20MHz
18. Uses hardware accelerators and DSP modules
19. LTE L2 (MAC, RLC, PDCP) for eNodeB and UE
20. Supports 3GPP Release 8 specifications
21. Inbuilt PHY abstractor to test end-to-end flow without PHY support
22. Communication System Toolbox, WLAN System Toolbox, Signal Studio Pro for 5G-NR, Signal Studio for Pre- 5G, Signal Studio for Custom Modulation, SDN

IDRBT will explore usage of opensource software and support that could be available from Banks. IDRBT will provide space and the related infrastructure/logistics support during the entire phase of the project with standard norms of 10% establishment funding support.



3.1.1 Pilot Cost

Operational Expense for Phase I and Phase II for prototyping – 5.5 Crores INR. This would be primarily used for People and Travel expenses.

Capital Expense for procuring banking software, 5G related devices, simulation software and other items mentioned in 3.1 would be 12 Crores INR.

3.1.2 Roll-out Cost

IDRBT will only be involved in prototyping and guiding banks. There is no effort and cost for roll-out. The roll-out plan will be aligned with the testbed readiness schedule at IITs and other research labs. IDRBT will provide technical guidance and support to SIs, Startups, Banks and Financial Services in productionalizing of the prototypes.

3.2 Funding strategy- Source of Funding

1. IDRBT will have a dedicated Researcher and 2 Research scholars working on 5G applied research during the entire phase of the project. Usage of available space, hardware, network and software at IDRBT. The total expense of **1.60 Crores INR for 3 years** will be funded internally by IDRBT.
2. IDRBT will contact and coordinate with public sector banks, insurance and capital market organizations to send 4 IT officers with skill set in Mobile Banking, Wireless technologies, Core Banking/Insurance/Capital Markets understanding, Digital Innovation, etc. The expense is about **3 Crores INR for 3 years** and this expense will be covered by Banking and Financial Services organizations as a commitment to the project based on DFS direction. Bank of Baroda, Union Bank of India, Bank of India, Punjab National Bank, Canara Bank, State Bank of India, Andhra Bank and other banks have already been informed about the initiative. Bank of Baroda and Union Bank of India have identified IT officers to be deputed to work at IDRBT from July 1st 2019.
3. 17.5 Crores INR is expected to be funded by DoT/TEC for setting up 5G Use Cases Lab for Banking and Financial Services at IDRBT. The payment schedule along with deliverables for Phase I is included in section 3.1. The payment schedule for Phase II should be made available after completion of Phase I. All payments for phase II will be processed on the recommendation of the project steering committee (see section 5), tied to project milestones being met.
4. IDRBT Bank Details for ECS/EFT/DD Transfer of Project Fund:

1. Name : **INSTITUTE FOR DEVELOPMENT AND RESEARCH IN BANKING TECHNOLOGY**

2. Particulars of Bank account

A. Name of the Bank: **AXIS BANK**

B. Name of the branch: **Mehdipatnam Ring Road**



Address: 'H.No.13-6-431/D/82/4, A.M.

Arcade Mehdipatnam Ring Road, Hyderabad - 500 028.

Telephone No. : 040-23525595

C. IFSC code of the Bank Branch: UTIB0000426

D. 9-Digit code number of the bank branch appearing on the MICR cheque Issued by the bank: 500211012

E. Type of the account (S.B., Current or Cash Credit) Saving Bank with code (10/11/13)

F. Account number (as appearing on the cheque book) 426010100018823.

4 Implementation Strategy

4.1 Implementation Model

As stated earlier, IDRBT would be focused only on building prototypes and assistance in pilots. The implementation plan is for prototypes only. IDRBT will provide technical guidance and support to SIIs, Startups, Banks and Financial Services in productionizing of the prototypes. The hardware and other equipment procured during Phase I and Phase II of the project may not have enough shelf life after 3 years considering the rapid development of technology. However, any usable life of the hardware beyond 3 years would be used by IDRBT for continuing the research on Wireless networks and training banking and financial services organizations on 5G and related technologies. IDRBT is only holding these procured assets funded by DOT, hence, DOT is the actual owner of the assets. An asset registry would be maintained for inspection and audit of the equipment procured in the project.

4.2 Phasing

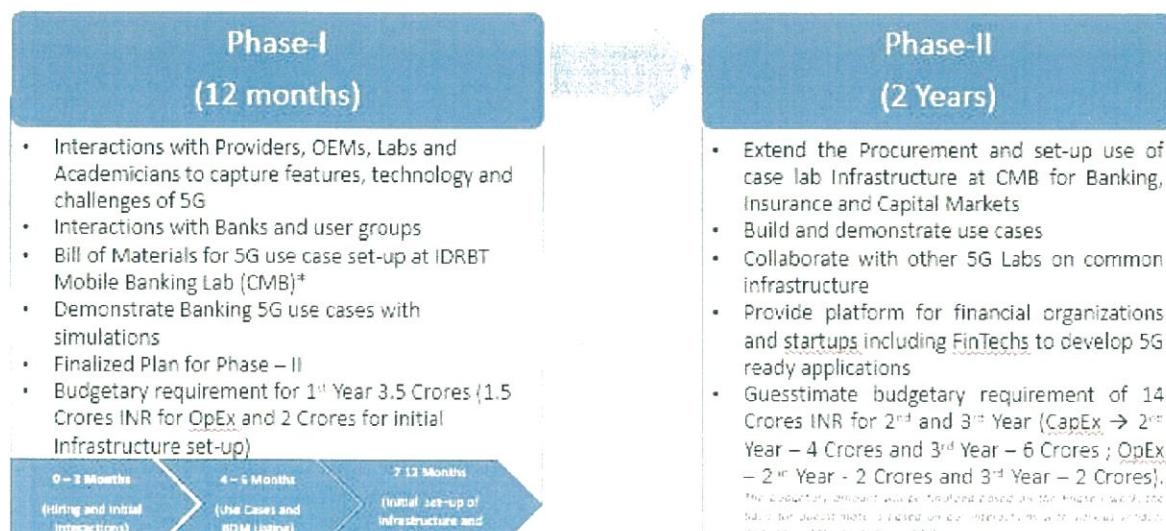
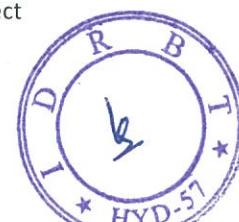


Figure 8: Phased Approach for the Project



Following are the criteria for phasing of the project

1. Inherent strengths in Banking sector, collaboration requirement with Insurance and Capital Markets
2. Emerging technology with changing features and lack of standard equipment. IDRBT will take the support of DoT, Banks and IITs to discover the pricing of 5G related equipment. IDRBT will take the support of Banking and Financial Services organizations for procuring banking and financial services related software. The procurement process will follow as per CVC guidelines, as applicable for newer technologies.
3. Time to identify and hire 5G experts

5. Governance Structure

5.1 Steering committee

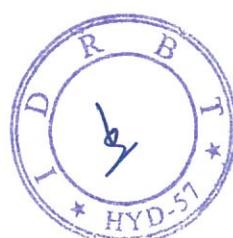
The project review and steering committee would comprise members from TEC, DOT, TSDSI, DFS and/or Banks, Researchers from Academics and IDRBT. It will be chaired by an eminent researcher from Banking Industry / Academia.

Following is the quarterly/monthly/weekly interactions to ensure project governance.

The project team will have a weekly meeting to discuss the activities planned, expected to be completed and discuss on impediments, if any. The status will be tracked on project tracking tools such as GitLab/Redmine.

On a monthly basis status updates will be shared to all internal and external stake holders.

The project review and steering committee will meet on a quarterly basis to review the project progress, provide technical mentoring and guidance, and review the future work items. Changes to operational aspects of the lab (e.g. IPR or startup participation policies) will also be approved by the project steering committee.



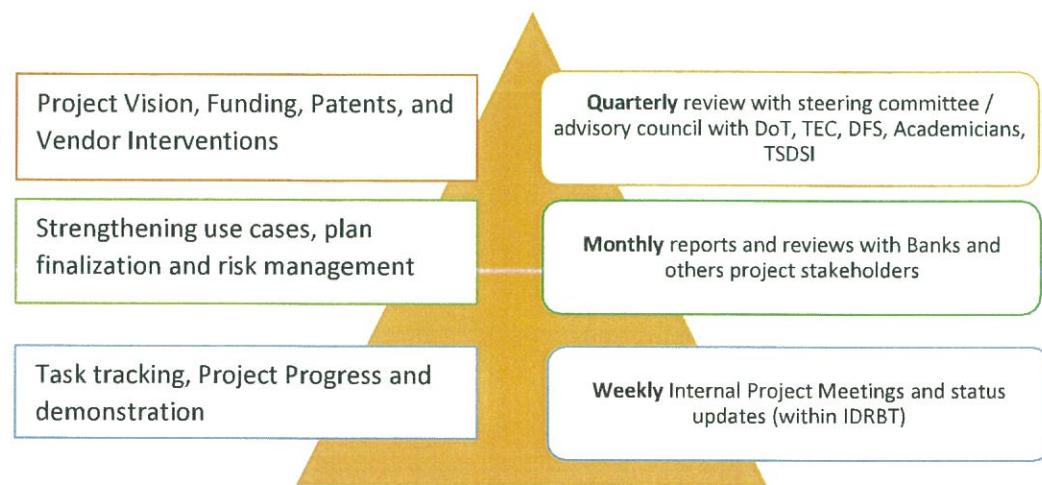


Figure 9: Governance Model for the Project

5.2 Project team composition

The team will have members from IDRBT (including 5G Expert), Banks, Developers, OEMs (Chip, Device and Network Equipment Manufacturer), ISPs, FinTech and Startups, SI and others as deemed necessary.

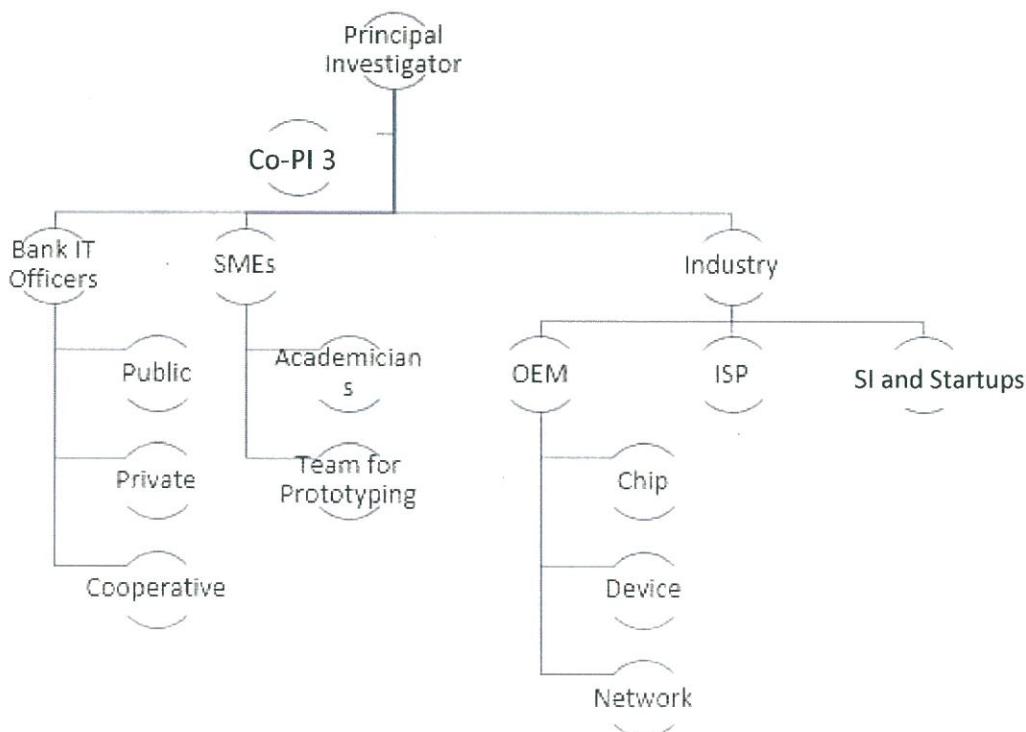


Figure 10: Organization Structure



5.3 Monitoring and Evaluation framework

#	Monitoring and Evaluation Mode	Implementation
1	Project Planning	Redmine/Gitlab with inputs from DOT, TEC, Academicians, Startups, TSDSI, IDRBT project team that includes IT officers from banks
2	Daily Meeting	To track progress – activities completed, to be completed and impediments, if any.
3	Weekly Meeting	Weekly reports to track project completion plan
4	Monthly Meeting	Project review and discuss major issues. Discussion, Participation over telecon/video call
5	Quarterly Meeting	In person meeting of the steering committee to ensure project alignment to overall objectives

The recursive nature of 5G Architecture implies that Banking and Financial Services organizations are consumers and providers of services and applications. Following are some of the tangible/intangible operational efficiencies that would be achieved due to 5G deployment -

- Augmenting wired connectivity with 5G wireless connectivity could facilitate removal of redundant MPLS/Leased line, this is expected to save about 20,000/- per month per branch. Considering that there 1.2 Lakhs bank branches apart from 1.5 Lakhs post offices that are turning into payment banks and 1+ Lakh primary agricultural cooperative societies. Even 10% of these branches convert to 5G for the redundant line; this would be a saving of ~2,400 Crores per year to the banking industry.
- The next generation branches, including virtual and white-label branches: savings of 1 personnel effort and space by downsizing the present branches. With 7,935+ town cities in India, even if there are only 10% of these have the next generation branches, and the average cost to the company for branch banker is 5 Lakhs per annum, the expected saving would be ~396 Crores per year to the banking industry. This would also reduce the cost of transaction at branch banking, which is approximately 40-50/- INR per walk-in.
- With ATMs hosting 5G towers/BTS and can contribute to shared surveillance, UPS etc. Even if banks seek 1,000/- per month for holding BTS and only 10% of the banks allow holding of BTS inside the ATM premises, Banks could generate ~120 Crores of revenue per year.
- As per data collated by RBI, approximately 168 Crores was lost in 972 incidents at ATMs during 2017-18. With near real-time image/video delivery, analysis and alerting, the amount and count of ATM frauds could reduce leading to the wellbeing of society and trust in the banking and financial services.
- Various reports state that Automobile/motor Insurance frauds are ~2500-3500 Crores per year. With 5G connectivity, capture and analysis of an incident can be expedited, even a 10% reduction in the frauds would lead to ~250 Crores savings to Insurance companies.
- About 148 member-brokers of NSEL have been identified to make “unlawful gains”, one of the possible solutions to reduce this is to allow mobile trading for clients. With low-



level latency and higher bandwidth, simple user interfaces that allows mobile trading will enhance the trust and participation in capital markets trading and also reduce the frauds.

6. Stakeholders Analysis

Commercial Banks – Banks are expected to provide initial use cases. Based on their depth in Banking and usage of technology for more than a decade, these Banks will take an aggressive implementation approach on demonstrating 5G use cases. Banks providing their IT officers to work on this project will certainly take advantage of the first mover. The same applies to Insurance and Capital Markets sector that have relatively large IT workforce.

Cooperative Banks – Have a lean or no IT teams. They will depend on SIs and IDRBT to guide on the implementation.

Insurance Companies – Public and Private Sector companies dealing in Life, Medical, Pharmacy, Automobile, Agriculture, Property and other categories will be involved in detailing the use cases. The existing collaborations between Banks and Insurance companies would be leveraging for expediting the interactions.

Capital Markets – The current interactions of IDRBT with BSE, NSE, SEBI on SFMS would be leveraged. Large, medium and small stock brokers, mutual fund organizations and other securities organizations would be involved along with FinTech for identifying and building use cases in Capital Markets.

SIs – Will benefit by extending the prototypes.

FinTechs – Will explore and possibly disrupt Banking and Financial services with innovative products and enhanced customer experience.

Test Bed Providers: IDRBT officials would visit, interact with experts and use the available Test Beds for 5G established at IITs, IISc etc.

End Customer – Will demand more from Banking and Financial Services with growing expectations on 5G technology and features.

ISPs – Will strengthen their ROI and increase their investment in 5G at remote locations.

OEMs – Based on the foreseeable potential will refine their technologies and place their chips, devices and other products easily available at affordable prices.

DFS and RBI – Will have the benefit to showcase innovative projects to the world. **Will have reduced concerns in the Banking sector due to advance technology and innovations.**

TEC, DoT and TSDSI – Will encourage other Use Case Labs, make the entire ecosystem viable and vibrant. India specific 5G needs being incorporated in Global standards. Increased 5G skill force

Researchers - Potential patents/publications on 5G research.



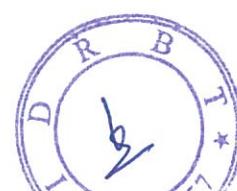
7. Services and Service Levels

The scope of the project is to identify and develop prototypes for Banking and Financial Services. There are no service level agreements as the project would be in research and prototyping only. Startups, SIs, Banking and Financial Services involved during all the phases of the project are expected to take forward the prototypes for actual realization. IDRBT will provide technical guidance and support to SIs, Startups, Banks and Financial Services in productionalizing of the prototypes. The Intellectual Property Rights associated with ideas and prototypes will be jointly held with stakeholders, the funding organizations (DoT, Banking and Financial Services and IDRBT) will elaborate the IPR guidelines during the project phases.

8. Risk Management

5G as a technology is evolving and expected to stabilize only by 2020. Banking and Financial Services Use Case lab is the pilot set-up for other sectors. Following are some of the risks and challenges that may need intervention

#	Risk/Challenge	Mitigation
1	Obtaining 5G related equipment may be difficult to get as there are no standard products and pricing is also not defined	Will request DOT, TEC and TSDSI intervention with OEM and service providers. Will use the existing infrastructure and labs set-up at IITs
2	Availability of 5G experts would be limited and expensive	Will conduct outreach and participate in 5G conferences and workshop to understand the availability of skilled resources. Plan on salary and incentives to attract and retain talent
3	Identifying bill of material may not be complete or correct	Technical experts from Industry and IITs help would be sought
4	There may not be compelling (<i>killer apps</i>) use cases that require 5G	Set realistic expectations, keep understanding technology and business more involving Banks, 5G OEMs and Sis
5	Bandwidth being claimed seems to be difficult to achieve (in future, it might be) because of incompetent technological support in most parts of the world	Regular interactions with 3GPP, TEC and DOT will set realistic expectations. Prototyping will provide confidence on the claim's vs reality
6	Many of the old devices would not be compatible with 5G; hence, all of them need to be replaced with a new one — expensive deal	Strengthening use cases could create a viable ecosystem



7	Interoperability - Unlike other radio signal services, 5G would have a huge task to offer services to heterogeneous networks, technologies, and devices operating in different geographic regions. So, the challenge is of standardization to provide dynamic, universal, user-centric, and data-rich mobile services to fulfill the high expectation of people	Participation in global meetings would provide a better understanding and will help in preparation for the changes.
8	These services largely depend upon the availability of radio spectrum, through which signals are transmitted. Though 5G technology has strong computational power to process the huge volume of data coming from different and distinct sources, it needs larger infrastructure support	Technologies like cloud computing and edge computing should be leveraged
9	5G needs to ensure the protection of personal data and will have to define the uncertainties related to security threats including trust, privacy, cybersecurity, which are growing across the globe	Network slicing and other secured communication methods need to be explored and validated for banking services
10	Lack of understanding of Intellectual Property Rights for the new ideas/concepts could lead to financial and other issues	DoT, IDRBT, Banking and Financial Services will elaborate this during the project phase. The initial guideline would be as per DoT understanding and agreement.

9. Overview of Functional and Technical Architecture

9.1 Functional features and requirements of the proposed applications

IDRBT studied that the following technical features will enhance banking and financial services in India

1. High increased peak bit rate
2. Larger data volume per unit area (i.e. high system spectral efficiency)
3. Higher reliability of the communications
4. Better connectivity irrespective of the geographic region
5. High Capacity to allow more devices connectivity concurrently
6. Larger number of supporting devices
7. Lower cost of infrastructural development
8. Lower battery consumption

Because of these technical features, some of the possible benefits are



1. Network availability will be everywhere and will facilitate people to use their mobile devices and computers from anywhere anytime in India.
2. IPv6 technology, visiting care of mobile IP address will be assigned as per the connected network and geographical position.
3. Cognitive radio technology will facilitate different version of radio technologies to share the same spectrum efficiently.
4. Facilitate people to avail radio signal at higher altitude
5. Subscriber supervision for quicker action leading to better monitoring.
6. Provide uniform, uninterrupted, and consistent connectivity

9.2 Overall approach adopted for architecture

5G applications are expected to use micro services. The underlying 5G technologies would be Software Defined Networking

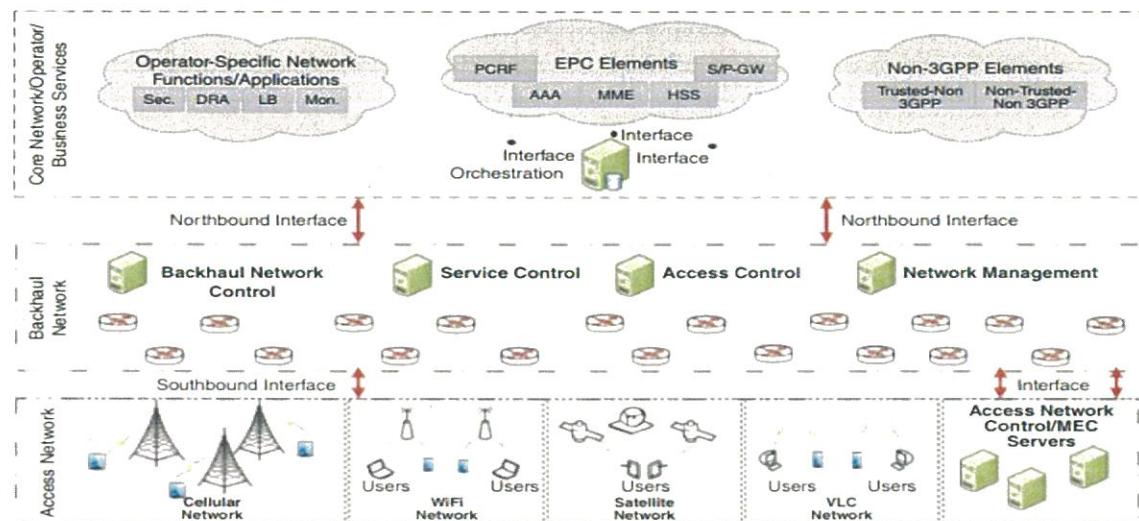


Figure 11: 5G Architecture (Source : Design Principles for 5G Security)



9.3 Layered view of system

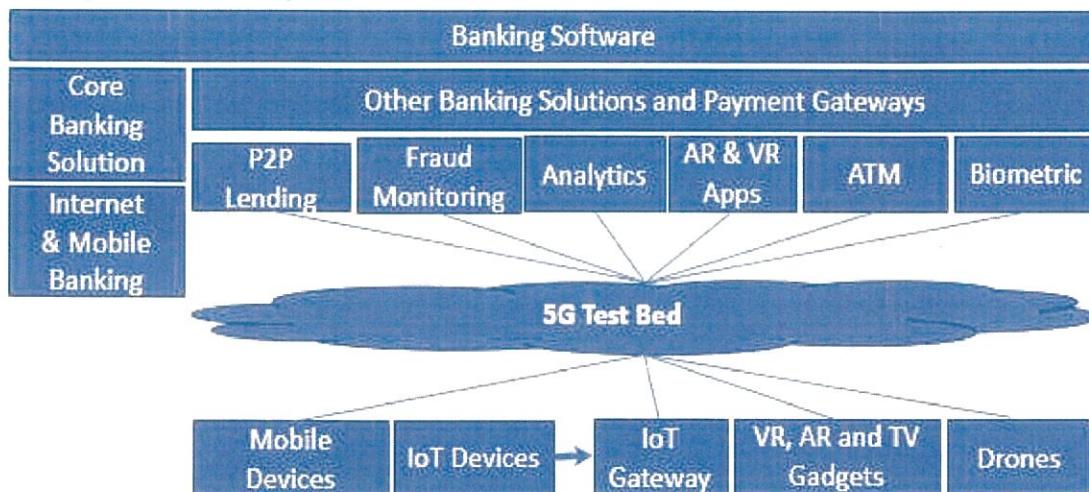


Figure 12: Architecture for 5G Prototyping

10. Change Management Strategy

10.1 Resistance management

IT officers from Banking and Financial Services along with SIs, FinTechs and academicians would be involved during the project execution. The job description of IT officers from Banking and Financial services would have an expectation to drive and front face the 5G use cases implementation.

10.2 Communication strategy

10.2.1 Administration /employee centric strategy

10.2.2 Communication plan

10.3 Capacity Building Requirement

10.3.1 Classification of stakeholders for training

10.3.2 Training requirements

10.3.3 Training Plan

NOT APPLICABLE AS WE ARE RUNNING IN A PROJECT MODE FOR NEWER TECHNOLOGY

11. Financial Estimates

11.1 Assumptions

Already covered in risk mitigation and contingency planning



11.2 Pilot Financial estimates- Summary

11.2.1 Pilot Implementation

Already provided

11.2.2 Rollout Alternatives

Not applicable

11.3 Cost Benefit Analysis

11.3.1 Tangible benefits

Not applicable as IDRBT scope is limited to prototyping. IDRBT will provide technical guidance and support to Startups, Banks and Financial Services in productionalizing of the prototypes, hence, there may be tangible benefits that could be measured during each quarterly meeting of the steering committee.

11.3.2 Intangible benefits

Explained in stakeholder analysis

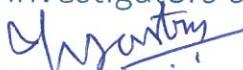
11.3.3 Cost Estimation of Application, Web, Application and Database servers

Already provided

11.4 Business Model / PPP options

As stated in previous sections, Startups, Banking and Financial Services organizations would be involved in all the phases of the project. They would explore the production roll-out of the prototypes. The IPR related to the concepts and ideas will be detailed by DOT and IDRBT during the phase I of the project.

Investigators contacts involved in this project


(Dr.V.N.Sastry)

(S.Lalit Mohan)

Principal Investigator

Co-Investigator

Professor, IDRBT

Senior Domain Expert

Road No.1, Castle Hills, Masab Tank

Road No.1, Castle Hills, Masab Tank

Hyderabad 500057

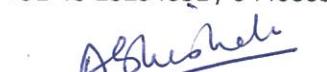
Hyderabad 500057

vnsastry@idrbt.ac.in

slmohan@idrbt.ac.in

+91-40-23294031 / 9440803813

+91-40-23294999 / 9849986236 / 7036228900


(Dr.Abhishek Kumar Thakur)


(Dr.N.P.Dhavale)



Co-Investigator

Assistant Professor, IDRBT

Road No.1, Castle Hills, Masab Tank
Hyderabad 500057

abhishek@idrbt.ac.in

+91-40-23294999 / 96182 58456

Co-Investigator

Associate Professor

Road No.1, Castle Hills, Masab Tank
Hyderabad 500057

npdhavale@idrbt.ac.in

+91-40-23294061 / 8331823830





File No. 6-33/2017-IC-AppUseCaseLab
Government of India
Department of Telecommunications
International Cooperation Division

.....
12th Floor, Sanchar Bhawan, New Delhi
Dated the 30th June, 2020

SANCTION ORDER

Sanction of the competent Authority is hereby conveyed for release of an amount of Rs.1.05 Crore (Rupees one crore and five lakhs only) to 'Institute for Development and Research in Banking Technology (IDRBT)' towards advance release of 30% of amount from Rs.3.5 Crore earmarked for first year share of Department of Telecommunications for first phase project of 5G Use Case Lab in Banking and Financial Services.

2. The expenditure is debitible to the Head of Account 32750080006-Technology Development and Investment Promotion (Plan) Scheme 060020-Other Administrative Expenses and will be met from the sanctioned budget of Department of Telecommunications for the year 2020-21.
3. This issues with the concurrence of Member (F) vide their Dy. No.4242/M/(F)/19 dated 05.09.2019.



(Atique Ahmed)
Director (IC)

Copy to:

1. Pay & Accounts Officer, DoT, Sanchar Bhawan, New Delhi
2. Cash Section (2 copies), DoT with the request to transfer the above sanctioned amount of Rs.1.05 Crore (Rupees one crore and five lakhs only) to 'Institute for Development and Research in Banking Technology', AXIS BANK Account number 919010059413057, Type of the account (S.B., Current or Cash Credit) - Saving Bank with code (10/11/13), IFSC code No. UTIB0000426(MICR-500211012), Mehdipatnam Ring Road, H.No.13-6-431/D/82/4, A.M. Arcade Mehdipatnam Ring Road, Hyderabad-500 028.
3. Director, IDRBT, Hyderabad with the request to keep the released amount in a separate dedicated bank account for 5G Use Case Lab in Banking and Financial Services.
4. Director (Budget)/Director (Finance), DoT
5. Guard File.



Reprocess Failed Transactions

Cheque E-Payment DBT TSA

DDO 205155 - DDO, SO(Cash), New Delhi

CPSMS

TransactionId

S062001165583

Transaction Details

Action Number-Voucher

6-33/2017-IC- -

Action*: ReProcess Permanent Cancel

Number-Voucher Date:

Amount: 10500000.00

Favour*: Institute for development and Reseah in Banking

IFSCCode*: UTIB0000426

Account

919010059413057

Number*:

Forward To AAO

b/-

Re: Project on "5G Use Case Lab for Banking and Financial Services".

Subhrendu Chattopadhyay

Tue 09-08-2022 15:50

Sent Items

To:Rashmi Dev S <srdev@idrbt.ac.in>;

Cc:D. Janakiram <dram@idrbt.ac.in>; Sirisha RS <rsshirisha@idrbt.ac.in>; Sastry VN <vnsastry@idrbt.ac.in>; Abhishek Thakur <AbhishekT@idrbt.ac.in>;

Dear Sir,

It would be an honor and privilege for me to share the responsibilities with Prof. Shastri and Dr. Thakur. Therefore, I would like to sincerely thank you for giving me the opportunity.

From: Rashmi Dev S

Sent: 08 August 2022 10:51:08

To: Sastry VN; Abhishek Thakur; Subhrendu Chattopadhyay

Cc: D. Janakiram; Sirisha RS

Subject: Project on "5G Use Case Lab for Banking and Financial Services".

Dear Sir,

Please note that Dr. Subhrendu Chattopadhyay, Faculty, would be a Co-Investigator for the Project on "5G Use Case Lab for Banking and Financial Services".

This takes immediate effect.

Best Regards,

Dr. S. Rashmi Dev,

Assistant General Manager



Castle Hills, Road No.1,
Masab Tank, Hyderabad - 500 057